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SatMagazine

Looking At Everything... Commercial Satellite Imagery : Part 1

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EDITOR'S NOTES

EDITORIAL + PRODUCTION

Silvano Payne
Publisher

Hartley Lesser
Editorial Director

P.J. Waldt
Associate Editor

THIS ISSUE'S AUTHORS

Paul Anderson

Lucy Bartamian

Patrick French

Chris Forrester

William B. Gail

Adam Keith

Pattie Lesser

Donald Martin

Iain B. Probert

Carlos Placido

David Shamir

& special thanks to
J. Armand Musey

SALES

Jill Durfee
Advertising Director
jill@satnews.com

DESIGN + DEVELOPMENT

Simon Payne
Creative Manager

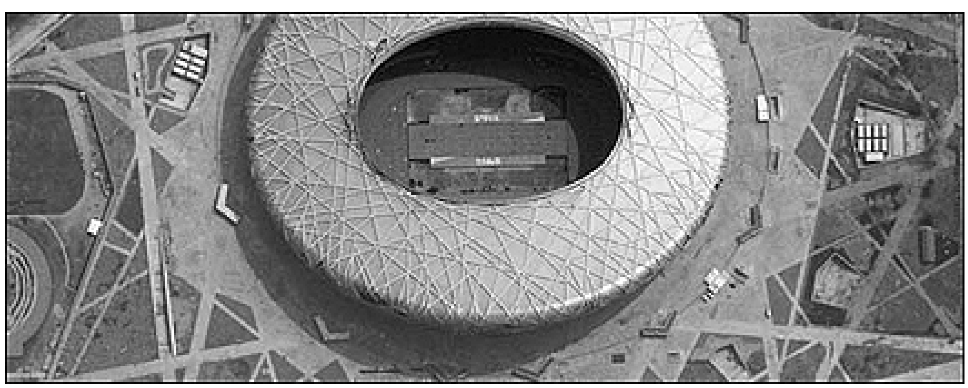
Published monthly by
Satnews Publishers
800 Siesta Way,
Sonoma, CA 95476 USA
Phone (707) 939-9306
Fax (707) 939-9235
E-mail: hartley@satnews.com
Website: www.satmagazine.com

An in-depth look at the world of satellite imagery is offered this month. The information we obtained for this highly viable sector of our industry was of megalithic proportions. Unless we were about to publish a book dealing satelite imagery — with the focus on the commercial side — there was absolutely no room for all of the material—in a single issue!

We made the decision to convert one huge article into smaller pieces of content to be more easily digestible, for inclusion in subsequent issues of *SatMagazine*. Such allows our readers to not be overtaxed with information, and also negates huge ".pdf" downloads if the interest is in the full, downloadable magazine.

Satellite imagery—remote sensing—Earth Observation—whatever you wish to call this environment is an income generator for commercial firms, a definite boon to citizens all around the world, and a life saver. The data captured by a (usually) sun synchronous satellite is converted into sometimes astounding imagery through the use of various software and hardware accoutrements Take, for example, the following two images, courtesy

of **DigitalGlobe.** The first is a natural color, 4-m *QuickBird* satellite image revealing the wildfires that devastated *Romona* and *Santa Clarita* in California in October of 2007. The second image is a panchromatic, 50-cm (1.6



foot), high-resolution *WorldView-1* satellite image that highlights the site of the 2008 Summer Olympics. I would also like to mention the image used in the cover of this month's magazine, also courtesy of DigitalGlobe, is an image of the northern shore of Kauai. We hope you enjoy this series.

Hartley Lesser, Editorial Director, SatNews Publishers

An Education Tree Without Enough STEMS

By Iain B. Probert

The recent Space Career Fair, held in conjunction with the 24th National Space Symposium in Colorado Springs, is a good barometer with which to gauge the workforce of today – and the future. The more than 200 attendees that braved the early Colorado spring snow conditions can be divided pretty evenly into two groups: under-graduate and graduate students, and transitioning military and aerospace personnel. All spent close to seven hours at the event listening to space industry companies talk about their respective missions, company ethos, and worker compensation packages.

After a networking lunch, all registrants were able to visit the 25 company and university booths to discuss opportunities, present and future. And what a future... the company representatives were extremely impressed with the quality of both groups of registrants.

Two days earlier, at the beginning of the symposium, the Space Foundation released The Space Report 2008, The Authoritative Guide to Global Space Activity. Extensively researched, The Space Report 2008's findings included that "the U.S. space industry workforce is well compensated, due in part to the high skill and educational level of most space industry workers and to the demand for their skills. The U.S. space industry's annual average wage was $88,200 in 2006. This was more than double the 2006 private sector average wage of $42,400. The U.S. space industry payroll reached $23.5 billion in 2006. In fact, all space industry wages are well above the average private sector wage."

Space industry employers today need workers who are creative problem solvers with strong math and science backgrounds to enable America's continued leadership in innovation and technology.

These same employers will, in 20 years, demand much the same of the children that are entering pre-kindergarten and kindergarten this year. Will this generation be equipped to become the innovators and entrepreneurs to lead our space efforts in the second quarter of this century? The Space Report 2008 found that "The high level of pay in space-related occupations stems in part from the fact that many of these skilled occupations require well-trained workers that hold at least a bachelor's degree, and often advanced degrees." It goes onto say that, "Well-trained engineers are a must for the U.S. space industry to grow and thrive."

Unfortunately, in spite of the lure of high salaries and the promise of high employer demand, the number of U.S. students enrolling in the requisite undergraduate Science, Technology, Engineering, and Mathematics (**STEM**) coursework is rapidly dwindling.

Across the nation's education community, the debate continues about the STEM education crisis. The concern is not just the small amount of U.S. students enrolling in STEM-related undergraduate studies, but also successful completion of STEM-related higher education once initiated.

Throw into the mix the ongoing discussions about the *No Child Left Behind Act* (**NCLB**), where for every educator and parent proponent there seem to be equal numbers of opponents to part, or all, of the program.

The core principles of NCLB reform are, in part:

- **Annual testing**
- **The publishing of data**
- **Assistance to students and schools that fall behind**
- **And for each child to be achieving on grade level or better in reading and math by 2014**

Is this focus on NCLB too little and too late, or just what the new Pre-K and kindergarten classes needs? NCLB does little to address how we inspire, enable, and propel our children toward success in STEM-related disciplines.

The commission on NCLB reported that the Act "has had significantly more success in assessing student performance than in improving it." One thing is certain, that the national STEM debate seems to be the best kept secret outside the education and space professions. Even inside, there are many who either refuse to admit we have a problem, or assume that the status quo is just fine!

Perhaps the current hurdle is that of analysis paralysis. I have stopped counting the number of STEM meetings and/or committees I have been asked to attend/serve on. Many are well meaning, while others seem just an excuse for an institution to garner more funds in the name of conducting STEM research.

Perhaps the responses from the Space Career Fair attendees illuminates part of the solution. Once each registrant had the opportunity to hand out copies of their resume, they were asked to give their feedback of the Space Career Fair experience and to answer a couple of questions regarding pre K-12 STEM education. One question was, "From your perspective, what year in school (pre K–12) do you think science content should be introduced into the curriculum?" The overwhelming response was very similar from all attendees: Pre-K to 3rd grade.

I totally agree. Spending significant time with a couple of youngsters who have recently "graduated" to age three and five, I continue to be amazed as *The* to what these young minds, with huge sponge-like properties, can absorb. Here is a golden, and yet often overlooked, opportunity to inspire and engage these young minds.

On the most basic level, for example, it is important that children, while being taught the joys of reading, be introduced to both fantasy and fact—exposing their minds to fiction and nonfiction. How about the significant adults in children's lives becoming highly encouraged, educated, and motivated themselves to become education partners with the teachers and schools responsible for their youngsters' progress? How about balanced K–12 curriculums where mathematics and science are given as much instruction time, resources, and glory as, say, football? Imagine a scenario where each subject interweaves with the next... where, regardless of subject taught, teachers interact with one another on a curriculum that calls for cross content pollination. For example, teaching space weather by using mathematics to integrate multiple content areas while addressing gaps in space science enrichment.

In addition, let us not forget one of our greatest resources, our teachers. For centuries, teaching was a revered profession. Now, judging by low compensation levels and abuse tolerated from student and parent alike, the profession appears to be regulated to the status of an also-ran.

In 2025, the space industry will be an even more attractive and lucrative place to work; however, the K–12 students of the next academic year will be short changed beyond imagination if they are not exposed to a balanced and quality education that includes STEM disciplines.

I will close with one more quote from *The Space Report 2008* about why the American space industry must have a qualified and highly skilled workforce to thrive.

"Shortages of these workers could undermine the ability of the nation's space industry to execute the portfolio of current and planned space programs. In addition, the complexity of space-related programs has increased, demanding more diverse engineering skill sets. An additional challenge for the space industry is that many new space programs demand a mix of skills that is forcing the industry to compete for talent in new areas. For instance, today's space industry must hire software or network engineers proficient in Internet protocols needed for transformational communications. In order to successfully compete in the labor market, the space industry must be able to continue to pay its employees well and offer them interesting tasks in order to attract the individuals who drive the process of innovation."

About the author

Iain B. Probert is the Space Foundation's Vice President, Education

by Adam Keith

SatMagazine was delighted to learn Adam was available to discuss his analysis and thoughts on the transformation of the Earth Observation (EO) sector of our industry... which was quite timely, given the theme of our May issue!

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Adam, thanks for taking the time to talk with us... we are hearing quite a bit about Earth observation these days. What are the key trends you are noticing in the industry?

Adam

The Earth observation (EO) sector has never been as attractive as it is today—for private sector actors, government entities not previously involved, and for the financing community, which is clearly a new development. The sector is growing by a number of measures...

First, the number of satellites to be built and launched in the coming 10 years is forecast to reach nearly 200, a real boom compared to the previous decade when only 102 satellites were launched (48 meteorology satellites, 151 for EO observation). More satellites means increased manufacturing revenues.

While the average satellite has a lower price tag, overall revenues for meteorology and EO observation are expected to reach $25.4 billion by 2017, a 34 percent increase from today. There is also real development in the commercial data market, which is currently in early stages but already showing real growth. In the next 10-years EO satellites will be launched from at least 29 countries, including government and commercial operators.

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What's driving this growth?

Adam

Established government space programs, such as NASA and ESA, remain the number one source for satellite capacity, with 54 satellites planned, or forecast, over the next 10-years. However, that number is relatively stable when compared to the previous decade.

Growth is really coming from two new areas. In the next 10-years, emerging government space programs—that is, government programs in countries not previously equipped with satellite technology—will launch 53 satellites. That's nearly one-third of non-meteorology satellites during that time and up from only 10. Countries such as *Algeria*, *South Africa*, *Turkey*, and *Thailand*, among many others, are launching their own programs.

The second area driving growth is the development of a true commercial sector, including private operators and capacity developed through Public-Private-Partnerships, with 29 such satellites to be launched during the 2007-2016 time frame.

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Why are we seeing new countries investing in various space programs today?

Adam

They are really targeting operational objectives to meet local/regional needs such as disaster management, natural resource monitoring, and cartography. Earth Observation is frequently considered a natural first step towards the acquisition of satellite capabilities, due to its relative low cost (a few tens of millions of dollars) and concrete returns.

An interesting point, though, is these countries often do not simply procure a satellite but usually include a technology transfer program (including engineer training) to progressively develop local capabilities in satellite technology. European companies have been especially successful in taking advantage of these opportunities. For instance, the UK satellite manufacturer **Surrey Satellite** (SSTL) has delivered 50-kg satellites to countries such as *Nigeria*, *Vietnam*, and *Turkey*, coordinated through the *Disaster Monitoring Constellation* (**DMC**).

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You mentioned the private sector. What does that look like today?

Adam

Contrary to 10-years ago, today there really is an emerging private sector, including non-governmental (EO) satellite operators and data distributors. This is especially true in the US, where significant government support enabled these companies to develop as is shown via the **ClearView**, and then **Nextview** contracts that were awarded by the *Department of Defense National Geospatial-intelligence Agency* (**NGA**). (In 2003-04, NextView provided $500 million in contracts, including funding to build capacity for next generation satellites).

The two private operators that ultimately emerged, **Digital Globe** and **GeoEye**, have succeeded in building world leadership in commercial data sales based on their high-resolution optical satellites. DigitalGlobe's successful launch of **WorldView-I** in 2007 was the first of the two satellites using NextView funding, with GeoEye's **GeoEye-1** to follow in 2008. NextView then provides a mechanism for data delivery to the NGA.

This has not been duplicated outside the US, probably due to a lack of large government-backed contracts. But in Europe, we are seeing the development of a private sector through Public-Private-Partnerships. PPPs are increasingly attractive to mitigate risks between public and private sectors that develop commercial ventures. There are currently two main PPP projects in the works. **TerraSAR-X** was launched in 2007 and was primarily funded by **EADS Space** and the **German Space Agency** (DLR). EADS Astrium Services subsidiary, **Infoterra GmbH**, is responsible for data commercialization. The **RapidEye** project is another good illustration. The 160 million euros, five satellite constellation (to be launched in 2008, 6.5-m resolution) is financed by a consortium including the DLR, local government agencies, and private investors. The company will be responsible for data sales and end services targeting the land-use sector (such as agriculture).

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What are the incentives for private sector actors?

Adam

The incentive is clearly to sell data. Revenues from commercial data sales from private and public operators are estimated to be at $735 million in 2007 and have grown by a Compound Annual Growth Rate (**CAGR**) of 15 percent over the last five years. This growth has come from a sound government market as well as the development of products and services better tailored to private customers.

Governments are currently the primary market for EO data for both civil and military purposes with 80 percent+ of data purchase, in particular high-resolution data for defense and security, including routine monitoring and intelligence gathering in combination with dedicated military systems (as in the US). High-resolution commercial data suppliers are also experiencing success in exporting data to meet international governments' requirements where a country simply doesn't have satellite capacity of its own. Similarly, export data is likely to be used for military as well as civil government applications.

Virtual-globes such as **GoogleEarth** have given the data and service industry a boost, bringing awareness to EO capabilities to a previously untapped mass market. Such virtual globes are seen as a major driver within the industry as they offer a new web-based approach for data distribution.

In 2007, GoogleEarth surpassed 300 million registered users, based on unique downloads. This has given rise to a second type of customer: generic users often requiring lower value-added services.

These trends will support strong growth in data sales over the next ten years. Revenues from commercial data sales are forecast to increase to roughly $3 billion by 2017.

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We see a real development in emerging space programs and development of a private sector. Where do the traditional established government programs fit in all this?

Adam

Established government programs are still the biggest part of the market, with a primary focus on environment and climate change missions—**NASA**, **JAXA**, and particularly the **ESA**, have clearly emphasized this fact. There has, however, been a paradigm shift in the type of mission, from expensive multi-instrument single satellites such as **Terra** (NASA), **Adeos** (JAXA) and **Envisat** (ESA), to more single-purpose missions. This is best demonstrated by the outline of missions planned through ESA's rolling *Earth Explore*r missions and GMES Sentinels, with a number of missions planned over the next 10-years.

Established government actors are also participating in the data commercialization boom, with an eye toward maximizing return on investment. This is not entirely new—we saw the same with **Landsat** (**NASA/USGS**) data and then **SPOT** (**CNES**) in the 1980s, though data is used for operational services, rather than research activities, as it was in the past.

Government satellites are producing more commercially viable data due to higher ground resolution and revisit times, which is increasing the number of government programs looking to commercialize data through dedicated entities such as the **Indian Space Research Organization** (**ISRO**) through **Antrix**; **KARI**, Taiwan, and **CNES** through the CNES-owned **SPOT Image**.

Finally, we are also beginning to see government military-civil, or dual-use, programs. Given the focus again on high-resolution data, these satellites also have commercial potential. With the completion of the four satellite **COSMO-Skymed** constellation in 2008, one meter radar will be commercially available at one day revisit time, with data sold commercially through Telespazio.

It is too early to tell which method for data commercialization will prevail—government commercial programs, dual-use, PPP and private companies—or, indeed, if this will vary by region.

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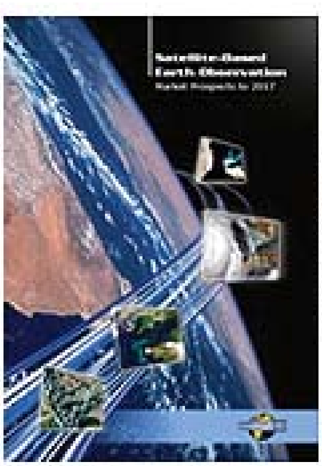
This, then, is a real period of transformation within the Earth observation sector?

Adam

Absolutely. New private and public actors, and new business models are revealing a re-shaping of the value chain. With increased operators upstream, consolidation downstream, and increasing vertical penetration, the traditional EO value-chain is radically transforming. This kind of change creates both opportunities and challenges for market players.

Manufacturers, for example, are gradually moving down the value chain, particularly in Europe and Canada, in an effort to access the value added business. For example, EADS Astrium has service capabilities through its Infoterra subsidiary. EADS Astrium Services is also likely to become majority shareholder of SPOT Image (it currently controls 40 percent of the company's shares) during 2008 and will take ownership control of the company from CNES.

MDA provides data and services through **MDA Geospatial Services**, formally **Radarsat International** and their service capabilities were recently bolstered by the acquisition of **Vexcel Canada** specializing in radar service solutions. **Thales**



Satellite-Based Earth Observation — Market Prospects to 2017

Satellite-Based Earth Observation, Market Prospects to 2017, a 140-page Euroconsult research report, provides a unique, in-depth analysis and benchmark of the Earth observation market from a satellite-based perspective. The report contains more than 30 full-page color graphs, benchmarks of government and commercial players in the value chain, and exclusive forecasts of satellite capacity, revenues from data sales and businesses...

similarly has data and service provision capabilities through **Telespazio**, a joint venture with **Finmeccanica**.

As virtual globes become more advanced certain 'basic' services previously handled by specialized service companies (such as applications in cartography and infrastructure planning) could be made available through the platforms, which may encourage data companies to rethink their portfolios and distribution methods.

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What else does the future hold?

Adam
The scenario of governments as primary customers for commercial Earth observation data (used mainly for defence purposes) is unlikely to change over the next 10-years. But with governments remaining stable anchor tenants, data providers will have the opportunity to develop commercial areas. Private operators are already diversifying their interests, with GeoEye and DigitalGlobe incorporating aerial data into their portfolios to provide complete geospatial solutions. Moves into the value-added market cannot be ruled out as part of a strategy to get closer to end-users. Furthermore, with government program (including emergent programs) satellites becoming more capable, there will be increasing efforts to find opportunities to commercialize data from these satellites.

Generally speaking, we are looking forward to a dynamic decade ahead: more satellites, different types of satellites, new actors in the private and public sectors, a changing value chain as established players expand their roles, and new technologies and distribution methods transform the sector, and growth in manufacturing and commercial data revenues. The only constant is change.

About the author

Adam is Senior Analyst for Earth observation and satellite services at Euroconsult. He is principal author for the report "Satellite-Based Earth Observation, Market Prospects to 2017", and contributes to several other Euroconsult reports and consulting projects.

The Hybrid Triple Play Is Here To Stay

by Patrick French

In the satellite industry, the word "hybrid" is used in reference to a variety of types of services. Often the context is some combination of satellite and terrestrial technology that is used to provide a service to an end-client. A typical example would be to use satellite to connect a remote location to a teleport, and then use fiber to backhaul the traffic from the remote site to another location, or for access to the greater Internet backbone.

There are about as many different variants on this concept as one can imagine. However, in all instances, the driving principle is to use the individual strengths of the satellite and terrestrial worlds, in order to come up with the most cost effective solution for a specific customer's needs. The whole point (after all) is not to expect that satellite and terrestrial services should always be in competition. Rather, that the services should find ways to be implemented in unison resulting in the whole is better than the individual parts.

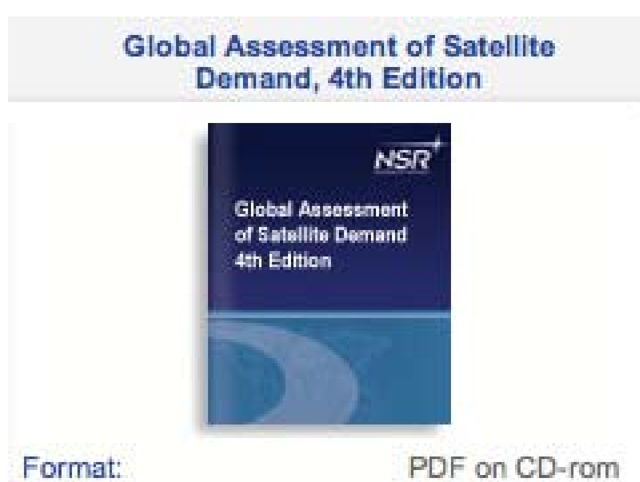
An interesting trend for bringing together satellite and terrestrial technologies has been debuting around the world for the last few years. NSR believes the acceptance of this hybrid architecture has reached a cusp that could move it from usage in a few limited circumstances, to a broad, new, and potentially large, emerging market for the satellite industry. This application is the Hybrid Triple Play. In short, NSR defines this application as using the broadcasting power of satellite for television, and the efficient two-way pipe of copper-based DSL for broadband Internet access and voice. This merges all three services onto one single box inside the consumer's home.

Those in the satellite industry are well aware that satellite broadcast of television content is the single, most cost effective way of delivering large quantities of video to a consumer's home. This is regardless of the customer's locale. However, satellite is less cost effective when it comes to competing head-to-head with cable modem, and DSL for broadband/voice services.

Conversely, bandwidth availability for a DSL based service is very much dependent on the distance that the client is from the *Digital Subscriber Line Access Multiplexer* (**DSLAM**). Telcos have been extremely successful in rolling out triple play services in high-density populated areas with good copper infrastructure. Yet the telcos face many hurdles when it comes to provisioning these same services to subscribers that are a bit too far from the DSLAM. The rapid growth in HD programming, and desire to offer a large selection of channels, means telcos quickly run into bandwidth problems even just a few kilometers from a DSLAM. Additionally, the cost of upgrading the infrastructure cannot always be offset by new subscribers because the services are provisioned to lower density areas.

An excellent example of the above issue for telcos is **Orange**, **France Telecom**'s broadband, mobile telephony, and IPTV service provider. France Telecom recently released press statements specifying, while it can offer DSL broadband services to the large majority of households in France, it can only offer its triple play service of broadband access, television, and telephony to about half of France's households. Those served are mainly in the city and town centers.

To keep growing their lucrative triple play services, Orange sought a way to quickly increase its addressable market without breaking the bank on infrastructure upgrades to its copper network. This was especially true in areas of the country where it would be a long time, if ever, before the company could recoup the investment. Further, Orange was under time constraints to reach a larger audience quickly, so it could profit by its recently acquired rights to **Ligue 1** football for the 2008 to 2012 seasons commencing this summer.



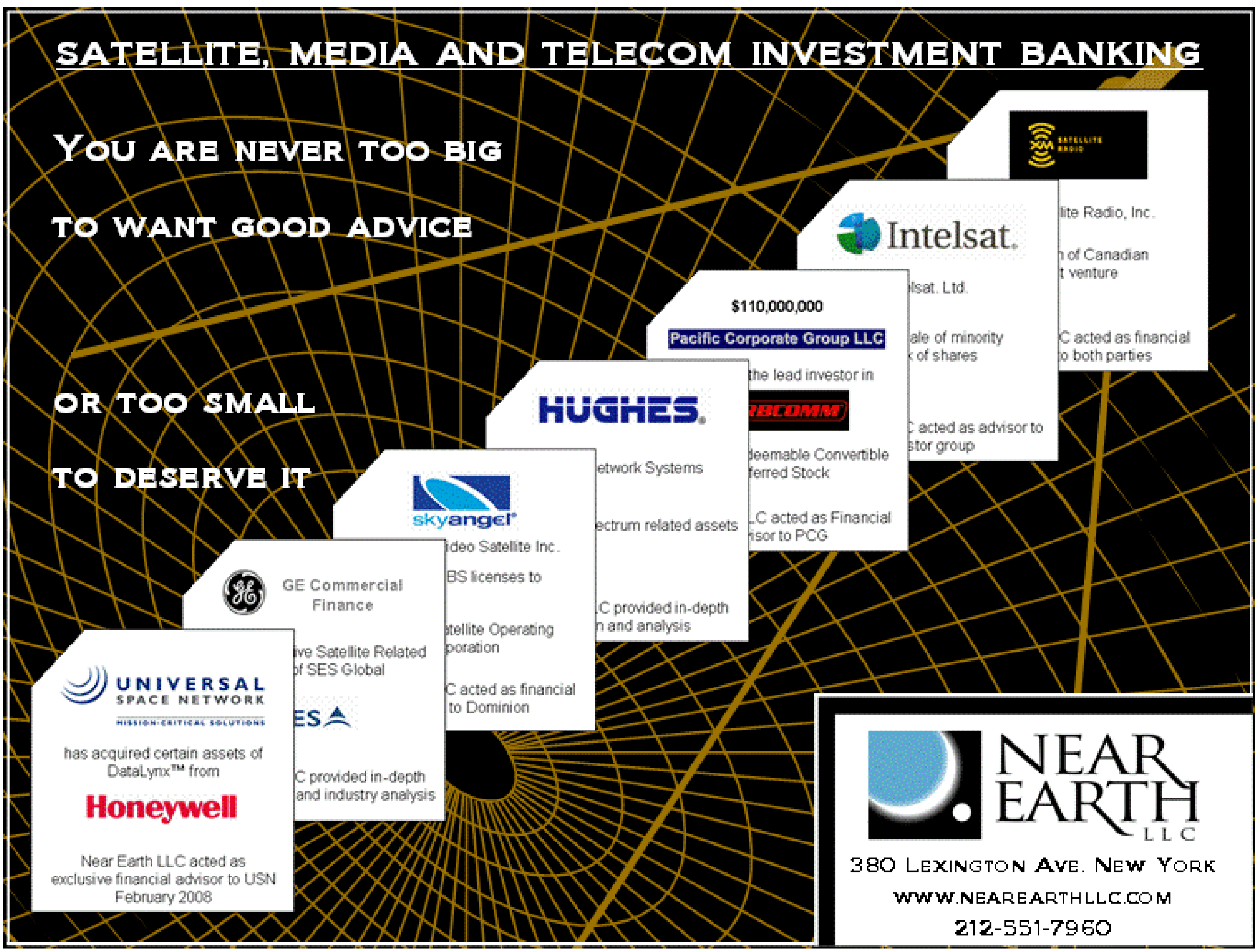
To overcome these challenges, France Telecom recently turned to Eutelsat to supply capacity on its Atlantic **Bird-3** and **Hot Bird** satellites. Using this capacity, Orange will begin to broadcast its **Orange TV** offer over satellite. They will have, essentially, 100 percent coverage of French households as of this coming summer.

For the end consumer, the result will essentially be invisible, at least inside their house, as all three services (broadband, TV, and telephony) will be integrated into a single box, just as if the consumer lived in a city center and subscribed to the current triple play offer. The only difference is that the television content will be fed into the box directly from a satellite dish on the outside of the residence, as opposed to being piped over the DSL copper infrastructure. Proving you *can* get what you don't see.

About the author

Mr. French joined Northern Sky Research in September 2003

and has since authored numerous studies, the most recent being the Global Assessment of Satellite Demand, 2nd. Edition and Broadband Satellite Markets 5th. Edition. He has sought to expand NSR's coverage of the satellite industry into areas such commercial satellite supply and demand modeling, video distribution and contribution, DTH, telephony and narrowband VSAT networks.



DVB-S2 ACM in Satellite Broadband

How Hughes "Coopetition" Contributed to Build the Second Largest Market for DVB-S2

by Carlos Placido, Analyst, SatCom, NSR

In March of 2008, Hughes Network Systems (HNS) announced having shipped 400,000 satellite VSAT terminals with DVB-S2 and Adaptive Code Modulation (ACM) capabilities. HNS shipments of DVB-S2/ ACM terminals now account for almost 30 percent of a cumulative 1.5 million broadband terminals ever shipped by the company. When seen in the overall satellite broadband context, it appears that DVB-S2 satellite broadband is well into the growth phase of adoption, with 2008 reaching a critical mass of shipments and semiconductor vendors fueling positive feedback toward new networks and replacements.

ViaSat and **iDirect**, among others, have also been active and have announced deployments and plans for DVB-S2. ViaSat has shipped DVB-S2 compliant terminals since 2006, and iDirect recently announced the successful evaluation of its new *eVolution* platform with DVB-S2 ACM support.

Hughes' leadership in the shipment of DVB-S2 satellite terminals with ACM is linked to the use of application-specific integrated chipsets (ASIC), network scale, and a first-mover advantage that dates back to the time when the DVB-S2 specifications were defined.

In 2003, Hughes demonstrated that a 1960s all-but-forgotten coding algorithm called *Low-Density Parity Check* (**LDPC**) was a better choice than turbo coding for the new DVB-satellite specification. It was believed that LDPC could achieve better performance than turbo coding and (more importantly) at a more efficient memory-to-CPU economic trade-off. The adoption of LDPC by the **DVB Forum** in the DVB-S2 spec caught leading semiconductor companies and set top box vendors off-guard. It gave HNS a timing advantage to license LDPC implementations to semiconductor companies and push ahead with the introduction of DVB-S2 with ACM.

Leading semiconductor companies naturally devoted initial efforts to the development of ASIC chipsets for the large broadcast sector seeking the efficiencies that DVB-S2 could bring in combination with MPEG-4 AVC, particularly for HDTV. DVB-S2 chipsets used in broadcast applications support only the Constant Code Modulation (CCM) mode of operation, which provides 25-30 percent performance improvements over DVB-S, but it is in the use of ACM where the largest gains are for unicast applications transported over rain sensitive Ka-band and Ku-band satellite broadband links.

Most satellite broadband vendors needed to rely on programmable chipsets (FPGA) for quicker time-to-market of ACM-compliant DVB-S2 satellite terminals. But higher component cost for terminals pushed the solution to the high-end of the users' spectrum.

As volumes increase, dedicated ASIC chipsets offer greater performance at lower cost—Hughes was the only vendor in 2007 with an ASIC-based solution. This situation is expected to change in 2008, as at least one leading semiconductor company is likely to diffuse the technology to a wider range of broadband vendors that will incorporate ASICs into less expensive DVB-S2 ACM satellite terminals.

One of the key aspects of HNS success in single site DVB-S2 satellite broadband is that the company was able to tap into a large base of users and a first mover advantage to gain an early lead. Its size allowed Hughes to afford the development of ASIC-enabled terminals because the company had also climbed up the learning curve substantially by the time it presented LDPC as a viable option within the DVB standardization efforts. Thus, HNS pushed for the inclusion of LDPC in the open standard and simultaneously benefited from its" know-how" in LDPC and scale as natural diffusion barriers.

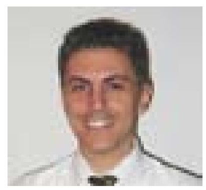
DVB-S2 with ACM can be considered "the holy grail" of industry standard performance in satellite modulation, but it is just one aspect of the satellite broadband business where vendors push to differentiate via proprietary extensions or through proprietary systems. DVB-S2 is not the only solution to ACM, and it was, in fact, introduced perhaps too late for the technology to have captured an even larger portion of the single-site broadband sector. At least two years before the first DVB-S2 ACM terminals hit the market

in 2006, IPStar and ViaSat had already developed proprietary ACM solutions to address the attenuation issues of Ka/Ku-band, limiting the market size for DVB-S2 satellite broadband primarily to new networks and upgrades to existing DVB-S based systems.

DVB-S2 effectively brings a quantum leap of efficiency to satellite broadband with the advantage of open migration because of backward compatibility with DVB-S. To smooth out providers' adoption of the technology, vendors will increasingly tend to ship satellite broadband indoor units with DVB-S2 forward compatibility regardless of the service provider's plans to make the transition to DVB-S2. This driver is gradually growing providers' installed base of DVB-S2 compliant end units and will erode the collective switching costs that deter providers from making a complete upgrade to the systems. With a growing base of DVB-S2 compliant terminals, the balance inclines towards faster ROIs facilitated by savings in satellite capacity, a situation that ultimately allows broadband vendors to capitalize on hub upgrades.

Satellite broadband and IP trunking is projected to be the second largest market for DVB-S2 equipment shipments, after DTH and satellite Free-to-Air (FTA) video, and is one of the applications analyzed by NSR in its recent report "*MPEG4 and DVB-S2: Assessing Implementation Schedules for Advanced Video Compression and Satellite Modulation*". Hughes' DVB-S2 is a good example of the opportunities that DVB-S2 will present to satellite broadband over the next five years and shows how "coopetition" can lead to reward maximization, building an early lead and pulling even farther ahead than through proprietary discontinuities.

About the author



Carlos Placido has more than 12 years of experience in consulting, program management, research and engineering, telecommunications and entertainment.

Russia: The Wild East of DTV?

by Chris Forrester

Russia's information technology and communications' business is already valued at 42 billion euros, an increase of 25.4 percent over 2006, and likely to top 50 billion euros in value by the end of this year. At every level, there's impressive growth. Some examples drawn from Russia's 49 million households (149 million people): computer ownership rising by 35 percent annually; Internet users up 40 percent annually; and, most importantly for us, the number of cable TV subs up 35 percent last year, and taking penetration beyond the main cities to 27.6 percent of the population.

Our data emerges from a major study of the Russian market that includes the *European Audio Visual Observatory* (**EAVO**), and data gathered and edited by Russia's **Groteck Co. Ltd.**, published in March 2008. The report reveals the growth in the average Russian's income, and the amount of disposable spending that now is directed into TV and communications. The sum typically totals 39.96 euros, of which the amount spent on TV is a miniscule (4.36 euros).

The domination of free terrestrial TV providing high quality content is a unique feature of Russia. Terrestrial broadcasting was the only method of delivery of TV signals to people up until the end of 1991 (before the disintegration of the USSR). The cost of access to terrestrial TV for households amounted to not more than 0.08 percent of the general average household costs (from 0.16 to 0.56 euros per month). The transition of terrestrial TV from analogue into digital format (in DVB-T standard) has been announced as being a government priority in Russia, according to EAVO.

Moscow control room, not quite state-of-the-art

Having selected the European standard for DTV, Russian market regulators now have to take into account the time constraints concerning Europe's transfer to digital broadcasting, and also European approaches to the organization of digital broadcasting. Russian operators have, so far, been mainly interested in the American model of television signal delivery to the population, as is apparent in the prevalence of satellite and cable television as the main modes of distribution of television channels. With such an approach, the players are following the opinion of leading experts such as former *Head of State Radio Institute and Academic Y. Zubarev*, regarding the Russian TV market.

They believe that terrestrial TV is only a necessity for a maximum of 10 to 15 percent of Russian households. All other households can be covered by satellite television (in particular when new players providing "economic" services emerge) and cable television, says the study.

In addition to planning for digital broadcasting, Russia's economic growth is, more or less, in place. Russia's GDP, when measured in U.S. dollars, has increased 5x in the last seven years, while the number of homes that can now be measured as 'middle class' has expanded to 20 percent of the population. A recent visit to Moscow and its suburbs revealed an significant rise in the quality of cars on the road, advertising hoardings, and billboards promoting high-end 'Western' merchandise, and an obvious increase in disposable income.

Left: Moscow city street in 1980
Right: Moscow city street in 2007

The total investment in transitioning Russia from an analogue broadcasting model to digital transmission is put at 10 billion euros during the period 2008 to 2015. Investment in digital cable TV is outside, and in addition to, this figure, and will focus on the usual ‘triple play’ benefits of TV, telephony, and broadband and exploiting *Data Over Cable Service Internet Specification* (**DOCSIS**), *Asymmetric Digital Subscriber Line* (**ADSL**) (and ADSL-2+) and Ethernet technologies.

Assessments of the market penetration of DTV in Russia differ. *The Ministry of Information Technologies and Communications* believes that DTV does not exist, in a practical sense, in today’s Russia. According to the study, the exceptions are several pilot zones where trials have been conducted introducing terrestrial television using the DVB-T standard. At the end of last year, some 2.5 million subscribers were viewing DTH satellite signals from the three main operators (of which there will be more later). Regarding cable TV networks (as of April 1, 2007), a minimum of one million subscribers viewed digital channels, which is 7.4 percent of the total number of cable TV subscribers. The Moscow subscribers of **STREAM TV**, who receive TV channels over ADSL with the use of IPTV technology, are included in this number.

According to expert estimations, as of December 31, 2007 the number of DTV subscribers within the cable networks had doubled to two million. fue to the aggressive policy pursued by such market players as **The Central Telegraph**, **AKADO** and **Corbina Telecom**, in connecting subscribers to DTV. More than 200,000 mobile TV subscribers (the largest operator is **MegaFon**), and those receiving TV using MMDS technology (the largest operator is **Cosmos TV**) also obtain TV channels in the digital format. In addition, there are about 100,000 DTV subscribers in the pilot zones where the introduction

	1992	1995	2000	2001	2002	2003	2004	2005	2006
Communication - total	0.1	21.4	146.4	195.7	269.9	395.6	540.3	659.9	833.7
including:									
Mail and special service	0.04	4.1	12,.5	16.5	21.3	28.7	34.3	42.7	53.6
Data services	0.01	1.0	8.2	13.0	14.9	25.6	37.3	48.6	63.8
Inter-city, local and international telephone communication	0.03	8.9	46.8	56.4	68.6	72.1	79.1	78.5	96.5
Local telephone	0.04	5.9	32.0	40.0	56.6	72.7	88.0	105.8	117.8
Radio communication, radio broadcast, TV and satellite communication, wire broadcast	0.02	1.5	6.8	9.3	11,9	15.9	19.0	25.4	28.7
Mobile communication	...	...	37.4	56.8	92.5	140.2	221.8	282.9	382.1
Connection and traffic transfer	...	...	...	...	...	34.6	54.8	71.3	85.0

Source: Federal Service of State Statistics, 2007

of the terrestrial DTV (DVB-T standard) was tested. This, everyone accepts, is a modest number and reveals how much more progress for the transition still has to be made in regard to cable (or satellite) TV. Terrestrial transmitters need replacing and almost every cable system has work to do in converting their infrastructure.

Terrestrial TV, other than the mentioned trials, has a huge task remaining, while cable TV is said to have a penetration base of 17 million, of which only two million are digitized. Satellite's 2.5 million subscribers are 100 percent digital, but progress is being made.

According to the EAVO report, "Telecommunication operators, who have entered the cable TV market, are the main accelerators of digital cable TV introduction in Russia. The share of digital broadcasting in cable television networks in Russia could reach 50 percent of all Russian households in 2008. IPTV technology is rapidly conquering the Russian pay TV market, despite the lack of consensus in the professional environment concerning the application of this technology in Russia. **J'son & Partners** forecast that over 1.1 million Russian households (over 2 percent) will receive their TV-signals via this technology by 2010."

Further IPTV progress can be made, continues the study, provided the modernization of Russia's antique telephony network proceeds as promised. Added to this is the current deployment of fiber-optic technology by firms such as **Golden Telecom** and **TransTeleCom**. One of the challenges the Russian economy has to face is the lack of reliable data. The report states bluntly that Russian government officials still use data drawn from 2001, and this doesn't help measure actual trends in the marketplace as far as telecommunications and broadcasting is concerned. The domination of free to air terrestrial channels, with high quality content, is a unique feature of Russia, while terrestrial broadcasting remained the only method for delivering TV signals to people to the end of 1991. The cost of access to terrestrial broadcasts for households amounted to not more than 0.08 percent of the general average household costs (from 0.16 to 0.56 euros per month), according to the report.

The number of households that use CATV networks to receive TV channels (both terrestrial and non-terrestrial) was estimated, by the end of 2006, to have doubled from 11.5 to 25 percent.

According to an **iKS-Consulting** report, the number of CATV subscribers in Russia reached 13.51 million (or 27.5 percent of the Russian households), as of April 1, 2007. The CATV Association believes that 70 percent of households in the large cities of Russia currently

have access to the CATV networks. According to data of the largest CATV operator of the country, **Mostelecom**, the number of subscribers exceeded three million (i.e. 100 percent of Moscow households receive terrestrial TV channels via the CATV system).
When correlating the data cited by analytical services, the largest CATV market players and the CATV Association of Russia one could estimate that the number of users (combined number of pay-TV subscribers and users of free of charge delivery of terrestrial TV channels through CATV networks) of CATV systems as a mode of delivery of TV channels in Russia amounted to 28 percent of households in 2007 (about 14 million households). According to a preliminary estimation of AKTR, the total number of satellite TV subscribers reached 2.5 million in 2007 (now exceeding 5 percent of the total number of households in Russia).

Pay vs. Free

Three models of TV broadcasting operate in Russia:

- **Government TV consists of the Federal State Unitary Enterprise comprised of ; All- Government State TV and Radio Broadcasting Company (FGUP VGTRK) with Russia, Culture and Sport channels;**
- **Free to air TV: free for the general public terrestrial channels, funded by advertising. There are 15 all-Federation channels operating in Russia, and also regional and local channels;**
- **Pay TV: CATV and satellite TV consisting of more than 600 market players**

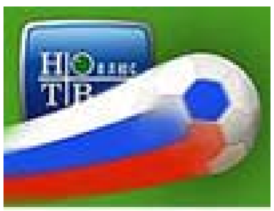
According to the senior management at the **All-Russia Government TV and Radio Broadcasting Company** (**VGTRK**), theirs is a corporation that performs special

Holding	Subscriber Base, thousands	Share in Total Subscriber Base
Nafta	4,616	34.2%
AFK 'Systema'/CMM	1,460	10.8%
Renova-Media	854	6.3%
Syazinvest	510	3.8%
ER-Telecom	405	3.0%
Multiregion	350	2.6%
Total:	8,195	60.7%

Source: iKS-consulting

Market share of the major cable businesses

functions in the area of TV and radio broadcasting. The Company has a double source of financing consisting of the state budget and advertising revenues with their budget financing amounting to 225 million euros in 2006. However, these funds are not used to support the Russia TV channel (financed via advertising). The Company's advertising revenues amounted to 386 million euros in 2006, and the sale of rights' revenues amounted to 40.2 million euros. The main sources of expenses of the Russia TV are programming, management costs, and communication services payments. The Company's expenses amounted to 369 million euros in 2006. *Thus, the gap between income and expenditure amounted to* 56,9 *euros in 2006. According to OBIDA, the rate of return totaled 51 percent in* 2006.



NTV, Russia's major payTV operator

The VGTRK has 86 regional stations (subsidiaries owned 100 percent by VGTRK which, prior to 2000, were independent broadcasting companies) that transmit via terrestrial more than three hours of information channels. It means that the VGTRK produces more than 250 hours per day exclusively regional information broadcasts. The main paradox of the Russian Government TV is that the operation of the main state TV channel, the Russia TV channel, according to the Company is not financed from the budget funds, but from advertising revenues.

Russia's current publicly funded sector is indebted to the actions of former president, *Vladimir Putin* (now Prime Minister). Most of the changes occurred in 2000. **NTV TV** was formerly controlled by *Vladimir Gusinsky* who is now in exile. The network was then passed into the ownership of **OAO**, better known as **Gazprom**, Russia's largest business, in which the State holds more than 50 percent of its shares. **ORST-TV**, a broadcaster that had been controlled by *Boris Berezovsky*, who is also now living in exile, was absorbed

Operator	Number of Subscribers	Expert Indicator of Monthly ARPU (EUR)	Total Annual Subscriber's Payments of (Max) (EUR million)	Total Revenue with Reference to Expert's Corrections (EUR million)
NTV+ Satellite TV	500,000	23,8	143	115,2
Cable pay TV operators (both analogue and IPTV)	5,400,000	2,3	154,5	182,3
Other pay TV operators, including mobile TV, cosmos TV, etc.	60,000	15,8	11,4	11,4
Cable TV users paying "Token" payment for access to terrestrial TV channels	6,540,000	0,79	62,3	62,3
TOTAL				371,4

Source: Groteck Co.

Turnover of the Russian Pay TV Market in 2006
(on the basis of expert estimations of monthly ARPU)

into OAO as its Channel 1, and thus 51 percent is also owned by the State.

Ren TV is currently owned by a supporter of the Kremlin, the head of **Severstal**, *A. Mordashov*; the head of **Surgutneftegaz**, *S. Bogdanchikov*; and **IK Abros**, a subsidiary of the **St. Petersburg Bank Russia** (the owner of the latter is *Yu Kovaltchuk*); together with the well-known media group, **RTL Group**.
The same triumvirate of Russian businessmen owns a new all-Federation TV Company Channel 5, the establishment of which is currently in progress, according to the report. This Channel 5 (otherwise known as **TRK St. Petersburg**) won the tender for 29 frequencies under the strategy for *Nationwide Channel of Russian Regions* on November 30, 2006. This enabled the Company to become one the largest federal networks broadcasting in 75 cities, including St. Petersburg and Moscow.
There are other Russian terrestrial channels with less influence on the population due to minor audiences and coverage. They are also controlled by the companies loyal to the government: **Interro**' (*V. Potanin*), **Gazprominvesthilding**' (*Usmanov*), **Alpha-Group** (*Friedman*); or such companies that are directly owned by regional governments (e.g. 100 percent of **TV-Center** and **TV-Center Stolitsa** is owned by the Mayor's Office of Moscow) and federal structures (51 percent of shares of **Zvezda TV** channel is owned by the **Federal State Unitary Enterprise, Uniform TV and Radio Broadcasting System of Armed Forces of RF**).

Pay TV Operator	Amount of Received Payments (EUR million)	Market Share
NTV+ Satellite TV	115,2	31%
Cable pay TV operators (both analogue and IPTV) either providing services of pay TV, or receiving payment for access to free terrestrial channels	244,7	65.9%
Other pay TV operators, including mobile TV, cosmos TV, etc.	11,4	3.1%
Total	**371,4**	**100%**

Source: Groteck Co.

Market share of the main payTV players (2006)

Thus, as far as the free-to-air TV sector is concerned, these terrestrial channels are shareware (people pay 0,7 euros for so-called common antenna, and people who use an individual antenna pay nothing at all).

Additionally, the government controls TV channels either directly (Channel First, TVTs, Zvezda), or through loyal business structures (NTV, Ren-TV, STS, etc.). The free-to-air TV sector constitutes the core of the government's television policy, and receives funds from the federal budget to broadcast signals to urban and rural areas. Total revenues of the free-to-air TV sector (advertising revenues of federal and regional terrestrial channels) amounted to just over 1.8 billion euros out of total TV advertising revenues of 2.1 billion euros.

Pay TV's State of the Market

Russia's Pay TV market has passed through several stages of development. At first, it was controlled by the satellite TV operators, who controlled 100 percent of the paid subscribers. The major operator, NV+, was established by the former media tycoon, *Vladimir Gusinsky* as a business project.

The core of the business consisted of premium-class services: provision of access to exclusive (not broadcast free-to-air) content for the well-to-do audience. Primarily, this included cinema and TV films and sport programs.

An additional motivation for connection to the NV+ involved the opportunity to receive a complete package of all Federation-wide channels in areas outside the cities. The number of paid subscribers of NTV+ is presently approaching 600,000. The Company has the highest ARPU (Average Revenue Per User) among all the payTV operators, about 25.2 euros.

In parallel to NTV+ expansion, those cable systems in the city, district, and in-house cable TV networks also began to develop. At first, entrepreneurs provided free access to cinema films, and afterwards they introduced payment. Finally, they began to offer subscribers packages of all Federation-wide channels.

The turning point for the cable TV market occurred in 2005, with a large amount of powerful investments entering the sector. The process of acquiring regional companies and establishing large Russia-wide holdings has also started. As of April 1, 2007, six large cable TV operators controlled more than 60 percent of the total subscriber base in Russia.

The turnover value of the pay TV market in Russia, and the number of Russian citizens paying subscription fees for watching TV channels, is a further source of disagreement between the main analysts of the Russian cable TV market. The iKS-consulting company claims that 12.5 million households used payTV services in Russia in 2006 (24.4 percent of 49 million households of Russia). The J'son & Partners report cited two different values for the end of 2006: 5.17 million and 6.6 million households that use pay TV services in Russia. The figures for the aggregate revenues of the cable TV operators as stated by the analytical companies are also contradictory, suggests the EAVO study.

The principal market players fail to share the optimism of JP and iKS with regard to degree of penetration of cable TV into Russian households. For example, representatives of the **National Cable Networks** (belonging to the largest cable TV holding **Nafta**) believe that, by 2010, the pay TV penetration in Russia shall reach 10-15 percent. This implies that between 4.9 and 7.35 million Russian households will use the pay TV services. The EAVO study says the actual number of Russian payTV subscribers can be estimated at about six million. This figure is based upon the following J'son & Partners data: as of the beginning of 2007, the paid subscribers of satellite TV reached 9 percent of the pay TV subscriber base. If it is assumed that the number of the NTV+ subscribers (about 500 thousand at the beginning of 2007) and Cosmos TV (about 50 thousand at the beginning of 2007) is the aggregate figure of the paid satellite TV subscribers, one may state with more confidence that the six million who are subscribers to pay TV at the end of 2006 proves would be a correct figure. Furthermore, the main market players agree on the estimated share of the subscribers of the satellite pay TV within the total subscriber base of the pay TV.

Operator	Declared Amount of Investments in Development of Broadband and Triple Play
Svyazinvest: in modernisation of its own network	€1,82 billion*
TransTelecom: in development of networks of broadband subscriber access	€364,4 million**
Golden Telecom: in development of networks of broadband subscriber access	€182,2 million***
Mass-media and Comstar-OTC system: in development of Stream TV networks acc. to ADSL technology	€36,4 million
Renova-Media: in development of 'ACADO' network of broadband access acc. to DOCSIS technology	€116,6 million
Central Telegraph Office: in development of broadband access network acc. to MetroEthernet technology	€109,3 million
Nafta: in modernisation of cable network of Moscow CATV operator 'Mostelecom'	€102 million****
TOTAL	**€2,73 billion**

Source: Groteck Co.

Largest Declared Investments of 2008 in Development of Networks for Broadband Access and Triple Play Services

The market players also agree that the cable TV operators service about 90 percent of subscribers, and less than 1 percent fall into other types of pay TV services. **Groteck** company analysts estimate that the turnover of the Russian pay TV market in 2006 was 365 to 373 million euros.

Our estimations, says the EAVO study, concur with the opinions of the senior management of the main cable TV holdings that the pay TV market size will reach US$650 in 2007 and increase by 40 percent compared to 2006 (in particular, the head of ER-Telecom Holding, *A. Semerikov*, announced such a forecast at a *MultiPlay Forum of Operators* organized by Groteck.

Channel	Owner
The First Channel	Open Joint Stock Company "The First Channel", 51% of shares belong to the state
Rossia	«Russian State TV/Radio Company» (Federal State Unitary Enterprise)
NTV	Gasprom-Media
CTC	CTC Media (Modern Times Group (40%), "Alfa-Group" (26%), Foundation Baring Vostok Capital Partners (9%), 25% of shares are offered for sale at NASDAQ)
TNT	Gasprom-Media
TV-Center	OJSC TV-Center, 100% of shares belong to the Government of Moscow
Ren-TV	30 % belong to the large German media RTL Group, 70% had been divided between Severstal group and the Bank of Russia. The number of shareholdings has not been disclosed.
Cultura	Russian State TV/Radio Company, the state holds 100% of shares (Federal State Unitary Enterprise)
DTV-Viasat	Modern Times Group (Sweden)
Domashny	CTC Media (Modern Times Group, Sweden (40%), "Alfa-Group" (26%), Foundation Baring Vostok Capital Partners (9%), 25% of shares are offered at NASDAQ)
TV-3	Prof-Media (100% of shares belong to "Interros")
Sport	"Russian State TV/Radio Company", the state holds 100% of shares (Federal State Unitary Enterprise)
2x2	Prof-Media (100% of shares belong to "Interros")
TV-Stolitsa	OJSC TV-Center, 100% of shares belong to the Government of Moscow
Muz TV	75% of shares belong to Alisher Usmanov, the owner of the "Commersant" Publishing House, The General Director of "Gasprominvestholding"
Zvesda	51% belong to FSUE «Unitary TV/Radio Broadcasting System of Armed Forces of Russian Federation»
MTV	Prof-Media (100% of shares are owned by "Interros"»)
7TV	50% of shares belong to Alisher Usmanov, the owner of the "Commersant" Publishing House, the General Director of "Gasprominvestholding»

Source: Groteck Co., 2007

Major terrestrial broadcasters — Russia's main TV players

Future Plans

In spite of the intentions of many influential market players (in particular, FGUP RTRS) to obtain budget funds for the modernization of on-land infrastructure used to distribute TV signals, the Government of the Russian Federation chose the way of a government-private partnership in the Concept of development of TV and radio broadcasting in Russian Federation in 2008-2015 approved on November 29, 2007. (If the Russian government wishes to finance any project, they first of all create and confirm a "Concept", then create and confirm a Federal program and then request financing), relates the EAVO report.

The Concept specifies that: "Construction of the TV broadcasting networks shall be performed on the basis of the market players' funds, and the government shall develop an easily understood and acceptable legal framework that meets the requirements of broadcasters, operators and consumers of TV broadcasting services."

The "expansion of the manufacture of TV and radio broadcasting equipment, the creation of new production capacity and involvement of excess capacity, the creation of additional employment positions, including those in research and engineering activity" were declared as being some of the targets of DTV implementation in Russia within the Concept.

This could mean that the government may allocate substantial amounts out of the Investment Fund to invigorate the production of Russian TV equipment. Experts consider that the Russian Technologies Corporation will be one of the front-runners for investments. The Corporation was founded at the end of 2007 to design, produce and export high-technology products.

To implement the Concept it is necessary to carry out a conversion of the radio-frequency spectrum in Russia. According to the **Comnews** analytical agency, about 35 percent of the spectrum ranging from 174—230 and 470—862 MHz assigned for digital broadcasting are presently occupied by radio-electronic means (REM) for military purposes. A further 30 percent of these bands are jointly used by both REM and radio-electronic means for civil purposes.

The Government Spectrum Commission terminated the allocation of bands for TV Broadcasting on December 17, 2007, until a new plan of spectrum allocation is developed. The Plan is scheduled for approval in the first half of 2008. The issue of licenses for digital broadcasting may start at the beginning of 2009, says EAVO. There's also scope for private investment, and the Ministry of IT & Communications is looking to attract at least $3.8 billion of private investment in digital, terrestrial TV.

However, and as far as this report is concerned, the declared plans contain no reference to investments of the largest players of the telecommunication and cable TV markets in the development of terrestrial digital broadcasting. The private investors focus on other methods of delivering the TV signal to viewers.

Satellite TV

The rapid growth of the number of satellite TV subscribers in Russia leads to optimism for the PayTV market players as, according to the results of 2007 (estimates of the *Russian Cable TV Association*), the number of satellite TV subscribers exceeded 5 percent of Russian households and reached 2.5 million.

The growth of the subscriber base of NTV+ reached up to 700 thousand people (preliminary estimates) and shows that solvent demand for content of a premium class, which costs more than 21.8 euros per month, constantly increases.

On the other hand, the unprecedented growth of the subscriber base of new operators of satellite TV (**Tricolor TV** and **Orion-express**), which provided a cheaper variant of satellite television at the price of 14,6 euros, where number of subscribers reached 1,8 million within the first year of the work of these operators, is an indicator of great demand for services of first-hand satellite broadcasting and a quite high potential for its development.

Experts, says the EAVO study, indicate that satellite operators have already exceeded the threshold of 1 to 2 percent of households utilizing satellite television, which was estimated by the Ministry of Information Technologies and communications. They will continue to expand their subscriber base.

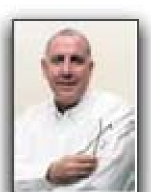
The main factors, which will promote an expansion of the subscriber base of satellite operators (first of all, operators, which provide "economical" services), include the development of an economical model for equipment renting (with monthly payments, which do not exceed 1,42 euros), according to experts.
In this case accessibility of satellite television in Russia will expand significantly.

At present experts cite the high price (over 182 euros) for equipment to receive satellite television as being the main obstacle to the business development of operators, which provide "economical" (cheaper) services.

Satellite television, which broadcasts in digital format and has started experiments in the provision of services on broadcasting of TV channels of high definition (by NTV+), is one of the main stimulators of DTV development in Russia.

*We acknowledge, with thanks, the extensive use of the **European Audio Visual Observatory**'s study on Russia and its DTV forecasts.

About the author
London-based Chris Forrester is a well-known entertainment and broadcasting journalist. He reports on all aspects of the TV industry with special emphasis on content, the business of film, television and emerging technologies.



How Countries Invest In, And Benefit From, The Space Industry

The 50-year anniversary of the launch of Sputnik, humanity's first venture into space, served to refocus global attention on the enormous progress made since the dawn of the Space Age. While space-related government programs and business activities have been more evolutionary than revolutionary on the whole throughout this era, human space activity has also been defined by sudden surges or changes driven by emergent forces.

In the 1950s, the Soviet Union's unexpected entry into space caught the United States off guard. This prompted a major, national initiative to catch up technologically that permeated even into the classrooms of US schoolchildren. In the 1960s, the ongoing Cold War dynamic fueled a decade-long "space race", culminating in the successful US landing of humans on the Moon. In the 1970s, Asia asserted its space presence, as Japan, China, and India built on rocket tests during the prior decade to develop launch vehicles with indigenous technology. In the 1980s, the tragic *Challenger* accident called the US Space Shuttle program into question and encouraged alternative launch vehicle development efforts.

In the 1990s, the telecommunications boom led to a surge in space and satellite activity that provided, for the first time, a sustained rationale for a global space industry segment, based mainly on commercial, rather than government, imperatives.

The collapse of that telecommunications boom in the 2000s, combined with a radically altered strategic environment for governments and militaries across multiple countries, has led to space industry restructuring, changes in government space priorities, the entry of small and agile private companies into the commercial space mix, and mounting international competition that has influenced all aspects of human space activity.

Against this backdrop, key strategic questions emerge that will define how the world engages in space in the future. In today's rapidly changing space environment, how competitive are traditional space powers such as Russia, the United States, and Europe? What role will emerging space powers such as China and India play? Will Japan aspire to a larger role in space, or continue in its more secondary position? What is the competitive role for lower-tier space participants, including Israel, Canada, South Korea, and Brazil?

As the space economy diversifies, both in the globalization of space enterprise and the expanding number of countries engaging in space activity, decision-makers will require a more sophisticated understanding of the strategic, economic, and societal advantages of space industry. Factors requiring understanding include how to work the key levers of space power; how should leadership in space should be qualified; and how will space competitiveness be measured across military, civilian, and commercial sectors.

To address these questions, Futron Corporation has developed a Space Competitiveness Index (SCI) to examine the underlying economic determinants of space competitiveness across 40 individual metrics. Together, these elements provide a cogent and holistic framework for assessing national space competitiveness and assess national space competitiveness in three major dimensions: government, human capital, and industry. This approach has allowed Futron Corporation to produce an in-depth comparative analysis of 10 leading nations in space and space-related activity.

In addition to its country-level analysis, Futron's 2008 Space Competitiveness Index also examines the competitive dynamics of three global industry segments of particular interest to the international space community: the military space arena; the positioning, navigation, and timing (PNT) sector; and the Earth observation (EO) market.

Futron's 2008 Space Competitiveness Index ranks the relative competitiveness of the 10 leading space nations in each of these three segments, and also surveys the broader strategic challenges and opportunities that each global industry segment presents.

Why Have a SPACE Competitiveness Index?

Currently, much of the vision surrounding the next generation of space missions and technology is tied to the perceived "second race to the Moon" and beyond. This civilian theme is complemented by an ongoing discussion about the military facets of space activity, as well as the role of both current and emerging commercial enterprises in space access and exploration.

Together, the civilian, military, and commercial space sectors focus the broader space discourse around questions about the elements of space competitiveness, the relative competitive position of traditional space leaders, and the role of emerging space powers such as China and India. This study, and its future updates, seeks to address pivotal strategic questions about space power and competitiveness:

- **What are the core measures of space competition?**
- **Is "space nationalism" on the rise, and if so, what are the implications?**
- **What is the current positioning of traditional space powers like the US, Europe, and Russia?**
- **What role will emerging powers such as India and China play? Partners or competitors?**
- **What is the competitive role for lower-tier players like Japan, Brazil, Israel, and others?**

- What are the implications of a multi-polar space community?

- What are the economic consequences of a commercial space environment based on multiple international providers of key technologies, systems, and services?

A brief overview of key findings is provided below.

2008 Space Competitiveness Index

Current Positioning

- The United States (US) is the current leader in space competitiveness, followed by Russia, Europe, and China

- The US leads significantly in each of the major categories: government, human capital, and industry

- Russian space power is resurgent, ending its decline following the fall of the Soviet Union

- Europe increasingly acts in concert via joint policy, multinational corporations, and the development of "European markets"

- China is emerging as a major space power with ambitious and visionary goals backed by heavy investment, centralized decision-making, and techno-nationalistic programs

- India is poised to be a major collaborative player, and is a global leader in remote sensing

- Canada's space program benefits from strong European and US relations, as well as solid human capital indicators, positioning it for advancement if space is more highly prioritized by national decision-makers

- Japan has overcome recent difficulties and continues to be an important player focused on the exploration and earth observation segments

- South Korea has significantly ramped up its space program, but its space sector remains small and immature

- Israel continues to be a leader in space technology but has limited commercial scale

- Brazil has seen its position decline relative to other leading space nations, and lacks a clear strategy and commitment to invest in space activities

2008 Space Competitiveness Index

Total Aggregate Scores by Country

- Ability for Government to Provide Structure, Guidance and Funding

- Transparency regarding space strategy, policy, and spending remains a significant issue with some countries, particularly in connection with military space activity. This reduces the ability of commercial space actors to optimize investment and participation in the industry

- The US has the most robust government policymaking structure, which includes detailed strategies for military, civilian, and commercial applications

- The US also spends more money—both military and civilian—on space capabilities, although investment is skewed toward military budgets

2008 Space Competitiveness Index

Government Scores by Country

- European governments, through the European Union (EU) and the European Space Agency (ESA), have well developed policymaking structures and are increasing spending, particularly within the civilian and commercial spheres

- Japan recently reorganized its space agency and is considering significant updates to its space law

- Ability for People to Develop and Use Space Applications and Technology

2008 Space Competitiveness Index

Human Capital Scores by Country

- **There is significant concern within industry and government regarding the development of adequate human resources supporting the space sector, particularly technically skilled personnel such as engineers**
- **Data regarding human resources within the space industry is sparse, and lacks consistency across countries**
- **Usage of and reliance on space-enabled services is skewed towards larger, advanced economies, particularly with the introduction of new satellite services, such as navigation and two-way Internet access**
- **Canada ranks well in human capital indicators due to its strong academic network and large number of university aerospace programs and civilian research centers**
- **Civil society interest and support is widespread, with a significant number of organizations throughout Asia, Canada, the EU, and the US, many of which have international components**
- **Ability for Industry to Finance and Deliver Space Products and Services**

2008 Space Competitiveness Index

Industry Scores by Country

- **Satellite communications is the one market segment that is principally in the hands of the private sector**
- **There is a significant increase of commercial interest in Earth observation, as well as a rapidly rowing downstream market based on the US-operated Global Positioning System (GPS)**
- **Despite its perceived export control burdens, the US commercial space industry is the clear leader, followed by Europe**
- **Despite the relatively high overall position of Russia and China, the government sector dominates their national space industries**
- **China has outlined a strategic objective to stimulate commercial space activity, but has not yet developed the legal and regulatory structure to support this goal**
- **Israeli space activities remain dominated by state-owned companies, but there are a number of small component manufacturers and entrepreneurs seeking venture capital**

The remaining portion of Futron's *2008 Space Competitiveness Index* study features 70 pages of research with six sections and an introduction and a conclusion, ranging from country-by-country profiles to global military space, PNT, and EO segments.

Conclusion

A convergence of space technologies combined with a divergence of space actors—among both national space agencies and commercial space companies—is stimulating competition, creating new products and services, and driving innovation throughout government, business, and society. As a result of these dramatic and worldwide changes to the information and communications landscape, access to space and space-based assets are no longer viewed as a luxury, but rather as a strategic necessity. Understanding space competitiveness, including government policy, human capital, and industrial innovation, is a daunting task—yet a vital one for national technological and economic strength.

Here's Looking... At Everything!

(Commercially Speaking) — Satellite Imagery

This is PART ONE of a multi-part, monthly series whose subject is the commercial side of satellite imagery, or, if you prefer, remote sensing...

by Hartley & Pattie Lesser
and a cast of dozens of subject-specific experts

The world our grandparents, fathers, and mothers experienced was far larger than the world we occupy today. Faster vehicles have sliced distance to the point where a trip overseas requires little in the way of second thought ... (except as to exactly what we must pack). Communication with other countries is a snap—areas of the globe once the domain of intrepid explorers and the ink-smudged fingers of cartographers are now mapped quickly, and in high resolution — by satellites.

What is now so easily downloaded for viewing on your computer screen, your mobile device, and your GPS unit, first had to be captured, in most instances, by the instruments resident within a satellite.

Such imagery capture is far from instantaneous — a satellite captures raw data and requires various applications, as well as revisits, to ensure a complete picture of any area.

Applications of various algorithms are required to then morph that data into a usable image. Other location data sets require the satellite image be spatially rectified and combined with raster or vector data. The databases that process satellite images are enormous in size—to produce a usable image is time consuming. In addition to the amount of time required to create a viewable image, weather can also hinder a satellite's quest for data. Frequent cloud cover over mountaintops is especially difficult, as spacecraft's current generation of instruments have difficulty penetrating thick weather blankets.

Different satellites offer various image resolutions. For example, the WorldView-1 satellite is able to credibly distinguish between objects on the surface that are at least 50 centimeters apart. This is a 50-cm resolution, and there are some smaller areas of the globe offering 10-cm resolution. There are panchromatic images, multispectral images, and the list goes on and on...

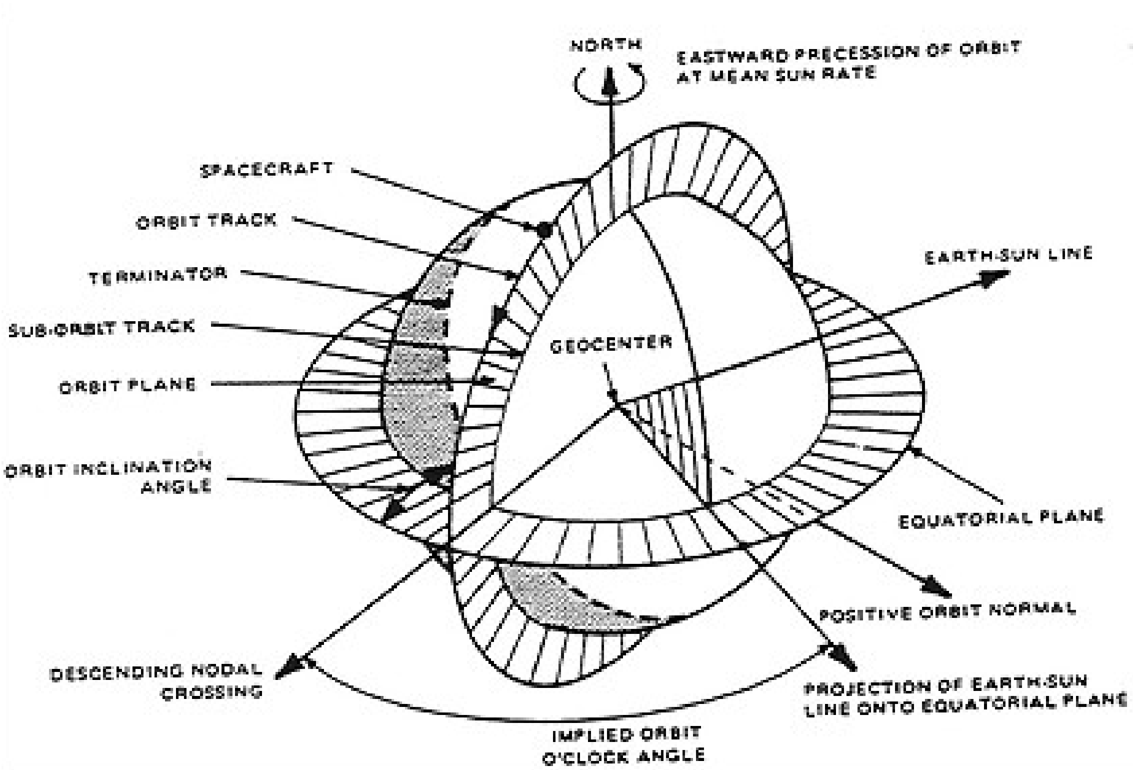
Remote sensing means just that—remote. Data is acquired without being in contact with the target. The information is collected through the use of various sensors. As the sensors are not in direct contact with their targets, data can be obtained regarding inhospitable or dangerous areas, locations where other means of information acquisition simply could not occur. For example, such would include data acquisition for military operations over hostile areas, or data assembly of areas surrounding active volcanoes. Additionally, satellites do not disturb the areas where data is being acquired.

Remote sensing may be categorized as either passive or active. For the former, a target area may reflect or emit natural energy (radiation), which is observed and recorded. Active remote sensing encompasses technology such as radar, where energy is emitted onto the target area and the reflective radiation is captured by a passive sensor and measurements obtained. Earth observation satellites capture multiple wavelengths of electromagnetic radiation to record landmass, called thematic mapping. Other satellites use interferometric synthetic aperture radar for the creation of digital elevation models involving the mapping of large-scale terrain areas. Additional sensors used include photometers and radiometers. They capture visible and invisible infrared, microwave, gamma ray and, sometimes, ultraviolet frequencies. Some sensors can also capture the data required for conversion by software applications into stereo pairs for topographic map creation.

Once the data is collected, processing is required. The quality of the final product is dependent upon a variety of resolutions. Spatial resolution, spectral resolution, radiometric resolution, and temporal resolution are all considerations for the final product. This data must be extrapolated in relation to a reference point and includes distances between known points on the ground, which is highly dependent upon the sensor type being used. This is called georeferencing, where data is tied to a real-world coordinate system. The images may then need to be corrected, with scale given to pixel values and each frequency band being rescaled to eliminate the haze of the atmosphere.

SSO

SSO is the acronym for sun synchronous orbit. This orbit



is designed to enable the satellite to always pass over a location at the same solar time. This term is used constantly when discussing remote sensing satellites. The SSO illustration on page 34 is courtesy of **NASA's** *Landsat-6 Programming and Control Handbook*, with more information at the Landsat-6 Handbook website.

GIS Matters

Another constantly used acronym you will frequently encounter is GIS. This is the acronym for geographic information system. A geographic information system (GIS) integrates hardware, software, and data for capturing, managing, analyzing, and displaying all forms of geographically referenced information.

GIS allows us to view, understand, question, interpret, and visualize data in many ways that reveal relationships, patterns, and trends in the form of maps, globes, reports, and charts. **ESRI**, a company that's been in business since 1969, is the fourth largest, privately-held software company in the world, and they design and develop GIS technologies. They offer our readers the following information regarding GIS... all images are courtesy of ESRI.

Three Views of a GIS

A GIS is most often associated with a map. A map, however, is only one way you can work with geographic data in a GIS, and is only *one* type of product that can be generated by a GIS. A GIS can provide a great deal more problem-solving capabilities than using a simple mapping program or adding data to an online mapping tool (creating a "mash-up").

The Database View

A GIS is a unique kind of database of the world—a geographic database (geodatabase). It is a "Geographic Information System." Fundamentally, a GIS is based on a structured database that describes the world in geographic terms.

The geodatabase is the common data storage and management framework and can be used wherever it is needed—on desktops, in servers (including the web), or in mobile devices. It supports all the different types of data that can be used by various GIS programs, such as ESRI's ArcGIS software. The geodatabase offers you the ability to:

- **Store a rich collection of data types in a centralized location.**
- **Apply sophisticated rules and relationships to the data.**
- **Define advanced geometric relational models (e.g., topologies, networks).**
- **Maintain integrity of spatial data.**
- **Work within a multi-user access and editing environment.**
- **Integrate spatial data with other IT databases.**
- **Easily scale your storage solution.**
- **Support custom features and behavior.**

The Map View

A GIS is a set of intelligent maps and other views that show features, and feature relationships, on the earth's surface. Maps of the underlying geographic information can be constructed and used as "windows into the database" to support queries, analysis, and editing of the information.

The Model View

A GIS is a set of information transformation tools that derive new geographic datasets from existing datasets. These geoprocessing functions take information from existing datasets, apply analytic functions, and write results into new derived datasets.

By combining data and applying some analytic rules, you can create a model that helps answer the question you have posed. GPS and GIS were used to accurately model the expected location and distribution of debris for the Space Shuttle Columbia, which broke up upon re-entry over eastern Texas on February 1, 2003.

Together, these three views are critical parts of an intelligent GIS and are used at varying levels in all GIS application GIS manages, analyzes, and displays geographic knowledge, which is represented using a series of information sets. These sets can include:

Maps and Globes

Interactive views of geographic data to provide answers to many questions, to present results, and to use as a dashboard for real work. Maps and globes provide advanced GIS applications for interacting with geographic data.

Geographic Datasets

File bases and databases of geographic information—features, networks, topologies, terrains, surveys, and attributes.

Processing and Workflow Models

Collections of geoprocessing procedures for automating, and repeating numerous tasks that perform analysis.

Data Models

GIS datasets are more than RDBMS tables. They incorporate advanced behavior and integrity like other information systems. Data models—the schema, behavior, and integrity rules of geographic datasets—play a critical role in GIS.

Metadata

Documents describing the specifications and properties of the data. A document catalog enables users to organize, discover, and gain access to shared geographic knowledge.

ESRI has a great deal of information available regarding GIS and how they apply their technologies in this highly technical field.

To find out more about ESRI and their applications as well as remote sensing, we recommend you head over to their well-designed websites at www.gis.com and www.esri.com for additional information.

GIS + The World Of Homeland Security

The analysis of the GIS (Geographic Information Systems) market continues, with estimation by **Daratech** in April of 2008 that estimated such worldwide revenues were 3.63B/USD in 2006.

Their thoughts also encompass the ever-increasing interest of the **Department of Homeland Security** (DHS) and that agency's realization of what remote sensing and geointelligence may be able to accomplish to help meet their objectives.

Expect DHS' interest and healthy budget to increase the remote sensing market as well as those who produce the tools for this business, which enable users to obtain the maximum use possible from the GIS data. In 2006, this vertical software accounted for 50 percent, data ranged at 25 percent, and GIS services at 20 percent of the market. Based in Cambridge, Massachusetts, Market Research Analyst may be accessed at their website.

Why the increased attention on DHS?

Homeland Security Market Research offers expertise for global clients to help them gain insight into the business opportunities that exist within the Homeland Security market. With nearly 300 private clients, including Fortune 500 companies, security decision makers, and government agencies, this research and analysis firm offers the following at their website:

The National Applications Office, which is a new DHS body; clears access of law enforcement, border security, Coast Guard and other agencies to critical satellite feeds. This move, while generating wide discussions over privacy issues and legal implications, may also have a profound impact on the market for commercial satellite imagery. Currently access to satellite feeds is mostly in the domains of DOD and Intelligence Community. On the DOD side, **Strategic Command** coordinates all military and civilian space assets, while **Air Force Space Command** acquires and operates the majority of military satellites. The **National Reconnaissance Office** (**NRO**) operates the nation's intelligence satellites, often known as *National Technical Means* (**NTM**).

Entrance of DHS into the sea of satellite information opens a window of opportunity for the vendors of commercial satellite imagery.

A report by Homeland Security Research Corporation *2007-2011 U.S. Homeland Security (Government & Private) Market Outlook* forecasts that the U.S. Homeland Security markets, driven by the government and private sectors, will grow from about 24B/USD in 2006 to 35B/USD by 2011. Acquisition of intelligence data from the private sector will not be a small market, either.

The two main advantages regarding commercial imagery are the lack of legal restrictions on their use over the United States and the data's unclassified nature. Privately owned commercial systems do not face the same restrictions as national systems. Their unclassified products can easily be distributed to anyone, provided the proper licenses are bought. This is important because many homeland-security agencies, especially at state and local levels, do not have the necessary security clearances for national imagery. In addition, the dissemination of these products can be done through the Internet, thus providing quick and easy access. The commercial satellite technology can map the border, ports and airports; potentially detect a tunnel under the border by seeing earth disturbances or unusual vegetation patterns and help the Coast Guard to zero in on a ship's location. Because of these advantages, commercial imagery, as it becomes more available, can become a major source of data from space for homeland security.

A commercial satellite owned by **Space Imaging** (acquired by **GeoEye**) took some of the most widely recognized pictures of the 9/11 attacks. The New York governor's office contacted Space Imaging directly to request information on the use of satellite imagery for disaster assessment

Hi-res image of auxiliary terminal at the King Khaled Int'l Airport Ryad, Saudi Arabia (source: DigitalGlobe, Google Maps)

and emergency management. It set a precedent whereby a state went directly to a private company rather than a federal agency for help on using space assets.

A Growth Environment

Satellites working within the imagery genre have experienced enormous growth. According to **Business Communications Company** (BCC) **Research**, and as reported by **Space Foundation** in their informative report *The Authoritative Guide to Global Space Activity*, sensing products revenue reached 7B/USD+ during 2006. The highest share of this total market is for weather forecasting, with 38 percent of the revenue. The growth of the total remote sensing market is nearly 50 percent, according to the **American Society of Photogrammetry and Remote Sensing** (**ASPRS**). BCC additionally reports that, by 2012, remote sensing data products will reach more than 9.9B/USD, with a growth rate of 6.3 percent, per year. This amount includes aerial, satellite platforms, and excludes products that are internal to governments.

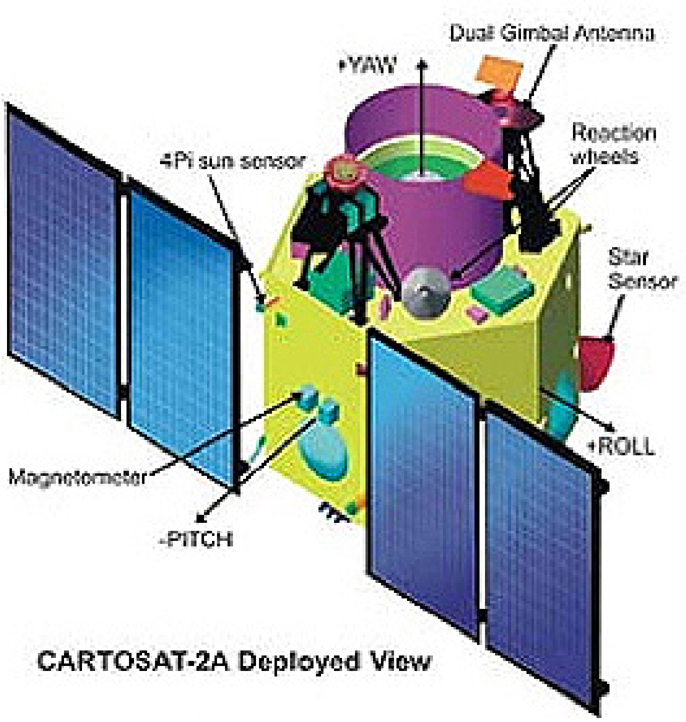
An example of the importance of satellite imagery is the acquisition by **Google** of **Keyhole Corporation** and that company's satellite imagery software, previously known as *Earthviewer*. If it hadn't been economically feasible, and possessing outstanding growth potential, Google would have shown little interest... currently that software and its data linkages are part of the widely-used *Google Maps* and *Google Earth* products.

What Do Remote Sensing Sats Do?

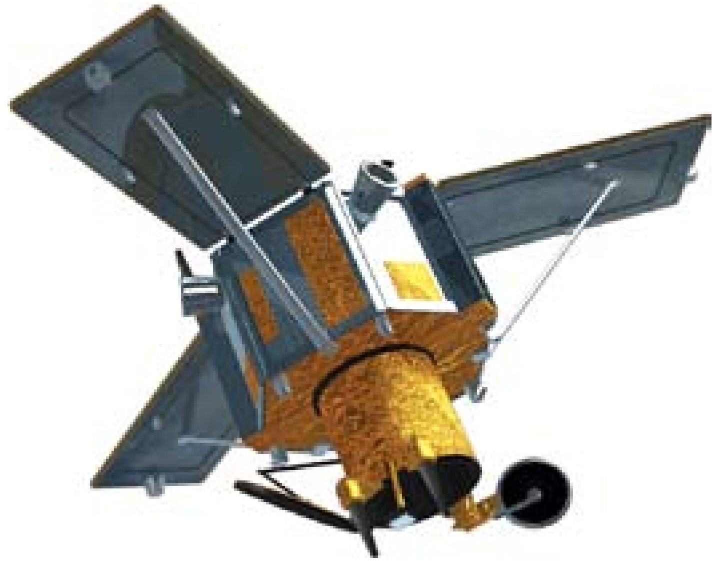
There are a number of uses for satellite imagery produced for commercial consumption. They include, but are not limited to,

- **Antenna tower site acquisition and coverage analysis**
- **Ecological and environmental monitoring (ozone, land use, pollution)**
- **Exploration and management of resources (i.e., agriculture, animals, forestry, minerals, oil, gas, and vegetation)**
- **Emergency situation mapping**
- **Game development (visual simulation)**
- **GPS-controlled and tracked vehicles**
- **Location optimization**
- **Media use (TV, movies, newspapers, and so on)**
- **Orbital debris remediation**
- **Pipeline health and management**
- **Verification of treaties**
- **Weather conditions, forecasting and tracking**
- **Well monitoring**

Human effects on the environment and natural resource management are both typical uses of satellite imagery. As is stated in *The Authoritative Guide to Global Space Activity* report, "Satellite technology can be critical to managing resources and protecting endangered species in natural areas with little existing infrastructure.



CARTOSAT-2A Deployed View



The use of satellite images allows researchers to study patterns of deforestation caused by logging and land clearing in remote areas of Africa and South America. This data is difficult to acquire by means other than the use of satellite imagery. Research institutions, non-governmental organizations, and governments use satellite data on deforestation to inform policy decisions." The distinctions between a remote sensing satellite and one dedicated to science work is not always clear—many satellites within the latter genre use remote sensing technologies. Such an example would be **CARTOSAT**, which is used by *India* for a variety of mapping applications.

The reason imagery satellites' orbits are circular is that if images of different locations are to be used for comparison purposes; the target captures must be acquired from the same altitude. This means each satellite must have a constant altitude, relative to the Earth's surface.

Remote sensing is a true collaborator for the condition of humankind, as well. Just one example finds GeoEye's **IKONOS** Earth imaging satellite responsible for helping locate health-related natural resources.

Paclitaxal is a chemical substance that, once processed, can treat cancer. This chemical is found in the Canadian yew tree. IKONOS can locate this slow-growing shrub, which otherwise would be a most difficult task as they are located in small, remote pockets and they grow under neighborhood trees. The high-resolution, map-accurate results localize not only tree density, but also its health. Once IKONOS collects all of the raw data, the information is sent to ViaSat GeoTechnologies, who are located in Montreal, Quebec. They complete the data processing and analyze the data to isolate the yew tree to make their detection a far easier task.

Some of the terms used in this article may be unfamiliar—one of the most complete glossary sites we've found is the **Remote Sensing Tutorial Page**. This glossary was extracted directly from a site prepared by Dr. *Jeff Weissel* and others at the **Lamont-Doherty Earth Observatory of Columbia University**. You might wish to use this glossary in a second web browser page as a reference tool.

To Be Continued...

In the next issue of *SatMagazine*, we delve into the companies who own, operate, and license the imagery from commercial remote sensing satellites. We hope you'll continue to share these verbal images of this highly dynamic and viable market segment—*The Lessers*

There are few greater rewards in life than working hard, attaining a measure of success, and then using those benefits to help others. One such individual is J. Armand Musey.... He may be used to the ups and downs of the stock market, but Wall Street's J. Armand Musey will soon be walking on new terrain—climbing Mt. Everest in an adventure that completes a personal goal as well as raises critically needed funds for the American Red Cross' International Response Fund (IRF). He was the lead industry analyst at Bank of America and later Solomon Smith Barney. In 2003, he partnered with a colleague to form the boutique investment banking firm Near Earth, LLC. Musey left the presidency of Near Earth in 2007 to train full-time for his attempt to scale Mt. Everest, the world's highest peak.

Musey has been an avid climber since 1991 and has scaled the highest peaks on six of the seven continents in the world. With his ascent of Mt. Everest this spring, he will complete the mountaineering challenge of the Seven Summits. Musey climbed Kilimanjaro in Tanzania in 2002 and has since climbed Mt. McKinley (AKA Denali) in Alaska, Mt. Elbrus in Russia, Aconagua in Argentina, Mt. Rainer in Washington, Mt. Vinson in Antarctica, and the Carstensz Pyramid in Indonesia. As part of his training for the cold weather of Mt. Everest, he went on a ski expedition to the South Pole in 2007, encountering -30 to -35 degree Centigrade weather almost the entire journey. The Mt. Everest expedition is scheduled to depart from Katmandu, Nepal, on March 29th, with the return scheduled for June 1st. Musey and his group will ascend the south side of Mt. Everest, up what is known as the South Column Route. This is the same route used by Sir Edmund Hillary and Tenzing Norgay on their first ascent in 1953.

Musey is paying the entire cost of the Mt. Everest expedition from his own funds; all money donated will go directly to the American Red Cross' International

Musey's expedition and obtain information concerning the donation process to the Red Cross in support of his challenge at www.museyeverest.com website.

After a nearly two-week trek carrying supplies through the panoramic Khumbu region of Nepal, J. Armand Musey and eight fellow climbers have reached base camp at 17,500 feet to start final preparations for their ascent of Mt. Everest. Musey, a widely respected securities analyst in the telecommunications and satellite industries, is climbing Mt. Everest to achieve a personal goal as well as raising the funds for the American Red Cross. In reports via satellite telephone, Musey said about 20 different climbing groups are amassed at the base camp on the southern approach to Mt. Everest. This assemblage has created a small tent city of some 400 climbers and their Sherpa guides on the small, rock-strewn plateau.

"We're busying ourselves setting up camp and practicing walking across long ladders that we'll use to traverse the large crevasses en route to Camp 1 [the first stage of the ascent]," Musey said in a recent blog "Tomorrow, we'll help rebuild the heliport at base camp. It's situated on a glacier that's continually shifting, so there's a lot of rock removal and clearing of the surface to enable emergency landings and takeoffs. On Thursday we will have our second Puja, a traditional Tibetan blessing. The first one last week was to bless our trip, while this one is specifically directed at blessing our climbing equipment."

On April 25th, Musey and his team returned from a two-day visit to Camp 1. They did so well, in fact, they managed to save two hours of their time in climbing up 20,000 feet.

Once they arrived at Camp 2, they began to get anxious as they awaited clearance in order to move beyond Camp 2 and higher up the mountain. As of this writing (in early May), Musey and his team are preparing to make the ascent to Camp 3 for the last time, an elevation of 23,000 feet. No one has experienced any altitude sickness, thanks to the acclimation all underwent when at the 13,000 feet altitude. In fact, they will return to that altitude once again for approximately three to five days before they attempt to reach the summit of Mt. Everest. Musey stated it requires about five days to reach the summit from the Base Camp.

In his postings, Musey has talked about the logistics of the journey and the numerous stopping points, starting at 9,380 feet at the Lukla airport when they arrived by plane from Katmandu.

His team consists of nine climbers, three guides and about 30 Sherpa staff to manage a small herd of yaks carrying much of their 1,700 pound of provisions, 70 tents, 2,000 liters of kerosene and other supplies.

To date, Musey has secured pledges to the Red Cross nearing $50,000 from a number of satellite industry firms in support of his climb. These include contributions of $15,000 each from **SES** and **Intelsat**, the two largest satellite operators in the world, at the "Summit" level. Dulles-based **GeoEye**, a satellite imaging company, is a "Katmandu" level sponsor. **Iridium** and **Vizada**, leading global satellite communications providers, are donating SIM cards respectively for phone and BGAN applications that will allow Armand to send reports, photos and maintain a blog of his summit attempt.

"SES applauds Armand for taking on this arduous challenge to support such a worthy goal," said **SES** chairman *Romain Bausch*, "His expedition will raise awareness of the role of satellites in global disaster response. We are pleased to make a challenge grant of $15,000 in hopes that other companies in the satellite community will match or exceed our contribution to this laudable organization."

Intelsat CEO *Dave McGlade* said, "Intelsat is excited to be returning to Mt. Everest 10 years after our 1998 demonstration of the efficiency of satellites in connecting the world, even from the most remote locations on the planet. The satellite industry is always among the first to respond to disaster scenarios, because of our ability to provide rapidly deployable infrastructure. A long-time supporter of the Red Cross, Intelsat commends Armand's altruistic commitment to raise funds for the organization."

Sponsors and supporters can follow Musey's expedition and find information on how to make a donation to the Red Cross in support of his challenge at www.museyeverest.com. All money donated will go directly to the **American Red Cross' International Response Fund**.

by William B. Gail

Increased demand, advanced technologies, and limited resources will all play roles in remote sensing's potentially sunny, but challenging, future.

Earth information is a foundation for the prosperity and security that progressive societies seek. Urban planning, protection from natural hazards, precision farming, climate treaty verification, efficient airline and ship routing, energy use optimization, and access to natural resources all require reliable and detailed information about the Earth's dynamic environment.

Aside from basic weather forecasts, this information has been traditionally the domain of academic and professional specialists. The raw observations were hard to come by, the tools for turning data into knowledge were difficult to use, and the means for communicating results were inefficient.

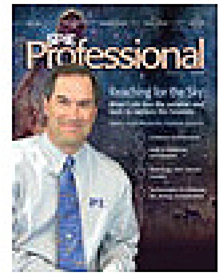
All this has changed over the last decade due to technological advances in sensors, the computing capacity to combine and analyze sensor information, and the communications tools for sharing this knowledge. As a result, mass-market consumer applications are emerging that will radically transform our use of Earth information over the next decade. GPS-based devices are now widely employed for car navigation.

Internet maps and virtual worlds (such as **Google Earth** and **Microsoft Virtual Earth**) enable everything from education to vacation planning to real-estate hunting. Mobile phones provide a ubiquitous distribution platform for location-based information, even in developing nations.

At the same time, much of the more traditional government Earth information infrastructure in the United States, including its sophisticated weather satellite system, is at risk from budget cuts and political decisions.

Prominent among the potential losses are critical climate monitoring measurements. A recent *U.S. National Research Council* report noted ominously that a third of the U.S. civil satellites will be non-operational by 2010 without decisive action.

SPIE
Connecting minds. Advancing light.



Getting the Full Picture

Remote sensing devices come in a variety of forms, but all are related by the basic function of "see and detect from a distance." The foundation of our Earth observation system is the scientific and operational satellites, which supply everything from weather observations to regularly updated global maps of land resources.

But the use of aerial systems—aircraft, uninhabited aerial vehicles, and even balloons—has seen a recent revival to provide resolutions or perspectives that can't be obtained from space. Ground-based remote sensing systems are also recognized as an important complement, the network of Doppler weather radars being one example.

A significant portion of our scientific and operational observations comes from low- to moderate-resolution imagers that provide critical environmental information at regional and global scales. *The National Oceanic and Atmospheric Administration* (**NOAA**) geostationary satellites are perhaps the best-known example, producing the "hurricane-from-space" imagery routinely shown on weather forecasts.

Information about human-scale activities, such as buildings and roads, is mostly provided by high-resolution imagers (with resolution of 1-m or better). These have historically been the domain of military surveillance, but increasing commercial demand led in the 1990s to the emergence of a small commercial satellite remote sensing industry. The success of these early commercial systems has spurred others to follow. A number of new commercial imaging satellites will be launched just within the next few years, including radar imaging systems with 1-m resolution.

Imagery alone is not sufficient to meet our Earth information needs. Imagers are commonly complemented by other sensing techniques to provide the "full picture" about the Earth.

Satellite-based spectrometers are employed by NOAA to determine height profiles of temperature and humidity, critical parameters for making accurate weather forecasts. Microwave sensors are routinely called on when it is important to “see through” clouds to the lower atmosphere or ground.

Even more sophisticated sensing techniques are being developed by **NASA**. The Jason mission (in partnership with France) employs a radar altimeter to measure sea surface height to a global average of within 5-cm of its actual value. Scientists use this to assess the impact of global warming and anticipate the arrival of El Niño.

NASA also operates the **GRACE** (*Gravity Recovery and Climate Experiment*) gravity gradient sensor mission (with Germany) that measures minute changes in Earth’s gravity field to pinpoint localized variations in the planet’s density; GRACE can readily detect the slow rise or “rebound” in Earth’s crust where ice sheets weighed down on the Earth 10,000 years ago.

The Next Decade

What new capabilities will arise during the next decade? A substantial thrust is doing things faster and cheaper rather than bigger and better. The military is developing new techniques for building reconnaissance satellites that can be launched on short notice as needs arise. We will expand our use of non-visible portions of the spectrum (particularly infrared and microwave), increase the number of active sensors such as lidar and radar, and improve our spatial and temporal sampling.

Particularly important will be new technologies for linking sensors through wireless and traditional means into sensor networks. This will allow the information to be combined so as to support rapid decisions in complex situations. In addition, the output of one or several sensors can be used to trigger observations from others, or even to rapidly reconfigure the other sensors so as to optimize observations of an event.

With the growing demand, novel sensor approaches are also likely to appear. One possibility is "interactive remote sensing," such as farmers genetically "tagging" their crops to enhance the remotely detectable spectral signature for crop distress or optimal harvesting. Policy efforts are underway to guide this future.

In 2003, NOAA spearheaded a global initiative called the *Global Earth Observation System of Systems*, or **GEOSS**, now a loose coalition of 66 nations aimed at coordinating much of the world's Earth observing activities. GEOSS is focused on using the resources we have more effectively—a worthy goal.

Within the United States, the National Research Council report referred to earlier laid out a "decadal plan" for Earth observation from space, including a set of 17 new missions to be launched during the coming decade.

What will remote sensing be like a decade from now? The competing forces of increased business demand, limited government resources, and advancing technological capability will play out over this time period. The rapidly growing consumer needs will introduce a new and somewhat unpredictable factor.

The future promises to be bright, but it won't happen on its own. Our community of professionals must work diligently to ensure its success.

About the author

William B. Gail is director of strategic development at Microsoft Corporation, with responsibility for expanding the capabilities and use of Virtual Earth. He previously led development of Earth remote sensing satellites at Ball Aerospace. Gail received his undergraduate and PhD degrees from Stanford University, focusing his research on wave-particle interactions in the Earth's magnetosphere.

by Donald Martin, Paul Anderson, and Lucy Bartamian

Although the performance of communication satellites could be predicted theoretically, until 1962 or 1963 there was considerable doubt concerning whether their actual performance would match the theory. This was one of the basic motivations for the early communication satellite experiments. Two other important factors were the desire to prove the satellite hardware (since space technology in general was still in its infancy) and the need to test operational procedures and ground equipment. Whereas the first few experiments (SCORE, Courier, and Echo) were very brief beginnings, the Telstar, Relay, and Syncom satellites laid definite foundations for the first operational satellites.

Communication satellites have been in commercial operation and military service since 1965 and 1967, respectively. However, there was, and still is, the need for additional experimental satellites. These are used to prove new technologies for later introduction into operational satellites.

Some satellites combine experimental objectives with preoperational demonstrations. Discussions of such satellites are included in this chapter if their emphasis is primarily experimental; those directly continued by operational satellites are described in later chapters.

Telstar

The Telstar experiment grew out of the **Bell Systems**' interest in overseas communication. **Bell Telephone Laboratories** was a major participant in communication experiments using **Echo 1**. The positive results of those experiments strengthened the interest in satellite communications generated by earlier analytical papers. Therefore, American Telephone and Telegraph Company (AT&T) decided to build an experimental active communication satellite. The objectives of the Telstar program were to:

- **Look for the unexpected**
- **Demonstrate transmission of various types of information via satellite**
- **Build a large ground antenna and learn how to use it**
- **Gain experience in satellite tracking and orbital predictions**
- **Study Van Allen radiation belt effects**
- **Face the design problems required for a space borne repeater**

An active satellite was decided on because the required balloon size for television bandwidths was much beyond the state of the art. The choice of the Delta launch vehicle provided basic design constraints such as size, weight, and orbit. In accordance with the fifth objective, the satellite contained a number of sensors to make radiation measurements. The third objective was accomplished by the construction and use of a ground station at Andover, Maine.

Two Telstar satellites were produced. The satellites were 34.5-inch diameter spheres with solar cells covering most of the outer surface. The solar array output alone could not support operation of the communication subsystem, so batteries were used to supply the peak power requirements. The batteries were recharged during the periods when the satellite was not in view of the ground terminals and the communication subsystem was turned off. This subsystem had a single channel with a 50 MHz bandwidth. The program details are as follows:

Satellite

- **Sphere, 34.5 in. diam**
- **170 lb in orbit (Telstar 1), 175 lb in orbit (Telstar 2)**
- **Solar cells and NiCad batteries, 15 W**
- **Spin-stabilized, 200 rpm**

Configuration

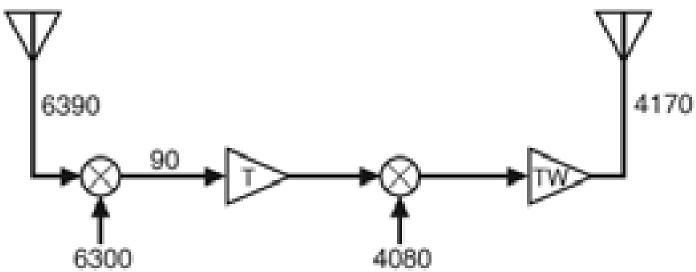
- **One 50 MHz bandwidth double-conversion repeater**

Capacity

- **600 one-way voice circuits or one TV channel**
- **60 two-way voice circuits (tests limited to 12 circuits by ground equipment)**

Transmitter

- **4170 MHz**
- **All solid state except TWT (traveling wave tube)**
- **TWT operated linear at 3.3 W (saturated power: 4.5 W)**



Telstar communication subsystem.

Receiver

- **6390 MHz**
- **All solid state**
- **12.5 dB noise figure**

Antenna

- **Transmit: 48 small ports equally spaced around satellite waist**
- **Receive: 72 small ports**
- **Uniform pattern around waist and ±30 deg from waist plane**
- **Circular polarization**

Telemetry and command

- **Telemetry: 136.05 MHz, 200 mW transmitter**
- **Command: approximately 123 MHz**
- **Four-element helical antenna**

Life

- **Two-year goal**

Orbit

- **Telstar 1: 514 x 3051 nmi, 45 deg inclination**
- **Telstar 2: 525 x 5830 nmi, 43 deg inclination**

Orbital history

- **Telstar 1: launched 10 July 1962, operated until 23 November 1962, and 4 January to 21 February 1963**
- **Telstar 2: launched 7 May 1963, operated until May 1965**
- **Delta launch vehicle**

Management

- **Telstar was developed by Bell Telephone Laboratories for AT&T**

After Telstar 1 was launched, in the following 6 months, about 400 transmission sessions were conducted with multichannel telephone, telegraph, facsimile, and television signals. In addition, more than 250 technical tests and measurements had been performed. Stations in the United States, Britain, and France participated in these activities. In November 1962, the command subsystem on the satellite failed. The cause was later established as degradation of transistors due to Van Allen belt radiation. Various operations effected a recovery that allowed the satellite to be used for another month and a half early in 1963, after which the command subsystem failed again.

Telstar 2 was nearly identical to Telstar 1. The only significant design change was the use of radiation-resistant transistors in the command decoders. The Telstar 2 satellite orbit had a higher apogee than Telstar 1, which increased the time in view of the ground stations and decreased the time in the Van Allen belts. Telstar 2 was launched in May 1963 and operated successfully for 2 years.

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Author Biography

Donald H. Martin is a senior engineering specialist in The Aerospace Corporation's Architectures and Spectrum Management Office. Martin joined the Communications Department in the Engineering Group at Aerospace in 1968 after receiving B.S. and M.S. degrees in engineering from the University of California, Los Angeles. He has been collecting information on satellite communications since 1972, when his manager offered him a choice of assignments: of the three options, he chose to write a description of communication satellites then in orbit. The assignment grew the next year to include a report describing satellites being built, and gradually expanded to the first edition of "Communication Satellites in 1986", with the book now in its Fifth Edition.

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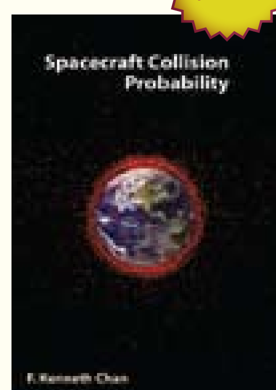

by David Shamir

SNG became popular with broadcasters as a replacement for microwave technologies because of its extended geographic reach and potential for supporting broader and deeper reporting of key local events. It also enabled timely coverage of global issues, with the technology's pioneering use often bringing television viewers fresh images from war-torn areas of the world. With the industry wide shift to digital technologies, DSNG increasingly became a mainstream means of delivering SD content.

Designed expressly for mobile trucks, SUVs, and flyaway packages, highly integrated DSNG solutions combine encoding, modulation and upconversion in a compact footprint and lightweight package ideal for news gathering applications requiring flexibility, responsiveness, and maneuverability.

In addition to saving space, the integration of these capabilities also allowed for a higher level of interoperability, with less dependence on the operator to manage bit rates and other parameters.

The development of sophisticated DSNG systems with built in multiplexing capabilities and telemetry served to simplify setup and transmission tasks so that journalists in the field could manage delivery of broadcast-quality MPEG-2 content without a great deal of technical expertise.

The emergence of HD broadcasting as the new norm made it important even for smaller broadcasters to look at ways of acquiring HD footage for inclusion in their newscasts or other programming. However, while MPEG-2 compression can be used for satellite-based delivery of HD content, the very high bit rate needed to encode HD content in turn requires a higher space segment on the satellite.

As a result, it costs far more to deliver MPEG-2 HD content to a central station, studio, or any other location than it would to deliver MPEG-2 SD content to that same site.

The introduction of H.264 technology, also known as MPEG-4 Part 10, and the development of DVB-S2 standards have changed the face of satellite news gathering. As broadcasters and other content providers seek effective ways of distributing high quality content, and HD content in particular, these technologies have enabled much greater efficiency than was possible through conventional SNG approaches.

The advanced MPEG-4 H.264 video codec was developed to address the problem of encoding efficiency, and this standard can reduce bit rates by 50 percent and significantly lower the cost of transmitting HD content via satellite. Broadcasters implementing H.264 encoding thus stand to realize substantial savings in capital and operational expenditures.

MPEG-4 H.264 technology presents a great opportunity for relatively economical HD delivery, enabling broadcasters to broaden their high-value premium offerings with the introduction of HD channels.

Encoders on the market today offer broadcasters high-quality video at a much improved bit rate, with the option to work in a low error, low-latency mode when required for two-way live interviews and similar real-time interactions.

This flexibility provides an optimal balance of image quality and transmission costs. Broadcasters can provide their viewers with engaging live reporting from the field while maximizing their use of satellite bandwidth.

The emergence of DVB-S2, an enhanced version of the DVB-S standard traditionally used for SD broadcasting over satellite, further adds to the efficiency of HD delivery. Developed around the same time that the H.264 video codec entered the market, DVB-S2 offers video compression and subsequent data rate improvements that reduce bandwidth consumption by another 30 percent. The DVB-S2 specification yields two critical benefits: greater resistance to noise, which in turn leads to better spectral efficiency, and more bits per hertz compared with earlier technology.

The resulting overall bandwidth savings enable broadcasters to transmit HD content via satellite using roughly the same bandwidth once required to deliver the same broadcast in SD using the DVB-S standard and MPEG-2 encoding. The combination of MPEG-4 H.264 encoding and the DVB-S2 specification delivers enormous cost savings in the transmission of high-quality HD content. Taking advantage of these cost savings, leading North American satellite providers already have migrated to DVB-S2 for uplink and downlink applications.

While not all broadcasters are directly constrained by the limitations of satellite-based transmission, any content producer today must be aware of how that content will be delivered downstream. Cable operators deliver HD content encoded as MPEG-2, and satellite operators offer H.264 to the home. As they migrate to H.264, then, broadcasters need to maintain the ability to encode in both MPEG-2 and MPEG-4 H.264 compression schemes.

A number of capabilities characterize current, cost-effective encoding solutions for point-to-point and point-to-multipoint satellite fix contribution, primary distribution, and DSNG from transportable uplink stations. Full support for H.264 HD/SD, as well as DVB-S/DVB-S2 technologies, provides broadcasters with the smooth migration path they need to continue handling SD video and to deliver sought-after HD content efficiently and at a high quality.

Versatile configuration options ensure that the broadcaster pays only for the functionality needed, and software upgradable systems make it easy to add or update features if those needs change. Intuitive menu-driven controls keep operation in the field simple, and automatic detection of stream type and format, either SD or HD, helps to save time and reduce the need for manual intervention.

Advanced encoding solutions also allow broadcasters to encode at a 4:2:0 profile when video will make just one hop prior to arriving at its intended destination, or at a 4:2:2 profile when more robust chroma components are required, as when video makes multiple downstream hops and is repeatedly decoded and re-encoded.

DSNG applications have come to include transmission of data along with video, and today's encoders provide low-speed data broadcast and high-speed multiprotocol encapsulation (MPE). MPE-enabled encoders can accept inputs from external PCs, encapsulate that data into the broadcast stream, and broadcast either simultaneous to the broadcast stream or as a separate piece to the receive site, where data is de-encapsulated and delivered to the server.

To support a rising demand for IP contribution, encoders can be configured to deliver IP-based content as a main link over satellite or as a backup. Because IP delivery can be plagued by packet loss and other factors that threaten the reliability of the link, added tools such as forward error correction (FEC), typically performed according to the Pro MPEG specification, and dual Gigabit Ethernet outputs help to ensure that the signal is secure.

With this built-in functionality, a single unit can provide a satellite feed and a main feed IP backup, which in turn has its own backup for dual redundancy. This type of one-box solution saves money, simplifies operations, and frees up space within the mobile unit.

The new generation of encoding solutions supports the broadcast industry's shift toward HD news gathering. While many broadcasters have yet to make the move, the industry's transition already has begun. An investment in advanced, future-proof DSNG solutions can ease the burden on reporting and technical staff, reduces expenses associate with satellite transmission, and paves the way to more sophisticated and compelling news broadcasts.

About Scopus

Scopus offers a range of solutions equipped with functionality for the broadcaster planning for MPEG-4 H.264 encoding and HD news gathering. The company's UE-9216, UE-9217, and UE-9318 DSNG MPEG-2 encoding platforms provide excellent picture quality and enable a cost-effective transition to H.264.

Scopus MPEG-4 encoding unit

About the author

David Shamir is Scopus' product marketing manager for Scopus' family of encoder products. David received his BS in Electronics Engineering from Tel-Aviv University.