



GeoMarc®

**Spatial DNA for
Advanced Geospatial Data Management**

Dr. Alex Philp

Founder and Manager

GCS Research LLC Proprietary

November 2007

GCS Research Success

ESRI Foundation Partner of the Year - 2007

ESRI Business Partner of the Year – 2006

National Visualization and Analytics Center Award - 2006

ESRI New Business Partner of the Year - 2005

Montana Small Business of the Year - 2006

USGS National Map Partner Award - 2004

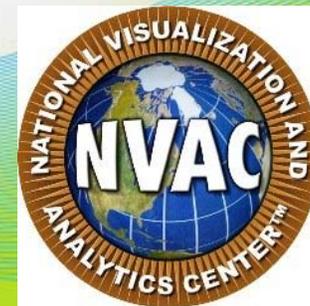
Microsoft Certified ISV – 2005, 2006, 2007

MSFT Research Review Committee – 2004, 2005



ISV/Software Solutions

GCS Research LLC Proprietary





**GCS Research –
Featured Success Story in NASA Yearly Publication**

2006

spinnoff



Overview

- Geospatial IT Company – 2002 to Present
 - Distributed Geospatial Solutions
 - Government and Commercial Customers\Research Partners
 - US Intelligence Community, US Army, US Navy (NUWC), SOCOM, TSA, Guard Bureau, US CBP, DOE-INL, USGS, USFS, USFWS, NASA, Insurance, Resource Utilization, Special Projects, Northrop Grumman, GeoEye, USDA-FAS, CSC, State of Montana, Immersive Media Company....
 - Geospatial Situational Awareness
 - Sensor Event Messaging and Mapping
 - SOA Implementation
 - ArcGIS Server and Client Arrays
 - Integrated Products and Services
 - 320 Combined Year of GIS Expertise
 - Smart Data Enterprise Applications



Product and Solution Groups

- GeoMarc – Desktop and Server Products

- Windows and Linux

- RDBMS

- Push Services

Distributed GIS

Network GIS

- Solutions Group – Enterprise Projects

- ArcObjects (AGS) and .NET

- Web Services

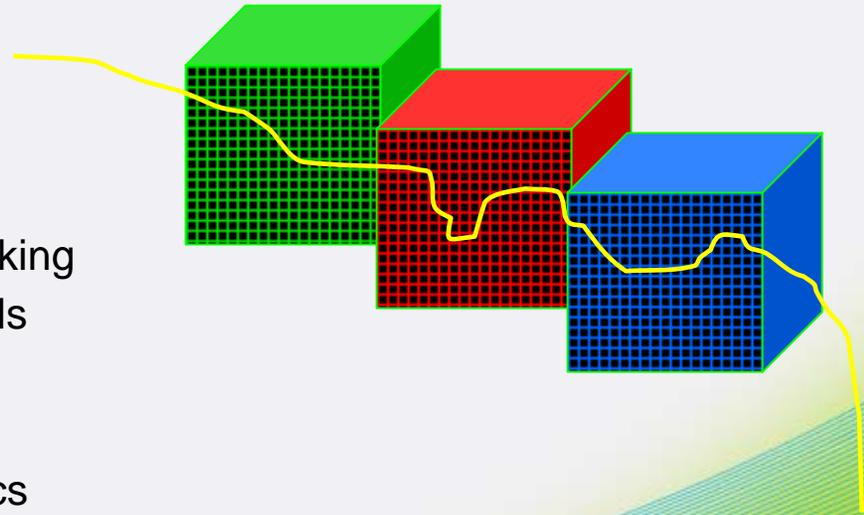
- SOA and SaaS

GeoMarc – Spatial DNA Programming

- Embed – Creating Payload in Pixels
- Extract – Reading Payload from Pixels
- Enhance – Improving Workflow and Utilization
- Exchange – Sharing Geospatial Intelligence

GeoMarc[®] Technology

- **Geospatial Digital Watermarking**
 - Creates unique “barcode” in the pixels for identification
 - Imperceptible and measurable alteration of imagery pixels to store data
 - Customized for spatial metadata exploitation and continuity
- **Redundant algorithm allows retrieval even after many image alterations**
 - Rotation, scaling, compression, cropping
 - Format changes and header loss
 - Orthomosaic creation
 - Distribution across Internet
- **Inherent Functions**
 - Reliable imagery identity, linking, and tracking
 - Associate specific users with specific pixels
 - Easy exchange of geospatial intelligence
- **Geospatial Applications**
 - Thematic display of barcode characteristics
 - Time, location, ownership, permission, area of interest



GeoMarc Concepts

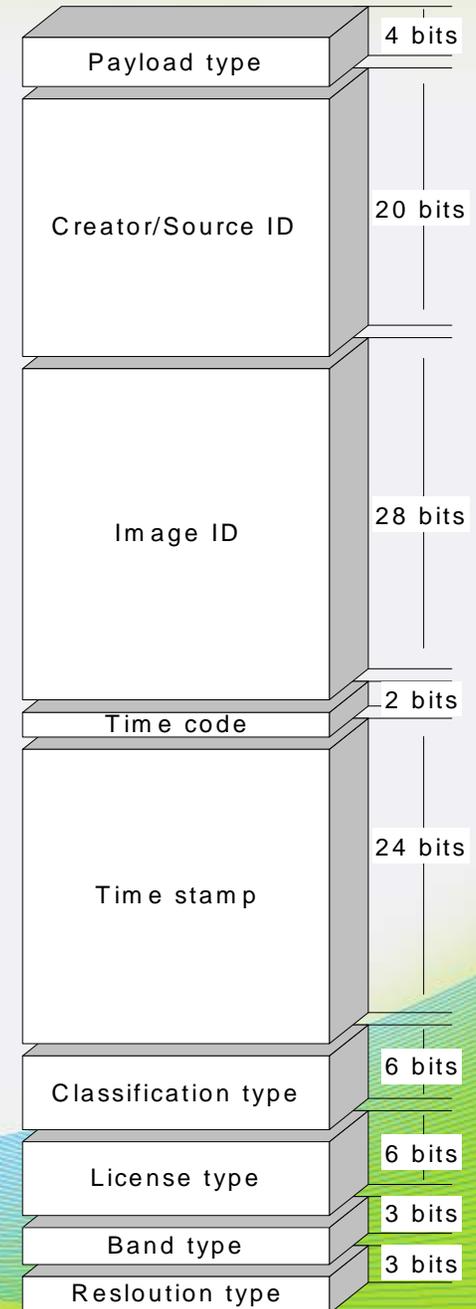
- GeoMarc Payload - “Barcode”
 - unique identifier: Owner ID + Image ID
 - small redundant payload for reliable retrieval
- Database Registry
 - distributed databases (local + enterprise)
- Push and Pull Architecture
 - user is presented with links and can choose which data to retrieve
- Managed Services
 - Embed, Extract, Enhance, and Exchange

GeoMarc Capabilities – “Barcode in the Pixels”

- Tools to enhance Geospatial Imagery Workflows:
 - Pixel level metadata
 - Identifying and tracking imagery assets
 - Linking the imagery to data and web services
 - Distributing related information to users and colleagues
 - Automating security and copyright rules
 - Area of Interest Linking

A GeoMarc Payload Definition

Field	Bits	Description
payload type	4	16 payload types - locked by GCS
creator/source ID	20	1+ million source and supplier IDs - must be purchased - assigned by GCS
image ID	28	268+ million image IDs for a single creator/source - automatically assigned by embedder
time code	2	4 different meanings for the time stamp: (0=capture date - hours since 0:00 1/1/1950 GMT, 1=embed date - hours since 0:00 1/1/2000 GMT, 2= session elapsed time - seconds, 3=user defined)
time stamp	24	time stamp dependent on time code above
owner flags	18	See below
TOTAL	96	
	Bits	Description
classification	6	64 classification types: (0=UNCLASSIFIED, 1=UNCLASSIFIED//LIMDIS, 2=SECRET//NOFORN/MR, 3=SECRET//REL TO USA, AUS, CAN and GBR//MR, remaining for future use)
license	6	64 license types (0=N/A, 1=ClearView, 2=NextView, 3=DOD/Title 50, 4=DOD/Title 50/Coalition, remaining for future use)
band types	3	8 band combination definitions (0=pan, 1=true color, 2=false color, 3=multi-band, 4=hyperspectral, remaining for future use)
original product resolution	3	8 resolution definitions for a given source (defined by source)
TOTAL	18	



1:16,757

GeoMarc

Scanning ...

- Watermarked
 - Auckland_Mosaic.tif
 - Mosaic Region 1
 - Mosaic Region 2
 - Mosaic Region 3
- Non-Watermarked

Payload Registry

Misc

RegionId	3
----------	---

PayLoad Information

Owner:	GCS Research - Demo Federal G
Date-Time Type:	Image_Capture_DateTime

Owner Flags:

Quality	Finished Product
License Type	Commercial
Absolute Accuracy C	4m<CE90%<10m
Sensor System Sourc	QuickBird
Original Resolution	62 cm
Image ID:	41746496
Date-Time Stamp:	7/28/2006 9:00:00 AM

Raw Payload:

Owner Id	404409
Owner Flags	215045
Image Id	41746496
Date-Time Value	934185



1:16,757

GeoMarc

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PayLoad Information

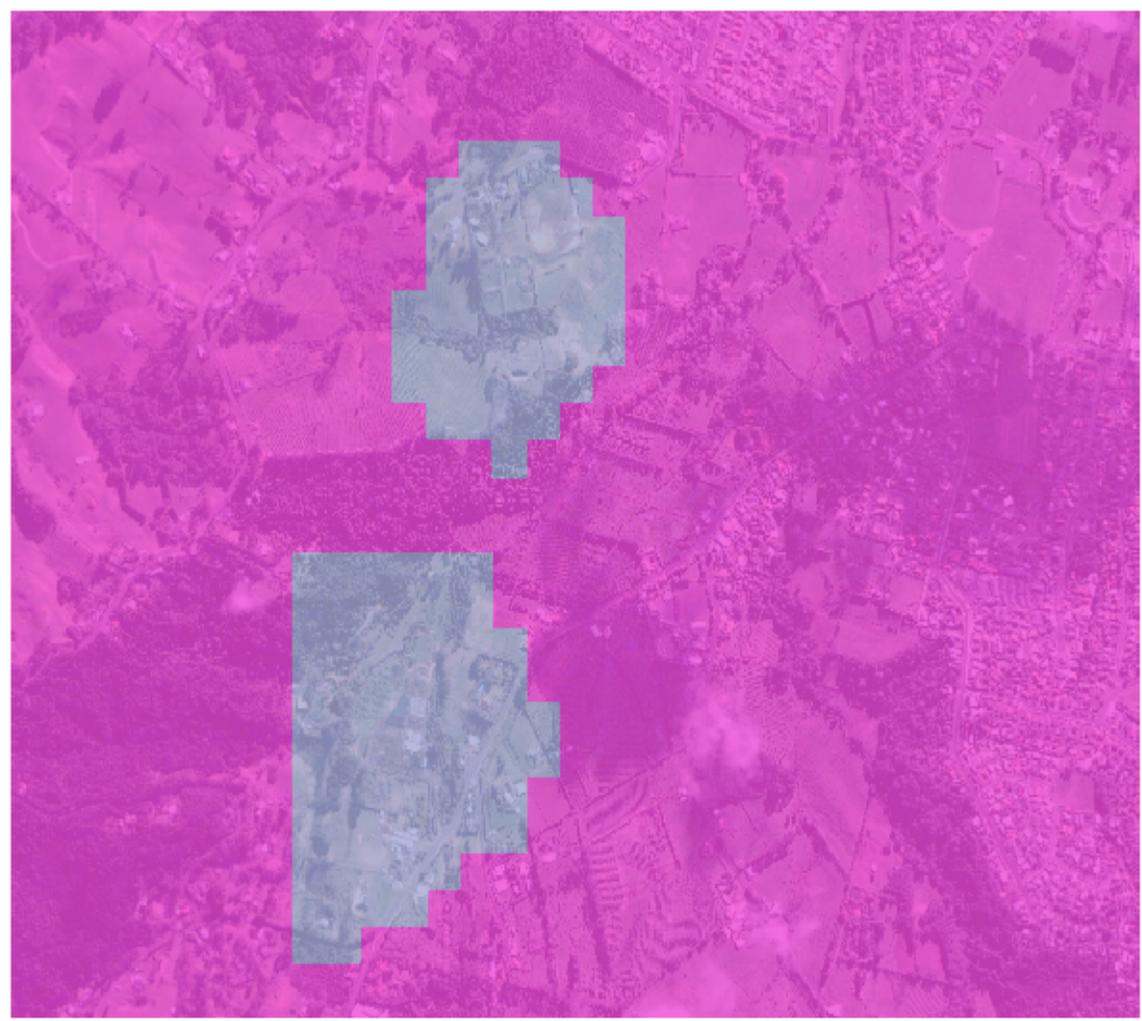
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Owner Id	404409
Owner Flags	215045
Image Id	41746496
Date-Time Value	934185
Date-Time Type	0





- Mosaic Region
- Owner/Source
- Unique Date-Time

Layer Name:

Options:

Date-Time Type:

	Color	Value	Label
		-1	Watermark not found
		932470	Image Capture Date: 5/17/2006 10:00:00 PM
		934185	Image Capture Date: 7/28/2006 9:00:00 AM





Project tree view showing a folder structure:

- Auckland_Mosaic.tif
 - Mosaic Region 1
 - Map Document
 - Mxd
 - Shapefile
 - Cloud
 - Source D
 - FAQ
 - GIS Data Links
 - DigitalGlobe Imagery Webservice
 - Mosaic Region 2
 - Mosaic Region 3

Link Information

Modifier	Admin
Image_ID	193807134
Image_OwnerID	404407
Created	10/23/2007 1:02 PM
Category	Shapefile
Modified	10/23/2007 1:02 PM
LinkName	Clouds
Data Type	GISDATA
Creator	Admin

Map view showing a satellite image with two blue-shaded regions. The project tree on the left shows the same structure as the first screenshot. The Link Information table below the tree is:

Modifier	Admin
Image_ID	193807134
Image_OwnerID	404407
Created	10/23/2007 1:02 PM
Category	Shapefile
Modified	10/23/2007 1:02 PM
LinkName	Clouds
Data Type	GISDATA
Creator	Admin

Map view showing the same satellite image. The project tree on the left has 'DigitalGlobe Imagery Webservice' selected. The Link Information table below the tree is:

Modifier	Tyler Otto - TRUSTED
Image_ID	193807134
Image_OwnerID	404407
Created	10/29/2007 9:21 PM
Category	GIS Data Links
Modified	10/29/2007 9:21 PM
LinkName	DigitalGlobe Imagery Webservi
Data Type	GISDATA
Creator	Tyler Otto - TRUSTED

Problem: Raster to Vector Continuity

- **Summary of Technical Challenge:**
- Explosive growth in utilization and availability of geospatial raster images (as predicated);
- Increasing demand for automated exploitation of geospatial raster images;
- Multiple copies of raster data across increasingly distributed, federated geospatial workflows;
- Multiple feature extractions from massive image libraries;
- Unnecessary utilization of CPU time to conduct multiple extractions;
- Disconnections between parent raster image(s) and extracted vector features and loss of inherent process and attribute metadata;

GeoMarc – Feature Extraction Vision

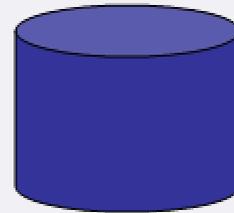
- A) Extract and embed GeoMarc once;
- B) Store in distributed server federated constellation or one dedicated server;
- C) Share single image file across network;
- C) Access vector features locally or via web services for enterprise solution

Server Side

EMBED Unique
GeoMarc™ Image ID



Geodatabase



Extraction Process

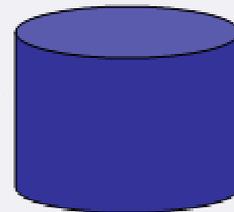
Image ID	Vector Metadata	Vector data
6324	car	Geodatabase
6325	Road	Geodatabase
6326	Building X	Geodatabase
6327	River Y	Geodatabase

Push Architecture is possible

Use GeoMarc™ Tool
to read Image ID



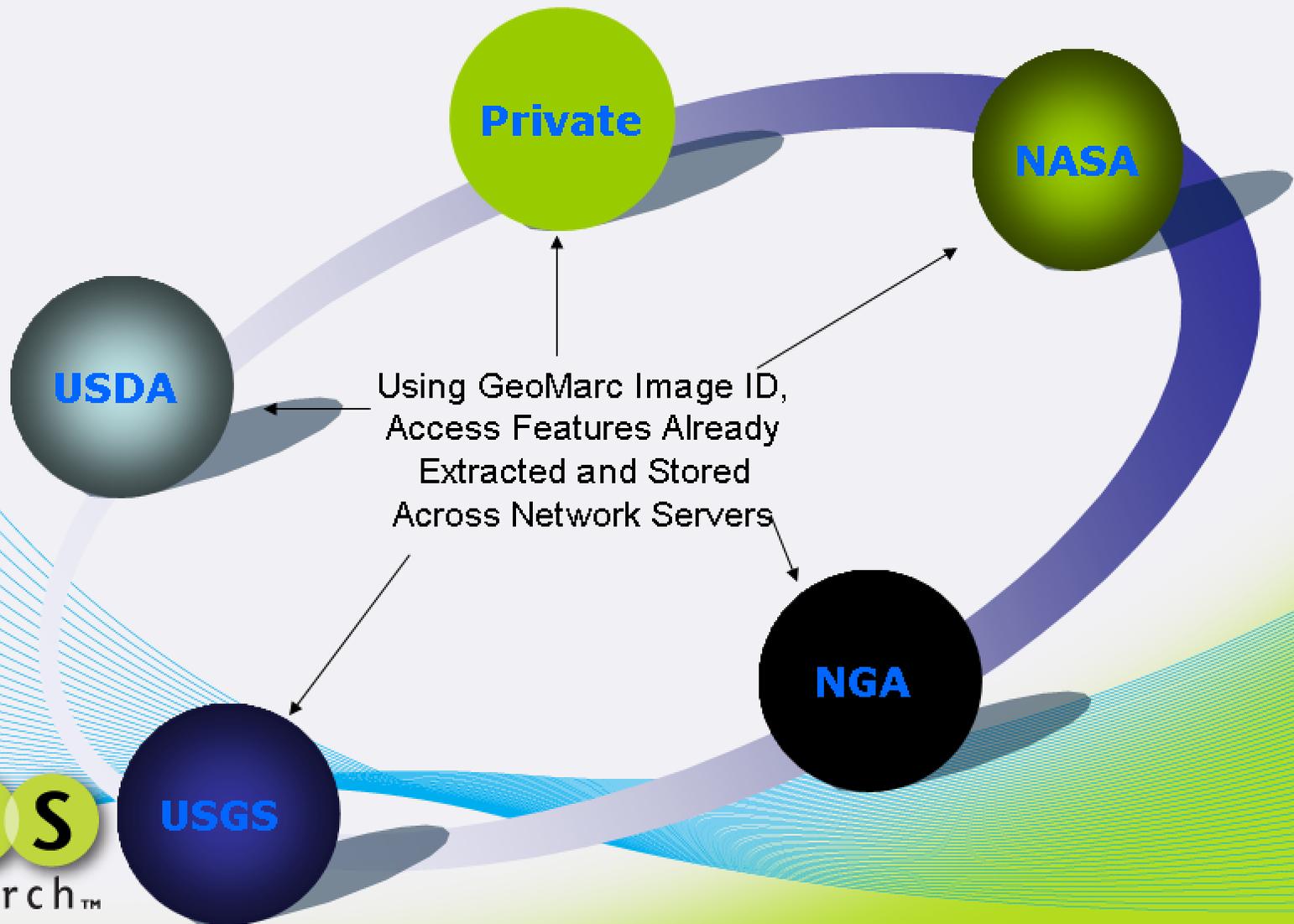
Geodatabase



Client Side

Pull Vector Data linked to ID
as XML Web Services

Distributed Vector Feature System



Prototypical Solution:

- A) GeoMarc Image ID # embedded in raster image as Extraction Process occurs;
- B) Link Image ID to extracted vector data and metadata and/or extraction algorithm libraries in RDBMS;
- C) Distribute GeoMarc image across network – not extracted data;
- D) User retrieves vector data using unique Image ID embedded in raster – push and/or pull architecture;
- E) Metadata connectivity – parent raster to vector extractions;

Smart Data Program

– GeoMarc Special Project

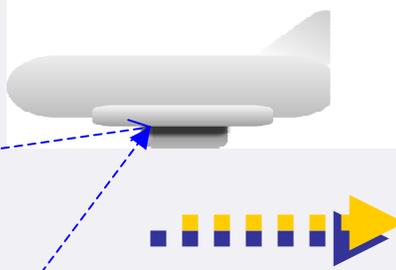
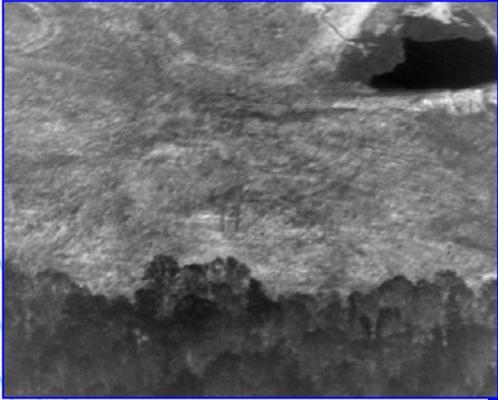
- Real-time GEOINT embedded in streaming UAS video systems
 - TRL 7-8
 - Flight Demonstration Success
 - Multi-variable watermarking algorithm
 - FPGA
 - Smart Card™ Development
 - Interact with Satellite and Aerial Photography GeoMarcs



DIGIMARC

Smart Data Program: Phase II - 2007

1) Video - Metadata Capture

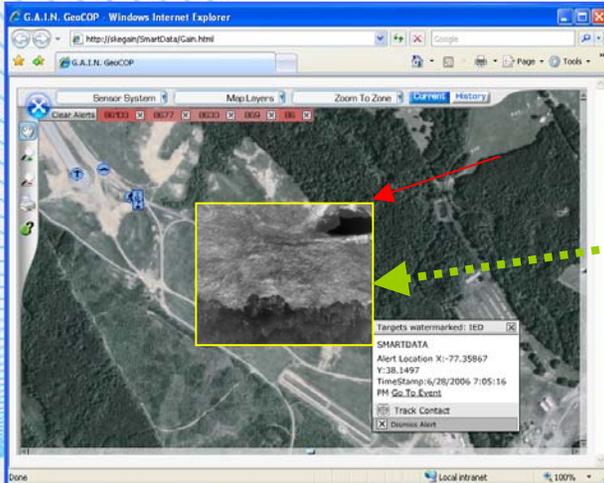


2) Metadata – Video Fusion

2) SmartTag:
SourceID
Time Stamp
Frame Coordinates
ATR Symbols
Advanced Gimbals

Actionable GEOINT

4) C4ISR Exploitation



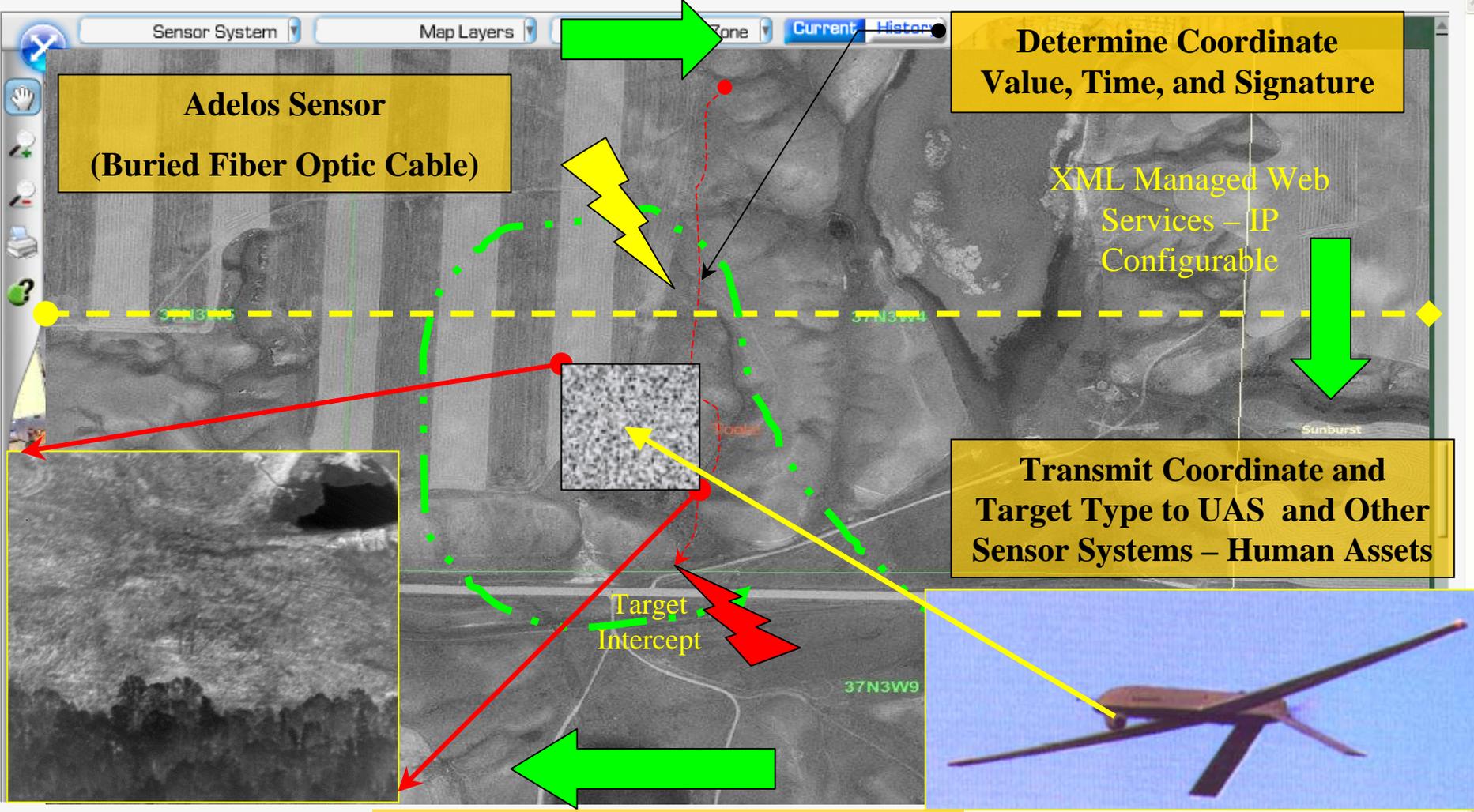
3) Smart Data Linking – Web Services



Smart Data Work Flow – A-Z of Spatial DNA

- **Video Collect**
- **Metadata Encode**
 - **GPS, ATR, Time, Flags, and Routing Links (Advanced Gimbals)**
- **Transmit**
 - **Bandwidth, Power, Distance, UAS Class**
- **Decode**
 - **Extract metadata package**
- **Structure Web Services – ISAA**
 - **XML**
- **Distributed to C4ISR GEOINT Utility**
 - **What, Where, and When + Plus Streaming Video**
- **All Digital System – WIFI in the Sky + IP Configurable Application**
- **Mission-oriented LBS**
- **Push Architecture – Linking to Ground Assets**
- **Move Beyond Search Mechanism**
- **Store, Retrieve, Index, Parse, Correlate, Analyze, Geospatial Functions (Proximity, Distance, Virtual Fence, Compare with other sensor networks as managed GEOINT Web Services)**
- **Microburst of Threat Intelligence for Tactical Situational Awareness**
- **Introduce Network and Routing Management**

Smart Border Project – Integrated Situational Awareness Architecture – Next-Generation Surveillance, Intelligence, and Interdiction



Determine Coordinate Value, Time, and Signature

Transmit Coordinate and Target Type to UAS and Other Sensor Systems – Human Assets

Smart Data – Target Type, UAS GPS, and Video Capture in Data Channel

Geospatial Intelligence from Earth Observation

Geospatial Intelligence from Earth Observation

Digital Geospatial Imagery

AOIs, Mosaics, Vector
Derivatives, Metadata, and
Targets

(Discrete Data Capture)



Digital Geospatial Acoustic –
(Continuous sensing element)

Digital Geospatial Video –
(Continuous and Discrete)

Moving Beyond Search – Geospatial Bits as Programmable DNA

Smart Data™



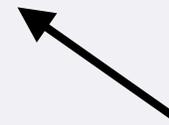
Defined User Profile -

Where?

When?

What?

My Spatial Domain

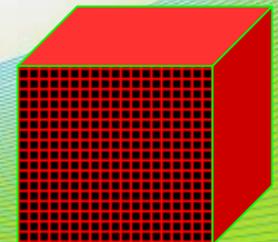


GeoMarc Sequence



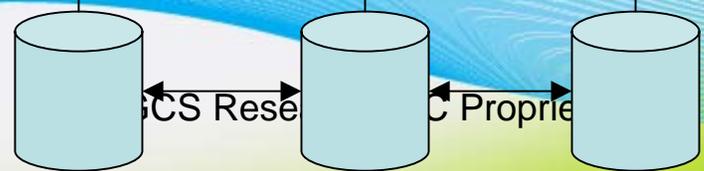
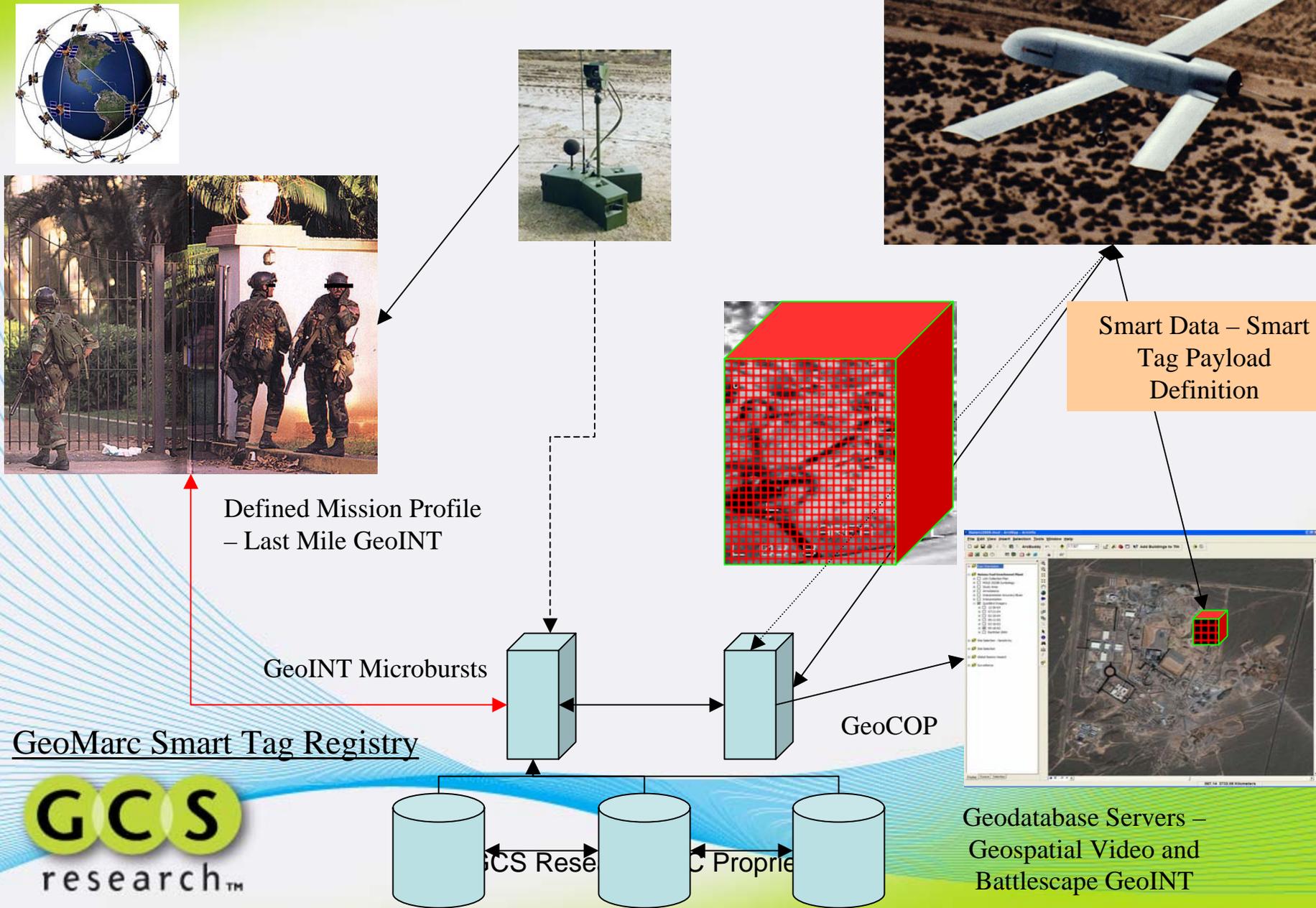
GeoMarc Dimensions

- Spatial
- Temporal
- Ontology



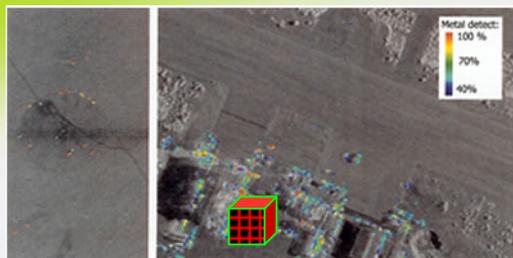
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Distributed Geospatial Framework for Smart Data Exploitation Across Battlescape



Geodatabase Servers – Geospatial Video and Battlescape GeoINT

Real-Time Sensor Fusion Utilizes Geospatial Registry and Smart Tag Push Architecture – GeoINT Microbursts



Smart Tag

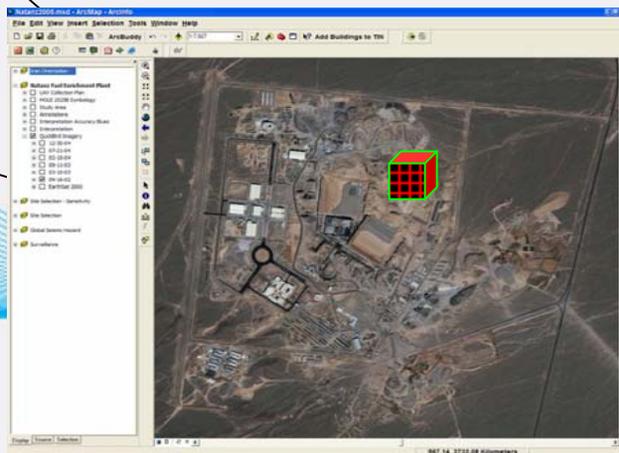


Smart Tag

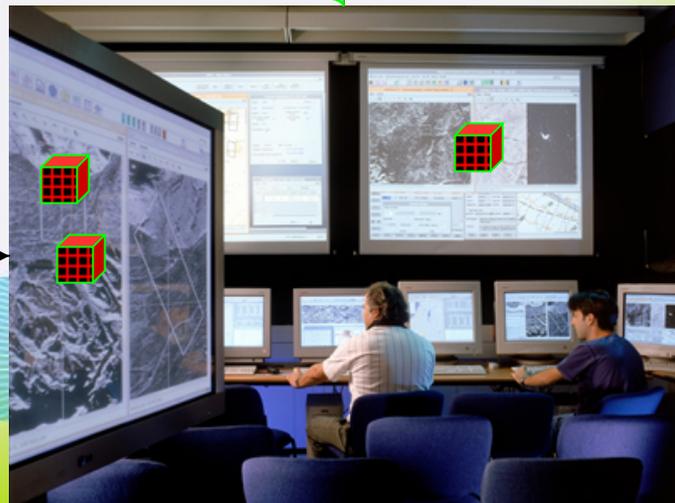


Smart Tag

Low Bandwidth Bursts



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GeoBrief™

GCS
research™

Contact

Mike Beltz – VP of Sales and Marketing

mbeltz@gcs-research.com

406-532-3254

406-532-3255 (Facsimile)

Dr. Alex Philp

aphilp@gcs-research.com

406-532-3254

1121 East Broadway, Suite 113

Montana Technology Enterprise Center

Missoula, MT 59812



GCS Research LLC Proprietary