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Enabling and Understanding Failure of Engineering Structures Using the Technique of Cohesive Elements

H. Jiang

Xiaosheng Gao

University of Akron, main campus, xgao@uakron.edu

T. S. Srivatsan

University of Akron, Main Campus, tsrivatsan@uakron.edu

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For details please write to the Executive Editor, International Journal of Engineering Sciences and Management,
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Telephones:

Landline: 0120-2323851, 2323852, 2323854, 2323855
Mobile : 09312247845, 09910380107

Telefax:

0120-2323853

E-mail.:

advisor.r&d@gnoida.dronacharya.info
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We, at Dronacharya College of Engineering, Greater Noida, are highly excited to release the first issue of bi-annual Research Journal “International Journal of Engineering Sciences and Management”. We hope that you will benefit while going through the research papers contributed for journal by the authors from India and abroad.

We, at our College, use innovative instructional tools and strategies to catalyze excellence in teaching and research in engineering, science and humanities. Our aim is to transform raw students to graduates who are not only sought after by the reputed employers, they also contribute their role in the development of our society. Our College presents a commendable confluence of traditional and contemporary culture.

My heartfelt thanks to “Advisory” and “Editorial” Boards comprising of eminent persons in their respective areas for their guidance and support. I also thank our Management and Principal of our College for their support in the launching of Journal.

I want to mention that it would not have been possible to bring out excellence of the Journal without the contribution of eminent authors from India and abroad. We were highly pleased to receive a large number of quality research papers for the very first issue of our Journal. It was a difficult task for the Reviewers and the honorable members of the 'Editorial Board' to review the shortlist and accept papers for this issue. Our deepest gratitude goes to all those authors and further, we request and wish similar cooperation and contribution for the subsequent issues of Journal.

Wishing you a very exciting and thought-stimulating reading.

Sincerely,

Prof. (Dr.) Jai Paul Dudeja
Executive Editor

February 2011

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ENABLING & UNDERSTANDING FAILURE OF ENGINEERING STRUCTURES USING THE TECHNIQUE OF COHESIVE ELEMENTS

H. Jiang, X. Gao, and T. S. Srivatsan

e-mail: tssl@uakron.edu

Department of Mechanical Engineering, The University of Akron, Akron, Ohio 44325

ABSTRACT

In this paper, we describe a cohesive zone model for the prediction of failure of engineering solids and/or structures. A damage evolution law is incorporated into a three-dimensional, exponential cohesive law to account for material degradation under the influence of cyclic loading. This cohesive zone model is implemented in the finite element software ABAQUS through a user defined subroutine. The irreversibility of the cohesive zone model is first verified and subsequently applied for studying cyclic crack growth in specimens experiencing different modes of fracture and/or failure. The crack growth behavior to include both crack initiation and crack propagation becomes a natural outcome of the numerical simulation. Numerical examples suggest that the irreversible cohesive zone model can serve as an efficient tool to predict fatigue crack growth. Key issues such as crack path deviation, convergence and mesh dependency are also discussed.

Keywords: *engineering structures; fatigue and fracture; finite element analysis; cohesive element; damage accumulation; crack initiation, growth and branching*

1. INTRODUCTION

Failure under conditions of cyclic loading often involves a gradual loss in the strength of a material with the progressive accumulation of damage. Up until now the prediction of life of a material and/or structural component under conditions of cyclic loading often remained very much an empirical art. The most widely used method for the prediction of crack growth during cyclic loading was put forth by Paris and co-workers [1]. This method relates the crack growth rate under cyclic loading, or fatigue crack growth rate (FCGR), to the applied stress intensity factor range () through a power law relationship. Despite its widespread popularity and use for the calculation of crack growth under the influence of cyclic loading, the Paris law only attempts to describe the experimental data under restricted conditions, such as, (i) small scale yielding, (ii) constant amplitude loading, and (iii) long cracks. The Paris law loses its predictive ability when these requirements are not fully satisfied [2,3]. Although the Paris law, to even include its various modified forms, is widely adopted, it provides a useful data correction scheme, rather than a predictive capacity, primarily because the physics of crack growth under conditions of cyclic loading was not captured in the model [3,4].

The concept of cohesive zone, initially conceived by Dugdale [5] and subsequently reinforced by Barenblatt [6], Rice [7], and few others, attempted at considering the fracture event to be a gradual phenomenon during which the material separation process takes place between the two adjacent virtual surfaces across an extended crack tip (cohesive zone) and is resisted by the cohesive forces. In this approach, the continuum is characterized by two constitutive relations:

- (i) A volumetric constitutive model describing “bulk behavior” of the material;
- (ii) A cohesive surface constitutive relation between the traction and the displacement that characterizes the behavior of bond surfaces between the volumetric elements.

The Cohesive Zone Model, referred to henceforth through the text of this manuscript as CZM, removes crack tip singularity and represents the actual physics of the fracture process occurring at the atomic scale. The cohesive traction-separation law governs the constitutive behavior of crack opening in addition to bulk stress-strain relationships of the surrounding material. New crack surfaces are created as a natural result of constitutive evolution, thereby enabling to maintain conditions of continuity at the mathematical level despite the occurrence of physical separation at the atomic level. This new numerical approach has been successfully applied to study various simulations of interface failure and crack propagation, and has proven itself to be an effective tool [8-11].

Over the years, various forms of cohesive zone models have been proposed. In attempting to study crack growth under monotonic

loading, an exponential cohesive law was implemented and successfully applied for the purpose of three-dimensional crack growth simulation in thin fracture specimens [16, 22]. Under conditions of cyclic loading, the actual degradation of the material that occurs even under subcritical load must be considered for studying crack growth. Further, the accumulation of damage should be path-dependent. Needleman [12] adopted an internal variable to account for the path dependence of the decohesion process. Camacho and Ortiz [9] proposed an irreversible cohesive law to account for the observed weakening of the cohesive strength with an increase in crack opening. De-Andrés and co-workers [13] extended the formulation of the irreversible CZM to predict three-dimensional crack growth in aluminum shafts that were subject to cyclic loading along the axis. Roe and Siegmund [14] introduced a damage evolution law that accounted for the accumulated separation into the cohesive zone model and carried out a numerical study of crack growth at the interface during cyclic loading.

In this research study using the cohesive zone model (CZM), the damage evolution law put forth by Roe and Siegmund [14] was used and extended for the three-dimensional formulation of material degradation under the influence of cyclic loading. An irreversible CZM was obtained by incorporating the updated damage based on the constitutive relations into the exponential form cohesive law adopted previously by the authors for studying crack growth under monotonic loading [15]. A viscous regularization technique was incorporated in the formulation of constitutive relations to improve convergence of the numerical solution. The irreversible cohesive law was validated for the simulation of cyclic crack propagation under different modes of loading. Finally issues such as convergence, mesh dependency and crack path deviation are discussed.

2. IRREVERSIBLE COHESIVE ZONE MODEL

In order to simulate crack propagation under the influence of cyclic loading, a damage mechanism is introduced in the cohesive zone that accounts for the occurrence of gradual degradation of the material with the progressive accumulation of irreversible deformation. A gradual degradation of the properties of the material in the region immediately ahead of the crack tip under the influence of cyclic loading is well reflected in the process zone through degraded values of cohesive strength and stiffness. A damage variable, D ($0 \leq D \leq 1$) was defined with the purpose of quantitatively evaluating the extent of material degradation. A value of zero represents a material that is essentially intact while a value of one is representative of complete failure of the material. The cohesive traction depends on both the prevailing state of damage and the level of separation. The traction-separation equations are thus irreversible while being dependent on history.

2.1 THE CONCEPT OF THE COHESIVE ZONE MODEL Consider a quasi-static solid having cracked surfaces. Along the potential crack path a pair of virtual crack surfaces is assumed, which is subjected to a separating force that is referred to as cohesive traction. Based on the principle of virtual work, the equation for mechanical equilibrium considering the contribution of the cohesive tractions can be expressed as

$$\int_V \vec{s} : \delta \vec{F} dV - \int_{S_{int}} \vec{T}_{CZ} \cdot \delta \vec{\Delta} dS = \int_{S_{ext}} \vec{T}_{ext} \cdot \delta \vec{u} dS \quad (1)$$

where in this expression:

- (a) V is the specimen volume, S_{int} the internal (cohesive) surface, and S_{ext} represents the external surface;
- (b) \vec{s} is the nominal stress tensor $\vec{s} = F^{-1} \det(F) \sigma$ where \vec{F} is the deformation gradient and σ is the Cauchy stress;
- (c) \vec{T}_{CZ} the cohesive traction vector while \vec{T}_{ext} is the external traction vector;
- (d) \vec{u} is the displacement vector and $\vec{\Delta} = \vec{u}^+ - \vec{u}^-$ represents the displacement jump across two adjacent cohesive surfaces, which is referred to as the relative displacement vector, or the separation vector

The cohesive surface contributions are well described by the integration term over the internal surface

$\int_{S_{int}} \vec{T}_{CZ} \cdot \delta \vec{\Delta} dS$ Comparable to the deformation behavior of the bulk material that can be easily described with the **conventional stress-strain relationship**, the evolution of separation that occurs due to local **traction** at the crack tip can be defined using a **constitutive law for a special field** between the virtual crack surfaces. The cohesive traction and separation are work conjugate, just as stress and strain being strain energy conjugate

For isothermal conditions, based on the first and second laws of thermodynamics, the traction vector acting on the cohesive surfaces (\vec{T}_{CZ}) simplified as \vec{T} henceforth through this manuscript, can be derived using the interfacial potential $\phi(\vec{\Delta})$ [13]

$$\vec{T} = \frac{\partial \phi(\vec{\Delta})}{\partial \vec{\Delta}} \quad (2)$$

Here $\phi(\vec{\Delta})$ represents the free energy density function per unit undeformed area. By selecting a proper potential function(ϕ) the constitutive equation between the cohesive traction and relative separation can be formulated. Under 3-D configuration, both $\vec{\Delta}$ and \vec{T} have three components (normal, tangential and transverse). We adopt the following notation:

$$\vec{\Delta} = (\Delta u_n, \Delta u_{t1}, \Delta u_{t2}) \text{ and } \vec{T} = (T_n, T_{t1}, T_{t2})$$

where $\Delta u_n = \vec{\Delta} \cdot \vec{n}$; $\Delta u_{t1} = \vec{\Delta} \cdot \vec{t}_1$; $\Delta u_{t2} = \vec{\Delta} \cdot \vec{t}_2$; $T_n = \vec{T} \cdot \vec{n}$; $T_{t1} = \vec{T} \cdot \vec{t}_1$; $T_{t2} = \vec{T} \cdot \vec{t}_2$; \vec{n} , \vec{t}_1 and \vec{t}_2 are unit

vectors representing the normal, tangential and transverse directions respectively.

Different potential forms, divided between linear/bilinear, polynomial and exponential forms, have been adopted by the researchers in their independent studies. The present study chooses the computationally convenient exponential form of the free energy density potential

$$\phi(\vec{\Delta}) = \sigma_{\max,0} e \delta_0 \left(1.0 + \frac{\Delta u_n}{\delta_0} \right) \exp\left(-\frac{\Delta u_n}{\delta_0}\right) \left[(1.0 - q) + q \exp\left(-\frac{\Delta u_{t1}^2 + \Delta u_{t2}^2}{\delta_0^2}\right) \right] \quad (3)$$

where $\sigma_{\max,0}$ is the initial normal cohesive strength under monotonic loading δ_0 is the characteristic cohesive length, i.e. the material separation required to achieve the normal cohesive strength q is the ratio between the normal cohesive energy Γ_n and shear cohesive energy Γ_t . The cohesive energy is the energy needed to fail the cohesive zone and to concurrently create a unit area of new free surface. With the assumption of transverse isotropy, the same shear cohesive energy for both the tangential and transverse directions are used: $\Gamma_{t1} = \Gamma_{t2} = \Gamma_t$ and $q = \Gamma_t / \Gamma_n$

2.2 THE MONOTONIC TRACTION-SEPARATION RELATIONS In this section we consider the monotonic loading situation with no degradation in the cohesive strength to be accounted for. The cohesive traction components can be computed from derivatives of the potential function and are expressed as follows:

$$T_n = \frac{\partial \phi}{\partial \Delta u_n}, \quad T_{t1} = \frac{\partial \phi}{\partial \Delta u_{t1}}, \quad T_{t2} = \frac{\partial \phi}{\partial \Delta u_{t2}}$$

Taking into consideration the free energy density potential, we now have the separation law for cohesive traction for the case of monotonic loading

$$\begin{aligned} T_n &= \sigma_{\max,0} \Delta u \exp(1 - \Delta u) \left\{ (1 - q) + q \exp(-\Delta v_1^2 - \Delta v_2^2) \right\} \\ T_{t1} &= 2q\sigma_{\max,0} (1 + \Delta u) \Delta v_1 \exp(1 - \Delta u) \exp(-\Delta v_1^2 - \Delta v_2^2) \\ T_{t2} &= 2q\sigma_{\max,0} (1 + \Delta u) \Delta v_2 \exp(1 - \Delta u) \exp(-\Delta v_1^2 - \Delta v_2^2) \end{aligned} \quad (4)$$

where Δu , Δv_1 and Δv_2 are the normalized normal, tangential and transverse separation components respectively

$$\Delta u = \frac{\Delta u_n}{\delta_0}, \quad \Delta v_1 = \frac{\Delta u_{t1}}{\delta_0}, \quad \Delta v_2 = \frac{\Delta u_{t2}}{\delta_0}.$$

The features of the traction-separation constitutive equations defined for both the pure normal condition and pure shear condition are illustrated in the normalized form in Figure 1. The traction values are normalized with respect to the corresponding cohesive strength $\sigma_{\max,0}$ (normal cohesive strength) or $\tau_{i\max,0}$ (shear cohesive strength $i=1,2$ for the tangential and transverse directions respectively), and the separation values are normalized with respect to the characteristic cohesive length (δ_0). As shown in **Figure 1**, the cohesive traction increases monotonically with increasing separation prior to the characteristic separation at which point the cohesive strength ($\sigma_{\max,0}$ or $\tau_{i\max,0}$) is achieved. For the case of pure normal loading the characteristic separation is δ_0 and for the case of pure shear (tangential and transverse) loading this separation value equals $\sqrt{2}\delta_0/2$. Subsequently, the traction value decreases with increasing separation and approaches to zero eventually.

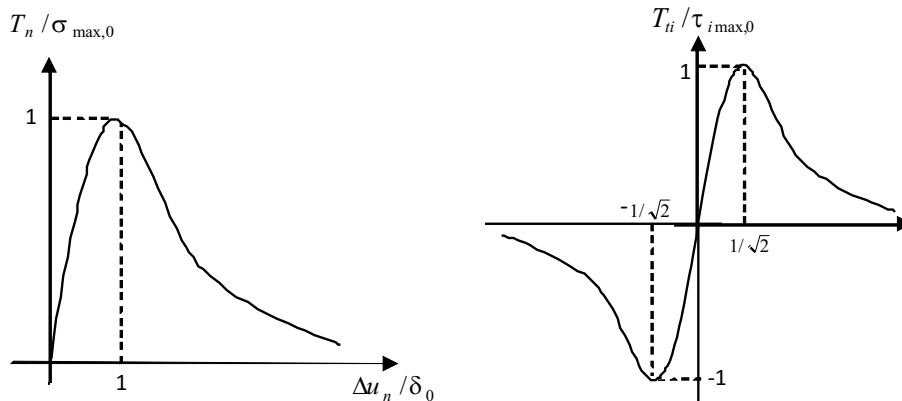


Figure 1. Monotonic traction-separation relation under (a) pure normal, and (b) Pure shear (tangential: $i = 1$; transverse: $i = 2$) loading.

The cohesive strength is taken to be the peak value of the cohesive traction. Further, it represents the maximum resistance offered by the material to crack opening under pure loading modes ($\sigma_{\max,0}$ for normal and $\tau_{i\max,0}$ for shear). Assuming the existence of in-plane isotropy, the initial shear cohesive strength under conditions of pure shear can be defined from the constitutive laws as

$$\tau_{1\max,0} = \tau_{2\max,0} = \sqrt{2eq}\sigma_{\max,0}$$

In this expression q is the ratio of the shear cohesive energy (Γ_t) to the normal cohesive energy (Γ_n).

The cohesive energy, or work of separation, per unit area, of the cohesive surface, is defined as

$$\Gamma = \int_0^\infty T d\Delta \quad (5)$$

It is represented by the area enclosed under the traction-separation curve. With the exponential constitutive law given by Equation (3), the critical cohesive energy for: (a) pure normal loading, and for (b) pure shear loading are as follows:

$$\begin{aligned} \Gamma_n &= e\sigma_{\max,0}\delta_0 \\ \Gamma_{ti} &= eq\sigma_{\max,0}\delta_0 = \sqrt{\frac{e}{2}}\tau_{i\max,0}\delta_0 \quad (i = 1, 2) \end{aligned}$$

2.3 DAMAGE EVOLUTION The evolution of damage takes into consideration the following three factors: Damage should not begin to accumulate until the accumulated separation is greater than the critical distance (δ_0)

- (i) The increment of damage is based on the increment of separation;
- (ii) There should be an endurance limit for damage accumulation based on the level of traction below which cyclic loading can proceed without causing failure.

Therefore, a damage variable (D) is introduced into the monotonic constitutive relations. In this context it is defined as the ratio of the damaged cross-sectional area over the initial cross-sectional area. With the essential factors of damage accumulation being considered, a nonlinear damage evolution law was put forth by Roe and Siegmund [14]. The rate of damage under conditions of cyclic loading (\dot{D}_c) is defined as

$$\dot{D}_c = \frac{\Delta \dot{\bar{u}}}{4\delta_0} \left[\frac{\bar{T}}{\sigma_{\max}} - C_f \right] H(\Delta \bar{u}_{tot} - \delta_0), \quad \text{and} \quad \dot{D}_c \geq 0 \quad (6)$$

The rate of damage under conditions of cyclic loading (\dot{D}_c) is defined as

$$\dot{D}_c = \frac{\Delta \dot{\bar{u}}}{4\delta_0} \left[\frac{\bar{T}}{\sigma_{\max}} - C_f \right] H(\Delta \bar{u}_{tot} - \delta_0), \quad \text{and} \quad \dot{D}_c \geq 0 \quad (6)$$

Therefore, the current amount of damage due to cyclic loading is

$$D_c = \int_t \dot{D}_c dt \quad (7)$$

where (a) $\bar{T} = \sqrt{T_n^2 + (T_n^2 + T_n^2)/(2eq^2)}$ is the effective traction;

(b) $\Delta \bar{u} = \sqrt{\Delta u_n^2 + (\Delta u_{t1}^2 + \Delta u_{t2}^2)/(2eq^2)}$ is the effective separation for 3-D situations;

(c) $\Delta \bar{u}_{tot} = \sum_t |\Delta \bar{u}|$ is the current extent of accumulated separation

The cohesive strength is σ_{\max} while the characteristic cohesive length is δ_0 . With the Heaviside step function $H(\Delta \bar{u}_{tot} - \delta_0)$ involved, the damage variable will not start to evolve until the instant the prevailing amount of accumulated separation is greater than δ_0 . The irreversibility of damage accumulation is ensured as $\dot{D}_c \geq 0$

The fatigue limit coefficient (C_f), is defined to be the ratio of uniaxial fatigue limit for a zero mean stress fatigue test (σ_f) and the initial cohesive strength of the material ($\sigma_{\max,0}$)

$$C_f = \frac{\sigma_f}{\sigma_{\max,0}} \quad (8)$$

A value of $C_f = 0.25$ is used in the present study. This coefficient ensures the existence of an endurance limit under conditions of cyclic loading.

Another concept to be considered is material damage that occurs under conditions of monotonic loading. Under monotonic loading, all of the energy dissipative events, such as dislocation pile-ups, occurring at the microscopic level are basically driven in one direction. In order to account for failure of the material under the direct influence of monotonic loading, a damage mechanism for the case of monotonic loading is proposed. The amount of damage due to monotonic loading is defined as

$$D_m = \frac{\Delta \bar{u}_{\max} - \delta_0}{4\delta_0} H(\Delta \bar{u}_{\max} - \delta_0) \quad (9)$$

The greater value of the two damage mechanisms is stored as the prevailing state of damage

$$D = \max(D_c, D_m), \quad 0 \leq D \leq 1 \quad (10)$$

Under the influence of cyclic loading, damage gets accumulated during repeated plastic deformation. When the damage variable reaches the limit value of 1, the material is considered to have failed at the current point. The constitutive equations of the traction-separation relation should now be modified using the incorporated damage evolution mechanism. The cohesive strengths (i.e., (i) normal cohesive strength, (ii) tangential cohesive strength, and (iii) transverse cohesive strength) degrade with an increase in the accumulation of damage.

$$\sigma_{\max} = \sigma_{\max,0} (1 - D), \quad \tau_{1\max} = \tau_{1\max,0} (1 - D), \quad \tau_{2\max} = \tau_{2\max,0} (1 - D) \quad (11)$$

where $\sigma_{\max,0}, \tau_{1\max,0}, \tau_{2\max,0}$ represent the initial cohesive strengths for $D = 0$ and $\sigma_{\max}, \tau_{1\max}, \tau_{2\max}$ are the strengths corresponding to the prevailing level of damage. The strength term ($\sigma_{\max,0}$) in Equation (4) is replaced with the prevailing strength (σ_{\max}) to account for degradation of the cohesive strengths in a three-dimensional (3-D) situation. The constitutive law updated with the degraded cohesive strength is as follows

$$\begin{aligned} T_n &= \sigma_{\max} \Delta u \exp(1 - \Delta u) \left\{ 1 - q + q \exp(-\Delta v_1^2 - \Delta v_2^2) \right\} \\ T_{t1} &= 2q\sigma_{\max} (1 + \Delta u) \Delta v_1 \exp(1 - \Delta u) \exp(-\Delta v_1^2 - \Delta v_2^2) \\ T_{t2} &= 2q\sigma_{\max} (1 + \Delta u) \Delta v_2 \exp(1 - \Delta u) \exp(-\Delta v_1^2 - \Delta v_2^2) \end{aligned} \quad (12)$$

2.4 DISTINCT UNLOADING/RELOADING PATHS With damage accumulation occurring during each increment of subcritical loading, the material behaves in a way that is dependent on its history. The prior loading history determines the prevailing amount of damage, which will not be recovered upon further unloading and reloading. To properly describe crack propagation under the influence of cyclic loading, the paths followed by unloading and reloading must be considered for the irreversible cohesive zone model.

The unloading is prescribed to be directed back to the origin of the traction-separation space, the same as for the case of monotonic loading. The traction components during unloading are calculated as follows:

$$\begin{aligned} T_n &= \Delta u_n * k_{n,0} & T_{t1} &= \Delta u_{t1} * k_{t1,0} & T_{t2} &= \Delta u_{t2} * k_{t2,0} \end{aligned} \quad (13)$$

with (a) $k_{n,0} = T_{n,\max} / \Delta u_{n,\max}$, $k_{t1,0} = T_{t1,\max} / \Delta u_{t1,\max}$, $k_{t2,0} = T_{t2,\max} / \Delta u_{t2,\max}$ being the constant unloading stiffness;

(b) $\Delta u_{n,\max}$, $\Delta u_{t1,\max}$ and $\Delta u_{t2,\max}$ are values of the normal, tangential and transverse separation components at the point of initiation of unloading;

(c) $T_{n,\max}$, $T_{t1,\max}$ and $T_{t2,\max}$ are the normal, tangential and transverse traction components corresponding to the maximum separation components in (b).

For the case of reloading, the traction-separation path turns out to be quite different than for the case of monotonic loading. Since the prevailing cohesive strength of the material depends on the existing accumulation of damage, new values of strength have to be calculated based on the newly accumulated separation

$$T_n = \Delta u_n * k_n \quad T_{t1} = \Delta u_{t1} * k_{t1} \quad T_{t2} = \Delta u_{t2} * k_{t2} \quad (14)$$

with $k_n = (1-D)k_{n,0}$, $k_{t1} = (1-D)k_{t1,0}$, $k_{t2} = (1-D)k_{t2,0}$ being the current stiffness under reloading. While reloading continues, more damage is progressively accumulated at the microscopic level. This causes the reloading stiffness to degrade, and is as shown in **Figure 2**. The entire loading sequence is irreversible and history dependent.

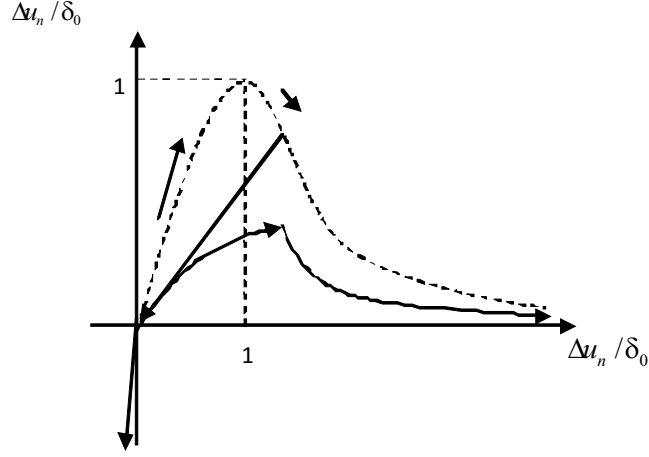


Figure 2. Illustration for unloading and reloading with damage

2.5 VISCOUS REGULARIZATION Material models that exhibit a softening behavior coupled with stiffness degradation often lead to difficulties in convergence in implicit finite element analysis. The cohesive zone model implemented exhibits distinctive material softening after a characteristic separation distance is reached and practical applications using the finite element software packages, such as, ABAQUS/STANDARD, often come up with problems related to convergence. A common technique to overcome some of the difficulties associated with convergence is the use of viscous regularization of the constitutive equations. The traction-separation laws can be regularized using viscosity by permitting the stresses to be outside the limits set by the traction-separation law. This causes the tangent stiffness matrix of the material that is experiencing softening to be positive for small increments of time.

The regularization process involves the use of a viscous stiffness degradation variable (D_v), which is defined by the evolution equation

$$\dot{D}_v = \frac{1}{\mu} (D - D_v) = \frac{dD_v}{dt} \quad (15)$$

In this equation: (a) μ is the viscosity parameter that represents the relaxation time of the viscous system, and (b) D is the damage variable evaluated in the current cohesive zone model.

For the purpose of incremental finite element calculations, the degradation of the viscous stiffness variable is calculated as

$$D_v(t+dt) = \frac{(D_v(t) + \frac{dt}{\mu} D(t+dt))}{(1 + \frac{dt}{\mu})} \quad (16)$$

In this expression $D \in [0,1]$, $D_v \in [0,1]$ and $D_v < D$.

When this viscous regularization technique is used, the damage term in Equation (11) is replaced with the current viscous stiffness variable (D_v), and the constitutive equations are updated with the variable D_v . For a small value of the viscosity parameter, viscous regularization helps in improving the rate of convergence without compromising on the results. A value of $\mu = 10^{-5}$ was used in this study and provides reliable results.

3. NUMERICAL IMPLEMENTATION AND APPLICATION

3.1 VERIFICATION OF THE IRREVERSIBLE COHESIVE ZONE MODEL The irreversible Cohesive Zone Model was implemented into a commercial finite element software ABAQUS [21] via a user defined subroutine. The general features of the irreversible model were tested using a simple, one-element model for purpose of verification. Consider a cohesive element having square top surface and a square bottom surface. The nodes on the square bottom surface are fixed. A cyclic force/displacement is imposed in the normal direction or in the shear/transverse direction. For the case of pure normal or pure shear/transverse loading acting on the nodes of the top-surface, the two other degrees-of-freedom (DOFs) are kept constrained

The cyclic traction-separation response of the cohesive element under constant amplitude cyclic loading is as shown in **Figure 3** and **Figure 4**. Under load-controlled loading is **Figure 3** and under displacement-controlled loading is **Figure 4**. For both the pure normal loading condition and pure shear/transverse loading condition, a gradual accumulation of damage due to cyclic loading progressively degrades the cohesive strength. This is reflected in a continuous reduction of the stiffness of the unloading/reloading path. As the traction value and unloading/reloading stiffness decrease, the cohesive zone finally loses its load carrying capacity and failure of the material occurs.

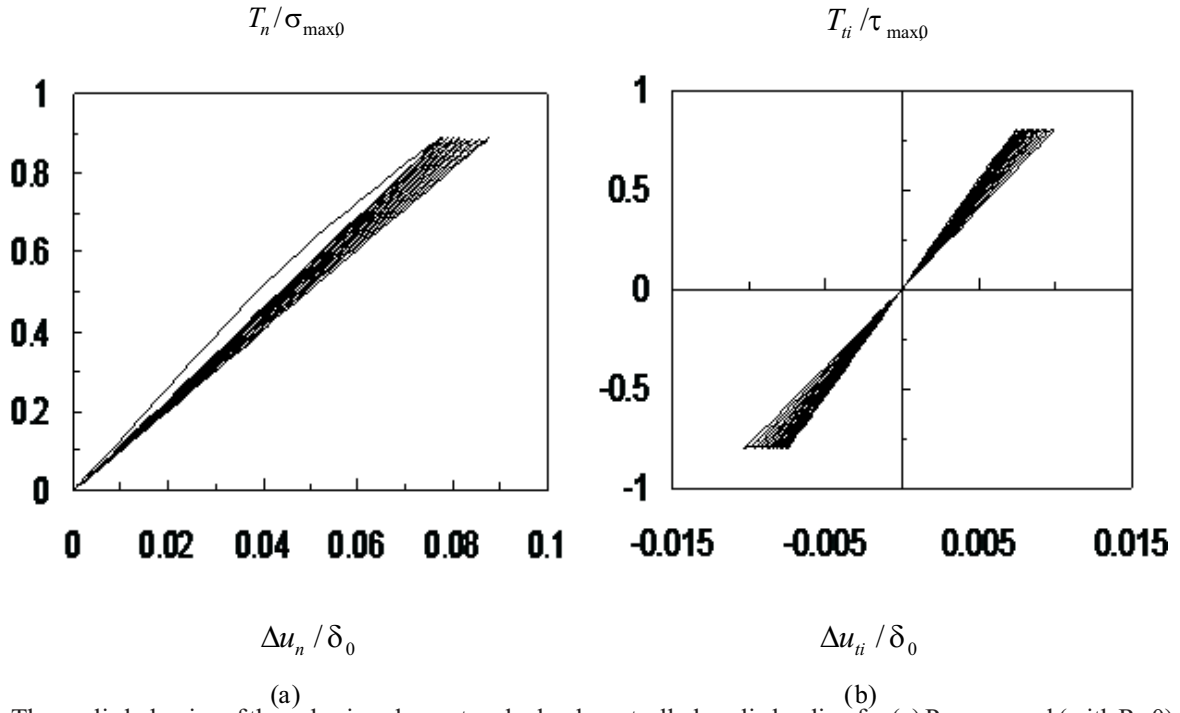


Figure 3. The cyclic behavior of the cohesive element under load-controlled cyclic loading for (a) Pure normal (with R=0), and (b) Pure shear/transverse (with R=-1).

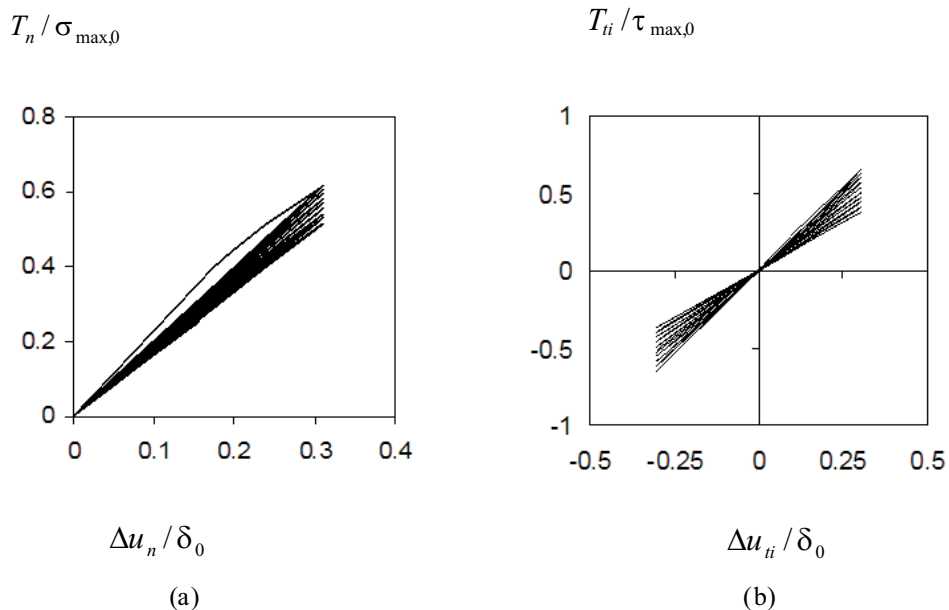


Figure 4. The cyclic behavior of the cohesive element under displacement-controlled cyclic loading for (a) Pure normal (with R=0), and (b) Pure shear/transverse (with R=-1).

3.2 VALIDATION WITH FATIGUE CRACK SIMULATION UNDER DIFFERENT LOADING MODES In this section, the irreversible cohesive zone model is applied to simulate crack growth behavior under conditions of: (i) Mode I cyclic loading, (ii) Mode II cyclic loading, and (iii) Mixed Mode cyclic loading. A Double-Cantilever Beam (DCB) specimen is studied for Mode I cyclic loading, an End-Loaded Split (ELS) specimen is studied for Mode II cyclic loading, and a Mixed-Mode Bending (MMB) specimen is studied for the mixed mode cyclic loading. The finite element simulations drew heavily on the work of Roe and Siegmund [14]. A schematic of the specimen geometries and the simplified loadings are as shown in **Figure 5**. The modeling thickness (B) for all the two-dimensional specimens was taken to be 25.4 mm.

The background material was assumed to be elastic having a Young's Modulus (E) of 70,000 MPa, and a Poisson's ratio (ν) of 0.33. The calibrated cohesive parameters of $\sigma_{\max,0} = 6.66 \text{ MPa}$, $\delta_0 = 0.203 \text{ mm}$ were used, yielding a cohesive energy value of $\Gamma_c = 3.675 \text{ kJ/m}^2$. The parameters are representative of a high-density polyethylene adhesive. In an earlier publication Roe and Siegmund [14] analyzed these specimens. For the following simulations, it is assumed that $\tau_{i\max,0} = \sigma_{\max,0}$ corresponding to $q = 1/\sqrt{2} \approx 0.4289$. The models were simulated for different ratios of the energy release rate with respect to cohesive energy. For all of the specimens chosen for this crack simulation study, the cyclic loading was applied using a load ratio (R = minimum load/maximum load) of 0.

For the DCB specimen, the applied Mode I load range (ΔP) was calculated from the given values of energy release rate range in conformance with the ASTM expression

$$\Delta G_{DCB} = \frac{12(\Delta P)^2 a^2}{B^2 h^3 E} \quad (17)$$

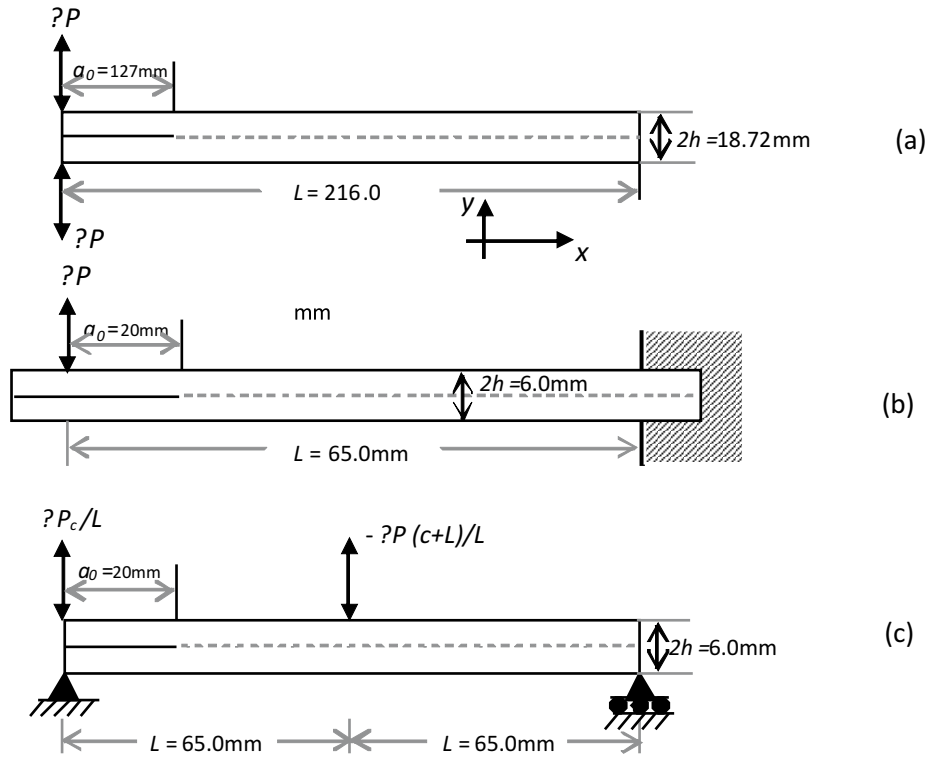
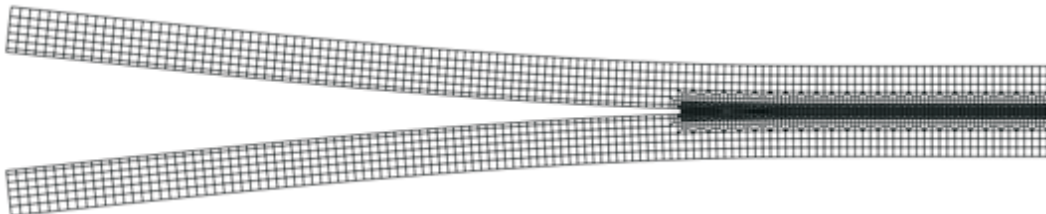


Figure 5. The dimensions and simplified loading of the specimens: (a) Double-Cantilever Beam (DCB), (b) End-loaded Split (ELS), and (c) Mixed-Mode Bending (MMB)

The cohesive elements having an initial zero thickness were placed along the symmetry line of the DCB model from the initial tip of the crack to the free end of the specimen. The deformed shape of the DCB specimen under Mode I cyclic loading is as shown in **Figure 6**. The resulting crack extension that occurs due to cyclic loading is plotted against the number of load cycles (N) for different values of the energy release rate range as shown in **Figure 7**. Stable growth of the fatigue crack was observed for the varying load ranges. The Mode I test specimen experiences static failure when $\Delta G = \phi_{n,0}$



crack tip detail

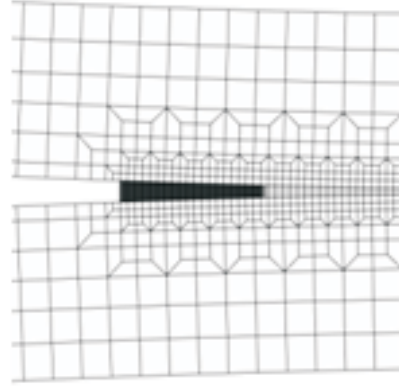


Figure 6. Deformed Double-Cantilever Beam (DCB) specimen and details at the crack tip

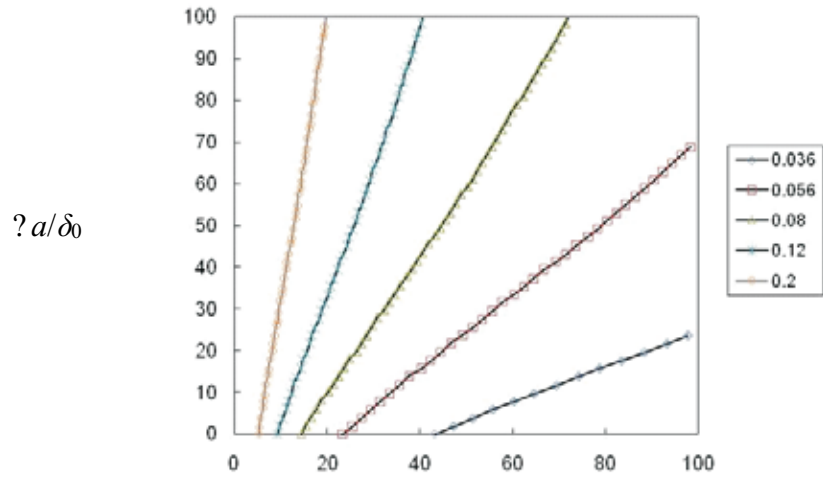


Figure 7. Fatigue crack extension vs. loading cycles for different values of normalized energy release rate range $(\Delta G / \phi_{n,0})$ for the double cantilever beam (DCB) specimen

A linear relationship was observed, on a log-log scale, for the variation of cyclic crack growth rate with energy release rate range. This fits a power law relationship and is as shown in **Figure 11**. The mathematical expression that is representative of the observed trend can be written as

$$\frac{d(a/\delta_0)}{dN} = C \left(\frac{\Delta G}{\phi_{n,0}} \right)^m \quad (18)$$

with $m = 1.6638$ and $C = 114.8947$.

For the Mode II end-loaded split (ELS) specimen, the applied load range (ΔP) was calculated using the following expression

$$\Delta G_{ELS} = \frac{9(\Delta P)^2 a^2}{4B^2 h^3 E} \quad (19)$$

The crack was constrained to grow along the centerline of the ELS specimen. It is worth noting that there is an extended length at either ends of the specimen, in order to eliminate possible end effects while concurrently ensuring proper application of the load at the crack tip. The built-in end on the right extended 10.0 mm from the uncracked end of the beam and was pinned on the boundary. The cracked end on the left also extended 10.0 mm beyond the loading point to ensure appropriate application of the load.

The deformed shape of the ELS specimen under the influence of Mode I cyclic loading is shown in **Figure 8**. The variation of the resulting extension of the crack with number of load cycles (N) for different values of the energy release rate range is shown in **Figure 9**. Essentially stable fatigue crack growth was observed for the varying load ranges.

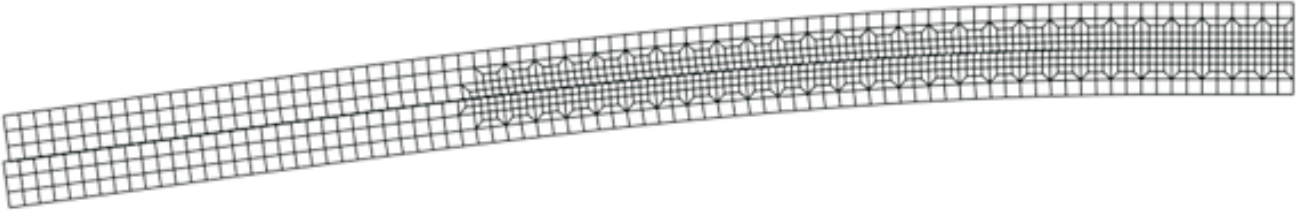


Figure 8. Deformed end-loaded split (ELS) test specimen

A linear relationship also exists on a log-log scale between the cyclic crack growth rate and the energy release rate range. The same power law form given by Equation (18) was found to be representative of the results, with $m = 1.663$ and $C = 2266.731$.

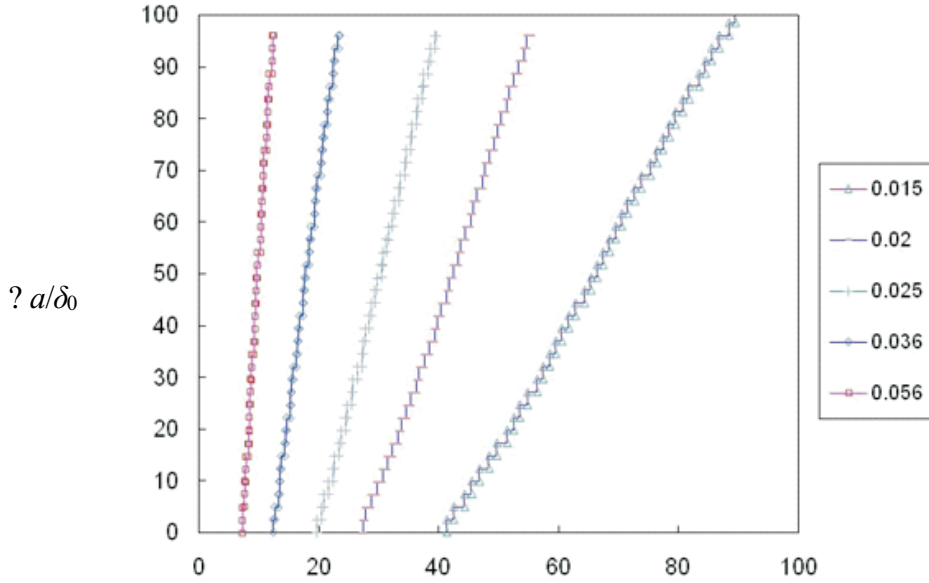


Figure 9. Fatigue crack extension versus number of load cycles for different values of the energy release rate range ($\Delta G / \phi_{n,0}$) for the ELS specimen

The mixed-mode bending (MMB) specimen can be understood to be essentially a linear superposition of the double-cantilever beam (DCB) specimen and an end-notched flexure (ENF) specimen. The energy release rate range for a MMB specimen considers contributions from both Mode I and Mode II, such that $\Delta G_{MMB} = \Delta G_I + \Delta G_{II}$. The contributions from Mode I and Mode II are expressed as follows:

$$\Delta G_I = \frac{12a^2}{B^2h^3E} \left[\left(\frac{3c-L}{4L} \right) \Delta P \right]^2; \quad \Delta G_{II} = \frac{9a^2}{16B^2h^3E} \left[\left(\frac{c+L}{L} \right) \Delta P \right]^2 \quad (20)$$

Propagation of the crack was constrained to be along the centerline of the specimen by defining cohesive elements at the potential crack path. Experimental loading is set-up through a lever arm of length $(c + L)$ mounted above the beam. The lever applies a load of $(\frac{Pc}{L})$ along the positive 'y' direction at the cracked end of the specimen, and as a load of $P(\frac{c+L}{L})$ in the negative 'y' direction at half-span length of the beam. The mode mixity (ψ_{MMB}) of the MMB specimen is dependent on: (i) length of the specimen, and (ii) length of the lever arm.

$$\psi_{MMB} = \tan^{-1} \left[\frac{3}{4} \left(\frac{c+L}{3c-L} \right)^2 \right]$$

By adjusting the length of the lever arm (c) the mode-mixity can be changed. The length of the lever arm was taken to be $c = 56.838$ mm, such that $\Delta G_I = \Delta G_{II}$ and ψ_{MMB} . The specimen was restricted by a pin boundary condition at the lower corner of the loaded, pre-cracked end. A horizontal roller boundary condition restricts the lower corner of the opposite end.

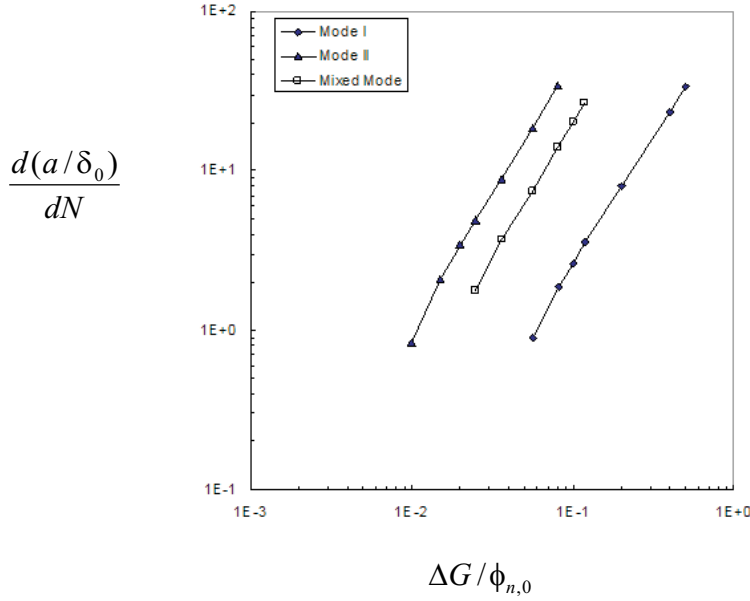
The deformed shape of the mixed-mode bend (MMB) specimen is as shown in **Figure 10**. Cyclic crack extension is plotted

against the number of load cycles (N) for different values of the energy release rate range. The numerical results were fitted to the power law expressed by Equation (18) with $m = 1.7337$, and $C = 1112.49995$.



Figure 10. The deformed Mixed Mode Bend specimen

The cohesive zone model (CZM) numerical results for crack growth under cyclic loading were plotted for the different specimens and are as shown in **Figure 11**. The fatigue threshold can be calculated according to the endurance limit [14]. The results shown here are in agreement with those presented in [14], which validates our numerical implementation and demonstrates the capability of the numerical model for predicting fatigue crack propagation



4. DISCUSSIONS: CRACK PATH DEVIATION AND FUTURE WORK

Most applications of the Cohesive Zone Model have been restricted to the condition where the crack path or the failure interface is predefined. In reality, crack propagation does not often follow a predefined line or plane. Due to the complex loading modes and specimen/component geometries, the crack path is most of the time unknown until such time when failure has occurred. In this section, research studies on crack path deviation is presented and briefly discussed for continuing exploration. The crack path is not restricted to a straight line or plane. Instead, possible crack path is enabled by putting cohesive elements along every element boundary. Although this does not ensure a strict 'free' crack path, both deviation and bifurcation of the crack during propagation and the effect of the finite element discretization are discussed.

4.1 CRACK PATH STUDY The small-scale yielding, boundary layer model [23] is often used in parametric studies of crack problems. **Figure 12** shows the finite element mesh of the small scale yielding model, where the outer radius of the domain is large enough such that the crack tip plastic zone is limited to a small fraction of the domain. Cohesive elements are placed between every two of the solid elements. This allows for the cracks to propagate along the inter-element boundaries driven by the distribution of local stress. Numerical solutions are generated by imposing displacements of the elastic, Mode I singular field on the outer circular boundary which encloses the crack.

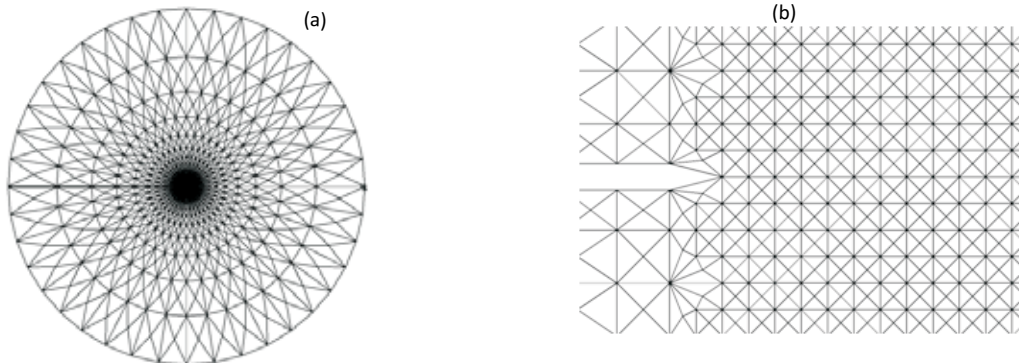


Figure 12. (a) Finite element mesh of the small scale yielding model; (b) Close-up of the initial crack tip region.

The simulations were first carried out using the previously implemented CZM in ABAQUS/STANDARD. Properties of the bulk material are chosen to represent an aluminum alloy 7075-T651 and the cohesive zone parameters calibrated for this material in [24] are employed here. A plot of the crack tip where one cohesive element at the point of complete damage under Mode I loading (a dark colored cohesive element is representative at the point of complete failure) is shown in **Figure 13 (a)**. The crack was supposed to evolve along the centerline. The stress contour and opening of the cohesive elements imply this trend. However, problems related to convergence prohibited further or continuing propagation of the crack. Considering the relatively versatile features of explicit finite element method, the cohesive zone model (CZM) was implemented into VUMAT and used with ABAQUS/EXPLICIT. Crack propagation was simulated without appreciable numerical difficulty. The crack path having a number of damaged cohesive elements is as shown in **Figure 12 (b)**. The crack tip from the explicit analysis is also shown in the figure

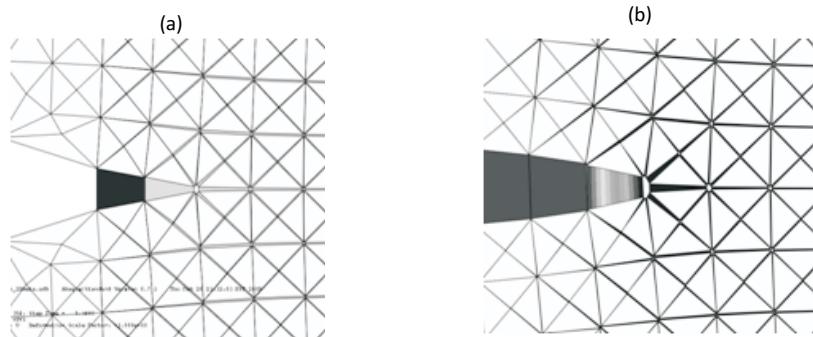


Figure 13. (a) FEA crack growth prediction using ABAQUS/Standard; (b) FEA crack growth prediction using ABAQUS/Explicit

As some researchers have pointed out (e.g., Xu and Needleman [8], Scheider and Brocks [16]), the crack tends to usually advance in a zigzag fashion. Some micro-cracking having no connection with the main crack takes place even though properties of the material are uniform. This can be seen in **Figure 14**. A small physical/numerical disturbance can lead to an asymmetric mode of crack growth to a certain extent. In the next simulation, a small imperfection is placed at the crack tip region. The occurrence of crack branching due to the conjoint or independent influence of material imperfection and numerical instabilities is as shown in **Figure 15**.

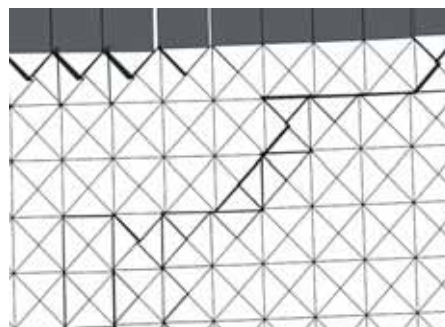


Figure 14. Local micro-cracking away from the main crack path

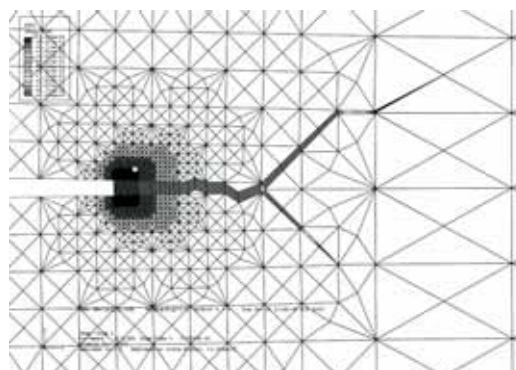


Figure 15. Crack bifurcation/branching caused by a small imperfection

Other models were built and analyzed using the CZM in ABAQUS/EXPLICIT and crack path deviation was witnessed along with promising results. A quantitative report requires additional further investigation, which will be conducted and presented in the future.

4.2 MESH DEPENDENCY Mesh dependency of the crack propagation path was first observed by Xu and Needleman [8] during their studies of arbitrary crack growth in essentially brittle, i.e., elastically deforming, materials. The predicted crack paths were found to be sensitive to the orientation of the triangular elements in the finite element discretization. This issue was also shown by Scheider and Brocks [16]. In a conventional finite element mesh, the possible path taken by the crack is limited by the topology of the finite element discretization. Material failure can only occur along the edges of the element. The aspect ratio of

the continuum element has to be simulated, Scheider and Brocks [16].

To solve this problem, an irregular mesh (Scheider and Brocks [16]), and a highly refined mesh (Xu et al. [8]; Arias et al. [17]) were employed. A most promising method would be adaptive meshing (Pandolfi et al. [18]; Nguyen et al. [19]; Yang and Xu [20]), in which the cohesive surfaces are only inserted as driven by critical crack tip loading.

4.3 NUMERICAL ISSUES Simulation of failure of the interface and crack propagation using the CZM often encounters numerical difficulties associated with sources of nonlinearities to include the constitutive laws governing softening. Problems related to convergence have been discussed for a long time. Even though specific numerical strategies have emerged in trying to deal with the problem, the method of viscous regularization is still an active research field and continues to demand more investigation.

As a viable alternative, the explicit approach was sometimes adopted for the many benefits it offers. However, since there is no equilibrium check in the explicit method, the computational accuracy cannot always be ensured and stability is conditional. Stability of the simulation can be checked by monitoring the system energy. This implies that the value of the kinetic energy should not exceed a small fraction (typically less than 10%) of the value of the strain energy. Also, the size of time increment has to be sufficiently small (less than the stability limit) in order to ensure accuracy.

Future work needs to look into the numerical problems while providing careful considerations for the case of individual modeling. This is essential for three-dimensional simulations where the computational burden increases significantly. Local constraint influences, mixed mode loading and normal/shear coupling also deserve further investigation.

5. CONCLUSION

A cohesive zone model which can be used to predict failure of engineering solids and/or structures is presented in this paper, where a damage-updated irreversible cohesive law was formulated for the simulation of crack growth under cyclic loading. Degradation of the material of interest was quantitatively described using a damage variable D ($0 \leq D \leq 1$). The prevailing cohesive tractions are determined by: (a) the current amount of damage, and (b) the current separation distance, leading to a history dependent feature of the constitutive laws. Verification with load-controlled cyclic loading and displacement-controlled cyclic loading effectively revealed noticeable deterioration of the chosen material with a gradual accumulation of damage. The irreversible cohesive law was validated for the simulation of cyclic crack propagation under different modes of loading. The simulation results captured the essential features of crack growth during cyclic loading and stable crack growth was fitted to the form of Paris Law. Finally issues such as convergence, mesh dependency and crack path deviation are discussed and future work to advance this numerical technique is suggested.

REFERENCES

1. Paris, P. & Erdogan, F.A. Critical analysis of crack propagation laws, *Journal of Basic Engineering*, 85, 1963, p.528–534.
2. Klesnil, M. & Lukas, P. Influence of strength and stress history on growth and stabilization of fatigue cracks, *Engineering Fracture Mechanics*, 4, 1972, p.77–92.
3. Suresh, S. *Fatigue of Materials*, 2nd Edition, Cambridge University Press, Cambridge, UK, 1998.
4. Bailon, J.P. & Antolovich, S.D. Effect of microstructure on fatigue crack propagation: a review of existing models and suggestions for further research. ASTM STP 811 (Lankford, D.L. Davidson, W.L. Morris and R.P. Wie, Editors), American Society for Testing and Materials, Philadelphia, PA, 1983, p.313–349.
5. Dugdale, D.S. Yielding of steel sheets containing slits, *Journal of the Mechanics and Physics of Solids*, 8, 1960, p.100–104.
6. Barrenblatt, G.I. The mathematical theory of equilibrium of cracks in brittle Fracture. *Advances in Applied Mechanics*, 7, 1962, p.55–129.
7. Rice, J.R. Mathematical analysis in the mechanics of fracture, *Fracture - An Advanced Treatise*, vol. 2 (edited by H. Liebowitz), Academic Press, New York, London, 1968, p.191–311.
8. Xu, X. & Needleman, A. Numerical simulations of fast crack growth in brittle solids, *Journal of the Mechanics and Physics of Solids*, 42, 1994, p.1397–1434.
9. Camacho, G. & Ortiz, M. Computational modeling of impact damage in brittle materials, *International Journal of Solids and Structures*, 33, 1996, p.2899–2938.
10. Roychowdhury, S.; Roy, Y.A. & Dodds, R.H. Ductile tearing in thin aluminum panels: experiments and analyses using large-displacement, 3-D surface cohesive elements, *Engineering Fracture Mechanics*, 69, 2002, p.983–1002.
11. Li, W. & Siegmund, T. An Analysis of Crack Growth in Thin Sheet Metal via a Cohesive Zone Model, *Engineering Fracture Mechanics*, 69, 2002, p.2073–2093.
12. Needleman, A. Micromechanical modeling of interfacial decohesion, *Ultramicroscopy*, 40, 1992, p.203–214.
13. De-Andres, A.; Perez, J.L. & Ortiz, M. Elastoplastic finite element analysis of three dimensional fatigue crack growth in aluminum shafts subjected to axial loading, *International Journal of solids and structures*, 36, 1999, p.2231–2258.
14. Roe, K.L. & Siegmund, T. An irreversible cohesive zone model for interface fatigue crack growth simulation, *Engineering Fracture Mechanics*, 70, 2003, p.209–232.

15. Jiang, H.; Gao, X. & Srivatsan, T.S. A cohesive zone model for studying crack growth in materials under the influence of monotonic loading, *Neural, Parallel & Scientific Computations*, 18, 2010, p.291-306.
16. Scheider, I. & Brocks, W. Simulation of Cup–Cone Fracture Using the Cohesive Model, *Engineering Fracture Mechanics*, 70, 2003, p.1943–1961.
17. Arias, I. Numerical modelling and experimental validation of dynamic fracture events along weak planes, *Computer Methods in Applied Mechanics and Engineering*, 196, 2007, p.3833–3840.
18. Pandolfi, A.; Guduru, P.R.; Ortiz, M. & Rosakis, A.J. Three Dimensional Cohesive-Element Analysis and Experiments of Dynamic Fracture in C300 Steel, *International Journal of Solids and Structures*, 37, 2000, p.3733-3760.
19. Nguyen, O.; Repetto, E.A.; Ortiz, M. & Radovitzky, R.A. A cohesive model of fatigue crack growth, *International Journal of Fracture*, 110, 2001, p.351–369.
20. Yang, Z. & Xu, X. A heterogeneous cohesive model for quasi-brittle materials considering spatially varying random fracture properties, *Computer Methods in Applied Mechanics and Engineering*, 197, 2008, p.4027-4039.
21. ABAQUS reference manuals (v. 6.7), Providence, RI, 2007.
22. Roy, Y.A. & Dodds, R.H. Simulation of ductile crack growth in thin aluminum panels using 3-D surface cohesive elements, *International Journal of Fracture*, 110, 2001, p.21–45.
23. Rice, J.R. Limitations to the small scale yielding approximation for crack tip plasticity, *Journal of the Mechanics and Physics of Solids*, 22, 1974, p.17-26.
24. Jiang, H.; Gao, X. & Srivatsan, T.S. Predicting the influence of overload and loading mode on fatigue crack growth: A numerical approach using irreversible cohesive elements, *Finite Elements in Analysis and Design*, 45, 2009, p.675 – 685.

AN INTEGRATED APPROACH TO SOFTWARE RELIABILITY ALLOCATION

Vibhash Yadav

email: vibhashds10@yahoo.com
Computer Science & Engg. Department
Krishna Girls Engineering College, Kanpur-208024 (India)

Dr. Raghuraj Singh

email: rscse@rediffmail.com
Computer Science & Engg. Department
Harcourt Butler Technological Institute, Kanpur-208002 (India)

ABSTRACT

Most of the existing methods of Software Reliability Allocation (SRA) badly rely on the experiential data and are based on non-linear optimization with specified objective function. In this paper, we have proposed a method which integrates users' requirements and preferences with the technical structure comprising components (functions, programs, and modules) at different levels of abstraction. Reliability allocation to the components is guided by taking users view on importance of each component and considering utility and cost of development of the software. Since, we have integrated the users view about software functions and their relative importance to the user with the Software Engineers (SE) and programmers (PR) view of the structure of software in terms of programs and modules, the use of linear equations will work and the complexity of optimization will be greatly reduced.

Keywords: Software Reliability Allocation, Software Utility, Hierarchical Structure, Reliability Optimization.

1. INTRODUCTION

Software Reliability Allocation (SRA) deals with the setting of reliability goals for individual components such that a specified system reliability goal is met and the component goals are well balanced among themselves¹. Well balanced usually refers to appropriate equality of development time, difficulty, risk or to the minimization of overall development cost.

A number of reliability allocation models have been developed. F. Zahedi & N. Ashrafi² and F. Zahedi³ contributed a SRA model based on system structure, utility, price and cost by using the method of Analytic Hierarchy Process (AHP). O. Berman and N. Ashrafi proposed four optimization models for reliability of modular software systems⁴, but it only draws the attention on how to make an optimal selection out of an available pool of modules with known reliability and cost, and give no guidance on how to allocate reliability to system modules in the planning and design stage of the system. M. R. Lyu discussed optimization methods of reliability allocation and testing schedule for software systems with single or multiple applications⁵, but it also does not figure out internal relationships among system modules, which is very important to guide the reliability allocation. J. Xiang, K. Futatsugi, and H.E. Yanxiang¹⁰ used the concept of Software Fault Tree Analysis (SFTA) for identifying and documenting the combinations of lower-level software events that allow a top-level event (or root node) to occur. When the root node is a hazard, the SFTA assists in the requirements process by describing the ways in which the system can reach that unsafe state⁶. The safety requirements for the system can then be derived from the software fault tree, either indirectly^{7,8} or directly via a shared model⁹. Raghuraj Singh et. al.¹¹ used the concept of fuzzy linguistic variables and multilevel technique to reduce the complexity of software reliability and utility equations from non-linear to linear equations.

In the work described here, we use hierarchical structure of the software development process which integrates users' requirements and preferences with the technical structure comprising components like functions, programs, and modules at different levels of abstraction. To accomplish this task, we set up a system hierarchy, which combines the users' view of the system with its technical specifications. The mathematical formulation of a reliability allocation model generally has a non-linear programming form but since our model integrates the users view about software functions and their relative importance to the user with the SE's and PR's view of the structure of software in terms of programs and modules, the non-linear formulation can be converted to linear one and hence making it less complex. It maximizes the software utility by considering the technical and financial constraints on software reliabilities at module and program levels.

2. THE HIERARCHICAL VIEW

Hierarchical view has been widely used for reliability analysis for years. They were first developed in the 1960s to facilitate analysis of the Minuteman missile system¹³ and have been supported by a rich body of research since then. Hierarchical structuring is a method for identifying and documenting the combinations of lower-level events (software components) that allow a top-level event (software here) to occur. The hierarchical approach has been used in the estimation of information systems reliability¹². Even in simulation modeling, one finds modeling formalism using hierarchically related module¹⁴. It seems that in complex problems, the hierarchical structure suggests itself as a natural framework for simplifying the problem.

User is the ultimate judge of a system's quality and reliability. Considering the fact that users requirement changes constitute over 40% of software maintenance, a reliability allocation scheme must include the users' view of the software from the start. Otherwise, the price of neglecting the users view in the reliability design will result into a higher maintenance cost. In the present approach, we construct a hierarchy that links the users' view to the SE and PR view of the software. We begin the hierarchy from the top with the users view, which is users overall assessment of the utility and reliability of the software. This hierarchical view has been presented in Fig. 1.

The user bases his assessments on the functionality and attributes of the software, which are represented at the second level of hierarchy. The user expects the software to perform a set of functions. Assume that a typical user enumerates f such functions functions denoted by F_1, F_2, \dots, F_f .

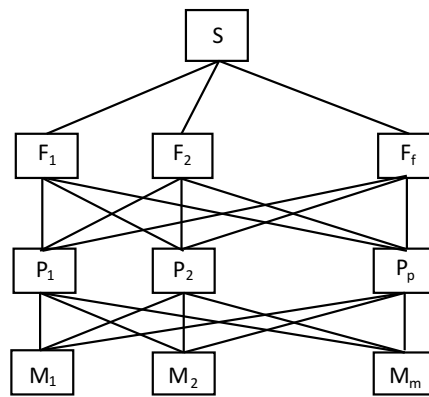


Fig. 1: Hierarchical view of the Software

The third level of hierarchy presents the computer programs written to accommodate functions specified by the typical user. This level encompasses the SE view of the software. There is no reason to believe that each user-specified function would be programmed into only one program - a one-to-one mapping from function to programs could be inefficient and unrealistic. Let us denote programs at the third level by P_1, P_2, \dots, P_p .

The fourth level of hierarchy contains the independent modules of which the programs are composed. In this formulation, we assume that the SE adheres strictly to the concept of structured programming, which has become an inevitable programming approach in medium and large systems. We consider the modules as independent units which themselves may have sub modules, but each sub module belongs to only one module – a many-to-one connection. Assume that the software uses modules denoted by M_1, M_2, \dots, M_m . We stop the hierarchical structure at the level of independent modules.

The links connecting software to the functions, functions to the programs, and programs to the modules may represent AND or OR logical relationships depending on whether a particular component is implemented by all other components or a single component connected to this component at one lower level of the hierarchy.

3. SOFTWARE RELIABILITY ANALYSIS

To analyze the software reliability by using the hierarchical structure, we consider the given reliability requirement of software system in the planning or design stage, and try to determine and investigate each module's reliability and their inherent relationships. Every component in the structure at different levels of hierarchy is assigned a reliability determined by the relative importance or weight of the component along with its logic relationship with ancestors.

For this purpose we have to identify the relative importance of each program P_i at the third level and each module M_i at the fourth level of the hierarchy, in the users' assessment of the software at the first level. Obviously, it will not be appropriate to ask directly from the user to express his preference for each program and module because his view of the software is an external one that ends at the functional level (F_i 's) of the hierarchy. Programmer too has only a partial view of the system because he sees only the third and the fourth levels (P_i 's and M_i 's). Hence to achieve this goal, we must find a method to combine the two views for

identifying the relative importance of the programs and their modules in the user's assessment of the software.

3.1 ASSIGNMENT OF RELATIVE WEIGHTS Three groups of Decision Makers (DM) consisting of some specified number of users, SE, and PR are constituted to assign relative importance to various functions, programs, and modules (components) respectively. Every member of a group of DM assigns his order of preference to the respective component. For example, the i th member of the group of SE will assign his relative importance of programs in the form of $\{P1_i, P2_i, P3_i, \dots, Pj_i, \dots, Pp_i\}$ where Pj_i denotes any one program of $\{P1, P2, P3, \dots, Pp\}$. The list of relative importance is then arranged in the descending sequence of the component importance. By assigning the importance value to each ordered component as $\{\frac{1}{2}, \frac{1}{4}, \frac{1}{8}, \dots, \frac{1}{2^p}\}$ we can get the importance or weight value of component ' j ' as:

$$w_j = \frac{1}{k} \sum_{i=1}^k \phi_j^i \quad (1)$$

where ϕ_j^i is the importance value of component j given by the i^{th} DM

3.2 INITIAL RELIABILITY ALLOCATION Knowing the relative weight (w_i) and the frequency ratio (X_{fi}) of various components, reliability (R_{fi}) of components can be calculated from the following formula.

$$R_{fi} = (R_{ci} + X_{fi} - 1) / X_{fi} \quad (2)$$

where R_{ci} the reliability of the i^{th} component without considering the frequency ratio, can be expressed as:

$$R_{ci} = (R_g)^{w_i} \quad (3)$$

where ' R_g ' is the reliability goal to be allocated to various components.

In the hierarchical structure, if a component (function, module) uses more than one other component (module, program) for its implementation, the component reliability will be the maximum of various reliability values calculated through different implementations of that component. Reliability R_i of the component i implemented through k other components is expressed as:

$$R_i = \text{MAX}\{R_{ij}\} \quad \text{where } j = 1 \text{ to } k. \quad (4)$$

4. SOFTWARE UTILITY AND COST BASED RELIABILITY ALLOCATION MODEL

We ideally define the user's utility of a software product as how reliably a user can perform various functions within the software. In other words, the software utility is a function of software attributes (functions) and the attributes' reliability.

$$U = h(F, R) \quad (5)$$

where U represents the utility measure and F & R are the vectors of software function and their reliability respectively. In this general formulation, h takes any functional form. Nowadays, the constraints are solved using the following non-linear equation².

$$U = \prod_{i=1}^f e^{w_i f_i \cdot r_i f_i} \quad (6)$$

Eq. (6) constitutes the utility measure that is maximized in the determination of module reliabilities, i.e., r_{mj} 's, given the system and cost constraints. Thus, the allocation model has the following structure:

$$\text{Objective Function} \quad \text{MAX} \left[U = \prod_{i=1}^p e^{w_i p_i \cdot \prod_{j \in m} r_j^{rm_j}} \right] \quad (7)$$

Constraints

$$\begin{aligned} rm_j &\leq u_j \quad \text{for } j=1, 2, \dots, m \\ rm_j &\leq l_j \quad \text{for } j=1, 2, \dots, m \\ a_j e^{c_j \cdot rm_j} &\leq \alpha p_j \quad \text{for } j=1, 2, \dots, m \\ \sum_{j=1}^m (a_j e^{c_j \cdot rm_j}) &\leq C \end{aligned} \quad (8)$$

For module i , in the above Eq. (7) and (8), u_i and l_i are the upper and lower limit of reliability, a_i is the cost given under constraint R_i , c_i is the adjustable cost, α is equal to 1 minus the profit rate, and v_i is the selling price. Thus, $\alpha \cdot v_i$ is the estimated developing cost of the module i , and its actual cost should not exceed it. C is the available developing resource and the whole cost of reliability must be less than it. Knowing the selling price (V) of the software, selling price of the module i is decided by considering its global importance/weight (w_{mi}) in view of the customer

$$v_i = w_{mi} \cdot V \quad (9)$$

Since we have already considered an integrated approach in which the users' assessment of the importance of software functions at the first level has been propagated down to determine importance of the programs and modules at the third and fourth levels of hierarchy, taking reliability and cost into consideration, it is not necessary to use non-linear equations. The use of linear equations will work and hence the complexity will be greatly reduced. The linear equations that can be used are:

Objective Function

$$\max_{rm_j} U = \sum_{i=1}^p w p_i \prod_{j \in m_i} r m_j \quad (10)$$

Constraints

$$\begin{aligned} r m_j &\leq u_j \quad \text{for } j = 1, 2, \dots, m \\ r m_j &\geq l_j \quad \text{for } j = 1, 2, \dots, m \\ a_j + c_j r m_j &\leq \alpha p_j \quad \text{for } j = 1, 2, \dots, m \\ \sum_{i=1}^m (a_j + c_j r m_j) &\leq C \end{aligned} \quad (11)$$

Eq. (10) and (11) have a linear objective function and $3m+1$ linear constraints respectively. Many software products for optimization can solve this linear optimization problem, and most mainframe computers have linear algorithms in their optimization packages. One can also find PC software packages for solving this problem. For instance, GAMS is an example of a product available on both PC and Mainframe, or try <http://gams.nist.gov/> for guide to Available Mathematical Software. In this paper, we have used a tool based on Genetic Algorithm (GA) approach, which has been specifically developed to solve the above linear equations. Because of the inherent advantages of global optimization and implicit parallelism of GA the results have been found to be more accurate and encouraging.

5. CONCLUSIONS AND DISCUSSIONS

Given the system reliability and cost budget, the model of software reliability allocation presented in this paper can get the maximum utility along with meeting the constraints of technical considerations, costs, resources and prices. We used the concept of hierarchical structuring of software that depicts the status of functions which users expect, programs through which these functions are logically implemented by the SE, and modules in which programs are actually divided by the PR. Reliability requirement (lower limit of reliability) of each function, program and the module was determined by considering their relative importance and the frequency ratio. Finally, a model to allocate software reliability which maximizes software utility and meets its constraints has been proposed. Method proposed in the paper has also been compared with the traditional methods and the SFTA method¹⁰. Our method has following advantages. Traditional methods such as AHP indicate that the lower limit reliability of components should be greater than zero and should be subjectively assessed by the DM. Our method not only finds out the lower limit reliability of the components but also depicts the inherent relationship of the software system structure with the actual reliability goal of the components. Thus, the initial reliability allocation is more reasonable and realistic.

The SFTA approach¹⁰ performs reliability allocation only at the level of functions. Whereas in our approach, we integrated the users view about software functions and their relative importance to the user (reflecting the user's specifications and requirements) with the SE and PR view of the structure of software in terms of programs and modules. Therefore, from this point of view, software reliability allocation in practical applications and projects is further improved. Traditional methods generally have non-linear formulation of constraints (technical considerations, cost, resources and prices) in maximizing software utility. We reduced their complexity by making them linear. Also, a tool developed on genetic algorithm concept has been used to solve the constrained linear optimization SRA problem. The inherent advantages of global optimization and implicit parallelism of GA can solve this problem more effectively as compared to other algorithms.

The links connecting various components at different level of hierarchy have been considered to depict AND logical relationships i.e. a particular component is implemented by all other components connected to this component at one lower level of the hierarchy. If the concept of OR logical relationship is also taken into consideration, and then minimum cut sets are determined in accordance with the formulation, the results will be more accurate and realistic.

REFERENCES

1. Musa, J.; Iannino, D. & Okumoto, K., Software Reliability: Measurement, Prediction. Application, New York: McGraw-Hill. 3rd. Edition, 1987, Ch. 5.
2. Zahedi, F.; Ashrafi, N., Software Reliability Allocation Based on Structure, Utility, Price and Cost, IEEE Transaction on Software Engineering, vol. 17, no. 4, 1991, p. 345-356.
3. Zahedi, F., The Analytic Hierarchy Process — A Survey of The Method and its Applications, Interfaces, vol. 16, no. 4, 1986, p. 96-108.
4. Berman, O; Ashraf,i N., Optimization Models for Reliability of Modular Software Systems, IEEE Transactions on Software Engineering, vol. 19, no. 11, 1993, p. 1119-1123.
5. Lyu, M. R.; Rangarajan S. & Aad P. A. van Moorsel, Optimization of Reliability Allocation and Testing Schedule for Software Systems, Bell Laboratories and Lucent Technologies. Available from: <http://citeseer.nj.nec.com/197728.html>.
6. Leveson N. G., Safeware: System Safety and Computers, Addison-Wesley, Reading, MA, USA, 1995, Ch.6.
7. De Lemos, R.; Saeed, A; & Anderson, T, Analyzing Safety Requirements for Process-control Systems, IEEE Software, vol. 12, no. 3, 1995, p. 42-53.
8. Lutz, R; Woodhouse, R. M., Requirements Analysis Using Forward and Backward Search, Annals of Software Engineering, vol. 3, 1997, p. 459-475.
9. Hansen, K. M.; Ravn, A. P.; & Stavridou, V., From Safety Analysis to Software Requirement, IEEE Transactions on Software Engineering, vol. 24, no. 7, 1998, p. 573-584.
10. Xiang, J.; Futatsugi K. & Yanxiang, H. E., Fault Tree Analysis of Software Reliability Allocation, Available from <http://www.jaist.ac.jp/~jxiang/publications/FTA%20in%20SRA.pdf>.
11. Singh, R.; Singh, Y.; Misra, U.; & Gundevia, U. D., Fuzzy Multilevel Methodology for Reduction of Complexity of Software Reliability and Utility Equations, Journal of Ultra Scientist of Physical Science, vol. 15, no. 1, 2003, p. 15-34.
12. Zahedi, F., Reliability of Information Systems based on Critical Success Factors – Formulation, MIS Quarterly, vol. 11, no. 2, 1987, p. 187-203.
13. Watson H. A.; & Bell Telephone Laboratories, Launch Control Safety Study, Bell Telephone Laboratories, Murray Hill, NJ USA, 1961.
14. Anderson, E. E., A Heuristic for Software Evaluation and Selection, Software – Practice and Experience, vol. 19, no. 8, Aug. 1989, p. 707-717.

MOBILE AD HOC NETWORKS CHALLENGES, APPLICATIONS & THEIR ROUTING PROTOCOLS

Dr. Rahul Rishi

email: rahulrishi@rediffmail.com

Professor & HOD, Department of Computer Science & Engineering
Technological Institute of Textile and Science, Bhiwani-127021, Haryana – India

Kevika Singla

email: kevikasingla@gmail.com

Sr. Software Engineer
Royal Bank of Scotland, Gurgaon-122001, India

Ajit Singh

email: er.ajit786@gmail.com

M.tech Student, Department of Computer Science & Engineering
Technological Institute of Textile and Science, Bhiwani-127021, Haryana – India

ABSTRACT

As the popularity of mobile devices (MDs) and wireless networks significantly increased over the past years, wireless ad hoc networks has now become one of the most vibrant and active fields of communication and networking research. A MANET (Mobile Ad-hoc Network) is a collection of wireless nodes that can dynamically form a network to exchange information without using any preexisting fixed network infrastructure. In order to facilitate communication within the network, a routing protocol is used to discover routes between nodes. Due to severe challenges, the special features of MANET bring this technology great opportunistic together. This paper describes the fundamental problems of ad hoc network by giving its related research background including the concept, features, status, and applications of MANET. This paper presents an overview and the comparative study of the routing protocols. Also include the several challenging issues and the future work.

Keywords: MANET, Wireless Networks, Ad hoc Networking, Routing Protocol.

1. INTRODUCTION

1.1 An ad-hoc wireless network is a collection of wireless nodes that self organize into a network without the help of an existing infrastructure. Some or possibly all of these nodes are mobile. Since the network can be deployed rapidly and flexibly, it is attractive to numerous potential applications. Possible commercial applications of MANET include business associates sharing information during a meeting, students using laptop computers to participate in an interactive lecture, and emergency disaster relief personnel coordinating efforts in natural disasters. Mobile ad hoc networks also a good alternative in rural areas or third world countries where basic communication infrastructure is not well established. A MANET is an autonomous collection of mobile users (nodes) that communicate over bandwidth constrained wireless links [1, 3].

1.2 Due to nodal mobility, the network topology may change rapidly and unpredictably over time. The network is decentralized, where network organization and message delivery must be executed by the nodes themselves. Message routing is a problem in a decentralized environment where the topology fluctuates. While the shortest path from a source to a destination based on a given cost function in a static network is usually the optimal route, this concept is difficult to extend in MANET. MANET ad hoc nodes present in range of different areas. Factors such as power expended, variable wireless link quality, propagation path loss, fading, multi-user interference, and topological changes, limited bandwidth become relevant issues. The network should be able to adaptively alter routing paths to alleviate any of these effects [5, 10].

2. RELATED BACKGROUND

2.1 MANET CONCEPT: A mobile ad hoc network is a collection of wireless nodes that can dynamically be set up anywhere and anytime without using any preexisting network infrastructure. It is an autonomous system in which mobile hosts connected by wireless links are free to move randomly and often act as routers at the same time. The traffic types in ad hoc networks are quite different from those in an infra-structured wireless network, including according to [3,13]:

**Corresponding Author*

Peer-to-Peer: Communication between two nodes which are within one hop. Network traffic (bps) is usually consistent.

Remote-to-Remote: Communication between two nodes beyond a single hop but which maintain a stable route between them. This may be the result of several nodes staying within communication range of each other in a single area or possibly moving as a group. The traffic is similar to standard network traffic.

Dynamic Traffic: This occurs when nodes are dynamic and moving around. Routes must be reconstructed. This results in a poor connectivity and network activity in short bursts.

2.2 MANET FEATURES: In [5, 9], MANET has the following features:

Autonomous terminal: In MANET, each mobile terminal is an autonomous node, which may function as both a host and a router. In other words, besides the basic processing ability as a host, the mobile nodes can also perform switching functions as a router. So usually endpoints and switches are indistinguishable in MANET.

Distributed operation: Since there is no background network for the central control of the network operations, the control and management of the network is distributed among the terminals. The nodes involved in a MANET should collaborate amongst themselves and each node acts as a relay as needed, to implement functions e.g. security and routing.

Multihop routing: Basic types of ad hoc routing algorithms can be single-hop and multihop, based on different link layer attributes and routing protocols. Single-hop MANET is simpler than multihop in terms of structure and implementation, with the cost of lesser functionality and applicability. When delivering data packets from a source to its destination out of the direct wireless transmission range, the packets should be forwarded via one or more intermediate nodes.

Dynamic network topology: Since the nodes are mobile, the network topology may change rapidly and unpredictably and the connectivity among the terminals may vary with time. MANET should adapt to the traffic and propagation conditions as well as the mobility patterns of the mobile network nodes. The mobile nodes in the network dynamically establish routing among themselves as they move about, forming their own network on the fly. Moreover, a user in the MANET may not only operate within the ad hoc network, but may require access to a public fixed network (e.g. Internet).

Fluctuating link capacity: The nature of high bit-error rates of wireless connection might be more profound in a MANET. One end-to-end path can be shared by several sessions. The channel over which the terminals communicate is subject to noise, fading, and interference, and has less bandwidth than a wired network. In some scenarios, the path between any pair of users can traverse multiple wireless links and the link themselves can be heterogeneous.

Light-weight terminals: In most cases, the MANET nodes are mobile devices with less CPU processing capability, small memory size, and low power storage. Such devices need optimized algorithms and mechanisms that implement the computing and communicating functions.

2.3 MANET STATUS: Ad hoc networking is not a new concept. As a technology for dynamic wireless networks, it has been deployed in military since 1970s. Commercial interest in such networks has recently grown due to the advances in wireless communications. A new working group for MANET [7] has been formed within the Internet Engineering Task Force (IETF), aiming to investigate and develop candidate standard Internet routing support for mobile, wireless IP autonomous segments and develop a framework for running IP based protocols in ad hoc networks. The recent IEEE standard 802.11 has increased the research interest in the field.

Many international conferences and workshops have been held by e.g. IEEE and ACM. For instance, Mobi Hoc (The ACM Symposium on Mobile Ad Hoc Networking & Computing) has been one of the most important conferences of ACM SIGMOBILE (Special Interest Group on Mobility of Systems, Users, Data and Computing). Research in the area of ad hoc networking is receiving more attention from academia, industry, and government. Since these networks pose many complex issues, there are many open problems for research and significant contributions [7, 13].

2.4 MANET APPLICATIONS: With the increase of portable devices as well as progress in wireless communication, ad hoc networking is gaining importance with the increasing number of widespread applications. Ad hoc networking can be applied anywhere where there is little or no communication infrastructure or the existing infrastructure is expensive or inconvenient to use. Ad hoc networking allows the devices to maintain connections to the network as well as easily adding and removing devices

to and from the network. The set of applications for MANET is diverse, ranging from large-scale, mobile, highly dynamic networks, to small, static networks that are constrained by power sources. Besides the legacy applications that move from traditional infra structured environment into the ad hoc context, a great deal of new services can and will be generated for the new environment. Typical applications include [5, 9]:

Military battlefield: Military equipment now routinely contains some sort of computer equipment. Ad hoc networking would allow the military to take advantage of commonplace network technology to maintain an information network between the soldiers, vehicles, and military information head quarters. The basic techniques of ad hoc network came from this field.

Commercial sector: Ad hoc can be used in emergency/rescue operations for disaster relief efforts, e.g. in fire, flood, or earthquake. Emergency rescue operations must take place where non-existing or damaged communications infrastructure and rapid deployment of a communication network is needed. Information is relayed from one rescue team member to another over a small hand held. Other commercial scenarios include e.g. ship-to-ship ad hoc mobile communication, law enforcement, etc.

Local level: Ad hoc networks can autonomously link an instant and temporary multimedia network using notebook computers or palmtop computers to spread and share information among participants at a e.g. conference or classroom. Another appropriate local level application might be in home networks where devices can communicate directly to exchange information. Similarly in other civilian environments like taxicab, sports stadium, boat and small aircraft, mobile ad hoc communications will have many applications.

Personal Area Network(PAN): Short-range MANET can simplify the intercommunication between various mobile devices (such as a PDA, a laptop, and a cellular phone). Tedious wired cables are replaced with wireless connections. Such an ad hoc network can also extend the access to the Internet or other networks by mechanisms e.g. Wireless LAN (WLAN), GPRS, and UMTS. The PAN is potentially a promising application field of MANET in the future pervasive computing context.

2.5 MANET Challenges: Regardless of the attractive applications, the features of MANET introduce several challenges that must be studied carefully before a wide commercial deployment can be expected. These include [7, 9]:

Routing: Since the topology of the network is constantly changing, the issue of routing packets between any pair of nodes becomes a challenging task. Most protocols should be based on reactive routing instead of proactive. Multi cast routing is another challenge because the multi cast tree is no longer static due to the random movement of nodes within the network. Routes between nodes may potentially contain multiple hops, which is more complex than the single hop communication.

Security and Reliability: In addition to the common vulnerabilities of wireless connection, an ad hoc network has its particular security problems due to e.g. nasty neighbor relaying packets. The feature of distributed operation requires different schemes of authentication and key management. Further, wireless link characteristics introduce also reliability problems, because of the limited wireless transmission range, the broadcast nature of the wireless medium (e.g. hidden terminal problem), mobility-induced packet losses, and data transmission errors.

Quality of Service (QoS): Providing different quality of service levels in a constantly changing environment will be a challenge. The inherent stochastic feature of communications quality in a MANET makes it difficult to offer fixed guarantees on the services offered to a device. An adaptive QoS must be implemented over the traditional resource reservation to support the multimedia services.

Inter-networking: In addition to the communication within an ad hoc network, inter-networking between MANET and fixed networks (mainly IP based) is often expected in many cases. The coexistence of routing protocols in such a mobile device is a challenge for the harmonious mobility management.

Power Consumption: For most of the light-weight mobile terminals, the communication-related functions should be optimized for lean power consumption. Conservation of power and power-aware routing must be taken into consideration.

Routing is the most fundamental research issue in MANET and must deal with limitations such as high power consumption, low bandwidth, high error rates and unpredictable movements of nodes. Generally, current routing protocols for MANET can be categorized as:

3. ROUTING PROTOCOLS

3.1 PRO-ACTIVE (table-driven): The pro-active routing protocols [2, 4] are the same as current Internet routing protocols such as the RIP (Routing Information Protocol), DV(distance-vector), OSPF (Open Shortest Path First) and link-state . They attempt to maintain consistent, up-to-date routing information of the whole network. Each node has to maintain one or more tables to store routing information, and response to changes in network topology by broadcasting and propagating. Some of the existing pro-active ad hoc routing protocols are: DSDV (Destination Sequenced Distance-Vector, 1994), WRP (Wireless Routing Protocol, 1996), CGSR (Cluster head Gateway Switch Routing, 1997), GSR (Global State Routing, 1998), FSR (Fisheye State Routing,

1999), HSR (Hierarchical State Routing, 1999), ZHLS (Zone based Hierarchical Link State, 1999), STAR (Source Tree Adaptive Routing, 2000).

3.2 REACTIVE (source-initiated on-demand driven): These protocols try to eliminate the conventional routing tables and consequently reduce the need for updating these tables to track changes in the network topology. In contrast to pro-active routing protocols which maintain all up-to-date at every node, routes are created only when desired by the source node in re-active protocols. When a source requires to a destination, it has to establish a route by route discovery procedure, maintain it by some form of route maintenance procedure until either the route is no longer desired or it becomes inaccessible, and finally tear down it by route deletion procedure. Some of the existing re-active routing protocols are [2, 5].

DSR (Dynamic Source Routing, 1996), ABR (Associativity Based Routing, 1996), TORA (Temporally-Ordered Routing Algorithm, 1997), SSR (Signal Stability Routing, 1997), PAR (Power-Aware Routing, 1998), LAR (Location Aided Routing, 1998), CBR (Cluster Based Routing, 1999), AODV (ad hoc On-Demand Distance Vector Routing, 1999). In pro-active routing protocols, routes are always available (regardless of need), with the consumption of signaling traffic and power. On the other hand, being more efficient at signaling and power consumption, re-active protocols suffer longer delay while route discovery. Both categories of routing protocols have been improving to be more scalable, secure, and to support higher QoS. Meanwhile, some protocols that combine the good properties of both pro-active and re-active protocols were proposed, such as ZRP (Zone Routing Protocol, 1999). Some of the above routing protocols have implementations for test.

3.3 HYBRID ROUTING PROTOCOLS: Hybrid routing protocols [4, 5] aggregates a set of nodes into zones in the network topology. Then, the network is partitioned into zones and proactive approach is used within each zone to maintain routing information. To route packets between different zones, the reactive approach is used. Consequently, in hybrid schemes, a route to a destination that is in the same zone is established without delay, while a route discovery and a route maintenance procedure is required for destinations that are in other zones. The zone routing protocol (ZRP) and zone-based hierarchical link state (ZHLS) routing protocol provide a compromise on scalability issue in relation to the frequency of end-to-end connection, the total number of nodes, and the frequency of topology change. Furthermore, these protocols can provide a better trade-off between communication overhead and delay, but this trade-off is subjected to the size of a zone and the dynamics of a zone. Thus, the hybrid approach is an appropriate candidate for routing in a large network.

At network layer, routing protocols are used to find route for transmission of packets. Routing is the most fundamental research issue in ad hoc networking. The merit of a routing protocol can be analyzed through metrics-both qualitative and quantitative with which to measure its suitability and performance. These metrics should be independent of any given routing protocol. Desirable qualitative properties of MANET are Distributed operation, Loop-freedom, Demand-based operation, Proactive operation, Security, Sleep period operation and unidirectional link support. Some quantitative metrics that can be used to assess the performance of any routing protocol are End-to-end delay, throughput, Route Acquisition Time, Percentage Out-of-Order Delivery and Efficiency. Essential parameters that should be varied include: Network size, Network connectivity, Topological rate of change, Link capacity, Fraction of unidirectional links, Traffic patterns, Mobility, Fraction and frequency of sleeping nodes [3, 6, 8].

4. AD-HOC ROUTING PROTOCOLS DESCRIPTION

4.1 DISTANCE VECTOR (DV) ROUTING: Distance Vector protocol [2, 5] is a classic routing protocol whose refined version are used in the current wired networks. It is a proactive protocol and is based on the concept of distance vector. Every node in a network maintains a distance table(a one dimensional array or a vector, called distance vector), where each entry in a distance table contains the shortest distance and the address of the next-hop router on the shortest path to every destination in a network.

4.2 WIRELESS ROUTING PROTOCOL (WRP): WRP [2, 5] is an extension of distance vector protocol that eliminates possibility of routing loops. Nodes in a network using WRP maintain a set of four tables: Link cost table, Distance table, Routing table, Message Retransmission list. WRP works by requiring each node to send an update message periodically. This update message could be new routing information or a simple “hello” if the routing information hasn't changed from the previous update. After sending an update message to its all neighbors, a node expects to receive an ACK from all of them. If an ACK message does not come back from a particular neighbor, the node will record the non-responding neighbor in MRL another update to the neighbor node later.

4.3 AD HOC ON-DEMAND DISTANCE VECTOR ROUTING (AODV): AODV [4, 11] discovers routes on an as needed basis via a similar route discovery process. However, AODV adopts a very different mechanism to maintain routing information. It uses traditional routing tables, one entry per destination. This is in contrast to DSR, which can maintain multiple route cache entries for each destination. Without source routing, AODV relies on routing table entries to propagate an RREP back to the source and, subsequently, to route data packets to the destination. AODV uses sequence numbers maintained at each destination to determine freshness of routing information and to prevent routing loops. All routing packets carry these sequence numbers. An important feature of AODV is the maintenance of timer-based states in each node, regarding utilization of individual routing table entries. A routing table entry is expired if not used recently. A set of predecessor nodes is maintained for each routing table entry, indicating the set of neighboring nodes which use that entry to route data packets. These nodes are notified with RERR packets when the next-hop link breaks. Each predecessor node, in turn, forwards the RERR to its own set of predecessors, thus effectively erasing all routes using the broken link. In contrast to DSR, RERR packets in AODV are intended to inform all sources using a link when a failure occurs. Route error propagation in AODV can be visualized conceptually as a tree whose root is the node at the point of failure and all sources using the failed link as the leaves.

Properties	DV	WRP	DSR	AODV
Type of Routing	Proactive	Proactive	Proactive	Proactive
Distributed	YES(hop-by-hop)	YES(hop-by-hop)	NO(source routing)	YES(hop-by-hop)
Routing loops	Possible	Not Possible	Not Possible	Not Possible
Use of Broadcast	No	No	Yes	Yes
Control Overhead	Constant to the number of sessions	Constant to the number of sessions	Affected by the number of sessions	Affected by the number of sessions
Routing entries	All Destinations	All Destinations	Destinations in use	Destinations in use
Alternative Path	Not Available	Not Available	Available	Available
Request Response	Short	Short	Long(if not cached)	Long(if not cached)
Advantages	Short response time Low message OH	Short response time	Quick path recovery	Small routing table Quick Recovery
Disadvantages	Routing loops Large routing table Long convergence time	Large routing table	Long response time Long packet header	Long response time Aggregate routing is not possible at intermediate nodes

5. CONCLUSION AND FUTURE SCOPE

The future of ad hoc networks is really appealing, giving the vision of “anytime, anywhere” and cheap communications. Before those imagined scenarios come true, huge amount of work is to be done in both research and implementation. At present, the general trend in MANET is toward mesh architecture and large scale. Improvement in bandwidth and capacity is required, which implies the need for a higher frequency and better spatial spectral reuse. Propagation, spectral reuse, and energy issues support a shift away from a single long wireless link (as in cellular) to a mesh of short links (as in ad hoc networks). Large scale ad hoc networks are another challenging issue in the near future which can be already foreseen. As the involvement goes on, especially the need of dense deployment such as battlefield and sensor networks, the nodes in ad hoc networks will be smaller, cheaper, more capable, and come in all forms. In all, although the widespread deployment of ad hoc networks is still year away, the research in this field will continue being very active and imaginative.

REFERENCES

- 1 S. Basagni et al., eds., Mobile Ad Hoc Networking, IEEE Press, (2003.)
- 2 E. M. Royer and C-K Toh, “A review of Current routing protocols for Ad Hoc Mobile Wireless.
- 3 Ilyas, M.. The hand book of ad hoc wireless networks. CRC press LLC (2003).
- 4 Belding-Royer, E.M. and C.K. Toh. A review of current routing protocols for ad-hoc mobile wireless networks. IEEE Personal Communication magazine pp:46-55 (1999).
- 5 M. Frodigh, P. Johansson, and P. Larsson. “Wireless ad hoc networking: the art of networking without a network network,” Ericsson Review, No.4, pp. 248-263 (2000).
- 6 Broch, J., A.M David and B. David. A Performance comparison of multi-hop wireless ad hoc network Routing protocols. Proc. IEEE/ACM MOBICOM'98, pp: 85-97 (1998).
- 7 Chlamtac, I., Conti, M., and Liu, J. J.-N. Mobile ad hoc networking: imperatives and challenges. Ad Hoc Networks, 1(1), pp. 13– 6 (2003).
- 8 C.E.Perkins and P. Bhagwat, “Highly dynamic destination-sequenced distance vector routing for mobile computers”, Comp, Comm. Rev., pp 234-44 Oct.(1994).
- 9 HaoYang, Haiyun & Fan Ye “ Security in mobile adhoc networks : Challenges and solutions,” Pg. 38-47, Vol 11, issue 1, Feb (2004.)
- 10 M. Frodigh, P. Johansson, and P. Larsson. “Wireless ad hoc networking: the art of networking without a network,” Ericsson Review, No.4, pp. 248-263 (2000).
- 11 Ian D. Chakeres and Elizabeth M. Belding-Royer. AODV Routing Protocol Implementation Design
- 12 David B. Johnson, David A. Maltz and Josh Broch. DSR: The Dynamic Source Routing protocol for Multi-Hop Wireless Ad Hoc networks.
- 13 Magnus Frodigh, Per Johansson And Peter Larsson. Wireless ad hoc networking—The art of networking without a network.

MARKET POTENTIAL OF AGRI-PRODUCTS: AN ANALYSIS OF RURAL MARKETS

Prof. S. K. Singh

dean@fmsbhu.ac.in

Dean, Faculty of Management Studies, Banaras Hindu University, Varanasi.

Dr. Abhijet Singh

abhijeetsingh@fmsbhu.ac.in, 91-9415684938.

Assistant Professor, Faculty of Management Studies, Banaras Hindu University, Varanasi.

Dr. Vibha Singh

vibhafss@gmail.com

Assistant Professor, VKMPG College, Banaras Hindu University, Varanasi.

ABSTRACT

On account of green revolution, the rural areas consuming a large quantity of industrial and urban manufactured products. The rural markets are growing at two times faster pace than urban markets and rural India accounts for 55% of the total national demand. 620 billion rural population are greater than total consuming markets of many countries like Canada, S.Korea etc. In 2008, the rural market have grown at an impressive rate of 22% compared to the 8-10% growth rate of urban consumer retail market. As per international consultancy firm Celent, rural markets in India will grow to a potential of US\$ 2.2billion by 2016 from the current US\$492million in sectors like retail, FMCG, CD, Insurance etc. Rural markets are growing at double the pace of urban and for many product categories, rural markets account for well over 55% of the national demand.

In recent years, rural markets of India have acquired significance as the overall growth of the Indian economy has resulted into substantial increase in the purchase power of the rural communities. Agricultural marketing has undergone several changes in the last sixty years with an increase in marketable surplus and demand, increase in income and techno-managerial innovations. The present work is an attempt to analyze the potential of agricultural produce from a marketing perspective.

Keywords: Terminal Markets, Rural Economy, Marketing Strategies, Agro-Products

1. INTRODUCTION

In India around 70-75% population stay in rural areas and hence accordingly account for rural markets. Urban markets are always predominant over rural markets in terms of consumption, quality, technology and brand awareness etc but the scenario is changing now-a days because of fast mode of communication. TV has now taken place in every corner of rural part which has become a trusted media of brand awareness. Rural marketing is generally agro-based and the production as well as consumption is agriculture oriented. There are few agro-processing units and their processing is not even 8% of the total food production. Thus there is a vast scope for value addition in agro-sector. In rural markets consumers seem to be less quality conscious that results in little brand awareness and promotional campaign seems to be with less potential. There is a vast potential for transistors, umbrellas, torches and several other consumer products which need to be tapped by way of innovative ideas and latest technologies. New institutional innovations like contract farming and terminal market are emerging and changing agricultural marketing systems in the country with amendments to APMC act. Terminal market was established on hub-and-spoke model to overcome some of the marketing problems of fruits and vegetables. It has formed farmers' associations at village level to take care of procurement and disbursement of payment to farmers. At terminal market complex produce is directly sold to wholesalers, retailers or traders through system of reverse auction.

The terminal market has reduced the number of intermediaries, improved coordination and information flow in the chain which resulted in considerable reduction in wastage and transaction costs while maintaining quality. It has gained the trust of farmers' by maintaining transparency in operations by using of digital balances for weighing, guaranteed payment, lower commission charges, and reducing risks. Farmers are also being benefited by extension services of terminal markets. Timely availability of required quantity of quality produce at competitive price has helped traders by reducing transaction costs. Traders and farmers are also being benefited by storage space, cold storage and ripening facilities available at the terminal market complex.

Marketing problems of fresh fruits and vegetables are due to their physical origin, inertia in marketing process and instability of supply sources (R.S.Thakur,1984). Lack of proper infrastructure facilities, large number of middlemen in supply chains and archaic marketing policies resulted in low efficiency in agricultural marketing (Maheshwari and Mittal,2005 and Nathani, 2007). In India about 25 to 30 per cent of perishables produced are wasted due to inefficient handling, transportation and storage conditions (R.K.Mittal 2007, Planning commission, 2007). The available cold storage capacity in the country is far less than the required and account for only about 0.1 per cent of the total production of fruits and vegetables of which the available 196 lakh tonnes of cold storage capacity about 94 per cent is with private players. Moreover, the present available cold storage infrastructure does not have the facility to store wide range of products with different temperature requirements.

Present marketing system is dominated by unorganized sector and small private traders who do not have the capacity and incentive to invest in infrastructure. The number of middlemen in perishable supply chains add margin but little value to the produce. Farmers receive only a small part of the price paid by the consumers while the major share is lost in the supply chain or absorbed by middlemen. These rational actors in the present supply chains try to maximize the gains from each transaction. Farmers are not rewarded adequately for quality and have no incentives to maintain quality.

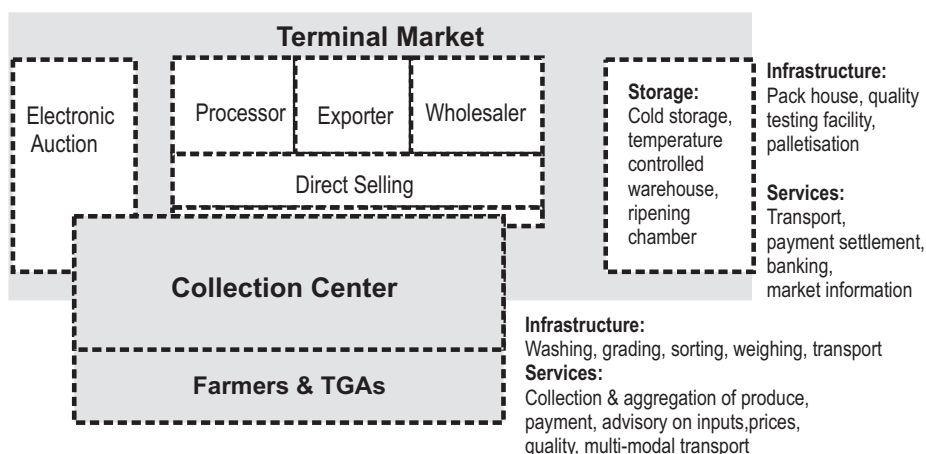
All these are resulting in low marketing efficiency. Agricultural marketing in India has undergone several changes in last sixty years with increase in marketable surplus and demand, increase in income, change in policies, urbanization, and innovations. The measures like regulation of markets, infrastructure creation and promotion of cooperative organizations to protect the interests of farmers have failed to achieve the desired objectives. Some of the problems remained unresolved over time while new problems have surfaced with changing conditions. Market functionaries in APMC markets have organized themselves into strong associations, creating barriers of entry and these markets have emerged as monopoly markets.(Rangacharya S.K.,2005).New institutional innovations like contract farming and terminal markets are emerging and transforming agricultural marketing in the country with modification of APMC act in several states. In absence of literature on terminal markets in India, it was attempted to explain the working of a terminal market, as an institutional innovation for some of the marketing problems of perishables. Government of India has to develop and establish operations for modern terminal market to address the marketing problems of fruits and vegetables like National Institute of Agricultural Marketing. Later, terminal markets was introduced as a new component for funding in public-private-partnership (PPP) mode under National Horticultural Mission launched in 2005-06 for holistic development of horticulture by the Union Ministry of Agriculture, (Ministry of Agriculture, 2006).

2.TERMINAL MARKET

Terminal Markets were planned to connect farmers directly with wholesalers and retailers under one roof, reducing the length of supply chain and transaction costs by maintaining produce quality. The envisaged operation of Terminal Market is based on hub-and-spoke model in which the Terminal Market complex (hub) is connected to many collection centers (spokes) located in production centers. The Terminal Markets would be located near consumption centers (usually cities) and the collection centers would be conveniently located in villages.

The catchment's area of a collection center depends on the convenience needs of farmers like transportation to collection center, operational efficiency and capital utilization at the center. Terminal Markets would establish backward linkages with farmers through collection centers by forming groups or associations and forward linkages with wholesalers, retailers, cash and carry stores, processing units and exporters. This model is also envisaged to provide transportation service, storage, warehousing and cold storage facilities to traders and farmers (Directorate of Marketing and Inspection) at nominal charges. According to operational guidelines of the Union Ministry of Agriculture for setting up of Terminal Market complex, the commodities that can be covered by Terminal Markets include perishables like fruits, vegetables, meat, poultry, herbs and aromatics. However, the proportion of non-horticultural products within perishables should not exceed 15 per cent of the total through put of the market. Terminal markets can also handle non-perishables, but, the proportion of non-perishables should not be more than 15 per cent of the total through put of the market. Terminal Markets in the country are envisaged to be built, operate and owned by a private enterprise selected through a competitive bidding process. The private enterprise that can participate in bidding may include individuals, group of farmers/consumers, partnership/proprietary firms, companies, marketing boards, corporations, cooperatives, producer organizations, self help groups or a consortium of entrepreneurs from agri-business, cold chain, logistics, warehousing, agri-infrastructure and related background (Gandhi P. Vasant,2005). The infrastructure facilities and services planned to be provided to different stakeholders at Terminal Markets and Collection Centers.

Figure 1:
Infrastructure
facilities and services
at Terminal Market
and Collection Centers



Terminal Market generates revenue from its operations in the form of service charges. Service charge of 3.5 and 1.5 per cent is being collected from farmers and traders, respectively. Other sources of income include entrance charge vehicles, license fee, service charges for cold storage facilities, ripening chambers and warehouses, transportation charges and rent for crates to handle the produce, banks and commercial blocks.

2.1 REDEFINED SUPPLY CHAIN Terminal Markets has redefined the supply chain by reducing the intermediaries, shifting the price discovery and delivery of produce away from traditional APMC markets. Terminal Market acts as a platform for connecting farmers through TGAs with wholesale buyers, processors and retailers.

2.2 WHOLESALERS AND RETAILERS Wholesalers and many organized retailers like *Reliance*, *Subhiksha*, *Food World* participate in auction at *Terminal Market* complex. They can participate in auction by paying a nominal amount as deposit. Service charge of 1.5 per cent will be collected by *Terminal Markets* from traders who purchase the produce. Apart from availability of reliable and quality produce at one place, retailers also utilize the cold storage facilities, ripening chambers and warehouses at *Terminal Market* on payment of service charges. The supply chain of fruits and vegetables in which the produce is sold to traders through auction at *Terminal Market* complex is shown in the figure given below.

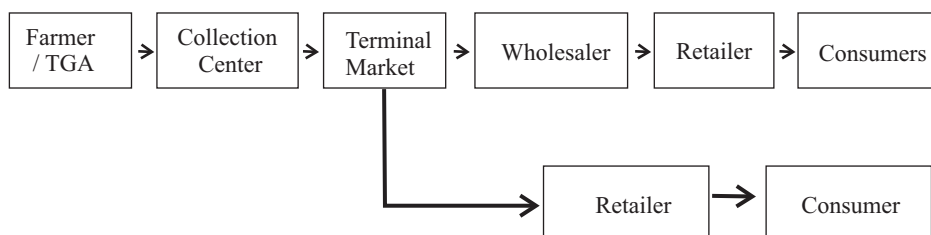


Figure 2 : Supply chain of fruits and vegetables at terminal Markets

3. OPPORTUNITIES AND CHALLENGES IN RURAL MARKETS OF INDIA

India is spread across 650000 villages with an average population of 1100 villagers. Earlier they were thought to be impoverished, primitive and irrelevant by the city dwellers, so no scope for creating a demand. Now, things have changed and improving lifestyle patterns are becoming more visible with a phenomenal growth in per capita income in rural areas. Rural India is witnessing a significant increase in expenditure across categories ranging from telephone calls per person to private tuition and education fees to petrol expenses. With over two thirds of population in rural remote areas, sectors like FMCG, Telecom, IT, Financial, Insurance and retail sectors are lucrative option.

- There are several policies that can be used in order to excel in rural market—
- Promoting the product in local language
- Getting hold of villagers who are prominent amongst there community
- Targeting a specific group of consumers
- A good distribution network
- Door-to-door promotional activity

The competitive edge is must in order to excel in rural market .Over the years the only company that has penetrated into rural market with promotional network and Advertisement budget. The product range also helps in providing options to the consumers.

3.1 CHALLENGES IN RURAL INDIA Gone are the days when a rural consumer used to go to a nearby city to buy branded products and services. The rural scenario in the country has been changing rapidly and many options for reaching rural consumers have come up in the recent past which supplements the existing means of retailing and distribution in the villages. Today, customized products for the rural masses are available and the marketers are ready to grab the opportunity.

According to NCAER, rural households form 71.7% of the total households in the country. Spending in the segment is growing rapidly and consumption in rural India is moving by leaps and bounds. Employment opportunities are multiplying particularly in the rural sector with companies focusing on the untapped potential there. Predictions for the rural market were made on the basis of the state of the monsoon but this trend has changed over the years, there is a large non-farming sector which generates almost 40% of the rural wealth. Hence the growth in the rural markets is sustained to a large extent by this class in addition to the farmer who will always be the mainstay of the rural economy. So rural markets in India have great potential, which is just waiting to be tapped. Progress has been made in this area but there seems to be a long way for marketers to go in order to desire and reap maximum benefits. There is an opportunity of value creation in the rural segment which can be met by building appropriate channels. The challenges that one faces while dealing with rural markets such as the understanding of the rural consumer and distribution aspects, is driven by tradition, custom and values.

In recent years, rural markets have acquired significance as the overall growth of the economy has resulted in an overall increase

in the purchasing power of the rural communities. Rural India accounts to about 74% of population, 56% of national income and about $\frac{1}{3}$ rd of the total savings of India. The size of rural economy was about INR 12 trillion in 2007-08. The rural consuming class is increasing by 3-4% per annum, translated into 1.2 million new consumers yearly. Such is the potential for marketers in rural India.

3.2 ROLE OF FINANCIAL INSTITUTIONS IN RURAL MARKET Financial sector plays an indispensable role in the overall development of a country. The most important constituent of this sector are the financial institutions, which act as a conduit for the transfer of resources from the net savers to net borrowers. These financial institutions can be broadly categorized into all India institutions and state level institutions base on the geographical coverage of operations. They cater to the diverse financial requirements of the entrepreneurs. They include all India development banks like IDBI, SIDBI, IFCI, IIBI, specialized institutions like IVCF, ICICI venture funds Ltd., TFCI, investment institutions like LIC, GIC, UTI etc. provide assistance to new enterprises, SMEs in backward areas. These help in reducing regional disparities by inducing widespread industrial development. Financial institutions consider growth and profitability besides interests of society and the environments by taking responsibility for the impact of their activities on stakeholders (employers, shareholders, customers, suppliers etc) It is needed to review the role of financial institutions to ensure better supervision, regulation and early warning and Corporate Social Responsibility through social and non-financial accounting. Rural markets play an important role in India's development strategy in socio-economic transformation. Industry leaders and MCs are rushing to tap the huge potential in Indian rural markets. It is difficult to operate in rural market for underdeveloped people, lack of proper communication, high initial market expenses and rural incomes mostly invested in gold ornaments and wedding.

Development of infrastructure, transport and communication is possible with help of financial institutions increasing the scope of rural markets. With the help of active and comprehensive role of financial institutions, rural markets development will take place and help in activating factors of production leading to higher rate of economic growth, improvement in living standards of our rural masses by empowerment and their active involvement in the process of growth. Rural unrest and indebtedness in India led to moneylender regulation and finance through institutional credit provision in various forms. The materialization, growth, interaction and relative performance of the co-operatives, PSU banks, RRBs, microfinance institutions and private sector banks are reviewed in relation to the financial service needs of the rural poor. RRBs lead the low income clients sector and hence problem of financial viability.

Being regional in character, RRBs are better suited to adjust their product design, delivery methods yields and staff in decision-making. Currently RRBs sponsored by bank would strengthen their economy and improve the HR management. The incremental business with decentralized decision-making backed by active stake holders' interest will help integrating the large informal sector.

Today, when recession came in Indian economy, people are thinking and rethinking upon the causes and factors responsible for the financial crises. Several studies have been conducted on this issue at several point of time but we could not find the reason behind this mishappening of market. For sustainable development of any economy, it is necessary that, every segment of that economy must be developed properly for balanced development of a country which is not happening in India. While analyzing sector wise GDP growth rates, we find that primary sector's contribution is decreasing while that of service sector is increasing. Economic indicators show how much we are concerned with primary sector rural development. Government has established Khadi & Village Industries Commission, Co-operative Societies, RRBs, and NABARD etc as refinancing and promoting agent to uplift the socio-economic status of rural people in India.

Over the years Government have been emphasizing rural development as agriculture commands the highest share of GNP not only in India but many developing countries. Financial Institutions can provide a range of credit services Short term & Long term loans for business and personal use to serve rural, agricultural and agribusiness clients. Financial intermediaries can mobilize deposits and transfer services need to be available to allow low-income, rural poor to maintain liquid and savings. To achieve average GDP growth of 8% annum, it is important to revamp agricultural sector and rural financial institutions. Inadequacies of financial services need to be addressed. Roles of formal and informal Financial Institutions in rural market development, the problem faced and provide services and measures to overcome.

3.3 TELECOMMUNICATION ERA IN RURAL INDIA India's telecom sector is witnessing an explosive growth, as falling tariffs and rising incomes are bringing mobile phones within the reach of millions of new customers. Today the country has become the second largest mobile market in the world with over 300 million telephones and a monthly addition ranging from 8-10 million. The tele-density stands at an average of 32% as compared to 2% in 1998 being world's fastest growing telecom market. It has the potential to transform the lives of 70% of population in rural areas and thereby enhancing the ability of people to participate in market economy improving standard of living. Growth of other sectors such as entertainment, medical, banking sector improves with the growth of telecom sector.

3.4 RURAL MARKETING STRATEGIES Rural India acquired significance as marketing and investment destination for green revolution, saturation of urban markets and increase in purchasing power. Rural India not only buys FMCG products but it is a huge market for cars, scooters, bikes, DVDs, TV sets, refrigerators, furniture, etc. In total it is a market estimated worth \$27 billion. The result is companies like HUL, Colgate, Palmolive, LG, Satyam, Hero Honda, P & G, Coca-Cola, Pepsi, Dabur, ICICI Bank, Nokia, etc. have made an inroad in the rural markets.

Rural markets have their own distinctive demand pattern and marketing mix needs. Communication for rural calls for a different kind of outlook. There must be a strong accent on familiarizing with the target audience and then designing promotion strategy. Indian and foreign MNCs need to frame their promotional awareness programmes with variety of matching brands. Since 16% of rural population has access to vernacular newspaper and hence the communication strategy has to be developed accordingly. Besides temple festivals, melas and other events used for promotions can bring good response. Various events like road shows, film shows, contests etc. rich and traditional media tool to have a strong impact. Companies try to induce local elements and flavors to the product to have emotional attachment.

By comparison, rural market is zooming ahead at around 25%. In present times when companies are loosing demand in urban India and abroad rural consumers are credible opportunities of growth and survival with increased purchasing power. The rural areas are upcoming as huge consumers of FMCG and consumer products. Rural market is growing faster than urban and is less affected by the slowdown. The market psychology, the culture and belief of rural consumers are entirely different from the rest of the world. Many people in rural India can not afford what urban India consumes as price conscious. It demands innovative pricing strategies to cater the village specific psychology. It is urging to extend strategy towards volume driven growth with low priced serving customers in a better way to develop small size packs, product variants, to keep perception of affordability, discount formats and bring price reduction through value engineering to meet with success in summation.

India have huge capacity in rural market. Marketer should know the price sensitivity of a rural consumer and Ad. creation for rural markets base on their culture for the brands selected. In rural products should have easy availability, it should be affordable and acceptable for the consumer to buy the products. There should be consumer awareness about all products and their usage by the organization. Rural marketer should try to know

the problems faced by the consumers regarding the fulfillment of their basic needs and wants. In India only a few companies are market oriented like Uni-Liver, Philips India and L&T. It is needed for the marketers to analyze the market to design strategies specific to each consumer segment. The strategies depend on the product characteristics, the target segment of rural market, choice of rural areas, its economic conditions and specific environment. Due to social and background condition, word of mouth is an important message. Opinion leaders are influencing promotion strategy. Agro input industry act as a guideline for consumer durable and non-durables. Mass media is very important.

3.5 HR CONSTRAINTS IN RURAL MARKETS Educational background of consumers has a varying influence on their buying decisions. Based on the survey it was found that literates were concerned about quality, brand name and features with the packaging. But illiterates were concerned about the price and influenced by advertisement. Rural women have been the victims of development processes and outcomes as evident from the increasing duration of their work-day, widening gap between male and female incomes and responsibility in managing of household affairs. About half of working hours is involved in food production affecting their health. Lack of medical care, food and social services results in higher mortality rates. Women farmers with lack of training and proper education information in decision making are outside the ambit of high-tech agriculture.

3.6 RURAL ECONOMY AND INDUSTRIALIZATION Handloom exemplifies the richness and diversity in India and is a part of cultural heritage. So adequate steps need to be taken for encouraging craftsman to enhance their skills in prevailing and traditional art. About 3.9 mn handlooms with 30% of total export income from handloom sector is second largest rural employment provider next to agriculture. Work is carried out in rural areas towards women employment of handicraft and areas like manufacturing, transportation and distribution channels etc. Study carried out to co-relate the supply chain with rural employment problems linked with lead time and overall cost with reference to handicrafts in rural and its impact on rural lifestyle. Pond is a major source to earn money through composite fish culture. The migration of people from rural to urban adds to the problem and solution being 'Rural Industrialization'. Industries should be setup in rural areas for the countries balanced economic development. To absorb the surplus labour, it is needed to industrialize rural areas as it can generate employment. Rural investors are providing wide scope to financial institutions in future. Rural households exhibit tremendous potential for elimination of unemployment if they are enabled to have easy access to acquisition of technical, financial, managerial and marketing skills. Investment in creating sustainable infrastructure in areas like drinking water, health, education, housing, food security, transport and communication etc to improve quality of life is a must.

4. INDIAN RURAL RETAILING

Trend in retailing changed in consumers' life. Growth of organized sector would provide the variety of things to consumers helping other sectors to grow. Modern retailing would lead to fill the urban rural gap. The new area develops the world class service delivery and setting the benchmarks for others and raising the standard of living of even a rural family. Rural Business Hubs is a decisive step to foster and permeate economic growth into rural India.

Rural Business Hubs is the unique concept of panchayat, public and private partnership possesses tremendous potential for growth for technological know-how and good farming practices, value addition, branding and marketing, training and skill development. It refers to agro-produce and wide spectrum of economic activities in dynamic business scenario. It assists farmers to gain higher incomes through increased yields and has the capacity to leverage on going Government schemes for rural economic advancement. RBH can contribute in forward and backward linkages of development. It is vital for the economic prosperity of the country facing unemployment and poverty. Rural expenditures on FMCG are growing at an impressive rate of 20-25%. The consumption pattern in rural get affected by affordability, availability, awareness and acceptability.

Understanding current trends and problems of rural consumers will help companies to improve making rural marketing system more effective. Some of the successful and innovative rural retail business models are ITC's e-choupal, aqua-choupal, choupal fresh, choupal sagar & e-auction, DCM Shriram's Hariyali Kisan Bazar, Godrej Agrivet's Aadhaar, Reliance's Rural Retail Hubs, Lifebuoy's bath soap for rural markets, Nirma's low price washing powder, BPCL's small retail outlets for fuel and non-fuel items, LG's Sampurna TV for rural, TTK's prestige pressure cooker, JK Dairy's whiteners in small packs to name a few.

5. FINDINGS

Terminal Markets has overcome some of the marketing problems by facilitating collection of produce from villages, reducing the number of intermediaries, creating infrastructure facilities like cold storages, warehouses and ripening chambers, maintaining produce quality, reducing post harvest losses and transaction costs in the supply chain. *Terminal Markets* has helped farmers considerably with reduction in market risks and transaction cost. The problem of exploitation by intermediaries is eliminated by bringing producers, wholesalers and retailers under one roof. This arrangement by *Terminal Markets* has greatly benefitted small farmers by bringing them together into a group who otherwise are exploited by middlemen due to lack of scale, bargaining power and information on market trends. *Terminal Markets* has virtually brought the market to farmers' doorstep by procuring the produce at village level. Now, member farmers of TGAs supply produce at TGA centers located near their villages and *Terminal* is taking care of transportation of produce from TGAs to terminal market complex. This collection system at village is saving considerable time of farmers and reduced the risk/drudgery in transportation to far away mandis through public or alternate transport arranged by farmers themselves. Post harvest losses were reduced with reduction in number of intermediaries, careful handling, storage and transportation of produce in plastic crates/ trays. Marketing costs for farmers have reduced by about 50 per cent with sale through *Terminal Market* (Kariappa and Thaigagaraj 2004). Quality based pricing has incentivized the farmers in maintaining the quality of produce. Price paid to farmers by *Terminal* is comparable to market price and sometimes it is more than the prevailing market price. The higher returns to farmers may be due to the good quality of produce compared to that of open market, reduction in transportation charges and post-harvest losses. Farmers are paid on third day of delivery of produce through cheque by TGAs. However, sometimes payment is delayed up to a week. The guaranteed payment by *Terminal* has eliminated the frequent trips of farmers to middlemen for collecting the amount in traditional channels.

Terminal has gained the trust of farmers' by maintaining transparency in operations with use of digital balances for weighing the produce, guaranteed payment, lower commission charges and extension services. Involvement of farmers as owners of TGAs by appointing the President and the Board among fellow farmers has reinforced the trust and a sense of ownership among farmers. However, sense of ownership is not found among all farmers. Farmers receive technical guidance from *Terminal* executives who visit their fields regularly.

Terminal Markets procure the produce only if it is according the standards specified. Farmers feel that the stringent quality norms for different grades of fruits and vegetables fixed by *Terminal* are difficult to meet. Failure to procure entire produce has not completely eliminated the dependence of farmers on local traders or traditional channels. Ideally, price being paid to the produce has to be known to farmers on succeeding day of delivery of produce in this arrangement. However, sometimes it is taking more than three days of delivery of produce to know the price being paid to their produce. Sometimes, payment to farmers is also being delayed for a period of seven to ten days which ideally should have been three to four days. Some members of TGA were tempted to sell their produce to organized retailers like *Reliance Fresh* and *More* who pay them immediately after delivery of produce. Farmers compare TGAs with other cooperatives like dairy co-operatives at village level and expect similar services like farmers education tours from TGAs.

Traders can get the required quality and quantity of produce at one place resulting in reduction in transaction costs. Produce quality is important criteria for organized retailers as consumers are sensitive to quality with increase in awareness and income level. In this arrangement quality is assured by cross-checking at collection center by the Secretary of TGA and at terminal market complex by quality control department.

Post harvest losses are reduced due to proper handling of the produce. Price paid by traders for the produce is also competitive to traditional channels. Traders use the storage and cold storage facilities at *Terminal* market complex which help them to avoid the investment and reduce fixed costs. Distant location of *Terminal* market complex from the city and unfamiliarity of auction process makes it difficult for small traders and hawkers to participate in auction process. Present market share of *Terminal* is not able to influence the market prices, instead, higher and lower auction prices of *Terminal* are determined based on market prices.

6. RECOMMENDATIONS

Arrangements for procurement of entire produce from farmers can be made by providing indents in advance specifying the required type and quantity of produce to be grown. Non-standard quality produce may also be procured and the channels for its disposal may be developed. Procurement of entire produce can significantly reduce the dependence of farmers on middlemen. Farmers prefer to know the price being paid to their produce at the earliest after auctioning. Information technology might be used to disseminate information about price.

Systems may also be developed for early disbursal of payments to farmers. Presently, farmers have to pack some of the vegetable like potato, onion, garlic in gunny bags for which they have to incur additional expenditure. The additional expenditure can be saved if the produce is accepted in trays or if gunny bags can be arranged by *Terminal* for a service charge. *Terminal Markets* can overcome the locational disadvantage by increasing the number of *cash and carry* centers in the city and enable small traders and hawkers to procure the produce.

Increasing the market share of *Terminal* in total fruits and vegetable business can help it to dictate the market prices and fetch good returns for farmers. *Terminal* may also explore the possibility of supply of produce to institutions like star hotels, canteens at industries, hospitals and educational institutes in and around the city.

7. CONCLUSION

As the urban markets are saturating, focus of the marketers is shifting towards the rural markets. It is not the buying power but the distribution, which is the biggest hindrance in realizing the potential of rural markets. Once the companies develop innovative low-cost models of reaching the rural markets, there is success like HUL and ITC etc. Rural India's problems are unique in nature, if addressed; tremendous growth can be expected by adopting exclusive and innovative strategies in sectors like FMCG, automobile, telecom etc. Recently India has seen a significant change in its socio-economic structure in its economy in rural and underdeveloped areas. Betterment of infrastructure, connectivity, educational facilities and income level of rural population has made rural markets significant and indispensable for corporate and marketers. Today as urban markets are reaching saturation in several commodities and showing negative growth, rural marketing is the alternate left for corporate as 742 mn. Live in more than 6 mn villages, out of which 2/3 of its work force engaged in agricultural and allied contribute more than 50% of India's GDP. *Terminal* market, a new initiative has overcome some of the marketing problems of perishables by setting up state-of-art infrastructure facilities, forming TGAs and selling the produce directly to wholesalers, retailers and institutions. This innovative institutional arrangement which is transparent has helped farmers to fetch reasonable price for their produce by maintaining the produce quality and reducing the length of supply chain, post harvest losses, transportation problems and transaction costs. Farmers are also being benefited from extension services provided by *Terminal*. Farmers' commitment and trust can further be improved by strengthening information system, making payments without delay and procuring entire produce. This terminal market is also beneficial to traders and wholesalers who can get graded and quality produce in required quantities at one place with minimum transaction costs and have access to warehousing and cold storage facilities.

REFERENCES

1. Rangacharya S. K. *Agricultural marketing and rural credit for strengthening Indian agriculture*, INRM policy brief No1. Asian Development Bank, New Delhi, (2005)
2. Directorate of Marketing and Inspection, *Modern terminal market for fruits, vegetables and other perishables*. Retrieved on September 5, 2008 from <http://agmarknet.nic.in>
3. Gandhi P. Vasant, *Marketing of Fruits and Vegetables in India: A Study Covering the Ahmedabad, Chennai and Kolkata Markets*, Indian Institute of Management Ahmedabad, (2005)
4. Thakur, R. S., *Wholesale marketing of fresh vegetables*, Annals of Association of European Geographers, 64(3):387-96, (1984)
5. Maheshwari & Mittal, *Postharvest losses due to gaps in cold chain in India* (ISHS), 7(12):777-84, (2005)
6. Nathani, T. G., *Information Technology in Rural Governance: Improving Retail Marketing*, Indica Books, (2007)
7. Gopalaswamy T.P., *Rural Marketing*, Himalaya Publication 2nd Ed., (2004)
8. Singh Sukhpal, *Rural Marketing Management*, Vikas Publication, (2005)
9. Ministry of Agriculture, *Operational Guidelines for setting up of Terminal Market Complex*, Retrieved on September 5, 2008 from <http://agricoop.nic.in>, (2006)
10. Mittal Surabhi, *Can horticulture be a success story for India?* Working Paper No. 197. Indian Council for Research on International Economic Relations, New Delhi, (2007)
11. National Institute of Agricultural Marketing, *Detailed Project Report on Development of Modern Terminal Market for Fruits & Vegetable at Chandigarh*, Retrieved on September 5, 2008 from <http://www.sbi.org.in/>
12. Planning Commission, *Report of the working group on agricultural marketing infrastructure and policy required for internal and external trade for the XI five year plan 2007-12*, Retrieved on August 14, 2007 from <http://planningcommission.nic.in>, (2007, January)

BRAND PROMOTION IN RURAL MARKETS OF INDIA

Prof. D.S. Chundawat

Dean, University College of Commerce & Mgt. Studies & Director,
MHRM Program, UCCMS, MLSU, Udaipur.

Prof. S.C. Sharma

Prof. & Board of Governor, Maharaja College of Management, Udaipur

Urvashi Sisodia

urvashi_smhrm@rediff.com, urvashisisodia85@gmail.com

+919460909169

Lecturer, Maharaja College of Management, Udaipur.

N.H. 76, Airport Road, Debari, Udaipur

ABSTRACT

"The future lies with those companies who see the poor as their customers."

The strong Indian brands have strong brand equity, consumer demand-pull and efficient and dedicated dealer network which have been created over a period of time. The rural market has a grip of strong country shops, which affect the sale of various products in rural market. The companies are trying to trigger growth in rural areas. They are identifying the fact that rural people are now in the better position with disposable income. The Indian established Industries have the advantages, which MNC don't enjoy in this regard. The low rate finance availability has also increased the affordability of purchasing the costly products by the rural consumer. Marketer should understand the price sensitivity of a consumer in a rural area.

Promotions of brands in rural markets require special measures. Due to the social and backward condition the personal selling efforts have a challenging role to play in this regard. The word of mouth is an important message carrier in rural areas. The experience of agricultural input industry can act as a guideline for the marketing efforts of consumer durable and non-durable companies. Relevance of Mass Media is also a very important factor. This paper is therefore an attempt to promote the brand image in the rural market.

Key words: rural marketing, market boom, market size & penetration, brand strategy, conclusion.

1. INTRODUCTION

On account of green revolution, the rural areas are consuming a large quantity of industrial and urban manufactured products. In this context, a special marketing strategy, namely, rural marketing has emerged. In India, leaving out a few metropolitan cities, all the districts and industrial townships are connected with rural markets.

The rural market in India is not a separate entity in itself and it is highly influenced by the sociological and behavioral factors operating in the country. The rural population in India accounts for around 627 million, which is exactly 74.3 percent of the total population. The rural market in India brings in bigger revenues in the country, as the rural regions comprise of the maximum consumers in this country.

The rural market in Indian economy generates almost more than half of the country's income. However, rural marketing determines the carrying out of business activities bringing in the flow of goods from urban sectors to the rural regions of the country as well as the marketing of various products manufactured by the non-agricultural workers from rural to urban areas. To be precise, Rural Marketing in Indian Economy covers two broad sections, namely:

- Selling of agricultural items in the urban areas
- Selling of manufactured products in the rural regions

2. RURAL MARKETING

It is the process of developing, pricing, promoting, distributing, and rural specific goods and services leading to exchange between urban and rural markets which satisfy consumer demands. The “rural marketing” which was earlier used as an umbrella term to refer all commercial transaction of rural people, acquires a separate meaning of great significance in the year 1990. Due to development program of central and state government, service organization and socially responsible business groups the rural area witnessed all round social –economic progress.



3. RURAL MARKET BOOM

India lives in her village. Profitable farming and better marketing options in some states have made a large number of villagers the potential consumers for Customer Durables and FMCG (Fast Moving Consumer Goods) companies. The size and profitability of rural market is increasing with agriculture development and infrastructure facility. The greater the agriculture development in an area, the greater the rural market. Trends indicate that the rural markets are coming up in a big way and growing twice as fast as urban.

Table 1: Distinctive Features Of Rural Markets Vis-à-vis Urban Markets

Features	Rural	Urban
Demand pattern	Seasonal	Uniform
Spread	Scattered	Concentrated
Literacy level	Low	Moderate
Per Capita Income	Low	Moderate
Awareness of needs	Not entirely known	Known
Infrastructure	Poor	Moderate
Sources of information, communication	Word of mouth personal/ direct selling, TV, radio, unconventional media	All
Supply	Erratic, untimely	Timely
Product info		
guidance	Needed	Adequate
Consumer Protection	No awareness	

SOURCE: NCAER (Economic Times)

4. MARKET SIZE AND PENETRATION

- The number of middle income and high-income household in rural India is expected to grow from 80 million to 111 million by 2007 while urban India is expected to grow from 46 million to 59 million.
- 53 per cent of all FMCGs and 59 per cent of all consumer durables are sold in rural India.
- Number of poor household is expected to shrink by half to 28 million in 2006-07 from 61 million in 1997-98, taking rural people from poverty to prosperity (according to 2001 census).
- Rural marketing involves addressing around 627 million potential consumers, over 40 per cent of the Indian middle-class, and about half the country's disposable income.
- The Indian rural market is almost twice as large as the entire market of USA or Russia.
- The rural market for FMCG is ₹ 65,000 crore, for durables ₹ 5,000 crore, for tractors and agri-inputs ₹ 45,000 crore and two- and four-wheelers, ₹ 8,000 crore. In total, a whopping ₹ 1,23,000 crore (according to The Financial Express).



Table 2: Rural product portfolio

Category I	Category II	III (Items costing more than Rs.6,000)
Pressure cookers	2 in 1 (mono)	CTV (S)
Pressure pans	2 in 1 (stereo)	CTV ®
Mono cassette recorders	B & W TV (S)	VCRs
Bicycles	B&W TV ®	VCPs
Wrist watches	Instant geysers	Scooters
Wrist watches (Quartz)	Storage geysers	Mopeds
Radio/ transistors	Sewing machines	Motorcycles Electric Irons
Electric Irons	Vacuum cleaners	Refrigerator
Ceiling fans	Mixer/ grinders	Washing machines
Table fans		

SOURCE: NCAER (Economic Times)

Thus, looking at the opportunities, which rural markets offer to the marketers, it can be said that the future is very promising for those who can understand the dynamics of rural markets and exploit them to their best advantage

5. BRANDING STRATEGY IN RURAL SECTOR

5.1 RURAL PRODUCT DEVELOPMENT The rural market is a fast growing one and has a huge population with a great level of disposable income. To encash this, products have to be specifically developed to meet the needs of rural markets. Sometimes, existing products might have to be modified to suit these markets too accordingly. Rural product development has the strong edifice on a great deal of research like feasibility studies, rural aspiration, rural profiling and so on. This paves way for a great deal of infrastructure and expertise in this area.

5.2 RURAL BRANDING Rural branding is attained by way of opting to a greater percentage of local media and a smaller percentage of the mass media. Rural gatherings like temple festivals, melas, and cinema halls and so on can be used as venues to promote brands. Direct Marketing and events like road shows; film shows, melas, street theatre can also be used to promote brands. A well-planned rural branding campaign cannot just create brand awareness but help your target relevant to your brand and promote sales. A long-term campaign will keep your brand at the top-of-the-mind and build brand loyalty. So the brands are in safe hands.

5.3 RURAL MARKET RESEARCH Rural markets behave most differently from urban markets. While many marketers have tried to market their products in rural areas, just a handful of the same only has succeeded. A strong insight into rural consumer behavior and sensitivity to their values and beliefs is essential; to upgrade the rural market rural market research encompasses not just gathering data but analyzing them and linking the findings to promoting your products.

5.4 RURAL COMMUNICATION CAMPAIGNS Communication for rural markets calls for a different kind of outlook. There must be a strong accent on helping the target relate to the message. The entire communication and media strategy has to devise a system based on research findings. These have to be developed in the regional vernacular languages and set in the local culture for easier acceptance and reach. Unlike communication campaigns in urban areas that rely greatly on the mass media, the strategy will be of

crying in the wilderness in rural areas. Besides mass and outdoor media, rural extravaganza where the villagers come together can be used for promotions.

5.5 RURAL EVENTS In the rural context, one of the best ways to capture the attention of the audience is through Event-management. Since rural areas have limited venues for entertainment, conducting an event in rural areas can bring a good response.

A well-planned event can get the product the mileage that we want. Some of the interesting events that can be conducted are Road Shows, Melas, Street-Theatre, and Film Shows and so on. These make a visually strong impact and build long term brand recall. Rural public are the target audience and hence the portfolio of event management has to be handled professionally with diligent care and broad perspective.

5.6 RURAL DIRECT MARKETING CAMPAIGNS DM is one of the most powerful way to meet the target on their turf and build product awareness as well as promotion. The success of any DM campaign depends on the field workers and their sensitivity and emotional connectivity to rural markets.

In the area of Direct Marketing, rural team has to be trained, to be sensitive to rural culture and beliefs. They can handle activities like Door-to-Door sampling, marketing and product promotion.

5.7 DATABASE CREATION & MANAGEMENT Marketing, branding and promotional activities in the rural context can be highly effective and thereafter have to create a database of prospects. The question is how will the company source this critical data? The data will contain details of the target segments at the village level / town-level. This data is essential to reach the target accurately and helps in marketing plan and communication strategies. Management Information System along with Database management paves ways for a congenial rural marketing through the information and data available for effective interpretations and use.

6.CONCLUSION

Rural marketing in India is seen by many brands as a huge growth opportunity. The rural consumer is growing and this is an opportunity to grab the market share for all the global players in the market -- whether it is into Fast Moving Consumer Goods (FMCG) sector or retail sector (either insurance or banking or for that sake any other sector). The rural market is vibrant and holds tremendous potential for growth of insurance business, particularly because of the strong saving habits. Of The 627 Million rural consumers realistically about 200 million have the propensity to spend. However, it is claimed that disposable incomes in higher income classes in rural areas is higher than in urban areas since many services such as housing, health and education (leaving quality issues aside) cost far less.

Segment % of consumers who preferred branded items	< 40%	40 –80%	>80%
Necessity/ popular	Coconut oil	Iodized salt	Toilet soaps
		Tea	Washing powder
		Biscuit	
		Blues(Neel)	Toothpaste
			Razor Blade
	Refined oil	Hair oils	Shampoo
		Bulbs	Batteries
			Rubs, balms
			Skin cream
			Toothbrushes
			Antiseptics
			Chyavanprash
			Digestives
			Mosquito Repellents
			Shaving creams Tube lights

REFERENCES

1. Bali Monish. The rural market likes it strong, The Economic Times, [Interview by An Awasthi], August 23, 2000.
2. Jha Neeraj. Gung-ho on rural marketing, The Financial Express, June 19, 2000.
3. Swamy Gopal T. P. Rural Marketing, Environment-Problems and strategies, Wheeler publishing, 1997.
4. The Marketing Mastermind Case study HLL- Rural Marketing Initiatives, ICFAI Press, Feb 2003, pp62.
5. Communication & Promotion in Rural Markets – Indian Journal of Marketing (June 2004)
6. Rural Marketing Challenges in the New Millennium -Delhi business Review (Jan-2003)
7. Strategies of Multinationals in Rural Marketing - Indian Journal of Marketing (July 2002).

A STUDY OF RADIATION DURING ARC WELDING USING FLUX CORED WIRES

LI Zhiyong

College of Materials Science and Engineering, North University of China
Department of Mechanical Engineering, The University of Akron, Akron, Ohio, 44325, USA

T.S. Srivatsan

e-mail: tsrivatsan@uakron.edu,
Department of Mechanical Engineering, The University of Akron, Akron, Ohio, 44325, USA

Yan Xiaocheng

College of Materials Science and Engineering, North University of China Taiyuan, Shanxi, 030051, China

Wang Yao

College of Materials Science and Engineering, North University of China Taiyuan, Shanxi, 030051, China

Guo Yong

College of Materials Science and Engineering, North University of China Taiyuan, Shanxi, 030051, China

ABSTRACT

The radiation of plasma, which occurs as arc welding is gradually applied in industry, is a basic phenomenon of the arc welding process. Over the years, a considerable amount of research work has been conducted and examined to use arc radiation for an actual diagnosis of the welding process and this has yielded promising results. The flux cored wire (FCW) arc welding is a process having the advantages of a stable arc, better bead formation, coupled with controlled properties of the weld metal. However, few research studies have been done to both study and examine the radiation that occurs during flux cored wire (FCW) arc welding. Radiation of the arc can and does provide useful information related to the elements present in the plasma arc and the overall stability of the process. Therefore, in this paper we examine the spectrum of arc radiation emitted by different kinds of flux during wire arc welding. Furthermore, a synchronous collecting system is used to collect both the electrical signal and spectrum signal of the process. A high speed photo of the plasma arc is taken in order to enable a better understanding of the actual process. The results are related to the welding parameters with the primary purpose of establishing a relationship between arc radiation and the welding parameter.

Key Words: Flux cored wire; Arc welding; Arc radiation; Spectrum; Synchronous collecting

1. INTRODUCTION

The flux cored wire was originated way back in 1954 and was initially applied as a self shielding welding process. Subsequently, the flux cored wire was commonly used along with gas shielding to obtain better and consistent mechanical properties [1]. However, extensive application of the flux cored wire for use in viable industrial applications was limited up until the mid-1970's when flux cored wire (FCW) having a diameter less than 2.0 mm was first introduced. Gas shielded flux cored wire (FCW) arc welding progressively gained advantage and strong hold due to a combination of better bead formation and resultant mechanical properties, which resulted from dual shielding of both the flux and gas [2, 3]. The required elements, which helped to improve properties of the weld metal, can be easily transferred by the addition of flux [4]. In more recent years, flux cored wire has been used in few to several industrial applications, such as, shipbuilding, and transportation. However, researchers and potential end-users continue to be concerned about the plume and fume that is emitted from the arc [5], which is often harmful to not only the welder but also the environment [6]. Besides, the welding parameters have a significant influence on properties of the weld bead and an overall stability of the welding process [7, 8]. In our earlier research study, the electrical signal of the welding process was collected and systematically analyzed for purposes of evaluating overall stability of the welding process [9]. However, this criterion is required to be provided for the different welding conditions, which often makes it difficult in industrial applications. In order to get a new method that can provide useful information on the process, the radiation of the plasma arc is studied and attempts have been made to correlate with the welding process, which is critical for its continued application.

Radiation of the plasma arc can be considered to be abundant with information related to the welding process. This resulted in its promising application in both the diagnosis and control of the actual welding process [10, 11]. Radiation of the plasma arc is an arc that discharges illumination, which is determined by (i) the temperature of the arc, and (ii) the particles that exist in the plasma. Since considerable amount of information can be easily acquired from the spectrum of a plasma arc, the

spectrum has been used to get the following: (a) the electronic temperature, (b) particle density, and (c) energy distribution of the plasma arc. In the arc welding process, radiation of the arc and its variation are both determined by (i) the welding parameter, and (ii) stability of the welding process. Therefore, a substantial amount of research work has been done to make a dedicated effort at correlating the welding parameters with radiation of the arc. For example, the arc length of Tungsten Inert Gas (TIG) welding is found to be linearly related to the intensity of arc radiation, especially in the Ar I dominated zone. Therefore, radiation of the TIG arc is used to effectively control arc length during TIG [12]. For gas metal arc (GMA) welding, researchers have attempted to diagnose the droplet transfer mode with the spectral signal [13]. Besides, the spectral signal is often used for detecting welding defects both for gas tungsten arc welding (GTAW) and gas metal arc welding (GMAW) [14,15].

However, up until now very few studies have been made to explore the spectrum of the flux cored wire (FCW) during arc welding. This technique has in more recent years shown the potential for promising industry-related applications. Therefore, in order to get a fundamental understanding of radiation of the plasma, which is formed during flux-cored wire (FCW) arc welding, the spectrum of three types of flux-cored wire was carefully collected and compared with the GMAW process. Also, a synchronous collecting system was applied for the purpose of analyzing the dynamic process of arc fluctuation and its intrinsic relationship with the welding parameter, which is helpful for an actual diagnosis of the overall stability of the welding process.

2. EXPERIMENT SETUP

2.1 WELDING MATERIAL AND WELDING PARAMETER The experiment was about striking a welding arc by moving a welding torch, which was set on a welding tractor. The welding plate was static and the weld bead was formed with the aid of relative movement. A NB500 welding power was used and carbon dioxide (CO_2), with a flow rate as 18L/minute, was used as the shielding gas. In order to achieve the objectives of this study, the experiment was divided into two distinct processes. In the first process, three different kinds of flux-cored wires (FCW) and one solid welding wire (chemical composition summarized in Table 1) were selected and their spectra were collected for purpose of comparison, thus providing useful information pertaining to the arc. The chemical composition of both the flux and slag of the titania-type flux cored wire is provided in Table 2. In the second process, the dynamic process of a selected wire was analyzed in an attempt to better correlate the actual radiation with the parameter, which had not been studied and established for gas metal arc welding (GMAW).

Table 1. Chemical content of the welding wire (percent)

Type of wire	C	Mn	Si	P	S	Ni	Cr	Mo	other
ER50-6(WH-50-6)	0.06-0.15	1.40-1.85	0.80-1.15	<0.025	<0.035	<0.30	<0.29	-	-
309LT0(SQA309L)	0.029	1.21	0.59	0.031	0.010	13.56	23.11	0.04	-
DW-100	0.05	1.35	0.45	0.009	0.013	-	-	-	-
K-71 TLF(AWS)									

Table2. Chemical content of flux and slag of the Titania type FCW (DW-100 and -71 TLF) (Weight percent)

	TiO ₂	SiO ₂	Fe	Mn	MnO	Fe ₂ O ₃	ZrO ₂	K ₂ O	CuO	C	CO ₂	Na ₂ O	CaF ₂	other
Flux	40.5	21	20	15.8	-	-	-	1.4	0.7	0.6	0.5	1.6	-	-
Slag	50	16.8	-	-	21.3	5.7	-	-	-	-	-	-	-	-

In an attempt to analyze the dynamic process, the arc is created using five groups of parameters (summarized in Table 3), which are selected for the different droplet transfer modes. A normal welding speed ranging from 14cm/minute to 28 cm/minute is applied for the different welding processes in accordance with the welding parameters.

There are different kinds of signals that can provide useful information on the arc during welding. The applied signals include: (a) electrical signal, (b) high speed photo, and (c) spectra of the plasma. The electrical signal is one of the most commonly applied signals for the purpose of detecting welding process because to its high speed and the likelihood of being collected. High speed photo is pure visualization and is also one of the best available methods for understanding the transient state of the plasma arc.

Radiation of the plasma arc is a promising signal primarily because it provides useful information pertinent to the weld arc. However, these signals have their own limitations. Therefore, following an analysis of the multiple signals, both the state of the arc and its radiation can be better understood.

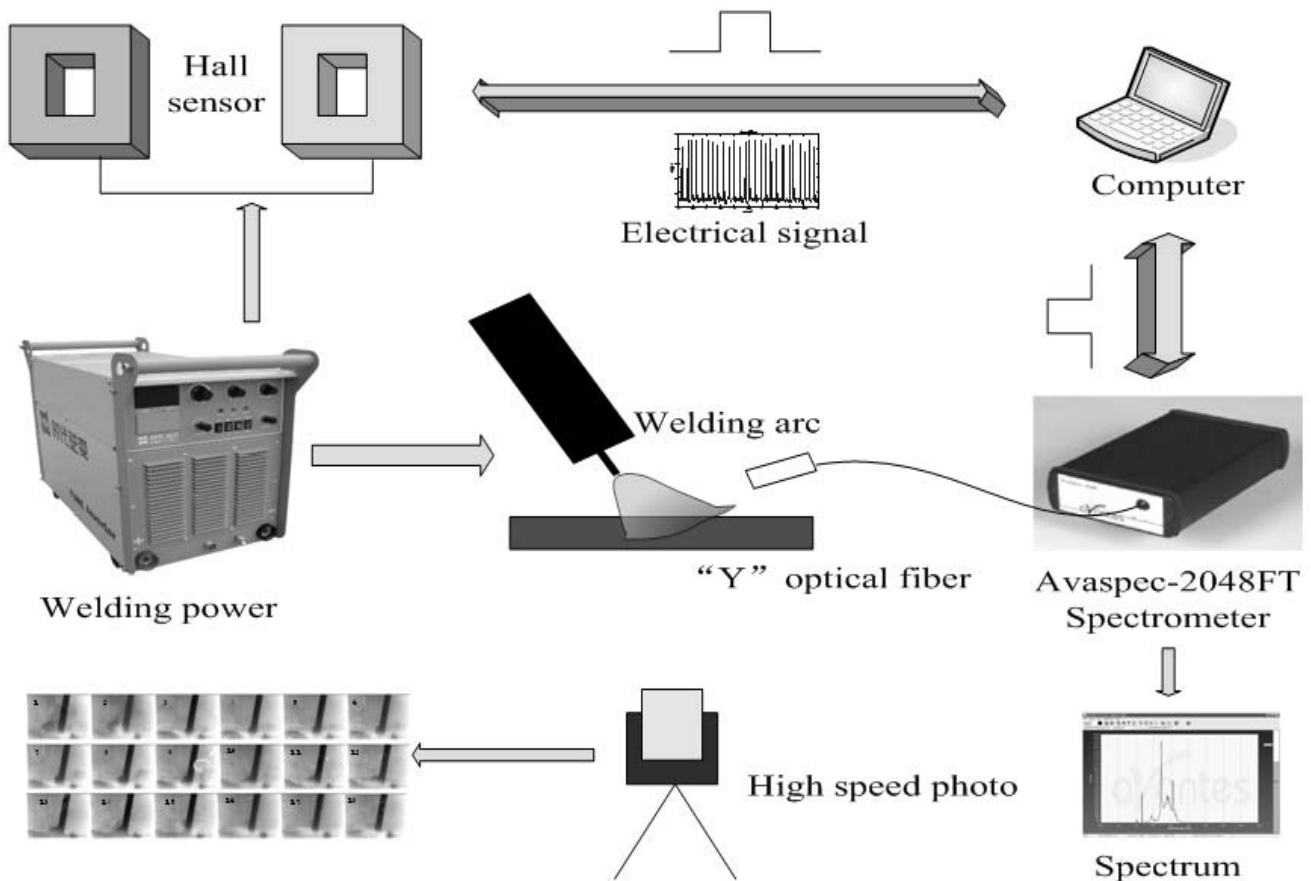
Table 3. Welding parameter

Welding parameter	Average voltage/V	Average current/A	Gas flow rate/L/min	Extension length /mm
1	20	160	18	20
2	25	190	18	20
3	28	240	18	20
4	30	250	18	20
5	35	330	18	20

2.2 THE DATA COLLECTING SYSTEM As shown in **Figure 1**, the data collecting system can collect spectra of the arc plasma, and the electrical signal simultaneously. A data collecting card (Type: PCI 1710) installed in the computer is used to produce the triggered pulse signal. The collecting process is carefully controlled using appropriate software, which is developed based on Labview 8.2 in our earlier research study [16]. The software attempts to control the sequence for both the collection of data and processing of data. The only difference being the system is not used to trigger a high speed photo that is discussed in this paper. When the collecting process is triggered by a pulse signal, synchronous pulsed electrical signals are transferred to both a digital spectrometer and associated sensors for purpose of triggering the collecting process. In order to ensure that the pulsed signal is in phase with the other signals, the pulsed signal is collected by the PCI card for purpose of comparison.

With the application of sensors, the electrical signals, to include both the weld current and arc voltage, are collected by the digital collecting card at a frequency as high as 100-KHz. The digital spectrometer has an external trigger function. When a pulse is received, a quick one shot spectra collection is done with a delay of less than 0.001ms. Furthermore, the high speed camera is applied in our test for the purpose of analyzing state of the arc and its transfer mode. It can easily capture the photos continuously at 1000 frames per second.

Figure 1. Schematic of the experimental setup



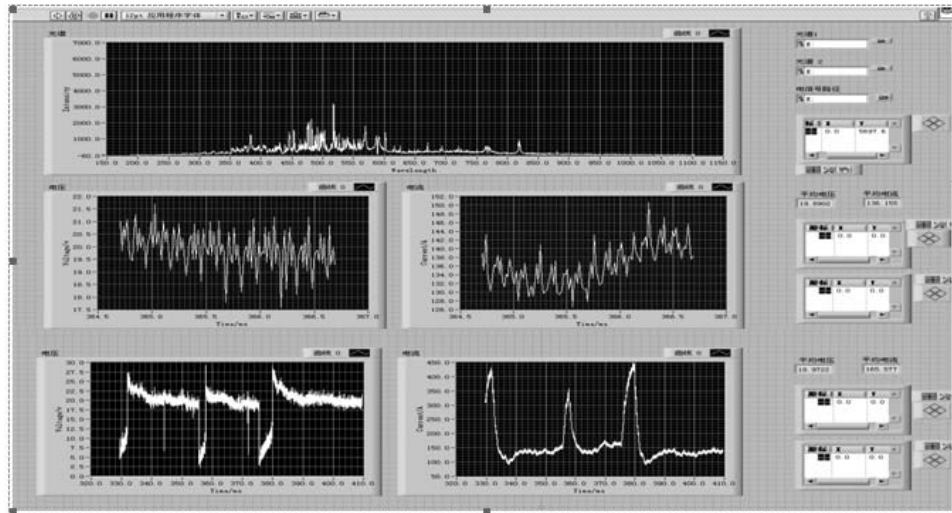


Figure 2. The synchronism collecting software for electrical signals and spectrum

As shown in **Figure 2**, the collected data of relevant electrical signals and pertaining to the spectrum are then carefully analyzed using the software. The synchronous signals are processed to be in phase, which is important for purpose of dynamic analysis of the arc during welding. In **Figure 2**, the collected spectrum from 200-nm to 1100-nm, within a 2-ms duration, is collected and shown in the up-window and the corresponding electrical signals pertaining to the welding process is shown in the bottom window. In an attempt to analyze the electrical signal and state of the arc within the same 2-ms spectrum, the enlarged electrical signal during the same time period is shown in the middle window.

3. A COMPARISON OF THE SPECTRUM OF DIFFERENT FLUX CORED WIRES

The collected spectra are shown in **Figure 3** to **Figure 6**. From the figures it is observed that different kinds of FCWs have different spectrum for the same welding parameter. For the DW-100 and K-71TLF, they are the same type of Titania flux-cored wires with the only difference being they come from different companies. The DW-100 is a Japanese product while the K-71TLF is a product that is made in China. After systemically and carefully comparing the two types of Titania flux-cored wires, the line spectrum is considered to be the same (**Figure 5** and **Figure 6**). The SQA309L flux-cored wire is often used for the welding of stainless steel. As shown in Table1, the chemical content of this wire is different from the wire of Titania type in that it has high chromium (Cr) and high nickel (Ni) content. As shown in **Figure 3**, the spectrum of the SQA309L FCW is quite different from spectrum of the DW100 and K-71TLF FCWs. The DW100 and K-71TLE flux cored wires have far more intense continuous radiation and their line spectra were observed to aggregate in 400nm-600nm. However, the SQA309L flux-cored wire has a few line spectra with enough intensity for wavelengths beyond 600-nm. The WH-50-6 is a solid welding wire, which is used for purpose of comparison

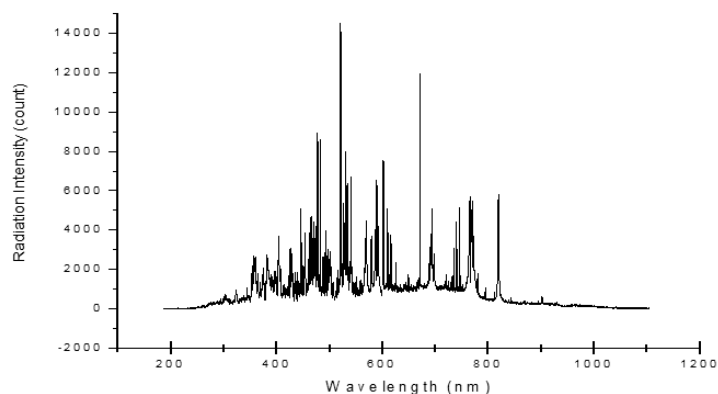


Figure 3. Spectrum of SQA309L flux cored wire

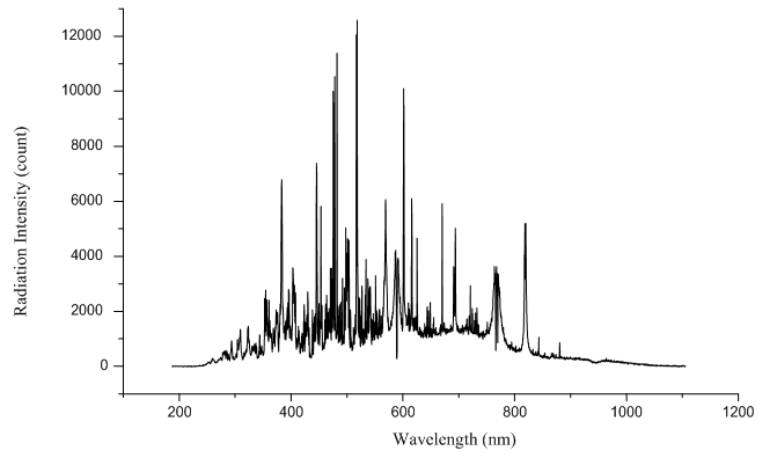


Figure 4 . Spectrum of WH-50-6 wire

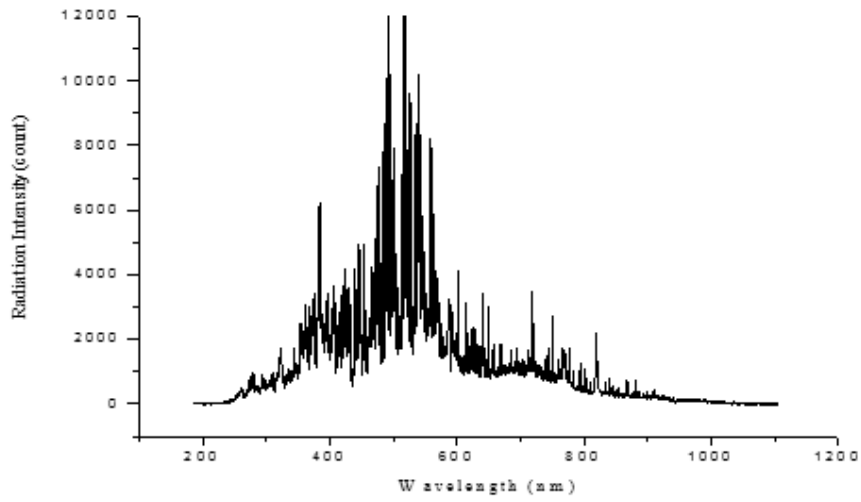


Figure 5 . Spectrum of DW100 flux cored wire

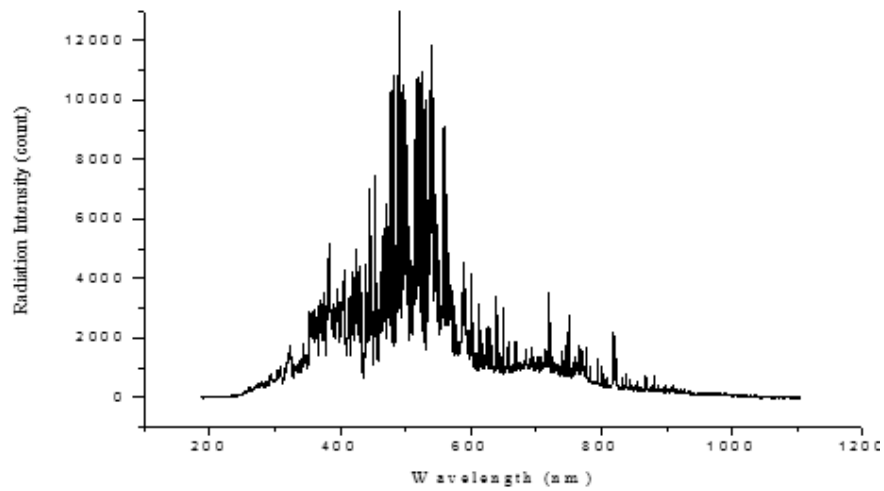


Figure 6 . Spectrum of K-71TLF flux cored wire

In order to identify the intrinsic differences between the line spectra, two selected bands (500-600nm, 600-760nm) were chosen for purpose of comparison and the line spectrum was calibrated using the data obtained or taken from the NIST (National Institute of Standards and Technology) database (**Figure 7** and **Figure 8**). For the spectrum from 500-nm to 600-nm (**Figure 7**), because the existence of a large amount of Fe I line spectrum, most of the line spectrum appears to have in the same wavelength. However, the Cr I line spectra at 529.60-nm and 578.86-nm provides the difference between the two kinds of wires used. For radiation in the domain 600-760nm (**Figure 8**), the difference is obvious. The line spectra of the SQA309L FCW is obviously stronger when compared to the line spectra of the K-71TLF FCW. A lot of line spectra, which is emitted by the Ni/Cu and other elements, can be found. This is essentially because of the elements added to the stainless wire (SQA309L). Through a careful diagnosis of the intensity of radiation of the line spectra of certain element, such as chromium, the fume density of the element, which is harmful to the environment can be defined and/or established. The diagnosis method provides a possible application of arc radiation for the purpose of evaluating environment effects on the weld material. The method is significant for flux-cored wire primarily because one of the main disadvantages of the flux-cored wire is the emitted fume, which is harmful to both the environment and the operator.

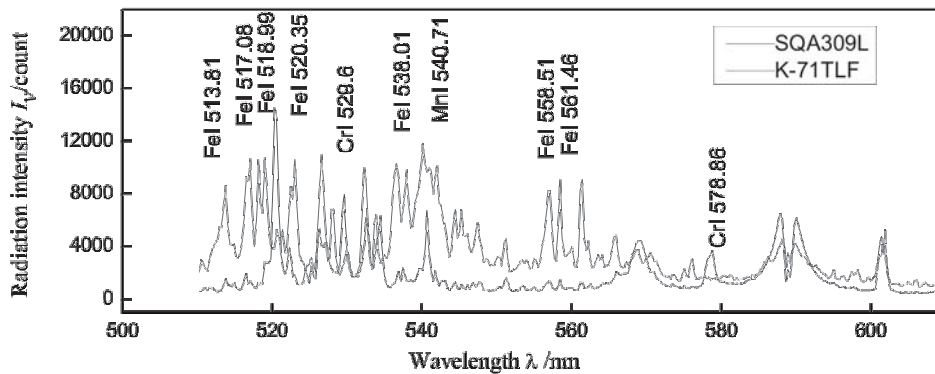


Figure 7. Spectrum of SQA309L and K-71TLF (500-600nm)

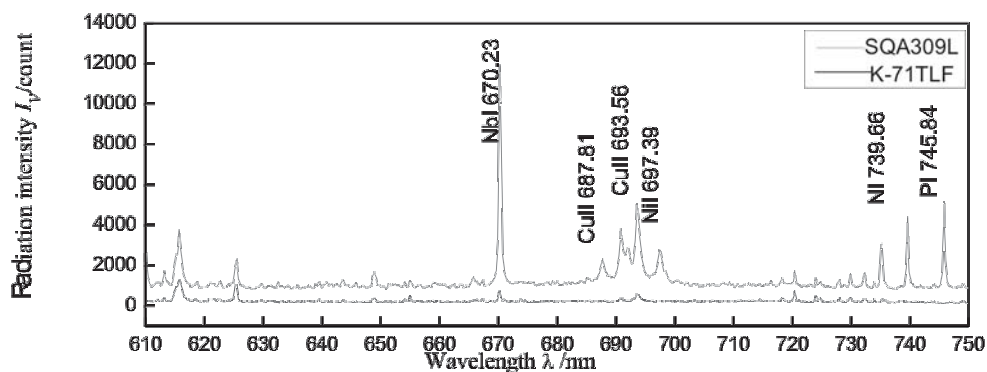


Figure 8. Spectrum of SQA309L and K-71TLF (600-760nm)

For the radiation of the solid welding wire (**Figure 4**), which have been studied and documented earlier, the radiation is quite different. As shown in **Figure 9**, there is a Si I and Ti I line spectrum for the flux-cored wire K-71TLF, which cannot be easily observed in the spectrum of the flux cored wire WH-50-6. For the flux cored wire SQA309L, the Si I and Ti I can also be observed to have enough intensity. The line spectra of both Ti I and Si I are caused by elements that existed in the flux of the specific FCW, which helps to form fume in the plasma arc. Besides, the line spectra of Si I can also be found at a wavelength near 769-nm. The line spectra do clearly provide useful information on state of the flux and its intrinsic influence on overall stability of the arc.

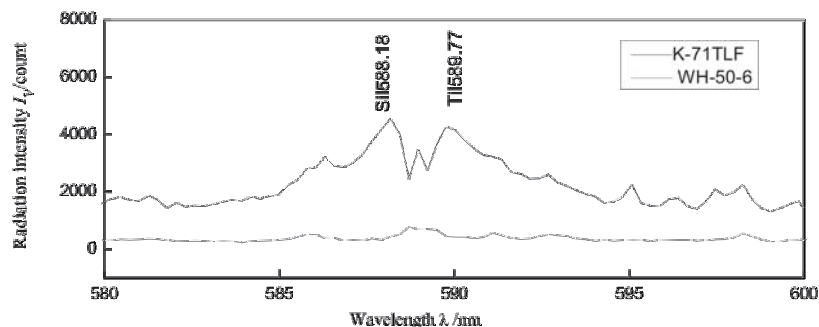


Figure 9. Spectrum of WH-50-6 and K-71TLF (580-600nm)

4. DYNAMIC RADIATION FROM PLASMA ARC OF THE FLUX CORED WIRE

Even though different kinds of FCWs exhibit dynamic properties showing a noticeable difference, the rule for dynamic fluctuation is basically the same. Therefore, in an attempt to analyze dynamic radiation of the plasma arc of the flux-cored wires (FCWs).

The flux cored wire DW100 is selected on account of its stable welding process coupled with continuous welding quality. The welding process in progress using the parameters is as shown in Table 3. Upon comparing the droplet transfer mode and arc radiation of the five groups of parameters, Group 1 and Group 5 are selected for the purpose of analysis primarily because they have a typical transfer mode of short circuit transfer and free droplet transfer.

4.1 DYNAMIC RADIATION OF THE SHORT CIRCUIT TRANSFER MODE The dynamic radiation of arc is significant for the purpose of understanding the welding process using melt droplet transfer. This has been a problem that limited the application of arc radiation in the diagnosis of the welding process. There are other factors, such as (i) droplet transfer, and (ii) variation of the arc length, that can affect radiation of the plasma arc. Due to the limitation imposed by continuous collection of the whole spectrum of the arc, it is often difficult to know what state of the arc will be and what the corresponding radiation is. Based on the large number of independent studies on the electrical signal along with high speed photo of the welding arc, it is reliable to establish state of an arc having an electrical signal, especially for short circuit transfer. As shown in **Figure 10**, the short circuit occurs when the droplet is growing and tends to make actual contact with the weld pool. Different stages of the short circuit transfer have or exert their characteristics on the welding current. In Stage 1, the arc is just a re-stroke and the droplet starts to form at the tip of the wire. Subsequently, the droplet begins to grow (Stage 2), which tends to slowly decrease the weld current due to a control of the welding power. When the droplet establishes contact with the actual physical weld pool (Stage 3), the welding current increases and reaches a peak. Following this a necking-down occurs and the droplet gets transferred (Stage 4). Subsequently starts a new cycle.

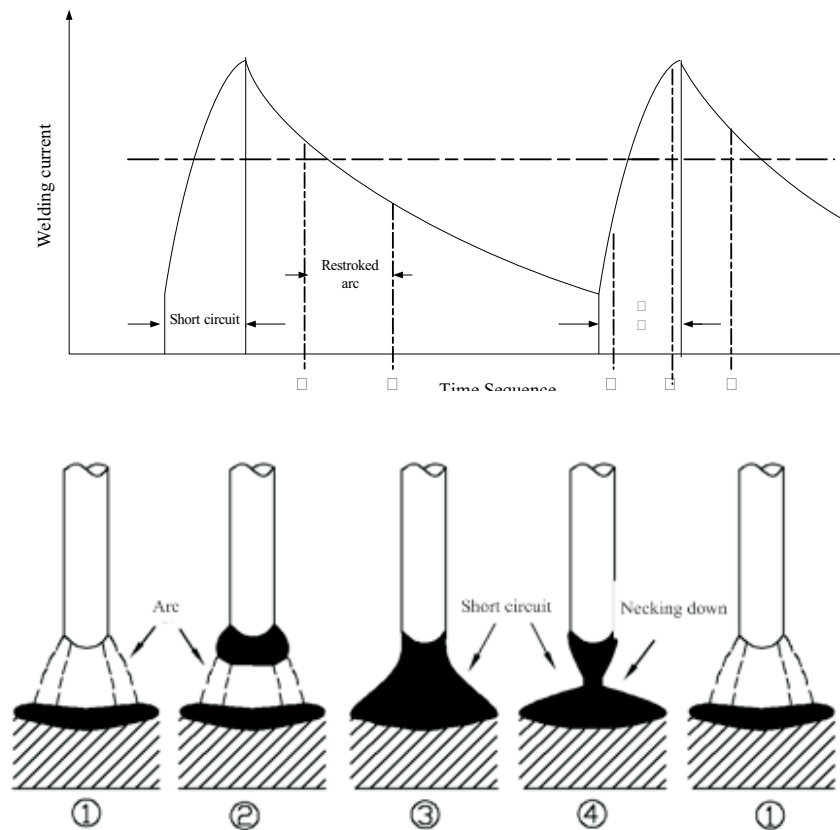


Figure 10 . The short circuit process of the arc welding

In **Figure 11** is shown a high speed photo of arc welding using the flux-cored wire. In **Figure 11**, from 1 to 10 is the time period for burning of the arc and size of the droplet grows with burning of the arc. The length of the arc is short with growth of the droplet until a short circuit occurs (11 to 15). When a short circuit does happen, the current required for welding quickly increases. This helps or enables to form a necking down of the droplet (as shown in 15).

Then, the arc was re-stroked (16) and a formation of this causes a high intensity radiation at the beginning of the arc (16 to 18), sometimes accompanied with spattering. Another phenomenon that is often observed during high speed photo is melt-retardation of the flux core and formation of a tip in the middle of the wire. This phenomenon is caused by a lower melting speed of the flux than melt speed of the metal wire around

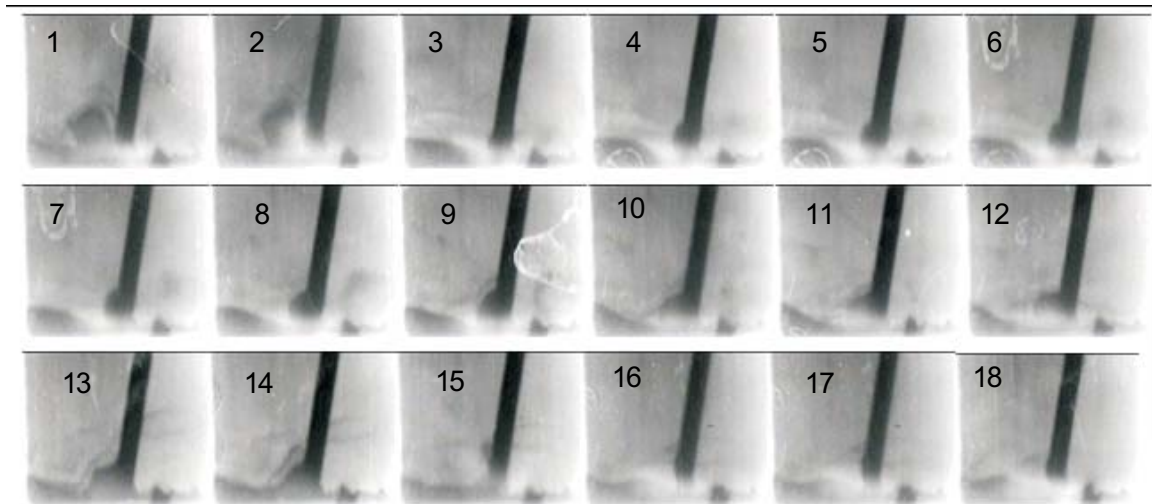


Figure 11. High speed photo of the short circuit transfer of Flux Core Wire

In an attempt to better understand radiation of the plasma arc at different instants of the transferring process shown in **Figure 10** and **Figure 11**, a synchronous collecting system shown in **Figure 1** is used to simultaneously collect both the spectrum and the electrical data. In **Figure 12** to **Figure 14** is shown the collected data corresponding to the states shown in **Figure 10**.

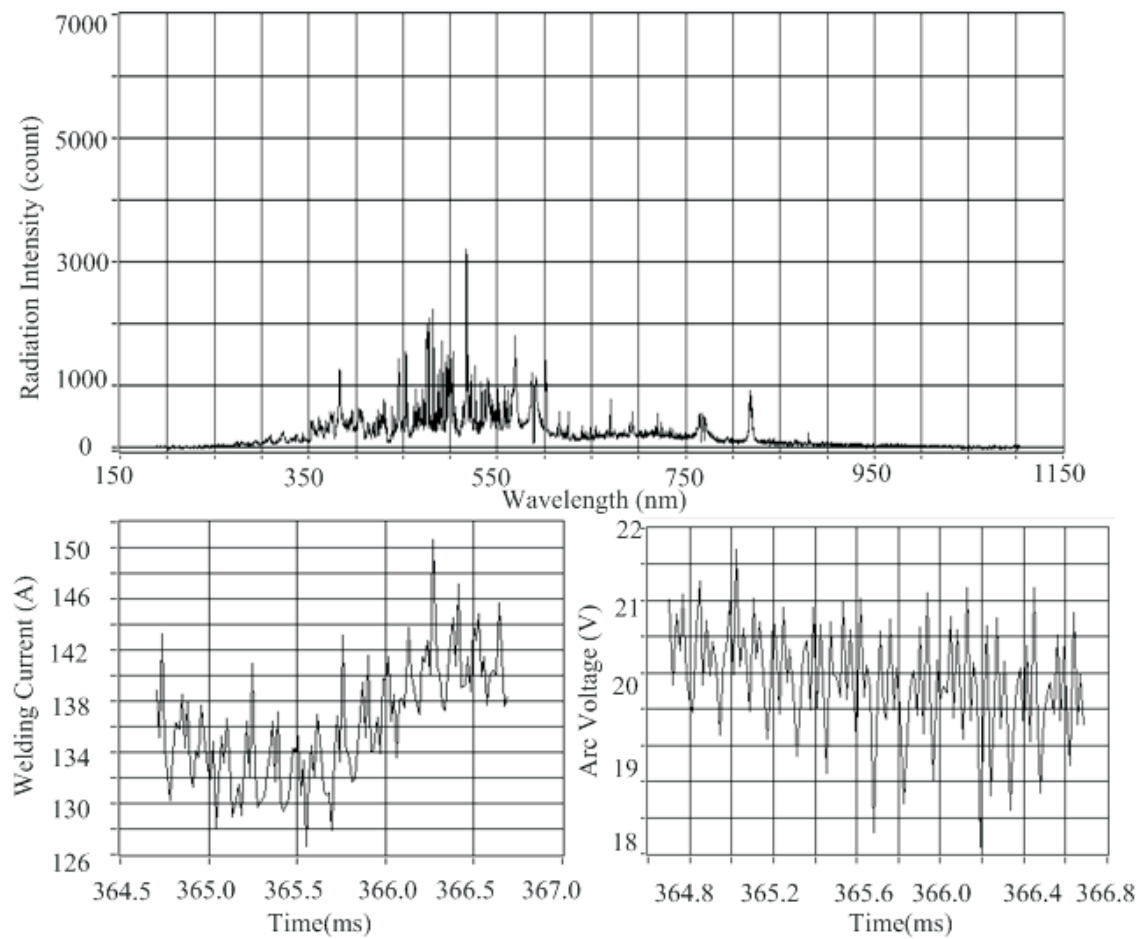


Figure 12. Synchronism signals of arc between stage 1 and 2

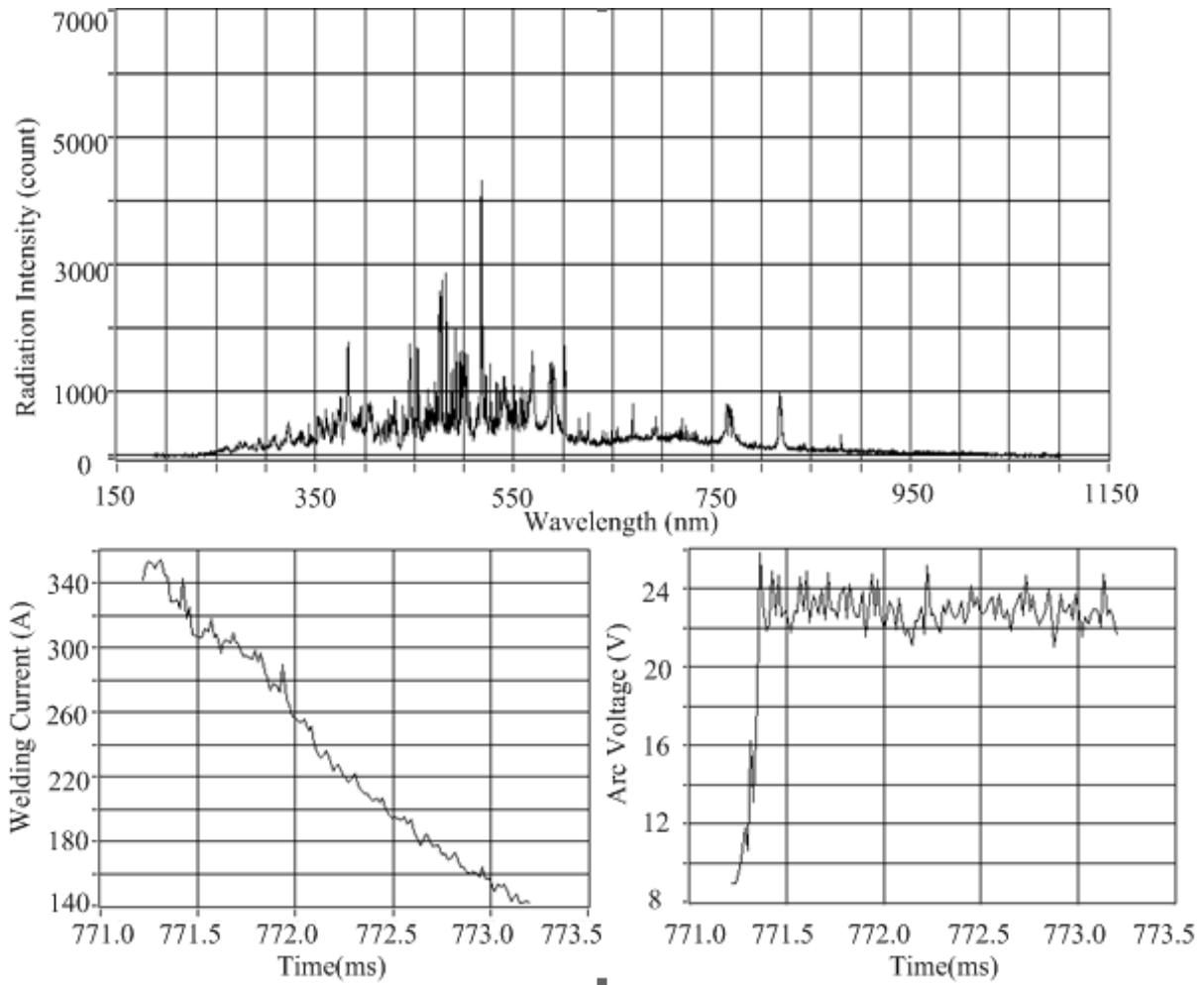


Figure 14. Signals of arc between stage 4 and stage 1

In Figure 12 is shown the arc radiation during the period of Stage1 and Stage 2 that is shown in Figure 10. The droplet is gradually growing in size with burning of the arc. As shown in Figure 12, the welding current increases and the arc voltage gradually decreases with a decrease in arc length, which is the direct result of the droplet growing. A corresponding spectrum of arc radiation reveals radiation of the arc to have a lot of line spectrum in the 350nm-600nm bands, which is dominated by Fe I and other metal line spectra as have been presented in Section 3. However, when the droplet comes in contact with the welding pool, a short circuit occurs and the plasma arc is now in Stage 3. In Figure 13 is shown the short current period corresponding to the period between Stage 3 and Stage 4 that is shown in Figure 10.

The welding current quickly increases and the arc voltage drops from 20V to nearly zero. This means that the droplet is in contact with the welding pool and a short circuit occurs. The corresponding radiation is very weak, which is the key reason for blowout of the plasma arc. In Figure 14 is shown the re-stroke of the arc after a short circuit period, corresponding to the period between Stage 4 and Stage 1 that is as shown in Figure 10. As shown in Figure 11, re-stroking the arc will tend to cause an instant occurrence of burning of the plasma arc. The welding current drops from more than 300A to less than 150A and concurrently the arc voltage jumps from near zero to 23 A (Figure 14). Even though the arc voltage is not kept at a normal value, the radiation is either nearly the same as or higher than that shown in Figure 12.

4.2 DYNAMIC RADIATION OF FREE DROPLET TRANSFER MODE When the arc voltage is high, the droplet transfers freely without establishing contact with the weld pool. However, when the welding current is low when a high arc voltage is applied, the droplet will grow to a noticeably large size and tend to harm the overall stability of the welding process by a transfer mode referred to as the globular transfer. However, if the welding current is improved simultaneously, fine droplets will be formed and even spray transfer occurs.

As shown in Figure 15, there is a free fine droplet transfer mode, which means there is no short circuit occurrence in the process. The plasma arc keeps burning during the welding process and at some time a slightly repelled transfer can occur. This is essentially caused by a cooling effect of the shielding gas (CO_2). Overall, fine droplet transfer is dominated in the whole welding process (1-8 and 14-18). This implies that the arc is burning with enough intensity to provide a stable welding process.

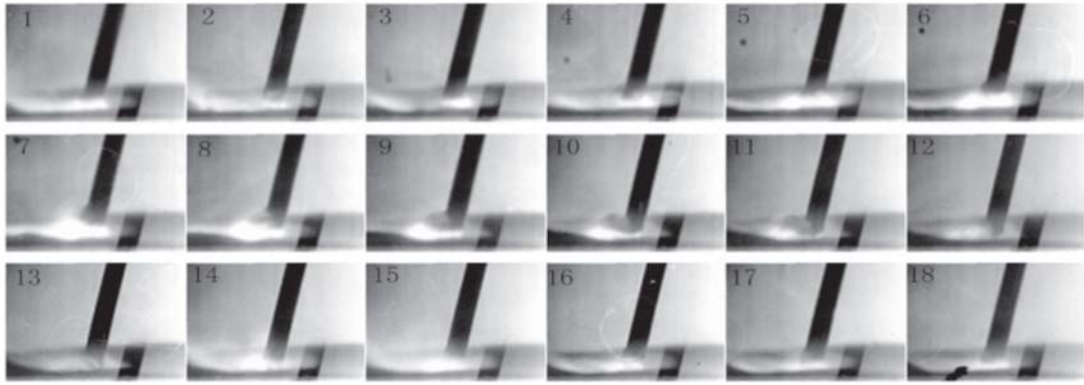


Figure 15. High speed photo of the free droplet transfer of FCW

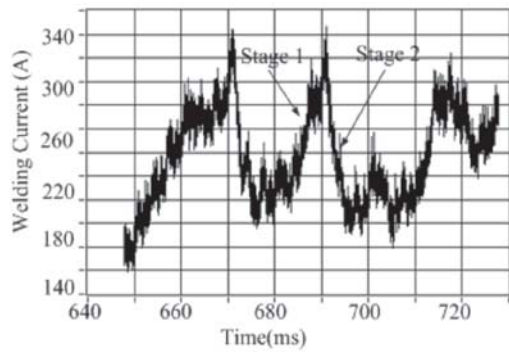


Figure 16. Welding current of free droplet transfer

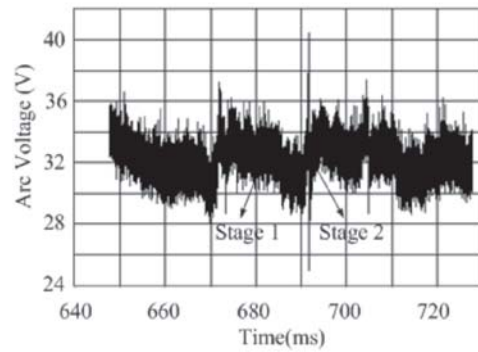


Figure 17. Arc voltage of free droplet transfer

For the free droplet transfer mode the corresponding welding current (**Figure 16**) and arc voltage signal (**Figure 17**) are as shown. As shown in **Figure 16**, the welding current fluctuated near 300A, which is essentially caused by the self adjusting process of the welding power corresponding to the arc voltage. In **Figure 17**, it is observed that the arc voltage fluctuates between 29V and 36V. This is due to (a) droplet transfer, and (b) deflection of the melting droplet. Upon comparing with the short circuit transfer mode, the welding current and arc voltage of the free droplet transfer are found to be stable without extinguishing the arc.

The free droplet transfer process is not as complex as that of the short circuit transfer process. The process can be simply divided into two distinct stages, as shown in **Figure 16** and **Figure 17**. In Stage 1, size of the droplet grows while the arc voltage decreases and the welding current increases. In Stage 2, the droplet transfer occurs with the welding current decreasing and the arc voltage increasing.

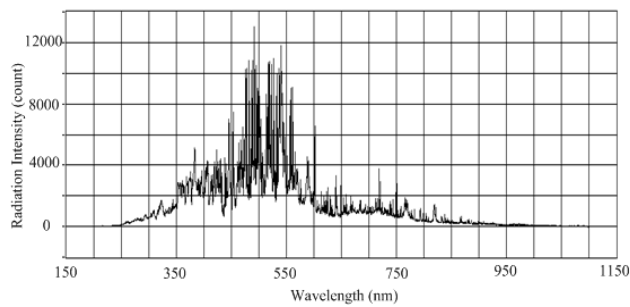


Figure 18. The spectrum of stage 1

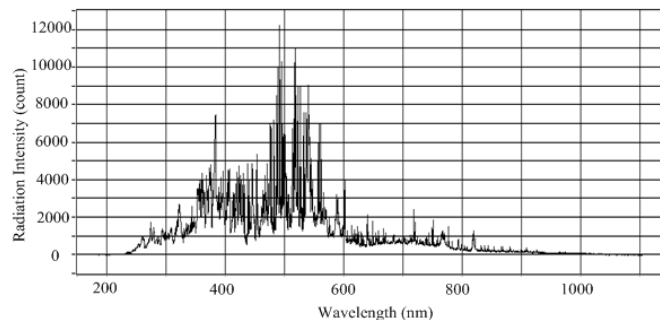


Figure 19. The Spectrum of stage 2

The spectra of Stage 1 and Stage 2 are provided in **Figure 18** and **Figure 19**. It is seen that spectra of the two stages have nearly the same intensity, which reflects upon the plasma arc being stable during droplet transfer. However, the distribution of arc radiation is quite different in the wavelength region of 350 nm to 400 nm and 700 nm to 900 nm. Comparing Stage 1 and Stage 2, it is observed that Stage 2 emits a stronger radiation in the 350-450 nm range than Stage 1, while the radiation of Stage 1 in the span of 700-900nm is weaker than the radiation of Stage 2. A possible reason for this is that there occurs a sharp increase in energy when the droplet is transferred. The energy peak aids in increasing the instant electronic temperature of the plasma arc and photons having a short wavelength are produced, which requires a higher energy input.

4.3 THE RELATIONSHIP BETWEEN RADIATION AND WELDING PARAMETER With a careful analysis of the dynamic radiation properties of the plasma arc produced by the flux cored wires (FCWs), it is observed that the radiation is quite different when the arc state is changed. The variation of transient radiation is decided by the instant parameter and state of the arc. In order to get a relationship between arc radiation and the instant parameter, the corresponding intensity of radiation in the selected spectral zone (near 500 nm), which is dominated by the Fe I line spectra, is calculated. The calculated radiation intensity is then related to the instant welding parameters, namely

(i) welding current, and (ii) arc voltage. Since the free droplet transfer mode is stable, Group 5 is used and applied as the welding parameter for purpose of analysis. The type K-71TLF and type DW0-100, which are both Titania flux-cored wires (FCW), are selected. In **Figure 20** is shown the relationship between radiation intensity and welding parameter of K-71TLF flux cored wire and in **Figure 21** is shown the relationship of the flux cored wire DW100. It can be seen from **Figure 20** and **Figure 21** that (i) arc radiation increases as the arc voltage grows, and

(ii) arc radiation decreases as the welding current increases. The linearity of observed relationship is used for the purpose of to diagnosis of the overall stability of the welding process. For example, a linear relationship for free droplet transfer is better than the short circuit transfer mode. Comparing the radiation of DW100 and K-71TLE, which are the same type of flux-cored wires, the DW100 provides a better linear relationship than the K-71TLE. Our experimental study showed that the DW100 provides a welding process that is far more stable and having fewer spatters. The observed scatter in the collected data is caused by instability of the arc even using the same parameter, which implies that more disturbing factors are introduced randomly during the welding process.

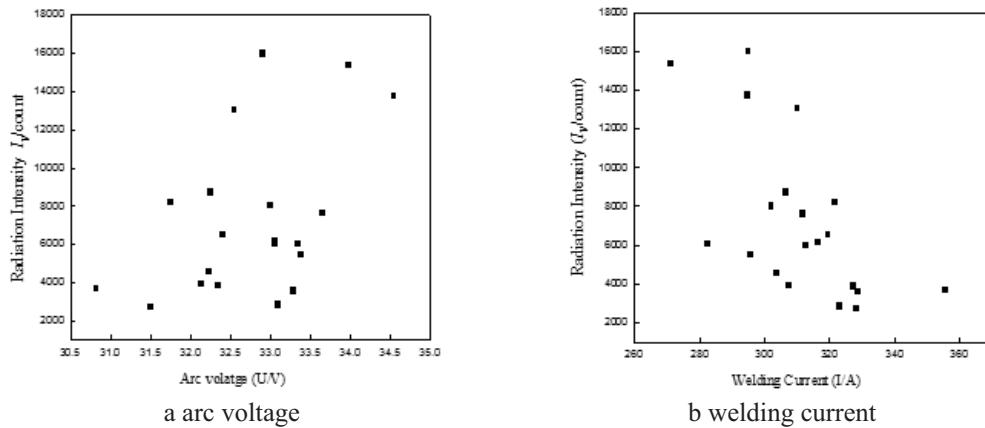


Figure 20. Radiation intensity verse welding parameter (K-7TLF)

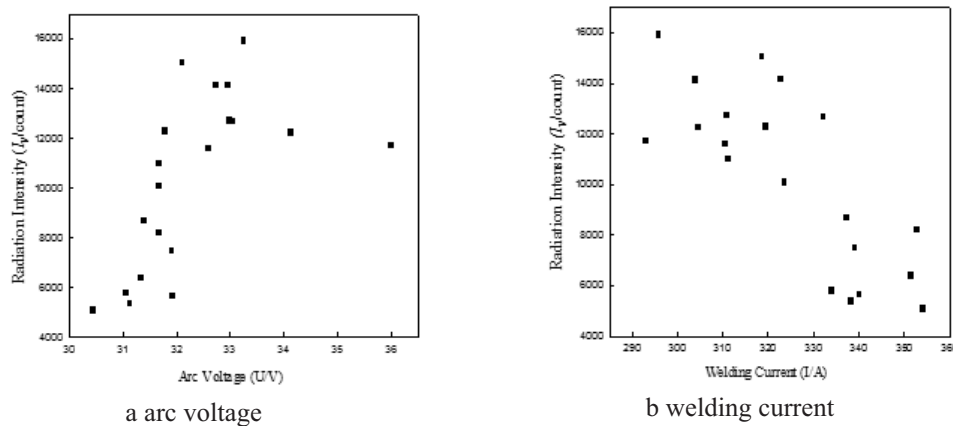


Figure 21. Radiation intensity verse welding parameter (DW-100)

5. CONCLUSIONS

Based on this exhaustive study on the use of flux cored wires (FCWs) during arc welding the following are the key findings:

- 1) Different kinds of flux cored wires emit arc radiation having different spectrum distribution. The line spectra of the SQA309L FCW is obviously stronger than that of the K-71TLF FCW in the near infrared wavelength (more than 700nm). A lot of line spectra, which is emitted by Ni/Cu and other metals, can be found in the stainless steel wire SQA309L. The line spectra of Ti I and Si I is caused by the element that existed in the flux of the FCW, which helps to form fumes in the plasma arc.
- 2) The dynamic radiation of the plasma arc is different for different droplet transfer modes. For the short circuit transfer mode, the radiation is divided into four stages for the purpose of analysis. For the free droplet transfer mode, two typical stages are considered and analyzed. An instant radiation of the arc is decided by state of the arc.
- 3) The correlation of radiation with the welding parameter provides the linearity that exists between the welding parameter and radiation intensity. The linearity is used as a criterion for the purpose of evaluating the properties of the FCW welding process. Even though they both provide normal welding process, the occurrence of linearity reflected well upon the technology of the process.

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REFERENCES

- 1 Liao M. T., Chen, W. J. "A Comparison of Gas Metal Arc Welding with Flux-Cored Wires and Solid Wires Using Shielding Gas", International Journal of Advanced Manufacturing Technology, 15(1) 1999: p.49~53
- 2 S. Mukhopadhyay, T.K. Pal. "Effect of shielding gas mixture on gas metal arc welding of HSLA steel using solid and flux-cored wires", International Journal of Advanced Manufacturing Technology, 29(3-4), 2006 p. 262~268
- 3 X.B.Li, J.M.Jiang, Z.H.Wang et al. "Effect of adding materials on fume formation rate of lime titania type flux cored wire", Science and Technology of Welding and Joining, 13(8), 2008, p.694~697
- 4 R. Kejar, J. Grum. "Hardfacing of wear-resistant deposits by MAG welding with a flux-cored wire having graphite in its filling", Materials and Manufacturing Processes, 20(6) 2005, p.961~976
- 5 Chung Sik Yoon, Nam Won Paik, Jeong Han Kim, et al. "Total and soluble metal contents in flux-cored arc welding fumes", Aerosol Science and Technology, 43(6), 2009, p. 511~521
- 6 Stridsklev I. C., Schaller K. H., Langard S. "Monitoring of chromium and nickel in biological fluids of stainless steel welders using the flux-cored-wire (FCW) welding method", Int. Arch Occupational Environ Health, 77(8), 2004, p. 587~591
- 7 P. K. Palani, N. Murugan. "Sensitivity analysis for process parameters in cladding of stainless steel by flux cored arc welding", Journal of Manufacturing Processes, 8(2), 2006, p. 90~100
- 8 P. K. Palani, N. Murugan. "Prediction of delta ferrite content and effect of welding process parameters in claddings by FCAW", Materials and Manufacturing Processes, 21(5), 2006, p.431~438
- 9 Li zhiyong, Wang bao, Song li. "Analysis on the characteristic electrical signal of CO₂ shielding FCW process with external disturbance", Welding & Joining, 1, 2007 p.25~28
- 10 Li J. Y., Li Z. Y., Li H. et al. "Basic theory and method of welding arc spectrum information", Chinese Journal of Mechanical Engineering, 17(2), 2004, p.315~318
- 11 Li J. Y., Song Y. L., "Spectral information of arc and welding automation", Welding in the World, 34(9), 1994 p.317~324
- 12 Li P. J., Zhang Y. M. "Robust sensing of arc length", IEEE Transactions on Instrumentation and Measurement, 50(3), 2001, p. 697~704
- 13 Han GuoMing, Yun ShaoHui, Cao XinHua. "Acquisition and pattern recognition of spectrum information of welding metal transfer", Materials and Design, 24(8) 2003, p. 699~703
- 14 J. Mirapeixa, A. Coboa, O.M. Condea, et al. "Real-time arc welding defect detection technique by means of plasma spectrum optical analysis", Non Destructive Testing and Evaluation International, 39(5), 2006 p. 356~360
- 15 Sadek C.A. Alfaro, Diogo de S. Mendonca, Marcelo S. Matos. "Emission spectrometry evaluation in arc welding monitoring system", Journal of Materials Processing Technology, 179(1-3), 2006 p.219~224.
- 16 Li zhiyong, Yang lijun, Gao ying et al. "Analysis of the hybrid pulsed MAG-YAG laser plasma with synchronization of multiple signals", Journal of Laser Applications, 22(3), 2010 p.106~115

FIBER LASER MACHINING OF 10 VOLUME Al-AI₂O₃ COMPOSITE MATERIAL

Arindam Ghosal

email: er_ghosal@yahoo.co.in

Assistant Professor, Department of Mechanical Engineering, Dronacharya College of Engineering, Greater Noida (India)

Dr. Alokesh Manna

Associate Professor, Department of Mechanical Engineering, Punjab Engineering College, Chandigarh (India).

Dr. Arun K Lall

Professor, Department of Mechanical Engineering, Punjab Engineering College, Chandigarh (India).

ABSTRACT

Non conventional machining processes have become popular today with compare to conventional machining process. In conventional machining processes so many problems may be arise like high pressure on work piece, tool failure, accuracy, surface finish etc. In nonconventional machining process like EDM, ECM, ECDM, LBM the above difficulties may be overcome. In this paper, some holes are drilled in Al-AI₂O₃ composites by 2 kW Ytterbium Fiber Laser and have been studied the characteristic of drilled holes for different parameters and a basic thermal modeling has also been done for various heat losing process in the form of conduction, convection and radiation.

Key words: LM, LAM, SEM

1. INTRODUCTION

In Laser Machining process, material removal is possible from selected area; good surface finish is also obtained. The principle of Laser Machining process is,

- LM process removes material in the form of vaporization.
- Pumping energy is utilized.

During Laser Machining process laser energy is converted into heat energy, which flows through the work piece. Modeling and analysis of Laser Machining process would also help for better understanding of heat losses during this process.

2. MECHANISM OF LASER MACHINING

Material can be machined by Laser directly is called Laser Machining (LM) (Fig-1b and 1c), other process is called Laser Assisted Machining (LAM). In Laser Assisted Machining process, with the help of Laser beam a particular area of work piece is heated to bring it in plastic stage and then cutting tool is used to cut the material. (Fig-1a)



Figure 1a, Laser Assisted Machinig

Figure 1b, Laser Machinig

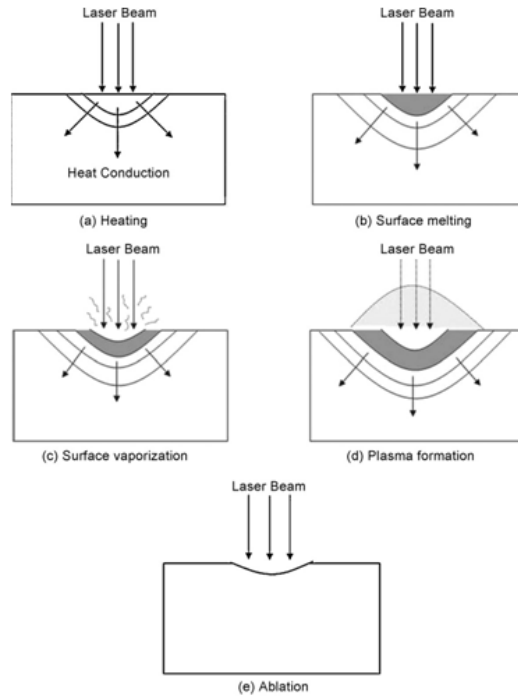


Figure 1c, Mechanism of Laser Machining

3. EXPERIMENT AND MODELLING

During Laser machining heat flows through the work piece in the form of conduction, convection and radiation. Conduction heat flow process is useful to heating the material, but in convection and radiation process heat losses takes place from the material, some heat is also absorbed in the material. (Fig-2)

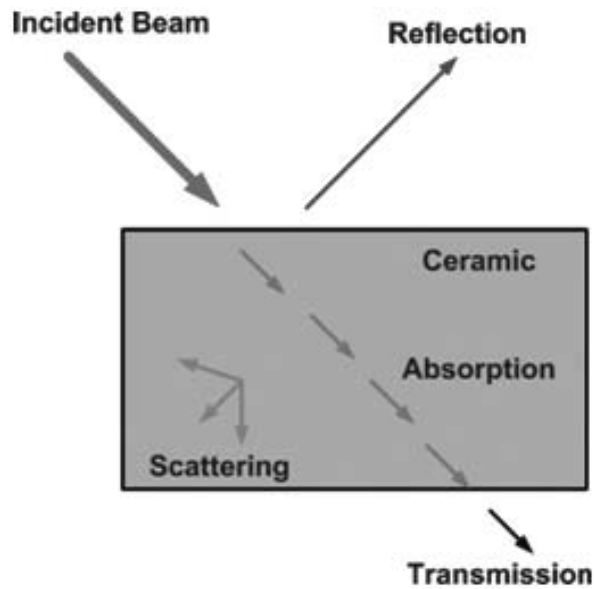


Figure 2. heat flowing process during laser cutting

Laser beam energy absorbed by the material, after n reflections is:

$$Q_a = Q(r)^n \quad (1)$$

Where, Q is incident Laser beam energy, r is angle-dependent reflection coefficient of silicon glass, and n is number of multiple reflections. Where,

$$n = \pi / 4\theta \quad (2)$$

The amount of absorbed energy depends on the reflection coefficient of work piece, magnitude of incident Laser energy, output wavelength of processing Laser and wall angle. This absorbed energy is converted into heat and its ensuing conduction into the material, establishes the temperature distribution within the material, which in turn affects machining time and depth of machined cavity.

The excitation energy provided by the Laser is rapidly converted into heat and this is followed by various heat transfer processes such as conduction into the materials, convection and radiation from the surface. The conduction of heat into the silica glass ceramic is governed by Fourier's second law of heat transfer equation stated as below:

$$\frac{\partial T(x, y, z, t)}{\partial t} = \alpha(T) \left[\frac{\partial^2 T(x, y, z, t)}{\partial x^2} + \frac{\partial^2 T(x, y, z, t)}{\partial y^2} + \frac{\partial^2 T(x, y, z, t)}{\partial z^2} \right] \quad (3)$$

Where, T is temperature field, t is time and x, y and z are spatial directions. The term $\alpha(T)$ is temperature dependent thermal diffusivity of the material which is given by

$$\alpha(T) = k(T) / \rho C_p(T) \quad (4)$$

Where, ρ is density of silicon glass, $C_p(T)$ and $k(t)$ are temperature dependent specific heat and thermal conductivity of the silica glass, respectively. From the above equations we can also verify the temperature rise during Laser machining.

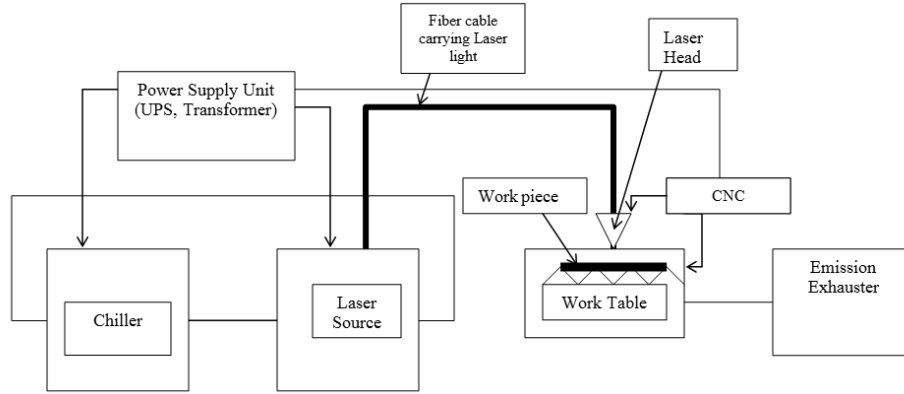
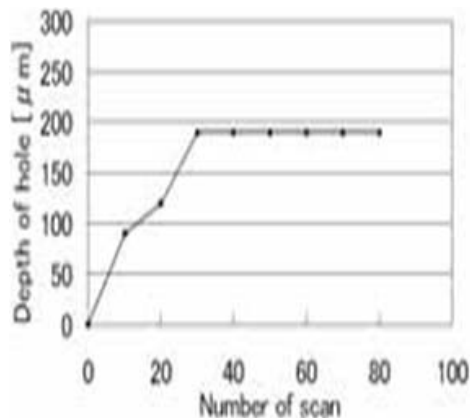


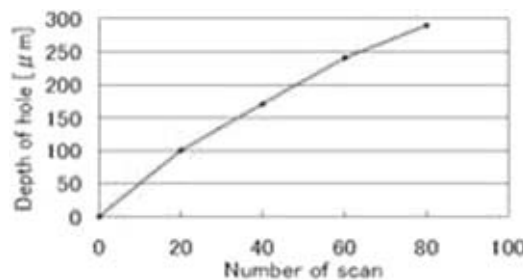
Figure 3. Block diagram of fiber laser

4. RESULT AND DISCUSSION

The relationship between the depth of the hole and the number of scans is shown in Fig. 3. The depth of the hole was measured by a Scanning Electron Microscope (SEM). The hole became deep no more if the number of scans exceeded a certain limit (i.e. 30). It is considered that waste scraps were adhered to the bottom and the side of the hole, and then blocked the Laser beam.



For the purpose of removing the scrap wastes, the absorbent powder (a mixture of cerium oxide powder and water, is coated on the glass and then dried) was coated on the composite, and depth of hole is increased with the increase of number of scan (Fig-5)



For drilling hole in Aluminium- Alumina composite the specification of fiber laser machine used is given in the Table-1
Table-1

Operation mode	CW
Nominal output power	2kw
Emission wave length	1070-1080 nm
Output fiber core dia.	150μm
Fiber length	10m
Polarization	Random
Operating voltage	400-460 VAC
Power frequency	50/60Hz
Power consumption	8 kw
Operating ambient air temp.	10-50 °C
Laser cooling water temp. range	22-24 °C
Laser cooling water flow rate	5 lt/min
Working area x ,y, z axis	1500 mm,3000 mm 150mm,
Maximum work piece weight.	750 kg
Maximum positioning speed:	
Axis parallel to X	100 m/min
Axis parallel to Y	200 m/min
Simultaneous X and Y	220 m/min



Fig 6, Fiber Laser Machine YLR 2000 used to cut the Al-AlO of volume 10%



Fig-7, Scanning Electron Microscope



Fig-8, Casted work Piece ii sample cutted from casted work piece and drilled by fiber laser of 2 ton



Figure 9. Ytterbium Fiber Laser machine used for drilling in 10 % volume Aluminium-Alumina composite material

Drilled holes which are shown in fig-8-ii are done by 2kW ytterbium fiber laser machine setting different laser parameters. SEM analysis is done of these holes (fig-10, i- xii).

In the following tables (table 2 & 3) combinations of parameters are given which are used to drill holes in 10% volume Aluminium-Alumina composite. Table 3 is also called L₂₇ table

Table 2

Symbols	Machining parameters	Levels			Units
		1	2	3	
A	Laser Power	1200	1500	2000	watt
B	Modulation frequency	800	900	1000	Hz
C	Assist gas pressure (N ₂)	15	17	20	Bar
D	Wait time	0.1	0.2	0.3	Second
E	Distance between nozzle and work piece	0.5	0.8	1	mm
F	Pulse width	80%	90%	100%	%

Table 3

Run	A	B	C	D	E	F	Surface Temp. (0C)	Drilling time (sec)
1	1	1	1	1	1	1	40	3.9
2	1	1	1	1	2	2	40	3.19
3	1	1	1	1	3	3	36	3.55
4	1	2	2	2	1	1	39	3.91
5	1	2	2	2	2	2	40	4.02
6	1	2	2	2	3	3	42	3.03
7	1	3	3	3	1	1	43	4.34
8	1	3	3	3	2	2	47	3.38
9	1	3	3	3	3	3	45	3.82
10	2	1	2	3	1	2	46	4.20
11	2	1	2	3	2	3	45	4.10
12	2	1	2	3	3	1	46	3.92
13	2	2	3	1	1	2	46	3.95
14	2	2	3	1	2	3	43	3.79
15	2	2	3	1	3	1	43	4.00
16	2	3	1	2	1	2	44	4.01
17	2	3	1	2	2	3	45	4.02
18	2	3	1	2	3	1	45	3.96
19	3	1	3	2	1	3	42	3.97
20	3	1	3	2	2	1	41	3.96
21	3	1	3	2	3	2	39	4.01
22	3	2	1	3	1	3	40	4.02
23	3	2	1	3	2	1	39	3.05
24	3	2	1	3	3	2	39	3.07
25	3	3	2	1	1	3	38	3.77
26	3	3	2	1	2	1	41	3.90
27	3	3	2	1	3	2	43	3.88

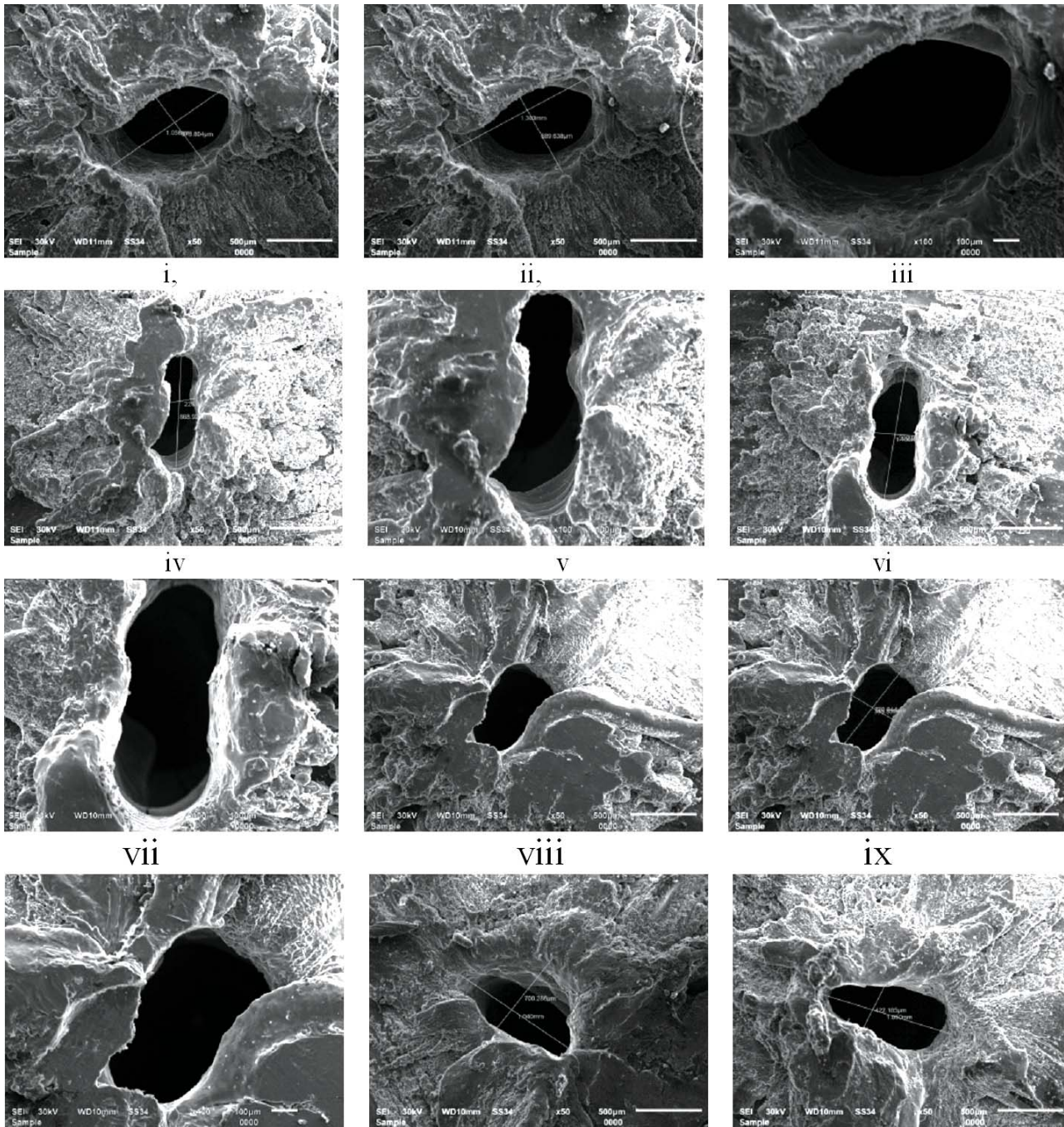


Fig-10, SEM Photograph of holes in 10% Al-AlO₂ composite.

From fig-10 (i-xii), it is clear that at each run some molten material is deposited on the surface of the work piece. In each SEM photograph, it is clear that hole drilled by laser is taper, in each case there is a maximum hole diameter at upper surface and minimum hole diameter at lower surface. It is also seen that some holes are not round. In fig-10 (i and xi) holes are near about round shape. Hole i is got by run 3 and hole xi is got by run 7. So the combination of parameters of run 3 and run 7 are accepted for drill hole of 10% volume Al-AlO₂ composite material.

5. CONCLUSION

From the above discussion, it is concluded that Laser Machining is a flexible, accurate and high level surface finishing process. Heat conducted and absorbed by the material is important to raise the surface temperature high for material vaporization. Laser Machining is time consuming and costly but high accuracy process. Temperature rise may be calculated during Laser Machining by using thermal model. The hole made by laser drilling is not uniform from top surface to bottom surface, all holes are taper and roundness of the hole may be control by proper adjusting the laser parameters.

REFERENCES

- 1 E.Kacer, "Journal of material processing technology", vol-209, issue-4, pp 2008-2014:characterization of drilling Alumina ceramic using Nd:YAG pulsed laser.
- 2 K. Itoh and W. Watanabe, Toward nano and microprocessing in glass with femtosecond Laser pulses, RIKEN Review, 50, (2003), pp.90-94.
- 3 K. Zimmer and R. Böhme, Precise etching of fused silica for micro-optical applications, Applied Surface Science, Vol.243 (2005), pp.415-420.
- 4 A.F.M Arif, "Optics and laser technology", vol- 41, issue 3, pp 224-232, Laser cutting of thick sheet metals:Residual stress analysis.
- 5 K.Li, "International journal of machine tool manufacturing", vol- 35, No. 11, pp 1493-1506,1995, Plane stress model for fracture of ceramics during laser cutting.
- 6 Chwan Huei Tsai, "Journal of material processing technology", 2009, pp 2838-2846, Investigation of underwater laser drilling for brittle substrate.
- 7 Lee Mein Wee, "Applied surface science", vol-247, 2005,pp 277-284, An analytical model for striation formation in laser cutting.
- 8 K.C.P. LUM, "Optics and laser technology", vol-32, 2000, pp 67-76, CO2 laser cutting of MDF: Determination of process parameter settings.
- 9 R M Miranda, "Materials characterization", vol- 53, 2004, pp 411-417, Structural analysis of heat affected zone of marble and lime stone tiles cut by CO2 laser.
- 10 Shbhranshu Roy, "International journal of Heat Mass transfer", vol-36, No. 14, pp 3515-3528, 1993, CW Laser machining of hard ceramics: Effects of three dimensional conduction properties and various laser parameters.
- 11 Chwan Huei Tsai, "Journal of material processing technology", vol-136, 2003, pp166-173, Laser cutting of thick ceramic substrates by controlled technique.
- 12 Jay C Rozzi, "International journal of heat and mass transfer", vol-43, 2000, pp 1425-1437, Transient three dimensional heat transfer model for laser assisted machining of silicon Nitride: Assessment of parameter effects.

BACKSCATTERING LIDAR SYSTEM DESCRIPTION AND DATA PROCESSING

S. Veerabathiran

e-mail: vrs_74@rediffmail.com

Ph: 011-23907472, Fax: +91-11-23811319

Laser Science and Technology Centre, DRDO, Metcalfe House, Delhi – 110054

M. K. Jindal and A. K. Razdan

Laser Science and Technology Centre, DRDO, Metcalfe House, Delhi – 110054

ABSTRACT

Backscattering lidar system has been designed and developed at Laser Science and Technology Centre, Delhi by using minimal number of off-the-shelf components. It uses 10 Hz, Nd:YAG laser operating at 1064 nm with pulse energy of 70 mJ and pulse width of 7 ns as a transmitter and 200 mm diameter Cassegrain telescope with 3 nm interference filter as a receiver. Si: APD module with built-in preamplifier and front-end optics is used as detector. The laser beam is transmitted into the atmosphere at an elevation angle of 13 degree along slant path. The return signals with respect to time are measured, digitized and stored in the PC using LabVIEW for further processing. This system has been operated mostly during daytime for the remote sensing of the atmosphere. Multiple clouds have been detected and processed the data to retrieve the atmospheric extinction coefficient. Preliminary results obtained from the experiments are presented and discussed in this paper.

Keyword: lidar, cloud, extinction coefficient, aerosol, lidar inversion

Short title: Lidar for cloud detection

1. INTRODUCTION

The use of toxic chemicals (chemical and biological agents) against civilian and military by terrorist and rogue countries is frequent¹⁻⁴. In general, these toxic chemicals are delivered in the air using artillery shell, aircraft, UAV etc. Such toxic chemicals in vapours start dispersing as soon as it is released in the atmosphere and form small-stratified layers/clouds in the lower troposphere due to background atmospheric wind speed. Lifetime of these clouds can be from an hour to a day depending upon its nature. In course of time these toxic clouds settle down and thereby causing health hazard to plants, cattle and human beings. Early detection of such chemical clouds in the atmosphere is very important. Specifically, the stand off detection and detection time are very important for threatened personnel to take defensive or preventive measures against such threat. Detecting such tenuous thin layers of toxic chemicals, and their spatial and temporal distribution along with the measurement on their optical properties is a challenging task. LIDAR (Llght Detection And Ranging) is the only realistic method for standoff detection of toxic clouds today and uses lasers as excitation source⁵⁻⁷. LIDAR transmits a high peak power laser pulse into the atmosphere, which interacts with the atmospheric constituents causing alterations in the intensity, polarization and wavelength of the backscattered light. From the measurement of these parameters of the received light, one can deduce the properties of the aerosols and other minor constituents of the atmosphere⁸⁻¹⁰. The distance to the scattering medium can be deduced with very high accuracy from the time delay of the return signal. Lidar systems are used in the wavelength range starting from ultraviolet (UV) to the mid infrared (IR) by using different types of lasers¹¹⁻¹³. The detection method can be based on several physics phenomena. The most common phenomena are elastic backscattering, laser induced fluorescence and differential absorption. The backscattering lidar with proper combination of pulse energy, pulse repetition frequency and suitable receiver optics can differentiate the chemical or biological cloud return signals from the background atmosphere. It is expected that this system could detect the presence of chembio clouds at distance of few kilometers depending on the cloud concentration and weather conditions. Laser Science and Technology Centre (LASTEC), Delhi, has been working on the project “Development of multiwavelength lidar system for detection of chemical and biological warfare agents”. As a part of main lidar activities, a backscattering lidar system operating at 1064nm has been designed and developed, which is based on Mie scattering principle. This has the capability of detecting the cloud structures formed by aerosols, water vapour or other toxic materials in the atmosphere at far ranges though it cannot identify its composition and concentration. In this paper, technical details of the lidar system and some of the preliminary experimental results have been discussed. Results presented in this paper are pertaining to the data taken during the daytime measurements and unique to this site.

2. SYSTEM DESCRIPTION

Fig 1 shows the block diagram of backscattering lidar system, which is designed and developed in-house at LASTEC. This system is assembled and integrated on a movable gimbal scanning platform. Gimbal is controlled manually to scan the atmosphere in 360 azimuth and -10 to 35 in elevation. Using this setup, the backscattered signals from the atmosphere were collected from near range to maximum distance of 7-8 km. Fig 2 shows the photograph of the lidar system and table 1 describes its technical details.

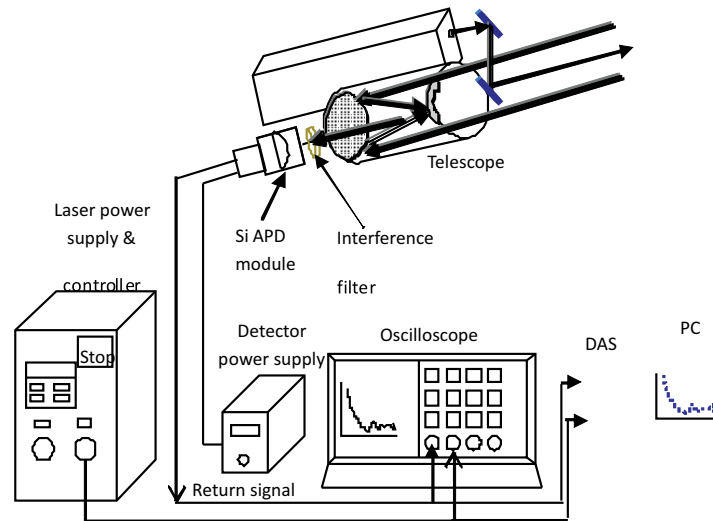


Fig 1: Block diagram of the lidar set up



Fig 2: Photograph of indigenously developed backscattering lidar

<u>Laser transmitter</u>	
Wavelength	1064 nm
Energy	70 mJ
Pulse width	7 ns
Repetition Rate	10 Hz
Beam divergence	0.6 mrad
<u>Receiver telescope</u>	
Type	Cassegrain
Diameter	200 mm
Interference filter	3 nm (FWHM)
FOV	< 3 mrad
<u>Detector module</u>	
Type	Si- APD module
Active diameter	3 mm
Responsivity	25 A/W
Preamplifier gain	11 mV/mA into 50Ω
Preamp bandwidth	DC-30 MHz
<u>Data acquisition unit</u>	
Hardware type	NI's PCI-6115 DAQ card
ADC resolution	12 bit
Sampling rate	10 MS/s
No. of channels	4

Table1: Technical specifications of the Lidar system.

2.1 LASER TRANSMITTER A linearly polarized laser source, Surelite I-10 laser from Continuum, is employed as transmitter in the present configuration. The laser source is a Q-switched, linear flash lamp-pumped Nd: YAG solid-state pulsed laser emitting at the fundamental wavelength of 1064 nm. Laser pulse energy is variable from 25 mJ to 400 mJ. The pulse width of the laser is 7 ns and its pulse repetition frequency is 10 Hz (variable from 1 to 10 Hz). The spatial profile of laser at far field is Gaussian in shape. The laser beam diameter is 6 mm and the far-field ($1/e^2$ power) divergence full angle is 0.6 mrad. The system is configured in coaxial mode by folding laser beam using beam steering unit. It consists of two high reflective mirrors (>98%) of 25 mm diameter. Distance between two mirrors can be adjusted very well because they are fitted on the vertical movable scaled rod. The bottom mirror bends the laser beam into vertical direction and second mirror, which is at the centre of telescope bends the beam again in horizontal direction (see fig 2). So that the laser beam enters telescope field of view right from the short ranges. Laser beam is transmitted continuously into the atmosphere during the operation of lidar.

2.2 TELESCOPE The backscattered radiation from the atmosphere is collected by the optical telescope. It is Celestron make optical tube assembly with primary mirror of 203 mm diameter. The telescope employs the schmidt-cassegrain design. This design uses a combination of mirrors and lenses that offers large diameter optics while maintaining very short tube lengths, making them extremely portable.

Once light rays enter optical system, they travel the length of the optical tube three times between primary and secondary mirrors. Inside the optical tube, a black tube extends out from the centre hole in the primary mirror. This is the primary baffle tube and it prevents stray light from passing through to detector. A disadvantage with these telescopes is the central obstruction where the secondary mirror is mounted. The telescope is 42 cm long. Its focal length is specified as 2032 mm (making it f/10), but a focus knob on the telescope back makes the location of the focus variable.

The celestron telescope has XLT star bright coating (enhanced multilayer coating) on the mirrors for increased reflectivity and fully coated corrector for the finest anti-reflection characteristics. A mechanical adaptor is designed to hold 50 mm diameter interference filter, which is integrated at the exit of telescope. The passband interference filter with bandwidth (FWHM) of 3 nm centered at the laser wavelength (1064 nm) is used to reduce the atmospheric background noise.

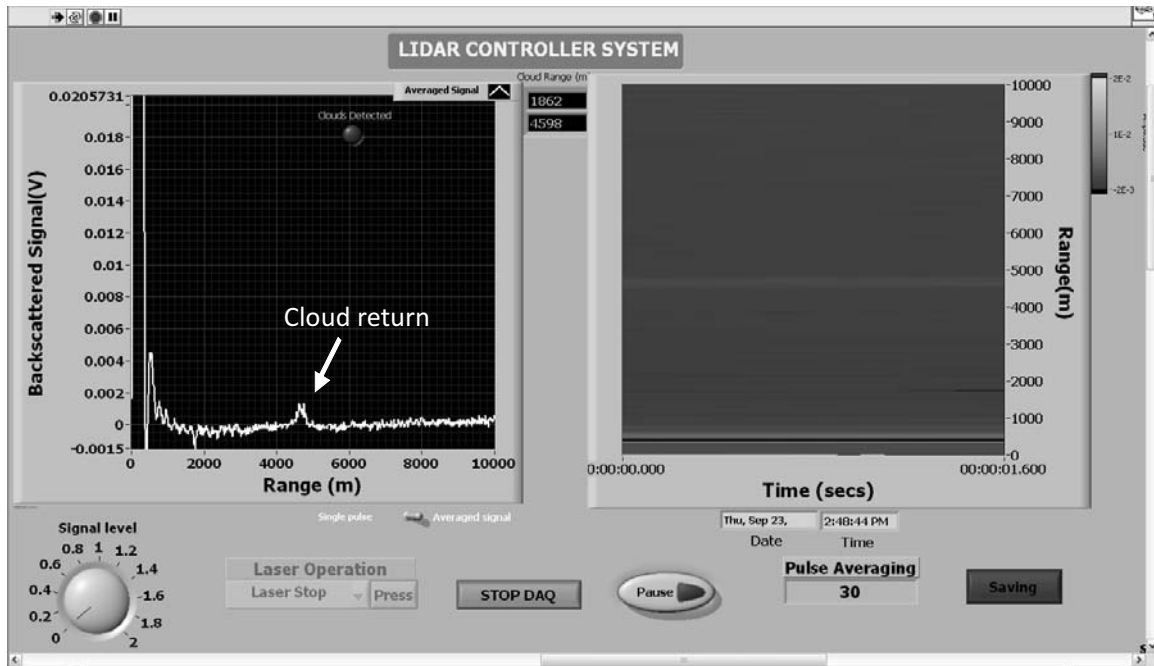
2.3 DETECTOR ASSEMBLY IR optical signal from the telescope is focused onto a high quantum efficiency Si: APD detector module (Licel, Germany). The Si: APD module is based on the EG&G C3095xE series of avalanche photodiodes. It consists of a detector head and a power supply unit. The detector head contains a APD and a preamplifier. The APD is mounted on a temperature stabilized thermoelectric cooler inside a hermetically sealed housing.

This detector head is mounted in a XYZ translation stage for easy optical alignment. The power supply unit contains a linear regulated +5V and 15 V power supply and a 0 to 400 V high voltage supply. This provides the voltage for the temperature controller and the preamplifier as well as the variable reverse voltage for the APD. A focusing lens with focal length of 33 mm (Melles Griot 01LAG010) is used as front end optics to collect the parallel beam. More technical details of the detector are presented in Table 1.

2.4 DATA ACQUISITION SYSTEM NI's PCI bus based DAQ card is used as data acquisition hardware in this system. The output signal from the detector is connected to analog input channel of DAQ card and the trigger signal from the laser source is connected to the digital trigger input of the card. DAQ is configured using LabVIEW to a sampling rate of 10 MHz to have a range resolution of 15m, which corresponds to 0.1 μ sec. Number of samples is set to 500 so as to collect data upto a range of 7.5 km. Panel 1 shows the lidar controller software developed in-house in LabVIEW platform to control the laser source and data acquisition hardware. Laser system is switched on by invoking controls in the user interface and it starts firing pulses at a rate of 10 Hz. Data acquisition process starts when start DAQ button is pressed and data for every 500 samples at 15 m range bins is stored in PC for each laser pulse for further offline processing. Si: APD signal reached a maximum value of about 1100 mV, which is saturation level of detector (Panel 1).

Thereafter, the signal started falling steadily with respect to range. It showed clearly that the experimentally measured multiple cloud signals (cloud signal strength is higher than the background signal) at a distance of 4.7 km. Image shown in right side of the panel 1 represents the temporal variation of the received signals.

Signals received from the nearby region are very strong and accordingly the color coding is assigned (red-strong signals and blue-weak signals). From the lidar signal, the pertinent information on the various parameters such as extinction coefficient, visibility also has been obtained by using suitable lidar inversion methods in real time. The entire lidar system is connected to a UPS system, which can keep the lidar operational with captive power for nearly one hour. This lidar system has been tested and validated by measuring return signals from the atmospheric aerosols and clouds in real time under different atmospheric conditions. Some of the measured signals are processed for further investigation and results are discussed in the subsequent sections.



Panel 1. Lidar controller and data acquisition display panel. The backscattered signals show the presence of cloud at distances of 4.7 km.

3. LIDAR DATA PROCESSING

Lidar inversion technique developed by Fernald¹⁴ (1984) was used to obtain the extinction and backscattering coefficients from the current lidar data. The basis of any lidar signal analysis is the lidar equation, which describes the receiver signal as a function of range. The standard form of the lidar equation for the case of monochromatic emission involving elastic scattering and negligible multiple-scattering processes is

$$P(z) = P_0 K \frac{c\tau}{2} \frac{A}{z^2} \beta(z) T^2(z)$$

... (1)

where $P(z)$ is the received signal power from distance z , P_0 is the transmitted pulse energy, K is the total efficiency of the system, $c/2$ is the range resolution, A is the active area of the receiving telescope, $\beta(z)$ is the total backscattering coefficient at distance z , which is given in terms of $\text{m}^{-1} \text{sr}^{-1}$. T is the atmospheric transmission factor. The term $T(z)$ refers to transmissibility offered by the atmospheric path to photons traveling from the ground to a given distance z . In the lidar equation, the term $T(z)$ appears as squared that refers to the total transmission offered by the atmospheric path to the traveling photons in the round trip distance. The atmospheric transmission $T(z)$ is represented as

$$T(z) = \exp\left(-\int_0^z \alpha(z) dz\right) \quad (2)$$

where $\alpha(z)$ indicates the total atmospheric extinction coefficient due to aerosol (α_a) and air molecules (α_m) observed in the atmospheric path length from ground to a distance z , given in terms of m^{-1} . If the effect of signal decrease due to z^2 is compensated, then the equation can be shown as “range corrected”,

$$X(z) = P(z)z^2 = C\beta(z)\exp\left(-2\int_0^z \alpha(z) dz\right) \quad (3)$$

Now the term $X(z)$ is a function of two unknowns primarily $\alpha(z)$ and $\beta(z)$ of the medium, hence the inversion of lidar equation leads to complexity. So the solution of the lidar equation is possible only if there exists a relation between these two unknowns. Following relationship is assumed between $\alpha(z)$ and $\beta(z)$ of the medium in this method.

$$\beta(z) = C\alpha(z)^k \quad (4)$$

where C and k depend on the lidar wavelength and various properties of the aerosol particles. Fernald (1984) had proposed a successful lidar inversion method, which assumes the following relationship between $\alpha(z)$ and $\beta(z)$.

$$S_1 = \frac{\alpha_a(z)}{\beta_a(z)} \quad \& \quad S_2 = \frac{\alpha_m(z)}{\beta_m(z)} = \frac{8\pi}{3}$$

where S_1 is the extinction to backscatter ratio for aerosols and S_2 is the extinction to backscatter ratio for air molecules. Takamura et al¹⁵ (1994) using simultaneous measurements of lidar, sun photometer and optical particle counter estimated the value S_1 to be in the range of 20 to 70. Fernald (1984) method of inverting lidar signal employs a fixed value of extinction coefficient at reference range z_r , and also a constant value of aerosol extinction to backscatter ratio (S_1). We used $S_1=40$ in our analysis. This technique of inversion of lidar signal by backward integration of lidar equation leads to the solution of the form for deriving the aerosol extinction coefficient given as

$$\alpha_a(I-1) = \frac{X(I-1)\exp[A(I-1,I)]}{\frac{X(I)}{\alpha_a(I) + \frac{S_1}{S_2}\alpha_m(I)} - [X(I) + X(I-1)\exp[A(I-1,I)]\Delta z]} - \frac{S_1}{S_2}\alpha_m(I-1) \quad (5)$$

where $A(I-1,I) = (S_1 - S_2)[\beta_m(I-1) + \beta_m(I)]\Delta z$ is used to replace the exponential terms that incorporate the effects of aerosol extinction between adjacent data points range Δz and $X(I) = P(z_r)z_r^2$. The maximum measurable range was determined to be the range at which the lidar signal drops below 0.7 mV (minimum detectable signal). The program also had the provision to change this maximum range allowing the user to choose the desired value of reference range by looking at the signal versus range profile. This eliminates the possibility of some important part of the data being eliminated by the above criteria. The reference range (z_r) is taken to be equal to the maximum range obtained using the above criteria and the aerosol extinction coefficient at this point (I) is taken to be zero. Then the value of the extinction coefficient in the next step ($I-1$) is calculated according to Eq (5). Then, taking this as the reference range, the extinction coefficient at the point ($I-2$) is calculated and so on until the near end of the range interval is reached. The values obtained at the very near end are inconclusive because of saturation of detector and therefore discarded. Similarly, the values at points where the signal is small compared to the noise (which happens mostly near the far end of the range interval) are also discarded. Meaningful information is obtained between these extremes of the range interval.

4. DISCUSSION

Using the lidar transmitter receiver assembly several experiments were conducted since July 2008. The backscattered signals from the near range to maximum detectable range of 7-8 km were obtained and stored in the computer. Laser pulse with energy of 70 mJ has been transmitted at an elevation angle of 13 degree into the atmosphere. Since most of the experiments were conducted during daytime, the sky conditions were also monitored visually. In general, the first information on the presence of a cloud is obtained by just looking at the signal profile with range in the visual display on the oscilloscope and computer. The lidar data show sudden upsurge in signal strength where the clouds are present from its normal fall with range in the presence of background aerosol. The visual display gives clearly a qualitative nature of the cloud layer indicating the range of its presence and information whether the layers are single or multiple layers. The presence of cloud is determined by following quantitative criteria: (1) a sudden upsurge, (2) a rapid decrease just after a maximum, and (3) actual value of the extinction coefficient at the peak. Detector channel measures both useful backscattered signals and noise signals which include background noise and electronic noises. The atmospheric background signal is measured independently without transmitting laser in to the atmosphere. The amplitude of this noise signal is found to be equal to the amplitude of far range lidar return signal, which is flat signal. The average of 20 range bins of far range signals for each return signals have been treated as background noise and this value is subtracted from the each range bin to get noise free lidar signals. Fig 3 shows typical example of the lidar signal obtained in the experiment conducted on 03 August 10. Due to strong sky background noise we would see the fluctuations in the return signals in the entire ranges (blue curve). The return signals do not show any significant variation with respect to distance beyond 3 km, in other words signal merges with background noise levels. The fluctuations in the lidar signal can be overcome easily by averaging more number of pulses. However, for our studies a total number of 128 pulses were averaged to obtain a single noise free smooth signal profile (red curve). Spatial moving averaging of 15 samples has been applied to remove random noise depending upon the signal behavior. The return signals have been multiplied by Z^2 at each range bin to correct the signal loss. Fig 4 shows the typical example of range normalised signal, which gives predominant peaks (cloud returns) in the ranges between 1100 m and 1700 m. Visual inspection at the experimental site revealed the presence of low-level rain bearing clouds on 03 Aug 2010 and experimental site also received intermittent rainfall. The total signal is basically characterized by the nature of cloud and other species in the atmosphere i.e. humidity, drizzle and aerosols contribute to increases in the backscattered signal. The cloud signal to noise ratio is large and the retrieval of cloud heights (i.e. base and top) from single profile is not difficult. The cloud base and heights have been derived from the measured waveforms at different times. The cloud thickness is then derived from the difference between the apparent cloud top and base. The cloud was detected between 1100 m (base) and 1700 m (top) region. The geometrical thickness of the cloud is about 600 m.

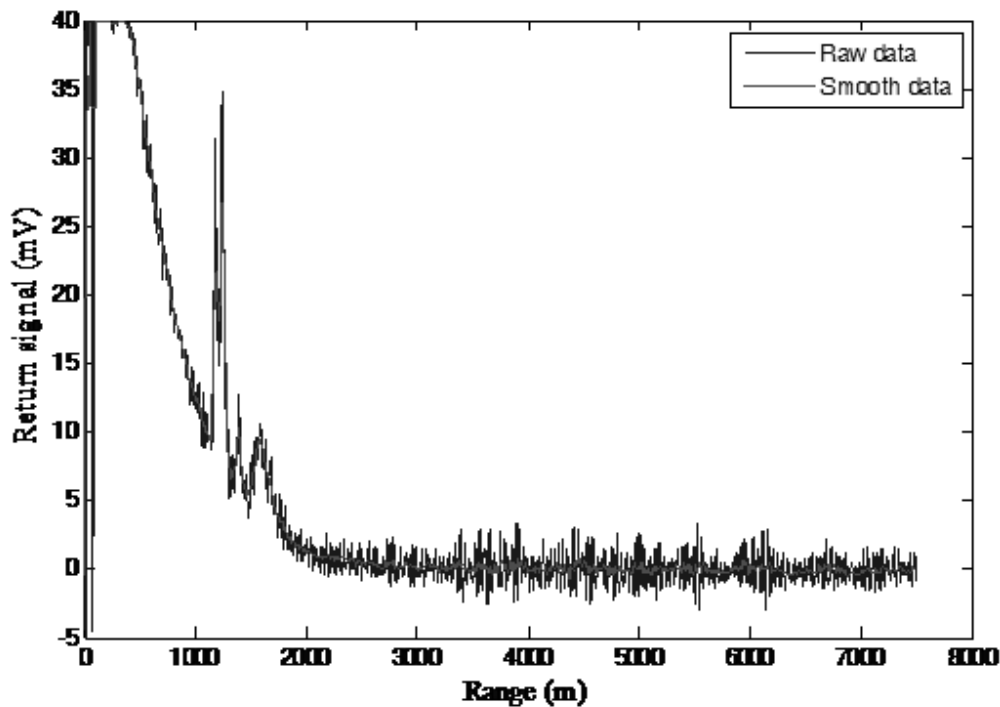


Fig.3. Detection of multiple clouds using lidar.

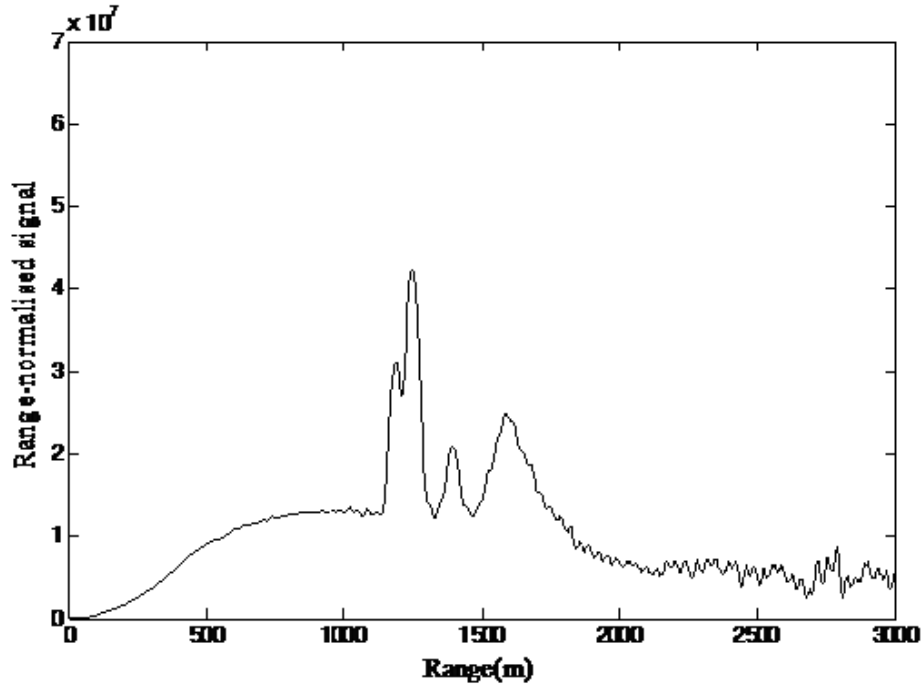


Fig. 4. Range normalized lidar signal

Atmospheric extinction coefficient values were derived from the lidar signals using the Eq. (5). The extinction coefficient, in general, falls with range in the lower troposphere and the values lie typically in the range $7.5 \times 10^{-5} \text{ m}^{-1} - 2.5 \times 10^{-4} \text{ m}^{-1}$ in the absence of any cloud whereas this value shoots maximum up to $1.56 \times 10^{-3} \text{ m}^{-1}$ in the presence of clouds. We have compared extinction coefficient profiles obtained on cloudy day (04 August 10) and clear day (03 August 10). Fig 5 clearly revealed that there would be always upsurge in signal strength when cloud is encountered in the laser beam path. It is found that enhancement in extinction values in the cloud region reaching the peak value of about $1.56 \times 10^{-3} \text{ m}^{-1}$. These values are in agreement with the results reported by Puchalski¹⁶ (2006), who conducted lidar measurements at 1064 nm and estimated the cloud extinction coefficient for low-level thin clouds of stratus type. Guaumet¹⁷ et al., (1998) also reported the similar phenomenon studied using lidar system. Fig 5 shows the typical example of temporal variation of cloud pattern. The system was operated continuously for about 1 hour. Here the lidar signal obtained from 1600 hrs to 1620 hrs is presented. An enhancement in signal strength is seen between 1200m and 1500m due to presence of clouds. The cloud thickness measured at various times is changing very fast as the clouds are moving fast away from the field of view of the telescope. It would be due to the prevailing thermodynamics process within the cloud leads to change in geometrical thickness. The maximum range achieved so far by recording the lidar-backscattered signal from clouds with this system was 10 km.

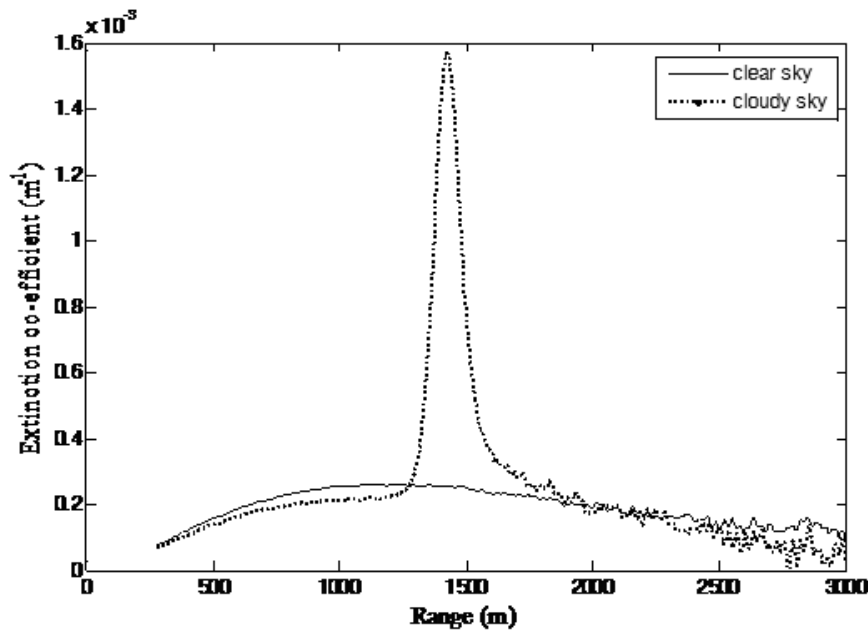
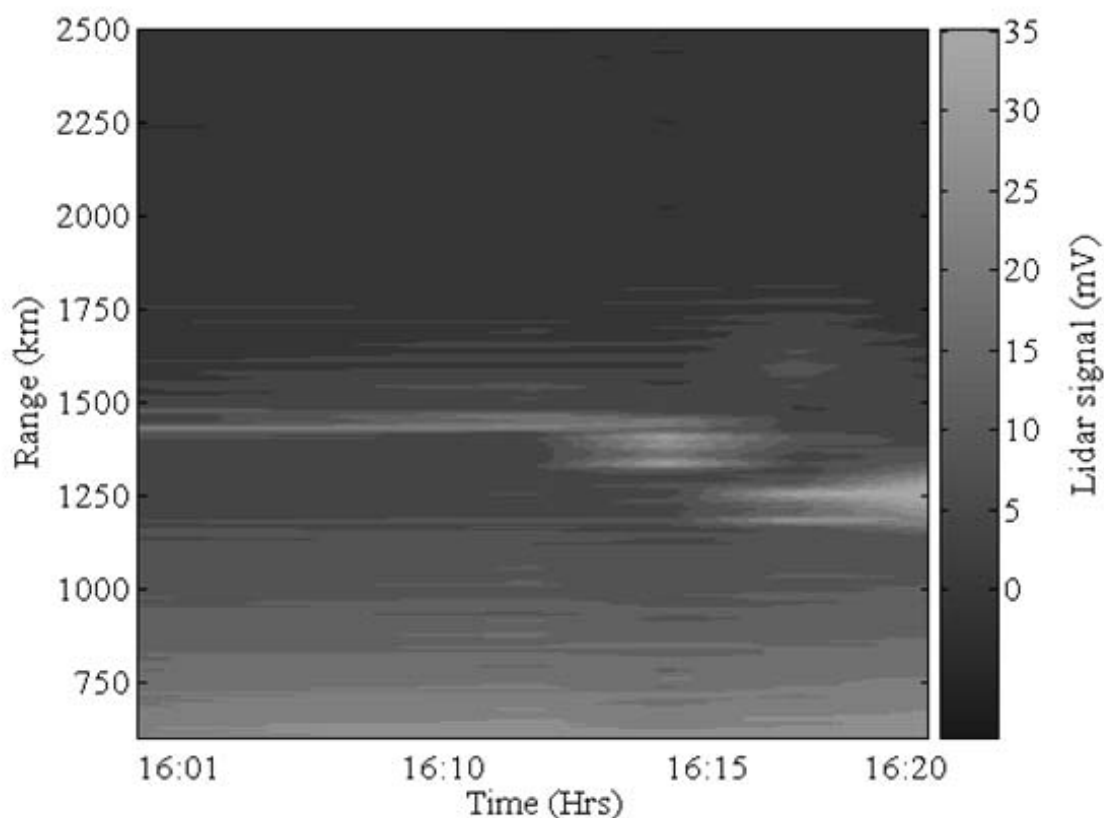


Fig.5. Atmospheric extinction coefficient obtained for the clear (03 August 10) and cloudy (04 August 10) atmospheric conditions.



5. CONCLUSION

The Mie Lidar system is designed and developed at LASTEC and put into regular operation. This system uses Nd: YAG laser source that operates at 1064 nm, 70 mJ pulse energy, 10 ns pulse duration and 10 Hz of pulse repetition frequency. The Si: APD module with built-in preamplifier is used as a optical detector for receiving the backscattered signals from the atmosphere. The behaviours of lidar return signal versus range were analysed and derived the extinction coefficient. The temporal averaging of 128 pulses and the spatial averaging of 15 samples resulted the smooth signal compared to the raw signal. The peak cloud extinction coefficient on a cloudy day is about $1.56 \times 10^{-3} \text{ m}^{-1}$. However, on a clear day it varied between $7.5 \times 10^{-5} \text{ m}^{-1}$ and $2.5 \times 10^{-4} \text{ m}^{-1}$. The experimental results are well in agreement with published literature values at 1064 nm. The experience gained through these measurements on clouds could be useful for the detection and forecast the movements of toxic/pollutant clouds in our upcoming DIAL lidar activities.

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REFERENCES

1. Szinicz L., *History of chemical and biological warfare agents*, Toxicology, 214, 2005, p. 167.
2. Carus W. S., *Bioterrorism and Biocrimes - The Illicit Use of Biological Agents in the 20th Century*, Center for Counter proliferation Research, National Defense University, Washington DC, USA. 1998.
3. A.T. Tu, *Basic information on nerve gas and the use of sarin by Aum Shinrikyo*, Journal of Mass Spectrometry Society of Japan, 44, 1996, p. 320.
4. http://en.wikipedia.org/wiki/2001_anthrax_attacks
5. Measures R.M., *Laser Remote Sensing- Fundamentals and Applications*, Kreiger Publishing Company, Krieger Drive, Malabar, Florida, 32950, 1992.
6. Kovalev V. A. & W. E. Eichinger, *Elastic lidar: theory, practice, and analysis methods*, Hoboken, NJ, Wiley, 2004.
7. Weitkamp C., *Lidar: Range resolved optical remote sensing of the atmosphere*, Springer, 2005.
8. Muller D.K; Franke F.; Wagner D.; Althausen A. & Heintzenberg J., *Vertical profiling of optical and physical particle*

- properties over the tropical Indian Ocean with six wavelength lidar*, 1. Seasonal cycle, *Journal of Geophysical Research*, 106, 2001, p. 28,567.
9. Sassen K., *The polarization lidar technique for cloud research: A review and current assessment*, *Bulletin of American Meteorological Society*, 72, 1991, p.1848.
 10. Satyanarayana M.; Veerabuthiran S.; Rao D.R. & Presennakumar B., *Color rain on the west coastal region of India: Was it due to a dust storm?*, *Aerosol Science and Technology*, 38, 2003, p. 24.
 11. Prasad C.R.; Kabro P. & Mathur S., *Tunable IR differential absorption lidar for remote sensing of chemicals*, *Proc. SPIE*, 3757, 1999, p. 87.
 12. Carlisle C.B.; Van der Laan J. E.; Carr L.W.; P. Adam & Chiaroni J. P., *CO₂ laser based differential absorption lidar system for range resolved and long range detection of chemical vapor plumes*, *Applied Optics*, 34, 1995, p. 6187.
 13. Simard J. R.; Roy G.; Mathieu P.; Larochelle V.; McFee J. & Ho J., *Standoff sensing of bioaerosols using Intensified Range Gated Spectral Analysis of Laser induced Fluorescence*, *IEEE Transactions on Geoscience and Remote Sensing*, 42, No 4, 2004, p. 865.
 14. Fernald F.G., *Analysis of atmospheric Lidar observation: some comments*, *Appl Opt*, 23, 1984, p. 652.
 15. Takamura T.; Sasano Y. and Hayakasa T., *Troposphere aerosol optical properties derived from lidar, sun photometer, and optical particle counter measurements*, *Appl. Opt.*, 33, 1994, p. 7132.
 16. Puchalski S., *Morphological classification of vertical profiles of aerosol extinction coefficient in the troposphere obtained from lidar measurements at Belk observatory in 2000-2003*, *Publs. Inst. Geophys. Pol. Acad. Sc.*, D-67, 2006, p. 382.
 17. J. L. Guaumet; Heinrich J. C; Cluzeau M.; Pierrard P. and Prieur J., *Cloud-Base Height Measurements with a Single-Pulse Erbium-Glass Laser Ceilometer*, *J. Atmos. Oceanic. Tech*, 15, 1998, p. 37.

DETECTION OF ELECTROLYTICALLY ACTIVE ELEMENTS IN *OCIMUM SANCTUM* L. (TULSI) USING LIBS

Devendra Kumar Chauhan

Department of Botany, University of Allahabad, Allahabad, India

Durgesh Kumar Tripathi

Department of Botany, University of Allahabad, Allahabad, India

Ashok Kumar Pathak

Laser Spectroscopy Research Laboratory, Department of Physics, University of Allahabad, Allahabad, India

Shikha Rai

Laser Spectroscopy Research Laboratory, Department of Physics, University of Allahabad, Allahabad, India

Awadhesh Kumar Rai

Email: awadheshkrai@rediffmail.com Phone: +91 8858773774

Laser Spectroscopy Research Laboratory, Department of Physics, University of Allahabad, Allahabad, India

ABSTRACT

Laser Induced Breakdown Spectroscopy (LIBS) has been applied to detect electrolytic elements present in the leaves of *Ocimum sanctum* (Tulsi). LIBS spectra of *Ocimum sanctum* leaves have been recorded in the spectral range 200-900 nm. LIBS spectra of *Ocimum sanctum* leaves contain the atomic lines of Potassium, Sodium, Calcium, Magnesium, Iron, Manganese, Silicon, and Strontium along with lighter elements like Carbon, Hydrogen, Oxygen and Nitrogen. The presence of electrolytic elements Potassium, Sodium, Calcium and Magnesium in Tulsi was observed for the first time using LIBS technique. All these elements are responsible for transmitting electrical signals from brain to the various parts of the body and help to regulate homeostasis of the human body.

Key Words: LIBS, Tulsi, Ca, Mg

1. INTRODUCTION

Medicinally significant plants are reward of nature for human beings on earth. Indian traditional medicines are mostly natural remedies based on herbal preparations with minimum or no side effects. Natural cures are gaining importance at a global level due to their low toxicity and cost, hence safe and economical [1]. *Ocimum sanctum* (Commonly known as Tulsi) belongs to family Lamiaceae and has many medicinal properties. The essential oil of *Ocimum* leaves, which contains eugenol, eugenal, carvacrol, methylchavicol, limatrol and caryophylline, a steroid ursolic acid and n-triacontanol. [2]. Leaves are generally used as nerve tonic bronchial asthma, cough, cold and memory loss [2]. From last few years several studies have been carried out by Indian scientists and researchers to suggest the role and potential of *O. sanctum* [3] in various diseases. Numerous studies approved *O. sanctum* (Tulsi) as a most medicinally important plant with the help of various pharmacological techniques [3, 4, 5, 6, 7, 8, 9, 10, 11, 12, and 13]. A number of biologically active compounds were isolated from leaves of *O. sanctum* (Tulsi) but no one has detected the active electrolytes elements in its leaves. In this present manuscript we have studied the elemental profile of *O. sanctum* using laser spectroscopic technique known as Laser Induced Breakdown Spectroscopy (LIBS). LIBS has been successfully applied for the analysis of elements in solid, liquid, and gas [14, 15]. Recently, Rai et al. have also suggested the utility of LIBS technique on the plant products [16, 17]. However various techniques are being utilized for elemental analysis of materials such as Ion mobility spectrometry (IMS), Mass spectroscopy, Inductively coupled plasma atomic emission spectrometry (ICP-AES), Graphite furnace atomic absorption spectrometry (GFAAS), but all these techniques are expensive, time consuming sample preparation and not suitable for in-situ and point detection analysis. Laser Induced Breakdown Spectroscopy (LIBS) has emerged as a valuable tool for in-situ and in-vivo analysis of any type of materials including biomaterials [18, 19]. Therefore, in the present manuscript we have used the LIBS technique to study the presence of electrolytic essential elements in the leaves of *O. sanctum* which helps to regulate myocardial and neurological function, fluid, balance, oxygen delivery and acid base balance.

2. MATERIAL AND METHOD

O. sanctum (Tulsi) leaves were collected from the Roxburgh Garden of Botany Department University of Allahabad, Allahabad, UP, India. The pellets of *O. sanctum* leaves were prepared by drying it in hot air oven at 104°C for 5 hours followed by grinding and finally make pellets by hydraulic pressure machine at 10 ton pressure. Each spectrum is the average of 10 laser shots. The data acquired simultaneously by the spectrometer has been stored in a computer through OOILIBS software for subsequent analysis.

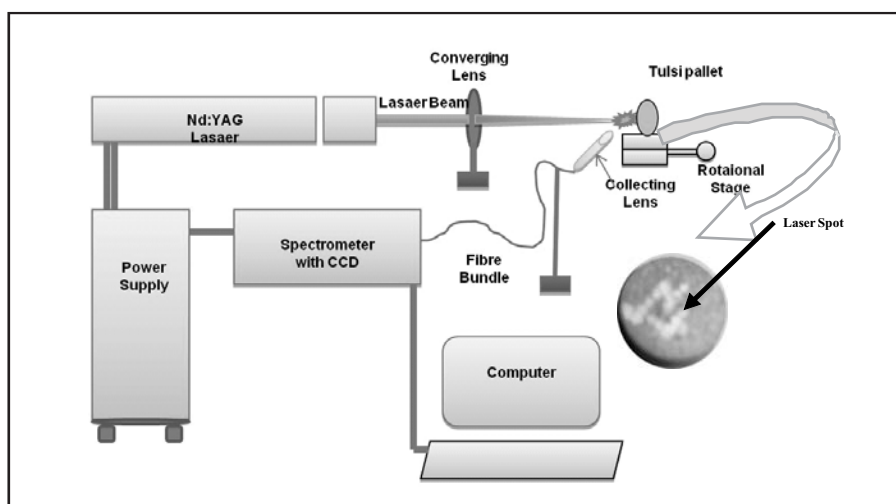


Figure1. Showing the experimental setup of LIBS

3. RESULTS AND DISCUSSION

The LIBS spectra of *O. sanctum* (Tulsi) leaves are recorded in the spectral range 200-900 nm as shown in Figures 2, 3, 4 and 5. The presence of persistent lines in the LIBS spectra were analyzed using standard NIST data [20]. Figure 2 clearly shows the presence of spectral lines of the elements like Carbon (C), Silicon (Si), Magnesium (Mg) and Manganese (Mn) where as figure 3, confirms the presence of atomic lines of Calcium (Ca), Sodium (Na), Iron (Fe) and Magnesium (Mg).

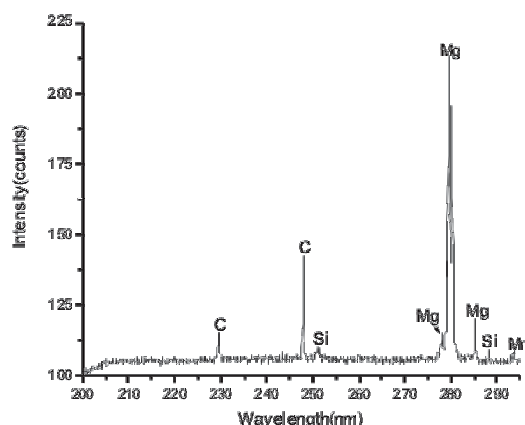


Figure 2- LIBS spectra of *O. sanctum* (Tulsi) in the spectral range 200nm- 295nm

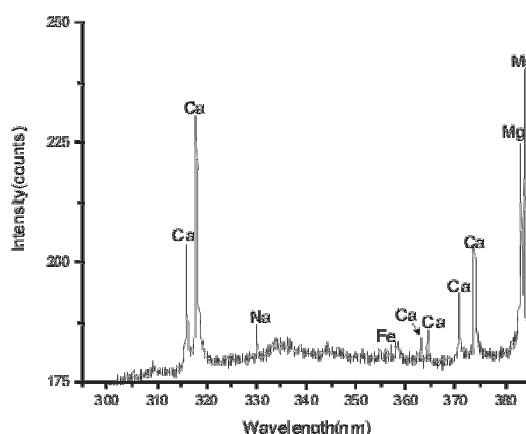


Figure 3- LIBS spectra of *O. sanctum* (Tulsi) in the spectral range 295nm- 385nm

In LIBS spectra shown in figure 4 signatures of elements Calcium (Ca), Strontium (Sr) and Nitrogen (N) are observed

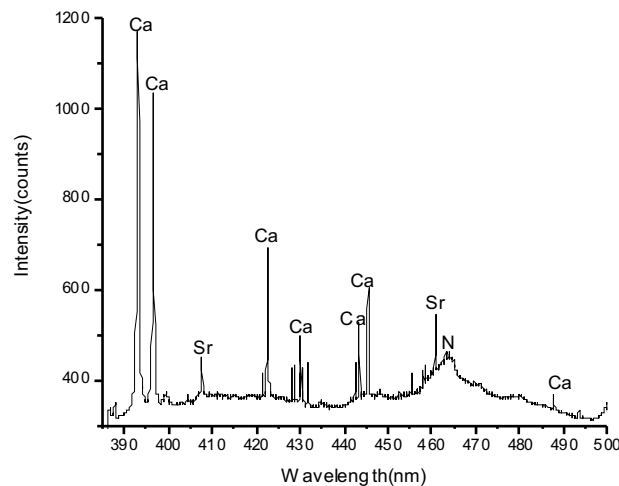


Figure 4- LIBS spectra of *O. sanctum* (Tulsi) in the spectral range 385nm-500nm

Spectra in figure 5 demonstrate the presence of Calcium (Ca), Sodium (Na), Iron (Fe), Hydrogen (H), Potassium (K), Nitrogen (N) and Oxygen (O). The detection of lighter elements like Carbon (C), Hydrogen (H), Nitrogen (N) and Oxygen (O) in Tulsi is an added advantage over other conventional spectroscopic technique. The spectral lines observed in LIBS spectra are tabulated in table 1 which explains the presence of various elements. The present study was undertaken to detect the major and minor elements of *O. sanctum* (Tulsi) to define their possible roles in various disease management. For an atomic transition having an upper level “k” to a lower level “i”, the intensity “I” of the spectral line from an excited atom or ion in homogenous and optically thin plasma can be written as [19]

$$I_{\lambda}^{ki} = F C A_{ki} \frac{g_k e^{-E_k / K_B T}}{U(T)}$$

Where C is the concentration of the atomic species, g and E are the statistical weight and energy of the upper level “k”, respectively, U is the partition function of relevant species, K_B is Boltzmann's constant, T is the temperature of

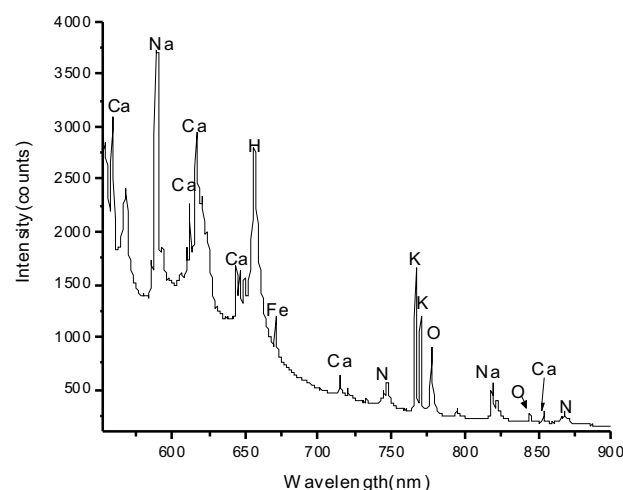


Figure 5- LIBS spectra of *O. sanctum* (Tulsi) in the spectral range 553nm- 900nm

Elements Identified	Observed Wavelengths (nm)
Ca	315.8 nm, 317.9 nm, 370.6 nm, 373.6 nm, 393.3 nm, 396.8 nm, 422.6 nm, 428.3 nm, 443.5 nm, 445.4 nm, 714.8 nm, 854.2 nm,
Mg	277.9 nm, 279.7 nm, 279.5 nm, 280.2 nm, 285.2 nm, 382.9 nm, 383.2 nm, 383.8 nm
Mn	293.3 nm, 294.9 nm
Fe	258.5 nm, 259.9 nm,
Na	330.2 nm, 588.9 nm
K	766.4 nm, 769.8 nm
Sr	407.7 nm, 421.5 nm, 460.7 nm
Si	251.4nm, 288.1 nm
N	463.0 nm, 744.2 nm, 868.0 nm
C	229.6nm, 247.8nm,
H	656.2nm
O	777.4 nm, 844.6 nm

the plasma, and F is a constant depending on experimental conditions. From above relation it is clear that the spectral line intensity of any elements is directly proportional to its concentration in the target sample. But the absolute concentrations of major or minor elements in *O. sanctum*, cannot be performed as standard samples to construct a calibration curve are not available.

Figures 2, 3, 4 and 5 clearly demonstrate the presence of Calcium, Magnesium, Potassium, Iron, Silicon, Sodium etc. Among the above observed elements K, Ca, Na and Mg are elements which maintain electrolytic balance of human body and Silicon is needed for the healthy bones, skin and muscles [21]. The active presence of Mg, K and Ca in Tulsi makes it suitable for diabetic and heart patients. Ca and Fe also play important role in maintaining the hemoglobin level and strong bones. Potassium is very important element because it stimulates kidneys to eliminate toxic substance from the body. Basically high potassium and low sodium diet protects against cardiovascular diseases and cancer, while the reverse, a low potassium and high sodium diet actually can persuade these diseases. Rai et al. 2007 [15] also reported role of potassium and sodium in *Psidium guajava* and suggested that their appropriate amount can help for diabetic management.

The active presence ratio of potassium and sodium strongly suggests that Tulsi may be as a medicine for the cancer, heart and diabetic patients.

4. CONCLUSION

The present study demonstrates the mineral profile of Tulsi (*O. sacctum*) using novel spectroscopic technique LIBS. Almost all nutritionally important elements has been detected in the Tulsi leaves, making it suitable for medicinally important. The presence of high concentration of K maintains the electrolytic balance of the human body and most suitable for Hypokalemia.. The presence of lighter elements C, H O and N demonstrates the presence of organic compounds in Tulsi leaves. Owing to the medicinally important organic and inorganic constituents, Tulsi has been given sacred place in the surroundings of human being since time immemorial.

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REFERENCES

1. Atal, C. K. & Kapoor B. M. Cultivation and utilization of medicinal plants (Eds. PID CSIR), 1989.
2. Shanker Gopal Joshi. Medicinal plants.. Oxford and IBH publishing Co. Pvt. Ltd., New Delhi. 2000.
3. Prakash, P. & Gupta Neelu. Therapeutic uses of *Ocimum sanctum* LINN (TULSI) with a note on eugenol and its pharmacological actions: a short Review. *Indian J Physiol Pharmacol*; 49 (2) 2005, p. 125–131
4. Sen, P. Therapeutic potentials of Tulsi : from experience to facts. *Drugs News & Views* 1(2), 1993, p.15–21.
5. Nadkarni, A. K. & Nadkarni, K. M. *Indian Materia Medica*. Published by Popular Prakashan Pvt. Ltd., Bombay), 1976.
6. Rajeshwari, S. *Ocimum sanctum*. The Indian home remedy. In: *Current Medical Scene*. March-April (published by, Cipla Ltd., Bombay Central, Bombay). 1992
7. Khanna, N. & Bhatia, J. Action of *Ocimum sanctum* (Tulsi) in mice: possible mechanism involved. *J Ethnopharmacology*. 88(2–3), 2003, p. 293–296.
8. Gupta, S. K.; Prakash, J. & Srivastava, S. Validation of claim of Tulsi, *Ocimum sanctum* Linn as a medicinal plant. *Indian J Experimental Biology*; 40(7), 2002. p. 765–773.
9. Reghunandana, R.; Sood, S.; Reghunandana, V.; Mehta, R. M. & Singh G. P. Effect of *Ocimum sanctum* Linn (Tulsi) extract on testicular function. *Indian J Medical Research*. 49(4), 1995. P. 83–87.
10. Bhargava, K. P. & Singh, N. Antistress activity of *Ocimum sanctum* Linn. *Indian J Medical Research*. 73 1981. p. 443–451.
11. Nagarajun, S.; Jain, H. C. & Aulakh, G. S. Indigenous plants used in the control of Diabetes. In: *Cultivation and utilization of medicinal plants*. Editors: Atal CK and Kapoor BM (Published by PID CSJR) 1989, p. 584.
12. Sarkar, A.; Pandey, D. N. & Pant, M. C. Changes in the blood lipid profile level after administration of *Ocimum sanctum* (Tulsi) leaves in the normal albino rabbits. *Indian J Physiology Pharmacology*. 38(4) 1994. p. 311–312.
13. Pritibha, D.; Nadig & Laxmi, S. Study of anti-tissive activity of *Ocimum sanctum* Linn in guinea pigs. *Indian J Physiol Pharmacol*; 49 (2), 2005. p. 243–245.
14. Rai, A. K.; Rai, V. N.; Yueh, F. U. & Singh, J. P. Laser-induced breakdown spectroscopy: a versatile technique for elemental analysis. *Rec. Tren. in Appl. Spectrosc.* 4, 2002. p.165–214
15. Rai, P. K.; Rai, N.K.; Rai, A.K. & Watal, G. Role of LIBS in elemental analysis of *Psidium guajava* responsible for Glycemic potential. *Instrum. Sci. Technol.* 35, (2007).p. 507–522
16. Rai, P. K.; Jaiswal, D.; Rai, N. K.; Pandhija, S.; Rai, A. K. & Watal, G.. Role of glycemic elements of *Cynodon dactylon* and *Musa paradisiaca* in diabetes management. *Lasers Med. Sci.* 2009 (doi:10.1007/s10103-008-0637-0).
17. Pathak, A. K. & Rai, A. K. In-vivo study of human nails using LIBS. *Asi Jour of Spectr.* In press (2010).
18. Pathak, A. K.; Singh, V. K.; Rai, N. K.; Rai, A. K.; Rai, Pradeep K.; Rai, Pramod K.; Rai, S. & Baruah G. D. Study of different concentric rings inside gallstones with LIBS. *Lase in Medi Sci* (Accepted Jan 06, 2011).
19. Singh, V. K.; Singh, Vinita; Rai, A. K.; Thakur, S. N., Rai, P. K., & Singh, J. P., Quantitative analysis of Gallstone by laser - induced breakdown spectroscopy. *Applie Opt.* 47, 2008. p. 38–47
20. Sansonetti, J. E.; & Martin, W.C. *Hand book of basic atomic spectroscopic data*. Natio. Insti. of Stand. and Techno. 2005.
21. Sripanyakorn, S.; Jugdaohsingh, R.; Thompson, R. P. H. & Powell, J. J.. Dietary Silicon and Bone Health. *Nutr. Bull.* 30, 2005. p. 222 - 230.

ENERGY EFFICIENT ROUTING IN WIRELESS SENSOR NETWORK

Malay Ranjan Tripathy

Department of Electronics and Communication Engineering,
Amity School of Engineering and Technology, Amity University, Noida, Uttar Pradesh.

Sonam Sharma

Department of Information Technology, Jind Institute of Engineering and Technology, Jind, Haryana.

Kunal Gaur

Department of Electrical and Electronics Engineering, Jind Institute of Engineering and Technology, Jind, Haryana.

Vijay Athavale

SVS Group of Institutions, Meerut, Uttar Pradesh

In this paper, we discuss about the secured energy efficient routing in wireless sensor network (WSN). We have considered heterogeneous topology for sensor nodes. We have described stack protocol for communication architecture of WSN. We proposed Geographic Adaptive Fidelity (GAF) as routing protocol for better communication. In order to explore the node behavior we have used the network simulator and found the usefulness of the proposed network.

Kew words – Wireless Sensor Networks (WSN); Geographic Adaptive Fidelity (GAF); HPSIM; Petri Net Algorithm.

ABSTRACT

Wireless sensor networks (WSN) have recently considered as promising research topic due to its large applications in different domains [1, 2]. Improvements in wireless network technology interfacing with emerging micro sensor based on MEMs technology [2] along with the real time embedded systems [3] based on limited computation, energy and memory resources make this subject more attractive to many researchers. However, due to the lack of tamper-resistant packaging and the insecure nature of wireless communication channels, these networks are vulnerable to internal and external attacks. The routing protocols are in general considered, taking the power consumption as on priority basis but not security. As security plays an important role in the ability to deploy and retrieve trustworthy data from a wireless sensor network. The proper operations of many WSNs rely on the knowledge of routing algorithms.

1. INTRODUCTION

Due to such issues, many new routing algorithms have been proposed in the literature [2, 4] for WSNs. These routing mechanisms have taken into consideration the inherent features of WSNs along with the application and architecture requirements. Almost all of the routing protocols are classified according to the network structures. They are known as flat, hierarchical, or location-based routing protocols. In flat networks, all nodes play the same role while hierarchical protocols aim at clustering the nodes so that cluster heads can do some aggregation and reduction of data in order to save energy. Location-based protocols utilize the position information to relay the data to the desired regions rather than the whole network. Many cases location based protocols are preferred because of its limited energy consumption, sensor mobility, power usage and low state complexity. Geography Adaptive Fidelity (GAF) protocol is one of them [2]. It has advantages even over the GEAR (Geographic And Energy Aware Routing) routing protocol in the sense of better scalability.

In this paper, we discuss stack protocol as wireless sensor node communication architecture in section II. GAF routing protocol is outlined in the section III. Proposed network topology is described in section IV. Section V is dealt with results and discussion. Conclusion is made in the section VI.

2. STACK PROTOCOL AS COMMUNICATION ARCHITECTURE FOR WIRELESS SENSOR NODE

In WSN applications and systems the increase in wide range of routing protocols and mechanisms need to address the issues of heterogeneity, link layers, MAC protocols and underlying transportation mechanisms. In this case we propose Stack Protocol (Fig.1) [5] as the communication architecture for WSN. **This protocol can be used by base stations and sensor nodes to communicate with each other. This transfer signals via wireless media which is handled by physical layer. This stack also ensures cooperative work of nodes.** The protocol stack consists of physical layer, data link layer, network layer, transport layer, application layer, power management plane, mobility management plane and task management plane. The functions of

physical layer is to provide transmission and receiving mechanisms, carrier frequency generation, frequency selection, signal detection, modulation and data encryption. The Data Link Layer function for medium access, error control, multiplexing of data streams and data frame detection and also ensures reliable point to point and point to multi-hop connections. The MAC layer in the data link layer must be capable of collision detection and utilize minimal power. The network layer functions for finding the optimal path for the transferring packet to destination node through the internet. It also helps in maintaining the flow control. The application layer is responsible for propagating requests from the application layer down to the lower layers.

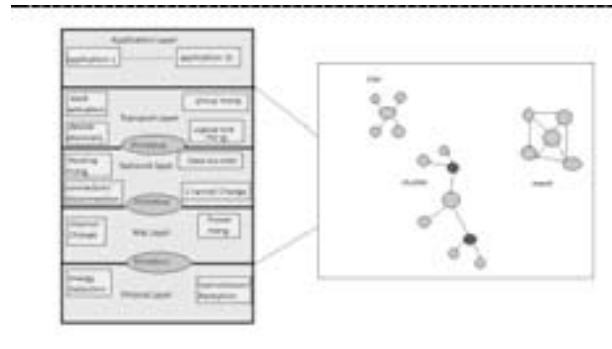


Figure 1 Stack Protocol as Communication Architecture for WSN

The power utilization is managed by the Power Management Plane. Mobility management plane functions for the movement pattern, if nodes are mobile. The task management plane does the scheduling of the sensing and forwarding responsibilities of the sensor nodes. There are certain limitations in this protocol such as limited energy, electromagnetic wave propagation, limited channel bandwidth, time varying conditions and mobility error-prone channel.

3. GEOGRAPHIC ADAPTIVE FIDELITY (GAF)

GAF is based on the concept of location based protocol [2] where, one node is in need to communicate with other sensor nodes. Distance between the two nodes can be calculated by either analyzing the strength of incoming signal or by the satellite communication. For this, the node must be equipped with a small low power GPS receiver. In order to minimize the energy consumption, the node can be kept on sleep mode when it is not collecting any data. More the number of nodes in sleep mode more will be the energy saving. It was designed earlier for mobile ad hoc networks, but works well for sensor networks. In this routing, network area is divided into small sided zones to form a virtual grid. Nodes in that small zone will select a particular node to stay active for collecting data for various nodes under its region. This node is called cluster head that is responsible for monitoring and reporting data to the base station on behalf of the other nodes in the zone. Hence, GAF conserves energy by turning off unnecessary nodes in the network i.e in sleep mode. GPS-indicated location will be associated with every node in a grid. There are three states in GAF. One is for finding the neighbors in the grid; others are active participation in routing and sleep. The mobility can be handled as, every node in the grid calculates its leaving time of grid and intimate this to its neighbors. Before the leaving time of the active node expires, node in sleep mode wake up and becomes active. For non-mobility (GAF-basic) and mobility (GAF-mobility adaptation) of nodes, GAF can be implemented. GAF always keep a cluster head in active mode so that network will always be connected. GAF is a location-based protocol; it can also be a hierarchical protocol, where the clusters are created on the basis of geographic location. Fixed clusters (non-mobility) are considered as squares (as shown in Fig.2). Square size is according to the communication direction and required transmitting power. For vertical and horizontal communication, signal should travel a distance of $x = r/5$ where, sensor nodes are in two adjacent square, horizontally or vertically. For diagonal communication, signal should travel as $y = r/2$

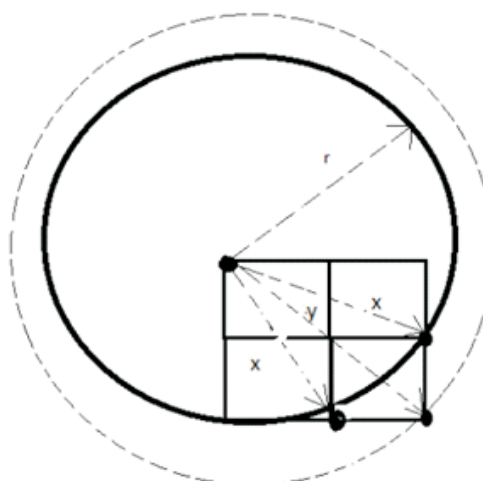


Figure 2. Zoning in GAF

4. PROPOSED NETWORK TOPOLOGY

The four layer heterogeneous network topology is shown in Fig.3. In this case the end user can retrieve data directly from master node. The sub leader collects data from nodes in node layer where all the nodes are connected in a mesh topology.

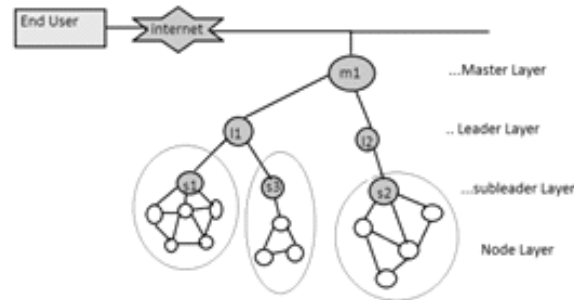


Figure 3. Proposed Network Topology

The mess topology is shown in the Fig.4. In this case, if node n1 wants to send packets to leader node, then at first it has to decide the path. It can be either a path through a node n2, n3 or n4. This decision will be based on the distance between destination node and the next adjacent node. These nodes can be provided by GPS technique. Our aim is to deliver packet successfully to sub-leader, which in turn deliver data to master node through which the end user can retrieve data via internet.

5. RESULTS AND DISCUSSION

To implement this topology, we have used a HPSIM network simulator which worked on the concept of Petri Net [6]. In general it is difficult



Figure 4. Mess Topology

to study the behavior of a network, when nodes send data to its cluster head. So we adopt a Petri Net simulation tool for this study

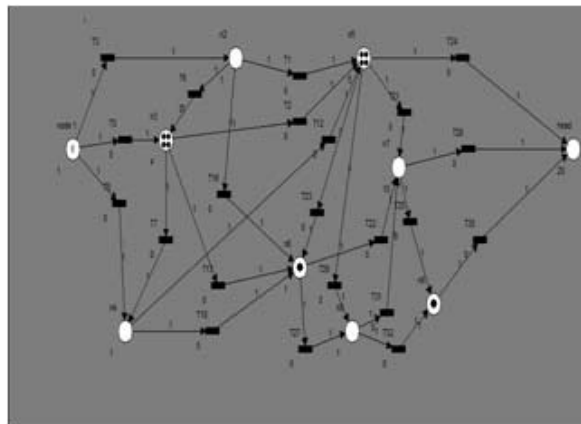
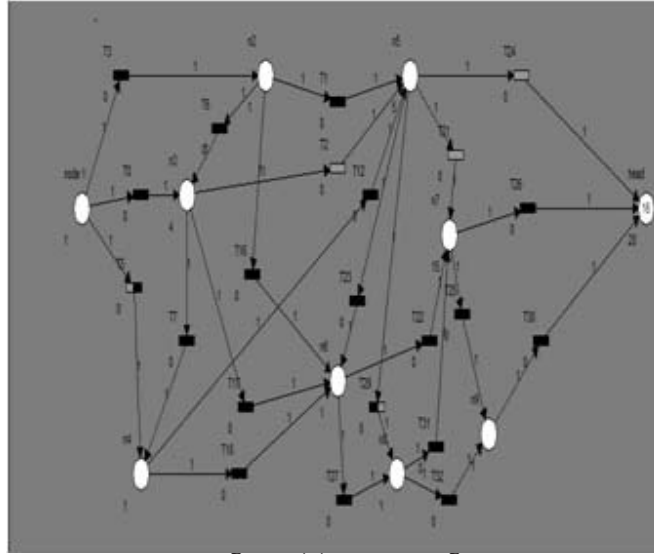


Figure 5(a) Before Firing



HP sim has a graphical editor for creating and simulating Petri Nets. It ensures the topology considered for this work has no deadlock states during execution. The resulting net has a property of liveness, soundness and bounded as it inherits the property of Petri Net's algorithm. The initial state of network is shown in Fig. 5(a). In this case, n1, n3, n5, n6 and n9 have the data to send and after firing all the packets should be collected at sub-leader nodes. It is seen that after firing (as shown in the Fig. 5(b)), all the data are successfully transferred to sub-leader node. This shows, there is no deadlock state during execution of the scheme.

6. CONCLUSION

In this paper we have considered stack protocol as communication architecture for WSN. GAF routing protocol is proposed as routing mechanism which is based on location based topology. Petri net modeling and HPSim simulator is used for a heterogeneous sensor network. It is seen that the network system is energy efficient, secure, dynamic and have the property of liveness, soundness, without any deadlock state during execution.

REFERENCES

- 1 Karlof, C and Wagner, D. "Secure routing in wireless sensor network: attacks and counter measures", *Ad hoc networks*, 1, 2003, pp.293-315.
- 2 Akyildiz, I. F., Su, W., Sankarsubramaniam, Y. and Cayirci, E. "A survey on sensor networks", *IEEE Communication Magazine*, 40(8), August 2002, pp.102- 114.
- 3 Aras, C. M., Kurase, J. F., Reeves, D. S. and Schulzine, H., "Realtime communication in packet switched network". *Proceedings of IEEE*, 82, 1, January 1994, pp.122-139.
- 4 Jain, E., and Liang, Q, "Sensor placement and lifetime of wireless sensor networks: Theory and performance analysis," *Sensor Network Operations*, S. Phoha, T. F. LaPorta, and C. Griñn, Eds., Wiley, New York, 2005.
- 5 Yang, Y., Ju, Y, Xim. H, Zhau, W and Zhen, Y "A network protocol stack based radiation sensor network for emerging system", *IJCSNS International journal of Computer Science and network security*, 8, 8, August 2008, pp.312-318.
- 6 Kim, S. Y., Guzide, O., and Cook, S., "Towards an optimal network topology in wireless sensor networks," *SUJUR*, Vol. 1, 2009.

ERA OF ENERGY HARNESSING: μ -ENERGY SCAVENGERS USING MICROSYSTEMS (MEMS) TECHNOLOGY

Tanuj Chauhan

email: tanujchauhan@gmail.com

Department of Electronics and Communication, Dronacharya college of Engineering B-27 Knowledge Park-III, Greater Noida-201306

Chayanika Das Bhagabati

email : chayanika27@gmail.com

Department of Electronics and Communication, Dronacharya college of Engineering B-27 Knowledge Park-III, Greater Noida-201306

Vinod Kumar

email: kumarvinod2001@gmail.com

Department of Electronics and Communication, Dronacharya college of Engineering B-27 Knowledge Park-III, Greater Noida-201306

ABSTRACT

With rising crisis of energy and power in the new millennium the lookout for alternative and new sources of power is being done on a magnum scale. The paper introduces techniques that are capable of harvesting and scavenging μ -energy from ambient atmosphere such as light, heat or vibrations and also harvests power from sources such as human activity. Microsystems devices are a viable option due to size and feasibility of integrating these devices with the electronics. Some of the energy scavengers are introduced as examples.

Keywords: energy scavenging, harvesting, comb drive, piezoelectric and electromagnetic MEMS systems.

1. INTRODUCTION

With the invent of batteries in eighteenth century portable energy sources came into mainstream picture and have been developed at every level in the present times to power up several mobile and static devices. In the earlier times when vacuum tubes were the cult of electronics, portability was big and insolvable issue. Advancement in Microsystems technology resulted in greater flexibility and has solved the “portability” issue to larger extent.

Energy scavenging from ambient energy resources is emerging as a potential solution to limited battery problems being faced in the past era of electronics. Batteries are being constantly transformed in a way that they can be powered by solar, electromagnetic fields, human motions, and mechanical vibrations. However, many such applications are limited by the amount of power extracted and conversion efficiency. While low-power circuit design techniques are explored [1] to reduce the power consumption of electronic devices, it is of tremendous interest to develop new energy conversion devices to increase the power density and conversion efficiency

Compared to the meso-scale counterparts, MEMS energy scavengers provide low power due to the small scale of micro sizes. However, in ultra-low power applications such as wireless sensor nodes and implantable medical devices, MEMS energy scavenging becomes a plausible solution due to its small form factor and low cost in mass production. New fabrication technologies have recently resulted in micro fuel cells aimed at recharging handhelds with power plants the size of a candy bar, and they promise fuel cells on a chip for powering wireless sensor nodes. More exotic emerging power technologies exhibit features that force them into niche applications.

2. BACKGROUND

Recently developed power management schemes enable battery-powered electronics to live longer. Such advances include dynamic optimization of voltage and clock rate, hybrid analogue-digital designs, and clever wake-up procedures that keep the electronics mostly inactive. Fig.1 suggests the battery energy density improvement with reference to other technological advancements

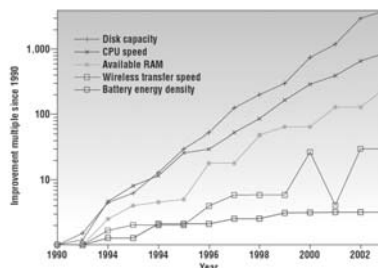


Fig 1. Relative improvements in laptop computing technology from 1990–2003.

The wireless-connectivity curve considers only cellular standards in the US, not including emerging, shortrange 802.11 “hot spots.” The dip marks the removal of the Metricom network Nonetheless, the field has encountered transformed interest as low-power electronics, wireless standards, and miniaturization conspire to populate the world with sensor networks and mobile devices. This article presents a whirlwind survey through energy harvesting.

Human motions such as swings, horizontal foot motions, and centre-of-mass motions are energy sources that have been attracting researchers on energy extraction for powering wearable electronic devices [11]. Energy extraction from human motion is especially useful for long-term monitoring of human body implantable devices. A PZT uni-morph piezoelectric power generator embedded in shoes produced a RMS power of 1.8 mW and used it to power a digital RFID tag successfully [1] as shown in the figure below.

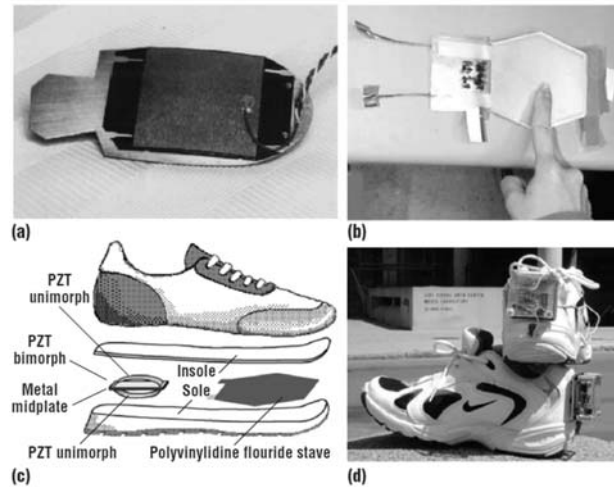


Fig 2: Integration of (a) a flexible PZT Thunder clamshell and (b) a 16-layer polyvinylidene fluoride bimorph stave under (c) the insole of a running shoe, resulting in (d) operational power harvesting shoes with heel-mounted electronics for power conditioning, energy storage, an ID encoder, and a 300-MHz radio transmitter.[1]

3. VARIOUS MODELS AND ANALYSIS

Some of the research is also been conducted in meso-scale electro-magnetic energy scavenger for energy extraction from center-of-mass motion of human body. The scavenger has achieved a power density of 0.44 mW/cm³. But due to the large amplitude (a typical value of 4 cm – 7 cm) and low frequency (typically 2Hz) for center-of-mass motion of human body, the power density will drop if the scavenger scales down to millimetre- scale or micro-scale, since the scavenger size will limit the amplitude of the proof mass vibration.

3.1. MASS-DAMPER-SPRING MODEL FOR VIBRATION ENERGY SCAVENGERS Electromagnetic and piezoelectric energy scavengers based on proof mass vibration can be modelled as a second-order mass-damper-spring dynamic system.

Fig. 3 demonstrates the schematic of a second-order energy scavenger model proposed by Williams and Yates [6]. The system consists a proof mass, m , a spring, k , a mechanical damping coefficient, b_m , and an electrical damping coefficient, b_e . x and y represent the spring deflection and the input displacement, respectively. The differential equation that describes the system is given as

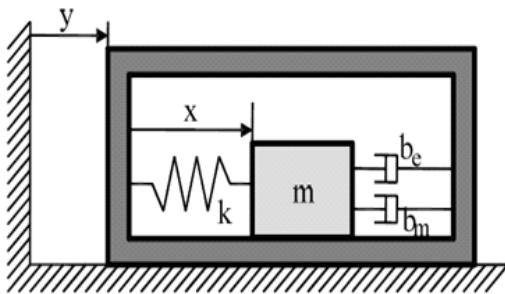


Fig 3. Schematic of an energy scavenger,[5]

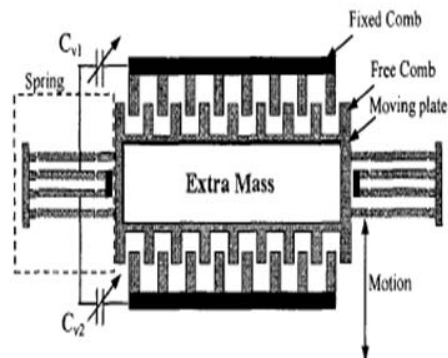


Fig 4: Comb Drive Structures,[2]

Fig 4 shows a practical implementation of one such Mass Damper scavenger in which comb drive makes a variable capacitance area created among the free and the fixed combs. From the structure one can make out that it will resonate and frequency of resonating structure will be same as that of input vibrations to bring out the maximum energy out of the surroundings. This kind of comb drive structure follows eqn. 1

Fig 5. guides us through the fabrication steps of the comb-drive structure.

3.2. ELECTROMAGNETIC ENERGY SCAVENGERS The extracted output power is maximized, if the resonant frequency of a mass-damper-spring system, described in the above Eqn. is equal to the input vibration frequency [16]. In this particular case and under the assumption that the power scavenging doesn't hamper the source vibration, the extracted power is given as eqn. (2)

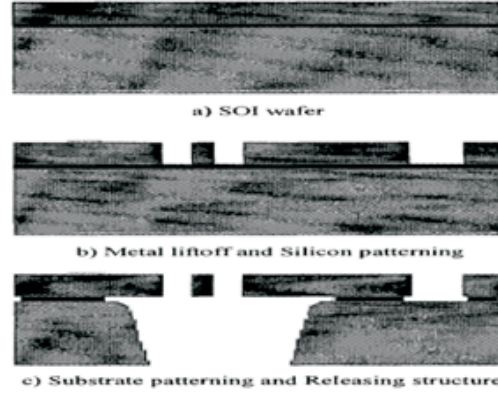
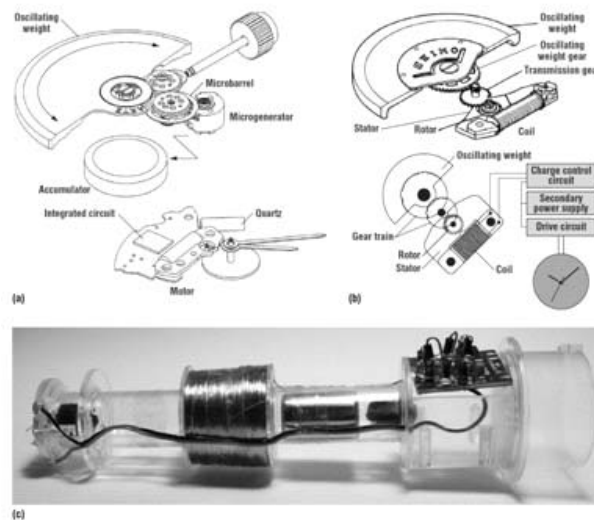


Fig 5 Fabrication of Comb-Drive structure, [2]

$$P_{EM} = \frac{m\phi e}{4\phi t} \omega^3 y^2 \quad (2)$$

Where PEM is the magnitude of the electromagnetically generated power, y is the magnitude of the input displacement the total damping ratio and ω is the input frequency. Above equation represents the maximum recoverable power for a scavenger. And the maximum extraction power is achieved when the electrical damping ratio matches the mechanical damping ratio.

3.3. INERTIAL ENERGY SCAVENGERS These scavengers work on the principle of inertia where in self winding mechanism is employed to generate power and is mostly used in watches. Inventors have long designed systems to harvest this energy, usually by exploiting the oscillation of a proof mass resonantly Tuned to the environment's dominant mechanical frequency. Self-winding watches use the motion of the user's body to wind their mechanisms. Fig 6 shows one of the inertial scavengers.



3.4. THERMOELECTRIC ENERGY SCAVENGERS Objects or environments at different temperature levels offer the opportunity for energy harvesting via heat transfer. The Carnot cycle—comprising adiabatic and isothermal operations—provides the fundamental limit to the energy obtained from a temperature difference. The Carnot efficiency is

$$(T_H - T_L)/T_H$$

where T_L and T_H are the low and high temperatures (degrees Kelvin) across which the thermal generator operates. Accordingly, Carnot efficiencies are limited for small ΔT . For example, going from body temperature (37 degrees Celsius) to a cool room (20 degrees Celsius) yields only 5.5 percent. Mechanical products have been designed to run off the meagre energy they harvest from ambient thermal cycling.

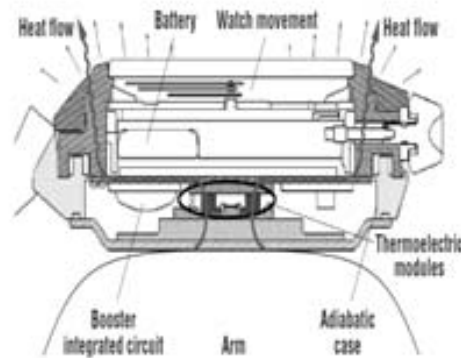


Fig 7: The Seiko Thermic wristwatch: a cross-sectional diagram, Copyright by Seiko Instruments. [1]

Research into the new thermoelectric and thermionic materials and the development of new kinds of devices, such as thermal diodes and micron-gap thermo-photovoltaic, desires to improve device efficiency. Energy conversion, however, limits available thermopile arrays, which attain efficiencies well under 10 percent for 200 degrees Celsius to 20 degrees Celsius, but below 1 percent for 40 degrees Celsius to 20 degrees Celsius. Accordingly, thermoelectric generators can deliver significant power with high-temperature sources (such as a hot exhaust pipe) but are much more limited for wearable applications or temperate environments.

4.DESIGN CONSIDERATIONS FOR MASS-DAMPER-SPRING MODEL FOR VIBRATION ENERGY SCAVENGERS

As the energy scavenger scales down in size ranging from milli-meters to microns, and these are typical scales of MEMS structures, the proof mass vibration amplitude is limited if the ambient vibration amplitude is too large. So for constant acceleration vibration, energy scavenging structures are suitable mostly for low-frequency and large-amplitude vibration applications while MEMS energy scavengers are more desirable for high-frequency small-amplitude applications.

Maximizing the scavenging power also requires that the total electrical damping ratio should match the mechanical damping ratio. At meso-scale, the mechanical damping coefficient of energy scavengers is very small due to the scale of movement. It is easy to design an electrical damping coefficient as large as the mechanical damping coefficient using either electromagnetic conversion piezoelectric conversion as well.

But instead in MEMS scavengers, the mechanical damping coefficient is large (e.g., higher than 0.5), and it is difficult to design an electrical damping coefficient for electromagnetic or piezoelectric scavengers as large as the mechanical coefficient, since it is not practical to fabricate too many turns of coils on a MEMS structures for electromagnetic conversion, or in other words the electrical damping coefficient is limited by the coupling coefficient. Therefore, energy scavenging is suitable via MEMS scavengers.

With a larger total electrical damping coefficient, energy scavenging maximizes the overall output power density and improves the energy conversion efficiency.

Table 1 shows the capabilities and scope, it clearly depicts that ambient sources such as radio frequency, light, heat and several others have major scope of development. Specifically seeing the vibrational microgenerator is capable of generating a power of $800\mu\text{W}/\text{cm}^3$ which is sufficient to run a MOSFET at nano scale.

5. CONCLUSION

MEMS based Energy scavengers are one of the possible and probable solutions to harvest energy specifically for mobile and small devices. Using MEMS as the choice of technology is done because of the processing capacity and mechanical properties of Silicon. Due to abundance of the raw material in these kinds of devices have lower cost and also come along with a significant advantage of wide application range. One can easily employ them at smaller scale such that of a watch, mobile phone etc.

There is surely solar power coming with a lower price tag but the efficiency of silicon based solar cell module goes maximum up to 20% and hence may become a hindrance in concomitant with applications. Energy harvesting proposed in this paper allows a better operating frequency and better efficiency specifically for small scale devices. As it is said that 'A Penny Saved is a penny earned', saving energy even on a smaller scale will help the human race develop a momentous pool of energy

Table 1. Scope and Opportunities in energy harvesting.[1]

Energy source	Performance ^a	Notes
Ambient radio frequency	< 1 $\mu\text{W}/\text{cm}^2$	Unless near a transmitter ³
Ambient light	100 mW/cm ² (directed toward bright sun) 100 $\mu\text{W}/\text{cm}^2$ (illuminated office)	Common polycrystalline solar cells are 16%-17% efficient, while standard monocrystalline cells approach 20%. Although the numbers at left could vary widely with a given environment's light level, they're typical for the garden-variety solar cell Radio Shack sells (part 276-124).
Thermoelectric	60 $\mu\text{W}/\text{cm}^2$	Quoted for a Thermo Life generator at $\Delta T = 5^\circ\text{C}$; typical thermoelectric generators $\leq 1\%$ efficient for $\Delta T < 40^\circ\text{C}$ ⁴
Vibrational microgenerators	4 $\mu\text{W}/\text{cm}^2$ (human motion—Hz) 800 $\mu\text{W}/\text{cm}^2$ (machines—kHz)	Predictions for 1 cm ³ generators. ⁵ Highly dependent on excitation (power tends to be proportional to ω^3 and y_0^2 , where ω is the driving frequency and y_0 is the input displacement), and larger structures can achieve higher power densities. The shake-driven flashlight of Figure 3, for example, delivers 2 mW/cm ² at 3 Hz.
Ambient airflow	1 mW/cm ²	Demonstrated in microelectromechanical turbine at 30 liters/min. ²⁰
Push buttons	50 $\mu\text{J}/\text{N}$	Quoted at 3 V DC for the MIT Media Lab Device. ²⁰
Hand generators	30 W/kg	Quoted for Nishio Engineering's Tug Power (vs. 1.3 W/kg for a shake-driven flashlight). ²
Heel strike	7 W potentially available (1 cm deflection at 70 kg per 1 Hz walk)	Demonstrated systems: 800 mW with dielectric elastomer heel, ²⁰ 250-700 mW with hydraulic piezoelectric actuator shoes, ²⁴ 10 mW with piezoelectric insole. ²⁵

REFERENCES

- 1 Joseph A Paradiso, Thad Starner , Energy scavenging for mobile and wireless technology, IEEE Com Soc, Jan 2005, p.18-26
- 2 Ahmed Nounou, Hani Ragaie A Lateral comb-drive structre for energy scavenging, IEEE Com Soc, Jan 2004, p.118-26
- 3 Bert Gyselinckx, Ruud Vullers ,Chris Van Hoof, Julien Ryckaert, Refet Firat Yazicioglu, Paolo Fiorini, Vladimir Leonov HUMAN++: EMERGING TECHNOLOGY FOR BODY AREA NETWORKS, Very Large Scale Integration, 2006 IFIP International Conference on, 2006, p.175 - 180
- 4 Shad Roundy, Paul k Wright, Micro electrostatic vibration to electricity converters, Proceedings of IMECE'02 ASME International Mechanical Engineering Congress & Exposition, Nov 2002, p. 1.
- 5 Xiaochun Wu, Alireza Khaligh, Yang Xu, Modeling, Design and Optimization of Hybrid Electromagnetic and Piezoelectric MEMS Energy Scavengers, IEEE 2008 Custom Intergrated Circuits Conference (CICC), p.177-180
- 6 C.B. Williams and R.B. Yates ,Analysis of a micro-electric generator for Microsystems, Proceedings of the Transducers 95/Eurosensors IX, (1995), p. 369-372.
- 7 K.E.Peterson ,Silicon as a Mechanical Material, Proc. of IEEE, Vol. 70, No. 5, May 1982, p.420-457
- 8 Jack W Judy UCLA, MEMS Fabrication, Design, and Applications, Smart Materials and Structures, Issue 6 (December 2001), p.17-24
- 9 M. Yeatman ,Applications of MEMS in power sources and circuits, Journal of micromechanics and microengineering, 17 (2007), p. S184-S188.
- 10 T. Starner and J. A. Paradiso ,Human generated power for mobile electronics, Low-Power Electronics Design, C. Piquet, Ed., CRC Press, 2004, ch. 45, p. 1-35.

COMET, THE REVERSE AJAX MECHANISM

R.Hema

email: hemaramji@gmail.com

Assistant Professor, Department of Information Technology Dronacharya College of Engineering, Khentawas, Gurgaon.

ABSTRACT

Conventional web-based applications are all about client-led communication, but there has been a repeated need to discuss server-led communication within the web development community and to provide a name for it. To understand the phenomenon of Comet and Reverse Ajax, we need to consider why there is a need for it and why it is so out of the ordinary as to require a label of its own. In this paper we will discuss the business need for Reverse Ajax, limitation of HTTP protocol and techniques used to achieve Comet.

KEYWORDS:

HTTP, Reverse Ajax, HTTP Pull, Streaming, Poll, DWR

1. INTRODUCTION

The term "Comet" was coined by Alex Russell of the Dojo project to describe exchanges between a client and a server in which the server, rather than the client, initiates the contact. Joe Walker of the Direct Web Remoting (DWR) project refers to a similar mechanism as "Reverse Ajax".

Conventional web-based applications are all about client-led communication, but there has been a repeated need to discuss server-led communication within the web development community and to provide a name for it. To understand the phenomenon of Comet and Reverse Ajax, we need to consider why there is a need for it and why it is so out of the ordinary as to require a label of its own.

2. BUSINESS USE CASES

Before understanding technical details of Comet, we should perhaps know usage of Comet at different instances. There are many use cases where it is important to update the client user interface in response to server-side changes. For example:

- An auction web site, where the users need to be alerted that another bidder has made a higher bid. In a site such as eBay, the user has to continuously press the 'refresh' button of his or her browser, to see if somebody has made a higher bid.
- A stock ticker, where stock prices are frequently updated.
- A chat application, where sent messages are delivered to all the subscribers.
- A news portal, where news items are pushed to the subscriber's browser when they are published.

The above mentioned web applications requiring real-time event notification and data delivery are usually implemented using a pull style, where the client component actively requests the state changes using client-side timeouts. An alternative to this approach is the push-based style, where the clients subscribe to their topic of interest, and the server publishes the changes to the clients asynchronously every time its state changes.

3. LIMITATIONS OF HTTP PROTOCOL

HTTP was designed as a protocol for retrieving documents from remote servers. As such, it has two important characteristics:

- Communication between the client and the server is always initiated by the client and never by the server.
- Connections between the client and server are transient, and the server does not maintain any long-term state information regarding the client. At least, this was the state of play with version 1.0 of the HTTP specification. By version 1.1, more application-like features, such as conversational state and persistent connections, were introduced. With HTTP/1.1, unless specified otherwise, the TCP connection between the server and the browser is kept alive, until an explicit 'close connection' message is sent by one of the parties, or a timeout/network error occurs. Prior to persistent connections, a separate TCP connection was established to fetch each URL, increasing the load on HTTP servers and causing congestion on the Internet.

4. WEB-BASED REAL TIME EVENT NOTIFICATION

The classical page-sequence web, based on the REST style, makes a server-initiated HTTP request impossible. Every request has to be initiated by a client, precluding servers from sending asynchronous notifications without a request from the client. There are several solutions used in practice that still allow the client to receive real-time updates from the server.

4.1 HTTP PULL Most web applications check with the server at regular user-definable intervals known as Time to Refresh (TTR). This check occurs blindly regardless of whether the state of the application has changed. In order to achieve high data accuracy and data freshness, the pulling frequency has to be high. This, in turn, induces high network traffic and possibly unnecessary messages. The application also wastes some time querying for the completion of the event, thereby directly impacting the responsiveness to the user. Ideally, the pulling interval should be equal to the Publish Rate (PR), i.e., rate at which the state changes. If the frequency is too low, the client can miss some updates. This scheme is frequently used in web systems, since it is robust, simple to implement, allows for offline operation, and scales well to high number of subscribers.

4.2 STREAMING HTTP Streaming is a basic and old method that was introduced on the web first in 1992 by Netscape, under the name 'dynamic document'. HTTP Streaming comes in two forms namely, Page and Service Streaming.

I. PAGE STREAMING This method simply consists of streaming server data in the response of a long-lived HTTP connection. Most web servers do some processing, send back a response, and immediately exit. But in this pattern, the connection is kept open by running a long loop. The server script uses event registration or some other technique to detect any state changes. As soon as a state change occurs, it streams the new data and flushes it, but does not actually close the connection. Meanwhile, the browser must ensure the user-interface reflects the new data, while still waiting for response from the server to finish.

II. SERVICE STREAMING Service Streaming relies on the XMLHttpRequest object. This time, it is an XMLHttpRequest connection that is long-lived in the background, instead of the initial page load. This brings some flexibility regarding the length and frequency of connections. The page will be loaded normally (once), and streaming can be performed with a predefined lifetime for connection. The server will loop indefinitely just like in page streaming, and the browser has to read the latest response to update its state on the Document Object Model (DOM). Currently, major AJAX push tools support Service Streaming. The application of the Service Streaming scheme under AJAX is now known as Reverse AJAX or COMET

5. COMET OR REVERSE AJAX

Comet is a programming technique that enables web servers to send data to the client without having any need for the client to request for it. It allows creation of highly responsive, event-driven web applications.

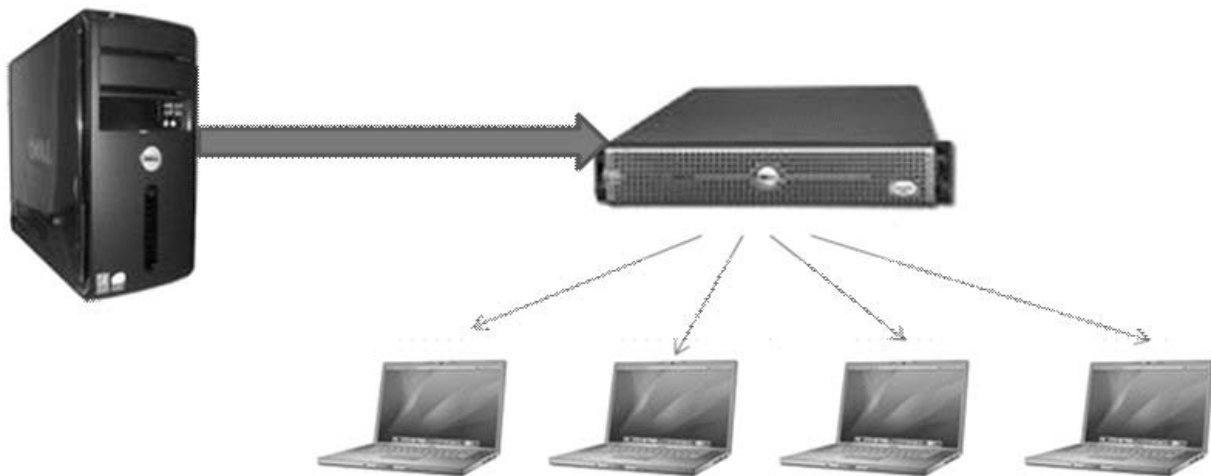


Figure 1 : Server mediated Collaboration

5.1 ADVANTAGES

- ▶ Lower latency, not dependent on polling frequency
- ▶ Server and network do not have to deal with frequent polling requests to check for updates

COMET implementations have mainly adopted the following techniques:

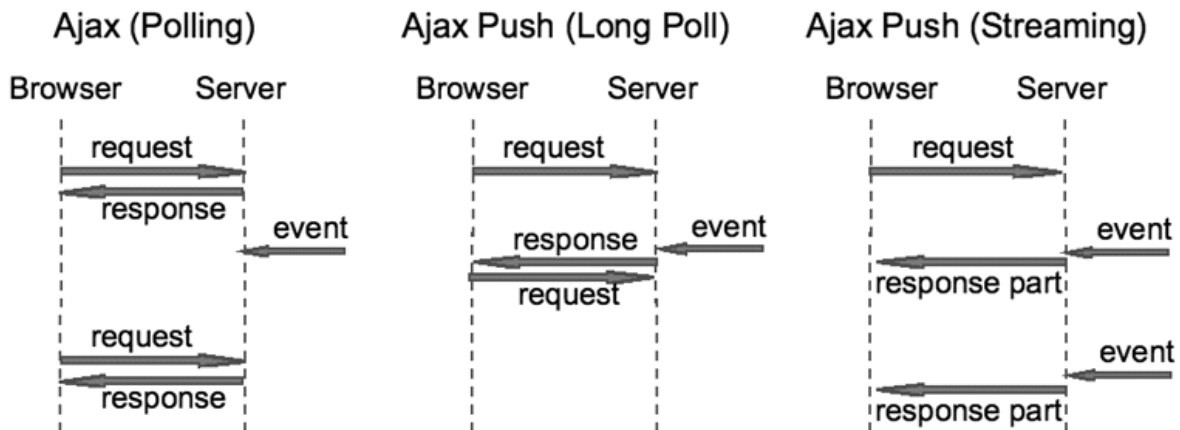


Figure 2: Polling, Long Polling and Streaming modes in COMET

5.2 POLL Client sends a request to the server every X seconds. The response is “empty” if there is no update.

5.3 STREAMING Figure 2 shows how the streaming mode operates. After the initial request, the server does not close the connection, nor does it give a full response. As the new data becomes available, the server returns it to the client in HTTP chunked mode, using the same request and the connection. Typical Comet server implementations implement this feature by opening a hidden iframe element in the browser after page load, establishing a long-lived connection inside the hidden iframe. Data is pushed incrementally from the server to the client over this connection, and rendered incrementally by the web browser.

5.4 LONG POLLING Figure 2 shows the operation of the long polling mode. In this mode, once again the server holds on to the client request, however this time until data becomes available. If an event occurs, the server sends the data to the client and the client has to reconnect. Otherwise, the server holds on to the connection for a finite period of time, after which it asks the client to reconnect again.

6. IMPLEMENTATION APPROACHES

COMETD and DWR are currently two actively developed open source libraries that bring COMET support to AJAX applications. In the following subsections we will discuss about these two libraries.

6.1 COMETD FRAMEWORK AND BAYEUX PROTOCOL The COMETD group released a COMET protocol draft called BAYEUX. The BAYEUX message format is defined in JSON (JavaScript Object Notation) which is a data-interchange format based on a subset of the JavaScript Programming Language. The protocol has recently been implemented and included in a number of web servers including Jetty and IBM Websphere. This protocol follows the 'topic-based' publish-subscribe scheme, which groups events according to their topic (name) and maps individual topics to distinct communication channels. Participants subscribe to individual topics, which are identified by keywords. It also allows topic names to contain wildcards, which offers the possibility to subscribe and publish to several topics whose names match a given set of keywords. BAYEUX defines the following phases in order to establish a COMET connection:

- The client performs a handshake with the server, receives a client ID and list of supported connection types, such as IFrame or long-polling.
- The client sends a connection request with its ID and its preferred connection type.
- The client later subscribes to a channel and receives updates.

Although the BAYEUX specification supports both streaming and long polling modes, the COMETD framework currently only implements the long polling approach.

6.2 DWR Direct Web Remoting (DWR) is a Java open source library which allows scripting code in a browser to use Java functions running on a web server just as if they were in the browser. DWR works by dynamically generating JavaScript based on Java classes. To the user it feels like the execution is taking place on the browser, but in reality the server is executing the code and DWR is marshalling the data back and forwards. DWR works similar to the RPC mechanism (e.g., Java RMI), but without requiring any plugins. It consists of two main parts:

- A Java Servlet running on the server that processes requests and sends responses back to the browser.
- A JavaScript engine running in the browser that sends requests and can dynamically update the DOM with received responses from the server.

From version 2.0 and above DWR supports COMET and calls this type of communication as “Active Reverse AJAX”. Currently, DWR does not support BAYEUX, and has adopted its own protocol to exchange data. DWR supports the long polling as well as the streaming mode.

7. USE CASE: STOCK TICKER

The Stock ticker publishes the stock prices at frequent interval to all subscribed clients. We have used DWR library for reverse ajax implementation.

Application Server: Tomcat 6.0 or any another application server

7.2 LIBRARIES REQUIRED

- dwr.jar (Version 2.0.5 and above). It can be downloaded from the URL:
<http://directwebremoting.org/dwr/download.html>
- commons-logging-1.0.4.jar
- OpenAjax.js: The OpenAjax Hub is a set of standard JavaScript that, when included with an AJAX-powered Web application, promotes the ability for multiple AJAX toolkits to work together on the same page. The central feature of the OpenAjax Hub is its publish/subscribe event manager (the "pub/sub manager"), which enables loose assembly and integration of AJAX components. With the pub/sub manager, one AJAX component can publish (i.e., broadcast) an event to which other AJAX components can subscribe, thereby allowing these components to communicate with each other through the Hub, which acts as an intermediary message bus.

8. CLIENT SIDE CODE

Stock.html: This client side code subscribes for a topic named “stock”. Therefore it receives the company names and their stock prices whenever published. Once the stock prices are received from the server, it is parsed and displayed to the user.

Source Code: Stock.html

```
<html>
<head>
<script type='text/javascript' src='/stockquotes/dwr/engine.js'></script>
<script type='text/javascript' src='/stockquotes/dwr/interface/StockTicker.js'></script>
<script type="text/javascript" src='OpenAjax.js'></script>
<script type="text/javascript">
dwr.engine.setActiveReverseAjax(true);
function subscribe() {
    OpenAjax.hub.subscribe("stock", objectPublished);
    StockTicker.startTicker();
}

function objectPublished(t, m) {
    updateData(m);
}
function updateData(data) {
    var priceHtml = '<table cellpadding="0px" style="font-family:verdana, Arial;font-size:11px;color:blue;"
                    id="data">';
    var arr = data.split(";");
    for(var i = 0; i < arr.length; i++) {
        var row = arr[i];
        var coNamePrice = row.split(":");
        var bgColor = '#E7E7E7';
        if (i % 2 == 0) {
            bgColor = 'white';
        }
        priceHtml += "<tr style='background-color:" + bgColor + "'><td width='120px'" + coNamePrice[0] + "</td>";
```

```

var priceData = coNamePrice[1];
var prices = priceData.split(",");

for(var j=0; j < prices.length; j++) {
    var priceStatus = prices[j].split("@");
    if (priceStatus[0] == "N") {
        priceHtml += "<td width='82px' align='center'>" + priceStatus[1] + "</td>";
    } else if (priceStatus[0] == "G") {
        priceHtml += "<td width='82px' style='color:green' align='center'>" + priceStatus[1] + "</td>";
    } else if (priceStatus[0] == "B") {
        priceHtml += "<td width='82px' style='color:red' align='center'>" + priceStatus[1] + "</td>";
    }
}
priceHtml += "</tr>";
document.getElementById("data").innerHTML = priceHtml;
}
priceHtml += "</table>";
}
</script>
</head>

<body onload="javascript:subscribe();">
<table style="font-family:verdana, Arial;font-size:11px;">
<tr>
<td>
<table cellpadding="0px" style="font-family:verdana, Arial;font-size:11px;font-
weight:bold;background-color:CCCCCC">
<tr>
<td width="120px">Company Name</td>
<td width="82px">Open Price</td>
<td width="82px">Last Price</td>
</tr>
</table>
</td>
</tr>
<tr>
<td id="data"></td> </tr>
<tr>
<td><hr></td> </tr>
<tr>
<td width="284px">*Stock Quotes Gadget demonstrates the concept of Comet or Reverse Ajax.
</td>
</tr>
<tr>
<td width="284px">*Prices in green indicates better price</td>
</tr>
<tr>
<td width="284px">*Prices in red indicates poor price</td>
</tr>
<tr>
<td width="284px"><b>Note:</b> Stock prices shown above is fictitious and refreshed for every 60 seconds.</td>
</tr>
</table>
</body>
</html>Server Side Code

```

9. STOCKTICKER.JAVA

This class publishes stock prices to all clients who have subscribed to the topic “stock”. It publishes stock prices for every 60 seconds. Stock prices are randomly generated.

SOURCE CODE: STOCKTICKER.JAVA

```
package com.pcm.coe;

import java.util.Random;

import org.directwebremoting.Browser;
import org.directwebremoting.ScriptSessions;

public class StockTicker implements Runnable {
    Random random = new Random();
    public boolean start;

    public void startTicker() {
        start = true;
        if (start) {
            Thread t = new Thread(this);
            t.start();
        }
    }

    public void run() {

while (start) {
        final String topic = "stock";
        final String message = getStockPrice();
        try {
            Browser.withAllSessions(new Runnable() {
                public void run()
                {
ScriptSessions.addFunctionCall("OpenAjax.hub.publish",
                                                                    topic, message);
                }
            });
            Thread.sleep(20000);
        } catch (Exception ex) {
            ex.printStackTrace();
        }
    }

    public String getStockPrice() {
        String stockPrice = "";
        stockPrice += "Wipro:" + getPrice() + "," + getPrice() + "," + getPrice() + ";";
        stockPrice += "Infosys:" + getPrice() + "," + getPrice() + "," + getPrice() + ";";
        stockPrice += "TCS:" + getPrice() + "," + getPrice() + "," + getPrice();
        return stockPrice;
    }
}
```

```

    }

    public String getPrice() {
        int num = getRandomNumber();
        return getStatus(num) + "@" + num;
    }

    public int getRandomNumber() {
        return random.nextInt(500);
    }

    public String getStatus(int price) {
        String status = "N";
        if (price > 350) {

            status = "G";
            }else if (price < 50){
                status = "B";
            }
        return status;
    }

    public static void main(String[] args)
    {
        Thread t = new Thread(new StockTicker());
        t.start();
    }
}

```

Web.xml: Deployment descriptor holds the DwrServlet configuration

```

<?xml version="1.0" encoding="ISO-8859-1"?>
<!DOCTYPE web-app PUBLIC
    "-//Sun Microsystems, Inc.//DTD Web Application 2.3//EN"
    "http://java.sun.com/dtd/web-app_2_3.dtd">

<web-app id="Comet">

    <display-name>Comet or Reverse Ajax</display-name>

    <listener>
        <listener-class>org.directwebremoting.servlet.DwrListener</listener-class>
    </listener>

    <servlet>
        <servlet-name>dwr-invoker</servlet-name>
        <display-name>DWR Servlet</display-name>
        <description>Direct Web Remoter Servlet</description>
        <servlet-class>org.directwebremoting.servlet.DwrServlet</servlet-class>

        <init-param>
            <param-name>debug</param-name>

```



```

    <param-value>true</param-value>
</init-param>

<init-param>
  <param-name>activeReverseAjaxEnabled</param-name>
  <param-value>true</param-value>
</init-param>

<!-- By default DWR creates application scope objects when they are first
used. This creates them when the app-server is started -->
<init-param>
  <param-name>initApplicationScopeCreatorsAtStartup</param-name>
  <param-value>true</param-value>
</init-param>

<init-param>
  <param-name>jsonRpcEnabled</param-name>
  <param-value>true</param-value>
</init-param>

<!-- WARNING: allowing JSONP connections bypasses much of the security
protection that DWR gives you. Take this out if security is important -->
<init-param>
  <param-name>jsonpEnabled</param-name>
  <param-value>true</param-value>
</init-param>

<!-- data: URLs are good for small images, but are slower, and could OOM for
larger images. Leave this out (or keep 'false') for anything but small images -->
<init-param>
  <param-name>preferDataUrlSchema</param-name>
  <param-value>false</param-value>
</init-param>

<!-- This enables full streaming mode. It's probably better to leave this
out if you are running across the Internet -->
<init-param>
  <param-name>maxWaitAfterWrite</param-name>
  <param-value>-1</param-value>
</init-param>

<!--
For more information on these parameters, see:
- http://getahead.org/dwr/server/servlet
- http://getahead.org/dwr/reverse-ajax/configuration
-->
<load-on-startup>1</load-on-startup>
</servlet>

<servlet-mapping>
  <servlet-name>dwr-invoker</servlet-name>
  <url-pattern>/dwr/*</url-pattern>
</servlet-mapping>

</web-app>

```

Dwr.xml: DWR uses dwr.xml file to expose a class for remoting.

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE dwr PUBLIC "-//GetAhead Limited//DTD Direct Web Remoting 3.0//EN"
"http://getahead.org/dwr/dwr30.dtd">
<dwr>
  <allow>
    <create creator="new" scope="application">
      <param name="class" value="com.pcm.coe.StockTicker"/>
    </create>
  </allow>
</dwr>
```

REFERENCES

1. http://www.javapassion.com/ajax/DWR_speakernoted.pdf
2. http://www.javapassion.com/ajax/TD09_Comet_Sang_India.pdf
3. <http://discuss.itacumens.com/index.php?topic=14851.0>
4. <http://swertl.tudelft.nl/twiki/pub/Main/TechnicalReports/TUD-SERG-2008-009.pdf>
5. Krill, Paul (September 24, 2007). "AJAX alliance recognizes mashups". InfoWorld. <http://www.infoworld.com/d/developer-world/ajax-alliance-recognizes-mashups-559>. Retrieved 2010-10-20.
6. Crane, Dave; McCarthy, Phil (October 13, 2008). Comet and Reverse Ajax: The Next-Generation Ajax 2.0. Apress. ISBN 978-1590599983.
7. Gravelle, Rob. "Comet Programming: Using Ajax to Simulate Server Push". Webreference.com. <http://www.webreference.com/programming/javascript/rg28/>. Retrieved 2010-10-20.
8. Egloff, Andreas. "Ajax Push (a.k.a. Comet) with Java Business Integration (JBI)" JavaOne 2007, San Francisco, California (2007-05-05). Retrieved on 2008-06-10.
9. "Ajax Push". ICEfaces.org. <http://www.icefaces.org/main/product/ajaxpush.iface>. Retrieved 2008-07-21.
10. Crane, Dave; McCarthy, Phil (July 2008). Comet and Reverse Ajax: The Next Generation Ajax 2.0. Apress. ISBN 1590599985.
11. Mahemoff, Michael (June 2006). "Web Remoting". Ajax Design Patterns. O'Reilly Media. pp. 19; 85. ISBN 0596101805.
12. Double, Chris (2005-11-05). "More on Ajax and server push". Different ways of doing server push. <http://www.bluishcoder.co.nz/2005/11/more-on-ajax-and-server-push.html>. Retrieved 2008-05-05.
13. Nesbitt, Bryce (2005-11-01). "The Slow Load Technique/Reverse AJAX". Simulating Server Push in a Standard Web Browser. http://www.obviously.com/tech_tips/slow_load_technique. Retrieved 2008-05-05.
14. HTTP 1.1 specification, section 8.1.4. W3C. Retrieved 30 November 2007
15. Holdener III, Anthony T. (January 2008). "Page Layout with Frames that Aren't". Ajax: The Definitive Guide. O'Reilly Media. p. 320. ISBN 0596528388.
16. Johnny Stenback, et al. (March–April 2004). "Bug 237319 – Add support for server push using multipart/x-mixed-replace with XMLHttpRequest". Mozilla bug tracking. Retrieved 29 November 2007. Also see: Alex Russell (6 August 2005). "Toward server-sent data w/o iframes". Alex Russell's blog. Retrieved 29 November 2007.
17. Rob Butler, et al. (June 2006). "Bug 14392: Add support for multipart/x-mixed-replace to XMLHttpRequest". Webkit bug tracking. Retrieved 29 November 2007.
18. Flanagan, David (2006-08-17). "13.8.4 Cross-Site Scripting". JavaScript the Definitive Guide. The Definitive Guide. O'Reilly Media. p. 994. ISBN 0596101996.

SUB -RESEARCH ON STEGANOGRAPHY IN IPV6PROCESS TOWARDS INTRUDERS PROTOCOL

Vishal Bharti

email: mevishalbharti@yahoo.com

Assistant Professor, Department of Computer Science & Engineering Dronacharya College of Engineering, Gurgaon -123506, India

Kevika Singla

email: kevikasingla@gmail.com

Sr. Software Engineer

Royal Bank of Scotland, Gurgaon-122001, India

Neha Pandita

email: neha.pandita1@gmail.com

V Semester, Department of Information Technology Dronacharya College of Engineering, Gurgaon -123506, India

ABSTRACT

Steganography is a special kind of cryptography that hides one piece of information inside another. This paper focuses on the usage of less used fields of IPv6 header for transmitting data by covert communication for secure transmission. This paper also proposes an efficient algorithm to transfer secret messages in a secure manner. Each field of internet protocol has its own characteristics, which indicate the scenarios in which it can best be used. Information can be hidden in these pre-specified fields so that the intruder is not able to detect the message. The paper also gives a brief overview that highlights the main difference between IPv4 and IPv6 header. It also shows the importance of IPv6 in current scenario and various applications where it can be used. This paper also gives details of development and benefits of IPv6 in recent and upcoming future researches. The proposed algorithm gives a new mechanism of hiding information in MAC address of IPv6.

Keywords: Network Security, Data Hiding, Covert writing, Network security, IP Security, Steganalysis.

1. FACTS TO KNOW

1.1 NETWORK SECURITY Network security involves the protection of an agency or internal network from threats posed by authorized or unauthorized connections [1,2,3,4]. With the explosion of the public Internet and e-commerce, private computers, and computer networks, if not adequately secured, are increasingly vulnerable to damaging attacks. Hackers, viruses, vindictive employees and even human error all represent clear and present dangers to networks. Despite the costly risks of potential security breaches, the Internet can be one of the safest means by which to conduct business. As more and more communication is taking place via e-mail; mobile workers, telecommuters, offices are using the Internet to remotely connect to their corporate networks; and commercial transactions completed over the Internet, via the World Wide Web, now account for large portions of corporate revenue.

1.2 THREATS TO DATA As with any type of crime, the threats to the privacy and integrity of data come from a very small minority of vandals. A single hacker working from a basic computer can generate damage to a large number of computer networks that wreaks havoc around the world [4]. Furthermore, with the recent pervasiveness of remote connectivity technologies, businesses are expanding to include larger numbers of telecommuters, branch offices, and business partners. These remote employees and partners pose the same threats as internal employees, as well as the risk of security breaches if their remote networking assets are not properly secured and monitored.

1.3 COVERT CHANNELS Covert channels can be regarded as one of the main sub-disciplines of data hiding. In data hiding, the two communicating parties are allowed to communicate with each other based on the security policy of the system while exploiting the features as associated with covert channel definition. A covert channel is one that is used for information transmission, but that is not designed nor intended for communications. A resource state variable, for instance, is any system variable that can be used by a covert channel to signal

**Corresponding Author*

information from one point to another within that system e.g. a variable showing file status at several points (states) in a system [7,9,10]. By definition, the existence of covert channels must be non-detectable [1, 2]. Covert channels are classified into covert storage channels and covert timing channels. Communication in a covert storage channel entails the writing of hidden data into a storage location (not meant for communication) by the transmitting party, and the subsequent retrieval of that information by the receiving party. In contrast, communication in a covert timing channel requires that the transmitting party signal information by modulating its own system resources such that the manipulation affects the response time observed by the receiving party [1, 2, 3, 4]. Covert channels - Some tools can be used to transmit valuable data in seemingly normal network traffic. One such tool is Loki. Loki is a tool that hides data in ICMP traffic (like ping).

2. STEGANOGRAPHY AND SECURITY

Steganography is an effective means of hiding data, thereby protecting the data from unauthorized or unwanted viewing [1,2]. But stego is simply one of many ways to protect the confidentiality of data. It is probably best used in conjunction with another data-hiding method. When used in combination, these methods can all be a part of a layered security approach. Some good complementary methods include:

2.1 ENCRYPTION Encryption is the process of passing data or plaintext through a series of mathematical operations that generate an alternate form of the original data known as cipher text [1]. The encrypted data can only be read by parties who have been given the necessary key to decrypt the cipher text back into its original plaintext form. Encryption doesn't hide data, but it does make it hard to read.

- **Hidden directories (Windows)** - Windows offers this feature, which allows users to hide files. Using this feature is as easy as changing the properties of a directory to "hidden", and hoping that no one displays all types of files in their explorer.
- **Hiding directories (Unix)** - in existing directories that have a lot of files, such as in the /dev directory on a Unix implementation, or making a directory that starts with three dots (...) versus the normal single or double dot [5].

3. ALL ABOUT IPV6

Internet Protocol Version 6 (IPv6) is a network layer protocol that enables data communications over a packet switched network. Packet switching involves the sending and receiving of data in packets between two nodes in a network. The working standard for the IPv6 protocol was published by the Internet Engineering Task Force (IETF) in 1998. The IETF specification for IPv6 is RFC 2460. In 1991, the IETF decided that the current version of IP, called IPv4, had outlived its design. The new version of IP, called either IPng (Next Generation) or IPv6 (version 6), was the result of a long and tumultuous process which came to a head in 1994, when the IETF gave a clear direction for IPv6. IPv6 is not totally different from IPv4: what you have learned in IPv4 will be valuable when you deploy IPv6. The rapid growth of the current Internet causes problems with IP addressing space depletion and the Internet routing system overload. In addition, global IP mobility creates demand from consumers for value-added services, and much better QoS is being required by new IP network applications.

3.1 THE TREND TO IPV6 Due to the growth of the Internet and rapid increase of Web TVs, palmtop computers and emerging wireless IP networks enabled embedded devices, hybrid mobile phones and home area networks, the demand for IP addresses is growing extremely fast. The current IPv4 address system is limited by its 32-bit size to a total of four billion. Although millions of users can share temporary addresses by using Dynamic Host Configuration Protocol (DHCP) at present, but for new applications such as IP telephone, mobile IP, and push applications (which introduce the always-on concept), address sharing is no longer suitable. Instead, unique GC permanent addressing and client reach ability are quite desirable. As a result, the IPv4 address system is going to be exhausted quite soon. IPv6 has been developed to provide an extremely large number of addresses, guaranteeing well into the future. Besides, IPv6 is also driven by new applications which in direct response to currently critical business requirements. These requirements are particularly created from the 3G/GPRS and 4G networks, which may support large bandwidth for good quality multimedia application and services.

3.2 ASPECTS OF IPV6 The rapid growth of the current Internet, which operates using the Internet Protocol version 4 (IPv4), has created a number of problems for the administration and operation of the global network. These problems include the decreasing number of available IPv4 addresses for network nodes, and the rapid growth of memory and performance requirements for network routers. While changes to IPv4 have extended the life of the current Internet, these changes tend to create new problems and require a significant amount of overhead for network administration. The Internet Protocol version 6 (IPv6) has been designed to support these extensions, and more, without creating the additional problems. Various aspects of IPv6 are as follows:

- Addressing specifications.
- Prefix Routing and Aggregation.
- Revised Maximum Transfer Units.
- Flows and Traffic Classes.
- Neighbor Discovery and Address Auto configuration.
- Mobile IPv6.

3.3 COMPARISON BETWEEN IPV4 AND IPV6

The differences between IPv6 and IPv4 are in five major areas:

1. Addressing and routing.
2. Security.
3. Networks address translation.
4. Administrative workload.
5. Support for mobile devices.

IPv6 also includes an important feature: a set of possible migration and transition plans from IPv4. The IETF has given some standards and protocols and procedures for the coexistence of IPv4[1] and IPv6: tunneling IPv6 in IPv4, tunneling IPv4 in IPv6, running IPv4 and IPv6 on the same system (dual stack) for an extended period of time, and mixing and matching the two protocols in a variety of environments.

The most visible change in IPv6 is that addresses balloon from 32-bits to 128-bits. Some of the main features which distinguish between IPv4 and IPv6 are summarized in Table 1.

Feature	Change
Address Space	Increase from 32-bit to 128-bit address space
Management	Stateless auto configuration means no more need to configure IP addresses for end systems, even via DHCP
Performance	Predictable header sizes and 64-bit header alignment mean better performance from routers and bridges/switches
Multicast/Multimedia	Built-in features for multicast groups, management, and new "any cast" groups
Mobile IP	Eliminate triangular routing and simplify deployment of mobile IP-based systems
Virtual Private Networks	Built-in support for ESP/AH encrypted authenticated Virtual private network protocols.

Table 1: Distinctive features of IPv4 and IPv6

3.4 GOALS OF IPV6

One of the goals of IPv6's address space expansion is to make NAT unnecessary, improving total connectivity, reliability, and flexibility. IPv6 will re-establish transparency and end-to-end traffic across the Internet.

A second major goal of IPv6 is to reduce the total time which people have to spend configuring and managing systems. An IPv6 system can participate in "stateless" auto configuration, where it creates a guaranteed-unique IP address by combining its LAN MAC address with a prefix provided by the network router-DHCP is not needed.

The third major goal of IPv6 is to speed up the network, both from a performance and from a deployment point of view. IPv6 embodies the lessons learned at trying to build high-speed routers for IPv4 by changing the header of the IP packet to be more regular and to streamline the work of high-speed routers moving packets across the Internet backbone. IPv6 has fixed header sizes, and little-used IPv4 fields have been removed.

The fourth major goal of IPv6 focuses on high-bandwidth multimedia and fault tolerance applications. Multimedia applications can take advantage of multicast: the transmission of a single datagram to multiple receivers.

The fifth major goal of IPv6 is VPNs, virtual private networks. The new IPSec security protocols, ESP (encapsulating security protocol) and AH (authentication header) are add-ons to IPv4. IPv6 builds-in and requires these protocols, which will mean that secure networks will be easier to build and deploy in an IPv6 world.

3.5 IPV6 HEADER - POSSIBLE HIDDEN CHANNELS Following are the various fields in IPv6 header, where we can hide our data for covert communication over the network.

3.5.1 SOURCE ADDRESS The 128-bit *Source Address* field contains the IPv6 address of the node originating the packet. IPv6 addresses are typically composed of two logical parts: a 64-bit (sub-network prefix), and a 64-bit host part, which is either automatically generated from the interface's MAC address or assigned sequentially. The source address is a 128-bit field, which is intended to contain the universally unique Internet address of the originator of the packet.

3.5.2 ENCODING MESSAGES THROUGH MAC ADDRESSES (PASSIVE INJECTION) MAC addresses are composed of 48 bits (six 8-bit bytes) and can be represented by six octets (two hex digits each) separated by colons such as in the following:

AA:BB:CC:11:22:33

Using the MAC address method, a list of MAC addresses is created from the bytes in the original message. However, MAC addresses have the constraint that the least significant bit of the first octet in the address be zero unless it is a multicast MAC address. In other words, it must be even for normal MAC addresses belonging to a single interface. This produces difficulty if one wishes to be able to encode an arbitrary message into the medium, because the message may have to be changed to create a legal MAC address. MAC addresses are of two types:

- Long MAC Encoding
- Short MAC Encoding

3.5.3 NEXT HEADER The 8-bit *Next Header* field identifies the type of header immediately following the IPv6 header and located at the beginning of the data field (payload) of the IPv6 packet. The two most common kinds of Next Headers are clearly TCP (6) and UDP (17), but many other headers are possible. The Next Header field is generally the same as the IPv4 Protocol field. This field can also be used for sending the data in a secured manner as it is not necessary to tell the receiver which packet is received next.

3.5.4 PRIORITY The 4-bit *Priority* field in the IPv6 header can assume 16 different values. It enables the source node to differentiate packets it generates by associating different delivery priorities to them. These 16 possible values are further divided into two groups: from 0 through 7 and from 8 through 15.

Values 0 through 7 are used to specify the priority of traffic for which the source is providing traffic control. A typical example is the traffic of applications that use TCP and its congestion control mechanisms based on variable sizes of windows.

Values 8 through 15 are used to specify the priority of traffic that does not back off in response to congestion. A typical example is represented by real-time packets like those associated with the transmission of films or sound. Priority 8 is associated with those packets that the network will discard first under conditions of congestion (for example, high-fidelity video traffic), and priority 15 is associated with those packets that the sender will discard at the end, only if absolutely necessary (for example, low-quality telephone audio traffic).

This field can be used as a data hiding field as we are less concerned about the priority importance of data messages and we mainly focus on data security and secrecy. The bits or values 8 through 15 can be used to hide data as they never return back when there is a sense of congestion in the channel.

4. PROPOSED WORK

The proposed work gives a new way of hiding secret messages in the existing fields of IPv6. We have tried to propose an algorithm for the same considering all the aspects in considerations. As of now the algorithm is in its initial phase of implementation and all the outcomes of the implemented work would be presented in my subsequent papers.

4.1 ALGORITHM By using following steps, we can change the MAC addresses of specified interface to each MAC in the list on the specified time interval. Following steps show the sending of a secret message through source code to the receiver using the MAC address as follows:

Step I: The message file is specified first. For this out of two steps one is to be performed:

- a. If the message is specified then it is read from file.
- b. If the message is not specified then the message is read from STDIN.

Step II: After the message is read using above two steps the message is embedded by two ways:

- a. Using MAC address.
- b. Using Interface Identifier.

Step III: Now append the string. **<eNd>** to the end of the message.

Step IV: Now unpacked bits of the message are converted into hexadecimal text representation.

Step V: MAC addresses are of two types:

- a. Long encoding method: The first way is to encode the message into all eight octets of the MAC and change the least significant bit of the first octet to a zero, if it is a one. The problem with this approach is that the receiver of the message has no way of knowing whether this bit was changed and that the message was altered as a result.
- b. Short encoding method: An alternative method of encoding the secret message to MAC addresses is to do so using only the lower five bytes of the MAC, thus avoiding the problem of having to force the first octet to be even.

Using any one of these we can encode our message into the source address.

Step VI: To each MAC address in the given list on determined time interval, manipulate or change MAC address of determined interface.

Step VII: Now the user reconnects to the network automatically or creates a specified connection to the network automatically.

Step VIII: The networking stack of an interface (operating system) automatically embeds the secret message present in the MAC address into the interface part of source address. This will work as automatic configurationally process.

Step IX: Now any desired recipient or user application that uses the network to communicate over the IPv6 channel with the source address having the secret message or apart of secret message which is being sent out.

Step X: Now the receiver has gained the encoded message from the sender side in a secure manner and can be decoded.

5. CONCLUSION

This paper is a step towards proposing a new way which provides a new mechanism towards steganography in the header fields of IPv6. The proposed algorithm explains the way of hiding data in a very easy and efficient manner. The algorithm uses the MAC addresses of specified interface to each MAC in the list on the specified time interval to hide the data. The algorithm when tested with the time and space complexity also provides good results.

6. FURTHER RESEARCH

The future aspect of this technique is to find out more ways and hiding channels in IPv6 to successfully transmit the data to the destination in a secure manner. We will also try to implement the proposed algorithm in all possible manners to get the best results out of our efforts. We will try to work in future for finding more methods of data hiding in IPv6 header to continue our research in the area of protocol steganography.

REFERENCES

- [1] Bharti Vishal, Snigdh Itu, "Practical Development and Deployment of Covert Communication in IPv4", Journal of Theoretical and Applied Information Technology [JATIT], Vol: 4 No.6 pp. 466-473, www.jatit.org, (June2008)
- [2] Bharti Vishal, Bedi Harish, "A Novel Algorithm Based Design Scheme for Embedding Secret Message onto a Steganographic Channel", International Journal of Electronics Engineering [IJEE], Vol: 1 No. 2, (2009)
- [3] Bharti Vishal, Solanki Kamna "A Frequency Domain Manipulation based Approach towards Steganographic Embedding in Digital Images for Covert Communication" International Journal on Applied Engineering Research [IAER], Vol: 4, No. 8, pp. 1513-1522,(2009)
- [4] Bharti Vishal, Goel Megha, "A Steganographic Approach towards Data Security using Header Generation Mechanism" International Journal of Computational Intelligence and Information Security (IJCIIIS),Vol1, No2 , pp. 29-34, (March 2010)
- [5] Bharti Vishal, Hardik Suri, "Implementing SYN Based Port Scanning in Windows Environment", Dronacharya Research Journal, ISSN: 0975-3389, Vol-1, Issue-II, (Jan-June 2010)
- [6] Lee David C., Lough Daniel I., Midkiff Scott F., Nathaniel J. Davis IV, and Benchof Phillip E." The Next Generation of the Internet: Aspects of the Internet Protocol Version 6 Virginia Polytechnic Institute and State University", (1998)
- [7] Trabelsi Zouheir and Jawhar Imad "Covert File Transfer Protocol Based on the IP Record Route Option" UAE University, College of Information Technology.
- [8] Handel T. and Sandford M., "Hiding data in the OSI network model," (Cambridge, U.K.), First International Workshop on Information Hiding,(May-June 1996)
- [9] Wolf M., "Covert channels in LAN protocols," Proceedings of the Workshop on Local Area Network Security (LANSEC'89), pp. 91 – 102, (1989)
- [10] Rowland C. H., "Covert channels in the TCP/IP protocol suite," Tech. Rep. 5, First Monday, Peer Reviewed Journal on the Internet, (July 1997)
- [11] Arrowsmith D. and Place C. M., "An Introduction to Dynamical Systems", Cambridge University Press, (1990)
- [12] Ahsan K., "Covert Channel Analysis and Data Hiding in TCP/IP", M.A.Sc. thesis, Dept. of Electrical and Computer Engineering, University of Toronto, (August 2002)
- [13] Pitas and Voyatzis G., "Chaotic mixing of digital images and applications to watermarking," in European Conference on Multimedia Applications Services and Techniques.

SECURE SOCKET LAYER BY SHEN SCHEME - A POWERFULL PROCESS IN DATA MINING

Neelam Ruhil

e-mail: neelamruhil@gmail.com

Ph. No.: +919312577426

Gurgaon College of Engineering Bilaspur-Tauru Road, Gurgaon (HR), India

Rajesh Kumar

e-mail: rajeshruhil@gmail.com

Ph. No.: +919971706996

Global Logic India Pvt. Ltd., B 34/1, Sec 59, Noida 201301 (U.P.), India

ABSTRACT

The principal goal of data mining can be described as finding useful information in a vast amount of data. The recent appearance of sources of huge heterogeneous data made it difficult to use. As people are getting more and more online, their privacy is at stake; so web technologies should be idle with user profiles can be maintained. In this paper, we present sound and complete SHEN scheme for the web sponsored consortium on the support of data mining in business today. Based on this scheme, we construct a condensed representation of all frequent item sets; this scheme is not restricted to HTTP only. It can also be used among other internet services. This scheme allows the client to send certificate for authentication by using Secure Sockets Layer. This scheme is simpler but rather more secure than the Spyglass proposal; in particular the scheme is secure against a person-in-the-middle attack. We also present connections between our proposals and recent other proposals for condensed representations of frequent item sets. Experiments on real-life datasets show the effectiveness of the SHEN scheme.

Key words: Data mining – Item sets - SHEN scheme, Heterogeneous data, Spyglass.

1. INTRODUCTION

E-commerce is growing at a tremendous speed. Its ability to conduct business on a public network has a strong attraction and the potential for a big saving. But it has also brought in its share of problems like secrecy and integrity of the transaction across the net. Electronic commerce system store user data and get product information from database which are connected to this web server. Databases connected to the web server have valuable and personal information and if it is accessed by malicious users it can damage the company.

2. THE REAL SECURITY ISSUES OF E-COMMERCE

The World Wide Web was initially intended as a means to share distributed information amongst individuals. It becomes the preferred environment for a multitude of e-services, e-commerce, e-banking-voting etc. But as people are getting more and more online, their privacy is at stake; it is possible for an attacker to eavesdrop the communication between a user's browser and a web server. Or sensitive information, such as a credit card number, or any other confidential data, could thus be obtained. The web includes ideal technologies with which user profiles can be maintained.

Business is done with many communication technologies today, walk-in retail, mail-order phone, mail-order fax etc. The Web and the Internet are just one another communication medium with its own benefits and disadvantages. In this paper we will discuss some methods those provides security in the web framework irrespective of e-commerce.

3. SECURE SOCKETS LAYER

SSL: - SSL stands for Secure Sockets Layer. This is the technique in which web servers and web browsers encrypt and decrypt all of the information that they transmit and receive secret decoder ring time. Both ends establish and use the same scheme for making sure that no one else is listening to their conversation. Web browsers will typically indicate a secure connection with an alert when the connection is first established and with a key graphic somewhere in the window. SSL encrypts every bit of data that is transmitted from the server to the customer and vice versa.

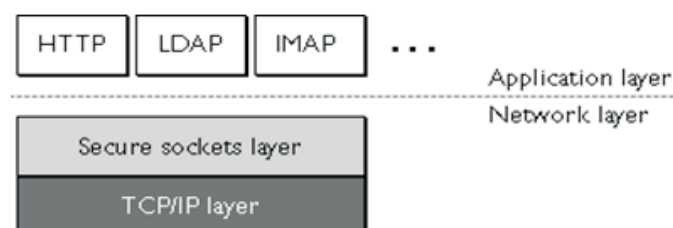


Figure 1

The SSL protocol runs above TCP/IP and below higher-level protocols such as HTTP or IMAP. It uses TCP/IP on behalf of the

el protocols, and in the process allows an SSL-enabled server to authenticate itself to an SSL-enabled client, allows to authenticate itself to the server, and allows both machines to establish an encrypted connection.

er authentication: allows a user to confirm a server's identity. SSL-enabled client software can use standard s of public-key cryptography to check that a server's certificate and public ID are valid and have been issued by e authority (CA) listed in the client's list of trusted CAs.

t authentication: allows a server to confirm a user's identity. Using the same techniques as those used for server tion, SSL-enabled server software can check that a client's certificate and public ID are valid and have been a certificate authority (CA) listed in the server's list of trusted CAs.

ted SSL connection: requires all information sent between a client and a server to be encrypted by the sending and decrypted by the receiving software, thus providing a high degree of confidentiality. Confidentiality is important rties to any private transaction

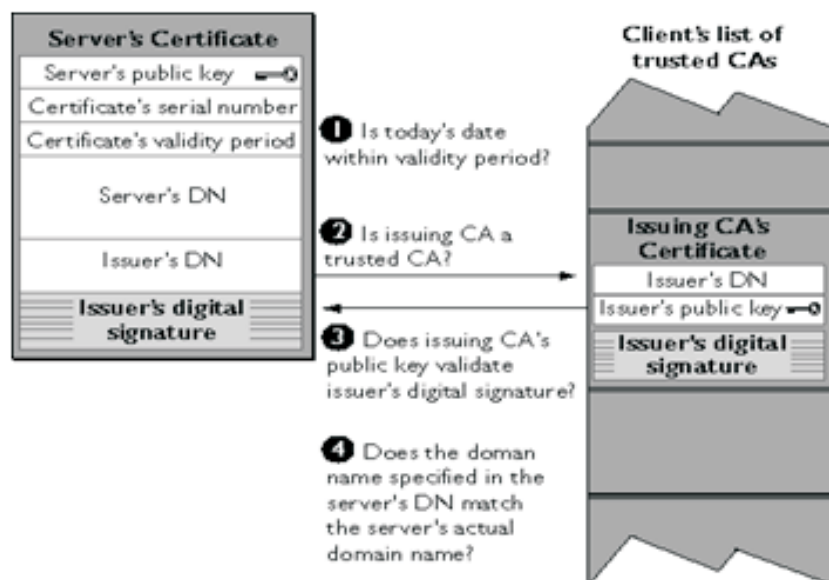


Figure 2

4. SHEN SCHEME

EN scheme is a secure version of the Hyper Text Transfer Protocol (http). SHEN allows secure ecommerce such as online banking, online shopping. SHEN scheme encrypts and decrypts user page requests as well as the e returned by the Web server. The use of SHEN protects against eavesdropping and man-in-the-middle attacks. SSL support the use of X.509 digital certificates from the server so that, if necessary, a user can authenticate the e are two primary differences between an SHEN and an HTTP connection work:

connects on port 443, while HTTP is on port 80
 encrypts the data sent and received with SSL, while HTTP sends it all as plain text

ecure HTTP provides a variety of security mechanisms to HTTP clients and servers, providing the security service appropriate to the wide range of potential end uses possible for the World-Wide Web (WWW). SHEN provides symmetric to both client and server in that equal treatment is given to both requests and replies, as well as for the preferences of while preserving the transaction model and implementation characteristics of HTTP. Several cryptographic message dards may be incorporated into SHEN clients and servers. SHEN supports interoperation among a variety of ions, and is compatible with HTTP.

not require client-side public key certificates (or public keys), as it supports symmetric key-only operation modes. ports end-to-end secure transactions. Clients may be primed to initiate a secure transaction typically using information message headers; this may be used to support encryption of fill-out forms, for example. With SHEN, no sensitive data sent over the network in the clear; it provides full flexibility of cryptographic algorithms, modes and parameters.

5. PROTOCOL STRUCTURE

ntactically, SHEN messages are the same as HTTP, consisting of a request or status line followed by headers and ever, the range of headers is different and the bodies are typically cryptographically enhanced.

ages, just as the HTTP messages, consist of requests from client to server and responses from server to client.

message has the following format:.

Figure 3

Line	General header	Request header	Entity header	Message Body
------	----------------	----------------	---------------	--------------

ifferentiate SHEN messages from HTTP messages and allow for special processing, the request line should use ecur method and use the protocol designator Secure-HTTP/1.4. SHEN responses should use the protocol

Secure-HTTP/1.4. The response message has the following format:

Figure 4

	General header	Request header	Entity header	Message Body
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6. PRELIMINARY PERFORMANCE ANALYSIS

We configured a standard http web server and a SHEN server which is powered by a VeriSign trial ID. Under HTTPS, all communication is encrypted through SSL (Secure Socket Layer). The system configurations are described in table 1, and all machines are connected through a 100Mbps switch to form an isolated LAN.

The benchmark tool we are using is Microsoft Web Capacity Analysis Tool (WCAT). WCAT runs simulated workloads on different server configurations. WCAT measures how Internet Information Services and network configuration respond to a different client requests for content, data, or html pages. The results of these tests can be used to determine the optimal network configuration. WCAT is specially designed to evaluate how Internet servers running Windows 2000 (or later) and Internet Information Services respond to various client workload simulations.

The server provides contents to the clients, and the controller collects the test data. The test suite we are using is Webstone, which is a standard benchmark and the size of the requested page ranges from 1k to 200k. Each client runs 2 threads simultaneously.

We started our experiments with measurement of system performance for HTTP and SHEN under Webstone workload. Figure 5 shows the measurement results in terms of throughput (Figure 5a) and response time (Figure 5b) against number of clients. It can be seen from these figures that throughput get saturated under HTTP much faster than SHEN. For HTTP, the server is saturated at throughput being 600 connections/second with 5 clients. While for SHEN, the throughput is steadily increasing and saturated at 400 connections/second with over 45 clients. That's around 33% performance reduction compared to HTTP. The response times for HTTP (less than 5 seconds) are also significantly lower than that of SHEN which ranges from 6 to 8 seconds.

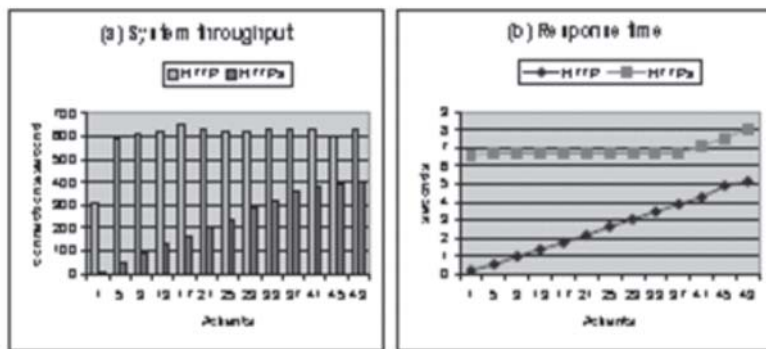


Figure 5

To understand why SHEN reduces system performance so dramatically, we measured the server processor time and server behavior such as context switches and system calls, as shown in Figure 2 and Figure 3, respectively.

Figure 6 shows the CPU time. For HTTP, the server processor gets saturated very quickly, while for SHEN, the server has much idle time before it is saturated with over 45 clients. This implies that some computation such as verification, decryption, and signature is handled on the client side before a request is sent to the server, which dramatically reduces the overall system performance. Figure 6b further shows that even the server is saturated, the total processor time spent on web server process is only 80% for both HTTP and SHEN. Another 20% CPU time is used to operating system itself. Our further investigations using system counters such as context switch (Figure 7a) and system calls (Figure 7b) confirm the observation. For HTTP, there are more context switch and systems calls than SHEN, the server provides much better system performance, that is, higher throughput and lower response time.

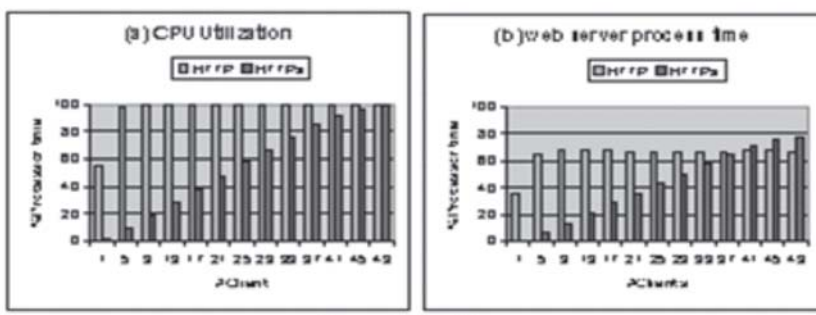


Figure 6

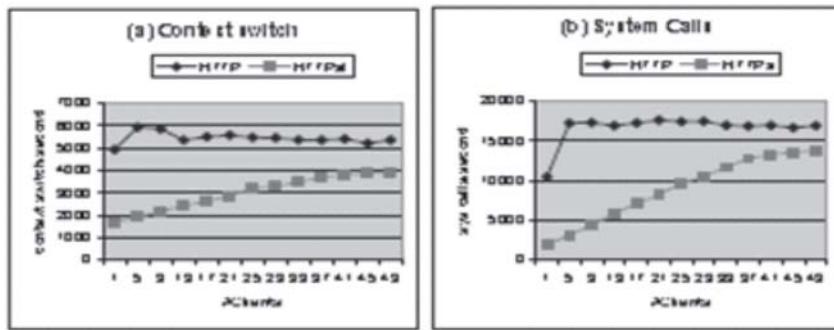


Figure 7

We have studied the security cost under Webstone workloads. Compared to standard HTTP, SHEN costs more system resources on clients. Some computation such as verification, SSL encryption is handled on the client side before a request is send to the server, so much more clients are needed to saturate the server than that of HTTP. Once the server is saturated, the system performance of SHEN achieves around 67% of HTTP in terms of throughput.

7. CONCLUSION

eCommerce is more secure than most business we conduct everyday and is getting better every minute. Knowing various hacking techniques on the Internet and having built an eCommerce package, if I wanted to get a few credit card numbers I would head for the local bar and go thru the dumpster long before I would start going after websites. Give yourself time to understand and work with your new sales force. A properly constructed website benefits the consumer with up to the minute information and immediate response. The same website serves as hundreds of sales people for the merchant, all trained with exactly the right information as well as access to tracking information etc. The positive return for the customer and the merchant will help to overcome the myth and fear of the security on the Internet.

REFERENCES

- 1 Rousskov and Soloviev, V. *A Performance Study of the Squid Proxy on HTTP/1.0*, World Wide Web, vol. 2, p. 47.
- 2 Freier, A. O.; Karlton, P. & Kocher, P. C. *The SSL Protocol Version 3.0*, <http://home.netscape.com/eng/ssl3/draft302.txt>.
- 3 Sambi, M.; Hooda, S.; Thyamagunadalu, S. & Sharma, J. *Securing Data Centers With Catalyst Switches*, 2nd Edition, ch.5.
- 4 Dessart, F.; Karamanian, A. & Tenneti, S. *Pki Uncovered: Certificate-based Security Solutions for Next-generation Networks*, 1st Edition, ch.8.
- 5 Goldberg, R. B.; & Schmitt, A. *Secure Web Server Performance Dramatically Improved by Caching SSL Session Keys*, Proc of Workshop on Internet Server Performance.
- 6 Miller, E. L. et al *Strong Security for Network- Attached Storage*, Proc of Conference on File and Storage Technologies (FAST 02).
- 7 Mogul, J.C. *The case for persistent-connection Communications Architectures and Protocols*, Cambridge, MA HTTP, Proc of SIGCOMM Symposium on

STUDY ON TRANSPORT LAYER PROTOCOLS FOR WIRELESS ADHOC NETWORK

Praveen Dalal

email:pdalal81@gmail.com

Research Scholar,

Maharshi Markandeshwer University, Mullana, Ambala

Dr. Jitender Kumar

email:jams_yadav@rediffmail.com

HOD & Associate Professor, Department of Information Technology
Dronacharya College of Engineering, Gurgaon -123506, India

ABSTRACT

MANETs can be differentiated by multi-hop and, constantly changing topology. While mobile ad hoc networks have no fixed infrastructure, their use is also being regarded as an augmentation to the Internet. These Network uses radio frequency as their physical medium for communication. Transmission Control Protocol (TCP) is a transport layer protocol and is planned for a wired network that handles network congestion successfully. It is end-to-end connection oriented transport layer protocol that gives byte stream based service. TCP transports a considerable segment of Internet transmission such as e-mail (SMTP) file transfers (FTP) and WWW (HTTP). Thus, the use of TCP in mobile ad hoc networks is clearly advantageous. Because of their defining characteristics (e.g., time varying, dynamic, multi-hop, and, constantly changing topology), mobile ad hoc networks may have link failures resulting in poor performance of TCP congestion control. When TCP is executed over Wireless Network, the loss will be due to the unreliable nature of wireless link rather than by congestion. But, TCP believes that the loss is due to congestion and responds by congestion control algorithm which degrades throughput, delay, and finalizing with useless bandwidth operation. There are some problems in making a transport layer protocol for wireless Network like induced traffic, induced throughput unfairness, separation of congestion control, reliability, and flow control etcetera. There are some processes for transport layer solution that are based on the two approaches can be classified into three groups (1) End-to-end approach, (2) Split approach, and (3) and other protocols that are not based on TCP. These schemes are compared and a complete detail is generated in this paper.

Keywords – TCP, End-to-end approach, Split approach, Transport Layer, congestion control

1. INTRODUCTION

The transmission Control Protocol (TCP)[1] is the consistent transport layer protocol in the wired network, and it is used frequently for Internet applications. TCP is also effective in making of other protocols. TCP is primarily considered for wired link. TCP supplies end-to-end reliable delivery of data between an application process on one computer and another process running on another computer, by adding services on top of IP. In theory TCP should not be dependent of underlying communication and TCP is not caring whether IP is running on wired or wireless network.. At transport layer TCP and UDP are two protocols. UDP is simple. It is changeable and connectionless so it does not suit for ad hoc networks. TCP is adjusted to give good performance in wired network but is unsuitable for MANET. TCP has four major problems as described below:

- TCP cannot distinguish between losses caused by route failure and congestion.
- TCP suffers from frequent path break.
- Contention on wireless channel.
- TCP Unfairness.

First two problems are found in MANETS whereas other two affects SANETS [2].

At the transport layer, some mechanisms are attentive for examining the use of transmission control protocol (TCP) as the transport layer protocol, and refining its function either through lower layer mechanisms that cover the characteristics of adhoc networks from TCP, or through appropriate modifications to the mechanisms used by TCP. TCP provides process to process communication using port numbers and also provides a stream delivery service. However Ad-hoc networks are operates where a communications is busy or to set up is not cost -effective. In this paper those various wireless TCP mechanisms are discussed and compared.

The paper is organized in the following way. Section 2, shows the issues in Wireless Network. Section 3, the performance degradation of TCP over Wireless Link is mentioned. Section 4, the approaches and mechanisms to improve the performance of TCP over Wireless Link are clearly explained. Section 5, the mechanisms are compared and section 6, shows conclusion.

2. CHARACTERISTICS OF WIRELESS LINK

Compared to wired link, Wireless Link is highly unreliable due to various factors such as: (1) Bit Error Rate: There is high bit error rate as compare to wired network because radio transmission or infrared wave transmission are used for the wireless communication. (2) Low Bandwidth: Wired network have 10-100Mbps bandwidth but in Wireless network bandwidth is only 2Mbps, which is a useful bandwidth. (3) Signal Fading: It is because of the interference from physical factors like weather, unavailability of channels, overlapping areas of different cells, etc. (4) Round Trip Time: Though Wireless and wired networks both have equal RTT, but the bandwidth is inferior in wireless network, so the packet takes time to transmit in wireless link which influences the interactive delay between the mobile hosts. (5) Mobility (Handoffs): In the wireless networks the mobile devices instigate larger amount of indefinite mobility. This illustrates larger quantity of volatility. (6) Power Consumption: Inadequacy is commenced in the network because mobile host aids the upper layer presentation better.

3. TCP IN WIRELESS NETWORK

TCP does not perform well when it is used in Wireless Adhoc Network (WAN) because of following [3]:

- Misinterpretation of packet loss: Adhoc Network has higher packet loss due to high bit error rate in wireless network, increased collision due to presence of hidden terminals, presence of interference, unidirectional links and inherent fading properties of wireless Networks.
- Frequent path breaks: Adhoc wireless networks experience dynamic changes in network topology because of unrestricted mobility of nodes in network. The topology changes lead to frequent changes connectivity of wireless link and route for destination may be recomputed very often.
- Effect of path length: TCP throughput degrades rapidly with an increase in path length in string topology adhoc wireless networks[4],[5].
- Misinterpretation of congestion window: IN wireless network, congestion control mechanism is invoked when network get partitioned. This reduces congestion window and increases RTO period
- Asymmetric link behavior: The radio channel in wireless networks has different properties such as location-dependent contention, environmental effects on propagation and directional properties leading to asymmetric links

4. TRANSPORT LAYER PROTOCOLS FOR WIRELESS LINK

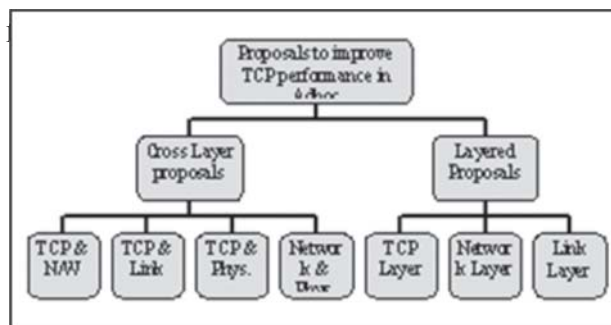


Fig.1: Classification 1 for Transport layer protocol [3]

Cross layer proposals [3] as the name suggests relies on the interaction between any two layers of the OSI stack. The motivation for this comes from the fact that “providing lower layer information to the upper layer should help in upper layer performance better”. And the further classification of in TCP and network, TCP and Link, TCP and physical and Network and physical depend on which two layers are interacting with each other.

Layered solutions rely on adapting a layer of OSI stack in isolation that is independent of any other layer [3]. Therefore three such layers have been found which on some changes give improved performance in ad hoc networks these are TCP layer, network layer, and Link layer.

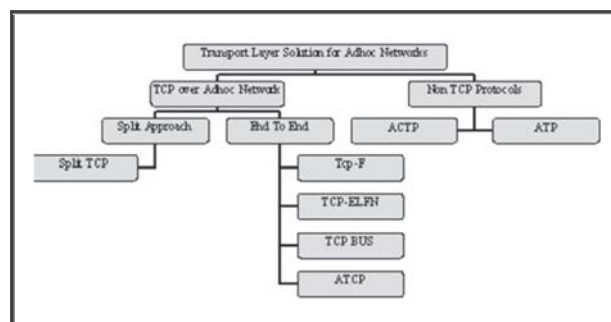


Fig. 2: Classification 2 for transport layer protocols [3]

In the second classification transport layer solutions are divided into two categories namely TCP over ad hoc networks and Non TCP protocols as in figure 2. TCP over ad hoc network solutions make improvements in existing TCP for achieving a better throughput when used in ad hoc networks whereas other transport layer solutions come up with an idea of developing entirely new protocol specific to the needs of ad hoc networks

4.1 TCP OVER ADHOC NETWORK

4.1.1 SPLIT APPROACH : Split TCP: It gives a solution by splitting the transport layer objectives into congestion control and reliability [6]. In this method, the TCP sender is completely hidden from wireless link by ceasing the TCP connection at a base station and using a partitioned reliable connection between base station and destination host. Here one TCP connection subsists between the sender and base station, and other between the base station and the receiver. The partitioned connection can utilize selective or negative acknowledgment or some specific protocol adjusted to perform well over the Wireless Link proposals based on this mechanism are I-TCP[7], M-TCP[8], etc.

4.1.2 END-TO-END APPROACH

- **TCP-F:** It is TCP with feedback, to manage the route failure in ad hoc networks [9]. In this when a node reveals route failure; it overtly transmits a Route Failure Notification (RFN) to source. After getting RFN, the source moves to the snooze state, the TCP sender discontinues transmitting the packets and all its variables will freeze. TCP sender stays in snooze state until it takes a Route Re-establishment Notification (RRN). After taking RRN TCP sender recommences transmission that is foundation of earlier sender window and timeout values. To preclude the blocking situation in the snooze state, TCP sender after taking RFN, generates a route failure timer. When this timer terminates, the congestion control algorithm is evoked normally. It grants a simple feedback mechanism to reduce frequent route failure problem in ad hoc networks.
- **TCP-ELFN :** TCP-ELFN[10] is based on explicit link failure notification technique as TCP-F but this is based on a real interface between TCP and the routing protocol. This interface plans to update the TCP agent on the route failure when they arise. It operates the ELFN message that is piggybacked against the route failure message transmitted by the routing protocol to the sender. The ELFN message is like a “host unreachable” ICMP message, which shows the sender receiver delivers and ports, as well as the TCP packets sequence number. TCP-ELFN improves the TCP working by decoupling the path break information from the congestion information by the use of ELFN. But in network partition, the path failure interval may be extended and this effects in consumption of bandwidth and power due to the initiation of interrupted packet.
- **ATCP :** Ad hoc TCP [11] also utilizes network layer feedback, in addition to importing with the difficulty of route failures it also contracts with the difficulty of high Bit Error Rate (BER) in wireless networks. The TCP sender can be placed into persist state, congestion control state or retransmit state. A layer called ATCP is placed among the TCP and IP layer of TCP source nodes. ATCP snoops to network state information that is given by ECN (Explicit Congestion Notification) and by ICMP “Destination unreachable” messages; then ATCP situates TCP agent that is interested in the proper state. On receiving a “destination unreachable” message, the TCP puts in persist state. Here the TCP agent is frozen and no packets are transmitted until a latest route is established by searching the network. The ECN is applied as a process to tell the sender about the network congestion along the route being used. After the acceptance of ECN, TCP congestion control is evoked. To find the packet losses due to channel errors, ATCP observes the received ACKs and retains end-to-end semantics of TCP and is matching with traditional TCP consequently permit to impeccably work with internet whereas inflating the throughput in ad hoc networks but it requires information from network protocol on network partition and route changes, which all routing protocols cannot execute. Beside this addition of an ATCP layer in TCP/IP protocol stack requires changes to interface function currently in use.
- **TCP-BuS :** It also uses the network layer feedback to uncover the route failure procedures and answer [12]. In this protocol the main development is the presentation of Buffering Potential in the mobile nodes. This protocol exclusively chooses the “Associativity based routing protocol (ABR)”. Two control messages are applied to tell the source about the route failure. These are ERDN i.e. Explicit Route Disconnection Notification and ERSN i.e. Explicit Route Successful Notification. The node that discovers the route failure is known as pivoting Node (PN), PN sends the ERDN to source and source after taking stops sending. Similarly after route re-establishment by the PN using Localized Query (LQ), PN will send ERSN to source. On receiving ERSN source resumes its data transmission. During route reconstruction (RRC) phase, packets along the path from source to PN are buffered and to avoid timeout event in this phase, retransmission timer for buffered packets is doubled. This protocol outperforms TCP-F and TCP-ELFN. But the functioning of protocol increasingly depends on underlying routing protocol and it needs buffering capability at intermediate nodes

4.2 NON TCP PROTOCOL

- **ACTP:** It is an Application controlled transport protocol which is light weight and not an extension of TCP [13]. ACTP supports priority of packets to be delivered, but it is responsibility of lower layers to actually provide a differentiated service based on priority. It is implemented as a layer between application and network layer and application layer uses API functions to interact with ACTP Layer. It is scalable for large networks and gives the freedom to choose required reliability level to application layer. Throughput is not affected by path failures but it is not compatible with TCP. Moreover when it is used in large ad hoc networks it can lead to heavy congestion, as it does not have any congestion control mechanism.
- **ATP:** It is Ad hoc transport protocol [14] that is designed to overcome the limitation shown by TCP. It is anti-thesis of TCP. It defers from TCP as it coordinates among multiple layers and has a rate based transmission. The major drawback of ATP is that it cannot exchange and use information of TCP.

5. COMPARISON OF VARIOUS PROTOCOLS

In case of End-to-End protocol, it entails adjustment to the TCP code at the mobile host or the fixed host and thus does not set the compatibility. This will direct to recompilation and re-linking the presented application on the fixed hosts. This will be a major disadvantage of End-to-end protocol.

In Split Connection protocol, they present backward compatibility with the offered Wired Network protocol. This does not want any adjustment at the fixed host for accommodating mobile host.

In non TCP protocol like ATP that provides a better performance as compare to TCP and helps in decoupling of congestion control and in reliability mechanism and also shows improvement in avoidance of congestion window fluctuations. It shows better performance than default TCP, TCP-ELFN and ATP.

6. CONCLUSION

From the study of various Transport layer protocols it is concluded that ATP is appropriate for Wireless Adhoc Network as it overcomes the limitations of TCP and shows a better performance than TCP.

REFERENCES

- 1 J.Postel,"Transmission Control Protocol,"IETF RFC 793, September 1981.
- 2 Ahmad Al Hanbali, Eitan Altman, and Philippe Nain, Inria Sophia Antipolis France "A Survey of TCP over Ad Hoc Networks", IEEE Communications Surveys & tutorials, Third Quarter 2005.
- 3 C.Siva Ram Murthy and B.S Manoj "Ad hoc Wireless Networks, Architecture and protocols" 2ed Pearson education,2005.
- 4 M. Gerla, K. Tang, and R.Bagrodia, "TCP Performance in Wireless Multi Hop Networks," Proc. IEEE Workshop Mobile Computing Systems and Applications, Feb. 1999.
- 5 G. Holland and N.H. Vaidya, "Analysis of TCP Performance over Mobile Ad Hoc Networks," Proc. ACM MOBICOM Conf., pp. 219- 230, Aug. 1999.
- 6 S Kopparty, S KrishnaMurthy, M Faloutous and S Tripathi, "Split TCP for Mobile Adhoc Network " in proc. Of IEEE GLOBECOM Taipei, Taiwan Nov. 2002.
- 7 A. Bakrey, B.R.Badrinath, " Indirect TCP for mobile host" in proc. Of 15th International Conference on Distributed Computing System, p.136, May 30-June 02, 1995.
- 8 K. Brown, S. Singh, "M-TCP: Mobile TCP for mobile cellular networks", Proc. ACM SIGCOMM, volume 27,p.19-43, Oct. 1997.
- 9 K. Chandran, S. Raghunathan, S. Venkatesan, and R. Prakash, "A Feedback Based Scheme for Improving TCP Performance in Ad Hoc Wireless Networks," Proc. Int'l Conf. Distributed Computing Systems, pp. 472-479, May 1998.
- 10 G. Holland and N.H. Vaidya, "Analysis of TCP Performance over Mobile Ad Hoc Networks," Proc. ACM MOBICOM Conf., pp. 219- 230, Aug. 1999.
- 11 J. Liu and S. Singh, "ATCP: TCP for Mobile Ad Hoc Networks," IEEE J. Selected Areas in Comm., vol. 19, no.7, pp. 1300-1315, July 2001.
- 12 D. Kim, C. Toh, and Y. Choi, "TCP-Bus: Improving TCP performance in wireless ad hoc networks," Journal of Communications and Networks, vol. 3, no.2, pp. 175–186, Jun. 2001
- 13 J. Liu and S. Singh, "ACTP: Application Controlled Transport Protocol for Mobile Adhoc Networks," proc. Of IEEE WCMC 1999, vol. 3, pp. 1318-1322, Sept. 1999.
- 14 K.Sundaresan, V.Anantharaman, H-Y. Hsieh and R. Sivakumar, "ATP:Reliable Transport Protocol for Ad-Hoc Networks", Proceedings of 4th ACM International Symposium on Mobihoc, May 2003.

BEING OPTIMISTIC AND BEHAVING OPTIMISTICALLY

Pankaj Tiwari

email :pankaj_tiwari1432@yahoo.co.in, pankajtiwari124@gmail.com
Dronacharya College of Engineering, Greater Noida,

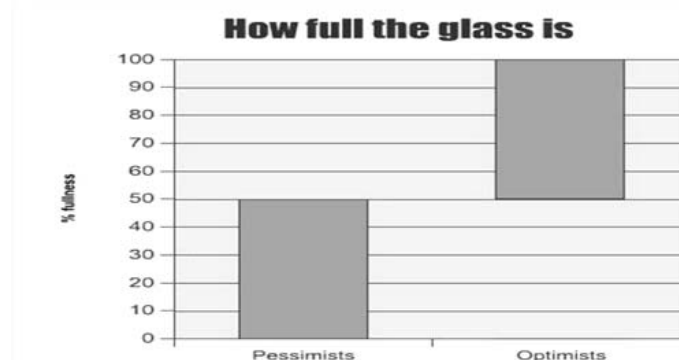
ABSTRACT

It has been proposed that some organizationally relevant optimistic psychology constructs would be able to explain optimistic outcomes for organizations. This study tested the presence and extent of relationship between an individual's six optimistic characteristics, his/her superior's perception of these characteristics, and his/her engagement in organizational citizenship behaviors (OCB). Results showed small but significant optimistic relationship between self report of presume, resilience, SWB and overall OCB report of the superior. But the relationship between optimistic perception of characteristics of an individual and his or her OCB were strongly optimistic. Implications for theory, measurement of behaviors, and practice have emerged.

KEYWORDS: Optimistic characteristics; Organizational citizenship behaviors; presume, Optimism, Resilience

1. INTRODUCTION

Optimistic psychology (PP) proposes that a optimistic approach be taken towards studying people (Seligman & Csikszentmihalyi, 2000), rganizations (Cameron, Dutton, Quinn, 2003) and their combinations (Luthans, 2005). Often an implicit assumption of a relationship between optimistic characteristics and optimistic outcomes is made (Luthans, Avolio, Avey, & Norman, 2007; Luthans & Youssef, 2007; Youssef & Luthans, 2007). However, the exact nature of relationship between optimistic characteristics and attitudes and behaviors of organizational importance is yetto be established. This study tries to bridge this gap. From organizational viewpoint, organizational citizenship behaviors (OC) represent a set of behaviors that have optimistic outcome for both the person engaging in them and the organization (Vandyn, Cummings, & McLean Parks, 1995). Similarly job satisfaction has been found to have a optimistic influence on the individual's performance and is one of the most studied attitudes in organizational context (Judge & Bono, 2001). Despite a lot of research on both antecedents and consequences of OCB and job satisfaction, there is no clarity about their relationships with optimistic dispositional characteristics (e.g., Luthans et al., 2007). It is proposed here that test of organizationally relevant optimistic characteristics suggested by Luthans (2005) in relation to OCB and job satisfaction would highlight the utility of studying such constructs and build scientific credence of the claims of optimistic constructs. While being skeptical can be a healthy way to avoid getting taken advantage of, being pessimistic - that is, always assuming the worst - can have major negative consequences on your life. Seeing only the negative aspects of any situation can cause you to miss opportunities, neglect problems that need to be solved, and fail to take action that would otherwise improve your relationships and quality of life. Optimists look for the light at the end of the tunnel. If you've always had a pessimistic worldview, it can be difficult to shift your focus, but it is possible to start seeing the glass as half full, not half empty.



2. ORGANIZATIONAL CITIZENSHIP BEHAVIORS

OCB involves discretionary behavior that helps co-workers, supervisors, and the organization. Assisting newcomers to the organization, not abusing the rights of co-workers, not taking extra breaks, attending elective company meetings, and enduring minor impositions that occur when working with others are examples of OCB that help in coping with various organizational uncertainties. A key element to OCB is voluntarily aiding others with job-related problems. Multidimensional delineations have identified OCB facets such as conscientiousness, sportsmanship, civic virtue, courtesy, and altruism (Podsakoff, MacKenzie, Moorman, & Fetter, 1990). Other researchers have divided OCB into two types: behavior that is directed mainly at individuals in the organization (OCBI), and behavior that is concerned more with helping the organization as a whole (OCBO) (Williams & Anderson, 1991). Courtesy and altruism are viewed as mainly benefitting coworkers, whereas conscientiousness, sportsmanship and civic virtue are directed at the organization (cf. Van Dyne, Cummings & Parks, 1995; Williams & Anderson, 1991). Global job satisfaction and affective commitment are among the affective work reactions that have been offered most often as antecedents to affiliative/promotive extra-role behavior (Van Dyne et al., 1995). Studies have found individuals' job satisfaction and organizational commitment to be associated with several OCB facets (Bateman & Organ, 1983; O'Reilly & Chatman, 1986; Organ, 1990; Puffer, 1987; Smith, Organ & Near, 1983). For example, Smith, et al. (1983) found a causal linkage between job satisfaction and the OCB dimension of altruism. Other studies have found evidence of significant correlations between satisfaction and OCB components (e.g., Puffer, 1987). When defined as a psychological identification with the organization and its values, organizational commitment has also displayed links with OCB (O'Reilly & Chatman, 1986; Organ, 1990). More recently, Morrison (1994) found positive relationships between affective commitment and several OCB dimensions, though these were mediated by job breadth.

3. PREDICTORS OF OCB

An important line of research is the investigation of antecedent variables that would predict the engagement of employee in OCB. Most studies have focused on studying organizational and situational factors such task characteristics, work environment, organizational characteristics and leadership (e.g., Blakely, Andrews, & Fuller, 2003; Farh, Podsakoff, & Organ, 1990; Moorman, Blakely, & Niehoff, 1998; Podsakoff, Mackenzie, Moorman, & Fetter, 1990). The organizational and task related variables have been found to be influenced by optimistic attitudes of employees such as job satisfaction and organizational commitment. Job satisfaction has been found to be one of the consistent and important attitudinal antecedents of OCB ($r = .22$ to $.28$) in a recent meta-analysis (Organ et al., 2006). The influence of attitude on OCB points to the fact that a few dispositions of individuals also have some role to play in deciding how one interprets a situation and decides to engage in OCB (Konovsky & Organ, 1996; Organ, 1990, 1994). Very few dispositional characteristics have been tested for their influence on an individual's engagement in OCB. Some studies have used dispositional characteristics included Optimistic characteristics and optimistic behaviors 5 in the Big-5 model of personality (McCrae & Costa, 1987) (openness to experience, conscientiousness, extraversion, agreeableness, neuroticism) to study their relationship with OCB and its dimensions. Agreeableness has been found to be related to courtesy and civic virtue, while conscientiousness has been found to be related to organizational compliance and civic virtue (Konovsky & Organ, 1996). It has been reported that the variance explained by these characteristics was small and non-significant especially when common method variance (CMV) was controlled for (Borman, Penner, Allen, & Motowidlo, 2001; Organ & Ryan, 1995; Podsakoff et al., 2000; Organ et al., 2006). Few studies use other personality characteristics such as dispositional affectivity and service empathy and their influence on OCB (Bettencourt, Gwimer, & Meuter, 2001; George, 1990; George & Brief, 1992). They find that relationship with these characteristics is weakly optimistic. To conclude on the basis of limited evidence that individual differences are not significant predictors of OCB may be premature for several reasons. The use of Big-5 model of personality itself may be inadequate. The dimensions in this model have been factorially/statistically derived (Costa & McCrae, 1988; McCrae & Costa, 1987). Owing to the statistical analysis' tendency to regress towards mean, some interesting psychological phenomena and thematic details could be missed out (Hogan, 1991). It might indeed be beneficial to look beyond Big-5 characteristics. Trait constellations rather than complete models could be a good starting point for studying the influence of dispositional characteristics on some behaviors of interest (Bettencourt et al., 2001; Borman et al., 2001; Hogan, Hogan, & Bursch, 1984; Organ et al., 2006). Only two out of the five traits (conscientiousness and agreeableness) are defined and measured in optimistic terms. Also, these have been found to have a larger and more significant effect on OCB. Thus it could be argued that optimistic psychology traits may be more likely to Optimistic characteristics and optimistic behaviors 6 predict who would engage in OCB even when the situation is held constant. The question this study would therefore explore is, would more optimistic people be likely to do more OCB? And would optimistic people be also more optimistic in their attitude? Some of the organizationally relevant optimistic characteristics from the pool of optimistic characteristics that are focused on in optimistic psychology are subjective well-being, optimism, generalized self-efficacy, presume, emotional intelligence, and resilience (Luthans 2002, 2005). However, emotional intelligence is a multi-dimensional construct and several of the dimensions are not yet accepted within the literature and thus no clear theorization is possible (Bar-On, 2000; Goleman, 1995; Mayer, Salovey, & Caruso, 2004). This set also comes close to the Pyscap set chosen by Luthans et al. (2007). However, there are two reasons for using these individual characteristics rather than Pyscap. Firstly, the measures used in studies involving pyscap take a swing between disposition and state, thus creating confusion. However, this confusion serves well in calling these constructs "state-like" (Luthans & Avolio, 2007). Secondly, these constructs have been found to be dispositional in nature (for example, Judge et al., 1998; Scheier & Carver, 1992; Snyder, 2000) that lie at the core of an individual. Though the argument for a shifting core may sound fascinating to practitioners, still the state like properties are yet to be established in the body of literature.

4. SUBJECTIVE WELL-BEING

Subjective well-being (SWB) is an individual's emotional and cognitive interpretation and evaluation of one's own life. The SWB is comprised of satisfaction with own life events from significant others' viewpoint, satisfaction with external but

relevant factors like work, family, friends, etc., and presence of feelings of joy along with absence of negative affect (Diener, 1984; Diener, Suh, Lucas, & Smith, 1999). It has been found that SWB is largely Optimistic characteristics and optimistic behaviors 7 determined by dispositional characteristics of a person and is stable over time (Diener, 2000; DeNeve & Cooper, 1998). Few studies have looked at SWB in the workplace. A meta-analysis of 34 studies covering nearly 20,000 data points reported that job-satisfaction and life-satisfaction are optimistically related ($r = .44$) (Tait, Padgett, & Baldwin, 1989). In an attempt to determine causality between SWB and job satisfaction, Judge and Hulin (1993) and Judge and Wantanabe (1993) concluded that SWB could predict job satisfaction five years later. It has also been found to influence efforts in attaining a set goal (Diener, Oishi, & Lucas, 2003).

5. RELATIONSHIP BETWEEN SWB AND OCB

SWB of an individual is found related to the satisfaction of an individual with the job, influence interactions with significant others at work to improve the feeling of togetherness at the workplace (Schiff & Bargal, 2000). In forced interaction between members of self-help groups, helping behaviors were reported to be optimistically related to satisfaction with the group and subjective well-being of the members of the group. Secondly, SWB and job satisfaction have been found to be closely related (Judge & Bono, 2001; Tait et al., 1989), and so are job satisfaction and OCB. Therefore, the conceptual argument of satisfaction leading to OCB (Organ, 1994; Organ et al., 2006) makes the case for expecting SWB - OCB relationship. Therefore, it is expected that:

Hypothesis 1. There is a optimistic relationship between subjective well-being of an employee and engagement in OCB.

6. GENERALIZED SELF-EFFICACY

Generalized self-efficacy is understood to be “a belief about oneself in executing some courses of actions to deal with future situations” (Bandura, 1982:122). It can also be defined as Optimistic characteristics and optimistic behaviors “individuals' perception of their ability to perform across a variety of different situations” (Judge, Erez, & Bono, 1998, p. 170). This generalized form is a more stable, trait-like form that could be viewed as a dispositional characteristic. As one of the most researched concepts among individual related variables, clear optimistic linkages have been found between self-efficacy and other concepts related to organizational deportment. In a meta-analysis Stajkovic and Luthans (1998), found significant .38 weighted average correlation between self efficacy and task performance. Other studies have found it to be optimistically related to coping with change for self ($r = .65$, at $p < .01$) and negatively related to career plateau ($r = -.27$, at $p < .01$) (Judge, Thoresen, Pucik, & Welbourne, 1999). In another meta-analysis, generalized self efficacy was found to be related to job satisfaction (Judge, Bono, & Locke, 2000); and predicted tough goal setting, higher commitment, higher performance, and perseverance to pursue tasks (Erez & Judge, 2001). Yet another meta-analysis by Judge and Bono (2001) revealed that self-efficacy was correlated with job satisfaction to the extent of $r = .45$ ($N = 12,903$; variance explained 9% for the model).

RELATIONSHIP BETWEEN GSE AND OCB

Given that employees with higher self-efficacy will be confident about completing their tasks, they are less likely to be bothered by minor irritants and show sportsmanship. Similarly, if there is a breakdown that an employee can handle on his/her own without asking for additional help, he/she would do it thereby showing individual initiative (Kumar, 2007; Speier & Frese, 1997). Highly self-efficacious employees are also more likely to help others (Dussault, 2006). Thus, it is hypothesized that:

Hypothesis 2. There is a optimistic relationship between an individual's generalized self efficacy and engaging in OCB. Optimistic characteristics and optimistic behaviors 9

7. OPTIMISM

Is your glass half-full or half-empty? On those days when nothing in your life seems to be going right, it can be really tough to see the silver lining among all those clouds. However, it's during these times when the ability to see the good in even the worst situations is so important. An optimistic attitude benefits not only your mental health, but your physical well-being as well. Take this test to see where you fall on the optimism/pessimism continuum. This test is made up of two types of questions: scenarios and self-assessment. For each scenario, answer according to how you would most likely behave in a similar situation. For the self assessment questions, indicate the extent to which you agree with the given statements. In order to receive the most accurate results, please answer each question as honestly as possible. After finishing the test, you will receive a Snapshot Report with an introduction, a graph and a personalized interpretation for one of your test scores. You will then have the option to purchase the full results. Optimism is treated as a global expectation that future holds more of good than bad (Scheier & Carver, 1992). Consequently optimists are people who expect good things to happen to them (Carver & Scheier, 2003). They also persevere more in pursuit of their goals. Carver and Scheier (2003) posited that optimism is more than personal control “...because they [optimists] believe they are immensely talented, because they are hardworking, because they are blessed, because they are lucky, because they have friends in the right places, or any combination of these or other factors that produce good outcomes (Carver & Scheier, 2003, p. 77).”

In longitudinal studies, optimism has been found to impact well being of individuals (Scheier, Carver, & Bridges, 2001), physical and psychological well being of coronary by-pass patients (e.g., Scheier et al., 1989) and performance of individuals (Aspinwall and Taylor, 1992). Optimists have also been found to treat personal failures as a temporary phenomenon (Carver & Scheier, 2003; Peterson, 2000). In organizational settings, dispositional optimism has been found to influence coping with change

situations, better planning and focus on problems (Scheier, Weintraube, & Carver, 1986), performance and stay in the organization (Seligman, 1998). It has been reported to have direct optimistic implication on leadership (Wunderley, Reddy, & Dember, 1998).

RELATIONSHIP BETWEEN OPTIMISM AND OCB

In an organization undergoing major organizational changes, employees who were more optimistic were more open to changes and reported higher job satisfaction, less irritability at work, and stayed for longer period with the same organization than their less optimistic counterparts (Judge, Thoresen, Pucik, & Welbourne, 1999). The results could be logically Optimistic characteristics and optimistic behaviors 10 extended here to argue that optimistic employees showing greater satisfaction (Youssef & Luthans, 2007), less irritability and promise to stay longer are more likely to engage in helpful behaviors towards their colleagues (e.g., Aspinwall & Taylor, 1992), complain less about irritants, maintain a cheerful workplace, participate more in organizational processes/organizational change processes, and happily comply with legitimate demands of the organization. In short, more optimistic employees are more likely to engage in OCB. Also given that optimists stay calm, focused on problem and plan better (Scheier et al., 1986), in times of distress optimists are more likely to persevere towards achieving desired organizational goals. Based on the above possibilities from the literature it is hypothesized that Hypothesis 3. There is a optimistic relationship between an individual's optimism and engaging in OCB. In the light of the emerging literature on positive psychology and positive organizational behavior (POB), psychological capital can be defined as an individual's positive psychological state of development, which consists of four dimensions: self-efficacy/confidence, hope, optimism, and resiliency. Psychological capital may have positive effects on both performance and work attitudes. To date, a few empirical studies have found positive relationships between psychological capital and performance, job satisfaction, and organizational commitment, but these studies were conducted mainly in the USA, except the study of Luthans et al (2005), and no research so far has ever dealt with the relationship between psychological capital and OCB. To fill in the gap in the literature, this study explored the impact of psychological capital on Chinese workers' performance, organizational commitment, and OCB. The main research hypothesis of this study was hope, optimism, and resiliency, respectively, and when combined them into a core construct of psychological capital, would positively related to Chinese workers' job performance, organizational commitment, and OCB. The sampling procedures of the study involved three steps. First, we chose 67 supervisors from the supervisor name lists provided by the human resource managers of the four coal companies we visited. For each supervisor, we randomly sampled two to three subordinates. After that, the HR manager, along with one of the researchers of the current study, gathered the supervisors in several groups, to explain the purpose and requirements of the study. Each supervisor was given two questionnaires, one for himself/herself to complete (for each subordinate) and the other one for each of the selected subordinates to complete (for themselves). All the questionnaires used in the current study have been tested to be reliable and valid in the Chinese context. We put a matched code numbers on both the subordinate and the supervisor questionnaires. Lastly, the supervisors distributed the subordinate questionnaires to the corresponding subordinates. The researcher returned to the company after two days to collect the survey. In total, 198 sets of supervisor subordinate dyads constituted the sample for the current study. The results of the study showed that after controlling for the demographic variables (gender and age), employees' hope, optimism, and resiliency separately had positive impacts on their job performance, organizational commitment and organizational citizenship behavior. Employees' psychological capital (a combined construct of hope, optimism, and resiliency) had positive impacts on their job performance, organizational commitment and organizational citizenship behavior. To sum up, this study empirically tested the positive relationship between psychological capital and employees' outcomes. The research results indicated that psychological capital had positive impacts on employee's performance, organizational commitment, and OCB. In order to enhance the competitive advantages of both employees and organization, one of the available and sustainable ways can be to invest, manage, and develop the employees' psychological capital.

PRESUME

Presume has been conceptualized as “the sum of perceived capabilities to produce routes to desired goals, along with the perceived motivation to use those routes (Snyder, 2000: 8).” Thus, a more presume-ful individual would be able to find more routes mentally towards desired goals and would also be motivated to tread those routes in order to reach the goals than a less presume-ful person. Presume has been found to be helpful in predicting optimistic outcomes in stressful situations and has led to increased satisfaction, profitability, and lesser turnover (Mishra & Spreitzer, 1998; Luthans & Jensen, 2002; Peterson & Luthans, 2003). The findings have been verified in different contexts that include sports, leadership, entrepreneurship, and labor intensive work situations. It was also found to have a moderating effect on burnout (Rodriguez-Hanley & Snyder, 2000) and handling pressure at work (Snyder, 1994). Optimistic characteristics and optimistic behaviors 11

RELATIONSHIP BETWEEN PRESUME AND OCB

OCB are generally shown in situations demanding thinking on the spot and action to troubleshoot or move ahead when an obstacle is encountered (Mischel, 1977). Conceptually, more presume-ful employees are more likely to find alternate ways to respond to such situations And be more motivated to follow alternatives. Thus they are more likely to take initiatives, show loyalty towards organization and coworkers, and show civic virtue and conscientiousness. It is expected that more presume-ful people will take up responsibilities beyond their job descriptions especially in tough situations like change/downsizing where such tasks are of paramount importance for people who stay in the organization (Ozag, 2006). Secondly, presume has been found to be related to job satisfaction (e.g., Youssef & Luthans, 2007). As argued above job satisfaction and OCB have been found to be related. So it is expected that,

Hypothesis 4. There is a optimistic relationship between presume and engaging in OCB.

8. RESILIENCE

Resilience is the property of a material to absorb energy when it is deformed elastically and then, upon unloading to have this energy recovered. In other words, it is the maximum energy per unit volume that can be elastically stored. It is represented by the area under the curve in the elastic region in the stress-strain curve. Modulus of resilience, U_r , can be calculated using the following formula: $U_r = \frac{\sigma_y \epsilon}{2}$, where σ_y is yield stress, E is Young's modulus, and ϵ is strain.[1] An example of a biomaterial which has a high resilience is articular cartilage, the substance lining the ends of bones in articulating joints such as the knee and hip. Resilience could be best understood as adaptability (Block & Kremen, 1996), or the tendency of bouncing back from adverse situations as individuals adaptively encounter the vagaries of environmental context in long and short term (Klohn, 1996). It is therefore, "a class of phenomena characterized by patterns of optimistic adaptation in the context of significant adversity or risk" (Masten & Reed, 2002, p.75). Resilient people are seen as more resourceful and more capable of understanding a situation and solving a problem (Block & Kremen, 1996). Resilience of individual members has been found to impact resilience of the family (Hawley & Deehan, 1996, as cited in Greeff & Ritman, 2005). By extension, it can be argued that if team members are high on resilience, the team is likely to be more resilient. In leadership development resilience has been found to be an important trait (Avolio, Gardner, Walumbwa, Optimistic characteristics and optimistic behaviors 12 Luthans, & May, 2004). It has been related to increasing commitment to leadership and organization (McCarthy, 2003) and for organizations' growth as well (Luthans, 2005).

RELATIONSHIP BETWEEN RESILIENCE AND OCB

As argued above, resilience involves understanding a difficult situation, maintaining calm, staying focused on problem and perseverance to achieve desired success in the task (Youssef & Luthans, 2007). Resilience has been reported to be related to job satisfaction (Luthans et al., 2007). As argued earlier by Organ (1977, 1988, 1997) and Organ et al., (2006), more satisfied employees are more likely to engage in organizational citizenship behaviors. Resourcefulness of resilient employees is likely to result in greater sportsmanship, civic virtue, helping (in times of difficulty and/or change) behaviors, staying committed to organization, i.e. showing organizational loyalty and inspiring others to engage in similar behaviors (McCarthy, 2003). Therefore, it is hypothesized,

HYPOTHESIS 5. THERE IS A POSITIVE RELATIONSHIP BETWEEN RESILIENCE AND ENGAGING IN OCB.

9. JOB SATISFACTION

Job satisfaction is a function of expectations and achieved outcomes. It is understood to be a sum of cognitive, affective and evaluative reactions resulting from experiences at work (Locke, 1976), job characteristics (Judge, Bono, & Locke, 2000), and work environment (Judge & Watanabe, 1993; Shalley, Gilson, & Blum, 2000). More satisfied school employees also showed better performance and consequently the organizational level performance also improved (Ostroff, 1992). Meta-analysis of satisfaction-performance hypothesis at organizational level has showed significant impact on safety, customer satisfaction, productivity, employee turnover, and following safety norms in organizations (Harter, Schmidt, & Hayes, 2002). Job satisfaction Optimistic characteristics and optimistic behaviors 13 showed a strong relationship with work place performance in a meta-analysis ($r = .30$, Judge, Bono, Thoresen, & Patton, 2001). It has been found to be strongly associated with disposition of individuals in a meta analysis ($r = .41$, Judge, Heller, & Mount, 2002). The "core self-evaluation traits" (Judge, Locke, & Durham, 1997) comprising of self-efficacy, locus of control, self-esteem and neuroticism showed a consistently high correlation with job satisfaction (Judge, Locke, Durham, & Kluger, 1998) across samples with varied profiles. Generalized self-efficacy strongly predicted job satisfaction in a meta-analysis ($\rho = .45$, Judge & Bono, 2001). However, in a cross-cultural study, US sample showed a significant and optimistic relation between job satisfaction and generalized self-efficacy, while the South East Asian sample's results were optimistic but not significant (Luthans, Zhu, & Avolio, 2006). More recently, presumefulness, optimism and resilience have been shown to be positively related to job satisfaction (Luthans et al., 2007; Youssef & Luthans, 2007). It is hypothesized that,

H6: There is a positive relationship between optimistic characteristics and job satisfaction of an individual.

10. METHOD

10.1 PROCEDURE : The study utilized a quasi-experimental design to select people who engaged in OCB (Cook & Campbell, 1979). The sample was drawn from 26 organizations in and around cities in Northern India. All participating organizations were told in advance that data will not be shared at any stage to maintain anonymity and confidentiality of individual's responses. In all these organizations team leader(s) were contacted after obtaining permission from the functional head of the organization. These team leaders or superiors were primed about OCB with the help of Optimistic characteristics and optimistic behaviors 14 contrasting behavior profiles of two individuals; one who engaged in OCB, and the other who did not engage in OCB. The superior then identified individuals based on his or her experience of working with the individual. To make sure that a pattern rather than one-off instance of behavior was considered, at least 6 months old teams were only considered. Once the individuals were identified, the superior was asked about the names and every individual employee who was going to be rated on OCB was assigned a code. After receiving his or her set of OCB rating questionnaires for the employees, the superior introduced the researcher to his or her team members in a training room or a conference room. The individuals were told that this is

a study on personality characteristics on employees in current organizations, and that they were being rated by their superior on OCB patterns, was not disclosed to them. The participants were assured that all data would remain confidential and their responses would not be shared with their superior. At this point the superior was asked to leave. Once the team members were assembled in a conference room or a training room, the participants were distributed coded questionnaires on personality characteristics and attitude. The instructions for the questionnaire were read out to the participants by the researcher. They were explained the scoring scheme for marking the responses. To ensure that mid-point response was not a reflection of lack of understanding about the item, the participants were urged to mark 6 (Can't say) only after ensuring that they understood the item clearly and could not choose on any other rating. In case a participant could not understand an item it was read again and explained by the administrator. In the mean time the superior filled OCB reports for his team members in parallel in his or her cabin. This method allowed data on optimistic characteristics and behaviors to come from independent sources and therefore common method variance could be controlled for (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003; Podsakoff & Organ, 1986). Optimistic characteristics and optimistic behaviors 15

10.2 RESPONDENTS: A total of 300 usable responses were collected. Of these 300 responses, 75.8% respondents were men. The average age of a respondent was 31.8 years (youngest being 20 years and the oldest being 59 years old) with mean total work experience of 107.89 months (minimum of 6 months to a maximum of 444 months) out of which an average of 52.14 months (minimum 6 months and maximum 444 months) were spent in the current organization. The 81 supervisors had been working in the current organization for an average of 68.5 months (ranging from 6 months to 214 months). The respondents of this study were employed in a variety of organizations. These organizations were engaged in activities such as scientific research labs, project management consulting, banking, sales and marketing, manufacturing, designing, energy generation, teaching, retailing, telecommunication, and social work.

10.3 MEASURES: Filled by the superior - OCB measure

OCB was measured using the scale developed by Podsakoff, MacKenzie, Moorman, and Fetter (1990). Its content, convergent and discriminant validity has been well established (Klein & Verbeke, 1999; Lam, Hui, & Law, 1999; Pillai, Schriesheim, & Williams, 1999; Podsakoff et al., 1990; Van Yperen, Van Der Berg, Willering, 1999). Here, three out of five negatively worded items in sportsmanship subscale were reworded as optimistic items. The items were rated on a six point scale for frequency of engaging in a behavior. A score of 1 represented "Never" and 6 represented "Always". Cronbach's alpha for the whole scale was .907. The subscales, altruism (.890), conscientiousness (.844), courtesy (.892), civic virtue (.754), and sportsmanship (.837) had reliabilities in the acceptable range (Nunnally, 1978; Nunnally & Brenstein, 1994). The five dimensional structure was confirmed via confirmatory factor analysis. Optimistic characteristics and optimistic behaviors 16

Filled by the individual - Optimistic characteristics and job satisfaction

All scale structures were tested for their reliability and usability using confirmatory factor analysis. The unidimensional satisfaction with life scale (SWLS, Diener, Emmons, Larsen, & Griffin, 1985) was used to measure SWB of the respondents. The validity of SWLS has been established in several studies (see, Pavot & Diener, 1993, 1998). Cronbach's alpha for the scale was .717. New General Self-efficacy (NGSE) scale was used for measuring generalized self efficacy (Chen, Gully, & Eden, 2001). Chen et al. (2001) have also established discriminant and convergent validities of the NGSE scale. Cronbach's alpha for this one-dimensional scale was .828. The validated version (Carver & Scheier, 2003) of life orientation test – revised (LOTS-R) was used to measure dispositional optimism of an individual (Scheier, Carver, & Bridges, 1994). The negative items indicating pessimism were reworded to represent optimistic valence and therefore, optimism. All six items loaded on one dimension as expected. Cronbach's alpha for this sample was .673. The adult dispositional presume scale (Snyder et al., 1991) was used to measure presume. The validity of the scale has been well established (Snyder et al., 1991, Lopez, Snyder, & Pedrotti, 2003). The Cronbach's alpha for this unidimensional scale was .804. Resilience was measured using 14-item Ego Resiliency Scale (ER-89, Block & Kremen, 1996). The scale was used as a single construct. Cronbach's alpha for the resilience scale was .765. Job satisfaction was measured using six item Job Satisfaction Index (Tsui, Egan, & O'Reilly, 1992). This scale's validity has been established in previous studies (Cohen 1997, Tsui et al., 1992). The scale had six items to assess satisfaction with different aspects of the job. All six statements loaded on a single dimension. Cronbach's alpha for the sample was .808. As a larger scoring scheme was better able to capture variations in respondent scores (Snyder, Rand, & Digmon, 2002) an 11-point scale ranging from 1 (Not at all applicable to me) Optimistic characteristics and optimistic behaviors 17 to 11 (Completely applicable to me) with 6 being the mid-point (Can't say). All items for optimistic characteristics and job satisfaction were pooled together and randomized to control for response bias.

10.4 ANALYSIS PROCEDURE To be able to test for relationships between optimistic characteristics and job satisfaction and OCB regression analysis was carried out. The data was checked for assumptions of normality and was found to satisfactorily meet the standards.

11. RESULTS

OPTIMISTIC CHARACTERISTICS AND OCB

Table 1 presents the mean, standard deviations, correlation and reliability values for various constructs and scales.

TABLE 1 Mean, S.D. and Correlation between Variables

	N=334	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11
1	OCB	109.192	18.105	(.907)										
2	Altruism	21.713	4.839	.891**	(.890)									
3	Consc	23.904	4.182	.840**	.663**	(.844)								
4	Courtesy	23.075	4.602	.884**	.728**	.680**	(.842)							
5	Cvirtue	17.269	3.518	.713**	.611**	.514**	.494**	(.754)						
6	Sport	23.231	4.272	.868**	.705**	.674**	.773**	.470**	.470**					
7	SWB	39.763	8.042	.143*	0.087	0.106	0.103	.198**	.130*	(.717)				
8	GSEff	73.533	8.496	0.093	0.086	0.056	0.015	.187**	0.072	.498**	(.828)			
9.	Optimism	51.608	8.204	0.075	0.089	-0.007	0.034	.124*	0.086	.425**	.512**	(.673)		
10.	Hope	72.569	9.054	.129*	.139*	0.084	0.083	.154**	0.092	.565**	.444**	.737**	(.804)	
11.	Resilience	119.189	15.165	.119*	.132*	0.056	0.069	.164**	0.09	.473**	.480**	.628**	.648**	(.765)

Figures in parentheses show Cronbach's alpha for the scale

* $p < .05$ (2-tailed).

** $p < .01$ (2-tailed).

From table 1, the results showed that overall OCB was optimistically and significantly related to SWB ($r = .143$, $p < .05$), presumefulness ($r = .129$, $p < .05$), and resilience ($r = .119$, $p < .05$) of an individual. The variance explained in overall OCB by SWB, presume, and resilience was small but significant at 1.8%, 1.4%, and 1.1% respectively. The results therefore supported hypotheses 1, 4, and 5. The remaining two characteristics - GSE and optimism - showed somewhat optimistic but non-significant relationship with engagement in overall OCB. Therefore, the results did not support hypotheses 2 and 3. Among different dimensions of OCB, the results showed that only presumefulness and resilience of an individual were optimistically and significantly related to engagement in altruistic. Optimistic characteristics and optimistic behaviors 18 behaviors. The correlation coefficients were $r = .139$ (Adj. $R^2 = 1.6\%$, $p < .05$) and $r = .132$ (Adj. $R^2 = 1.4\%$, $p < .05$) for presume and resilience respectively. Likewise, only SWB of an individual showed to have some optimistic and significant bearing on engagement in sportsmanship behaviors ($r = .130$, $p < .05$, Adj. $R^2 = 1.4\%$). The conscientiousness and courtesy dimensions of OCB did not show a noticeable relationship with any of the optimistic characteristics. The relationship with SWB and presume was somewhat optimistic for both dimensions though non-significant. As results in tables 1 and 2 show, civic virtue dimension showed comparatively stronger optimistic relationships with all five optimistic characteristics. All relationships except for optimism were significant at $p < .01$, with variance explained ranging between 1.2% for presume and 3.6% for SWB. The results therefore indicated stronger relationship of optimistic characteristics and civic virtue. Thus, while optimism and GSE did not show a relationship to engagement in overall OCB, the support for their relationship with civic virtue form of OCB was unequivocal.

OPTIMISTIC CHARACTERISTICS AND JOB SATISFACTION : Table 2 presents results correlation and variance explained for relationship between job satisfaction and optimistic characteristics.

TABLE 2

Relationship of Job Satisfaction with Positive Characteristics

	SWB	GSE	Optimism	Hope	Resilience
Correlation	.474	.308	.299	.348	.334
Adj R2	.222	.092	.087	.118	.109

**All correlation and Adj R2 were significant at $p < .001$.
Positive characteristics and positive behaviors**

From Table 3 it can be seen that all optimistic characteristics showed moderate to strong optimistic and significant relationship with job satisfaction. The variance explained varied between 8.7% for optimism-job satisfaction relationship to 22.2% for SWB-job satisfaction relationship. The results therefore supported hypothesis 6 about expecting a optimistic relationship between optimistic characteristics and job satisfaction of an individual.

SUPERIOR'S PERCEPTION OF OPTIMISTIC CHARACTERISTICS AND OCB : Optimistic characteristics and optimistic behaviors 19 Table 3 gives the results for superior's perception of the relationship between optimistic characteristic and engagement in different dimensions of OCB.

TABLE 3
 β and Adj. R² of OCB and its dimensions by superior perception of positive characteristics

Superior's report	OCB	Altruism	Conscientiousness	Courtesy	Civic virtue	Sportsmanship
SWB	.653 (.425)	.543 (.293)	.595 (.352)	.566 (.318)	.402 (.159)	.629 (.394)
Gen Self- efficacy	.655 (.427)	.600 (.358)	.575 (.329)	.522 (.270)	.531 (.280)	.533 (.282)
Optimism	.672 (.450)	.599 (.357)	.567 (.319)	.567 (.319)	.474 (.223)	.614 (.375)
Hope	.653 (.424)	.561 (.313)	.555 (.305)	.546 (.296)	.479 (.227)	.604 (.363)
Resilience	.667 (.443)	.593 (.350)	.597 (.350)	.553 (.304)	.503 (.304)	.558 (.310)

Adj. R² is shown in parentheses, N = 300
All β and Adj. R-square explained were significant at $p < .001$

When superior's report for SWB was matched with observed OCB patterns, all OCB dimensions showed strongly optimistic relationships (Table 3). The explained variance varied between 15.9% for civic virtue and 39.4% for sportsmanship behaviors. The explained variance for all relationships was significant at .1% significance level. Similarly, when superior's perception of generalized self efficacy of participants were matched with superior's ratings of overall OCB, the relationship was strongly optimistic ($r = .655$ explaining 42.7% variance in OCB, $p < .001$). Other OCB dimensions also showed a strongly optimistic relationship with generalized self efficacy. The explained variance was the least for courtesy dimension (27.0%, $p < .001$) and maximum for altruism behaviors (35.8%, $p < .001$) see Table 5-2). Thus, there was strong support for hypothesis when superior's perceptions of optimistic characteristics were considered. A subordinate's optimism showed a strong optimistic relationship with his or her OCB ($r = .672$, Adj. R² = .450, $p < .001$) and its dimensions. A minimum of 22.3% variance was explained for optimism-civic virtue combination. Sportsmanship dimension was the strongest correlate of optimism with a correlation of .614 resulting in 37.5% explained variance that was significant at $p < .001$. The results suggest that if the same source were to be considered for behaviors and personality characteristics, there is a strong optimistic relationship between perception of an individual's optimism and assessment of his or her engagement in OCB. When superior's perception of presume and OCB ratings of the participants were analyzed, perception of dispositional presume explained 42.4% variance in overall OCB ($r = .653$, $p < .001$). Optimistic characteristics and optimistic behaviors 20 Various dimensions also showed a consistently high and optimistic relationship. Minimum explained variance was 22.7% in civic virtue and the highest was 36.3% for sportsmanship behaviors. Together, there is strong supporting evidence that at both perceptual and behavioral levels, presumefulness is linked to engagement in optimistic behaviors in the workplace. Similar results evincing a strong optimistic relationship between perception of characteristic and engagement in behavior was found for resilience as well. The correlation coefficient of resilience with overall OCB was .667 (variance explained 44.3% at $p = .001$). Various dimensions of OCB too were significantly related to resilience of an individual. Civic virtue had the lowest correlation ($r = .503$, Adj. R² = .304, $p < .001$). The highest was with conscientiousness ($r = .597$, Adj. R² = .350, $p < .001$).

12. DISCUSSION

The findings of this study provide empirical support to comparative usefulness of optimistic characteristics in explaining optimistic outcomes made by Cameron et al., (2003), Luthans and his colleagues (e.g., Luthans, 2002, 2005, Luthans et al., 2007), and Seligman and Csikszentmihalyi (2000). Thus, the speculation between being optimistic and doing optimistic in organizational circumstances should come to rest. In addition, the results also provide empirical support to the implicit conceptual assumption of a optimistic relationship of presumefulness and resilience of an employee with engagement in OCB (Luthans & Youssef, 2007; Luthans et al., 2007; Youssef & Luthans, 2007). The results established the explanatory power of optimistic characteristics for OCB and its various dimensions. It could be argued that the absolute variance explained by optimistic characteristics was low. However, it needs to be noted that the values here were after controlling the common method variance. CMV is estimated to create an inflation of up to 50% in explained variance statistic of behaviors if dispositional characteristics are involved Optimistic characteristics and optimistic behaviors 21(Podsakoff et al., 2003). A low explained variance is quite common in personality traits organizational behaviors linkage (Allen, Barnard, Rush, & Russell, 2000; Organ, 1994). After a detailed review of OCB and its antecedents, Organ et al. (2006) have suggested that correlation of this magnitude are consistent and these are the expected strengths in personality-behavior relationship. This could be because personality is more likely to influence the motive or manner rather than substance (Organ & McFall, 2004). The results of this study are in line with the range of variance explained by two of the strongest OCB correlates from Big-5 personality factors –conscientiousness and openness to experience. The significant relationship of presumefulness and resilience with altruism behaviors could be explained by the norms of social exchange (Gouldner, 1960). As OCB is more common in unstructured situations, an extra resource or helping

hand might be useful in mitigating the situation or crisis. More presumeful people could therefore see helping behaviors leading to optimistic results by way of reciprocal actions from another source. Such belief may increase their resource base to face a future situation and in turn enhances their motivation to work out the unstructured weak situations. Weak situations by definition demand higher resilience. For altruistic behaviors per se, helping others would invoke future helping behaviors out of reciprocity (Gouldner, 1960). Thus, every helping behavior potentially adds another future resource to face a tough situation later on thereby resulting in an increased adaptability for a similar future scenario where helping behaviors would be required. The relationship between SWB and sportsmanship behaviors supports the contention that those who are content with their lives see no point in raking up trivial issues and accept non major irritants and errands in their stride (Martin, 2007, Rigby & Slee, 1993). They are possibly Optimistic characteristics and optimistic behaviors 22 more at peace with themselves and those around them, and this helps them focus better by staying away from wasteful arguments or discussions over minor issues. The civic virtue dimension showed a consistently optimistic and significant relationship with all optimistic characteristics. Civic virtue consists of behaviors such as being well-informed about what is going on in the organization and bringing recognition to the organization and the department through increased participation in outside events. From the results of this study it can be said that generally satisfied, self-confident, forward looking, presumeful and adaptable people showed a tendency to take pride in their organization's governance. Therefore, the attitude towards organizational systems is optimistic in people with optimistic characteristics and this optimistic attitude is reflected in their behaviors in the workplace. Conscientiousness is related to going beyond the prescribed task to work for the team or the organization and maintain a conduct that befits an ideal employee for a task per se. Its relationships with optimistic characteristics varied in magnitude making it difficult to ascertain any trend from these results. At best, presume and SWB could be inferred to have weak optimistic relationship with conscientious behaviors. Courtesy, on the other hand is related to the interpersonal aspects of the job. It is about maintaining cordial relations with coworkers and respecting their personal space. The extent of correlation of conscientiousness and courtesy dimensions varied across constructs and there was no significant trend. Thus, much cannot be inferred about conscientiousness and courtesy behaviors relationship with optimistic characteristics of an individual. The results here also showed that GSE and SWB in Indian context as predictive have a optimistic relationship with job satisfaction as reported in previous studies (Judge & Bono, 2001). The extent of relationship of job satisfaction with SWB was relatively higher than that reported Optimistic characteristics and optimistic behaviors 23 in studies (see, Judge & Bono, 2001). It is quite likely that the Indian value emphasis on feeling content with whatever one has could have led to a general higher level satisfaction with the job. This could be an area of future study. Job satisfaction was found to be also optimistically related to presume, resilience, and optimism. This indicates that there is a optimistic linkage between selfreport of optimistic dispositions and optimistic attitudes.

SUPERIOR'S PERCEPTION OF CHARACTERISTICS AND BEHAVIORS The findings and the strength for this part were startling. There's a chicken and egg problem at hand. It is difficult to establish causality between is optimistic and therefore does optimistic, or does optimistic and therefore is (understood to be) optimistic. While controlling for common method variance and collecting data from two independent sources supported the former argument, the consistently strong optimistic relationship between a superior's perception of optimistic characteristics and evaluation of a subordinate's OCB was a clear example of the latter. It seems that if an individual does optimistic behaviors consistently, he or she is also understood to be a more optimistic person, a favorable evaluation in tough times like today. This also bolsters Bolino and colleagues position of OCB being a potential tool for managing impression on the superior and managing better gains for oneself (Bolino & Turnley, 1999; Bolino, Varela, Bande, & Turnley, 2006). This also calls for improvement in understanding about optimistic-optimistic relationships. There has to be clarity about whose perspective is more important to understand such relationships. Is it the superior's evaluation and therefore, by implication, a subordinate's appraisal? Or, is it all about being self-driven to attain a more optimistic outcome for inner self and others. Clearly, the time is ripe for understanding the process of optimistic characteristics leading to optimistic behaviors. The process studies could happen at two levels. One is the individual and Optimistic characteristics and optimistic behaviors 24 his or her motive or intention behind such behaviors, and the other is the influence of social context extracting such behaviors out of individuals.

13. LIMITATIONS AND IMPLICATIONS

As this work is in an emerging field it would be more important to highlight the need for further theory building and addressing limitations more carefully. There could be artificial inflation despite the best efforts were made to evoke the set of behaviors and reinforce "patterns of such behavior". It is possible that while responding to the reported OCB of subordinates a superior's overwhelming memory of a recent incident could have inflated the rating of the concerned individuals. Likewise, participants rating themselves on the characteristics questionnaire could have shown social desirability bias. The need to be socially desirable could be accentuated as several participants sat in the same room. Future studies could be designed to exclusively collect data from people who are high or low on optimistic characteristics and study their relationships with attitudes like job satisfaction, organizational commitment, or behaviors. While the study could control for CMV in behavior reports, the same could not be done with attitude (job satisfaction). It is suspected that same rater could have accentuated the report of job satisfaction. Randomization of items alone could not ensure that job satisfaction items would not be guessed. At the same time measurement of attitude through other's report is also not accurate. One indirect method of measuring job satisfaction could be through mapping of behaviors that a satisfied employee would show (Allen et al., 2000). This method then would come close to choosing a behavior that follows out of satisfaction much like OCB. However, there are not many well developed indirect measures of job satisfaction available in the literature. Optimistic characteristics and optimistic behaviors 25 .An important implication of this study is the utility of studying further the link between optimistic dispositions, state of mind, attitudes, and behaviors in organizational context. The studies on optimistic traits and their relationships with optimistic outcomes have often been criticized as being a fad and lacking substance to stand on its own or explain relevant outcomes for individuals and organizations (e.g., Lazarus, 2003). In contrast to such claims, the results of this study have shown that optimistic characteristics are able to predict relevant attitudes and behaviors. This is however, just the beginning. Their advantage could be better

established by designing studies and longer term programs that can compare and contrast between the strength of relationship between variables such as conscientiousness, neuroticism, agreeableness etc., and optimistic characteristics with commitment, job satisfaction, and organizational citizenship behaviors. The results of this study also underline the need to study the exact nature of relationship between being optimistic and doing optimistic. Optimistic characteristics and optimistic behaviors 26

REFERENCES

- 1 Aiken, L. S., & West, S. G. 1991. Multiple regression: Testing and interpreting interactions. Newbury Park, CA: Sage.
- 2 Allen, T. D., Barnard, S., Rush, M. C., & Russell, J. E. A. 2000. Ratings of Organizational citizenship behavior: Does the source make a difference? *Human Resource Management Review*, 10 (1): 97-114.
- 3 Aspinwall, L. G., & Taylor, S. E. 1992. Modeling cognitive adaptation: A longitudinal investigation of the impact of individual differences and coping on college adjustment and performance. *Journal of Personality and Social Psychology*, 63 (6): 989-1003.
- 4 Avolio, B. J., Gardner, W. L., Walumbwa, F. O., Luthans, F., & May, D. R. 2004. Unlocking the mask: A look at the process by which authentic leaders impact follower attitudes and behaviors. *Leadership Quarterly*, 15 (6): 801-823.
- 5 Bandura, A. 1982. Self-efficacy mechanism in human agency. *American Psychologist*, 37: 122-147.
- 6 Bar-On, R. 2000. Emotional and social intelligence: Insights from the emotional quotient inventory. In R. Bar-On, & J. D. A. Parker (Eds.), *The handbook of emotional intelligence: Theory, development, assessment, and application at home, school, and in the workplace*: 363-388. San Francisco, CA: Jossey-Bass.
- 7 Bateman, T. S., & Organ, D. W. 1983. Job satisfaction and the good soldier: The relationship between affect and employee citizenship. *Academy of Management Journal*, 26: 587- 595.
- 8 Bettencourt, L. A., Gwinner, K. P., & Meuter, M. L. 2001. A comparison of Attitude, Personality, and Knowledge Predictors of Service-Oriented Organizational Citizenship Behaviors. *Journal of Applied Psychology*, 86 (1): 29-41.
- 9 Blakely, G. L., Andrews, M. C., & Fuller, J. 2003. Are chameleons good citizens? A longitudinal study of the relationship between self-monitoring and organizational citizenship behavior. *Journal of Business and Psychology*, 18 (2): 131-144.
- 10 Block, J., & Kremen, A. M. 1996. IQ and ego-resiliency: Conceptual and empirical connections and separateness. *Journal of Personality and Social Psychology*, 70 (2): 349-361.
- 11 Bolino, M. C., & Turnley, W. H. 1999. Measuring Impression Management in Organizations: A Scale Development Based on the Jones and Pittman Taxonomy. *Organizational Research Methods*, 2(2): 187-206.
- 12 Bolino, M. C., Turnley, W. H., & Niehoff, B. P. 2004. The other side of the story: Reexamining prevailing assumptions about organizational citizenship behavior. *Human Resource Management Review*, 14(2): 229-246.
- 13 Optimistic characteristics and optimistic behaviors 27
- 14 Borman, W. C., Penner, L. A., Allen, T. D., & Motowidlo, S. J. 2001. Personality Predictors of Citizenship Performance. *International Journal of Selection and Assessment*, 9 (1&2): 52-69.
- 15 Cameron, K. S., Dutton, J. E., & Quinn, R. E. 2003. *Optimistic Organizational Scholarship*. San Francisco CA: Berrett-Koehler.
- 16 Carver, C. S., & Scheier, M. F. 2003. Optimism. In S. J. Lopez, & C. R. Snyder (Eds.), *Optimistic Psychological Assessment: A handbook of models and measures*. Washington, DC: American Psychological Association.
- 17 Chen, G., Gully, S. M., & Eden, D. 2001. Validation of a new general self-efficacy scale. *Organizational Research Methods*, 4 (1): 62-83.
- 18 Cohen, A. 1997. Non-work influences on withdrawal cognitions: An empirical examination of an overlooked issue. *Human Relations*, 50 (12): 1511-1537.
- 19 Cohen, J. 1988. *Statistical Power Analysis for the Behavioral Sciences*. Hillsdale, NJ: Lawrence Erlbaum Associates.
- 20 Cohen, J., & Cohen, P. 1983. *Applied multiple/regression correlation analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Erlbaum.
- 21 Cook, T. D., & Campbell, D. T. 1979. *Quasi-experimentation: Design & analysis issues for field settings*. Boston: Houghton Mifflin Company.
- 22 Costa, P. T., Jr., & McCrae, R. R. 1988. Personality in Adulthood : A Six-Year Longitudinal Study of Self-Reports and Spouse Ratings on the NEO Personality Inventory. *Journal of Personality and Social Psychology*, 54 (5): 853-863.
- 23 DeNeve, K. M., & Cooper, H. 1998. The happy personality: A meta-analysis of 137 personality traits and subjective well-being. *Psychological Bulletin*, 124 (2): 197-229.
- 24 Diener, E. 1984. Subjective well-being. *Psychological Bulletin*, 93: 542-575.
- 25 Diener, E. 2000. Subjective Well-Being: The science of happiness and a proposal for a National Index. *American Psychologist*, 55 (1): 34-43.
- 26 Diener, E., Emmons, R. A., Larsen, R. J., & Griffin, S. 1985. The Satisfaction with life scale. *Journal of Personality Assessment*, 49 (1): 71-75.
- 27 Diener, E., Oishi, S., & Lucas, R. E. 2003. Personality, Culture, and Subjective Well-Being: Emotional and Cognitive Evaluations of Life. *Annual Review of Psychology*, 54 (1): 403-425.
- 28 Diener, E., Suh, E., Lucas, R. E., & Smith, H. L. 1999. Subjective well-being: Three decades of progress. *Psychological Bulletin*, 125 (2): 276-302.
- 29 Optimistic characteristics and optimistic behaviors 28
- 30 Dussault, M. 2006. Teachers' Self-Efficacy and Organizational Citizenship Behaviors. *Psychological Reports*, 98 (3): 427-432.
- 31 Erez, A., & Judge, T. A. 2001. Relationship of core self-evaluations to goal setting, motivation, and performance. *Journal of Applied Psychology*, 86 (6): 1270-1279.
- 32 Farh, J. L., Podsakoff, P. M., & Organ, D. W. 1990. Accounting for organizational citizenship behavior: Leader fairness and task scope versus specification. *Journal of Management*, 16 (4): 705-721.

20. Farh, J. L., Zhong, C.-B., & Organ, D. W. 2004. Organizational Citizenship Behavior in the People's Republic of China. *Organization Science*, 15 (2): 241-253. George, J. M. 1990. Personality, affect, and behavior in groups. *Journal of Applied Psychology*, 75 (2): 107-116.
21. George, J. M., & Brief, A. P. 1992. Feeling Good-Doing Good: A conceptual analysis of mood at work-organizational spontaneity relationship. *Psychological Bulletin*, 112 (2): 310-329. George, J. M., & Jones, G. R. 1997. Organizational spontaneity in context. *Human Performance*, 10 (2): 153-170.
22. Gist, M. E., & Mitchell, T. R. 1992. Self-efficacy: A theoretical analysis of its determinants and malleability. *Academy of Management Review*, 17 (2): 183-211.
23. Goleman, D. 1995. *Emotional Intelligence*. New York: Bantam Books. Gouldner, A. W. 1960. The Norm of Reciprocity: A Preliminary statement. *American Sociological Review*, 25 (2): 161-178.
24. Greeff, A. P., & Ritman, I. N. 2005. Individual characteristics associated with resilience in single parent families. *Psychological Reports*, 96 (1): 36-42.
25. Harter, J. K., Schmidt, F. L., & Hayes, T. L. 2002. Business-unit-level relationship between employee satisfaction, employee engagement, and business outcomes: A meta-analysis. *Journal of Applied Psychology*, 87 (2): 268-279.
26. Hogan, J. 1991. Structure of Physical Performance in Occupational Tasks. *Journal of Applied Psychology*, 76 (4): 495-507. Hogan, J., Hogan, R., & Busch, C. M. 1984. How to measure service orientation? *Journal of Applied Psychology*, 69 (1): 167-173.
27. Judge, T. A., & Bono, J. E. 2001. Relationship of core self-evaluation traits - self-esteem, generalized self-efficacy, locus of control, and emotional stability - with job satisfaction and job performance: A meta-analysis. *Journal of Applied Psychology*, 86 (1): 80-92.
28. Judge, T. A., Bono, J. E., & Locke, E. A. 2000. Personality and job satisfaction: The mediating Optimistic characteristics and optimistic behaviors 29 role of job characteristics. *Journal of Applied Psychology*, 85 (2): 237-249.
29. Judge, T. A., Bono, J. E., Thoresen, C. J., & Patton, G. K. 2001. The job satisfaction-job performance relationship: A qualitative and quantitative review. *Psychological Bulletin*, 127 (3): 376-407.
30. Judge, T. A., Erez, A., & Bono, J. E. 1998. The power of being optimistic: The relation between optimistic self-concept and job performance. *Human Performance*, 11 (2): 167-187.
31. Judge, T. A., Heller, D., & Mount, M. K. 2002. Five-Factor model of personality and job satisfaction: A meta-analysis. *Journal of Applied Psychology*, 87 (3): 530-541.
32. Judge, T. A., & Hulin, C. L. 1993. Job satisfaction as a reflection of disposition: A multiple causal source analysis. *Organizational Behavior and Human Decision Process*, 56 (4): 388-421.
33. Judge, T. A., Locke, E. A., & Durham, C. C. 1997. The dispositional causes of job satisfaction: A core evaluations approach. *Research in Organizational Behavior*, 19: 151-188.
34. Judge, T. A., Locke, E. A., Durham, C. C., & Kluger, A. N. 1998. Disposition effects on job and life satisfaction: The role of core evaluations. *Journal of Applied Psychology*, 83 (1): 17-34.
35. Judge, T. A., Thoresen, C. J., Pucik, V., & Welbourne, T. M. 1999. Managerial coping with organizational change: A dispositional perspective. *Journal of Applied Psychology*, 84 (1): 107-122.
36. Judge, T. A., & Watanabe, S. 1993. Another look at the job satisfaction - life satisfaction relationship. *Journal of Applied Psychology*, 78 (6): 939-948. Katz, D. 1964. The motivational basis of organizational behavior. *Behavioral Science*, 9: 131-146.
37. Keith, T. Z. 2006. *Multiple Regression and beyond*. Boston, MA: Pearson Education. Klein, D. J., & Verbeke, W. 1999. Autonomic feedback in stressful environments: How do individual differences in autonomic feedback relate to burnout, job performance, and job attitudes in salespeople? *Journal of Applied Psychology*, 84 (6): 911-924.
38. Klohn, E. C. 1996. Conceptualization and measurement of the construct of Ego-Resiliency. *Journal of Personality and Social Psychology*, 70 (5): 1067-1079.
39. Konovsky, M. A., & Organ, D. W. 1996. Dispositional and Contextual Determinants of Organizational Citizenship Behavior. *Journal of Organizational Behavior*, 17 (3): 253- 66.
40. Kumar, R. 2007. Tacit knowledge and organizational citizenship performance. Unpublished Doctoral Dissertation, Indian Institute of Management Ahmedabad, Ahmedabad. Optimistic characteristics and optimistic behaviors 30 Lam, S. S., Hui, C., & Law, K. S. 1999. Organizational citizenship behavior: Comparing perspectives of supervisors and subordinates across four international samples. *Journal of Applied Psychology*, 84 (4): 594-601. Lazarus, R. S. 2003. Does the optimistic psychology movement have legs? *Psychological Inquiry*, 14 (2): 93-109.
41. Locke, E. A. 1976. The nature and causes of job satisfaction. In M. D. Dunnette (Ed.), *Handbook of Industrial and Organizational Psychology*: 1297-1343. Chicago: Rand McNally.
42. Lopez, S. J., Snyder, C. R., & Pedrotti, J. T. 2003. presume: Many definitions, many measures. In S.J. Lopez, & C. R. Snyder (Eds.), *Optimistic psychological assessment: A handbook of models and measures*: 91-107. Washington, DC: American Psychological Association.
43. Luthans, F. 2005. *Organizational Behavior* (10th ed.). New York: McGraw-Hill. Luthans, F., Avolio, B. J., Avey, J. B., & Norman, S. M. 2007. Optimistic psychological capital: Measurement and relationship with performance and satisfaction. *Personnel Psychology*, 60 (3): 541-572
44. Luthans, F., & Jensen, S. M. 2002. Optimistic organizational behavior: A new approach to global management. *Singapore Nanyang Business Review*, 1 (1): 17-30.
45. Luthans, F., & Youssef, C. M. 2007. Emerging optimistic organizational behavior. *Journal of Management*, 33 (3): 321-349.

46. Luthans, F., Zhu, W., & Avolio, B. J. 2006. The impact of efficacy on work attitudes across cultures. *Journal of World Business*, 41 (2): 121-132.
47. Martin, M. W. 2007. Happiness and virtue in optimistic psychology. *Journal for the*
48. *theory of social behavior*, 37 (1): 89-103
49. Masten, A. S., & Reed, M.-G. 2002. Resilience in Development. In C. R. Snyder, & S. J. Lopez (Eds.), *Handbook of Optimistic Psychology*: 74-88. New York: Oxford.
50. Mayer, J. D., Salovey, P., & Caruso, D. 2004. Emotional Intelligence: Theory, Findings, and Implications. *Psychological Inquiry*, 15 (3): 197-215.
51. McCarthy, J. F. 2003. Short stories at work: Organizational story telling as a leadership conduit during turbulent times. Paper presented at the Academy of Management Proceedings.
52. McCrae, R. R., & Costa, P. T., Jr. 1987. Validation of the five-factor model of personality across instruments and observers. *Journal of Personality and Social Psychology*, 52 (1): 81-90.
53. Mischel, W. 1977. The interaction of person and situation. In D. Magnusson, & N. S. Endler (Eds.), *Personality at the crossroads: Current issues in interactional psychology*. Optimistic characteristics and optimistic behaviors 31 Hillsdale, NJ: Lawrence Erlbaum.
54. Mishra, A. K., & Spreitzer, G. M. 1998. Explaining how survivors respond to downsizing: The roles of trust, empowerment, justice, and work design. *Academy of Management Review*, 23 (3): 567-588.
55. Moorman, R. H., & Blakely, G. I. 1995. Individualism-Collectivism as an individual difference predictor of organizational citizenship behavior. *Journal of Organizational Behavior*, 16 (2): 127-142.
56. Moorman, R. H., Blakely, G. I., & Niehoff, B. P. 1998. Does perceived organizational support mediate the relationship between procedural justice and organizational citizenship behavior. *Academy of Management Journal*, 41 (3): 351-357.
57. Nunnally, J. C. 1978. *Psychometric Theory* (2nd ed.). New York: McGraw-Hill. Nunnally, J. C., & Bernstein, I. H. 1994. *Psychometric Theory* (3rd ed.). New York: McGraw-Hill.
58. Organ, D. W. 1977. A reappraisal and reinterpretation of the satisfaction-causes-performance hypothesis. *Academy of Management Review*, 2 (1): 46-53.
59. Organ, D. W. 1988. *Organizational Citizenship Behavior: The Good Soldier Syndrome*. Lexington, MA: Lexington Books. Organ, D. W. 1990. The motivational basis of Organizational Citizenship Behavior. In B. M.
60. Staw, & L. L. Cummings (Eds.), *Research in Organizational Behavior*, Vol. 12: 43-72.
61. Greenwich, CT: JAI Press. Organ, D. W. 1994. Personality and organizational citizenship behavior. *Journal of Management*, 20 (2): 465-478.
62. Organ, D. W. 1997. Organizational Citizenship Behavior: It's construct clean-up time. *Human Performance*, 10 (2): 85-97.
63. Organ, D. W., & McFall, J. B. 2004. Personality and citizenship behavior in organizations. In B. Schneider, & D. B. Smith (Eds.), *Personality and organizations*: 291-316. Mahwah, NJ: Lawrence Erlbaum.
64. Organ, D. W., Podsakoff, P. M., & MacKenzie, S. B. 2006. *Organizational Citizenship Behavior: Its Nature, Antecedents, and Consequences*. Thousand Oaks: Sage.
65. Organ, D. W., & Ryan, K. 1995. A meta-analytic review of attitudinal and dispositional predictors of organizational citizenship behavior. *Personnel Psychology*, 48 (4): 775-802.
66. Ostroff, C. 1992. The relationship between satisfaction, attitudes, and performance: An organizational level analysis. *Journal of Applied Psychology*, 77 (6): 963-974. Optimistic characteristics and optimistic behaviors 32
67. Ozag, D. 2006. The relationship between the trust, presume, and normative and continuance commitment of merger survivors. *Journal of Management Development*, 25 (9): 870- 883.
68. Pavot, W., & Diener, E. 1993. Review of the satisfaction with life scale. *Psychological Assessment*, 5 (2): 164-172.
69. Pavot, W., Diener, E., & Suh, E. 1998. The Temporal Satisfaction with life scale. *Journal of Personality Assessment*, 70 (2): 340-354.
70. Peterson, C. 2000. The future of optimism. *American Psychologist*, 55 (1): 44-55. Peterson, S. J., & Luthans, F. 2003. The optimistic impact and development of resumeful leaders. *Leadership and Organizational Development*, 24 (1): 26-31.
71. Pillai, R., Schriesheim, C. A., & William, E. S. 1999. Fairness perception and trust as mediators for transformational and transactional leadership: A two-sample study. *Journal of Management*, 25 (6): 897-933.
72. Podsakoff, P. M., MacKenzie, S. B., Lee, J. Y., & Podsakoff, N. P. 2003. Common method biases in behavioral research: A critical review of the literature and recommended remedies. *Journal of Applied Psychology*, 88 (5): 879-903.
73. Podsakoff, P. M., MacKenzie, S. B., Moorman, R. H., & Fetter, R. 1990. Transformational leader behaviors and their effects on followers' trust in leader, satisfaction, and organizational citizenship behaviors. *Leadership Quarterly*, 1 (2): 107-142.
74. Podsakoff, P. M., MacKenzie, S. B., Paine, J. B., & Bachrach, D. G. 2000. Organizational Citizenship Behaviors: A Critical Review of the Theoretical and Empirical Literature and Suggestions for Future Research. *Journal of Management*, 26 (3): 513-563.
75. Podsakoff, P. M., & Organ, D. W. 1986. Self reports in organizational research: Problems and prospects. *Journal of Management*, 12 (1): 69-82.
76. Rigby, K., & Slee, P. T. 1993. Dimensions of interpersonal relation among Australian children and implications for psychological well-being. *Journal of Social Psychology*, 133 (1): 33-42.

77. Rodriguez-Hanley, A., & Snyder, C. R. 2000. The demise of presume: On losing optimistic thinking.
78. In C. R. Snyder (Ed.), *Handbook of presume: Theory, Measures, and Applications*. San Diego, CA: Academic Press.
79. Roethlisberger, F. J., & Dickson, W. J. 1939. *Management and Workers: An account of a research program conducted by the Western Electric Company Hawthorne Works*. London: Harvard Business School Press.
80. Scheier, M. F., & Carver, C. S. 1992. Effects of optimism on psychological and physical wellbeing: Theoretical overview and empirical update. *Cognitive Therapy and Research*, 16 Optimistic characteristics and optimistic behaviors 33 (2): 201-228.
81. Scheier, M. F., Carver, C. S., & Bridges, M. W. 1994. Distinguishing optimism from neuroticism (and trait anxiety, self-mastery, and self-esteem): A reevaluation of the Life Orientation Test. *Journal of Personality and Social Psychology*, 57 (6): 1024-1040.
82. Scheier, M. F., Carver, C. S., & Bridges, M. W. 2001. Optimism, pessimism, and psychological well-being. In E. C. Chang (Ed.), *Optimism and Pessimism: Implications for theory, research, and practice*: 189-216. Washington, DC: American Psychological Association.
83. Scheier, M. F., Matthews, K. A., Owens, J. F., Magovern, G. J., Lefebvre, R. C., Abbott, R. A., & Carver, C. S. 1989. Dispositional Optimism and Recovery From Coronary Artery Bypass Surgery: The Beneficial Effects on Physical and Psychological Well-Being. *Journal of Personality and Social Psychology*, 57 (6): 1024-1040.
84. Scheier, M. F., Weintraub, J. K., & Carver, C. S. 1986. Coping with stress: Divergent strategies of optimists and pessimists. *Journal of Personality and Social Psychology*, 51 (6): 1257-1264.
85. Schiff, M., & Bargal, D. 2000. Helping characteristics of self-help and support groups: Their contribution to participants' subjective well-being. *Small Group Research*, 31 (3): 275-304.
86. Seligman, M. E. P. 1998. *Learned optimism: How to change your mind and your life*. New York: Pocket Books.
87. Seligman, M. E. P., & Csikszentmihalyi, M. 2000. Optimistic Psychology: An introduction. *American Psychologist*, 55 (1): 5-14.
88. Shalley, C. E., Gilson, L. L., & Blum, T. C. 2000. Matching creativity requirements and the work environment: Effects on satisfaction and intentions to leave. *Academy of Management Journal*, 43 (2): 215-223.
89. Shim, W. S., & Steers, R. M. 2001. The entrepreneurial basis of Korean enterprise: Past accomplishments and future challenges. *Asia Pacific Business Review*, 7 (4): 22-43.
90. Smith, C. A., Organ, D. W., & Near, J. P. 1983. Organizational Citizenship Behavior: Its Nature and Antecedents. *Journal of Applied Psychology*, 68 (4): 653-663. Snyder, C. R. 1994. The psychology of presume: You can get there from here. New York: Free Press. Snyder, C. R. 2000. Hypothesis: There is presume. In C. R. Snyder (Ed.), *Handbook of presume: Theory, Measures, and Applications*: 3-21. San Diego, CA: Academic Press. Snyder, C. R., Harris, C., Anderson, J. R., Holleran, S. A., Irving, L. M., Sigmon, S. T., Yoshinobu, L., Gibb, J., Langelle, C., & Harney, P. 1991. The will and the ways: Development and validation of an individual differences measure of presume. *Journal of Optimistic characteristics and optimistic behaviors* 34 *Personality and Social Psychology*, 60 (5): 570-585.
91. Snyder, C. R., Rand, K. L., & Digmon, D. R. 2002. presume Theory: A member of the Optimistic psychology family. In C. R. Snyder, & S. J. Lopez (Eds.), *Handbook of Optimistic Psychology*: 257-276. New York: Oxford.
92. Speier, C., & Frese, M. 1997. Generalized self-efficacy as a mediator and moderator between control and complexity at work and personal initiative: A longitudinal field study in East Germany. *Human Performance*, 10 (2): 171-192.
93. Stajkovic, A. D., & Luthans, F. 1998. Self-Efficacy and work related performance: A metaanalysis. *Psychological Bulletin*, 124 (2): 240-261.
94. Tait, M., Padgett, M. Y., & Baldwin, T. T. 1989. Job satisfaction and life satisfaction: A reexamination of the strength of the relationship and gender effects as a function of the date of the study. *Journal of Applied Psychology*, 74 (4): 502-507.
96. Tsui, A. S., Egan, T. D., & O'Reilly, C. A. I. 1992. Being different: Relational demography and organizational attachment. *Administrative Science Quarterly*, 37 (4): 549-580.
97. Van Dyne, L., Cummings, L. L., & McLean Parks, J. 1995. Extra-role behaviors: In pursuit of construct and definitional clarity (A bridge over muddied waters). In B. M. Staw, & L. L. Cummings (Eds.), *Research in Organizational Behavior*, Vol. 17: 215-285.
98. Van Yperen, N. W., Van Den Berg, A. E., & Willering, M. C. 1999. Towards a better understanding of the link between participation in decision-making and organizational citizenship behavior: A multi-level analysis. *Journal of Occupational and Organizational Psychology*, 72 (3): 377-397.
99. Wunderley, L. J., Reddy, W. P., & Demer, W. N. 1998. Optimism and pessimism in business leaders. *Journal of Applied Social Psychology*, 28 (7): 751-760.
100. *Journal of Management*, WPS No. 651,
101. Youssef, C. M., & Luthans, F. 2007. Optimistic organizational behavior in the workplace: The impact of presume, optimism, and resilience. *Journal of Management*, 33 (5): 774-800.

ETHICS OF INTERNATIONAL BUSINESS MOVING BEYOND LEGALISM

Prof. (Dr.) Satish C. Sharma

Board of Governor, Maharaja College of management, Udaipur.

Meghashree Agarwal

e-mail: meghashreeagarwal@gmail.com

Assistant Professor, Maharaja College of Management, Udaipur.

ABSTRACT

This paper examines the importance of global business ethics. People make ethical decisions based on their own personal values and sometimes ignore the ethics of the organization or others. It is important, therefore, that an organization establish a code of ethics that calls for, among other things, high standards of honesty, objectivity, diligence and loyalty to which everyone in the organization.

Today organizations, regardless of their size, are required to have a clear and transparent moral code so consumers or customers, employees and the general public can make rational choices. Ethics should be consistent, clear and communicated to all levels as part of an organization's unique organizational culture. Most big corporations understand that a responsible organization is dependent upon a combination of virtuous people and professional integrity. With the advancement of growing technologies, competitors in market are also growing. This had resulted in various ethical issues in any business. Every business organization must comply with these principles to be ethically valued. Ethics covers a wider area in terms of business. Ethical values, one should follow in business should satisfy the customers, employee and employer. “**Business etiquettes**” are the process of survival and succeeding to the business in the competitive world. A General Ethical Code should be inspirational, declaratory, exhortatory, and educational but not enforceable. By embracing the business ethics and the social responsibility business will benefit from your increased goodwill.

Keywords: - *Business ethics, Shareholder's ethical values, Business Ethics - 6 Basic Principles of Business Etiquette, Ethical codes of conduct, Ethical problems in International Business, Business Ethics and Social Responsibility.*

1. INTRODUCTION

Importance of ethics in the business world is superlative and Global. Net trends and issues arise on a daily basis, which may create an important burden to organizations and end-consumers. Nowadays, the need for proper ethical; behavior within organizations has become crucial to avoid possible lawsuits. The recent expansion of global business and fall of trade barriers worldwide have further underlined the interests in the topic of ethical behavior and social responsibility.

As multinational companies expand globally and enter foreign markets, ethical conduct of the officers and employees assume added importance since the very cultural diversity associated with such expansion may undermine the much shared cultural and ethical values observable in the more homogeneous organizations. While business ethics emerged as a field in the 1970s, international business ethics did not emerge until the late 1990s, looking back on the international developments of that decade. Foreign countries often use dumping as a competitive threat, selling products at prices lower than their normal value. This can lead to problems in domestic markets. It becomes difficult for these markets to compete with the pricing set by foreign markets. In 2009, the International Trade Commission has been researching anti-dumping laws. Dumping is often seen as an ethical issue, as larger companies are taking advantage of other less economically advanced companies. **Business ethics** as an academic area is defined by the interaction of business and ethics, and the set of related problems thus generated. At its broadest, it studies the moral justification of economic systems, whether national or international. Within a given system it studies the moral justification of the system's structures and practices. Since corporations are a dominant feature of the free-enterprise system, a good deal of work has focused on the structures, governance, responsibilities, and activities of corporations. Within the corporation business ethics deals with the moral responsibilities and rights of individual managers and employees—the more traditional focus of previous work on ethics in business.

In the increasingly conscience-focused marketplaces of the 21st century, the demand for more ethical business processes and actions is increasing. Simultaneously, pressure is applied on industry to improve business ethics through new public initiatives and laws. Businesses can often attain short-term gains by acting in an unethical fashion; however, such behaviour tends to undermine the economy over time. The range and quantity of business ethical issues reflects the degree to which business is perceived to be at odds with non-economic social values.

The basis of a code of ethics defined by what is important to you, what your core values are and how they will contribute to your client's success and the increased greatness of the society are key to creating sustained growth. Today organizations, regardless of their size, are required to have a clear and transparent moral code so consumers or customers, employees and the general public can make rational choices. In the more sophisticated markets such codes become deciding factors when choosing where to shop, where to work, where to invest, etc.

Ethics should be consistent, clear and communicated to all levels as part of an organization's unique organizational

culture. Most big corporations understand that a responsible organization is dependent upon a combination of virtuous people and professional integrity. cohesive strength with an increase in crack opening. De-Andrés and co-workers [13] extended the formulation of the irreversible CZM to predict three-dimensional crack growth in aluminum shafts that were subject to cyclic loading along the axis. Roe and Siegmund [14] introduced a damage evolution law that accounted for the accumulated separation into the cohesive zone model and carried out a numerical study of crack growth at the interface during cyclic loading.

In this research study using the cohesive zone model (CZM), the damage evolution law put forth by Roe and Siegmund [14] was used and extended for the three-dimensional formulation of material degradation under the influence of cyclic loading. An irreversible CZM was obtained by incorporating the updated damage based on the constitutive relations into the exponential form cohesive law adopted previously by the authors for studying crack growth under monotonic loading [16]. A viscous regularization technique was incorporated in the formulation of constitutive relations to improve convergence of the numerical solution. The irreversible cohesive law was validated for the simulation of cyclic crack propagation under different modes of loading. Finally issues such as convergence, mesh dependency and crack path deviation are discussed.

2. ADVANTAGES OF BUSINESS ETHICS

The importance of international business has led to discussions of international business ethics and to a reconsideration of moral and cultural relativism, which take on special significance when considering doing business in societies with corrupt governments and in the absence of many traditional restraints. Every decision involves some ethics. Whether negotiating with suppliers or customers, hiring or firing employees, allocating responsibilities, or launching a promotion, the matter of ethics is always present. Individual ethics and organizational ethics cannot be completely separated, since, after all, those who perform the tasks in organizations are individuals with their own ethics and personal convictions about what should and should not be done at any time. Moreover, in the diverse work environment in which we live nowadays, individuals bring ethical values that may not be consistent with those of the organization or other individuals. People make ethical decisions based on their own personal values and sometimes ignore the ethics of the organization or others. It is important, therefore, that an organization establish a code of ethics that calls for, among other things, high standards of honesty, objectivity, diligence and loyalty to which everyone in the organization should conform regardless of his/her cultural background. The various advantages of business ethics are:

2.1 ETHICS PLAYS A PROMINENT ROLE IN THE BUYING PROCESS: - When is time to choose between you and your competitors, clients will go with the one that displays the highest ethics in accordance with their own value reference framework. If you appreciate honesty and integrity, you will attract clients that place a high regard on those values as well.

2.2 CLIENTS REWARD ETHICAL COMPANIES WITH LOYALTY: - Let's suppose your client sent you a payment in an amount greater than the amount due on the invoice. Do you elect to ignore the error and keep the extra cash for yourself? Or do you call your client and let him/her know about the error? If you do the latter, your client will always remember you for your honesty. You will be rewarded with loyalty, and your reputation will be increased.

2.3 ETHICAL COMPANIES ATTRACT MORE EMPLOYEES: - If your company has a bad reputation and is usually in the news for scandals, complaints from employees and customers, or breaking regulations and mandates that will automatically scare away good, honest and reliable employees. Remember, its human nature to look for those that share similar values and standards as our own.

2.4 ETHICAL COMPANIES ARE LESS VULNERABLE TO LEGAL ACTIONS: - Businesses today are characterized by transparency. The Internet has opened the doors to what used to be confidential information, and corporate wrongdoing is constantly being uncovered in cyberspace. A lack of ethical conduct can negatively impact the bottom line of an organization, often by necessitating expenditures for litigation and fines, not to mention causing serious damage to the firm's reputation.

2.5 ETHICS CAN BENEFIT THE BOTTOM LINE: - Ethics can benefit the bottom line by ingraining motivation and productivity in employees, thereby leading to a good corporate reputation. A good reputation will also strengthen customer loyalty and help maintain and increase market share.

All organizations have an ethical obligation to each of the five groups that constitute them - owners, shareholders, employees, customers, suppliers and the community - not only in terms of rules and obligations but in terms of values: freedom, equality, solidarity, ongoing respect and dialogue. The organization as a whole, with the guidance of its chief executives and owners, must lead in the generation of three fundamental ethical elements that enable the development of values: **the ethics of responsibility, the ethics in everyone's interest, and the ethics of the organization**. That is, an organization must facilitate the development of its business ethics based on these elements: a strong corporate culture (collectively constructed values), the human talent as the main asset of the organization, quality as a fundamental aspiration, the combination of tangibles (material) and intangibles (harmony, cooperation, warmth, avoidance of conflict), and concern for its customers, employees, suppliers and competitors. An organization must assume the social responsibility for its actions; exercise leadership based on values, and governs a moral contract - beyond the legal contract - between it and its members..

3. NEED OF ETHICAL IN BUSINESS

It is clear that there are always problems that need our solutions as long as we live in this planet. We need many things to live and getting them all is not an easy task. We can not get all we want separately or individually. We need each other very much. Business is a problem solving mechanism by which we give solutions for our problems that surround us. Since business is a solution, in order to give solutions for the problems of people, you need to be someone who cares about people. However for some, business has no meaning apart from some profit maximization method.

Business has its own ethics. Even though there are many issues when we talk about business ethics, what I want to say now is about one and, in my opinion, the most awful mistake people do when doing it. That is placing their need ahead of the need of their customers.

Your customers need you to solve their problems, to satisfy their needs, but not to take advantage of them. They want trustworthy business people in order to put their trust on them. If people think that you are taking advantage of them or you being selfish, they do not want to see you again. Do not make maximizing profit the first and foremost goal of your business. Solve problems first. Wish to see a satisfied customer. Profit is a reward your customers give you when you satisfy their needs. If you want to run a successful business, get rid of 'money first' attitude out of your mind. Money is not the only or the primary thing you need in life. Be able to see beyond the boundaries of money and material possessions. You can do far more than that. Unfair or unethical way of doing business damages society, country, and the entire business system. If those things are damaged, you are the one who suffer in return.

4. SHAREHOLDER ETHICAL VALUES

The first problem is that it is very difficult to know what will maximize long-term shareholder value. Although the end may be measured in a simple way, the means to achieve it are highly complicated. One way in which some attempt to release values other than profit is to argue that these other values (and ethical values in general) are in the long term self interest of the shareholders. There is no single plan for such an ethics regime or integrity system. It will depend partly on differences in the legal and bureaucratic cultures and the way that business is done (though not, it would seem, particularly on national culture). It will also depend on what is already in place with the potential to contribute to an integrity system.

When it comes to the raising of standards and/or the reduction of corruption, there is no silver bullet, no single measure, and no single institution that can achieve this by itself. This is the reason why we see governance reform in terms of what we have long called an 'ethics regime' and which we call an 'integrity system'. It is through a combination of mutually reinforcing institutions, ethical standards, legal regulation, and other measures that standards can be raised and corruption reduced in public sector agencies.

The final problem is that those who would act unethically to maximize corporate profits while ignoring all other values might seek to maximize their own fortunes irrespective of other values like 'shareholder value'. The alternative, of course, is to recognize that there are other values for public corporations and those real managers manage for a number of values. They believe that achieving them will advance the corporation on the various measures on which it is asked to perform. However, they do not see their managerial role so simply as managing for only one value. Public sector managers have always known this in the past.

Shareholder value is deceptively simple; but, what do shareholders value? They do not merely value the monetary price for which their shares can be sold either today or at some distant and indeterminate point in the future. **First**, if values are used to make reforms consistent and coherent, then they will be more easily integrated -not only in practice but also in the minds of those who must pursue that practice. If the values and the ethical and legal principles derived from them are used to organize the reforms, then they can also help to integrate the reforms conceptually for public sector managers. **Secondly**, value based reforms of the public sector should help to reinvigorate morale of the public sector.

5. ETHICAL ISSUES IN BUSINESS ARE GROWING EVERYDAY

With the advancement of growing technologies, competitors in market are also growing. This had resulted in various ethical issues in any business. Every business organization must comply with these principles to be ethically valued. Some companies may tend to boost their sales by following various techniques, most common among them is the promotional adaptations, in which they will not completely give the details of the product and hence customers are in one way or the other defrauded.

Ethics covers a wider area in terms of business. Ethical values, one should follow in business should satisfy the customers, employee and employer. There are values that should be satisfied internally within the organization, between the employer and employee or between employees.

5.1 Treating one or more employees with partiality is also unethical.

5.2 The business organization should not give out the customer details to any other third parties without the consent of the customer in the written form. The customer is eligible to determine whether he would like to give his details to the third party or not, or which third party to choose and to terminate the details whenever he wishes.

5.3 The company should be able to change the information of the customers whenever they request it to. In addition, the company should be able to retrieve the information whenever the customer wishes to. However, once the contracts of the clients are completed, or the customer is no longer within the company, then the information stored must be erased and they should never be

sold out.

These are some of the ethical issues in business. These are also covered inside the legal terms for the customers provided by the law. Some violation of ethical values often occurs around us and we fail to notice them, since they have become a practice. The doctor should never give out the details of the patient to anyone. A lawyer must not appear for a client that one of his previous clients have sued. This is typical violation of ethical values. However, the professionals have never worried in making these violations. With the opportunity of social network marketing or the online marketing, one should take care in not to violate the cultures or harass people of different regions. The contents used for marketing products should not violate the ethical terms. Sometimes, companies may sell lower standard products bribing the government officials, which is a clear form of ethical violation. Ethical issues in business are particular in certain areas. The business organization must take care and plan well to avoid these ethical issues.

6. BUSINESS ETHICS - 6 BASIC PRINCIPLES OF BUSINESS ETIQUETTE

One of the most important, if not the most important factor in determining the chances of success in any business or professional activities is the ability to behave properly with people. Even in the early 1930s Dale Carnegie observed that the success of a man in his financial affairs, even in the technical field or engineering are fifteen percent dependent on his professional knowledge and eighty-five percent on his ability to communicate with people. In this context it is easy to explain the attempts of many researchers to formulate and justify the basic principles of ethical business communication or, as they are often called, the commandments of personal public relation or "business etiquette". Business etiquette or the process of survival and succeeding in the business world could be explained in the following six basic principles:

6.1 PUNCTUALITY (DO EVERYTHING ON TIME) Delays affect the work and are a sign that a person cannot be relied upon. The principle to do everything on time applies to all service tasks. Experts studying the organization and distribution of working time recommend adding extra 25 percent to the time period that is required to perform the assigned task.

6.2 PRIVACY (DO NOT REVEAL TOO MUCH) In any institutions, corporations, or particular deals there are secrets that should be kept as carefully as the ones of a personal nature. There is also no need to recount anyone heard from a colleague, supervisor or subordinate about his or her performance or personal life.

6.3 COURTESY, FRIENDLINESS AND AFFABILITY In any situation it is necessary to behave politely, kindly and benevolent with customers, clients, customers and co-workers. This, however, does not require being friends with everyone whom you communicate in a work setting.

6.4 ATTENTION TO PEOPLE (THINK OF OTHERS, AND NOT ONLY OF YOURSELF) Attention to the people surrounding you should be extended to colleagues, superiors and subordinates. Respect the opinions of others; try to understand why they have formed a particular point of view. Always listen to criticism and advice of colleagues, superiors and subordinates. When someone questions the quality of your work, show that you value the views and experiences of other people. Confidence should not prevent you to be modest.

6.5 APPEARANCE (DRESS AS EXPECTED) The main approach is to fit in your environment at work, and within that environment - in your level of contingent workers. You should look the best way, which is to dress with taste, choosing matching colors. Carefully choosing accessories is important.

6.6 LITERACY (SPEAK AND WRITE GOOD LANGUAGE) Internal documents or letters to outside agencies should be composed paying attention to the proper language used, and all proper names transferred without errors. Do not use abusive words. Even if you only quote the words of another person around, they will be perceived as part of your own vocabulary.

7. ETHICAL CODES OF CONDUCT

Institutionalizing of ethics is not done by the passage of legislation, regulation, or by any executive fiat. Building ethics into the consciousness, reasoning, and action of a public sector not only takes time but involves an extensive process. To an extent, the regime is about the process of building ethics into the way employees think and act. Not only must they be involved in the process, the process of their ethical involvement is the core of the regime.

The only mandatory requirements were on CEO to involve employees in developing codes, to engage in ethics education, and to report annually on the process in the organization. The act required the process rather than command the result.

Building ethics into an organization is one of those complex processes through which you seek to move from where you are, to where you hope to be. Furthermore, many of the benefits may be generated by the process as much as by the end result. Participation in the process can be one of the best forms of ethics education available. For the organization, it constitutes one of the best methods of identifying the ethical issue it has to confront.

A General Code should be inspirational, declaratory, exhortatory, and educational but not enforceable. In particular, the primary obligations should not be enforceable by themselves but through the more specialized codes for individual public sector agencies. This process can be entirely 'in house' involving staff from different units, by a long or short term internal unit, or done with the assistance of outside experts.

8. ETHICAL PROBLEMS IN INTERNATIONAL BUSINESS

In addition to these codes, the moral corporation should address human rights and whistle blowing and the international ethics code under which it operates. These issues are not very new. In a survey of 300 multinational corporations, 80 percent agreed with seven items being ethical issues for business:

- ▶ Employee conflict of interest,
- ▶ Inappropriate gifts to corporate personnel, Sexual harassment,
- ▶ Unauthorized payments,
- ▶ Affirmative action (6) employee privacy, and Environmental issues

9. BUSINESS ETHICS AND SOCIAL RESPONSIBILITY

Generation of maximum returns for its owners and shareholders are the ultimate purpose of any business. Insatiability is no longer good & focusing purely on the profits is unacceptable for your existing as well as potential customers. By embracing the business ethics and the social responsibility business will benefit from your increased goodwill. And therefore, a business is bound to the core responsibility of ensuring that profit enhancing activities are pursued which in turn increases the value of the business. In addition, a business should have an ethical behavior that will necessitate target achievement. A business also should strive to enhance local community service and also facilitate better living conditions for its employers. Putting real policies in place that take care of the employees and as well the local community can bring about enhancement of your business brand. This ultimately, will conclude into higher profitability. It is also essential to offer training to staff members besides facilitating promotions from within the organization. This will ultimately lead to employees that feel empowered, which will in turn lead to hard working staffs that have the capability of making better decisions. There are lots of methods to do this includes education, sports as well as environment. In a short term, there are some perceivable advantages in the terms of profitability however these actions can serve to improve the business brand as well as an increase the profitability over the longer term.

10. CONCLUSION

Every decision involves some ethics. It applies to all aspects of business conduct and is relevant to the conduct of individuals and business organizations as a whole. Individual ethics and organizational ethics cannot be completely separated. All organizations have an ethical obligation to each of the five groups that constitute them - owners, shareholders, employees, customers, suppliers and the community - not only in terms of rules and obligations but in terms of values: freedom, equality, solidarity, ongoing respect and dialogue. Ethics covers a wider area in terms of business. Ethical values, one should follow in business should satisfy the customers, employee and employer.

Building ethics into an organization is one of those complex processes through which you seek to move from where you are, to where you hope to be. Furthermore, many of the benefits may be generated by the process as much as by the end result. A General Code should be inspirational, declaratory, exhortatory, and educational but not enforceable. A business also should strive to enhance local community service and also facilitate better living conditions for its employers. Ethical actions usually bare fruits in the long term as they serve in enhancement of the brand of the business, which ultimately will bring about profitability over the long term. Thus, pointing to the fact that ethical dimension of employee's behavior has a clear impact on the profitability of the company. In order to improve the ethical climate of an organization, management must effectively communicate proper ethical behavior throughout the organization. Training sessions, codes of ethics, reward systems and coaching are a few methods that organizations employ in this regard. To that end, it is postulated that probably an international organization is the best vehicle through which a code of ethics covering all aspects of business can be developed. Meanwhile, global organizations need to develop and enforce their own codes of ethics specifically directed at the issues related to multicultural and multinational business environment.

REFERENCES

- 1 Brooks, L.J.: 1989, "Corporate Codes of Ethics", *Journal of Business Ethics* 8, 117-129.
- 2 Delaney, J.T. and D. Sockell: 1992, "Do Company Ethics Training Programs Make a Difference? An Empirical analysis", *Journal of Business Ethics* 11, 719-727.
- 3 Getz, K.A.: 1990, "International Codes of Conduct: An analysis of Ethical Reasoning", *Journal of Business Ethics* 9, 567-577.
- 4 Jones, T.: 1991, "Ethical Decision Making by Individuals in Organizations; An issue- Contingent Model", *Academy of Management Review* 16(2), 366-395.
- 5 Mahdavi, Iraj: 2005, "Origins of Business Ethical Behavior", *Proceedings of International Business Association Conference*, 2005.
- 6 Morf, Duffy A., Schumacher, Michael G., and Vitell, Scott J.: "A Survey of Ethics Officers in Large Organizations", *Journal of Business Ethics* 20, 265-271: 1999.
- 7 Robertson, C. and P.A. Fadil: 1999, "Ethical Decision Making in Multinational Organizations: A Culture-Based Model", *Journal of Business Ethics* 19, 385-392.

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