Packaging Technology Trends
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Outline

Market Dynamics

Market Trends

Key Package Platforms

Summary
Economics of Packaging Today
Semiconductor Outlook

- Continued growth
  - Moore’s Law extends
  - Mobility
  - Automotive
  - IoE through a connected world

- Greater need for advanced packages
  - Advanced SiP
  - Heterogeneous integration
Advanced Packaging: Must Pay to Play

- Developing & manufacturing new package platforms is expensive
  - Requires a high degree of engineering expertise
  - Requires perpetual funding in R&D
  - Requires ability to invest in ‘new’ ideas
  - Adding new blocks of capacity expensive – challenging ROI
Economics of Business Today

- Changing competitive environment
  - Tier 1 OSATs dominate in technology
  - Entry of foundry
  - Suppliers upward ambition

- Pace of change accelerating!
  - Forcing “all in” mentality
Market Trends
Major Package Trends

Mobility
- Ultra Thin, Small
- Integration, SiP
- 5G
- Envelope Tracker
- AR/Streaming

IoT
- Miniaturization
- Integration
- Secure
- Power/Connected
- Home/Factory/Auto

Automotive
- Reliable, AEC-006
- Integration, SiP
- 5G
- ADAS/Connected
- Infotainment/ECU

HPC/Networking
- Performance
- Integration
- Thermal, Power
- AI/AR
- Data Center/SiPHO
Choices narrow as product becomes more complicated
Mobile Market Growth

- Global 2017 SP demand unchanged @ 4% YoY
- China outlook lowered to 2% YoY (prior 3%), offset by India at 7% YoY (prior 5%)
- 2017 SP Eco
  - iPhone: 221Mu (2.8% YoY)
  - Samsung: 309Mu (flat YoY)
  - China/ROW: 947Mu (5.5% YoY)

Source: GFK May 2017
### Smartphone Segments

<table>
<thead>
<tr>
<th></th>
<th>Low-end</th>
<th>Mid-end</th>
<th>High-end</th>
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<tbody>
<tr>
<td><strong>Model Name</strong></td>
<td>Lenovo K3 Note</td>
<td>OPPO R9S</td>
<td>Apple iPhone 7</td>
</tr>
<tr>
<td><strong>Price</strong></td>
<td>~$X</td>
<td>~$2X</td>
<td>~$4X</td>
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<tr>
<td><strong>AP Spec</strong></td>
<td>MediaTek MT6752</td>
<td>Snapdragon 625</td>
<td>A10</td>
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<tr>
<td><strong># of Pkgs</strong></td>
<td>26</td>
<td>49</td>
<td>69</td>
</tr>
<tr>
<td><strong>Source</strong></td>
<td>Amkor Teardown</td>
<td>Amkor Teardown</td>
<td>Amkor Teardown</td>
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~80 packaged die opportunities in high end smartphone
Technology in the Mobile Market Segments

AP/BB, Standalone AP or BB
- fcCSP
- fcCSP-Hybrid
- TMV® PoP
- MEP/Fan-In PoP
- SWIFT®

RF Connectivity Codec
- fcCSP
- WLCSP
- WLFO

PMIC Sensor SoC
- fcCSP
- WLCSP
- WLFO
- SIP

Peripherals
- LCCSP (ETS, MSP)
- WLCSP
- 5s WLCSP
- WLFO
- SiP
Wafer-Level Packaging

- Smartphones driving wafer-level packaging
- Phones getting thinner
- Number of WLP per phone increasing
- WLP proliferating into other applications and markets

Source: TechSearch International, Inc.
Number of SiP Packages Increasing

- RF related packages: power amplifier, front-end module, antenna switch and Wi-Fi

<table>
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<tr>
<th>Product</th>
<th>2G</th>
<th>3G</th>
<th>4G</th>
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<tbody>
<tr>
<td>Nokia 1800</td>
<td>Nokia 1800</td>
<td>ZTE Z Phone</td>
<td>Samsung Galaxy S7</td>
</tr>
<tr>
<td>Total Number of SiPs</td>
<td>1</td>
<td>2</td>
<td>8</td>
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</table>
5G Requires Massive Filtering

- ~50 filters (15 Bands)  
  More bands 4x4 MIMO

- ~100 filters

2020

# of Supported Bands

- 3G
- LTE
- 5G

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Automotive ICs
Ubiquitous

- Electronic value added to vehicles estimated at 40% and increasing with ~100 packaged die opportunities in high end automobiles.
2016 Data Center Data

- DC fabrication investment rivals semiconductor fab investment
- China has 7 of the 10 largest DCs in the world

Largest Data Center in World = China Telecom ~10M sq.ft. with 150 MW power requirement

Source: Finisar OFC 2016
2016 Largest DC in The World

China Telecom: 10,763,910 sq. ft.
Hohhot (Inner Mongolia)

Wembley Stadium: 172,000 sq. ft.
Can fit ~63 Wembley stadiums
High Performance Computing & Networking

Data needs to be accessible always and in real-time

More Devices
400GE
100GE
10G/40GE
WLAN
Silicon Photonics
Hyperscale Data Centers
Data Centers, Enterprise
WiFi, LTE, Small Cell
SWIFT®
2.5D TSV
fcBGA
SIP

More Applications

More Data
Next Level of Package Integration

Major Package Platform
“The Big 5” Packaging Platforms

- Chip Scale Packaging
  - Wafer

- Flip Chip
  - Laminate

- MEMs
  - Laminate/Leadframe/Wafer

- System in Package: SiP
  - Laminate

- Next Gen SiP
  - Wafer
Flip Chip Technologies

- The best choice for larger single die & big body packages
- A mature technology with focus on lowering cost
- Enables SiP packaging
MEMS

- IoE, wearables & industrial
  - Sensor fusion
  - SOIC, QFN & laminate
  - Low power, form factor & cost
  - A step into SiP
    - System & functional integration
SiP Requires State of the Art Technology
Advanced SiP (Wafer-based)

- Provides very best in performance
- Thinnest form factor
- Ultimate in:
  - Power
  - Electrical
  - Thermal
Fan-Out Package Evolution to Adv Wafer SiP

- **Low Density FOWLP**
  - Limited scalability & platform extension to MCM, SiP and 3D

- **High Density FOWLP**
  - Better scalability, 3D compatible process and extended platform to SiP

- **Adv Wafer SiP**
  - Logic to Memory or Logic
  - Fan-out module attach to substrate as alternative to TSV 2.5D

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Miniaturization
Integration
Performance
Reliability
Cost
Summary…Technology Pace has Quickened
Heterogeneous Integration is the over riding common theme

Mobility
- Ultra Thin, Small
- 5G
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Packaging the Future

- Economics of packaging
  - Requires **intelligent** growth & investments

- Mobility, IoT, Automotive & Networking
  - Biggest market drivers for next 5-10 years

- Innovative technologies
  - Enabling **more functionality** and offering higher levels of integration is a clear focus
Thank You

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