

## Käynnistyminen, multimediajärjestelmät

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## Sisältöä

- Käynnistyminen
  - Miten käyttöjärjestelmä ladataan?
  - Miten tietokone pääsee käyntiin sähkön kytkemisen jälkeen
  - (Miten tämä tapahtuu virtuaalikoneessa?)
- Multimediajärjestelmät
  - Miten videodataa esimerkiksi käsitellään?

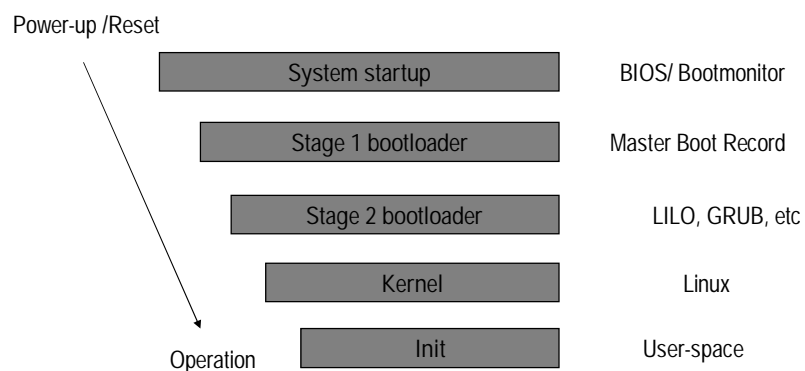
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## Booting

- Key problem: How do you initiate a system using only itself?
- Booting <- Bootstrapping
- Bootstrapping - why this term?
  - Baron Munchausen pulled himself out of swamp using his boot straps

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## View of the Linux boot process



Source: <http://www-128.ibm.com/developerworks/library/l-linuxboot/index.html>

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## BIOS tasks

- BIOS – Basic Input / Output System
  - BIOS refers to the firmware code run by a personal computer when first powered on.
  - BIOS can also be said to be a coded program embedded on a chip that recognizes and controls various devices that make up x86 personal computers. (source: wikipedia)
- Execution starts from a fixed location (on x386 that location is 0xFFFF0000)
- Check hardware, locate the boot device
  - Disk, CD, ...
- Load the first 'loader' from Master Boot Record

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## BIOS example sequence

1. Check the CMOS Setup for custom settings
2. Load the interrupt handlers and device drivers
3. Initialize registers and power management
4. Perform the power-on self-test (POST)
5. Display system settings
6. Determine which devices are bootable
7. Initiate the bootstrap sequence

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## BIOS loading the boot loader – pseudocode example

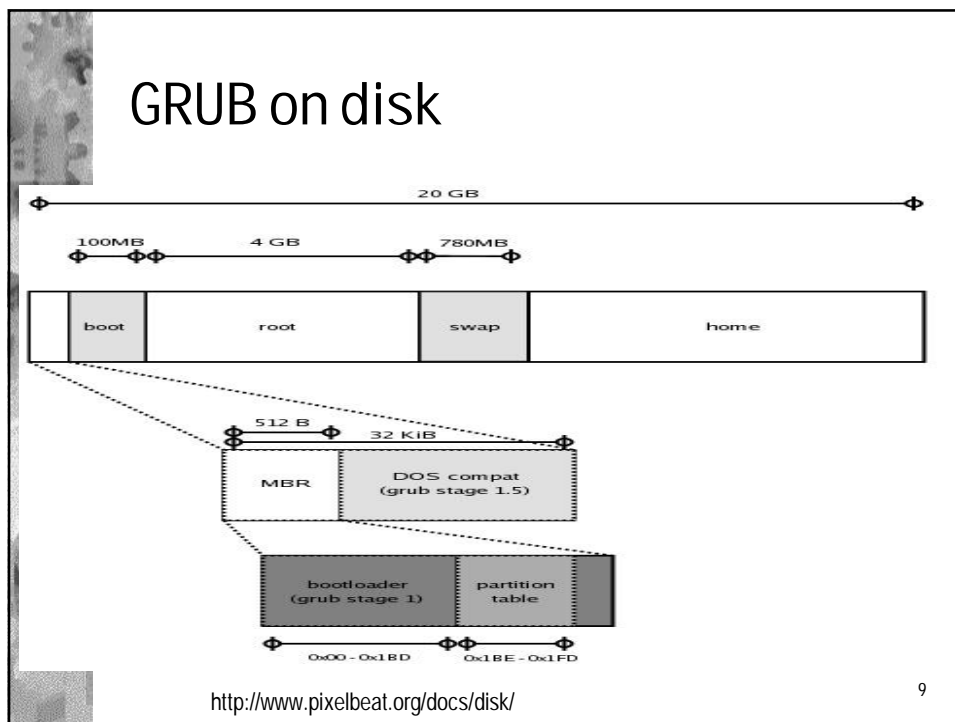
- 0: set the P register to 8
- 1: check paper tape reader ready
- 2: if not ready, jump to 1
- 3: read a byte from paper tape reader to accumulator
- 4: if end of tape, jump to 8
- 5: store accumulator to address in P register
- 6: increment the P register
- 7: jump to 1

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## Boot loader

- Linux: Lilo, GRUB
- Windows NT: NTLDR
- Initial location on primary disk, for example: Master Boot Record
  
- Main task: Load and start operating system
- Dual boot: offer menu and start the chosen one

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## GRUB - GRand Unified Bootloader

- GRUB is independent of any particular operating system and may be thought of as a tiny, function-specific OS.
- It's primary task is to load the actual operating system and pass control to it.
- GRUB is large service:
  - It does not fit to MBR: needs to be handled in two phases
  - Phase 1 (loaded from MBR by BIOS) load phases 1.5 and 2
- A lot of features: file systems, command line interface, chain-loading other boot loaders, ...

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## Loading Linux

- Bootsector loads setup, decompression routines and compressed kernel image.
- The kernel is uncompressed in protected mode.
- Low-level initialisation is performed by asm code `arch/i386/kernel/head.S`:
  - Initialise segment values and page tables.
  - Enable paging by setting PG bit in `%cr0`.
  - Copy the first 2k of bootup parameters (kernel commandline).
  - The first CPU calls `start_kernel()`, all others call `initialize_secondary()`.
- High-level C initialisation

Source: [http://www.faqs.org/docs/kernel\\_2\\_4/lki-1.html](http://www.faqs.org/docs/kernel_2_4/lki-1.html)

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## OS Initialising: `start_kernel()`

- Arch-specific setup (memory layout analysis, copying boot command line again, etc.).
- Initialise traps, irqs, data required for scheduler, time keeping data, softirq subsystem.
- Initialise console.
- Enable interrupts.
- Set a flag to indicate that a schedule should be invoked at "next opportunity"
- Create a kernel thread `init()`
- Go into the idle loop, this is an idle thread with `pid=0`.

Important thing to note here that the `init()` kernel thread calls `do_basic_setup()` which in turn calls `do_initcalls()`

More detailed version available from: [http://www.faqs.org/docs/kernel\\_2\\_4/lki-1.html](http://www.faqs.org/docs/kernel_2_4/lki-1.html)

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## Process Init

- Init is the father of all processes. Its primary role is to create processes from a script stored in the file `/etc/inittab` (man init)
- Establishes and operates the entirety of user space.
  - checking and mounting file systems,
  - starting up necessary user services, and
  - switching to a user-based environment when system startup is completed
  - Uses `etc/rc` directory hierarchy

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## etc/rc.d

- debian: run `/etc/init.d/rcS` which runs:
  - `/etc/rcS.d/S*` scripts
  - `/etc/rc.boot/*` (deprecated)
  - run programs specified in `/etc/inittab`
- Scripts in `/etc/rc*.d/*` are symlinks to `/etc/init.d`
- Scripts prefixed with S will be started when the runlevel is entered, eg `/etc/rc5.d/S99xdm`
- Scripts prefixed with K will be killed when the runlevel is entered, eg `/etc/rc6.d/K20apache`
- Executed in numerical order

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Runlevel	Scripts Directory (Red Hat/Fedora Core)	State
0	/etc/rc.d/rc0.d/	Shutdown/halt system
1	/etc/rc.d/rc1.d/	Single user mode
2	/etc/rc.d/rc2.d/	Multiuser with no network services exported
3	/etc/rc.d/rc3.d/	Default text/console only start. Full multiuser
4	/etc/rc.d/rc4.d/	Reserved for local use. Also X-windows (Slackware/BSD)
5	/etc/rc.d/rc5.d/	XDM X-windows GUI mode (Redhat/System V)
6	/etc/rc.d/rc6.d/	Reboot
s or S		Single user/Maintenance mode (Slackware)
M		Multiuser mode (Slackware)

<http://www.yolinux.com/TUTORIALS/LinuxTutorialInitProcess.html>

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## Windows NT

- Power-on self test (POST) phase
- Initial startup phase
- Boot loader phase: NTLDR
  - Startup phase: create interrupt descriptor table, page tables and enable paging
- Detect and configure hardware phase
  - osloader.exe: knows file systems,
    - read boot.ini, check if hibernated,
    - Load Ntoskrnl.ece, hal.dll (hardware abstraction)
    - Load boot drivers (hard drive, file system, etc)
- Kernel loading phase
  - Interrupt controller, memory manager, object manager, process manager, System idle process
  - Load and initialize system drivers
- Logon phase
  - Start Session manager subsystem

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# Multimediajärjestelmät

Silbershatz, Galvin & Gagne:  
Operating system concepts with Java,

Luku 20

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## Objectives

- To identify the characteristics of multimedia data
- To examine several algorithms used to compress multimedia data
- To explore the operating system requirements of multimedia data, including CPU and disk scheduling and network management

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## What is Multimedia?

- Multimedia data includes
  - audio and video clips (i.e. MP3 and MPEG files)
  - live webcasts
- Multimedia data may be delivered to
  - desktop PC's
  - handheld devices (PDAs, smart phones)

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## Media Delivery

- Multimedia data is stored in the file system like other ordinary data.
- However, multimedia data must be accessed with specific timing requirements.
- For example, video must be displayed at 24-30 frames per second. Multimedia video data must be delivered at a rate which guarantees 24-30 frames/second.
- Continuous-media data is data with specific rate requirements.

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## Streaming

- Streaming is delivering a multimedia file from a server to a client - typically the deliver occurs over a network connection.
- There are two different types of streaming:
  1. Progressive download - the client begins playback of the multimedia file as it is delivered. The file is ultimately stored on the client computer.
  2. Real-time streaming - the multimedia file is delivered to - but not stored on - the client's computer.

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## Real-time Streaming

- There are two types of real-time streaming:
  - (1) Live streaming - used to deliver a live event while it is occurring.
  - (2) On-demand streaming - used to deliver media streams such as movies, archived lectures, etc. The events are not delivered in real-time.

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## Multimedia Systems Characteristics

- Multimedia files can be quite large.
- Continuous media data may require very high data rates.
- Multimedia applications may be sensitive to timing delays during playback of the media.

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## Compression

- Because of the size and rate requirements of multimedia systems, multimedia files are often compressed into a smaller form.
- MPEG Compression:
  - (1) MPEG-1 - 352 X 240 @ 30 frames/second
  - (2) MPEG-2 - Used for compressing DVD and high-definition television (HDTV)
  - (3) MPEG-4 - Used to transmit audio, video, and graphics. Can be delivered over very slow connections (56 Kbps)

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## Operating Systems Issues

- The operating system must guarantee the specific data rate and timing requirements.
- Such requirements are generally known as Quality-of-Service (QoS) guarantees.
- Guaranteeing QoS has effects in a computer system:
  - (1) CPU processing
  - (2) Scheduling
  - (3) File systems
  - (4) Network protocols

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## Requirement of Multimedia Operating Systems

- There are three levels of QoS
  - (1) Best-effort service - the system makes a best effort with no QoS guarantees.
  - (2) Soft QoS - allows different traffic streams to be prioritized, however no QoS guarantees are made.
  - (3) Hard QoS - the QoS requirements are guaranteed.

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## Parameters Defining QoS

- Throughput - the total amount of work completed during a specific time interval. (*läpimeno*)
- Delay - the elapsed time from when a request is first submitted to when the desired result is produced. (*viive*)
- Jitter - the delays that occur during playback of a stream. (*huojunta, viipeen vaihtelu*)
- Reliability - how errors are handled during transmission and processing of continuous media. (*luotettavuus*)

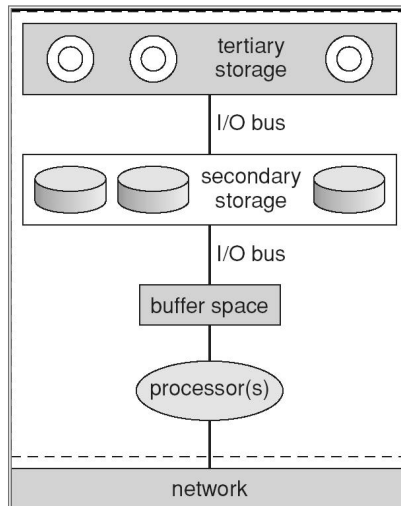
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## Further QoS Issues

- QoS may be negotiated between the client and server.
- Operating systems often use an admission control algorithm that admits a request for a service only if the server has sufficient resources to satisfy the request.

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Figure 20.1  
Resources on a file server



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## CPU Scheduling

- Multimedia systems require hard realtime scheduling to ensure critical tasks will be serviced within timing deadlines.
- Most hard realtime CPU scheduling algorithms assign realtime processes static priorities that do not change over time.

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## Disk Scheduling

- Disk scheduling algorithms must be optimized to meet the timing deadlines and rate requirements of continuous media.
- Earliest-Deadline-First (EDF) Scheduling
  - The EDF scheduler uses a queue to order requests according to the time it must be completed (its deadline.).
- SCAN-EDF Scheduling
  - SCAN-EDF scheduling is similar to EDF except that requests with the same deadline are ordered according to a SCAN policy.

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## Network Management

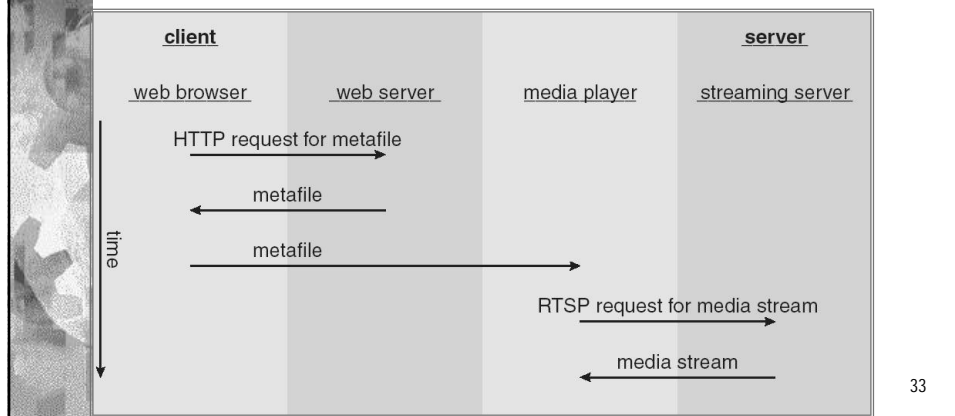
- Three general methods for delivering content from a server to a client across a network:
  - (1) Unicasting - the server delivers the content to a single client.
  - (2) Broadcasting - the server delivers the content to all clients, regardless whether they want the content or not.
  - (3) Multicasting - the server delivers the content to a group of receivers who indicate they wish to receive the content.

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## RealTime Streaming Protocol (RTSP)

- Standard HTTP is stateless whereby the server does not maintain the status of its connection with the client.

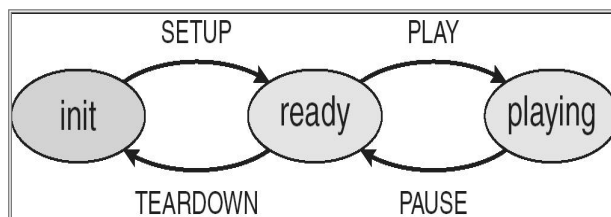
[SGG07] Fig 20.3



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## RTSP States

- SETUP - the server allocates resources for a client session.
- PLAY - the server delivers a stream to a client session.
- PAUSE - the server suspends delivery of a stream.
- TEARDOWN - the server breaks down the connection and releases the resources allocated for the session.



[SGG07] Fig 20.4

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## CineBlitz Multimedia Server

- CineBlitz supports both realtime and non-realtime clients.
- CineBlitz provides hard QoS guarantees to realtime clients using an admission control algorithm.
- The disk scheduler orders requests using C-SCAN order.

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## CineBlitz Admission Controller

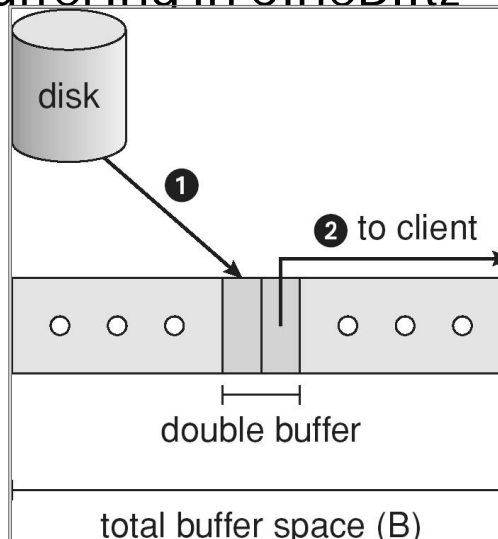
- Controller monitors resources: disk bandwidth, latency, available buffer space
- Total buffer space required for  $N$  clients where each client has rate requirement of  $r_i$

$$\sum_{i=1}^N 2 \times T \times r_i \leq B.$$

T duration of the period  
 $r_i$  rate

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Figure 20.05  
Double buffering in CineBlitz



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## CineBlitz Admission Controller (cont)

- Admission controller accepts new requests only, if the new one does not increase the estimated service cycle duration above a set upper limit ( $T$ ).
- If  $t_{seek}$  and  $t_{rot}$  are the worst-case seek and rotational delay times, the maximum latency for servicing  $N$  requests is

$$2 \times t_{seek} + \sum_{i=1}^N \left( \left\lceil \frac{T \times r_i}{b} \right\rceil + 1 \right) \times t_{rot}.$$

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## CineBlitz Admission Controller (cont)

- The CineBlitz admission controller only admits a new client if there is at least  $2 \times T \times r_i$  bits of free buffer space and the following equation is satisfied

$$2 \times t_{seek} + \sum_{i=1}^N \left( \left\lceil \frac{T \times r_i}{b} \right\rceil + 1 \right) \times t_{rot} + \sum_{i=1}^N \frac{T \times r_i}{r_{disk}} \leq T.$$

Total latency

Service time

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