



Defence Research and
Development Canada

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Situation Services Development on the Intelligence S&T Integration Platform

Architecture Report Group B

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Contractor's Document Number: JCDS-CTB-TA69-242-0429-AR
PWGSC Contract Number: W7701-5-3182, Task 69
CSA: Valérie Lavigne, Defence Scientist, 418-844-4000 x 4114

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Defence Research and Development Canada – Valcartier

Contract Report
DRDC Valcartier CR 2011-261
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Abstract

This document presents the Software Architecture Description according to the IEEE 12207. Its purpose is to define a list of requirements for an application framework that will allow re-usage of components in different applications, to define a list of requirements for the visualization services of Situational Fact Visualization and Global Position Warehouse Tracks Visualization, and to evaluate open source visualization components available on the web to fulfill the requirements.

Résumé

Le document présente la description de l'architecture logicielle, conformément à la norme IEEE 12207. Il vise à dresser la liste des exigences visant un cadre d'application permettant sa réutilisation dans diverses applications et des exigences visant les services de visualisation de faits situationnels et de pistes de l'entrepôt de données de positionnement mondial, ainsi qu'évaluer les modules de visualisation en source ouverte accessibles en ligne pouvant répondre à ces exigences.

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***Situation Services Development on the Intelligence S&T
Integration Platform***

Architecture Report

Group B Deliverable 1

JCDS-CTB-TA69-242-0429-AR

*This work was performed
Under contract to the*

**DEFENSE R&D CANADA VALCARTIER
Intelligence and Information Section**

Contract Number: W7701-5-3182, Task Authorization 69

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Version 0.3

History

| Version | Description | Author | Date |
|----------------|--------------------|---------------|---------------------|
| 0.1 | Initial Draft | Daniel Bart | February 17th, 2011 |
| 0.2 | Initial Draft | Daniel Bart | February 18th, 2011 |
| 0.3 | Review | Daniel Bart | February 22nd, 2011 |
| | Final version | | |

NOTES

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1. About this Document

This document presents the Software Architecture Description (SAD) according to the IEEE 12207.

Purpose

- To define a list of requirements for an application framework that will allow re-usage of components in different applications.
- To define a list of requirements for the visualization services of Situational Fact Visualization (SFV) and GPW Tracks Visualization (GPWTV).
- To evaluate open source visualization components available on the web to fulfill the requirements

2. Analysis of the Situational Facts Visualization Capability

2.1 Applications framework

Purpose of an application framework

By creating an application framework, we will be able to grow the offer of available widgets for the future applications as we need it. This will allow to re-use the widgets (components) and all application will benefit of maintenance done in each one.

Selection of the Google Web Toolkit (GWT)

If we adopt Google Web Toolkit (GWT) as our base framework technology, the technological constraint won't be a factor as it could be if we were choosing a Flash/Flex technology or Java webapps. Open source usage will also allow to quickly develop a good shell for future application. But, the disadvantage of open source could be the lack of support and/or missing of evolution. GWT, with its great community of developers, its features that are still evolving, and the fact that it's not limited to one technology, seems to be the best solution for our framework technology.

Overview

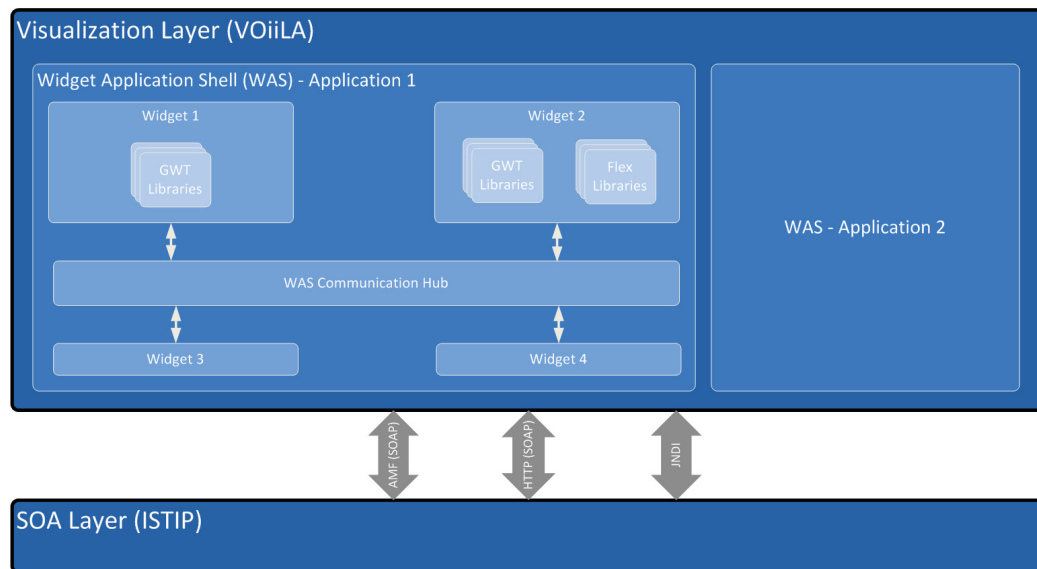


Figure 1 : Architecture of the Visualization Capability

The main objective of this application framework is to provide:

- Ability to create new web applications easily.
- Re-usage of existing components (or widgets) and services.
- Basic set of UI components.
- Widgets re-usable in web pages
- Interoperability between the Visualization layer and the SOA layer.

As shown in the figure 1 above, the VOiLA infrastructure allows creation of multiple applications from a base application shell called Widget Application Shell (WAS).

Widget Application Shell (WAS)

WAS is an extended GWT Application that has features (i.e.: input controls, window management, communication hub) added to quickly create new widget-oriented applications.

Widgets

Widgets are UI components that can be re-used in different web applications. Some widget content could be developed with libraries unknown by the application shell but it should respond to a basic API to ensure communication and synchronization within the application and the other widgets. Each widget is responsible to communicate with SOA Layer (ISTIP), using its own technology. In figure 1, Widget 1 is entirely developed with GWT but it is also possible to wrap another UI technology in a GWT Widget such as Flex (as shown in Figure 1 for Widget 2) or Silverlight.

Communication Hub

The Communication Hub is basically an event controller that simplifies communication between widgets. By subscribing to a specific kind of event (or channel), a widget is notified for any activity on this channel. Thus, it will be able to react to context changes done by another widget via the same channel of the hub. For instance, a map that shows the situational fact selected in another widget. GWT has already an event handling architecture (see <http://code.google.com/webtoolkit/doc/latest/DevGuideUiHandlers.html>). Our Communication Hub will define custom GWT events needed for the basic widgets communication, such as object selection. It will also define an event dispatcher, which will notify any widget previously register to a specific event (or channel).

Requirements list

- Basic components
 - Input controls (Buttons, links, radio buttons, checkboxes, drop down lists, lists)
 - Layout controls (panels, tabs)
- Data visualization components
 - Tree view
 - Grid / lists
 - List sorting
 - List Filtering
 - List data paging
- Advanced layout components
 - Floating panel (window) , widget containers
 - Charts components
 - Time line
 - Area chart
 - Bar chart

- Column chart
- Line chart
- Pie chart
- Scatter chart
- Map component
 - GPW Tracks Visualization (GPWTV)
- Managers / Utilities
 - Notification manager (broadcast/events) to allow synchronization of widgets.
 - Error manager (manage errors generated by application)

2.2 Situational Facts visualization (SFV)

Overview

The SFV service should offer the use of an ensemble of display types and enable interactions in multiple coordinated views. The display components must be easy to integrate in future web applications, based on the new application framework.

Requirements list

- Network graph information visualization
- Information overlays on geographic map display
- Data charts, plots, parallel coordinates view, treemaps
- Use of blobs, heatmaps, flowmaps
- Ability to create geometric shapes on map
- Interaction with information elements, selection and filtering
- Data exploration, focus+context view, pan+zoom interactions
- Mechanism to coordinate multiple views
- Use of data lenses
- Use of a lasso selection tool

Analysis results

Many open source libraries offered on the market will help us achieve the needed features. Many of these already have a wrapper to use it in GWT which will make the implementation easier.

3. Evaluation of Open Source solutions

3.1 Google Web Toolkit (GWT)

Description

Google Web Toolkit (GWT) is a development toolkit for building and optimizing complex browser-based applications. GWT is used in many Google products, including Google AdWords and Orkut. It's open source, completely free, and used by thousands of developers around the world.

Other information

Version: 2.1

References: <http://code.google.com/webtoolkit/>

3.1.1 Evaluation

| | |
|-------------------------------|--|
| Supported Technologies | Development in Java. It generates AJAX applications. |
| Features | <ul style="list-style-type: none"> • All basic input components (Checkbox, Text input, etc.) • List, Tree view • Menu bar • Many layout panels to define complex layout • Table, Cell list, Cell Table, Cell tree • Internationalization (I18N) features • Event handling architecture (for notification between widgets) <p>See http://gwt.google.com/samples/Showcase/ for complete list of features.</p> |
| Pros | <ul style="list-style-type: none"> • Developer community is growing up and framework is still evolving. • Open source libraries available to enhance features list • Java-based development. • Allows embedding any technologies that could run in a web browser. Important if we want to use an open source visualization component developed in other technology such as Flash or AJAX. • Easier communication with back-end. |
| Cons | <ul style="list-style-type: none"> • Embedding other technology may be more complex for coordination between widgets. |
| Overall score | 4 out of 5 |

3.1.2 Recommendations

According to the needs described in the ramp-up meeting with the SA, GWT is a very good option to develop the application framework. Unlike Flex, GWT will allow embedding other technology such as Flash/Flex. It also covers good parts of our needs for the framework.

3.2 Smart GWT

Description

Smart GWT is a GWT-based framework that allows you to not only utilize its comprehensive widget library for your application UI, but also tie these widgets in with your server-side for data management.

Other information

Version: 2.4

License: GNU LPGL (<http://www.gnu.org/licenses/lgpl.html>)

References: <http://code.google.com/p/smartgwt/>

3.2.1 Evaluation table

| | |
|-------------------------------|---|
| Supported Technologies | GWT 1.5.3, GWT 1.6.4, GWT 1.7.x and GWT 2.x |
| Features | <ul style="list-style-type: none"> • Grids, Trees, Tiles • Layouts, Windows, Sections, Tabs • Forms, Form controls • Buttons, Menus & Dialogs • Calendar • Filtering & sorting of datasets • Drag and Drop • DataSources & Data binding • Client-side validation • REST / WSDL support • Skinning / Branding • Printing support |
| Pros | <ul style="list-style-type: none"> • Huge amount of features • GWT compatible |
| Cons | <ul style="list-style-type: none"> • Performance unknown |
| Overall score | 4.5 out of 5 |

3.2.2 Recommendations

The smart GWT framework offers a large library of components and it could be a nice add-on to GWT. Some features would allow creating applications quickly and using widgets such as lists, trees, etc.

3.3 GWT-OpenLayers

Description

GWT-OpenLayers is a Java wrapper for the OpenLayers JavaScript API. It allows GWT projects to use the OpenLayers JavaScript API. OpenLayers makes it easy to put a dynamic map in any web page. It can display map tiles and markers loaded from any source. OpenLayers has been developed to further the use of geographic information of all kinds. OpenLayers is completely free.

Other information

Version: 0.5

License: [modified BSD license](#)

References: <http://gwt-openlayers.sourceforge.net> , <http://openlayers.org>

3.3.1 Evaluation table

| | |
|-------------------------------|---|
| Supported Technologies | GWT, Java, Javascript, AJAX |
| Features | <ul style="list-style-type: none"> • WMS Layers • Navigation • Icons • Markers • Layer Selection |
| Pros | <ul style="list-style-type: none"> • GWT integrated • Many examples available (http://openlayers.org/dev/examples/) |
| Cons | <ul style="list-style-type: none"> • Mouse capture may be a little more complex to manage than a Flex/Flash version. • 2D only |
| Overall score | 3.5 out of 5 |

3.3.2 Recommendations

Even if 3D is not available, OpenLayers seems to be the most advanced map control on the open source market at this time. Its integration to GWT will make it easier to use in our framework and applications. An interesting test case for the GWT-OpenLayers would be to use and test this technology to visualize a selected and modeled subset of tracks extracted from the GPWTracks database available from the ISTIP.

3.4 GWT Mosaic

Description

GWT Mosaic is a feature rich toolkit for creating graphical Rich Internet Applications. Offering a complete set of widgets, GWT Mosaic is suitable for projects ranging from small one-off projects to complete application suites.

The goal is to provide a complete widget set by keeping the API as close as possible to the GWT's standard widgets API.

Other information

Version: 0.4.0

License: Apache License 2.0

References: <http://code.google.com/p/gwt-mosaic/>

3.4.1 Evaluation table

| | |
|-------------------------------|---|
| Supported Technologies | GWT 2.0.1, Java, Javascript, AJAX |
| Features | <ul style="list-style-type: none"> • Basic form controls (button, inputs, etc.) • Popups • Windows • Layouts • Tree, List • Drag & Drop • Beans Binding <p>See a showcase at http://mosaic.analytical-labs.com</p> |
| Pros | <ul style="list-style-type: none"> • Good set of features |
| Cons | <ul style="list-style-type: none"> • Decreasing development activity • GWT 2.0 (not 2.1) |
| Overall score | 3 out of 5 |

3.4.2 Recommendations

Having analyzed Smart GWT before, I don't think GWT-Mosaic has any features that Smart GWT doesn't offer. The decreasing activity in development let me think that future versions of GWT could be hard to maintain within GWT-Mosaic. I clearly prefer Smart GWT.

3.5 Client-side GChart

Description

Client-side GChart is a GWT chart library that supports line, pie, bar, area, combination charts, popups, mouse events, and more.

Other information

Version: 2.7

License: Apache License 2.0

References: <http://code.google.com/p/clientsidegchart/>

3.5.1 Evaluation table

| | |
|-------------------------------|--|
| Supported Technologies | GWT (seems to work with 2.1) |
| Features | <ul style="list-style-type: none"> • Line, Pie, Bar, Area Charts. • pan and zoom • Mouse events, allowing some interactivity <p>See live demo</p> |

| | |
|----------------------|--|
| Pros | <ul style="list-style-type: none"> • Interactive charts • complete JavaDoc |
| Cons | <ul style="list-style-type: none"> • GWT version supported is not clearly identified but it seems to work with 2.1. • Only |
| Overall score | 3.5 out of 5 |

3.5.2 Recommendations

This library could be nice to display charts and have minimum of interactivity. Selection in charts may need more development.

3.6 OFCGWT (Open Flash Chart for GWT)

Description

The OFCGWT project provides a simple to use chart widget for GWT based on Open Flash Chart 2. The library includes the needed flash insertion, update and manipulation methods for the chart widget. It also includes a POJO model for the chart elements and components that assist in the generation of the JSON to provide the correct chart data for OFC 2.x API.

The project has released a beta of version 2.x and a stable 1.3.x release - with over 12,000+ downloads

Other information

Version: 2.0.1 (beta)

License: GNU LGPL

References: <http://code.google.com/p/ofcgwt/>

3.6.1 Evaluation table

| | |
|-------------------------------|--|
| Supported Technologies | GWT 2.X, Java, Javascript, AJAX, OpenFlash |
| Features | <ul style="list-style-type: none"> • Pie, Bar, Cylinder, Line Charts • Scatter chart • Radar Chart • Area chart • Sketch chart • Stack chart |
| Pros | <ul style="list-style-type: none"> • Many charts types • Animation, great looking |
| Cons | <ul style="list-style-type: none"> • Limited interaction • Flash-based |
| Overall score | 3.0 out of 5 |

3.6.2 Recommendations

This library generates great looking charts but they are in flash. It's very limited in interactivity. It might be interesting to use for charts display only.

3.7 GWT2SWF: Flash/Flex Widget for GWT

Description

GWT2SWF intend to provide a software bridge between GWT and Flash/Flex. It means that using GWT2SWF you will be able to communicate between GWT and Flash/Flex. GWT2SWF provides SWFWidget and FlashPlayer version detection.

Other information

Version: 0.6.0 (beta)

License: Apache License 2.0

References: <http://code.google.com/p/gwt2swf/>

3.7.1 Evaluation table

| | |
|-------------------------------|---|
| Supported Technologies | GWT 2.X, Java, Javascript, AJAX, Flash |
| Features | <ul style="list-style-type: none"> • Bridge between Flash and GWT. |
| Pros | <ul style="list-style-type: none"> • Easy way to communicate with Flash/Flex Widget |
| Cons | <ul style="list-style-type: none"> • Still in beta since 2009 • Minimal documentation |
| Overall score | 2.5 out of 5 |

3.7.2 Recommendations

If we have to include Flash/Flex widgets in the framework, GWT2SWF might be the quickest way to add bridge to communicate between GWT and SWF. Because of its lack of documentation and its beta status, that library is more risky to integrate. Use it only if you really needed to add a communication bridge.

3.8 Protovis

Description

Protovis composes custom views of data with simple marks such as bars and dots. Unlike low-level graphics libraries that quickly become tedious for visualization, Protovis defines marks through dynamic properties that encode data, allowing inheritance, scales and layouts to simplify construction. It uses JavaScript and SVG for web-native visualizations; no plug-in required.

Other information

Version: 3.2

License: [BSD License](#)

References: <http://vis.stanford.edu/protovis/>

3.8.1 Evaluation table

| | |
|-------------------------------|--|
| Supported Technologies | Javascript |
| Features | <ul style="list-style-type: none"> • Area charts • Bar & Column Charts • Scatter plots • Pie and Donut Charts • Line & Step Charts • Stacked Charts • Grouped Charts • And more... <p>See complete list at http://vis.stanford.edu/protovis/ex/</p> |
| Pros | <ul style="list-style-type: none"> • Huge amount of chart types • Customizable • SVG does better graphic quality |
| Cons | <ul style="list-style-type: none"> • No built-in interactivity • No GWT wrapper |
| Overall score | 3.5 out of 5 |

3.8.2 Recommendations

Its huge amount of chart types makes Protovis a great charting library. The examples shown at <http://vis.stanford.edu/protovis/ex/> seem to answer many of our needs for display. Choosing Protovis will add the need to develop our own GWT wrapper. There's also no built-in interactivity with the charts, further investigation and test could tell if there's a way to add some interactivity in the future.

3.9 Synapse Application Framework

Description

Synapse is a thin client application SDK based on the Ozone Widget Framework (OWF), a framework for hosting widgets (lightweight software components) in Web browsers.

Other information

Version: 2.1.4

License: GNU GPL

References: <http://www.potomacfusion.com/capabilities/synapse/>

3.9.1 Evaluation table

| | |
|-------------------------------|---|
| Supported Technologies | Apache Shindig |
| Features | <ul style="list-style-type: none"> • publish/subscribe messaging system • Based on Ozone Widget Framework |
| Pros | <ul style="list-style-type: none"> • Built-in messaging system |
| Cons | <ul style="list-style-type: none"> • Base on Apache Shindig • Real lack of documentation and information |

| | |
|----------------------|---|
| Overall score | <ul style="list-style-type: none"> Community of developers |
| | 2 out of 5 |

3.9.2 Recommendations

Due to the lack of information on the product, and to the fact that it is running on Apache Shinding, I do not recommend the use this framework.

3.10 Prefuse Visualization Toolkit

Description

Prefuse is a set of software tools for creating rich interactive data visualizations. It provides a visualization framework for the Java programming language. Prefuse is written in Java, using the Java 2D graphics library, and is easily integrated into Java Swing applications or web applets.

Other information

Version: beta 2007.10.21

License: BSD License

References: <http://prefuse.org/>

3.10.1 Evaluation table

| | |
|-------------------------------|---|
| Supported Technologies | Java Swing |
| Features | <ul style="list-style-type: none"> Flow Map Stack chart Radial graph view Tree map Graph view Tree view |
| Pros | <ul style="list-style-type: none"> Many types of charts and graphs. Good looking |
| Cons | <ul style="list-style-type: none"> for Java Swing applications or web applets No recent activity, and still in beta version. |
| Overall score | 2.5 out of 5 |

3.10.2 Recommendations

Even if that library has some cool charts and graphs, I don't recommend integrating it in the framework base. It could be used by applications only if needed in a specific context. The lack of recent activity let think that it will not evolve in the future.

3.11 Flare

Description

Flare is an ActionScript library for creating visualizations that run in the Adobe Flash Player. From basic charts and graphs to complex interactive graphics, the toolkit supports data management, visual encoding, animation, and interaction techniques. Even better, flare features a modular design that lets developers create customized visualization techniques without having to reinvent the wheel.

Other information

Version: Alpha 2009.01.24

License: BSD license

References: <http://flare.prefuse.org/>

3.11.1 Evaluation table

| | |
|-------------------------------|---|
| Supported Technologies | Flash / Flex, ActionScript 3.0 |
| Features | <ul style="list-style-type: none"> • Tree map • Stack chart • Timeline • Scatter • Bars & Pie chart • Interactive graphics • Data Management • Animations |
| Pros | <ul style="list-style-type: none"> • Great graphs and charts • Interactivity and animation • Complex graphs • Good documentation (ASDoc) |
| Cons | <ul style="list-style-type: none"> • Flash/Flex based • No recent activity and still in Alpha version |
| Overall score | 3.5 out of 5 |

3.11.2 Recommendations

Flare offers good complex graphs with some interaction but it's based on Flex framework which is running under a Flash Player. The Flare library could be a good option for specific needs in applications if we don't find an equivalent in Javascript (or GWT).

4. Evaluation of Implementation efforts

The table below shows estimated efforts (in days) that could be needed to demonstrate the functionality / feature in a demo application. Note that some of the features need more time due to unavailability of open source currently. These efforts are estimate and there are risks of incompatibility when we use many libraries together. Priority column shows a priority based on a range of 1 to 5.

| Features | Effort | Priority |
|--|--------|----------|
| Basic Components | | |
| Input controls | 2 | 1 |
| Layout controls | 2 | 1 |
| Data Visualization | | |
| Tree view | 3 | 2 |
| Lists | 2 | 2 |
| List sorting | 1.5 | 3 |
| List Filtering | 1.5 | 3 |
| List data paging | 2 | 3 |
| Advanced layout components | | |
| Floating panel (window) | 2 | 1 |
| Charts components | | |
| Time line | 1.5 | 2 |
| Area chart | 1.5 | 3 |
| Bar chart | 1.5 | 3 |
| Column chart | 1.5 | 3 |
| Line chart | 1.5 | 3 |
| Pie chart | 1.5 | 3 |
| Scatter chart (plots) | 2 | 3 |
| Parallel coordinates view | 2 | 4 |
| Tree maps | 2 | 4 |
| Blobs | 10 | 3 |
| Heat maps | 5 | 4 |
| Flow maps | 5 | 4 |
| Managers / Utilities | | |
| Notification manager (widget synchronization) | 2.5 | 1 |
| Error Manager | 2 | 4 |
| Map component | | |

| | | |
|--|----|---|
| GPW Tracks Visualization (GPWTV) | 7 | 2 |
| Use of a lasso selection tool | 1 | 3 |
| Use of data lenses | 10 | 5 |
| Pan & Zoom | 1 | 2 |
| Ability to create geometric shapes on map | 5 | 2 |
| Information overlay on geographic map | 2 | 2 |

5. Summary

As the previous sections demonstrate, GWT is a very good solution as base for our Widget Application Shell (WAS). Many libraries are available with a GWT wrapper. This will accelerate the development process by concentrating our efforts on specific feature instead of developing the basis. Some other libraries, such as Protovis which is a very nice chart library, are only in Javascript. That means we will need to develop our own wrapper to use it within our applications and/or widgets. According to searches and analysis, I retained 4 majors libraries that I recommend to integrate in WAS: GWT, Smart GWT, GWT Open Layers and Protovis. With these, we should cover most of the desired capabilities. Refer to the table below for features supported by each library. Estimates in this document do not include the kind of risks that could force us to abandon a library.

| | GWT | Smart GWT | GWT-OpenLayers | GWT Mosaic | clientsidegchart | OFCGWT | Protovis | Prefuse | Flare |
|-------------------------------|-----|-----------|----------------|------------|------------------|--------|----------|---------|-------|
| Input controls | x | x | | x | | | | | |
| Layout controls | x | x | | x | | | | | |
| Tree view | x | x | | x | | | | | |
| Lists | x | x | | x | | | | | |
| List sorting | | x | | | | | | | |
| List filtering | | x | | x | | | | | |
| Data paging | | | | x | | | | | |
| Windows | | x | | x | | | | | |
| Drag n' Drop | | x | | x | | | | | |
| Time line | | | | | | | x | | x |
| Area chart | | | | | x | x | x | | |
| Bar Chart | | | | | x | x | x | | x |
| Column Chart | | | | | x | x | x | | |
| Line chart | | | | | x | x | x | | |
| Pie Chart | | | | | x | x | x | | x |
| Scatter chart | | | | | | x | x | | x |
| Parallel coordinates view | | | | | | x | x | | |
| Tree maps | | | | | | | x | x | x |
| Blobs | | | | | | | | | |
| Heat maps | | | | | | | x | | |
| Flow maps | | | | | | | | x | |
| Widget communication (events) | x | | | | | | | | |
| Error Manager | | | | | | | | | |
| Lasso selection | | | | | | | | | |
| Data lenses | | | | | | | | | |
| Pan & Zoom | | | x | | | | | | |
| Geometric shapes on map | | | x | | | | | | |
| Map overlays | | | x | | | | | | |

This table compares the different open source libraries with regards to the features to implement. Note that for some features (in red), no open source library was found at this time to support them. Columns in green are the libraries that I recommend to use.

6. Glossary of Acronyms

AJAX - Asynchronous JavaScript and XML

API - Application programming interface

GPW - Global Positioning Warehouse

GPWTV - GPW Tracks Visualization

GWT - Google Web Toolkit

I18N - Internationalization

ISTIP - Intelligence Science & Technology Integration Platform

SA - Scientific Authority

SDK - Software development kit

SFV - Situational Facts visualization

SOA - Service-Oriented Architecture

SVG - Scalable Vector Graphics

UI - User Interface

VOiLA - Visionary Overarching Interaction Interface Layer for the Analyst

WAS - Widget Application Shell

WMS - Web Map Service

| DOCUMENT CONTROL DATA | | |
|---|--|---|
| (Security markings for the title, abstract and indexing annotation must be entered when the document is Classified or Designated) | | |
| 1. ORIGINATOR (The name and address of the organization preparing the document. Organizations for whom the document was prepared, e.g. Centre sponsoring a contractor's report, or tasking agency, are entered in section 8.) DMR Conseil 2000 Boulevard Lebourgneuf, Bureau 300, Quebec (Québec) G2K 0B8 | 2a. SECURITY MARKING (Overall security marking of the document including special supplemental markings if applicable.) UNCLASSIFIED | |
| | 2b. CONTROLLED GOODS (NON-CONTROLLED GOODS) DMC A REVIEW: GCEC APRIL 2011 | |
| 3. TITLE (The complete document title as indicated on the title page. Its classification should be indicated by the appropriate abbreviation (S, C or U) in parentheses after the title.) Situation Services Development on the Intelligence S&T Integration Platform : Architecture Report Group B | | |
| 4. AUTHORS (last name, followed by initials – ranks, titles, etc. not to be used) Bart, D. | | |
| 5. DATE OF PUBLICATION (Month and year of publication of document.) February 2011 | 6a. NO. OF PAGES (Total containing information, including Annexes, Appendices, etc.) 30 | 6b. NO. OF REFS (Total cited in document.) 0 |
| 7. DESCRIPTIVE NOTES (The category of the document, e.g. technical report, technical note or memorandum. If appropriate, enter the type of report, e.g. interim, progress, summary, annual or final. Give the inclusive dates when a specific reporting period is covered.) Contract Report | | |
| 8. SPONSORING ACTIVITY (The name of the department project office or laboratory sponsoring the research and development – include address.) Defence Research and Development Canada – Valcartier 2459 Pie-XI Blvd North Quebec (Quebec) G3J 1X5 Canada | | |
| 9a. PROJECT OR GRANT NO. (If appropriate, the applicable research and development project or grant number under which the document was written. Please specify whether project or grant.) JCDS | 9b. CONTRACT NO. (If appropriate, the applicable number under which the document was written.) W7701-5-3182, task 69 | |
| 10a. ORIGINATOR'S DOCUMENT NUMBER (The official document number by which the document is identified by the originating activity. This number must be unique to this document.) JCDS-CTB-TA69-242-0429-AR | 10b. OTHER DOCUMENT NO(s). (Any other numbers which may be assigned this document either by the originator or by the sponsor.) DRDC Valcartier CR 2011-261 | |
| 11. DOCUMENT AVAILABILITY (Any limitations on further dissemination of the document, other than those imposed by security classification.) Unlimited | | |
| 12. DOCUMENT ANNOUNCEMENT (Any limitation to the bibliographic announcement of this document. This will normally correspond to the Document Availability (11). However, where further distribution (beyond the audience specified in (11) is possible, a wider announcement audience may be selected.) Unlimited | | |

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This document presents the Software Architecture Description according to the IEEE 12207. Its purpose is to define a list of requirements for an application framework that will allow re-usage of components in different applications, to define a list of requirements for the visualization services of Situational Fact Visualization and Global Position Warehouse Tracks Visualization, and to evaluate open source visualization components available on the web to fulfill the requirements.

Le document présente la description de l'architecture logicielle, conformément à la norme IEEE 12207. Il vise à dresser la liste des exigences visant un cadre d'application permettant sa réutilisation dans diverses applications et des exigences visant les services de visualisation de faits situationnels et de pistes de l'entrepôt de données de positionnement mondial, ainsi qu'évaluer les modules de visualisation en source ouverte accessibles en ligne pouvant répondre à ces exigences.

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software architecture description; visualization; situational facts

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