CHINA NOW
China on the Move
July 26 & 27, 2019

The Rise of China in Technology Development
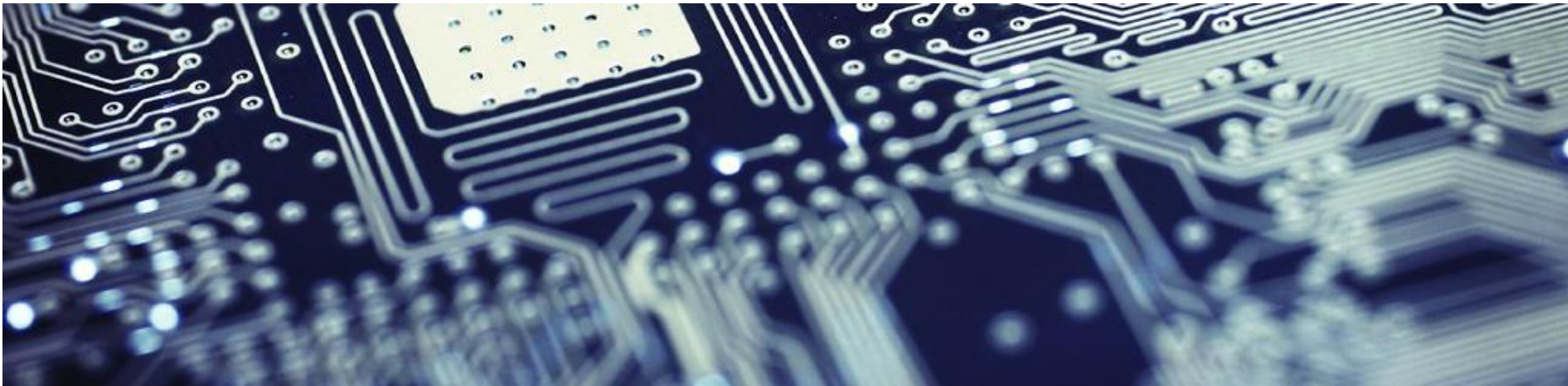
Francis Lee

July 27, 2019

Poll

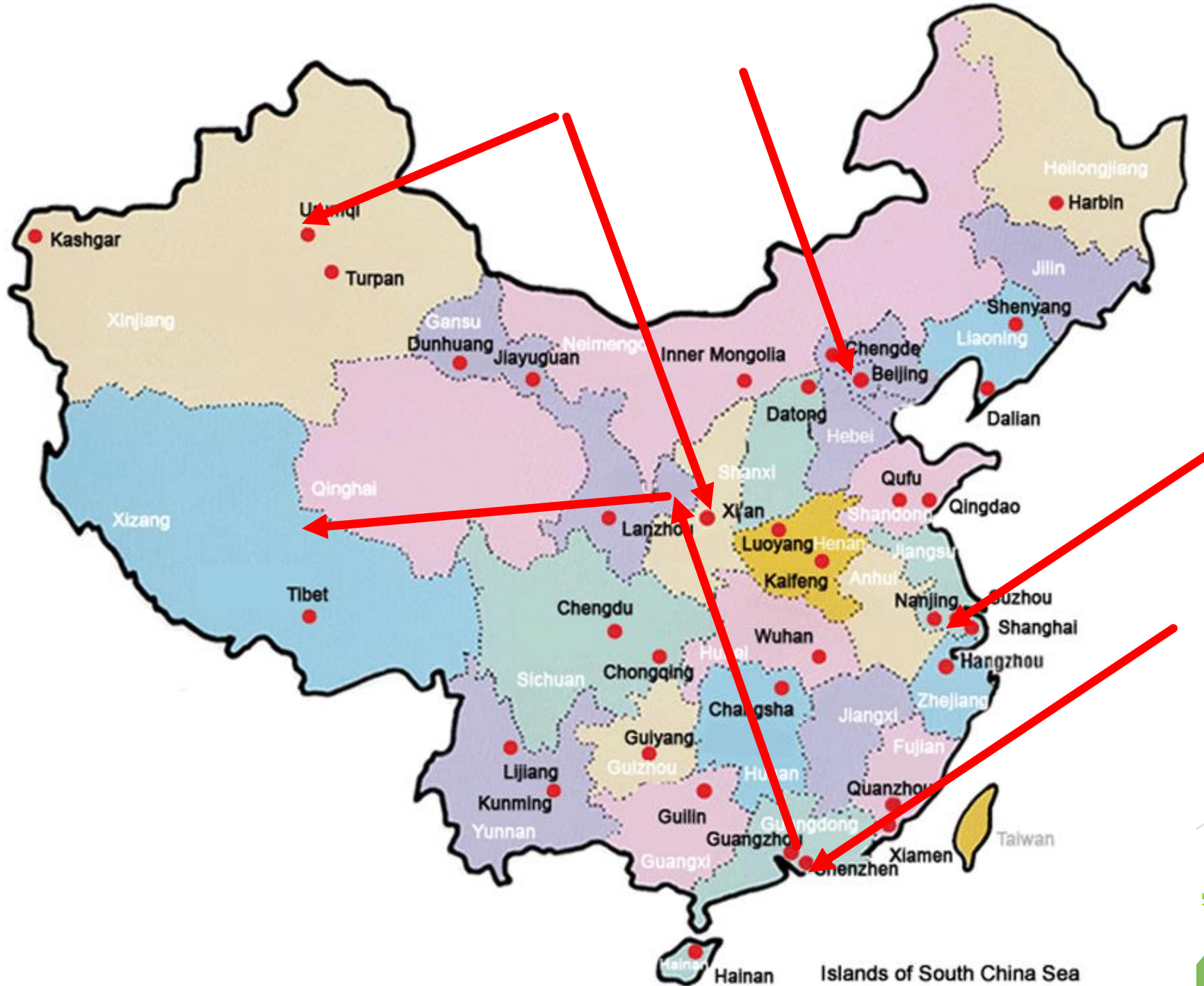1. Who has visited China?
2. Who has visited China the last 12 months?
3. Map of my China trips the last 12 months
    a. Tibet Trip (2018)
    b. Zhenjiang (March)
    c. Kunming/Shenzhen (April)
   d. Xian, BJ, Shanghai (May)
    e. Silk Road (September)

China on the Move

1. Who is winning the Technology Race?

2. What enables Technology Development?

3. What are the implications of the current Technology Developments?

China-USA Comparison

|	CHINA	USA
▶ *Per Capita Income*	$8,000 (Shanghai/Beijing >$20,000)	$56,000
▶ *Area*	3.71 million sq. miles (Europe: 3.93 Million Sq. Miles)	3.80 million sq. miles
▶ *Population*	1.39 Billion (peaks at 2027)	326 Million (will surpass 400 Million after 2058 with immigration growing 2x faster than natural births)

1. Who is winning the current Technology race?
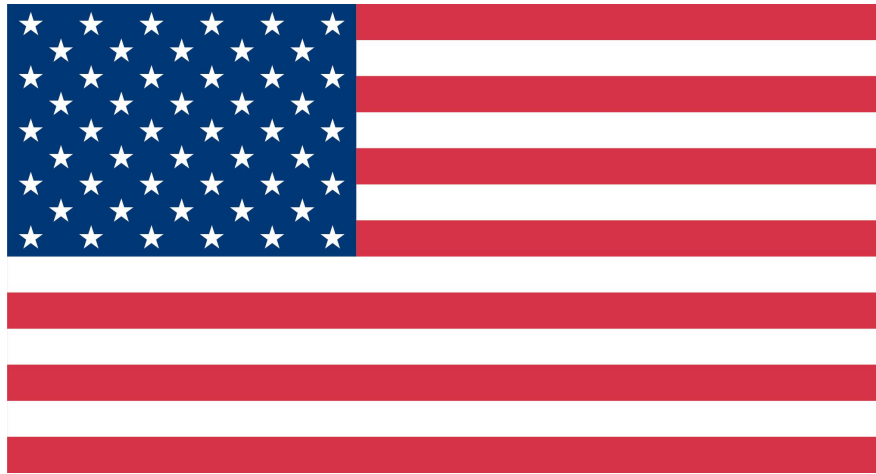
Poll: Which Country is winning the Technology race?

Definition of Technology

► Technology is the "collection" and "knowledge" of techniques, skills, methods, and processes used in the production of goods or services.
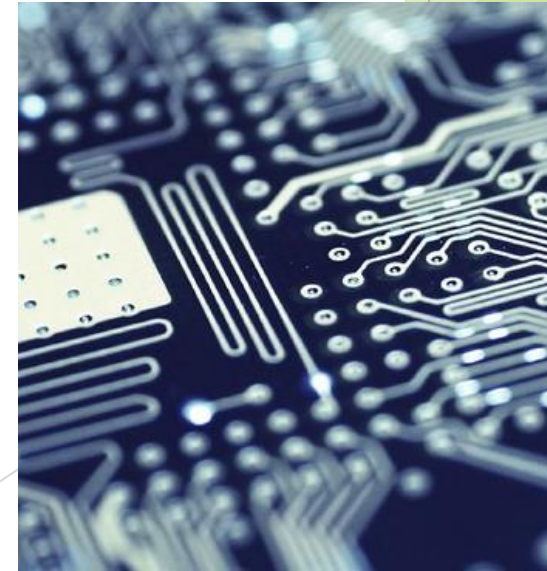
Analogy: Personal Health System

► Are you "healthy"?

► Easier to answer if one is NOT healthy

► Many sub-systems in "personal health"

    ► Respiratory

    ► Pulmonary

    ► Digestive

    ► Cardiovascular (silent killer)

► Annual Health check up is routine and preliminary

► Additional diagnostics are needed to provide complete picture

Technology Evolution

- ▶ 1960's and 70's: Semiconductor
- ▶ 1980's: Personal Computer, BioTech
- ▶ 1990's: Cell phone
- ▶ 2000's: Internet
- ▶ 2010's: Social Media

Semiconductor

▶ Silicon Wafer Size (1.5 inch to 12 inches)

▶ Resolution in Processing: "Line Width" today 14 nanometer (nm=1 billionth of a meter, average sheet of paper is 100 thousands larger than 1nm)

▶ Improve in processing resulted in Moore's Law (more transistors onto the same area)

▶ 2D vs 3D Design and Processing increased density even further

Semiconductor

▶ More and more powerful circuits can be built into Semiconductor circuits (chips)

▶ Improved Communication/Computing capabilities

▶ Higher resolution of Displays

  ▶ CRT to LCD

  ▶ LCD to OLED

  ▶ Rigid to foldable

Moore's Law – The number of transistors on integrated circuit chips (1971-2016)

Moore's law describes the empirical regularity that the number of transistors on integrated circuits doubles approximately every two years. This advancement is important as other aspects of technological progress – such as processing speed or the price of electronic products – are strongly linked to Moore's law.

Cost of Memory per Megabyte

Historical Cost of Computer Memory and Storage
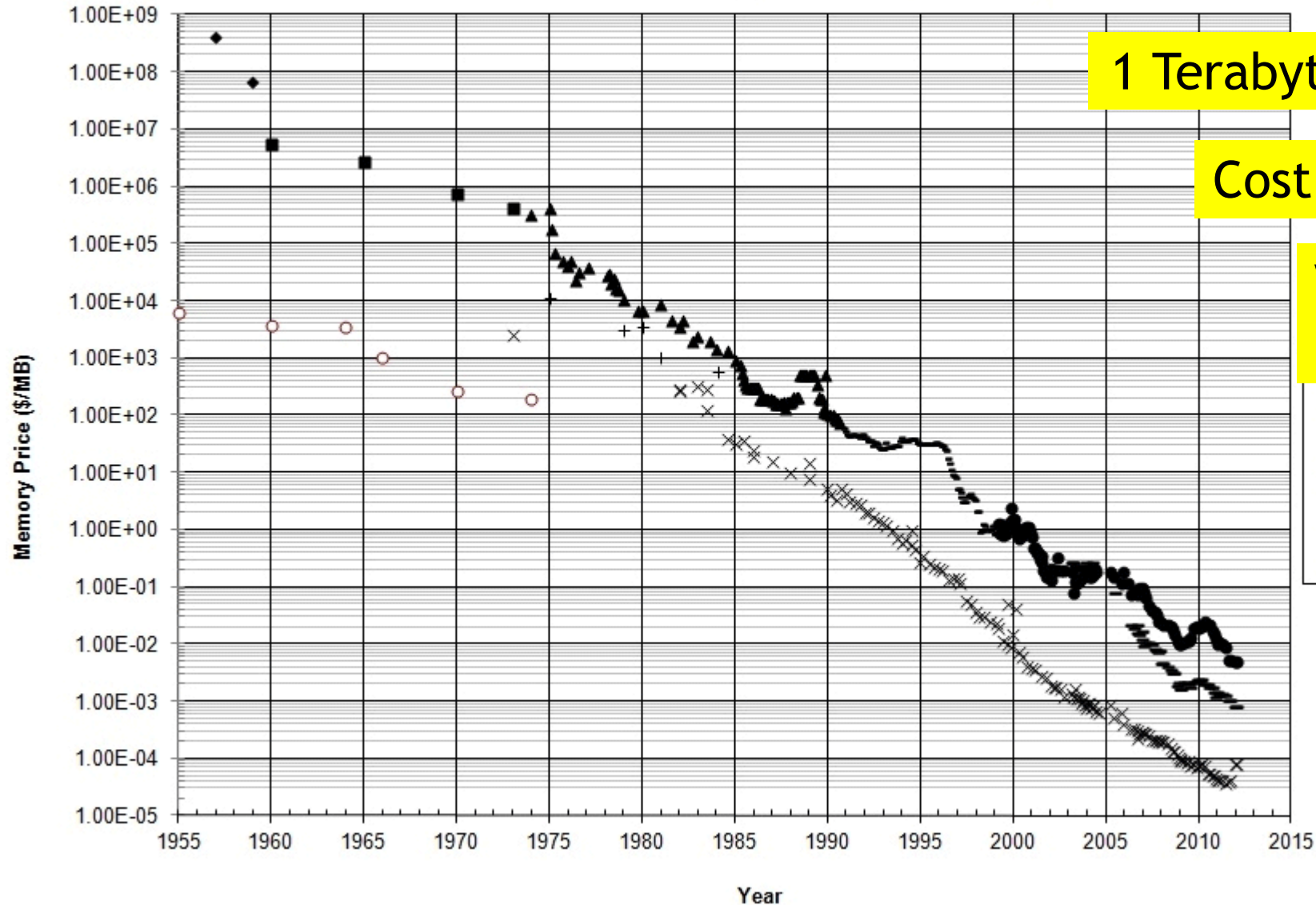
1 Terabyte = 1 million Megabyte
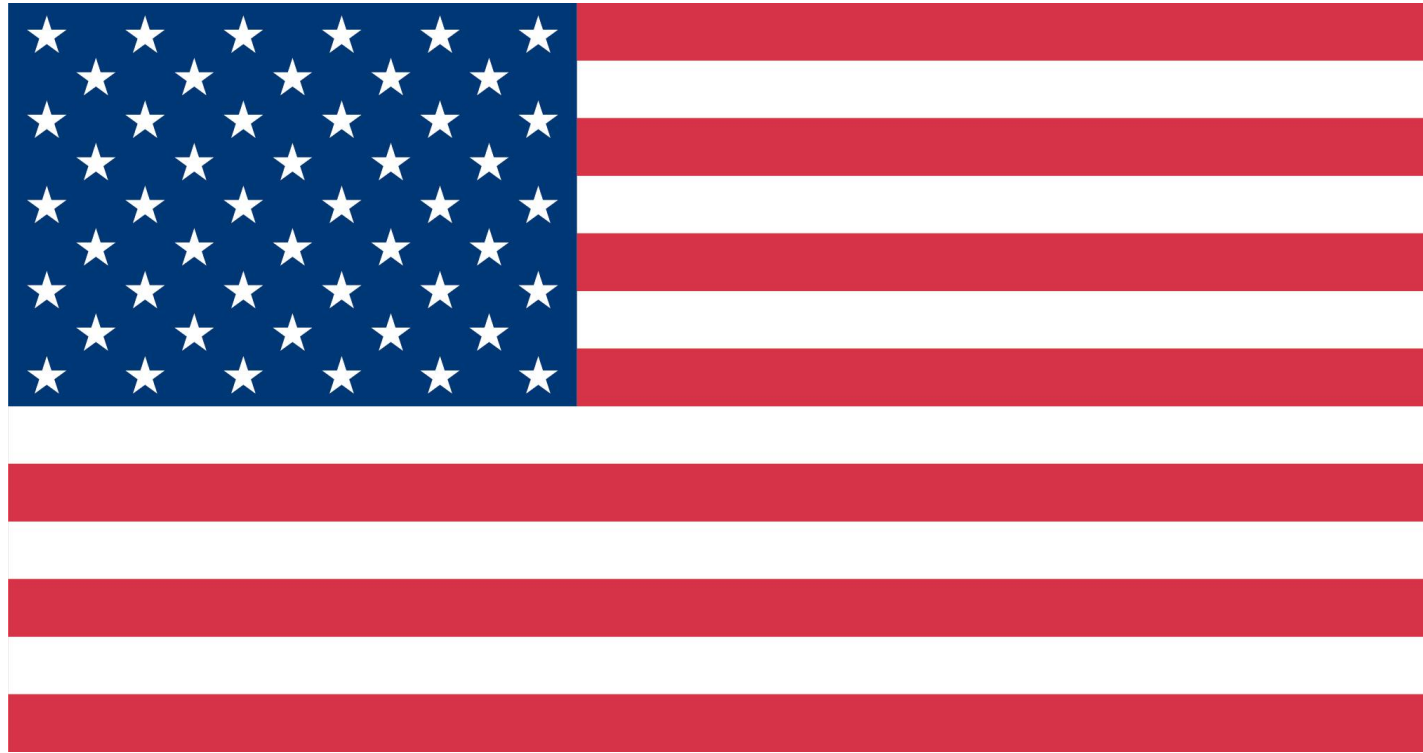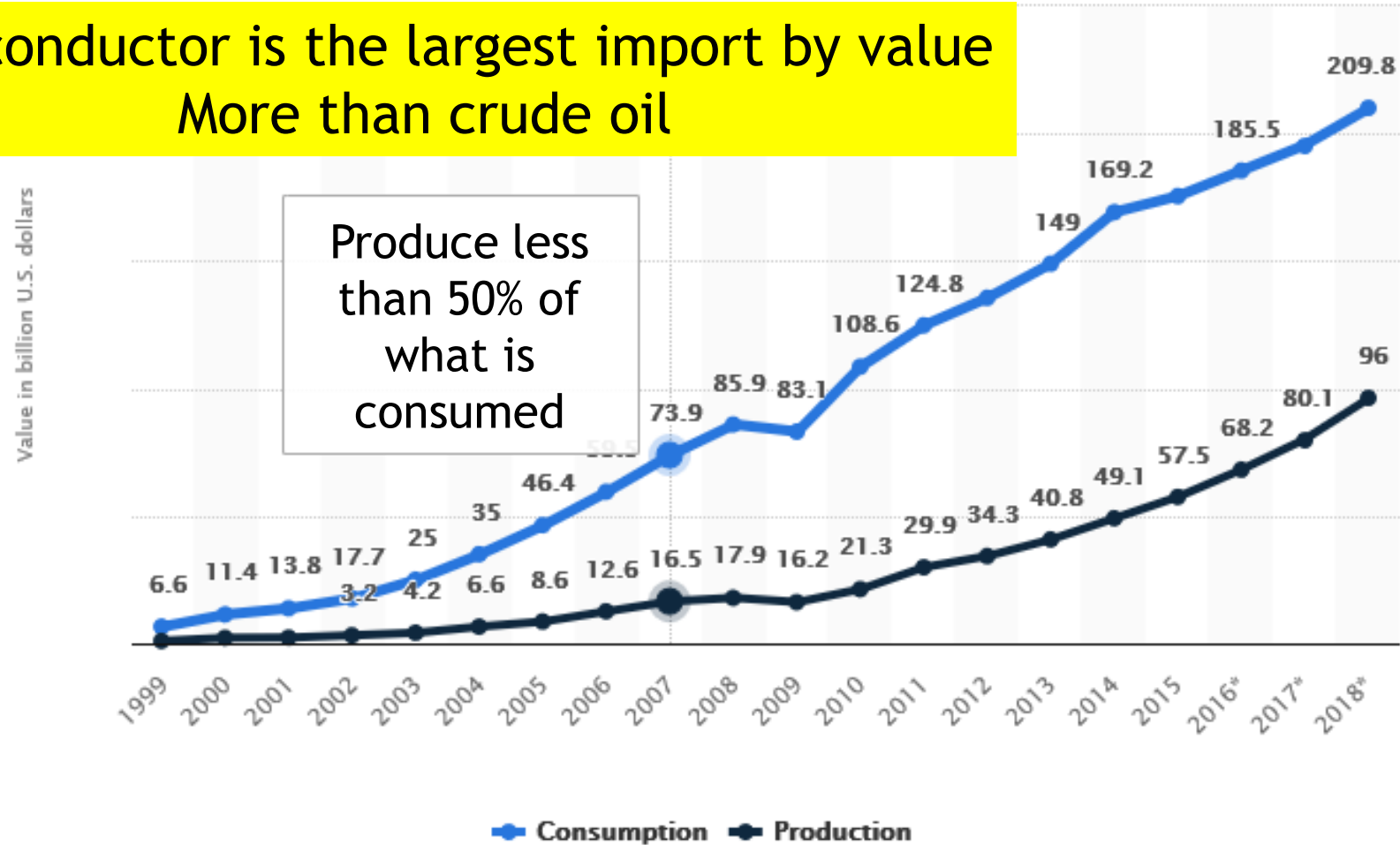
Cost of a 1 Terabyte HD?

Walmart $13.43
(free delivery)

1. Who is winning the current Technology race in Semiconductors?

China Semiconductor Consumption and Production

Semiconductor is the largest import by value
More than crude oil

Produce less than 50% of what is consumed

Value in billion U.S. dollars

Consumption: 6.6, 11.4, 13.8, 17.7, 25, 35, 46.4, 59.5, 73.9, 85.9, 83.1, 108.6, 124.8, 149, 169.2, 185.5, 209.8

Production: 3.2, 4.2, 6.6, 8.6, 12.6, 16.5, 17.9, 16.2, 21.3, 29.9, 34.3, 40.8, 49.1, 57.5, 68.2, 80.1, 96

1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016* 2017* 2018*

— Consumption — Production

Semiconductor

▶ Industry is maturing and consolidating

▶ Manufacturing facility (Fab) VERY expensive (>$10 billions per State of Art Fab)

▶ Bifurcate into Fab and Fabless Semiconductor Companies

  ▶ Intel the only "meaningful" exception

  ▶ Fab ("Foundry", Manufactory only, Capital Intensive)

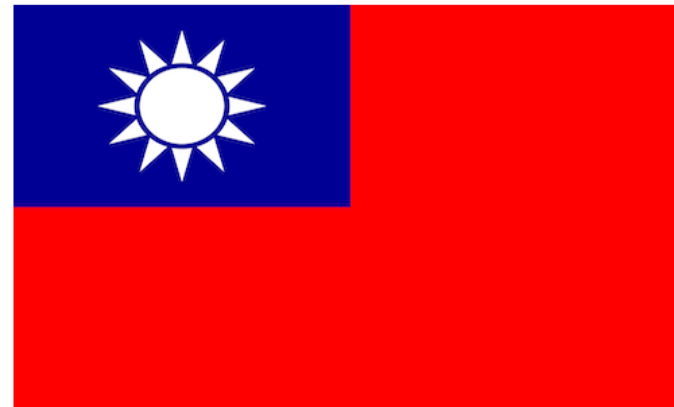 ▶ Fabless (Design only, Software and IP Intensive)

1. China is investing heavily to catch up in Semiconductors

Examples of Foundry
TSMC, UMC and Global Foundry
SMIC in China

Design is SW and IP Intensive
Cadence, Synopsis, ARM
HiSilicon in China

TSMC, UMC

China on the Move

Made in China 2025

- A strategic plan of China issued by Chinese Premier and his cabinet in May 2015.
  - China aims to move away from being the world's "factory" and move to producing higher value products and services.
  - Goals include increasing Chinese-domestic content of core materials to 40% by 2020 and 70% by 2025.
  - The plan focuses on high-tech fields including, but not limited to, industries like pharmaceutical, automotive, aerospace, semiconductors, Information Technology and robotics.
- By 2049, the 100th year anniversary of founding of People's Republic of China, wants to achieve dominant position in Global Market.

Mobile Phone

	CHINA	USA
Total number of mobile phone users in 2017	1071 Mu	266 Mu

~4X more phones users

2nd Quarter 2018

Vendor	Shipments	Market Share
1. Samsung	71.5 Mu	20.9%
2. Huawei	54.2 Mu	15.8%
3. Apple	41.3 Mu	12.1%

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Cell Phone Supplier

Vendor	2Q18 Shipments	2Q18 Market Share	2Q17 Shipments	2Q17 Market Share	Year-Over-Year Change
1. Samsung	71.5	20.9%	79.8	22.9%	-10.4%
2. Huawei	54.2	15.8%	38.5	11.0%	40.9%
3. Apple	41.3	12.1%	41.0	11.8%	0.7%
4. Xiaomi	31.9	9.3%	21.4	6.2%	48.8%
5. OPPO	29.4	8.6%	28.0	8.0%	5.1%
Others	113.7	33.2%	139.5	40.1%	-18.5%
Total	**342.0**	**100.0%**	**348.2**	**100.0%**	**-1.8%**

Source: IDC Worldwide Quarterly Mobile Phone Tracker, July 31, 2018

Cell Phone Evolution

▶ l980's – 1G, first-generation technology made communication possible.

▶ 1990's – 2G, next generation allowed for more efficient and secure phone calls and introduced mobile text messaging.

▶ 2001 – 3G started the smartphone era.

▶ 2009 – 4G facilitated high-speed connections that make it possible to stream HD video on our phones.

Cell Phone Evolution

▶ 2019 (5G)

1. **Faster speed**: 10 times higher than 4G to allow significant faster transmission of images and videos. For example, 4G takes 10 minutes to download high-definition movie but 5G could take seconds.

2. **Shorter delays:** 5G reduces lag time between data sent/received, making it possible, for example, to watch high-speed virtual reality video with no delays or glitches.

3. **Increased connectivity**: Cell towers equipped with 5G technology would have greatly increased capacity over 4G and enables more people and more devices to communicate at the same time.

Examples of 5G Cell Phone capabilities

▶ Seamlessly work with wireless sensors, vehicle-to-vehicle communication technologies, smart traffic lights, smart energy grids, mobile wearables, smart home devices and other cutting-edge technologies.

▶ Help the Internet of Things (IoT) finally realize its long promised potential as IoT applications typically need to collect massive amounts of data from large numbers of devices and sensors, the technology requires an efficient network for data collection, processing, transmission, control and real-time analytics.

Huawei leads in 5G technology implementation

Mobile Payment

▶ The number of transactions made through non-banking mobile apps from 2013 to 2016 increased from *3.8 billion* to more than *97 billion*. (data from the Payment and Clearing Association of China)

▶ Mobile payment transactions in China reached a record *US$12.8 trillion* from January to October 2017, compared to *US$49.3 billion* for USA in 2017

▶ About 583 million people used mobile payment in China in 2018, up 10.7 percent over 2017.

Mobile Payment

▶ WeChat Pay and Alipay accounted for 93% of China's mobile payments market in 2017. China Union Pay becomes the 3rd vendor in 2018.

▶ Chinese tourists estimated to spend US$452 billion overseas the next 5 years and 93% prefer Mobile payment when they travel overseas.

▶ By 2021, *79.3%* of smartphone users in China will be using mobile payment as compare to *23%* in USA and 15% in Germany.

**Many Chinese cities are now the closest we have to cashless consumer economies**

High Speed Rails

▶ China has the world's fastest and largest high-speed rail network — more than 19,000 miles, the vast majority of which was built in the past decade.

▶ In US, automobiles replace rails after 1945 due to strong lobbying by car and oil companies.

▶ High speed rails planned in US but none in substantial operation

Electric Cars

▶ The number of electric vehicles sold in China reached 254,000 in Q1 2019, a 118% year-over-year jump from the 117,000 sold in Q1 2018.

▶ In Feb 2018, 3.2 Mu electric cars in the world, 1.2 Mu in China, 750K in USA

Picture: xllbber
Source: Flickr
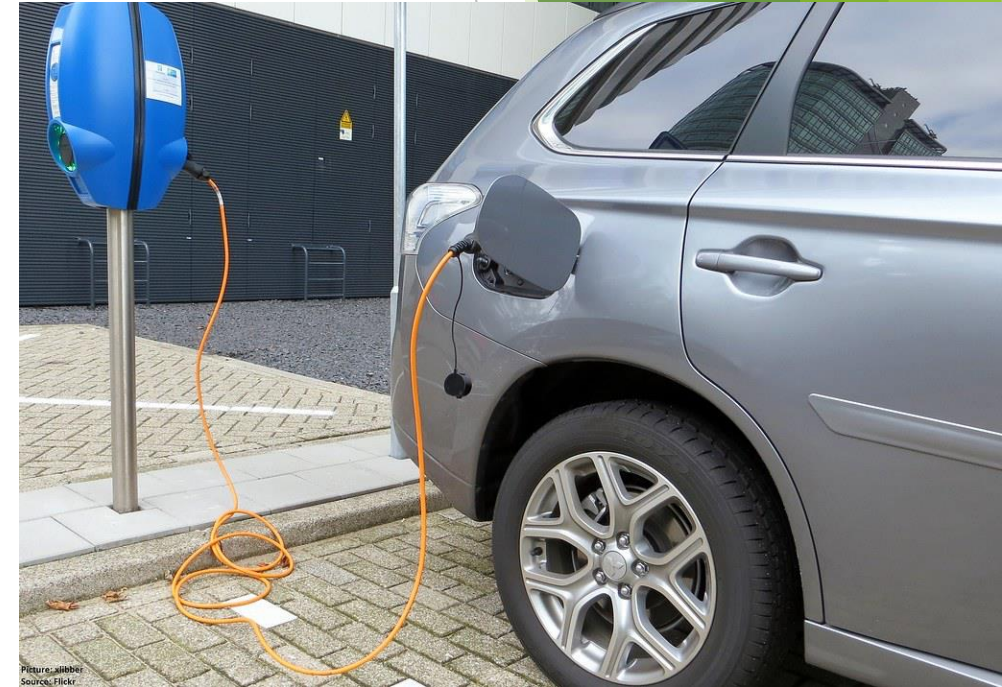
Supercomputer

- Supercomputers are very critical in research and discovery due to the vast amount of modeling and simulation capabilities needed.

- The race is to bring the first "exascale" supercomputer to do at least one exaFLOP (i.e. a quintillion or 10^{18} or a billion billion) calculations per second.

- 2012 US Titan: 27 petaFLOPS (i.e. million billion or 10^{15} calculations per second) (1 exaFLOP = 1000 petaFLOPS)

- 2017 China Sunway TaihuLight Super Computer: 125 petaFLOPS

Supercomputer

- 2018 US Summit Super Computer: 200 petaFLOPS (Equates to every person on Earth to do a calculation every second of every day for 305 days to crunch the same amount of data that Summit does in a blink of an eye)

- As of November 2018, of the top 10 fastest supercomputers, US has 5 and China has 2.

- China has 206 supercomputers and the US has 124 as of 2018.

Artificial Intelligence (AI)

- AI is NOT spaceship computer system called (HAL) in 1968 movie *Space Odyssey 2001*
- AI is "ability" of a machine to perform cognitive functions we associate with human minds, such as perceiving, reasoning, learning and problem solving
  - Examples of technologies that enable AI to solve problems are robotics and autonomous vehicles, computer vision, language, virtual agents and machine learning


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Artificial Intelligence (AI)

- Most recent advances in AI have been achieved by applying Machine Learning (ML) to very large data sets.

- ML algorithms detect patterns and learn how to make predictions and recommendations by processing data and experiences, rather than by receiving explicit programming instruction. The algorithms also adapt in response to new data and experiences to improve efficacy over time.

- Deep Learning: A type of ML that can process a wider range of data resources, require less data preprocessing by humans, and often produce more accurate results and traditional ML approaches.

Example of AI on Chess Game "Go"

▶ Go is played on a 19x19 board and pieces are put on intersection of the lines by 2 opposing players to capture open spaces.

▶ Go is supposed to be out of reach for computers because of the tremendously vast number of available moves.

▶ Alphabet (Google) DeepMind in London developed "Alpha Go" and defeated a Korean Go Master, Lee Sedol in a 5 game match (4:1) in October 2015

Lee Sedol (B) vs AlphaGo (W) - Game 1

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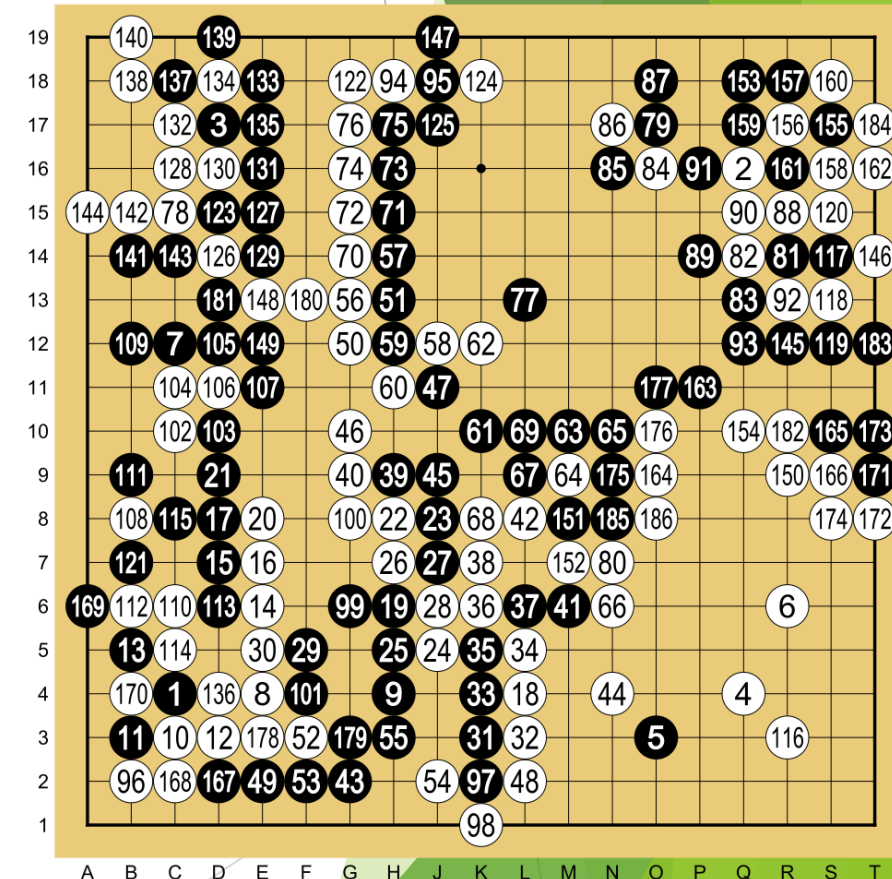
Example of AI on Chess Game "Go"

- "AlphaGo" had three far more powerful successors, "AlphaGoMaster", "AlphaGoZero" and "Alpha Zero".

  - May 2017: Future of Go Summit, "AlphaGo Master" beat Chinese Go Master, Ke Jie, in a 3 game match

  - October 2017: "AlphaGo Zero" was introduced and in 40 days of learning beat "AlphaGo Master" 100 to 0

  - December 2018: "Alpha Zero" was introduced in *Science* as the most powerful Go Computer in the world. It defeated "AlphaGo Zero" 60 to 40

English AI Anchor

This is my very first day in Xinhua News Agency

Artificial Intelligence (AI)

- Boston Consulting Group AI Implementation Study in December 2018 is based on a global survey of over 2,700 managers in seven countries.
  - China is leading in AI globally when ranked by share of active players
    - 85% of Chinese companies are active players in the field of AI
  - United States is in second place when ranked by share of active players
    - 51% of US companies are active players in the field of AI
- Launched in 2017, China's New Generation Artificial Intelligence Development Plan is delivering strong results and has become a topic of national pride.

Internet Connectivity
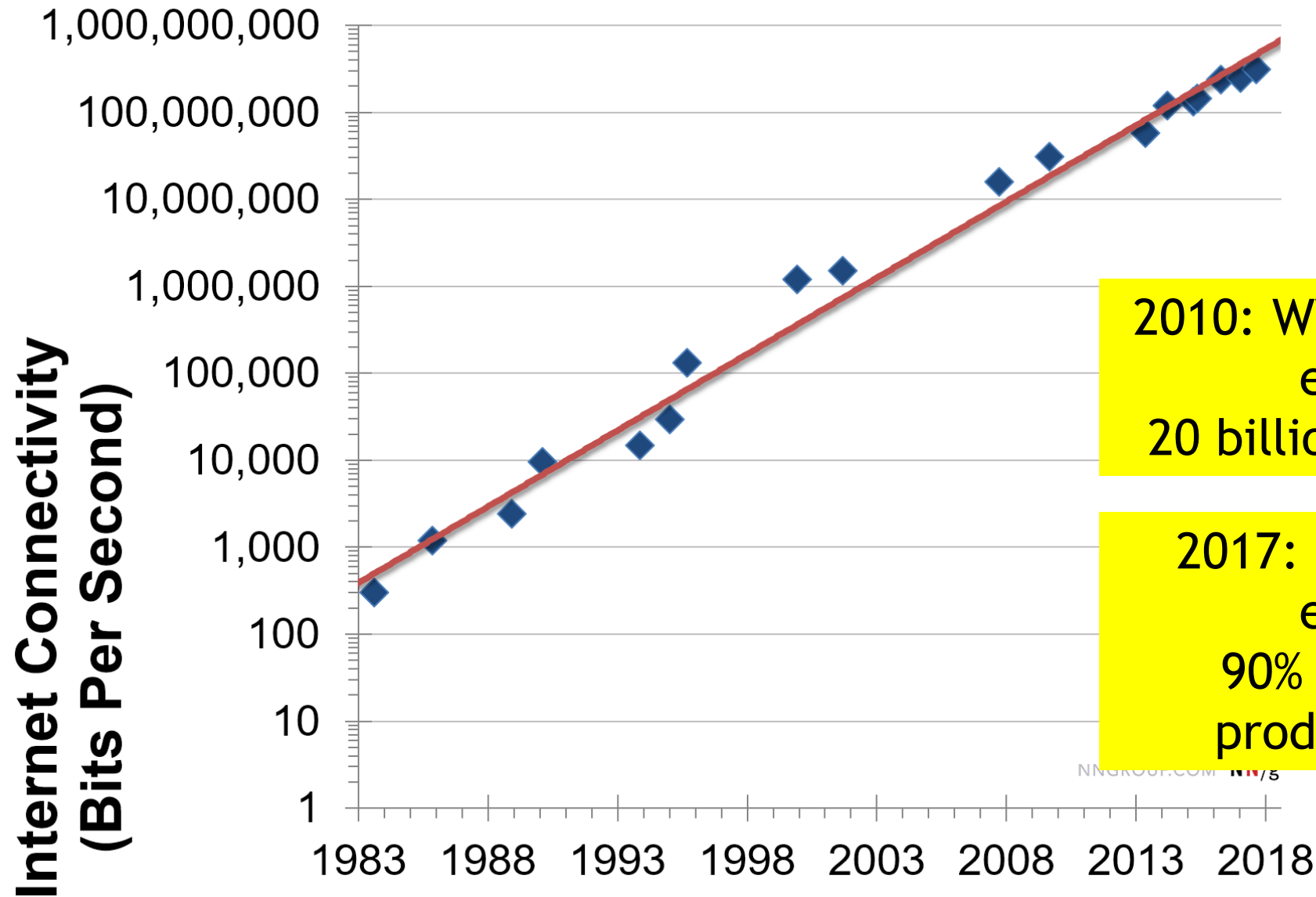
2010: WW IP traffic exceeds 20 exabytes/month
20 billion gigabytes (18 zeros)

2017: Electronic devices 75 exabytes/month
90% of the world's data produced in last 2 years

Chinese Internet Companies

▶ Internet environment brutally competitive.

▶ Successful Internet start ups grow bigger faster (or perish)

▶ On average in 2018 new "Unicorn" created every 38 days

▶ Aggressively targeting emerging markets like SE Asia, India, Latin America and Africa (44/100 top apps in India and 5/10 top mobile apps are developed by Chinese companies)

Chinese Internet Companies

▶ Alibaba generated US$6.39 billion on tech investments (47.3% of EBIT)

▶ WeChat generated US$2.42 billion on tech investments (17.7% of EBIT)

▶ Didi (similar to UBER): 30 million trips per day completed on Didi's platform in China with strategic alliances in US, India, SEA, Middle East, Europe and Brazil

▶ Meituan: World's largest Online to Offline platform. Ambition is to serve 1 billion customers around the world daily

▶ Toutiao: China largest mobile platform of content creation, aggregation and distribution using Machine Learning techniques to customize content for each user
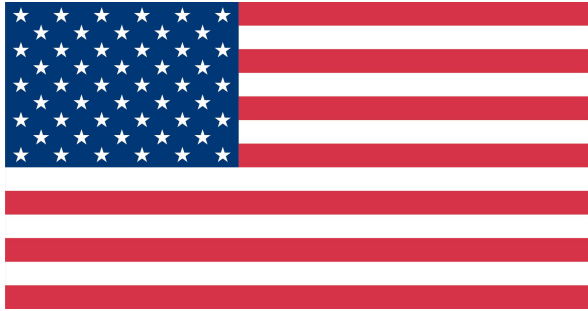
1. Who will win the Technology race?
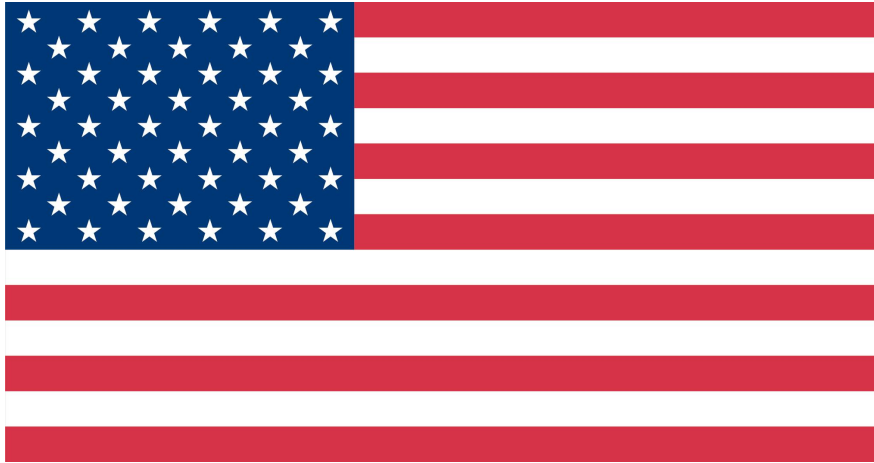
USA and China are leaders

Too many sectors and too big a market for a single country to dominate

1. Who will win the Technology race? "Geo Political Factors"

1. World Leadership/Influence

2. Trade War and/or Technology War

3. Access to Market, Talent and Technology

4. US-China relationship

2. What enables Tech Development?

2. Ecosystem of Technology Development

1. Government Policy
2. Knowledge Base
3. Human Resources
4. Finance Capital
5. Business Opportunities

2. Government Policy

US Congress

▶ Average age in Senate: 62
Average age in House: 58

▶ Mostly lawyers

▶ Technology companies are sources of concerns on jobs, privacy, market dominance

▶ Poor understanding and influence between Government and Technology sector

China

▶ Mandatory retirement age: 60

▶ Mostly Engineers

▶ Totalitarian Government: Single party control with a Capitalism focus

▶ Longer Term Planning: China 2025 National Goal

2. Knowledge Base/Human Resources Financial Capital/Business Opportunities

USA

- "Best in Class" in R&D, University and College Education

- 15% of college grads have STEM degree

- Quality of life, freedom and liberty attracts foreign talents

- Venture Capitalist, Angel Investors, Security Market incentivize risk & reward

- Technology continues to open up new markets but manpower could be the constraint/liability

China

- Graduates more engineers than USA

- 40% of college graduates have a degree in STEM

- Key investment areas for State and Private Sectors

- Abundant and growing business opportunities

- Declining population growth after 2027

3. Implications of current Tech Development

3. Industrial Revolutions
(World Economic Forum 4th Industrial Rev, July 2015)

▶ 1st – Steam Engine

▶ 2nd – Electricity

▶ 3rd – Electronic and Information Technology
      to automate production

▶ 4th (current) – Digital Revolution
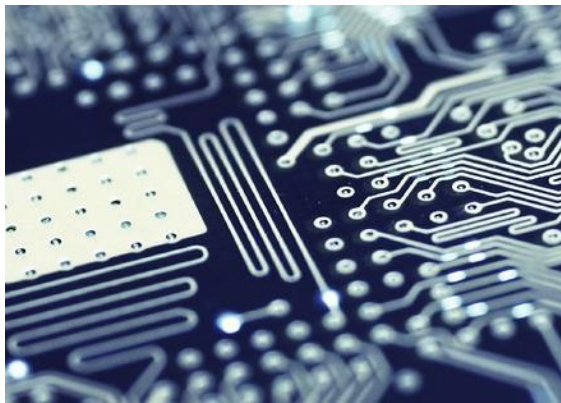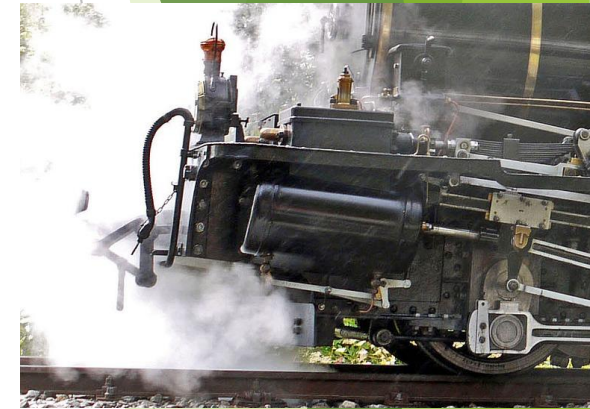
3. Industrial Revolutions
(World Economic Forum 4th Industrial Rev, July 2015)

- 4th (current): Digital Revolution
  - Billions of people connected by mobile devices, with unprecedented processing power, storage capacity, and access to knowledge
  - Opportunities will be multiplied by emerging technology breakthroughs
    - Artificial Intelligence, Autonomous Vehicles, Internet of Things
    - Robotics, 3D Printing, Material Science, Energy Storage
    - Nanotechnology, Biotechnology, Quantum Computing

3. Implications of each Industrial Revolution

▶ Increase Productivity

▶ Improve Quality

▶ Lower Costs

▶ Expand Mobility

▶ Lower Communication Barriers

▶ Enhance Quality of Life

▶ Increase Economic Opportunities

Implication of the current Technology Development

▶ Special Characteristics of the current Industrial Revolution:

1. Much more Innovation and in many different sectors
2. Speed and the Rate of Change much faster
3. Knowledge workers have significantly better and more opportunities

Closing Remarks

Space Exploration

▶ April 1961: First Human Travel to Space, Soviet Cosmonaut Yuri Alekseyerich

▶ May 1961: JFK Challenge to the Nation: Land a human on the moon by the end of the decade

▶ July 1969: Apollo 11, Neil Armstrong landed on the moon

▶ Launched in 1998: International Space Station

    ▶ 15 countries collaborated
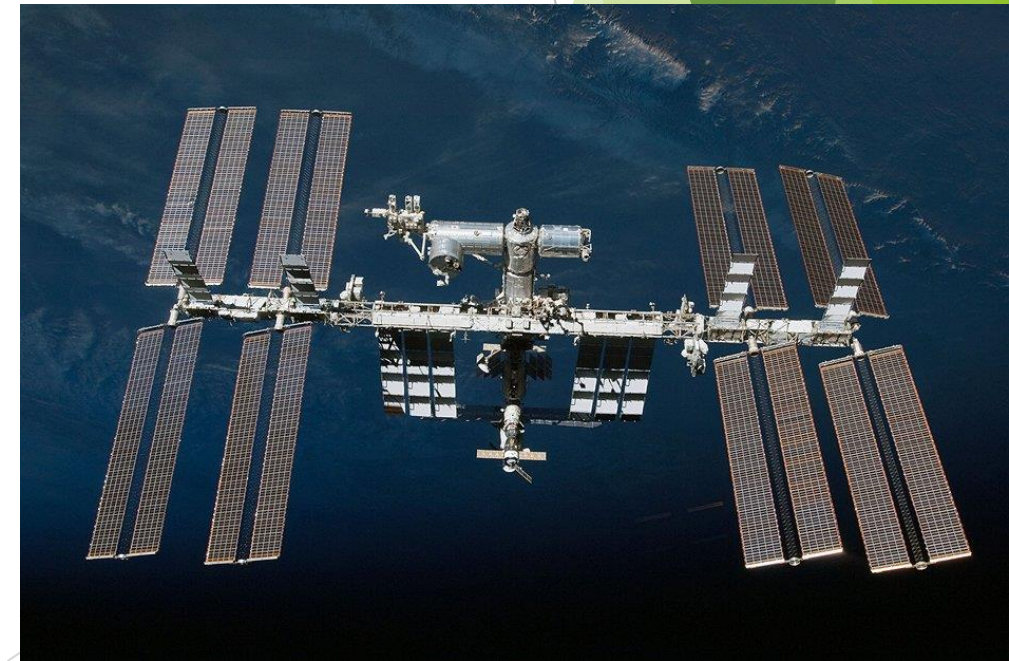
Technology Race: USA and China

▶ International Space Station as a good example:
  ▶ Copetition (Competition and Collaboration)
  ▶ Lots of opportunities in emerging technology breakthroughs
    ▶ Agriculture, Renewable Energy, Drug Discovery, Health Care
    ▶ BioScience, Consumer Entertainment, Cybersecurity

Technology Race: USA and China

- STEM talents are _urgently_ needed in USA:
  - In 1969 Apollo 11, NASA engineer average age: 28
    In 2014, average age: 47
  - USA 15% 20M College students = 3M potential STEM graduates
  - China 40% of 20M College students = 8M potential STEM graduates

Thank you for your attention and being Teachers!

Best wishes for your future and encouraging STEM Education

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