XXI. Digital Economy Infrastructure Development and the "Belt and Road" Initiative

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This paper explores the strategic role of digital economy infrastructure in the "Belt and Road" initiative, highlighting its impact on regional economic development. It discusses the growth of computing power, data centres, and the challenges and opportunities in building digital infrastructure along the route. The paper concludes that international cooperation and policy support are essential for overcoming challenges and leveraging the potential of the digital economy for mutual growth.

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1 Introduction

In today's information age, the concept of the digital economy has become deeply embedded in public consciousness. Centred on data and computing power, it is gradually emerging as a new competitive frontier in the global economy. Computing power, often referred to as arithmetic power, is not only a driving force behind scientific and technological innovation, industrial upgrading, and economic growth but also a key enabler of digital economy development. This power manifests in various forms, including different types of processors such as central processing units (CPUs), graphics processing units (GPUs), and tensor processing units (TPUs), each designed for specific computing tasks and application scenarios.

As general-purpose processors, CPUs excel at managing complex control logic and diverse computational tasks, functioning as the "brains" of computer systems. GPUs, originally designed for graphics and video rendering, have become essential in deep learning and artificial intelligence due to their ability to process large volumes of data in parallel. TPUs are specialised processors tailored for machine learning; they optimise neural network computations, delivering higher performance and efficiency. They are especially suitable for large-scale deep-learning model training and inference.

According to the China Arithmetic Development Index White Paper (2023) published by the China Academy of Information and Communications Technology (CAICT), the global computing power of digital devices reached 906 EFlops (ExaFLOPS) in 2022, reflecting a 47% year-on-year growth. This scale is expected to grow by more than 50% annually over the next five years, surpassing 3 ZFlops by 2025 and reaching 20 ZFlops by 2030. In 2022, global server shipments totalled 15.16 million units, with a market value of $121.58 billion—an increase of 12% and 22.5% year-on-year, respectively. The AI server market alone reached $18.3 billion, growing 17.3% year-on-year. The global AI chip market was valued at $16.86 billion.

In this context, building computing infrastructure—including data centres, supercomputing facilities, and edge computing nodes—has become a strategic objective for countries worldwide. The “Belt and Road” initiative not only creates new opportunities for infrastructure collaboration between China and participating countries but also paves new pathways for the global expansion and evolution of the

digital economy. This paper explores the strategic importance of digital economy infrastructure within the Belt and Road initiative and its broader implications for regional economic development.

2 The rise of the digital economy and the global landscape

The rise of the digital economy is due to the rapid development of cloud computing, big data, artificial intelligence and other technologies. The application of these technologies has driven massive growth in data, creating unprecedented demand for computing power. Globally, countries are actively laying out their arithmetic infrastructures to compete for competitive advantages in the era of the digital economy. The construction of computing power infrastructure, such as data centres, super-computing centres, and edge computing nodes, has become the key to promoting technological innovation and industrial upgrading (Guo, Song, & Zhang, 2024).

The construction and layout of global data centres are the foundation of the digital economy. The United States, China, and Europe are the main concentrations of data centres, and the scale and number of data centres in these regions take the lead globally. According to the International Data Corporation (IDC) report, the U.S. leads the global data centre market with about 30% share as of 2022, followed by China with about 10% of the worldwide market. For example, Silicon Valley in the United States, Guizhou and Ningxia in China, and Frankfurt in Europe are essential data centre clusters. The scale of the global arithmetic industry is growing rapidly, especially in artificial intelligence, big data analytics, and cloud computing, where the demand for arithmetic power is rising (Ghimire, Ali, & Sun, 2023). China, the United States and other countries have invested heavily in developing the arithmetic industry, and the scale and growth rate of arithmetic power are among the top in the world.

The internal architecture of a data centre typically consists of server racks, network switching equipment, storage systems and security facilities. As data centres grow in size, effective cooling technologies become critical. Modern data centres use various technologies, such as air and liquid cooling, to maintain equipment at the proper temperature, ensure system stability and extend the life of the hardware. Energy efficiency is a key consideration in data centre operations. Adopting virtualisation

technologies, optimising server utilisation, and using energy-efficient hardware and software-defined data centres can significantly reduce energy consumption. According to The Green Grid, through these measures, the global data centre energy efficiency ratio (PUE) has been reduced from 2.0 in 2007 to about 1.6 in 2022.

In addition, open-source technologies have played an essential role in developing cloud computing and big data. Open-source software such as Apache Hadoop and Spark provide potent platforms for big data processing, and their support for distributed computing makes processing large-scale datasets more efficient and cost-effective. Open-source technologies in cloud computing, such as OpenStack, promote the standardisation and interoperability of cloud services, helping enterprises and service providers build scalable and flexible cloud infrastructures (Nguyen, Toan, & Phong, 2024).

With the development of 5G, IoT and other technologies, the construction of global arithmetic networks has become a new trend. Governments and enterprises are promoting the construction of arithmetic networks to realise data's rapid transmission and processing. For example, China's "East Counts, West Counts" project aims to optimise the allocation of computing power resources in the East and West and improve the overall efficiency of the computing power network (Niankara & Traoret, 2023). According to China's National Development and Reform Commission (NDRC), the project is expected to increase the utilisation rate of arithmetic resources in the western region to more than 80% by 2025. In the global layout of the digital economy, international cooperation and competition coexist. While promoting the development of their arithmetic industries, countries are also seeking international cooperation to jointly promote the progress and application of arithmetic technology (Herman & Oliver, 2023). At the same time, the control and distribution of arithmetic resources have become a new focus of competition among countries.

To improve the efficiency of the utilisation of arithmetic resources, countries are exploring the optimal allocation of arithmetic resources, including the establishment of arithmetic trading platforms and the construction of arithmetic network monitoring platforms, to achieve accurate planning and efficient utilisation of arithmetic resources. These measures promote the rational allocation of arithmetic resources and support the sustainable development of the digital economy.

According to the analysis of Frost & Sullivan, a global business consulting firm, the global arithmetic service market is expected to reach a size of about US$250 billion by 2027 through optimising the allocation of arithmetic resources (Mao, Geng, & Shao, 2023).

3 Infrastructure development under the "Belt and Road" initiative

The "Belt and Road" Initiative aims to promote connectivity among countries along the routes and regional economic integration through infrastructure construction. Under this framework, the construction of arithmetic infrastructure helps improve the informatisation level of countries along the route and provides solid support for developing the digital economy (Rong, 2022). Constructing cross-border data channels and cloud computing platforms can promote the sharing of data resources and accelerate scientific and technological innovation and industrial digital transformation.

The construction of cross-border data channels is key to realising data connectivity. These channels rely on efficient data transmission protocols, such as TCP/IP and HTTP/2, significantly enhancing transmission speeds and reliability. According to Akamai's report, websites using HTTP/2 experienced a 16% reduction in average page load time.

Deploying cloud computing platforms is an essential part of arithmetic infrastructure development. Containerisation technologies such as Docker and Kubernetes are crucial in this process. According to a CNCF survey, 78% of organisations had adopted Kubernetes in their production environments by 2021 (Nguyen, Toan, & Phong, 2024).

Cooperation between China and Belt and Road countries in digital infrastructure has been expanding. For instance, China has signed memorandums on the Digital Silk Road with 17 countries and established Silk Road e-commerce mechanisms with 23 others. At the Digital Economy Forum during the third Belt and Road Summit, the Beijing Initiative for International Cooperation on Digital Economy was jointly released by China and several partner nations, reinforcing international cooperation in digital infrastructure, transformation, capacity, and security (Ghimire, Ali, & Sun, 2023).

Chinese enterprises have been active in building data centres in countries such as Pakistan and Egypt, contributing to local digital transformation. According to the China Academy of Information and Communications Technology, the number of overseas data centres constructed by Chinese firms increased by about 150% between 2019 and 2022.

4 Challenges and opportunities in building infrastructure for the digital economy

In the countries along the "Belt and Road," the construction of computing power infrastructure is driving the digital transformation of regional economies, but it also brings a series of challenges. The lack of uniform technical standards has led to cross-border equipment compatibility issues, affecting the efficiency of data flow. Cybersecurity risks are particularly prominent, as the globalised layout of computing power exposes cross-border data transmission and storage to threats of hacking and data leakage (Niankara & Traoret, 2023). Energy supply and environmental impact are also significant concerns, with data centre power demands putting pressure on energy systems while increasing carbon emissions. Furthermore, building such infrastructure requires massive investment, especially in developing countries where capital mobilisation is difficult and return on investment is uncertain. Talent shortages further limit the ability to build and maintain infrastructure, and variations in national policies and regulations can hinder implementation and operations. Geopolitical risks, cultural and linguistic barriers, mismatches between market demand and supply, and maintenance and upgrade challenges must all be addressed.

International cooperation, policy support, technological innovation, and talent development are crucial to overcome these challenges. Jointly formulating international standards, strengthening cybersecurity cooperation, promoting green energy, and offering financial and educational support are all necessary to ensure the healthy development of digital economic infrastructure along the Belt and Road (Herman & Oliver, 2023).

Regarding cybersecurity, technologies such as encryption, intrusion detection systems (IDS), and security information and event management (SIEM) are critical. Encryption protects data transmission, IDS enables real-time monitoring, and SIEM centralises security data to detect and respond to potential threats. According to

IBM, adopting encryption technology can reduce the financial damage of data breaches by approximately $3.82 million (Nguyen, Toan, & Phong, 2024).

Intelligent operations and maintenance (AIOps) significantly improve the reliability and efficiency of data centres through real-time data processing, automated monitoring, and predictive maintenance. Markets and Markets (Mao, Geng, & Shao, 2023) estimated that the AIOps market, valued at $2.3 billion in 2020, will grow to $7.3 billion by 2025.

Meanwhile, the construction of computing infrastructure stimulates the development of related industrial chains, including equipment manufacturing, cloud computing services, and big data analytics. For example, the global data centre equipment market was valued at approximately $150 billion in 2022 and is expected to grow at a compound annual growth rate of 5% by 2025 (Guo, Song, & Zhang, 2024).

International collaboration also offers an opportunity to develop technical standards, enhance cybersecurity, optimise energy use, and support green development. These efforts promote informatisation and contribute Chinese wisdom and solutions to global digital economy advancement (Ghimire, Ali, & Sun, 2023).

Despite the challenges, there are immense growth opportunities. Many Belt and Road countries are in the midst of digital transformation and face significant demand for computing infrastructure. This presents vast market potential, not only for China's technology exports but also for the economic development of the partner countries. The global cloud computing market is expected to reach $650 billion by 2025, with Belt and Road countries becoming key growth areas (Ghimire, Ali, & Sun, 2023).

Governments along the route are introducing supportive policies—such as tax incentives and financial aid—to encourage infrastructure development. At the same time, China's strengths in 5G, big data, and cloud computing offer a competitive edge in exporting technology and collaborating with local enterprises to create customised solutions (Rong, 2022).

The Belt and Road Initiative also offers a platform for multilateral cooperation, allowing countries to share resources and reduce risks. Infrastructure development drives the growth of upstream and downstream sectors—software, hardware, data analytics—and provides demand for skilled professionals, creating opportunities for education, training, and exchange.

Green, low-carbon development has become a global consensus. Computing infrastructure construction can adopt green energy and efficiency technologies to promote sustainable development while meeting international environmental standards. The Digital Silk Road supports data sharing and regional integration through investments in fibre-optic cables and data centres. Interconnected infrastructure improves information flow and reduces transaction costs, enhancing regional competitiveness.

Finally, building computing infrastructure stimulates innovation, supports new business models, and unlocks new growth drivers for partner countries. High-quality regional development can be achieved by seizing these opportunities and managing risks through cooperation, policy, innovation, and talent development.

5 Synergies between the digital economy and the "Belt and Road" initiative

The construction of digital economy infrastructure should be aligned with the overarching goals of the "Belt and Road" Initiative to achieve mutual benefit and win-win outcomes. On one hand, China can leverage its technological expertise and experience in computing infrastructure to support informatisation in Belt and Road countries. On the other hand, these countries' vast data resources and market potential present significant opportunities for Chinese enterprises. Through collaborative construction and resource sharing, the optimal allocation of computing power can be achieved, promoting the advancement of the Digital Silk Road (Ghimire, Ali, & Sun, 2023).

Achieving the synergistic development of the digital economy and the Belt and Road Initiative requires strategic efforts in multiple areas. Firstly, strengthening policy communication and coordination is essential. Countries should harmonise standards and technical specifications for computing infrastructure to ensure compatibility and

efficient data exchange. For instance, adopting unified cloud interface standards can reduce cross-border technical barriers and support seamless service delivery (Rong, 2022).

Secondly, fostering technological cooperation and innovation is key. This involves encouraging joint research, knowledge sharing, and co-development of localised technological solutions. Open-source software and hardware play a crucial role in this context. They promote technology diffusion, reduce development and deployment costs, and enhance flexibility. For example, open-source software has been reported to lower IT costs by 10–20%, while tools like the Raspberry Pi offer affordable platforms for education and innovation in emerging markets.

Talent development is another pillar of synergistic progress. Education systems must be adapted to train professionals in key digital economy areas such as data science, cybersecurity, and cloud engineering. Project-based learning and industry collaboration—such as involving students in real-world technical projects—have proven effective in enhancing employability and providing practical skills (Guo, Song, & Zhang, 2024).

In addition, establishing a multi-level cooperation mechanism is vital. Participating countries can share information and complement each other's resources through platforms such as the Digital Silk Road. Policy incentives, investment support, and risk-reduction frameworks can help attract domestic and international capital to support infrastructure development (Herman & Oliver, 2023).

Promoting green development is also crucial. Adopting energy-efficient technologies and renewable energy sources in computing infrastructure projects—such as in the construction of green data centres—contributes to sustainability and global environmental goals (Mao, Geng, & Shao, 2023). Ensuring cybersecurity through strict data security protocols and oversight of cross-border data flows is equally essential for the safe and stable operation of digital infrastructure (Nguyen, Toan, & Phong, 2024).

Furthermore, integrating upstream and downstream industrial chains will foster a complete digital economy ecosystem and strengthen competitiveness. The Belt and Road Initiative also opens international markets for digital services and products,

enabling global optimisation of computing resource distribution and service delivery (Ghimire, Ali, & Sun, 2023).

Lastly, robust risk management mechanisms must be in place. These include comprehensive risk assessment and response systems that ensure the long-term sustainability of infrastructure investments. By implementing these measures, countries can realise deep integration between the digital economy and the Belt and Road Initiative, accelerating digital transformation and fostering high-quality regional development.

This coordinated approach advances national economies and contributes to the inclusive and sustainable development of the global digital economy.

6 Conclusion

This paper has examined the strategic significance of developing digital economy infrastructure within the "Belt and Road" Initiative framework and its broader implications for regional economic development. The findings suggest that digital infrastructure construction is a key pillar of the initiative and a powerful driver of economic cooperation and integration among participating countries. Amid the challenges, international cooperation is a central strategy to advance computing power infrastructure's construction and effective deployment. A globally coordinated approach to the digital economy allows countries to enhance their competitiveness while contributing Chinese experience and solutions to the growth of the global digital economy (Ghimire, Ali, & Sun, 2023).

Computing power infrastructure—such as data centres, cloud computing platforms, and 5G networks—is fundamental in enabling digital transformation and boosting economic growth. These facilities support efficient information flow, productivity improvements, and new business models, accelerating regional integration. By enabling interconnectivity and information sharing, such infrastructure contributes to the collective prosperity of economies along the Belt and Road (Guo, Song, & Zhang, 2024).

In the era of globalisation, cross-border collaboration is essential for the successful development of computing infrastructure. The Belt and Road Initiative provides a framework through which China and its partners can share technological know-how, financial resources, and talent, thereby fostering mutual benefits. Open standards and open-source technologies are particularly valuable in this context as they enhance system compatibility, lower technological barriers, and promote collaborative innovation (Rong, 2022).

Policy support and coordination among governments are also essential. This includes creating investment-friendly environments, safeguarding data privacy, and standardising technical norms. Technological innovation and talent cultivation are the foundation of digital economy development, requiring robust education systems, digital literacy enhancement, and the development of high-end technical talent (Herman & Oliver, 2023).

Furthermore, machine learning and data analytics offer novel methods for optimising the allocation of computing resources. These technologies can forecast demand, improve resource efficiency, reduce waste, and enhance service quality. For instance, predictive models based on machine learning can effectively manage data centre workloads and support energy efficiency optimisation (Mao, Geng, & Shao, 2023).

Environmental sustainability must also be prioritised. Energy-efficient technologies and renewable energy sources should be integrated into infrastructure projects to meet sustainable development goals while reducing long-term operational costs. Green computing principles are critical to minimising environmental impact and supporting global climate objectives (Niankara & Traoret, 2023).

Lastly, cultural and linguistic exchange is vital to successful cross-border cooperation. Through intercultural dialogue and language training, collaborative efficiency can be improved, misunderstandings minimised, and partnerships deepened.

In conclusion, the challenges associated with digital economic infrastructure can be overcome through international cooperation, strong policy frameworks, continuous technological innovation, and focused talent development. Seizing the opportunities

offered by the Belt and Road Initiative will boost the economic development of participating countries and contribute significantly to the advancement of the global digital economy.

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