Value Enhancement Through Collaboration

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The Evolution of Personal Computing

- **Productivity**: 80s and 90s
- **Portability**: 00s
- **Ubiquity**: 10s

Key Terms:
- TAM
- INTEGRATION
- COST
- CYCLE TIME
Moore’s Law
It’s Still About Economics While Enabling Complex Scaling

• Higher Integration
• More Energy Efficient
• Better Performance
• Lower Cost

4,000x Faster
5,000x Less Energy/Transistor
50,000x Cheaper/Transistor

4004 (1971)
3rd Generation Intel Core Processor (2012)

Source: Intel
Technology Complexity is Increasing Costs

- **Leading Edge Fab Cost**: +575%
- **Process Development Cost**: +450%
- **Chip Design Cost**: +733%

*Source: Global Foundries, BofA Merrill Lynch Global Research Estimates*
Complexity Sells

• Enables the impossible to become possible

• Complexity that enables simplicity of use

• Complexity can take many forms (density, structure, data, function, ...) but ultimately people pay for use

• Delivering complexity makes our business go!
Technology Innovation and Manufacturing Efficiency Are Complimentary Growth Engines

Flawless and synchronized execution across the industry is required to deliver both in parallel

Source: Intel
Collaboration Enables Complex Supply Chain Orchestration

• Envisioned possibilities
• Inspired by the customer
• Enabled by ecosystem investment
• Delivered with supply chain precision
## The Business Case for Collaboration

Hunt for Value Across **I.C.E.**

<table>
<thead>
<tr>
<th><strong>INNOVATION</strong></th>
<th>Product innovation</th>
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<tbody>
<tr>
<td></td>
<td>Business creation</td>
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<tr>
<td><strong>CUSTOMERS</strong></td>
<td>Cross-selling</td>
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<td>Customer service</td>
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<td><strong>EFFICIENCY</strong></td>
<td>Cost savings</td>
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<td></td>
<td>Better decisions</td>
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Source: “Collaboration”, Morten T. Hansen
450mm: Worldwide, Multi-Faceted Efforts
Collaboration In Action

Notchless wafer initiative
Component lift solutions
Reference designs for non-differentiating components

Standards
Sub-component Suppliers
Equipment and Materials Suppliers

Prototypes
EHS optimization
Streamlined installation

Utilities use rates
Effluent analysis
Emissions data
Pump idle mode
Abatement

Industry Synchronization

Device Makers

Test Bed Guidelines

• Identify focus areas / concepts
• Define pilot work
• Demo feasibility of approaches
• Drive timely adoption
450mm Technical Challenges

**450 Technical Challenges**
- Die to die matching

**Innovative Design Improvements**
- Match material/feature characteristics
- Match die level e-test results
- Match all film variability

**Best In Class Equipment**
- Uniform plasma density
- Improve thermal control
- Better thickness control
- Optimized pumping
- Film stress management
- Optimize vertical space
- Optimized pumping
- Platform innovations
- Common modules/parts
- Green friendly materials
- Max. recycle/reuse
- Smart idling

450mm scalar targets
- Optimized Throughput/m² ≥ 300mm
- Processing cost per wafer ≤ 300mm
- Environmental footprint ≤ 300mm

Intelligent scale-up requires **close synchronization** with 300mm HW innovation and technology roadmaps
300mm/450mm R&D Synchronization

450 mm strategy

- Strive for commonality of 300 mm and 450 mm modules, parts and software:
  - Commonality of parts
  - Ease of mix and matching
  - Sharing technological innovations
- Modular system design
- New modules are designed against design rules for future nodes
- Keep focus on cost and uptime

<table>
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<tr>
<th>Design rule</th>
<th>ArFi</th>
<th>EUV</th>
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<tbody>
<tr>
<td>Matched overlay</td>
<td>1.7 nm</td>
<td>1.7 nm</td>
</tr>
<tr>
<td>Focus uniformity</td>
<td>8 nm</td>
<td>10 nm</td>
</tr>
<tr>
<td>Throughput</td>
<td>150 wph (6&quot;mask)</td>
<td>115 wph (&gt;250W source)</td>
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</tbody>
</table>

EUV re-use

- Not used in 450
- 2% Re-use
- 1% Not yet defined
- 18% New
- 5% Revision
- 74% Not used in 450

Immersion re-use

- Not used in 450
- 2% Re-use
- 1% Not yet defined
- 44% New
- 15% Revision
- 33% Not used in 450

Source: Martin van den Brink, ASML, IMEC ITF US 2013
450mm Considerations

• **Cost reduction** and **capacity management** are needed to enable the continued growth of the semiconductor industry

• IC maker pilot line timing depends on:
  - Critical mass of customer interest in 450mm
  - Supplier composite readiness and equipment extendibility
  - Manufacturing ROI – cost, productivity, and capacity management

• Pre-competitive industry cooperation programs (and collaboration between them) are increasing 450mm industry readiness in a mutually cost-effective, efficient manner
New Collaboration Models Emerging to Continue Innovation and Growth

- Equity for NRE, M&A, Sub-supplier aggregation, Deterministic sourcing
- Equipment/materials co-optimization, Supply Chain Engineering, Consortia
- JVs, Multi-gen collaborations, Consortia cooperation, Universal platforms

Source: Intel
Risk Factors

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