

THE INTELLIGENT DRIVER SUPPORT SYSTEM (IDSS) – OPEN ARCHITECTURE FOR AUTOMOTIVE SYSTEMS: A LOCATION BASED SOCIAL NETWORKING ARCHITECTURE

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ABSTRACT

How system architecture has to be built to relieve social networking services from spatial constraints? This article presents the technical and technological concept behind a Location Based Social Networking Architecture, to make conventional Internet services, Web-Services and Social Networking platforms available easily for mobile applications on the basis of Location Based Services. First the concept is explained taking a brief description of Location Based Social Networking and the resulting requirements for such a platform. Then the focus is on presenting the open system architecture, based on Web-Services, agent, XML and peer-to-peer technology. This paper closes with a summary and gives a short preview of further developments.

Index Terms — Location based social networking, agent technology, peer-to-peer technology, patterns for system design, automotive, intelligent driver support system, car pc, service oriented architecture, micro kernel

1. LOCATION BASED SOCIAL NETWORKING

The term *Location Based Service* constitutes a concept and a technology from the intersection (Figure 1) of Geographic Information Systems (GIS) with spatial databases, New Information and Communication Technology (NICT) for mobile connections with mobile devices and the Internet as a worldwide communication network [7][19][21][24]. The objective of a Location Based Service (LBS) is to offer information over mobile devices dependent from the user's current geographic location [22].

With the invention of the internet in 1962 [9] and the development of the World Wide Web in 1989 [5] a global information and communication network was built, which can connect people worldwide. The wide range, the interactive communication channels and multi-medial possibilities of content delivery have made the internet important for business and private use.

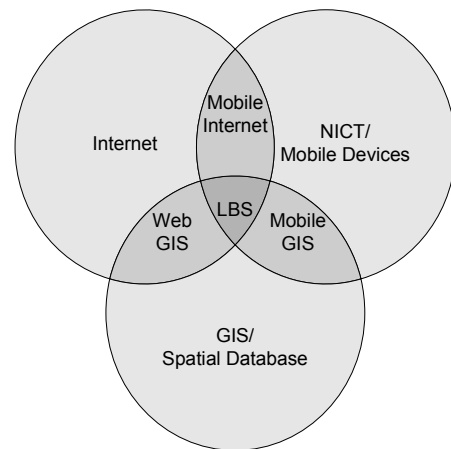


Figure 1: Enabling technologies for Location Based Services [7]

Mobile networks and mobile devices relieved the utilization of the internet from spatial constraints by offering mobile internet access [10]. Geographic Information Systems are used for professional geographic data processing and can be offered web-based in combination with the internet and mobile in combination with mobile networks and mobile devices. LBS in contrast offer public non-professional mobile services as the combination of all three enabling technologies [21].

LBS are used to achieve a certain user objective by supporting user activities. Within the field of LBS, activities are sequences of spatial related user actions. Reichenbacher (2004) differentiates five elementary mobile actions. First action is that the user wants to know where he is located in respect to somebody or something else (*locating*). Second the user wants to search for other persons, objects or events (*searching*) and wants to know the way to the location of it (*navigation*). Additionally he can ask for properties of a location (*identifying*) or ask for the current state of an object or person at a certain location (*checking*) [18]. To fulfill the actions not only geo-information have to be used, additionally the user's current context is important [12]. A context is defined by any information used to characterize a situation

of an entity (person, place or object). Therefore the *spatial context* (location, orientation, height, navigation history), the *social and cultural context*, the *information context* (time, purpose of use) and the *system context* (physical surroundings, system properties) can be differentiated [12][16][20].

One context based activity for a Location Based Service might be the use of existing internet based social networking services, which helps to search, to navigate to, and to check the state of own contacts (relations to other persons). Before such a service will be described the term *Social Network* should be introduced, which was first used by J. A. Barnes in 1954 to depict a global view on social systems [4][14]. A system is built of elements and their relations [6].

Barnes emphasized that a social network is a tool for the analysis of social classes by showing “relations between pairs of persons according each other approximately equal status” [4]. Barnes also stated out, that a social system of a person can be seen in three different social fields where this person builds relations to other persons for. First *administrative contacts* – Social relations in this field are based on contacts of a person with administrative units, which are arranged hierarchically. Second *business contacts* – Relations in this social field are generated by systems based on functionality (social groupings or organizations). The membership of a person in this social field does not remain fixed and this groups or organizations don’t persist through time necessarily. Third *private contacts* – This kind of social field has no borders nor is it coordinated by an organization. It is build up of the ties of friendship and acquaintance. The elements of this field are not fixed: new links are formed and old links can be broken or suspended. Some contacts are inherited others are built up by persons themselves.

In the broader sense all the social fields mentioned above can be represented by a social network. In the direct sense Barnes only called the social field of private contacts as a social network, because the first and second social fields constitute mainly hierarchical structures [4]. For the following consideration social networks in the broader sense are used, because modern tools to maintain social relationships also support all kinds of contacts. Additionally in some lines of business, like investment counseling, distribution channels are built on references by customers or word of mouth, which also form networks of relations.

A social network therefore can be characterized as follows [4]: Each person has a number of contacts (relations to other persons); these contacts have contacts of their own. Each person sees oneself in the center of the network.

The graphical representation is made of nodes, describing persons or groups, which are joined by lines, describing relationships. Such a network is generated by the social life of a person [4]. So this network structure provides opportuni-

ties and imposes constraints for each individual person. The absence or presence of one node could have a substantial effect on the overall social structure of a person [1][2][3][14]. This effect was analyzed by Milgram in 1967. He demonstrated in an experiment that on average every person is six links away from another person [15]. The size of a social network also depends on the society a person lives in. In modern societies, people don’t have many friends in common, so the network size is larger than in small-scale societies, where more overlapping contacts exist [4].

The verb networking means “trying to meet and talk to other people who may be useful” for a person at work [13]. Therefore the term *social networking* as the combination of the term *social network* and the term *networking*, describes **all actions to establish and to maintain a social network for private or business use.**

Emerging developments in the internet technology especially improvements in user interface design and technologies like *Web 2.0* [17] and its key technique *Asynchronous JavaScript and XML* (AJAX) [25] or web services led to the development of services and communities based on the internet as a platform, like wikis, blogs, video, music or photo sharing sites and social networking sites. The latter type of internet-based community platforms enables users to establish and maintain virtual social networks worldwide.

A combination of Social Networking, mobile networks and devices and spatial data processing is a Location Based Service and should therefore be called Location Based Social Networking. This article should answer the question: How system architecture has to be built to relieve social networking services from spatial constraints? Inside the next section a short example scenario for such a service is given.

2. EXAMPLE SCENARIO FOR LBSN

At short notice a person decides to visit a client or friend in a city far away. Because the visit lasts longer than planned he decides to stay overnight. From this point on many LBS are imaginable, like hotel search, restaurant search to invite the friend or the client for dinner or navigating to some locations. The only thing the person has to do is to press a button to request a certain service. Besides of booking a hotel room automatically, which corresponds or comes very close to the individual preferences stored in the user’s profile [10], the combination of social networking features and location based services extends the possibilities of such a person. The person gets information, which of one’s friends are also staying in the same city. Moreover for business people it might be interesting to get not only information of direct contacts than also from contacts of these contacts to extend the network by meeting them. It is also possible to search for people with same interests or events where some of these

contacts may attend. By using a mobile device the user can be navigated to every point of interest, like locations, persons or events.

This example emphasizes that the user can easily access the requested objective with minimal user interaction. Therefore the server side has detailed knowledge about user preferences related to services. A mobile client like a navigation system or a carPC is used as a client to transmit only the request with a coordinate and to receive the resulting information. According to the current user's context the information will be prepared and the system adapts itself to it [12].

3. REQUIREMENTS FOR A LOCATION BASED SOCIAL NETWORKING PLATFORM

From the outlined scenario and considerations of LBS and Social Networking following general requirements can be derived:

- **Adaptation**
To offer an effort bringing LBS the service and therefore the mobile device has to be aware of the context and adapt itself to this condition of life [10]. Four level of adaptation can be identified: first the information level, which means the adjustment of information details (only relevant and location dependent contacts should be loaded). Second the adaptation on technology level, which means the encoding of information for a certain mobile device. The user interface level means automatic adaptation of the user interface to suit certain situations. The last level is the presentation level, which means the visualization of information is adapted to context [21].
- **Privacy**
Although the sensing of context information helps to tailor user specific information delivery, but this raises many privacy concerns as well [21]. A platform should support encryption of data communication and user sensitive data should never be transferred to a service provider without the permission of the user [10].
- **Minimal communication of mobile devices**
Over wireless networks the data throughput should be minimized for every kind of mobile device [10].
- **Simple integration of existing services**
This platform should be understood as an add-on for existing social networking services with the possibilities to aggregate different services in one [10].

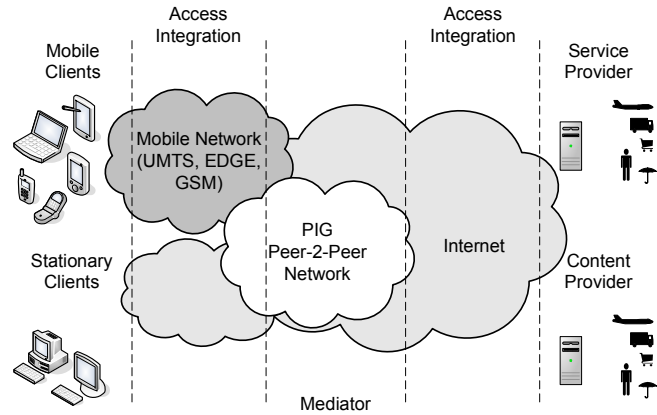


Figure 2: PIG Scenario Overview [10]

- **High availability, scalability and openness**
Every user of a mobile device is a potential user of the platform; hence it has to be focused to mass markets. It must be highly available, scalable and open to be extended [10].

Further requirements can be found in Herden et. al. (2006) and Steininger et. al. (2006).

4. THE INTELLIGENT DRIVER SUPPORT SYSTEM ARCHITECTURE

The objective of the project PIG (Personal Information Guide), which started in the year 2001, is creating a universal and non-proprietary server platform for Location Based Services on the basis of existing internet services, which satisfies the before mentioned requirements as good as possible and develop a mobile client prototype. The focus is on integrating existing internet services (not specific services, which are defined in proprietary products like Multimedia Car Platform, DRiVE or products from automotive manufacturers) and creating a server infrastructure which can be easily connected with existing devices and environments [10]. In Figure 2 the overall setting is shown. Users of mobile and stationary devices have a self-adapting software client (PIG client) on their devices. The Personal Information Guide makes it possible to request services based on location and further information if necessary.

Queries reach the server infrastructure, which is distributed in a peer-2-peer network over mobile or stationary networks. Every user is represented as an autonomous software agent who stores and manages the knowledge about certain user preferences to fulfill the service requests and to hide the sensitive user data. An agent requests a service provider or content provider to answer these requests. The agent only hands out the user preferences needed to fulfill the requests successfully. Both agent technology and peer-2-peer technology are used to fulfill the requirements of minimal com-

munication, adaptation and privacy respectively simple integration of existing services and high availability, scalability and openness. Inside the following sections a special PIG client (IDSS client) will be described in more detail.

4.1 IDSS Client architecture

A stationary client is used to configure and manage the user preferences for certain conditions of life. The user is able to select PIG-Services and therefore to configure them dependent on the user's specific condition of life (user role like private, business etc.). A PIG-Service constitutes a service which is offered by PIG-Servers located inside the PIG Peer-2-Peer Network. Such a PIG-Service aggregates different Web-Services from content or service providers (e.g. hotel booking from hrs.com, motel6.com or varta.de). These Web-Services can be contacted anonymously by the user agents until a specific booking will be processed [11].

An essential task in constructing a mobile IDSS-Client as a special type of a PIG-Client is the integration of local automotive services (like Tuner, GPS, TMC or board computer) together with PIG-Services. The architecture is built on a 3-Layer-Architecture with a micro kernel [8] in the center (Figure 3). It offers hot deployment capabilities for new modules, a security manager and a monitoring system, which monitors the overall system and module states [12].

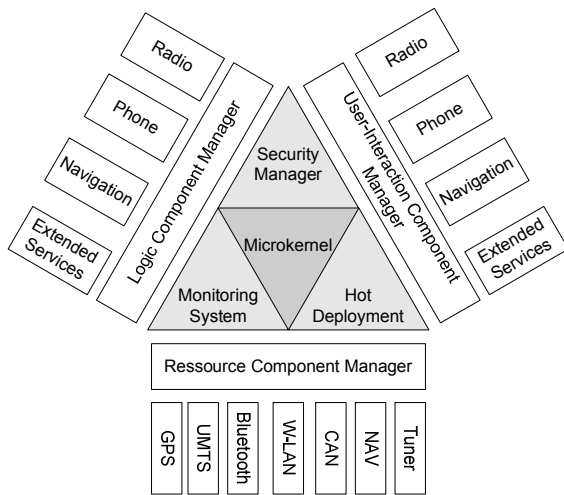


Figure 3: IDSS Client Architecture [12]

The three layers are the *Resource Component Manager*, which controls the hardware resources of the mobile device, the *Logic Component Manager*, which is responsible for the business logic of the IDSS-Client (like content aggregation and integration of different services; muting the tuner sound if the phone rings). On top of these components is the *User-Interaction Component Manager* located. It generates the user interface and processes the user input [12].

A Location Based Social Networking service can easily be integrated as an extended service for the IDSS-Client and as a PIG-Service for the overall PIG server infrastructure. This PIG-Service is built on top of existing social networking platforms like XING, Facebook etc. Every social networking platform is suitable, which offers location related information of contacts a person has. The main task for the IDSS open architecture platform is to use the current user location and request the user agent to show all contacts or contacts of contacts situated at the current city (location). The agent requests all configured social networking platforms and aggregates the information it got back to suit location based requirements. It sends this information back to the IDSS client, who shows it inside a geographical map of the navigation system or it uses google's map service to layer this location based information onto a map from google. Additionally the latter possibility is also offered as a free Web-Service of google.

5. CONCLUSION AND FUTURE WORKS

The Personal Information Guide is a system, which makes conventional internet services available for mobile environments. The consistent use of agent and peer-2-peer technology ensures the system is extremely flexible to be extended, the scalability of the server infrastructure and the adaptability to individual user requirements make it a reliable and a secure platform to offer Location Based Services dependent on the user's current condition of life. With the combination of PIG, IDSS and the use of social networking platforms a prototype was built, which fulfills the requirements of Location Based Social Networking architecture.

Further developments and research addresses problems like determining the user context to build conditions of life automatically by monitoring the user's behavior. A requirement not implemented as good as demanded is the integration of various mobile devices. The reason is that these devices (navigation systems and on-board computers) are mostly closed units. The presented IDSS architecture for a mobile automotive device is implemented as a fully usable prototype only. Additionally the user should be able to configure and compose its services itself in the future by using technologies like BPEL (Business Process Execution Language).

6. REFERENCES

- [1] Barabasi, A., *Linked: The New Science of Network*, Basic Books, May 14, 2002.
- [2] Barabasi, A., *Linked: How Everything Is Connected to Everything Else and What It Means*, Plume, April 29, 2003.
- [3] Barabási, A., “The Architecture of Complexity”, *IEEE Control Systems Magazine*, pp. 33-42, 2007.
- [4] Barnes, J., “Class and Committees in a Norwegian Island Parish”, *Human Relations*, pp. 3-38, 1954.
- [5] Berners-Lee, T., *Information Management: A Proposal* CERN, 1989.
- [6] Bertalanffy, L., *General System Theory*, Braziller (George) Inc., U.S., 1968.
- [7] Brimicombe, A., “GIS - Where are the frontiers now?” *Proceedings GIS 2002*, Bahrain, pp. 33-45, 2002.
- [8] Buschmann, F., Meunier, R., Rohnert, H., Sommerlad, P., *Pattern-Oriented Software Architecture: A System of Patterns*, Wiley, 1996.
- [9] Hauben, M., Hauben, R., Truscott, T., *Netizens: On the History and Impact of Usenet and the Internet (Perspectives)*, Wiley-IEEE Computer Society Press, 1997.
- [10] Herden, S., Rautenstrauch, C., Mkrtchyan, A., Zwanziger, A., Schenk, M., “Personal Information Guide - A Platform with Location Based Services for Mobile Powered E-Commerce”, *Proceedings of the 14th International Workshop on Database and Expert Systems Applications (DEXA'03)*, University of Prague., p. 895, 2003.
- [11] Herden, S.; Zwanziger, A., “A Mediator for Interorganisational Integration of Relationship Management Systems in E-Business”, *Proceedings of IV International Conference on Applied Enterprise Science (International Symposium on Business Informatics) (CICE'2004)*, Santa Clara (Cuba), pp. 354-367, 2004.
- [12] Herden, S., Gomez, J., Rautenstrauch, C., Zwanziger, A., *Software-Architekturen für das E-Business: Enterprise-Application-Integration mit verteilten Systemen*, Springer, Berlin, 2006.
- [13] Hornby, A., *Oxford Advanced Learner's Dictionary of Current English*, Cornelsen, 2005.
- [14] Mika, P., *Social Networks and the Semantic Web (Semantic Web and Beyond)*, Springer, Berlin, 2007.
- [15] Milgram, S., “Small World Problem” *Psychology Today*, pp. 61-67. 1967.
- [16] Nivala, A.-M., Sarjakoski, L. T., “An Approach to Intelligent Maps: Context Awareness”, *Proceedings of the workshop W1 "HCI in Mobile Guides 2003". In conjunction with: Fifth International Symposium on Human Computer Interaction with Mobile Devices and Services, Mobile HCI 03, September 8-11, 2003*, Udine, Italy, pp. 45-50, 2003.
- [17] O'Reilly, T., *What Is Web 2.0: Design Patterns and Business Models for the Next Generation of Software*, <http://www.oreillynet.com/pub/a/oreilly/tim/news/2005/09/30/what-is-web-20.html>, last accessed: 2008/09/16
- [18] Reichenbacher, T., “Mobile Cartography - Adaptive Visualisation of Geographic Information on Mobile Devices” *Technische Universität München, Fakultät für Bauingenieurwesen und Vermessungswesen*, Ph.D. Thesis, <http://tumb1.biblio.tu-muenchen.de/publ/diss/bv/2004/reichenbacher.html>, last accessed: 12. September 2008.
- [19] Schiller, J., Voisard, A., *Location Based Services*, Morgan Kaufmann, San Francisco, 2004.
- [20] Schillit, B., Adams, N., Want, R., “Context-aware computing applications”, *Workshop on Mobile Computing Systems and Applications: Proceedings*, pp. 85-90. Santa Cruz, California, 1994.
- [21] Steininger, S., Neun, M., Edwards, A., “Foundations of Location Based Services” *Lecture Notes on Location Based Services*, 2006.
- [22] Timpf, S., Location-based Services - Personalisierung mobiler Dienste durch Verortung, *Informatik Spektrum*, pp. 70-74. 2008.
- [23] Travers, J., Milgram, S., “Experimental study of small world problem” *Sociometry*, pp. 425-443. 1969.
- [24] Virrantaus, K., Markkula, J., Garmash, A., Terziyan, V., Developing GIS-Supported Location-Based Services, *Proceedings of WGIS'2001 - First International Workshop on Web Geographical Information Systems*, pp. 423-432. Kyoto, Japan, 2001.
- [25] Wenz, C., “AJAX schnell + kompakt”, Entwickler.Press, 2007.