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NATO and 5G: what strategic lessons?

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Thanks to their higher speed, larger data volume, lower latency, and capacity to sustain very high density-connections (including machine-to-machine communications), 5G networks are set to unleash a major economic revolution, potentially adding trillions of dollars to the global economy (at least according to recent forecasts).[1] From smart cities to Artificial Intelligence (AI); telemedicine to driverless cars; virtual reality to the Internet of Things (IoT); Industry 4.0 to all manner of applications that will comprise this new ecosystem, 5G ushers in enormous opportunities. 5G communications still require significant investments, both for research and development of key technologies, and for building the supporting infrastructure. Moreover, the next generation of telecommunications raises several important questions about the political economy of spectrum allocation and standard definition, their military applications, the role of Chinese companies and the attendant cybersecurity risks. These are all relevant topics for NATO from which the Alliance can draw some strategic lessons.

What is 5G?

Mobile wireless technology has evolved over four generations: voice calls in the 1980s (1G), messaging in the 1990s (2G), limited multimedia, text and internet data in the late 1990s and early 2000s (3G), and true data with dynamic information access and variable devices in the late 2000s (4G and LTE). All these generations were built, primarily, around handset-to-handset voice and data communication. Therefore, the more recent (4G) infrastructure will simply be unfit for handling the explosion of heavy data packages resulting from the diffusion of extremely high-density, large-volume and machine-to-machine communications that will soon take place.[2]

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Wireless communications use the electromagnetic spectrum, which is finite, to distribute data that, because of the increase in connectivity, is growing exponentially. The new generation of mobile telecommunication networks and technology will deliver, in comparison to its predecessor, larger volumes, up to 20 times higher speeds (enhanced mobile broadband), 10 times lower latency (ultra-reliable low latency communication), resilience, ubiquitous digital connections (massive machine-to-machine communications) and power efficiency (owing to the energy-saving features of the 5G New Radio).[3] This will be the product of several technological innovations enabling, among other things, the increase of spectral efficiency through numerous signal paths (MIMO: multiple input, multiple output) or efficient transmission of high resilience to reflection and interference (OFDM: orthogonal frequency-division multiplexing).

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2 E. Lee and T. Chan, "Telecom services: the geopolitics of 5G and IoT", *Jefferies Franchise Note*, Hong Kong, 2017.

3 D. Abecassis, C. Nickerson and J. Stewart, "Global race to 5G – Spectrum and infrastructure plans and priorities", Final Report for CTIA, London, Analysys Mason, 2018.

The promise of 5G

Through its superior performance, 5G communications promise tremendous opportunities, both for the civilian economy and in military affairs. Telecommunications have vertical or horizontal spill-over effects which can broadly affect economic growth. 5G networks hold the power to set off an economic revolution similar, and possibly superior to the one sparked by 4G when the iPhone and other smartphones spawned the growth of the app ecosystem (Twitter, Facebook, WhatsApp, Uber or Snapchat), which taken together, generated trillions of dollars in economic value. 5G networks provide the physical and software infrastructure that enables massive distribution of data and ubiquitous use of AI and cloud computing. They can lead to major surges in efficiency and productivity as well as to new, revolutionary innovations: Big Tech of tomorrow; next generation mobile devices; and new software and applications.[4]

Historically, communications have been at the centre of geopolitical competition among countries. Technology opens new opportunities. When new opportunities emerge, countries compete to reap the benefits. 5G networks are no exception

There are also important military implications, such as the advent of the so-called Internet Battlefield of Things. High-speed and ubiquitous connectivity will enable real-time and widespread distribution of massive data packages gathered through distributed sensors and across the entire force structure. In order to execute the "intelligentization" of its armed forces – i.e. the massive exploitation of artificial intelligence – China's defence planners have identified 5G networks as a fundamental enabler. Similarly, according to recent US Department of Defense documents, 5G networks are a strategic asset for transforming warfare.[5] Even NATO, in some of its recent public statements, has highlighted the central role of 5G in security and defence matters in the near future.

Competition in 5G technology

Historically, communications have been at the centre of geopolitical competition among countries. Technology opens new opportunities. When new opportunities emerge, countries compete to reap the benefits. 5G networks are no exception and this explains why, at this moment when 5G technological developments are reaching critical stages, the issue has become more sensitive.[6] Geopolitical competition around 5G revolves around three intertwined issues: 1) technological primacy; 2) spectrum allocation; and 3) standards definition.

First, industrial transitions are driven by technological change: some companies, and by default their upstream countries, will establish a temporary dominant position from which they will accrue enormous economic and political benefits. Microsoft's Office, Apple's iPhone or Intel's processors are a few examples from the past. Across all industries, there is no one perfect recipe to become an industry leader: in some cases, it is those who have the first-mover edge; in others, it is the fast follower; while in other cases, it is the second mover that ends up dominating. Nokia, for instance, invented the first smartphone but it was Apple's iPhone that conquered the market.[7] In the past four decades of telecommunications, however, first movers have been better positioned to achieve technological leadership. In the case of 5G, China not only aspires to reach this goal, but is already ahead of the pack in several critical technological domains.[8]

Spectrum allocation is the second major issue. Like other devices such as pre-digital radio and TV, wireless communications rely on the electromagnetic spectrum. At high frequencies (3 to 30 Ghz), electromagnetic waves are short and can ensure wider and cleaner bandwidth but have only limited range due to high signal attenuation. At low frequencies (30 to 300 Khz) radio communications have long electromagnetic wavelengths: low signal attenuation permit more extensive signal range and hence superior wide-area coverage but such frequencies are very congested.[9] 5G networks utilize both high (also known as mmWave, above 24GHz) and low (sub-6) frequency bands. While some countries like the US are investing in the former, others, like China, have invested in the latter. Multinational decisions about spectrum allocation – which are taken by the International Telecommunications Union (ITU) – will therefore dramatically shape international competition in 5G. Technical decisions about bands will, in effect, strengthen or weaken companies' existing technical expertise and accelerate or slow down their trajectory to industrial leadership.[10] Two additional considerations are in order. While low frequencies are already con-

4 F. Grijpink, E. Kutcher, A. Ménard, S. Ramaswamy, D. Schiavotto, J. Manyika, M. Chui, R. Hamill, and E. Okan, "Connected world: an evolution in connectivity beyond the 5G revolution", Discussion Paper, San Francisco, CA, McKinsey Global Institute, 2020.

5 Office of the Secretary of Defense, *US Department of Defense (DoD) 5G Strategy (U)*, Washington, DC, 5 May 2020.

6 S. D. Krasner, "Global communications and national power: life on the Pareto Frontier", *World Politics*, Vol.43, No.3, April 1991, pp.336-366.

7 D. C. Mowery and R. R. Nelson, *Sources of industrial leadership: studies of seven industries*, Cambridge, Cambridge University Press, 1999.

8 M. Medin and G. Louie, *The 5G ecosystem: risks and opportunities for DoD Defense Innovation Board*, Washington, DC, Defense Science Board, 3 April 2019.

9 W. Gosling, *Radio spectrum conservation*, Oxford, Newnes, 2000.

10 X. Gu, C. Heidbrink, Y. Huang, P. Nock, H. W. Ohnesorge and A. Pustovitovskij, "Geopolitics and the global race for 5G", *CGS Global Focus*, Bonn, Center for Global Studies, May 2019.

gested in many countries, and especially the US (where they are used by the military), they are more available in China. Due to their more limited range, high frequency bands are conversely less crowded, but utilizing them invariably requires more towers to distribute the signal and, hence, more capital investments. This, in turn, further affects international competition and adoption patterns.

Standardization is the third major issue: standards define a system's or piece of equipment's technical specificities in order to ensure efficiency, effectiveness, reliability, as well as interoperability among and throughout different parts of the network. Standards are also decided by consensus through Regional Standards Organizations (RSOs) and the ITU. Agreements on standards will determine both the size of the economic pie generated by 5G and how its slices get doled out. Standards are, in fact, based on existing technology. Existing technology is developed and patented by private companies. With ITU-defined global industry standards, all operators will have to rely, and pay royalties, on technologies developed by other companies. This means, on the one hand, annual cashflows amounting to billions of dollars; and on the other, a competitive advantage or disadvantage when it comes to manufacturing.[11]

China, 5G communications and their vulnerabilities

The 5G ecosystem is populated by several companies such as Cisco, Intel and Qualcomm (US), Eriksson (Sweden) and Nokia (Finland), Fujitsu and Panasonic (Japan), Samsung and LG (South Korea). The dominant role of China and Chinese companies (like Huawei and ZTE) however, makes the country a key driver of the transition to 5G, which consequently has further underscored the geopolitical salience of this issue. Two aspects deserve attention: the sources of China's prowess in 5G, and the risks such prowess poses.

China's current and potentially leading position in 5G technology has two explanations. On the one hand, China tried and failed, over a decade ago, to enter 3G competition, but learned valuable lessons which it then applied to 4G and even more so to 5G. The Chinese government launched major public investments and developed a coherent strategy, whilst private companies conducted research and patented their seminal technologies in this domain. Results have been remarkable. For instance, the Chinese telecommunications industry has already managed, among other things, to lead the 5G System Architecture Project, which shaped 5G networks structure worldwide, and secured integration of its own technology and polar coding into the 5G global standard.[12] The other explanation is that China can count on a mix of existing infrastructure and institutional features that give the country's 5G companies a competitive edge when approaching foreign markets, including widespread availability of fibre, deployments of small cells and maturity of 4G. Coupled with higher domestic availability of spectrum in low frequency bands, as well as a huge internal market and early roll-out of 5G networks, China is well placed to be a dominant worldwide player in the 5G transition.[13]

Historically speaking, this is the first time since the end of World War II that a leader of a key technology is neither an Ally nor a NATO/Western country. The concerns caused by China's rise in the field of 5G have, however, deeper and broader implications. Chinese companies have direct political connections to the Chinese government which, in the case of high-tech, involve the intelligence community. Second, China's internal big data policy – based on massive surveillance and limited privacy – is at odds with many other countries' systems of values, ethics and law. Some are concerned that the reliance on China-made equipment may bolster China's dominance of 5G; strengthen its ability to export it around the world; or both. The Belt and Road Initiative (BRI) and China's aggressive 5G foreign marketing campaigns play no small role either.[14]

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Third, and in the same vein, there are already complaints about Big Tech companies's (i.e. Google, Facebook, Twitter or Apple, among others) illegitimate or unvetted powers. These features will likely further exacerbate if the Big Tech of tomorrow are politically connected to non-liberal regimes.[15]

Finally, in recent years, Chinese companies have been repeatedly accused of stealing intellectual property and using cyber-espionage to access proprietary information. Moreover, tests on Chinese electronic devices have revealed several security vulnerabilities including backdoors that can lead to direct transfer of data to China. In the discussion about 5G networks, these issues become particularly salient because of enhanced

11 S. M. Besen and J. Farrell, "The role of the ITU in standardization: pre-eminence, impotence or rubber stamp?", *Telecommunications Policy*, Vol.15, No.4, August 1991, pp.311-321.

12 C. Bartholomew, "China and 5G", *ISSUES*, Vol.36, No.2, Winter 2020, pp.50-57.

13 S. Lo and K. Lee, *China is poised to win the 5G race: key steps extending global leadership,* London, Ernst & Young Global Limited, 2018.

14 E. B. Kania, *Securing our 5G future: the competitive challenge and considerations for US policy*, Washington, DC, Center for New American Security, November 2019.

15 J. D. Caverley, "Slowing the proliferation of major conventional weapons: the virtues of an uncompetitive market", *Ethics & International Affairs*, Vol.31, No.4, 2017, pp. 401-18.

bandwidth and growing connectivity. Perimeter cyber defence will no longer be effective as it will not be possible to grant access exclusively to authorized devices. This raises the risk and severity of attacks. Moreover, in 5G architecture, software will play a much more critical role than in the past because network virtualization and AI can both ensure higher efficiency and be better able to handle network complexity. However, this will blur the previous distinction between core portion (comprising the central switching and transport networks) and the radio access network (RAN: base stations and antennas). As a result, equipment integrators (i.e., potentially, Chinese companies) will enjoy wider and deeper access to network operations, thus raising serious questions about trust and reliability. 5G networks will in fact distribute huge amounts of sensitive data, including industrial equipment's performance and analytics on new innovations. A network operator could extract such data either to offset competition or pass it to friendly companies in other fields which in turn would have the effect of stifling emerging innovators.[16]

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What strategic lessons for NATO?

For NATO and its Allies, the 5G debate highlights some strategic lessons. First of all, the lack of a unified transatlantic voice about 5G observed thus far does not just reveal divergences in threat assessments. It possibly highlights a new normal: NATO is a military alliance of democracies which was not designed to deal with trade policy, industrial leadership and market competition in the world of high-tech. However, as new bubbles of innovation emerge beyond the Alliance's borders, adjustments may become necessary. Whether such adjustments should consist of a significant redefinition of NATO responsibilities as one possibility, or deployment of strategies, policies or frameworks as another, is up to the Allies to decide.

Second, even though 5G networks are not primarily and squarely about defence and security, they have important ramifications for these domains. Transatlantic cooperation in these areas is still key. Cybersecurity and cyber defence play a growing role in the NATO collective defence effort and working together on these issues is therefore not only of the utmost importance for the Alliance, but already part and parcel of its core responsibilities. By the same token, if 5G delivers on its promise, it will significantly impact warfare in the years ahead. There will be major implications for defence planning, modernization, procurement and quite possibly for deterrence and defence. Attention from the Alliance and the Allies to these issues is crucial.

Third, because of their common values, the wide set of common members, and the complementarities between the two organizations, the European Union and NATO have a strong interest in working together on 5G. The EU promotes research and investments, sets common parameters on spectrum allocation among its members, fosters internal competition and monitors compliance with existing laws and regulations (from privacy to fundamental rights). On its part, NATO can continue to work on cyber security and defence.

Fourth, China's 5G ascendancy raises questions about economic and technological intelligence. Has this rise been understood and was it anticipated? What was done and what could or could not be done? As technology accelerates outside NATO borders, beyond the world of security and defence, economic and technological intelligence becomes all the more imperative. In hindsight, it may have been warranted to strengthen existing open-source and public capabilities in this domain and even establish a new unit or organization, akin to the US Office on Technological Assessment (which was dismantled in 1995).

Finally, as NATO Allies navigate the present and learn from the past, they also need to start looking into the future. Mobile communications have transitioned from one generation to the next about every ten years in the past four decades. China leaped into 5G from its failed bid into 3G. Preparing for the 6G race is therefore crucial. Such preparation should probably start soon.

16 D. Kim and M. Zarri, *Road to 5G: introduction and migration*, London, GSMA, 2018.

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