



Talking
to the
Future

—ZTE broadband metro network solution

Electro-optical cross connection “inducing” higher value

ZTE中兴

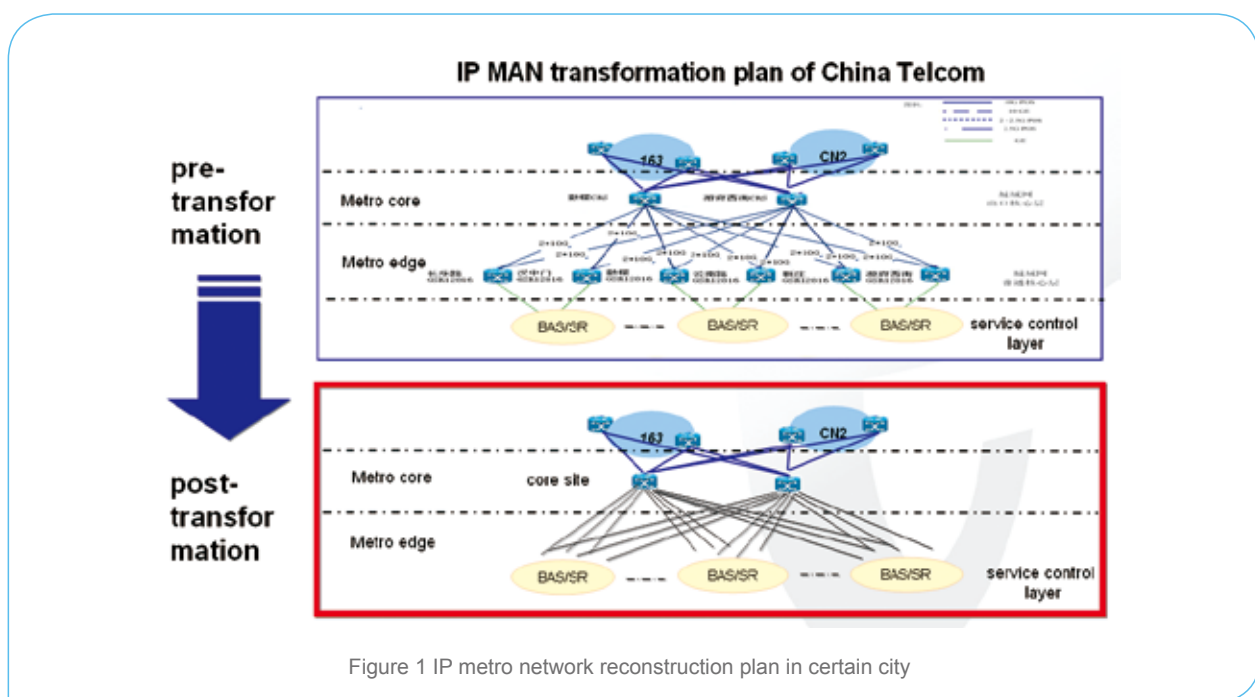
Challenges to IP-based metro transport network

As telecoms networks are in the shift to be packetized and broadband-based, All-IP has been the future development trend of service networks. According to prediction, bandwidth is expected to grow at an annual rate of over 30% in the next five years. The two-layer networking mode "IP over WDM" is gradually replacing the traditional three-layer "IP over SDH over WDM" mode at both backbone layer and metro layer, and the flat architecture enabling carriage of IP packets directly over photonic layer has been an inevitable trend. IP over WDM networking architecture poses new requirements for photonic layer WDM equipments, and WDM layer will take over the networking, service grooming and end-to-end circuit monitoring and management functions originally provided by SDH networks.

As the carriage platform of IP bearer network, optical transport network confronts the transformation primarily driven by IP bearer network demands. The service granularity carried over IP bearer network becomes larger and larger, large-granule services like 10GE are emerging as a result. WDM equipments should offer agile grooming of large-granule services.

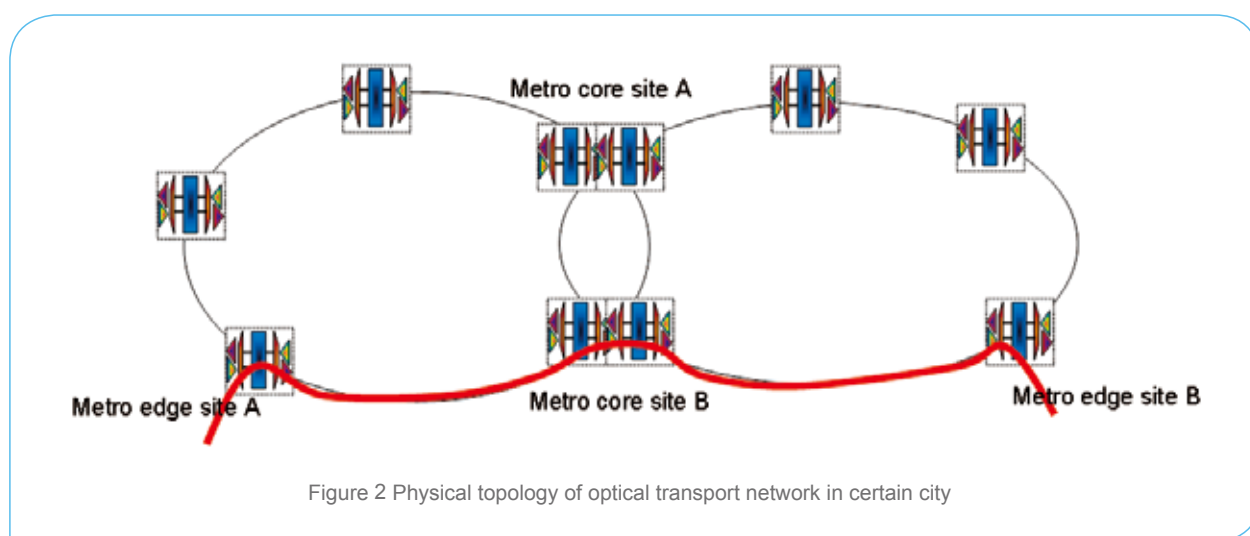
As exemplified by certain operator in certain city of East China market:

With the flattening of IP metro network, original three-layer IP metro network structure becomes two-layer structure, which eliminates the common core layer of metro network and uses dual-homing mechanism to directly bring the service control layer to the egress core layer of metro network. Such architecture triggers new requirements for lowering the WDM layer.



Operator's metro network reconstruction plan is shown in above figure. The overall demand of the city is stressing IP metro network reconstruction, which subsumes over 40 offices, with traffic amounting to 60+ 10GEs and 100+ GEs. Bandwidth demand from

government and enterprise customers is getting a boost, and demand for high-speed interconnection in the city is experiencing continued growth. The physical topology that IP metro network logic topology corresponds to optical transport network is shown below:



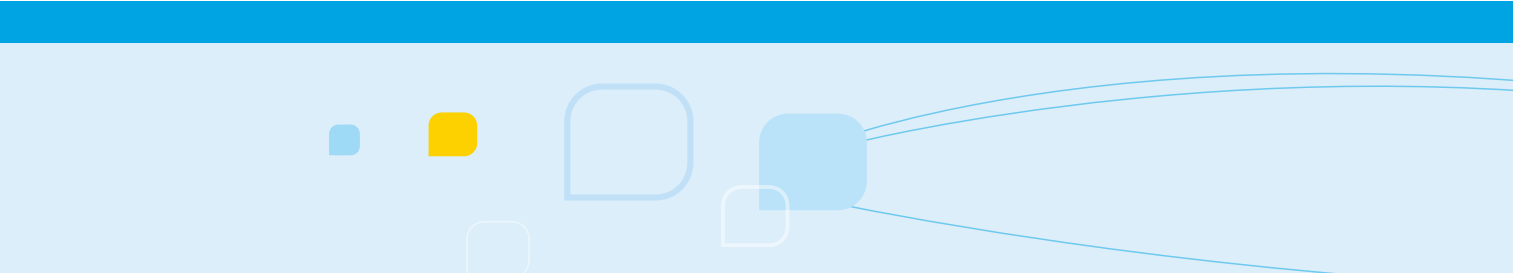
All aggregation nodes are dual-homing to the core node. The IP-based process results in huge demand for 10GE bandwidth in IP metro network and ever-increasing bandwidth granularity for leased services. For example, key account services at granularities of GE/2.5G/10GE (the red curve in the figure) exist between County A and County B. The growth of such key account services necessitates Core Site B's ability to perform cross-connect grooming. Traditional WDM networking has disadvantages in terms of unfitted structure (to build based on original IP network structure) and inflexible grooming (unable to address the requirements for high-speed turn-up in the city).

The fervent hope for IP metro network reconstruction put new requirements on photonic layer WDM equipments under existing IP over WDM network architecture. WDM layer will take over the networking,

service grooming and end-to-end circuit monitoring and management functions originally provided by SDH networks.

In the face of further escalating turn-up and grooming requirements for large-granule services like 10GE, if WDM layer is still only responsible for pipe-line transport and unable to implement agile grooming of large-granule services, all services are processed and forwarded by routers under IP over WDM architecture. Although simplifying operations at the WDM layer, this mode burdens IP devices, leading a much higher demand on router capacity, and markedly higher port and grooming costs. Researches also find that most capacity of P routers at core layer is consumed for forwarding, rather than handling the add/drop services at the node.

Considering huge demand for 10GE bandwidth in IP metro network and ever-increasing bandwidth granularity



for leased services, as well as the possible emergence of wavelength leasing and large-granule storage services, operators now are turning to such network construction approach, which requires WDM layer to implement flexible service grooming, fit free network extension and adapt to port changes.

Overall network construction approach required is listed below:

- Layer-by-layer construction, domain-by-domain

grooming, introducing electrical-layer cross-connect equipment;

- Strong core cross-connect capability, agile grooming (enabling agile grooming of services at granularities ranging from GE to 10GE), responsible for inter-domain aggregation and grooming;
- Use of ring structure for regional builds, responsible for offering service ports.

Electro-optical cross connection to enable flexible grooming

The IP-based trend necessitates metro optical network equipments to feature agile service grooming capability. Service grooming cross connection technologies currently in use are ROADM-based optical cross connection and OTN-based electrical cross connection, neither of which cover all network scenarios. In the case of pure ROADM networking, as ROADM lacks of wavelength non-blocking function and is prone to such factors as signal-to-noise ratio, dispersion and non-linearity, it is unsuitable for large-scale networking. Pure OTN networking provides limited λ -level grooming capability due to relatively small cross-connect capacity of OTN electrical cross connection.

To tackle the problems mentioned above, ZTE launches new generation All-IP-oriented intelligent WDM solution. This solution adopts electro-optical networking mode to enable agile grooming of λ /sub- λ services. It adapts to IP-based services, fully supports OTN functions and allows more delicate network management at transport layer; it accommodates the requirements for intelligent grooming of dynamic IP services at various layers and granularities; it loads control plane to speed service delivery and implement intelligent protection

restoration. Targeting diversified service demands, different QoS guarantees are also available to offer the entire network with enhanced flexibility and agility.

In support of 3-dimensional electro-optical service grooming system, intelligent WDM system can perform λ -level (10G/40G) and sub-10G/40G-level (ODU0/1/2) service grooming, provide rigid and elastic transport pipe-line for data services to effectively boost carriage efficiency, and deliver different QoS services for different services.

Multi-degree ROADM system

The emergence of ROADM system makes it viable for λ -level large-capacity service grooming. Deployment of multi-degree ROADM and OTN standardized interfaces pushes traditional WDM backbone network to evolve to mesh-based, multi-layer and multi-domain network from point-to-point network. Meanwhile, leveraging on its remote wavelength configuration function, ROADM system enables fast end-to-end service provisioning, and effectively improves service turn-up and maintenance efficiencies. It also allows add/drop of any wavelengths in any directions at the same

port, capable of building mesh-based complex network and implementing fast wavelength grooming.

Multi-degree ROADM system with GMPLS control plane can accelerate grooming and delivery of λ -level services under complex topologies, tackling the problem of large-granule service grooming at core layer in bearer network. Intelligent WDM multi-degree ROADM system can be used to build mesh-based WDM network across cities and counties, offering fast λ -level service delivery for service layer.

Multi-degree ROADM system with control plane makes flexible grooming of large-granule services (10G/40G) realistic, whilst preventing multi-node failures at core layer of metro network, resulting in invigorated adaptability of metro core layer to service variation and much higher carriage reliability at core layer.

■ ODUk cross-connect platform

ODUk electrical-layer cross-connect capability implements X-ADM (add/drop multiplexing of any services) of services, provides network traffic aggregation, grooming under complex topologies, and achieves higher wavelength utilization with full use of wavelength channels.

ODUk electrical cross-connect platform, on basis of ODU0/1/2 granularities, can serve as diversified client-side service units to access varieties of services, such as GE/FC /FICON/SDH and then cross connect them to different line units via OTN electrical cross-connect matrix. In this way, agile grooming of services is realized. Furthermore, the optical transport network can dynamically distribute and flexibly control bandwidth resources, fast generate services, offer mesh network protection and restoration, feature network dynamic scalability and capacity expansion capability, provide diversified classes of services, and finally becomes an operationable service network.

ZTE intelligent WDM series products comprise small-to-medium-capacity electrical cross-connect equipments, and large-capacity (1.28T cross-connect capacity) electrical cross-connect equipments. In combination with optical cross-connect ROADM, the total cross-connect capacity can reach more than 10T, fully accommodating the requirements for network node scheduling in IP-based backbone/metro optical networks.

■ Intelligent and flexible WSON

Driven by IP-based trend, WDM network is evolving to mesh network, making it more difficult for service management and network management due to more complex network topology. Additionally, use of optical cross-connect and electrical cross-connect planes requires mutual coordination of the two planes to implement end-to-end service connection and higher level of network management, while taking into account for multi-policy protection mode, especially to offer re-routing protection in case of multiple fiber cuts. Pure network management system is unable to address above requirements, and the independent control plane is required to enable more efficient and reliable service and network management.

The gigantic change of optical network is due to introduction of GMPLS control plane, which not only offers multi-layer, multi-vendor control plane interoperation, but also makes it possible for rollout of new services. GMPLS control plane supports auto-discovery of topology, dynamic “click” service provisioning, and remote end-to-end activation of circuit in packet network, and provides MESH-based service restoration, as well as safe, reliable end-to-end services. Based on OTN and ROADM, next generation optical transport network can implement intelligent control by means of introducing GMPLS control plane.

Conclusion

Services are inevitably becoming All-IP-based, following by increasingly higher network bandwidth. The emergence of ROADM/OTN switched technologies enables new generation intelligent WDM to build end-to-end and large-granule service bearer network, effectively lowering total cost of network construction.

ZTE intelligent WDM offers three-dimensional electro-optical service grooming, supports ROADM photonic layer scheduling and OTN electrical layer cross connection, and realizes agile grooming of

services. ROADM photonic layer scheduling provides highly flexible 10-degree scheduling scheme, whilst supporting cost-effective 2-degree scheduling scheme. OTN electrical layer cross connection comprises large-capacity centralized/distributed cross connection options, which can be selected based on traffic. Furthermore, WSON functions add intelligent features, such as rapid service turn-up, multi-node failure prevention and CoS services, to the new generation intelligent WDM network.



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ZTE中兴 ZTE CORPORATION

ZTE Plaza, Keji Road South, Hi-tech Industrial Park, Nanshan District, Shenzhen, P.R.China

Postcode: 518057

Website: www.zte.com.cn

Tel: 86-755-26770000

Fax: 86-755-26771999

S.N.: xczl200