Television broadcasting systems

Introduction

DVB T /T2
ATSC 3.0
ISDB-T
DTMB
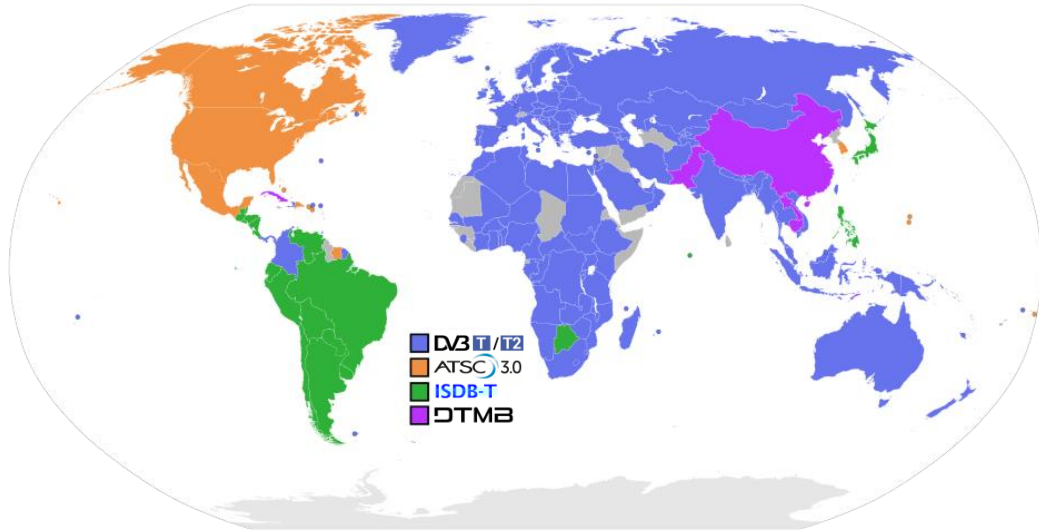
HELLO!

Darío Alfonso Pérez-Calderón Rodríguez

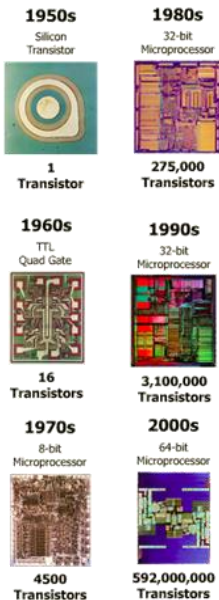PhD. Telecommunication Engineer

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1.
A walk through history

"Know from where we come to understand where we are and foresee where we go"

Communication systems have changed our way of life

- In the late 60s the germ of internet was an United States Department of Defense project known as ARPANET
- It is strange nowadays to find someone without an internet connection in the palm of his hand
  - Integrated electronics made possible to improve the performance and the computing capacity of electronic device by reducing their size to nanometers

1950s Silicon Transistor
1 Transistor

1960s TTL Quad Gate
16 Transistors

1970s 8-bit Microprocessor
4500 Transistors

1980s 32-bit Microprocessor
275,000 Transistors

1990s 32-bit Microprocessor
3,100,000 Transistors

2000s 64-bit Microprocessor
592,000,000 Transistors

Motorola 8900X-2 Nokia 2146 Nokia 3210 Nokia 6210 Ericsson T39 Alcatel OT511 Samsung E250 Apple iPhone BlackBerry Curve 8900 Samsung Galaxy S2 Samsung Galaxy S4 Sony Xperia Z Ultra iPhone XR

THE EVOLUTION OF TELEVISION

1928
OCTAGON
General Electric made the Octagon in 1928 as part of their experimental TV program in Schenectady, New York. The first TV drama, the Queen's Messenger, was produced in September of that year by GE.

1930
BAIRD
The Baird Televisor was made by Plessey in England from 1930 through the early 30s. It was the first television receiver sold to the public.

1936
EMYVISOR & COSSOR
In the year 1936 two T.V was invented the first was the Emyvisor which picture in black & white. the next TV was the Cossor which not only show picture in black and white but also in color.

1938
MARCONI
Here's a 1938 Marconi 707 Television & All Wave Radio Receiver. Measuring 26" x 19" x 19" and weighing more than 100 pounds, the set was actually considered to be somewhat compact in its day, and though its 7 inch screen would be regarded as miniscule by contemporary standards, in 1938 it was not insubstantial.

1939
RCA
RCA introduced television to the American public at the 1939 World's Fair. Before the fair, they published a brochure for their dealers to explain television.

1946
RCA
The RCA 630TS television became an immediate hit when it was introduced in 1946, right after World War II.

1948
MOTOROLA
Motorola's "Golden View" was the most popular 7-inch television in the late 1940s and early 1950s. It came in both tabletop and portable cabinets and it was one of the cheapest TVs available at the time.

1949
RAYTHEON
The Raytheon M-1101 is an American TV set manufactured in Raytheon's Belmont Radio plant in Chicago on October 1949, the CRT face was more or less masked to give a rectangular appearance), this style of TV is known as "porthole", like the "windows" on a ship.

1953
SHARP
Sharp started producing as the first Japanese television in mass production. The 14-inch TV was the standard in the first Japanese households for years. With its wooden frame, it precisely met the design aesthetic taste of the fifties.

1958
PHILCO
Is this the ultimate TV? Love it or hate it, the Philco Predicta television is unarguably one of the design icons of the 20th Century.

1962
MEIDENSHA
Meidensha TVs were really contemporary in style and design. The wooden frame and high voltage tubes were considered as a great combo back then.

1973
PHILCO-FORD
1973 Philco-Ford – Model B450ETG - One of the last 'vacuum tube' sets. It was in this time period that the American television set industry migrated to a transistorized TV chassis.

1998
SONY
The Sony T.V was created in 1998, it was the first television that had a built in VCR and DVD player. The Sony t.v had better picture and a lot more channel with color.

2007
SAMSUNG
Samsung emerged as one of the largest flat panel TV producer worldwide. Samsung also introduced a ten-millimeter thick only, 40-inch LCD television panel for the first time too.

2014
SAMSUNG
Samsung started selling commercial curved smart TVs. In the IFA2014, Samsung also displayed the first bendable TV with 5,120 x 2,160 resolutions.

- The relationship between these two disciplines form a "vicious circle"
  - The evolution of electronics produces new services demand
  - The demand produces new technologic challenges
 - The new challenges are translated into technologic evolution

TECHNOLOGIC EVOLUTION

NEW TECHNOLOGIC CHALLENGES

NEW SERVICES DEMAND

2G (GSM)

2.5G (GPRS)

3G (UMTS)

4G (3GPP LTE)

5G

PAL

DVB-T

DVB-T2
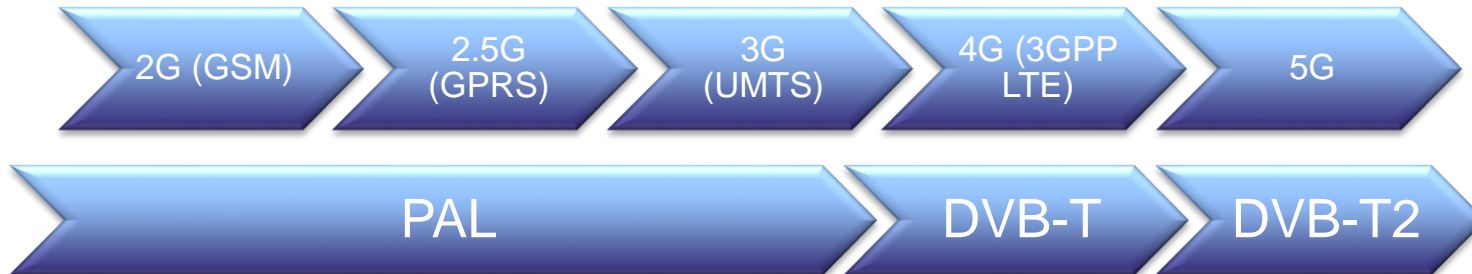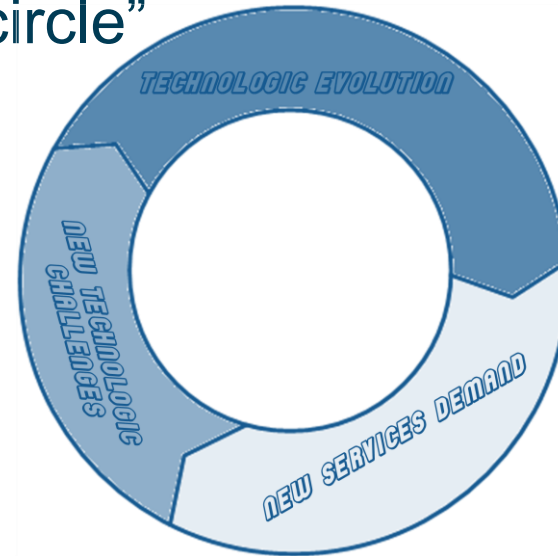
- The evolution of communication systems cannot be conceived without the evolution of electronics
  - In the 40s computers had the size of a whole room
    - ENIAC was the first electronic general purpose computer
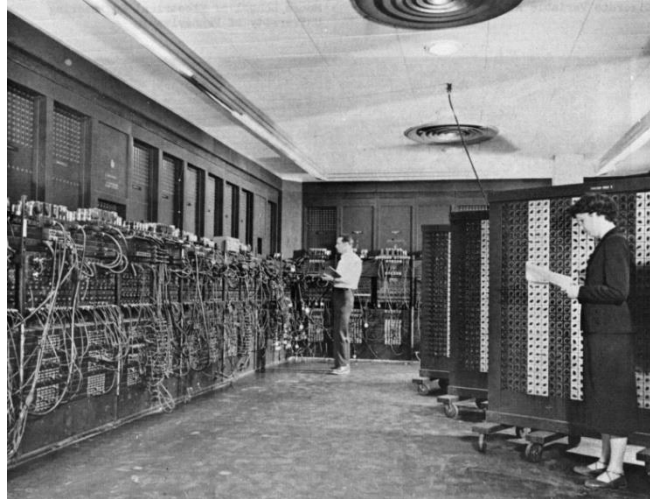
    - It was mainly used to calculate artillery firing tables for the United States Army's Ballistic Research Laboratory

- The evolution of electronics had very marked milestones
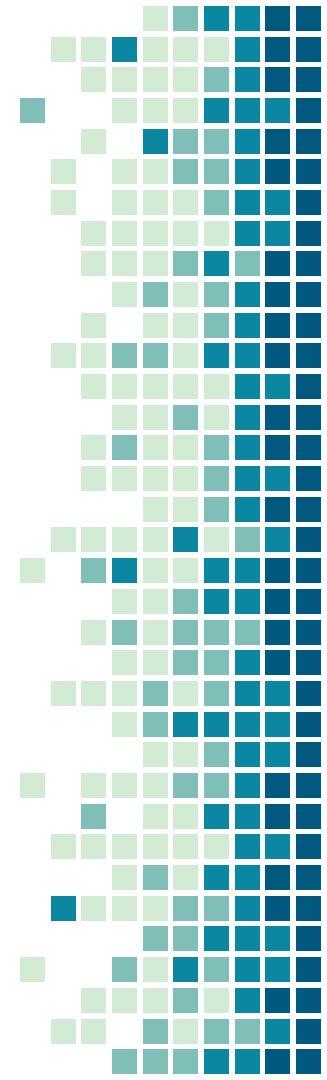 - **1904:** Diode or vacuum tube was invented by Fleming (rectification)
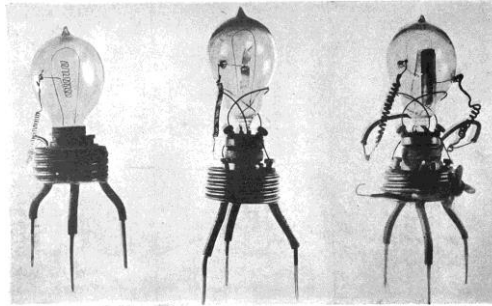
  - **1906:** Triode was invented by De Forest (rectification, amplification)
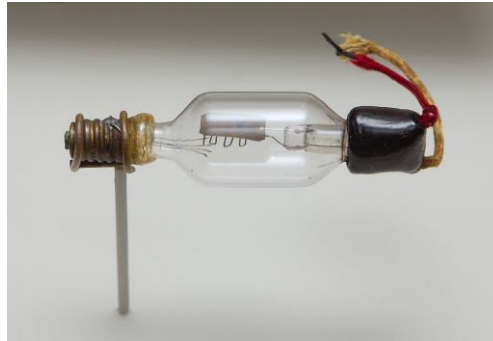
- **1920:** First radio broadcasting service (Westinghouse Electric Corp.)
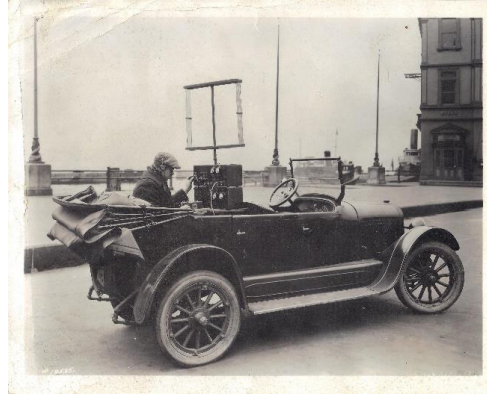

Brown Bros. Photos
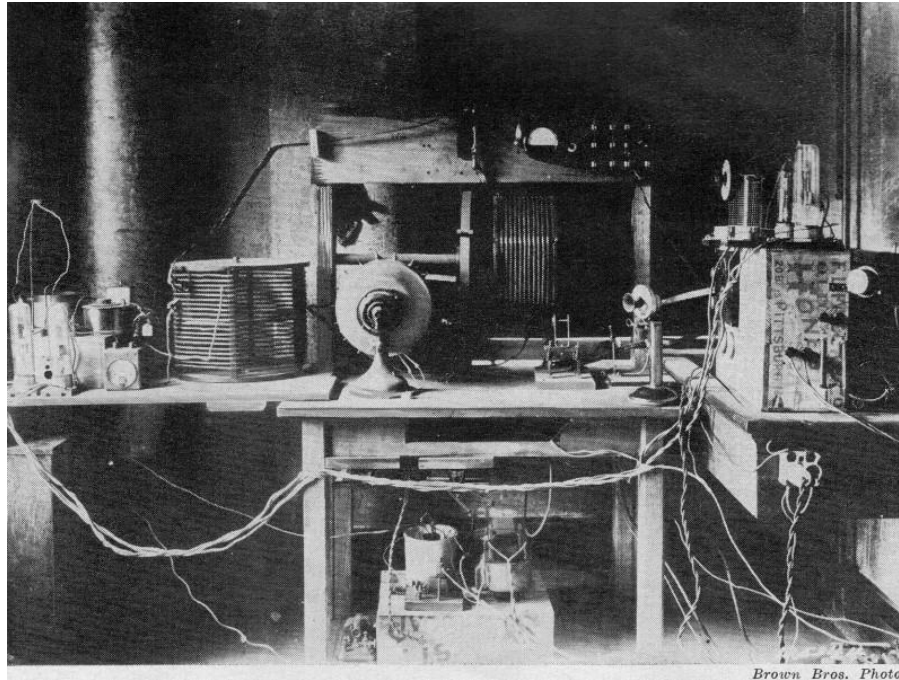
1948: First transistor is invented in Bell Labs

- **1958:** Integrated circuit was invented by Kilby
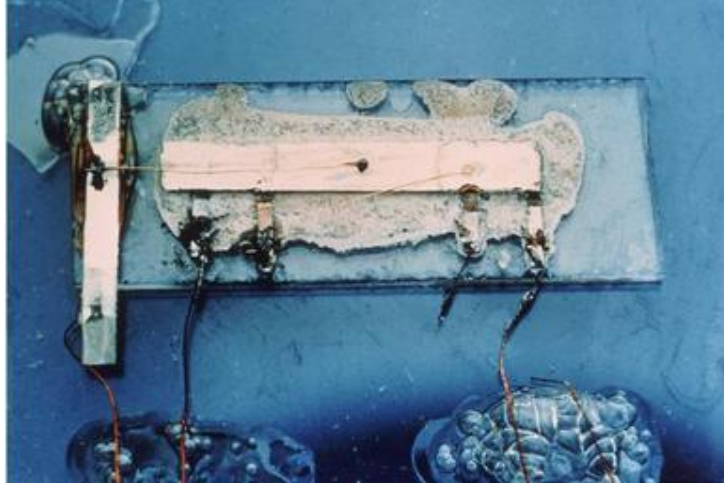
- Awarded with the Nobel Price in 2000
- His work was named an IEEE Milestone in 2009

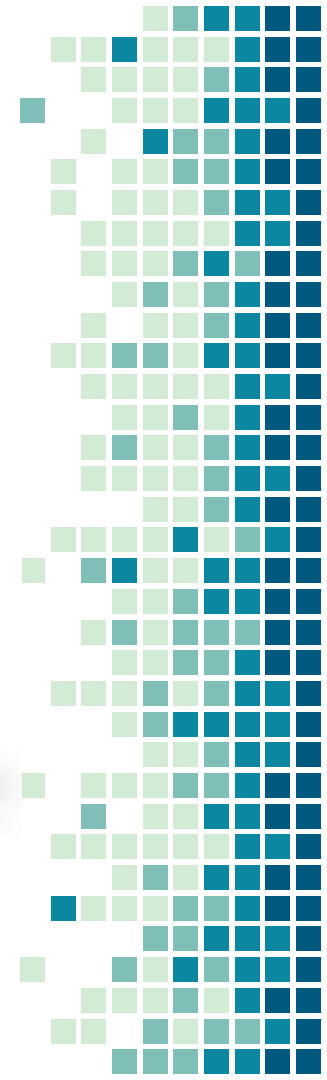- **1924:** Two-way radio telephone for car (Bell Labs)

- **1973:** First mobile phone (Motorola, Martin Cooper)

1928: Octagon (General electric)

2019: 4K television

Moore's Law

Microprocessor Transistor Counts 1971-2011 & Moore's Law

- The improvement of the scale of integration boosted the computation capabilities of integrated circuits
  - More complex operations to be performed in the same time and space
  - Very complex techniques available for real time data processing
    - Fast Fourier Transform (1805, Gauss-1965, Cooley and Tukey)
    - Low Density Parity Check codes (1963, Gallager)

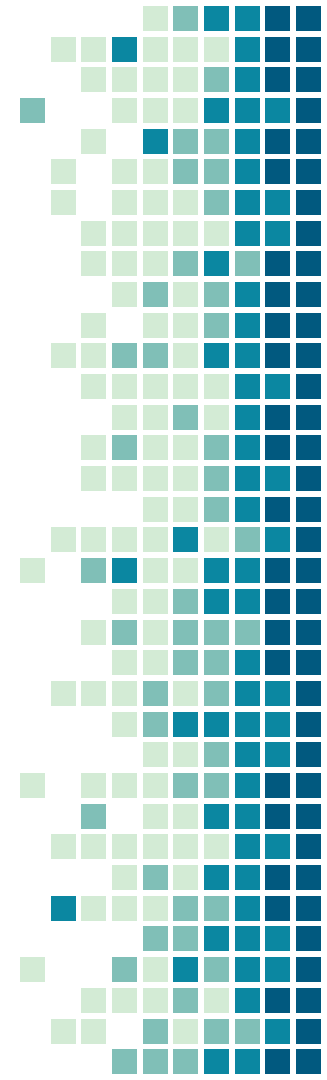- **Our imagination runs faster than the technology that can bring it to the real world!**
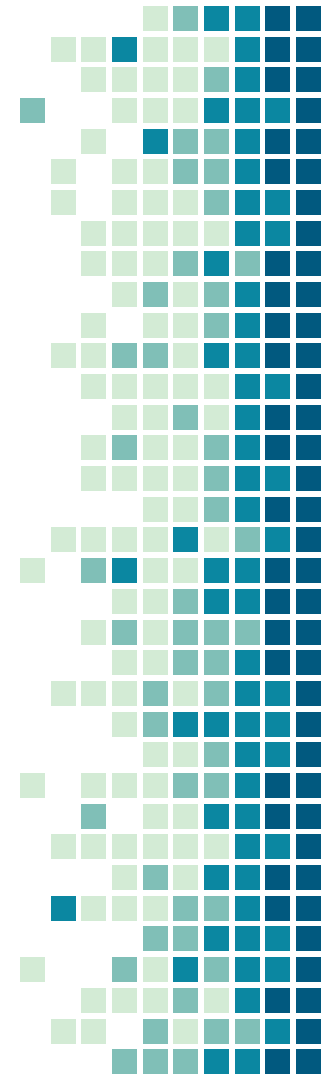
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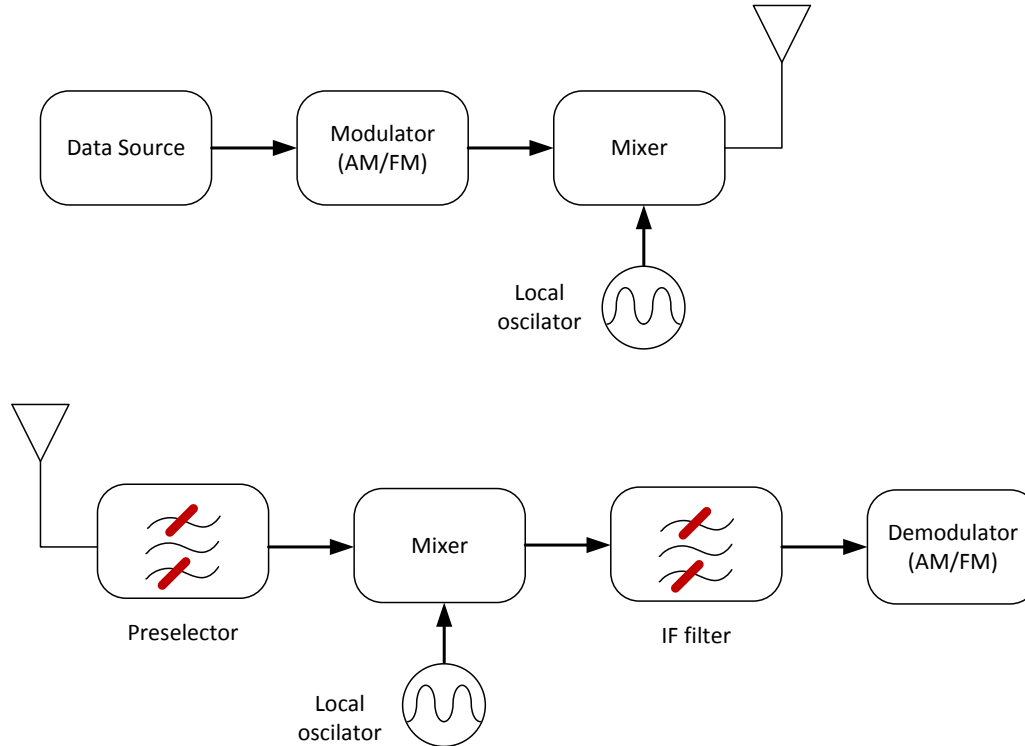# Communication systems concepts

*"A good base makes your knowledge stronger"*
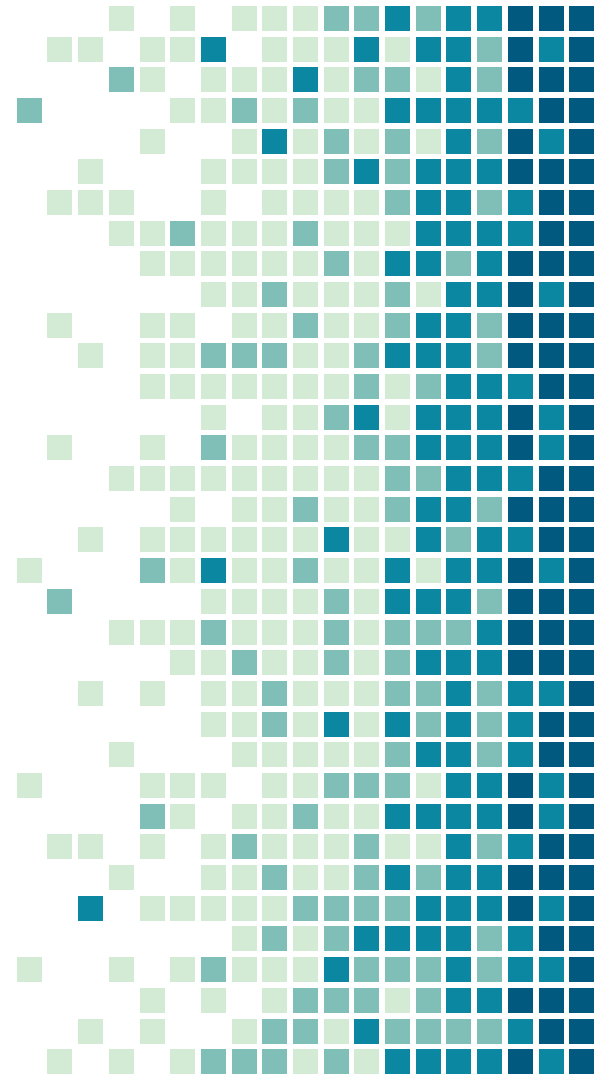
- There are many structures and classifications of communication systems as
  - Type of data processing: digital or analogue (these last ones not very used today, AM and FM radio, PAL TV)
  - Information flux: point to point, broadcast, …
- The ones we will focus on in this subject are the broadcast systems
  - DTV is a clear example
 - DVB-T2 is one of the most advanced communication systems used nowadays

As an example a simple analogue AM/FM scheme

Data Source → Modulator (AM/FM) → Mixer

Local oscilator

Preselector → Mixer → IF filter → Demodulator (AM/FM)

Local oscilator

- Digital Systems have a very interesting advantage, after sampling the signal we can perform whatever operation we want
  - Mathematical operations don't need discrete physical components to implement them (don't decay, don't have tolerance in the manufacturing process …)
- However there is a drawback, we need to sample the signal
  - Sampling frequency must be higher than 2 times the higher frequency in the data to be able to recover the original data (Nyquist theorem)
  - Discretizing the signal carries information loss
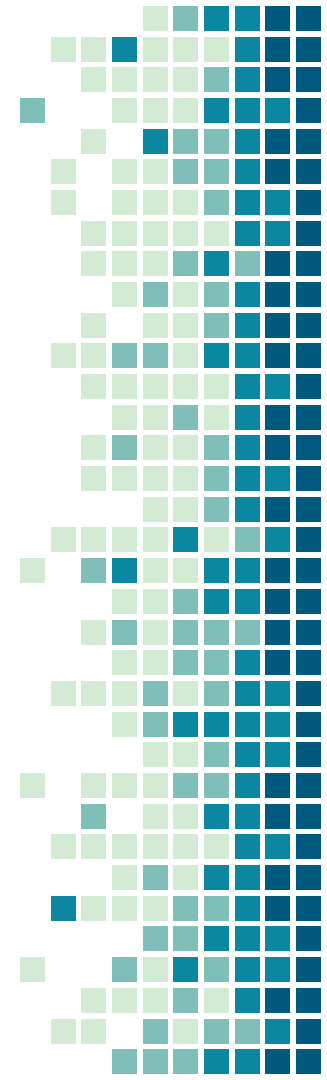
Nyquist theorem in the frequency domain
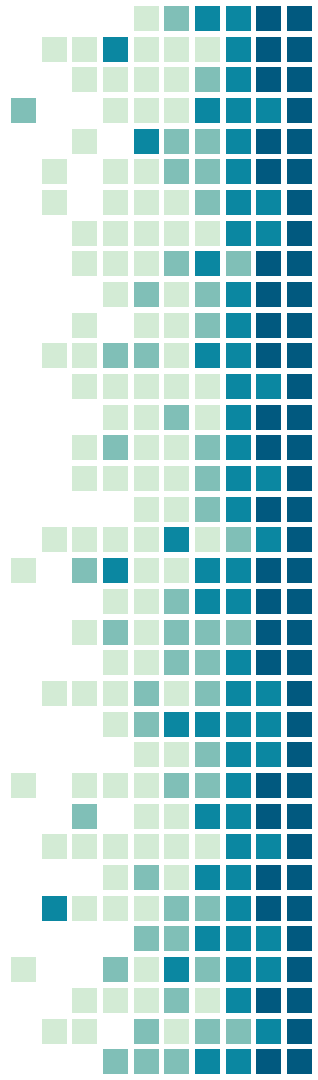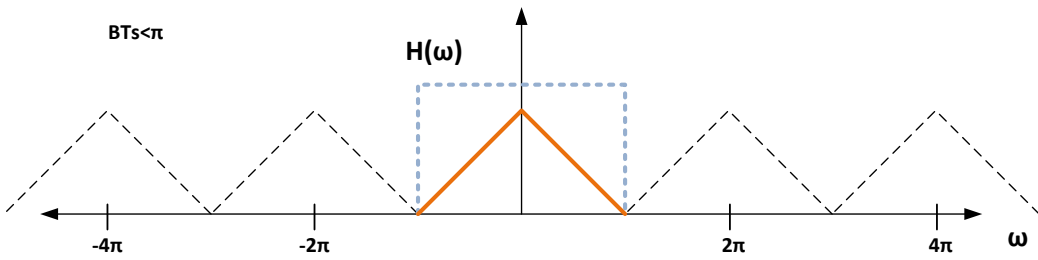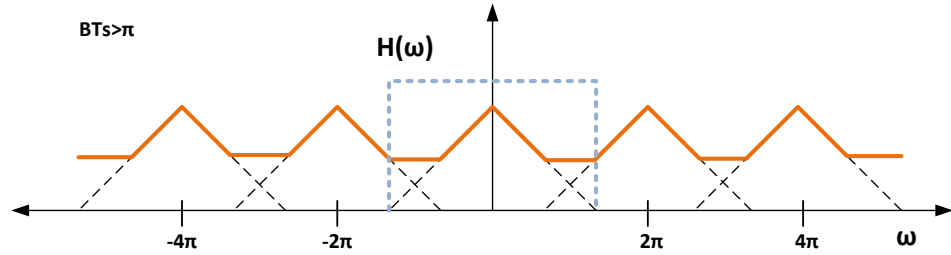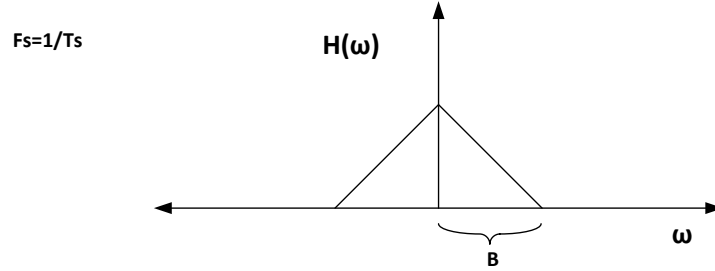
- The extreme case of a digital system would be what is know as Software Define Radio

  - Only an acquisition and sampling system
  - The rest of the operations are done in the digital domain defined by a "program"

- High frequency systems need at least twice higher sampling frequency and thus Analogue to Digital Converters

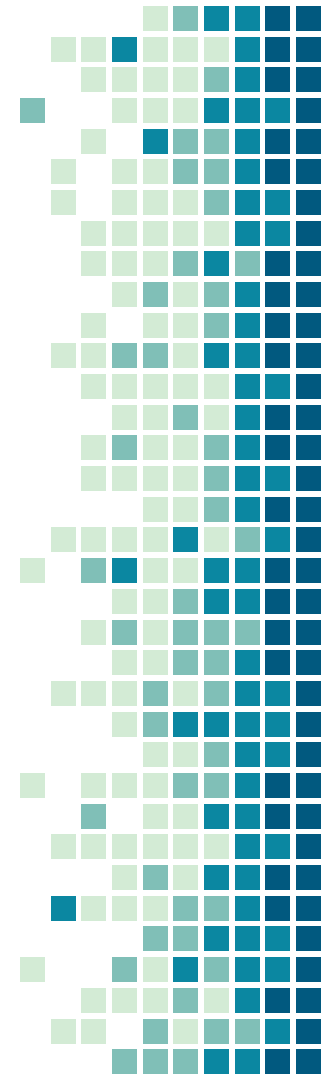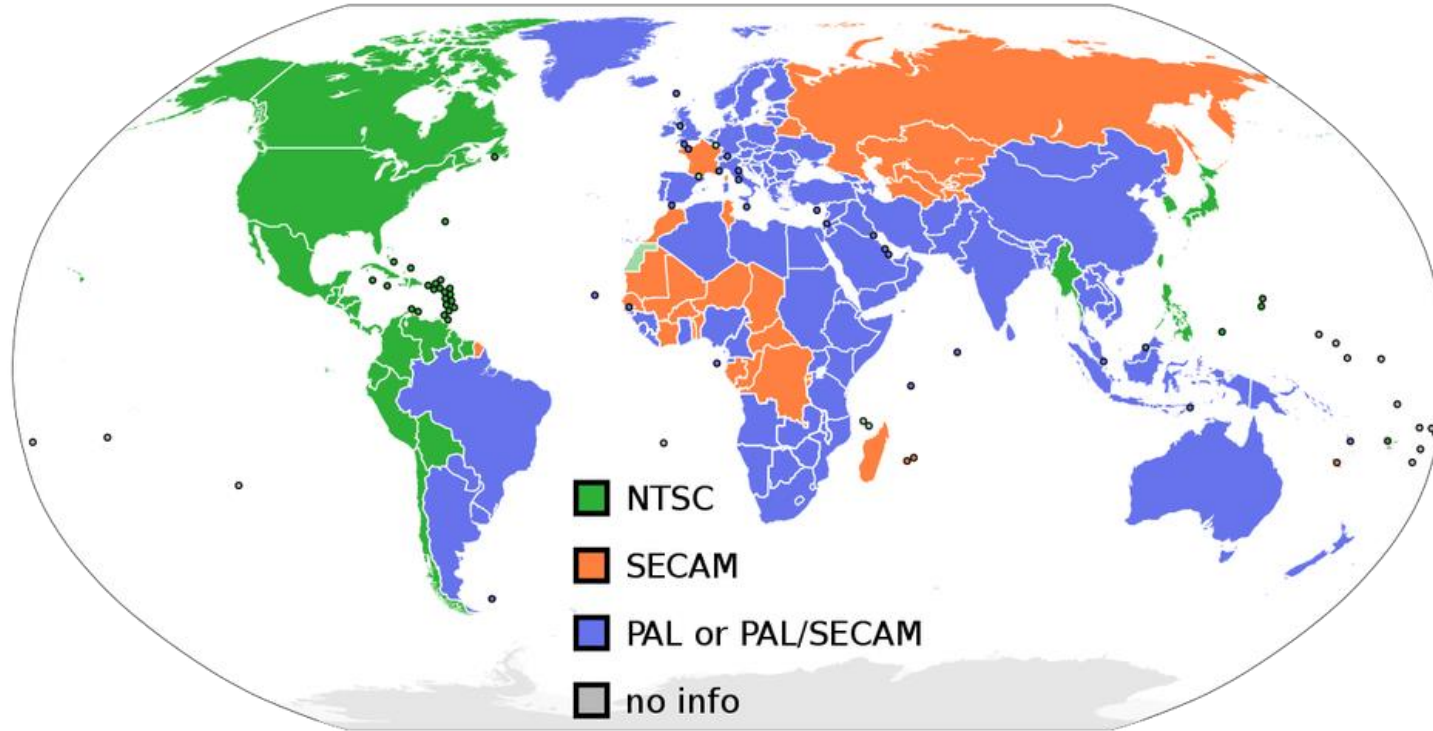 - Very expensive or inexistent for determinate uses
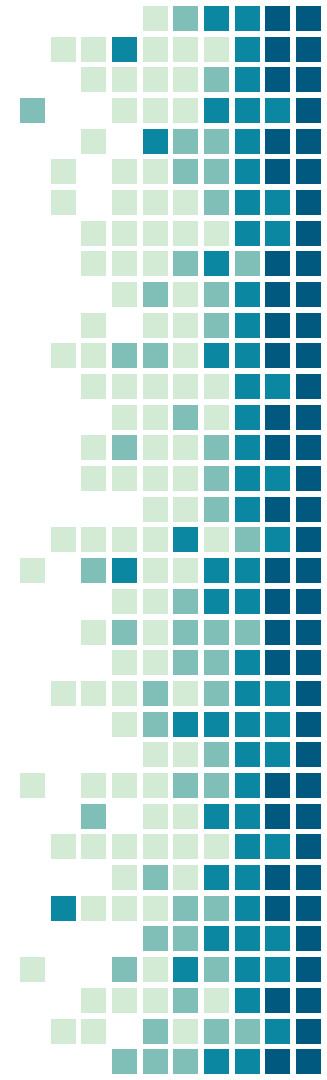
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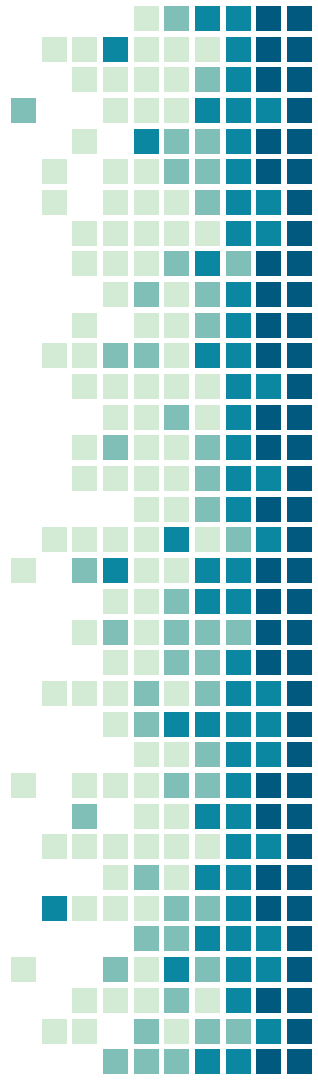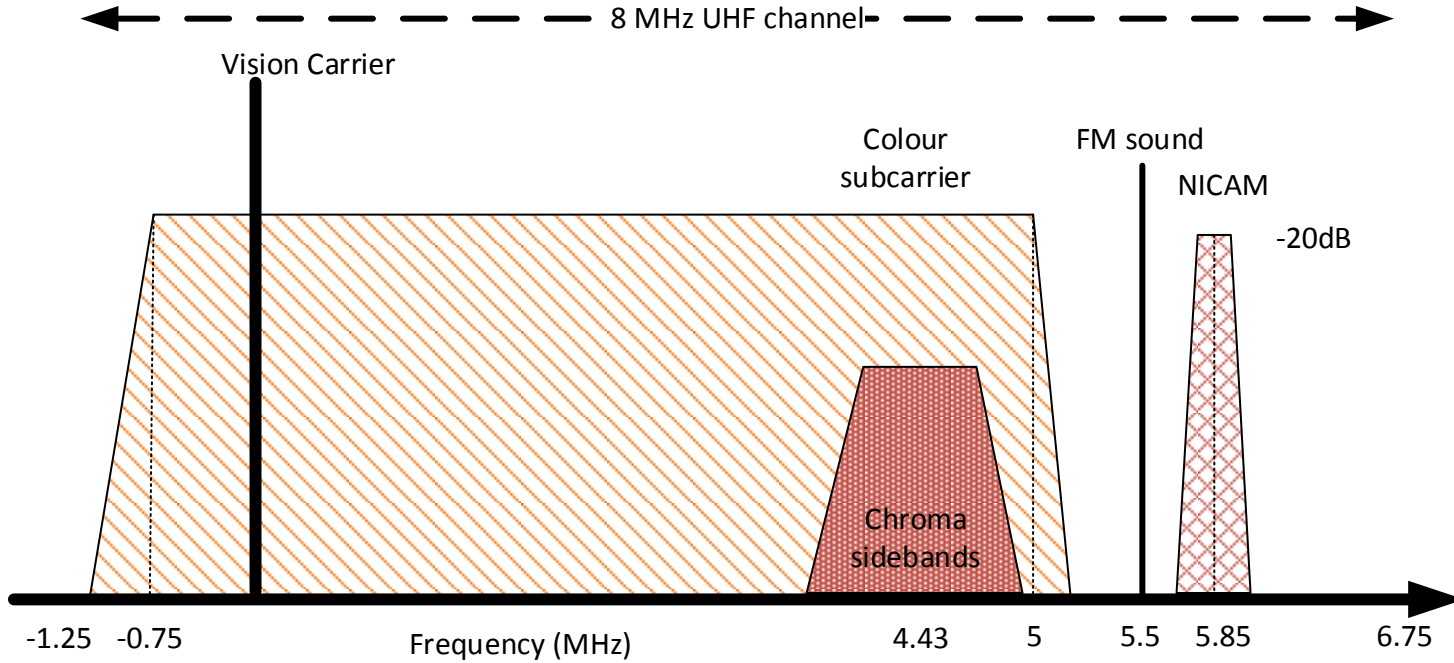# Television standards in the world

"*Past and present*"

Analogue television standards

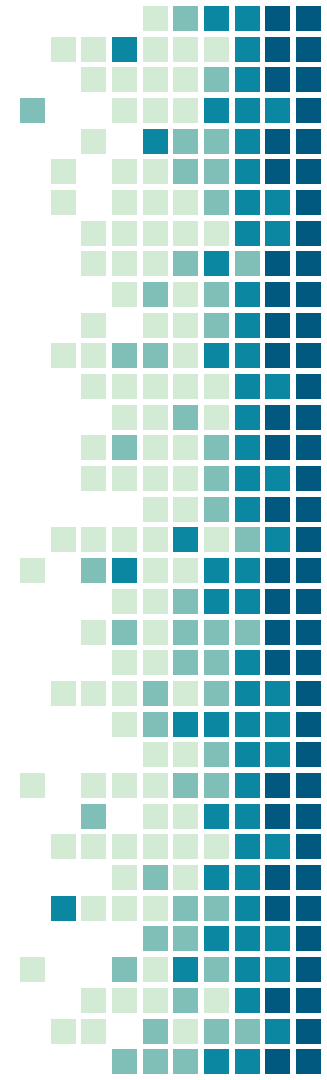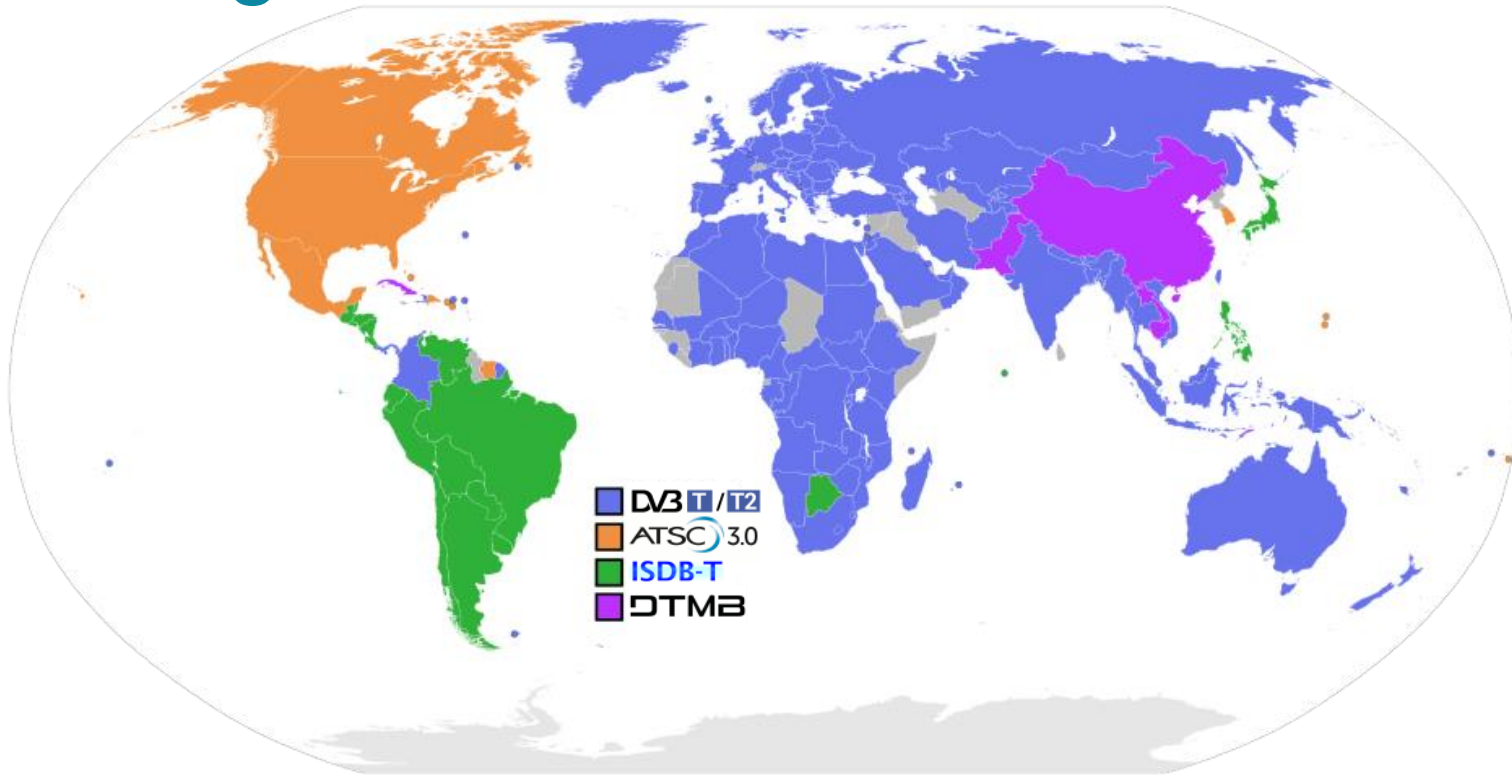

NTSC
SECAM
PAL or PAL/SECAM
no info

Standard	Introduced	Lines	Frame rate	Channel bandwidth (MHz)	Video bandwidth (MHz)	Vision sound carrier separation (MHz)	Vestigial sideband (MHz)	Vision modulation	Sound modulation	Frequency of chrominance subcarrier (MHz)	Vision/sound power ratio	Usual colour
A	1936	405	25	5	3	−3.5	0.75	pos.	AM		4:1	none
B	1950	625	25	7	5	+5.5	0.75	neg.	FM	4.43		PAL/SECAM
C	1953	625	25	7	5	+5.5	0.75	pos.	AM			none
D	1948	625	25	8	6	+6.5	0.75	neg.	FM	4.43		SECAM/PAL
E	1949	819	25	14	10	±11.15	2.00	pos.	AM			none
F		819	25	7	5	+5.5	0.75	pos.	AM			none
G		625	25	8	5	+5.5	0.75	neg.	FM	4.43	5:1	PAL/SECAM
H		625	25	8	5	+5.5	1.25	neg.	FM	4.43	5:1	PAL
I	1962	625	25	8	5.5	+5.9996	1.25	neg.	FM	4.43	5:1	PAL
J	1953	525	30	6	4.2	+4.5	0.75	neg.	FM	3.58		NTSC
K		625	25	8	6	+6.5	0.75	neg.	FM	4.43	5:1	SECAM/PAL
K'		625	25	8	6	+6.5	1.25	neg.	FM	4.43		SECAM
L	1970s	625	25	8	6	-6.5	1.25	pos.	AM	4.43	8:1	SECAM
M	1941	525	30	6	4.2	+4.5	0.75	neg.	FM	3.58		NTSC
N	1951	625	25	6	4.2	+4.5	0.75	neg.	FM			PAL

Example of PAL signal

8 MHz UHF channel

Vision Carrier

Colour subcarrier

FM sound

NICAM

-20dB

Chroma sidebands

-1.25   -0.75   Frequency (MHz)   4.43   5   5.5   5.85   6.75

Digital television standards

Legend:
- DVB T/T2
- ATSC 3.0
- ISDB-T
- DTMB

Standard	DVB-T	DVB-T2	ISDB-T	DTMB	ATSC	ATSC 3.0
Transmission Modes	OFDM 2k, 8k	OFDM 1k, 4k, 16k, 32k	BST-OFDM 2k, 4k, 8k	TDS-OFDM 3780, Single carrier	Single carrier	OFDM 8k, 16k, 32k
Guard intervals	1/4, 1/8, 1/16, 1/32	19/256, 19/128, 1/128	1/4, 1/8, 1/16, 1/32	1/4, 1/7, 1/9	-	192, 384, 512, 768, 1024, 1536, 2048, 2432, 3072, 3648, 4096, 4864
Constellation Order	QPSK, 16QAM, 64QAM	256QAM	QPSK, 16QAM, 64QAM	8-VSB	4/16/32/64 QAM	QPSK, 16QAM, 64QAM, 256QAM, 1024QAM, 4096QAM
Bandwidth	5, 6, 7, 8 MHz	1.712 , 10 MHz	6, 7, 8 MHz	6, 7, 8 MHz	6, 7, 8 MHz	6, 7, 8 MHz
External code	RS (204, 188)	BCH	RS (204, 188)	BCH (762, 752)	RS (207,187)	BCH
Internal code	Convolutional	LDPC	Convolutional	LDPC	Trellis 2/3	LDPC
Capacity	4.98-31.67	7.44-50.32	3.65-23.23	4.81-32.49	19.39	1-57

OFDM spectrum example
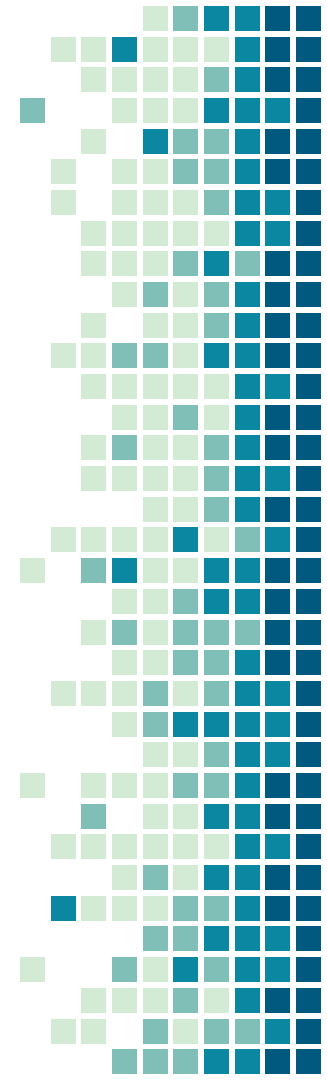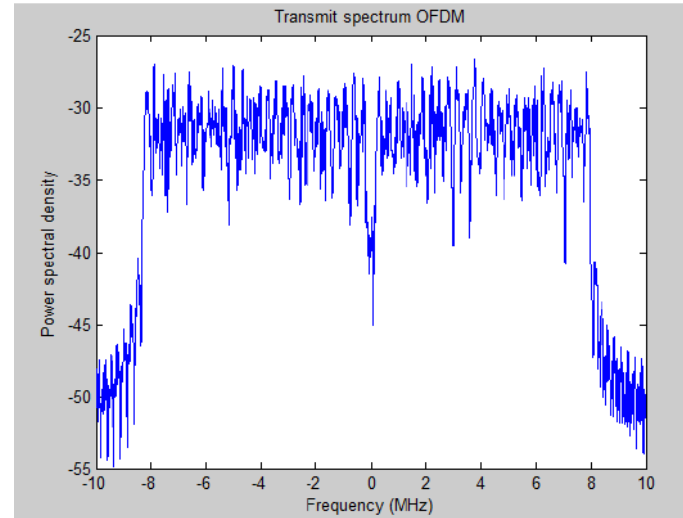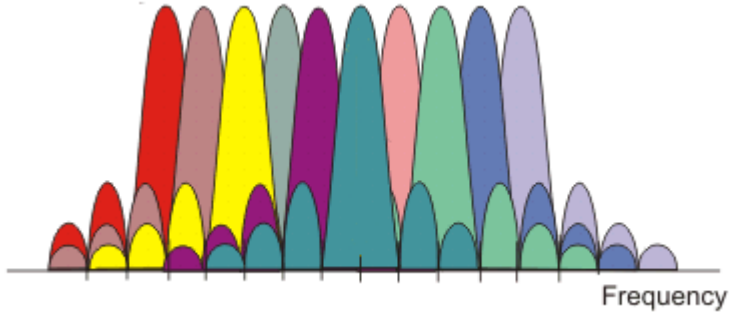
THANKS!

Any questions?

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