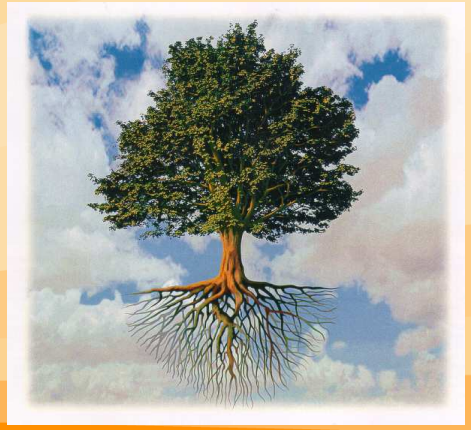
Fundamentals of Collective Adaptive Systems



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Future and Emerging Technologies Proactive

SEVENTH FRAMEWORK PROGRAMME

European Commission
Information Society and Media

Pervasive Adaptation (2007)

- **Key features:**
  - Adaptation in software, hardware, protocols, architectures, …
  - Massively scalable
  - Capable of adapting to highly dynamic contexts
  - Autonomous adaptation strategies (bio-inspired, stochastic, ...)
  - Multidisciplinary, human-centric research

- **Evolve-able pervasive systems**
  - From short term adaptation to long term evolution

- **Networked societies of artefacts**
  - From local autonomy to collaborative systems; ensembles of artefacts

Pervasive Adaptation (2007)

SYMBRION (IP)
Desiging and developing paradigms for pervasive robotic systems based on bio-inspired adaptation and self-* strategies applied to robotic organisms; applying artificial long term evolution to robotic organisms; aggregation of robots into symbiotic organisms

REFLECT
self-organised and adaptive collaboration between people and their specific environments.

Allow
Based on the concept of adaptive pervasive flow.

SOCIALNETS
social anthropology and social networks used to design trustable and adaptive networking protocols

ATRACO
Ecologies comprising people, context-aware artefacts and digital commodities.

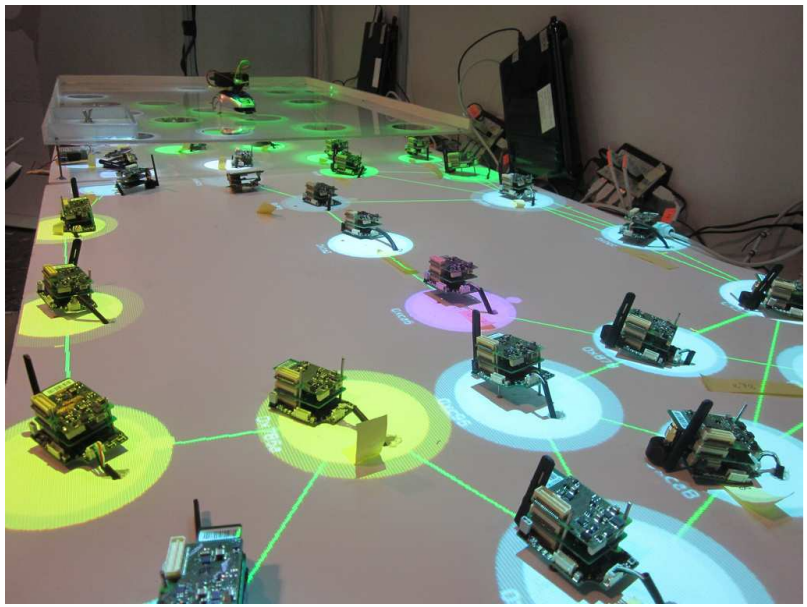
FRONTS
foundation for adaptive networked societies of small or tiny heterogeneous artefacts

overview FOCAS

"The socio-technical fabric of our society more and more depends on systems that are constructed as a collective of heterogeneous components and that are tightly entangled with humans and social structures. Their components increasingly need to be able to evolve, collaborate and function as a part of an artificial society."

What is a Collective Adaptive System?

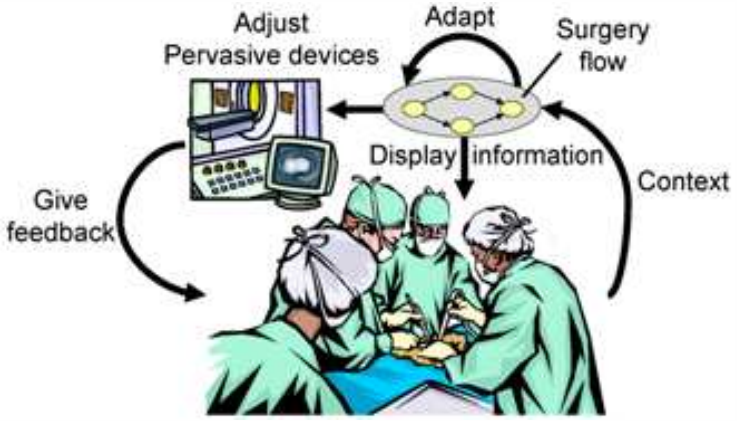
- Many units/nodes with individual properties
- Distributed/dispersed decision making
- Entering or leaving collective at any time
- Fluid boundaries
- Units can be highly heterogeneous
  - *computers, robots, agents, devices, biological entities, etc*
- Different temporal and spatial scales
- Different (potentially conflicting) objectives and goals



(FRONTS project)

Target Outcome (a)

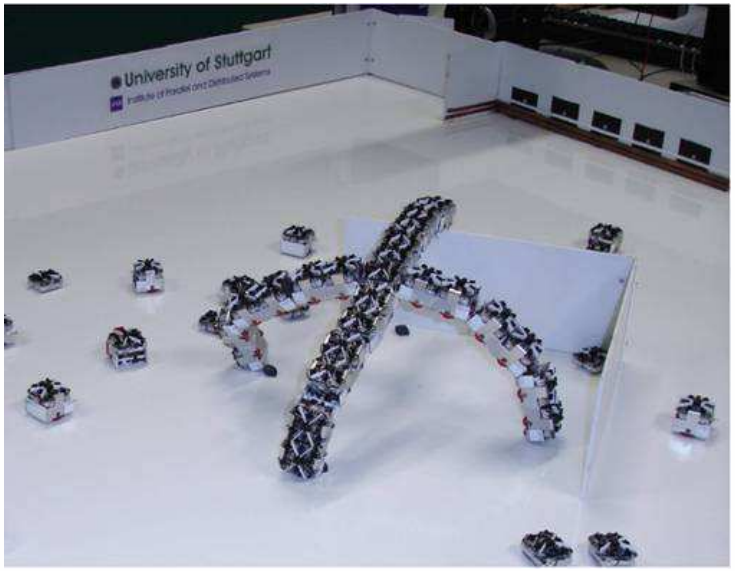
- **Operating Principles**: principles by which CASs can operate. These should go beyond existing control and optimisation theories, taking into account the diversity of objectives within the system, conflicts resolution, long term stability, and the need to reason in the presence of partial, noisy, out-of-date and inaccurate information



(ALLOW project)

Target Outcome (b)

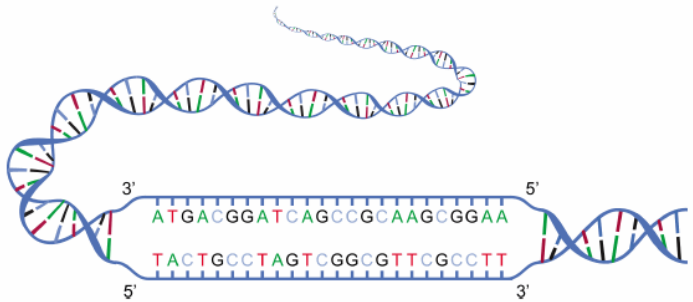
- **Design Principles**: principles necessary to build and manage CASs, such as enabling the emergence of behaviour and facilitating prediction and control of those behaviours. These principles should exploit the inherent concurrency and include methods for system validation.



(Symbrion project)

Target Outcome (c)

- **Evolutionary Properties**: properties concerning the evolutionary nature of CASs, e.g. open-ended (unbounded) evolutionary systems, the trade-off and interaction between learning and evolution, and the effect of evolution on operating and design principles.



Expected Impact & funding

- New functionalities for adaptive ICT systems enabled through novel principles, methods and technologies for designing and operating collective adaptive systems.
- New insights into the general properties of large scale distributed systems.

- IP (all 3 bullets)
- STREP (one main focus)
- 23 M Euro

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