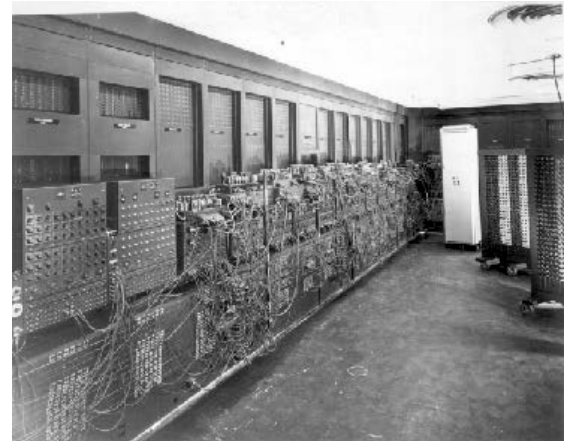


If the automobile had followed the same development cycle as the computer, a Rolls-Royce would today cost \$100, get a million miles per gallon, and explode once a year, killing everyone inside.

-- *Robert X. Cringely*

Chapter 1

Historical Background



Operating system (Definition according DIN 44300)

“The programs of a digital computing system which lay - together with the basic properties of the computing system - the foundation for the possible modes of operation and especially control and monitor the execution of programs.”

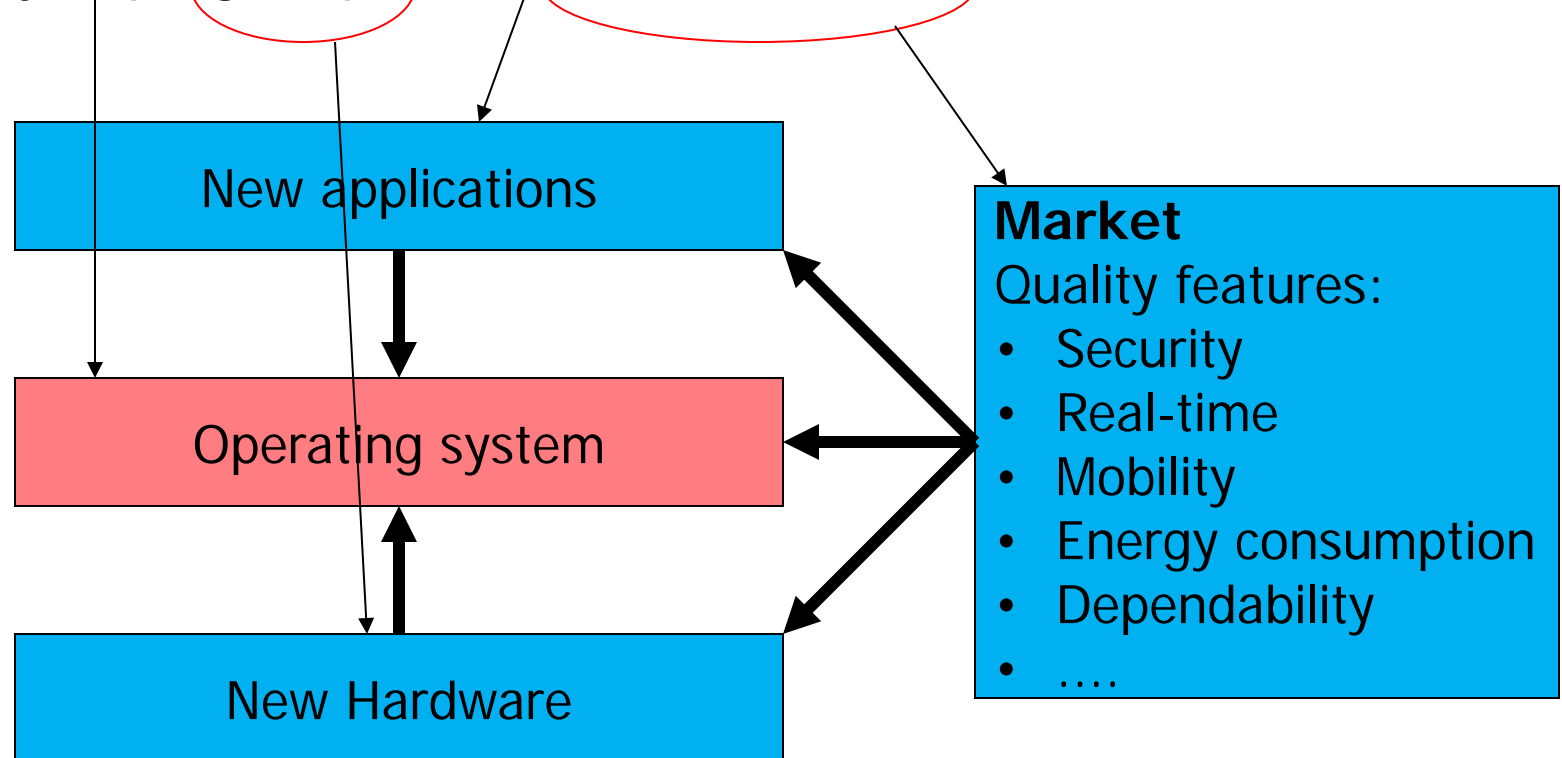
Main Tasks

- Provision of virtual machine
 - as an abstraction of the computer system
- Resource Management

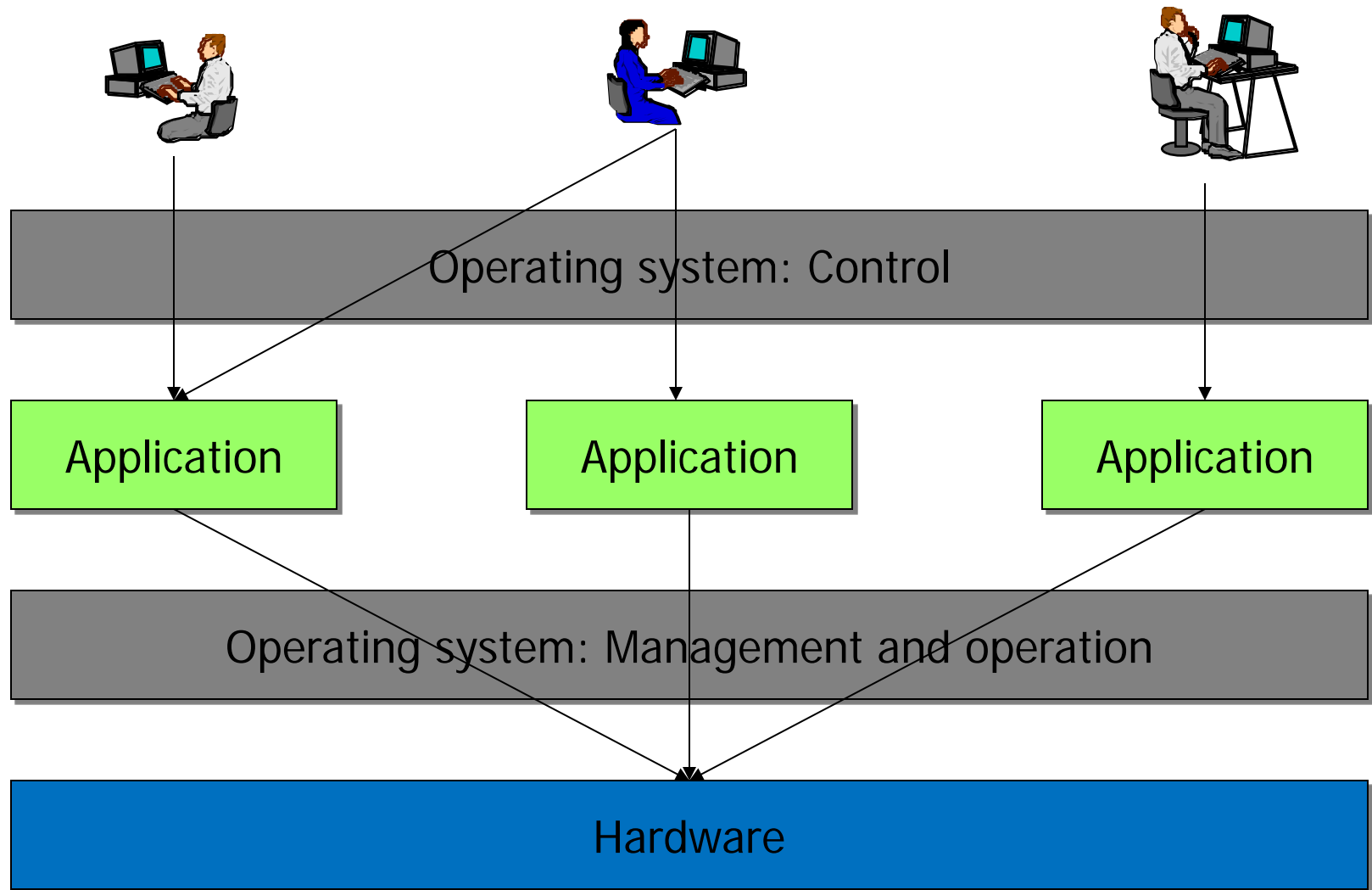
- Adaption of machine structure to user requirements
- Laying the foundation for a controlled concurrency of activities
- Management of data and programs
- Efficient usage of resources
- Support in case of faults and failures


- Quotation:

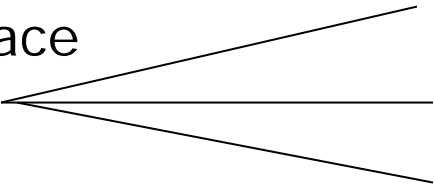
„The job of a system architect is similar to the one of a witty octopus juggling daily new balls of different size on the back of a jumping dolphin at the shore of Waikiki.“



Operating systems for general purpose computers



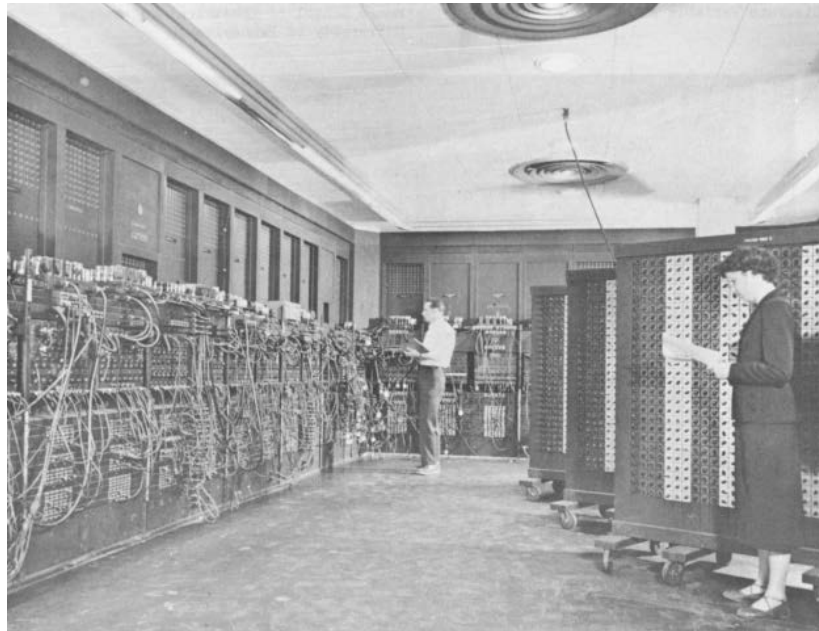
- Complex systems (in all areas) are composed of single components of different types.
 - Successful design of a complex system requires the knowledge of different variants of the components and their interplay.
 - Example: Buildings (20 000 years of experience)
 - Walls
 - Columns
 - Ceilings
 - Roofs
 - Stairs
 - Doors
 - Windows
- 

- Example Electrical Engineering (ca. 100 years of experience)
 - Resistor
 - Coil
 - Capacitor
 - Diode
 - Tube
 - Transistor
- **Example Operating systems (ca. 50 years of experience)**
 - Process
 - Signal
 - Address space
 - Channel
 - Interrupt
 - Driver
 - File
 - Capacity
 - Synchronization
 - Type of message transfer

1.2 Historical Sketch

The Fifties (Early stages)

- *One* program is being executed by *one* processor.
 - Batch operation
- The Operating system functionality is limited to
 - support of input/output,
 - transformation of number and character representation.



The Sixties (Virtualization)

- The ratio between CPU- and I/O-speed becomes large.
- OS support the interleaving execution of several independent programs (Multiprogramming).
- Real parallelism due to the advent of I/O-processors.
- The notion of a *process* as a *virtual processor* is born.
- Also the memory is „virtualized“ (*virtual memory*).
- The process also becomes an internal mean of structurization for OS.
- Interactive operation by more than one user (Timesharing).
- Prototypes or predecessors of today's mainframe OS are developed (OS/360, CTSS/Multics, CP67, VMOS/BS2000).



- The beginning of the software crisis: OS become large, complex and error prone.
- Unix is built according to the principle „simple is beautiful“ based on simple hardware (PDP-11).
- The quest for structured system design, maintainability, reliability, protection and security comes up.
- Employment of high level programming languages to implement OS.
- Process becomes a protection domain (context) with a private protected address space and access control (rights, capabilities).
- Quest for support of modular programming abstract data types and object orientation.
- Application of these principles to the operating system itself.



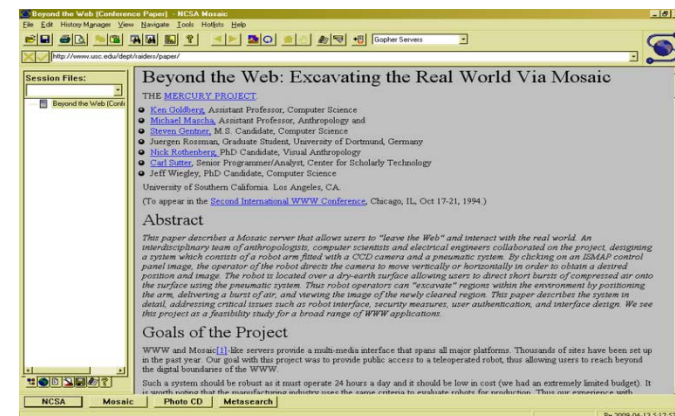
- Workstation computers and personal computers come up.
- Increased communication bandwidth: Ethernet, connected systems.
- For efficient implementation of communication software processes are needed.
- Processes are meanwhile complex entities: A process switch costs several thousand machine instructions. Therefore, address space and process are separated allowing for several processes sharing an address space (*lightweight process, thread*).
- Concepts for parallelism are integrated into program languages.
- Distributed (parallel) computing on networks of workstation computers.
- Workstations provide an ideal means for dissemination of UNIX and UNIX becomes sort of a "standard".
- Necessity for integration generates pressure for standardization (OSI, TCP/IP, NFS, POSIX, OSF, X/OPEN, OMG, ODP).
- OS overcome node boundaries: From communicating computers to distributed systems.



The Nineties

(Highly Parallel Systems, PCs,
Embedded Systems, Internet & Web)

- Due to high production numbers, microprocessors become cheap.
- Connecting thousands of microprocessors achieves (theoretically) higher performance at a lower price compared to super-computer (e.g. Cray).
- New OS-Functionality needed to support parallel processing.
- PCs and GUIs for OSs become mainstream (Windows 3, Linux).
- Multimedia-applications require support for audio- and video data (real-time capabilities).
- Software in *embedded systems* needs OS-support (e.g. Consumer Electronics).
- Birth and rise of the Web leading to distributed systems in heterogeneous environments (e.g. Corba, Web services)



The 2000s and Today

(Ubiquitous Computing,
Pervasive Computing,
Cloud Computing)

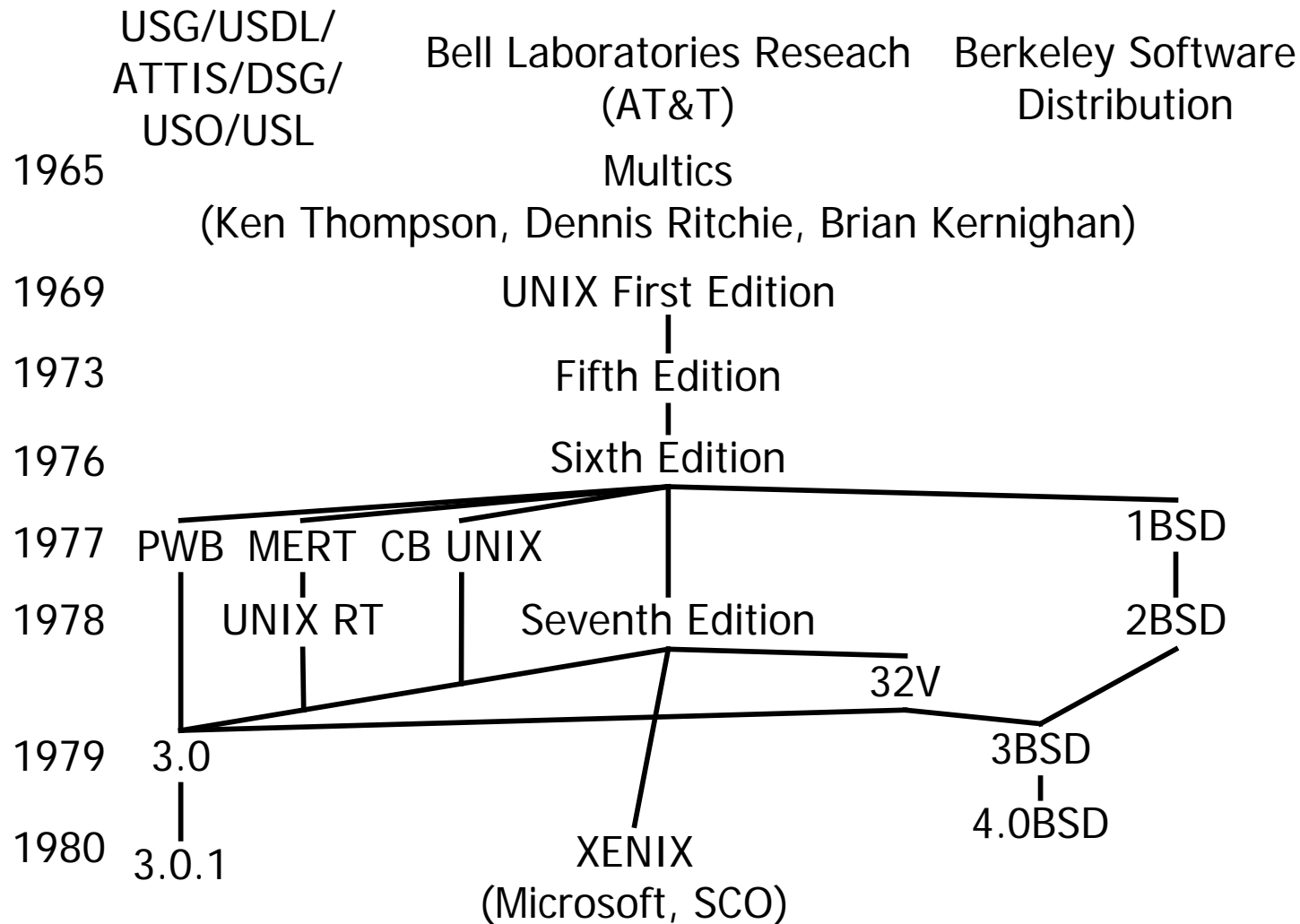
- Computing technology moves into the everyday while becoming increasingly small and invisible.
- OS support for ubiquitous and pervasive computing and intelligent devices (cf. Internet of things)
- OS platforms for mobile phones with multi-touch user interfaces (e.g. iOS and Android OS)
- Thin clients running web-applications within a browser (e.g. Chrome OS)
- Emulation of other OS-interfaces (i.e. several “OS worlds” on the same computer).
- Converged infrastructures, shared services and the renaissance of virtualization are enabling factors for Cloud computing.



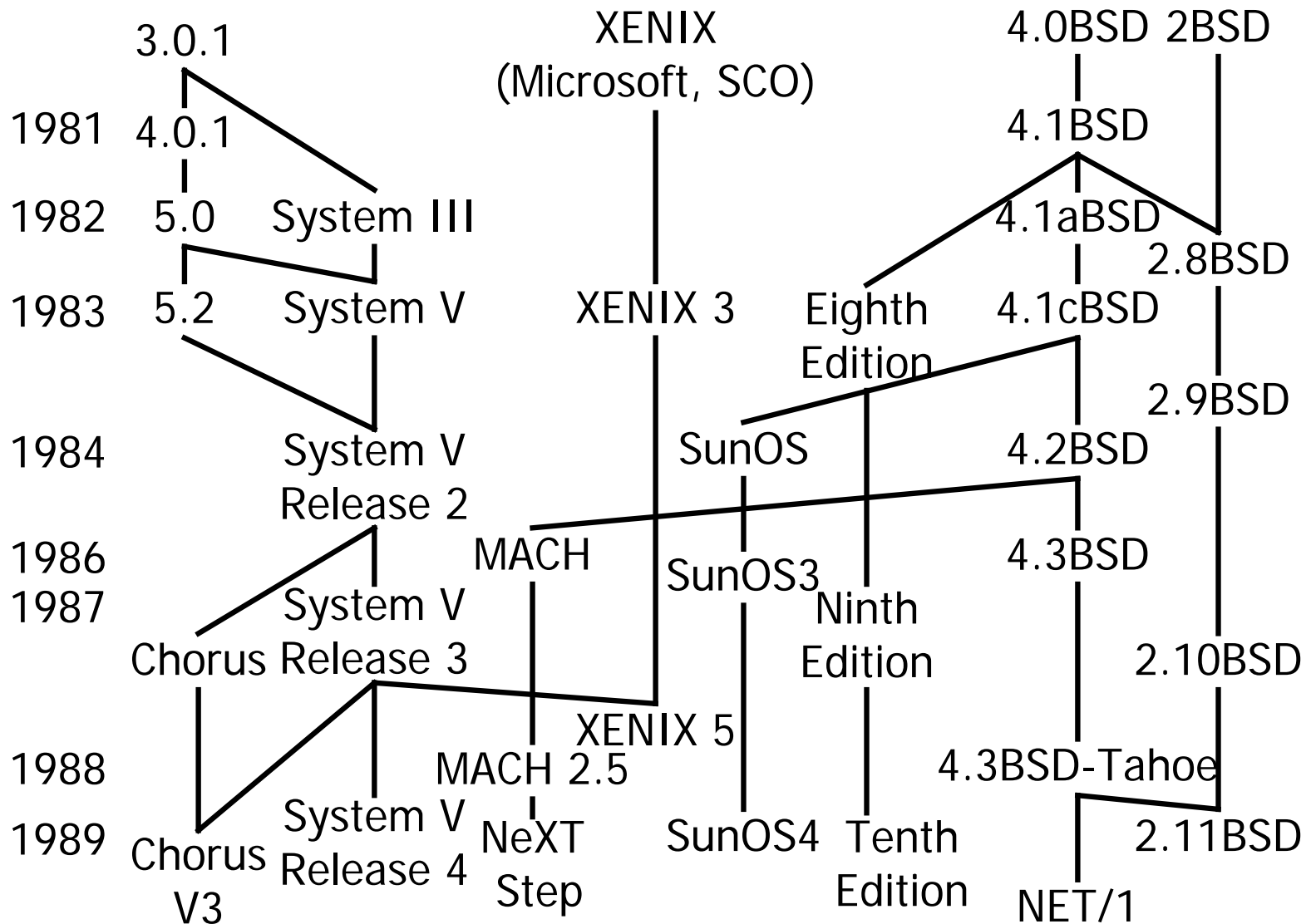
- Safety and security
- Robustness and dependability
- Virtualization
- Optimization for multi- and many-core processors (scheduling, locking)
- Energy consumption (mobile devices, data centers)
- User interface
- Database support for file systems
- Cluster-, Grid-, and Cloud-Computing
- Small OS (e.g. for sensor networks)

- Hansen, P.B.: Classic Operating Systems
Springer, New York, 2001
- The Virtual Museum of Computing
<http://vlmp.museophile.com/computing.html>
- ACM Special Interest Group on Operating systems:
<http://www.sigops.org>

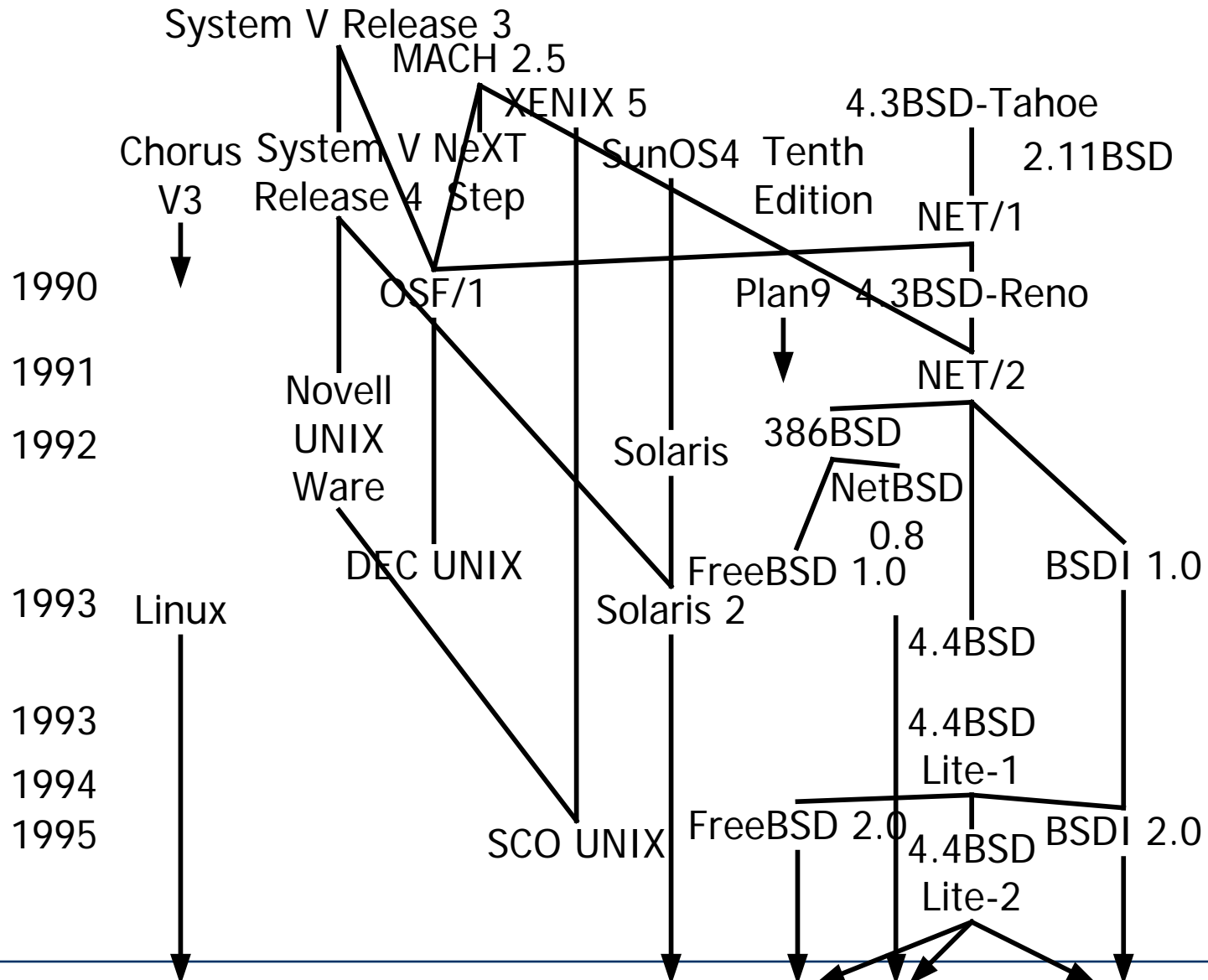
Example: UNIX



Example: UNIX



Example: UNIX



- **Halt and Catch Fire**

- https://de.wikipedia.org/wiki/Halt_and_Catch_Fire

