RECONFIGURABLE OADM BRANCHING UNIT WITH COMMAND-CONTROL CAPABILITY

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Abstract: We have studied a command-control type of Reconfigurable Optical Add/Drop Multiplexer Branching Unit (ROADM-BU) for submarine cable applications. This paper describes the ROADM-BU feature including key components, configuration and performance of highly reliable LSI device. In addition, we have also studied the re-configuration operation of OADM paths.

1 INTRODUCTION

In accordance with rapid growth of internet services, the international communication demands among multiple countries are increasing significantly. Accordingly, many submarine cable systems today are being planned in a mesh or multi-ring network providing direct point-to-point or simple ring connections. The attractive technical approaches in this area are optical signal branching, not per fibre but per wavelength band (i.e. optical add/drop multiplexing (OADM) system) and flexible power feeding path re-configuration during cable failures. Current submarine network with conventional BUs have fixed optical signal paths by pre-determined wavelength arrangement. However, the traffic in the global communication network is becoming more dynamic as Internet-based traffic becomes more dominant. Therefore the optical signal path re-configurability is required for the next generation submarine network.

In order to realize the flexible submarine network, Reconfigurable OADM BU manages optical signal path by remote command. The BU enables optical signal band switching by optical control commands from terminal stations in multi-landing submarine cable network

2 ROADM BU FEATURE

Figure 1 shows the configuration of ROADM-BU.

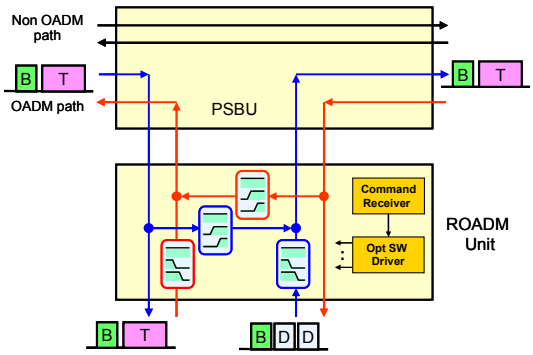

Figure 1: ROADM-BU Configuration

The ROADM BU is composed of a Power Switching BU (PSBU) body and the ROADM unit. The PSBU divides multiple fibers accommodated in a trunk and branch by terminating three cables. It also provides a power switching function which is remotely controlled by optical command signals. PSBU can provide mainly four power configurations. Each power configuration is shown in Fig. 2.

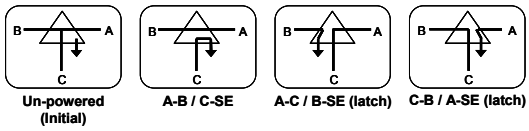

Figure 2: Power configurations in PSBU

Initial un-powered configuration is that 3-legs (A/B/C) are connected to one another and isolated from Sea Earth (SE). Simple trunk A & B powering up operation establishes A-B/C-SE configuration. In this configuration, if all the power stops, A-B/C-SE configuration automatically goes back to un-powered condition. On the other hand, some command operations and power feeding operations offer A-C/B-SE and C-B/A-SE configurations. Both A-C/B-SE and C-B/A-SE configurations can be maintained even if the system power goes down when cable failures occur. For an example, even if unexpected power down occurs during cable repair work, the cable repair work can be performed without any concerns on sudden power configuration change.

The ROADM Unit provides the wavelength add/drop functionality. It is composed of optical couplers, OADM filters, optical switches and a control circuit for the ROADM operation. In-coming signals from the PSBU are split into the pass-through and drop signals. While the drop signals are directly connected to the branch fiber, pass-through signals are sent to an OADM filter which selects the desired sub-band. Alternatively, in-coming signals from the branch fiber (add-signals) are filtered by a second OADM filter which removes unnecessary sub-bands. Then, branch wavelengths are added to the pass-through signal by means of an optical coupler. The combined signals are transmitted to the PSBU.

In this configuration, the OADM filter which selects the desired signals of pass-through and add/drop can be selectable from three pre-installed configurations in each OADM fiber pair path. One of the three configurations is 100% pass-through, the other 2 configurations will be designed with some add/drop ratio in accordance with communication capacity demand of each path. Each filter configuration is selected by optical switches installed in ROADM unit. These switches are remotely controlled from the management system by optical-command signals.

In ROADM system, the OADM filters need a guard band between the pass-through signals and the add-drop signals in order to provide sufficient optical isolation and prevent cross-talk. Figure 3 shows schematic guard band for OADM operation

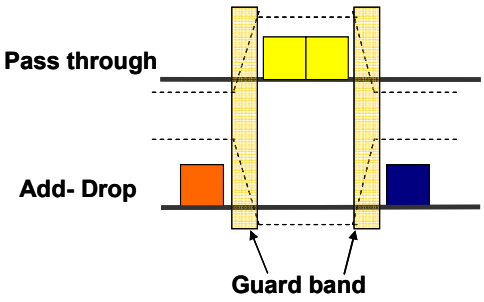

Figure 3: Schematic Guard Band

The OADM filter technology is field proven as pre-fixed OADM BU.

Table 1 shows the main parameter of the mechanical design. The mechanical design of this PSBU and ROADM unit is the same as one of a conventional BU and a submerged repeater, respectively, which are fully field proven. Then, the conventional loading and laying methods and procedures can be applied to the new ROADM-BU.

Parameters	PSBU	ROADM unit
Water depth	max 8000m	
Housing	Beryllium copper alloy	
Insulation resistance	>2000MΩ	
Dielectric Strength	>15kV	
Weight	< 730 kgf	< 350 kgf

Table 1: Mechanical Main Parameters

3 LSI DEVICES

In order to realize command control functions for both functions of the remote power switching and ROADM, we have developed a LSI device with high reliability. The LSI is made using silicon bipolar technology. The LSI device has several functions such as command receiving, demodulation, decoding and switch device control. The LSI design parameters are shown in Table 2. The LSI makes specified control operations, whenever the address code in command signals corresponds to the pre-assigned BU address. To prevent miss-operations due to bit errors, the LSI can operate only when the decoded result of 2 set bits in a command line are identical with each other.

Parameter	Design value
Input port	4ch
Carrier frequency	150kHz
Modulation format	ASK
Signal format	PWM
BU address	9bit
Control port	9ch

Table 2: LSI Design Parameters

The LSI is designed to control not only vacuum relays of PSBU but also optical switches of ROADM functions.

4 ROADM DEMONSTRATION

We have demonstrated the functionality of ROADM based on optical switching. Figure 4 shows two type of optical configurations of ROADM function and optical spectra in each configuration.

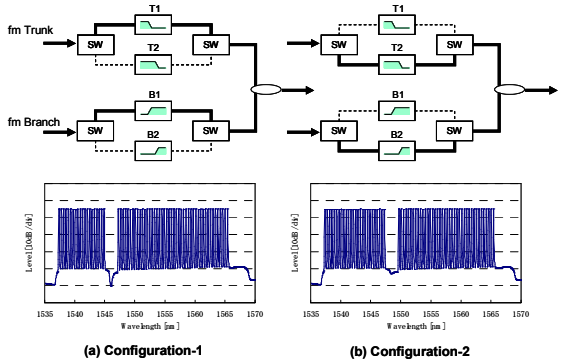

Figure 4: Optical Spectrum in each ROADM Configuration

In this demonstration, ROADM unit is composed of OADM filters, 1x2 optical switches, an optical coupler and optical switch control circuit. The WDM Channels are 66 optical CW source. In initial configuration (Configuration-1), the trunk signals and the branch signals passes the OADM filters of T1 and B1, respectively. After optical switching operation and re-arrangement of WDM channels in order to change the configuration from Configuration-1 to Configuration-2, the trunk signals and the branch signals have passed the OADM filters of T2 and B2, respectively.

5 CONCLUSION

We have studied a command controlled Reconfigurable OADM Branching Unit. The command controlled ROADM BU will provide re-configuration of optical add/drop ratio easily and great flexibility for capacity demands.

6 REFERENCES

[1] T. Inoue, et al,

"OADM Technology for Meshed Connection in Advanced Submarine Cable Network", ECOC 2011, Geneva, Symposia