

# A SOFTWARE PLATFORM FOR THE INTEGRATION OF A MOBILE CLIENT TO INTRANET SERVICES

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## ABSTRACT

The paper examines how to enable mobile clients to exploit intranet information services. The paper starts by examining problems mobile workers currently have with using online internet services across a mobile data link. These problems are addressed in the definition of a software platform to address these problems and provide an infrastructure to allow enable mobile access to an intranet. Implementation considerations briefly examines issues related to how best to implement the platform functionality. Conclusions are drawn concerning the problems mobile workers face and how these can be addressed.

## INTRODUCTION

The unexpected growth in the use of Internet software technologies, in particular the World Wide Web (WWW) has provided client/server computing with standard protocols for both network (TCP / IP, HTTP) and information presentation (HTML). This in turn has caused great growth in the use of Internet technologies for corporate information systems, Intranets. The concept of corporate intranets has been applied to everything from news boards to integrated groupware applications; all built on top of internet protocols and using internet tools on an existing LAN or WAN infrastructure. The other common aspect of all intranet applications is that they exist to communicate information - the corporate intranet exists to provide fulfil the information requirements of the organisation and the organisation's employees (Flohr 1997).

However, the intranet's strength, in that it exists on top of existing Internet protocols, can also cause problems when looking at applications outside of the traditional client/server environment - namely in the mobile domain. Mobility in the workplace is also currently an area of great growth, driven by both the increased power and availability of mobile hardware and changes in business climate driven by greater pressure to be competitive. Mobility in the workforce provides organisations with the means to develop more flexible working practices,

which is beneficial to both the organisation and the worker.

Recently, there has been a growing backlash against mobile working, with studies highlighting problems, both culturally (Flohr (1997)) and in terms of providing information resources (Becker et al. 1995). Both focus on the issue that rather than benefit the worker, mobile work environments lead to greater worker dissatisfaction due to:

- reduced interaction with the rest of the company / workforce, leading to feelings of dissatisfaction / isolation from the "corporate culture";
- spending more time working than those in the "traditional" workplace, negating the benefits of mobile work;
- having reduced access to information within the company, again leading to feelings of isolation from the company.

If groupware, and more specifically intranet, information services can aid in workflow management and information dissemination throughout the company, surely intranets can provide an effective platform for addressing some of the problems of the mobile worker. Theoretically, it is the ideal environment in which to communicate information to the worker and also provide the worker with a virtual environment which provides them with corporate identity. However, the technical problems with mobile data communication make mobile information services on Internet protocols at best unsatisfactory and, at worst, impossible. The main issue to address is that of the restricted bandwidth provided by a mobile data communications link. This bandwidth causes any data communication between client and server to be extremely slow compared to a fixed communication link. If we consider the volume of traffic with the transmission of text content (even a simple email message can be 3 or 4kbytes), transmission across a standard GSM data link (9.6 kbps) can be slow. If we add multimedia content (as one would find in a WWW page) to the equation then data communication can become infeasible (the difference in size between a text

based web page and one with a couple of images can be huge).

The work discussed in this paper is part of ongoing work at the Network Research Group, University of Plymouth, addressing the problems in integrating mobility into a intranet infrastructure. The paper focuses on two aspects of the “mobile intranet”:

1. The requirements of the mobile worker, both in general and also focusing on a specific user group.
2. How these requirements can be met within the current intranet infrastructure, addressing ongoing work in the analysis, design and development of a software platform which provides the transparent integration of fixed and mobile client access to intranet information services. While the software platform is intended to be generic enough to be used for all manner of clients, the work focuses on requirements identified from the given user group.

The first part of the paper focuses on mobile workers, their role in the workforce and how their requirements differ to those of users of the “traditional” intranet. The target user group is defined, along with the requirements identified through interview and discussion with representative users.

The remainder of the paper focuses on the software platform, from software definition based on user requirements, software architectural definition, both high level definition and individual tier and component specification, and implementation considerations which need to be addressed before implementation. Conclusions are drawn from analysis of the requirements and the proposed implementation.

## **ANALYSIS OF CLIENT REQUIREMENTS**

### **Definition of the target user**

The global group in which the target user resides is that of mobile workers - business users who do not have a single fixed location for work. Obviously, there are numerous sub categories that fall beneath the umbrella term “mobile worker” - salesmen, consultants, managers, etc. In order that the software platform can be implemented for a sample client, it is necessary to identify a user group which can provide specific information requirements that can be realised with the software platform.

The focus for the intended software product is that of the high level manager / executive. Generally users in this group spend a great deal of time out of the traditional office environment, while still having a high level requirement for both personal and company

information. Therefore, there is a great reliance on both portable computing and mobile communication, for both online and off-line work.

### **Requirement identification**

Consultation with members of the user group has provided a clear picture of existing practices with mobile applications, the restrictions and problems faced in mobile working, and also further requirements for an “ideal” mobile information resource.

The dominant working practice among users was to use mobile technology for off-line work - standard office applications such as word processing. Online work exists mainly in the use of email, with perhaps some web browsing if any specific information is particularly required. The main reason for the not doing as much online work as some would have liked is no surprise - online mobile work takes too long.

The issue of reliability of mobile communication can also cause problems, particularly when coupled with the speed of communication. A loss of coverage, which results therefore in loss of data, is common when dealing with anything other than very small data transmissions.

Also, due to the fact that information communication needs to be across a low bandwidth data link, it can take a long time to transmit the information. The longer the data call is open, the more costly the use of the technology is for the user; once again the user is discouraged from using the information services as much as they would like.

Another major criticism with current software, is the difference in user interface between one information service and another. If the user is hampered by problems with mobile online work, as discussed above, they do not want these problems compounded by software that is complex to set up and use.

The general impression that can be drawn from the analysis of current work practices was that central difficulty with current mobile online work is that it provides more problems than benefits, the user feels obliged to use the technologies rather than wanting to. It also means that even though there may be as many information tools and resources available to the mobile worker as there are for the fixed worker, they will not use all of the tools that are available - they are too problematic to use. This can, in turn, lead to even greater mobile worker dissatisfaction.

### **Requirement realisation**

The research into mobile worker dissatisfaction identifies a number of problem areas with working in the mobile environment. These form the foundation for the development of a generic software platform which should provide solutions to the problems identified above. The platform should ultimately allow the mobile worker to exploit intranet technologies in the same way as a user of a fixed network.

The overall aims of the platform are:

- to provide a software infrastructure that will fulfil the users' requirements for personalised, up-to-date information, without the usual problems of mobile online work - an increase in data communication speed is extremely advantageous, without sacrificing information presentation on the client side (i.e. something other than text would be nice);
  - to provide a platform which deals with reliability problems with the mobile link - incomplete communication should not be processed, and the user should be informed of any problems that occurred. In the event that the user loses coverage and cannot reconnect immediately - the user should be informed of any errors in communication when they next logon;
  - to provide a sample mobile client software application, which integrates information services provided by the platform (email, scheduler, workflow management, etc.) with a simple, clear interface. The mobile client should also deal with the connectivity of a data call, so all aspects of the mobility are encapsulated into one integrated application;
  - to implement information requirements to match the users' own personal preferences - the platform should have an awareness of the user as an entity;
  - to implement the platform with standard intranet technologies so that the platform is not exclusively for mobile use - and can therefore be integrated with existing intranet resources.
- An integrated, intelligent client that exploits the processing power of modern notebook computing by moving some of the processing away from the server side and allowing server to transmit both structured and unstructured data in simple form, which the client understands, processes and displays as multimedia content.
  - A user proxying tier, which provides the user with an intelligent "agent" on the fixed side, which exploits the greater speed and reliability of the fixed network and play a role in decision making of client / server interaction in order that communication across the mobile link is kept to a minimum. By isolating all of the mobility functionality into two tiers, independent from the information processing and data aspects of the platform, fixed clients can be integrated into the platform without having to use any of the mobility functionality.
  - A user profile database which stores structured information about a given user so components on the fixed domain can determine custom information requirements based on common information coming from the server backend.
  - Intelligent transaction and information processing components that tailor the standard roles of transaction and information server in the intranet infrastructure to the additional requirements of the mobile intranet platform.

## DEFINITION OF THE SOFTWARE ARCHITECTURE

The following details the design of a software platform to realise the requirements discussed above. The platform bridges fixed and mobile domains, combining existing intranet technologies with custom components to address the problems discussed in section 2. It is envisaged that the software platform will extend the three tier model to include a communications / user proxying tier between the top and middle tiers. The following details major aspects of the software platform - they are placed in context of the overall software architecture in the following section:



Figure 1 provides a graphical illustration of the software architectural specification. Following an overview of the software architecture, this section details each aspect of the architecture.

### Components of the Software Platform

#### 1. Client / User Services Tier

The top layer of a traditional three tier application, the client tier resides entirely in the mobile domain.

##### 1a. Client Configuration

It is intended that the client software will reside on a notebook P.C. with a mobile phone and GSM data card used for the communication.

The client software consists of a container application that provides a common interface to the user and a container for all of the top level service components. The client should be as lightweight as possible in terms of local storage requirements, etc. while at the same time exploiting the processing power of a modern notebook computer.

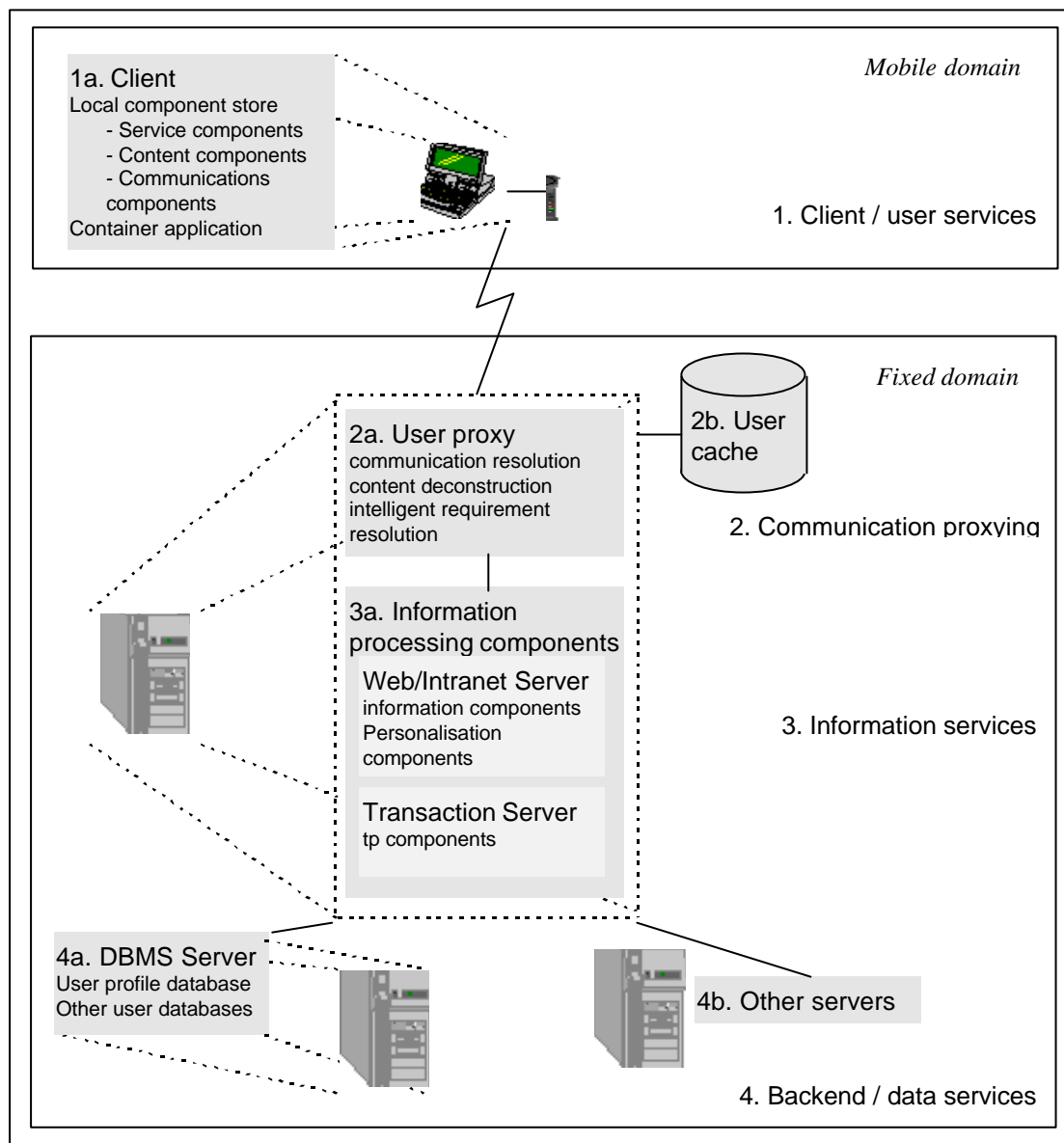


Figure 1 - Software Architecture

Three types of component will make up the client software:

- service components that provide the high level interface to a required information service (HTML container, email client, etc.);
- content components which reconstruct stripped-down content transmitted from the server side into the required format on the client side. See below, in aspect 2, for further discussion on client side content construction;
- communications components which understand the communications protocols used in the transmission of information and inter - client communication across the mobile link. Third party components can be exploited to integrate standard Internet protocols, with additional functionality developed to deal with any communications protocols that need to be developed to streamline mobile communication.

## 2. Communication Proxying Tier

The communication proxying tier provides two main functions in the architecture:

- user proxying: A user proxy allows a manifestation of the user to reside outside of the mobile domain, able to exploit the additional bandwidth of the fixed domain. The user proxy is discussed in further detail below;
- transparent integration: Discussion above has raised the issue of using the platform for both mobile and fixed clients. The communications proxying layer allows this by encapsulating all of the mobility aspects of the application into this tier. Therefore, a fixed client could use the business and data service tiers of the application without any modification.

### 2a. User proxy

The user proxy consists of a number of components providing various functions on behalf of the user in the fixed domain:

- Communication resolution: It is expected that inter-component communication and information transmission across the mobile link will be carried out using custom application level protocol. The role of the communication resolution component is to convert the custom protocol requirements into messages that the rest of the architecture can understand.
- Content streamlining: The above has already mentioned content construction components on the client side, the content conversion aspects of the user proxy provide the complementary server side functionality. Content streamlining in the user proxy tier takes data from the information services tier and streamlines it (for example, stripping out header information for an email) in order to make data communication over the mobile link as minimal as possible. It is anticipated that meta information will also need to be sent, but this can be specified in a lightweight mark-up set that is understandable to the content construction components on the client side. Once the streamlined data and meta data are received by the client content construction components can convert the simple data into effective content. Note that although the content meta information is not a standard intranet protocol, its isolation into non standard tiers of the platform means that fixed clients would completely bypass this functionality - taking content directly from the information services tier.
- Requirement resolution: In order to keep communication over the mobile link to a minimum, intermediate communication between components should be kept to a minimum. Therefore, it is the role of the requirement resolution component to determine whether the client components, or the user, need to deal with a communication, or whether the component can resolve the communication. To take a simple example, if the user wished to check whether they had new email, there are a number of negotiations between mail client and server. If this was to happen on a mobile client, the amount of data traffic is large for such a small link. Therefore, all that the mobile client mail component transmits to the user proxy is the *intention* to check whether there is new mail. The requirement resolution component then acts as the mail client for the communications between client and server before telling the actual client whether or not they do have new mail.

### 2b. User Cache

As the user has a proxy within the intranet, it is also required that the user has an account on the system. Therefore, the user will also be allocated storage space on the server. This can be used by the proxying tier as local storage for both transient and persistent data applicable to the user. This reduces the storage requirement on the client side.

### 3. Information Services Layer Tier

The middle tier of the traditional three tier model, it provides the custom logic for this specific application. The information services tier is essentially divided onto two servers - an intranet server and a transaction server.

#### 3a. Information Processing Components

These components will interact to bridge the user requirements and the data backend to convert user requirements into, for example, database queries and to construct the returned data views into understandable content. Information processing components are divided into two distinct areas. Firstly, information personalisation components and transaction processing components. Information personalisation components provide the extra functionality required to achieve further personalisation of information to be communicated to the client. For example, a mail filtering component that can access an email filter from the user profile database and filter out any non-essential mail - leaving it on the server until a time when the user is using a fixed, more reliable (and cheaper) line.

The transaction processing components can exploit the power of transaction processing to address the reliability problems of the mobile link. While from the users' viewpoint transactions (to use a simple example, the transmission of an email message from mobile client to server) take place from mobile client to the respective server in the data backend. However, in reality a lot of transactions would take place between the proxying tier and the data backend. Therefore we can reduce the risk of lost information across the mobile link in two ways. Firstly, through performing transactions entirely on the fixed side of the platform, and secondly, by providing custom components within the transaction server which can communicate with the proxy components to deal with any failed transactions.

### 4. Backend / Data Services Tier

The lower tier of the architecture is comprised of all of the information services that serve the business and client requirements.

#### 4a. DBMS Server

Holds the databases used by the application to fulfil the user requirements. At the very least a database infrastructure will manage user profile and personalisation requirements.

#### 4b. Other Servers

At this stage undefined, it is possible that the user requirements will highlight the need for other information services not provided by DBMS. At the very least a mail server is required within the software platform.

## IMPLEMENTATION ISSUES

The previous section has referred to a lot of the functionality as being encapsulated into “components”. While that discussion uses the term component in its general sense, it seems sensible to take a software component based approach (Chappell 1997) (implementing new functionality in components on top of a distributed component architecture). At the present time this presents us with two viable options, a Java based approach (using CORBA (Orfali et al. 1996) or Java Remote Method Invocation for distribution) or the Microsoft Distributed Network Architecture (DNA) (Edstrom 1997). The Microsoft DNA has been chosen as it provides a stronger, more mature platform than Sun’s Java platform (Tribble 1997). Using components on top of Windows DNA provides an implementation approach which will:

- ease platform implementation on top of an architecture which already understands the standard internet protocols. Therefore, the software platform can expose its services to any client that uses standard Intranet tools;
- allow for a componentised client, meaning the interface can be implemented mainly in a container application, with components switched depending on information service being currently used;
- allow for component implementation in the most suitable language for the functionality of each component;
- provide database connectivity with higher level APIs (ADO, RDO (Microsoft 1997)) than ODBC/JDBC;
- provide the underlying mechanisms for component persistence, which is especially required in implementing the client proxy components; components that need to “remember” aspects of user behaviour;
- provide standard intranet tools (web server, transaction server) which also understand the underlying component architecture and are fully customisable with new components.

However, even with such a platform, the following still need to be addressed:

- *Component interaction across the mobile link.* Tests need to be carried out to see the

effectiveness of DCOM across a mobile link. In the event of DCOM interactions being too slow, a bespoke interaction approach will need to be defined.

- *Data communication across the mobile link.* In order that the client can reconstruct information into effective content, both data and meta-data need to be communicated, but with as low an overhead as possible. Investigations are currently underway for the effectiveness of XML (W3C 1997) for this purpose.

## CONCLUSIONS

The current environment for mobile, online work is at best highly restrictive and at worst unusable. Mobile users are hampered by the speed and cost of mobile communications technology, and the problems of different software packages for different information needs. Rather than resolve some of the cultural problems of mobile working, the current technologies can add to them.

This paper has proposed a software platform based on an intranet infrastructure, which addresses the problems of both information personalisation and the problems of using mobile communication. Central to this platform is the use of an intelligent client / proxy tier pairing. Having complementary components on either side of the mobile link allows for communication load and communication time to be kept to an absolute minimum. Further communication security is ensured through the customisation of transaction processing services; additional components can communicate with components in the proxy tier to inform of the success or failure of an information transaction. Components in the proxy tier can either decide to deal with the problem, or communicate back to the mobile client.

The intended implementation approach of a component architecture, with additional functionality being implemented on top of standard intranet applications (web server, transaction server, etc.) aids in the portability and adaptability of the platform. Should further issues / requirements arise, these can be added to the existing infrastructure, without having to redesign the entire system.

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## **BIOGRAPHY**

Andy Phippen is a researcher in the Network Research Group, University of Plymouth having graduated from the University with a first class honours degree in Computing and Informatics. He is currently doing research for a PhD in software component architectures and their impact on software development in the enterprise. He is also currently a project worker on the ACTS project DOLMEN involved in the design and development of trial software. His research interests included mobile and Internet computing, leading edge software technologies and the adoption of these technologies into the mainstream.