The Architecture of Worknets

Matts Ahlsén
Peter Rosengren

Swedish Institute for Systems Development
Electrum 212, KISTA
Sweden

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Abstract

A current trend is to exploit information technology in support for virtual organisations. The research and practice focus on the development and evaluation of information and communication technologies intended to manage the business processes in such organisations, i.e., organisations characterised by distribution and ability to change. In this article we discuss the "worknet" as one type of information system that can support the activities in such a virtual organisation. A worknet connects a number of participants for a limited amount of time in order to achieve some common objective, e.g., to establish a consortium or to form a coalition for some business objective.

1. Introduction

Background

The application of information technology to support networked organisations are currently receiving much attention among users and by the IT-industry. A major issue is to provide organisational flexibility, e.g., in terms of adaptability to changing requirements on business from the environment, and also to provide workers with technology for cooperation.

This development is facilitated by the increasing connectivity made possible by new products and services in information and communication technology, and by research in CSCW and in cooperative and interoperable information systems. Other areas important to this development include computer-

supported work flow and business process management, new applications of Electronic Data Interchange (Edi), high speed networks and mobile (wireless) computing.

A number of issues are raised as a consequence of this development, including social, political and organisational aspects of cooperative work, as well as issues related to business process management and emerging technologies. The latter issues include different models for cooperation through coordination of business processes and information sharing. Aspects of business process coordination include the definition of roles, organisational autonomy, principles of electronic trading and information exchange.

In this article we discuss the "worknet" as one type of information system that can support the activities of groups using IT-based networks.

Information Systems Architecture

The purpose of this article is to discuss worknets from the perspective of requirements on their information systems architecture. This implies the definition of those components and information systems concepts that constitute a worknet architecture, and which are needed to run worknet applications. Interoperability and distribution are dominant characteristics of such applications, characteristics common to distributed systems in general.

Information systems architecture can in general be understood as the structure and inter-relationships of information systems, as well as their relation to the organisation and business context they support. An information system is here understood intuitively as some coherent set of computer-supported business functions, serving a set of human users. A primary purpose of an architecture is to provide the frame and terminology for a more precise meaning of information systems. The architecture includes a set of principles and a set of models that reflect these principles in terms of information systems constructs (or artefacts). An important aspect is to relate the architecture to the supporting technology.

We characterise a worknet architecture as the form, function and structure of the information technology based services and the information systems constructs, used to inter-connect a number of participants for some cooperative application.

2. Worknets

Networking

The term net*work*ing has been coined by researchers in CSCW field [Clement and Wagner 1994] and refers to the phenomenon of linking people and organisations using information technology. As networking is made possible through commonly available IT and involves multiple organisations, it will have fundamental implications on how organisations perform and specifically how people work.

The interest in networking can also be related to the changing perspective on information systems, where the communicative nature of information systems are in focus, as opposed to a perspective focusing information management and storage.

The worknet is a type of "information system" whose primary purpose is to coordinate the activities of a group of people cooperating to perform some common task based on some common objective. A worknet is based on an information systems architecture that supports networking. A worknet is distinguished from other types of systems supporting group interaction, by its focus on coordination and by its goal orientation.

Supporting Business Processes by Worknets

The contemporary view of many business activities is that of a process implementing a value chain with a primary goal of satisfying a customer (or curing a patient). A number of methods and technologies support this view, such as business process modelling and workflow management [Schäl and Zeller 1993].

This view is a result of a successive development from functionally oriented to process based organisations, where the processes may extend beyond the context of the local organisation. This has consequences for how the supporting information systems architecture should be designed, e.g., in order provide inter-organisational information systems. Typically the users involved in these processes will assume different roles, depending on the step of process. This aspect is supported by some of the current standardisation efforts such as Open Edi [Ahlsén et al. 1994].

The worknet approach to process is to support business activity in terms of a set of interfaces between groups, functions or units [Robinson 1993], rather than as a predetermined set of steps. The business activities supported by worknets can then be seen as more project oriented than process oriented. Some

approaches to workflow management are similar to a worknet, e.g., speech-act based.

Users and Applications

Networks are often characterised as loosely coupled, referring to the degree of autonomy that participants may have. Different forms of networks include [Wagner 1994] work groups, which are often task centred and stable; coalitions, which are short term alliances designed to pursue some specific objective; and cliques which can be seen as a form of ad hoc group.

Worknets may typically support coalitions, such as a team of users organised as a project. This does not imply any specific size or scope of the project or its domain. The users in a worknet will have different capabilities and obligations defined by a set of roles specific to an application.

Examples of applications based on a worknet architecture include: the formation a consortium for procurement, the marketing of a product, the establishing an emergency management team. Common characteristics of these applications are their rapid deployment, limited time of operation and goal direction. Possibly, some worknet applications will only be "executed once", as opposed to process oriented applications. In addition, worknet applications are distributed and possibly inter-organisational, with a high degree of autonomy for the involved participants.

3. Worknet Architecture Elements

Architecture principle

The Worknet is based on a federated information systems architecture. In general, federated information systems [Johannesson 1993] is a generalisation of federated databases [Sheth and Larson 1990]. Federated architectures can be specialised into functional and organisational architectures. The basis of these architectures is to view information systems as a set of loosely coupled interoperating subsystems that can be associated to organisational or functional units in some business context. An inter-organisational architecture is a special case of a federated architecture describing information systems spanning several separate organisations, implying a high degree of autonomy and possibly the use of public open standards. Open-Edi is an example of a inter-organisational architecture.

In the general case, a federation would consist of a network of nodes. A node is a general abstraction, representing an autonomous decision making entity, typically it could correspond to an information system, an application or perhaps a user. Nodes are inter-connected, based on communication channels and well-defined interfaces. The federated architecture strives to minimise global controls and constraints as far as possible.

Modelling Worknet Users

In the worknet architecture the nodes are represented by actors. Actors could be people, i.e., real "intelligent agents", business functions, or perhaps an organisation. Flexibility achieved by allowing actors to assume different roles in the worknet.

Roles represent functionality as well as the different types of relationships that may hold among actors. Two categories of relationships may exist [Blyth et al. 1993], structural relations implying commitments, obligations between actors, e.g., a consumer-supplier relationship, and, functional relations describing different services requested or performed by actors, e.g., provision of supplier information.

These relationships provide a means for grouping the services that roles may provide or request. The association of actors to roles also provides a means for defining authorisation.

Communication and Coordination

Actors communicate on the basis of the relationships that may exist between the set of roles in the worknet. These are represented in a role relationship model, which describes the set of roles and any constraints imposed on the usage of the roles. Only those properties visible to other roles are described in this model, procedural aspects and state descriptions are considered internal to a role.

The role constraints refer to the instantiation of roles and to the binding of actors to roles. The number of active instances of roles may for example be restricted, and actors may perhaps not be allowed to act in several different roles simultaneously.

In order to compensate for the lack of global controls, sharing is coordinated by explicit agreements, represented by contracts. The contract has the dual purpose of acting as a documentation of an agreement and as an authorisation mechanism.

The contract includes terms for the different forms of information exchange provided in the worknet. Contracts have similarities with the so called interchange agreements for Edi .

Information Management in the Worknet

Following the federated architecture principles there is no concept of a (global) database in the worknet architecture, information is only available through the services accessible by the roles.

Flexible and reliable information exchange become critical in the light of autonomy. The worknet architecture provides two forms this exchange, message based exchange and direct (remote) service access. The former is characterised by asynchronicity, low volume and low response times, the latter by the opposite. The choice of which depend on requirements on actuality and performance. They also imply different degrees of coupling with respect to the dependencies between roles.

Although the worknet architecture tries to minimise global structures and controls, there still have to be some generic and global components, e.g., in order to maintain knowledge about the worknet and its actors, and to provide objects/services from which common interfaces can be defined. Two such components are the Federal Map and the Common Concepts Base. The former can be seen as a directory service (cf X500), and the latter is catalogue service which can be used to define concepts or objects considered to be global. One or more selected roles are required to assume responsibility for these global services in a worknet.

Technology platform

The current development of mobile (wireless) computing, can provide a possible technological framework for applications of the worknet architecture. A number of technical issues still remain to be solved concerning mobility including mobile data management, directory services and scaling [Imielinski and Badrinath 1994]. A number of product and services are however available today that can be used in a worknet architecture. Below we discuss three such technologies that may support a worknet architecture.

Of special interest is the development in video conferencing technology. Previously video conferencing was based on analogue techniques requiring specialised expensive equipment. These restrictions limited the market penetration for video conferencing for a number of years. Now a new generation desktop video conferencing products are quickly emerging [Jeffcoate et al. 1993]. This new generation of products run on ordinary

personal computers and use digital communication to transmit video, either through LANs or ISDN (Integrated Subscriber Digital Network). Not only do these new products offer video communication between two PC-users, but they also offer data and application sharing. The latter provides a way to implement the services in a worknet.

Thus, two users are able to connect to each other through their desktop PCs and see and talk to each other through a video windows on their screen. They can also share and simultaneously edit for example a text document or spread sheet. Examples of such new desktop video conferencing products are Intel Proshare, AT&Vistium and PictureTel Live PCS 1000. Desktop video conferencing is likely to be one cornerstone in most worknet applications.

The limitation in currently available technology are the lack of support for group conferencing between many different sites. Today this can be solved with special gateway products/services, however this is still expensive and the technology is not easily accessible.

Another emerging technology area of interest is hand-held mobile computers. These are often referred to as personal digital assistants or personal communicators. These are hand-held devices with a pen-based user interface that allows its user to input commands and notes with a pen. The first generation PDAs suffered from problems with text recognition. This caused bad reviews in the press and many analysts considered the technology as dead. Now new hand recognition software seems to have overcome many of the problems. An assistant or communicator becomes an interesting tool when equipped with wireless communication. This will allow its user to send and receive fax, email, data etc. when not in the office. Examples of products are Sony Magic Link, Apple MessagePad, Motorola Envoy among many others.

A third emerging technology that might used in a worknet architecture is intelligent agents. This research field is now rapidly being commercialised. As an example AT&T offers an agent-based service called Personal Link Services which consist of a set of agent-based services. The agents are able of sorting and filtering incoming email and fax messages and scheduling meetings between a group of users. Personal Link Services have been build around the new operating system Magic Cap for agent-based applications. This means that the services can be accessed by devices running Magic Cap, for instance the above mentioned personal communicators Envoy and Magic Link.

4. Practical Considerations and Research Issues

The three technologies mentioned above - desktop videoconferencing, mobile computing and agent-based services - show that it today exist commercially available technology that might form the platform of a worknet architecture. In addition to the networking capabilities offered by the Internet such as the

World Wide Web, several architectures for building inter organisational applications are also emerging, such as Network Notes offered by AT&T and several BBS-products like First Class.

As an example of a worknet application supported by Internet services it is worth mentioning that the authors recently participated in the creation of a large project proposal. This was done entirely through World Wide Web since the participants belonged to different research organisations distributed all over Sweden. The proposal work was divided in a hierarchical fashion. At one central site the home page of the proposal was located with links to other sites' WWW-servers. The communication within the work group was done entirely through email while the actual proposal was organised in World Wide Web. This made it possible for the participants to work independently of each other avoid meetings and cumbersome document integration problems.

This application had most of the characteristics of a worknet application:

- the work group was established for a short period of time with a common goal to be achieved.

- the work group was inter-organisational.

- there was no central database, data was stored and managed locally. In a sense, the proposal existed only in the worknet and in fact the reviewers evaluated it through World Wide Web.

- the work group would have been unable to fulfil their goals without support of information and communication technology.

This experience has lead us to believe that there exists many opportunities to experiment with worknet applications in order to evaluate different worknet concepts, some of which have been mentioned in the paper.

Some of the research issues that need to be investigated are:

- balancing the autonomy of participants and global controls

- coordination of roles including commitments and authority

- service definition and sharing

- inter-organisational aspects of worknets

We expect that a part of the future work will include case studies where a simple worknet prototype will set up.

5. Conclusion

The worknet architecture can be seen as an environment for experimentation with information technology that supports group work and inter-organisational applications, i.e., technology for net*work*ing. As such it will also provide a framework for studying some of the wide range of research issues currently addressed in the areas of CSCW and inter-organisational information systems, such as role-based interactions and coordination of business activity across organisations. A starting point is to study worknets from a users perspective, including the investigation of how existing technology and products can be combined into worknet applications.

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