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An Architecture of FoaF-based Peer 2 Peer Knowledge Management System

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ABSTRACT

A number of researches have been focused on improving the productivity of knowledge workers. Effective communication is determinative, and one important problem has been to find the right person for collaboration. The Semantic Web efforts improve it by better wide-range knowledge management. Through extending the FoaF (Friend of a Friend) vocabulary, knowledge workers can share their machine-readable knowledge world widely, so that their PCs can facilitate effective collaboration efficiently. This paper presents an approach to support networked personal knowledge management. An example of extended FoaF is also described

Keywords: FoaF, Social Network, Peer 2 Peer, Knowledge Management

1. INTRODUCTION

Efforts in improving the productivity of knowledge workers are on the cutting edge of technology development. Recent research has proved that social network is important for the successful generation, acquisition, diffusion, and exploitation of knowledge, which is the keys to strong performance in the Knowledge Based Economy (KBE). Various efforts were devoted to discover and release the "strength of weak ties" [1]. By adding metadata management capacity, Peer 2 Peer networks are in the early stage in evolving its application from 'file sharing' to 'collaboration infrastructure' [2]. In the mean time, FoaF is being widely used to connect people over the Internet. However, by only sharing the name, address etc. is inadequate for effective and efficient collaboration among peers. Furthermore, all these initiatives are facing challenge due to the emergence of Semantic Web (i.e. the next generation web) [3]. Therefore, it is necessary to investigate how semantic technology can facilitate Peer 2 Peer application and personal knowledge management, and improve the productivity of knowledge workers consequently.

This paper presents an application architecture with the purpose of manage personal knowledge management in social network environment. It manages the knowledge generated by user, structures collaboration-relevant information with an extended FoaF vocabulary, and publishes them into shared space. In addition, agents are used to make some processes automatic.

The structure of the paper is as follows. In section 2, theor[1]y foundation such as social network, knowledge workers, and FoaF are introduced and discussed. Afterward, a FoaF-based approach for networked personal knowledge management is presented in section 3. Finally section 4 concludes the paper by discussing the applicability of this approach and potential further research.

2. SOCIAL NETWORKING AND FOAF

This section focuses on the human side of knowledge application and innovation management. At first, the importance of social network is briefly introduced and how FoaF can support collaboration is discussed at last.

2.1 Social Networks

There have already been several organization structures so far (see Fig 1). Despite that functional organization is still the basic structure of enterprise, a number of organization structures, such as market-oriented, team-based, cop-based, appeared as a result of seeking comparative and competitive advantage.

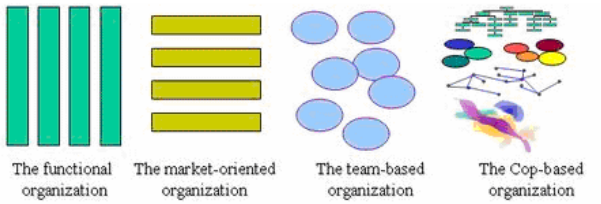

Fig. 1. Structures of organization (source: COP Consortium 2000)

Even in a traditional function-oriented organization (e.g. a corporation), there are various informal organizational channels, which is important for the internalization of organizational knowledge and externalization of individual knowledge. Fig 2 illustrates the difference between formal and informal organizational structure.

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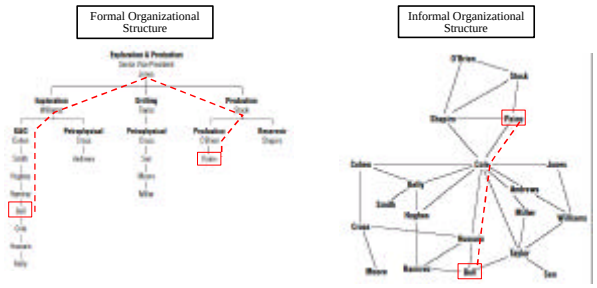

Fig. 2. Contrast between Formal and Informal Structure (source: Rob Cross, Andrew Parker and Stephen P. Borgatti, 2002, A bird's-eye view: Using social network analysis to improve knowledge creation and sharing, IBM Institute for Business Value)

From Fig. 2, we can see that in the informal organizational structure, a common employee (Cole) becomes the core of the network.

Suppose that Paine is an expert in one production equipment, and Bell is going to do some work with that, which is totally new to him. In formal organizational structure, Bell can not contact directly with Paine due to organizational barrier. The problem must be reported one level after another, and responded in the same route. The easier way is to appeal to the social network: Bell can contact Cole through Hussain, and ask who is the expert of that subject, and hopefully Cole will find Paine and return the relevant knowledge or arrange a meeting. Thus, a social network can impact the effectiveness and efficiency of communication [4].

The analysis of social networks is not dominated by the sociologists now. IT engineer can use it to quantify and map such "soft" phenomena as knowledge flows and communication. At the mean time, the focus of research is moving from small groups to larger groups and industry [5]. The Web is all about making connections between things, and the Internet itself is a big social network, distributed in nature.

A number of online applications focusing specific topic (such as disabled people employment, children nursing) have attracted some eyeballs. However the real power of social network is to help members to share knowledge instead of 'reinvent the wheels', yet none of the applications support intelligent web pages (i.e. containing knowledge of expert). The reasons lay in two aspects. On the one hand, the technology of the Internet is limited, machine can not help his user to find the knowledge, since they do not understand the static and plain content of web pages, which contains rich information. On the other hand, few of them support advanced knowledge management (e.g. data mining), and the structured information is very limited. So nothing happens after registered online. Fig 3 illustrates a personal profile in a typical online Community Of Practice (COP), indicating his basic information and other members (registered in this centralized service) known to him. In addition, they are very difficult to use, and not integrated with any application people use daily.

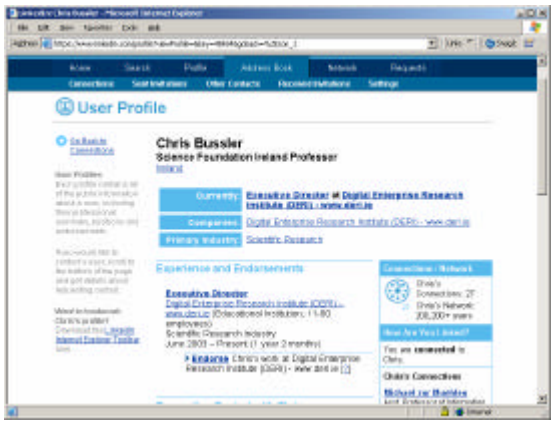

Fig. 3. A web based community (screenshot of www.linkedin.com)

Knowledge workers need more effective and efficient collaboration. In order to support automatic information manipulation by machine, the information must be coded before machine can read and understand (in the way human do). In addition, the information needs to be organized with certain structure and linkage so as to be easily discovered. That is, the connections between information make more sense [6].

2.2 FoaF

The Internet nowadays has changed the way we communicate. Moreover, the recent development of Semantic Web leads to more possibility and capability for machines to understand the encoded knowledge. Moreover, it is a better way of keeping track of the scattered fragments of data currently represented in the Web.

FoaF (rdfweb.org) is an approach for 'create and use machine-readable homepages that describe people, the links between them and the things they create and do' [7]. As a RDF (Resource Description Framework) description, it has advantage in sharing information over distributed network (e.g. the evolving Internet). Similarly Dumbill indicated that information from FoaF could be used in many ways, including 'locate people with interests similar to yours' [8].

Traditionally, yellow pages are used to help locate people. They are centralized services, and are easy to use when provided with index. However, they are very difficult to maintain since all the information must be centralized. FoaF codes the machine-readable personal information in distributed way, and its vocabulary consists of 'name', 'email', etc. so computer can find these information easily through the Internet, without any interference of user.

However, the name or email address of a friend is inadequate for collaboration between knowledge workers.

In other words, there are no further information about the friend's value, goal, current plan etc. Furthermore, the exiting class and property in FoaF vocabulary can not carry the information for collaboration. An important feature of FoaF is that its vocabulary (classes and properties) can be extended according to requirement. For example, some researchers in DERI (www.deri.org) are extending the FoaF vocabulary for a semantic web portal [9], and there is also an effort in defining often changing variables in FoaF [10]. However, little attention has been conducted on FoaF extension for improving the productivity of knowledge workers. Therefore this study proposes a corresponding approach, and an example of FoaF extension is presented in section 3.

3. APPLICATION FRAMEWORK BASED ON EXTENDED FOAF

Based on previous analysis, it is possible to extend FoaF vocabulary and build an application in pursuit of the productivity of knowledge worker community. In this section, the application background and methodological framework are introduced, and some design specifications for personal information management in a community context is also presented.

3.1 Application Background

There are lots of applications dedicated to managing personal knowledge, and most of them are document based. The Iinternet/intranet is also a carrier of knowledge, which became more and more popular due to its convenience. As for the system, it is generally accepted that lifecycle support feature can largely affect the effectiveness. Fig. 4 illustrates one paradigm for individual knowledge management.

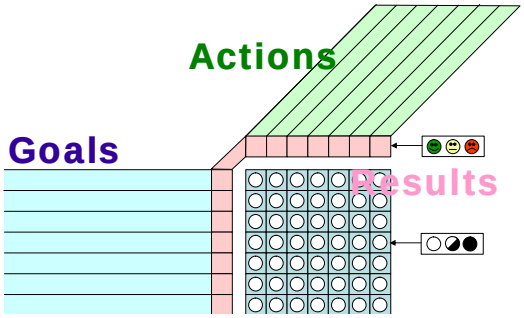

Fig. 4. Personal knowledge management matrix

Each goal, action, and their relationship are measured by qualitative indicators (see the following step 4). Thus, Goals, Actions, and their relations form a 'matrix', which is an excellent channel to monitor in order to achieve individual efficiency and effectiveness. Furthermore, sharing the general description of goals and actions will facilitate knowledge reuse, improve collaboration consequently. There are four steps in utilization of this matrix:

Step 1. Define personal Goals: Identify and populate the most important Goals. Goals are defined as the objectives of effort. They are also known as strategies or visions (e.g.).
Step 2. Define personal Actions: Identify and populate the most important Actions. Actions are defined as expenditure of effort and are also known as projects or tasks (e.g.).
Step 3. Link Goals with Actions: Indicate the strength of the relationship between each action and goal. An empty box indicates no relationship; a half full box indicates a partial relationship; and a full box indicates a strong relationship (i.e. completing the action will have a high impact on attaining that particular goal).
Step 4. Indicate the status of Goals and Actions: Continuously monitor and report the status of goals and actions. In this case, red indicate that urgent attention is required, yellow indicates that more work is needed and green indicates that the goal or action requires no immediate attention.

After finish all the steps, we will get a picture as Fig 5 illustrates.

Fig. 5. Example of personal knowledge management modules

It should be noted that this methodology is based on the concepts which any knowledge workers are sharing. However, in order to be proficient in it, one must practise projecting his ideas into the matrix items. Moreover, if any action does not have relationship with any goal, or if any goal does not have relationship with any action, their necessity needs to be reconsidered. Thus an iterative process is necessary for accuracy.

3.2 Information Exchange Framework

A personal knowledge management paradigm, described in section 3.1, is established by three major objects. However, not every piece of information from them is good for sharing. In fact, information about the 'result' is designed for individual feedback control. Therefore it is necessary to make a distinction between the two kinds of information. In addition, the data format will be likely different since the consumer of them are inhomogeneous. Furthermore, the data will accumulate with time going on, and publish publicly the past data will not make any sense. Fig 6 illustrate a model for information exchange.

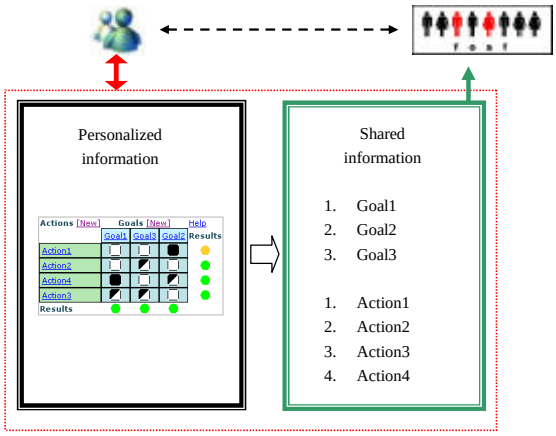

Fig. 6. Information for personal knowledge management and exchange model

From Fig 6, we can see, information is divided into two categories: Personalized information and Shared information:

-*Personalized information*: operated with traditional user interface; can be located in a PC or a repository on a server; and contains all the data, including past data.
-*Shared information*: stored in a web server which is accessible to the public; in standard format (in this case, it is an extended FoaF); and only contains the current published data.

Knowledge workers will change their personalized information occasionally, while shared information, as a subset of Personalized information, will impel collaboration among knowledge workers. In this way, one can find a friend with interesting goal or similar action through extended FoaF. At the mean time, everyone can update their personal information easily with their traditional tools (e.g. Planplus from franklincovey). Fig 7 illustrates this scenario.

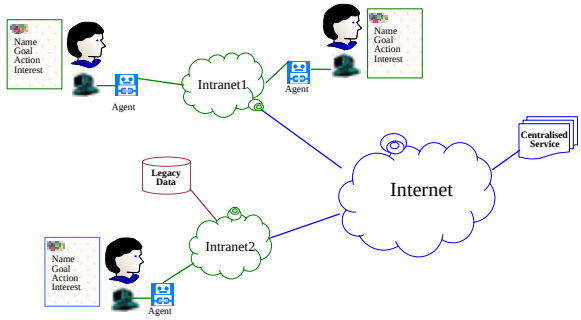

Fig. 7. An framework of networked personal knowledge management system

In this design, data are structured with extended FoaF vocabulary. Thus we can share straightly information based on FoaF files, distributed across web servers. However, the data are stored in plain text with human language, which cannot be directly understood by machines. In order to make machine manage more tasks for users, agents are necessary for interaction on behalf of 'friends'(see Fig7). Therefore, the basic roles of agent should consist of: (1)Publishing- provide information to user's FoaF file; (2)Searching- search in the FoaF files across the web; (3)Reasoning- analysis the language to discover the relationship between different pieces of data; (4)Contact- send and receive message to and from other people.

3.3 Extension of FoaF

The individual information about 'goal' and 'action' is similar to 'interest' and 'plan', which are two developing concept included in FoaF vocabulary. However, the purpose of them are not the same, 'interest' and 'plan' are more about personal life, which could be 'water surfing', 'go to Valencia for vacation' etc. In other words, they are not mission critical, and it is necessary to extend FoaF vocabulary to facilitate collaboration by sharing individual goals and actions(see Fig 8).

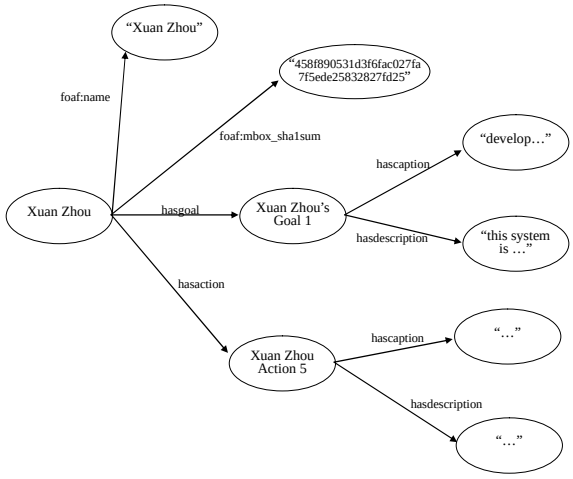

Fig. 8. RDF description of FoaF extension

There are two classes created, i.e. goal and action (in Fig8, they are two instance). They are linked to the person with two properties: 'hasgoal' and 'hasaction'. And each goal has two properties: 'hascaption' and 'hasdescription'. The content of goal or action are strings stored in these two properties. Table1 is an example of vocabulary extension in FoaF.

With extended vocabulary, we can now build the machine-readable FoaF file for collaboration. Table 2 is an example of the content of an extended FoaF file.

In this incomplete example, there are one instance of goal and one instance of action. The content of them are stored in two properties respectively (the description is omitted for concision). This is a first step for knowledge worker to collaborate over Internet. However, more artificial intelligence can be added to the initiative by define the connection between goals, actions. For example, friend1:goal3 is associated with friend8:aciton2. In addition, it is also reasonable to define several relationships for the connection.

Table 1. FoaF vocabulary extension

Class: foaf:Goal
Goal – An objective of this person.
The **foaf:Goal** class represents an objective of a foaf:Agent.

Class: foaf:Action
Action – An objective of this person.
The **foaf:Action** class represents an action of a foaf:Agent.

Property: foaf:hasgoal
define – something which is defined by this person.

Status:	Testing
Domain:	foaf:Person
Range:	foaf:goal

The **foaf:hasgoal** property represents an objective of a foaf:Agent.

Property: foaf:hasaction
define – something which is defined by this person.

Status:	Testing
Domain:	foaf:Person
Range:	foaf:action

The **foaf:hasaction** property represents an objective of a foaf:Agent.

Property: foaf:hascaption
define – something which is defined by this person.

Status:	Testing
Domain:	foaf:goal
Range:	foaf:goal

The **foaf:hasgoal** property represents an objective of a foaf:Agent.

Table 2. Content example of an extended FoaF file

```
<rdf:RDF

xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
         xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
         xmlns:foaf="http://xmlns.com/foaf/0.1/"
<foaf:Person rdf:nodeID=”me”>
<foaf:name>Xuan Zhou </foaf:name>
<foaf:mbox_sha1sum>458f890531d3f6fac027fa7f5ede258328
27fd25</foaf:mbox_sha1sum>
       ……
         <foaf:hasgoal>
<foaf:goal>
<foaf:hasname>p2p knowledge management</foaf:hasname>
<foaf:hasdescription>…</foaf:hasdescription>
</foaf:goal>
         </foaf:hasgoal>
<foaf:hasaction>
<foaf:action>
<foaf:hasname> design the architecture </foaf:hasname>
<foaf:hasdescription>…</foaf:hasdescription>
</foaf:action>
</foaf:hasaciton>
……
</foaf:Person>
</rdf:RDF>
```

4. CONCLUSION

The productivity of knowledge workers are impacted by both technology and social aspects. The approach presented in this paper extended the FoaF vocabulary to support personal knowledge management in a networked environment. Knowledge workers will benefit from a dedicated front-end application for managing their personalized knowledge and an open interface (extended FoaF) for managing their shared knowledge.

It should be noted that this framework is mainly a conceptual and logic design, and can be easily used to setup a centralized service(e.g. within a corporation) or improve it. However, to implement it in totally distributed way(e.g. internet) is another pair of shoes, because several underground technologies are still in their developing phase. In addition, trust relationships between knowledge workers are another practical issue needs further discussion.

Notwithstanding its limitation, this study does suggest a framework, which provides a channel for knowledge workers to collaborate more productively over the Internet. It can improve the productivity of researchers in public section (e.g. universities) immediately after implemented and further research and development will make it more practical and effective.

ACKNOWLEDGEMENT

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