The Home Entertainment Networking Standard

Enabling Consumers to Experience Interactive HD Everywhere

December 2009
A Global Standard for Home Entertainment Networking, Enabling a Greener and More Interactive TV Experience
Accelerating Demand for China & Networked DTVs

Worldwide DTV Shipments

- Total DTV Shipments
- Chinese DTVs
- Networked DTVs

Units in Millions

<table>
<thead>
<tr>
<th>Year</th>
<th>Networked</th>
<th>Chinese</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>0</td>
<td>29.6</td>
<td>29.6</td>
</tr>
<tr>
<td>2006</td>
<td>0</td>
<td>61.2</td>
<td>61.2</td>
</tr>
<tr>
<td>2007</td>
<td>0.4</td>
<td>85.9</td>
<td>86.3</td>
</tr>
<tr>
<td>2008</td>
<td>1.5</td>
<td>109.2</td>
<td>110.7</td>
</tr>
<tr>
<td>2009</td>
<td>5.5</td>
<td>126.7</td>
<td>132.2</td>
</tr>
<tr>
<td>2010</td>
<td>23.5</td>
<td>145.2</td>
<td>168.7</td>
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<tr>
<td>2011</td>
<td>53.0</td>
<td>160.5</td>
<td>213.5</td>
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<tr>
<td>2012</td>
<td>85.8</td>
<td>173.3</td>
<td>259.1</td>
</tr>
</tbody>
</table>

Source: HP, DisplaySearch, Synerchip Internal Forecast
DiiVA Delivers Interactive Content and Conserves Energy

- Routable USB, Routable Uncompressed AV and Gb Ethernet in a Single CAT6 Cable
- Easy to Set Up and Use Networked CE Devices

- Promotes Innovative Consumer-Friendly Applications
- New Business Models for CE Manufacturers and Content Owners

- Devices Share Resources Efficiently to Conserve Energy
- Devices Adjust Energy Consumption Based on Content
DiiVA for Home Entertainment Networking
<table>
<thead>
<tr>
<th></th>
<th>Video</th>
<th>Data</th>
<th>Power</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Packet Type</strong></td>
<td>Uncompressed Video &amp; Audio</td>
<td>Virtual Data Packet Switch &amp; Routing</td>
<td>Power Delivery &amp; Management</td>
</tr>
<tr>
<td><strong>Topology</strong></td>
<td>Point-to-Point</td>
<td>Any-to-Any (Ethernet) Point-to-Point (USB)</td>
<td>Point-to-Point</td>
</tr>
<tr>
<td><strong>Interface</strong></td>
<td>HDMI</td>
<td>Ethernet, USB</td>
<td>USB</td>
</tr>
</tbody>
</table>

**Diiva: Unification of 3 Packet Types**

- Watch Video
- Access Data
- Deliver/Manage Power
Challenges with Point-to-Point Interfaces

- **Devices are Islands**
  - Devices are unaware of each other
  - User must interact with each device separately
  - Each device can only rely on its own compute resources

- **Difficult to Navigate**
- **Limited Topology**

**End-User Confusion**
DiiVA Solution: Networking Designed for Consumer Electronics

- TV is Center of Home Entertainment Network
  - Devices are aware of each other
  - Enables power management
- Easy Thumbnail Navigation
- Create Synergy Between Devices
  - Share compute resources
- Topology Independent

Simple, Flexible & Powerful

DiiVA

Set-top Box

PC

DVD/Blu-ray

Game Console

USB

Confidential
Problems with Ethernet in Consumer Electronics

Ethernet is Good for Data, Bad for Video & Audio

- Video is Treated Like Data
- Codec Support is Problematic
- Problem with Islands
  - No uncompressed A/V for multi-room
  - Ethernet data is independent from HDMI (uncompressed A/V)
  - Must interact with each device directly (e.g., can’t play PS3 from other room)

Video over Ethernet is Constrained by Bandwidth
Any DiiVA Display Can Access and Control Any DiiVA Source

- Uncompressed Video is Circuit Switched
  - Guarantees bandwidth
- Packetized Hybrid Data Channel for
  - Audio
  - Ethernet
  - USB
  - Network Management

Packet Independent

- Uncompressed Video is Circuit Switched
- Packetized Hybrid Data Channel for
  - Audio
  - Ethernet
  - USB
  - Network Management

Topology Independent

- Network Discovery Handled by Interface
- All DiiVA Devices can Route Packets
New CE Usage Models Enabled By DiiVA

- **Thumbnail Navigation**
  - By sending video & data over same interface, devices can send thumbnails to TV user interface
  - Makes navigation easier

- **USB Peripheral & Ethernet Sharing**
  - USB peripheral connected to TV can be routed to any source
  - Ethernet connection is shared by multiple devices

- **Distributed Application Processing/ Local Grid Computing**
  - Use DiiVA API remote procedure calls to launch apps on other DiiVA-network CPUs
    - Example: Use TV as front-end GUI, applications are run on PCs

- **Enhancement to DLNA**
  - In case codec is not supported by TV, different device’s codec can be used
  - Network can decode any file

- **Power Management**
  - Ability to intelligently power down devices not in use
Competitive Positioning
Networking Overview: 5 Layers

- **Ethernet**
  - Ethernet is packet based data only
  - All 5 layers of network are defined

- **HDMI** & **DisplayPort**
  - HDMI & DisplayPort use circuit switched video & audio
  - Only Physical and Link layers are defined

- **USB**
  - USB uses circuit switched data
  - Only Physical & Link Layers are defined

**Layers**

- Applications
- Transport
- Network
- Data Link
- Physical

**Port Types**

- **Any to Any**
- **Point to Point**
### Connection Comparison

<table>
<thead>
<tr>
<th></th>
<th>HDMI 1.4</th>
<th>USB 2.0</th>
<th>Ethernet</th>
<th>DiiVA 1.0</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Uncompressed Video</strong></td>
<td>Point to Point</td>
<td>None</td>
<td>None</td>
<td>Any to Any</td>
</tr>
<tr>
<td><strong>Uncompressed Audio</strong></td>
<td>Point to Point</td>
<td>None</td>
<td>None</td>
<td>Any to Any</td>
</tr>
<tr>
<td><strong>Data</strong></td>
<td>Point to Point</td>
<td>Point to Point</td>
<td>Any to Any</td>
<td>Any to Any</td>
</tr>
<tr>
<td><strong>USB</strong></td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Ethernet</strong></td>
<td>Yes</td>
<td>Yes (Ethernet over USB)</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Content Protection</strong></td>
<td>HDCP</td>
<td>None</td>
<td>DTCP</td>
<td>HDCP, DTCP</td>
</tr>
<tr>
<td><strong>Charging Power</strong></td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

**DiiVA** is a ‘Any-to-Any’ network connection that can route **Video, Audio, USB, Ethernet, Commands, Power** from any point to any point on the DiiVA network.
Architecture Overview
DiiVA Architecture: Physical & Link Layers

Uncompressed Video Stream

8B/10B Encoder

8B/10B Decoder

Bi-Directional Data Channel

Forward Packet
Backward Packet

ANSI802.1AS Encoder & Decoder

ANSI802.1AS Encoder & Decoder

Red
Green
Blue

HSYNC, VSYNC

Clock

Recovered Clock

Forward Packet
Backward Packet

CAT6 Cable

PVR

Blu-ray Player

HDTV

Patent-Pending Technology Operating Over Standard Ethernet Cable
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Bi-Directional Data Channel

Audio SubChannel
A Forward Digital Audio Stream
A Backward Digital Audio Stream

Command SubChannel
Commands for Content Protection and CE Control

Data SubChannel
Multimedia Bulk Data Stream (Ethernet, USB)

DiiVA Source

Virtual Switching for Multiple SubChannels

DiiVA Sink

Bi-Directional Data Channel

High-Speed
4.26Gbps (2.13Gbps, Bi-Directional) Using 8b10b, Embedded Clock

Bi-Directional
Advanced Protocol to Optimize Channel Efficiency

High Reliability
Error Detection, Packet Re-Transmission

Network Support
Ethernet Over Hybrid Channel

USB Support
Networked USB

Protocol Agnostic
DiiVA encapsulation enables transfer of any data type within network

Patent-Pending Technology Operating Over Standard Ethernet Cable
DiiVA is a complete networking interface that makes separate provisions for video, data & power.
Dynamically Power Up & Power Down Devices over DiiVA Network
- Power on and standby commands can be sent from device to device
- Intermediate devices can be powered down to standby mode to conserve power

Power over DiiVA (POD)
- Interface can deliver 5W (1A@5V) to the chain
- Can power PHY of intermediate devices so systems can be left in standby
DTV DiiVA Software Layers and Responsibilities

**Software Responsibility**

<table>
<thead>
<tr>
<th>TV OEM &amp; 3rd Party Developers</th>
<th>DiiVA Software Layers</th>
<th>Hardware</th>
</tr>
</thead>
<tbody>
<tr>
<td>DTV SOC</td>
<td>DiiVA IC</td>
<td>DTV SOC</td>
</tr>
<tr>
<td>TV OEM</td>
<td>DiiVA (SDK)</td>
<td>DTV SOC</td>
</tr>
<tr>
<td>DiiVA IC</td>
<td>DiiVA IC Firmware</td>
<td>DiiVA IC</td>
</tr>
</tbody>
</table>

- **Applications**
  - (Value-added Feature by TV OEM)
- **DCL APIs with Device Driver**
  - (SOC Interface to DiiVA HW)
- **DiiVA Middleware & APIs**
  - (Application Interface to DiiVA)
- **DiiVA IC Firmware**
  - (Manages Physical, Link, Network & Transport Layers)
DiiVA Links DTV Software to Source Software

**DiiVA DTV Software**
- Send/Receive Commands
- Send/Receive Data
- Select Input
- Receive Video

**Applications**
(Value Added Feature by TV OEM)
- DCL APIs with Device Driver
  (SOC Interface to DiiVA HW)
- DiiVA Middleware & APIs
  (Application Interface to DiiVA)

**DiiVA IC Firmware**
(Manages Physical, Link, Network & Transport Layers)

**DiiVA Hardware**

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**DiiVA Source Software**
- Send/Receive Commands
- Send/Receive Data
- Activate Output
- Send Video

**Applications**
(Value Added Feature by BluRay/DVD OEM)
- DCL APIs with Device Driver
  (SOC Interface to DIVA HW)
- DiiVA Middleware & APIs
  (Application Interface to DiiVA)

**DiiVA IC Firmware**
(Manages Physical, Link, Network & Transport Layers)

**DiiVA Hardware**

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*Network*
DiiVA Enables Recurring Revenue for TV Manufacturers i.e. TV Manufacturer’s Apps Store
Thank You!
Backup Slides
DiiVA for Mobile & Portable Applications
Interface Challenges for Mobile Devices

Interfaces on Phones Exist to Support 3G Voice/Data Plans

- **USB**
  - Data/file transfer
  - Power

- **A/V or HDMI**
  - Uncompressed video & audio

- **WiFi**
  - Internet access

- **Audio/Video**

- **USB** (Data & Power)

- **WiFi (Data)**

- **Ethernet**

- **Internet**
DiiVA Solution: Enable Mobile Device to Connect to Home Network

- Show uncompressed content from Mobile Phone on TV
  - Content from camera
  - HD Content downloaded from 3G network
- Allow Device to Charge While Playing Content
- Sync with other DiiVA Devices
- Use TV as Interface to Applications on Mobile Phone
New CE/Mobile Usage Models Enabled By DiiVA

- **TV Control of Mobile Devices**
  - TV Applications can link to mobile devices
  - Once connected to TV, mobile devices are connected to DiiVA network

- **USB Peripheral & Ethernet Sharing**
  - USB peripheral connected to TV can be routed to any source
  - Ethernet connection is shared by multiple devices

- **Distributed Application Processing/Local Grid Computing**
  - Use DiiVA API remote procedure calls to launch apps on other DiiVA-network CPUs
    - Example: Use TV as front-end GUI, applications are run on netbooks or smartphones

- **Power Management**
  - Ability to charge mobile devices

Result: DiiVA Enables Mobile Devices to be Used More Often