

Real Time Systems – SS2016

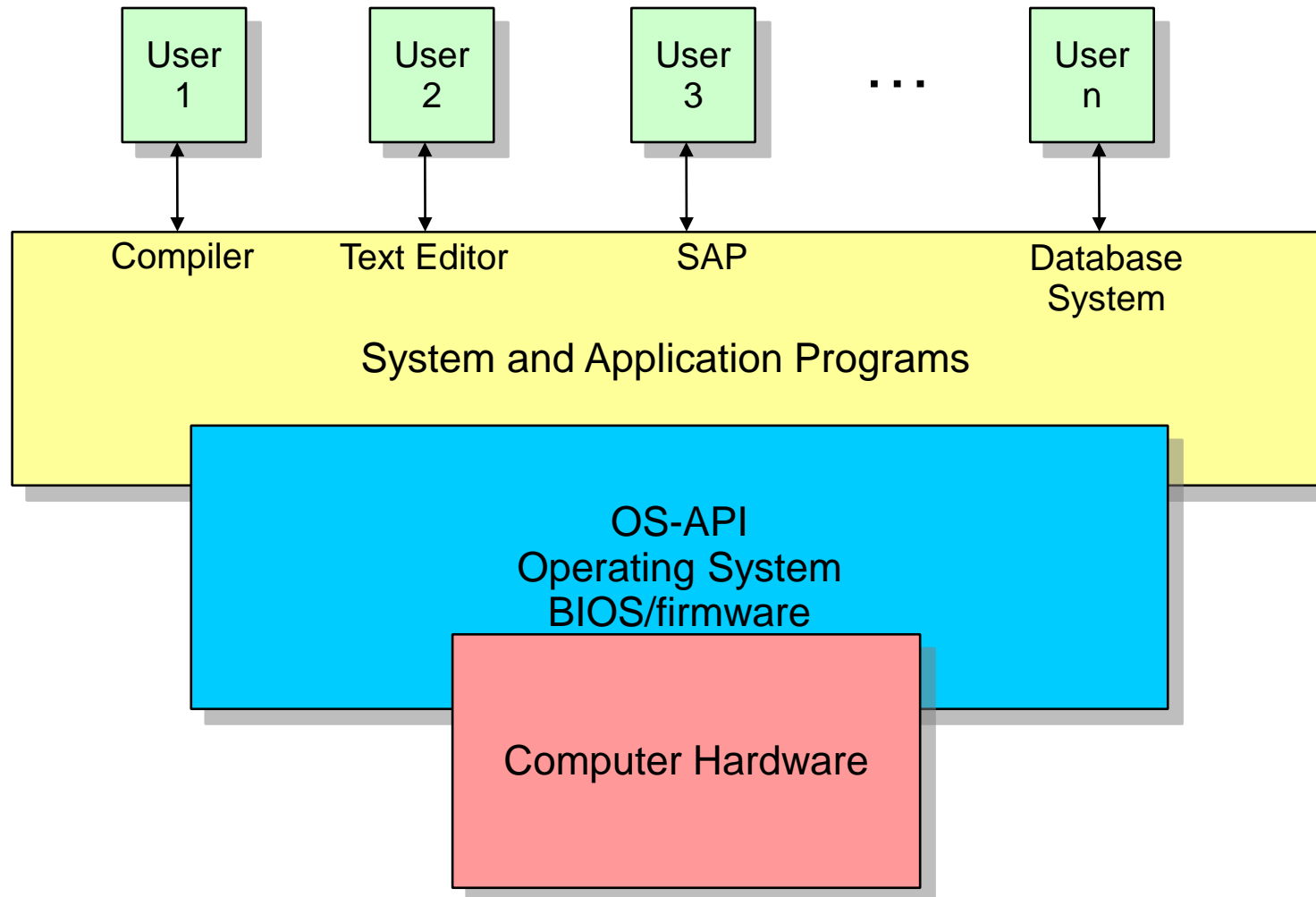
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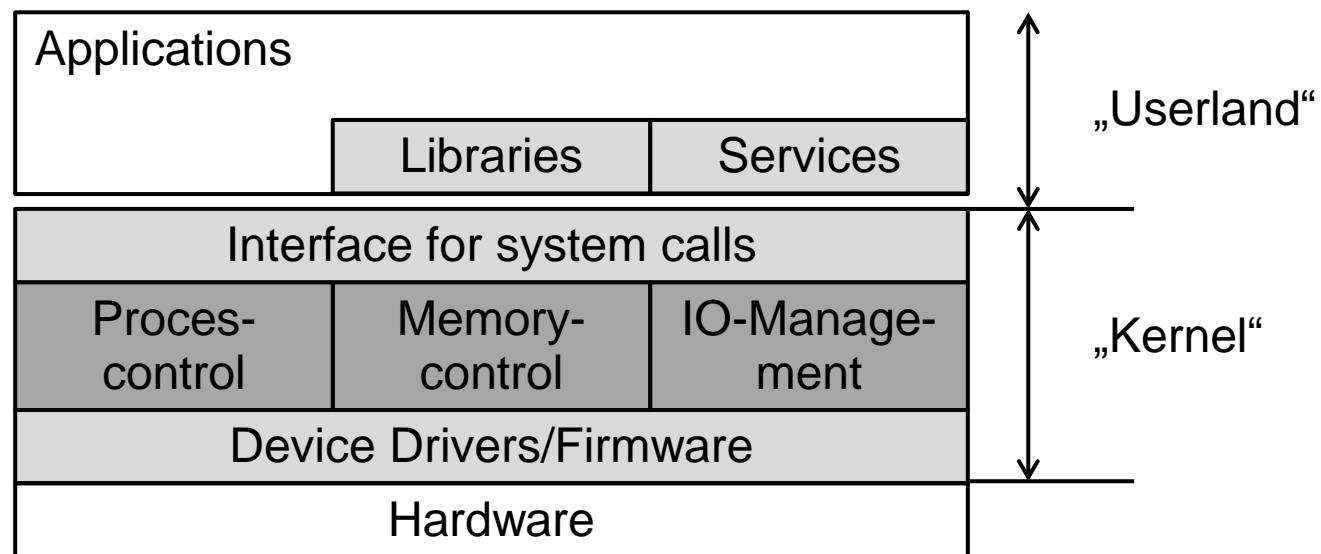
Real-Time-Operating Systems
RTOS

Remember: “computer system”

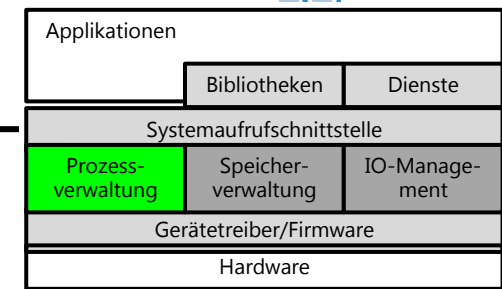


Quelle: Holten, König, 2004 c/o Silberschatz, Galvin: Operating System Concepts, Fifth Edition, 1999

- Interface between HW and user/partner systems
- Ressourcen management:
 - Process-/Processor-Management
 - Memory-Management
 - IO-Management (Device- and Filemanagement)

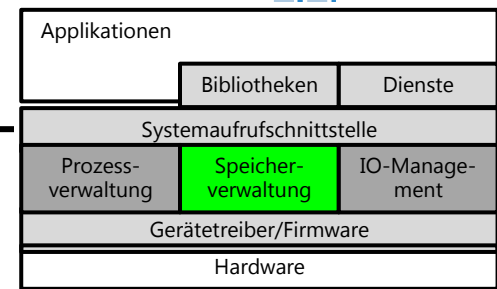


nach J. Quade, M. Mäctel, Moderne Relzeitsysteme kompakt, Eine Einführung mit Embedded LINUX, dpunkt.verlag, Heidelberg 2012

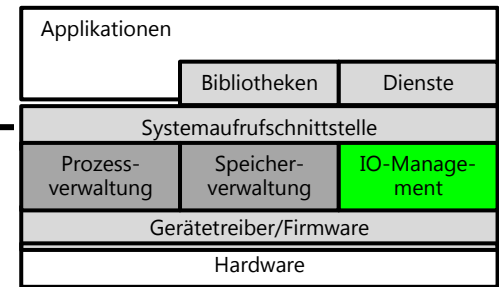


- (quasi-)parallel information processing of multi computing tasks on a single- or multi-core-processors
- Tasks: Threads and Processes (have their own data segments)
- preemptive multitasking by:
 - static/dynamic scheduling („plan & control“)
 - with static and/or dynamic priorities
- Scheduling Strategies (e.g.):
 - Monocore: FCFS/FIFO; prior. time slices; EDF (earliest deadline first)
 - Multicore: partitioned / global scheduling / or in combination
- State of Tasks (in TCB=Task Control Block: Code-/Data/Stack-Segment)
 - running (also activ) maximal 1 on single-core): actual in processing
 - ready (enabled): will be the next one
 - blocked (also waiting): waits for others
 - suspended: needs to be loaded first (no existing TCB)

See: <http://www.freertos.org/RTOS-task-states.html>



- **Tasks for the Memory-Management-Unit (MMU):**
 - **Memory Protection**
Applicationens and processes (not threads) have its own address-space, that is protected against mutal access.
 - **Address Translation**
(formely done by loaders), today the MMU makes sure, that Code-Segments start with memory adress 0 : code-share, less memory, faster.
 - **Provisioning of extended Memory**
when more memory is required than is accessible by the bus
 - **Provisioning of virtual Memory**
provides more memory than available physical memory by paging und swapping. Often this is not reasonable for critical areas of RT-applications bcause paging and swapping is not time-deterministic.



- Provision of standardised **Application Programming Interface (API)** (create, open, read, write, close)
- Enable a system-conform integration of hardware (driverinterface)
- Enable structured storing of information in data and directories (filesystem)
- **Time Control:**
additionally an RTOS has to provide different time controls:
 - Measurement of time (Clocks)
 - Time Control für Services (Timer)
 - Time Monitoring (Watchdog)
 - Time synchronisation

Requirements with direct time dependance

- Time services
 - absolute and relative Clocks, Timer, Timeouts
- defined reaction times
- RT-compliant scheduling
- Synchronisation of prozesses (Semaphores, Mutexes, etc.)
- RT-compliant process communication (IPC)

Non-functional requirements:

- Availability (7x24)
- Scalability
- minimal memory requirements (Microkernel)



- **Windows CE, Microsoft**
OEM-Version by Microsoft, for vendor customisable, needs less than 1MByte
- **PREEMPT-RT-Patch für Linux**
modifies Linux to be RTOS
- **LynxOS:**
komm. RTOS, POSIX-konform for army, aerospace, medical applications etc.
- **VxWorks (Wind River Systems)**
prop. OS u.a. for small devices aerospace, defense, health, networks, (Marsmission)
- **QNX (Neutrino)**
komm. RTOS, POSIX-konform, Open-Source, free not for commercial use
- **RTEMS (Open Source)**
für display-less, RT-embedded systems, (US-army)
- **eCos:**
Free RTOS, for large number of different processors
- **and many more**

- A gallery of disruptive technologies**
- Estimated number of years before each technology reaches some application in the U.S. (1 = 1 year, 10 = 10 years)
-
- | Technology | Estimated years to application |
|--|--------------------------------|
| 1. Social media | 1 |
| 2. Expansion of knowledge base | 2 |
| 3. Internet of Things | 3 |
| 4. Cloud | 4 |
| 5. Nanotechnology | 5 |
| 6. Robotics and cyber-physical systems | 6 |
| 7. Nanopower generation | 7 |
| 8. Energy storage | 8 |
| 9. 3D printing | 9 |
| 10. Artificial intelligence | 10 |
| 11. Expansion of real-time location services | 11 |
| 12. Renewable energy | 12 |