DodOrg Project Overview

L. Bauer, R. Buchty, T. Ebi, D. Kramer, A. von Renteln, C. Schuck
Prof. J. Becker, Prof. U. Brinkschulte, Prof. J. Henkel, Prof. W. Karl

DodOrg

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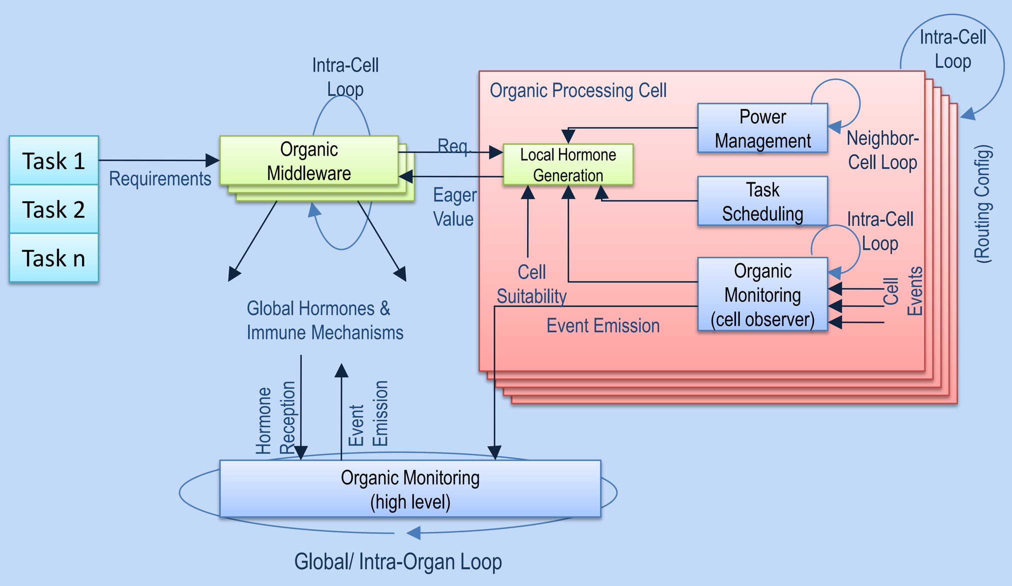
Stability and Plasticity



Definition Stability

When only minor external environmental changes apply then the system shall settle down to a steady state and avoid oscillation.

Definition Plasticity

The ability of the system to leave a stable state in order to adapt to lager environmental changes.

Interleaved distributed control loops demand for special attention within DodOrg Artificial Hormone System

System parameters (not adjustable by Organic Middleware):	Middleware internal parameters:
#OPCs	
#Tasks	Accelerator values per task,
Eager value per task/OPC	Suppressor values per task,

- Challenge: Wrong parameter settings (of accelerators and suppressors) may lead to unstable System behavior (e.g. oscillations)
- Solution: Formally determine the relationship and constraints (e.g. borders) for these parameters (that assure stability while allowing plasticity) and evaluate them using DodOrg's artificial hormone simulator

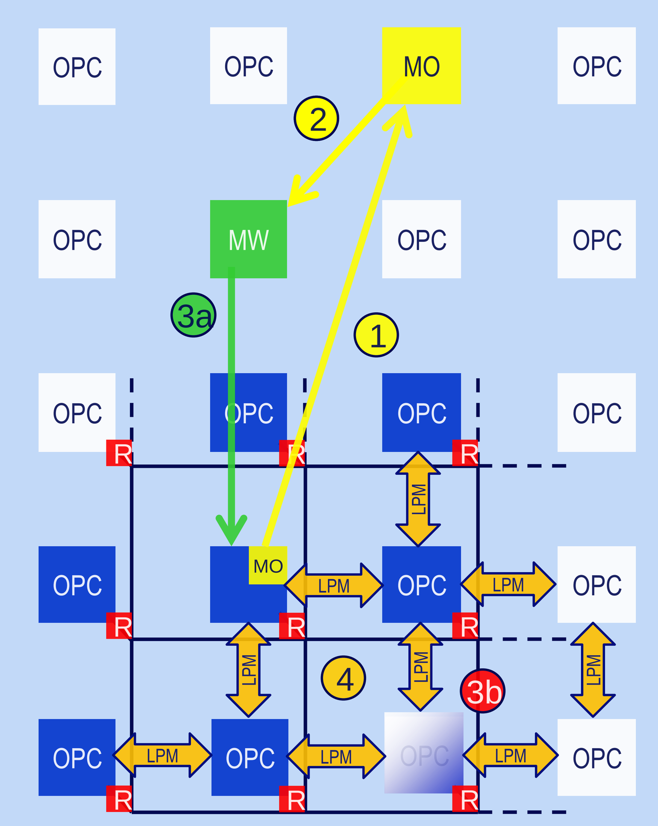
Dynamics

Situation detection

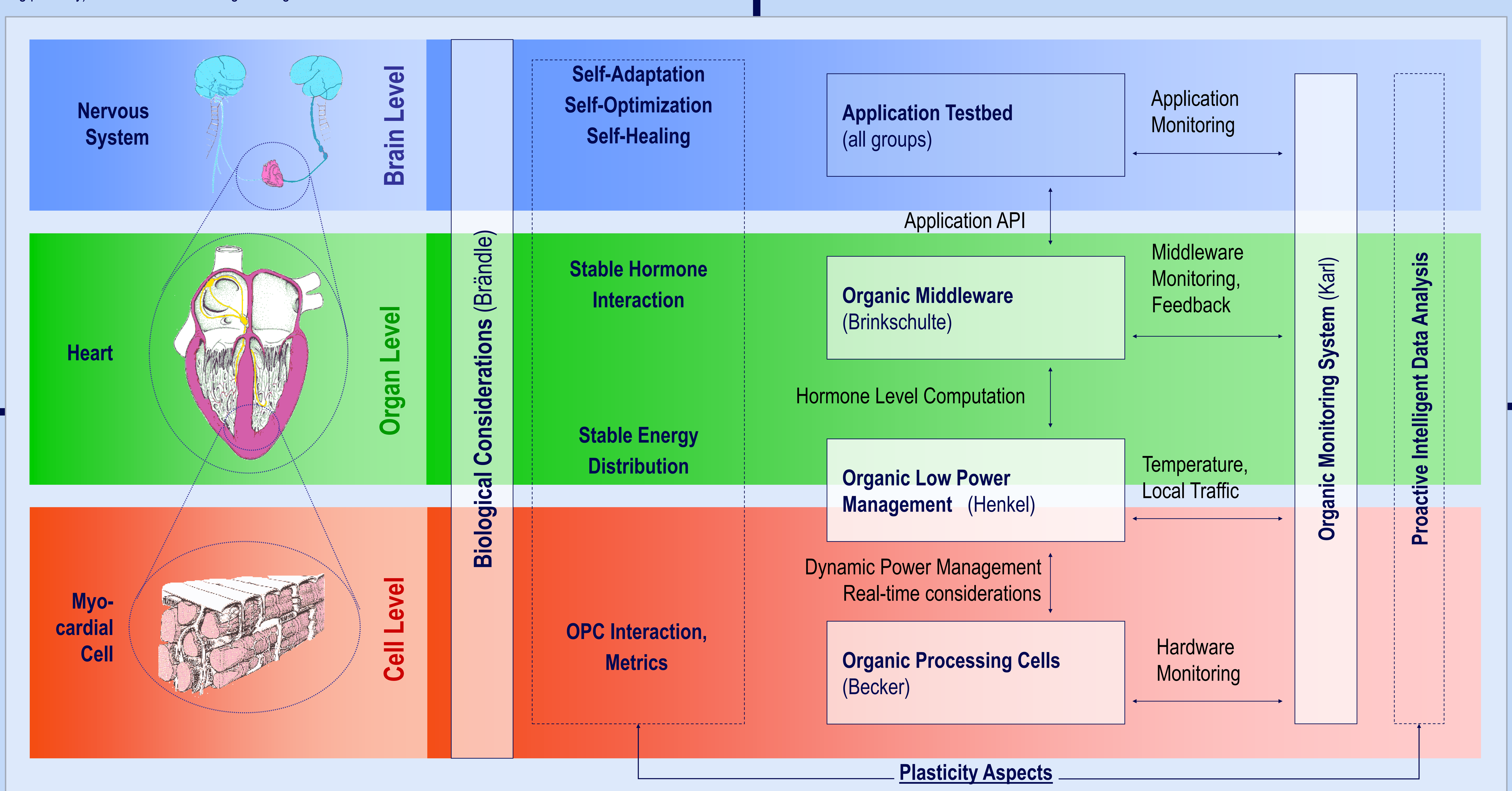
- Cause: Change in local system parameters (e.g. on-board temperature), application requirements
- Indication: Monitored errors (e.g. increased bit-error rates), hormone levels

Dynamic reaction:

1. Cell emergency event picked up by monitor cell
2. Monitor cell decides to inform middleware (MW)
3. Task migration
   a. Initiated by MW
   b. Cell configuration and data path adaptation in NoC
4. Energy adjustment by low-power manager
5. System settling

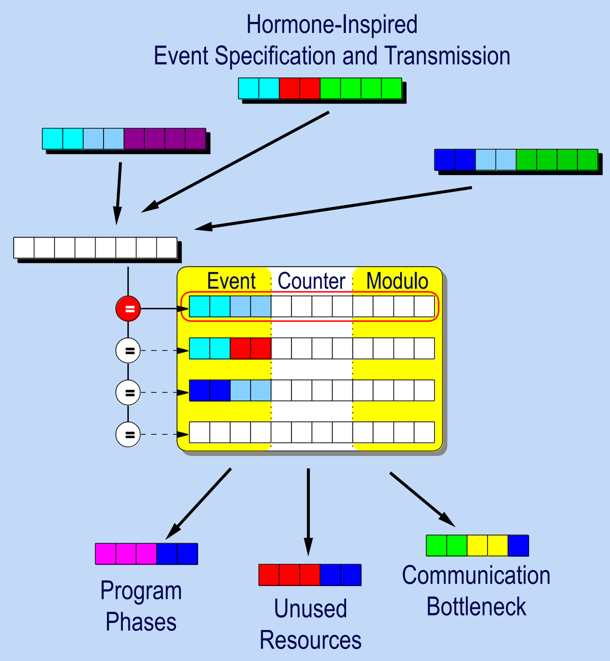


Legend: OPC Organic processing cells; MO Monitor instance; LPM Low Power Management; MW Middleware representative; OPC Idle cells



Ongoing Work

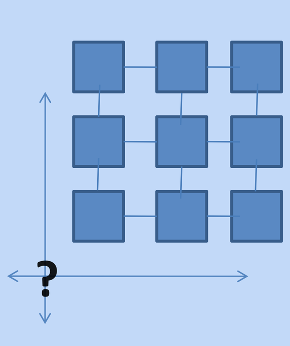
Decentral Event Detection and Evaluation



Second Messenger (correlated events)

Hormone System: Quality Analysis

- Finding limits of systems:
  - How many tasks/jobs are suitable for a given number of OPCs
- Calculating minimum requirements of the system:
  - How many OPCs will be needed for a given scenario (at a minimum)

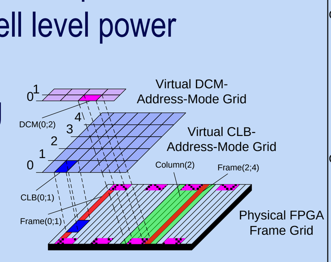


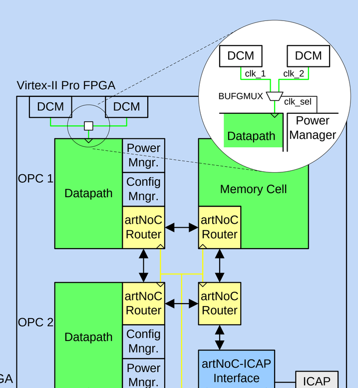
Stability Criteria

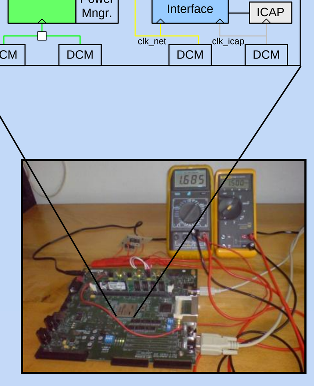
$$\text{if } sup_{min} > (v-1)\cdot acc_{max}:$$
$$\left\lceil \frac{ev_{max} + lacc_{min} - lsup_{max}}{sup_{min} - (v-1)\cdot acc_{max}} \right\rceil \le n_j$$
$$\le \left\lceil \frac{ev_{max} + lacc_{max} + lsup_{min}}{sup_{min} - (v-1)\cdot acc_{max}} \right\rceil$$

OPC- FPGA –Hardware Prototype

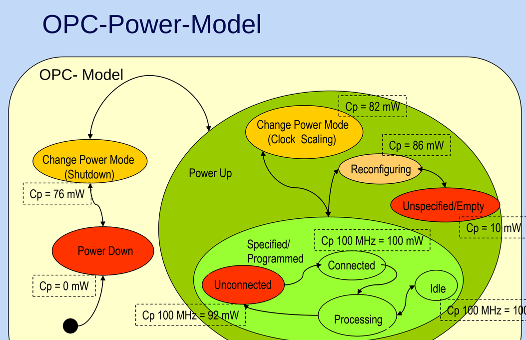
- Runtime reconfigurable HW-datapath
- Decentralized self-reconfiguration through virtual-ICAP-port
- Fine grained cell level power management
- HW-monitoring (temperature, NoC –traffic)



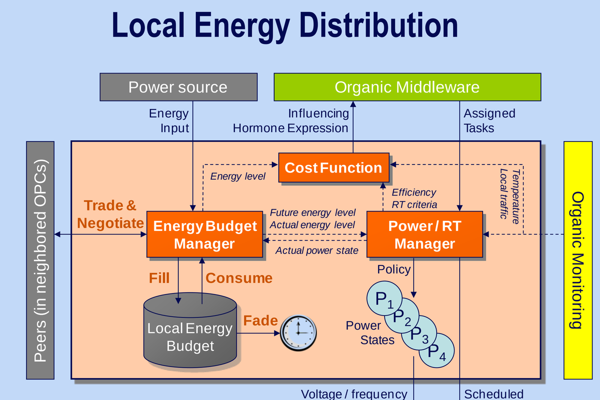




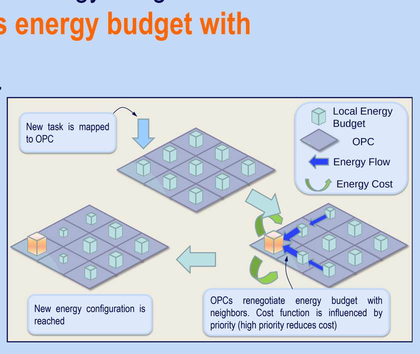
OPC-Power-Model



Local Energy Distribution



- Goals: Low energy consumption and convergent system behavior (plasticity)
- Local energy budget simulates the available energy
- Energy budget manager
  - Agent controlling local energy budget
  - Negotiates & trades energy budget with neighboring OPCs
  - Influences power/RT manager policies
- Global power source
  - Assigns energy budgets to OPCs (pulse-based) depending e.g. on state of charge

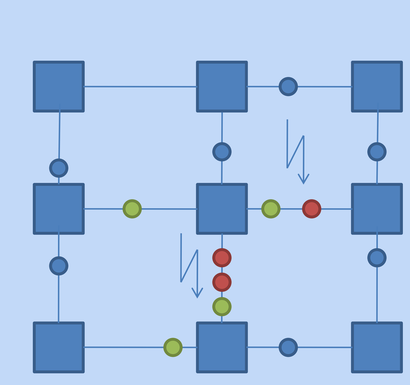


Outlook Phase III

Proactivity ⋆ Stability ⋆ Robustness

Hormone System: Quality Analysis

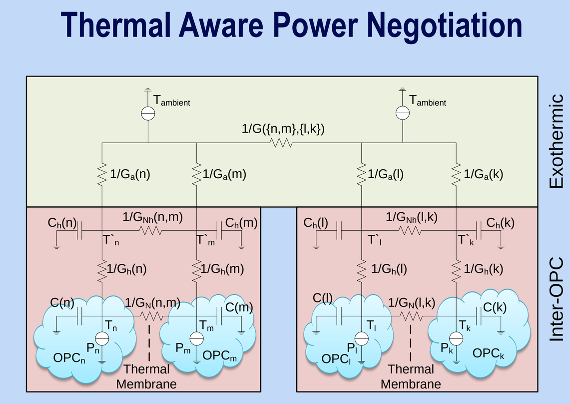
- Realizing Task communication via Hormones
  - This will simplify message exchange between running tasks on different OPCs
- Being able to react to „ill" OPCs
- Counter-measures against malicious attacks



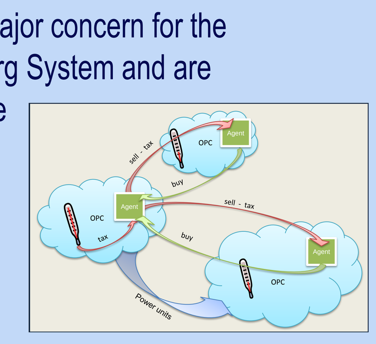
Intelligent Data Analysis Techniques

- Event Correlation
  - Classifying events as either good, bad, or neutral
  - For avoiding unstable states
- Trend Detection
  - Prediction of future states
  - Identification of potentially harmful states
- Avoiding Potential Conflicts Through Proactivity
  - Based upon trend detection and event correlation
  - Initiating required systems changes before an actual problem occurs
  - Proactive self-healing and self-optimization

Thermal Aware Power Negotiation



- Thermal issues are a major concern for the robustness of the DodOrg System and are directly influenced by the power distribution



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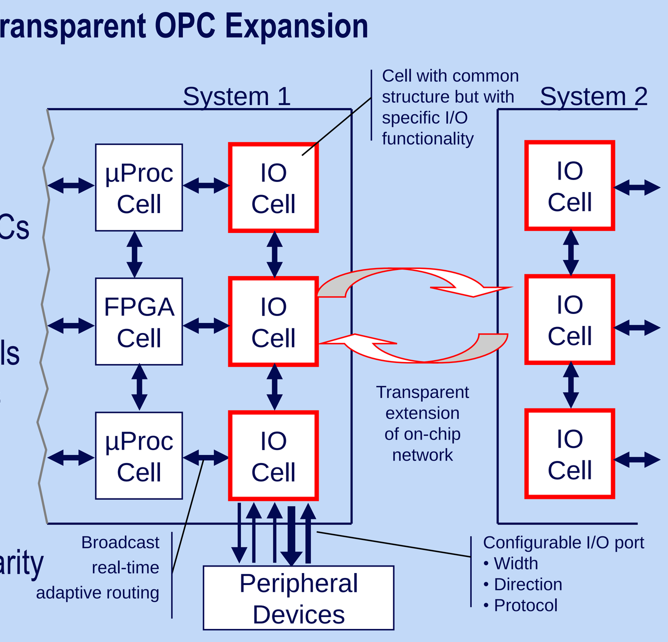
- Thermal models need to be developed and incorporated in the power negotiation process
- Improvement of negotiation process using economic learning

Transparent OPC Expansion

- Challenges
  - Transfer of network services
  - Removing/adding OPCs
- Research Goals
  - Communication mechanisms of IO-cells
  - Adaptation of address space through DNA Configuration management
  - Achieving true modularity



Overall System Integration