The Key to Unlocking the Full Potential of 5G with the Traffic Management Solution (TMS)

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Abstract

In light of growing environmental concerns and the introduction of 5G services, mobile operators face three significant challenges. These challenges involve dealing with packet congestion, reducing the total cost of ownership (TCO) in telecommunications facilities, and achieving carbon neutrality. To address the issue of packet congestion resulting from the high potential of 5G networks, the NEC Traffic Management Solution (TMS) provides an effective solution. By accurately predicting real-time data transmission volumes based on current transmission conditions, TMS effectively alleviates congestion. Under normal operating conditions, TMS maximizes the potential of 5G while improving the throughput degradation caused by concentrated user access and temporary congestion at specific times and locations. TMO also helps to reduce unnecessary data transmission, which not only helps minimize the TCO for telecommunications facilities but also aids in the pursuit of carbon neutrality objectives.

Keywords

traffic management, packet congestion, total cost of ownership (TCO), carbon neutrality

1. Introduction

In recent years, the business landscape for mobile operators has changed significantly in several ways. The introduction of 5G services has revolutionized communication networks, leading to a surge in high-capacity Internet services such as high-definition videos. At the same time, there is a growing emphasis on enabling users to fully enjoy these high-capacity services, resulting in efforts to reduce communication fees, introduce essentially unlimited usage plans, and implement other initiatives aimed at meeting user needs.

Also, the emphasis on environmental concerns within the mobile operator industry is growing. In line with global efforts to combat global warming, there is a significant societal demand to minimize the environmental impact associated with carbon emissions.

This paper aims to clarify the challenges faced by mobile operators within the current social context and introduces NEC's Traffic Management Solution (TMS), specifically designed to effectively tackle these challenges.

2. Challenges Faced by Mobile Operators and TMS as the Key to Unlocking Solutions

2.1 Challenges faced by mobile operators

Mobile operators face several challenges (**Fig. 1**). One challenge revolves around packet congestion, resulting in delayed server responses. With the rapid growth of data-intensive internet technologies such as high-definition content and the emergence of new billing plans and protocols such as QUIC[*1], certain internet services and users are prone to generating substantial traffic. When access becomes concentrated in specific times or locations, packet flow becomes hindered, causing interruptions in video playback and subsequently leading to user dissatisfaction. Therefore, the elimination of packet congestion is imperative.

Another challenge involves reducing the total cost of ownership (TCO) in telecommunications facilities. As mobile operators provide 5G services, facility costs escalate whereas the unit price of services continues to de-

[*1] Standardized transport layer network protocol that is designed to enhance transmission control protocol (TCP), using user datagram protocol (UDP).

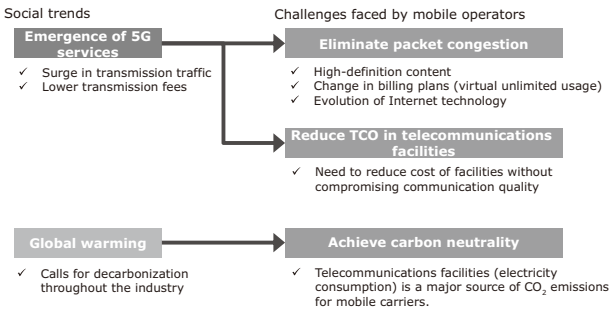

Fig. 1 Challenges faced by mobile operators.

cline as a result of reduced real rates. The management of TCO in telecommunications facilities — done without compromising the transmission quality discussed in the previous section — has become an important management concern.

The final challenge revolves around achieving carbon neutrality. Mobile operators can effectively reduce power consumption by decreasing packet congestion, minimizing unnecessary traffic, and lowering facility costs. It is essential to implement these measures as telecommunications facilities are significant contributors to CO_2 emissions for mobile operators. This underscores the importance of addressing these factors to achieve carbon neutrality.

2.2 TMS as the key

TMS can simultaneously achieve two solutions: enhanced transmission speed and improved efficiency in network usage. By combining these, TMS can be the key to solving the challenges faced by mobile operators.

2.2.1 Enhanced transmission speeds

5G technology has the potential to deliver transmission speeds that are 10 times faster than 4G (LTE). However, when Internet services are accessed, they initially start at a slower transmission speed and gradually accelerate if the network is not congested. This is known as the slow start phase. The shorter the time delay (latency) between launching an application on a smartphone and the availability of the service, the faster the transmission speed feels to the users and they have a more satisfying user experience. Currently, the slow start phase limits the ability to realize significant improvements over 4G. However, with the introduction of TMS to efficiently control transmission speeds and rapidly achieve maximum speed, the quality of service that users experience can be dramatically enhanced.

2.2.2 Improved network usage efficiency

During periods of high access rates, packet congestion can occur and lead to packet accumulation in network devices such as base stations. When packets remain in these devices for a certain period of time, the server at the source starts retransmitting the packets and creates a vicious cycle of further congestion that results in a significant deterioration of the user's perceived quality. To address this issue, TMS deliberately suppresses the transmission speed to ensure a smoother packet flow and ultimately improve the perceived quality of the user's experience. Furthermore, if the packet congestion is caused by specific Internet services or users generating large volumes of traffic, control measures must be implemented to ensure fairness. TMS can handle such control in accordance with the policies of the mobile operator.

Eliminating packet congestion not only reduces communication costs but it also reduces environmental impact. When packet congestion occurs and the server retransmits the packets, the same packet travels through the network multiple times, wasting resources within the telecommunications facilities. In the past, mobile operators have responded to packet congestion by making network facilities bigger and better. However, to provide 5G services at reasonable fees, it is necessary to avoid excessive expansion of the network's capacity. Achieving carbon neutrality also requires reducing power consumption by improving the efficiency of network usage.

2.2.3 Achieving enhanced transmission speeds and improved network usage efficiency

For effectively alleviating packet congestion, it is crucial to increase transmission speed when the network is less congested and reduce the speed when congestion occurs. To achieve this challenging task, accurate observation of the actual status of the network congestion is essential. The technology capable of accomplishing this complex process is NEC's adaptive TCP optimization (A-TCP). Section 3 describes this technology.

3. Features and Attributes of TMS

The traffic management configuration of the TMS (**Fig. 2**) is achieved by combining the values delivered in the three layers with adaptive TCP optimization (A-TCP) at the core.

3.1 Improvement of basic network performance

The improvement of basic network performance posi-

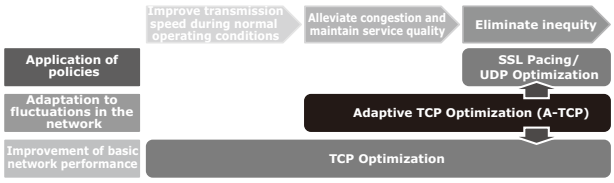

Fig. 2 Traffic management configuration of TMS.

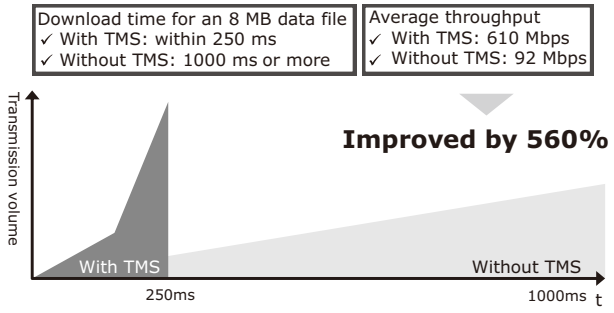

Fig. 3 Improvement in initial transmission speed achieved with TMS.

tioned in the bottom layer is realized through the adaptive TCP optimization feature. This feature enables the flexible adjustment of the transmission speed, so that tuning can facilitate proactive packet transmission to achieve increased initial acceleration or a higher maximum speed. As shown in **Fig. 3**, TMS has improved the average throughput during the initial transmission phase by 560% for commercial services.

However, proactively sending data in this way can significantly deteriorate service quality during network congestion. As a result, general TCP optimization products must be limited to moderate settings and cannot unleash the full potential of 5G.

3.2 Adaptation to network fluctuations

The adaptation to fluctuations in the network positioned in the middle layer is realized through adaptive TCP optimization (A-TCP). At the core of adaptive TCP optimization is a technology that continuously monitors the transmission status at the user's session level and predicts in real time the number of packets that can be sent at any given time. This enables proactive packet transmission when the network is less congested while also controlling throughput to prevent packets from being unnecessarily retransmitted when congestion due to high access rates is detected. Additionally, it promptly detects speed changes and adapts during handovers between networks with different maximum speeds, such as between 4G and 5G networks or between Sub6GHz and millimeter wave (mmWave) bands in 5G. While 5G offers high maximum speeds, its transmission speed can vary significantly. Without proper control, retransmissions could be induced, and the 5G network would become slower than the 4G. As shown in **Fig. 4**, TMS reduced retransmissions in congested areas by approximately 66% and improved throughput during handovers between 4G and 5G by approximately 80%. Having adaptive TCP optimization to regulate transmission speeds as needed enables the tuning of TCP optimization (described in section 3.1) with a specific emphasis on prioritizing performance.

3.3 Application of policies

The application of policies that is positioned on the topmost level is realized through SSL Pacing and UDP optimization. These provide the ability to control individual applications, including videos. In cases where certain Internet services or users are using an excessive amount of network resources and hindering fair usage, SSL Pacing and UDP optimization enable effective control in accordance with policies set by the mobile operators. **Fig. 5** illustrates successful instances where TMS effectively managed traffic at peak times, reducing the traffic by 97% without significantly impacting service quality in commercial services. However, because it is acceptable for certain users to generate a large amount

Improvement in throughput during handover

Without TMS	With TMS	Rate of improvement
309.0 Mbps	553.3 Mbps	79.1%

Reduction in number of retransmissions during congested periods

Without TMS	With TMS	Rate of improvement
17,917,324	6,139,342	65.7%

Fig. 4 Adaption to fluctuations in the network achieved with A-TCP.

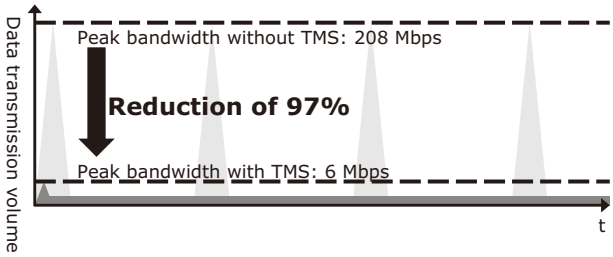

Fig. 5 Reduction in traffic at peak times with TMS.

of traffic when the network is not congested, the presence of adaptive TCP becomes influential in this scenario as well. Typically, minimal control is maintained, but during periods of congestion, stronger control can be exerted to effectively manage network resources.

4. Toward 5G-Advanced and 6G

In the future, 5G will continue to evolve and offer not only ultra-high capacity that has already been achieved but also soon offer ultra-massive connectivity — where a vast number of devices will be connected to the network — and ultra-low latency to minimize delays to the utmost extent. These advancements are being implemented as part of 5G-Advanced.[*2] Further improvements in performance are expected with the upcoming 6G scheduled for around 2030. Alongside the emergence of diverse use cases, including the decentralization of service endpoints facilitated by the deployment of mobile edge computing (MEC), the advancement of these services will contribute to the complexity of networks. In the case of ultra-low latency traffic accommodated by MEC, transmission fluctuations have a significant impact on service quality, making adaptive TCP, as mentioned earlier, an essential control technology. While it is possible that we may encounter unprecedented challenges in the future, these can be effectively resolved using TMS. TMS is capable of analyzing the quality of end-to-end transmission and applying appropriate control measures in accordance with the specific situation.

5. Conclusion

In this paper, we introduced the NEC Traffic Management Solution (TMS) as a comprehensive solution to address the challenges faced by mobile operators. Leveraging this solution will enable mobile operators to deliver new services through 5G while maintaining reasonable rates and reducing their impact. TMS offers ongoing advancements by promptly incorporating the latest technologies and market trends to provide effective resolutions to the management issues encountered by mobile operators. Mobile operators experiencing challenges similar to those discussed in this paper are encouraged to explore the potential benefits of implementing the NEC Traffic Management Solution (TMS) as their solution.

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The details about this paper can be seen at the following.

Related URL:

Traffic Management Solution
(Traffic Optimization Solution) (Japanese)
http://jpn.nec.com/nsp/tms/index.html

[*2] A generic term for specifications that have been standardized since the 3GPP (the 3rd Generation Partnership Project) Release18 for further evolution of 5G.

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