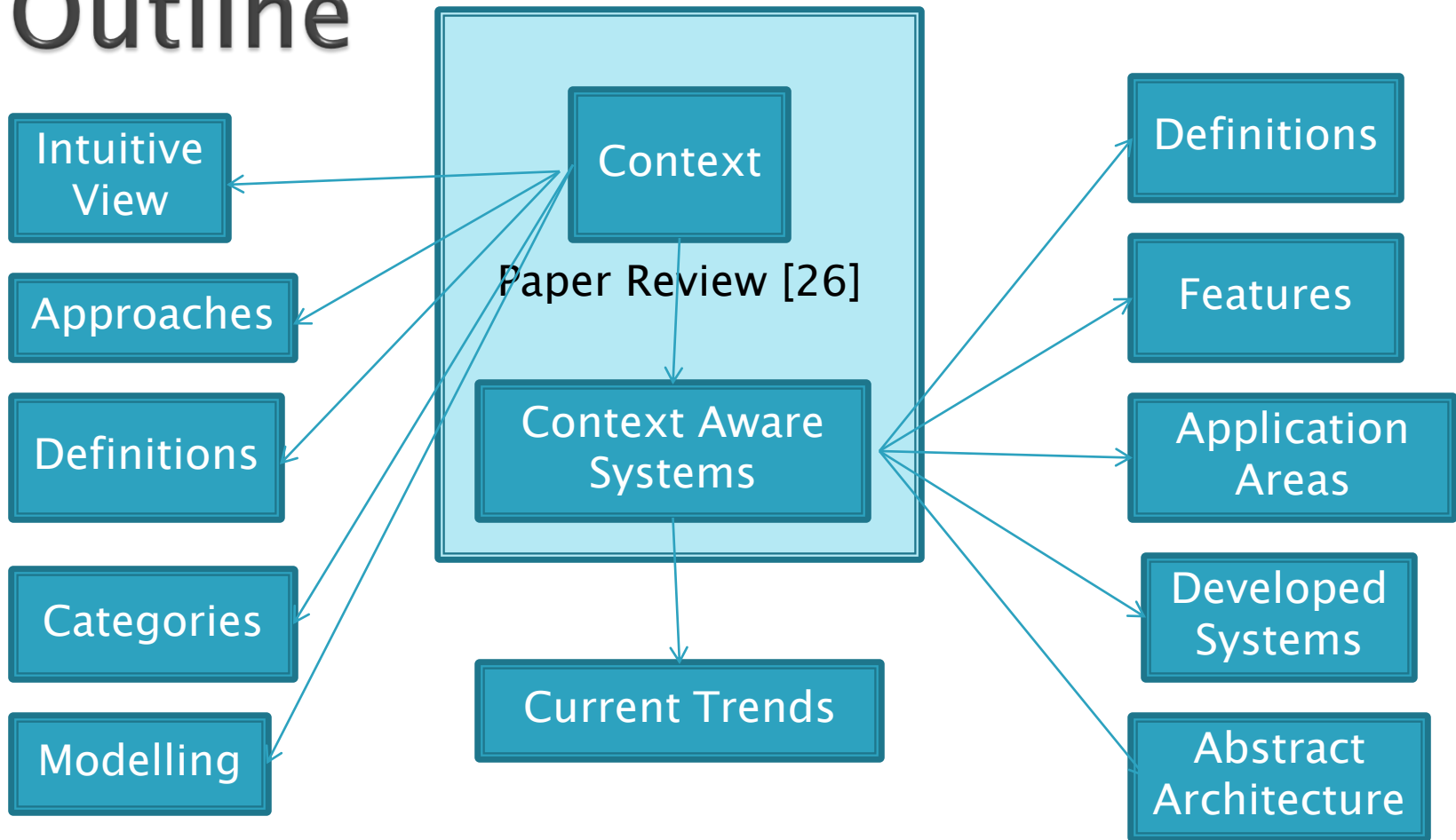


Context-Aware Dynamic Knowledge Assembly

Part 1. Context-Aware Systems Review
Dimoklis Despotakis

Outline



Intuitive View of Context



Entity

- Human
- Object
- Device
- Place
- Application

*“the **situation** within which **something** exists or happens and that can help explain it”*

Cambridge Advanced Learner's Dictionary

Intuitive View of Context

- All the **information** that encapsulate the entity
- An entity is always in a **situation** (time point/ duration)
- The **set** of information for a specific situation consists the **description** of the entity and **characterizes** it.

Our programmer likes bowling and this an information entry for his profile. But, in his current situation this does not consist a descriptive characteristic for him

States and **attributes** of the entity

Enumerated set of values

Measured set of values

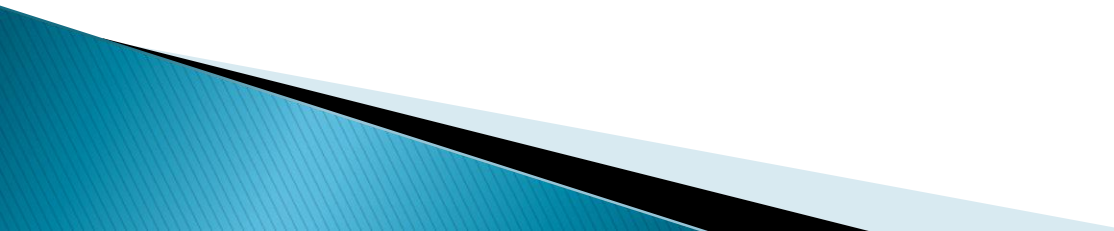
Intuitive View of Context

An entity may contain **other related entities** in its context for a given situation

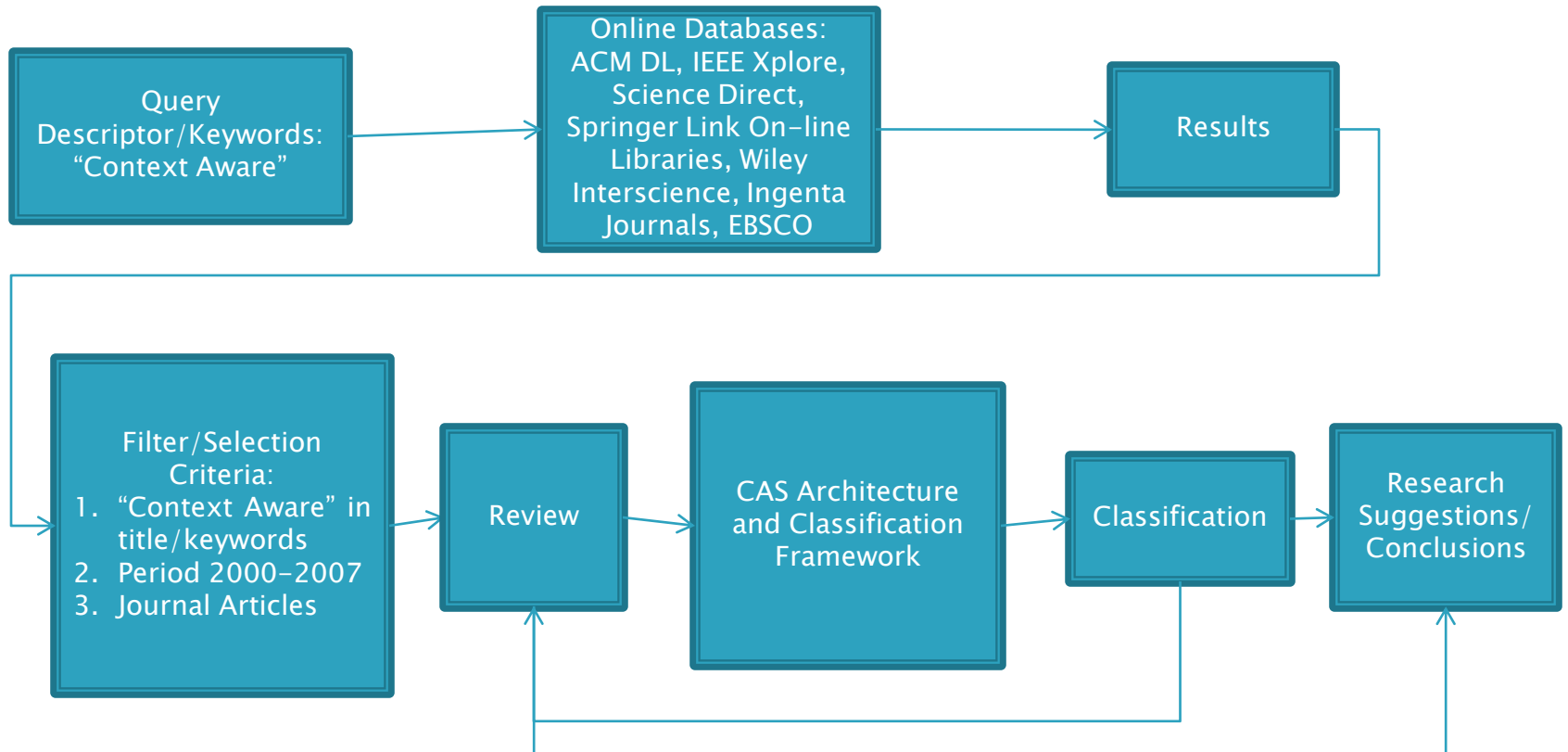
Our programmer is closely related with his PC which consists an other entity with its own context (memory, HD, applications he has used)

Review Paper – Introduction

Scope: The work at [26] aimed to:

- ▶ Review literature over Context–Aware Systems (time period 2000 – 2007)
 - ▶ Provide a Classification Framework based on the architecture of Context – Aware Systems.
 - ▶ Classify published research work using this framework.
 - ▶ Suggest research topics and trends based on the literature review.
- 

Review Paper – Workflow



Approaches to Define Context

- ▶ **Application specific/Example:** refer to specific information that context includes [1, 3], fit to purpose of current application and enumerate characteristics [6]. Include location and time [1, 4, 5], identity and emotional state [8].
- ▶ **Provide Synonyms:** environment or situation [4, 12, 13]
- ▶ **Global:** a more operational definition that *“helps the developer to enumerate the context for a specific application scenario”* [7], while the definition itself is not fitted to purpose.

Definitions of Context

- ▶ Schilit et al. [1]: a combination of location and time characteristics, while later in [2] takes into account *“where you are, who you are with, and what resources are nearby”* and environmental attributes as well.
- ▶ Brown et al. [3], Ryan et al. [5] : included identity and environment in their approach.
- ▶ Pascoe [6]: enumerates the states of a specific context type in a given situation.

Dey [7, 8]: *“any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered to be relevant to the interaction between a user and an application, including the user and applications themselves”*.

Categories of Context

- **Physical** [1, 3, 5, 7, 26]:
location, place
- **User** [2, 3, 5, 8]: identity
emotional state, preferences
- **Environment** [3, 7, 12,13]:
activity, user situation
- **Time** [3,5,7]: calendar /
duration of tasks

Dey at [7]:

- Location
- Identity
- Activity
- Time

A generalization for secondary context

Model approach in [39]:

- **Environmental**: surroundings (services, people)
- **Personal**: identity, mood, expertise, disabilities etc.
- **Social**: user's roles
- **Task**: goals, tasks, activities
- **Spatio-temporal**: time, location etc.

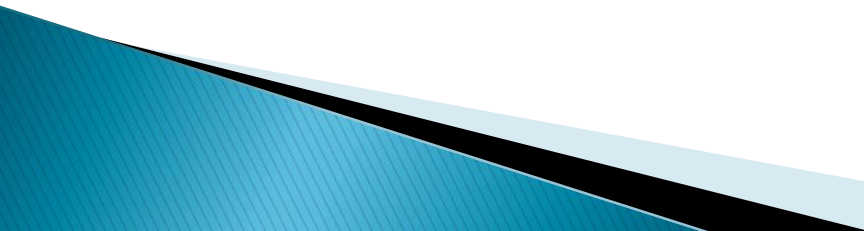
Context Modelling Techniques

- ▶ **Key – Value** [2]: pairs of variable – value , exact matching for querying.
- ▶ **Markup Scheme** [15]: hierarchical data structures, tags – attributes – content, XML/RDF(S). Extend the *Composite Capabilities/ Preferences Profile (CC/PP)*[16] and the *User Agent Profile (UAProf)*[17].
- ▶ **Graphical Models** [18]: Unified Modeling Language (UML), Object–Role Modeling (ORM) [19].
- ▶ **OO Models** [20, 21, 22]: encapsulation and re–usability.
- ▶ **Logic Based** [23, 24]: facts, rules and presuppositions, Prolog
- ▶ **Ontology Based** [25, 34]: concepts, interrelations.

Context Aware Systems (CAS) – Intuitive Approach

Use of **context** to extract necessary (situational) information in order to **adapt their functionality**.

CAS – Definitions and Features

- ▶ **Ability of an application to react in environmental changes** [1, 2]
 - Takes into account other related entities and nearby resources
 - Manual or automatic task for information retrieval and command execution
 - ▶ **Expand the supported features** [6]
 - Sensing, adaptation, resource discovery and augmentation
 - ▶ **Uses context to provide relevant information and/or services to the user, where relevancy depends on the user's task** [7, 8]
 - Presentation of information, automatic execution of a service, tagging of context to information for later retrieval
 - ▶ **A CAS can react and adapt its operations to contextual changes** [9, 10]
 - Combines Dey and Schilit's view
- 

CAS – Main Characteristics

- ▶ Independent operation from users
- ▶ Anticipate future behaviour
- ▶ Interconnectivity and interoperability of devices
- ▶ Adaptation to user's movement

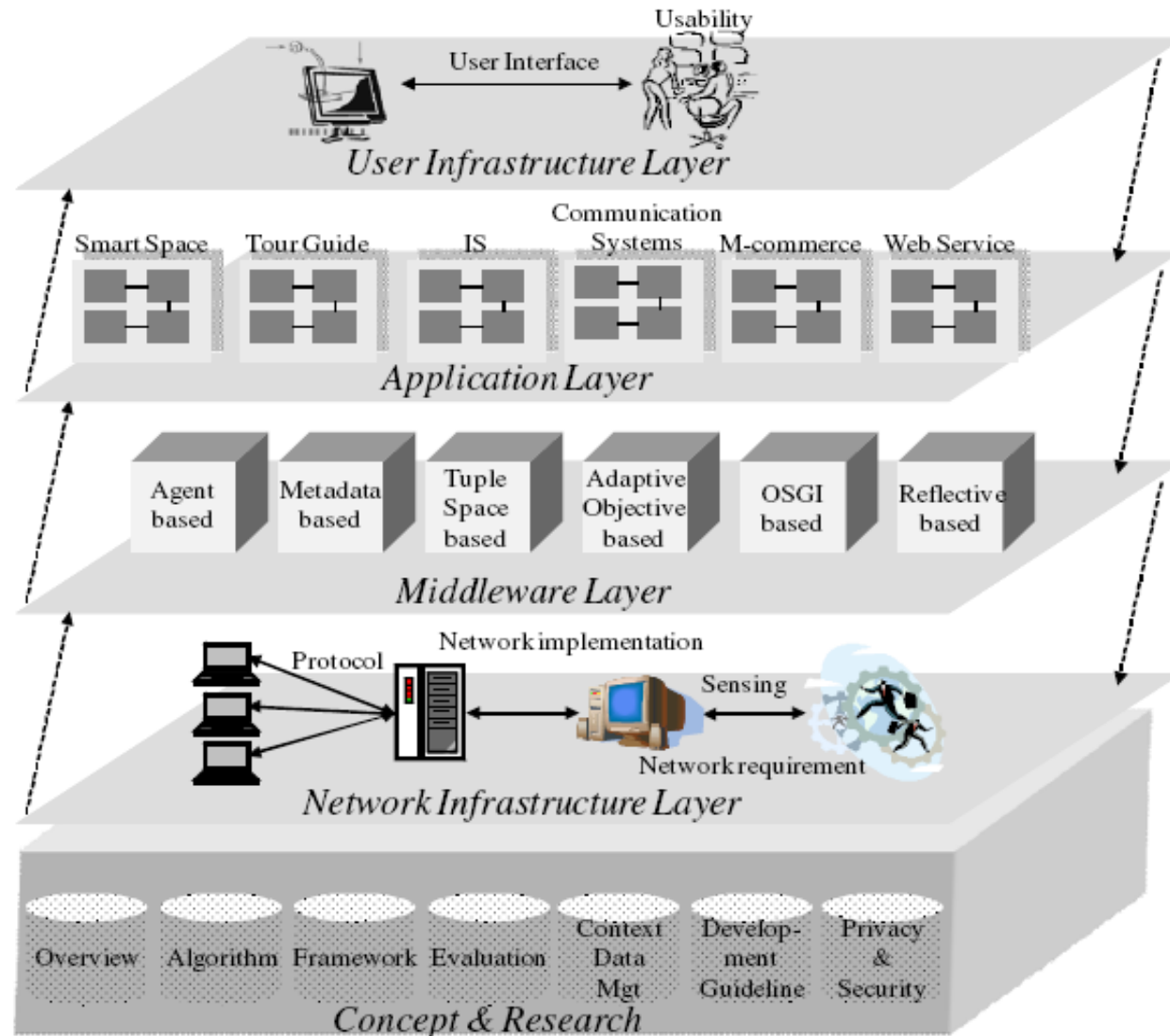
CAS – Application Areas

- ▶ Smart Spaces: Home, Hospital, Office
- ▶ Tour Guides
- ▶ Information Systems
- ▶ Communication Systems
- ▶ Mobile Commerce
- ▶ Web Services

CAS Review paper [26]



CAS – Abstract Architecture and Classification Framework



CAS – Example Applications

- ▶ **Prototyping of context aware applications, e.g. Context Toolkit [31]**
- ▶ **Frameworks for context aware applications on mobile devices, e.g. CASS [29], Hydrogen[30], SOCAM [28]**
- ▶ **Agent-based architecture for supporting context-aware systems in smart spaces – CoBra [34]**
- ▶ **Active Space system – Gaia [32]**
- ▶ **Tour guide applications, e.g. CyberGuide[33], GUIDE System[22]:**
- ▶ **Personalized services in academic communities – MyCampus [http://www.cs.cmu.edu/~sadeh/mycampus.htm]**

Current Trends

- ▶ Context-Awareness vs User's awareness [35, 36]
- ▶ Utilize context history (*"lifelong user modelling" UMAP 09*):*security issues on context distribution* [35, 26, 38]
- ▶ From simple user profiles to adaptive user models (experiences, preferences, background, interrelations with other individuals, emotional state)[26]
- ▶ Adjustment of context -aware system's behaviour according to user's activity [35]
- ▶ Context-aware + Adaptive Learning
- ▶ Community modelling (resolve preference conflicts)[26]
- ▶ Situation monitoring -> decision making [26, 35, 36]
- ▶ Content and quality of context (trust) [26, 27]
- ▶ Context-Aware Web Services [37]

Bibliography

1. B. Schilit and M. Theimer. Disseminating active map information to mobile hosts. *IEEE Network*, 8:22-32, 1994.
2. B. Schilit, A. Norman, and R. Want. Context-aware computing applications. In *Proceedings of the Workshop on Mobile Computing Systems and Applications*, pages 85-90. IEEE Computer Society, 1994.
3. P. J. Brown, J. D. Bovey, and X. Chen. Context-aware applications: from the laboratory to the marketplace. *IEEE Personal Communications*, 4(5):58-64, October 1997.
4. P. J. Brown. The Stick-e Document: a framework for creating Context-Aware Applications. *Electronic Publishing 96'* (1996)259-272.
5. N. S. Ryan, J. Pascoe, and D. R. Morse. Enhanced reality fieldwork: the context-aware archaeological assistant. In V. Gaffney, M. van Leusen, and S. Exxon, editors, *Computer Applications in Archaeology, 1997, British Archaeological Reports, Oxford, October 1998. Tempus Reparatum*.
6. Jason Pascoe. Adding generic contextual capabilities to wearable computers. In *ISWC '98: Proceedings of the 2nd IEEE International Symposium on Wearable Computers*, pages 92-99. IEEE Computer Society, 1998.
7. A.K. Dey and G.D. Abowd. Towards a better understanding of context and context-awareness. Technical report, Graphics, Visualization and Usability Center and College of Computing, Georgia Institute of Technology, Atlanta,GA, USA, 2000.
8. A.K. Dey. Understanding and using context. *Personal and Ubiquitous Computing*, 5:4-7, 2001.
9. H. Byun and K. Cheverst. Utilizing context history to provide dynamic adaptations. *Applied Artificial Intelligence*, 18(6):533-548, July 2004.
10. M. Baldauf, S. Dustdar, and F. Rosenberg. A survey on context-aware systems. *Int. J. Ad Hoc and Ubiquitous Computing*, 2(4):263-277, 2007

Bibliography

11. T. Strang and C. Linnhoff-Popien. A context modeling survey. In: Workshop on Advanced Context Modelling, Reasoning and Management, UbiComp 2004 – The Sixth International Conference on Ubiquitous Computing, Nottingham/England, 2004.
12. Hull, R., Neaves, P., Bedford-Roberts, J. Towards Situated Computing. 1st International Symposium on Wearable Computers (1997) 146–153
13. Franklin, D., Flaschbart, J. All Gadget and No Representation Makes Jack a Dull Environment. AAI 1998 Spring Symposium on Intelligent Environments, Technical Report SS-98-02 (1998)155–160
14. Dey, A.K. Context-Aware Computing: The CyberDesk Project. AAI 1998 Spring Symposium on Intelligent Environments, Technical Report SS-98-02 (1998) 51–54
15. Held , A., B Uchholz , S., Schill , A. (1998), pp. 92–99. Modeling of context information for pervasive computing applications. In Proceedings of SCI 2002/ISAS 2002 (2002).
16. W3C. Composite Capabilities / Preferences Profile (CC/PP). <http://www.w3.org/Mobile/CCPP>.
17. WAPFORUM. User Agent Profile (UAPProf). <http://www.wapforum.org>.
18. Bauer , J. Identification and Modeling of Contexts for Different Information Scenarios in Air Traffic, Mar. 2003. Diplomarbeit.
19. Haplin , T. A. Information Modeling and Relational Databases: From Conceptual Analysis to Logical Design. Morgan Kaufman Publishers, San Francisco, 2001.
20. Schmidt, A., Beigl , M., Gellersen , H.W. There is more to context than location. Computers and Graphics 23, 6 (1999), 893–901.
21. Schmidt, A., Laerhoven , K. V. How to Build Smart Appliances. IEEE Personal Communications (August 2001).

Bibliography

22. Cheverst, K., Mitchell, K. and Davies, N. Design of an object model for a context sensitive tourist GUIDE. *Computers and Graphics* 23, 6 (1999), 883–891.
23. Gray, P. and Salber, D. Modelling and Using Sensed Context Information in the design of Interactive Applications. In LNCS 2254: Proceedings of 8th IFIP International Conference on Engineering for Human–Computer Interaction (EHCI 2001) (Toronto/Canada, May 2001), M. R. Little and L. Nigay, Eds., Lecture Notes in Computer Science (LNCS), Springer, p. 317 ff.
24. Bacon, J., Bates, J. and Halls, D. Location-oriented multimedia. *IEEE Personal Communications* 4, 5 (1997).
25. Otzturk, P. and Aamodt, A. Towards a model of context for case-based diagnostic problem solving. In *Context-97; Proceedings of the interdisciplinary conference of modeling and using context* (Rio de Janeiro, Feb. 1997), pp. 198–208.
26. J. Hong, E. Suh, and S. Kim. Context-aware systems: A literature review and classification. *Expert Systems with Applications*, 36, 2009.
27. T. Moran and P. Dourish. Introduction to this special issue on context-aware computing. *Human–Computer Interaction*, 16:87–95, 2001.
28. T. Gu, H.K. Pung, and Da Q. Zhang. A middleware for building context-aware mobile services. In *Vehicular Technology Conference, 2004. VTC 2004–Spring. 2004 IEEE 59th, volume 5*, pages 2656–2660, 2005.
29. P. Fahy and S. Clarke. Cass – a middleware for mobile context-aware applications. In *Workshop on Context Awareness, MobiSys, 2004*.
30. T. Hofer, W. Schwinger, M. Pichler, G. Leonhartsberger, J. Altmann, and W. Retschitzegger. Context-awareness on mobile devices – the hydrogen approach. In *HICSS '03: Proceedings of the 36th Annual Hawaii International Conference on System Sciences (HICSS'03) – Track 9*, page 292.1, Washington, DC, USA, 2003. IEEE Computer Society.

Bibliography

31. Daniel Salber, Anind K. Dey, and Gregory D. Abowd. The context toolkit: aiding the development of context-enabled applications. In CHI '99: Proceedings of the SIGCHI conference on Human factors in computing systems, pages 434{441, New York, NY, USA, 1999. ACM.
32. URL: <http://gaia.cs.uiuc.edu/index.html>.
33. Gregory D. Abowd, Christopher G. Atkeson, Jason Hong, Sue Long, Rob Kooper and Mike Pinkerton. Cyberguide: A Mobile Context-Aware Tour Guide. Baltzer/ACM Wireless Networks, Vol. 3. 1997
34. Harry Chen et al., "Intelligent Agents Meet the Semantic Web in Smart Spaces", IEEE Internet Computing, November 2004
35. Fujii, A.. "Trends and Issues in Research on Context Awareness Technologies for a Ubiquitous Network Society",In *Proceedings of the 6th International Conference on Advances in Mobile Computing and Multimedia, 2008*, pp.422-426.
36. Dey, A.K. And Avrahami D.. *Why and Why Not Explanations Improve the intelligibility of Context -Aware Intelligent Systems, CHI 09'*, pp. 859-868.
37. Truong H.L and Dustdar S.. A Survey on Context-Aware Web Service Systems . *International Journal of Web Information Systems,5(1):5-31, (c) Emerald, 2009*
38. Hong, J. Suh, E.H., Kim J. and Kim S..Context-aware system for proactive personalized service based on context history. *Experts Systems with Applications, 36: 7448-7457, 2009*
39. Kofod-Petersen, A. and Cassens, J.. Using Activity Theory to Model Context Awareness.