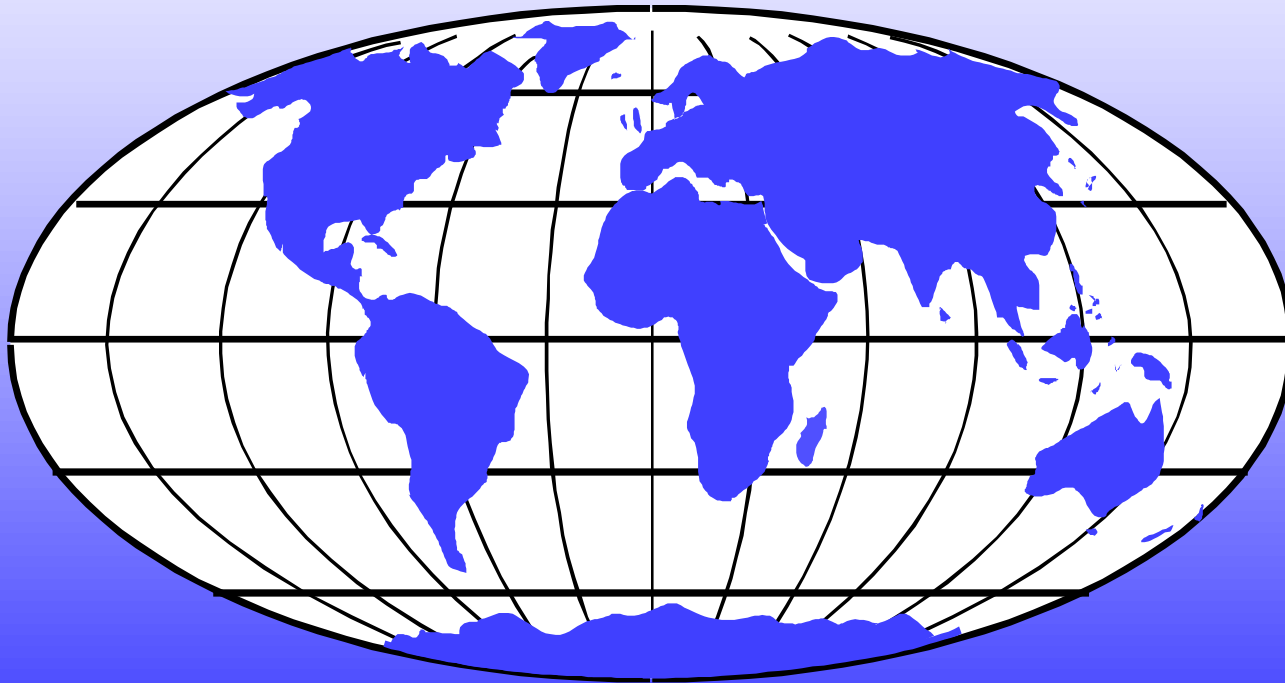


GROWTH AREAS FOR IOT AND IMPACT ON FD SOI

APRIL 13, 2017



INTERNATIONAL BUSINESS STRATEGIES, INC.

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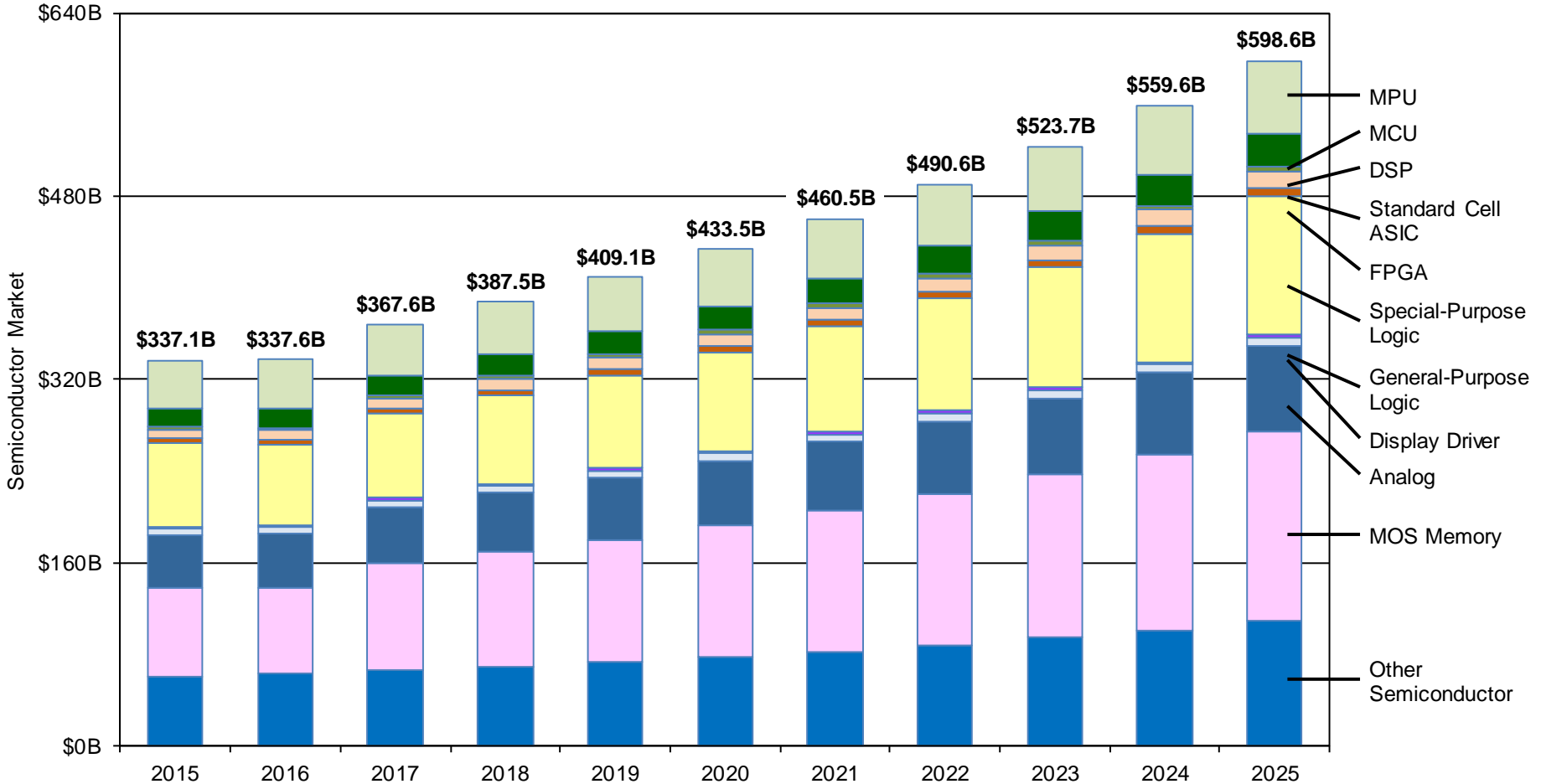
INTERNATIONAL BUSINESS STRATEGIES BACKGROUND

IBS

- Has been in business for over 28 years
- Previous experience in managing 1500+ engineers at Rockwell International, which included avionics, communications, and semiconductors, and strong emphasis on communications
- Interface with most global leaders in electronics industry, with customers in U.S., Europe, South Korea, Japan, Taiwan, China, India, etc
- Interface and support for major global corporations such as Intel, Qualcomm, Broadcom, Microsoft, Nokia, Samsung, SK Hynix, Sony, Toshiba, Apple, Cisco, Huawei, IBM, Fujitsu, Canon, NEC, Hitachi, Renesas, TSMC, STMicroelectronics, TI, ARM, Cadence, Synopsys, Mentor Graphics, Seagate, Globalfoundries, SMIC, NXP Semiconductors, and others
- Interface and support for financial institutions such as Goldman Sachs, Carlyle, Blackstone, CitiGroup, Warburg Pincus, Walden, KKR, Morgan Stanley, Credit Suisse, BNP Paribas, Bain Capital, Bank of America, TPG, and others
- Participated with French government on their advanced technology initiatives
- Involved with advanced technology concepts, price-sensitive platforms for smartphone and other high-volume platforms, and high-performance infrastructure companies on global basis
- Strong expertise in China. Published two books on China: [*China's Globalization \(How China Becomes No. 1\)*](#) and [*Chinamerica*](#) (McGraw Hill). Wall Street Journal, Economist, New York Times, Forbes blog contributor, China Daily articles, Global Times editorials, EE Times, etc
- Involved in number of due diligence projects on number of IPOs
- Support for strategic initiatives for number of global technology leaders

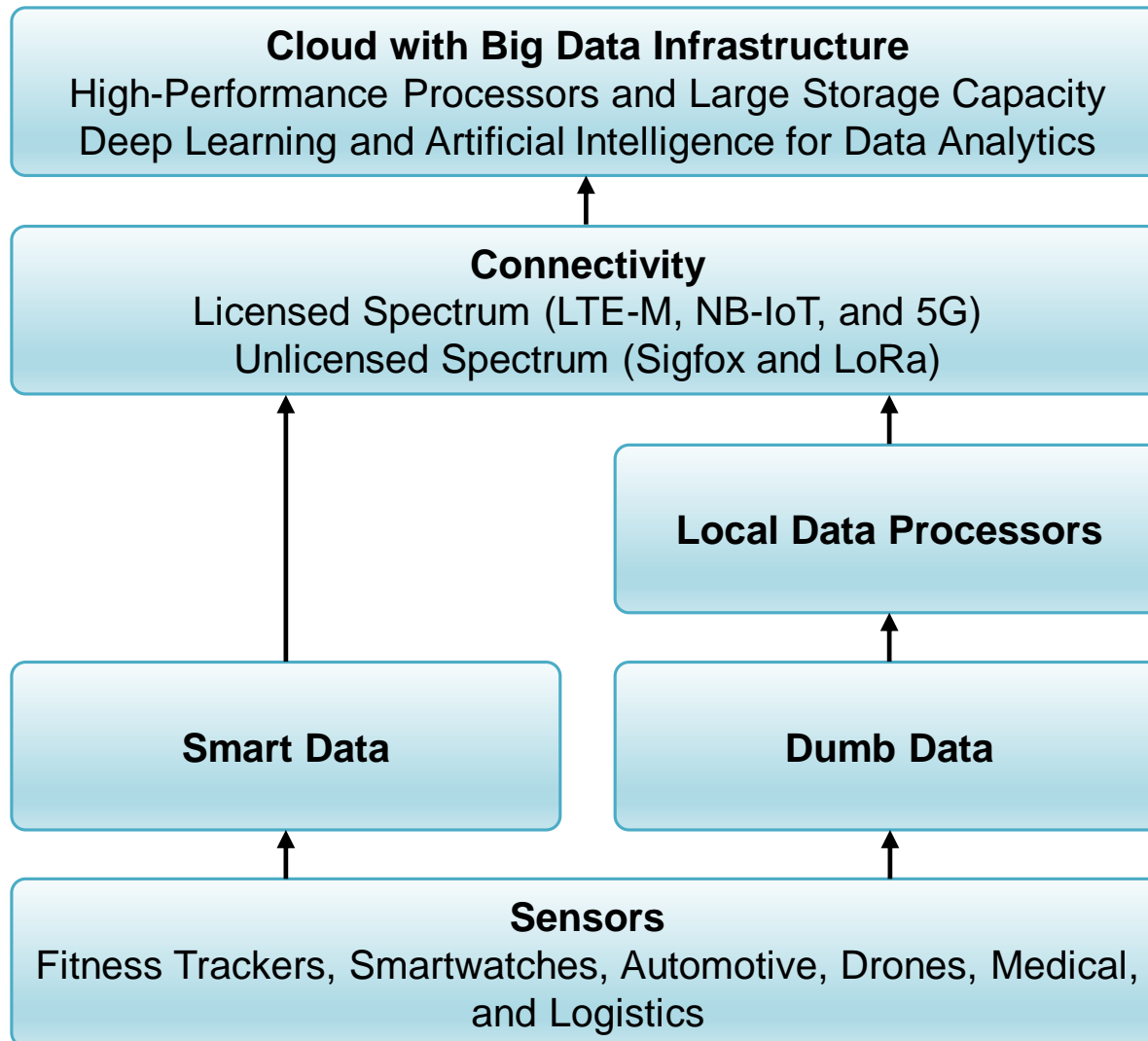
IBS HAS HIGH MARKET SHARE ON TECHNOLOGY AND STRATEGY BUSINESS

SEMICONDUCTOR MARKET BY PRODUCT



GROWTH IS DRIVEN BY INCREASE IN GB PRICES OF DRAM AND NAND
SLOWING GROWTH IN SMARTPHONES

IOT ECOSYSTEM



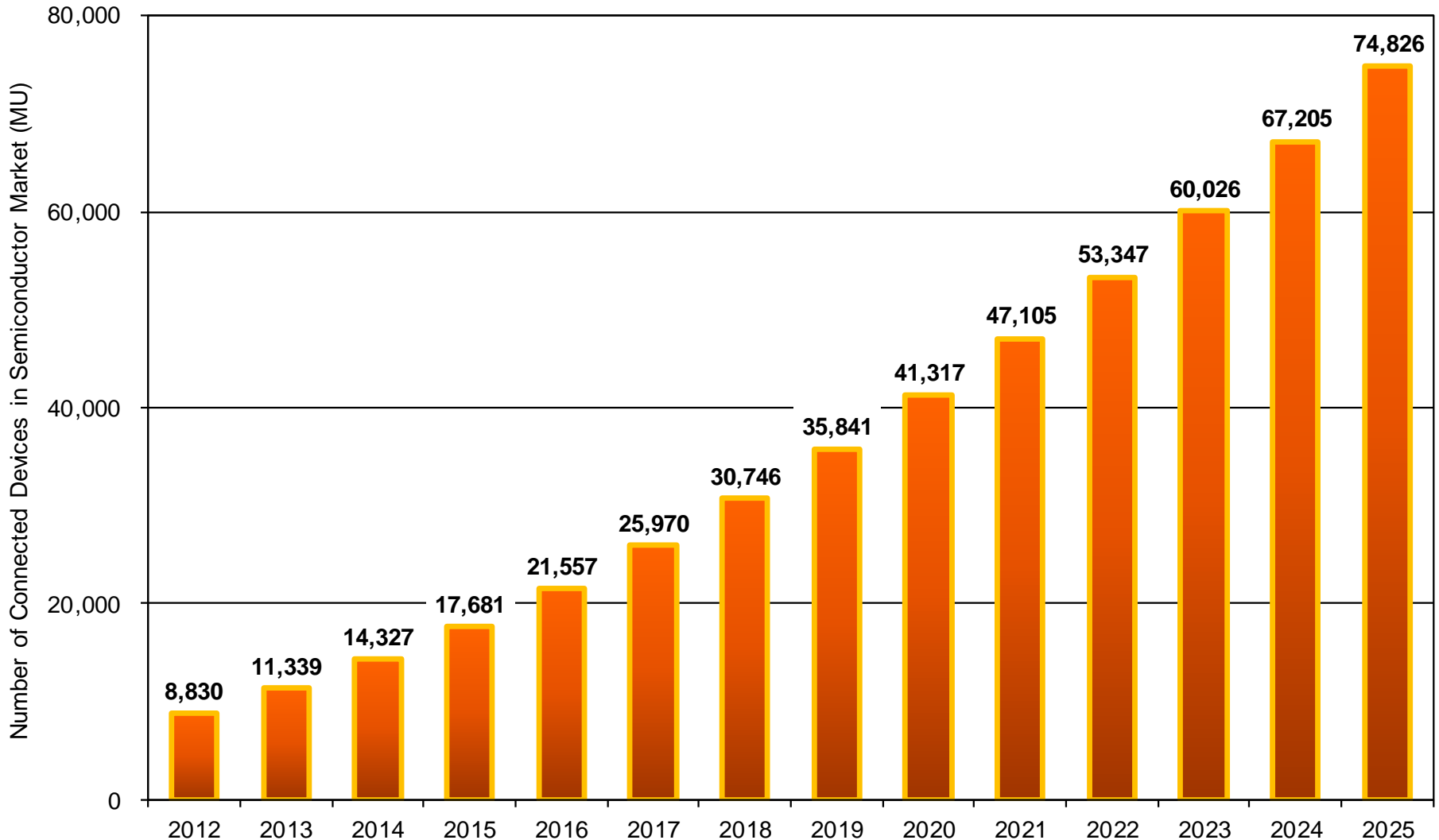
IOT IS ABOUT MONETIZATION OF DATA

IOT PERSPECTIVE

- IoT devices include fitness trackers, smartwatches, smart cameras, connected smart cars, etc
Autonomous driving is in high growth mode and requires very high-performance processors as well as low costs
Smartwatches and other wearable devices have not reached expected growth because their battery lifetime is too short and user interface is not intuitive
- Sensors are key building block functions and include image sensors and MEMS
Sensors are also important part of IoT signal chain
- ISP functionality will be important building block function in many IoT applications
Vision processing will be area of very high growth potential
Need high performance and very low power consumption
- Need technology that can support RF, mixed-signal functionality, and eNVM
Technology will also need to be low cost
- Security represents key part of IoT
ARM Trust Zone is widely adopted
- Software value will be higher than hardware value for most IoT applications

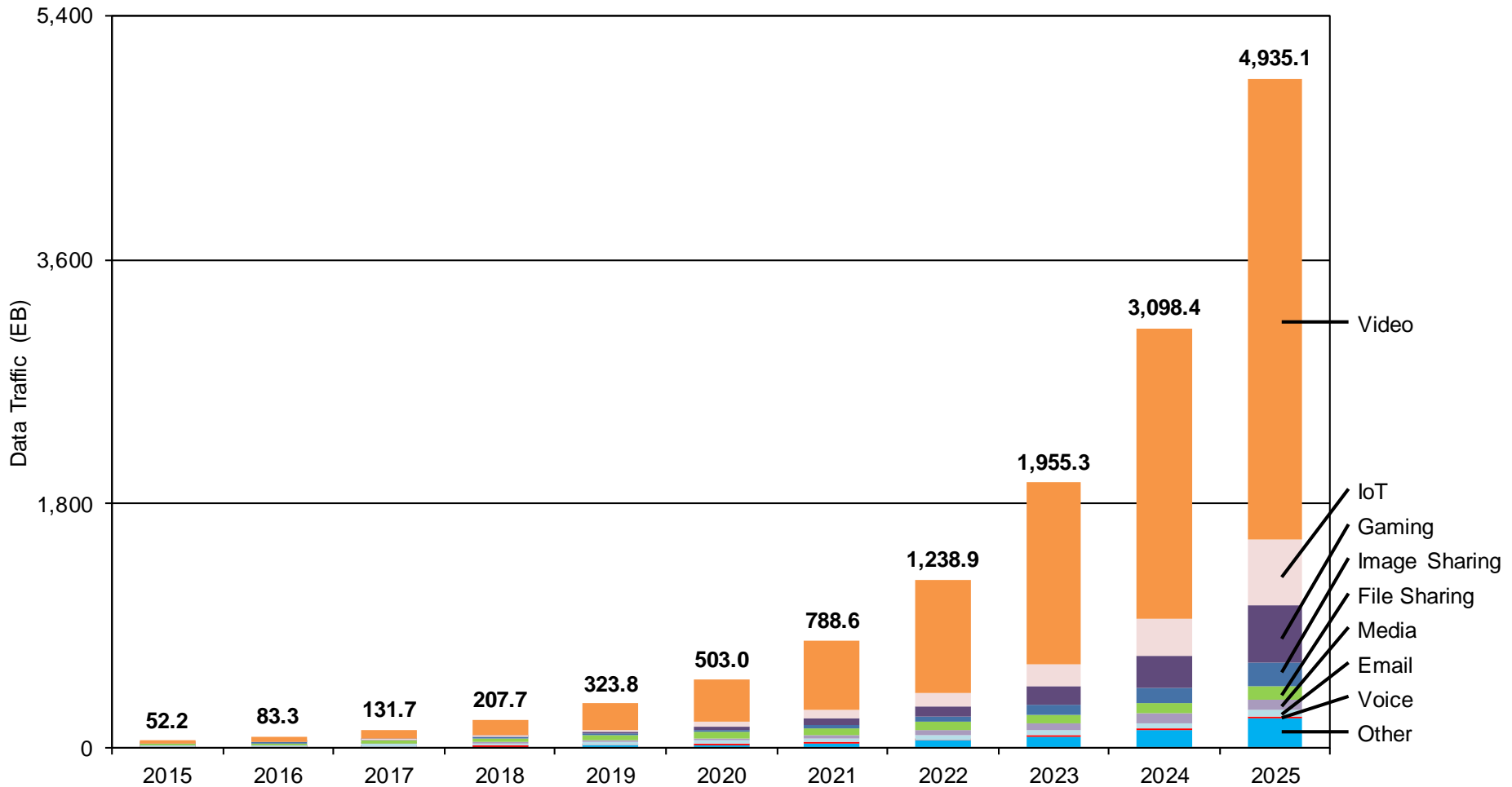
IOT IS PART OF BIG DATA ECOSYSTEM, WITH DEEP LEARNING AND AI

NUMBER OF CONNECTED DEVICES



NUMBER OF CONNECTED DEVICES IS 74B+ IN 2025

INTERNET DATA TRAFFIC



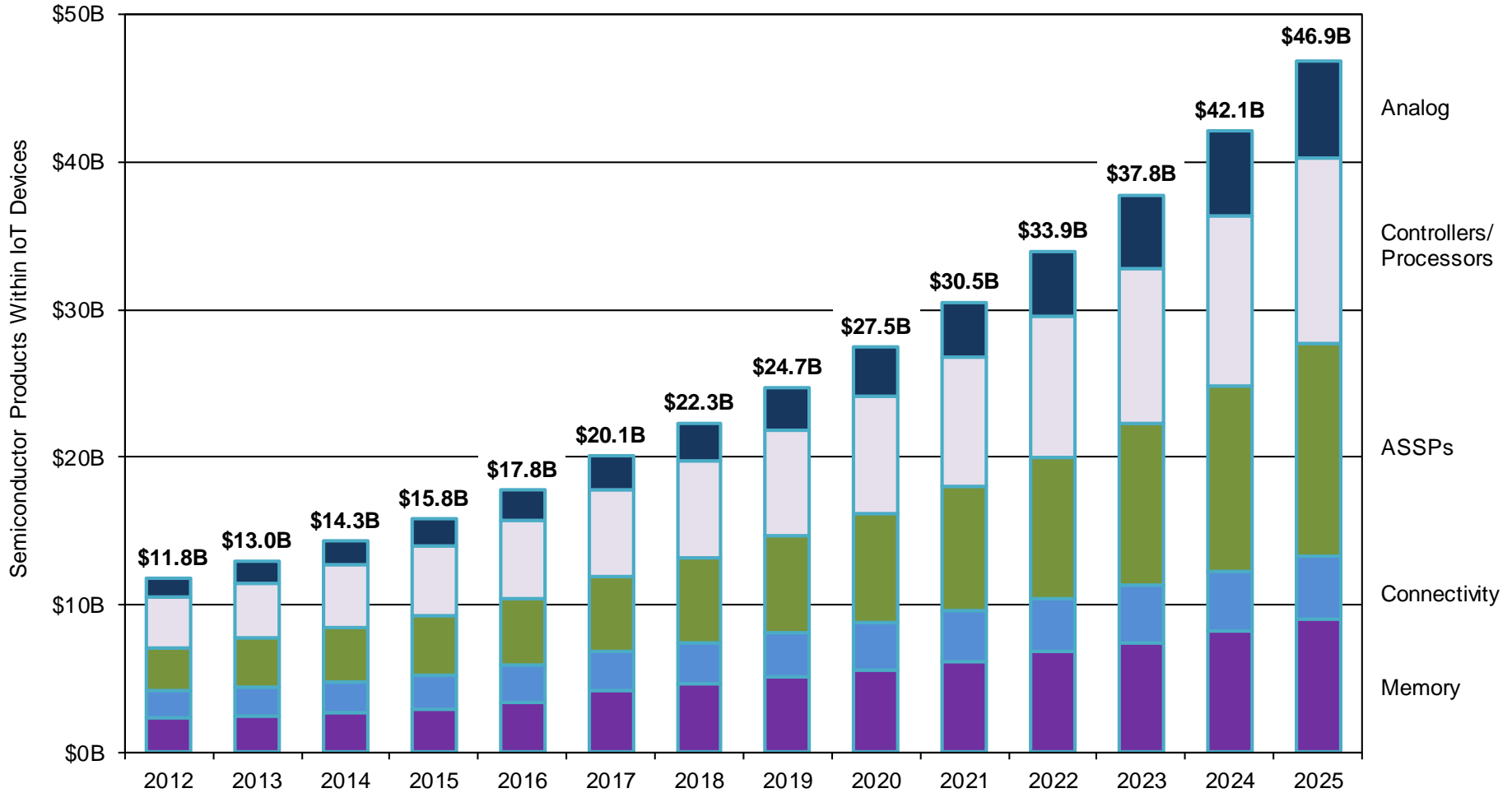
GROWTH IS HIGH BASED ON DATA BECOMING ASSET THAT HAS HIGH VALUE IF EFFICIENTLY MANAGED

PROCESSORS, CONTROL, AND CONNECTIVITY

	2015	2016	2017	2018	2019	2020
Mobile computing						
Processors (MU)	1,840	1,910	2,020	2,090	2,160	2,270
• Growth rate (%)	NA	3.80	5.76	3.47	3.35	5.09
Control and connectivity (MU)	11,800	12,900	13,870	15,100	16,140	18,880
• Growth rate (%)	NA	9.32	7.52	8.87	6.89	16.98
Consumer electronics						
Processors (MU)	1,250	1,380	1,510	1,630	1,750	1,860
• Growth rate (%)	NA	10.40	9.42	7.95	7.36	6.29
Control and connectivity (MU)	9,400	9,900	10,500	11,100	11,900	13,000
• Growth rate (%)	NA	5.32	6.06	5.71	7.21	9.24
Enterprise infrastructure						
Processors (MU)	25	27	29	31	33	36
• Growth rate (%)	NA	8.00	7.41	6.90	6.45	9.09
Control and connectivity (MU)	670	760	860	955	1,150	1,275
• Growth rate (%)	NA	13.43	13.16	11.05	20.42	10.87
Automotive						
Processors (MU)	125	168	210	255	310	365
• Growth rate (%)	NA	34.40	25.00	21.43	21.57	17.74
Control and connectivity (MU)	2,850	2,970	3,000	3,150	3,280	3,410
• Growth rate (%)	NA	4.21	1.01	5.00	4.13	3.96
Embedded intelligence						
Processors (MU)	650	760	870	990	1,100	1,240
• Growth rate (%)	NA	16.92	14.47	13.79	11.11	12.73
Control and connectivity (MU)	21,000	23,000	25,000	27,000	29,000	31,000
• Growth rate (%)	NA	9.52	8.70	8.00	7.41	6.90
TOTAL	49,610	53,775	57,869	62,301	66,823	73,336
Processors (MU)	3,890	4,245	4,639	4,996	5,353	5,771
• Growth rate (%)	NA	9.13	9.28	7.70	7.15	7.81
Control and connectivity (MU)	45,720	49,530	53,230	57,305	61,470	67,565
• Growth rate (%)	NA	8.33	7.47	7.66	7.27	9.92

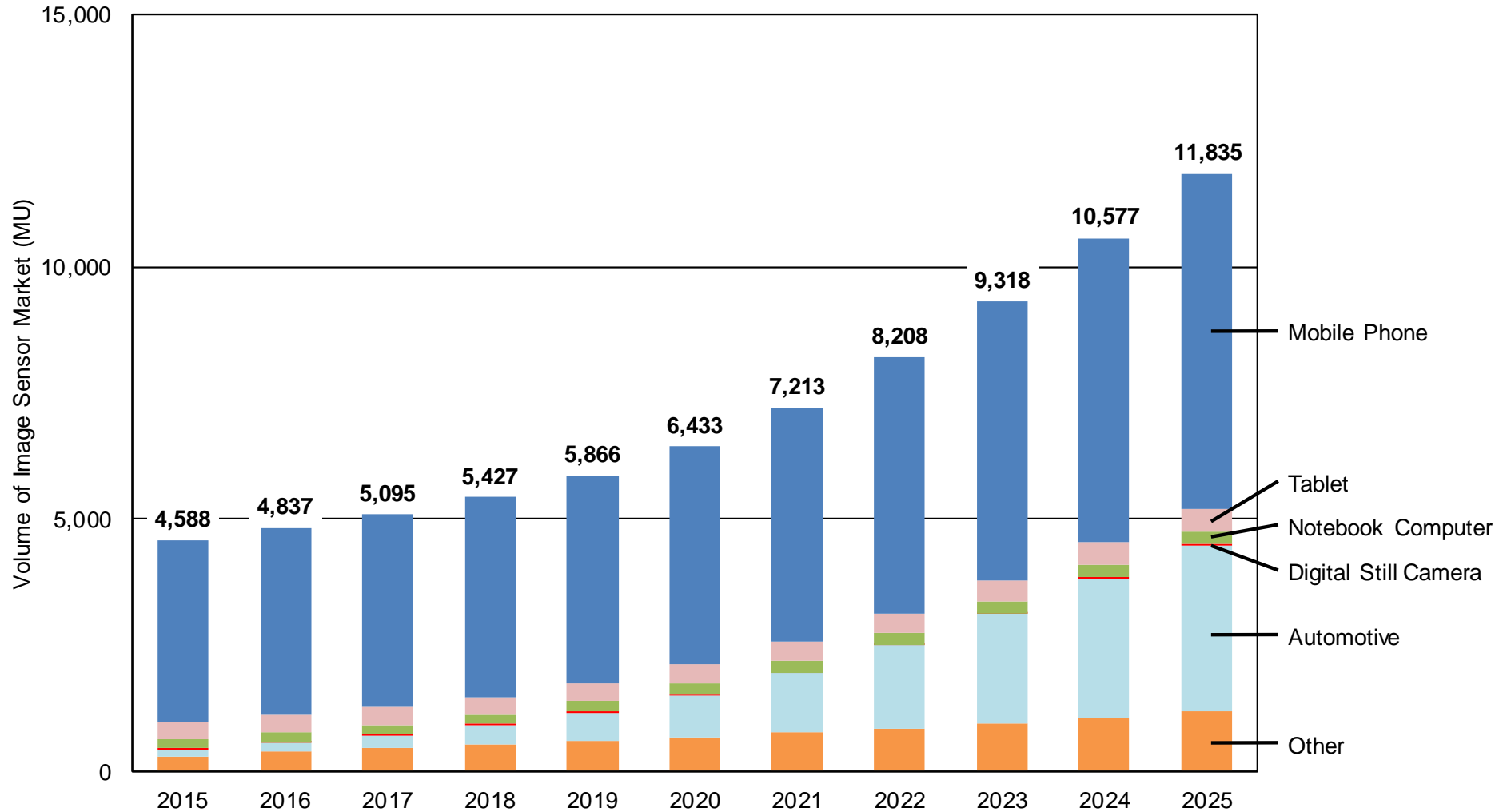
IOT INCLUDES PROCESSOR, CONTROL, AND CONNECTIVITY

IC MARKET FOR IOT APPLICATIONS



STRONG GROWTH POTENTIAL FOR IOT

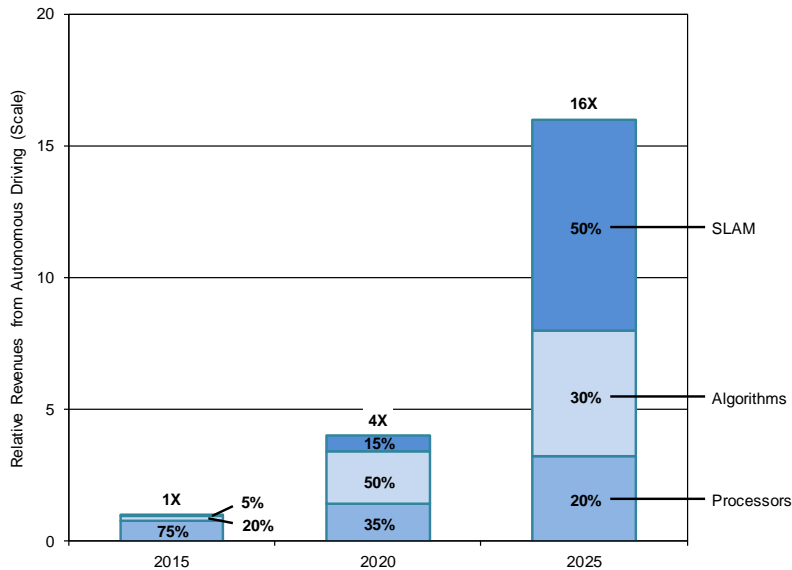
IMAGE SENSOR VOLUME



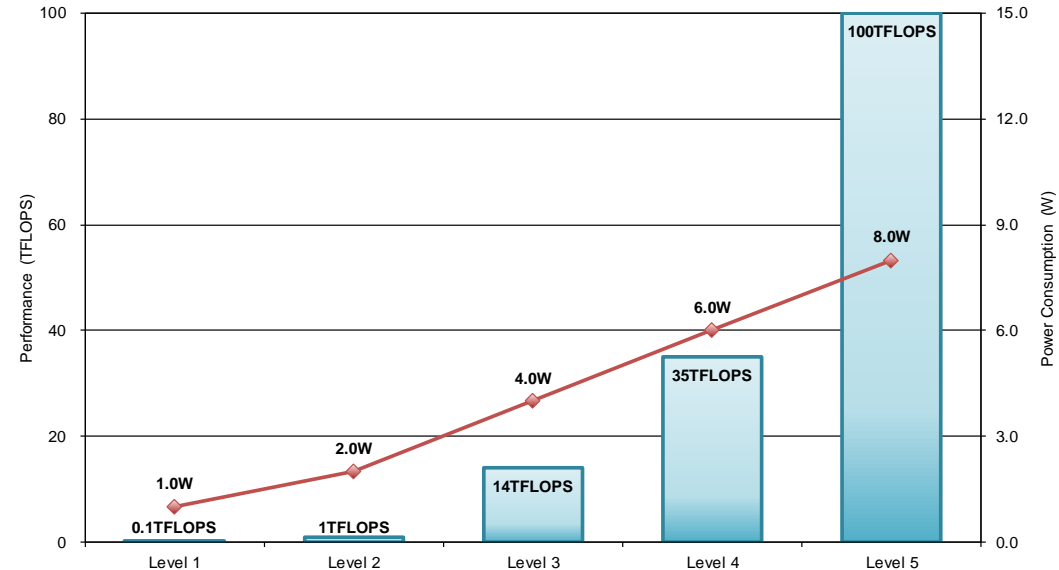
NEED ISP AND HIGH-PERFORMANCE SIGNAL PROCESSING (HPSP)

AUTONOMOUS DRIVING

AUTONOMOUS DRIVING BY SEGMENTATION



PROCESSOR REQUIREMENTS FOR SAE LEVELS



**NEED VERY HIGH PERFORMANCE AND VERY LOW POWER
OPTIONS ARE 10/7nm FINFETS OR 12nm FD SOI**

SMARTPHONE IMAGING

- Evolving to be CIS plus ISP+DRAM+algorithms and will be 6.5 billion units in 2025

New smartphones include two camera modules for support of segmentation and convergence, which are required for support of AR

AR is next area of high growth

- Need very low power consumption for ISP

CIS is very sensitive to heat

- Sony is market share and technology leader in CIS and is likely to maintain this position

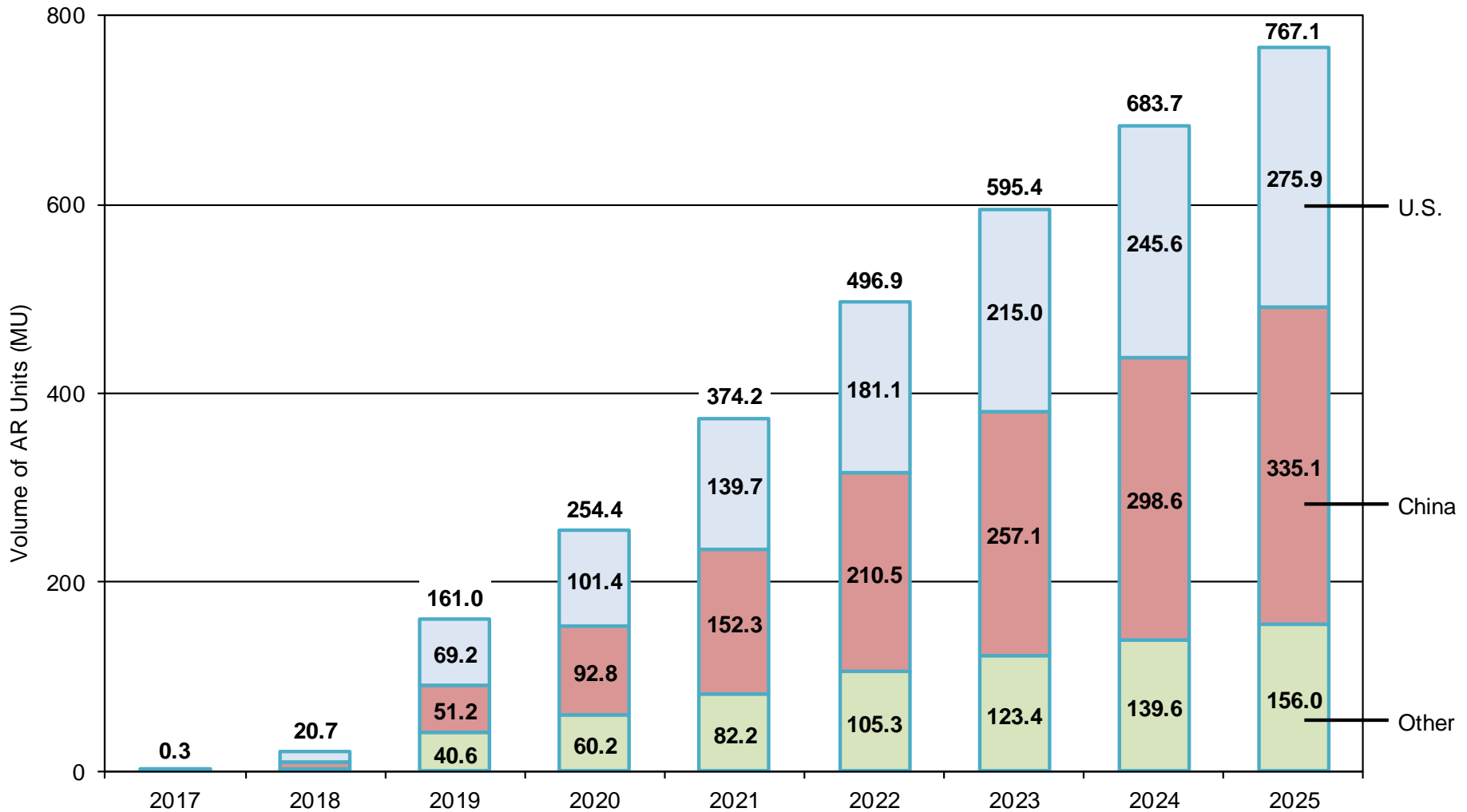
Samsung has second highest market share

- Time-of-flight sensors are in high growth

Technology leader is STMicroelectronics

TECHNOLOGY OPTIONS ARE 22FDX, 22ULP, AND 22FFL FOR ISP

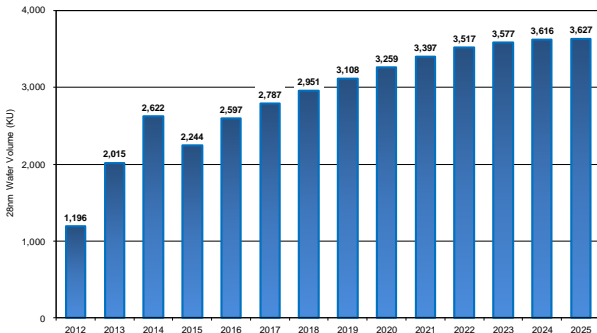
VOLUME OF AUGMENTED REALITY DEVICES



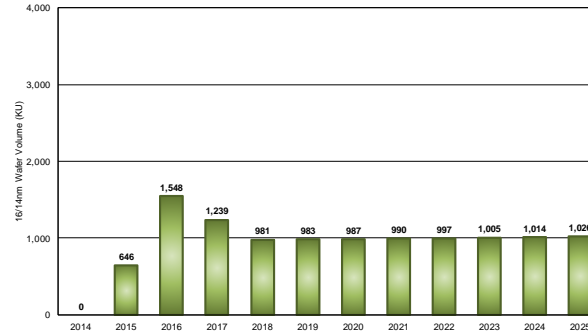
NEXT BIG GROWTH SEGMENT OF SEMICONDUCTOR MARKET

WAFER VOLUME TRENDS

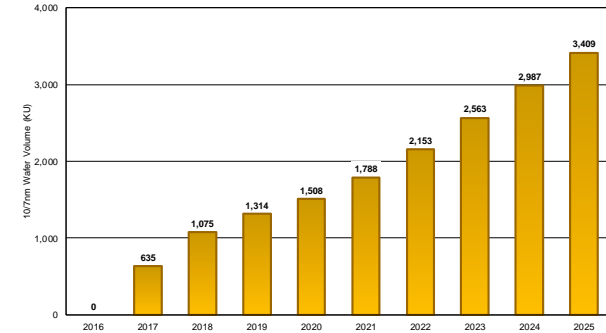
28nm



16/14nm

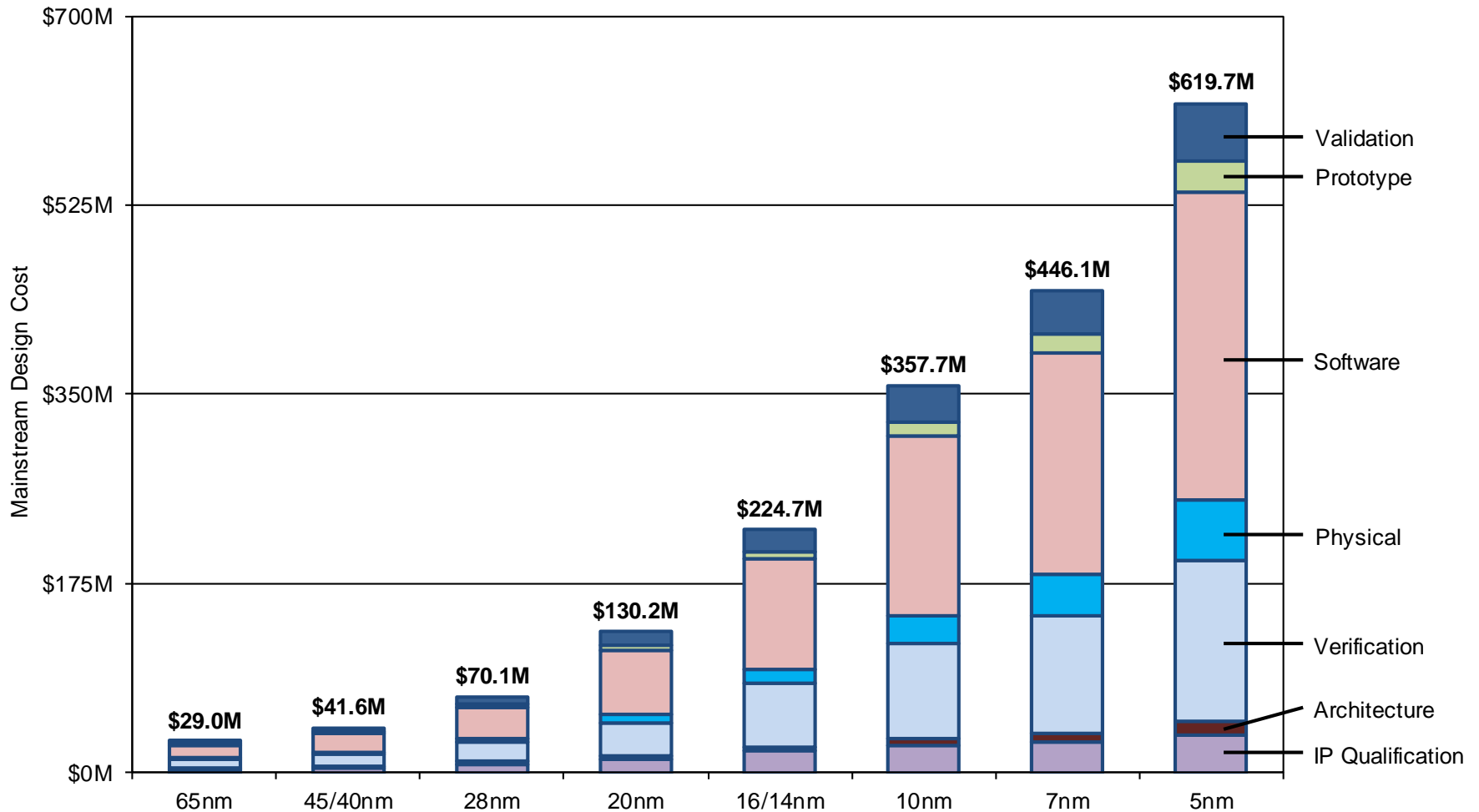


10/7nm



28nm WILL BE IN HIGH VOLUME FOR MANY YEARS

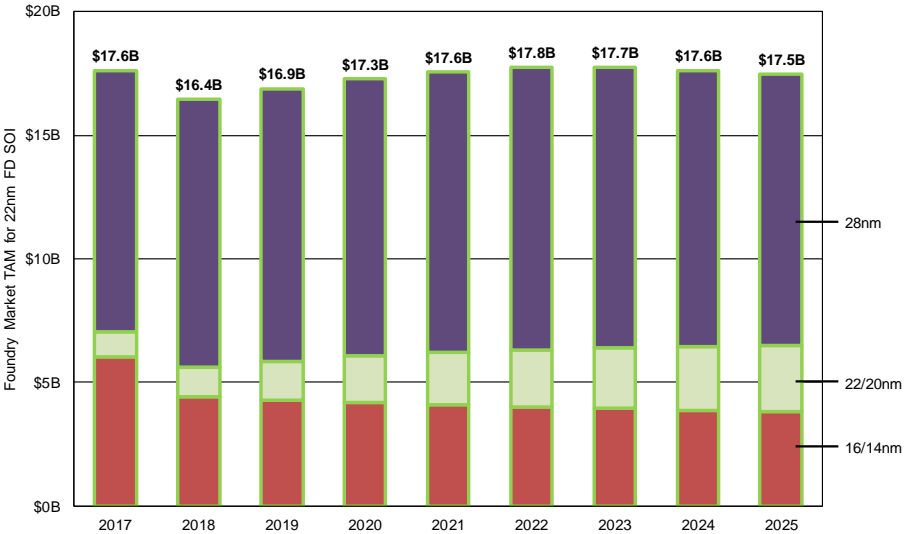
DESIGN COST



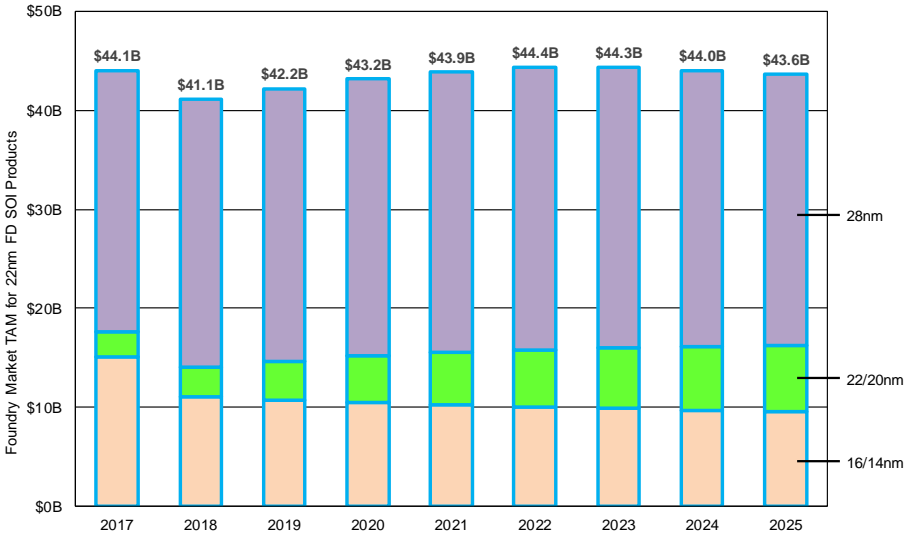
LARGE INCREASE IN DESIGN COSTS, WHICH LIMITS NUMBER OF PARTICIPANTS IN ADVANCED TECHNOLOGIES

FD SOI TAM

TAM 22nm FD SOI FOUNDRY



TAM FOR 22nm FD SOI PRODUCTS



FD SOI IS WELL POSITIONED FROM PERFORMANCE, POWER CONSUMPTION, AND RF CONNECTIVITY

CONCLUSION

- Decision processes at 28/22nm for IoT applications involve following:
 - 22FDX
 - 22ULP
 - 22FFL

Need to evaluate power consumption, performance, chip costs, and long-term migration path for various application segments

- Decision processes at 16/14/12nm involve following:
 - 12FDX
 - 12FFC
 - 14nm FinFET
 - 10nm FinFET
 - 7nm FinFET

Will require determination of product lifecycle costs as well as chip costs

FD SOI TECHNOLOGY CAN PROVIDE BEST COMBINATION OF FUNCTIONALITY FOR WIDE RANGE OF HIGH-VOLUME APPLICATIONS