Best Ways to use Billions of Devices on a Wireless Mobile SoC

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Wireless Mobile SoC Trends

• The state-of-the art SoC for Wireless Handheld Devices

One-Chip Integration (SoC/SiP)

• Application Processor
  - Ever-increasing performance (over 1GHz)
  - Diverse applications: VoIP, Video, Audio, Graphics, Game, Navigation, Web-browse, Email
  - Multiprocessors: MPCore CPUs + Graphic Processors

• Samsung’s mDirac / SAVm Processors
• Marvell PXA / TI’s OMAP3

• Baseband Processor
  - Ever-increasing communication data-rate (over 100Mbps)
  - Diverse Standards: 2G/3G/WMAN/WLAN/ WPAN/MobileTV
  - Multiprocessors: CPU + DSPs
  - One-Chip RF Integration

• Samsung’s 802.16e / Marvell’s 802.11n

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Requirements of Wireless Mobile SoC

- Wireless application has different requirements than other computer or embedded applications.
  - Higher Clock Speed does NOT guarantee the Higher Air Throughput.
  - Integration density is not so high as computer application SoCs.
    because Ultra-Low-Power/Heat/form-factor design is more important.
  - Inter-Operability Test may take the most time of chip development.
  - Communication Protocol SW development is larger scale and costly.

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<th>Computer SoC</th>
<th>Embedded SoC</th>
<th>Wireless Mobile SoC</th>
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<tbody>
<tr>
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Engineering Issues for Baseband Processor

1. System-level Low-power design
   - Performance is ever-increasing but battery is never sufficient.
   - Top-down low-power design is needed from system-level to physical-level

2. Programmability and Reconfigurable design
   - Multi-standard support on a single chip
   - Early development before the standard fixed
   - Flexible Repair and debugging without silicon re-spin!

   - ASIC+DSP design for PHY processing, CPU for protocol processing
   - Seamless Data Flow via RF → BP → Host (AP) → Storage or Display

4. System Integration
   - SoP / Embedded PCB Integration of AP+BP or BP+RFIC

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Low-Power Issue for Handsets

- Many high-end computer applications are running on Smart-Phones.
- Baseband Processing and RF needs more power which always comes with Heat!
  (e.g., MIMO tech. $\rightarrow$ Multiple Antennas $\rightarrow$ Multiple Power Amplifiers)
- **Aggressive Low-Power Techniques are being used** and will be used in BP.
  - Dynamic Power Reduction: Clock Gating, Dynamic Voltage Freq. Scaling, $\rightarrow$ Adaptive Voltage Scaling
  - Leakage Power Reduction: Multi-$V_{th}$ Cell, Power Gating. $\rightarrow$ Sleep Tr., Body-Bias Control
- **System-level Low-Power design is more crucial**
  - Algorithm: **Power-aware Protocol Standard**
  - Architecture: Low-Power Modem H/W architecture (Less Buffer, Lower Frequency, Modular design)
  **Parallel Processing** lowers the frequency and voltage.
**Reconfigurability Issue for Handsets**

- **Existing Mobile Chip contains Multiple RF Transceivers / Baseband Modems**
- **Multiband RF, Multimode Modem**
  - Provides Multiple Telecom. Mode on a single architecture
  - **Multiband RF Transceiver**: Variable Frequency Tunable RF structure
  - **Multimode Baseband Modem**: Reconfigurable structure according to Telecom. Mode

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**Today**

- **Multiple RF Transceiver**
  - 2.4GHz (WLAN)
  - 5 GHz (WLAN)
  - 2.3GHz (WiMax)
  - 200MHz (T-DMB)

**Future**

- **Multiband Antenna**
- **Multiband RF Tx/Rx**
- **Freq. Control**
- **Controller**
- **Mode Control**

- **Multiple Baseband Modem**
  - WLAN BB 11a/b/g
  - WiMax BB WiBro, 16e
  - DMB BB T-DMB, DVB-H

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Requesting to EDA, Fabrication, IP Industrials and Academia

“Wireless Terminal Manufacturers are facing more urgent challenges than increasing the chip density and its clock speed!”

1. Ultra Low-Power Design Technology
   – Need to Reduce Power Consumption to a Tenth!
     • Completely New System, Architecture, Circuit and Process technology
   – IP Provider should support aggressive Low-Power Mode and Features.
     • ex) Sleep-mode support when it is idle, Data-driven clock gating
   – Highly Scalable and Parallel Architecture is preferable.

2. Reconfigurable Technology
   – Highly Scalable & Flexible Multicore/Multithread DSP architecture
   – Ultra low-power & less-area embedded FPGA and its compiler support
   – Various Multimode-supporting IPs for Wireless Modem

GALS: Globally Asynchronous Locally Synchronous