ICT4D with focus on technology

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Section 1: Introduction

ICT, definition and terminology

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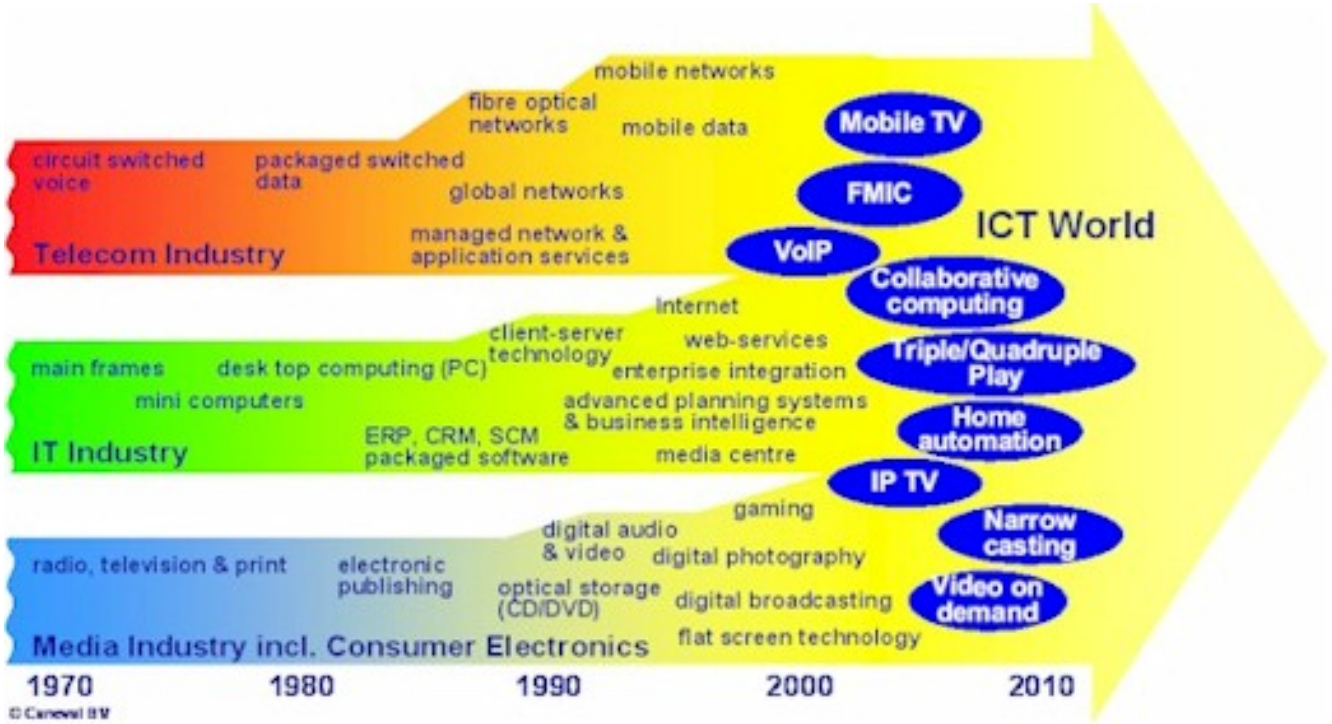
What is ICT?

- Information
- Communication
- Technology

Data, computers, pads, phones, cameras, networks, videos, songs, mail, software, radio, television, compact disc, camera, projector, head phones, ...

Merge of three main industries



ICT, technical perspective

- Processing of data to produce useful information and increase efficiency
  - Hardware
  - Software
  - Content
- Communication of data and information to provide efficient exchange of information
  - Networks
  - Transmission

Terminology and acronyms

- Important when working with technology
  - Available in the course glossary on iLearn
  - Knowledge of terminology is assessed through quizzes
- Enormous terms and acronyms
  - Some terminology is assumed to be known from previous experience

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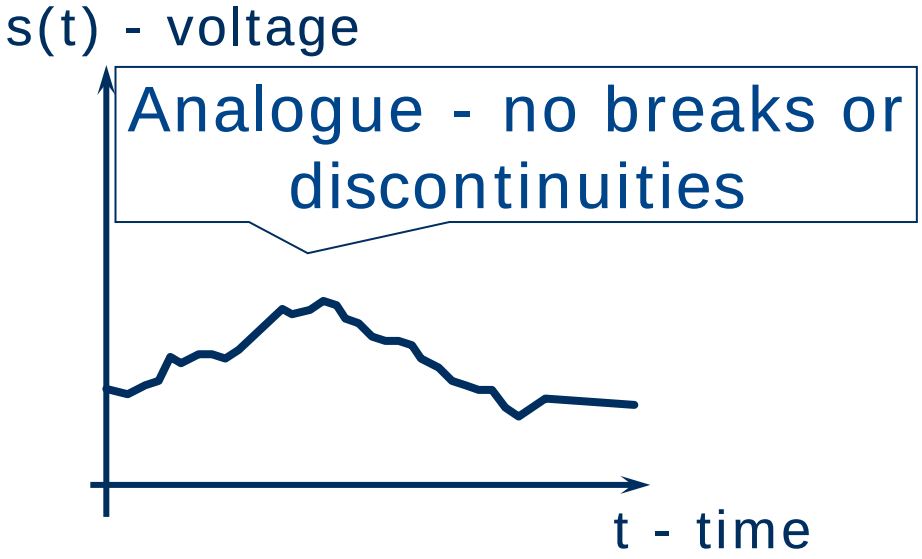
Advantages of Digital Technology

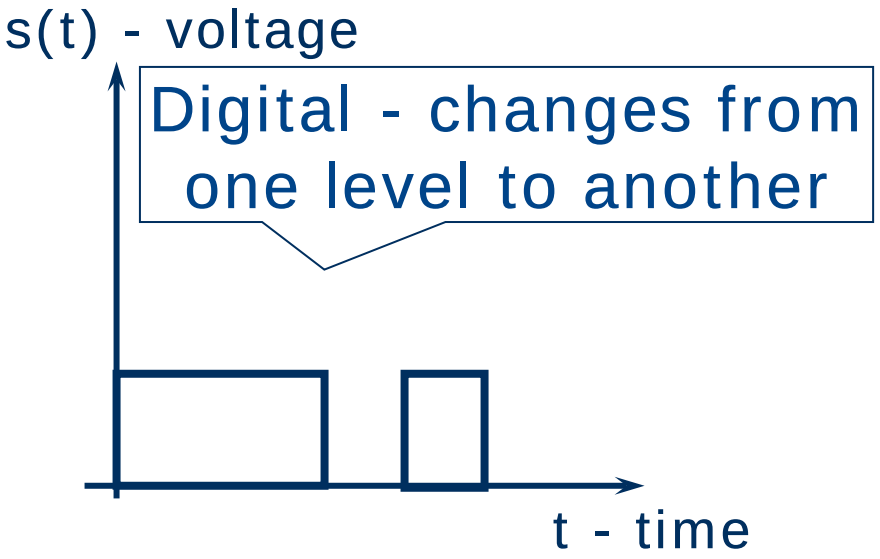
Types of data

- Analogue data
  - Can take any value within a range
  - Human voice, instrument sound, temperature, weight, height, …
- Digital, discrete data
  - Can take limited number of values, or two values only
  - Letters in English alphabet, positions on electric switch, Morse code

Electrical signals

- Data (analogue or digital) are represented with electrical signals when transmitted





Analogue vs. digital environment

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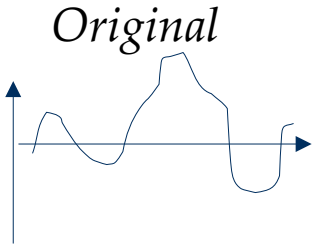
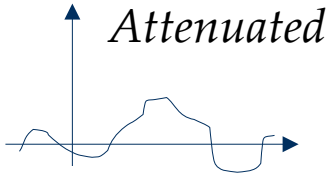
Today both (analogue and digital) environments for data transmission

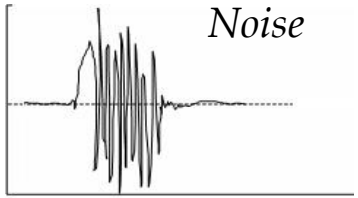
- Analogue
  - Classical local telephone loop
  - Traditional radio and TV broadcast
- Digital
  - Internet
  - Computers and computer networks
  - Everything else including digital radio and TV

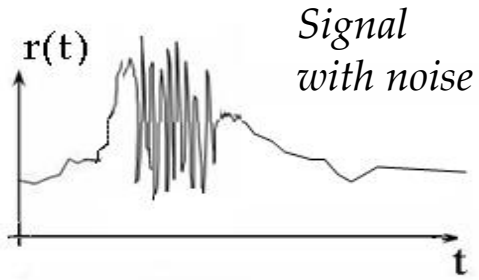
Transmission degradations

- When transmitted on distance signals change due to
  - Attenuation
    - Overall reduced power
  - Distortion
    - Selectively reduced power
  - Noise, S/N (dB)
    - External energy





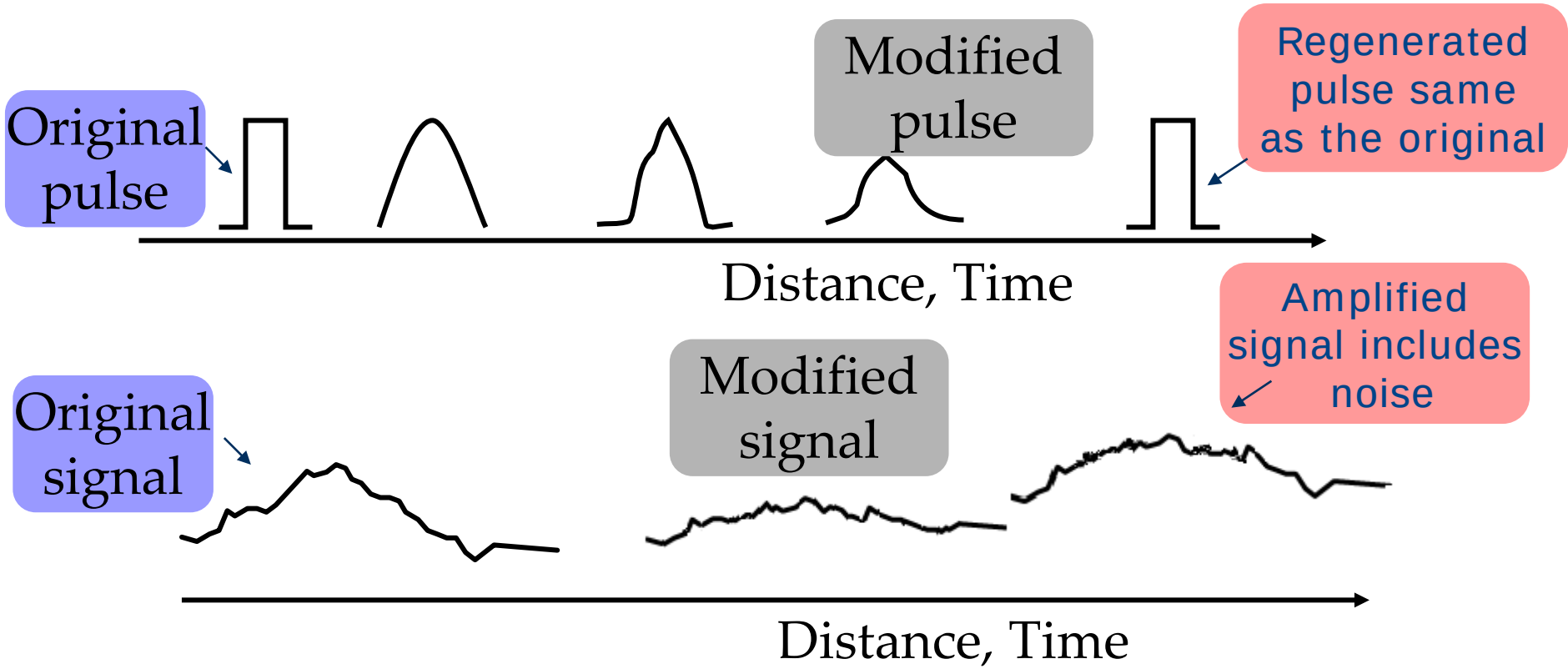




Recovery of the original signal

- Digital transmission
  - Create a threshold, and decision rule
    - If signal is below the threshold, 0 is the original, if it is above the threshold 1 is the original
    - The same pulse is recovered
- Analogue transmission
  - Amplify the signal together with noise

Digital vs. analogue transmission



Benefits from digital signals

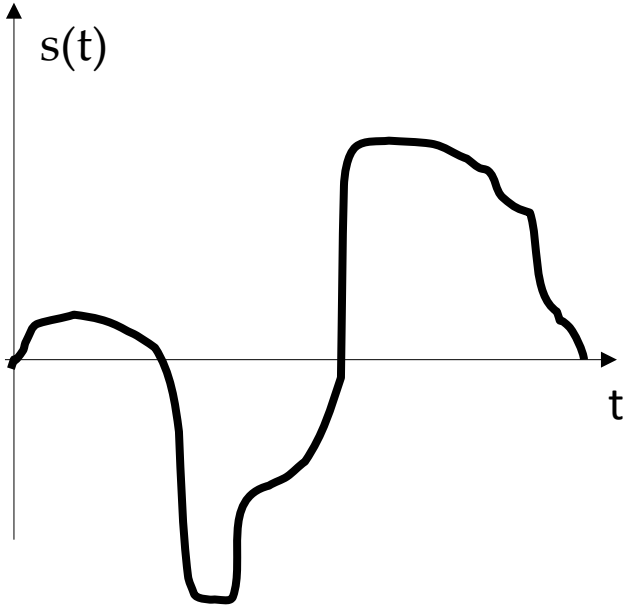
Providing more efficient transmission on distance is the main advantage. Other benefits are:

- Computers use digital signals
- Easier to generate electric signals
- Easier to encrypt (scramble)
- Copying does not affect quality
- When in digital form audio or video can be easily compressed

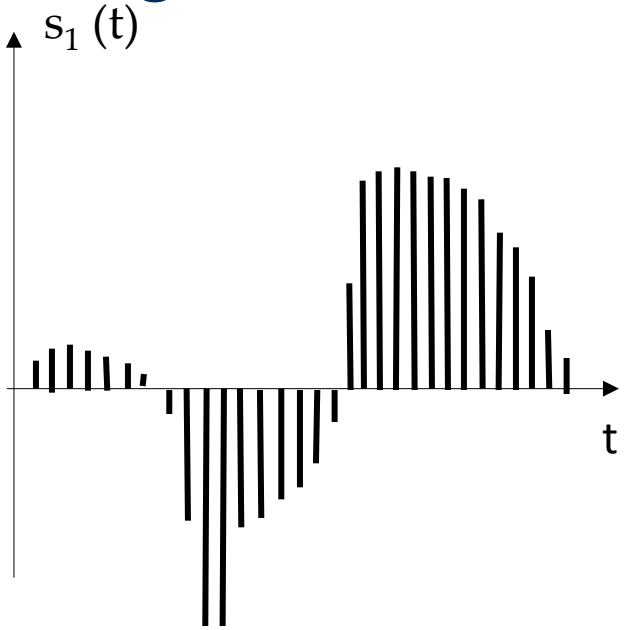
Analogue-to-digital conversion

- Necessary to transfer voice, video and other analogue data into bits (0s and 1s)
- Two steps process
  - Sampling the analogue signal at particular times
  - Coding the samples into bits

Sampling the analogue signal

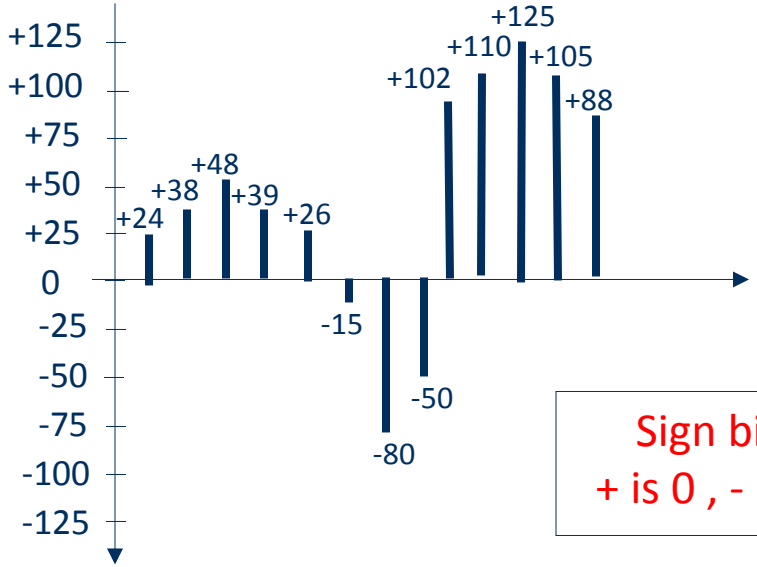


Analog signal



Samples from the analog signal

Coding the samples into bits



Sign bit
+ is 0 , - is 1

+024	00011000	+102	01100100
+038	00100110	+110	01101110
+048	00110000	+124	01111101
+39	00100111	+105	01101001
+26	00011010	+85	01011000
-015	10001111		
-80	1101000		
-50	10110010		

Digital-to-analogue conversion

- Necessary to transmit 0s and 1s using older transmission systems
- A sine wave as analogue signal (called carrier) is used
  - It is characterised with amplitude, frequency and phase
  - Changes in one of the from one to another value represent 0s and 1s

Conversion of a digital signal

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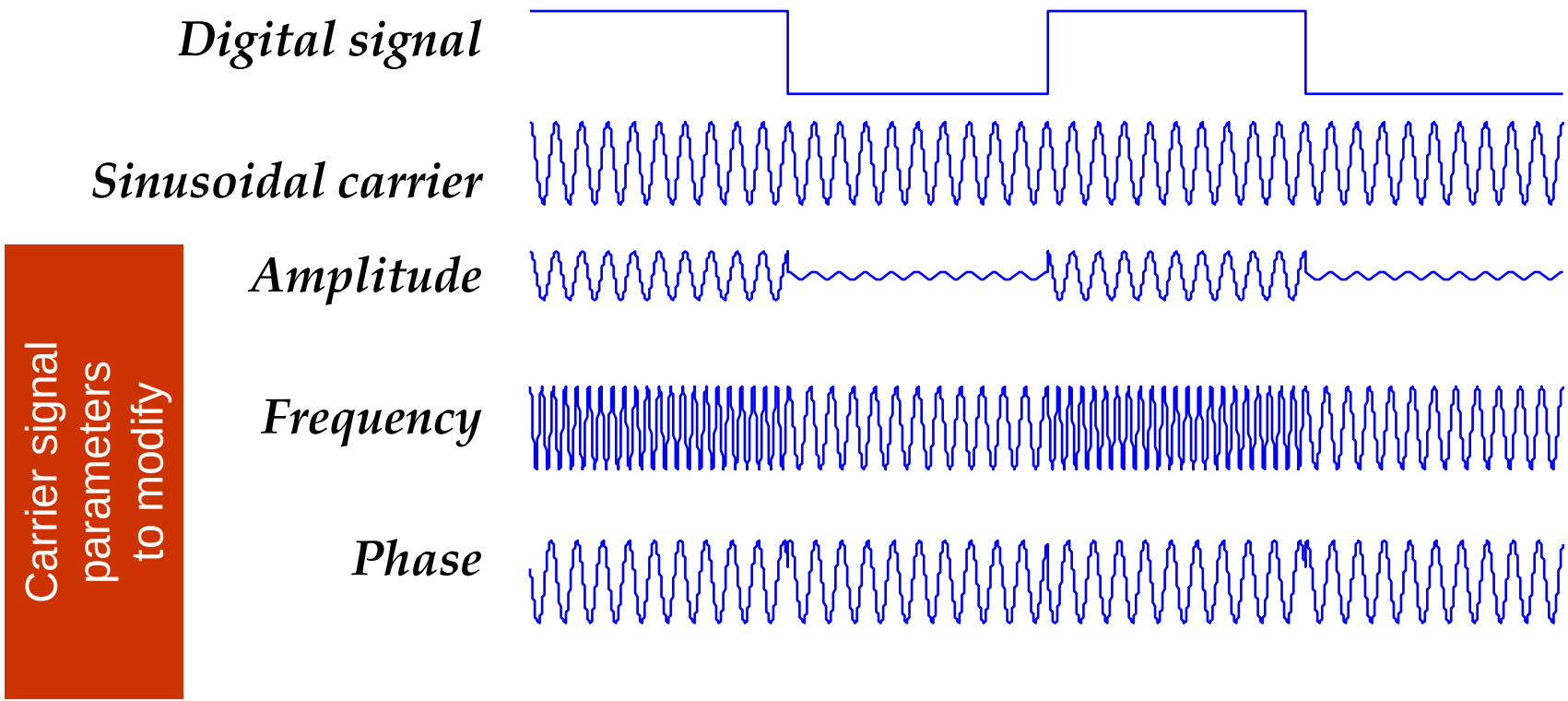


Codecs and modems

- Codec
  - COder-DECoder
  - A device used to provide digital transmission of analog signals
- Modem
  - MOdulation-DEModulation
  - A device used to provide analog transmission of digital signals

Examples of data and transmission

- Analogue to analogue

Voice (analogue data) →Telephone →Analogue signal

- Digital to analogue

PC (digital data) →Modem →Analogue signal

- Analogue to digital

Voice (analogue data) →Codec →Digital signal

- Digital to digital

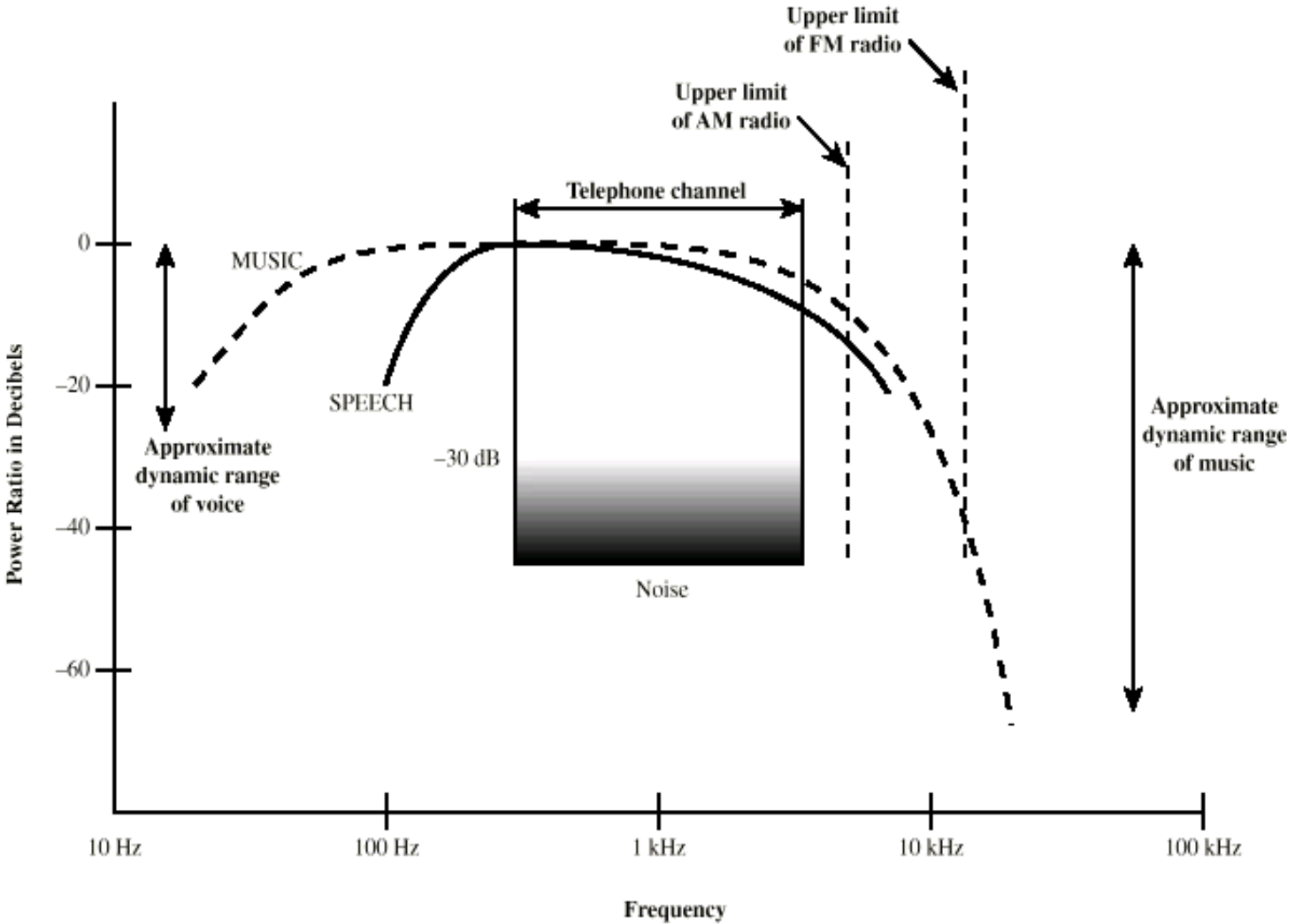
PC (digital data) →Digital transmitter →Digital signal

Time and frequency domain

- Time domain for an electric signal
  - s(t) – the voltage changes with time
- Frequency domain of an electric signal
  - S(f) - specifies the constituent frequencies of the signal s(t)
  - Frequency spectrum of the signal defines the power of each frequency
- Carrier
  - A sine-wave signal with a single frequency

Bandwidth

- Absolute bandwidth – width of the signal spectrum, $B = f_{highest} - f_{lowest}$
- Effective bandwidth – range of frequencies containing the most of the signal power
- Analogue channel bandwidth – range of frequencies passed by the channel (measured in Hz)
- Digital channel bandwidth – capacity of the channel (measured in bits/s)


Upper limit
of FM radio
Upper limit
of AM radio
Telephone channel
0
–20
–40
–60
MUSIC
SPEECH
–30 dB
Noise
Approximate
dynamic range
of voice
Approximate
dynamic range
of music
Power Ratio in Decibels
10 Hz
100 Hz
1 kHz
10 kHz
100 kHz
Frequency

Bits and bytes

- BIT = BInary digiT (1 or 0)
  - Used in expressing channel capacity (b/s or bps)
- Byte - a unit for measuring amount of data
  - Used to measure size of files
  - 1 Byte = 8 bits

Decimal numbers in binary

- $2^0=1$, $2^1=2$, $2^2=4$, … $2^6=64$, $2^7=128$, …
- Examples
  - 129 = $2^7 + 2^0$ (10000001)
  - 195 = $2^7 + 2^6 + 2^1 + 2^0$ (11000011)
  - 76 = $2^6 + 2^3 + 2^2$ (1001100)

File size, capacity and time

- A file of 1000 Bytes will be transmitted in 8 seconds via a channel with capacity of 1 Kb/s
  - 1000 B = 1000*8 = 8000 bits
  - 1 Kb/s = 1000 bits/second
  - Time = size of the file (bits)/capacity (bits/second)
  - Time = 8000/1000 = 8 seconds

Digital divide, e-readiness

Digital divide

- Inequality in availability and use of ICT
- The Internet considered as the most powerful ICT if used properly
- Different types of digital divide based on
  - Economic power
  - Age
  - Gender
  - Area of residence (rural, urban)
  - Education level

E-readiness assessment

- Compare progress with respect to ICT
  - Aiming to help developing countries to develop suitable policies
  - Progress of the countries is followed
- Different tools calculate different indexes
  - The purpose is usually different
- Ranking of countries as a result of calculating the readiness index are produced

Economist Intelligence Unit e-readiness rankings and scores, 2009

2009 rank (of 70)	2008 rank	Country	2009 score (of 10)	2008 score
1	5	Denmark	8.87	8.83
2	3	Sweden	8.67	8.85
3	7	Netherlands	8.64	8.74
4	11	Norway	8.62	8.60
5	1	United States	8.60	8.95
6	4	Australia	8.45	8.83
7	6	Singapore	8.35	8.74
8	2	Hong Kong	8.33	8.91
9	12	Canada	8.33	8.49
10	13	Finland	8.30	8.42
11	16	New Zealand	8.21	8.28
12	9	Switzerland	8.15	8.67
13	8	United Kingdom	8.14	8.68
14	10	Austria	8.02	8.63
15	22	France	7.89	7.92
16	19	Taiwan	7.86	8.05
17	14	Germany	7.85	8.39
18	21	Ireland	7.84	8.03
19	15	South Korea	7.81	8.34
20	20	Belgium	7.71	8.04
21	17	Bermuda	7.71	8.22
22	18	Japan	7.69	8.08
23	23	Malta	7.46	7.78

Top of the table

50	53	Jordan	4.92	5.03
51	46	Saudi Arabia	4.88	5.23
52	58	Colombia	4.84	4.71
53	51	Peru	4.75	5.07
54	55	Philippines	4.58	4.90
55	52	Venezuela	4.40	5.06
56	56	China	4.33	4.85
57	57	Egypt	4.33	4.81
58	54	India	4.17	4.96
59	59	Russia	3.98	4.42
60	63	Ecuador	3.97	4.17
61	62	Nigeria	3.89	4.25
62	61	Ukraine	3.85	4.31
63	60	Sri Lanka	3.85	4.35
64	65	Vietnam	3.80	4.03
65	68	Indonesia	3.51	3.59
66	64	Pakistan	3.50	4.10
67	67	Algeria	3.46	3.61
68	70	Iran	3.43	3.18
69	66	Kazakhstan	3.31	3.89
70	69	Azerbaijan	2.97	3.29

Bottom of the table

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Factors used for comparison

- Technology infrastructure
  - Fixed telephone lines, mobile subscribers, Internet users, Internet hosts, …
- ICT policies and market conditions
- Prices and ICT industry
- Level of education and literacy
- Social and cultural factors

Problems in developing world

- Poor physical infrastructure
  - Fixed phone lines
  - Electricity
  - Connection with the world
- Lack of knowledge
  - Low literacy
  - Brain drain of educated people
- Internet introduced by commercial ISP
  - High prices, lack of peer agreements
- Lack of financial and human resources

Is there progress?

- ICT plays important role
  - Large investments by donor agencies
  - Raised awareness of governments
  - Wireless technologies
  - Education in focus
- Still doubts of how ICT can help
  - Many failed projects
  - Success stories
  - Ongoing research

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Challenges with ICT in developing regions

ICT at national level

- National ICT strategy
  - Raises awareness about the benefits and requirements
  - Creates environment for adoption of ICT
  - Sets framework for regulating access, costs, investments, …
  - Builds capacity and skills necessary for information society

ICT for the bottom of the pyramid

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- Assistance in reaching millennium development goals (MDG)
  - Micro enterprises
  - Mobile banking
  - Telecenters/Media centers
  - ICT in education
  - Information system for farmers
  - GIS (Geographical Information System) for making land ownership
  - Telehealth with phone based monitoring and alert system

How can ICT be used?

- Using ICT for development
  - Technology is used as it is to reach development goals – not always appropriate
- Adapting ICT for development
  - Technology is adapted to local specific needs – the most common way
- Developing ICT for development
  - New solutions are devised – not always possible

ICT4D projects

- Many ICT4D projects fail
  - Common reason
    - Direct replication
    - Dumping old ICT
    - Not involving beneficiaries and users
    - Ignoring local capacities
    - Ineffective leadership
    - …

ICT4D project design

- Take in consideration
  - Problem
  - Stakeholders
  - Technology
  - Metrics for measuring and evaluating success
  - Sustainability

Problem

- Originates from users, beneficiaries
- Has appropriate scope
- Can be addressed with ICT
- Questions to be asked
  - Has similar problem been addressed?
  - What are lessons learnt?

Stakeholders

- Beneficiaries, targeted population
- Service providers
  - Government, NGOs, commercial entities
- Funding agencies, regulators
- ...

All stakeholders should be included in all phases of the project

Technology

- Most appropriate, optimized
- All prerequisites in place
  - Electricity, needed equipment, software, content, …
- Cost effective
  - Initial and maintenance costs
- Does not harm the environment

Metrics for measuring success

- Metrics are clearly defined
- Methodologies for measuring are clarified
- Who measures is decided
- All stakeholders agree on the metrics and measurement process
- Lessons from failures learnt

Sustainability

- Ownership is defined in the early stage
- Beneficiaries can afford it
- Suppliers are satisfied (profitable)
- Culturally acceptable
- Can be scaled up or down if conditions change