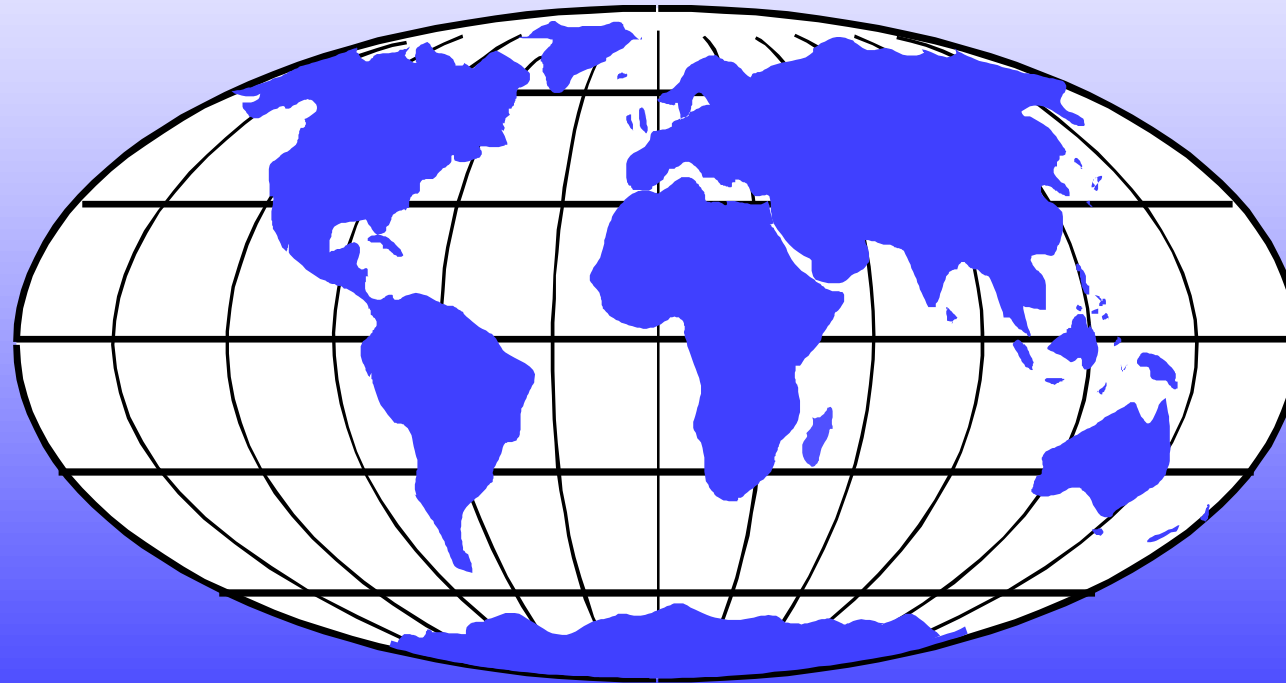


# MARKET OVERVIEW AND FD SOI OPPORTUNITIES

JULY 11, 2018



**INTERNATIONAL BUSINESS STRATEGIES, INC.**

632 Industrial Way | Los Gatos CA 95030 | USA | 408 395 9585 | 408 395 5389 (fax)

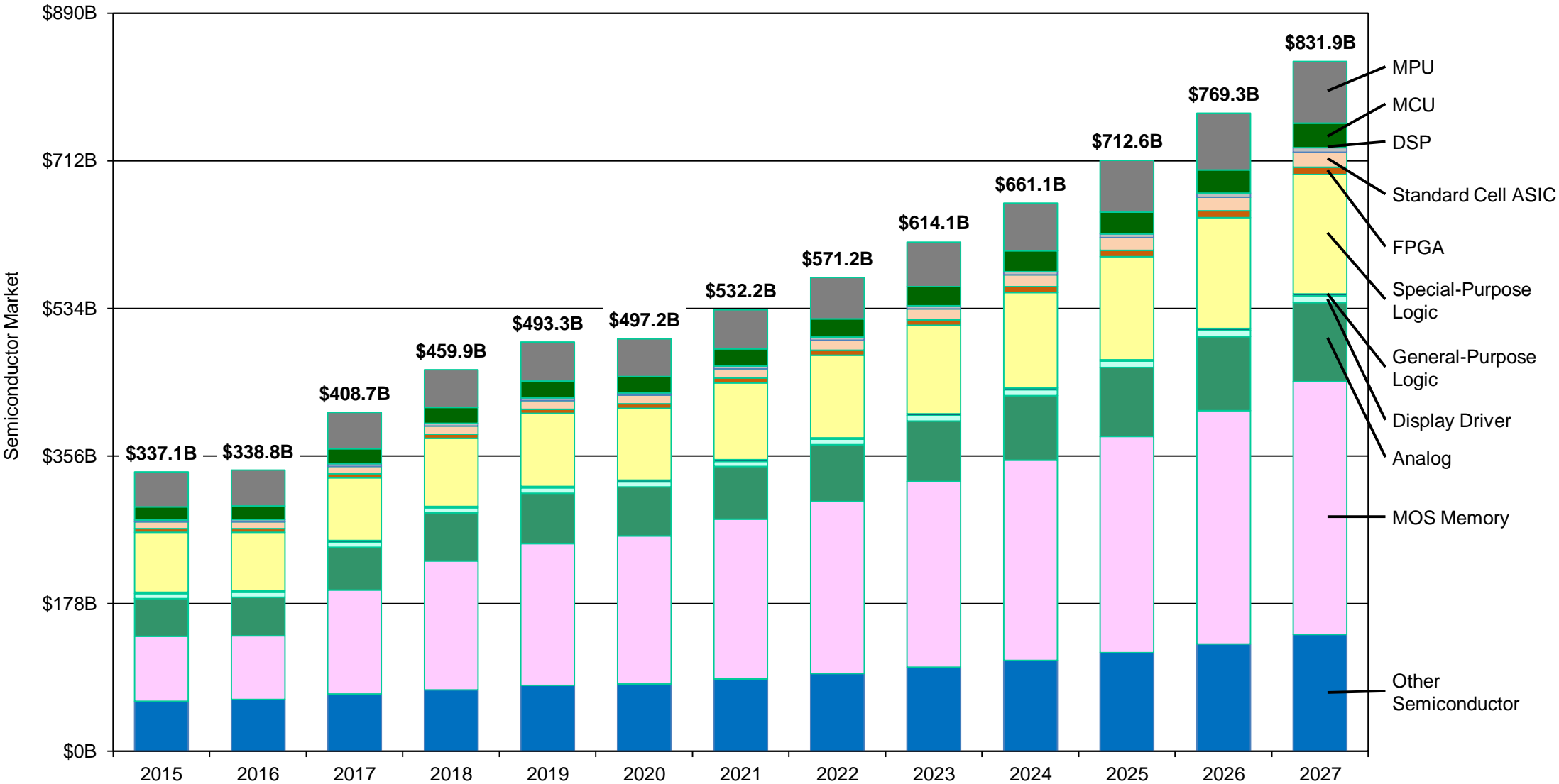
[www.ibs-inc.net](http://www.ibs-inc.net) | [info@ibs-inc.net](mailto:info@ibs-inc.net)

# TOP-LEVEL PERSPECTIVE IN SEMICONDUCTOR INDUSTRY

- Semiconductor market will grow by 12.5% in 2018 and 7.3% in 2019  
There is relatively high probability that market will be in downturn in 2020
- Smartphones will continue to be largest user of semiconductors, and next phase is based on AR
- AI phase is emerging, with strong growth for processors (including neural network processors) and supporting memory  
ADAS is example of AI, and 100TOPS throughput is needed for level 5 autonomous driving
- AI-based smart robots will replace 0.5 billion to 1.0 billion factory workers by 2030  
There is similar pattern in service industry where many workers will be displaced by robots
- IoT growth will accelerate, and key factors include widespread availability of 5G and increased adoption of AI  
NB-IoT is also important connectivity option for IoT
- Leadership AI technology is in U.S. and U.K. (DeepMind), but China is making largest investments  
AI will have dramatic impact on electronics industry

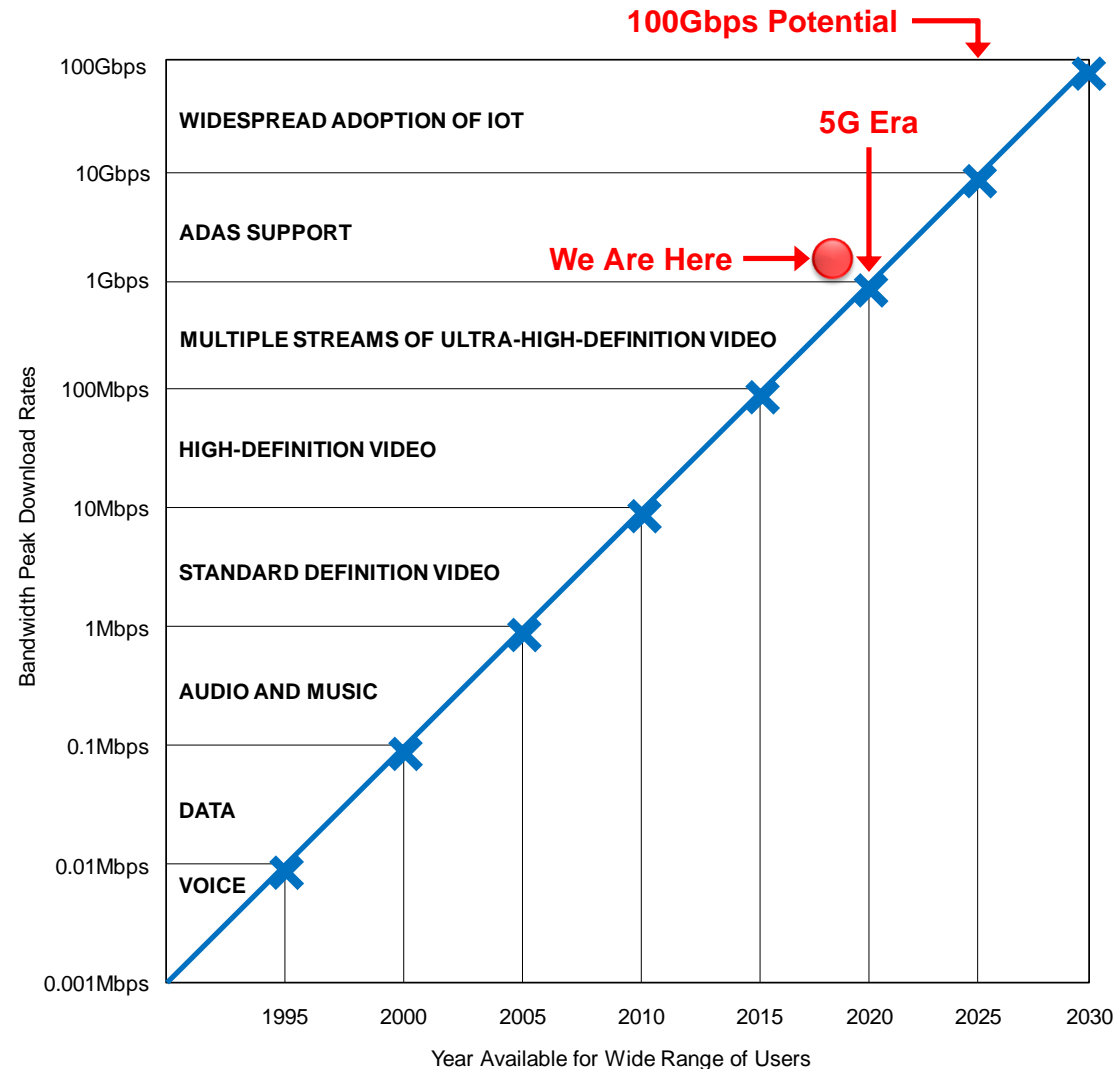
**KEY REQUIREMENTS IN AREAS OF SEMICONDUCTOR GROWTH INCLUDE HIGH PERFORMANCE AND LOW POWER CONSUMPTION**

# SEMICONDUCTOR MARKET BY PRODUCT



**HIGHEST GROWTH PRODUCTS ARE DRAM AND NAND**

# BANDWIDTH TREND AND EMERGENCE OF 5G



**PEAK DOWNLOAD RATES OF 5G WILL BE 100Gbps BY 2030**

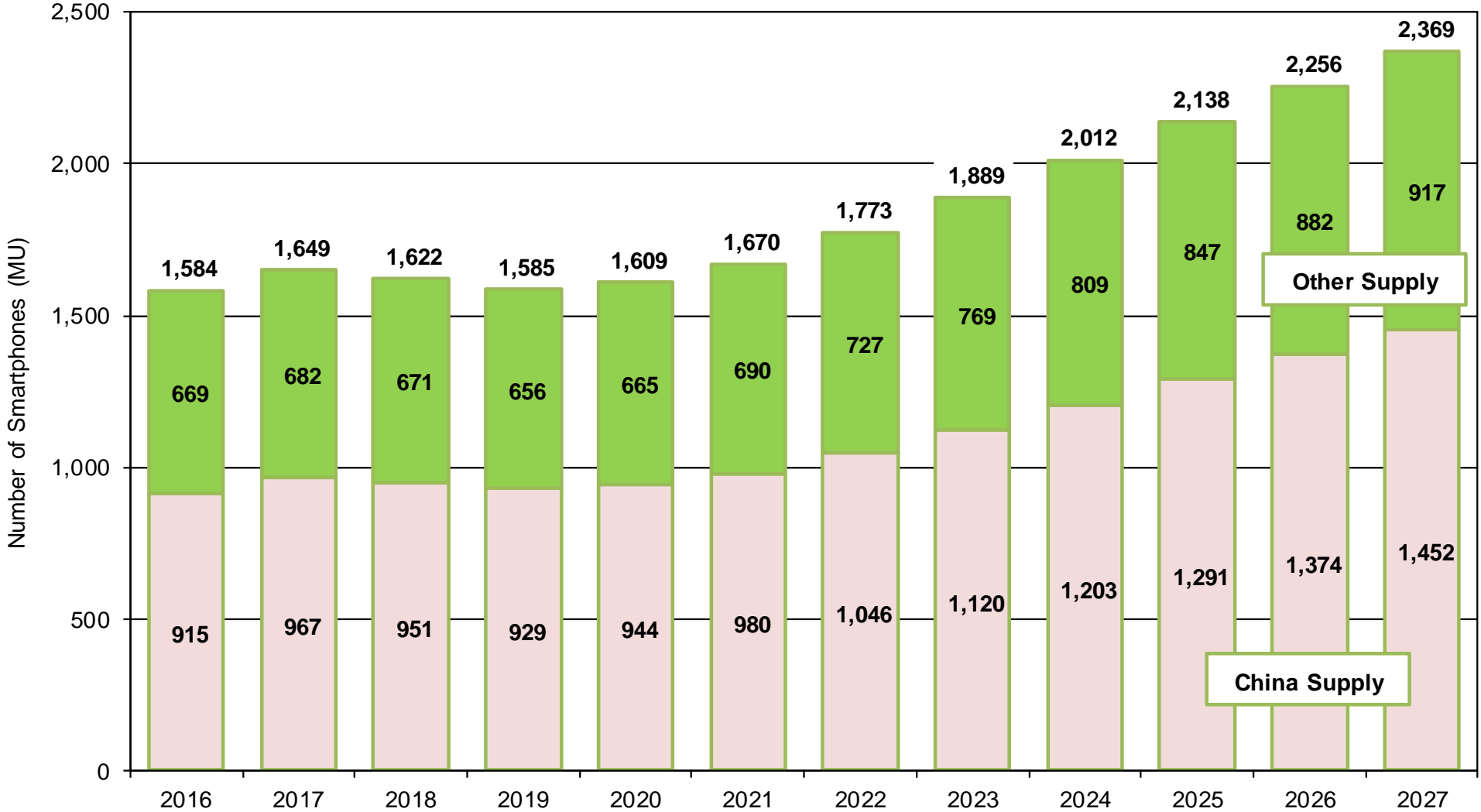
# 5G ACTIVITIES

- U.S. is focused on fixed 5G (mmWave spectrums) and places lower priority on mobile 5G  
Sprint and T-Mobile have access to spectrums for mobile 5G but are in merger discussions
- 5G will support UHD video, gaming, ADAS, and IoT
- IMT-2020 (5G) Promotion Group announced China will likely distribute 5G frequency bands in H2/2018 (many bands)
  - Deployment of 5G networks is expected in H2/2019 or H1/2020
  - Large-scale commercialization of mobile 5G is planned for 2020 in China
  - Huawei has announced availability of 5G-enabled processors in H1/2019
- China expects to have one billion 5G mobile users by 2025 to 2028
- Huawei is global leader in 5G infrastructure followed by Ericsson, Nokia, Samsung, and ZTE
- 5G modems will be available from Qualcomm, HiSilicon, MediaTek, Intel, Samsung, and Unigroup  
Spreadtrum & RDA

Key requirement is full application solution

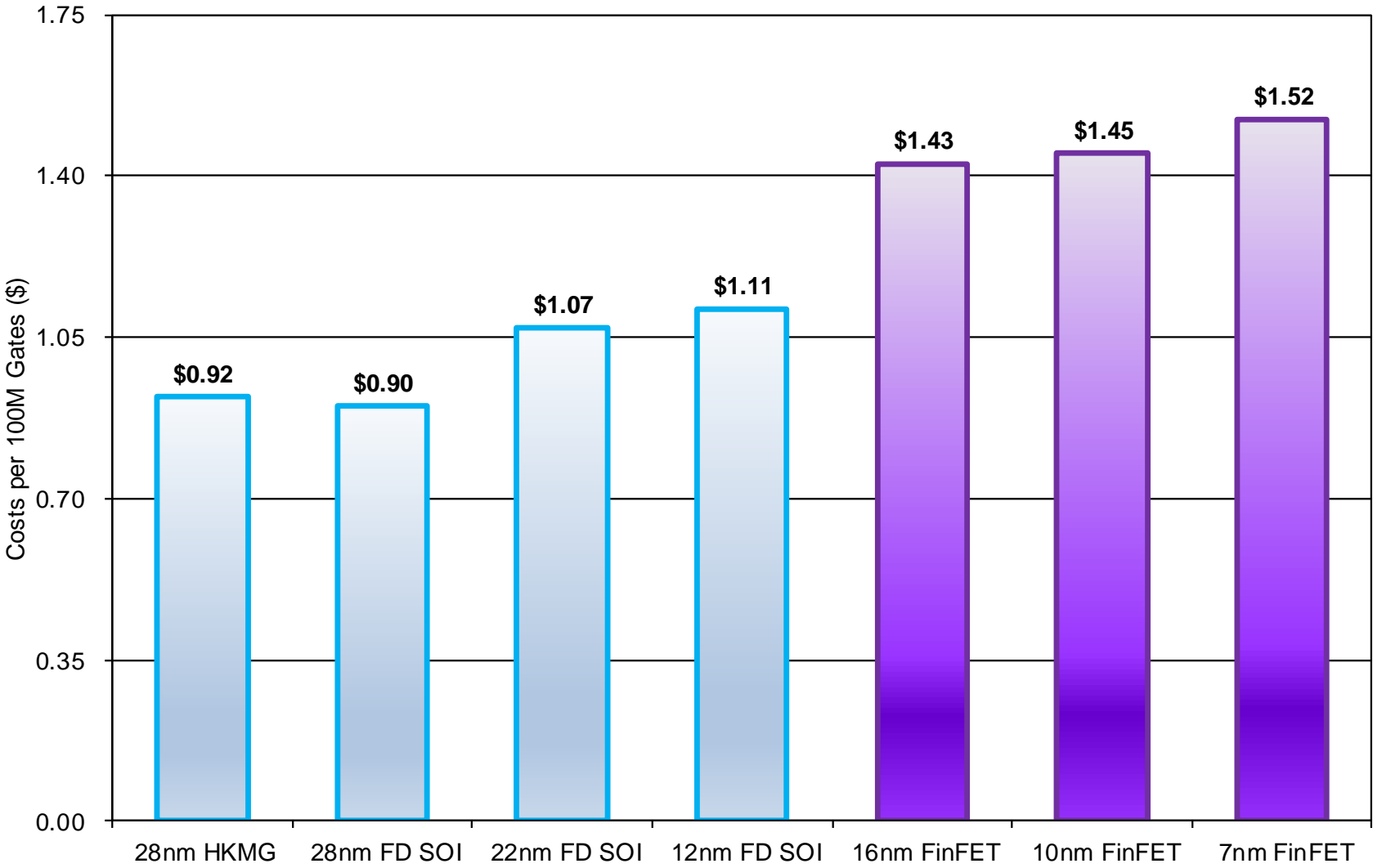
**5G WILL BE IMPORTANT CAPABILITY FOR WIDE RANGE OF APPLICATIONS**

# SMARTPHONE VOLUME



**CHINESE VENDORS PRODUCE HIGHEST VOLUME OF SMARTPHONES**

# GATE COST OF FD SOI, FINFET, AND HKMG



**FD SOI IS COST COMPETITIVE AND GIVES LOW POWER CONSUMPTION**

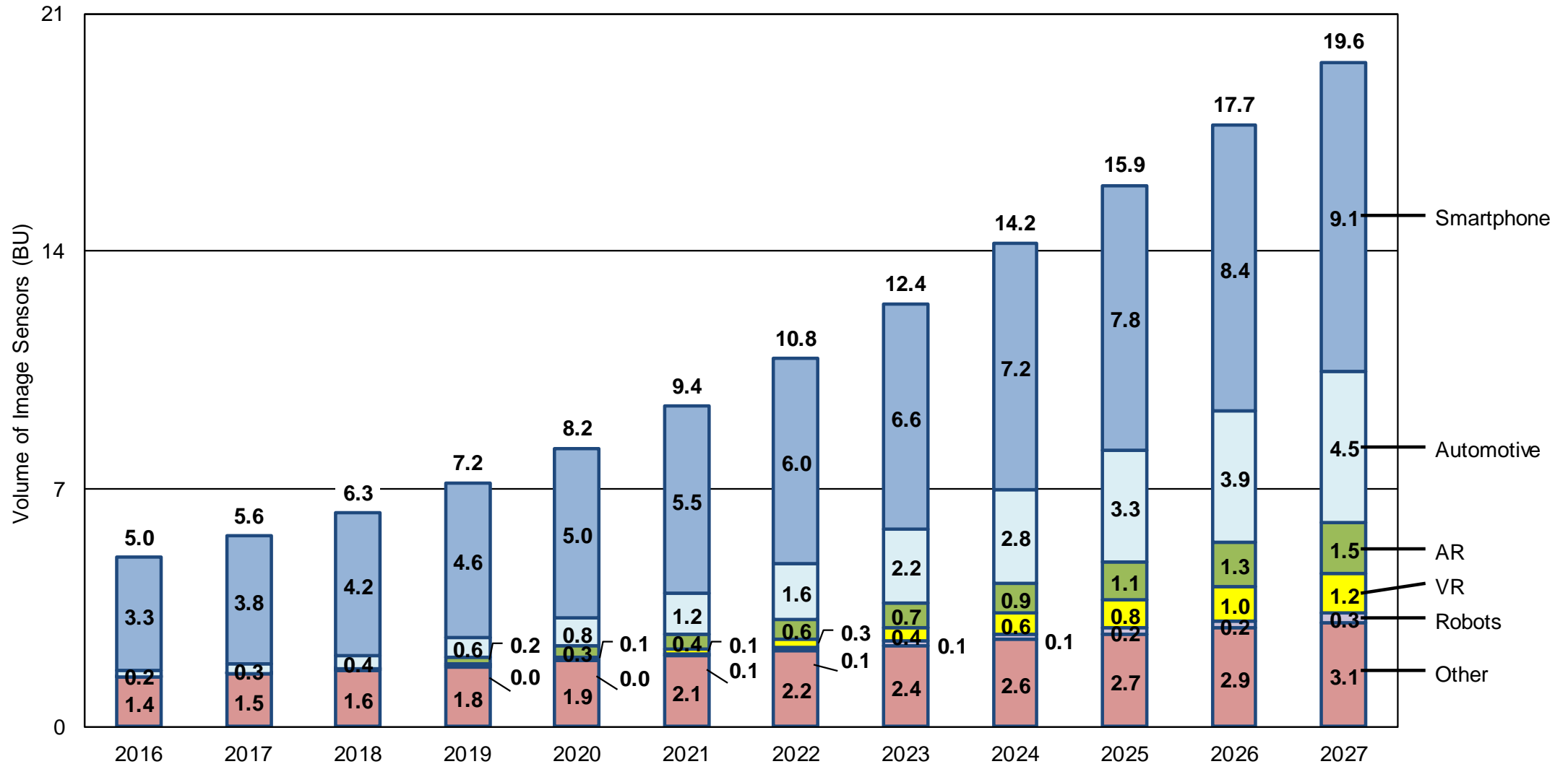
# PRODUCT OPPORTUNITIES FOR FD SOI

- Products that can obtain competitive advantages from FD SOI include:
  - ISP that is part of camera module (chip-to-chip bonding): Ultra-low power
  - ISP that is part of chipset outside of camera module: High performance and low power
  - Transceiver for LTE Advanced Pro and 5G mobile broadband (sub-6GHz): Good linearity and low noise
  - Transceiver for 5G fixed broadband (>24GHz): Good linearity and low noise
  - IoT devices with integrated RF: Ultra-low power
  - Controller products with eNVM: Metal mask integration (three to four mask steps)
  - Wearable devices: Ultra-low power
- Key factors for adoption of FD SOI include ultra-low power, relatively high performance, effective integration of RF functionality, and cost competitiveness due to lower number of mask steps for HKMG bulk CMOS and FinFETs

**TECHNOLOGY IS COMPETITIVE, BUT ECOSYSTEM NEEDS TO STRENGTHEN**

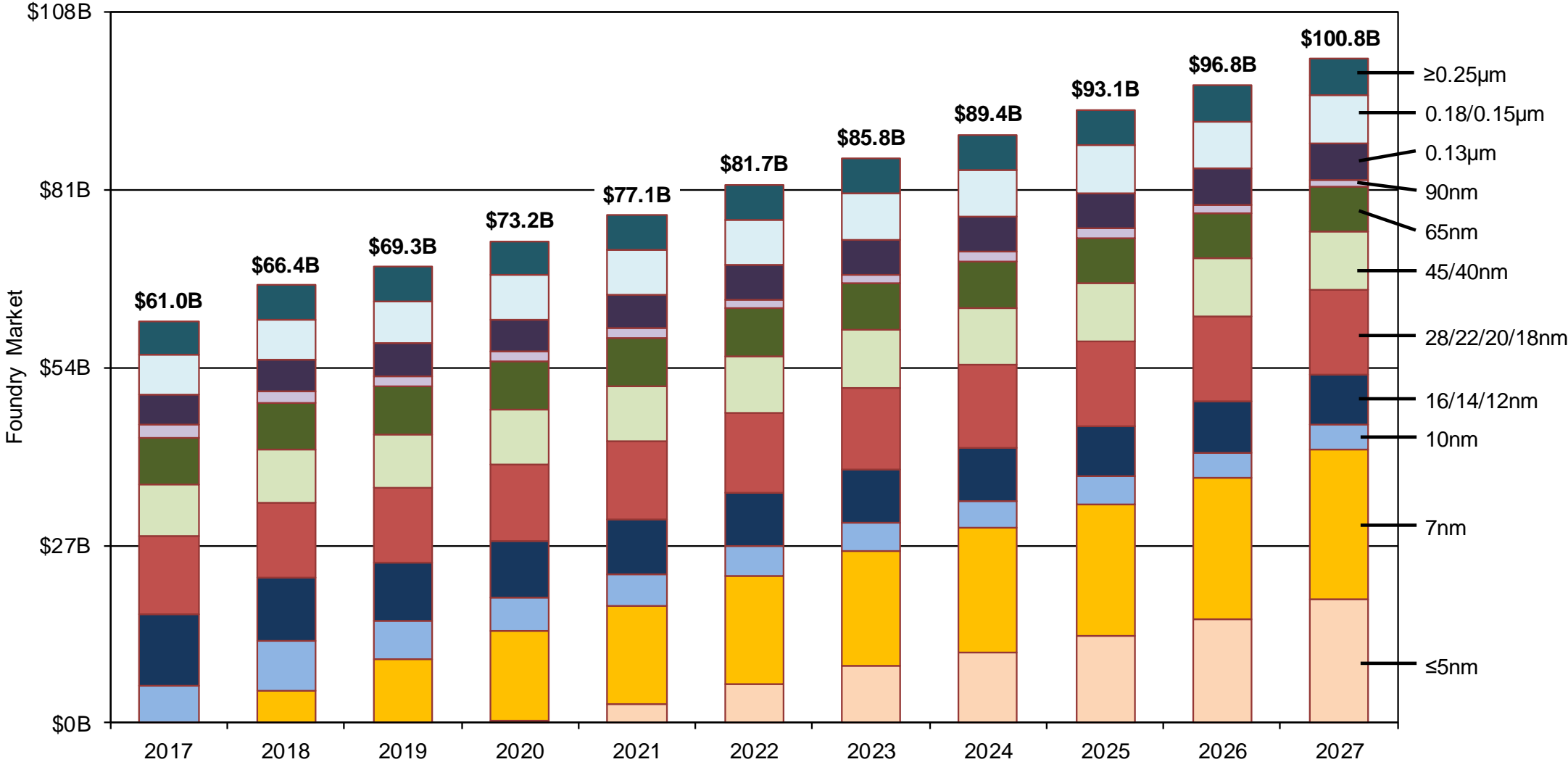


# IMAGE SENSOR VOLUME BY APPLICATION



**ISP WILL BE LARGE MARKET OPPORTUNITY FOR SUPPORT OF CIS**

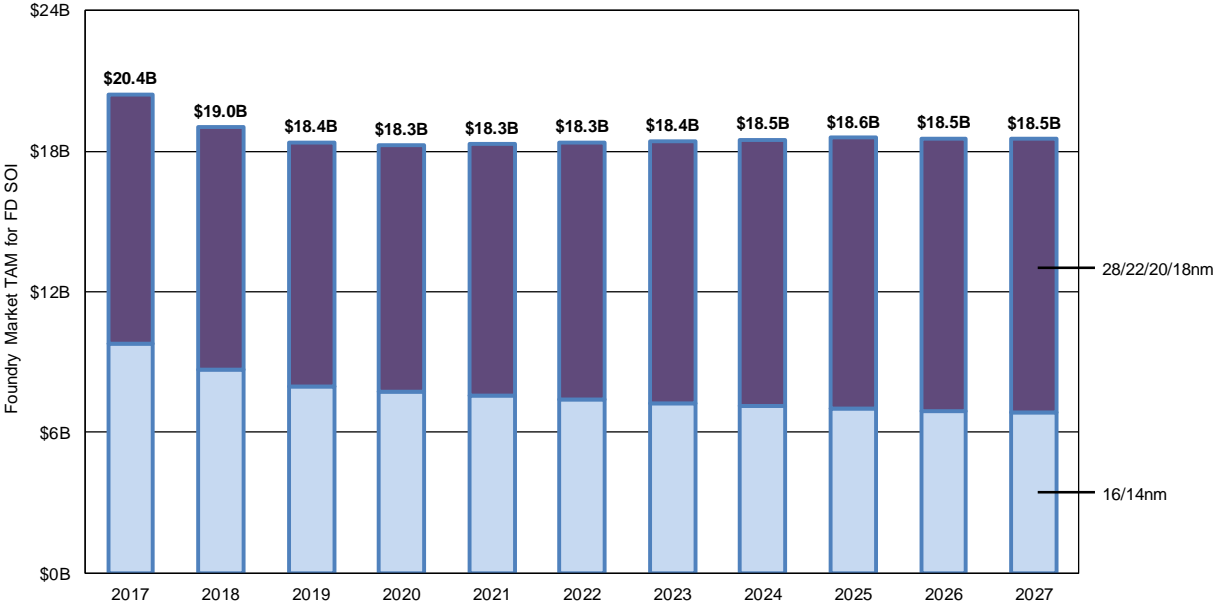
# FOUNDRY MARKET BY FEATURE DIMENSION



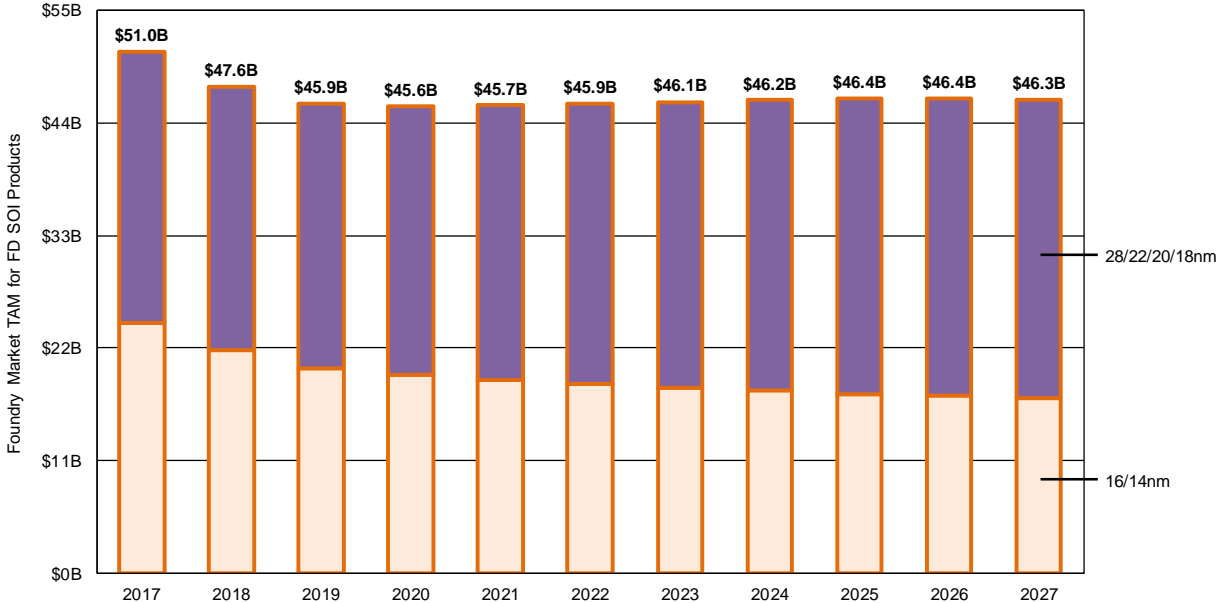
**MATURE TECHNOLOGIES CONTINUE TO GENERATE LARGE REVENUES**

# FD SOI TAM

## TAM FD SOI FOUNDRY



## TAM FOR FD SOI PRODUCTS



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

# TECHNOLOGY TRENDS

- 5nm is scheduled to be in high-volume production in 2020 (based on TSMC's definition)  
4nm, 3nm, and potentially 2nm structures are being developed
- 7nm FinFET is in high-volume production for chipsets for smartphones, ASICs for cryptocurrency mining, and GPUs
- 10nm represented 25% of TSMC's revenues in Q4/2017 but will be 10% in Q4/2018  
This gives visibility in strengths and weakness of FinFETs
- Samsung is global process technology leader at  $\leq 10\text{nm}$   
TSMC, however, has strongest design enablement capabilities
- 16/14/12nm continue to be in high volume, but their volume will decline as digital designs migrate to 7nm

Key reason is difficulty in integrating RF

# TECHNOLOGY TRENDS (CONTINUED)

- 28nm and 22nm HKMG bulk CMOS are experiencing growth for integration of RF
    - Potential high growth for eMRAM
    - Samsung is leader with its STT MRAM structures
  - 28/22/18nm FD SOI provides competitive advantages for:
    - Ultra-low power consumption with back biasing
    - Effective integration of RF

This will be important for wearables and IoT and other applications

    - Cost competitiveness with bulk CMOS and lower cost than FinFETs
  - Large opportunity for FD SOI based on technology advantages
- Key issue for FD SOI is design enablement capabilities

**WIDE BREADTH OF APPLICATIONS REQUIRE DIFFERENT TYPES OF TECHNOLOGIES**

# CONCLUSION

- Semiconductor market growth is based primarily on DRAM and NAND  
Potential for decline in 2020
- Many applications require ultra-low power  
Demand for integrated RF is also strong  
22FDX is best technology for integrated RF
- Large opportunities for eNVM  
Samsung MRAM with 28nm FD SOI is best technology option
- Momentum is building for FD SOI  
Growth, however, is lower than expected due to very strong market position of TSMC  
Design enablement ecosystem for FD SOI has also not strengthened rapidly enough
- RF SOI has gained very strong market position

**FD SOI IS EXPECTED TO BUILD MOMENTUM RELATIVELY RAPIDLY IN INTERIM TIME FRAME**