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A strategic management perspective of science and technology ventures by China

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Abstract

Objectives: To analyze the primary strategic motives for China venturing into Disruptive Technologies and Innovations R&D at a very rapid pace. China has been galloping the Technology Highway for the past decade, with technological and innovation inroads in almost all the key sectors with the government playing a pivotal role. **Method:** The apparent drivers for the rapid strides in technology are economic growth, social development and the national aspirations of establishing a powerful and prosperous China. Forays in disruptive technologies has been preceded near-simultaneously by a plethora of strategic geopolitical ventures by China within its land mass, in the various seas, across the Asian, Europe and African continents and also in the space dimension. Thus, the methodology adopted is to study the various strategic initiatives China has implemented in the backdrop of global geopolitics. Thereafter, correlate the disruptive technologies to the various Chinese strategies. **Findings:** The initiatives to be a world leader in Disruptive Technologies correspond to China's other Strategic programs in global geopolitics and expansionist steps in the five dimensions of Land, Air, Sea, Space and Cyber Space. This cannot be dismissed as a mere coincidence. This study establishes that Technology is the common underlying driver of all the geopolitical overtures, viewed as strategic overlays, by China. Further, it is found that China is boosting R&D on dual-use technologies as compared to the single civil-end use technologies to complement its military component in implementation of its strategic manoeuvres. **Application:** The study will facilitate in mapping the global repercussions of these technologies, especially in the Indian sub-continent, given the stand-off relationship between the two nations.

Keywords: Technology management; China's science & technology policy; Science & technology road-map; India implications; Strategic management

1 Introduction

China's national goal is to become a reasonably prosperous society by 2021 (100th anniversary of the CCP) and a modern socialist country by 2049 [100th anniversary of the People's Republic of China (PRC)]⁽¹⁾. China views the current time period

as a phase of strategic opportunity and progressively looks to leverage its growing economic, diplomatic and military might to achieve these goals and expand its global arc of influence⁽²⁾. It has devised a large number of geopolitical strategies in all the dimensions towards this end.

Concurrently, China has embarked on a wide array of disruptive technologies and innovations in various sectors, apparently aimed at upgrading the standard of living and experience of its citizens. The Chinese government is playing a pivotal role in promoting technology and innovation, having enunciated the National Long-term Science and Technology Development Plan (2006–20), to give impetus to science and technology.

Disruptive technologies such as AI, big data, block chain, cloud computing, IoT, quantum communications etc. are being infused in various sectors, like consumer products, public security (AI in facial recognition), automotive (autonomous driving), healthcare (big data analytics in diagnostics and early detection) and fintech (anti-money laundering and credit approval). It has specifically taken concrete steps in AI technology development, closing the gap with other technologically advanced countries. China has enunciated a lot of related policies in public domain indicating that technology and innovation is a national priority for China and the core focus of many corporate operating in the country⁽³⁾.

This paper highlights the strategic backdrop of the Disruptive Technologies and Innovations initiated by China in the first two decades of the 21st century. It introduces the concept of the Chinese Dream and brings out the various geopolitical strategies initiated by China towards its National goals. Thereafter, the policies/ strategies by China towards advancements in technology and innovation have been examined. The paper illustrates some notable disruptive technologies invented by China and highlights the possibilities of ulterior linkages between its drive towards achieving disruptive technologies and the various geopolitical strategies that China has initiated. These disruptive technologies are bound to exert an overwhelming influence not only on the Asian neighborhood but also have colossal global connotations.

2 The Chinese Dream

2.1 The concept

The State Council Information Office of the PRC⁽⁴⁾ assesses that international conditions in the next three decades will facilitate domestic development and the expansion of China's comprehensive national power through its strategic objectives i.e. to ensure internal stability, maintain economic growth and development, safeguard national sovereignty and territorial integrity and sustain China's status as a great power. The government has dovetailed these objectives into the Chinese dream of national rejuvenation. The concept, first expressed by Xi in 2012 during the leadership transition, articulates the national aspiration of a powerful and prosperous China, linking it to the milestones of 2021 and 2049 brought out earlier.

2.2 New Grand Strategy

Chen⁽⁵⁾ refers these two milestones as a new 'grand' strategy for China. The earlier strategy of Deng Xiaoping era, generally labeled as 'hide the light, bide the time' strategy was driven by a conservative vision as compared to this new grand strategy. The new approach will steer China through the next three decades, to achieve its final goal of becoming a leading socialist world power. China has an interim goal, i.e. basic attainment of socialist modernization by 2035, which translates to China becoming one of the most innovation oriented countries with a superior economic prosperity⁽⁶⁾.

3 Various Chinese Geopolitical Strategies

China's basic approach to National Strategy has been guided by three key requirements — to secure its boundaries and keep at bay any external threats, to ensure internal law and order despite any environment of social strife and to be a geo-political force to reckon with⁽⁷⁾. China has embarked upon numerous strategic ventures - coercive and non-coercive since the last two decades within its land mass, in the various seas/ oceans, across the Asian, Europe and African continental triad and also forays in the Air and the Space dimensions.

3.1 Securing Sea Lanes of Communication (SLOCs)

China imports 70% of its Oil and 40% of its Gas requirement. Bulk of this oil ships initially through the Strait of Hormuz and later transits through the Strait of Malacca. Both of these choke points are vital to global maritime traffic and susceptible to potential conflict⁽⁸⁾. China has therefore taken coercive strategic measures to secure the SLOCs in the Indo- Pacific and the Indian Oceans.

3.2 Pipelines

China, being the top global importer of fossil fuels, has strategized development of more secure and reliable alternate routes for its energy supply chain management. It plans to import oil and gas through an extended oil and gas pipeline network across Central Asia and South Asia⁽⁹⁾. The major networks are mainly the Central Asia-China, Pakistan- China and Myanmar- China pipelines⁽¹⁰⁾.

3.3 China-Pakistan Economic Corridor (CPEC)

CPEC is a strategic joint venture between China and Pak, put forth as the solution to the Malacca predicament and tensions in South China Sea. China established a base at Gwadar port complex in Pakistan taking advantage of ongoing Indo Pak rivalry. The CPEC will enable cost effective transportation to move Oil/ Gas and goods⁽¹¹⁾ as also a strategic presence to complement the SLOCs.

3.4 String of Pearls

China is seeking to project its power from the chain of islands bordering the Indian Ocean to the Persian Gulf⁽¹²⁾. The Strait of Malacca is an intrinsic part of this. This proposition, called the String of Pearls theory, refers to the chain of islands and ports subject to heavy Chinese influence and growing assertion of China's increasing number of naval bases in the Indo-Pacific Ocean region. The String of Pearls corresponds to the sea-lanes, showing the high value that China places on protecting its oceanic interests⁽¹³⁾.

3.5 Belt and Road Initiative (BRI)

China's leadership has highlighted the BRI, also referred as the One Belt One Region (OBOR), as a major economic and regional infrastructural initiative. The \$900 billion BRI aims to establish extensive links between Asia, Europe and Africa and their surrounding regions. The goal is to tap the market potential of the regions, push investment and consumption and create job opportunities. The Silk Road Economic Belt focuses on linking Central Asia, Russia, Europe extending upto the Persian Gulf and the Mediterranean Sea with China as the focal point. The linkages are planned to encompass South East Asia, South Asia and the Indian Ocean. BRI is reflective of a map of pipelines and shipping routes that the Chinese government hopes to keep secure by engaging with local economies along the way⁽¹⁴⁾.

3.6 Focus on South East Asian Economies

China has stepped-up its economic traction with the South East Asian countries, especially Philippines, Indonesia, Brunei, Singapore and Myanmar, resulting into a range of political and foreign policy leverage for China. It has already successfully isolated the global attention from its territorial assertion in the South China Sea to a regional diplomatic process. This will ensure resolving these disputes, favorably, at regional level by a consultative mechanism without interference of the Western powers⁽¹⁵⁾. South East countries like Singapore, Indonesia and Vietnam that are more skeptical to China seem to be re calibrating their relations to achieve a balance between China and other developed nations. South East Asia has clearly become the cauldron of a new Great Game.

3.7 The Nine Dash Line

The Nine-Dash Line refers to the undefined, vaguely located, demarcation line used by China for their claims of the major part of the South China Sea. The area in the South China Sea contested by China includes the Parcel Islands, Spratly Islands and various other areas like the Pratas Islands, the Macclesfield Bank and the Scarborough Shoal.

3.8 Student Power

The number of Chinese graduates in science, technology, engineering and maths (STEM) increased from 359,000 to 1.65 million between 2000 and 2014. 25% of STEM graduate students in the US are Chinese citizens. While there has been increase in number of Chinese students studying abroad, the trend since 2011 shows that a majority has gone back home after graduation (Figure 1). This shift could be attributed to China strategizing on plowing back its own brains for the nation's technology and innovation drive. Moreover, in the past decade, about 2500 Chinese scientists affiliated with its armed forces were sent to western universities, disguising their military connection, for research collaboration to boost Beijing's military technology

development⁽¹⁶⁾.

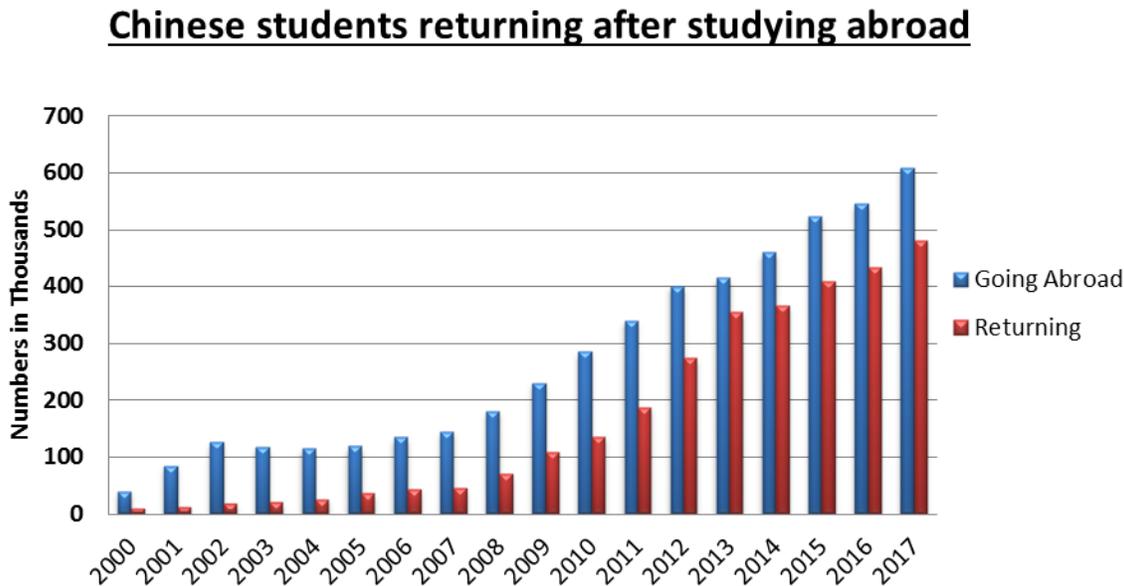


Fig 1. Chinese Students Returning After Studying Abroad

4 Policies/ Strategy For Technology And Innovation

4.1 Science, Technology & Innovation

China has been unleashing a vast range of disruptive technologies and innovations since the past decade through a three-step strategy of innovation-driven development⁽¹⁷⁾ - firstly, to shape China into an innovation ecosystem by 2020, secondly, to move China to the forefront of innovative countries by 2030 and thirdly, to make China an Innovation and Technology powerhouse by 2050⁽²⁾. Clearly, this strategy is synchronized with the timing of its National Goals of 2021 and 2049. S&T advances in the commercial sector are increasingly influencing China's future military modernization with an impetus on greater military-civilian collaboration. In early 2017, the Ministry of Science and Technology (MOST) and the Science and Technology Commission of the Central Military Commission jointly announced the "13th Five-Year Plan–Military-Civilian Fusion S&T Developmental Guide," a roadmap for military-civilian fusion efforts in the next five years signaling the importance of the strategy to revitalize the country through science, education and innovation-driven breakthroughs and the strategy of military-civilian integrated development – both key to complete building a well-off society with a great Chinese military and a modernized economic system. There are a number of plans in various domains as part of this three step strategy. The same are discussed in Paragraphs 4.2 to 4.7.

4.2 Path to Chinese Technology Goals till 2020

China has adopted a steady path towards realizing its goals since the 1970s and is rapidly emerging as a technology superpower. China chalked out a national program in 2006 for the development of Science & Technology to become an innovation-driven country by 2020 by increasing the R&D expenditure, strengthening domestic innovative capacity to reduce dependence on foreign technology and enabling the enterprises and the business sector to be the central driving force of the innovation process⁽¹⁸⁾.

4.3 R&D Expenditure

The importance that China attributes to technology and innovation is evident from the way it has bridged the gap in R&D expenditure, in terms of percentage of GDP, with the USA (its main competitor) since 2002 (Figure 2). Specifically, it has

increased the R&D expenditure by almost 10 times from 52,000 million dollars in 2002 to 526,200 million dollars in 2018 as compared to only 1.52 times that US has increased from 360,000 to 551,517 million dollars in the same time frame (Figure 3)⁽¹⁹⁾. In fact, Chinese enterprises account for 70% of their national R&D expenditure being the main drivers for innovations⁽²⁰⁾. It has also invested in about 40 billion dollars venture capital apart from other international business investments to develop emerging dual-use technologies such as quantum computing, 5G communication, customized server chips, microchips, AI, Machine Learning and others to transform itself from manufacturer of low tech goods to an economic, technology and production hub of high tech systems⁽²¹⁾.

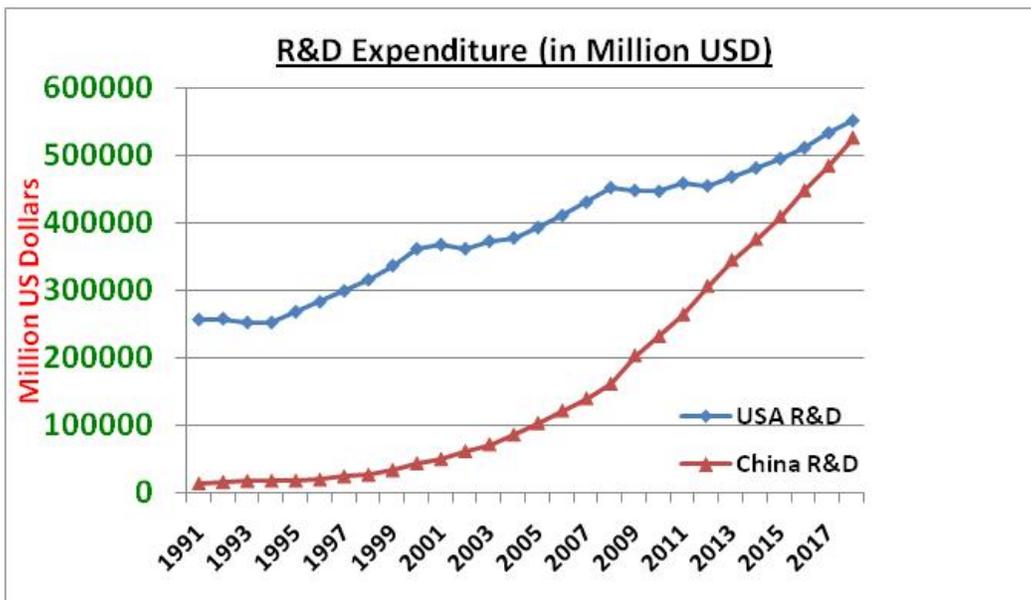


Fig 2. R&D Expenditure (in million USD)

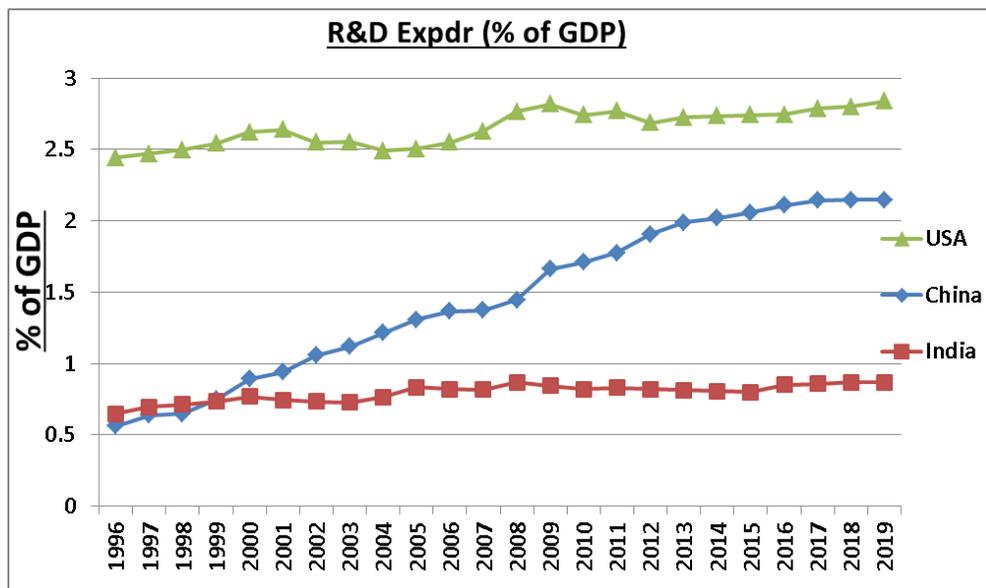


Fig 3. R&D Expenditure of China as Compared to USA and India

4.4 Researchers

China holds the largest scientific forces in the world with 18.66 lacs full time researchers, though China is 1/4th that of the USA in terms of number of researchers per million people (Figure 4)⁽²²⁾. Also, while Korea boasts the highest number of researchers per 1000 people employed at 15.32, China has only 2.4 researchers per 1000 people employed⁽²³⁾. However, China is fast aggregating the number of researchers since 2011, going by the increasing number of students returning to China from higher studies (STEM) abroad as brought out at paragraph 3.8.

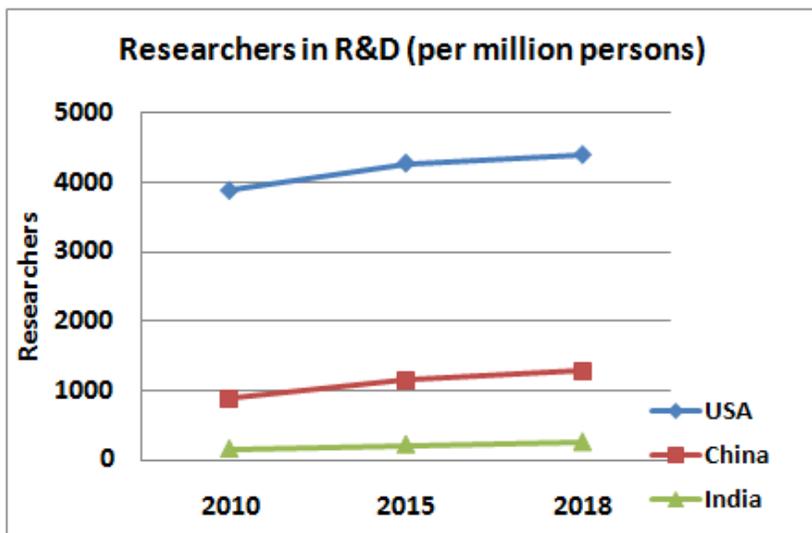


Fig 4. Researchers in R&D (per million persons)

4.5 Research Publications

China has encouraged its researcher fraternity in production of Scientific/ Technical articles. It has also put in place a system of additional rewards to researchers for publishing their research work in suitable journals. Since then China has been publishing 10% more articles every year since the last two decades as against USA which has just maintained a constant rate⁽²⁴⁾. Even India has been publishing 9% more research articles every year. China surged ahead of USA in the number of research articles in 2017 (Figure 5).

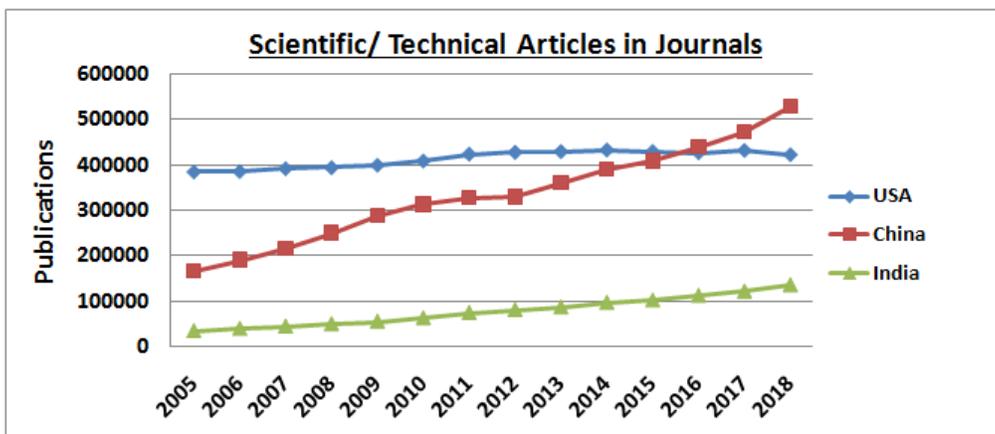


Fig 5. Scientific/Technical Articles Published

4.6 Research Laboratories

China's main research platforms are the Chinese Academy of Sciences (CAS) with its 104 research institutes, 3707 government research institutes, 1354 higher education institutes doing R&D and 29879 corporate R&D labs⁽²⁵⁾. In 1984, China started establishing State Key Laboratories (SKLs). SKLs represent the best research groups in China for basic research. China also has National Laboratories having a status higher than key laboratories to deal with large-scale scientific programs. National laboratories and state key labs have the highest funding and are considered to be superior. These labs focus on scientific fundamental research⁽²⁶⁾. More applied research is appointed to the Chinese National Engineering Research Centres (CNERC). There are more than 200 CNERCs in all major engineering areas. China has also incorporated private enterprises in the R&D ecosystem by according status of National Enterprise Technology Centre (NETC) to R&D by enterprises with strong innovation capacities and remarkable technology results. China has a total of 220 national key laboratories, 254 university SKLs, 177 enterprise SKLs and 1276 NETCs as of 2016⁽²⁷⁾. China aims to triple the national key laboratories to around 700 by 2020. By 2025, China will have completed its national key laboratory system, remarkably boosting its scientific research level and international influence⁽²⁸⁾. One of the reflections of the success of the R&D labs is the number of patent filed by China. Figure 6 shows China's path towards filing of patents since 2008⁽²⁹⁾.

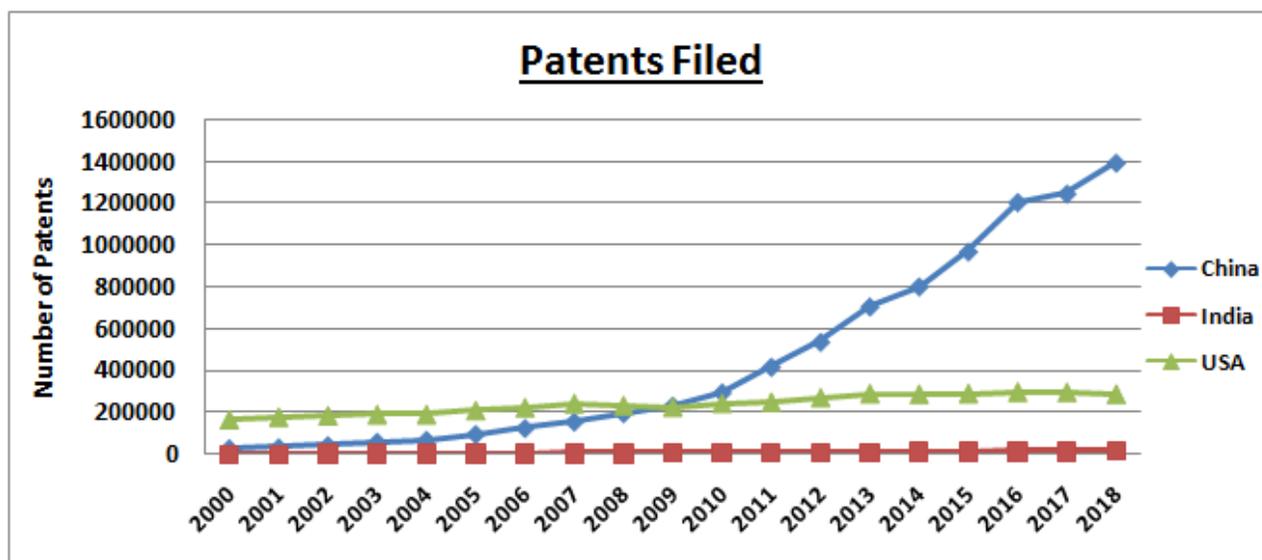


Fig 6. Number of Patents Filed

The 13th Five-Year Plan (2016–2020) on national economy and social development laid down more than 21 goals for development of civilian and military technologies. This has been complemented by the 13th Defence Science & Technology and Industry Five-Year Plan (2016–2020) laying out investments in core areas, accelerating weapons development, increasing arms exports and incorporating collaboration between military and civilian organizations⁽³⁰⁾.

China has also unveiled a three-year Action Plan for Development of AI Industry from 2018 to 2020⁽³¹⁾. Once implemented, China would be capable of producing neural-network processing chips, robots for disabled people with machine learning to help radiologists. China also expects that AI will make industrial production more eco-friendly⁽³²⁾. Fast tracking of AI technology will also complement the implementation of the MIC 2025 plan (paragraph 4.8 below), which aims to propel smart manufacturing by infusion of IoT in manufacturing technology, to transform China into a manufacturing and a cyber-superpower⁽³³⁾. China is also well on its charted course in the space dimension with a reasonable success thus far. It has already developed the heavy-lift launch technology for various types of payloads and orbits and is in advanced stages of a range of satellite technology having successfully landed a probe on the dark side of the moon

4.7 Future Innovation Milestones

Innovation-driven development strategy of China has four major future milestones. Drive domestic competency for global innovation competition with the aim to catch up with other innovation-driven countries by 2020. Reduce imports of technology by 2025 in IT, Aerospace, Marine, Energy Material and Biomedicine sectors. Make significant contributions to the

global scientific community by 2030 for dual benefit of Chinese economy and military with projects such as AI 2.0, national cyberspace security, aircraft engines and combustion turbines, quantum computing and quantum communication, advanced manufacturing, agriculture, resource management in both space, ocean and deep-earth exploration. Lead and dominate as the S&T powerhouse by 2050 with advances in dual-use technology.

4.8 Made in China 2025 Plan (MIC 2025)

China has charted MIC 2025 plan with a view to build internationally competitive businesses, improve technical, equipment and quality standards to international levels and to achieve core technology breakthroughs and collaborative innovation centres for S&T⁽³⁴⁾.

One overarching objective of MIC is to consolidate the manufacturing sector to become the world's leading manufacturing power by 2049⁽³⁵⁾. Key technologies/ sectors identified by China to achieve MIC by 2049 converge with the S&T goals of IT, Aerospace, New Material, Robotics, Ocean engineering etc⁽³⁶⁾.

4.9 Smart Manufacturing

“Smart Manufacturing”, “Industry 4.0” or “Industrial Internet” are the labels given to disruptive changes in industrial production happening due to the integration of intelligent machines, communication technologies, big data and cloud computing etc. This paradigm shift in technology will redefine the dynamics and direction of the global competition and an excellent opportunity for China to bridge the economic and technology gap with other developed nations⁽³⁴⁾. The goal is to infuse Chinese footprints in technology world-wide thereby become a global leader in international business of high-tech quality products by 2050⁽³⁷⁾.

Industrial development has undergone three major revolutions. The first one, Industry 1.0, which unraveled in the 18th century, witnessed industrial production driven by steam and water power. The second, Industry 2.0, in the 19th century saw industrial production driven by electric machines while the third revolution, Industry 3.0, in the 1970s was signaled by industrial robots, programmable logic controllers and ITisation of production. A fourth disruption to global manufacturing, called Industry 4.0 or Industrial Internet, is currently ongoing. The Chinese understanding of smart manufacturing often blurs the boundaries between Industry 3.0 and Industry 4.0⁽³⁸⁾.

4.10 Emerging Space Strategy

China views space as a vital asset, as any nation who controls space will rule the world. China's space program has been in force since the last six decades starting with the ballistic missile program. It has a five pronged Space Strategy – build facilities for cost effective space launch, establish a modular space station, develop infrastructure for protracted presence on the moon, control cis-lunar as well as trans-lunar space, and deep space exploration and resource extraction from asteroids.⁽³⁹⁾

It has already developed the heavy-lift launch technology and is in advanced stages in various categories of satellite technology, having landed successfully a probe on the dark side of the moon. China is now focused on space based navigation for the BRJ, space station and inter planetary missions. It plans to continue the lunar exploration to get some rock & soil samples from the Moon and, in 2020, launch a probe that will orbit, land and rove on Mars for undertaking various observations.

4.11 Emerging Cyber Strategy

Cyber space is a common fulcrum for all its geopolitical strategies. China's objectives of the Cyber Strategy are economic growth, information control, propaganda, ensuring military superiority in cyber space, studying and understanding potential adversaries' military infrastructures, motivations, objectives, capabilities and limitations in the cyber domain, and advancing alternative narratives of government control over/handling of cyber security internationally. China has a six pronged Cyber strategy ([Figure 7](#)).

4.11.1 Guiding Opinions on Actively Promoting Internet Plus

The State Council released the “Internet Plus” Action Plan in 2015, leveraging China's scale and applications of the internet to drive deep and comprehensive integration between the Internet and the market economy with the aim of achieving rapid economic growth and high-quality industry development⁽⁴⁰⁾.

4.11.2 13th Five-Year Plan on Information

The plan identifies six major directions: innovation-driven development, promoting balanced and coordinated development, boosting green growth, driving joint construction and sharing, and preventing safety risks. China plans to allocate more resources



Fig 7. Six Pronged Cyberspace Strategy

for development of cutting-edge information technology, including 5G, IPv6, smart manufacturing, cloud computing and IoT so as to establish a space based navigation system by 2020 including for international clients. Thrust will be given for ‘Smart Governance’ by investing more funds in IT infrastructure in rural/ remote regions, enabling a countrywide online system of integrating information and services from different departments and levels by 2020. The plan is also focused on cyber security⁽⁴¹⁾.

4.11.3 International Strategy on Cooperation on Cyberspace

The strategy devised in 2017, with a premise of peace, shared governance, shared benefit and sovereignty, identifies the fundamental priorities, strategic goals, and action points of China’s cyber diplomacy. China plans to develop a cyber force and boost capabilities to safeguard cyberspace, maintain national security and social stability, and prevent major cyber crisis⁽⁴²⁾.

4.11.4 National Informatisation Development Plan (2016)

The plan is a 10 year roadmap of boosting China’s ICT globally through a multi-stakeholder approach. It encourages wider use of ICT to foster economic and social development⁽⁴³⁾.

4.12 Consolidated Technology Strategy of China.

Figure 8 depicts China’s consolidated strategy of technology-driven development. It is evident that the individual plans are enmeshed with complementary goals towards the overall objectives of the strategy.

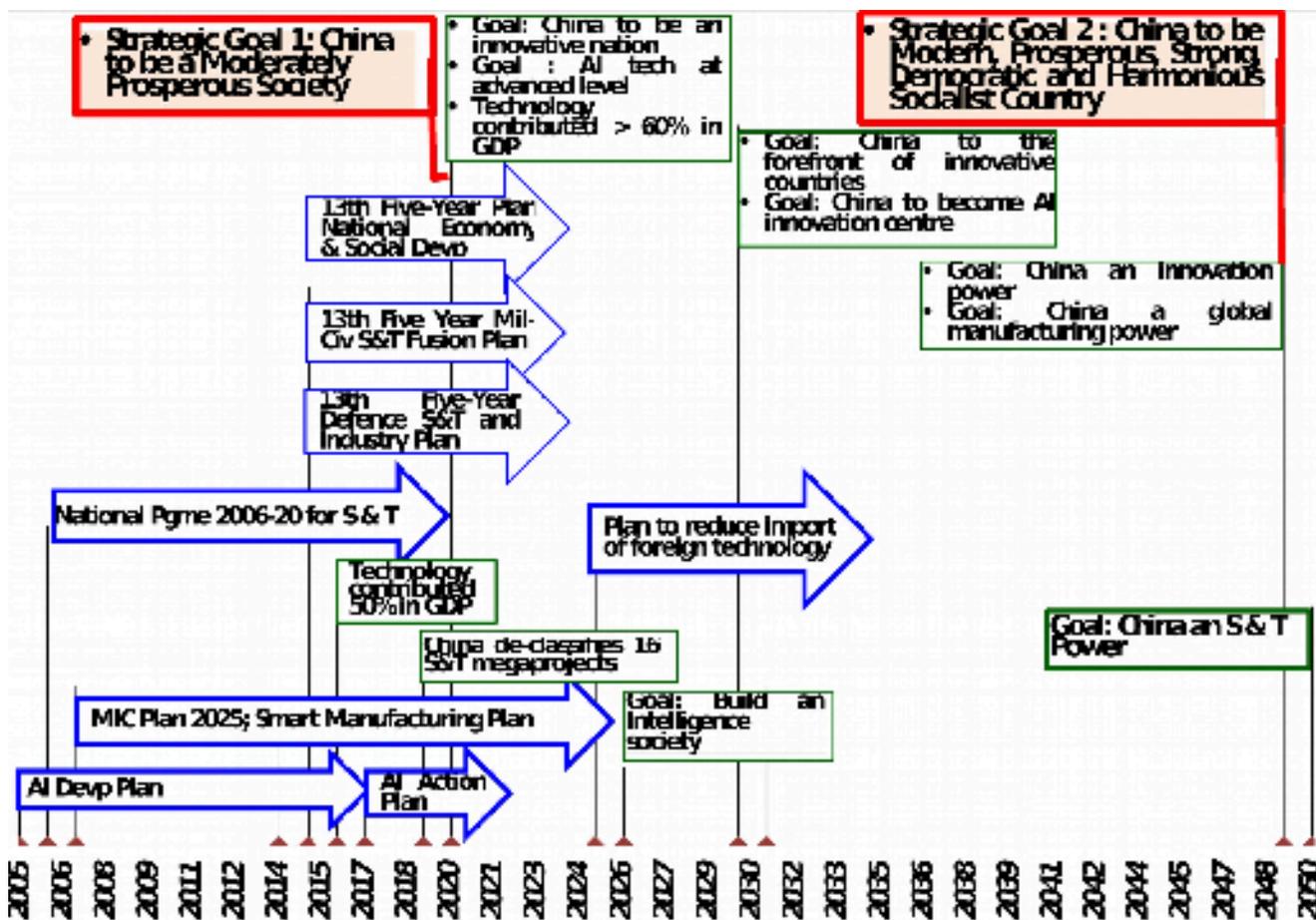


Fig 8. Milestones of China's Strategy of Technology Driven Development

5 Disruptive Technologies By China

The intervening period between the time when Xi Jinping outlined his vision in May 2016 for China to become the leading player in science and technology globally and 2020 has made it clear that the country is making technology innovation a major priority - having become a leader in quantum research, customizing and indigenizing very high speed processors for servers and venturing successfully in multifarious ambitious space programs.

China is working towards increasing the average R&D expenditure per person by about 35% by 2021 by which time it would have caught up with developed nations like the USA⁽⁴⁴⁾. Several development zones like in Zhongguancun, Zhangjiang, Chengdu, Xi'an and Shenzhen have been established specifically for high-tech and innovative industries. Various incentive programs have been announced to promote technology and innovation in these zones. Many business incubators have also being instituted across the country to nurture technology and innovation start-ups. A number of Chinese companies like Alibaba (e-commerce), Tencent (social networking), Didi Chuxing (transportation) and Lufax & Zhong (fintech) have matured as market leaders⁽³⁾.

Some of the innovations that have emerged from China in recent years are Mass Scale production of Electric buses, Super Solar Expressway, Floating solar power plant, Waste-to-Energy Plant, Quantum Computing, Quantum Communication, Customized Server Chips, Ultrafast 3D Microscope, Robotic Doctor, Passenger Drone, Elevated Transit Bus, Cloning of Primates

etc. (45) (46) (47).

5.1 Significant disruptive technology breakthroughs are amplified below:

5.1.1 Change'e-4 Dark Moon Probe

China successfully landed a discovery probe on the far side of the moon on 02 Jan 2019⁽⁴⁸⁾. It will test numerous types of recording and measuring equipment including a spectrometer for low-frequency observations, useful for conducting experiments without the interference of radio noise from Earth. Since the dark side of the moon never faces Earth, Change'e-4 will communicate with Earth by reflecting data from a relay satellite (Figure 9). This Queqiao relay satellite has potential dual use strategic applications as the technology can be used for jamming such ventures by adversaries. China can potentially deny the data emitted from celestial bodies in deep space to adversaries and thus gallop ahead of them in Deep Space Exploration.

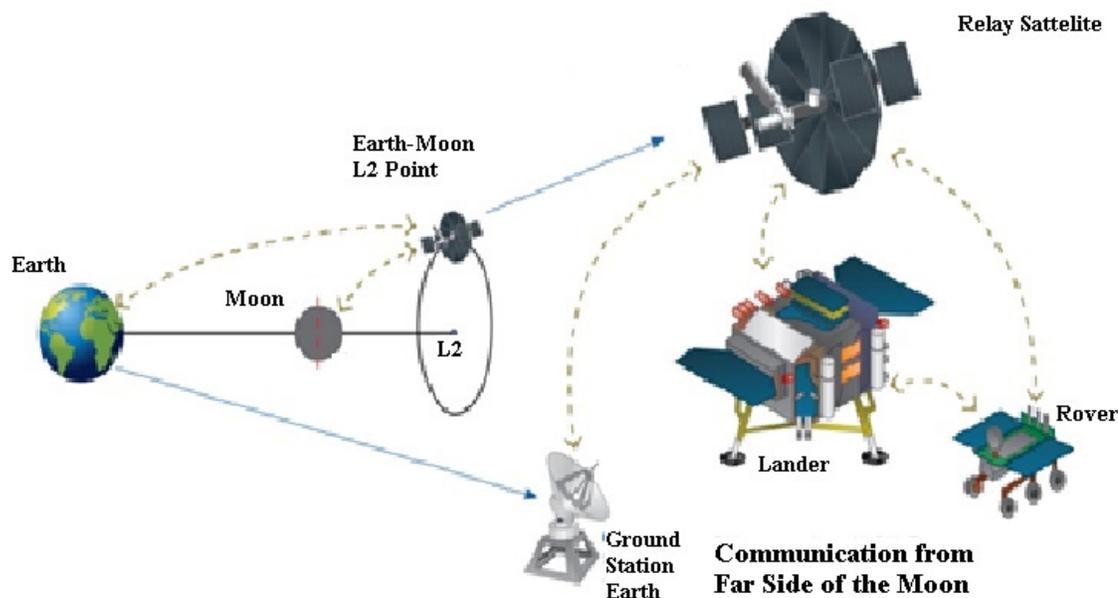


Fig 9. Chang'e-4 Discovery Probe

5.1.2 Artificial Moon Project

China plans to launch an 'artificial moon' (Figure 10) in 2020 to complement the real one⁽⁴⁹⁾. The moon would be bright enough to replace street lights and be eight times brighter than the real moon. It has potential military applications as the moon could be used to illuminate battlefield in a pitch dark night at will or to create an artificial lunar eclipse which could have seasonal implications on geographical processes.

5.1.3 Hongyun Satellite Project

China successfully launched a low orbit satellite in Dec 2018 to provide stable internet access to the country's rural regions under its 'Hongyun Project'⁽⁵⁰⁾. The satellite has communication, remote sensing and navigation functions also. China plans to launch 156 such satellites (Figure 11) into the low Earth orbit by 2025. It might be tempting to dismiss this low orbit technology as one of the broadband satellite projects. Such a thought would be a mistake, as China has an ambitious, global Internet infrastructure and application program called the Digital Silk Road. Once it puts in space a blanket of 156 satellites, China will virtually rule the low orbit space.

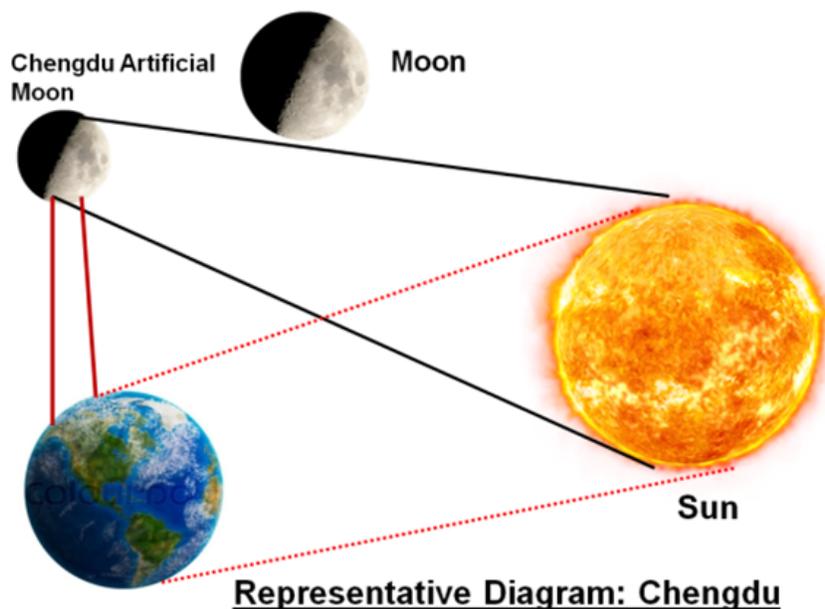


Fig 10. Chengdu Artificial Moon

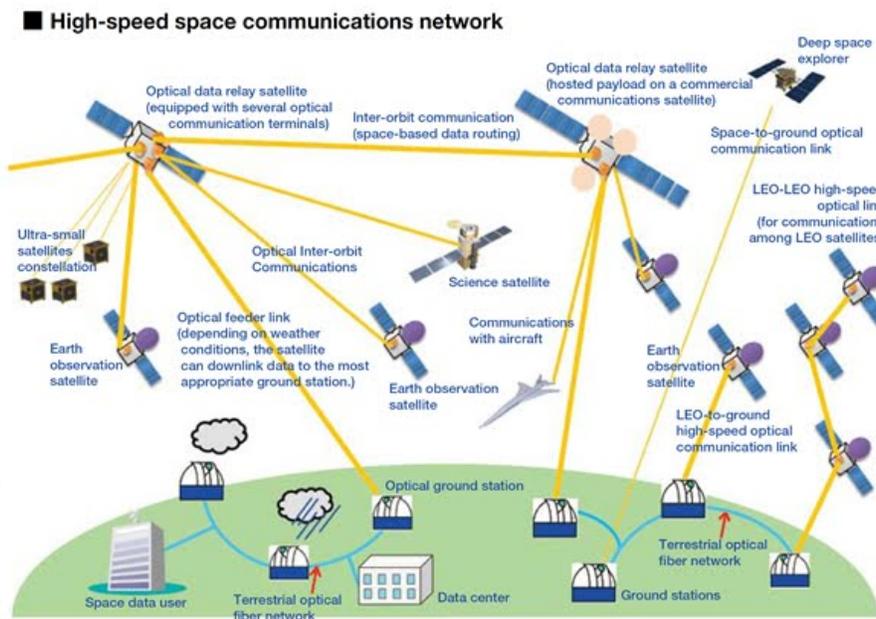


Fig 11. Hongyun Satellite Project

5.1.4 Quantum Satellite

China launched the world's first quantum satellite from the Jiuquan Satellite Center on 16 Aug 2016. The Quantum Science Satellite (QUESS) mission is an intense test of the peculiar properties of quantum mechanics and a test bed for an unhackable communications network technology (Figure 12). Relevant quantum teleportation experiments will spur the development of quantum computers that would have profound military, economic and political implications. This disruptive technology using qubits (Figure 13) is a potential game changer for information and space warfare.

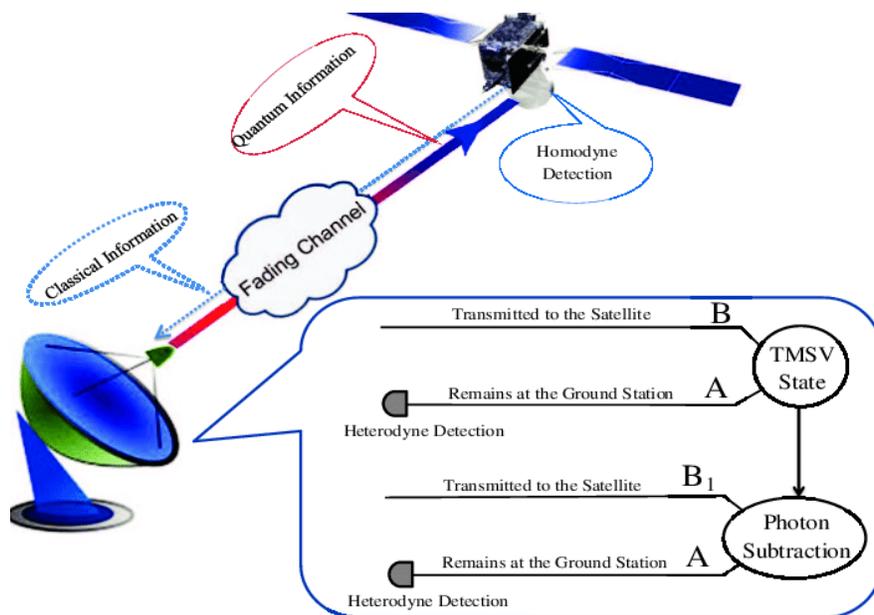


Fig 12. Quantum Satellite

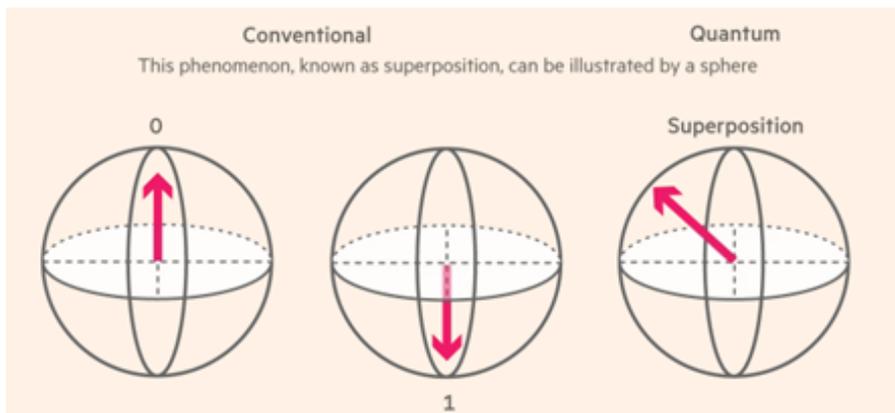


Fig 13. Qubits

5.1.5 500m Aperture Spherical Telescope (FAST)

China constructed a radio telescope, The FAST in 2018. The world's biggest single-aperture radio telescope with 4,600 triangular panels comprises a fixed 500 m diameter dish (Figure 14) built in a natural basin, Dawodang depression, in the landscape. It is monitoring the cosmos for signs of alien life and hooked up to an astronomical supercomputer, with a peak performance of more than 1000 teraflops, to process the enormous amount of data as it explores alien life and dark matter. The aim of radio telescopes is to sense radio waves from space - gas clouds, galaxies, quasars.

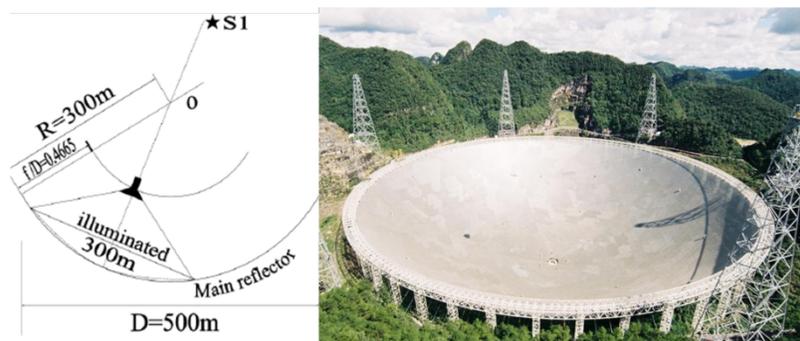


Fig 14. FAST

5.1.6 Supercapacitor

China is developing the world's most powerful supercapacitor that could make 'Star Wars' weapons a reality. Prototype models of such weapons (eg laser cannons and ray guns) have been developed by few nations, but only a few have been produced for actual use beyond the laboratories due to their size and weight. Now, a research team from Peking University and the Chinese Academy of Sciences has achieved a breakthrough in capacitor technology. The power density of this supercapacitor can reach 26 KW per kg, i.e. 130 times that of lithium-ion batteries⁽⁵¹⁾. A capacitor required to meet a power demand of 1 MW, using conventional technology, would weigh more than 10 tons while the new supercapacitor would weigh only 40 kg.

6 Discussion and Evaluation

Technology and innovation boosts exponential growth. And sustained economic growth is the key to reinstate the geopolitical eminence of China which it had in the bygone era⁽⁵²⁾⁽⁵³⁾. China is thus taking a giant leap forward in innovation because of economic, business and military reasons. Obtaining critical civilian and dual-use technologies are vital to sustaining Chinese security in the evolving regional order⁽⁷⁾.

The disruptive technologies behind the projects brought out in Paragraph 5 can be summarized as Quantum Technologies (quantum computing/ quantum communication/ quantum encryption), Super-capacitor Technologies, Space Technologies, Robotics, AI, Genetic Engineering, Advanced Drone Technology, Missile Intelligentization, Cognitive Radio/EW and so on. These are significant due to their dual-use applications, for example, Advanced Computing essential for weapons design and testing, robotics has a great usage for advanced weapons manufacturing, new material technology like Titanium could enhance characteristics of advanced weapon systems, Quantum technology could empower C4ISR and cyber capabilities, improved technology of electronics device manufacturing could enable development of high tech directed energy weapons and AI would boost next-generation autonomous systems such as missiles, swarming technology or cyber capabilities⁽²⁾.

China's increasing space capabilities would enable it to pursue activities aimed at preventing its adversaries from using assets in the space dimension when required. Of the many emerging technologies China is helping to advance, AI is perhaps the most significant as it has potential military applications having doctrinal ramifications. The technology's potential for rapid data processing and analysis enable strategic decision making and applications in asymmetric warfare. China's offensive cyber capabilities could be used to strengthen China's strategic position in incremental ways. Thus China is now at the capability threshold where it can unleash information warfare to exploit the entire range of electromagnetic spectrum⁽⁵⁴⁾.

Technology is exerting a key influence on national policies. Technology creates an imperative, a technological imperative, for its use by defining what is possible and creating new capabilities and thereby influences human choices and policy decisions⁽⁵⁵⁾. China continues to rely on "imported" core technologies⁽⁵⁶⁾ thus jeopardizing the dream of national rejuvenation. Relentless pursuit of Disruptive Technologies and Innovation by China in the last one and a half decades therefore is central to China's grand strategic plans. The increased synergy between Military and Civil R & D towards dual-use technologies is therefore notable. Clearly, China will leverage the disruptive dual-use technologies for complementing the strategic initiatives mentioned at paragraph 3 as well as its aspiration to become the top global power.

6.1 Implications for the Asian Sub-continent

China's emergence as a technology superpower has significant ramifications for the Asian subcontinent. China is harnessing the military and civilian applications of the dual use technologies which will not only alter its status from a cheap manufacturer of

low tech products to an economic and technology super power⁽⁵⁷⁾ but also have geopolitical traction in the Asian subcontinent and the Indo-Pacific region. On the other hand, though China has taken incredible strides in disruptive technologies, it may be debated that it might be premature to assume that China will surpass other technology giants like USA or Japan given that some of their forays into technology or innovation have met with only limited success⁽⁵⁸⁾. However, India would be concerned about the Chinese forays into vital military technologies in view of the simmering acrimony between China and India in the South East Asian neighborhood⁽⁵⁹⁾. China's progress in defence, commerce, health and space applications of these technologies, as compared to India, will have a bearing on its regional defence, economic and foreign policies. Therefore, India being an emerging regional power will have to particularly take note of the dual-use technologies. India's R&D in these technologies is at a developing stage, thus their government, military, scientific, academic establishments and industry have to work together to strategize accelerating investments in the critical sectors⁽⁶⁰⁾.

The implications of China's technological rise are not restricted to the military domain. It would have ramifications for India's energy supply chain since the nations have competing interests in energy imports and transits, especially of the dwindling fossil fuels. Yet another effect will be the influence on various multilateral treaties and groupings like the BRICS, SCO, and ASEAN etc. China's leap ahead will also dictate the response India extracts from its neighbors in bilateral cooperation and matters related to trade and commerce.

Thus, if the countries of the Asian sub-continent including India have to protect their national interests, exert their will in the Indo-Pacific region and the positioning in the global power matrix, the happenings in the technology domain by China will have to be seriously taken note of.

7 Conclusion

A vast amount of research has been done by research scholars worldwide as also the 'think tanks' of different Nations in the various geopolitical strategies by China. However the precise linkages between China's geopolitical poise and the disruptive technologies and innovations it has harnessed are not clearly articulated from a strategic management perspective. China's vigorous geopolitical posturing in the last two decades and its forays in the similar time frame into R & D for becoming the global leader in Technology and Innovation cannot be dismissed as mere coincidence and needs to be researched deeply. The individual geo-political or supply chain management strategies outlined earlier may have specific long and short term objectives, but viewed through the prism of time and technology, these strategies converge into an overall "Grand Strategy".

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