IDF14

Leading at the edge of Moore's Law with Intel Custom Foundry

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General Manager, Intel Custom Foundry

Vice President, Technology and Manufacturing Group

SPCS011

Agenda

- Overview
- Platform Offerings
- Summary

Intel Custom Foundry: Flexible Business Models

Intel Custom Foundry: Flexible Business Models

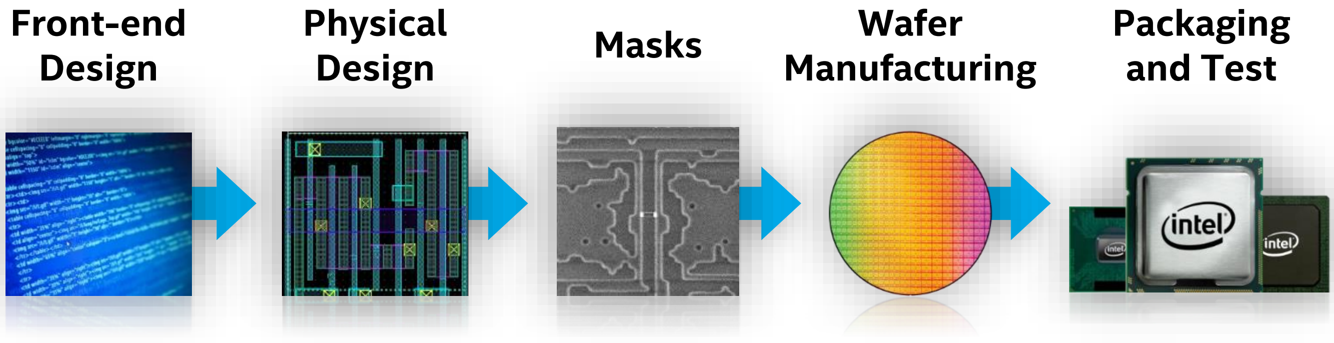
Customer Design + Intel and Third Party IP = Custom Product

Intel Custom Foundry: Flexible Business Models

Customer Design + Intel and Third Party IP = Custom Product

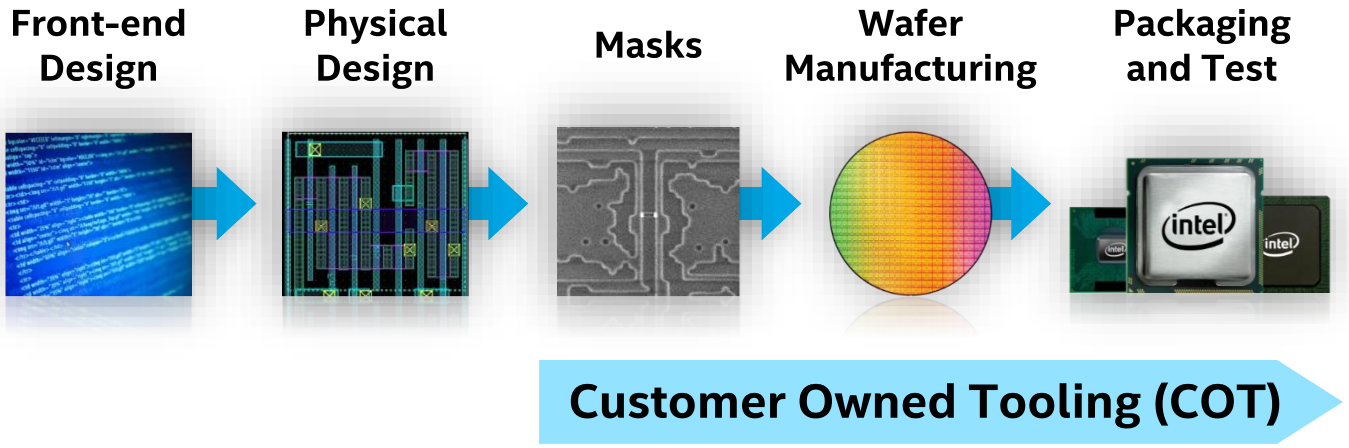
Intel Standard Product Design + Customer and Third Party IP = Semi-Custom Product

Intel Custom Foundry: Flexible Execution Models



Delivering value beyond a traditional foundry model

Intel Custom Foundry: Flexible Execution Models



Front-end Design

Physical Design

Masks

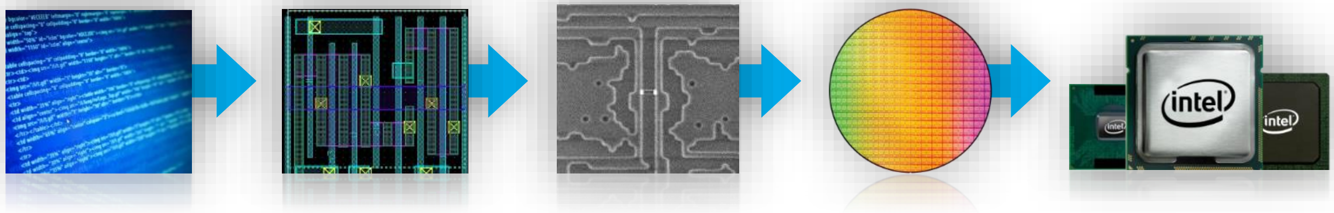
Wafer Manufacturing

Packaging and Test

Customer Owned Tooling (COT)

Delivering value beyond a traditional foundry model

Intel Custom Foundry: Flexible Execution Models



Front-end Design → **Physical Design** → **Masks** → **Wafer Manufacturing** → **Packaging and Test**

Customer Owned Tooling (COT)

Full Service (ASIC)

Delivering value beyond a traditional foundry model

Business & Execution Models Matrix

	Custom Product	Semi-Custom Product
Customer Owned Tooling	✓	✓
Full Service (ASIC Model)	✓	✓

Intel Custom Foundry: Design Ecosystem

Design Services	intel	cadence	Open-Silicon The Science of ASICs	SMARTPLAY™ Services for your success	SYNOPSYS®	WIPRO Applying Thought
Soft IP	intel	cadence	NORTHWEST LOGIC	SYNOPSYS®		
Advanced IP	intel	cadence	SYNOPSYS®			
Foundation IP	intel	SYNOPSYS®				
Design Tools & Flows	intel	ANSYS®	cadence	Mentor Graphics®	SYNOPSYS®	

Note: Logos in alphabetical order..

Intel Custom Foundry: Worldwide Assets

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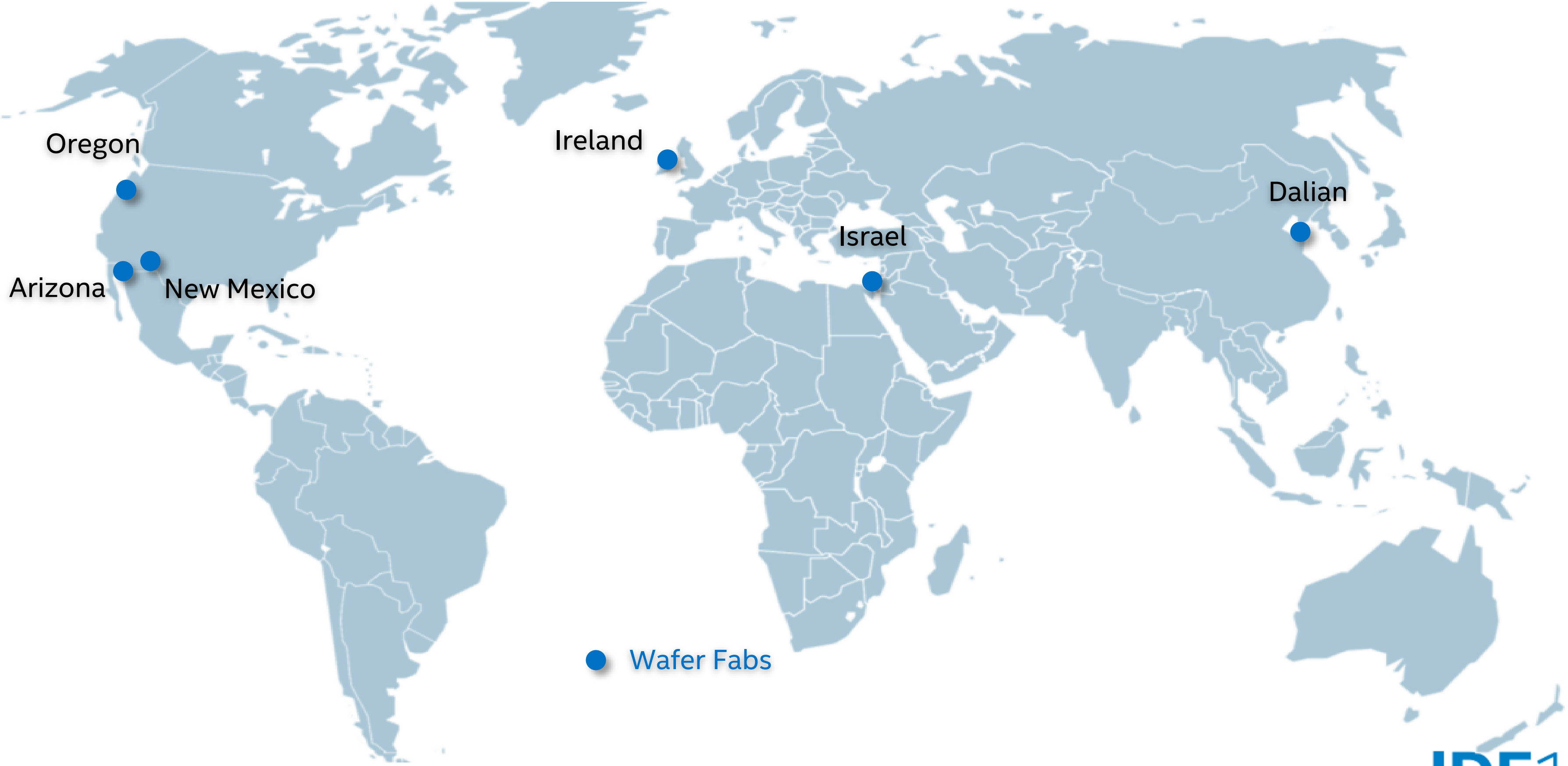
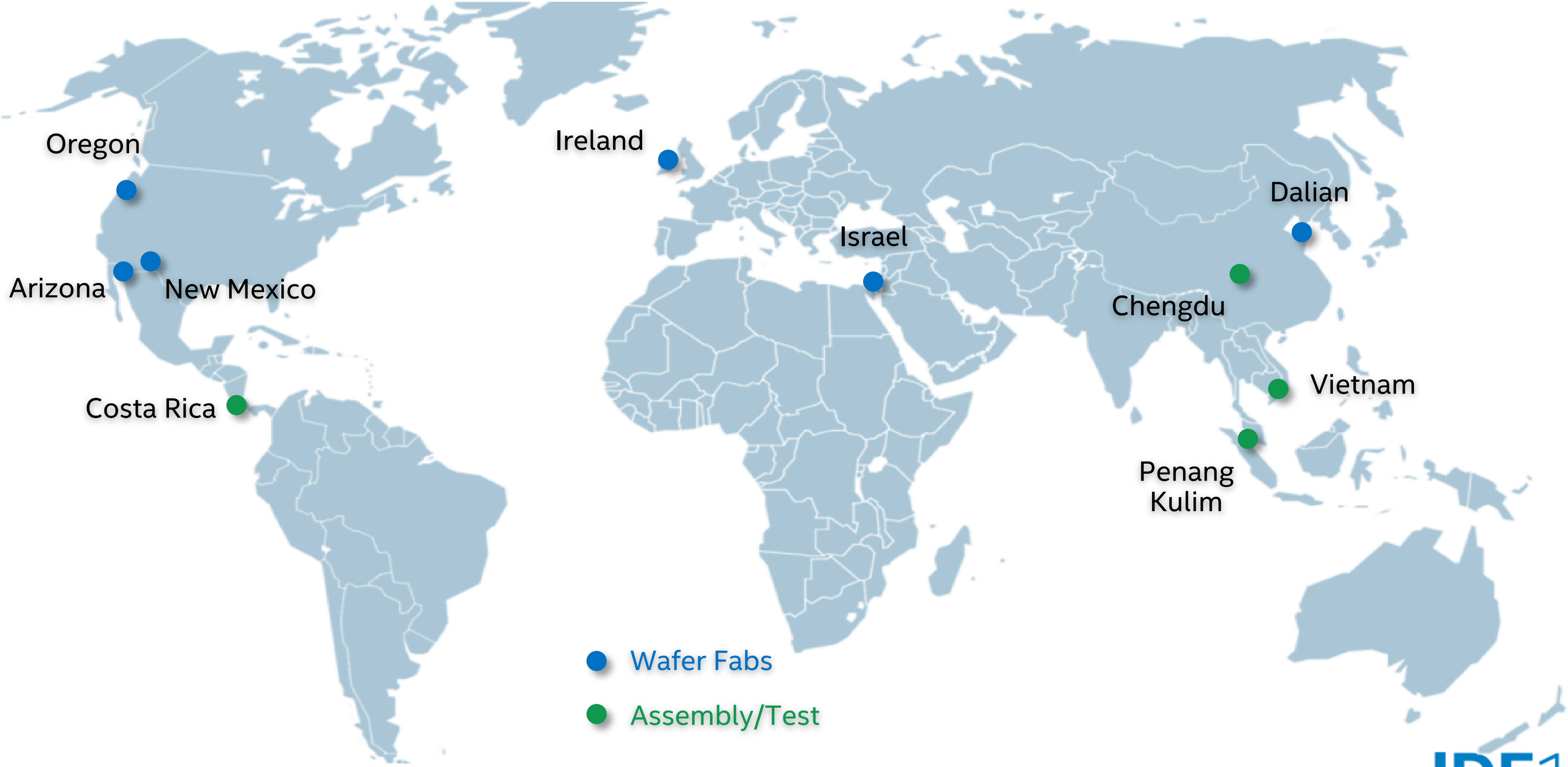


Intel Custom Foundry: Worldwide Assets



● Wafer Fabs

● Assembly/Test

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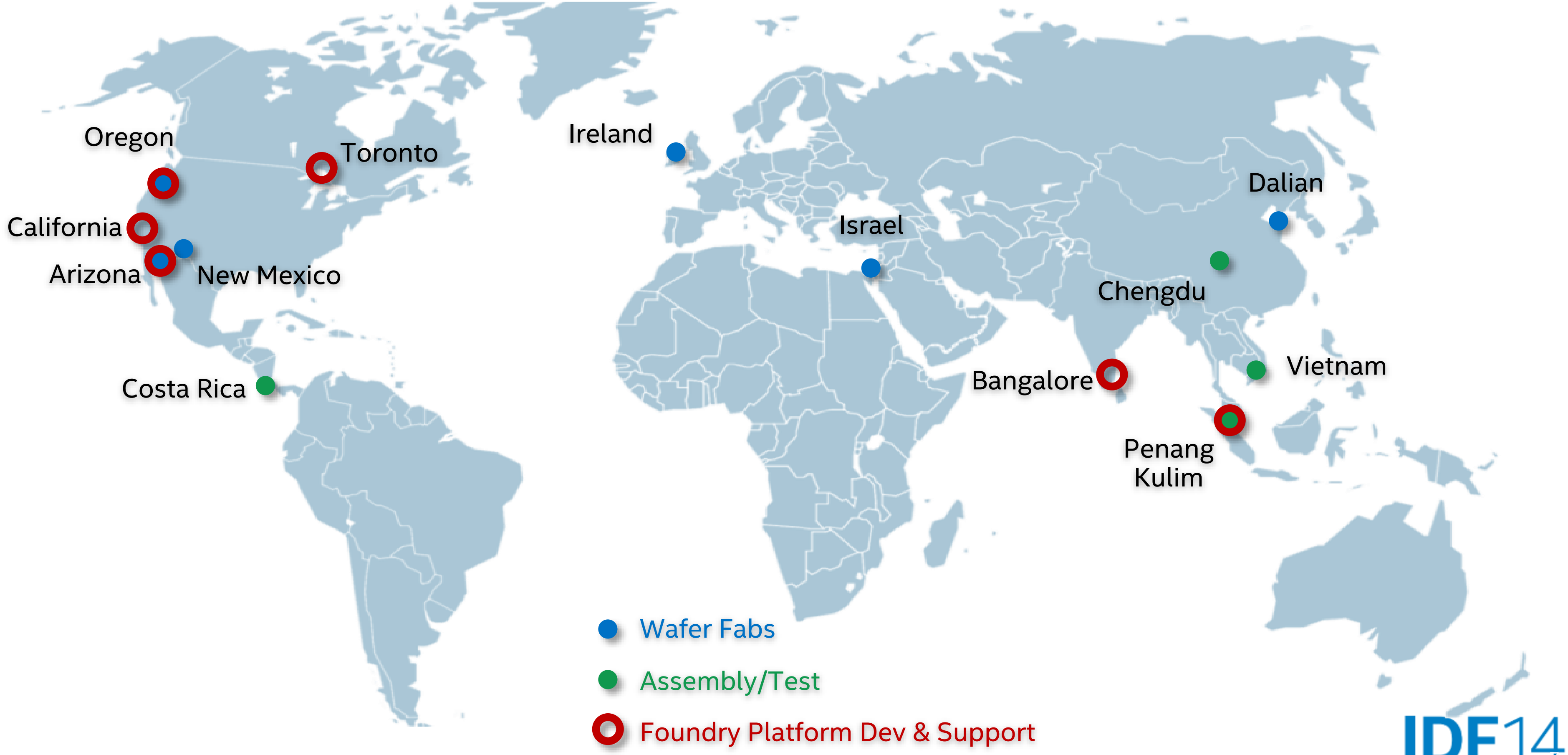
Intel Custom Foundry: Worldwide Assets



Intel Custom Foundry: Announced Customers

achronix
SEMICONDUCTOR CORPORATION

ALTERA®

Microsemi

NETRONOME
The Flow Processing Company

Panasonic

tabula

Note: This list of customers does not include those who choose not to disclose relationship with Intel Custom Foundry. Logos are in alphabetical order.

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- Platform Offerings
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Intel Custom Foundry Platform Offerings

Intel Custom Foundry Platform Offerings

Technology Platform | Silicon | Package | Test

Intel Custom Foundry Platform Offerings

Design Platform	Kits	IP	Design Services
Technology Platform	Silicon	Package	Test

Intel Custom Foundry Platform Offerings

Manufacturing Platform	Engineering Services	Production Services	
Design Platform	Kits	IP	Design Services
Technology Platform	Silicon	Package	Test

Intel Custom Foundry Platform Offerings

Online Service Platform	Information Exchange	Service Transactions	
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Intel Custom Foundry Platform Offerings

Online Service Platform	Information Exchange		Service Transactions
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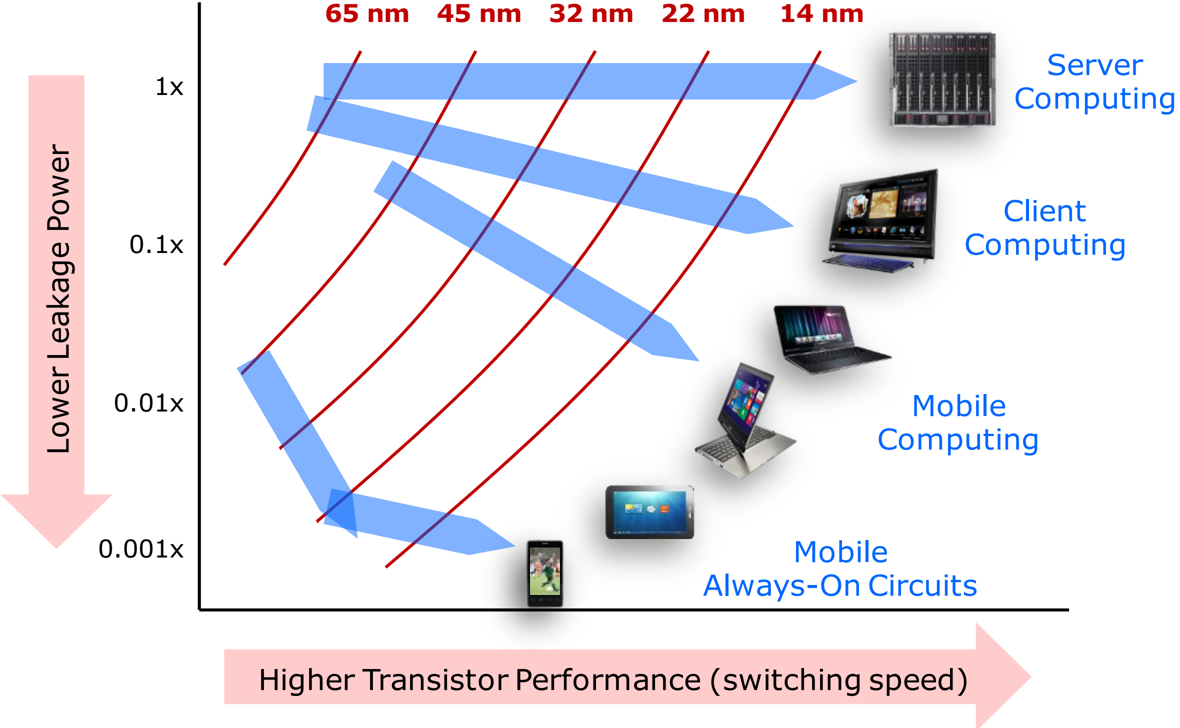
The Wide Moving Edge of Moore's Law

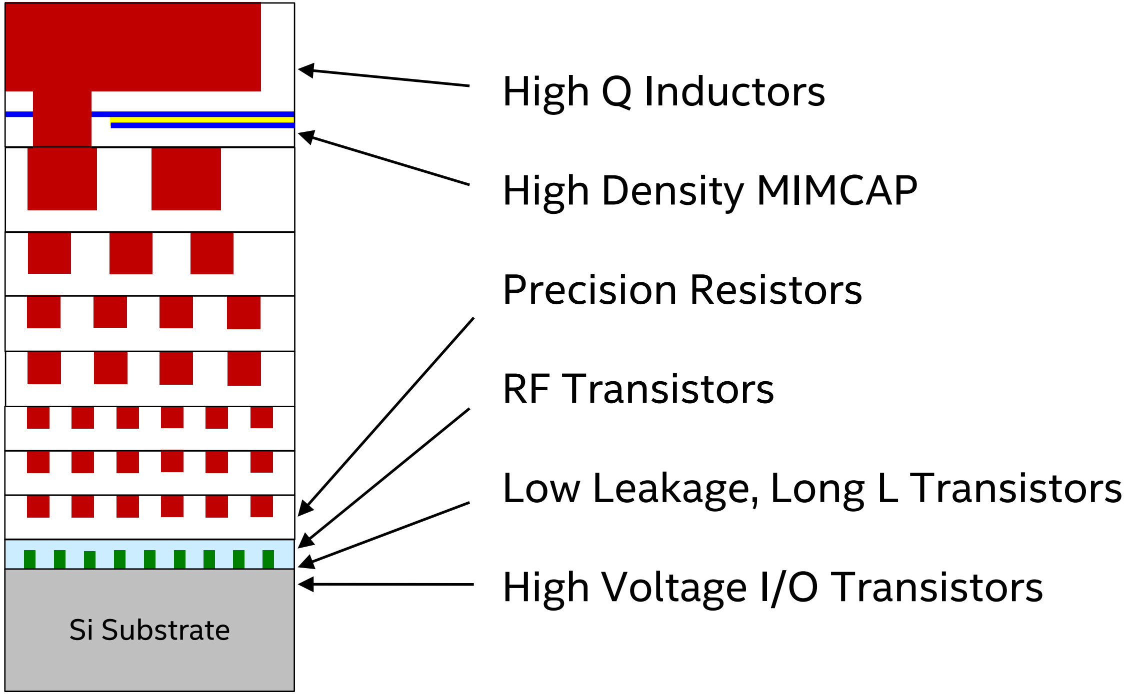


Delivering performance/watt improvement to a wide range of products

Intel Custom Foundry: Silicon Technology Platform Offerings

	22nm	14nm	10nm
Cloud/Infrastructure	General Purpose ✓	General Purpose ✓	General Purpose In Dev
Client/Consumer		Low Power ✓	Low Power In Dev

SOC Features in 14nm technology



High Q Inductors

High Density MIMCAP

Precision Resistors

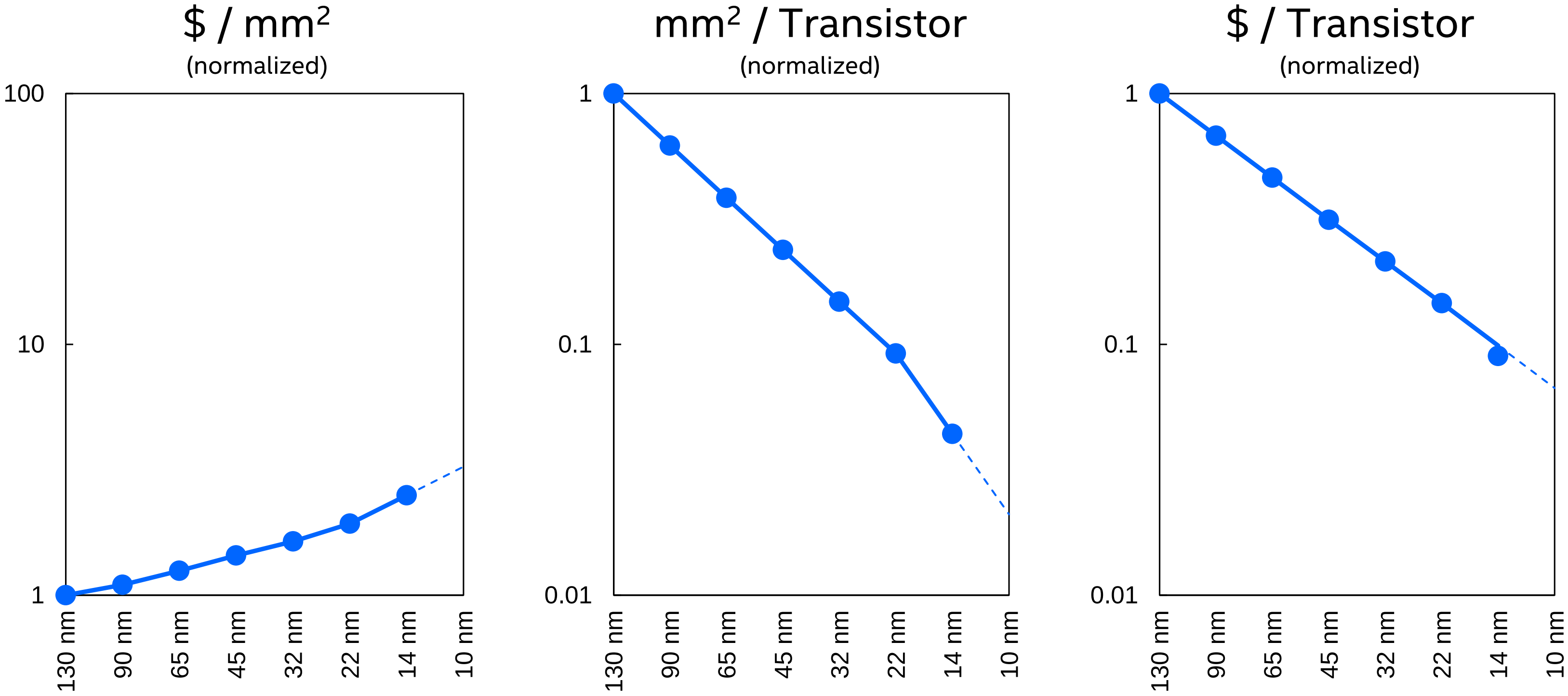
RF Transistors

Low Leakage, Long L Transistors

High Voltage I/O Transistors

Full featured technology enables integration of system functions on a chip

Cost per Transistor



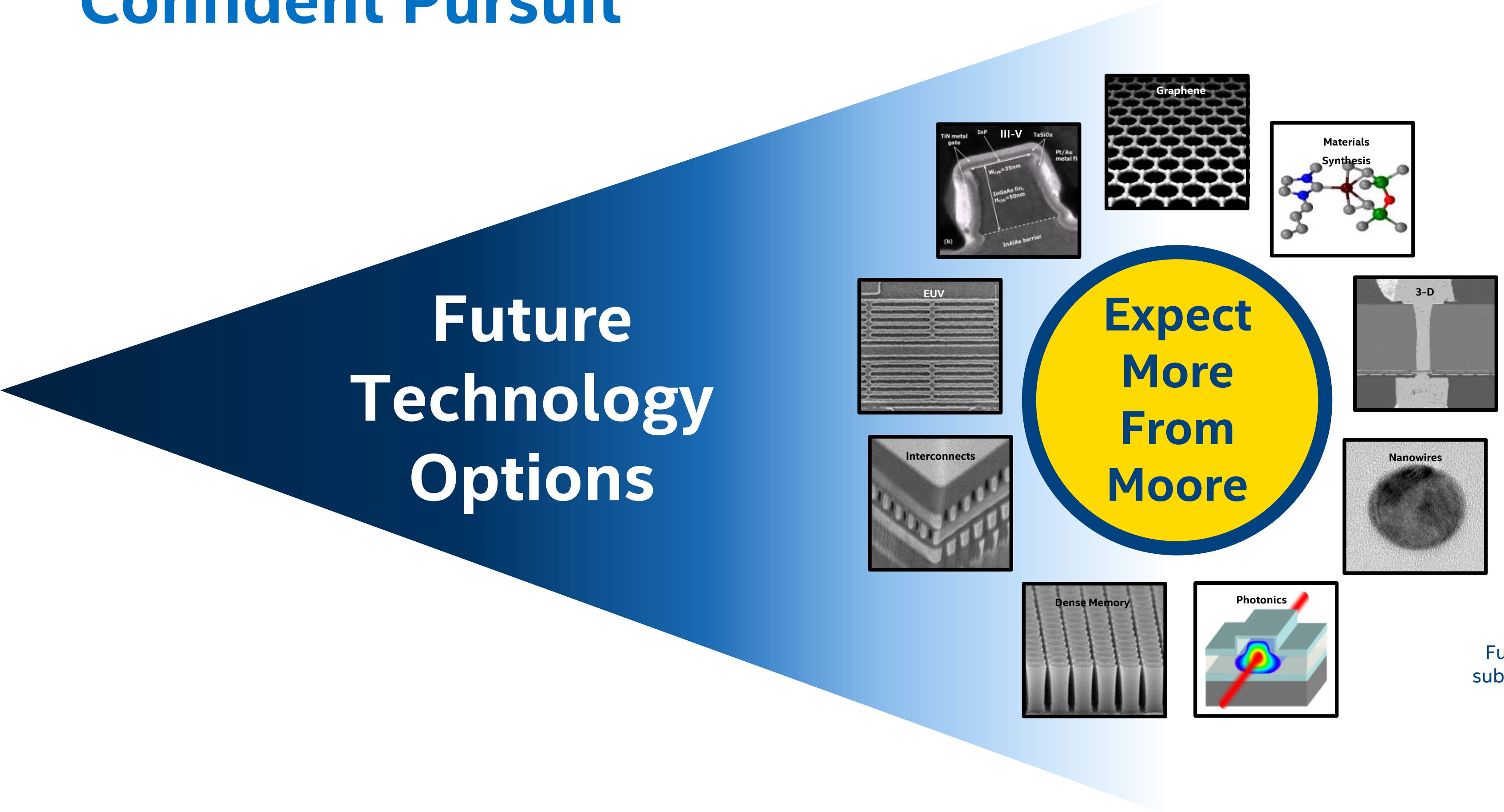
$ / mm² (normalized)

mm² / Transistor (normalized)

$ / Transistor (normalized)

Intel 14 nm continues to deliver lower cost per transistor

Confident Pursuit



Future Technology Options

Expect More From Moore

Future options subject to change

Source: Intel

Intel Custom Foundry Platform Offerings

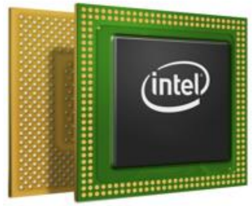
Online Service Platform	Information Exchange	Service Transactions	
Manufacturing Platform	Engineering Services	Production Services	
Design Platform	Kits	IP	Design Services
▶ **Technology Platform**	Silicon	Package	Test

Intel's Flip Chip Package Portfolio

Cloud/Infrastructure

Client

SOC/Consumer



- Package-on-Package
- Ultra-thin
- Small Form Factor Chip Scale Packages

Serving the requirements of multiple market segments

Intel's Flip Chip Package Portfolio

Cloud/Infrastructure

Client

SOC/Consumer

- Enhanced thermal solutions
- LGA socket

Desktop

- Thin Core Substrate
- Multi-chip packages
- Embedded and surface passives

Mobile

Serving the requirements of multiple market segments

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Intel's Flip Chip Package Portfolio

Cloud/Infrastructure

Client

SOC/Consumer

Server

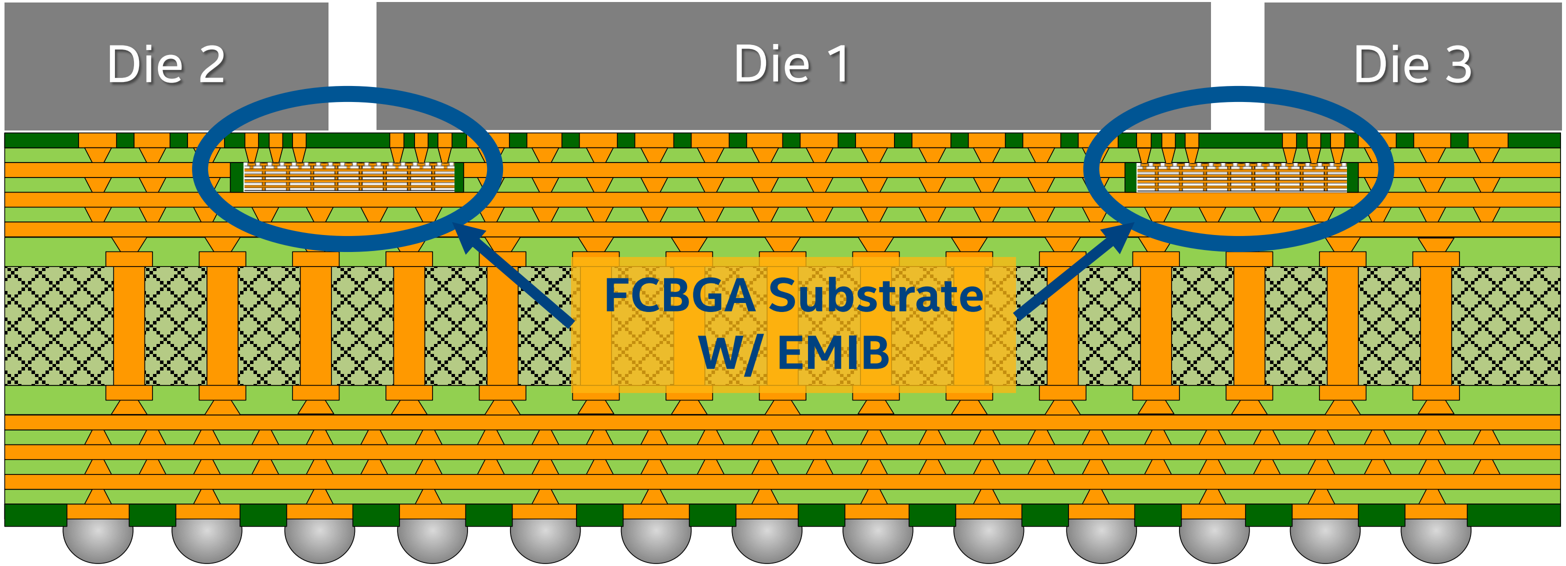
- High pin count LGA sockets
- Optimized for high speed signaling
- Large die

HPC

- Very High pin count LGA sockets
- Very large footprint BGA
- Reticle size die assembly

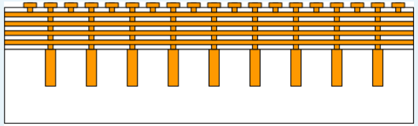
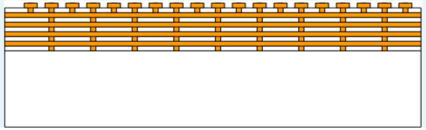
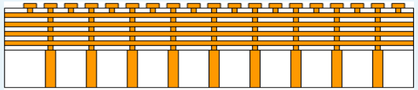
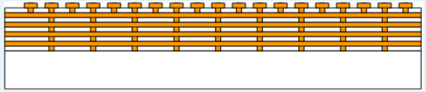
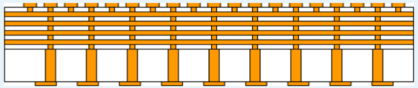
Serving the requirements of multiple market segments

Introducing:
Embedded Multi-die Interconnect Bridge (EMIB)



An elegant approach to in-package high density interconnect of heterogeneous die

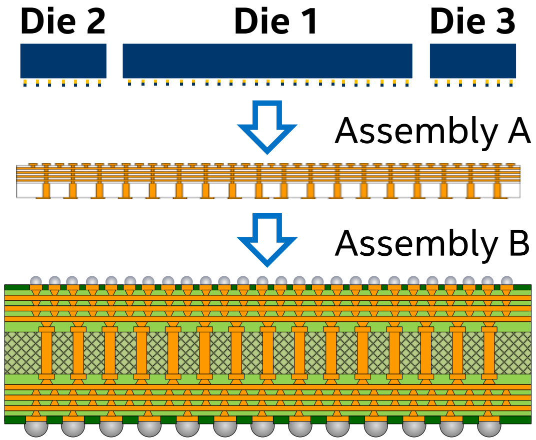
EMIB Wafer Process Compared to Typical 2.5D

Typical 2.5D Interposer Process		**EMIB Bridge Wafer Process**
Starting Wafer		Starting Wafer
	**TSV Formation & Fill**	***Not Required!***
	**BEOL Metallization**	
	**Wafer Thinning**	
	**TSV Reveal & Backside Surface**	***Not Required!***

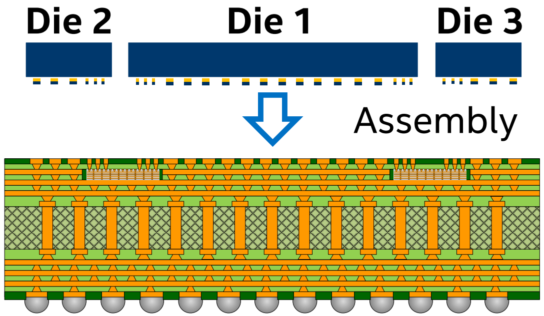
EMIB wafer fabrication is simpler than typical silicon interposer

EMIB Assembly Process Compared to Typical 2.5D

Typical 2.5D Interposer Process Flow



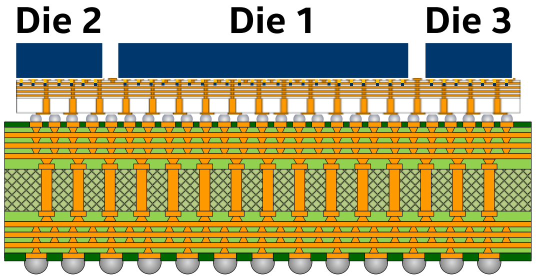
EMIB Process Flow



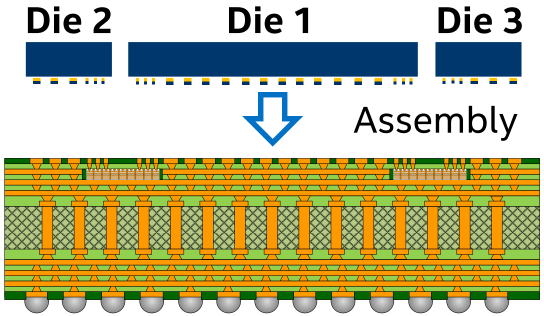
EMIB Requires Less Assembly Processing Than typical Silicon Interposer Assembly

EMIB Assembly Process Compared to Typical 2.5D

Typical 2.5D Interposer Process Flow



EMIB Process Flow



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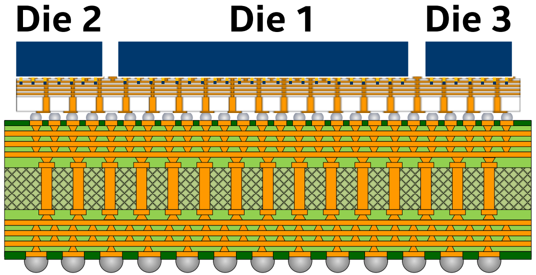
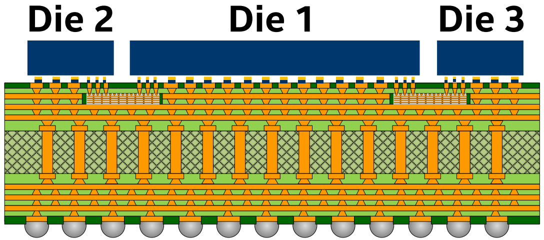
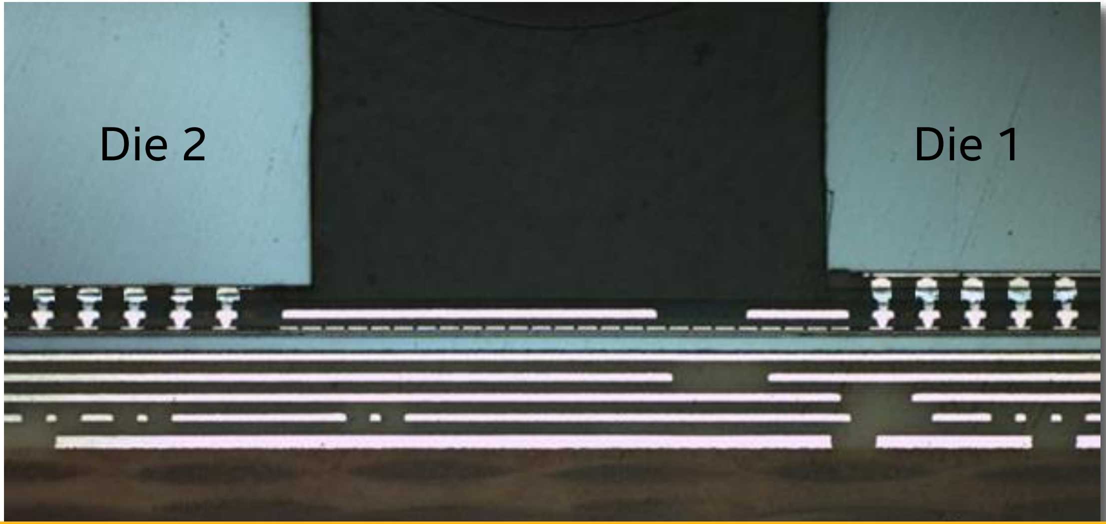


EMIB Process Flow



EMIB Requires Less Assembly Processing Than typical Silicon Interposer Assembly

EMIB Progress



EMIB Package (Cross Section)

Available for sampling in 2015

Intel Custom Foundry Platform Offerings

Online Service Platform	Information Exchange	Service Transactions	
Manufacturing Platform	Engineering Services	Production Services	
Design Platform	Kits	IP	Design Services
Technology Platform	Silicon	Package	Test

Introducing High Density Modular Test (HDMT)

Engineering Module | **Production Module**

- **Common Architecture**
  - Fast TTM Engineering Module
  - >30 sites with parallel, asynchronous operation in production module
- **Flexible Architecture**
  - Enables standard instrumentation integration (PXI)
- **Low Cost**
  - > 2X Cost improvement over conventional test platforms

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Foundry Design Kit (FDK)

Analog / Mixed Signal Flows

Digital Flows

Primitive Libraries

Process Collaterals

Design Tool Drivers: Technology files

DFM Templates: Device, Layout, Fill

Design Rules: Run-sets LVS[1], DRC[2], RV[3]

Models: Simulation and RC[4] Extraction

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[1] Layout connectivity verification system

[2] Design Rule Checking

[3] Reliability Verification

[4] Resistance * Capacitance

Foundry Design Kit (FDK)

Analog / Mixed Signal Flows

Digital Flows

Primitive Libraries

Process Collaterals

- Full Chip Integration Collateral Library
- Memory (SRAM[1]) Cell Library
- Analog Primitive Library[2]

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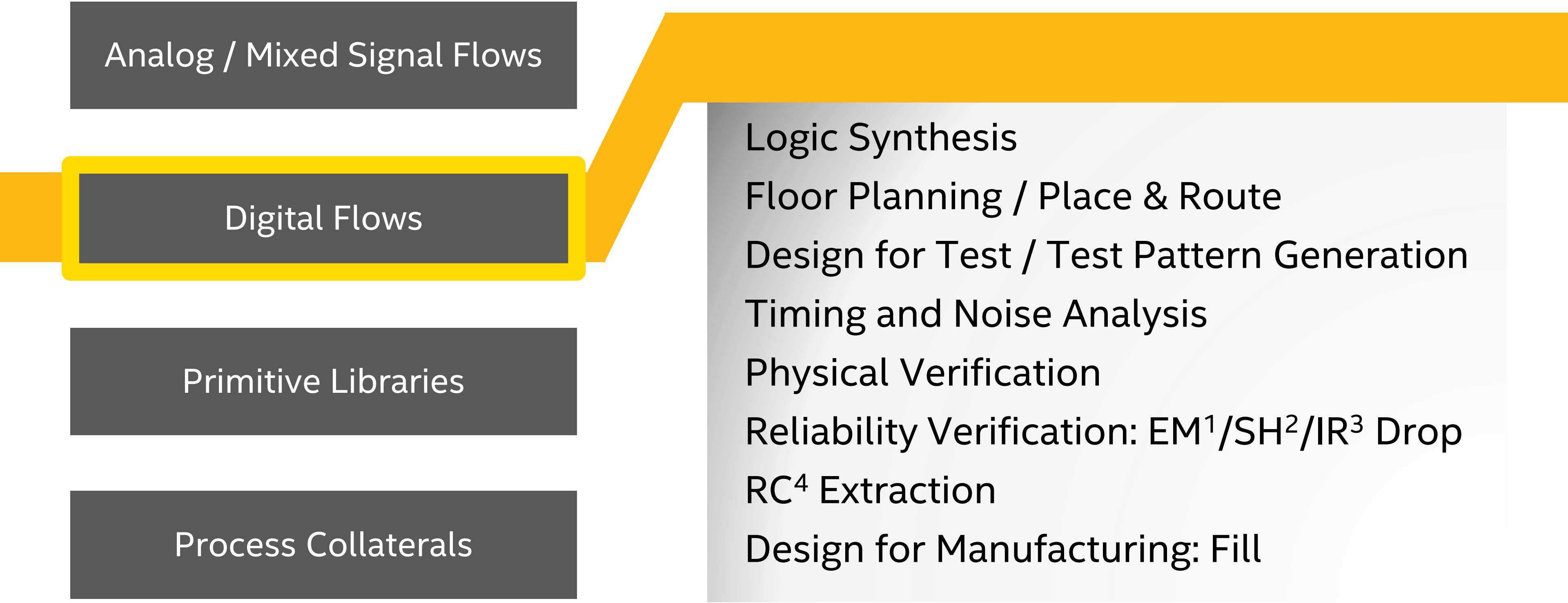
[1] Static Random Access Memory

[2] Capacitors, resistors, inductors, etc.

Foundry Design Kit (FDK)



Analog / Mixed Signal Flows

Digital Flows

Primitive Libraries

Process Collaterals

Logic Synthesis

Floor Planning / Place & Route

Design for Test / Test Pattern Generation

Timing and Noise Analysis

Physical Verification

Reliability Verification: EM[1]/SH[2]/IR[3] Drop

RC[4] Extraction

Design for Manufacturing: Fill

[1] Electro-migration

[2] Self Heat

[3] Voltage (Multiplication of current and resistance) drop

[4] Resistance * Capacitance

Foundry Design Kit (FDK)

Analog / Mixed Signal Flows

Digital Flows

Libraries

Process Collaterals

- Schematic Capture
- Circuit Simulation
- Custom Routing
- Custom Layout
- Physical Verification
- Reliability Verification: EM[1]/SH[2]/IR[3] Drop
- RC[4] Extraction
- Design for Manufacturing: Fill

---

[1] Electro-migration

[2] Self Heat

[3] Voltage (Multiplication of current and resistance) drop

[4] Resistance * Capacitance

FDK: Digital Flows
Breadth of Industry Standard Tools

Logic Synthesis	SYNOPSYS	cadence		
Floor Planning / Place & Route	SYNOPSYS	cadence		
Test Pattern Generation	SYNOPSYS	cadence	Mentor Graphics	
Timing and Noise Analysis	SYNOPSYS	cadence		
Physical Verification	SYNOPSYS		Mentor Graphics	
Reliability Verification				ANSYS
RC[1] Extraction	SYNOPSYS	cadence		
Design for Manufacturing: Fill	SYNOPSYS		Mentor Graphics	

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[1] Resistance * Capacitance

FDK: Analog Mixed Signal Flows
Breadth of Industry Standard Tools

Schematic Capture	SYNOPSYS®	cadence®		
Circuit Simulation	SYNOPSYS®	cadence®	Mentor Graphics®	
Custom Routing	SYNOPSYS®	cadence®		
Custom Layout	SYNOPSYS®	cadence®		
Physical Verification	SYNOPSYS®		Mentor Graphics®	
Reliability Verification				ANSYS®
RC[1] Extraction	SYNOPSYS®	cadence®		
Design for Manufacturing: Fill	SYNOPSYS®		Mentor Graphics®	

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[1] Resistance * Capacitance

Intel Custom Foundry Platform Offerings

Online Service Platform	Information Exchange	Service Transactions	
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▶ **Design Platform**	Kits	IP	Design Services
Technology Platform	Silicon	Package	Test

IP Offerings: Foundational IP

Processor IP

Interface IP

Advanced Mixed Signal IP

Foundational IP

High Speed Lib

High Density Lib

Foundational Digital Libraries

Register File Compilers

SRAM Compilers

TCAMs Compilers

ROMs

Fuses (High density/High Speed)

Foundational Memory

IP Offerings: Advanced Mixed Signal IP

Processor IP

Interface IP

Advanced Mixed Signal IP

Foundational IP

Phase Locked Loop/Delay Locked Loop
Low Drop Out voltage Regulator
Crystal Oscillator
Adaptive Voltage Scaling circuits
Clock Receiver & Divider
Digital Thermal Sensor
General Purpose IO
High Speed Programmable IO
Voltage Reference IO
Digital Random Number Generators

IP Offerings: Interface IP

- Processor IP
- **Interface IP**
- Advanced Mixed Signal IP
- Foundational IP

Memory	SerDes	Storage	Display
DDR2/3	USB2/3	eMMC4/5	eDP/DP
DDR4	PCI Express* 1-4	SD3.0	HDMI1.4/2.0
LPDDR3/4	Ethernet[2]		
HBM[1]	MIPI (DPHY, HSI)		
WIO[1]	LP 1-12.5G[3]		
	CEI/IEEE 25-32G		
	CEI/IEEE 40-56G[1]		

1. Roadmap item under consideration 2. KR, XAUI, CEI. 3. Multi Standard

IP Offerings: Processor IP

Processor IP

Interface IP

Advanced Mixed Signal IP

Foundational IP

Intel® Architecture Cores

Intel® Atom™ processor[1]

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1 Roadmap item in planning and development

Intel Custom Foundry Platform Offerings

Online Service Platform	Information Exchange	Service Transactions	
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ASIC Design Enablement & Services

Prototyping Shuttle

Support

Design Implementation

Block Level physical implementation for COT business model

Full Chip physical implementation for ASIC business model

ASIC Design Enablement & Services

Prototyping Shuttle

Support

- Customer bring-up / Training
- Optimized reference methodology and flows
- Common debug environment

Design Implementation

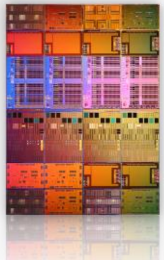
ASIC Design Enablement & Services

Prototyping Shuttle

Support

Design Implementation

From GDS to Prototype units



22nm

14nm

Coming Soon

10nm

Intel Custom Foundry Platform Offerings

Online Service Platform	Information Exchange	Service Transactions	
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Engineering Services

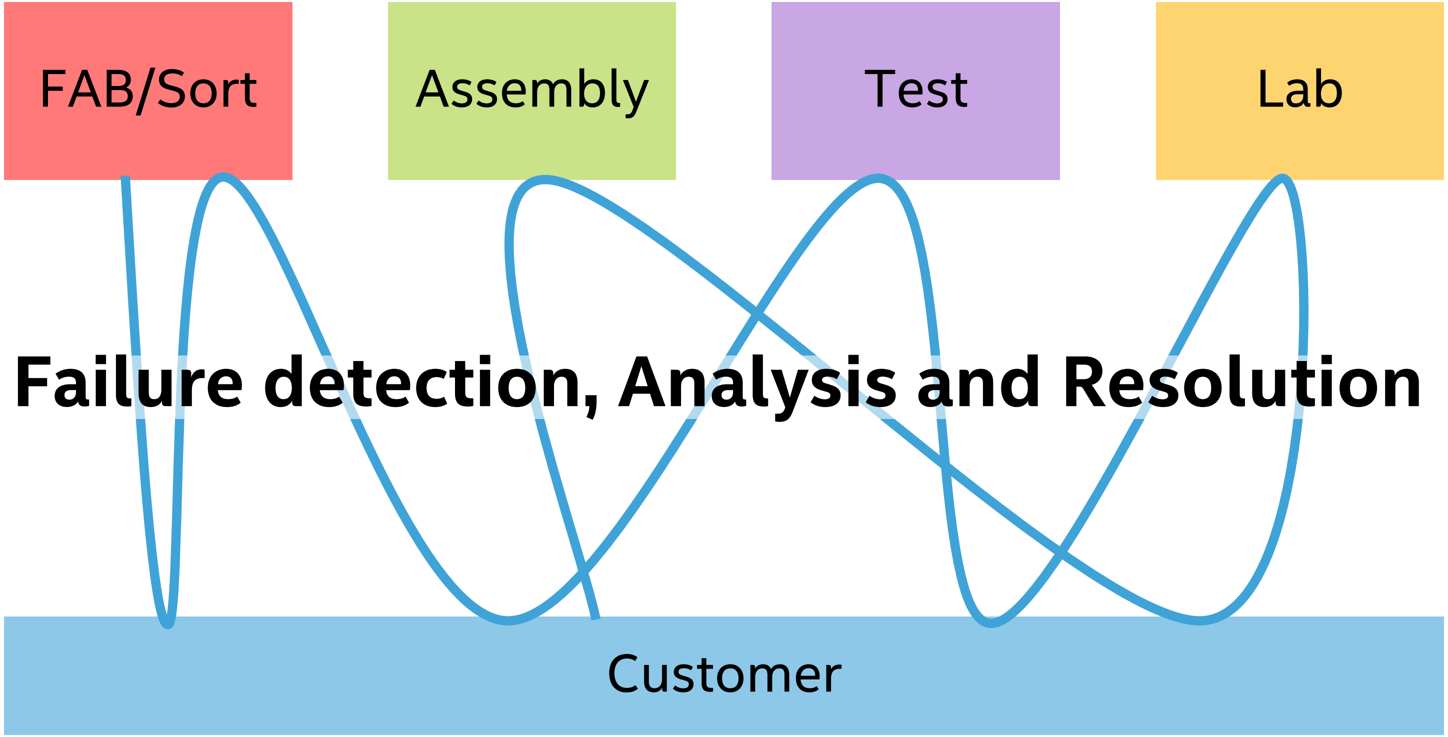
One-stop comprehensive engineering services

- Package Design Service
- Wafer and Final Test Service
- Failure Analysis & Debug Service
- Product Qualification Service
- Engineering Samples

- Leading edge technology capabilities
- Integrated engineering data network

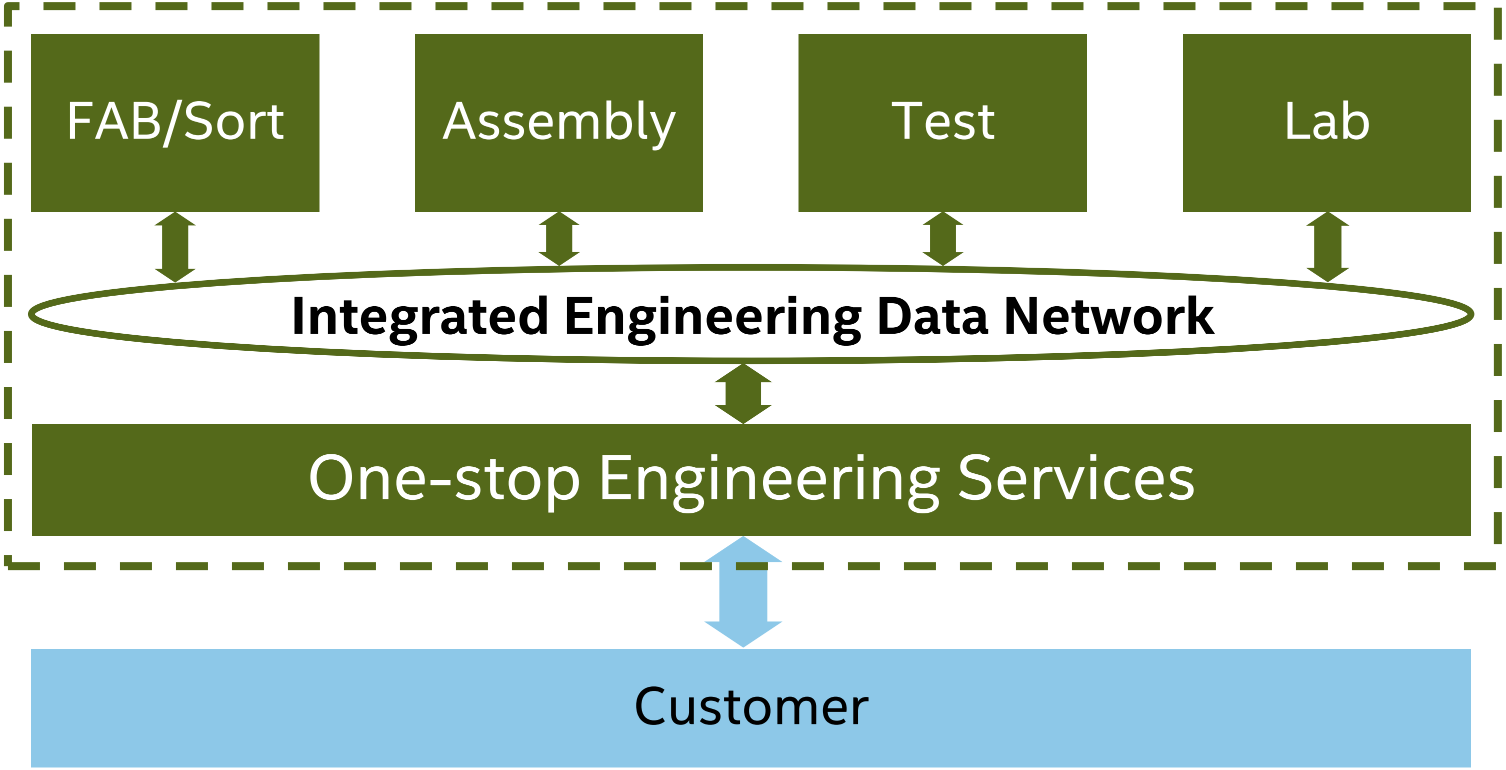
Faster Time to Production Ramp

Example:
Post Silicon Debug – Fabless Industry Model



Failure detection, Analysis and Resolution

Example:
Post Silicon Debug with Intel Custom Foundry



FAB/Sort

Assembly

Test

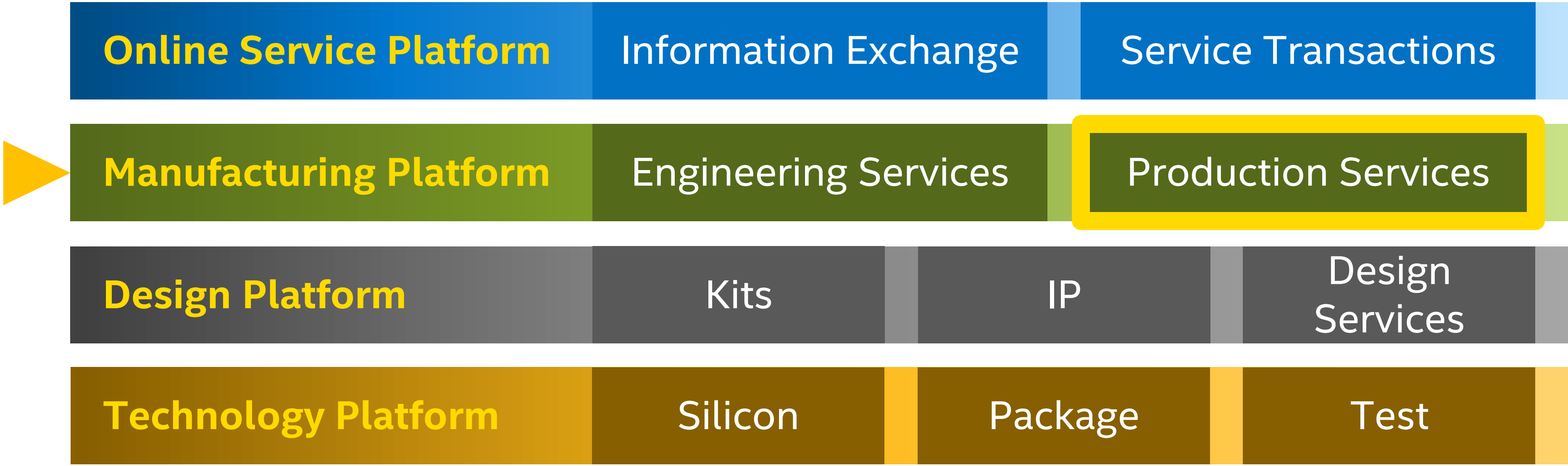
Lab

Integrated Engineering Data Network

One-stop Engineering Services

Customer

Intel Custom Foundry Platform Offerings



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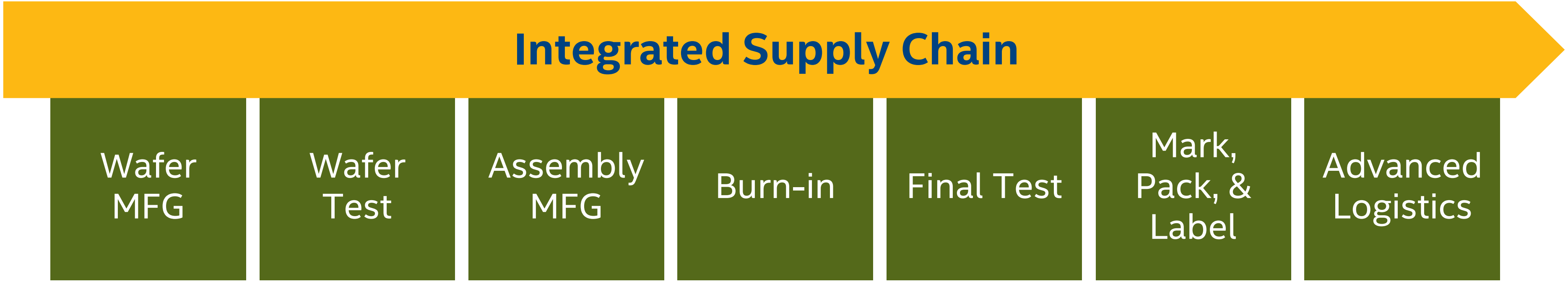
Production Services



Integrated Supply Chain

Wafer MFG

Wafer Test

Assembly MFG

Burn-in

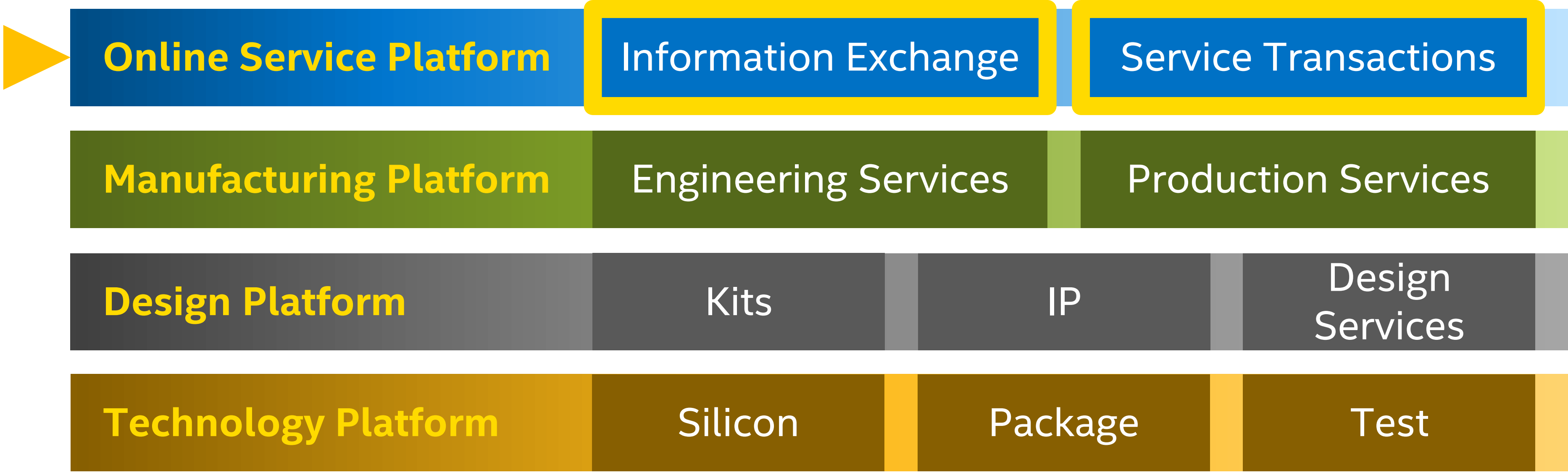
Final Test

Mark, Pack, & Label

Advanced Logistics

- Manufacturing scale and business continuity
- Integrated quality management
- Yield optimization

Intel Custom Foundry Platform Offerings



- **Online Service Platform**: Information Exchange | Service Transactions
- **Manufacturing Platform**: Engineering Services | Production Services
- **Design Platform**: Kits | IP | Design Services
- **Technology Platform**: Silicon | Package | Test

Online Services Platform

Customers

Ecosystem Partners

Online Services Portal

Information Exchange

- Design kits/IP exchange
- Documentation access
- Design data upload
- Mfg data download
- Collaborative Meetings

Service Transactions

- Tapeout services
- Shuttle services
- Material tracking & control
- Issue resolution
- Ad hoc online support

Agenda

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Summary

Summary

- Intel Custom Foundry is open for business. We support a full range of flexible custom and semi-custom service business models.

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- Our customers have access to co-optimized advanced manufacturing technologies including silicon, packaging and test.

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- To enable customer designs, our design platform offers industry standard kits, silicon proven IP blocks and design services for low power SOCs to high performance infrastructure devices.

Summary

- Intel Custom Foundry is open for business. We support a full range of flexible custom and semi-custom service business models.
- Our customers have access to co-optimized advanced manufacturing technologies including silicon, packaging and test.
- To enable customer designs, our design platform offers industry standard kits, silicon proven IP blocks and design services for low power SOCs to high performance infrastructure devices.
- Our manufacturing platform offers highly optimized silicon engineering and production services that take full advantage of Intel's Integrated Device Manufacturing (IDM) capabilities.

Come lead with us
at the edge of Moore's Law

Additional Sources of Information

- A PDF of this presentation is available is available from our Technical Session Catalog: www.intel.com/idfsessionsSF. This URL is also printed on the top of Session Agenda Pages in the Pocket Guide.
- Sunit Rikhi's presentation at Intel Analyst Event in London (May 2013):
  http://www.intc.com/common/download/download.cfm?companyid=INTC&fileid=666570&filekey=1F334D17-5F6F-4CA5-A72B-2D3BCF8AAB3B&filename=05-23-13_Intel_Mftr_and_Tech_Capabilities_-_Sunit_Rikhi_London_with_Risk_Factors.pdf
- Recent Press Release
  - VLSI video interview:
    - http://electronics.wesrch.com/wequest-EL1QIXV-intel-custom-foundry
  - EMIB/HDMT announcement:
    - http://newsroom.intel.com/community/intel_newsroom/blog/2014/08/27/intel-announces-new-packaging-and-test-technologies-for-foundry-customers
  - Panasonic announcement:
    - http://newsroom.intel.com/community/intel_newsroom/blog/2014/07/07/intels-custom-foundry-will-manufacture-future-panasonic-system-on-chips-using-intels-14nm-low-power-process
  - Altera and Intel Extend Manufacturing Partnership to Include Development of Multi-Die Devices:
    - http://newsroom.intel.com/community/intel_newsroom/blog/2014/03/26/altera-and-intel-extend-manufacturing-partnership-to-include-development-of-multi-die-devices

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