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Using an inference engine to manage UI complexity

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Philips Applied Technologies
Alcor Scenario Engine
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…about the speaker…

- Iulia Dobai
  - Born in Brasov, Romania
  - 2000 – 2004 - Bachelors in Computer Science from “Transylvania University” in Brasov
  - 2004 – 2005 – research assignment at TU Delft
  - 2005 – 2007 – postmaster in Software Technology (OOTI), Stan Ackerman’s Institute, TU/e
  - Passionate about dancing (salsa), sports (squash, tennis), mountains.

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…why this presentation?...

- OOTI Program:

  - assignment at Philips Applied Technologies in the ALCOR project.
- Supervisors:
  - Gerrit-Jan Bloem & Njin-zu Chen: AppTech
  - Alexander Serebrenik: TU/e
- Role of this presentation:
  - Give you a practical example of when and how a rule-based engine can be applied.
  - Underline some of the advantages and disadvantages

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Agenda

- Introduction into the assignment (5 min)
- Inference engine based solution (10 min)
- Assessment of the solution and comparison with traditional approach (7 min)
- Conclusions (3 min)

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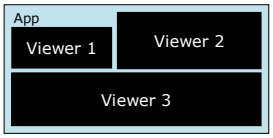
…Alcor…???

- What?
  - uses innovative interaction devices and new interaction concepts
  - develops experience demonstrators
- Why?
  - to prove the feasibility of using innovative interactions in future applications



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Alcor – Problems

- Development speed (managing complexity)
- Extending & changing an existing demonstrator
- Verification & testing

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Alcor Scenario Engine assignment

- Develop a high level **definition language** to express application behavior (interactions).
- Develop a **Scenario Engine** component that automates the application behavior execution.
- Develop proof of concept applications
- Why? (key drivers)
  - Better support for **rapid application prototyping**
  - Increased **maintainability** (changeability and testability)
  - **Usability** (software developers, designers need to use this solution)
- Constraints
  - **Latency**
  - **Interoperability**

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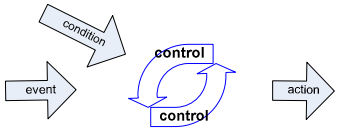
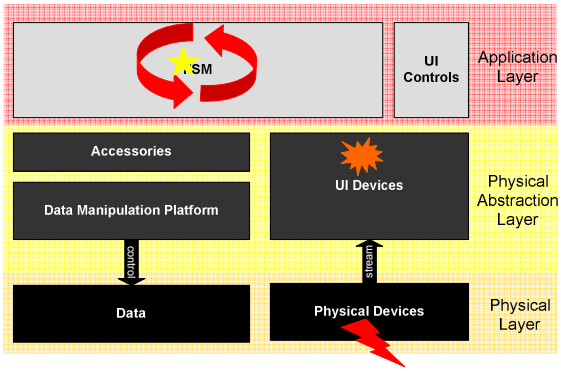
ALCOR - Initial Problem and Solution





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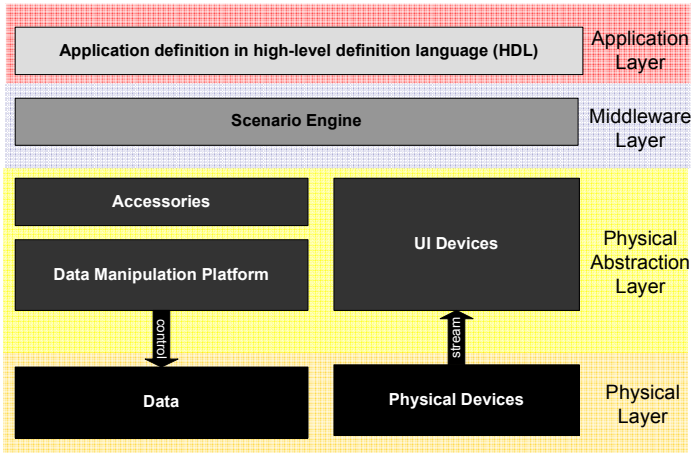
ALCOR – expected outcome



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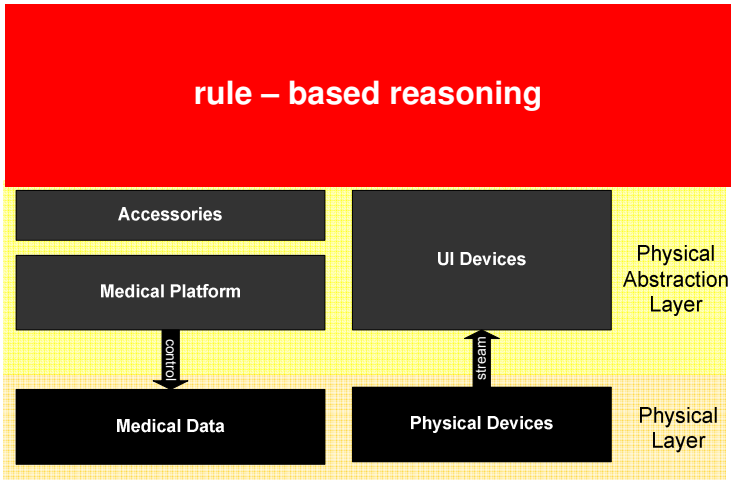
ALCOR Proposed Solution



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Rule-based reasoning

- In a rule-based approach:
  - The problem-dependent set of data declarations (called the **knowledge base/rule base**) is expressed in the rule-based language.
  - The problem independent program uses an inference mechanism (called the **inference engine)** to derive conclusions from premises**.**

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Rule-based System

- What is?
  - **A rule-based system is a system that uses rules to derive conclusions (actions) from premises (conditions and events)**
- What is it made out of?
  - An inference engine
  - A rule base/ knowledge base
  - A working memory

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The inference engine

- Implements a pattern matching algorithm (most commonly: RETE) to determine which rules apply given the current status of the working memory.
- Implements an agenda, which stores the rules that apply and which uses a conflict resolution strategy to determine which rule should be fired first.
- Implements an execution engine that fires the rules.

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Rule-based terminology and heuristics

Rule-based world

- Rule
- **Fact**
- Template
- Data – driven execution
- Rule-based systems are natively non-deterministic.

Metaphor in OO programming

- A static if-then or switch construction
- Instance of a class of objects
- Class
- Sequential execution

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On applying a rule-based solution

I chose **CLIPS** (C Language Integrated Production System) because
- It is developed in C (speed)
- It can be embedded in any C++/Java/Perl/C# application
- It has support for rule-based, procedural and OO programming
- It is mature (20 years), documented, supported
- It is free (LGPL license), approved by IP&S

The ScenarioEngine is the “borderline” component that ensures the communication between CLIPS and the rest of the C# code.

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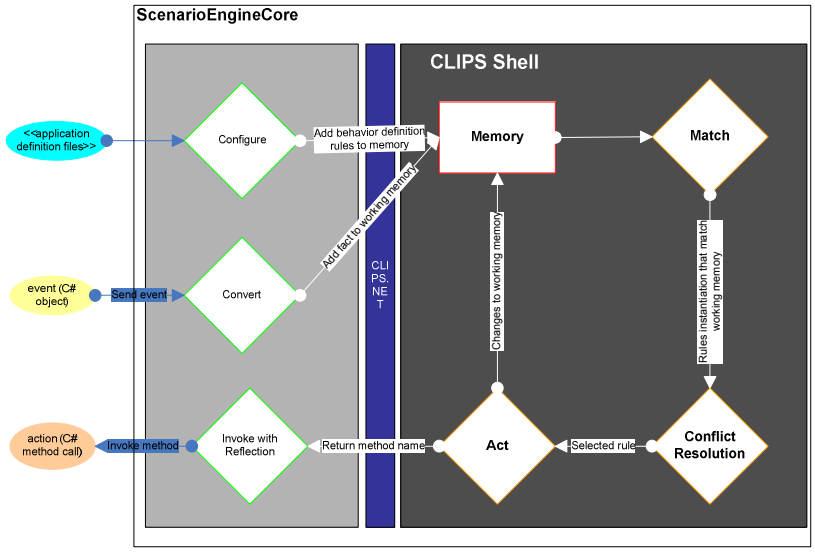
CLIPS and the ScenarioEngine



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Example Simple Application

RotatingScreen
-ID = "screen"
+isImgSmall()() : bool +rotate()(in degrees : int) : void

rotation.clp

```
(deftemplate screen
        (slot mode
        (type STRING))
)

(deftemplate vc_evt
        (slot command
        (type STRING)
        (default ?NONE))
)

(defrule rotationRule
   (screen (mode "rotation_mode"))
   (vc_evt(command ?c&: (eq (str-compare ?c "rotate") 0)))
   (test (= (condition "screen" isImgSmall) 1))
   =>
   (action "screen" rotate 90)
)
```

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Redesigned & Implemented an existing Demo

- Proved that the proposed scenario engine solution can be used for complex real ALCOR Demonstrators.
- Offered a reference application to the ALCOR team for future ALCOR demonstrators' development
- Performance
- Reusable & Extensible design of applications
- Maintainability and Rapid Application Prototyping

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Scenario Engine Throughput

- In the first four tests, old approach is about 8 times faster than the new one.
- In the last two tests the two approaches are comparable
- The decision making in the scenario engine approach takes on average 1 ms/event.
- The bottleneck for execution time is the medical platform
- The decision time is about 10% of the entire execution time.
- We conclude that the scenario engine approach is not a hindrance in achieving the desired latency.

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Maintainability (1)

- **Criteria (what influences maintainability)**
  - Size
  - Localization of change
  - Clear/concise mapping
- Analyzability
- Verifiability
- Forces explicitness
- Completeness
- Reliability

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Maintainability (2) - Size

- Smaller size => higher maintainability
- The ScenarioEngine approach contains 7 times less lines of C# code; however it adds to the C# lines of code, 50% lines of CLIPS rules.

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Rapid Application Prototyping

- Criteria (what influences RAP?)
  - Modularity
  - Scalability
  - **High-level of abstraction**
- Speed
- Reliability of what is developed

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Usability ?

- Very hard to assess – time and practice can prove it or usability tests (any volunteers?)
- Usability Drawbacks:
  - Developers need to perform mental switches between C# and CLIPS. The two languages are used concurrently.
  - For CLIPS development – mathematical logics awareness is required as well as insight in the heuristics of rule-based reasoning.
- Usability Advantages:
  - It is more strait forward, the level of abstraction (being higher) is closer to our mental models.
  - It can be easier accessible for people with other backgrounds: designers (with understanding of predicate logics)

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Scenario Engine - Conclusions

- Yes, a rule-based language is a valid option for specifying UI interactions (state transitions become rules)
- Yes, an inference engine is a valid option for managing complex UI behavior (especially if it is evolving and changing)
- The solution provides support for rapid application prototyping and better maintainable applications !
- Usability