

# Digital TV – The Software Components

[SIBGRAPI 2007](#) – Tutorial

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SIBGRAPI 2007  
Digital TV: The Software Components  
Demonstration & Motivation

Alisson Sol  
Paulo Sérgio Pinto

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## What Consumers Like About TV

- Clearer Picture And Sound: 78%
- Variety of TV Channels: 72%
- Electronic Programming Guide: 44%
- DVR: 38%
- Digital Music Channels (Audio Only): 34%
- VOD: 32%
- Picture-In-Picture: 23%
- Metadata (Info about directors, etc.): 22%
- Sports Premium Channels: 20%
- Interactive TV Services: 13%

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## Learning From Customers

- Computer: *"Do what I want!"*
- Television: *"Entertain me!"*
  
- Distance
  - Computer: 2 feet (~0.6m)
  - Television: 10 feet (3m)

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## The Next Generation

- Beloit College's Mindset List
  - The Class Of 2011 (Born 1989)
    1. What Berlin wall?
    9. Nelson Mandela has always been free...
    14. Music has always been "unplugged."
    33. U2 has always been more than a spy plane.
    47. High definition television has always been available.
    66. The World Wide Web has been an online tool since they were born.
- What About Those Born on 1999?

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## Interactivity Video

- Notes
  - Nintendo Wii
  - Xbox 360
  - Xbox Live
  - YouTube.com

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## Television Would Have To Change

- This Generation (3 Top Features)
  - Clearer picture and sound
  - Variety of TV channels
  - Electronic program guide
- The Next Generation
  - Interactivity

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### Digital TV Myths

- Analog TV Systems Cannot Add Data
  - Closed captions, ...
- Digital TV Transmission Is “Digital”
  - The signal is still an electromagnetic wave, now encoding “digital” information
- Old TVs Have To Be Replaced
  - You can use a digital-to-analog converter to get digitally encoded signal to a traditional TV

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### Set Top Box

- STB (Set Top Box)
- IRD (Integrated Receiver Decoder)
- PT: URD (Unidade Receptora Decodificadora)

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### User Experience Video

- Notes
  - DVB (Digital Video Broadcasting)
  - Scanning and configuring
  - EPG (Electronic Programming Guide)
  - Interactivity (local)
  - DVR (Digital Video Recorder)

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### Erosion Of Terrestrial TV Revenue

- Competing TV Transmission Media
  - Satellite, Cable, Broadband
- DVR
  - 53% of DVR users skip commercials (Source: Jupiter Research)
- Alternative Ads Destination
  - Internet, Games, etc.
- “Digital Convergence”
  - Content available in computers and devices

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### Storage Convenience

- High Definition Content Formats
  - HD DVD: 30GB
  - Blu-Ray: 50GB
- TV Content (If all in HD)
  - Blu-Ray 2-hours movie = 50GB (Max)
  - 1 day = 1200GB
  - 1 year = 427TB
    - At \$1/GB: 1 year ~ \$437,000
    - Compare to 4380 2-hour tapes...

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### Motivations Summary

- Customer Features
  - More Channels
  - Better picture and sound
  - Interactivity
- Revenue Model
- Industry Pressure

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Terminology

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## Agenda

- Browse Terminology
  - Define acronyms that will be used, but are mostly out of scope
  - Have broad view before going deeper into specific areas of interest

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## Video Frame Definitions

- Frame
  - Single image from video
- Field
  - Half of the frame from interlaced video
- Video scanning
  - Progressive x Interlaced
- Interlacing: getting fields from frame
- Deinterlacing: getting frame from fields

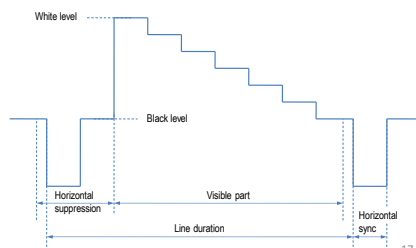
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## Initial B&W TV System

- Scanning: Progressive
- VBS: Video Baseband Signal
  - Black level
  - White level
  - Synchronization
    - Per line
    - Per frame (retrace)

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## Video Signal Line

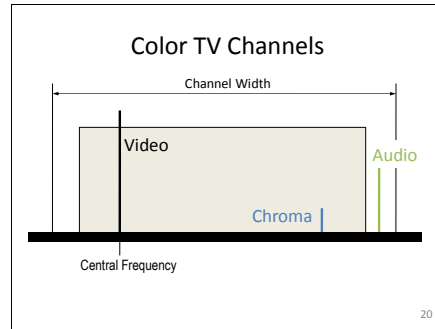
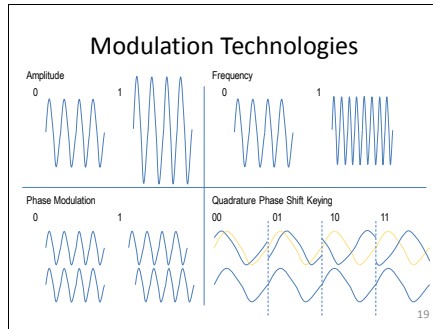


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## STB and Modulation

- Different Technologies
  - AM: Amplitude Modulation
  - FM: Frequency Modulation
  - QAM: Quadrature Amplitude Modulation
  - QPSK: Quadrature Phase Shift Keying
  - VSB: Vestigial Sideband Modulation
  - DQPSK: Differential Quadrature Phase Shift Keying
  - COFDM: Coded Orthogonal Frequency-Division Multiplexing
  - BST-OSDM: Band Segmented Transmission Orthogonal Frequency Division Multiplexing

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- ### Analog Color TV Systems
- NTSC (National Television Systems Committee)
    - Chroma: 3.579MHz
    - QAM (Quadrature amplitude modulation)
  - SECAM (Séquentiel couleur avec mémoire)
    - Same color information for two consecutive lines
  - PAL (Phase Alteration Line)
    - Inversion of carrier every second line
    - PAL M: 525 lines/59.94 Hz, subcarrier 3.576 MHz

- ### Video Resolution
- Lines And Scanning
    - 480i, 480p
    - 576i, 576p
    - 720i, 720p
    - 1080i, 1080p
  - Aspect Ratio
    - 4:3
    - 16:9
  - Conversion
    - Upscaling
    - Downscaling
  - Common Resolutions
    - DVD: 720x480
    - HDTV: 1280x720 (16:9)
    - HDTV: 1920x1080 (16:9)
    - DCI (Digital Cinema Initiatives): 4096x2160
    - RED Digital Cinema: 4520x2540
    - UHDV (Ultra High Definition Video): 7680x4320

### Transmission of Video

Technology	Bandwidth (Mbps)
640x480x24 bits * 24fps	168.75
Wired Cable (100BaseT)	100
802.11b/g/n	11/54/248
xDSL	8
WiMax (802.16)	70

Bandwidth is maximum from standards

- ### Viable Digital TV Transmission
- Source Coding
    - Maximize compression and minimize information loss during video digitization
  - Channel Coding
    - Limit bandwidth utilization and minimize effect of errors during transmission

### Source Coding

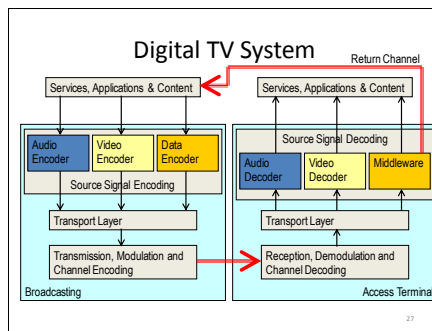
- JPEG: Joint Photographic Experts Group
- DCT: Discrete Cosine Transform
- MPEG: Moving Picture Experts Group
  - MPEG-1: Video/Audio (MPEG-1, layer 3 = MP3)
  - MPEG-2: Program Streams
  - MPEG-4: AV + objects, HD
  - MPEG-7: XML metadata
  - MPEG-21: Multimedia framework

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### Channel Coding

- Stream Multiplexing
- Scrambling
- CAM (Conditional Access Messages)
- FEC (Forward Error Correction)

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### Digital TV Systems

- DVB-S: Digital Video Broadcasting – Satellite
- DVB-C: Digital Video Broadcasting – Cable
- DVB-T: Digital Video Broadcasting – Terrestrial
- ATSC: Advanced Television Systems Committee
- ISDB: Integrated Services Digital Broadcasting
- SBTVD: Sistema Brasileiro de Televisão Digital

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### Connections

- RCA connector (Composite Cable)
- S-Video
- Component Cable
- SCART (Syndicat des Constructeurs d'Appareils Radiorécepteurs et Téléviseurs)
- HDMI (High-Definition Multimedia Interface)
- DVI (Digital Visual Interface)

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### Content Protection

- HDCP (High-bandwidth Digital Content Protection)
- Region Coding
  - DVD (Digital Video Disc) Region Codes
    - 0 (All), 1 to 6 (7 future, 8 international)
  - Blu-Ray Region Codes
    - Regions A, B, C
  - HD DVD
    - Currently Region Free

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### Audio

- Surround Sound
  - 3.0, 4.0, 5.1, 6.1, 7.1, 10.2, 22.2
- 3D Audio Effect

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### Interactivity

- Middleware - Application Environments
  - DASE (Digital TV Applications Software Environment)
  - BML (Broadcast Markup Language)
  - MHP (Multimedia Home Platform)
  - GEM (Globally Executable MHP)
  - OCAP (OpenCable Applications Platform)
  - Ginga
- Profiles
  - Enhanced Broadcast
  - Interactive Broadcast
  - Internet Access

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### Recording

- DVR (Digital Video Recorder)
  - PVR (Personal Video Recorder)
  - TiVo
- EPG (Electronic Programming Guide)
- Tuners
  - Dual Tuners
- VOD (Video On Demand)

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### Mobility

- DVB-H (Digital Video Broadcasting – Handheld)
- DVB-IPDC (DVB specifications for IP Datacasting)
- GPRS (General Packet Radio Service)
- EDGE (Enhanced Data rates for GSM Evolution)
- 3GPP (3rd Generation Partnership Project)

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International Scenario And Digital TV Systems

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## Agenda

- Historic Reasons for Different TV Systems
- Digital TV Systems Factors and Choices

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## World Electrical/Electronic Issues

- Differences
  - Power outlet
  - Voltage
  - Frequency
  - Analog TV systems
  - “Regions”: DVD regions, Blu-Ray regions, Internet content regions

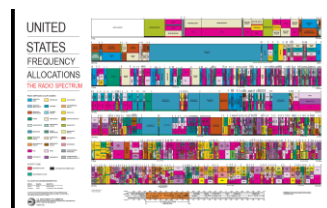
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## Terrestrial TV System Factors

- Frame/Field Rate
- Color Information
- Channel Regulatory Issues
- Standard Committees

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## Electromagnetic Spectrum



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## Analog Color TV Systems

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  - Chroma: 3.579MHz
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- PAL (Phase Alteration Line)
  - Inversion of carrier every second line
  - PAL M: 525 lines/59.94 Hz, subcarrier 3.576 MHz

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### Digital TV Systems Factors

- Current Installed Base
  - Compatibility
  - Transition Phase
- Economical and Political Factors

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### ATSC

- Advanced Television Systems Committee
- Main Usage: North America
- Channel Bandwidth: 6 MHz
- Modulation: 8-VSB, 16-VSB
- Bit rate: Up to ~19Megabits/second

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### DVB-T

- Digital Video Broadcasting
- Main Usage: Europe
- Channel Bandwidth: 5, 6, 7 or 8 MHz
- Modulation: COFDM, QPSK, 16-QAM, 64-QAM
- Bit rate: Up to ~32Megabits/second
  - 31.668Mbps in 8MHz channel using 64-QAM

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### ISDB-T

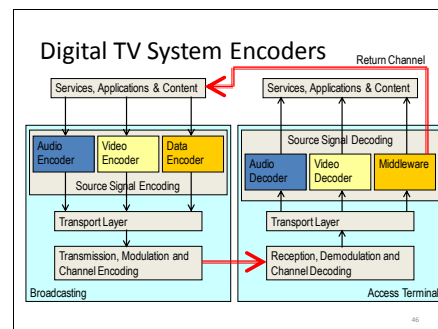
- Integrated Services Digital Broadcasting
- Main Usage: Japan
- Channel Bandwidth: 6 MHz
- Modulation: BST-OSDM, QPSK, DQPSK, 16-QAM, 64-QAM
- Bit rate: Up to ~19Megabits/second (62-QAM)

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### SBTVD-T

- Sistema Brasileiro de Televisão Digital
- Main usage: Brazil
- Channel Bandwidth: 6 MHz
- Modulation: BST-OSDM, QPSK, DQPSK, 16-QAM, 64-QAM
- Bit rate: Up to ~19Megabits/second (62-QAM)

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### Digital TV Systems Choices

System	Video Coded	Middleware
ATSC	MPEG-2	DASE, ACAP
DVB-T	MPEG-2	MHEG, MHP, SMS
ISDB-T	MPEG-2	ARIB BML
SBTV-D-T	MPEG-4 (H.264)	Ginga

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### Switchover

- Simulcast
- Analog Turn Off
  - Luxembourg: September 1, 2006
  - Netherlands: December 11, 2006
  - Finland: September 1, 2007
- Population Guidance
  - Schedule
  - Example: Japan (ISDB) analog terrestrial broadcast ends on July 24, 2011

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### Technologies Out Of Scope

- But Worth A Brief Citation
  - Satellite TV Systems
  - Cable TV Systems
  - Terrestrial Return Channel

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Encoding, Streaming and Video Applications

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## Agenda

- Video Technologies Review
- Encoding For the Bandwidth Profile
- Video Applications

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## Digital Images

- Raw Format
- Encoding
  - RLE: Run Length Encoding
- JPEG
  - Color Quantization
    - RGB: Red, Green, Blue
    - YCbCr: Luminance, Chrominance Blue, Chrominance Red
  - DCT (Discrete Cosine Transform)

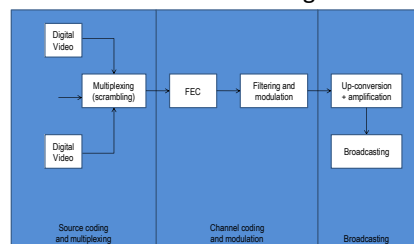
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## Video Digitization

- Digitization in the Analog Lines
- Video Signal in 4:2:2 YCbCr format
- Other formats

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## Video Broadcasting

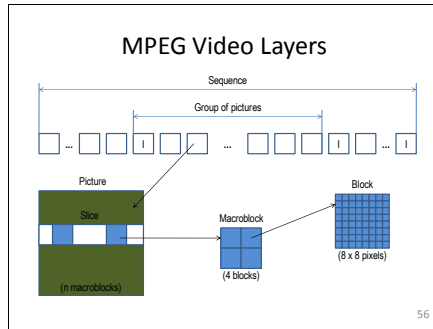


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## MPEG Video Coding

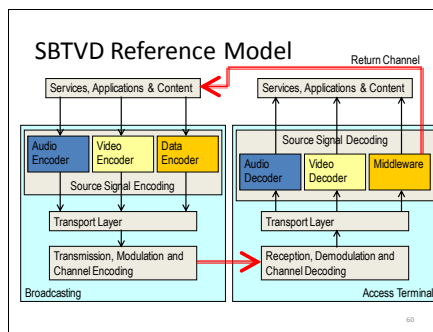
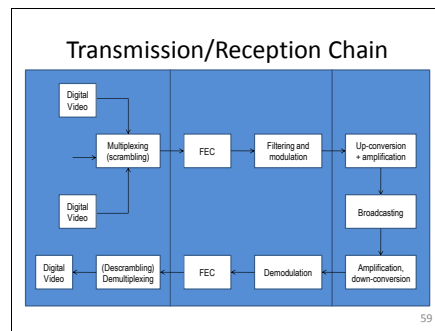
- Picture Types
  - Intra pictures: all information for reconstruction
  - Predicted pictures: motion from previous I or P
  - Bidirectional pictures: bidirectional interpolation
- Movement Estimator
  - Prediction
  - Motion estimation
  - Compensation

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- ### MPEG-2 Broadcasting
- Levels (Resolution)
    - Low: 360x288
    - Main: 720x576
    - High-1440: 1440x1152
    - High: 1920x1152
  - Profiles
    - Simple: No B pictures
    - Main: I, P, B
    - Scalable
      - Spatial
      - SNR
    - High: HDTV

- ### Transport Streams
- Video, Audio, Data
  - Transport Packet
  - Scrambling and Conditional Access



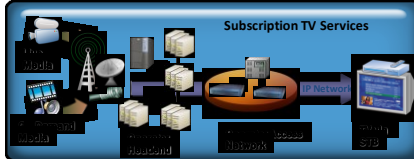
- ### Aerial Transmission
- Error Factors
  - BET (Bit Error Rate)
  - Super Channel
  - Error Correction

## Streaming Over IP

- IPTV
- Broadband Internet
- Routing Schemes
  - Anycast
  - Broadcast
  - Multicast
  - Unicast

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IPTV



**Subscription TV Services**

- **What IPTV is not:**
  - Video streaming over the Internet
  - Watching TV on your PC
  - Best-efforts video services
  - Based on unproven business models
- **What IPTV is:**
  - Competitive TV services over managed IP networks
  - Broadcast television
  - All forms of on-demand
  - Electronic program guide
  - Connected entertainment

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## Video On Demand

- Content Storage
- VOD on Private Networks
- Push Video On Demand
- Content Protection

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## Video Database Applications

- Metadata Search
  - Actors, directors, producers...
  - Keywords
  - Script, director comments
  - Rating
- Metadata Issues
  - Mistakes
  - Globalization/Localization

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## Internet Applications

- Content Distribution
  - Video streaming
  - Movie download
- Content Management
- Content Distribution Network
  - Mirroring
  - P2P (Peer-To-Peer)

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## Peer To Peer Systems

- Concepts
  - Seeds
  - Registrar
- Algorithms
- Live Content Distribution

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**Programmability And Interactivity**  
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## Agenda

- Interactive Television Standards
- International Scenario
- SBTVD Middleware Overview

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## TV Video Audience Safety

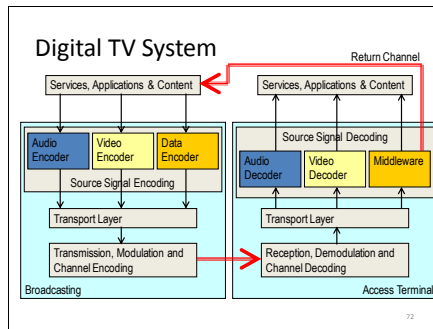
- “TV Safe”
  - Colors
  - Action area
  - Title area
  - Movement speed
    - London 2012 motion graphics causing people epileptic seizures...
- Video Games
  - Action-packed video games have warnings...

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## Taxonomy and Usage

- Rigid Taxonomy
  - eTV (enhanced TV): features depend on content and data delivered to the STB
    - Personalized TV: user can change the TV appearance
  - iTV (interactive TV): there is a return channel to the content provider
- User’s point-of-view
  - If the user can influence, it is “interactive”
  - Consider video games (few use a return channel)

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### Software Layers

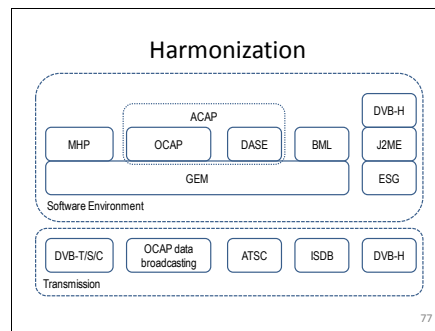
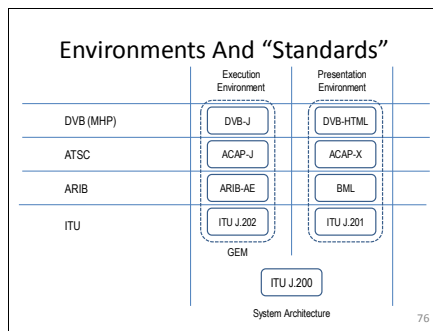
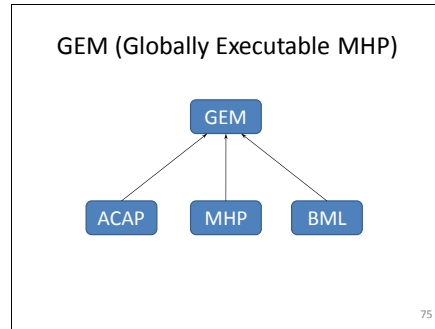
	Set Top Box	PC	
<b>Application API</b>	Applications	Applications	API
<b>Middleware API</b>	Middleware	Windows	
<b>Platform API</b>	Adapter Layer	MS-DOS	
	Drivers RTOS	BIOS	
	Hardware	Hardware	

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### Middleware Choices

- ATSC
  - DASE: DTV Applications Software Environment
  - OCAP: OpenCable Application Platform
  - ACAP: Advanced Common Application Platform
- DVB
  - MHP: Multimedia Home Platform
- ISDB
  - ARIB: Association of Radio Industries and Businesses
  - BML: Broadcast Mark-up Language (ARIB STD-B23)

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### GEM MHP Xlets

- Package javax.tv.xlet
  - public interface javax.tv.xlet.Xlet
    - {
    - public void init(XletContext ctx) throws XletStateChangeException;
    - public void startXlet() throws XletStateChangeException;
    - public void pauseXlet();
    - public void destroyXlet(boolean unconditional) throws XletStateChangeException;
    - }
  - public interface XletContext
    - {
    - public static final String ARGS = "javax.tv.xlet.args";
    - public void notifyDestroyed();
    - public void notifyPaused();
    - public void resumeRequest();
    - public Object getXletProperty(String key);
    - }

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### Demo

- Xlet Applications
- XHTML Applications
- Microsoft Mediaroom ADK Simulator

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### Getting Applications to STB

- Data Broadcasting
- DSM-CC (Digital Storage Media - Command and Control)
- Data Carousel
- Application Environments
  - Native Application Environment
  - Java Application Environment
  - XHTML Application Environment

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### Middleware Engineering

- Updates
  - Service channels
- Software Deployment
  - Channel stream
- Security Issues

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### SBTVD Middleware

- Ginga
  - Ginga-CC (Common Core)
  - Ginga-J
  - Ginga-NCL
- Ferramentas
  - Composer
  - Scripting language: Lua

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### Enhanced TV Applications

- Multi Screen News
- Traffic Cameras
- Angle From Sports Show
  - Soccer/Football
    - Traditional view, reverse angle, goalkeeper
  - Car Race
    - Pilot view, choice from car
- Enhanced Ads

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### Return Channel

- Cable or Broadband
  - Wired Connection
- Satellite or Terrestrial
  - Mobile Phone Message
    - SIM card directly into STB
  - Internet
  - Traditional
    - Phone

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### Interactive Applications

- Voting
  - Audience influencing show
- Public Services
  - Internet-like applications
    - Utility bills, public service scheduling
    - Educational shows

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Complimentary Issues

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### Perception and Reality

- Customers Report Higher Satisfaction, But...
  - Most digital broadcasts are not in high definition
  - Most digital broadcasts have less resolution than traditional analog broadcasts
  - Depending on user location, the digital signal may be too weak

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### UK Ofcom Communications Market

- Office of Communications Report 2007
  - Converging Communication: >50% household have broadband
  - HDTV: 1.7% households
  - Freeview success sparked interest into Freesat
    - Freesat to be based on one-off fee; to start on 2008
  - Quiz TV down (using telephone as return channel)
    - March/2007: 1000 hours/week
    - July/2007: 90 hours/week

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### Switchover to Digital TV

- Almost Always Slower Than Expected
  - Only Complete in Small Countries
- Regulatory Agencies Work
  - Consumer Education
  - Coupons
    - EUA: 2 US\$40.00 coupons/house that relies on terrestrial
    - Coupon to get STB for digital-to-analog conversion

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### Content Protection

- In Some Countries, the STB Will Use DRM
  - DRM (Digital Rights Management) will limit ability to copy the digital content
- Tagging Digital Broadcasts
  - Lower resolution than normal
  - Inserting special frames

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### Privacy

- STB Identification Diminishes Privacy
  - Allow viewing habits to be tracked
  - Happening already in cable systems
- Enhanced/Interactive Advertisement

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### Enhanced Advertising

- Ad based on target for current show and...
  - ...time since switched channel...
  - ...shows recorded in digital recorder...
  - ...viewer gender...
- Ad pop-up when fast forwarding show
- “Extended Ad”
  - Push extended ad to local storage
  - Offer extended ad during “normal ad”

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### Accessibility

- Current Interactivity: Mostly Visual
- Issue Not Only For Disabled People
  - “Red button” confusion in DVRs
  - Text too small
  - Misunderstanding of “setup issues”
    - Wrong cables may prevent real high definition
    - Black areas around picture
    - Buffer loss when switching channel (involuntarily happens when pressing wrong key)

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### HD Content

- Blu-Ray versus HD DVD
  - Several HDTVs will downscale resolution
    - Not able to really show 1080p or 1080i

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### Current Developments: Standards

- DVB-T Now 10 Years Old
- DVB-CPCM (DVB Content Protection & Copy Management)

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### Mobile Devices

- Terrestrial Broadcast to Mobile
  - DVB-H (Digital Video Broadcasting – Handheld)
  - DMB (Digital Multimedia Broadcasting)
  - ISDB-T (Integrated Services Digital Broadcasting)
  - MediaFlo

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### Mobile Specific Technologies

- WAP (Wireless Application Protocol)
  - New XML based language was created
    - WML (Wireless Markup Language)
  - Some sites had WAP versions
  - Several explanations for failure, but mostly: mobiles simply got to “desktop level”
- Digital TV Development For Mobiles
  - Other than lower resolution, little should be different for developers at authoring level

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- DVB: <http://www.dvb.org/>
- ISDB-T: <http://www.dibeg.org/techp/isdb/isdbt.htm>
- MHP: <http://www.mhp.org>
- Microsoft Mediaroom: <http://www.microsoftmediaroom.com/>
- Middleware Ginga: <http://www.ginga.org.br/>
- Motion Picture Experts Group: <http://www.chiariglione.org/mpeg/>
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- YouTube: <http://www.youtube.com/>