

# Graphics Architecture for Multimedia Non-Desktop Devices: a Study of Digital Television Receivers

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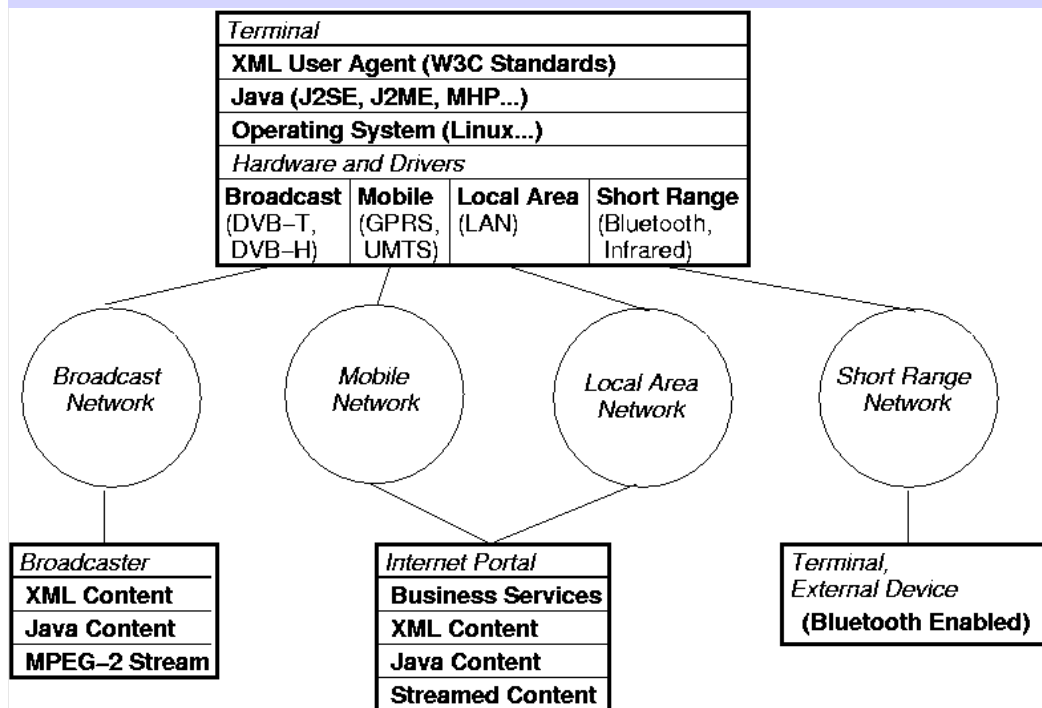
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# Outline

- Introduction
  - Variety of Devices
- Background
  - Graphics Architectures
  - Content Authoring Formats
  - Digital Television
- Research Questions
- Thesis
- Results / Contributions
- Conclusions

## Introduction: Device Chaos



- Variety of multimedia devices
  - Desktop (PCs)
  - Non-desktop (STB)
- Number of networks
  - Broadcast
  - Mobile
- Diversity of Content
  - MPEG-2
  - Java
  - XML based

## Introduction: Variety of Devices (1/2)

- Desktop Device (PC):
  - Multipurpose platform
  - Development Environment
- Non-Desktop Devices: User's expectations
  - Information Management: information in an small device (PDA)
  - Person to Person Communication: Mobile Phones
  - Entertainment: game consoles, interactive TV receiver
- All Devices Fall into Information Access Systems:
  - Open: information retrieved from different sources (e.g., WWW)
  - Closed: devices rely on specific providers (e.g., Broadcast)

## Introduction: Variety of Devices (2/2)

		PC	Non-Desktop device		
			DTV Receiver	Mobile Phone	PDA
Development		+++	+	+	++
Information Access	Open	+++	+	++	++
	Closed	+	+++	+	++
Information Management		+++	+	++	+++
Communication		++	+	+++	++
Entertainment		+++	+++	+	++

## Background: Graphics Architectures (1/3)

***Applications***

Higher-level Tools

Toolkit

Windowing System

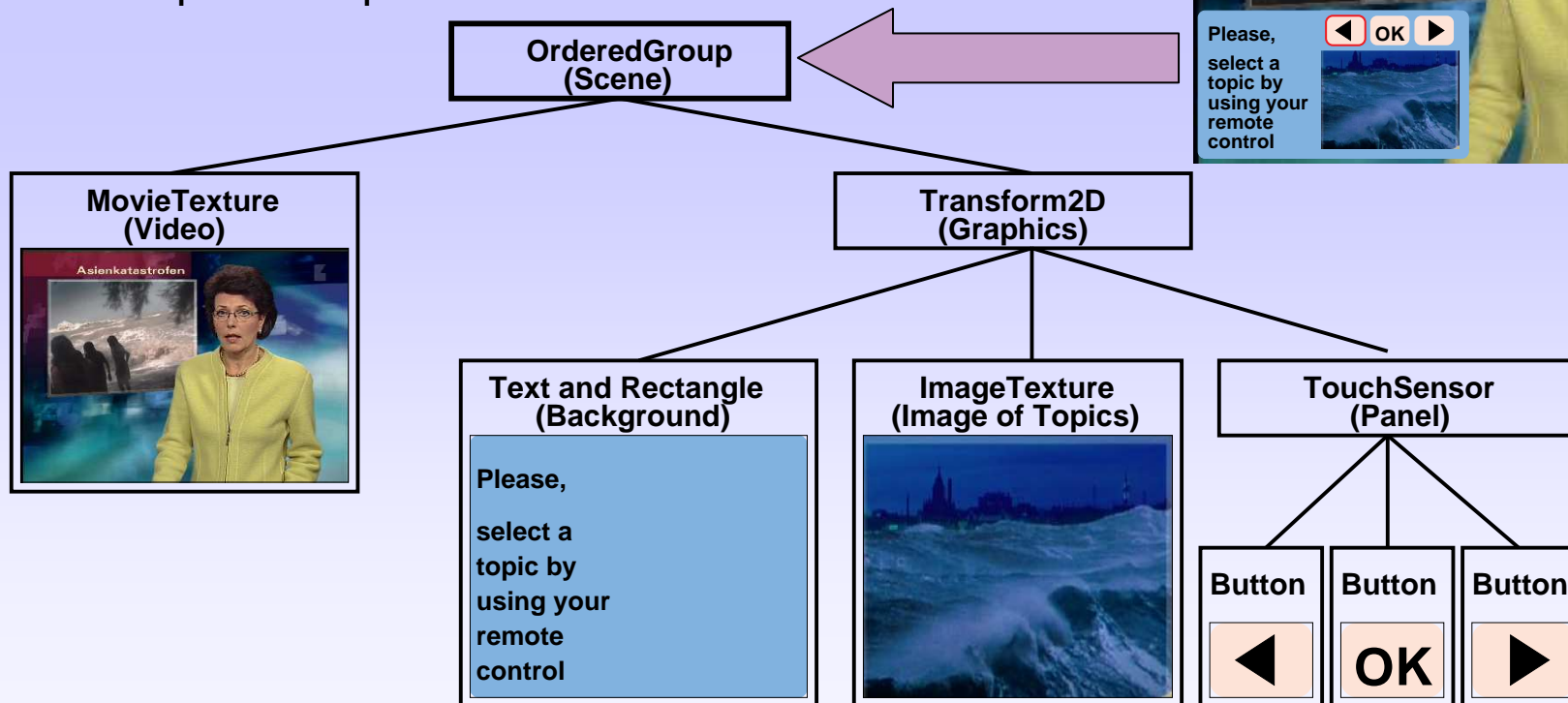
***Operating System***

- Myers definition of a layered architecture
  - Applications implemented using higher-level tools
  - Toolkit: a library of widgets used by applications
  - Windowing System: helps user to monitor and control different contexts (input and output functionality)
- 
- Digital Television as Non-WIMP User Interfaces (based on Green and Chorianpoulos findings):
    - Temporal based nature (Multimedia)
    - Embedded System
    - Hypermedia capabilities

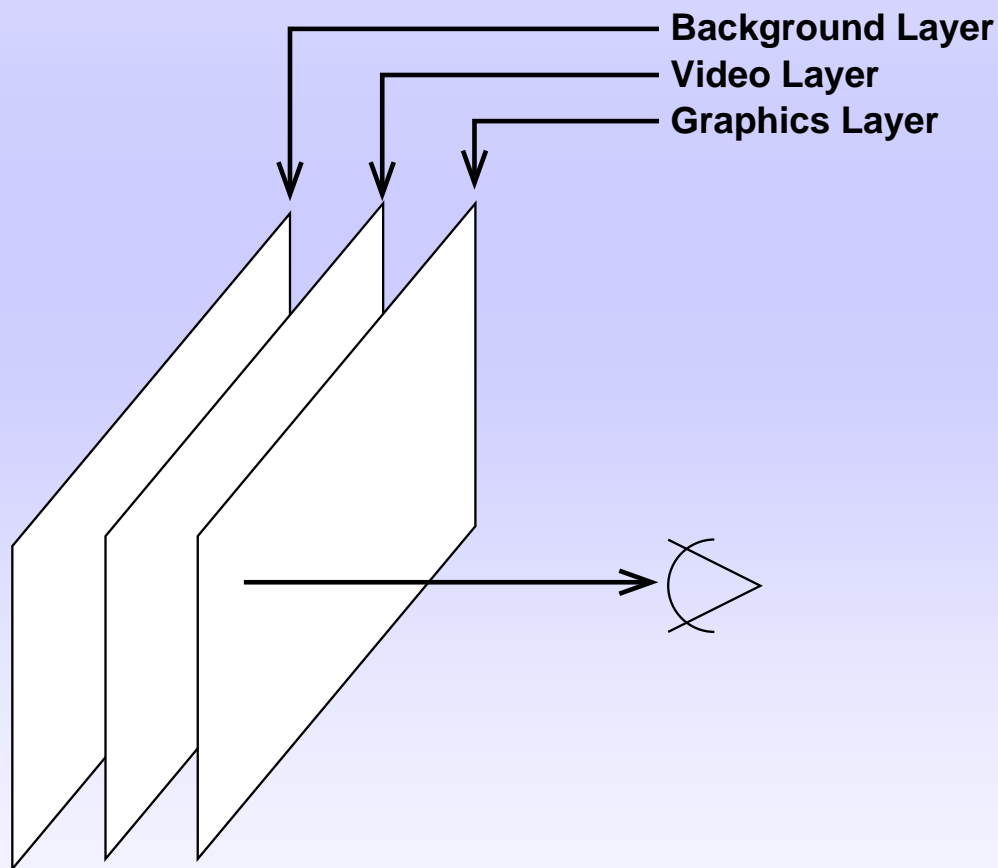
# Background: Graphics Architectures (2/3)

## Scene Based Architectures

- Can be considered as a subset of windows architectures
- Implies the performance of one task at the time



## Background: Graphics Architectures (3/3)



- Digital Television Architecture:
  - Three overlapping layers
  - Using transparencies (alpha channel)
  - Background + Video + Graphics
- Graphics Layer:
  - Use of video objects
  - Use of 3D graphics objects
  - Use of 2D graphics objects



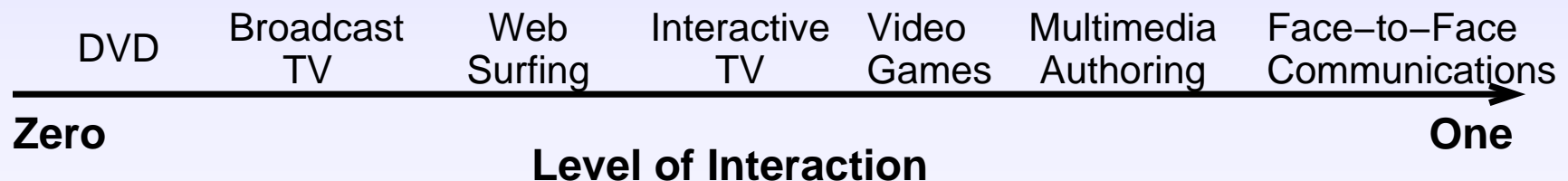
## Background: Content Formats (1/2)

### Multimedia (Heller/Purchase)

- Modality: aural and visual
- Nature of the sign: concrete iconic (photorealistic image), abstract iconic (map), symbolic (written word)
- Syntax / Arrangement: spatial and temporal

### Interaction (Aleem)

- Passive: only visualization
- Reactive: limited interaction (e.g., Scroll Pane functionality).
- Proactive: choose a path or make selections (e.g., Button).
- Reciprocal: corresponds to user authoring of information



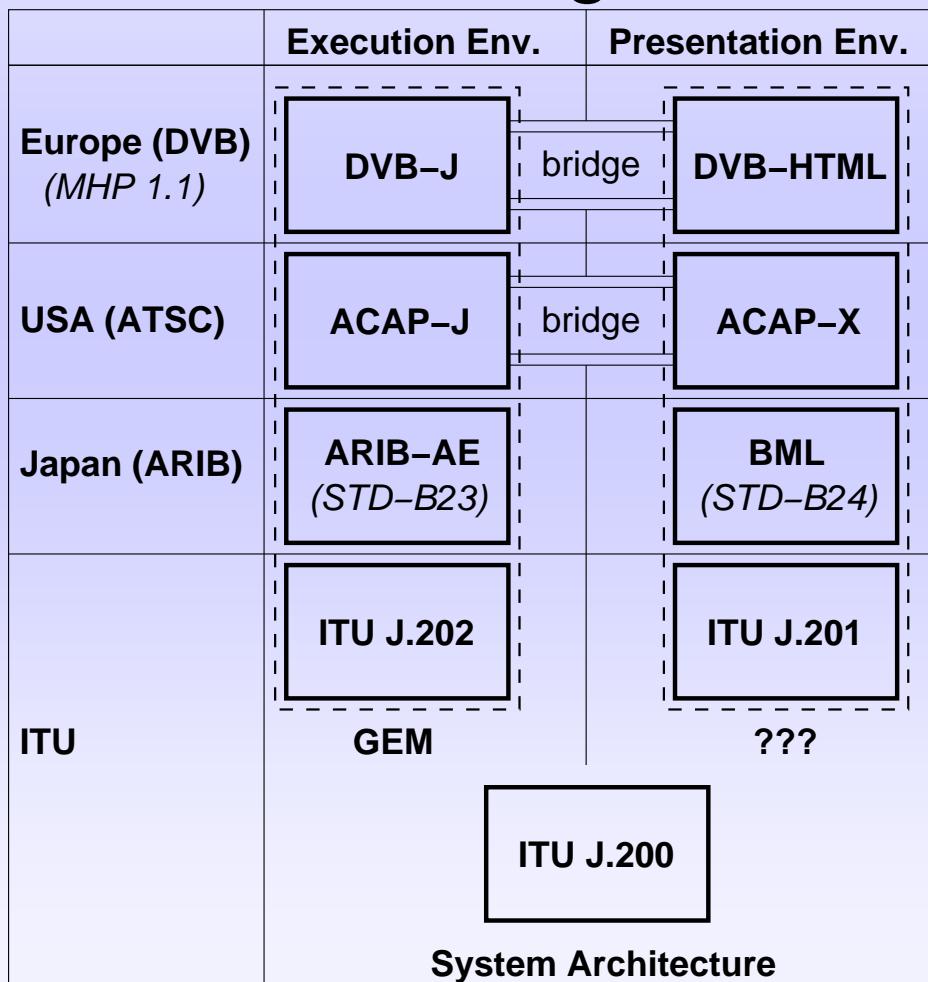
## Background: Content Formats (2/2)

### Requirements

- Supported Media Types: audio, video, text, graphics, and animation
- Arrangement of the signs: spatial and temporal
- Interaction: passive, reactive, proactive, and reciprocal
- Difficulty to use (threshold)
- Expressional power (i.e., ceiling)
- Safety of Distribution
- Interoperability

	Threshold	Ceiling	Interoperability	Safety of Distribution
Procedural Intermediate	+++	+++	+	+
Procedural Interpreted	++	++	++	++
Declarative	+	+	+++	+++

## Background: Digital Television



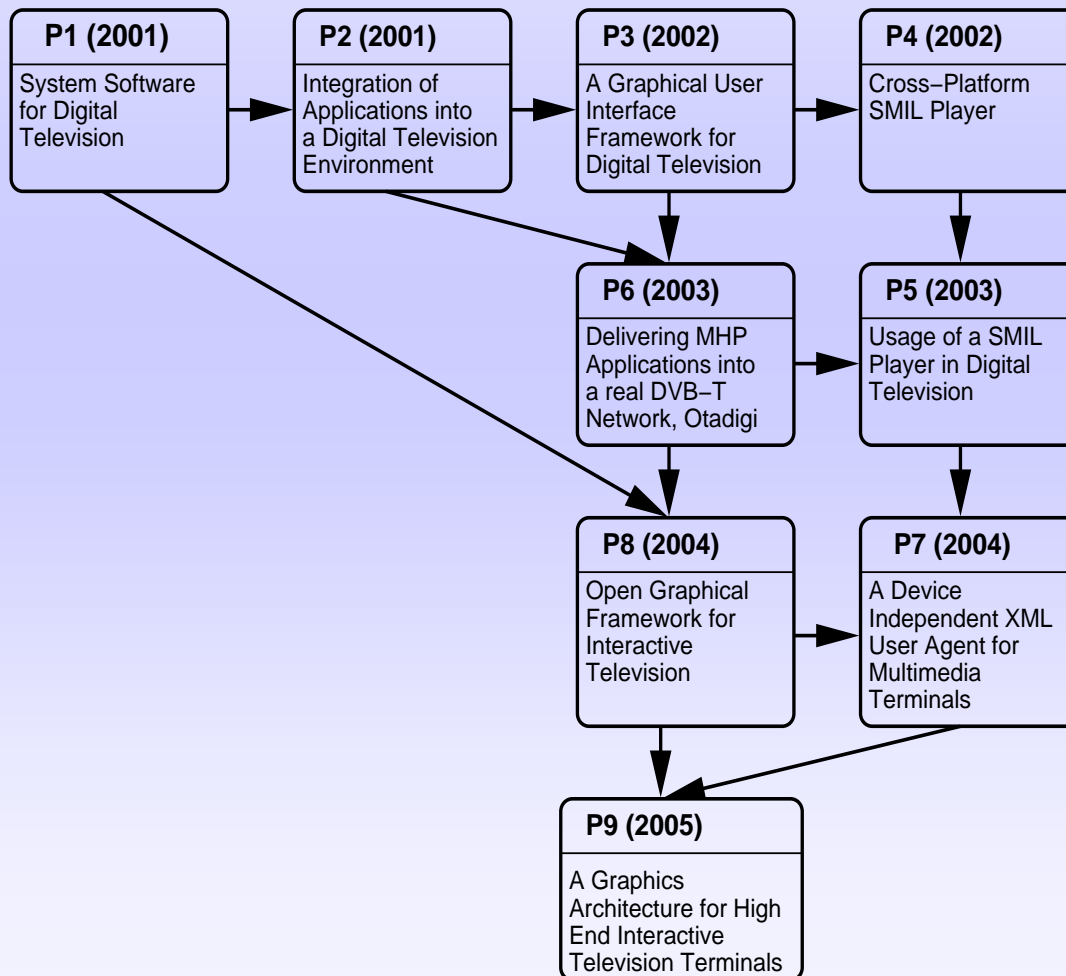
### Worldwide Application Environment

- Procedural Interpreted: GEM (DVB-J)
  - Basic Java (e.g., java.lang)
  - Java TV: applications lifecycle
  - JMF: audio and video
  - HAVi: 2D User Interface
- Declarative: Undecided
  - XHTML: structure of document
  - CSS: look
  - Media types: images, video
  - TV Specific extensions: for example remote control interaction

## Research Questions

1. How Digital Television receivers will technologically evolve?
2. Definition of a worldwide application environment for digital television receivers including execution and presentation engines?
3. Definition of a valid graphics architecture for Home Media Stations?
4. How GEM should graphically evolve to take into account future requirements on time?
5. How manufacturers can differentiate their products, following GEM?

## Thesis: Publications



P1: general study on the system software for DTV

P2: description of a system model to run different DTV applications

P3: Graphical User Interface Toolkit for DTV

P4: portable SMIL player running on different devices

P5: possible use case scenarios for SMIL in DTV

P6: description of two services transmitted over a DTV network

P7: definition of an XML based profile for developing interactive multimedia services (SMIL+XForms)

P8: layered graphics architecture for non-desktop devices

P9: extension to P8 with detailed study on graphics architectures alternatives. Complete reference implementation

# Thesis: Introductory Part

**Name:** Graphics Architectures for Multimedia Non-Desktop Devices:  
a study about digital television receivers  
**Author:** Pablo Cesar  
**Year:** 2005  
**Place:** Helsinki University of Technology, Finland

**Chapter 1: Introduction**  
*(Big Picture of multimedia systems)*  
Multimedia Systems  
Convergence of Networks  
Multimedia Content and Applications  
UI and Graphics Architectures

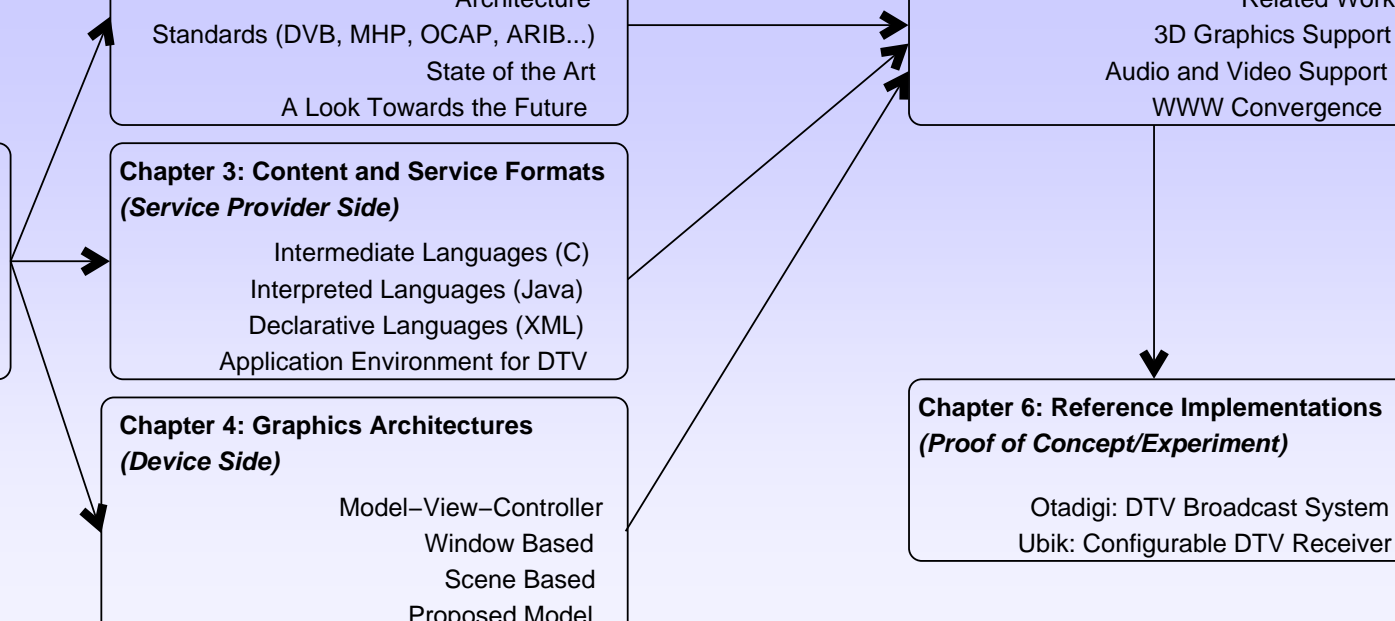
**Chapter 2: Digital Television**  
*(Overview of DTV Environment)*  
Architecture  
Standards (DVB, MHP, OCAP, ARIB...)  
State of the Art  
A Look Towards the Future

**Chapter 3: Content and Service Formats**  
*(Service Provider Side)*  
Intermediate Languages (C)  
Interpreted Languages (Java)  
Declarative Languages (XML)  
Application Environment for DTV

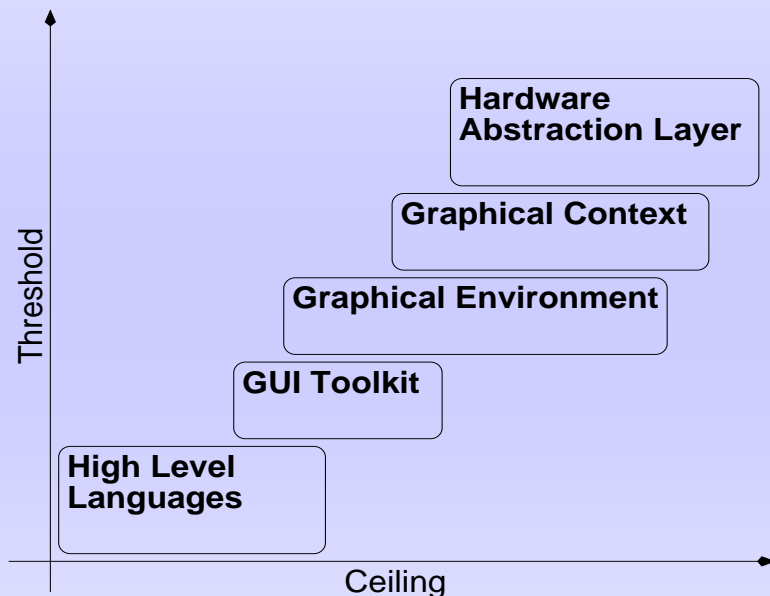
**Chapter 4: Graphics Architectures**  
*(Device Side)*  
Model-View-Controller  
Window Based  
Scene Based  
Proposed Model

**Chapter 5: Extensions to GEM**  
*(Proposals to Enhance GEM)*  
Related Work  
3D Graphics Support  
Audio and Video Support  
WWW Convergence

**Chapter 6: Reference Implementations**  
*(Proof of Concept/Experiment)*  
Odadigi: DTV Broadcast System  
Ubik: Configurable DTV Receiver



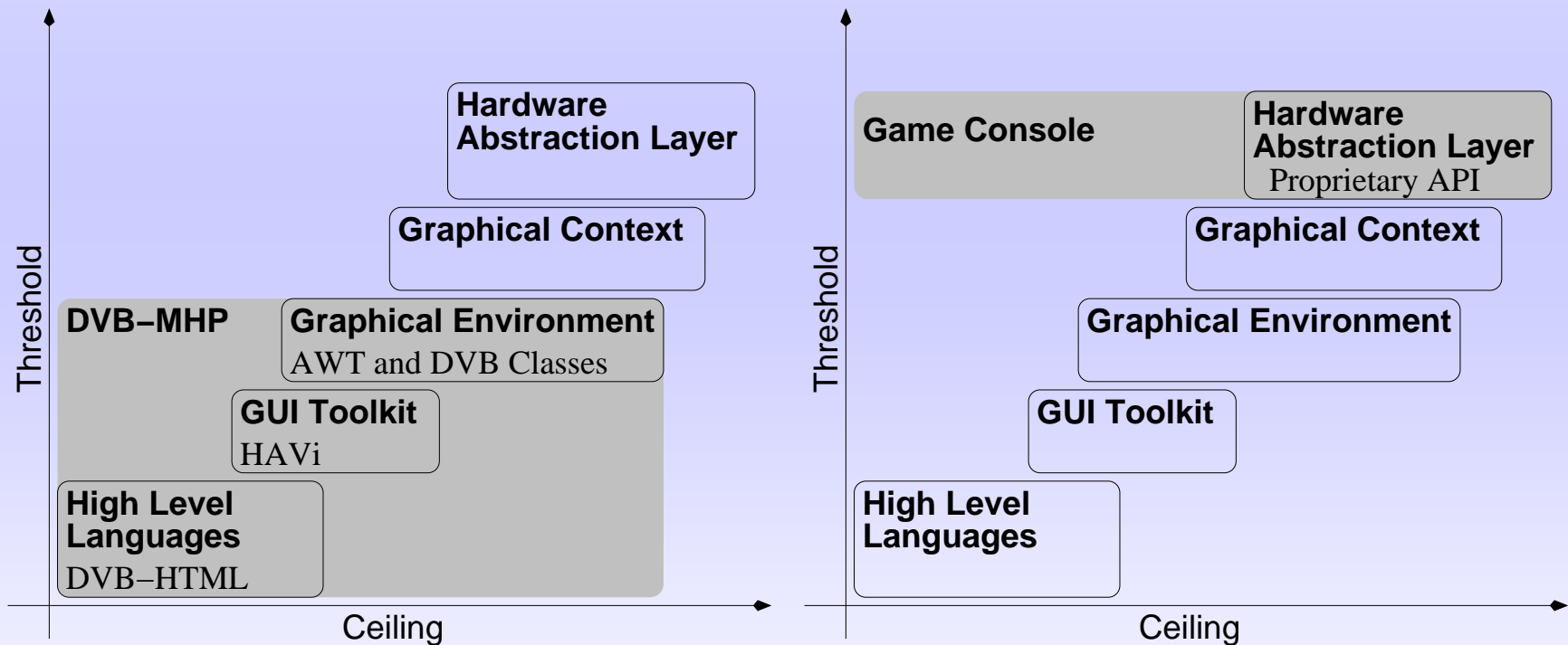
## Results: Graphics Architecture



- Lack of pointing device
- Usage: One task at the time
- Screen composed of multimedia objects
- Seamless integration of video, 2D and 3D objects
- A layered architecture, so developers can implement at any level

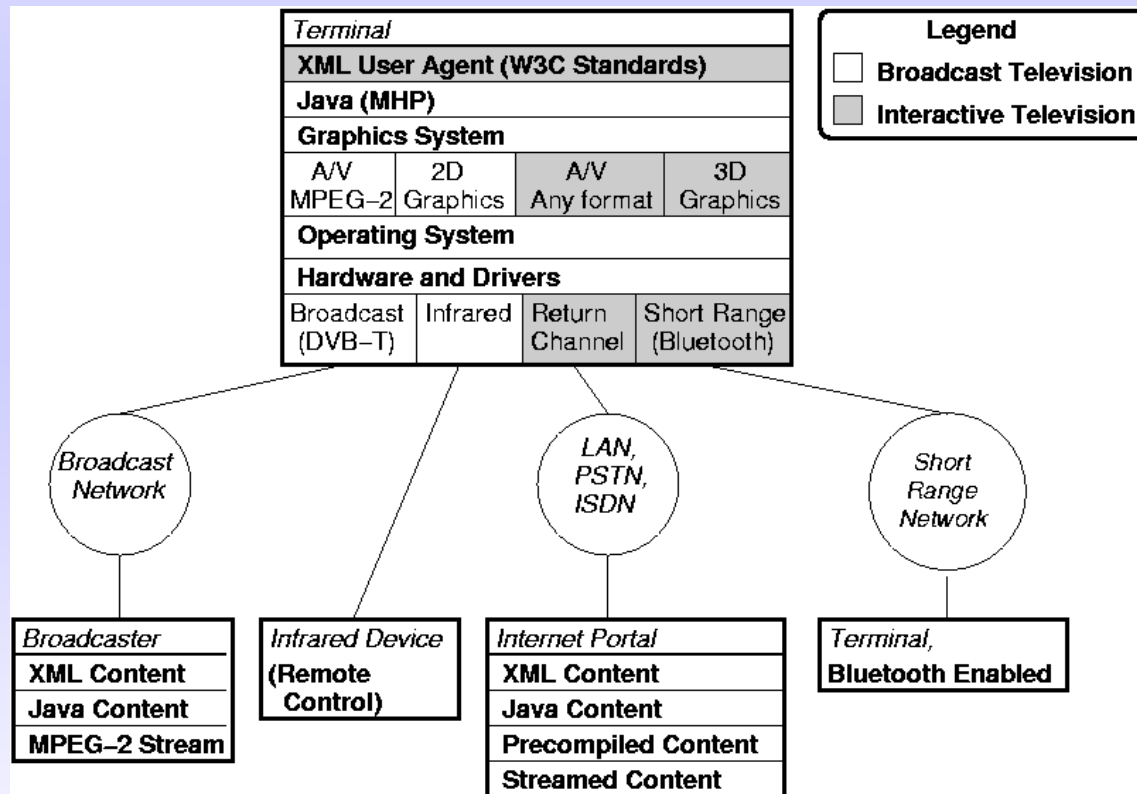
- HAL: renders the final graphics output
- Graphical Context: cross-platform abstraction of the rendering region
- Graphical Environment: means to control different contexts
- GUI Toolkit: "ready-made" user interface widgets
- HLL: to develop simple services

# Results: Graphics Architecture Validation





# Results: Applicability to Digital Television



## Results: Digital Television Profiles (1/2)

### **Broadcast: Basic**

- Requirements:
  - Television usage: sit on the sofa and watch the favourite show at a given time
  - Catch majority of the population
- Proposed profile:
  - Audio Visual Content Digitised
  - Examples: DVB-T/C/S (Europe), ISDB (Japan), ATSC (USA)

### **Broadcast: Enhanced**

- Requirements:
  - Interactive applications with internal logic
  - Procedural environment: Java
- Proposed profile:
  - DVB-J (as part of GEM, worldwide accepted version of MHP 1.0)

## Results: Digital Television Profiles (2/2)

### **Interactive: Basic**

- Requirements:
  - Browse simple XML documents
  - Limited navigation
  - Images, text
- Proposed profile:
  - XHTML + CSS

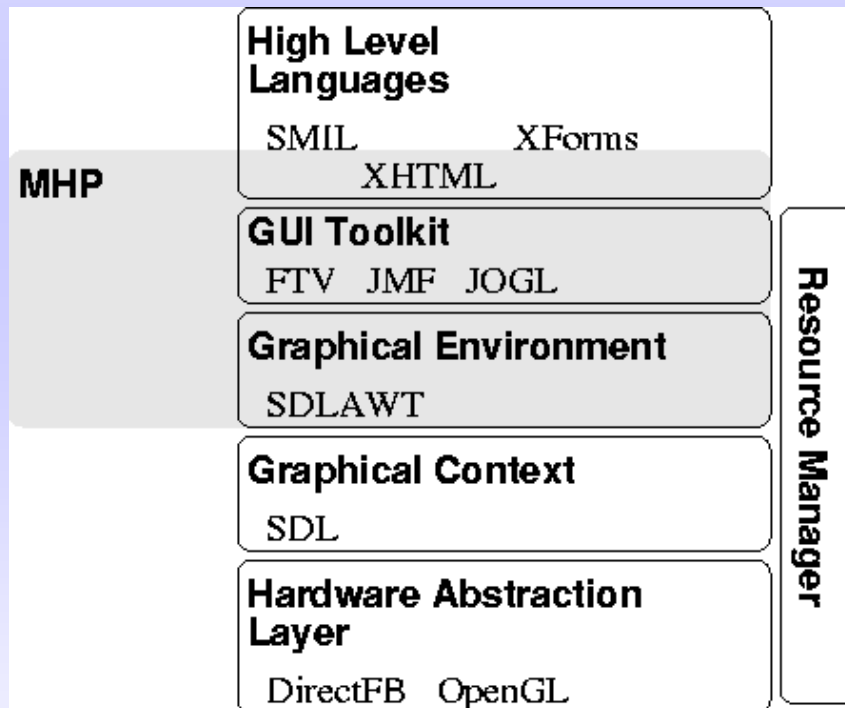
### **Interactive: Internet Access**

- Requirements
  - Browse XML Compound Documents (complex)
  - Interactive
  - Temporal Synchronisation
  - Video and audio
- Proposed profile:
  - XHTML 2.0 + Timesheet
  - SMIL + XForms

### **Interactive: High End**

- Requirements
  - Integration of all kinds of multimedia objects
  - Temporal Dimension
- Proposed profile:
  - DVB-J + OpenGL Java Wrappers
  - JMF media player (all kind of formats)

## Results: Reference Implementation (Ubik)



- DVB-T reception and visualisation of the A/V stream
- HAL: DirectFB and OpenGL
- Resource Manager: to control the different processes
- Graphical Context: SDL
- Graphical Environment: SDLAWT (java.awt)
- GUI Toolkit
  - FTV: 2D widgets
  - JMF: other video than A/V
  - Java OpenGL: 3D Graphics
- HLL: X-smiles (XHTML, SMIL, XForms)

## Results: Ubik HAL (1/2)

- Example composition of scenes:
  - 3D graphics object
  - A/V Stream
- Performance
  - Around 60 FPS



## Results: Ubik Graphical Context (2/2)

- Example native 3D Graphics
  - Some games downloaded from a portal



# Results: Ubik Graphical Environment + GUI Toolkit



- Java Applications
- Profile:
  - Broadcast Enhanced
- Target:
  - Procedural Language Applications (internal logic)
- Languages:
  - DVB-J
- Interaction:
  - Colour Buttons
  - HAVi Widgets
- Multimedia Objects:
  - Images/Text
  - Animations
  - Video/audio

## Results: Ubik High Level Languages (1/2)

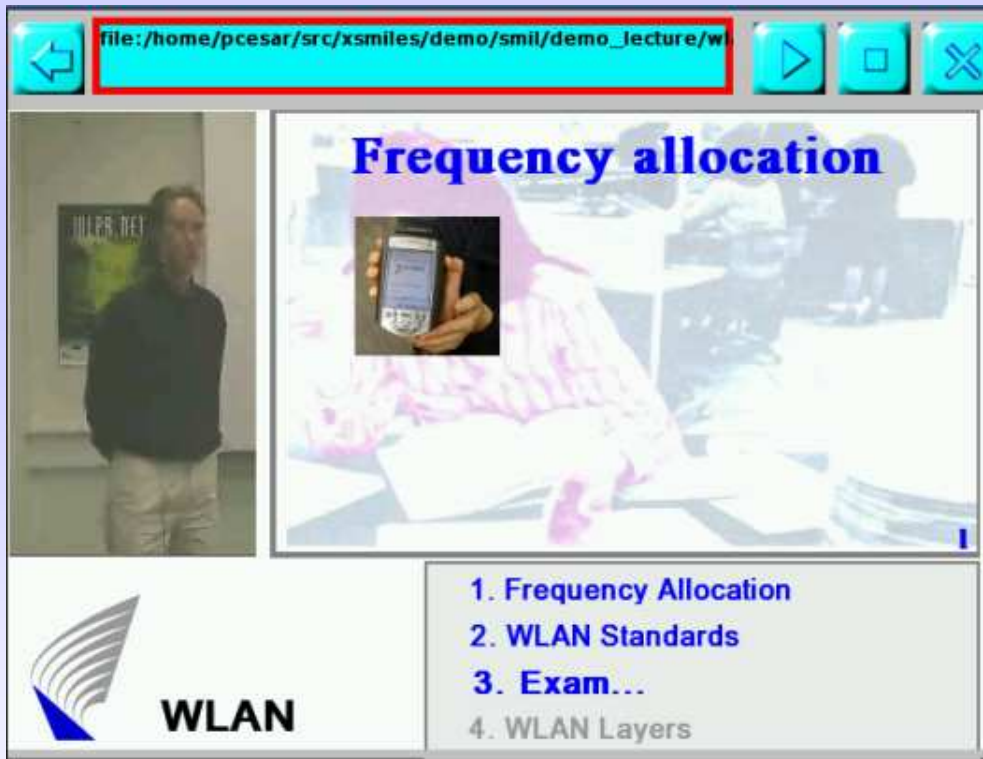


The screenshot shows a web browser window with a file path in the address bar: `file:/home/pcesar/src/xsmiles/demo/testsuite/xmlcss/headl`. The browser interface includes navigation buttons (back, forward, home, close). The main content area displays a news article with a sidebar on the left containing categories: National, International, Economy, Sports, Culture, and Local News. The article title is "Chavez named as referendum winner". The text states: "President Hugo Chavez has won a referendum on his rule, electoral authorities in Venezuela say." Below the text is a photograph of Hugo Chavez celebrating. The article continues: "Officials from the National Electoral Council said that, with 94% of ballots counted, Mr Chavez had 58% of the vote. It now appears clear that an opposition attempt to force him from office has failed, as have previous attempts, the BBC's James Menendez in Caracas says." At the bottom, it says: "But opposition members on the electoral body rejected the partial result as a fraud, claiming their side had won."

- XML Based Document
- Profile:
  - Interactive Television Basic
- Target:
  - Information Services (e.g., Teletext)
- Languages:
  - XHTML 1.1
- Interaction:
  - Navigation
- Multimedia Objects:
  - Images
  - Text



## Results: Ubik High Level Languages (2/2)



The screenshot shows a presentation slide titled "Frequency allocation" in blue text. The slide features a background image of a person holding a mobile phone. In the bottom left corner, there is a logo for "WLAN" with a stylized blue and white graphic. In the bottom right corner, there is a table of contents with four items:

1. Frequency Allocation
2. WLAN Standards
3. Exam...
4. WLAN Layers

- XML Based Document
- Profile:
  - Interactive Internet Access
- Target:
  - Complex Applications (e.g., E-learning Portal)
- Languages:
  - SMIL (or XHTML+Timesheets)
  - XForms
- Interaction:
  - Buttons/Selections...
  - Navigation
- Multimedia Objects:
  - Images/Text
  - Video/Audio

## Conclusions

How Digital Television receivers will technologically evolve?	WWW Convergence, Streamed media and 3D graphics
Definition of a worldwide application environment for digital television receivers including execution and presentation engines?	Procedural (GEM), declarative (XHTML, CSS, continuous media objects, TV extensions such as remote control)
Definition of a valid graphics architecture for Home Media Stations?	Five layers proposed model: HAL, Graphical context, Graphical Environment, GUI Toolkit, and HLL
How GEM should graphically evolve to take into account future requirements on time?	GEM procedural extensions (Java bindings of OpenGL), Declarative (XHTML + XForms + SMIL syntax)
How manufacturers can differentiate their products, following GEM?	For example, game console convergence