OrganicBus – Organic Self-organizing Bus-based Communication Systems

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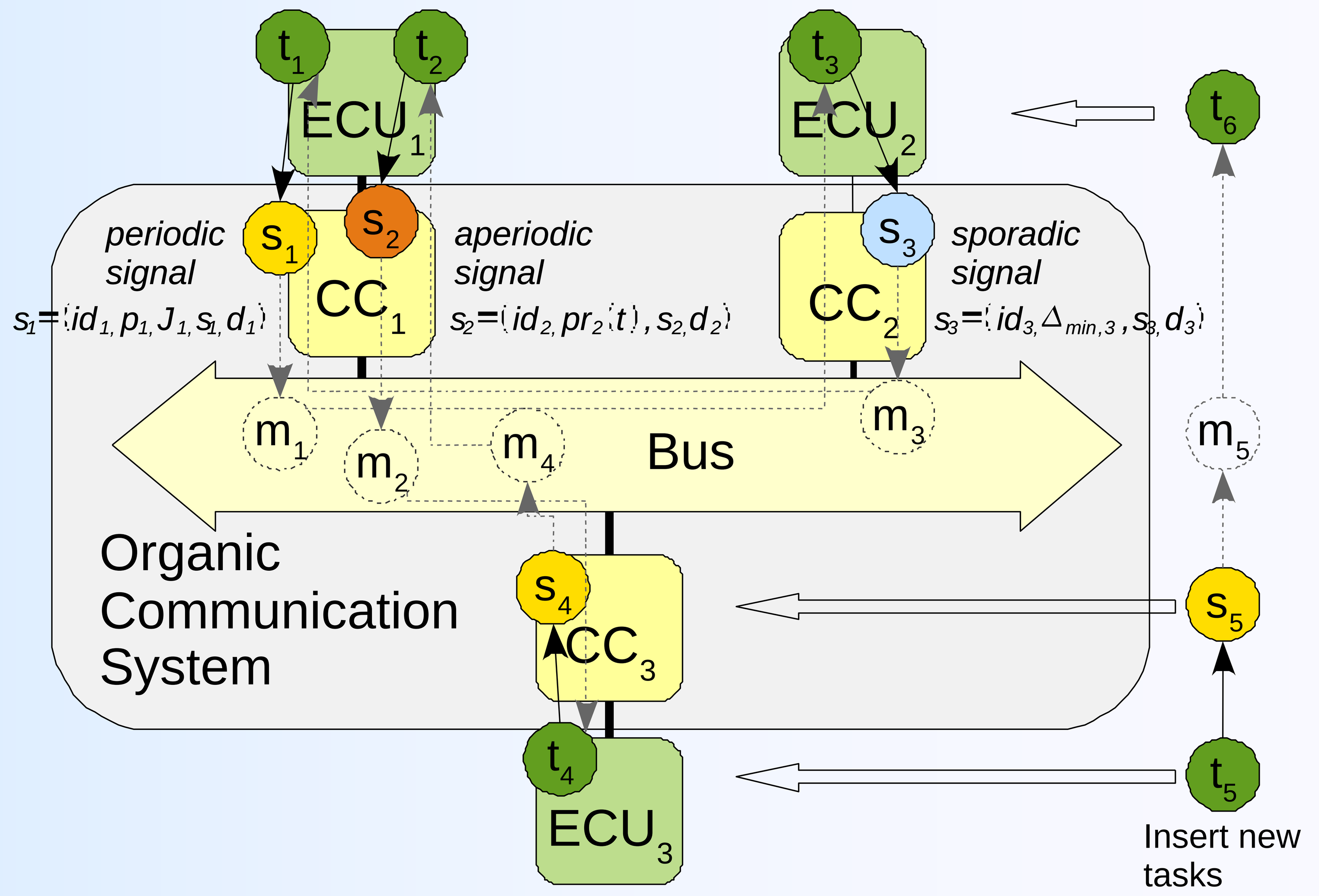
Overview

- Today's electronic systems comprise a multitude of complex components interacting over bus systems
- An organic approach for the analysis, design and optimization of bus-based communication systems is investigated

Goals:

- Theoretical foundations on self-organization for bus-based communication architectures
- Models as well as a design methodology to implement properties for conflicting requirements
- Simulation testbed
- Hardware demonstrator to prove the benefits of the investigated approaches in a realistic environment



Self-organizing Bandwidth Sharing

Problem Formulation:

- Each ECU want to send as much as possible
- Adjust sending probability to reach fair (equal) distribution of bandwidth

Formal Foundation:

- Game theoretic modeling of the priority-based medium access

Player 2

Player 1	wait	send
wait	0,0	0,1
send	1,0	1,0

- Utility: $u_i(p) = p_i \cdot \prod_{j>i} (1-p_j)$
- Goal: $u_1(p) = u_2(p) = \ldots = u_n(p)$
- Choose sending probability:

$$p_i = \frac{b}{n-(n-i)\cdot b}$$

n: Number of players
b: Available bandwidth

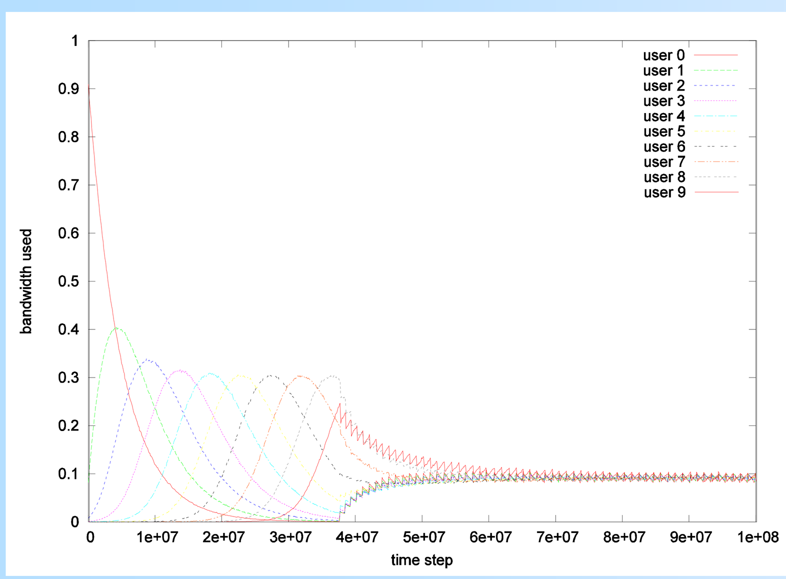
Enhancement of the Game:

- Achieve fairness with distributed local rules
- Demand that a free amount ε of the bandwidth stays free

$$u_i(p) = \begin{cases} p_i \cdot \prod_{j>i}(1-p_j), & \text{if } \prod_{j>i}(1-p_j) \geq \varepsilon \\ 0, & \text{else} \end{cases}$$

- Fair bandwidth distribution is Nash equilibrium, but not the only one
- Decentralized Reinforcement learning algorithm:

```
foreach learning interval {
   calculate(load); //overall utilization
   calculate(success); //individual
   utilization
   if (load > 1-ε) {
     p -= learningrate * success;
   } else {
     p += learningrate * (1-success);
   }
}
```



Work in Progress

Increase the quality of real-time tasks:

Current questions:

- How can the information nodes learn from the current bus traffic be formed appropriate?
- What kind of adaptations are the most beneficial?

Possible Solutions:

- Create a profile only of the traffic of nodes that are conflicting and change behavior to resolve the conflict
- Adapt bandwidth sharing algorithm to achieve fair soft real-time

Open issues with bandwidth oriented tasks:

- The algorithm should be able to adapt the bandwidth according to a weight given by the designer
- Research behavior when tasks with higher priority exist in the system and the bandwidth oriented tasks are using the remaining bandwidth