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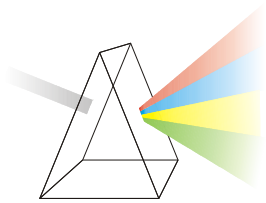
Summer School in Trento



Trento, June 19-30 2006

# Overview on Engineering Issues in Ubiquitous Web Applications

## THE UWA APPROACH TO CUSTOMIZATION



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Department of Telecooperation

## Outline of the Module 2/2

### Modeling of Ubiquitous Web applications

- Motivation
- Customization
- Excuse: Supporting person with disabilities
- Excuse: Linzer Mobile Guide
- Design space of Customization

### The UWA Approach to Customization

- Customization Architecture
- Context Models
- Customization Rules
- Customization Example
- Tool Support

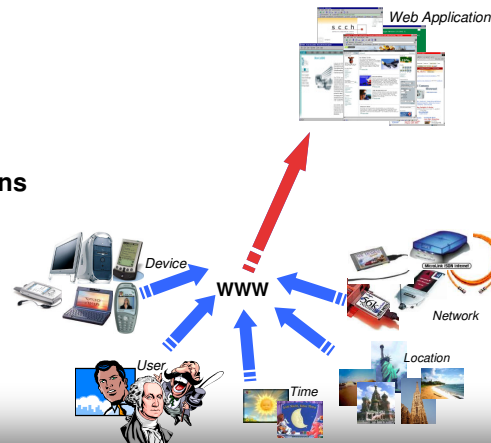
## Motivation

### Demand for Ubiquitous Web Applications

- additionally to the criteria of "traditional Web applications" allow for **ubiquitous access to services anytime / anywhere / anymedia**

### Development Goals

- accessibility **despite of restrictions** = **semantic equivalence**
- **best quality** of service = **semantic enhancement**



## Motivation

### Ubiquitous Web Applications:

- have to be **"aware"** of their **context** - **"Situation of Use"**
  - Context is not what is explicitly provided but which comes aside
  - e.g.: device, network, user, location, time
- have to **adapt accordingly**
  - changing the "standard" Web application

**Customisation = Adaptation to Context**

**Modelling is important but existing modelling approaches fall short in considering all aspects of UWAs**

### Currently

- **disregarding full potential of ubiquity**



## Objectives and Approach

### EU-funded Fifth Framework Program project (IST-2000-25131)

#### Objectives:

- Define a set of **methodologies, notations, and tools** to support the **design and fast prototyping** of complex **ubiquitous web applications**
- Propose a set of **notations** based, along with a set of **heuristics and guidelines** to help developers
- Provide **tool support** to make the design activity more efficient

#### Approach:

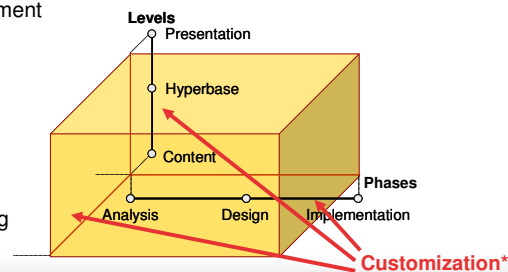
- Explicit **requirement elicitation, hypermedia modelling, transaction support and ubiquity modelling**
- **UML profile** for UWA-specific concepts
- **Dynamic rules** as a means to deal with ubiquity
- **Extension of existing UML tool** to facilitate an integrated development process

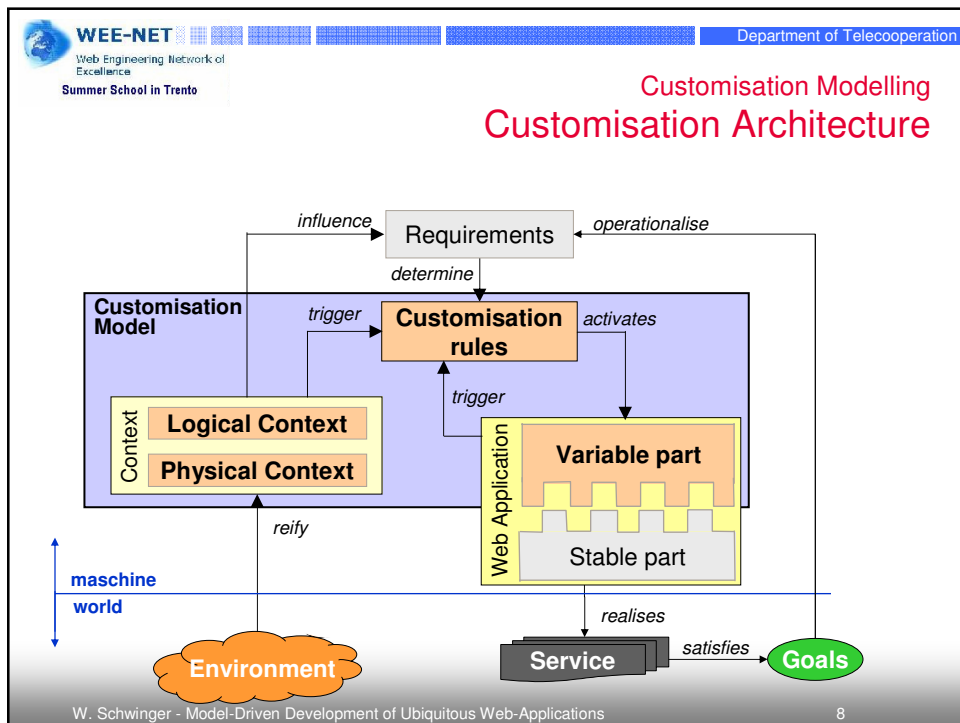
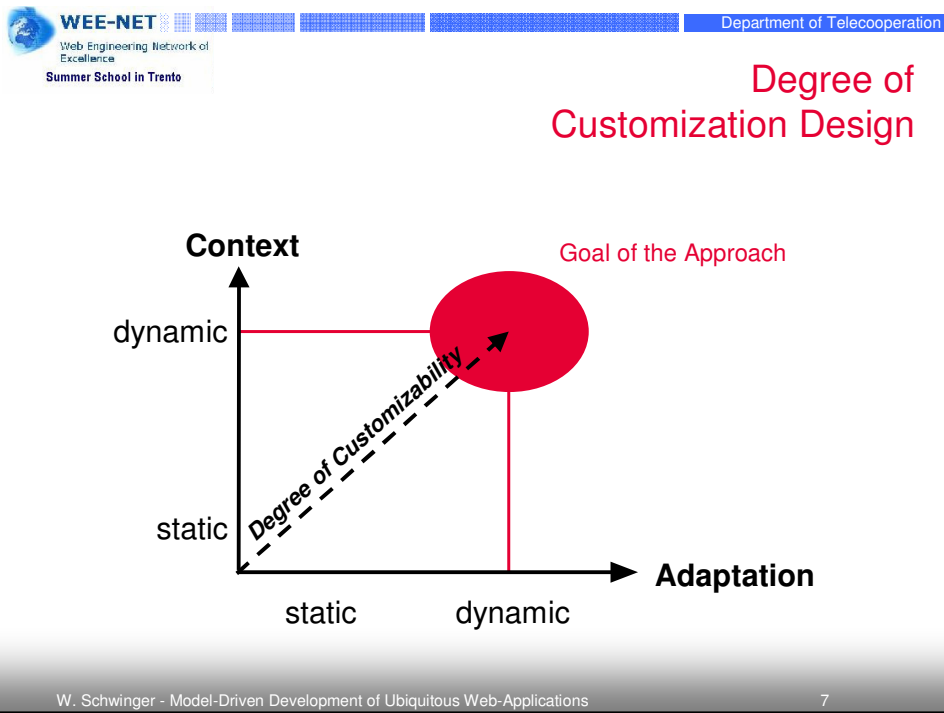
<http://www.uwaproject.org>

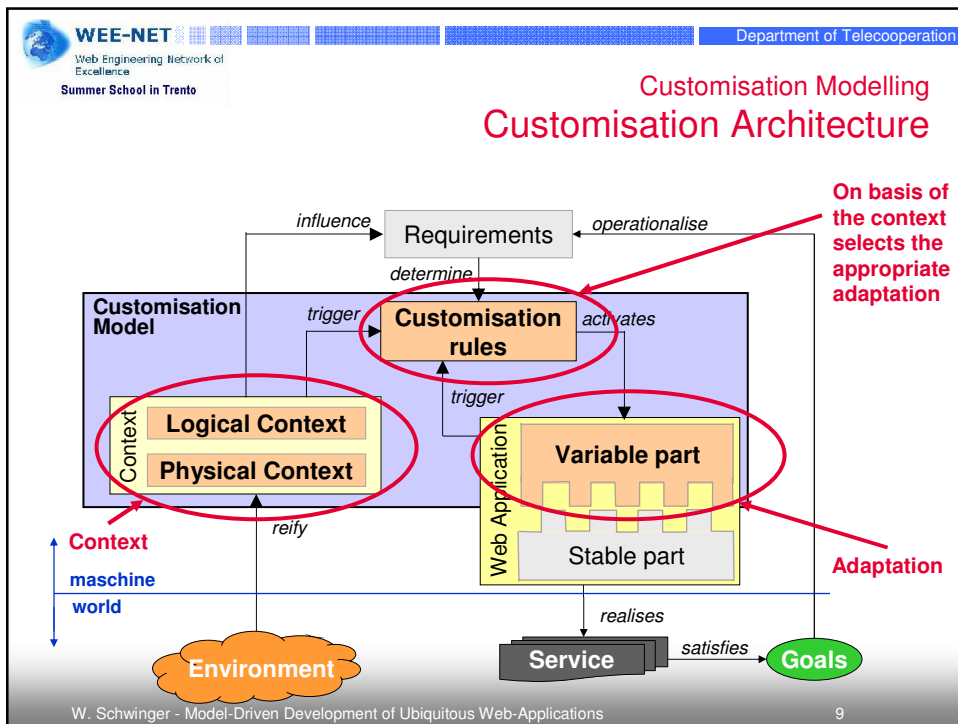


## UWA Approach To Customization Modeling

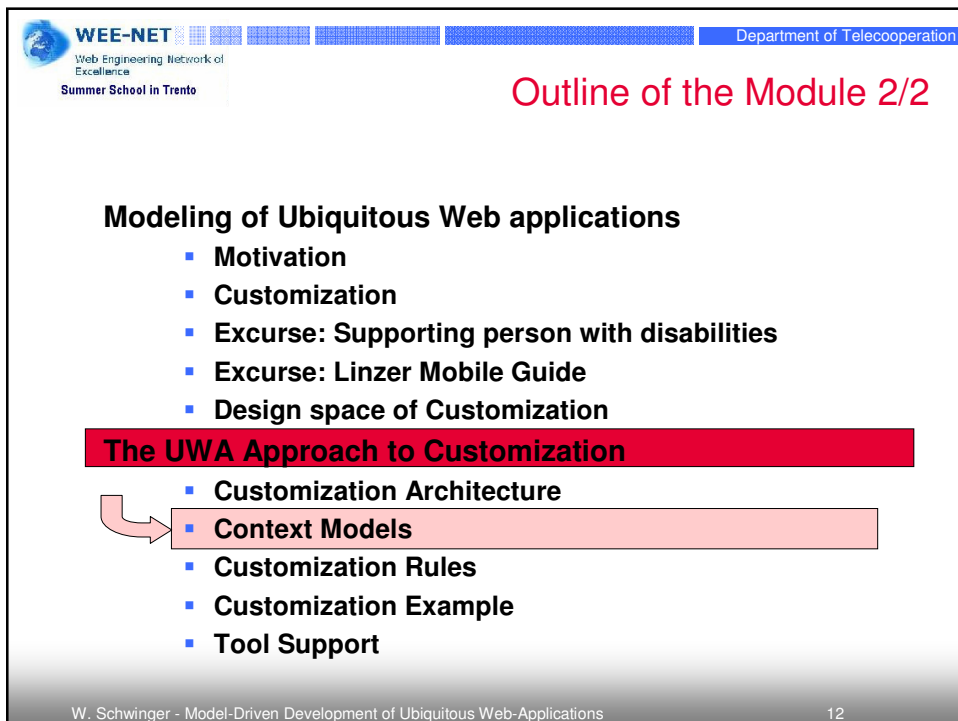
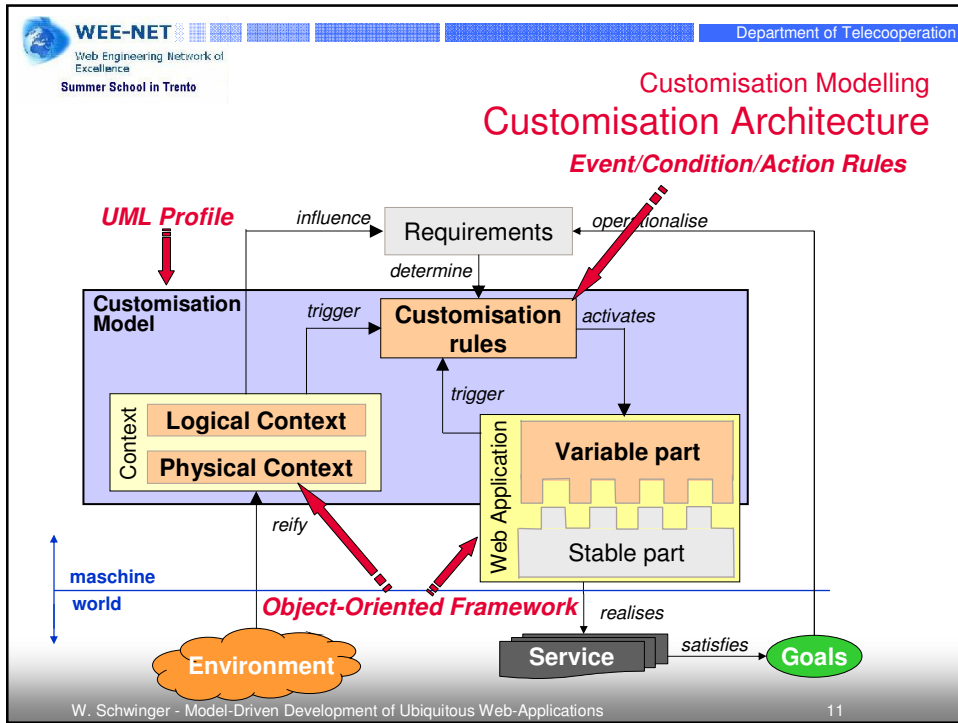
- **Goal: regarding all requirements of customization**
- **Designed from the start** to take the ubiquitous nature into account
- **Customization as the uniform mechanism** to enable ubiquity
  - **by adapting** towards a particular
  - **context** which reflects the environment
- **Holistic view** on the development
- process by introducing
  - **customization as additional**
  - **design dimension**
  - **effecting all dimension** of
  - **traditional web application modeling**







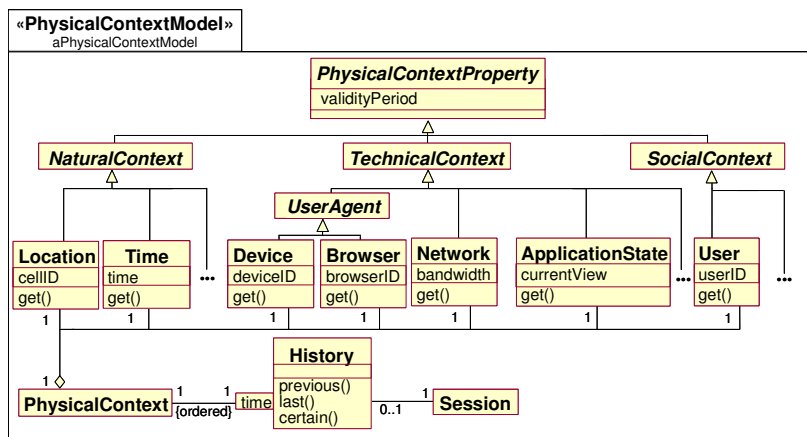
- WEE-NET Web Engineering Network of Excellence Summer School in Trento Department of Telecooperation
- ## UWA Approach To Customization Modeling Cont.
- ❑ Reification of the environment in terms of an explicit
    - **physical context model**: information sensed from the environment
    - **logical context model**: high-level descriptions of the situation of use
  - ❑ **Separation** of the core functionality of a web application (stable part) from its **context-dependent part** (variable part)
  - ❑ Adaptation of **all aspects** of navigation, operation, transaction
  - ❑ Specification of dynamic customisation in terms of **event-condition-action rules to reflect dynamicity**
  - ❑ Development of a **UML profile** for customisation modelling
  - ❑ **Extension of Rational Rose** to facilitate an **integrated development process**
- W. Schwinger - Model-Driven Development of Ubiquitous Web-Applications 10



## Customisation Modelling Physical Context Model

- ❑ **Manageable description of the environment** and the Web application itself
- ❑ At a **very low level of abstraction** (e.g. what is provided by sensors)
- ❑ **Open and extensible** to include new properties (e.g. temperature, altitude, battery level ) in the sense of an object-oriented framework
- ❑ **Updates outside the scope** of the Web application

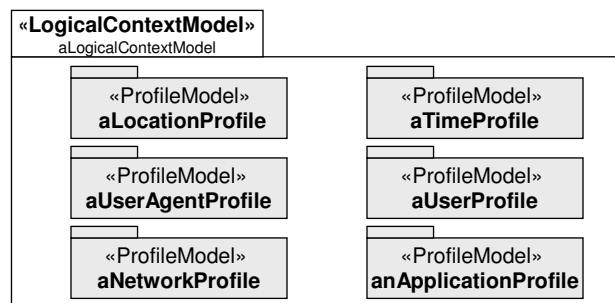
## Customisation Modelling Physical Context Model



## Customisation Modelling Logical Context Model

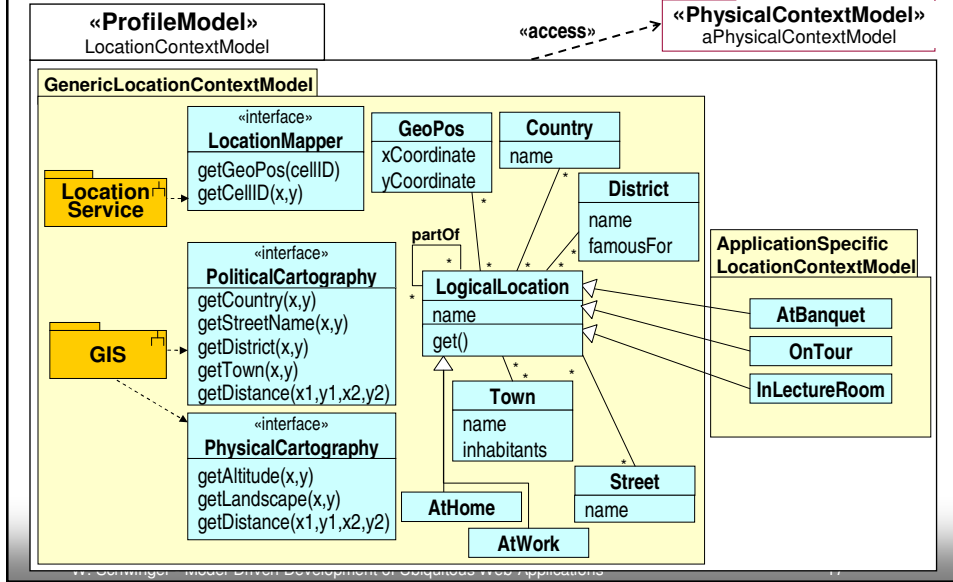
- ❑ Logical context represents **more stable, abstracted information**
- ❑ Can be provided simply by means of **profiles** or by using **abstraction mechanisms** such as aggregation and inference
- ❑ Needed to **enrich the physical context**, e.g. to derive the street name from a sensed X/Y-position
- ❑ Modelled as profiles and **organized in UML packages**
- ❑ **Open and extensible** to include new profile information and abstractions

## Logical Context Models - Profiles

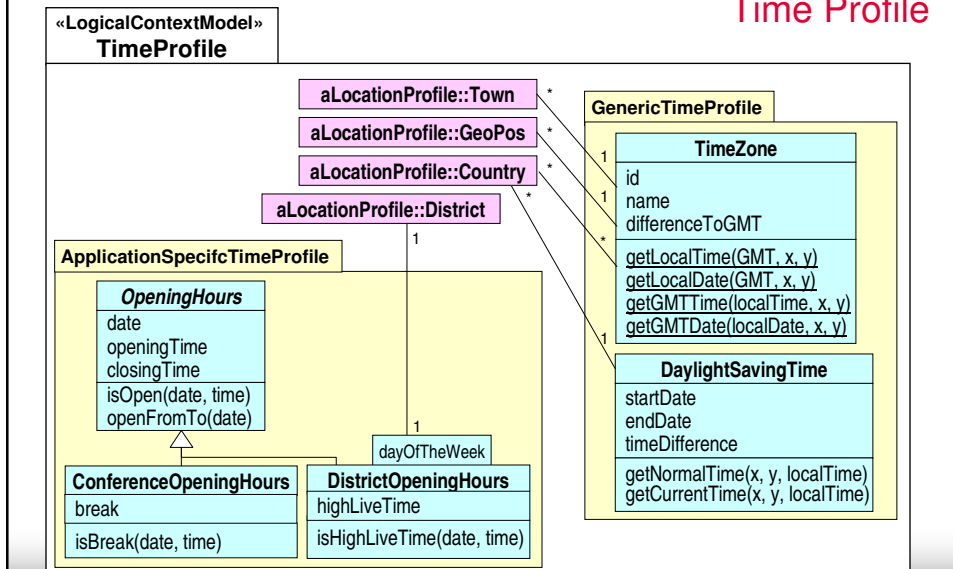




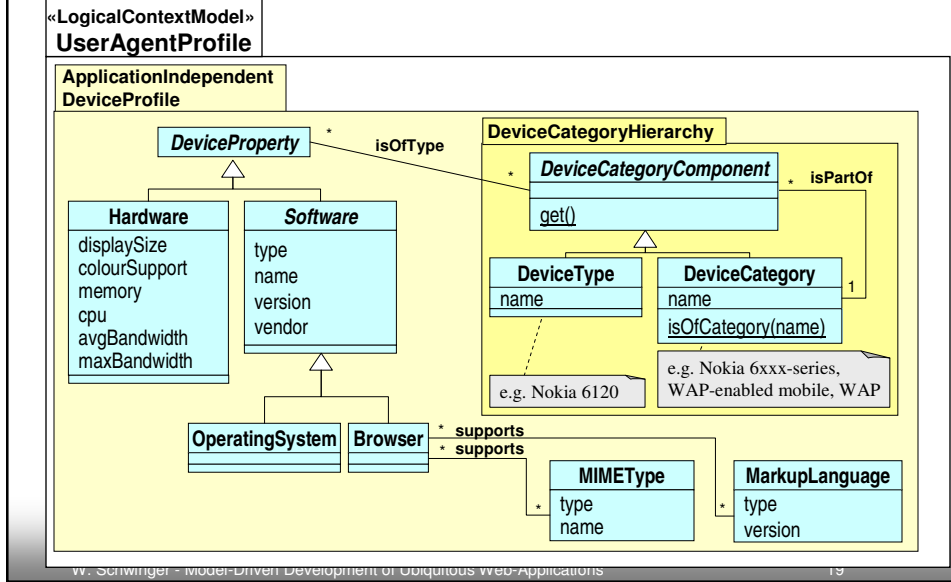
## Logical Context Model Location Context



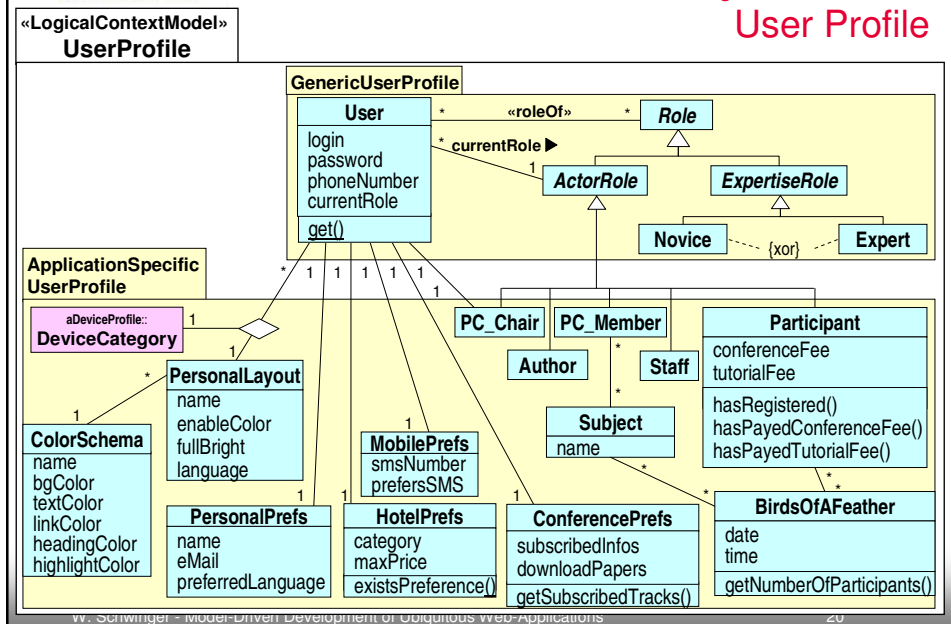
## Logical Context Model Time Profile



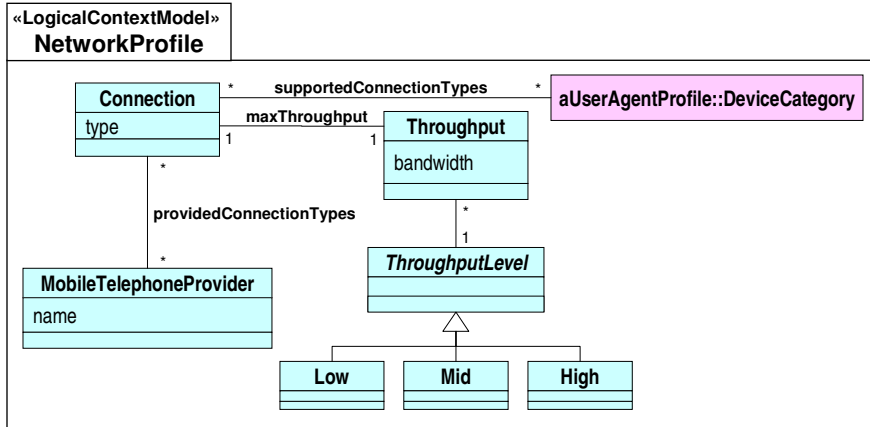
## Logical Context Model UserAgent Profile



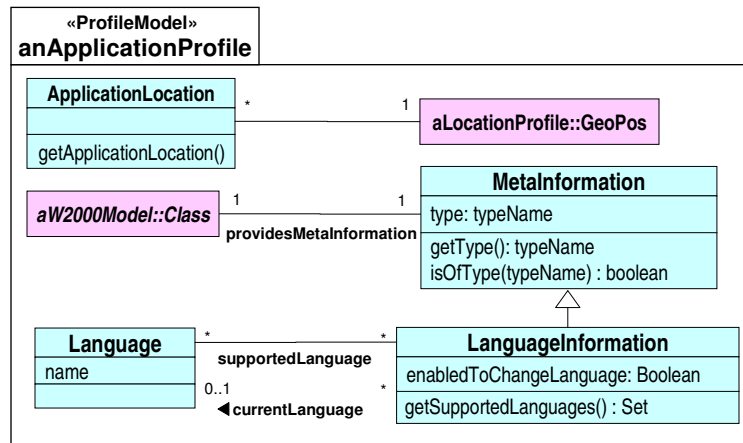
## Logical Context Model User Profile



## Logical Context Model Network Profile



## Logical Context Model Application Profile



## Modeling Adaptation

- ❑ **Adaptation activates the variable part** of the Web application
- ❑ **Generic adaptation operations**
  - **more than 70** generic adaptation operations have been defined for **hypermedia and transaction modelling elements**
  - e.g.: any collections can apply a filter operation to its extension
- ❑ **Application-specific adaptation operations**
  - the designer is enabled to introduce **arbitrary** adaptation operations

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## Customisation Modeling Modeling Customisation

### Customisation Rules are:

- formulated in terms of **event/condition/action-rules**
- allow declarative specification of dynamic customisation

#### Event:

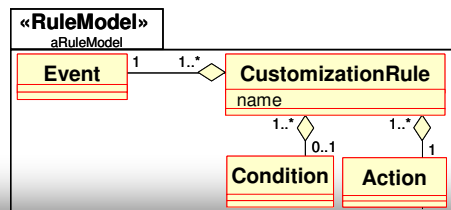
- identifies the **potential need** for customisation
- **predefined** in a **generic Event Model**
- **extensible** by additional primitive events and composite events

#### Condition:

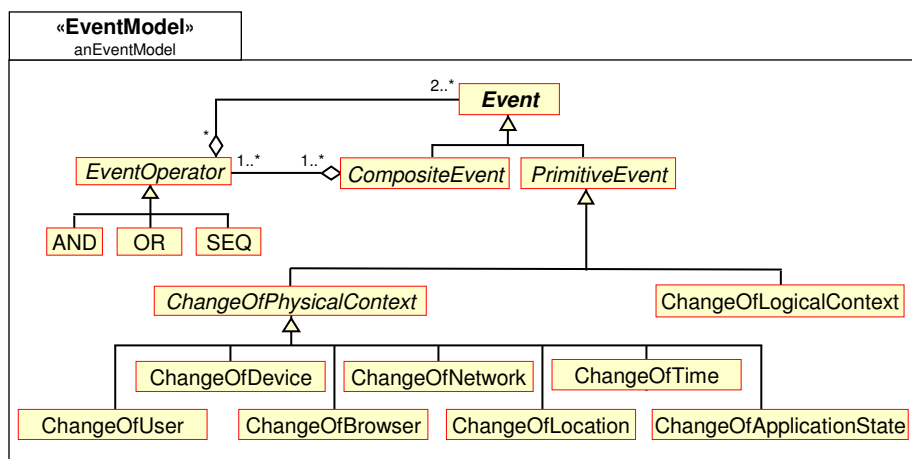
- **identifies if** customisation **is actually needed**
- very often **reasons** about the **context**
- specified in **OCL**

#### Action:

- **activates** a certain **adaptation operation**



## Event Model

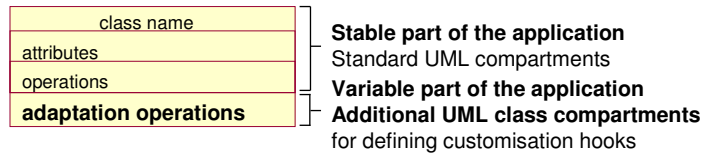


## Modeling Adaptation

### Adaptation hooks

- Allow customisation rules to **adapt** the Web application
- Support **micro and macro adaptation**
- Resemble **object-oriented framework** idea

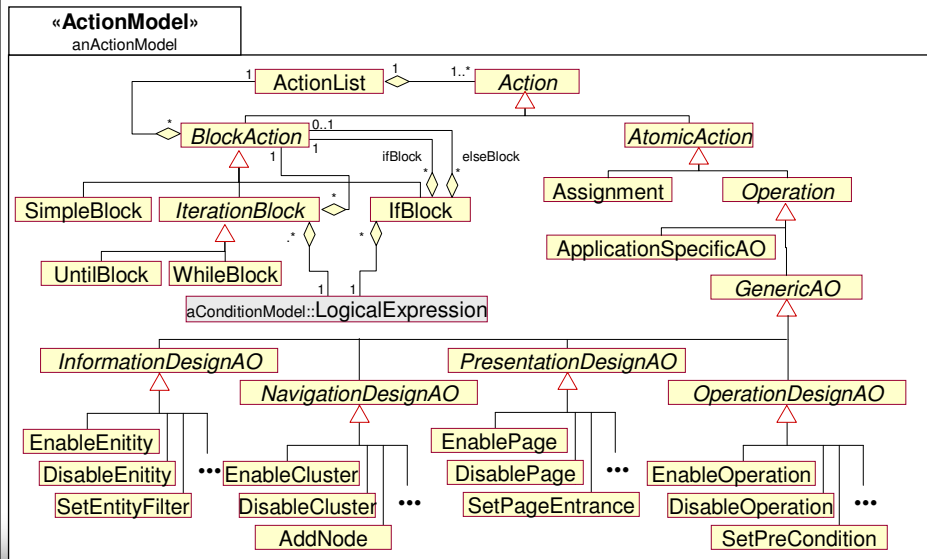
### Micro Adaptation (a single model element is adapted)



### Macro Adaptation: (more than one) model element



## Action Model



## Customisation Rule Modeling (cont.)

### □ Example 1/3 - Requirements

**Context:** Device used is not graphics enabled

**Adaptation:** Change the description to text mode

## Customisation Rule Modeling (cont.)

### □ Example 1/3

**Context:** Device used is not graphics enabled

**Event:**  
changeOfDevice

**Condition:**  
`session.history[current].context.userAgent.deviceType =  
profile.device.type AND  
profile.device.graphicEnabled = 'FALSE'`

**Adaptation:** Change the description to text mode

**Action:**  
`textMode {  
    description.switchTo('text')  
}`



## Customisation Rule Modeling (cont.)

### □ Example 2/3

**Context:** Moved more than 5 km

**Adaptation:** Recompute the route description



## Customisation Rule Modeling (cont.)

### □ Example 2/3

**Context:** Moved more than 5 km

**Event:**  
`changeOfLocation`

**Condition:**  
`session.history[current].context.location.  
distance(session.history['StartTime'].context.location)  
>= '5 km'`

**Adaptation:** Recompute the route description

**Action:**  
`recomputeRoute {  
 routeDescription.compute(context.location);  
}`



## Customisation Rule Modeling (cont.)

### □ Example 3/3

**Context:** Bandwith fallen below 10kb

**Adaptation:** Adapt the graphics accordingly

## Customisation Rule Modeling (cont.)

### □ Example 3/3

**Context:** Bandwith fallen below 10kb

**Event:**  
changeOfBandwidth

**Condition:**  
`session.history[current].context.bandwidth <= '10 KB'`

**Adaptation:** Adapt the graphics accordingly

**Action:**

```
resizeGraphics {  
    overviewMap.resize(context.bandwidth);  
    detailMap.resize(context.bandwidth);  
}
```

## Macros and Rule Patterns

- We introduce the notation of **macros and rule patterns** to:
  - increase expressiveness
  - ease the task of the customisation designer
  - support reusability
- **Macros** represent pre-defined parts of customisation rules in terms of condition and action (currently 67 macros are supported)
- **Rule patterns** are **templates** abstracting customisation rules **as a whole**
- Both can contain **parameterised components**

## Customisation Macros

- **Specification of a non-parameterised macro**

```
CURRENT_CONTEXT = (Session.History)->last()
```

- **Usage**

```
...  
E: ...  
C: CURRENT_CONTEXT.User.eMail =  
    "sysadmin@uwaproject.org"  
A: ...
```



## Customisation Macros

### □ Specification of a parameterised macro

```
CERTAIN_CONTEXT(Time t) = (Session.History)->certain(t)
```

### □ Usage

```
...  
E: ...  
C: CERTAIN_CONTEXT("2001/NOV/22 11:00").User.eMail  
    ="sysadmin@uwaproject.org"  
A: ...
```



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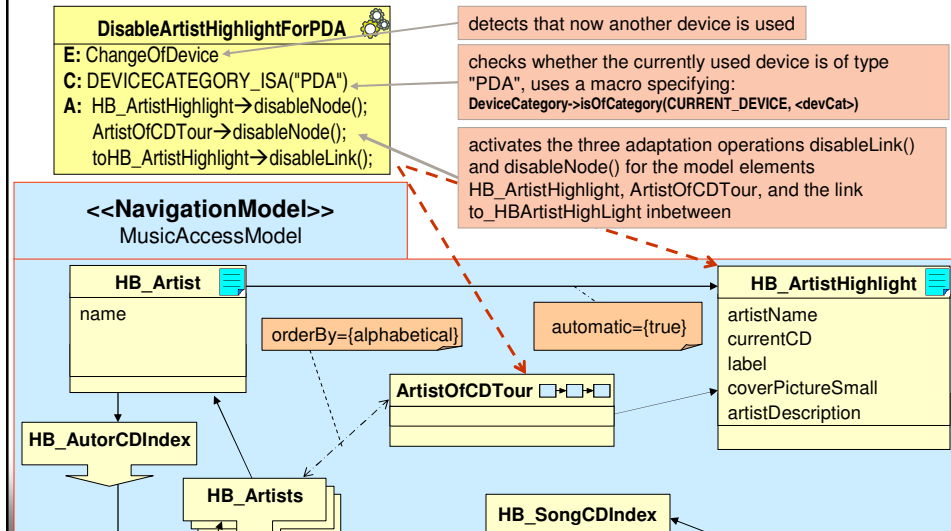
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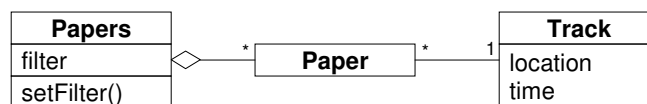


## Customization Example 1

"If a device of type PDA is used than the Artist Highlight should and the link to that node should not be available"



## Customization Example 2



### «CustomisationRule»

**Name:** FilterPapers

**Requ:** Only the papers currently presented in the current room's track should be available

**E:** ChangeOfLocation OR ChangeOfTime

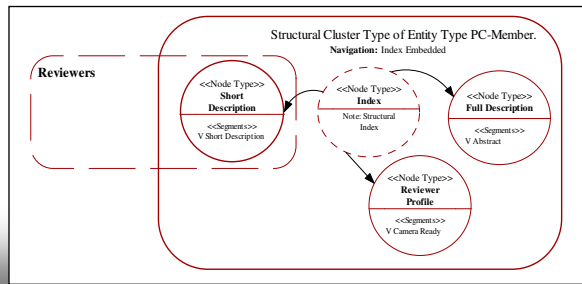
**C:** CURRENT\_LOGICAL\_LOCATION\_ISA("InLectureRoom")

**A:** Papers->setFilter("Paper.Track.Location=" +  
CURRENT\_LOGICAL\_LOCATION\_GET("InLectureRoom") +  
" AND Paper.Track.Time=" + CURRENT\_TIME)

## Customization Example 3

"If a device of type PDA is used than the node "Full Description" and the link to that node should not be available"

Web application model in W2000



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## Customization Example 3

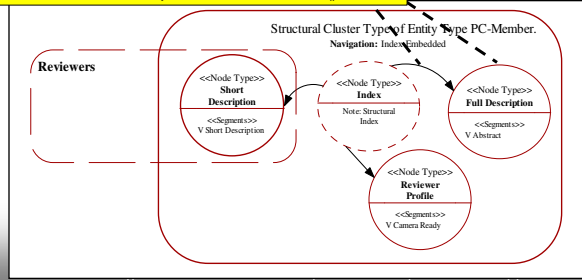
"If a device of type PDA is used than the node "Full Description" and the link to that node should not be available"

**«CustomisationRule»**  
**Name:** ReducePC\_MemberForNavigation  
**Requ:** Maximise Usability  
**E:** ChangeOfDevice  
**C:** DEVICECATEGORY\_ISA("PDA")  
**A:** Index\_FullDescription→disableLink();  
 FullDescription→disableNode()

detects that now another device is used

checks whether the currently used device is of type "PDA", uses a macro specifying:  
 DeviceCategory->isOfCategory(CURRENT\_DEVICE, <devCat>)

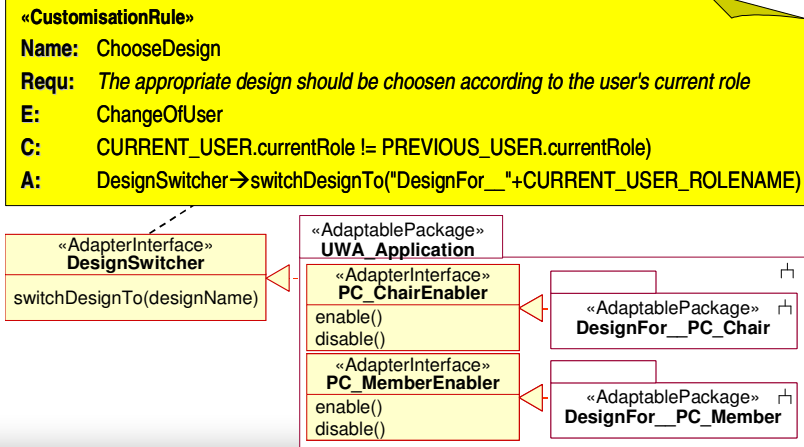
activates the two adaptation operations disableLink() and disableNode() for the model elements FullDescription and Index\_FullDescription, respectively



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## Customization Example 4

"On basis of the users current role select the according design"

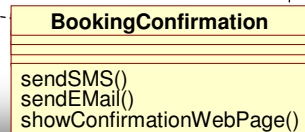


## Customization Example 5

**<<customizationRule>>**  
**Name:** SMSConfirmation  
**E:** CommitTransaction  
**C:** CommitTransaction.name='Booking' AND  
 UserAgentProfile->getDeviceType(Session.History[CURRENT].UserAgentContext.get())='MobilePhone'  
**A:** BookingConfirmation->sendSMS()

**<<customizationRule>>**  
**Name:** WebConfirmation  
**E:** CommitTransaction  
**C:** CommitTransaction.Name ='Booking' AND  
 UserAgentProfile->getDeviceType(Session.History[CURRENT].UserAgentContext.get()) = 'PC'  
**A:** BookingConfirmation->sendEMail();  
 BookingConfirmation->showConfirmationWebPage();

As soon as the user commits booking,  
 construct an appropriate booking confirmation  
 according to the characteristics of the device used



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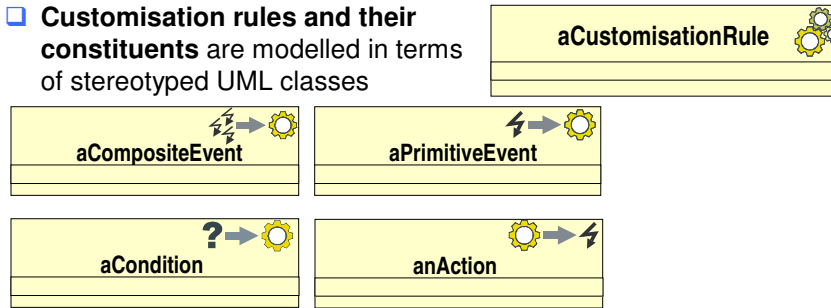
- Tool Support

## Tool Support

- Modeling supported by **customization modeling tool**
- Extension** of commercial UML modeling tool **Rational Rose**
- UWA** tool framework comprises:
  - UML profile including e.g.: stereotype definition
  - Generic models, e.g.: event model, logical context models
  - Plug-ins - providing functionality
    - Wizard supporting customization rule creation
    - Model checking
    - Lockup
- Currently available as **prototype**

## Customisation Modeling Modeling Customization

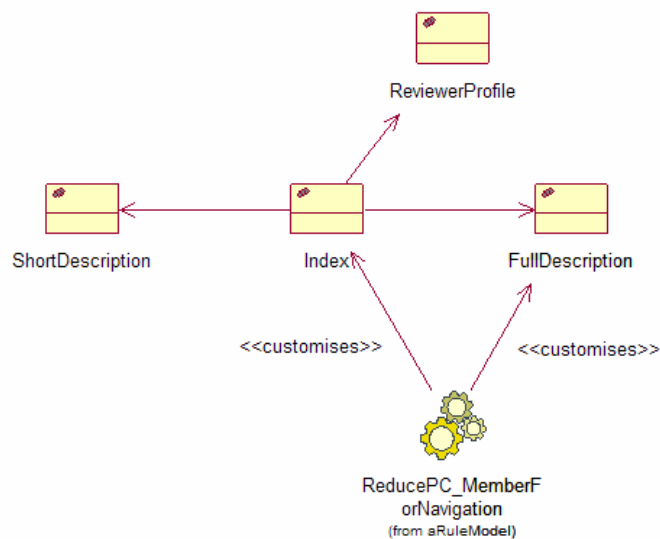
- Customisation rules and their constituents are modelled in terms of stereotyped UML classes



- Customisation rules are attached to

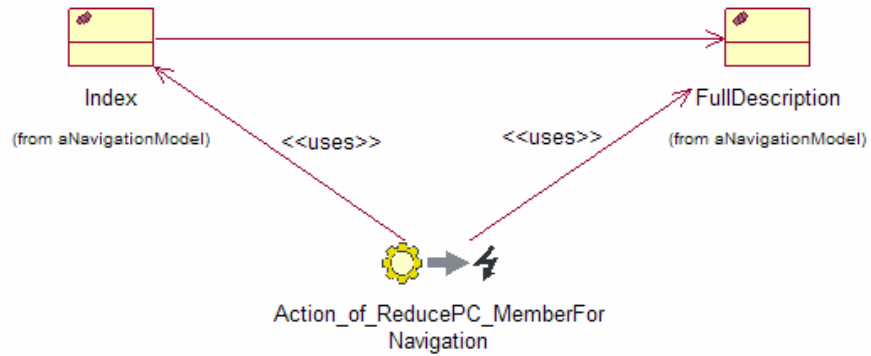
- those **hypermedia or transaction modelling elements** being subject to adaptation using an association stereotyped «**adapts**» and to
- those **requirements** which are realised using an association stereotyped «**realises**»

## Customisation Rule Example With Rational Rose Tool

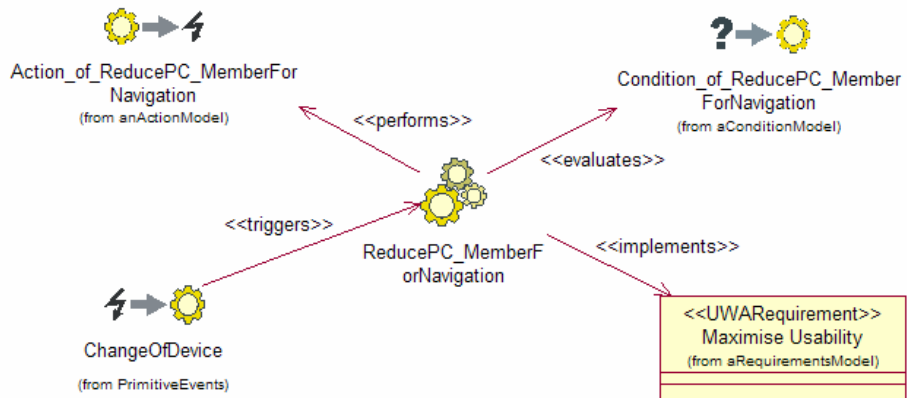




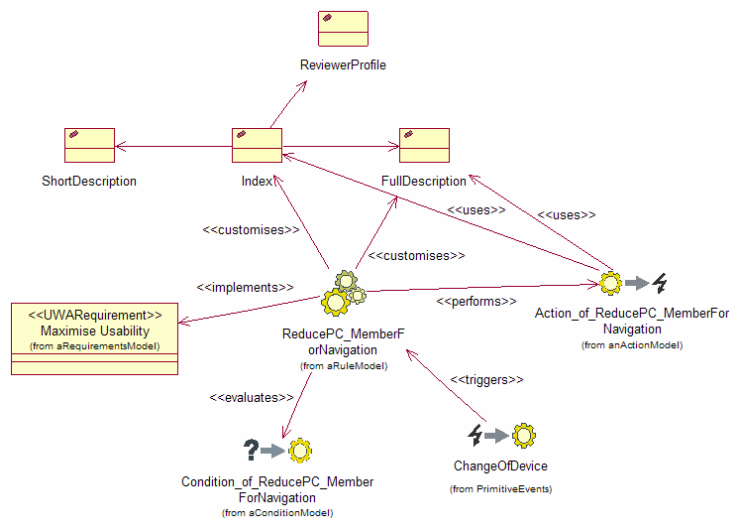
## Customisation Rule Example With Rational Rose Tool



## Customisation Rule Example With Rational Rose Tool



## Customisation Rule Example With Rational Rose Tool



## Summary

- ❑ Modeling of Ubiquitous Web Applications is important but Software Engineering methods can not be directly applied
- ❑ **Design space** of Web Applications comprises:
  - **Levels:** content, hyperbase, presentation
  - **Aspects:** structure and behavior
  - **Phases:** from analysis to implementation
- ❑ **Customization** (adaptation to content) as uniform mechanism to address the requirements of ubiquity
- ❑ **Customization modeling** comprises:
  - **context** modeling in terms of **physical and logical context models**
  - **adaptation** modeling: **adaptation operations** and **adaptation hocks**
  - **customization** rules: in terms of **ECA-rules**



## Benefits of that Approach

- ❑ Enabling new types of applications like **personalised services, location-aware services and device-optimised services** using customisation as **uniform mechanism**
- ❑ **Ensuring a systematic development of high-quality UWAs** by conceptual modelling of customisation
- ❑ Respecting the **highly dynamic nature of UWAs** by employing customisation rules
- ❑ **Reducing maintenance efforts and increasing reusability** by separation of context-dependent and independent parts of UWAs and by providing pre-defined macros and pattern libraries
- ❑ Coping with **technology evolution and changing requirements** by allowing to extend context models and adaptation possibilities
- ❑ Going in line with **current software engineering standards** using UML as basic formalism
- ❑ Facilitating an **integrated development process** by proper tool support



## Issues of that Approach

- ❑ What belongs to content and what belongs to context is sometimes blurred
- ❑ Very "fine grained" - concerned may be too much with the details of formulating constraints
- ❑ Notation hard to understand and to communicate to the user
- ❑ Way of annotating clutters the customization model
  - e.g. what if I want to see all personalization
- ❑ No "semantics" of how the context is actually filled
- ❑ Event-driven approach might not be "feasible" way of thinking for often changing context
- ❑ Static adaptation realization quite artificial



## Lessons Learned

- Let it be said in the words of the user
- Notation matters - need for easy to understand icons and graphic representation
- Understandability prevails detailed semantics
- Need to see customization as cross-cutting concern
- Modeling can be either
  - full specification prior to implementation
  - pragmatic approach to communicate to the user



## Outlook

## Outlook

### Final End

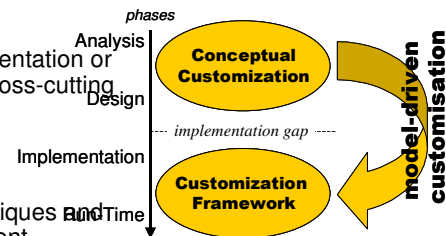
- Model-Driven Development of Ubiquitous Web applications

### Open Issues

- make customization modeling more handy
- extensible customization run-time environment
- realizing ubiquitous web applications

### Current Work

- Explore capabilities of aspect-orientation or representing customization as cross-cutting concern
- Run-time customization framework
- Elaborate on the methods, techniques and tools for model-driven development



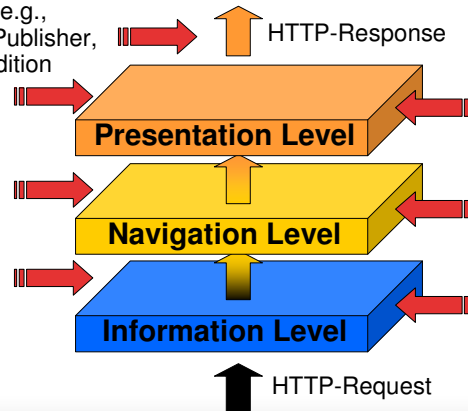
## Where does Customisation take place?

### External (proxy-based) Customisation

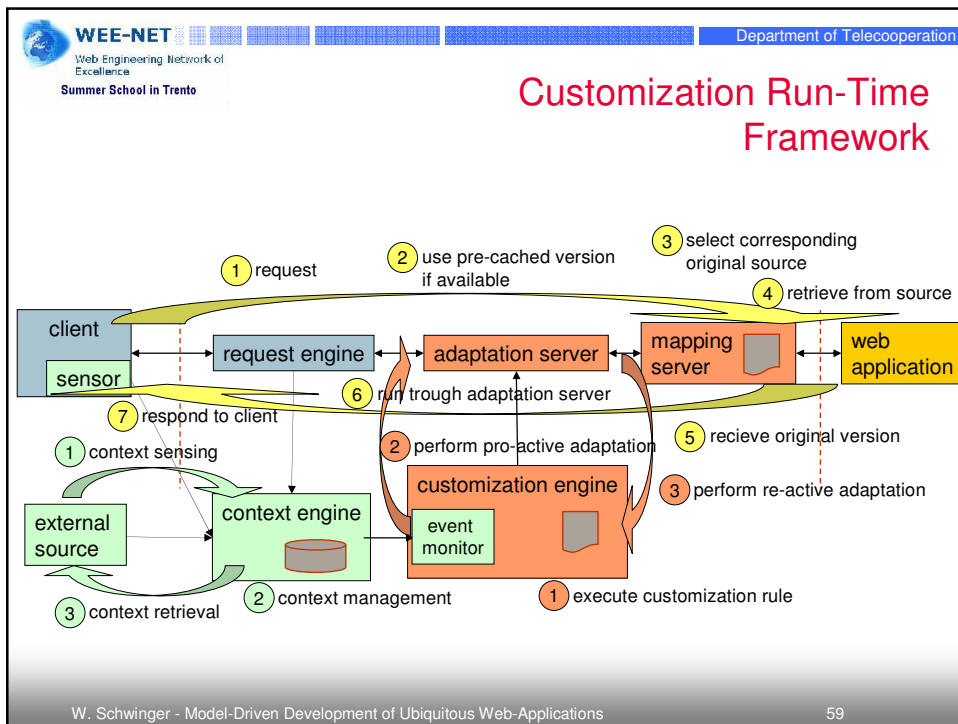
most approaches, e.g.,  
IBM Transcoding Publisher,  
Oracle Wireless Edition

> *Is the application customisation-aware or not?*

Inter-Level Customisation  
e.g., WebML



Intra-Level Customisation  
e.g., OOHDM,  
WUML



- WEE-NET Web Engineering Network of Excellence Summer School in Trento Department of Telecooperation
- ## Take Home Message
- 1** Physical Context is the reification of the environment extended by logical context (profiles)
  - 2** Context and content sometimes blend
  - 3** Separation of the stable and the adaption by means of adaptation hooks
  - 4** Approach provides dynamic customization by means of customization rules (ECA-rules)
  - 5** Semantics of adaptations on the Web applications problematic
  - 6** Users need to be able to express customization at a suitable level of abstraction
  - 7** Modelling is fine but also a suitable run-time platform is needed
- W. Schwinger - Model-Driven Development of Ubiquitous Web-Applications 60



**Thank you  
for your attention!**



**Annex**



## Selected Publications

1. Retschitzegger W., Schwinger W.:  
**"Towards Modeling of Data Web Applications – A Requirements' Perspective"**,  
Proc. of Americas Conf. on Information Systems (**AMCIS2000**), Long Beach, USA, 2000,  
**awarded best paper in technical track.**
2. Kappel G., Retschitzegger W., Schwinger W.:  
**"Modeling Customizable Web Applications – A Requirements' Perspective"**,  
Proc. of the Int'l Conf. on Digital Libraries: Research and Practice (**ICDL2000**), Kyoto, Japan, 2000.
3. Kappel G., Retschitzegger W., Schwinger W., Hofer Th.:  
**"Modeling Ubiquitous Web Applications - A Comparison of Approaches"**,  
Proc. of the 3rd Int'l Conf. on Information Integration and Web-based Applications and Services (**iiWAS2001**),  
Linz, Austria, 2001.
4. Kappel G., Retschitzegger W., Schwinger W.:  
**"Modeling Ubiquitous Web Applications - The WUML Approach"**,  
Proc. of Int'l Workshop on Data Semantics in Web Info. Systems (**DASWIS2001**), Yokohama, Japan, 2001.
5. Finkelstein A., Savigni A., Kappel G., Retschitzegger W., Kimmerstorfer E., Schwinger W., Hofer Th.,  
Feichtner Ch.:  
**"Ubiquitous Web Application Development - A Framework for Understanding "**,  
The 6th World Multiconference on Systemics, Cybernetics and Informatics (**SCI2002**), USA, 2002.
6. Hitz M., Kappel G., Retschitzegger W., Schwinger W.:  
**"Ein UML-Framework zur Modellierung ubiquitärer Web-Anwendungen"**,  
submitted as article to journal "Wirtschaftsinformatik", 2002.
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