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'CHINA: PATH TO HI-TECHNOLOGY'

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The world is on the threshold of major technology advances that will translate what has so far been in the realm of science fiction to everyday reality. There is clear promise of transformational changes, with the next couple of decades being witness to technology driving almost every aspect of life.

2. Signs of this are already visible in robotics; artificial intelligence; telecommunications; Internet of Things; unmanned automobiles; biomedicine; etc. In the race not to be left behind in a world of advanced technologies, the US, Russia, some European countries and China have been working on different aspects of these technologies for a while. Taiwan, South Korea and Vietnam too are readying to compete globally in 5G communications.

3. China is striving to progress in hi-tech research areas like organelles to build tissue for soldiers injured in war and 3-D printing to build weapons on the battlefield. It finalised a Civil-Military Fusion Programme so that hi-tech advances made by the military and civilian private industry could be pooled and optimised. China has made huge capital investment in Artificial Intelligence (AI), already crafted an AI policy and holds more patents than the US. Its PLA-affiliated information and telecommunications companies like Huawei and ZTE are exerting to roll out fifth generation (5G) networks across the world – Huawei is already present in fifty countries! China has made great strides in quantum communications. Interestingly, though, Beijing has chosen to go in for the 5G networks of Ericsson and Nokia inside China!

4. Cognisant that advanced technology is the future, China decided to undergo short-term pain to become a leading global power in technology. Despite its huge surplus manpower, China chose to train and upgrade manpower skills and opted for robotics in its factories. In 2017, China bought 36% of all factory robots in the world the previous year, more than any other country including the U.S., with the aim of boosting its own production of robots to become the pre-eminent technological superpower. By 2019, China had the largest number of factories using robotics. China's declining workforce would have been an important factor. China's work force started to drop in 2012, with the slide gathering pace in the 2020s and predicted to fall by over 20 per cent, or around 210 million, by 2050. In other words, against the present about 7 workers for each retiree, by the 2040s, this will have fallen to 2.5 workers!

5. China's leadership was prescient in recognising the importance of advanced technology and its potential for varied applications. The 'Long March' era of Chinese leaders understood that without technology China could again be subject to "bullying" by major powers with Mao

Zedong himself harbouring apprehensions about the U.S. and Soviet Union with their atom bombs. There have been three factors that put China on the track of acquiring and developing advanced technology. These were: (i) Mao's vision of the future China; (ii) dominance of the military in China's politics; and (iii) the wave of nationalist sentiment in the wake of China's "liberation" and leadership-led programme which combined to persuade Chinese scientists to return and serve the Mainland.

6. This is reinforced by the substantive presence of senior Party cadres with scientific backgrounds. There are 14 members in the new 19th Central Committee (CC) of the Chinese Communist party (CCP) who have a background in academics and universities especially in aeronautical sciences indicating a focus on R&D and scientific research.

7. Three key areas provide a clear idea of China's ambitions and goals. These are Civil-Military Fusion, also called Civil-Military Integration and which is the foundation for China's S&T effort; Artificial Intelligence; and 5G, or fifth generation information and communications technology.

CIVIL-MILITARY FUSION (军民融合/CIVIL-MILITARY INTEGRATION)

8. Civil-military fusion (军民融合) -- also called 'military-civil integration' -- is an important policy enunciated, with some variations, by Mao Zedong, Deng Xiaoping, Hu Jintao and Xi Jinping and is inextricably intertwined with China becoming an advanced world technology power as envisaged in 'Made in China-2035'. The "China Military-Civilian Integration Development Report 2014" issued by the National Defence Economic Research Center of the PLA National Defence University revealed that China's military-civilian integration is around 30%. Xi Jinping acknowledged that many private high-tech enterprises in China are technologically advanced, have great potential for development and can tie up with traditional defence military enterprises to mutual advantage. On March 12, 2015, at the plenary meeting of the People's Liberation Army (PLA) delegation of the Third Session of the 12th National People's Congress of China, Xi Jinping for the first time stressed the need for "Improving the integration of military and civilian development into a national strategy". In January 2017, the Chinese Communist Party (CCP) Central Committee (CC) Political Bureau (PB) established a Central Military-Civilian Integration Development Committee, with Xi Jinping as its Chairman.

9. Xi Jinping linked the development of military-civilian integration with the "realization of the great rejuvenation of the Chinese nation" and effectively blended guarding national sovereignty, security, and development interests. Civil-Military Fusion was promptly backed by the heads of prominent Chinese military State owned Enterprises (SoEs) like Peng Jianwei, President of the Beijing Modern Industrial Planning Research Institute, Gao Hongwei, Chairman of China Aerospace Science & Industry Corporation, Lu Guangshan, Chairman of AVIC Aerospace, and Guo Zhengbiao, CEO of Nanjing World-based Space-Based Communication Technology Co., Ltd., who is also founder of a start-up and a serial entrepreneur. They did, however, point to the many obstacles impeding such integration, including mind-sets of discrimination against private enterprises.

10. The Chinese authorities, including in the provinces, were quick to initiate efforts to promote Civil-Military Fusion and persuade private companies to participate in the joint development and manufacture of military equipment and systems. In September 2017, Beijing held its third Integrated Military and Civilian Development Technology and Equipment Exhibition and began developing the Zhongguonancun Science Park. On April 9, 2018, Xi Jiayin, Chairman of the Evergrande Group signed a contract with the Chinese Academy of Sciences, which provided that Evergrande will invest 100 billion Yuan over the next ten years in the hi-tech areas of life sciences, aerospace, integrated circuit, quantum science and technology, new power sources, artificial intelligence, robotics and modern agricultural science and technology.

11. Other examples include the Beijing Civil-Military Integration Expo 2019 held in Beijing from May 6 to 8, 2019, to promote military-civil trade between China and countries involved in the Belt and Road Initiative, in partnership with the China Electronics International Exhibition Advertising Co Ltd, China National Electronics Import & Export Corp, CETC International Co Ltd, and Poly Defence Research Center. On February 26, 2019, Xinhua reported that the PLA and Chengyang District in Qingdao are creating the "Chengyang Military-Civilian Integration Industrial Park Project" with a total investment of 2.34 billion yuan and a technical team has undertaken transformation of advanced technological achievements and market expansion of the PLA Information Engineering University and Qingdao Ocean University. Chengyang District has 20 military-civilian integration enterprises such as radar, electronic information and special vehicles, and the national high-speed train technology innovation center. Chongqing Municipality has proposed developing a model 5G network and applications demonstration together with China Telecom, China Mobile, and the China Aerospace Science and Technology Corporation. Sichuan plans to promote partnerships for military-civil fusion in 5G. At least 36 national-level industrial zones to promote Civil-Military Fusion have opened across China.

12. AI is a priority area for Civil-Military Fusion. Mao Yongqing, Head of the 28th Research Institute of China Electronics Technology Group, which develops electronic warfare technology for the PLA and Yin Shiming, Vice President of Cloud Computing at the privately owned internet group Baidu, announced that CETC and Baidu will partner in a "joint lab for intelligent command and control technology" -- facilities used to direct military operations -- and work together "to link up computing, data and logic resources to further advance the application of new generation AI technologies". Mao Yongqing is one of a small group of state cadres entrusted by Chinese President Xi Jinping with the task of pushing the military into the era of Artificial Intelligence.

13. Reporting on Civil-Military fusion, the PLA Daily (March 2, 2019,) said that in the past 40 years of reform and opening up, China's private enterprises have accumulated a large number of advanced technologies and products to become the main force in the national economy and a new force for building the national defence forces. It said by the end of 2017, nearly 10,000 private enterprises of the 27.72 million private enterprises in the country had entered national defence and military construction. Thousands of private enterprises are deeply involved in the research, production, maintenance and technical services of weapons and equipment, but the speed of "military and civil integration" is still slow. The PLA Daily observed this was because weapons and equipment are products with special attributes such

as monopoly production, complicated technology, high quality standards, and relatively small volume. It called for streamlining procedures.

14. Pointing to the potential for Civil-Military fusion, official Chinese statistics state that there were more than 80,000 high-tech private enterprises in China in 2017, with the output value of more than 1,500 exceeding 100 million yuan. Some enterprises having reached or exceeded the military standard in the fields of new materials, electronics, information and other fields. Statistics disclosed, however, that less than 1% can presently participate in equipment research and production.

ARTIFICIAL INTELLIGENCE (AI)

15. The “13th Five-Year Plan for Developing National Strategic and Emerging Industries” (2016-2020) identified AI development as the 6th among 69 major tasks for the central government to pursue. It received impetus after the 19th Party Congress in October 2017, when Chinese President Xi Jinping declared he would like to see China as ‘a scientific and technology power superpower’.

16. China sees Artificial Intelligence (AI) as one of the leading technologies of the next decade with its predictive capabilities ensuring its application in maintaining social stability (predicting social unrest), military (graduating from *informationisation* to *intelligentisation*), medicine etc. The State Council formulated a AI superpower strategy (人工智能强国战略) which envisages an ambitious three stage process aimed at China leading the world in AI. It outlines: by 2020, China’s AI industry will be “in line” with the most advanced countries, with a core AI industry gross output exceeding RMB 150 billion (US\$ 22.5 billion); by 2025, China should reach “world-leading” level in some AI fields, with core AI industry gross output exceeding RMB 400 billion (US\$ 60.3 billion); and by 2030, China is likely to become the world’s “primary” AI innovation center, with core AI industry gross output exceeding RMB 1 trillion (US\$ 150.8 billion). In other words, the three strategic phases of AI development are: (a) catching up to the most advanced AI powers, (b) becoming a world leader in AI, and (c) achieving primacy in AI innovation.

17. China has a limited talent pool of around 39,000 AI researchers, less than half the size of the U.S. pool of over 78,000 researchers. With AI as a priority, the Chinese government has encouraged development of AI start-ups and enhanced efforts to bring back researchers from abroad under its ‘Thousand Talents Programme’ begun in 2008. South China Morning Post reported (November 8, 2018) that breaking new ground the Beijing Institute of Technology, recruited 31 ‘patriotic’ youngsters straight from high school to begin training as the world’s youngest AI weapons scientists in a new AI weapons development programme. The 27 boys and four girls, all aged 18 and under, will develop their skills in specialised weapons laboratories during a four-year course and thereafter enrol in a PhD programme to become the next leaders of China’s AI weapons programme.

18. China at the same time began funding AI start-ups through “government guidance funds” (GGF) set up by local governments and state-owned companies. In two years since 2016 the Chinese government invested more than US\$ 1 billion on domestic start-ups. According to Tsinghua University, private funding for Chinese AI-related companies in 2017 totalled US\$

19. 7 billion dollars, equivalent to 70 percent of global investments in the industry. Xinhua on December 9, 2018, quoted Bloomberg Intelligence (BI)'s latest report, which said that China's core AI industry could exceed US\$ 145 billion by 2030 and "China may overtake the U.S. in global technology-patents share by 2025".

20. A report said the increase in quantum of GGFs and their possibly eclipsing China's private venture capital (VC) investments would, in parallel with accelerating AI development, encourage tech companies to incorporate party committees thereby promoting the Party's goals. In the past few years, more than 35 tech companies, including Baidu and Sina, have created company party committees.

21. Tsinghua University is the lead university for AI in China and is ranked second in the world in the number of high-level papers published in the field of AI in the past decade. An authoritative report released by it in 2018, revealed that it has established a number of AI research bases, most with military related research. Among these are the State Key Laboratory of Intelligent Technology and Systems (智能技术与系统"国家重点实验室) established in 1990; the Intelligent Microsystems Ministry of Education Key Laboratory (智能微系统教育部重点实验室) of the CMC Science and Technology Commission National Defence Frontier Innovation Special Zone (国防前沿创新特区); the CMC Science and Technology Commission's High-End Laboratory for Military Intelligence (军事智能高端实验室); "Tsinghua Brain and Intelligence Laboratory" (清华脑与智能实验室) established in 2017; and interdisciplinary research center, the "Tsinghua University Intelligent Unmanned Systems Research Center."

22. In the commercial AI ecosystem, the Chinese government actively picks winners in the AI space. For example, in November 2017, it designated Baidu, Alibaba, Tencent, and iFlyTek to lead the development of national AI innovation platforms in self-driving cars, smart cities, computer vision for medical diagnosis, and voice intelligence, respectively. South China Morning Post separately disclosed that China named Huawei Technologies and Hikvision Digital Technology as new 'national champions' in artificial intelligence (AI) to join ten companies including Xiaomi, JD.com, Qihoo 360, Megvii and Yitu.

23. Much of China's research on AI is focussed on military applications. Chinese military experts refer to changing the PLA's goal from that of *informationisation* to *intelligentisation*. The predictive aspect of AI appears to be of special interest with its application in the behaviour of military adversaries and what China euphemistically describes as, 'stability maintenance' to anticipate social unrest. The "Tsinghua Brain and Intelligence Laboratory" in 2017 confirms such research is underway.

24. The U.S. think-tank Jamestown Foundation reported that in early 2019, PLA Senior Colonel Li Minghai, Director of the National Security Studies Institute at NDU and Deputy Secretary of NDU's Communist Party Committee, published a pair of articles that offered a new set of terms and theoretical ideas related to the incorporation and operationalization of AI by the PLA. Li Minghai introduced a new term: the "algorithm game" (suanfa boyi, 算法博奕), which was presented in the context of conflict between first-tier military forces in a dawning age of

“intelligentized warfare” (zhinenghua zhanzheng, 智能化战争). The author pointed out that the terms have been used since 2017, including by Professor An Bo of Nanyang Engineering University, who discussed how AI and algorithmic game theory will more efficiently deploy resources for a range of domestic security missions. Discussions of “intelligentized” warfare have also been used with increasing frequency by PLA writers in recent years suggesting a nascent effort to develop a doctrine for integrating AI into PLA operations. Adam Ni, China researcher from Macquarie University in Sydney, said that China has set up two major research organisations focused on AI unmanned systems. Referring to a description of a swarm of drones in the PLA Daily, he said future “intelligent” wars will be fought with smart weapons and systems, supported by AI and capable of undertaking missions on their own.

5G COMMUNICATIONS TECHNOLOGY

25. The fifth generation of information and communications technology, or 5G, is viewed in the West as the next big change after the industrial revolution. According to a report issued by the Asia Studies Centre in U.K. in May this year, the fifth generation of wireless networks (5G) will deliver a profound change in latency, data speed and volume, allowing for new technologies – such as agricultural or delivery drones, self-driving vehicles, and other data-driven tech. The 5G equipment is complicated and will play a major part in the economic and national security of nations. Concerns about security arise because it is much faster than the 4G with huge numbers of channels and will link literally millions of pieces of equipment in the world. China’s Huawei has emerged as a leader in this sector with a presence in over 50 countries. It is presently establishing AI nodes in approximately 30 countries along the Digital Belt and Road Initiative.

26. Two main considerations weighing with prospective buyers of 5G are expense and national security. Additionally, there are very few providers in the market. Ericsson and Nokia are the two European companies and China’s Huawei is the other. South Korea’s Samsung, Taiwan and Vietnam are about to ready their systems. However, 5G equipment supplied by Ericsson and Nokia cost twice as much as that of Huawei. Countries, therefore, have three choices: pay almost double the cost for ensuring national security, if they feel European companies are less likely to succumb to government pressure to tap communications; try and upgrade their existing 4G system, which is feasible but will not give the same speed and capabilities as 5G; and opt to continue with the present system till they develop one indigenously or purchase a lower priced 5G from South Korea, Taiwan or Vietnam. Countries like India can consider the third option.

27. Experts say that unlike the old 4G where antennae were on the periphery away from the core, the 5G network relies upon a complicated series of active advanced multiple-input/multiple-output (MIMO) antenna closely integrated with the hardware and software required for transmission and reception of radio signals, and signal processing algorithms to support the execution of the entire system. The antennae control the radiation pattern, gain, bandwidth, polarisation, and frequency range and power across the network. The key to multiple input, multiple output (MIMO) and the ability to control multiple data streams using the same time and frequency resource is the ‘antenna’. Experts say it is possible for the systems provider to insert a ‘backdoor’ within the antennae and allow it to stay dormant till required. It is very unlikely to be detected by even technically advanced and proficient

agencies. The China Electronics Technology Group Corporation (CETC), a state-owned defence conglomerate, produces antennae and microwave equipment for Huawei's 5G.

28. While evaluating 5G network systems India needs to give prime consideration to national security and the fact that the 5G system will expose and render vulnerable the entire communications traffic, whether it is civil or military. Already the ingress by Chinese companies like Huawei, ZTE and others into the Indian telecommunications market facilitates collection of huge volumes of personal data. Huawei has very close documented links with China's military and security establishments. It will play an important contributory role as China works towards developing AI for 'predictive' battlefield capability and upgrading the PLA from an "informationised" force to an 'intelligentised' force. China is already using AI and big data to develop smart city technologies to track and shape the political behaviour of its population. The 'Civil-Military Fusion Programme' has blurred even the thin line that might have existed. Huawei founder Chairman Ren Zhengfei is a CCP member and 12,000 Huawei employees are CCP members. Sun Yafang, formerly of the Ministry of State Security was Huawei's Chairwoman from 1999 to 2018.

29. China has made rapid advances in future advanced technologies, many of which like AI and 5G networks are dual-use. China's effort is driven primarily by domestic security and strategic military considerations, though commercial factors play an important role. As China narrows the gap, its effort to reach the level of the world's advanced technology powers has met obstacles. The biggest is U.S. specifically targeting China's technology sector, or 'Made in China-2025' programme in its trade war. China, which has been dependent on foreign imports for vital components, is now scrambling to develop its own capability. Tighter controls by the West on these supply chains will hamper China's efforts which could mean delays in meeting target deadlines.

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