Agenda Today

- SD Association Overview
- SD Standard Specification Overview
  - Specification Evolution History
  - Direction for High Speed Interface
  - Card Types
  - SD Specification Structure
  - Interface Speed
  - Bus Speed Mode
  - Speed Class
- UHS-II Card
- iSDIO TransferJet SD Card with TransferJet Technology
- smart microSD
  - Consumer Centric Model with Global Platform
- Q & A
SD Association Overview
SDA and Market Trend

About the SD Association

Founded in January 2000 by Panasonic, SanDisk and Toshiba, the SD Association is a group dedicated to establishing SD standards and facilitating their adoption and development. At its outset the Association represented just 14 member companies and has grown into a global alliance comprised of over 1,000 member companies. By developing and adopting SD standards, members enjoy better compatibility of member cards between devices, greatly enhancing consumer enjoyment and convenience.

Projected Flash Memory Card Market Share

The flash memory card market is expected to continue growing through 2014 with SD memory cards leading the market.

Source: iSuppli, 2011 Global Card Share Data

SD Logos are trademark of SD, 3C-LLC.
SDA Board of Directors
SD Association: SDA (www.sdcard.org)

- Open Standard/SD Card Standardization
- Promotion and Adaption of SD Standard Worldwide

- Organization Established in 2000
- Member Company: Around 1,000 Companies Worldwide (as of August 2014)
- #1 Market Share in small size memory card in the world
- Member Fee: Executive Member $4,500/yr, General Member $2,000/yr
### Comparison between Executive and General Benefits

<table>
<thead>
<tr>
<th>Member Benefits</th>
<th>Executive</th>
<th>General</th>
</tr>
</thead>
<tbody>
<tr>
<td>May be elected to the Board of Directors</td>
<td>✓</td>
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<tr>
<td>Participate and vote in Committees</td>
<td>✓</td>
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<tr>
<td>Propose and lead Work Groups</td>
<td>✓</td>
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<td>Vote in Chair Work Groups</td>
<td>✓</td>
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<tr>
<td>Participate in all email reflectors</td>
<td>✓</td>
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<tr>
<td>Obtain pre-release access to documents &amp; deliverables</td>
<td>✓</td>
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<tr>
<td>Ability to execute HALA License</td>
<td>✓</td>
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<tr>
<td>Access to the complete SD specification matrix</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Participate and contribute to Work Group work items</td>
<td>✓</td>
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<tr>
<td>Attend Annual Meetings, workshops, events</td>
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<td>Participate in selected email reflectors</td>
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<td>Access to the “Members Only” website</td>
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<td>Participate in Self-Certifications</td>
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<tr>
<td>Participate in marketing events and press releases</td>
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<tr>
<td>Annual Dues</td>
<td>$4500</td>
<td>$2000</td>
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SD Standard Specification Overview
**SD Standard Evolution History**

### SD Specification Evolution

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<td><strong>Basic Specifications</strong></td>
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<td>SD</td>
<td>(minISD, microSD)</td>
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<td>SDHC</td>
<td>(minISD, microSD)</td>
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<td>SDXC</td>
<td>(microSD)</td>
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<td><strong>Embedded SD (eSD)</strong></td>
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<td>DS</td>
<td>(Default Speed)</td>
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<td>Speed Class 2, 4, 6</td>
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<td>SDIO</td>
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</tbody>
</table>

SD Logos are trademark of SD, 3C-LLC
**SD Standard Direction for High Speed Interface**

- **Capacity (and file system)**
  - 2TB (max.; exFAT)
  - 32GB (max.; FAT32)
  - 2GB (max.; FAT12/16)

- **SD Bus Speed**
  - Normal speed (NS): 12.5MB/sec
  - High speed (HS): 25MB/sec
  - UHS-I: 104MB/sec, 50MB/sec
  - UHS-II: 312MB/sec, 156MB/sec

SD Logos are trademark of SD, 3C-LLC
**SD Card Types**

- **Form Factors**
  - Standard Size SD Card
  - microSD Card

- **Functions**
  - SD Memory Card
  - SDIO Card
  - SD Combo Card (SD Memory + SDIO Functions)
    - iSDIO Wireless LAN SD Card
    - iSDIO TransferJet SD Card
  - smart microSD (microSD with Secure Element or with or without NFC interface)

- **Memory Capacities**
  - SDSC: Standard Capacity (≤ 2GB)
  - SDHC: High Capacity (2GB< - ≤32GB)
  - SDXC: eXtended Capacity (32GB< - ≤2TB)

- **Bus Interfaces**
  - Non UHS (Non Ultra High Speed) Card
  - UHS-I Card
    - UHS50: SDR50 is mandatory (50MB/sec Max.)
    - UHS104: SDR50 and SDR104 is mandatory (104MB/sec Max.)
  - UHS-II Card
    - UHS156 FD156 is mandatory (Full Duplex 156MB/sec Max.)
    - HD312 is optional (Half Duplex 312MB/sec Max.)

SD Logos are trademark of SD,3C-LLC
Comparison of Interface Speed

- **Bus mode**
  - **Default Speed**
    - DS
  - **High Speed**
    - HS
  - **UHS50**
    - UHS-I SDR50/DDR50
  - **UHS104**
    - UHS-I SDR104 (Optional)
  - **UHS156 (Gen.1)**
    - UHS-II FD156
    - UHS-II HD312 (Optional)
  - **UHS312 (Gen.2 TBD)**
    - UHS-II (Gen2) FD312
    - UHS-II (Gen2) HD624 (Optional)

- **Gen1**: Generation 1 Card Type
- **Gen2**: Generation 2
- **FD**: Full Duplex
- **HD**: Half Duplex

**Throughput (MB/s)**: 0, 12, 25, 39, 50, 78, 104, 156, 312, 624
### Bus Speed Modes

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Default Speed (DS)</td>
<td>25MHz</td>
<td>3.3V</td>
<td>12.5MB/sec</td>
<td>1.01</td>
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<tr>
<td>High Speed (HS)</td>
<td>50MHz</td>
<td>3.3V</td>
<td>25MB/sec</td>
<td>1.10</td>
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<td><strong>UHS-I</strong></td>
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<tr>
<td>SDR12</td>
<td>25MHz</td>
<td>1.8V</td>
<td>12.5MB/sec</td>
<td>3.01</td>
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<tr>
<td>SDR25</td>
<td>50MHz</td>
<td>1.8V</td>
<td>25MB/sec</td>
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<tr>
<td>SDR50</td>
<td>100MHz</td>
<td>1.8V</td>
<td>50MB/sec</td>
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<tr>
<td>SDR104</td>
<td>208MHz</td>
<td>1.8V</td>
<td>104MB/sec</td>
<td></td>
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<tr>
<td>DDR50</td>
<td>50MHz</td>
<td>1.8V</td>
<td>50MB/sec</td>
<td></td>
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<tr>
<td><strong>UHS-II</strong></td>
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<tr>
<td>FD156</td>
<td>52MHz x30</td>
<td>LVDS</td>
<td>156MB/sec</td>
<td>4.00</td>
</tr>
<tr>
<td>HD312</td>
<td>52MHz x30</td>
<td>LVDS</td>
<td>312MB/sec</td>
<td>4.20</td>
</tr>
</tbody>
</table>

SDR : Single Data Rate (Use rising clock edge)
DDR: Double Data Rate (Use rising and falling clock edge)
UHS: Ultra High Speed
LVDS: Low Voltage Differential Signaling
**SD Speed Class & Video Speed Class**

<table>
<thead>
<tr>
<th>SD Bus Mode</th>
<th>Ver. 4.0 Card</th>
<th>Ver. 5.0 Card</th>
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</thead>
<tbody>
<tr>
<td>Default Speed Mode</td>
<td>SDSC</td>
<td>SDHC/SDXC</td>
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<tr>
<td></td>
<td>Class 2, 4, 6 (C2, C4, C6)</td>
<td>Class 10 (C10)</td>
</tr>
<tr>
<td>High Speed Mode</td>
<td>SDHC</td>
<td>V6, V10</td>
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<td></td>
<td>Class 10 (C10)</td>
<td>V6</td>
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<tr>
<td></td>
<td>SDXC</td>
<td>V10</td>
</tr>
<tr>
<td></td>
<td>UHS Speed Class 1 (U1)</td>
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<tr>
<td></td>
<td>UHS Speed Class 3 (U3)</td>
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<tr>
<td>UHS-I and UHS-II Mode</td>
<td></td>
<td></td>
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<tr>
<td>UHS-II Mode</td>
<td></td>
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</tr>
</tbody>
</table>
UHS-II SD Card
Market Evolution Driving UHS-II

High Capacity / High Speed Drivers

- 4K DSLR/Video
- 4K Video Recording (4K videos)
- Light Field Lenses
- Computational Photography

High speed Download/Upload

- 4K Smart Phone ~1000MB/s
- 4K Tablet ~700MB/s
- 4K Recorder ~100MB/s (Pick)

Matching Internal Data I/O

- ~2000MB/s
- ~400MB/s

Caching streamed content
- Eliminates bandwidth latency
- When no internet access available

Market Evolution Driving UHS-II

Caching streamed content
- Eliminates bandwidth latency
- When no internet access available
## Challenge in UHS-II Electrical

<table>
<thead>
<tr>
<th></th>
<th>UHS-I</th>
<th>UHS-II</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Rate</td>
<td>104MB/s</td>
<td>312MB/s</td>
<td>Achieved 3 times faster</td>
</tr>
<tr>
<td>Synchronous Clock</td>
<td>Yes, direct data sample</td>
<td>No, PLL/CDR based data sampling</td>
<td>Huge technology gap to serial interface from parallel.</td>
</tr>
<tr>
<td>Termination</td>
<td>No</td>
<td>Yes</td>
<td>Impedance control is the key for good data transfer quality. This is new concept that UHS-I doesn’t have.</td>
</tr>
<tr>
<td>Impedance Control</td>
<td>No</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Signal Amplitude</td>
<td>1.8V</td>
<td>400mV differential</td>
<td>Small amplitude in UHS-II have more sensitivity against loss and noise from system.</td>
</tr>
<tr>
<td>Noise/Jitter specification</td>
<td>Simple Timing budget between clock and data</td>
<td>Complex Jitter specification for serial data transmission</td>
<td>Noise/Jitter spec for serial interface is not simple. Some knowledge about serial link will be required to understand it.</td>
</tr>
<tr>
<td>SD Card Connector</td>
<td>Electrically Sensitive but no electrical spec</td>
<td>Electrically sensitive and return loss is defined</td>
<td>Impedance mismatch in SD connector will affect whole UHS-II channel characteristics.</td>
</tr>
</tbody>
</table>
**Standard Size SD Card Interface**

**SD/UHS-I Mode Interface**
- **CLK**: Clock Pin (5)
- **CMD**: Command/Response Pin (2)
- **DAT0 - DAT3**: 4-bit Data Pins (7, 8, 9, 1)
- **VDD**: 3.3V Power Pin (4)
- **VSS1, VSS2**: Ground Pins (3, 6)

**UHS-II Interface**
- **D0+, D0-**: Lane 0 Differential Data Pins (11, 12)
- **D1+, D1-**: Lane 1 Differential Data Pins (15, 16)
- **RCLK+, RCLK-**: Reference Clock Pins (7, 8)
- **VDD2**: 1.8V Power Pin (14)
- **VSS3, VSS4, VSS5**: Ground Pins (10, 13, 17)
There are 4 types of Pads Appearance:

- **Basic Pin Assignment**
- **Antenna Pads**
- **NFC Interface**
- **NFC + UHS-II Interface**
iSDIO TransferJet SD Card
SD Card with Wireless Technologies

Part E7 TransferJet Addendum
- Device-to-Device File Transfer
- Contents D/L KIOSK
- Photo Print KIOSK

Part E7 Wireless LAN Addendum
- Sharing Internet Connection in Public Area
- Office Network
- Home Network

Part 1 NFC Interface Addendum
- Mobile Payment
- Railroad Ticket

Part A1/A3 Advanced Security

New

Part E2/E3 Bluetooth Type A/B
- Music Streaming
- Hands-Free Headset
TransferJet Technology

Wireless Technology Comparison

- Device-to-Device file transfer
- Content download KIOSK
- Photo print KIOSK
- Mobile payment
- Tollgate payment
- Internet connection in public area
- Office network
- Home network
- Music streaming
- Hands-free headset

TransferJet Format Roadmap

- Instantly getting content at tollgate while NFC payment
- 4K video file transfer
- HD video file transfer
- High-performance industrial applications
- Photo, music and video file transfer
**iSDIO TransferJet**

iSDIO TransferJet Addendum:

What is TransferJet:
- High speed proximate interface
- 560Mbps, more than 1000 times faster NFC
- 10Gbps range in near future
- Transfer rich content (e.g. video data)
smart microSD
Various smart microSD Types

smart microSD without NFC
smart microSD features an SE that is accessible through ASSD for host applications

smart microSD with optional SWP
smart microSD features an SE that is accessible through ASSD for host applications and may connect to the host NFC frontend via SWP

Contactless smart microSD
Contactless smart microSD is a self-contained solution for SE and contactless smart card emulation for most microSD host devices. SDA doesn’t define the contactless interface
smart microSD with HCE

- Android 4.4 (Kit Kat) provides HCE (Host-based Card Emulation) for NFC applications
- smart microSD has chance to get NFC function using this new route of HCE (red break line)
- Higher security level on HCE by using SE in microSD
smart microSD as security token for HCE

Optimize Your HCE Solution Using smartSD

MINIMAL HCE
- App short term security
- Challenging User experience
- Costly App maintenance

BUSINESS OPTIMIZED HCE
- HW Root of trust
- Authentication
- User identification
- Certification
- Non-repudiation
- Privacy
- Confidentiality
- Secure storage
- No TSM required
- ... and more

- Consumer centric option
- Multiple App, 1+ cardlet
- MNO independent
- Device independent
- Mailing, retail and kiosk
- Subsidized or sold
- Extra storage
- ... and more

Digital security and secure element

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smart microSD Use Cases

- User Interface
- Mobile Payment
- Connectivity
- Online payment
- Authentication
- Secure storage
- HW root of trust
- And many more
smartSD-based or not?

Minimal HCE (software only)

- smartSD security token for HCE
- smartSD Secure Element

Driven by business needs such as:
- User identification
- Remote Authentication
- Non-repudiation
- Confidentiality

+ technical aspects such as:
- Local secure computing to reduce transaction time while secured
- By requirements such as MIFARE, Calypso

App with limited financial risk for service provider and end user

Typical of private use of NFC card emulation

smartSD could be issued personalized as current contactless card.
HCE security token cardlet could be generic enough to apply to most services
TSM is only required to enable post-issuance of secure element cardlets.
Consumer-Centric Model

- SDA and GLOBAL PLATFORM™ are jointly working
  - Whitepaper is available at:

- Existing Issuer-Centric Model
  - Card issuers distribute cards to end users. End users should have many cards

- Concept of Consumer-Centric Model
  - End users can buy Consumer-Centric Model smart microSD cards from retail stores
  - End users download Trusted Token and activate cards
  - End users can choose services from service providers and download applications

- smart microSD is most appropriate for Consumer-Centric Model
  - Consumer-Centric Model enable smart microSD will be available at retail stores
  - smart microSD is appropriate for smart phones and tablets
GlobalPlatform and SD Association have been working on Consumer Centric Specifications that smoothens issuance and provides more control to the end user.

- **Issuer Centric and Consumer Centric configurations**
  - Issuer centric: no different from today’s UICC and eSE
  - Consumer centric: better adapted to user-owned product yet no different from issuer centric for service providers

- **GlobalPlatform provides Consumer Centric Cardlet life cycle management**
  - User acceptance for cardlet issuance
  - Reset smartSD to blank status

- **GlobalPlatform provides security for multiple services to share the same smart microSD**
  - No different from issuer centric

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Thank you!