MOVING THE 'DESKTOP' INTO THE FIELD

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Introduction. The electricity industry, as other utilities, is concerned with the management of large scale distribution networks. These networks have been developing for more than a century and the methods for operating them have changed over this time. For almost fifty years mobile communications have played an increasingly important role in the co-ordination of activities in the field. In more recent years, the industry has exploited IT with the result that a significant amount of mixed-media information is now held in computerised form. This information is available to office workers on their desktop. However, it is believed that substantial benefits could be accrued by making this information available to those workers who operate in the field, i.e. by moving the desktop into the field. This paper reports on the initial findings of the DTI/SERC supported MOST project [Davies,93a] which aims to produce a pilot system to demonstrate how mixed-media information can be exploited in the field using mobile computers and wide-area radio communications as enabling technologies.

Requirements and Implications. The MOST project is focusing on the IT requirements of field engineers within the power distribution industry. Although engineers typically operate either as individuals or as collaborating groups while in the field, they are traditionally co-ordinated by a single control centre. For example, the control centre co-ordinates and approves all switching of the power distribution network and maintains an overall picture of the current state of the network. The benefit of this approach is that the control centre is able to ensure that conflicting switching requirements of different engineers are resolved safely. The disadvantage of this approach is that the control centre becomes a bottleneck, a problem which is accentuated when bad weather damages the network and the number of people working on the system increases..

The bottleneck is caused in part by the fact that an up-to-date representation of the network state exists only at a single central point (the control centre). More generally, power distribution companies tend to hold information solely at central information repositories. Providing access to the network diagram and other computer based information to all who need it, including those in the field, would help to enable more effective ways of working. Much of the information required in the field changes infrequently and there are a number of pilot schemes being proposed which would provide field engineers with mobile computers and CD-ROMs containing, for example, map based data. This could lead to significant improvements in efficiency by, for example, reducing the number of times a field engineer must return to the information repository during a given period. However, a significant percentage of the information required by field engineers does change frequently, e.g. the state of the network. To cater for this type of information a communications link must be provided between the field engineers mobile computer and the information repository. Such a system would allow field engineers to access the current state of the network and to update the state to reflect any operations they carry out in the field. This would reduce the engineers' dependency on information provided by the control centre.

It should be noted, however, that providing engineers with access to up-to-date information in the field would not be sufficient to remove the bottleneck caused by the control centre. This is because (as mentioned earlier) the primary role of the control centre is as a co-ordinator between engineers to ensure that conflicting switching requirements are resolved safely. In order to address this issue it is necessary to provide an environment which supports the essential interaction between engineers (such support would require the integration of a number of media types including voice, image and text). Hence, to remove the bottleneck created at the control centre engineers require access to up-to-date

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information regarding, for example, the network state *and* support for a high-degree of collaboration while working in the field.

Approach. The approach we are adopting to address the issues highlighted above is to provide field engineers with generalised support for accessing multiple information sources including, but not limited to, the current network state. In particular, we hope to support access to a number of databases used by engineers on a regular basis. Examples of these include databases containing details of distribution plant, job records and stock and costing information. Furthermore, we aim to provide access to geographical data such as the location of switches within the network.

In order to integrate access to a variety of information sources the project has adopted the emerging ISO standard for Open Distributed Processing (ODP) [ISO,92]. This defines a basic model of interaction between entities (or *services*) which can be used both for access to a variety of applications, irrespective of their supporting hardware and location, and for communication between collaborating users. However, while the ODP standard has been designed to abstract over network issues, wide-area radio communications have a number of characteristics which impinge on the model and applications implemented using the model. For example, applications must be able to tolerate extremely low-bandwidth communications channels and periods of total disconnection; factors which the current model attempts to hide from the application layers. To support applications operating in this environment, we propose a number of extensions to the ODP model which allow applications to monitor and respond to changes in the quality-of-service (QoS) provided by their underlying communications infrastructures. This revised version of the ODP model forms part of the MOST project architecture as shown in figure 1.

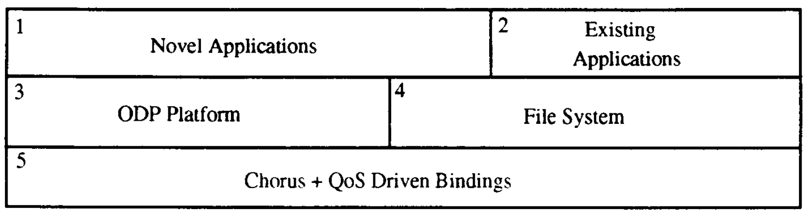

Figure 1 : The MOST Architecture

The architecture is supported [5] by a version of the Chorus distributed operating system [Rozier,90] which has been extended to provide QoS driven bindings for inter-process communications. A related project at Lancaster is currently investigating this issue with the aim of supporting real-time continuous media processing [Coulson,93]. The QoS parameters which have thus far been identified within this project are throughput (the average number of bits that may be transferred in a given period), latency (the time the receiver must wait for the first bits of information) and jitter (the variation in delay between packets of information). The MOST project is building on these results with the addition of new QoS parameters to reflect the impact of mobility. In particular, the project has proposed QoS parameters which can be used to express the notion of degree of connectivity [Davies,93b].

The extended version of Chorus is being used to implement both an ODP compatible distributed systems platform [3] and a distributed file system [4]. In the former case the QoS bindings will be made visible to application programmers who will be able to specify the desired QoS of a given communications channel and be notified if this QoS cannot be provided. In the latter case (the distributed file system) the QoS driven bindings will be used in the implementation of the file system. In particular, it is anticipated that the file system will make use of changes in throughput, latency and degree of connectivity to determine its caching and cache consistency strategies. The distributed file system will be used to support both mobile aware, ODP based applications [1] and conventional applications [2] for which mobility must be made as transparent as possible.

Pilot Study. In order to evaluate the suitability of our approach we will be conducting a number of pilot studies in conjunction with a U.K. regional electricity company. For the purposes of these studies, field engineers will be provided with a portable 486 PC equipped with an internal CD-ROM drive and radio and conventional communication facilities. The PCs will run a variety of operating systems including our extended version of Chorus on those units supporting applications which require QoS monitoring and control facilities. To mask the heterogeneity of the environment APM's

ANSAware distributed systems platform will be used. This provides a partial implementation of the ODP platform described above.

Currently, we are developing a number of ANSAware services in a desktop based environment but we anticipate moving to a fully mobile configuration in the near future. The services under development include:-

The Base Services. These provide support for manipulating continuous media information (e.g. audio data) in a heterogeneous environment [Coulson,92].

GIS Services. Engineers require access to large amounts of geographical data. To support this requirement we have implemented a number of ANSAware services which provide support for the display and manipulation of geographical data. These services are based on the public domain GRASS GIS [Westervelt,91].

The initial pilot study will provide collaborative access to geographical data. For example, engineers will have the facility to display and highlight map data on both their own and a remote engineer's PC. Clearly, providing these facilities over low-bandwidth communications links relies on minimising the quantity of information which must be transmitted and hence generic tools such as XTV [Abdel-Wahab,91] which transmit large quantities of windowing-system specific data are unacceptable. Instead, we transmit only a small number of co-ordinates when the engineer actually highlights a map section. In addition, all co-ordinates are specified as standard world (NorthEasting) co-ordinates. This enables us to ensure consistency even when engineers are viewing maps at different resolutions or using different implementation of our geographical services.

Concluding Remarks. Power distribution companies seek to provide a high degree of reliability in their networks while operating them as efficiently as possible. In this paper we have provided a number of examples of how the efficiency of a power-distribution company could be improved by 'moving the desktop into the field'. In particular, we have argued that gains in efficiency arising from the deployment of mobile computing technology can be increased if collaborative applications are supported. An architecture to support such applications has been presented. The architecture is based around the ISO ODP model in order to address the problems of heterogeneity which are an inevitable consequence of mobility. A number of services which conform to this model and which have been specifically designed to operate in a mobile environment have been described. These services will be deployed in a pilot study in the near future which will provide field engineers with collaborative access to geographical data. It is anticipated that through this study we will gain an insight into the precise impact of mobile computing on the working practices of power distribution companies.

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