Empowered by Innovation NEC

White Paper

Next Generation WDM
~ FN series WDM/OTN Equipments~

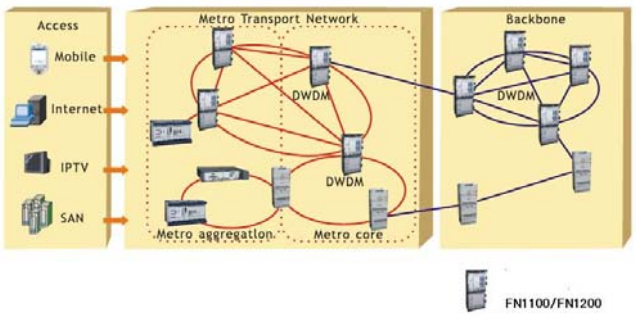
June 2011, NEC Corporation

1. Executive summary

For rapid development of broadband, video and mobile services, NEC has launched FN series WDM/OTN equipments – FN1100/1200 to meet the requirements of Backbone network and Metropolitan networ. FN Series OTN equipments enable operators to build a flexible, high availability and intelligent low-OPEX transport network.

FN Series OTN equipments are multi-service WDM product based on OTN technology. FN1100/1200 adopts combined dispatching technology in optical and electrical layer and has aggregation, cross-connection and transmission function. After loading intelligent control plane based on GMPLS, FN1100/1200 has SDH-like flexibility of management and WDM-Like large capacity and long haul transmission advantages. The platform adopts many advanced technologies such as ROADM, 40G, 100G(*1), ASON/GMPLS etc and also has flexible structure, so it is more suitable for broadband service transmission.

*1 100G is under development



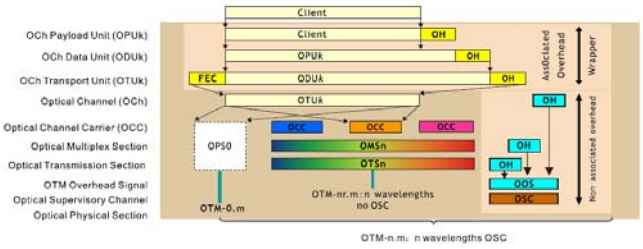
FN1100/1200 Chassis

2. Key technology of OTN Network

OTN is based on WDM, and it's a new transmission System defined by G.872, G.709 etc. It can resolve these problems that WDM network can't do wavelength/sub-wavelength dispatching and weak networking protection capability by G.709, ROADM, sub-wavelength cross-connection and intelligent control plane.

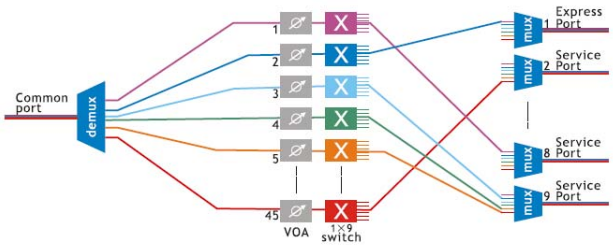
2.1 OTN Interface (G.709)

Similar to SDH layered structure, according ITU-T G.709 regulation, OTN is divided into optical layer (OTSn, OMSn, OCh) and electrical layer (OTUk, ODUk, OPUk), Any two adjacent layers relationship is client/server for each other. The following figure is OTN layered structure:



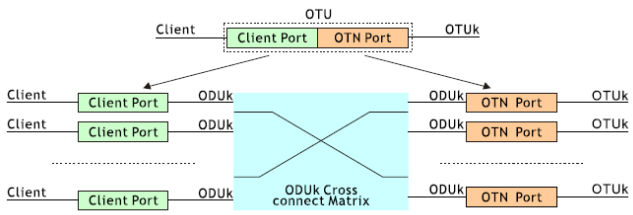
2.2 ROADM

ROADM adopts reconfigurable optical device to realize configuration for any wavelength/wavelength group add/drop, block and pass through of OTN node. ROADM can be defined two types, two-dimension ROADM which can support two directions and multi-dimension ROADM which can support more directions. There are three types of ROADM: WB(wavelength block), PLC(Planar lightwave circuits) and WSS(Wavelength selective switch)



2.3 Sub wavelength Cross-Connection and Scheduling

OTN should support sub-wavelength cross-connection and scheduling function in electrical layer. Nowadays, NEC can support GE, ODU1/ODU2/ODU3 granule dispatching with splitting OTU unit into client unit and OTN unit, as it shows in the following figure.



Compared with SDH dispatching, OTN has the following characteristics.

- Large service granules: 1Gb/s – 40/100Gb/s
- Large cross-connect granules: ODU1/ODU2/ODU3/ODU4
- No united cross-connect granules like SDH VC4
- Strong protection and dispatching ability similar to SDH
- Only need to change client port when service changed,
- The types of OTS are reduced from MxN to M+N; it will reduce types of boards.

2.4 Intelligent Control Technology

As a new technology of transport network field, OTN based on ASON, compared with traditional WDM network, has many advantages in service configuration, bandwidth efficiency and protection.

OTN equipment has the following functions after loaded ASON control plan.

1) Realize auto-discovery of filber/wavelength/board and management of resource/label/tunnel, implement service configuration from end-to-end; When configure service, only choosing source node and sink node and constitute some parameters such as service type are necessary, OTN will configure the services automatically according to these resources discovered automatically.

2) Control plane can realize cross-connection dispatching of optical and electrical layer and provide route choosing and protection functions for different levels; it will improve network bandwidth utilization and save network resource.

3) Support Mesh network; Realize not only traditional protection, but also service recovery automatically. Compared with SDH VC4 dispatching and protection granule, the granules of OTN based on ASON is larger, such as Och/ODUk;

4) Realize different QoS guarantee to satisfy different customer requirements.

3. Main Features of NEC FN series

3.1 Super Large System Capacity

48/96 wavelength upgrading ability in C band, Support 10/40G transport bit-rate for single wavelength, the maximum capacity of C band will be up to 3.84Tbit/s. And further, NEC is developing 100G DWDM which will drastically increase the capacity.

3.2 Plenty of Service Interfaces

Adopting G.709 Digital wrapping protocol to carry all types of traffic over an optical channel regardless of the protocol (IP/Ethernet, ATM, SDH, Fibre Channel, ESCON and Digital Video, etc.) or bit-rate (STM-1 to 2.5Gbps, 10Gbps, 40Gbps etc). New design idea which adopts separating tributary board from line board, can not only get flexible dispatching of service signal but also guarantee carriers' investment.

Type	Service	Standard
SDH	STM-1/4/16/64/256、OC3/12/48/192/768	ITU-T G.707、ITU-T G.691、ITU-T G.957
Ethernet	GE、10GE、40GE	IEEE 802.3z、IEEE 802.3a、IEEE 802.3u
SAN	ESCON、FICON、FC12/25/50/100/200/400/800/1200	ANSI X3.296、ANSI X3.303
OTN	OTU1、OTU2、OTU3	ITU-T G.709、ITU-T G.959.1
Video	DVB、HDTV	EN 50083-9、SMPTE 292M、SMPTE 259M

3.3 Flexible service dispatching

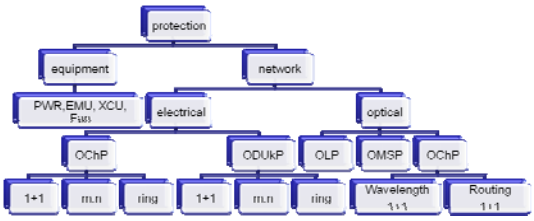
Adopt combined dispatching technology of electrical layer and optical layer. Optical layer supports multi-dimension optical signals dispatched among different NE; Electrical layer support strictly non-blocking electrical cross-connect, the capacity of electrical cross-connection is up to 1.44T, the granules includes ODU1/ODU2/ODU3. The FN series can implement end-to-end flexibly dispatching for low bit-rate service such as GE/FC.

3.4 High Reliability

Adopt Intelligent FAN unit, DC power input from dual -48V source with one working as a back up for the other. Some boards support 1+1 redundancy backup, such as XCU, EMU, ASCU, PWR, etc.

3.4 Perfect Protection Mechanism

Provide perfect service protection mechanism in both electrical layer and optical layer.



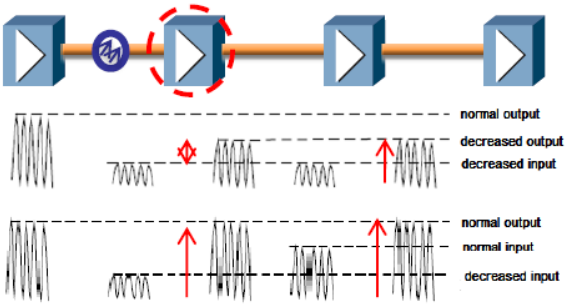
3.5 Ease of Maintenance

FN series adopts intelligent optical power and dispersion compensation technologies, which make rapid operation easy and maintenance simple. FN series can also guarantee system steadily running via dynamic adjustments when there are changes on lines. It contributes to ease of expansion of lambda channels too. When line bit-rate is up to 40Gbit/s, FN series can support automatic dispersion compensation.

Following functionality is a major automatic control feature which can reduce the OPEX.

1) Automatic Power Control / Dynamic Power Adjustment

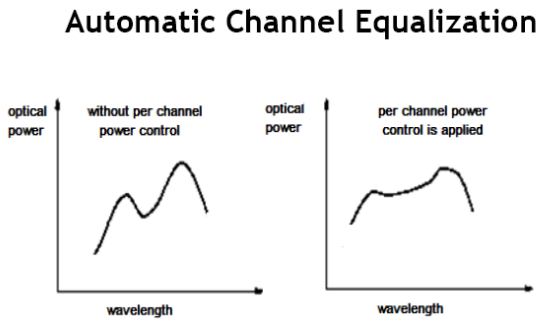
The FN series provides the DPA (Dynamic Power Adjustment) function. After the DPA function is enabled, when the abnormal attenuation value of the line reaches the threshold value, the system will automatically raise the output power to make the input and output power of other downstream amplifiers remain the same, and the OSNR of the system will restore. This function ensures the normal operation of services. Following Figure shows the operation image.



2) Automatic Channel Equalization:

Both the inherent gain "unflatness" of the amplifier and the cascade application of the multi-level amplifier will cause great variance and optical signal-to-noise ratio degradation of the optical channel power, which limits the transmission distance of the DWDM system.

The function of channel optical power automatic adjustment mainly refers to: Introducing the Optical Power Monitoring function into the transmitting end and receiving end, and it will conduct spectral detection on the multiplexing signals from the Optical Mux or WSS. If the optical power variation between the different channels in the multiplexing signals crosses the configured threshold, the system will report an optical power unbalance alarm. Then the Optical Mux or WSS will automatically adjust the EVOA attenuation value of the single wave channels, so as to guarantee that the flatness of each channel in the transmitting end and receiving end meet the requirements. Following Figure shows the operation image.



3) Automatic CD Compensation:

The FN series provides automatic dispersion compensation function for 40G. By collecting FEC error correction counts and bit error rate of lines, the equipment is able to feed back and control the TDCM modules of every channel. It can automatically adjust the dispersion compensation value as per the actual status of fiber. In such a way, the accuracy of dispersion compensation is largely enhanced, and the load and complexity of maintenance work is reduced.

3.6 Optical network automatic planning

NEC can provide WDM network based on OTN optimized planning software, which can provide the following functions to provide perfect support for network design, operation, maintenance, etc.

- Network Topology Layout For WDM Network based on OTN
- Service Protection and Route Design
- Wavelength Distribution
- Auto configuration of Equipments
- Physical Features calculation and Auto Adjustments
- Analyses of Network Faults
- Service Simulation and Recovery
- Output Statistics Analyses Report
- Data Exchange with Network Management System;

3.7 Intelligent Optical Network

Support Control plane loading based on GMPLS, support smooth upgrade to ASON transport network based on OTN. OTN –Based ASON network provides following features.

- Automatic discovery of neighborhoods and links
- Signaling-based set-up, tear-down and maintenance of end-to-end links
- Routing
- Protection against network faults and restoration
- Issuance of link status information
- Flexible service Implementation, (e.g. BoD Bandwidth on Demand)
- Differentiation Service