Successful Entrepreneurship for Microsystems

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October 23, 2014

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Course presented at UCSD CSE 190, Fall Quarter 2014
“DOOM and GLOOM”
BAU

“EXCITING Times”
Must ADAPT,
INNOVATE,
Be ENTREPRENEURIAL
...

after “Let’s Make a Deal”
Changes are coming at an amazingly RAPID rate!
On the Metro in Shenzen, China, October 28, 2013
Semiconductors drive the Electronics food chain

Let’s educate the people around us, ...about our complex business
Let’s educate the people around us, …about our **complex** business
Smartphones – Looking Inside

Source: iFixit iPhone5
MANY Levels of Innovation

Software
Display
Antenna
Touchscreen
Processor
Radio/RF Front End
Sensors
...
...

Source: iFixit iPhone5
Some Market Opportunities

…and some food for thought!
Mobile Wireless Evolution

Enabling the First:
- Internet experience
- Computing experience

Mobile & Connected
Anywhere, Anytime, for Anyone

Situation Aware
vs. Location Aware

The Largest Platform in the History of Mankind
Continued smartphone momentum

~20% CAGR for smartphone unit shipments expected between 2012-2017

~7B

Cumulative smartphone unit shipments forecast between 2013-2017

Source: Gartner, Sept '13

Ref: Qualcomm Analyst Day, November 20, 2013
Emerging region growth

~3.4B 3G/4G connections expected by 2017

>80%

Of handset shipments expected to be smartphones in 2017

Source: GSMA Intelligence, Nov '13; Gartner, Sep '13. This data now includes Eastern Europe in emerging regions, which was previously included in developed regions.

Ref: Qualcomm Analyst Day, November 20, 2013
Applying mobile technologies to everything
Making them more aware, connected, intelligent and interactive

Ref: Qualcomm Analyst Day, November 20, 2013
The 1000x Data Challenge

Data Demand Increase

Richer Content

Global Traffic

More Devices

Ref: Qualcomm Stockholder Meeting, March 4, 2014
Expanding Application Areas

Smartphone experience influencing tablet designs

~30% CAGR forecast of tablet shipments from 2012-2017

Common HW/SW

Long battery life

Touch screen

Embedded sensors

Advanced camera capabilities

Common app development

Source: Gartner, Sep '13

Ref: Qualcomm Stockholder Meeting, March 4, 2014
Snapdragon automotive solutions for connected infotainment
Driving the next generation of in-car connected experiences

Ref: Qualcomm Stockholder Meeting, March 4, 2014
The New Paradigm: "Things"

Mobile
Connected
Smarter..

Sensors everywhere…
Healthcare
Digital Home
Green Energy

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The Internet of Things (IoT)

Connected smarthome
Transforming the home experience

- Game consoles
- Smartphones
- Tablets
- TVs

Connectivity (802.11ac and low power Wi-Fi)

Home gateway

- Security
- Appliances
- Temperature
- Lighting

Internet processor

Small cells

Ref: Qualcomm Stockholder Meeting, March 4, 2014
Qualcomm® AllPlay™ smart media platform is built on top of AllJoyn™

Stream music directly from the cloud
Stream music from phones/tablets
Stream from multiple sources to multiple syncs

AllJoyn open source project is hosted by the AllSeen Alliance.

Ref: Qualcomm Stockholder Meeting, March 4, 2014
The Skyworks View...

Connected Home Applications

- Smart Door Locks
- Notebook PC
- Printer
- Home Stereo
- 802.11ac Access Point
- Home Security
- Smart Appliance
- Set-top Box
- Blu-Ray Player
- Gaming Console
- Smart Meter
- Media Gateway
- HDTV
- Monitoring
- Smart Home Controller
- Wireless Door and Window Sensors
- Smart Thermostat and Smoke/CO₂ Alarm
- Smart Lighting

Ref: Skyworks, Investor Presentation 2014
Canary, a surprisingly simplistic smart-home security device, surpassed all expectations last year when it achieved 1962% of its original fundraising goal of $100,000 (approx. £60,000). Raising nearly $2million dollars the device proved that there was a desire for home-security to enter the digital age.

Canary is a plug-in unit that can operate using homeowners Wi-Fi or Ethernet connection. The device includes: a siren, a 1080p hd camera, a motion detector, microphone, and environment monitoring technology. Keeping track of the homes activity, noise levels, air quality, temperature and humidity, Canary then alerts homeowners via its smartphone app when it senses something out of the ordinary. From the alert the user can see video of the event, as well as the option to view a live stream, and choose how to respond correctly – call the emergency services, sound the siren, or simply ignore.

The device is unique in the home security market as at its most basic level it simply requires a one off payment ($199) rather than a monthly security subscription, and it is also accessible for renters who may have limited options on home security. Users can also set a back-up for when they are unable to respond, nominating a neighbor or family member to monitor the notifications whilst on holiday.

The brand also take data security seriously and have utilised 256-bit (AES encryption, firewalls, extended validation SSL certification, and automatic notification for connection-loss events (in this case a user controlled cloud system will allow access to historical audio/visual for up to 30 days).

http://www.techxx.net/2014/06/12/smart-home-start-up-canary-begins-beta-testing/

200 units went into production this month which will be used for extended testing of how the device responds to different environments, paving the way for an expanded beta
Healthcare applications...

Millimeter-Scale Computer for Glaucoma Patients:

Taking charge ...many Sensors

Source: University of Michigan, Feb 2011

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Digital 6th Sense…
Augmentation of human ability

- KNOW the LOCATION
- SENSE the user’s MOTION
- SEE the user’s ENVIRONMENT
- HEAR the user’s SURROUNDINGS

Ref: Qualcomm Analyst Day, November 20, 2013
Good news for Start-ups!

Targeted M&A

Acquisitions over the past 5 years*

<table>
<thead>
<tr>
<th>Range</th>
<th>Count</th>
<th>Company</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;$350M</td>
<td>1</td>
<td>Atheros</td>
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<tr>
<td>$50M-$350M</td>
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<tr>
<td>&lt;$50M</td>
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</table>

Strategy

- Technology focused
- Extension of R&D program
- Accelerate position in new growth areas
- Atheros only >$350 million in last five fiscal years
- >75% of deals less than $50M

Ref: Qualcomm Analyst Day, November 20, 2013
History

Market Drivers

Industry Directions & Challenges
Smartphones drive diverse technologies

Performance

Compact

Low Cost

Battery Life

Low Power

User Experience

Architecture, SW, Design, …

More Moore

More than Moore

FC + WB stack

TSV + FC stack

TSV system stack

MEMS Sensors
More Moore

...Transistor complexities have doubled every 2 years

Transistors per Chip, M
Minimum Feature Size, um

Moore’s Law
2x / 12mos…1965-70
2x / 18mos„1970-90’s
2x / 24mos…now

-13% / year

+43% / year

Year

Source: IC Knowledge, ISSCC, TCX

Fabless Co.’s
Semiconductor Co.’s – Fairchild, T.I., Motorola, National, Intel, Toshiba, …

System Co.’s – IBM, Hitachi, Sony, Philips, Unisys,…

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**ECONOMIC challenges are threatening**

Increased Cost of Capital, R&D, Design

Costs associated with node progression have been rising significantly

<table>
<thead>
<tr>
<th>Node</th>
<th>Fab cost</th>
<th>Process development cost</th>
<th>Chip design cost including fabless overhead costs*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$ Millions</td>
<td>$ Millions</td>
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<tr>
<td>130nm</td>
<td>1,450</td>
<td>250</td>
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<tr>
<td>22nm</td>
<td>6,700</td>
<td>1,300</td>
<td>150</td>
</tr>
</tbody>
</table>

* Chip design cost includes product R&D cost (design, verification & photomask) and other fabless costs (overhead, IP licensing, etc.)

Estimated cost CAGR

- 16% p.a.
- 18% p.a.
- 17% p.a.
- 21% p.a.
- 25% p.a.
- 25% p.a.

<30% ~40% ~60%
Typical QFN Package

QFN: Qual Flat-pack No-lead

Source: ASE
Innovative Packaging Examples for Reducing Form Factor

Stacked Chips

Stacked Packages

Side-by-Side

3D Stacked IC’s

Source: IMEC
HTC Desire Smartphone uses Qualcomm’s MSM 8255

HTC Desire HD
4-die stack BGA package

Source: ASE
4-die stack

Source: STATS chipPAC
An example ASIC* Development Cycle

ASIC DESIGN

FPGA
Ref Board

Proto

Prod Ramp

Hi Volume

Year 0

Year 1

Year 2

Start Design

Tapeout

ES

QS

Prod
HW/SW

Launch

Software

α

Software

β

Software

Prod.

Initial Silicon

Initial Silicon Ramp

Initial Product Ramp

Volume Production

* ASIC: Application Specific Integrated Circuit