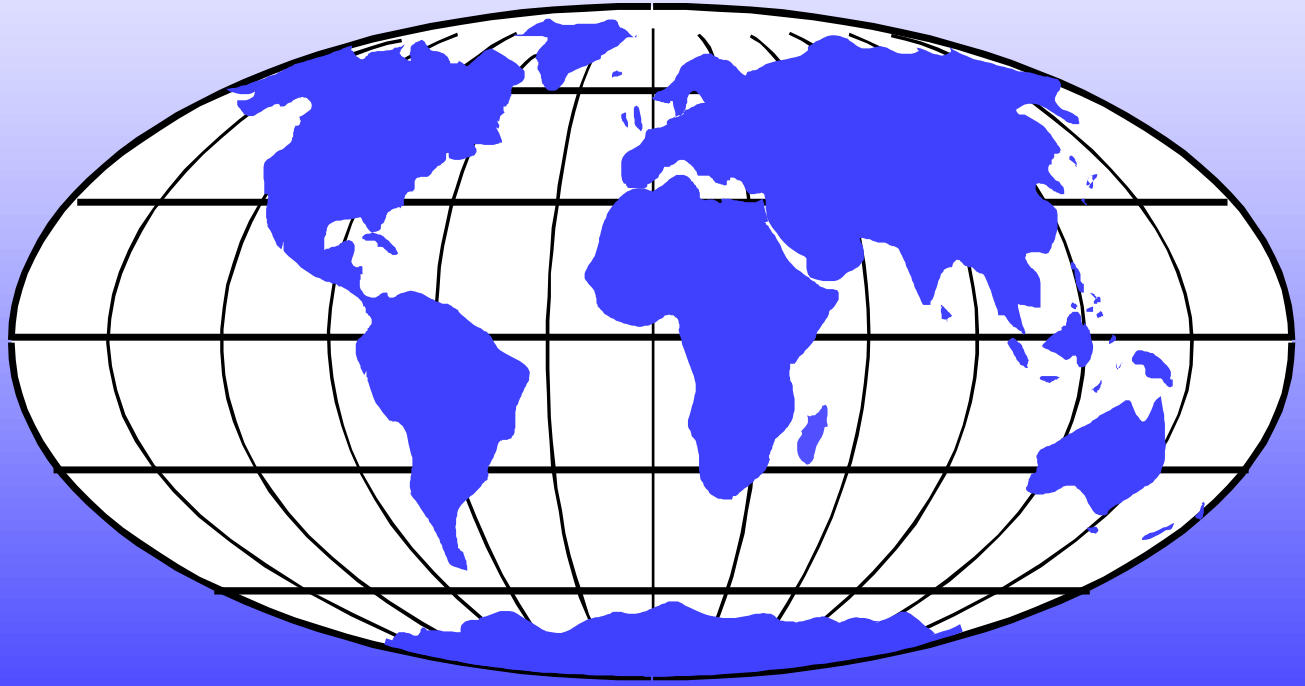
WHY CHINA IS A GOOD MARKET FOR FD SOI

SEPTEMBER 15, 2015



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INTERNATIONAL BUSINESS STRATEGIES BACKGROUND

IBS

- Has been in business for over 25 years
- Previous experience in managing 1.5K+ engineers at Rockwell International, which included avionics, communications, and semiconductors. 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, Sony, Toshiba, Apple, Cisco, Huawei, IBM, Fujitsu, NEC, Hitachi, Renesas, TSMC, STMicroelectronics, TI, ARM, Cadence, Synopsys, Mentor Graphics, Seagate, SK Hynix, Canon, Globalfoundries, SMIC, NXP Semiconductors, and others
- Participated with French Government on their advanced technology initiatives
- 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
- 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). Forbes blog contributor, China Daily articles, Global Times editorials, EE Times Asia, 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

TOP-LEVEL PERSPECTIVE ON CHINA MARKET

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- China is evolving to becoming high technology, which will require building strong design expertise
  - 50% of smartphones provided globally in 2015 will come from Chinese companies, eg, Huawei Technologies, Xiaomi, and others

    Increased supply of semiconductors for smartphones from Chinese companies
  - ***China is projected to be global leader in 5G***

    Initial field tests will be in 2018. Initial deployment will be in 2020
  - 250M 4G subscribers out of 1.3M handsets in China as of July 2015

    China is Internet savvy
- $20B available for setting up wafer foundry, NAND Flash, and DRAM

  Will require partnerships
- Acquisition of OmniVision Technologies, Integrated Silicon Solution, NXP Semiconductors' RF Power business (by Jianguang Asset Management) and STATS ChipPAC

  Many more acquisitions will be made, but key is how to manage them

TOP-LEVEL PERSPECTIVE ON CHINA MARKET (CONTINUED)

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- Increased emphasis on big data, which will leverage 5G, IoT, and cloud

  Supercomputers designed and manufactured in China are competitive but primarily based on Intel and NVIDIA processors

  New semiconductor designs are based on Chinese processors, ARM, MIPS, and Power Architecture

- Entering HD video age
  - Samsung plans to manufacture 11K panels in high volume in 2018 and projects sales of 97M UHD televisions in 2019

    China will manufacture 8K and 11K panels in 2020

    China is strengthening rapidly in displays
  - HD entertainment content is being actively supported, including investments in Hollywood ecosystem, eg, Hanhai Studio
  - Medical, industrial, security, and other applications can benefit from HD video

CHINA IS CHANGING, AND SEMICONDUCTORS ARE KEY PART OF THIS CHANGE

TOP-LEVEL METRICS FOR CHINA

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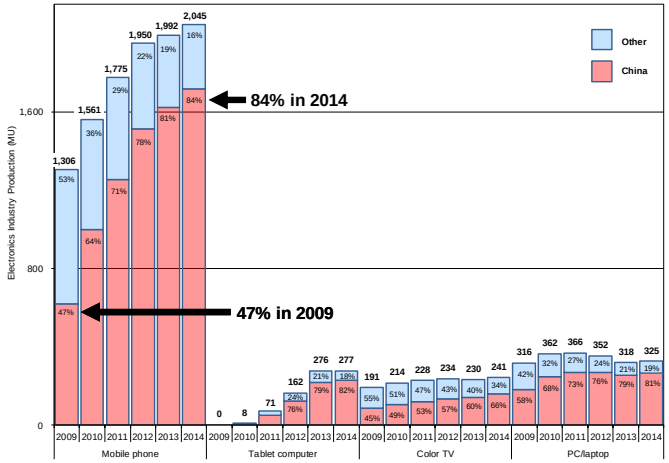
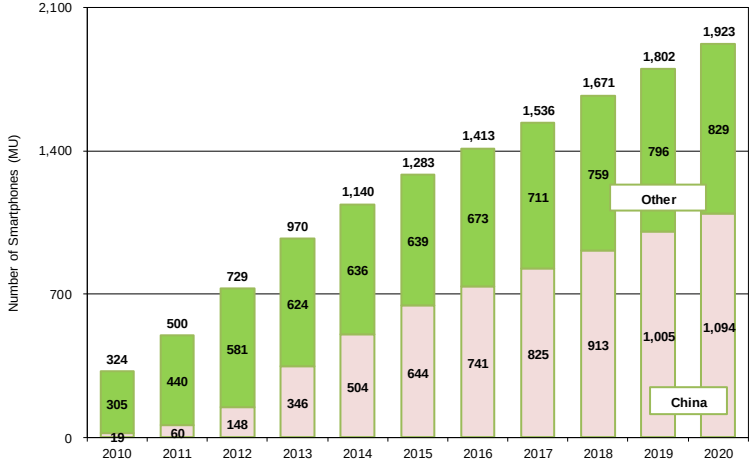
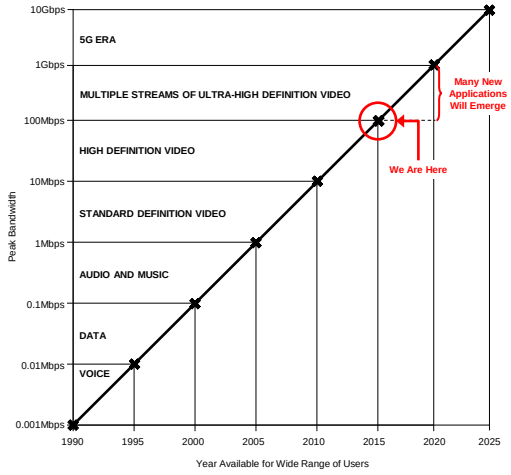
CHINA'S ELECTRONICS INDUSTRY PRODUCTION



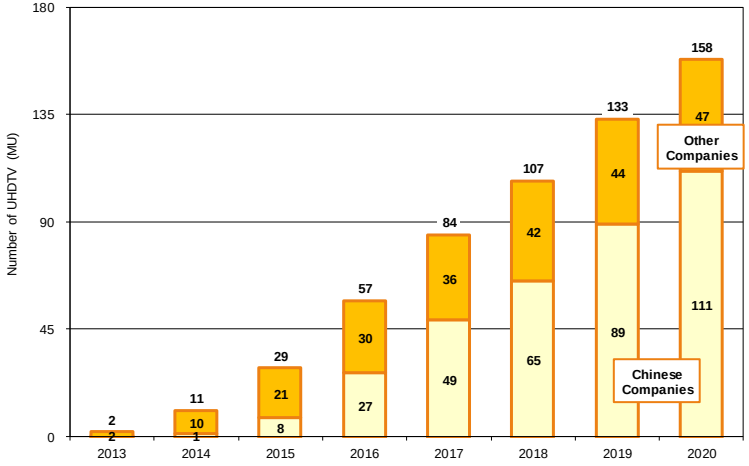
SMARTPHONE SUPPLY



BROADBAND WIRELESS CONNECTIVITY



UHD TELEVISION SUPPLY



RATE OF PROGRESS IS ACCELERATING

GLOBAL SEMICONDUCTOR MARKET

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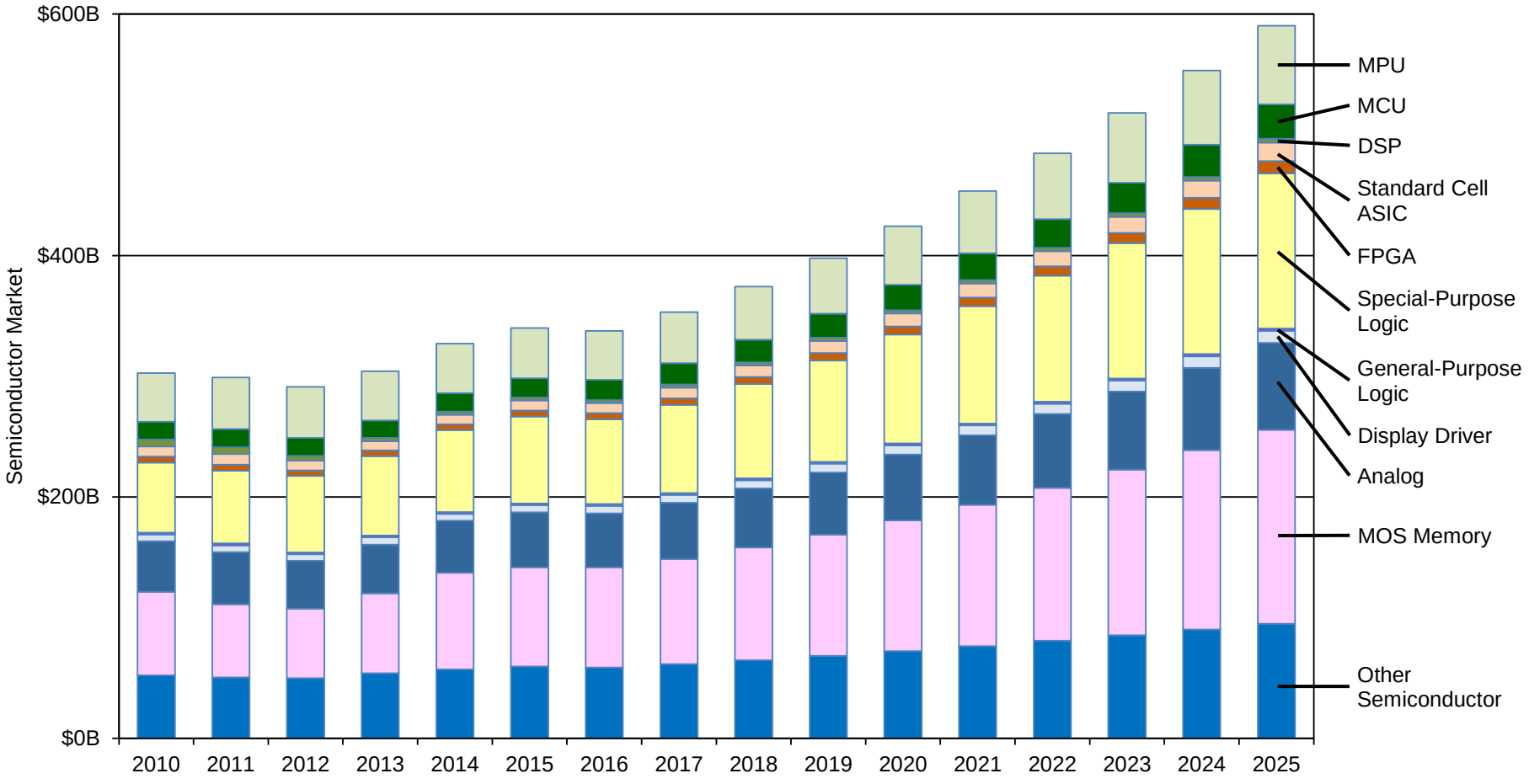

TOTAL GLOBAL MARKET WILL BE $590B IN 2025

CHINA'S SEMICONDUCTOR MARKET

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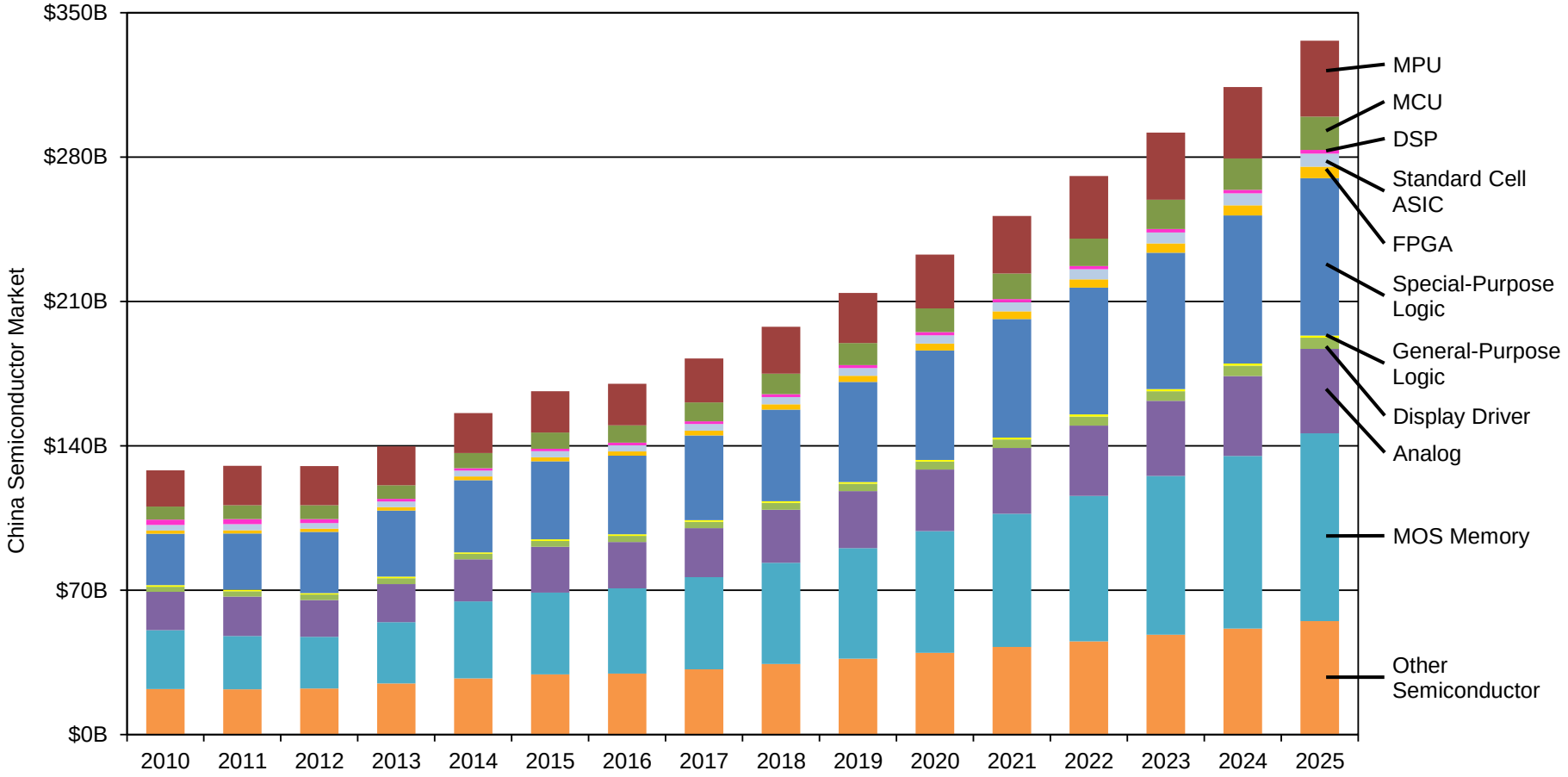

CHINA MARKET WILL BE $336B,
REPRESENTING 57% OF GLOBAL MARKET IN 2025

SEMICONDUCTOR CONSUMPTION PATTERN IN CHINA

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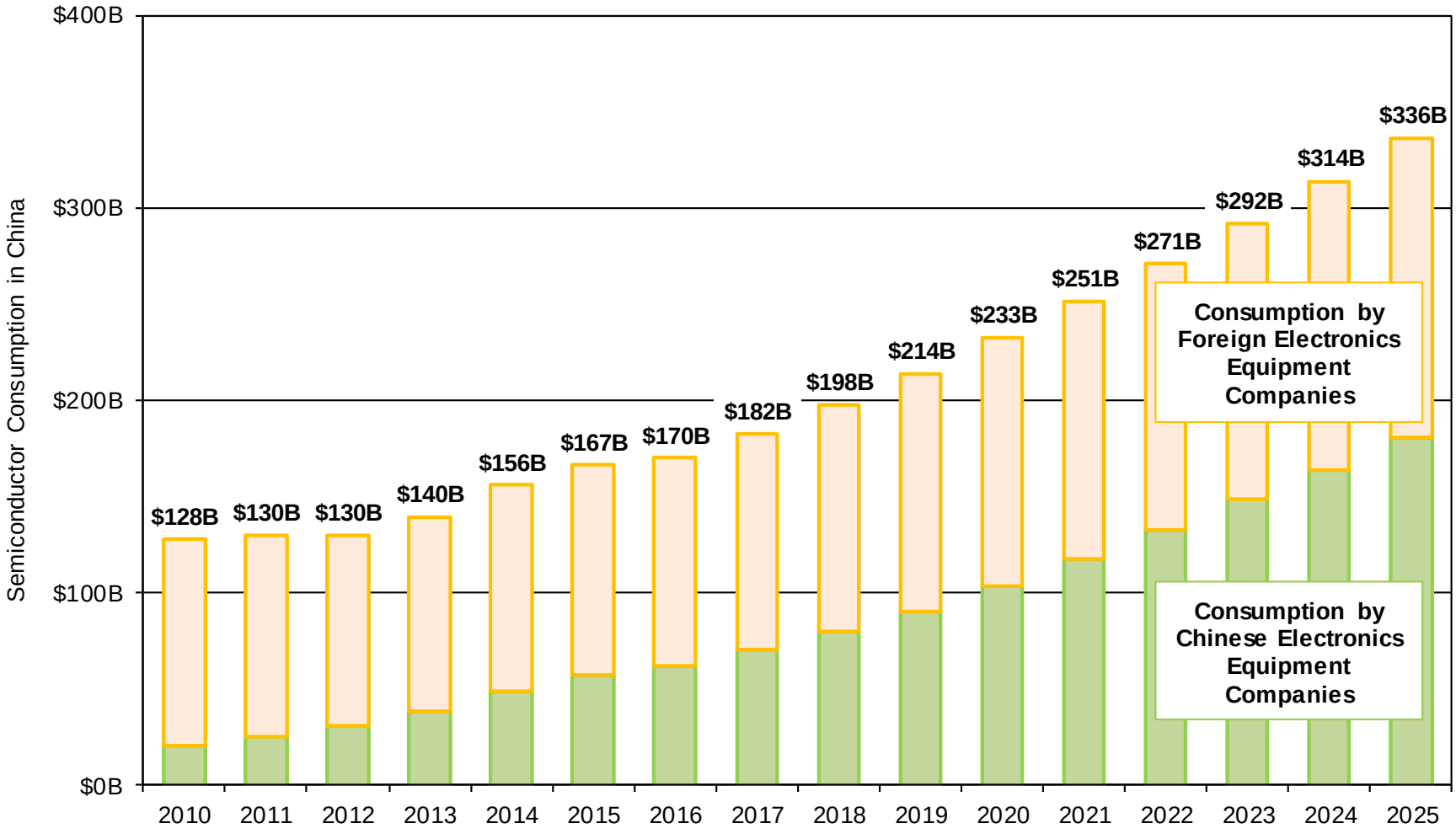

CHINESE COMPANIES CONSUMED 15.8% OF TOTAL SEMICONDUCTORS IN CHINA IN 2010 BUT WILL BE 53.8% IN 2025

SEMICONDUCTOR SUPPLY IN CHINA

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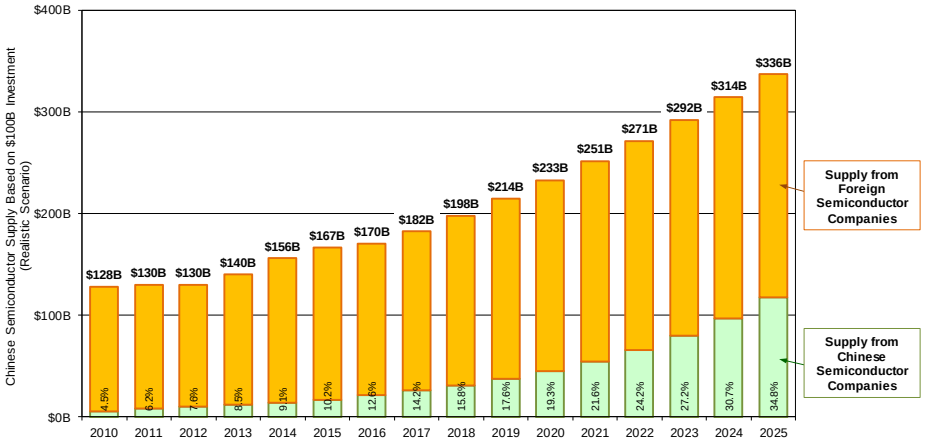
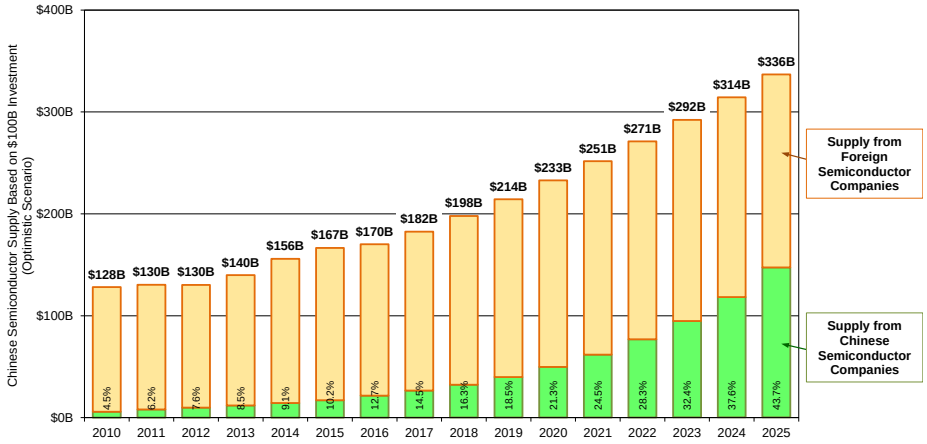
REALISTIC



OPTIMISTIC



FOREIGN COMPANIES DOMINATE SUPPLY OF SEMICONDUCTORS IN CHINA

HOWEVER, THIS MAY CHANGE WITH APPROPRIATE STRATEGIES BY CHINESE COMPANIES

GLOBAL FOUNDRY MARKET

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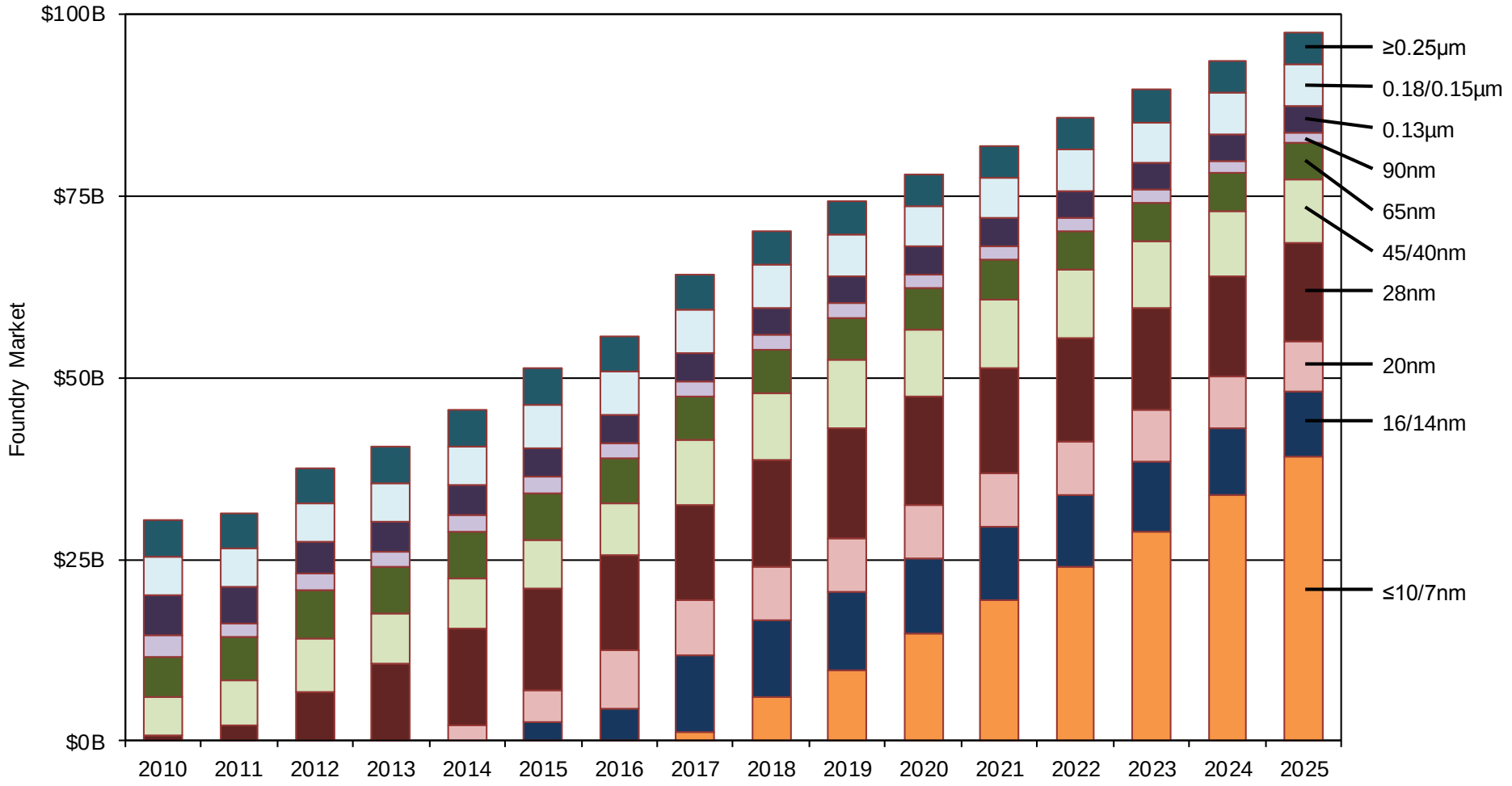

28nm AND DERIVATIVES SUCH AS 22nm FD SOI WILL BE HIGH VOLUME LONG LIFETIME TECHNOLOGY NODES. 10/7nm WILL BE IMPORTANT TECHNOLOGY NODE

CHINA'S FOUNDRY MARKET

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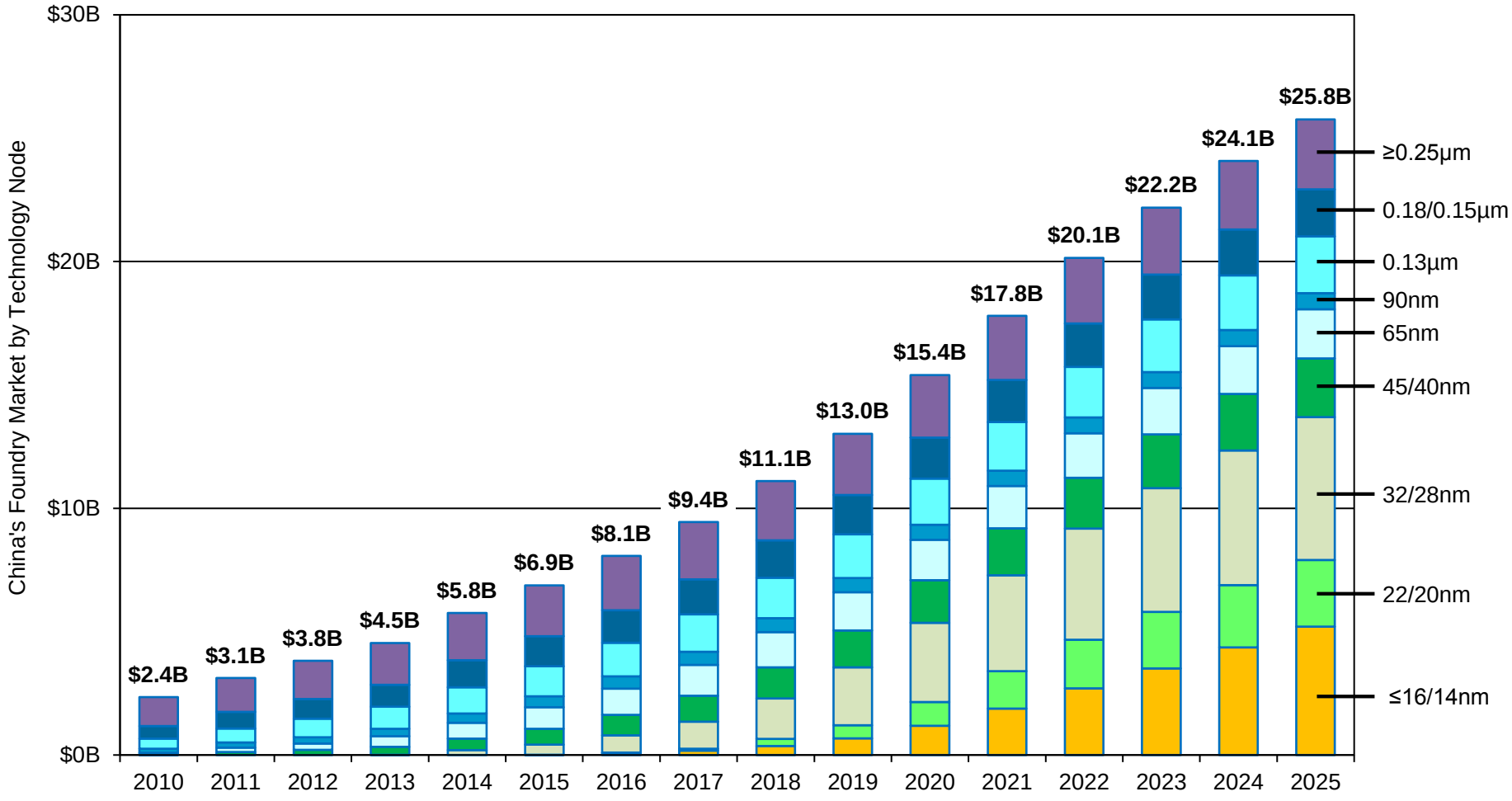

WAS 7.8% OF TOTAL GLOBAL MARKET IN 2010

WILL BE 26.4% IN 2025

DESIGN STARTS BY TECHNOLOGY NODE

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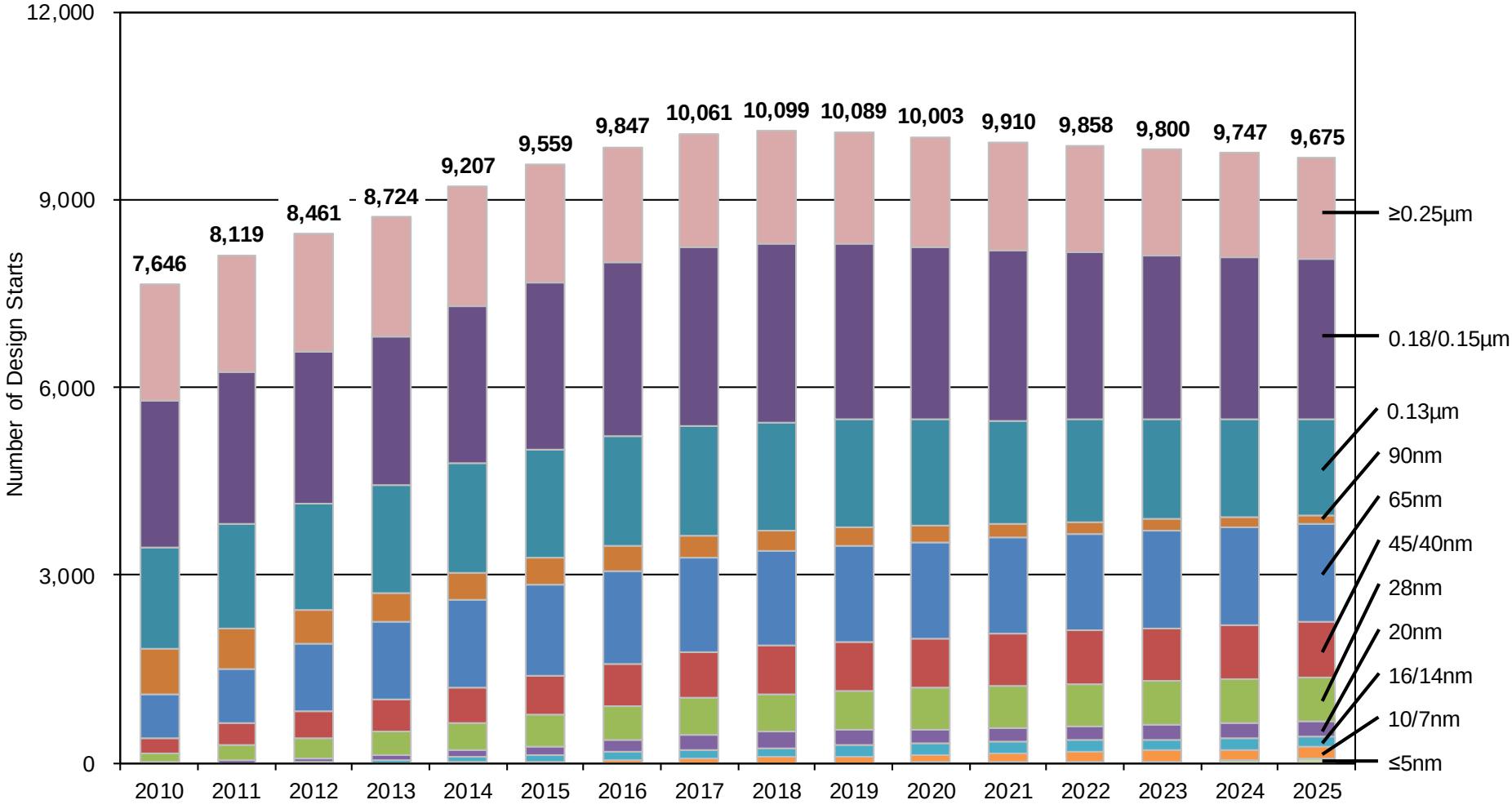

VERY SMALL NUMBER OF DESIGNS IN ≤10nm,
BUT REVENUES PER DESIGN ARE VERY HIGH

DESIGN STARTS BY GEOGRAPHIC REGION

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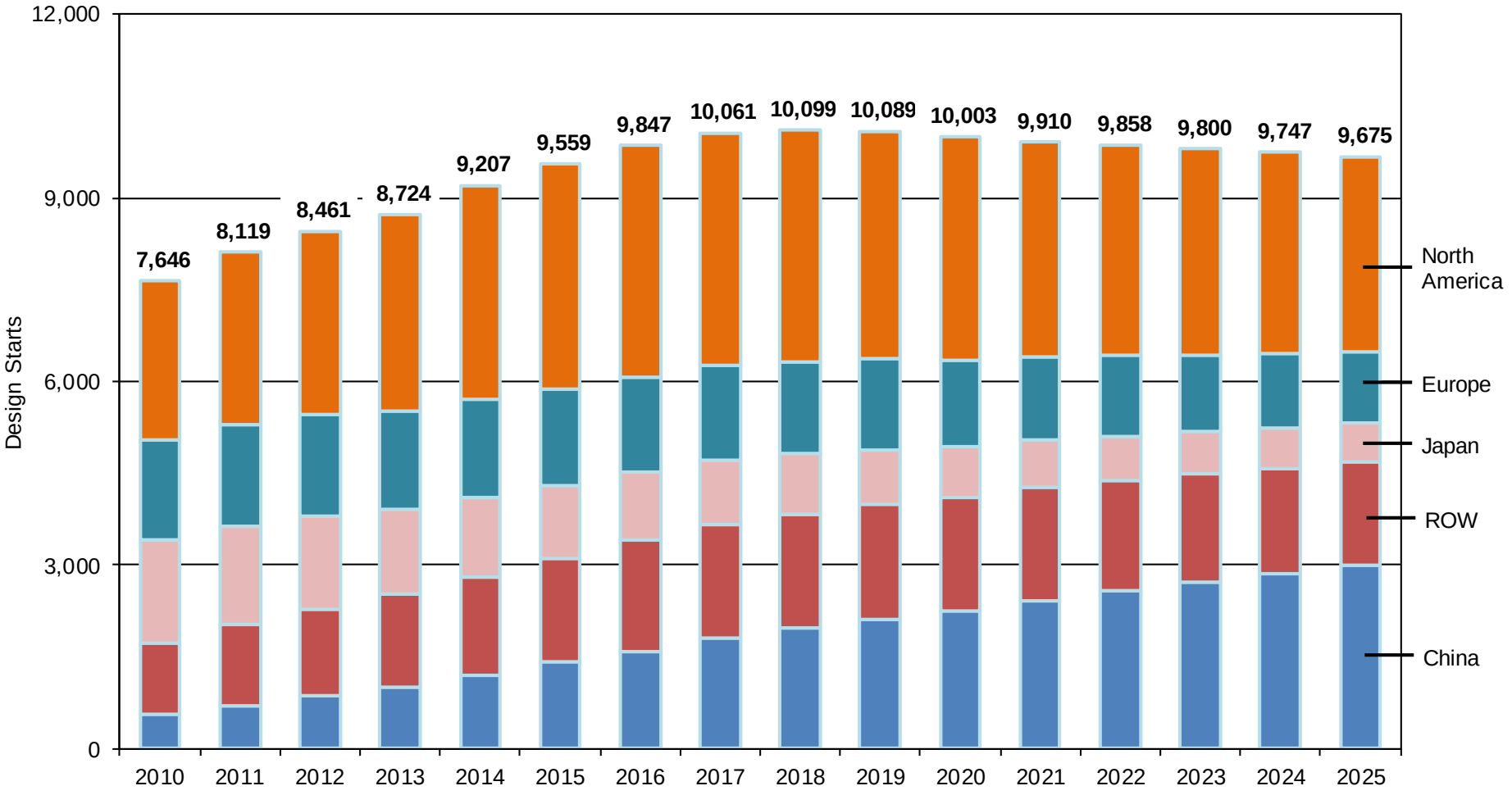

HIGH GROWTH FOR DESIGN STARTS IN CHINA

DESIGN COSTS

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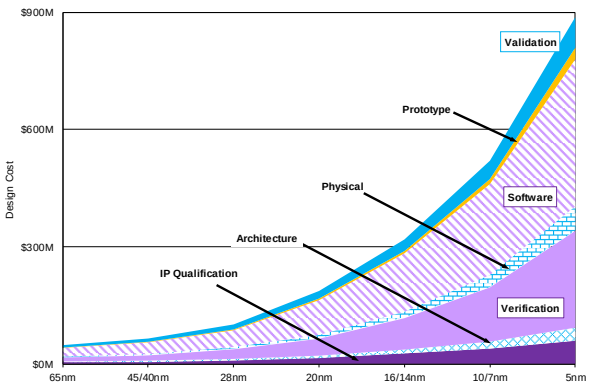
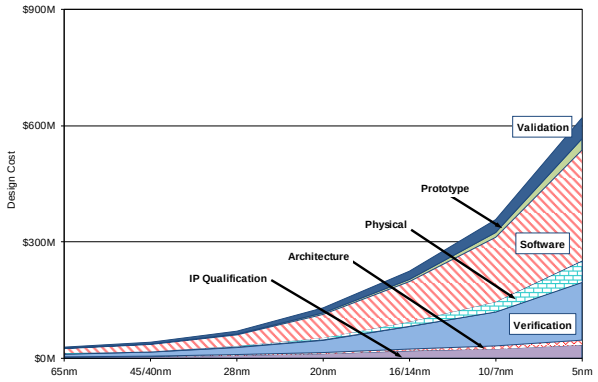
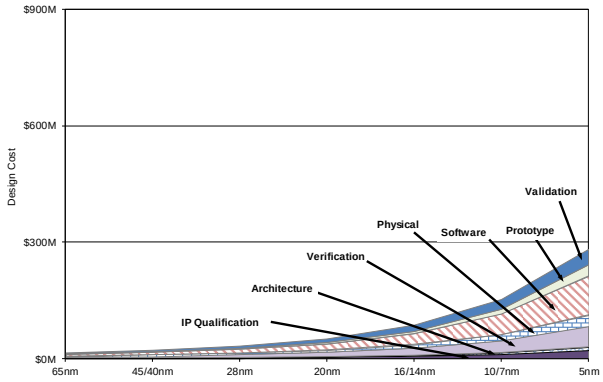
ADVANCED



MAINSTREAM



FOLLOWER



DESIGN COSTS ARE INCREASING RAPIDLY WITH REDUCTION IN FEATURE DIMENSIONS

FOR ADVANCED TECHNOLOGY, DESIGN COSTS WILL BE COMPARABLE IN CHINA TO OTHER COUNTRIES

REVENUE LEVELS TO SUPPORT MAINSTREAM DESIGNS

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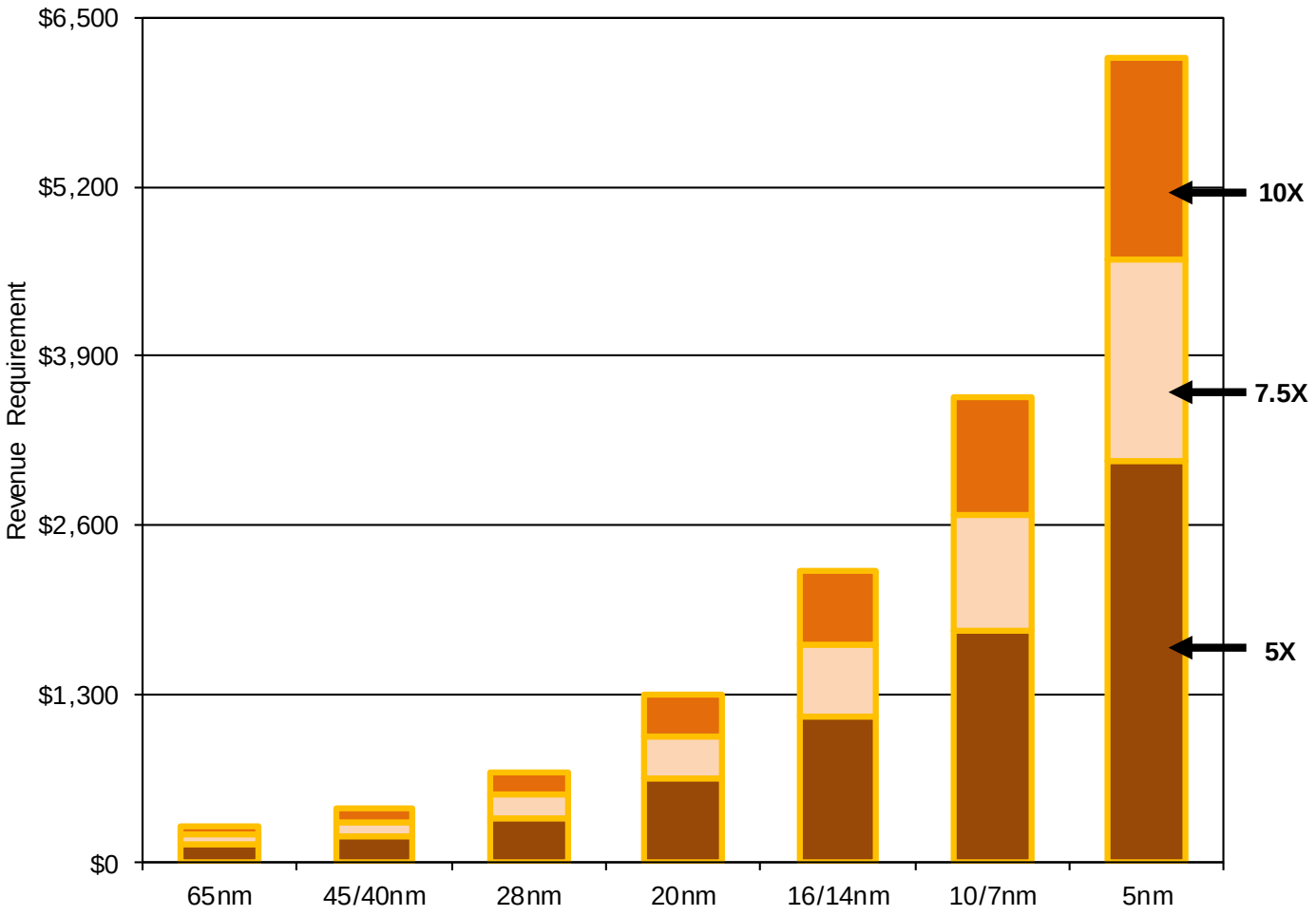

REVENUES PER DESIGN NEED TO BE 10X DESIGN COSTS

NEED NEW DESIGN METHODOLOGIES

GATE COST ANALYSIS

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($)	28nm		22/20nm		16/14nm	
	Bulk CMOS	FD SOI	Bulk CMOS	FD SOI	FinFET	14nm FD SOI
Q4/2015	1.44	1.39	1.46	1.20	1.78	1.22
Q4/2016	1.07	1.06	1.39	1.12	1.65	1.12
Q4/2017	0.92	0.90	1.34	1.07	1.57	1.11

AT 16/14nm, GATE COST OF FD SOI IS 29.2% LOWER THAN FINFET IN Q4/2017

FD SOI GIVES HIGH LEVELS OF DESIGN FLEXIBILITY FOR RF AND MIXED-SIGNAL

TECHNOLOGY ASSESSMENTS

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- ***28nm HKMG:*** Excellent technology for many applications

  HPC+ of TSMC gives 15% lower power than HPC

- ***22nm FD SOI:*** Better technology than 28nm HKMG

  Lower power consumption, higher performance, and superior for RF and analog-centric mixed-signal functionality

- ***20nm HKMG bulk CMOS:*** High gate cost compared to 28nm HKMG and high leakage

  Apple is high volume user but changing to FinFET for digital designs

  Small number of new designs are in 20nm HKMG bulk CMOS

  22nm FD SOI is much better technology

- ***16/14nm FinFET:*** Has low standby power but relatively high switching power

  Can be lower in power consumption compared to 28nm and 20nm HKMG bulk CMOS

  Very high design costs and very difficult to implement RF

  Expect 16/14nm FinFETs to be displaced in digital designs by 10/7nm FinFETs in H2/2017 or 2018

  Apple is driving 10/7nm, and Xilinx will release FPGA products in H2/2017

  16/14nm FD SOI can give gate cost that is 29.2% lower than 16/14nm FinFETs in H4/2017, with lower design costs and ability to support RF and other specialty requirements

CHINA MUST MAKE IMPORTANT DECISIONS REGARDING TECHNOLOGY ROADMAP

PRODUCT OPPORTUNITIES FOR FD SOI

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- ***Application processors:*** 8- and 10-core 64-bit application processors in FD SOI can be lower cost, lower power consumption, and better flexibility in making enhancements than other technologies
- ***Modems and transceivers:*** China is strengthening rapidly in modems for smartphones

  FD SOI is best technology
- ***Image signal processors:*** Represent high growth market for smartphones, automotive, industrial, and other applications

  Need low power and high performance
- ***SSD controllers:*** Enterprise as well as client SSDs can obtain benefits from FD SOI
- ***Wi-Fi, Bluetooth, and NFC:*** Low noise, good linearity, and low power
- ***High bandwidth SERDES:*** Low jitter and high drive
- ***ADAS processors:*** High performance and low power
- ***IoT:*** Support for processors and low power connectivity

  Many segments, and FD SOI is best technology for most segments

MANY PRODUCT OPPORTUNITIES FOR FD SOI

KEY REQUIREMENT IS TO BUILD STRONG IP ECOSYSTEM AND SUPPLY CHAIN

SUMMARY OF TECHNOLOGY TRENDS

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- Following mainstream 16/14nm FinFET roadmaps can support high performance designs but does not give competitive advantage either for China's supply chain ecosystem or Chinese fabless companies for many high volume products
- Important for China to have leadership product functionality in order to compete effectively in China market in longer term

  This means low power, high performance, and low cost

  Also needs to support RF, mixed-signal, and embedded nonvolatile memory
- 5G will be very important in next few years and will need high performance semiconductor products

  FD SOI is best technology option for infrastructure and devices
- Smartphone market is largest segment for semiconductors in China

  With 1B+ units in 2020 and $50 per unit, nonmemory semiconductor market is $50B
- IoT will be $91.9B semiconductor market in 2025

  China will be over 50% of market
- Automotive supply chain is expected to strengthen rapidly in China
- Implementing designs in FD SOI are much more efficient and shorter time-to-market than FinFETs for mixed-signal and RF-based designs

IMPORTANT TO SELECT BEST TECHNOLOGY OPTION FOR TARGETED APPLICATIONS

CONCLUSION

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- Markets within China are large and growing

  Important to build up strong supply chain

  Very high growth potential for fabless semiconductor companies in China

  Important to be competitive in global markets in order to be key participant in China market
- Chinese government agencies are willing to provide support to build strong semiconductor industry in China

  Funding is also available from financial institutions

  Critical to have strong design expertise as well as strong management and to select best technology
- Acquisitions are expected to continue but have risks because key people can leave

  Joint ventures can be better option for many market segments
- There will be high volatility in China, but this is normal when competitive environment changes rapidly
- Following FinFET roadmap can be part of decision processes in China, but it is important to have some form of differentiation

  FD SOI can be approach to have differentiation, low cost, and low power consumption

  Important to build up FD SOI supply chain ecosystem in China, but key is to build demand

CHINA IS FACING MANY CHALLENGES, BUT OPPORTUNITIES IN SEMICONDUCTORS ARE EXCELLENT