Successful Entrepreneurship for Microsystems

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Course presented at UCSD CSE 190, Spring Quarter 2014
OUTSOURCING

- When to use
  - Not your core-competency
  - Need quick entry/service
  - Conserve capital
  - Does not compromise your IP

- Some ‘watchouts’
  - “Make” vs “Buy”
  - Margin stacking
  - Supplier Management
    - Meet your goals for Schedule, Performance, Quality, Reliability,…
COT Outsourced Margin Stacking – SoC GDSII Handoff

Company X
SoC IC

“General Contractor”

Masks → FAB → Assembly → Package → Test

Supplier Cost:
1 m  1 d  1 a  1 p  1 t  1 s

Marked-up Cost (typ):
1.1 m  1.3 d  1.1 a  1.1 p  1.1 t  1 s

Price for Company X:
1.3<sup>a</sup> x [ 1.1 m  1.3 d  1.1 a  1.1 p  1.1 t  1 s ]

Notes:

<sup>a</sup> this markup could vary (1.0 - 1.3), depending on price negotiation

m  mask cost, could be amortized over unit volume
d  die cost
a  assembly cost
p  package cost
t  test cost
s  product and other support cost
Mark-up vs Margin

MARKUP = \[P - C\] / \(C\)

or, \(P = [1 + MU] \times C\)

MARGIN = \[P - C\] / \(P\)

or, \(P = C / [1 - GM]\)

aka Gross Profit Margin

Example:
\(C = $10\)

\(MU = 30%\)

\(P = $13\)

Margin = ?
Lifecycle of a Startup development – the 4 phases

- Global Planning
- Design
- Proto-typing
- Production

Grants, Incubators, FFF...

- Angel
- Series A
- Series B

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Lifecycle of a Fabless IC development – activity highlites

“System” Architecture / Design / Simulation / Verification

FPGA Implementation
Reference Design
Customer Evaluation “Proof of Concept”

Customer Samples
Reference Boards
Customer Evaluation Design Acceptance

Global Planning
High Level Design
Floor Planning

IC Design
Chip Design
RTL NL
Physical Design
NL GDSII
Analog IP Design

IC Prototyping
IC Production
IC Qualification
Prod. Ramp
Debug
Hi volume

Series A
Series B

30 – 50% of TT$
Fabless Value Chain using IFM approach

Fabless success depends on a strong Eco-system of suppliers and partners
Multi-Tiers of Value Chain and Ecosystems

PP Supplier’s Supplier → PP’s Supplier → Product Provider → Customer → Customer’s Customer

Technology

Value Chain ➔ Supply Chain

PCB
Foundry
Packages

MANY Opportunities for Innovation & Electronics Development
Electronics Value Chain...Auto Nav System

Display
Touchscreen Overlay
MCU 32 bit 32 MHz 1 MB Flash 64 KB RAM
16-Channel 10-bit ADC
Regulator DC_DC converter
Power Management IC

Chrysler 300
Hyundai Sonata

Source: IHI Electronics360 130813

OMAP Processor, ARM11
Dual core 400 MHz
MCU 32-bit 32 MHz 128 I/Os
MCU 32-bit 400 MHz
Gyroscope
GPS Receiver
Flash 8GB MLC
Flash 4GB
CD/DVD Drive
Smartphones – Looking Inside

Source: iFixit iPhone5
## Electronics Value Chain ...Smartphones BoM (Bill of Materials)...iPhone5 S

### Table 1: Preliminary Teardown Bill of Materials and Manufacturing Cost Estimate for the Apple iPhone 5s (Cost in US Dollars)

<table>
<thead>
<tr>
<th>Components / Hardware Elements</th>
<th>Details</th>
<th>16GB</th>
<th>32GB</th>
<th>64GB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pricing without contract</td>
<td>$649.00</td>
<td>$749.00</td>
<td>$849.00</td>
<td></td>
</tr>
<tr>
<td>Implied Margin</td>
<td>69%</td>
<td>72%</td>
<td>74%</td>
<td></td>
</tr>
<tr>
<td>Total BOM Cost</td>
<td>$190.70</td>
<td>$200.10</td>
<td>$210.30</td>
<td></td>
</tr>
<tr>
<td>Manufacturing Cost</td>
<td>$8.00</td>
<td>$8.00</td>
<td>$8.00</td>
<td></td>
</tr>
<tr>
<td>BOM + Manufacturing</td>
<td>$198.70</td>
<td>$208.10</td>
<td>$218.30</td>
<td></td>
</tr>
</tbody>
</table>

#### Major Cost Drivers

- **Memory**
  - NAND Flash: 1GB LPDDR3 $9.40, $18.80, $29.00
  - DRAM: 1GB LPDDR3 $11.00, $11.00, $11.00
- **Display & Touch Screen**
  - 4" Retina Display w/ Touch $41.00, $41.00, $41.00
- **Processor**
  - 64-Bit A7 Processor + M7 Co-Processor $19.00, $19.00, $19.00
- **Camera(s)**
  - 8MP (1.5-micron) + 1.2MP $13.00, $13.00, $13.00
- **Wireless Section - BB/RF/PA**
  - Qualcomm MDM9615M+WTR1605L+Front End $32.00, $32.00, $32.00
- **User Interface & Sensors**
  - Includes fingerprint sensor assembly $15.00, $15.00, $15.00
- **WLAN / BT / FM / GPS**
  - Murata Dual-Band Wireless-N Module $4.20, $4.20, $4.20
- **Power Management**
  - Dialog + Qualcomm $7.50, $7.50, $7.50
- **Battery**
  - 3.8V~1560mAh $3.60, $3.60, $3.60
- **Mechanical / Electro-Mechanical**
  - $28.00, $28.00, $28.00
- **Box Contents**
  - $7.00, $7.00, $7.00

*Source: IHS, September 2013*
Electronics Value Chain ... Smartphones
BoM (Bill of Materials) ... iPhone 5

<table>
<thead>
<tr>
<th>Components / Hardware Elements</th>
<th>iPhone 5 Hardware Comments</th>
<th>16GByte</th>
<th>32GByte</th>
<th>64GByte</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pricing without Contract</td>
<td></td>
<td>$649</td>
<td>$749</td>
<td>$849</td>
</tr>
<tr>
<td>Total BOM Cost</td>
<td></td>
<td>$199</td>
<td>$209</td>
<td>$230</td>
</tr>
<tr>
<td>Manufacturing Cost</td>
<td></td>
<td>$8.00</td>
<td>$8.00</td>
<td>$8.00</td>
</tr>
<tr>
<td>BOM + Manufacturing</td>
<td></td>
<td>$207</td>
<td>$217</td>
<td>$238</td>
</tr>
<tr>
<td>Major Cost Drivers</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Memory</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NAND Flash</td>
<td>1GByte LPDDR2</td>
<td>$10.40</td>
<td>$20.80</td>
<td>$41.60</td>
</tr>
<tr>
<td>DRAM</td>
<td>1GByte LPDDR2</td>
<td>$10.45</td>
<td>$10.45</td>
<td>$10.45</td>
</tr>
<tr>
<td>Display &amp; Touchscreen</td>
<td>A6 Processor</td>
<td>$17.50</td>
<td>$17.50</td>
<td>$17.50</td>
</tr>
<tr>
<td>Processor</td>
<td>8 Megapixel + 1.2 Megapixel</td>
<td>$18.00</td>
<td>$18.00</td>
<td>$18.00</td>
</tr>
<tr>
<td>Wireless Section - BB/RF/PA</td>
<td>Qualcomm MDM9615+RTR8600+Front End*</td>
<td>$34.00</td>
<td>$34.00</td>
<td>$34.00</td>
</tr>
<tr>
<td>User Interface &amp; Sensors</td>
<td></td>
<td>$6.50</td>
<td>$6.50</td>
<td>$6.50</td>
</tr>
<tr>
<td>BT / WLAN</td>
<td>BTv4.0 + Dual-Band Wireless-N</td>
<td>$5.00</td>
<td>$5.00</td>
<td>$5.00</td>
</tr>
<tr>
<td>Power Management</td>
<td></td>
<td>$8.50</td>
<td>$8.50</td>
<td>$8.50</td>
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<tr>
<td>Battery</td>
<td>Assumed 1800mAh</td>
<td>$4.50</td>
<td>$4.50</td>
<td>$4.50</td>
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<tr>
<td>Mechanical / Electro-Mechanical</td>
<td></td>
<td>$33.00</td>
<td>$33.00</td>
<td>$33.00</td>
</tr>
<tr>
<td>Box Contents</td>
<td></td>
<td>$7.00</td>
<td>$7.00</td>
<td>$7.00</td>
</tr>
</tbody>
</table>

Source: IHS iSuppli Research, September 2012
### iPhone5 vs, iPhone4 Bill of Materials ("BoM")

#### IHS iSuppli Table: Preliminary iPhone 5 vs. iPhone 4S Cost Estimates

<table>
<thead>
<tr>
<th>Components / Hardware Elements</th>
<th>iPhone 5 Hardware Comments</th>
<th>iPhone 4S Hardware Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pricing without Contract</td>
<td>$649, $749, $849</td>
<td>$649, $749, $849</td>
</tr>
<tr>
<td>Implied Margin</td>
<td>68%, 71%, 72%</td>
<td>70%, 71%, 70%</td>
</tr>
<tr>
<td>Total BOM Cost</td>
<td>$199, $209, $230</td>
<td>$188, $207, $245</td>
</tr>
<tr>
<td>Manufacturing Cost</td>
<td>$8.00, $8.00, $8.00</td>
<td>$8.00, $8.00, $8.00</td>
</tr>
<tr>
<td>BOM + Manufacturing</td>
<td>$207, $217, $238</td>
<td>$196, $215, $253</td>
</tr>
</tbody>
</table>

#### Major Cost Drivers

- **Memory**
  - NAND Flash: $10.40, $20.80, $41.60
  - DRAM: 1GB LPDDR2: $10.45, $10.45, $10.45
- **Display & Touchscreen**
  - 4" Retina Display w/ In-Cell Touch: $44.00, $44.00, $44.00
  - 3.5" Retina Display w/ Touch: $37.00, $37.00, $37.00
- **Processor**
  - A6 Processor: $17.50, $17.50, $17.50
  - A5 Processor: $15.00, $15.00, $15.00
- **Camera(s)**
  - 8MP + 1.2MP: $18.00, $18.00, $18.00
  - 8MP + VGA: $17.60, $17.60, $17.60
- **Wireless Section - BB/RF/PA**
  - Qualcomm MDM9615M + RTR8600 + Front End: $34.00, $34.00, $34.00
  - Qualcomm MDM6610 + RTR8605 + Front End: $23.50, $23.50, $23.50
- **User Interface & Sensors**
  - $6.50, $6.50, $6.50
- **WLAN / BT / FM / GPS**
  - Murata Dual-Band Wireless-N Module: $5.00, $5.00, $5.00
  - Murata Single-Band Wireless-N Module: $6.50, $6.50, $6.50
- **Power Management**
  - Dialog + Qualcomm: $8.50, $8.50, $8.50
  - Dialog + Qualcomm: $7.20, $7.20, $7.20
- **Battery**
  - 3.8V ~1400mAh: $4.50, $4.50, $4.50
  - 3.7V ~1400mAh: $5.90, $5.90, $5.90
- **Mechanical / Electro-Mechanical**
  - $33.00, $33.00, $33.00
  - $33.00, $33.00, $33.00
- **Box Contents**
  - $7.00, $7.00, $7.00

Source: IHS iSuppli Research, September 2012

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# Samsung Galaxy S4/S3 Bill of Materials (“BoM”)

<table>
<thead>
<tr>
<th></th>
<th>Samsung Galaxy S4 (HSPA Version)</th>
<th>Samsung Galaxy S4 (LTE Version)</th>
<th>Samsung Galaxy S3 (HSPA Version)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total BOM Cost</strong></td>
<td>$236</td>
<td>$233</td>
<td>$205</td>
</tr>
<tr>
<td><strong>Manufacturing Cost</strong></td>
<td>$8.50</td>
<td>$8.50</td>
<td>$8.00</td>
</tr>
<tr>
<td><strong>BOM + Manufacturing</strong></td>
<td>$244</td>
<td>$241</td>
<td>$213</td>
</tr>
<tr>
<td><strong>Major Cost Drivers</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Memory (NAND Flash + DRAM)</td>
<td>16GB eMMC + 2GB LPDDR3</td>
<td>16GB eMMC + 2GB LPDDR3</td>
<td>16GB eMMC + 1GB LPDDR2</td>
</tr>
<tr>
<td>Display &amp; Touchscreen</td>
<td>5&quot; 1920x1080 Super AMOLED (441ppi), w/ Gorilla®Glass3 by Corning</td>
<td>5&quot; 1920x1080 Super AMOLED (441ppi), w/ Gorilla®Glass3 by Corning</td>
<td>4.8” 1280x720 Super AMOLED, w/ Gorilla®Glass2 by Corning</td>
</tr>
<tr>
<td>Processor</td>
<td>Samsung Exynos 5 Octa (5410)</td>
<td>Qualcomm Snapdragon 600 (APQ8064T) - Quad-Core</td>
<td>Samsung Exynos 4 Quad</td>
</tr>
<tr>
<td>Camera(s)</td>
<td>13MP + 2MP</td>
<td>13MP + 2MP</td>
<td>8MP + 1.9MP</td>
</tr>
<tr>
<td>Wireless Section - BB/RF/PA</td>
<td>$16.00</td>
<td>Possibly contains MDM9615 + WTR1605L + Front End</td>
<td>Contains PMB9811 + PMB5712 + Front End</td>
</tr>
<tr>
<td>User Interface &amp; Sensors</td>
<td>Contains accelerometer, RGB Light, e-compass, Gyro, Barometer, Temperature &amp; Humidity, IR Gesture</td>
<td>Contains accelerometer, RGB Light, e-compass, Gyro, Barometer, Temperature &amp; Humidity, IR Gesture</td>
<td>Contains Capella CM3663 ALS / Proximity, ST LSM330DLC Accelerometer / Gyro, AKM AK8975C e-compass, &amp; ST LP331AP Barometer Sensors</td>
</tr>
<tr>
<td>WLAN / BT / FM / GPS</td>
<td>Possibly contains Broadcom BCM4335 + BCM47521</td>
<td>Possibly contains Qualcomm Atheros WCN3680</td>
<td>Contains Broadcom BCM4334 + BCM47511</td>
</tr>
<tr>
<td>Power Management</td>
<td>Samsung PMIC (TBD)</td>
<td>Qualcomm PMICs</td>
<td>Contains Maxim PMIC</td>
</tr>
<tr>
<td>Battery</td>
<td>3.8V, 2600mAh w/ NFC Antenna (TBD)</td>
<td>3.8V, 2600mAh w/ NFC Antenna (TBD)</td>
<td>3.8V, 2100mAh w/ NFC Antenna</td>
</tr>
<tr>
<td>Mechanical / Electro-Mechanical</td>
<td>$22.00</td>
<td>$22.00</td>
<td>$21.40</td>
</tr>
<tr>
<td>Box Contents</td>
<td>$6.00</td>
<td>$6.00</td>
<td>$6.00</td>
</tr>
</tbody>
</table>

*Source: IHS iSuppli Research, March 2013*
## iPhone5 vs, iPhone4 Bill of Materials (“BoM”)

<table>
<thead>
<tr>
<th>Components / Hardware Elements</th>
<th>iPhone 5 Hardware Comments</th>
<th>16GB3</th>
<th>32GB4</th>
<th>64GB5</th>
<th>iPhone 4S Hardware Comments</th>
<th>16GB32</th>
<th>32GB43</th>
<th>64GB54</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pricing without Contract</td>
<td></td>
<td>$649</td>
<td>$749</td>
<td>$849</td>
<td></td>
<td>$649</td>
<td>$749</td>
<td>$849</td>
</tr>
<tr>
<td>Implied Margin</td>
<td></td>
<td>66%</td>
<td>71%</td>
<td>72%</td>
<td></td>
<td>70%</td>
<td>71%</td>
<td>70%</td>
</tr>
<tr>
<td>Total BOM Cost</td>
<td></td>
<td>$199</td>
<td>$209</td>
<td>$230</td>
<td></td>
<td>$188</td>
<td>$207</td>
<td>$245</td>
</tr>
<tr>
<td>Manufacturing Cost</td>
<td></td>
<td>$8.00</td>
<td>$8.00</td>
<td>$8.00</td>
<td></td>
<td>$8.00</td>
<td>$8.00</td>
<td>$8.00</td>
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<td>$217</td>
<td>$238</td>
<td></td>
<td>$196</td>
<td>$215</td>
<td>$253</td>
</tr>
</tbody>
</table>

### Major Cost Drivers

#### Memory
- NAND Flash: $10.40, $20.80, $41.60
- DRAM: 1GB LPDDR2, $10.45, $10.45, $10.45, 512MB LPDDR2, $9.10, $9.10, $9.10

#### Display & Touchscreen
- 4" Retina Display w/ In-Cell Touch: $44.00, $44.00, $44.00
- 3.5" Retina Display w/ Touch: $37.00, $37.00, $37.00

#### Processor
- A6 Processor: $17.50, $17.50, $17.50
- A5 Processor: $15.00, $15.00, $15.00

#### Camera(s)
- 8MP + 1.2MP: $18.00, $18.00, $18.00
- 8MP + VGA: $17.60, $17.60, $17.60

#### Wireless Section - BB/RF/PA
- Qualcomm MDM9615M+RTR8600 + Front End: $34.00, $34.00, $34.00
- Qualcomm MDM6610+RTR8605 + Front End: $23.50, $23.50, $23.50

#### User Interface & Sensors
- $6.50, $6.50, $6.50
- $6.85, $6.85, $6.85

#### WLAN / BT / FM / GPS
- Murata Dual-Band Wireless-N Module: $5.00, $5.00, $5.00
- Murata Single-Band Wireless-N Module: $6.50, $6.50, $6.50

#### Power Management
- Dialog + Qualcomm: $8.50, $8.50, $8.50
- Dialog + Qualcomm: $7.20, $7.20, $7.20

#### Battery
- 3.8V ~1400mAh: $4.50, $4.50, $4.50
- 3.7V ~1400mAh: $5.90, $5.90, $5.90

#### Mechanical / Electro-Mechanical
- $33.00, $33.00, $33.00
- $33.00, $33.00, $33.00

#### Box Contents
- $7.00, $7.00, $7.00

Source: IHS iSuppli Research, September 2012

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Fabless Eco-system Alignment Across Entire Value Chain is Required
HW 8 – Value Chain

...Due Wednesday, May 28th

- Create a Value Chain for your Project
  - Identify the suppliers including any “sub-contracting” work
  - What do you consider as the top 3 Risk areas?