Concurrent Systems

Nebenläufige Systeme

XIV. Pickings

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Outline

Recapitulation
Concurrent Systems

Perspectives
Parallel Systems
Computing Equipment
Further Education

Content of Teaching and Cross-References

transactional memory
PFP
elementary operations
critical sections
simultaneous (concurrent/interacting) processes
concurrency
deadly embrace
guarded sections
non-blocking synchronisation
progress guarantee
lock
semaphore
monitor
deadly embrace
guarded sections
non-blocking synchronisation
transactional memory
progress guarantee
Main Research at the Chair

- **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...

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**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

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**Coherency Kernel**

- **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)

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1. [http://univis.uni-erlangen.de](http://univis.uni-erlangen.de) → Research projects → LAOS

2. [http://univis.uni-erlangen.de](http://univis.uni-erlangen.de) → Research projects → COKE
Heterogeneous Resource-Aware Multi-Processing

- **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-orientied 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

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Run-Time Support System for Invasive Computing

**Octo**

- borrowed from the designation of a creature that:
  1. is highly parallel in its actions and
  2. 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**

- abbrv. 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

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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

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Multi/Many-Core Processor Pool

<table>
<thead>
<tr>
<th>faui4*</th>
<th>clock</th>
<th>cores per domain</th>
<th>domain</th>
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<td></td>
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<td>logical</td>
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<tr>
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<td>16</td>
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<tr>
<td>InvasIC</td>
<td></td>
<td>2</td>
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</tbody>
</table>

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

**OctoPOS**

- *n* ≥ 64, in 2015

**PAX**

- *n* ≥ 16, in 2016, plus several multi-core micro-controllers