Executive Summary

This White Paper covers network computing and network computers. These topics have been the subject of extensive debate and discussion of late and, if anything, the subject has become more confused.

The broad term "Network Computing" represents a way of designing systems to take advantage of the latest technology and maximize its positive impact on business solutions and their ability to serve their customers.

Network computers are the client component of a networked architecture. They provide, at minimum cost and maximum simplicity, an essential set of functionality necessary to support the appropriate client functions. Unlike conventional PCs they do not need to be individually configured and maintained according to their intended use.

The principal features of network computing and network computers include flexibility, lower cost of ownership, security, system management, and control. These translate into business benefits giving cost savings, improved productivity and service availability, increased functionality, and enhanced business confidence, especially where secure commerce is involved.

Operational factors in the short term include software availability, server and network capability, and the required skills to deliver and maintain the network environment. Cultural factors concern the willingness to transfer control over desktop applications back to the IT department.

The importance of standardization is underlined by the recognition that growth of network computing depends on a common, minimal but mandatory set of functionality for all network computers as well as interoperability. Fragmentation in the marketplace can hinder or prevent the full benefits of network computing being realized.

There is a need to establish user requirements and to place everything into context through the use of a model or framework. This is vital given the wide range of network applications and devices that will be deployed and convergence across the IT, telecommunications, and media industries. The Open Group has developed such a framework, the IT DialTone architecture described below

Network computing helps link organizations with their suppliers and customers across the world, brings the benefits of computing to new audiences, and extends the scope of electronic commerce. This vision can be achieved by ensuring that both your organization and your vendors are committed to and using the IT DialTone architecture.

Contents

Introduction

This white paper is concerned with network computing and especially the role of the network computer.

It is written at a time of great debate when advocates of network computing and of network computers are promoting and detractors are challenging its virtues, and potential users are trying to grasp what it all means. For example, the needs of so-called knowledge workers for PCs with standalone software applications and local storage cannot be discarded but they are not the main focus of network computing.

This paper has been prepared to assist the debate and to establish the need for work on user requirements, architecture, standardization and market adoption.

This paper is written with the early majority rather than the early adopter in mind. This audience will want to examine the merits of network computing and will want to examine the benefits very closely before investing in it. At the beginning of each Chapter are some of the current questions. The issues raised should be resolved in the coming months and new issues may well arise.

This paper does not provide information about the current suppliers of network computers, nor does it dwell on the merits of particular forms of network computer.

Please refer to the Contents page for the overall structure.

Network Computing - Definitions

What is network computing and what is a network computer? How important is it for network computers to have common functionality? What level of functionality do we need? When do competitive forces come into play? How important is it to remove any confusion in the market?

The Growth in Network Computing

A number of leading industry analysts predict the move to network computing. Bloor Research says that 90 percent of end users are examining, piloting, or implementing network computing within their organizations. Gartner Group has predicted that 40 percent of businesses will deploy network computers by 1999, rising to 60 percent by 2001. An Ovum report shows that Network-centric computing will be the dominant IT paradigm for the next century.

The future for network computing looks assured, but are we certain that everyone is talking about the same thing? An IDC End User Survey of Enterprise Computer Customer Buying Patterns and Directions reveals that the market is confused over what a network computer is and is not.. IDC believes that network computer vendors will need to develop strong marketing messages that articulate and define network computers.

A lead article in NC World argues that research organizations are wasting effort trying to calculate cost of ownership issues regarding network computers *versus* the PC. They say it isn't a matter of replacement. A platform-neutral network-centric computing environment could be easily based on entirely different principles and business models than the ones we are using today. The author discusses mobile network computers, TV set-top boxes, and other devices that could be used, perhaps with the use of a SmartCard, to communicate with a server. He observes that the essence of network computing is that the data must be kept on the server and that its transport and presentation must be via standard mechanisms such as HTML, Java, and so on.

What is Network Computing?

What do we mean when we talk about network computing and network computers? Here is one definition:

Network computing represents the current wave in the progression of IS architectures from mainframe to mini to PC-LAN and onward. Information systems adhere to the Network Computing paradigm when functions are appropriately distributed between clients and servers connected by local and wide-area networks. Functionality is centralized to the extent that performance constraints allow and sufficient intelligence is provided locally to support a powerful user interface. Furthermore, server capabilities are physically distributed as necessary to improve performance and resilience. This differs from the earlier paradigms of "mainframe/terminal" based where everything is centralized and the later "fat client" where almost everything is held on client PC or Workstation.

Network computers are intelligent devices connected to the network that work solely as clients. They rely on software and data provided from one or more servers on demand. There are no particular physical characteristics. Although it is possible to configure and use a PC in this way, new devices designed to optimize this environment and described by their suppliers as Network Computers (NCs) are now being introduced.

A simple example of network computing is the use of a browser to view static information on the World Wide Web. A more complex example is the case of an order entry system where there is a central database that is accessed through a Java applet running in a browser. Any changes of data are validated by a Java program associated with the browser be-

fore the amended data is transferred and used to update the central database. The Java program may also manipulate the data for display.

Traditional terminals connected to a network cannot function as network computers. However, a PC connected to a network can be made to work as a network computer. Custom-made network computers are available from many suppliers.

The Open Network Computer

Devices that are licensed to describe themselves as Open Network Computers have been tested and guaranteed by the supplier to conform to the standards agreed by the industry. This standard assures buyers that an Open Network Computer they buy from any supplier, irrespective of underlying technologies, will always provide the same set of functionality and behave in exactly the same way, for example in the look and feel of the application. The Open Network Computer is not a specific piece of hardware or a computer system.

Being implementation independent, the Open Network Computer describes a set of functionality - application programming interfaces and protocols - that applies to a product. Conformance is dictated by the content of the Product Standard and the underlying technical standards. The Open Group Product and Technical Standard for the network computer are published on The Open Group web site (URL http://www.opengroup.org/nc). They provide a minimum set of functionality for a network computer.

Functionality is the Key

Functionality is the principal factor in the evolution and growth of network computing and the network computer. This must be matched to existing and future requirements, and an explanation based on functionality should be used to articulate the merits of network computing to help the user community.

The main functional characteristics of an Open Network Computer are listed below:

- The User Interface is web-browser software
- Content delivery through a content description language (HTML or XML)
- Server-based execution technology with a run-time environment evolved from today's Java and CORBA technology[1]
- Ability to run application software for office automation, development tools, and vertical applications
- Management functions carried out remotely from the server

Having established this new model of computing, the market can begin to choose between one network computing solution and another. Here, competition comes into play. Issues of price, performance, quality, and the total cost of ownership begin to mean something. Concerns about monopoly of supply are resolved. In addition, suppliers can add features to their products to extend the basic functionality.

[1]Arguably a network computer could be based on other execution technologies such as ActiveX and DCOM. An option would be to support both. The decision to base the Open Network Computer on Java and CORBA reflects the status of these technologies in the market. They perform all the functions required within the constraints (such as enforceable security) and meet The Open Group;s adoption criteria for technical standards.

The Nature and Impact of Network Computing Today

What are the claims for network computing? How do these translate into real business benefits? Can we verify and quantify these?

Features of Network Computing

The claimed features and advantages of network computing and network computers can be grouped according to the likely business benefit.

Feature	Business Advantage
Flexibility	Productivity and Competitiveness with the ability to respond to change more quickly
Optimization – the right software and data at the right time	Productivity and Service Availability
Availability and reliability – reduced incidence and downtime due to system failure	Productivity and Service Availability
Management Control	Increased productivity
Improved System Management	Effective control of infrastructure and lower costs
Improved Security	Higher confidence leading to new types of business applications, e.g. web based commerce
Greater Access to Shared Resources	Increased productivity and organizational effectiveness
Cheaper Equipment	Cost Savings
Environmental Factors	Lower costs and greater ease in achieving environmental targets
Competition	Flexibility, wider choice, improved services and support.

These points are discussed in more detail below. In each case the key question is how can these claims be realized and quantified.

The Total Cost of Ownership

Network computing can bring down the total cost of ownership, as shown in recent studies. The Gartner Group distinguishes between the visible costs of owning a PC (purchase price, support, and training) which are around 21%, and the invisible support cost (people, downtime, administrative services, and technology refresh) which are around 79%. There are significant potential savings for organizations that carry out software distribution, software support, and system administration and management from the server. Gartner Group shows that these savings, as compared with the costs of local support, can be around $2,000 per workstation per year.

The Meta Group says that the total cost of ownership of network computers is $2,176 per workstation per year compared with a PC's at $2,824 when supported in a network environment. These costs are made up of training, support, management, server, network, client, and applications.

Both studies highlight the costs involved and especially the high costs of system administration, maintenance, and user support. To these should be added the human costs in terms of staff training and staff time for backup, software updates, and so on, which are reduced or eliminated when employing a network computer, or configuring a PC to act in the same manner, in a network computing environment. These cost studies are indicative of potential savings; business managers will want to look at their existing costs now and projections for the future. Clearly the hardware purchase cost remains a small factor in the equation.

Flexibility

Network computing allows you to respond to changing needs: software applications are easily updated, enhanced or new functionality added and deployed. This may involve changing the functionality at any time, based on the stage in an operation or task, invoked by change in another part of the business, or prompted by the management. Managers can respond to new requirements by setting up new software and data environments as required and without major impact on the user or the business. The speed of response may often be turned to competitive advantage.

Optimization

Network computing can provide the right software and data at the right time to ensure the user can work in a fast and efficient manner. This may involve customized user interfaces that are related to specific tasks with access to specific shared data. Here lies the opportunities to provide systems that are both easier to use and less error-prone, reducing the need for staff training.

The Open Network Computer offers managers a way of controlling the functionality and optimizing the system for the benefit of the operation.

Availability and reliability

Network computing minimizes the risk of and aids speed of recovery in the event of failure. For the individual user of a network computer there is less to go wrong. In the event of a hardware failure the equipment can be substituted without any set-up and there is no software or data to recover. The use of replicated data located on different servers provides resilience and suitable backups. Single point failures in the network, NC or servers have minimal impact on a correctly designed business application.

Management Control

One of the fundamental issues in the deployment of computers is the exercise of business management control over application use. We readily acknowledge the importance of access control - security, especially where financial transactions are involved. Perhaps less obvious is the need for managers to control the environment for the computer user. This follows from a desire to ensure that the correct procedures are followed, to limit functionality, to promote good habits, to optimize workflow, to customize software for a particular purpose, and so on. Network computing offers new ways to do this.

Improved System Management

The most significant savings apply to maintenance of and the updating of software which is downloaded from the server. User data is secured on the server, thus obviating the need for local backup and restore. System management and administration functions can be centralized. Users do not have to know how to carry out administrative tasks, and less time and effort is spent by users and support staff when things go wrong. Of course, a limited amount of remote system management can be carried out through a computer network to existing PCs, but in the case of network computers the total load is carried on the servers.

Improved Security

A network computer communicating with a server and having no user-accessible storage devices is inherently more secure than a PC connected to the network. Viruses can be introduced locally through the PC. Security can be breached in other ways through such as access to the PC's own operating system, local applications, or independent modem connection. The network computer, unlike the PC, has an operating system that is not user configurable. It is designed to enforce much tighter security than is possible in a Windows-based environment. In a network computer the tools for the hacker are just not there.

Greater Access to Shared Resources

Network computing is built on a shared resource model. The value of this benefit is tied to the size and nature of the organization and the extent to which users currently share data. The opportunities for developing and exploiting common data sources accessed through network computing and network computers are there to be used.

Cheaper Equipment

This claim is based on the observation that network computers have no user accessible local storage devices and hence a lower parts count. They also need, in general, less processing power since they employ browser and Java-based applications allowing the use of proven, less expensive technology for most applications.

Environmental Factors

Network computers have a smaller footprint, consume less power and emit less noise as a result of the lower parts count.

Competition and Choice

The Open Network Computer guarantees portability and interoperability and a common set of features. With the confidence of this guarantee, the buyer can focus on choosing a supplier that understands their business, provides the best support and competitive services.

Network Computing – the Challenges

Does the software exist to support network computers? How do you persuade users to hand control back to the IT function? Confidence - should you move to network computing or wait? What is the likely impact of these and other barriers or factors on the growth and development of network computing?

One way to identify the factors that may affect the take-up, growth, and development of network computing is to look at the functional characteristics of network computers. The following table identifies some of the factors. The second column labeled Challenges identifies some of the functional requirements.

Functional Characteristics	Challenges
User Interface	Additional functionality
Content Description	HTML - move to XML
Server-based Execution	Network availability Server capability Versioning issues
Software Applications	Software availability
Management	Skills to implement

Some of these challenges are significant and the Industry is addressing them. However, the optimum solutions can only be determined with appropriate input from the buy-side. To this end, The Open Group has established within it Forum a group dedicated to this task.

User Interface

Web browsers probably have all the functionality required for network computing today. The ideal in the future is a combination of the best features from the browser software that leads the market.

In terms of the user interface, key advances in browser technology have included scripting and remote execution, specifically support for ECMAscript and Java. The latter is still evolving in significant ways to improve usability. However, the functions available today are sufficient for business applications.

Content Description

HTML Version 3 provides the current basis for content description. The move towards XML will aid the evolution towards more structured information.

Server-based Execution

Commercial network availability will affect those with remote network computers and mobile network computers who wish to connect to the network at an acceptable speed. Reliability of the network is equally important. Both are essential

to effective network computing which will only be viable if connection can be guaranteed and software and data can be transferred at acceptable speed. Fortunately, the telecommunications industry has made significant strides in answering this need and the day of unlimited bandwidth and highly reliable networks are within sight.

Server capability covers the range of tasks to be performed by the server in support of the network computer. These tasks now include building and maintaining information about the user environment. If the applications are to be customized for each user or group of users, the server will have to respond to user requirements by delivering the right subsets of software and data according to need. Although configurations issue, there may be implications for developers and systems management. This implies a re-engineering of systems in parallel with handling the need to support Java and browser-based applications with the object of identifying and delivering the right functionally related subsets.

Versioning issues may cause problems in network computing. This is especially true in a fast growing area with software being modified to keep pace with demand. Careful tracking of differences between versions of software will be needed to ensure that network users, especially those from third parties, can continue to interact. Changes can be distributed to all network computer users once the need for and method of updating have been determined.

Software Applications

In the short term especially, one of the most critical challenges will be the availability of appropriate business software including Java-based applications. There is a good deal of evidence that suppliers are working to fill the gap. This is reported in a Zona Research Paper covering the deployment of Java-based applications, and reflected in the recent announcement by many organizations to develop Java versions of their software. Organizations requiring custom-built software will have to acquire the skills to integrate standard object based applications to meet their business needs.

Management

The ability to manage systems in a client/server environment will be enhanced to include management of all the applications and data on the server. The focus will move away from (remote) assistance to users with applications on their PCs who need help in upgrading their software and recovering from mishaps.

Resistance to Change

Some new factors can be characterized as cultural rather than operational. Network computing presents a host-centric approach where users rely on software and data being downloaded from the server. The loss of some aspects of computing, notably software maintenance and backup, will be welcomed by users. The requirement to access a software environment on the server, dictated by management, may meet resistance from those who have experienced personal control through having their own PC-based applications. For this reason it is unlikely that network computers will have large impact for "knowledge workers" with their need for flexible support from office applications.

The PC has been a liberating force for many employees who have benefited from generalized software for word processing, spreadsheet, and small-scale database applications. However, these applications are most often used in a standalone environment. Organizations with PCs will have to plan carefully for the transition to network computing and consider a phased migration of applications.

Implications for Standardization

How can we ensure that network computing reaches its full market potential? How can we avoid fragmentation whilst giving freedom of choice? Can the user have confidence in the functionality of network computers and be encouraged to build networks that extend access to and use of their computer systems?

What do We Need?

We can find numerous examples where the take-up and growth of new technology has been impacted by the absence of a single standard. These include the videocassette, the laser disc and precursors to the CD-ROM, digital television, and adoption of 56kbs modem standards. Network computing and the network computer are no exception.

Organizations want to be free to purchase their hardware and software from different sources, but be assured that these will work together now and in the future. Businesses need to be sure that the hardware and software they buy is fit for purpose. Where they connect to third parties they want to communicate effectively deliver the appropriate information and minimize security and other risks.

For the reasons explained in this white paper, to achieve the full potential for network computing the linking of all the trading entities (suppliers, partners, intermediaries, and customers), all network computers must have the same minimum level of functionality. Each element must conform to the relevant standard and interoperate "out of the box".

To achieve success for network computing we must have:

- Guaranteed functionality
- Ease of integration
- Competitive and cooperative suppliers
- Avoidance of fragmentation
- A critical mass.

The last three items are of particular importance and concern the marketing strategies of the key suppliers in any industry. It is necessary to create a market for network computing and software that supports it. If organizations can obtain the benefits of network computing they will promote its virtues to others. This will ensure that a critical mass is achieved and the costs of hardware and software come down and stimulate real growth in both vendors' and buyers' businesses.

At the outset the danger is one of market fragmentation with the customers confused by the different offerings. Suppliers need to cooperate to build momentum for network computing.

How are these Goals Achieved?

Our goals in this area can be achieved through a number of steps:

1. Establish customer requirements for network computing
2. Ensure that the requirements are consistent and coherent
3. Agree Technical Standards including identification of existing standards, adaption and adoption according to need, and filling of gaps.

4. Provide the means for suppliers to demonstrate conformance

5. Obtain buy-side support

What has been Achieved to Date?

The Open Group has formally adopted the Network Computer Reference Profile developed by a group of vendors. The resulting Technical Standard has been published as the Network Computer Technical Standard. This document can be accessed free of charge from The Open Group web site (URL http://www.opengroup.org/pubs/catalog/c720.htm).

The Open Group has also established the Open Network Computer brand program. Products registered to use the name Open Network Computer and the associated logo must conform to the contents of the Open Network Computer: Foundation Product Standard. The Indicators of Compliance and Test Suites are specified in the Product Standard, the full text of which is available free of charge on the Open Group web site (URL http://www.opengroup.org/nc). Vendors can obtain guidance, access to the test suites, and can apply for their products to be registered on-line. A register of products will be published.

The Network Computer Working Group where standards for network computing are developed and agreed with industry, is currently working on Version 2 of the Technical Standard. They are also working on network management issues in close cooperation with industry focus groups. It is anticipated that Version 2 of the Standard will be released in mid-1998.

Fortunately the direction of Version 2 illustrates that it will be 100 percent upwardly compatible with the earlier version; there is no need to wait for it before building network solutions.

The introduction of these standards for the network computer can prevent unwelcome fragmentation at a time when confidence is paramount to the adoption of this new paradigm. Through adoption of a common definition, we will see reduced market fragmentation and broader, faster adoption of network computing. Buyers will benefit because the Open Network Computer brand guarantees conformance to the standards, enabling buyers to make better, safer investment choices thereby realizing the benefits of network computing.

This brings us to the question of user requirements and the architectural setting for them and for the standards themselves. User requirements have, and continue to directly influence the development of the standards. The Open Group has Program Groups that are tasked to document and champion user requirements.

When the majority of vendors adopt The Open Network Computer brand and promote its merits, purchasers will be able to distinguish Open Network Computers from other devices in the market. This will diminish the risk of fragmentation and ensure that users can build network computing to its fullest potential.

Future Activity

The Open Group expects to work on a number of standards related to network computing including those for mobile network computers and SmartCards. This activity is linked to the IT DialTone Strategy that is explained below.

The Relationship of Network Computing to the IT DialTone

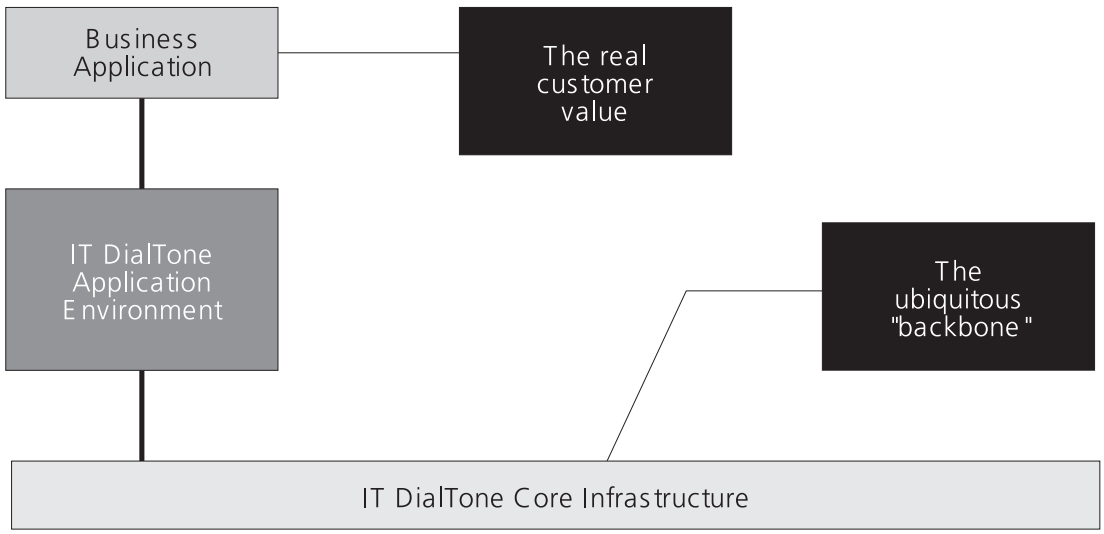
How do we ensure that the Open Network Computer as defined will integrate with other components and serve the functional needs of the IT DialTone? How can we be sure of the future role of the network computer? How will it need to change in the light of developments?

The Open Network Computer is a vital element of The Open Group IT DialTone strategy, which aims to establish a ubiquitous, trusted, reliable information infrastructure to support the deployment of distributed business applications.

Customers will not in general procure the complete IT DialTone Infrastructure from a single source. The implication of this, is that the IT DialTone Infrastructure must be an open system, integrated from products delivered by different suppliers which work together because they adhere to common standards where they interact.

The IT DialTone Architecture is a structure that portrays information about and relationships among all of the elements of the IT DialTone Infrastructure, including a full list of all of the standards that define the necessary interfaces between products and references to products which adhere to those standards.

There are two distinct elements to the IT DialTone infrastructure.



To achieve global interoperability, the infrastructure is based on the comparatively simple **IT DialTone Core Infrastructure**. This core communications capability, the backbone upon which the rest of the IT DialTone infrastructure is built, is the single item which differentiates the IT DialTone initiative from anything that has gone before.

- To achieve global interoperability, the **IT DialTone Core Infrastructure** must be ubiquitous. That means that it must be the same everywhere and anything that uses it must understand completely the structure of the data and information

being exchanged.

- To achieve interoperability, the **IT DialTone Core Infrastructure** does not need to define the totality of IT, merely a core set of capabilities that need to be done in a consistent manner. The **IT DialTone Core Infrastructure** needs to be able to deliver a piece of information to the right destination, securely, reliably and within a predictable period of time.
- To define interoperability, the **IT DialTone Core Infrastructure** is concerned with the structure of the information that is flowing around a network, not with the way in which applications cause that information to flow. That means it is totally defined in terms of protocols and data structures and is not concerned at all with Application Programming Interfaces.

The second element of the IT DialTone initiative enables the deployment of business applications.

Building on the ubiquitous backbone established by the IT DialTone Core Infrastructure, **IT DialTone Application Environments** define all of the necessary distributed computing services necessary to support business applications that want to communicate using the IT DialTone Core Infrastucture.

The IT DialTone Architecture will define a number of different **IT DialTone Application Environments**, but will highlight how the different pieces fit together and what interdependecies there are, and will identify the areas where divergence cannot be tolerated even at the Application Programming Interface level.

The first fully defined **IT DialTone Application Environment** is the Network Computer Profile.

Initially intended as the basis for the development of standard "thin client" network computer devices, the final Network Computer Profile is much more than that:

- It **does** define the minimum capabilities of a diskless network computer
- The same capabilities can, however be deployed on virtually **any** personal computer or workstation

The Network Computer Profile defines a standard IT DialTone client with:

- Full support for the IT DialTone Core Infrastructure
- A core set of user interface capabilities built in
- A JAVA application environment which can used for the deployment of additional application components in a completely platform independent manner

The Wider Context and the Future

How will network computing develop? What other devices will serve as clients? What will be the effect of convergence between telecommunications, the media, and IT?

Supporting a Wide Range of Client Devices

Business managers seek effective communications with a computer network linking distributed employees, suppliers, and customers. They need flexible solutions - the means to be able to adapt rapidly to new circumstances with computer solutions that are easier to manage and to change. Network computing provides new opportunities for linking resources and reducing costs that match the ways in which people wish to do business. It brings with it a new business paradigm for the twenty-first century.

A wide range of devices will be linked to the network - anything from a PDA to a mainframe computer. Some of these devices will always perform as either a server or a client, while others will perform in both ways. Client devices will include phones, palmtops, TVs, laptops, desktops, workstations - as network computers. Other devices may have special functions: voice recognition, finger print and other biometric devices, SmartCards, badge and label readers, PDAs, sensors and actuators, and so on.

The needs of users on the move need to be taken into account, whether this be through mobile network computers, provision of network computers which support identification through a SmartCard, or other devices which enable a user to be identified to the network and provided with the appropriate work environment.

The factor that really opens up the marketplace, is that all these client devices share a minimum, common set of functionality. There should be compatibility "up the scale" so that, for example, two vendor's products could interoperate and be easily integrated into the network. Any network computer should meet the conformance requirements for an Open Network Computer and this definition will expand as other classes of devices are standardized and added into the brand program.

Convergence of IT, Telecommunications, and the Media

IT, Telecommunications, and Media industries are converging, sharing the same or very similar technologies. Digital television and set top boxes give rise to devices that embody the functionality of the network computer. Modern phones exhibit similar characteristics.

A full discussion of convergence would be the subject of a different white paper. It is sufficient at this stage to mention the possibilities and to ensure that those who are planning or implementing network computing take account of the whole spectrum of possibilities.

The Content

This white paper has focused on technology rather than on content. Indeed the only reference to content has been to content description languages such as HTML and XML. Computers are the tools, a means to an end in handling and manipulating data, which becomes knowledge when in the hands of human beings. We should be prepared to examine basic issues of information handling – presentation, communication, and structure of information and data – so as to develop network computers that fit user needs.

Once again, we can do no more than reflect on the rapid change in our society and the opportunities for network com-

puting, converged with other telecommunications and other media, to be all-pervasive. In laying the foundations for the true Information Age we must have the foresight and imagination to set network computing off in the right direction. This reinforces the need for more exhaustive work to establish user requirements looking at present and future needs. We need to look at vertical industry segments especially those relating to the communication and information industry. The IT DialTone is The Open Group's blueprint for the future and can be used as a basis for mapping user requirements. The current standard for the Open Network Computer is a first step. We need to ensure that it leads in the right direction, though equally we need to ensure that the first step opens up the full potential for network computing.

The Open Network Computer, IT DialTone and The Open Group are trademarks of The Open Group in the U.S. and other countries.