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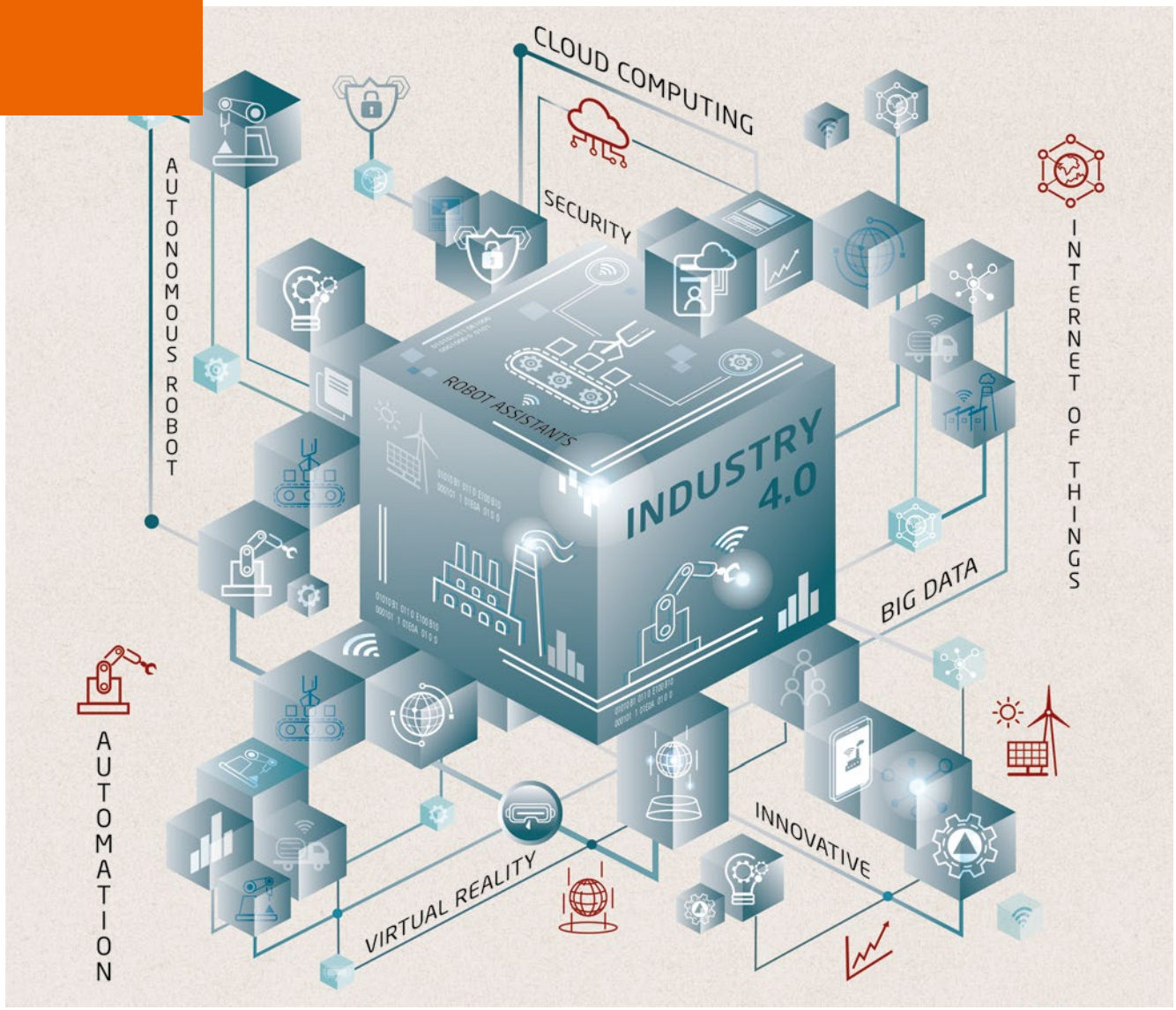

CHINA'S DIGITAL PLATFORM ECONOMY: ASSESSING DEVELOPMENTS TOWARDS INDUSTRY 4.0

Challenges and opportunities for German actors

Rebecca Arcesati | **Anna Holzmann** | **Yishu Mao** | **Manlai Nyamdorj** | **Kristin Shi-Kupfer** | **Kai von Carnap** | **Claudia Wessling**

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Content

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Rebecca Arcesati, Anna Holzmann, Yishu Mao, Manlai Nyamdorj, Kristin Shi-Kupfer, Kai von Carnap and Claudia Wessling

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und Energie

aufgrund eines Beschlusses
des Deutschen Bundestages

Executive Summary

CHINA'S DIGITAL PLATFORM ECONOMY WILL DETERMINE ITS INDUSTRIAL FUTURE

China's leadership has set an ambitious deadline to become a superpower in science and technology innovation by the 100th birthday of the People's Republic in 2049. The digitalization of industrial production is central to their ambition. Digital platforms in the manufacturing sector are considered crucial to upgrade industry, improve productivity, optimize resource allocation and increase employment.

Other countries can benefit, especially Germany, with its strong industrial base and rich experience in the realm of "Industrie 4.0". German companies like Siemens, SAP and Bosch are already engaged in China's emerging digital industrial platforms economy. However, European actors must brace themselves for challenges. The competition is on: China will be a major contestant in the "battle for industrial data", as EU Commissioner Thierry Breton recently coined the new phase of digitalization, in which Europe hopes to gain a stronger foothold after being outperformed by US and Chinese tech companies.

CHINA'S PUSH INTO THE DIGITAL PLATFORM ECONOMY

China is investing heavily to become a leader of the Fourth Industrial Revolution; spending on IT technologies reached CNY 2.6 trillion (EUR 337 billion) in 2018, research and advisory firm Gartner has estimated. Software and data center systems accounted for CNY 250 billion (EUR 32 billion) of this. Government policy pressure will see more companies invest in the Internet of Things. Market observers estimate that China will account for one third – 4.1 billion – of global Industrial IoT connections (IIoT) by 2025.

China is investing heavily to become a leader of the Fourth Industrial Revolution

Chinese digital industrial platforms are starting to compete on a global level. One of the most important is INDICS, set up by China Aerospace Science & Industry Corporation Limited (CASIC), a state-owned missile manufacturer under direct central government control. Two other corporate giants have set up increasingly influential platforms: Haier, the appliances and electronics manufacturer, and Alibaba, the internet retail giant.

THE STRATEGIC CONTEXT: DIGITAL PLATFORMS ARE CONSIDERED CRUCIAL FOR INDUSTRIAL MODERNIZATION

China's promotion of the digital platform economy sits within an ecosystem of major policy initiatives, Internet+, Made in China 2025 and China Standards 2035, an effort to standardize cutting-edge technologies, e.g. AI, cloud computing, IoT and big data. The digital platform drive combines corporate initiatives from China's internet giants with the state-led push to integrate traditional industries using advanced information and communication technology (ICT).

The scarcity of advanced manufacturing in China is a key reason for the gulf between industrial digitalization and flourishing consumer oriented service platforms such as video-sharing hub TikTok, the e-commerce portal Taobao and Tencent's WeChat ecosystem: the enterprise-on-cloud rate in China was only 30.8 percent in 2018, compared to 50 percent in the US and 73 percent in Germany, all reported for 2018, according to a Chinese survey.

Government targets aim to remedy these deficiencies: policymakers want to see one million companies "go cloud", a crucial prerequisite for utilizing digital platforms. Bold targets to foster platform development include the establishment of one leading global digital industrial platform, 10 cross-sectoral platforms and 300,000 industrial apps by 2020. Policymakers' top-down approach combines ambitious, regularly adjusted targets with selected pilot projects to pressure industrial and ICT actors to fulfill policy goals.

The Chinese government sets targets on all levels

Key policy goals to develop industrial internet platforms

1 MILLION

new companies with cloud-based platforms & 1 million benchmark applications by 2025

10

cross-sectoral industrial platforms by 2020, final list released in August 2019

ALL LAYERS OF THE IoT STACK

Industrial Apps
(300,000 by 2020)

Standards
(upgrade to IPv6, push for NB-IoT, ≥ 10 security standards at various levels)

ID resolution system
(≥ 10 public service nodes and identification registration amount of 2 billion by 2020)

3–5

internationally competitive platforms by 2025, with 300,000 participating companies by 2020

Source: State Council 2017; MIIT 2018

THE ACTORS: TOP-LEVEL DESIGN DRIVES A HIGHLY COORDINATED INDUSTRIAL INTERNET DEVELOPMENT PROGRAM

The main player orchestrating digital industrial platform development is the Ministry of Industry and Information Technology (MIIT). In 2018, MIIT published its first ever list of 93 industrial internet projects in a comprehensive effort to build, scale up, regulate and standardize China's platforms. The Ministry of Finance (MOF) funded the first batch of projects with CNY 4.9 billion (EUR 679 million).

MIIT presides over the Alliance of the Industrial Internet (AII), the major forum for interaction between policy makers and industry. The AII was created in 2016 and has more than 1,300 members. The AII's few foreign members include SAP, Siemens, Schneider Electric and GE. The body is active in setting technical standards for China's industrial internet platforms.

State-owned enterprises (SOEs) are tasked with generating sector-specific platforms. For instance, a unit of oil giant Sinopec has set up a platform for the petrochemical industry.

THE RESULT: A STATE-LED INDUSTRIAL PLATFORM LANDSCAPE IS EMERGING FAST

Three push factors are combining to shape the industrial digital platform landscape: government strategy is driving work by giant SOEs in key sectors; private sector firms have joined in; and ICT giants are venturing into B2B to counteract stagnating user growth in their B2C strongholds.

The Industrial Internet Convergence Platform for Centrally Administered State-owned Enterprises was founded in June 2019 with 289 SOEs, including giants like China State Shipbuilding Corporation, Baosteel (partnered with Siemens since 2015) and oil major Sinopec's unit Petrochemical Yingke. Several set up cloud platforms intended to optimize collaborative R&D and manufacturing.

Among the most successful private sector players, Haier's COSMOPlat combines 12 industries from textiles to electronics and ceramics and claims to serve 35,000 companies with 320 million end-users. ICT companies like Alibaba, Tencent, Huawei and Baidu seek to leverage data from a massive pool of internet users: using consumer behavior data to optimize industrial design and production is a core feature of Industry 4.0.

Some Chinese ICT players will benefit from their strength in cutting-edge applications. Baidu's Apollo, the world's first open-source autonomous vehicle technology platform, has over 130 corporate partners, including major German carmakers.

Some Chinese ICT players will benefit from their strength in cutting-edge applications

THE CAVEAT: CHINA LACKS CORE CAPABILITIES FOR PLATFORM DEVELOPMENT

Nonetheless, China's own analysts openly debate weaknesses in this mass of activity. Their views are consistent with MERICS own research. China's structural dependence on key foreign components like industrial software is a fundamental deficiency that provides opportunities for foreign companies.

China lacks indigenous solutions in key layers of the industrial internet platform architecture, e.g.:

- **Sensors:** the PRC has to import almost 80 percent of high-end sensors and up to 90 percent of chips to meet domestic demand.
- **Device connection:** in 2019, 95 percent of high-end programmable logic controllers (PLC) and common industrial protocols were imported. Lack of interoperability with devices from different foreign companies is also an issue.
- **Software as a service (SaaS):** over 90 percent of high-end industrial software used in China is of foreign origin. Companies like SAP, Microsoft and Salesforce dominate the market.

CHINA'S SOLUTIONS: SETTING STANDARDS AND STRATEGIES TO RESOLVE DOMESTIC WEAKNESSES

China's government has begun to tackle shortcomings with centrally devised implementation blueprints. Key implementation mechanisms are:

- **Devising** region-specific, sub-national pilot projects involving local governments, state-

owned companies and private firms (such as Alibaba's SupET in Zhejiang, CASICloud in Guizhou or XCMG's XREA in selected BRI countries)
- **Experimentating** with more market-driven funding mechanisms, including private equity investment, to reduce the dominance of state subsidies
- **Devising** a comprehensive industrial internet standardization system by 2020.

Obstacles to Chinese companies engaging in the IIoT include the lack of interoperability standards and insufficient rules on data ownership and security. China's regulators therefore want more robust technical standards and a basic industrial internet standardization system by 2020.

Most of China's 324 industrial internet standards are still awaiting formulation. The AII has judged platform standardization work in China as "early stage". Standardization is an area in which foreign actors could and should engage with China.

CONDITIONAL PARTNERS: FOREIGN PARTICIPATION DEPENDS ON CHINA'S TECHNOLOGICAL NEEDS

China's official rhetoric proposes an open digital platform economy that is cross-border and "win-win" in nature. It is not currently pushing for outright self-sufficiency, or a model decoupled from developments in other countries that would result in the exclusion of foreign actors.

Many digital platforms analyzed in our study have benefited from strategic partnerships with foreign companies like Siemens, Bosch, SAP or GE and foreign research. Even so, China's constant theme is the need for strong domestic capabilities that advantage its firms vis-à-vis foreign competitors.

China's constant theme is the need for strong domestic capabilities that advantage its firms vis-à-vis foreign competitors

Our observations suggest that foreign players have limited ability to influence regulatory developments. The environment favors indigenous solutions in the digital platform economy. Cybersecurity and data regulations are likely to be the main challenges for foreign companies doing business with China in the digital platform economy.

THE IMPLICATIONS FOR GERMANY: EXPLORING OPPORTUNITIES AND MITIGATING RISKS

Germany is a key partner for China in developing an Industry 4.0 of its own. German companies and institutions play an important facilitating role in China's work to create digital industrial platforms, with joint research and development projects the main form of cooperation. E.g.:

- The R&D institute behind Haier's COSMOPlat has cultivated strong links with several German research institutes.
- Siemens gave support to the development of CASICloud's INDICS cloud platform from early on.

Opportunities for German platform providers to offer services to Chinese customers are far more limited. However, they could arise in the areas of use and integration of sensors, device connection and "software as a service" solutions.

China's rapid advance in the realm of digital industrial platforms demands attention from German political and corporate actors on various levels. Germany should not delay mitigating potential risks.

RECOMMENDATIONS FOR GERMAN ACTORS REVOLVE AROUND THREE AREAS

1. Learning from China's strengths. This requires, among other things, a solid understanding of China's overall innovation capacity, going beyond showcase projects. A realistic assessment of the overall impact of China's digital platform economy needs more research on regional specifications and development stages.

2. Conditional cooperation with China to leverage German strengths. China is highly dependent on foreign IIoT stack components and services. German actors can use this to demand greater transparency in the application of cybersecurity regulations and equal access to the market for foreign companies. At the same time, maintaining a high level of cooperation on Industry 4.0 is in Germany's interest.

3. Mitigate risks arising from China's idiosyncratic policy environment. China's drive to achieve self-reliance in every layer of the industrial internet creates challenges for German partners. Joint research needs to be conditionalized and IP protection needs to be a key priority in setting up cooperation frameworks.

This MERICS study is based on a deep search and analysis of primary Chinese language sources with data as of December 2019. We made a systematic analysis of official policy documents since 2015, Chinese experts' research papers and interviews with and feedback from 25 experts from politics, the corporate sector and research institutions.

1. Introduction: China's push into the digital platform economy

For China, digital platforms are a crucial tool to realize its goal of becoming an industrial superpower by 2025

For the People's Republic of China (PRC), digital platforms are a crucial tool to realize its goal of becoming an industrial superpower by 2025. Beyond that lies the party-state's self-chosen 2049 deadline to achieve the status of a superpower in global manufacturing, cyber- and science and technology innovation in time for the PRC's 100th birthday[1]. From 2017 onwards, the government set out to transform the manufacturing realm into a digital platform economy, partly by leveraging China's strength in business-to-customer (B2C) digital platforms. China accounted for 28 percent of global spending on Internet of Things (IoT) and 29 percent of total robotics investment in 2017, according to the US market intelligence company International Data Corporation (IDC)[2]. By 2025, China will account for one third (4.1 billion) of the world's Industry IoT (IIoT) connections[3].

China's ambitious goal of catching up with the leaders of the fourth industrial revolution is demonstrated by the example of a digital industry platform operated by the state-owned high-tech group China Aerospace Science & Industry Corporation Limited (CASIC). The government named CASIC a "national flagship company", a high-tech state-owned corporation listed in the "Fortune 500" list of the world's largest companies, and prime contractor for the Chinese space program, which produces missiles and aerospace equipment. The company is expected to lead China's push into the industrial digital platform economy. CASIC has a business-to-business (B2B) digital platform called INDICS: it incorporates hardware devices, Infrastructure as a Service (IaaS), Software as a Service (SaaS) and Platform as a Service (PaaS) as well as a wide range of industrial applications.

Germany plays a key role in the development and internationalization of many Chinese digital industrial platforms, as can be seen from the example of INDICS[4]. Since 2016, CASIC has cooperated closely with German companies like Siemens (they signed a "strategic partnership" in 2016) and SAP (for software procurement). The INDICS platform targets SMEs in traditional industries, providing them with matchmaking and resource sharing through cloud-based manufacturing. It had 1.6 million registered users in 2018, with a total transaction value exceeding CNY 400 billion, according to the company. In June 2019, INDICS launched an international version called CASICloud INDICS (http://intl.indics.com) Its services and functionalities are being investigated as part of a Sino-German joint research project that seeks to improve understanding of the processes and capabilities of new technologies, such as cloud technologies, and to provide use-oriented applications and assistance to companies. The German Ministry of Education and Research and China's Ministry of Science and Technology jointly support the research project[5].

Such projects sit within wider Sino-German efforts to promote cooperation between researchers and corporates while familiarizing themselves with each other's approach to industrial policy[6]. There is huge interest on both sides.

The basis for the cooperation was the Memorandum of Understanding (MoU) signed in July 2015 by the Federal Ministry of Economic Affairs and Energy (BMWi) and the Chinese Ministry for Industry and Information Technology (MIIT) to promote "German-Chinese cooperation in the field of Industry 4.0" and the Memorandum of Understanding on "Intelligent Manufacturing (Industry 4.0) and Smart Services" between the BMBF and the MoST on 19 January 2016[7]:

- three annual conferences and symposia at State Secretary/Vice Minister Level on intelligent manufacturing and interconnected production processes
- a regular Sino-German Company Working Group on "Industrie 4.0" and intelligent manufacturing
- 44 joint projects on industrial cooperation, standardization, talent cultivation and industrial parks (as of 2018)[8]

Germany has a lot to offer to China because of its strength in high-end manufacturing, including a high level of digitalization in manufacturing and leading products/services for the industrial internet. Likewise, the size of China's market is appealing to German actors: China spent CNY 2.6 trillion (EUR 337 billion) on IT technologies in 2018, of which CNY 250 billion (EUR 32 billion) was spent on software and data center systems. The PRC's government-led and subsidized push for companies to adopt cloud and IoT software means Chinese companies are likely to invest more in these categories, stimulating the generation of vast amounts of industrial data[9]. Furthermore, the less restrictive regulatory environment in terms of data protection facilitates experiments for joint projects on the ground in China.

China is tapping into the German economy's traditional stronghold – its industrial base – to ramp up its efforts to develop globally competitive digital industrial platforms. A deeper, systematic understanding of China's digital platform economy is therefore urgently needed, including matters of access and sustainability. Only in this way can Germany better protect its own interests in its relations with China (see box 1).

Box 1

Making sense of the industrial internet in the German and Chinese context
Working definitions for this study

A **DIGITAL PLATFORM** (互联网平台, hulianwang pingtai) is a digital space that facilitates value-creation via online interactions of two or more groups of companies.
An **ECOSYSTEM** (互联网平台生态系统, hulianwang pingtai shengtaixitong) describes the industry-specific platform environment that is composed of actors and their output in creating the infrastructure and setting the regulatory framework necessary for platform interactions.
The **DIGITAL PLATFORM ECONOMY** (互联网平台经济, hulianwang pingtai jingji) refers to the sum of all platform ecosystems (including their various platforms and actors) and their relations to one another.
A **DIGITAL INDUSTRIAL PLATFORM** (工业互联网平台 gongye huliangwang pingtai), often also referred to as an Industrial Internet of Things (IIoT) platform, is essential for linking machines and devices in a smart, connected factory with applications (typically on a cloud). The platform collects, stores, processes and delivers data and is the basis for monitoring manufacturing processes, for predictive and automated maintenance, digital integration of value chains or customization of design and production.

Source: MERICS

In the realm of digital industrial platforms China is progressing fast with flagship projects, such as cross-sectoral industrial platforms. It is already setting international standards in the Industrial Internet of Things (IIoT). Chinese champions like INDICS, Haier's COSMOPlat platform or Alibaba's SupET have started to compete globally with leading US and European providers such as Microsoft's Azure, PTC's Thingworx platform, Siemens' Mindsphere or SAP's HANA Cloud Platform[10].

China's rapid development of its digital platform economy was enabled by low regulatory requirements and innovative approaches to service integration. Chinese digital platform companies in the B2C realm, like Alibaba, Tencent, or JD, often outsmart US competitors because they can test and adapt their products in a home market protected from foreign competition[11]. They also oftentimes benefit from state subsidies and support, e.g., in public tendering or in target fulfilment (see chapter 6.1). The flipside is that their services fail to meet international requirements for data privacy and cyber security.

China's rapid development of its digital platform economy was enabled by low regulatory requirements and innovative approaches to service integration

This study sets out to assess the current state of the digital platform economy in China and the key trends within it, putting a special focus on digital industrial platforms.

Chapter 2 introduces the strategic context. We examine what motivates China's government to support the development of a digital platform economy, and how it approaches this project. In so doing, we will attempt to answer the question of how strategies for digitization of Chinese industry differ from those of Germany with relation to Industry 4.0.

Chapter 3 addresses the overall institutional framework of the industrial internet and explores which political actors shape China's digital platform economy.

Chapter 4 looks into the corporate landscape of the industrial internet. It analyzes how the development of digital industrial platforms is being shaped by different companies from both the manufacturing and ICT sectors, and by a wide spectrum of funding mechanisms.

Chapter 5 scrutinizes core weaknesses affecting the evolution of China's industrial platforms by examining factors on the supply side and the demand side.

Chapter 6 assesses Beijing's current policy measures to cope with these weaknesses. A wide range of policy experiments on the national and sub-national level will be addressed, followed by an analysis of existing funding mechanisms to support the development of digital industrial platforms.

Chapter 7 covers the scope of foreign participation, sounding out opportunities beyond the established Sino-German cooperation on "Industrie 4.0". Challenges flowing from China's regulatory environment are also addressed.

The authors have undertaken an extensive stocktaking and analysis of primary Chinese-language policy documents and research reports, and an in-depth analysis of 10 Chinese industrial platforms. The cases were picked from a self-compiled frequency ranking based on Chinese documents. We have sought to cover the whole spectrum of platform providers, including manufacturing companies and ICT firms, bigger state-owned players, smaller and medium size private enterprises (SMEs), cross-sectoral and sector-specific platforms and local pilots[12].

2. The strategic context: Digital platforms play a critical role for Beijing's industrial modernization plans

China's government sees the expansion of the "digital platform economy" as a critical new driver of economic development and essential to transform the nation into an industrialized, globally competitive superpower.

Beijing views the creation of digital platforms as a way to

- upgrade industry,
- optimize resource allocation,
- create better quality jobs.

China's decision makers have identified industrial internet platforms as a vital means to achieve the efficiency increases needed for innovation-driven "quality growth" and innovation.

To foster the build-up of competitive digital industrial platforms, the government has given them strategic weight as a key tool for China to become an industrial superpower. Beijing wants to replicate the success of Chinese platforms in the B2C sector within the B2B industrial realm. The PRC leadership is thereby making "platformization" (the setting up of digital platforms) a key solution to the challenges of the industrial internet.

2.1 BEIJING PURSUES AMBITIOUS TARGETS FOR THE DEVELOPMENT OF DIGITAL INDUSTRIAL PLATFORMS

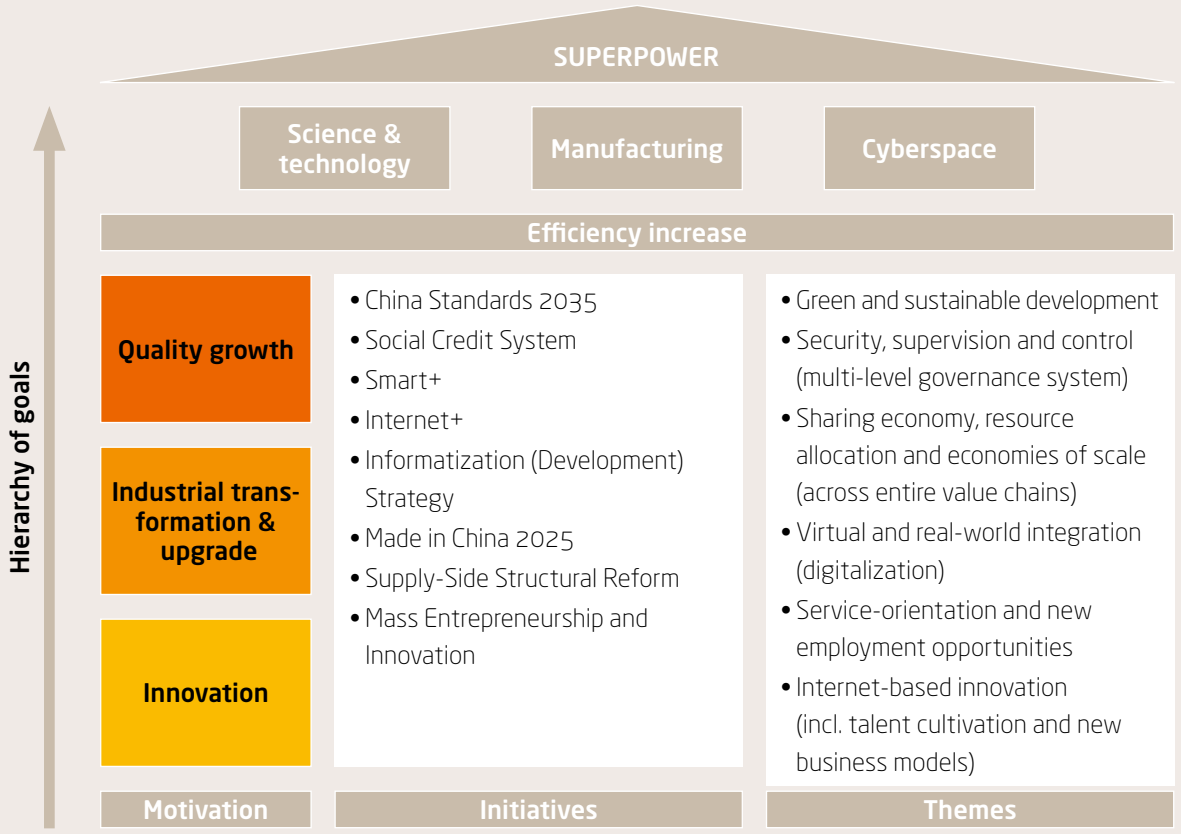
China's ambitions for industrial internet platforms are embedded in a larger context. The promotion of a "digital platform economy" is linked to major initiatives including Internet+ (互联网+) that promote broadly similar themes and seek to foster China's cyberspace, science and technology (S&T) and manufacturing capabilities (see exhibit 1).

Until now the development of digital platforms in many varied industries has been driven by a mix of corporate initiatives from Chinese internet giants and the state-led push to integrate "traditional" industries with advanced information and communication technology (ICT). However, the expansion of platforms has not penetrated all sectors of China's economy equally. The business-to-business (B2B) sector – especially in manufacturing – lags behind the considerable progress evident in the business-to-consumer (B2C) domain.

To remedy these deficiencies, China's government has begun to emphasize the need to integrate internet-based solutions into manufacturing industry. The State Council set ambitious targets for the development of digital industrial platforms in November 2017.

China's government emphasizes the need to integrate internet-based solutions into the manufacturing industry

Boosting a digital platform economy for China's industrial superpower
Strategic context based on an analysis of keyword-coded policy documents from 2017 to 2019



Source: MERICS

Known as the "Guiding Opinions on Developing the industrial internet by Deepening "Internet+ Advanced Manufacturing'" (关于深化"互联网+先进制造业"发展工业互联网的指导意见), they set goals with a deadline of 2020 which include[13]:

- one leading global digital industrial platform,
- 10 cross-sectoral platforms,
- the first cohort of company-level platforms to promote corporate digitalization, (数字化), connectedness (网络化) and "smartification" (智能化).

Work to fulfill these targets ranges from basic efforts in the field of cloud-based corporate platforms to more technical (e.g. standards-related) and comprehensive goals that reflect international ambitions (see exhibit 2). The goal of having 10 cross-sectoral industrial platforms in place by 2020, for instance, had already been reached in August 2019[14].

Exhibit 2

The Chinese government sets targets on all levels

Key policy goals to develop industrial internet platforms

1 MILLION

new companies with cloud-based platforms & 1 million benchmark applications by 2025

10

cross-sectoral industrial platforms by 2020, final list released in August 2019

ALL LAYERS OF THE IoT STACK

Industrial Apps
(300,000 by 2020)

Standards
(upgrade to IPv6, push for NB-IoT, ≥ 10 security standards at various levels)

ID resolution system
(≥ 10 public service nodes and identification registration amount of 2 billion by 2020)

3–5

internationally competitive platforms by 2025, with 300,000 participating companies by 2020

Source: State Council 2017; MIIT 2018

2.2 PLATFORM DEVELOPMENT IN CHINA'S MANUFACTURING INDUSTRY IS STILL IN ITS INFANCY

China's consumer-oriented service platforms are thriving and expanding internationally. Success stories include Bytedance's TikTok (video-sharing), Alibaba's Taobao (e-commerce), NetEase's Youdao (e-education), Chunyu Doctor (e-health care), Didi Chuxing (ride-hailing) and Tencent's WeChat Pay (fintech). Their rise has been facilitated by a large home market with ample demand, internet-savvy consumers and an initially laissez-faire regulatory environment.

In contrast, China's industrial sector is generally much less digitalized[15]. Industry surveys covering the PRC and the US yield the following aggregate findings:

- According to a report by the management consultants McKinsey, for example, in 2018 the proportion of companies in China that were active in the Cloud was just 40 percent, in comparison to 85 percent in the United States and 70 percent within the EU[16].
- In 2016, only 46 percent of the surveyed Chinese manufacturing companies had dedicated Industrial Internet of Things (IIoT) strategies. Major obstacles cited were lack of inter-operability and common standards, data ownership and security-related issues, and under-qualified operators[17].
- In 2017, more than 50 percent of the surveyed Chinese manufacturing companies did not have industrial clouds in operation[18].

The picture is beginning to change. As of March 2018, according to the iResearch institute, the Chinese market counted 269 industrial internet platforms, up from only 50 in 2014. Of these, 65 percent were run by manufacturing enterprises or industrial equipment suppliers, whereas ICT firms provided 35 percent. Platform use cases were mainly found in highly digitalized sectors, with 58 percent of the total concentrated in the machinery and energy industries[19].

Thus far, China has few industrial national champions that compete on a global scale. According to the US company Forrester Research, leaders include Haier's COSMOPlat and the China Aerospace Science & Industry Corporation (INDICS platform from CASICloud). Forrester groups three US and one German supplier (Siemens' Mindsphere) in the same category[20].

Haier's COSMOPlat has acquired massive quantities of user information through its flagship model "mass customization" (大规模定制). Users can engage in the whole production process from idea and design all the way to final product and delivery. COSMOPlat has therefore been able to attract many other resources: designers, and module, equipment and logistics providers to build a strong user and resource base. As of 2019, it has 12 industry clusters including ceramics, agriculture, recreational vehicles, electronics, textiles, equipment, construction, transportation and chemicals. COSMOPlat claims to serve 35,000 companies with 320 million end-users[21].

Another early success story of Chinese digital industrial platforms provides a glimpse into the ecosystem in which Chinese industrial platforms thrive. The XREA platform, deployed by Xuzhou Construction Machinery Group is reported by official Chinese media to be the only profitable industrial Platform as a Service platform (PaaS); it reportedly had revenue growth of 150 percent in the first 10 months of 2019[22]. One reason for Shanghai-based XREA's success is that it has a mature, strong manufacturing company behind it.

Like Haier, XREA was built on first mover advantage. It launched in 2016, when industrial platforms where still in the early stage of development. XREA has strong partnerships: first, with China's leading cloud provider AliCloud and, second, a strategic cooperation – via its manufacturing platform provider Xugong (XCMG) – with German multi-national SAP. Its big data technology and applications like Enterprise Resource Planning (ERP) have helped XCMG to expand the basic IoT smart cloud computing service to intelligent manufacturing, as well as managing XCMG's products, and providing intelligent logistics, risk prediction and risk warnings[23].

2.3 CHINA'S TOP-DOWN APPROACH TO INDUSTRIAL DIGITALIZATION REFLECTS UNIQUE CONDITIONS

Despite some successes, the current level of digital platform development in China's industrial landscape reflects the scarcity of advanced manufacturing there. Compared to more industrialized nations like Germany, there is a gulf in the level of digital platform use. The structural differences in the German and Chinese industrial base can be seen in their different national strategies to master digital evolution in the industrial realm.

Structural differences in the German and Chinese industrial base can be seen in their different national strategies to master digital evolution

For China's government, digital platforms are an important innovation tool to catch up on lost ground from the third industrial revolution (digitalization) and to be at the forefront of the fourth industrial revolution (networking of the physical, digital and biological world).

As can be seen in the “Made in China 2025” initiative, China pursues a state-driven, top-down approach, using fixed targets and selected pilots in various sectors. China’s government wants to digitize existing production capacities to improve efficiency and to accelerate the integration of manufacturing and ICT industries, thereby creating new value for participants in platform ecosystems.

Consequently, Beijing’s approach to industrial data (so far) has been rather laissez-faire (see chapter 7.2), incentivizing manufacturing companies to set up and participate in digital industrial platforms without hinderance. However, following the introduction of the Cyber Security Act in 2017 and the adoption of a number of implementing regulations, the party state has tightened control over collecting and sharing industry data. Recently announced draft regulations underline the importance of industrial data security. This could have far-reaching consequences for digital industrial platforms.

China’s official rhetoric endorses the view of an open digital platform economy that is cross-border and “win-win” in nature[24]. It does not push for outright self-sufficiency, or a model that is decoupled from developments in other countries and would lead to the exclusion of foreign actors. For foreign governments and companies, this can be used as point of reference with Chinese officials to follow up on when it comes to addressing questions of openness and interoperability, for instance. Nevertheless, the development of strong domestic skills and capacities that allow Chinese companies to be independent of foreign competitors remains an important aspect of China's strategic ambitions in the digital platform economy (see also chapter 5).

China’s official rhetoric endorses the view of an open digital platform economy that is cross-border

Beijing has come to realize the importance of a state-driven approach to building up leading national platforms and of centralized data-flows. For example, the "Internet+regulation" system (互联网+监管 "系统) is to be linked to corporate platforms in order to use the data obtained from them to optimize the Social Credit System and regulate the behavior of platform economy players accordingly[25]. In the reviewed policy documents, central government’s main responsibility is portrayed as establishing an ecosystem that enables companies to forge ahead with developing and expanding corporate IIoT platforms, while retaining Beijing’s overall steering power.

One of the core documents of the State Council’s “Guiding Opinions on Deepening ‘Internet + Advanced Manufacturing’ and the Development of the Industrial Internet,” pledges central government to strengthen overall planning and guidance, further simplify administration and decentralization, combine decentralization and management, and optimize service reforms. “We will intensively implement the innovation-driven development strategy, build the three functional systems of network, platform, and security, and strengthen the supply capacity of the industrial internet industry,” it says[26].

3. The actors: China's top-level design enables highly coordinated development of the industrial internet

China's key political institutions – in the party and state – have taken on the leading role in promoting the digital platform economy in the manufacturing sector. The Chinese Communist Party's (CCP) Central Committee and the State Council have been highly active in publishing guidelines to promote industrial platforms.

China's key political institutions have taken on the leading role in promoting the digital platform economy

The key player orchestrating digital industrial platform development is the Ministry of Industry and Information Technology (MIIT), especially through its Informatization and Software Services Department (信息化和软件服务业司). First, it administers working groups and research institutes and issues specific regulations, target lists and pilot project calls. Second, MIIT presides over the Alliance of the Industrial Internet (AII), the most important platform for interaction between policy makers and industry.

3.1 THE MINISTRY OF INDUSTRY AND INFORMATION TECHNOLOGY ORCHESTRATES DEVELOPMENT OF CHINA'S DIGITAL PLATFORMS

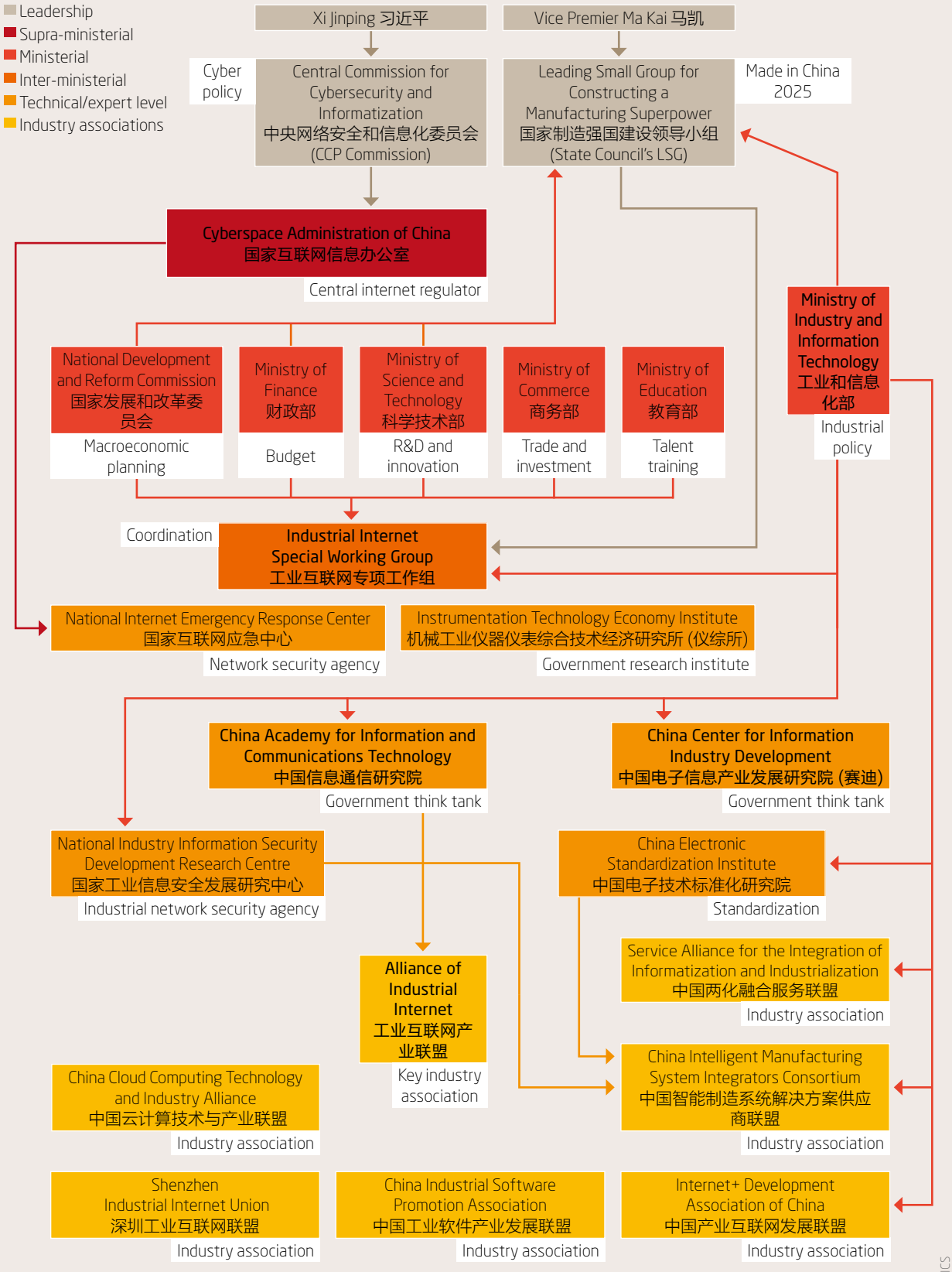
The MIIT clearly has the lead role in stimulating and steering China's platform development. It has set up industry associations at national and provincial level focused on the industrial internet and presides over several key actors. These include think tanks such as the *China Academy of Information and Communications Technology* (CAICT; 中国信息通信研究院), *the China Academy for Industrial Internet* (CAII 中国工业互联网研究院) and the *China Center for Electronic Information Industry Development* (CCID; 中国电子信息产业发展研究院), as well as standardization and network security agencies, such as *China Electronic Standardization Institute* (CESI; 中国电子技术标准化研究院) and the *National Industry Information Security Development Research Center* (CIC; 国家工业信息安全发展研究中心).

Even more relevant is the Industrial Internet Special Working Group (工业互联网专项工作组), established by the State Council's Leading Small Group for Constructing a Manufacturing Superpower and administered by MIIT. It oversees and coordinates implementation work on industrial internet development. Its work plan specifies major tasks related to digital platforms (up to December 2019), including building and testing platforms, improving their public service capacity, and promoting industry adoption and application – partly by encouraging matchmaking between financial institutions and platform providers[27].

The work plan sets three vaguely defined targets: **1)** accelerating platform rollout, **2)** enhancing operational capacity, **3)** expanding existing platforms. The most consistently emphasized item was the establishment of "open service platforms," presumably to have the capacity to incorporate participants from various sectors (see exhibit 3).

Industrial internet platforms are a new government priority

Political actors and industry associations shaping the development of China's digital platform economy



Source: MERICS

In addition to oversight and coordination, MIIT selects which platform projects and key demonstration enterprises are to serve as national and international frontrunners. In 2018, MIIT published its first ever list of 93 industrial internet projects – the Industrial Internet Innovation Development Project featured industrial platforms (cross-sectoral, sector-specific, and regional) as a special sub-category[28].

The 2018 list revealed a comprehensive effort to build, scale up, regulate and standardize China's platforms, grouped into 11 tasks. The tasks covered everything from fundamental research and identity (ID) resolution (the process of combining identifiers with industrial equipment and devices) to platform testbeds, quality control and supervision. The document put notable emphasis on the security aspects of both industrial networks and control systems. It also emphasized the construction of platforms in priority process manufacturing sectors (petrochemicals, steel and energy) and discreet industries (automotive, construction machinery and electricity).

State-owned enterprises should build up sector-specific trial test platforms

The MIIT tasked state-owned enterprises with much of the work to build up sector-specific trial test (试验测试) platforms. Beneficiaries included, among others, China Petroleum & Chemical Corporation/Sinopec (platform for the petrochemical industry); the State Grid Corporation of China (platform for new energy industries); and Beijing Orient National Communication Science & Technology (platform for the iron and steel industry). However, this list also included private manufacturing sector players (i.e. Haier, XCMG and Changhong Electric) and ICT companies such as Inspur, Yonyou and Alibaba. This approach reflects expressed Beijing's goal of nurturing a mixed corporate ecosystem for platform development. The Ministry of Finance (MOF) funded the first batch of industrial internet projects with 4.9 billion CNY[29].

The MIIT issued a second project list in September 2019, which showed that platform development had reached a crossroads. Along with roughly 100 listed projects, the MIIT set out a fresh goal, namely improving technical conditions for connectivity, especially by making progress on ID resolution. Another new goal was focused on addressing internet security challenges, such as the need for comprehensive security and defense mechanisms, data security and monitoring, and even the need for a security support platform for the Beidou Satellite Navigation System.

3.2 AN INDUSTRY ASSOCIATION ACCELERATES INDUSTRIAL INTERNET DEVELOPMENT

The Alliance of Industrial Internet (工业互联网产业联盟, AII) was established in 2016 to facilitate collaboration between government agencies, leading industrial platform companies and research institutes. It was patterned on the US Industrial Internet Consortium (IIC) – while reserving a much larger role for the state[30]. It was established by the China Academy for Information and Communications Technology (CAICT), a think tank with significant regulatory power in China's ICT sector, with support from its parent body, the MIIT, working closely with industry leaders.

The AII has more than 1,300 members, including a few foreign companies, and is the most important avenue for policy-industry interaction and coordination in the industrial internet space.

The AII describes itself as an institution facilitating exchanges, cooperation, and knowledge sharing to foster the development of China's industrial internet ecosystem. Its research

program covers platform architecture, information security and industrial development, and supports technological innovation through testbeds, verification, evaluation and pilot demonstration work.

As explained in Chapter 4, the AII is also active in setting the emerging technical standards for China's industrial internet platforms. Part of this effort entails defining an industrial internet architecture for China. In August 2019, the AII issued the "Industrial Internet System Architecture 2.0" (工业互联网体系架构2.0), which replaced an earlier, simpler version. According to state media, it is intended as the guiding framework for all actors involved in China's industrial internet[31].

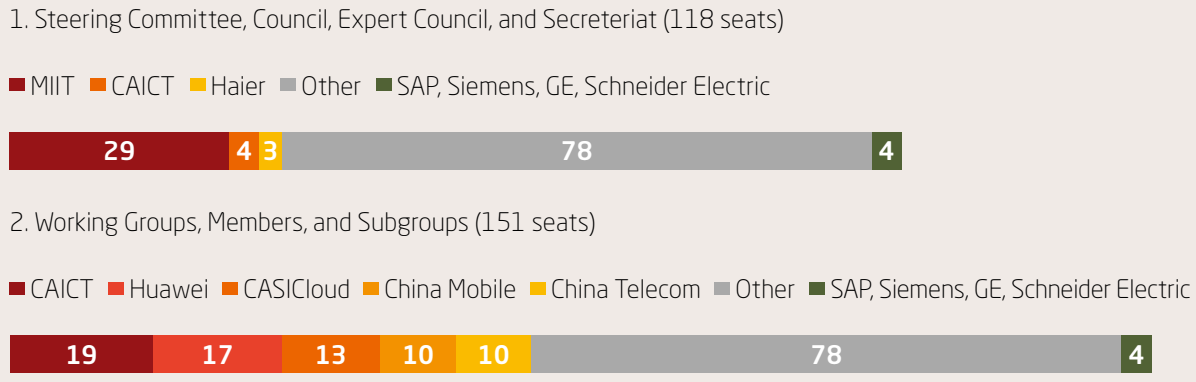
The composition of AII's working groups shows how a handful of companies wield the most power: Huawei alone chairs or co-chairs six of the 20 thematic and ad-hoc working groups (see exhibit 4). The Industrial Internet Platforms Group (工业互联网平台组) is chaired by a representative from CAICT. Other members represent CASICloud, Huawei, Rootcloud, China Telecom, Haier, Foxconn, Sysware, BONC, and XCMG. Other working groups deal with the full spectrum of industrial internet-related technical, technological and regulatory matters; these range from the use of technologies such as Virtual Reality (VR), Augmented Reality (AR) and blockchain to questions of intellectual property rights, frequency allocation, cybersecurity, talent cultivation and financing.

The AII's Technology and Standards Working Group (技术与标准组) is also noteworthy. It is led by defense and aerospace conglomerate CASIC with representatives from Haier, ZTE, Huawei, China Telecom, China Mobile, China Unicom, Weichai, and the Shenyang Institute of Automation of the Chinese Academy of Sciences (CAS). The group formulates proposals within the state standardization system.

Foreign participants have their place within the AII. Four foreign multi-nationals hold seats on its decision-making council: SAP is the most notable, sending one of 22 vice-presidents. Siemens, Schneider Electric, and GE each have one Governing Unit Representative within the AII. The four companies also have representatives within different working groups, such as the groups for international cooperation, blockchain, and industrial development.

Exhibit 4

Few foreign companies can lobby in China's Alliance of Industrial Internet (AII)
Distribution of the of decision making power within the A.I.I.



Source: Alliance of Industrial Internet (AII)

4. China's industrial platforms landscape is evolving fast

Large manufacturers and ICT firms are emerging as the driving forces of China's digital platform economy, a scenario referred to locally as being "two-wheel driven" (双轮驱动).

Beijing combines state incentives with low regulatory requirements, for example regarding market access for players in the platform economy (see also chapter 7.2), in order to create a favorable environment for testing and expanding digital business models within industry in China[32]. Companies in various sectors are already operating industrial internet platforms, experimenting with new ways to transform and modernize manufacturing.

These digital platforms are supposed to become part of a fast-maturing ecosystem where different players – large manufacturers, equipment suppliers, industrial technology and software firms, ICT equipment makers, and large internet companies – collaborate and compete as platform orchestrators or providers of complementary services. Private and state-owned national champions are spearheading platforms that combine advanced machines, internet-connected sensors, big data analytics and cloud computing to enable China's transition towards intelligent manufacturing.

4.1 NATIONAL CHAMPIONS LEAD THE DEVELOPMENT OF CHINA'S INDUSTRIAL INTERNET PLATFORMS

The PRC still lacks large industry players that can integrate multiple control resources, according to Chinese experts' assessments. They cite control systems, along with communication protocols, production equipment, execution systems, management tools, professional software, and platform construction. Chinese companies' ability to build industrial PaaS, expand the developer community and innovate business models is also limited[33]. These shortcomings are one reason for Chinese enterprises to cooperate with well-established industrial companies like Siemens, Bosch, SAP or GE. Likewise, they favor open-source collaboration as no individual platform can independently provide solutions that combine cloud infrastructure, connection, data analytics and application services all in one[34].

The PRC still lacks large industry players that can integrate multiple control resources, according to Chinese experts' assessments

The AII's "Industrial Internet Platforms White Paper" ranks over 50 platforms as having "regional and industry influence"[35]. Our research, based on white papers, information from industry alliances and company websites identified 201 industrial internet platforms (工业互联网平台) of various sizes, maturity and industry focus.

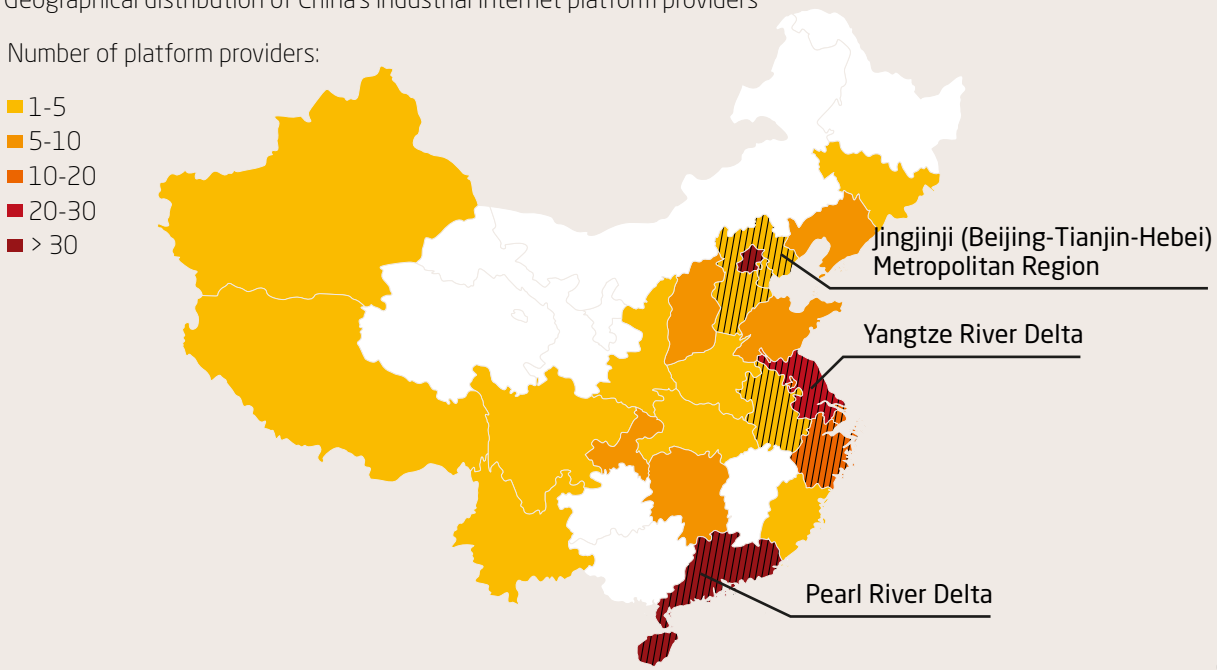
Using platform providers' headquarters as a proxy we concluded these platforms are concentrated in China's economic powerhouses: the Pearl River Delta, the Yangtze River Delta around Jiangsu and Shanghai, and the Beijing-Tianjin-Hebei corridor (see exhibit 5).

In 2018, the MIIT, following the general guidelines announced by the State Council a year earlier, announced plans to compile a list of 10 cross-sectoral platforms by 2020[36]. Preliminary lists were released in 2017 and 2018, naming about 25 – 30 companies. In August 2019, a list of 10 platforms followed[37]. Little is known about the benefits, beyond the prestige of being a national champion.

Exhibit 5

Landscape of industrial platforms

Geographical distribution of China's industrial internet platform providers



Source: MERICS

Whatever support they receive from the government, digital platforms on the list are clear first movers (see case studies). Consumer electronics and home appliances giant Haier is seizing the commanding heights of the digital platform economy globally with its mass customization platform COSMOPlat. Haier is already setting international standards in this realm.

Construction machinery maker XCMG has developed the XREA platform, which focuses on equipment management and optimization and already has links to 20 countries and 63 industries. These include construction machinery, renewable energy, military, fiber-optic cables and components manufacturing.

In addition to these manufacturing giants, China's ICT firms make up the other driving force behind the creation of cross-sectoral platforms. Cloud computing, AI and the IoT offer new opportunities for telecom equipment makers. For instance, Huawei has developed FusionPlant to serve traditional industries in the domestic market, providing them with the full spectrum of platform services. Huawei also operates the internationally-facing Ocean Connect, a narrowband IoT platform that manages the interconnection of devices and supports developer APPs for smart home, cars, cities and factories.

Companies specializing in industrial software solutions and information technology services are also well-positioned to set up digital platforms. Yonyou, Irootech, BONC and Inspur have all made it to the MIIT's hall of fame. Irootech's Rootcloud IIoT platform (founded in 2016 as a unit of construction machinery giant Sanyi) has already networked over 500,000 industrial devices and is eyeing the European market[38]. In June, it closed a Series B funding round of CNY 500 million (see case studies).

The ecosystem extends well beyond MIIT-designated companies. A host of startups provide platform solution services to specific industrial sectors, e.g. You Ye, CyberInsight, Neucloud and Beijing Kunlun. Automation-focused companies such as Hualong Xunda, Zhejiang SUPCON, and MJ Intelligent System have amassed know-how in providing industry 4.0 solutions.

A host of startups provide platform solution services to specific industrial sectors

The involvement of small companies can also be seen in MIIT's November 2019 list of new use cases (工业互联网平台创新应用案例). The first category includes already-mentioned cross-sectoral platforms. Two new categories analyze **a)** 14 large enterprise use cases and **b)** 11 small enterprise use cases, encompassing multi-dimensional monitoring and management of wind power equipment's health, optimization of decision-making related to energy storage in new energy power stations, and AI-based predictive maintenance of rotating equipment.

4.2 PRIVATE INTERNET GIANTS SHIFT FROM CONSUMER TO INDUSTRIAL PLATFORMS

Chinese internet giants venturing into the B2B space are a major push factor in the creation of industrial internet platforms. In the consumer internet industry, companies like Baidu, Alibaba and Tencent have established China's comparative advantage in the B2C and C2C domains of the digital platform economy. Faced with slowing growth in online users[39] and the government's call for a digitalization (数字化) and smartification (智能化) of manufacturing, these companies are harnessing new opportunities in the Industrial Internet of Things (IIoT).

Industrial internet platforms enable internet companies to leverage the availability of data from a massive pool of Internet users. A core feature of Industry 4.0 is the use of consumer behavior data to optimize design and production. At the World Artificial Intelligence Conference in 2018, Tencent CEO Ma Huateng explained his company's desire to parley its strength in consumer internet (Tencent unit WeChat has over one billion monthly active users) into the smart retail and smart manufacturing fields[40].

Tencent's organizational restructuring has created a new cloud and smart industry business group. Likewise, Alibaba's B2C online marketplace Tmall has opened an innovation center that helps sellers customize their products via access to Alibaba's technologies and a data pool of 600 million online users[41].

The strength of China's internet giants in certain applications of cutting-edge technology, e.g. in autonomous driving or industrial AI, may favor them in the new phase of the digital platform economy:

- **Baidu's Apollo,** the world's first open source autonomous vehicle technology platform, has over 390,000 lines of code,12,000 Github developers, and 130 corporate partners, including major German carmakers[42].
- Open AI platform **Baidu Brain** puts its top-notch AI capabilities to use in several industries: In manufacturing, its image recognition technology is used to detect material defects.

On the demand side, the vast numbers of small and medium enterprises (SMEs) in China's highly fragmented manufacturing sector are a major pull factor drawing internet firms to the industrial internet. These SMEs often rely on third party-provided resource-matching or general enabling platforms to go digital.

- **AliCloud,** the cloud computing arm of Alibaba, developed ET Industrial Brain, an industrial PaaS platform which uses AI algorithms, machine learning and data analytics to support intelligent manufacturing – from smart supply chain management and R&D to smart production and marketing – across a range of industries, from renewable energy to heavy industry.
- Based on ET Brain as a foundational technology and "1+N" as a concept, Alibaba developed the cross-sectoral **SupET platform**; it allows companies in virtually all industries ("N") to participate in its ecosystem and launch industrial APPs[43]. SupET is a co-operation between Alibaba, SUPCON (a leading provider of automation and information technology) and the provincial R&D center Zhejiang Lab.

Investments and international partnerships are integral to the strategy of the BAT three (as Baidu, Alibaba and Tencent are known) for conquering the industrial internet. Last year, the three were among the strategic investors in Foxconn industrial internet's record IPO on Shanghai Stock Exchange: It raised CNY 27 billion, becoming the most valuable China-listed tech company[44]. AliCloud secured a milestone deal with Siemens for bringing "Industrie 4.0" solutions to China and promoting the IIoT, thereby making Siemens' Mindsphere available in the Mainland[45].

Internet companies can utilize their command of platform business models and the huge amount of consumer data collected to create digital platforms that automate and transform upstream industrial processes. However, successful value-creation will depend on China's overall progress towards digital and intelligent manufacturing, particularly in traditional industries.

Internet companies can utilize their command of platform business models and the huge amount of consumer data collected

4.3 THE GOVERNMENT INCENTIVIZES SOES TO SET UP PLATFORMS TO BOOST EFFICIENCY

China's government recognizes the huge potential of industrial internet platforms to spur innovation and productivity in the state sector, which fits the imperatives of high-quality growth. SOEs play a critical role in China's economy, though they remain significantly more leveraged and less efficient than private firms[46]. For industrial SOEs, industrial internet and platform business models can act as catalysts of innovation and upgrading. A 2016 survey revealed that only 44 percent of Chinese SOEs felt prepared for Industry 4.0, compared to 71 percent companies in the United States and 68 percent in Germany[47].

In June 2019, the State-Owned Assets Supervision and Administration Commission (SASAC) unveiled the Industrial Internet Convergence Platform for Centrally Administered State-owned Enterprises (中央企业工业互联网融通平台)[48]. The platform exists to promote resource sharing and overall industrial upgrading. Its construction began in 2018; it was carried out by 289 SOEs, with China Aerospace Science and Industry Corporation (CASIC) as the lead developer.

A small group of China's largest conglomerates have already gained a foothold in the digital platform economy. A case in point is CASIC, a Fortune 500, hi-tech SOE which is the main contractor to China's space program and develops and manufactures missiles and aerospace equipment. CASIC's cloud computing subsidiary, CASICloud, started building China's first industrial internet platform as early as 2016. The platform focuses on matchmaking and resource sharing through cloud manufacturing, and targets SMEs in traditional industries. It had 1.6 million users registered as of 2018, with a total transaction value exceeding CNY 400 billion, according to the company (see case studies)[49].

Other state-owned giants followed suit, setting up dedicated information technology subsidiaries to build industrial internet platforms.

- **China State Shipbuilding Corporation** (CSSC) uses a cloud platform to optimize collaborative R&D and manufacturing along its supply chain, which guarantees timelier equipment delivery and higher production efficiency.
- Steel-making giant **Baosteel** (a partner since 2015 in the "Baosteel & Siemens Go to Industry 4.0 project") applies platform-based solutions such as remote-control systems for on-demand production to monitor output through data visualization and apply data modeling to improve decision-making.
- With the help of Huawei, Alibaba, the MIIT and several research institutes, **Petrochemical Yingke** (Sinopec Group) launched the **ProMACE** industrial cloud platform to support digital transformation in China's petrochemical industry.
- Other noteworthy platform experiments are underway in power generation (Huaneng, State Grid) and automotive (FAW Group, BAIC Group).

The party-state actively supports these enterprise-led experiments by allocating financial resources and sponsoring pilot projects. For instance, in 2018, the MIIT selected some demonstration enterprises – including two of those mentioned above – to spur digital industrial platform development in the process industry, as part of efforts to build up to five national-level platforms[50]. Beijing also sees the platform economy as a potential growth engine for commodity markets[51].

There is still a long way to go before these efforts translate into a smartification of production in the state sector at large. A few technologically advanced SOEs appear to be frontrunners in the industrial platform economy. However, leapfrogging from basic automation, computer numerical control (CNC) and software-based production to the IIoT is not an easy task. Many SOEs are burdened by overcapacity, debt and inefficiency and therefore less likely to adopt cutting-edge technologies. Meanwhile, many of the existing platform experiments would not be possible without technology and know-how from the private sector.

Competition in the global platform economy is slowly heating up. Until now, only a few Chinese industrial platforms – such as Haier's COSMOPlat – have become influential overseas. However, Beijing has stated its intention to promote the industrial internet as part of the Belt and Road initiative (BRI). The focus seems to be digitalization and smart control of transport, energy and logistics projects operated by Chinese companies in BRI markets through digital platforms. There is also an emphasis on matchmaking and international cooperation on regulations and standardization[52].

Until now, only a few Chinese industrial platforms have become influential overseas

5. China lacks core capabilities to develop industrial digital platforms unaided

Despite the government's grand top-level strategies and the rise of national champions, China's own analysts openly debate the weaknesses in the current level of development. The shortcomings discussed in Chinese language reports[53] are consistent with the findings of our own MERICS research.

Three key weaknesses are fundamentally interlinked:

1) Manufacturing industry has a low level of digitalization overall. This is the driver for China's "platformization" effort, as the CCP hopes to leapfrog beyond the manufacturing industries of advanced industrial economies by levering digital technologies.
2) Platforms are highly dependent on key foreign components like industrial software – a general structural problem for China and a key opportunity for foreign companies.
3) The low level of demand and usability for the more sophisticated solutions of digital industrial platforms. When the quality of machinery and equipment is not high, it does not create much added value to connect them with sensors and integrate data into an overall fragmented semi-digital factory. Many companies will not rush to do this.

5.1 THE OVERALL LEVEL OF DIGITALIZATION IN CHINA'S MANUFACTURING REMAINS LOW

The extent of digitalization and networking within manufacturing governs the level of integration and use of industrial internet platforms. The PRC has become a global leader in sectors like e-commerce or fintech, yet it has the lowest overall level of digitalization in manufacturing compared to any area of the economy.

China has the lowest overall level of digitalization in manufacturing

The International Data Corporation (IDC), China's leading global provider of market intelligence for the ICT sector, has analyzed seven dimensions of digitalization. It found severe shortcomings in the manufacturing sector, leading to "data islands" within companies, and between upstream and downstream ends of the industrial chain. The IDC's seven areas are:

1) application of digital technology,
2) integration of internal corporate decision-making,
3) integration of service procedures,
4) product services,
5) customer experience,
6) business models,
7) labor resource management.

China's potential for economies of scale, digital industrial platforms that integrate multiple factory sites and companies have strong growth potential. However, looking at the optimization of production processes along corporate supply chains, it can be seen that uneven digital connectivity of production equipment across industries hinders deployment of larger-scale platforms, especially cross-sectoral ones.

In the raw materials and ICT sectors, there is relatively high production device connectivity (46.8 and 44.2 percent). Scores are low for the equipment in both the machinery (31.3 percent) and traffic/mobility (39.1 percent) sector. The consumer product sector is also below the average of 40.3 percent, with the lowest score in light industry (34.1 percent)[54].

Enabling conditions like centralized data management to set up and use such a platform efficiently are also lacking, even when the scope of a platform is limited to a single factory or company. For example, in 2018, only 14.6 percent of manufacturing companies assessed by the National Development and Research Center for Industrial Information Security collected and managed all information from their business units centrally. The figure was 13.7 percent for those centralizing information flow from external business units[55].

5.2 CHINA LACKS CORE COMPONENTS AND HUMAN RESOURCES TO DEVELOP DIGITAL PLATFORMS

China lacks indigenous providers at nearly every layer of the industrial internet platform architecture

Looking more deeply at the specific components required to build industrial platforms, China lacks indigenous providers at nearly every layer of the industrial internet platform architecture – the edge, IaaS, PaaS, and SaaS layers. This lack of domestic supply is constantly referred as a key problem by Chinese research reports[56].

- Data collection is the essential function of the edge layer – the bottom layer – of industrial internet platforms. China still lacks capable domestic equipment and solution providers.
- China's share of the global sensor market was around 10 percent in 2018. The PRC has to import almost 80 percent of high-end sensors and up to 90 percent of chips to meet domestic demand[57].
- Chinese companies also struggle to connect devices. In 2019, 95 percent of high-end programmable logic controllers (PLC) and common industrial protocols were imported, according to a CCID report assessing prospects for the industrial internet platform[58]. Devices from different foreign companies are often not interoperable, posing problems for collecting data and taking equipment to the cloud.
- In the Software-as-a-Service (SaaS) layer, over 90 percent of high-end industrial software is foreign[59]. Although some Chinese companies have overtaken foreign competitors in developing information management software (Yongyou over SAP) and plug-in software (Huawei over Siemens), yet foreign companies lead in the R&D and design production software fields, according to the 2019 White Paper on China Industrial Software Development[60]. The Chinese market for SaaS is still dominated by foreign companies such as Germany's SAP or US-based Microsoft and Salesforce[61].

China also lacks the talent pool to build enabling conditions for digital industrial platforms, according to official media and research reports. The transformation to industry from digital technologies will bring far-reaching changes to the labor landscape. The need for new technical skills will grow, with data analytics being the most indispensable. China is estimated to need 1.8 million data analysts in the next three to five years, but currently has only about 300,000[62].

The China Industrial Control Systems Cyber Emergency Response Team, a research unit of MIIT, has pointed out that the lack of multi-disciplinary skilled workers has become a significant factor for the bottleneck of the further development of the industrial internet[63].

5.3 CHINA'S INDUSTRIAL PLATFORMS ARE NOT USED FOR HIGH VALUE-CREATION

The majority of the use-cases of Chinese industrial digital platforms are still focused on helping enterprises to realize digitalization, getting various devices connected and their data into a cloud.

China's companies, especially SMEs, still struggle to recognize a potential new source of income in the added value from data-based additional solutions like customization of product design or predictive maintenance, according to sector reports. Chinese media reports have coined the phrase "not daring to use it, not being able to use it, can't be bothered to use it" (不敢用 不会用 用不起) to describe a common view among SMEs.

Especially SMEs still struggle to recognize a potential new source of income in the added value from data-based additional solutions

The AII has concluded that solutions offered by Chinese providers focus more on production monitoring and optimization, whereas foreign platforms have a stronger emphasis on predicative maintenance and after-sales services, using platforms to generate new sources of income[64].

Among solutions closer to existing production processes, the level of big data usage is below 35 percent, according to the AII's latest report to the National Committee of Technology and Standardization Managing the Integration of Informatization and Industrialization. The AII research showed that the lowest level of big data analysis is found in solutions moving up from the existing business model of manufacturing companies, namely environmental risk assessment (EIAs) and accident analysis and prevention[65].

6. China's policy evolution targets domestic weaknesses

China's government recognizes current domestic weaknesses in developing industrial platforms and has started to follow through with centrally devised blueprints that set forth specific implementation mechanisms to push the digital platform economy deeper into the manufacturing sector.

Key implementation mechanisms are:

- Region-specific, sub-national pilot projects, often emphasizing public-private partnerships between local governments, state-owned companies and private firms,
- Introduction and experimentation with more market-driven funding mechanisms, including private equity investment, to reduce dominance of state subsidies,
- Setting up of a comprehensive industrial internet standardization system by 2020.

6.1 REGION-SPECIFIC PLATFORM EXPERIMENTS AND GOVERNMENT-CORPORATE PARTNERSHIPS DRIVE IMPLEMENTATION

Provincial, municipal and city governments[66] started to issue their own industrial platform implementation plans in 2019. One year before, the 2018 "Guidelines on the Construction and Development of Industrial Internet Platforms" (工业互联网平台建设及推广指南)[67] had mandated demonstration work and financial incentives. These are now being rolled out to create an enabling environment for platform development. Local governments are gearing up to advance Beijing's platformization agenda, often through strategic partnerships with state-owned and private companies.

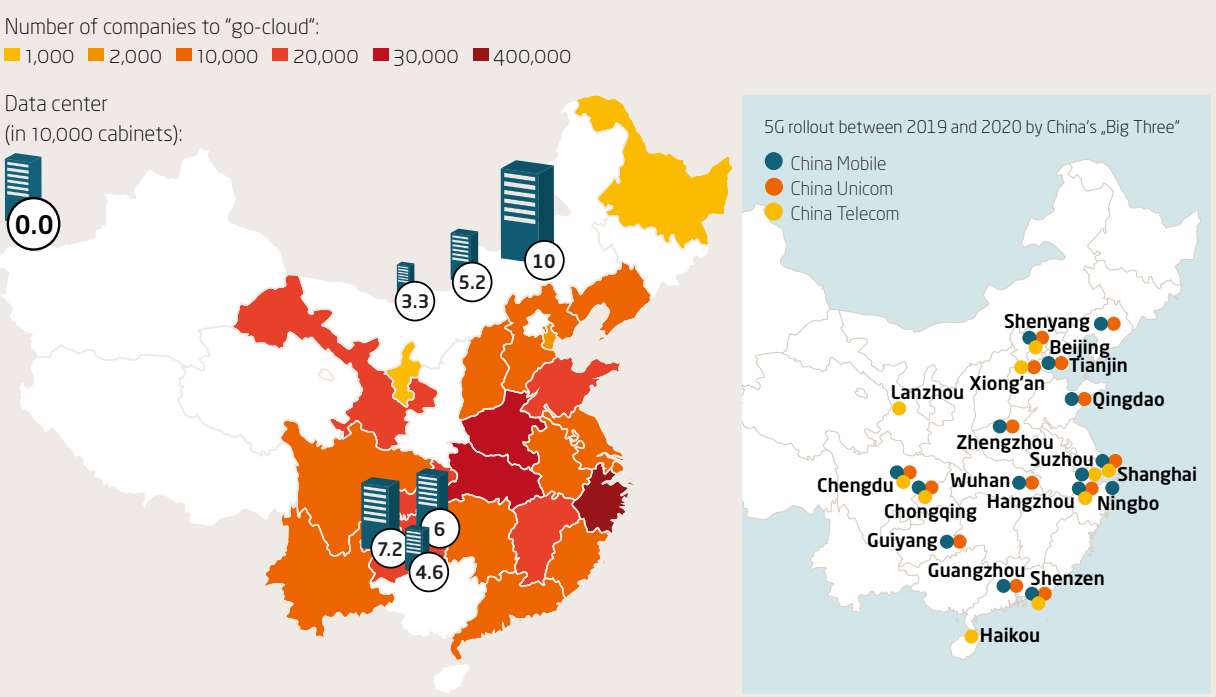
Provincial, municipal and city governments started to issue their own industrial platform implementation plans in 2019

Likewise, the "Guiding Opinions on promoting a standardized and healthy development of the platform economy (国务院办公厅关于促进平台经济 规范健康发展的指导意见), released by the State Council in August 2019, call for improved data sharing mechanisms between platforms and the government. The "Internet+regulation" system and the "National System for Disclosure of Corporate Credit Information" (国家企业信用信息公示系统), among others, will be used for this purpose[68]. This indicates that the digital platform economy is to be linked with the state-controlled social credit rating system.

Sub-national governments have set specific targets for the number of companies "to go cloud" (上云). The most ambitious provinces are not located in the comparatively well-developed coastal region of China, but notably further inland (e.g. Henan, Hubei, Chongqing and Guizhou)[69]. The regional push for cloud-connected companies seems to align with current efforts to build large data centers in Guizhou province and parts of Sichuan[70]. In contrast, China's 5G development, a key enabler of the digital industrial platforms, centers on big cities in coastal areas (see exhibit 6).

In local implementation, a key trend is the establishment of region-specific platforms. Henan, Guangdong and Chongqing, mirror the national approach by seeking to set up one or two globally competitive platforms, two or three cross-sectoral platforms and up to 20 sector-specific platforms[71].

Infrastructure build-up to push digital industrial platform development
Provincial "going-cloud" ambitions and China's biggest data centers



One of the key platform development tasks assigned by the government was to build region-specific platforms. Four projects of this kind were selected by the MIIT as national focus projects to receive further funding and support:

- Guizhou Industrial Cloud (Guiyang, Guizhou Province, by CASIC),
- Unicloud Regional Industrial Internet Platform (Shanghai, by Unigroup Cloud Engine),
- Industrial Internet Platform of Beijing Automotive Industry Gathering Area (Beijing, by BAIC Group),
- Industrial Internet Platform of Sichuan Electronic Information Industry Gathering Area (Chengdu, by Sichuan Changhong Electric)[72].

Provincial and municipal governments are developing implementation plans to support platform development, platform application demonstrations, and industrial enterprises' "go-cloud" efforts.

In tandem, companies are responding to central and local government plans for digital platform creation by tailoring their platformization strategies to specific regions and cities, following the "regional platform + demonstration base" (区域平台+示范基地) model[73].

- **Haier's COSMOPlat** pursues a nation-wide strategy and is already present in 20 countries,
- **XCMG's Xrea** serves 330 cities and localities within China in addition to 10 markets along the BRI,
- **AliCloud** chose to link its cross-sectoral **SupET** platform to regional industries by creating special sub-platforms (Feilong in Guangdong and Feixiang in Chongqing),
- **SupET** is also the core foundation of Zhejiang Province's "1 + N" industrial internet platform system strategy, which envisions the cultivation of one cross-domain industrial platform as well as various specific platforms,
- **CASICloud** is behind **Guizhou's Industrial Cloud,** an integrated service platform partly aimed at facilitating the local government's industrial management and control work.

China leverages public-private collaboration in IIoT adoption

Government-corporate partnerships drive many of these experiments. In the Yangtze River Delta area (YRD), local authorities and CAICT work together with leading industrial internet platform companies (XCMG, Isesol, AliCloud, Baosight, Helishi) to nurture regional platform clusters. The end goal is to have four to five cross-industry and cross-domain platforms by 2020, to boost the regional "networked and intelligent transformation of enterprises"[74].

China also leverages public-private collaboration in IIoT adoption, promoting innovation test beds that are scaled up if successful. One example is the manufacturing quality management (MQM) test bed, a collaboration between Huawei, Haier, China Academy of Information and Communications Technology (CAICT) and China Telecom. It seeks to improve product quality standards and reduce defect rates based on the IIC's Industrial Internet Reference Architecture (IIRA)[75].

Another batch of pilot demonstration projects places special emphasis on integrated development of manufacturing and the internet. Two sub-projects focus on sector-specific platform pilots. They are spread remarkably widely, from Shandong on the east coast to Gansu province in the west and Yunnan province in the south-west. With a few exceptions, like Lenovo or Haier, the participating companies are not well-known platform providers. There is no specific sectoral focus. The list of 36 platform pilots (out of 137 projects related to the overall functioning of cyber-physical systems (CPS) or specific tasks like data collection) runs the gamut of industries from food, to raw materials, textiles or steel[76].

6.2 BEIJING SEEKS TO SHIFT FINANCIAL SUPPORT FROM SUBSIDIES TO MORE MARKET-DRIVEN MODES

The development of all China's industrial internet platforms has been mainly based on government subsidies, combined with corporate internal resources. Beijing is now aiming for more market-driven financing, hoping to inspire mixed public-private projects as well as equity financing.

On a continuum of outright state support to a stronger integration of market-driven mechanisms, the spectrum of funding mechanisms includes the following approaches (see exhibit 7).

China's wants to move towards market-driven funding mechanisms
Existing sources of funding for digital industrial platforms

State

Market

Type of funding	Example
Regional cash subsidies (兑现补贴券)	About CNY 20,000 per company going cloud
National government procurement by the Ministry of Industry and Information Technology (MIIT)	More than CNY 3 billion for the strategic development of industrial internet layers and components such as identification resolution; cloud and edge, platforms standardization, security features
Subsidies for public tenders by provincial governments	Up to 20–30 percent of the applied funding, with a maximum sum of CNY 2–5 million
Partnerships between state-owned enterprises (SOEs) and local government funds	China Electronics Corporation plus Changsha City invested CNY 2 billion to set up China Electrics Industrial Internet Co.
Corporate funding: big companies develop and run platforms on their own expense, often by setting-up their own designated platform companies	China State Shipbuilding Corporation invested CNY 50 million to set up the China Shibuilding Industrial Internet Company
Attracting venture capital investment	Rootcloud got CNY 500 million (B round)
Going public: initial public offerings (IPOs) of Chinese platforms have not yet happened in the industrial realm, but have proven very successful with B2C platforms	Foxconn Industrial Internet Co Ltd IPO in Shanghai in May 2018

Source: MERICS

6.3 CHINA PUSHES FOR DEFINITION OF TECHNICAL STANDARDS FOR THE INDUSTRIAL INTERNET

Standards regulate everything, from the way machines communicate with each other and data is safely shared among participants in a platform ecosystem, to the architecture of digital platforms and technical requirements for third-party developers who build industrial apps on top.

A 2016 Deloitte survey of Chinese manufacturers identified three major challenges for domestic companies in the Industrial Internet of Things (IIoT). Two of them stemmed from insufficient regulatory frameworks, namely lack of interoperability standards and unclear rules on data ownership and security[77].

China's regulators are keenly aware that these challenges remain today. First, as more companies start deploying platforms, China's government seeks to push the definition of more robust technical standards, from platform reference architecture down to interoperability between platforms[78]. However, according to an AII assessment, platform standardiza-

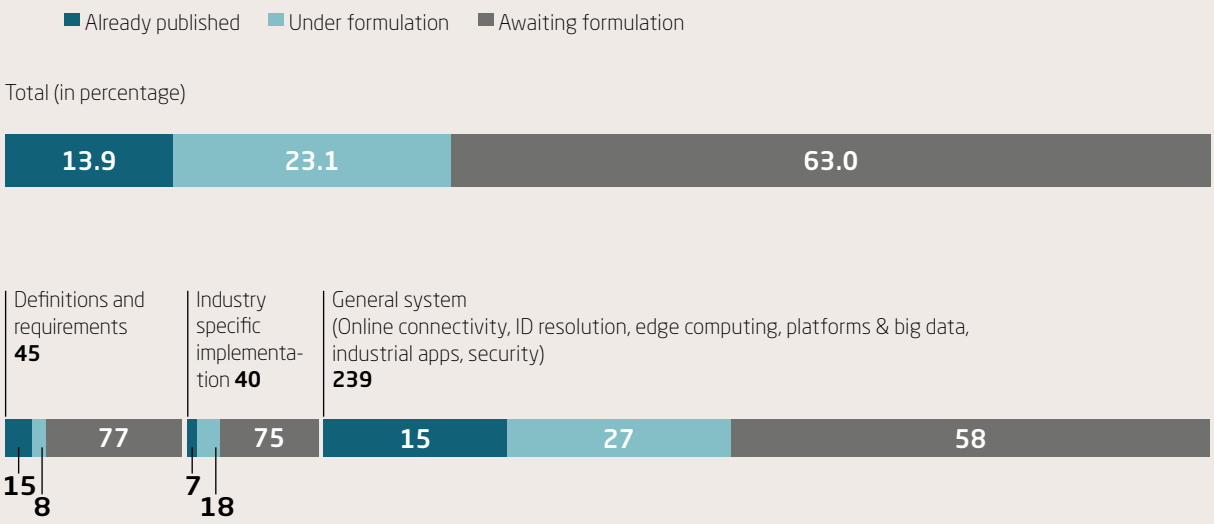
tion work in China is still at an early stage, especially as regards the interconnection of platforms with equipment and intelligent products. Standards on data sharing and mutual recognition are still lacking, as are regulations on platform operations, resources and services[79].

China aims to build a basic industrial internet standardization system by 2020 that includes digital platforms. By 2025, more than 100 standards are due to be established, and a "unified, comprehensive and open industrial internet standardization system" is to be in place[80]. In March 2019, MIIT and SAC jointly issued the "Guidelines for the Construction of an Integrated Industrial Internet Standardization System" (工业互联网综合标准化体系建设指南). Notably, it appears that regulators took up suggestions made by AII when the guidelines were released for public comment[81]. The document names three crucial parts of the industrial internet:

- internet (network and connection, ID resolutions, edge computing),
- platforms (platforms and data, industrial APPs, edge),
- security.

Exhibit 8

Most of China's 324 Industrial Internet Standards are still awaiting formulation
Progress of the Industrial Internet Standard System (工业互联网标准体系)



Source: Industrial Internet System Framework released by MIIT and SAC, January 2019

Taken together, the three parts enable the construction of a new type of network infrastructure with the full interconnection of people, objects and machines. At least on paper, Beijing emphasizes mutually beneficial international collaboration on industrial internet standardization. But despite China's vision for its standardization framework being highly ambitious, the process is still in its infancy and only a few standards have been published so far.

The second challenge is to establish clear standards for data ownership and security. China's regulators are trying to eradicate "data islands" and the lack of basic infrastructure

supporting the acquisition, aggregation, classification and large-scale sharing of industrial big data[82]. The smooth flow of data between industrial enterprises and companies in the ICT and data analytics sectors is a precondition for the scalability and adoption of digital platforms, without which the convergence of information technology and manufacturing cannot be realized. Chinese cloud and IIoT platform providers often cite the scarcity of data, as many companies (especially SMEs) often have incomplete information systems or simply stick to their old systems[83].

MIIT's newly released draft Guidelines for the Development of Industrial Big Data (工业大数据发展指导意见(征求意见稿) aim to address these problems. They call for the establishment by 2025 of "the industrial big data resource system, integration system, industrial system and governance system". Specific targets include setting up a National Industrial Internet Big Data Center to serve as a nation-wide resource platform and cultivating three to five internationally recognized industrial big data solution providers[84].

Openness and collaboration are extremely important for designing scalable platform business models, since network effects are greater as more actors interact in a platform ecosystem. Removing bottlenecks to (big) data trading and sharing can considerably boost China's capabilities in the B2B platform economy.

At the same time, security is an increasingly pressing concern for China as it looks to promote digital platform adoption in the manufacturing sector. The interconnection of millions of machines and devices magnifies potential vulnerabilities, fueling demand for robust regulatory frameworks to protect information security. According to data from China Industrial Control Systems Cyber Emergency Response Team, security loopholes exist in over 90 percent of the more than 3,000 industrial control systems already connected to the internet[85]. A strong security focus was already visible in the MIIT's assigned pilot demonstration work for 2018, where 29 out of 93 sponsored projects focused on cyber and data security, including platform security.

Security is an increasingly pressing concern for China as it looks to promote digital platform adoption in the manufacturing sector

In August 2019, MIIT together with nine other government agencies issued the "Guiding Opinions on Strengthening the Industrial Internet Security Work" (加强工业互联网安全工作的指导意见). The document called for the establishment of a "complete and reliable industrial internet security system by 2025", with an initial system ready by 2020[86]. Among the main tasks, the government will produce a classification system for grading enterprises, formulate at least 20 cyber-security standards by 2020, promote pilot demonstration work in priority sectors (automotive, electronic information, aerospace, energy) and nurture a number of competitive industrial internet security companies.

In addition to dealing with internal structural challenges, China's government seeks a greater say for Chinese firms in international standard-setting bodies. China tries to actively shape international standards for digital technologies underpinning industrial platforms, such as the IoT. It uses a sophisticated, comprehensive and multi-pronged strategy combining investment, well-trained human resources and targeted international partnerships, first and foremost with Germany's Industry 4.0. In the view of the German experts interviewed for this study, China definitely considers Germany to be an important partner in the standardization of the industrial Internet and intelligent manufacturing, including within the IEC and ISO organizations.

Several IoT-specific plans, such as the "Special Project Action Plan for Standards Formulation" (标准制定专项行动计划) emphasize China's goal of gaining leadership positions in

international bodies, such as ISO/IEC and ITU)[87]. The strategy has already yielded results. In July 2018 China's IoT Reference Architecture proposal (known as ISO/IEC 30141) passed the final draft international standard voting process of the joint ISO/IEC body[88]. Intense lobbying within standardization bodies is combined with the promotion of Chinese standards through R&D, testing and commercialization of digital infrastructure built by Chinese companies at home and in foreign markets. Notable examples include 5G network solutions and Narrowband (NB) IoT.

Chinese companies are scoring relatively well in terms of Industry 4.0 patents. According to study by Fraunhofer, as early as in 2015 China had already overtaken the US and Germany in patents for basic Industry 4.0 technologies. China was mostly innovative in wireless sensor networks, embedded systems, low-cost robots and big data. The picture was more ambiguous in industrial information security, smart sensors, smart robotics, and Industry 4.0 applications[89].

Chinese companies are scoring relatively well in terms of Industry 4.0 patents

Currently, only a handful of Chinese platforms stand out in international standardization. Haier's COSMOPlat is well-positioned to set mass customization standards globally, having seen its proposal adopted by the Institute of Electrical and Electronics Engineers (IEEE). The company has also taken a leading role within ISO's first mass customization standard project. Its presence in international bodies has active government backing: SAC (jointly with the International Organization for Standardization (ISO)) launched a training base in Haier's home city Qingdao to advance the enterprises' role in standardizing intelligent manufacturing[90]. Haier also heads SAC's manufacturing model standard working group (SAC/TC573/WG10), established as part of the government's "China Standards 2035" (中国标准2035) research effort to standardize cutting-edge technologies like AI, cloud computing, IoT and big data and eventually export Chinese standards[91].

7. The scope of foreign participation depends on China's technological needs

Many of the digital platforms analyzed in this study benefited from strategic partnerships with foreign companies and research institutes at various stages of their development. For China, Germany is a key partner in developing an Industry 4.0 of its own.

The analysis of China's digital platform economy and of existing mechanisms for foreign participation shows that international collaboration is geared towards accessing the competences and know-how China needs as it catches up in smart manufacturing. China's relative weaknesses in mastering core components of the IoT technology, such as SaaS and industrial applications, has created opportunities for German and other foreign companies. Many collaborations have been established: For instance, Siemens obtained a license to operate its MindSphere digital platform in China using the infrastructure of Alibaba Cloud. Likewise, Bosch signed an agreement with Huawei to run its IoT suite on Huawei Cloud[92].

From our observation, however, it appears that foreign players' ability to influence regulatory developments is highly limited. The regulatory environment largely favors indigenous solutions in the digital platform economy. Cybersecurity and data regulations will likely constitute the main challenge for foreign platform companies in doing business with China in the coming years.

The regulatory environment largely favors indigenous solutions in the digital platform economy

7.1 FOREIGN COMPANIES' PARTICIPATION AND THEIR INFLUENCE ON REGULATION IS LIMITED

China's approach to international cooperation in the digital platform economy puts domestic industrial upgrading first. The government regards foreign collaboration primarily as a means to acquire know-how in Industry 4.0, to share best practices and jointly work on testbeds and standardization. This is reflected in AII's partnership with the IIC, "Plattform Industrie 4.0", and international bodies such as the International Telecommunications Union (ITU).

Cooperation with other countries is not mentioned once in the detailed work plan of China's Industrial Internet Special Working Group for 2019. However, foreign states do come up in the context of two self-serving measures: they send Chinese experts abroad for training and "on the premise of maintaining national information and data security, (...) actively serve eligible industrial internet companies to directly raise funds in overseas capital markets"[93].

German companies and institutions play an important role in facilitating Chinese companies' platformization efforts. Joint research and development projects have become the main form of cooperation between Germany and China.

The R&D institute behind Haier's COSMOPlat cultivated strong links with several German research institutes from the start. Germany's Siemens supported the development of CASI-Cloud's INDICS cloud platform with a strong partnership from the early stages, following an agreement signed during Chancellor Angela Merkel's visit to China in 2017.

CASICloud is also working with TU Darmstadt and the company Festo Didactic SE within the research project CaMPuS. The project investigates which competencies employees at different hierarchical levels in Germany and China need in order to analyze and optimize production processes with industry 4.0 technologies. The Instrumentation Technology and Economy Institute (ITEI) also participates on the Chinese side[94].

Notably, CASIC's advances in industrial internet and cloud manufacturing could bolster China's capabilities in developing advanced weapon systems, albeit indirectly[95]. CASICloud is already used by the People's Liberation Army (PLA) for managing weapons and equipment procurement information[96], as well as by CASIC itself for outsourcing defense and commercial contracts and managing its supply chain. China's defense industry clearly sees platform business models as an important driver of industrial modernization.

Chinese counterparts generally describe their cooperation with German actors in utilitarian ways: For instance, XCMG, a state-owned heavy machinery manufacturing company, ranking 5th in the world's construction machinery industry, highly values its partnership with SAP: "With the help of SAP's successful experience in Industry 4.0 high-tech strategy project, we wish to boost *XCMG's globalization* under the 'Made in China 2025' initiative and continue to build up our sustainable competitiveness in the global market[97]."

The partnership agreement between SAP and XCMG was signed in 2015 to support the intelligent manufacturing and management of XCMG products in global markets, shortly after the Suzhou-based company had started working on its industrial IoT platform XREA. The construction machinery company has since opened a wholly owned subsidiary, XCMG Europe, in Krefeld, Germany, to tap into the industrial base, the essential foundation of every digital industrial platform. XCMG's research center wants to optimize and develop new transmission systems for its machinery. To achieve this, Jiangsu-based XCMG recruits systematically and in large numbers, judging from job advertisements on its website[98].

Chinese platform providers have also attracted German manufacturers as customers

Chinese platform providers have also attracted German manufacturers as customers (supply-side end users), starting with carmakers, the industry that is most dependent on the Chinese market. Digital platforms for autonomous driving, such as Baidu's Apollo, Huawei's OceanConnect Connected Vehicle Solution, and QiMing's Venus Cloud attract major German carmakers, from Volkswagen to BMW and Daimler.

For German platform providers, opportunities to offer services to Chinese customers seem much more limited. Siemens, Bosch and SAP all signed agreements with Chinese cloud providers to be able to operate their services in the PRC. Those agreements seem to be motivated by China's own technological needs, specifically in the realm of SaaS and PaaS, rather than by any growing openness in China's digital platform ecosystems. German and other foreign companies are more likely to participate as suppliers of components for the IoT stack, or as providers of complementary services.

Furthermore, foreign companies have little say over regulatory developments that affect digital platform ecosystems within China. For instance, despite the 2016 admission of foreign companies to the National Information Security Standardization Technical Committee (全国信息安全标准化技术委员会, or TC260), the body that writes national information security and data protection standards, their influence is limited. Foreign industry representatives have shared that foreign members are only be allowed to join TC260 if they do not pose real obstacles to the overall agenda. To mitigate conflict arising from comments by foreign

companies, TC260 has moved the issue of standards to one of the working groups without foreign participation[99]. Interaction with Chinese companies on association and enterprise standards (which in China's standardization system are distinct from government-issued standards) is possible within AII, although only a few, highly influential foreign platform owners sit in its working groups.

7.2 CYBERSECURITY AND DATA REGULATIONS THREATEN FOREIGN PARTICIPANTS

The goal of creating a Chinese platform economy is not mentioned directly in official Chinese statements. However, the regulatory environment clearly favors indigenous solutions. Beijing conflates information security with national security and industrial policy objectives – most notably those emphasized by "Made in China 2025" and related policy plans. The industrial internet can help China realize its ambitions of global tech and manufacturing leadership and reduced dependence on foreign inputs.

The formidable rise of Chinese digital platforms in B2C and C2C domains was as much due to innovative entrepreneurs as the result of government digital protectionism. The CCP's desire to censor and control the internet conveniently shielded platform providers like Alibaba from foreign competition in their home market[100]. The impact of these market access restrictions goes well beyond e-commerce.

Cloud computing is a case in point. European businesses have long expressed concerns about existing limitations on their access to China's cloud computing market for the IaaS and PaaS segments[101]. While encouraging Chinese companies to go abroad, the PRC government has disadvantaged foreign cloud providers by imposing regulations that require them to form joint operations and license their technology to a local partner to get into the market. As a result, Chinese providers dominate the sector, with Alibaba Cloud taking 43 percent of China's public cloud IaaS market in the first half of 2018 while Amazon's AWS, the top performer among foreign players, occupied a mere 6.9 percent[102].

The signs are that the emerging regulatory environment will be especially rigid for foreign companies as the digital platform economy expands into industrial domains. Information and network security, data privacy and cross-border data flow regulations are poised to facilitate Chinese industrial internet platforms in their home market.

The signs are that the emerging regulatory environment in the digital platform economy will be especially rigid for foreign companies

The Ministry of Public Security (MPS) released the draft "Cybersecurity Multi-Level Protection Regulation" (网络安全等级保护条例), in June 2018 for public comment. It was the first layer of a framework sometimes referred to as Multi-Level Protection Scheme (MLPS 2.0)[103]. The new system emphasizes protection of critical information infrastructure (CII), as highlighted in the 2017 Cybersecurity Law, and expands the original scope of MLPS to cover emerging technologies such as big data, cloud computing, and internet of things (IoT) (article 34). Three further draft standards were released in May 2019, in addition to those issued between 2018 and 2019, and were set to take effect on December 1st, when the full MLPS 2.0 is due to enter into force[104]. The framework also covers industrial control systems.

First introduced in 2007, the MLPS is a framework for protecting information security which ranks ICT products and services based on the potential consequences of a damage in information systems. Industrial platforms seem likely to fall under Level 3 or above, meaning that national security could be compromised and so require companies to undergo complex regulatory monitoring, testing and certification processes[105].

China's regulators appear to have dropped a previous requirement which demanded Chinese intellectual property (IP) be used within Level-3 core IT systems and key hardware components. However, considerable regulatory uncertainty and lack of transparency surrounds implementation, and foreign companies may be required to disclose sensitive IP and source codes as part of increasingly demanding cybersecurity review processes[106].

Beijing's emphasis across several official documents on "secure and controllable" technology (interpreted as favoring indigenous ICT technology)[107], is set to have a significant impact on foreign providers in the industrial internet market. It is a frequent theme in discussions within China's expert community on the security and safety of industrial control systems. Many experts argue that these problems can only be solved by developing core technology that is "indigenous and controllable" (自主可控)[108].

China's emerging data protection regime creates further potential hurdles for foreign participation in the industrial sphere of the digital platform economy. The Cybersecurity Law (article 37) limits the outbound transfer of vaguely defined "important data" by CII operators, making it possible only in exceptional circumstances and with regulatory approval[109]. Implementation was suspended after the United States submitted a complaint to the WTO, but it is far from clear how the relationship between a draft called "Data Security Administration Measures" (数据安全管理办法（征求意见稿）), released in May 2019, and an earlier, non-binding draft dated 2017 is going to play out.

China's emerging data protection regime creates further potential hurdles for foreign participation

The new measures do not classify network operators' business and production data as "important data"[110]. However, the 2017 "Guidelines for Data Cross-Border Transfer Security Assessment" (数据出境安全评估指南) featured a very comprehensive appendix on industry-related important data which, though not constituting "state secrets", were nevertheless considered "closely related to national security, economic development and public interests"[111].

If the PRC government translated these guidelines into tangible regulations, the ability to access industrial data on Chinese platform systems could be curtailed for foreign participants. Likewise, if China succeeds in becoming more self-reliant in core components of the IoT, Beijing could conditionalize the already selective access of foreign companies in the name of national security.

8. China's advances in digital industrial platforms: implications for Germany

China's rapid advance in the realm of digital industrial platforms demands attention from German political and corporate actors on various levels. Germany – as well as other European and foreign countries – should take a deeper look at the key characteristics of China's policy and corporate developments in this vital economic segment. Furthermore, Germany should not delay mitigating potential threats if it is to also to be capable of exploring arising opportunities in a fast changing global economic and technological environment:

1. LEARN FROM CHINA'S STRENGTHS IN THE DIGITAL PLATFORM ECONOMY

A solid understanding of China's overall innovation capacity requires going beyond "lighthouse" projects. **A realistic assessment of the overall impact of China's digital platform economy needs more research on regional specifications and development stages.**

German actors need to have a better understanding of the factors that shape China's unique approach to the digital platform economy. **They need to get a better understanding of the unique evolution of cross-sectoral industrial, regional-focused platforms and of network effects beyond smart factories.**

German actors should realize that China's investment in crucial infrastructure for Industry 4.0 are decisive for the rapid progress in the sector. **The Chinese experience shows that the ubiquity of data center capacities and 5G connectivity are essential for the successful development of a digital platform economy.**

2. CONDITION COOPERATION WITH CHINA TO PURSUE GERMAN INTERESTS

China continues to be highly dependent on foreign IIoT stack components and services. This creates leverage for German actors to demand greater transparency and access and to put a higher price tag on delivery of components China depends on.

Maintaining a high level of cooperation on Industry 4.0 is in Germany's interest. In negotiating a new framework of cooperation Germany needs to ensure that German industry priorities are given greater consideration. To this end, the German government should coordinate its own research activities more closely and create consistent rules for cooperation with China.

Priority should be given to setting up more joint research projects on digital industrial platforms on German, and not only on Chinese soil. China's ambitions to expand their platforms into other markets should be leveraged to reach this goal.

To maintain a favorable position in IT standard setting, Germany needs to double down on standardization research and industry-driven standardization efforts. This would also require investments into human resources to be able to better shape decisions in international standardization bodies.

3. MITIGATE RISKS ASSOCIATED WITH CHINA'S BUILD-UP OF DIGITAL INDUSTRIAL PLATFORMS

Despite openness for cooperation, China's drive to achieve self-reliance in every layer of the industrial internet creates challenges for German partners. Joint research needs to be conditionalized and IP protection needs to be a key priority of cooperation frameworks.

Cyber security regulations create the biggest risk for foreign partners because of ambiguity in the regulatory environment and new data-sharing requirements. Risk assessment needs to take into account arbitrary or tighter application of regulations by Chinese authorities.

The development of the Industrial Internet of Things in China takes place in a highly politicized environment. Therefore, cooperation with Chinese partners requires a thorough investigation of potential political risks and vulnerabilities.

IIoT platforms can have dual-use purposes. For German actors there can be high reputational costs if they get entangled in surveillance and defense technology development in China.

Case Study 1: Haier COSMOplat

FOCUS ON MASS-CUSTOMIZATION

FACT SHEET

- Owned by Haier Group
  (world's largest producer of consumer electronics and home appliances)
- Designed in cooperation of *Tianjin Research Institute for Advanced Equipment* and *German Fraunhofer Logistics Research Institute* (BMBF project InFa-CTS)
- Operational since 2015
- Revenue of parent company: CNY 202 billion (2019)
- www.cosmoplat.com

Main characteristics

COSMOPlat is a platform catering to a variety of industrial sectors, with a focus on home appliance manufacturing. It provides seven regional sub-platforms within China, e.g., in Shanghai, Tianjin, Xi'an and in Shandong and Jiangsu provinces. Its flagship product focuses on mass customization (pre-tailoring technology to become adaptable to the needs of each individual user) and utilizes consumer data for improving production processes. The platform is not open source but follows a collaborative model: third-party developers are invited to support further development of services.

Users and modes of participation

As of 2019, the platform was provided to 12 industry clusters including ceramics, agriculture, recreational vehicles, electronics, textiles, construction, transportation and chemicals. Geared towards production-intensive sectors, it connects more than 35,000 companies and 320 million end-users/consumers within an ecosystem providing for mass customization[112].

Services and modes of value creation

COSMOPlat offers efficiency-enhancing, tailor-made industrial apps and solutions for SaaS, PaaS, IaaS and the edge layer, meaning pre-defined business-relevant KPIs, cloud services and AI-supported Big Data analytics, as well as smart devices. The list of partners contributing knowhow to the platform includes foreign and domestic players like SAP, Bosch Service, Ehlebracht AG as well as Alibaba, Huawei, China Telecom and Baosteel[113].

International outreach

COSMOPlat's key products are still China-focused. However, it has built a reputation among specialists worldwide, being named one of "the lighthouses of manufacturing" in a World Economic Forum/McKinsey report in 2019. It has increased its global presence via its acquisitions of Fisher & Pakel, GE's appliance division; Candy group; and facilities in Indonesia and the Phillipines. The R&D institute that operates behind COSMOPlat is associated with German research institutions like the Industry 4.0 Training Base at Aachen University. The company is beginning to play a crucial role in shaping and defining standards for models of mass customization and smart manufacturing[114]. It participated in the formulation of 29 national and international standards and cooperates with international organizations like IEEE (Institute of Electrical and Electronics Engineering); IEC (International Electrotechnical commission); and ISO (International Standardization Organization).

Case Study 2: Huawei Cloud's FusionPlant

FOCUS ON CLOUD EXPERIENCE AND OPEN SOURCE

FACT SHEET

- Owned by telecom carrier Huawei
- Combines Huawei cloud and industrial connectivity platforms
- Established in 2015
- Revenue of parent company: CNY 715 billion
- www.huaweicloud.com/solution/fusionplant/

Main characteristics

While Huawei's general IoT services are already used by a large number of customers in transportation, construction and utilities, FusionPlant is an industrial IoT platform catering to more manufacturing-oriented sectors in China. Huawei has also partnered with public players to build regional industrial internet platforms, for instance in Guangdong.

Users and modes of participation

FusionPlant services vertical industries including manufacturing, petrochemicals, chemicals and industrial products. In the electronics sector, FusionPlant supported the strategic transformation of consumer electronics provider Changhong in IaaS, industrial PaaS, IoT and other areas. It introduced an IoT architecture to the State Grid Corporation of China. Huawei has built an open-source operating system, offering tools to help software engineers develop applications that are compatible with servers powered by its Kunpeng chip series. According to a recent study, FusionPlant's pre-built applications and integration with third-party apps remain limited when compared with its competitors[115].

Services and modes of value creation

FusionPlant provides cloud-based services like IaaS and SaaS and leverages the enterprise intelligence capabilities of Huawei's cloud, like big data management and an AI development platform as PaaS. It provides configurable solutions by combining Huawei technologies and services with third party plug-ins and products offered on the Huawei cloud marketplace. Huawei has announced investment of USD 436 million over the next five years to build a computing ecosystem around its ARM-based server chips[116] to establish its server systems more firmly in domestic industries.

International outreach

Partnerships with other global platforms are a key development strategy for Huawei. FusionPlant partners with foreign firms like ABB, SAP and Bosch. For example, the software platform Bosch IoT Suite collaborates with Huawei Cloud to offer functions needed to connect devices, users, and businesses[117]. Other partnerships involve French software company Dassault Systèmes and US-based ANSYS. Huawei is very active in standardization bodies like the Industrial Internet Consortium, the Edge Consortium, the European Telecommunications Standards Institute, and the 5G Alliance for Connected Industries and Automation (5G-ACIA).

Case Study 3: Rootcloud

FOCUS ON PARTNERSHIPS TO BUILD AN ECOSYSTEM

FACT SHEET

- Incubated by Sany Heavy industry
- Focused on machine-relationship management and the internet of machines
- Operational since 2016
- http://en.rootcloud.com/

Main characteristics

Rootcloud is one of the first vendors to offer an Industrial Internet of Things (IIoT) platform in China. It offers two types of platforms, one for machine relationship management (MRM), connecting machines with cloud data storage and data analysis, and one Internet of Machines platform (IOM) providing 360-degree lifecycle management for equipment.

Users and modes of participation

The company's open platform[118] has around 200 partners and clients, connects 560,000 industrial devices over 61 verticals, including foundry, injection molding, machine tool manufacturing, textile and diesel engine manufacturing. Rootcloud also contributed to the buildup of 14 industry-specific vertical cloud platforms. It has branches in Suzhou, Xi'an, Guangzhou, Beijing, Shanghai, and Changsha.

Services and modes of value creation

Rootcloud partners with hardware and software API vendors and systems integrators. Its IaaS is based on the Tencent Cloud. Rootcloud wants to provide a broad range of PaaS features to a broad variety of industrial sectors, such us equipment manufacturing, energy, textiles, and construction equipment. The platform can integrate with a wide range of devices and systems to map data in a visual approach.

International outreach

Rootcloud has established a global industrial IoT ecosystem and cooperates with international partners. These include AWS, Telenor, ARM and Honeywell, among others[119]. The firm launched an overseas IIoT platform in 2018. Chinese-owned machine builder Putzmeister is one of its key clients in Germany. According to its website, Rootcloud has provided services to foreign companies in India, Kenya, South Africa, Indonesia, Mexico[120].

Case Study 4: CASICloud INDICS

FOCUS ON UPGRADING TRADITIONAL INDUSTRIES

FACT SHEET

- Established by state-owned *China Aerospace Science and Industry Corporation* (CASIC)
- Industrial IoT platform with manufacturing operations management capabilities
- Operational since 2015
- Revenue of parent company: CNY 250 billion
- http://www.indics.com/

Main characteristics

CASICloud and its industrial platform INDICS benefit from defense giant CASIC's equipment and manufacturing experience. INDICS provides an industrial IoT platform but its services extend far beyond this to include manufacturing operations and product data management and resource planning.

Users and modes of participation

INDICS provides smart manufacturing and service solutions to government at all levels and to industries like aerospace, ICT, industrial machinery, automotive, wind power, petrochemical, light engineering, and hydroelectric. It was designed to facilitate the upgrading of China's traditional industries and seeks to achieve this aim by integrating online and offline operations[121]. According to information on the INDICS website, more than 20,000 enterprises across 212 countries and regions have registered, with transaction values amounting to USD 1.1 billion.

Services and modes of value creation

INDICS cloud manufacturing platform offers IaaS, PaaS and SaaS and edge devices, predefined device models as well as VR-based production line optimization. It provides comprehensive software development kits and templates for development of industrial apps. Its general PaaS is partly realized through CloudFoundry, a US provider. Some industrial protocols like Profibus, HART, and Canbus are not yet supported.

International outreach

In 2019, CASICloud set up a multiple-language environment (English, German, Russian, Spanish and French) to launch an international version of INDICS. The company has an office in Germany[122]. Parent company CASIC has established cooperation with major international enterprises and institutions, including Siemens, SAP, BOSCH, TU Darmstadt and RWTH Aachen. Since summer 2019, CASICloud has installed part of its capacities on servers provided by the TU Darmstadt to provide a protected test bed for German and European SMEs.

Case Study 5: XREA

FOCUS ON HIGH COMPATIBILITY AND STRONG INTERNATIONAL OUTREACH

FACT SHEET

- Platform provided by XCMG IT, affiliate of state-owned Xuzhou Construction Machinery Group
- XREA claims to be compatible with 98 percent of industrial protocols
- XCMG IT was founded in 2014
- Revenue XCMG (2018): CNY 56 billion
- www.xreacloud.com

Main characteristics

XREA was an early player in the China's industrial internet and claims to be the first nationwide industrial internet platform. It benefits from the experience of its parent company, which is a major manufacturer of heavy machinery for the construction, mining and energy sectors. XREA is specifically tasked with incorporating SMEs into IoT platform ecosystems.

Users and modes of participation

XREA provides services across more than 60 industries, including construction machinery, renewable energy, military, wind power and core component manufacturing and serves more than 1000 enterprises and 640,000 users in 20 countries, according to its website[123]. The platform has more than 680,000 connected devices and manages high-value equipment assets of more than CNY 550 billion[124].

Services and modes of value creation

XREA provides a public and a private cloud, the latter targeting enterprises concerned with data protection. The platform offers the full range of the IIoT stack. According to technical analysts, the platform has strong capabilities in device connectivity, edge access, cloud-service based data analysis and in delivering tailor-made solutions for specific industrial sectors. XCMG IT has seven R&D centers in China including Xuzhou, Beijing, Nanjing, Shanghai, Wuxi, Suzhou and Foshan. It partners with innovative internet firms like Alicloud. The company has accumulated several patents and copyrights and formulated 10 national standards for the industrial internet with 27 patents submitted[125].

International outreach

XCMG is the 5th biggest construction machinery group worldwide, with operations in more than 180 countries. Its IT arm benefits from this huge network: according to reports, the XREA platform is used in 20 markets[126] along China's Belt & Road initiative. In Germany, XREA cooperates closely with ERP provider SAP and has acquired Krefeld-based machinery manufacturer Schwing. Other cooperation partners abroad include the industrial group ABB and the Taiwanese IIot specialist Advantech.

Case Study 6: Venus Cloud (Qiming Xingyun)

FOCUS ON AUTOMOTIVE

FACT SHEET

- Provided by – largely state-owned – *Qiming Information Technology*
- Claims to be first automotive industry internet platform
- Operates since 2018
- Revenue: CNY 1,5 billion (2018)
- http://www.qm.cn/

Main characteristics

Venus Cloud provides industrial software to car manufacturers mostly from the state sector. It also develops vehicle-to-vehicle communication and smart-city solutions. Qiming was established under direct guidance of China's Ministry of Industry and Information Technology (MIIT) to push the introduction of digital infrastructure solutions to the car industry[127]. The solutions for data collection and digital infrastructure development are largely based on software from US provider Oracle.

Users and modes of participation

Venus Cloud has served more than 3,000 upstream parts and raw material suppliers, more than 10,000 downstream dealers and service providers, 2 million network vehicles and 7 million owners[128]. State-owned enterprises like the major car maker FAW group have implemented platform solutions from Venus. Qiming also serves state-owned banks and cigarette factories. Unlike other industrial platforms, Venus Cloud does not offer a marketplace for third parties. Products offered on the website are designed and supplied by Qiming, although many build upon existing international products.

Services and modes of value creation

Venus Cloud's services are geared towards smart manufacturing, smart cars and smart city implementations. There is a focus on R&D software for new product design. Other services include consultancy, customer relationship management and analysis of industrial data[129]. Qiming CEO Wu Jianhui has said the company's ambition is to expand Venus Cloud to other manufacturing industries, and to create an open and shared integrated ecosystem[130].

International outreach

Qiming has long-standing relations with international companies, especially in Germany. It has provided electric vehicle manufacturing-related services to Volkswagen and Bosch (environmental adaptability, electrical performance and product platform testing as well as performance failure analysis)[131]. Qiming has also tested autonomous driving algorithms with FAW-Volkswagen. The company leadership has expressed the strategic goal of conquering the global market of IT services for the automotive industry.

Endnotes:

1 | Zenglein, Max and Holzmann, Anna (2019). "Evolving Made in China 2025." MERICS Papers on China. July. https://www.merics.org/en/papers-on-china/evolving-made-in-china-2025. Accessed: October 25, 2019.
2 | Evans, Jon (2018). "China's next great leap: Industry 4.0." Orange Business. August 15. https://www.orange-business.com/en/blogs/chinas-next-great-leap-industry-40. Accessed: August 28, 2019.
3 | Figures include Taiwan; GSMA (2018). "How Greater China is set to lead global industrial IoT market." July. https://www.gsma.com/iot/wp-content/uploads/2018/06/GSMA_Report-How_Greater_China_Is_Set_To_Lead_Global_Industrial_IoT_Market-en-July2018.pdf. Accessed: September 12, 2019.
4 | GIZ (2016). „Deutsch-Chinesische Zusammenarbeit bei Industrie 4.0 中德工业4.0合作 Deutsch-Chinesische Kooperationsprojekte 2016. https://www.plattform-i40.de/PI40/Redaktion/DE/Downloads/Publikation-gesamt/dt-chn-kooperationsprojekte.pdf?__blob=publicationFile&v=1. Accessed: May 8, 2020.
5 | See: Technische Universität Darmstadt (n.d.). "CaMPuS." https://www.dik.tu-darmstadt.de/forschung_dik/projekte/aktuelleprojekte_5/campus_2/campus.en.jsp. Accessed: January 31,2020.
6 | For a detailed description of the range of activities see: https://www.plattform-i40.de/PI40/Redaktion/DE/Standardartikel/internationales-kooperationen-china-2018.html und des BMBF, https://www.produktion-dienstleistung-arbeit.de/de/projekte-2118.html.
7 | Siehe „Deutschland und China: Ein gemeinsames Verständnis für Industrie 4.0". https://www.plattform-i40.de/PI40/Redaktion/DE/Standardartikel/internationales-kooperationen-china-2018.html. Accessed: May 12, 2020
8 | See: GIZ (n.d.) "Sino-German Cooperation on Industrie 4.0." https://www.giz.de/en/worldwide/71332.html. Accessed: January 31, 2020.
9 | Gao, Kathy (2019). "Where Next For China's Technology Policy? Creating the Industrial internet." Bloomberg, December 19. https://about.bnef.com/blog/where-next-for-chinas-technology-policy-creating-the-industrial-internet. Accessed: February 1, 2020.
10 | Mu, Danny et. al. (2019). "The Forrester Wave™: Industrial IoT Software Platforms In China, Q4 2019." November 25. https://www.forrester.com/report/The+Forrester+Wave+Industrial+IoT+Software+Platforms+In+China+Q4+2019/-/E-RES146895#. Accessed: November 27, 2019 [full report purchased].
11 | European Centre for International Political Economy (ECIPE) (2019). "Patterns of Trade Restrictiveness in Online Platforms: A First Look". January 2019. https://ecipe.org/wp-content/uploads/2019/01/Patterns-of-Trade-Restrictiveness-in-Online-Platforms-A-first-look-final.pdf. Accessed: May 8, 2020.
12 | CCID 赛迪智库 (2018). "Outlook of China's Industrial internet Platform Development in 2019" [2019年中国工业互联网平台发展形势展望]. p. 490. December. http://www.ccidwise.com/uploads/soft/181220/1-1Q220155227.pdf. Accessed: September 12, 2019.
13 | State Council of the PRC 中华人民共和国国务院 (2017). "Guiding Opinions of the State Council on Deepening the 'Internet + Advanced Manufacturing' Development of the Industrial internet" [国务院关于深化 '互联网+先进制造业' 发展工业互联网的指导意见]. November 19. http://www.gov.cn/zhengce/content/2017-11/27/content_5242582.htm. Accessed: September 20, 2019; Ministry of Industry and Information Technology 中华人民共和国工业和信息化部 (MIIT) (2018). "Notice On the Distribution of the Action Plan for Development of Industrial internet (2018-2020) and 2018 Action Plan of the Industrial internet Special Working Group" [关于印发 '工业互联网发展行动计划（2018-2020年）'和'工业互联网专项工作组2018年工作计划'的通知]. June 7. http://www.miit.gov.cn/n1146295/n1652858/n1652930/n3757016/c6212005/content.html. Accessed: September 29, 2019.
14 | Ministry of Industry and Information Technology 中华人民共和国工业和信息化部 (MIIT) (2019). "The list of cross-industry and cross-sector Industrial internet platforms in 2019" [2019年跨行业跨领域工业互联网平台清单公示]. August 26. http://www.miit.gov.cn/newweb/n1146295/n7281310/c7291030/content.html. Accessed: September 29, 2019.
15 | Zhang, Longmei and Chen, Sally (2019). "China's Digital Economy: Opportunities and Risks". International Monetary Fund (IMF). https://www.imf.org/en/Publications/WP/Issues/2019/01/17/Chinas-Digital-Economy-Opportunities-and-Risks-46459. Accessed: October 12, 2019.
16 | For values on China and US and Germany, see: Dong, Peixin董培欣 (2018). "'2018 Chinese Enterprise Cloud Report' Released" ["2018中国企业上云报告"发布]. Zhiding Wang 至顶网. July 25. http://cloud.zhiding.cn/2018/0725/3109365.shtml. Accessed: September 30, 2019.
17 | Deloitte (2017). "From Interpretation to Prediction: Unleashing the Value of the Industrial internet of Things." April 25. https://www2.deloitte.com/cn/en/pages/consumer-industrial-products/articles/from-interpretation-to-prediction.html. Accessed: October 21, 2019.
18 | Deloitte (2019). "China's smart manufacturing: a steady push for the long term – 2018 China smart manufacturing report". April 3, 2019. https://www2.deloitte.com/content/dam/Deloitte/cn/Documents/energy-resources/deloitte-cn-eri-2018-china-smart-manufacturing-report-en-190403.pdf. Accessed: September 28, 2019.
19 | iResearch 艾瑞网 (2019). "China Industrial internet Platform Research Report" [2019年中国工业互联网平台研究报告]. July. http://report.iresearch.cn/report/201907/3416.shtml. Accessed: August 20, 2019.
20 | Mu, Danny et. al. (2019). "The Forrester Wave™: Industrial IoT Software Platforms In China, Q4 2019." November 25. https://www.forrester.com/report/The+Forrester+Wave+Industrial+IoT+Software+Platforms+In+China+Q4+2019/-/E-RES146895#. Accessed: November 27, 2019 [full report purchased].
For Level of maturity of global and Chinese; see: iResearch 艾瑞网 (2019). "China Industrial internet Platform Research Report" [2019年中国工业互联网平台研究报告]. July. http://report.iresearch.cn/report/201907/3416.shtml. Accessed: August 20, 2019.
21 | Haier (2018). "Haier IoT ecosystem brands: COSMOPlat Mass Customization Platform." July 25, 2018. http://www.haier.net/en/about_haier/news/201807/t20180725_412004.shtml. Accessed: January 31, 2020.

22 | EastMoney 东方财富网 (2019). "Industrial internet platforms urgently need to break the industry shackles of 'don't dare to use, not likely to use, too expensive to use'" [工业互联网平台亟待打破"不敢用 不会用 用不起"的行业枷锁]. November 8. http://finance.eastmoney.com/a/201911081286648235.html. Accessed: November 10, 2019.
23 | PR Newswire (2015). "XCMG signs strategic cooperation agreement with SAP during Merkel state visit." October 20, 2015. https://www.prnewswire.com/news-releases/xcmg-signs-strategic-cooperation-agreement-with-sap-during-merkel-state-visit-300169554.html. Accessed: January 31, 2020; phone interview with SAP representative on January 21, 2020.
24 | NDRC 发展改革委 (2017). "Internet Economy Leads to the New Era of Economic Growth" [数字经济引领经济增长新时代]. October 10. http://www.gov.cn/xinwen/2017-10/04/content_5229522.htm. Accessed: February 4, 2020; Economic Daily 经济日报 (2019). "The Development of Internet Economy Boosts Supply-side Structural Reform" [数字经济发展助推供给侧结构性改革]. April 3. http://jingji.cctv.com/2019/04/03/ARTIZiUjUg6BYB8oAixmkQ9Q190403.shtml. Accessed: February 4, 2020.
25 | State Council of the PRC 中华人民共和国国务院 (2018). "Guiding Opinions of the General Office of the State Council on Promoting the Well-regulated and Sound Development of the Platform Economy" [国务院办公厅关于促进平台经济规范健康发展的指导意见]. August 8. http://www.gov.cn/zhengce/content/2019-08/08/content_5419761.htm?trs=1. Accessed: February 4, 2020.
26 | State Council of the PRC 中华人民共和国国务院. "Guiding Opinions of the State Council on Deepening the 'Internet plus Advanced Manufacturing Industry' and Developing the Industrial internet" [国务院关于深化"互联网+先进制造业"发展工业互联网的指导意见]. November 27. http://www.gov.cn/zhengce/content/2017-11/27/content_5242582.htm. Accessed: February 4, 2020.
27 | Ministry of Industry and Information Technology 中华人民共和国工业和信息化部 (MIIT) (2019). "MIIT: 2019 Work Plan for Industrial internet Special Working Group" [工信部：工业互联网专项工作组 2019 年工作计划]. Chainnews, June, 25. https://www.chainnews.com/articles/607018618160.htm. Accessed: February 4, 2020.
28 | Ministry of Industry and Information Technology 中华人民共和国工业和信息化部 (MIIT) (2018). "2018 List of Industrial internet Innovation Development Projects to be supported" [2018 年工业互联网创新发展工程拟支持项目名单]. June. http://www.miit.gov.cn/n1146285/n1146352/n3054355/n3057656/n3057661/c6219154/part/6219158.pdf. Accessed: August 5, 2019.
29 | CCID 赛迪智库 (2018). "Outlook of China's Industrial internet Platform Development in 2019" [2019年中国工业互联网平台发展形势展望]. December. http://www.ccidwise.com/uploads/soft/181220/1-1Q220155227.pdf. Accessed: September 12, 2019.
30 | See: Alliance of Industrial Internet (n.d.). http://en.aii-alliance.org/. Accessed: February 4, 2020.
31 | Xinhua 新华网 (2019). "China's Industrial internet Architecture 2.0 Released" [我国工业互联网体系架构2.0版发布]. August 8. http://www.xinhuanet.com/fortune/2019-08/27/c 1124928859.htm. Accessed: September 3, 2019.
32 | PRC State Council: 中华人民共和国国务院 (2019). "Guiding principles of the State Council's Central Office to foster a healthy development of a platform economy" [国务院办公厅关于促进平台经济规范健康发展的指导意见]. http://www.gov.cn/zhengce/content/2019-08/08/content_5419761.htm?trs=1. August. Accessed: February 4, 2020.
33 | CCID 赛迪智库 (2019). "Outlook of China's Industrial internet Platform Development in 2019" [2019年中国工业互联网平台发展形势展望]. March. https://www.ccidgroup.com/sdgc/12913.htm. Accessed: February 4, 2020.
34 | China Industrial Control Systems Cyber Emergency Response Team (CIC), Contemporary Service Alliance for Integration of Informatization and Industrialization (CSA), and Internet + Development Association of China (IDAC) (2019). "Industrial internet Platform Innovation and Development White Paper" [2018 工业互联网平台创新发展白皮书]. http://cspiii.com/go/AttachmentDownload.aspx?id=%7B4eb16337-7ee9-4db8-aca3-3a47d84cf44b%7D. Accessed: October 3, 2019.
35 | Alliance of Industrial Internet (2019). "Industrial internet Platform White Paper (2019)" [工业互联网平台白皮书（2019）]. January. http://www.aii-alliance.org/index.php?m=content&c=index&a=show&catid=23&id=673. Accessed: February 4, 2020.
36 | Ministry of Industry and Information Technology 中华人民共和国工业和信息化部 (MIIT) (2018). "Notice On the Distribution of the Action Plan for Development of Industrial internet (2018-2020) and 2018 Work Plan of the Special Working Group for Industrial internet "[关于印发‘工业互联网发展行动计划（2018-2020年）’和‘工业互联网专项工作组2018年工作计划’的通知]. June 7. http://www.miit.gov.cn/n1146295/n1652858/n1652930/n3757016/c6212005/content.html. Accessed: September 29, 2019.
37 | Shanghai Securities News 上海证券报 (2019). "List of cross-industry and cross-industry Industrial internet platforms in 2019" [2019年跨行业跨领域工业互联网平台清单公示]. August 26. http://news.cnstock.com/news,bwkx-201908-4421856.htm. Accessed: February 4, 2020.
38 | Hegde, Zenobia (2018). "Chinese IIoT platform provider launches into European market." IoT Now, April 18. https://www.iot-now.com/2018/04/18/80856-chinese-iiot-platform-provider-launches-european-market/. Accessed: February 4, 2020.
39 | Boston Consulting Group (BCG), AliResearch, and Baidu (2019). "Decoding the Chinese Internet 2.0: Get Ready for the Next Chapter – Chinese Internet Economy White Paper 2.0." BCG, Jan 11. https://www.slideshare.net/TheBostonConsultingGroup/chinese-internet-economy-white-paper-20-decoding-the-chinese-internet-20-get-ready-for-the-next-chapter-130016382. Accessed: February 4, 2020.
40 | Deng, Iris and Chen, Celia (2018). "Pony Ma sets out Tencent's Industrial internet ambitions as it looks to China's future economy." South China Morning Post, October 31. https://www.scmp.com/tech/big-tech/article/2171079/pony-ma-sets-out-tencents-industrial-internet-ambitions-it-looks. Accessed: February 4, 2020.
41 | Barbaschow, Asha. "Alibaba's Tmall Innovation Center uses data to help sellers develop products." ZDNet, November 12. https://www.zdnet.com/article/alibabas-tmall-innovation-center-uses-data-to-help-sellers-develop-new-products/. Accessed: February 4, 2020.

42 | See: Apollo (n.d.). http://apollo.auto/index.html. Accessed: February 4, 2020.
43 | GKong 新闻中心 (2019). "Expand 'Industrial internet + new technologies' to accelerate the '1+N' platform system extension" [向"1+N"平台体系扩展 "工业互联网+新技术"加速落地]. August 9. http://www.gkong.com/item/news/2019/08/97789.html. Accessed: September 17, 2019; CCID 赛迪智库 (2019). "Expand 'Industrial internet + new technologies' to accelerate the '1+N' platform system extension" [向"1+N"平台体系扩展 "工业互联网+新技术"加速落地]. August 9. https://www.ccidgroup.com/sdgc/14227.htm. Accessed: September 17, 2019
44 | Taipei Times (2018). "Foxconn Industrial internet shares soar on China IPO." June 9. http://www.taipeitimes.com/News/biz/archives/2018/06/09/2003694556. Accessed: February 4, 2020.
45 | Alibaba (2018). "Siemens and Alibaba Cloud jointly launch MindSphere in Chinese mainland." September 21. https://www.alibabacloud.com/blog/siemens-and-alibaba-cloud-jointly-launch-mindsphere-in-chinese-mainland_594016. Accessed: February 4, 2020.
46 | Rosen, Daniel (2019). "The China Dashboard: Fall 2019 Edition." Rhodium Group, December 4. https://rhg.com/research/china-dashboard-fall-2019/. Accessed: February 4, 2020.
47 | Wang, Kevin Wei et. al. (2017). "Digital China: Powering the economy to global competitiveness." McKinsey Global Institute Report, December. https://www.mckinsey.com/featured-insights/china/digital-china-powering-the-economy-to-global-competitiveness. Accessed: February 4, 2020.
48 | State-owned Assets Supervision and Administration Commission of the State Council (SAC) 国务院国有资产监督管理委员会 (2019). "The Industrial internet platform for central enterprises was officially launched" [中央企业工业互联网融通平台正式启动]. June 17. http://www.sasac.gov.cn/n2588025/n2588124/c11513727/content.html. Accessed: January 11,2020.
49 | Zhao, Lei (2018). "Chinese Industrial internet site has almost 1.7m global users." China Daily, June 17. https://global.chinadaily.com.cn/a/201806/17/WS5b25f04da310010f8f59d5b9.html. Accessed: January 11,2020.
50 | EastMoney 东方财富网 (2018). "A national Industrial internet platform is emerging" [国家级工业互联网平台呼之欲出]. December 20. https://baijiahao.baidu.com/s?id=1620317687252664691&wfr=spider&for=pc. Accessed: September 12, 2019.
51 | Ministry of Commerce of the PRC (MOFCOM) 中华人民共和国商务部 (2019). "Guidelines of the Ministry of Commerce and other 12 departments on promoting the development of commodity trading market platform economy" [商务部等12部门关于推进商品交易市场发展平台经济的指导意见]. February 27. http://www.mofcom.gov.cn/article/b/d/201902/20190202838305.shtml. Accessed: December 1, 2019.
52 | Vincent (2019). "Launch 'Belt and Road' Industrial internet international cooperation to create a high-quality world economy seminar." ZTOPlus, July 9. https://www.ztoplus.com/techfocus/launch-belt-and-road-industrial-internet-international-cooperation-to-create-a-high-quality-world-economy-seminar.html. Accessed: November 3, 2019.
53 | CCID 赛迪智库 (2019). "Outlook of China's Industrial internet Platform Development in 2019" [2019年中国工业互联网平台发展形势展望]. March. https://www.ccidgroup.com/sdgc/12913.htm. Accessed: October 13, 2019; Alliance of Industrial Internet (AII) (2019). "White paper on Industrial internet platform (2019 discussion draft)" [工业互联网平台白皮书（2019讨论稿）]. http://www.aii-alliance.org/index.php?m=content&c=index&a=show&catid=23&id=514. Accessed: August 17, 2019; iResearch 艾瑞网 (2019). "China Industrial internet Platform Research Report" [2019年中国工业互联网平台研究报告]. July. http://report.iresearch.cn/report/201907/3416.shtml. Accessed: August 20, 2019; China Industrial Control Systems Cyber Emergency Response Team (CIC), Contemporary Service Platform for Integration of Information and Industralization (CSPIII), and Internet+ Development Association of China (IDAC) (2018). "White Paper on the Innovation and Development of Industrial internet Platform" [工业互联网平台创新发展白皮书]. Industrial internet Research Series, report No. 3 [工业互联网系列研究报告 No. 3]. https://www.innovation4.cn/library/r34137. December 17. Accessed: February 4, 2020.
54 | Data based on an assessment of 130.000 manufacturing companies by the National Development and Research Center for Industrial Information Security under the Ministry of Industry and Informatization; see: Chainnews 链闻 (2019). "Zhou Jian: Perspectives on the digital transformation of China's manufacturing industry (2009 ~ 2019)" [周剑：中国制造业数字化转型全景图（2009～2019）]. May 9. https://www.chainnews.com/articles/482791628487.htm. Accessed: December 5, 2019.
55 | Ibid.
56 | Alliance of Industrial Internet (AII) (2019). "White paper on Industrial internet platform (2019 discussion draft)" [工业互联网平台白皮书（2019讨论稿）]. http://www.aii-alliance.org/index.php?m=content&c=index&a=show&catid=23&id=514. Accessed: August 17, 2019.
57 | Mantian, Xin 满天芯 (2019). "Overview of global sensor technology development" [全球转感器技术发展概况一贤]. IC Zhiku IC智库. November 19. https://www.iczhiku.com/hotspotDetail/+6FGM896rsMF4h7u-JDdL0Q==. Accessed: December 14, 2019.
58 | CCID 赛迪智库 (2019). "Outlook of China's Industrial internet Platform Development in 2019" [2019年中国工业互联网平台发展形势展望]. March. https://www.ccidgroup.com/sdgc/12913.htm. Accessed: February 4, 2020.
59 | Ibid.
60 | CCID 赛迪智库 (2019). "CCID Consulting: China's industrial software development white paper 2019" [赛迪顾问：2019年中国工业软件发展白皮书]. July. http://www.199it.com/archives/913824.html. Accessed; October 7, 2019.
61 | International Data Cooperation China (IDC China) (2018). "IDC: in the first half of 2018, the IaaS market of public cloud in China started to take off and the market integration was booming" [IDC: 2018上半年中国公有云IaaS市场风起微澜，市场整合渐兴]. December. https://www.idc.com/getdoc.jsp?containerId=prCHC44540318. Accessed: December 3, 2019.
62 | Wan, Jiaxi 方家喜 (ed.) (2018). "The 'Golden Age' of big data Industry is facing four obstacles" [大数据产业"黄金期"面临四道坎]. Xinhua/Economic Information Daily. February 7. http://www.xinhuanet.com/yuqing/2018-02/07/c_129807394.htm. Accessed: February 4, 2020.

63 | Supra note 49.
64 | Alliance of Industrial Internet (2019). "Industrial internet Platform White Paper (2019)" [工业互联网平台白皮书（2019）]. January. http://www.aii-alliance.org/index.php?m=content&c=index&a=show&catid=23&id=673. White Paper, p.3. Accessed: February 4, 2020.
65 | Chainnews 链闻 (2019). "Zhou Jian: Perspectives on the digital transformation of China's manufacturing industry (2009 ~ 2019)" [周剑：中国制造业数字化转型全景图（2009～2019）]. May 9. https://www.chainnews.com/articles/482791628487.htm. Accessed: December 5, 2019.
66 | Shenzhen Industrial and Information Technology Bureau 深圳市工业和信息化局 (2019). "Shenzhen Industrial and Information Technology Bureau Action Plan for Development of Industrial internet 2018-2020" [深圳市工业互联网发展行动计划（2018—2020年）]. http://gxj.sz.gov.cn/xxgk/xxgkml/qt/gzdt/201907/t20190712_18051790.htm. December 7. Accessed: February 4, 2020.
67 | Ministry of Industry and Information Technology 中华人民共和国工业和信息化部 (MIIT) (2018). "MIIT on Issuing Guidelines for the Construction and Promotion of Industrial internet" [工业和信息化部印发"工业互联网网络建设及推广指南"]. http://www.gov.cn/xinwen/2019-01/19/content_5359232.htm. December 29. Accessed: February 4, 2020.
68 | State Council of the PRC 中华人民共和国国务院 (2019). "Guiding Opinions of the General Office of the State Council on Promoting the Well-regulated and Sound Development of the Platform Economy" [国务院办公厅关于促进平台经济规范健康发展的指导意见]. http://www.gov.cn/zhengce/content/2019-08/08/content_5419761.htm?trs=1. August. Accessed: February 4, 2020.
69 | For an overview see: Orient Securities 东方证券 (2018). "Industrial internet boosts the reforming of the manufacturing industry" [工业互联网引领制造业变革]. p. 8f. http://xqdoc.imedao.com/1637da0b4dc32f6b3fd8ceb3.pdf. Accessed: February 4, 2020.
70 | China IDC Quan 中国IDC圈. "Distribution of Data Centers in China" [全国数据中心分布图]. http://www.idcquan.com/Special/idcmap/. Accessed: February 4, 2020.
71 | Guangdong Provincial Government 广东省人民政府 (2018). "Guangdong province has deepened the implementation plan of 'Internet + advanced manufacturing' to develop Industrial internet" [广东省深化'互联网＋先进制造业'发展工业互联网的实施方案]. March. http://www.gd.gov.cn/gkmlpt/content/0/146/post_146713.html. Accessed: August 2, 2019; Henan Provincial Government河南省人民政府 (2018). "Three-year Action Plan for Intelligent Manufacturing and Industrial internet Development in Henan Province (2018-2020)" [河南省智能制造和工业互联网发展三年行动计划(2018—2020年)]. April. https://www.henan.gov.cn/2018/04-26/239902.html. Accessed; August 2, 2019; General Office of Chongqing Municipal People's Government 重庆市人民政府办公厅 (2018). "Guiding Opinions of the General Office of Chongqing Municipal People's Government on Accelerating the Development of Industrial internet Platform Enterprises to Enable the Transformation and Upgrading of Manufacturing Industry" [重庆市人民政府办公厅关于加快发展工业互联网平台企业赋能制造业转型升级的指导意见]. July. https://www.ddk.gov.cn/upfiles/201908/20190801140635628.pdf. Accessed: August 2, 2019.
72 | Ministry of Industry and Information Technology 中华人民共和国工业和信息化部 (MIIT) (2018). "Notice on the Project to Support the 2018 Industrial internet Innovation and Development Project" [2018年工业互联网创新发展工程拟支持项目公示]. June. http://www.miit.gov.cn/n1146285/n1146352/n3054355/n3057656/n3057661/c6219154/content.html. Accessed: February 4, 2020.
73 | Anonymous (2019). "The mode of "regional platform + demonstration base" is adopted to speed up platform landing" [通过"区域平台+示范基地"的模式加快平台落地]. Loumalaile 博客主题. May 6. http://www.loumalaile.com/hulianwang/1312.html; CCID 赛迪智库 (2018). "Outlook of China's Industrial internet Platform Development in 2019" [2019年中国工业互联网平台发展形势展望]. December. http://www.ccidwise.com/uploads/soft/181220/1-1Q220155227.pdf. Accessed: September 12, 2019.
74 | CAICT 中国信通院 (n.d.). "CAICT Signed Strategic Cooperation Framework Agreement on Promoting Industrial internet Platform Development in the Yangtze River Delta Area." http://www.caict.ac.cn/english/news/201806/t20180611_174025.htm. Accessed: February 4, 2020.
75 | Industrial internet Consortium (IIC) (n.d.). "MANUFACTURING QUALITY MANAGEMENT TESTBED." https://www.iiconsortium.org/manufacturing-quality-management.htm. Accessed: November 28, 2019.
76 | Ministry of Industry and Information Technology (MIIT) (2019). "The 2019 list of pilot demonstration projects for the integrated development of manufacturing and the Internet" [2019年制造业与互联网融合发展试点示范项目名单公示]. http://www.miit.gov.cn/n1146295/n7281310/c7504462/content.html. November. Accessed: December 10, 2019.
77 | Deloitte (2017). "From Interpretation to Prediction: Unleashing the Value of the Industrial internet of Things." April 25, 2017. https://www2.deloitte.com/cn/en/pages/consumer-industrial-products/articles/from-interpretation-to-prediction.html. Accessed: October 21, 2019.
78 | Xu, Yiyan徐一嫣 (ed.) (2019). "Accelerate the Construction of Standards and set the Foundation for the Development of Industrial internet Platform" [加快标准体系建设 夯实工业互联网平台发展基础]. Xinhuanet 新华网. March 1. http://www.xinhuanet.com/info/2019-03/01/c_137859769.htm. Accessed: October 21, 2019.
79 | Alliance of Industrial Internet (AII) (2018). "Industrial internet platform standard architecture framework (Version 1.0)" [工业互联网平台标准体系框架（版本1.0）]. February. http://www.aii-alliance.org/index.php?m=content&c=index&a=show&catid=23&id=208. Accessed: August 23, 2019.
80 | Ministry of Industry and Information Technology (MIIT) and Standardization Administration of China (SAC) (2019). "Guidelines for the construction of a comprehensive standardization system for Industrial internet" [工业互联网综合标准化体系建设指南]. January. http://www.gov.cn/xinwen/2019-03/08/5371933/files/48de99f08f124d91bd7567641b4a89b0.pdf. Accessed: February 4, 2020.
81 | Alliance of Industrial Internet (AII) (2019). "Industrial internet Standard System (Version 2.0)" [工业互联网标准体系（版本2.0）]. February. http://www.aii-alliance.org/index.php?m=content&c=index&a=show&catid=25&id=482. Accessed: October 13, 2019.

82 | Gao, Chang 高畅 (ed.) (2019). "This will have a revolutionary impact! MIIT issued a document to promote the development of Industrial Big Data" [将带来革命性影响！工信部发文力推工业大数据发展]. Xinhuanet. September 5. http://www.xinhuanet.com/2019-09/05/c_1210267744.htm. Accessed: February 4, 2020.
83 | Interview to CASICloud's Deputy GM (found via Jeff Ding's ChinAI Newsletter no. 70), see: Wang, Jinwang 王金旺 (2019). "How many steps does it take to move the digital capabilities of national aerospace equipment to manufacturing?" [将国家级航天装备数字化能力搬到制造业，需要几步？]. Weixin微信. October 8. https://mp.weixin.qq.com/s/2GeOYIe4AM6djPuMeATELQ. Accessed: November 21, 2019.
84 | Ministry of Industry and Information Technology 中华人民共和国工业和信息化部 (MIIT) (2019). "Industrial big data development guidelines" [工业大数据发展指导意见]. Law-lib 法律图书馆. September 9. http://www.law-lib.com/fzdt/newshtml/20/20190909135458.htm. Accessed: December 4, 2019.
85 | Ma, Si (2019). "Cybersecurity system on the way for Industrial internet." Chinadaily. August 29. http://www.chinadaily.com.cn/a/201908/29/WS5d672668a310cf3e355687ab.html. Accessed: December 2, 2019.
86 | Ministry of Industry and Information Technology 中华人民共和国工业和信息化部 (MIIT) (2019). "Notice on Issuance of Guiding Opinions on Strengthening the Industrial internet Security Work" [十部门关于印发加强工业互联网安全工作的指导意见的通知]. http://www.gov.cn/xinwen/2019-08/28/content_5425389.htm. July 26. Accessed: December 4, 2019.
87 | National Development and Resource Commission (NDRC) (2013). "Special Action Plan for the Development of Internet of Things 2013-2015" [物联网发展专项行动计划(2013-2015年)]. https://wenku.baidu.com/view/08da72e6d5bbfd0a79567347.html. Accessed: February 4, 2020.
88 | Zhou, Wenbo (2018). "ISO chooses China's IoT standards." Chinadaily. June 7. http://www.chinadaily.com.cn/m/jiangsu/wuxinewdistrict/2018-07/11/content_36609586.htm. Accessed: February 4, 2020.
89 | Le, Truong and Fischer, Thomas (n.d.). "China's high-impact patents of Industry 4.0 from January 2013 to April 2015." CHINESE INDUSTRY 4.0 PATENTS. https://www.iao.fraunhofer.de/lang-de/images/iao-news/chinese-industry-1.pdf. Accessed: November 27, 2019.
90 | Zhang, Dandan (2019). "Qingdao sets standards for interconnected future." Chinadaily/Telegraph. November 20. https://www.telegraph.co.uk/china-watch/business/qingdao-manufacturing-standards/. Accessed: February 4, 2020.
91 | People's Deaily 人民网 (2018). "Haier COSMOPlat led the establishment of the country's first manufacturing model standards working group" [海尔COSMOPlat牵头成立国内首个制造模式类标准工作组]. December 20. http://homea.people.com.cn/n1/2018/1220/c41390-30479144.html. Accessed: November 2, 2019.
92 | Freist, Roland (2018). "The two companies want to build an infrastructure for the Chinese Internet of Things. Siemens MindSphere and Simatic MindApps will be running in the Alibaba cloud in the future as well." Hannovermesse. July 21. https://www.hannovermesse.de/en/news/news-articles/siemens-and-alibaba-are-pooling-iot-resources-in-china; Gasgoo (n.d.). http://autonews.gasgoo.com/china news/70015245.html [not available]. Accessed: September 12, 2019.
93 | Ministry of Industry and Information Technology 中华人民共和国工业和信息化部 (MIIT) (2019). "Notice on the issuance of the 2019 work plan of the special working group on Industrial internet" [关于印发《工业互联网专项工作组2019年工作计划》的通知]. June. http://www.miit.gov.cn/n1146295/n1652858/n1652930/n3757020/c7013751/content.html. Accessed: August 30, 2019.
94 | See: Technische Universität Darmstadt (n.d.). "CaMPuS." https://www.dik.tu-darmstadt.de/forschung_dik/projekte/aktuelleprojekte_5/campus_2/campus.en.jsp. Accessed: January 31,2020.
95 | Nurkin, Tate (2018). "Ministry of Industry and Information Technology (MIIT)." Jane's by HIS Markit. May https://www.uscc.gov/sites/default/files/Research/Jane's%20by%20IHS%20Markit China's%20Advanced%20Weapons%20Systems.pdf. Accessed: October 28. 2019.
96 | Dong, Lei 董磊 (2018). "Foreign media pays close attention to China's civil-military integration achievements: aerospace cloud network platform turnover exceeds 300 billion" [外媒关注中国军民融合成绩斐然：航天云网平台成交额超3000亿]. http://www.cankaoxiaoxi.com/mil/20181220/2365959_2.shtml. Cankao Military 参考军事. December 20. Accessed: January 31,2020.
97 | XCMG (2015). "XCMG signs strategic cooperation agreement with SAP during Merkel state visit". PRNewswire. December 3. https://www.prnewswire.com/news-releases/xcmg-signs-strategic-cooperation-agreement-with-sap-during-merkel-state-visit-300169554.html. Accessed: September 30, 2019.
98 | XCMG Europe (n.d.). "XCMG – An International Employer." https://xcmg-europe.de/en/career/. Accessed: October 23, 2019.
99 | Sacks, Samms and Li, Manyi Kathy (2018). "How Chinese Cybersecurity Standards Impact Doing Business In China". CSIS Briefs. August. https://www.csis.org/analysis/how-chinese-cybersecurity-standards-impact-doing-business-china. Accessed: November 4, 2019.
100 | Several research studies have emphasized China's digital protectionism. For instance, the ECIPE's Digital Trade Restrictiveness Index found that China restricts digital trade more than any other country, including by imposing information security and data restrictions. See: Ferracane, Martina Francesca et. al. (2018). "Digital Trade Restrictiveness Index". Europe Centre for International Political Economy. April. https://ecipe.org/dte/dte-report/. Accessed: December 1, 2019.
101 | EU Chamber of Commerce in China (2017). "China Manufacturing 2025 – Putting Industrial Policy Ahead of Market Forces." http://docs.dpaq.de/12007-european_chamber_cm2025-en.pdf. Accessed: January 31,2020.
102 | International Data Cooperation China (IDC China) (2018). "IDC: in the first half of 2018, the IaaS market of public cloud in China started to take off and the market integration was booming" [IDC: 2018上半年中国公有云IaaS市场风起微澜，市场整合渐兴]. December. https://www.idc.com/getdoc.jsp?containerId=prCHC44540318. Accessed: December 3, 2019
103 | Ministry of Public Security of the People's Republic of China (2018). "The Ministry of Public Security issued the 'public consultation notice on the draft regulations on the multi-level protection of network security" [公安部关于《网络安全等级保护条例（征求意见稿）》公开征求意见的公告]. June 27. http://www.mps.gov.cn/n2254536/n4904355/c6159136/content.html. Accessed: October 3, 2019.

104 | Seconded European Standardization Expert in China (SESEC) (n.d.). "SAC issued standards for Cybersecurity Classified Protection V2.0". p.2. May 16. https://www.sesec.eu/sac-issued-standards-for-cybersecurity-classified-protection-v2-0/. Accessed: November 16, 2019. For the Chinese version of the standards see: China National Standards 中华人民共和国国家标准(n.d.). "China security GB Standards List." http://www.gbstandards.org/index/Standards_Search.asp?word=security. Accessed: November 16, 2019.
105 | State Administration for Market Regulation and Standardization Administration of the People's Republic of China (2018). "Information Security Technology - Information Security Classification Specifications of Industrial Control Systems" [信息安全技术 工业控制系统信息安全分级规范]. http://www.iscn.org.cn/uploadfile/2019/0121/20190121051136153.pdf. Accessed: November 25, 2019.
106 | Sacks, Samms and Li, Manyi Kathy (2018). "How Chinese Cybersecurity Standards Impact Doing Business In China". CSIS Briefs. August. https://www.csis.org/analysis/how-chinese-cybersecurity-standards-impact-doing-business-china. Accessed: November 4, 2019.
107 | Sacks, Samm (2018). "Addressing China's Technology Policies: Beyond the Whiplash of a ZTE Deal". Lawfare. https://www.lawfareblog.com/addressing-chinas-technology-policies-beyond-whiplash-zte-deal. Accessed: November 26, 2019.
108 | Wei, Wei魏巍 (ed.) (2018). "Experts call for strengthening the indigenous and controllable technology of China´s Industrial internet" [专家呼吁中国加强工业互联网自主可控技术]. Chinanews. June 19. https://www.chinanews.com/cj/2018/06-19/8541242.shtml. Accessed: February 4, 2020.
109 | Standing Committee of the National People´s Congress 全国人民代表大会常务委员会 (2016). "Cybersecurity Law of the PRC" [中华人民共和国网络安全法]. http://www.xinhuanet.com/politics/2016-11/07/c_1119867015.htm. Accessed: February 4, 2020.
110 | Cyberspace Administration of China 国家互联网信息办公室 (2019). "Measures for the Administration of Data Security" [数据安全管理办法]. http://www.cac.gov.cn/2019-05/28/c_1124546022.htm. Accessed: February 4, 2020.
111 | State Administration of Quality Supervision, Inspection and Quarantine and Standardization Administration of the People's Republic of China (2017). "Guidelines for Data Cross-Border Transfer Security Assessment" [数据出境安全评估指南]. https://www.tc260.org.cn/ueditor/jsp/upload/20170527/87491495878030102.pdf. Accessed: November 27, 2019.
112 | See: CosmoPlat (n.d.). CosmoPlat website. https://www.cosmoplat.com/platform/plat. Accessed: November 27, 2019.
113 | Ibid.
114 | Haier (2018). "Haier IoT ecosystem brands: COSMOPlat Mass Customization Platform." http://www.haier.net/en/about_haier/news/201807/t20180725_412004.shtml. July 7. Accessed: February 4, 2020.
115 | Mu, Danny et. al. (2019). "The Forrester Wave™: Industrial IoT Software Platforms In China, Q4 2019." p. 7 [The seven providers that matter most and why they stack up]. November 25. https://www.forrester.com/report/The+Forrester+Wave+Industrial+IoT+Software+Platforms+In+China+Q4+2019/-/E-RES146895#. Accessed: November 27, 2019.
116 | Smolaks, Max (2019). "Huawei is planning to inject $436m into Arm-based server silicon - With its eye mostly on the domestic market." TheRegister. July 25. https://www.theregister.co.uk/2019/07/25/huawei_is_planning_to_sink_436m_into_armbased_server_silicon/. Accessed: February 4, 2020.
117 | Bosch (2018). "Bosch launches IoT software solutions on Huawei Cloud." Press release. October 10. https://www.bosch-presse.de/pressportal/de/en/bosch-launches-iot-software-solutions-on-huawei-cloud-172992.html. Accessed: February 4, 2020.
118 | See: Rootcloud Company Website (n.d.). http://en.rootcloud.com/aboutus.html [not accessible].
119 | Ibid.
120 | Ibid.
121 | Sohu (2018). "'White Paper on Innovation and Development of Industrial internet Platform 2018' formally issued" ["工业互联网平台创新发展白皮书（2018）" 正式发布]. Sohu. December 18 http://www.sohu.com/a/282918779_680938. Accessed: February 4, 2020.
122 | See: Indics (n.d.). "Indics." Company website. https://www.indics.de/imprint.ht. Accessed: February 4, 2020.
123 | See: Xrea (n.d.). "Company Introduction" [公司价绍] Company website. http://www.xreacloud.com/introduction.jhtml. Accessed: February 4, 2020.
124 | MarketScreener (2019). "XCMG Construction Machinery: Xrea - The Digital Transformation for Manufacturing Industry." June 28. https://www.marketscreener.com/news/XCMG-Construction-Machinery-Xrea-The-Digital-Transformation-for-Manufacturing-Industry--28828042/. Accessed: February 4, 2020.
125 | Supra note 122.
126 | Supra note 123.
127 | See: "Qiming Cloud Provider." Company website. http://www.qm.cn/znzz.jsp?cate=3&l=00 [not accessible].
128 | Ibid.
129 | Ibid.
130 | "Wu Jianhui" [吴建会]. https://baike.baidu.com/item/%E5%90%B4%E5%BB%BA%E4%BC%9A. Baidu Baike 百度百科. Accessed: February 4, 2020.
131 | Bob (2017). "Beijing Pilot Zone for national smart car officially started" [国家智能网联汽车应用（北方）示范区正式开工]. Cheyunnet 车云网. August 31. [not accessible].

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