COMMERCIAL REMOTE-SENSING: OPEN SOURCE IMAGERY INTELLIGENCE

by
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INTRODUCTION

Each day, in a remote and restricted office in the Washington area, a team of satellite engineers, infrared phenomeologists, and telecommunications specialists work to insure that the day's "take" of satellite-collected data has been properly sensed, recorded, and transmitted to users. This daily ritual, now highly formatted after years of experience, is important for very soon an audience of experts will be reviewing the day's collected data. They are a critical audience. Important decisions, some effecting the lives of thousands, may be made based on the data prepared by this team. Who are these people who work so hard to satisfy their product users? Are they preparing a classified briefing for the Secretary of Defense on a potential international crisis? Do they monitor and analyze data from top secret CIA satellites?

Actually, they are the quality assurance group at NOAA headquarters. They are weathermen. Their critical audience will be the millions of viewers of early morning television programs who expect to be told, and graphically shown, how meteorological conditions will affect their lives today. Based on the NOAA team's work, some of these people will make expensive decisions about an impending space launch, perhaps. Some will anticipate critical business decisions. Others will simply want to know if they will need an umbrella or how warmly to dress the kids that day. But they all are paying customers of open-source remote-sensing data. They are *intelligence users* in a very real sense. They have expectations of accuracy and reliability. They are generally intolerant of error. They know they are paying for this information and also how to make their dissatisfaction felt.

The idea of collecting information from the air about activity on the ground goes back well over a hundred years. Using balloons and early aircraft, pioneers of what has since been called aerial reconnaissance found that as an extension of a high hill or tall tower, machines that enlarged the view of the earth below were incomparable. By World War I, aircraft observers were regularly scanning enemy areas for the movements of troops and supplies. And since that information was combined with other reports from spies and then further analyzed to provide a more comprehensive understanding, it became known as "military intelligence" and a marriage between *remote sensing* and military (later to include strategic) *intelligence* was made.

The marriage did not last forever, but while it lasted some mutual habits and life-style decisions were made. Intelligence was felt to be something that should be protected from the enemy. It was not a good thing to let your enemy know exactly how much you knew about him. So the information was believed to need protection; and information -- that commodity which had previously so freely obtained -- became *classified*, known only to a few. Technology made it so. Because to understand really important information about the enemy it became necessary to devise really clever ways to obtain it. Ways which could permit the collection of the information without the enemy even knowing that it had been done.

If technology was the driver behind keeping the really good information secret, it also ultimately became the force which even now is "unbinding" information from the intelligence-based classification systems. The eighty-year marriage between intelligence

and remote sensing is surely on the rocks, if not already over. Perhaps it's as if information has found a new suitor. The classified marriage may continue, for the sake of national security (perhaps the "children's" role in this marriage), but users with no access to classified information have become the "other woman".

New remote sensing technologies, born of scientific research and not of national security concerns, have become widely understood. Infrared, radar, electro-optical, multispectral sensor data (and other types), collected from both aircraft and earth satellites have in recent years moved out of their technologist's hobby shops and into the world of useful applications. Such applications as have little or nothing to do with national security, as the NOAA quality team surely realizes. The era of unclassified, remotely-collected open source data about what is happening on the earth's surface and in its atmosphere is here today.

DATA USES

Today's satellites offer a rich variety of uses unforeseen only a decade ago -- data transmission of all kinds; Search and Rescue assistance; medical emergency support; images of war and other disasters for new audiences; and if the regions beyond Earth are considered, spectacular images of Venus and of the more distant planets. In their way, each of these data collection missions have contributed to the overall technology health of Open Source Remote Sensing. For the collection of imagery data -- both spatial and spectral -- two mission uses are pertinent for the new Open Source era. These are Environmental Change and Commercial (or, unclassified) Intelligence.

Environmental Change. The uses of remotely sensed data in support of all kinds of environmental investigations, from oil fires in Kuwait to the destruction of the Amazon Rain Forest, are well documented. For the purpose of this paper, the focus is on the detection of *change*, as opposed to other measurements. Investigation of the environment is, of course, nothing new. Thus, this community brings with it a legacy -- call it a "culture" -- of doing business in a particular manner. In the sense of having their own cultural biases they are not unlike national security investigators. If the national security culture is characterized by classification and secrecy; the requirement to investigate "denied" areas; and a military, pragmatic style, then the environmental community has a legacy of openness; the view of the earth as a borderless ecosystem; and an academic, methodological style. Environmental investigators place high reliance in on-scene investigation to establish the database, coupled with sophisticated computer modeling to establish today's "ground truth" and tomorrow's projected reality. For this culture the value of remote sensing lies less in its ability to establish today's truth, than to assemble and analyze a history of coverage for the purpose of understanding change.

Environmental on-site investigation is a very effective (and usually far less costly) way to determine the present local condition. But it is always only a snapshot, with temporal limitations -- the price to be paid for detailed on-site understanding. Open-source remote sensing systems provide a measure of "temporal truth", one far more accurately than computer models. When each new LANDSAT or SPOT image becomes available, the temporal "resolution" becomes more sharply focused. And most important of all, the *detection of change* can be more accurately measured and confidently predicted.

While individual new unclassified sensors will be discussed more fully later, sufficient now to note that many of them have environmental measurement as their very reason for being. The European, Japanese, and Canadian Synthetic Aperture Radar (SAR) systems all perform (or will perform) to certain levels appropriate to environmental problem solving.

"The main purpose of the JERS-1 development is to observe the whole land area, including Antarctica. It is expected to obtain the data useful for the Earth observation [and] to contribute to the land survey, agriculture, forestry, fishery, environmental protection, disaster prevention, and coastal monitoring."

JERS brochure, 1991

"Over recent years, public concern about the state of the environment has grown significantly. ...The European Space Agency, together with Canada, took a far reaching decision to begin the construction of Europe's first environmental satellite, known as ERS-1. Its objective is to increase substantially the quantity and quality of scientific data about the Earth and its environment."

ESA flyer, 1991

The investment of the necessary millions into these systems would not have happened had there not been a strong consensus among environmental scientists that remote-sensing is not only a good source of data for their work, but probably represents a *critical* resource for environmental understanding which is at once global (not local, as in the past); technologically sound (not subjective); rapid (not ponderously slow); and wholly quantitative (not subject to a collector's interpretive bias).

Commercial Intelligence. The term might also be "commercially available national security intelligence". It should certainly not be confused with intelligence about commerce. The discussion of this use of the data sort of picks up where the introductory paragraphs left off. As the technologies of remote sensing matured and became better known, people with no government classified clearances wanted to know more about what was going on in the world. And they wanted to see the same kinds of pictures that classified sensors were able to provide. Perhaps not the same images, but something that might be useful to, say, show on the nightly news or in an illustrated news weekly. The journalism community showed interest. The CNN "revolution" in rapid, world-wide reporting had resulted in an excellent dissemination base, but was still largely the fast reporting of HUMINT collection (to use government terminology). A better way would be to take advantage of broadcast journalism's visual dimension by actually showing relevant remotely collected imagery. If there are unclassified imaging satellites (like LANDSAT), why not?

In the late 1980's interest within the journalism community surrounded the notion that the press should have its own imaging satellite, a Mediasat. Some of the most newsworthy aspects of the Chernobyl nuclear reactor accident were LANDSAT and SPOT images of the power plant. These scenes offered a visual impact that no amount of pithy explanation by Swedish scientists could match. Chernobyl imagery became a powerful icon representing the aspirations of a free press to present the story unhindered by government spokesmen and no longer hobbled by dependence on unclassified (read: "watered down") verbiage drawn from classified imagery. LANDSAT was discovered by the press which used it to help cover the Iran-Iraq War and sometimes Soviet military activities in Afghanistan. But discovering imagery and understanding it did not go hand in hand. Interest in such imagery by the broadcast media eventually waned, as did hold-out support for an expensive mediasat.

Interest within the printed media survived, however. Publications such as Aviation Week and Space Technology and Jane's Defense Weekly began regular use of SPOT or LANDSAT imagery on their pages, if the editors thought its use would add to the story. This reasoned approach went lengths to establish open-source imagery as an information source right along with reporter's cables, interviews, and other traditional news sources.

Government intelligence agency analysts have long valued open-source information to collaborate, amplify, or even tip-off events within their areas of production responsibility. Thus it should be no surprise that these agencies have long taken advantage of unclassified remote-sensing products to enhance their own understanding of what is happening. But where this story has taken us so far has been entirely within the imagery (or *spatial*) domain. Use of LANDSAT data by print journalists has usually been limited to its ability to provide a picture -- a *photograph* -- with which to illustrate the story. In fact, both SPOT and LANDSAT are multispectral imagery (MSI) systems. Upon that fact alone pushes these sensor types far into the lead as valuable unclassified, open-source sensors for the production of both commercial and government intelligence.

THE SENSORS: WHAT'S OUT THERE

Simply put, the answer is that there is *a lot* out there. Already mentioned are the US-developed LANDSAT and French SPOT MSI systems, and the magnificent Japanese JERS-1 multisensor imager. The European Space Agency ERS-1 SAR system is now providing regular data, as was the Russian *ALMAZ* SAR system, until its recent demise. Canada will launch its own SAR system, SARSAT, in the next few years. In addition there are the American Advanced Very High Resolution Radiometer (AVHRR) and EOS systems, as well as many others. (A basic overview table discussing each of these systems and others is in the appendix). The point to be made by their inclusion at this place in the paper is that these sensor types are all unclassified, available in the public domain (or soon will be), and provide a capability to offer open-source solutions in support of both Environmental Change and Commercial Intelligence users.

Arguably the most valuable sensors are the two MSI instruments, LANDSAT and SPOT. Although other sensors may offer specialized capabilities, these two share a leading position by way of established marketing procedures, technical understanding by the user community, and MSI versatility. Certainly SAR systems also offer special capabilities as well, but the marketing for these products remains immature (ERS-1 probably leads), and many users have budget constraints which will keep them close to the MSI sensors, at least for now. For all users, these two MSI systems offer much.

- Wide-area coverage
- Adequate resolution, especially for environmental change detection
- Both panchromatic imagery and a selection of spectral bands

But there are some serious limitations, as well.

- Resolution limitations (30 meters for LANDSAT, 10 for SPOT) do pose some problems, especially for intelligence users.

- There is a national competitiveness issue. (Not only for the U.S., either. This issue is that it is one thing to be a leader in the use these open data sources; quite another to be a serious player in the development of technology that the sensors represent).

MSI AS OPEN SOURCE INTELLIGENCE

In this author's view one point needs to made clear at this time in the discussion. MSI as an intelligence source is no more useful nor any less useful simply because of its unclassified nature, particularly for the intelligence producer. Certainly the print journalists would be less likely to use the material if it were classified, but as explained before, its value for this user is as a simple space-based photograph. That MSI (and throughout this discussion, the term MSI is appropriate for either LANDSAT or SPOT) is unclassified is more because of a fortunate "accident at birth" than the result of any grand design. Impetus for its development came from the private sector in general and the scientific remote sensing community in particular. Its applications today as an unclassified (or "open") source for intelligence work is no more than a fortuitous circumstance.

Like most intelligence disciplines, multispectral intelligence can provide precious information to both the "traditional" intelligence analyst and the "warfighter". But MSI is a relatively "new" discipline, coming in to its own about the same time as the current emphasis on warfighter support. This is important. For in order to be perceived as something more than just another low resolution wide-area imagery system, or another technically complex Science and Technology (S&T) data source, I believe MSI must prove its utility in warfighter support.

Is this reasonable? How can it be that this *open source* solution can be of real worth to the military warfighters after decades of their having access to both highly classified national sensor data and to theater-collected reconnaissance imagery?

Operation Desert Storm revealed many interesting things across the entire spectrum of warfighting, from intelligence collection and pre-mission targeting to weapons employment and battle management. Aggressive new operations personnel were eager to investigate and try out a variety of new procedures and systems. Many of these, unlike their predecessors in Vietnam, possessed special access clearances and knew the capabilities of a variety of intelligence sensors. Furthermore, a wider variety of sources were in fact available to them. Collection systems had been growing in numbers and sophistication for years. Finally, new technology data transmission, processing, and display capabilities were mature enough to be fielded for the first time. These circumstances lead to a variety of innovations, particularly by Air Force and Marine Corps aviators. And some of these resulted in imaginative procedures involving LANDSAT data sets. For these innovators LANDSAT MSI represented a data source which:

- Offered a high degree of wide area coverage.

- Provided resolution that while perhaps not good enough for precise terminal mission targeting was sufficient for highly accurate en route mission planning.

- Was free of classification constraints.

Simultaneously, as has been widely reported elsewhere, the rapid dissemination of data from other systems was hampered by inadequate training or by dissimilar processing and transmission connectivity. Finally, the absence of the SR-71 aircraft did little to serve the need for near real time wide-area coverage.

During the two years since Desert Storm, all the services have been continuing to explore how remote sensing as an open source solution can better serve the warfighter. The Navy Space Command in particular has been rigorous in seeking the limits of MSI in this regard. Future Naval and Marine Corps air operations will surely benefit from this

effort. The other services are likewise examining MSI and other innovative remote-sensing solutions. The military is currently benefiting from industry experts and from academic research in the areas of spectroscopy, radiometry, and photogrammetry to bring long-established data exploitation techniques to the warfighter's planning table.

CONCLUSION

As any intelligence analyst knows, no one system, no one information source, can do it all. As interesting and impressive as the open source remote sensing solutions I've described are, none of them can replace the superb capabilities of our national, theater, and unit level collection resources. Rather than being alternative or replacement systems, the emerging unclassified systems provide a remarkable adjunct capability for the established ones. In the meantime, the classified systems themselves are undergoing steady and sure product and dissemination improvements. All of the shortcomings identified in Desert Storm postmortems are being addressed or have in fact been already corrected. What this means is that for the intelligence analyst as well as for the warfighter, the resources bin has just been greatly enlarged. The intelligence analyst who believes he has *all* the information inputs he can use has yet to be discovered. The warfighter who believes he needs *no more* of a technical edge than he presently enjoys does not exist. Open source remote sensing simply enlargens the quiver, the tool kit, the pantry (call it what you will), providing greater variety of data sources, greater flexibility, and more operational alternatives.

APPENDIX: WHAT'S OUT THERE

Sensor	Type	Country	Resolution (m)	Incl (deg)	Date	Comment
Almaz 1AB	SAR	Russia	15-30	73	1990 to 1992	Not flying
AVHRR	MSI	USA	1,000	98.7	1983 to date	
CBERS	MSI	China/Brazil			Unk.	
EOS SAR	SAR	USA	20 to 250	98	1999	
ERS-1	SAR	ESA	30	98	1991 to date	
IRS-1	VIS/IR	India	36 to 72	99.02	1988 to date	4-band MSI
JERS-1A	SAR/VIS/IR	Japan	30	98	1992 to date	
LANDSAT	MSI	USA	30	98.2	1982 to date	L-5 flying
MOMS-02	MSI	Germany	Unk.	N/A	1992	Shuttle Mission
MOS	MSI	Japan	50	99.1	1987 to date	MESSR/4-b IR
MOS	MSI	Japan	900 to 2700	99.1	1987 to date	VTIR/4-b Thrml
OMI	VIS	UK			Unk.	
Radarsat	SAR	Canada	10 to 100	98.6	1994	
SPOT	PAN	France	10	98.7	1986	
SPOT	MSI	France	20	98.7	1986	3-band MSI

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Previous	Metamorph: Theoretical Background and Operational Functionality
Next	Government Information Wants to Be Free

Return to Electronic Index Page