

# **Principles of Communications**

## **(通信系统原理)**

### **Undergraduate Course**

## **Communications System Project**

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# Communications System Project

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# Communications System Project

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# Motivation

- We want to review the most important concepts of the course and glue them together into a fully functional system
- In order to make it easier we will restrict the contents to digital base-band simulations and a simple additive noise channel
- Starting from an *continuous analog* signal, we will design the whole transmitter and receiver chains
- We will evaluate the performance of the receiver for different values of added noise

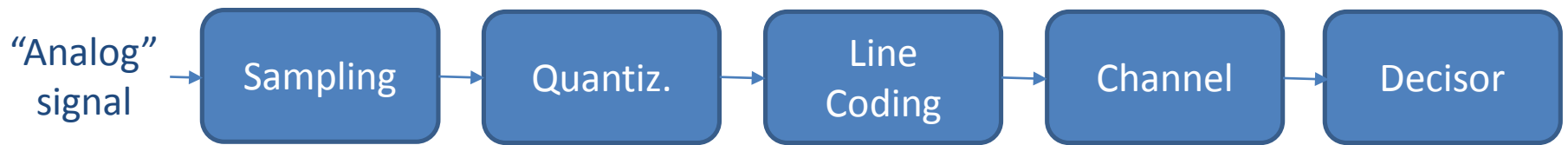
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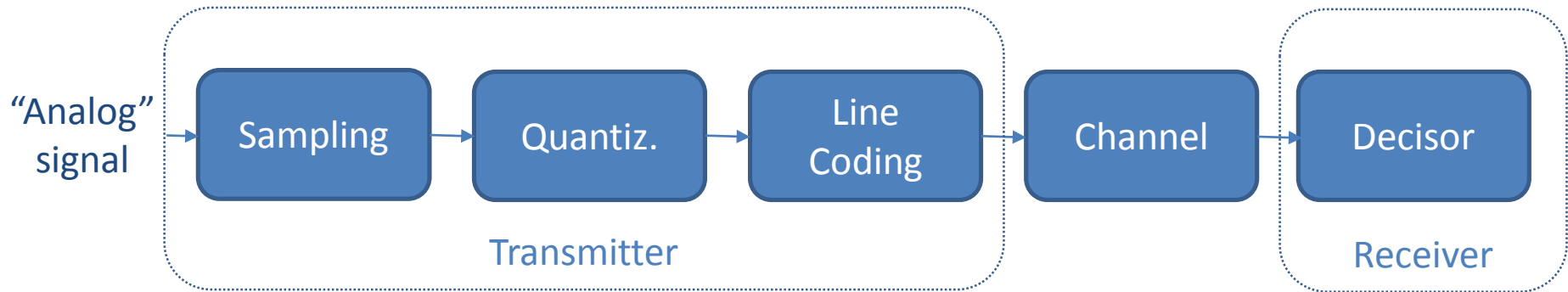
# The Project

## What do we want



# The Project

## What do we want



# The Project

## What do we have

“Analog”  
signal →



- 我会为你提供一个连续的模拟信号
- 由于信号保存在数字文件中，所以实际上不可能是连续和模拟的
- 我们将考虑非常高的采样频率和非常多的量化电平，使信号可以被认为是连续的和模拟的
- 信号的原始参数：
  - 高采样频率（已知）
  - 量化水平数：可以认为它们是无限的（浮点表示）

“模拟”信号 →

# The Project

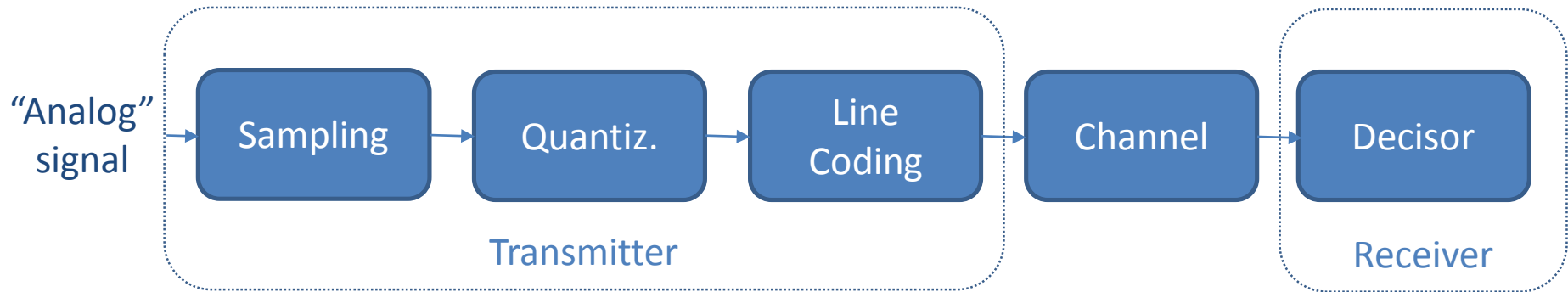
## What do we have

- I will provide you with an *continuous analog* signal
- Since the signal is saved into a digital file, it cannot actually be continuous and analog
- We will consider very high sampling frequency and a very large number of quantization levels, so that the signal can be considered *continuous and analog*
- Original parameters of the signal:
  - High sampling frequency (known)
  - Number of quantization levels: you can consider them infinite (floating-point representation)

“Analog”  
signal →

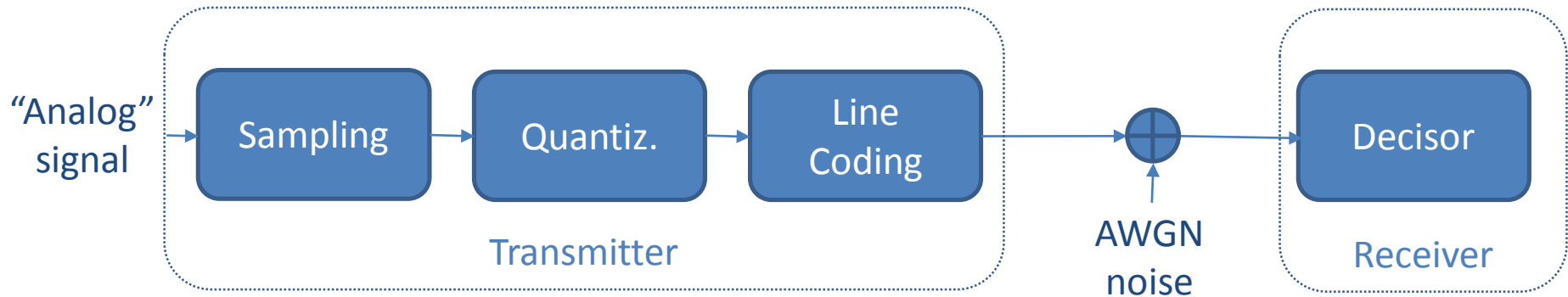
# The Project

## What do we want in detail



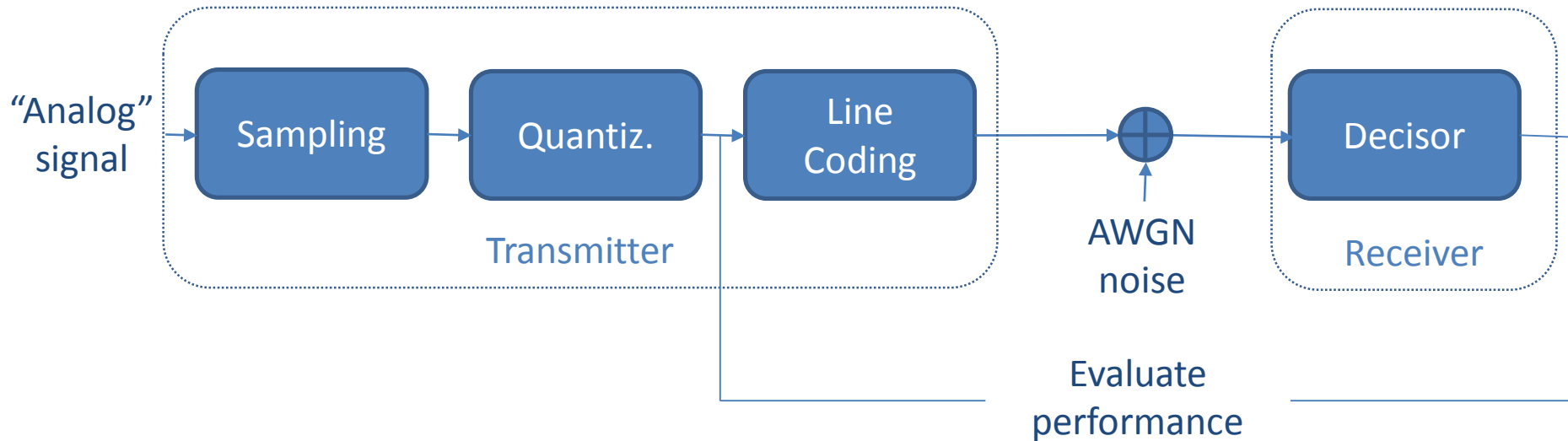
# The Project

## What do we want in detail



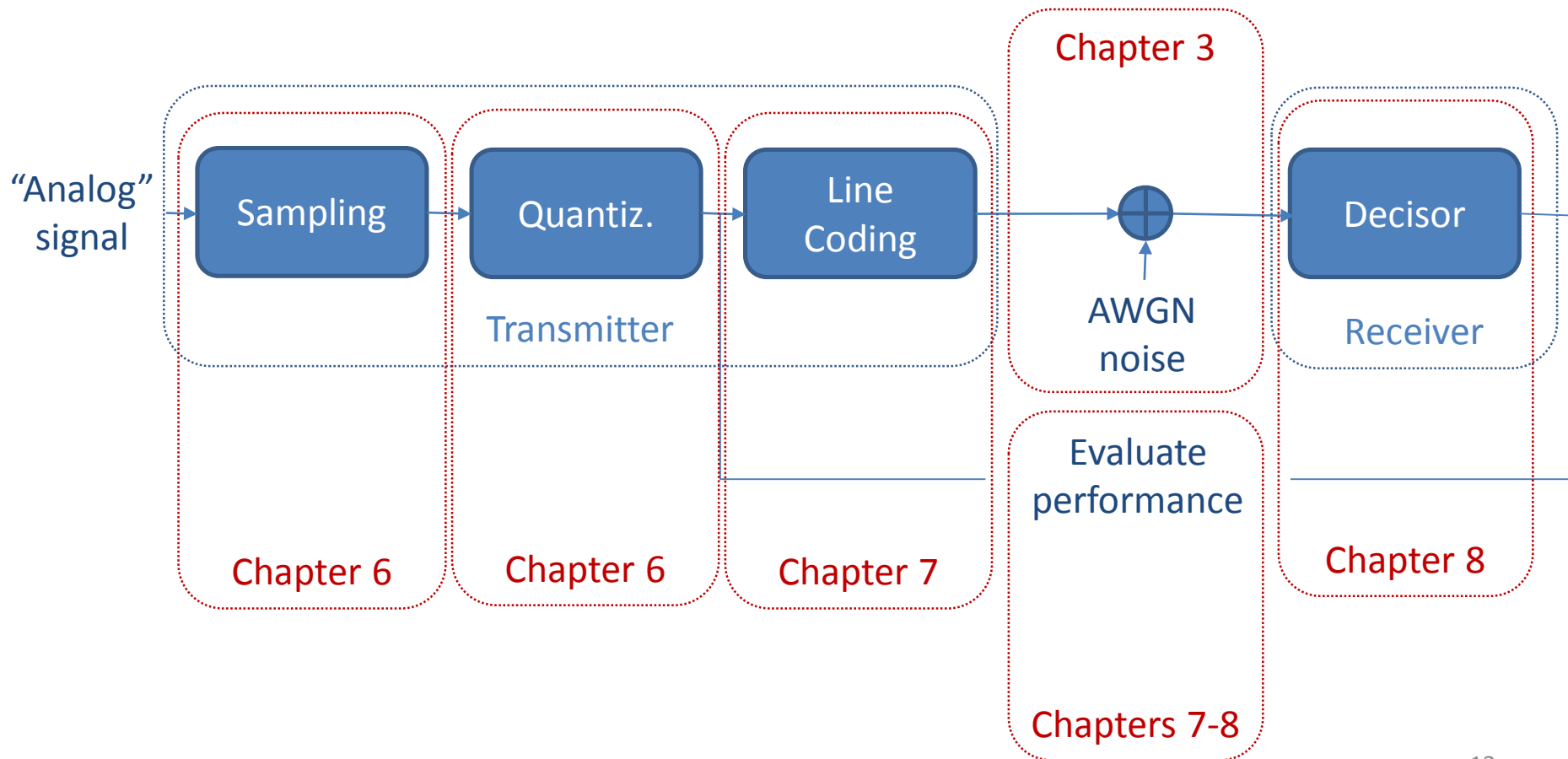
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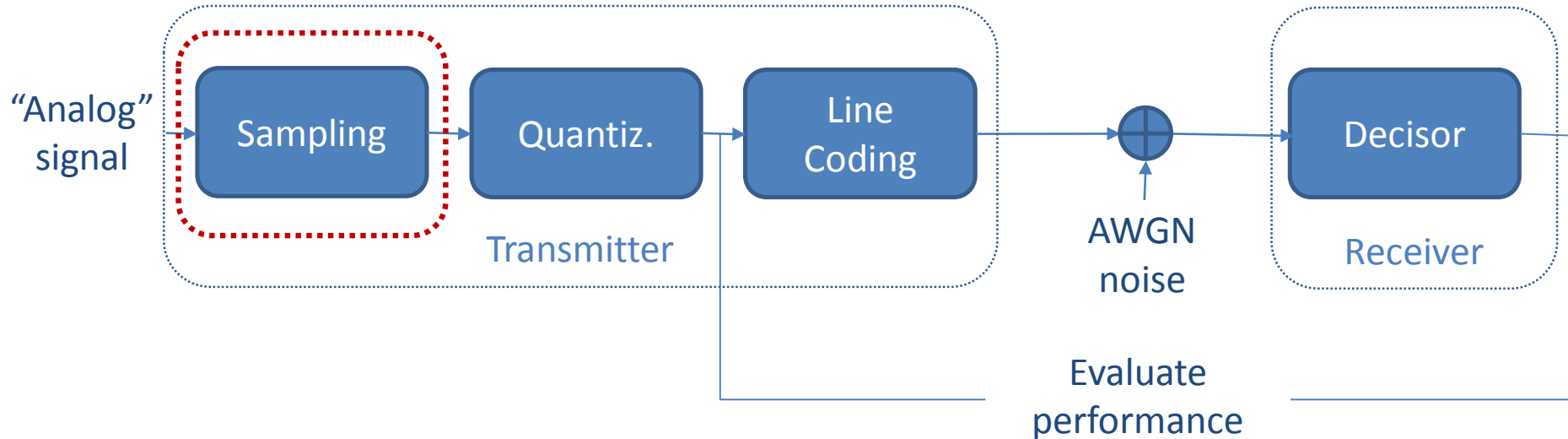
# The Project

## Where to find the information



# The Project

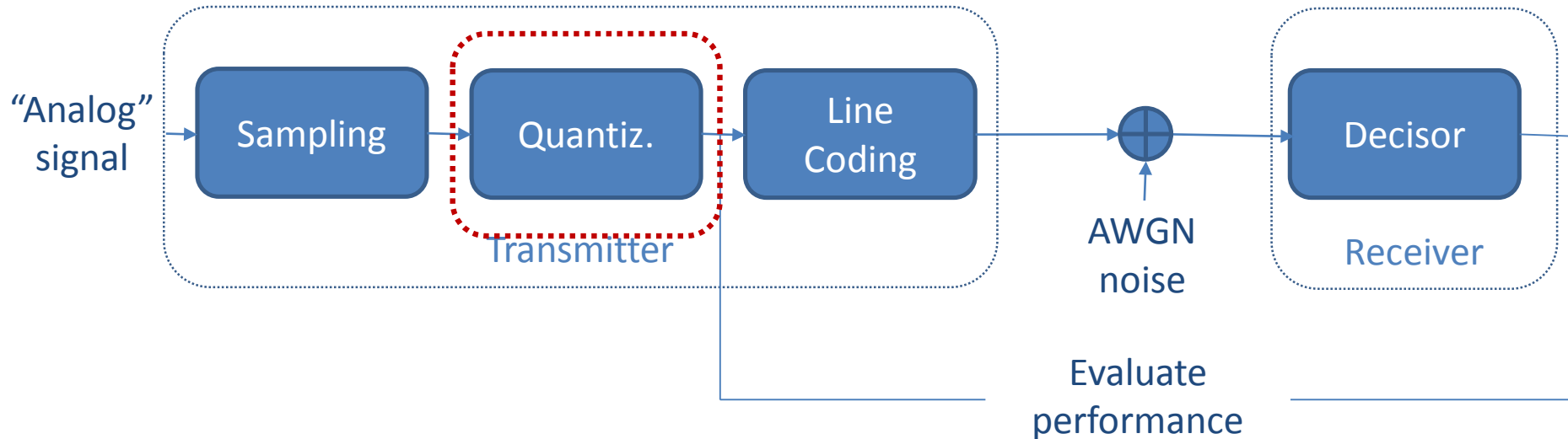
What do we want in more detail



- Determine sampling frequency
- Check with different sampling frequencies and evaluate the presence of “aliasing”

# The Project

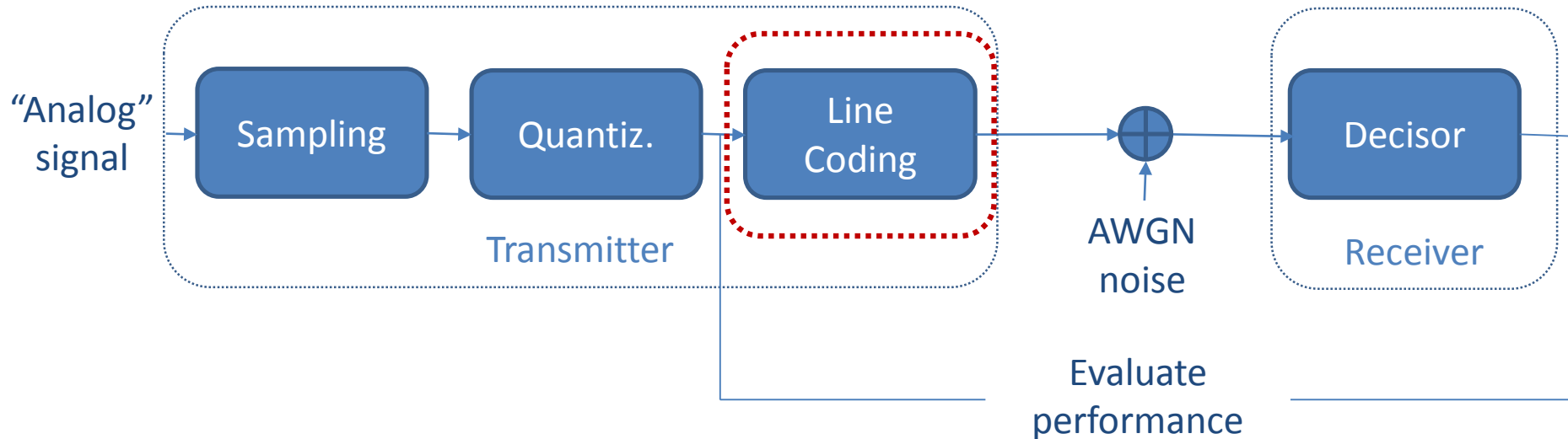
What do we want in more detail



- Choose quantizer (quantization steps, number of quantization levels...)
- Evaluate quantization error

# The Project

What do we want in more detail

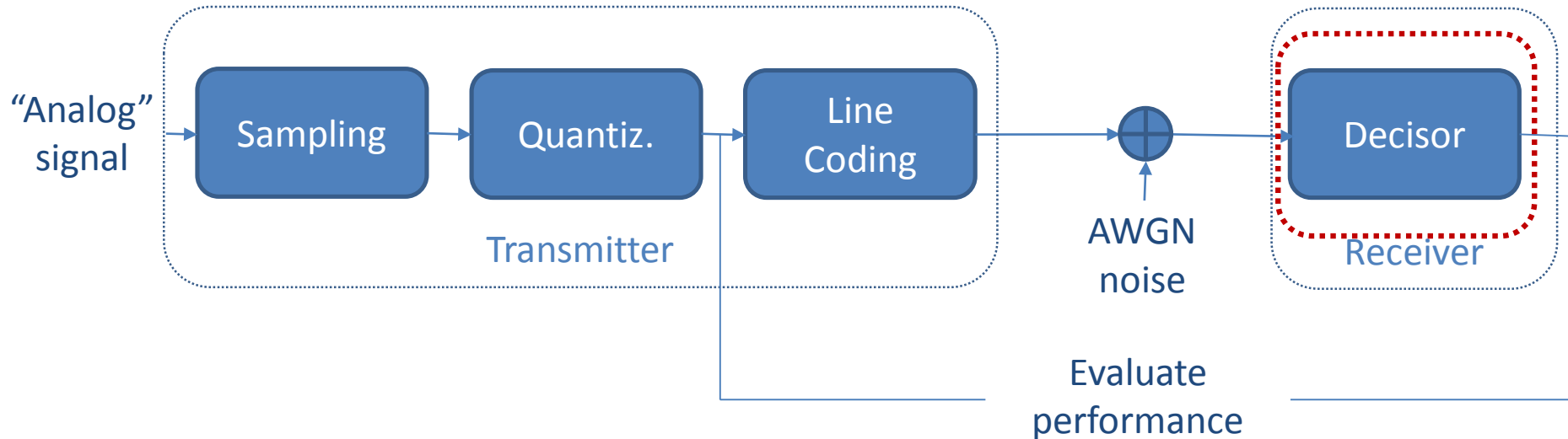


- Choose proper multi-level line coding scheme
- Estimate SER and BER



# The Project

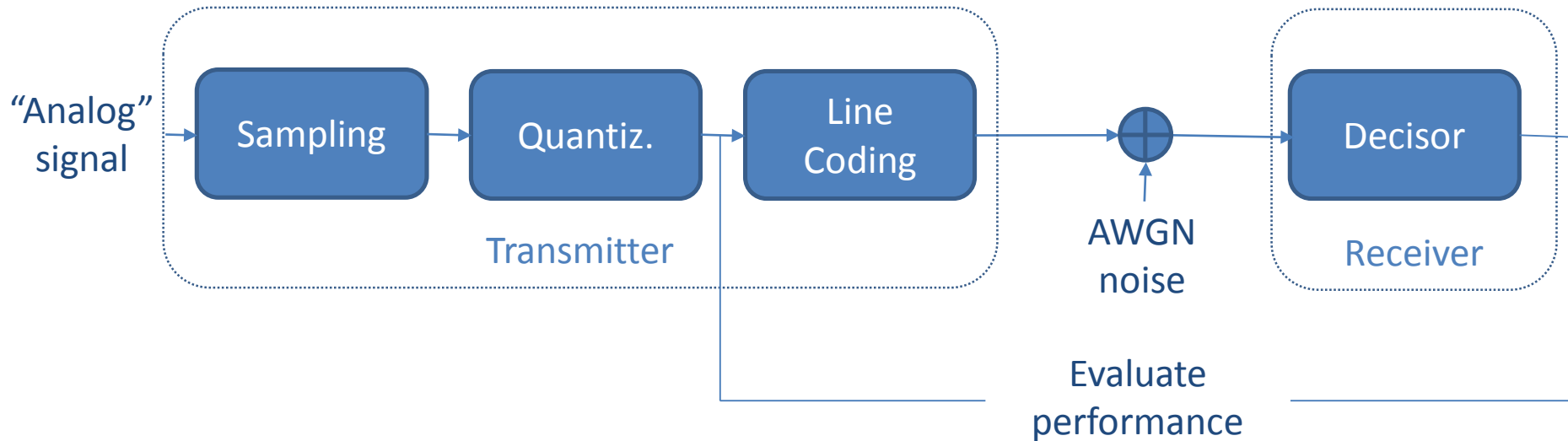
What do we want in more detail



- Choose an appropriate decision criterion
- Evaluate performance for different SNR values

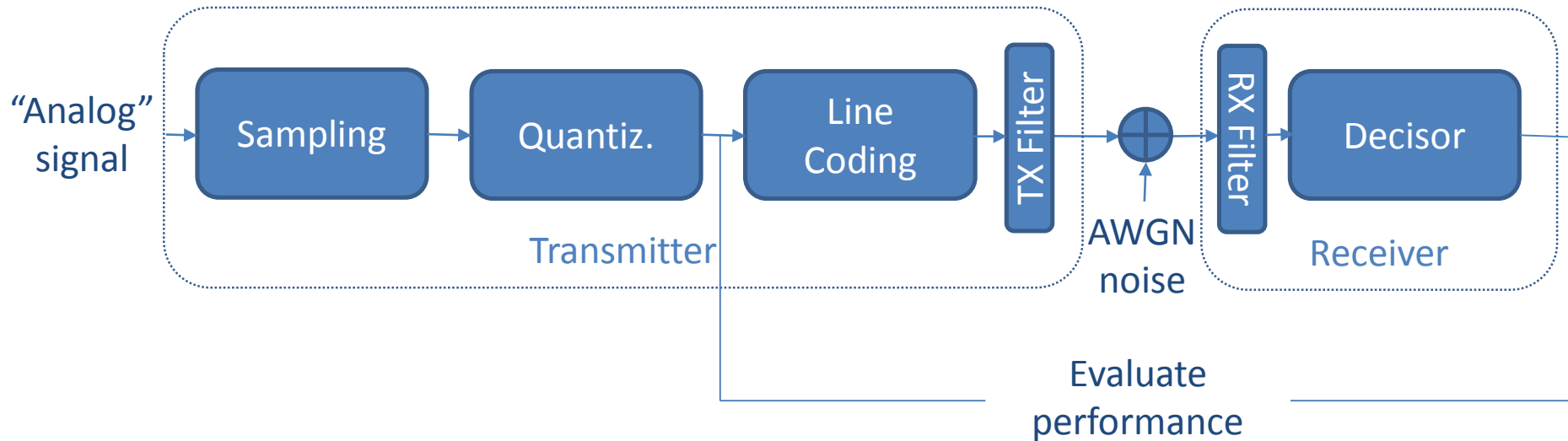
# The Project

## If you still want more



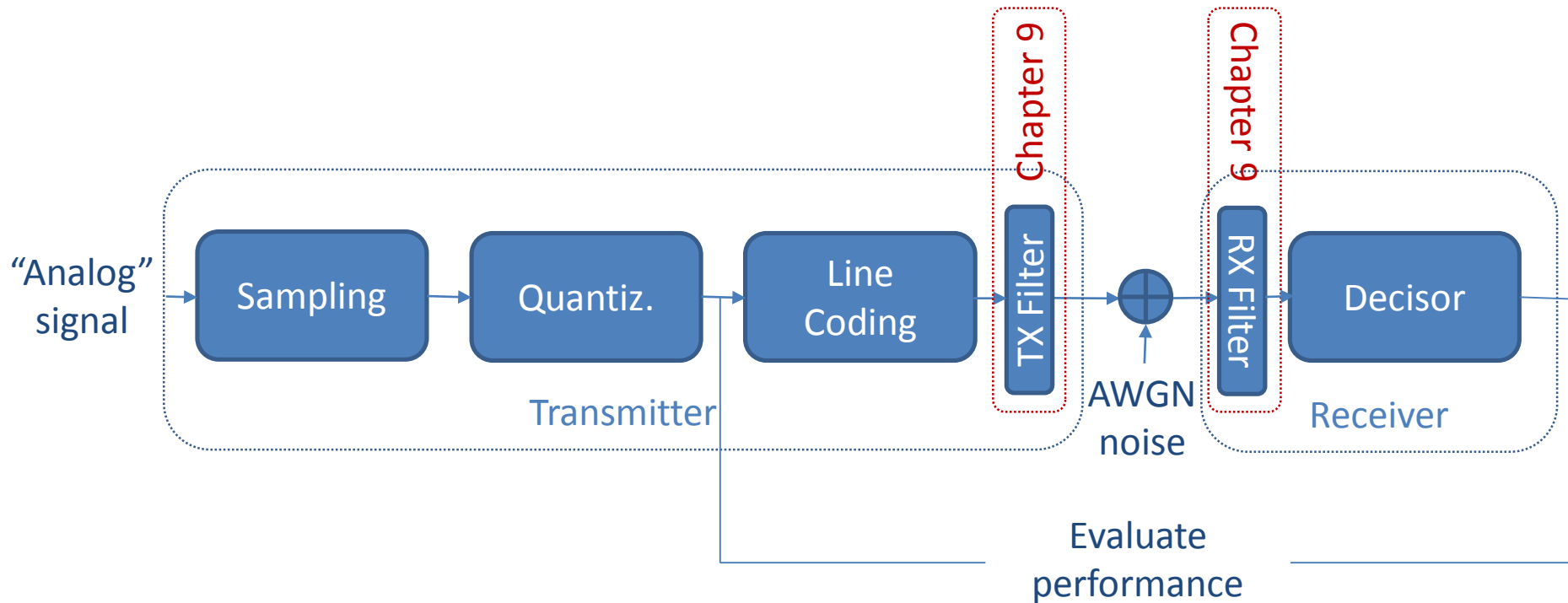
# The Project

## If you still want more



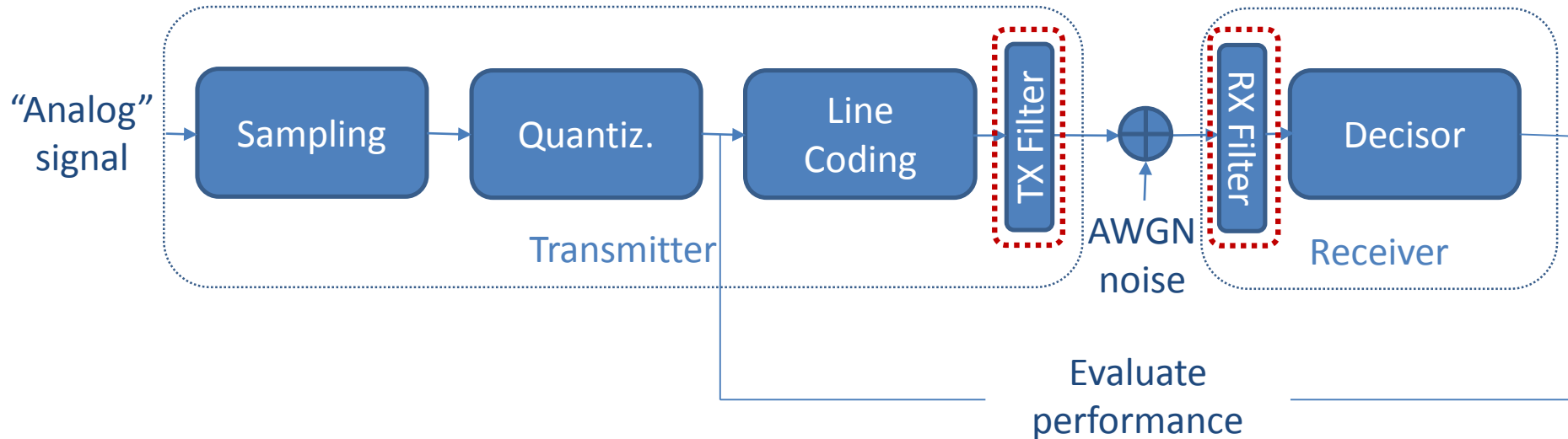
# The Project

## If you still want more



# The Project

## If you still want more



- Evaluate the original bandwidth
- Propose a pair of TX and RX filters
- Evaluate the resulting bandwidth and performance

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# Practical Data

## Expected results

- Based on the contents learned, you are expected to reasonably develop a whole transmitter-receiver chain and evaluate its overall performance
- The final expected result will be a report with the obtained implementation and results, explaining how it was obtained and the reasons why the different decisions were made
  - *We can have certain flexibility on this...*
- The report should be accompanied by all the code and any other resource used to obtain the results
- A personal interview with me will be required for each of you. In such interview you will need to reason how the results were obtained and answer some simple questions related with the obtained results
- The interview is more a continuation of the learning process than an evaluation: I will explain the concepts that are unclear and you can still gain knowledge with it, which is the final goal of the whole project

# Practical Data

## Important dates

- The project should be finalized at least one week before the last lecture of the course
  - *We can have certain flexibility on this...*
- Depending on the general evolution of your work in the project, we will decide if to remove some parts of it



# Practical Data

## Recommended path to follow

1. Review the related theoretical concepts
2. Study the format of the provided data
3. Based on the theoretical concepts, reason what kind of implementation or design decisions should be taken for each individual step
4. Analyze and reason the obtained results for each step
5. When everything is complete, check the overall results and try to reason them
6. Prepare the report and required documentation

... and, during all the steps, contact me anytime if you have any doubt or if you want to discuss your ideas before applying them

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# Practical Data Evaluation

1. **Quality is more important than quantity:** I will not value the work depending on how long the report is
2. **How to get the results is more important than the results themselves:** Even if the results are not totally correct, the reasoning regarding how they have been obtained and the discussion about them will concentrate most of the value of the work

# Practical Data Evaluation

- 3. Learning how to use the tools and understanding the concepts is the key:** The only important thing in this course is that you understand the concepts and get to know how to apply them. If you show me that you can do this, you do not need to worry about your mark
- This does not mean to repeat the same sentences and reasonings as the rest of your classmates. Not a single conclusion or result could be valid, several of them could be possible. Do not learn sentences or recipes, just understand what you have done

# Practical Data Evaluation

- 4. Notes on cheating:** I am perfectly fine with that you cooperate or comment aspects together with your classmates; this is not cheating. However, you will need to understand all the aspects of the work you perform. I recommend that, even though you discuss some methods or results, try to still keep your own work independent from others
- I am not a person really worried about students telling lies to me, but keep in mind that if you lie to me you are actually telling lies to yourself and, as a result, you will not learn the concepts of the course

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