

# [ An Architectural Pattern for Non- functional Dependability Requirements ]

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# [ Outline ]

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- Research Agenda
- Our approach
  - Extend the distinction between functional versus nonfunctional requirements
  - Propose an architectural pattern, model dependability requirements in software architectures directly and explicitly
- Example
- Conclusions

# Research Agenda

## Motivation:

- The intersection of three areas of research:
- Requirements Engineering:
  - Goal Refinement [Lamsweerde et al]
  - The NFR Framework [Mylopoulos et al]
    - NFRs specified during Requirements Engineering are often verified after implementation
- Software Architecture:
  - Original requirements not always visible, traceable
    - Non Functional Requirements (NFRs) are especially underrepresented
- Aspects:
  - Aspects have the potential to seamlessly model and integrate NFRs through architectures to implementations
    - Need development methodology from NFRs through architectures to AOP solutions
    - Need corresponding analysis and testing of the artifacts of such methodology

## Additional Objectives:

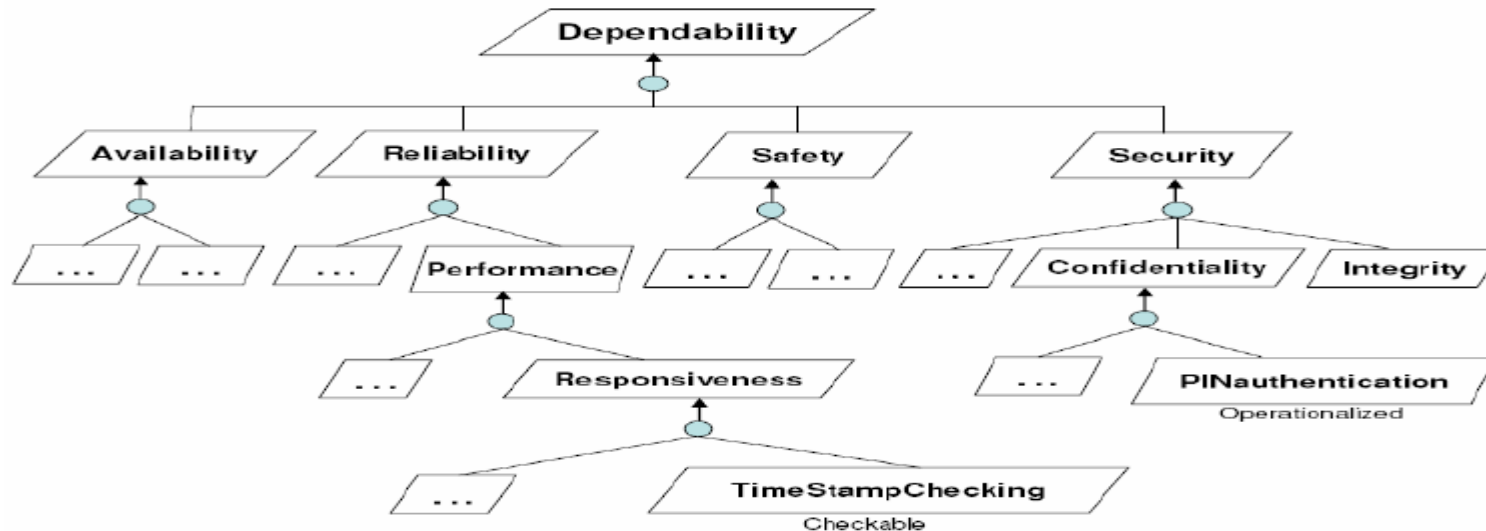
- separation of cross-cutting functional and nonfunctional concerns at the architecture level
- architectural analysis against NFRs early in the software lifecycle
- establishing confidence of properly chosen architecture style and designed architecture before the architecture is implemented.

# [ Our Approach ]

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- Model NFRs in software architectures directly and explicitly
  - Rely on the “design decision” made for each NFR
- Three types of Requirements
  - Functional
  - Operationalizable Nonfunctional
  - Checkable Nonfunctional
- Types of Architectural Components
  - Core Components
  - Aspectual Components
  - Monitoring Components
- Connectors
  - XML Binder

# Requirements Classification



## NFRs:

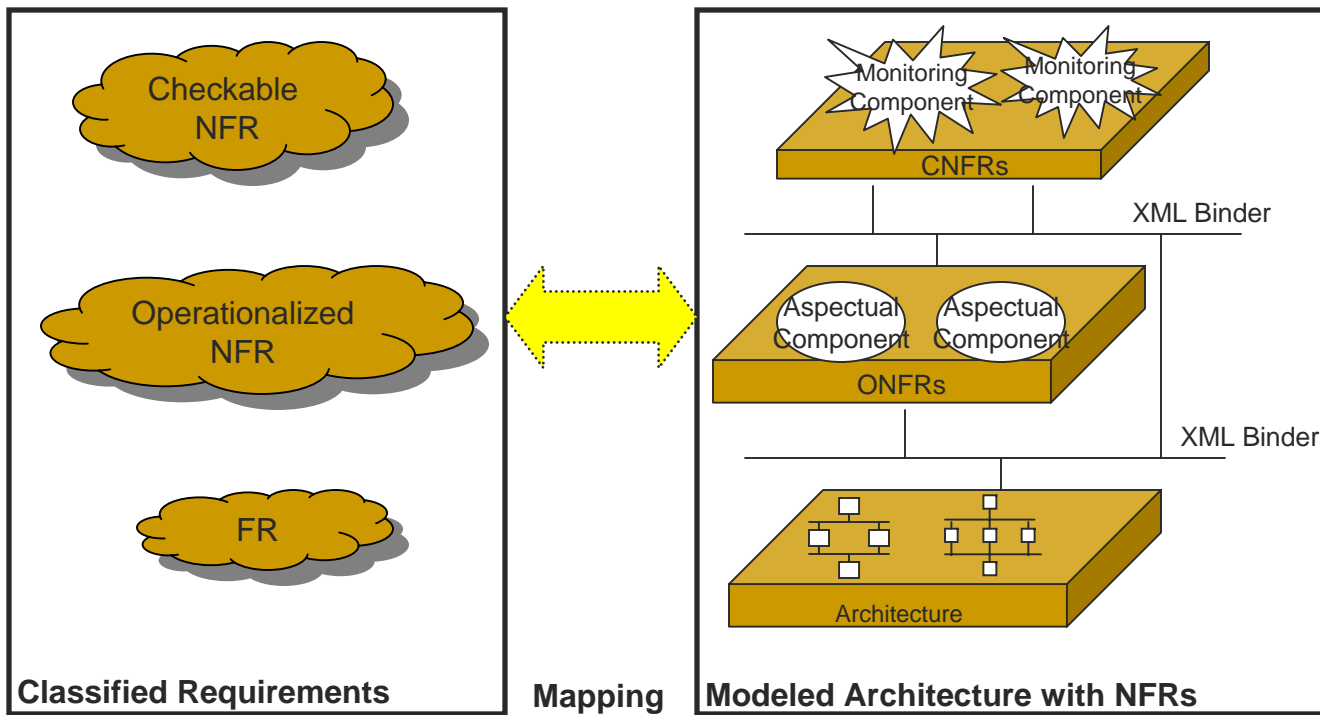
- **Operationalizable:**

Upon decomposition to “design decision”, the chosen strategy can be realized by functional components in the software architecture

- **Checkable:**

The chosen strategy is to monitor functional behavior to check and verify that desirable quality properties are met

# Requirements & Architectures



# XML Binder

```
Component aspect ConfidentialityInterceptor {  
    PlayerIDProtection () {  
        // the code for checking PlayerID goes here  
    }  
    ...  
}
```

```
<xml>  
  
  <Binder id = "confidentiality">  
  
    <pointcut id="Update">  
      <or>  
        <pointcut type="component"  
pattern="Received(event)&&Preparing(action)" />  
      </or>  
    </pointcut>  
  
    <interceptor  
      Component = "ConfidentialityInterceptor">  
      <advice  
        type = "before"  
        pointcut-refid = "update"  
        interceptor-method = "PlayerIDProtection()" />  
    </interceptor>  
  
  </Binder>  
  
</xml>
```

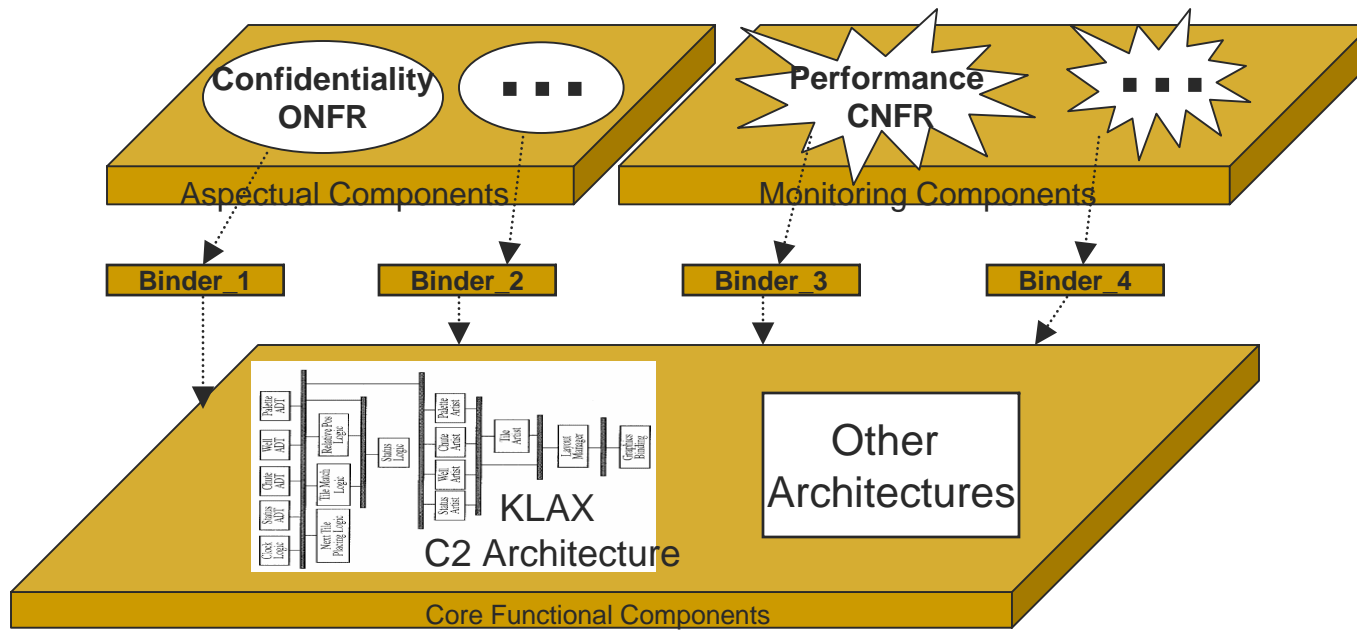
# XML Binder II

```
Component monitor ResponsivenessInterceptor {
    TimeStampCheckingBefore () {
        // the code for gathering starting time data goes here
        // add one timestamp to the start point of
        // each function where the request has been made
        // and sent out
    }
    TimeStampCheckingAfter () {
        // the code for gathering stopping time data goes here
        // add one timestamp to the end point of
        // each function where the request has been received
        // and updates have been made accordingly
    }
    TimeStampChecking () {
        // the code for verifying the timeslot used for
        // performing the request goes here
        // record the time difference between timestamps
        // resulting from the previous two methods,
        // and verify against the requirement
    }
    ...
}
```

```
<xml>
  <Binder id = "responsiveness">
    <and>
      <pointcut id="Starting">
        <or>
          <pointcut
            type="component"
            pattern="Preparing(event)&&Sending(event)" />
          </or>
        </pointcut>
      <pointcut id="Update">
        <or>
          <pointcut
            type="component"
            pattern="Received(event)&&Updated()" />
          </or>
        </pointcut>
      </and>
    <interceptor
      Component = "ResponsivenessInterceptor">
      <advice
        type = "before"
        pointcut-refid = "Starting"
      interceptor-method=TimeStampCheckingBefore() />
      <advice
        type = "after"
        pointcut-refid = "Update"
      interceptor-method=TimeStampCheckingAfter() />
    </interceptor>
  </Binder>
</xml>
```



# Architectural Pattern



# Differences from Previous Work

- NFRs as first class requirements elements that will be mapped into architectural design elements
- Provide clear means and guidance to identify the related core components for each NFR, and to integrate the several types of components
- Generality: Can be used in conjunction with existing architectural styles or other approaches to modeling and mapping of NFRs

# [ Conclusions ]

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## **An architectural pattern to support multiple views of software architecture design:**

- Traditional architectural design
- Impose constraints for making the architecture designed correspond and “implement” those NFRs
- Many to many relationships

## **A step toward a broader set of objectives:**

- “Seamless” synthesis from NFRs through architectures to aspect-oriented solutions
- Analysis and testing of development artifacts
- Traceability of development artifacts