First prototypes of the User, Device and Application Models

Deliverable D5.2 :: Public

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Executive Summary

This document is an addendum to the first prototypes of the User, Device and Application Models delivered in M12 and provides a short summary of their respective key aspects. The deliverables per-se are the semantic descriptions in RDF and their corresponding instances. All the models are released under the I2Web Public License, Version 1.0. Modelling of the User, Device and Application is a major feature of I2Web architectural design and implementation, as it provides the basis for the adaptation process.

This document has been updated including a revision of the user and device models with more descriptive information as requested by the reviewers and improved capabilities as result of our testing. These models have been successfully presented to the scientific community in the paper Ackermann et al. (2012).

1 http://i2web/LICENSE.html
1 Introduction and architecture

This document is an addendum to the first prototypes of the User, Device and Application Models delivered in M12 and provides a short summary of their respective key aspects. The deliverables per-se are the semantic descriptions in RDF and their corresponding instances. The document is organised as follows: this section presents the modelling architecture, section 2 the device model, section 3 the user model, section 4 the application model and section 5 some conclusions.

As mentioned in many deliverables, user, device and application models are a major feature of I2Web architectural design and implementation, as it provides the basis for the adaptation process. We are going to present in the rest of the section a brief overview of the modelling architecture.

The objective of the designed architecture is to cover the entire life-cycle in the development and delivery of a modern web application, represented in Figure 1. The upper part covers the authoring process, which is discussed in other deliverables. The architecture includes as well access to remote evaluation services for web accessibility. An evaluation client facilitates the access to the remote evaluation API. This client sends evaluation requests in the XML or JSON formats and parses the response, an evaluation report in the EARL format (EARL, 2011). The access to the model repository allows the creation of an application model that is key to the adaptation process.

Focusing on the lower part of the diagram (delivery component), we can initiate the foreseen workflow when a user makes a request to the server. The request analyzer component identifies the user based on information sent inside this request. This may be an extended HTTP header (e.g., x-i2web-uprof) or her login information. Then the transformer component retrieves the appropriate user model from the model repository and stores a reference to it in the current user session.

The device model can be determined by two alternative ways: either via an extended HTTP header which identifies the device (e.g., x-i2web-dprof) or directly from the user model—when the user model contains a reference to her available devices. The first approach allows the user to switch her device on the fly. As long as the device sends the correct header, the application will adapt accordingly. The second approach requires that the user selects manually her current device.

An extension considered is a HTTP client-side proxy (initially envisaged in Velasco et al., 2004), which automatically sends information about the current device with every request. Note that detecting the device based on the User-Agent HTTP header is not sufficient in our case because of the following reasons. Firstly, it only contains information about the user agent and the operating system. It does not contain information about, e.g., assistive technologies and other important client capabilities. Secondly, the information inside the header is not always reliable.
After both the device and the user model are determined, the transformer component reads the application model and applies one or more transformations to create the adapted application.

There are different types of transformations as described in Coutaz and Calvary, 2008: suppression, insertion, substitution and reorganization (see Section 3 for some typical examples). Figure 2 shows a single-step transformation process that uses as input the three models to generate the new application interface. Figure 3 presents a multi-step transformation with the application model and at least one of the user or device models as
input. Every transformation generates an application that again can be used as input for another transformation, similar to the pipes and filters pattern.

All these adaptation processes are enabled by the following models.
2 Device model

As described in D5.1, device modelling started to acquire relevance as ubiquitous and mobile computing became mainstream. The most relevant industrial application has been the User Agent Profile (UAProf, 2006), which provided a framework for describing capabilities of mobile devices until the middle of the previous decade. This vocabulary became obsolete because its applicability to the recent generations of smartphones is minimal. On the basis of a classification of input devices, Schulz et al., 2011, uses device models to categorize interaction problems that occur because of wrong use of devices. However this categorization is at a functionality metalevel and has no applicability for UI adaptation. Other strand of work is focused on the adaptation of the device to the content, like in the Universal Remote Console (URC) standard (LaPlant et al., 2004).

The I2Web user and device models are going to be based in the CC/PP 2.0 Framework (CC/PP, 2007). CC/PP allows to construct user and device profiles as a two level hierarchy: a profile with a number of components, which have a number of attributes. The attributes of a component may be included directly in a profile document, or may be specified by reference. This simple framework allows an efficient processing of profiles without the parsing overhead of semantic models based on OWL, for instance.

For illustrations purposes, we are using a pseudo-UML representation for our models (see RDF-Schema-UML, 1998).

2.1 Dublin Core Terms

All our models make use of several Dublin Core Terms properties, represented in the namespace: http://purl.org/dc/terms/, with the prefix dct:. The core properties used in our RDF classes will be:

- dct:title (mandatory)
- dct:description (mandatory)
- dct:alternative (optional)
- dct:conformsTo (optional)
- dct:creator (optional)
- dct:date (optional)
- dct:hasPart (optional)
- dct:isPartOf (optional)

2.2 Web Technology model

One of the novelties of our approach is the definition of a decoupled Web Technology model, which could be used by any other component of our architecture. This approach offers several advantages:

- it allows the expression of device capabilities for either hardware or software components;

http://dublincore.org/documents/dc-q-rdf-xml/
• it allows the expression of user preferences; and
• it simplifies the expression of matching rules for adaptation with different granularities, ranging from top components like, i.e., images or movies to HTML elements and attributes, or CSS properties, for instance.

The namespace of the model is: http://i2web.eu/ns/2012/technology#. Its standard prefix wt:. An updated documentation can be found online at: http://i2web.eu/ns/2012/technology/. See Appendix B: Web Technology model.

2.2.1 Classes

The following classes have been defined:

• wt:Component: abstract class derived from ccpp:Component used as placeholder for the default Dublin Core properties. Additionally, it has the optional property:
  o wt:version
• wt:WebTechnology: main container for a web technology. Domain of:
  o wt:contentType
• wt:MarkupTechnology: a generic container for markup technologies. Domain of:
  o wt:elements
• wt:XMLTechnology: a generic container for XML technologies. Domain of:
  o wt:namespace
• wt:StyleTechnology: a generic container for style technologies. Domain of:
  o wt:styleProperties
• wt:ContentType: content type used in the web delivery of the given technology. Range of:
  o wt:contentType
• wt:Element: element of the object model of the given markup technology.
• wt:Attribute: attribute of the object model of the given markup technology.
• wt:StyleProperty: property of the object model of the given style technology.

See Figure 4 for a graphical representation. A list of technologies can be found in: http://i2web.eu/ns/techs/.

2.2.2 Properties

The following properties have been defined:

• wt:version: generic version identifier of a given element. Range:
  o xsd:string (XML Schema)
• wt:elements: collection of elements of the specification.
• wt:attributes: collection of attributes of the specification.
• wt:namespace: namespace URL of the web technology.
• wt:styleProperties: collection of style properties of the specification.
2.2.3 Content Types

Based upon this model, an ontology of content types has been developed: [http://i2web.eu/ns/techs/contenttypes#](http://i2web.eu/ns/techs/contenttypes#), with a list of registered Media Types by IANA. This ontology serves as well as input to the user model configuration. An example of the information provided is shown on Table 1.

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2.3 Device model

As mentioned earlier, our approach for the device model is similar to that of UAProf. However, we have decided not to extend it but to design our own vocabulary, denoting a semantic equivalence or difference where appropriate.

The namespace of the model is: http://i2web.eu/ns/2012/devicemodel#. The default prefix is dm:. An updated documentation can be found here: http://i2web.eu/ns/2012/devicemodel/. See Appendix C: Device model.

2.3.1 Classes

The main classes are:

- **dm:Component**: abstract class derived from ccpp:Component used as placeholder for the default Dublin Core properties. Additionally, it has the optional properties:
  - `wt:version`
  - `foaf:maker`
- **dm:HardwarePlatform**: the HardwarePlatform component is used as a generic platform description. It is different from HardwarePlatform in UAProf, which contains properties of the device's hardware, such as display size, supported character sets, etc. In our model, these properties belong to the individual dm:Hardware components.
- **dm:Hardware**: this component identifies individual hardware elements like displays, graphic cards, sound cards, keyboards, mice, etc. It can also be used to identify assistive technology hardware like Braille-lines, etc. Typical subclasses are: dm:Display, dm:Mouse or dm:Keyboard.
- **dm:SoftwarePlatform**: the SoftwarePlatform component is used as the operating system description of the device. Again, it is different from the UAProf SoftwarePlatform component, which contains properties of the device's application environment, operating system, and installed software.
- **dm:Software**: this component identifies individual software components of the device. We distinguish two subclasses: dm:ApplicationSoftware (software that performs some kind of activity for the user) and dm:InteractionSoftware (software that supports the interaction of the user with the device like a screen-reader, an on-screen keyboard, etc.). A key subclass from the former is the dm:UserAgent class, used to define any software that retrieves and renders web content for users (this may include web browsers, media players, plug-ins, and other programs that help in...
retrieving and rendering web content\textsuperscript{4}). The UserAgent component is similar to the UAProf BrowserUA component.

### 2.3.2 Properties

The key property of the model is:

- \textit{dm:technologies}: technology container (rdf:Bag) for the technologies supported by the component.

Additional properties have been defined in the model referring to specific types of components. See Figure 5 for a graphical representation of the key components of the model.

![Figure 5. Pseudo-UML representation of the Device Model.](http://i2web.eu/ns/devs/)

A list of model instances can be found in: [http://i2web.eu/ns/ devs/](http://i2web.eu/ns/ devs/).

\textsuperscript{4} [http://www.w3.org/TR/UAAG10/glossary.html#u](http://www.w3.org/TR/UAAG10/glossary.html#u)
3 User model

User modeling is an active research topic for more than four decades. Since the beginnings of the 1970s many dedicated and general user modeling systems have been developed to enable user-adaptation in different domains (see, e.g., reviews in Fischer, 2001, Kobsa, 2001, or a more recent survey targeted to the web in Schulz et al., 2011). Recent approaches manifest a convergence of the adaptive web and the semantic web (Sosnovsky and Dicheva, 2011) by utilizing standardized web ontology languages and their publicly available software infrastructure (inference engines, distributed repositories, mature APIs and editors).

Among the models reviewed in D5.1, the project has evaluated in detail those developed by the FP7 Virtual User Modelling and Simulation Cluster (VUMS) cluster. The cluster is formed by the GUIDE, MyUI, VERITAS and VICON projects. In this cluster Fraunhofer plays a very active role and the I2Web Consortium had the chance to review their developments in depth.

The projects ACCESSIBLE and AEGIS have developed large ontologies targeting users with special needs. These are modeled at a higher level in terms of their capabilities or functional limitations. Various stereotype profiles with adjusted settings are provided in order to serve use cases like automatic accessibility assessment and visualization. Due to their holistic and declarative nature these models tend to become too complex and demanding with respect to management and run-time processing. Therefore we investigated more tailored approaches for explicitly stating user preferences and adaptation needs by means of a dedicated ontology while rendering the interpretation of declarative models unnecessary. The major drawbacks of these models are:

- Lack of reuse of existing standards. Some of them repeat properties and modules that are available in other frameworks.
- A verbose and holistic approach trying to cover all aspects of “a user.” This verbosity has the cost of performance, which is unacceptable in real application environments.
- Some of them are focused on other domains, like household devices and CAD, where detailed descriptions of e.g. dexterity are relevant.
- Lack of commonalities with the device model, making matching of user and device characteristics a time-consuming exercise in which heuristics will play a predominant role.

Our attention is focused on the research area of Model-Based User Interface design, which aims at identifying high-level models for the specification and analysis of interactive

5 http://www.veritas-project.eu/vums/
6 http://www.guide-project.eu/
7 http://www.myui.eu/
8 http://www.veritas-project.eu/
9 http://www.vicon-project.eu/
12 The World Wide Web Consortium (W3C) hosted an incubator working group on Model-Based UI design. For the interested reader, we recommend its final report and references therein: http://www.w3.org/2005/Incubator/model-based-ui/XGR-mbui-20100504/. The group has been relaunched recently.
applications from a semantic perspective (as opposed to the more traditional syntactic perspective). Our work is based upon the CAMELEON Unified Reference Framework (Calvary et al., 2002 and 2003), which “…is a framework that serves as a reference for classifying user interfaces supporting multiple targets, or multiple contexts of use in the field of context-aware computing.”

The namespace of the model is: [http://i2web.eu/ns/2012/usermodel#](http://i2web.eu/ns/2012/usermodel#). Its default prefix is um:

### 3.1.1 Classes

No classes are defined in this model.

### 3.1.2 Properties

Our user model is oriented towards an **efficient mapping between device capabilities and user preferences**. The model is depicted in Figure 6 and supports the four UI remoulding approaches described in Coutaz (2008) via 4 properties that link different components:

- **um:suppression**: Suppression of the UI components that become irrelevant, i.e., elimination of decorative images for a blind user
- **um:insertion**: Insertion of new UI components to provide access to new services relevant in the new situation/context, i.e., addition of subtitles and text descriptions to a movie for a hard-of-hearing user or addition of additional help cues for an older adult;
- **um:substitution**: Substitution of UI components when UI components are replaced with new ones (substitution can be viewed as a combination of suppression and insertion of UI components), i.e., provision of an alternative text description for a blind user;
- **um:reorganization**: Reorganization of UI components by revisiting their spatial layout and/or their temporal dependency. This could result in simplified layouts for processes that may reduce the cognitive load for complex operations.

All properties are in the wt:Component domain and range. An updated documentation can be found here: [http://i2web.eu/ns/2012/usermodel/](http://i2web.eu/ns/2012/usermodel/). See Appendix D: User model. A list of instances can be found in: [http://i2web.eu/ns/refs/](http://i2web.eu/ns/refs/).
4 Application model

As described in deliverable D5.1, application modelling generally involves three major aspects: architecture, implementation, interaction. Ensuring a good level of accessibility for an application is a task that has impacts on all the three aspects. Accessibility obviously affects the user interaction modelling, but it affects also the implementation and architectural choices, because sophisticated and adaptive user interaction can scale only if the underlying architecture and implementation patterns are appropriate.

Since it is realistically impossible to impose architectural and implementation patterns that adapt to all application types, I2Web application models are for this first prototype implementation a set of guidelines that implement application modelling best practices for incorporating accessibility into a Web application. The model is based upon the WAI-ARIA recommendation (see Appendix E: WAI-ARIA model). The model concentrates on the semantics of the application and does not contain any domain-dependent information. This approach is validated by expert and user tests running in this phase of the project.

4.1 Application model guidelines

I2Web Application modelling comprehends the following guidelines:

- The application model of a Web application ultimately consists of a non-empty set of XHTMLs/DOMs that give the actual user interface definition, including its interaction schema (i.e., the way the UI reacts to user actions). I2Web application models essentially correspond to the “Concrete UI Definition” and “Final UI” layers of the CAMALEON Unified Reference Framework (see Figure 7).
- I2Web application models adopt WAI/ARIA to enrich UI widgets with roles/states that better clarify their purpose, and help mapping with accessibility APIs
- If possible, a Web application should adopt the Model-View-Presenter design pattern to fully decouple data/user-interface/logic. This design pattern allows for having multiple views that the presenter can choose based on the current user/device profile, thus simplifying the implementation of an adaptive application.

The following sections summarize the characteristics of first prototypes of I2Web applications in the three project scenarios: Web banking, eGovernment, and Media Management. In principle, these prototypes are due at M15, but a preliminary release has been developed to verify the appropriateness of our modelling framework.

In these first prototypes, user and device characteristics are controlled via a login action that fetches the relevant information. The prototypes will be subject to a CHE evaluation previous to the user evaluation. This will be reported in the following period.
4.2 HP I2Web Bank demo

The first prototype of HP I2Web Bank demo is a simplified banking application that simulates two important functionalities:

- Viewing details of a bank account
- Performing a money transfer

The application is available to project partners at http://i2web.eu/I2WebBankDemo/. Additionally, project partners can download the application itself as a war file from BSCW for testing purposes. The I2Web Bank Demo is built using Java and version 2.4 of the Google Web Toolkit (GWT – http://code.google.com/webtoolkit/), which supports development of rich Internet applications.

The architecture and implementation design is based on Model-View-Presenter (see deliverable D5.1), and it adopts the notions of Activities and Places\(^\text{13}\) to properly model user interaction tasks and handle browser history management. All major functionalities in the application are modelled as Places:

- User Home page
- View my account (see Figure 8)
- Perform money transfer
- Logout

There is one-to-one correspondence between application Places and user tasks. Additionally, GWT framework automatically handles browser’s history based on places: using the browser back button the user correctly navigates to the previous place, and can thus resume the previous task.

The first prototype of the I2Web Bank demo supports three different User Models (generic, blind, and old users) on two different Device Models (desktop/laptop and mobile). The

Application Model, i.e. the Document Object Model (DOM), automatically adapts to the various combinations of User Models and Device Models.

![Figure 8: HP I2Web Bank Demo: viewing account task.](image)

Figure 9 shows a screenshot of the I2Web Bank Demo application for a blind user.

![Figure 9: HP I2Web Bank Demo: application model (WAI-ARIA annotated XHTML fragment).](image)

The lower section of the screenshot in Figure 9 displays part of the application model. Note how the left-side application menu is modelled as an XHTML div containing an invisible heading (h1), and a ul/li structure defining the menu. The ul/li structure is also annotated...
with WAI-ARIA roles “menu” and “menuitem”, to unambiguously state the semantics of such tags. The XHTML fragment displayed in Figure 9 is an example of how the Application Model adapts to the User Model for blind person.

4.3 Public-i eGovernment demo

The Public-i Connect application is a web application for local government. The aim of Connect is to facilitate the engagement of the public with local government and the opportunity for greater involvement in council decisions. In this version of the Connect application this is achieved through the public webcasting of council meetings to the general public and the ability for them to contribute. The application is written in PHP and uses the Code Igniter application framework. Code Igniter is a Model-View-Controller (MVC) architectural framework; adopting an MVC architecture enables the developers to create device- (and user-) specific displays and workflows with relative ease.

When a user goes to the application (at http://test.i2web.public-i.tv) they are shown the main page with welcome information and, on the right hand side, a list of webcasts that are available to view (see Figure 10).

![Public-i prototype: user home page](image)

Figure 10: Public-i prototype: user home page

Clicking on one of these webcast titles takes the user to the ‘player’ page where the webcast will load and play. See Figure 11.
Figure 11: Public-i prototype: player page.

Some WAI/ARIA roles are included in the application. For example, the navigation links listed across the grey bar have ‘role=”navigation”’ (marked ‘1’ in Figure 12), each webcast listed in the “Webcast overview” section has ‘role=”article”’ (marked ‘3’ in Figure 12), and the main content area has ‘role=”main”’ (marked ‘2’ in Figure 12).
4.4 Polymedia demo

Polymedia CMS is a full-featured and integrated Multichannel Content Management System specifically designed for supporting the entire content life cycle, from its creation to its distribution on different distribution chains and devices. It is developed using open standards such as Java and XML/XSLT. By means of the XML/XSLT technologies, Polymedia CMS permits the creation of content once and the publication of the same item of content on several distribution chains.

The first prototype of Polymedia demo is a simple example of a media site developed using Polymedia CMS, it is published on Polymedia server and usually used for commercial purposes. It is available online at the following link: http://demos.txt.it/pv/Web/index.shtml.

The example will be soon duplicated and installed on a dedicated machine to work on it without changing the official version.

The site contains a header consisting of the name and the logo of the site and, just below the header, a navigation bar which allows shifting between the different sections of the portal. It has a three column layout:

---

Figure 12: Public-i prototype: DOM fragment (WAI-ARIA enriched application model).
• ‘Most visited articles’ section on the left side
• Advertising section on the right side
• News section on the centre column

By clicking on the title of an article it is possible to display the content of the selected article in the centre column and to insert a comment about that.

Figure 13 shows a page displaying an article of the Polymedia demo prototype. The example shows an HTML tag annotated with WAI/ARIA roles: the DIV element is annotated with “navigation” role since it contains a collection of navigation elements, while the UL element is annotated with “menubar” role since it is a menu that remains visible and fix in all the pages of the portal. The <li/> elements are annotated with “menuitem” role since they are options of the menubar.
5 Model Transport

As specified in the introduction, there are two ways to access the models:

1. Via login data of the user, which allows direct access to specific user and device model information to the web application; or
2. Via extended HTTP headers:
   - `x-i2web-uprof` for user profiles.
   - `x-i2web-dprof` for device profiles.

These headers are general header fields which MUST contain the following:

- an absolute URI referencing the profile (as defined by RFC2396), or
- an RDF profile instance serialized as RDF/XML.\textsuperscript{14}

\textsuperscript{14} http://www.w3.org/TR/REC-rdf-syntax/
6 Conclusions

This document has presented an overview of the first prototypes of the User, Device and Application Models. The first versions of these models have been integrated with the prototypes of WP7. Since the first release, a set of refinements have been included, like:

- Introduction of “abstract” classes like wt:Component or dm:Component to group core properties;
- Re-grouping of components;
- Dropping of UAProf due to its semantic limitations;
- Declaration of the model transport; etc.

Current work is oriented to the declaration of conformance requirements as a step to prepare standards submission, definition of more fine-grained properties for some components, creation of common stereotypes and the optimization of query mechanisms for triple stores. These improvements will be reported in D5.3.
7 References


Appendix A: List of abbreviations and acronyms

An up-to-date list of common abbreviations and acronyms used in our documents can be found online at:

http://services.imergo.com/ns/abbreviations.html
Appendix B: Web Technology model

```xml
<?xml version="1.0"?>
<rdf:RDF
  xmlns:ccpp="http://www.w3.org/2006/09/20-ccpp-schema#"
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns="http://i2web.eu/ns/2012/technology#"
  xmlns:owl="http://www.w3.org/2002/07/owl#"
  xmlns:dcterms="http://purl.org/dc/terms/"
  xmlns:xsd="http://www.w3.org/2001/XMLSchema#"
  xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
  xml:base="http://i2web.eu/ns/2012/technology">
  <owl:Ontology rdf:about="">
    <owl:imports rdf:resource="http://purl.org/dc/terms/"/>
  </owl:Ontology>
  <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string" >I2Web Web Technology Model.</rdfs:label>
  <dcterms:identifier rdf:datatype="http://www.w3.org/2001/XMLSchema#string" >$HeadURL:
  http://gforge.i2webdev.org/svn/device_model/device_model/trunk/src/main/resources/META-INF/vocabularies/technology.rdf
  $</dcterms:identifier>
  <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string" >I2Web Web Technology Model to be used in third party environments.</rdfs:comment>
  <rdfs:seeAlso rdf:resource="http://bentoweb.org/refs/TCDL2.0/"/>
  <dcterms:date rdf:datatype="http://www.w3.org/2001/XMLSchema#string" >$Date: 2012-05-28 16:00:54 +0200 (Mo, 28 Mai 2012) $</dcterms:date>
  <rdfs:Class rdf:ID="Element">
    <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string" >Element of the object model of the given markup technology.</rdfs:label>
    <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string" >Element</rdfs:label>
    <rdfs:subClassOf rdf:ID="Component"/>
  </rdfs:Class>
  <rdfs:Class rdf:about="#Component">
    <rdfs:subClassOf rdf:resource="http://www.w3.org/2006/09/20-ccpp-schema#Component"/>
  </rdfs:Class>
</rdf:RDF>
```
<rdfs:comment
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
>A generic Component container derived from
ccpp:Container.</rdfs:comment>
<rdfs:label
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
>Generic Component container.</rdfs:label>
</rdfs:Class>
<rdfs:Class rdf:ID="XMLTechnology"
<rdfs:label
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
>Generic XML Technology.</rdfs:label>
<rdfs:comment
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
>A
generic container for XML technologies.</rdfs:comment>
<rdfs:subClassOf>
<rdfs:Class rdf:ID="MarkupTechnology"/>
</rdfs:Class>
</rdfs:Class>
<rdfs:Class rdf:ID="WebTechnology"
<rdfs:comment
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
>Main container for a web technology.</rdfs:comment>
<rdfs:label
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
>Web Technology</rdfs:label>
<rdfs:subClassOf rdf:resource="#Component"/>
</rdfs:Class>
<rdfs:Class rdf:ID="Attribute"
<rdfs:comment
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
>Attribute of the object model of the given markup
technology.</rdfs:comment>
<rdfs:subClassOf rdf:resource="#Component"/>
<rdfs:label
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
>Attribute</rdfs:label>
</rdfs:Class>
<rdfs:Class rdf:ID="StyleTechnology"
<rdfs:comment
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
>A generic container for style technologies.</rdfs:comment>
<rdfs:subClassOf rdf:resource="#WebTechnology"/>
</rdfs:Class>
<rdfs:Class rdf:ID="ContentType"
<rdfs:comment
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
>Content type used in the web delivery of the given
technology.</rdfs:comment>
<rdfs:subClassOf rdf:resource="#Component"/>
<rdfs:label
rdf:datatype="http://www.w3.org/2001/XMLSchema#string"
>Content Type.</rdfs:label>
<rdfs:Class rdf:ID="StyleProperty">
  <rdfs:comment>
    Property of the object model of the given style technology.
  </rdfs:comment>
  <rdfs:subClassOf rdf:resource="#Component"/>
  <rdfs:label>
    A Style Property.
  </rdfs:label>
</rdfs:Class>

<ccpp:Attribute rdf:ID="version">
  <rdfs:range rdf:resource="http://www.w3.org/2001/XMLSchema#string"/>
  <rdfs:label>
    Version identifier.
  </rdfs:label>
  <rdfs:comment>
    Generic version identifier of a given element.
  </rdfs:comment>
</ccpp:Attribute>

<ccpp:Attribute rdf:ID="contentType">
  <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">
    Content type(s) for the specification.
  </rdfs:comment>
  <rdfs:range rdf:resource="#ContentType"/>
  <rdfs:domain rdf:resource="#WebTechnology"/>
</ccpp:Attribute>

<ccpp:Attribute rdf:ID="elements">
  <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">
    Collection of elements of the specification.
  </rdfs:comment>
  <rdfs:domain rdf:resource="#MarkupTechnology"/>
</ccpp:Attribute>

<ccpp:Attribute rdf:ID="attributes">
  <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">
    Collection of attributes of the specification.
  </rdfs:comment>
  <rdfs:domain rdf:resource="#MarkupTechnology"/>
</ccpp:Attribute>
<ccpp:Attribute rdf:ID="styleProperties">
  <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">Collection of style properties of the specification.</rdfs:comment>
  <rdfs:domain rdf:resource="#StyleTechnology"/>
  </ccpp:Attribute>
</ccpp:Attribute>

<ccpp:Attribute rdf:ID="namespace">
  <rdfs:range rdf:resource="http://www.w3.org/2001/XMLSchema#anyURI"/>
  <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string">Namespace URL.</rdfs:label>
  <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">Namespace URL of the web technology.</rdfs:comment>
  <rdfs:domain rdf:resource="#XMLTechnology"/>
</ccpp:Attribute>
Appendix C: Device model

<?xml version="1.0"?>
<rdf:RDF
   xmlns:ccpp="http://www.w3.org/2006/09/20-ccpp-schema#"
   xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
   xmlns:foaf="http://xmlns.com/foaf/0.1/"
   xmlns:wt="http://i2web.eu/ns/2012/technology#"
   xmlns:owl="http://www.w3.org/2002/07/owl#"
   xmlns:dcterms="http://purl.org/dc/terms/"
   xmlns:http://i2web.eu/ns/2012/devicemodel#"
   xmlns:xsd="http://www.w3.org/2001/XMLSchema#"
   xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
   xml:base="http://i2web.eu/ns/2012/devicemodel">
   <owl:Ontology rdf:about="">
      <owl:imports rdf:resource="http://xmlns.com/foaf/0.1/"/>
      <owl:imports rdf:resource="http://purl.org/dc/terms/"/>
      <dcterms:rightsHolder>
         <foaf:Organization rdf:about="http://i2web.eu/ns/I2Web">
            <foaf:homepage rdf:resource="http://i2web.eu/"/>
            <dcterms:identifier rdf:datatype="http://www.w3.org/2001/XMLSchema#string">Device Model ontology for the I2Web project. </dcterms:identifier>
      </dcterms:rightsHolder>
      <dcterms:title xml:lang="en">Device Model ontology for the I2Web project.</dcterms:title>
      <dcterms:identifier rdf:datatype="http://www.w3.org/2001/XMLSchema#string">Device Model ontology for the I2Web project.</dcterms:identifier>
      <dcterms:license rdf:resource="http://i2web.eu/LICENSE.html"/>
      <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string">Device Model ontology for the I2Web project. </rdfs:label>
      <owl:versionInfo rdf:datatype="http://www.w3.org/2001/XMLSchema#string">Device Model ontology for the I2Web project. </owl:versionInfo>
   </owl:Ontology>
   <rdfs:Class rdf:ID="SoftwarePlatform">
      <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string">Software Platform</rdfs:label>
   </rdfs:Class>
</rdf:RDF>
<rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">Software Platform.</rdfs:comment>
<rdfs:seeAlso rdf:resource="http://www.openmobilealliance.org/tech/profiles/uaprof/ccp3schema-20070511.rdf#SoftwarePlatform"/>
<rdfs:subClassOf>
  <rdfs:Class rdf:ID="Component"/>
</rdfs:subClassOf>
</rdfs:Class>
<rdfs:Class rdf:ID="ScreenMagnifier">
<rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">Screen Magnifier</rdfs:comment>
<rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string">Screen Magnifier</rdfs:label>
<rdfs:subClassOf>
  <rdfs:Class rdf:ID="InteractionSoftware"/>
</rdfs:subClassOf>
</rdfs:Class>
<rdfs:Class rdf:ID="Hardware">
<rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string">Hardware</rdfs:label>
<rdfs:subClassOf rdf:resource="#Hardware"/>
</rdfs:Class>
<rdfs:Class rdf:ID="Mouse">
<rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">A hardware component of the device.</rdfs:comment>
<rdfs:subClassOf rdf:resource="http://www.w3.org/2001/XMLSchema#string">Hardware</rdfs:subClassOf>
</rdfs:Class>
<rdfs:Class rdf:ID="UserAgent">
<rdfs:isDefinedBy rdf:resource="http://www.w3.org/TR/UAAG10/glossary.html#u"/>
<rdfs:comment rdf:resource="http://www.w3.org/2001/XMLSchema#string">Any software that retrieves and renders web content for users (this may include web browsers, media players, plug-ins, and other programs that help in retrieving and rendering web content</rdfs:comment>
<rdfs:label rdf:resource="#UserAgent"/>
<rdfs:seeAlso rdf:resource="http://www.openmobilealliance.org/tech/profiles/uaprof/ccp3schema-20070511.rdf#BrowserUA"/>
First prototypes of the User, Device and Application Models

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A generic Component container derived from ccpp:Component.

Interaction software is software which changes the interaction of the user in some way, either in terms of the modality of input/output or in the way the user understands the information presented to them. This software can be embedded in the operating system, or it might be an add-on application.

Interaction software is software which changes the interaction of the user in some way, either in terms of the modality of input/output or in the way the user understands the information presented to them. This software can be embedded in the operating system, or it might be an add-on application.
<rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string">Screen Reader</rdfs:label>
</rdfs:Class>
<rdfs:Class rdf:ID="Display">
<rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">Display</rdfs:comment>
<rdfs:subClassOf rdf:resource="#Hardware"/>
</rdfs:Class>
<rdfs:Class rdf:about="#ApplicationSoftware">
<rdfs:subClassOf rdf:resource="#Software"/>
</rdfs:Class>
<rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string">Application Software</rdfs:label>
<rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">Application software is software which performs some kind of activity for the user.</rdfs:comment>
</rdfs:Class>
<rdfs:Class rdf:about="#Software">
<rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">Software is a conceptual entity which is a set of computer programs, procedures, and associated documentation concerned with the operation of a data processing system.</rdfs:comment>
</rdfs:Class>
<rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string">Software</rdfs:label>
</rdfs:Class>
<ccpp:Attribute rdf:ID="technologies">
<rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">Technology container (rdf:Bag) for the technologies supported by the container.</rdfs:comment>
</ccpp:Attribute>
<rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string">Technology</rdfs:label>
</rdfs:Class>
<ccpp:Attribute rdf:ID="resources">
<rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">Resource container (rdf:Bag) for the resources supported by the container.</rdfs:comment>
</ccpp:Attribute>
<rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string">Resource</rdfs:label>
</rdfs:Class>
Appendix D: User model

<?xml version="1.0"?>
<rdf:RDF
   xmlns:ccpp="http://www.w3.org/2006/09/ccpp-schema#"
   xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
   xmlns="http://i2web.eu/ns/2012/usermodel#"
   xmlns:wt="http://i2web.eu/ns/2012/technology#"
   xmlns:owl="http://www.w3.org/2002/07/owl#"
   xmlns:dcterms="http://purl.org/dc/terms/"
   xmlns:xsd="http://www.w3.org/2001/XMLSchema#"
   xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
   xml:base="http://i2web.eu/ns/2012/usermodel">
   <owl:Ontology rdf:about="">
     <dcterms:date rdf:datatype="http://www.w3.org/2001/XMLSchema#string"/>
     <rdfs:seeAlso rdf:resource="http://bentoweb.org/refs/TCDL2.0/"/>
     <rdfs:comment rdf:datatype="http://www.w3.org/2001/XMLSchema#string">
       Substitution of UI components when UI components are replaced with new ones (substitution can be viewed as a combination of suppression and insertion of UI components), i.e., provision of an alternative text description for a blind user. </rdfs:comment>
     <rdfs:label rdf:datatype="http://www.w3.org/2001/XMLSchema#string">Substitution Component.</rdfs:label>
   </owl:Ontology>
</rdf:RDF>
Suppression Component.

- Suppression of the UI components that become irrelevant, i.e., elimination of decorative images for a blind user.

Insertion Component.

- Insertion of new UI components to provide access to new services relevant in the new situation/context, i.e., addition of subtitles and text descriptions to a movie for a hard-of-hearing user or addition of additional help cues for an older adult.

Reorganization Component.

- Reorganization of UI components by revisiting their spatial layout and/or their temporal dependency. This could result in simplified layouts for processes that may reduce the cognitive load for complex operations.
Appendix E: WAI-ARIA model

See:  http://www.w3.org/WAI/ARIA/schemata/aria-1.rdf. More information available, including licensing, at: http://www.w3.org/TR/wai-aria/.

```xml
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE rdf:RDF [ 
<!ENTITY xsd "http://www.w3.org/2001/XMLSchema#"> 
<!ENTITY dc "http://dublincore.org/2003/03/24/dc1es#"> 
<!ENTITY owl "http://www.w3.org/2002/07/owl#"> 
<!ENTITY rdfs "http://www.w3.org/2000/01/rdf-schema#"> 
<!ENTITY rdf "http://www.w3.org/1999/02/22-rdf-syntax-ns#"> 
<!ENTITY states "http://www.w3.org/2005/07/aaa#"> ]>

<rdf:RDF xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#" 
xmlns:role="http://www.w3.org/1999/xhtml/vocab#" 
xmlns:states="http://www.w3.org/2005/07/aaa#" 
xmlns:xsd="http://www.w3.org/2001/XMLSchema#" 
xmlns:dc="http://purl.org/dc/elements/1.1/#" 
xmlns:owl="http://www.w3.org/2002/07/owl#" 
xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#" 
xmlns:xm:base="http://www.w3.org/WAI/ARIA/Schemata/aria-1">! -- Objects -->
<owl:ObjectProperty rdf:ID="baseConcept">
<rdfs:comment xml:lang="en">This is similar to type but without inheritance of limitations and properties. role:baseConcepts are designed as a substitute for inheritance for external concepts.</rdfs:comment>
</owl:ObjectProperty>

<owl:ObjectProperty rdf:ID="supportedState">
<rdfs:comment xml:lang="en">A state that can be supported for this Role</rdfs:comment>
</owl:ObjectProperty>

<owl:ObjectProperty rdf:ID="requiredState">
<rdfs:comment xml:lang="en">A state that must be provided for this Role</rdfs:comment>
</owl:ObjectProperty>

<owl:ObjectProperty rdf:ID="mustContain">
<rdfs:comment xml:lang="en">A child that must be contained by this role</rdfs:comment>
</owl:ObjectProperty>
```

```xml
</rdf:RDF>
```
<rdfs:subpropertyOf rdf:resource="#scope"/>
</owl:ObjectProperty>
<owl:ObjectProperty rdf:ID="nameFrom">
  <rdfs:comment>How a role type name is extracted and referenced inside a document. Values are "author": name comes from values provided by the author in explicit markup features; and "subtree": name comes from the text value of the element node.</rdfs:comment>
  <rdfs:domain rdf:resource="#widget"/>
</owl:ObjectProperty>
<owl:ObjectProperty rdf:ID="childrenArePresentational">
  <rdfs:comment xml:lang="en">The children are presentational. Assistive technologies may choose to hid the children from the user.</rdfs:comment>
  <rdfs:range rdf:resource="http://www.w3.org/2001/XMLSchema#boolean"/>
  <rdfs:domain rdf:resource="#roletype"/>
</owl:ObjectProperty>
<owl:Class rdf:ID="alert">
  <rdfs:subClassOf rdf:resource="#region"/>
  <rdfs:seeAlso rdf:resource="http://www.w3.org/TR/2007/REC-xforms-20071029/#ui-common-elements-alert"/>
  <role:nameFrom>author</role:nameFrom>
</owl:Class>
<owl:Class rdf:ID="alertdialog">
  <rdfs:subClassOf rdf:resource="#alert"/>
  <rdfs:subClassOf rdf:resource="#dialog"/>
  <rdfs:seeAlso rdf:resource="http://www.w3.org/TR/2007/REC-xforms-20071029/#ui-common-elements-alert"/>
  <role:nameFrom>author</role:nameFrom>
</owl:Class>
<owl:Class rdf:ID="application">
  <rdfs:subClassOf rdf:resource="#landmark"/>
  <rdfs:seeAlso rdf:resource="http://www.w3.org/TR/di-gloss/#def-delivery-unit"/>
  <role:nameFrom>author</role:nameFrom>
</owl:Class>
<owl:Class rdf:ID="article">
  <rdfs:subClassOf rdf:resource="#document"/>
  <rdfs:subClassOf rdf:resource="#region"/>
  <rdfs:seeAlso rdf:resource="http://www.w3.org/TR/2010/WD-html5-20100624/sections.html#the-article-element"/>
  <role:nameFrom>author</role:nameFrom>
</owl:Class>
<owl:Class rdf:ID="banner">
  <rdfs:subClassOf rdf:resource="#landmark"/>
  <role:nameFrom>author</role:nameFrom>
</owl:Class>
<owl:Class rdf:ID="button">
  <rdfs:subClassOf rdf:resource="#command"/>
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<owl:Class rdf:ID="complementary">
  <rdfs:subClassOf rdf:resource="#landmark"/>
  <role:nameFrom>author</role:nameFrom>
</owl:Class>

<owl:Class rdf:ID="composite">
  <rdfs:subClassOf rdf:resource="#widget"/>
  <role:supportedState rdf:resource="http://www.w3.org/2005/07/aaa#aria-activedescendant"/>
  <role:nameFrom>author</role:nameFrom>
</owl:Class>

<owl:Class rdf:ID="contentinfo">
  <rdfs:subClassOf rdf:resource="#landmark"/>
  <role:nameFrom>author</role:nameFrom>
</owl:Class>

<owl:Class rdf:ID="definition">
  <rdfs:subClassOf rdf:resource="#section"/>
  <role:nameFrom>author</role:nameFrom>
</owl:Class>

<owl:Class rdf:ID="dialog">
  <rdfs:subClassOf rdf:resource="#window"/>
  <role:nameFrom>author</role:nameFrom>
</owl:Class>

<owl:Class rdf:ID="directory">
  <rdfs:subClassOf rdf:resource="#list"/>
  <role:nameFrom>contents</role:nameFrom>
  <role:nameFrom>author</role:nameFrom>
</owl:Class>

<owl:Class rdf:ID="document">
  <rdfs:subClassOf rdf:resource="#structure"/>
  <rdfs:seeAlso rdf:resource="http://www.w3.org/TR/digloss/#def-delivery-unit"/>
  <role:supportedState rdf:resource="http://www.w3.org/2005/07/aaa#aria-expanded"/>
  <role:nameFrom>author</role:nameFrom>
</owl:Class>

<owl:Class rdf:ID="form">
  <rdfs:subClassOf rdf:resource="#landmark"/>
  <role:baseConcept rdf:resource="http://www.w3.org/TR/html401/interact/forms.html#edef-FORM"/>
  <role:nameFrom>author</role:nameFrom>
</owl:Class>

<owl:Class rdf:ID="grid">
  <rdfs:subClassOf rdf:resource="#composite"/>
  <rdfs:subClassOf rdf:resource="#region"/>
  <role:baseConcept rdf:resource="http://www.w3.org/TR/html4/struct/tables.html#edef-TABLE"/>
  <role:mustContain rdf:resource="#row"/>
  <role:mustContain rdf:resource="#rowgroup"/>
  <role:mustContain rdf:resource="#row"/>
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<role:supportedState rdf:resource="http://www.w3.org/2005/07/aaa#aria-multiselectable"/>
<role:supportedState rdf:resource="http://www.w3.org/2005/07/aaa#aria-required"/>
<role:nameFrom>author</role:nameFrom>
</owl:Class>

<owl:Class rdf:ID="listitem">
<rdfs:subClassOf rdf:resource="#section"/>
<role:baseConcept rdf:resource="http://www.w3.org/TR/html4/struct/lists.html#edef-LI"/>
<rdfs:seeAlso rdf:resource="http://www.w3.org/TR/2007/REC-xforms-20071029/#ui-common-elements-item"/>
<role:scope rdf:resource="#list"/>
<role:supportedState rdf:resource="http://www.w3.org/2005/07/aaa#aria-level"/>
<role:supportedState rdf:resource="http://www.w3.org/2005/07/aaa#aria-posinset"/>
<role:supportedState rdf:resource="http://www.w3.org/2005/07/aaa#aria-setsize"/>
<role:nameFrom>contents</role:nameFrom>
<role:nameFrom>author</role:nameFrom>
</owl:Class>

<owl:Class rdf:ID="log">
<rdfs:subClassOf rdf:resource="#region"/>
<role:nameFrom>author</role:nameFrom>
</owl:Class>

<owl:Class rdf:ID="main">
<rdfs:subClassOf rdf:resource="#landmark"/>
<role:nameFrom>author</role:nameFrom>
</owl:Class>

<owl:Class rdf:ID="marquee">
<rdfs:subClassOf rdf:resource="#section"/>
</owl:Class>

<owl:Class rdf:ID="math">
<rdfs:subClassOf rdf:resource="#section"/>
<role:nameFrom>author</role:nameFrom>
</owl:Class>

<owl:Class rdf:ID="menu">
<rdfs:subClassOf rdf:resource="#list"/>
<rdfs:subClassOf rdf:resource="#select"/>
<rdfs:seeAlso rdf:resource="http://www.loc.gov/nls/z3986/v100/dtbook110doc.htm#sidobar"/>
<rdfs:seeAlso rdf:resource="http://www.w3.org/TR/2007/REC-xforms-20071029/#ui-selectMany"/>
<rdfs:seeAlso rdf:resource="http://download.oracle.com/javase/6/docs/api/javax/accessibility/AccessibleRole.html#MENU"/>
<role:mustContain rdf:resource="#group"/>
<role:mustContain rdf:resource="#menuitemradio"/>
<role:mustContain rdf:resource="#menuitem"/>
<role:mustContain rdf:resource="#menuitemcheckbox"/>
<role:mustContain rdf:resource="#menuitemradio"/>
<role:nameFrom>author</role:nameFrom>
</owl:Class>
First prototypes of the User, Device and Application Models

I2Web project (Grant no.: 257623)
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<role:supportedState rdf:resource="http://www.w3.org/2005/07/aaa#aria-atomic"/>
<role:supportedState rdf:resource="http://www.w3.org/2005/07/aaa#aria-busy"/>
<role:supportedState rdf:resource="http://www.w3.org/2005/07/aaa#aria-controls"/>
<role:supportedState rdf:resource="http://www.w3.org/2005/07/aaa#aria-describedby"/>
<role:supportedState rdf:resource="http://www.w3.org/2005/07/aaa#aria-disabled"/>
<role:supportedState rdf:resource="http://www.w3.org/2005/07/aaa#aria-dropeffect"/>
<role:supportedState rdf:resource="http://www.w3.org/2005/07/aaa#aria-flowto"/>
<role:supportedState rdf:resource="http://www.w3.org/2005/07/aaa#aria-grabbed"/>
<role:supportedState rdf:resource="http://www.w3.org/2005/07/aaa#aria-haspopup"/>
<role:supportedState rdf:resource="http://www.w3.org/2005/07/aaa#aria-hidden"/>
<role:supportedState rdf:resource="http://www.w3.org/2005/07/aaa#aria-invalid"/>
<role:supportedState rdf:resource="http://www.w3.org/2005/07/aaa#aria-label"/>
<role:supportedState rdf:resource="http://www.w3.org/2005/07/aaa#aria-labelledby"/>
<role:supportedState rdf:resource="http://www.w3.org/2005/07/aaa#aria-live"/>
<role:supportedState rdf:resource="http://www.w3.org/2005/07/aaa#aria-owns"/>
<role:supportedState rdf:resource="http://www.w3.org/2005/07/aaa#aria-relevant"/>
<role:supportedState rdf:resource="http://www.w3.org/TR/xhtml-role/#s_role_module_attributes"/>
<role:supportedState rdf:resource="http://www.w3.org/TR/html401/struct/links.html#edef-LINK"/>
<role:supportedState rdf:resource="http://purl.org/dc/elements/1.1/type"/>

owl:Class rdf:ID="row">
<owl:Class rdf:subClassOf rdf:resource="#group"/>
<owl:Class rdf:subClassOf rdf:resource="#widget"/>
<owl:Class rdf:resource="http://www.w3.org/TR/html4/struct/tables.html#edef-TR"/>
<owl:Class rdf:resource="http://www.w3.org/2005/07/aaa#aria-level"/>
<owl:Class rdf:resource="http://www.w3.org/2005/07/aaa#aria-selected"/>
First prototypes of the User, Device and Application Models

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<owl:Class rdf:ID="rowgroup">
  <rdfs:subClassOf rdf:resource="#group"/>
  <role:baseConcept>
    rdf:resource="http://www.w3.org/TR/html4/struct/tables.html#edef-TBODY"/>
  <role:scope rdf:resource="#grid"/>
  <role:mustContain rdf:resource="#row"/>
  <role:nameFrom>contents</role:nameFrom>
  <role:nameFrom>author</role:nameFrom>
</owl:Class>

<owl:Class rdf:ID="rowheader">
  <rdfs:subClassOf rdf:resource="#gridcell"/>
  <rdfs:subClassOf rdf:resource="#sectionhead"/>
  <rdfs:subClassOf rdf:resource="#widget"/>
  <role:baseConcept>
    rdf:resource="http://www.w3.org/TR/html4/struct/tables.html#edef-TH"/>
  <role:scope rdf:resource="#row"/>
  <role:supportedState rdf:resource="http://www.w3.org/2005/07/aaa#aria-sort"/>
  <role:nameFrom>contents</role:nameFrom>
  <role:nameFrom>author</role:nameFrom>
</owl:Class>

<owl:Class rdf:ID="search">
  <rdfs:subClassOf rdf:resource="#landmark"/>
  <role:nameFrom>author</role:nameFrom>
</owl:Class>

<owl:Class rdf:ID="section">
  <rdfs:subClassOf rdf:resource="#structure"/>
  <rdfs:seeAlso rdf:resource="http://www.loc.gov/nls/z3986/v100/dtbook110doc.htm#frontmatter"/>
  <rdfs:seeAlso rdf:resource="http://www.loc.gov/nls/z3986/v100/dtbook110doc.htm#level"/>
  <rdfs:seeAlso rdf:resource="http://www.w3.org/TR/REC-smil/#par"/>
  <role:supportedState rdf:resource="http://www.w3.org/2005/07/aaa#aria-expanded"/>
  <role:nameFrom>contents</role:nameFrom>
  <role:nameFrom>author</role:nameFrom>
</owl:Class>

<owl:Class rdf:ID="sectionhead">
  <rdfs:subClassOf rdf:resource="#structure"/>
  <role:supportedState rdf:resource="http://www.w3.org/2005/07/aaa#aria-expanded"/>
  <role:nameFrom>contents</role:nameFrom>
  <role:nameFrom>author</role:nameFrom>
</owl:Class>

<owl:Class rdf:ID="select">
  <rdfs:subClassOf rdf:resource="#composite"/>
  <rdfs:subClassOf rdf:resource="#group"/>
  <rdfs:subClassOf rdf:resource="#input"/>
<owl:Class rdf:ID="tooltip">
  <rdfs:subClassOf rdf:resource="#section"/>
</owl:Class>

<owl:Class rdf:ID="tree">
  <rdfs:subClassOf rdf:resource="#select"/>
  <role:mustContain rdf:resource="#group"/>
  <role:mustContain rdf:resource="#treeitem"/>
  <role:mustContain rdf:resource="#treeitem"/>
  <role:supportedState rdf:resource="http://www.w3.org/2005/07/aaa#aria-multiselectable"/>
  <role:supportedState rdf:resource="http://www.w3.org/2005/07/aaa#aria-required"/>
  <role:nameFrom>author</role:nameFrom>
</owl:Class>

<owl:Class rdf:ID="treegrid">
  <rdfs:subClassOf rdf:resource="#grid"/>
  <rdfs:subClassOf rdf:resource="#tree"/>
  <role:mustContain rdf:resource="#row"/>
  <role:nameFrom>author</role:nameFrom>
</owl:Class>

<owl:Class rdf:ID="treeitem">
  <rdfs:subClassOf rdf:resource="#listitem"/>
  <rdfs:subClassOf rdf:resource="#option"/>
  <role:scope rdf:resource="#group"/>
  <role:scope rdf:resource="#tree"/>
  <role:nameFrom>contents</role:nameFrom>
  <role:nameFrom>author</role:nameFrom>
</owl:Class>

<owl:Class rdf:ID="widget">
  <rdfs:subClassOf rdf:resource="#roletype"/>
</owl:Class>

<owl:Class rdf:ID="window">
  <rdfs:subClassOf rdf:resource="#roletype"/>
  <role:supportedState rdf:resource="http://www.w3.org/2005/07/aaa#aria-expanded"/>
  <role:nameFrom>author</role:nameFrom>
</owl:Class>