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RESEARCH ARTICLE

From Cold War Geopolitics to the Crisis of Global Capitalism: The History of Chinese Wireless Network Infrastructures (1987–2020)

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Abstract
This paper explores the genesis and growth of the current Chinese wireless network infrastructures by pulling together the historical threads of two telecommunications infrastructures: first, the development of the first-tier inter-provincial optical backbone, the "Eight Vertical and Eight Horizontal Fibre-optic Grid," in the late 1980s and 1990s; and second, the deployment of two broadband-access cellular networks, the third-generation (3G) cellular networks in 2008 and the fourth-generation (4G) networks from 2013 to now, which constitute the wireless network's edges. I insert the development of Chinese wireless networks since the 1980s into the interconnected global technological environment, contextualizing the infrastructure deployment in the history of Sino-American technological cooperation and competition, traversing the final decade of the Cold War era (the 1980s), the dual global expansion of economic neoliberalism and informational technology since the 1990s and the crisis of global capitalism since 2008. This historical inquiry reconciles two historical (meta-)narratives that are not always compatible with each other – the Chinese narratives grounded on the overarching concept of Chinese post-socialism, and the narratives in Western discourses that often evoke Cold War/post-Cold War dialectics. This paper examines the global distribution of wireless network infrastructures on the basis of commercialization, technology transfers and trades of techno-commodities across borders, challenging the reduced depiction of the Chinese wireless network as an extension, or an exception, to the West-centred techno-capitalist system.

摘要
本文探讨当代中国无线通信网络基础设施的发展历史。本研究指出中国现今使用的无线通信网络是由两大电信基础设施叠加构成：其核心网络沿用从兴建于八十年代末和九十年代的"八纵八横"大容量光纤通信网；接入网则由 2008 年至 2013 年建成的 3G 移动通信网络和 2013 年建设至今的 4G 移动通信网络共同组成。本文梳理了在互联互通的全球科技环境中，中国无线网络基础设施建设。通过追溯中美科技合作和竞争从冷战最后十年（80 年代）开始，到经济新自由主义和信息技术的双重国际扩张（90 年代），再到自 2008 开始的国际资本主义危机，本文将无线网络基础设施建设的发展历程置于中美科技合作和竞争大背景下，进而调和两种并不完全兼容的历史叙事：即基于中国后社会主义这一框架下的中方叙事和以冷战/后冷战为核心辩证逻辑的西方叙事。本文将全球无线网络基础设施建设具体化为一系列的技术商业化，跨国技术转让和商品交易，并以此为切入点，挑战了主流观点中两级分化的简单描述，即将中国互联网基础设施视为以西方为中心的科技资本主义系统的延伸抑或系统之外的孤例。

Keywords: digital infrastructures; wireless and mobile networks; US–China technology cooperation; global economic crisis; Cold War geopolitics; neoliberalism

关键词: 数字基建; 无线通信网络; 中美科技合作; 全球经济危机; 冷战地缘政治; 新自由主义

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On 27 January 2020, soon after the outbreak of COVID-19 in Wuhan, CCTV Live collaborating with China Telecom launched a livestreaming channel that invited audiences at home and abroad to constantly monitor the construction progress of Leishenshan 雷神山 and Huoshenshan 火神山 hospitals, two emergency medical care facilities to be built to expand Wuhan city's hospital capacity that was strained by the skyrocketing number of coronavirus patients. Lasting for six days and nights until the construction was completed on 2 February, this 24/7 livestream fascinated more than 90 million viewers. It successfully changed the public's attitude from blaming the Wuhan government for not responding more quickly to the early outbreak to marvelling at its efficiency and effectiveness in handling the crisis, bringing hope to people that the pandemic might soon come to an end with the building of new medical facilities.

It is not a completely new story that rapid infrastructure-led development has been employed in contemporary China to keep public faith in social progress and a better future. But the livestream of the entire hospital construction process reveals two new tendencies in infrastructure-based development and state governance that are worthy of our critical attention: First, for national policymakers, infrastructure development has become a panacea for all problems and crises, including not only scientific and technological backwardness, economic stagnation and social inequity, but also pandemic diseases. Second, while livestreaming, as a new media venue, showcases the expeditious development of infrastructure development in traditional areas of civil engineering, the Wuhan livestream also gave exposure to a new infrastructure that provides the material foundation and technological support for reliable transmission of high-definition video in real time – the 5G mobile network. More than enabling the livestreaming of construction sites, installed 4G/5G network systems would also serve to facilitate remote diagnosis when the hospitals were put into use.

If the makeshift COVID-19 treatment facilities threw a public spotlight on wireless and mobile network infrastructures, these infrastructures soon became a hot topic in China and worldwide. As China planned to restart its economy in early March 2020, the central government devised the development of these network infrastructures as a socio-economic tool and boosted them to the top of the national agenda to kickstart the economic recovery. After the Politburo Standing Committee urged all levels of government and relevant sectors of the economy at its meeting on 4 March 2020 to "expedite the development of new infrastructures such as 5G networks and data centres" as the key engine of economic growth, news headlines seized on neologisms such as "new infrastructure" (*xin jijian* 新基建) and "digital infrastructure" (*shuzi jijian* 数字基建) as buzzwords. Differentiating them from "old" infrastructures (now satirically referred to as *tie gong ji* 铁公基), including roads, railways, water supply and electrical grids, as well as older telecommunications infrastructures of wired configuration, the National Development and Reform Commission (NDRC) officially defined "the new infrastructures" by establishing three categories of digital infrastructure: (1) new information and communications technology infrastructures enabling frontier technologies, such as communication infrastructures for 5G networks, the "internet of things" (IoT), industry IoT, satellite internet, infrastructures facilitating artificial intelligence (AI), cloud computing, blockchains and data centres and high-performance computing centres; (2) physical digital-integrated infrastructures that use the internet, big data and AI technologies to transform and upgrade old public facilities; and (3) public-benefit infrastructures providing support for fundamental research in the fields of science and technology.[1] This categorization calls for prioritizing the deployment of new infrastructures in the next round of infrastructure-based development, encouraging local governments to partner and cooperate with private high-tech companies as well as diverse investments from the private sector. More than an ad hoc manoeuvre to fuel an economic boom at a time of global pandemic, the new infrastructure development was included in the 14th Five-Year Plan (FYP) (2021–2025) in May 2020 and assigned a key role in the new economic

1 "Guojia fagai wei jintian shouci mingque xinxing jichu sheshi de fanwei" (NDRC defined and classified new infrastructures today), *Guancha.cn*, 20 April 2020, https://www.guancha.cn/politics/2020_04_20_547551.shtml.

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and industrial development emphasizing a stronger domestic economy, industrial restructuring and the digital transformation of society. Among other focal areas, the 14th FYP highlights the development of new infrastructures in the master plan of digitalizing rural China, enlisting it as part of the continuous efforts to advance agricultural and rural modernization.[2] The accelerated extension of the coverage of high-speed-access networks, 4G/5G wireless networks and gigabit fibre networks to rural areas will help to bolster new models for the rural digital economy (as well as rural governance), contributing greatly to the alleviation of poverty and the improvement of rural livelihoods.

While next-generation wireless and mobile network infrastructures are gaining momentum in China's domestic socio-economic activities, these new network technologies were caught in the crossfire of ideological and geopolitical tensions as the US–China trade war waged in 2018 escalated into a high-tech war in the following year. Perceiving China's rise as a scientific and technological threat to US technological superiority and economic supremacy, the White House took a series of steps to crack down on Chinese tech companies, ranging from sanctions against Chinese apps WeChat and TikTok to the Clean Network Initiative intended to keep Chinese hardware companies like Huawei and ZTE out of the 5G infrastructures of the US and its allies.[3] These policies feed the increasingly dominant narratives about Chinese digital development in American media coverage, which often paint networked infrastructures as a symbol of the monolithic authoritarian state in contrast to the "democratic West." Echoing Cold War politics and rhetoric, these narratives, as an AI Now Institute essay illuminates,[4] often lead to unproductive "whataboutism," and ignore the reality of the US and China's interdependence in the technological environment. Moreover, these narratives erase efforts calling for reflection on and regulation of digital technologies on both sides.

Written at this moment of historical uncertainty, this inquiry reinserts the development of Chinese wireless networks infrastructures since the 1980s into the interconnected global technological environment, reconciling two historical (meta-)narratives that are not always compatible with each other – the Chinese narrative grounded on the overarching conception of Chinese post-socialism, and the narrative in Western discourse that often evokes Cold War/post-Cold War dialectics. Rather than simply depicting Chinese wireless network infrastructures as an extension or exception to the West-centred techno-capitalist system, I examine wireless network infrastructures as the result of commercialization, technology transfers and the trading of techno-commodities across borders. In doing so, this paper excavates an overdue, hidden history of Chinese wireless and mobile network infrastructures – the *new* infrastructure par excellence. Rather than conforming to current conceptions, or intentional misconceptions, of digital infrastructures that overstate their "newness" to mark a radical rapture and legitimize future investment plans in digital infrastructures, I reveal that what undergirds the current wireless network system is the large assemblage of heterogenous yet interconnected interoperable systems mixing old and new, wireless and wired networks. Seeing the existing wireless network as the result of the accidental amalgamation of multiple networks, this paper brings together the historical threads of two network infrastructures: first, the development of the first-tier inter-provincial optical backbone network, the "Eight Vertical and Eight Horizontal Fibre-optic Backbone" ("*bazong baheng*" *guangqian ganxian wang* "八纵八横"光纤干线网; hereafter the fibre-optic backbone), in the late 1980s and 1990s as part of the nationwide telecommunications network; and second, the deployment of two broadband-access cellular networks, the third-generation (3G) cellular networks in 2008 and the fourth-generation (4G)

2 "China to further empower rural development with digital technologies," *English.www.gov.cn*, 9 May 2020, http://english.www.gov.cn/statecouncil/ministries/202005/09/content_WS5eb6ac70c6d0b3f0e949746c.html.

3 Ana Swanson, "Trump bans Alipay and 7 other Chinese apps," *The New York Times*, 5 January 2021; David Shepardson, "U.S. FCC votes to advance proposed ban on Huawei, ZTE gear," *Reuters*, 18 June 2021.

4 Meredith Whittaker, Shazeda Ahmed and Amba Kak, "China in global tech discourse," *AI Now Institute*, 27 May 2021, https://medium.com/@AINowInstitute/china-in-global-tech-discourse-2524017ca856.

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networks from 2013 to now, which constitute the wireless access networks connecting users to local networks and the internet. Initially following independent trajectories, the development of these two telecommunications networks converged with the advent of dual-mode (wi-fi + cellular) mobile devices, and they were consolidated into the current wireless network system.

The deployment of these telecommunications infrastructures must be contextualized in a history of Sino-American technological cooperation and competition traversing the final decade of the Cold War era (the 1980s), the twin globalization processes of economic neoliberalism and informational technology since the 1990s and the crises of global capitalism that have unfolded since 2008. The first section examines the development of the Chinese fibre-optic backbone under post-socialist China's efforts to assimilate into global capitalism since the 1980s and its complicity with the US's shifting political and economic ideologies and policies towards China in the transition from the Cold War to the post-Cold War. It details the technology transfer of fibre-optic core network systems from the US to China, first as a dual-use technology to change the geopolitical order of the Cold War, and then as a techno-commodity facilitating the rise of global neoliberalism in the 1990s. The second section focuses on the massive development of 3G and 4G cellular network infrastructures since 2009. Rejecting the myth of the linear progression of Chinese wireless technology encapsulated by this generational nomenclature, this paper sees the deployment of 3G and 4G wireless infrastructures as a turning point in post-socialist Chinese economic and industrial policies in the face of the crisis of global capitalism that exploded in 2008. The development of 3G and 4G wireless infrastructures was wielded as a part of the economic stimulus plan to fend off the impact of allegedly exogenous global economic crises on China's national economy. The investment in wireless infrastructure was also instrumentalized as a politico-economic tool to facilitate crisis-induced industrial and economic restructuring with the goal of reducing the Chinese information and communication technology (ICT) sector's increasing dependence, developed in the early reform days, on export-led economic growth and foreign technologies.

The "Eight Vertical and Eight Horizontal" Fibre-optic Backbone (1987–1998)

Notions of the Chinese internet prevailing in Western political, popular and even scholarly discourse almost invariably revolve around the most sensational Chinese internet "infrastructure" – the infamous "Great Firewall." Collapsing network security technology that monitors and controls incoming and outgoing network traffic (the firewall) with the architectural symbol of nation-state border enforcement (the Great Wall), the imagery of the Great Firewall perpetuates an imagination of the Chinese internet as enclosed, centralized and highly totalitarian, which represents the sharp antithesis of the West-centred global internet – professed to be decentralized, egalitarian, open and free in many accounts available in English. However, an investigation of the historical configuration of the physical substratum of the Chinese internet, known as the "Eight Vertical and Eight Horizontal" Fibre-optic Backbone, disrupts the imagined structure of the Chinese internet as one that hinges solely on the imagery of the Great Firewall.

Serving as the network core of the current wireless and mobile network system, the "Eight Vertical and Eight Horizontal" Fibre-optic Backbone refers to the nationwide, inter-provincial, fibre-optic core network of the Chinese internet and telecommunications networks designed and built up in the 1980s and 1990s. Taking the shape of a grid, this long-haul fibre-optic core network consists of 22 long-distance fibre-optic cables totalling 800,000 km in length, criss-crossing the entire country, and interconnecting almost all the provincial capitals.[5] Few know that the incipient development of the fibre-optic backbone took place in Wuhan, on a trial basis between Wuhan and Nanjing in 1987. The resultant "Ning–Han Optical Cable" (*Ning Han guanglan* 宁汉光缆) is then

5 Li 2008, 20–22.

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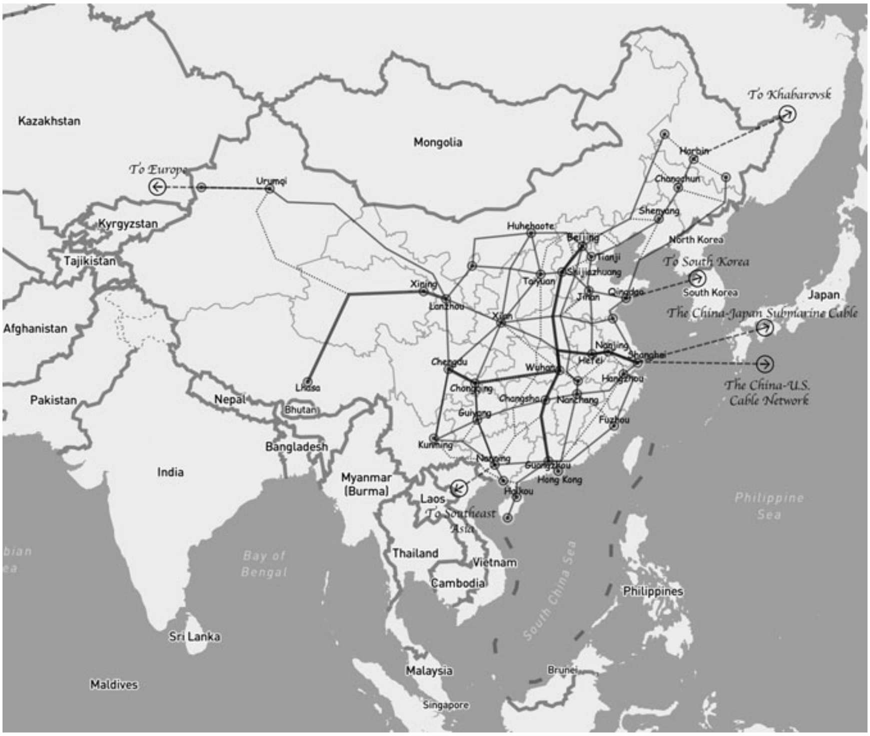

Figure 1. The "Eight Vertical and Eight Horizontal" Fibre-optic Backbone

considered to be the first long-haul optical cable of this megaproject.[6] The "Jing–Han–Guang Optical Cable" (*Jing Han Guang guanglan* 京汉广光缆), constructed in 1993, became the first vertical artery running north and south to connect Beijing, Wuhan and Guangzhou. The completion of the "Lan–Xi–La Optical Cable" (*Lan Xi La guanglan* 兰西拉光缆) in 1998 symbolically marked the end of the construction project, in the sense that the far-flung optical network had stretched all the way to the Qinghai–Tibet Plateau, covering even the farthest frontier zone of the nation.[7]

The development of the fibre-optic backbone can be divided into two phases based on different scales and speeds. The first phase, characterized by preparatory technology transfers and small-scale pilot projects, can be traced back to the mid-1980s (1985–1987). The second phase, covering the entire decade of the 1990s, witnessed the deployment of the fibre-optic backbone on a national scale, with a programme that was initiated in 1987 and moved into higher gear in 1994. In the conventional, quasi-official narrative in China, the Eight Vertical and Eight Horizontal megaproject is often depicted as an achievement of Chinese post-socialism, the fruitful outcome of the country's 40 years of reform and opening up. The retrospective delineation of infrastructural development as an achievement of the Chinese party-state's unwavering pursuit of reform policies under post-socialism imposes a framework of relentless linear progress, which recentres rapid socioeconomic development, with science and technology modernization playing the key role. More than a period "after" socialism as the prefix "post-" suggests, post-socialism is a historical period of turmoil and transformation full of irreconcilable ideological contradictions resulting from the paradoxical negation and inheritance of social relationships and political organisations of the socialist era.

6 Wang 1996.

7 Ya Zeng et al., "Chongzou Lan Xi La xinxi tianlu jixing" (Retracing the route of Lan–Xi–La Optical Cable: a travelogue of the informational "road in heaven"), *Renmin youdian bao*, 11 December 2019.

On the one hand, the Chinese post-socialist reform features a gradualist strategy that simultaneously retains socialist central planning in strategic industries while adopting market reforms. Later termed the "China model," with mixed connotations, the Chinese post-socialist transition distinguishes itself from sudden and dramatic neoliberal reform, i.e. the "shock therapy" prescribed to Chile, Bolivia and the post-Soviet states. The construction of the fibre-optic backbone, included in the Seventh FYP and led by the now-defunct Ministry of Posts and Telecommunications (MPT), is vaunted as the vindication of the Chinese model of rapid economic development and modernization in which centralized planning and top-down design are major determinants.

By the same token, the "eight vertical and eight horizontal" grid has also been standardized as the Chinese model for developing large-scale network infrastructures, in telecommunications and beyond, at home and abroad, garnering wide use in naming and mapping megaprojects. The "eight vertical and eight horizontal" grid structure that characterizes the fibre-optic backbone has been appropriated as the paradigm for mapping other networked infrastructures. For example, the Railway Network Plan (2016–2030) that set the goal of doubling the nation's total railway route length adopted the same terminology by expanding the almost-completed "four vertical and four horizontal" high-speed railway network to a new "eight vertical and eight horizontal" network. The grid pattern is also being exported to the Global South under the Belt and Road Initiative as a viable, transferable and reproducible paradigm of infrastructural development. The China–Africa telecommunications infrastructure cooperation project inaugurated in 2017, for example, also adopts the language of "eight verticals and eight horizontals" and employs this grid design to form the fibre-optic backbone of a planned high-speed internet network covering the entire African continent (connecting 48 countries and 84 major cities).[8]

On the other hand, undertaking a "radical negation" of the Cultural Revolution, Chinese post-socialism at the turn of the 1980s dislodged the prior association of "revolution" with social and political transformation and replaced it with technological revolution.[9] As Xiao Liu elucidates, in the post-socialist era, the alleged "new" era of drastic difference, modernization became synonymous with economic development and the superiority of technology, especially information technology.[10] Deng Xiaoping's 1978 speech at the opening ceremony of the National Conference on Science elevated science and technology to the primary productive forces, and spurred the rapid development of high technologies, such as electronic computing, cybernetics and telecommunications. A concomitant policy restoring the socio-political status of intellectuals encouraged scientists, engineers and technicians to concentrate their energy in research. Science and technology were subsequently fetishized as the liberating force emancipating post-socialist subjects from the shackles of political roles, thereby unlocking a different, democratic future. For this reason, retrospective reports on the development of information technology often celebrated Chinese scientists' and engineers' independent research and great resilience in making technological breakthroughs during the Cultural Revolution.[11] In an article reviewing the research and development of the first fibre-optics in China in the 1970s, scientist Zisen Zhao was dubbed the "father of China's fibre-optics," suggesting that he and his team developed the first fibre-optics from scratch despite the political upheaval. Although this article celebrated the lost history of Chinese fibre-optic technology, its post-socialist narrative style led to an overstatement of Zhao's achievement. The narrative of the independent development of the first fibre-optics becomes less convincing if we recall the Chinese scientific community's decades-long stagnancy amid internal strife and international isolation.[12]

8 "Zhongtongfu wenbu tuijin feizhou baheng bazong kuandai jianshe" (China communication services are advancing the construction of "eight vertical and eight horizontal" wideband communication networks in Africa), *Fmprc.gov.cn*, 25 January 2017.

9 Liu 2019, 30.

10 Ibid.

11 He 2017.

12 Ibid.

Although the Chinese narratives illuminate some aspects of the development of the fibre-optic backbone, they fail to tell the whole story. The overarching descriptive framework of Chinese post-socialism leads to a convenient depiction of post-1980s China in isolation, with the global context largely dismissed. The post-socialist framework and its implied simple equation of China's post-Mao era (post-1979) with the end of the Cold War (post-1989) excludes the Cold War geopolitical tensions that loomed large in the 1980s and undermining post-Cold War struggles persisting until today. Post-socialist China doesn't exist in a vacuum; on the contrary, the contradiction of Chinese post-socialism also manifests itself in the complex relationship with global capitalism, as Arif Dirlik has elucidated.[13] The reinsertion of the Chinese development of the fibre-optic backbone into the global context will help to recoup the role of the changing international political and economic order that created and continued to create an array of opportunities, challenges and constraints for the existing socialist state as it seeks a certain relationship to global capitalism.

Far from being an independent development as is often alleged, the fibre-optic backbone carried out in the 1980s and 1990s is inseparable from the checkered history of US–China cooperation and competition in science and technology that began in the final decade of the Cold War era and flourished across the post-Cold War era in the form of technology transfer, technical assistance, financial subsidies and international bank loans. With the US and its allies acting, more often than not, as the technology provider and China as the recipient and importer, the technological cooperation imbricated the Chinese development of fibre-optic infrastructures deeply with that of the West and exerted an impact on the shape of the fibre-optic backbone, as well as the scale and speed of its construction.

Instead of seeing the grid pattern of the fibre-optic backbone as the embodiment of the Chinese state's centralized and top-down planning within the purview of Chinese socialism/post-socialism, this pattern can also be understood as the topographical foundation of a distributed network. To do so, we must adopt a perspective that acknowledges the indispensable role of US–China technological cooperation and the shifting politics of the Cold War/post-Cold War transition.

More than a coincidence, the topography of the Chinese grid happens to closely resemble the distributed networks designed by Paul Baran when he was a researcher at the RAND Corporation. Featuring a mesh-like topography, Baran's diagram was widely recognized as the origin of the US internet as well as the global internet and thus sat at the heart of Cold War/post-Cold War debates. Contemporary media scholars and internet historians, such as Fred Turner and Alexandra Galloway, argue that the distributed diagram buttresses the US internet's transformation from a state-sponsored military-industrial machine powering the Cold War to the emblem of the decentralized, egalitarian and free society of post-Cold War America, because the distributed diagram can function independently from centralized command.[14] Others insist that, despite the end of Cold War, the residue of military power is nonetheless deeply buried in the subterranean infrastructures of the internet and continues to haunt it. Richard Barbrook argues that Baran's network, devised to improve the reliability of battlefield communication, reinstates the lingering Cold War influence in the architecture of telecommunications and computer networking.[15] Tonghui Hu's inquiry into the physical geography of the ARPAnet detects the actual physical geography of the US internet's secret entanglement with the state's Cold War military apparatus.[16] Not unlike the contestation surrounding the US internet, the similarly geographically distributed Chinese grid, whose development straddles the Cold War/post-Cold War transition, is also a complex intertwining of two legacies: that of the persistent Cold War geopolitical strategies, and that of ascending neoliberalism, which co-opted rather than dismantled the force it opposed.

13 Dirlik 1989.
14 Galloway 2005, 30; Turner 2006, 8.
15 Barbrook 2007, 165.
16 Hu 2015, 7.

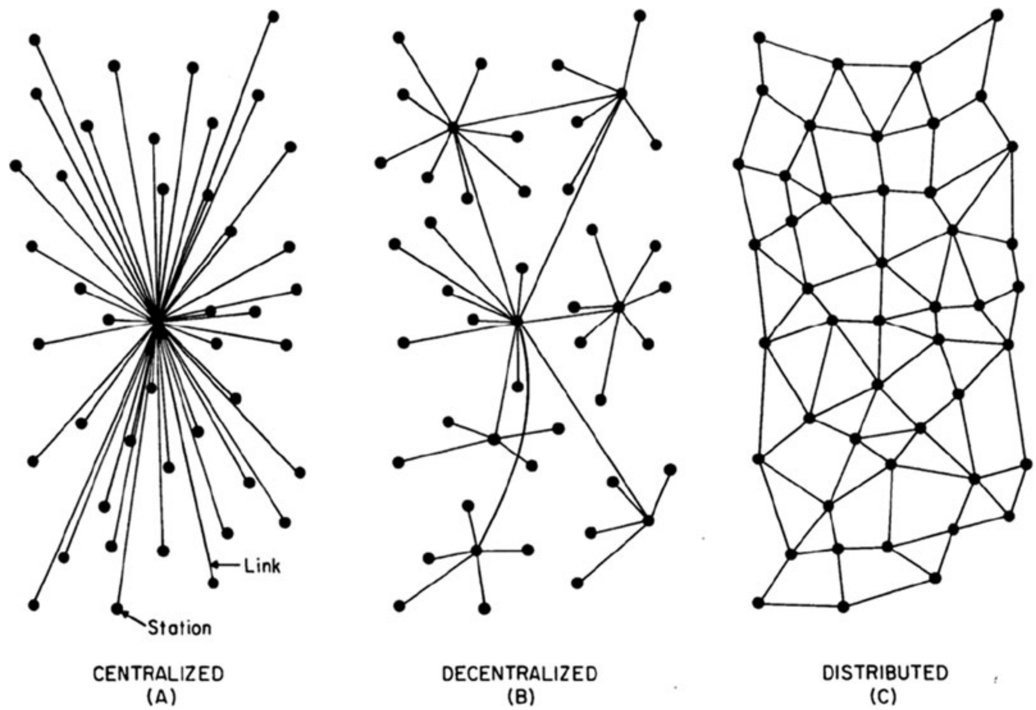

Figure 2. Paul Baran's Centralized, Decentralized and Distributed Networks
Source: Baran 1962.

Similarly, the aforementioned two-phase development of the fibre-optic backbone manifests, rather than the continued expansion assumed by the Chinese narrative, a Cold War/post-Cold War rupture. The tempo and scale of China's fibre-optic core network development are contingent upon, and thus reflective of, the ebb and flow of the struggle between two forces in US global strategy: the political goal of containment that dominated Cold War American foreign policy; and the rise of neoliberalism, or the arrival of the "new economy," that pushed the twin global expansions of capital and information technologies. In the 1980s, since key optical communication technologies (i.e. fibre-optics and digital switching) were still considered critical dual-use technologies serving both military and civilian purposes, their recognition either as critical weapons-related technologies whose acquisition by potential enemies would pose threats to American national security or as technologies primarily geared toward civilian use by commercial interests mirrored the political pendulum's swing in favour of Cold War politics or the post-Cold War rise of neoliberalism. The 1990s witnessed a shift of this bilateral technology cooperation from one in the name of military sales and defence cooperation in the Cold War era to that of post-Cold War cooperation featuring technology commercialization and global diffusion in tandem with the configuration of the global economy.

In the 1980s, the closing decade of the Cold War, US–China cooperation in optical communications was paradoxically enabled and frustrated by the US's pro-China adjustments in international politics and defence strategies in order to fight another round of the Cold War. According to Paul Edwards, Cold War US politics manifested a conversion of direct military conflicts into defence build-up contests and a strategic transference of all political conflicts to a struggle with the Soviet Union.[17] The strengthening of military and technological ties between Washington and Beijing in the 1980s was by no means a digression from this major Cold War theme. As evoked

17 Edwards 1996, 278–288.

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in the Washingtonian parlance of "playing the China card," the alignment with China was intended to form a "strategic triangle" among the US, the Soviet Union and China, using the escalation of Sino-Soviet conflict as a counterweight to curb growing Soviet expansionism, and eventually to improve America's global position vis-à-vis that of the Soviet Union.[18] Facing the implacable enemy of the Soviet Union, China has little recourse but to seize this chance of mending fences with the US after two decades of hostility. To form this strategic triangle, Washington decided to initiate munitions and technology transfers to China, using Sino-American cooperation in defence-related technology as one powerful lever. Although couched as "American assistance to China's modernization program," this defence-related technological cooperation was more motivated by US desires to achieve a delicate geopolitical power balance, and as such it was carefully planned to be accompanied and limited by American precautions against the competition. According to the Pentagon's guidance, US assistance in increasing China's defence capabilities, on the one hand, would help China protect itself more effectively against Soviet aggression, frustrating Moscow's global ambitions. On the other hand, it would not contribute to the improvement of China's offensive capabilities, which would pose a risk to US national security in the future.[19] It is via such strange facilitative and restrictive arrangements that technologies and equipment crucial to the development of the fibre-optic backbone were transferred to China as "militarily critical technology" under multi-level policies and regulations.

Little has been preserved in recent memory, but the embryonic idea of the fibre-optic backbone was incubated as part of one of the largest, yet ultimately ill-fated, military-technological cooperative projects between the US and China in the 1980s.[20] This cooperative project was dubbed the Peace Pearl Project by the US side and the 82 Project (*Ba er gongcheng* 82 工程) in China.[21] Despite their mutual interests, the two different and seemingly counterintuitive monikers for the same project suggest the American and the Chinese sides' divergent understandings of the project: the American side apprehended the project as part of Cold War politics; the Chinese side named the project after the total investment of US$8.2 billion and saw the cooperation as a step towards rapprochement with the US and assimilation into the global capitalist system. It was under the auspices of this mammoth programme that a package of optical communication technologies was transferred from the US to China and a group of American technical advisors was sent to China to provide corresponding training.[22]

While the Sino-American military-technological cooperative programme opened a channel for the transfer of sophisticated telecommunications technologies to China, Washington also devised dual-pronged export controls to ensure that the export of fibre-optic cabling equipment and the transfer of related technologies to China were limited to a controllable scale and pace. The dual-pronged export controls consisted of one prong involving US national export-control policy, and the other a multi-national export-control regime, in particular the Coordinating Committee for Multi-lateral Export Controls (CoCom), established by the US and its allies. Although the 1983 American Export Administration Regulations – the national export policies in operation at that time – had lifted the strict embargo on high-tech transfers with China by establishing the three-tiered control system,[23] they still categorized optical communication technologies and telecommunications equipment (e.g. digital switches and fibre-optics) in the intentionally ambiguous "yellow zone" and demanded that these technologies and equipment be transferred to China on the basis of

18 Yuan 1995, 47–79.

19 "Munitions/Technology Transfer to the People's Republic of China," US White House national security decision directive no. 11, 22 September 1981, https://irp.fas.org/offdocs/nsdd/nsdd-11.pdf.

20 Jim Mann, "China cancels U.S. deal for modernizing F-8 jet," *Los Angeles Times*, 15 May 1990.

21 Wen Tiejun discusses the 82 Project as a continuation of 1970s' 43 Project and a shift of the priority of investments from heavy industry to light industry in his book *Eight Crises: True Experience in China, 1949–2009*. Wen 2013, 86.

22 Yi 2018.

23 Meijer 2018, 69.

a case-by-case inter-agency review by the Department of Commerce, the Department of Defense and other agencies.[24] Whereas the export regulations de jure allowed the transfer of telecommunications technologies to China by creating the "yellow zone," the slow and cumbersome export license review process held down the numbers and restricted the purposes of sophisticated technological commodities destined for China. Meanwhile, the Ronald Reagan administration refused to remove China from CoCom control, requiring the submission of Chinese cases to exceptional review. These control policies resulted in a simultaneous acceleration and braking of technology transfers to China. In addition to regulating the pace, the dual controls also restricted the use of exported technological commodities. As a major supplier of digital switches, AT&T's sale of its 5ESS Switching System to Wuhan for the experimental arrangement of trunk lines was subject to the dual export controls.[25] AT&T's export license was approved only for digital switches to be installed in Wuhan city's local telecommunications systems and inter-city connections within Hubei province between Wuhan, Jingzhou and Shashi. The development of the fibre-optical core network beyond the provincial scope was strictly prohibited.

This dual export control was not eased until 1987. And, notably, it was the 1987 relaxation of the dual export control that afforded an expansion of the haphazard local arrangement of trunk lines to the deployment of a nationwide telecommunications system. Ironically, the relaxation of the control resulted from the discrepancy between American control strategies and multinational control policies. In 1986, CoCom authorized a new regulation that divided its International Industrial List into three groups, imitating the three-tiered US export control system, in order to reduce the processing time of soaring exports destined for China. But whereas the US export control system categorized optical communication technologies under case-by-case review, CoCom enumerated telecommunications equipment (including fibre-optic cables, fibre-optic manufacturing equipment, tooling for fibre-optic connectors and couplers, communications switching equipment, etc.) in its newly created China "green line" and, by doing so, made it possible for these technologies and their equipment to be exported to China at "national discretion," with no need to ask CoCom for prior approval.[26] The relaxation of CoCom controls emboldened other CoCom members, such as Japan, France, Belgium and Germany, to vie with each other for China as an untapped market by adopting more flexible export policies and offering financial subsidiaries to their Chinese customers. The competitive pressure from allies also forced the US to further free up items on its own control list to accommodate the export sales and economic interests of American tech companies.[27] The relaxed controls and enlarged commodities options offered by CoCom members energized the Chinese development of fibre-optic networks that had heretofore remained circumscribed, upgrading the regional experiment into a major national project in 1987. The Ning–Han Optical Cable, for example, was built with a mixture of technologies and components imported from different countries: it used 12 core single-mode fibre-optic cables from America's Siecor and a 140Mbit/s (megabits per second) PHD digital switching system from PKI Germany.[28] Stretching the line linking Wuhan, Jingzhou and Shashi across the Yangtze River to Nanjing, the Ning–Han Optical Cable became the first artery of the inter-provincial network connecting North and South China.

The whirlwinds of the development of the fibre-optic backbone gathered new momentum in 1993–1994 and swept through the whole country in the following decades in the wake of the further liberalization of US export controls vis-à-vis China after the collapse of the Soviet Union and the demise of CoCom at the end of the Cold War. This liberalization, while signifying a decline of Cold War controls, also embodies the rise of neoliberalism as the new ideological hegemony ruling

24 Yuan 1995, 56.

25 "AT&T sells city-made communication system to China," *Oklahoma City News*, 10 July 1985.

26 Meijer 2018, 69.

27 US House of Representatives, "Technology Transfer to China, Hearing Before the Subcommittee on Oversight and Investigations of the Committee on Energy and Commerce," 100th Congress, first session, 1988.

28 Li 2008, 20–22.

the political, economic and technological exchanges between the US and China, in view of the liberalization that was attained through liberalization policies deliberated and imposed by governments and international institutions such as the International Monetary Fund, World Bank and World Trade Organization (WTO). In this new era of the "new economy" with "informational, global and networked" as its distinctive features, the global expansion of the information and communications infrastructures intertwined closely with the globalization of economics and deregulation of trade and financial markets.[29] Following the shift of the R&D centre of information and communications technologies from the defence-budget-funded military-industrial complex to the commercial high-tech sector, the US government redefined its role in technological innovation and international technology diffusion. Becoming the main advocate of globalization, the new Bill Clinton–Al Gore administration devoted all-out effort to dynamizing rather than hindering the new economy and the global diffusion of internet and telecommunications technologies. The initiative to build a Global Information Infrastructure (GII) envisaged weaving together a seamless web connecting all telecommunications and computer networks worldwide. The GII fostered American telecom companies' expansion to new overseas markets to absorb their growing productive capacity in telecommunications products and services as domestic demand was close to saturation. It also unified more economies around a set of homogenous rules governing the quasi-free flows of capital, technology and trade around the planet, to the degree that few countries dared to defy the rules or stay out.

Seeing this new global infrastructure as an opportunity to modernize their telecommunications sector and reform the economy, China responded favourably to these initiatives and developed the nationwide fibre-optic backbone rapidly and systematically from 1994 to 1998. The configuration of the network backbone has barely changed since then, performing to this day as a network core for the current wireless and mobile network system. The temporary breakdown of the Jing–Han–Guang Optical Cable on 30 March 2017, which caused an internet speed drop throughout South China, reveals that internet traffic today still depends on the main routes developed in the 1980s and 1990s, despite multiple technology upgrades. Connecting to telecommunications and computer networks worldwide through multiple optical submarine cables (e.g. the "China–Japan Submarine Cable" in 1993, the "China–US Cable Network" in the early 2000s, and the "South-East Asia–Middle East–Western Europe 3" in the late 2000s), China incorporated its fibre-optic network into the global informational infrastructures and linked their fate to the West-centric global capitalist system. Moving towards greater integration into the global technological and economic system, China began to ride the tiger of the free flows of capital and technology thereafter: opening itself to international trade and global outsourcing at the cost of submitting to the unfair international division of labour and uneven distribution of wealth and technology, China unlocked continued high technological and economic growth while planting the seeds for economic crises to be fixed by future investments in new wireless network infrastructures.

The Evolution of the Wireless Edges (1998–2020)

In contrast to the fibre-optic core network whose changes happen outside our consciousness, the technological transformations occurring at the network edges, the location where a device or local area network (LAN) connects to the internet core, are hardly imperceptible, even to ordinary digital media users. The widespread availability of dual-mode mobile devices in the 2010s, ranging from smartphones to portable and wearable computational devices, instigated the complexification and convergence of the two most popular types of wireless network – wireless LAN and broadband cellular networks. These wireless networks, as well as their periodic evolution, contribute to the popular myth of wireless and mobile network infrastructures as forever new and increasingly

29 Castells 2009, 117.

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atmospheric or even cloud-like, thus differentiating wireless infrastructures from older and longer-lasting infrastructures. Such popular myths lead to a common misconception that emerging wireless networks cause a complete transformation from wired to wireless and render fixed-line networks largely obsolete. In fact, the proliferation of wireless media networks is still largely grafted on the mass of wired systems.[30] Only at the edges of the network, e.g. between laptops and wireless routers (in wi-fi networks) or between cell towers and phones (in cellular networks), are wireless signals freed from cables.[31] The generational evolution of wireless networks, on the one hand, has superseded the legacy of copper-based wiring infrastructures that are buried underground and too intricately woven to be maintained or upgraded regularly, leading to the intensive deployment of fibre-optic networks as the backhaul system linking together subnetworks at the edges – i.e. wireless base sites – to main data centres. The Ministry of Industry and Information Technology's (MIIT) three-year plan (2021–2023) for the simultaneous deployment of the 5G cellular networks and gigabit fibre-optic internet infrastructures epitomizes the synergy of wired and wireless networks.[32]

The current Chinese wireless and mobile access networks are the result of two infrastructural booms in the 2010s: the commercial buildout of 3G systems for nationwide availability from 2009 to 2011 and the "upgrade" to – or the massive deployment of – 4G LTE (and later LTE-Advanced) networks since 2014. Different from the "Eight Vertical and Eight Horizontal" Fibre-optic Backbone constructed under the MPT's auspices, these gargantuan projects of wireless infrastructures are carried out by the concerted efforts of state and corporate actors: the Ministry of Information Technology (MII, the successor of the old MPT and later renamed the MIIT) functions as the government agency that governs the radio-frequency spectrum and regulates the activities of telecommunications companies; the three major state-owned telecommunications enterprises, China Mobile, China Unicom and China Telecom, undertake the task of deploying wireless networks as well as providing communications-related services. The boom in 3G and 4G wireless network infrastructure in the 2010s featured unprecedented scale and speed, presenting a gradual shift in emphasis from cities to rural areas. Although the 3G networks are now being phased out to repurpose the radio frequency spectrums for 4G and 5G wireless usage, the infrastructural buildout carried out a decade ago was a vast and lavish project in many senses.[33] With a direct investment of more than 58 billion yuan per year, China Mobile built more than 220,000 new 3G base stations nationwide in just a two-year period, sweeping across the country at breakneck speed. By the end of 2010, 3G mobile connectivity was provided to more than 238 county-level cities.[34] The building of 3G wireless networks complied with the existing administrative divisions and replicated the uneven spatial distribution of populations and economic activities. Rather than spreading out to adjoining territories after blanketing an area with seamless network coverage as the theoretical topology may suggest, the deployment of 3G started simultaneously from unconnected prefecture-level municipalities of higher population density and then radiated out to subordinate counties or county-level cities. The five years after 2014 saw an exponential increase in 4G base stations. From 2014 to 2019, the total number of 4G base stations skyrocketed from 730,000 to 5.44 million, accounting for more than half of the 8.41 million telecommunications base stations deployed across the country. These 4G stations formed a widespread wireless network that quickly spread from the south-eastern Yangtze Delta and Pearl River Delta metropolitan regions to the central and western hinterlands, and from urban to rural areas. Providing high-speed network coverage to more than 98

30 Starosielski 2015, 54–56.

31 Mattern 2015, 103.

32 "Gongye he xinxi bu guanyu yinfa shuang qianzhao wangluo xietong fazhan xingdong jihua (2021–2023) de tongzhi" (The MIIT announces the plan of synergetic development of 5G cellular networks and gigabit fibre-optic Internet infrastructures [2021–2023]), *Gov.cn*, 24 March 2021.

33 Chen, Zhao and Peng 2014.

34 "2010 niandi Zhongguo yidong 3G wangluo jiang fugai quanguo suoyou xiancheng" (China Mobile's 3G wireless network will cover all the county-level cities by the end of 2010), *Xinhua*, 25 November 2011.

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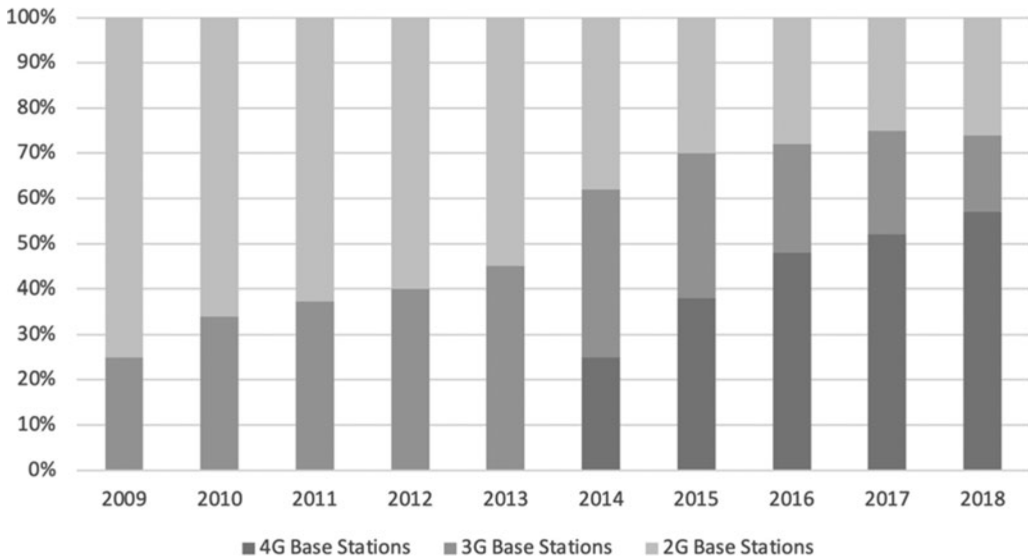

Figure 3. 4G, 3G and 2G Base Stations (2009–2018)
Source: Based on statistics sourced from MIIT 2019.

per cent of administrative villages, the 4G wireless infrastructure coincides with the party-state's efforts to develop rural areas and transform the landscape of the countryside in the recent "National Plan for Rural Revitalization."

Popular criticisms in Western discourses tend to unequivocally attribute the frenzy of wireless and mobile infrastructure development to the rise of a surveillance state that tightens totalitarian control over populations and territories. This reading, despite understandable concerns about the future of surveillance, reduces the complexity of infrastructural development to ideologically and politically convenient prejudices. Instead, a careful examination of the massive development of wireless and mobile networks and the associated popular, political and scholarly discourses shed light on other factors contributing to the explosion of wireless infrastructures in China largely ignored by Western criticisms.

In the Chinese popular narrative on the development of cellular networks, the generational evolution of wireless technology standards is often interwoven with China's pursuit of a post-socialist alternative to capitalist development. The widely accepted encapsulation of the Chinese evolutionary process is as follows: "In the 1G era, China was left behind in the field of mobile communications technology. China narrowed the technological gap with Western early starters in the 2G era, made a breakthrough in the 3G era, and finally kept pace with them in the 4G era." (*1G kongbai, 2G gensui, 3G tupo, 4G bingxing* 1G 空白、2G跟随、3G突破、4G并行). The proverbial evolution of mobile communications standards from 1G to 5G has firmly established the popular myth that broadband cellular networks optimize themselves gradually through incremental improvements, rather than technological "revolutions." When adapted to the Chinese context, this generational evolution serves as a metahistorical paradigm to tell the story of a technologically backward country's step-by-step journey to catch up, against all odds, with more advanced countries. Suggesting a linear, continuously advancing technological process, this story evokes the "belated" hypothesis that dominates writings on the history of science and technology in China. It also echoes the narrative of Chinese socialist development towards communism in the light of the Marxist multi-stage scheme of historical development.[35] However, refusing to see a sequence of necessary

35 Dirlik 1989, 33–44.

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developmental stages as determined or unescapable, this narrative embraces the "dialectic of backwardness" – that latecomers, by absorbing technological accomplishments from their more advanced counterparts, can "skip" or "compress" developmental stages and eventually reverse the unequal international order.[36] This snapshot almost heralds a future in which China will leapfrog over its Western counterparts in implementing the 5G standard.

At variance with this accepted narrative, scholarly accounts reject linear delineations of Chinese wireless technology progress and see the deployment of the 3G and 4G wireless networks instead as the crucial historical turning point. Chinese communication and media scholar Yu Hong acclaims the standardization and marketization of homegrown 3G TD-SCDMA and 4G TD-LTE specifications as milestones both in terms of proactive participation in the international standard-setting process and in the quest for greater self-reliance in developing communication and networking technologies.[37] Hong unfolds the making of homegrown 3G and 4G wireless standards not as successes that came naturally in the linear progression, but as painful yet decisive steps to reduce the increasing dependence on international commercial and technological exchanges developed in the early post-socialist reform.[38] The standardization of 3G TD-SCDMA and 4G TD-LTE is seen as the praxis of Samir Amin's theories of dependent development and strategies of active delinking. As Amin illuminated in his critique of the imperialist nature of global capitalism, capitalist globalization has further exacerbated global inequalities by integrating all nations into a production system that tolerates exploitation of peripheral countries for the benefit of core countries. The countries on the periphery of capitalism rely on externally oriented dependent development for the accumulation of capital, organizing their economic activities more around exports than satisfying domestic consumption needs.[39] Although this notion of dependent development is based on the observation of the export-substitution strategy pursued by many developing countries in the 1960s and 1970s, the industrialization and marketization of the Chinese ICT sector carried out several decades later nevertheless followed this well-trodden path.

Departing from complete dependence on hardware imports and technology transfers in the 1980s and 1990s, China engaged in a new form of technological dependence, one associated with neoliberal reform and export-oriented industrialization, in the late 1990s and the 2000s. Partly as a concession to gain admission to the WTO, and partly as steps to introduce market forces, the Chinese telecommunications sector has embarked on a series of institutional reforms that streamlined state agencies, created state-owned enterprises and sought a new division of responsibility between the government and telecom companies. Paralleling institutional reforms, the telecom industry underwent three major shakeups that formed two big state-owned telecom companies, China Mobile and China Unicom, plus several small ones to promote market competition. Meanwhile, pursuing export-led industrial policies, China opened and recomposed itself both as the world's factory and a booming overseas market for large international telecom equipment providers and mobile phone vendors. Multinational telecom companies established joint ventures in or moved their factories to mainland China, further exploiting cheap labour to fill their assembly lines.[40] In the early 2000s, Western telecom equipment and mobile phone makers, such as Nordic telecom giants Ericsson and Nokia and the US's Motorola, not only dominated the equipment supply to wireless infrastructure construction but also carved up the lucrative Chinese mobile phone market. Nascent domestic players, including Huawei and ZTE, failed to break into the domestic market until the late 2000s and were forced into low-end markets in rural areas.[41] Dependent development and export-led industrialization led the Chinese ICT industry to rapid capital accumulation

36 Lin 2006, 24–28.
37 Hong 2017, 81–86.
38 Ibid.
39 Amin 1974, 9–26.
40 Hong 2017, 89.
41 Ibid., 83–88.

and fast assimilation of advanced technologies at the price of greater exposure to the renewed form of capitalist-imperialist domination and exploitation as well as the increased vulnerability of the infant domestic telecom industries.

At the heart of technological dependence lies the politics of standard and standardization. As a set of documented requirements designed to build a cohesive network and facilitate its expansion, technology standards inevitably encourage monopolies because the process of standardization always entails the consolidation of one patented technology's dominance, while excluding others. Despite legislative efforts to counteract the inherent monopolistic power, standardization colludes in centralizing power and capital in the hands of oligarchic standard makers and standard-essential patent holders, who are usually large multinational companies capable of covering the prohibitive R&D costs for new technologies. The 2G era witnessed the competition between the duopoly of the European-backed GSM standard and the CDMA standard promoted by California-headquartered Qualcomm. The contemporaneous rivalry between China Mobile and China Unicom was nothing more than a proxy war between the two dominant Western standards. As adopters of foreign wireless standards, Chinese telecom component manufacturers and suppliers found that they were forced into an unequal international division of labour and an inferior position in the global value chain. They paid a high royalty fee for standard-essential patented technologies while profiting little from assembly line hard work. Standards and standardization tipped the whole Chinese telecom ecosystem into a dilemma of dependence that beset not only telecom service providers but also telecom equipment manufacturers and mobile terminal devices vendors.

Under the banner of remedying economic and technological dependence, the deployments of 3G and 4G networks have been carried out since 2009 with priority given to the commercialization of networks of homegrown 3G TD-SCDMA and 4G TD-LTE standards. Featuring mergers and acquisitions, the fourth industrial reshuffle prepared the full-scale buildouts of wireless networks by consolidating three telecom giants capable of carrying out large-scale wireless infrastructure projects. The tripartite arrangement, while propelling the implementation of the homegrown standards, also allowed the telecom sector to hedge its bets by diversifying into the implementation of European or American standards. When MII issued 3G spectrum licenses to the three wireless carriers in early 2009, China Mobile, the largest wireless carrier in the 2G era, was saddled with the more challenging task of building and promoting the 3G wireless network based on the nascent, homegrown TD-SCDMA standard. China Telecom and China Unicom were tasked with deploying 3G networks based on American and European standards in the 3G family, CDMA-2000 and WCDMA respectively. In the same fashion, when rolling out the 4G LTE wireless networks in December 2013, TD-LTE spectrums were licensed first to all three operators to prioritize homegrown TD-LTE technology, the 4G successor to TD-SCDMA. As the only stalwart of the TD-SCDMA standard in the 3G era, China Mobile immediately responded favourably and devoted itself unflinchingly to upgrading to 4G TD-LTE, while China Unicom and China Telecom delayed the implementation of homegrown systems after weighing the costs and benefits of switching to a different technological system. By upping the ante for deploying an LTE wireless network at higher network capacities, China Mobile attempted to build an early lead and gain market share for 4G services. Neither China Unicom nor China Telecom started its large-scale buildout of 4G LTE networks until half a year later. China Unicom waited for LTE-FDD licenses to develop an alternative scheme to upgrade its WCDMA 3G networks to its next iteration instead of throwing itself into the buildout of 4G wireless networks from scratch based on an unfamiliar standard. China Telecom, the Chinese implementer of the 3G CDMA 2000 standard, was caught in a dilemma as to whether to switch to the TD-LTE camp and thereby start its 4G buildout at a significant cost or to join with China Unicom in waiting for the LTE-FDD licenses, because Qualcomm, the leading developer and sponsor of the CDMA 2000, standard chose to exit the CDMA 2000 family of standards in favour of the rival LTE specifications. With controlled license issuance processes and preferential policies, the deployment of 3G and 4G wireless infrastructures achieved the large-scale commercial implementations of homegrown standards, ending the monopoly of Western standards.

Although scholarly accounts recognize the development of 3G and 4G standards as a break from the previous mode of dependent development, they err in delineating the process as driven by a self-determined, forward-looking plan relentlessly pushed ahead by forceful ministerial interventions. This delineation assumes a direct causality between the R&D of 3G and 4G standards and their commercialization. It also fails to factor in certain historically contingent socioeconomic circumstances that played a decisive role. Taking into consideration the global economy, the development of wireless infrastructures carried out at critical junctures should be viewed less as the direct and inexorable outcome of a planned standard development of great foresight, and more as a major action to combat the adverse effects of the global financial crises besetting the Chinese economy.

The 2008 global financial crisis that exploded in the US and rapidly hit the UK, Europe and the rest of the world plunged the global economy into the most severe global recession since the Great Depression. Contrary to a post-crisis recovery painted by the comforting assumptions made in 2012–2013, the crisis is not in fact over but has continued to metastasize and mutate in the past decade into an economic, political and geopolitical collapse that profoundly challenges the foundations of the post-Cold War order created by the rise of global, informational capitalism.[42] The global economic crisis, which spread from the core capitalist countries and emerged paradoxically from systemic elements of global capitalism – the excessive financialization of the economy, the globalization of financial markets and the unfettered liberalization of intercontinental flows of capital – exposes the dangerous fragility and internal contradictions of this capitalist economy that has dominated the world in the preceding 30 years. On the periphery of capitalism, this crisis and its aftermath created growing distrust of the Euro-American model of progress and development and caused widespread disillusionment with the hegemonic culture of unrestricted economic liberalism and globalism. This disenchantment promoted the resurgence of interest in Keynesian economics in China and worldwide. The deployment of 3G and 4G mobile network infrastructures is an example of the crisis-fighting measures prescribed by neo-Keynesian macroeconomic theories. The much-heralded goal to reduce technological and economic dependence should be understood more as a protectionist action symptomatic of the bankruptcy of neoliberal hope. Its flourishing Marxist rhetoric and anti-capitalist advocacy aim not so much at separation from the global system (decoupling) as tactical manoeuvres to survive the worldwide slump and move China's position up in the global hierarchy.[43]

As a crisis-fighting measure, wireless infrastructure megaprojects constitute a crucial component of the economic stimulus plans devised to break the economic stalemate. Such projects were treated as high-tech saviours of the faltering national economy amid the global recession. In the wake of the global financial crisis, the Chinese central government announced a mammoth 4-trillion-yuan stimulus programme of at the end of 2008, with a substantial proportion allocated to key infrastructure projects such as transportation systems (37.5 per cent), affordable housing (10 per cent) and rural infrastructures (9.25 per cent). Echoing this massive stimulus programme, the 2022 19-point policy package aiming to stabilize economic growth amid the gloom of the global pandemic injected a further 1 trillion yuan into infrastructure construction. Among such packages, infrastructure spending shows a tilt towards the "new infrastructures," such as wireless networks and data centres, in comparison to the transport and power infrastructures favoured by the stimulus programme a decade ago.

More than a short-term measure to counteract the aftermath of global economic crises, the development of wireless infrastructures is also legitimized as a future-oriented plan that will facilitate crisis-induced industrial and economic restructuring. The "Three-year Plan for Revitalizing and

42 Castells, Caraça and Cardoso 2012, 2–3.

43 Hardt and Negri 2019, 74–75.

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Reforming the Electronics and Information Industries" (hereafter the Plan) promulgated in early 2009 recognized the electronics and information industry as one of the three pivot points of the rehabilitation and restructuring of the national economy, pledging to propel the construction of 3G wireless network infrastructures, the adaptation of the homegrown TD-SCDMA 3G standard, and the deployment of fibre-based last-mile access networks.[44] Maintaining consistency with the Plan, the 12th Five-Year Plan for the Strategic Emerging Industries issued in 2012 and the 13th Five-Year Plan on National Informatization (2016–2020) restated the imperative to expand and upgrade wireless network infrastructures and emphasized the crucial role these infrastructural developments should play in invigorating the national economy.[45] These plans reconceived crisis as an opportunity for economic restructuring, characterizing Chinese economic and technological development as not just a crisis-ridden but a crisis-induced process.

It is not the first time that China's macroeconomic plan has dealt with economic crises by recourse to infrastructural investment. Nor is China the only country that responded to the economic crisis with government interventions and stimulus measures. Paralleling China's fiscal policies in response to the crisis, the US also designed stimulus plans, from the American Recovery and Reinvestment Act of 2009 to the Joe Biden administration's US$1.9 trillion fiscal stimulus package. However, apart from the shared rationale of these stimulus measures, the Chinese and American stimulus measures differ greatly: while the American monetary and fiscal policies prioritize bailing out the banks to stabilize the financial system and issuing stimulus checks to fuel consumption, the Chinese economic recovery measures instead favour infrastructural constructions to boost the economy. This preference for infrastructural projects has a long history, with massive infrastructural constructions instrumentalized in 2008 and thereafter as shovel-ready, fast-acting projects for weathering economic crises. As David Harvey notes, the Chinese government has repeatedly used debt-financed infrastructural construction since 1998 as an economic tool to push through economic reform and sustain economic growth.[46] The reliance on infrastructural investment caused growing concern that these infrastructure projects, financed by government spending, are dangerous to healthy and sustainable economic growth, for they impose a mounting burden of debt on the fiscal system.[47] Debt and deficit are invoked again in the debate on whether expansionary fiscal policy is the right response to the economic crisis: after all, the problem created by debt cannot be solved by running up even more debt. In response to the concern over debt, neo-Keynesian economics argues that, counterintuitively, budgetary deficits and debt are not dangerous but rather the necessary answer to the debt-induced depressed economy; sudden deleveraging and austerity measures to reduce debt and deficit would aggravate the declining economy.[48] Such politico-economic analyses present three reasons why debt-financed infrastructure investment could positively regulate the economy: government-funded, labour-intensive infrastructural constructions could, first, absorb the large-scale unemployment created by the economic crisis; second, turn liabilities into fixed assets; and third, overcome infrastructural bottlenecks for future development.

These analyses are undeniably still relevant, however, with the emphasis shifted to new digital infrastructures, the infrastructural development as part of the socioeconomic recovery plan manifests new features beyond the current discussion. The development of digital infrastructures in principle would generate a broader snowball effect (or, in economic terms, a greater multiplier effect) on all aspects of economic activities. More than providing employment opportunities in construction

44 "Dianzi chanye tiaozheng he zhenxing jihua" (The three-year plan for revitalizing and reforming the electronics and information industries), *Gov.cn*, 15 April 2009.

45 "'Shierwu' guojia zhanlüexing xinxing chanye fazhan guihua" (The 12th Five-Year Plan for the Development of Strategic Emerging Industries), *Gov.cn*, 20 July 2012.

46 Harvey 2007, 131–134.

47 Ibid.

48 Eggertsson and Krugman 2010, 1–3.

sites, the new infrastructural development also spawns new types of work and working opportunities in digital realms and beyond. The proliferation of gig workers, remote workers and e-commerce livestreamers to supplement income reduction and job loss due to economic downturns are telling examples of the rise of technologically mediated employment and digital entrepreneurship made possible by the expansion of wireless network infrastructures. Furthermore, the increased capital injections into digital infrastructures not only lead to investment-driven economic growth but also play a role in incentivizing consumption. As the 3G and 4G networks keep extending from metropolitan centres to rural margins, from more developed places to underprivileged areas, groups of people who were formerly excluded from up-to-date communications technologies and digital commodities due to the "digital divide" are gradually turned into users of mobile and wireless-enabled gadgets, subscribers to mobile telecom services and consumers of digital media content. The ever-expanding wireless networks bring about an increase in telecom customers, create more digital goods and services, unlock the potential of the internal market, stimulate economic growth based on consumption and ultimately help to break the vicious circle of economic downturn.

In times of economic woe, when the normal patterns of investment and consumption are frozen and short-term returns on investment less possible, investments are forced to be more patient and turn to long-term projects, such as digital infrastructure investment, to weather market fluctuations. In this sense, the imperative to fend off the exogenous economic crises has somehow mobilized, if not forced, telecom and internet services providers, as well as mobile device manufacturers and vendors, to align themselves with all levels of government to tackle the knotty issues relating to rural development they have long avoided. The task to maintain socio-economic resilience in the face of a series of economic crises dovetails with a socialist government's alleged responsibility to rewire the rural economy, narrow the developmental disparity between urban and rural areas and alleviate poverty. In the next round of 5G wireless network deployment – which is just around the corner – the upsurge of rural wireless consumers will further encourage the expansion of wireless and mobile network infrastructures to the underprivileged demographics in the most marginalized areas at the price of commercial encroachment. Yet whether the new infrastructural development will become the new engine of socioeconomic development driving China to an alternative digital future or cause adverse effects and repeat past failures over time remains to be seen.

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