Summary Report for CENIIT project 01.07

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Summary of Scientific Results

I present the three different projects by first giving a short intro to the research questions, and then the results have been put in italics. The work has been carried out in the following three sub-projects:

Project 1. COMET - COMponent-based Embedded real-Time database systems

People: Aleksandra Tesanovic (PhD Student, LiTH), Jörgen Hansson (principal investigator and supervisor, LiTH), Dag Nyström (PhD Student, MdH), Christer Norström (supervisor, MDH).
The goal of this research is to bridge the gap between embedded systems, real-time systems, and database systems, with a particular focus on the software development tools and components. A significant amount of research has focused on how to incorporate database functionality into real-time systems without jeopardizing timeliness and how to incorporate real-time behavior into embedded systems. However, research for embedded databases used in embedded real-time systems, which explicitly addresses the development, design process, and limited resources in embedded systems is sparse. This research explicitly addresses system resource demand in the design of embedded databases in order to minimize system resource usage. *In this work we have developed design principles and a real-time component model (RTCOM) that allow us to manage resources in a time-cognizant way and verify timeliness properties. Using these techniques, we have built the COMET database platform that provides techniques and protocols for storing and manipulating data (in components and aspects), which can be used to design and tailor a database module for application-specific embedded systems, where the module can be embedded with the run-time system.*

Industrial partners are Volvo Construction Equipment Components AB and Upright Database Technology. The project is funded by SSF/SAVE (Foundation for strategic research).

Project 2. Real-time databases for engine control

People: Thomas Gustafsson (PhD Student, LiTH), Jörgen Hansson (principal investigator and supervisor, LiTH).
The car industry has identified a strong need for increased tool support in order to handle the increasing functionality and complexity for the next generation of engine control systems. This need originates from increased law regulations and diagnosis requirements for handling faults, with the implication that the amount of data managed by the engine control system has increased drastically, as well as the complexity of the engine control system itself. Databases have are considered as one tool to improve the situation. This research focuses on incorporation of database and transaction support in engine control systems for automobiles, with the vision that all data transactions, including extremely fast and critical transactions in the control loop as well as transactions outside the control loop, e.g., for diagnosis, should be carried out by a real-time database that is integrated with the engine control system. Emphasis is given to software architectural considerations of the database and the engine control system, and models for

transaction execution under temporal constraints on data and transactions (primarily expressed as absolute validity intervals, relative validity intervals, deadlines etc.), where the workload consists of multi-class transactions requiring differentiated processing due to transaction criticality and real-time performance requirements.
The impact of successful deployment of a database in this type of system is high. First, by using a central repository for data management, one can avoid unnecessary data storage at the different processes, which enhances software maintainability and fosters better software evolution due to simpler structure and the removal of data subscription models. Second, the programmers' tasks are also simplified since the database can perform much of the synchronization and enforce time constraints such as data validity. Third, the database can manage limp-home-values, decreasing the complexity and the cost of sensors in the engine.
In this project we have developed a scheme for handling changes in data items, which allows for adaptability to new states. The scheme controls the update of base data items (aka sensor data) and schedules updates of (derived) data items. Essentially, when a base data item changes, a check is made to determine whether the change is significant compared to the previously used value of the base data; if the change is significant, then derived data items should be recomputed using the new base data. We have developed new scheduling algorithms that adopt the scheme (the scheme has also been evaluated with existing on-demand scheduling algorithms), and results show that the scheme adjusts the number of necessary updates that are required to achieve desired level of data freshness.
When a data item is used it must be fresh. This implies that the validity of a derived data item is dependent on the validity of the data items involved in deriving it. To achieve this, we have developed algorithms DF and BF that schedule updates of data items and maintain data validity bounds by modeling the expected error of a data item. The maximum deviation of the value of a data item is approximated and is used by the scheduling algorithms to prioritize the updates. Performance experiments show that the proposed algorithms perform better for all types of loads than consistency-centric on-demand algorithms. In comparison to through-put- centric algorithms, the proposed algorithms perform better at light to moderate loads, while for heavy loads they are worse.

Industrial partners are Saab Automobile AB and Mecel AB. The project is funded by VINNOVA's Center of Excellence ISIS (Information Systems for Industrial Control and Supervision).

Project 3. Managing QoS for real-time data services in unpredictable performance-critical environments
People: Mehdi Amirijoo (PhD Student, LiTH), Jörgen Hansson (principal investigator and supervisor, LiTH), Sang Hyuk Son (co-supervisor, University of Virginia, Charlottesville), Svante Gunnarsson (co-supervisor, LiTH).
Most real-time applications are more complex and their real-time data needs are sophisticated. This complexity arises from several causes. First, the problem of determining adequate worst-case execution times, which should not be overly conservative in order to avoid underutilization of system resources. Second, the level of timeliness required by tasks does not benefit from a simplification of time constraints to hard time constraints. Time constraints are critical but less stringent than for hard real-time systems, and, hence, the timeliness requirements are more complex to express and reason about than the process models used in the hard real-time paradigm. Third, it is not enough to guarantee the availability of data; temporal constraint (e.g., freshness) of data is another critical requirement that can be specified as the quality of data (QoD). Fourth, applications may operate in open environments, in which arrival patterns and resource requirements of tasks and transaction are in general unknown. This implies that tasks

cannot be subject to exact schedulability analysis given the lack of a priori knowledge of workload and data access patterns, making transient overloads inevitable.
Developing real-time data services should involve techniques for managing unpredictability of the environment, handling imprecise or incomplete knowledge, reacting to overloads and unexpected failures (i.e., those not expressed by design-time failure assumptions), in order to achieve the performance requirements and temporal behavior necessary for accomplishing the specified tasks. To address this problem, we propose a management scheme for real-time data services that provides guarantees on QoS and QoD of several fundamental performance metrics for real-time applications, with a focus on scheduling and concurrency control. This scheme has a profound impact on system performance, especially on meeting QoD constraints in real-time data services. Feedback control real-time scheduling defines error terms for schedules, monitors the error, and continuously adjusts the schedules to maintain stable performance. It has been shown to be feasible in dynamic systems that are resource insufficient, exhibiting unpredictable workloads. It can also be integrated with flexible real-time requirements. This new paradigm is based on the theory and practice of control theory. Results include the following:

- *A framework consisting of a model for expressing QoS requirements in terms of data and transaction preciseness, an architecture based on feedback control scheduling, and a set of algorithms implementing different policies have been developed. This work has been extended to support differentiation in QoS and application importance. The algorithms have been evaluated for managing steady state and transient state performance in terms of data and transaction quality. Performance evaluation has shown that the algorithms give robust and controlled behavior for real-time database transaction processing, in terms of data and transaction quality, even during transient overloads and when we have inaccurate run-time estimates of the transactions.*
- *To efficiently use feedback control scheduling it is necessary to have a model that adequately describes the behavior of the system. A novel model (DYN) has been presented and evaluations show that DYN is significantly more accurate than models presented earlier. Controllers tuned using DYN show a substantial improvement compared to controllers tuned with other models.*
- *It has been shown that the disturbance in the measured controlled variable decreases as the sampling period increases. We have quantized the disturbance present in the controlled variables, deadline miss ratio and utilization, as a function of the sampling period and we have proposed a measurement disturbance suppressive control structure. This work has been extended with a more general task model, an additional controlled variable (quality of task results), and improved efficiency in quantifying the measurement and system disturbances. The experiments we have carried out show that a controller using the proposed control structure outperforms a traditional control structure, with regard to performance reliability and adaptation.*
- *Dynamically updating the software of real-time systems is needed in response to errors and added requirements to the software. However, updating a system during run-time may degrade the performance of the system, which cannot be tolerated for performance critical real-time systems. We have developed an approach for guaranteeing that the performance of a system under update satisfies a given worst-case performance specification. This is achieved by predicting the system performance and comparing the prediction with the given worst-case performance specification. If the predicted performance does not conform to the specified worst-case performance, then the desired software update has to be altered.*

Supervised THESES (Doctoral Students)

1. T. Gustafsson, "Maintaining data consistency in embedded databases for vehicular systems", Department of Computer Science, Linköping University; PhD thesis defense is planned to Spring 2007.
2. A. Tesanovic, "Developing resuable and reconfigrable real-time software using aspects and components", Doctoral thesis, Department of Computer Science, Linköping University, March 2006. (Main supervisor). Opponent: Prof. Heinz Schmidt, Monash University, Australia.
   Dr. Tesanovic is affiliated with Phillips Research in Eindhoven, Netherlands (May 2006 -).
3. D. Nyström, "Data Management in Vehicle Control-Systems", Doctoral thesis, Department of Computer Science and Engineering, Mälardalen University, Mälardalen University Press Dissertations, October, 2005. (Assistant supervisor and co-PI of project). Opponent. Dr. Robert Van Ommering.
   Dr. Nyström is affiliated with Mälardalen university and also involved in starting up a spin-off company on COMET.
4. T. Gustafsson, "Maintaining data consistency in embedded databases for vehicular systems", Licentiate thesis, Department of Computer Science, Linköping University, December 2004. (Main supervisor).
5. A. Tesanovic, "Towards aspectual component-based real-time system development", Licentiate thesis, Department of Computer Science, Linköping University, June 2003. (Main supervisor).
6. D. Nyström, "COMET: A component-based real-time database for vehicle control systems", Licentiate thesis, Department of Computer Science and Engineering, Mälardalen University, May 2003. (Assistant supervisor and co-PI of project

Summary of thesis projects undertaken

Master's and Bachelors theses during 2000- present

1. Ying Du, "Active Behavior in a Configurable Real-Time Databases for Engine Control", Master's thesis, 20 credits, 2006.
2. Torgny Andersson, "Finite Horizon Prediction of Computer System State and its Applications to Reconfigurable Component-Based Real-time Systems", Master's thesis, 20 credits, 2005.
3. Daniel Nilsson and Henrik Norin, "Adaptive QoS Management in Dynamically Reconfigurable Real-Time Databases", Master's thesis, 20 + 20 credits, 2005. **
4. Peng Mu, "Configuration tool for component-based real-time databases", Master's thesis, 20 credits, 2005.
5. Tommy Strandelin, "Efficient overload management in real-time operating systems", Master's thesis, 20 credits, 2004.
6. Mikael Björk, "QoS management in configurable real-time databases", Master's thesis, 20 credits, 2004.
7. Hugo Hallkvist, "Data versioning in a real-time data repository", Master's thesis, 20 credits, 2004.
8. Kristoffer Erlandsson, "Concurrency control in a configurable component-based real-time database", Master's thesis, 20 credits, 2004.

9. Carl Olsson, "Implementing differentiated services in a real-time database simulator", 10 credits, 2004.
10. Natalia Dulgheru, "Management of QoS in distributed MPEG video systems", Master's thesis, 20 credits, 2004. **
11. Joakim Bodin, "Aspect analyser tool verification", Master's thesis, 20 credits, 2003.
12. Pernilla Uhlin, "Aspect analyzer: a tool for automated worst-case execution time analysis of aspects and components", Master's thesis, 20 credits, 2003.
13. Markus Eriksson, "Efficient data management in engine control software for vehicles", Master's thesis, 20 credits, 2003.
14. Mehdi Amirijoo, "Algorithms for managing QoS for real-time data services using imprecise computation", Master's thesis, 20 credits, 2003. Awarded national prize for the best real-time thesis 2003 by SNART. Nominated by Linköping university for "Lilla Polhemspriset" (national prize for the best thesis in science and engineering).
15. Ke Sheng, "Structuring aspects in embedded database systems", Master's thesis, 20 credits, 2003.
16. Martin Jinnelöv, "Analysis of an engine control system in preparation of a real-time database", Master's thesis, 20 credits, 2002. **
17. Tobias Forsberg, "Realtidssystems- och schemaläggningssimulator med dynamiska exekveringsprofiler", Bachelor's thesis, 10 credits, 2002. **
18. David Steen, "Integration of real-time services into a commercial relational database system", Master's thesis, 20 credits, 2002. **

Funding

Jörgen Hansson is the only person who has been funded by the CENIIT grant.

Summary of Industrial Collaboration

Current industrial collaborators include:
- Volvo Construction Equipment Components AB (contact person: Nils-Erik Bånkestad, Eskilstuna)
- Upright Database Technology (previously known as Mimer Information Technology AB (a company focusing advanced database system development) (contact person: Bengt Gunne, Uppsala)
- Saab Automobile, Engine division, Södertälje (contact person: David Holmgren, Södertälje)
- Mecel AB, Åmål (contact person: Anders Göras, Åmål)

Technology transfer

The results coming out from the COMET-project focusing on component-based real-time database systems, and the COMET prototype database platform represent the technical platform for a startup company. Seed funding for this start-up has been provided by SSF, and is done in collaboration with Upright Database Technology (one of the collaborators). The people involved

in the company are Dag Nyström (main lead), Christer Norström, Aleksandra Tesanovic, Jörgen Hansson, and Mikael Nolin.

The work on data validity, conducted as an ISIS project, is in its final stage. Seminars and technical discussions have been held specifically to facilitate technology transition, primarily with Mecel AB.

Summary of People and Academic Collaboration

Group at LiU
Jörgen Hansson, Associate Professor
Aleksandra Tesanovic, PhD student, PhD thesis defended in 2006
Thomas Gustafsson, PhD student, PhD thesis to be defended in 2007 (Licentiate degree awarded in 2005)
Mehdi Amirijoo, PhD student, PhD thesis to be defended in 2007

Other collaboration
Sang H. Son, Professor, UVA, USA
Svante Gunnarsson, Professor, LiTH
Christer Norström, Professor, MdH
Sten F. Andler, Professor, HS
Dag Nyström, PhD student, MdH

Contacts with other CENIIT projects

Discussions with Prof. Uwe Assman was carried out in the design about the real-time component model RTCOM.

Establishment of a new research group

Since July 2005, I have been on part-time leave from Linköping university. The research group I have been heading has consisted of three doctoral students under my direct supervision + several doctoral students for which I was the secondary supervisor. The group has successfully secured funding from ARTES/SSF, ISIS, CUGS etc, and up till now we have published approximately 50 papers, supervised about 18 final year project students, and started up a company. Aleksandra Tesanovic has secured a research position at Philips Research in Eindhoven, Netherlands. Thomas Gustafsson has joined University of Jönköping as an adjunct (vik) assistant professor. I have been promoted to associate professor, and I am in the process of submitting my application for being promoted to full professor, with the supporting consent of the department of computer science.

Publications

Journal Publications

1. M. Amirijoo, J. Hansson, S. H. Son, and S. Gunnarsson, "Linear time-invariant models for feedback control scheduling in real-time systems:" Accepted to Real-Time Systems Journal (to appear).

2. M. Amirijoo, J. Hansson, S. Gunnarsson, and S. H. Son, "Suppressing the measurement distrubance in feedback controlled real-time systems" (in review).

3. A. Tesanovic, M. Amirijoo, and J. Hansson, "Providing Configurable QoS Management in Real-Time Systems with QoS Aspect Packages", LNCS Transactions on Aspect-Oriented Software Development, 2006.

4. M. Amirijoo, J. Hansson, and S. H. Son, "Specification and management of QoS in real-time databases supporting imprecise computations", IEEE Transactions on Computers, Vol 55, No 3, pp 304-319, Mach 2006.

5. D. Nyström, M. Nolin, A. Tesanovic, C. Norström, and J. Hansson, "Database pointers: efficient and predictable data access in real-time control-systems" (in review Real-Time Systems Journal).

6. A. Tesanovic, D. Nyström, J. Hansson, and C. Norström, "Aspects and components in real-time system development: towards reconfigurable and reusable software", in Journal of Embedded Computing, Cambridge International Science Publishing, Feb. 2004.

Reviewed Conference/workshop papers etc.

7. V. Prasad, T. Yan, S.H. Son, J.A. Stankovic, and J. Hansson, "ANDES: an ANalysis based DEsign tool for wireless Sensor networks" (in review).

8. T. Gustafsson and J. Hansson, "CPU Utilization of Updates: a Comparison of Periodic and On-Demand Updating of Data Items", (in review).

9. J. Hansson, P. Feiler, A. Greenhouse, "Modeling and validation of data quality attributes in software architectures", Technical Note, Software Engineering Institute, Carnegie Mellon University, 2006 (to appear).

10. J. Hansson and A. Greenhouse, "Architectural modeling and validation of security", Technical Note, Software Engineering Institute, Carnegie Mellon University, 2006. (in review).

11. J. Hansson, P. Feiler, A. Greenhouse, J. Hudak, and L. Wrage, "Impact of Architecture Concurrency on Performance Engineering", Technical Note, Software Engineering Institute, Carnegie Mellon University, 2005.

12. T. Gustafsson, A. Tesanovic, Y. Du, and J. Hansson, "Engineering Active Behavior of Embedded Software to Improve Evolution and Performance: an Aspect-Oriented Approach , ACM Symposium on Applied Computing, Track on Embedded and Real-Time Systems, 2007.

13. M. Amirijoo, A. Tesanovic, T. Andersson, J. Hansson, and S.H. Son, "Finite horizon QoS prediction of reconfigurable soft real-time systems", Proceeding of the IEEE Conference on Real-Time Computing Systems and Applications (RTCSA'06), Austrailia, Aug 2006

14. T. Gustafsson and J. Hansson, "Data freshess and overload handling in embedded systems", Proceeding of the IEEE Conference on Real-Time Computing Systems and Applications (RTCSA'06), Austrailia, Aug 2006.

15. A. Tesanovic, T. Gustafsson, and J. Hansson "Separating active and on-demand behavior of embedded systems into aspects", Proceeding GI/ITG Workshop on Non-Functional Properties of Embedded Systems (NFPES '06), March 2006.

16. T. Gustafsson, J. Hansson, A. Göras, D. Holmgren, and J. Gäddevik, "Database functionality in engine management system", Proceeding of SAE Conference, April, 2006.

17. A. Tesanovic, M. Amirijoo, D. Nilsson, H. Norin, and J. Hansson, "Ensuring Real-Time Performance Guarantees in Dynamically Reconfigurable Real-Time Systems'", IFIP Conference on Embedded And Ubiquitous Computing (EUC), 2005, Japan.

18. M. Amirijoo, N. Chaufette, J. Hansson, S.H. Son, "Generalized performance management of multi-class real-time imprecise data services", 26th Proceedings of Real-Time System Symposium (RTSS), Miami, Florida, USA, 2005.

19. T. Gustafsson, H. Hallqvist, and J. Hansson, "A similarity-aware multiversion concurrency control and updating algorithm for up-to-date snapshots of data', Proceedings of the 17th Euromicro Conference on Real-Time Systems, July 2005.

20. A. Tesanovic, M. Amirijoo, M. Björk, J. Hansson, "Empowering configurable QoS management in real-time systems", ACM Proceedings of the 4th Aspect-Oriented Software Development (AOSD 2005), Chicago, USA, March 2005.

21. A. Tesanovic, P. Mu, and J. Hansson, "Development environment for configuration and analysis of embedded and real-time systems", Proceedings of the 4th AOSD International Workshop on Aspects, Components, and Patterns for Infrastructure Software (ACP4IS'05), Chicago, USA, March 2005.

22. M. Amirijoo, J. Hansson, S. Gunnarsson, S. H. and Son "Enhancing feedback control scheduling performance by on-line quantification and suppression of measurement disturbance" Proceedings of 11th IEEE Real-Time Application Symposium, San Francisco, USA, March 2005.

23. M. Amirijoo, J. Hansson, S. H. Son, and S. Gunnarsson, "Robust quality management for differentiated imprecise data services", 25th IEEE Proceedings of Real-Time Systems Symposium (RTSS), Lisbon, Portugal, December 2004.

24. D. Nyström, A. Tesanovic, M. Nolin, C. Norström, and J. Hansson, "COMET: a component-based real-time database for automotive systems", Proceedings of 26th ICSE - International Conference on Software Engineering - workshop on Software Engineering for Automotive Systems, May 2004. In association with IEEE and ACM.

25. D. Nyström, M. Nolin, A. Tesanovic, C. Norström, and J. Hansson "Pessimistic concurrency control and versioning to support database pointers in real-time databases", Proceedings of 16th Euromicro conference on Real-Time Systems (ECRTS'04), July 2004.

26. A. Tesanovic, K. Sheng, and J. Hansson, "Application-tailored database systems: a case of aspects in an embedded database systems", Proceedings of 8th IEEE International Database Engineering & Applications Symposium (IDEAS '04), Portugal, July 2004.

27. T. Gustafsson and J. Hansson, "Data management in real-time systems: a case of on-demand updates in vehicle control systems", Proceedings of 10th IEEE Real-time Applications symposium (RTAS), Toronto, Canada, May 2004.

28. A. Tesanovic and J. Hansson, "Structuring criteria for the design of component-based real-time systems", in Proceedings of the IADIS International Conference on Applied Computing 2004, Mar. 2004.

29. T. Gustafsson and J. Hansson, "Dynamic on-demand updating of data in real-time database systems", Proceedings of ACM SAC 2004 – Symposium on Applied Computing - track on Embedded Systems: Applications, Solutions, and Techniques, March 2004.

30. A. Tesanovic, J. Hansson, D. Nyström, C. Norström, and P. Uhlin, "Aspect-level WCET analyzer: a tool for automated WCET analysis of a real-time software composed using aspects and components", in Proceedings of the 3rd International Workshop on Worst-Case Execution Time Analysis (WCET 2003), Porto, July, 2003.

31. M. Amirijoo, J. Hansson, S. H. Son, "Algorithms for managing real-time data services using imprecise computation", in Proceedings of the 9th International Conference on Real-Time and Embedded Computing Systems and Applications (RTCSA), 2003, Taiwan, R.O.C.

32. M. Amirijoo, J. Hansson, S. H. Son, "Error-driven QoS management in imprecise real-time databases", in Proceedings of the 15th Euromicro Conference on Real-Time Systems (ECRTS), June 2003, Portugal.

33. M. Amirijoo, J. Hansson, S. H. Son, "Specification and management of QoS in imprecise real-time databases", Proceedings of 7th IEEE International Database Engineering and Applications Symposium (IDEAS), July 2003, Hong Kong.

34. A. Tesanovic, D. Nyström, J. Hansson, and C. Norström, "Aspect-level worst-case execution time analysis of real-time systems compositioned using aspects and components", in Proceedings of the 27th IFAC/IFIP/IEEE Workshop on Real-Time Programming (WRTP'03), May 2003.

35. A. Tesanovic, D. Nyström, J. Hansson, and C. Norström, "Towards aspectual component-based development of real-time systems", Proceedings of the 9th International Conference on Real-Time and Embedded Computing Systems and Applications (RTCSA 2003), Feb. 2003.

36. D. Nyström, A. Tesanovic, C. Norström, and J. Hansson, "Database pointers: a predictable way of manipulating hot data in hard real-time systems", Proceedings of the 9th International Conference on Real-Time and Embedded Computing Systems and Applications (RTCSA 2003), Feb. 2003.

37. A. Tesanovic, D. Nyström, J. Hansson and C. Norström, "Integrating symbolic worst-case execution time analysis with aspect-oriented system development", OOPSLA 2002 Workshop on Tools for Aspect-Oriented Software Development, November 2002, Seattle, WA.

38. D. Nyström, A. Tesanovic, C. Norström, and J. Hansson, "Data management issues in vehicle control systems: a case study", Proceedings of the 14th Euromicro Conference on Real-Time Systems, Vienna, June 19-21, 2002.

39. J. Hansson, M. T. Helgason, S. H. Son, "Using artificial neural networks for admission control in firm real-time systems", Proceedings of the 8th International Conference on Real-Time Computing Systems and Applications (RTCSA'02), Tokyo, Japan, March 2002.

40. F. Gustafsson, J. Hansson, and S. H. Son, "Process migration in distributed real-time systems", Proceedings of the 8th International Conference on Real-Time Computing Systems and Applications (RTCSA'02), Tokyo, Japan, March 2002.

41. J. Hansson, M. Thuresson, and S.H. Son, "Imprecise task scheduling and overload management using OR-ULD", Proceedings of the 7th International Conference on Real-Time Computing Systems and Applications (RTCSA 2000), 12-14 December 2000, South Korea, IEEE Computer Society.

42. M. Berndtsson and J. Hansson, "Time is the shadow of reactive behaviour", 2000 International Database Engineering and Applications Symposium (IDEAS), Yokohama, Japan. September 18-20, 2000, IEEE Computer Society.

Book chapters

43. A. Tesanovic, M. Amirijoo, D. Nilsson, H. Norin, and J.Hansson "Dynamically Reconfigurable QoS-aware Embedded Systems", to appear in "Embedded System

Optimization", World Scientific Publisher, to appear in 2007. (Invited; twenty-five papers were selected for the book among the 115 accepted papers to the conference).

44. A. Tesanovic and J. Hansson, "Application-Specfic Databases for Real-Time Systems", Handbook on Real-Time Systems, edited by Insup Lee and Sang H. Son, CRC Press, to appear in 2007.

45. A. Tesanovic, S. Nadjm-Tehrani, and J. Hansson, "Modular verification of reconfigurable components", in Component-Based Software Development for Embedded Systems - An Overview on Current Research Trends, to appear in 2005 (peer-reviewed book chapter).

46. A. Tesanovic, D. Nyström, J. Hansson, C. Norström, "Reconfigurable embedded real-time systems: the story of COMET", in "ARTES – A Network for Real-Time research and Graduate Education in Sweden", edited by Hans Hansson 2006 (invited).

47. J. Hansson and S.F. Andler, "System framework for active real-time database systems", in 'Real-Time Database Systems: Issues and Design', K-y. Lam and T-W. Kuo (Eds), Kluwer Academic Publishers, 2001 (invited).

48. J. Hansson and S.H. Son, "Overload management in real-time database systems", in 'Real-Time Database Systems: Issues and Design', K-y. Lam and T-W. Kuo (Eds), Kluwer Academics Publishers, 2001 (invited).