

Probability and Random Processes

ECS 315

Asst. Prof. Dr. Prapun Suksompong

prapun@siit.tu.ac.th

6.3 Bernoulli Trials



Office Hours:

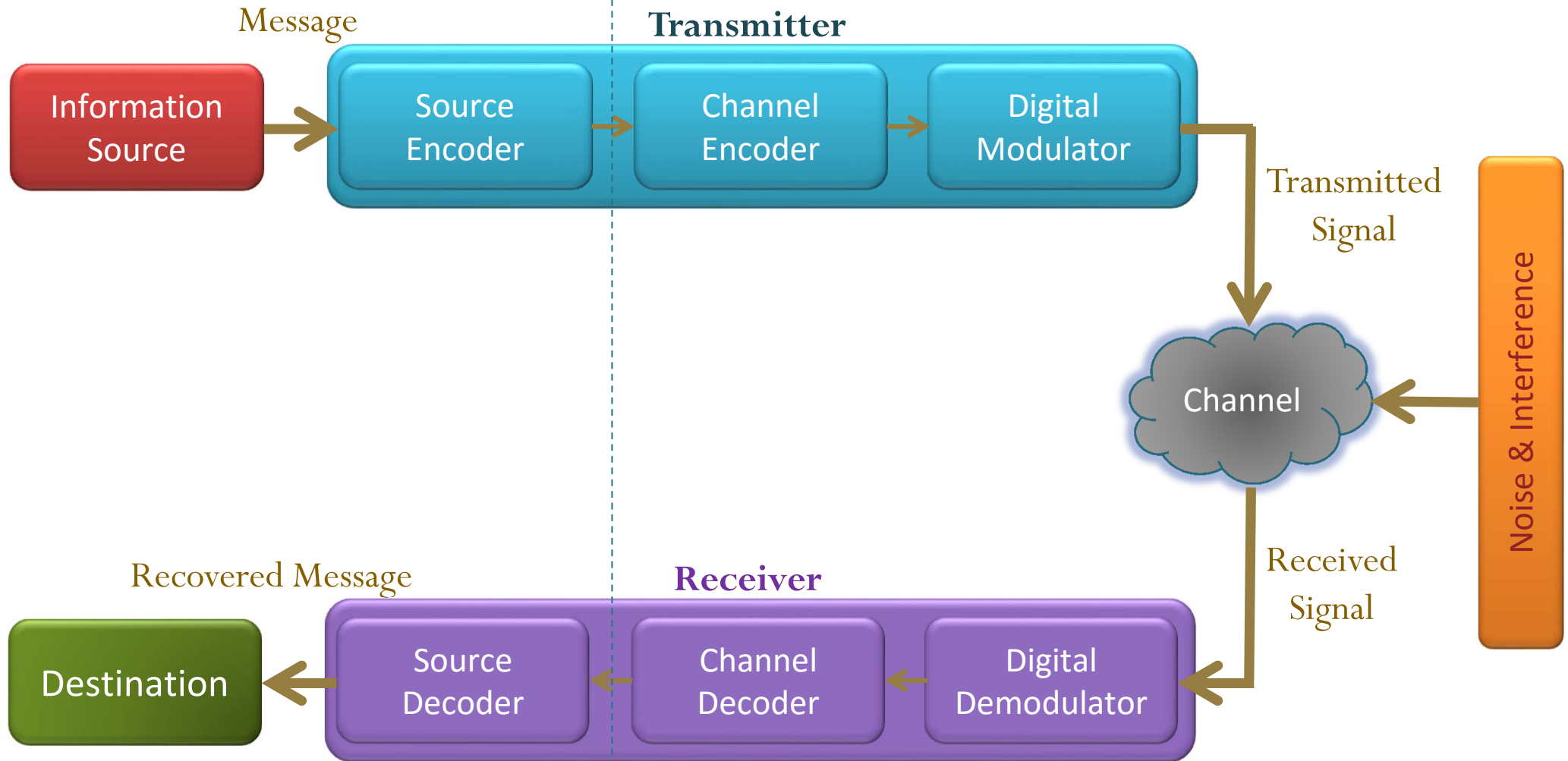
BKD, 6th floor of Sirindhralai building

Tuesday **9:00-10:00**

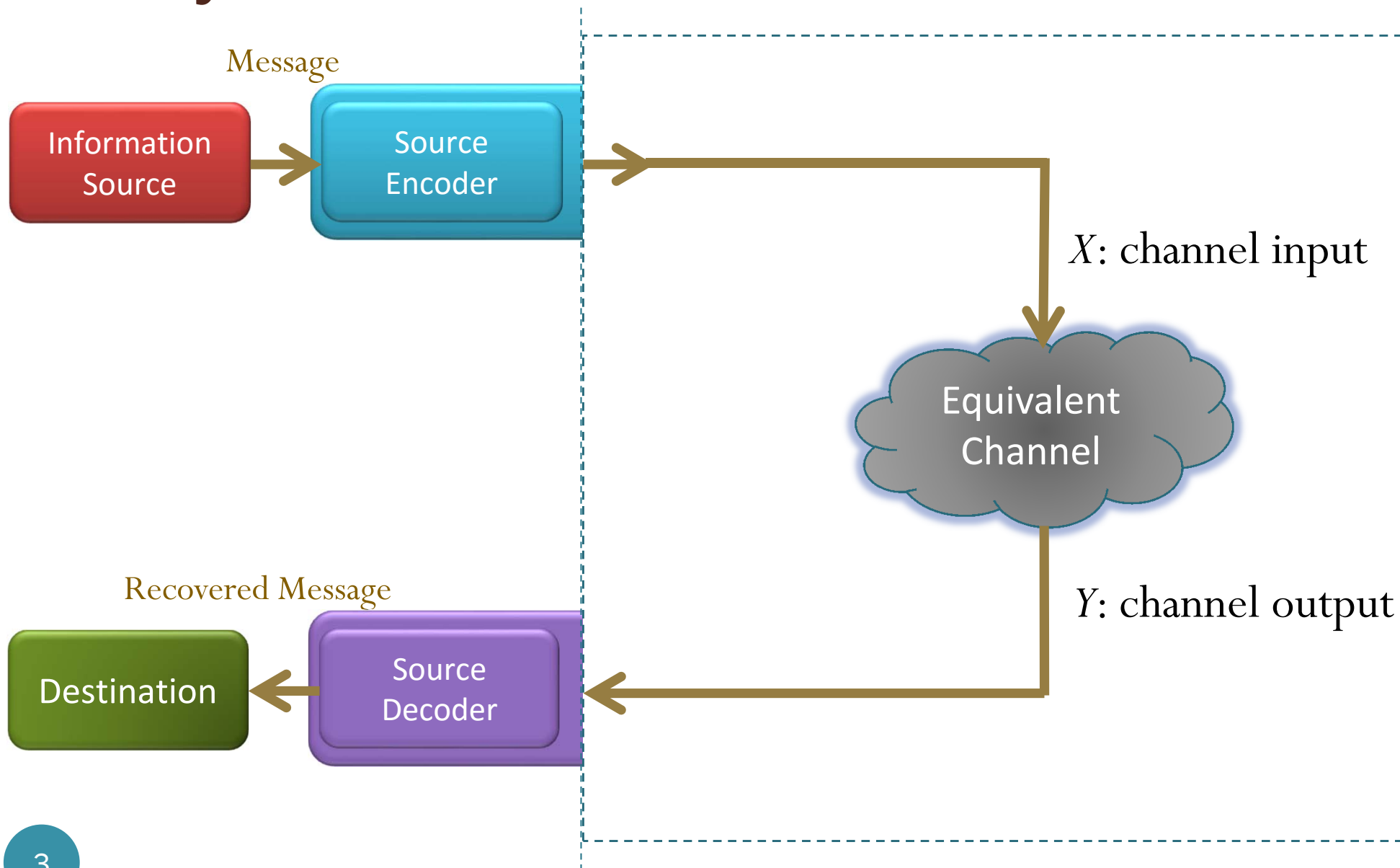
Wednesday **14:20-15:20**

Thursday **9:00-10:00**

Elements of digital commu. sys.



System considered



The ASCII Coded Character Set

| | | | | 6 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | | | | | | | |
|---------------|---|---|---|-----|---|-----|----|-----|----|----|----|---|----|---|----|---|----|-----|-----|
| <i>Bit</i> | | | | 5 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | | | | | | | |
| <i>Number</i> | | | | 4 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | | | | | | | |
| | | | | 1st | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | | | | | | | |
| 3 | 2 | 1 | 0 | Hex | | | | | | | | | | | | | | | |
| | | | | 2nd | | | | | | | | | | | | | | | |
| 0 | 0 | 0 | 0 | 0 | 0 | NUL | 16 | DLE | 32 | SP | 48 | 0 | 64 | @ | 80 | P | 96 | 112 | p |
| 0 | 0 | 0 | 1 | 1 | 1 | SOH | | DC1 | | ! | | 1 | | A | | Q | | a | q |
| 0 | 0 | 1 | 0 | 2 | 2 | STX | | DC2 | | " | | 2 | | B | | R | | b | r |
| 0 | 0 | 1 | 1 | 3 | 3 | ETX | | DC3 | | # | | 3 | | C | | S | | c | s |
| 0 | 1 | 0 | 0 | 4 | 4 | EOT | | DC4 | | \$ | | 4 | | D | | T | | d | t |
| 0 | 1 | 0 | 1 | 5 | 5 | ENQ | | NAK | | % | | 5 | | E | | U | | e | u |
| 0 | 1 | 1 | 0 | 6 | 6 | ACK | | SYN | | & | | 6 | | F | | V | | f | v |
| 0 | 1 | 1 | 1 | 7 | 7 | BEL | | ETB | | ' | | 7 | | G | | W | | g | w |
| 1 | 0 | 0 | 0 | 8 | 8 | BS | | CAN | | (| | 8 | | H | | X | | h | x |
| 1 | 0 | 0 | 1 | 9 | 9 | HT | | EM | |) | | 9 | | I | | Y | | i | y |
| 1 | 0 | 1 | 0 | A | A | LF | | SUB | | * | | : | | J | | Z | | j | z |
| 1 | 0 | 1 | 1 | B | B | VT | | ESC | | + | | ; | | K | | [| | k | { |
| 1 | 1 | 0 | 0 | C | C | FF | | FS | | , | | < | | L | | \ | | l | |
| 1 | 1 | 0 | 1 | D | D | CR | | GS | | - | | = | | M | |] | | m | } |
| 1 | 1 | 1 | 0 | E | E | SO | | RS | | . | | > | | N | | ^ | | n | ~ |
| 1 | 1 | 1 | 1 | F | F | SI | | US | | / | | ? | | O | | _ | | o | DEL |

Example: ASCII Encoder

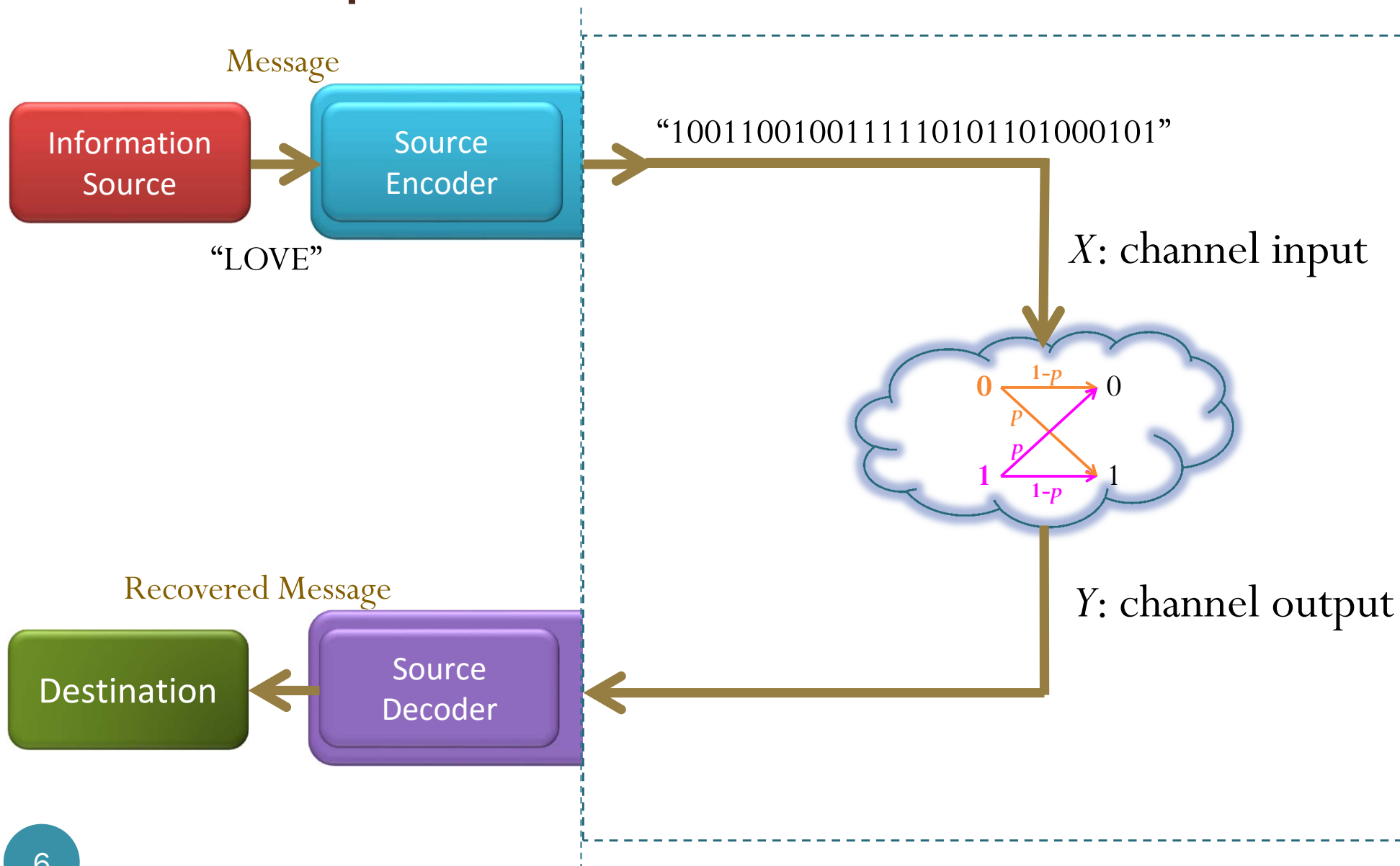
| Character | Codeword |
|-----------|----------|
| : | |
| E | 1000101 |
| : | |
| L | 1001100 |
| : | |
| O | 1001111 |
| : | |
| V | 1010110 |
| : | |

MATLAB:

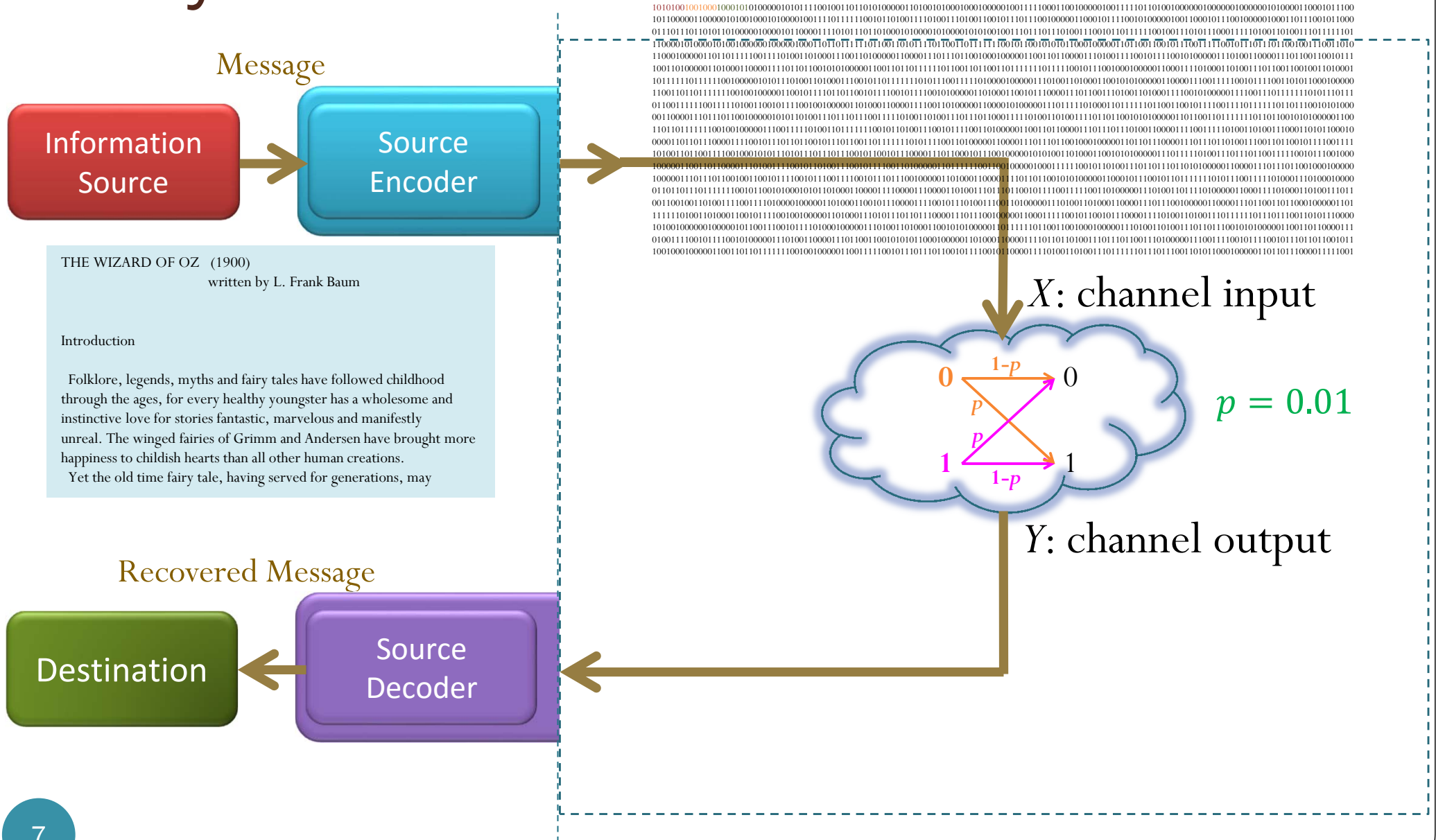
```
>> M = 'LOVE';  
>> X = dec2bin(M, 7);  
>> X = reshape(X', 1, numel(X))  
X =  
1001100100111110101101000101
```



Example: ASCII Encoder and BSC



System considered



Results

THE WIZARD OF OZ (1900)
written by L. Frank Baum

Introduction

Folklore, legends, myths and fairy tales have followed childhood through the ages, for every healthy youngster has a wholesome and instinctive love for stories fantastic, marvelous and manifestly unreal. The winged fairies of Grimm and Andersen have brought more happiness to childish hearts than all other human creations. Yet the old time fairy tale, having served for generations, may

THE WIZARD _F OZ (19009 written by L. Frank0Baum

Introduction

0Folklore. legendsS myths and faiby talgs have fmlloed childhood through the ages, for\$every nealthy youngster has a wholesome and ilsynctire love for storieq fa.tastic, marvelou3 end manifestly unreal. The winged fairies of Grimm and*Andersen havE brought more happiness to chihdish hearts than all odhur human creations/ Yet the0old"timm fai2y tale, having qerved for generationq, may

- The whole book which is saved in the file “OZ.txt” has 207760 characters (symbols).
- The ASCII encoded string has $207760 \times 7 = 1454320$ bits.
- The channel corrupts 14545 bits.
- This corresponds to 14108 erroneous characters (symbols).

Results

```
>> ErrorProbabilityoverBSC
biterror =
  14545
BER =
  0.010001237691842
theoretical_BER =
  0.0100000000000000
symerror =
  14108
SER =
  0.067905275317674
theoretical_SER =
  0.067934652093010
```


$$\frac{14545}{1454320} \approx 0.01 \quad \leftarrow$$


$$\frac{14108}{207760} \approx 0.0679 \quad \leftarrow$$

- The file “OZ.txt” has 207760 characters (symbols).
- The ASCII encoded string has $207760 \times 7 = 1454320$ bits.
- The channel corrupts 14545 bits.
- This corresponds to 14108 erroneous characters (symbols).

Results

BER $p = 0.01$

$$\frac{14545}{1454320} \approx 0.01$$


$$\frac{14108}{207760} \approx 0.0679$$


SER

$$P(\mathcal{E}) = 1 - (1 - p)^7$$

- The file “OZ.txt” has 207760 characters (symbols).
- The ASCII encoded string has $207760 \times 7 = 1454320$ bits.
- The channel corrupts 14545 bits.
- This corresponds to 14108 erroneous characters (symbols).

A character (symbol) is successfully recovered if and only if none of its bits are corrupted.