Why DVD+RW/+R Formats have been developed?

- DVD-ROM Compatibility
- Ease of USE
- Loss-less inking
- Consumer Video
- Computer Data
Technical Introduction to DVD+RW+/+R

- Features of DVD+RW+/+R Format
- Physical Format Overview
  - DVD+RW
  - DVD+R
- Logical Format Overview
  - DVD+RW
    - DVD+MRW
  - DVD+R
Features of DVD+RW/+R Formats

• Compatible with DVD-ROM
  – Loss-less linking
  – HF Wobble Groove

• Ease of use
  – Background Format for DVD+RW
  – Multi Session for DVD+R

• Convergence between PC and CE platforms
  – Same discs can be used for both PC drives and CE video recorders
DVD+RW/+R Physical Specifications

- **DVD+RW**
  - Rewritable media using phase change materials
- **DVD+R**
  - Write once media using dye materials
- **Write Speed**
  - 1.0X to 2.4X, CAV/CLV
    - Higher recording speed at CLV 2.4X recording
    - Quick access time for CAV random access recording
- **Data capacity and physical parameters**
  - Capacity: 4.7GB (Data Zone)
  - Reflectivity: 18-30% (DVD+RW)
    - 45-85% (DVD+R)
  - Basic physical parameters same as those for DVD-ROM
Compatibility with DVD-ROM
- Addressing and Linking Rule -

• Addressing
  – HF (1/32T) wobbled groove and ADIP (ADdress In Pre-groove)
  – Accurate within +/- 5ch bit (Loss-less linking) by PLL synchronizing

DVD-ROM

<table>
<thead>
<tr>
<th>32K ECC Block</th>
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<th>32K ECC Block</th>
</tr>
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</table>

DVD+RW4.7GB

<table>
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<tr>
<th>32K ECC Block</th>
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± 5 ch-bit from theoretical pos.
Logical Format Overview

- DVD+RW Logical Format
  - Formatting
    - Background Formatting
    - Sequential Recording
  - Defect Management
    - DVD+MRW
- DVD+R Logical Format
  - Multi Session
- File System
- Command Set
• Formatting for Random Access Recording
  – Background formatting
• Sequential Recording
Background Formatting

Format will proceed background by the drive.

- The Data Zone shall be filled with ECC blocks containing all (00) bytes or with User Data when requested.
- When the application requests disc access, the De-icing process is suspended and the control of the disc is returned to the application.
- Random access is always available even in background formatting.

De-icing*:

User recorded areas

Formatted areas

(Lead-Out)
If the user wishes to remove the medium prior to format completion:
- Temporary Lead-out can be recorded for read compatibility with DVD-ROM drives.
- Temporary Lead-out shall contain “00”.
- Temporary Lead-out will be De-iced or overwritten by user data when formatting is restarted.

**Diagram Description**

- **During background formatting**
  - Lead-In
  - Data
  - (Lead-Out)
  - User recorded areas
  - De-iced area

- **Early eject with temporary Lead-out**
  - Lead-In
  - Temporary Lead-out

- **Background formatting restarted**
  - Lead-In
  - Data
  - (Lead-Out)
**Sequential Recording**

- The recording mode, in which user data is recorded contiguously from the inner to the outer of the disc
  - Temporary Lead-out can be recorded for read compatibility with DVD-ROM drives
  - Temporary Lead-out shall contain “00”
  - Temporary Lead-out will be overwritten by user data when recording is restarted.

### Diagram

<table>
<thead>
<tr>
<th></th>
<th>Lead-In</th>
<th>Data</th>
<th>(Lead-Out)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>During sequential recording</strong></td>
<td><img src="image.png" alt="Diagram" /></td>
<td>User recorded area</td>
<td><img src="image.png" alt="Diagram" /></td>
</tr>
<tr>
<td><strong>Early eject with temporary Lead-out</strong></td>
<td><img src="image.png" alt="Diagram" /></td>
<td><img src="image.png" alt="Diagram" /></td>
<td><img src="image.png" alt="Diagram" /></td>
</tr>
<tr>
<td><strong>Recording restarted</strong></td>
<td><img src="image.png" alt="Diagram" /></td>
<td><img src="image.png" alt="Diagram" /></td>
<td><img src="image.png" alt="Diagram" /></td>
</tr>
</tbody>
</table>
Defect Management System

- Host Based Defect Management
  - UDF 1.50/2.00/2.01 provide for defect management
  - Follow the CD-RW manner
**DVD+MRW (Mt. Rainier)**

- **What is Mt. Rainier?**
  - The original Mt. Rainier specification was defined for CD-RW (CD-MRW)
    - Defect management in the drive
    - 2k addressing handled by the drive
    - Background formatting

- **DVD+RW adopted the similar defect management of CD-MRW**

- **Read-out by current DVD-ROM drives**
  - Re-mapper driver will be provided for reading the data in spare area.
### DVD+MRW Disc Layout (1)

- **MTA (Main Table Area):**
  - Reserved from the lead-in
  - Contains structures that identify the media format and structures for management of the defect replacement system.

- **STA (Secondary Table Area):**
  - A backup copy of the MTA
  - Provides a way for a host to access the MRW structures when connected to a read-only device that is not MRW capable

**Table:**

<table>
<thead>
<tr>
<th>Lead-In</th>
<th>Data</th>
<th>Lead-out</th>
</tr>
</thead>
<tbody>
<tr>
<td>MTA</td>
<td>GAA</td>
<td>SA1</td>
</tr>
<tr>
<td>(variable)</td>
<td>64</td>
<td>(256)</td>
</tr>
<tr>
<td></td>
<td>UDA</td>
<td>SA2</td>
</tr>
<tr>
<td></td>
<td>(64)</td>
<td>(3840/16128)</td>
</tr>
<tr>
<td></td>
<td>STA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(139218/126930)</td>
<td>(66)</td>
</tr>
<tr>
<td></td>
<td>DMA</td>
<td>(Number of ECC blocks)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
• **GAA (The General Application Area):**
  – Provides minimally 2 MB of user space and must align its logical address space exactly with the logical address space associated with the traditional media format

• **DMA (The Defect Managed Area):**
  – Contains both UDA (User Data Area) and SA (Spare Area 1/2)
  – The DMA is independently addressable, so it contains its own, well-defined LBA 0.

(Number of ECC blocks)
Compatibility of DVD+MRW

- **DVD+RW Drive**
- **DVD+RW Media**
- **MRW Enabled DVD-ROM Drive**

- Write
- Read
- Read with device driver
DVD+R Logical Overview

• Compatibility with DVD-ROM
  – Disc Layout
• Writing Mode
  – Disc at once
  – Incremental Recording
  – Multi-Session
• File System
• Command Set
**DVD+R Disc Layout**

**Lead-In**
- Lead-in Zone:
  - Guard zones, reserved zones
  - Inner Disc ID zone
  - Reference code zone, buffer zones and control data zone

**Data**
- Inner Drive Area:
  - Disc Test zone
  - Disc Count zone
  - Disc Administration Zone
  - Table of Contents zone

**Lead-Out**
- Outer Drive Area:
  - Disc Test zone
  - Disc Count zone
  - Disc Administration Zone

**Unrecorded Zone**
After finalizing by recording Lead-out, the disc seems like those discs that was recorded in disc at once recording mode.
**DVD+R Multi-Session**

**Disc Layout**

– 1st session compatible to existing DVD-ROM drives and Video Players
– Session overhead is ~ 4 MB per session
– Maximum number of session is 191

![Diagram of DVD+R Multi-Session Disc Layout](image)

- Intro
- Open Session
- Closure
- 1st Session
- 2nd Session
- 3rd Session
- Intro for 4th session
- Written on opening of the session
Multi-Session Session Information

TOC (Table of Contents)

- new session is allowed or not
- session start address: PSN of the first physical sector in the Data Zone of the session specified
- session end address: PSN of the last physical sector in the Data Zone of the session specified
- Recorded Area Indicator
  - 1024 physical sector is used for kind of Bitmap

Session DCBs (Disc Control Blocks)

- DCB’s are provided as a structure on the disc to include additional information for interchange
  - type 1: specifies the Fragments in the current Session
  - type 2: specifies the start and end addresses of all previous Sessions.
Read Compatibility by current DVD-ROM drive

- **Control data zone**
  - Byte 4 to 15 Data Zone allocation in Physical format information shall be set to 26053F to specify PSN 2,491,711 as the last possible Physical Sector

- **Intros/Closures**
  - Bits 27 to 26 of Sector Information shall be set to ZERO ZERO (same as Data zone)

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**Diagram**

- TOC
- 1st session
- 2nd session
- 3rd session

Accessible by current DVD-ROM drive

Area that may be accessible using multi-session device driver

Accessible by Multi-session enabled DVD-ROM drive

TOC may be readable by some drives
Multi-session file system and Read device driver

• File system for multi-session DVD+R
  – OSTA is discussing this issue.
    – DCN (Document Change Notice) will be issued
  – Based on multi-session CD-R.

• Device driver for reading multi-session
  – Current DVD-ROM drives will need drivers to access the sessions beyond the session boundaries.
  – Generic drivers may be provided by OS vendors or ISV’s.
UDF file system is recommended. Can be bridged to ISO9660.

- Recommendations to UDF implementations for DVD+RW/+R/MRW media are discussed in OSTA.
- For compatibility with DVD-ROM drives and Video players UDF1.02 shall be used.
Command Set

- DVD+RW command set was integrated into MMC3
- DVD+R command set draft will be proposed to MMC4
  - MMC drafts are available at www.t10.org
- New Feature/Profile for DVD+RW/+R/+MRW

- The following commands are modified for DVD+RW
  - FORMAT UNIT
  - CLOSE TRACK/SESSION
  - GET EVENT STATUS NOTIFICATION
  - READ (10) / READ (12)
  - READ CAPACITY
  - READ DISC INFORMATION
  - READ FORMATTED CAPACITIES
  - READ TOC/PMA/ATIP
  - START/STOP UNIT
  - WRITE (10) / WRITE (12)
  - WRITE AND VERIFY (10)
  - Read/Write Error Recovery Page

- The following commands will be modified for DVD+R
  - CLOSE TRACK/SESSION
  - READ (10)
  - READ (12)
  - READ CAPACITY
  - READ DISC INFORMATION
  - READ TOC/PMA/ATIP
  - Read/Write Error Recovery Page
  - RESERVE TRACK
  - WRITE PARAMETERS MODE PAGE
Conclusions

• DVD+RW/+R formats provide for;
  – DVD-ROM Compatibility
    • Loss-less linking
  – Ease of use
    • High speed recording (2.4X)
    • Background formatting (DVD+RW)
    • Multi session recording (DVD+R)
  – More reliable
    • Drive based defect management by introducing Mt. Rainier

• And higher recording speed...