Eingebettete Systeme

GOETHE UNIVERSITÄT FRANKFURT AM MAIN

# The „Artificial Hormone System“ Organic Middleware

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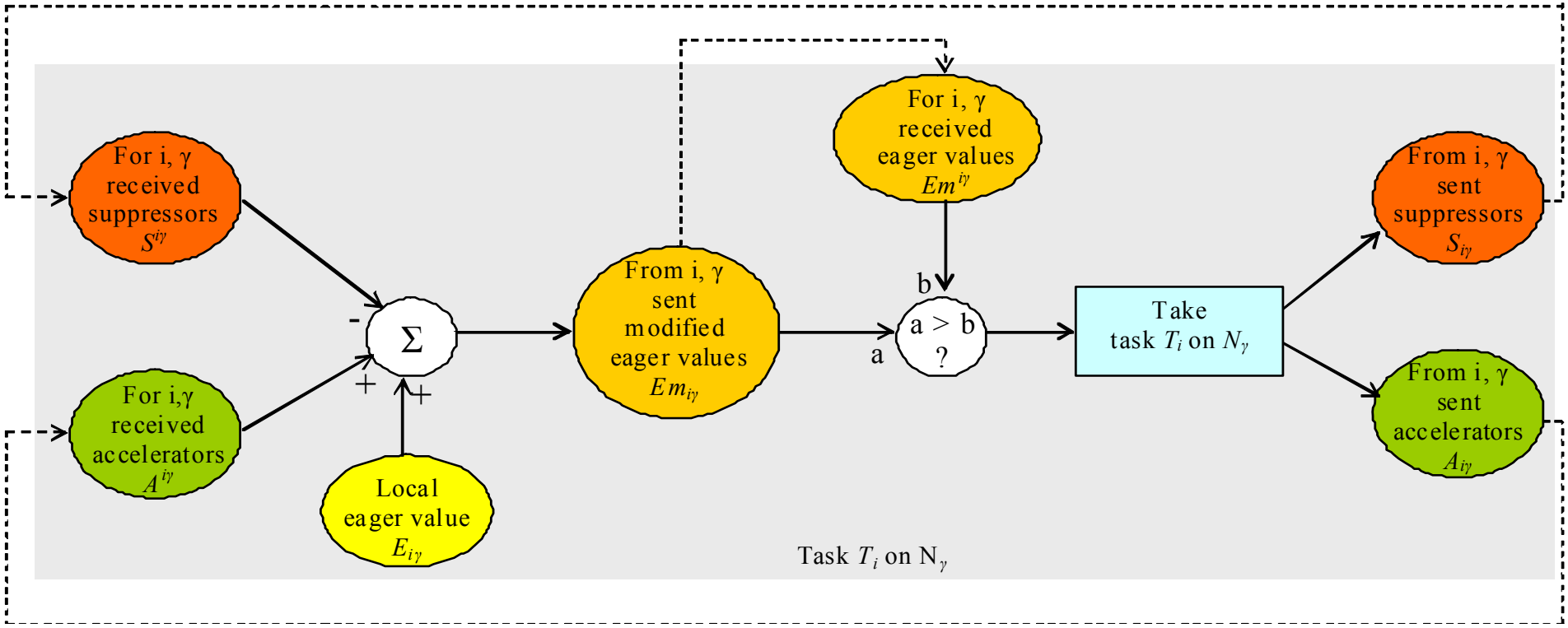
# AHS - Artificial Hormone System
# Organic Middleware



An artificial hormone system for task mapping in heterogeneous, distributed, embedded systems

- Hormones are simulated with short messages (artificial hormones)
- Artificial hormones are distributed locally in the neighborhood (local multicast) or in the whole system (broadcast)
- Local reaction of the processing elements (artificial cells) to the artificial hormones
- The reaction of the artificial cell to an artificial hormone depends solely on the artificial cell itself
- Antagonists of the artificial hormones allow closed feedback

# Principle of closed feedback, antagonists




Notation: $H^{iγ}$ Hormone for task $T_i$ on node $N_γ$
$H_{iγ}$: Hormone for task $T_i$ on node $N_γ$, latin letter for task indices, greek letter for node indices

## Properties of the AHS

- **self-organizing**

There is no outside organization instance which controls the task mapping. The task mapping takes place solely by the interaction of the single nodes.

- **self-configuring**

The system determines a start configuration based on the skills (e.g. computation power, memory, ...) as well as the condition (e.g. Operating temperature, energy supply, ...) of the heterogeneous nodes.

- **self-optimizing**

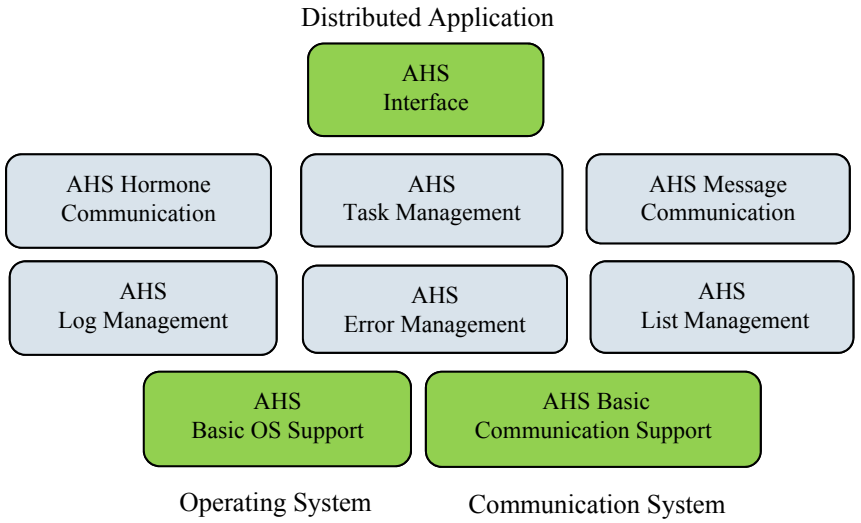
The mapping will automatically adjust to changing conditions and status of the nodes (e.g. decreasing energy, increasing temperature).

- **self-healing**

As there is no central instance and the system is able to self-optimize, the system is automatically able to replace a malfunctioning task or node by remapping.

# AHS - Artificial Hormone System
# Organic Middleware

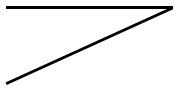
- Pure ANSI C for deployment in environments from small µCs to large PCs
- 7729 Total Physical Source Lines of Code (SLOC)
- Simple exchange of underlying OS due to the “AHS Basic OS Support” abstraction layer
- Network protocol easily interchangeable due to “AHS Basic Communication Support” interface



## Example of use:

Autonomous Guided Vehicle (AGV)

Sensors: laser scanner
transponder receiver
bumper



orientation

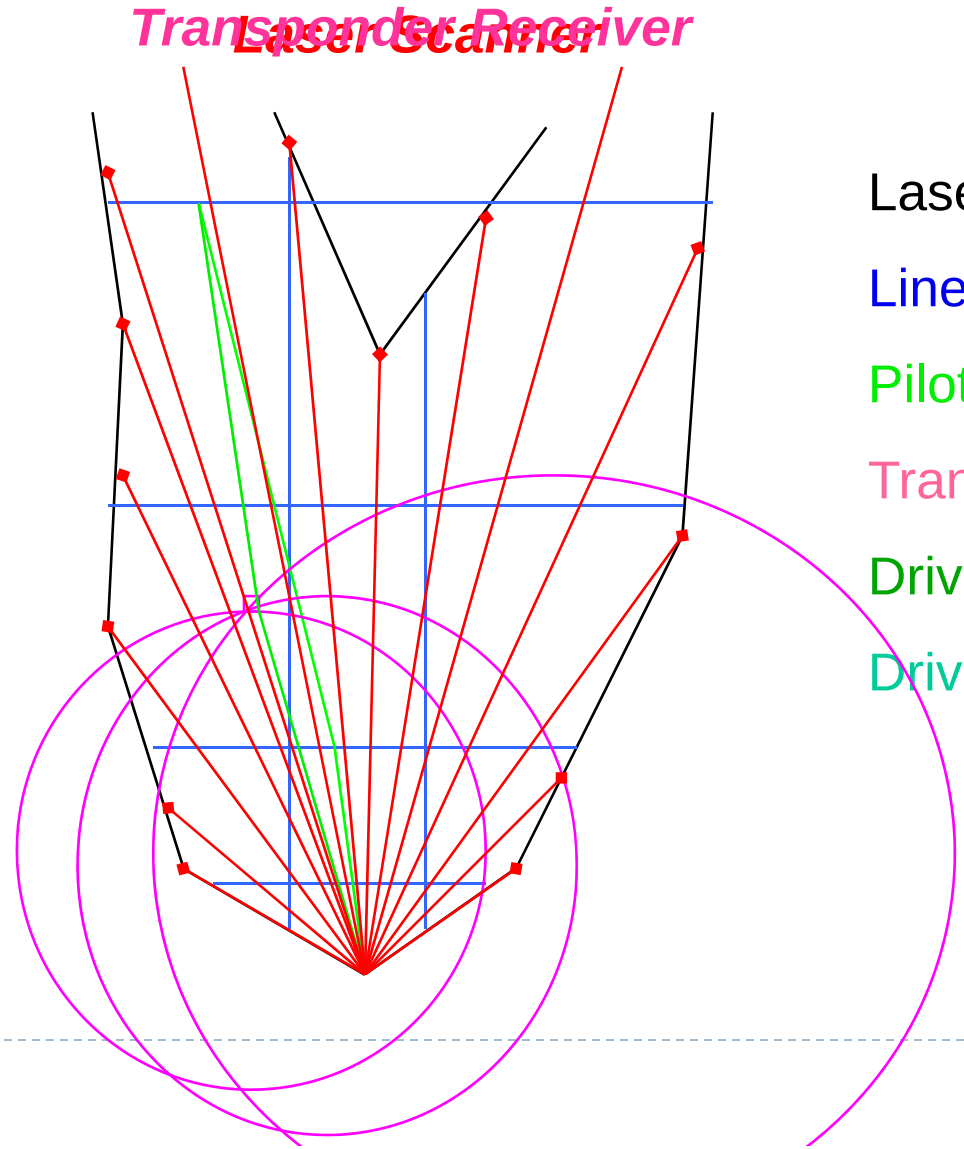
emergency break
on collision

Actuators: differential drive

Goal: navigation in an unknown environment
finding transponders

(only example of use for the AHS, not a stand-alone scientific goal)

# Navigation with laser scanner and transponder




Laser Corridor Task

Line Segment Task

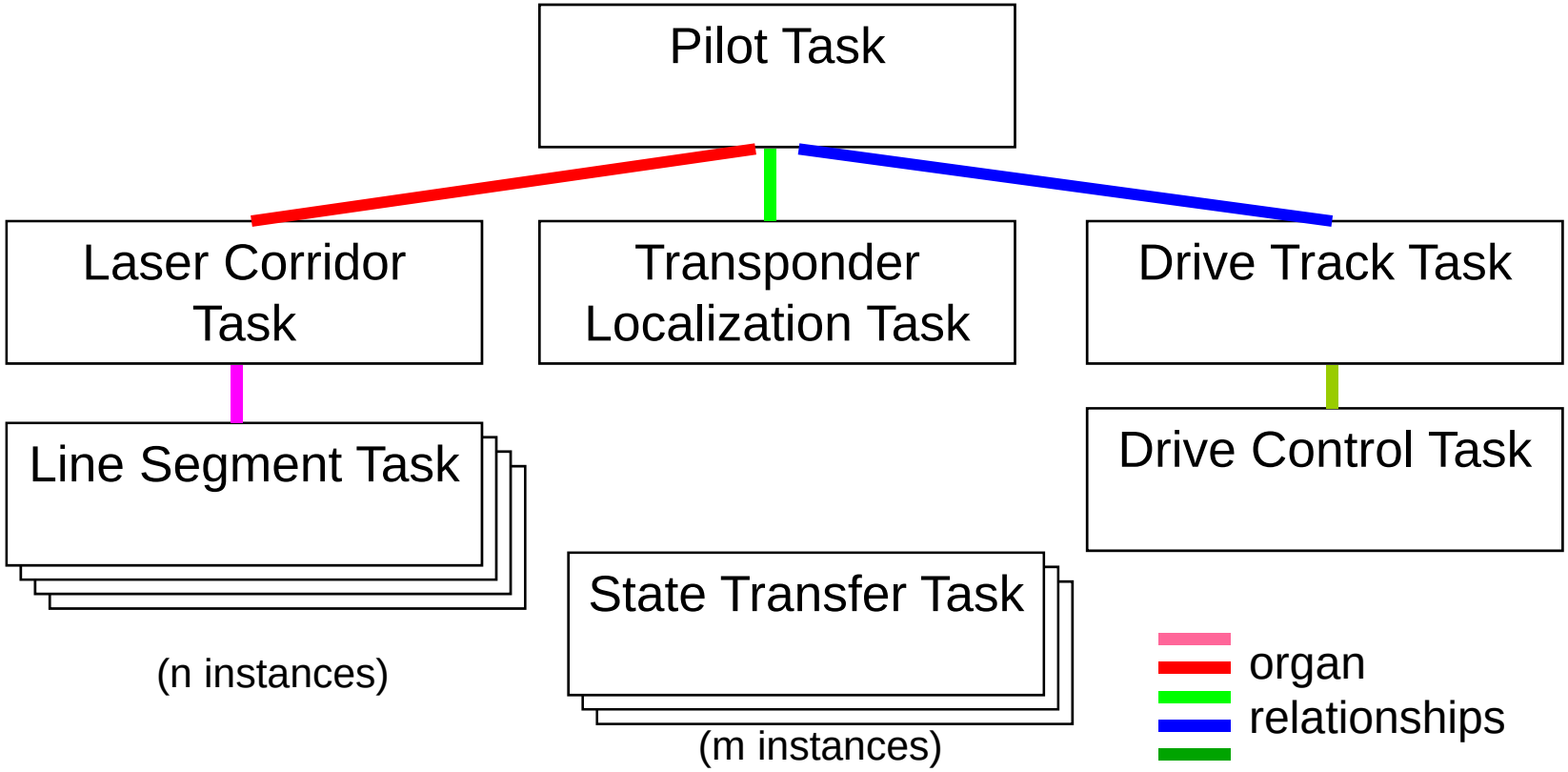
Pilot Task

Transponder Localization Task

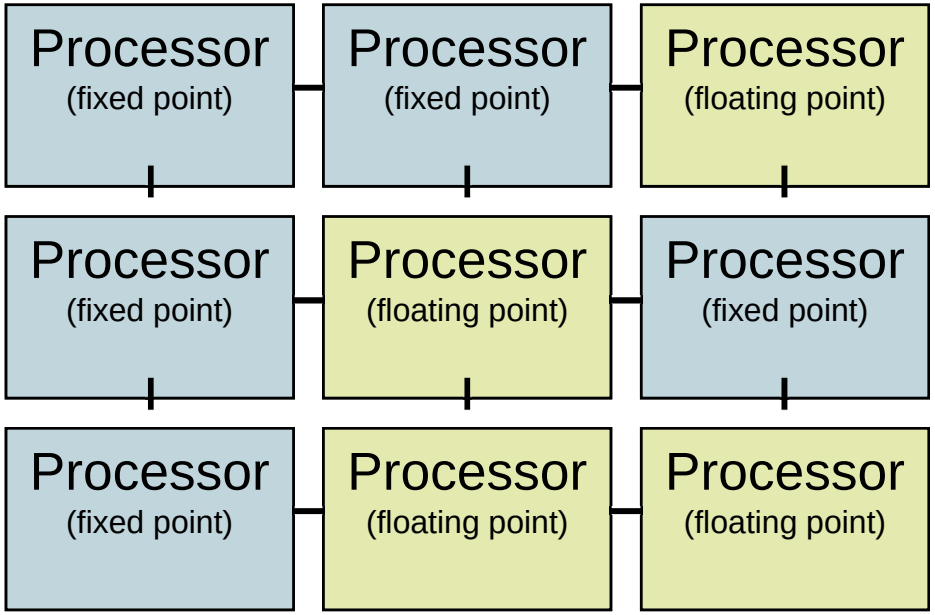
Drive Track Task

Drive Control Task

## Structure of tasks:



## Structure of processors:




Self-Configuration: automatic adaptation of the structure of the processors

Self-Optimization: Consideration of properties, temperatures, …

Self-Healing: automatic compensation of break-downs

Self-Organization: no external controll instance

live demo