EE 233. LIGHTWAVE SYSTEMS

Optical Communication Systems Simulation

Guest Instructor
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Outline

- Introduction to optical communication systems simulation
  - Optsim software package by Rsoft Corporation (www.rsoftdesign.com)
- Design
  - Single channel point-to-point optical communication link
  - Single channel passive optical network (PON)
  - Wavelength division multiplexed (WDM) point-to-point optical communication link

Overview

- Design of optical communication systems involves optimizing a large number of parameters
  - transmitters, optical fibers, amplifiers, receivers
  - optical multiplexers, optical demultiplexers, optical filters, optical cross connects, optical add drop multiplexers
- Since mid-90's, computer simulations have been used to realistically model optical communication systems
- Computer-aided design techniques if used appropriately
  - optimize entire system
  - provide optimum values of system parameters
  - Design goals are met with minimal time and cost
- Commercially available design software packages
  - Optiwave, VPITransmission Maker, Optisim

Optsim Simulation Software

- Used to design and optimize
  - DWDM and CWDM amplified systems
  - FTTX/PON systems
  - OTDM systems
  - CATV digital/analog systems
  - optical LANs
  - ultra long-haul terrestrial and submarine systems
  - free space optics (FSO) systems

- Optsim uses block-orientated simulation methodology: optical communication system is represented by an interconnected set blocks

- Each block models a component or subsystem

Optsim Simulation Software

- Each block model is presented graphically as an icon, has own set of parameters which can be modified by user
- Signal data is passed between block models during simulation run
- Each block model is simulated independently of the others based only on signals passed into it and its own set of parameters
- Extensive model library
  - optical sources, optical modulators
  - electrical and optical amplifiers
  - fibers
  - optical receivers
  - optical cross connects, OADM
  - data display tools (spectra, eye diagrams, BER)

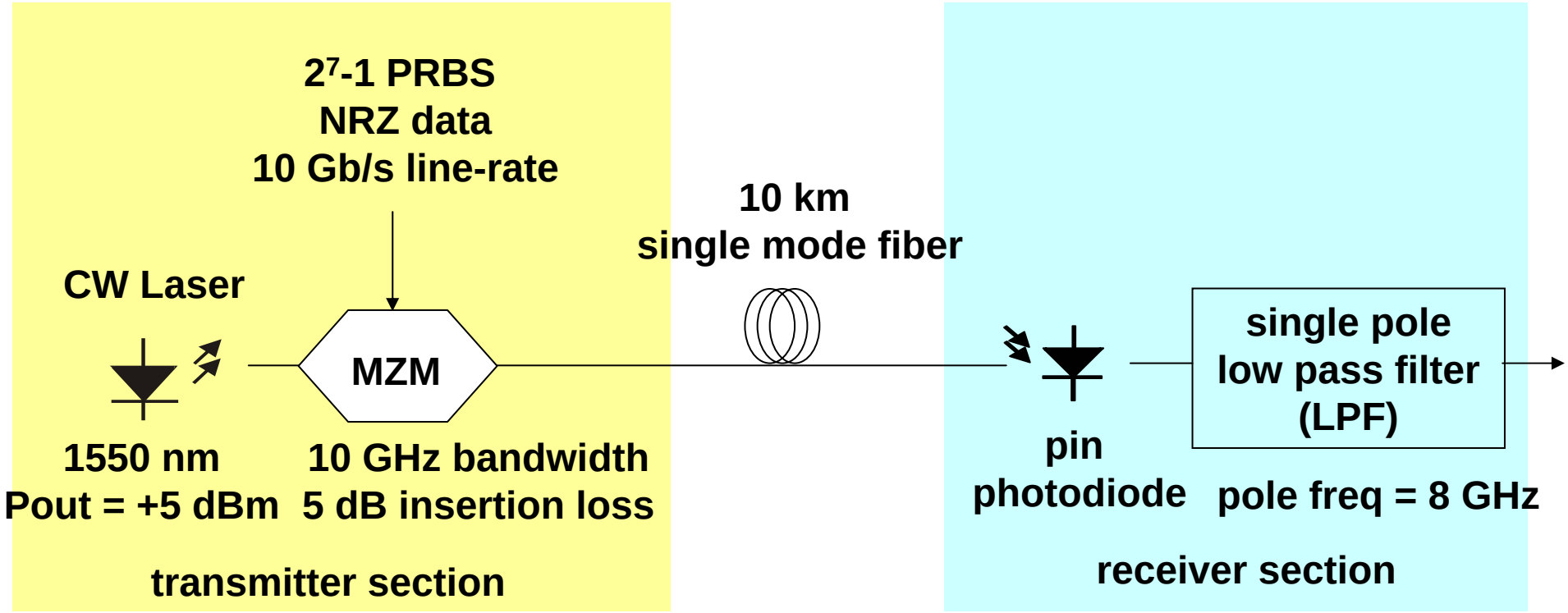
Simulation Approaches

- Optsim supports two simulation engines
- Block mode simulation engine: signal data is represented as one block of data and is passed between block to block
- Sample mode simulation engine: signal data is represented as single samples that is passed between block to block

Simulation Steps

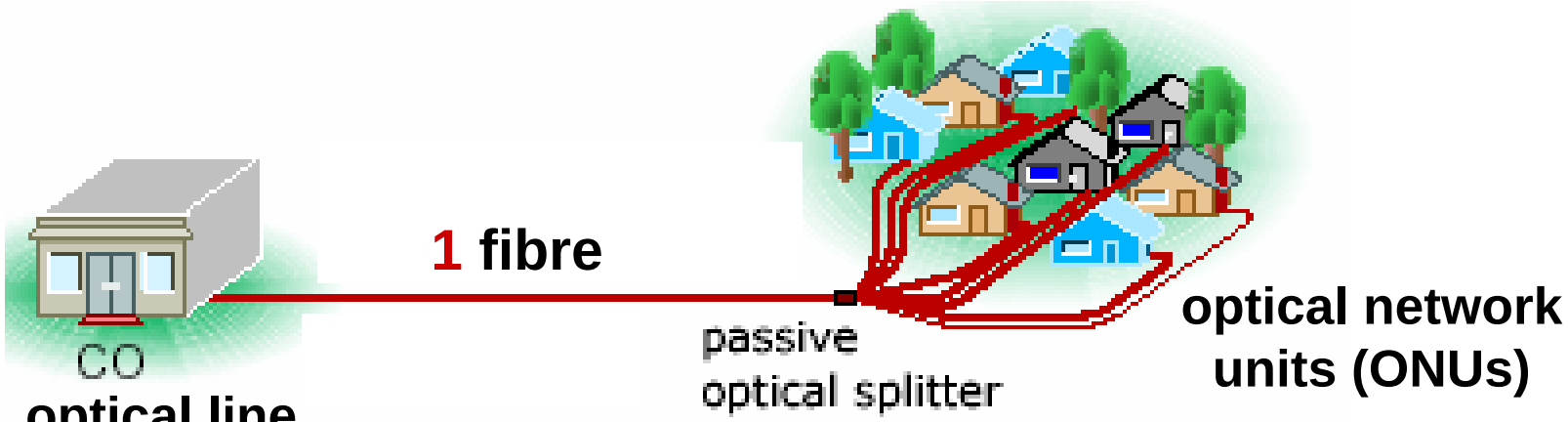
- Four steps to setting up a simulation of a communication systems
  - Create Optsim project and set simulation parameters
  - Draw the schematic diagram, set parameter values of block models
  - Run simulation
  - View results with data display tools

Single Channel Point-to-point Link



- Observe the optical spectrum at output of transmitter
- Measure received optical power
- Observe the electrical signals before and after transmission
- Observe the electrical eye diagrams before and after transmission

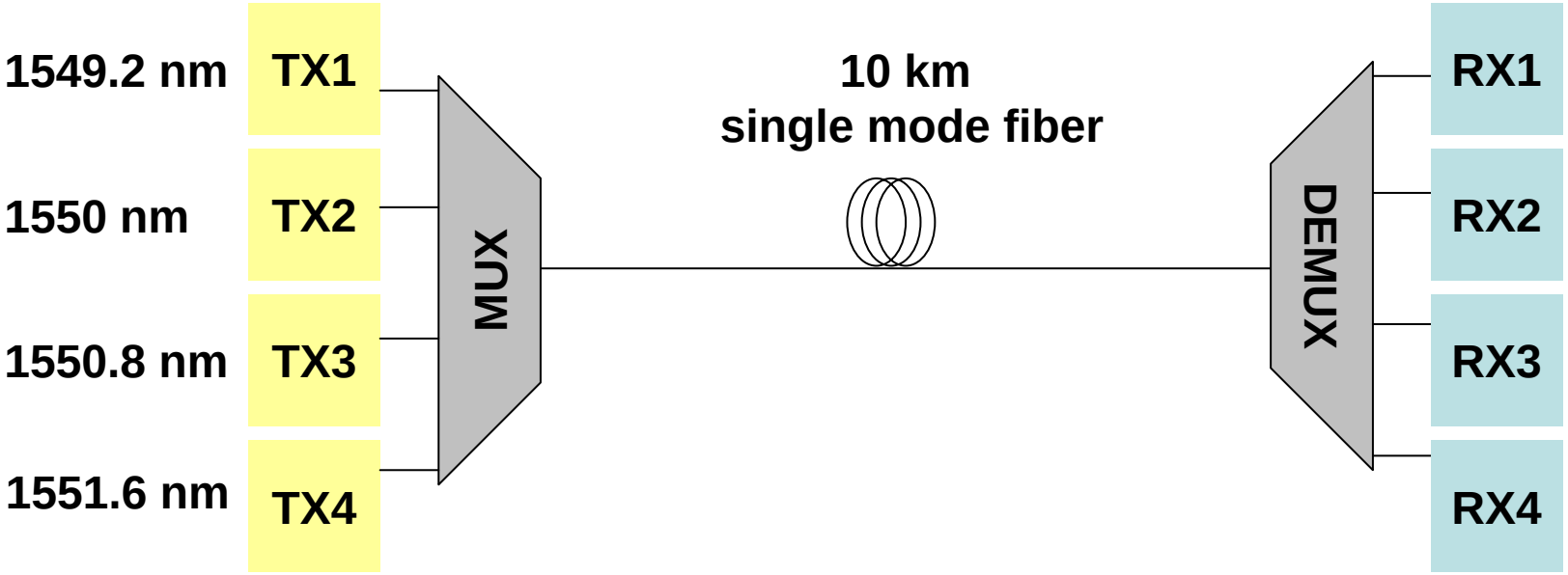
Passive Optical Network



• *www.ieee802.org/3/efm/public/index.html*

- Point-to-multipoint topology
- Fiber plant is typically 20-25 km and unpowered
- May include one or more splitting stages depending on location of ONUs

WDM Point-to-point Link



- 4 channel system, channel spacing 100 GHz (0.8 nm)
- 10 GHz NRZ data with 2^7-1 PRBS pattern length
- Transmitter and receiver modules are identical to those in single channel point-to-point link

Homework Assignment

- This is team assignment (2 persons) and the deadline is 20th of April 2006
- Design a 64 channel WDM system with the following specifications:
  - Channel spacing = 100 GHz (total bandwidth 6.4 THz)
  - Transmission line rate = 10 Gb/s
  - NRZ modulation format, 2^{15}-1 PRBS pattern length
  - Transmission link length = 400 km
- The design goal is to achieve error free transmission (BER < 10-9) for all channels
- Design the transmitter and receiver modules, use of different types and combinations of fibers, location and number of EDFAs deployed are your choice

Homework Assignment (cont.)

- All parameters values must adhere to existing specifications in data sheets which can be found on-line

- Your report (max. 10 pages) must include
  - a printout of the schematic diagram of the system
  - the design methodology in order to achieve error free transmission (BER < 10^{-9}) for all channels
  - printouts of the optical spectra of the multiplexed 64 channels at the 0 km, 200 km and 400 km mark
  - printouts of BER plots (BER vs received optical power) of the four channels, Channel 1, Channel 17, Channel 39 and Channel 64, and their corresponding eye diagrams at BER = 10^{-9}
  - and any additional measurements to support your design methodology