

AUDIO AND VIDEO COMMUNICATION

Fernando Pereira



Relation and Logistics

**Nothing great was ever achieved
without enthusiasm.**



Ralph Waldo Emerson

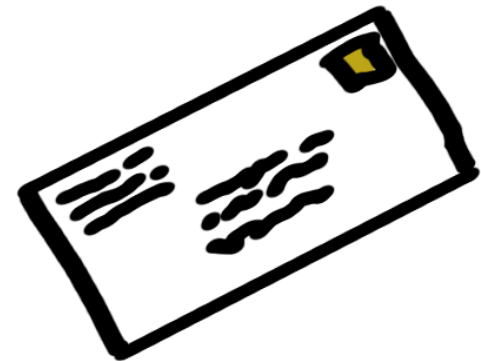
US essayist & poet (1803 - 1882)

Web Page and Mailing List

http://www.img.lx.it.pt/~fp/cav/Welcome_CAV.htm

To subscribe the course
mailing list send a message
to fp@lx.it.pt

Mailing list address:
CAV_MEEC@lx.it.pt



Lectures Schedule

Theoretical Lectures

- ★ 2 lectures of 90 minutes per week – Monday, 9.30am, room EA1, and Wednesday, 9.30am, room VA2

Practical Lectures (in weeks with no lab)

- ★ 1 lecture of 90 min per week – Monday, 11am and 2 pm, room E1, Tuesday, 5pm, room E2

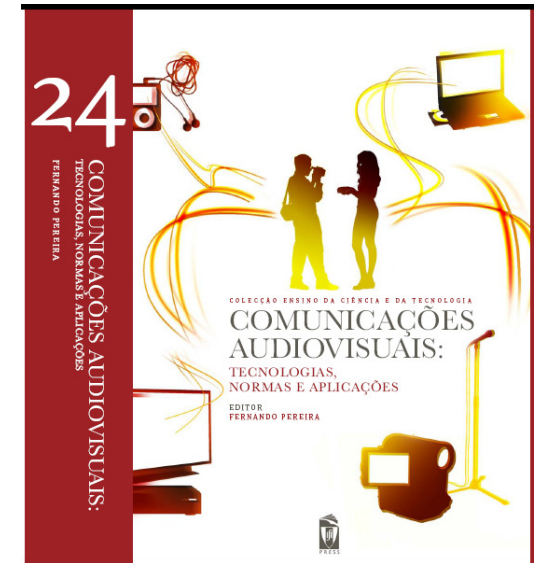
Laboratory Sessions (in weeks with no practical)

- ★ 1 lecture of 90 min per week – Monday, 11am and 2 pm, room LT4, Tuesday, 5pm room LT4

The weeks with practical lectures or lab sessions will be announced in the CAV mailing list.

Studying material made available consists in:

- ★ **Book “Comunicações Audiovisuais: Tecnologias, Normas e Aplicações”, IST Press, 2009 (details at the CAV Web Page)**
- ★ **Slides from theoretical lectures (available at CAV Web Page)**
- ★ **Additional supporting texts for each topic (available at the CAV Web Page)**
- ★ **Collection of exercises with the corresponding solutions (available at CAV Web Page)**
- ★ **Laboratory guides (available at CAV Web Page)**
- ★ **Exams from previous years with solutions (available at CAV Web Page)**



Book ... *Ma Non Troppo* ...

- ★ Introduction
- ★ Basic on AV Representation
- ★ Digital Images
- ★ Videotelephony and Videoconference
- ★ Digital Video Storage
- ★ Digital Television
- ★ Advanced Multimedia Coding

Chap. 1

Chap. 5

Sec. 8.3, 10.4

Sec. 9.1, 9.2, 9.3, 9.6 (brief), 11.3-5 (brief)

Sec. 3.3, Sec. 7.1-7.5, Sec. 9.4, 11.6

Sec. 9.5, 10.1, 10.3, 11.7

Sec. 9.7 e 11.8 (brief), 9.8



Note: The book authors gave up on any royalties to reduce the price of the book.

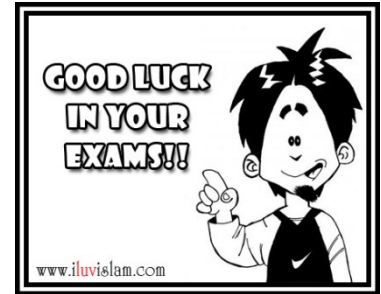
References for Slides and Figures

Many of the slides have been inspired (or even simply reused) by materials provided by several friends, notably Touradj Ebrahimi (EPFL, Switzerland), Anthony Vetro (MERL, USA), and G.Sullivan (Microsoft, USA).

Also many figures have been taken from the Internet ...



Appropriate references should have been used throughout the slides !



The evaluation method includes three components, notably:

1. **WRITTEN EXAM**

- After the end of the lecturing period (weight 70%) – 15th and 29th January, 8h 2015;

2. **OVERVIEW PAPER** (in groups of 2 or 3)

- About a selected topic, to be finished by 12th December 2014 (weight 30%); preliminary table of contents by 31st October 2014

3. **LABORATORY PARTICIPATION** (in groups of 2)

- Just filling a form during the laboratory session.

The final mark is computed as:

$$\textit{Final_Mark} = \textit{round} [(0.7 \times \textit{Exam} + 0.3 \times \textit{Paper}) \times \textit{Lab}]$$

where *Lab* is 1 if the student participated in, at least, *N-1* out of the *N* lab sessions, and 0.95 otherwise.

Evaluation Method: Some Rules ...

★ Written exam

- The minimum mark for the exam is **9.5**.

★ Overview paper

- The minimum mark for the divulgation paper is **9.5**.
- The overview paper should be written in groups of **2 or 3 students**.
- The overview paper mark is individual even if the paper is a group work.
- The evaluation of the overview paper may include a self-assessment component.
- The evaluation of the overview paper may include a presentation and/or discussion, if found necessary.

★ Final mark

- The students with a final mark higher than 17 may have to make an oral exam to confirm the mark; not making this oral exam, if requested, implies getting a mark of 17.

Evaluation Method: Paper Self-Assessment

- ★ By the paper deadline date, each student (not each paper) will provide to a previously identified student representative, his/her 'estimate' of the mark for his/her paper. The professor will have NO access to these 'score estimates'.
- ★ The professor will score the papers in a 0-20 scale.
- ★ The students which estimated mark is **the same** as the professor's mark will get a bonus of 1 point in the paper mark.
- ★ The students which estimated mark is **± 1 point** regarding the professor's mark will get a bonus of 0.5 point in the final paper mark.



About the Overview Paper

- ★ **The overview paper shall provide the most relevant information about a topic related to multimedia communication. The paper does not have to be original but should provide a good summary of the topic using appropriate references.**
- ★ **The paper targets to stimulate in the students the contact with bibliographical research and also with the reality including relevant companies and industry.**
- ★ **The paper will be produced in two versions:**
 1. **Paper version** which shall not have more than **8 PAGES** using the template made available at the CAV Web Page.
 2. **Web version** with a similar content of the paper version but exploiting HTML capabilities typical of Web content, e.g. including video and audio material, and interactivity.
- ★ **Deadlines**
 - ★ **31st October 2014** – 2 pages pdf file (by email) with the paper table of contents (the topic should have been selected before)
 - ★ **12th December 2014** – Paper (printed) and Web (by email) versions

Overview Paper: Example Topics

- ★ Aquisição e visualização de imagem
- ★ Codificação de música
- ★ Codificação de vídeo: a guerra dos formatos
- ★ Descrição e procura de informação visual
- ★ Descrição e procura de música
- ★ *Digital Video Disc*
- ★ *Blu-ray*
- ★ *Tablets*
- ★ *YouTube*
- ★ *Skype*
- ★ Protecção de conteúdos multimédia
- ★ *Digital Video Broadcasting*
- ★ *TV 3D*
- ★ Videotelefonia e videoconferência
- ★ Sistemas de videovigilância
- ★ Televisão interactiva
- ★ TV digital terrestre
- ★ IPTV
- ★ Vídeo de ultra alta definição
- ★ Vídeo na Internet
- ★ *High dynamic range imaging*
- ★ *Video in the cloud*
- ★ Vídeo móvel
- ★ *Displays 3D*
- ★ Holografia
- ★ ...

Special Overview Papers



If you are interested in doing a M.Sc. Thesis in video processing, coding, etc:

- ★ **May select the CAV overview paper topic as preparation for your M.Sc. Thesis**
- ★ **Overview paper will be in English and may be longer than 8 pages**
- ★ **Weight of the work may be raised up to 50%**
- ★ **Selection based on interview**

Explaining the Overview Paper ...



Today at 11am and 2 pm, E1

Tomorrow at 5pm, E2



Students should request the overview paper topic by sending an email to fp@lx.it.pt with the topic and the names and numbers of the students.

Lab Registration

Monday 11am and 2 pm, LT4

Tuesday, 5pm, LT4

Send email to fp@lx.it.pt with
(2 names+numbers)/group.

FIFO processing ...



The Course Context

Audio and Video Communication

Transference of image, audio and video information through space, time, or space and time simultaneously.



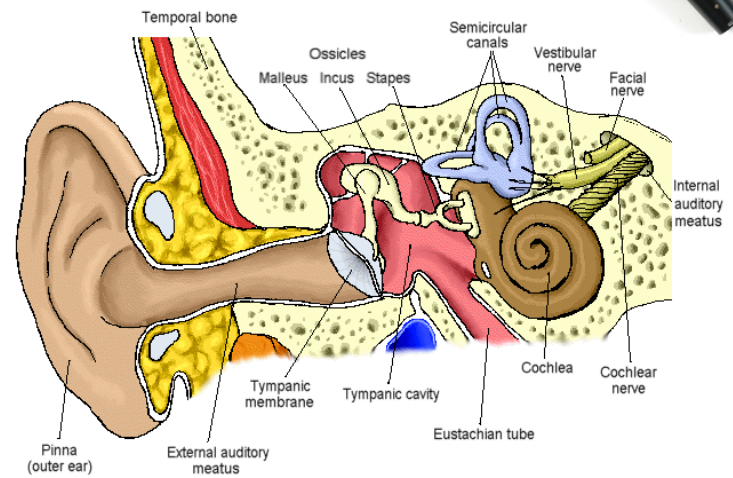
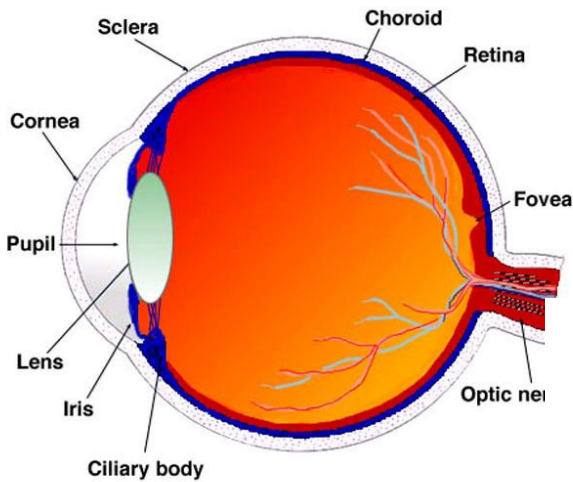
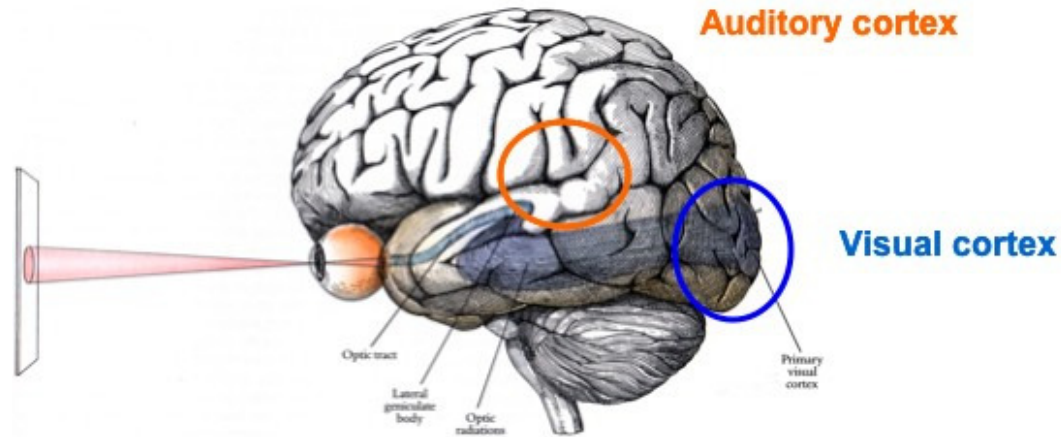
The Importance of the User ...



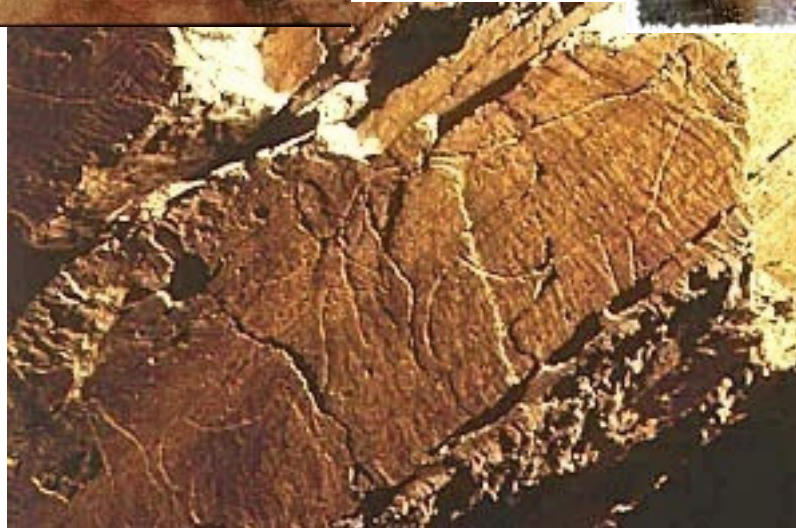
We All Communicate ...



Sensations, Perceptions and Emotions ...



Communicating Since a Long Time Ago ...



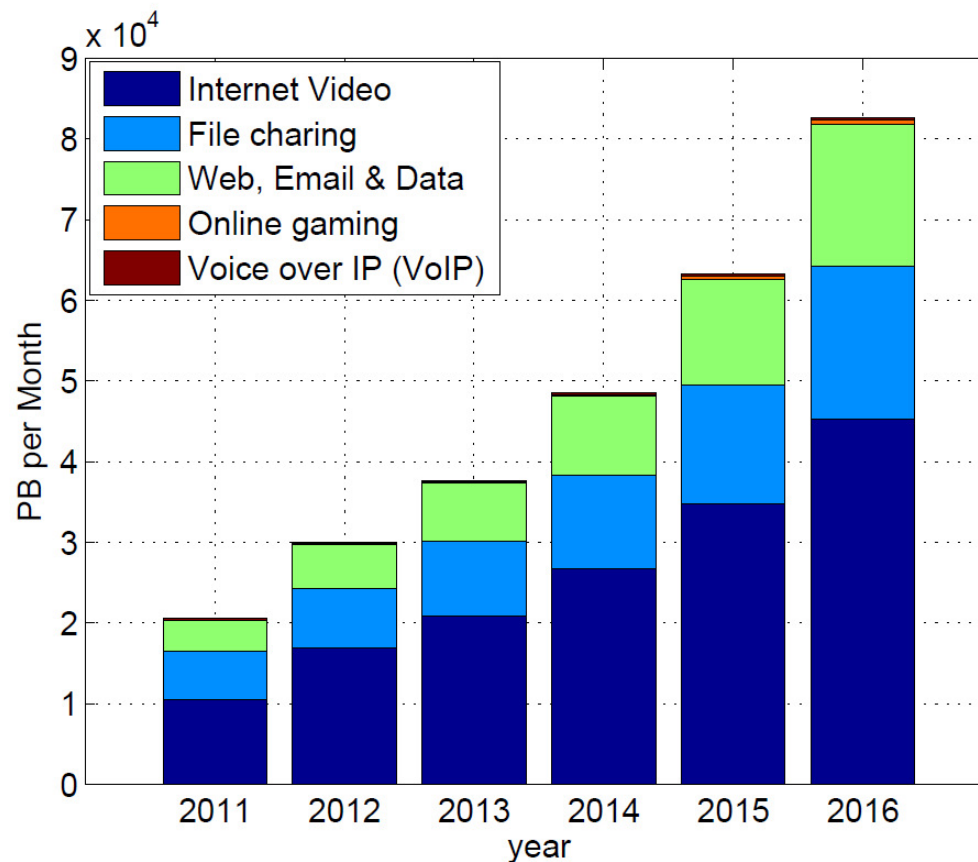
And After Telecommunicating ...



You Tube
Broadcast Yourself



Video Traffic is Exploding ...



- ★ **The sum of all forms of IP video will ultimately reach 86% of total IP traffic.**
- ★ **Only Internet video (excluding file sharing and gaming) will account for 55% of consumer Internet traffic in 2015.**
- ★ **Every second, 1.2 million minutes of video content will cross the network in 2016.**

from Cisco Visual Networking Index (VNI), Tech. Rep., 2012

What do the Users Want ?

- ★ Information
- ★ Entertainment
- ★ Communication
- ★ Games
- ★ Education
- ★ Shopping
- ★ ...



How can Clients be Convinced ?

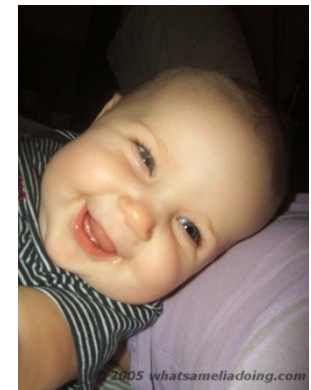
- ★ Satisfaction of personal needs
- ★ Added value, new capabilities
- ★ Interoperability
- ★ Quality and robustness
- ★ Content variety
- ★ (Low) cost of equipment and usage
- ★ Easy usage
- ★ ...



Satisfaction: Quality versus Service

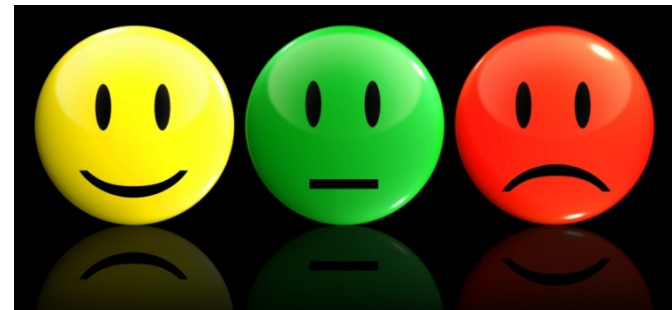
The minimum required quality of service/experience depends on the service:

- ★ **Videotelephony**
- ★ **Videoconference**
- ★ **Television**
- ★ **High definition digital television**
- ★ **Ultra high definition television**
- ★ **3D TV**

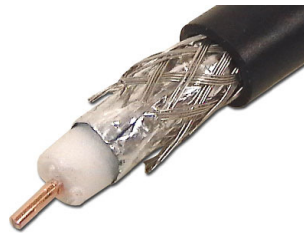
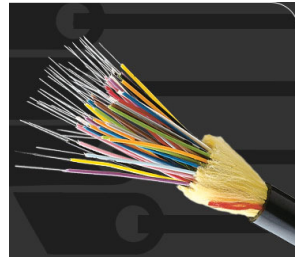


Quality ? What Quality ?

- ★ **What does ‘quality’ mean ? What is and what determines ‘good quality’ ?**
- ★ **YouTube video and audio quality are sometimes quite poor ... but improving fast ... still, this does not prevent some of this content to be very popular ...**
- ★ **Which are the components determining quality ?**
 - Signal fidelity
 - User profile and needs
 - User involvement
 - Context, e.g. train, abroad
 - Natural environment, e.g. noisy, dark
 - ...



Service Paradigms: (Conventional) Broadcasting



- ★ Unidirectional
- ★ Point to multipoint
- ★ Real-time or not
- ★ Low delay but not critical
- ★ High quality
- ★ Generic content
- ★ Centralized content production model
- ★ Several channels and networks
- ★ ...

Service Paradigms: Interactive Broadcasting



- ★ Bidirectional but asymmetric
- ★ Point to multipoint and point to point
- ★ Real-time or not
- ★ Critical reaction delay
- ★ High quality
- ★ Generic content
- ★ Centralized content production model
- ★ Several channels and networks
- ★ ...

Service Paradigms: Personal Communications



- ★ Bidirectional and symmetric
- ★ Point to point
- ★ Real-time
- ★ Critical delay
- ★ Low or medium quality
- ★ Specific content
- ★ Several channels and networks
- ★ ...

Service Paradigms: Storage



- ★ Local, no transmission
- ★ High storage capacity
- ★ Very high quality
- ★ Low delay
- ★ Generic content
- ★ Centralized content production model
- ★ Mainly optical storage
- ★ ...

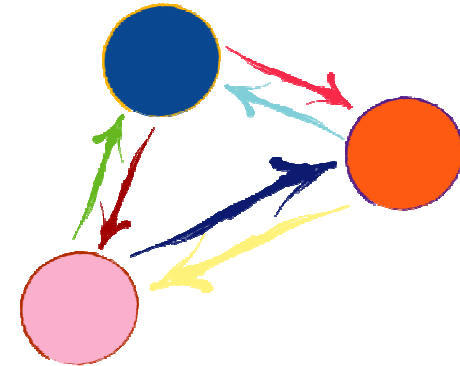
Service Paradigms: Games



- ★ Storage (or bidirectional)
- ★ Point to point (or multipoint)
- ★ Real-time
- ★ Critical delay
- ★ High quality/realism
- ★ Synthetic and natural content mix
- ★ Centralized content production model
- ★ Mainly optical storage
- ★ ...

The Course Contents

Course Objectives



- ★ **To understand the main concepts and tools in video and audio representation, especially targeting compression**
- ★ **To understand how the concepts and tools build complete solutions to address the needs and requirements of relevant applications**
- ★ **To study some relevant compression solutions, both standard and non-standard based**
- ★ **To discuss future trends in audio and video compression technology and services**

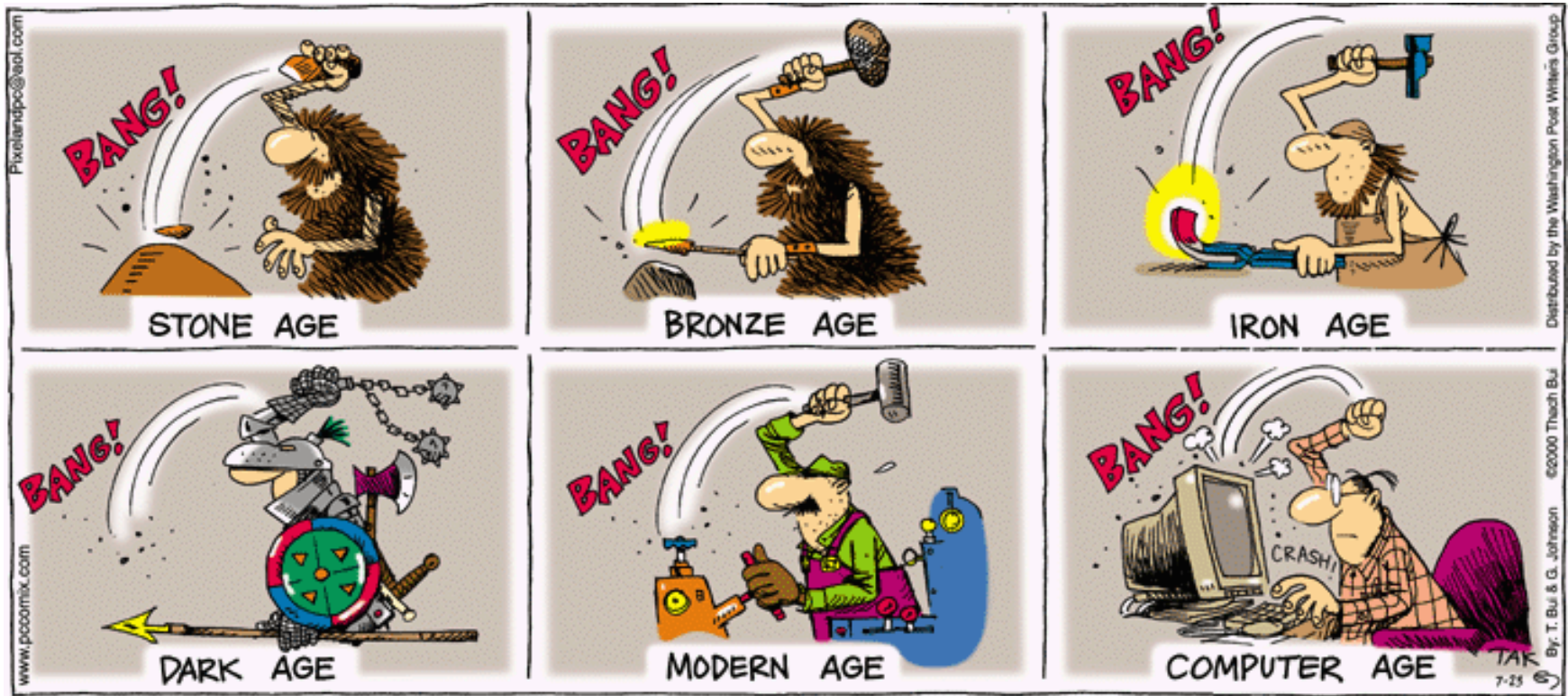
Non scholae, sed vitae discimus

Seneca

We do not learn for the school, but for life

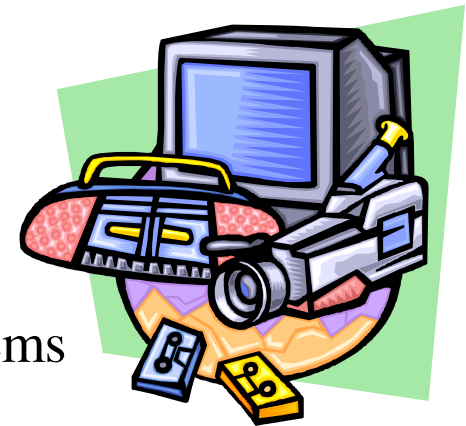


Program: an Evolutive Perspective

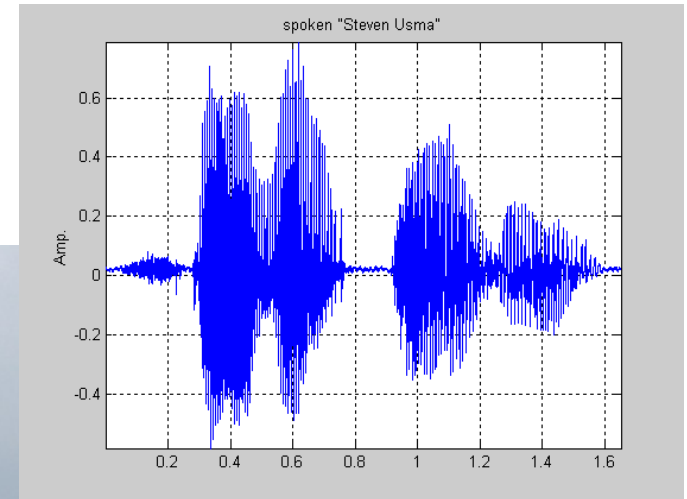


Program: a Summary

- 1. Introduction to Audio and Video Communication**
- 2. Basics on Digital Audio and Video Representation**
- 3. Digital Audio and Video Communication Systems**
 - 3.1 Photographic imaging
 - 3.2 Videotelephony and videoconference
 - 3.3 Digital video storage
 - 3.4 Digital television
 - 3.5 Advanced multimedia communication systems
 - 3.6 3D video systems



An Analogue World ...

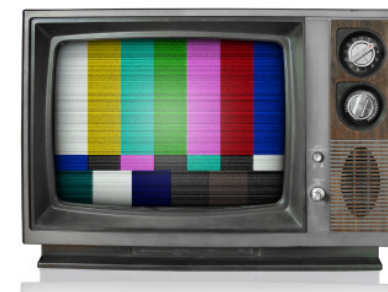


Analogue Communications World ...



±1880

±1905



±1920

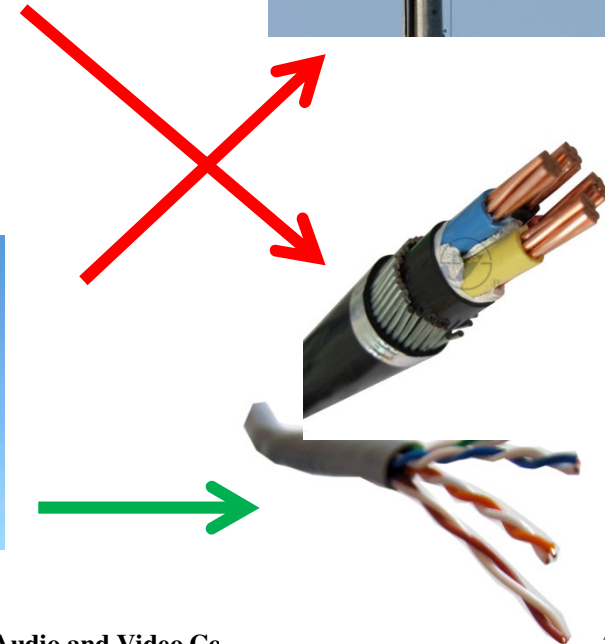
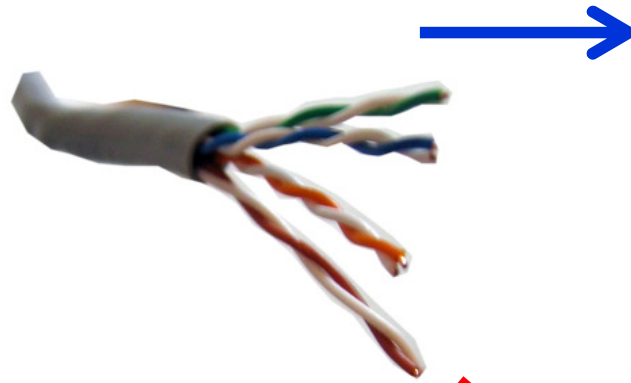
Audio

, 2014/2015

The World Up Side Down ...

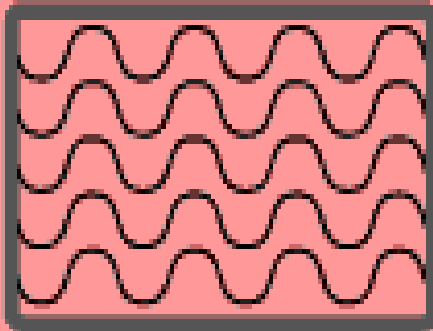


The World is Made of Change...



Bit Jumping ...

ANALOGUE



DIGITAL

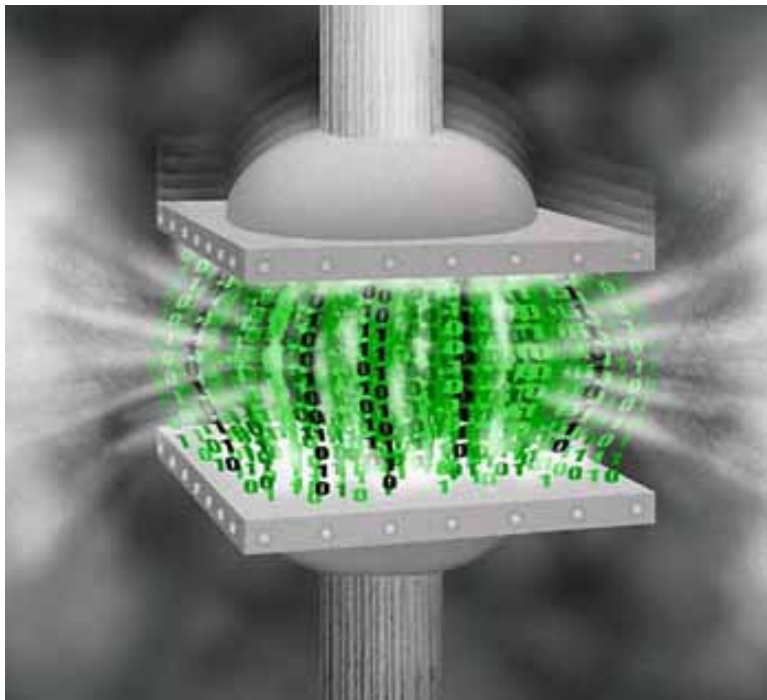
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Many, Really Many, Bits ...

- ★ **Speech** – 2×4000 samples/s with 8 bit/sample – **64000 bit/s = 64 kbit/s**
- ★ **Music** – 2×22000 samples/s with 16 bit/sample – **704000 bit/s = 704 kbit/s**
- ★ **Video** – $(576 \times 720 + 2 \times 576 \times 360) \times 25$ (20736000) samples/s with 8 bit/sample – **166000000 bit/s = 166 Mbit/s**
- ★ **Full HD 1080p** - $(1080 \times 1920 + 2 \times 1080 \times 960) \times 25$ (103680000) samples/s with 8 bit/sample – **829440000 bit/s = 830 Mbit/s**

We Need a Miracle !



Digital TV: Only an Example

- ★ ITU-R 601 standard: 25 images/s with 720×576 luminance samples and 360×576 samples for each chrominance, at 8 bit/sample

$$[(720 \times 576) + 2 \times (360 \times 576)] \times 8 \times 25 = \mathbf{166 \text{ Mbit/s}}$$

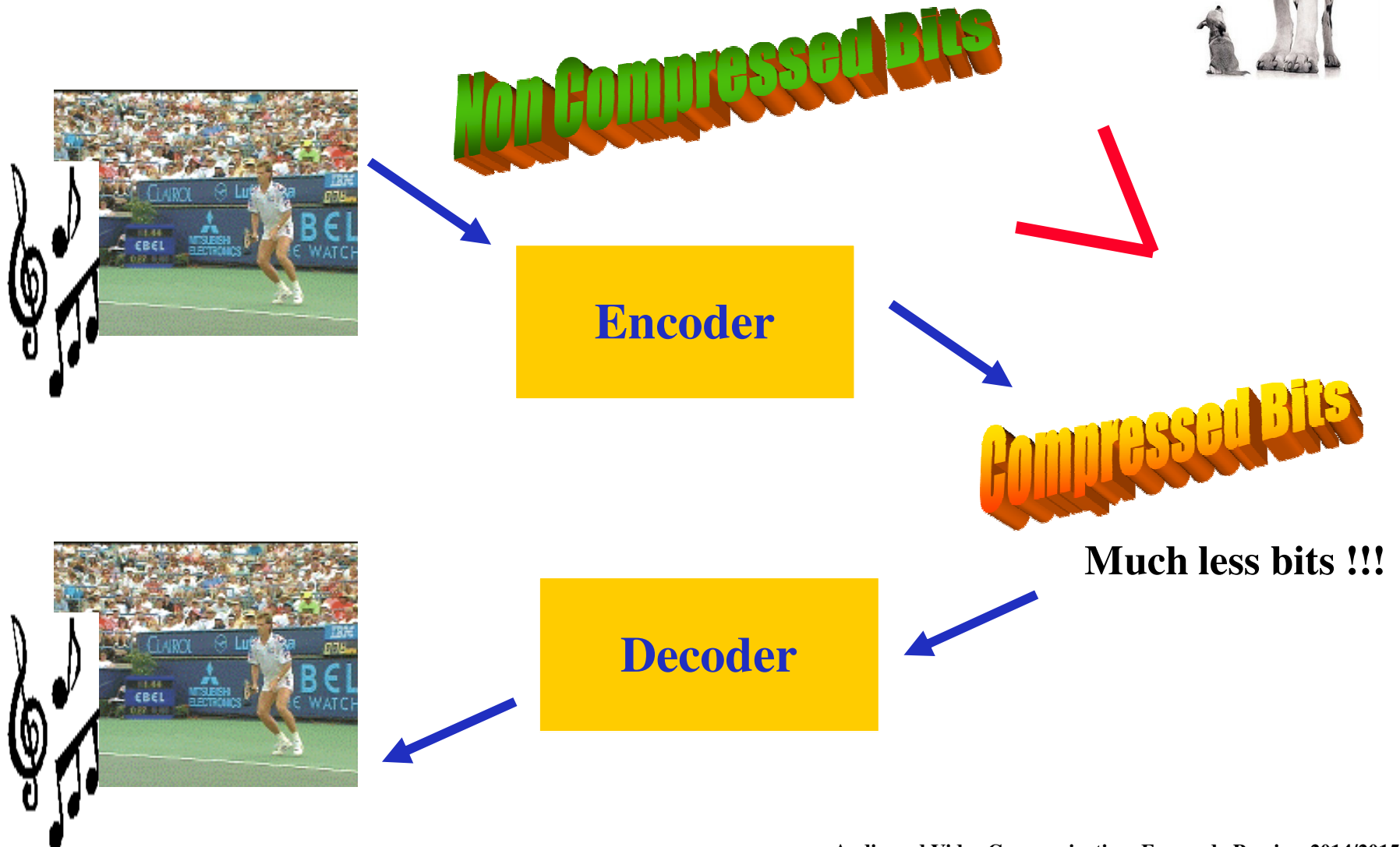
- ★ Practical bitrate with H.264/MPEG-4 AVC codec: **2 Mbit/s**

=> Required Compression Factor: $166/2 \approx 80$



The difference between compressing or not implies the existence or not of many largely used services.

The Compression Miracle ...



The Consequences of the Miracle (1) ...



The Consequences of the Miracle (2) ...



The Multimedia Babel Tower ...



4 billion (June 2009)

- ~4000 uploads/minute
- 128 years to view all of them (1s per image)
- 2% Internet users visit
- Daily time on site: 4.7 minutes



120 million (July 2009)

- ~20 hours uploaded/minute
- 600 years to see all of them
- 20% Internet users visit
- Daily time on site: 23 minutes
- 2007 bandwidth = entire Internet in 2000
- March 2008: bandwidth cost US\$1M a day



15 billion (April 2009)

- ~22000 uploads/minute
- 480 years to view all of them (1s per image)
- 24% Internet users visit
- Daily time on site: 30 minutes



From Hunger to Plenty or Drowning in Data ...



Filtering TV ...



File TV Channel Radio Channel Digital Text Channel EPG Capture Video Recorder Help

PVR Main Menu

- 1 7 Day Guide
- 2 Timer
- 3 TV Recordings
- 4 Radio Recordings
- 5 Playlist

Today

- BBC ONE
- BBC TWO
- ITV 1
- Channel 4
- five
- ITV 2

Change to Mark for

Countdown

The... Fi De

Jerry Springer

BBC TWO Ready Steady Cook

Take a coup Ainsley Harr

Programm-Führer

3 SAT.1 19.33, 11/11/2002 (Mon)

19:30 - 20:15	11/11 (Mon)	Die Quiz Show
20:15 - 21:15		SK Kölsch
21:15 - 22:15		Brotli & Patek - irgendwa...
22:15 - 23:15		Helicops
23:15 - 23:55		Spiegel TV-Reportage
23:55 - 00:25		24 Stunden

EPG Ansicht wählen Vorheriger Tag

OK Markierte Sendung auswählen.

↵ nächster/vorheriger Kanal.

番組ナビ 番組表 (全チャンネル一覧) 1/16(日) 10:25

	1/19(水)	19	20
	BS207 穴蔵酒造華の鶴「春」		ウィーニーとチッチ
	BS208 めだかの夜		EDIT
	BS209 憂愁		追跡「アレはどこいった？」スペシャル
	スカパー! WMM CQ・地底人とモグラ達の暮らし		重機とデザ...
	スカパー! RED-Q 趣味の演歌		テックハウスの時間
	NHK G 011 ニュース7		試しました
	NHK E 021	オリバ ひ、み、つ	福祉教室
	NHK E 022 蟬の命と今		ルネッサンス

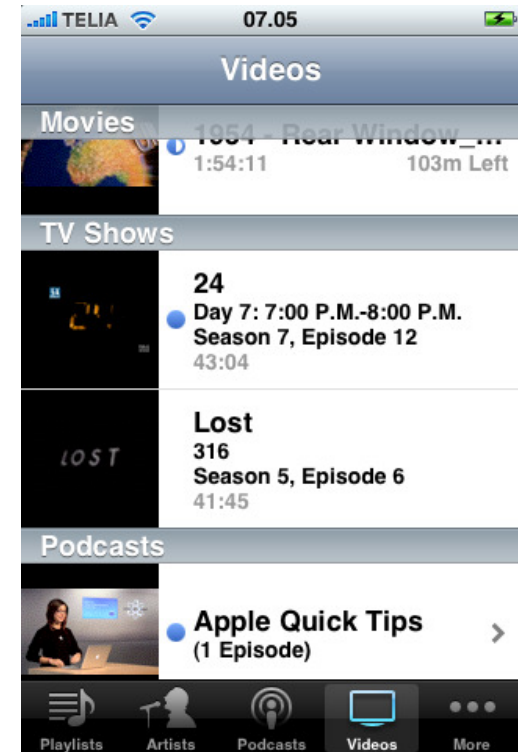
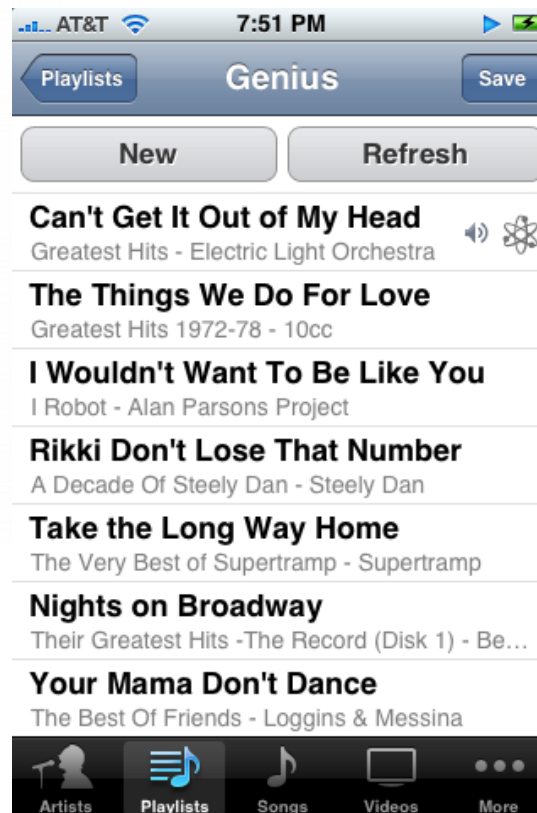
BS209 M-BS 内蔵 1/19(水) 19:30-21:30

追跡「アレはどこいった？」スペシャル 01 16:9

ドラマ全種 映画全種 スポーツ全種 アニメ/特撮全種 音楽全種

⏪ 前時間 選択 予約 上下頁 モード チャンネル別 次時間 ⏩

Managing iPods Data ...



Data and Metadata Make a Great Couple ...



Digital is Easy: The Piracy Effect



Patents and Copyright ...

Intellectual property (IP) enjoys legal protection and stems from the exercise of the mind. IP regards patents, trademarks, copyright, design protection and some minor rights.



- ★ **A patent for an invention is granted to the applicant, and gives him the right for a limited period to stop others from making, using or selling the invention without permission.**



- ★ **Copyright is a legal right (usually of the author or composer or publisher of a work) to exclusive publication production, sale, distribution of some work.**

Business Model: The Key to Success ...



A business model is the method of doing business by which a product/service can sustain itself - that is, generate revenue.

Some business models are quite simple. Other models can be more complex such as free television. The broadcaster is part of a complex network of distributors, content creators, advertisers, and listeners or viewers. Who makes money and how much is not always clear at the outset.

- ★ Digital representations and networks give rise to new kinds of business models, since acquiring, transmitting, and storing information (now just bits) became much easier.
- ★ But it is also likely to reinvent ‘old’ models such as auctions. New and interesting variations of old models should be expected in the future.

New Systems and ... New Business Models ...



iPod

Vídeos, Músicas, Fotos.
30GB, 80GB



iPod nano

Totalmente novo.
2GB, 4GB, 8GB



iPod shuffle

Leve suas músicas.
1GB



iPod may play the following audio formats: MP3, WAV, AAC, Protected AAC, AIFF and Apple Lossless.

About Forecasting ...

LILLIPUT

*"Hallo! Is that Barrod's Stores?
Show Me some Pink Roses, please"*



ELECTRONICS
IN
INDUSTRY TO-DAY



A microscopic error in printing or cutting labels or wrappers will waste much paper. Dead accuracy is guaranteed by ELECTRONIC PRINTING CONTROL.

Valves have solved many industrial problems. If you need advice think of Mullard.

Mrs. Futura will shop by ELECTRONIC VISION 'PHONE SERVICE. She will "go to market" in any of her favourite stores by just dialling their Vision-phone number. "Impossible" you may say. "Quite the contrary" say Mullard, who have developed the Thermionic Valve and who appreciate the boundless possibilities of Electronics in the homes, in the offices and in the industries of tomorrow.

MULLARD
THE DOMINANT NAME
IN ELECTRONICS

Radio Valves and other Electron Tubes

THE MULLARD WIRELESS SERVICE CO. LTD., CENTURY HOUSE, SHAFTESBURY AVE., W.C.2. 046

This TV advertisement about flat screens appeared in 1945 in a English newspaper !

Advices about forecasting:

- ★ You may try to forecast **'WHAT' ...**
- ★ But never try to forecast **'WHEN' ...**



- ★ **It is today much easier than before to create and sell multimedia related products and services (mainly software based).**
- ★ **Internet helps the success of small, innovative companies created without much investment.**
- ★ **The competition between companies may stimulate also the operators to more easily embrace more innovative challenges.**
- ★ **Users are increasingly open to new services.**
- ★ **International contact is changing old habits and prejudices ...**

In summary, multimedia technology is an interesting field for Portuguese young engineers with initiative to launch their own companies !