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Mobile Location Services

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Executive summary

Today, the penetration of mobile phones in a number of countries has passed the 50 % mark. In fact, mobile penetration has already started to overtake fixed line penetration. For telecommunication service providers, this means that the mobile market continues to be extremely attractive. By definition, wireless networks offer subscribers one distinctive benefit that fixed networks cannot provide, being mobile. With Mobility, location becomes a critical attribute that can be exploited by all involved in the wireless value chain.

Driven by rapid evolution in positioning technologies, the value of mobile services is shifting from voice-based services towards value-added localized, personalized and time critical services offering connectivity anytime, anyplace, anyhow. Ease of use, personalization and a focus on consumer needs will be crucial elements in take-up as will the availability of a variety of access platforms such as WAP, SMS and voice. From an operator perspective, Mobile Location Services provide benefits in terms of increased revenue, improved customer loyalty and service differentiation.

Terminal- or network-based positioning methods provide means to locate a subscriber and/or valid mobile equipment. Positioning may be initiated by the subscriber, the network or an external application. Among the entities that will leverage the capability are mobile operators (e.g. home/office zone applications and network

planning applications), third-party service providers and government agencies (e.g. locating emergency calls), (e.g. electronic yellow page for nearby services and “where am I” applications).

Mobile Location Services are value-added services that utilize the user’s position information. From the user’s perspective these services provide

- localized and up-to-date information. Up-to-date information that is relevant in a particular location is given at the right moment.
- personalized information. The information is relevant to the user.
- increased efficiency and pertinence. The information can be more focused and of higher quality, when it is also tailored according to the user’s location.
- increased safety. The positioning functionality increases user safety by being able to locate someone in distress.

From the operator’s perspective, the location element allows information to be more precisely targeted for users. Further, location-based applications are enablers of catchy user services, which enhance brand and user loyalty.

The location information has no value in itself, it is only a parameter for provisioning valuable applications relevant to a user at a specific location and at a specific point in time. Although location information is a highly efficient feature for bringing added value to

several applications, positioning should remain transparent to the end-user.

Operators should get into the business today in order to ensure future market leadership in the Mobile Location Service landscape. However, the choice of positioning technology solutions for the network is affected by business considerations. If the operator wants to get into the business today, Cell-ID is the available technology. If the market entry is planned for 2002, the operator should consider investing in the widely available E-OTD solution. In third-generation (3G) networks, the RTT/IP-DL solution is the investment for volume markets. At the same time, GPS-enabled handsets and networks will be also rolled out for the high-end users. Naturally, it is up to the operator at which market stage it wants to enter the market. Yet, our view is that in order to gain experience, establish a strong brand, and develop customer relationship, the opportunity should be seized today.

In general, Mobile Location Services and wireless communication devices form a good combination. The location information adds a new dimension to mobile applications and brings more value to customers by improving their safety, their productivity and/or the quality of information needed. Mobile Location Services have a large appeal across all customer segments. For operators, Mobile Location Services provide the answer to this demand.

A day in the life of...

Daniel Newmark is getting ready to leave his home for work, just before seven in the morning. He uses his mobile terminal for a quick check of the local weather forecast, sees that the weather should be fine this morning, but some heavy rain may move in towards the evening. Daniel grabs his umbrella and walks to his car. Having just sat in the car, his mobile phone alerts him to a traffic jam on the motorway he uses to drive to work. This time there has been an accident, and there is an 8-mile tailback. Instead of driving his car, he decides to take the subway, thinking that this will also contribute to a greener environment.

It has been a while since he last used the subway; therefore he checks the timetable of his local station with his mobile terminal, and buys the ticket at the same time. The cold autumn breeze catches his face just as he passes by the local café. His mobile terminal alerts him again pointing to an offer for a hot chocolate and a muffin for only 99 cents. He has agreed to take messages from his mobile network operator's partners in exchange for cheaper call rates during the day. Without hesitation he steps in and buys the day's special offer to go.

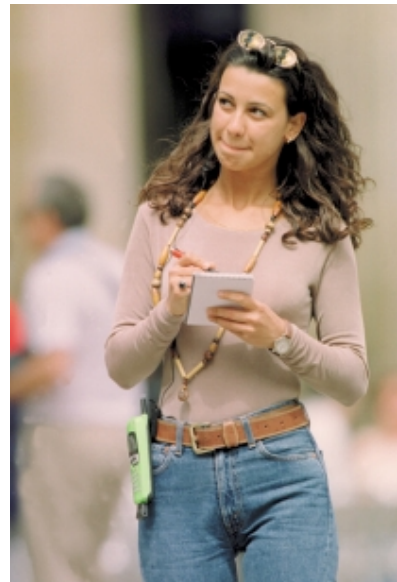
While waiting for the subway, he checks his agenda for the day. Some of his meetings are at the other side of the town, somewhere he has never been before. He checks the meeting locations from the local map service on his terminal. Remembering that he has no car

today, he preorders a taxi for the meetings giving the location of his office he has already bookmarked along with other places of interest. The day passes, business as usual, but after work he is to meet his wife downtown for dinner in a trendy restaurant; it is their anniversary. Daniel is due to meet his wife, Jane, at seven o'clock, leaving him one hour to spare in the downtown area. As soon as the clock strikes six, his phone alerts him telling him that the local bar has a happy hour. Daniel eagerly accepts the message; after all, he has had a long day, and he thinks he could unwind with a drink before meeting his wife. Thinking he should seize this opportunity to touch base with his friends he checks his 'buddy list' on his terminal presence feature. Seems like one of his old school friends is in another bar just across the street; he sends an instant message inviting him to join him and enjoy the happy hour too.

After having the drink with his friend, Daniel heads for dinner with his wife. He has preordered the menu, preparing for a perfect romantic dinner. They meet, enjoy the dinner, and leave the restaurant satisfied. It isn't raining after all so they decide to take a walk around the neighborhood. At some point, they are so deeply involved in their discussion that they don't notice that they have wandered into a district that is rather dark and uninviting. As they turn back, Daniel feels for his mobile terminal in his pocket and puts his finger on the alert button. Thankfully, there

are no threats to their safety. However, the emergency feature gives Daniel some confidence by knowing that if they were in trouble, pressing the alert would have allowed the emergency services to locate them and to be there in no time.

After a while, they feel like going home. By pressing 'Taxi' in his phonebook, the terminal directs the call to the nearest taxi station. The terminal automatically gives their location to the taxi service, and within a few minutes, the taxi picks them up.



Attractive market opportunity for Mobile Location Services

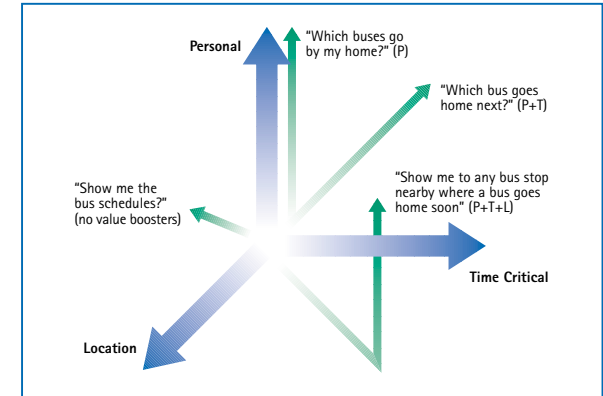
Wireless location technologies will become a crucial tool for providing mobile customers with the right service, at the right time, in the right location. In the fast approaching age of the wireless Internet, end-users will not want to pay wireless Internet charges for irrelevant information. Cellular operators must be able to deliver pertinent and accessible information to their customers.

The ability to pinpoint the location of an individual has an obvious and vital value in the context of emergency services. Pinpointing the location of people and other valuable assets also opens the door to a new world of previously unimagined information services and m-commerce possibilities.

Mobile services benefit from three major factors that boost information value to the end-user: personality, time-criticality, and location-dependency.

According to the market studies, the market opportunity for Mobile Location Services ranges between \$1.5 and \$2 billion today, and the market will grow as technologies such as GPRS and 3G come to the market and evolve.

Ovum forecasts that Mobile Location Services will continue to be popular, generating around \$4.7 billion revenue in 2004. Furthermore, according to ARC estimates, with the market for Mobile Location Services forecast



to grow to \$33 billion by 2005, there are significant opportunities for content and application providers, equipment manufacturers and operators to gain a lucrative share in this emerging marketplace.

According to Strategy Analytics' research, of the top six most popular services in the European and US surveys, four were Mobile Location Services: step-by-step directions, tracking family members, traffic information and facilities-based services. This emphasizes the critical requirement to have adequate Mobile Location Services on the mobile network. In Europe, operators can leverage the success of short messaging by adding location information into the message, thus creating additional sources of revenue. In-car traffic and congestion information also emerges as a potentially strong feature in market surveys.

In the United States, step-by-step driving instructions and family tracking are expected to become the most popular future value-added services. Both US and European youth users, but particularly US, are interested in location-based advertising, or rather permission marketing.

The Strategis Group estimates that the number of Mobile Location Service subscribers will grow to over 60 million users and achieve over \$16 billion in annual revenues by the year 2005 worldwide.

Location-based services are expected to generate \$9 billion in service revenues in Western Europe by 2005 according to the research company, Strategy Analytics. The same report predicts revenues of \$6.5 billion in the USA.

Location-sensitive notifications and alerts to mobile phones will be the most popular services in the next five years achieving 27 % and 35 % penetration in Western Europe and the USA, respectively. Finding or guiding services, including mobile yellow pages, will attract 30 % of US and 21 % of Western European subscribers. Tracking will remain a niche application.

Location-aware alerts and mobile yellow pages are seen as the key services that will drive the location information business in Europe to \$9 billion and North America to \$7 billion by 2005, says a study released by Strategy Analytics.

According to analysts, proximity-sensitive notifications and alerts to cell phones will be the most popular services in the next five years achieving North American and West European penetration rates of 35 % and 27 %, respectively. Pull-oriented finding/guiding services, including mobile yellow pages, will be used by 30 % of North American and 21 % of West European cellular users, while tracking applications will remain a niche end of the market still to be played for.

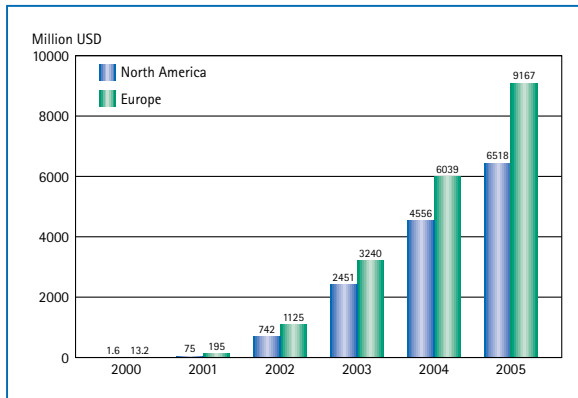


Figure 1. Mobile Location Services revenue forecast, 2000–2005. Y-axis in million USD (Strategy Analytics)

Market segments can be identified as vertical, business and consumers segments. Analysys expects the consumer segment to generate 77 % of Mobile Location Services revenues by 2006. Vertical segments are characterized by location information being important in successful business, e.g. companies in the transportation and distribution sector. The business segment is formed by those companies that require MLS in their regular business operations, e.g. sales representatives, and mobile managers.

Market drivers for Mobile Location Services

There are three major market drivers for Mobile Location Services. These can be identified as commercial, technological and regulatory drivers.

Commercial drivers

Mobile Internet itself is one of the biggest driving forces behind Mobile Location Services, giving the possibility to bundle location-sensitive information into other applications, such as mobile commerce, which brings the opportunity to develop appealing personalized services and offset the decline of voice revenues expected to take place from 2003. End-users are in a position to steer the service market towards their own needs. In the end, they are the ones in a position to accept or reject new types of services. In general, their behavior is driving the development of future services and applications.

Operators are planning new revenue models for the next generation networks, and Mobile Location Services provide the solid revenue stream they are looking for. Services will also be a key asset in the battle for customer loyalty. When saturation points are reached in mobile markets, operators will be looking at ways to retain their customers, and issues such as cost, quality, and service differentiation will become of paramount importance.

Technological drivers

Development of standards and cost-efficient location technologies are key technology drivers. Also, deployment of 2.5 and 3G networks, as well as the introduction of new terminal categories, such as Communicators and Media Phones, enable whole new service categories to be implemented and offered, on which location will be a key attribute. Already WAP provides the sophisticated platform and environment for the delivery of Mobile Location Services, and in future networks, the performance will improve in terms of reliability and speed. As terminals improve, their user interface will enable improved services, for example, applications on color displays with enhanced resolution and sound.

Regulatory drivers

One should note that regulation is one of the strongest drivers of Mobile Location Services. The US FCC mandate for E-911 services, as well as the equivalent European Union requirements for E-112, have an impact on the positioning technology adopted by mobile network operators.

Mobile Location Services are available today

When talking about Mobile Location Services, it is useful to make a distinction between location-based services and location-dependent services, both of which come under Mobile Location Services. Location-based services are actual services that are visible to the user, e.g. find-a-friend, navigation, yellow pages, etc. Location-based services are provided either by the operator or a third-party service provider that utilizes the available location information of the terminal. Additionally, the location application offers the user interface for the service. Services that are available depending on the user's actual (x,y) position are called location-dependent services. Such a service is provided either by the operator or a third-party service provider that is available (pull type) or is activated (push type) when the user enters a certain area. Location-based charging is a good example of this kind of service. Furthermore, when talking about one's position, it refers to rather exact information usually presented in terms of longitude and latitude. The distinction between position and location is that position is accurate information on one's location, i.e. location can be seen as quite a wide area geographically.

From the operator's perspective, Mobile Location Services present an opportunity to reduce churn and increase customer loyalty through the delivery of a unique and personalized service in a

competitive market. A number of critical success factors will determine the ability to achieve these objectives; technology adoption is one of them. As technology adoption will ultimately be driven by consumer demand, the starting point for any service must be a focus on end-user needs. To this extent ease of use and personalization are key elements in building a profitable subscriber base. For this reason, optimized device interfaces and platforms that support multiple access and service delivery methods should be implemented with personalized content provisioning being made available across multiple devices according to the end-user's location.

Mobile Location Services will not in themselves be identified as a set of killer applications but rather location information will be integrated as the value-adding element in a whole range of services. For example, tourist information services letting you know the price of fuel in a country do not deliver value but being directed to the cheapest petrol station near your location does. An attractive set of location-based killer applications will be based on life management services supported by a dynamic portal that uses end-users' personalization details to change the type of information and delivery method according to the end-user's changing time or context (home, office, morning, evening, etc.).



Location service category	Explanation
Category 1 (Basic service level)	Location of all (including legacy) handsets with cell accuracy, or improved cell accuracy
Category 2 (Enhanced service level)	Location of all new handsets with reasonable cost, improved accuracy
Category 3 (Extended service level)	Location of new handsets with high accuracy and higher (compared to Category 2) costs based on customer choice

Table 1.

Many existing information services can be enhanced thanks to positioning technology. In Japan, operators do not charge extra for the location element but rather exploit the increased usage and hence maximize revenue streams from customers who are attracted by the ease of use of location-enabled applications. There are also new applications that are built on top of the positioning technology. For example, fleet management or group management applications can be developed on top of tracking services. Group management (locating your friends, family, etc.) applications will be successful in high SMS penetration countries because operators can leverage the already massive use and customer familiarity with SMS.

Services that are forced to the user's domain are dead before they are even born. Push services (e.g. permission marketing) based on the user's location is a sensitive issue, since the user's privacy may be threatened. However, by introducing appealing benefits for the user to agree to these services (e.g. more favorable call/service

charging schemes), these issues are likely to be solved. It is important to note that the user has to agree to receive advertisements to his mobile terminal. Permission marketing, including location-based advertising, raises privacy issues, e.g. the Wireless Advertising Association steers and sets commonly agreed practices. Nokia is a member of the WAA.

Service categorization

In order to allow for a smooth market introduction for Mobile Location Services, the freedom must be given to the subscriber to choose how much he/she will pay for the terminals supporting those services as well as the accuracy levels required from the services. This demand creates the need to categorize the location services. The Location Technology Solution, described further in this document, contains three location service categories, which are described in Table 1.

The Location Service Categories ensure that all handsets can be located and also that the customer has the choice of selecting higher accuracy with higher cost. All categories are standardized for specific cellular systems and are available in parallel. Categories 1 and 2 will be cellular system specific and Category 3 common to all systems.

Operators should get started with Mobile Location Services today in order to have an early start on the learning curve. As more accurate technologies develop for these services, operators need to pay attention to what applications and services work best in today's mobile environment, and use that experience when rolling out next generation services.

Privacy is an issue

Three factors will determine end-users' trust in Mobile Location Services: privacy, security and ease of use. A clear prerequisite is that it is the customer and not the operator or service provider who has control over the use of his/her location information.

Because a user's privacy is at stake, mobile advertising based on the user's location is a sensitive issue. However, the introduction of appealing benefits for the user in return for accepting the advertisement, e.g. more favorable call/service charging schemes, could solve these issues and turn it into marketing that it is based on the permission given by the end-user. In other words, end-users would not receive advertisements unless they had given prior permission to this.

Of all the challenges facing Mobile Location Service providers, privacy is undoubtedly the biggest single potential barrier to market take-up. Whilst operators may be tempted to treat position information as their own, it actually belongs to the end-user and its use is regulated by data protection laws. Consequently,

the operator must implement absolute physical separation of position data from the various applications that utilize the position data. Thus, whilst personal position data travel through the servers of the Application Service Provider (ASP), they physically reside in the operator's network. Even though the user has control over his position information, there has to be an open relationship based on mutual trust between the user and the operator, since they both benefit from each other. Mobile location privacy can be considered analogous to the use of car license plates. The fact that a device is in a certain location is not a privacy issue. This becomes a privacy issue when the link to the user of the device is also known and/or the information is conveyed to an unauthorized third party.

The best way to support privacy, and to ensure that the user is in charge of his position information, is to implement privacy control in mobile terminals. Controlling one's own privacy must be easy and understandably implemented. This can be naturally supported, when the handset takes part in positioning of the subscriber, e.g. by providing the required measurements, or actually calculating the position. These capabilities will be enabled in new handsets, which will support sophisticated positioning technologies and standards.



The technology behind Mobile Location Services

Positioning technologies can basically be divided into handset-based and handset-assisted, and similarly network-based and network-assisted, each of which offer different levels of accuracy according to a three-tiered service level structure of basic, intermediate and high level accuracy. Moreover, location accuracy and the degree of coverage dictate what types of application can be deployed. Hybrid positioning solutions combine two or more positioning technologies thus achieving an improved accuracy in positioning. A successful positioning technology must meet the accuracy requirements set by the specific service, at the lowest possible cost and with good sensitivity and minimal impact on the network and subscriber equipment.

In handset-based technology, the terminal performs the position calculation autonomously, e.g. stand-alone GPS. However, in handset-assisted technology the mobile terminal provides some assistance for positioning, while the network performs the actual position calculation, e.g. terminal assisted E-OTD (Enhanced Observed Time Difference). Further, in network-based positioning technology, the network performs the position calculation by itself, e.g. Cell-ID. Finally, in network-assisted technology, the network provides some assistance in positioning, while the terminal itself performs the position calculation, e.g. A-GPS, and mobile terminal-based E-OTD.

The three major emerging technologies for wide-area positioning are:

- Cell Identification with variations, e.g. Service Area Identity (SAI) for 3G, LocWAP and enhanced Cell-ID, and enhancements with propagation time measurements, such as Timing Advance (TA) and Round Trip Time (RTT) and measured signal levels (RX levels).
- Cellular signal timing based methods, like E-OTD for GSM and its variations AF-LT (Advanced Forward Link Triangulation) and IP-DL (Idle Period Downlink), for CDMA and WCDMA, respectively, and
- GPS (Global Positioning System), stand-alone or network assisted (A-GPS).

In addition to wide area positioning technologies, user self-locating and, for example, complementary local area technologies, such as Bluetooth Local Positioning may be used to improve coverage. Short-range wireless technologies, such as PHS (Personal Handyphone System), Bluetooth IEEE 802.11, Ultra Wideband (UWB) and other proprietary technologies, can be used to provide position determination, where they provide coverage. In multi-mode devices, this can be used to complement other positioning technologies, to enhance accuracy, coverage and/or acquisition time. The Bluetooth 'Local Positioning' profile is being developed to provide GPS-like accuracy, especially in places where GPS does not work very well or not at all, such as indoors.



The development of different technologies is now rapid, with FCC's E-911 mandate acting as the major driver, especially in the US market. But no clear winner has emerged yet in the technology race and there will probably not be a single positioning technology solution. Rather, there will be multiple solutions – depending on the need and on the price that people are willing to pay. Nokia is, on its own behalf, participating in forming the industry standards for easy adoption of Mobile Location Services.

In Figure 2, using Cell-ID as point zero and moving along the accuracy axis through E-OTD, AF-LT and GPS to A-GPS, it can be seen that as accuracy and resolution increase coverage decreases. One of the problems with standard GPS is the long Time To First Fix which ranges between 10 and 60 seconds. This problem is overcome with A-GPS as the assistance data, which are sent to the handset, significantly reduce the Time To First Fix which currently stands at less than 5 seconds. Accuracy requirements will progressively increase from approximately 1 km now, to approximately 1 m in a few years time.

The various positioning technologies are complementary, there being no single universal solution. Where both accuracy and coverage are important, hybrid technologies may provide an optimum solution. Cellular and Local Positioning technologies can be used to fill in the gaps in coverage from satellite-based systems, like GPS.

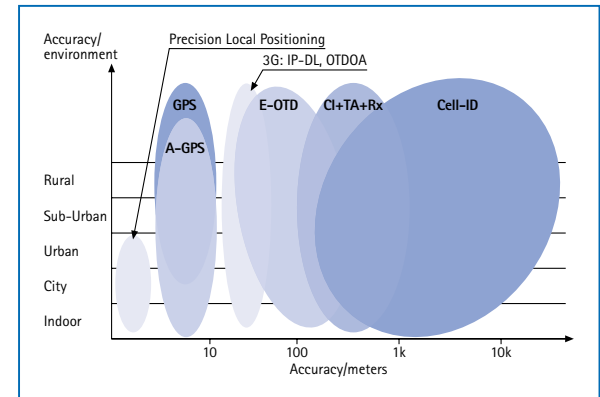


Figure 2. Relative coverage and accuracy of most important positioning methods

Table 2. Location service category mapping

System	Category	Location Technology
GSM	Category 1	Improved CI positioning method. The improved CI positioning method utilizes in addition to CI information, e.g., TA and other GSM-specific measurement data. This accuracy category can be implemented without changes to MS.
	Category 2	GSM-specific E-OTD (MS-assisted/based) positioning technology, which is, standardized for GSM Release'98.
	Category 3	The MS-based GPS concept which is standardized for GSM Release'98.
TIA/EIA-136	Category 1	Cell-coverage based method, which is already included in ANSI-136.
	Category 2	Currently no support in TIA/EIA-136 C standard exists for this category.
	Category 3	MS-based GPS positioning concept that is standardized for TIA/EIA-136 C. Recognizing the commonalities and convergence in TIA/EIA-136 and GSM, the TIA/EIA-136 implementation of NW-Assisted MS-Based GPS positioning technology is harmonized with the GSM GPS concept to the greatest extent practical.
IS-95	Category 1	Cell-ID-based method, which is standardized for TIA/TR45.2 IS-41.
	Category 2	IS-95 specific AF-LT (MS assisted/based) position technology, which is standardized for TIA/IS-801.
	Category 3	MS-based GPS concept which is standardized for TIA/IS-801.

The basic positioning accuracy category is focused on penetration and should be available for all phones enabling fast time to market. The intermediate accuracy level will have a software impact on handsets and the high accuracy category will have a hardware impact on handsets. All three levels of accuracy will exist in parallel in the future.

The accuracy of Cell-ID is primarily dependent on cell radius significantly improves as cell size gets smaller. Likewise, the accuracy of measurement analysis techniques, such as TA and methods that employ network measurements from neighboring cells in certain situations, can reach 100–200 m. E-OTD and TOA (Time of Arrival) in GSM networks have slightly better accuracy profiles (even 50–100 m) but E-OTD is dependent on the visibility of base stations for its performance whereas TOA is dependent on the visibility of terminal transmissions at LMU (Location Measurement Unit) sites. A-GPS is the most accurate method but this is subject to degradation in certain environments, such as inside buildings and “urban canyons”, where the line of sight to satellites is established with difficulty if at all. Indeed any geographical impediment that degrades the signal will result in reduced accuracy. Unfortunately, GPS fails to work in many indoor environments, where people typically spend significant proportions of their time.

Position accuracy and the degree of coverage dictate what type of application can be deployed. Currently most commercial applications use information-based services over Cell-ID due to its broad coverage and cost implications. In cases where accurate but costly positioning solutions are not viable, a solution requiring no modification to user equipment can be offered to all terminal users, thereby making the technology compatible with all cellular telephones currently in use. Whilst Cell-ID accuracy is very low this can be enhanced by a self-location method, whereby the end-users use landmarks and addresses to improve their positioning precision. This in turn makes it possible to deliver more tailored and relevant content. The role of mid-accuracy technologies such as E-OTD is found in the services needing the next level of accuracy, capacity and availability. While E-OTD’s accuracy might not be enough to deliver services such as turn-by-turn navigation and whilst it is important to base any decisions on consumer research, the likelihood is that it is accurate enough for services such as E911, tracking and permission marketing. With A-GPS, it is possible to provide rich applications that users are willing to pay for, such as zonal billing, pinpoint services, self-navigation and emergency services.

Network Assisted GPS (A-GPS) seems to be the preferred solution for CDMA, mostly because of active vendor promotion, and a general belief that a network-based approach will not work because of CDMA power-control peculiarities. GPS might not be the right solution

for E911 because it is expensive to implement on the handset side within the given timeframe. On the other hand, GPS and hybrid solutions are very good solutions for value-added services.

It is essential to choose the optimal technological business solution. Several factors influence the decision making:

- Standards compliant
- Open interfaces
- Optimized network loading
- Interoperability between networks and equipment
- Upgradability
- Scalability
- Support of as many positioning technologies as possible

As a summary, cell-based techniques are subject to the characteristics and behavior of the radio network. Currently, it cannot be guaranteed that the mobile terminal chooses the same network cell every time it is in the same position, due to the fact that the cell ranges overlap. Also, changes in the radio network configuration (new cells, modifications in old cell parameters) affect the cell selection, and may require changes to subscriber-specific definitions. In the office environment, the problem can be partly overcome by using dedicated low-power cells for indoor coverage. By utilizing information from neighboring cells (already available in the MS (Mobile Station) and BSS (Base Station Subsystem) for handovers), measured signal levels, propagation time measurements between the terminal and base station, the reliability of cell-based techniques can be further improved.

In many cases, the cellular signal timing-based technologies can provide better accuracy than cell-based. Their performance depends on the number of measured BTSs (Base Transceiver Station). Nevertheless, the characteristics of radio network behavior, such as reflections caused by, e.g. buildings, can cause severe problems to these technologies. These technologies also require software or hardware support from MS, BSS and NSS (Network Subsystem), depending on the technology used. In a mobile terminal, normally only software support is required.

It seems that both of these basic methods (cell- and cellular signal timing-based) will continue to be developed to provide standard positioning techniques in mobile telephone networks. For the time being, the cell-based methods are the available means of gaining experience of localized services, subscriber preferences, etc. The experience so far indicates that they can be a major driving force in increasing mobile usage, in spite of the current technical restrictions.

In general, there is a trade-off between the accuracy of the location method and the modification needed for the mobile terminals. As a rule of thumb, the better the measurement accuracy the more modifications are needed for the mobile terminals and, therefore, the higher the added costs are for the terminals. Nokia suggests an evolutionary path, whereas Cell-ID, E-OTD and A-GPS location methods complement each other and support different terminals available for different accuracy.



Nokia believes that today’s basic location method (Cell-ID type) for legacy phones and E-OTD-based location services will become a mass market, since only a basic SW update for the E-OTD-capable mobile terminals is needed. Global Positioning System (GPS) is quite accurate, but requires SW and HW modification in the terminals. Market reports estimate that the GPS functionality will add significantly to today’s terminal cost. Therefore, only the high-end market segments will use this location technology during the next few years. With lower prices for the GPS modifications, the GPS technology will become the mass-market technology in the future. At approximately the same time, proximity technologies will be introduced, bringing enhanced accuracy especially for indoors.

- Step 1:* Cell-ID-based location technology available today: Minimum investment for legacy phones
- Step 2:* E-OTD location technology: Better accuracy for new advanced location services – E-OTD-capable terminals will be available only with SW modifications
- Step 3:* Highest accuracy for GPS-capable phones: High-end market segment – GPS-capable terminals will be available with SW and HW modifications

Seize the day

The techniques needed to start offering Mobile Location Services are already in place. Commercial services for location-based tariffing and location-based information delivery have been launched by a number of operators. As more operators get on the Mobile Location Services bandwagon, the need to maintain service flexibility and a growth path must be kept in mind.

For different services, different technologies can be used. In addition to technologies, different services may require different business models, in order to succeed. As more technologies become standardized, it is important for operators to adopt solutions today that will continue using identical platforms and databases that will help in the implementation of new services. This will ensure the leading edge for those operators who have started using these services from the beginning. In particular, the technologies selected in the current, second-generation networks should enable a smooth evolution path to the technologies of the third generation.

Cell-ID-based positioning is a natural way to start offering Mobile Location Services. With this technology, operators can begin to offer basic level services today. Cell-ID gives a solid foundation for the future because all legacy handsets as well as new handsets will support the technology. However, untapping the long-term Mobile Location Service market potential requires more sophisticated positioning technologies. In 2002,

E-OTD will give improved accuracy that will enable different and better services. These services will be, for example, targeted advertisement and more accurate traffic information. By 2003, the 3G era will have dawned, and IP-DL positioning technology will be available. Basically similar to E-OTD, it will improve positioning accuracy mainly due to the smaller network cell size. Around the same time, GPS positioning technology will take positioning accuracy to a higher level. However, due to its high costs, GPS will not be implemented in all handset categories. One can also expect complementary proximity-based Local Positioning, when Bluetooth becomes a widespread technology in 2003.

When choosing the most suitable positioning technology path that will offer an appealing set of services, as well as ensuring future growth potential, operators should look at Mobile Location Services as services that can be optimized to specific application categories and customer segments. Operators need to find out what categories and segments to target in order to select the right positioning technology.

The operator can implement three major revenue models: payment by the end-user, by a third-party, or no payment at all. The end-user payment can be on a subscription basis, as a premium payment, or a payment in the form of increased air-time. The third-party payment model enables, for example, permission marketing,

premium placement, sponsorship, coupons-and-vouchers, as well as transaction fee schemes. In addition to these, the operator may use the location element in its service offering as a means of reducing customer churn, as a differentiating factor, etc. where no actual payments take place. In this case, the operators bear the costs brought by position technology investments.

It is important to notice that there is no single revenue model that fits all applications and services. For example, end-users are not actually willing to pay for location-sensitive call routing, E-911/112 emergency service, or location-sensitive charging and billing. On the other hand, consumers will be happy to pay for child tracking, find-a-friend, and navigation services. Besides, third parties may be keen to pay for advertising possibilities, as well as "slotting" services.

The introduction of complementary mobile technologies such as high-speed circuit-switched data, General Packet Radio Service (GPRS) and 3G networks promise a multitude of information delivery options to suit each segment of an operator's subscriber market – whether location-dependent or not. Entering the information-provisioning market early allows an operator to determine what information is of most use to its subscribers (and how they want to have it delivered) before moving them up the value chain.

The location value proposition is based on an incremental approach to service provisioning with further value-added content being built around an initial request or transaction. For example a request to find the nearest hotel might be followed by further filtering criteria leading to the m-commerce transaction of booking a room. This in turn could be followed by direction information on the hotel's location, which could be displayed on a map if supported by the device.

Mobile Location Services provide the means to reach the goals set by a competitive market. Through personalization and customization services, operators can enhance the value end-users perceive when using the services provided. This provides the opportunity to ask for premium tariffing or to maintain current tariffing levels and move services into the "premium" charging category. While the technology remains terminal-based, the extra equipment required to support the service means that users are less likely to churn once they have made the up-front investment.

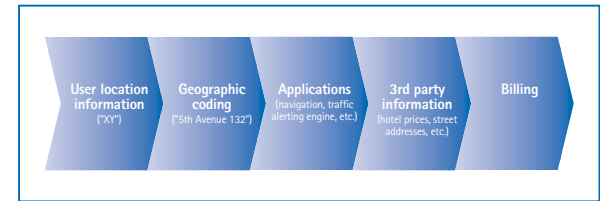


Figure 3.

Application plus content equals service

That is the equation every service provider should remember, whether the service in question is a multimedia, mobile location, or m-commerce service. Users will not want to pay for "services" that do not offer any personal content. For example, in multimedia messaging, the content is generally created by the user him/herself, and in Mobile Location Services the content created around location information is relevant to the user. The value chain for a chargeable service can be presented as in Figure 3.

Given the speed and exponential development of location services, companies should enter the market now to gain a first mover advantage. The organizations that delay their entry and focus on technology and accuracy, will be last in the race for a market share. Cell-ID presents an ideal platform over which to launch information services, but it is important to ensure that the positioning platform adopted is scalable and can be migrated through standards-compliant architecture to take advantage of the increased bandwidth and higher accuracy which will accompany the deployment of 3G networks. Consequently, at this early stage of development, the focus should be on deploying user-friendly applications that familiarize end-users with Mobile Location Services and build a subscriber base for future, more profitable services.



Nokia is committed to standards and open platforms

Mobile Location Services allow mobile users to receive services based on their geographic position. Although there are a number of mobile positioning systems in use throughout the world today, they lack interoperability. The aim of the Location Interoperability Forum (LIF) is to produce a common view on positioning technologies and system solutions to meet the emerging service requirements such as information retrieval and mobile commerce applications.

Given the variety of positioning technologies available, standards are necessary to ensure seamless service roaming and to provide a platform for developing open system architectures capable of interfacing with a variety of application protocols and positioning technologies. To address this issue the Location Interoperability Forum (LIF) has been set up with the objective of creating the specifications and the industry consensus necessary to implement an interoperable, standards-compliant, technology and solution roadmap for location services.

The Location Interoperability Forum (LIF), a global industry initiative, was formed jointly by Ericsson, Motorola and Nokia on 26 September, 2000, with the purpose of developing and promoting a common and ubiquitous Mobile Location Services solution.

The standards endorsed by the LIF will be network protocol- and positioning technology-independent. Mobile Location Services allow mobile users to receive personalized and lifestyle-oriented services relative to their geographic position. Mobile positioning is predicted to become one of the most valuable technologies enabling the creation of value-added services and allowing wireless appliance users to combine mobility with the Internet. More than 100 organizations have already joined LIF. More information can be found at <http://www.locationforum.org>.

Nokia is actively participating in the LIF to define, develop and promote interoperable, common and ubiquitous location services solutions. Nokia supports open standards and common platforms that stimulate growth and enable wide market adoption.

In addition to LIF, Nokia is a key contributor in the following related industry bodies:

- Bluetooth 'Local Positioning' Working Group (<http://www.bluetooth.com>)
- IETF Spatial Location Group (<http://www.ietf.org>)
- MeT, Mobile Electronic Transaction (<http://www.mobiletransaction.org>)
- SyncML (<http://www.syncml.org>)
- Wireless Advertising Association (<http://www.waaglobal.org>)
- WAP Location Forum (<http://www.wapforum.org/>)



A look into the future

In the Mobile Information Society, consumer behavior is driving the development of applications and services. The key to commercial success lies in understanding end-users, their lifestyles and attitudes, and in creating the product-service combinations that match their expectations and needs. Those who deliver winning product categories and platforms with the right technologies will be the victors in the 3G world.

In the quest to further develop and facilitate the next generation of products and services, Nokia will develop a technical architecture that enables high-quality, seamless interoperability between key applications, network environments and user identity/addressing. However, we will limit the complexity of the technical environment supporting 3G applications and services; users simply do not want to be concerned with the underlying technologies.

In addition, Nokia supports open technologies, standards and relevant initiatives that support and facilitate the deployment of global technologies and applications and stimulate market growth.

Bringing together all the key elements and managing the challenges they pose is at the core of this task. We will succeed by identifying the relevant communication modes, by defining the key technologies required to support them and by orchestrating the industry's drive to develop a common wireless platform.

Who are tomorrow's mobile consumers? We need to answer this question in detail since their rapidly evolving demands – in their personal and business lives alike – are driving the development of applications and services in the Mobile Information Society.

That's why Nokia pioneers the open technologies, standards and initiatives behind the terminals and applications for the new generation. We are identifying the relevant communication modes, defining the key technologies required to support them and playing a highly active role in the drive to develop a common wireless platform.

Nokia has a vision of a Mobile Information Society where not only voice but also a significant part of data communications is wireless. In the Mobile Information Society, mobility and the Internet are combined, offering seamless services for end-users.

In the Mobile Information Society, services will be scalable and accessible, wherever and whenever, based on end-user needs. Uniform services will be available through all types of access options, and will always be optimized for the terminal. Nokia's ultimate target is seamless interoperability between technologies, thus enabling seamless services.

Nokia's end-to-end application capability and platforms enable the rapid and continuous launch of new services. The Nokia Mobile Location Services platform (including applications, content, terminals, charging, security, network management, core and radio access networks) ensures open interfaces and guarantees future growth.

Summary

Operators have several components to take care of as they plan for the Mobile Location Services. The choice of positioning technology may be limited, but then, location middleware platform, location applications, location-based content, and terminals form a rather complex ensemble. Nokia has the ability to offer operators a one-stop-shopping experience, providing complete end-to-end solutions for Mobile Location Services with future migration potential to future networks.

The operator can benefit from an early introduction of Mobile Location Services and enjoy significant economic benefits. Nokia, with its proven track record, can assist the operator in the realization of these benefits.

For the operator, it is important to notice that no single technology can support all Mobile Location Service categories in all environments. A suite of technologies is needed for a comprehensive service portfolio.

To facilitate the take-off of the Mobile Location Services, privacy issues must be addressed to facilitate end-user comfort and accessible APIs must be implemented to deliver an open market platform.

In the end, open standards and platforms in Mobile Location Services ensure everybody benefits by lower costs, earlier terminal deliveries and faster service creation. An open, common platform for all the key players of the industry will enable interoperability between different terminal and operator service platforms.

Nokia's end-to-end solution for Mobile Location Services facilitates new styles of communication that respond to the needs of the Mobile Information Society – a society where business and personal lifestyles are changing and evolving ever faster. This calls for flexible products and services that facilitate and support our new routines, and provide pleasant experiences. Communication is at the heart of people's lives – and as a result, the mobile phone is infused with a rich new meaning.



Glossary

AF-LT	Advanced Forward Link Triangulation
A-GPS	Assisted GPS
ASP	Application Service Provider
BSS	Base Station Subsystem
BTS	Base Transceiver Station
E911	Enhanced Emergency Call (US)
E-OTD	Enhanced Observed Time Difference
FCC	Federal Communications Commission
GPS	Global Positioning System
GPRS	General Packet Radio Service
IEEE	The Institute of Electrical and Electronics Engineers
IP-DL	Idle Period Downlink
LIF	Location Interoperability Forum
LMU	Location Measurement Unit
MLS	Mobile Location Services
MS	Mobile Station
NSS	Network Subsystem
PHS	Personal Handyphone System
RTT	Round Trip Time
SAI	Service Area Identity
SMS	Short Message Service
TA	Timing Advance
TOA	Time of Arrival
UWB	Ultra Wideband
WAP	Wireless Application Protocol

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