



IP9 Communicating Embedded Systems

Architecture Exploration in CES

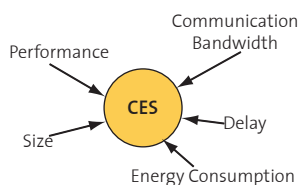
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Architecture Exploration

Conflicting Criteria

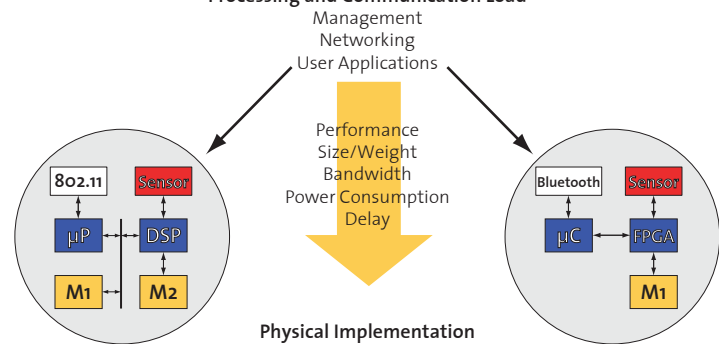
IP9 is dealing with the design of CES where issues of **low power, small size, real-time operation, performance and communication bandwidth** all arise together.

What are the *right* abstractions? Provide a **domain-specific set of models** and

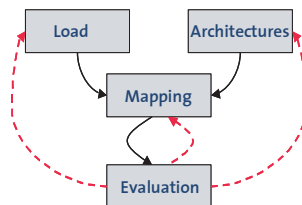


Design Alternatives

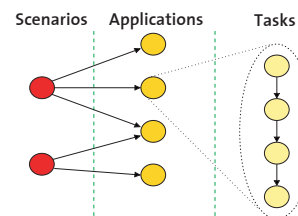
Processing and Communication Load



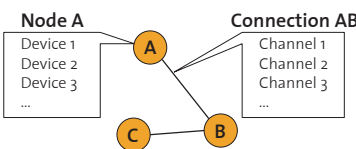
Models



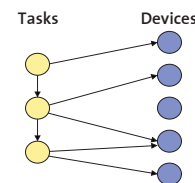
Exploration Model: Finds in an iterative way architectures that are optimal for the given design problem.



Load Model: Defines processing and communication load hierarchically with tasks, applications and scenarios.



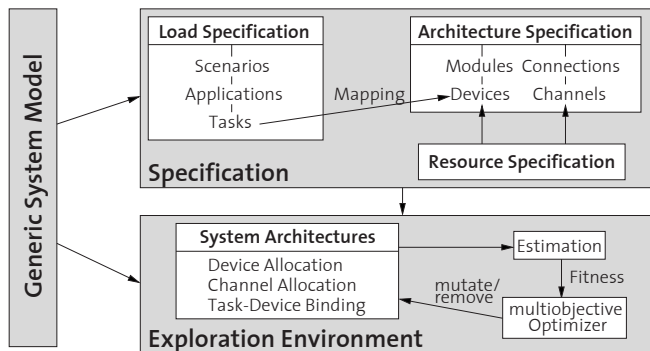
Architecture Model: Defines possible processing and communication devices for each CES-node and the network structure.



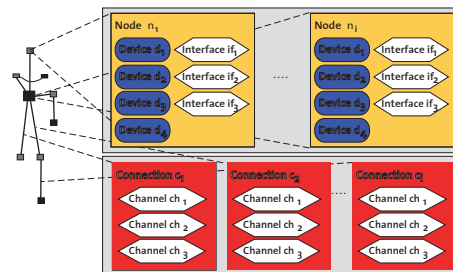
Mapping Model: Defines for each task possible target devices.

Case Study – Design of Heterogeneous Distributed CES

Exploration Methodology



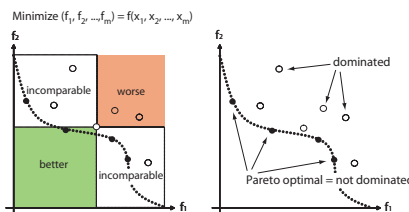
Generic System Model



Specification

- Load Specification**
 - instruction mix of tasks to characterize computational load
 - 4 - 7 different scenarios
- Device Specification**
 - Frequency scaling
 - Op. modes (idle, sleep, stby...)
 - Resource sharing
- Communication Specification**
 - wired + wireless
 - comm. modes (burst, cont.)
 - Resource sharing

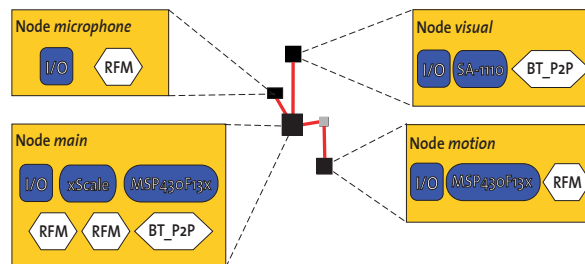
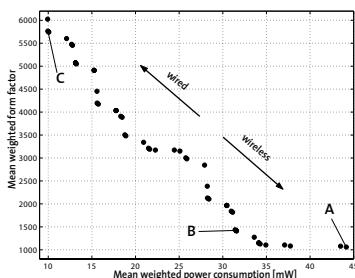
Multi-objective exploration



- complex, non-linear fitness functions
- 2 objectives: power consumption and formfactor (size, weight, fitness)
- delay as additional constraint
- evolutionary search techniques
- use of well known evolutionary multi-objective optimizer SPEA II
- search for pareto-optimal points

Example Result

- 4 nodes (main, microphone, visual, motion)
- 5 scenarios (just-monitor, view-picture, rec-picture, voice-input, network-read)
- 500 generations, ~30 min on SunBlade 1000
- each dot represents individual architecture with detailed information on:
 - nodes (power, form)
 - devices (power, load, op. mode, freq.)
 - channels (power, load, comm. mode)
 - tasks / application (delay, binding)



Conclusion

- design of CES as multi-objective optimization process
- embedded in automatic exploration environment

Future Work

- evaluation with real-time calculus
- dynamic allocation/binding based on context information
- dynamic network model

Publication

[AnlikerBDELT] *A Systematic Approach to the Design of Distributed Wearable Systems*, IEEE Transactions on Computers (submitted)