OSSIM WHITEPAPER

Mark Lucas
Principal Scientist
RadiantBlue Technologies Inc.
mlucas@radiantblue.com
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Overview

OSSIM is an open source software project that provides advanced remote sensing and geospatial technologies. The project is hosted at www.ossim.org and is one of the founding projects of the Open Source Geospatial Foundation www.osgeo.org . The software distribution contains several software libraries as well as a number of tools, applications, and services that are based on the underlying libraries. OSSIM is used by a wide range of commercial companies, government projects, scientists, and satellite ground stations. The project is open sourced under the LGPL license encouraging widespread adoption and use. Commercial and government support for the technology is available through RadiantBlue Technologies and various consultants.

> OSSIM is a contrived acronym - Open Source Software Image Map, pronounced 'awesome'. The project was named by our first government customer - a member of the US intelligence community.

The open source software approach provides the technology and solutions to evolve independent of any organization, project, customer, or individual developer. The best solutions tend to win out over time, all users of the software baseline benefit from improvements, contributions, and funded development. Professional services, documentation, maintenance and support are still required for critical implementations. A growing number of companies provide service and support to open technologies as their business model.

Current implementations that use OSSIM include batch processing systems, automated archives and processing centers, advanced geospatial decision support systems, analyst and production tools, and highly collaborative 3D geospatial visualization environments. It is used in a number of intelligence operations with classified data, production of aerial and satellite data, geospatial web services, and as embedded functionality in commercial, government, and academic solutions.

OSSIM uses NIMA certified projection and datum transformations from the GEOTRANs source code. It successfully passed through the NIMA CELTIC Pathfinder evaluation in 2003. In 2002 NRO AS&T performed a classified assessment and validation of classified sensor models in the OSSIM baseline.

Design Criteria

The designers and architects of the OSSIM software baseline have established an overall strategy and criteria in the implementation of the distribution. Key criteria are:

- Three dimensional accuracy and preservation of information
- High performance processing at the core
- Platform independent, GUI agnostic approach
- Native file access to geospatial formats
- Parameter based image processing chains
- Avoid limitations on the number and size of files
- Build in parallel processing capabilities
- Support for rigorous sensor models
- Support for Residual Polynomial Coefficients (RPCs)
- Functionality embedded in layered libraries - used in applications
- Plugin architecture to support add ons and segregated functionality
- Orthoprojection, precision terrain correction, conversion between projections and datums, and resampling handled automatically
- Take advantage in the latest Graphics Processing Unit (GPU) capabilities

Three dimensional accuracy and preservation of information

The OSSIM core is implemented in C++ using double precision mathematics in the image processing chains. Geodetic accuracy is obtained with photogrammetric approaches using geoids and local elevation surfaces. Ray tracing approaches are used for image to ground and ground to image calculations.

High performance processing at the core

Image chain processing with double precision accuracy generates a large computational load on the system given the amount of data being processed through the system. Parallel processing has been implemented in the core library with the MPI (Message Passing Interface) libraries. This type of processing scales well on multiple processors and clusters.

Platform independent, GUI agnostic approach

The project maintains a platform independent approach with standardized development tools, libraries, and layered functionality. Any Graphics User Interface (GUI) can then be applied for specific solutions. Supported GUI implementations in the distribution are currently focused on Trolltech QT and Java implementations as these interfaces work consistently across multiple platforms. OSSIM currently can be built under various versions of unix, Windows, and MacOSX.

Native file access to geospatial formats

A wide range of geospatial raster and vector formats are supported by the system. These include GeoTiff (including BigTiff), raster, NITF, DTED, SRTM, CADRG. The distribution includes OSGeo's Geospatial Data Abstraction Library (GDAL) which includes a wide range of geospatial formats for both read and write access. Overviews or pyramid layers can be automatically created if they do not exist for high speed roaming, zooming, and resampling. Classified formats including NITF and TFRD are available in a classified plugin.

Parameter based image processing chains

Non destructive, parameter based image chains are used for internal processing within the libraries. This approach avoids the creation of temporary files and provides just in time optimized processing as pixels are pulled from their input stores, through projections, resamplings, and image processing functions in order to fill the desired area of interest and resolution. Modules and functions can be added and removed to the processing chain, parameters can be adjusted, and rapid prototyping is supported with this approach. Image chain templates or spec files can be saved and retrieved for subsequent processing. The visual chain editor in ImageLinker provides a graphical interface to these chains.

Avoid limitations on the number and size of files

The production background of many of the developers has helped to avoid unnecessary limitations on production capabilities. Image files remain disk based, image chain processing provides an efficient processing footprint, and parallel processing capabilities allow the system to scale. Current limitations are inherited from the number of file pointers and file sizes allowed by the underlying operating system.

Build in parallel processing capabilities

Parallel processing through the MPI libraries is available to ossim production engines in the core library. OssimPlanet applies multi-threaded operations to enhance overall performance and the user experience.

Support for rigorous sensor models

The baseline and associated plugins support a range of sensors. The sensors are organized into classes - aerial frame, pushbroom, scanners, radar, etc with specific implementations for many commercial and government sensors. The libraries apply a rigorous photogrammetric approach in modeling the sensor, its associated parameters and error models, as well as the specific formats for metadata and initial parameter initialization. Image data is projected through the sensor model on to the appropriate elevation models and sampled in the desired map projection.

Support for Residual Polynomial Coefficients (RPCs)

Support for RPCs, classified and unclassified tags, are supported in the baseline and the associated classified plugins. RPCs provide a mechanism for projecting the image data in a generic fashion without revealing the specific capabilities of the underlying sensor.

Functionality embedded in layered libraries - used in applications

Algorithmic implementations and functionality reside in the core libraries. Higher level functionality is layered in targeted libraries that have dependencies on the core libraries. Finally, tools and applications, interface with those libraries to provide solutions.

Plugin architecture to support add ons and segregated functionality

OSSIM and ossimPlanet provide plugin interfaces to external shared libraries. This allows classified, proprietary, or unique capabilities to be developed and managed separately from the core baseline. The core libraries implement 'factories' that search, load, and register these capabilities at runtime.

Orthoprojection, precision terrain correction, conversion between projections and datums, and resampling handled automatically

Many common functions and transformations can be handled automatically by the library. The user of the system does not have to manually convert map projections, or take special action for common workflows. Formats, map projections, datums, resolution, and spectral radiometry are handled by default in the libraries. Display typically defaults to orthographic projections with automatic precision terrain correction against the elevation data sets in that have been set up by the user. Resampling to the desired resolution and projection also will occur automatically and can be adjusted at will by the user.

Take advantage in the latest Graphics Processing Unit (GPU) capabilities

Recent development activity has taken advantage of GPU shaders and high performance processing that is available on modern day graphics cards. Specifically, ossimPlanet can provide real time three dimensional combinations, swipes, and change detection between disparate layers using GPU shaders. OssimPlanet takes advantage of the OpenSceneGraph 3D visualization library and its OpenGL capabilities.

Library and Module Overview

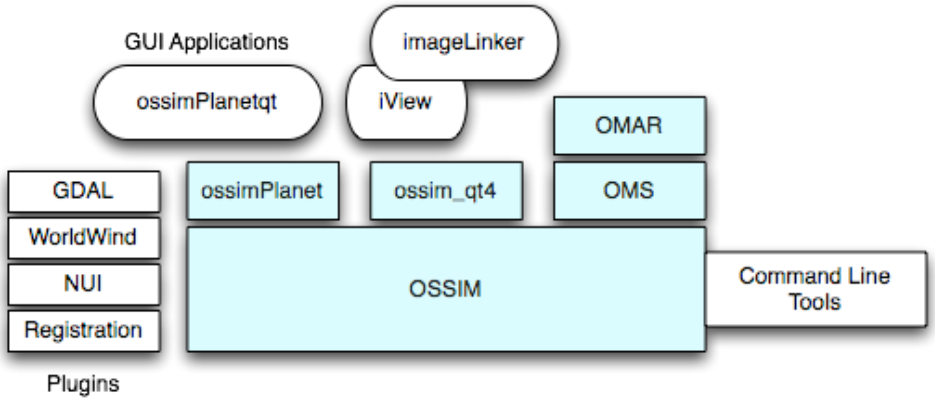

Fig 1. Organization of Libraries and Applications in the OSSIM baseline

OSSIM

OSSIM is the core library of the distribution. This library contains many classes and methods that implement remote sensing, sensor modeling, image processing, and elevation processing algorithms and functionality. The entire structure, classes, and methods can be browsed online with the doxygen system. http://trac.osgeo.org/ossim/doxygen/

Plugins

A plugin architecture and a number of plugins are supported with the distribution. Notable examples are the GDAL library for handling a wide variety of geospatial formats, a plugin for extracting data from WorldWind servers.

Command Line Tools

Many command line utilities and tools are provided for the OSSIM library. These tools can status data sets, generate products, mosaics, provide automated conversions, etc. Often, these tools are scripted in larger systems to provide background or automated processing. Documentations for the tools can be found at http://ossim.telascience.org/ossimdata/tutorials/pdfs/commandlineapps.pdf .

ossimPlanet

OssimPlanet is the library for 3D geospatial visualization. It depends on the OSSIM core for remote sensing and geospatial capabilities and on OpenSceneGraph for advanced 3D visualization. The library also contains a sophisticated router/action mechanism for collaboration between applications and users. Alerts, data and navigation synchronization is enabled through this library. An OpenGL application - ossimplanetviewer, is included which can be used to provide a full screen OpenGL

visualization of the planet. This system is being used on video walls and decision support systems around the world.

ossimPlanetQt

OssimPlanetQt is the library that provides the planet and Trolltech Qt4 interfaces. The GUI adds legends and controls for manipulating data and navigating the planet.

The ossimPlanet application uses this library as its main interface. Recently, a high level API has been defined to provide a simpler programmatic interface for other GUIs and application to application communication.

ossim_qt4

This library binds the Trolltech Qt 4.0 GUI library to functionality in the OSSIM core. It replaces the previous ossim_qt library which was based on qt version 3.0. ImageLinker and Iview are two GUI applications that are included in this module.

iView

iView is a simple image viewer. It maintains no geographic context - it simply can read in and display image files that OSSIM supports. Useful for inspecting the source files and simple display in image coordinates.

ImageLinker

ImageLinker is a tool that demonstrates much of the functionality in the OSSIM library. Useful for analysis, prototyping, and production, this tool displays and manipulates geospatial imagery. Most of the tutorials and the users guide are based on ImageLinker examples. Tutorials can be found at: http://ossim.telascience.org/ossimdata/tutorials/pdfs/ .

OMS

OMS is the module for OSSIM Mapping Services. Using the OSSIM processing engine it can quickly render maps and imagery to the web. Intended as a replacement for MapServer and other web based mapping tools - OMS provides the ability of maintaining and processing the data on the fly to support web services.

OMAR

OSSIM Mapping Archive is a web based system for managing, processing, and serving geospatial imagery. It incorporates a relational database, user management, resource management, and on demand processing and serving of user defined products.

Solutions Overview

Most users of the OSSIM technology will focus on ossimPlanet, ImageLinker, and/or OMAR. Each solution has a different focus, but all build upon the functionality and algorithms in the OSSIM libraries. A brief overview of each of these solutions with pointers to additional information is provided below:

ossimPlanet

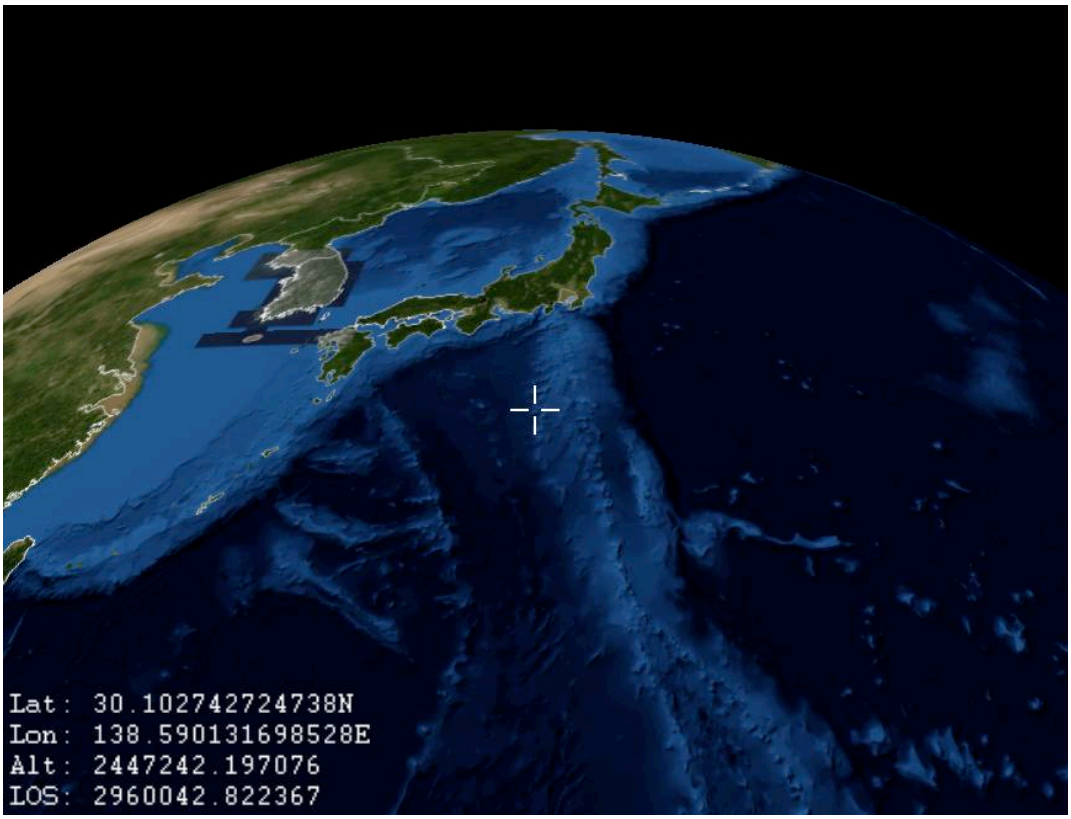

Figure 2 - ossimPlanet is an accurate, collaborative 3D geospatial visualization client.

OssimPlanet is focused on accuracy, collaboration, and rapid ingest of new data and alerts. It builds upon the geospatial capabilities of OSSIM and the three dimensional visualization of OpenSceneGraph to provide collaborative access to new data and events. Most geospatial data formats can be rapidly placed on the globe and immediately analyzed. The internal router/action system allows agents, dashboard widgets, and other clients to synchronize data and navigation. The ultimate goal is to allow online communities of interest to discover, communicate, and collaborate on rapidly changing world events. The system also contains a high level API and router/action communication interface for interaction with other systems. Updated users documentation for ossimPlanet can be found at http://ossim.telascience.org/ossimdata/Documentation/ in the ossimPlanetUsers.pdf file.

ImageLinker

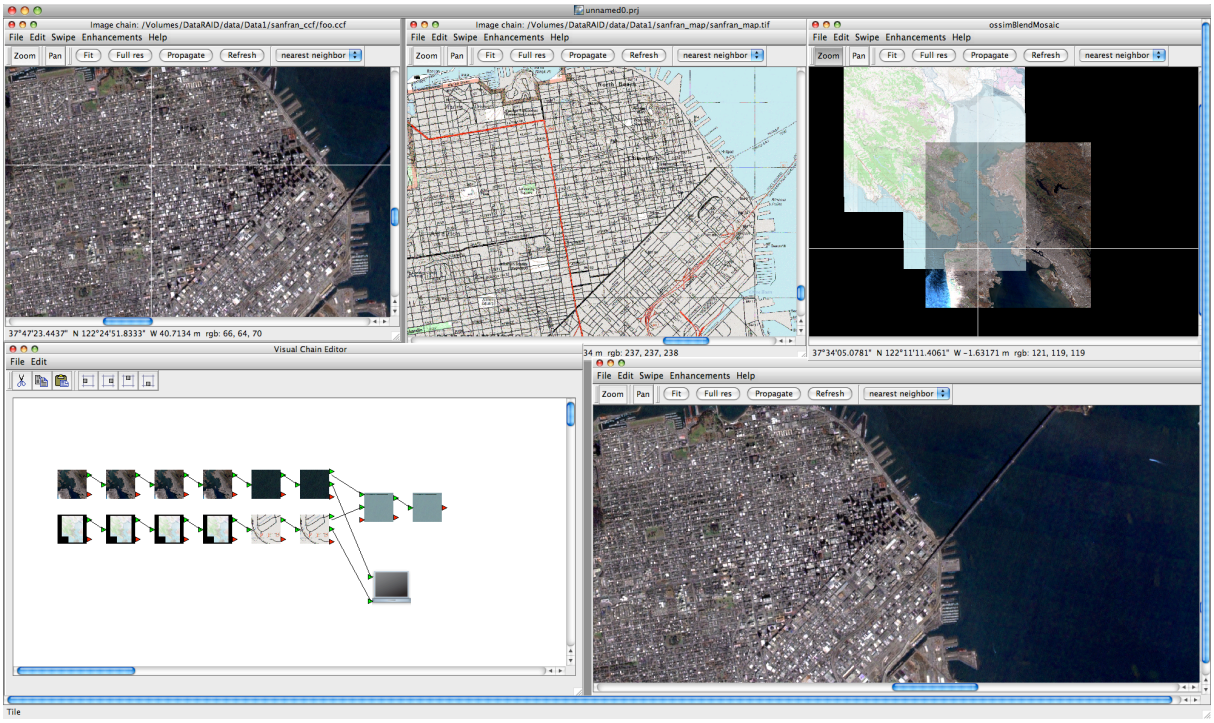

Figure 3 - ImageLinker provides rapid geospatial prototyping and production

ImageLinker is a prototyping and production tool that demonstrates much of the geospatial and image processing functionality that is resident in the OSSIM library. Imagery loaded into ImageLinker automatically displayed in an overview in orthographic projection and intersected with the underlying elevation database. The user can select different map projections, arbitrarily roam and zoom and propagate viewing conditions to other displayed data sets. The cursor is geographically tracked in all open windows. Standard functions such as histogram operations, mosaics, change detection swipes, and various combiners can be quickly accessed through the menu system. The visual chain editor allows the user to manipulate all of the processes and parameters available in the system. Resulting products can be specified and produced out of the tool. Much of the ossim users guide uses ImageLinker to demonstrate the functionality of the OSSIM distribution. The guide can be downloaded from http://ossim.telascience.org/ossimdata/Documentation/ ossim_users_guide.pdf. Additionally, there are several step by step tutorials based on ImageLinker at http://ossim.telascience.org/ossimdata/tutorials/ (quicktime movies and pdf documents).

OMAR

OMAR is a World Wide Web Consortium (W3C) compliant map server that will have the ability to serve up Web Mapping Services (WMS), Web Coverage Services (WCS), and Web Feature Services (WFS) outputs to customers by request. The OMAR system is coupled to a relational database for user account management. The underlying OSSIM processing engine has the ability to rapidly produce new products by applying image chain definitions to source material that is managed by the database. Future plans in include optimized streaming interfaces and services to ossimPlanet clients and analysis tools. Strong compliance with Services Oriented Architectures (SOA), OGC, W3C, and standard interfaces will guarantee interoperability with other systems and solutions.

For additional information

www.ossim.org is the stepping off point for more information about the OSSIM baseline. News, development information, binary packages, and communication channels are maintained at that site.