

Image Exploitation for the Enterprise

Brad Skelton Leica Geosystems Geospatial Imaging Photogrammetric Week 2007

when it has to be right



Imagery is being used more and more to drive decisions in large organizations. Maturing standards along with improvements in image compression, delivery and processing power are bringing image exploitation to the enterprise. The capabilities which have traditionally been locked in the image analysts' labs are now moving into the nearest browser.



Evolution of Geospatial Technology....

A Brief Look Back

- when it has to be right



The 1st Generation....

1800's to 1900's

- Analog technologies were used to make hardcopy maps
- Maps were rarely updated
- Mapping was limited to a few
- Maps were not shared

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 Referred to as the 'Paper Generation'











- when it has to be right

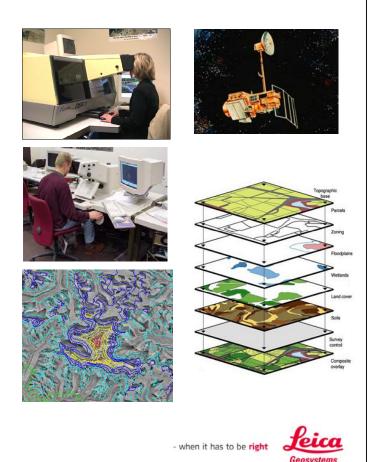
The 2nd Generation....

1970's to 1990's

- The 'File' Generation
- Digital Mapping Generation
- Birth of GIS

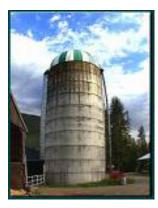
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- Commercial Remote Sensing Satellites
- Digital Photogrammetry
- The '2D Mapping' Generation



Which Brought About the SILO Effect

The 'Silo' effect of departments not working together to share data resulting in disconnected workflows and redundant mapping....



Photogrammetry Department



Remote Sensing Department



GIS Department



IT Department

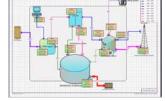


The 3rd Generation....

1990's to 2000

- The Internet Age
- The beginning of the '3D Generation'
- Relational databases to share information within an organization
- Web services to deliver geospatial content to a wider audience
- Internet Mapping capabilities to shift paradigm from desktop to HTML
- Broadening of market from professional users to prosumer and consumers of geospatial information

















The 4th Generation....

2000+....

- 'On-Demand' Generation I Want it Now!
- Time is Critical...4D
- Mobile Generation
- Google Earth and Virtual Earth
- Online Collaboration for Sharing
- Instant Messenger
- Online Social Networks
- Synthesis of IT, Internet, Business Systems and Geospatial Technology to create true Decision Support Systems
- OGC/ISO standards for interoperability
- Open Source
- Geospatial Data Currency is a Driver



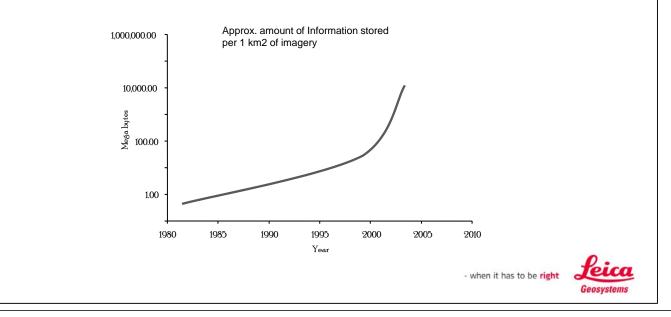
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The Size and Number of Images Continues to Grow

• Imagery always contains information...

In 2002, 1 km² of ADS40 imagery produced approx 14,222 Mbytes of information





Which increases the need for...

- Management of the Data Using folders to manage this data will no longer work. We must rely catalogs to organize and access our data.
- Effectively Manage Storage Though disk space is cheap, it is never enough. Compression must be used to effectively store all of the data.
- Automation of Information Extraction There is too much information for human processing and too few specialists. We need to publish algorithms as easily as we publish data.
- Collaborate and Share the Information The information that is extracted must be effectively shared.



What is an Enterprise System....

Organize, Discover and Share Information

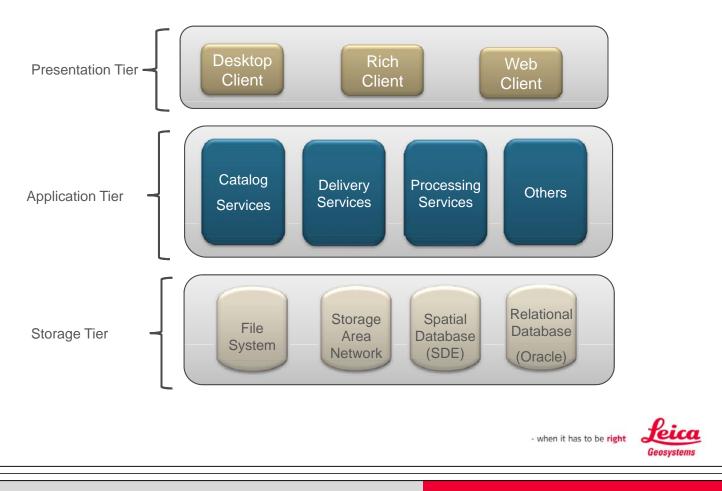


Characteristics of an Enterprise System

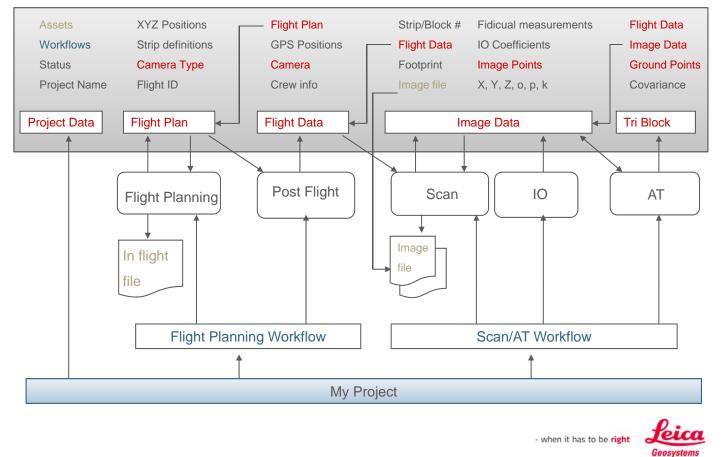
- True multi-user, simultaneous access to the same production project from any workstation in the production network
- Project access and security on par with the system domain
- Rational schemes for managing high volume data types
- Capabilities provided as interoperable services
- Scalable to meet the growing production and throughput demands of an organization
- Ability to persist all variables and parameters associated with the workflow
- Extensible platform for customizing the workflow and integrating them with other business workflows



An Enterprise Architecture



Full Domain Modeling Example



Interoperability Requires Standards

Open Geospatial Consortium (OGC)

- Coordinate Transformation Service provides interfaces for general positioning, coordinate systems, and coordinate transformations
- Catalog Service (CSW) defines common interfaces to discover, browse, and query metadata about data, services, and other potential resources
- Web Map Service (WMS) provides three operations in support of the creation and display of registered and superimposed map-like views of information that come simultaneously from multiple remote and heterogeneous sources
- Web Coverage Service (WCS) supports the electronic interchange of geospatial data as "coverages" – that is digital geospatial information representing space-varying phenomena
- Web Processing Service (WPS) provides open method for describing and implementing interoperable processing engines
- SensorML provides an efficient method for transporting sensor data and preparing it for fusion through spatial and temporal associations

International Standards Organization (ISO)

- ISO 19130 sensor and data models for imagery and gridded data
- ISO 19115 schema required for describing geospatial data and services



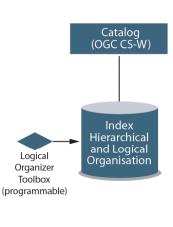
Catalog....

Organize and Discover Information

Catalog Capabilities

The catalog is the central mechanism for the storage and discovery of information about available data and services. It should have the following properties:

- Be based on a standardized data model (ISO 91130, ebRIM)
- Crawl and harvest geospatial datastores
- Register and harvest services
- Support multiple spatial reference systems
- Support access and edting of metadata
- Support complex queries
- Conform to OGC Catalog Service (CS-W)

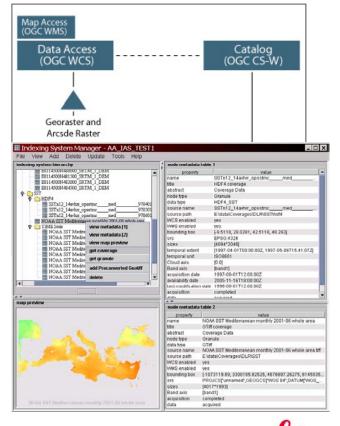


- when it has to be right



IONIC Red Spider Image Archive

- CS-W Compliant Catalog Implementation.
- Full ebRIM support
- Capable of registering tens of thousands images per day
- Metadata viewing and editing along with image and content viewing

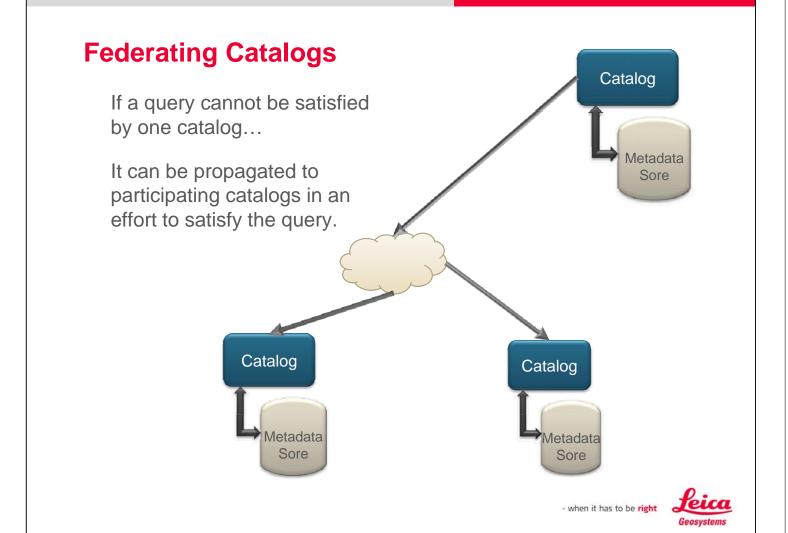


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Geosystems

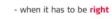
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Sensor Models....

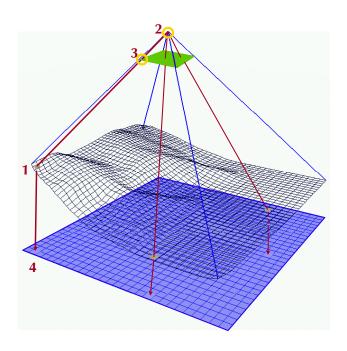
Creating a 3D Image...





Sensor Model

- Describes the Image to Ground Transformation.
- Enables
 - Stereo Viewing
 - 3D Measurement
 - 3D Feature Collection
 - Terrain Extraction



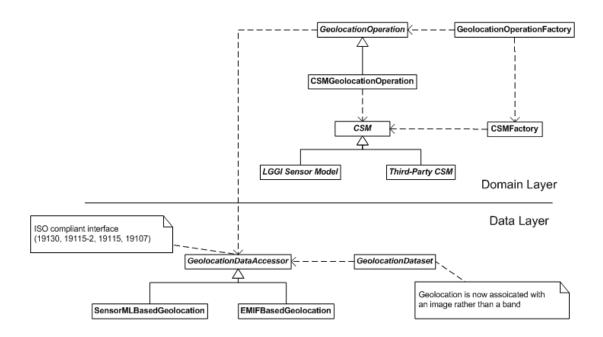


Standards are moving it to mainstream

- OGC Standardization now exists for Coordinate Transformation Service - provides interfaces for general positioning, coordinate systems, and coordinate transformations
- Sensor Model Standardization is in progress
 - ISO 19130 defines features of an interface
 - SensorML defines persistence
 - Community Sensor Model (CSM) implements standard API for sensor model DLL



Merging ISO 19130, SensorML and CSM





Deliver Effectively....

High Speed Delivery of Pixels





Protocols for Delivering Pixels

- WMS is a simple protocol for delivering a "map" as pixels in the form of a web image (PNG, JPG) at a selected scale.
- WCS is a rich protocol for delivering a true image in a broad range of formats.
- JPIP is an evolving standard for streaming delivery of pixels as a wavelet (JPEG2000) compressed stream along with metadata.
- ECWP is an existing protocol for delivering pixels as JPEG2000 code blocks.



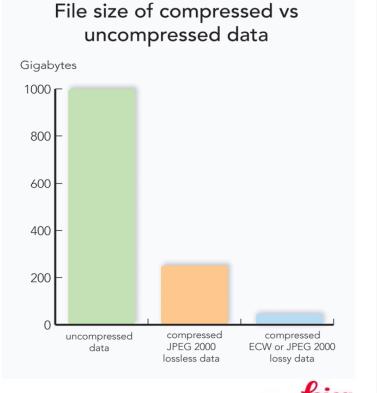
Benefits of Compressed Imagery

- Compressed imagery is *easier* to use and *manage* than uncompressed image tiles
- Compression can be lossless
- Serving compressed imagery is *faster* than uncompressed images
- Share and use imagery throughout your business processes (desktop and server applications)



Wavelet Compression

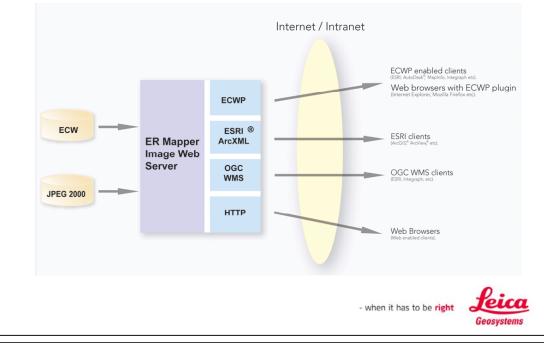
- Wavelet compression can provide up to 5 fold improvement without loss.
- The improvement can up to 20 times with minimal loss of data.
- Subsets can be accessed without decompression.



Geosystem

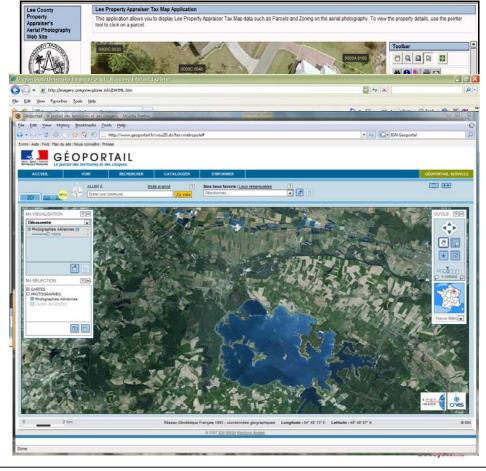
ER Mapper Image Web Server

- Terabytes or more of imagery
- 1000's of concurrent users (ECWP)
- Moderate hardware requirements



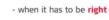
Implementations of Image Web Server

- Lee County
- Oregon State
- IGN Geoportal



High Performance Computing....

Maximizing Production





Coarse Grained

- MPI: Message Passing Interface
- PVM: Parallel Virtual Machine
- Condor: High Throughput Job Scheduler
- DCOM: Distributed Component Object Model
- Fine Grained
 - OpenMP: Shared Memory Parallelization

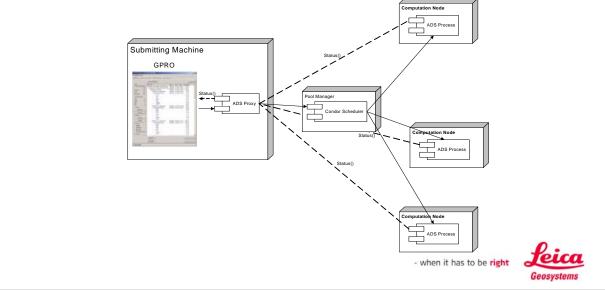


HPC Approaches in GPRO

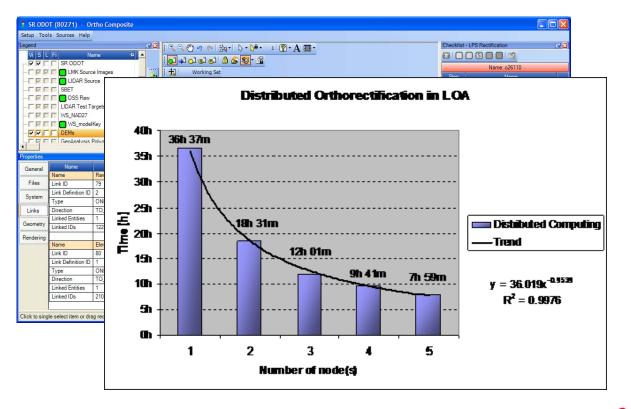
GPRO Uses a mix of fine and coarse grained strategies

Uses Condor to distribute computation across participating machines

 Rectifier uses multithreading to improve per image performance



Performance Realized in Leica Ortho Accelerator





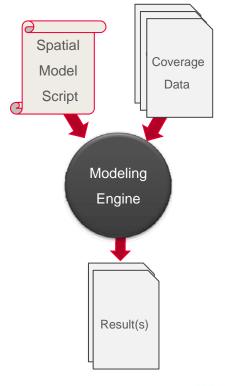
Spatial Models....

Extracting Information from Imagery



Spatial Modeling Engine

- Combines an algorithmic script with data to produce results
- One or more results from a single script
- Multiple Instances of the engine can be run simultaneously



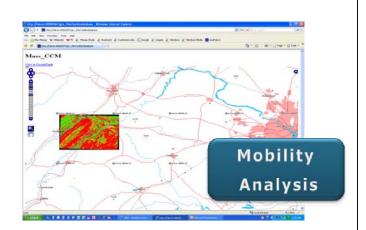


Modeling Service Concept

A single author may define and provide models to solve various problems for multiple users. The users would select the model from a library and request that the modeling service apply this to the selected data to generate a result. The model is self describing and Model Consumers is meant to be used in conjunction with a query system to select the appropriate data. Modeling Service **Model Consumers** Model Author Model Consumers - when it has to be right

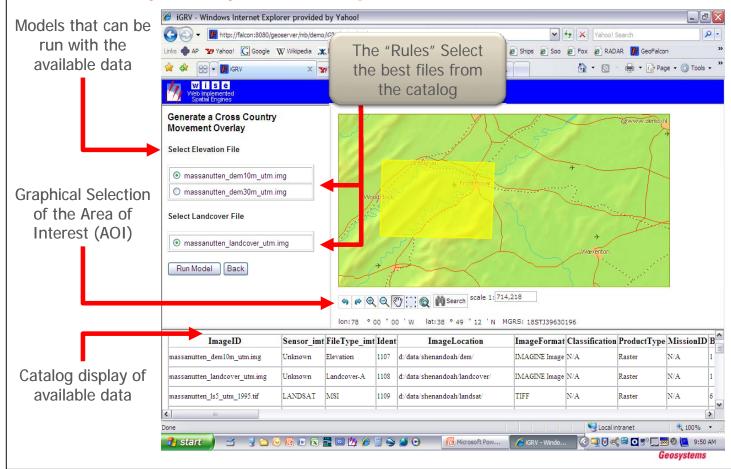
Potential Applications







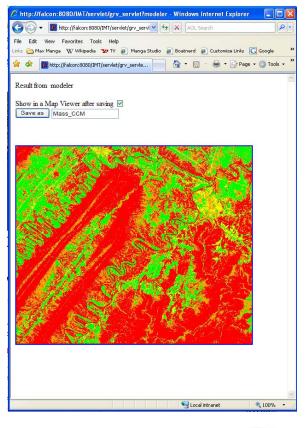
Mobility Analysis Example



A Simple Web User Experience

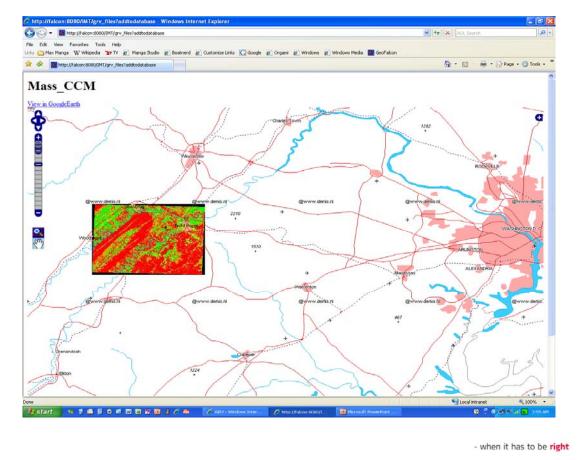
The Result of the Model is returned as a separate HTML from which it could be:

- Downloaded to a Local File
- Stored in the Catalog
- Loading into a WMS Client





Display the Results in an OGC Client

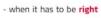




Or Display the Results in Google Earth...

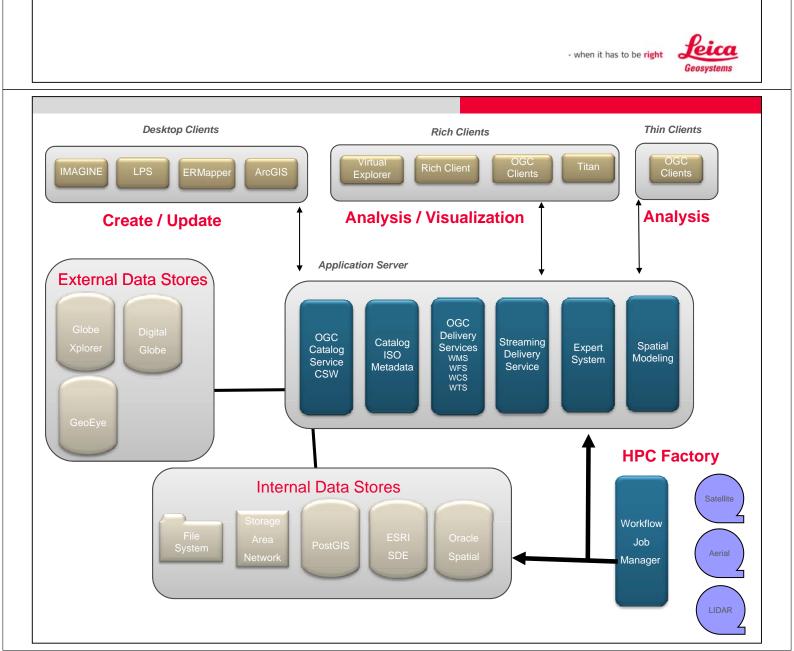
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What if we put all together...

Combine these elements into a single rich client



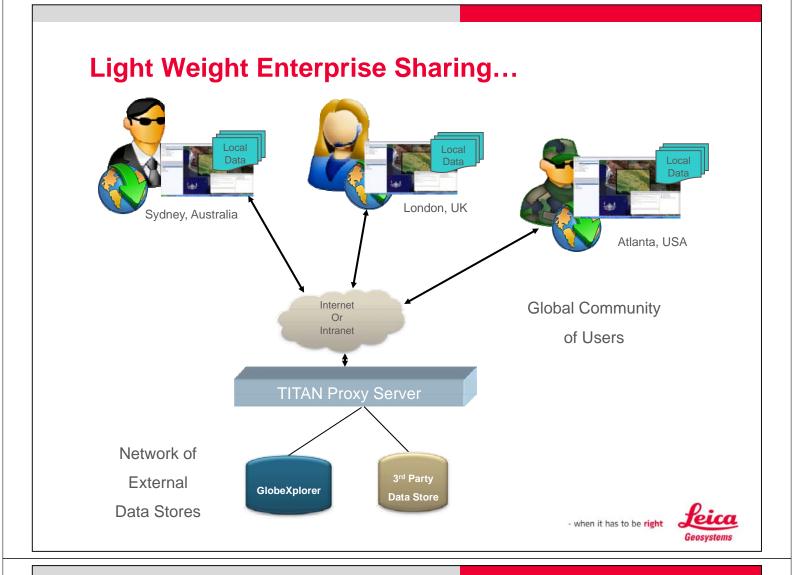
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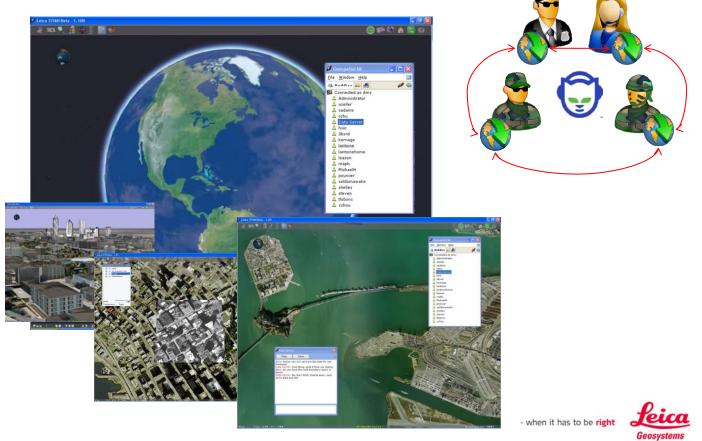
What if the Enterprise gets in the way...

Peer to peer collaboration and sharing





Collaborate and Share Data Directly in a 3D Environment



Conclusion

Geospatial processing will become a mainstream tool in the general enterprise toolbox which will be integrated at many levels throughout the organization.

Thank You

