Addressing On-Demand Assembly and Adaptation

Using a Runtime Intentional Versioning Engine

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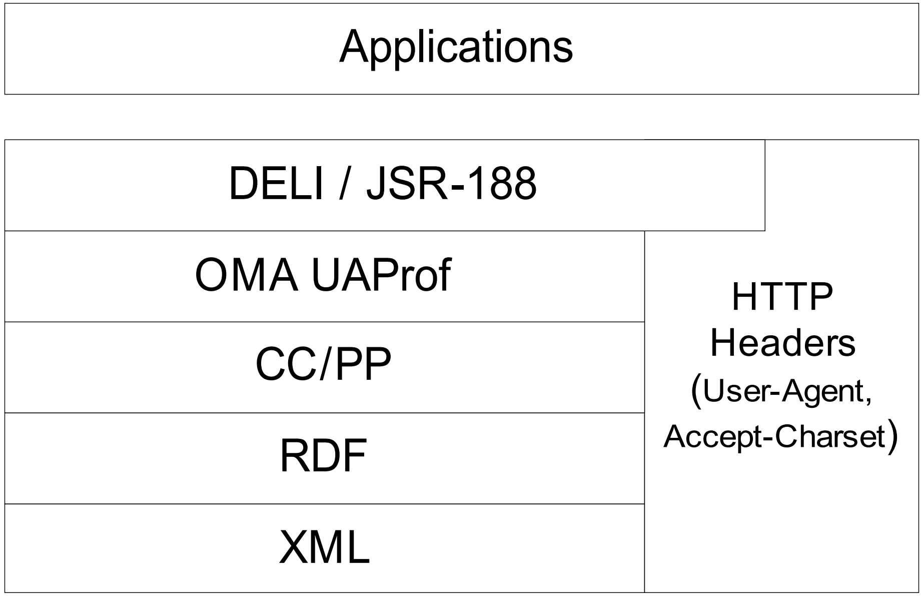
Context: Multimodal Web Applications

- Multimodal <u>Web</u> Applications
  - the client capabilities only known at runtime
- <u>Multimodal</u> Web Applications
  - allowing for different <u>modes of interaction</u> depending on a client device and its capabilities
  - providing several alternative user interface with possibly very different interaction styles
- Current situation: Multi-authoring
  - separate applications for PCs, mobile, voice, etc.
  - duplication of efforts, inconsistent user experience
  - device-driven adaptation resulting in poor coverage
- Target: Single Authoring
  - enable parallel development in a single integrated and coherent application framework
  - device independent capability-driven adaptation
  - expand coverage while managing the cost

Background: Existing Standards

W3C/OMA have been trying to address device independence:

- RDF – Resource Description Framework (W3C)
  - the foundation of the Semantic Web
- **CC / PP** – Composite Capabilities / Preference Profiles (W3C)
  - structure and transport framework
- **UAProf** – User Agent Profile (OMA)
  - a concrete CC/PP vocabulary
- JSR-188 - CC/PP Processing Specification (Java Community Process)
  - standard Java extension API



Applications

DELI / JSR-188

OMA UAProf

CC/PP

RDF

XML

HTTP Headers (User-Agent, Accept-Charset)

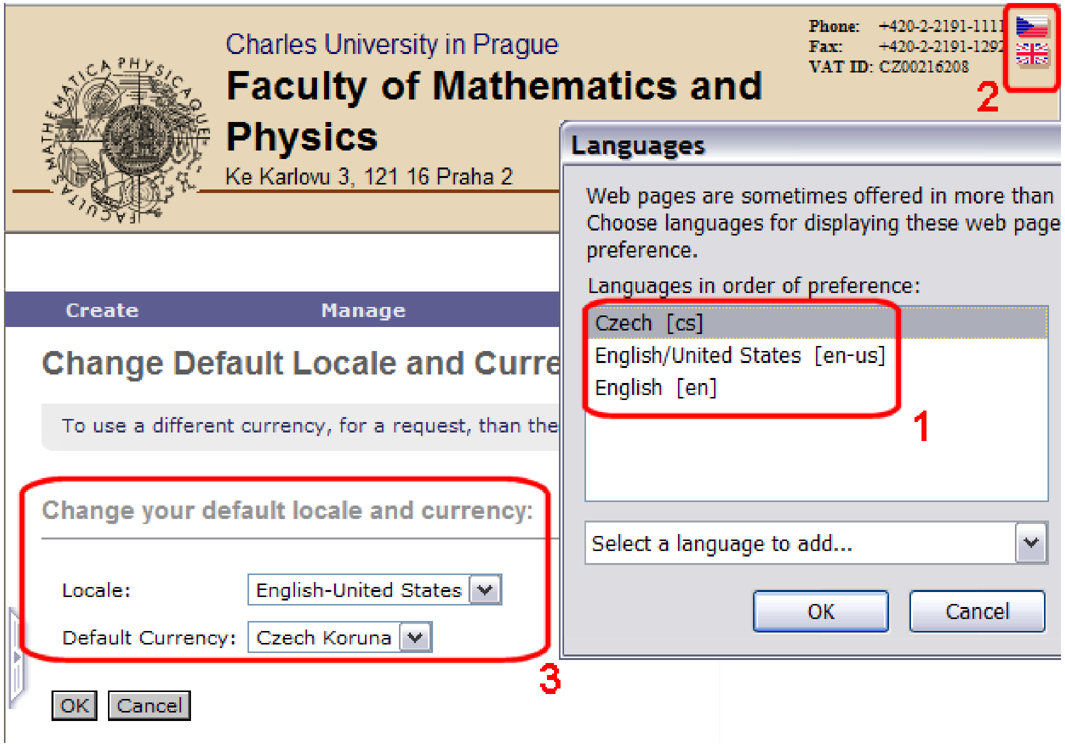
W3C: World Wide Web Consortium
OMA: Open Mobile Alliance
JSR: Java Specification Request
XML: eXtensible Markup Language

Problem Statement

- The W3C/OMA standards stack provides the necessary technological basis
  - does not sufficiently address all aspects
  - introduces some issues on its own
- Three major issues still affecting multimodal applications development

(1) Metadata Consolidation
(2) Metadata Canonicalization
(3) Level of Abstraction Gap

(1) Metadata Consolidation



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Change Default Locale and Curre

To use a different currency, for a request, than the

Change your default locale and currency:

Locale: English-United States

Default Currency: Czech Koruna

Languages

Web pages are sometimes offered in more than
Choose languages for displaying these web page
preference.

Languages in order of preference:

Czech [cs]
English/United States [en-us]
English [en]

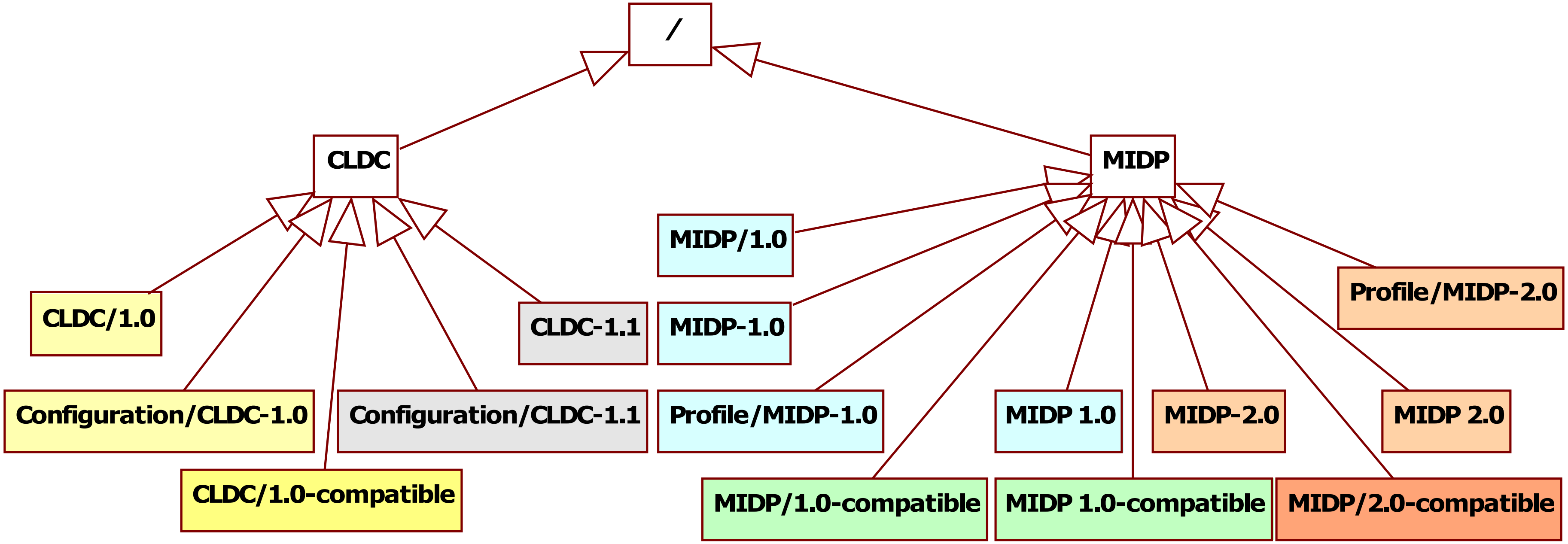
Select a language to add...

The same metadata attribute (*locale*) needs to be consolidated from multiple overlapping sources:

1) web browser (HTTP header)
2) web application (session cookie)
3) user profile (persistent storage)

- CC/PP is not the exclusive source of relevant metadata
- Not all devices support CC/PP
  - CC/PP broadly supported by cell phone manufacturers
  - abandoned by traditional web browser providers
- There is a need to support heterogeneous environments with many metadata sources
- We need to be able to define
  - resolution policy (order of precedence)
  - fall-back strategy (if preferred source can not provide metadata)

(2) Metadata Canonicalization

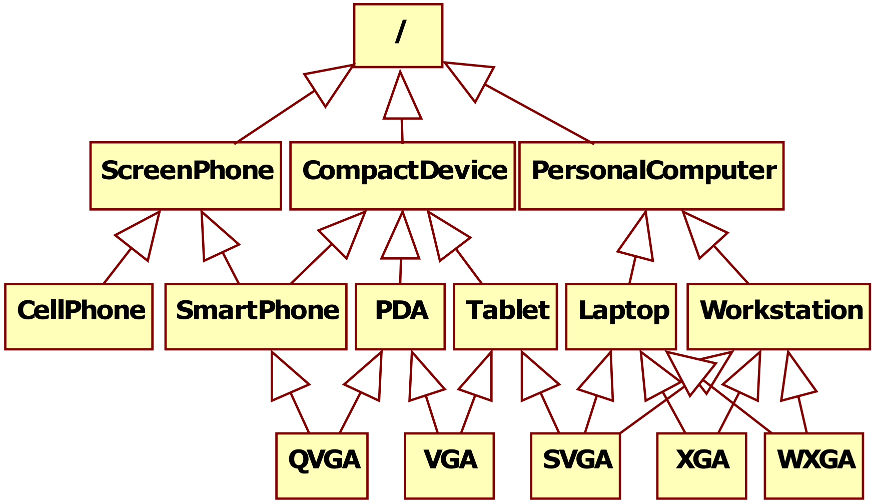


- above: UAProf 2.0 **JavaPlatform** attribute values*)
- fact: **64** out of 109 UAProf 2.0 metadata attributes are of type *Literal* (an arbitrary string)

*) References (used for data analysis):
[UAREP1] *UAProf Repository*, WWW Repository, W3Development.de, 2005,
http://w3development.de/rdf/uaprof_repository/ (**234** profiles, all major vendors represented)
[UAREP2] *UAProf Profiles*, WWW Repository, Nokia Corporation, 2007,
http://nds.nokia.com/uaprof/ (**436** profiles of Nokia and Vertu devices)

(3) Level of Abstraction

- UAProf 2.0 RDF Schema: **ScreenSize** of type *Dimension*
  - a pair of *positive integers* (e.g. 640x480 or 1024x768)
- UAProf 2.0 does not mention the fact that screen resolutions are actually well standardized
  - QVGA, VGA, SVGA, etc.
- CC/PP does not directly support any kind of classification/clustering schema
  - impossible to customize an application for each and every *potential* or even *actual* screen resolution



- possible solution: ScreenSizeClass **taxonomy**:
  - hierarchical classification of screen resolutions
  - can be derived from the UAProf **ScreenSize** or other sources
  - raises the level of abstraction
  - allows for incremental generalization (subsumption) and clustering (resource variant reuse)

Goals

- Support Metadata Consolidation
  - resolution rules and fall-back strategies
- Support Metadata Canonicalization
  - prevent proliferation to the main application logic
- Raise the Level of Abstraction
  - hierarchical classification, device clustering, generalization

- *Secondary Goals*
  - Avoid the Domain Expertise Issue
    - leverage common knowledge (no need to master Semantic Web in order to develop web applications)
  - Best Practices Enforcement
    - separation of concerns, modularity

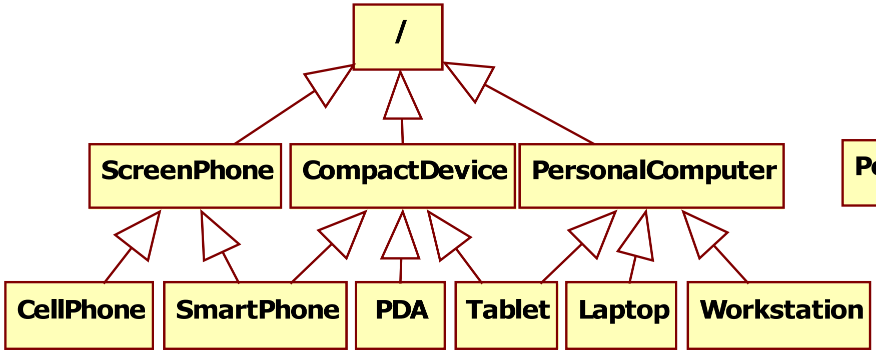
Versatile Framework: Key Concepts

- Semantically rich metadata Properties
  - **taxonomy**, controlled vocabulary, binary relation, (partial) order
- Chained Value Providers and Property Mappings
  - resolution rules and fall-back strategies for metadata acquisition
  - metadata canonicalization and transformation services
- Delivery Context
  - centralized metadata provider integrating all external metadata sources into a single coherent view
- Query Templates
  - high-level configuration rules used to express **constraints** and **preferences**
  - reusable – one query template for each category of resources
- Resource Providers
  - resource/class factories for versioned entities
  - implement multicriterial constraining and subsumption-based approximate matching with result scoring (fidelity score)

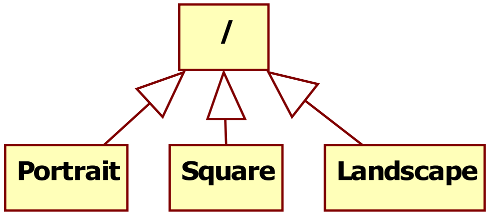
Layout Manager Example

- Task: instantiate a layout manager for a particular device
  - a layout manager is a component which controls how individual user interface widgets are positioned on the screen.
- The device provides its capabilities as a list of concrete attribute/value pairs.
- The application abstracts away from concrete values where appropriate, by clustering devices by similarity
  - in order to reuse layout managers for similarly capable devices

ScreenSize = 480x640
FramesCapable = false



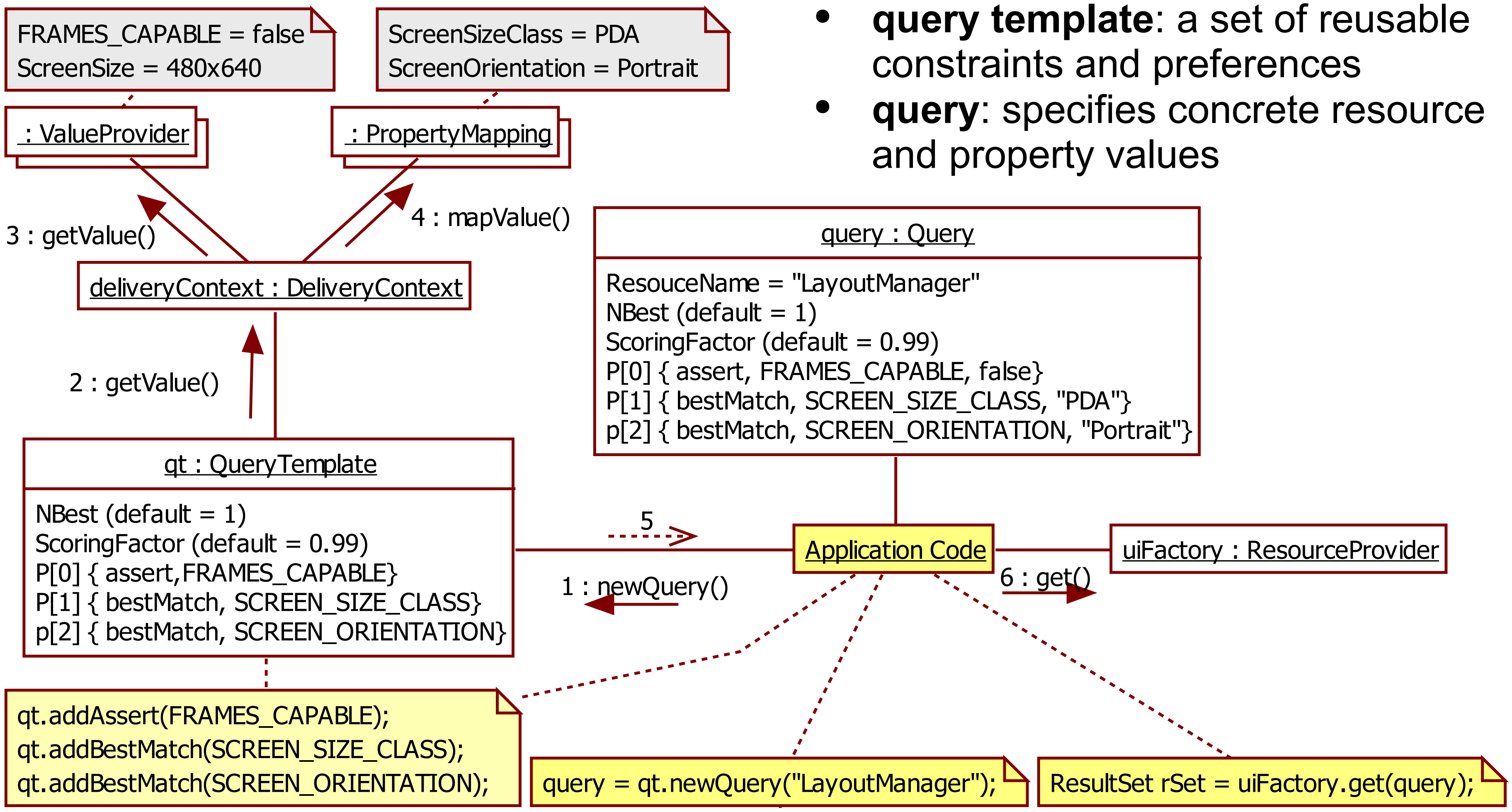
SCREEN_SIZE_CLASS



SCREEN_ORIENTATION

Part I – Delivery Context

- **query template**: a set of reusable constraints and preferences
- **query**: specifies concrete resource and property values



FRAMES_CAPABLE = false
ScreenSize = 480x640

ScreenSizeClass = PDA
ScreenOrientation = Portrait

: ValueProvider

: PropertyMapping

3 : getValue()

4 : mapValue()

deliveryContext : DeliveryContext

2 : getValue()

query : Query

ResouceName = "LayoutManager"
NBest (default = 1)
ScoringFactor (default = 0.99)
P[0] { assert, FRAMES_CAPABLE, false}
P[1] { bestMatch, SCREEN_SIZE_CLASS, "PDA"}
p[2] { bestMatch, SCREEN_ORIENTATION, "Portrait"}

qt : QueryTemplate

NBest (default = 1)
ScoringFactor (default = 0.99)
P[0] { assert,FRAMES_CAPABLE}
P[1] { bestMatch, SCREEN_SIZE_CLASS}
p[2] { bestMatch, SCREEN_ORIENTATION}

5

1 : newQuery()

Application Code

6 : get()

uiFactory : ResourceProvider

```
qt.addAssert(FRAMES_CAPABLE);
qt.addBestMatch(SCREEN_SIZE_CLASS);
qt.addBestMatch(SCREEN_ORIENTATION);
```

```
query = qt.newQuery("LayoutManager");
```

```
ResultSet rSet = uiFactory.get(query);
```

- Metadata acquisition/interpretation managed and automated by the framework.
  - consolidation, canonicalization/transformation
- The developer works in terms of high-level constraints/preferences.

Part II – Resource Provider

query : Query

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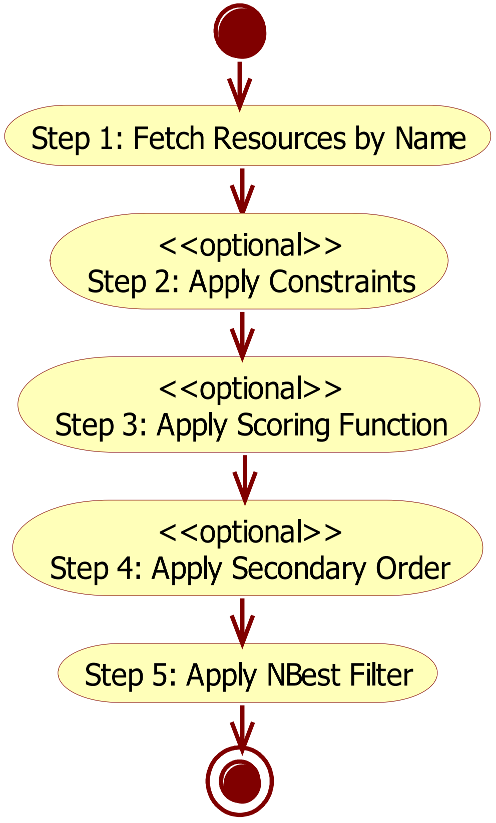

Step 1: Fetch Resources by Name
<<optional>> Step 2: Apply Constraints
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Step 5: Apply NBest Filter

- Finding the *most appropriate* implementation of the layout manager in the user interface components repository.
- Key feature is the ability to support both *constraints* and *preferences* applied to multiple metadata attributes
  - multicriterial constraining and matching

UID	ResourceName	FramesCapable	ScreenSizeClass	ScreenOrientation
1	MainMenu	TRUE	Tablet	Landscape
2	ToolBar	TRUE	PersonalComputer	Landscape
3	ContextMenu	FALSE	CellPhone	Portrait
4	LayoutManager	TRUE	PDA	/
5	LayoutManager	FALSE	PDA	/
6	LayoutManager	FALSE	CompactDevice	Portrait
7	LayoutManager	FALSE	PDA	Landscape

Table 1: A resource repository example

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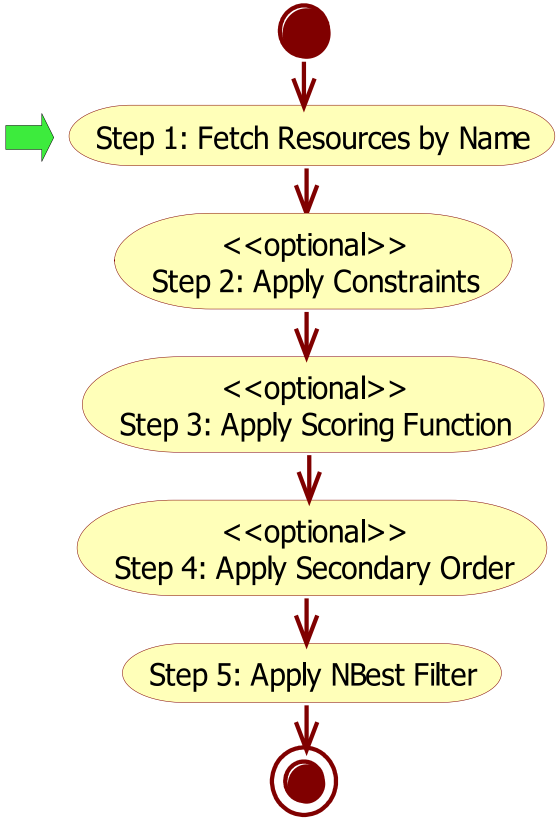

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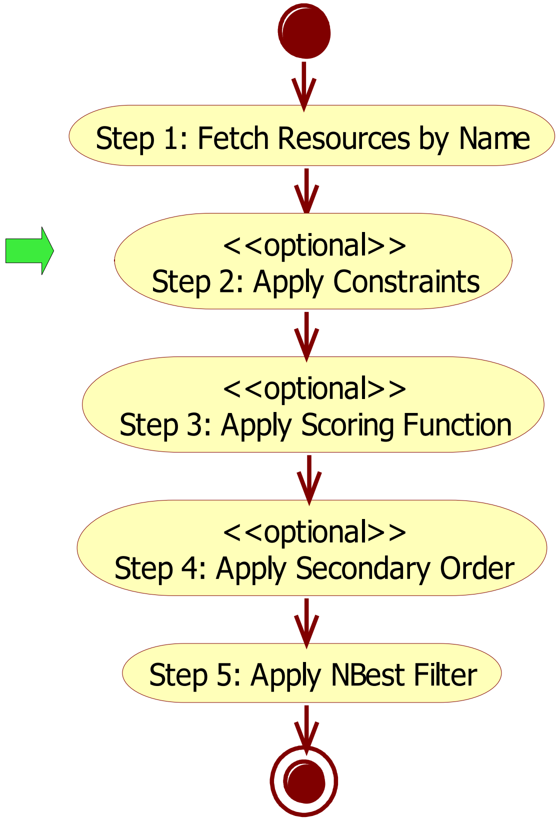

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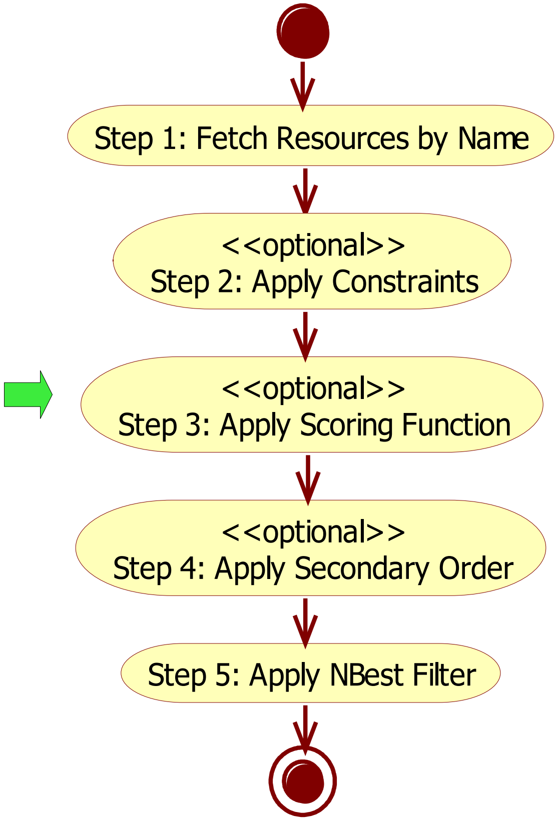
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0.505	5	LayoutManager	FALSE 0	PDA 0	/ 1
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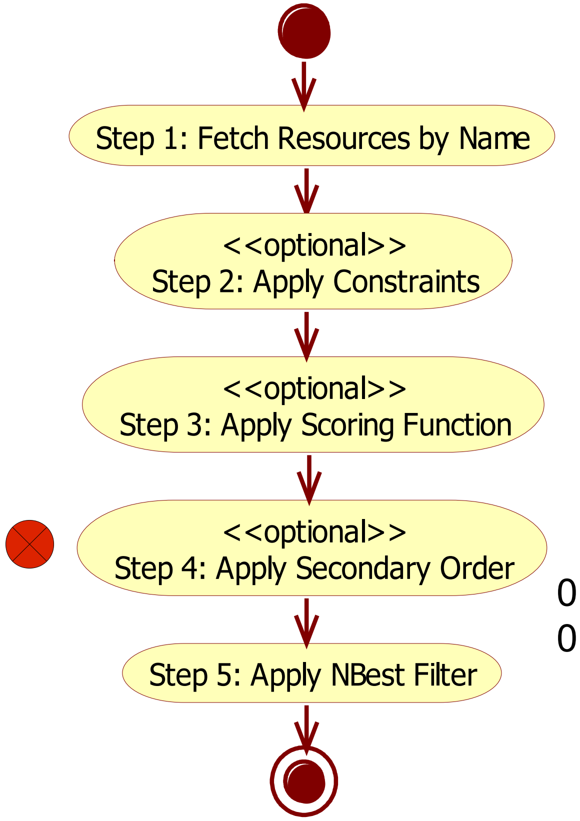
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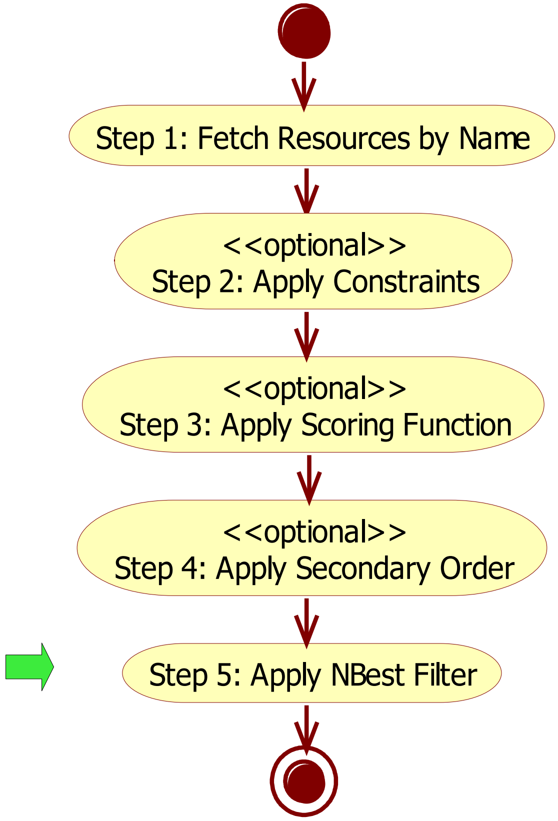
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Evaluation / Related Work

	Metadata Consolidation	Metadata Canonicalization	Level of Abstraction	Domain Expertise	Best Practices
The Versatile Framework	++	++	++	+	++
Volantis Mobile Content Framework (commercial)	+	++	++	++*)	n/a
MobileAware Interaction Server (commercial)	++	++	++	++*)	n/a
WURFL / WALL (Luca Passani, an open source project)	+	++	+	++	+
DELI with Capability Classes (Mark H Butler, HP Labs, UK)	–	+	++	+	+
Project PACE (Indulska J., et al.; University of Queensland, Australia)	–	–	–	+	–
"Simple CC/PP" (Korolev V., et al.; University of Maryland Baltimore County, USA)	–	–	+	+	++
OPERA Project, WAM Project (Lemlouma T., Layaïda N.; INRIA Rhône Alpes, France)	–	–	+	+	++
InfoPyramid (Mohan R., et al.; IBM T.J. Watson Research Center, USA)	–	–	++	–	++
CC/PP and annotation (Hwe-Mo Kim, Kyong-Ho Lee; Yonsei University, South Korea)	–	+	++	+	++
Rule-based adaptation (Stephen J.H. Yang, Norman W.Y. Shao; National Central University, Taiwan)	–	–	++	+	+
Graceful Degradation (Florins M., et al.; Université catholique de Louvain, Belgium)	–	–	+	+	++
Project MONA (Telecommunications Research Center - ftw., Vienna, Austria)	–	–	+	+	++
The W3C / OMA Standards Stack (CC/PP, UAProf)	–	–	–	+	–

++ good, **+** moderate, **–** out of scope, ***)** vendor lock-in, **n/a** – not enough information

Current Status and Future Work

- versatile.jar – a Java API library consisting of 45 interfaces and abstract classes
- versatile-api.pdf – an API Reference Manual, over 100 pages
  - detailed specifications, implementation guidelines and examples
- The library can be loaded into a Java IDE (e.g. Eclipse) and used to develop examples
  - sufficient for dry run testing and code-impact analysis
  - as there are not concrete implementations of the framework entities, the examples compile, but can not be actually executed
- Given the extent of the framework, not possible to proceed with a full-scale implementation as a single person
  - possibility: an open source community effort
- Possible applications outside of the chosen domain
  - web services, business rules

Publications

Master's Thesis

🟪 [1] J Gergic: *A Versioning Model for SOFA/DCUP Architecture*, Master's Thesis, Dept. of SW Engineering, Charles University, Prague,1999

Refereed Papers

🟪 [2] J Gergic: *Towards a Versioning Model for Component-based Software Assembly*, In proceedings of 19th International Conference on Software Maintenance (ICSM 2003), Amsterdam, Netherlands, 22-26 September 2003, pages 138 - 147, IEEE Computer Society, 2003

🟦 [3] V. Demesticha, J.Gergic, J.Kleindienst, M. Mast, L.Polymenakos,H.Schulz, L.Seredi: *Aspects of design and implementation of multi-channel and multi-modal information system*, In proceedings of 2001 International Conference on Software Maintenance (ICSM 2001), Florence, Italy, pages 312 - 319, IEEE Computer Society, 2001

🟦 [4] Yannis Despotopoulos, George Patikis, John Soldatos, LazarosPolymenakos, Jan Kleidienst, Jaroslav Gergic: *Accessing and Transforming Dynamic Content based on XML: Alternative Techniques anda Practical Implementation*, In proceedings of 3rd International Conference on Information Integration and Web-based Applications and Services (IIWAS 2001), pages 162 - 164, Linz, Austria, Sep 2001

🟦 [5] J. Gergic, J. Kleindienst, Y. Despotopoulos, J. Soldatos, G. Patikis, A. Anagnostou, L. Polymenakos: *An Approach to Lightweight Deployment of Web Services*, In proceedings of 14th International Conference on Software Engineering and Knowledge Engineering (SEKE '02), pages 635 - 640, Ischia (Italy), ACM Press New York, NY, USA, 2002

International Standards

🟥 [6] J. Engelsma, C. Cross, J. Gergic, R. Hosn, T. Ling, C. Wiecha, M., Pearce, R. Chaudhri, J. Ferrans, P. Baggia, A. Wahbe: *Distributed Multimodal Synchronization Protocol*, Internet Engineering Task Force (IETF), Internet-Draft, 2005-2007, http://www.ietf.org/internet-drafts/draft-engelsma-dmsp-04.txt (4th revision)

Patent Applications

🟥 [7] Hosn Rafah A., Gergic Jaroslav, Ling Nai Keung Thomas, Wiecha Charles: *System for factoring synchronization strategies from multimodal programming model runtimes*, United States Patent Application #20060036770, U.S. Patent & Trademark Office, 2006

🟦 [8] Gergic Jaroslav, Kleindienst Jan, Maes Stephane H., Raman Thiruvilwamalai V., Sedivy Jan: *Systems and methods for providing conversational computing via javaserver pages and javabeans*, United States Patent Application #20030046316, U.S. Patent & Trademark Office, 2003

🟦 [9] Gergic Jaroslav, Hosn Rafah A., Kleindienst Jan, Maes Stephane H., Raman Thiruvilwamalai V., Sedivy Jan, Seredi Ladislav: *Reusable voiceXML dialog components, subdialogs and beans*, United States Patent Application #20020198719, U.S. Patent & Trademark Office, 2002

Projects: 🟪 SOFA/DCUP 🟦 CATCH 2004 🟥 WSVA/MMOD

Thank you ...

http://dsrg.mff.cuni.cz

For more information please refer to http://dsrg.mff.cuni.cz/~gergic/versatile/