
Pablo Cesar
Helsinki University of Technology
Finland
pcesar@tml.hut.fi
http://www.tml.hut.fi/~pcesar
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)**

<table>
<thead>
<tr>
<th></th>
<th>PC</th>
<th>Non-Desktop device</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>DTV Receiver</td>
</tr>
<tr>
<td>Development</td>
<td>+++</td>
<td>+</td>
</tr>
<tr>
<td>Information Access</td>
<td>Open</td>
<td>+++</td>
</tr>
<tr>
<td></td>
<td>Closed</td>
<td>+</td>
</tr>
<tr>
<td>Information Management</td>
<td>+++</td>
<td>+</td>
</tr>
<tr>
<td>Communication</td>
<td>++</td>
<td>+</td>
</tr>
<tr>
<td>Entertainment</td>
<td>+++</td>
<td>+++</td>
</tr>
</tbody>
</table>
Background: Graphics Architectures (1/3)

- 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

<table>
<thead>
<tr>
<th>DVD</th>
<th>Broadcast TV</th>
<th>Web Surfing</th>
<th>Interactive TV</th>
<th>Video Games</th>
<th>Multimedia Authoring</th>
<th>Face-to-Face Communications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zero</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>One</td>
<td></td>
</tr>
</tbody>
</table>

Level of Interaction
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

<table>
<thead>
<tr>
<th></th>
<th>Threshold</th>
<th>Ceiling</th>
<th>Interoperability</th>
<th>Safety of Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Procedural Intermediate</td>
<td>+++</td>
<td>+++</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Procedural Interpreted</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>++</td>
</tr>
<tr>
<td>Declarative</td>
<td>+</td>
<td>+</td>
<td>+++</td>
<td>+++</td>
</tr>
</tbody>
</table>
### Background: Digital Television

#### System Architecture

<table>
<thead>
<tr>
<th>Region</th>
<th>Execution Env.</th>
<th>Presentation Env.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Europe (DVB) (MHP 1.1)</td>
<td>DVB−J</td>
<td>bridge</td>
</tr>
<tr>
<td>USA (ATSC)</td>
<td>ACAP−J</td>
<td>bridge</td>
</tr>
<tr>
<td>Japan (ARIB)</td>
<td>ARIB−AE (STD−B23)</td>
<td>BML (STD−B24)</td>
</tr>
<tr>
<td>ITU</td>
<td>ITU J.202</td>
<td>GEM</td>
</tr>
</tbody>
</table>

#### 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

- General study on the system software for DTV

P2 (2001): Integration of Applications into a Digital Television Environment
- Description of a system model to run different DTV applications

- Graphical User Interface Toolkit for DTV

- Portable SMIL player running on different devices

- Possible use case scenarios for SMIL in DTV

P6 (2003): Delivering MHP Applications into a real DVB-T Network, Otadigi
- Description of two services transmitted over a DTV network

P7 (2004): A Device Independent XML User Agent for Multimedia Terminals
- Definition of an XML based profile for developing interactive multimedia services (SMIL+XForms)

- Layered graphics architecture for non-desktop devices

- Extension to P8 with detailed study on graphics architectures alternatives. Complete reference implementation
The 3rd International Conference on Pervasive Computing
Doctoral Colloquium

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)
Otadigi: 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

Graphical Context
- Threshold
- Ceiling

Hardware Abstraction Layer
- Game Console
- Graphical Environment
- GUI Toolkit
- Proprietary API

High Level Languages
- DVB-MHP
- AWT and DVB Classes
- HAVi
- DVB-HTML
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)

<table>
<thead>
<tr>
<th>Interactive: Basic</th>
<th>Interactive: Internet Access</th>
<th>Interactive: High End</th>
</tr>
</thead>
<tbody>
<tr>
<td>Requirements:</td>
<td>Requirements</td>
<td>Requirements</td>
</tr>
<tr>
<td>– Browse simple XML documents</td>
<td>– Browse XML Compound Documents (complex)</td>
<td>– Integration of all kinds of multimedia objects</td>
</tr>
<tr>
<td>– Limited navigation</td>
<td>– Interactive</td>
<td>– Temporal Dimension</td>
</tr>
<tr>
<td>– Images, text</td>
<td>– Temporal Synchronisation</td>
<td>Proposed profile:</td>
</tr>
<tr>
<td>Proposed profile:</td>
<td>– Video and audio</td>
<td>– DVB-J + OpenGL Java Wrappers</td>
</tr>
<tr>
<td>– XHTML + CSS</td>
<td>Proposed profile:</td>
<td>– JMF media player</td>
</tr>
<tr>
<td></td>
<td>– XHTML 2.0 + Timesheet</td>
<td>(all kind of formats)</td>
</tr>
</tbody>
</table>
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)

- 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)

• 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

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