Semiconductor Industry and Market Outlook

Semiconductor Team

February 2021

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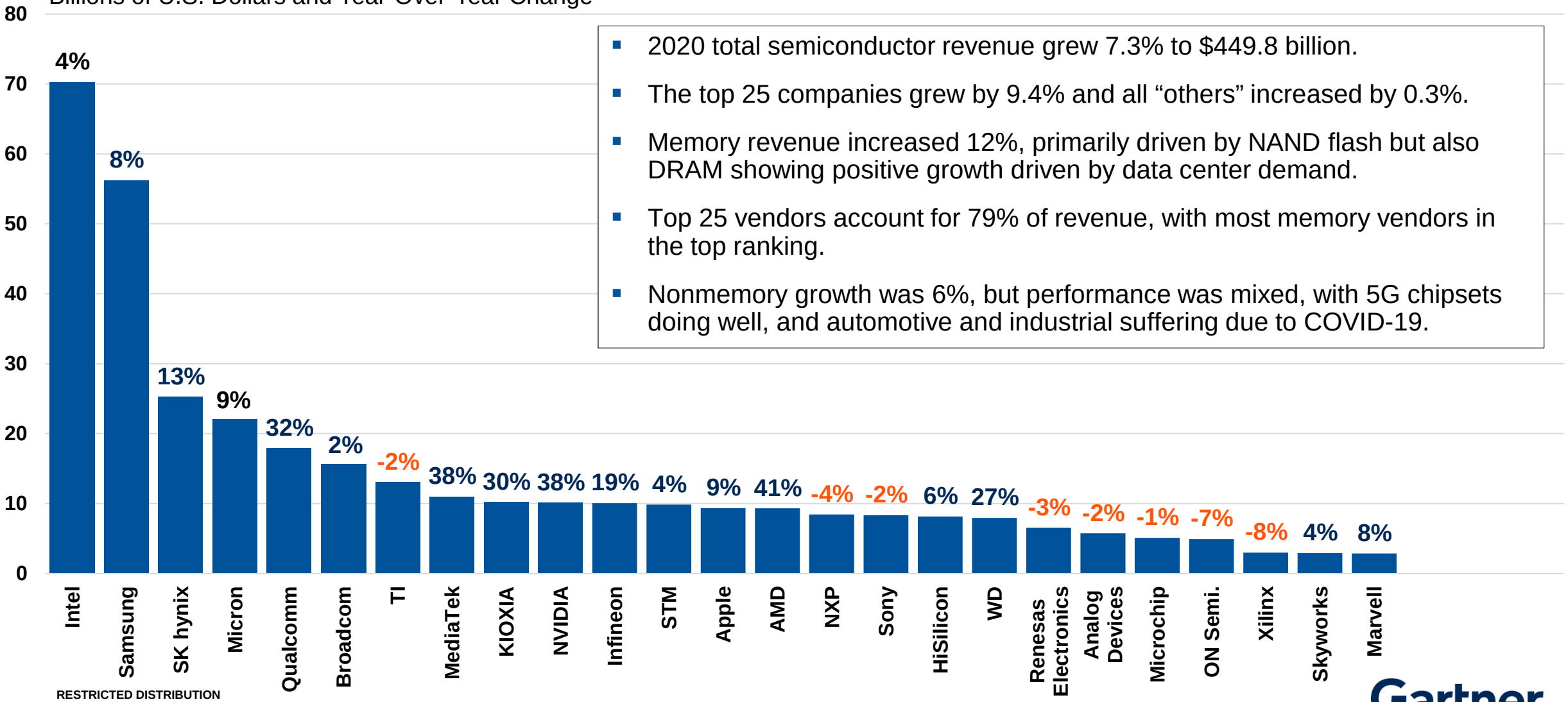
Contents

2020 Recap

Preliminary Market Share Estimates: Top 25 Semiconductor Vendors by Revenue, 2020

Billions of U.S. Dollars and Year-Over-Year Change

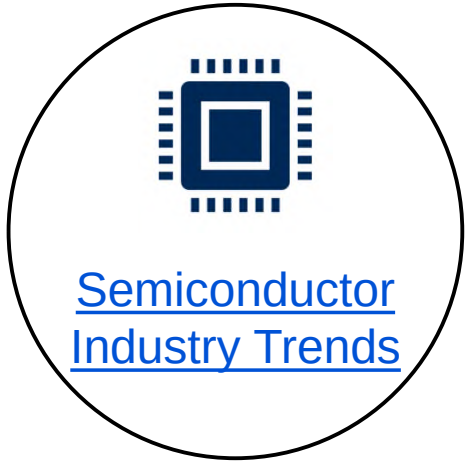


- 2020 total semiconductor revenue grew 7.3% to $449.8 billion.
- The top 25 companies grew by 9.4% and all “others” increased by 0.3%.
- Memory revenue increased 12%, primarily driven by NAND flash but also DRAM showing positive growth driven by data center demand.
- Top 25 vendors account for 79% of revenue, with most memory vendors in the top ranking.
- Nonmemory growth was 6%, but performance was mixed, with 5G chipsets doing well, and automotive and industrial suffering due to COVID-19.

ON Semi. = On Semiconductor, STM = STMicroelectronics, TI = Texas Instruments, WD = Western Digital

Context for Semiconductor Market Outlook

Context for Semiconductor Market Outlook: 4 Themes



Semiconductor Forecast

COVID-19: Economic Impact Devastating (for *SOME* Sectors) …

1Q'20 Virus Outbreak

Economic Impact: China as the Epicentre

- Electronics manufacturing in China severely disrupted
- Government efforts to contain and then delay spread of COVID-19 affects movement of goods and people
- Wafer fab production unaffected
- Global economy begins to slow down

2Q'20 Virus Peak

Economic Impact: Collapsing Global Demand

- Global economy effectively "stalled"
  - Widespread lockdowns and social distancing
  - Businesses slash costs, halt investment
  - Unemployment surges
  - Consumer confidence evaporates
- In response:
  - Massive government financial aid packages
  - Interest rates near zero

3Q'20 Virus Suppressed

Economic Impact: Collateral Damage

- Lockdowns paused
  - Social distancing measures remain
  - Test, track and trace measures rolled out
  - For some businesses operations begin to recover; others will fail
  - Uncertainty and lack of confidence remains
- China leads rebound in electronics production

4Q'20 Second Wave

Economic Impact: Reset levels established

- Restrictions re-imposed
  - Best practice virus control measures established
  - Localised lockdowns
- Sector-specific reset for future economic growth
  - Enterprise budget planning reset for 2021
  - Targeted government financial aid packages
- Vaccine progress

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… But a Route to Recovery is Becoming Clearer

1Q'21
Vaccine Approved

Economic Impact: Preparing for Recovery

- Ongoing virus control measures continue to hamper economic activity
- Vaccines approved and initial roll-out to high priority people begins
- Relief rally on world stock markets gathers pace
- Threat of a "third wave" in some regions

2Q'21
Vaccine Roll Out

Economic Impact: Confidence Returns

- Businesses begin process of reflating to previous levels
- Re-hiring accelerates
- Consumers begin "big ticket" discretionary spending
- Vaccination of high priority people continues
- "Third wave" impact understood

3Q'21
Vaccination Ongoing

Economic Impact: Spending Accelerates

- Deferred enterprise and consumer spending switches back on
- Strategic business investment spending starts to ramp up
- Some restrictions on movement relaxed to allow more normal business activities
- Vaccination programs roll out to broader communities

4Q'21
Post COVID-19 World

Economic Impact: New Growth Drivers

- New geopolitical and macroeconomic environment post COVID-19
- Ongoing government and central bank intervention to support economic recovery
- New priorities and attitudes change consumer buying behaviour and business investment

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Semiconductor End-Market Assumptions, 2021

Areas of Relative Weakness

Demand pulled forward into 2020

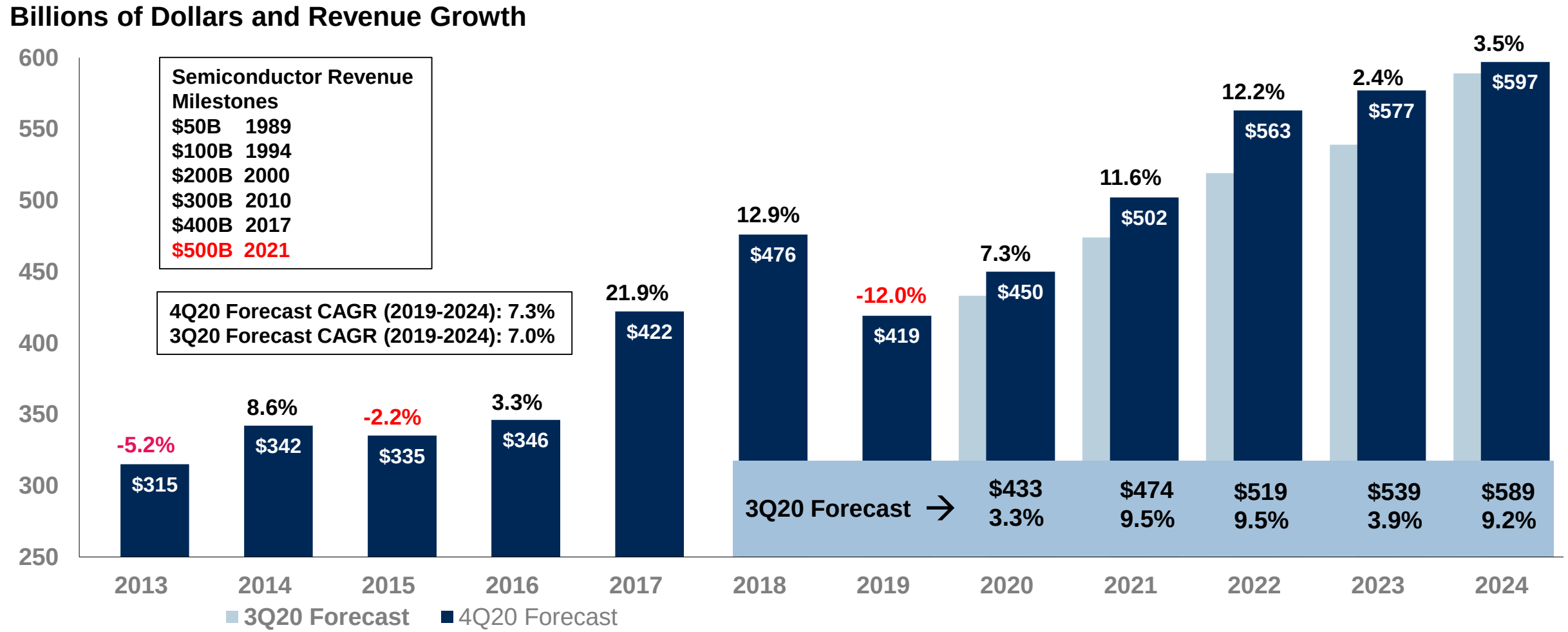
- **PCs:** With social distancing continuing to be a reality throughout 2021 and organizations making strategic shifts to remote work, PC demand will decelerate from 6.5% in 2020 to 1% in 2021 after the strong demand in 2020. Semiconductor TAM in PCs will grow slightly at 0.9% in 2021.
- **Chromebooks and Basic Tablet:** Unit production growth for Chromebooks and basic tablets will decline at over 10% in 2021 after a strong boost of education-related spending and remote working in 2020.

Areas of Relative Strength

Rebound in demand in 2021

- **Automotive:** Vehicle production in 2021 will gain 11 million units of vehicles to reach 85 million in 2021. Semiconductor TAM in EV/HEV and ADAS will grow over 40% to lead the whole automotive segment to grow 24% in 2021.
- **Smartphone:** Unit production forecast to grow 12.9% to 1.52 billion in 2021. This will offset the unit decline in 2020 from the COVID-19 impact. Semiconductor TAM in smartphones will grow 17.2%, reaching 130.8 billion, while the 5G smartphone percentage will increase as the shift from 4G LTE is accelerating in 2021.
- **Game consoles:** Ramp in production of next-generation models (Nintendo Switch, PS5, Xbox Series X/S) through 2021. Semiconductor TAM in game consoles will gain another high growth at 67% in 2021, reaching 9.2 billion units.
- **Industrial:** Mixed, depending on the vertical. Demand stronger in security and transportation from economic recovery but weaker in areas such as medical care and solid-state lighting in 2021.

Worldwide Semiconductor Revenue Forecast, 4Q20 Update: Mild Growth in 2020 and Will Break US$500 Billion Milestone in 2021



Source: "Semiconductor Forecast Database, Worldwide, 4Q20 Update"

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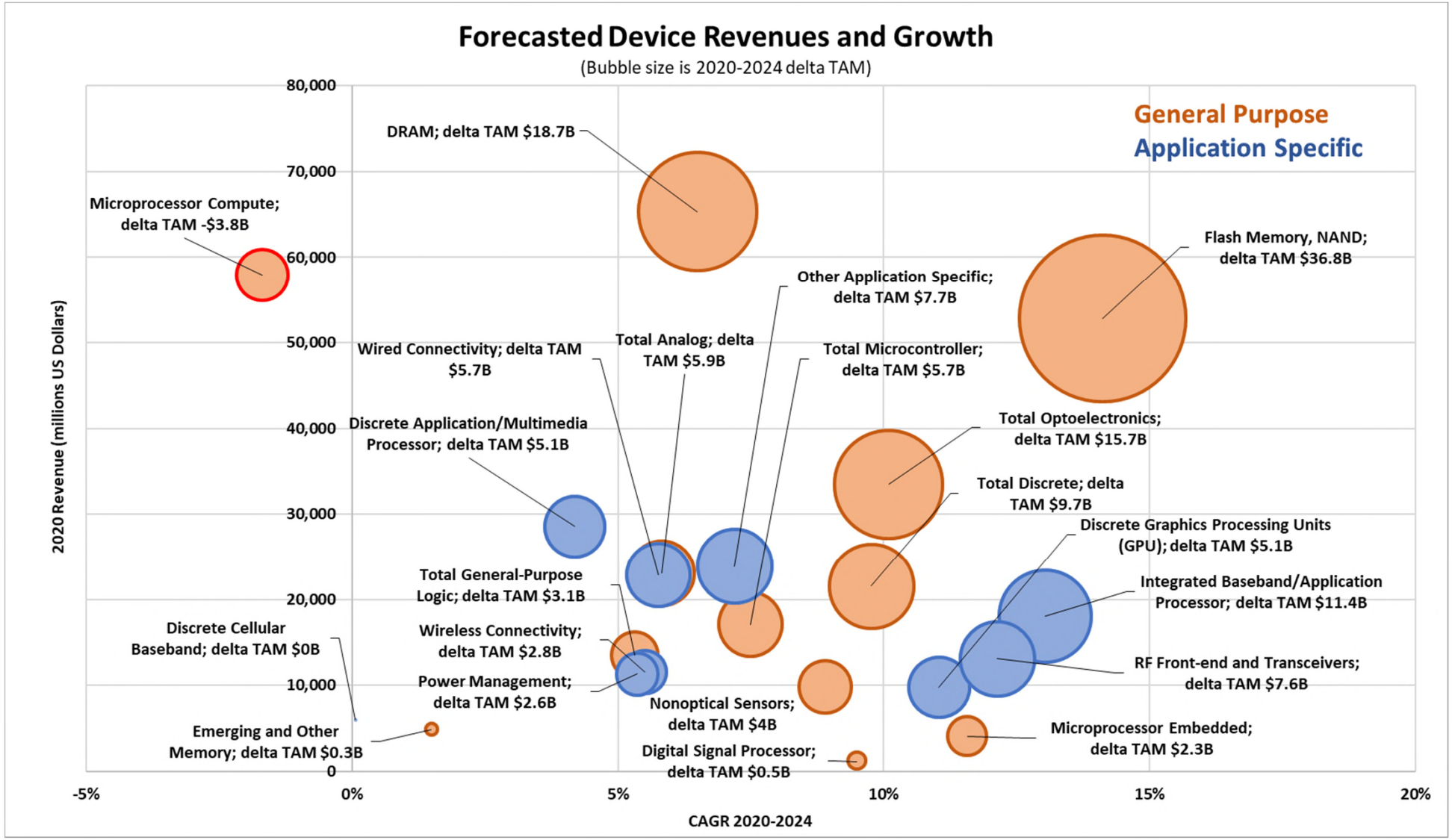
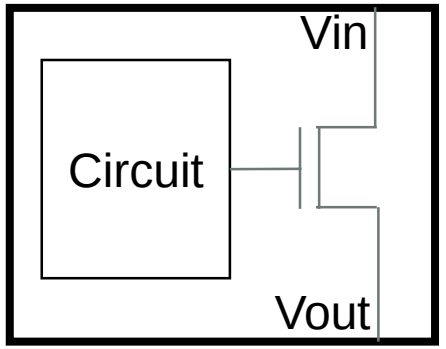
Semiconductor Device Market Outlook



Power Semiconductors

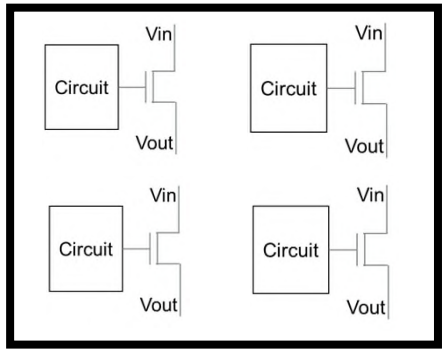
Power Semiconductors - Terms

General Purpose Voltage Regulator



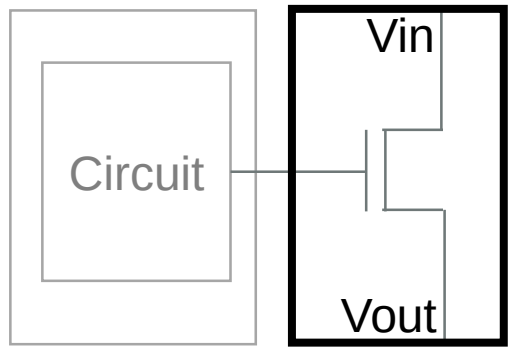
Integrated Chip

Application Specific Power Management



Integrated Chip

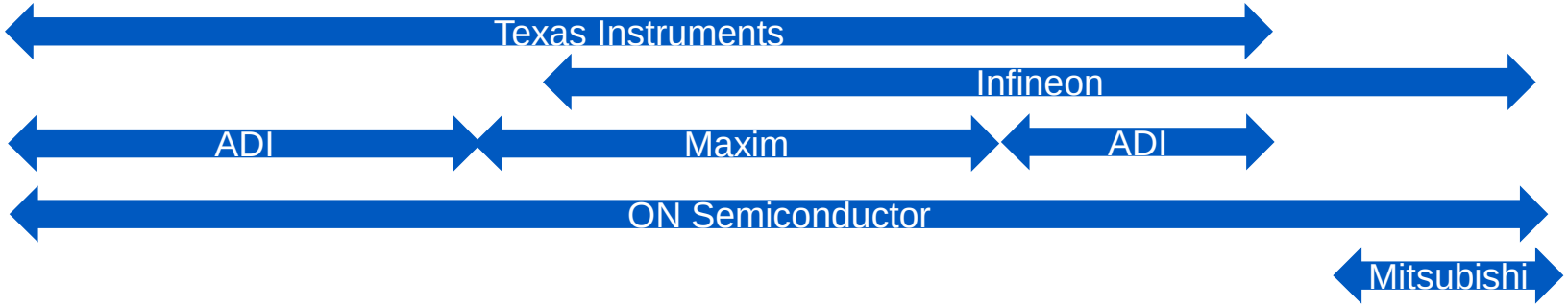
Discrete Transistor



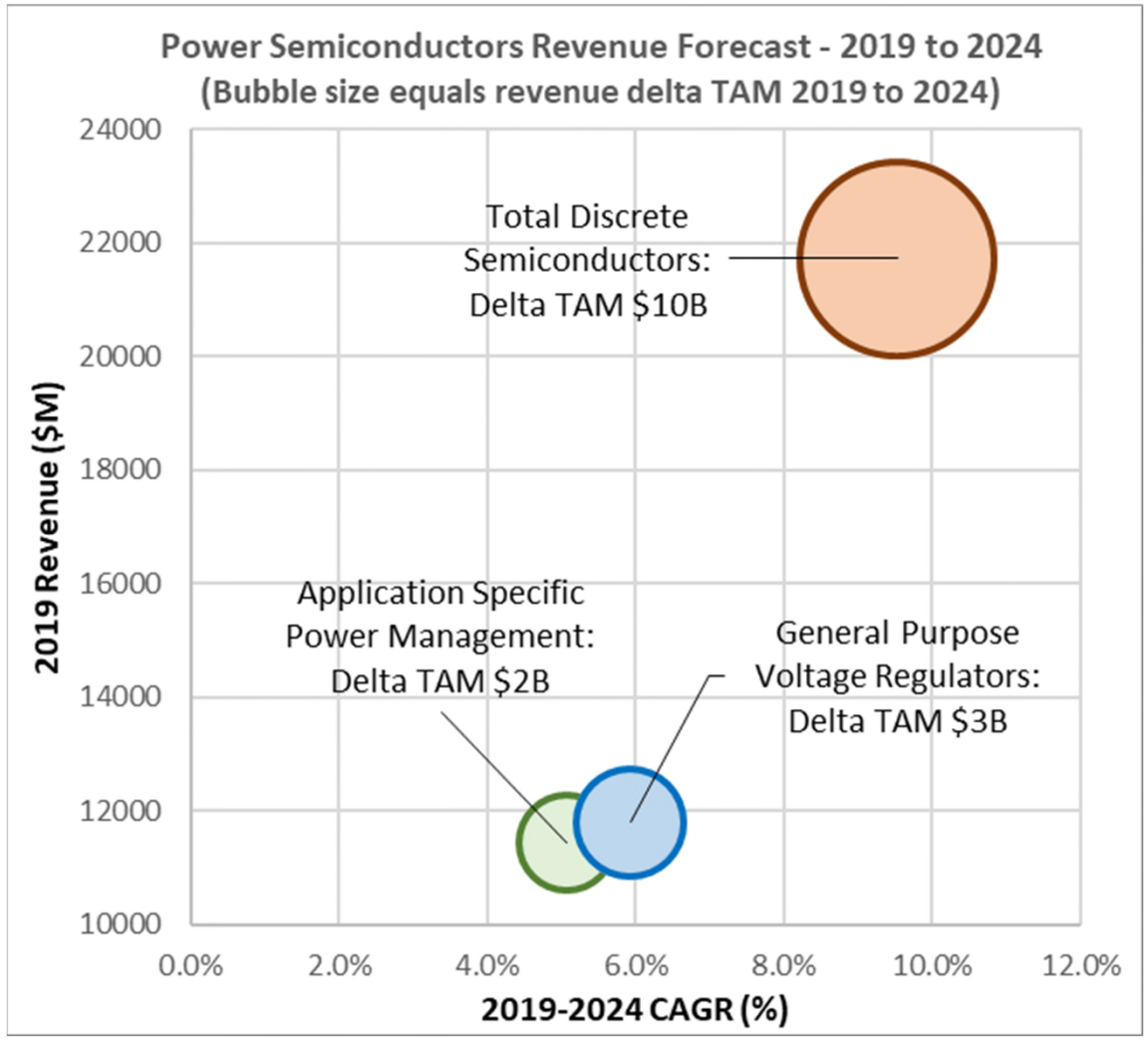
Integrated Chip Discrete Transistor

Applications	**Broad based applications**	**1. Smartphone 2. Automotive 3. Consumer**	**1. Automotive 2. Industrial 3. Consumer**

Example Vendors

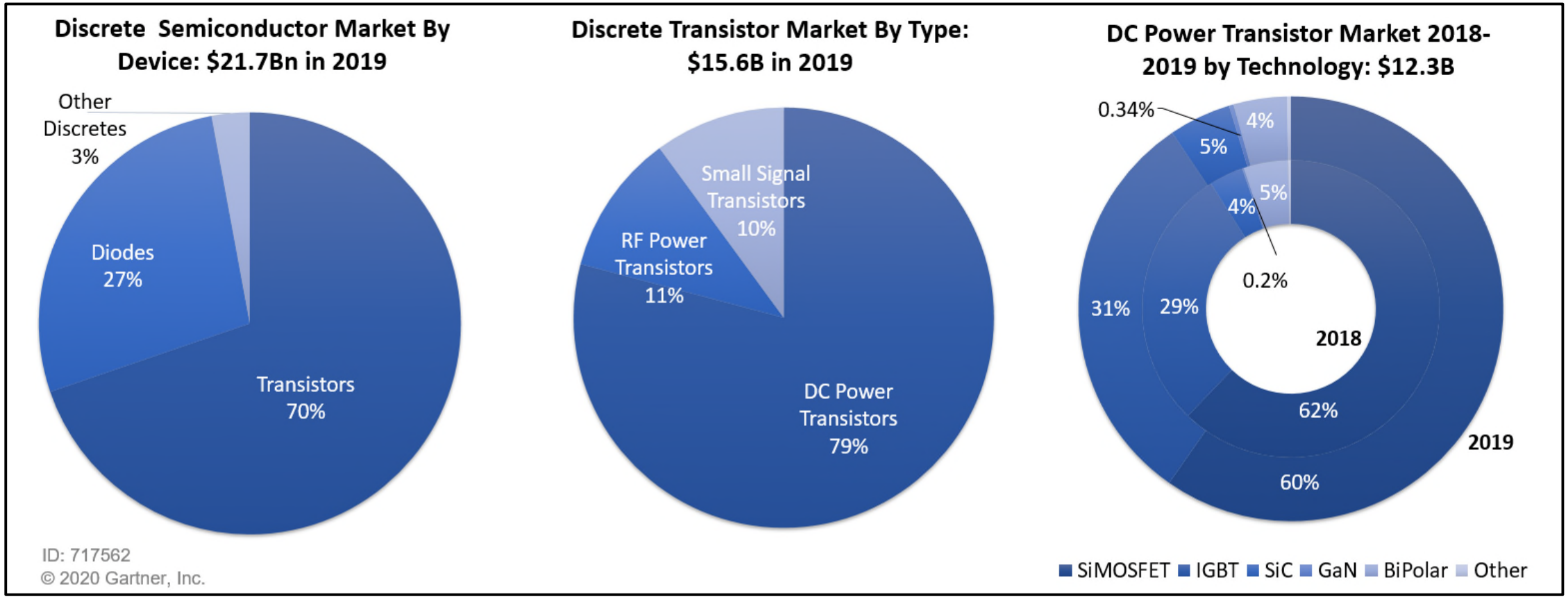


Power Semiconductors: Power Transistors 2x the delta TAM over Power Regulation ICs



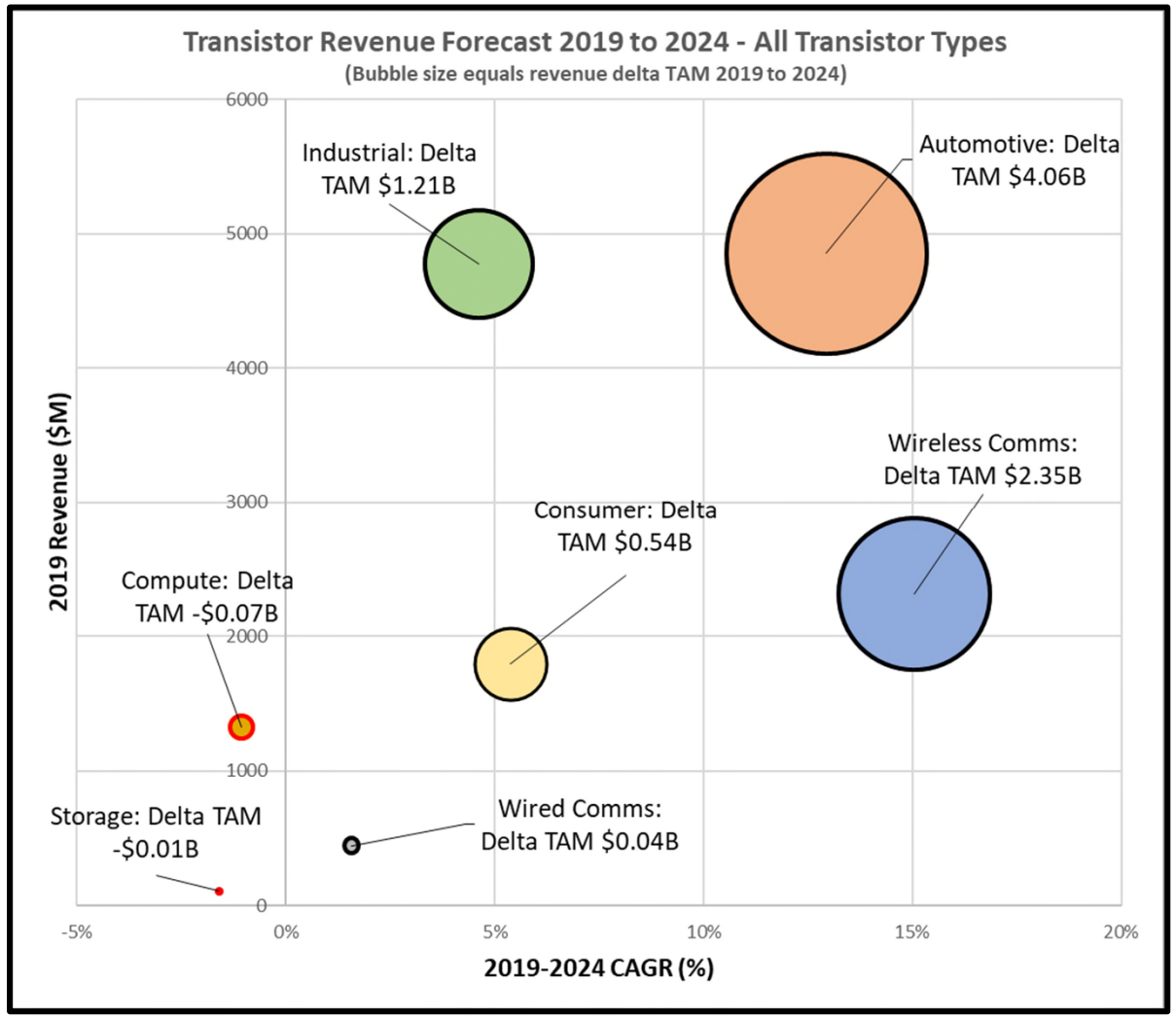
- Discrete driven by high adoption equipment trends compounded by significant content increases

Transistors Dominates Discrete Market Share



Market Share Analysis: Discrete Semiconductors, Worldwide, 2019
Market Share: Discrete Semiconductors, Worldwide, 2019

Transistor Revenue to Grow 9% CAGR 2019-2024 to $24B



- Power is constraining some of the highest growth tech trends
- This drives demand for power transistors across end markets
- Some key use-cases will drive TAM expansion within the next 5 years

Semiconductor Forecast Database, Worldwide, 4Q20 Update

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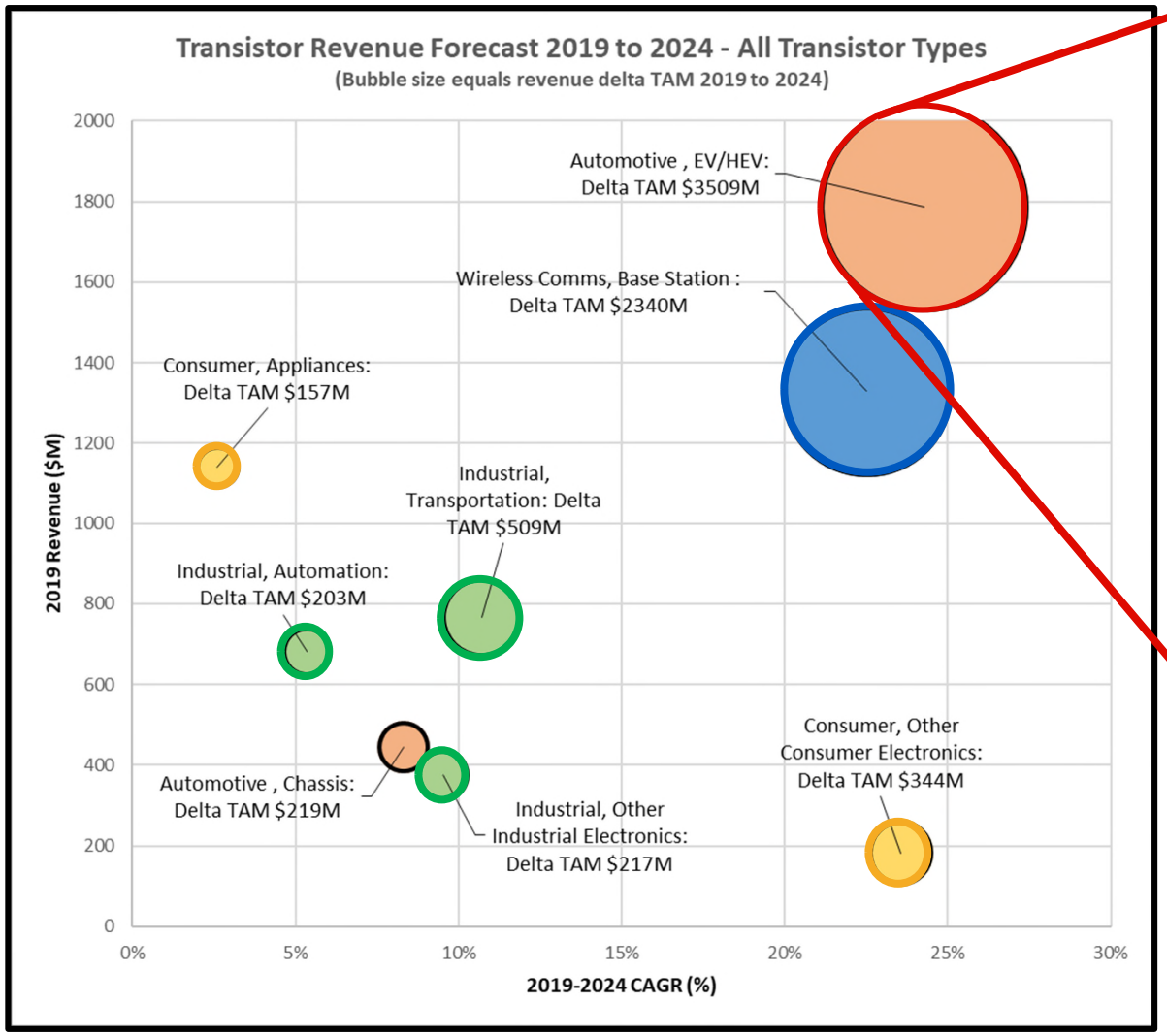
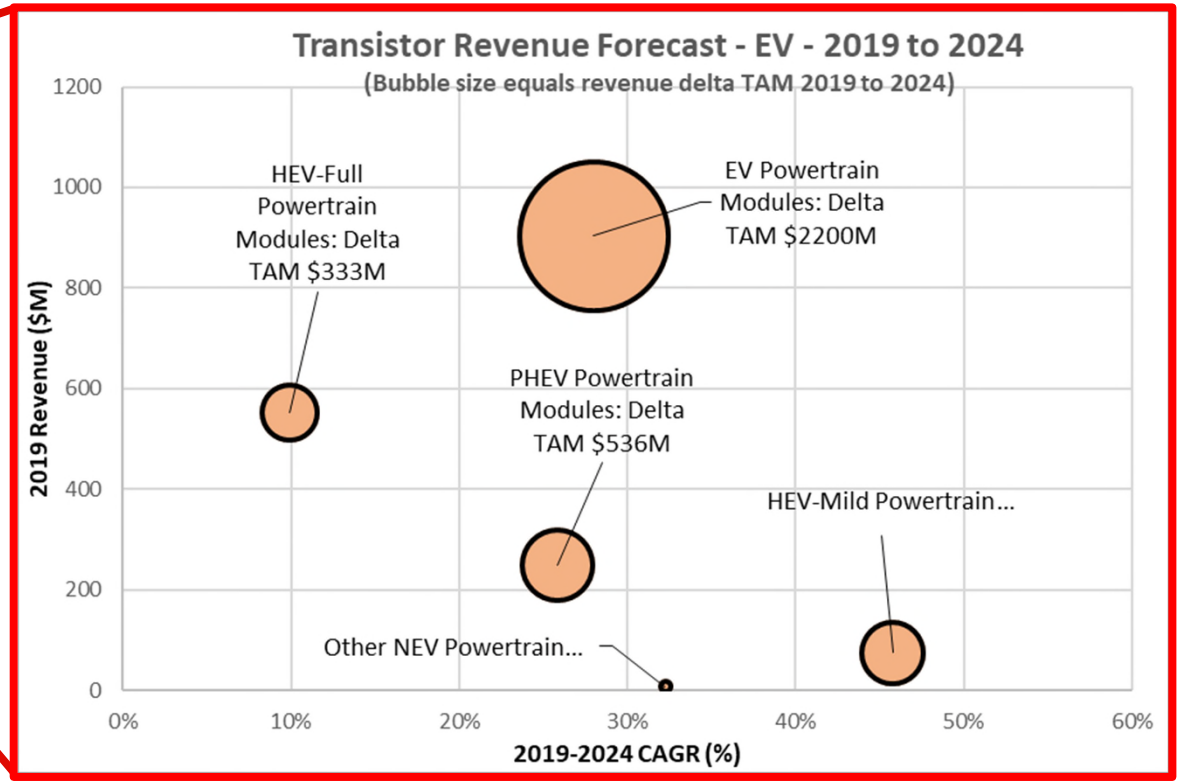
Electric Vehicles Dominates Growth in Discrete Transistors, $3.5Bn TAM growth 2024





- **EV/HEV:** Demand for greater range and pressure to reduce carbon foot print.

Semiconductor Forecast Database, Worldwide, 4Q20 Update

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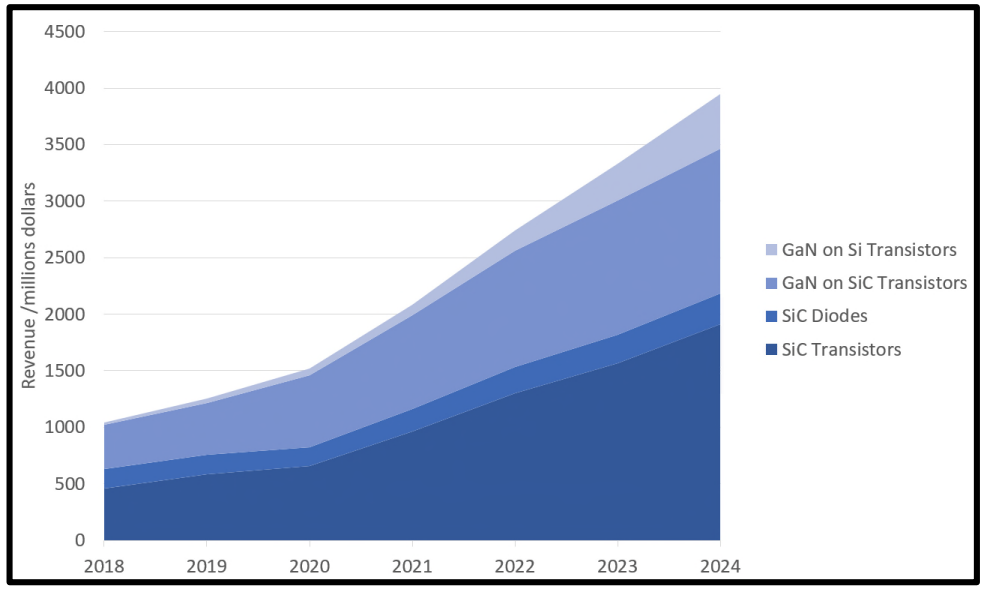
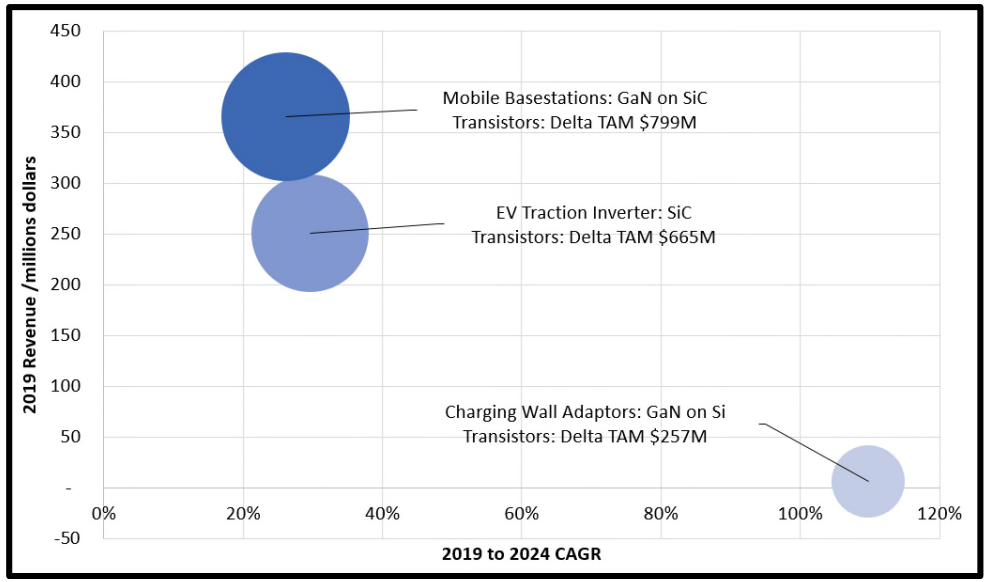
WBG Devices Grow 27% CAGR over next 5 years





- Its not all about Silicon Carbide, three technologies emerge
  - **Silicon Carbide:** Very High Power
    - ST, Cree, IFX, Mitsubishi, Rohm
  - **GaN-SiC:** High Power, High Bandwidth
    - Ampleon, Sumitomo, Cree, Quorvo, NXP
  - **GaN-Si:** Brings GaN to lower cost base
    - Established: IFX, TI, PI
    - Start-ups: GaN Systems, Transform, EPC, Exagan

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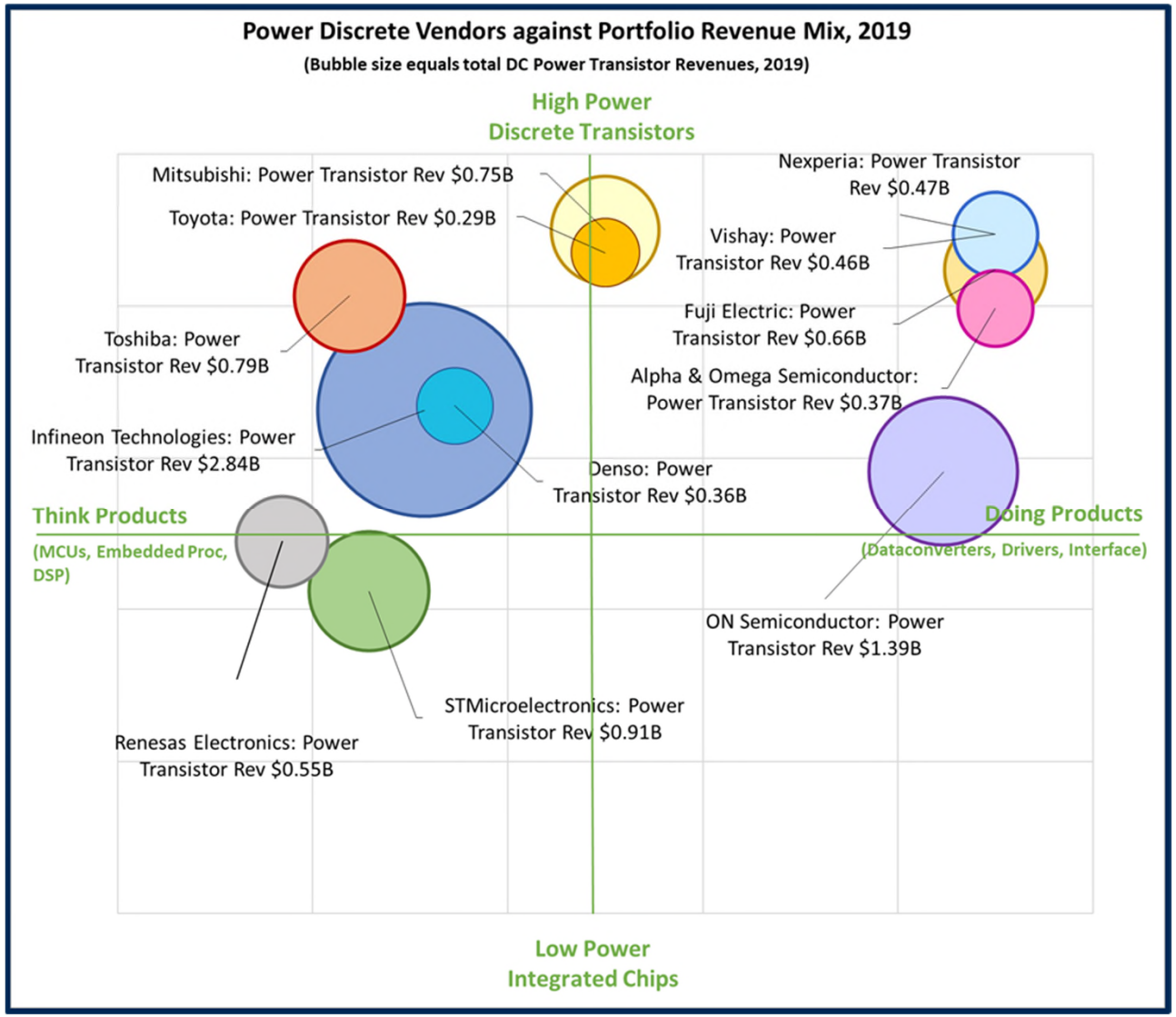
Forecast Analysis: Wide-Bandgap Semiconductors, Worldwide

Power Transistor Vendor Positioning: Broadline Versus Narrow Portfolios



- Increasing semiconductor content = growing R&D expense
- OEMs/Tier 1's push this into the supply chain requiring fully tested reference designs
- Vendors with a broad portfolio can better capitalise on this demand
- Narrow focused vendors must partner and/or target best of breed

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Appendix 1:
4 Themes

7 Trends Will Shape the Post Covid-19 World

Big Government	Wellbeing	Environmental Protection	Anti-globalization	Risk-averse Decision-making	Social-distancing	Collective Responsibility
• Public more accepting of authoritarianism • Expect ongoing periodic disruption to economic activity • Expect more market intervention and increased business regulation • Expect increased monitoring and surveillance of individuals • Expect massive economic stimulus focused on infrastructure	• Policy focus shifting to physical and mental health • Expect importance of economic growth (GDP) as a measure of national success to be downplayed • Expect stronger union lobbying on employee safety • Expect employee costs to business increase	• Climate change lobby boosted by lockdown effects • Expect "green strings" to be attached to economic stimulus • Expect "green" business investments to be incentivised • Expect "green" taxes • Expect tighter regulation on polluting industries	• Vulnerability of global supply chains exposed • Expect the global supply chain to be re-structured • Expect an increase in trade tariffs and visa requirements • Expect elements of the value stack to be repatriated • Expect an increase in vertically-integrated business models	• Economic impact of pandemic has hit finances hard • Expect short-term consumer and business confidence to suffer • Expect increased cost-control / purchase scrutiny • Expect build-up of cash reserves • Expect increased ROI rigour • Expect shifting buyer preferences	• Inter-personal contact discouraged • Expect increased work-from-home, online education, online retail • Expect social-distancing infrastructure to be designed in to future workplaces / public spaces • Expect face-to-face interactions to be designed out of business transactions	• Interests of wider society prioritized over individual's • Expect increased public spending on health and social care • Expect a re-design of public spaces and infrastructure to manage individual behaviour • Expect pressure to give access to personal data for the common good

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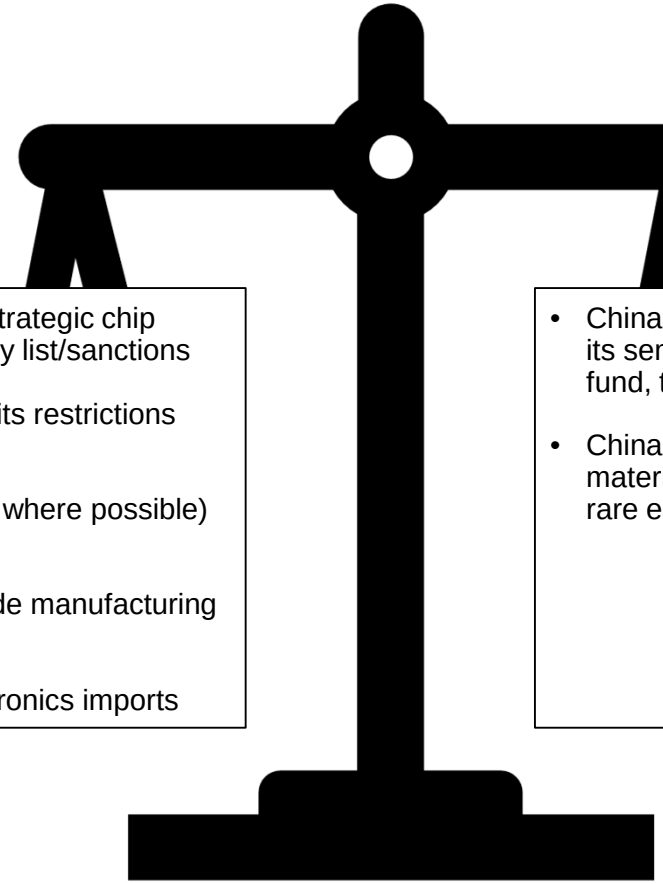
Future Impact of USA / China Trade Dispute:
"Silicon Cold War" and the Rise of "Techno-nationalism"



- US blocks manufacturing technology and key strategic chip supply into China/Chinese companies e.g. entity list/sanctions
- US leverages its influence with allies to further its restrictions and sanctions against China
- US mandates non-Chinese sourcing (domestic where possible) for all strategic infrastructure deployment
- US incentivises onshore advanced process node manufacturing (IDM and Open Foundry)
- US implements/increases tariffs on China electronics imports

- China takes policy steps to accelerate its semiconductor independence (big fund, tax incentives)
- China blocks/restricts strategic materials from shipping into US (e.g. rare earth minerals)

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4 Key Semiconductor Industry Trends

1. **OEM Foundry Direct Business Model**
   - OEMs and End-users develop / acquire internal hardware / semiconductor capabilities
2. **Decline of Moore's Law as a Performance Driver**
   - Chip architecture, advanced packaging and software increasingly dominate semiconductor performance innovations
3. **Concentration of Capital for Leading Edge Manufacturing Investment**
   - Intel, Commodity Memory, TSMC
4. **Single Points of Failure Beginning to Emerge Across the Value Stack**
   - Leading Edge Foundry
   - What's next? Rare Materials, Wafer Supply, Advanced Packaging?

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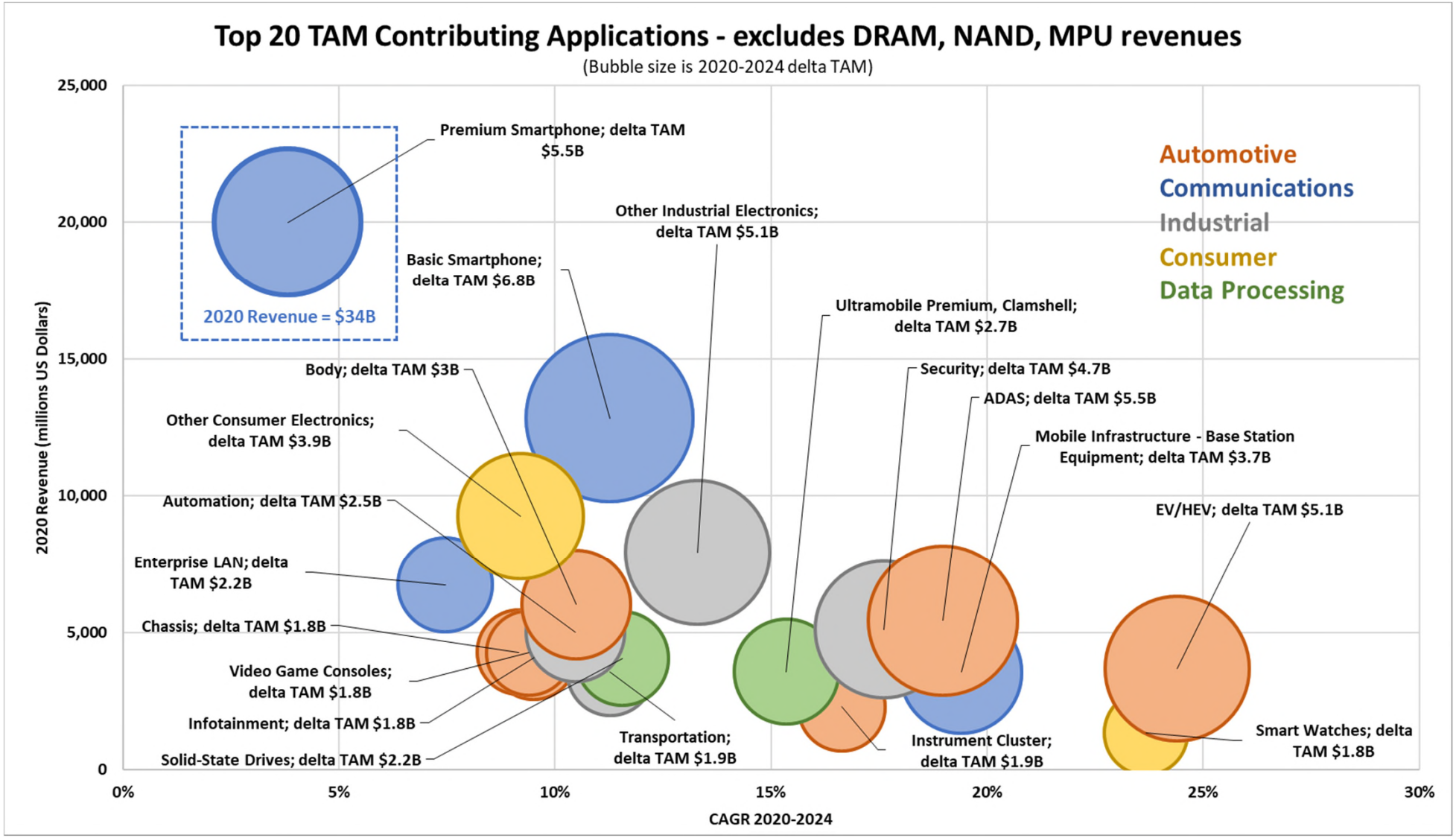
Semiconductor Market Drivers



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