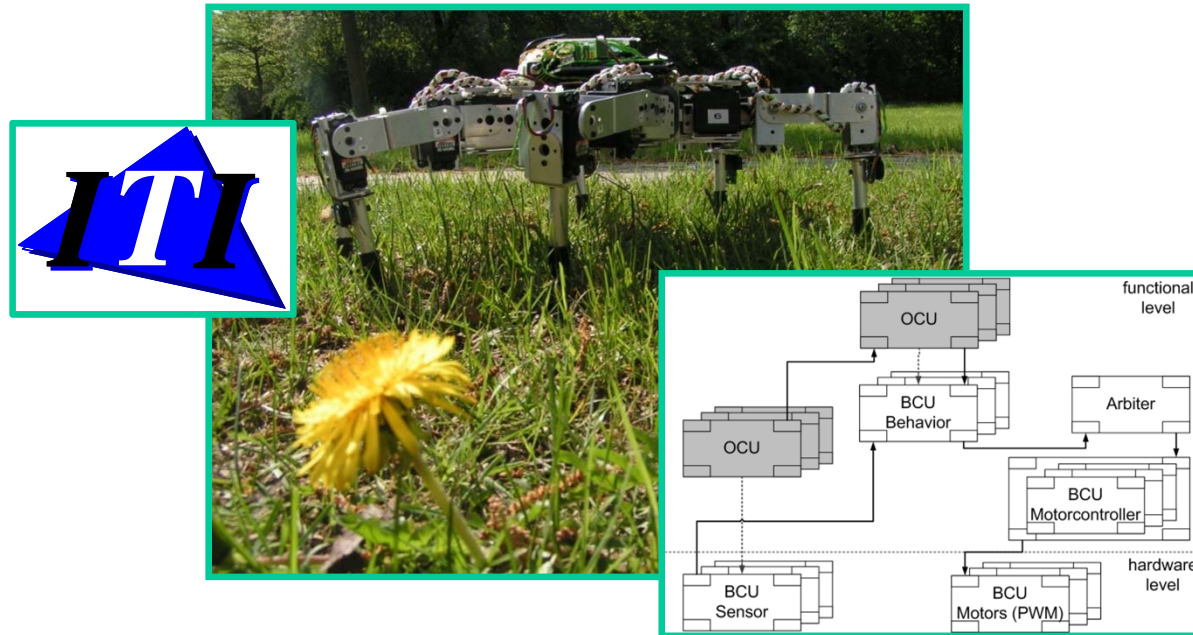
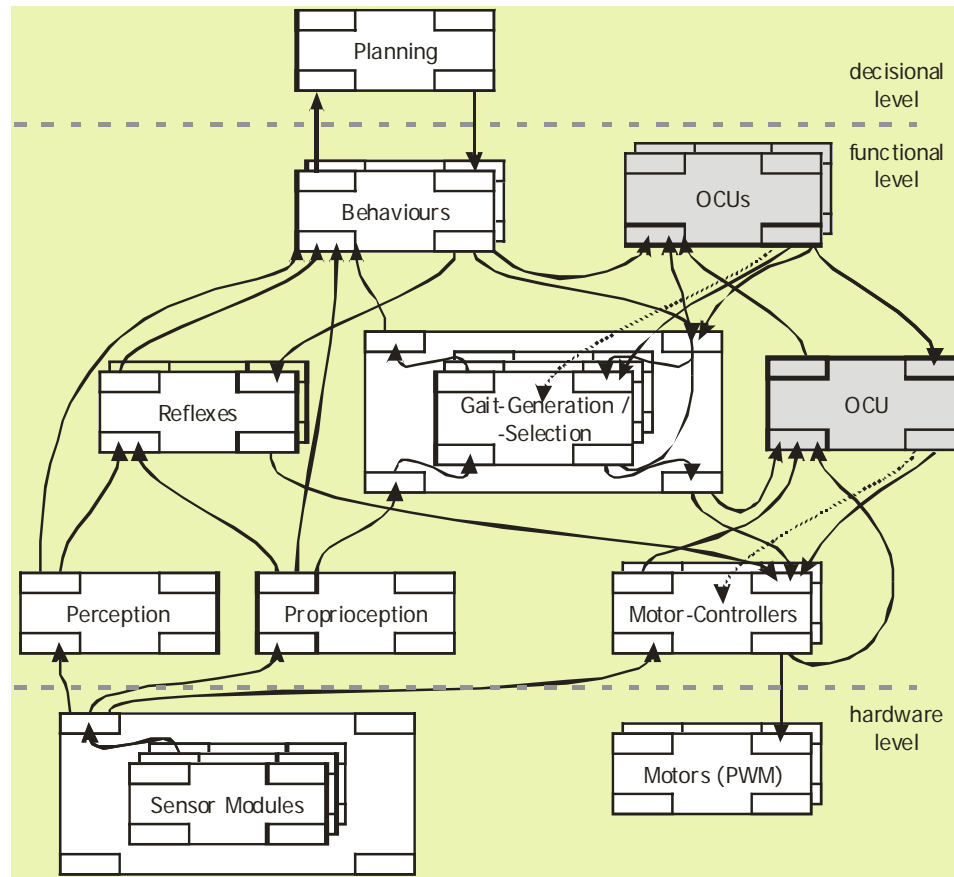


Organic Fault-tolerant Robot Control Architecture



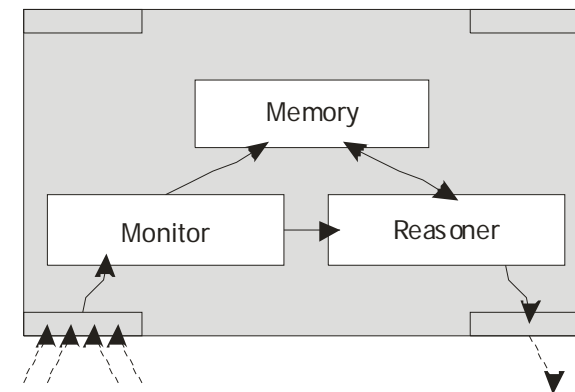
**Stephan Krannich, Erik Maehle (University of Lübeck)
Werner Brockmann, Nils Rosemann (University of Osnabrück)**

ORCA – Organic Robot Control Architecture



BCU = Basic Control Unit
OCU = Organic Control Unit

OCU-Architecture



- Monitor: anomaly detection
- Memory: short term history (learning)
- Reasoner: hard real-time determination of a counteraction

Variant of Observer/Controller Architecture
Decentralized organization, no global Observer
Optional use of learning in monitoring and for counteractions

Characteristics of ORCA

- Application of ORCA in complex embedded automation systems
- Reduction of complexity of overall system design by structuring functionalities and providing the system with self-x-properties
- Anomalies and uncertainties are treated in a uniform way, by encapsulating monitoring and reconfiguration reasoning into OCU modules (inspired by immune system)
- Bypassing the problem of impossibility to make complete world/environmental and failure models by emergent failure treatment due to OCU interplay
- Incorporation of learning methods into the OCUs
- Modular structure fits object-orientated programming style

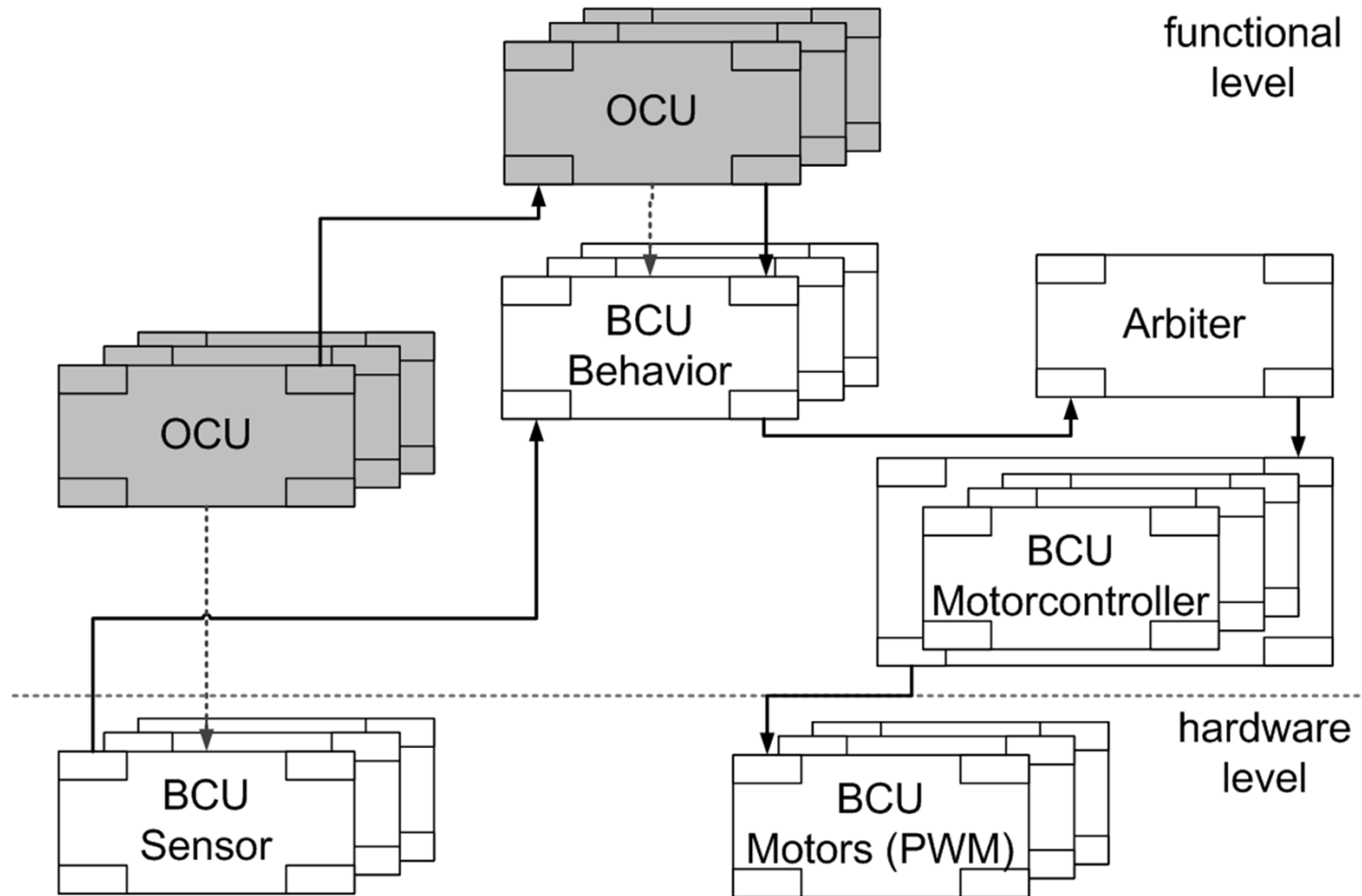
Framework

- Java
- Platform independent , utilized on
 - Jcontrol
 - Gumstix
 - Netbook
- But extension packages needed e.g. for serial port access

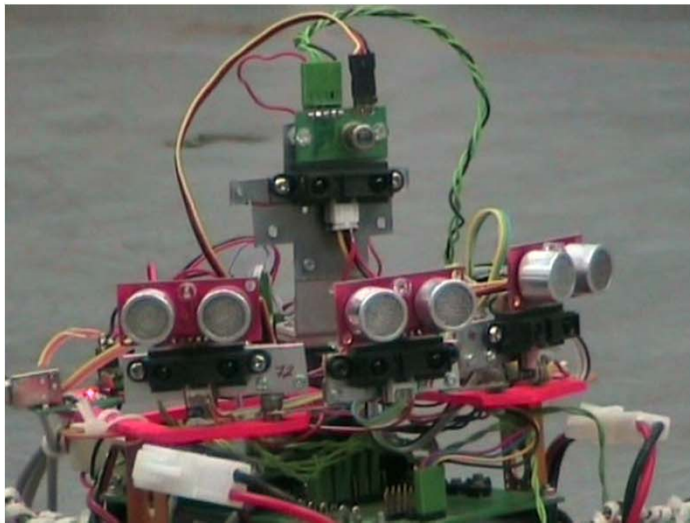
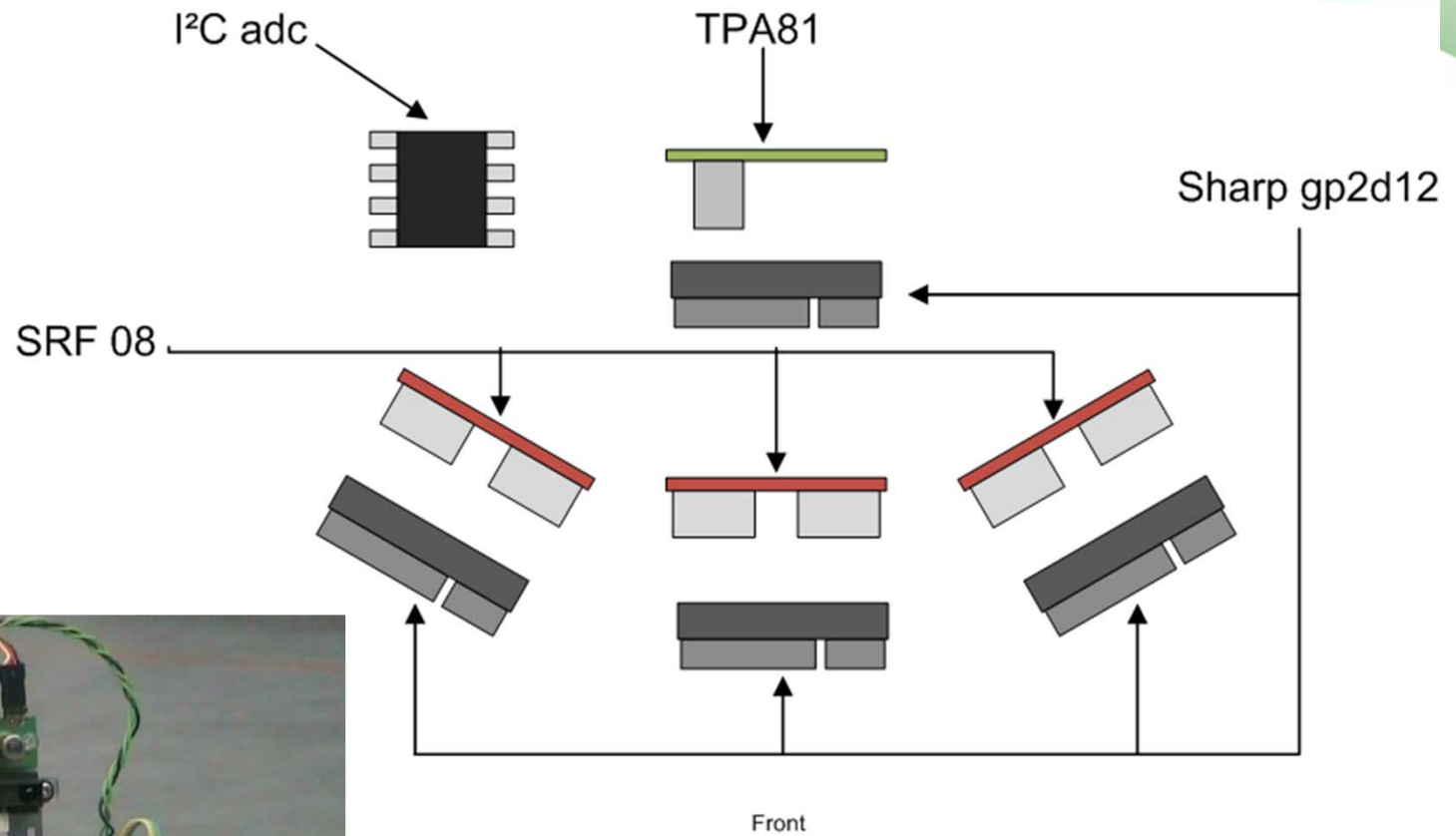
Reactive Behavior Layer

- Implementation of Reactive Behavior Layer following ORCA principles
- Obstacle avoidance and search of heat sources for rescue/monitoring scenario, achieved via behavior arbitration (Chase heat, Escape, Avoid, Wander)
- Self reconfiguration (parameters, exchange of sensor inputs), initiated by monitoring and interconnected OCUs, in case of errors
- OCU interplay leads to safe state in worst case errors

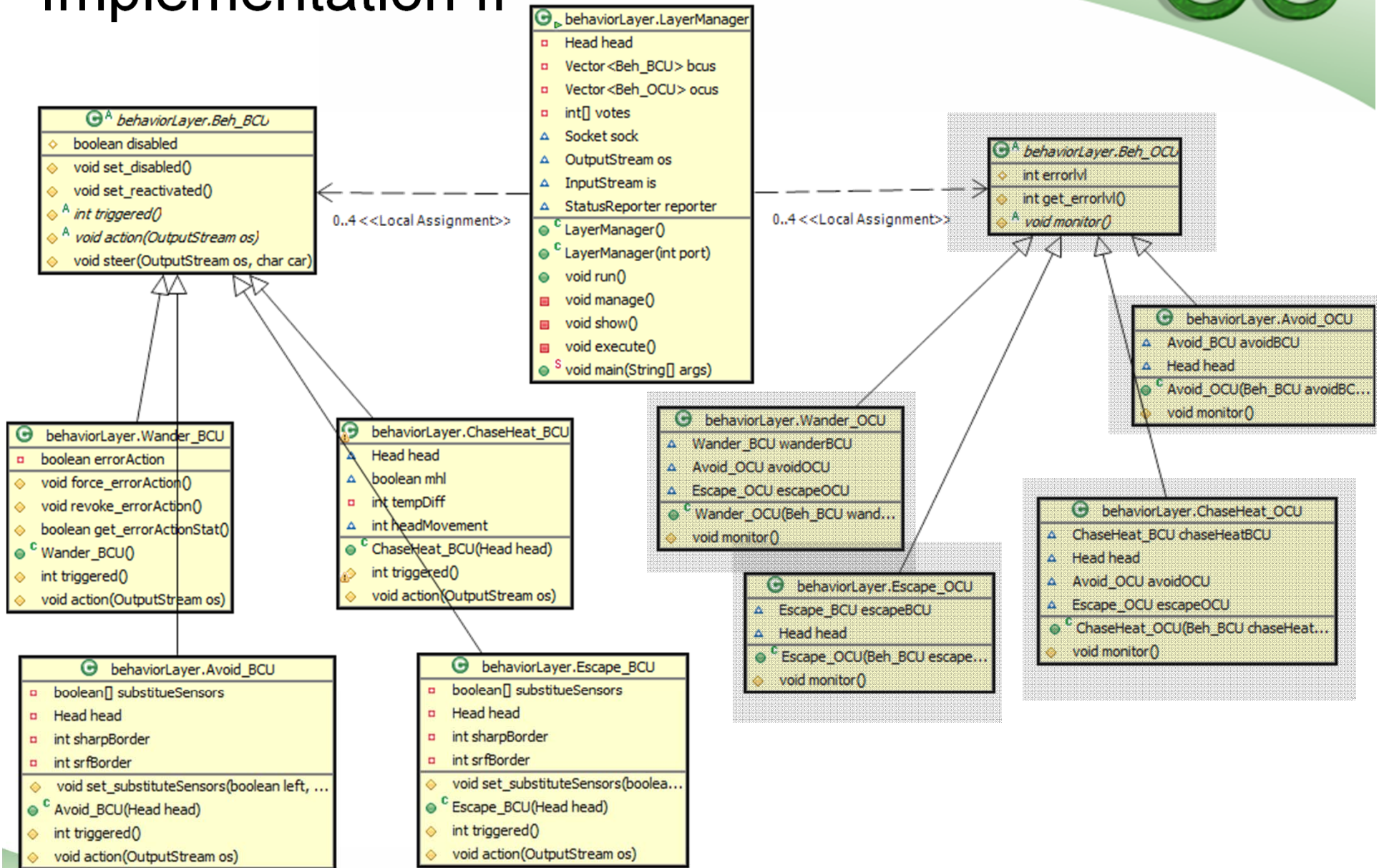
Behavior Layer ORCA Schematic



Implementation



Implementation II



Reusability?

- General concept applicable to embedded systems that can be structured into behavioral units (BCUs)
- Upgrade of modular systems subsequently possible by addition of organic control units (OCUs)
- Shown implementation rather robotic-specific
- Use of sockets allow connections to lower, higher and same level components, also distributed over network
- Already ported to another robot platform (i-robot create)



Thank you for your attention