OCμ

Organic Computing Middleware for Ubiquitous Environments

Status report and outlook

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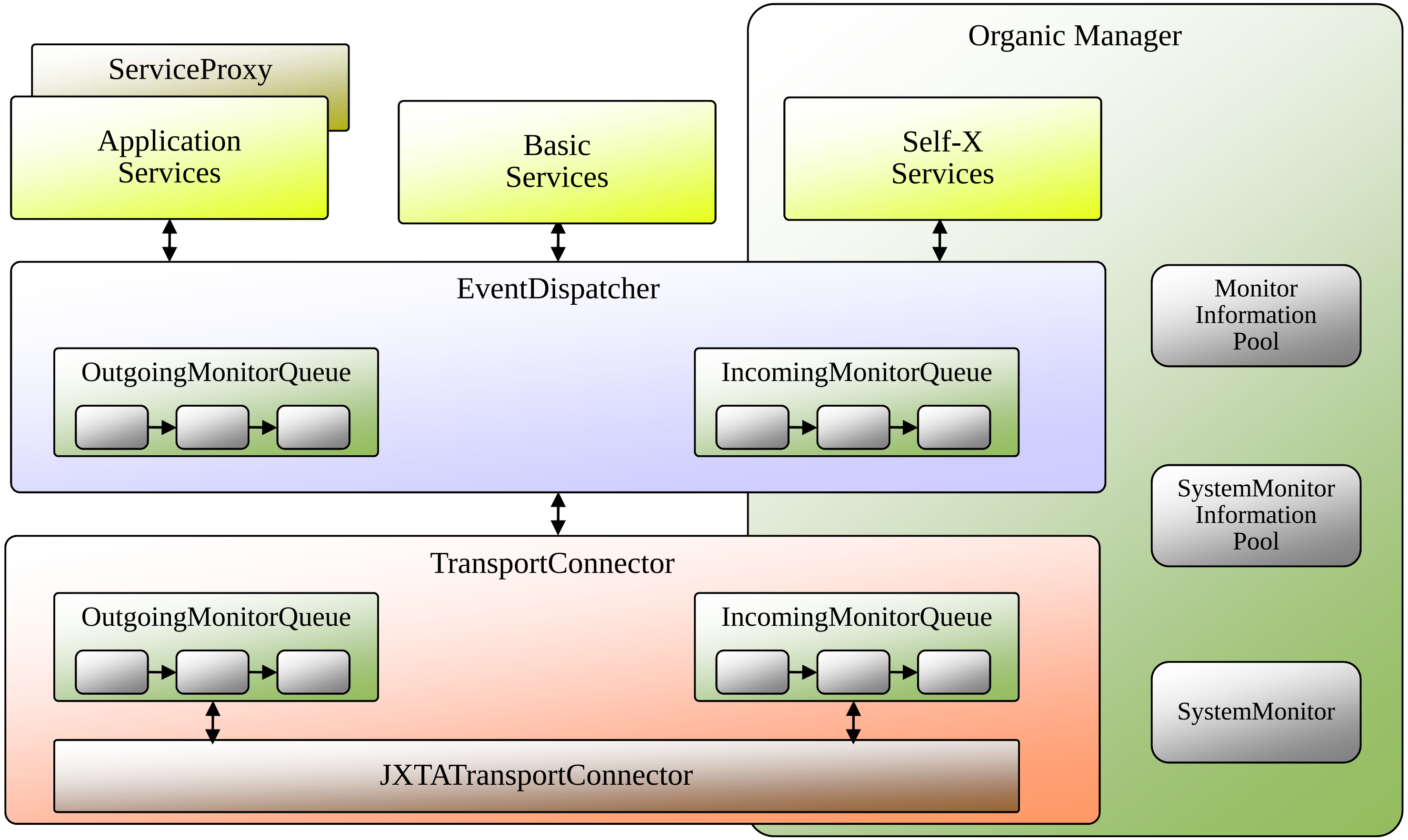
Outline

- Status report (1st & 2nd phase)
  - Architecture of OCµ
    - Self-configuration
    - Self-optimization
    - Self-healing
    - Self-protection
  - Achievements and Problems
- Outlook
  - Ailments and Cures
  - New OCµ Architecture (3rd phase)
  - Further research
- Summary

Architecture of OCμ

- Service-oriented middleware for smart environments
- Sophisticated monitoring by monitor queues
- Organic Managers on each node
  - System monitors
  - Include self-x services
- Software developed in Java, currently based on JXTA and implemented on networked PCs
- Application prototype: Smart Doorplates

Architecture of an OCµ Node



Self-configuration Service

by Dr. Wolfgang Trumler

- Task: Initial system configuration

- Based on cooperative social behavior
- Nodes negotiate service distribution under configuration constraints
- Distributed and decentralized approach

Self-optimization Service
by Dr. Wolfgang Trumler

- Task: Runtime load-balancing

- Inspired by artificial hormone system
- Nodes append workload values to messages
- Four transfer strategies to decide upon service relocation

Self-protection Service

by Dr. Andreas Pietzowski

- Task: Protect against attacks, identify malicious messages

- Authorization system for services
- Role management for nodes
- Detection of malicious messages
  - Computer immunology approach
  - Generation, distribution, update of antibodies
- Defense against threats

Self-healing Service

by Dr. Benjamin Satzger

- Task: Recovery after system failures

- Failure detection
  - Accrual failure detection algorithm
  - Grouping for scalability
- Failure recovery engine
  - Automated distributed planning
  - User specifies the desired system properties
  - System:
    - Consistency check
    - Automated planning
    - Plan execution

Achievements and Problems

- All self-X services are well investigated, implemented and evaluated on simulators as well as on the middleware running a Smart Doorplate application
- The self-X services partly use the same monitor database, but are not interconnected
  - No synergy between the different algorithms exists so far
- The automated distributed planning of the self-healing service can be resource-intensive and takes a long time

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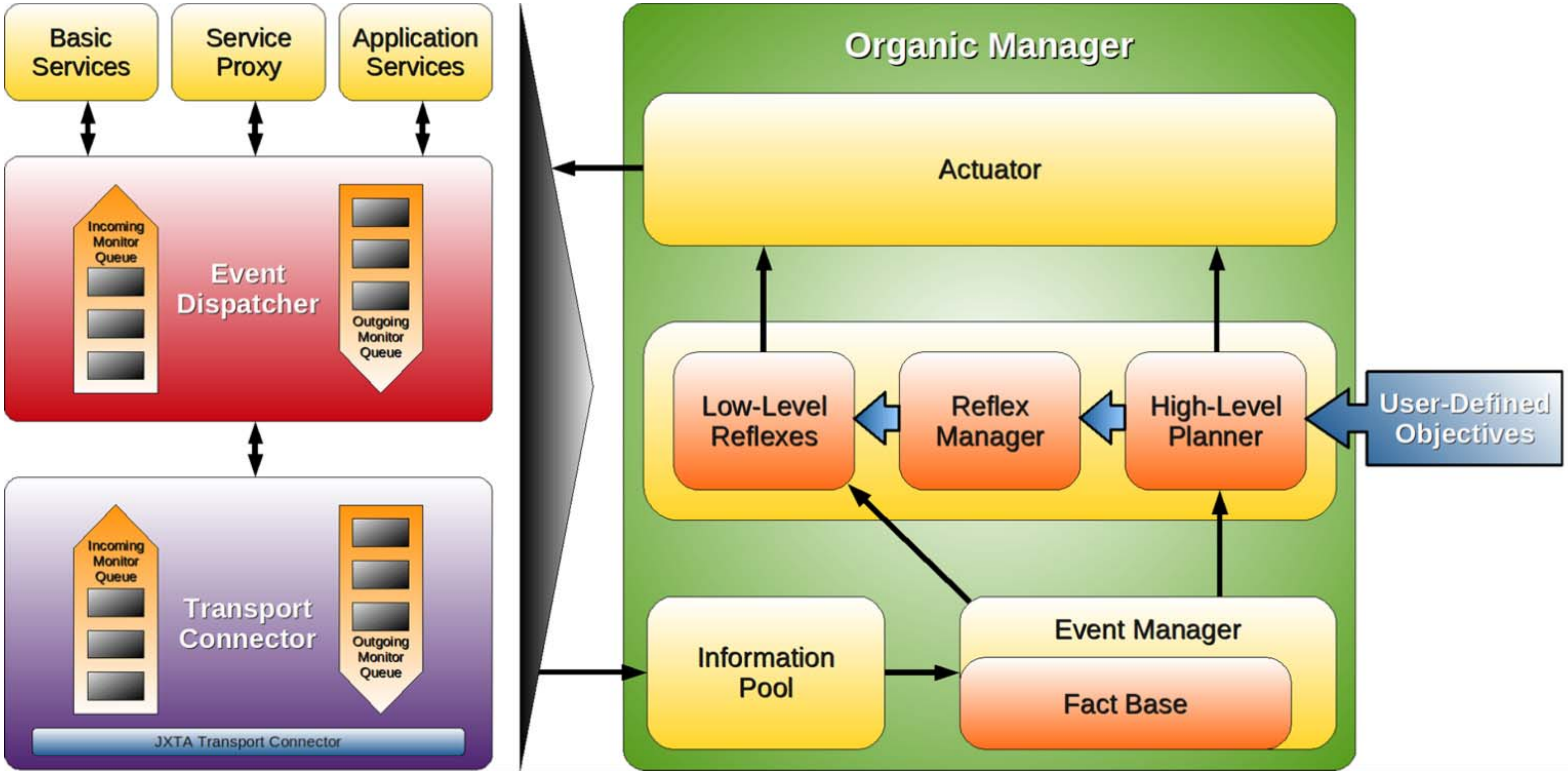
Ailments and Cures

- No synergy between the different self-X algorithms exist
  - Cure: Integrate self-configuration, self-optimization and self-healing more closely using the same planning engine

- Automated distributed planning takes a long time
  - Cure: two-level planner with
    - an elaborate High-level Planner and
    - Low-level Reflexes

- Automated distributed planning is resource-intensive
  - Cure: Implement only reflexes on resource-restricted nodes

New OCμ Architecture (3rd phase)



Further research (1)

- New DFG Research Group OC-TRUST targets to add

  Trust mechanisms to Organic Computing
  - University of Augsburg (Reif, Andrè, Ungerer)
  - University of Hanover (Müller-Schloer, Hähner)
- Work to be done at Chair of Systems and Networking:
  - Decide upon trust models, metrics, and values
  - Improve self-x algorithms by
    - adding trust values to decide and by
    - generating trust values byself-x algorithms for other self-x algorithms
  - Implement trust techniques in OCµ

Further research (2)

- FP-7 Project TERAFLUX on future many-cores (start 2010)

  Our Objective: Core and link failure detection

  – Previous research: adaptive routing in NoC applying the hormone-based self-optimization techniques (Sebastian Schlingmann)
  – Current research: task placement on many-cores with faulty elements (Sebastian Schlingmann)
  – Our approach within TERALUX: apply OC techniques to improve reliability

- DFG project CarSoC (together with Uwe Brinkschulte):

  AC/OC techniques targeting (hard) real-time systems

Further research (3)

- Migrating OCµ to a Java many-core processor based on Jamuth/Komodo cores
  - The „Augsburg Many-core“: A 200-300 core processor will be implemented on 64 interconnected Altera FPGAs
  - OCµ Transport connector must be adapted
  - Suitability of OCµ middleware and self-X techniques for resource-limited cores
  - Objectives: Investigate OC techniques for
    - reliability and fault-tolerance,
    - load-balancing, and
    - automatic task distribution.

Summary

- Status of OCμ SPP project
  - OCμ prototype matured
  - Self-x algorithms implemented and investigated
    - Self-configuration
    - Self-optimization
    - Self-healing
    - Self-protection
- 3rd phase
  - Improved Organic Manager
  - two-level planning approach
  - Unified basis for self-x algorithms
- Further research going on towards Trust and Many-cores

Publications

- Benjamin Satzger, Florian Mutschelknaus, Faruk Bagci, Florian Kluge, Theo Ungerer, Towards trustworthy self-optimization for distributed systems, Seventh IFIP Workshop on Software Technologies for Future Embedded and Ubiquitous Systems (SEUS), Newport Beach, 2009 (accepted for publication)
- Benjamin Satzger, Andreas Pietzowski, Theo Ungerer, Autonomous and Scalable Failure Detection in Distributed Systems, International Journal of Autonomous and Adaptive Communications Systems, 2009 (accepted for publication)
- Andreas Pietzowski, Benjamin Satzger, Wolfgang Trumler, Theo Ungerer, A Practical Computer Immunology Approach for Self-Protection Enhanced by Optimization Techniques, Journal of Autonomic and Trusted Computing (JoATC), 2009 (accepted for publication)
- Benjamin Satzger and Theo Ungerer, Grouping Algorithms for Scalable Self-Monitoring Distributed Systems,Autonomics 2008: Proceedings of the 2nd ACM/ICST International Conference on Autonomic Computing and Communication Systems, September 23-25, 2008, Turin, Italy
- Wolfgang Trumler, Sebastian Schlingmann, Theo Ungerer, Jun Ho Bahn, Nader Bagherzadeh, Self-optimized Routing in a Network-on-a-Chip, IFIP 20th World Computer Congress, Second IFIP TC 10 International Conference on Biologically-Inspired Collaborative Computing , September 8-9, 2008
- Benjamin Satzger, Andreas Pietzowski, Wolfgang Trumler, Theo Ungerer, Using Automated Planning for Trusted Self-organising Organic Computing Systems, 5th International Conference on Autonomic and Trusted Computing (ATC 2008), June 23-25, 2008
- Benjamin Satzger, Andreas Pietzowski, Wolfgang Trumler, Theo Ungerer, A Lazy Monitoring Approach for Heartbeat-Style Failure Detectors, Proceedings of ARES 2008, The Third International Conference on Availability, Security and Reliability, Barcelona, Spain, March 4-7, 2008
- Wolfgang Trumler, Jörg Ehrig, Andreas Pietzowski, Benjamin Satzger, Theo Ungerer. A Distributed Self-healing Data Store,. The 4th International Conference on Autonomic and Trusted Computing (ATC-07), Hong Kong, China, July 11-13, 2007
- Wolfgang Trumler, Andreas Pietzowski, Benjamin Satzger, Theo Ungerer. Adaptive Self-optimization in Distributed Dynamic Environments. First IEEE International Conference on Self-Adaptive and Self-Organizing Systems, Boston Massachusetts, USA, 9 - 11 July 2007
- Wolfgang Trumler. Organic Computing Middleware. KI - Künstliche Intelligenz, Heft 2/2007
- Benjamin Satzger, Andreas Pietzowski, Wolfgang Trumler, Theo Ungerer. Variations and evaluations of an adaptive accrual failure detector to enable self-healing properties in distributed systems. ARCS'07: Architecture of Computing Systems, Zurich, Switzerland, March 12-15, 2007, Published in "Lecture Notes in Computer Science" (LNCS), ISSN: 0302-9743
- Benjamin Satzger, Andreas Pietzowski, Wolfgang Trumler, Theo Ungerer. A new adaptive accrual failure detector for dependable distributed systems. The 22nd Annual ACM Symposium on Applied Computing, Seoul, Korea, March 11 - 15, 2007
- Andreas Pietzowski, Benjamin Satzger, Wolfgang Trumler, Theo Ungerer. Using Positive and Negative Selection from Immunology for Detection of Anomalies in a Self-Protecting Middleware. 36th annual conference of the Gesellschaft für Informatik e.V. (GI), Informatik für Menschen, INFORMATIK 2006, October 2-6, 2006, Dresden, Germany. LNI, Volume P-93
- Andreas Pietzowski, Benjamin Satzger, Wolfgang Trumler, Theo Ungerer. A Bio-Inspired Approach for Self-Protecting an Organic Middleware with Artificial Antibodies International Workshop on Self-Organising Systems, IWSOS 2006, September 18-20, 2006, Passau, Germany. LNCS 4124