

Towards systematic usability evaluations for the OR: an introduction to OR-Use framework

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OR in a Nutshell:

- Collaborative Environment
- Surgical Workflow
- Distributed Platform

Motivation

- Complicated technological equipment in the OR
 - Increased complexity
- Deficiencies in the design of medical technology
 - Risk of human error
- Preventable medical errors
 - 44,000 to 98,000 people die each year just in the U.S.
 - 60% of adverse events are caused by use errors
 - Wrong usage of technical equipment is the main reason for adverse events in medicine
- Usability engineering is aiming at improving the human computer interaction
 - the complexity of the medical domain aggravates the work of usability specialists

[Wachter, 2004: The end of the beginning: Patient safety five years after 'to err is human'.]

[Bleyer, 1992: Medizinisch-technische Zwischenfälle in Krankenhäusern und ihre Verhinderung]

Usability Testing in General

- Technique used to evaluate a product by testing it on users
 - Direct input on how real users use the system
- Usability can be measured with Nielsen components defined as
 - Learnability
 - Efficiency
 - Memorability
 - Errors
 - Satisfaction
- Main steps of usability engineering:
 - Planning
 - Conduction
 - Analysis and Report
- In complex domains it is very challenging and requires high level of domain knowledge and expertise.



[Jakob Nielsen, 1994: Usability Engineering]

Objectives

- Performing a complete usability test is not always an easy endeavor and requires high level of domain knowledge and expertise:
 - Acquisition of usability data
 - Management of usability data
 - Analysis of huge amount of collected information
- Several usability testing support tools have been proposed in different domains.

Our Goal

- To exploit the Domain Knowledge into the usability study for the OR.
- Define a new tool to support usability testing in the OR.
- Propose a novel and flexible analysis method.

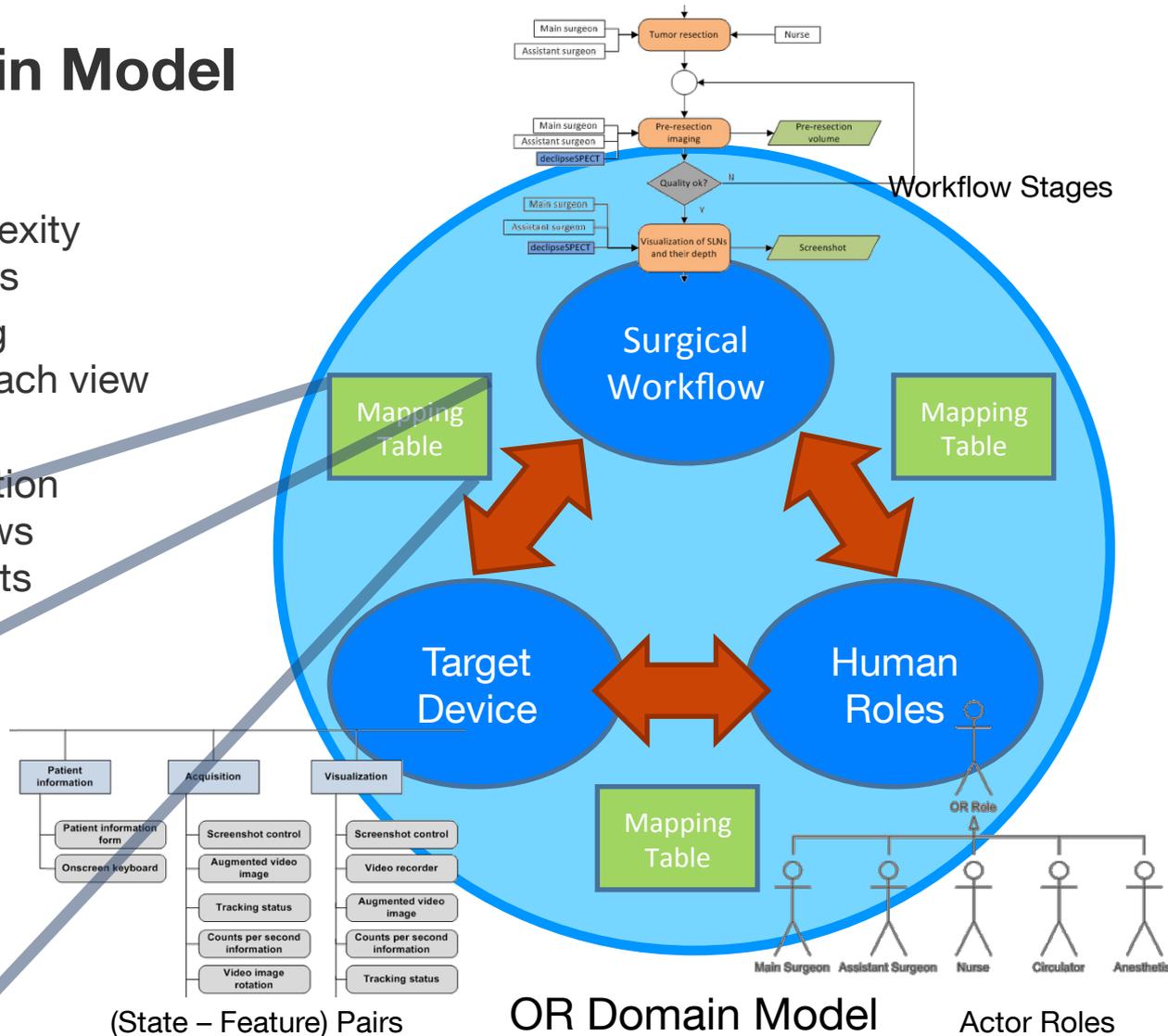


<http://www.infodesign.com.au/usabilityresources/usabilitytesting>

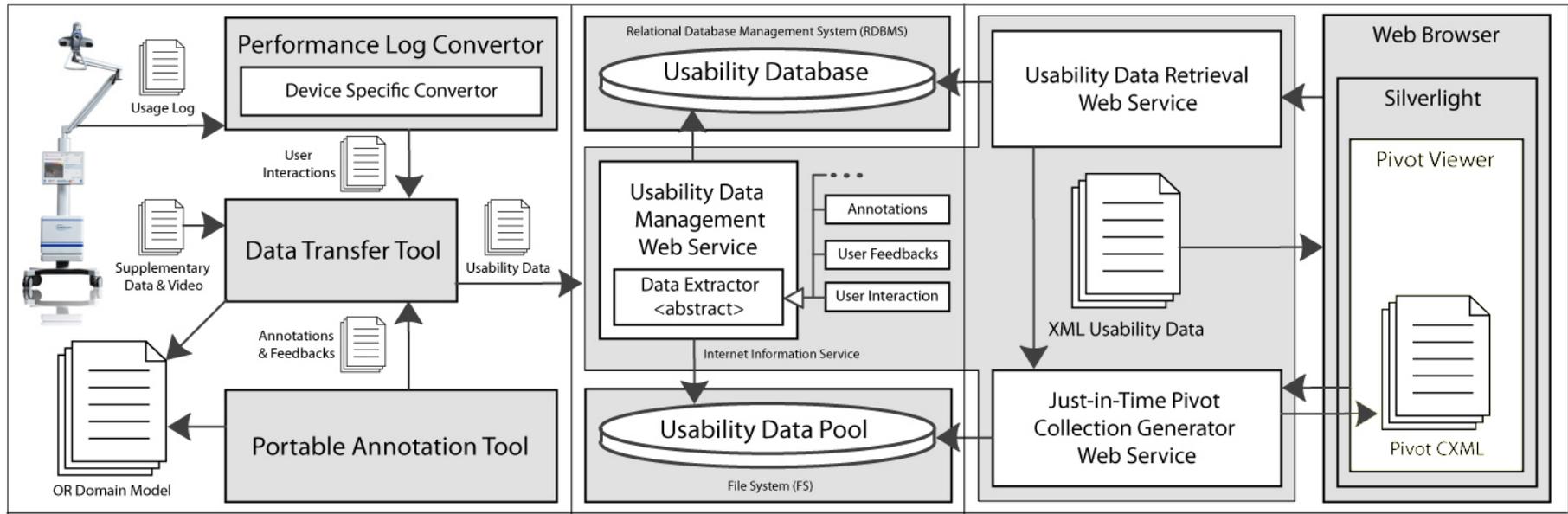
OR Specific Domain Model

1. Decompose the domain into its sources of complexity modeled as distinct views
2. Select a proper modeling technique to represent each view and driving its elements and driving its elements
3. Establish a clear connection between the defined views by mapping their elements

Device state	Workflow stage	Device feature					
		Anesthesia	Device positioning	Patient preparation	Sterilization of assistant surgeon	Device Preparation	Sterilization of main surgeon
Device preparation							
Lens aperture						x	
Device position			x				
Device arm position						x	
Reference target							x

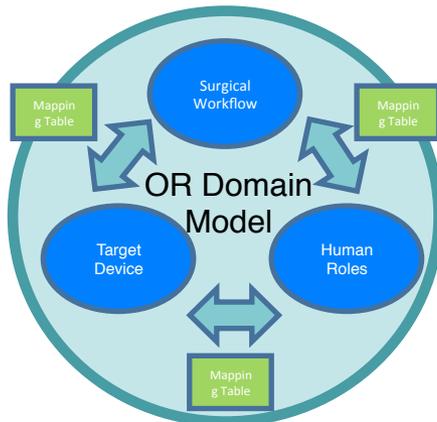
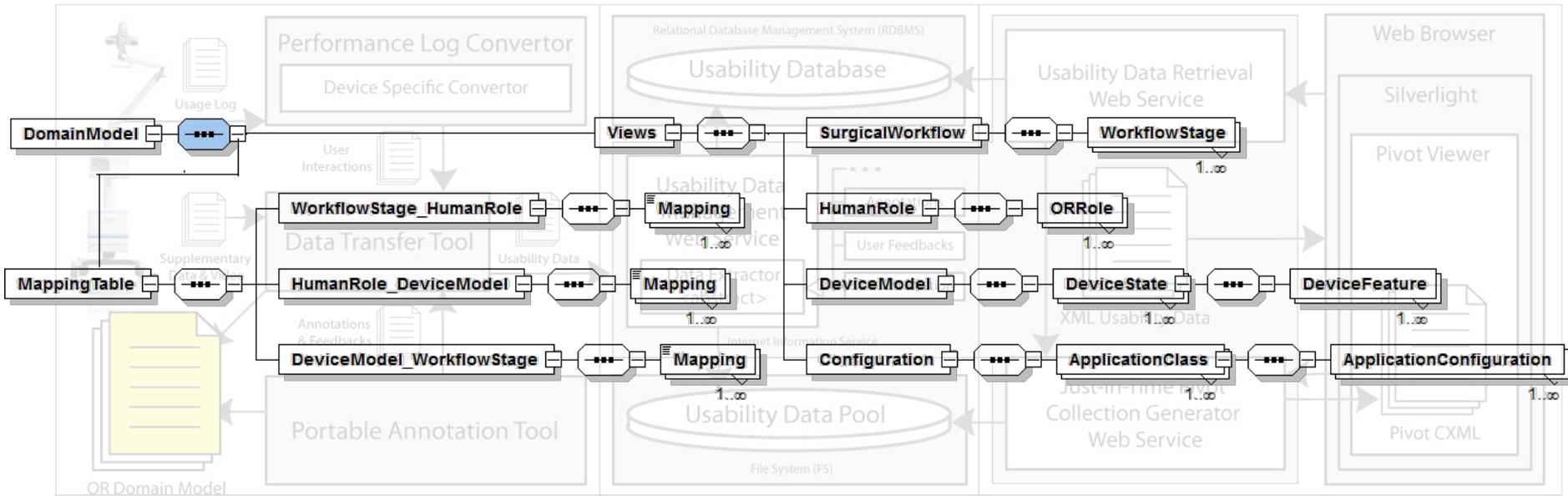


Architecture of OR-Use Framework



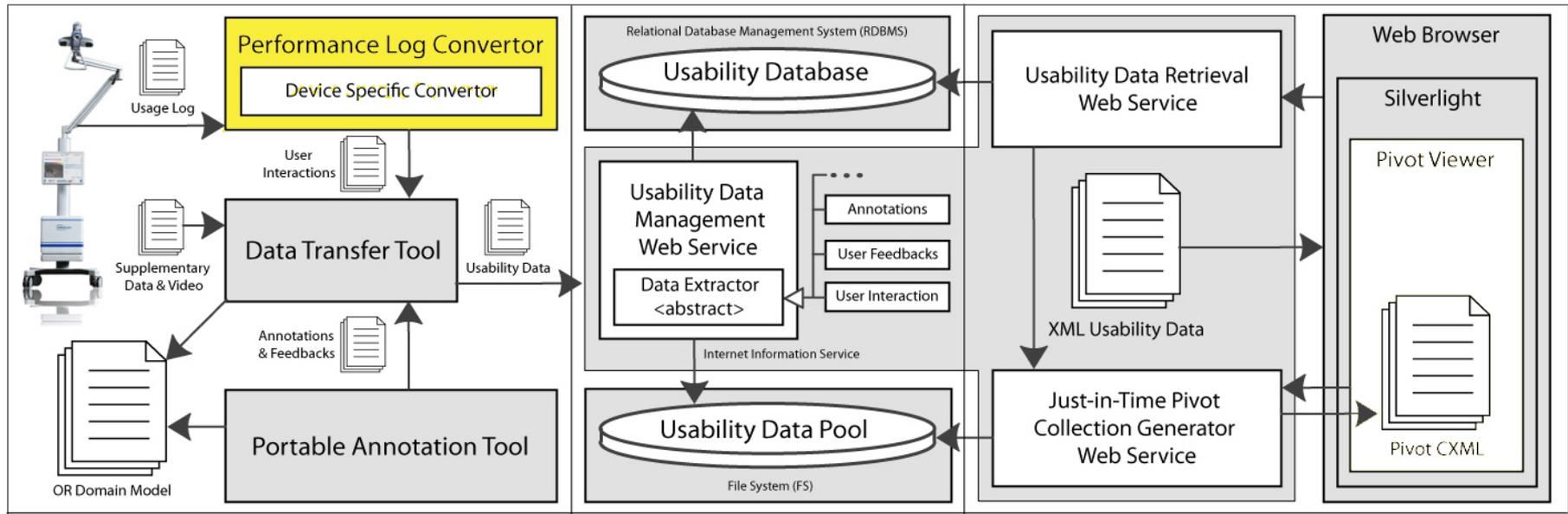
- In order to support the conduction of usability tests a specialized architecture is proposed and developed at CAMP.
- Here we briefly go through main components of the proposed framework.

Architecture - Planning



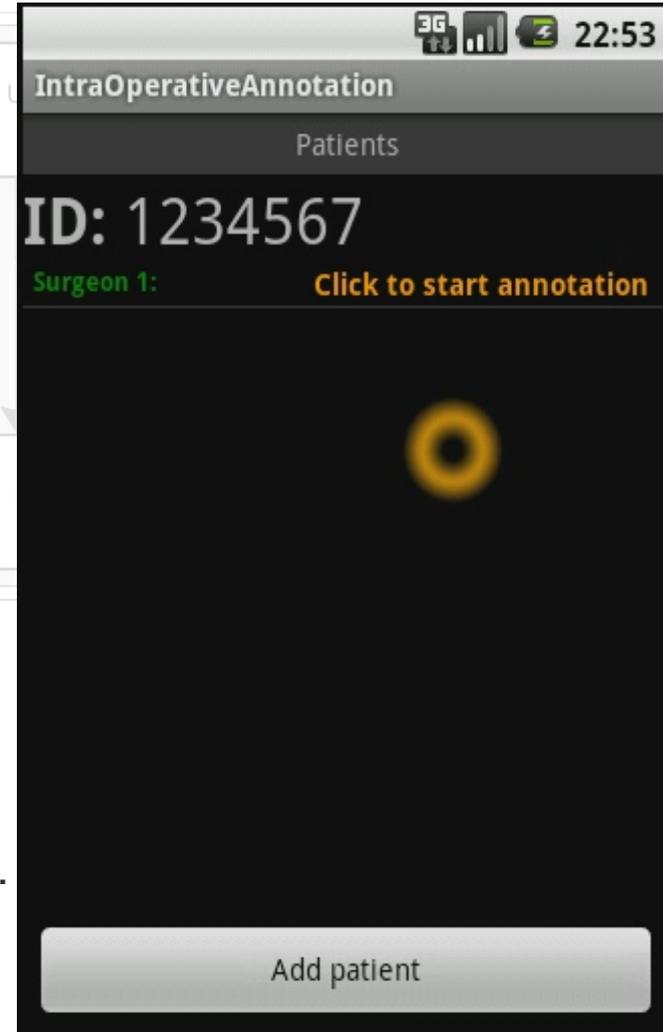
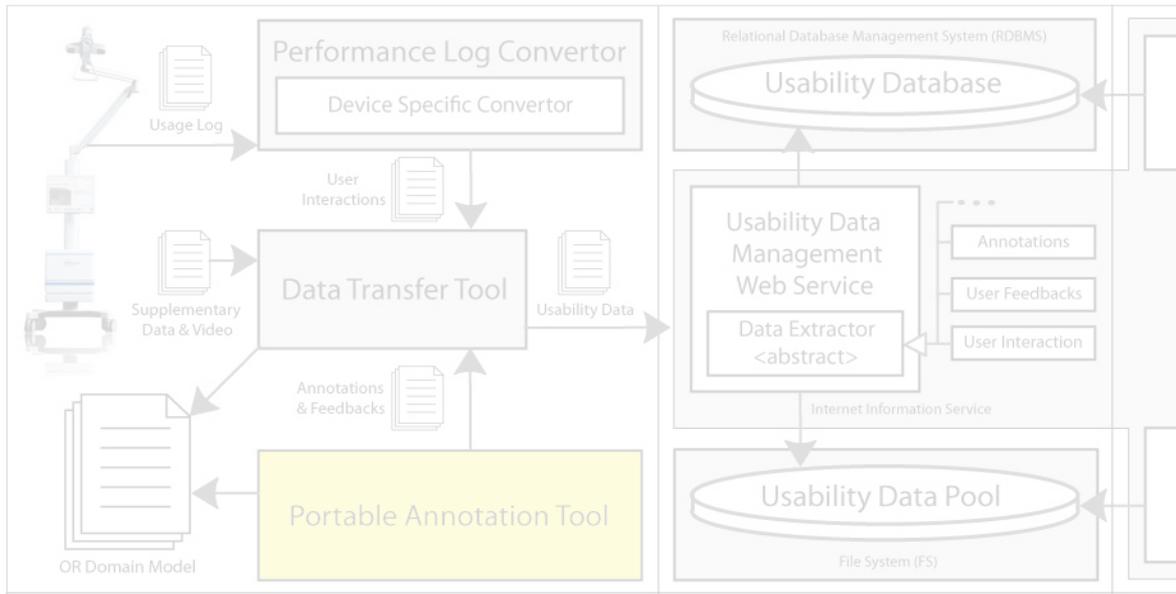
- During the planning stage a specific model of the target surgery can be defined.
- This model consists of instances of each view and their correlations stored in Mapping Tables.
- The model is stored in a XML format.
- Several part of the framework use this model to tailor their functionalities based on the target scenario.

Architecture - Conducting



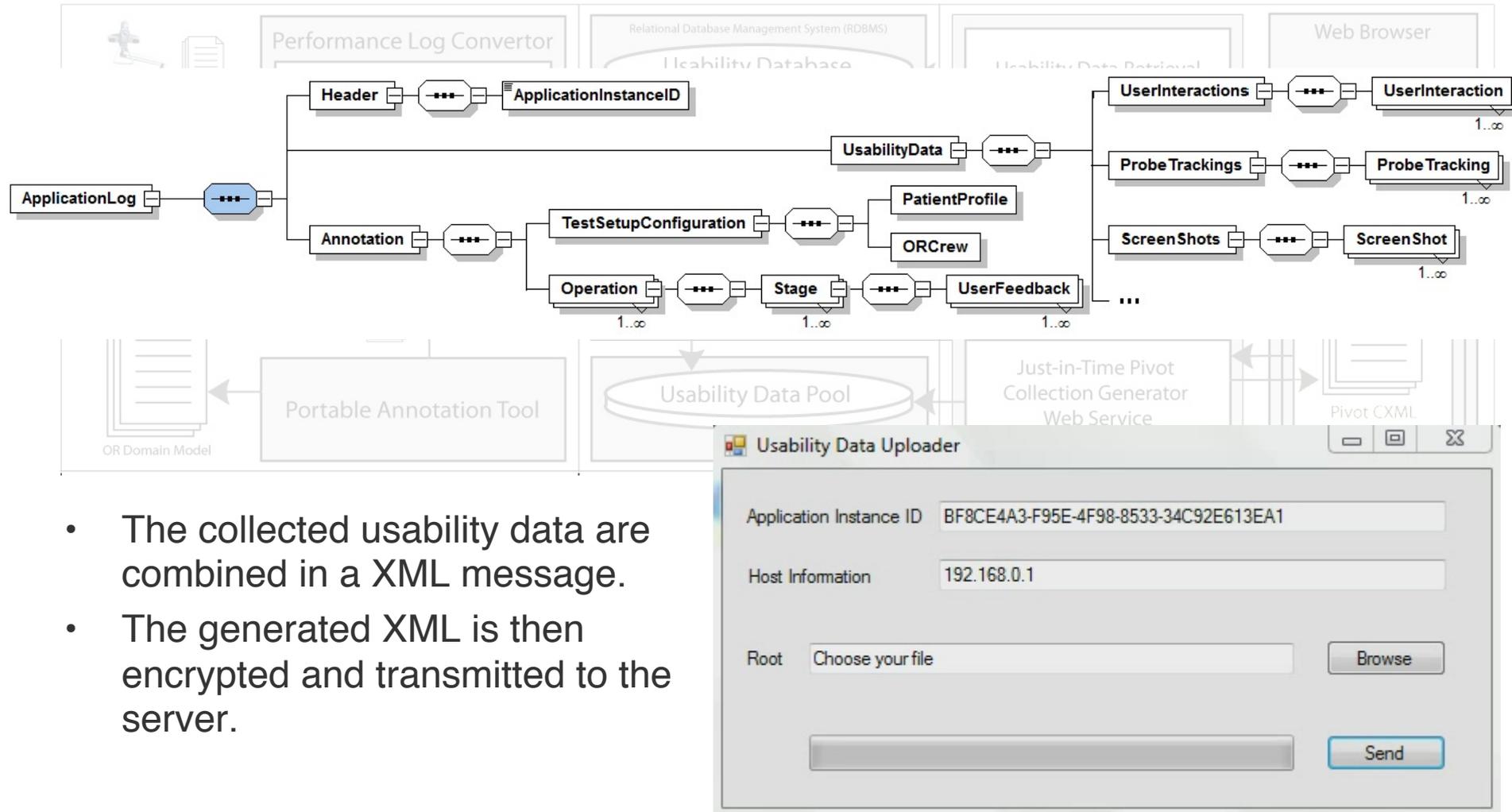
- The original performance log of the device is converted to the format known to the OR-Use framework.
- For each new device a convertor is needed for the conversion.
- This design decision makes the framework independent from particular platform that has been used for the intra-operative device.

Architecture - Conducting



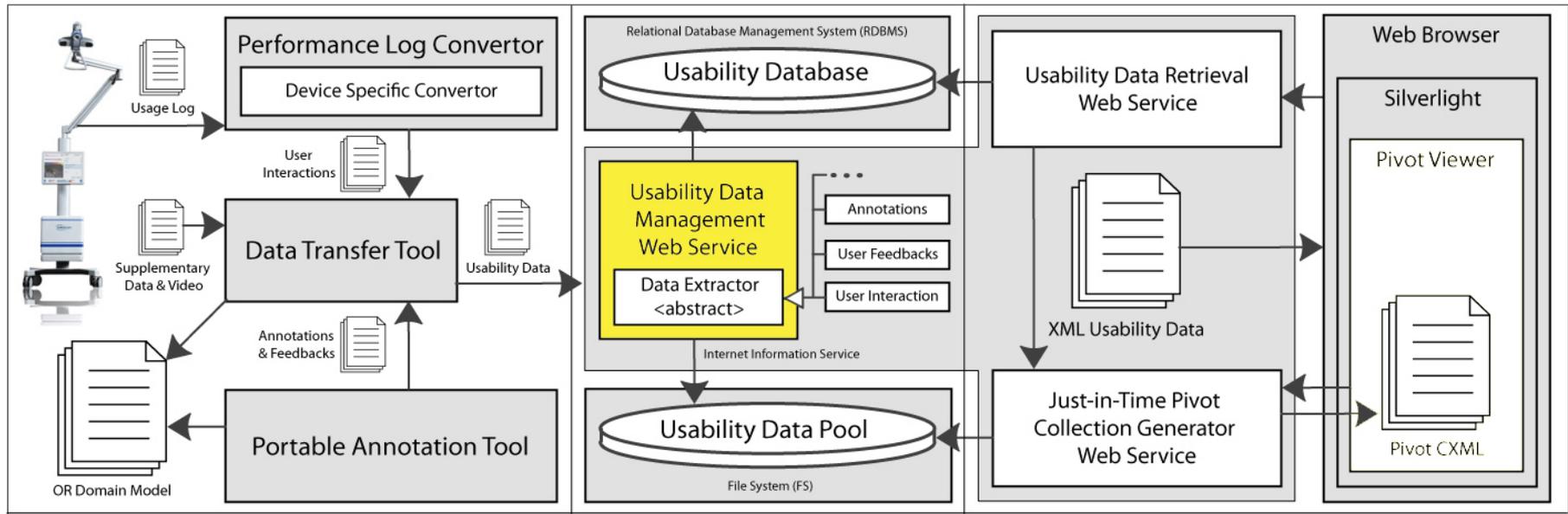
- A handheld annotation tool is designed to facilitate the annotation of usability testing phase.
- This is developed for Android smart phones.
- The domain model XML is used to populate the UI.
- The proposed GUI is designed based on tasks of the usability engineer within the test.

Architecture - Conducting



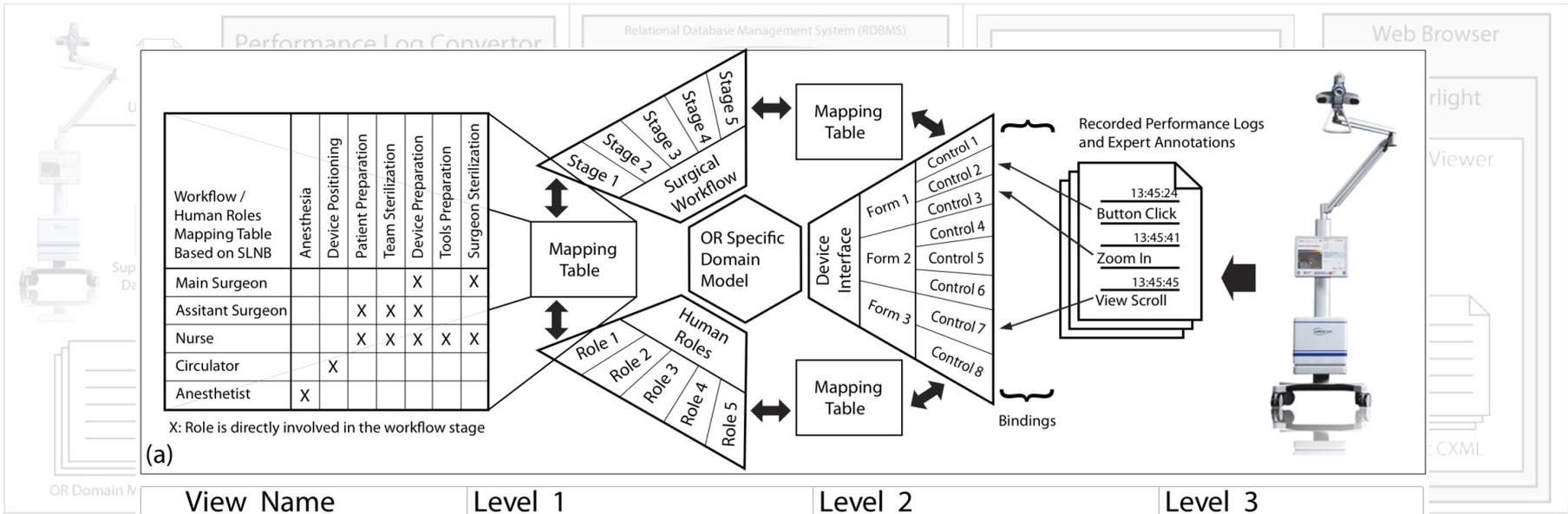
- The collected usability data are combined in a XML message.
- The generated XML is then encrypted and transmitted to the server.

Architecture - Centralized Data Management



- A dedicated web service enables the simultaneous access to the server.
- After receiving the encrypted XML message, the usability data are decrypted and extracted using a proper extractor.
- This design enables definition of new data types specific for a given device.

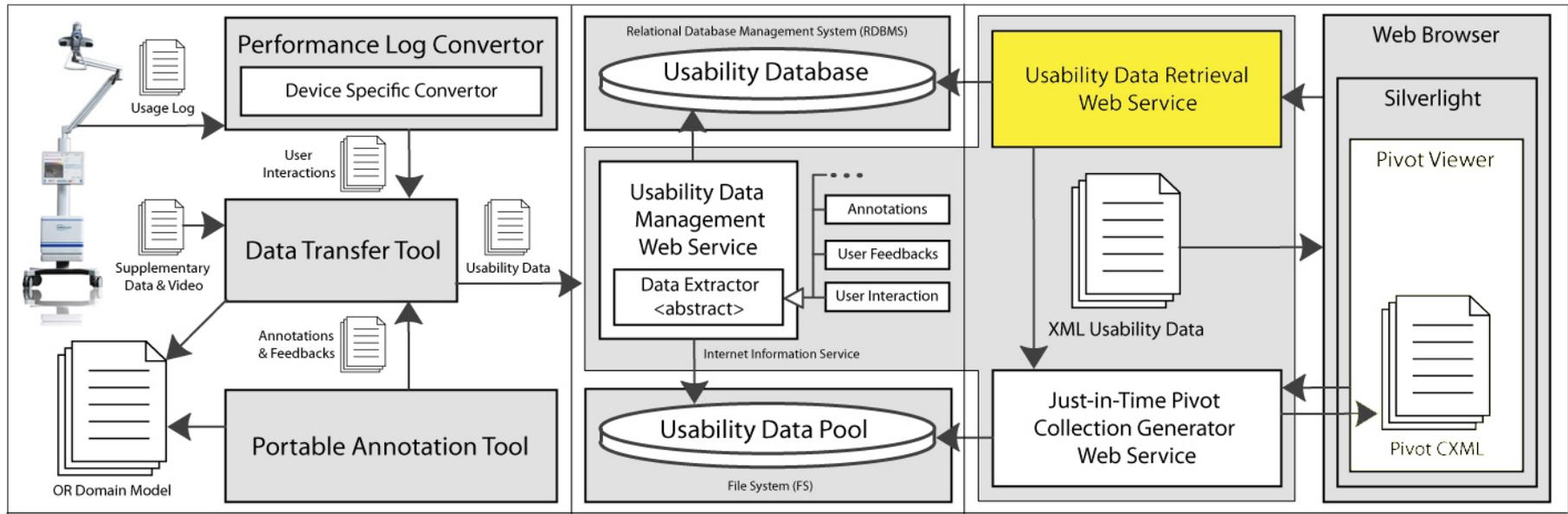
Architecture - Centralized Data Management



View Name	Level 1	Level 2	Level 3
Surgical Workflow	Surgeries	Workflow Stages	
Device Model	Device Configurations	Device States	Device Features
Human Roles	Human Roles		
(b) Configuration	Device Classes	Device Configurations	Device Instances

- The File pool.
- A relational database has been used in order to map the usability data to the OR specific domain model.

Architecture - Analysis

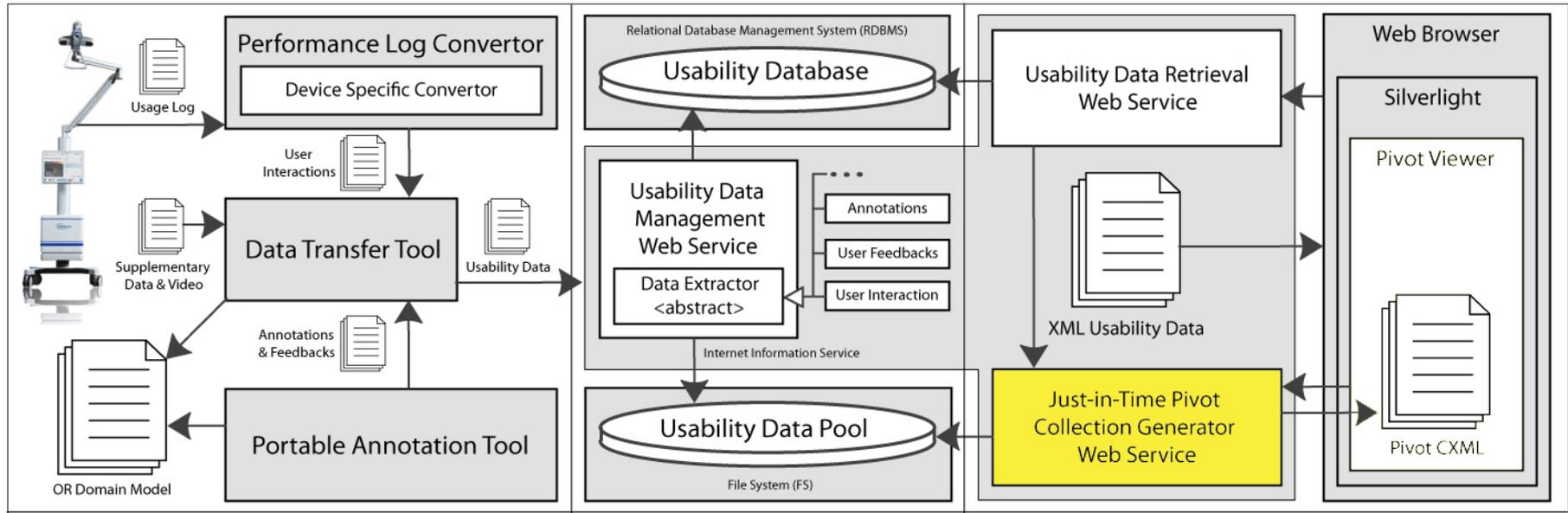


- A dedicated web service is used to retrieve the usability data, which enables multiple view of the data (as needed for cross configuration analysis).
- The data can be filtered specifying a proper query including search criteria.

HostAddress?

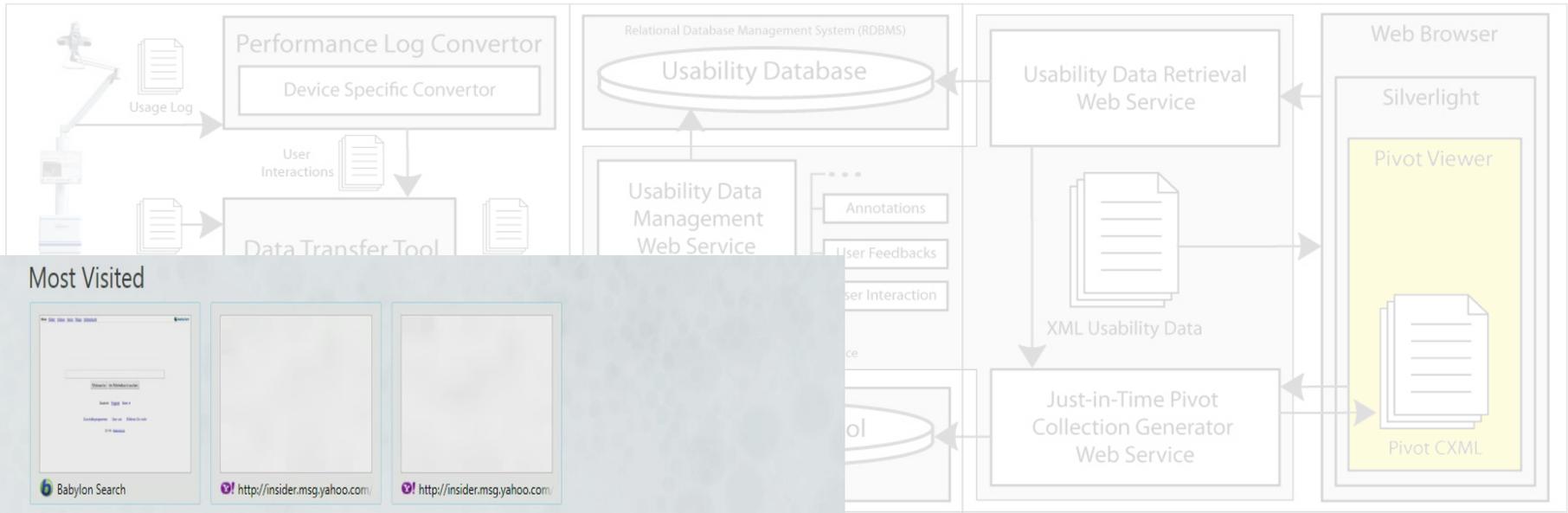
```
collection="UserInteraction"&Configuration="2.3"&WorkflowStage="Scanning"&HumanRole="Surgeon"&DeviceFeature="Brightness"
```

Architecture - Analysis



- A higher level view of data has achieved facilitating MS Pivot visualization toolkit.
- A dedicated web service generates Pivot collections (CXML files) based on the results retrieved from the data retrieval service.
- The same query format has been proposed and used for generating the results.

Architecture - Analysis



- Any web browser, equipped with Silverlight and with internet access can be used to view the Pivot visualization.

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Pivot

- Pivot Collection Gallery
- Creating Collections
- Technical Discussion

**THANK YOU FOR YOUR
ATTENTION**