Coding technology

Lecturer:

- Prof. Dr. János LEVENDOVSZKY (levendov@hit.bme.hu)
- Office: IB129, Building I
- Phone: 463 3547

Suggested literature and references

- T.M. Cover, A.J. Thomas: *Elements of Information Theory*, John Wiley, 1991. (IT)
- S. Verdu, S. Mclaughlin*: Information Theory: 50 years of discovery*, IEEE, 1999 (IT)
- D. Costello: Error control codes, Wiley, 2005
- S. Golomb: *Basic Concepts in Information Theory and Coding*, Kluwer, 1994. (IT + CT)
- E. Berlekamp: *Algebraic Coding Theory*. McGraw Hill, 1968. (CT)
- R.E. Blahut: *Theory and Practice of Error Correcting Codes*. Addison Wesley, 1987. (CT)
- J.G. Proakis: *Digital communications,*McGraw Hill, 1996

Course information

LECTURES:

- Wednesday 10.15-12.00 (every week)
- Friday 10.15-12.00 (odd weeks)

CLASSES:

- Numerical examples, Q&A

REQUIREMENTS:

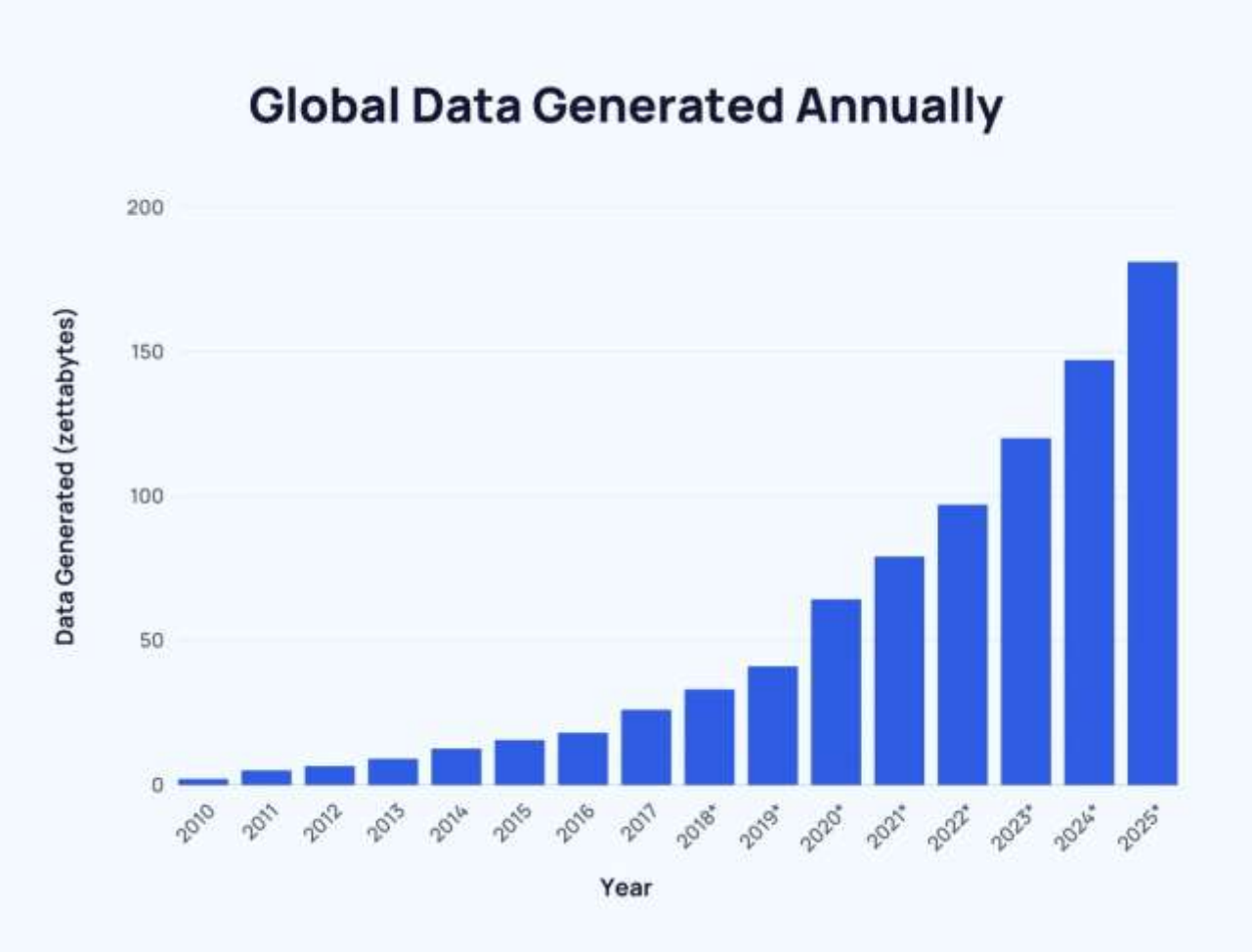
- One major test (with recap possibility**)**
- Signature is secured if and only if the grade of the test (or its recap) is higher (or equal) than 2 !
- The test is partly problem solving !
- Exam (written)
- Final grade= (midterm points + exam points) /2

GRADING POLICY:

Fail (1)	Pass (2)	Satisfactory (3)	Good (4)	Excellent (5)
0-39 points	40-53 points	54-67 points	68-81 points	82-100 points

Scores both in the *midterm* and in the *exam* has to be at least 40 points !

Data = the “oil” of modern society



1992	1997	2002	2013	2018	…	2022
100GB/day	100GB/hr	100 GB/sec	29,000 GB/sec	50,000 GB/sec		3,800,000 Gb/sec

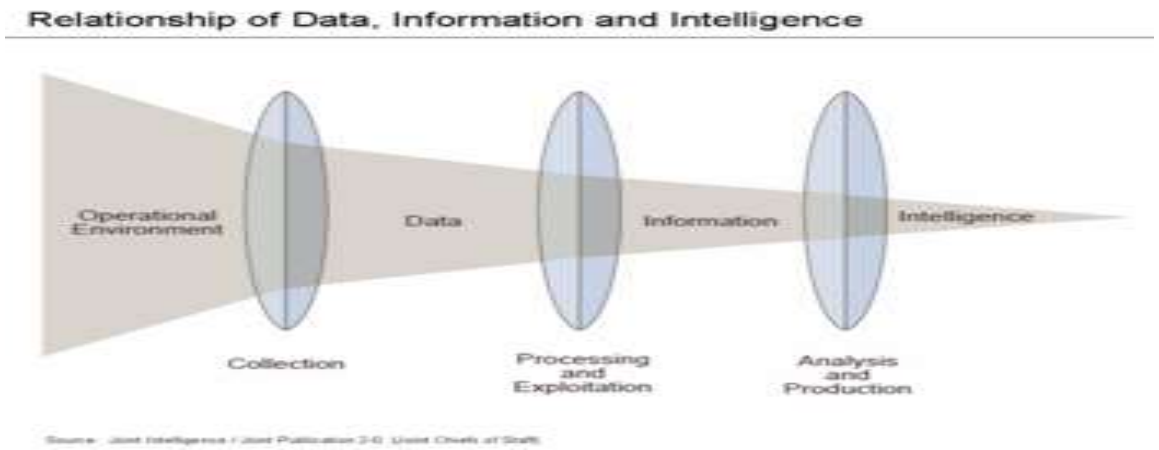
- Economic strogae — Information theory
- Processing
- Economic transmission — Information theory
- Reliable transmission — Coding theory
- privacy — Cryptography

⇩

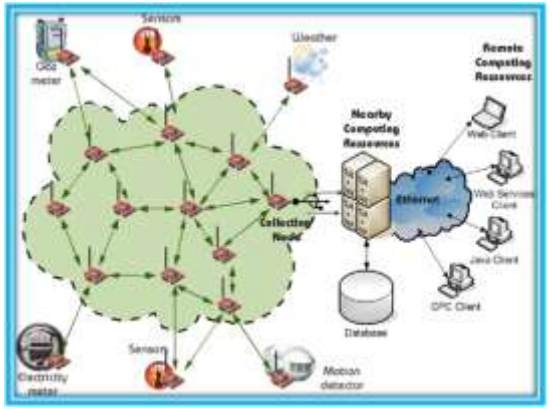
CODING TECHNOLOGY !

Scope – fundamentals of ICT

Modern Information technologies=A PATH FROM *DATA* TO *INTELLIGENCE*



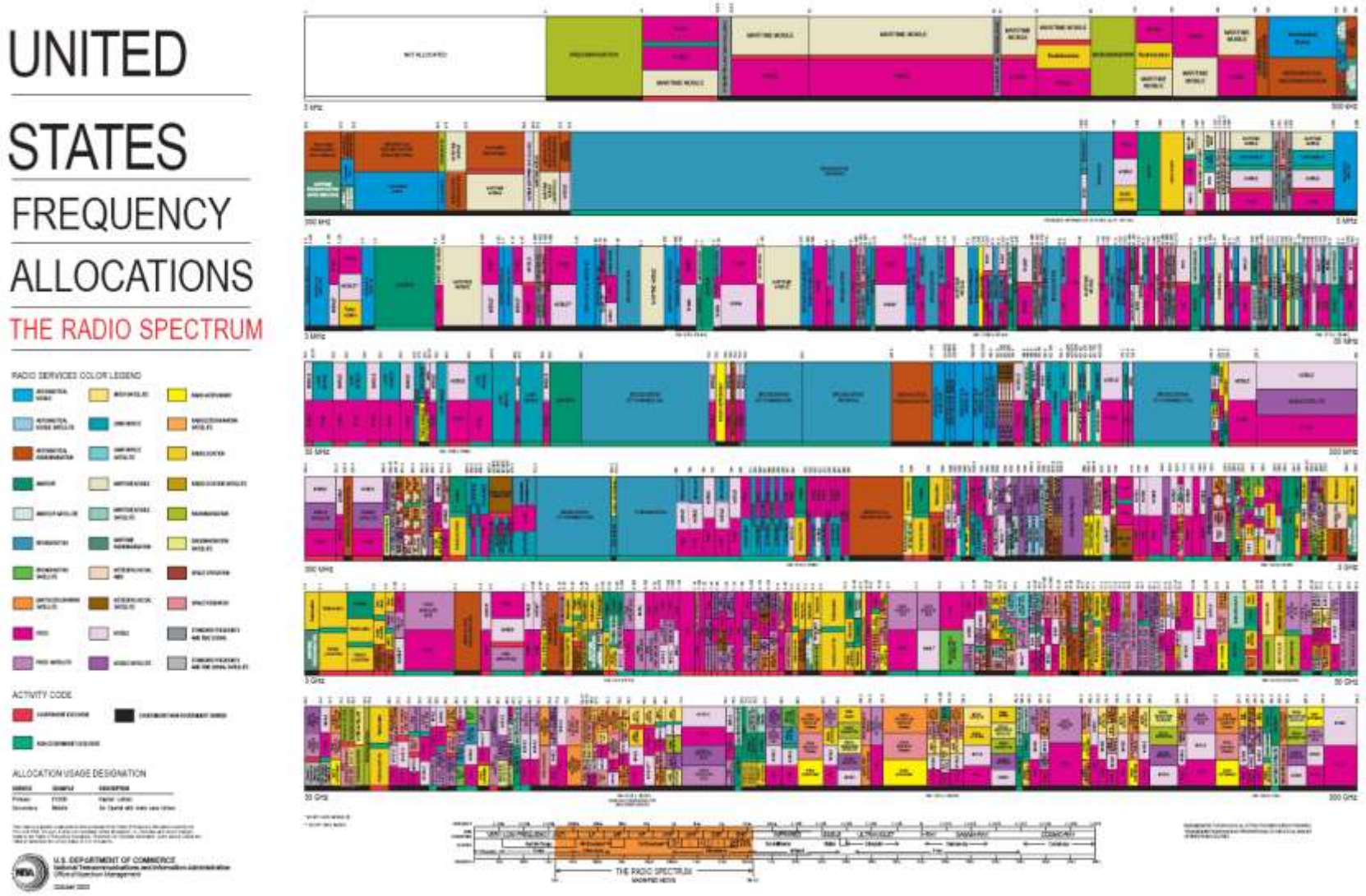
How to turn raw data into structured data in the most reliable and efficient way ?



Networking (IoT, WSN ..etc.) Storage: cloud computing Processing: Big Data

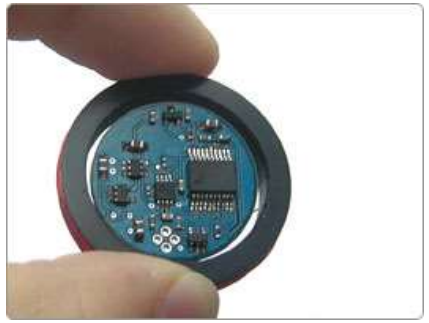
Reliability (Channel Coding) **Efficiency (Source Coding)** **Security (Cryptography)**

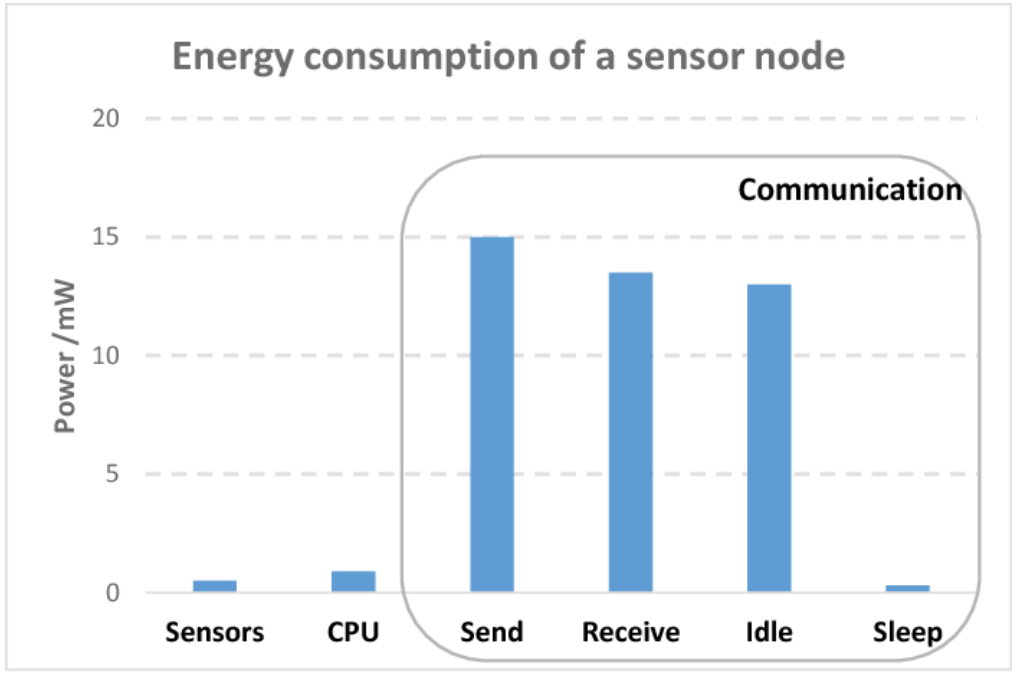
Contsraints I – radio spectrum



http://en.wikipedia.org/wiki/File:United_States_Frequency_Allocations_Chart_2003_-_The_Radio_Spectrum.jpg

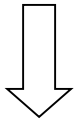
Constraints II – energy





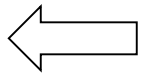
Batteryy powered devices with limited energy
(eg. mobil devices , IoT and WSN sensors)

LIMITED RESOURCES: bandwidth , transimission power

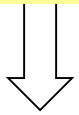


$$QoS = f(\text{resources})$$

???



Fundamental challenge of Communication Engineering



QIALITY OF SERVICE COMMUNICATION (QoS):

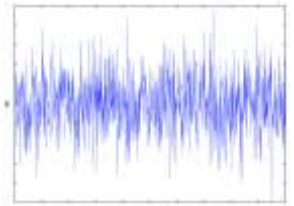
pre-defined parameters (error rate, data speed..) to be achieved

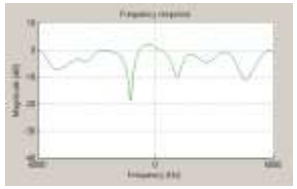
Spectral efficiency – a fundamental measure of performance

SE [bit/sec/Hz] = what is the data transmission rate achievable over 1 Hz physical spectrum

- 1G: 0.064 [bit/sec/Hz]
- 2G: 0.33 [bit/sec/Hz]
- 3G: 0.51 [bit/sec/Hz]
- 4G: max 6.1 [bit/sec/Hz] downlink
- LTE: 16.32 [bit/sec/Hz]
- 5G: max 30 [bit/sec/Hz]

Wider bandwidth: higher frequencies, worse channel characterisitics, more sophistictaed algorithms and technologies are needed - CODING TECHNOLOGY





noise distortion evesdropping

Channel

Finite resources (transmission power, bandwidth…etc.)

Challenge: *Efficient*, *private*, and *reliable* communication over unreliable public channels !

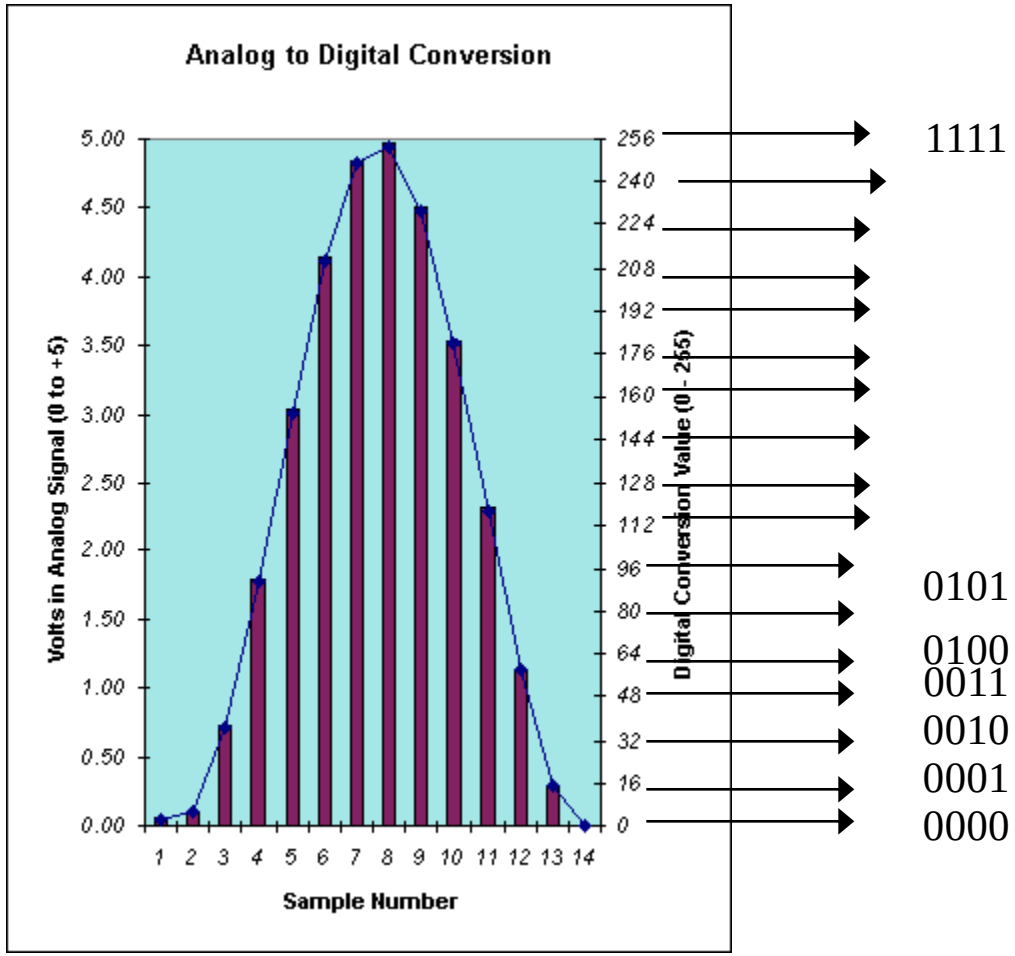
Questions:

1. What is the most compact (shortest) representation of information ?
2. How to communicate reliably over an unreliable channel ?
3. How to ensure private communication over a public channel ?
4. By what algorithms can these goals achieved ?

Information, coding and number theory

→ Coding technology

Source coding (data compression)



szimbólum	kódszó
a1	01
a2	10111
a3	111
a4	110
aN	01110

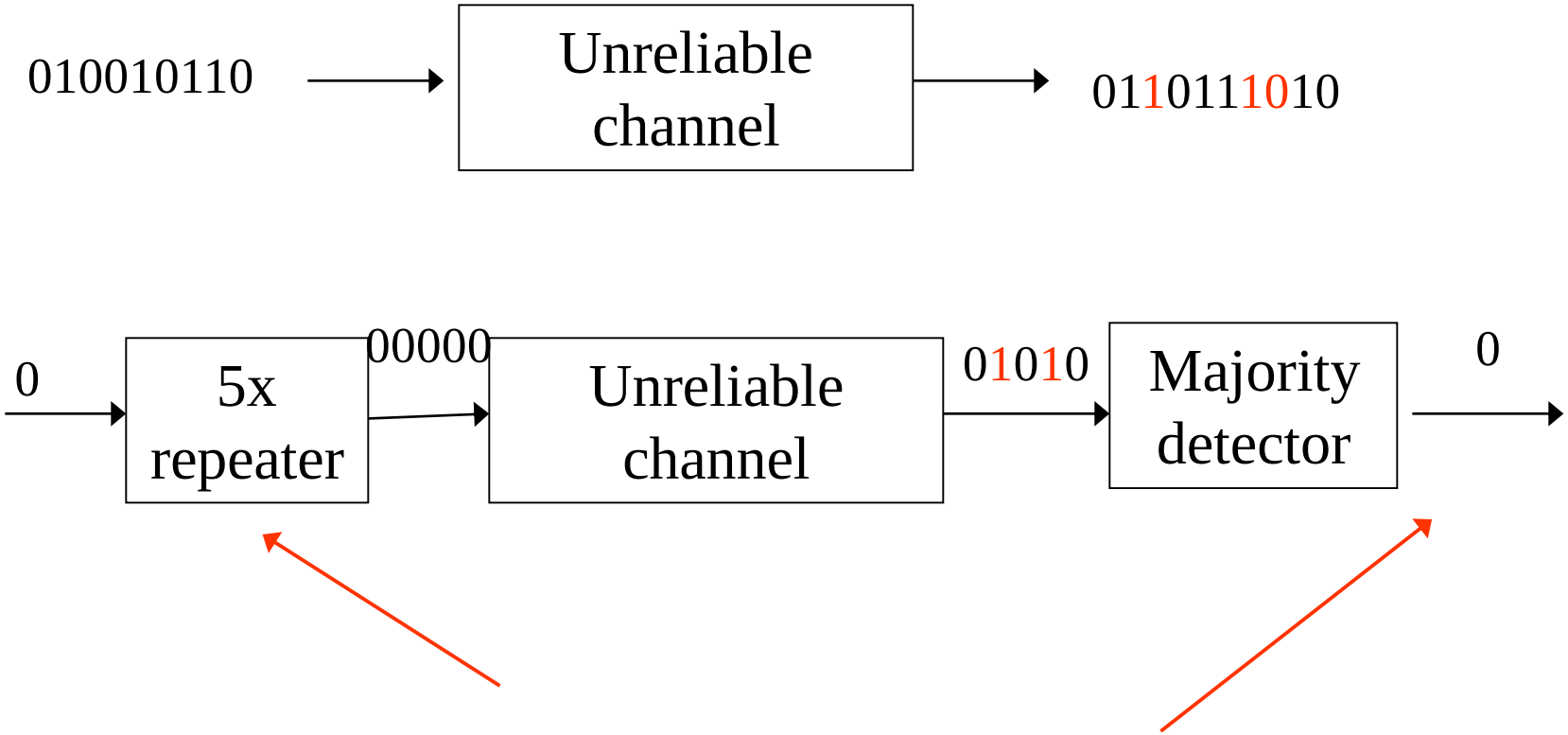
Optimal code ?

0000 0001 0010 0011 0100 0101 ……0000

0000 1 1 1 1 1 ……0

number of bits are reduced

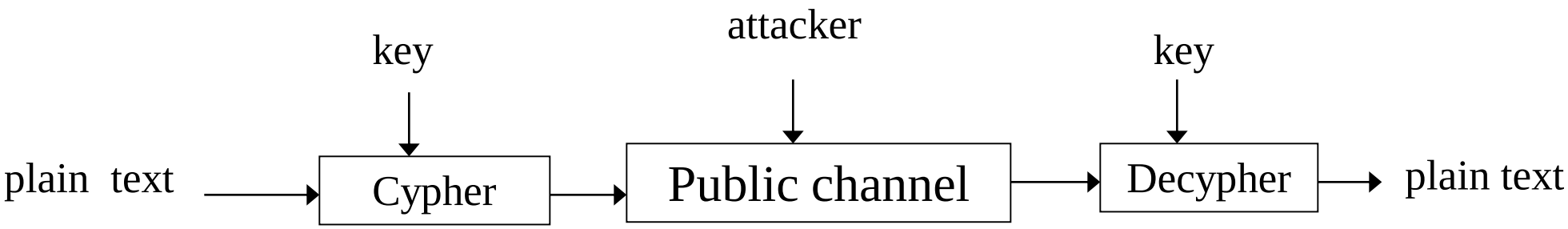
Channel coding – error control



Reliable communication !

Loss in dataspeed ?

Data security



Algorithms to ensure secure communication with small complexity but in the lack of certain parameters (key) present very high complexity for the attacker.

THANK YOU FOR YOR ATTENTION !