

Seminar: Multimedia Coding and Transmission

Digital Versatile Disk

DVD

10110100

Ifi, UiO

Norsk Regnesentral

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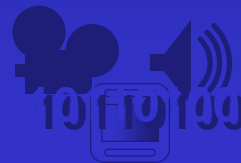
This part of the course ...

Digital Versatile Disk

- ... is prepared by

Wolfgang Leister

- ... uses material from Technicolor ...





## DVD

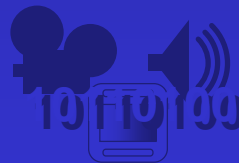
- A DVD looks like a CD
- A DVD is two "half-discs" bonded together
- A DVD contains data on one or both sides
- A DVD has a dual-layer feature
- A DVD disc has 1-4 data layers
- A DVD has 7-25x the capacity of a CD
- DVD read-rate is 8-9x faster than CD-ROM
- DVD players play CDs

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## DVD

- Closed specification (industrial consortium)
- ca. 5000\$, secrecy agreement



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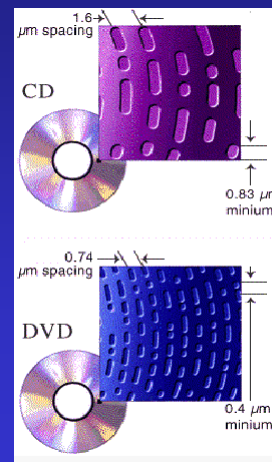
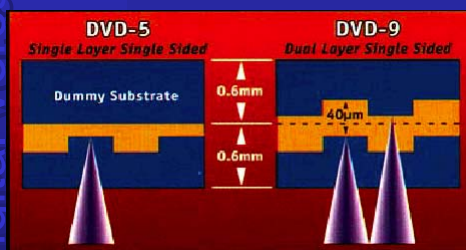
# DVD physical and logical

- area: 86 cm<sup>2</sup> ⇒ 87.6 cm<sup>2</sup>
- track width: 1.6 μm ⇒ 0.74 μm
- pit length: 0.833 μm ⇒ 0.4 μm
- packet length per 2048 bit:  
3390 bit ⇒ 2418 bit
- Eight-To-Fourteen ⇒ EFM+

$$\frac{87.6}{86} \cdot \frac{1.6}{0.74} \cdot \frac{0.833}{0.4} \cdot \frac{3390}{2418} \cdot \frac{17}{16} \approx 7$$


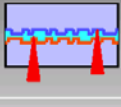

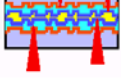


# DVD





## DVD

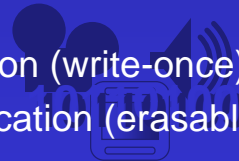
	DVD 5 Single Sided, Single Layer 4.7 GB, 133 minutes playback
	DVD 9 Single Sided, Double Layer 8.5 GB, 241 minutes playback
	DVD 10 Double Sided, Double Layer 9.4 GB, 266 minutes playback
	DVD 18 Double Sided, Double Layer 17 GB, 482 minutes playback



## DVD formats

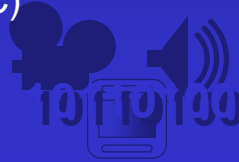
DVD formats:

- Pre Recorded Formats
  - Book A: DVD-ROM specification
  - Book B: DVD-Video specification
  - Book C: DVD-Audio specification
- Recordable formats
  - Book D: DVD-R specification (write-once)
  - Book E: DVD-RAM specification (erasable)



## Data Flow in DVD player

- Step 1: 26.16 MBit/s  $\Rightarrow$  13 MBit/s
  - Detection of synchronisation codes
  - EFM+ demodulation
  - de-scrambling
- Step 2: 11.8 MBit/s
  - Reed-Solomon Code (ECC)



## Data Flow in DVD player

- Step 3:
  - Decrypt (CSS)
- Step 4:
  - EDC (Error Detecting Code) check
- Step 5: 10.8 MBit/s (MUX Rate)
  - write to Track Buffer





## DVD

- Digital Video: 4 hrs MPEG-2/side
  - 1 video stream w/ 4 user selectable angles
  - 8 audio streams
  - 32 sub-picture streams
- Digital Audio: CD quality or 5.1 channel digital surround sound
- Interactivity and User Features: Control menus, chapters, feature buttons, ...

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## DVD

- 4:3 and 16:9 version discs
- Regional coding
- NTSC and PAL versions
- Multiple angles / alternative simultaneous storylining
- Parental lock feature
- Digital Copy Protection (CSS)
- Analog video copy protection

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## DVD

DVD Video discs **must** contain

- Either
  - PCM 48kHz stereo (very rare)
- Or
  - 2-channel Dolby Digital (NTSC)
  - 2 channel Dolby Digital or MPEG-2 audio (PAL)

DVD-Video discs **can also** contain

- 5.1 channel Dolby Digital surround sound
- 5.1 DTS surround sound
- 5.1 channel MPEG-2 surround sound

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## Dolby Digital

- also: Dolby AC-3
- 2-channel
- 5.1-channel (DD 5.1)
  - The 0.1 channel = low-bandwidth sub-woofer
- Introduced 1992, de-facto standard
- 5.1-channel surround uses ca. 25% of stereo CD
- 5.1 DTS = Digital Theater Surround (higher fidelity and bandwidth)

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## DVD Video display formats

Recorded Data	Display on 4:3 TV			Display on 16:9 TV
	Normal	Pan-Scan	Letter-Box	
4:3				
16:9				

## Content on DVD

- Directory structure:
  - AUDIO\_TS
  - VIDEO\_TS
- File types
  - .VOB ⇒ MPEG system stream
  - .IFO ⇒ formatting information of VOB files
  - .BUP ⇒ backup for .IFO





## DVD ROM

- 4.7-17 GB capacity
- UDF and ISO 9660 File System
- 9X data read rate of CD-ROM drive
- Drives fully backward compatible
- DVD-ROM uses a micro UDF / ISO 9660 bridge file system
- UDF is standard, ISO 9660 for compatibility

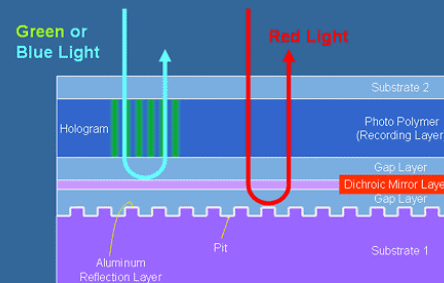
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## The Future?

- Blu-ray
  - 25 GB/layer – 50 GB for two layers
- HD DVD
  - 30 GB
- HVD (holographic)
  - 1 TB



### Disc Structure



## CSS

Content Scrambling System

- Prevent from copying DVD content
  - disk key data block, 409 \* player keys
  - stored in non-writable area on disk
  - 40 bit key length (due to export limitations, and weak HW in players)
  - CSS streamcipher primitive
  - CSS mangling step
  - method cryptographically weak



## Literature and Links

- DVD:  
<http://www.technicolor.com/services/DVD4Dummies2001v1.pdf>
- DVD and MPEG:  
<http://www.mpeg.org/MPEG/DVD/>



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## The End of Part

