

NG-SDH Multi-Service Provisioning Platform (MSPP) for Metro Networks: FLASHWAVE 4X70 Series

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The considerable expansion of Internet, Intranet and broadcast applications has been forcing carriers to transform their telecommunication infrastructures from voice-optimized networks to universal, converged networks. Especially in a metro network, where a large capacity of diverse service protocols is delivered among multiple nodes, a carrier's survival heavily depends on the efficiency of its data traffic transport. The FLASHWAVE 4X70 series is a powerful Multi-Service Provisioning Platform (MSPP) which can provide optimal solutions to such concerns of carriers. This platform provides the flexibility of true packet switching and Ethernet transport, while operating with the inherent reliability of SDH. Multiple network elements are integrated and consolidated into a single compact node. This paper introduces the features of the FLASHWAVE 4X70 series and its applications, as well as its extensive data transport capabilities.

1. Introduction

Since the early 1990s when it was first introduced in optical networks, Synchronous Digital Hierarchy (SDH) technology has been rapidly deployed at all levels of network infrastructure from long-haul backbone networks (voice and data) to access networks. The ability of SDH to support a quick failover mechanism, combined with its extensive performance monitoring features has well succeeded in providing a resilient and reliable transport mechanism required for carrier-class transport.

However, legacy SDH was designed mainly to transport circuit-oriented services like voice; when it comes to transporting data, it is a less flexible and efficient method. Traditionally, a single, wire-speed Gigabit Ethernet service (1.25 Gb/s) had been allocated to one STM-16 channel (2.5 Gb/s), which means there was a loss of as much as 48% of the STM-16 capacity.

The recent expansion of Internet, Intranet and broadband applications, especially video

contents services, and in contrast, the decrease of fixed telephone services have made it clear that a native data transfer ability is crucially important for a telecommunication infrastructure. Ethernet has become the de facto standard for enterprise networks.

The solution is Next-Generation SDH—technology that transforms rigid, voice-oriented SDH networks into a universal transport mechanism that is optimized for both voice and data. This technology enables carriers to keep up with growing demands for bandwidth, to efficiently carry both streaming and burst traffic, and to adapt to constantly changing traffic patterns. Multiple protocols and thus services are supported from basic TDM voice to Ethernet and SAN.

2. Overview of FLASHWAVE 4X70 series

Fujitsu has introduced a new range of equipment called the FLASHWAVE 4X70

Multi-Service Provisioning Platform (MSPP) series. As opposed to legacy SDH products, this platform provides the flexibility of true packet switching and Ethernet transport, while operating with the inherent reliability of SDH. Multiple network elements are integrated and consolidated into a single compact node. The efficiency of this approach, together with the extensive use of highly integrated components allows the FLASHWAVE 4X70 series to be offered at lower costs than current solutions, serving as an ideal platform for carriers to evolve their network architecture from circuit-based to packet-based because it protects previous equipment investments while providing the opportunity to support new value-added services and applications.

In order to address the varying needs and requirements of carriers and enterprises, the FLASHWAVE 4X70 series consists of a diverse range of products, namely:

- FLASHWAVE 4570: Multiple STM-64 MSPP
- FLASHWAVE 4470: Multiple STM-16 MSPP, upgradable to STM-64
- FLASHWAVE 4370: STM-4/1 MSPP, upgradable to STM-16
- FLASHWAVE 4270: Multiple STM-16 MSPP

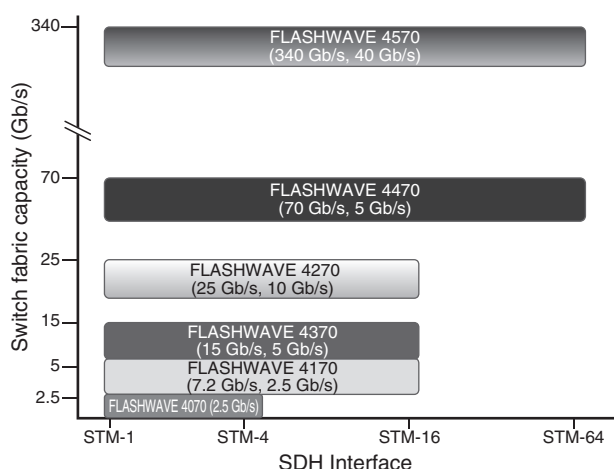


Figure 1
Positioning of FLASHWAVE 4X70.

- FLASHWAVE 4170: Compact STM-4/1 MSPP, upgradable to STM-16
- FLASHWAVE 4070: STM-4/1 Customer Premise Equipment (CPE)

Figure 1 shows the cross-connect capacity and SDH interface supported by the FLASHWAVE 4X70 series to give you an overview of the lineup.

Figure 2 illustrates the architecture supported by the FLASHWAVE 4X70 series.

3. Data transport features

As NG-SDH MSPP, the FLASHWAVE 4X70 series supports extensive Ethernet data transport capabilities. This section introduces some of the important features among them.

3.1 SDH data transport functions

- 1) Generic Framing Procedure (GFP) encapsulation acc. to G.7041/Y.1303: FLASHWAVE 4X70 incorporates an advanced GFP-F mapping scheme to encapsulate Ethernet traffic into SDH payloads. GFP encapsulated data is then mapped into SDH payloads using Virtual Concatenation techniques acc. to ITU-T standard G.707/Y.1322. This process

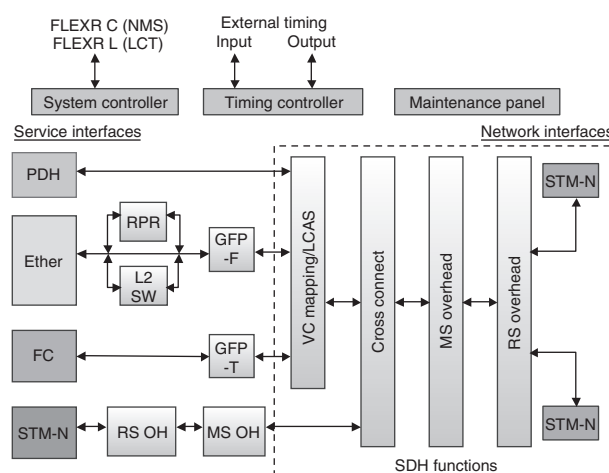


Figure 2
Architecture of FLASHWAVE 4X70.

provides the most efficient mapping of packets and the greatest bandwidth efficiency within a network. GFP mapping can be viewed as a multi-service encapsulation method, which strips out unnecessary legacy mappings of SDH to provide a standardized thin Layer 1 capability that supports a wide range of client-service protocols.

- 2) Virtual Concatenation: VCat provides fine-tuned SDH pipes to match the needs of packets and to boost carriers' traffic-handling scalability and efficiency. For example, the system can accommodate a difference in delay of up to 16 ms between the fastest VC-12 member and the slowest VC-12 member.
- 3) Link Capacity Adjustment Scheme LCAS: The standardized LCAS technique enables dynamic adjustment of the size of virtually concatenated groups of channels. VCat and LCAS in combination provide soft protection schemes.

3.2 Basic forwarding function

- 1) Layer 2 switching and multicast: FLASHWAVE 4X70 supports Layer 2 switching and multicast functions including preprovisioned static multicast, or IGMP Snooping controlled dynamic multicast. Layer 2 switching performs switching of Ethernet frames from a number of LAN ports to a (smaller) number of WAN ports based on MAC addresses or VLAN-IDs.
- 2) Layer 2 aggregation: Layer 2 aggregation performs concentration of (lower speed) Ethernet streams coming from a number of WAN ports to a small number of LAN ports based on MAC addresses or VLAN-IDs. The streams are differentiated on the aggregation port by VLAN tags (eventually double tags).

3.3 Quality of service (QoS)

- 1) Input rate limiting: Input rate limiting allows carriers to control the maximum

bandwidth per port that an end user can obtain from the network.

- 2) Strict policing scheme: For this purpose Queues are implemented. The Queues occupy the bandwidth strictly according to their priorities. A queue with a lower priority can transmit only when a queue with a higher priority has no frames to transmit (is empty).
- 3) VLAN acc. to IEEE 802.1Q: At the ingress side, each port can be set either to accept both VLAN-tagged and untagged frames, or to accept only VLAN-tagged frames, depending on the application requirements. Additionally, a VLAN tag can be assigned to untagged incoming frames in order to assign such frames to an existing VLAN within the network, or untagged frames will be assigned the predefined VLAN-ID (PVID) according to their Class of Service (CoS) settings. At the egress side, each port can be set to remove VLAN tags arriving from the network or keep the VLAN tags unattended. Additionally, VLAN tags can be assigned to frames leaving the network on an aggregation port.
- 4) CoS acc. to IEEE 802.1p on a port basis or a VLAN basis: At the ingress side of every port, there is a buffer memory to store frame bursts at the input when their respective output ports are congested. The memory for buffering is shared among all ports on a card. At the egress side of the WAN ports, there are four queues, which can be assigned with different priorities or weights. The scheduling scheme can be set either to strict policing or Weighted Round-Robin.

3.4 Ethernet protection

- 1) RSTP acc. IEEE 802.1w: Spanning tree prevents loops at the Ethernet level of the network while providing Layer 2 protection. Thus, meshed configurations and even ring configurations such as Ethernet shared

rings are supported.

- 2) Link aggregation (LAG): Besides making the transmission rate more flexible, grouping two or more links to build one trunk link with increased capacity, the link aggregation functionality can also guarantee traffic continuity, even if one of the links in the group goes down.
- 3) Resilient Packet Ring (RPR) acc. IEEE 802.17: RPR is a network topology designed to meet the requirements of a packet-based MAN, such as guaranteed service quality and bandwidth management within Service Level Agreements. RPR uses a ring topology to carry the traffic in a highly resilient manner. It has three classes of service (class A, class B, and class C) which can be used to give higher protection to higher priority traffic. In the event of a fiber break, RPR uses either wrapping or steering protection to quickly reroute high priority traffic.

3.5 Ethernet service application

The various areas of Ethernet data functionality introduced above enable the following typical Ethernet service applications through the FLASHWAVE 4X70 network:

- 1) Ethernet Private Line (EPL): EPL provides dedicated, point-to-point Ethernet connectivity.
- 2) Ethernet Virtual Private Line (EVPL): EVPL still delivers point-to-point connectivity, but over shared instead of dedicated bandwidth. IEEE 802.1p QoS/CoS with four priorities is supported.
- 3) Ethernet Private LAN (EPLAN): EPLAN service provides multipoint connectivity over dedicated bandwidth. The difference from EPL is in that instead of using a predefined mapping between VLAN tags and link connections, EPLAN uses Ethernet switching (i.e. Bridge learning) to pass Ethernet frames to the appropriate link.
- 4) Ethernet Virtual Private LAN (EVPLAN):

EVPLAN is the most cost-effective service providing Layer 2 multipoint connectivity between Ethernet edge devices with the network bandwidth being shared among the customers. Customer separation is accomplished via encapsulation or Ethernet virtual connections.

4. FLASHWAVE 4570

FLASHWAVE 4570 is a powerful core network product suitable for being deployed in metro and regional areas with combined SDH and Layer 2 switching functionalities. It is equipped with a 340 Gb/s switch fabric specifically targeted for handling large amounts of GE, 10 GE, and STM-64 traffic. FLASHWAVE 4570 provides carriers with an opportunity to smoothly transfer their core networks to next-generation ones.

As a large capacity MSPP, FLASHWAVE 4570 addresses a whole variety of applications from metro to backbone networks and provides service aggregation, grooming and cross-connection regardless of the service protocol.

Figure 3 shows the appearance of FLASHWAVE 4570. The physical dimensions are $500 \times 278 \times 1068$ mm (WDH).

FLASHWAVE 4570 shelf has fifteen 20 Gb/s traffic slots plus four 10 Gb/s traffic slots which are designed to accommodate a wide range of

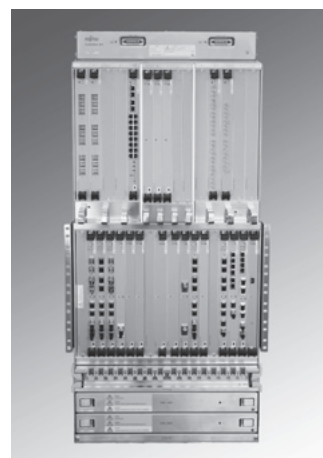


Figure 3
Appearance of FLASHWAVE 4570.

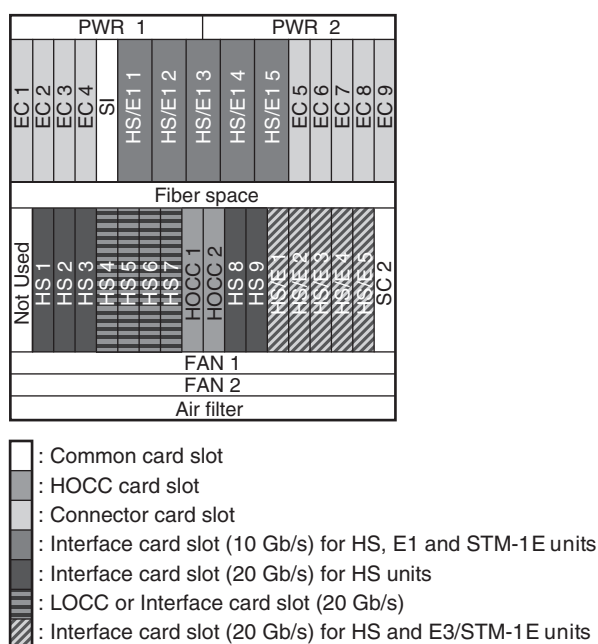


Figure 4
Shelf layout of FLASHWAVE 4570.

interface cards from STM-64 to STM-1 SDH interfaces, E1 and E3/DS3 PDH interfaces, and 10 GE, GE, and FE as well as Fiber Channel data services. See **Figure 4** for details of the FLASHWAVE 4570 shelf layout.

In this shelf, FLASHWAVE 4570 can accommodate as many as 34 STM-64 or 136 STM-16 ports. The E1, E3/DS3 and STM-1E tributary traffic can be protected using the 1: n ($n=\max. 4$) unit protection mechanism while simultaneously up to 504 E1, 48 E1/DS3 or 64 STM-1E ports can be accommodated in one shelf. In order to support a more reliable network suitable for a carrier-class metro network, FLASHWAVE 4570 supports a full range of SDH traffic protections including SNCP, 1+1 MSP, 1: n MSP, as well as 2-fiber MS-SPRing.

5. FLASHWAVE 4470/ FLASHWAVE 4270/ FLASHWAVE 4070

FLASHWAVE 4470, FLASHWAVE 4270 and FLASHWAVE 4070 make up a close family among the FLASHWAVE 4X70 MSPP series, sharing the

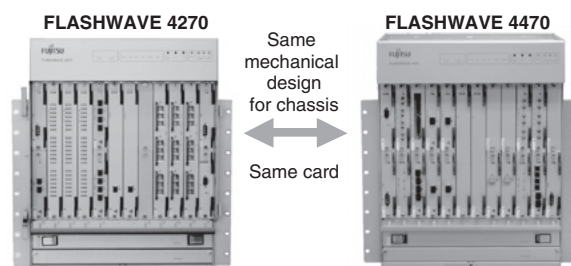


Figure 5
Appearances of FLASHWAVE 4270 and FLASHWAVE 4470.

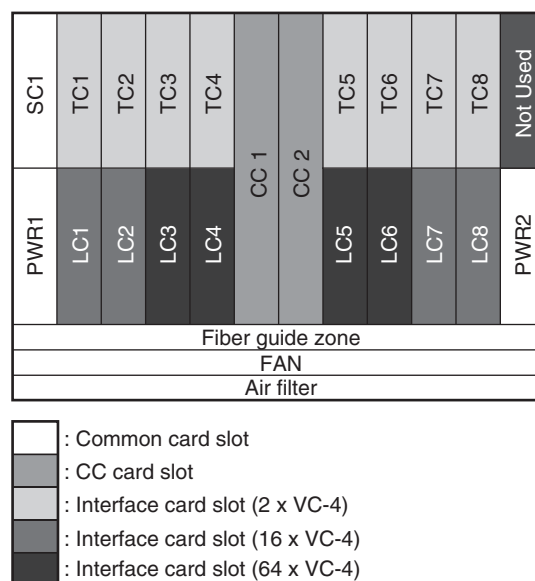


Figure 6
Shelf layout of FLASHWAVE 4470.

same core and interface cards. Even the chassis of FLASHWAVE 4470 and FLASHWAVE 4270 employ the same mechanical design.

Figure 5 shows the appearances of FLASHWAVE 4270 and FLASHWAVE 4470. The physical dimensions are $447 \times 332 \times 566$ mm (WDH).

FLASHWAVE 4470 is a high-capacity MSPP positioned for a metro aggregation network. It is equipped with 70 Gb/s high-order and 5 Gb/s low-order switch fabrics, supporting the high-capacity backplane path between the switch fabric and each of traffic slots, to enable the add/drop of a larger amount of high-capacity traffics including STM-64. See **Figure 6** for details of the shelf

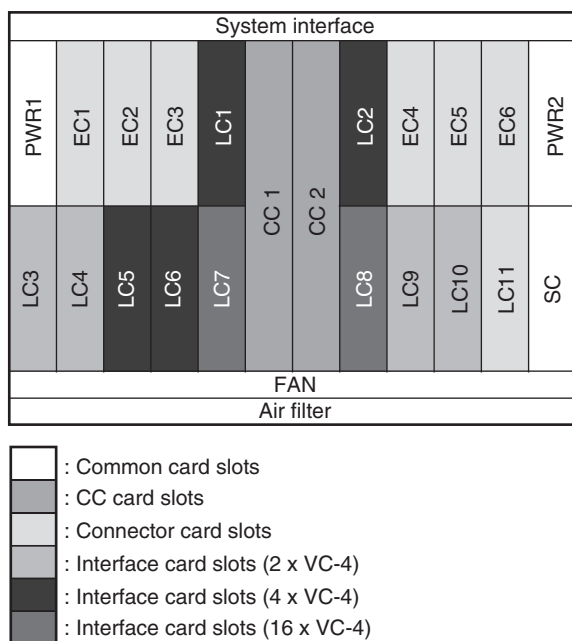


Figure 7
Shelf layout of FLASHWAVE 4270.

layout of FLASHWAVE 4470.

Meanwhile, FLASHWAVE 4270 is a medium-capacity MSPP also aimed at a metro aggregation network, supporting 25 Gb/s for the high-order switch fabric and 10 Gb/s for the low-order traffic grooming and cross-connection. In comparison with FLASHWAVE 4470, its backplane bus has also less capacity; therefore the cost for the chassis can be greatly reduced. See **Figure 7** for details of the shelf layout of FLASHWAVE 4270.

FLASHWAVE 4070 is a compact STM-1/STM-4 MSPP aimed at applications in a metro access network. It is installed at the end user's premises or at carrier networks and delivers any mix of voice and Ethernet connectivity, e.g., intranetworking, business video application, as well as Internet access applications.

Figure 8 shows an appearance of FLASHWAVE 4070. The physical dimensions are $439 \times 265 \times 78$ mm (WDH).

The shelf has three traffic slots where STM-1 SDH, E1 and E3/DS3 PDH, and FE/GE data card can be housed. By changing a main



Figure 8
Appearance of FLASHWAVE 4070.

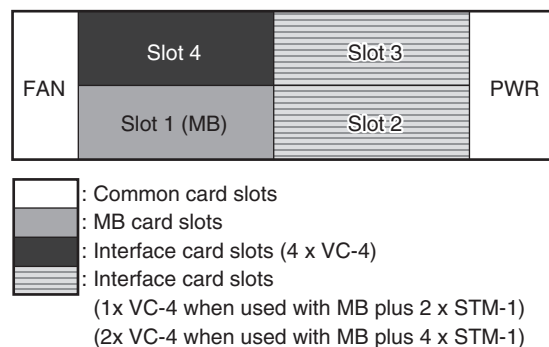


Figure 9
Shelf layout of FLASHWAVE 4070.

board (MB), the network line rate and cross connect capacity is also selectable from the following two options: 1) STM-1 with 1.25 Gb/s capacity, and 2) STM-4 with 2.5 Gb/s capacity. See **Figure 9** for details of the shelf layout of FLASHWAVE 4070.

The key features of FLASHWAVE 4070 are as follows:

- AC and DC power option as well as rack mounting, wall mounting, and desktop installation options, allowing operation in carrier's site and business office environments
- Card commonality with FLASHWAVE 4270 and FLASHWAVE 4470, reducing and simplifying holding of spares and logistics
- Extensive data transport features same as FLASHWAVE 4270 and FLASHWAVE 4470 support

6. Applications

FLASHWAVE 4570 offers the highest levels of flexibility and scalability, providing

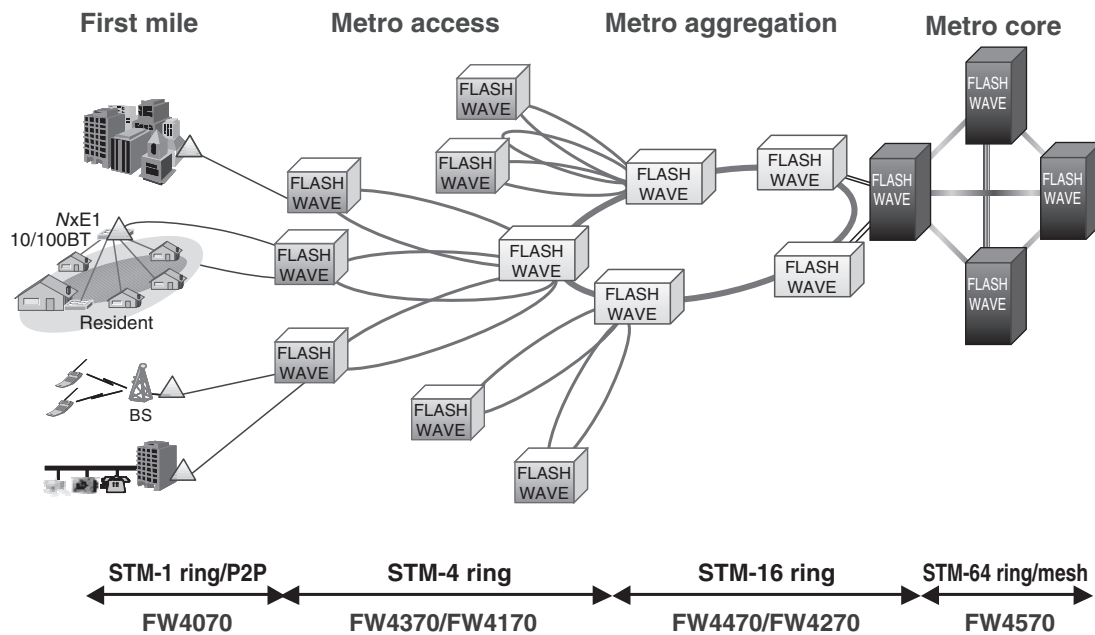


Figure 10
Network application example of FLASHWAVE 4X70.

high-density interfaces and switch fabric capacity. FLASHWAVE 4570 can be deployed as STM-64 and STM-16 terminals or as an add-drop multiplexer, local cross-connect or multi-ring in point-to-point, chain, ring and meshed topologies, and ring interconnections in a metro core network.

FLASHWAVE 4470 and FLASHWAVE 4270 are also suitable for metro core and metro aggregation networks whose network capacity is mainly STM-16.

Meanwhile, the remarkable modularity and scalability of FLASHWAVE 4170 and FLASHWAVE 4370 are an ideal solution for metro access networks where the traffic volume generated through broadband access by residential and small business customers depends heavily on the type and the actual rollout of new applications and services.

FLASHWAVE 4070 serves as a complete multi-service access for corporate customers. This CPE delivers multiple services for telephony, Ethernet connectivity such as intranetworking, business video applications,

storage area networking (SAN) and Internet access applications.

Figure 10 illustrates an example of a FLASHWAVE 4X70 network application.

7. Conclusions

The FLASHWAVE 4X70 series provides a full range of multi-service provisioning platforms leading the market. It allows carriers to evolve their legacy telephony service-oriented infrastructure to a converged transmission network seamlessly at the minimum cost.

Packet-centric transport networks can be built utilizing FLASHWAVE 4X70 MSPP with data, Ethernet and SAN functions being added to the classic transport features. Its modularity meets strict cost and multi-service requirements and its scalability accommodates the expected traffic growth and increasing variety of services.

As the recent technical trend, ASON/GMPLS technology is considered to be one of the key elements to be introduced at the next stage. ASON/GMPLS supports the capability to transform the network into a more dynamic

and service-aware network to allow the services offered to become more personalized by enabling the provision of high-quality services and time schedules depending on the end users' requests. As a product supplier

who supports carriers' continuous success in a fiercely competitive telecommunication market, we will be seeking better solutions to further reduce CAPEX and OPEX as well as to increase revenue.



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