

# Concurrent Systems

*Nebenläufige Systeme*

## XIV. Pickings

Wolfgang Schröder-Preikschat

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# Agenda

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Recapitulation

Concurrent Systems

Perspectives

Parallel Systems

Computing Equipment

Further Education

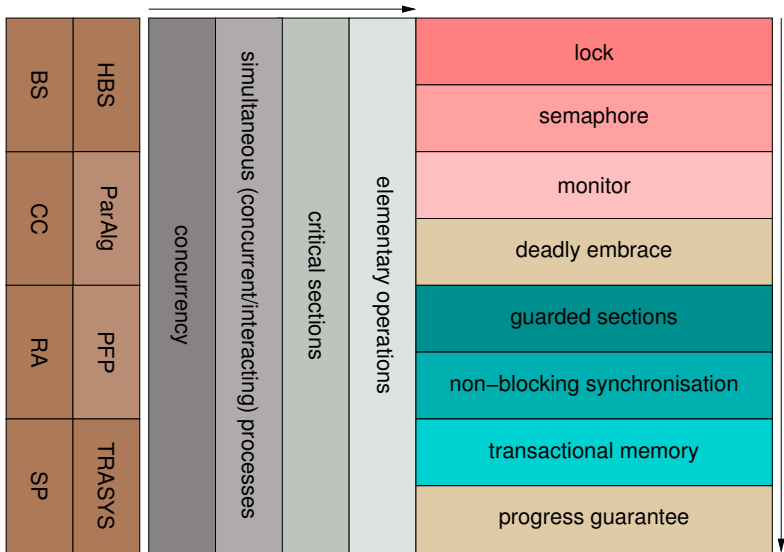


Recapitulation  
Concurrent Systems

Perspectives  
Parallel Systems  
Computing Equipment  
Further Education



# Content of Teaching and Cross-References



Recapitulation

Concurrent Systems

Perspectives

Parallel Systems

Computing Equipment

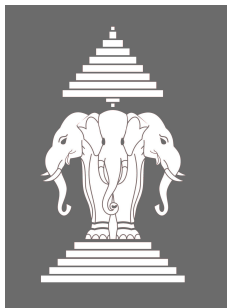
Further Education



- **composability** and **configurability**
    - application-oriented (varying, type-safe) system software
  - **specialisation**
    - dedicated operating systems: integrated, adaptive, parallel
  - **reliability**
    - gentle fault and intrusion tolerance
  - **thriftiness**
    - resource-aware operation of computing systems
  - **timeliness**
    - migration paths between time- and event-triggered real-time systems
  - **concurrency**
    - coordination of cooperation and competition between processes
- ↳ “concurrent systems” is more or less **cross-cutting** thereto. . .

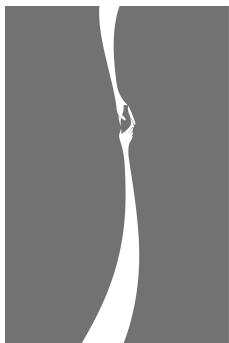


- **latency prevention**
  - lock- and wait-free synchronisation
  - integrated generator-based approach
- **latency avoidance**
  - interference protection
  - race-conflict containment
- **latency hiding**
  - operating-system server cores
  - asynchronous remote system operation
- experiments with different **operating-system architectures**
  - process-/event-based and hardware-centric operating-system kernels
  - LAKE, Sloth
- DFG: 2 doctoral researchers, 2 student assistants



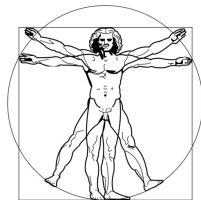
<sup>1</sup><http://univis.uni-erlangen.de> → Research projects → LAOS

- **event-based minimal kernel**
  - cache-aware main-memory footprint
  - hyper-threading of latent actions
- featherweight **agreement protocols**
  - overall kernel-level synchronisation
  - familie of consistency kernels
- **problem-oriented consistency**
  - sequential, entry, release consistency
  - functional hierarchy of consistency domains
  - memory domains for NUMA architectures
- implementation as to different **processor architectures**
  - partial or total, resp. {in,}coherent shared memory
- DFG: 2 doctoral researchers (1 FAU, 1 BTU)



<sup>2</sup><http://univis.uni-erlangen.de> → Research projects → COKE

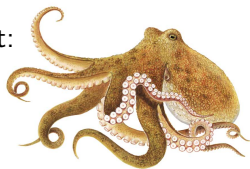
- GPU-centric **resource management**
  - timely predictable run-time system
    - run-to-completion kernel
  - prioritisation and isolation of GPU tasks
    - scheduling according to execution costs
  - trade-off handling as to throughput and response time
- RAM-centric **run-time executive** for heterogeneous processors
  - application-specific and problem-oriented memory management
  - run-time adaptation and relocation of dynamic data structures
- **tailor-made system software** for heterogeneous image systems
  - support of an incremental improvement of visual quality
  - patterns for adaptive detail adaptation of geometry or textures
- DFG: 1 doctoral researcher, 1 student assistant



<sup>3</sup><http://univis.uni-erlangen.de> → Research projects → RAMP

## *Octo*

- borrowed from the designation of a creature that:
  - i is highly parallel in its actions and
  - ii excellently can adapt oneself to its environment
- the kraken (species *Octopoda*)
  - can operate in parallel by virtue of its eight tentacle
  - is able to do customisation through camouflage and deimatic displays and
  - comes with a highly developed nervous system
    - in order to attune to dynamic ambient conditions and effects



## *POS*

- abbrev. for *parallel operating system*
  - an operating system that not only supports parallel processes
  - but that also functions **inherently parallel** thereby
- DFG: 2.5 doctoral researchers, 1 research/3 student assistants

<sup>4</sup><http://univis.uni-erlangen.de> → Research projects → iRTSS

# Power-Aware Critical Sections

- scalable synchronisation on the basis of **agile critical sections infrastructure**
  - load-dependent and self-organised change of protection against race conditions
- **linguistic support**
  - preparation, characterisation, and capturing of declared critical sections
- automated extraction of critical sections
  - notation language for critical sections
  - program analysis and LLVM integration/adaptation
- power-aware system programming
  - mutual exclusion, guarded sections, transactions
  - dynamic dispatch of synchronisation protocols or critical sections, resp.
- tamper-proof power-consumption measuring
  - instruction survey and statistics based on real and virtual machines
  - energy-consumption prediction or estimation, resp.
- DFG: 2 doctoral researchers, 2 student assistants

The logo for PAX consists of the letters 'PAX' in a bold, black, sans-serif font. The letter 'X' is replaced by a large, green, stylized 'X' shape.

<sup>5</sup><http://univis.uni-erlangen.de> → Research projects → PAX

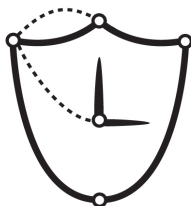
## ■ real-time capable network communication

- transport channel for cyber-physical systems
- predictable transmission latency
- in a certain extent guaranteed quality criteria

## ■ deterministic run-time support

*Auffassung von der kausalen [Vor]bestimmtheit allen Geschehens bzw. Handelns (Duden)*

- latency-aware communication endpoints, optimised protocol stack
  - specialised resource management, predictable run-time behavior
    - in time (phase 1) and energy (phase 2) respect
- DFG: doctoral researchers, 2 student assistants (1 FAU, 1 Uni SB)



<sup>6</sup><http://univis.uni-erlangen.de> → Research projects → LARN

## Multi/Many-Core Processor Pool

fau4*	clock	cores per domain		domain		
		physical	logical	NUMA	tile	
8e 8f	2.9 GHz	8	16	2	–	Xeon
9big01	2.5 GHz	6	–	8	–	Opteron
9big02	2.2 GHz	10	20	4	–	Xeon
9phi01	1.2 GHz	6	12	2	–	Xeon
	1.1 GHz	57	228	2	–	Xeon Phi
scc	1.5 GHz	4	2	1	–	Xeon
	800 MHz	2	–	–	24	Pentium
InvasIC	3.5 GHz	8	16	2	–	Xeon
	25 MHz	4	–	6		LEON/SPARC

- budgeted acquisition: further  $n$ -core systems, transactional memory

OctoPOS ■  $n \geq 64$ , in 2015

PAX ■  $n \geq 16$ , in 2016, plus several multi-core micro-controllers



# Bachelor, Master, or Doctoral Thesis

