Introduction

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Overview

Course Description

Optical Communication Networks

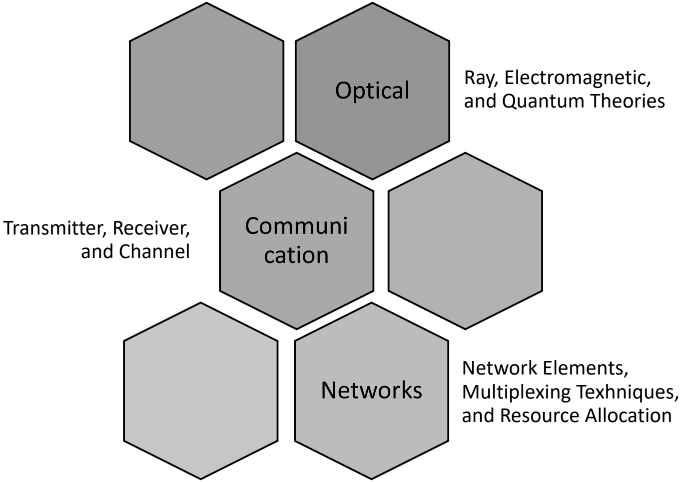

Figure: Puzzle of course title representing the main pillars of optics, communications, and networks.

Optics

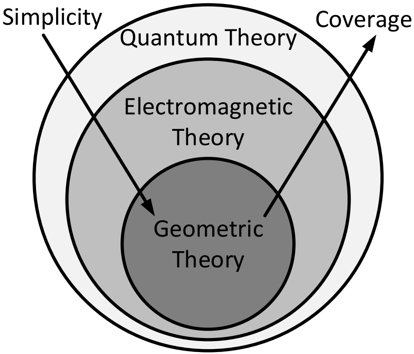

Figure: Coverage-simplicity tradeoff in optical theories.

1. Geometric theory: $\partial \int_A^B n(\mathrm{r}) dl = 0$
2. Electromagnetic theory: $F_{\mu\nu} = \partial_\mu A_\nu - \partial_\nu A_\mu$
3. Quantum theory: $j\hbar \frac{d}{dt} |\Psi(t)\rangle = \widehat{H}\Psi(t)$

Optics

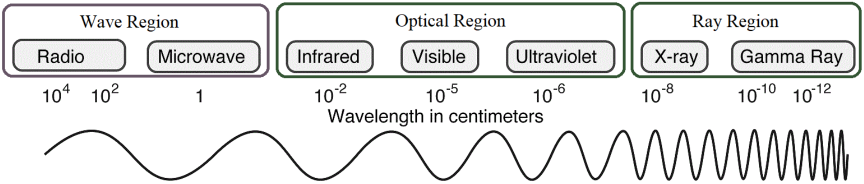

Figure: Electromagnetic spectrum with wave, optical, and ray regions.

- Typical applicability conditions
  1. Geometric theory: $\lambda \ll$ system dimension and $h\nu \ll$ system sesitivity
  2. Electromagnetic theory: $h\nu \ll$ system sesitivity
  3. Quantum theory: Otherwise
- Optical region falls in boundaries of applicability conditions.

Optics

Geometric Optics	Electromagnetic Optics	Quantum Optics
• Particle • Geometry • Deterministic	• Wave • Continuous • Deterministic	• Particle/Wave • Continuous/Discrete • Deterministic/Stochastic

Figure: Comparison of optical theories based on nature, math, and certainty.

- Discrete random process analysis, continuous deterministic differential calculus, and common geometric concepts are widely used in the course.

Communications

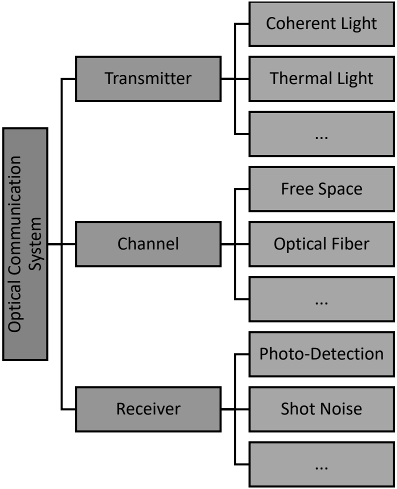

Figure: An optical communication system with its three fundamental blocks transmitter, channel, and receiver. For each fundamental block, two relevant topics are mentioned.

Communications

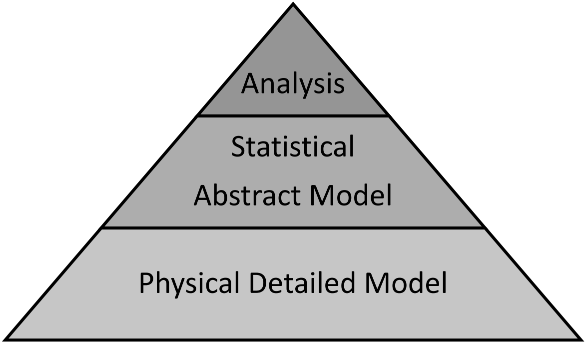

Figure: The course focuses mainly on statistical modeling and performance analysis as well as partially on physical modeling.

- The randomness may originate from information in the transmitter, noise in the channel, stochastic operation in the receiver, etc.

Communications

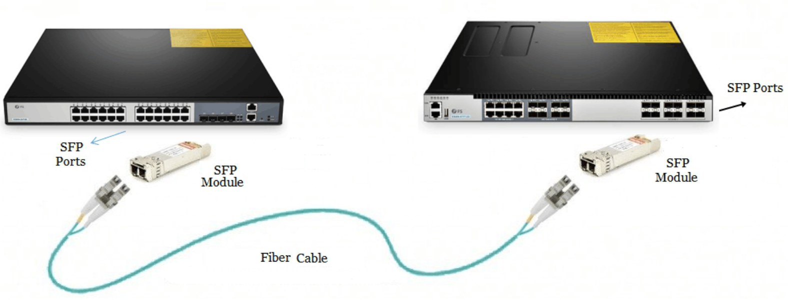

Figure: A typical point-to-point optical communication link with its physical layer interconnection.

Networks

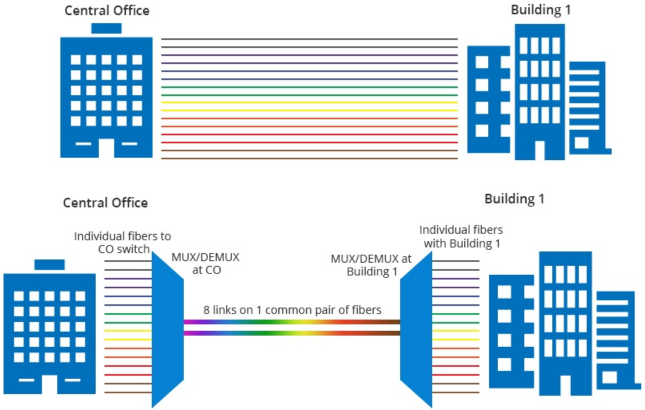

Figure: A simple networking scenario with and without communication multiplexing.

Networks

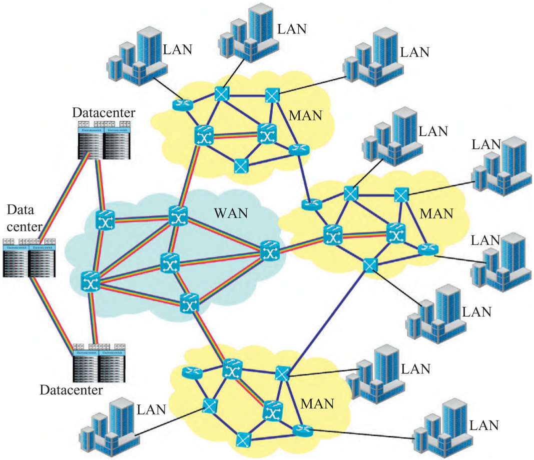

Figure: A typical optical communication network with its physical layer interconnections.

Networks

Figure: A typical optical communication network with its physical layer interconnections.

Networks

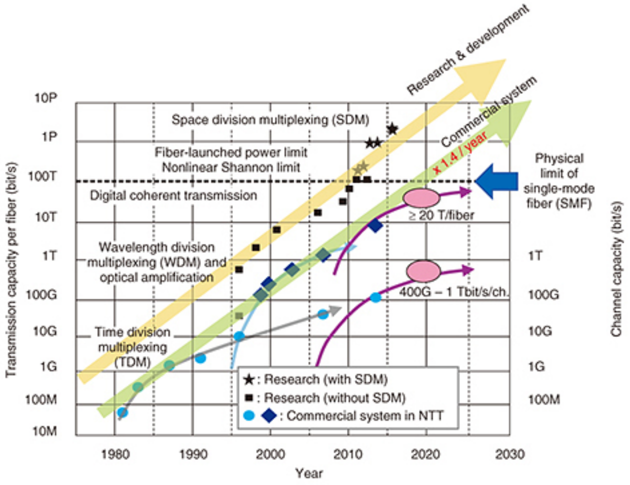

Figure: Optical capacity evolution using various multiplexing techniques.

Networks

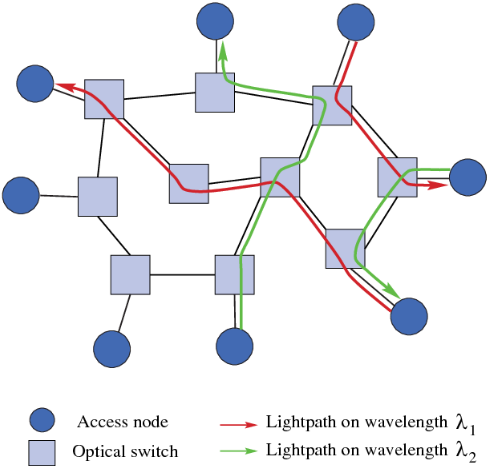

Figure: A sample resource allocation scenario.

Networks

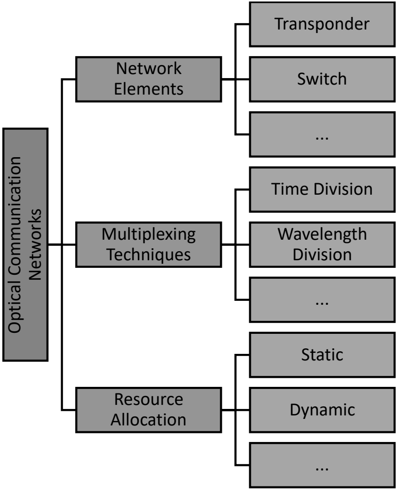

Figure: An optical communication network with its three fundamental concepts network elements, multiplexing technique, and resource allocation. For each fundamental concept, two relevant topics are mentioned.

Course Requirements

Requirements

1. Basic Knowledge
   - Communications
   - Networks
   - Optics
2. Mathematical Tools
   - Differential Equations
   - Random Processes
   - Mathematical Optimization
   - Classical Geometry
   - Vector Analysis
3. Simulation Tools
   - MATLAB
   - YALMIP
   - Pyomo
   - OptiSystem

Course Resources

Resources

1. Online teaching class on Sundays and Tuesdays, 15:00-16:30 at https://vc.sharif.edu/ch/mohammad.hadi
2. Online practicing class on ???, ???-??? at https://vc.sharif.edu/ch/mohammad.hadi
3. Course website at http://cw.sharif.edu
4. Telegram channel at https://t.me/+8TNlU6Ir_X81Zjg0
5. Telegram group at https://t.me/+MZrtsfPomqgyNzQ0
6. Personal email to mohammad.hadi@sharif.edu
7. Telegram message to @MohammadHadiDastgerdi

Course Contents

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Course Assessment

Assessments

Item	Frequency	Contribution	Bonus
Work Assignments	5	20%	✓
Midterm Exam	1	25%	✗
Final Exam	1	30%	✗
Oral Exam	1	10%	✗
Software Project	1	10%	✓
Class Attendance	25	5%	✗

Table: Items involved in the course assessment. The specified contribution weights are tentative.

Course References

References

R. Gagliardi and Sh. Karp (1995)
Optical Communications
John Wiley & Sons

Joseph W. Goodman (2015)
Statistical Optics
John Wiley & Sons

Bahaa E. Saleh and Carl E. Malvin (2019)
Fundamentals of Photonics
John Wiley & Sons

R. Hui (2019)
Introduction to Fiber-Optic Communications
Academic Press

J. Simmons (2014)
Optical Network Design and Planning
Springer

The End