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5G Industry Virtual Private Network (VPN) Capability Improvement and Practice

Mr.P.Boopathi
Assistant Professor,
Nehru Arts and Science College,
Coimbatore-641105
Dr.L.Ramesh Kumar,
Assistant Professor and Head Department of Computer Science
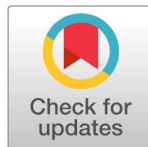*TIPS College of Arts and Science Coimbatore-641107*

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Abstract: China's digital economy is a key driver of economic growth and a national strategy. The digital economy focuses on industrial transformation and the next wave of scientific and technical revolution. Industry digitization is the primary battleground for the growth of the data economy. 5G networks are crucial for supporting this digital economy, as they offer advanced information and communication technology. The 3GPP 5G international standard continues to progress, with the R17 version offering a wider variety of applications and enhancing communication. The network focuses on pilot verification and commercial implementation to enhance 5G application scenarios and assist in replicating from "1" to "N." Mining, industrial manufacturing, and energy are among the top industries setting application standards. Applications like remote excavation, unmanned inspection, and machine vision quality inspection can produce large-scale copies of pilot situations.

Keywords: 5G Spectrum, VPN, Data Economy

1. Introduction

1. 5G supports industrial digital transformation

The digital economy has become a national strategy and has become a driving force for China's economic growth important engine. The development of the digital economy is of great significance. The digital economy is the strategic choice to grasp the new round of scientific and technological revolution and the new opportunities of industrial transformation. Among them, the production Industry digitization is the main battlefield for the development of the data economy. As a new generation of information and communication technology is the leading technology in the field of technology, 5G network is a key new type of enabling digital economy Infrastructure[1-2].

5G industry virtual private network [3] It is the only way to realize the integrated development of the 5G industry. The integration of 5G industry virtual private network and traditional operational technology (OT) can connect the bottom Layer equipment and enterprise information "brain", providing high speed, high reliability, and low latency The information transmission channel is helpful to open up the vertical circulation channel of information within the enterprise, Build horizontal data transmission channels between enterprises and between enterprises and customers. Pass With the further combination of big data, artificial intelligence, cloud computing and other technologies, 5G will Industrial virtual private network can effectively enable industrial applications and promote the integration of 5G networks and industries. Integrate to help the digital transformation of the industry.

General Secretary Xi Jinping has made important instructions on many occasions, requesting to speed up the 5G network, etc. New infrastructure construction to enrich 5G technology application scenarios. July 2021, The Ministry of Industry and Information Technology, together with the Office of the Central Network Security and Information Technology Committee, The National Development and Reform Commission and other departments jointly released the "5G Application "Sail" Action Plan (2021-2023)" (hereinafter referred to as the "Action Plan"). The "Action Plan" determines the development path of 5G applications in the next three years, and points out the future new direction of progress, while deploying specific new tasks.

1.1 The value and status of virtual private network in 5G industry

In fact, many industries have already used network technologies such as Ethernet and Wi-Fi Carry out a variety of production, business and other activities. In the era of 3G and 4G, transportation, Private networks have long been used in steel, petrochemical and chemical industries. However, traditional private network communication it is difficult to apply to scenarios with strong mobility such as smart transportation and industrial interconnection. Multi-terminal, large bandwidth and other network requirements. In the industrial field, the application has problems such as inconsistent industrial protocols and complicated wiring. Wi-Fi network the reliability, stability, and mobility are relatively poor, making it difficult to carry ports and mines information transmission services in complex environments.

In terms of 5G network construction and operation, enterprises hope to obtain network manageable on the premise of controllable capabilities, further reduce the cost of 5G network use, While obtaining the right to operate a 5G network, reduce the company's own network operating costs. 5G virtual private networks is logically divided based on public network resources, enabling some network elements to realize and share some network resources exclusively according to industry needs, thereby reducing the 5G network usage and operating costs. Whether it is the transmission rate, network high requirements for network delay and security, or to reduce network construction and operation cost to urgent needs make the 5G industry virtual private network the best choice for now. According to statistics from the Ministry of Industry and Information Technology, by the end of 2021, China has built a total of the number of 5G base stations completed and opened reached 1.425 million, and the number of 5G terminal connections exceeded over 490 million. 5G has been built in key areas such as industrial parks, ports and hospitals number of industry virtual private networks exceeds 2,300. These all speed up the 5G network system formation.

2. Enhanced private network capabilities to promote the integrated development of 5G industry applications

With the continuous integration of 5G networks and industry applications, key industries and typical the application scenarios are gradually clarified. However, 5G applications still need to achieve scale development solve some problems. At present, the integration of 5G network technology and the existing business of the industry still in its infancy. 5G is mainly used in auxiliary production services and information the management business has not yet realized the bearing of the core business of the industry. Meet industry business Demand is the premise of all convergence work.

When the industry introduces 5G, it mainly considers the following five requirements: (1) Multi-domain Multi-class service bearer. 5G networks need to meet the requirements of wide-area and local-area fields in enterprise campuses. Differentiated network requirements of multiple types of businesses in the scenario, such as park production and management services, communications between parks, etc. (2) Business isolation and data security. The 5G network must be able to ensure the security isolation of public network services and enterprise services, so that the core Business does not leave the park. (3) High reliability network. 5G network must meet the high requirements of enterprises Reliable requirements, providing continuous communication services to ensure production safety and production efficiency rate and reduce losses caused by network failures. (4) Network exclusive and built into this is low enough. Enterprises hope to reduce the 5G network as much as possible on the premise of exclusive network construction and use costs. (5) Simple and autonomous operation and maintenance of 5G network. Business hope It has the operation and management rights of the internal 5G network and simplified network operation and maintenance.

2.1 Enhance network reliability and ensure end-to-end highly reliable transmission

For the sake of production safety and production efficiency, enterprises require the network to provide uninterrupted service. Even in the event of a network failure, the

network can Quick recovery and enable network data to be transmitted stably and securely. This article wills the two dimensions of system networking reliability and service availability are used to discuss the improvement of network reliability.

(1) System networking reliability

Link redundancy, wireless dual connectivity based on dual customer premises equipment (CPE) Redundancy and end-to-end dual-session redundancy, capable of establishing end-to-end dual connections, i.e. Establish two independent, redundant Protocol Data Unit (PDU) sessions. but in parallel The redundancy of the link will greatly consume system resources and increase the system cost, only applicable to Those scenarios that require the highest level of guaranteed end-to-end business.

Combined with the access router (AR) dual transmission and selective reception function, when a link outgoing In the event of an abnormality, the dual CPE-based link redundancy can seamlessly switch to another chain On the road, the round-trip time of the link can be calculated in real time without re-establishing the handshake (RTT) value to select the link with the lowest latency. This ensures that the control instruction the timeliness and reliability of the release.

Wireless dual connection redundancy through the active and standby base stations and the same user plane functional network element (UPF) to connect. Redundant transmission of QoS flows in a PDU session is managed by the session Management function network element (SMF) to decide. The end-to-end dual-session redundancy is implemented based on the redundant transmission of the N3 interface. The 5G Radio Access Network (NG-RAN) replicates the uplink data packets and passes the two Redundant links (N3 interface) Channels send different UPFs. These UPFs will be combined with Connected to the same data network (DN).

(2) Business availability

Packet Data Convergence Protocol (PDCP) replication [4] means that in carrier aggregation and In the dual-connection scenario, the PDCP layer data is copied (including transmission and powerful). The PDCP entity transmits the same data on both radio links to eliminate

The impact of the deterioration of the wireless environment. Under the same channel conditions, highly reliable modulation and coding strategy (MCS) The adaptive coding modulation of the table is more conservative. Through lower modulation order and coding rate, MCS can improve the anti-interference ability of the service, reduce the bit error rate, and enhance the air interface the fault tolerance of the channel.

2.2 Improve the business SLA guarantee and serve the core production domain of the enterprise

In order to deepen the integration of 5G and industry applications, the 5G network will further carry the core production business of the enterprise. This will affect SLA indicators such as uplink bandwidth and network delay. Put forward higher requirements. On the premise of ensuring business isolation, the virtual private network is connected to the line capacity and network delays are optimized to meet the needs of different production services need.

(1) Resource reservation and guarantee

2. In addition to logical soft slicing based on 5QI resource assurance, virtual private networks can also Resource assurance is achieved with hard slices reserved through physical resource blocks (PRBs). PRB can adopt dedicated reservation, priority reservation, and sharing mode for resources on demand division to meet the differentiated SLA requirements of industry users.

(2) Uplink capacity enhancement

The enterprise campus will involve video surveillance, machine vision, and programmable logic control for applications such as remote control of PLC (PLC), it is necessary to obtain high-definition image and video data. This has higher requirements on uplink capacity. 5G uplink capacity enhancement technologies are mainly including the following aspects. In some special scenarios, such as closed and isolated mines or 4.9 GHz private network farms

In the scene, the introduction of 1D3U frame structure can greatly increase the proportion of spectrum uplink, so that the upstream capacity is improved. Local coverage of 4.9 GHz frequency band and millimeter wave frequency band helps to improve the network capacity within the business premises. In [5], the uplink and downlink capacity of the 4.9 GHz frequency band is analyzed. Analysis was done. Application in smart steelmaking of Ansteel Group[6] medium, upstream bandwidth up to 750 Mbit/s. Because mmWave frequency bands provide greater signal bandwidth in ultra-high-capacity regions, we can increase the absorption capacity of mmWave sites.

In addition, for the intensive deployment of indoor small stations, the super multi-input multi-output the combination of Super MIMO cell + space division multi-user multiple-input multiple-output (MUMIMO) technology can give full play to the advantages of distributed antennas. this combination the technology can perform multiple UE space allocation pairs according to the user equipment (UE) distribution location, Resource multiplexing can be realized, and cell capacity can be improved while solving the interference problem.

3. Practice of virtual private network in 5G industry

Since the 5G industry virtual private network has been commercialized for two years, in terms of industry applications, Basic telecommunications companies and vertical industry companies jointly explore 5G application pilots, and 5G technology has been applied in key industries such as metallurgy, ports, mining, and electric power and scene validation. ZTE summarizes the problems and experience, supplement and improve the virtual private network capabilities and technical system of the 5G industry, further guide other pilot applications to promote large-scale replication of 5G industry applications development trend.

3.1 Special scene coverage optimization

With the increasing complexity of the wireless environment and the continuous proliferation of 5G industry application scenarios 5G network coverage continues to face new challenges war. By segmenting scenarios and requirements, virtual private networks can be flexibly implemented in a variety of ways coverage, which can meet the coverage of special scenarios, such as low altitude, underground mines, and

offshore seas face and so on. This greatly expands the application scenarios of 5G networks.

4. Conclusion

With the continuous advancement of 3GPP 5G international standard development, the evolution of technical standards will continue to promote the development of industry applications. The R17 version continues to improve the communication base at the same time; it will support a wider range of industry applications. 5G Industry Virtual Specialists the network will focus on the pilot verification and commercial implementation of the technology to further enrich 5G Application scenarios, helping industry applications achieve replication from "1" to "N". Row Industrial applications have now completed a breakthrough from "0" to "1". Industrial manufacturing, energy several leading industries such as mining are building application benchmarks. Some pilot scenarios should applications, such as machine vision quality inspection, unmanned inspection, remote excavation, etc., will achieve large-scale copy.

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