

# Concurrent Systems

*Nebenläufige Systeme*

XIV. Pickings

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## Agenda

Recapitulation  
Concurrent Systems

Perspectives  
Parallel Systems  
Computing Equipment  
Further Education



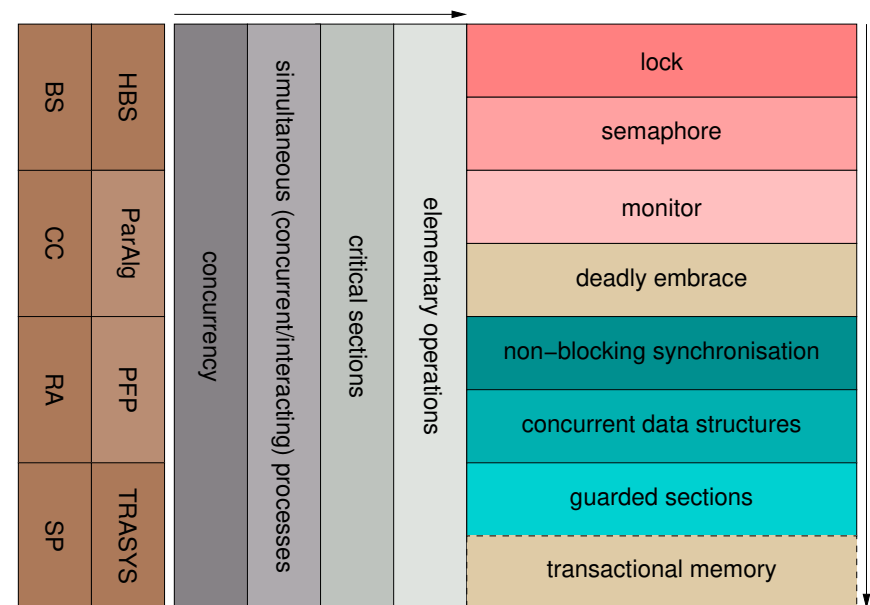
## Outline

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

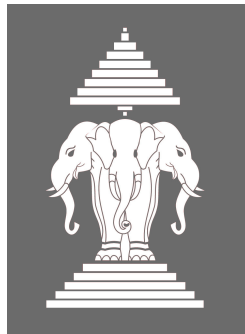


- **composability and configurability**
    - application-oriented (varying, type-safe) system software
  - **specialisation**
    - dedicated operating systems: integrated, adaptive, parallel
  - **reliability**
    - gentle fault and intrusion tolerance
  - **thriftiness**
    - resource-aware operation 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 Awareness in Operating Systems

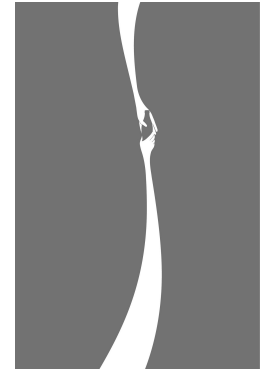
- **latency prevention**
  - lock- and wait-free synchronisation
  - integrated generator-based approach
- **latency avoidance**
  - interference protection
  - race-conflict containment
- **latency hiding**
  - operating-system server cores
  - asynchronous remote system operation
- experiments with 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

## Coherency Kernel

- **event-based minimal kernel**
  - cache-aware main-memory footprint
  - hyper-threading of latent actions
- featherweight **agreement protocols**
  - overall kernel-level synchronisation
  - families 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

## 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

**PAX**

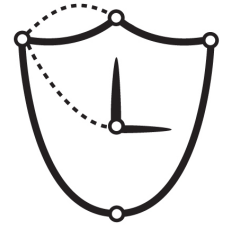
<sup>3</sup><http://univis.uni-erlangen.de> → Research projects → PAX

## Latency- and Resilience-Aware Networking

- 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 behaviour
    - in time (phase 1) and energy (phase 2) respect
- DFG: doctoral researchers, 2 student assistants (1 FAU, 1 Uni SB)

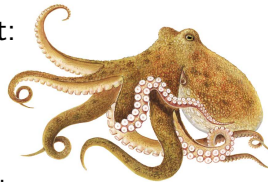


<sup>4</sup><http://univis.uni-erlangen.de> → Research projects → LARN

## Run-Time Support System for Invasive Computing

### Octo

- borrowed from the designation of a creature that:
  - is highly parallel in its actions and
  - 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

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

## Multi/Many-Core Processor Pool

fau4*	clock	cores per domain		domain		#	
		physical	logical	NUMA	tile		
*8e *8f	2.9 GHz	8	16	2	1	32	Xeon
*9big01	2.5 GHz	6	6	8	1	48	Opteron
*9big02	2.2 GHz	10	20	4	1	80	Xeon
*9big03	2.1 GHz	12	24	4	1	96	Xeon
*9big04	2 GHz <sup>6</sup>	64	128	2	1	256	Epyc
*9big05	2.5 GHz	16	128	2	4	1024	ThunderX2
*9phi01	1.2 GHz	6	12	2	1	24	Xeon
	1.1 GHz	57	228	2	1	456	Xeon Phi
*scc	1.5 GHz	4	8	1	1	8	Xeon
	800 MHz	2	–	–	24	48	Pentium
fastbox InvasIC	3.5 GHz	4	8	1	1	8	Xeon <b>TSX</b>
	50 MHz	5	5	16		80	LEON/SPARC

2160

<sup>6</sup>mit boost 3.35 GHz

