

# Tools and Methods for the Design of Multi-Device User Interfaces

Fabio Paternò

[fabio.paterno@isti.cnr.it](mailto:fabio.paterno@isti.cnr.it)

<http://giove.isti.cnr.it/~fabio/>

ISTI-C.N.R.

Pisa, Italy



# Pervasive Usability

- Ever-increasing introduction of new types of interactive devices
- How to support designers and developers?
- How to obtain interfaces able to adapt to multiple devices (any device) while preserving usability?



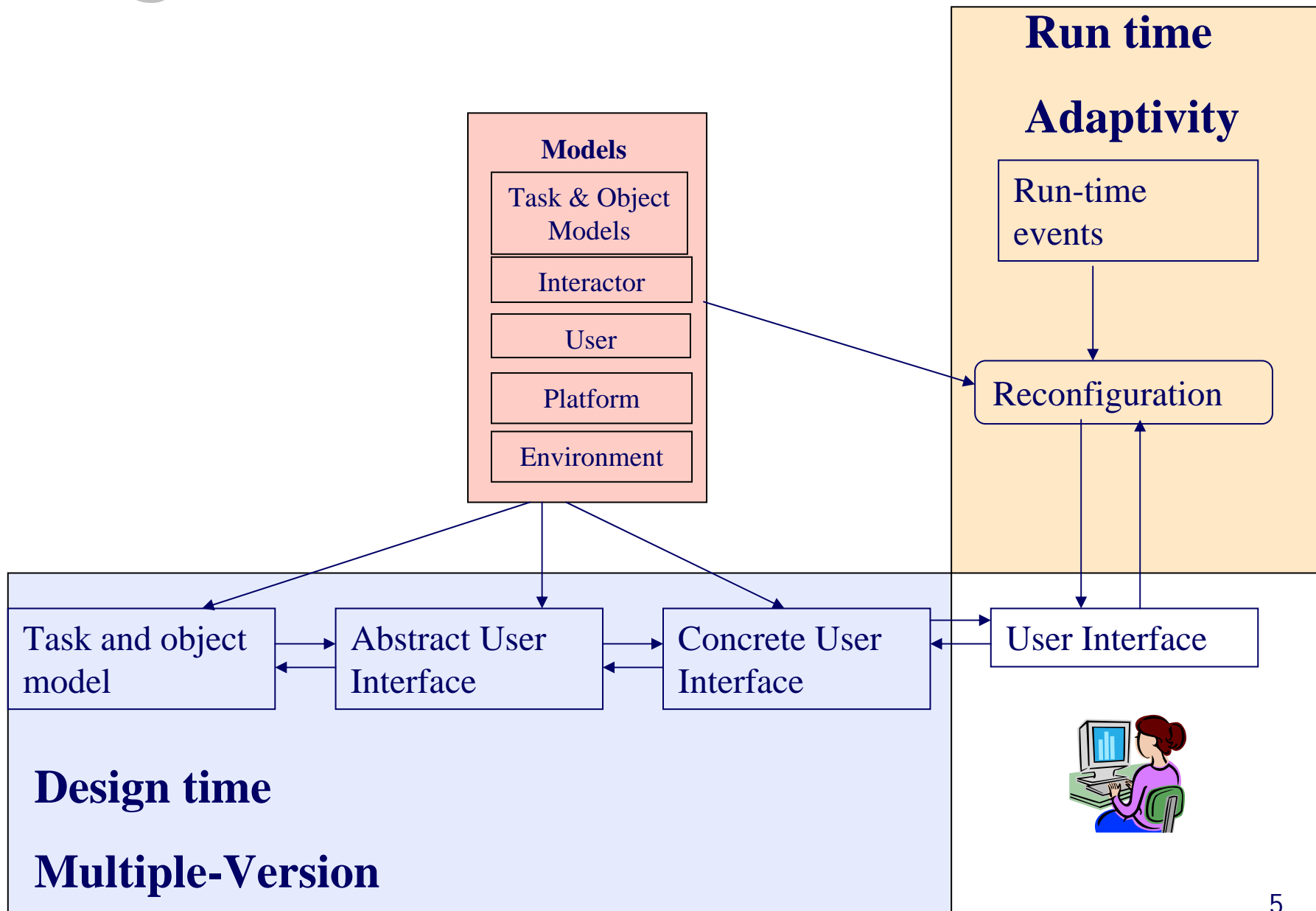
# Structure of the Tutorial

<b>Time</b>	<b>Subject</b>	<b>Duration</b>
9.00-9.15	Introduction, Basic Concept, Issues	15'
9.15-9.30	Model-based design of multi-device interfaces	15'
9.30-9.45	Task/Platform Taxonomy	15'
9.45-10.00	<i>exercise – Multi-device interface</i>	15'
10.00-10.15	Task Analysis and Modelling	15'
10.15-10.45	TERESA	30'
10.45-11.00	Semantic redesign for different interaction platforms	15'
11.00-11.30	<i>Coffee Break</i>	30'
11.30-11.45	Model-based design of multi-modal interfaces	15'
11.45-12.15	Migratory Interfaces	30'
12.15-12.30	<i>exercise – Migratory interfaces</i>	15'
12.30-12.45	Architectures for Migratory Interfaces	30'
12.45-13.00	Research agenda & Conclusions	15'

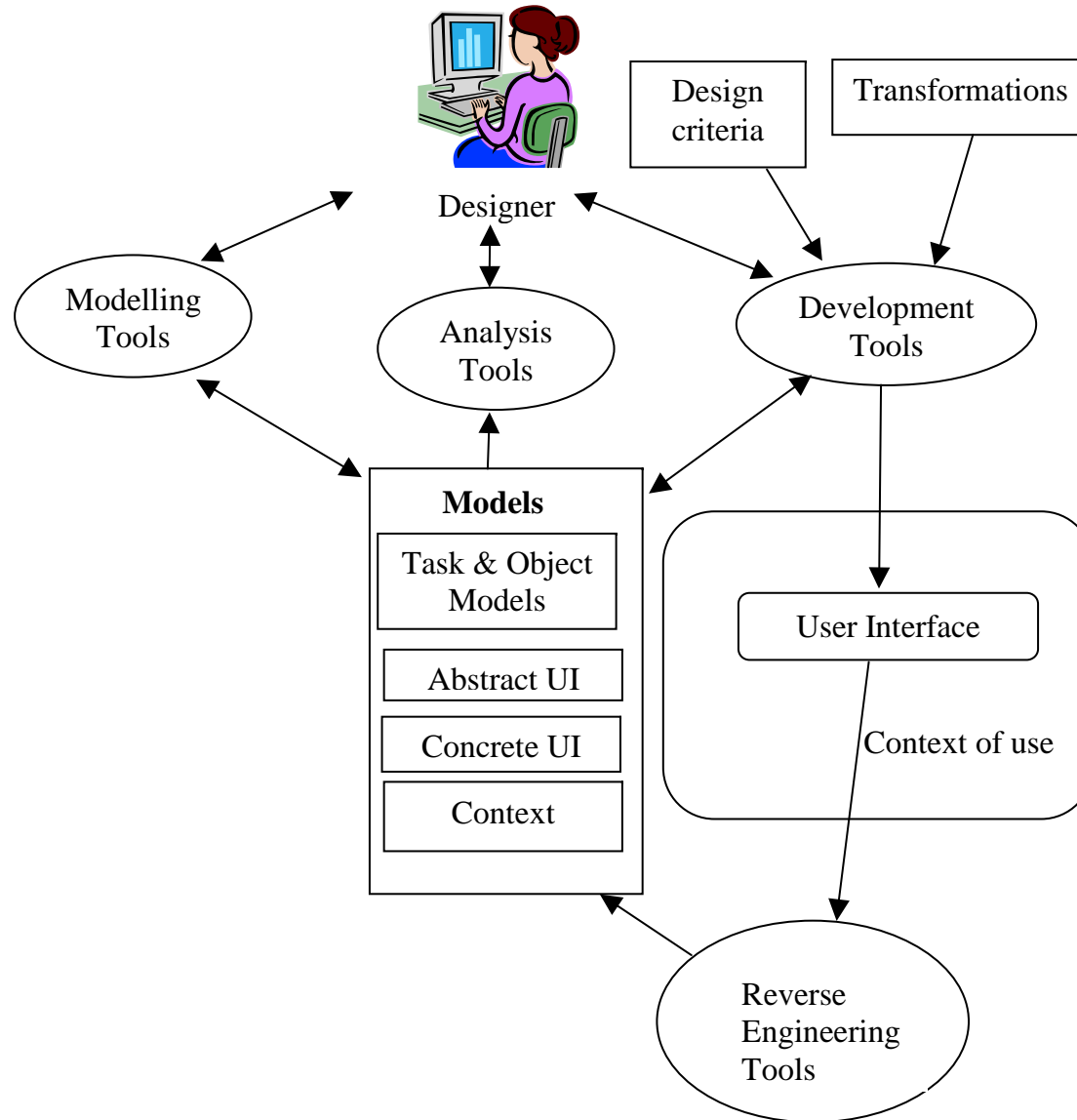
# Possible Views of an Interactive Systems

- Task and object – *I want to select a work of art*
- Abstract Interface – *Single selection object with high cardinality*
- Concrete Interface – *List Interaction object with  $X$  elements*
- Code – *List object in Java or XHTML or ....*

# Significant Models in HCI



# Tools in Model-based environments

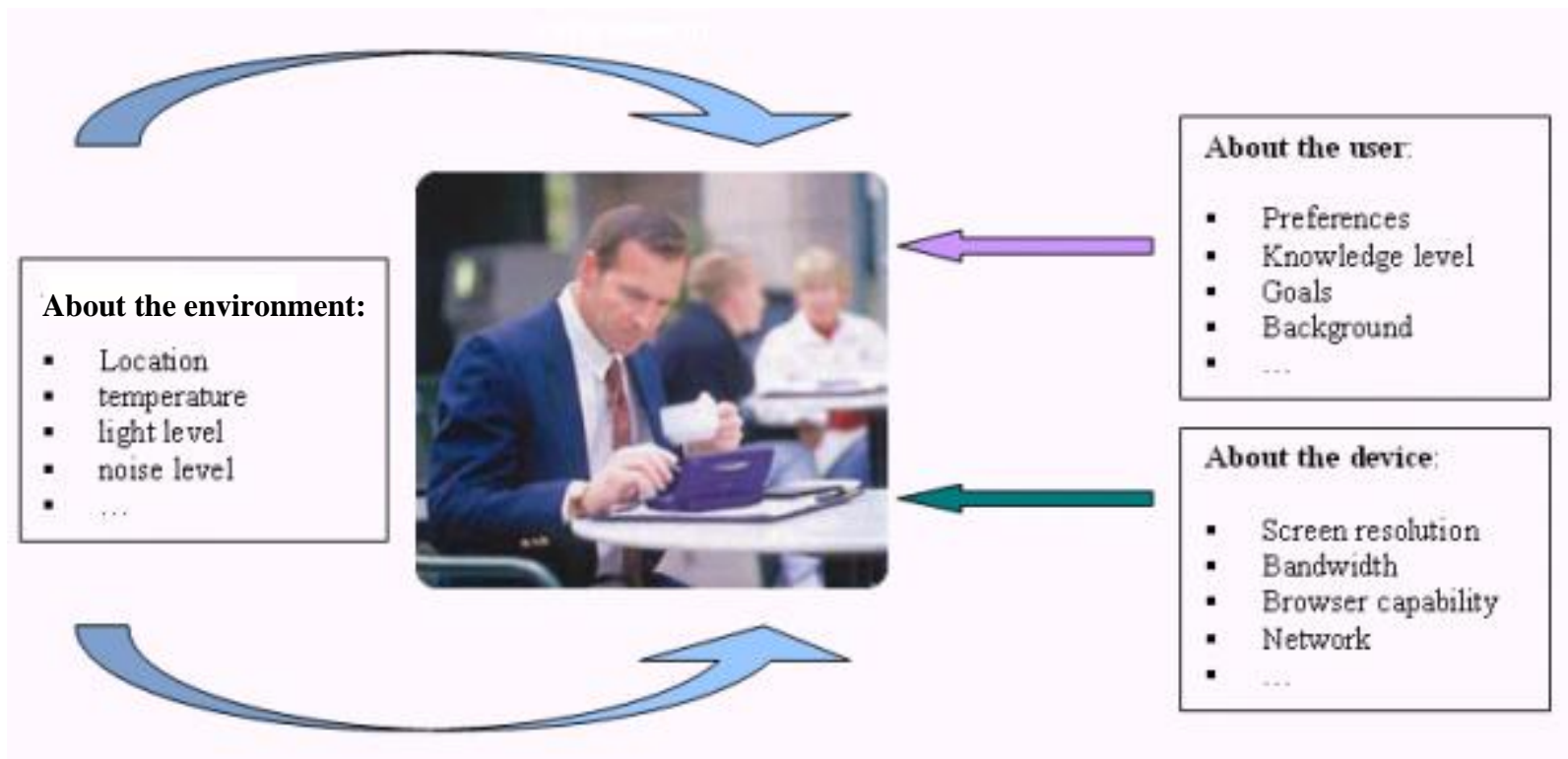




# Adaptation

- Adaptability - Capacity of a UI to adapt its behaviour from an explicit human intervention
- Adaptivity - Capacity of a UI to adapt without any explicit human intervention
- What can be adapted? Presentation, Navigation, Content

# Context-dependent Adaptation





# Design of Multi-Device Interfaces: Current Practice

- **Manual solutions,**
  - expensive
- **Transcoders,**
  - low cost/low usability
- **Style sheets,**
  - partial solution

# State of Art

- Aura project at CMU (adaptation at application level)
- Pebbles project at CMU (limited to appliances control)
- XIML has not public tool support  
<http://www.ximl.org/> (developed by a forum driven by RedWhale software)
- UIML does not support high-level task descriptions  
<http://www.uiml.org/> (developed by Harmonia and cooperation with Virginia Tech)



# XForms

- Apply concepts from model-based design
- Separate presentation from content (form controls markup is separated from data-types and returned values)
- XForms 'native' form controls are device-independent
- Reduce need for scripting through client-side checking
- XML instance is returned allowing strong typing



# Motivations for task analysis and modelling

- Main usability principle:
  - *Focus on the users and their tasks*
- Tasks represent the logical activities performed for reaching user goals
- Need for modelling is most acutely felt when the design aims to support system implementation as well
  - Especially for large projects and some application domains



# Definitions

- Task – activity that has to be performed to reach a goal
- Goal
  - desired modification of state
  - Attempt to receive state information
- Each task is associated with one goal
- Each goal is associated with one or multiple tasks
- Multiple abstraction levels - Basic task
- Task Analysis
- Task Models

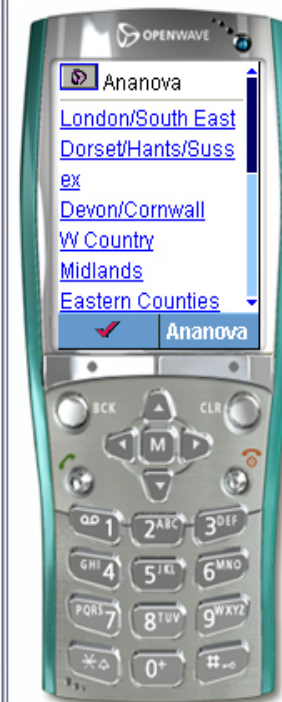
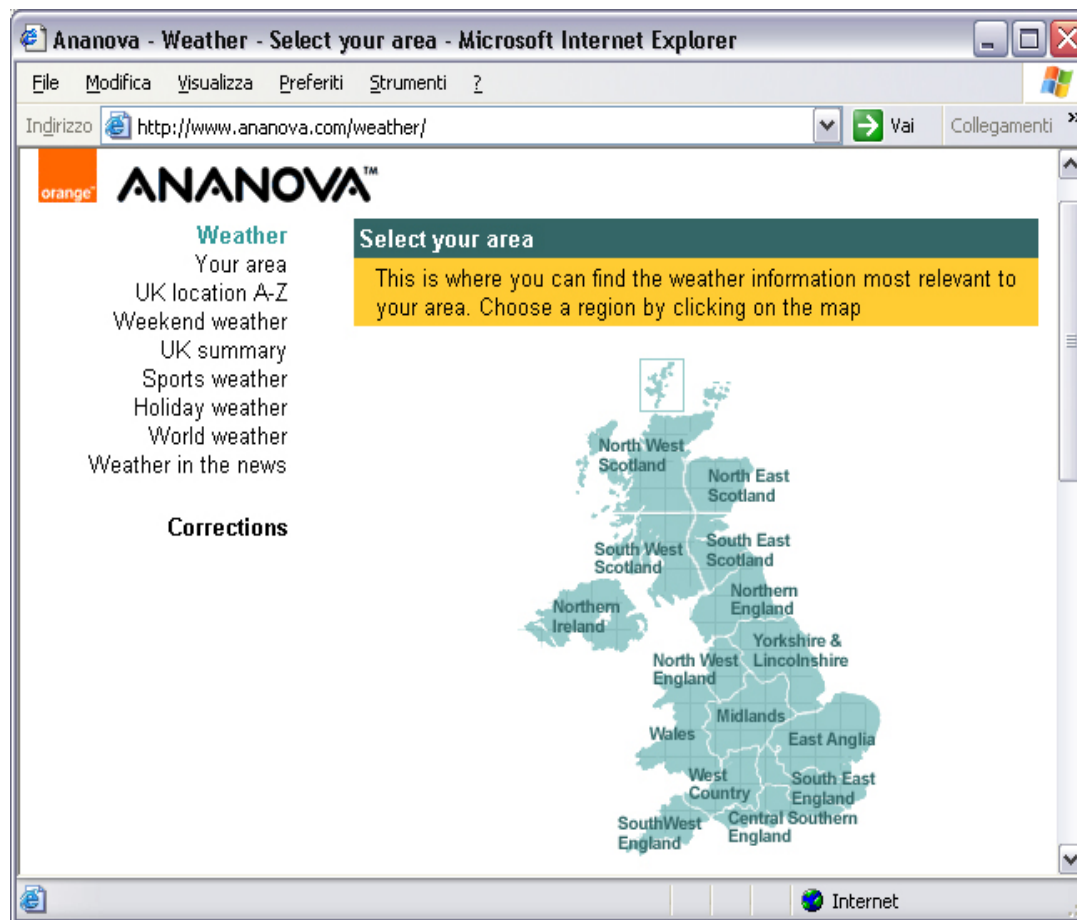
# Task –related issues in multi- platform environments

- Platform definition
- Same task on multiple platforms in the same manner
- Same task on multiple platforms but performed in different manner
- Dependencies among tasks performed on different platforms
- Tasks meaningful only on a single platform type

# Examples of Platform-dependent tasks

<b>Desktop system</b>	<b>Mobile System</b>
<b>Comparing prices of flights and making reservations.</b>	<b>Checking status of a particular flight.</b>
<b>Gathering background on a company, including maps.</b>	<b>Getting driving directions to a company—while on the road.</b>
<b>Browsing medical information.</b>	<b>Monitoring a medical condition.</b>
<b>Reading a movie review and/or watching a trailer.</b>	<b>Purchasing a cinema ticket to avoid the line.</b>

# Same task on multiple platforms with different user interface objects





# Same task on multiple platforms with different task decomposition

Beppu Spa Suginoi Hotel Beppu Japan - Microsoft Internet Explorer

File Modifica Visualizza Preferiti Strumenti ?

Indirizzo [http://www.sino.net/properties/reservation.html?hotel\\_id=1176](http://www.sino.net/properties/reservation.html?hotel_id=1176) Vai Collegamenti

**Beppu Spa Suginoi Hotel, Beppu**  
If you would like to fax your reservation, fill out this form, print it and fax it back to:  
+848 827 5840.

Click [here](#) to connect to our non-secure server

<b>Hana Wing Single</b>	2003-04-01 - 2003-09-30 (1)	USD 160.00
<b>Main Wing Single</b>	2003-04-01 - 2003-09-30 (4)	USD 136.00

Please select	Room Type	Hotel Type
Arrive on: 4 June 2003	Hana Wing Single (1)	Style: Business/Holiday Hotel Location: City Suburban Rating: 4 Stars
Depart on: 4 June 2003	Breakfast: Not Included	

**Reservation Details**

Full Name as in Passport	<input type="text"/>	1st Room
Full Name as in Passport	<input type="text"/>	2nd Room
Full Name as in Passport	<input type="text"/>	3rd Room
Address	<input type="text"/>	
City & Postal code	<input type="text"/>	
Country	<input type="text"/>	
Telephone (include Country code)	<input type="text"/>	
Telefax (include Country code)	<input type="text"/>	
Email Address	<input type="text"/>	

Internet

OPENWAVE

Hotel name: Beppu Spa Suginoi Hotel

Your name:

Your mobile number:

✓

OPENWAVE

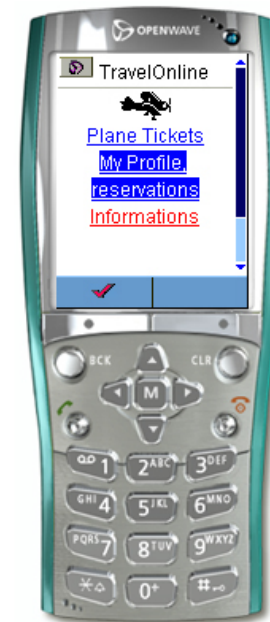
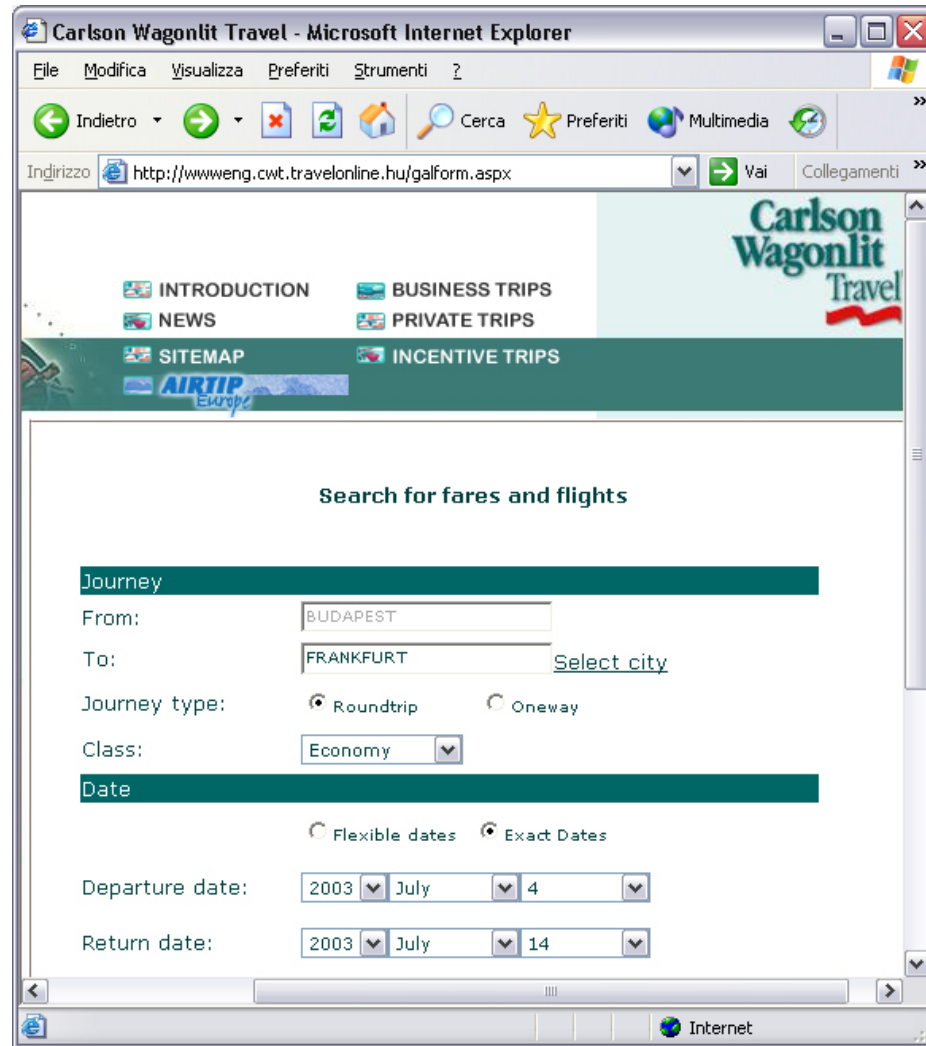
Check-in date (dd/mm/yyyy): 1 2003

Check-out date (dd/mm/yyyy): 1 2003

Make reservation

✓

# Dependencies among tasks performed on different platforms





# Exercise

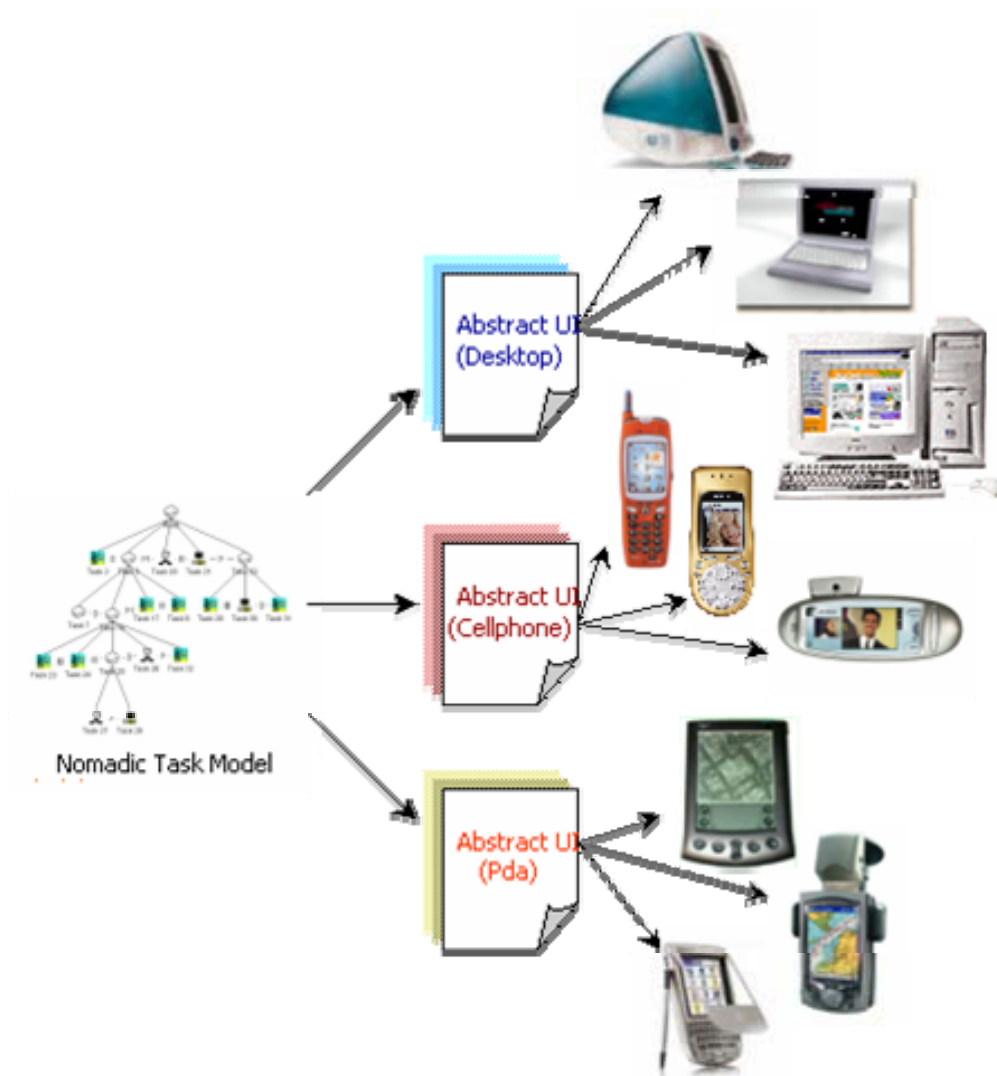
## Multi-device Interfaces



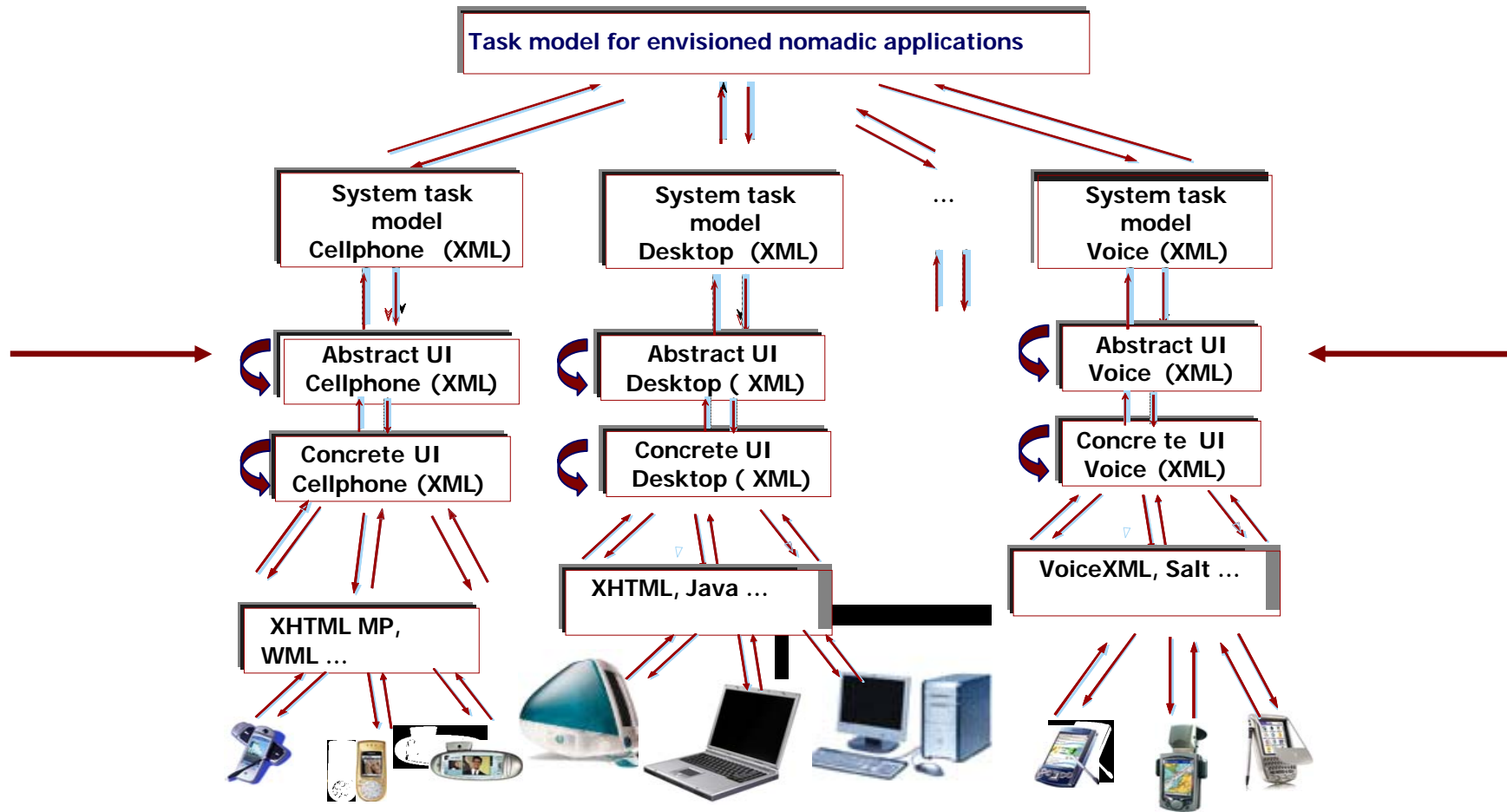
# TERESA

- Mixed initiative
- Model-based
- XML-based
- Flexible development
- Web-oriented but can be extended to other environments
- Available at  
<http://giove.isti.cnr.it/teresa.html>

# One Model – Many Interfaces



# TERESA Environment for Flexible Development



# TERESA XML

- Two platform-independent languages : task (CTT) and abstract interface
- One level (concrete interface) represented through a number of platform dependent languages
- Designers aware of the potential platforms (not devices) early on in the design process
- Method allows developers to avoid dealing with a plethora of low-level details (transformation from concrete description to implementation is automatic)
- Easy to add support for new implementation languages

# Design Practice

The image shows a screenshot of the la Repubblica.it website with several design annotations. A red box highlights the search bar and navigation menu, labeled "Relation". A blue box highlights the main content area, labeled "Grouping". A yellow box highlights the left sidebar, labeled "Grouping". A green box highlights the "Ordering" section. A blue arrow points to the "Important!" text at the bottom.

**Ordering**

**Relation**

**Grouping**

**Grouping**

**Important !**



# Another example

The image shows a screenshot of the Times Online website from February 11, 2005. The page layout includes a top navigation bar with links like ARCHIVE, CLASSIFIED, SHOPPING, PROMOTIONS, GAMES, FAST TIMES, MY TIMES, and WEATHER. A search bar is located below the navigation. The main content area features a large article titled "Charles puts affair in order" with a photo of Prince Charles and Camilla Parker Bowles. To the right of this article is a "OTHER TOP STORIES" section. Below the main article are sections for "JOIN THE DEBATE", "MARKETS LOG", and "QUOTE OF THE DAY". At the bottom, there are sections for "SPORT", "BUSINESS", and "EDITOR'S CHOICE".

Annotations on the screenshot include:

- Relation:** A box pointing to the search bar.
- Ordering:** A box pointing to the top navigation bar.
- Grouping:** A box pointing to the left-hand navigation menu.
- Grouping:** A box pointing to the "OTHER TOP STORIES" section.
- Important!:** A box pointing to the "QUOTE OF THE DAY" section.



# Communication-oriented Composition operators

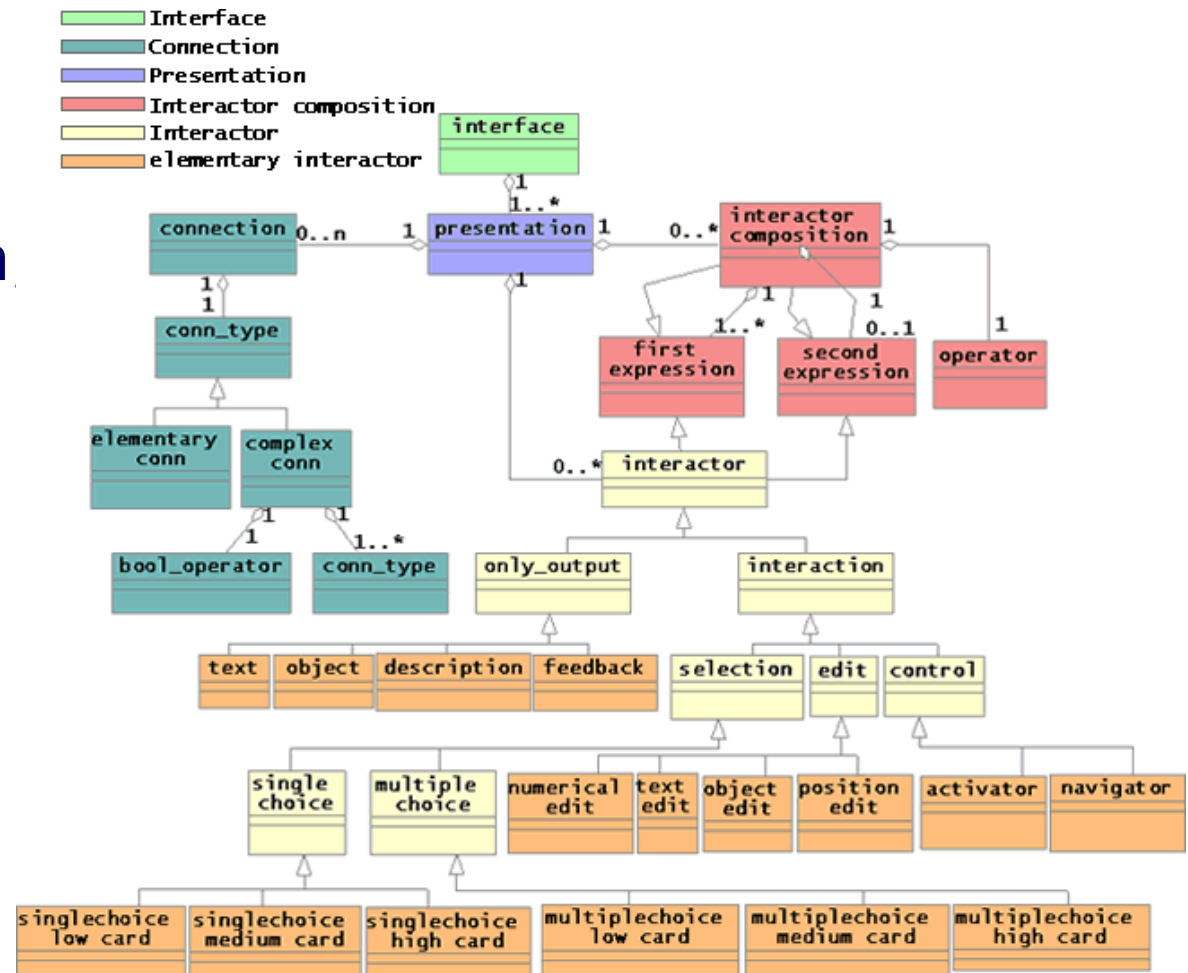
- **Grouping:** a set of elements logically related to each other
- **Ordering:** existing of an order among interactors (i.e. temporal)
- **Relation:** One interactor related to a group of other interactors (i.e. disabling them)
- **Hierarchy:** a logical hierarchy among a set of interactors

# Structuring the User Interface

- Grouping – Example: Task decomposition -> grouping of corresponding interaction techniques
- Ordering – Sequential communicating tasks -> adjacent interaction techniques
- Relation – Control tasks (one to many relations)
- Hierarchy – Frequent tasks -> More space or larger attributes

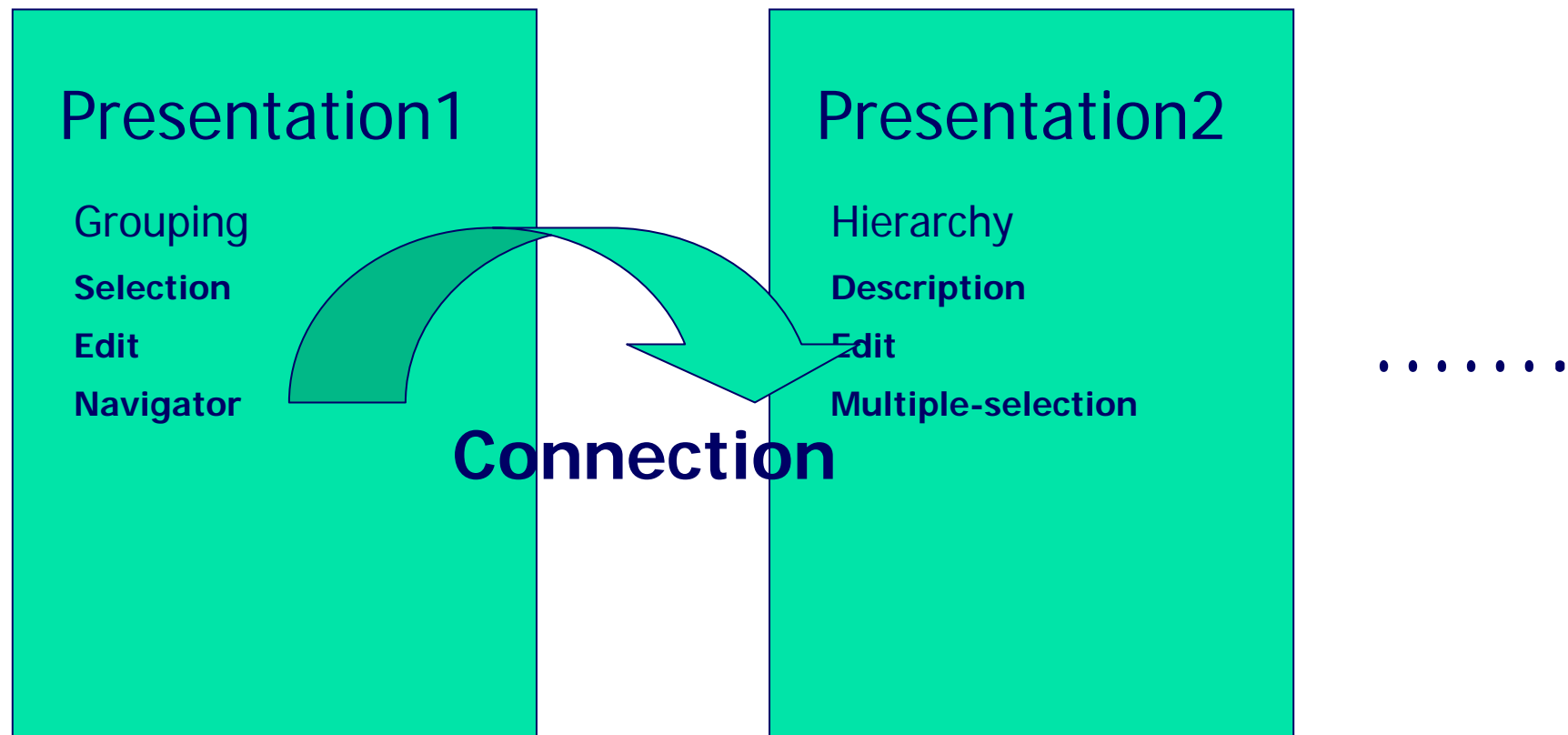
# The Structure of the Abstract User Interface

- Language platform-independent
- Interactors (selection navigator, activator, ...)
- Communication-oriented composition operators
- Connections among presentations

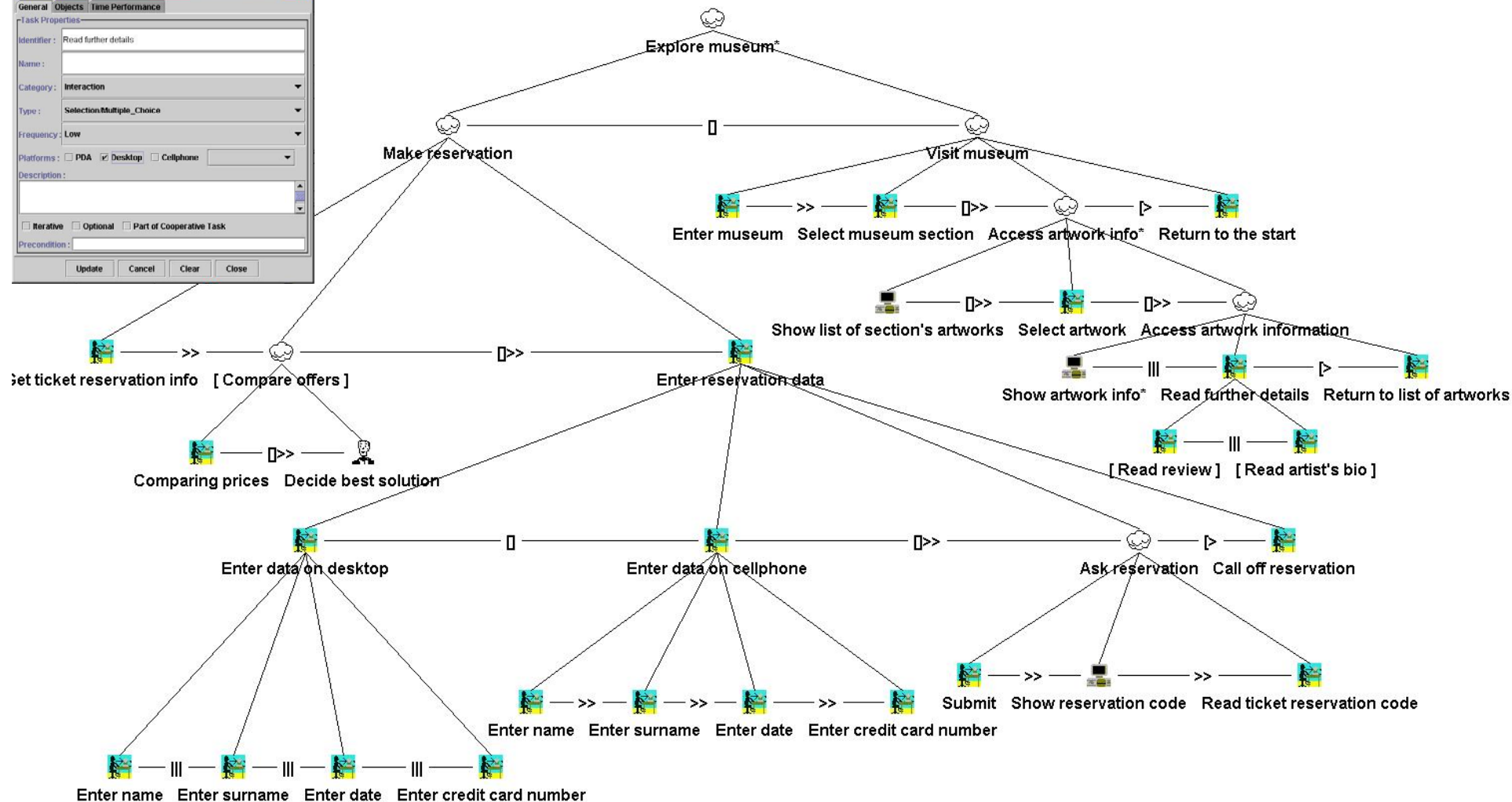
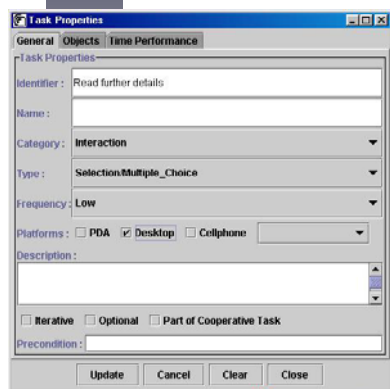


# The Structure of the Abstract User Interface

## User Interface



# A nomadic museum application





# TERESA support in Development

- Choice of device platform/type
- Settings for general attributes,
- How to implement composition operators
- How to implement interactors
- Summary of design choices and preview
- Recording and reuse of concrete aspects defined

# Concrete User Interface

- Defines some concrete aspects of the user interface
- Provides indications for the implementation of abstract interactors

## EXAMPLE

### Abstract level

```
- <interactor id="Go_to_section3">⋮  
  <interaction category="interaction">⋮  
    <control type="control">  
      <navigator object="navigator"/>  
    </control>  
  </interaction>
```

### Concrete level

```
- <interactor id="Go_to_section3">⋮  
  <interaction>⋮ <control>⋮  
    <navigator>  
      <button label="Go to selected section"/>  
    </navigator>  
  </control>  
 </interaction>
```



# Example of platform-dependent concrete interactor choice

EXAMPLE:

Single choice abstract interactor

<b>Cardinality</b>	<b>Desktop Computers</b>	<b>Mobile Phones</b>
Low cardinality	Radio Button	Radio Button
Medium cardinality	List Box	Drop Down List
High cardinality	List with scrollbars	Drop Down List

# Example of platform-dependent composition operator implementation

## EXAMPLE: Grouping Operator

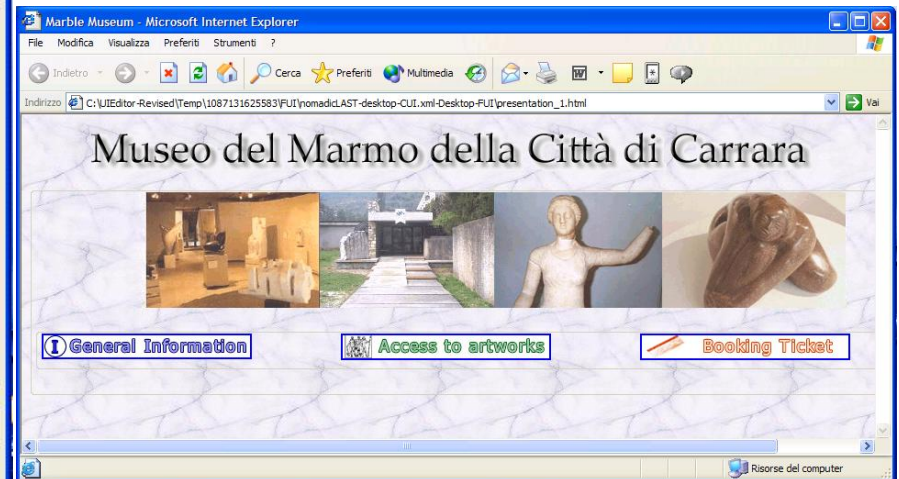
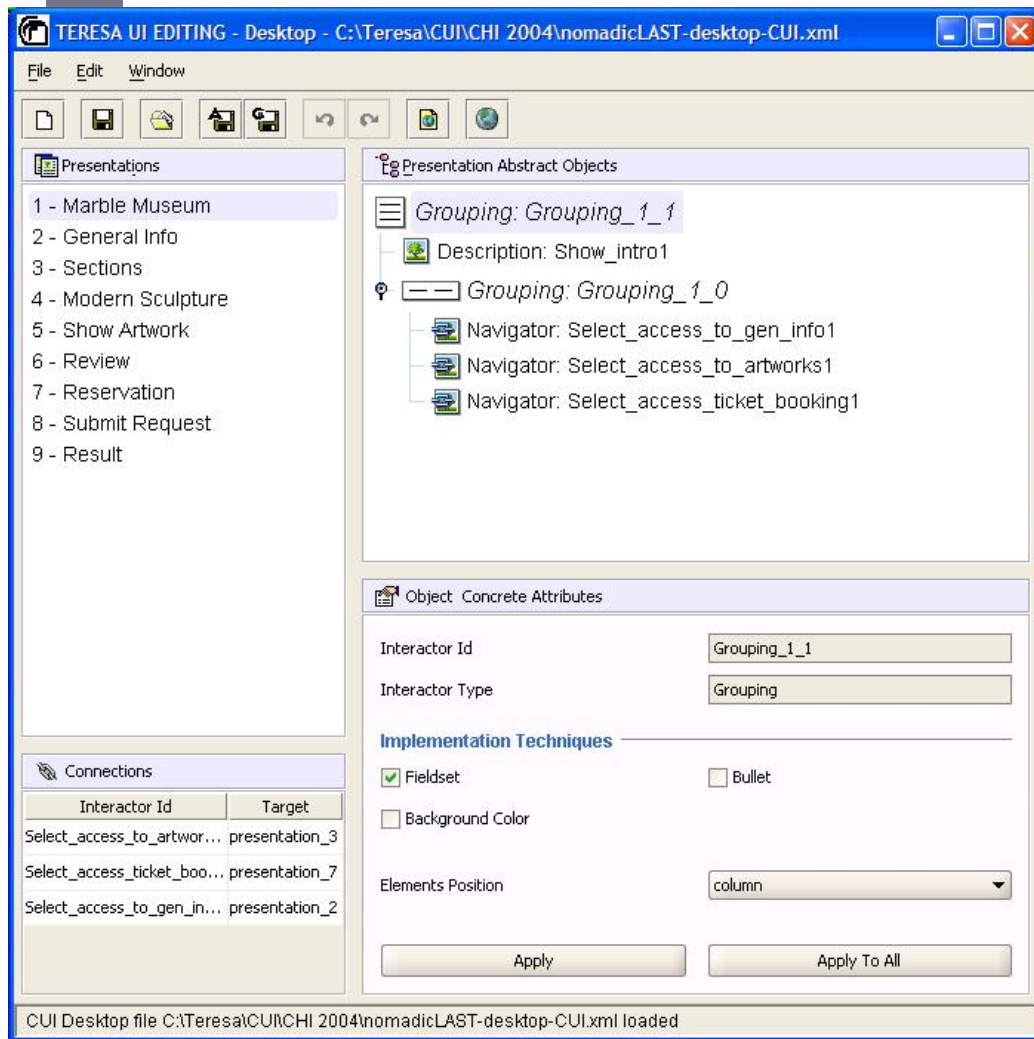
### ■ Desktop Computers

- Fieldset
- Bullet
- Background Color
- Column-oriented organization
- Row-oriented organization

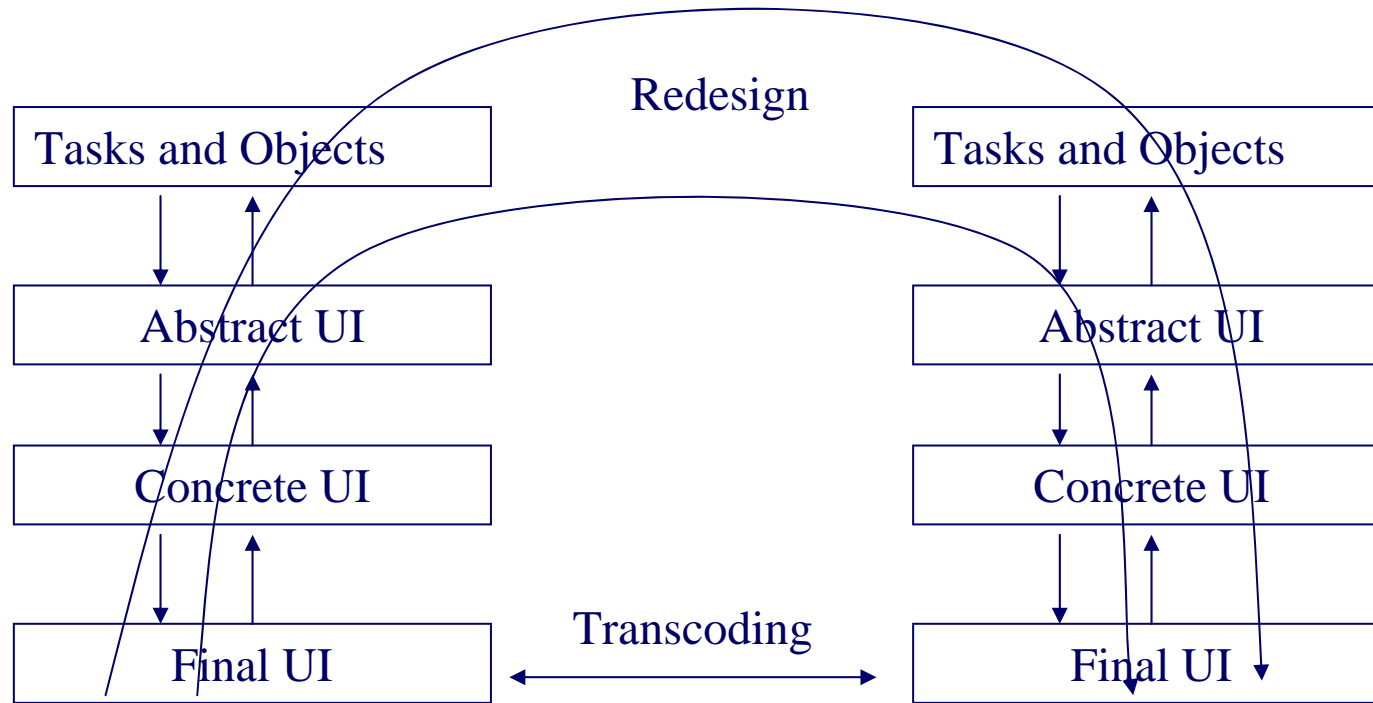
### ■ Mobile Phones

- Unordered List On Column
- Fieldset (only for medium-large phones)

# Example of TERESA-generated User Interface- DEMO



# Use of Reverse Engineering



Platform X

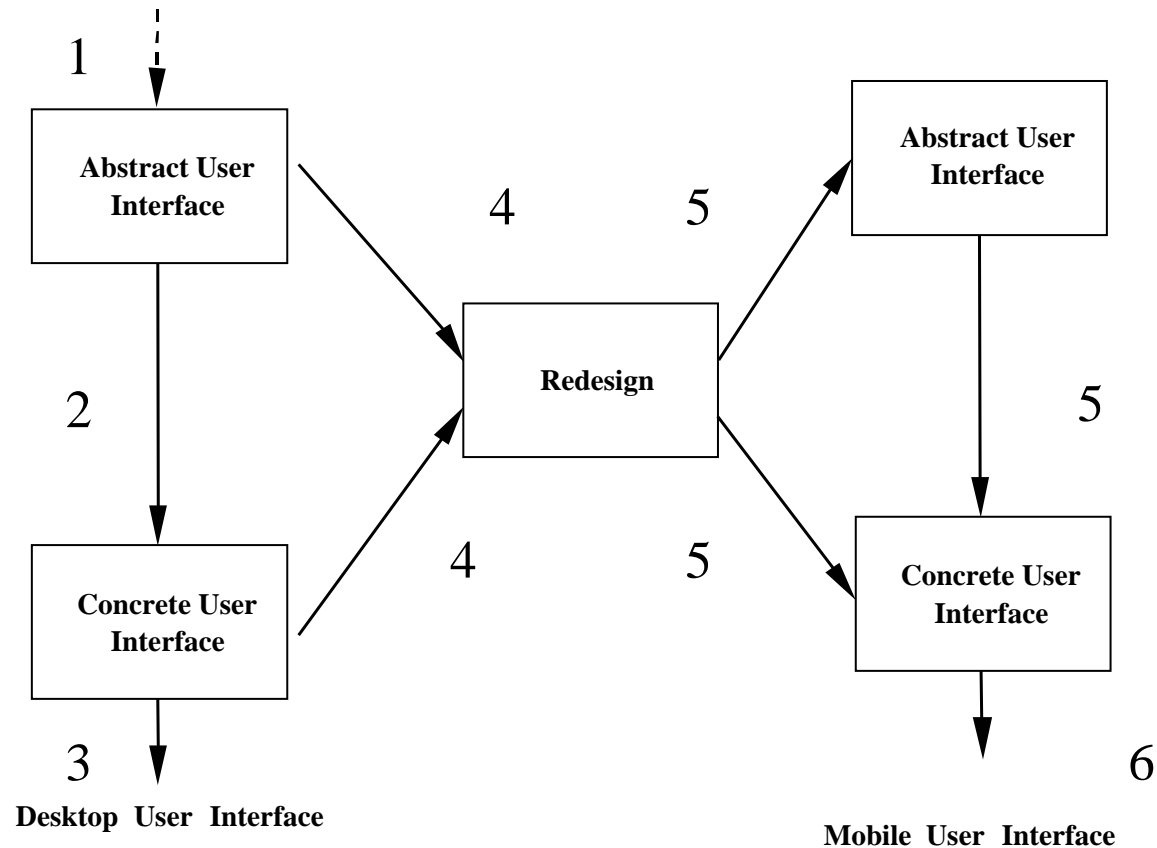
Platform y



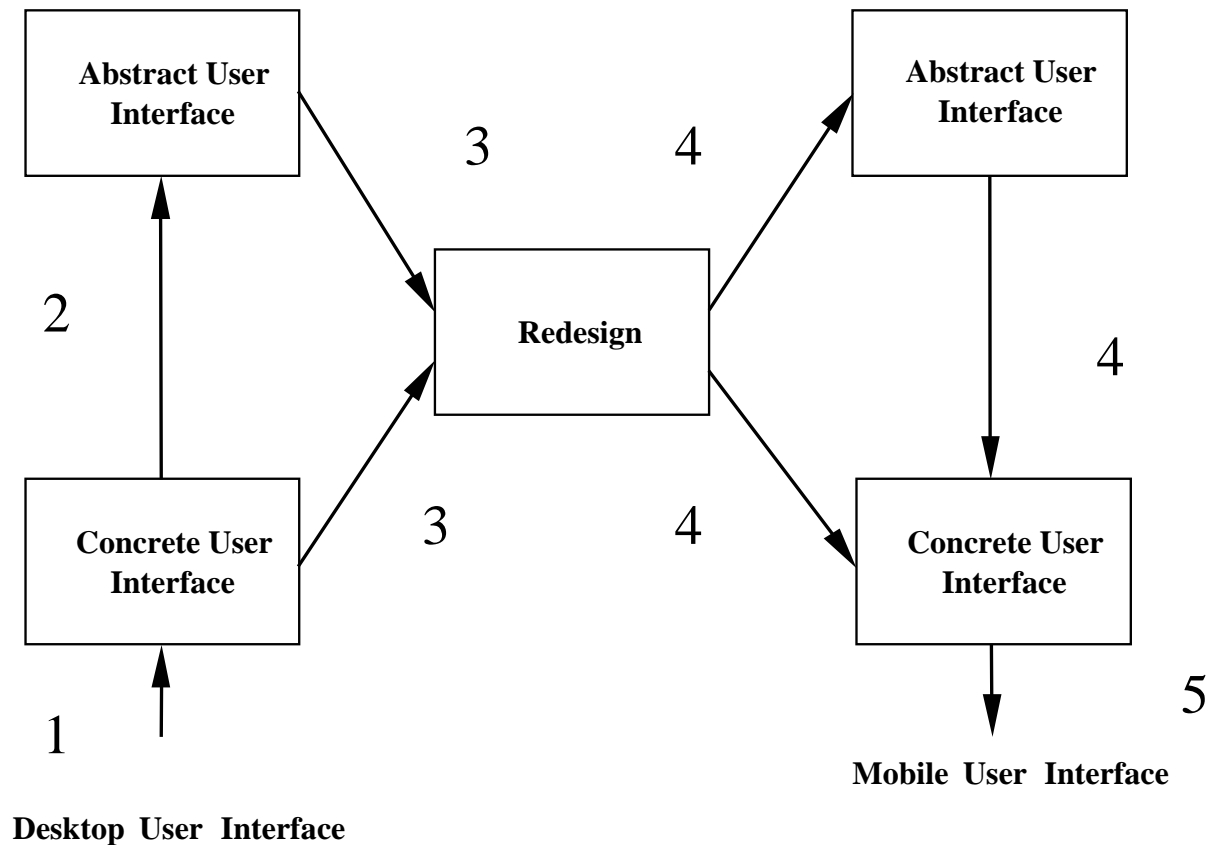
# Semantic Redesign

- Use of abstractions for changing the design for a new target platform
- Use of reverse engineering to obtain the abstractions
- Different possible solutions

# Semantic Redesign with Forward Engineering



# Reverse and Forward Engineering





# Support for Redesign

- Page splitting based on the composition operators and the number of interactors
- Connections: original ones + those derived from page splitting
- Images: resize depending on target device keeping the same aspect ratio
- Tables for converting terms and labels



# From Desktop to Cell-phone

## Download Software

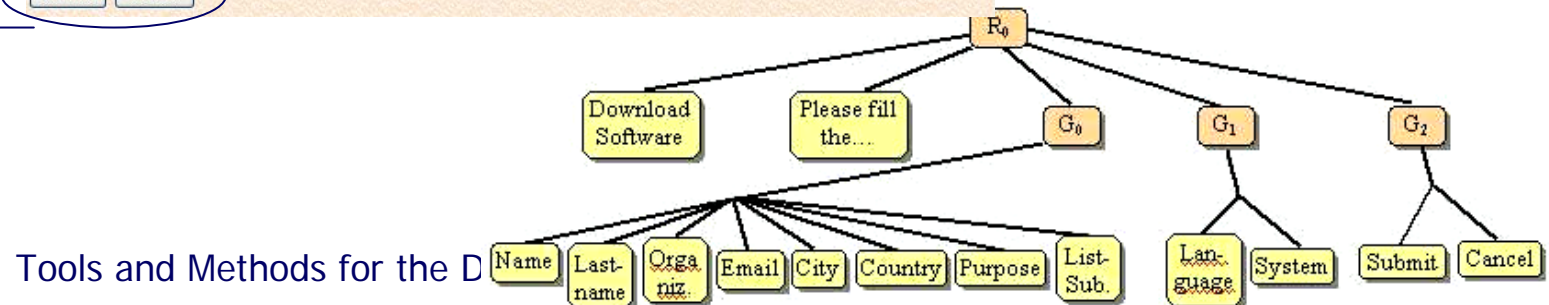
Please fill in the form and then select the link that will appear on the bottom

Name:	<input type="text"/>
LastName:	<input type="text"/>
Organization:	<input type="text"/>
E-Mail:	<input type="text"/>
City:	<input type="text"/>
Country:	<input type="text" value="Italy"/>
Purpose:	<input type="checkbox"/> Research Project <input type="checkbox"/> Application Designer <input type="checkbox"/> Teaching <input type="checkbox"/> Development
List Subscription:	<input type="radio"/> Yes <input type="radio"/> No
Language:	<input type="radio"/> French <input type="radio"/> English
System:	<input type="text" value="Win 2000"/>
<input type="button" value="Submit"/> <input type="button" value="Cancel"/>	

Grouping 0

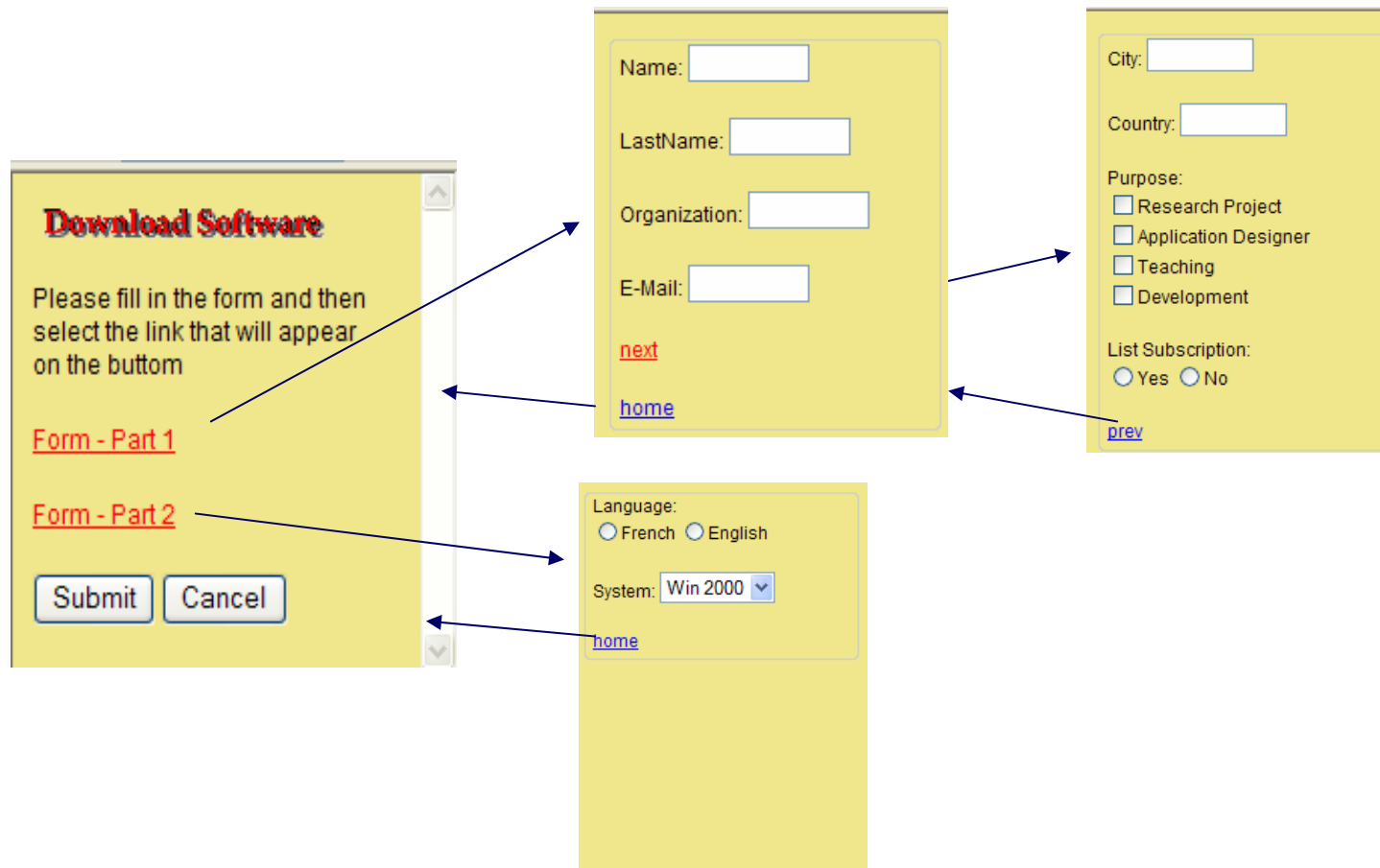
Grouping 1

Grouping 2

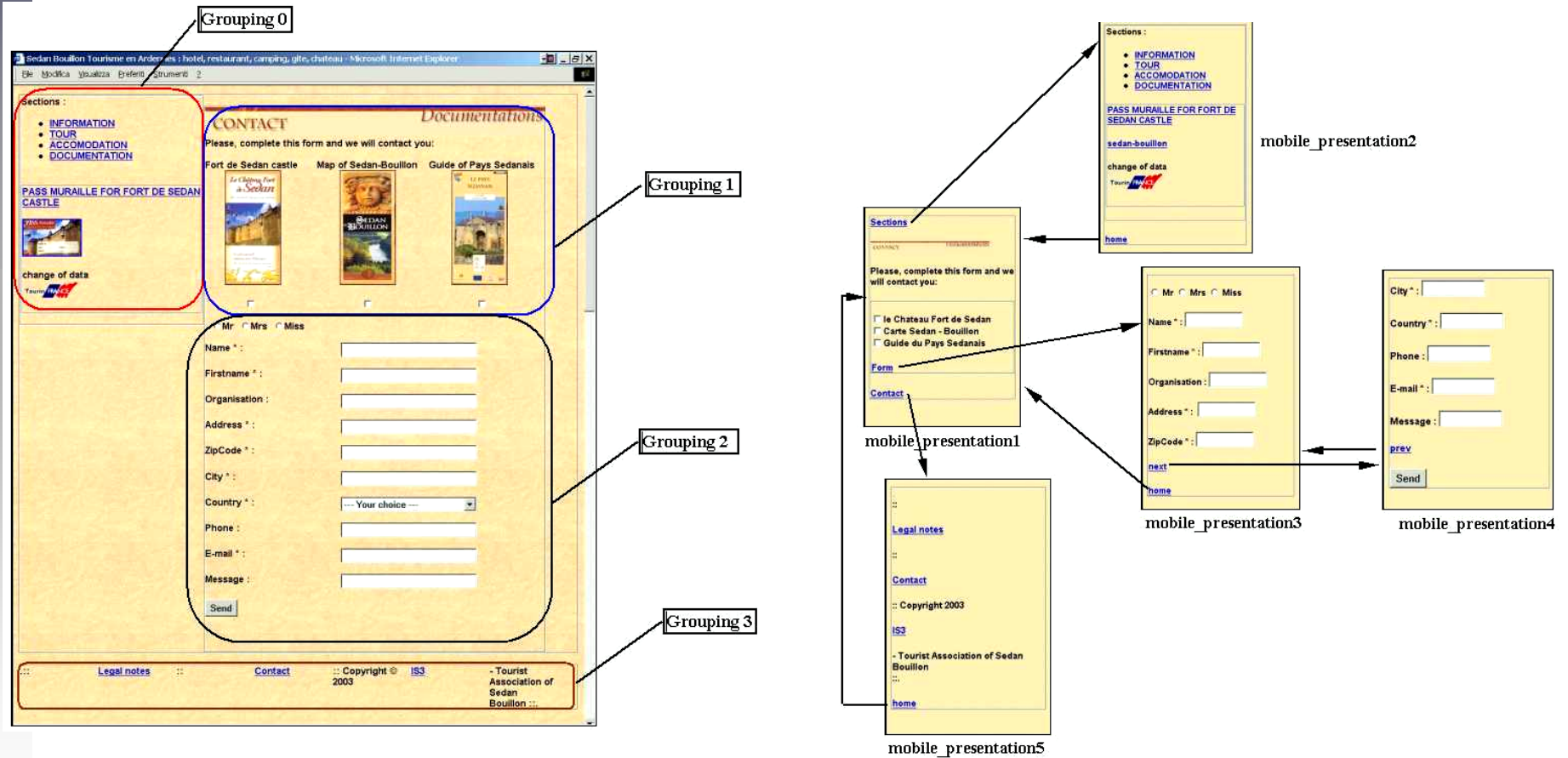


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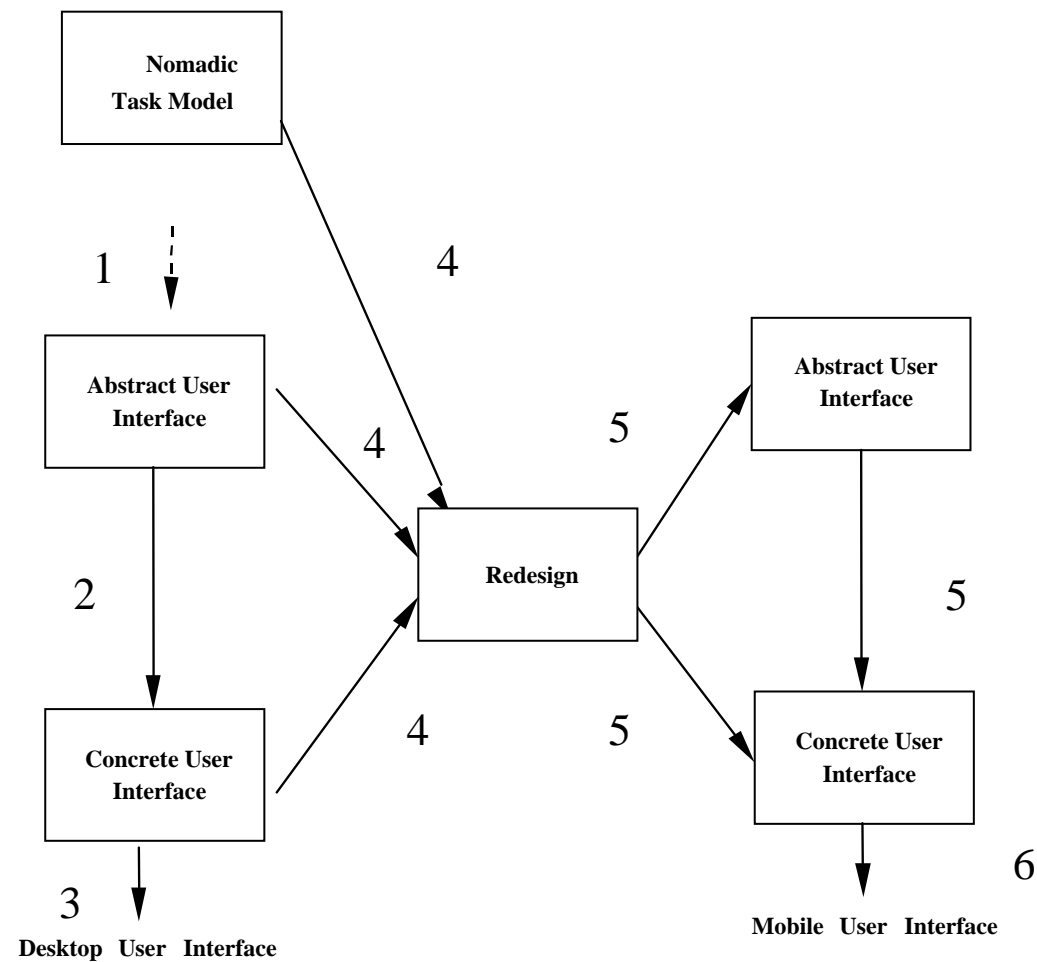
# From Desktop to Cell-phone



# Another example of semantic redesign



# Task-based Semantic Redesign



# From Desktop to Cell-phone

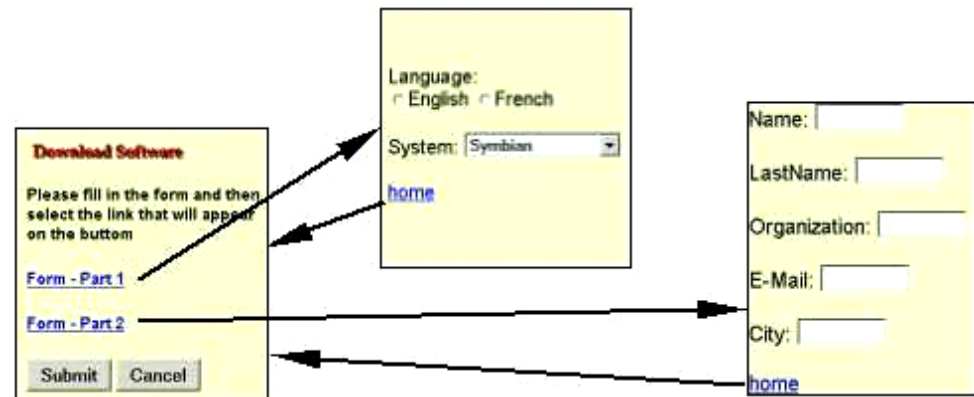
presentation\_1 - Microsoft Internet Explorer  
file toolbar view help print document

## Download Software

Please fill in the form and then press the Submit button at the end of the page

Name:   
LastName:   
Organization:   
E-Mail:   
City:   
Country:   
Purpose:  
 Research Project  
 Application Designer  
 Teaching  
 Development  
List Subscription:  
 Yes  
 No  
Comments:

Language:  English  French  
System:





# Semantic redesign - demo



# Vocal Interaction

- Characteristics: linear, not persistent, faster and more natural for some operations
- Provide feedback to check the status of application
- Brief prompts and short lists of options to reduce memory capability
- Management of events (no-input , no-match, help)



# Speech implementation of composition operators

## Grouping:

- Insert a sound
- Insert a pause
- Use some keywords
- Use a specific volume of synthesizer voice

## Ordering

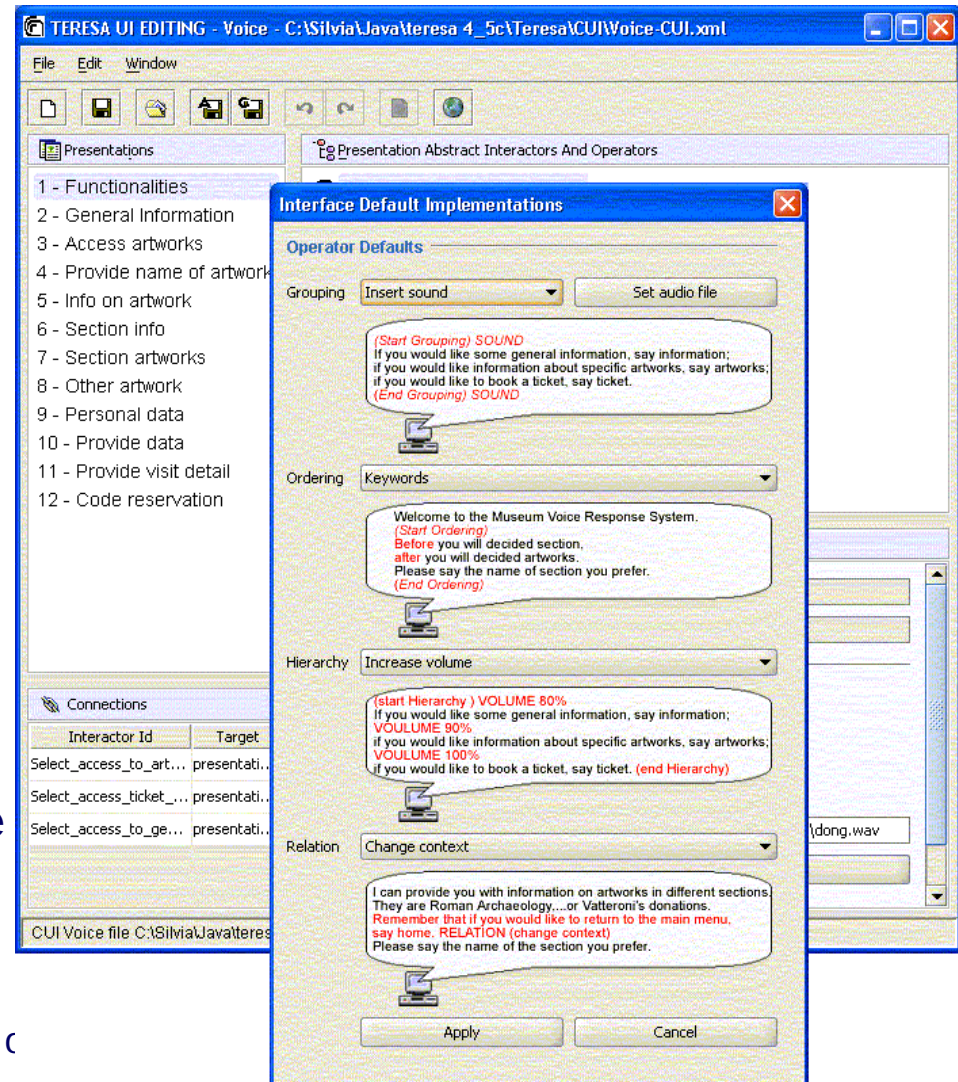
- Alphabetical order
- Use some keywords

## Relation

- Change context (change type of menu)

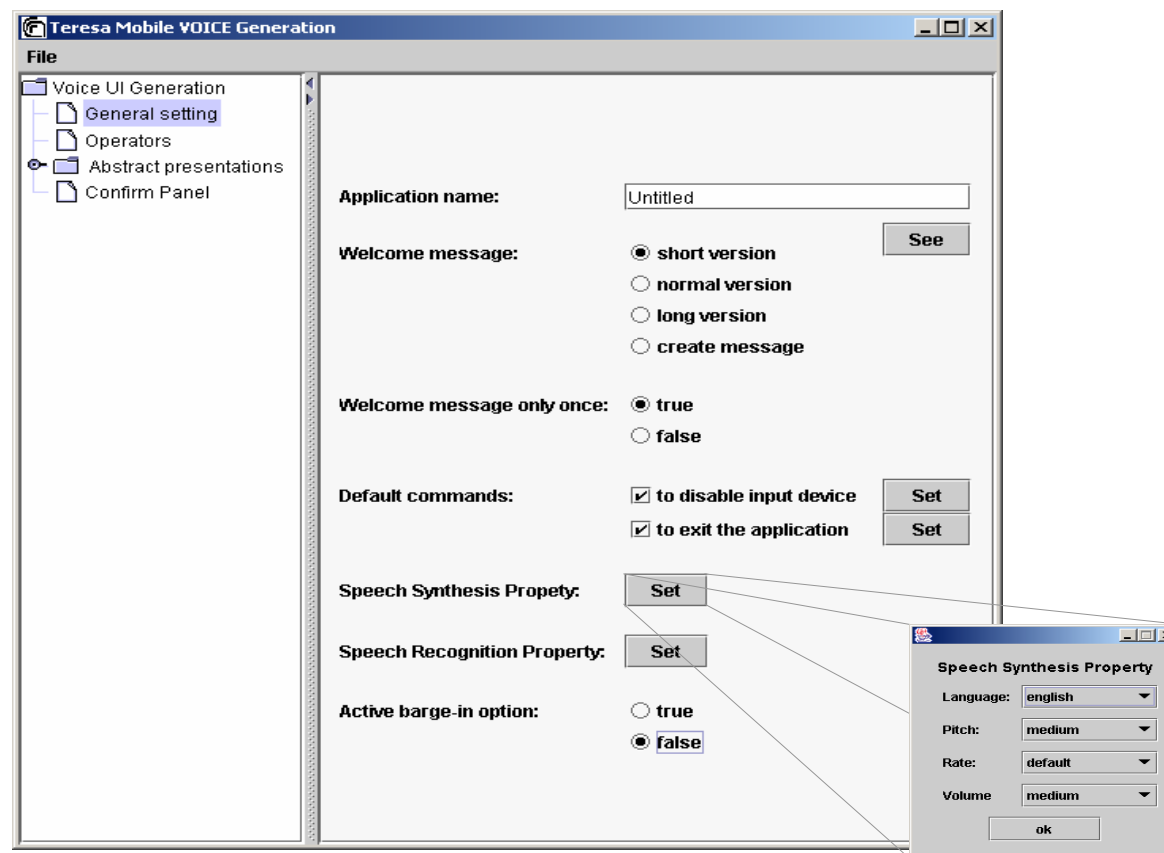
## Hierarchy

- Increase or decrease the volume of synthesizer voice







# Specifying general parameters for all presentations

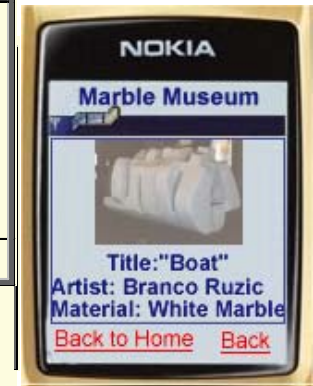




# Vocal Interaction Generation - DEMO

# VUI vs GUI

Fifth presentation	 System:	The Boat has been achieved through the subtle divisions of the planes enveloping its central part, which is only rough-hewn; the material is white marble. <i>(Five second pause)</i> Remember that if you would like to return to the main menu, say home or if you would like to go back to the previous menu, say back.
	 Caller:	Home



- Welcome message
- Management of no input event
- Provide feedback
- Description Object
- Composition operators



# Generation of Multi-Modal Interfaces

- X+V
- Supported by OPERA Browser, also for PDAs
- EMMA not supported by any public tool
- SMIL not interaction oriented
- Identification of design criteria for multimodal platforms



# Interactor Interaction

- Prompt: represents the interface output indicating that it is ready to receive an input.
- Input: represents how the user can actually provide the input.
- Feedback: represents the feedback of the system after the user input.



# Multimodal properties

- Complementary
- Redundancy
- Assignment
- Equivalence

# Design of Multimodality Support

- Identification of new platforms (multimodal desktop, multimodal PDA, ...)
- Design how to support composition operators and interactors
- multimodal desktop:
  - composition operators -> graphically supported
  - interactors -> graphical prompt, input either graphical or vocal, feedback in both modalities
- multimodal pda:
  - composition operators -> supported both graphically and vocally
  - interactors -> vocal prompt, input either graphical or vocal, feedback in both modalities



# Multimodal desktop

- Composition operators → Graphical Assignment
- Interactors
  - OnlyOutput → Graphical Assignment
  - Interaction
    - Prompt: Graphical Assignment
    - Input: Equivalence
    - Feedback: Graphical Assignment





# Multimodal PDA

- Composition operators → Redundancy
- Interactors
  - OnlyOutput → Complementary/  
Redundancy
  - Interaction
    - Prompt: Redudancy
    - Input: Equivalence
    - Feedback: Redudancy

# Example - Demo

Welcome in the description page of Robots film

**Multi-screen cinema of Pisa**

**Title:** Robots  
**Genre:** Animation  
**Director:** Carlos Saldanha, Chris Wedge  
**Key Cast:** Voices of Ewan McGregor, Halle Berry, Mel Brooks, Stanley Tucci  
**Running time:** 90 minutes  
**Release Date:** 18-MAR-05  
**User Rating:** ★★★★★☆ 6.4/10 (2,384 votes) [Vote](#)

**Summary**  
Even in a world populated entirely by mechanical beings Rodney Copperbottom (McGregor) is considered a genius inventor. Rodney dreams of two things, making the world a better place and meeting his idol, the master inventor Bigweld (Brooks). On his journey he encounters Cappy (Halle Berry), a beautiful executive 'bot with whom Rodney is instantly smitten, the nefarious corporate tyrant Ratchet (Kinnear) who locks horns with Rodney, and a group of misfit 'bots known as the Rusties, led by Fender (Williams) and Piper Pinwheeler (Bynes).

[View Trailer](#)

[Book now!](#)

(grouping sound)

Welcome in the movie description page.  
In the Robots film a world is populated entirely by robots. This is the story of a young genius, Rodney, who wants to make robots capable....

(grouping sound)

Would you like to book a ticket or come back to home?

**Multi-screen cinema of Pisa**

**Title:** Robots  
**Genre:** Animation  
**Directors:** Carlos Saldanha, Chris Wedge  
**Key Cast:** Voices of Ewan McGregor, Halle Berry, Mel Brooks, Stanley Tucci  
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