Digital Communications Laboratory

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Chapter Four

Principles of Digital Data Reception

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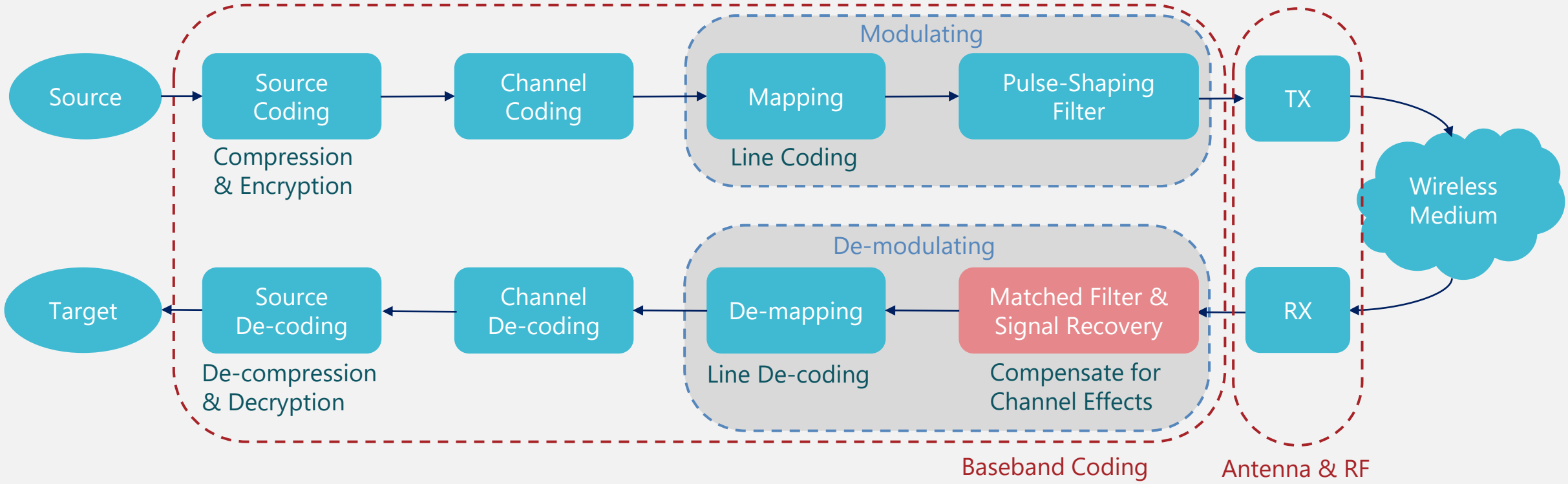
Section A

Linear Modulation Schemes

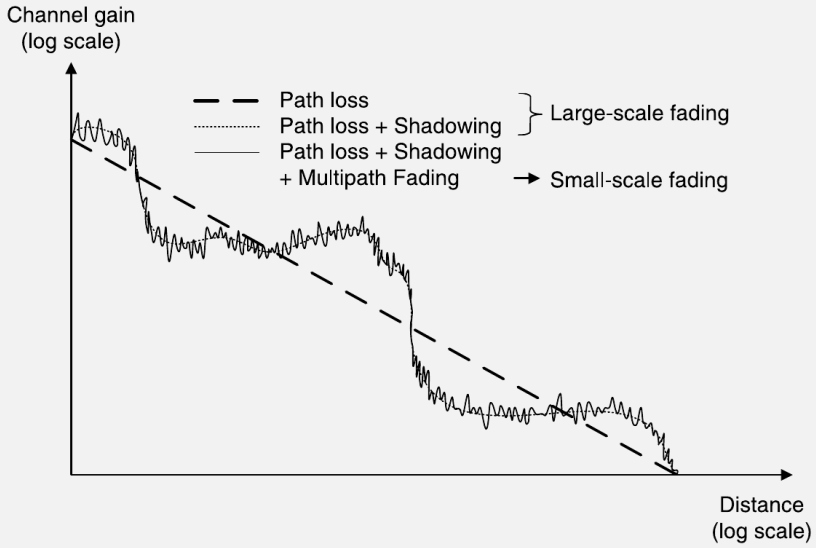
Wireless Digital Communications



Wireless Channel Impairments

What can we do to compensate for the impairments?

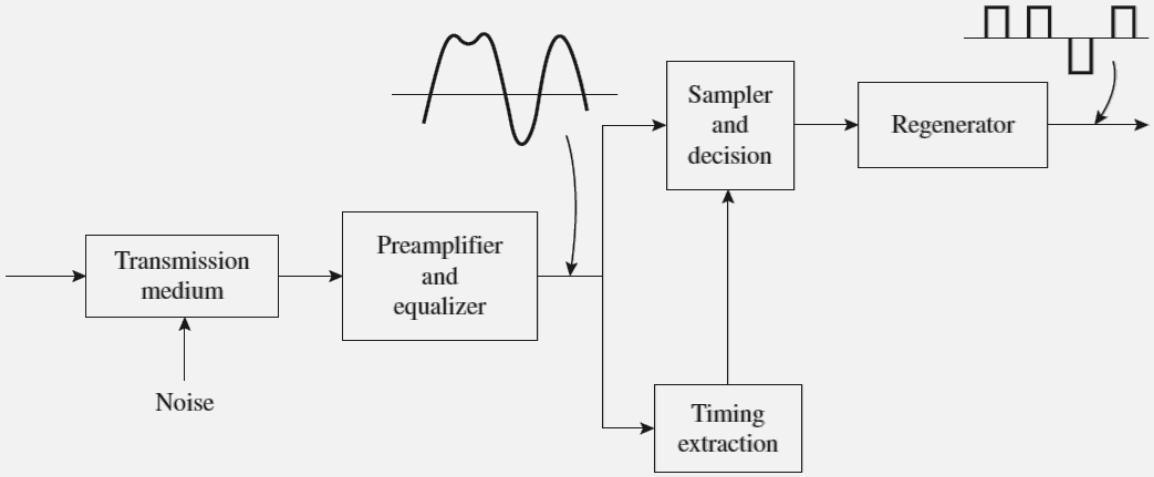
Impairment	Solution
Noise	LNA
Interference	DSSS & FH
Large-scale fading (path-loss and shadowing)	Preamplifier
Small-scale fading (multi-path, scattering, and doppler)	Equalizer
Timing offset	Synchronizer
Phase offset	Costas loop & DPLL
Frequency offset	



Equalization

The main idea of using an equalizer is to combat the ISI and suppress the channel noise!

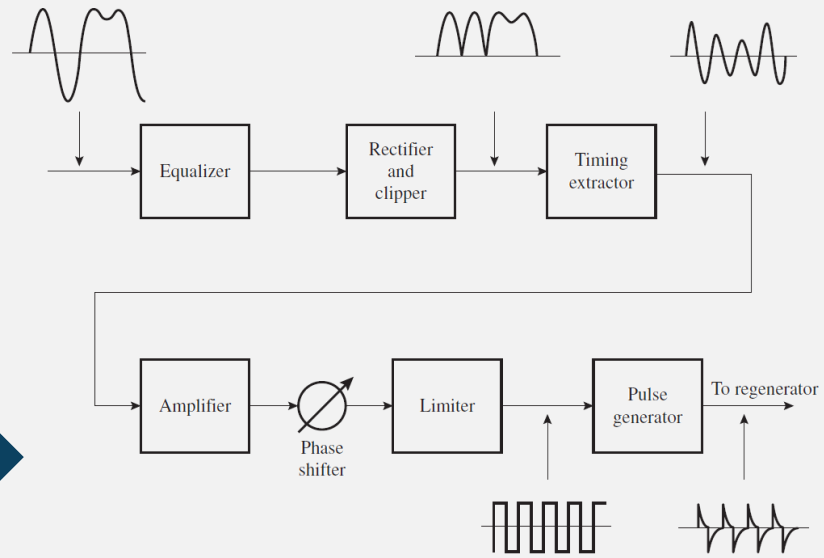
No	Equalization technique
1	Adaptive
2	Zero-forcing
3	Minimum MSE
4	Zero-forcing with successive interference cancellation
5	Successive interference cancellation using optimal ordering



Symbol-Timing Extraction

The main idea is to obtain precise clock cycle and recover the received data!

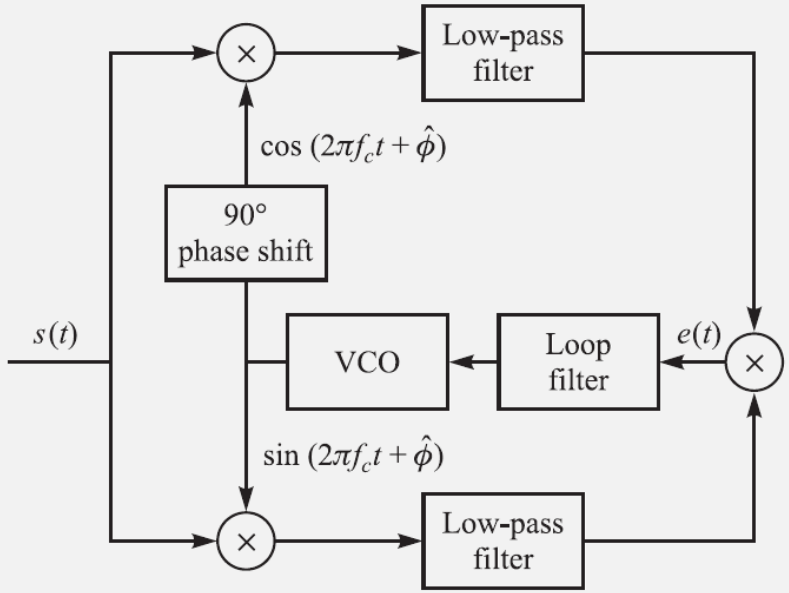
No	Equalization technique	Usage
1	Master timing source (e.g. GPS)	Large-scale and high data rates (LTE)
2	Separate synchronization pilot	Excessive BW and power
3	Self-synchronization	For any system



Carrier Phase-Detection

The main idea is to carrier phase recovery!

No	Equalization technique
1	Squaring loop
2	Costas loop
3	Digital PLL



Section C

GNU Radio and SDR

GRC Example for 4-QAM

Preferred GRC Blocks:

Transmitter	Wireless Channel	Receiver
Wav. file source	AWGN	Polyphase Clock Sync
Signal source		Equalizer
Low Pass Filter		Costas Loop
Packet Encoder		QAM Demodulator
QAM Modulator		Band Pass Filter
Throttle		Time sink
Time sink		Frequency sink
Frequency sink		Constellation sink
Constellation sink		

Note: You may need other essential blocks.

Assignments

Session Six

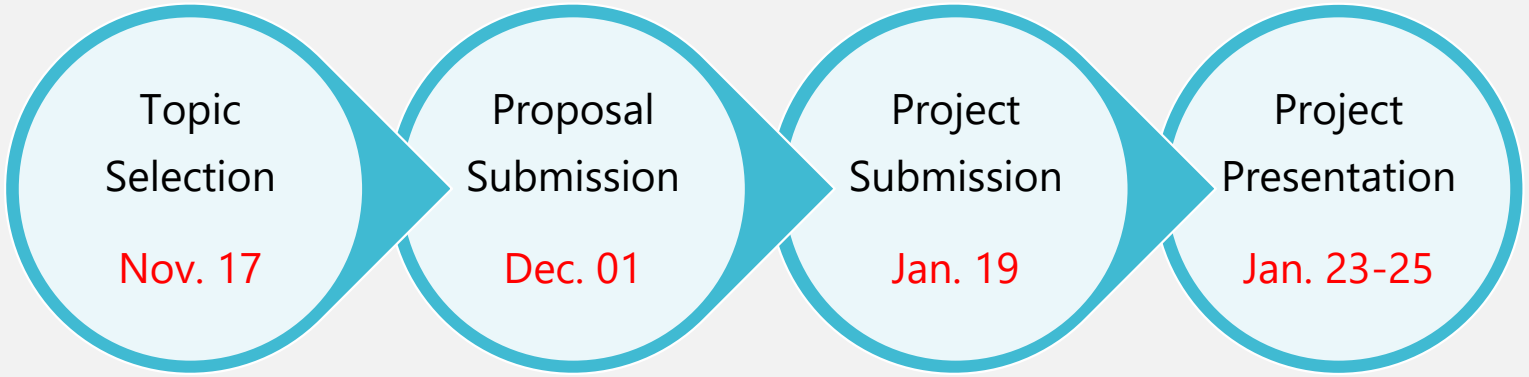
Problem:

Design a transceiver based on 8PSK modulation/demodulation via GNU Radio.

Due: Nov. 10, 2020

Term Project

Timeline:



Project Topic:

Any practical project in telecommunication that can be deployed via GNU Radio and SDR, including

- Satellite (e.g. Cubesat) networks
- Internet of things (IoT)
- Wireless sensor network (WSN)
- Vehicle to vehicle (V2V) communications
- Smart house & smart city