Using Commercial Software to Enhance Commercial Imaging Acquisition

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Abstract – This paper documents the ways commercially available software from Analytical Graphics, Inc. (AGI) can improve the acquisition of remote sensing products by reducing the time and cost required to procure new imagery from remote sensing satellites. The method uses the industry-standard STK desktop software and software development kits and the new Standard Object Catalog (SOC) library of satellite platforms and sensor models.

AGI's STK and the STK Engine software development kit are commercial software packages with more than 22 years of history in the remote sensing market. The SOC is a new effort from AGI to create a community-driven library of spacecraft with accurate and thorough descriptions of mission capabilities. SOC entries can be searched and the data automatically loaded into STK for simulation and planning.

1. Commercial Remote Sensing Challenge – Everyone can benefit from remote sensing. As anyone who has used Google Earth, Bing Maps or Bhuvan can attest, seeing the Earth in high resolution from above provides a unique perspective that empowers decision-making and planning on scales never seen before in human history. However, getting new imagery is a complex job.

Satellite tasking (or requesting a satellite operator to take an image of a specific place) is a costly and time-consuming endeavor. Tasking for some satellites is free, while other satellites cost $10,000 or more per image request. Furthermore, it may take days or weeks for a single satellite to pass over a target in such a way that its sensors can retrieve an image of a specific area (assuming there is no cloud cover during that pass).

For response to flooding, fires, storms or other disasters, this duration is often not acceptable. However, with commercial software tools outlined below, that process can be greatly improved by providing knowledge and choice to individuals.

2. Commercial Remote Sensing Industry – The satellite remote sensing industry has seen a dramatic change in the past 20 years. In 1991, there were only five nations that had access to satellite remote sensing assets: the United States, Japan, Russia, India and France.[1] Since then, the world has seen the impact of low-cost and micro-satellite technology spread around the world with a current fleet of 62 satellites with optical payloads from more than 19 countries. [2]

Forty-seven of these platforms are civilian/commercial programs, and most of their data can be procured publicly. Figure 1 shows the growth of this market along with the distribution of countries contributing to it. With so many publicly available sources of data, resolutions varying from tens of meters to less than 1 meter; satellites with different agility (the ability to change orientation and point at a target); sensors with different swaths (the area on the Earth's surface it can cover); payloads with different operating frequencies and satellite orbits with different revisit rates, it becomes challenging for someone who is not a rocket scientist to know which satellite is really best for getting an image quickly and affordably. Figure 2 shows this challenging problem in STK's 3D environment populated with the active imaging satellites

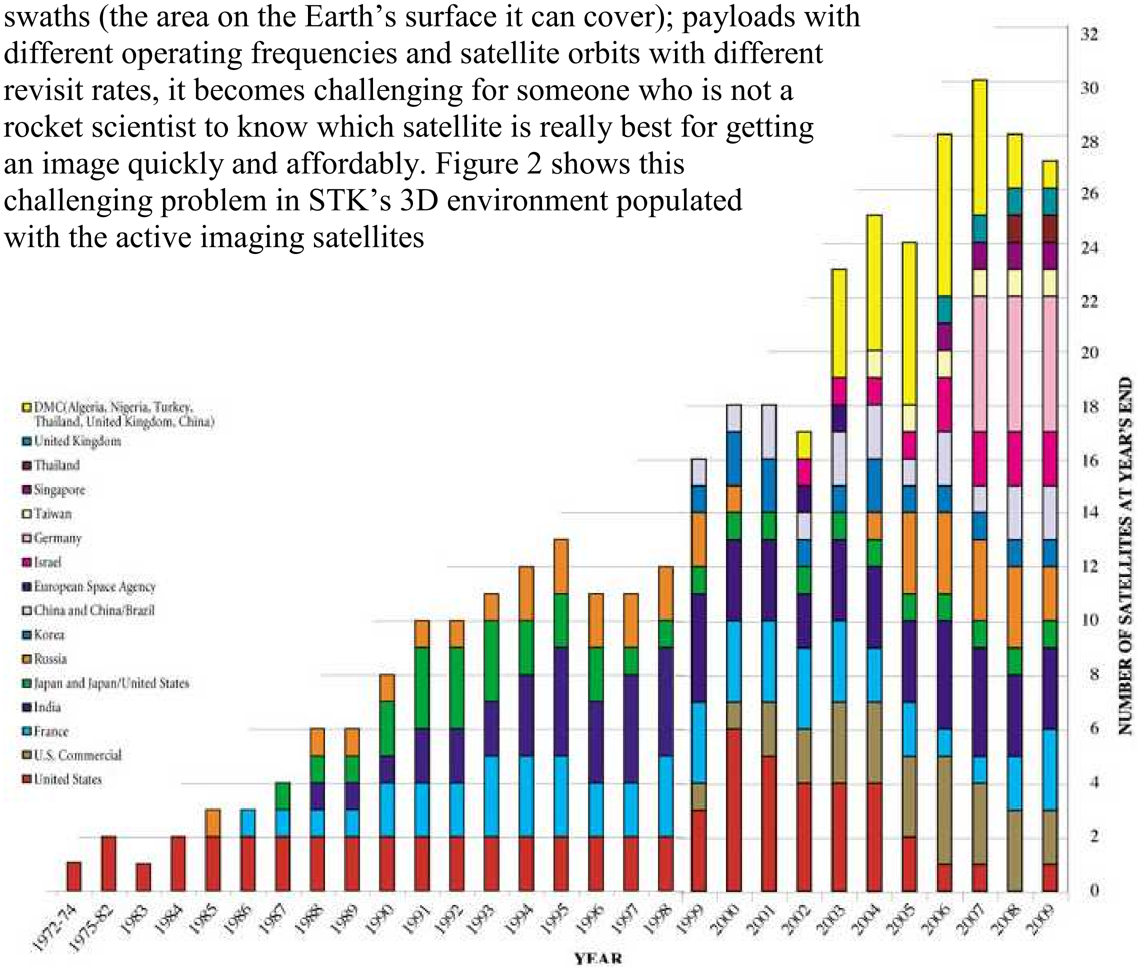

Figure 1: Number and distribution of commercial remote sensing satellites [1]

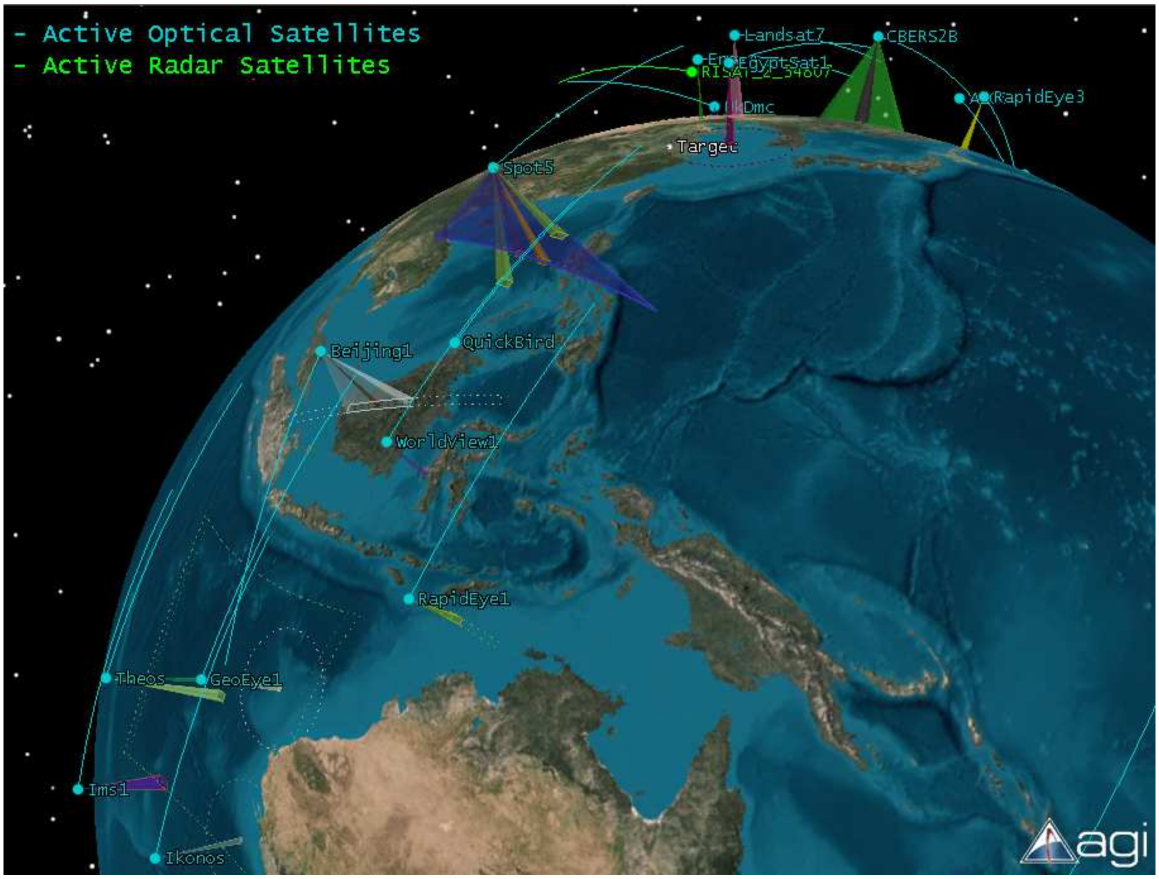

Figure 2: Screenshot from STK 3D environment using SOC satellite orbit and sensor data

4. Software modeling of remote sensing platforms – Fortunately for the global remote sensing community, AGI has been producing software with the ability to answer these difficult questions for the past 22 years. STK is a robust and highly accurate simulation software that predicts the location of satellites and performs time-based analysis on their orbits (such as the times when they will fly over a certain point on the globe). STK also includes an interface to the United States Strategic Command (USSTRATCOM) database of satellite orbits using Two-Line Element (TLE) sets that allows the software to predict the locations of actual satellites in orbit. Additionally, STK includes the capability to model the sensor characteristics of satellite payloads and analyze their line of sight to targets on the ground.

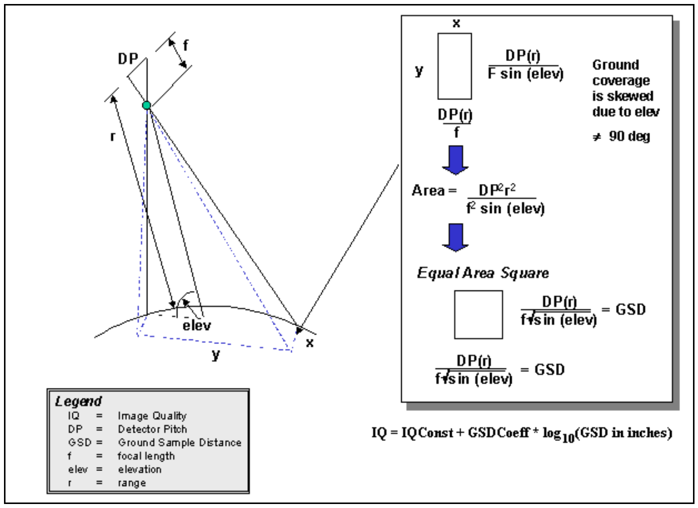

Figure 3: STK equations for modeling sensor resolution from STK desktop interactive help documentation

Recently, AGI embarked on a new initiative to make searching for this information easier for our community of 40,000 users. The company created a service called the Standard Object Catalog (SOC) that contains a library of accurate and thorough descriptions of satellite payloads. [3] The SOC also contains STK-formatted objects for use in image collection planning and other analysis tasks. The SOC data is available from a web portal at http://soc.agi.com as well as built in to the STK software through the AGI Data Federate (ADF), AGI's data management and collaboration software package. The ADF stores, manages and disseminates remote sensing assets in much the same way as a geographic information system (GIS) collects, stores and disseminates geography.

Together, STK and the SOC allow users to search for any set of active remote sensing satellites and accurately predict the times when any of these satellites' sensors will be able to acquire an image in question.

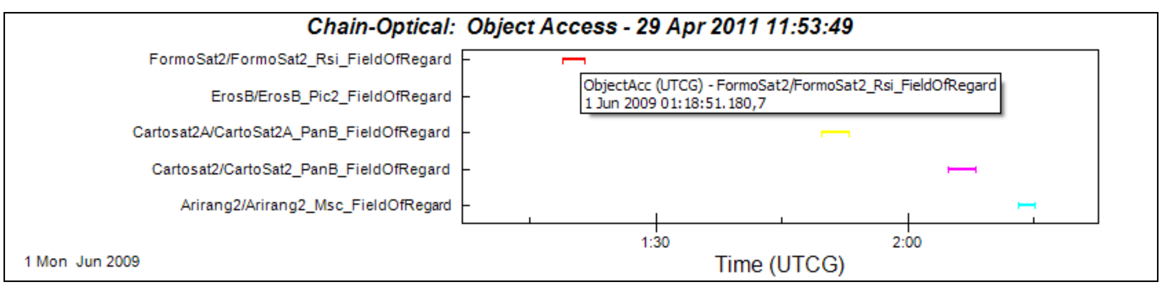

Figure 4: Graph from STK reporting overflight times of specific sensors

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                                                                                  29 Apr 2011 11:55:31
Chain-Optical:  Individual Strand Access


Target to ALOS/Alos_Avnir2_FieldOfRegard
----------------------------------------

                     Start Time (UTCG)           Stop Time (UTCG)        Duration (sec)
                  ------------------------    ------------------------    --------------
                  1 Jun 2009 02:56:45.020     1 Jun 2009 02:56:55.716            10.697

Min Duration      1 Jun 2009 02:56:45.020     1 Jun 2009 02:56:55.716            10.697
Max Duration      1 Jun 2009 02:56:45.020     1 Jun 2009 02:56:55.716            10.697
Mean Duration                                                                    10.697
Total Duration                                                                   10.697
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Figure 5: Report from STK reporting overflight times of specific sensors

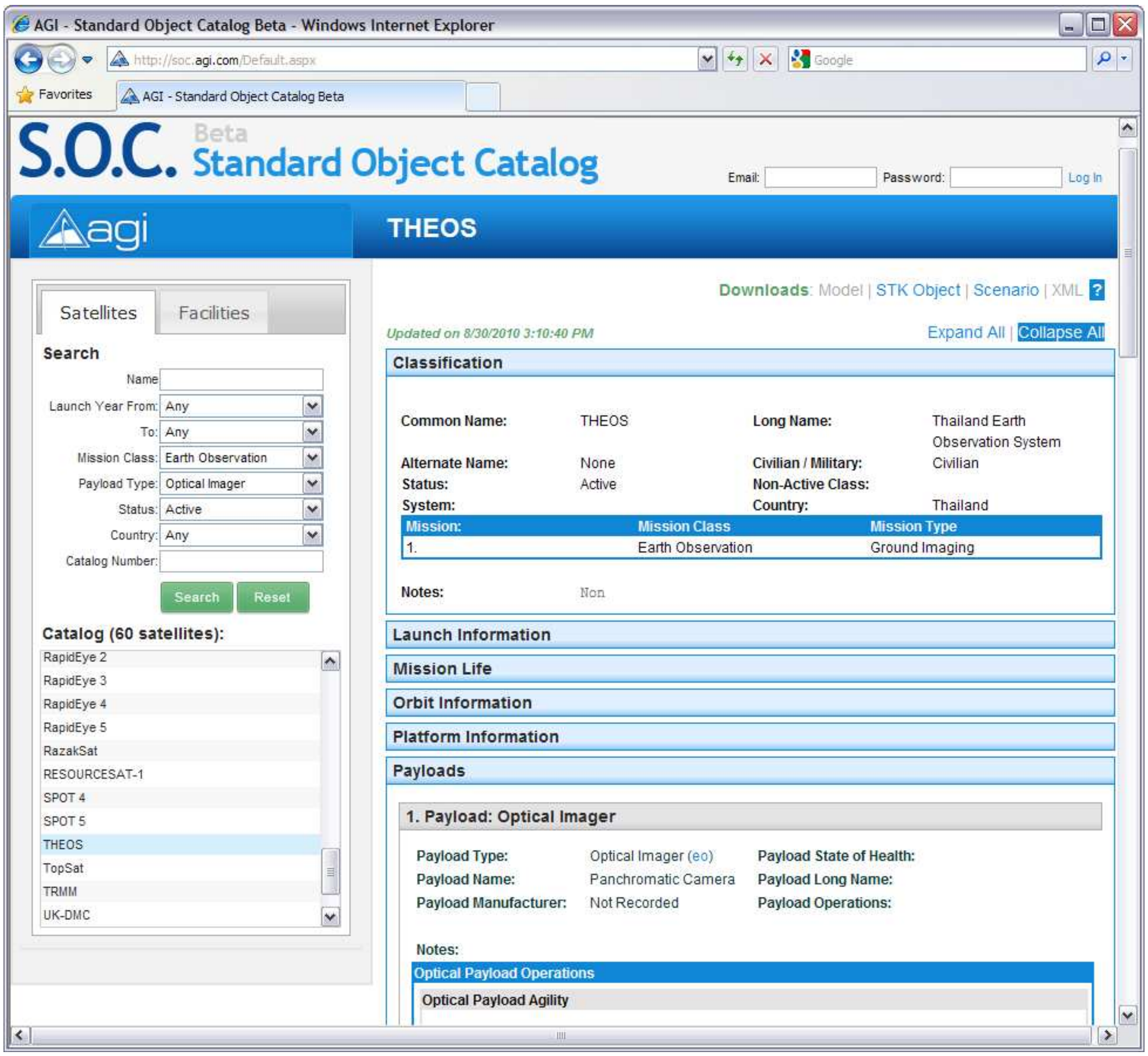

Figure 5: AGI Standard Object Catalog (SOC) library of satellites and payloads

5. Remote sensing for the GIS customer – The integration of GIS into remote sensing systems is critical to meeting modern technological requirements, in that GIS is used by many industries including transportation, the environment, commerce and security. To best serve these industries, remote sensing systems need to tie directly into the authoritative content of GIS systems. AGI software meets that requirement by interoperating directly with GIS through modern geospatial standards. The features housed within the GIS can be used as input parameters to the remote sensing system, and the features' geography and associated attributes can optimize collection and overall performance of the system.

6. Benefits of remote sensing prediction – With the combination of AGI's commercial STK software and the content of the SOC, anyone can now determine which satellites will cover a target in the shortest amount of time and allows users to go to the right imagery provider for their request. Additionally, users can look back at historical satellite orbits to see which providers *could* have taken a particular image under particular conditions such as lighting, weather and image direction.

The true benefits of these capabilities are realized when a user combines the analytical power of STK software with weather data, large lists of targets and robust scheduling algorithms to optimize the collection of assets based on resolution, priority and cost.

Moreover, AGI has used our software development kits to showcase the flexible nature of these capabilities in an online showcase: http://spacedata.agi.com. From the Satellite Overflight Portal, you can select a list of satellites, a target location and set of criteria (date, image direction, image elevation, etc), and the software will return a time-based list of satellites that meet those criteria.

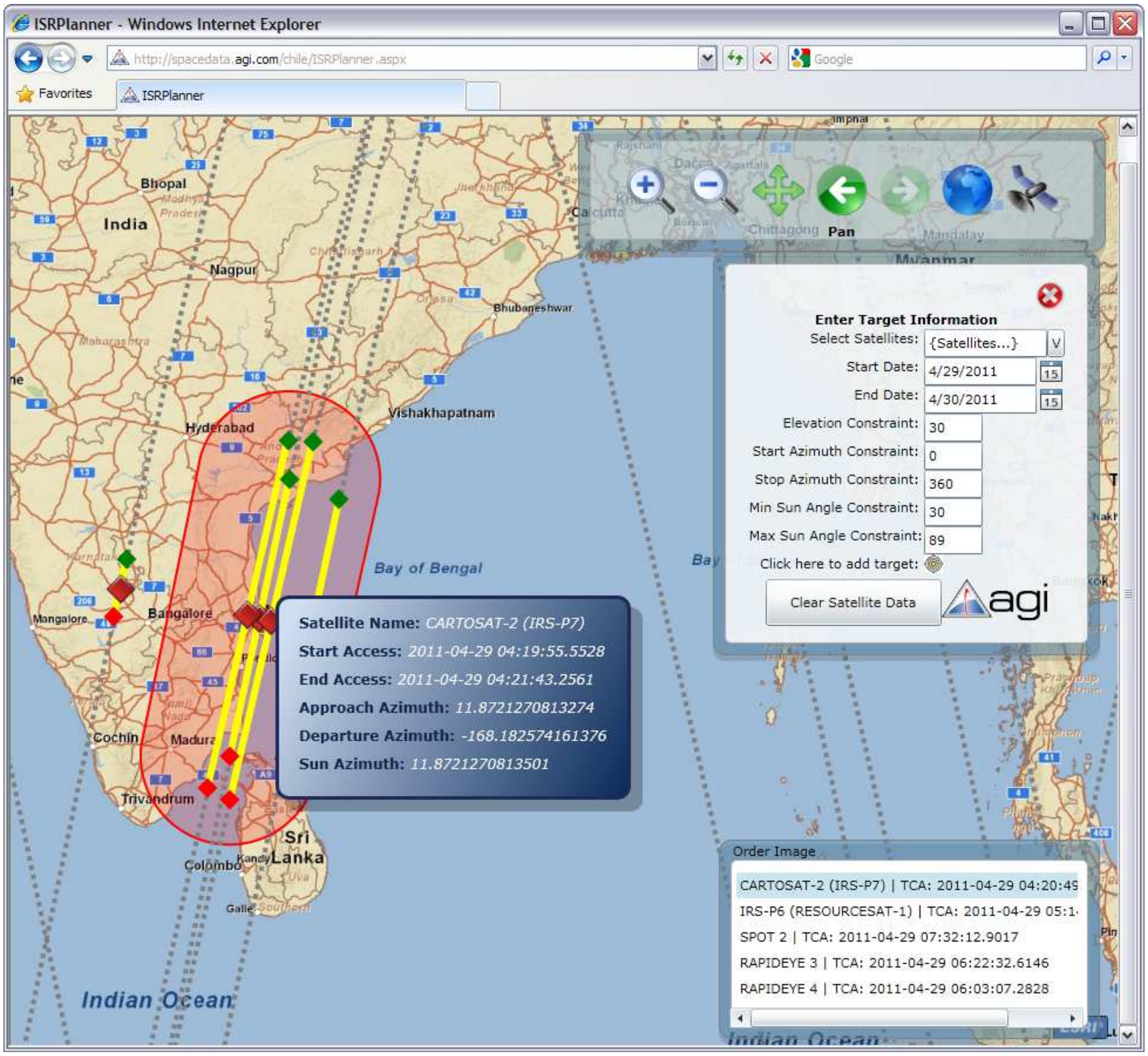

Figure 6. Satellite Overflight Portal, an AGI implementation of web-based satellite imagery planning system built with AGI software development kits and SOC sensor data

7. Conclusion – The satellite remote sensing industry has become a complex and challenging market to enter for those who are not already experts in the field. However, recent advances in software technology and data distribution allow anyone with the right set of tools to face this challenge easily and quickly. AGI's commercial software and SOC data library are examples of such software/data combinations that empower users to save time, money and effort in the acquisition of remote sensing products.

References

[1] Stoney, William E., "Markets and Opportunities?" ***Earth Imaging Journal***, September 2009. http://www.eijournal.com/Markets_Opportunities.asp

[2] AGI Standard Object Catalog April 2011. http://soc.agi.com

[3] Kaslow, David, **"**COTS Implementation of a Sensor Planning Service GetFeasibility Operation - Interim Status #2", 2011 IEEE Aerospace Applications Conference Proceedings, March 5-12, 2011.

Biography

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Adam supports customer applications in the United States, Europe, Asia and Australia. He has been the lead engineer for AGI in the Asia-Pacific region providing training and coordination for customers and AGI business partners since 2009. Adam graduated with a Bachelor of Science degree in aerospace engineering from the University of Illinois at Urbana-Champaign and is a graduate of the US Marine Corps Officer Candidates School in Quantico, VA.