Technology & Solution
Roadmap – Mobile Perspective

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System LSI Division
Samsung Electronics
December 8, 2008

I  Mobile Market Trend
II  Application Trend
III  Samsung’s SOC Strategy
IV  Total Mobile Solution Provider
MOBILE MARKET TREND

Mobile Device Market Trend

Source: Gartner Dataquest / SEC S.L.I.S Marketing
Emerging Mobile Computing Market

- Boundaries between PC & Phones blurring

<table>
<thead>
<tr>
<th>Display Size</th>
<th>Display Resolution</th>
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<tbody>
<tr>
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<tr>
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- High Performance
- Touch, Qwerty
- JG Cellular, WiFi
- Linux, Windows XP
- Web browsing

Net-book
- Full-size Keyboard
- WiFi
- Windows XP, Vista

Mobile
- Cramped Keyboard
- WiFi
- Linux, Windows XP
- Browsing → Computing

Smartphone
- Touch, WiFi/BT/GPS

MID
- Touch, Qwerty
- JG Cellular, WiFi
- Linux, Windows XP
- Web browsing

Tablet
- Telephony + Web
- WiFi

Notebook
- Full-size Keyboard
- WiFi
- Windows XP, Vista

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Figure: Worldwide HDTV Shipment Forecast (2004-2012)

- HD becoming popular in both home & mobile markets
- Flat panel HDTV represents the major portion of the TV market
- Mobile devices increasingly support HD capability

Source: Gartner 2008
DSC-quality Camera Phone

Camera as Energized Communication!

Mobile phones are converging upon DSCs in picture quality

APPLICATION TREND
Mobile Service Trend

- Mobile Services: Evolving from Voice-Only to Mobile Internet

**Voice-Only**
- Voice Service
- Text-based SMS/WAP

**Mobile Internet**
- Location Based Service
- E-mail
- Web Search
- Social Networking
- MP3/ UCC
- Full Web Browsing

User Interface Trend

- A touch screen and fancy graphical user interface define the modern smart-phone

- **Touch-screen Interface**
- **Enhanced User Interface (2D/3D)**
**Multimedia Application Trend**

- User Created Content (UCC) made possible on mobile devices with the help of advancing multimedia technology
- UCC on mobile devices will include HD video

**Mobile Device**
- Camera Phone
- Pictures
- Videos

**UCC**
- Flickr
- YouTube

**Location Based Service**

- Location-based Services (LBS) are creating many business opportunities

**LBS Applications**
- Photo Geo Tagging
- 3D Navigation
- Point of Interest
- Targeted Advertising
Requirements for Future Mobile Device

**Mobile Internet needs**
- Hz CPU & Multi-core

**Advanced UI needs**
- 2D / 3D Graphics
- Large/Touch Display

**Low power & high performance**
- System-level Optimization
- Memory Synergy

**UCC/MM applications need**
- HD Multimedia Codec
- Mega-pixel Camera

III

SAMSUNG SOC STRATEGY
Samsung SOC Solution

- Based on advanced technology & SOC design methodologies, Samsung builds high performance SOC solutions optimized across the entire system

- System-level Optimization
- High Performance Mobile SOC Solution
- CPU
- Advanced IP
- Memory Synergy
- Low Power / High Performance Process Technology

World’s First 32nm HKMG Development

- Samsung, IBM and its partners announced the development of 32nm high-k metal gate technology (Dec. 2007)
  - The World’s first low-power 32nm HKMG process technology
  - First to mass produce 32nm HKMG devices

The project leaders of the alliance

32nm high-k metal gate transistors
32nm High-K/ Metal Gate Technology

- Cannot meet the gate leakage requirement with Poly/SiON

32nm: High K & Metal Gate

- **Technical Benefits**
  - Reduced Gate leakage
  - Tox scaling

- **Technical Challenges**
  - Reliability
  - Thermal budget

**Advantages of 32nm CP HKMG over SiON**

- **Higher Performance** (at the same leakage level)
- **Lower Power**: dynamic & standby power
- **Easy to shrink gate** due to device controllability
- **Reliability**: Green light based on reliability data in the early stage

32nm HKMG Enables GHz Mobile CPU

- 32nm HKMG opens the GHz era of mobile processors
- Lower power & smaller geometry enable multi-core integration
  - Performance of mobile devices will be comparable to PCs

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<th>Mobile Multi-core using 32nm</th>
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- 32nm HKMG opens GHz era of mobile processors
- > 1 GHz 32nm HKMG
- ~800MHz 32nm SiON

- Further integration (ex. Quad-core) will lead to PC-comparable performance with ultra low power (< 2W)

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**Technical Benefits**

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- Tox scaling

**Technical Challenges**

- Reliability
- Thermal budget

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The standby time of mobile devices has been constant despite increase of mobile phone features.

- Offset by advances in process technology
- Increasing leakage current might break the equilibrium

- 32nm HKMG keeps the phone “mobile”

- Processing power of mobile phones approaching that of PCs
  - High-speed mobile Internet requires greater processing power

*Processing Power of Mobile Phones*

*Processing Power of PC*
### Mobile Multimedia Roadmap

- Samsung’s multimedia IP supports both encoding & decoding
  - Programmable hardware codec can support multiple formats
  - Low power consumption for mobile applications

#### Mobile Multimedia Market Requirements

<table>
<thead>
<tr>
<th></th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
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<tr>
<td><strong>Resolution</strong></td>
<td>VGA 30fps</td>
<td>D1 30fps</td>
<td>HD 720p 30fps</td>
<td>HD 1080p 30fps</td>
</tr>
<tr>
<td><strong>Codec Requirements</strong></td>
<td>MPEG-4, H.264, VC-1</td>
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#### Samsung Mobile Multimedia Roadmap

<table>
<thead>
<tr>
<th>Resolution</th>
<th>Codec Support</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1 Codec (720x576)</td>
<td>MPEG-4, H.264, VC-1</td>
</tr>
<tr>
<td>HD 720p 30fps (1280x720)</td>
<td>MPEG-4, H.264, VC-1, MPEG-2</td>
</tr>
<tr>
<td>Full-HD 1080p 30fps (1920x1080)</td>
<td>MPEG-4, H.264, VC-1, MPEG-2</td>
</tr>
<tr>
<td>Full-HD 1080p 60fps (1920x1080)</td>
<td>MPEG-4, H.264, VC-1, MPEG-2, AVS, RV, H.265</td>
</tr>
</tbody>
</table>

### 3D Graphics Roadmap

- Mobile 3D graphics capabilities approach that of PCs
  - Applications: 3D-map, 3D U/I, 3D gaming...

#### Samsung 3D Graphics Roadmap

<table>
<thead>
<tr>
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<th>2007</th>
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<th>2010</th>
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<tbody>
<tr>
<td><strong>Displays</strong></td>
<td>HVGA</td>
<td>WVGA</td>
<td>XGA</td>
<td>UXGA</td>
</tr>
<tr>
<td><strong>Performance</strong></td>
<td>4M tri/s</td>
<td>10M tri/s</td>
<td>20M tri/s</td>
<td>40M tri/s</td>
</tr>
<tr>
<td><strong>Applications</strong></td>
<td>3D Navigation</td>
<td>3D User Interface (Low-end)</td>
<td>3D User Interface (High-end)</td>
<td>3D Games</td>
</tr>
<tr>
<td><strong>Supporting Standard</strong></td>
<td>Open GL 1.1</td>
<td>Open GL 1.1/ 2.0</td>
<td>Open GL 2.0</td>
<td>Open GL 2.0</td>
</tr>
</tbody>
</table>

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High Performance AP: Taurus1

- Taurus1 is a GHz AP supporting full-HD video codec and 3D U/I (Available in 2Q of 2009)

**High Performance**
- 1GHz Cortex-A8n CPU (45nm LP)
- Multiple LPDDR2 port

**Rich Multimedia**
- 1080p 30fps MFC
- fully supported Profiles
- Image Enhancement
- Γamma, Visibility Enhance

**Multi-tasking**
- Browser + MP3 player
- SD-Video Conferencing
- Video Juke box

Mobile Infotainment Solution

- Full HD recording
- Multi-tasking
- 2D/3D UI/Appl.
- Full HD Play
- Internet Contents
- Full Browser
**NAND Flash Solution**

- System LSI’s SOC is aligned with MLC NAND & MoviNAND

![Diagram showing NAND Flash Solution](image)

**POP (Package-On-Package) Solution**

- POP is the result of synergies between S.LSI AP & Memory MCP
  - Small & thin size, low EMI achieved through joint optimization
    - Enables slim phone design and reduces debugging time with low EMI

![Diagram showing POP Solution](image)
**System-level Optimization: OneDRAM**

- Slim modem + AP + OneDRAM solution results in a better design than single-chip modem / AP solution

**SoC Integration:**
- Small Size
- High Performance

**But......**
- HIGH Design Cost
- LONG Time-To-Market

**Samsung OneDRAM™ Solution**

**System-Level Design:**
- Small Size
- High Performance

**Also,**
- Lower Design Cost
- Faster Time-To-Market

**System-level Optimization: HSI**

- System power, cost and EMI noise can be reduced with the use of HSI (High-speed Serial I/F) instead of parallel I/F

- Samsung has the complete suite of HSI solutions
  - MIPI DSI/CSI, HDMI I/F

**Parallel Interface**
- High power consumption
- Larger board area (cost)
- High EMI noise

**High-speed Serial Interface**
- Low power consumption
- Smaller board area (cost)
- Low EMI noise
Samsung’s Total Solution for Mobile Devices

- Samsung provides total mobile solution

**Display Driver IC**: STN, TFT, OLED

**Connectivity**: UWB, NFC, Mobile TV

**Camera**: CIS, ISP

**Mobile Processor**: AP

**Working RAM**: Mobile DRAM, SRAM, UtRAM

**Smart Card**: SIM

**Flash Memory**: Code/Data Storage

**SIP / POP, MCP**
Five Strategic Products

- Samsung has been focusing on 5 strategic products
- The success of these products evidenced by their W/W M/S

<table>
<thead>
<tr>
<th>Process</th>
<th>IP</th>
<th>Product</th>
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<tbody>
<tr>
<td>DDI</td>
<td>90nm</td>
<td>High Speed I/F</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MIE (Mobile Image Enhancement)</td>
</tr>
<tr>
<td>CIS</td>
<td>90nm (1.4um Pixel)</td>
<td>Wafer Level Module</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EDoF (Extended Depth of Focus)</td>
</tr>
<tr>
<td>Smart Card IC</td>
<td>90nm e-Flash</td>
<td>Security IP</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SWP (Single Wire Protocol)</td>
</tr>
<tr>
<td>Mobile AP</td>
<td>65nm Low Power</td>
<td>GPS S/W Solution</td>
</tr>
<tr>
<td></td>
<td></td>
<td>OneDRAM POP</td>
</tr>
<tr>
<td>Media SOC</td>
<td>65nm e-DRAM</td>
<td>Multimedia IP</td>
</tr>
<tr>
<td></td>
<td></td>
<td>800MHz CPU</td>
</tr>
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Mobile DDI: Key Technologies (1/2)

- Full Frame Buffer Integration
  - qVGA, VGA, wVGA
- Low Power Solution
  - Advanced display algorithm (CABC/LABC/RGBW)
  - 1.2V Process technology
- High Speed Serial Interface
  - MSPI
- Touch Integrated Display Driver IC

* ABC: Adaptive Backlight Control
* CABC: Content-based ABC
* LABC: Light-based ABC
* RGBW: RGB-White
* MSPI: Mobile Industry Processor Interface
Mobile DDI: Technology Roadmap (2/2)

- Low power & Image enhancement solutions
  - Full Memory (WVGA)
  - 1.2V (Core voltage)

- Higher Resolution by process migration
  - QVGA: migration from 1.8V to 1.2V
  - HVGA: migration from 1.8V to 1.2V
  - WVGA: migration from 1.8V to 1.2V

- New U/I and MIPI Roadmap
  - Touch Integration
  - Samsung MIPI IOT platform

CI S: Mobile Camera Solution (1/3)

- 1.4um pixel (5MP/8MP/12MP) technology
  - High sensitivity (Backside Illumination), high speed (Full-HD)

- Low Cost: 1/5" 3MP, 1/6" 1.3MP

- Matching ISP (12MP/8MP)
- Backside illumination
- Size Reduction
- High SNR, Video Telephony
CIS: Low Cost Camera Solution (2/3)

- Cost reduction by Wafer Level Camera
- TSV-ready wafer - 2MP (6BA), 1.3MP (6AA), VGA (A3D)

![Graph showing cost reduction over years]

CIS: EDoF (Extended Depth of Focus) (3/3)

- EDoF will dominate in Fixed-Focus Camera Phone segment
  - Macro capability & cost/size advantages
- Samsung's EDoF solution has better macro capability than competitors
  - Applications: 2D bar code reading, business card recognition...

![Graph showing EDoF capabilities]

* FF: Fixed Focus  * CIS: CMOS Image Sensor
Smartcard: Biz History (1/3)

- 1993 Started to Develop Smart Card IC
- 1998 SIM shipment Ramp up

Fast Growth

- 2002 Developed Flash Products
  - First EMV product shipment

Market Leader

- 2003 Developed 128KB SIM
- 2004 Developed 512kB SIM
  - Presented S-SIM sample
  - Driving EMV migration in Korea
- 2006 WW SIM M/S #1
  - Driving W/W EMV migration & ID/Pay TV solution

- SIM Card Market Share
  - World #1 M/S in 2008
- Finance / ID / Pay TV
  - Significant growth in 2008

Smartcard: Core Competence (2/3)

Fast Process Migration

- EEPROM
  - 0.15u
  - 0.13u
  - 0.18u
  - 0.11u

- FLASH
  - 0.18u
  - 0.13u

- 90nm (2008)

Innovation

Flash-based SIM Technology

- EEPROM
- Flash
Smartcard: S-SIM (3/3)

- S-SIM is a new type of SIM with large secure memory
  - Applications: Mobile TV, Smartcard Web Server, etc.

(AS-IS)

Conventional Flash Card
Conventional SIM

(To-Be)

Less Space Enhanced data security Lower BOM Cost
Single Slot
Save Cost & Space

2 Cards 2 Sockets More Space More Cost

Backward Compatibility with Standard SIM Card

Smartcard: S-SIM (3/3)

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Other Solutions: Mobile TV (1/2)

Worldwide Mobile TV Deployment

Korea : 2005

Majority DVB-H
Minority T-DMB

Majority CMMB
Minority TMMB

Majority T-DMB
Minority S-DMB

North America

Majority MediaFLO
Minority DVB-H

USA : 2007

South America

Majority ISDB-T
Minority DVB-H

Brazil : 2007
Uruguay : 2008
Peru : 2008

Majority ISDB-T
Minority DVB-H

EU

Majority DVB-H
Minority T-DMB

France, Russia, Switzerland : 2008

Kenya : 2007
Nigeria : 2007
Namibia : 2007
Ghana : 2007/T-DMB

EU DVB-H (1.6GHz)

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EU DVB-H (1.6GHz)

EU DVB-H (1.6GHz)

MediaFLO (700MHz)

T-DMH (200MHz)

T-DMB (200MHz)

Korean S-DMB (25MHz @ 2.6GHz)

Brazil : 2007
Uruguay : 2008
Peru : 2008

Videoex (700MHz)

T-DMB (200MHz)

Other Solutions: Mobile TV (1/2)

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Videoex (700MHz)

T-DMB (200MHz)
Other Solutions: Mobile TV (2/2)

Samsung Mobile TV Solution

- Multi mode support
- Low cost, Small size
- Low power consumption
- Complete Solution

- 65nm SoC
- Maximum power (DVB-H mode) < 200 mW

- High mobile performance
- ~300km/ hr

Other Solutions: Wireless USB (1/2)

Market Needs

- **Cable Replacement Solution**
  - PC and peripherals (printer, scanner, external storage)
  - PC and mobile devices (phone, MP3, camera, camcorder)
  - Short range / high speed

- **Low-power Wireless Solution**
  - WiFi drains battery (~1W)
  - Need ~300mW solution

Technology

- **Ultrawideband (UWB)**
  - Unlicensed band (3GHz ~ 10GHz)
  - 480Mbps @3m (< 10m range)
  - Low power (<300mW target)

- **Wireless USB**
  - WiMedia UWB PHY + MAC
  - Replacement for USB 2.0
  - Easy market penetration
**Other Solutions: Wireless USB (2/2)**

- **Samsung Wireless USB Solution**
  - Direct interface to mass storage
  - High throughput (120Mbps) data transfer from/to mass storage
  - Reduces AP's load for multi-tasking
  - No driver installation
  - Standard interface (USB, SD card, SRAM I/F) between AP & UWB BB

**Other Solutions: NFC (1/2)**

**Secure Data Exchange**

1. **Card Emulation**
   - Payment, Ticketing, Accessing

2. **Reader/Writer**
   - Get Info from NFC Tags

3. **Peer-to-peer**
   - Share Contents between devices

**Technology**

- **Short-range HF-band Communication**
  - Carrier Frequency = 13.56MHz, Working Distance <10cm
  - Data Rate: 106kbps, 212kbps, 424kbps

- **Compatible with Existing Contactless Infrastructure**
  - Simple extension of contactless smartcard standard (ISO 14443 A/B)
Other Solutions: NFC (2/2)

Advantages of Samsung NFC Controller

- **Very Low Power CPU**
  - Self-timed logic
- **eFlash Memory for High Flexibility**
  - Easily patched
  (Minor standard changes expected)
- **Secure Element I/F**
  - SWP for UICC(SIM)
  - S²C for phone-embedded SE
- **Low Power RF/Analog**
  - Advanced design rule (0.13um)
  - Supports Battery-off Mode

Conclusion

- **Mobile Internet and multimedia applications**
  → smarter mobile devices
  - Require High-performance & Low-power SOC
- **Samsung’s high performance SOC technology:**
  - 32nm High-k & Metal Gate process technology
  - Low power & high performance CPU
  - Advanced multimedia & 3D graphics IP
  - Memory synergy & System-level optimization
- **Samsung has mobile total solution capability:**
  - DDI, CIS, Smartcard IC and others (Mobile TV, WUSB, NFC)