Information Society Technologies

ARTIST2 – Year 1 Review

Grenoble, October 3rd-4th, 2005

Activity *Execution Platforms*

Design For Low Power

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Outline of the Presentation

Participants + Objectives

Industrial Needs and Experience

Year 1 Activities

- Interaction Between Partners
- Achievements
- Management Perspective
- Spreading Excellence

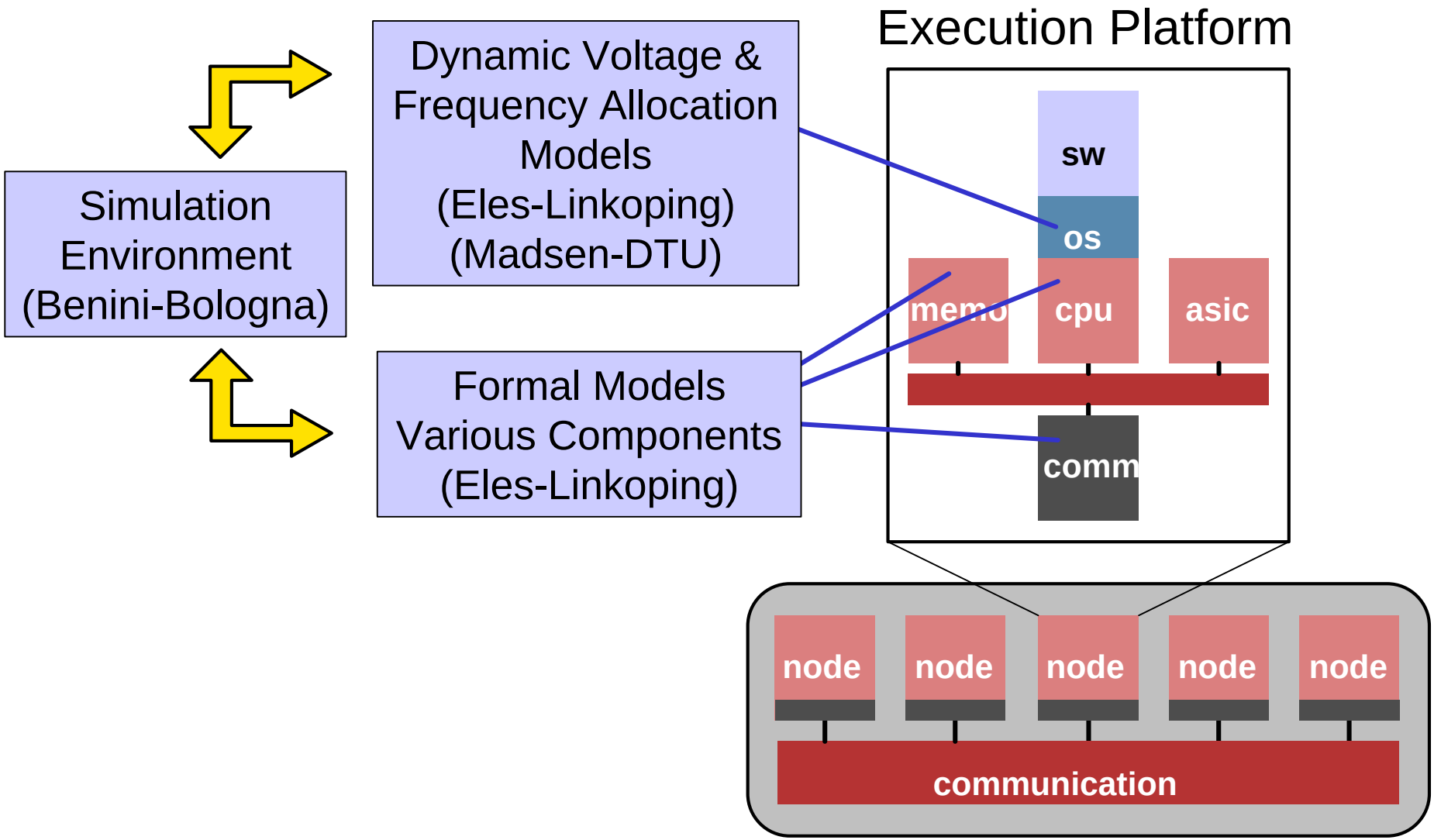
18 Month Perspective

- Ongoing Work
- Significant events or achievements expected

Participants and Objectives

- ***Participants:*** Eles-Linkoping, Madsen- DTU, Benini-Bologna, BullDast
- ***Objective***: Develop a complete high-level power **modelling** methodology which encompasses **all system components**; develop **realistic scheduling and allocation models** for dynamic frequency and voltage allocation and scheduling.
- ***Plan***: (i) Power model development for processing elements, communication links, storage units, power supply circuits, followed by a model integration step. (ii) Study of the formal properties dynamic and quasi-static approaches with realistic **consideration of on-line overhead**, followed by application on **detailed and accurate simulation and power modelling platform**
- ***M3-M18***: Development of stand-alone power models and Integration of the models in a full-system simulation environment. Describing frequency setting algorithms and their formal properties. Implementation of the algorithms on an accurate functional and power modelling platform and analysis of the quality of results achieved and of the sources of inaccuracy in abstract modelling and optimisation.

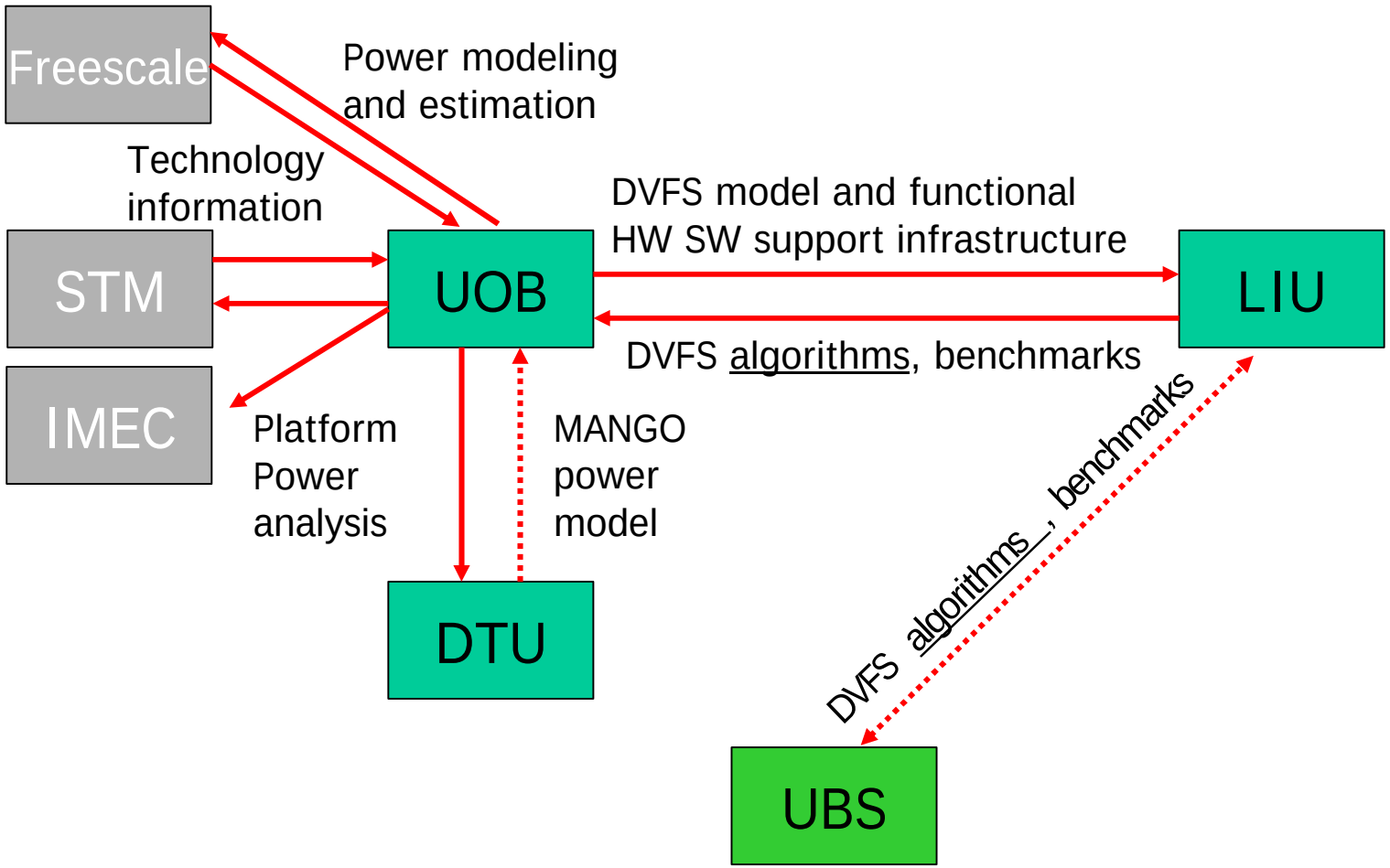
Partners' roles



Industrial Needs and Experience

- Artist2 Interaction with Industry
  - Communication and consumer electronics industry: cooperations with *STMicrolectronics, Freescale, Philips* (joint research projects)
  - Actively linking with new industrial sectors for wireless sensor networks: *IO technology*
- Industrial Needs
  - Power is now a first-class constraint for embedded system design
  - Semiconductor technology evolution is exacerbating the power crisis
- Global Impacts of Research Results
  - Longer battery lifetime
  - Smaller, lighter, cheaper embedded systems

Achievements: our integration work



Year 1 activities

Technical achievements

Output file: *totals*

```
Power estimation
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  Energy spent:
ARM 0
  core:   25609147.30 [pJ]
  cache:  105048808.17 [pJ]
ARM 1
  core:   25609092.30 [pJ]
  cache:  105048808.17 [pJ]
ARM 2
  core:   25609092.30 [pJ]
  cache:  105048808.17 [pJ]
ARM 3
  core:   25614207.30 [pJ]
  cache:  105048808.17 [pJ]
RAM 0:  2825183.87 [pJ]
RAM 1:  2825183.87 [pJ]
RAM 2:  2825183.87 [pJ]
RAM 3:  2824958.26 [pJ]
RAM 4:     0.00 [pJ]
BUS:  50778876.39 [pJ]

  Power spent:
ARM 0
  core:     51.18 [mW]
  cache:    209.95 [mW]
ARM 1
  core:     51.18 [mW]
  cache:    209.95 [mW]
ARM 2
  core:     51.18 [mW]
  cache:    209.95 [mW]
ARM 3
  core:     51.18 [mW]
  cache:    209.95 [mW]
RAM 0:     5.65 [mW]
RAM 1:     5.65 [mW]
RAM 2:     5.65 [mW]
RAM 3:     5.65 [mW]
RAM 4:     0.00 [mW]
BUS:   101.49 [mW]
```
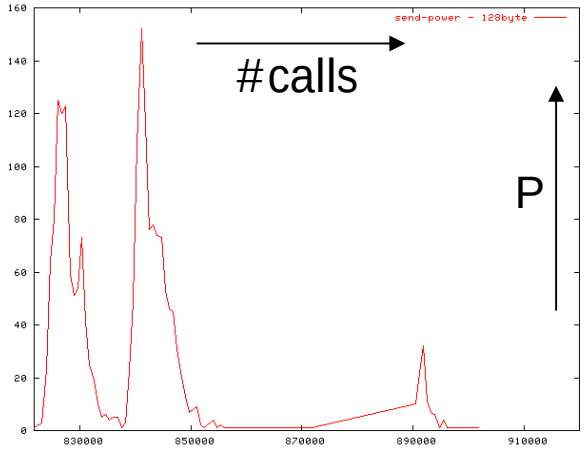
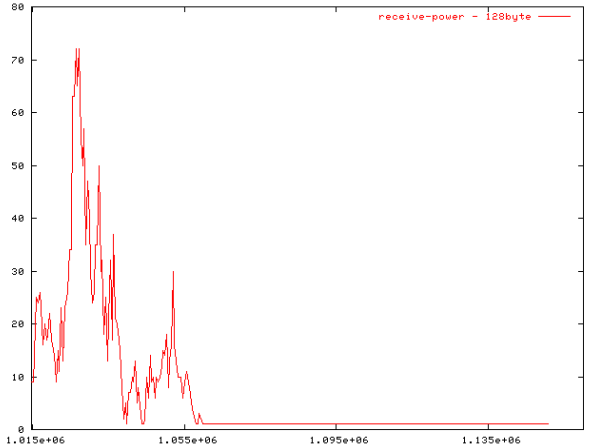

Power models in .13µm t echnology frim STM

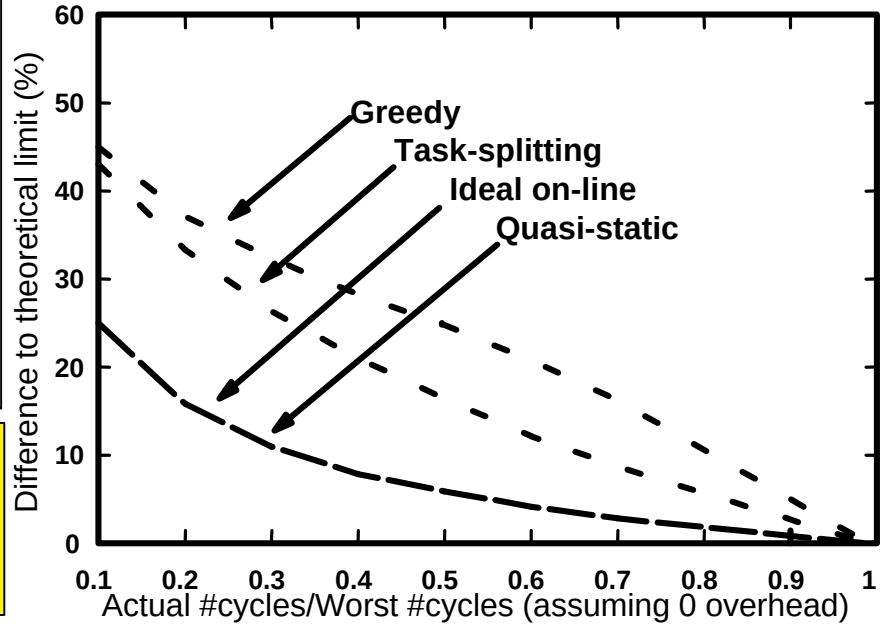
Power distributions for send



Message size: 128 byte

Power distributions for receive





Additional Achievements

- **Linköping University**
  - Scheduling and allocation considering power & reliability
- **Technical University of Denmark**
  - Wireless sensor network analysis and prototyping
  - Asynchronous low-power NoC
- **University of Bologna**
  - Power management techniques for linux-based SoC platforms

Year 1 activities

Management Perspectives

- **What worked well**
  - Close partner cooperation including exchange of research personnel would not have been possible without Artist 2
  - Active cooperation with several companies on low-power embedded systems design (funded projects and student exchanges): STM, Freescale, Philips
- **Difficulties encountered**
  - Industry is working in a bottom-up fashion (try to solve the problem with circuits first)
  - The layering of software markets makes it difficult to adopt holistic power analysis/optimization solutions

Year 1 activities

Spreading Excellence

- **Numerous publications at leading international conferences:**
  - DATE, DAC, Codes-ISSS, ICCAD, CASES, ISLPED, etc.
- **Tutorials and industrial training**
  - Philips, STM, Freescale
- **Joint technical work with several universities and research institutes inside and outside Europe including:**
  - IMEC, EPFL, POLITO, STANFORD, PENN STATE, KAIST, SOUTHAMPTON
- **Low-power research results exploited by several companies including:**
  - STM, Freescale, Bulldast

19-36 Month Perspective

Plan and Achievements Expected

- ***Participants:*** Eles-Linkoping, Madsen- DTU, Benini-Bologna, BullDast, IMEC, Freescale
- ***Objective***: Develop online algorithms for power minimization and adaptation and temperature aware power management.
- ***Plan***: Study of the formal properties dynamic and quasi-static approaches with realistic **consideration of on-line overhead**. Apply these approaches on a **detailed and accurate simulation and power modelling platform** to assess the quality of results and areas of improvement.
- ***M19-M36***:Develop and test on-line algorithms within an operating system framework for Multi-processor platforms. Design space exploration for heterogeneous Multi-processor platforms. Power modelling for WSNs