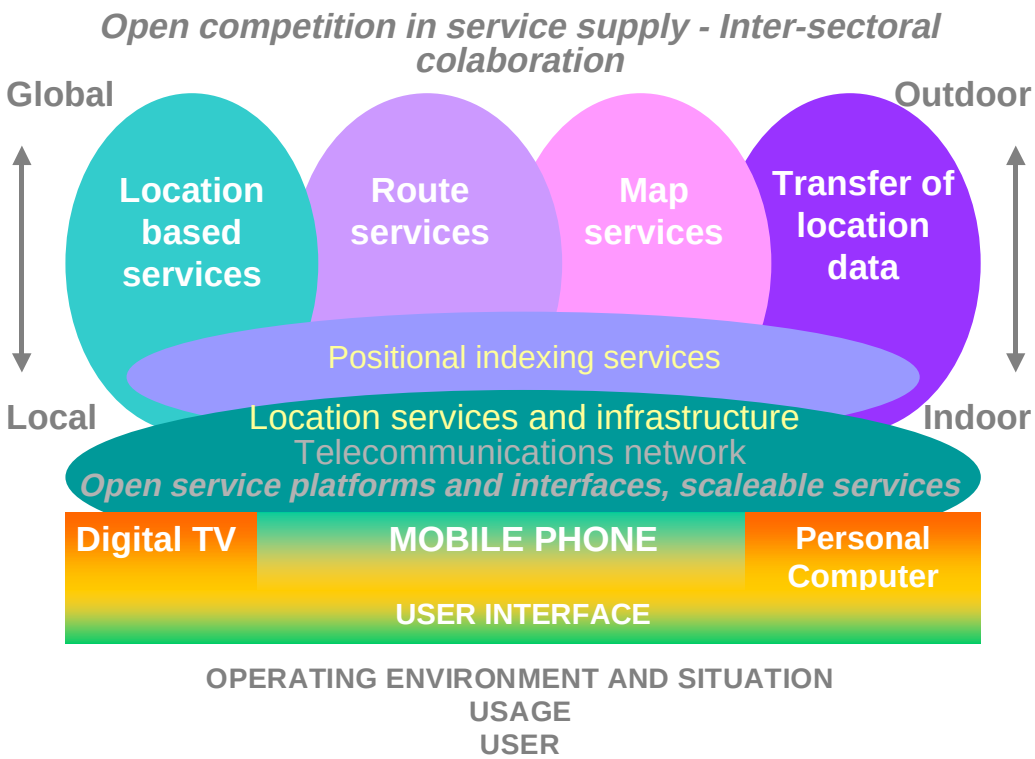
VTT TIEDOTTEITA

Personal Navigation

NAVI Programme 2000–2002



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Abstract

The planning project for the Personal Navigation (NAVI) programme proposes a three-year national programme. About one hundred experts from enterprises, the administration, research institutes and universities took part in the planning project under the leadership of VTT Information Technology. The development of technologies and markets, the usability of devices and services, and legal and ethical issues were examined in the planning project to serve as the background and starting point for the programme. This report summarises the information gathered in the planning project and seeks to present an intelligible analysis of the topic.

Chapter one examines the creation of the mobile multimedia market, the structure of personal navigation's value chain, different scenarios and concepts concerning the nature of the market and competition, and co-operation issues. Location-based services are expected to become a significant part of the mobile multimedia market globally. There will be intense competition between mobile portals, and user groups' own services will play a key role in shaping the usage culture.

Chapter two deals with the key functions and service contents of personal navigation. Personal navigation involves positioning the user and using information on positioned sites, phenomena and services to help the user choose the route and mode of transport necessary to reach a particular destination in both indoor and outdoor environments. Navigation services should answer the user's questions about the location of the user him/herself, some other person or selected site, and should provide guidance by different routes and modes of transport. It is generally assumed that the personal communicator, i.e. the terminal device, will be a mobile phone or some other small portable device capable of accessing data network services.

Chapter three describes positioning methods based primarily on terrestrial radio or satellite positioning systems. Requirements set for the accuracy of positioning will become greater as the positioning technology is developed. The accuracy of consumer devices has improved from a few hundred metres to a few tens of metres over the past twenty years, and the aim is to achieve an accuracy of a few metres in the near future. The accuracy requirement of consumer devices in particular will be limited by factors such as the costs of devices and infrastructure as well as the size and power consumption of the positioning device. Current methods are not particularly suitable for indoor positioning.

Chapter four outlines the service architecture that would not only be clear and simple from the perspective of device and service compatibility, but also capable of offering a sufficiently diverse range of services. The information system architecture in personal navigation will be a distributed one. The format of the information to be communicated will be a key criterion for the compatibility of applications. Application interfaces should be based on international standards in widespread use, and should be open so that they support free competition in service supply. Internet and WAP standards represent a key starting point. The most important standardisation co-operation bodies as far as personal navigation is concerned are presented at the end of the chapter.

Chapter five examines user needs and motives and the shaping of usage culture. Identification of user groups and their needs is the starting point for user-centred product development when defining product concepts and functions. Technology offers the tools necessary for the development of new devices and services, but the essential thing is how the different usage cultures will adopt new products and how demand and supply will meet one another. User-centred product development will ensure that the products meet the needs and likings of users. Finally, the methods of user-centred product development are described.

Chapter six deals with many legal questions concerning the positioning of people and the exploitation of location data. Topics such as data protection, consumer protection, copyrights to service contents and other rights are examined. Key questions are: When can location data be used? What rights apply to service contents and to whom do these rights belong? What restrictions should be placed on the monitoring of people's movements and what kind of new legislation would the provision of location services require?

The final chapter considers ethical questions posed by the development of personal navigation and the technology that it requires. Innovations and their increasingly widespread use are raising questions and fears among users. For example, on whose terms is the technology being developed and what will its consequences be? An ethical audit and the criteria developed for it will seek to reveal the perspectives of different stakeholder groups and to engage them in the innovation process. Human conceptions and world views are influencing background factors, and a set of values should be defined as a starting point for interaction.

On-going projects concerning the topic of personal navigation as well as the themes of the EU's Fifth Framework Programme's IST programme are presented in the report's appendices.

Foreword

Mobile multimedia is now developing rapidly as mobile telecommunications moves from second to third generation technology. The Internet and its services are coming to wireless terminal devices. The convergence of content and technology is deepening and the market is being reorganised. Different actors want to reserve their place in the mobile digital economy.

Personal navigation is mobile multimedia. The purpose of the development programme (2000–2002) is to develop everyday navigation services on the basis of user needs. In this development work there is room not only for the public and private sectors but also for the consumers themselves. The creation of usable hardware and services will require intensive research, product development, trials and training, but also infrastructure investment and, if necessary, new legislation.

The task of the programme is to produce and test technology and service innovations. The aim is to develop a service concept in which advanced mobile telecommunications allow people find out where they are, how they can get to a destination and where they can find the products and services that they need. In the best case scenario, the programme will also create a network of knowledgeable experts and competitive companies as well as new businesses and export products.

In the background to the NAVI Programme is the Personal Navigation national spearhead project proposed in the National Information Society Strategy co-ordinated by the Finnish National Fund for Research and Development (Sitra). On the basis of this proposal, planning work on the programme began in August 1999 under the leadership of VTT Information Technology. The organisations participating in the planning project either as financiers or as research service providers included hardware and software vendors, telecom operators, media and new media companies, public authorities, universities and other VTT research institutes – altogether more than twenty organisations.

The organisations involved in the planning project were *principal financiers:* the Finnish National Fund for Research and Development (Sitra), the National Technology Agency (Tekes) and VTT Information Technology; *companies*: Arcus software, Benefon, Digita, Intergraph Finland, Karttakeskus, Miragel, Nokia/Nokia Mobile Phones, Novo Group, Radiolinja, Sanoma-Wsoy/Geodata, Talentum/Interaktiivinen satama, Sonera, Suunto, Tekla and Turku Technology Centre; *public authorities*: the Ministry of Transport and Communications, the National Land Survey of Finland, the Finnish Maritime Administration, the Finnish National Road Administration and the Population Register Centre, and *universities and research institutes*: University of Oulu,

University of Tampere, Tampere University of Technology, Helsinki University of Technology, VTT Automation, VTT Electronics and VTT Communities and Infrastructure.

A wider background report based on internal reports of the planning project was produced.

Table of contents

Terminology

Personal navigation means determining an individual's location (positioning), selecting and providing guidance on the required route and mode of transport to a desired destination in either an outdoor or indoor environment, using geographic or spatial information, and information on location-based phenomena and services.

Mobile multimedia means digital, wirelessly transmitted multimedia (text, graphics, sound, video, etc.) information services and applications.

Navigation means determining a location and orientation to a desired destination.

Location-based service, position-dependent service means a service that can be found easily on the basis of its described location with the aid of different kinds of indexing and guidance services. In connection with personal navigation, location-based services form the kernel content and they can be found using the location data of a mobile phone as the search criterion.

Location service, mobile location service generally means determining a location and, in connection with personal navigation, especially determining the location of a mobile phone supported by a mobile telecommunications network.

Geographic information, spatial information is a logical set of data describing the location of an object or phenomenon. Geographic information is typically different kinds of computerised map-based information. In connection with personal navigation, geographic information describes especially location-based services and the routes of different modes of transport.

Location data, position data is data that describes the position of an object within an agreed two- or three-dimensional co-ordinate system (in Finland this is often north and east co-ordinates and elevation above sea level). A location can also be described by an address or by referring to a site of known co-ordinates (e.g. place names or the names of different areas). In connection with personal navigation, location data typically means the location of a mobile phone.

1. Introduction

The aim of the Personal Navigation (NAVI) development programme (2000–2002) is to develop navigation services on the basis of the needs of mobile users. Amongst other things, these service must allow the user to effortlessly determine his/her own position, locate a destination, and receive guidance on how to get there. The navigation services will help the user to find not only locations, services and products, but also the resources and members of organisations. The services to be developed will provide the user with guidance on the use of different transport modes and the routes reserved for them, and will also meet user needs in areas related to travel, tourism and recreational pursuits.

The navigation services will answer the following questions:

1. Where is the desired site or service located?

2. Where is the user him/herself located?

3. What different modes of transport can take the user to his/her desired destination?

4. Where are the members, resources or customers of an organisation located?

The Personal Navigation programme aims to create a comprehensive service that will be increasingly easy to realise as further advances are made in the development and convergence of information and telecommunications technologies. The separate development of information services for individual modes of transport is not enough. Rather, the aim should be to satisfy the needs of users more broadly – at least ”door-to-door” and ”just on time”. The programme will focus on information services associated with the movement of people, mainly for mobile consumers but also from perspective of occupational use. As far as infrastructure is concerned, the scope of the programme is confined to positioning technology. Goods transportation and logistics are included only with regard to finding products.

1.1 Development trends

The development of mobile multimedia is driven by advances in mobile telecommunications technology and different kinds of utility, lifestyle and recreational applications. The needs and expectations of users are shaping navigation technology and the services based upon it, on the one hand, creating a tool for working and everyday

life, and on the other, a means of enhancing recreational activities and leisure-time convenience.

1.1.1 Utility applications and the lifestyle market

The introduction of innovations often follows a path where consumers find ways of using a new tool that the developers of the technology had not envisaged. In business and working life, new tools and operating models are traditionally justified on the basis of the savings, benefits and efficiency gains that they generate. Often initially expensive equipment and applications developed for professional users eventually find utility and lifestyle applications for consumers as the market grows and costs fall. However, the mobile telecommunications market and electronic services on data networks have developed to such an extent that the consumer market already exists as a point of departure. As disposable income and leisure time have increased, the needs of consumers have become increasingly individualised, so it is difficult to predict what kind of tool or service will achieve wide popularity. For example, this manifests itself as difficulty in forecasting the needs of Internet users.

Consumers and different recreational user groups may have a significant role to play in the creation of new markets and services. Examples in the realm of mobile telecommunications include the birth of the text message culture and the popularity of mobile phone ring melody services, which are based on the idea that the consumer produces the content him/herself. One can envisage similar phenomena occurring as mobile multimedia develops and, like the Internet, wireless networks offer a platform for the assembly and distribution of content. The needs of content production and distribution may be both individual and collective, and the background motives may vary from ideological to economic. The thirst for experiences and the need to share them with others have become as important as practical utility.

1.1.2 Mobile telecommunications and convergence

The use of mobile phones is growing rapidly. According to the forecasts of mobile phone manufacturers and the latest market surveys, there will be over a billion mobile phones in use by the year 2003. At the same time the mobile phone is being developed into a terminal device capable of accessing network services such as e-mail and e-commerce services. Conventional mobile phones are being joined by palm-top computers that utilise the mobile phone network or wireless LANs. Terminal devices that are embedded in clothing or in some other way worn on the body, i.e. wearable

computers, are also being developed. Digital television and even radio will in the fullness of time be offered as a portable terminal device.

The main trends in mobile telecommunications are

- Wireless data transfer
- Mobile multimedia

Wireless data transfer is limited to the frequencies reserved for it. The growth in volume of traffic will require methods of transmitting information based on more efficient digital data transfer. The new services will be implemented in the initial stage as a *high-speed GSM data service* (HSCSD, High Speed Circuit Switched Data) via a *wireless packet network* (GPRS, General Packet Radio Service). The high-speed GSM data service already offers the simultaneous use of four parallel channels (38.4 kbit/s). From the year 2001, the packet network will offer approximately the same data transfer rate as Internet modem users are now accustomed to (approx. 50 kbit/s). Possibly from the year 2002, the *third-generation mobile telecommunication network* (UMTS, Universal Mobile Telecommunication System) will provide 5-10 times more efficient data transfer links (approx. 300 kbit/s). The network will probably be quite local at first.

Mobile data networks are also being joined by *wireless local area networks* (WLAN) and other wireless data transfer systems (Bluetooth). These wireless data transfer methods operate in different bands and will offer already this and next year much faster links than mobile phone networks (WLAN 11 Mbit/s, Bluetooth approx. 700 kbit/s), although their coverage is only ten or one hundred metres. *Digital television* (DVB, Digital Video Broadcasting) and *digital radio* (DAB, Digital Audio Broadcasting) are already offering an efficient one-directional data transfer channel (DVB-T as fast as 20 Mbit/s and DAB approx. 1 Mbit/s), which is reserved mainly for radio and television broadcasting, but can be partly utilised for other data transfer.

In ***Mobile multimedia*** the aim is to bring electronic services to wireless terminal devices. Even though the data transfer capacity of mobile phone networks will grow in the near future, its exploitation may be limited by service cost even in the future. Bringing Internet services to wireless terminal devices is less problematic, because wireless local area networks and, in the case of limited information content, digital television and radio offer sufficient data transfer capacity. The mobile phones and other mobile terminal devices supporting HTML already announced have actually been deliberately simplified.

The leading mobile phone manufacturers are marketing the abbreviation mmm (MMM, Mobile Multimedia Mode) as a sibling for www (World Wide Web). The development of mobile multimedia will receive added impetus from the new WAP (Wireless

Application Protocol) standard, which in data transfer can be based on many different technologies, ranging from text messages and GSM data calls to GPRS and UMTS services of the future. WAP has been designed and is being developed especially with a eye to the limited capacity of wireless data transfer. In the future the Internet and WAP will converge. The common denominator is XML (eXtensible Markup Language), which has been used to specify WAP's Wireless Markup Language (WML). The starting point for the development of the Internet is now the proposed XML-based eXtensible HyperText Markup Language (XHTML).

The complexity of portable terminal devices and data transfer rates poses its own challenges to the production of mobile multimedia and the development of a user interface that meets the scalability requirement. It must be possible to access the service using different terminal devices and via different types of data transfer networks.

1.1.3 Growth of mobility and interaction

The information society is continuing to develop and to spawn an ever more plentiful supply of electrical services, which in itself is increasing people's freedom to obtain information, learn new things, do work, engage in electronic commerce, and to interact with other people regardless of time or physical location. On the one hand, this development reduces the need for mobility because these functions can be performed remotely. On the other hand, the electronic network offers the opportunity for human interaction across even long distances and thus increases the need for mobility in order to cement these relationships in person. The improvement of transport facilities and the growth of international trade and other interactions are increasing the mobility of people in their work and leisure time. Increasing traffic is also causing problems such as congestion, the rapid consumption of natural resources and environmental pollution. Ensuring the free flow of traffic, precise guidance to destinations and increasing the appeal of public transport may promote sustainable development. The mobile phone in itself may offer logistical savings in everyday life. The development of navigational services will support this development.

1.2 Navigation technology and services

The development of navigation services can be seen as three trends:

- vehicle navigation
- personal navigation in outdoor environments
- indoor services

In addition to these trends, positioning, identification and positioning technology supporting tracking are also important.

Vehicle navigation has been under development for twenty years and the work continues. The point of departure was route-finding services especially in unfamiliar surroundings, but information serving the free flow and safety of the growing volume of daily traffic has also become important. In the 1980s vehicle navigation began to take shape as a system in which different types of positioning methods (compass & distance meter, inertia, satellite, ...) could be used to display the vehicle's position on an electronic map of the road and street network, and the driver could be given directions accordingly. At first the system's database was quite static (CD-ROM), but with the development of wireless data transfer in the 1990s the systems have been developed in the direction of utilising real-time data (congestion, weather conditions, etc.).

Vehicle navigation has matured into a consumer product and is now in widespread use in the United States and especially in Japan. Annual sales in Europe are currently running at about half a million units. The availability and upkeep of map data sets its own limits on widespread use in small countries such as Finland, where its use is limited to professional transport (e.g. raw wood procurement). The data content and transfer format of road maps is the subject of standardisation work, and in Europe the GDG standard (Geographic Data File, ISO 14825) is widely applied.

Personal navigation has as its starting point the user's need to move about without getting lost in unfamiliar surroundings regardless of the mode of transport, and to receive guidance appropriate to his/her needs and circumstances at any given time. Wireless data transfer allows the user to be offered value added services such as information concerning his/her position, e.g. a map, or information on different kinds of services available in his/her vicinity. One might expect the development of the car phone into a pocket phone will be similarly repeated in navigation applications and products.

It is already technically possible to embed satellite positioning and other positioning methods into the mobile phone. The computing necessary in *satellite positioning* (GPS, Global Positioning System) is being carried out by smaller and smaller microprocessors with lower and lower power consumption. The new Galileo satellite position system is being planned in Europe as an alternative to the US-controlled GPS. In addition to satellite positioning, the *network positioning* of mobile phones, i.e. positioning using the base stations of the mobile phone network, is under development. *Network-supported satellite positioning* is also being developed as a hybrid method.

A number of methods have already been included in ETSI's GSM standards (LCS, Location Services). The development of methods has been given added impetus by a law passed in the United States requiring that from October 2001 it must be possible to determine the location from which emergency calls are made by mobile phone with an accuracy of one hundred metres. The EU Commission is considering the implementation of a similar directive from the beginning of 2003.

Indoor services extend personal navigation services to the indoor environment. The user can obtain more detailed guidance and information on the sites in which he/she is interested. The technical basis for the development is provided by rapidly developing wireless local area networks (WLAN, Bluetooth) and their associated positioning methods. If the consumer's terminal device supports the use of a wireless local area network in addition to the mobile phone network, it opens up many opportunities for indoor services. A local area network can offer site-specific ”local information” and other services such as access to the Internet.

Different kinds of guidance and marketing information and their linkage to a certain location in a department store, museum, terminus and other such public spaces may be the most important aspect of personal navigation. Indoor services can also be connected to a building access control system and to control automation. The premises could be developed into an active environment in which ”intelligent” objects know their positions and if necessary can communicate that information to the consumer or to some management system.

Tracking involves the use of global or local transponder systems to monitor the movements of carriers of objects or sensors. The object to be tracked can be a vehicle, a shipping container or even a wild animal or a person. Possible applications includes search, surveillance and logistical control.

2. Personal navigation service system

Personal navigation services mean services which support the positioning of an individual, the selection and finding of a desired location, and guidance to the location on the basis of different modes of transport. The navigation services can provide guidance in indoor as well as outdoor environments. Even though many aspects of the services will be locally and nationally implemented, the service supply will be based on common international standards.

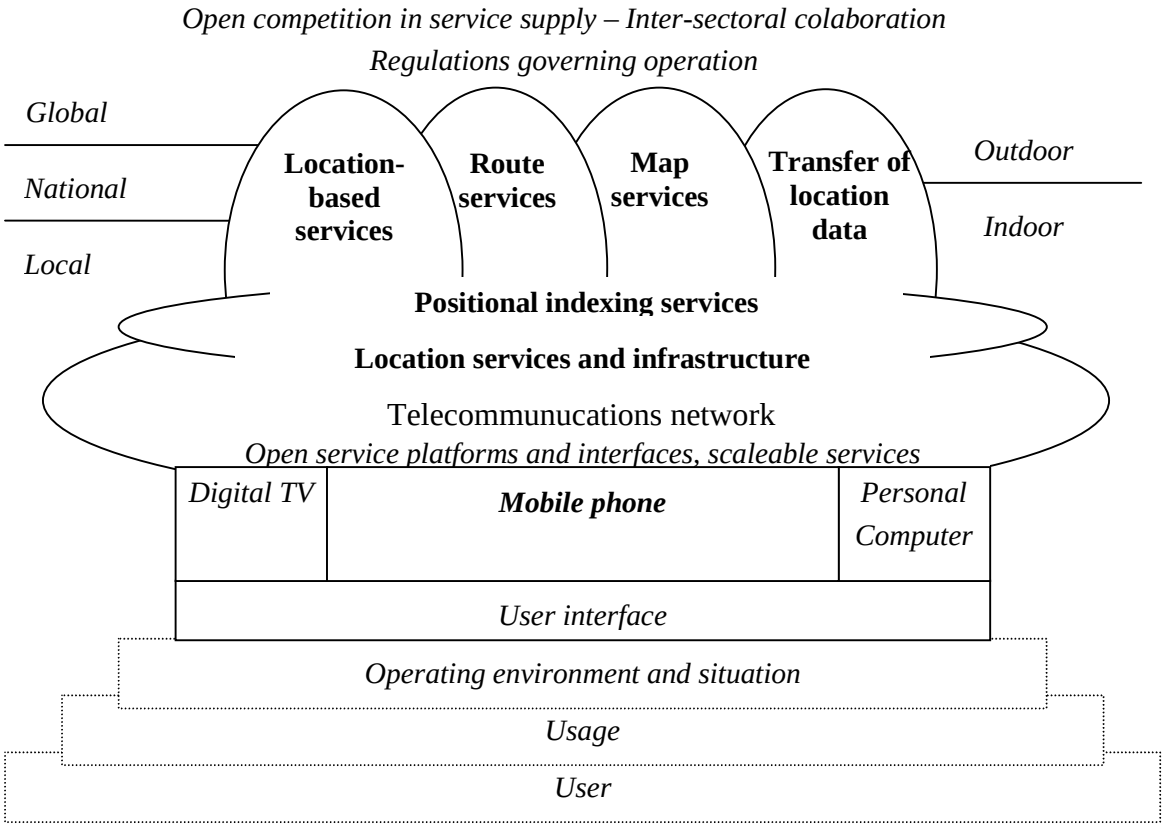

Figure 1. The personal navigation service system.

2.1 Usability

Improving the usability of equipment and services is a great challenge and an important competitive factor. The users' needs and usage situations vary greatly, and the correct prediction and identification of the users' needs are the starting point for usability. Navigation phones and services can be targeted in the same way at both the young and the old, at both work and leisure-time usage, at consumers in Finland, Europe and

globally, etc. The equipment manufacturers believe that differing uses will be catered for by dedicated devices.

Ultimately the users will create new usage cultures through their own choices and will decide what works and meets their needs through their own experiences. Collecting and analysing their experiences can produce invaluable information from the standpoint of product development and business success. The designers of advanced concepts have already learned the importance of utilising such information. The challenge is that design must be predictive and not retrospective. Greater emphasis than at present should be placed on the perspective of usability and the concept's ability to satisfy user needs.

The technical usability of services are primarily affected by the

- user interface
- terminal devices
- information content and structure

The ***user interface*** can be text-based, graphical, auditory, sensory (haptic) or a combination of the above. The graphical user interface is leading the way, but it is being challenged by the rapid development of speech control. The size of the device and its display as well as other characteristics (e.g. graphical resolution and number of colours) set limitations on the use of services. The operating environment and situation (e.g. vehicle control) can also significantly limit the use of services and set special requirements for the user interface. For example, the user interface and other forms of guidance, such as different kinds of graphical and spoken turning instructions, suit different kinds of usage situations. The service needs of the users vary greatly depending on the specific context of work or leisure-time usage. The different lifestyles of the users in themselves generate different kinds of needs and requirements for the content and usability of services.

Terminal devices are being rapidly developed with regards processing, memory and data transfer capacities, display technologies and power consumption. Personal navigation services will be accessed using different terminal devices, such as the mobile phone, the personal computer and digital television, typically with the aid of generic browsers. Portable terminal devices based on wireless data transfer are best placed owing to the nature and purpose of the services, although fixed network terminal devices will find uses, especially in the planning of journeys either in advance or at suitable service points along the route. The technical positioning of the terminal device will bring many opportunities to the development of services and significant value added to the terminal device user. Wearable computers are one trend of development in terminal devices.

Information content and structure have a significant effect on service usability. The clarity, readability and understandability of information is underlined especially when using navigation and other telematic devices in traffic, e.g. when driving a vehicle. The information must not be contradictory, nor may it lead to incorrect actions and thus dangerous situations, nor may it overload the user cognitively so as to interfere with some primary function. As the devices become more versatile, the information and functions must be structured so that the risk of user overload is avoided.

The usability of mobile multimedia services is affected by the entire service chain from data acquisition, transfer and delivery to the end-user. Regardless of the complexity of the service chain, the user should always be well informed about the quality of the information he/she receives and about who is responsible for its quality (e.g. the accuracy and up-to-dateness of maps, hours of service availability, price tariffs, etc.).

The short time window during which it must be possible to transfer the message to the user's terminal device and deliver it through the limited user interface in an understandable form is a special requirement of personal navigation.

2.2 Services

The supply of services is visible to the users as different service applications, in the background of which can be generic services and technologies (data management, customer administration, data security,…).

Service applications can support all modes of transport (walking, skiing, vehicles such as the wheelchair, bicycle, motorbike, skidoo, car, taxi, bus, train, ship, plane, etc.). The services can include address, route, timetable, weather, accommodation, restaurant and other guidance, traffic and travel services as well as descriptions of any commercial and public services to be positioned.

The services can help the user to find different kinds of open service points (pharmacies, service stations, flower shops, restaurants, etc.) and different kinds of events (concerts, exhibitions, sporting events, cultural and religious events, etc.). The services may be associated with different hobbies (rambling, sport, nature, fishing, hunting, boating, caravanning, the arts, etc.). The service content can be information on different kinds of sites and activities (nature trail, shopping trips, sight-seeing excursions, etc.). The nature of the information can be travel directions, historical and cultural information, marketing and product information, programme and event information, official regulations, etc. Positioning in the indoor environment will facilitate different kinds of guidance services when looking for specific indoor areas and

products, as well as background and product information services when they are found (exhibitions, fairs, department stores, museums, etc.).

Safety is enhanced by the automatic transmission of the terminal device's location data when making emergency calls. Positioning and the transmission of location data can also be applied in connection with different kinds of orders (e.g. ordering a taxi, consignment of goods) and when trying to trace a lost person, animal or object. The terminal device user may also need to send information on his/her location to the home, workplace, friends, etc.

Generic services mean services that are not tied to any specific application. Positioning, map and route services can be regarded as generic navigation services. Moreover, general services based on the above could be the transmission of location data to another terminal device or service centre, and surveillance based on positioning.

The definition of location by means of co-ordinates is a universal generic solution and it supports the standard use of map and other location data in different applications. Maps, aerial and satellite photographs, and other types of location data, including three-dimensional models, already exist but converting them into navigation services will require refinement of the data and product development of the services. The quality, up-to-dateness and detail of the material can always be improved within the limits permitted by costs and benefits. Conversions between the co-ordinate system and the street address system are generally necessary. The limitation of map information on the basis of the user's location or the site he/she is looking for is also a generic application, in which not only location data but also any speed and direction data in the case of a mobile site can be exploited. Calculating the route between two or more points using different criteria (shortest, quickest, cheapest, "most interesting", etc.) is also by nature a generic task.

With regard to generic services, consideration must also be given to the question of whether the nature of the network location service is such that its provision, availability and exploitation opportunities should be assured and controlled, if necessary, by means of regulations.

2.3 Value network

The main points of departure for the construction of the value network are

- vertical partnership and horizontal competition in the value chain
- sectoral roles and collaboration

The parties involved in the personal navigation ***value chain*** and network are

- equipment manufacturers
- telecom operators and service operators
- data processing service providers and software houses
- new media companies, publishers and other content producers and developers
- the land survey and population register authorities, other national and local authorities (transport, safety, emergency services, health care, electronic public services).
- service chains of different sectors (trade, tourism, restaurant, service stations, etc.) and self-employed transport operators.
- different official and unofficial user organisations
- research institutes, universities and colleges
- standardisation and other co-operation bodies

Telecom and other service operators or organisations that already have an extensive and well-established customer base are regarded as the parties with the most potential as providers of integrated services.

Customers using navigation devices and services will expect them to satisfy their basic everyday needs and their desire for lifestyle and recreational services. Typical first-wave users might be people working in occupations based on or requiring mobility and consumers who can make use of navigation services in their hobbies. As safety-enhancing and different kinds of special services are developed, the elderly and physically disabled may form an important user group. From the standpoint of market development it would be important to identify at the earliest possible stage the users' fears and concerns of the new technology and to find solutions that would allay them.

The service markets are likely to be simultaneously local, national and global. The services will be implemented and gradually diversified as the terminal devices and data transfer technologies develop. The starting point should be a service interface based on common international standards, which will promote competition in the supply of both hardware and services. A mobile portal architecture based on a local portal architecture

that is scalable to different terminal devices and covers both private and public sector supply will be needed to ensure the supply of uniform and usable services for mobile users.

The market can be constructed *vertically* with, for example, telecom operators or equipment manufacturers acting as the integrators and accelerators of service supply. From the perspective of the consumers and market renewal in the long term, it would be advantageous if the market were an open network in which competition is ensured by several jointly acting *horizontal* layers such as equipment manufacture, data transfer and value added services.

The more extensive and diversified the service supply becomes, the more necessary it will be for the user that service indexing services are available. The user will be supported initially by the service portals but later by meta data that positions and describes the service. Then the services can be profiled and specialist search engines can help the user to find the services that best meet his/her needs.

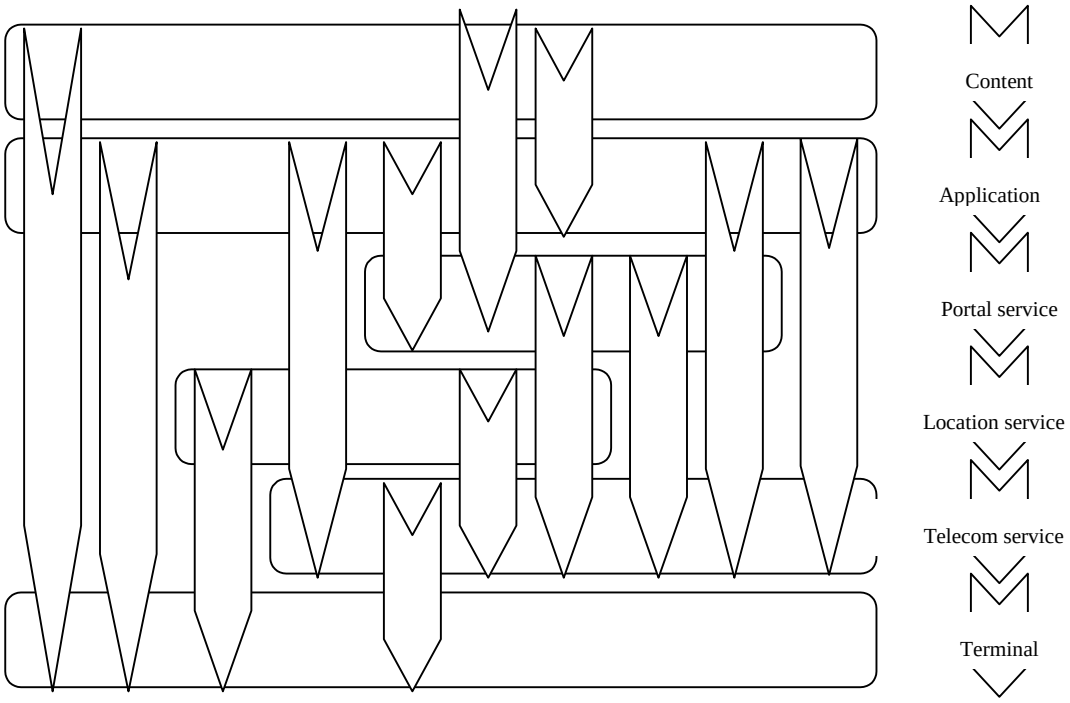

Figure 2. Horizontal functions of the value network and examples of the vertical service chain's partnerships.

The ***private, public and consumer sectors*** not only play their own roles but also work together in close collaboration. The supply of services consists of market goods, public goods and "club goods" produced by the consumer sector itself. Inter-sectoral collaboration is often necessary in the development of new services and also in the production of goods. For example, companies can add value to the public sector's

register and map data to meet consumer needs. Companies can also provide servers and generic data management solutions to serve as a basis for consumers' "club goods", and the public sector can support the creation of added value in their own data resources and by updating the data associated with them. Examples of synergistic collaboration areas include public transport, recreation and sports, and travel information services.

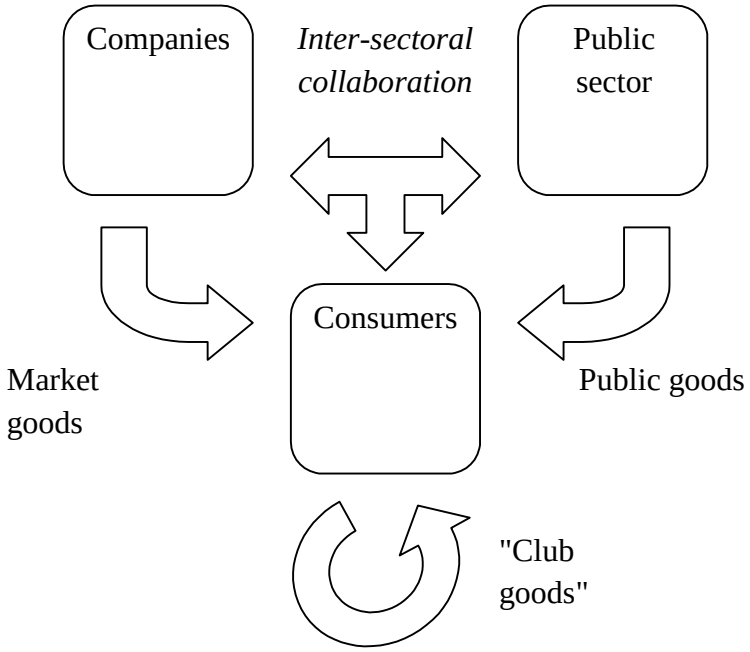

Figure 3. Content and service production.

The forms of collaboration between the public and private sectors are still rather undeveloped in the process of adding value to the public sector's data resources. Rapid technological development and convergence is continuously changing the market's starting points and giving rise to new markets for information products and services. There is a need to experiment with different kinds of collaboration models in the refinement of raw data and the creation of new services. The role of micro-enterprises as innovators of new products and businesses may be crucial. In the development of content we will see the emergence of many new distribution channels and the possibility to publish produced data content just once, followed by automatic tailoring to different usage environments.

The input of consumer organisations is regarded as possessing great potential, and their possible role as collectors and updaters of information should be put to the test. Club goods may be extremely important in recreational and life-style services, which may account for a very significant share of the market for personal navigation services. The

provision of generic platforms to the social innovators of user organisations may prove to be an important area of product development.

2.4 Regulation

Regulation will play a role in guiding the development of services. The handling of personal location data in Finland is governed, depending on the situation and interpretation, by the Personal Information Act and the Telecommunications Privacy Protection and Data Security Act. The monitoring and surveillance of a person is also subject to interpretation of the criminal law concerning domicilary peace and electronic surveillance and to a law on the protection of privacy in working life, which is now being prepared for enactment. Other legal questions include the copyright of data material used in the production of services, the protection of lists and databases, and questions concerning direct marketing, the ordering of services, and consumer protection.

The starting point for the use of navigation services will be the initiative and permission of the customer or his/her guardian. The mobile phone operator will be allowed to position the customer's mobile phone when the customer has given his/her consent. The performance of a statutory official duty may also be a basis for the positioning of a person. The user him/herself must decide on the transmission of his/her location data for the purpose of ordering a value added service. The navigation service provider must clearly inform the customer about the recipients of his/her location data and on what conditions the information will be passed on.

If the customer so desires, he/she will therefore make an agreement with the operator on the use of the location service. The recipients of the location data will be specified in the agreement. The options are:

- the customer him/herself
- a party specified by the customer (e.g. value added service provider, service integrator or another customer)
- anonymously to a party specified by the customer

In all cases the release of location data will occur on the initiative of the customer.

Legislation should anticipate new developments and open up opportunities for new functions.

2.5 Ethical questions

The points of departure for the ethical audit of navigation services are the behaviour, hopes and fears of the users. Consumers have conflicting encounters with new products and they are not always aware of what needs the products are supposed to satisfy. The products gradually find unexpected uses and contribute towards changing the culture. The ethical audit draws attention to ethical standards as well as their grounds and consequences. Key questions include what kind of human concept or world view is in the background and whose interests does the development serve. Credibility dictates that the values must be stated publicly and the choices justified.

Personal navigation throws up many ethical questions and gives rise to many fears on the part of users. Will there be an explosive growth in the amount of "tracking" data and how will the use of location data for controlling consumers be avoided? How can the user cover his tracks if necessary? There are major differences between people and different groups in the adoption of technology. Will those who quickly adopt the technology gain a significant advantage over those who do not, and will the new services lead to inequality? In the future will ordinary people be able to manage without a navigator? How will the new technology change people and the culture – will it lead to a helpless dependence on the technology?

The following tensions and conflicts are common when new innovations are encountered:

- Freedom of choice – Excessive dependence on technology
- Life control – Total chaos
- Social integration – Isolation
- Engagement – Alienation
- Efficiency – Inefficiency
- Satisfaction of needs – Creation of new needs
- Expertise – Lack of expertise
- New technology – Redundant technology

These conflicts and tensions are equally apparent in individuals and in organisations.

3. Programme aims

The overall aim of the programme is to develop and test infrastructure, devices, software and services within the framework of consumer demand and the possibilities of technology. The services must help people to navigate on work-related and leisure journeys, to choose the route and mode of transport necessary to reach a particular destination, and to find the service or product that they desire. The services will be based on mobile multimedia and will be available in both outdoor and indoor environments.

The purpose of the programme is to develop a service system based on mobile telecommunications and positioning that will help people to navigate their way to and get information on the places, products and services that they require. The programme aims to identify significant benefits and applications of personal navigation and to create new markets, which will require significant public and private sector investments in research, product development and infrastructure.

The programme will run for three years (2000–2002) and its direction and emphases will be adjusted annually.

The detailed aims of the programme are:

I To promote the creation of new businesses and social innovations in the application of navigation technology in different programme areas.

II To pilot and productise personal navigation location services and to promote the development and application of navigation devices and infrastructure.

III To evaluate and develop the usability of devices and services, collect feedback on the services from users, and clarify user needs for further development of the services.

IV To monitor and evaluate developments on international service markets, relevant research, and standardisation and technological development, and to promote the success and interests of the involved parties in international competition, collaboration and European research and development programmes.

V To report on personal navigation services and their development, and to organise seminars on the subject, product and service presentations and familiarisation visits.

VI To promote service compatibility and competition in service businesses by developing a standardised service architecture, by applying international standards, and, if necessary, by influencing their development and amending the legislation governing the field.

VII To increase the interaction between on-going and future projects, to promote networking and the development of expertise and processes, and to generate synergy benefits for the involved parties.

VIII To promote collaboration between the public, private and consumer sectors, and to test new operating models capable of exploiting the consumer sector's own content production and the public sector's data resources in the supply of personal navigation services.

The programme will seek to contribute to the achievement of the goals set for the development of Finland's information society, to produce easy-to-use and secure information and electronic services to satisfy the needs of users in their working lives and leisure hours.

In addition to the foregoing, the programme's social goals include improvement of the quality of traffic, travel and hobbies by guiding people precisely and smoothly to the desired destination and to help them to avoid unnecessary congestion or wrong choices. The services to be developed in the programme will enhance the appeal of public transport and improve the mobility opportunities of the elderly and physically disabled. The programme will promote the development of versatile information services and mobility-enhancing service infrastructure within the framework of demand and the opportunities offered by technology.

4. Links with other programmes

The focus of the NAVI Programme is on navigation services to be developed for personal use. The same choice of perspective is also found in the National Technology Agency's USIX programme and the European Union's IST programme. There are a number of programmes with content related to the NAVI Programme, e.g. the Ministry of Transport and Communication's telematic and logistical TETRA and KETJU programmes. There are also many research projects with related themes. The NAVI Programme has links to other spearhead projects of the Information Society Programme as well.

Personal navigation is one of the six areas of emphasis in the National Technology Agency's ***User-oriented Information Technology***" (USIX) technology programme. One of the programme's other areas of emphasis is active environments, which is closely associated with indoor navigation in particular. The USIX programme will run from 1999–2002, and it is continuously open to corporate projects. The first round of research project applications ended at the end of October 1999 and it attracted a number of project applications concerning personal navigation. The National Technology Agency has also launched the ***Software Products*** (SPIN) technology programme, and one of its projects focuses on mobile telecommunications software products and innovations.

Research programmes of the European Union have included many research projects on related themes, especially telematic research projects involving Finnish participants. In the ***Information Society Technologies, IST*** programme of the EU's Fifth Framework Programme, positioning applications are highlighted in connection with the development of traffic and travel services, and especially in the form of the ***Info-mobility*** theme that will be added to the year 2000 programme, the application round of which will open in September 2000.

The Ministry of Transport and Communication's ***Transport Telematics*** programme (TETRA) is laying the foundations for personal navigation services. In particular, the development of a traffic information system covering all modes of transport will provide the main information infrastructure for the production of consumer services. The NAVI Programme will partly extend the Transport Telematics programme and will seek to ensure that the benefits of the transport telematics system are passed on the users of different modes of transport. The FIST group set up by the Ministry of Transport and Communications has acted as a forum for the development for travel services. Many of the proposed services ideas can be realised through the NAVI Programme.

There are some research projects on themes related to personal navigation underway in Finland. These belong to the National Technology Agency's Telecommunications – Creating a Global Village (TLX) technology programme and Electronics for the Information Society (ETX) technology programme and the Academy of Finland's Teletronics research programme. Every effort will be made to establish fruitful interaction with all of the above-mentioned programmes and also with any other thematically related programmes launched during the period of the NAVI Programme, especially through co-operation with the programmes' co-ordinators.

The NAVI Programme has links with the spearhead projects of the Information Society Programme, such as the Content Industry project hosted by the Ministry of Education, the Electronic Transactions Services project (including the JUNA project) hosted by the Ministry of the Interior, and the Local Information Society project hosted by the Association of Finnish Local and Regional Authorities. Contact with these programmes was already established during the planning stage and is being maintained through the Finnish National Fund for Research and Development's Spearhead Network and other channels. It will be necessary to deepen this collaboration during the course of the programme.

5. Programme organisation

Personal Navigation (NAVI) is a three-year (2000–2002) co-operation and development programme hosted by the Ministry of Transport and Communications. The kernel of the programme is an open information exchange forum, the NAVI Network.

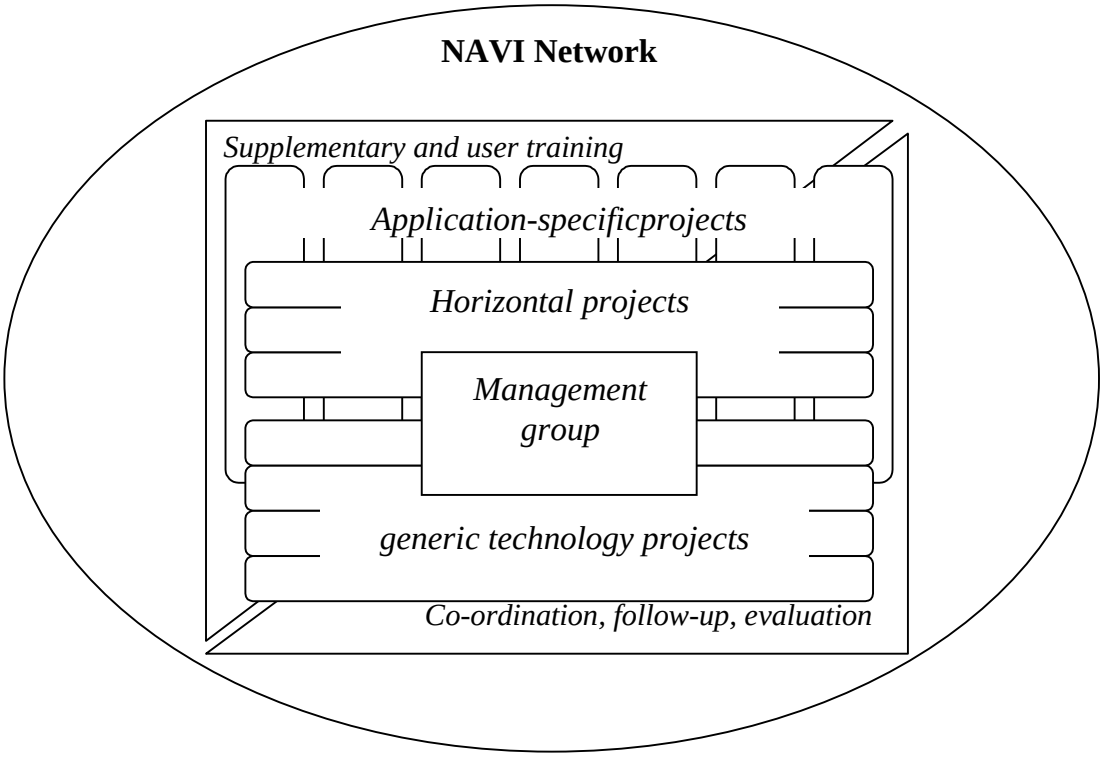

Figure 4. Organisation of the NAVI Network.

5.1 NAVI Network

The NAVI Network acts as the programme's open information exchange forum. Its task is to promote networking and close co-operation between the public, private and consumer sector participants. Information distributed via the network is assembled mainly by the programme co-ordinator and horizontal support projects.

The members of the NAVI Network are involved in the development of personal navigation services and technology. Any organisation that either needs information on the development of personal navigation services and technology or wishes to influence the direction of the programme and the use of public resources may become a member of the network. The network members pay an annual subscription fee (which will not be collected in the year 2000 from those contributing to the programme's planning stage). It must be ensured that the network membership threshold for micro-enterprises is not

too high. Units of universities and research institutes can join the network by producing enough information for network use.

5.2 Management group

The Ministry of Transport and Communications has set up a management group to oversee the different areas of the programme. The group consists of representatives appointed by the programme financiers. The parties also jointly finance the programme's horizontal support projects. Each financier of the programme makes funding decisions in respect of his own participation and, if necessary, agrees with other financiers how the funding of joint projects should be divided.

The programme's management group keeps abreast of developments in the field and the progress of the programme's projects. It can invite experts from different scientific fields to join the group. On this basis it develops and maintains the visions and strategy of the NAVI Programme and creates the prerequisites for market development. The programme's direction is adjusted as the programme progresses and the management group decides on the programme's goals and emphases and thus the direction of fund allocation. The management group approves the programme plan and amendments to it, and is responsible for the programme's internal communications.

5.3 Co-ordination

The Ministry of Transport and Communications has appointed a programme co-ordinator to take responsibility for monitoring the programme and maintaining contact between the different programme participants and other thematically related programmes in Finland and abroad. The co-ordinator follows international market and research developments in conjunction with the support projects. He also takes part in the planning and organisation of seminars as and when necessary.

The co-ordinator acts as the secretary of the management group and the NAVI Network, and relates the views of the network to the management group and any other parties deciding the direction of fund allocation. The co-ordinator takes part in the preparation of projects and invitations to tender, and can also participate as a non-voting member in the meetings of the programme's project groups, bringing the decisions and views of the meetings to the attention of management groups. The co-ordinator is bound by a commitment not to reveal confidential information to any third party.

The co-ordinator ensures that the programme produces correct results and functions efficiently, and together with the Ministry of Transport and Communications and the other parties is responsible for the programme's external communications.

5.4 Programme areas and projects

The practical implementation of the programme is the responsibility of the projects for the programme areas, which have their own management groups and staff. If necessary the Ministry of Transport and Communications will appoint individuals in the different programme areas to assist the co-ordinator. These individuals will prepare the start-up of new projects and will follow the progress of projects in their respective programme areas.

In each programme area there may be one or more projects which are normally put out to competitive tender by the public funding provider. In such cases the financier (client) is responsible for the project's completion as part of the programme, and the contractor is responsible for the completion of the commissioned work.

5.5 Contractual procedures

Each financier applies his own contractual practice, and in the case of jointly funded projects the financiers may agree a suitable practice amongst themselves.

5.6 Quality assurance and evaluation of results

The management group monitors the progress of the programme with the aid of status reports. The projects submit the status reports quarterly and the co-ordinator prepares a summary of them for presentation to the management group. The status reports describe the results achieved, the future outlook, timetables and resources, and assess the effectiveness of the activity. The reports are public unless otherwise agreed because of business secrecy.

At the end of each project the results achieved in relation to the set goals, the problems encountered and the effectiveness of the activity are assessed for the programme's use.

At the end of the programme an independent outside party will evaluate the whole programme.

5.7 Communications and interaction

Internal communications ensures that the members of the NAVI Network receive information on the progress and results of the various projects and on national and international developments in the field (research, standardisation, product development, etc.) and market. The main tools in internal communications are e-mail and the NAVI Network's intranet site, on which up-to-date information on the projects is posted.

The purpose of external communications is to report on the programme as well as its goals and results. Internet websites, brochures and press releases as well as fairs and seminars ensure that the media and the programme's external parties in Finland and abroad receive information on the development of personal navigation and the opportunities that it offers, and on the members of the NAVI Network as potential partners. Efforts will be made to use many communication channels, e.g. industry associations.

The Spearhead Network website (http://karkiverkosto.sitra.fi) that is provided by the Finnish National Fund for Research and Development for all the spearhead projects of the Finnish Information Society is also utilised in the programme's external communications. The NAVI Programme produces news and information on events, projects and publications for the Spearhead Network website and also engages in dialogue. The programme also uses the communication channels provided by the Future Times Consortium (http://nykyaika.lasipalatsi.fi) in order to reach a wide audience and to promote interaction between national and international experts.

The management group approves the communications plan, which is maintained by the co-ordinator. The programme's co-ordinator is responsible for the content of the Internet and intranet websites in conjunction with the projects.

5.8 Exploitation of results

Each project plans the exploitation, marketing/reporting and introduction into use of its own results. The results of each project are reported at the end of and, if necessary, during the project. The project parties handle the reporting in conjunction with the programme's co-ordinator.

The results of the different projects are presented at seminars arranged at least once a year.

5.9 Progress of the programme

The programme will run for three years and the management group meets at approximately three-monthly intervals. The direction of the programme is adjusted annually and the financiers make their own decisions during the programme according to these guidelines.

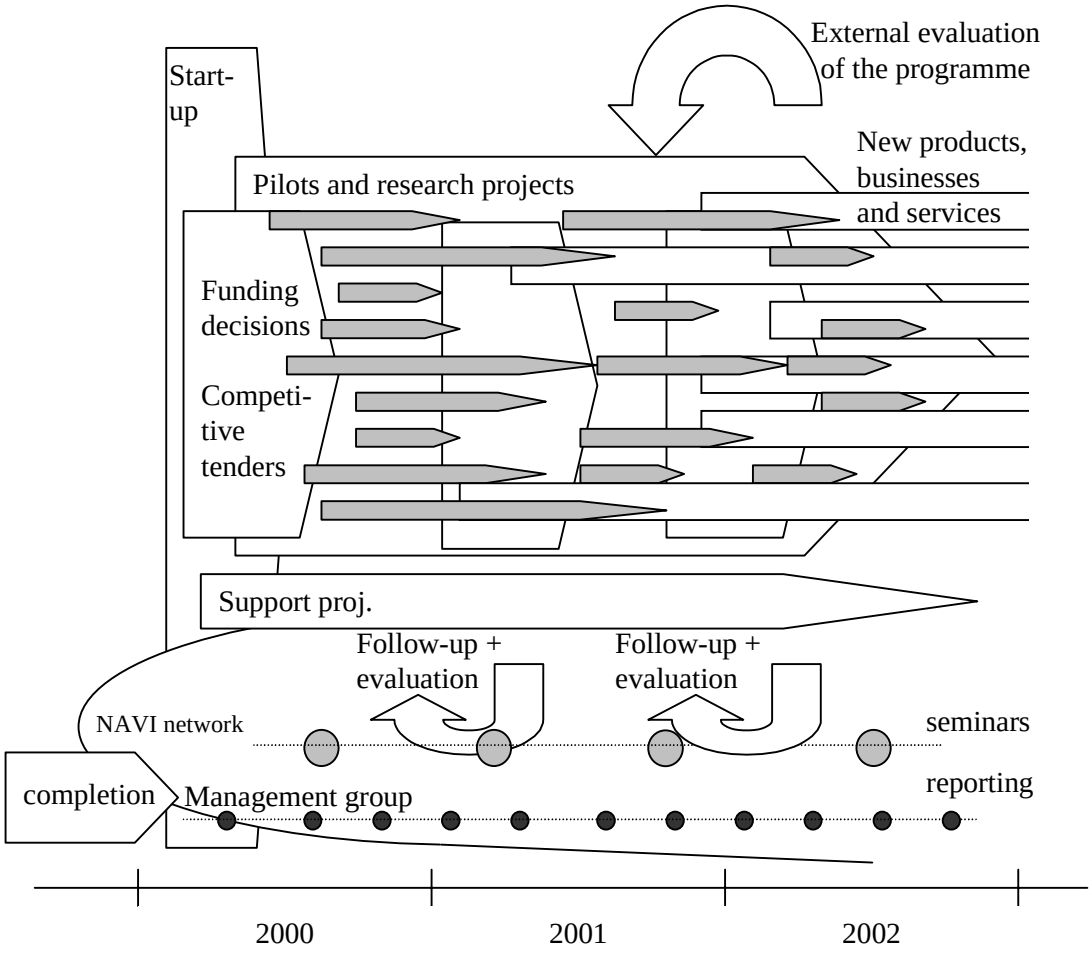

Figure 5. Approximate progress of the NAVI Programme.

6. Programme areas and projects

The Personal Navigation programme consists of research, product and service development projects supporting the above-described goals, legislative revision work, reporting, supplementary and user training, monitoring, programme co-ordination and strategy work.

The programme consists of the following elements:

- Vertical applications
- Generic technologies
- Horizontal support projects
- Supplementary and user training
- Programme co-ordination

The application-specific pilot projects utilise predominantly the same terminal devices and other generic technologies. Largely the same questions and problems concerning usability, service interfaces and regulation are encountered in the pilot projects. It is therefore necessary to include in the programme, on the one hand, horizontal support projects and, on the other, areas of generic technology that will yield universal, application-independent technical solutions. The development and orientation of supplementary training in order to raise the level of expert knowledge will be necessary in both technical questions and the implementation of applications. It will also be necessary to train different types of users in order to carry out trials and collect experiences. The purpose of follow-up, evaluation and programme co-ordination is to produce information for decision-making and strategic work.

In the development of services in the different programme areas the goal will be, where possible and taking account of the nature of the service, independence of distribution channel and terminal device (mobile phone, PC, digital television, …).

With regard to practical trials it will necessary to select areas and locations, where trials will be made for as long as network positioning services and other location services are not available nationwide. Interaction between co-ordination and the application projects will be necessary here as well.

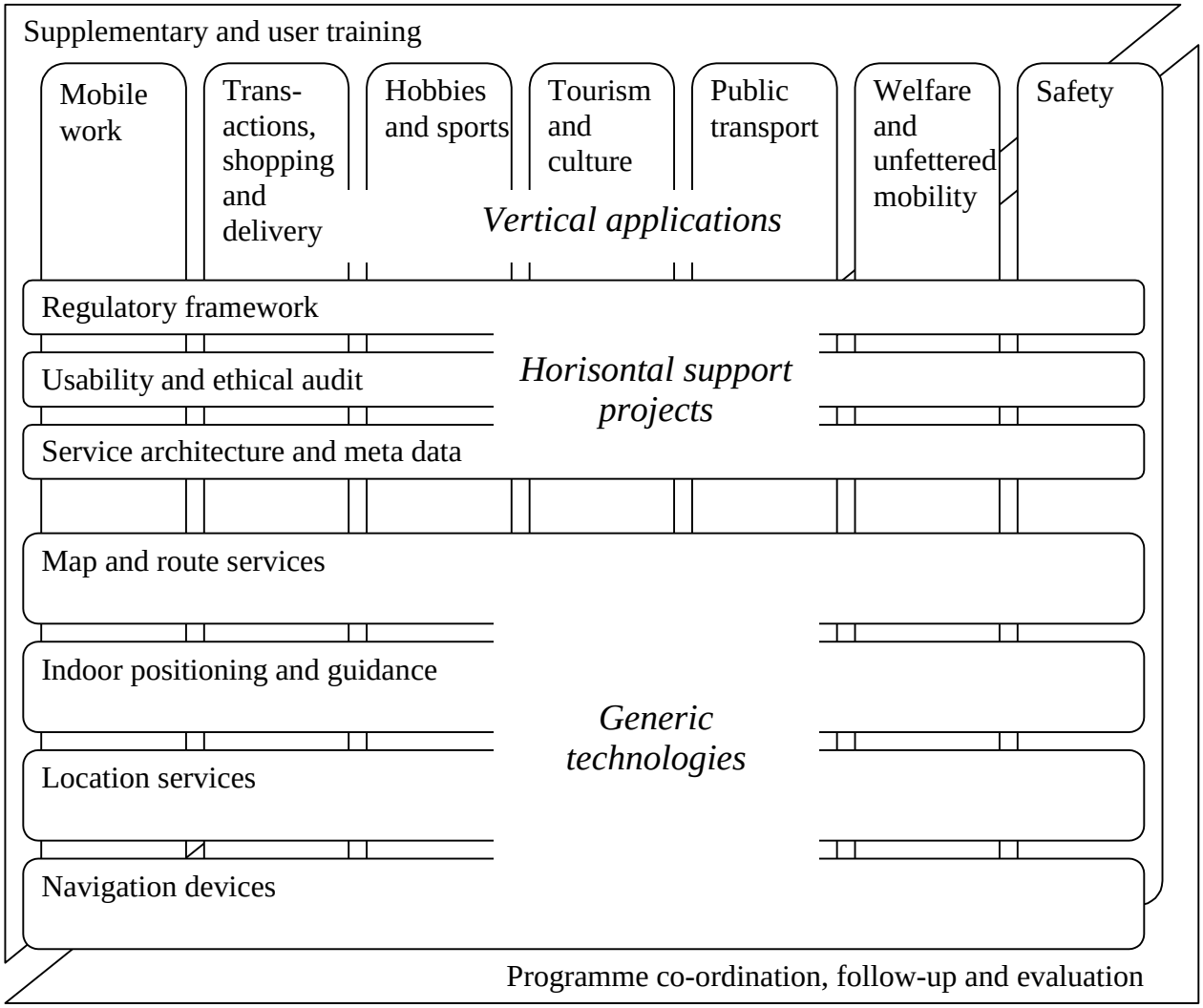

Figure 6. Structure and areas of the NAVI Programme.

6.1 Vertical applications

The vertical applications of the programme are:

1. Mobile work
2. Transactions, shopping and delivery
3. Hobbies and sport
4. Tourism and cultural services
5. Public transport
6. Welfare and unfettered mobility
7. Safety

The boundaries between application areas are not unconditional because the areas are strongly bound to one another. Travel, guidance and other services are often necessary in mobile work. Public transport serves tourism and cultural services. Unfettered mobility is an essential perspective in both cases. Participation in many sports is often dependent on mobility and travel. Emergencies occur in traffic and are a factor in mobility generally.

6.1.1 Mobile work

The problem of finding the destination is typically associated with mobile work. The mobile phone has already become an important tool, and the use of portable computers is increasingly quickly as the size of the machines continues to shrink. Furthermore, information on the environment and its services is needed in mobile work (e.g. ground excavating, real estate selling, etc.). The modest usability of the devices may still be a barrier to wider exploitation of information and telecommunications technology in many jobs. In mobile work the employer often needs to know the whereabouts of his employees and equipment at any given time for the purposes of operational optimisation, the efficient handling of urgent cases, and so on.

Different kinds of control and monitoring systems have long been available for the logistical management of transport equipment. The productisation of services and their application to many different industries and small businesses poses development challenges.

The topics of the application projects include:

- Selling work
- Home care
- Construction
- Property management, upkeep and repair
- Real estate agents
- Security services

6.1.2 Transactions, shopping and delivery

The availability of transaction and shopping services has been continuously changing. It has not been easy for the consumer to keep up with the availability of different services and products in shops and other service points, as different types of joint service, kiosk and service station networks have significantly expanded their product and service ranges and at the same time there has been a trend towards concentration and specialisation in the traditional retail trading sector. The product range and inventories

of traditional transaction points and shops could be linked to a real-time product information service that would inform the consumer of the closest whereabouts of a particular desired product.

As a consequence of electronic commerce, delivery is diversifying and taking on new forms. Models in which the consumer indicates his/her desired pick-up point from a range of alternatives could be applied to delivery. However, this programme will focus on the development of conventional logistical systems.

The topics of the application projects include:

- Positioning of service points
- Linking products and inventories to a location service
- Delivery jobs
- Linkages between personal navigation and delivery.

6.1.3 Hobbies and sports

Outdoor recreation, hobbies and sports can all be supported by information services. People who enjoy the outdoor life need information on different kinds of sites and routes. Information on fishing permits and popular fishing spots are both location-specific in nature. Hunting is often a collaborative pursuit in which information on the position of the group members is required. Positioning and effective information exchange are key requirements in birdwatching. There has been a long tradition of navigation in boating and yachting, and various navigation devices are available in this area. As a starting point in the development of services for various hobbies and sports, it can be assumed that the users will also be potential content producers as long as suitable servers are available.

The topics of the application projects include:

- Location service for outdoor recreation
- Ski track guidance
- Fishing and hunting
- Berry and mushroom picking
- Birdwatching
- Boating and yachting

6.1.4 Tourism and culture

Tourism is a rapidly growing industry. Often finding themselves in unfamiliar surroundings, both business and pleasure travellers naturally need and use a large number and variety of information and guidance services. Personal navigation services

can help the traveller to find services associated with his/her basic needs and according to interest a very wide range of events and locations. On the one hand, the services can be clear commercial applications for shopping excursions and, on the other, guidance services concerning perhaps cultural heritage and ancient monuments or library information services.

Tourism has been a theme in many of the EU's telematic projects, in which new services are demonstrated. In Finland trials have been planned, for example, in the E-18 highway development project, the Matkain project, and in some projects concerning tourism in Northern Finland. The Finnish Tourist Board's system could act as one starting point for the development of information services.

The topics of the application projects include:

- Local weather conditions and forecasts
- Accommodation and restaurant services
- Events
- Local news
- Sights, guided tours
- Cultural environment and ancient monuments
- Library services (e.g. nearest on-shelf copy of a particular book).

6.1.5 Public transport

The promotion of public transport is an aim in itself. The public transport service is to a large extent an information service, the development of which could simultaneously increase the demand for and use of public transport. Getting from place to place requires information on different public transport services, route alternatives and timetables. Planning a journey using several modes of transport poses a challenge because it requires the linkage and interaction of different information systems. The goal in the development of a public transport information service will be to give people a service providing real-time information on public transport timetables and routes as well as any exceptions, delays and service disruptions. It is extremely important that the service is nationwide, multi-channelled and scalable.

The public transport information service has been developed with the advent of the Internet, but it remains fragmented and heterogeneous. Some trials on the use of the mobile phone as a terminal device have been made on the basis of text messages, and new trials based on the WAP standard have started. Positioning offers the trials new opportunities. The traffic information system covering all modes of transport that is being developed in the Ministry of Transport and Communications' TETRA programme could serve as a starting point for the further development of the services.

The topics of the application projects include:

- Local timetable information
- Travel planning covering all modes of transport
- Demand-responsive public transport (e.g. national taxi ordering service).

6.1.6 Welfare and unfettered mobility

Different kinds of care and safety services can derive great benefit from the positioning of mobile phones. People in need of assistance can easily send their location data to a service centre, and such a service centre can trace a missing person. Practical experiences have been collected in the EU's MORE project.

New technology can support the mobility of people whose senses have been weakened by disability or some other cause. People who find it difficult to get about have great need for information on obstacles, routes and transport services on urban streets and in buildings. Other groups, people with prams for instance, may also find their mobility restricted in practice. Factors such as the general ageing of the population underline the importance of collecting and organising this information into services available by mobile phone. Public transport information is beginning to reflect a growing awareness of the needs of different customer groups. For example, obstacles to the mobility of wheelchair-bound people in public buildings have to some extent been inventoried in Helsinki. The perspective of urban planning and building design is receiving increasing attention. For example, a city block in the Arabia district of Helsinki is to be selected as a model site for the Safely Home Without Hindrance Project. As far as existing buildings are concerned, the wider collection and organisation of information into services poses a great challenge.

The topics of the application projects include:

- Care services (e.g. patient monitoring or alerting the nearest physician)
- Route guidance avoiding obstacles to mobility
- Pram navigation (incl. availability of child care rooms, play areas, etc.)
- Guidance for the visually impaired

6.1.7 Safety

Technology is bringing new opportunities for improved safety in everyday life. The mobile phone makes it easy to summon assistance from the exact location where it is needed. Already 30 per cent of all emergency calls are made from mobile phones in Finland, and this proportion is rising by 10 per cent per annum. In the United States the positioning of mobile phones used to make emergency calls will required by law from October 2001. Also in the event of evacuations, the use of mobile phones to contact and

relay instructions to people in danger will be more effective than the present system, as the target group can be precisely defined and the necessary messages targeted exclusively at them.

Efforts will be made to improve traffic safety by means of traffic surveillance and dissemination of the information gathered. The positioning of mobile phones offers new ways of controlling traffic at a reasonable cost level. Such methods have been tested, for example, in the United States.

The topics of the application projects include:

- Positioning of emergency calls
- Evacuation and emergency bulletins (e.g. abnormal air quality)
- Traffic monitoring
- Neighbourhood surveillance

6.2 Horizontal support projects

The aims and projects of the programme are supported by horizontal projects, which are:

- Regulatory framework
- Usability and ethical audit
- Service architecture and meta data

The support projects can be organised thematically by challenging the research institutes to form a working consortium, which will ensure the availability of wide-ranging expertise. The work will be deepened by the research institutes' own research projects.

6.2.1 Regulatory framework

The development of services will be guided by both national and international regulations. The correct interpretation of legislation and carefully prepared contractual matters are prerequisites for successful trails and services. Legislative reforms should, whenever possible, anticipate future developments. Working is an international environment, which can hardly be avoided in connection with electronic networks, poses its own challenges. The availability of services in different countries is an important starting point in personal navigation.

The role of the Regulatory Framework project is to inform and guide the programme participants about the application of regulations concerning the development, implementation, marketing and use of personal navigation service, to evaluation service concepts produced for the market, collect feedback on possible breaches of legislation and needs for change, and to monitor the development of national and international legislation.

6.2.2 Usability and ethical audit

The uniformity, ease-of-use, safety and reliability of personal navigation services are important matters from the user's perspective. The identification and analysis of users' opinions and needs are the starting point for any successful service concept.

The role of the Usability and Ethical Audit project is to develop a set of criteria for the usability of devices and services and to provide guidance on the application of good implementation principles. The project will test the usability of services developed and produced for the market and will provide the developers with valuable feedback. At the same time a set of ethical criteria will be developed to evaluate user-orientation, and the adoption of the technology and the evolution of usage cultures will be monitored. The results of the project and the knowledge gained will be deepened by the research institutes' own usability studies.

User needs will be clarified by means of an extensive interview study as a part of the support project. The study will also support the development of transport telematics, for example, in connection with the safety assessment of using navigation services in traffic.

6.2.3 Service architecture and meta data

International standards are the starting point for the operational compatibility of services and equipment. Their rapid development will be actively monitored and, if necessary, efforts will be made to influence their content. The national architecture constructed to meet the needs of transport telematics will also play its part in guiding the development of services based on public infrastructure. Open service interfaces are a prerequisite for healthy competition and for the development of generic technologies. Operational compatibility of the services will also enhance the usage value of individual services and save resources in their implementation.

As the volume of personal navigation services grows, the users' ability to find and exploit them effectively can be improved by developing by special position-based retrieval methods, which will require the inclusion in the service of meta data that describes locations in a uniform way.

The role of the Service Architecture and Meta Data project is to inform and guide the programme participants in questions concerning the technical service interfaces associated with service implementation, and to monitor the development of the field's official and 'de-facto' standards and practices. The project will evaluate and test open interface solutions produced for the market and will provide the developers with feedback on them. The project will study the needs and initiatives of the participants and will seek to find generally workable solutions that promote the compatibility, scalability and attainability of services delivered via different terminal devices and distribution channels.

The support project will also monitor and, if necessary, participate in the development of recommendations concerning position-dependent meta data, and will carry out trials on the incorporation of meta data into existing services, and on the indexing of services and their retrieval on that basis.

6.3 Generic technologies

The generic technologies serving the programme's different applications are:

- Map and route services
- Indoor positioning and guidance
- Location services
- Navigation devices

Positioning technology, its incorporation into terminal devices, and location services supported by the mobile phone network represent the starting point for the development of different applications in the programme. As the use of mobile multimedia becomes more widespread and further advances are made in the displays of portable terminal devices, the importance of mobile map services will also grow. In addition to the wireless delivery of content, the production and upkeep of these services will require generic systems.

6.3.1 Map and route services

Digital map data is available in Finland and almost everywhere else as well. The quality of this material is variable and its price (especially in Europe) is high, although the opening up of consumer markets is changing the situation. Map services are already present in abundance on the Internet, but the challenge is to bring them to the mobile phone. Image files (formats: .gif, .jpg, ...) are rather large and vector graphics is the generally preferred solution. Its advantages are smaller file size and better opportunities in map visualisation (wider choice of scales, filtering of data content, layering, etc.) It seems likely that the vector graphics format will be a special language based on the XML standard (SVG, Scalable Vector Graphics, GML, Geography Mark-up Language, etc.).

Route optimisation has been highly developed and incorporated into various map and navigation software applications. Route selection sets special requirements for the content of map data (especially in the case of vehicle guidance, when information on the direction of one-way streets and other turning restrictions must be available; in this respect the coverage of data available in Finland is not extensive, although the TETRA/Digiroad project is improving the situation.). There are already examples of route optimisation offered as a network service (e.g. Yellow Pages, the French Webraska and Dutch PalmTop Software wireless service demonstrations).

As far as the generic technology of map and route services is concerned, the challenge is the development of generic mobile vector graphic maps and their related services, and the provision of route optimisation and guidance as a mobile phone service. The incorporation of maps and guidance as well as other content production and upkeep into services will require more and more advanced tools. Close collaboration with the application pilots will be necessary. One service idea could be the provision of map and route services via digital television or super-teletext.

6.3.2 Indoor positioning and guidance

No workable generic solutions have yet been proposed for indoor positioning and even network-supported satellite positioning would not offer sufficient accuracy for indoor guidance applications. One can well imagine uses for a solution accurate to one metre or even a few tens of centimetres in increasingly precise guidance applications, whether it be a question of cultural or commercials services. Indoor guidance mainly for fixed multimedia displays or specially manufactured terminal devices have been developed, for instance, in some EU research projects. The challenge is to integrate the yet-to-be-developed positioning method into general terminal devices.

The boundary between the indoor and outdoor environments is quite fluid and in many applications the starting point may well be “local guidance” and “local information” on limited areas. In addition to plans, three-dimensional models of buildings and urban spaces can also be utilised for guidance purposes. The availability of three-dimensional models is still minimal, although in Finland “Virtual Helsinki” is a notable exception.

As far as the generic technology of indoor positioning and guidance is concerned, the challenge is research and product development of indoor positioning methods. Different guidance applications can be tested in practice, for example, at fairs, congresses and different events, in shops and department stores, museums and exhibitions, and colleges, libraries and public transport termini. The production and upkeep of data content is an essential aspect of guidance systems, for which software supporting two- and three-dimensional modelling will be needed.

6.3.3 Location services

Today’s mobile phones can be positioned by the mobile phone network to at least the nearest base station, which it in itself is sufficiently precise to serve as a starting point for a local service menu, but remains inadequate for the positioning of emergency calls. The introduction into service of more advanced network positioning methods (AOA, OTD, ...) will yield better precision, although some methods do require upgrades of the terminal device software (in practice, they work in new devices). Satellite positioning (GPS) is the most accurate method and its performance in shadow areas and inside buildings can be supported and boosted by the mobile phone network, either by sending correctional data to the terminal device or calculating the location in the network server on the basis of a signal sent from the terminal device. Telecom operators occupy a key position in the supply of location services. Despite this, the customer should be able to select freely the desired value added services in which location data is used as the basic service data.

Address data can also often be used as navigation data, especially when a location cannot be shown from a map and cannot be positioned using the above-mentioned methods. Conversions between address and co-ordinate systems as a generic service will be needed in order to enhance the compatibility of services.

As far as the generic technology of location services is concerned, the challenge is to develop and test different kinds of location services and to create location service systems covering the whole of Finland and supporting different kinds of user needs.

6.3.4 Navigation devices

The development of services is largely dependent on the supply of terminal devices, which often dictates the practical possibilities. Mobile phones supporting different kinds of location services are most suitable for personal navigation, but wearable devices and components are visible on the horizon. In addition to the foregoing, the limits of application development may, of course, be dictated by the device's software or the size and characteristics of its display. The goal is that the same scalable services can be used by different kinds of mobile phones, the personal computer and digital television.

In the future, mobile phones and other portable terminal devices may develop into PC-like general devices for which a range of software and accessories will be available. We can already see on the horizon that such a device will have a browser allowing the use of the same services on different types of hardware. Standard information formats (WML, HTML, ...) supported by generic browsers are therefore the starting point for service implementation. Standards supporting different functions (e.g. Benefon's Mobile Phone Telematics Protocol, MPTP) will also be necessary between the terminal devices and service systems.

Equipment manufacturers occupy a key position in the development of navigation devices. However, devices and services together form a single concept, and it is this whole system that will determine user value. As the supply of applications and services grows, it will become increasingly difficult to market anything other than a mainstream device supporting the broad range of available services.

As far as the generic technology of navigation devices is concerned, the challenge is to develop and test new terminals together with application pilots and other generic technologies. Ensuring usability poses special challenges. Distributed, embedded and wearable hardware innovations also pose a research and product development challenge.

6.4 Supplementary and user training

Seminars dealing with the programme's different themes will be arranged as the programme progresses. The seminars will be targeted primarily at the project participants and members of the NAVI Network.

The technology and applications of personal navigation are being rapidly developed. The information, knowledge and experience gained from programme follow-up, the support projects and other projects will be used in collaboration with the parties

organising supplementary training to develop and specifically tailor supplementary training for the developers of personal navigation services. The training will be provided within the normal competitive framework.

Users of new services will be trained for different kinds of service trials. The training of these users may also contribute to the programme's usability studies. Training and teaching of the necessary skills is important from the perspective of bringing the new opportunities to the attention of different user groups, and co-operation with different organisations is essential in this process.

7. Funding

The NAVI Programme will require funding of about FIM 100 million in the years 2000–2002. The aim is that the public sector's share of total programme funding will be about a half. The members of the NAVI Network will pay an annual subscription fee of FIM 10 000–20 000. The organisations represented in the management group will provide funding of FIM 100 000–200 000 annually for the programme's support projects.

Public funding will be allocated, on the one hand, to universities and other research institutes for basic and applied research, and, on the other hand, to companies for product development work. Funding for the latter will be channelled primarily through National Technology Agency's technology programmes. Public funding will also be allocated to companies and other parties for the development of services produced by the public sector. These funds will be distributed on the basis of competitive tenders issued by different branches of the administration. Private sector funding will be targeted especially at the companies' own research, product development and marketing.

The horizontal support projects will play a key role in the programme. About one fifth of the public funding will be channelled into these projects and the programme's co-ordination function. Public funding for applications will be weighted in favour of service development. As far as generic technologies are concerned, especially research, product development and innovations likely to generate new businesses and export markets in the foreseeable future will be supported by public funding.

In line with development trends in navigation, just under one third of the programme's funding will go to the development of indoor guidance and positioning, one fifth to the development of vehicle navigation applications and services, and a half to other personal navigation applications.

In addition to the Ministry of Transport and Communications, the key public sector financiers will include the Ministry of the Interior, the Ministry of Social Affairs and Health, the Ministry of Trade and Industry, the Ministry of Agriculture and Forestry, the Ministry of Education, the Academy of Finland, the National Technology Agency (Tekes) and many central administrative boards. RAY (Raha-automaattiyhdistys) and Veikkaus are appropriate financiers of several projects. The support of the EU's structural funds may enter the equation in projects that are geographically targeted at support regions. Some projects may also be a part of the EU's research and development programmes and could therefore receive funding through EU channels.

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Abstract

The planning project for the Personal Navigation (NAVI) programme proposes a three-year national programme. About one hundred experts from enterprises, the administration, research institutes and universities took part in the planning project under the leadership of VTT Information Technology. The development of technologies and markets, the usability of devices and services, and legal and ethical issues were examined in the planning project to serve as the background and starting point for the programme. This report summarises the information gathered in the planning project and seeks to present an intelligible analysis of the topic.

Chapter one examines the creation of the mobile multimedia market, the structure of personal navigation's value chain, different scenarios and concepts concerning the nature of the market and competition, and co-operation issues. Location-based services are expected to become a significant part of the mobile multimedia market globally. There will be intense competition between mobile portals, and user groups' own services will play a key role in shaping the usage culture.

Chapter two deals with the key functions and service contents of personal navigation. Personal navigation involves positioning the user and using information on positioned sites, phenomena and services to help the user choose the route and mode of transport necessary to reach a particular destination in both indoor and outdoor environments. Navigation services should answer the user's questions about the location of the user him/herself, some other person or selected site, and should provide guidance by different routes and modes of transport. It is generally assumed that the personal communicator, i.e. the terminal device, will be a mobile phone or some other small portable device capable of accessing data network services.

Chapter three describes positioning methods based primarily on terrestrial radio or satellite positioning systems. Requirements set for the accuracy of positioning will become greater as the positioning technology is developed. The accuracy of consumer devices has improved from a few hundred metres to a few tens of metres over the past twenty years, and the aim is to achieve an accuracy of a few metres in the near future. The accuracy requirement of consumer devices in particular will be limited by factors such as the costs of devices and infrastructure as well as the size and power consumption of the positioning device. Current methods are not particularly suitable for indoor positioning.

Chapter four outlines the service architecture that would not only be clear and simple from the perspective of device and service compatibility, but also capable of offering a sufficiently diverse range of services. The information system architecture in personal navigation will be a distributed one. The format of the information to be communicated will be a key criterion for the compatibility of applications. Application interfaces should be based on international standards in widespread use, and should be open so that they support free competition in service supply. Internet and WAP standards represent a key starting point. The most important standardisation co-operation bodies as far as personal navigation is concerned are presented at the end of the chapter.

Chapter five examines user needs and motives and the shaping of usage culture. Identification of user groups and their needs is the starting point for user-centred product development when defining product concepts and functions. Technology offers the tools necessary for the development of new devices and services, but the essential thing is how the different usage cultures will adopt new products and how demand and supply will meet one another. User-centred product development will ensure that the products meet the needs and likings of users. Finally, the methods of user-centred product development are described.

Chapter six deals with many legal questions concerning the positioning of people and the exploitation of location data. Topics such as data protection, consumer protection, copyrights to service contents and other rights are examined. Key questions are: When can location data be used? What rights apply to service contents and to whom do these rights belong? What restrictions should be placed on the monitoring of people's movements and what kind of new legislation would the provision of location services require?

The final chapter considers ethical questions posed by the development of personal navigation and the technology that it requires. Innovations and their increasingly widespread use are raising questions and fears among users. For example, on whose terms is the technology being developed and what will its consequences be? An ethical audit and the criteria developed for it will seek to reveal the perspectives of different stakeholder groups and to engage them in the innovation process. Human conceptions and world views are influencing background factors, and a set of values should be defined as a starting point for interaction.

On-going projects concerning the topic of personal navigation as well as the themes of the EU's Fifth Framework Programme's IST programme are presented in the report's appendices.

Keywords
mobile multimedia, personal navigation, location-based service, mobile location service, position-dependent service

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