Multimedia Content on Mobile Devices: Opportunities and Challenges

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The Basics of Mobile Services

Wireless Subscriber Growth is Still Strong through 2010

Global Telecom Subscriber Growth

<table>
<thead>
<tr>
<th>Year</th>
<th>Wireless (Millions)</th>
<th>Wireline (Millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1998</td>
<td>318</td>
<td>846</td>
</tr>
<tr>
<td>1999</td>
<td>490</td>
<td>905</td>
</tr>
<tr>
<td>2000</td>
<td>740</td>
<td>983</td>
</tr>
<tr>
<td>2001</td>
<td>955</td>
<td>1053</td>
</tr>
<tr>
<td>2002</td>
<td>1155</td>
<td>1129</td>
</tr>
<tr>
<td>2003</td>
<td>1363</td>
<td>1210</td>
</tr>
<tr>
<td>2004</td>
<td>1689</td>
<td>1300</td>
</tr>
<tr>
<td>2005</td>
<td>2057</td>
<td>1360</td>
</tr>
<tr>
<td>2006</td>
<td>2346</td>
<td>1420</td>
</tr>
<tr>
<td>2007</td>
<td>2619</td>
<td>1470</td>
</tr>
<tr>
<td>2008</td>
<td>2850</td>
<td>1520</td>
</tr>
<tr>
<td>2009</td>
<td>3072</td>
<td>1570</td>
</tr>
<tr>
<td>2010</td>
<td>3285</td>
<td>1610</td>
</tr>
</tbody>
</table>

Source: ITU, U&S Research

*Fixed Residential & Business telephone lines
.. With Strong Revenue Growth

- ARPU is lower among the fastest growth areas
The handset market growth will start to slow down..

- Predictions for over 1 billion handsets with multimedia capability by end of 2008
- 5 key players - Nokia, Motorola, Samsung, LG and Sony-Ericsson - supply 75% of world's handsets
- Leaders release 30+ models/year
- The "40 Million handset" threshold..
- Almost 78% of the subscribers use GSM technology - the trend is expected to extend to 3G as well
Personal Entertainment Scenario in 2008

Total 2008 Installed Base c.2Bn Including Multiple Ownership


Source: U&S Digital Consumer Electronics Service

** Digital Still/Video Cameras
Evolution of Storage has a strong influence..

- **Tape**
- **HDD**
- **BD/HD-DVD**
- **mobileDRIVE**
- **DataPlay, Philips SFFO**
- **solid state modules**

**Graph Details:**
- **[GByte]**
- Professional vs. Consumer
- DataPlay, Philips SFFO
- MobileDRIVE
- Solid state modules
- 4th gen optical storage

**Timeline:**
- 1999-2010

**Graph Labels:**
- Data Play
- HD Movie compressed
- SD Movie compressed
- DVD
- Tape
- HDD
- BD/HD-DVD
- MobileDRIVE
- Solid state modules

**Thomson Images & Beyond**
Storage will be more prevalent in clients

<table>
<thead>
<tr>
<th>Units: Millions</th>
<th>2005</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total WW Cellphone Sales</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Installed Base</td>
<td>816m</td>
<td>1308m</td>
</tr>
<tr>
<td><strong>‘Smart Phones’</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Annual Sales</td>
<td>7%</td>
<td>25%</td>
</tr>
<tr>
<td>Installed Base</td>
<td>2058m</td>
<td>3325m</td>
</tr>
<tr>
<td><strong>With Removable Media Slots</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Annual Sales</td>
<td>&lt;2%</td>
<td>25%</td>
</tr>
<tr>
<td>Installed Base</td>
<td>100m</td>
<td>700m</td>
</tr>
<tr>
<td><strong>With HDD</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Sales</td>
<td>0</td>
<td>10-15%</td>
</tr>
<tr>
<td>Installed Base</td>
<td>0</td>
<td>70m</td>
</tr>
</tbody>
</table>

*Source: Understanding & Solutions Digital Imaging Service*

- Storage on Clients can be better leveraged for new applications
How much do consumers pay for content?

- Consumer Spend on mobile content will experience strong growth
- Prediction: 150 Millions subs will receive broadcast TV on portable devices by 2010
- Prediction: Consumers will spend upwards of $40 Billion on mobile content (including broadcast)
What are the likely new "killer applications"?

- Mobile Video Entertainment
  - Broadcast and downloaded
  - Time sensitive content - short clips genre
  - Aggregated and personalized content
  - Time-shift on-the-go (with inexpensive storage on the phone)
- Wireless gaming
- Music (building on ring tones)
- Person-to-person video interactivity
Technical aspects to be visited:

- **Wireless capacity**
  - Best effort vs. QoS capacity
  - Effect of overlay infrastructures
    - WiFi, Broadcast (DVBH, DMB, MediaFLO etc)
- **Storage on the client devices**
- **Power performance of client devices**
  - RF to applications
- **Content Security**
- **Architecture of the distribution Infrastructure**
  - Edge Caching, multicasting etc
  - Caching inside the cellular infrastructure?
Spectrum is King!

- Desirable spectrum (below 2 GHz) is very scarce
  - 3G allocations under serve the market in terms of content distribution requirements
    - Has resulted in overlay networks to deliver wireless content
      - WiFi for local filler connectivity - accomplishes microcell functionality
      - Broadcast overlays - DVBH, DMB, MediaFLO
    - Quality of Service for Streaming is still a key issue
      - Short form content is less affected by QoS since reliable downloading may solve the issue
      - Unicast delivery is bandwidth inefficient
      - Support for multicasting at the edge of the radio network would be desirable
      - Ability to monitor end-to-end quality is an important technical issue that needs resolution
Overlay Networks - Solving the BW crunch?

- WiFi Overlays are beginning to consolidate
  - Power performance of WiFi is still an issue - power control on handset?
  - Need to develop applications to leverage WiFi bandwidth to enable predictive and opportunistic downloads to handsets
  - Tight coupling between WiFi and Cellular network is needed to enable seamless QoS
    - Is this a problem worth solving?
    - Should WiFi networks simply be used for data services and opportunistic download?
Mobile TV - its time has come!

• Broadcast Overlays are beginning to emerge
  – DVBH, MediaFLO, DMB
  – Issues with cellular vs. broadcast coverage disparities
    • How will this affect consumer behavior?

• Operators believe broadcast TV alone will not result in very strong ARPU growth
  – Need interactive applications over cellular network

• Interactivity will require a more elaborate service delivery platform
Mobile TV Ecosystem

Broadcast Network Operator

Cooperation Platform

Mobile Phone Operator

Core Network

Cellular Network Base Station

Transmitter

Cellular Network

Mobile Receiver
The Mobile TV Ecosystem - DVBH Example

**Content Creation, service management, …**

**DVB-CBMS**
- Convergence of Broadcast & Mobile Services
- Electronic Service Guide
- Content Protection
- Content Delivery
- QoS and Network performance

**Transport**

**DVB-H / Media FLO**
- Modulation
- IP encapsulation
- Better reception
- Hand over
- Power consumption

**Interactivity**
- Recorded Content Play-out
- Live Content Compression

**Synchronization & Transmission**
- Remultiplexing
- Encapsulation
- Synchronization & Transmission

**Reception**
- Electronic Service Guide (ESG)
- Conditional Access System (CAS)
The Service Delivery Platform

**DVB-H Broadcast: Mobility**
- **Live Content Management**
  - MPEG-4 AVC Encoder
  - Live Encryption Server
- **DVB-H Encapsulation**
  - IP Encapsulator
  - Including MPE-FEC & Time Slicing features
- **DVB-H / DVB-T Processing**
  - MPEG-2 Multiplexer
  - Concatenation of multiple DVB-H feeds & combining of DVB-H & DVB-T streams
- **Transmission**
  - DVB-H Transmitter
  - DVB-T / H modulation & transmission

**Service Management: Mobility**
- **Content Delivery**
  - Content Delivery Server
  - Multicast File Delivery using FLUTE protocol
- **Electronic Service Guide**
  - ESG Generator
- **NVOD Management**
  - NVOD Server
  - NVOD Server
- **Administration Platform**
  - Web Server
  - Application Server
  - Database Server
- **Digital Rights Management**
  - CAS Server
  - License Server
- **Mobile Operator Interface**
  - SMS Server
  - Billing Server
  - WAP Server

**Interactive Application Components**
- **Live Content**
- **Interactive Application Components**
- **Metadata**
  - XML
- **NVOD**

**Reception**
- **Mobile Reception**
- **Car Reception**
- **PDA Reception**

**Applications**
- **Live TV**
- **NVOD**
- **Interactive TV**
The Storage Lever

- Cost of storage is falling faster than the cost of bandwidth
  - Power performance of storage systems will determine the race between solid state storage (Flash) and other types of media (HDD, optical etc.)
- With densities approaching 100 GB/in² (eg. holographic), prepackaging enormous amounts of catalog content may enable new service models
Power Performance of Client Devices

• RF power is well optimized in today's receivers and will continue to evolve
• Applications on a generic back-end processor are not very power efficient
  – In 2010, expect to have 1000 Mips on a handset
    • Will need better power management
  – Encoding of video using advanced codecs will be a big challenge
    • Power efficient H.264 encoders will require dedicated silicon implementations for efficiency
  – 3D graphics rendering (for games) will be challenging
Rights Management Issues

- Conditional Access System(s)
  - Today's broadcast world
- Digital Rights Management System(s)
  - Today's PC world
Content Distribution Architectures

- Traditional Content Distribution Networks can bring IP content to the edge of the cellular network (at the GGSN)
  - Solutions that bring caching closer to the edge of the cellular radio network need to be developed
- Cache on the client device could be considered as part of the hierarchy
- Need to develop content distribution optimization techniques to reduce overall cost of delivery
- Emerging Peer-to-peer techniques may also have a role to play to further reduce delivery cost
Content Owners vs. the Pipe Provider

• The "net neutrality" debate and its effects on content distribution over cellular infrastructures
  – eg. will Google be able to distribute content over a Verizon network without Verizon participating in the transaction?
• Need to develop tools to monitor fair access in the end-to-end networks?
Services in a Net-Neutral World?

MBE3000 H.264 Encoder - dual SW encode

QVGA

Unicast: RTSP

Cable modem

cable network

GPRS Network

Multicast: RFC 3984 (RTP)

Off-air - Live Content

WiFi

i-mate - Xscale PDA

Symbian Phone

40 Kbits/sec, video only, CBR, H.264 Baseline Profile over GPRS network

MBE3000 H.264 Encoder - dual SW encode

QCIF

QVGA

Fireflo server, relay mode

Unicast: RTSP

GPRS Network

Symbian Phone
May you live in interesting times…

- Content over mobile networks is in its infancy
  - Strong opportunities, technical challenges abound
- Economic models need to be researched concurrently with technical solutions
- Tradeoffs in bandwidth, storage and power-performance needs to be constantly tuned to maximize economic value
- One of the few industries where solutions/uptake has exceeded predictions…
  - Indicative of level of interest from customers
Discussion....