DFG Schwerpunktprogramm 1183
Priority Program 1183

Organic Computing

program/steering committee:

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Startkolloquium

Karlsruhe
14./15. Juli 2005

mit freundlicher Unterstützung durch die EnBW Die Energie-AG.

Background

- German initiative to identify new challenges for research in Computer Engineering (GI/ITG/VDE)
- Objectives
  - **Develop a vision for the system architecture beyond 2010.**
  - **Identify key challenges for research.**

- Result: **Organic Computing Initiative**
  (combined with related, earlier initiative by C. v.d. Malsburg)

  - **New Priority Research Program on Organic Computing, funded by the German Science Foundation (DFG) (6 years, 2005 - 2011)**
  - **Series of conferences and workshops on Organic Computing (e.g. ARCS 2004/5/6..)**
  - **...**

Observations

- Technology roadmaps show
  - **Moore's Law will be valid for at least 10 more years.**
  - **Sizes will shrink, numbers will grow.**
  - **We will be surrounded by multitudes of intelligent devices, capable to interact.**

- Consequence:
  - **Essentially, we know quite well the type of hardware that will be around us in 2010,**
    but the scaling will have changed dramatically.
  - **We have to come up with good ideas for**
    - **managing unlimited dynamic networks of intelligent embedded systems**
    - **making best use of the available technology.**

Propositions and Vision

- Information technology is moving towards the ubiquitous networked computer.
- Complex ubiquitous systems need new concepts for organization and user interfaces to remain manageable and controllable.

- Future computer systems have to be designed with respect to **human needs**.
- Future computer systems have to be **trustworthy** and **dependable**.
- Future computer systems have to be **adaptive** und **flexible**.
- **Systems having these properties will be life-like.**
  We call them *Organic Computer Systems*.

Organic Computing

It is not the question,
whether adaptive and self-organising systems
will emerge,
but ***how*** they will be designed

Vision for System Architecture > 2010

- **Organic Computer Systems**
  - will possess lifelike properties.
  - will consist of autonomic and cooperating sub systems and will work, as much as possible, in a self-organised way.
  - will adapt to human needs,
  - will provide customized service in a user-friendly way
  - will be trustworthy and dependable.

- **Self-organisation** allows for adaptive and context dependent behaviour:
  - self-configuring
  - self-optimizing
  - self-healing
  - self-protecting
  - self-explaining
  - ...

- **Self-organisation** will lead to **emergent global behaviour**.

Emergence

- **Local actions/behaviour of the members of a self-organizing system may lead to observable, emergent global patterns, structure, or behaviour.**
- **This global behaviour is of a different kind than the behaviour of its components (in particular, not a linear combination of the individual actions).**
- ...

(cf: *Emergence, a Journal of Complexity Issues in Organisation and Management)*

Examples of Emergence

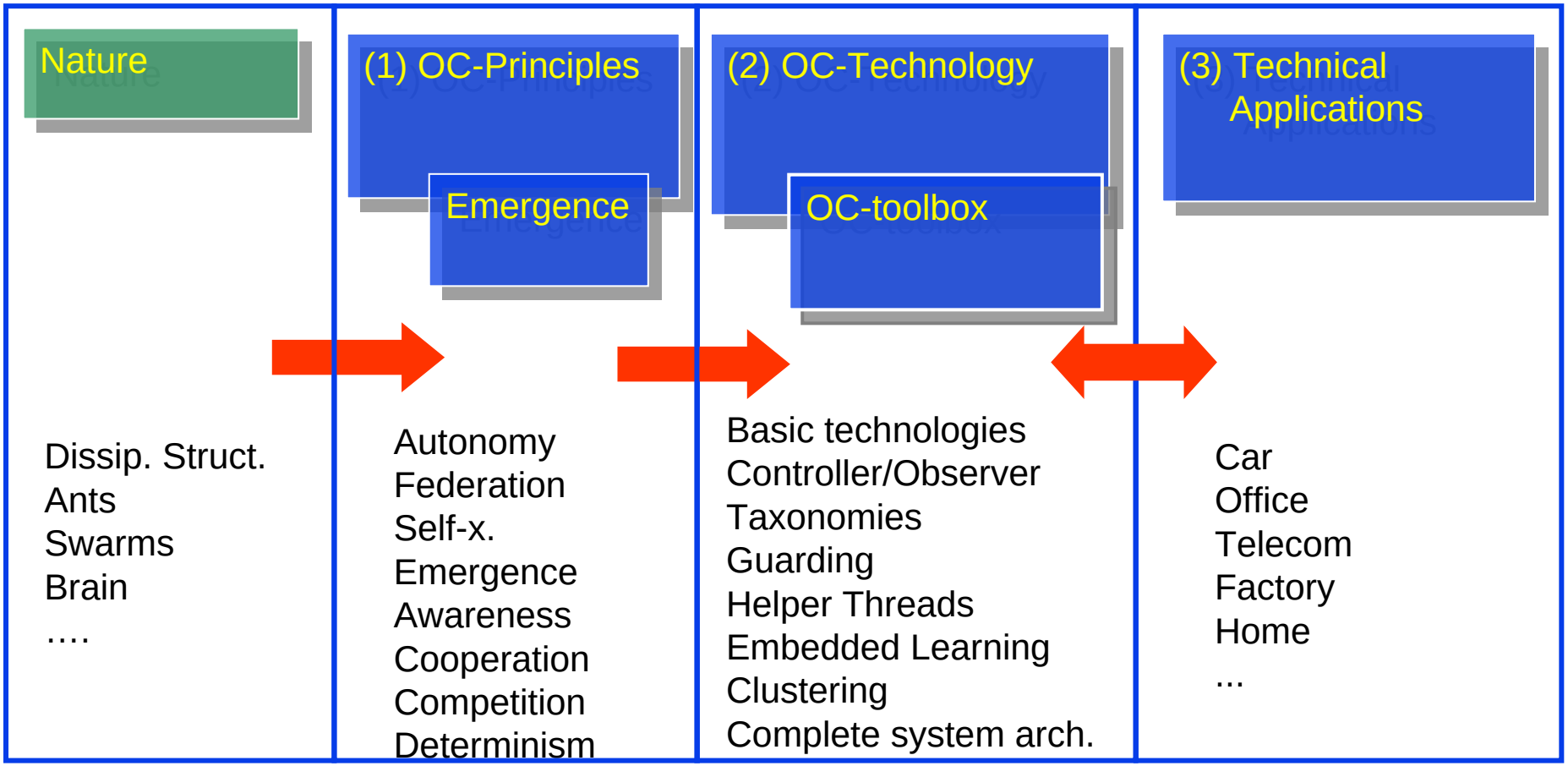
- Ability of ant colonies to determine shortest paths
- Swarm intelligence (termites, bees, ants, fish, birds,...)
- Pressure and temperature in physical systems
- Deadlock and lifelock in distributed systems
- Traffic jams, “green waves”
- Malfunctioning of components as soon as they are embedded in very large networks (e.g. within cars)
- ...

How can we control emergent behaviour in technical systems?

Challenges for System Design and Architecture

- Provide systems with sufficiently large degrees of freedom for adapting to different requirements.
- Systems have to be aware of
  - what type of service they can provide,
  - what type of service they need from others,
  - what the current environment wants to get done.
- Systems should have a “desire” to be active (→incentives?).
- Systems should be robust with respect to external changes.
- There will be a need for “controlled self-organization”.

DFG priority program 1183
„Organic Computing“



Priority program „Organic Computing“
Call for Proposals - Fall 2004

- **Emergent behaviour in technical systems**
  - Problems of security and stability of self-organized technical systems.
  - Methods for controlling emergent behaviour, i.e. to direct a system towards desired emergent behaviour and to detect and prevent undesirable emergence.
- **Technologies for Organic Computing**
  - Utilise principles of self-organisation
  - Design adequate (multi-level) system architectures.
  - Build up a versatile toolbox containing balanced concepts, methods, and tools for the design and implementation of organic computer systems.

- Evaluate the anticipated methods and technologies of OC with respect to **technical application areas**.
- Plan for a duration of two years, but have a longer perspective.

Selection process

- 60 proposals
- International group of reviewers
  - W. Brauer
  - K. De Bosschere
  - M. Jarke
  - E. Maehle
  - F. Langhammer
  - D. Polani
  - P. Rojas
  - P. Stenström
  - J. Teich
  - G. Tempesti
  - L. Thiele
  - D. Wagner

- Recommendation to accept 18 proposals
  (+ coordination project)
- **Final decision by DFG expected before the end of this July.**

Now we are here to start our work!

- High expectations:

  We have to demonstrate that organic computing is not just a vision, but that it will become reality with benefits for many.

- Needed:
  - **Innovative ideas**
  - **Desire to cooperate**
  - **“special interest groups” on cross-section topics**

- **Semi-annual colloquiums + workshops (sometimes sponsored by external partners!)**

Zeitplan für das Startkolloquium

Donnerstag

09:35 - 10:00	**Vorstellung des Gastgeber-Unternehmens EnBW** (Matthias Schultze, EnBW Energie Baden-Württemberg AG)
10:00 - 10:45	**Applications of Organic Computing - an Industrial View** (Rudolf Kober, Siemens Corporate Technology, München)
11:00 - 12:30	4 Projektvorstellungen
12:30 - 13:30	Mittagessen
13:30 - 15:00	4 Projektvorstellungen
15:30 - 16:30	Interprojektkooperation
17:00 - 18:30	4 Projektvorstellungen
18:30 - ca. 22:30	Abendprogramm

Freitag

08:30 - 09:45	3 Projektvorstellungen
10:00 - 11:15	3 Projektvorstellungen
11:30 - 12:30	Interprojektkooperation
12:45 - 13:00	Abschluss
13:00	Optional: Mittagessen bei der EnBW

Querschnittsthemen

Architekturen **Ungerer**

- Allgemein verwendbare Observer/Controller-Plattform
- Adaptive Beobachtungs-/Monitoring-Konzepte (Vorbild Natur)
- Monitoring
- Architekturen (Hw und Sw) mit / für Selbst-X Eigenschaften
- Umsetzung und Monitoring von nicht-funktionalen Garantien (Power, Timing, dependability)
- Selbstorganisationstechnik
- Grundlagen der Selbstorganisation im Kontext des OrganicComputing
- Sicherheit von nicht-deterministischen Systemen
- OC-Middleware

Große Netze **Fischer**

- Organic Computing in hochverteilten, dynamischen (adhoc-)Netzwerken
- Organische Sensor-Netzwerke
- Organic Computing in Sensornetzwerken
- Organische eingebettete (Echtzeit)-Systeme

Selbstorganisation und Emergenz **Müller-Schloer**

- Theoretische Grundlagen: Qualitative und Quantitative Aspekte von Emergenz und Selbstorganisation
- Methoden der Selbstorganisation in technischern Systemen
- Selbstschutz
- Beispiele für Selbstorganisation in technischen Systemen (Referenzapplikationen)
- Ensemble Dynamics Emergenz Grundlagen
- Online-Lernen/Emergenz
- Modellierung von Dynamik und emergentem Verhalten in Netzwerken

Entwurfsmethodik **Heiß**

- Entwurf und Analyse von lokal arbeitenden, verteilten Strategien zur Lösung globaler Aufgaben in dynamischen, heterogenen Netzwerken
- Softwareentwicklungsverfahren für Organic-Computing-Lösungen
- Theoretische Grundlagen zur Konstruktion/Programmierung selbstorganisierender Systeme

- Einheitliche Begriffsbildung → **Glossar**

Outlook

- Cooperation between projects (update matrix!)
- Work on cross section topics:
  - Architectures
  - Self-organisation and Emergence
  - Design Methodology
- Next colloquium:
  - End of winter semester (mid february, Munich?)
    contents, focus?
  - Mid-July 2006
- Further conferences
  - Dagstuhl Seminar January 14-20, 2006
  - ARCS 2006 , Frankfurt, March 2006, CfP 18. September 2005
  - BICC 2006, Santiago de Chile, August 2006, CfP 15. January 2006
  - ...

Cooperation matrix

Zeile möchte mit Spalte kooperieren!

X: Kooperation erwünscht

(X): Eingeschränkte Kooperation erwünscht

X(S): Kooperation in einer späteren Projektphase erwünscht

?: Kooperation möglicherweise erwünscht

Grau markiert: Kooperation wurde von beiden Seiten gewünscht

- Please update and send to coordinator!

	Digital On-Demand Computing Organism for Real-Time Systems	The bio-chemical information processing metaphor as a programming paradigm for organic comp.	Embedded Performance Analysis for Organic Computing	*AutoNomos*: A Distributed and Self-Regulating Approach for Organizing a Large System of Mobile	Organic architectures for self-organising smart pixel sensor chips	Model-Driven Development of Self-Organizing Control Applications	Organic Fault-Tolerant Control Architecture for Robotic Applications	Learning to Look at Humans	Smart Teams: Local, Distributed Strategies for Self-Organizing Robotic Exploration teams	Organisation and Control of Self-Organising Systems in Technical Compounds	Organic Traffic Control	Multi-Objective Intrinsic Evolution of Embedded Systems (MOVES)	Formal Modeling, Safety Analysis, and Verification of Organic Computing Applications – SAVE OR	Architecture and Design Methodology for Autonomic System on Chip	Quantitative Emergence – Metrics, Observation and Control Tools for Complex Organic Ensemble	On-line Fusion of Functional Knowledge within Distributed Sensor Networks	Energy Aware Self Organized Communication in Complex Networks	OCμ - Organic Computing Middleware for Ubiquitous Environments
Digital On-Demand Computing Organism for Real-Time Systems		X					X							X	X			X
The bio-chemical information processing metaphor as a programming paradigm for organic computing				X		X			X				X			X		X
Embedded Performance Analysis for Organic Computing							X		(X)		(X)		X	(X)	X			
AutoNomos: A Distributed and Self-Regulating Approach for Organizing a Large System of Mobile Objects						X	?		X		X				?	X	X	
Organic architectures for self-organising smart pixel sensor chips	X	X					(X)			X		X		(X)				
Model-Driven Development of Self-Organizing Control Applications	X	X		X														X
Organic Fault-Tolerant Control Architecture for Robotic Applications	X				X						X		X	X				
Learning to Look at Humans	X	(X)		(X)			X		X	(X)	X				X			
Smart Teams: Local, Distributed Strategies for Self-Organizing Robotic Exploration teams				X		X	?			X	(X)				(X)		X	
Organisation and Control of Self-Organising Systems in Technical Compounds	(X)	(X)		X			(X)		X		(X)	(X)			X		X	
Organic Traffic Control				X											X			
Multi-Objective Intrinsic Evolution of Embedded Systems (MOVES)	X			X(S)	?		?		X(S)		X			X		X(S)		
Formal Modeling, Safety Analysis, and Verification of Organic Computing Applications – SAVE C	X					X	X		X						X			
Architecture and Design Methodology for Autonomic System on Chip																		
Quantitative Emergence – Metrics, Observation and Control Tools for Complex Organic Ensemb	X								X	X	X							X
On-line Fusion of Functional Knowledge within Distributed Sensor Networks																		
Energy Aware Self Organized Communication in Complex Networks				X		X			(X)	X					X	X		
OCμ - Organic Computing Middleware for Ubiquitous Environments	X										X		X	X	X			

… and finally

- Lots of thanks to
  - the reviewers for selecting these projects
  - the participants for really interesting and inspiring presentations and discussions
  - the organizing team for providing the ressources and the environment for this colloquium
    - in particular to Michael Stein and my secretary I. Götz
    - and definitely very special thanks to

the team of EnBW for the fabulous support !