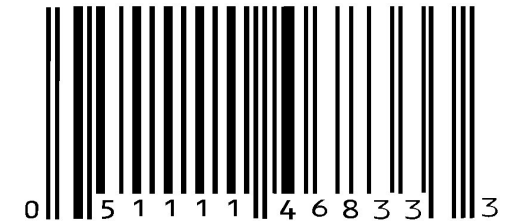
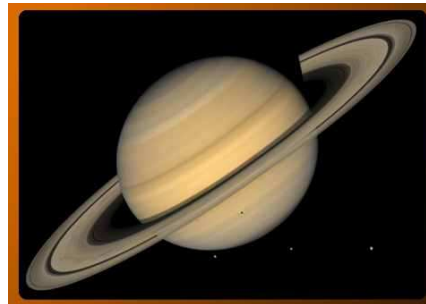
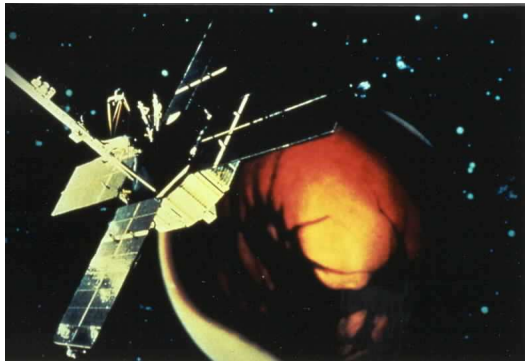




# CODING THEORY

Dwi Lestari, M.Sc  
Jurdik Matematika  
FMIPA UNY  
[dwilestari@uny.ac.id](mailto:dwilestari@uny.ac.id)  
0819 317 33249

# Pendahuluan: aplikasi





# What is Coding Theory?

- Teori pengkodean mrp studi tentang kode pendeteksi/pengontrol kesalahan.
- Digunakan untuk mendeteksi dan mengoreksi kesalahan yang muncul saat data dikirimkan atau disimpan
- **Ex: CD players, TV, fax machines, internet, satelites, mobiles**



# What is Coding Theory?

- A mix of mathematics, computer science, electrical engineering, telecommunications
  - Linear algebra
  - Abstract algebra (groups, rings, fields)
  - Probability&Statistics
  - Signals&Systems



# General Problem

- Saat mengirim data dari satu tempat ke tempat lain .....
  - channels: telephone lines, internet cables, fiber-optic lines, microwave radio channels, cell phone channels, etc.
- Saat kita ingin menulis dan mendapatkan kembali suatu data...
  - channels: hard drives, disks, CD-ROMs, DVDs, solid state memory, etc.
- **BUT!** the data, or signals, may be corrupted
  - Sebab: noise/gangguan, hardware yg tdk berfungsi, dll.





# General Solution

- Memberikan redundansi pada setiap pesan untuk memberikan kesempatan pesan dapat diterima sesuai aslinya.

# The ISBN Code



- $x_1 x_2 \dots x_{10}$
- $x_{10}$  is a *check digit* chosen so that
$$S = x_1 + 2x_2 + \dots + 9x_9 + 10x_{10} = 0 \pmod{11}$$
- Can detect all single and all transposition errors

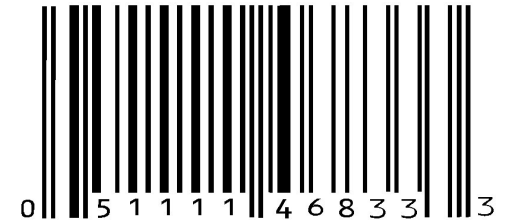


## ISBN Example

- *Cryptology* by Thomas Barr: 0-13-088976-?
- Want  $1(0) + 2(1) + 3(3) + 4(0) + 5(8) + 6(8) + 7(9) + 8(7) + 9(6) + 10(?) =$   
multiple of 11
- Compute  $1(0) + 2(1) + 3(3) + 4(0) + 5(8) + 6(8) + 7(9) + 8(7) + 9(6) = 272$
- Ponder  $272 + 10(?) =$  multiple of 11
- Modular arithmetic shows that the check digit is 8!!

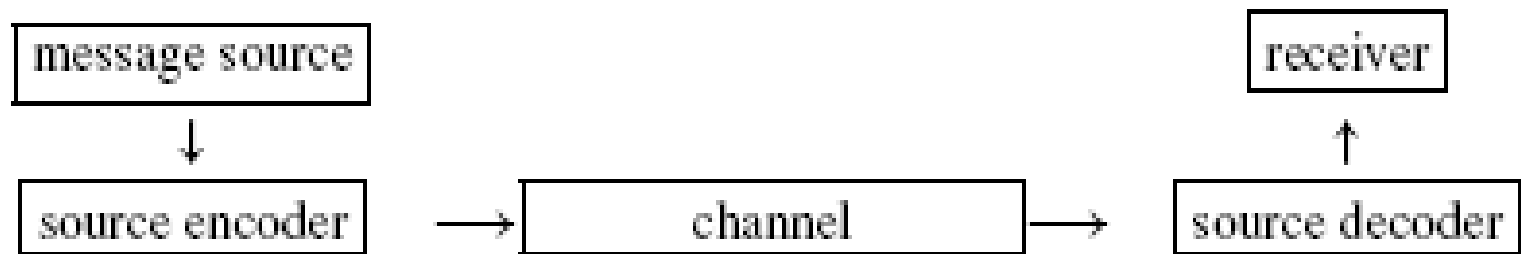


# UPC (Universal Product Code)



- $x_1 x_2 \dots x_{12}$
- $x_{12}$  is a check digit chosen so that
$$S = 3x_1 + 1x_2 + \dots + 3x_{11} + 1x_{12} = 0 \pmod{10}$$
- Can detect all single and most transposition errors
- What transposition errors go undetected?

# Proses Pengkodean



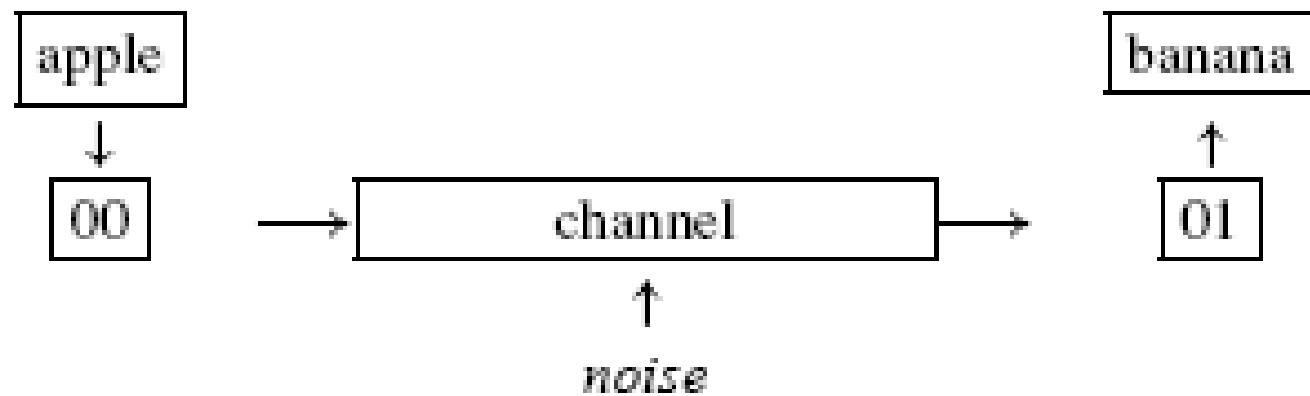
**Fig. 1.1.**



## Contoh:

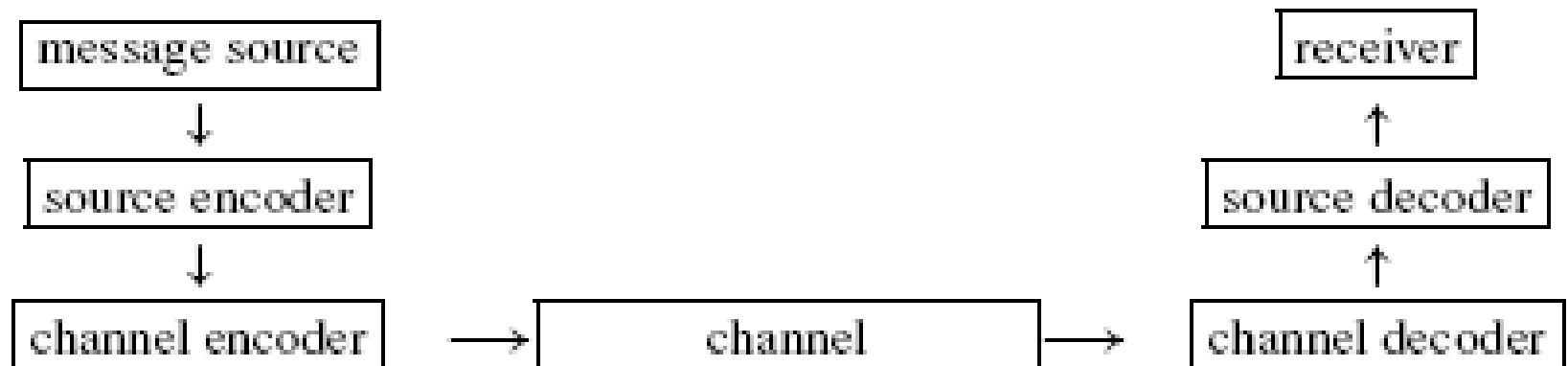
apple  $\rightarrow$  00, banana  $\rightarrow$  01, cherry  $\rightarrow$  10, grape  $\rightarrow$  11.

# Lanjut : proses pengkodean



**Fig. 1.2.**

# Lanjut: pengkodean



**Fig. 1.3.**





## Contoh :

00  $\rightarrow$  000, 01  $\rightarrow$  011, 10  $\rightarrow$  101, 11  $\rightarrow$  110.

- Misal pesan apple dikirim sbg kode 000,
- Satu eror terjadi shg User menerima kode 100, 010, atau 001
- Bagaimana koreksinya ???



# Penambahan redundansi

00 → 00000, 01 → 01111, 10 → 10110, 11 → 11001.

- Misal pesan apple dikirim sbg kode 00000,
- Satu eror terjadi shg User menerima kode 10000, 01000, 00100, 00010, atau, 00001
- Bagaimana koreksinya ???