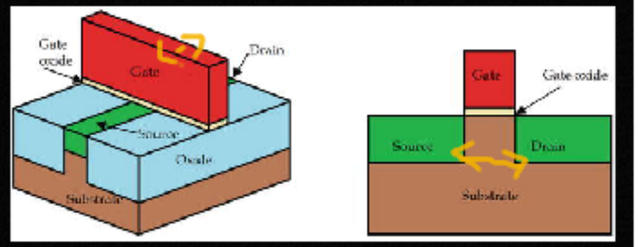
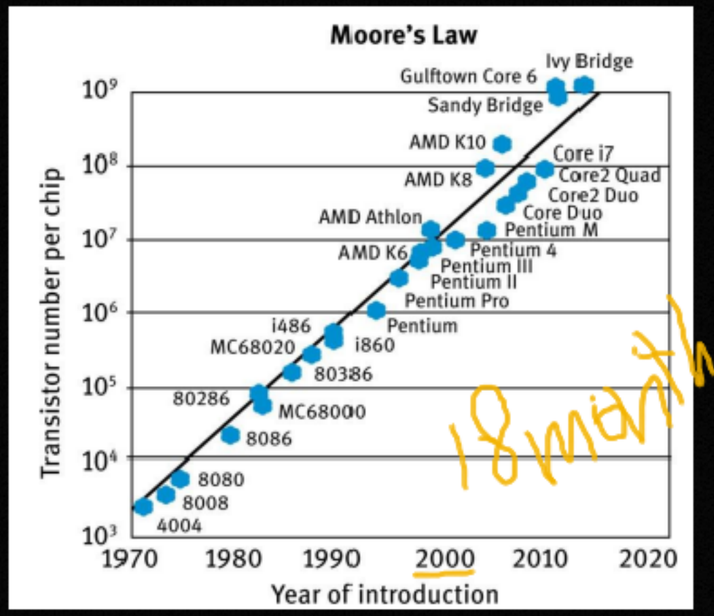
Very large-scale integration (VLSI)

==> refers to an IC or technology with many devices on one chip.

=======>"SSI" (small-scale integration),



=======>"LSI" (large-scale integration),



=======>& several others, defined by the number of transistors or gates per IC.

What does nm mean in chipset?
==> It is the channel width of the "gate" of the transistors.
In general, a smaller "nm" means that the transistor can be made smaller.

End of Moore's Law ==> depends upon the continuous reduction in the size of a transistor to maintain positive momentum in both cost and performance.

==> The problem: as the size of transistors continued to shrink, the cost to produce them got bigger. Other costs, such as designing, packaging and testing have also escalated, and the overall bill to develop an advanced silicon-based device has become unaffordable.

Our Target

=> Understanding digital circuits

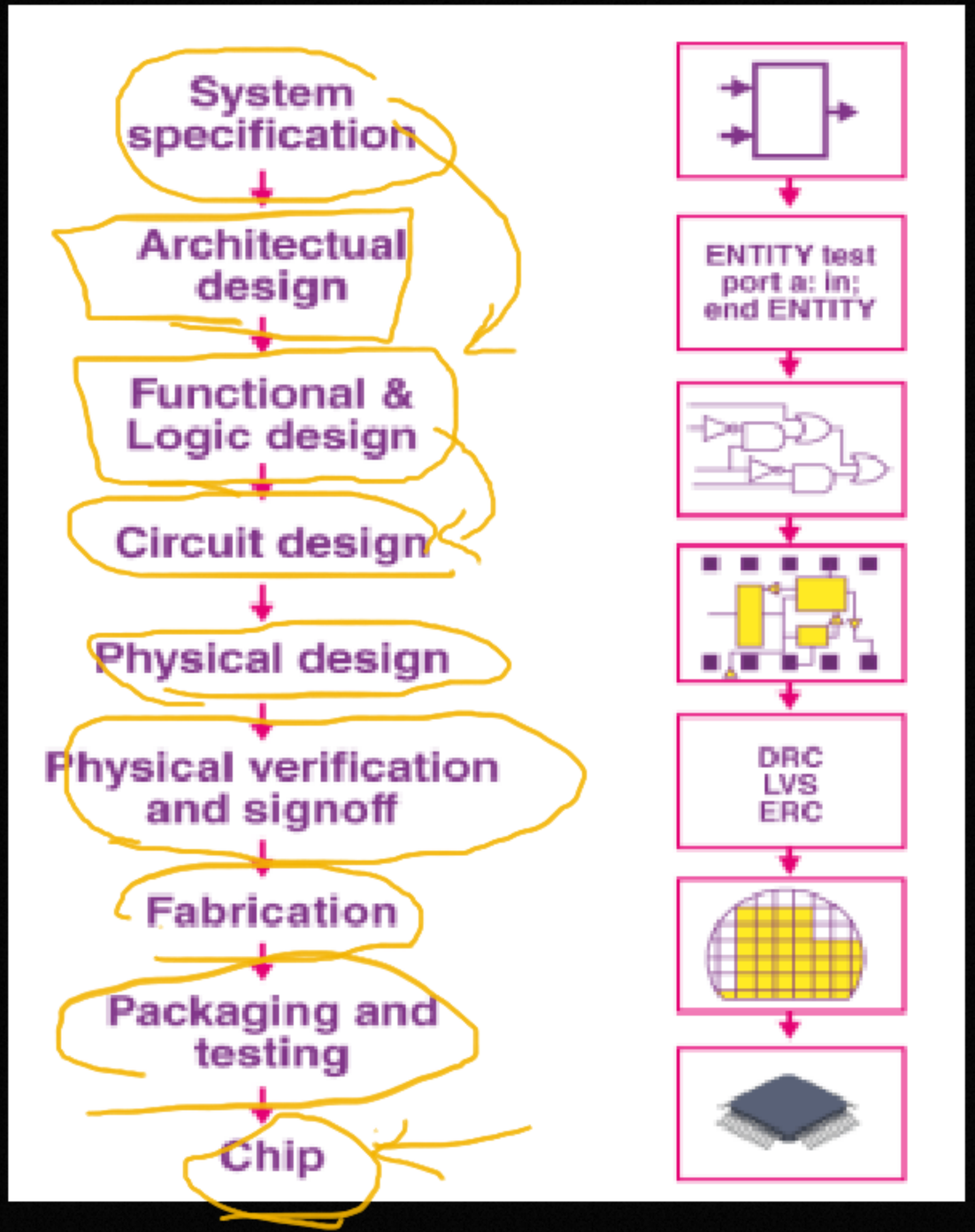
=> Designing digital circuits

=> Optimizing digital circuits

Quality Metrics:

==>Size, Speed, Power dissipation,

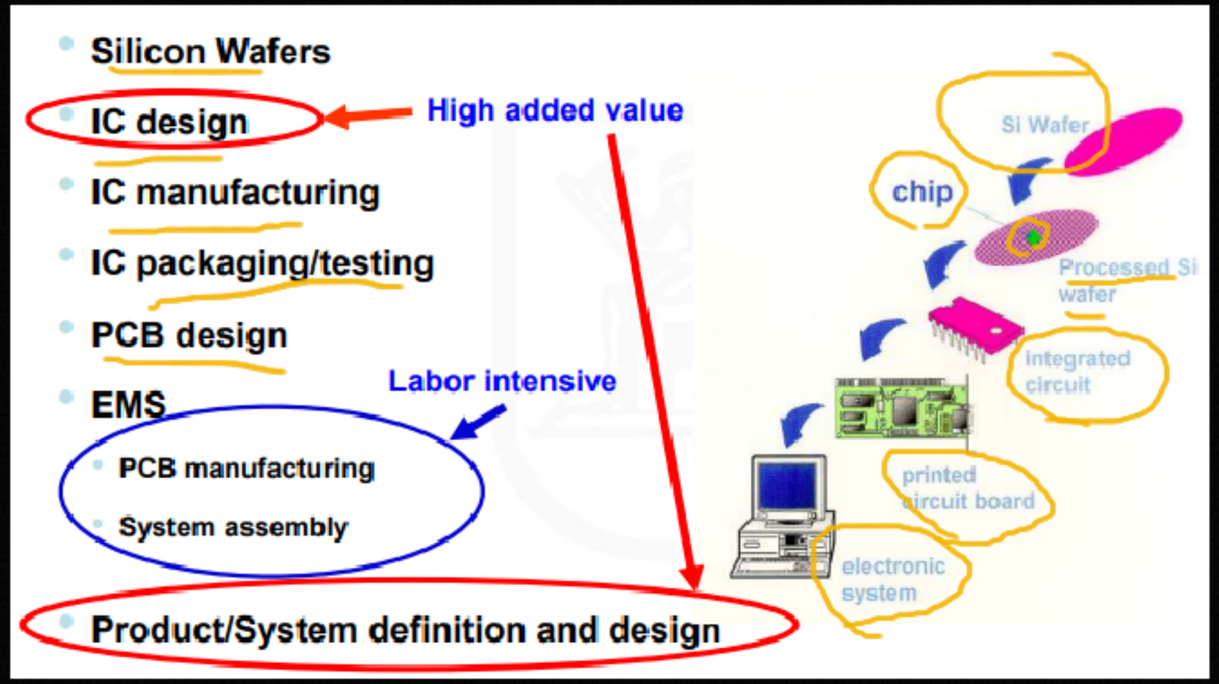
==>Reliability, and Cost.



Introduction to Silicon Process and VLSI

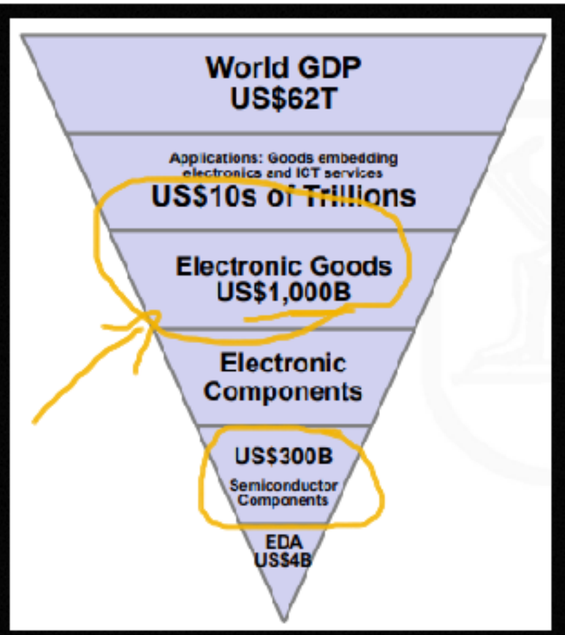
What does the Electronics Industry Produce?

- **System Designs**
- **IC Designs**
- **Physical Products**
  - Integrated Circuits (IC) aka Chips
  - Printed Circuit Boards (PCB)
  - Systems



- Digital IC design is a procedural process involves converting specifications and features into digital blocks and then into logic circuits.

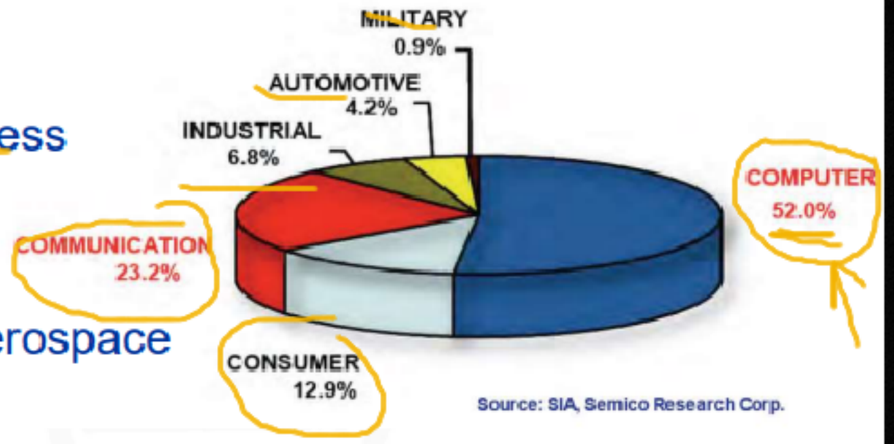
- Many of the constraints associated with digital IC design come from the foundry process and technological limitations.



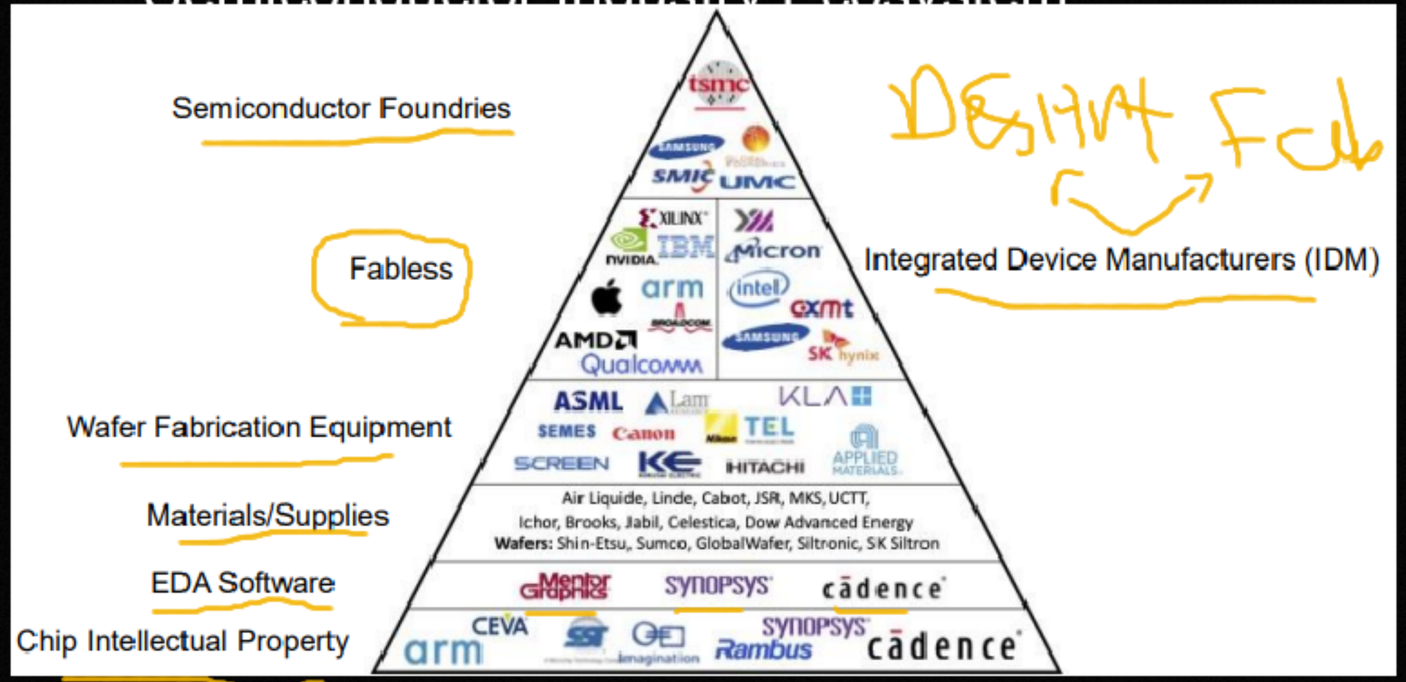
Electornics Industry Segments: By End-User Market

==> Total available market of ~352 Billion $ in 2016

- Computing
- Telecom/Wireless
- Consumer
- Automotive
- Military and Aerospace
- Medical
- Industrial/Process Control/Measurement and more…



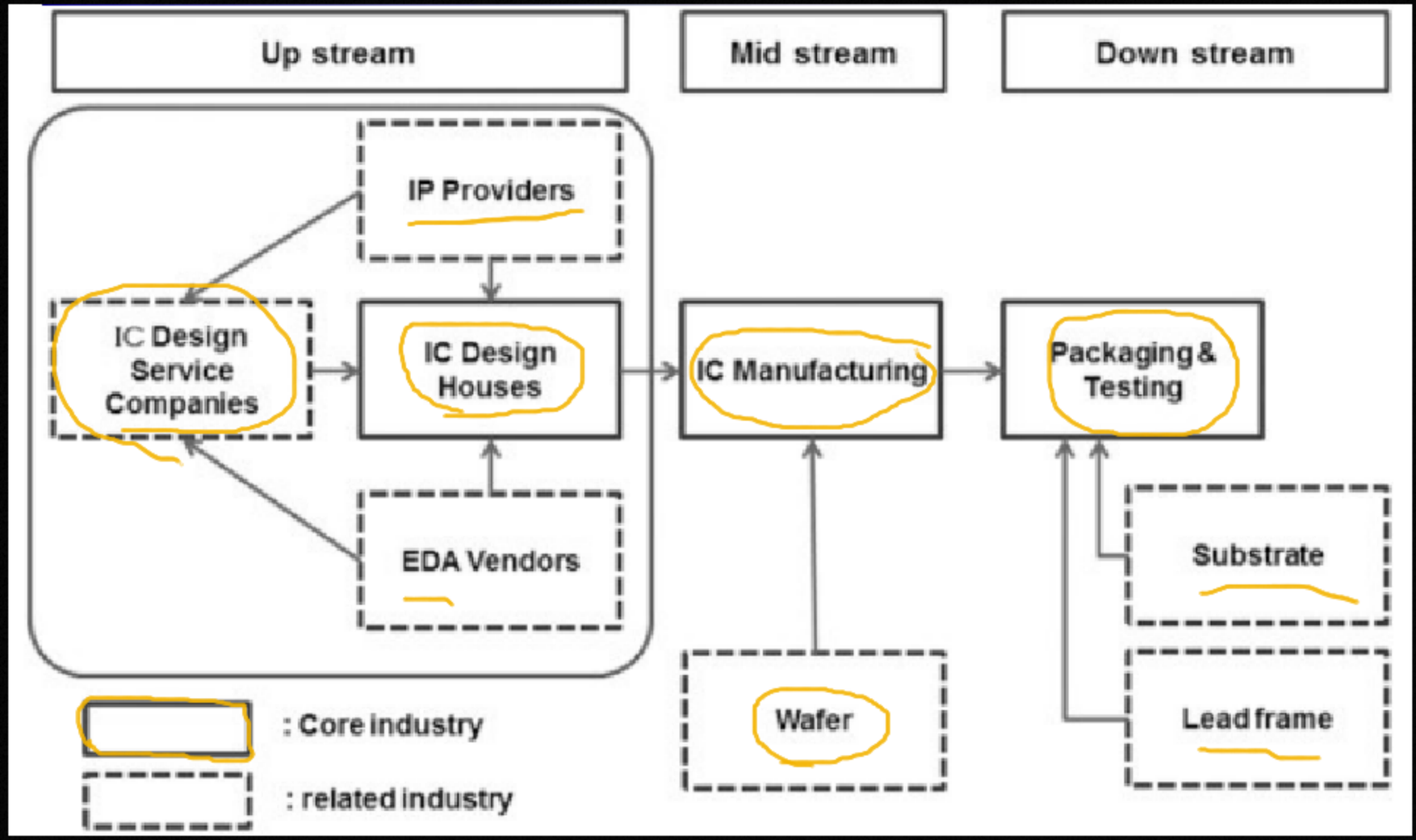
Semiconductor Industry Ecosystem

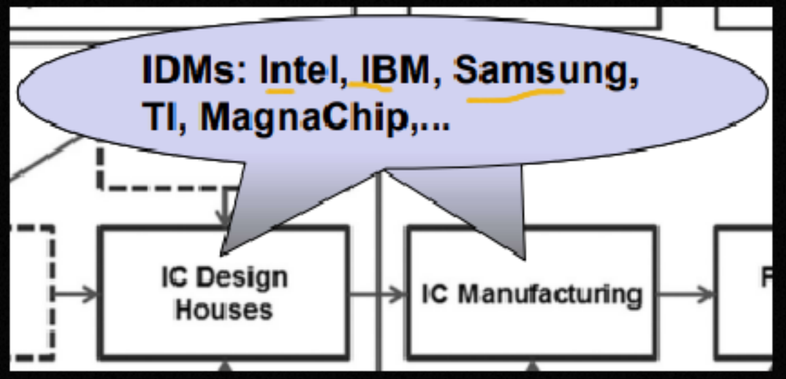


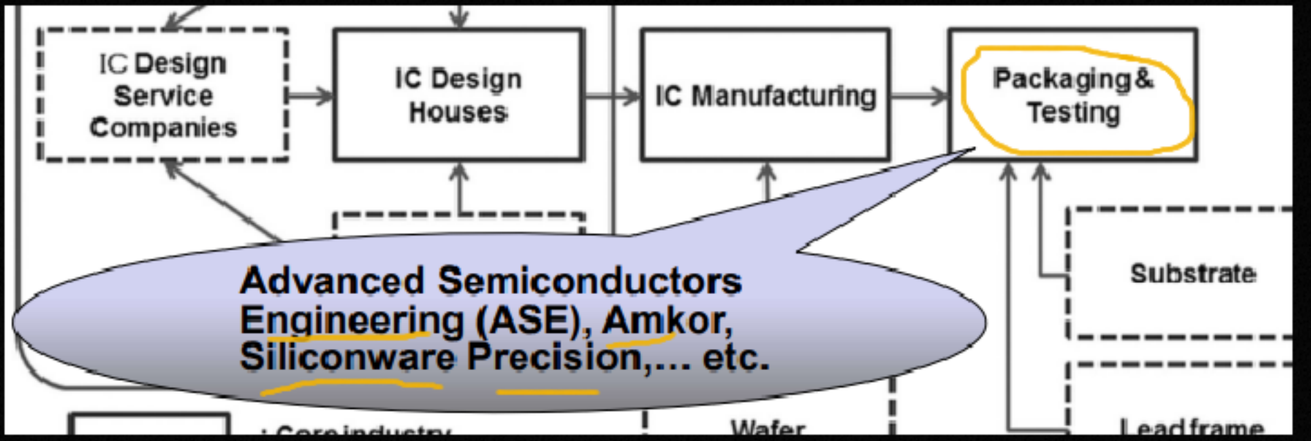
SemiConductor Industry Segments: By Business Model

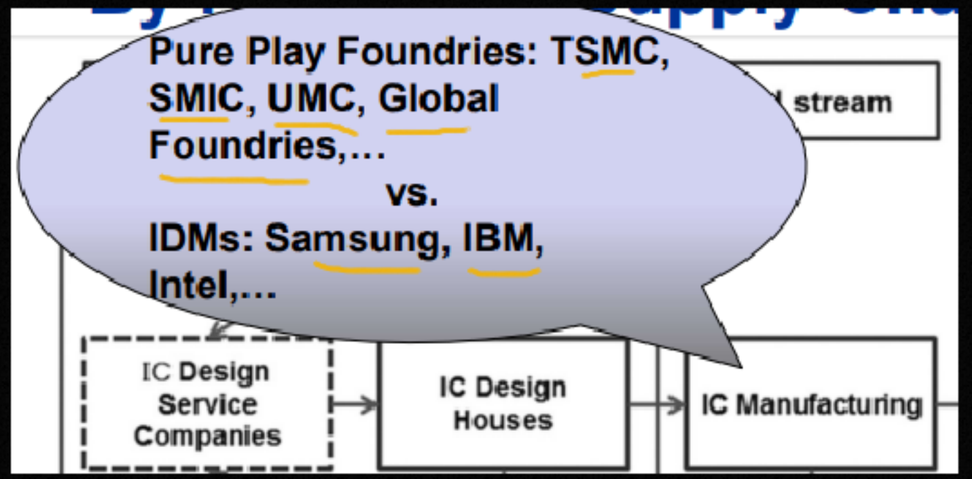
1. **Integrated Device Manufacturer (IDM)**
   - Samsung Semiconductor, IBM, MagnaChip, Intel, TI, Infineon, Toshiba, NEC, Mitsubishi, Motorola,... etc.
   - Has in-house manufacturing using its own Fabs besides its own design capabilities (vertical integration).
2. **Fabless**
   - Qualcomm, Broadcom, ON Semiconductor, nVidia, MediaTek, Cirrus Logic,… etc.
   - Outsources manufacturing to (usually) a foundry.
   - Focuses on products, IP, patents and licensing.
3. **Merchant Foundry**
   - TSMC, Global Foundries, UMC, SMIC, PowerChip, TowerJazz, Dongbu HiTek, X-Fab,… etc.
   - Finds work from the pool of fabless companies.
   - Requires careful scheduling, pricing and contracting to remain at full utilization.

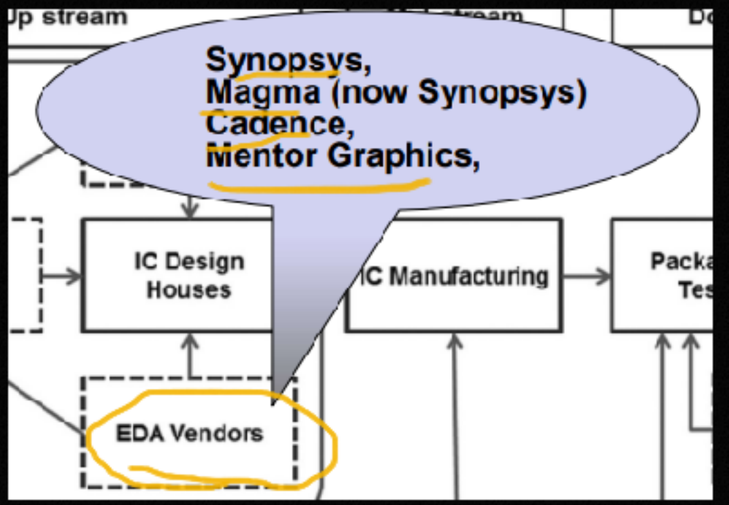
SemiConductor Industry Segments: By Role in Supply Chain

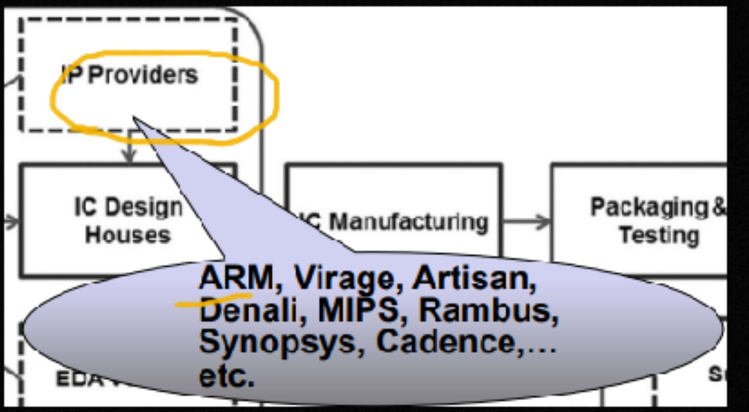


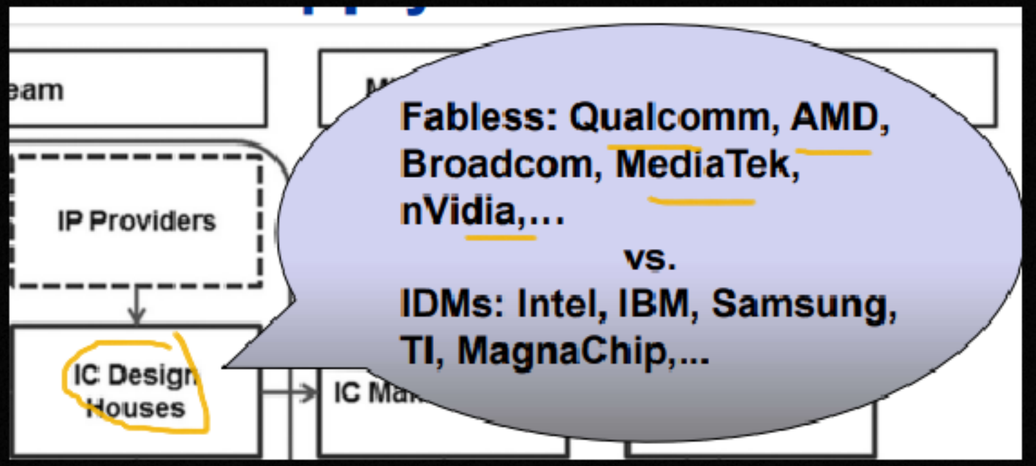

IDMs: Intel, IBM, Samsung, TI, MagnaChip,...
IC Design Houses
IC Manufacturing

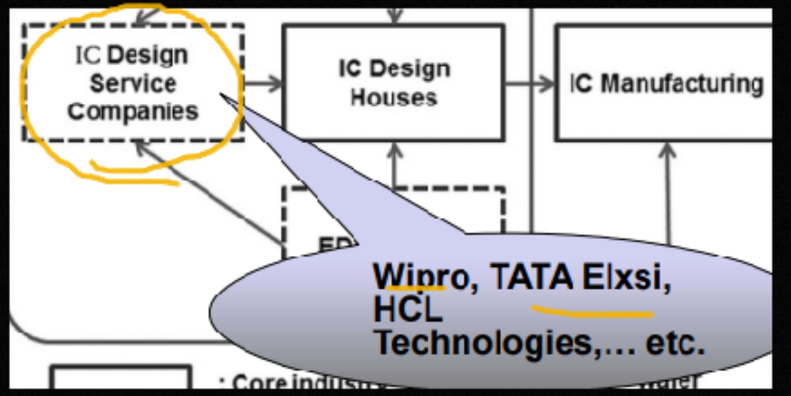

IC Design Service Companies
IC Design Houses
IC Manufacturing
Packaging& Testing
Substrate
Leadframe
Advanced Semiconductors Engineering (ASE), Amkor, Siliconware Precision,... etc.

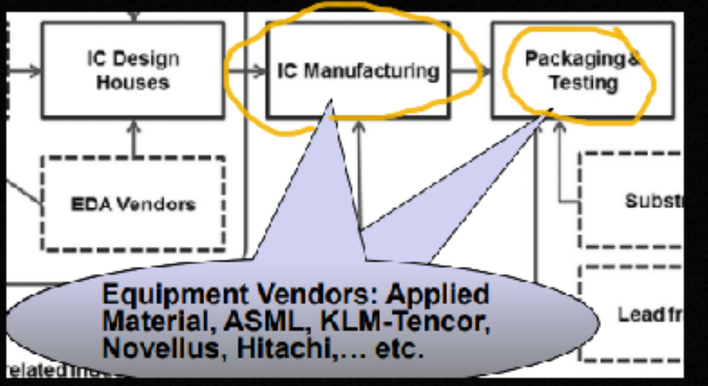

Pure Play Foundries: TSMC, SMIC, UMC, Global Foundries,...
vs.
IDMs: Samsung, IBM, Intel,...
IC Design Service Companies
IC Design Houses
IC Manufacturing


Synopsys,
Magma (now Synopsys)
Cadence,
Mentor Graphics,
IC Design Houses
IC Manufacturing
EDA Vendors


IP Providers
IC Design Houses
IC Manufacturing
Packaging& Testing
ARM, Virage, Artisan, Denali, MIPS, Rambus, Synopsys, Cadence,... etc.


IP Providers
IC Design Houses
Fabless: Qualcomm, AMD, Broadcom, MediaTek, nVidia,...
vs.
IDMs: Intel, IBM, Samsung, TI, MagnaChip,...


IC Design Service Companies
IC Design Houses
IC Manufacturing
Wipro, TATA Elxsi, HCL Technologies,... etc.


IC Design Houses
IC Manufacturing
Packaging& Testing
EDA Vendors
Equipment Vendors: Applied Material, ASML, KLM-Tencor, Novellus, Hitachi,... etc.

SemiConductor Industry Segments

1Q14 Top 20 Semiconductor Sales Leaders Ranked by Growth ($M, Including Foundries)

1Q14 Rank	Company	Headquarters	1Q13 Tot Semi	1Q14 Tot Semi	1Q14/1Q13 % Change
1	MediaTek + MStar**	Taiwan	1,083	1,608	48%
2	SK Hynix	South Korea	2,577	3,507	36%
3	AMD**	U.S.	1,088	1,397	28%
4	Micron + Elpida	U.S.	3,300	4,175	27%
5	Infineon	Europe	1,208	1,440	19%
6	Freescale	U.S.	931	1,071	15%
7	Avago + LSI**	Singapore	1,136	1,305	15%
8	NXP	Europe	1,085	1,246	15%
9	Nvidia**	U.S.	940	1,072	14%
10	UMC*	Taiwan	899	1,006	12%
11	Samsung	South Korea	7,946	8,797	11%
12	TSMC*	Taiwan	4,470	4,852	9%
13	Qualcomm**	U.S.	3,916	4,243	8%
14	GlobalFoundries*	U.S.	946	1,010	7%
15	TI	U.S.	2,717	2,792	3%
16	Broadcom**	U.S.	1,962	1,984	1%
17	Intel	U.S.	11,555	11,666	1%
18	Renesas	Japan	1,886	1,865	-1%
19	Toshiba	Japan	2,939	2,793	-5%
20	ST	Europe	1,994	1,801	-10%
—	Top 20 Total		54,578	59,630	9%

*Foundry **Fabless

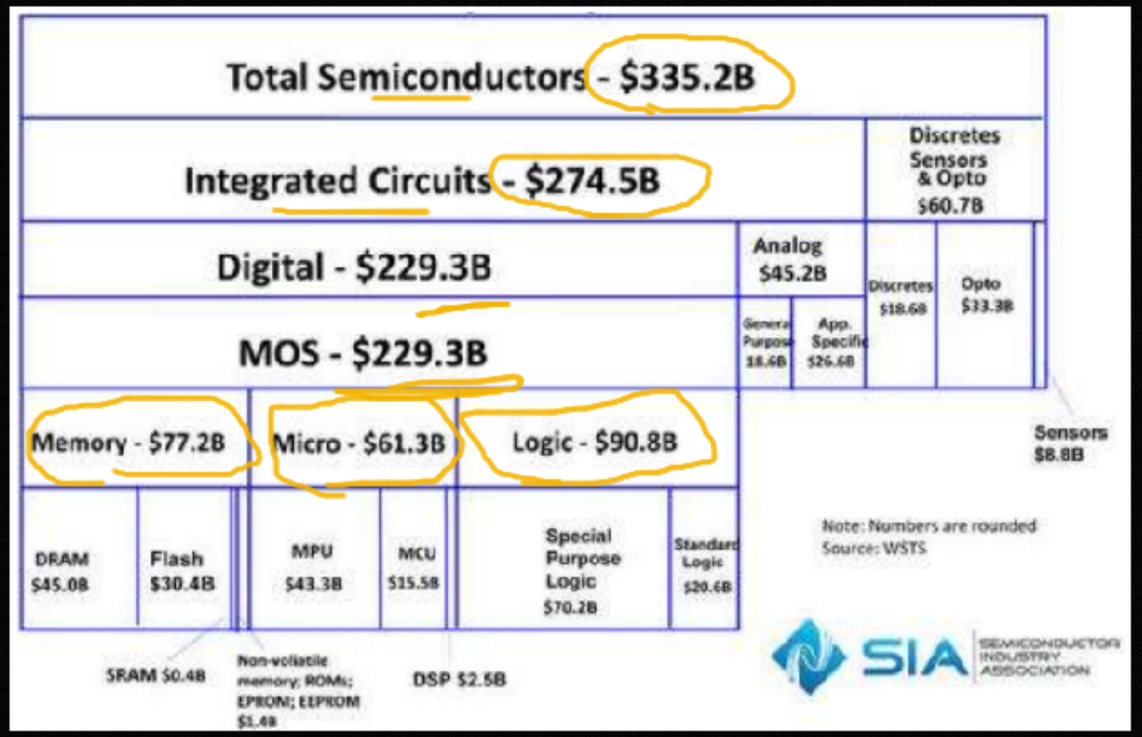
Top 10 Ranking by 2016 Revenue

Worldwide Ranking of the Top 10 Suppliers of Semiconductors in 2016
(Ranking by Revenue in Millions of U.S. Dollars)

2015 Rank	2016 Rank	Company Name	2015 Revenue ($)	2016 Revenue ($)	Revenue Percent Change	Revenue Percent of Total	Revenue Cumulative Percent
1	1	Intel	51,420	54,981	6.9%	15.6%	15.6%
2	2	Samsung Electronics	38,713	40,323	4.2%	11.4%	27.0%
4	3	Qualcomm	16,496	15,405	-6.6%	4.4%	31.4%
N/A	4	Broadcom Limited*	15,304	14,979	-2.1%	4.2%	35.7%
3	5	SK Hynix	16,502	14,699	-10.9%	4.2%	39.8%
5	6	Micron Technology	14,080	12,963	-7.9%	3.7%	43.5%
6	7	Texas Instruments	12,258	12,686	3.5%	3.6%	47.1%
8	8	Toshiba	8,833	10,258	16.1%	2.9%	50.0%
7	9	NXP	9,619	9,306	-3.3%	2.6%	52.7%
13	10	MediaTek	6,654	8,733	31.2%	2.5%	55.1%
		Top 10 Companies	189,879	194,333	2.3%	55.1%	
		All Others	155,715	158,116	1.5%	44.9%	
		Total Semiconductor	**345,594**	**352,449**	2.0%	100.0%	

SemiConductor Industry Segments: By Product

- Discretes
- Logic
- DRAM Memory
- Flash Memory
- Other Memories
- Analog
- Optoelectronics
- Sensors/MEMS
- DSP
- Microcontrollers
- Microprocessors
- CPLDs/FPGAs
- ASICs/ASSPs



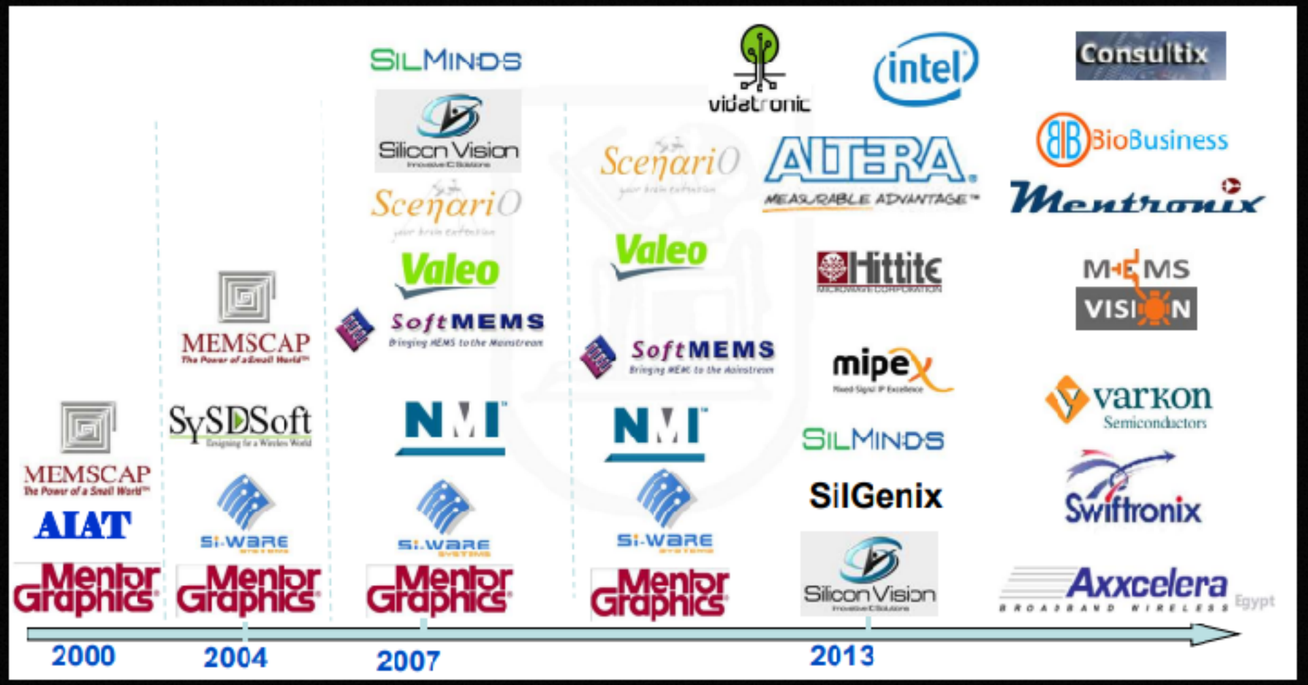
SemiConductor Industry In Egypt

- Which role in the semiconductors industry can be readily adopted in the Egyptian industry?
- Which business model to use?
- Why do that?

- What careers to expect?
- Is there any risk?
- Is there any reward?

- Mentor Graphics (EDA Multi-national)
- Goodix Egypt (Chinese)
- Si-Ware Systems (Fully Egyptian)
- Si-Vision (Egyptian with ties to Synopsys)
- Hittite now Analog Devices Inc. (US)
- ICpedia (used to be Swiftronix)
- Mipex
- MEMS-Vision
- Pearl Semiconductors
- Used to have Newport Media Inc. (acquired by ATMEL then Dialog)
- Used to have SysDSoft (then Intel – Siemens Acquisition)

Local SemiConductor Industry Growth



Other Related Companies

- PCB Manufacturing and Assembly
  - Al-Araby, AOI, AlSweedy Electrometers, … etc
  - Samsung (Beni Swaif)
- Electronic systems manufacturing
  - Samsung, LG
  - Bio-Business
  - Valeo
- Morocco
  - Sizable operation for ST-Microelectronics
- Kingdom of Saudi Arabia and UAE
  - Sizable research activities

Challenges in Digital Design

Microscopic Problems:

=> Ultra-high speed design

=> Interconnect

=> Noise, Crosstalk

=> Reliability, Manufacturability

=> Power Dissipation

=> Clock distribution

Macroscopic Issues:

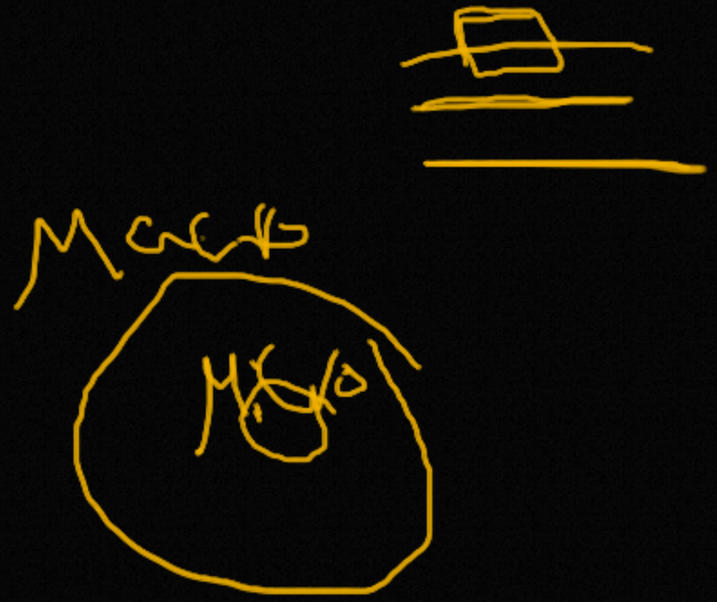
=> Time-to-Market

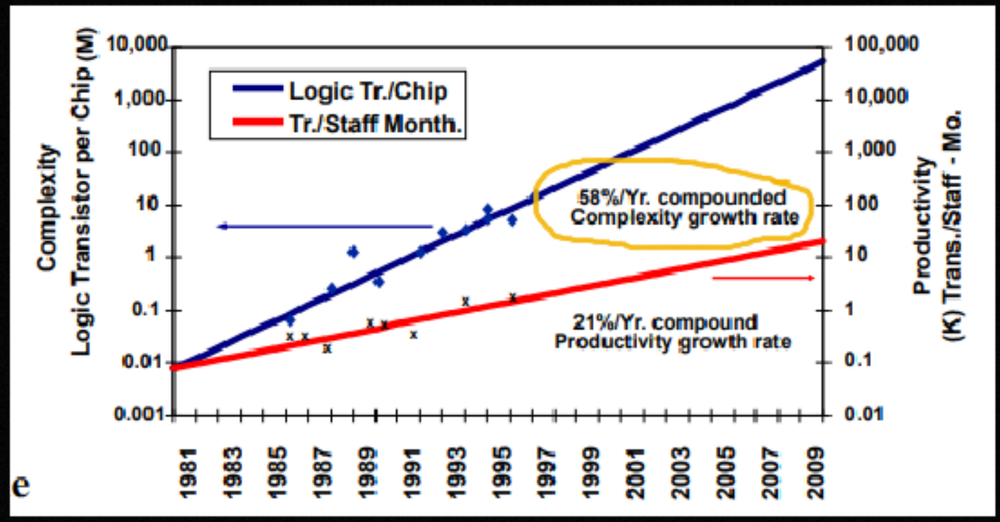
=> Millions of Gates

=> High-Level Abstractions

=> Reuse & IP: Portability

=> Predictability





Complexity increasing

Macro- is used as a combining form meaning "large" or "great."
Micro describes something that is very small in size or scope.

Fabrication Facility In-House Vs Fabless Company

Advantages of Owning a Fabrication Facility In-House:

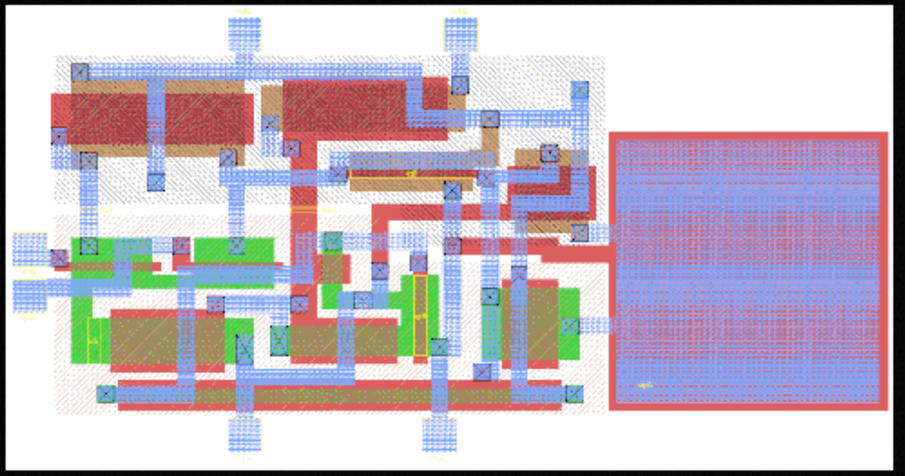
IDM

1- Control over the manufacturing process.

2- Reduced dependency on external manufacturers.

3- Intellectual property protection which keeps the entire production process within the company's own facilities.

4- Faster time-to-market.



Disadvantages of Owning a Fabrication Facility In-House:

1- High initial investment.

2- Requiring regular technology refreshes to keep pace with industry advancements.

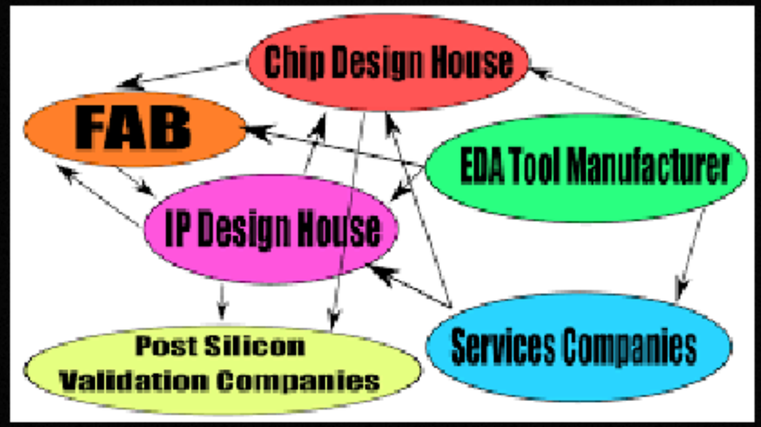
3- Limited production capacity: In-house fabrication facilities have finite production capacities, and scaling up can be challenging. If demand exceeds capacity, companies may face production bottlenecks or delays.

Advantages of Fabless Companies:

1- Focus on core competencies: This allows them to allocate more resources to research and development.

2- Access to specialized expertise: Contracting with established manufacturers can provide access to advanced fabrication technologies.

3- Cost-effective production: It avoids the significant upfront investments required to establish and maintain an in-house facility.



Disadvantages of Fabless Companies:

1- Limited control over production.

2- Intellectual property risks: Sharing design specifications with external manufacturers increases the chances of IP theft.

3- Longer lead times: Coordinating with external manufacturers, especially during periods of high demand, can introduce delays in the production process.

Finally:
In my opinion, the decision to own a fabrication facility in-house or be a fabless company depends on various factors such as:

- financial resources
- production volume
- technological requirements
- strategic priorities

Each approach has its own set of advantages and disadvantages, and companies need to carefully evaluate their specific circumstances before choosing the most suitable path

Functional Structure of Fabless Companies

- **Business Units own**
  - Design
    - System
    - Digital
    - Mixed Signal/Analog.
  - Verification
    - System
    - Digital
    - Mixed Signal/Analog.
  - Marketing
  - Applications Engr'g
- **Functional pools support**
  - CAD/EDA tools and IT
  - PCB/Hardware
  - Testing or Validation
  - Layout (Physical Design)
  - Technology / IP Acquisition
  - Assembly/Packaging
  - Product Engineering/ Production

Die Size Growth

A die ==> is a small block of semiconducting material on which a given functional circuit is fabricated.

==> The die size of a specific chip is the length and width of the integrated circuit.

==> Increased workload demands and the need to move data faster have driven SoCs to become more complex with advanced functionality and die sizes that approach the reticle limits of manufacturing equipment.