INFINITE TECHNOLOGIES

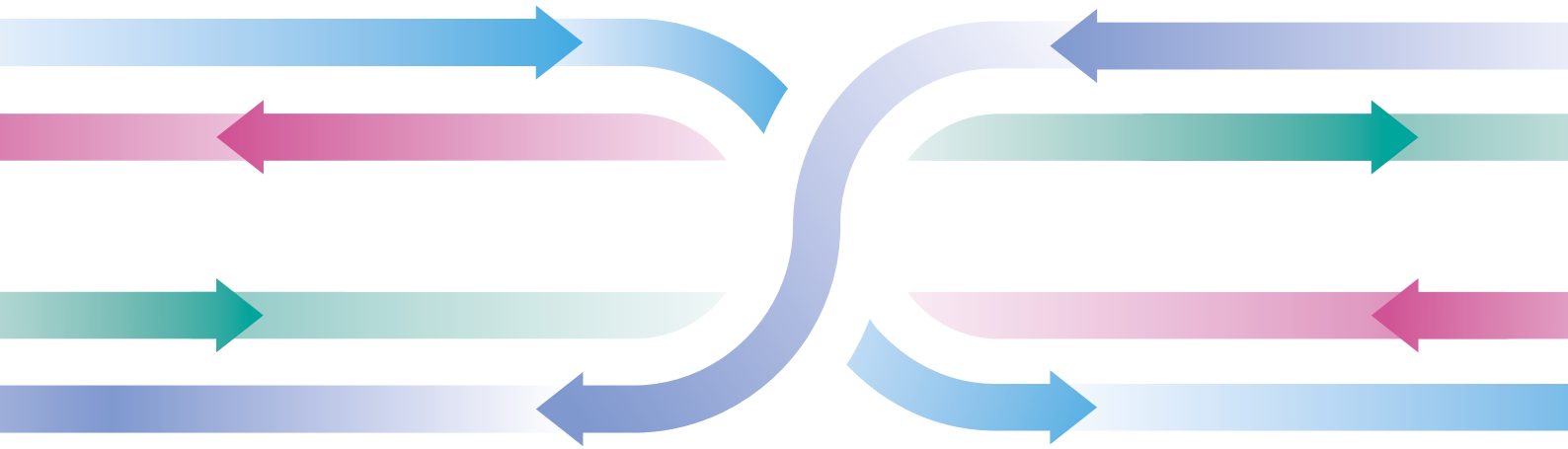
T8 COMPANY

T8 I DWDM SYSTEMS

CDC-F

Colorless Directionless Contentionless Flex Grid

Technology



The review considers the key provisions that determine the ROADM technology (Reconfigurable optical Add/Drop Multiplexer), supporting the functionality of the new generation of the CDC-F type

C – Colorless

Ability to connect optical channels to any port of the multiplexing equipment and remotely adjust the wavelength of each channel

D – Directionless

Ability to add/drop optical channels from or to any direction of transceiver and remotely change the direction of the channel transmission

C – Contentionless

Add/drop of optical channels using the same wavelength to different directions in multi-degree node

F – Flex Grid

Flexible frequency grid

Flex Grid

On existing transport networks built using OTN/DWDM technology, most often for optical channels use a standard fixed frequency grid (Fixed Grid) with a step of 50 or 100 GHz. To build such a communication line, the simplest equipment is used, but this approach has a number of limitations.

Firstly, a high level of spectral efficiency of the DWDM system is not achieved, especially in cases where optical signals with a spectral width much smaller than the fixed frequency grid step are used (Figure 1 – Fixed Grid).

Secondly, it is not possible to use optical channels with a high symbol rate, the spectrum width of which exceeds the fixed frequency grid spacing.

To overcome the restrictions provided, telecommunications equipment that supports the Flex Grid functionality is used (ITU-T G.694.1 (10/2020) «Spectral grids for WDM applications: DWDM frequency grid»). In such equipment, it is possible to adjust the frequency grid flexibly, allocating a frequency band for each channel, consistent with the spectrum width of this channel (Figure 1 – Flex Grid). The minimum tuning step of the central wavelength of the channel is 6.25 GHz. More information on Flex Grid technology are provided in ITU-T Rec. G.694.1.

Application of Flex technology Grid provides the possibility to increase the level of spectral efficiency and throughput of the DWDM system, as well as increase the transmission distance without 3R regeneration (without the use of an intermediate OEO transform) by using channels with a high symbol rate and with lower level modulation formats.

Due to the denser packing of the frequency spectra of individual optical channels in the DWDM group signal spectrum (spectral defragmentation), it becomes possible to build new, previously unavailable, routes for optical channels on a network with a complex topology.

Fixed Grid

Flex Grid

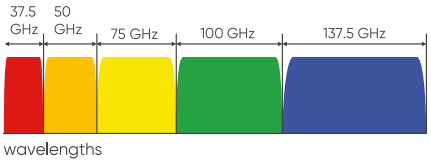


Figure 1 – Fixed Grid and Flex Grid

Ability to connect optical channels to any port of the multiplexing equipment and remotely adjust the wavelength of each channel (Colorless)

Most modern transponders support channel center wavelength reconfiguration. This functionality ensures the unification of solutions, for example, it makes it possible to use one transponder model in different sections of the network, or change the wavelength on a previously installed pair of transponders, and thereby optimize the frequency channel scheme of the network.

In usual (Colored) systems, one specific optical channel center wavelength is defined for each port of the multiplexer/demultiplexer. Therefore, it requires the physical patch cords rewiring, even if it is possible to change the wavelength on the transponder transceiver remotely, for example, through the centralized network management system NMS (Figure 2 – 1). Such a scheme of network maintenance in the long term will require more time and effort from maintenance personnel, since it does not allow full remote configuration of the node. Ultimately, such a scheme leads to a decrease in the flexibility of the network and an increase in the cost of its maintenance.

Colorless have become widely used on DWDM networks, which allows to connect an optical channel with any central wavelength to any port of the add/drop network node and quickly remotely adjust the wavelength of any optical channel without involving a service team (Figure 2 – 2).

With this solution, it is possible to reduce network maintenance costs (OPEX), speed up the process of changing frequency channel plans, increase the durability of network equipment by eliminating mechanical operations during network maintenance.

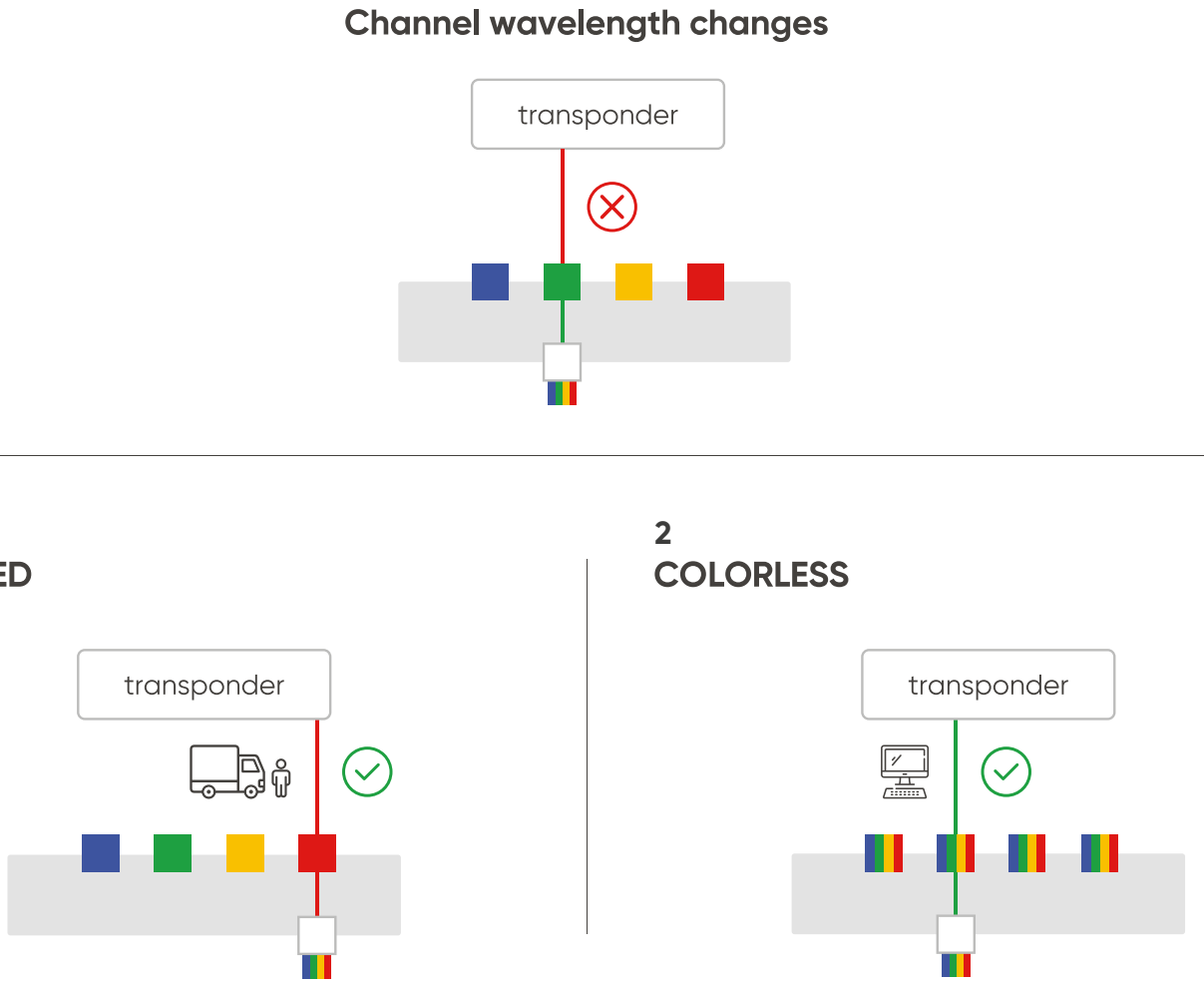


Figure 2 – Changing the wavelength of the channel on the transponder for "Colored" and "Colorless" ROADM systems:
1 – Colored: requires physical port switching
2 – Colorless: a channel with any wavelength can be connected to any port

Ability to add/drop optical channels from or to any direction of transceiver and remotely change the direction of the channel transmission (Directionless)

Multi-degree ROADM nodes are necessary for flexible routing of optical channels in different directions on a single network.

Using the classic ROADM node scheme (Colored Directional) implies manual re-switching patch cords, which has the following disadvantages:
• decrease in the durability of optical ports of telecommunications equipment due to systematic physical impact
• the need to follow clear instructions for maintaining network equipment in order to avoid incorrect connections
• the need for technicians to visit to reconnect the channel to another port in case of a change of direction
• the impossibility of carrying out fully automatic remote reconfiguration of the line when changing the direction (routes) of channels.

A ROADM node with Directionless functionality allows to remotely change the route of an optical channel through a DWDM communication network without changing its connection port in the network node (Figure 3).

Typically, the Directionless functionality is implemented in conjunction with the Coloreless functionality in order to eliminate any need for physical port switching on the network throughout its life cycle (for example, due to a change in wavelength or direction of transmission / receiving). It should be possible to remotely connect the optical channel to any transmission direction with the choice of the required wavelength of optical radiation. In this case, there is no need to call technicians in the field and physically reconnect ports when changing the wavelength or direction of the channel transmission, which reduces the cost of maintaining the network in the long term.

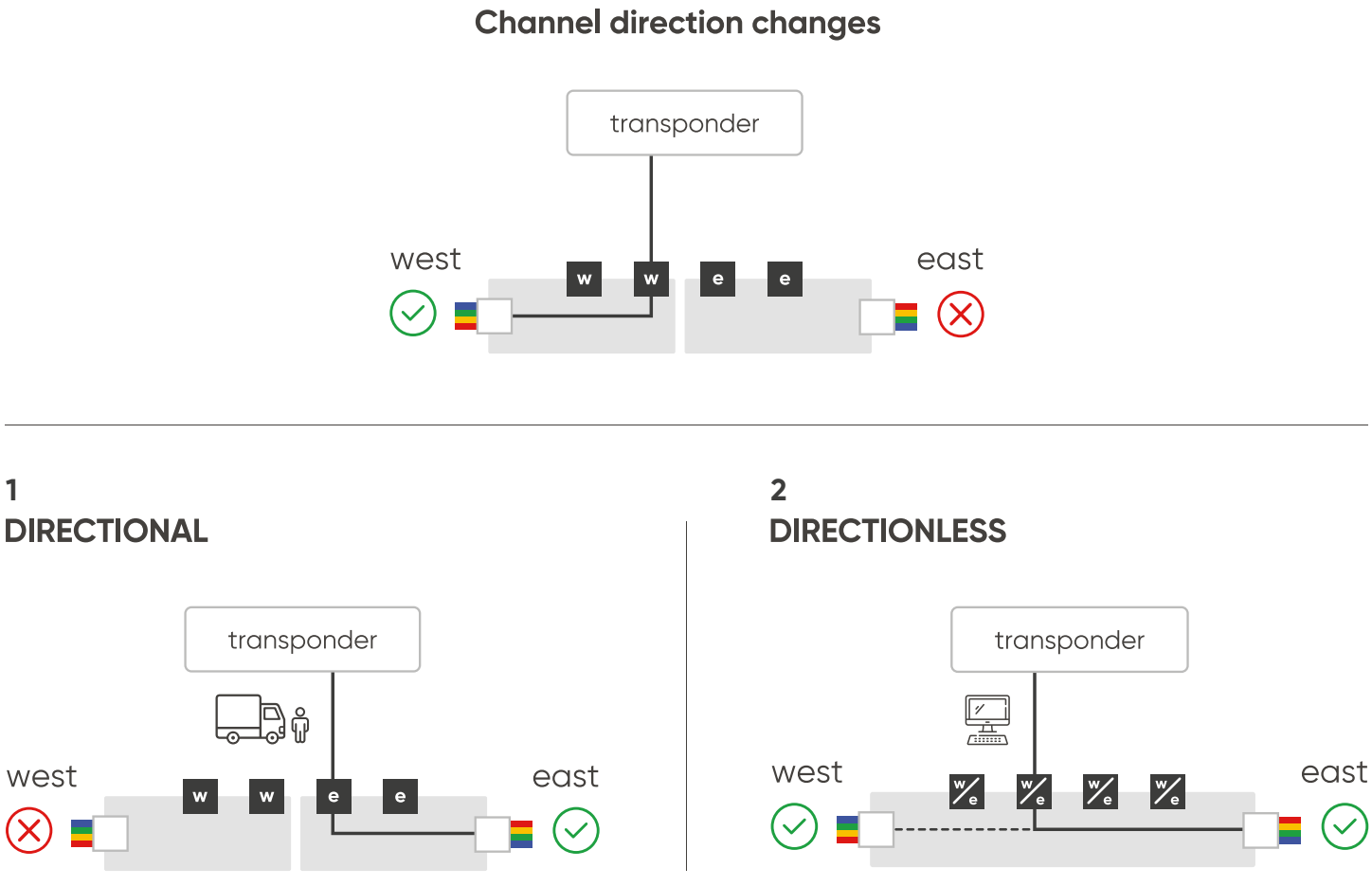


Figure 3 – Changing direction of the channel for "Directional" and "Directionless" ROADM systems:
1 – Directional: requires physical switching of ports
2 – Directionless: channel can be connected to any port and to any chosen direction (but only one)

Add/drop of optical channels using the same wavelength to different directions in multi-degree node (Contentionless)

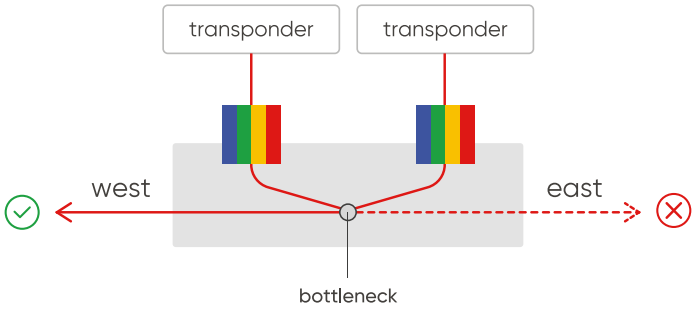
The presence of all three functions of Colorless, Directionless and Flex Grid in DWDM network nodes is enough to implement a flexible network solution with ample opportunities for remote configuration and optimization of the use of network infrastructure during operation. However, in this case, the flexibility of the network and the number of add/drop channels on the node are limited due to the lack of the «Contentionless» property: there is no possibility in a multi-degree node to add/drop several optical channels with the same wavelength in different directions connected to this node (Figure 4 – 1).

To overcome this limitation, a multi-degree node must have a full set of CDC-F properties (Colorless, Directionless, Contentionless, Flexgrid) (Figure 4 – 2).

When implementing multi-degree CDC-F nodes on the network, both the full flexibility of the network solution is achieved, and the opportunity to implement the functionality GMPLS/ASON (ITU-T G.8080/Y.1304 (11/2001) «Architecture for the automatically switched optical network (ASON)»; G.7718/Y.1709 (10/2020) «Framework for the management of management-control components and functions») to ensure the resistance to multiple failures with the implementation of automatic restoration of connections at the photon level of the DWDM network.

1

CONTENTIONAL



2

CONTENTIONLESS

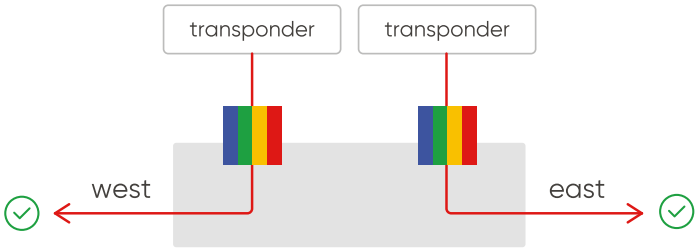


Figure 4
1 – Contentional: it's impossible transmit two channels with the same wavelength to different directions through one add/drop subsystem
2 – Contentionless: possibility of transmission of two channels with the same wavelengths simultaneously to the west and east through one add/drop subsystem

T8 I DWDM SYSTEMS

T8 is a Russian developer and manufacturer of DWDM telecommunications equipment and innovative solutions for fiber-optic communication lines.

Moscow

44/1, Krasnobogotyrskaya Street, 107076
+7 (499) 271 61 61
Fax:
+7 (495) 380 01 39

Saint-Petersburg

10-A, room 314, Energetikov Avenue, 195027
+7 (812) 611 03 12
+7 (812) 612 08 12

Novosibirsk

1a, room 401a, Voskhod Street, 630102
+7 (383) 266 05 55

export@t8.ru
t8.ru