Universität Stuttgart

NEXUS

Spatial World Models for Mobile Context-Aware Applications

Collaborative Research Center 627
Sonderforschungsbereich 627

ANNUAL REPORT 2007

Preface

Deutsche Forschungsgemeinschaft (DFG) has decided to fund the Sonderforschungsbereich 627 - Nexus for another period from 2007 to 2010. We highly appreciate the opportunity to continue our interdisciplinary research in the challenging field of mobile context-aware systems!

The research of the second period is still driven by the vision of the "World Wide Space" and involves the areas of context-aware communication and security, context management, interaction with context models as well as applications. However, we started to look into some additional interdisciplinary research challenges which we came across during the first period. This includes the issue of context quality on various levels of abstraction, high-level context going far beyond sensor data as well as middleware support for context-aware applications. To tackle these issues we started a new cross-project on context quality, which aims at a common reference architecture covering aspects of data degradation, consistency as well as trust. In addition, we initiated a new research area including three projects on middleware issues for context-aware systems.

To continue the dialog between Nexus and leading experts from industry and academia we organized a Colloquium entitled "Towards a World Wide Space". We are pleased that a number of highly-ranked speakers accepted our invitation and shared their views on context-aware systems with us. The colloquium was very well received by the attendees from both industry and academia. In addition, Nexus organized two invited lecture series, one on "Positioning with GPS/GLONASS and Galileo" and the other one on "Reflection and Evaluation of Context-aware Systems". We would like to thank all the speakers for their interesting and inspiring talks as well as the fruitful discussions.

The Nexus application TANIA (Tactile-Acoustical Navigation and Information Assistant) has found great attention on several fairs and conferences. TANIA significantly increases orientation and mobility for the blind, deaf blind, and visually impaired, especially in unknown environments. Its context model provides access to location-based information presented acoustically or in Braille. Encouraged by this great interest, in particular of those people that could substantially benefit from this technology, the principle investigator of TANIA, Dr. Andreas Hub founded a startup company to develop and market this technology.

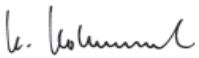
As in the years before, Nexus researches were invited to present their work on numerous conferences, symposia and workshops, and their research results were published in high-ranked proceedings and journals. Moreover, they participated in the organization of prestigious scientific events: Dr. Pedro José Marrón cochaired the 8th International Conference on Mobile Data Management 2007, and Dr. Daniela Nicklas was the program chair of 4th IEEE Workshop on Context Modeling and Reasoning 2007. Prof. Frank Leymann was the area coordinator for "SOA Middleware" of the 6th International Conference on Service Oriented Computing, general cochair of the Inter-

national Conference on Web Services 2007, and organizer of the track "IS Architecture" of the conference Wirtschaftsinformatik 2007. Prof Ertl was editor in chief of the Journal on IEEE Transactions on Visualization and Computer Graphics.

Also in this year a young researcher of Nexus, Dr. Pedro José Marrón accepted an offer for a professorship. Congratulations and thanks for the many contributions to Nexus!

Finally, we would like to thank our collaboration partners, whose expertise and help supported our research considerably. However, the substantial progress made during the last year would never have been possible without the enthusiasm and creativity of the people involved in Nexus. We really appreciate that!

Stuttgart, April 2008



Prof. Dr. Kurt Rothermel
(Center Coordinator)

Funding:	Deutsche Forschungsgemeinschaft (DFG)
Duration:	8 years (1st and 2nd funding period)
Project Start:	January 2003

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- Life Cycle Management Research Group
  Prof. Dr. Engelbert Westkämper

Institute of Communication Networks and Computer Engineering (IKR)
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Institute of Formal Methods in Computer Science
- Software Reliability and Security Group
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Institute of Parallel and Distributed Systems (IPVS)
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Institute of Philosophy
- Philosophy of Science and Technology Research Group (WTTP)
  Prof. Dr. Christoph Hubig

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Prof. Dr. Dieter Fritsch

Institute for Visualization and Interactive Systems (VIS)
Prof. Dr. Thomas Ertl, Dr. Daniel Weiskopf

The research builds on the results of DFG Forschergruppe Nexus (2000–2002).

Content

Vision

World Models | Federation | Context | Sharing

1 Vision

The proliferation of sensor technology, along with advances in wireless communication and mobile devices, allow for context-aware applications. Those applications take into account the context of real world entities, such as a user's current location, physical environment, or even activity. They are able to act upon and adapt to changes in the real world and select and present information depending on the application's context. Since almost all application domains can benefit from context information, we envision most applications to be context-aware in the near future.

Billions of sensors located in our physical environment collect a huge amount of context information. This information will be fed into numerous spatial context models building the basis for context-aware applications. The models may include stationary objects, like streets or buildings, as well as mobile objects, such as people or vehicles. The spatial models may differ in various ways, e. g., in topographical or topological nature, in different levels of detail, or in coverage of different areas and aspects of the real world.

For both economic and technical reasons, it is highly desirable for context information to be shared by a wide variety of applications. We envision - in analogy to the WWW - a World Wide Space, which provides the conceptual and technological framework for integrating and sharing context models. It is open in the sense that any commercial and non-commercial provider can "place" context models into this space. The collection of context models is federated and leads to a large scale context model, offering a global and consistent view on the context data. The federation allows for complex spatial queries, including continuous evaluation and stream-based processing. If the context model is enriched by temporal concepts, applications can query not only the current model state, but also states of the past or even predicted ones. To protect context data, application-specific views can be defined for individually controlling model access. We envision the World Wide Space to be the common basis for future context-aware applications.

Scientific Goals

Scalability | Consistency | Security | Acceptability

2. Scientific Goals

The main research objective is to investigate methods to create, manage, visualize and use federated context models, which are the foundation of the envisioned World Wide Space. The context models under investigation are large-scale, highly dynamic, and complex in terms of the abstractions supported.

In particular, the abstractions to be offered include stationary geographic objects, mobile objects, objects associated with dynamic state information, as well as virtual objects augmenting reality. Moreover, the research will focus on innovative context-aware applications built on spatial context models. It is also investigated how the existence of those models affects the system-level concepts and mechanisms themselves. Of particular interest is the quality of context, which impacts almost all areas of research in Nexus. The investigations focus on quality concepts and metrics as well as algorithms considering context quality.

Therefore we see research challenges in the following areas:

- Modeling and Extensibility Concepts
- Federated Model Management
- Integration of Temporal Aspects
- Generic Integration of Sensor Data
- Concepts of Consistency
- Model-based Communication
- Security Concepts
- Automatic Acquisition of Model Data
- Model Presentation and Interaction
- Security, Acceptability, Business Models
- Quality of Context Information
- Higher Level Context
- Homogenized Query Processing
- Application Support

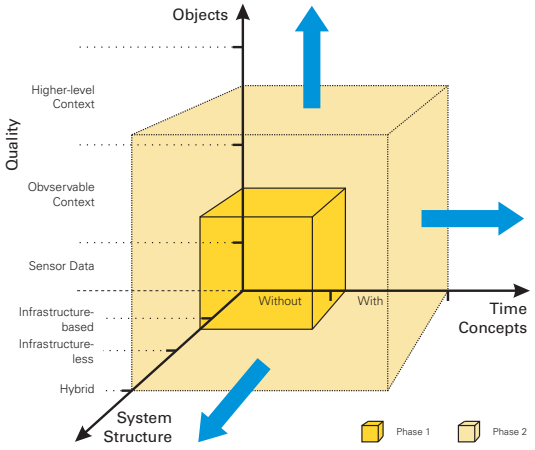


Figure 1: Complexity Dimensions -- shows the development of the complexity from the first to the second funding period. First, we consider not only the modeling of geographic, mobile, and virtual objects, but also higher-level context information (situations) derived from observable context information. Secondly, we investigate context model management in hybrid system structures consisting of infrastructure-less and infrastructure-based parts. Thirdly, besides current context information, we also consider time concepts. As cross-cutting topic, the influence of context quality is investigated.

Research Program

Management | Communication | Presentation | Applications

3. Research Program

Communication & Security	Management of Context Models	Model Interaction & Sensors	Applications & Acceptability	Application Support
Context-Aware Communication Control Kühn, IKR	Homogenized & Virtualized Model Management Mitschang, IPVS	Consistency & Generalization of 3D Geo Data Fritsch, IfP	Smart Factory Westkämper, IFF	Context-Aware Workflows Leymann, IAAS Nicklas, IPVS
Context-Aware Communication Rothermel, IPVS	Hybrid Model Management Marrón , IPVS Rothermel, IPVS	Sensor-Supported, Context-Based Consistency Analysis Levi, IPVS	Context-Based Assistant Systems for People with Sensory Handicaps Ertl, VIS	Semantic Methods for Managing Context Models Schütze, IMS
Security, Privacy & Accounting in Context-Aware Systems Kühn, IKR	Dynamic, Time-Referenced Model Data Mitschang , IPVS Rothermel, IPVS	Context-Aware Mobile Visualization Ertl, VIS	Reflection & Evaluation Hubig, WTTP	Distributed Situation Recognition Based on Evaluated Context Information Levi, IPVS Rothermel, IPVS
Formal Methods for Modelling and Analysis of Mobile Context-Aware Systems Esparza, FMI				
Metrics & Valuation of Context Levi, IPVS Rothermel, IPVS				
Mobility & Security				
Modeling & Consistency				

The overall structure of the research program is composed of five research areas:

Research Area 1: Communication & Security

Communication and security aspects will remain the predominant topics of this project domain. Starting from the results of the first project period we will focus on both, communication aspects between mobile applications and the federation as well as the spatial model services and on the design of new communication mechanisms relying on the use of context information (contextcast). In the area of security, comprehensive security solutions conforming with both, the security requirements of the users and the information demand of service providers (e. g. for accounting purposes), will be investigated. Model-checking methods will be applied in two areas: First, the status of authorization credentials in a highly distributed environment will be analyzed with the aid of efficient algorithms. Second, model checking methods will be used to monitor the spatial world model for prediction and verification purposes.

Research Area 2: Management of World Models

The main task of this domain is the development of concepts for the distributed management and provisioning of data of the world model. The world model contains location-based data and objects, which consist of partly proprietary data of different information providers and which are made available to applications in a unified representation and language. To provide this comprehensive information service, the subprojects have to deal with problems of the system architecture, the federation and processing of data, and the quality and timeliness of data. The scalability and openness of the system architecture are especially important. In the second period, the requirements resulting from the provisioning of temporal, stream-based and three dimensional data are considered, in terms of management in dynamic infrastructures as well as in infrastructureless and hybrid systems.

Research Area 3: Model Interaction & Sensor Integration

Domain 3 studies both the efficient processing of model data and the consistent preparation of acquired sensor data. This heterogeneous information should be consolidated, so that a consistent spatial world model can be generated from these semantic and sensory aspects. The analysis and quantification of fuzziness, uncertainness, incompleteness and impreciseness shall be applied to detect the reason of occurring inconsistencies and to provide appropriate methods for their solution. In addition, cost-benefit analysis for dissolving inconsistency will be developed, which will help to resolve the question if solving an inconsistency is worthwhile or if the respective application can handle the available inconsistent data in a meaningful manner. Other main research aims are the 3D acquisition of object surfaces, the modeling of 3D point clouds and the generalization of 3D city models. In particular, context-dependent gen-

eralization and projections will be used. For the context sensitive visualization of the spatial world model, user-oriented information visualization methods are used.

Research Area 4: Applications & Acceptability

In this domain applications are evaluated concerning ethical as well as economical aspects. The considered applications can only be developed on the basis of the Nexus technology. The domain is thought to be a proof-of-concept of the Nexus vision in general, which serves at the same time as basis for a comprehensive evaluation concerning acceptability and profitability. The different application scenarios of the first funding period are deepened and enlarged thus offering a wide range of new research goals, potential use cases and newly emerging problems. Particularly sensor networks and context-depended data representation and communication are investigated. As a result of the different research perspectives and the special requirements of the subprojects, interdisciplinary methods of resolutions and improvements for the Nexus concept are expected. For the new development, assessment and evaluation of the different application scenarios, special research on topics like acceptability, privacy, responsibility and accountability as well as on the economic potentials is essential.

Research Area 5: Application Support

For the development of context aware applications, new approaches and concepts are necessary that take into consideration the information about the characteristic properties of the applications (e. g. mobility, context quality and heterogeneous system environments). Having discussed architectures of application environments during the past years, the second research period now focuses on architectures and functionalities as well as the generation of context aware applications. These applications require further information in addition to the context data that has been used so far. Therefore, the new project domain E has been established which deals with the generation of components for the derivation of such information. The three main topics are: the identification of complex situations, the accumulation of natural language context information from text modules that can be found in the World Wide Web and the creation of software architectures and development tools for context aware applications. The subprojects give support to the application related projects of project domain 4.

Cross-Section Project & Working Groups

In addition, there are two interdisciplinary working groups and a cross-section project that are concerned with research issues relevant to all of the above research areas:

- Cross-Section Project: Metrics and Valuation of Context
- Working Group 1: Mobility and Security
- Working Group 2: Modeling and Consistency

3.1 Research Area: Communication & Security

3.1.1

PROJECT: Context-Aware Communication Control

RESEARCHER: Christian Müller, Michael Scharf

This project focuses on two different communication aspects: First, it studies how detailed context information can be gathered and used for network management and control in heterogeneous wireless access networks. Second, the project analyzes how to optimize the communication of context-aware applications, using improved network protocols and cross-layer adaptation mechanisms.

The usage of context information for communication control in heterogeneous environments requires common interfaces: On the one hand, the mobile terminals must be able to get access to context information, e. g., stored in an Augmented World Model. On the other hand, mobility supporting entities within the network infrastructure must be able to retrieve context data from the user terminal, including informa-

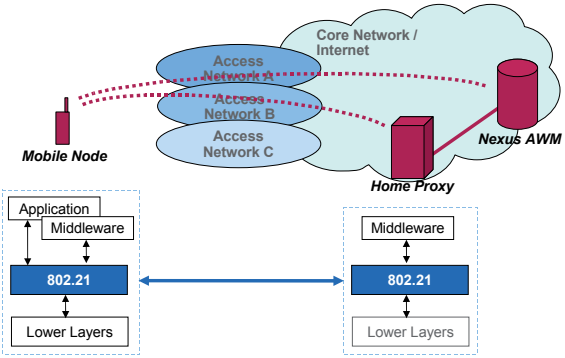


Figure 2: Mobility management with the IEEE 802.21 architecture and the Nexus Augmented World Model (AWM)

tion about the characteristics and the quality of currently used and potentially available communication channels. The IEEE 802.21 "Media Independent Handover" framework defines such functions and interfaces. Therefore, this framew0ork has been evaluated with respect to its applicability as part of a context-based communication control plane. It has been demonstrated that the IEEE 802.21 framework can make context data available to a communication middleware on the user terminal, and that it can support its access network selection decision [Mue07]. An example is the usage of

radio coverage data that has been gathered from distributed measurements on mobile terminals and that are stored in the Nexus Augmented World Model [LMS+07].

A large number of mobile context-aware applications require seamless connectivity to context and application servers. In [MB07], the project was involved in the performance evaluation of mobility supporting mechanisms in future IP-based wireless networks. As alternative, mobility management solutions at higher protocol layers have also been investigated [Glo07,WOS07].

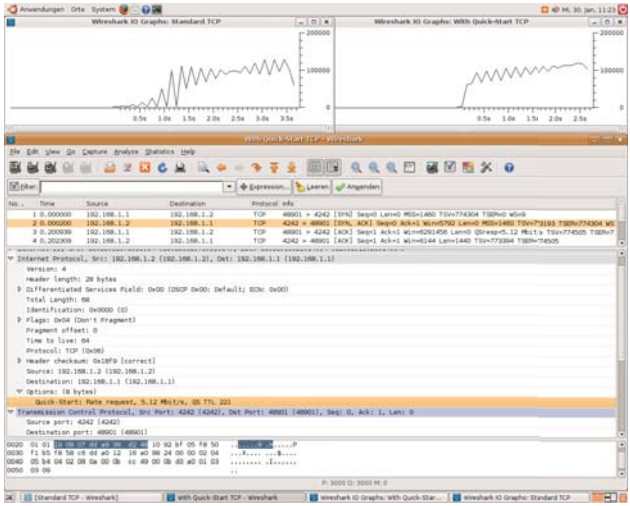


Figure 3: Test with the prototype implementation of the Quick-Start mechanism, showing a performance improvement compared to a default protocol stackl

Certain applications, such as the visualization of three dimensional world models, can be quite resource demanding, i. e., they require the availability of a high bandwidth. Such soft real-time requirements constitute a challenge for today's communication networks [Sch07b,WPS07]. The project has analyzed whether novel protocol stack extensions could be beneficial for such applications. One promising example is the "Quick-Start" extension of the TCP/IP protocol suite, which allows applications to immediately use all available bandwidth on a path. It has been shown that this mechanism can significantly improve the performance of network-demanding interactive applications. Furthermore, a full-featured prototype implementation for the Linux kernel has been developed [Sch07a,SZ07]. In this context there have also been contributions to standardization [SFS07].

3.1.2

PROJECT: **Context-Aware Communication**

RESEARCHERS: Frank Dürr, Matthias Gauger, Lars Geiger

In this project, the focus is on context-based communication mechanisms, especially geographic routing (geocast) and a new communication paradigm, which we call contextcast.

In the area of geocast, we finalized our investigations of infrastructure-based geocast overlay networks [DR08, SKD+07, SWK+07]. In the second funding period, we continue the research on geocast protocols by focusing on ad-hoc and hybrid systems. Initially, we designed a system for routing geocast messages in an ad-hoc system based on symbolic location information. To achieve this, we used a source routing approach where the sender determines the route of locations along which the message is routed. In this scenario, the nodes need only know their neighboring nodes. This minimal state information on the nodes, combined with low computational complexities for forwarding, makes this approach ideal for small, low-power devices like nodes in a sensor network.

In addition to geocast, we also started work on a new contextcast paradigm. Previously, the context used for communication was limited to the receiver's location. Contextcast extends this to also include more attributes like receiver type, age, availability, etc., which makes contextcast suitable for a broad range of application scenarios To leverage the existing IP infrastructure and create an easily extensible system, a network of overlay routers forwards messages to the addressed receivers. Since the contextcast concept is similar to existing content-based publish-subscribe systems, we implemented a first prototype building on the algorithms and techniques used in such systems. Our first approach separates location information from further context attributes using two different routing tables (with little fluctuations in the location routing table). Although this approach reduces the number of context updates, the evaluation of the prototype also showed that the separation leads to a large amount of false positives during message forwarding [GD07]. Solving this problem is part of ongoing work.

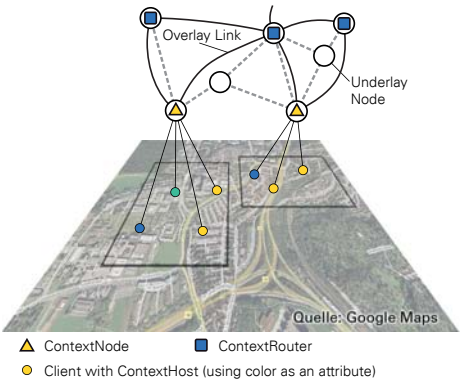


Figure 4: Contextcast overlay network, showing two access nodes, their respective service areas and connected clients, as well as a part of the router network.

3.1.3

PROJECT: Security, Privacy & Accounting in Context-Aware Systems

RESEARCHER: Andreas Gutscher, Michael Scharf, Christian Hauser, Martin Neubauer

Security and privacy aspects are crucial factors in open service delivery platforms if they process personal and possibly sensitive context information of users. Therefore, our research focuses on trust and reputation, on privacy protection with "Virtual Identities", and on network security solutions in such platforms.

In the area of trust and reputation, the proposed trust model was refined and extended [Gut07]. Various trust and authenticity relations and different representation formats can be used to express the degree of confidence a user has in the trustworthiness of objects, services, other users, and the authenticity of cryptographic keys, which are used to sign certificates. Reputation systems can then combine the opinions of different users and draw conclusions (e. g., build trust chains) according to a set of inference rules. Based on this, they calculate the expected confidence in the derived trust and authenticity relations.

In context-aware systems, services may be composed of different basic services. This is why we started to develop methods that compute the trustworthiness of such federated services from the trustworthiness of the involved basic services and the federation function (see figure 5).

In the area of privacy protection, we pursue the approach of using different so-called "Virtual Identities" (VIDs). This means that different applications use different user identities in order to avoid links between the VIDs and the real identity of a user. However, the IP addresses of terminals cause privacy threats, since they may not only allow to approximately locate users, but also to identify whether different VIDs belong to the same user. This can be addressed by an architecture for mobile IP communication that keeps different pieces of information separated on different changing servers (see figure 6). This architecture was evaluated and it has been shown that it can significantly reduce privacy threats [Hau07].

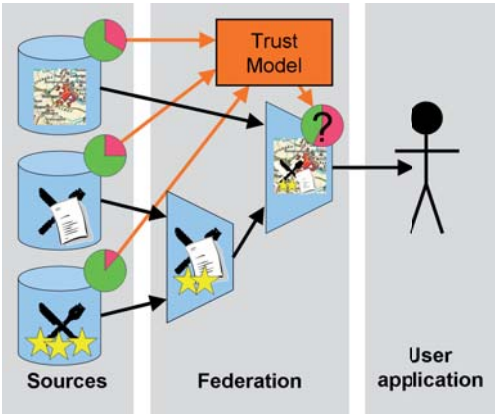


Figure 5: Trustworthiness of federated context information

If context-aware services are offered commercially, further security requirements do exist. From a provider's point of view, the systems must be protected against misuse, which requires an authentication, authorization and accounting infrastructure. Emerging telecommunication service delivery platforms offer such a secure environment for new services, using the Session Initiation Protocol (SIP) as converged signaling protocol. An example are the IMS/TISPAN systems standardized by 3GPP and ETSI, respectively. The project was involved in several studies of these new service delivery platforms, including an evaluation of security signaling protocols [KS07], SIP performance issues [WSK+07], and a discussion of architectures that integrate user context information and communication preferences [WOS07].

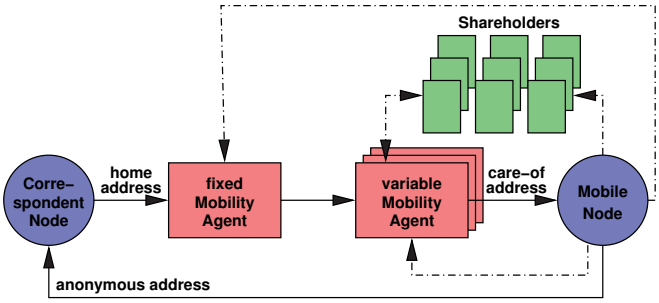


Figure 6: Architecture for protecting privacy in mobile IP communication

3.1.4

PROJECT: Formal Methods for Modelling and Analysis of Mobile Context-Aware System

RESEARCHER: Dejvuth Suwimonteerabuth

The work of the project has focused on the design of efficient algorithms for evaluating authorization queries. We consider a scenario in which the world model (Umgebungsmodell) is required to contain information about the trust that objects have in other objects or groups of objects. An object A can query the administrator of the model, asking for the global trust it can place in B. A can place trust in B directly, or because it trusts group G containig object C, who trusts B.

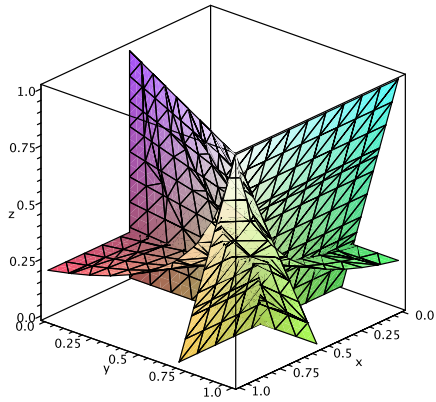
An important requirement for mobile and context-aware systems is that an object should be able to express its trust in a group of objects without knowing its members, which allows for local dynamic reconfiguration of the group. For instance, an object

must be able to express trust in all providers owning a certificate of quality given by a third party.

We have developed a framework for modeling trust that satisfies these requirements, and have provided an efficient algorithm to compute the total trust that objects have in each other, as well as their reputations, defined as the trust that the society of objects as a whole places in them. The results have been published in [BES+06].

Technically, our work is based on the SPKI/SDSI authorisation framework for describing authorization policies in a distributed environment. The framework is only defined for binary trust relations (``I fully trust an object'' or ``I have no trust in

Figure 7:
Computing total trust boils down to solving a system of non-linear equations. The figure shows an example of three equations deriving from a very simple system



the object''). We have extended it to a ``fuzzy'' model in which degrees of trust and degrees of membership to a group can be expressed. The new framework is called SDSIRep. Using a probabilistic interpretation of trust, we have shown that total trust and reputation can be computed by numerically solving certain systems of non-linear equations. We have developed techniques for solving the equations, and studied their performance in some examples.

3.2 Research Area: Management of Context Models

3.2.1

PROJECT: **Homogenized & Virtualized Model Management**

RESEARCHER: Nazario Cipriani, Matthias Großmann, Dr. Daniela Nicklas

During the second funding period, this project focuses on a tighter integration of different interaction concepts between applications and the Nexus platform - namely query-response, data streams and events - and on performance as well as flexibility improvements by distributing the operators of a query to different execution nodes.

We developed a federated cursor concept, which supports more efficient transferral of query results from context servers to applications via federation nodes [CGNM07]. The query language was extended by cursor commands, enabling applications to piecewise retrieve result sets. This is particularly beneficial for applications running on small, mobile devices. For queries containing a sorting criterion, the federation node processing the query holds histograms of the data provided by the different context servers involved in answering the query so that the federation node can retrieve exactly the objects required for executing the application's current next-operation. This minimizes the memory required for storing query results on federation nodes and also avoids unnecessary data transfers when the application prematurely cancels its request. We also showed that the additional overhead caused by cursors to the query processing at the context servers is negligible.

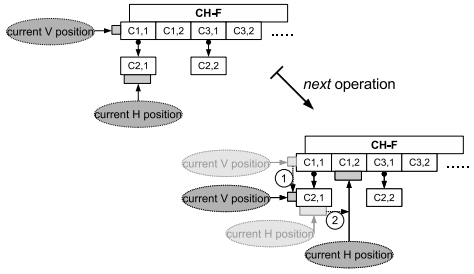


Figure 8: Federated cursors: a cache histogram retrieval step

Although the query language of the Nexus platform is mainly targeted at the syntactical level, applications requiring more complex semantical query capabilities can also benefit from using the Nexus platform. Context reasoning tends to be complex and with an increasing number of objects in a system, the query processing time quickly reaches unacceptable values. We proposed a two phase approach to solve

this problem, exploiting the observation that semantical context queries typically only require objects within a small area: The first step selects relevant objects based on a simple region query, and only those objects serve as input for a more powerful reasoner. In [NGMW08], we presented the Nexus semantic service, which implements this approach, and applied it to the ConferenceGuard, an application observing the noise level in a room containing both a laboratory and a meeting area.

In [HGN+2008], we presented a component for compressing trajectories of mobile objects. We also discussed alternatives for the placement of this component. The best placement alternative depends on the actual requirements, but to optimize for performance, it should be integrated with th location service.

In 2007, we also started the study project "Nexus Explorer", which implements an application for selecting and visualizing stream data. The application focuses at first on the smart factory scenario, where it will use data on factory floor plans, current and past states of machines and tools and workflows for generating assignments for workers. However, it is based on a plug-in concept, which will allow us to easily adopt it to other application scenarios. When finished, we will use the application to analyze and further refine the new operator concept of the Nexus platform.

3.2.2

PROJECT: **Hybrid Model Management**

RESEARCHER: Dominique Dudkowski, Harald Weinschrott

The subject of this project is to efficiently manage context data in hybrid system structures where infrastructure-based and infrastructure-less ad-hoc networks are integrated. Beyond the support for geographic location models, we further aim at the support of symbolic and hybrid location models as a base for the context management system.

In 2007 we concluded our work on mechanisms for migration of data in mobile ad-hoc networks [DMR07]. Moreover, we started research on context management for hybrid network structures. Our first findings are based on breaking the simplistic assumption that access to data items is co-located with their acquisition [DWM08]. Based on this assumption, our system for infrastructure-less ad-hoc networks stored data at the location where it was acquired, which allowed for efficient processing of spatial queries. However, in a hybrid system the challenge of data storage and data access needs to be reconsidered. Therefore, we identified different logical links

between the infrastructure and the ad-hoc network. First, there is assisted ad-hoc where the infrastructure can be used simply as a means for improving the performance of the ad-hoc network through communication and control. Secondly, the ad-hoc network can be exposed to the infrastructure through the abstraction of service primitives, i.e., spatial queries. Thirdly, in the hybrid system, data storage and query processing can be optimized by adaptively placing data within the different parts of the network. We also introduced a reference model for data management in mobile ad-hoc networks [DWM08].

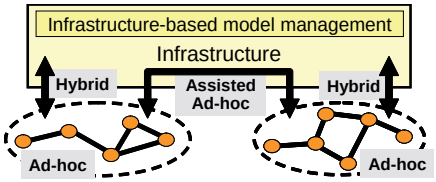


Figure 9: Model management in hybrid system structure

Besides the research on hybrid system structures, we also started to investigate context management based on symbolic and hybrid location models. Initially, we focused on topographically enhanced context models where connections between different locations can be modeled by a variety of metrics in order to allow for more flexible queries.

Finally, we started our work on providing data with defined quality. This work will be integrated within the Q-project to a reference model for quality management.

3.2.3

PROJECT: **Dynamic, Time-Referenced Model Data**

RESEARCHER: Tobias Farrell, Nicola Hönle, Ralph Lange

Our research on dynamic, time-referenced model data comprises three areas: (1.) Optimized access to dynamic context information on mobile devices. (2.) Efficient persistent storage of time-series in History Servers and their analysis in the History Warehouse. (3.) Scalable indexing of context providers like history servers in the Context Broker for efficient retrieval of context information in Nexus.

Regarding the optimized access to dynamic context information we focused on the energy-efficient transmission of position data from moving objects with embedded positioning sensors to location management systems or moving objects databases. Existing position update protocols minimize the wireless communication but do not

take into account the power consumption for position sensing. We invented a new update algorithm for distance-based tracking of a moving object that optimizes the power consumption for position sensing and the transmission of update messages [FLR2007]. We analyzed different uncertainty-aware tolerances semantics for continuous range queries and presented efficient algorithms for query processing that reduce the total energy consumption for position sensing and reporting [FCR2007].

History Servers should be able to store time-series data of different data types persistently. Our main focus lies on storing data histories of stream data (e.g., measurement values of sensors or position histories of mobile objects) and therefore handling the fast increasing of the data volume within stream data. As the first example for stream data types, we examined position histories of mobile objects. We determined several preprocessing algorithms to reduce the data volume of position histories and found, that the data reduction is working very well also with simple algorithms. We developed a component for preprocessing position updates and discussed the placement of the component in our system as well as necessary recovery mechanisms [HGN+2008].

The Context Broker shall provide a global directory service for context providers in Nexus. In 2007 we researched fundamental approaches for describing partial world models managed by context providers and for matching such descriptions with queries for context information. Similar to reasoning with defined classes this requires a deliberate trade-off between the expressiveness of descriptions and queries and the computational complexity of matching them.

An important challenge for indexing within the Context Broker are moving objects as they are not bound to one or few context providers. We invented a new, distributed index structure called DTI+S for indexing trajectories of moving objects in a network

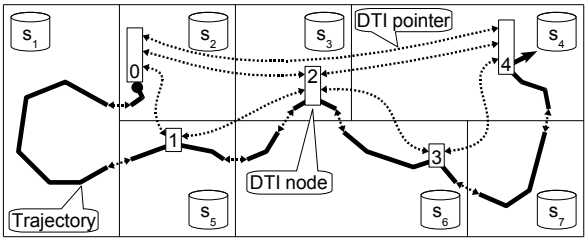


Figure 10:
DTI+S index for a trajectory stored by seven database servers

of database servers. Figure 10 illustrates such an index for a trajectory stored by a set of seven servers. DTI+S is high scalable and robust regarding repartitioning of the trajectory data. Besides queries for object trajectories it particularly supports trajectory-based aggregate queries like the maximum velocity of a certain object during a given time interval.

3.3 Research Area: Model Interaction & Sensors

3.3.1

PROJECT: **Consistency & Generalisation of 3D Geo Data**

RESEARCHER: Susanne Becker, Michael Peter

One key activity of this subproject is to preserve the consistency between geometric world models and the real world. For updating and refining existing 3D models we use 3D data derived from both image measurement and terrestrial laser scanning. The alignment of the different data sets is required in a pre-processing step. For this purpose, we proposed a two-step approach aiming at a fully automatic georeferencing process. First, the LIDAR data is georeferenced by matching the point clouds from terrestrial laser scanning against the corresponding faces of the given 3D building models [BH07].

In a second step, the images are registered to the terrestrial laser scans. Common terrestrial laser scanners sample object surfaces in an approximately regular polar raster. Each sample provides 3D coordinates and an intensity value representing the reflectivity of the respective surface point. Based on the topological information inherent in data acquisition, the measured reflectivity data can be depicted in the form of an image. This allows for the application of image processing tools to connect the images collected by the photo camera to the LIDAR data. However, images generated from laser reflectivities considerably differ from images that have been acquired by a standard digital camera. The main differences are due to spectral band width, spatial resolution and imaging geometry. Nevertheless, laser reflectivity images and photo images can be matched against each other automatically by means of the SIFT (Scale Invariant Feature Transform) operator, which is insensitive to changes in illumination and scale and uses region descriptors instead of edge detectors [BB07].

Figure 11: Image sequence (left), reconstructed camera stations and 3D points (right)

As a result of the matching, control point information can be derived for a subsequent bundle block adjustment. Figure 11 shows an image sequence (left) and the reconstructed camera stations and 3D points (right). Based on aligned data sets consistency analyses, model refinement and visualizations can be carried out [KBH+07].

Another research area of this subproject is the generalization of 3D building models [Kad07a]. The generalization algorithm presented by [Kad07b] significantly reduces the model's level of detail, however, the resulting models no longer fit into the ground plans of the originals. Thus, the generalized models have to be adjusted to the original ground plans to ensure consistency between different levels of detail.

In an analyzing step, the dominant lines of the original ground plan are determined. These are used to compute the adjusted vertices of the generalized ground plan using least squares adjustment and constraints for parallelism, collinearity and perpendicularity (figure 12). The remaining 3D building structure not adjacent to the ground plan is decomposed into planes using e.g. distance ratios between parallel planes and height constraints for ridge lines. After ground plan adjustment, the new planes are derived using this information and the vertices of the generalized building are computed as intersections of these planes.

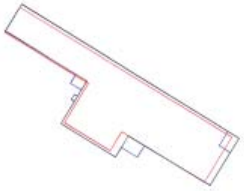


Figure 12 (blue), generalized (red), generalized and adjusted ground plan (black)

3.3.2

PROJECT: **Sensor-Supported, Context-Based Consistency Analysis**

RESEARCHER: Uwe-Philipp Käppeler

Concepts are developed for the evaluation of the quality of sensor data, in order to be able to integrate indistinct measurements and inaccurate results into distributed environment models. A quality measure shall be applicable to different context information treating different quality criteria, in order to resolve application-oriented the conflicts in environment models.

The focus in 2007 was on the development of a degradation model for sensor data which describes the quality of a single measurement. In Addition we developed Algorithms for distributed observation of objects from different angles in order to obtain 3d position information of objects and users. The main issue of this algorithm is the

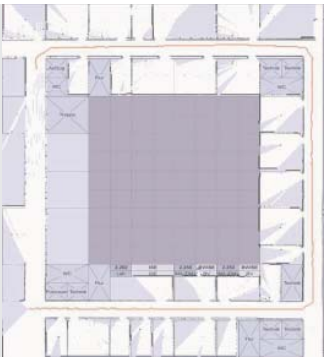


Figure 13: Map of the 2nd Level of the Informatics Institute with 30x30 m², Fast-SLAM with 4 Particels, Runtime 70 Minutes

possibility to combine position information of cameras which are not synchronized. The asynchronous recorded images are communicated via network devices which adds an undefined delay from image recording to processing of the combined information. Kalman Filtering of the position information enables the processing of asynchronous information [Kin07], [ZKR07].

Another algorithm was developed to combine position information gathered by different types of cameras [Hoe07]. This algorithm is treating each position information with regards to the different spatial resolutions for distance and direction of each camera system. This enables a reliable combination of perspective and omnidirectional cameras.

To improve and integrate Service Robotics into the Nexus Platform we implemented Simultaneous Localization and Mapping (SLAM) for our robot platform [Aic07]. With SLAM we can operate robots in previously unknown buildings. The alignment of the obtained map and a map of the building enables the navigation to particular rooms as shown in figure 13

3.3.3

PROJECT: **Context-Aware Mobile Visualization**

RESEARCHER: Mike Eißele

Visualization on mobile devices using context-aware presentation techniques is the focus of this project. Previous work concentrated on position and orientation as major context aspects that are relevant for visualization. With the recently developed support for further context attributes and a quality metric to describe the accuracy of the data, the system is now capable to adapt visualizations based on the quality of the available context information. Figure 14 shows a prototypical implementation of a position-quality-aware flow visualization system. Dependent on the pose-estimation quality and the distance of the camera, different techniques are utilized to present the flow char-

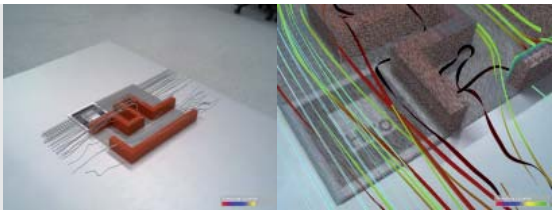


Figure 14:
A quality-aware flow visualization system. The visualization of the entire flow (left) makes only use of simple alignment-tolerant streamlines, as the quality of the pose estimation is not accurate enough to allow direct surface overlays. In contrast, details of the flow can be shown if highly accurate positioning is available

acteristics. This way, the Augmented Reality (AR) application can dynamically reconfigure itself, based on the currently available pose accuracy and can therewith cope with inaccurate positioning systems.

Mobile devices, like smart phones or personal digital assistants, are suitable to realize AR visualization systems, as users can easily carry and use them wherever they want. However, the available computation power on these devices is often not enough to generate interactive visualizations. Remote-rendering approaches overcome this limitation, but require an increased network bandwidth. Therefore, a technique for fast high-quality zoom of 2D images has been implemented to allow a transmission of medium-sized visualization images that are enlarged for display on the client device [KES07]. Figure 15 shows the result of an enlarged image from a visualization of air-flow data using streamribbons, combined with a rendering of the underlying city to visualize the spatial relation of the data.

Figure 15:
Combined visualization of georeferenced air-flow data with a rendering of the underlying city model. A hardware-based zooming technique is used to zoom the remotely generated visualization-image stream

3.4 Research Area: Applications & Acceptability

3.4.1

PROJECT: Smart Factory

RESEARCHER: Dr.-Ing. Carmen Constantinescu, Dominik Lucke

The Smart Factory approach represents a real-time, context-sensitive manufacturing environment that can handle turbulences in production using decentralized information and communication structures for an optimum management of production processes. But also other functions in a manufacturing enterprise gain advantages from the up-to-date data of the Smart Factory. Especially functions from Factory Life Cycle like the planning of processes and equipment can benefit from the information coming from

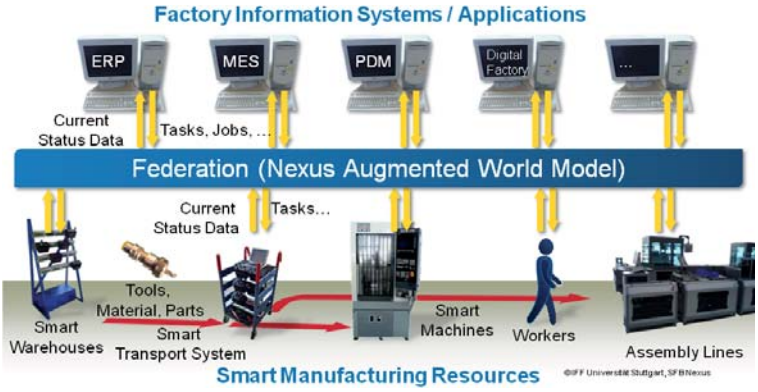


Figure 16: Architecture of the Smart Factory (ERP: Enterprise Resource Planning, MES: Manufacturing Execution System, PDM: Product Data Management)

the Smart Factory. The enhanced concept of the Smart Factory enables the real-time collection, distribution and access of manufacturing relevant information anytime and anywhere. The downscaling of computer and sensor technologies supports the integration of knowledge in all scales of a holistic production system, aiming at increasing the transformability of the factory as a whole. Based on the progress made during the first funding period concerning the management of mobile production resources like tools, the second funding period take other production resources into account, by integrating further systems operating on the shop floor level, e.g. a milling machine with systems on the management level e.g. Manufacturing Execution Systems (MES). The first step which has been already achieved concerns the innovative definition of the

Smart Factory related to the Nexus approach, the design of architecture and the development of scenarios. Furthermore, the context-data model as the first step for implementing new context-aware applications and services in a manufacturing environment has been conceived and modeled. This was based on the analysis of operating information systems in a factory. From this analysis, challenges for new context-aware applications have been derived. High relevance for the development of new context-aware applications represents the analysis of the required enabling technologies for manufacturing purposes. The research's progress was presented on different events [LUW07] to the scientific European and German community.

3.4.2

PROJECT: **Context-Based Assistant Systems for People with Sensory Handicaps**

RESEARCHER: Dr. Andreas Hub

A navigation assistant based on a tactile-acoustical interface and augmented map information was developed, affording blind people real and virtual exploration of their current environment. The TANIA (Tactile Acoustical Navigation and Information Assistant) system consists of a portable computer suspended in front of the user, with a GPS sensor and small inertial sensor mounted on the neck strap. Using these sensors the pedestrian's velocity can be estimated, steps counted, direction determined, and path tracked. By tapping the map presented on the computer's touch screen, users can obtain their current position, whether indoors or outdoors. Additionally, map information about environmental features and objects can be provided acoustically [HKBE07].

Figure 17: TANIA: Assistant System for the Blind and Deafblind

The TANIA system was combined with a head-mounted system based on a stereo camera, a second inertial sensor, and 3D environmental models. This system allows identification of modelled objects by shape and color, and tracking of movable objects.

A common face detection algorithm informs the user about the presence and position of others [HHKE07].

Further, by connecting a small portable Braille display, the TANIA system can be utilized by deafblind people. Not only can its navigation and information functions be accessed, but the system with Braille display enhances socialization by allowing deafblind users to communicate with everyone capable of typing [HKBE07a]. This was

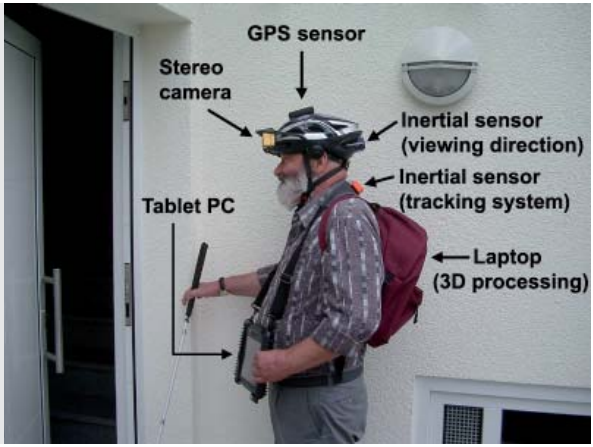


Figure 18: TANIA with Head-Mounted Object Recognition System

demonstrated at the 14th Deafblind International World Conference in Perth, Australia, last October. There, deafblind participants used the TANIA system with Braille display to navigate mapped areas of the conference environment, to access related information such as schedules and restaurant menus, and to communicate their feedback to the researcher.

Several improvements have been made to the TANIA system. A smaller, lighter portable computer module makes it easier to carry. Two new map features, guiding grids and shape-adapted segments, have been integrated to maintain system accuracy of one large step, even in open areas without physical markers, or on curved or irregular floors and streets [Hub08]. Usability tests have shown that the TANIA system can be learned easily, even by elderly people [Hub08a]. Alteration of the environment is not required, and the system can be used everywhere in the world where adequate mapping has been done.

3.4.3

PROJECT: **Reflection & Evaluation**

RESEARCHER: Dr. Jessica Heesen, Oliver Siemoneit, Dr. habil. Klaus Wiegerling

In 2007 the project focussed especially five subjects. First, the typification of szenarios for identification situations by a smart system. Here we especially explored the limitations of automatic situation recognition and their consequences for system design. Second the articulation of relevance-criteria for supporting an every-day action by smart systems. Here we focussed on ontological theories in philosophy and in computer science, especially relating to the perspective of temporalization and the process of history. In regard to practical implementation we co-operate with project D2 "Navigation for Visually Impaired People". Third the important questions of acceptability, trust and privacy. Here Heesen and Siemoneit published a paper and furthermore prepared a cross-publication with project A3 "Security & Privacy" to the subject "Possibilities and Limitations of Modelling Trust and Reputation". Reputation systems are one possibility to support individuals in distinguishing trustworthy partners from malicious and unreliable parties in open and decentralized communication networks. Possibilities and limitations of different types of reputation systems and their underlying trust models are discussed. We address the properties of trust relations, the quantification and representation of trust values as well as reasoning and computation with trust. Forthly, we distinguished the Stuttgart Concept of parallel communication in different papers and lectures. The concept gives an option to handle with problems of a smart system in a way to make it more transparent, to verify its information and to control it. Fifthly, we discussed some questions of economical ethics, for example the agency of RFID-technology especially in the view of privacy.

Figure 19: Control & Error

We participated in important scientific events. Every researcher of the project presents a paper on the 37. annual meeting of the society of computer science (GI) "Computer Science meets logistics" in Bremen: Oliver Siemoneit: "Context-Awareness and Rational Risk Perception "; Jessica Heesen: "Strategies for a self-determined and liberal usage of ubiquitous communications services", Klaus Wiegerling: "The main problem of UbiComp and the Stuttgart Concept of Parallel Communication". Furthermore Klaus Wiegerling gave amongst others a lecture on "Philosophical aspects in human-machine interaction with ubiquitous systems" (University of Jena, broadcasted directly to the universities of Leipzig, Ilmenau and Weimar). On the interdisciplinary conference "Economics of the internet and ethics" in Münster/Westfalia he presents a paper with the title "On agency of RFID-Technology within measurement and cross-linking the world".

3.5 Research Area: Application Support

3.5.1

PROJECT: **Context-Aware Workflows**

RESEARCHER: Matthias Wieland

This project started with the second funding period of Nexus. The aim of this project is to support the development of context aware applications in process oriented domains like, e.g., the Smart Factory. For this purpose, the interaction between context aware applications and their superior processes are examined. Context aware applications are developed as workflows. This allows the development of long running and complex context aware applications with the help of two-stage programming. The applications are aggregated from basic context aware services to context aware workflows.

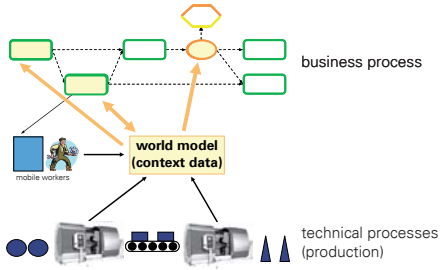


Figure 20: Vision of context aware workflows

The research activity in the first year mainly dealt with the detailed analysis of the vision of context aware workflows: with the help of a spatial context model that provides context information, technical processes can be integrated with business processes. This helps to better monitor and control technical processes (e.g. production processes in the Smart Factory). Furthermore, better process efficiency can be reached. The Nexus context model acts as a connection between business processes, technical processes, and mobile agents (humans or mobile, context aware applications, see figure 20). The result of this integration is comparable to the introduction of workflow systems for the management of business processes, which helped to bridge the gap between business and IT (Business-IT-Gap). Similarly, context aware workflows can close the gap between business processes and technical processes in production environments (Business-Production-Gap) [WLJ+06].

In addition, an architecture for the execution of context aware workflows was developed in 2007. For the development of context aware workflows, new workflow con-

cepts are necessary that take the information about the characteristic properties of context aware applications into account, e.g., mobility, context quality, and heterogeneous system environments [WKN+07].

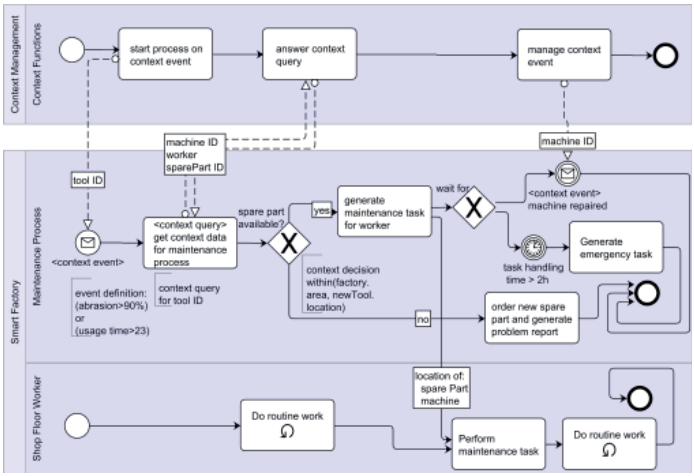


Figure 21: Example for a context aware workflow in the Smart Factory

Furthermore, in close collaboration with the Nexus application project Smart Factory the tool maintenance workflow was specified as a first example workflow. This workflow is pictured in figure 21. The workflow monitors all tools used in the factory and checks if any of the tools is attrited. If this is the case, the workflow takes care that this tool is replaced in time by a new one.

3.5.2

PROJECT: Semantic Methods for Managing Context Models

RESEARCHER: Andre Blessing

E2 is a new project that was added to Nexus at the beginning of 2007. The main goal of E2 is to provide semantic interfaces to the Nexus framework. To this end, we focus on two different research challenges. The first problem is geographic information extraction. It deals with the integration of external data into the context model using

semantic methods. The second problem is automatic and semi-automatic semantic mapping. It considers external data which either originate in applications whose models (containing geographic as well as textual elements) need to be mapped to the context model; or external data that consist of textual content, which we use to verify the consistency of the Nexus context model. We use machine learning methods for semantic mapping and information extraction from text.

We started our work on geographic information extraction with some basic requirements analysis. Especially quality aspects were considered. Information extraction uses complex information units. Simple one-dimensional quality measures (for example, tolerance as it is used by a temperature sensor) are not sufficient for this task. We had to combine a large amount of meta data (text source, text quality, current context, extraction method used...) to assess the quality of the information.

In the next step we developed a geo-tagging system for German. We developed a new model to handle the new challenges: German has many words starting with capital letters (not only proper nouns), German morphology is very rich, simple gazetteers are not sufficient. Multiword expressions are hard to detect because of the free word order in German. We have designed a three-step model (spotting, typing, referencing) that specifies the sources of information that are necessary for geo-tagging and their dependency relationships [BKS07], see figure 22.

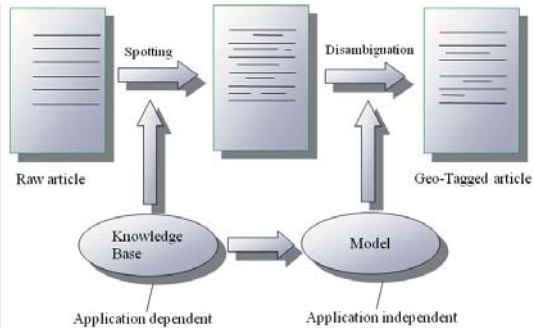


Figure 22: Complete geo-tagging processing chain

For the semantic mapping task we hosted a student from the Indian Institute of Technology, Kharagpur. He helped us create a baseline implementation of a machine learning algorithm to match data sets which have different representations.

3.5.3

PROJECT: Distributed Situation Recognition Based on Evaluated Context Information

RESEARCHER: Stamatia Rizou, Oliver Zweigle

The target of the joint project E3 is to develop a general distributed situation recognition approach and embed it into the Nexus platform.
As first steps the existing methods for reasoning about situations had to be studied and a general system architecture for integrating a situation recognition component into the Nexus platform was designed. Initially, we focused on a simple scenario. For this scenario, we analyzed methods for describing and deriving situations. Moreover a first approach to the distribution of the reasoning algorithms has been designed.

In parallel to the project-specific tasks the work on a cross publication embedded into the Situation Working Group was started that provides formal definitions about important terms like situation or situation templates building the core of the situation recognition approach. Furthermore, predicate logic approaches were analyzed to set the constraints for every situation. From this predicate description a tree structure called situation tree can easily be derived, which describes constraints in terms of a graph. This structure also allows for distribution which is one of our essential requirements. Based on the basic principle of situations trees, a new kind of interaction network technique (XPIM Nets) was developed. It bases on Petri networks and expands this paradigm with features especially tailored to the situation recognition processes. An editor to facilitate the creation of those interaction networks was developed, which defines complex situation structures in an XML-like language.

XPIM Nets cannot only be used as an algorithm for recognizing situations, they are also providing a very efficient method to generate logical and physical execution plans. Every node can be mapped to a sensor reading or a complex algorithm itself and then according to the output a transition selects the next node to be executed until the final node is reached. Unlike Petri networks, temporal aspects as well as further enhancements like sub-nets or communication between distributed XPIM nets can be handled.

A first approach to the distribution of the execution plans will be to assign parts of the tree structure to different physical nodes of the network. The sensor readings will be provided by special nodes in the network called producers and finally the result of the reasoning process will be returned to the consumers (physical nodes running the application). The goal of the distribution is to find an optimal assignment of operators to physical nodes of the network according to a performance metric and adjust the distribution to the dynamic state of the network. In order to achieve an optimal distribution, we have to exploit the similarity of parts of different situation trees to maximize the reusability of operators. Furthermore, we should also take into consideration the characteristics of the network (bandwidth, delay). Designing a suitable distribution algorithm considering these constraints is part of ongoing work.

3.6 Cross-Section Project: Metrics & Valuation of Context

RESEARCHER: Uwe-Philipp Käppeler
Oliver Zweigle

A goal of Nexus is the investigation of questions in connection with the administration of complex environment models in a global and open system. Therefore the quality characteristics linked closely with each kind of context information must be considered constantly and in a uniform way during the collection, administration, analysis and supply of context. For this purpose a reference model will be developed in the Q-project.

The first pillar of the Q-project covers the degradation of context and sensor data. The main aspects of the research in 2007 have been degradation of position information of objects and modeling of degradation for sensor data in environmental models.

Uncertainty-aware tolerances provide correctness guarantees of results to spatial queries with consideration of periodic updates and different sources of data uncertainty: sensing uncertainty, sampling uncertainty, and communication delay [FCR07a]. The algorithm operates with the restriction that an application has to handle an area of uncertainty as shown in figure 23.

The working group concerned with the consistency aspect of data quality started by collecting the requirements of the participating projects for a consistency metrics. To capture all relevant types of inconsistencies, a consistency metrics has to be continuous and has to be able to measure the consistency of single data items as well as data sets. For data sets, the information about the origin of individual data items has to be retained and exploited.

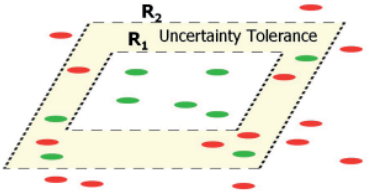


Figure 23: Uncertainty Tolerance that enables guarantees of results to spatial queries

We also decided to focus on two concrete scenarios to exemplify those requirements: The first scenario consists of a person waiting at a bus stop. This scenario reflects inconsistencies between position information of different sensors in geographical and symbolical formats and the problem of determining the consistency of query results and detected situations. In the second scenario, inconsistencies between readings from sensors observing a building, the 3D model of the building and its generalized variant are detected and measured. Both scenarios contain a visualization component for inconsistencies.

In 2007 the pillar trust and trustworthiness of the Q-project focused mainly two aspects: First we discussed vastly the possibilities and limitations of modeling trust and reputation and thus the reliability and trustworthiness of these systems and their effects on privacy. Second we explored, how trustworthiness is altered if independent trust entities get fused and merged over different hierarchical levels. This all should lay the basis for an overall evaluation in 2008 of the Nexus systems, which should ensure trust, privacy, reliability for the user.

3.7 Working Group: Mobility & Security

GROUP COORDINATORS: Prof. Dr. Paul J. Kühn
Michael Scharf

The working group "Mobility and Security" continues to coordinate interdisciplinary research activities in the center of excellence. The organization and the research topics of the group have been adapted to the new structure of the project. Compared to the first funding period, the research activities are now organized in smaller, target-oriented taskforces. This new structure is expected to better foster research cooperations.

Mobility and security are key issues of the technologies that are investigated in the center of excellence. In 2007, the working group has organized a kick-off workshop, focusing in particular on security issues. In order to obtain a common understanding of this complex topic, the involved projects have presented and discussed the existing solution approaches. Furthermore, current research activities in other related projects have been analyzed with respect to their applicability in the center of excellence.

After the kick-off workshop, significant potential for interdisciplinary research has been identified for the following topics:

Mobility

For location-based systems, user mobility imposes many constraints. One challenge is the limited availability of resources in today's - and future - wireless access networks. This is in particular critical for some Nexus applications that require broadband Internet connectivity. Such an example are 3D visualization applications. There are various solutions to optimize the communication of such Nexus applications, which have been discussed regarding both application development as well as networking issues.

Reputation and Trust

This taskforce addresses interdisciplinary issues in the field of reputation and trust. This includes to get a fundamental understanding of the underlying concepts and a comprehensive discussion of technical systems and methods. A further major work items was to identify the possibilities and limitations of trust and reputation systems.

Privacy

Virtual identities allow users to reveal sensitive data in a controlled way. Given the new contraints in the second funding period of the center of excellence, the suitability of this concept has been analyzed and reviewed again, both from a technical, social and ethical point of view.

Interdisciplinary publications in the above mentioned field are expected for the year 2008.

3.8 Working Group: Modeling & Consistency

GROUP COORDINATORS: Dr. Daniela Nicklas, Matthias Wieland

This newly founded working group covers topics of context modeling (like symbolic vs. geometric coordinates, 3D context models, or modeling quality) and development support for context aware applications (like application modeling, context model contents, or use cases) . Thus, the working group integrates the new project area E application support and acts as a major interface between the infrastructure projects (project area A-C), the application support projects (project area E) and the application projects (project area D). One example for this collaboration is the development of a Smart Factory context model extension that was published in [LG07].
In its first year, the working group founded three subgroups to discuss the associated topics in more detail:

- Subgroup 3D data (chaired by Mike Eißele, project C5): three dimensional context data modeling and processing
- Subgroup Situations (chaired by Oliver Zweigle, project E3): higher level context and the modeling and usage of situations
- Subgroup Degradation and Quality of context (chaired by Uwe-Philipp Käppeler project C3): representation of inaccurate, missing, or vague context data on different levels. This subgroup has a strong relationship to the project Q.

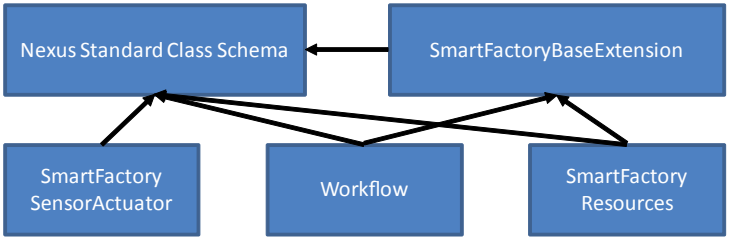


Figure 24: Smart Factory Context Model Extensions [LG07]

Also, the working group organized two application workshops. Their goal was to clarify and adjust the scenarios used throughout the Center of Collaborative Studies.

- On 30.5.2007, projects from project areas A, B, C, and E presented research directions and usage options of their project work
- On 7.11.2007, the application projects from project area D presented application scenarios that make use of the offered methods and functionalities. Also, the study project "Nexus Explorer" was introduced that develops a demonstration scenario within the Smart Factory environment. It is collaboratively counseled by sub projects B1, B5, D1, and E1.

3.9 Infrastructure & Demonstrator

The first major event in 2007 in which the project participated was the Science Day of Universität Stuttgart.We presented the Nexus vision and possible applications to the interested public and our visitors could experience firsthand what is possible with the Nexus technology and how this might translate into real world applications.

Another noteworthy event was the open colloquium in late 2007 during which industrial and scientific experts presented and discussed their view of the future of our research area. The colloquium also included demos and poster sessions which were organized and executed with the help of the infrastructure & demonstrator project.

Throughout the year the Nexus lab remains the main working area for our numerous students related to the Nexus project such as the study project AIMS (Advanced Instant Messaging Service) which focuses on a next-generation contextual instant messaging service based on Nexus concepts and technology.

Professional Activities
Conferences | Workshops | Colloquia | Committees

4 Professional Activities

4.1 Nexus Related Scientific Events

4.1.1 COLLOQUIUM: On the Way to the World Wide Space

On October 5, 2007, the Nexus project organized a public colloquium with the title "On the Way to the World Wide Space" to foster the dialog between Nexus and experts from academia and industry. More than 100 people attended in this event, including a significant number of representatives from industry. Invited speakers and speakers from the Nexus project presented current trends, visions, and driving forces on the topics "positioning, sensor systems, geo data", "visualization", and "data management". Prof. Rothermel (Nexus) and Prof. Aberer (École Polytechnique Fédérale de Lausanne, Switzerland) introduced the visions of aworld wide Space and a Smart Earth, respectively, who both anticipate a world interspersed with billions of sensors and wireless devices collecting and communicating various types of data about the physical world. Dr. Blomenhofer (Thales ATM GmbH, Germany) started the session on "positioning, sensor systems, geo data" with a talk about applications of GPS and the upcoming European Galileo global navigation satellite systems and their market potentials. In the second part of this session, Dr. Norbert Haala (Nexus) presented multi sensor systems for capturing geographic data. In the session on "visualization", Prof. Fellner (Fraunhofer-Institut für Graphische Datenverarbeitung, Germany) focused on graphical interactive working in mobile environments, followed by a talk of Prof. Weiskopf (Nexus) about real-time computer graphics on mobile devices. In the last session on "data management", Dr. Mattos (Google Inc., Vice-President of Engineering for Europe, Middle East, and Africa) introduced Google's challenging goal: organizing the world's information and making it universally accessible. Finally, Prof. Schütze (Nexus) and Prof. Mitschang (Nexus) presented the Nexus approach for managing context information,

and how to derive context information from text. Additionally some individual Nexus projects and prototypes were presented during a poster and demonstrator session.

4.1.2 COLLOQUIUM: Where? What? Where to? – Positioning with GPS/Glonass and Galileo

The lecture series organized by the CRC in summer term 2007 bore the title "Where? What? Where to? – Positioning with GPS/Glonass and Galileo". Prof. Dr. Alfred Kleusberg from the University of Stuttgart explained ihn the starting talk the basic principles of global positioning and gave a historical outline of Global Navigation Satellite Systems from the Sputnik satellite to future systems like Galileo, GPS III and Baidou.

This was followed by a scientific view on Galileo, given by Prof. Dr. Bernd Eisfeller, Bundeswehr University München, with in-depth information about the system's architecture, signal structure and the technical challenges in building end user devices. In the third talk, Dr. Helmut Blomenhofer from Thales AG presented the chances of Galileo concerning industry and economy. His talk comprised information about the different services delivered by the European system and examples of new applications in aerial, maritime, railway and automotive domains.

Prof. Dr. Jörg Wagner from the University of Stuttgart gave an introductory talk about inertial navigation systems. After presenting the functional principle, he discussed the recent developments towards small and cheap inertial sensors. Dr. Jens Kremer from IGI Kreuztal talked about mobile mapping using car-mounted 3D laser scanning systems. By showing datasets acquired by IGI's system, he presented applications like 3D city models and the results of first accuracy tests.

Dr. Torben Schüler, Bundeswehr University München, presented approaches towards using GPS in indoor positioning and alternatives like infrared, ultrasonic and WLAN positioning systems, emphasizing the respective accuracy demands of indoor and outdoor positioning. Christian Hilker from Leica Geosystems AG (Heerbrugg) highlighted Global Navigation Satellite Systems from a geodetic instrument manufacturer's point of view by explaining upcoming changes caused by the altered GPS signal structure and Galileo. Matthias Jöst, EML Heidelberg, concluded the lecture series by presenting the mobile city portal "Heidelberg Mobil", the project's experiences with context-aware applications and business models for the commercialization of location based services.

4.2 Committees

Nexus researchers were involved in the organization of the following events:

- Advisory Board D21, Berlin (Member)
- Advisory Board Galileo BW, Wirtschaftsministerium BW, Stuttgart (Member)
- Autonome Mobile Systeme (AMS), Kaiserslautern, 18.-19. Oktober 2007 (Program Committee)
- Board of Trustees German University in Cairo (GUC) (Member)
- Board of Trustees The ISPRS Foundation, Internationale Gesellschaft für Photogrammetrie und Fernerkundung, Washington D. C. (Chairperson)
- BPM'2007, Brisbane, Australia (Program Committee)
- BTW'2007, Aachen, Germany (Program Committee (Demo Track))
- CoopIS'2007 (Co-Chair Program Committee)
- DMC'2007 (Int'l Workshop on Mobile and Distributed Collaboration), Paris, France (Program Committee)
- ECOWS'07 (Halle, Germany, November 26 - 28, 2007) (Program Committee)
- Editorial Advisory Board Bollettino di Geodesia e Scienze Affini, Florenz (Member)
- EDOC'2007 - Int'l Conf Enterprise Distributed Object Computing (Annapolis, MD, USA, October 15 - 19, 2007) (Program Committee)
- Emotion and Computing, Current Research on Future Impact, KI-Workshop, Osnabrück, 10. September 2007 (Program Committee)
- Eurographics / IEEE VGTC Symposium on Visualization (Eurovis) (Program Committee)
- EUROGRAPHICS 2007 (Program Committee)
- EUROVIS 2007 (Program Committee)
- Graphics Interface 2007 (Program Committee)
- IAS (Intelligent Autonomous Systems), Baden-Baden, 23. - 25. July 2008 (Program Co-Chair Europe)
- IASTED Conference on Visualization, Imaging, and Image Processing (Program Committee)
- ICCS Workshop on Efficient Data Management for HPC Simulation Applications (Program Committee)
- ICSOC'2007 (Vienna, Austria, September 17 - 21, 2007) (Area Coodinator "SOA Middleware", and Program Committee)
- ICWE'2007 (Int'l Conf Web Engineering), Como, Italy (Program Committee)
- ICWS'07 (Int'l Conf Web Services), Salt Lake City, Utha, USA (Co-General Chair and Program Committee)
- IEEE International Workshop on Context Modeling and Reasoning, 2007 and 2008 (Co-Chair)
- IEEE Visualization (Program Committee)

- Journal on IEEE Transactions on Visualization and Computer Graphics (Editor-in-Chief)
- Robotik 2008, München, 11-12. Juni 2008 (Program Committee)
- Scientific Advisory Board Baden-Württemberg International (bw-i) (Chairperson)
- Scientific Advisory Board Finnish Geodetic Institute (FGI), Helsinki (Member)
- Scientific Advisory Board Deutsche Geodätische Kommission (DGK), München (Member)
- SIBGRAPI 2007 (Keynote Speaker and Program Comitte)
- Simulation and Visualisation (SimVis) (Program Committee)
- Special Issue of Pervasive and Mobile Computing Journal on Context Modelling, Reasoning, and Management (Guest Editor)
- Steering Committee EuroSDR (Member)
- Third Workshop on Context Awareness for Proactive Systems (Program Committee) VMV 2007 (Technical Program Committee)
- Volume Graphics Workshop (VG) (Program Committee)
- WI'07 (Wirtschaftsinformatik) Karlsruhe, Germany (Organizer and Program Committee, Track "IS Architekturen")
- WSCG Conference on Computer Graphics, Visualization, and Computer Vision (Program Committee)
- WWW'2007, Banff, Alberta, Canada (Program Committee)
- YR-SOC, Leicester, UK (Program Committee)
- 3rd International Conference on Computer Graphics Theory and Applications (Program Committee)
- 4th International Conference on Ubiquitous Intelligence and Computing (UIC-07) (Program Committee)
- 5th IEEE International Workshop on Context Modeling and Reasoning 2008 (Publication Chair, Program Committee)
- 5th International Workshop on Mobile Distributed Computing (MDC'07) (Program Committee)
- 6th Annual IEEE International Conference on Pervasive Computing and Communications (Program Committee)
- 6th International Conference on Pervasive Computing 2008 (Program Committee)
- 7th Eurographics Symposium on Parallel Graphics and Visualization (EG PGV) 2007 (Program Committee)
- 8th International Conference on Mobile Data Management (MDM'07) (Proceedings Chair)
- 18th International Conference on Database and Expert Systems Applications (DEXA 2007) (Program Committee)

4.3 Spin-Off

In April, 2007 "BNI Blindnavigation International gemeinnützige GmbH" was founded by Dr. Andreas Hub (University of Stuttgart) and Prof. Dr. Hanns Ruder (University of Tübingen). This non-profit organization is dedicated to improve the orientation ability, navigation options, and independent mobility of sensory-handicapped people across the globe by developing and supplying precise navigational maps and assistant systems to blind, deafblind, and visually-challenged users (www.blindnavigationinternational.org). To enhance their usability, assistant systems are created to meet the individual needs and personal skill-levels of users. Research and development involve cooperation with sensory challenged individuals, national and international partners, as well as worldwide organizations of the blind and deafblind (DbI (www.deafblindinternational.org), DBSV (www.dbsv.org), NFB (www.nfb.org), Sense (www.sense.org.uk), VzFB (www.vzfb.de)).

Support in many forms has helped us to realize our goals in 2007. Individuals have contributed time and effort, financial donations were received from private parties and organizations, basic maps have been donated, and political promotion begun by blind and deafblind organizations. Augmented maps were created for use by blind and visually impaired attendees at the International Fair for Low Vision Aids "SightCity", in Frankfurt, Germany, in May, and at the National Convention of the National Federation of the Blind in Atlanta, Georgia, in July. Similarly, the maps for an augmented navigation and communication system were created for deafblind attendees at the 14th Deafblind International World Conference 2007, in Perth, Australia, in October. Ongoing projects include pilot studies in cooperation with the cities of Biberach/Riss and Reutlingen, in Germany, with Sense, a deafblind organization currently moving to a new office in London, and with the California State University, Northridge Center on Disabilities to prepare environment maps of the Technology and Persons with Disabilities Conference in Los Angeles, in March [Hub08].

Ongoing research in the creation of environment models and context-based navigation systems will support the development of a global, web-based system offering adequate worldwide maps and augmented information to sensory handicapped people. Progress is hastened by the support of governments, city councils, and generous individuals who share BNI goals to improve integration and socialization opportunities for blind, deafblind, and visually impaired people.

4.4 Publications

[Aic07] Aichele, Fabian: SLAM zur Navigation im Gebäude für Serviceroboter. Universität Stuttgart, Fakultät Informatik, Elektrotechnik und Informationstechnik, Diplomarbeit Nr. 2575 (2007).

[BB07] Böhm, Jan; Becker, Susanne: Automatic Marker-Free Registration of Terrestrial Laser Scans using Reflectance Features. In: Proceedings of 8th Conference on Optical 3D Measurement Techniques, Zurich, Switzerland, July 9-12, 2007, pp. 338-344.

[BH07] Becker, Susanne; Haala, Norbert: Refinement of Building Facades by Integrated Processing of LIDAR and Image Data. In: Proceedings of PIA07 (Photogrammetric Image Analysis), Munich, Germany, September 19-21, 2007, pp.7-12.

[BKS07] Blessing, A., Kuntz, R., and Schütze, H. 2007. Towards a Context Model Driven German Geo-Tagging System. In Proceedings of the 4th ACM Workshop on Geographical information Retrieval (Lisbon, Portugal, November 09 - 09, 2007). GIR '07. ACM, New York, NY, 25-30. [CGNM07] Nazario Cipriani, Matthias Grossmann, Daniela Nicklas, Bernhard Mitschang: Federated Spatial Cursors. Proceedings of the IX Brazilian Symposium on Geoinformatics, São José dos Campos, Brazil, 2007.

[DMR07] Dudkowski, D.; Marrón, P. J.; Rothermel, K.: Migration Policies for Location-Centric Data Storage in Mobile Ad-Hoc Networks. In: Proceedings of the 3rd International Conference on Mobile Ad-hoc and Sensor Networks (MSN'07), Beijing, China, December 2007.

[DR08] Dürr, Frank; Rothermel, Kurt: An Adaptive Overlay Network forworld wide Geographic Messaging. In: Proceedings of the 22nd IEEE International Conference on Advanced Information Networking and Applications (AINA 2008); Gino-wan, Okinawa, Japan, 2008.

[DWM08] Dudkowski, D.; Weinschrott, H.; Marrón, P. J.: Design and Implementation of a Reference Model for Context Management in Mobile Ad Hoc Networks. Accepted for International Workshop on Data Management for Wireless and Pervasive Communications (DMWPC'08), Okinawa, Japan, März 2008.

[EE07] M. Eissele and T. Ertl. Mobile Navigation and Augmentation utilizing Real-World Text. In Proceedings of Mensch und Computer 2007, Workshop on Nomadic and Wearable Computing 2007, pages 121-124, 2007.

[FCR2007] Tobias Farrell, Reynold Cheng, Kurt Rothermel: Energy-Efficient Monitoring of Mobile Objects with Uncertainty-Aware Tolerances. In: Proceedings of the 11th International Database Engineering and Applications Symposium (IDEAS 2007). Banff, Canada. September 2007.

[FCR07a] T. Farrell, R. Cheng, K. Rothermel: Energy-Efficient Monitoring of Mobile Objects with Uncertainty-Aware Tolerances. In: Proc. Int'l Database Engineering and Applications Symp. (IDEAS), Banff, Canada, Sept. 2007 [FLR2007] Tobias Farrell, Ralph Lange, Kurt Rothermel: Energy-efficient Tracking of Mobile Objects with Early Distance-based Reporting. In: Proceedings of the 4th Annual International Conference on Mobile and Ubiquitous Systems: Computing, Networking and Services (Mobiquitous 2007). Philadelphia, USA. August 2007.

[GD07] Geiger, Lars; Dürr, Frank: Kontextbezogene Kommunikation. In: Roth, Jörg (ed.); Küpper, Axel (ed.); Linnhoff-Popien, Claudia (ed.): 4. GI/ITG KuVS Fachgespräch Ortsbezogene Anwendungen und Dienste, 2007, pp. 22-26.

[Glo07] Gloss, Bernd: System Architecture of a Mobile Message Transport System. International Journal of Internet Protocol Technology (IJIPT) 2007, Vol. 2.2, April 2007, pp. 79-87

[Gut07] Gutscher, Andreas: A Trust Model for an Open, Decentralized Reputation System. Proc. Joint iTrust and PST Conferences on Privacy Trust Management and Security (IFIPTM 2007), Moncton, New Brunswick, 2007

[Hau07] Hauser, Christian: Protecting Virtual Identities in Mobile IP-Based Communication. Dissertation, Universität Stuttgart, 2007

[HDM+07] Hähner, J.; Dudkowski, D.; Marrón, P. J.; Rothermel, K.: Quantifying Network Partitioning in Mobile Ad Hoc Networks. In: Proceedings of the 8th International Conference on Mobile Data Management (MDM'07), Mannheim, Germany, May 2007.

[Hes07] Heesen, J., Strategien für einen selbst bestimmten und freiheitlichen Umgang mit allgegenwärtigen Kommunikationsdiensten. In: Rainer Koschke u.a. (Hg.): Informatik trifft Logistik. Beiträge der 37. Jahrestagung der Gesellschaft für Informatik e. V. – Proceedings 110, Band 1, 369 – 374, Bremen 2007

[HGN+2008] Nicola Hönle, Matthias Grossmann, Daniela Nicklas, Bernhard Mitschang: Preprocessing Position Data of Mobile Objects. In: Proceedings of the 9th International Conference on Mobile Data Management (MDM 2008). Beijing, China. April 2008. (To appear.)

[HHKE07] A. Hub, T. Hartter, S. Kombrink and T. Ertl. Real and virtual explorations of the environment and interactive tracking of movable objects for the blind on the basis of tactile-acoustical maps and 3D environment models. Disability and Rehabilitation: Assistive Technology, May 2007, 1-12.

[HKBE07] A. Hub, S. Kombrink, K. Bosse and T. Ertl. TANIA - A Tactile-Acoustical Navigation and Information Assistant for the 2007 CSUN Conference. Conference Proceedings of the California State University, Northridge Center on Disabilities' 22nd Annual International Technology and Persons with Disabilities Conference, March 19-24, Los Angeles, CA, USA, 2007.

[HKBE07a] A. Hub, S. Kombrink, K. Bosse and T. Ertl. Conference Navigation and Communication Assistant for the Deafblind based on Tactile and Acoustically Amplified Augmented Map Information for the 14th Deafblind International World Conference. Conference Proceedings of the 14th Deafblind International World Conference, September 25-30, Perth, Australia, 2007.

[Hoe07] Höferlin, Markus: Stereovision durch Kombination einer omnidirektionalen und einer perspektivischen Kamera. Universität Stuttgart, Fakultät Informatik, Elektrotechnik und Informationstechnik, Studienarbeit Nr. 2126 (2007).

[Hub08] A. Hub. Guiding Grids in Augmented Maps for Precise Installation-Free Worldwide Blind Navigation. To appear in: Conference Proceedings of the California State University, Northridge Center on Disabilities' 23rd Annual International Technology and Persons with Disabilities Conference, March 10-15, Los Angeles, CA, USA, 2008.

[Hub08a] A. Hub. Taktil-Akustische Navigationsunterstützung für ältere blinde und sehbehinderte Menschen auf der Basis erweiterter Umgebungsmodelle (accepted). Usability Day VI, Seniorengerechte Schnittstellen zur Technik, 16. Mai, Dornbirn, Österreich, 2008.

[JEN07] Jendoubi, Lamine: Management mobiler Betriebsmittel unter Einsatz ubiquitärer Computersysteme in der Produktion. Heimsheim; Jost-Jetter Verlag, 2007 (IPA-IAO Forschung und Praxis 457). Stuttgart, Univ., Fak. Maschinenbau, Inst. für Industrielle Fertigung und Fabrikbetrieb, Diss. 2007

[Kad07a] Kada, M., 2007: Zur maßstabsabhängigen Erzeugung von 3D-Stadtmodellen. Dissertation. Universität Stuttgart 2007.

[Kad07b] Kada, M., 2007: Scale-Dependent Simplification of 3D Building Models Based on Cell Decomposition and Primitive Instancing. In: Proceedings of the International Conference on Spatial Information Theory: COSIT '07, Melbourne, Australia.

[KBH+07] Kada, Martin; Balz, Timo; Haala, Norbert; Fritsch, Dieter: Programmable Graphics Processing Units for Urban Landscape Visualization. In: Proceedings of the 26th International Symposium of Urban Data Management, Stuttgart, Germany, October, 10-12, 2007.

[KES07] M. Kraus, M. Eissele, M. Strengert. GPU-Based Edge-Directed Image Interpolation. In Image Analysis (Proceedings of SCIA 2007), volume 4522 of Lecture Notes in Computer Science, pages 532-541, 2007.

[Kin07] Kinkeldei, Patrick: 3D Objektlokalisierung anhand verteilter Messungen. Universität Stuttgart, Fakultät Informatik, Elektrotechnik und Informationstechnik, Diplomarbeit Nr. 2569 (2007).

[KS07] Kiesel, Sebastian; Scharf, Michael: Modeling and Performance Evaluation of Transport Protocols for Firewall Control. Computer Networks (ComNet) 2007, Vol. 51.11, August 2007, pp. 3232-3251

[LG07] Lucke, Dominik; Wieland, Matthias: Umfassendes Kontextdatenmodell der Smart Factory als Basis für kontextbezogene Workflow-Anwendungen. In: Roth, Jörg (ed.); Küpper, Axel (ed.); Linnhoff-Popien, Claudia (ed.): 4. GI/ITG KuVS Fachgespräch Ortsbezogene Anwendungen und Dienste", 2007 (German)

[LMS+07] Lueck, Stephan; Mueller, Christian M.; Scharf, Michael; Fetscher, Robert: Algorithms for Hotspot Coverage Estimation based on Field Strength Measurements. Proc. 65th IEEE Vehicular Technology Conference (VTC 2007 - Spring), Dublin, 2007

[LUW07] Lucke, Dominik; Wieland, Matthias: Umfassendes Kontextdatenmodell der Smart Factory als Basis für kontextbezogene Workflow-Anwendungen. In: Roth, Jörg (Hrsg.) u.a.; Gesellschaft für Informatik u.a.: Ortsbezogene Anwendungen und Dienste : 4. GI/ITG KuVS Fachgespräch, 13. und 14.9.2007, München. München : Verl. Dr. Hut, 2007, S. 47-51

[Mue07] Mueller, Christian M.: IEEE 802.21 and its Usage as an Access Network Discovery Database. Proc. VDE/ITG-Fachgruppe 5.2.4 workshop on "Network Databases", Berlin, 2007

[MB07] Mueller, Christian M.; Blume, Oliver: Network-based Mobility with Proxy Mobile IPv6. Proc. 18th Annual IEEE International Symposium on Personal Indoor and Mobile Radio Communications (PIMRC '07), Athens, 2007

[NGMW08] Daniela Nicklas, Matthias Grossmann, Jorge Mínguez, Matthias Wieland: Adding High-level Reasoning to Efficient Low-level Context Management: a Hybrid Approach. 5th IEEE Workshop on Context Modeling and Reasoning (CoMoRea) at the 6th IEEE International Conference on Pervasive Computing and Communication (PerCom'08) Hong Kong, 17-21 March 2008 (to appear)

[REP+07] M. Rotard, M. Eissele, R. van Putten, T. Ertl. Zoomable User Interfaces in Scaleable Vector Graphics. In electronic Proceedings of Open SVG 2007.

[Sch07a] Scharf, Michael: Performance Analysis of the Quick-Start TCP Extension. Proc. 4th International Conference on Broadband Communications, Networks and Systems, IEEE BROADNETS, Raleigh, NC, USA, 2007

[Sch07b] Scharf, Michael: Future Internet Transport Layer - Heading towards a Post-TCP Era? Proc. Future Internet Design Workshop, 33rd European Conference and Exhibition on Optical Communication (ECOC 2007), Berlin, 2007

[SFS07] Scharf, Michael; Floyd, Sally; Sarolathi, Pasi: Avoiding Interactions of Quick-Start TCP and Flow Control. IETF Internet Draft, work in progress, 2007

[Sie07] Siemoneit, O., Context-Awareness und rationale Risikowahrnehmung In: Rainer Koschke u.a. (Hg.): Informatik trifft Logistik. Beiträge der 37. Jahrestagung der Gesellschaft für Informatik e. V. – Proceedings 110, Band 1, 369 – 374, Bremen 2007.

[SKD+07] Saternus, Martin; Knoll, Mirko; Dürr, Frank; Weis, Torben: Symstry: Ein P2P-System für Ortsbezogene Anwendungen. In: Proceedings of 15. ITG/GI - Fachtagung (KiVS 2007).

[SLZ+07] Schanz, M., Lafrenz, R., Zweigle O. et al.: Evaluating Coupled Selection Equations for Dynamic Task Assignment Using a Behavior Framework, Autonome Mobile Systeme, Informatik aktuell, Springer Verlag, S.118-125, 2007

[SWK+07] Saternus, Martin; Weis, Torben; Knoll, Mirko; Dürr, Frank: A Middleware for Context-Aware Applications and Services Based on Messenger Protocols. In: Proceedings of the Fifth Annual IEEE International Conference on Pervasive Computing and Communications Workshops (PerComW'07), 2007.

[SZ07] Scharf, Michael; Zeeh, Christina: Experience with Simulating Real TCP/IP-Protocol Stacks. Proc. VDE/ITG-Fachgruppe 5.2.1 workshop on "Network Engineering", Essen, 2007

[WES07a] Westkämper, Engelbert: Anpassungsfähige Fabriken für traditionelle und neue Produkte. In: mic - management information center u.a.: Fabrikplanung : Fabrikplanung - schnell, sicher, effizient. 7. Deutsche Fachkonferenz, Esslingen, 22. und 23. Mai 2007. Esslingen, 2007, 24 S.

[WES07b] Westkämper, Engelbert: Nachhaltige Strategien der Produktion am Standort Deutschland. In: Zahn, Erich (Hrsg.); Universität Stuttgart / Förderkreis Betriebswirtschaft: Erfolgreich produzieren am Standort Deutschland : Eine strategische Herausforderung. Bonn :Lemmens, 2007, S. 28-47

[WES07c] Westkämper, Engelbert: Null-Fehler-Produktion in Europa. In: Forschungsgemeinschaft Qualität: Zukunft Qualität - Risiken beherrschen : Tagungsband. FQS-Forschungstagung, 27. September 2007, Braunschweig. Braunschweig, 2007, S. 95-116 (FQS-Band 80-07).

[WES07d] Westkämper, Engelbert: Optimierungspotentiale in der Produktion ausschöpfen. In: VDI Kompetenzfeld Informationstechnik u.a.: MES 2007 - Steigerung der Produktivität - ein Beitrag zur Standortsicherung : VDI-Expertenforum, Darmstadt, 28. März 2007. Düsseldorf, 2007, 11 S.

[Wie07] Wiegerling, K., Das Grundproblem des UbiComp und das Stuttgarter Konzept der Parallelkommunikation. GI (Hg.): Informatik trifft Logistik. Beiträge der 37. Jahrestagung der 37. Jahrestagung der Gesellschaft für Informatik e.V. – Proceedings 110, Band 2, 2007

[WHSH08] Wiegerling, K., J. Heesen, O. Siemoneit, C. Hubig: Ubiquitäres Computing – Singulärer Mensch? In: Klumpp/Kubicek/Roßnagel/Schulz (Hg.): Informationelles Vertrauen für die Informationsgesellschaft. Springer: Heidelberg/Berlin/New York 2008.

[WLJ+06] Wieland, Matthias; Leymann, Frank; Jendoubi, Lamine; Nicklas, Daniela; Dürr, Frank: Task-orientierte Anwendungen in einer Smart Factory. In: Kirste, Thomas (ed.); König-Ries, Birgitta (ed.); Pousttchi, Key (ed.); Turowski, Klaus (ed.): Mobile Informationssysteme - Potentiale, Hindernisse, Einsatz. Proceedings MMS´06, 2006

[WKN+07] Wieland, Matthias; Kopp, Oliver; Nicklas, Daniela; Leymann, Frank: Towards Context-Aware Workflows. In: Pernici, Barbara (ed.); Gulla, Jon Atle (ed.): CAiSE´07 Proceedings of the Workshops and Doctoral Consortium Vol.2, Trondheim, Norway, June 11-15th, 2007. Bd. 2

[WOS07] Wahl, Stefan; Oberle, Karsten; Scharf, Michael: Personal Communication Assistant Application for comprehensive FMC support. Proc. VDE/ITG-Fachgruppe 5.2.4 workshop on "Fixed-Mobile Convergence", Darmstadt, 2007

[WPS07] Welzl, Michael; Papadimitriou, Dimitri; Scharf, Michael: Open Research Issues in Internet Congestion Control. IRTF Internet Draft, work in progress, 2007

[WSK+07] Wanke, Stephan; Scharf, Michael; Kiesel, Sebastian; Wahl, Stefan: Measurement of the SIP Parsing Performance in the SIP Express Router. Proc. 13th Open European Summer School and IFIP TC6.6 Workshop (EUNICE 2007), Enschede, 2007, pp. 103-110

[ZKR07] Zweigle, Oliver; Käppeler, Uwe-Philipp; Rühr, Thomas; Häußermann, Kai; Lafrenz, Reinhard; Schreiber, Frank; Tamke, Andreas; Rajaie, Hamid; Burla, Avinash; Schanz, Michael; Levi, Paul: CoPS Stuttgart Team Description 2007. In: Proceedings of the RoboCup International Symposium; Atlanta, Georgia, July 9-10, 2007.

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