This part of the course ...

- ... 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

DVD

- Closed specification (industrial consortium)
- ca. 5000$, secrecy agreement
DVD physical and logical

- area: $86 \text{ cm}^2 \Rightarrow 87.6 \text{ cm}^2$
- track width: $1.6 \mu\text{m} \Rightarrow 0.74 \mu\text{m}$
- pit length: $0.833 \mu\text{m} \Rightarrow 0.4 \mu\text{m}$
- packet length per 2048 bit:
  $3390 \text{ bit} \Rightarrow 2418 \text{ bit}$
- Eight-To-Fourteen $\Rightarrow$ EFM+

\[
\begin{array}{cccccc}
87.6 & 1.6 & 0.833 & 3390 & 17 \\
86 & 0.74 & 0.4 & 2418 & 16 \\
\end{array}
\approx 7
\]
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)

- 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, …

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
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

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)
DVD Video display formats

<table>
<thead>
<tr>
<th>Recorded Data</th>
<th>Display on 4:3 TV</th>
<th>Display on 16:9 TV</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Normal</td>
<td>Pan-Scan</td>
</tr>
<tr>
<td>4:3</td>
<td>![Image]</td>
<td>![Image]</td>
</tr>
<tr>
<td>16:9</td>
<td>![Image]</td>
<td>![Image]</td>
</tr>
</tbody>
</table>

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

**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:
- DVD and MPEG:
  http://www.mpeg.org/MPEG/DVD/

The End of Part