White Paper

Mobile Terminal Software – Markets and Technologies for the Future

NOKIA

CONNECTING PEOPLE

Contents

Executive Summary

Worldwide sales of mobile phones has risen to remarkable 400 million units per annum. This has been mainly driven by voice communication, with increasing impact by newer applications such as text messaging. The arrival of the next generation mobile networks and new devices, like smartphones, are expected to boost the telecommunications market even further. Smartphones will facilitate the introduction of new applications and data services, created by software developers, operators and IT vendors.

New markets for software applications and data services look more than promising since mobile phones are being equipped with browsers and Java environments, and PDAs with wireless connectivity. Potential applications can now cover a wide scope from business-critical field service to simple games. However, which ones offer the greatest opportunities to operators and software developers? Messaging, mobile commerce, entertainment and corporate applications are often considered among the top candidates.

Mobile messaging has more than proved itself to consumer and corporate uses alike with SMS (Short Message Service). MMS (Multimedia Messaging Service), instant messaging and email will add more business value and entertainment to subscribers. Mobile commerce, by facilitating convenient payment methods and security systems, is contributing to turning mobile terminals into personal trusted devices. The introduction of downloadable graphics, photographs, audio and video clips to mobile terminals is inevitably bringing entertainment to mobile devices. From the corporate perspective, enterprises are mobile-enabling both their vertical and horizontal business applications, such as field service, email and scheduling.

Across all terminal categories – mobile phones, smartphones and PDAs – the key technologies for the emerging mobile applications are XHTML (eXtensible HTML), MMS and Java. An operating system originally designed for mobile terminals lays a solid foundation for these technologies and applications. Symbian OS, with a choice of user interface software modules, is expected to be the most popular smartphone operating system. The next wave of mobile technologies, such as terminal management, presence awareness, location, user profile management and streaming will add to the interoperability requirements of terminal platforms and components.

Thriving markets are built on standards-based technologies. For ensuring the interoperability of devices, applications and networks built on such technologies, the Open Mobile Alliance addresses interoperability across telecommunication, software, and networking technologies. After all, the flood of SMS messages rapidly hit the balance sheets of telecommunications businesses after subscribers were able to transmit messages to recipients in other networks.

Mobile Terminal Market Trends

The target market and planned software architecture for mobile terminals can be used to divide devices into three categories: mobile phones, smartphones and PDAs.

So far, the mainstream market for software developers and for providers of electronic commerce and messaging services has been the PC market. However, we are now seeing a fundamental change in mobile software and data service opportunities, as new smartphones and mobile phones are able to download application software over the air, and wireless connectivity is being embedded in PDA devices.

Mobile phone shipments totaled nearly 400 million units worldwide in 2001 according to an estimate by Nokia, as compared to 128 million delivered PCs reported by Gartner. IDC reported that in the same year, 43 million units of console and handheld gaming devices were shipped to markets. Nokia estimates the worldwide subscriber base of mobile phones will reach 1 billion in 2002.

Although mobile phones are getting smaller, they are still being bundled with more features. Positive experiences in Japan are reinforcing the trend for color screens, radios, MP3 players, keyboards, and game controls that are being fitted into phones along with more memory and advanced software.

Mobile phones typically use a proprietary operating system as their software platform. Until now, this has meant a lucrative, but unobtainable market for software developers. Open, standard, and interoperable software technologies are about to change the situation for proprietary platforms. Now even the smallest phones are getting a browser software, MMS software for multimedia messaging, and the capability to download and run Java applications.

A smartphone typically combines mobile phone and PDA functionality into a package the size of a large mobile phone. Some smartphones have a numeric keypad, some a full keyboard, while others incorporate a touch screen for user input and control. This variety is perhaps a sign of a market in its early stages, but color screens and a full set of applications for messaging, entertainment and personal information management are becoming the norm.

Software platforms with published interfaces and application development tools are also available for smartphones, making it possible for developers and service providers to prepare their products for new markets in early stages. IDC forecasts Symbian OS to be the market leader in smartphone operating systems through to the end of the forecast period 2005.

PDAs, also known as handheld computers, or personal organizers, were originally used as standalone devices for maintaining a personal calendar, contacts and other notes. Now, wireless modules are connecting PDAs to mobile networks, enabling online access to data services. PDAs typically have large color screens and pen based input on a touch screen.

Applications And Services Drive Market Growth

The GSM Association has estimated that 24 billion SMS messages are sent each month. SMS has also facilitated the creation of simple applications, such as finding phone numbers from directories and receiving selected news clips. Now, considering the functionality new networks provide for WAP/XHTML, Java and MMS enabled terminals, it is clear that there are plenty of business opportunities for innovators of new applications.

IDC forecasts that not one, but multiple applications will attract the attention of mobile subscribers. Information services, email, and Internet access are expected to be the most popular services through to 2005. The second group of popular services, shopping, gaming and banking/finance, are expected to mature by 2005.

Messaging

Messaging in mobile networks today mainly involves SMS, but during 2002 MMS is set to enrich terminals with pictures, audio and video clips. At the same time, the popular messaging services on the Internet, email, chat and instant messaging, are extending their reach to mobile terminals.

According to a study by HPI Research Group, mobile phones are already used more often for messaging than PCs in markets such as United Kingdom, Germany, Italy and Singapore. In other markets, like US and Brazil, people who have mobile phones still prefer using their PCs for messaging. In both cases, the study indicates that mobile messaging hasn't yet reached its full potential as the study group of 16 to 45 year old mobile phone users showed high interest in new messaging formats, such as video.

The study also points out that three-quarters of people with access to a messaging device welcomed functional advancements to mobile terminals, such as easier text input and being able to send messages to any devices. Also, improvements regarding the content types, such as being able to send and receive photographs, music, graphics and video clips were considered important.

Email and SMS messaging were seen as quick, every day communication methods in the future as well. Personal, or family and friends related messages, and just for fun communications were seen as the practical applications for multimedia messaging.

Getting messages through instantly to a recipient's mobile device is already a proven concept, which users are willing to pay for. In addition to the growing messaging services business, new applications enabled by multimedia and instant messaging are likely to affect other business segments, such as entertainment and advertising.

Mobile Commerce

Successful electronic commerce services are expected to have tight security, yet they are also expected to be easy to use. Today's technologies already provide many solutions for secure mobile transactions, but consumers have been hesitant in taking them up. Instant access to services, the ability to personalize them, and user friendliness are the key functions to improve for encouraging the use of mobile commerce.

In addition to paying for physical goods, mobile commerce will involve different types of digital content, such as games, tickets, ring tones, music and video clips. In most cases, this digital content ends up being consumed in a mobile terminal and can be managed with new technologies, such as DRM (Digital Rights Management).

Wireless Identity Module (WIM) can store and process data and security keys for the user in the mobile terminal. WIM enables digital signatures that are required to authenticate mobile transactions. Closer to the user's mind (and wallet) is the Wallet application that stores protected personal data, such as credit card information in the terminal, and simplifies the use of personal data in financial transactions.

Market research agency e-MORI found in a mobile commerce survey that the proportion of respondents who would consider carrying out a transaction of more than USD 25, using a mobile device, ranged from 24% to 54% across markets. e-MORI also concluded that people see it as inevitable that technology will be increasingly used for payments of goods and services in the future.

The future is not only inevitable, but it can also be improved. A mobile device that can electronically replace the functionality of credit and debit cards in a consumer's wallet, was seen as highly desirable in the study. More than 60% of users, (Brazil 60%, Great Britain 61%, USA 63%, South Korea 72% and Finland 84%), look forward to having a single device that helps them to organize the many different aspects of their lives.

Although mobile terminals will increasingly have built-in security features, low cost purchases, like parking fees and bus tickets can utilize simpler mechanisms. Pre-paid accounts, or charging payments on a phone bill, will allow all mobile phone subscribers a convenient access to mobile commerce services.

With security users can trust, and with the convenience of having personal data always electronically available, mobile terminals are steadily evolving into Personal Trusted Devices. These trusted devices not only enable mobile commerce, but also facilitate a new range of applications, where security and authentication is required, at home and at work.

MeT (Mobile Electronic Transactions) organization, along with other standardization forums, plays a crucial role in defining interfaces for mobile commerce. Open technologies such as WAP and ECML (Electronic Commerce Modeling Language, also used by many e-commerce applications) support the creation of wallet-type applications in the terminal.

Entertainment

Watching TV, listening to radio, or surfing the Internet quickly confirms why the entertainment industry has high expectations for mobile entertainment. So far, entertainment has successfully ventured into each new medium, and mobile devices are unlikely to be an exception. Mobile entertainment consists of information, gaming, messages and other entertaining content delivered to terminals by service providers.

A study by the HPI Research Group found that 72 percent of respondents would like to have at least one entertainment service available on their future mobile terminals. Nine out of ten younger respondents 'definitely' wanted at least one entertainment feature. The good news for service providers is that 60% of the respondents said they were willing to pay additional fees for entertainment services.

A mobile device is not seen as a direct replacement for other electronic devices, but rather as a multifunctional device that can be used for entertainment when there is no access to a TV, video, or game console. For example, three-quarters of consumers indicated they would use features of 3G networks and terminals when traveling, or outside the home.

Interest in games is high in age groups from 15 to 24 years, but decreases significantly after that, which may explain why gaming didn't make it to the top ten list of mobile entertainment features:

- Sending SMS messages
- Local traffic and weather information
- Use as a camera
- Getting latest news headlines
- Sending photos to friends
- Use as a video camera
- Book/buy tickets for movies
- Getting info on movies
- Listening to radio
- Requesting specific songs

Two observations stand out about users see mobile entertainment in the future. First, users regard a terminal that features mobile entertainment as an online version of a Walkman. It is entertaining when alone, but unlike a Walkman, it can also be connected to more resources. Second, entertainment on a mobile device is attractive because it is nearly always with the user, whether commuting, traveling, or waiting for that 'it'll be ready in two minutes' hamburger meal.

Corporate Applications

Banks and transport companies were among the first businesses to deploy mobile applications, mostly built on WAP (Wireless Application Protocol) for their customers and employees. The former wanted to reduce consumer banking transaction costs, and the latter was seeking the capability to track transportation and delivery status online. Customized applications downloaded in terminals will radically enhance the functionality and usefulness of mobile solutions for enterprises and governmental organizations.

Gartner Research expects most corporations to implement mobile applications in four overlapping phases:

- The first applications are readily justifiable: high-value, vertical niche solutions, such as field force automation.
- The second phase of horizontal infrastructure applications include e-mail and personal information management applications, such as scheduling.
- The third wave of applications consists of vertical applications, such as mobile extensions to customer relationship management, sales force automation or enterprise resource planning systems.
- In the long-term, Gartner expects some 40 percent to 60 percent of all corporate systems to involve mobile elements.

Many established IT vendors and new software suppliers have introduced and are continuously adding mobile functionality in their products. In particular, there is more focus on middleware and Web services products since they are the key enablers and bridge builders between the mobile and Internet worlds.

Technologies Connecting Terminals, Networks And Applications

New packet based mobile networks and advanced smartphones enable a wide range of functionality in connecting terminals to data services. Multimedia messages, consisting of pictures and audio, and downloadable Java applications enrich the user experience, but at the same time introduce new challenges for software developers and content creators.

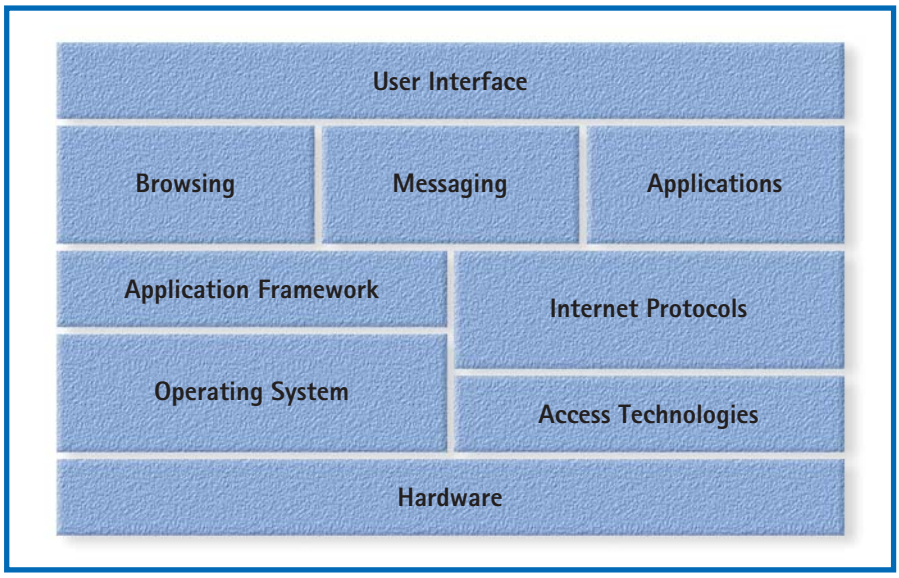

Figure 1. The software building blocks of a mobile terminal (adapted from the book Inside MITA).

The software technology inside a mobile terminal has to support functionality from network protocols and middleware to graphical user interfaces. Access technologies carry data over different mobile networks, such as GSM and CDMA. Internet protocols connect a terminal to network servers using protocols like HTTP and WSP (Wireless Session Protocol).

The operating system is the foundation upon which everything else is built. Voice and wireless specific features can make a real difference in a small device that has to manage restricted memory, power resources and run networked applications at the same time. Some operating systems provide application frameworks for adapting new user interfaces to devices.

The browser component in a mobile terminal is typically built on specifications by WAP Forum and W3C. The messaging module of a terminal must support SMS, MMS, and email, and will have to support instant messaging in the future. Mobile terminals include the essential applications for daily use when they leave the factory, but they also allow the downloading of additional applications to them. Java technology is the popular choice from the smallest phones to the larger PDAs for creating and downloading additional applications.

User interfaces vary from simple menu systems in small mobile phones to graphical interfaces in large touch screen PDAs. Two or three function keys and a numeric keypad are used to control the former, while the latter is directed by pen and character recognition software.

Three Key Technologies

XHTML, MMS and Java are the primary technologies for operators and developers to start building mobile services on. XHTML was specified by the W3C and the WAP Forum, MMS was defined by the WAP Forum and 3GPP, and Java is developed further by the Java Community Process.

The fourth key element is the operating system which lays the foundation for the other technologies and applications. Symbian OS has been designed for mobile terminals with wireless connectivity, and has become the choice of many smartphone manufacturers.

XHTML is taking further the vision that WAP initiated: using a browser in a mobile terminal to access content. XHTML specifies a document type that enables authoring content with text, graphical and color elements, and defines the precise document layout on a variety of devices.

The use of Cascading Style Sheets (CSS) allows the same XHTML pages to be viewed on different devices, such as PCs, PDAs, TVs and mobile phones without modifications to the actual content. The separation of content from the screen size is particularly important for operators and content authors who have to manage devices from multiple vendors. XHTML content can be delivered to terminals over WAP, or TCP/IP protocols and browsers can also be used for downloading Java applications.

MMS (Multimedia Messaging Service) is the next generation for the commercially successful SMS (Short Message Service), promising even more value for subscribers. MMS specifies rich content such as images, audio, video clips and text that can be sent between mobile terminals, from a terminal to an e-mailbox, or from an online service to a terminal.

Operators and application developers can innovate new multimedia services, and make use of MMS as the relaying service between networks and terminals. Advertisements, maps, postcards, plan drawings and songs are examples of content that can be delivered by MMS. Depending on the terminal capability and operator service, MMS content can be saved in terminals, or stored in network servers.

The interoperability of MMS is ensured by using a standard description language SMIL (synchronized multimedia integration language), an XML based language.

Java technology, with the mobile terminals' capability to download applications, is kicking off a new, large software and service business. Sun Microsystems predicts that during 2002 about 100 million Java enabled phones will be sold worldwide. Compared to the number of annual PC shipments (128 million in 2001), it is clear why developers and service providers are turning to Java for applications.

Java run time environment ranges from small devices to network servers. J2ME (Java 2, Micro Edition) specifies MIDP (Mobile Information Device Profile) and PersonalJava configurations for mobile terminals.

In addition to a large development community and built-in security, Java separates applications from hardware and operating system, enabling platform independence for operators and application developers. One of the benefits of the Java run time environment is that it manages the different screen sizes of mobile terminals for developers.

The Next Wave

As mobile data services are being implemented in MMS, Java, and XHTML, the next wave of technologies is already being specified for further enhancing new mobile services:

- Terminal provisioning and management – eases the take-off of mobile services by provisioning and managing settings of terminals remotely. For instance, WAP access point settings can be sent to a terminal over the air.
- Synchronization – backing up and synchronizing terminal data with PCs, or other devices. SyncML specifies the required protocols and data formats.
- Terminal Profile – information about terminal properties including screen size, number of colors and memory made available to applications allows content optimization.
- Delivery – downloading various content such as applications, or music into a terminal. The process covers preliminary negotiations (e.g. supported media types, available memory) as well as the post-download operations, such as delivery confirmation.
- Identification/Authentication – service providers and applications can identify and authenticate users and terminals, for instance for delivering personalized services.
- Payment – transactions with monetary value that use commonly accepted payment methods like credit, debit, account and e-cash/micropayment.
- Mobile DRM (Digital Rights Management) – managing the copyrights of the content owner allows the consumption of digital content in a terminal.
- Presence – status information about a user, such as availability and current activity, made available to applications and other users.
- Location – data and protocols for defining a terminal's physical location, which can be utilized, for instance in mapping, routing people to their destinations and finding people.
- User Profile – access to user profile and preferences enable personalized services, which enhances convenience and creates user loyalty.
- Instant Messaging – popular instant messaging complemented with mobile support enables persons and groups to communicate easily and effectively while on the move.
- Streaming – a method for transferring content to a terminal. Streaming is particularly useful with large pieces of content, such as songs and video clips.

Standardization organizations manage the specifications for their respective technologies. Among the organizations are: 3GPP, Bluetooth, GSMA, Java Community Process, Liberty Alliance, Mobey Forum and W3C. Open Mobile Alliance is a new organization formed on the foundation of WAP Forum and the Open Mobile Architecture initiative, and the Location Interoperability Forum (LIF), MMS Interoperability Group (MMS-IOP), SyncML Initiative Ltd. and Wireless Village initiative have announced their intent to consolidate with the Open Mobile Alliance.

Web Services

Rather than managing many different mobile technologies, some businesses want to rely on readily accessible application-level services. Web services are well-defined protocol interfaces through which businesses can provide electronic services to their customers and business partners over the Internet.

For example, a mobile network operator wishes to establish partnerships with companies that provide traffic information for their local cities. The companies need terminal location information from the operator. The operator can open up a terminal positioning Web service, and for a fee, deliver the location of the requested terminal, without exposing its internal systems to other parties.

Web services specify a common and interoperable way for defining, publishing, invoking and using application services over networks. They are built on existing and emerging technologies such as XML (Extensible Markup Language), SOAP (Simple Access Object Protocol), WSDL (Web Services Description Language), UDDI (Universal Description, Discovery and Integration), and HTTP (Hypertext Transfer Protocol).

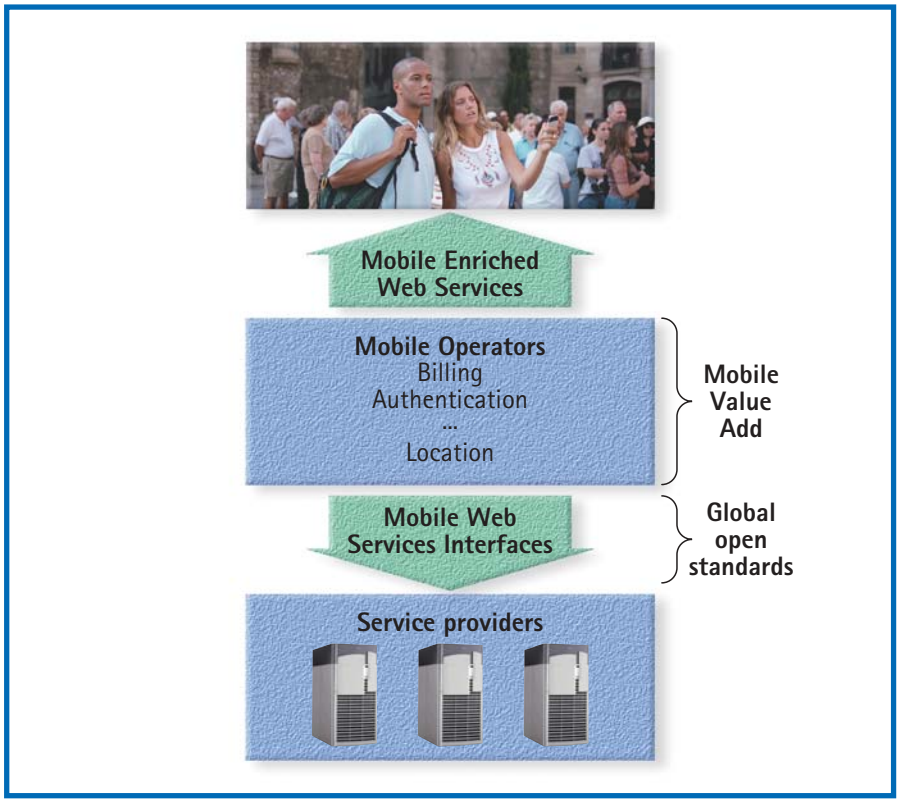

Figure 2. Mobile Web Services.

An enhancement, which recognizes the special characteristics of mobile networks, such as location and voice is necessary for complementing the Internet Web services. Mobile Web Services provide content delivery, location discovery, user authentication, presence awareness, user profile management, data synchronization, terminal profile management, and event notification services.

Initially terminals are likely to access Mobile Web Services indirectly, through application servers. In the traffic information example earlier, a terminal could be running a Java client and access an application server over HTTP. The application server would manage the interactions with the required Web services. An advantage of this approach is that the large number of terminals already in the market, that only have WAP browsers, are able access these services as well.

Mobile Terminal Software Architecture

A fundamental change is taking place in the software architecture of mobile terminals. Terminals need to manage not only voice communication, or personal scheduling, but also a wide range of simultaneous data communications.

A browser that accesses text and images on a web server and displays the results on a screen seems simple enough. But in a mobile terminal, which can communicate by messaging, browsing, circuit switched data connection, packet connection, and over several transfer protocols, the situation is more challenging.

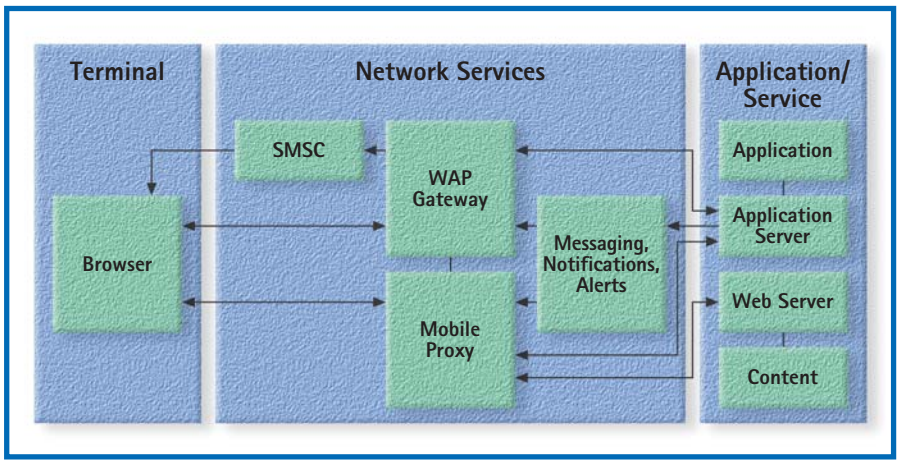

Figure 3. Browser's impact on the mobile terminal software.

The browser connects to data services through a network gateway, such as a WAP gateway, or a mobile proxy. The proxy is intended for managing request filtering, caching and a wireless optimized TCP.

The terminal has to be ready to receive push messages from an SMS Center at any time. Messages in different formats, notifications and alerts can also be transmitted to the terminal no matter what is going on in the browser. Content servers and back-end application servers deliver their data to the gateway which hands the data over to the browser. Security mechanisms for identifying the user and the terminal, and for encrypting the data add another dimension to mobile data access.

The range of mobile terminals available on the market with largely different capacities, hardware specifications, and target customer segments has created differentiation among devices. However, as the software architecture inside terminals becomes more complex, the trend is to build terminals on licensable, but customizable platforms, or in case of a proprietary terminal architecture, complementing it with licensable software components.

Platforms

The more functionality a mobile terminal is intended to have, the more likely it is that the device manufacturer is to license, port and customize a full software platform into the device. The choice of available platforms ranges from operating systems derived from PCs, systems originally designed for handheld organizers, to platforms specifically designed for mobile wireless devices.

A complete mobile terminal platform architecture must cover network drivers, peripherals, local connectivity, an intrinsically designed voice communication interface, security, browsing, messaging, user interface, packaged applications and development tools.

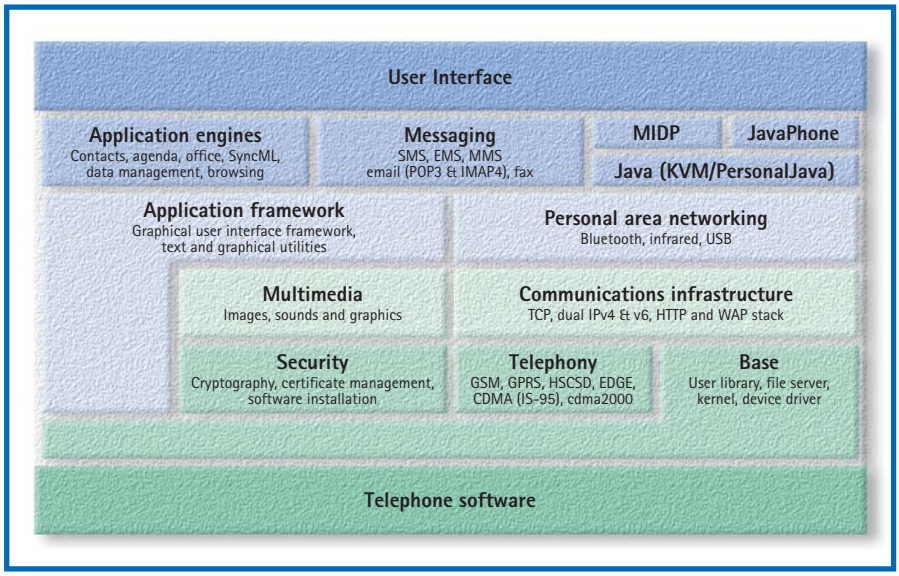

Figure 4. A mobile terminal platform architecture (adapted from the Symbian OS architecture).

A complete platform usually provides choices for operators and developers on how to create applications. Whether to use C/C++, scripting, or Java is a decision to be made according to the application requirements.

A user interface is often a component of a full software platform, but the depicted reference architecture, Symbian OS, doesn't mandate a user interface. Device manufacturers have used the application frameworks to produce user interfaces that are targeted at different ways of using the Symbian OS devices.

Two user interface products exemplify this approach: Series 60 Platform and UIQ. A user interface which mobile phone users are familiar with, is featured in Nokia's Series 60. Supporting a color screen, it provides single hand operation with a numeric keypad and a four-way navigation key.

UIQ user interface product from UIQ Technology supports a large color screen with pen input and direct object manipulation for media-rich phones.

Software Components

Smartphones and PDAs rely on operating systems that can be licensed from software vendors, but mobile phones are still largely being built on proprietary operating systems. The internal architectures of phones vary, but they are tuned for voice communications with data communications as another essential function.

The introduction of WAP browsers started the data access era for mobile terminals. Browsers also started the trend of licensable software components and porting them on proprietary phone operating systems. This trend will continue as other technologies are made available as licensable components.

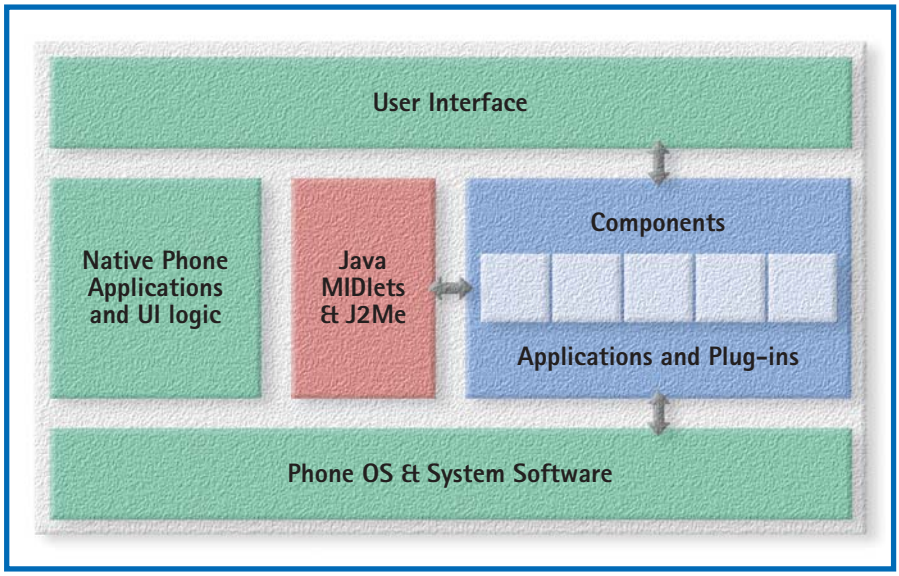

Figure 5. A component-based terminal software architecture.

The desired functionality of a phone will dictate whether it features MMS, XHTML, WAP, download, DRM and security technologies. Java run-time environment allows applications to be downloaded to phones running proprietary operating systems where the applications are executed in a standardized environment.

No matter which software components make up a phone, application developers and service providers benefit from tested and proven pieces of software running in mobile phones, that ensure application software compatibility.

Development Tools

The established key mobile technologies and a variety of emerging technologies have such diverse requirements that developers tend to use several development tools for creating applications, picking and choosing the best tool for the job. Java, C++ and tools for MMS and WAP content authoring are the key tools for implementing applications for existing and new mobile technologies, such as synchronization, DRM and positioning. The availability of a platform, or terminal-specific emulators is a fundamental requirement for developers to test the functionality and behavior of their applications.

Applications are eventually consumed in mobile terminals, although they may be running on network servers. For instance, creating WAP and XHTML content will result in a server application with portions of code executed in a terminal, and the respective software development kit maybe running on a PC. Java technology lets developers choose the solution architecture: client only, server only, or client-server application.

Applications that are compatible with a wide range of devices and run on multiple networks are a common design goal for developers. Development tools that produce code for such open platforms and standard technologies are likely to attract developers.

Closing The Gap To The Future

The global roaming of GSM phones and the networking model of the Internet have proven the pervasiveness of interoperable technologies. In a similar manner, the software platform and components for mobile terminals, based on common standards, are in the best position to boost the mobile data services market.

The launch of any new service is a revenue opportunity that operators wish to deploy to as many terminals as possible. By supporting mobile terminals built on the software platform that uses standard, interoperable technologies, benefits operators by giving them a choice of development tools and a selection of competitive terminals.

As application developers and IT vendors make investment decisions on software platforms, the ones with a meaningful market share, or an established presence in the vendor's customer segment take priority. The mobile terminal platform built on open technologies, that doesn't lock developers in proprietary solutions, is a viable long-term solution.

The software platform originally designed for mobile terminals, is a natural choice for device manufacturers as they implement new devices that integrate mobile phone and PDA functionality. An additional benefit is the availability of compatible applications for the new device from the beginning, and its recognition by operators as a data services platform.

Established standardization organizations are promoting technologies which hardware suppliers and software vendors rely on for producing compatible products and services for mobile markets. A standard, however, is not necessarily enough for making a complex solution work – interoperability of all components is required. Mobile terminal software is in a key position as the converging point of technologies in devices in the hands of millions of users. Open Mobile Alliance is addressing the need for interoperability of technologies across mobile terminals, networks and services.

References

e-MORI: 3G Market Research mCommerce: An end user perspective
Edita Plc IT Press, 2001: Inside MITA – Mobile Internet Technical Architecture
Gartner: Mobile Terminal Statistics Worldwide, 1996–2005
Gartner: First Take: Worldwide PC Shipments Fall for Only Second Time in History
GSM Association: GSM Statistics on http://www.gsmworld.com
HPI Research Group: 3G Market Research Mobile messaging: An end user perspective
HPI Research Group: 3G Market Research Mobile entertainment: An end user perspective
IDC: The Next Generation of Gaming: Forecast and Analysis, 2000–2005
IDC: The Usage of Mobile Internet and Data Services by Business – An End User Study (2001)
Nokia: www.nokia.com
Symbian Ltd: Symbian OS Functional Description at www.symbian.com

Nokia Mobile Phones
P.O. Box 100
FIN-00045 NOKIA GROUP, Finland
Phone: +358 (0) 7180 08000
www.nokia.com

NOKIA
CONNECTING PEOPLE