Architecture of Infotainment Systems
Course 2

https://www.continental.com/en

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Infotainment and Connectivity
Human Machine Interface
Agenda

1. Introduction
   • Infotainment System – @ Continental
   • Features

2. System Architecture
   • Definitions
   • Requirement analysis
   • Decomposition
   • Decisions

3. Case Study
Agenda

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3. Case Study
What is an Infotainment System?

Infotainment System - @ Continental - #1

Infotainment System - @ Continental - #2

Infotainment System - @ Continental - #3

## Infotainment features - #1

<table>
<thead>
<tr>
<th>Year</th>
<th>Feature</th>
</tr>
</thead>
<tbody>
<tr>
<td>1930</td>
<td>The first commercially successful car radio by Motorola.</td>
</tr>
<tr>
<td>1946/50</td>
<td>The first record player for in-car operation is developed.</td>
</tr>
<tr>
<td>1953/54</td>
<td>FM reception and station keys.</td>
</tr>
<tr>
<td>1961 – 1971</td>
<td>Cassese drives Stereo</td>
</tr>
<tr>
<td>1976 – 1979</td>
<td>Digital display and microprocessor are produced.</td>
</tr>
<tr>
<td>1994</td>
<td>Navigation</td>
</tr>
<tr>
<td>1995</td>
<td>DAB Audio CD</td>
</tr>
<tr>
<td>1997 / 1998</td>
<td>First car radio with Telematics</td>
</tr>
<tr>
<td>2000/2001</td>
<td>iRadio</td>
</tr>
<tr>
<td>2004</td>
<td>DVD navigation voice recognition</td>
</tr>
<tr>
<td>2006</td>
<td>Bluetooth for handsfree telephony.</td>
</tr>
</tbody>
</table>
| 2007   | - large touch screen
- HDD
- Smartphone integr.
- SD card / USB
- MP3 player |
| 2009   | phase diversity satellite radio for Sirius/XM                         |
| 2010   | - voice recognition for destination input and online Google Maps.     |
## Infotainment features - #2

<table>
<thead>
<tr>
<th>Year</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>“eHorizon” technology for anticipatory driving</td>
</tr>
</tbody>
</table>
| 2015 | • Full HD Display  
      | • Carplay  
      | • Android Auto |
| 2016 | • Carlife  
      | • Mirrorlink |
| 2016 | Touch screen with optical bonding and multi gesture control. |
| 2018 | • Infotainment  
      | • Cluster  
      | • Even more domains |
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3. Case Study
What is a system?

Figure 1: Various examples of systems
What is a system?

› https://www.macmillandictionary.com/dictionary/british/system

system - definition and synonyms

NOUN
/Pronunciation /ˈsɪstəm/
Word Forms

1 [COUNTABLE] a set of connected things that work together for a particular purpose
What is (system) architecture?

Figure 2: Various examples for architecture
What is architecture?

• ISO/IEC/IEEE 42010:2011(E), Systems and software engineering — Architecture description

3.1 architected
process of conceiving, defining, expressing, documenting, communicating, certifying proper implementation of, maintaining and improving an architecture throughout a system’s life cycle

3.2 architecture
〈system〉 fundamental concepts or properties of a system in its environment embodied in its elements, relationships, and in the principles of its design and evolution

• “An architecture is the set of significant decisions about the organization of a software system, the selection of the structural elements and their interfaces by which the system is composed, together with their behavior as specified in the collaborations among those elements, the composition of these structural and behavioral elements into progressively larger subsystems, and the architectural style that guides this organization—these elements and their interfaces, their collaborations, and their composition.” (Kruchten: The Rational Unified Process, 1999)

• But why do we need System Architecture?
Figure 3: Representation of all the activities involved in Software Development
#1: Requirements analysis

Exercise 1:

Establish requirements for an Infotainment System.

Figure 4: Infotainment System for Fiat
#1: Requirements analysis

Purpose:

- Analyze requirements.
- Create **System Use Cases**.
- Define the system from the architectural viewpoint: **Context**
  - External entities (within environment)
  - Interdependencies
  - Connections
  - Interactions
  - Interfaces

Figure 5: Representation of Context View
#1: Requirements analysis

Figure 6: (Simplified) Context view for OVIP system
#1: Requirements analysis

• A **System Use Case** describes the interaction between an **actor** and the **system** in order to achieve a **goal**.

• Description: Multiple template are available.

Figure 7: Examples of templates
#1: Requirements analysis

Exercise 2:

Define the System Use Case for: Drive in reverse gear.

Figure 8: Part of diagram for system use case: “Drive in reverse gear”
#1: Requirements analysis

Input:

• Requirements.

• Environment.

Output:

• Reviewed requirements.

• System use cases.

• Use case diagrams.

• Requirements refinement diagrams (for each system use cases).
#2: Decomposition

• Subsystem = component of the system (has-a, composition)

• Can be:
  • Real
    • Examples: Radio Module (HW), OS (SW);
  • Conceptual
    • Examples: Audio;

Figure 9: Example of decomposition: Car - Engine

Alexandru Lupu, © Continental Automotive GmbH, 2018
#2: Decomposition

Architectural viewpoints

• Building-Block view / Component view / Module view
  • What are the subsystems?
  • What are the responsibilities for each subsystem?
  • What are the dependencies between subsystems?
  • How are the interfaces used by subsystem to communicate?
  • Are the subsystems loose coupled?

• Runtime view
  • What is the flow for each system use case?
  • What are the subsystems (and what do they do) for each system use case?
#2: Decomposition

**Purpose:**

- System is decomposed into **subsystems**. Each subsystem has allocated a specific set of requirements.
- **Interfaces & Ports** between subsystems are identified and documented.
- Illustrate the **dynamic interaction** between subsystems for defined use cases.

**Input:**

- Requirement analysis = done.
- System use cases = done.

**Output:**

- High level view of subsystems;
- Interfaces, ports;
- Use case realization diagrams.
#2: Decomposition

Exercise 2:

Based on the requirements defined in Exercise 1:

• What would be some of the subsystem(s) in our infotainment system?

• Which is real and which is conceptual?

Figure 4: Infotainment System for Fiat
#2: Decomposition

Figure 10: (Simplified) Building-Block view for OIP
Figure 11: (Simplified) Runtime view for Fiat – Use case: “Drive in reverse gear”
#3: Decisions

- Resource allocation
  - Processes
  - Memory
  - CPU core, time
- Quality attributes
  - System Performance
  - Start-up time
- Middleware
- Make-or-buy
- Reuse existing solutions
- Requirements for Testing against system architecture
- Alternatives
#4: Tools - @ Continental

- Rational Rhapsody
  - ✔ Documentation **SysML** (Systems Modeling Language based on UML)
- Rational Doors
  - ✔ Requirements
- Rational Rhapsody Gateway
  - ✔ Import requirements from Doors to Rhapsody
  - ✔ Requirement Coverage
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3. Case Study
End of theory.
Start of practice.
Thank you.