Trends in Telecommunications and Their Impact on VLSI

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Presented in VLSI 2008 Conference in Hyderabad, India
January 8, 2008
The world will be increasingly “Wire-less”
  - Especially in access space

Home Gateway / Femtocell will be pervasive
  - WiFi interface to the client / Handset
  - X-DSL / Cable / WiMAX / LTE to network

WiMAX and LTE will rival X-DSL / Cable modem in cost / performance

Intelligence will migrate to Handset / Home Gateway
  - Expert Systems and AI Concepts Will Be Incorporated In Handsets

Low power design / process will dominate the semiconductor industry

These trends will have impact throughout the semiconductor industry food chain
We are Migrating to a **World Without Wire**!

**Voice**

**Date**

**Video**

**Objective:** Seamless Mobility
Intelligence Will Migrate More to the Handset

Starting in 1992 with Basic Handsets

1. NEC Cellstar 500 (1992)
5. Audiovox CDM8300 (2002)

Intelligence is Moving to the Handset (2007)

- Bluetooth
- Camera
- Windows
- Mobile TV
- Wireless LAN
- GPS
- MP3
- Gaming
- MPEG4
- Software Apps

1. Blackberry Curve
2. Samsung Blackjack
3. Apple IPhone
4. Palm Treo
Effect of Intelligence migration!

- Voice
- Data
- Video

Handsets Will Be The Future Workstation - AI / Expert Systems Will Be Used
Standardized Core and Access Network Elements

General Purpose

Core Network

Access Box/ Base Stations

Femtocell

Handset

ATCA and MicroTCA standards will be utilized to develop off-the-shelf HW/SW solutions

Windows NT
Linux

Specialized/Custom Hardware and Software

Windows Mobile
Palm OS
Blackberry OS

Short Product Life-cycle will be the Norm
## Semiconductor Technology in the Wireless Food Chain

<table>
<thead>
<tr>
<th>Cost</th>
<th>Tech</th>
<th>Equipment Supplier</th>
<th>IC Supplier</th>
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<tbody>
<tr>
<td>Core</td>
<td></td>
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<tr>
<td>10%</td>
<td>ASSP</td>
<td>Alcatel, Cisco, Ericsson, Fujitsu, Hewlett Packard, Huawei, IBM, NEC, Nortel, Sun</td>
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<tr>
<td>60%</td>
<td>FPGA</td>
<td>Apple, LG, Motorola, Nokia, RIM/Palm, Samsung</td>
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**Intelligence/Caching:**
- **SHRINKING**
- **EXPANDING**
Wire-less Issues that will Drive the Semiconductor Industry

Issues in the Wire-less World

- Power
- Size
- Performance
- Short Product Life Cycle
- Time-to-Market
- Cost

How the Semiconductor Industry will Respond

- Ultra Low-Power Process Technology/Low-Power Design
- Package-less Packaging
- Higher Levels of Integration
- Standard Hardware and Software Platforms
- Highly Programmable Solutions
- Migration from SiGe and GaAs to CMOS
Low Power will Dominate

- TSMC’s logic technology roadmap introduced at the 2007 Technology Symposium
- Low power technology nodes dominate the future
- Through 2009 there will be three low power nodes introduced while general purpose and high performance nodes will be combined for two nodes.
Packaging will go through dramatic changes to address the key issues of power, size, performance and cost for the Handset and Home Gateway.

- Cost breakdown for a typical ASIC using a flip chip is dominated by the package.
- Package sizes are prohibitive and must be reduced and even eliminated.
- Migration to “Package-less Packaging” and Chip Scale technology will continue to be the future direction.

### IC Cost Breakdown

- Package: 10%
- Die: 10%
- Test: 10%
- Other: 40%

As the industry shifts to higher levels of integration today’s packages will vanish.

**Apple iPhone**
IC Cost Breakdown

- Package: 40%
- Die: 40%
- Test: 10%
- Other: 10%
Package Technology for the Handset and Home Gateway

Packaging will go through dramatic changes to address the key issues of power, size, performance and cost for the Handset and Home Gateway

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As the industry shifts to higher levels of integration today’s packages will vanish
Advanced TCA Standardization

- Standard Blades
- Standard Modules
- Push for open standards

Switch Cards (1-2)  LineCards (3-16)

Example ATCA-Based Telecom System
Source: Light Reading
Access and Core Differentiation Migrates to Software Apps

Stack for Server Applications

- Differentiation Migrates to the Software Applications
- OS Based on Standard Linux
- Standardized Hardware in the Core

Source: Motorola
Specific Challenges in the Handset

The Issues

► Power & Cost

► Very Short Product Life Cycles

► Continuous Drive to Add Functions, Features and Intelligence in very short time-frames

► Must Meet Multiple Geographic Markets with Different Standards with Little Change

Hardware and Software Platforms will be Deployed to Reduce Time to Market While Increasing Levels of Integration, Function and Programmability

Typical Platforms

- RF
- MEMS
- Baseband
- Software Defined Radio
- Control
- Specialized platform
The 70's Main Frame Brought Vertical Integration

The Vertical Integration in the Main Frame Domain

Service
- Applications
- Operating System
- Peripherals
- System Hardware
- ASIC/CPU
- FAB

Large Corporate Installation

Main Frames Were Sold to Large Corporations and Not to the End Users

The End Users

IBM 370

Large Corporate Installation

Main Frames Were Sold to Large Corporations and Not to the End Users
The PC Deconstructed: Vertical Integration

The Horizontal Deconstruction brought by the PC

- **FAB**
  - TSMC
  - UMC
  - Chartered
  - SMIC

- **ASIC/CPU**
  - Intel
  - AMD
  - Toshiba
  - OpenSilicon
  - eSilicon

- **System Hardware**
  - Acer
  - HP
  - Dell
  - Apple

- **Peripherals**
  - Maxtor
  - Seagate
  - Kingston
  - SanDisk

- **Operating System**
  - Microsoft
  - Apple

- **Applications**
  - Microsoft
  - Apple
  - Adobe
  - Corel

System Integrator & Direct Sales

Diverse Customer Base from Corporations to Individuals

Direct Sales to the Customer
Seamless Mobility will have a Major Socioeconomic Impact

Pre-Industrial Revolution

► The Company Provided the Space to Work
► The Workers Brought Their Own Tools

Post-Industrial Revolution

► The Factory Provides the Space and the Tools

We are Returning to a Pre-Industrial Revolution Model
Seamless Mobility will have a Major Socioeconomic Impact

Modern Society of Today

The Personal Computer is the Primary Tool

Content Provided by Private and Corporate Servers

Post-Modern Society

The Handset is the Worker’s Tool

The “workers” will bring their own tools to the office

During this transition certain layers within the food-chain that are not adding significant value will disappear

Content Provided by Open and Public Suppliers

As more of the intelligence migrates to the handset it will become the primary tool of the office and personal life
You Must Add Value in the New World to Survive

Examples of Who Will Face Threat in the Food Chain

The Laptop  →  Nokia
Apple

The Handset

Retailers  →  Wireless Carries

The Middlemen Will Be Under Threat - Package Vendors, Distributors, & Reps

Business Model Will Have Dramatic Change
You Must Add Value in the New World to Survive

What will happen to the Equipment Suppliers to the Core Network?

**Hardware Manufacturers**

- **FOXCONN**
  - Advanced TCA Standardization

New manufacturing focused companies will dominate the hardware for the core network as standardization takes place.

**Equipment Suppliers**

- **Nortel**
  - System Integration And Services

Traditional equipment suppliers will be forced higher in the food chain to system integration to add value.

**Wireless Carriers**

- **verizonwireless**
  - **at&t**

Access to the Content

Providing access to the content will become a large portion of the Carriers’ business similar to the TV Networks.

Equipment Suppliers Will Become System Integrators
You Must Add Value in the New World to Survive

What will happen to the Carriers’ Business Model?

End Users

Carriers

Content Supplier

Carriers Must Give the End User Seamless Mobility and Seamless Access to Content
What Will the World Look Like in the Future?

- It will be a world without wire
- It will be a Mad-berry world
- Certain layers that dominate the food chain today will disappear
- And the workers will bring their own tools to work with him
• It will be a world without wire

• Intelligence will migrate more to the handset
  ▪ Expert System and AI Concepts Will Be Incorporated

• Core and access network will be based on standardized hardware and software platforms
  ▪ Differentiation Will Be In Applications and Managements SWR

• FPGA / ASSPs used mostly in the core and access
  ▪ ASSP Business Future?
  ▪ Platforms concept will dominate

• Volume is in the Handset / Home Gateway requiring specialized software programmable IC's

• SiGe / GaAs will face threat… CMOS is IN ?

• “Package-less Packaging” and chip scale technology will dominate

• In the End, Low-Power will be King!
Thank You