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Preface

Dear Participants,

Confronted with the ever-increasing complexity of technical processes and the growing demands on their efficiency, security and flexibility, the scientific world needs to establish new methods of engineering design and new methods of systems operation. The factors likely to affect the design of the smart systems of the future will doubtless include the following:

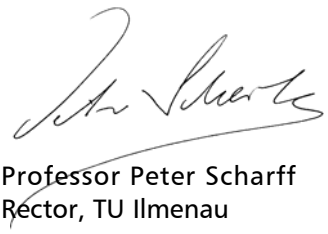
- As computational costs decrease, it will be possible to apply more complex algorithms, even in real time. These algorithms will take into account system nonlinearities or provide online optimisation of the system's performance.
- New fields of application will be addressed. Interest is now being expressed, beyond that in "classical" technical systems and processes, in environmental systems or medical and bioengineering applications.
- The boundaries between software and hardware design are being eroded. New design methods will include co-design of software and hardware and even of sensor and actuator components.
- Automation will not only replace human operators but will assist, support and supervise humans so that their work is safe and even more effective.
- Networked systems or swarms will be crucial, requiring improvement of the communication within them and study of how their behaviour can be made globally consistent.
- The issues of security and safety, not only during the operation of systems but also in the course of their design, will continue to increase in importance.

The title "Computer Science meets Automation", borne by the 52nd International Scientific Colloquium (IWK) at the Technische Universität Ilmenau, Germany, expresses the desire of scientists and engineers to rise to these challenges, cooperating closely on innovative methods in the two disciplines of computer science and automation.

The IWK has a long tradition going back as far as 1953. In the years before 1989, a major function of the colloquium was to bring together scientists from both sides of the Iron Curtain. Naturally, bonds were also deepened between the countries from the East. Today, the objective of the colloquium is still to bring researchers together. They come from the eastern and western member states of the European Union, and, indeed, from all over the world. All who wish to share their ideas on the points where "Computer Science meets Automation" are addressed by this colloquium at the Technische Universität Ilmenau.

All the University's Faculties have joined forces to ensure that nothing is left out. Control engineering, information science, cybernetics, communication technology and systems engineering – for all of these and their applications (ranging from biological systems to heavy engineering), the issues are being covered.

Together with all the organizers I should like to thank you for your contributions to the conference, ensuring, as they do, a most interesting colloquium programme of an interdisciplinary nature.
I am looking forward to an inspiring colloquium. It promises to be a fine platform for you to present your research, to address new concepts and to meet colleagues in Ilmenau.



Professor Peter Scharff
Rector, TU Ilmenau

Professor Christoph Ament
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Table of Contents

C O N T E N T S

10 Mobile Communications

11 Education in Computer Science and Automation

N. Z. Khan / K. Ghanem / S. Leistritz / F. Liers / M. A. A. Kalil / H. Kärst / R. Böringer

Network Management of Future Access Networks

ABSTRACT

The future heterogeneous networks will be more sophisticated and complex. The access network in future will mostly depend on wireless medium of communication with a demand of high bandwidth for the subscribers. The management of such a heterogeneous system is a big challenge. In this paper, we present the overview of a study for future access network management. General ideas involved in the development of simulated and emulated future networks are also presented. Different tools those are developed during the study are also discussed in this paper. To provide the higher bandwidth we used **M**ulti **P**rotocol **L**abel **S**witching (MPLS) networks and reconfigurable wireless devices such as multi party access gateways to represent the wireless access networks are used in this work. The paper discusses the idea of management in future heterogeneous networks.

INTRODUCTION

The future heterogeneous networks are supposed to be more sophisticated and complex than today's networks. The management of such networks is becoming a greater challenge. On one hand the access networks are becoming more dependent on wireless access networks and on the other hand the high speed packet forwarding technologies such as **M**ulti **P**rotocol **L**abel **S**witching (MPLS) are expected to be a part of future access networks. There are lots of different issues to manage when one looks into an integrated view of such future access networks. Management issues related to wireless access to client are on one hand important. On the other hand the management of faults and traffic at the packet level is becoming more important too. In order to study these problems, a work was done keeping in mind the demands of future access networks that involves MPLS technology with wireless access to the clients.

MULTI PROTOCOL LABEL SWITCHING

MPLS is a technology that attempts to improve the speed of packet forwarding in IP networks. MPLS-capable routers known as **L**abel **S**witching **R**outers (LSRs) can use link-level forwarding to provide a simple and fast packet forwarding capability [1-4]. MPLS combines the simplicity of IP routing with the high-speed switching capability of **A**synchronous **T**ransfer **M**ode (ATM). It has significant benefits which can allow future systems to use the MPLS not only in the backbone but also in access networks. It is necessary to use a label distribution protocol to setup the **L**abel **S**witching **P**ath (LSP) [5][6].

MULTI PARTY ACCESS GATEWAYS

The multi party access gateway is a wireless access point, which could be used by more than one wireless access networks as well as a service provider. As an example, two service providers could offer their services over one physical device. One provider could offer VoIP and the other could offer internet web browsing without interfering each other. This new technology is provided by IDEO Laboratories GmbH and was developed in co-operation with the TU Ilmenau. The usage of this technology causes a higher administration work load than normal networks. Due to the existence of independent environments on one single access gateway, the configuration work load for an administrator is higher than in a usual network without these virtual environments. Manual configuration of all devices of a large scale networks with a high number of involved parties is very time consuming and therefore expensive. The delay between the arrival of a request for a network setup and the finishing of the installation is high and would prevent fast changes due to variable user traffic load. For an efficient usage in a large scale network an automatic configuration and management system is needed.

DYNAMIC MONITORING OF NETWROK ELEMENTS

Future networks have to control and optimize themselves in wide ranges. The operator is not longer able to take decisions as it is required to ensure that services are not interrupted. Therefore, a smart monitoring system has to gather information about the network status and failures in order to enable a decision engine to react on the problem in the right way. It is easy to imagine that this would lead to the issues of high signaling load and high demand for computing resources for examining the monitoring data (e.g. determining trends and reducing the alarm rates). Two main approaches can be used to overcome such problems:

- Reducing the information per monitored network element or
- Decreasing the number of monitoring points in the network.

This work has examined these approaches. The aim is to observe an MPLS-based network and to detect if a network element (nodes or links) fails. Therefore a network generator was built in co-operation with IDEO & TU-Ilemanu that provides large network structures which are close to real network structures. Emulation and simulation of MPLS networks has been developed and used to study different monitor placement mechanisms. One of the targets of this work is to develop some approaches to reduce the number of monitors. The number of monitoring nodes can be dramatically reduced if a smart placement mechanism is used.

IMPLEMETATIONS

The TU Ilmenau has developed such a system, which provides a fully automatic management of the multi party access gateways as well as the optimum placement of monitors to find the faults in the access network. It supports the whole workflow for configuring the devices from the moment of power on until the full integration in the network. This workflow consists of three phases, which are separated in different steps. The first phase is the information collection phase with the steps of hardware integration, discovery and description. The new hardware device had to be integrated in the network physically. In special there had to be power supply of the device and a wire or wireless connection to the network backbone. Now the device had to be detected by the network and a description of the device and its features had to be determined. The second phase is the information evaluation and decision making phase. Based on the collected data of the device and the configuration of the other network elements a reconfiguration decision is made. Therefore the required services for the network have to be mapped to the available resources. This service to device mapping must take into account several constrains. First of all the hardware requirements of all services must be fulfilled. A device, which should run a service, must provide enough memory, disk capacity and CPU speed. Second a device should not be overloaded with services. This is especially critical for services with resource consumption depending on the number of user and requests, respectively. Therefore the load of a service and its resource needs must be forecast. Due to the uncertainty of this forecast a part of the resources of a device should be reserved for peak load and finally the quality of service for services must be considered for the placement of the service entities. The main focus here is on the delay

and communication relationships between the services and the service entities. If services must communicate with each other and if they are placed on different devices, a communication delay occurs. In case of a defined maximum delay for the whole service, the placement must respect the delay constrains. When the decision phase is over, the last phase starts. This reconfiguration phase consists of a building and delivering the device and service configuration and execution of services on the devices. The configuration does not consist of some plain configuration files only. For most devices complete hardware depended operation systems with special device drivers and application programs are needed. They must be compiled with cross compiler, which supports the hardware architecture and CPU instruction set.

With this management system it is possible to detect and configure multi party wireless access gateways without manual interactions on one hand and on the other hand the same system manages the dynamic placement of monitors to reduce the monitoring cost of access networks. This work has resulted in the development of a more efficient and integrated management system for future access networks.

CONCLUSIONS

The future heterogeneous networks will mostly be using wireless medium and a high bandwidth will be demanded by subscriber. To have an uninterrupted higher bandwidth, the networks should be managed by using less costly and dynamic monitoring mechanisms. Advanced wireless access gateways are configurable and a step further towards a management of future access networks. TU Ilmenau along with IDEO laboratories has researched management of future access networks. The research resulted in development of a management system prototype which dynamically configures devices according to demands and also places different types of monitors according to demand. A prototype of this management system is currently working in Wireless lab of TU Ilmenau. In future, more sophisticated fault detection and smarter placement of monitors for several different services will be considered.

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