Assembly, Test, Marking and Packaging
Concepts & Practice

Primer

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Semiconductor & ATMP Primer

Semiconductor Basics

- Scaling & Moore's laws
- Definitions, Device Structures
- Devices in Systems

Semiconductor Manufacturing

- Manufacturing Process
- Semiconductor Equipment
- The Fab (possible layout, cleanroom concepts, subfab & related concepts)

Semiconductor Device Types

- Analog vs Digital vs SIA Framework vs Oppenheimer Framework

Semiconductor Industry

- Size and forecast
- Key players
- Players by end-markets
- Sizing

Evolving Frontiers

- ATMP
- WBG Semiconductors
- India Options

External Use

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ATMP Primer-Oct 9th, 2020

Semiconductor Industry

- Size and forecast
- Key players
- Players by end-markets
- Sizing

Evolving Frontiers 1

- ATMP Evolution
- Current Tech trends
- Manufacturing Processes

Evolving Frontiers-2

- WBG Semiconductors
- Current Tech Trends
- Manufacturing Processes

Evolving Frontiers-3

- MEMS
- Current Tech Trends
- Manufacturing Processes

Evolving Frontiers-4

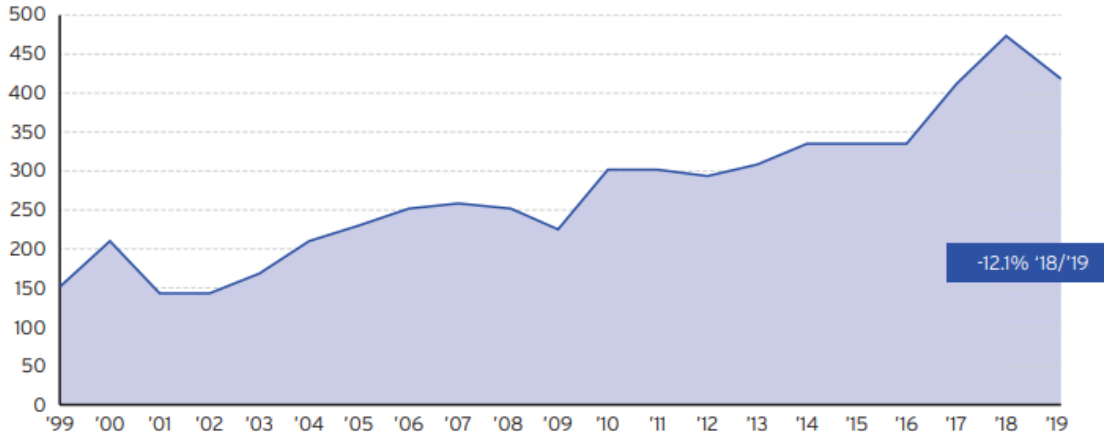
- India Demand Strategy
- Industry Enablement Options

External Use

Semiconductor Industry
Size, Structure, Forecast
Key Players
Key Players by end-sectors

Semiconductor Industry 2019

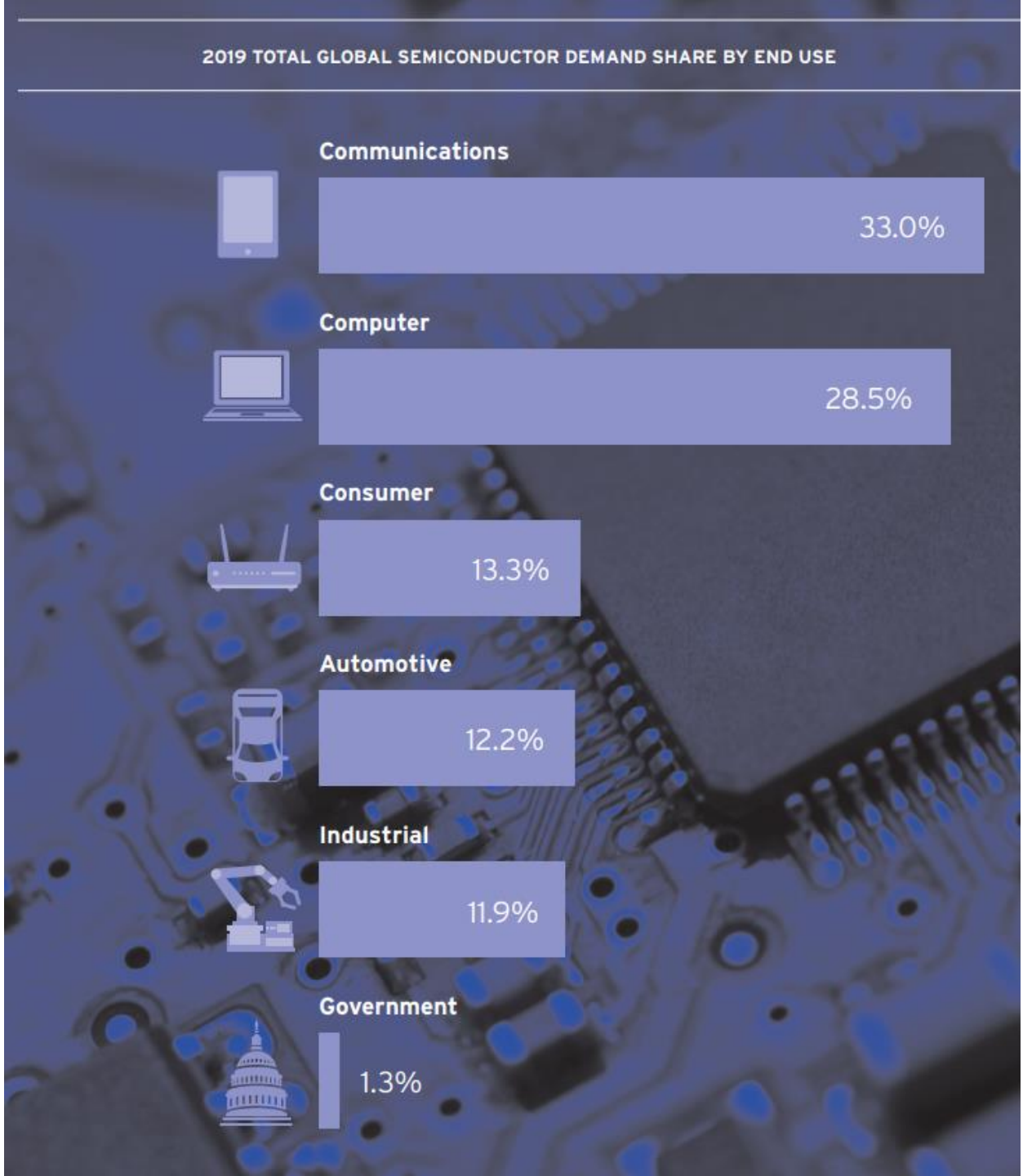
GLOBAL SEMICONDUCTOR SALES ($B)



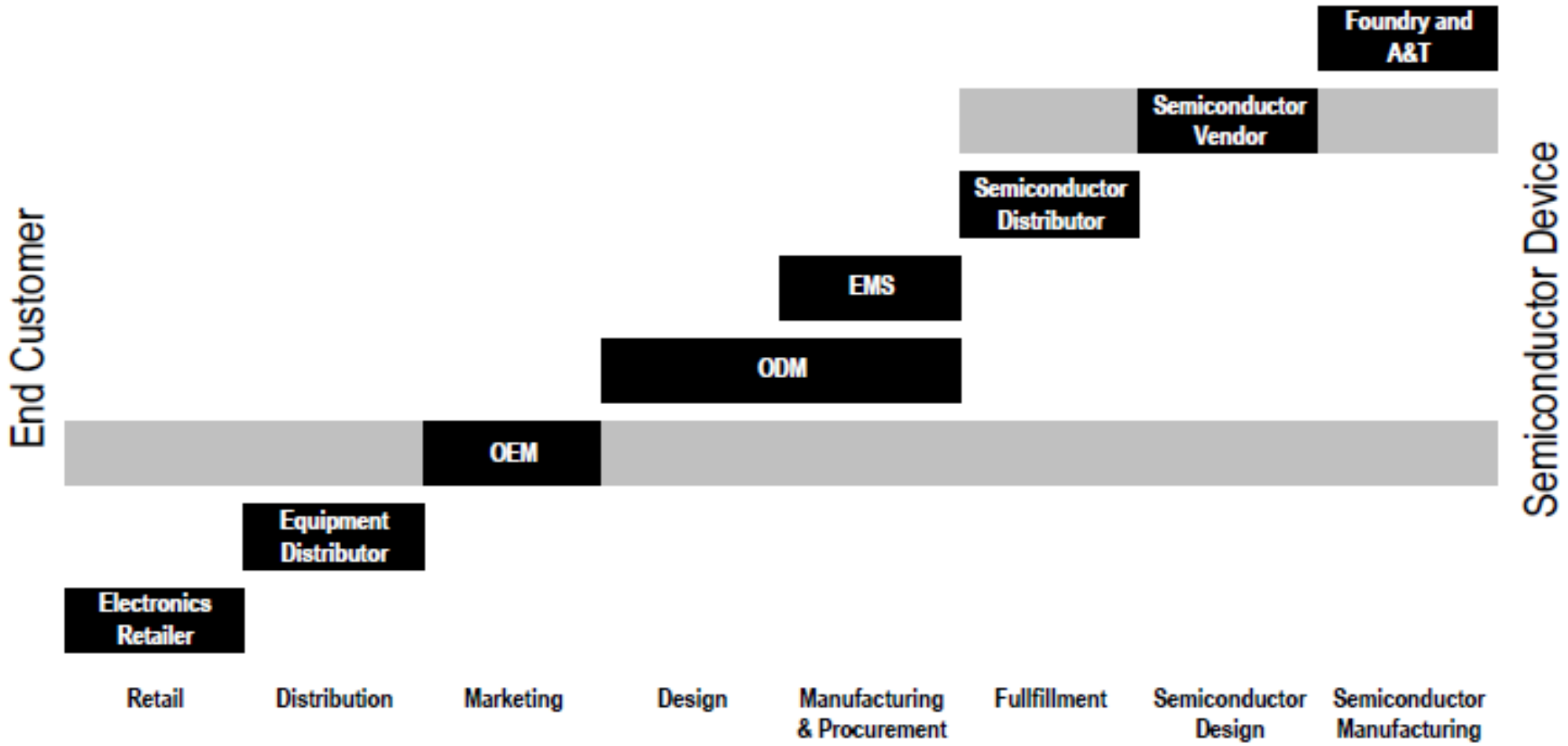
2019 DEMAND BY END-USE

End-Use Category	Communication	Computer	Consumer	Automotive	Industrial	Government
Annual Growth	-10.5	-18.7	-5.2	-6.9	-13.0	13.0
Total Value ($B)	**136.0**	**117.3**	**54.7**	**50.2**	**48.9**	**5.2**

2019 TOTAL GLOBAL SEMICONDUCTOR DEMAND SHARE BY END USE



Electronic Equipment Supply-Chain



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But the supply-chain is a lot more complex…

Integrated Device Manufacturers (IDMs) manufacture their own devices. Typically, these are mature vendors dealing in high volume products. IDMs have lots of operating and cyclical leverage.

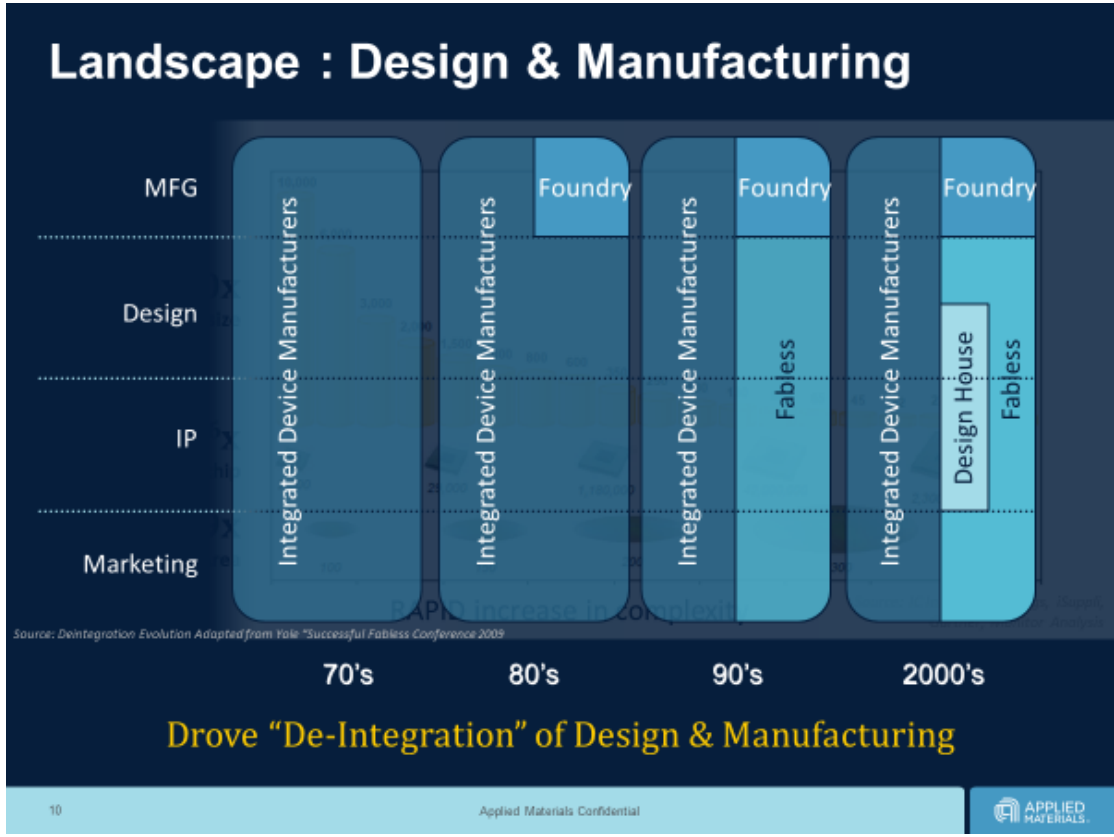
Examples: Intel, Texas Instruments, Samsung, Toshiba, Renesas

Fabless companies design devices themselves but contract the manufacturing to others. These companies are more focused on design, and enjoy more margin and earnings stability as well as lower capital requirements.

Examples: Broadcom, Qualcomm, NVIDIA, Xilinx, Marvell, MediaTek

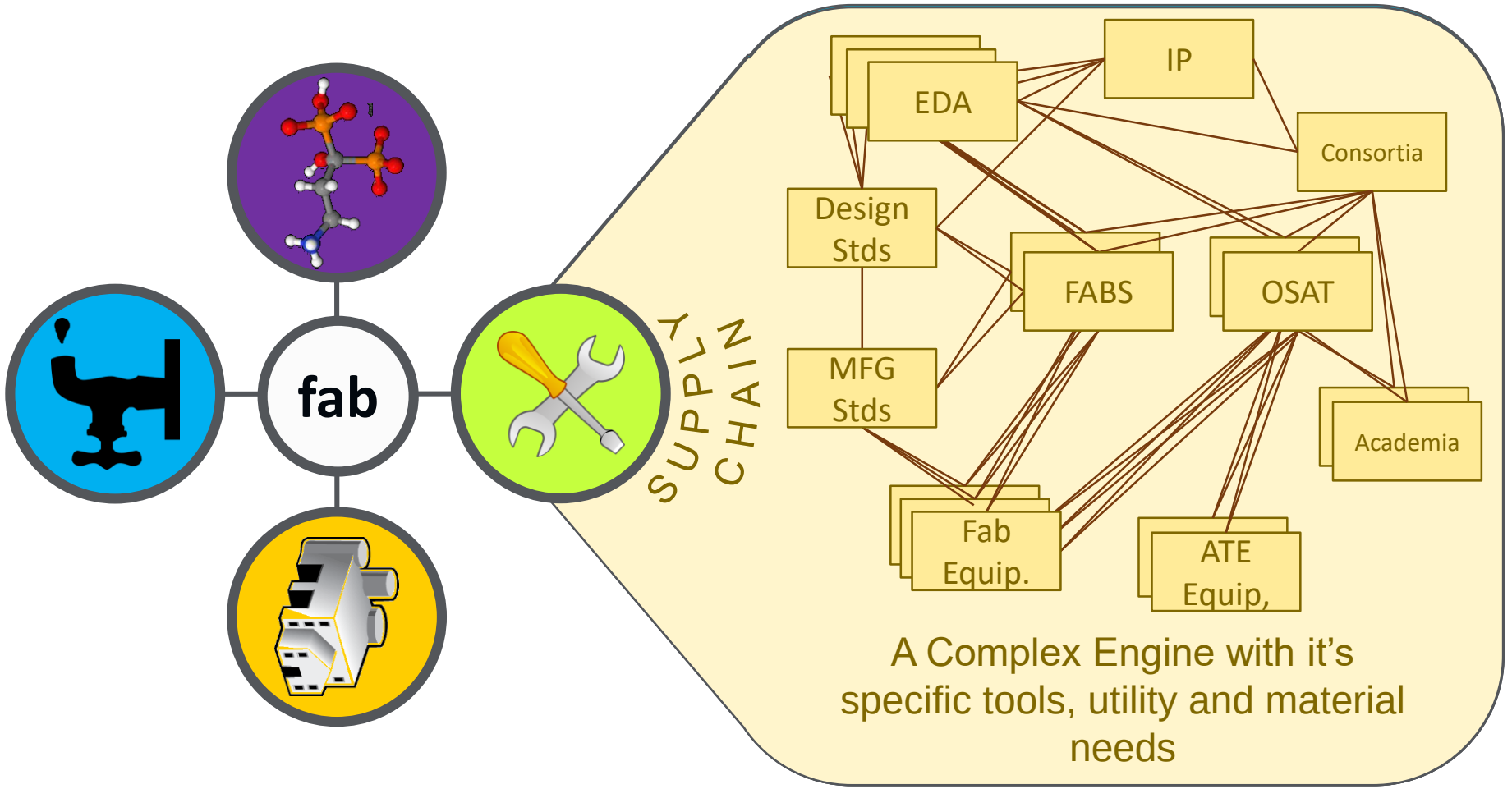
Foundries and **Assembly and Testers** are specialized third-party manufacturers that perform wafer fabrication or back-end processing for others on a contract basis.

Examples (foundry): Taiwan Semiconductor, UMC, Global Foundries
Examples (assembly and test): ASE, Amkor, Siliconware Precision



Semiconductor Equipment industry is a large and specialized industry sector that supplies capital equipment (tools) for front-end and back-end processing. Ex. Applied Materials, ASML, TEL …

Fab: creating opportunities in the ecosystem



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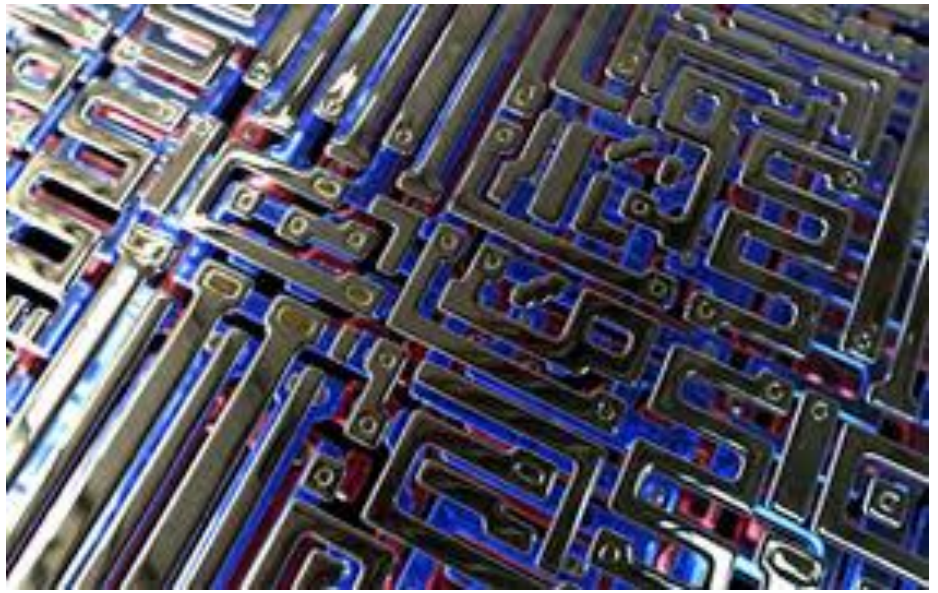
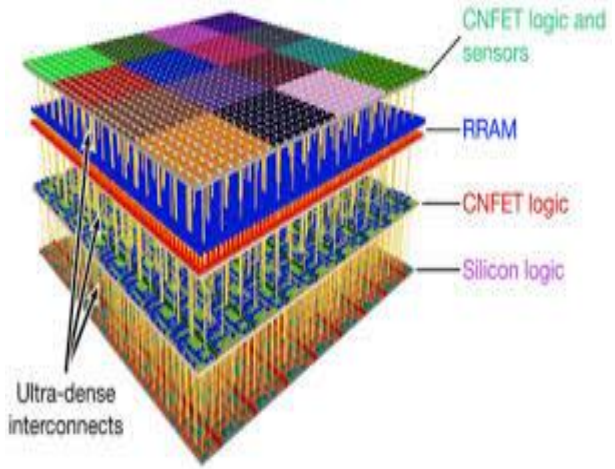
Semiconductor Design Landscape

- Strong MNC Global Engineering Centre base in India for semiconductor design
- Weak startup fabless design base (~12)
- Serious exposure to China fabless rampup predicted by 2025 (already ~1000+/ IESA)
- IESA creating virtual incubation centre with Karnataka Government
- More robust PDK management, tape-out logistics handling (refer MOSIS case-study) required for domestic fabless startups
- Burning need for creating designs for India-specific products





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OSAT Landscape Evolving with M&A

- Intel , TSMC lead the ATMP companies
- And OSAT is evolving more into advance packaging with increasing capture of product value
- ASE leads the pack…but top 10 have Taiwan in lead, followed by China with 1 (USA- AMKOR) and (Singapore-UT, ripe m&a case)
- Key India challenge:
  - What will drive demand to an India OSAT?
  - It may not be practical to have a fab create a finished wafer, transport to India for ATMP – and then re-export finished product abroad..

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INDIA OSAT OPPORTUNITY

- Actual Indian OSAT revenue ’18-19 estimated at $5-6 mln (SCL; SPEL; CDIL; misc)
- Latent Potential ~$600 Mln

(Method 1

Basis estimated 1.7 mln wafer starts/annum demand

(F&S estimates’18/ IESA Vision Summit)

Method 2

Global ATMP market at $60 bln, OSAT is 40% of ATMP India is approx. ~3.36 % of global GDP. Similar ball park figure emerges on latent demand)

- Potential Breakup of OSAT demand on proposed segment strategy

Sector/Chip	Wafer starts Demand/yr	OSAT Revenue opportunity $M
Auto/2 Wheeler Electronics	50000	$17 mln
Consumer/ STB-OTB	80000	$28 mln
Digital Payment/PoS Chips- tags/	50000	$17 mln
Smart Energy Meters	37500	$12 mln
NAVIC GIS Chip	22000	$7.5 mln
Total	240000	$ 81.5 mln

* Indicative estimates/ final figures will depend on specifics of packaging design, customer requirements and volumes

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SCL CHANDIGARH – proof point of capability

- Shows India can make end-to-end semiconductors (SCL operates like a mini-IDM with in-house design,wafer processing and ATMP capabilities)
- Over 100 design tapeouts for a wide range of PSU applications
- 180nm 8” logic line ; 600nm 6” MEMS line; GaN line

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Semiconductor Mfg Eco-system

1 *Semiconductor Mfg is a critical element of NEP to address the high value add component of ESDM*

2 *Pervasiveness of semiconductors offers broad range of technology adoption avenues*

3 *Wide opportunities exist in supply chain, logistics, materials, and supporting areas*

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