Best of semiconductor market view
Content

• Market data and outlook
• Market Trends / Challenges
  – Growth Drivers
  – Internet of Things
  – Technology / EUV / 450mm
• Europe’s positioning
2015 Semiconductor (IC) Revenue Forecasts

<table>
<thead>
<tr>
<th>Source</th>
<th>Forecast Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>VLSI (Jan 15; IC only)</td>
<td>7.8%</td>
</tr>
<tr>
<td>IC Insights (Jan 15)</td>
<td>7.0%</td>
</tr>
<tr>
<td>WSTS (Nov 14)</td>
<td>6.5%</td>
</tr>
<tr>
<td>Henderson Ventures (Jan 15)</td>
<td>6.4%</td>
</tr>
<tr>
<td>Gartner (Jan 15)</td>
<td>5.4%</td>
</tr>
<tr>
<td>JPMorgan (Jan 15; 4% to 6%)</td>
<td>5.0%</td>
</tr>
<tr>
<td>Cowan LRA (Jan 15)</td>
<td>4.1%</td>
</tr>
<tr>
<td>IDC (Jan 15)</td>
<td>3.6%</td>
</tr>
</tbody>
</table>

Source: SEMI
2015 Semiconductor Equipment Revenue Forecasts

- SEMI (Dec 14): 15.0%
- VLSI (Jan 15): 9.0%
- JPMorgan (Jan 15; 6% to 8%)
- Gartner (Jan 15): 7.0%
- Advanced Forecasting (Jan 15): 5.6%
- SEMI (Dec 14): 2.0%

Source: SEMI
2014 Worldwide GDP = $76.5 Trillion

**WW Electronic System Production**
- 2013: $1.412B (5%)
- 2014: $1.488B (6%)
- 2015F: $1.534B

**Semiconductor Market**
- 2013: $325.4B (9%)
- 2014: $353.3B (7%)
- 2015F: $377.9B

**Semi Cap Spending**
- 2013: $57.1B (14%)
- 2014: $65.0B (6%)
- 2015F: $69.0B

**Semi Materials Market**
- 2013: $43.5B (3%)
- 2014: $44.8B (3%)
- 2015F: $46.2B

Source: IC Insights
WW Semiconductor Market History and Forecast (94-19)


1994-2004 CAGR = 7.7%
2004-2014 CAGR = 4.5%
2009-2014 CAGR = 8.3%
2014-2019 CAGR = 5.8%

Source: IC Insights
IC Marketshare by System Type ($)

Source: IC Insights
Industry on Chips $ 1.9 Trillion by 2020 (Economic Value-Add by Industry Sector)

- Manufacturing 15%
- Healthcare 15%
- Insurance 11%
- Banking & Security 10%
- Retail & Wholesale 8%
- Computing 8%
- Government 7%
- Real Estate & Business Services 4%
- Transportation 6%
- Utilities 5%
- Agriculture 4%
- Communications 3%
- Others 4%

Source: Gartner
WW IC Market by Region

Source: IC Insights
## Top 30 IC Sales Leaders

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>Intel</td>
<td>U.S.</td>
<td>48,321</td>
<td>0</td>
<td>48,321</td>
<td>51,368</td>
<td>0</td>
<td>51,368</td>
<td>6%</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>Samsung</td>
<td>South Korea</td>
<td>32,520</td>
<td>1,858</td>
<td>34,378</td>
<td>34,874</td>
<td>2,385</td>
<td>37,259</td>
<td>8%</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>TSMC*</td>
<td>Taiwan</td>
<td>19,935</td>
<td>0</td>
<td>19,935</td>
<td>24,976</td>
<td>0</td>
<td>24,976</td>
<td>25%</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>Qualcomm**</td>
<td>U.S.</td>
<td>17,211</td>
<td>0</td>
<td>17,211</td>
<td>19,100</td>
<td>0</td>
<td>19,100</td>
<td>11%</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>Micron + Elpida</td>
<td>U.S.</td>
<td>14,189</td>
<td>105</td>
<td>14,294</td>
<td>16,814</td>
<td>0</td>
<td>16,814</td>
<td>18%</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>SK Hynix</td>
<td>South Korea</td>
<td>12,970</td>
<td>0</td>
<td>12,970</td>
<td>15,838</td>
<td>0</td>
<td>15,838</td>
<td>22%</td>
</tr>
<tr>
<td>7</td>
<td>7</td>
<td>TI</td>
<td>U.S.</td>
<td>10,794</td>
<td>680</td>
<td>11,474</td>
<td>11,329</td>
<td>850</td>
<td>12,179</td>
<td>6%</td>
</tr>
<tr>
<td>8</td>
<td>8</td>
<td>Toshiba</td>
<td>Japan</td>
<td>9,868</td>
<td>2,090</td>
<td>11,958</td>
<td>9,566</td>
<td>1,650</td>
<td>11,216</td>
<td>-6%</td>
</tr>
<tr>
<td>9</td>
<td>9</td>
<td>Broadcom**</td>
<td>U.S.</td>
<td>8,219</td>
<td>0</td>
<td>8,219</td>
<td>8,360</td>
<td>0</td>
<td>8,360</td>
<td>2%</td>
</tr>
<tr>
<td>10</td>
<td>10</td>
<td>ST</td>
<td>Europe</td>
<td>5,847</td>
<td>2,167</td>
<td>8,014</td>
<td>5,339</td>
<td>2,035</td>
<td>7,374</td>
<td>-8%</td>
</tr>
<tr>
<td>11</td>
<td>11</td>
<td>Renesas</td>
<td>Japan</td>
<td>6,405</td>
<td>1,570</td>
<td>7,975</td>
<td>5,947</td>
<td>1,425</td>
<td>7,372</td>
<td>-8%</td>
</tr>
<tr>
<td>12</td>
<td>12</td>
<td>MediaTek + MStar**</td>
<td>Taiwan</td>
<td>5,723</td>
<td>0</td>
<td>5,723</td>
<td>7,032</td>
<td>0</td>
<td>7,032</td>
<td>23%</td>
</tr>
<tr>
<td>13</td>
<td>13</td>
<td>Infineon</td>
<td>Europe</td>
<td>3,402</td>
<td>1,858</td>
<td>5,260</td>
<td>3,863</td>
<td>2,125</td>
<td>5,988</td>
<td>14%</td>
</tr>
<tr>
<td>14</td>
<td>14</td>
<td>Avago + LSI**</td>
<td>Singapore</td>
<td>3,989</td>
<td>990</td>
<td>4,979</td>
<td>4,366</td>
<td>1,308</td>
<td>5,674</td>
<td>14%</td>
</tr>
<tr>
<td>15</td>
<td>15</td>
<td>NXP</td>
<td>Europe</td>
<td>3,534</td>
<td>1,281</td>
<td>4,815</td>
<td>4,025</td>
<td>1,600</td>
<td>5,625</td>
<td>17%</td>
</tr>
<tr>
<td>16</td>
<td>16</td>
<td>AMD**</td>
<td>U.S.</td>
<td>5,299</td>
<td>0</td>
<td>5,299</td>
<td>5,512</td>
<td>0</td>
<td>5,512</td>
<td>4%</td>
</tr>
<tr>
<td>17</td>
<td>17</td>
<td>Sony</td>
<td>Japan</td>
<td>1,141</td>
<td>3,598</td>
<td>4,739</td>
<td>745</td>
<td>4,447</td>
<td>5,192</td>
<td>10%</td>
</tr>
<tr>
<td>18</td>
<td>18</td>
<td>Freescale</td>
<td>U.S.</td>
<td>3,341</td>
<td>636</td>
<td>3,977</td>
<td>3,833</td>
<td>715</td>
<td>4,548</td>
<td>14%</td>
</tr>
<tr>
<td>19</td>
<td>19</td>
<td>GlobalFoundries*</td>
<td>U.S.</td>
<td>4,122</td>
<td>0</td>
<td>4,122</td>
<td>4,350</td>
<td>0</td>
<td>4,350</td>
<td>6%</td>
</tr>
<tr>
<td>20</td>
<td>20</td>
<td>UMC*</td>
<td>Taiwan</td>
<td>3,940</td>
<td>0</td>
<td>3,940</td>
<td>4,350</td>
<td>0</td>
<td>4,350</td>
<td>10%</td>
</tr>
<tr>
<td>21</td>
<td>21</td>
<td>Nvidia**</td>
<td>U.S.</td>
<td>3,898</td>
<td>0</td>
<td>3,898</td>
<td>4,348</td>
<td>0</td>
<td>4,348</td>
<td>12%</td>
</tr>
<tr>
<td>22</td>
<td>22</td>
<td>Marvell**</td>
<td>U.S.</td>
<td>3,352</td>
<td>0</td>
<td>3,352</td>
<td>3,756</td>
<td>0</td>
<td>3,756</td>
<td>12%</td>
</tr>
<tr>
<td>23</td>
<td>23</td>
<td>HiSilicon**</td>
<td>China</td>
<td>2,106</td>
<td>0</td>
<td>2,106</td>
<td>3,220</td>
<td>0</td>
<td>3,220</td>
<td>53%</td>
</tr>
<tr>
<td>24</td>
<td>24</td>
<td>Sharp</td>
<td>Japan</td>
<td>2,566</td>
<td>2,663</td>
<td>3,229</td>
<td>440</td>
<td>2,741</td>
<td>3,181</td>
<td>-1%</td>
</tr>
<tr>
<td>25</td>
<td>25</td>
<td>ON Semi</td>
<td>U.S.</td>
<td>1,825</td>
<td>958</td>
<td>2,783</td>
<td>2,094</td>
<td>1,060</td>
<td>3,154</td>
<td>13%</td>
</tr>
<tr>
<td>26</td>
<td>26</td>
<td>Fujitsu</td>
<td>Japan</td>
<td>3,210</td>
<td>299</td>
<td>3,509</td>
<td>2,881</td>
<td>270</td>
<td>3,151</td>
<td>-10%</td>
</tr>
<tr>
<td>27</td>
<td>27</td>
<td>Rohm</td>
<td>Japan</td>
<td>1,557</td>
<td>1,178</td>
<td>2,735</td>
<td>1,640</td>
<td>1,280</td>
<td>2,920</td>
<td>7%</td>
</tr>
<tr>
<td>28</td>
<td>28</td>
<td>Analog Devices</td>
<td>U.S.</td>
<td>2,357</td>
<td>280</td>
<td>2,637</td>
<td>2,556</td>
<td>223</td>
<td>2,779</td>
<td>5%</td>
</tr>
<tr>
<td>29</td>
<td>29</td>
<td>Skyworks</td>
<td>U.S.</td>
<td>1,807</td>
<td>36</td>
<td>1,843</td>
<td>2,500</td>
<td>56</td>
<td>2,556</td>
<td>39%</td>
</tr>
<tr>
<td>30</td>
<td>30</td>
<td>Xilinx**</td>
<td>U.S.</td>
<td>2,297</td>
<td>0</td>
<td>2,297</td>
<td>2,451</td>
<td>0</td>
<td>2,451</td>
<td>7%</td>
</tr>
</tbody>
</table>
Consolidation will continue

Memory Industry Transformation

2003

Memory Producers have consolidated
By 2013 there are only four Scaled Manufacturers

2013

10 Years
Only 2% of world manufacturing by native Chinese manufacturers
Capital Sources by Industry Segment

Note: Capital is defined as cash and short-term investments.
Sources: Company financials, Wells Fargo
Flat capital spending

Source: IC Insights
SEMI® 2014 Year-End Equipment Forecast by Market Region

Source: SEMI December 2014
Wafer Process Equipment Trends
Content

• Market data and outlook
• Market Trends / Challenges
  – Growth Drivers
  – Technology / EUV / 450mm
• Europe’s positioning
Market Trends

• 4% - 8% IC growth in 2015
• 10% (CAGR) 14-19 in Automotive
• 9% (CAGR) 14-19 in Industrial Applications
• 23% (CAGR) 14-19 in Internet of Things
  (Practical it means: more Chips, Sensors, Actuators, Memories at lower costs)
• 5-15% equipment growth in 2015
The IoT information universe demands an increase for data / bandwidth / low power.

Innovation is needed at device technology, circuit and architecture level to find solutions to serve this wide spectrum of applications.
IoT Smart Thermostat

- ST Microelectronics STM32L151VB ultra-low-power 32 MHz ARM Cortex-M3 MCU
- TI AM3703CUS Sitara ARM Cortex A8 microprocessor
- Samsung K4X51163PK 512 Mb mobile DRAM
- Sensirion SHT20 humidity and temperature sensor
- TI TPS65921B power management and USB single chip
- Micron MT29F2G16ABBEAH4 2 Gb NAND flash memory
- TI WL1270B 802.11 b/g/n Wi-Fi solution
- TI LW051A 8-channel CMOS analog multiplexer/demultiplexer
- Ember EM357 integrated ZigBee/802.15.4 system-on-chip
- Skyworks 2436L high power 2.4 GHz 802.15.4 front-end module
Content

• Market data and outlook
• Market Trends / Challenges
  – Growth Drivers
  – Technology / EUV / 450mm
• Europes positioning
5nm shrinks by 2020

<table>
<thead>
<tr>
<th>Early production</th>
<th>2013 - 2014</th>
<th>2015 - 2016</th>
<th>2017 - 2018</th>
<th>2019 - ...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vdd (V)</td>
<td>0.8</td>
<td>0.8-0.7</td>
<td>0.7-0.5</td>
<td>0.7-0.5</td>
</tr>
</tbody>
</table>

Device:
- Planar SOI
- Bulk FinFET
- SOI FinFET
- SiGeGe channel
- IIIV channel
- Lateral Nanowire
- Vertical Nanowire

- **FinFET width (nm)**
  - 42-48nm
  - 30-32nm
  - 21-24nm
  - 14-16nm

- **FinFET pitch (nm)**
  - 64-80nm
  - 50-64nm
  - 32-42nm
  - 22-32nm

- **Gate Stack**
  - HKMG
  - HKMG
  - HKMG
  - HKMG

- **CPP (nm)**
  - Si / SiGe
  - Si / SiGe (Ge>80%)
  - Si / SiGe (Ge)
  - Si / SiGe (IIIV / Ge)

- **Channel n/p**
  - N/S/D Si/P
  - N/S/D Si/P: C
  - N/S/D Si/P: C
  - TBD

- **S/D Strain**
  - P:Si/D:SiGe (58%)
  - P: Si/D:SiGe (60%) 105%
  - P:Si/D:SiGe (60%)
  - TBD

- **Lgate (nm)**
  - 20-25nm
  - 15-20nm
  - 10-15nm
  - 10nm

Source: IMEC
Technology Pipeline

Enabling Moore’s Law Through Materials Innovation

<table>
<thead>
<tr>
<th>32 nm</th>
<th>22 nm</th>
<th>14 nm</th>
<th>10 nm</th>
<th>7 nm</th>
<th>5 nm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturing</td>
<td>Development</td>
<td>Research</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Future options subject to change
Volume Production Per Node - Slowdown in transition

Volume Production Technology Node Transitions

Source: data collection of SEMI World Fab Forecast reports (June 2014)
Costs of Transtor increasing!

Economics of Technology Scaling

- Increasing process flow complexity — Longer flow, more fab space, more equipments
- Increasing equipment and materials complexity
- Increasing cost of transition resulting in reduced $/GB reduction driving lower ROI for planar scaling even when scaling is enabled from fundamental technology perspective
- Diversified product needs from customers lead to complex fab mix

Source: Micron
28nm May Become an Optimal Cost Node

Source: Handel Jones, IBS
EUV delayed

Main Issues:

- Power Light Source
- Collector
- Throughput
450mm Quo Vadis?

IMEC's 450mm R&D/Pilot Production Facility Timeline

- **Phase 1**
  - Selected Module Assessment
  - 300mm/450mm (IMEC Fab 1)

- **Phase 2**
  - Process & Device Development
  - In Full Flow Facility
  - 300mm/450mm (IMEC Fab 2)

**450mm-Ready Facility at IMEC**
(EEMI450, SOI450, NGC450, EEM450PR,...)

**Gradually 300mm → 450mm R&D/Pilot Facility at IMEC**

Source: IMEC
Content

• Market data and outlook
• Market Trends / Challenges
  – Growth Drivers
  – Technology / EUV / 450mm
• Europe’s positioning
USA leads the worldwide IC Sales by company Headquarters Location
ASIA has the highest CAPEX worldwide for semiconductors...

Source: IC Insights
Europeans fastest growing equipment suppliers!
Momentum for micro-/nano-electronics in Europe

European initiatives to support growth of the micro-/nano electronics in Europe:

- EU Key Enabling Technologies (KETs)
- EU 10/100/20 strategy
- ECSEL Joint Undertaking + Horizon 2020 funding
- European Strategic Investment Fund
- European Project of Common European Interest
- Swiss Funding (CTI, SNSF, Regional)

Europe needs a common vision and concerted policies/actions to win.
Summary

• IC devices continue to grow,
• Demanding new technology leads to high R&D spending and to further consolidation of the entire supply chain,
• EUV and 450mm delayed
• Europe’s IC industry successful at More than Moore, but is stuck at 7% of world-wide production.
• Several EU and national initiatives launched to increase Europe’s market-share and competitiveness but still some inertia for radical change.
Thank you

Semi.org