Set-Top Box Market Trends
Towards Smaller, Faster, Cheaper

IEEE SCV-CE Chapter

• Hoan Tran – Micron Global Sr. Segment Mgr, Connected Home
  February 28, 2017
Agenda

- Introduction
- Overview of Set-Top Box Market Trends and Dynamics
- Set-Top Box System Architecture and Key Feature Trends
- System Design Challenges
  - Mechanical designs – Thermal Managements
  - High Performance – High Speed design rules
- Q&A
Introduction: Micron at a Glance

**Founded:** October 1978, Boise, Idaho and Corporate Headquarter

**Global Presence:** 13 Manufacturing and R&D sites spanning over 18 countries

**Global Strengths:** +30K employees with +$12 Billion Revenue in FY-2016

**Technology Drivers:** +26K Patents

**Technology Innovations:** 3D XPoint™ Memory, 3D NAND, HMC, and Integrated memory devices

**Market Trusted Advisor:** Guide our partners towards a balanced memory Technology–Supply–Costs

**Broad Product Portfolio:** Flash and DRAM Memory solutions designed to meet the diverse needs & trends of Networking, Auto, M2M, Mobile, Consumer, and Cloud/Big Data

**DRAM Memory Solutions:** PC-DRAM, LP-DRAM, HMC, DRAM Modules

**Flash Memory Solutions:** NOR (SLC, MLC, Serial), NAND (2D SLC and Serial, 2D/3D MLC and TLC)

**Integrated Device:** e.MMC, UFS, MCP, PoP, SSD, and Cards (SD, USB, CF)

**Next Generation Memory:** 3D XPoint™ Memory, 3D NAND (MLC, TLC, Next Gen)

**Global Memory Market Size:** DRAM ($38B), Flash ($33B)
Overview of Set-Top Box Market Trends and Dynamics
PayTV Multimedia Service Operator (MSO) - Dynamics

Canada
• Low-Cost Sat/Cable/Telco STB
• Low-Cost Services

Western Europe (WU)
• Increase MSS & Rev thru Consolidation: Cable-Sat
• Push for 4K Content & TSB
• Smart Media Gateway for IoT and OTT BW demand

Eastern Europe
• DTT Conversion
• Low-Cost Sat/Cable STB
• Low-Cost Services

Russia
• DTT Conversion
• Low-Cost Sat/Telco STB
• Low-Cost Services

China (PRC)
• DTT Conversion
• Low-Cost Sat/Cable/Telco STB
• Low-Cost Services

Japan/Korea (JPK)
• Push for 4K Content
• Low-Cost Sat/Cable STB
• Low-Cost Services

North America (NA)
• Increase MSS & Rev thru Consolidation: Cable-Telco
• Push for 4K Content & TSB
• Smart Media Gateway for IoT and OTT BW demand

Latin America (LA)
• DTT Conversion
• Low-Cost Sat/Telco STB
• Low-Cost Services

Central Africa (CA)
• DTT Conversion
• Low-Cost Sat/LTE STB
• Low-Cost Services

India
• DTT Conversion
• Push for 4K Content
• Low-Cost Sat/LTE STB
• Low-Cost Services

Australia
• DTT Conversion
• Low-Cost Sat/Telco STB
• Low-Cost Services

Eastern Europe
• DTT Conversion
• Low-Cost Sat/Cable STB
• Low-Cost Services

Russia
• DTT Conversion
• Low-Cost Sat/Telco STB
• Low-Cost Services

Japan/Korea (JPK)
• Push for 4K Content
• Low-Cost Sat/Cable STB
• Low-Cost Services

North America (NA)
• Increase MSS & Rev thru Consolidation: Cable-Telco
• Push for 4K Content & TSB
• Smart Media Gateway for IoT and OTT BW demand

Latin America (LA)
• DTT Conversion
• Low-Cost Sat/Telco STB
• Low-Cost Services

Central America (CA)
• DTT Conversion
• Low-Cost Sat/LTE STB
• Low-Cost Services

India
• DTT Conversion
• Push for 4K Content
• Low-Cost Sat/LTE STB
• Low-Cost Services

Australia
• DTT Conversion
• Low-Cost Sat/Telco STB
• Low-Cost Services
Pay TV Multimedia Service Operator* (MSO) Trends

- **What does this all Mean to an MSO?**
  - **Acquisitions** = More Subscribers = Greater leverage Price Negotiation of Content
    - Premium Content (Live TV, Movies, Sports)
    - Immediate increase in market penetration with “new” technology and services
  - Government Influence* = MSOs are tightly regulated by local government: content, services, cost

**Top MSO:**
- **Canada**
  - Rogers Comm
  - Videotron-Bell Canada
- **Europe**
  - Vodafone-Kabel Deutschland + ONO
  - LGI-Ziggo-Virgin Media
  - Sky (BSkyB); On Digital
  - Easynet: O2/BE/EU Sat
- **Russia**
  - RSCC (Sat)
  - VimpelCom (Telco)
  - Rostelecom
- **Korea/Japan**
  - J.Com/NTT – Japan
  - KT, SK; LG Uplus – Korea
- **LA**
  - NET; DirecTV-Brazil
  - Televisa; Megacable: Mexico
  - VTR: Chile
- **CA**
  - Vodacom-Neotel
  - Multichoice - So.Africa
- **India**
  - Tata Sky: Sky/STAR/Tata Grp
  - Den Networks
  - Sun; Reliance - India
- **PRC**
  - China Telecom (South)
  - China Unicom (North)
  - China DBSat (Rural)
- **Russia**
  - China Telecom (South)
  - China Unicom (North)
  - China DBSat (Rural)
- **Australia**
  - Foxtel & Telstra
- **Canada**
  - Rogers Comm
  - Videotron-Bell Canada

**Consolidation:**
- **NA**
  - Comcast
  - AT&T-DirecTV
  - Charter-Bright House-TWC
  - Verizon-Intel OTT
- **Europe**
  - Vodafone-Kabel Deutschland+ONO
  - LGI-Ziggo-Virgin Media
  - Sky (BSkyB); On Digital
  - Easynet: O2/BE/EU Sat
- **Consolidation: Europe**
  - Vodafone-Kabel Deutschland + ONO
  - LGI-Ziggo-Virgin Media
  - Sky (BSkyB); On Digital
  - Easynet: O2/BE/EU Sat

Source: Various MSO Press Releases

*Other names and brands may be claimed as the property of others
Set-Top Box + CPE Market Size Trends

- **Satellite:**
  - Lower Infrastructure cost - Emerging Countries
  - Partnership with Telco & CPE to grow IP-STB

- **Cable & Telco:**
  - Expand Gb/s Network & CPE to grow IP-STB
  - Expand Smart Media Gateway to grow users

- **IP-STB** to grow as it gets bundle with CPE Media Gateway and Internet services
  - Smaller and lower costs: No HDD, No Fans
  - High performance: 4K/8K UHD & Gb/s support

- **DTT** slowing – Digital Conversion slowing

*Other names and brands may be claimed as the property of others*
Global Set-Top Box Market Size Dynamics

- **Revenue** Declining – Flattening
  - “Cut the Cord” OTT, Mobile, and Smart DTV
    - SVoD (Netflix*, Hulu*, HBO*, Channel-Apps)
  - “Skinny Bundle”
    - SlingTV*, DirecTV NOW*, Dish Flexpack*, etc
  - Market Consolidation

- **Unit** Shipped Flattening – Growing
  - Smaller, Faster, Cheaper Boxes
    - 4K/8K IP/Client STB
    - Hybrid STB
    - Emerging market “new wealth,” adoption of Western trends, & new infrastructure investment
  - Cross-Ventures: TV/Telco/Mobile MSOs and SVoD

*Other names and brands may be claimed as the property of others*
Set-Top Box Viewing Habits

- Time-Shift and Place-Shift are Top Priority and Highly Valued Emerging TV Watching Trends
- Time-Shift TV = Watch “Live TV” when you want to, wherever you want to ...
- Place-Shift TV = TV anywhere – any device
- MSO and CDN tracks viewing habits: In-Home continue to dominate TV viewing time

- Monetizing Personalized TV is about high ROI Dynamic and Targeted Advertisements
- US TV habits will proliferate to other GEOs
  - Average Weekly TV time ~ 28 Hrs/wk
  - Time-Shift TV (18yrs – 49yrs) ~ 3 Hrs/wk (Time watch before jumping to new content)
  - TV at Home and TV ads are still relevant

*Other names and brands may be claimed as the property of others
### TV Anywhere Market Announcements

- **Roku**: TV sets can now pause live TV on a 16GB USB drive (Roku OSv7.5).
  - [The Verge](https://www.theverge.com/2016/1/2/11106735/roku-tv-cloud-dvr-usb-drive) 1/2/16

- **Sling TV**: Introduces (100hrs) Cloud DVR Beta Program on Roku devices.
  - [Sling](https://www.sling.com) 11/28/16

- **Comcast**: offers cDVR with X1 Platform: Gateway + IP-STB
  - Gateway adds Local PVR capability
  - IP-STB drops HDD, adds NVM storage
  - [Comcast](https://www.comcast.com) 11/4/16

- **Comcast** license X1 Platform to US & Canada MSO – expands X1 platform
  - Various

- **AT&T DirecTV**: offers Online Streaming service; cDVR in ’18
  - [ARS Technica](https://arstechnica.com) 11/29/16

- **Comcast**: adds Netflix App on X1 Platform
  - [Comcast](https://www.comcast.com) 11/4/16

- **MSO** adds Apps on OTT device
  - Various

- **Roku TV sets** can now pause live TV on a 16GB USB drive (Roku OSv7.5).
  - [The Verge](https://www.theverge.com) 1/2/16

- **Sling TV**: Introduces (100hrs) Cloud DVR Beta Program on Roku devices.
  - [Sling](https://www.sling.com) 11/28/16

- **Cloud DVR & Local Storage PVR proliferating**

- **IP/OTT STB to offer Cloud DVR and Local Card PVR**

- **STB & OTT merging with Local Storage Model**

---

**Cloud DVR (cDVR) and Local Storage PVR are being explored by MSO and SVoD providers**

*Other names and brands may be claimed as the property of others*
# STB Local vs Cloud Storage

<table>
<thead>
<tr>
<th>Storage</th>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
</table>
| Cloud            | • Unlimited storage capacity & bi-directional update  
• MSO controlled the contents & infrastructure costs  
• Increase revenue with "ala-carte“ add-on services  
• Low cost to set-up, "self-installation“  
• Streams content “anytime, anywhere, any device” | • Content licensing: Single vs Shared vs Distributed  
• Infrastructure upgrade costs (Backend vs Edge)  
• Must upgrade CPE to existing customer base  
• Balance showing Ads vs Consumer behavior of Ads  
• Customer QoE due to network lag/buffer/glitch |
| HDD              | • Legacy additional revenue for DVR service  
• Easy to use, and Fast deployment to consumer | • High-cost of service (send tech to home)  
• High reliability issue (mechanical failures)  
• Limit storage capacity @ time of deployment  
• Device must send to Service Center, down-time  
• No content “anytime, anywhere, any time“ |
| Video Storage Cards | • Similar to HDD, **but** lower power, cost, & small size  
• Removable & Easy Field Service by tech, quick-turn  
• Masks temporary Cloud Network lag/buffer/glitch | • Similar to HDD, **but less** effort to service by tech |
| e.MMC            | • Similar to HE-Cards, **but** as “unified” or Data NVM  
• Higher Quality & Reliability, Design-in Isolation | • Similar to Video Card, **but more** effort to service by tech |
| Retail USB/SDCard | • Available thru Retail & inexpensive  
• Consumer decides density & where/when to buy | • Unreliable, No quality control, Not tested in system  
• Customer dissatisfaction **impacts** Brand reputation |
Set-Top Box and OTT Box – Services

- **Set-Top Box (STB)** = Pay TV services from Satellite, Cable, Telco, or Free Antenna (DTT) TV
- **STB Services*:** Premium Linear (Live TV) and SVoD
  - **Linear TV:** Live TV with scheduled programs/shows
  - **VoD TV:** Video-on-Demand TV from library of recorded current and past Live TV programs/Shows

- **OTT Box (Over The Top) =** Free Internet TV & 3rd party Paid Subscription Video on Demand (SVoD) services
- **SVoD Services*:** Premium and non-premium Streaming On-Demand Video services
  - **Premium:** Paid Streaming On-Demand & recorded-Live TV/Video from library offered these popular services
  - **Non-Premium:** Free Streaming On-Demand & recorded-Live “Free Internet” TV/Video with Advertisement

<table>
<thead>
<tr>
<th>MSO*</th>
<th>Broadcaster &amp; Content Owner*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comcast</td>
<td>ABC, FIFA, HBO</td>
</tr>
<tr>
<td>AT&amp;T</td>
<td>CBS, ESPN, Showtime</td>
</tr>
<tr>
<td>Dish</td>
<td>NBC, NFL, Disney</td>
</tr>
<tr>
<td>LGI</td>
<td>AlJazeera, Canal+, CCTV</td>
</tr>
<tr>
<td>Sky</td>
<td>BBC, TF1, Univision</td>
</tr>
</tbody>
</table>

**SVoD Content Provider*:

<table>
<thead>
<tr>
<th>Netflix</th>
<th>YouTube</th>
<th>Hulu</th>
<th>DirecTV Now</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amazon</td>
<td>Starz</td>
<td>SFR</td>
<td>Freeview</td>
</tr>
<tr>
<td>Vivendi</td>
<td>Alibaba</td>
<td>PPTV</td>
<td>Pickbox.tv</td>
</tr>
</tbody>
</table>

*Other names and brands may be claimed as the property of others
Set-Top Box and OTT Box – Hardware

**STB:**
- Traditional STB = link to PayTV service
- Hybrid STB = Traditional STB + Home Network
- DTT (Digital Terrestrial Transmission) = Free OTA TV STB Converter Box
  - Note: Modern DTV have DTT Tuner inside

**Flexibility:** NO – STB is a 1:1 connection between STB and Pay TV service provider per Household
- PayTV service providers starting to offer subscription streaming of their content over Mobile devices

**OTT:**
- OTT device: Roku, Amazon Fire, Google Chromecast, AppleTV, SlingTV, LeTV, NowTV;
- Game Console: PlayStation Vue, Xbox, Wii
- Smart DTV with OTT function (Roku TV, GoogleTV)

**Flexibility:** YES – OTT can be connected to any Internet connections and SVoD goes where you go
- SVoD content can also be streamed from Mobile devices
- MSO are now offering Hybrid IP/OTT-STB to compete and re-gain new consumer (Cord-Cutters)

*Other names and brands may be claimed as the property of others*
System Architecture and Key Feature
**Smaller – Faster – Cheaper Trends**

- **Today**: STB (per room) + Modem + Router + Gateway + IoT Hub
- **Tomorrow**: IP-STB (per room) + Modem/IoT Gateway
- **Accessory**: Game Console + OTT Device compliments STB devices

*Other names and brands may be claimed as the property of others*
Smaller STB Enclosure Design Trend

Legacy STB

- WiFi 802.11 SoC
- 10/100 Ethernet Transceiver
- Nor Flash Memory
- HDD
- DRAM (x16)
- DRAM (x16)
- NAND Flash Memory
- Smart Card

IP-STB

- WiFi 802.11 SoC
- 10/100 Ethernet Transceiver
- Nor Flash Memory
- SD or µSD Card
- e.MMC Flash Memory
- DRAM (x16)
- DRAM (x16)
- DRAM (x16)

Next Gen IP-STB

- WiFi 802.11 SoC
- 5G LTE SoC
- Nor Flash Memory
- e.MMC Flash Memory
- LPDRAM (x32)
- Nor Flash Memory

Legend:

- Optional
- Next Gen

Average Box size: 12” x 8” x 4”

Average Box size: 6” x 6” x 3”

Average Box size: 4” x 4” x 2”
Smaller IP-STB and OTT Enclosure Design Trends

**IP-STB**
- WiFi 802.11 SoC
- 10/100 Ethernet Transceiver
- NOR Flash Memory
- e.MMC Flash Memory
- SD or µSD Card
- DRAM (x16)
- SD or µSD Card
- DRAM (x16)
- DRAM (x16)

**OTT**
- WiFi 802.11 SoC
- 10/100 Ethernet Transceiver
- NOR Flash Memory
- e.MMC Flash Memory
- DRAM (x16)
- DRAM (x16)

**Next Gen IP-STB / OTT**
- WiFi 802.11 SoC
- 5G LTE SoC
- NOR Flash Memory
- e.MMC Flash Memory
- DRAM (x16)
- SD or µSD Card
- DRAM (x16)
- LPDRAM (x32)
- e.MMC + LPDRAM (x32) MCP

**Legend:**
- Optional
- Next Gen

**Average Box size:**
- IP-STB: 12” x 8” x 4”
- OTT: 6” x 6” x 3”
- Next Gen IP-STB / OTT: 4” x 4” x 2”
**Faster STB System Design Trends**

### IP-STB

- **SoC (4K UHD Video Decoder)**
- WiFi 802.11 Gbit/s SoC
- 10/100 Ethernet Transceiver
- SD or uSD Card
- e.MMC Flash Memory
- DRAM (x16) 1866 MT/s
- DRAM (x16) 3200 MT/s
- NOR Flash Memory

### OTT

- **SoC (32-bit Applications Processor)**
- WiFi 802.11 Gbit/s SoC
- 10/100 Ethernet Transceiver
- SD or µSD Card
- e.MMC Flash Memory
- DRAM (x16) 1866 MT/s
- LPDRAM (x32) 3200 MT/s
- NOR Flash Memory

### Next Gen IP-STB / OTT

- **5G LTE SoC**
- WiFi 802.11 Gbit/s SoC
- 10/100 Ethernet Transceiver
- SD or µSD Card
- e.MMC Flash Memory
- DRAM (x16) 1866 MT/s
- LPDRAM (x32) 3200 MT/s
- NOR Flash Memory

Legend:
- Optional
- Next Gen

© 2017 Micron Technology, Inc. | Feb. 28, 2017
Cheaper STB Design Trends

- Reduce Box size from (12” x 8” x 4”) to (4” x 4” x 2”) = Significant Saving
- Mold Injected Plastic Enclosures = Significant Saving vs Metal Enclosure
- Remove HDD and Fan = Reduction in Power and Significant Saving
- Integration of SoC = Simplify PCB Design and Significant PCB Saving
- Use of Multi-Chip Memory Device = Simplify PCB Design and Significant PCB Saving
Flash and DRAM Memory Usage

SoC

- Secure Boot Code
- OS & Syst Code & Library

At Boot-up, Codes Stored in flash will Download into DRAM (SnD)

DRAM

- Video Decoder Work Space (density grows from STD-HD to HD to 4KUHD)
- Video Frame Buffer (main driver for higher density)

Downloaded from Flash

SPI NOR or pNOR

- Operator Apps
- Programming Guide
- Extended Channel & Programming screen data
- Pre-loaded Games

Downloaded from Flash

SLC or MLC NAND

- Temporary storage of Cloud Video (PVR/DVR)
- Video Time-Shift Buffer

e.MMC or SD/µSDCard

Configurable

x32

Flash Memory

© 2017 Micron Technology, Inc. | Feb. 28, 2017
System Design Challenges
System Design Challenges: Small Form-Factor Designs

- **Smaller** and “Artistic” form-factor
  - No or very little ventilation = Elevated Thermal accumulations
  - Plastic enclosure has very poor Thermal Dissipation property

- **Faster** SoCs and Memory components
  - High Clock Speed CPU and Memory generates Heat > JEDEC test standard
  - Heat causes Charge Loss in Memory = Risk incorrectly read “1” or “0”
  - Heat may cause Drifts in High-Speed Signals if relaxed design rules are used

- **Consumer Usage Model** are not fully understood
  - Design for Worse-Case: Continuous Viewing TV Content 24/7 x 7yrs
  - Denial Design Approach: Under design to cut cost – **Ticking Time to Failure**
How this looks with respect to $V_t$

SLC case: useful $V_t$ limit are much **wider** and **higher**

MLC case: useful $V_t$ limit are much **narrower** and **lower**

Incorrect $V_t$ charge loss from “Heat” = Incorrect Detection of “1” or “0”
Example of an IP-STB: Thermal Image in 25°C Ambient (Top view zoom in) with no enclosure

External “Ambient” Temp = 25°C

**Note:** The result may be slightly different with different measurements
Example of an IP-STB: DUT with Enclosure @ 65°C Ambient

Note: The result may be slightly different with different measurements

Note 1: $t_c$ = Case Temperature of the IC
Note 2: External “Surface” temp - Gov Fire Hazard Temp (>65°C)
System Design Challenges: High Performance

- PCB designs require Very High-Speed Design Rules
  - Gbit/s WiFi and 5G LTE = Requires Very High Speed Design Rules
  - 4K/8K UHD or 32-bit/64-bit Apps SoC = Lots of high-speed I/O
  - DRAM/LPDRAM at 3200MT/s to 4266 MT/s may require Terminations

- High Quality DRAM are required to minimize design variations

- Small PCB = potential higher PCB Layers = Higher cost

- Proper Shielding are required
  - But too much shielding isolates and limits Thermal Dissipation from Heat source: SoC (WiFi, Video Decoder, Apps Processor)
### Set-Top Box Design Trend Summary

<table>
<thead>
<tr>
<th>Smaller</th>
<th>Faster</th>
<th>Cheaper</th>
</tr>
</thead>
<tbody>
<tr>
<td>IP/OTT-STB will lead the market volume</td>
<td>4K/8K UHD Decoding SoC</td>
<td>Smaller enclosure &amp; PCB</td>
</tr>
<tr>
<td>“Artistic” shapes, round edges</td>
<td>Up to 50Mb/s (typ 12-25Mb/s) per Compressed Video stream</td>
<td>Use of latest memory technology</td>
</tr>
<tr>
<td>Thinner profile</td>
<td>Future 5G integration</td>
<td>– NOR – NAND – e.MMC</td>
</tr>
<tr>
<td>No HDD or Fan</td>
<td></td>
<td>– Shift from HDD to SD/µSDCard</td>
</tr>
<tr>
<td>– Legacy STB has HDD and Fan</td>
<td></td>
<td>Future “Cloud” only storage</td>
</tr>
<tr>
<td>Thermal Dissipation must be considered</td>
<td>High-Speed design rules must be strictly follow</td>
<td>Lower Cost can be achieved with using latest component technology</td>
</tr>
<tr>
<td>– High Quality and Reliability Component are needed</td>
<td>– High Quality and High Speed Components can’t be swap with low-cost/quality devices</td>
<td>integrations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>– Memory Component decision can impact system costs</td>
</tr>
</tbody>
</table>

- Smaller enclosure & PCB
- Use of latest memory technology
  - DDR3/4 – LPDDR4 – LPDDR5
  - NOR – NAND – e.MMC
  - Shift from HDD to SD/µSDCard
- Future “Cloud” only storage
- Lower Cost can be achieved with using latest component technology integrations
  - Memory Component decision can impact system costs
## Micron Product Innovations Available to meet STB Trends

<table>
<thead>
<tr>
<th>Smaller</th>
<th>Faster</th>
<th>Cheaper</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓ Micron has Flash and DRAM devices in small form-factor</td>
<td>✓ Flash memory operating up to 200MHz DDR</td>
<td>✓ Micron Flash device cost reduce to 3D MLC/TLC NAND</td>
</tr>
<tr>
<td>✓ Low to High Density Flash and DRAM designed for Code/Data requirements</td>
<td>✓ DRAM operating up to 3200 MT/s with DDR4 and 4266MT/s with LPDDR4</td>
<td>✓ DRAM devices cost reduce with latest DRAM technology to maintain “best” cost/supply</td>
</tr>
<tr>
<td>✓ Flash High Data Reliability @ Extended High Temperature</td>
<td>✓ Next generation DDR5 and LPDDR5 are being defined</td>
<td>- DDR4 on 2017 designs</td>
</tr>
<tr>
<td>✓ Flash designed for Video Recording (TSB and PVR)</td>
<td></td>
<td>- LPDDR4 on 2018 designs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- DDR5 or LPDDR5 in 2019/2020</td>
</tr>
</tbody>
</table>

Contact your Local Micron Sales for a Confidential Review of your Designs
Thank You

Q&A