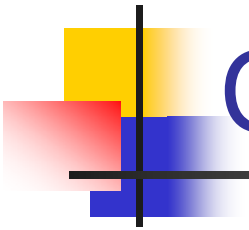


OADM Architectures

- Most practical OADMs use either fiber Bragg gratings, dielectric thin-film filters, or arrayed waveguide gratings.
- We view an OADM as a black box with two line ports carrying the aggregate set of wavelengths and a number of local ports, each dropping and adding a specific wavelength.
- The key attributes to look for in an OADM are the given on next slide.

OADM Architectures

- What is the total number of wavelengths that can be supported?
- What is the maximum number of wavelengths that can be dropped/added at the OADM?
- Some architectures allow only a subset of the total number of wavelengths to be dropped/added.
- Are there constraints on whether specific wavelengths can be dropped/added?
- Some architectures only allow a certain set of wavelengths to be dropped/added and not any arbitrary wavelength.
- How easy is it to add and drop additional channels?

OADM Architectures

- Is it necessary to take a service hit (I.e., disrupt existing channels) in order to add/drop an additional channel?
- This is the case with some architectures but not with others.
- Is the architecture modular, in the sense that the cost is proportional to the number of channels dropped?
- This is important to service providers because they prefer to “pay as they grow” as opposed to incurring a high front-end cost.

OADM Architectures

- Service providers usually start with a small number of channels in the network and add additional channels as traffic demands increase.
- What is the complexity of the physical layer (transmission) path design with the OADM and how does adding new channels or nodes affect this design.
- Fundamentally, if the overall passthrough loss seen by the channels is independent of the number of channels dropped/added,then adding/dropping additional channels can be done with minimal impact to existing channels.

OADM Architectures

- Is the OADM reconfigurable, in the sense that selected channels can be dropped/added or passed through under remote software control?
- This is a desirable feature to minimize manual intervention.
- For instance, if we need to drop an additional channel at a node due to traffic growth at that node, it would be simpler to do so under remote software control rather than sending a craftsperson to that location.

OADM Architectures

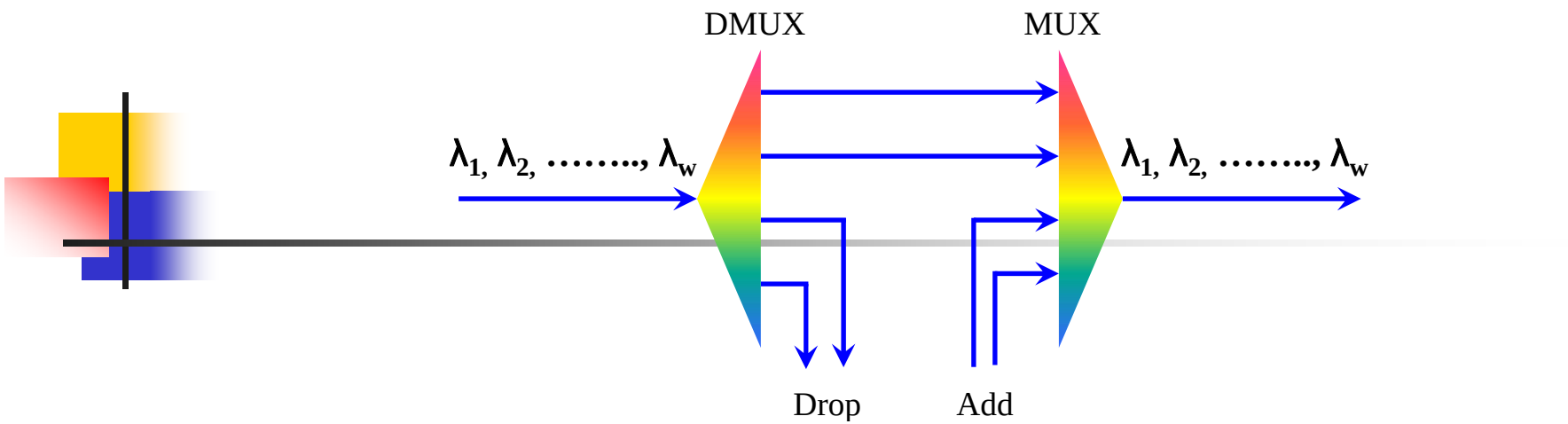
- In the parallel architecture all incoming channels are demultiplexed.
- Some of the demultiplexed channels can be dropped locally and others are passed through.
- An arbitrary subset of channels can be dropped and the remaining passed through.
- So there are no constraints on what channels can be dropped and added.
- As a consequence this architecture imposes minimal constraints on planning lightpaths in the network.

OADM Architectures

- In addition, the loss through the OADM is fixed, independent of how many channels are dropped and added.
- So it the other transmission impairments discussed in chapter 5 are taken care of by proper design, then adding and dropping additional channels does not affect existing channels.
- Unfortunately, this architecture is not very cost-effect for handling a small number of dropped channels because, regardless of how many channels are dropped, all channels need to be demultiplexed and multiplexed back together.

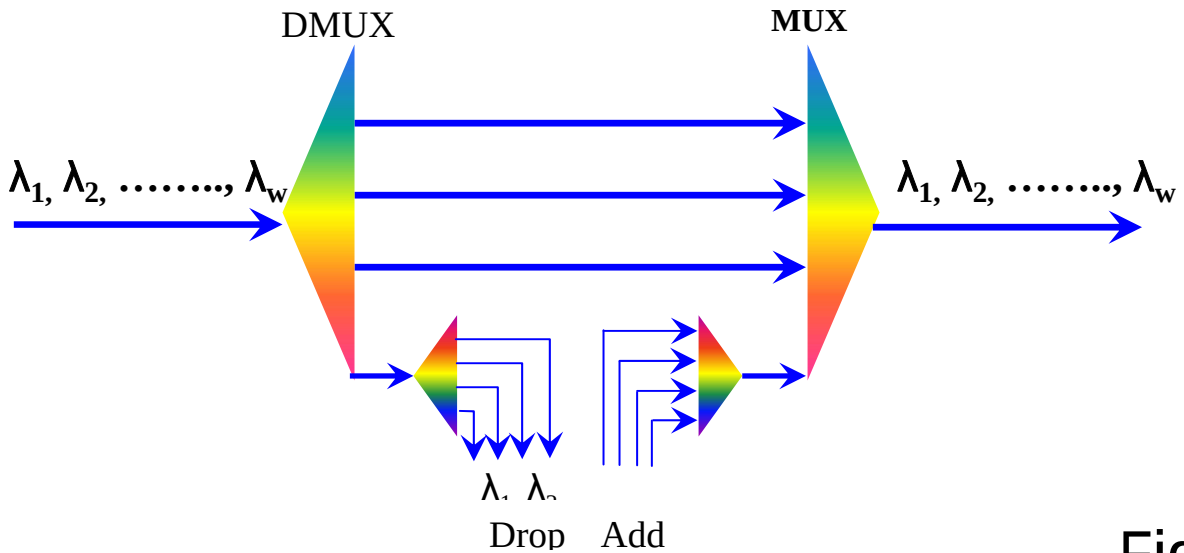
OADM Architectures

- Therefore we need to pay for all the demultiplexing and multiplexing needed for all channels, even if we need to drop only a single channel.
- This also results in incurring a higher loss through the OADM.
- Architecture becomes cost-effective if a large fraction of the total number of channels is to be dropped, or if complete flexibility is desired with respect of adding and dropping any channel.
- The other impact of this architecture is that since all channels are demultiplexed and multiplexed at all the OADMs, each lightpath passes through many filters before reaching its destination.



(a)

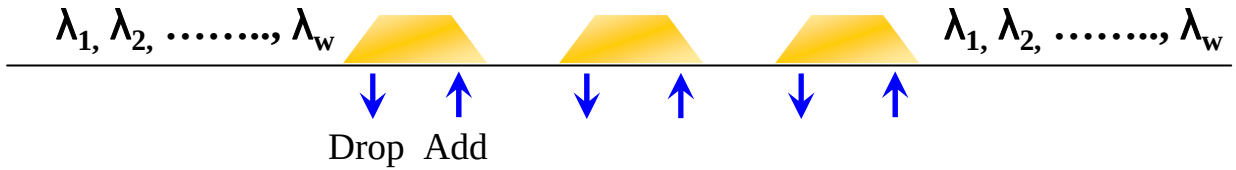
Parallel, where all the wavelengths are separated and multiplexed back



(b)

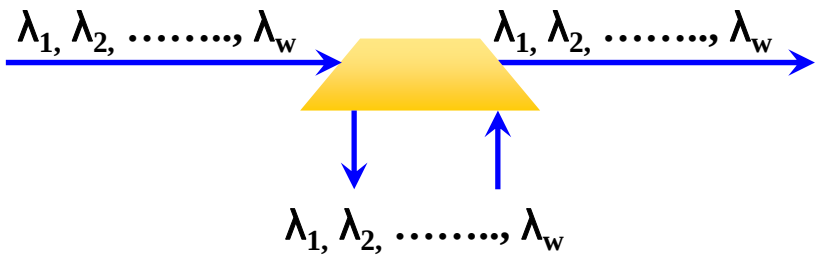
Modular version of the parallel architecture

Fig 7.5



(c)

Serial, where wavelengths are dropped and added one at a time



(d)

Band drop, where a band of wavelengths are dropped and added together.
W denotes the total number of wavelengths

Fig 7.5

OADM Architectures

- As a result, wavelength tolerances on the multiplexers and lasers can be fairly stringent.
- Some cost improvements can be made by making the design modular.
- Multiplexing and demultiplexing is done in two stages.
- The first stage of demultiplexing separates the wavelengths into bands, and the second stage separates the bands into individual channels.
- For example, a 16-channel system might be implemented using four bands, each having 4 channels.

OADM Architectures

- If only 4 channels are to be dropped at a location, the remaining 12 channels can be expressed through at be band level, instead of being demultiplexed down to the individual channel level.
- In addition to the cost savings in the multiplexers and demultiplexers realized, the use of bands allows signals to be passed through with lower optical loss and better loss uniformity.
- Several commercially available OADMs use this approach.

OADM Architectures

- Moreover, as the number of channels becomes large, a modular multistage multiplexing approach becomes essential.
- Parallel OADMs are typically realized using dielectric thin-film filters and arrayed waveguide gratings, and may use interleaver-type filters for large channel counts.
- In the serial architecture, a single channel is dropped and added fro an incoming set of channels.

OADM Architectures

- We call this device a single-channel OADM (SC-OADM).
- These can be realized using fiber Bragg gratings or dielectric thin-film filters.
- In order to drop and add multiple channels, several SC-OADMs ae cascaded.
- This architecture in man ways complements the parallel architecture described above.
- Adding and dropping additional channels disrupts existing channels.
- Therefore it is desirable to plan what set of wavelengths need to get dropped at each location ahead of time to minimize such disruptions.