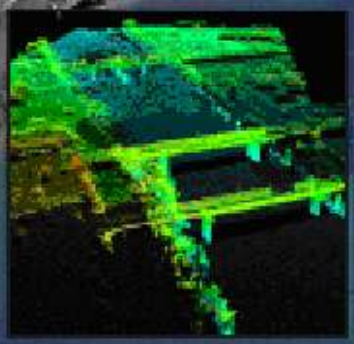
Survey and Analysis of Remote Sensing Market Aerial and Spaceborne



Study Documentation 2005

Acknowledgments:

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Corbley Communications

MAPPS

Spectrum Mapping

GeoSearch

Earth Imaging Journal Magazine

EURIMAGE

MDA GeoSpatial Services

Woolpert

URISA

GSDI Association - SDI (Spatial Data Infrastructure) – Africa Newsletter

ORBIMAGE

PCI Geomatics

GITC America

Z/I Imaging/Intergraph

Directions Magazine

GeoWorld Magazine
GeoPlace.com

GITA

American Surveyor Magazine
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Spatial Resources

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First Side Image: Rome, Italy taken on NASA's Landsat 7 Satellite. Acquisition Date: August 3, 2001. Cover and first image courtesy of USGS.
Second Side Image: Fort Morgan Peninsula, at the mouth of Mobile Bay, AL. A Leica ADS40 digital aerial sensor with Leica Narrow Angle FCIR option upgrade produced the image. Acquisition Date: April 16, 2005. Image provided by Woolpert, Inc. courtesy of Baldwin County, AL
Third Side Image: Empire State Building, NY City, NY. A Leica RC-30 camera produced the image. Acquisition Date: May 2, 2005. Image provided by Keystone Aerial Surveys, Inc.
Fourth Side Image: Nashville, TN. An Optech ILRIS System, ground-based LIDAR Sensor was merged with Aerial Data from RAMS LIDAR System to produce the image. Acquisition Date: April 2003. Image provided by Spectrum Mapping, LLC.

NOAA's
Satellite and Information Service

Survey and Analysis of Remote Sensing Market Aerial and Spaceborne

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1 Executive Summary-Aerial and Spaceborne Survey Overview

In September 2004, the National Oceanic and Atmospheric Administration (NOAA's Satellite and Information Service) contracted with Global Marketing Insights, Inc. to provide a comprehensive review of the international remote sensing market for aerial and spaceborne sensors based upon their specific requirements. As of 15 August 2005, 1,547 online surveys and 250 personal interviews had been completed. These surveys and interviews provide a sample from the following eight project sectors:

- Aerial Film
- Aerial Digital
- Aerial Sensor
- Satellite
- Software/Hardware
- Commercial End User
- Government
- Academic

The survey results also represent global input, with respondents from the US, Canada, Europe, Africa, Asia, Australia, Central America and South America.

In addition to completing extensive technical and business components of the survey, the respondents selected technical, political, economic, and environmental trend information which they feel will have the greatest impact on their businesses in five years and ten years.

The most frequently mentioned technical advances centered around improvements on existing technology rather than the development of new technology. This included the integration of existing technologies, which for purposes of this study is defined as the integration of presently independent and/or semi-independent technologies to generate a geospatial product. For example, airborne global positioning systems (GPS) and inertial measuring units (IMU) have already been successfully integrated with aerial film and digital cameras to produce a product which allows users to know exact x, y, and z locations. This study uncovered an even greater expectation and desire of the remote sensing industry for additional technology integration. In addition, the respondents indicated their belief that ever-increasing processing speeds for computers, increased data storage capabilities, and processing software (to lessen image noise) would be technology trends in 2015 which would impact their businesses. Greater ground resolution is just another step along a continuum of improvements in the hardware and software that makes remote sensing possible and this study supports a global view that increased resolution will continue to be a growing area of interest and a significant trend in the development of new sensor technologies.

There were some variations in technical trend responses by sector and by geography that reflect an individual sectors particular needs. For example, the Aerial Digital and Satellite sectors were most concerned with Greater Ground Resolution, while the other sectors had

Technology Integration as their top selection. Geographically, the respondents from Africa selected Improved Airborne GPS Units as their top choice, while South America selected Greater Ground Resolution, and all other geographic regions selected Technology Integration as the most significant technical trend that would impact their businesses in the years 2010 and 2015.

The Local, State, Federal Defense, and Federal Civil respondents tracked very closely on which technical advances would impact them the most, with Technology Integration and Greater Ground Resolution at the top of the list. In 2015, Stereo Data and Artificial Intelligence were included in the top ten for all government units as technology trends which will impact their use of remote sensing data.

The respondents in the Satellite sector also selected Technology Integration and Greater Ground Resolution as having the greatest impact on their businesses, but advances such as Improved Digital Elevation Models (DEMs), Improved Ground Control and Increased Channels and Bands ranked higher than in the overall survey group. In 2015, Virtual Operators/Sensors and Lighter-than-air Remote Controlled and Piloted Airships were also included in the top ten technology trend selections.

The 250 Personal Interviews supplied additional data about the importance of certain technical advances in the remote sensing industry. In particular, these individuals mentioned that improved access to remote sensing data will positively impact there businesses. As the amount of data available increases and the methods of delivering and storing data improve, use of the information will become more widespread, as individuals are more apt to use information that is easier to access.

Respondents were also asked to select Political, Economic, and Environmental trends that will impact their businesses in the years 2010 and 2015. Overall, respondents indicated National Defense/Homeland Security is the trend that will have the greatest impact on the industry in 2010, and will continue to have an impact in 2015. This is not surprising considering the emphasis in the US that has been placed, at local, state and federal government levels, on emergency preparedness since September 11, 2001. There has been a surge of interest in geographic information systems (GIS) and demand for the data needed to populate these databases. A major push to share data and fill data “gaps” has been strongly influenced by the threat of terrorist attacks throughout the world, but particularly in the US.

Another economic trend ranking high on the list of respondents was the interest in Remote Sensing Data becoming a Commodity. This trend was selected by the data producers as well as data users. Although organizations often hope that their “product” becomes a household name, most businesses do not want that product to become a commodity since it generally means prices decrease and competition increases. This trend, if realized, could have a dramatic impact on the commercial end users and the software/hardware/value added businesses, due to data becoming more standardized and easier to purchase at lower prices. This same trend may cause the data providers concern over their profit margins in future years.

Several of the top ten Political, Economic, and Environmental trends selected such as Endangered Species/Natural Resource/Heritage Protection, Required Cadastral Mapping,

and Global Warming, will have a positive effect on the industry as a whole by increasing demand for data and services.

Trend comparisons between sectors show a slight difference in emphasis for the Commercial and Academic sectors. Both sectors selected Remote Sensing Data Becoming a Commodity as their top influence, probably due to their price sensitivity when purchasing data, while all other sectors picked National Defense/Homeland Security as the most influential impact most likely due to the prospective changes this trend will cause in their operating units and product and service offerings.

The geographic comparisons between sectors indicated more pronounced differences in the Political, Economic, and Environmental trends than in the Technical Advances. The US and Canada were most concerned about National Defense/Homeland Security, while the other sectors geographically were split between Remote Sensing Data Becoming a Commodity, Required Cadastral Mapping, Expansion of the European Union and Licensing Issues.

The top trends varied slightly between the government units. In 2010 Local, State and Federal Defense selected National Defense/Homeland Security as the largest impact on the way in which they operate. In 2015, the emphasis changed somewhat for the State respondents. They selected, along with the Federal Civil unit, Global Warming and Endangered Species and Natural Resources/Heritage Protection as the most important impacts.

The Satellite sector made some unique selections in their top ten list of trends. Some of the items that rank higher on their list than in the overall results are Licensing Issues, Availability of Prime Orbits, and Recovery of Investment. They also show a more consistent interest in the international trends, such as Expansion of the European Union, most likely due to their global data collection and distribution operations.

The 250 Personal Interviews further supported the importance of National Defense/Homeland Security and Endangered Species/Heritage Protection throughout the remote sensing industry. Outsourcing/Privatization was also emphasized in the personal discussions (particularly with US respondents) more so than in the overall survey. The respondents indicated an ongoing concern related to the fact that companies providing data services in the remote sensing industry are being forced to consider new business practices that include outsourcing in order to remain cost competitive.

The survey responses shed light on the eight project sectors' thoughts concerning the future. The study clearly indicated the aerial and spaceborne sectors are significantly impacted by government policies that determine the volume, quality, and areas of interest for aerial data. The US response from these sectors, indicate growth in the industry closely tied to National Defense/ Homeland Security issues. Overall, the global outlook for the remote sensing industry is strong and growth oriented.

1.1 Survey Responses – Technical Trends

All of the respondents were asked to identify from a list of over forty choices, the technical advances they see impacting their businesses in the years 2010 and 2015. Tables 1 and 2 list the areas most frequently mentioned overall by the 1,547 respondents. In 2010, Technology Integration, Greater Ground Resolution, and Greater Horizontal and Vertical Accuracy were the top three advances selected, while in 2015, Even Greater Ground Resolution, Even Greater Computer Processing Speed, and Even Better Processing Software were the most frequently selected.

Table 1: 2010 Technical Advances Cross Sectors

	2010 Technical Advances	Total Respondents
1.	Technology Integration (LIDAR, Digital Cameras, Airborne GPS Units, etc.)	1180
2.	Greater Ground Resolution	997
3.	Greater Horizontal and Vertical Accuracy	856
4.	Improved Airborne GPS Units	764
5.	Greater Computer Processing Speed	737
6.	Increased Data Storage Capabilities	732
7.	Increased User Friendliness of Software	690
8.	Better Processing Software (Less Noise)	640
9.	Spaceborne Sensors	564
10.	Increased Channels and Bands	561

Table 2: 2015 Technical Advances Cross Sectors

	2015 Technical Advances	Total Respondents
1.	Even Greater Ground Resolution	864
2.	Even Greater Computer Processing Speed	686
3.	Even Better Processing Software (Less Noise)	686
4.	Continued Increased Channels and Bands	640
5.	Continued Increased Data Storage Capabilities	601
6.	Continued Increased User Friendliness of Software	586
7.	Spaceborne Sensors	564
8.	Stereo Data	535
9.	Even Greater Onboard Storage Capacity	506
10.	Artificial Intelligence	483

1.2 Survey Responses – Political, Economic, and Environmental Trends

The Political, Economic, and Environmental trends that are likely to have the greatest impact on the project sectors, are listed for the years 2010 and 2015. Some of these trends could potentially have negative effects on certain sectors, while having positive effects on others. It depends on whether the respondent is a producer of data and services or a user of data and services. For example, the increased interest in homeland security may result in restricted access to data collection and distribution, but the demand for data from the government will spur growth in the market. Respondents were asked to select from a list of over 40 potential choices and had to make their own decision about how they defined the trend. For instance, if someone was not familiar with the Open Skies Initiative they probably would not select it. However, most individuals involved in remote sensing understand there is an Open Skies Treaty signed (in Helsinki, Finland in 1992) by a number of countries that allow the operation of aircraft and sensors, without undue hardship, in the airspace of another nation in order to monitor various types of military activity.

Tables 3 and 4 list the top ten trends selected across sectors. Although the selection of National Defense/Homeland Security had the highest response level by far, all ten selections were listed in order to show the actual response level and provide an indication of the significance of and interest in the trend by the respondents.

Table 3: 2010 Political, Economic, and Environmental Trends Cross Sectors

	2010 Political, Economic, and Environmental Trends *Cross Sectors (Number of responses include Personal Interviews)*	**Total Respondents**
1.	National Defense/Homeland Security	1051
2.	Endangered Species and Natural Resources/Heritage Protection	753
3.	Required Cadastral Mapping	720
4.	Remote Sensing becoming a Commodity	710
5.	Global Warming	688
6.	Licensing Issues	681
7.	International Trade	492
8.	Open Skies Initiative	420
9.	Expansion of the European Union	411
10.	Outsourcing/Privatization	401

Table 4: 2015 Political, Economic, and Environmental Trends Cross Sectors

	2015 Political, Economic, and Environmental Trends *Cross Sectors (Number of responses include Personal Interviews)*	Total Respondents
1.	National Defense/Homeland Security	844
2.	Global Warming	687
3.	Endangered Species and Natural Resources/Heritage Protection	672
4.	Licensing Issues	576
5.	Required Cadastral Mapping	573
6.	Remote Sensing becoming a Commodity	566
7.	International Trade	486
8.	Open Skies Initiative	404
9.	Expansion of the European Union	360
10.	Outsourcing/Privatization	327

2 Introduction to the Remote Sensing Survey Study

2.1 Methodology

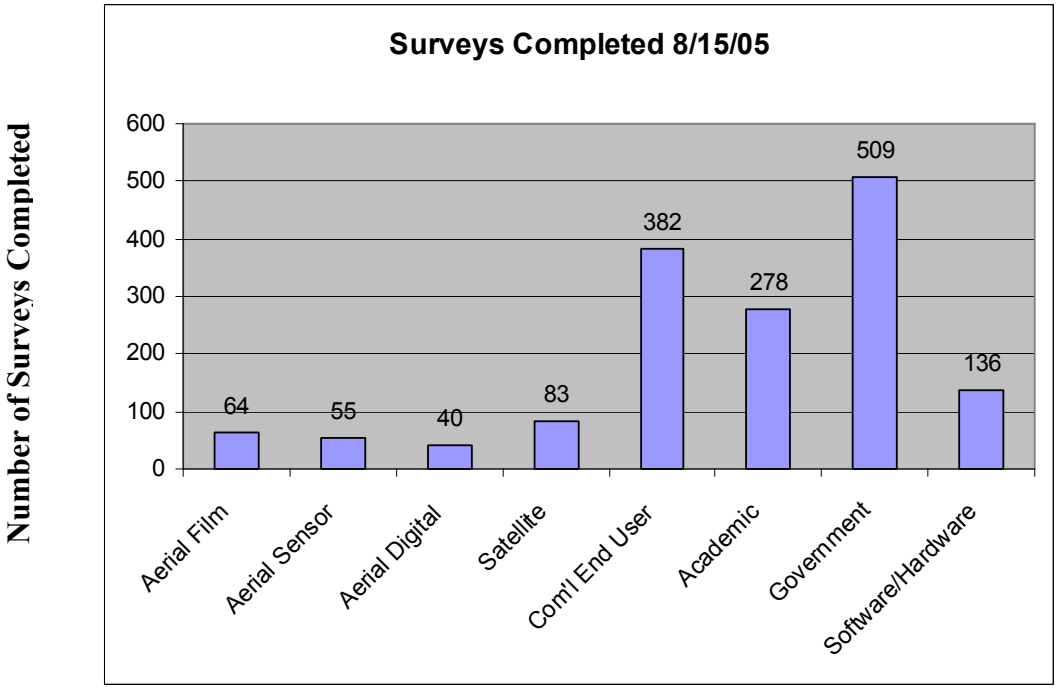
The methodology used to complete the survey of the international remote sensing market (aerial and spaceborne) made use of multiple research techniques and a global database of over 10,000 contacts. The results provide an overview of the impact of technical, political, economic and environmental trends upon the aerial and satellite remote sensing industry as well as, revenue and employee projections and other technical data which relates specifically to each individual sector. The research was collected utilizing detailed, twenty page, on-line surveys, and personal interviews. The surveys were developed in close coordination with NOAA's Satellite and Information Service. In order to improve the final survey quality they were reviewed by fifteen industry luminaries and were pre-tested in focus group settings with the Management Association for Private Photogrammetric Surveyors (MAPPS), a US-based geospatial professional organization. The 1,547 on-line responses to the eight sector surveys and 250 personal interviews provided over 2,000 pages of statistical data.

For the purposes of this report, distinctions will be made between impacts on the project sectors; Aerial Film, Aerial Digital, Aerial Sensor (Hyperspectral/LiDAR/SAR), Satellite, Commercial End User, Software/Hardware, Government, and Academic.

2.2 On-line Surveys

Respondents were invited to participate in the survey at nine industry conferences and events that took place in the US between January and July 2005, including MAPPS (three locations), GeoTec, AFCEA (Armed Forces Communications and Electronics Association), ASPRS (American Society of Photogrammetry and Remote Sensing), International LiDAR Users Conference, Intergraph International Users Conference, and ESRI International User Conference. Advertisements were placed in industry publications, such as *PE&RS (Photogrammetric Engineering and Remote Sensing)*, *GeoSpatial World*, GITA (Geospatial Information and Technology Association) Conference Program Guide, ASPRS Conference Program Guide, *Imaging Notes*, and *Geospatial Solutions,* to make potential respondents aware of the survey.

Figure 1: Survey Responses by Sector



The respondents for each sector come from a variety of countries around the world. The eight sectors and the geographic composition of the respondents of each sector are shown in Table 5. US representation is largest in the Aerial Film (69%), Aerial Sensor (80%), Aerial Digital (70%), and Government (66%) sectors, while International representation is the largest in the Satellite (63%) and Academic (51%) sectors.

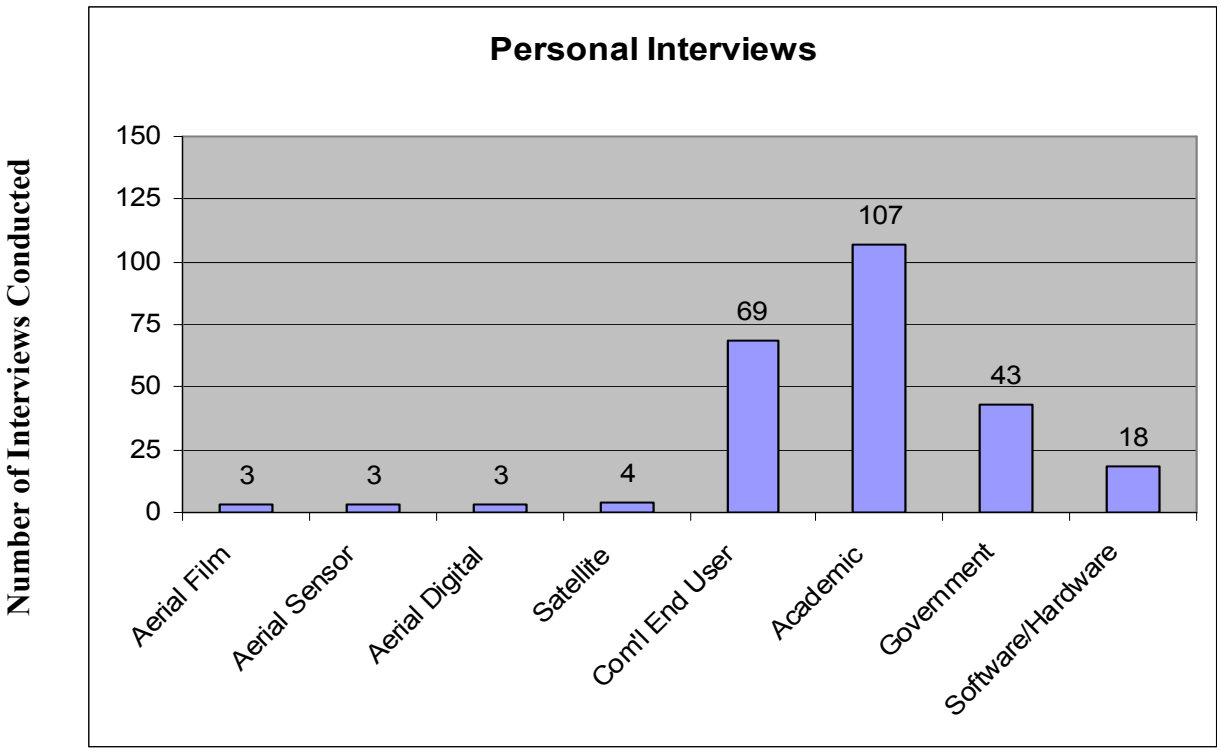
Table 5: Survey Responses by Sector and Geographic Region

SECTOR RESPONSES	AERIAL FILM	AERIAL SENSOR	AERIAL DIGITAL	SATEL-LITE	COM'L END USER	GOVERN-MENT	ACADEMIC	SOFT/ HARD-WARE	TOTAL
U.S.	44	44	28	31	221	335	136	75	914
CANADA	2	2	2	5	49	55	14	17	146
EUROPE	11	7	4	20	34	26	38	10	150
ASIA	3	0	2	9	17	28	33	18	110
AFRICA	2	1	2	9	33	36	34	5	122
AUSTRALIA	0	1	1	2	5	3	2	0	14
CENTRAL & SOUTH AMERICA	2	0	1	4	15	12	14	5	53
OTHER	0	0	0	3	8	14	7	6	38
TOTAL	**64**	**55**	**40**	**83**	**382**	**509**	**278**	**136**	**1547**
International %	***31%***	***20%***	***30%***	***63%***	***42%***	***34%***	***51%***	***45%***	***41%***
U.S. %	***69%***	***80%***	***70%***	***37%***	***58%***	***66%***	***49%***	***55%***	***59%***

2.3 Personal Interviews

The 250 personal interviews were conducted during the on-line data collection time period at industry conferences and with volunteers who had also completed the online survey. The largest numbers of interviews were conducted at industry conferences which had a cumulative attendance of over 20,000 geospatial users worldwide representing the eight sectors of interest for this study. The personal interviews were conducted to provide more detailed input about the technical, political, economic, and environmental trends impacting the project sectors.

Figure 2: Personal Interview Response by Sector



Of the 250 personal interviews, 221 were US-based responses and 29 were International responses. The US had responses from each sector, while International responses represented the Aerial Digital, Commercial End User, Government, Academic and Software/Hardware sectors.

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The data from the interviews were reviewed and categorized in order to find similarities and differences in the responses to the on-line surveys in the technical and political, economic, and environmental trend areas. The eight sectors and the geographic composition of the respondents of each sector are shown in Table 6.

Table 6: Personal Interviews by Sector and Geographic Region

SECTOR RESPONSES	AERIAL FILM	AERIAL ENSOR	AERIAL DIGITAL	SATELLITE	COM'L END USER	GOVERN-MENT	ACADEMIC	SOFT/ HARD-WARE	TOTAL
U.S.	3	3	2	4	58	101	36	14	221
INTERNATIONAL	0	0	1	0	11	6	7	4	29
TOTAL	3	3	3	4	69	107	43	18	250
U.S. %	*1%*	*1%*	*.9%*	*2%*	*26%*	*46%*	*17%*	*6%*	*88%*
International %	*0%*	*0%*	*3%*	*0%*	*38%*	*21%*	*24%*	*14%*	*12%*

Over half of those interviewed, 59%, were in the position of a Technical/GIS Manager or Technical Analyst, and another 16% were CEO/Presidents and Academic Professors/Instructors. Their experience varied with 35% having less than 5 years, 33% having 5-10 years of experience, and 32% having more that 20 years of experience. The comments selected for this study documentation are representative of the overall response of the personal interviews and are quoted directly from the interviews.

2.4 Alliance Research Partner Network

Twenty-six companies and associations joined forces with Global Marketing Insights, Inc. and assisted in the collection of research responses by distributing information about the survey to thousands of their customers and industry contacts, thus broadening the reach of the survey. These alliance research partners—consisting of industry publication organizations, commercial companies, universities, and non-profit professional associations—reached the remote sensing profession globally. The alliance research partner network directed approximately 60% of the total respondents to the on-line survey site with Global Marketing Insights, Inc. directing 40% of the respondents to the on-line survey site utilizing their company database, industry conferences and advertisements. A listing of the network partners is provided in Table 7 and provides the name of the partner and the geographic target area which they reached.

Table 7: Alliance Research Partners and Target Geographic Areas

Alliance Partner	Target Geographic Area
1. American Surveyor, GIS User.com & Map User	US and International
2. Association of American Geographers	US and International
3. BAE Systems	US and International
4. Corbley Communications	US and International
5. Directions Magazine	US and International
6. Earth Imaging Journal Magazine	US and International
7. Eurimage	Europe, Asia, Africa, Australia
8. GITA	US and International
9. GITC America	US
10. Geo Community International	US and International
11. GeoSearch	US
12. GeoVantage	US
13. GeoWorld Magazine/ GeoPlace.com	US and International
14. GSDI Association	Africa
15. ICTAF at Tel-Aviv University	Europe
16. Intelligence Data Systems	US
17. MAPPS	US
18. MDA Geospatial Services (Radarsat)	Canada and United States
19. OrbImage	US and International
20. PCI Geometrics	US and Canada
21. Position Magazine	Asia, Australia & Pacific Rim
22. Spatial Resources	US
23. Spectrum Mapping	US and International
24. URISA	US and Canada
25. Woolpert	US
26. Z/I Imaging - Intergraph	US and International

2.5 Report Content Selection

Over 2,000 pages of statistics were produced from the eight sector surveys (each survey averaged twenty pages in length). NOAA's Satellite and Information Service contracted specifically for the analysis of the information which is contained in this study documentation.

In addition to the data collected by the sector surveys and personal interviews NOAA's Satellite and Information Service, requested independent research completed at a macro level related to technical, political, economic, and environmental trends impacting the use of remotely sensed data worldwide. This information is provided in the Future Technology section. In addition to the analysis for this study documentation, the on-line surveys also produced a considerable amount of data related specifically to each of the eight sectors studied; Aerial Film, Aerial Digital, Aerial Sensors, Satellite, Value Added Hardware and Software Providers, Commercial End Users, Academic, and Government (which is further divided into local, state/provincial, Federal Defense, and Federal Civil units).

3 Technology Trend Comparisons

3.1 Industry Sectors

The survey respondents were asked to identify the technical advances impacting their businesses in the years 2010 and 2015. Technology Integration was selected most often by the 1,547 respondents overall. When analyzed by sector, the order of importance of the trends varied somewhat, but Technology Integration was still clearly the trend selected as first choice for all of the sectors except Satellite and Aerial Digital in which it ranked second. Aerial Digital ranked Greater Ground Resolution and Better Processing Software first and second.

Table 8: Technical Advances 2010 by Sector

Technical Advances 2010	Aerial Digital	Aerial Sensor	Aerial Film	Soft/ Hardware	Comm'l	Gov't	Academic	Satellite
Technology Integration (LIDAR, Digital Cameras, Airborne GPS Units, etc.)	50%	**73%**	**53%**	**86%**	**80%**	**81%**	**77%**	49%
Greater Ground Resolution	**78%**	38%	44%	58%	74%	64%	66%	**54%**
Greater Vertical and Horizontal Accuracy	40%	62%	41%	58%	60%	55%	56%	40%
Improved Airborne GPS Units	43%	29%	25%	51%	58%	52%	49%	24%
Greater Computer Processing Speed	33%	0%	11%	57%	60%	53%	51%	0%
Increased Data Storage Capabilities	18%	0%	8%	54%	60%	53%	54%	0%
Increased User Friendliness of Software	0%	0%	0%	55%	60%	48%	51%	0%
Better Processing Software (Less Image Noise)	**78%**	31%	38%	39%	46%	37%	47%	29%
Spaceborne Sensors	8%	9%	17%	47%	44%	33%	41%	34%
Increased Channels/Bands	23%	25%	11%	45%	40%	30%	47%	42%

There was more diversity in the top selections for the 2015 technical advances, no doubt due to the responses being more speculative rather than based on short-term business plans. Greater Ground Resolution was the top choice for five of the sectors; however the Aerial Sensor sector selected Better Processing Software as their top choice, the Software/Hardware sector chose Greater Computer Processing Speed, and the Academic sector chose Continued Increased Channels and Bands.

These selections reflect the specific interests of each sector. For example, the ability to collect more channels and bands in the imagery would provide new opportunities for research in the academic world, while the software/hardware industry is focused on the speed and efficiency of their products.

Table 9: Technical Advances 2015 by Sector

Technical Advances 2015	Aerial Digital	Aerial Sensor	Aerial Film	Soft/ Hardware	Comm'l	Gov't	Academic	Satellite
Even Greater Ground Resolution	**93%**	35%	**42%**	51%	**58%**	**59%**	56%	**45%**
Even Greater Computer Processing Speed	0%	0%	0%	**54%**	53%	53%	50%	0%
Even Better Processing Software (Less Image Noise)	60%	**38%**	30%	42%	48%	45%	46%	33%
Continued Increased Channels and Bands	0%	20%	0%	49%	42%	33%	**74%**	34%
Continued Increased Data Storage Capabilities	0%	0%	0%	46%	47%	48%	41%	0%
Continued Increased User Friendliness of Software	0%	0%	0%	44%	47%	44%	44%	0%
Spaceborne Sensors	43%	9%	17%	43%	40%	38%	37%	31%
Stereo Data	20%	5%	34%	34%	39%	33%	40%	34%
Even Greater Onboard Storage Capacity	48%	18%	33%	35%	34%	33%	31%	31%
Artificial Intelligence	15%	9%	11%	32%	41%	31%	33%	18%

3.2 Geographic Highlights-Technology Trends

An analysis of the survey results based on geographic origin of the respondents shows that the regions track fairly close regarding technical advances in 2010. All of the regions ranked Technology Integration high on the list and South America showed more emphasis on Greater Ground Resolution and Africa ranked Improved Airborne GPS Units as the technical advance having the most impact on their businesses. The percentage responses from Asia are 42% or higher in every category, perhaps indicating a greater desire for new technology

to advance their capabilities and to build a high-tech industry to bring revenue to the developing countries of their region. Although the actual number of respondents from Australia was low (14 respondents) the value in including the region's responses provides an indication of where their interests lie.

Table 10: Geographic Highlights - Technical Advances 2010 by Sector

Technical Advances 2010	US	Canada	West/ East Europe	Asia	Central America	South America	Australia	Africa
Technology Integration	**83%**	**72%**	**67%**	**69%**	**71%**	62%	**71%**	58%
Greater Ground Resolution	67%	61%	56%	62%	64%	**67%**	64%	60%
Greater Horizontal and Vertical Accuracy	58%	56%	46%	52%	43%	44%	50%	51%
Greater Computer Processing Speed	51%	49%	31%	43%	64%	41%	29%	46%
Increasing Data Storage Capabilities	51%	53%	31%	42%	64%	38%	14%	51%
Improved Airborne GPS Units	47%	47%	33%	55%	43%	44%	57%	**62%**
Increased User Friendliness of Software	46%	47%	29%	48%	57%	33%	14%	48%
Better Processing Software	42%	32%	32%	46%	36%	44%	36%	48%
Spaceborne Sensors	37%	35%	35%	45%	29%	36%	36%	30%
Increased Channels and Bands	33%	41%	37%	46%	29%	41%	43%	37%

The results for 2015 were slightly less consistent from region to region, but six of the regions placed Even Greater Ground Resolution at the top of the list. Other top results were Even Greater Computer Processing Speed in Central America and Continued Increased Channels and Bands in South America. Stereo Data and Artificial Intelligence are in the top ten for 2015, indicating that more complex data, and the tools necessary to process and analyze that data, will begin to have a greater impact throughout the remote sensing industry.

Table 11: Geographic Highlights - Technical Advances 2015 by Sector

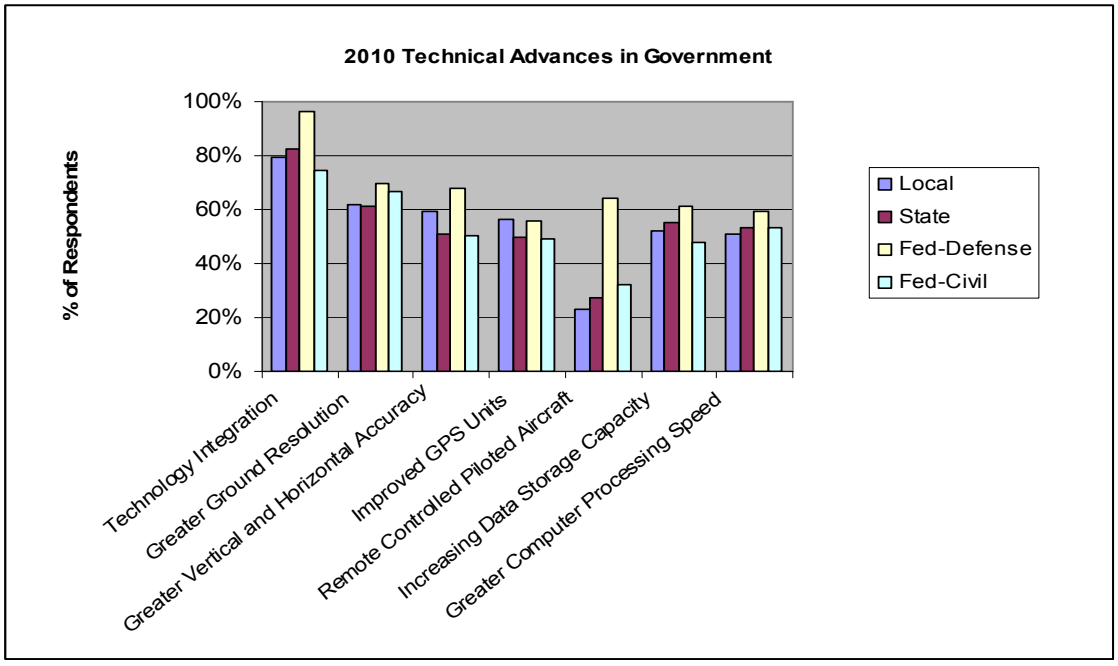
Technical Advances 2015	US	Canada	West/ East Europe	Asia	Central America	South America	Australia	Africa
Even Greater Ground Resolution	**58%**	**53%**	**38%**	**50%**	57%	28%	**71%**	**52%**
Even Better Processing Software	46%	39%	26%	**50%**	36%	28%	36%	48%
Even Greater Computer Processing Speed	46%	26%	23%	33%	**64%**	21%	7%	30%
Continued Increasing Data Storage Capabilities	42%	24%	16%	26%	50%	21%	0%	28%
Continued Increasing User Friendliness of Software	41%	18%	13%	29%	57%	21%	7%	26%
Even Greater Onboard Storage Capacity	37%	25%	23%	31%	29%	15%	21%	24%
Spaceborne Sensors	37%	36%	33%	29%	43%	28%	36%	25%
Continued Increased Channels and Bands	35%	39%	35%	36%	29%	**38%**	43%	38%
Stereo Data	33%	34%	26%	36%	43%	31%	29%	20%
Artificial Intelligence	30%	27%	26%	41%	29%	33%	43%	39%

3.3 Government Sector-Technology Trend Highlights

The following four units within the government respondents were identified: Local, State/Provincial, Federal Defense, and Federal Civil. For the most part, similar interests and applications were reflected by the unit respondents, with a few exceptions noted.

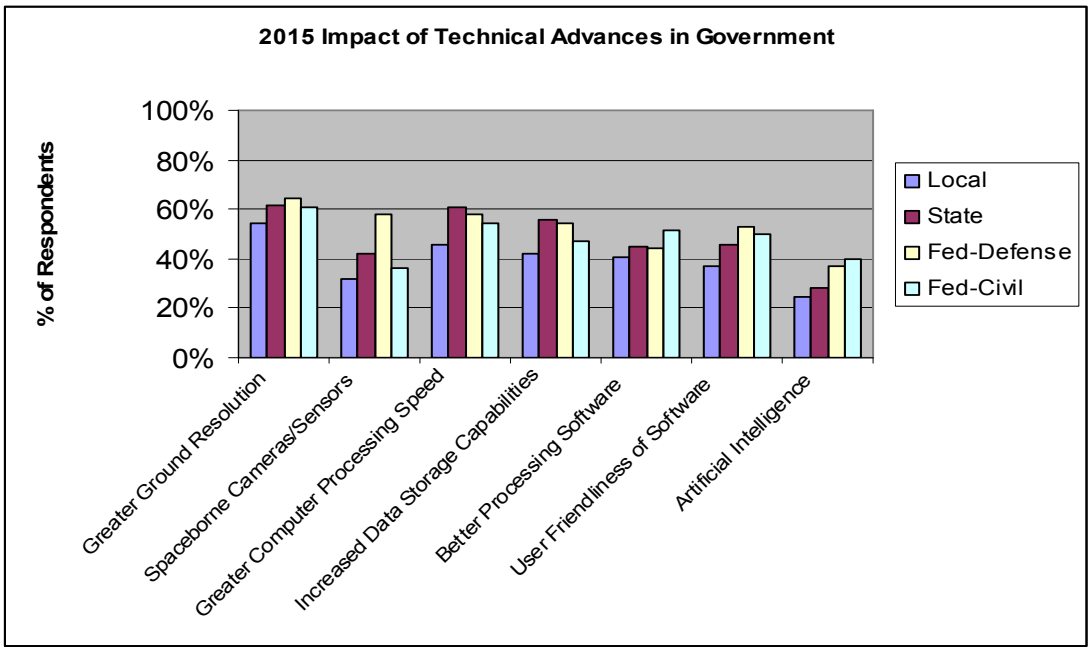
When asked about the technical advances that will impact their organizations in 2010, respondents in all four units selected Technology Integration and Greater Ground Resolution the most often. Other selections included in the top ten for all four units are: Greater Horizontal and Vertical Accuracy, Improved GPS Units, Increasing Data Storage Capacity, Greater Computer Processing Speed, and Increasing User Friendliness of Software. Better Processing Software was in the top ten for Local, State, and Federal Civil. Spaceborne Cameras/Sensors was in the top ten for State, Federal Defense, and Federal Civil. Remote Controlled Piloted Aircraft and Greater Onboard Storage Capacity were in the top ten for Local and Federal Defense. Increased Channels and Bands were in the top ten for State and Federal Civil.

Figure 3: Government Highlights - Technical Advances 2010



In 2015, Greater Ground Resolution became the number one impact for all four units. The other trends most often selected are similar to those selected for 2010, with the addition of Stereo Data and Artificial Intelligence in all units. Stereo data is very valuable for emergency response activities, which may be why it is of interest. Artificial intelligence applied to image processing can improve the accuracy and speed of interpreting the data, which can be useful in many types of analysis, supporting defense, emergency response, and environmental applications.

Figure 4: Government Highlights - Technical Advances 2015



3.4 Satellite Sector-Technology Trend Highlights

The Satellite sector is of particular interest in the remote sensing industry because of the dramatic changes that have occurred in the past decade. Since 1999, commercial high-resolution satellite imagery has been available to the public, whereas in the past only governments had access to one meter or better resolution data. The new accessibility has created many opportunities for application and software development.

The technical advances that are expected to impact the Satellite sector are similar to the other sectors, with a few exceptions, like Greater Collection Capacity and Improved Digital Elevation Models and Ground Control in 2010, and Virtual Camera/Sensor Operators in 2015. The basic technologies driving ground resolution, data storage, and data processing will continue to be important to the satellite industry as they “push the envelope” of what is possible to achieve from space.

Tables 12 and 13 list the top ten technical advances selected by the satellite sector respondents as having the most impact to their business in the years 2010 and 2015. The 2010 responses in Table 12 demonstrate the closeness in the choices of the top ten selections by the respondents. Table 13 represents the selections for the year 2015 indicating the respondents were still more focused on selecting technical advances which

represented improvements in current technology however, some respondents did begin to consider the impact new technology would have on their businesses by selecting Artificial Intelligence, and Virtual Camera, Sensor, and Pilot Operated Vehicles.

Table 12: 2010 Technical Advances Satellite Sector

	2010 Technical Advances Satellite Sector	# of Responses
1.	Greater Ground Resolution	45
2.	Technology Integration (LIDAR, Digital Cameras, Airborne GPS Units, etc.)	41
3.	Improved DEM's and Ground Control	37
4.	Increased Channels and Bands	35
5.	Greater Vertical and Horizontal Accuracy	33
6.	Spaceborne Sensors	28
7.	Greater Collection Capacity	27
8.	Better Processing Software (Less Image Noise)	24
9.	Greater Onboard Storage Capacity	24
10.	Improved Airborne GPS Units	20

Table 13: 2015 Technical Advances Satellite Sector

	2015 Technical Advances Satellite Sector	# of Responses
1.	Greater Ground Control	37
2.	Continued Increased Channels and Bands	28
3.	Stereo Data	28
4.	Even Better Processing Software (Less Image Noise)	27
5.	Spaceborne Sensors	26
6.	Even Greater Onboard Storage Capacity	26
7.	Artificial Intelligence	15
8.	Virtual Camera/Sensor Operators	11
9.	Lighter-Than-Air Remote Controlled and Piloted Airships	8
10.	Virtual Pilots for Present Retrofitted Aircraft	6

3.5 Personal Interviews-Technology Trend Highlights

The Personal Interviews were analyzed in order to determine if they supported or disputed the trends completed in the on-line surveys. Keep in mind the participants provided the data collectors their own thoughts and were not provided with a list of technology trends to choose from, unlike the on-line respondents. The analysis of the interviews did not yield significantly different results from the online surveys, but they did highlight the importance of the trend "Greater and Easier Access" to remote sensing data. Access to the data is a key business ingredient for value-added service providers and end users. The greater the variety of data

available and the lower the price, the more likely it is that products will become available to meet the needs of a broader user base.

Table 14: 2010 Technical Advances Personal Interviews

	2010 Technical Advances Personal Interviews	# of Responses
1.	Greater Ground Resolution	44
2.	Greater and Easier Access	36
3.	Greater Computer Processing Speed	32
4.	Lower Cost	24

Table 15: 2015 Technical Advances Personal Interviews

	2015 Technical Advances Personal Interviews	# of Responses
1.	Too Far into the Future, not sure	58
2.	Even Greater Computer Processing Speed	27
3.	Greater and Easier Access	24
4.	Even Greater Ground Resolution	23

The following statements are representative of the most often received comments mentioned in the personal interviews and support the selections of the respondents in the on-line surveys:

- *"There will be a greater need for higher resolution imagery and the trend will continue toward the use of digital. Technology will be easier to access, become faster, and be available at a lower cost. It will be more automated, and be used by the masses, not just the technically oriented individuals, or those in the GIS field."*
- *"The distinction toward GIS and IT will fade; they will become the same. The challenge will be in finding adequate and sufficient numbers of trained individuals to perform all of the tasks. Educational institutes will not be able to keep up with this demand."*
- *"Hyperspectral data will provide more systems with narrower wave lengths. The application for these will be primarily in agriculture and geology for uses such as disease analysis, bio-stress and yield analysis."*
- *"The price of LiDAR data will decrease and there will be better storage and processing available. The trend toward LiDAR data and digital imagery that is georectified and fused, along with sensor fusion is expected. There appears to be concern over the lack of standardization of both the digital and LiDAR data, resulting in methodology and equipment that are not consistent, causing varied output."*

In regard to accessing data, the interviewees believe, " In the future it will be easier to access, and there will be more ways in which to access the data, from the desktop using

Windows to get directly to maps and other pertinent information without having to go through a third party."

Many of the respondents (23%) felt that it was too difficult to attempt to predict the technical impact for 2015 since the rate of technology change and development is so rapid. Some indicated that they "cannot even imagine what will be going on ten years from now in this industry."

Those that did respond however indicated that for the year 2015 the trends for Greater Processing Speed, Greater and Easier Access, and Greater Ground Resolution will continue. Also they indicated, "the use of LiDAR will increase as prices continue to fall and storage and processing capabilities improve."

In addition, it is predicted, "the technology will allow for Telemetric downlinks directly to a ground station. This means the satellite will be able to collect imagery and downlink the data already georeferenced, thus greatly reducing the data processing time and increasing the quality of the data. Others stated, "industry growth will be a result of technology improvements in the computer industry rather than the remote sensing industry."

Additionally, it is believed there will continue to be a proliferation of satellite development by countries which have never been able to develop satellite technology (some interviewees mentioned specifically countries such as Iran and Thailand would have this capability). Since there will be other countries acquiring data, the new observation methods, tools, and techniques will require new algorithms to be developed, which will take considerable time. Overall, the interviews clearly supported the results of the survey findings in terms of the technical trend analysis.

4 Political, Economic, and Environmental Trend Comparisons

4.1 Industry Sectors

Respondents were asked to select the Political, Economic, and Environmental trends that are likely to have the greatest impact on their businesses in the years 2010 and 2015. Overall, the 1,547 respondents selected National Defense/Homeland Security as the primary trend, and all but two of the individual sectors showed the same result. In the US since September 11, 2001, a huge emphasis has been placed on Federal, State and Local Programs for emergency response and disaster preparedness. These programs will continue to be defined and implemented over the next ten years. Large amounts of money have been earmarked for national defense; however it appears the programs need to be clearly established before a direct revenue impact can be seen throughout the industry.

The Commercial and Academic sectors are most interested in Remote Sensing Data Becoming a Commodity. Prices of data are expected to decrease as supply increases. For example, the Aerial Film sector has become extremely cost-competitive over the past five years because there are so many aerial mapping companies all competing for the same projects. The number of digital aerial companies is expected to increase steadily, which could also cause the price of digital data to fall as well. There are only a handful of satellite remote sensing companies, and most of them offer a unique type of data so supply is limited and prices have remained high.

The second most frequently selected trend by the Aerial Digital and Aerial Sensor sectors is Outsourcing/Privatization. This was also mentioned in 60% of the Personal Interviews. As aerial mapping companies have looked for new ways to remain competitive over the past few years, outsourcing the data processing and value-added services has become more common. Wages in developing countries are lower than in the US and Canada, and with the ability to electronically transfer large volumes of data quickly, it has become increasingly attractive to establish overseas operations.

Table 16: Political, Economic, and Environmental Trends 2010 by Sector

Political, Economic, and Environmental Trends 2010	Aerial Digital	Aerial Sensor	Aerial Film	Soft/ Hardware	Comm'l	Gov't	Academic	Interviews	Satellite
National Defense/Homeland Security Issues	**63%**	**65%**	**58%**	**64%**	52%	**60%**	46%	**81%**	**45%**
Endangered Species and Natural Resources/ Heritage Protection	20%	24%	13%	35%	41%	43%	44%	65%	18%
Required Cadastral Mapping	38%	27%	31%	36%	40%	41%	35%	57%	25%
Remote Sensing Data Becoming a Commodity	0%	0%	0%	57%	**59%**	49%	58%	0%	0%
Global Warming	18%	22%	11%	32%	37%	34%	**51%**	60%	18%
Licensing Issues	25%	22%	27%	25%	37%	36%	40%	57%	34%
International Trade	20%	11%	14%	33%	27%	19%	26%	54%	24%
Open Skies Initiatives	20%	13%	13%	26%	22%	19%	23%	39%	20%
Expansion of the European Union	23%	22%	14%	24%	21%	15%	27%	38%	20%
Outsourcing/Privatization	40%	40%	33%	31%	34%	0%	0%	60%	23%

In 2015, Global Warming and Endangered Species and Natural Resources/Heritage Protection are fairly high on the list for Government, Academic, Commercial, and Software/Hardware. Over 60% of the Personal Interviews mentioned these topics as well. This bodes well for the industry, as remotely sensed data is becoming increasingly valuable for these types of analysis. Archaeological ruins never before identified are being detected from the air and space, and environmental studies that combine a myriad of data sources are being used to study many aspects of the environment.

Table 17: Political, Economic, and Environmental Trends 2015 by Sector

Political, Economic, and Environmental Trends 2015	Aerial Digital	Aerial Sensor	Aerial Film	Soft/ Hardware	Comm'l	Gov't	Academic	Interviews	Satellite
National Defense/Homeland Security Issues	**53%**	**44%**	**48%**	**49%**	39%	**49%**	38%	**68%**	**39%**
Global Warming	20%	24%	9%	35%	35%	37%	46%	57%	20%
Endangered Species and Natural Resources/ Heritage Protection	20%	13%	9%	26%	30%	40%	**47%**	61%	18%
Licensing Issues	18%	18%	27%	32%	29%	31%	32%	48%	29%
Required Cadastral Mapping	35%	25%	23%	26%	29%	33%	25%	50%	24%
Remote Sensing Data Becoming a Commodity	0%	0%	0%	43%	**43%**	41%	**47%**	0%	0%
International Trade	28%	11%	6%	29%	27%	20%	27%	50%	23%
Open Skies Initiatives	28%	11%	13%	21%	20%	20%	22%	38%	17%
Expansion of the European Union	20%	18%	9%	19%	18%	16%	21%	37%	12%
Outsourcing/Privatization	40%	22%	31%	21%	27%	0%	0%	52%	19%

4.2 Geographic Highlights-Political, Economic, and Environmental Trends

There was considerably more diversity for the political, economic, and environmental trends when the responses were looked at geographically. For 2010, the US and Canada were the only regions that selected National Defense/Homeland Security the most frequently, while four of the other regions selected Remote Sensing Data Becoming a Commodity the most frequently. This reflects the emphasis that North America has placed on preparedness for terrorist attacks since September 11, 2001, as opposed to the rest of the world, much of which has lived with ongoing civil unrest for decades. Western and Eastern Europe's primary concern is the Expansion of the European Union, while South America selected Required Cadastral Mapping the most frequently and Africa is most interested in Remote Sensing Data Becoming a Commodity.

Table 18:
Geographic Highlights - Political, Economic, and Environmental Trends 2010 by Sector

Political, Economic, and Environmental Trends 2010	US	Canada	West/ East Europe	Asia	Central America	South America	Australia	Africa
National Defense/Homeland Security	**67%**	**61%**	33%	41%	43%	31%	43%	32%
Remote Sensing Data Becoming a Commodity	44%	41%	41%	**65%**	**71%**	41%	**64%**	**58%**
Licensing Issues	37%	35%	23%	38%	**71%**	21%	36%	35%
Endangered Species	36%	48%	31%	36%	43%	33%	43%	52%
Required Cadastral Mapping	33%	38%	41%	48%	**71%**	**49%**	29%	43%
Global Warming	29%	48%	34%	45%	50%	46%	57%	43%
Outsourcing	25%	14%	14%	35%	21%	8%	14%	25%
Open Skies Initiatives	23%	24%	12%	24%	29%	13%	7%	20%
International Trade	20%	29%	21%	38%	43%	38%	29%	25%
Expansion of the European Union	18%	17%	**45%**	28%	21%	13%	7%	16%

The results for 2015 indicate that half of the regions—Canada, West/East Europe, Asia, and South America—feel that Global Warming will have a large impact on their businesses. The US will still be focused on National Defense/Homeland Security, while Australia and Africa selected Remote Sensing Becoming a Commodity the most frequently. The international-related topics, such as Open Skies Initiatives, International Trade, and Expansion of the European Union (EU), remained in the top ten selections indicating the importance of the global market throughout the remote sensing industry.

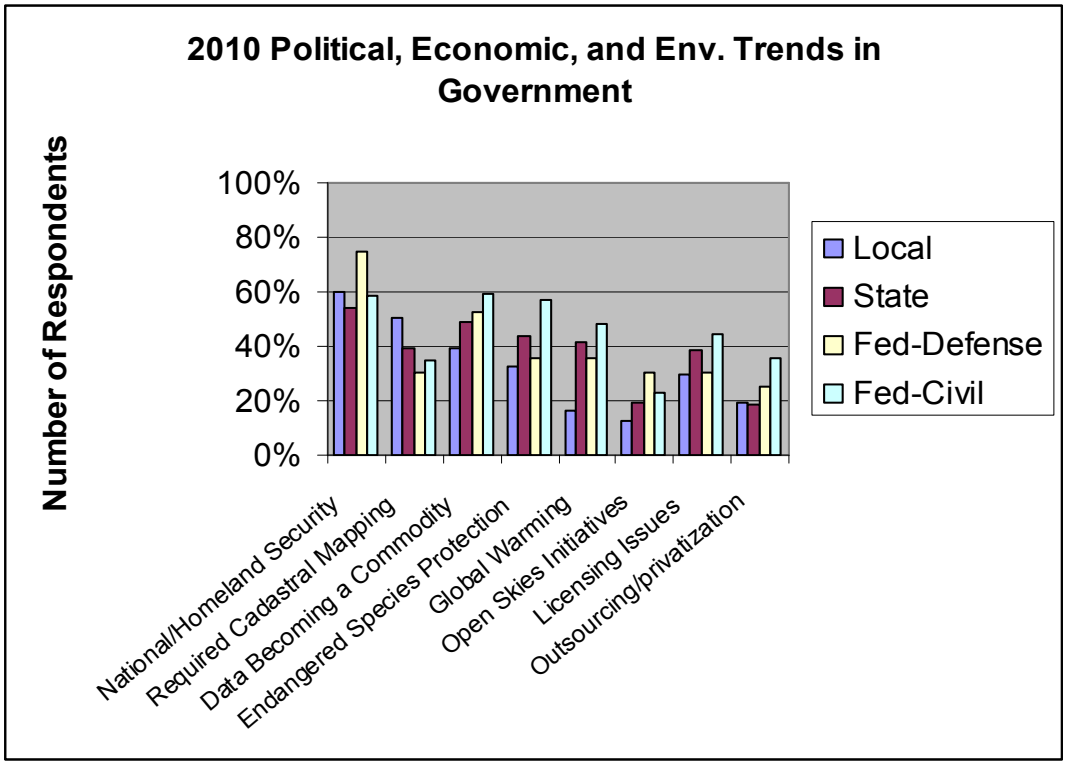
Table 19:
Geographic Highlights - Political, Economic, and Environmental Trends 2015 by Sector

Political, Economic, and Environmental Trends in 2015	US	Canada	West/ East Europe	Asia	Central America	South America	Australia	Africa
National Defense/Homeland Security	**54%**	39%	27%	27%	36%	21%	29%	27%
Remote Sensing Data Becoming a Commodity	36%	34%	30%	43%	36%	38%	**50%**	**45%**
Endangered Species	32%	44%	29%	35%	**57%**	28%	36%	39%
Licensing Issues	31%	31%	22%	36%	43%	21%	21%	28%
Global Warming	29%	**48%**	**40%**	**46%**	50%	**46%**	29%	44%
Required Cadastral Mapping	29%	27%	27%	35%	43%	31%	29%	24%
Outsourcing	21%	17%	11%	31%	0%	8%	14%	16%
International Trade	21%	25%	21%	39%	36%	31%	29%	25%
Open Skies Initiatives	20%	25%	13%	28%	7%	13%	7%	19%

4.3 Government Sector Trend Highlights-Political, Economic, and Environmental Trends

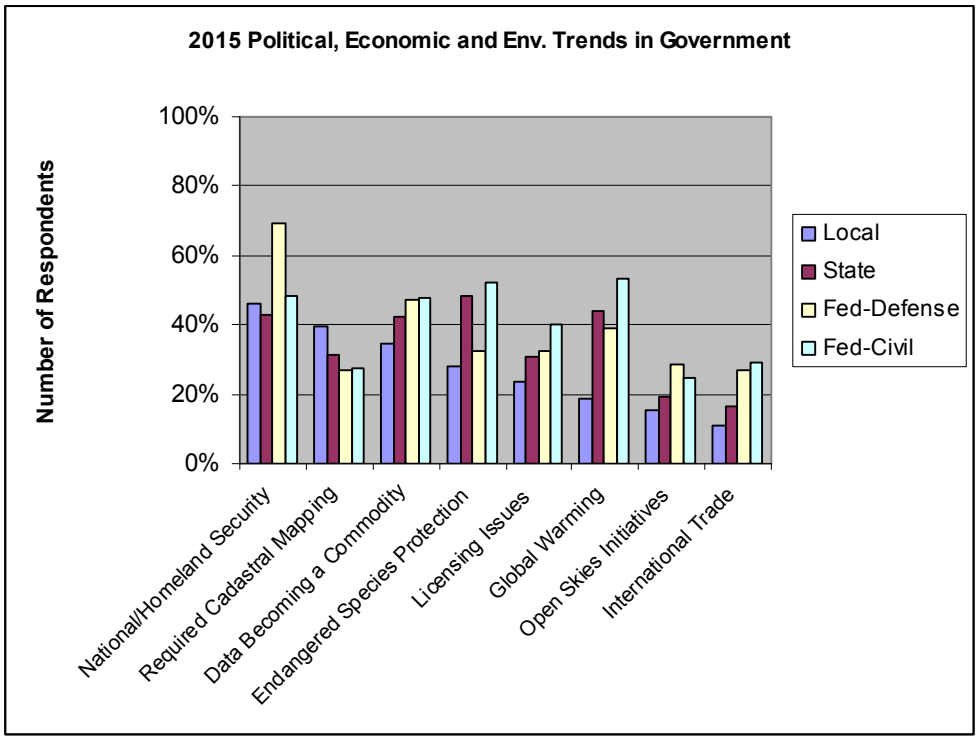
The top responses to the question about Political, Economic, and Environmental impacts in 2010 were divided between national security, data costs, international issues, and the environment. National Defense/Homeland Security was the most frequent response in the Local, State and Federal Defense units, and a close second in the Federal Civil unit. Remote Sensing Data Becoming a Commodity was in the top three responses for all units. International Trade, Open Skies Initiatives, Required Cadastral Mapping, Endangered Species and Natural Resources/ Heritage Protection, Licensing Issues, Outsourcing/ Privatization, and Global Warming were also in the top ten for all four units.

Figure 5: Government Highlights – Political, Economic, and Environmental Trends 2010



In 2015, Global Warming and Endangered Species and Natural Resources/Heritage Protection were the most important issues for State and Federal Civil government units, while National Defense/Homeland Security remained the top concern for the Federal Defense and Local units.

Figure 6: Government Highlights – Political, Economic, and Environmental Trends 2015



4.4 Satellite Sector Trend Highlights-Political, Economic, and Environmental Trends

National Defense/Homeland Security Issues were the top selection for the Satellite sector. The respondents also appear to be very international in their focus, with a belief that International Trade, the Open Skies initiative, and the Expansion of the European Union will provide an impact on their businesses. The fact that the satellite sector collects, processes, and distributes data collected worldwide also requires a greater awareness of international issues than, for example, a regional aerial mapping company would need.

Table 20: 2010 Political, Economic, and Environmental Trends Satellite Sector

	2010 Political, Economic, and Environmental Trends Satellite Sector	# of Responses
1.	National Defense/Homeland Security Issues	37
2.	Licensing Issues	28
3.	Required Cadastral Mapping	21
4.	International Trade	20
5.	Outsourcing/Privatization	19
6.	Open Skies Initiative	17
7.	Expansion of the European Union	17
8.	Endangered Species and Natural Resource/Heritage Protection	15
9.	Global Warming	15
10.	Prime Orbit Availability (Orbit Traffic Jams)	14

The responses for 2015 were very similar to 2010, with the addition of Recovery of Investment. Due to the high costs involved with building and launching traditional remote sensing satellites, less expensive options are being researched to make it more likely that an investor will see a reasonable return. The development of microsatellites as a less expensive source of remotely sensed data is discussed further in this document.

Table 21: 2015 Political, Economic, and Environmental Trends Satellite Sector

	2015 Political, Economic, and Environmental Trends Satellite Sector	# of Responses
1.	National Defense/Homeland Security Issues	32
2.	Licensing Issues	24
3.	Required Cadastral Mapping	20
4.	International Trade	19
5.	Global Warming	17
6.	Outsourcing/Privatization	16
7.	Endangered Species and Natural Resources/Heritage Protection	15
8.	Open Skies Initiative	14
9.	Recovery of Investment	14
10.	Prime Orbit Availability (Orbit Traffic Jams)	12

4.5 Personal Interviews-Political, Economic, and Environmental Trends

The personal interviews were conducted to obtain more detailed observations by the respondents. The 250 personal interviews were provided the same list as the on-line respondents and asked to make their selections and provide comments. Their responses support those of the 1,547 online survey respondents as they addressed Political, Economic, and Environmental trends for 2010 and 2015. Although the personal interview respondents had varied backgrounds, experience, and knowledge levels, their similar selections as the on-line respondents provides an even stronger basis that these are the trends which will have the greatest impact on the remote sensing industry.

Table 22: 2010 Political, Economic, and Environmental Trends Personal Interviews

	2010 Political, Economic, and Environmental Trends Personal Interviews	# of Responses
1.	National Defense/Homeland Security Issues	202
2.	Endangered Species and Natural Resource/Heritage Protection	163
3.	Global Warming	150
4.	Outsourcing/Privatization	150
5.	Required Cadastral Mapping	143
6.	Licensing Issues	142

For the year 2015 the highlights are similar to 2010 with the addition of International Trade coming into focus and Licensing Issues dropping off.

Table 23: 2015 Political, Economic, and Environmental Trends Personal Interviews

	2015 Political, Economic, and Environmental Trends Personal Interviews	# of Responses
1.	National Defense/Homeland Security Issues	169
2.	Endangered Species and Natural Resource/Heritage Protection	153
3.	Global Warming	143
4.	Outsourcing/Privatization	129
5.	Required Cadastral Mapping	126
6.	International Trade	125

The following statements are representative of the most often received comments mentioned in the personal interviews and support the selections of the respondents in the on-line surveys for the Political, Economic, and Environmental Trends impacting their businesses in the years 2010 and 2015:

- *"The trend toward outsourcing project work off-shore will continue due to lower wage rates in developing countries. While the processing may be transferred overseas, the flight crews and ground control teams will continue to be local. Processing can be done in any location, so larger shops (today) will become significantly smaller and their functions will shift from production to quality control."*

- *"There will be a continued drive for better data and higher levels of cooperation with the government and private sectors. Resources, especially with Homeland Security need to be pulled together."*

- *"As Global Warming continues there will be an increase in melting ice caps and rising oceans, so more money will be needed for radar and marine systems and additional monitoring. As all of this is continuing, the technology will be getting better, become more mechanized with less human interaction needed."*

- *"Remote sensing will need to become a part of daily life. It will be difficult to make money selling imagery back to the government. It will need to be integrated into society for the greatest profits and the greatest competition. It is like the PC's. They did not take off until they became a part of one's daily life. The focus on National Security is going to speed up this acceptance curve."*

The majority of interviewees indicated that National Defense/Homeland Security will have a strong impact on remote sensing, as will Endangered Species and National Resources/ Heritage Protection, Global Warming, Outsourcing/Privatization, Required Cadastral Mapping and Licensing Issues.

5 Satellite Sector Detail

Of particular interest to many are the future business prospects of the satellite remote sensing industry. Since the launch of Space Imaging's *Ikonos* satellite in 1999, use of high-resolution commercial satellite imagery has grown in the public and private sectors. The US federal government has been the largest customer for all of the US-based high-resolution data providers, i.e. Space Imaging, DigitalGlobe, and OrbImage.

The contract awards by the National Geospatial Intelligence Agency (NGA; formerly NIMA) to DigitalGlobe and OrbImage to build and operate <.5-meter resolution satellites provided vital financial support for the industry. A more recent development is the upcoming purchase of Space Imaging by OrbImage, which will make OrbImage the only provider with two 1-meter resolution satellites, with a <.5-meter satellite due to be launched in 2007.

The survey responses from the satellite sector that provide insight into the future growth by 2010 and 2015 are discussed in the following section.

5.1 Projected Revenue-Satellite Sector

Respondents from the Satellite sector were asked to quantify the revenue of their department/divisions from US and international sources, and the revenue of their entire company from US and international sources, for the years 2005, 2010, and 2015.

The results indicated the number of departments/divisions and companies with less than $100,000 revenue will decrease over time, while the number of higher revenue departments and companies will increase in 2010 and 2015. For example, 22 respondents selected US revenue for a department/division in 2005 in the less than $100,000 category, and only 10 respondents selecting the same category in 2015. Also, the number respondents selecting the departments/divisions with US revenue greater than $10 million category, increased from 7 in 2005 to 11 in 2015.

Figure 7: Satellite Highlights – Revenue from US Department/Division (US Dollars)

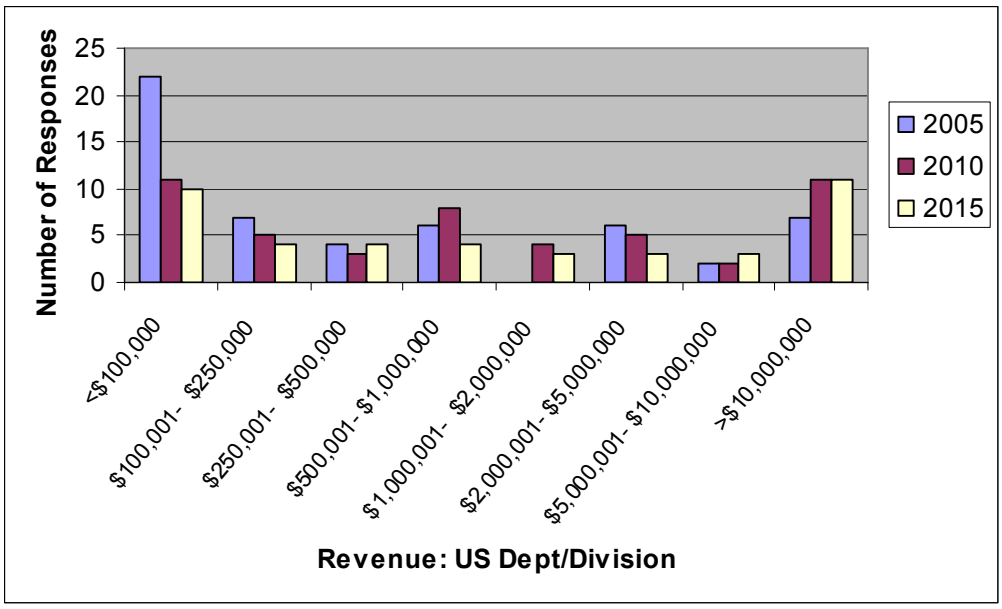


Figure 8: Satellite Highlights – Revenue from International Department/Division(US Dollars)

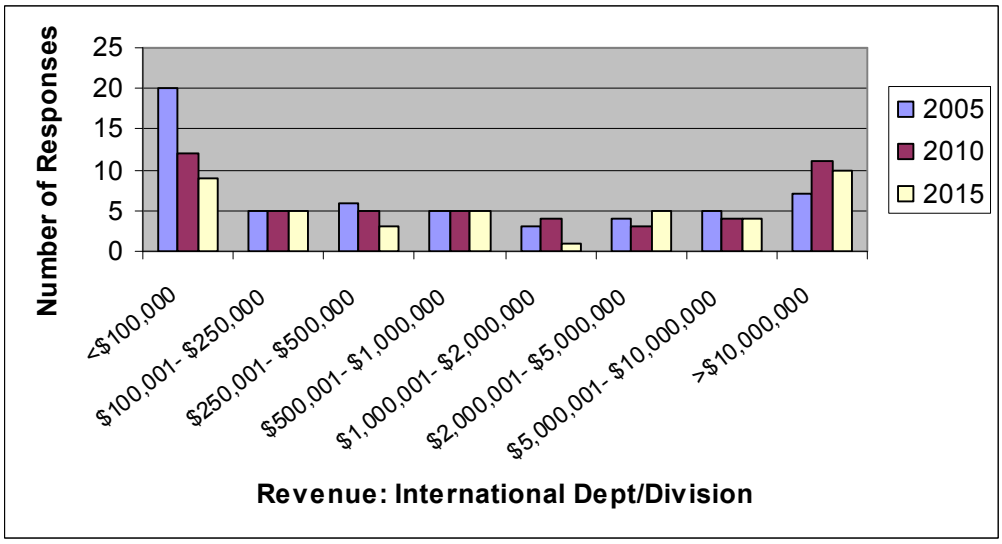


Figure 9: Satellite Highlights – Revenue from US Company/Affiliation (US Dollars)

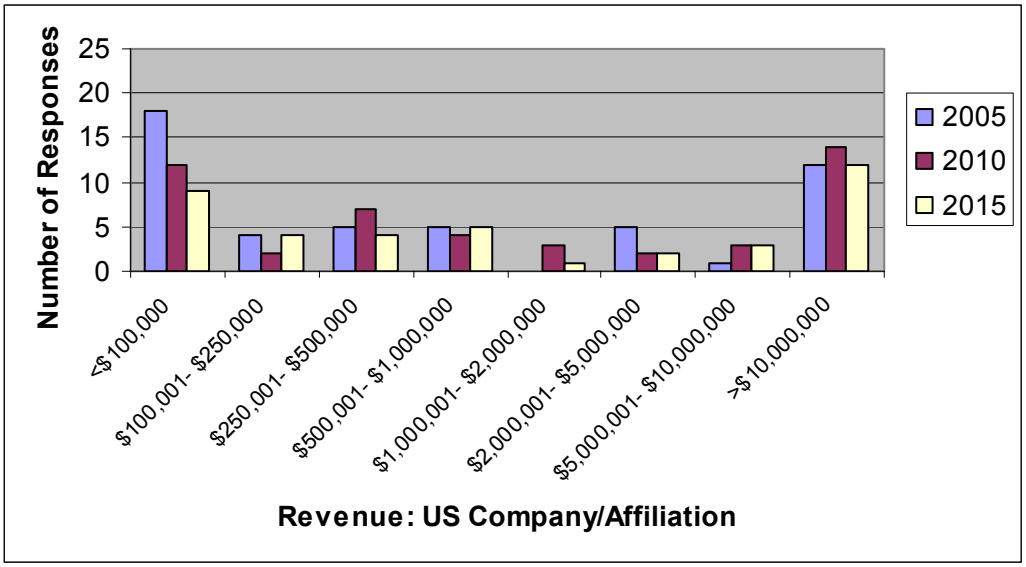
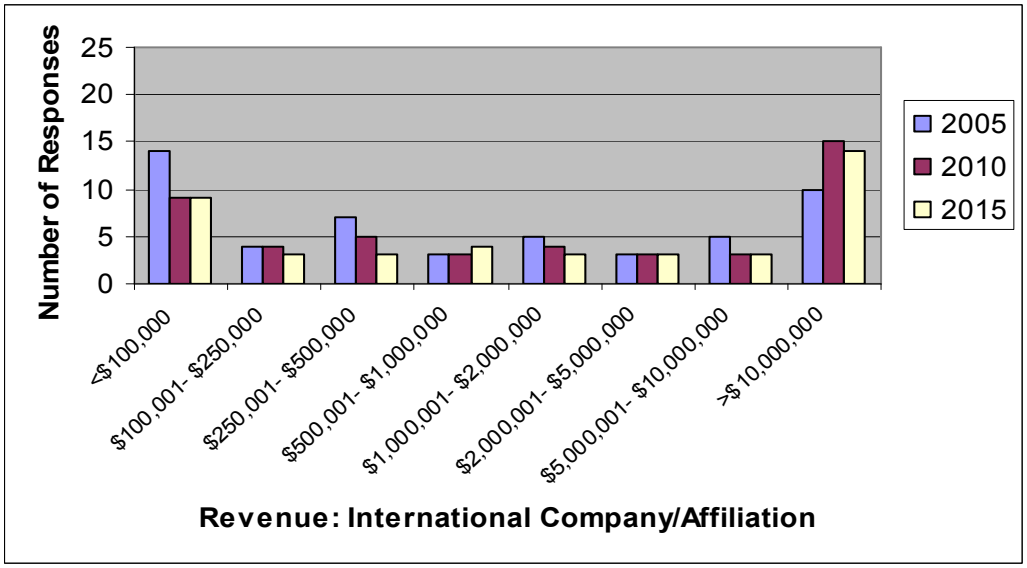


Figure 10: Satellite Highlights – Revenue from International Company/ Affiliation (US Dollars)



Between 2005, 2010, and 2015, the responses show a significant decrease in the number of departments and companies with less than $100,000 in revenue. There is also an indication from the increased number of respondents selecting international companies in the greater than $10 million in revenue category (10 respondents in 2005 compared to 15 in 2010 and 14 in 2015) that some respondents believe their growth potential lies in expanding their international markets.

5.2 Number of Employees-Satellite Sector

Respondents in the satellite sector were asked to quantify the number of employees in their department/division and company for 2005, 2010, and 2015. The results for the department/division clearly showed expectations for growth, with the number of departments with less than 10 employees decreasing from 29 respondents selecting this category in 2005 to only 12 in 2015, and significant increases in the middle ranges, i.e. 3 respondents selecting the category of departments with 51-100 employees in 2005 compared to 12 in 2015. The results at the company level for number of employees tracked much more closely year-to-year, showing less expectation for growth in total number of employees.

Figure 11: Satellite Highlights – Number of Employees, Department/Division

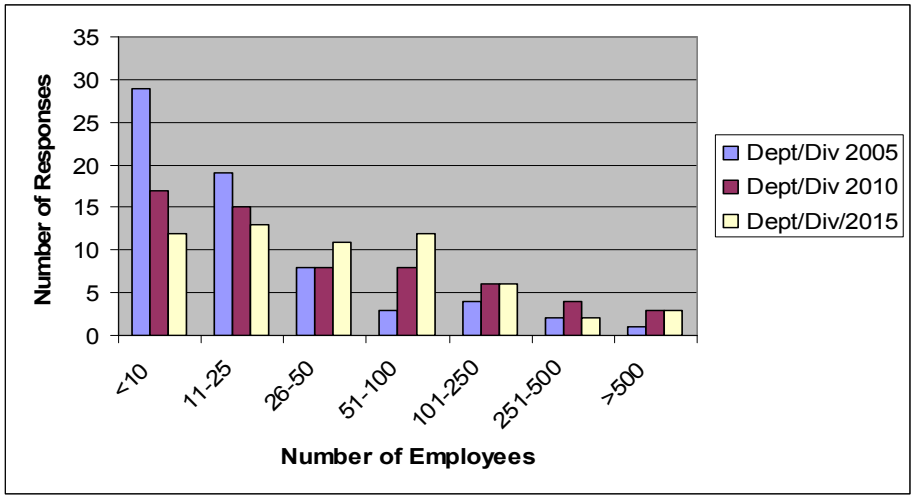


Table 24: Satellite Highlights – Number of Employees, Department/Division

Department/Division Employee Projections			
# of Employees	2005	2010	2015
<10	29	17	12
11-25	19	15	13
26-50	8	8	11
51-100	3	8	12
101-250	4	6	6
251-500	2	4	2
>500	1	3	3
Total Responses	66	61	59

Figure 12: Satellite Highlights – Number of Employees, Company

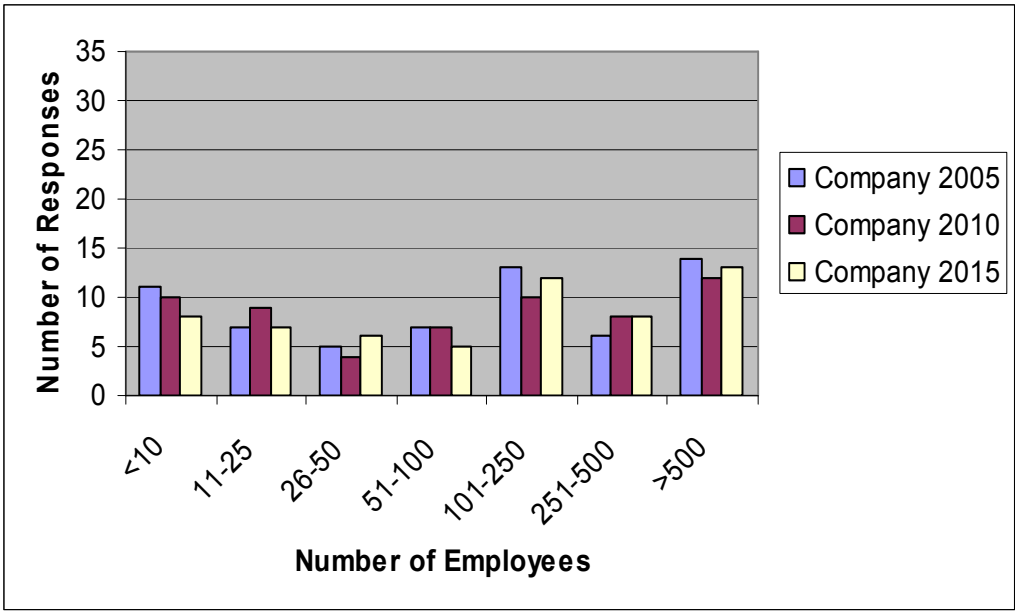


Table 25: Satellite Highlights – Number of Employees, Company

Company Employee Projections			
# Employees	2005	2010	2015
<10	11	10	8
11-25	7	9	7
26-50	5	4	6
51-100	7	7	5
101-250	13	10	12
251-500	6	8	8
>500	14	12	13
Total Responses	63	60	59

5.3 Applications-Satellite Sector

The Satellite sector respondents were asked to indicate their top four applications for satellite data. Environmental-related applications were the four most frequently selected on the list. The top ten responses are shown in Table 26. The responses were very closely split among their top ten application choices. However, it should be noted that there is a great deal of overlap in applications and it is often difficult to categorize a project as a specific application.

For example, Land Management uses some of the same data and analysis methods as Sustainable Development, and Utilities use both Engineering and Land Management techniques which could explain the even spread of the responses.

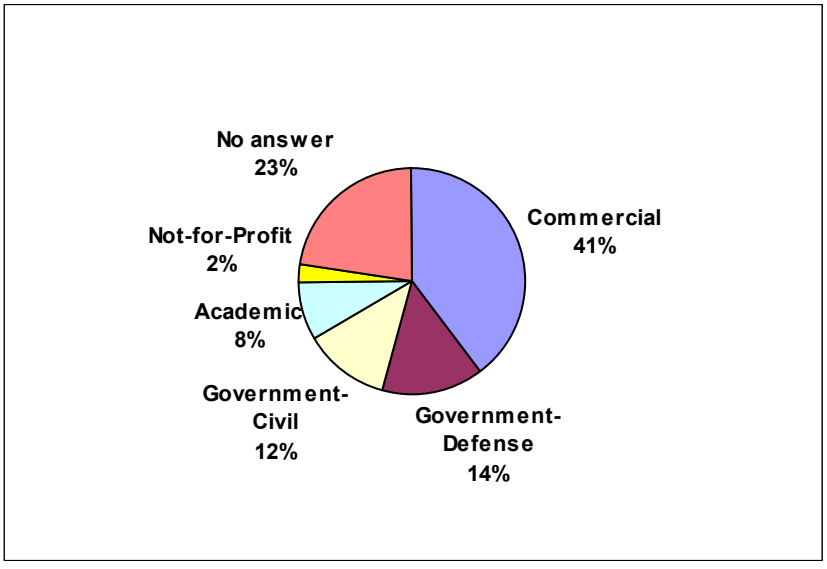
Table 26: Satellite Highlights – Satellite Data Applications

Satellite Data Application	# Responses	% of Respondents
Environmental Monitoring/Management	42	51%
National Resource Management	38	46%
Land Management/Development	34	41%
Forestry	31	37%
Security (National Defense/Homeland Security)	30	36%
Utilities	24	29%
Damage Assessment	24	29%
Engineering	24	29%
Cadastral	23	28%
Sustainable Development	20	24%

5.4 Market Type -Satellite Sector

The Satellite sector respondents were asked to indicate their market type. Over 40% were commercial companies, followed by 14% Government-Defense, 12% Government-Civil, 8% Academic, and 2% Not-for-profit organizations.

Figure 13: Satellite Highlights – Market Type



6 Additional Sector Highlights

6.1 Remote Sensing Software Purchases - 2005

Four of the project sectors—Academic, Government, Commercial and Software/Hardware—were asked how much they had spent on their remote sensing software during 2005. The Academic sector indicated 23% of the respondents receiving their software for free or paying $1,000 or less, compared to 21% for Commercial and 18% for Government and Software/Hardware. Only 1% of the Academic sector paid over $50,000 for their software, compared to 5% to 6% in the other three sectors. This is not surprising given the special programs software vendors provide to the academic sector to encourage the use of their products and to help broaden the use of remotely sensed data. Approximately one third to one half of the respondents in all of the sectors selected a remote sensing software purchase price range between $1,000 to $20,000.

6.2 Remote Sensing Software and Data Purchases – 2010 and 2015

When asked about their future spending on remote sensing software/data in 2010, 17% of the Government respondents selected the "No Additional Spending," category along with 15% of the Software/Hardware sector, 13% of the Academic sector, and 9% of the Commercial sector. Approximately 30% of all of the respondents selected the price range of $5,000 to $30,000 for software and data purchases, with the Academic sector having the largest response in that price range. Of the Software/Hardware, Commercial, and Government sectors 9% of the respondents estimated purchases greater than $250,000.

The results in 2015 were similar, with the Academic sector showing a tendency to purchase in the mid-range (25% of the respondents selected the $5,000 to $30,000 price range), while 5% to 6% of the other sectors respondents projected $1 million in spending on remote sensing software/data.

6.3 Projected Revenue

The Aerial Digital, Aerial Sensor, Aerial Film, and Satellite sectors were asked to project their revenues in 2005, 2010, and 2015, broken out between US and international sources, and by department and company. The Aerial Digital respondents predicted particularly strong revenue growth, with 26% of the respondents selecting the US company revenue category of greater than $10 million category in 2005 compared to 58% in 2015, and 25% selecting the international company revenue category of greater than $10 million in 2005 increasing to 44% selecting the same category in 2015.

The companies in the Aerial Digital and Aerial Sensor sectors overall selected larger revenue levels than Aerial Film and Satellite, however the Aerial Film sector selected higher revenue categories in the US department levels, with 24% of the respondents selecting the category of $500,000 to $1 million, as compared to 9% in Aerial Digital and 2% in Aerial Sensor. This is not surprising given the maturity of the technology of the Aerial Film sector when compared to the new entry of digital and sensor technologies. However, by the year 2010 the Aerial Digital and Aerial Sensor sectors plan to have increased their market share as indicated by their increasing revenue and employee projections.

The Satellite sector appears to do greater business in the international market than the other three sectors. In 2005, 22% of the Satellite sector respondents selected the international departmental category of greater than $5 million in revenue, and 30% of the respondents selected the international company revenue category of greater than $5 million. However the Aerial Digital sector projects an increase in international activity, so by 2010, their percentages of high-earning departments and companies are similar to those selected by the Satellite sector.

6.4 Types of Remote Sensing Data Used

Four of the sectors were asked to describe which types of remote sensing data they used. The top three types of data selected as most used were GIS Data, Processed Imagery, and Digital Orthophotos among the Academic, Government, Commercial, and Software/Hardware sectors.

Table 27: Other Sector Highlights – Remote Sensing Data Usage

Remote Sensing Data Usage	Soft/Hardware	Commercial	Gov't	Academic
GIS Data	**83%**	**90%**	**90%**	**87%**
Processed Imagery	80%	80%	78%	79%
Digital Orthophotos	67%	73%	75%	67%

The least used types of data are Unprocessed LiDAR and Unprocessed Hyperspectral, with usage percentages ranging from 11% to 22% in all of the sectors. This response is not unusual given that these data sets are still somewhat new and users are discovering that processing this data is more difficult than other types of aerial and satellite data.

Raw imagery usage ranged from a high of 65% (Academic) to a low of 45% (Government). These are not surprising selections given that unprocessed imagery is more appropriate for use by academics in research, while government employees would rather save time by receiving processed data in order to be able to directly utilize the imagery in their project applications.

6.5 *Applications of Satellite Data*

All of the sectors were asked to select their top four applications for remote sensing data. Although there was some variation between sectors, Environmental Monitoring/Management was at the top of the list for five of the eight sectors, with other natural resource applications, such as Forestry, Land Management and National Resource Management, mentioned frequently.

Table 28: Other Sector Highlights – Remote Sensing Data Applications

Applications by Sector	% Respondents
Aerial Digital	
Cadastral	48%
National Defense/Homeland Security	48%
National Resource Management	45%
Engineering	45%
Aerial Sensor	
Coastal Management	42%
Environmental Monitoring/Management	40%
Utilities	40%
Forestry	36%
Aerial Film	
Engineering	59%
Transportation	56%
Land Management/Development	55%
Utilities	42%
Software/Hardware	
Environmental Monitoring/Management	43%
Land Management/Development	35%
National Resource Management	32%
National Defense/Homeland Security	32%
Commercial	
Environmental Monitoring/Management	55%
Land Management/Development	40%
Engineering	31%
National Resource Management	29%
Government	
Environmental Monitoring/Management	46%
Land Management/Development	40%
National Resource Management	33%
Cadastral	27%
Academic	
Environmental Monitoring/Management	77%
National Resource Management	49%
Forestry	44%
Land Management/Development	41%
Satellite	
Environmental Monitoring/Management	51%
National Resource Management	46%
Land Management/Development	41%
Forestry	37%

7 Future Technology Development

The ongoing challenge in the remote sensing industry is how to make high quality data accessible to more users—for an affordable price. The use of maps, aerial photos, and digital imagery has already evolved dramatically during our lifetime—from primarily scientific and academic applications to commercial use in the media and on the internet—but there stills seems to be a distance to go. Widespread consumer application of geospatial data has continued to evade the industry, but there are several technology developments that have the potential to broaden the access and use of geospatial data.

7.1 Microsatellites

Until recently, remote sensing satellite programs were thought to be too expensive for most developing countries (India being the major exception). However, advancements in microsatellite technology have made the cost more affordable, and a growing number of countries are acquiring their own satellites, many through technology transfers or collaborative agreements with academic research institutions in other countries. Developing countries benefit from the less expensive access to remote sensing assets. It is a matter of national pride to have a space program and allows workers to be trained to establish a new high-tech industry, while also providing some independence from foreign data sources.[1]

Perceived advantages of microsatellites:

- Shorter development time
- Less expensive to build
- Less expensive to launch
- Less power consumption
- Lower cost justifies use for a specific short term need, i.e. military, environmental, weather, etc.
- Provides technology experience for less-developed countries

The US military is also supporting the development of less-expensive rockets with reusable parts that will be capable of launching imaging and communication satellites into space with less lead time. The Pentagon is moving away from the traditional decades-long, billion-dollar space programs and seeking a new solution that will provide battlefield launch capabilities for satellites that will only last one to two years and weigh less than 1,000 pounds.[2]

There are a number of companies trying to meet the demands of the Pentagon and secure additional funding for the future to develop partially or fully reusable systems. These companies include[3]:

- Kistler Aerospace Corporation
- Beal Aerospace Technologies

[1] http://www.globalsecurity.org/org/news/2003/031014-space-sights01.htm
[2] Pentagon envisions bringing smaller satellite to the battlefield, *Wall Street Journal,* 26 August 2005, http://www.mindfully.org/Technology/2005/Pentagon-Small-Satellites26aug05.htm
[3] http://www.bookrags.com/sciences/astronomy/aerospace-corporations-spsc-01.html

- Rotary Rocket Company
- Kelly Space and Technology
- Pioneer Rocketplane

In addition to governments in over 100 countries, commercial and university-based developers of small satellites include[4]:

- AeroAstro
- Surrey Satellite Technology Limited
- Stanford's Starlab
- Weber State
- Technical University of Berlin
- Technion (Israel)
- University of Stellenbosch (South Africa)
- University of Mexico

Surrey Satellite Technology Limited (SSTL) has developed and launched 23 micro satellites since 1985, many for countries outside the UK, such as Algeria, China, Nigeria, Thailand and Turkey. A new 4-meter panchromatic, 32-meter multispectral satellite has been built and will belong to China after its launch. Its intended use is primarily to prepare for the 2008 Beijing Olympics. Also, the 2.5-meter panchromatic, 5-meter multispectral TopSat microsatellite is ready for launch. This spacecraft was funded by the British National Space Centre (BNSC) and the UK Ministry of Defence (MoD).[5] Another microsatellite was successfully launched on October 27, 2005 for the United Kingdom with a 2.5-meter panchromatic and 5-meter multispectral capability. Surrey Satellite Technology Limited built the platform and the telecommand and control system.[6]

There is also a combination of a unique imager (video/multispectral/hyperspectral) being developed in South Africa, scheduled for completion in March 2006. The Multi-Sensor Micro-satellite Imager (MSMI) is funded by the South African government. Its primary purpose is for supporting renewable resource management and food security throughout the African continent. The successful completion and launch of the MSMI will be an important step in advancing the remote sensing industry in Africa, as well as providing valuable information for managing and improving their agriculture resources.[7]

NASA is also funding research and development of “micro spacecraft” that could be used to report conditions on other planets, as well as serve as “black boxes” on larger spacecraft that

[4] http://www.bookrags.com/sciences/astronomy/small-satellite-technology-spsc-01.html
[5] http://www.bnsc.gov.uk/default.aspx?nid=5380
[6] http://www.asd-network.com/press_detail_B.asp?ID=5599
[7] http://www.mpsys.co.za/Downloads/PSNext/PSNext_South_African_satellite.pdf

would monitor heat shields and measure temperature, pressure, etc. The Aerospace Corporation is under contract to develop and test a micro spacecraft in 2006.[8]

Advances in the development of microsatellite technology may begin to address the recurring themes of the survey respondents for the needs of greater revisit capability of satellites to insure greater data availability at reduced prices.

7.2 Hyperspectral and Advanced Imaging Technologies

Remote sensing technology developers have also refined the use of the spectrum to expand detection limits in wavebands, spectral resolution, and spatial resolution. Spectral imaging involves dividing the electromagnetic spectrum into narrow spectral bands, primarily in ultraviolet, visible, and shortwave, mid-wave, and long-wave infrared. Multi-spectral imaging provides few bands, hyperspectral more bands, and ultraspectral many bands. Spectral imaging data allows extraction of features not detectable in conventional imagery.

An example of one of the pioneering companies in this area is Kestrel Corporation. Kestrel Corporation designed, built, tested and deployed a cost effective hyperspectral imager using new Fournier Transform design developed under the Small Business Innovation Research program[9]. This hyperspectral imager was launched on an Air Force MightySat satellite bus in 2000, and remained operational two times longer than its design life. The Air Force, stated that Kestrel's hyperspectral imager was "the first earth remote-sensing hyperspectral imager collecting data from space."[10] Kestrel Corporation continues its work in this area with the development of a 2-D (two dimensional) hyperspectral imaging capability.[11] This 2-D hyperspectral imaging directly supports higher ground speed imaging of the earth over the traditional 1-D (one dimensional) detector design currently used, a factor which has limited the most efficient use of airborne hyperspectral imagery.

There are also improvements underway which will open the door to imaging in lower light conditions, and supports access to more spectral data in lower energy bands. Such advances incrementally move hyperspectral imaging toward more widespread and cost effective use.

Other advances in the state-of-the art in imaging science include the use of wavefront sensors and the resulting adaptive optics capabilities. Adaptive optics, which have long been an element in astronomical work, allows for the correction of atmospheric distortions (removing the twinkle in a star). This capability supports real-time atmospheric correction between the imaging source and the target. The result is an image with superior quality as the correction is based upon real parameters, not just the estimated effects. The use of adaptive optics is not limited to traditional airborne passive imagers, but applicable to LiDAR and other active imaging systems as well.

There are many imaging advances that are occurring in the traditional remote sensing market that have other applications in areas such as computer vision, biomedical, industrial manufacturing, and defense related activities.

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[8] http://www.nasa.gov/centers/ames/research/exploringtheuniverse/blackbox.html
[9] http://www.spaceref.com:16080/news/viewpr.html?pid=2553
[10] http://www.afrlhorizons.com/Briefs/Dec03/VS0302.html
[11] http://www.kestrelcorp.com/advanced.html

As developments like these continue they are likely to yield a cross-fertilization of technologies that will also find their way back into the traditional remote sensing arena. As part of the entire imaging science field, remote sensing will continue to grow and expand its overall customer base as these new technologies are incorporated and new applications emerge from their use.

7.3 Online Mapping Services

The value of remotely sensed data has been recognized by several heavy-hitters in the web services/search industry. Microsoft and Google, with combined annual revenue of over $42 billion, have developed online mapping services called "MSN Virtual Earth" and "Google Earth," respectively. These huge consumer-oriented companies already have large market bases, so remotely sensed data and user-friendly mapping tools will be made available to "the masses." This should create a new awareness among consumers and potentially spur even more growth in the market and development of new applications.

MSN Virtual Earth is being released in phases, each with additional layers of data and functionality. Microsoft has contracted with Pictometry for oblique photos that provide side views of buildings and with OrbImage for satellite imagery with worldwide coverage. Since 1998, Microsoft has offered online maps and imagery through the TerraServer database that contains US Geological Survey satellite imagery and aerial photography. This database will continue to provide background imagery for MSN Virtual Earth and will be augmented by updates from the OrbView family of satellites.[12]

Google purchased Keyhole in October 2004, which gave them access to an extensive database of aerial photography and satellite imagery, as well as the unique technology that allows the user to "zoom" in from a low resolution image to get a close-up view of a high resolution image. The service will include driving directions in addition to the imagery.[13] The automated nature and ease of use of Google Earth has already attracted global attention with over 212,500 registered users since June 28th, 2005.[14] The interest level in these on-line services is clear and time will tell if it is a profitable venture for these service providers.

Microsatellites, hyperspectral and advanced imaging, and online mapping services are just a few technology developments which will eventually lead to a greater access to data. Combining improved data capabilities and lower cost data with mapping tools which are more user-friendly, are a few of the ingredients needed for demand to grow from areas outside of the traditional mapping market, thereby helping increase the size of the entire remote sensing industry.

[12] Will Virtual Earth scale up the spatial market?, *Geospatial Solutions*, Sept. 2005
[13] Microsoft's Virtual Earth provides location-relevant search, *Geospatial Solutions*, June 2005
[14] http://www.earth.google.com

8 Summary-Aerial and Spaceborne Survey Overview

The results of this survey of the international remote sensing industry show several themes common to all of the eight sectors studied, i.e. Aerial Film, Aerial Digital, Aerial Sensors, Satellite, Commercial, Government, Academic, and Software/Hardware. There are also similar areas of interest and concern between various regions of the world. In 2010, Technology Integration, Greater Ground Resolution, and Greater Horizontal and Vertical Accuracy were the top three advances selected, while in 2015, Even Greater Ground Resolution, Even Greater Computer Processing Speed, and Even Better Processing Software were the most frequently selected. These results show a strong interest in improving the basic technology that supports the remote sensing industry, which will allow new applications to be developed and potential customer base to be expanded.

The political, economic, and environmental trends are slightly more specific to geographic regions. Overall, respondents indicated that National Defense/Homeland Security is the trend that will have the greatest impact on their industry in 2010, and will continue to have an impact in 2015. However, Western and Eastern European companies are expecting the expansion of the European Union to create a larger impact than other regions. Companies in the US were particularly conscious of homeland security efforts impacting them, while other regions of the world are more concerned about global warming and how environmental protection efforts may impact them.

The projections for increased revenue over the next ten years indicate a good growth potential for the industry. The Aerial Digital respondents predicted particularly strong revenue growth, with 26% of the respondents selecting the US company revenue category of greater than $10 million in 2005 compared to 58% of the respondents selecting that category in 2015, and 25% selecting the international company revenue category of greater than $10 million in 2005 increasing to 44% in 2015. The Satellite sector appears to be more advanced in the international market than the other three sectors in 2005, with 22% of the respondents selecting the international departments with greater than $5 million in revenue category, and 30% of the respondents selecting the company category of greater than $5 million. The multiple examples of interest in international trade throughout the survey indicate excellent potential for market expansion for all geographic regions.

Fortunately the significant developments in remote sensing knowledge over the past forty years have laid the groundwork for many people today to use remotely sensed data and to benefit from the wealth of information it provides. Today, there are programs in hundreds of countries using aerial imagery, high-resolution satellite imagery, LiDAR and SAR data, multispectral/hyperspectral data, meteorological data, and GIS data. There is huge value in remotely sensed data that can support decision making at all levels and this value will clearly grow in the coming decade.

9 Executive Summary – Aerial Market Analysis

For this portion of the NOAA's Satellite and Information Service, Remote Sensing Survey, the analysis concentrates on only the US respondents in the three aerial sectors, with some international comparison where relevant. There are 116 US and 43 international respondents in the Aerial Digital, Aerial Film and Aerial Sensor sectors.

Respondents indicated the primary Technology Advance in 2010 that will impact their businesses is Technology Integration (LiDAR, Digital Camera, Airborne GPS, IMU, etc.). The aerial market wants to improve both the Accuracy and the Ground Resolution of aerial-derived data to meet user needs. Technology Trends in 2015 indicate a continued expectation of Increased Ground Resolution. However, based on their trend selections it appears the aerial market is driven more by computer hardware type issues, such as processing speed and storage, than data or software issues.

Based on their Political, Economic, and Environmental Trends selected in 2010 and 2015 the aerial sector is clearly being impacted by National Defense/Homeland Security issues. Outsourcing/Privatization issues and Energy Fuel Cost Fluctuations are also a concern for aerial companies due to the impact on their cost structure in an increasingly competitive global market. The aerial sectors will also be impacted by governmental requirements to supply high quality and accurate property and tax map data and services to maintain current cadastral records. The Political, Economic, and Environmental trends selected by respondents in 2015 indicate these same issues will continue to be major influences on the aerial sector in the US marketplace.

The three US aerial sectors selected as their primary applications of remote sensing data Engineering, Transportation, Land Management/Development, and Utilities. These are all areas that traditionally have made use of aerial data.

Over half of the US and international respondents in the aerial sectors were Commercial companies. The next largest groups of respondents, were from the Government-Civil area, followed by Government-Defense, and Academic. The international respondents from the aerial sector provided similar results to the US with the largest response coming from Commercial companies.

The current and projected revenue and the employee projections for 2005, 2010, and 2015 indicate growth prospects at both the departmental and company levels, for US and international entities. The data indicates a shift in revenue and employment, from small/medium sized companies to large/very large sized companies in the upcoming ten years. The Aerial Digital market projected very strong revenue growth as compared to Aerial Film and Aerial Sensor sectors; however the number Aerial Film respondents that selected the large company revenue category exceeded that selected by the Aerial Digital sector. This could be related to the fact that the aerial digital capability is still somewhat of a new entry to the market and traditional Aerial Film companies are exercising caution in investing in new (more expensive) digital cameras in order to be sure they will receive a return on investment. Another noticeable difference between the US and the international revenue responses was the international responses had a much higher response rate in the small-revenue departmental and company categories in all the Aerial sectors. This indicates that much of

the international aerial industry is composed of small companies serving small geographic regions.

Overall the survey results reflect a positive future for the aerial market. There are exciting technological improvements taking place that allow higher quality data to be collected in larger quantities than ever before. The storage capabilities are increasing, and the processing of data is faster. There are new applications being discovered as unique types of data become available from different sensors. The aerial market is going through a dynamic period of change, with digital cameras, LiDAR, and hyperspectral sensors offering new possibilities for applications. These are all positive indications the aerial market will continue to grow during the next decade. The following analysis provides details concerning technology, political, economic, and environmental trends that will impact the future of aerial companies.

10 Introduction to Aerial Sector Analysis

10.1 Goals and Objectives

Beginning on 20 February 2005 and extending until 15 August 2005, Global Marketing Insights, Inc. conducted a comprehensive survey of aerial imagery and remotely sensed data platform and service providers in the United States (US) and internationally. NOAA's Satellite and Information Service required this analysis focus of the Aerial Market in the US. In order to accomplish this, survey responses were focused on from the following sectors:

- Aerial Film
- Aerial Digital
- Aerial Sensor

This portion of the analysis of the aerial market reviews current revenue for the year 2005 and the future revenue projections for the years 2010 and 2015. Of the 1,547 surveys collected in this remote sensing survey, 159 of these responses related directly to these three sectors. This analysis focuses on US respondents, with some review of the international responses for comparative purposes. The analysis of the aerial market comprises specific items of interest to NOAA's Satellite and Information including:

- Revenue Projections
- Number of employees
- Applications of the data
- Market type

A second goal of the surveys was to develop a trend analysis of the aerial market. The trend analysis, designed to be a cross-sector comparison, includes the following trends which could provide potential impact to the businesses of the respondents in the years 2010 and 2015:

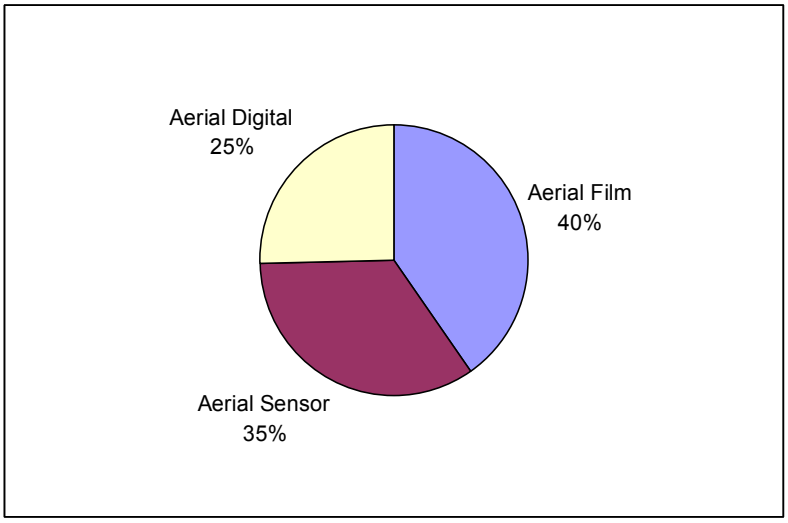
- Technical Advances
- Political Trends
- Economic Trends
- Environmental Trends

This portion of the study document summarizes the pertinent results of the surveys, analyzes the results and provides assessments of the implications of the results for the domestic (US) and overall aerial market.

10.2 Summary of Online Responses by Aerial Sector

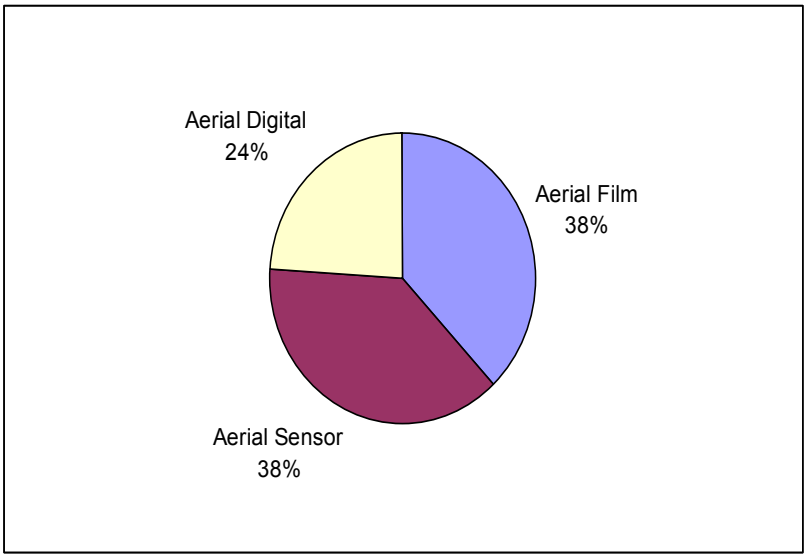
The 159 online survey responses were received from the Aerial Film (40%), Aerial Sensor (35%), and Aerial Digital (25%) sectors.

Figure 14: Total Survey Responses, Aerial Sectors



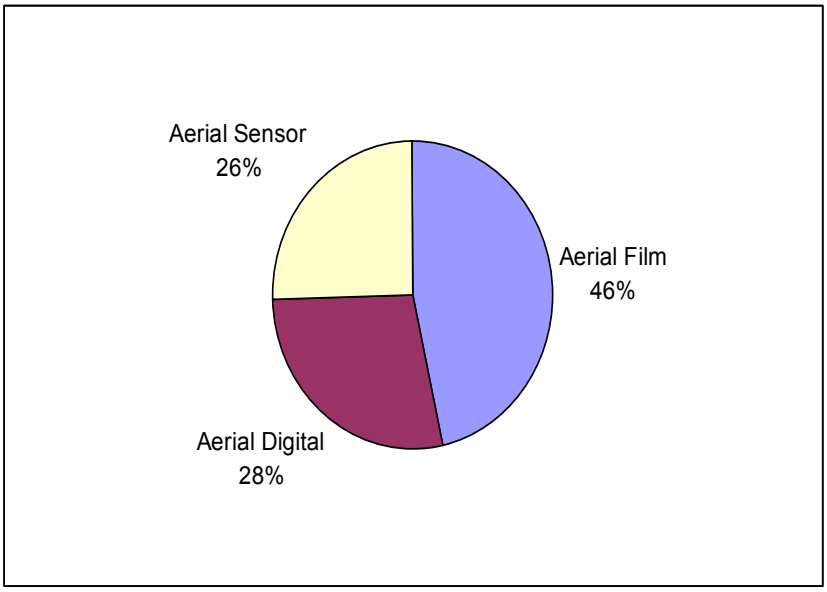
Of the total 159 responses, 116 (73%) were from the US. As shown in Figure 15, the US responses were split between Aerial Film (38%), Aerial Sensor (38%), and Aerial Digital (24%), similar to the break-out of sectors for the total responses.

Figure 15: US Responses, Aerial Sectors



The Aerial Film sector contained the highest number of international responses with 46% of the respondents, followed by Aerial Digital with 28%, and Aerial Sensor with 26%, as shown in Figure 16.

Figure 16: International Responses, Aerial Sectors



The Aerial sector respondents were invited to participate in the survey at nine industry conferences and events that took place between January and July 2005. Advertisements were placed in industry publications, such as *PE&RS (Photogrammetric Engineering and Remote Sensing)*, *GeoSpatial World*, GITA (Geospatial Information and Technology Association) Conference Program Guide, ASPRS (American Society of Photogrammetry and Remote Sensing) Conference Program Guide, *Imaging Notes*, and *Geospatial Solutions,* to make potential respondents aware of the survey. More emphasis was put on collecting surveys from US representatives of the aerial industry, although considerable effort was made to reach as many international respondents as possible.

The 73% US response rate is not unexpected given the study focus and the fact the US aerial market represents a significant portion of the global market. In particular, demand for aerial data from US government entities has influenced the development of the industry and is likely to continue to do so given the increasing number of requests by many Federal-Civil agencies for aerial data for their on-going projects. For example, in the US the National High Altitude Photography (NHAP) program began providing state-wide aerial coverage in 1980, and was followed by the National Aerial Photography Program (NAPP) in 1987. This and other government programs are ongoing and continue to provide the basis for growth in the aerial market.

International government programs such as the European Union's Common Agricultural Policy (initiated in 1962), has supported for many years the aerial film sector and satellite

sector. The data are utilized to promote compliance and assist in monitoring agricultural regions. These types of government programs worldwide continue to support the growth of the aerial industry.

11 Analysis of Revenues-Aerial Sector

The Aerial Digital, Aerial Sensor, and Aerial Film sectors were asked to indicate the Size of their Market for Aerial Image Sales in 2005, 2010, and 2015, broken out between US and international sources, and by department/division revenue and total company/affiliate revenue. These ranges, representing US dollars in annual revenue, are further categorized into the following company sizes in order to simplify the interpretation of the data:

Revenue (US Dollars)

Small: <$100,000
$100,001 - $250,000
$250,001 - $500,000

Medium: $500,001 - $1,000,000
$1,000,001 - $2,000,000

Large: $2,000,001- $5,000,000
$5,000,001 - $10,000,000

Very Large: >$10,000,000

Figures 17 through 20 highlight the combined responses of the Aerial Digital, Aerial Sensor, and Aerial Film sectors for each of the revenue categories for the years 2005, 2010, and 2015. Overall the results show a decrease in the number of small companies and an increase in the number of large and very large companies in terms of revenue.

The Aerial Digital respondents predicted particularly strong revenue growth in both the US and international markets, with 26% of the respondents selecting the US company revenue category of greater than $10 million in 2005 compared to 58% in 2015, and 25% selecting the international company revenue category of greater than $10 million in 2005 which increases to 44% in 2015.

The respondents in the Aerial Digital and Aerial Sensor sectors overall selected larger revenue levels than Aerial Film and Satellite, however the Aerial Film US departmental revenue category had significantly higher revenues indicated, with 24% of the respondents selecting the revenue category of $500,000 to $1 million, as compared to 9% in Aerial Digital and 2% in Aerial Sensor. As shown in Figures 17 through 20, there are considerably higher response rates in the Small revenue category for International departments and company, as compared to the US, particularly in 2005. This could indicate many things such as the

continued specialization of aerial firms to support their individual country (smaller land mass) as opposed to larger multi-country wide governmental projects (larger land mass).

Figure 17: Aerial Sectors-US Department/Division Revenue

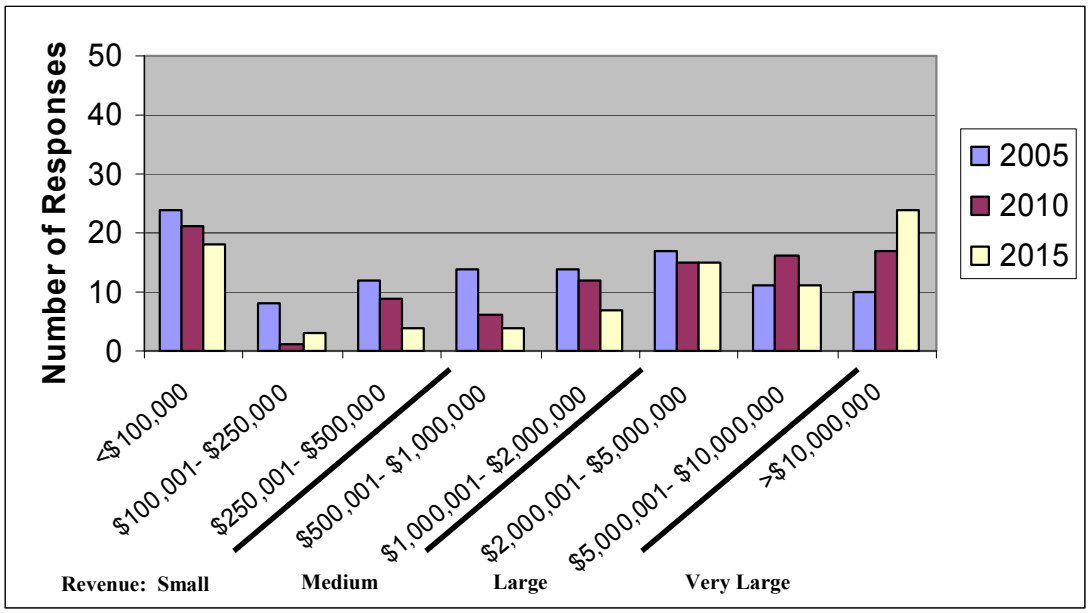


Figure 18: Aerial Sectors-International Department/Division Revenue

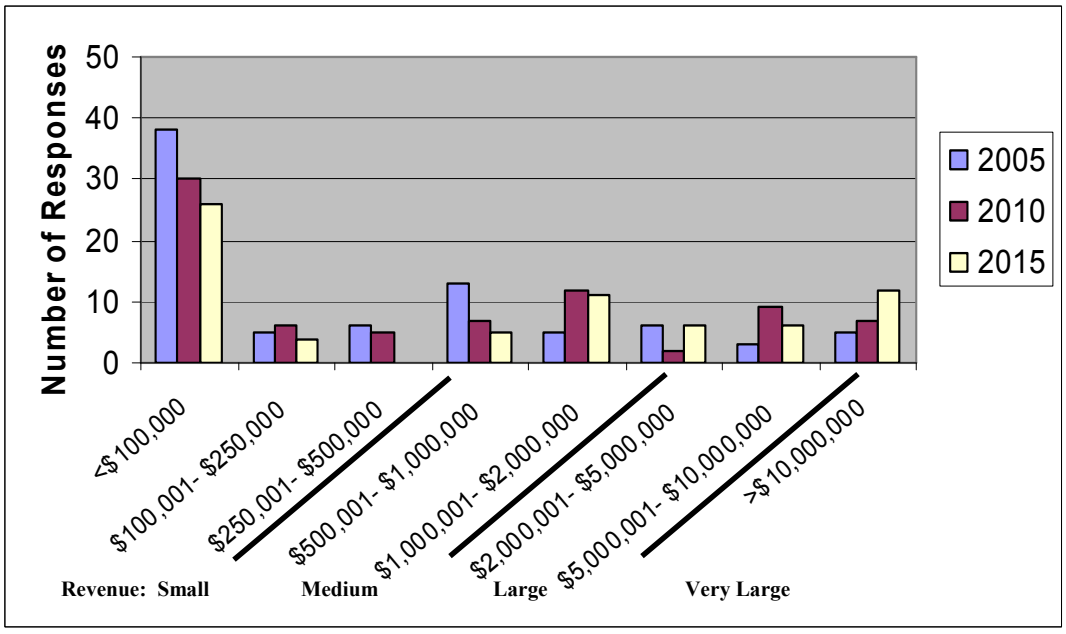


Figure 19: Aerial Sectors-US Company/Affiliation Revenue

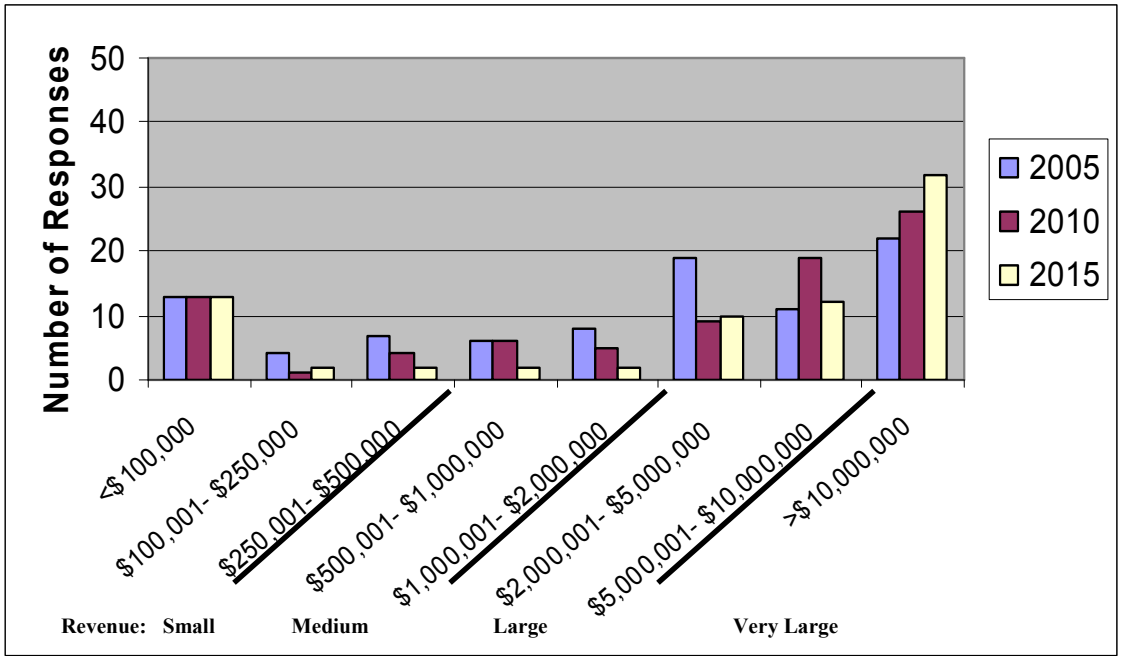
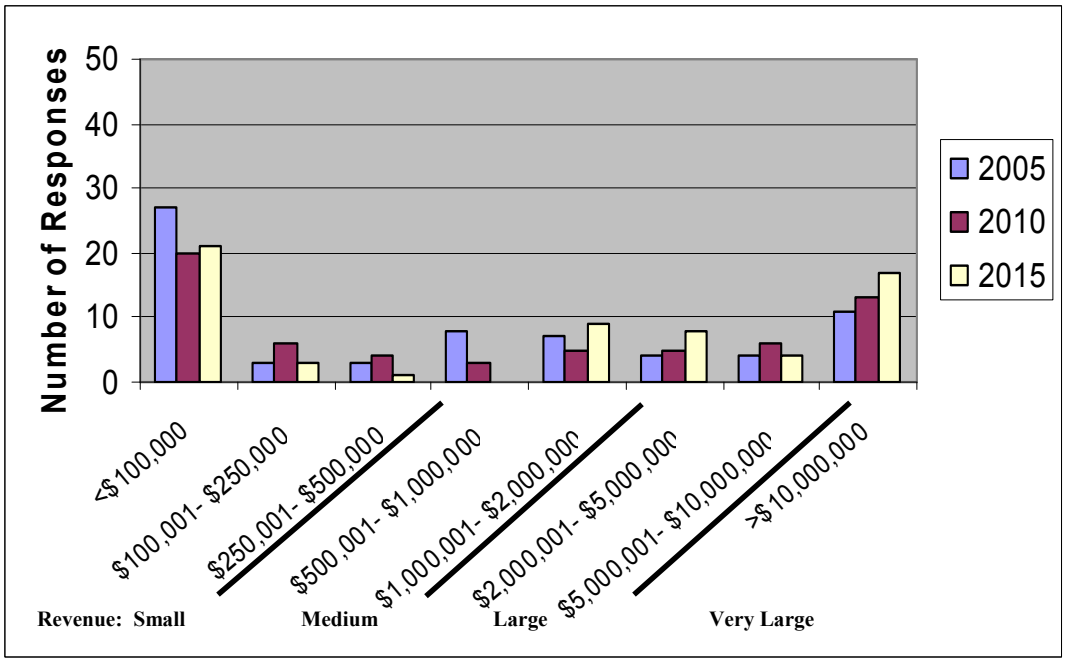


Figure 20: Aerial Sectors-International Company/Affiliation Revenue



12 Analysis of Number of Employees-Aerial Sector

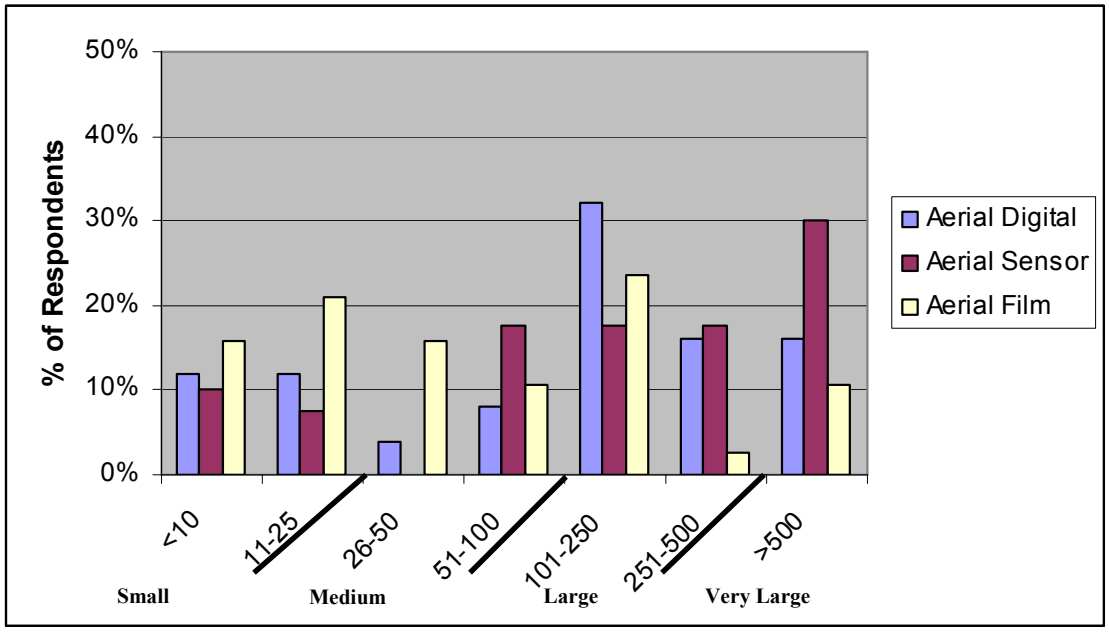
The Aerial Film, Aerial Digital, and Aerial Sensor sectors provided their current number of employees in 2005 and projected employee numbers for the years 2010 and 2015 at the department/division level as well as at company level. The responses for the division and company levels were very similar for all the trend year projections. Due to this similarity the following analysis focuses on the responses at the company level with some commentary provided on the department level responses.

The respondents selected from the following categories representing the number of employees for both the department and company level selections. These ranges are further categorized into the following company sizes in order to simplify the interpretation of the data.

	Number of Employees
Small	<10
	11-25
Medium	26-50
	51-100
Large	101-250
	251-500
Very Large	>500

As shown in Figure 21, the Aerial Sensor sector had the largest percentages of respondents selecting the Large/Very Large company categories with a 66% response rate, followed by the Aerial Digital sector with a 64% response. The International Aerial Digital sector and Aerial Sensor sector respondents predominantly chose Small and Medium company employee categories, with only 33% of the Aerial Digital selecting the Large/Very Large company category and 17% of the Aerial Sensor sector selecting the Large company category. These selections demonstrate a close correlation to the revenue categories selected by both the US and International respondents.

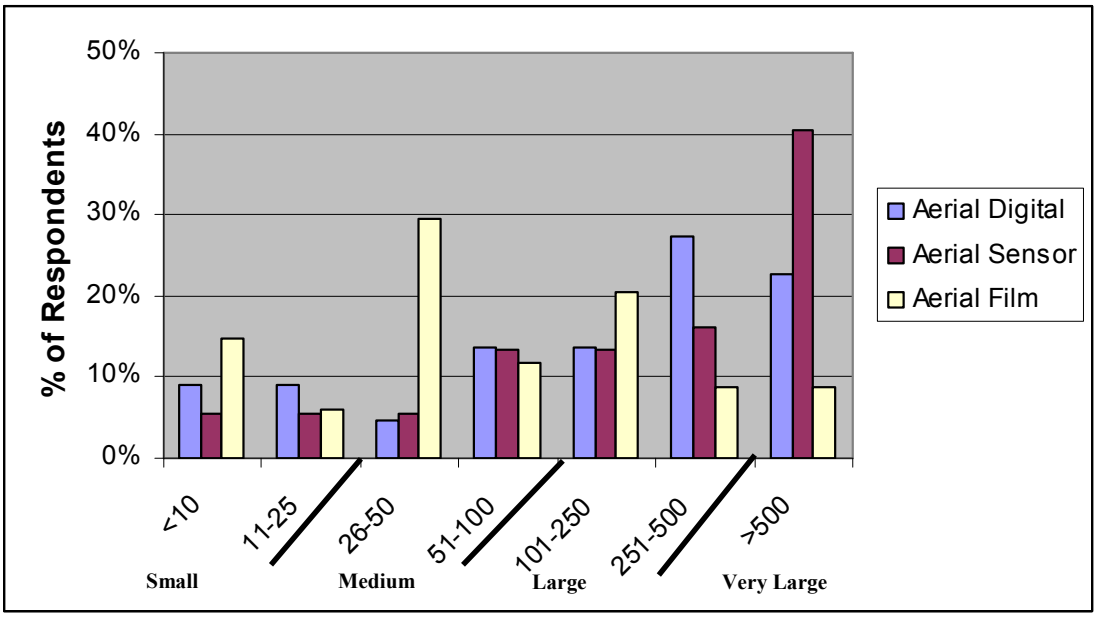
Figure 21: 2005 Number of Employees – Company (US Aerial Sectors)



In 2005 on a departmental basis, the majority of respondents selected the Small category, i.e. Aerial Digital (56%), Aerial Film (65%) and Aerial Sensor (56%). None of the respondents selected the Very Large (>500 employees) category for their number of departmental employees, but 16% of the Aerial Sensor respondents selected the Large (101-500 employees) category, while 13% of the Aerial Digital respondents and 5% of the Aerial Film respondents selected the Large departmental category.

As shown in Figure 22, in 2010, at the company level, the Aerial Sensor sector had more respondents selecting the Very Large category than did the Aerial Digital and Aerial Film sectors. The Aerial Sensor sector also had a significant increase from 2005 to 2010 of 30% to 41% in the Very Large category, and Aerial Film had an increase from 27% to 41% in the Medium category, and showed a decrease in the Small category. In comparison the International Aerial Film sector showed a 7% decrease in Small company selections and an increase of 6% in Large/Very Large company selections.

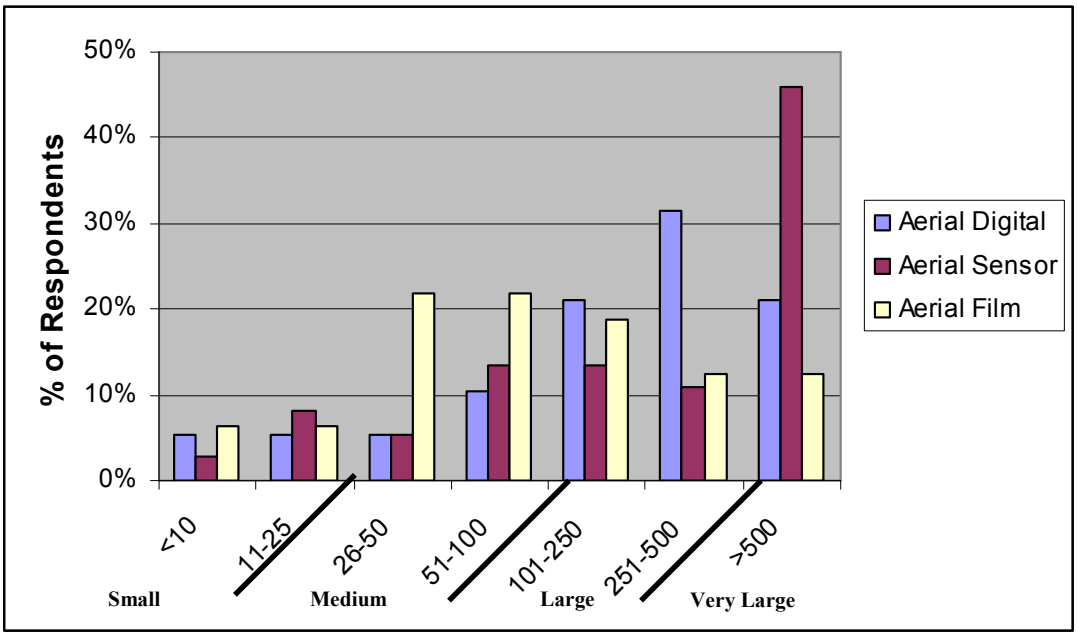
Figure 22: 2010 Number of Employees - Company (US Aerial Sectors)



The responses at the department/division level for 2010 showed an increase in all three aerial sectors from 2005. The percentage of Aerial Sensor respondents in the Large category increased from 16% in 2005 to 24%, with an additional 5% forecasting the move to the Very Large category by the year 2010. In the Aerial Digital sector, the percentage of respondents selecting the Large category increased from 13% in 2005 to 27% in 2010, as well as the percentage of respondents increased from 5% in 2005 to 9% in 2010 in the Large category in the Aerial Film sector.

In 2015 at the company level, the Aerial Digital sector increased over 2010 from 41% to 53% in the Large category, with a decrease in the Small category, while the Aerial Sensor sector continued to grow in the Very Large category from 41% to 46%. As shown in Figure 23, by the year 2015, the respondents predict all of the aerial sectors will shift from Small/Medium size company employments levels to Large/Very Large company employment levels. Internationally, only the Aerial Digital sector respondents showed such significant movement from 33% selecting the Large/Very Large category in 2005 to 51% in 2015.

Figure 23: 2015 Number of Employees - Company (US Aerial Sectors)



The employee number projections for 2015 continued to increase over 2010 also on a departmental basis. The percentage of Aerial Sensor respondents in the Large category increased from 24% to 38%, while the Aerial Digital respondents predicted an increase from 27% to 40% Large and 5% in the Very Large category, and Aerial Sensor respondents in the Large category stayed even at 9%, but increased to 3% in the Very Large category.

13 Analysis of Applications of Data-Aerial Sector

Respondents in the Aerial Film, Aerial Digital, and Aerial Sensor sectors selected their top four applications for remote sensing data. Their combined answers resulted in Engineering as the top application selected, followed by Transportation, Land Management, and Utilities. Applications such as Engineering, Transportation, Utilities, and Cadastral generally require large-scale mapping data (1:2,400 or lower) and high-resolution imagery (1 meter or less) for designing and maintaining facilities and infrastructure, while applications such as Land Management/Development, National Resource Management, Forestry and Environmental Monitoring/Management generally utilize small-scale mapping data (1:24,000 and higher) and low-resolution (5 meter or more) imagery.

Figure 24: Applications (Aerial Sectors)

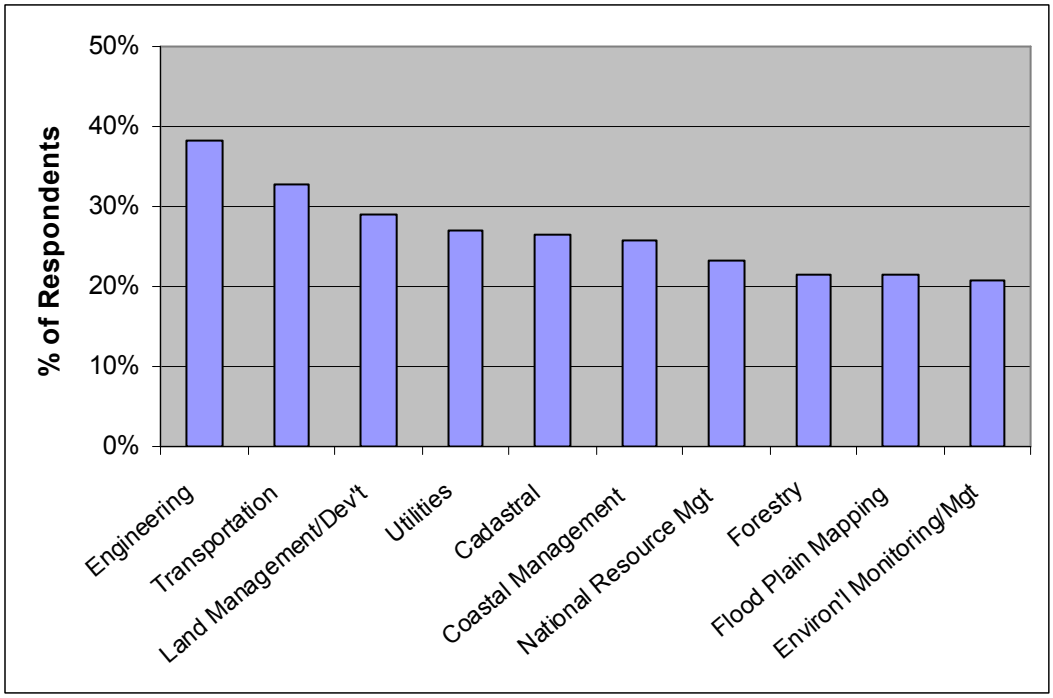


Table 29 highlights the top four applications selected by each sector. Aerial Digital respondents selected National Defense/Homeland Security as their top application, followed by Cadastral, Utilities and Engineering. Aerial Film respondents chose Engineering as their primary use, followed by Transportation, Land Management/Development and Utilities. Aerial Sensor respondents selected Coastal Management as number one, followed by Environmental Monitoring/Land Management, Utilities and Engineering.

Although the sectors have fairly close percentages of responses for each of the top four applications, it should be recognized that there is overlap between applications, such as Engineering and Transportation, and Coastal Management and Environmental Management. It can be difficult to clearly identify many projects as a single application because the data and the analysis can be used to achieve multiple goals. It appears though from the

selections made that the Aerial Market overall is widening its capabilities due to the technology advances in the Aerial Digital and Aerial Sensor sectors.

Table 29: Applications (Aerial Sectors)

Applications by Sector	% Response
Aerial Digital	
National Defense/Homeland Security	11%
Cadastral	9%
Utilities	9%
Engineering	9%
Aerial Film	
Engineering	16%
Transportation	14%
Land Management/Development	13%
Utilities	8%
Aerial Sensor	
Coastal Management	12%
Environmental Monitoring/Management	8%
Utilities	8%
Engineering	8%

14 Identification of Market Type-Aerial Sector

The Aerial Digital, Aerial Film, and Aerial Sensor respondents were asked to identify which type of market they are in from the following choices: Government/Defense, Government/Civil, Commercial, Academic, or Not-for-Profit. In Figure 25, the majority of US respondents in all three sectors were in the Commercial market, followed by Government/Civil, Government/Defense, and Academic. No one considered themselves to be a Not-for-Profit organization. As seen in Figure 26, the International respondents followed the same pattern, although there was one Not-for-Profit organization.

Figure 25: Market Type (US Aerial Sectors)

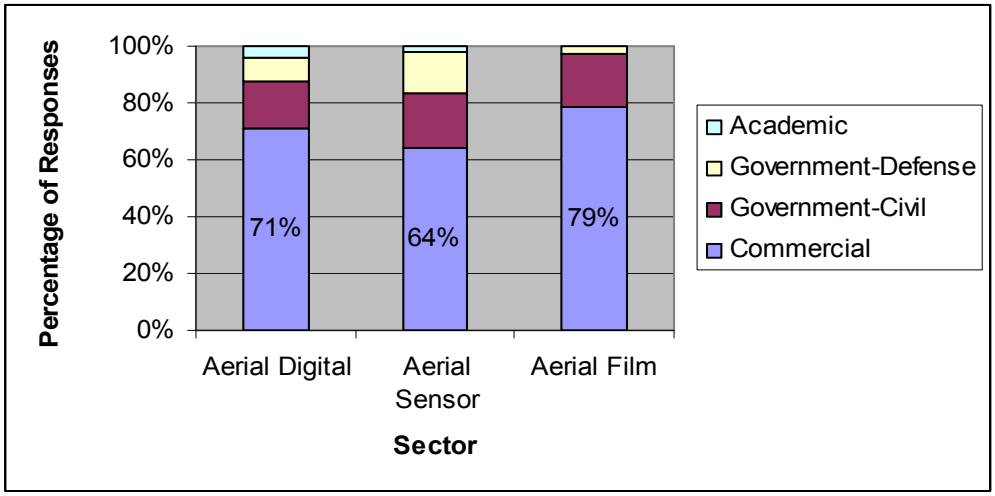
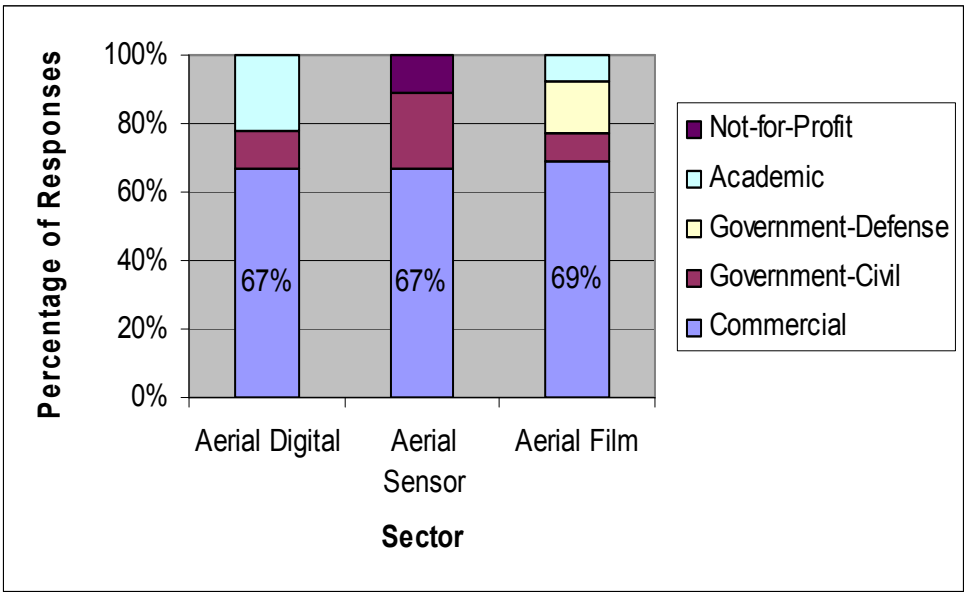


Figure 26: Market Type (International Aerial Sectors)



These selections correlate with other industry research which identifies the majority of the aerial market as commercial companies which support a government based clientele.

15 Analysis of Technical Advances-Aerial Sector

The aerial sector respondents were asked to select which technical trends may impact their businesses in the next five and ten years (2010 and 2015). Overall, as seen in Figure 27, Technology Integration was selected most frequently by the three sectors: Aerial Digital, Aerial Sensor, and Aerial Film. Table 31 is a comparative analysis of the top four technology trends selected in 2010 by the sectors. Technology Integration was the top choice for Aerial Sensor and Aerial Film, while Greater Ground Resolution was selected most often by the Aerial Digital respondents.

Technology Integration impacts the bottom line for all sectors of the aerial industry. Integration influences productivity, costs, quality of products and services, and ultimately revenue for data producers and users alike which is the most likely reason that it was so highly ranked. However, other technology advances, such as Greater Ground Resolution, has a direct impact on the type of products which can be delivered and what applications can be performed which influences the type of client the aerial data provider can support.

Figure 27: 2010 Technical Advances (Aerial Sectors)

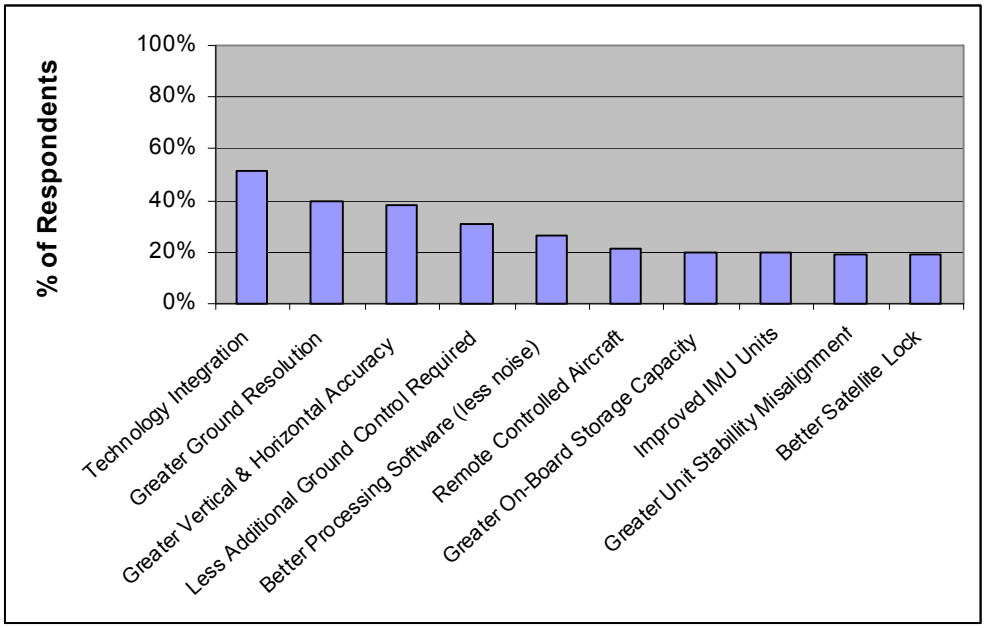


Table 31 highlights the exact selections of each aerial sector. It is interesting to note that Greater Ground Resolution for the Aerial Digital sector was selected by 86 % of the respondents well above Technology Integration which was selected by only 57% of the respondents. This clearly supports the fact that Aerial Digital providers are focused on a client base (the US government) with current and continuing requirements for high resolution products. Although the Aerial Sensor sector and Aerial Film sector selected Technology Integration as their first choices there is quite a difference in the spread of their selections. The Aerial Sensor sector selected Technology Integration by 91% of the respondents while

the next closest selection was Greater Vertical & Horizontal Accuracy selected by 57 % of the respondents. This demonstrates the level of focus the Aerial Sensor providers have on improving the quality of the products they can deliver to their client base and perhaps improving the speed of product delivery. The Aerial Film sector selections for Technical Advances had a much tighter selection range from 59% to 45%, indicating they are a more mature provider focused on across the board technology improvements in order to improve their level of support to their client base.

Table 30: Technical Advances by Sector 2010 (Aerial Sectors)

2010 Technical Advances by Sector	%
Aerial Digital	
Greater Ground Resolution	86%
Technology Integration	57%
Greater On-Board Storage Capacity	46%
Better Processing Software	43%
Aerial Sensor	
Technology Integration	91%
Greater Vertical & Horizontal Accuracy	66%
Less Additional Ground Control Required	50%
Remote Controlled Aircraft	45%
Aerial Film	
Technology Integration	59%
Greater Ground Resolution	52%
Greater Vertical & Horizontal Accuracy	48%
Digital Aerial Cameras	45%

The analysis of technical trends indicates within five years (2010) the aerial market will be driven by efforts to integrate existing technology (LiDAR, Aerial Imagery, Airborne GPS and IMU). Also the aerial market will be pushed to increase both the ground resolution and the accuracy of aerial-derived data. An important point in this analysis if these are technical trends identified by the aerial producers in the Aerial Film, Aerial Digital, and Aerial Sensor sectors. Thus, future investments are likely to be made in those areas that will support the technology improvements they selected.

As depicted in Figure 28, in 2015, the technology selected most frequently across all of the sectors as impacting their businesses is Even Better Processing Software, followed by Greater Ground Resolution and Even Greater Onboard Storage Capacity.

The Aerial Digital respondents selected Even Greater Ground Resolution as the top technical advance that will impact their business by 2015 as shown in Table 31. Aerial Sensor respondents chose Virtual Sensor Operators and the Aerial Film respondents chose Greater Vertical/Horizontal Accuracy as their top impacts.

Figure 28: 2015 Technical Advances (Aerial Sectors)

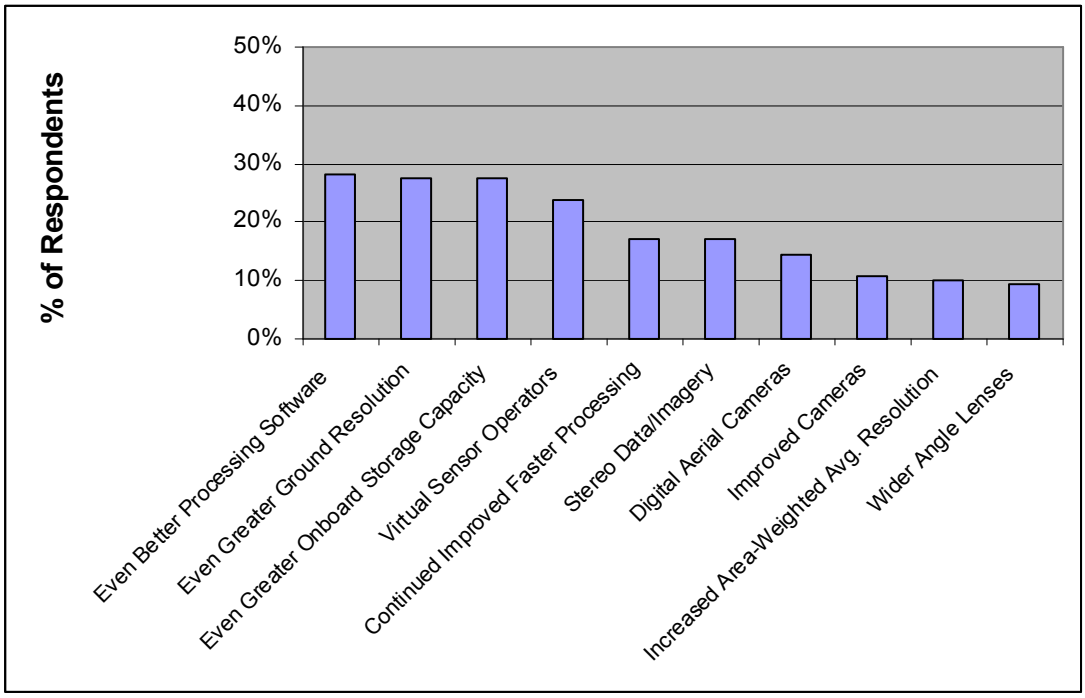


Table 31: Technical Advances 2015 (Aerial Sectors)

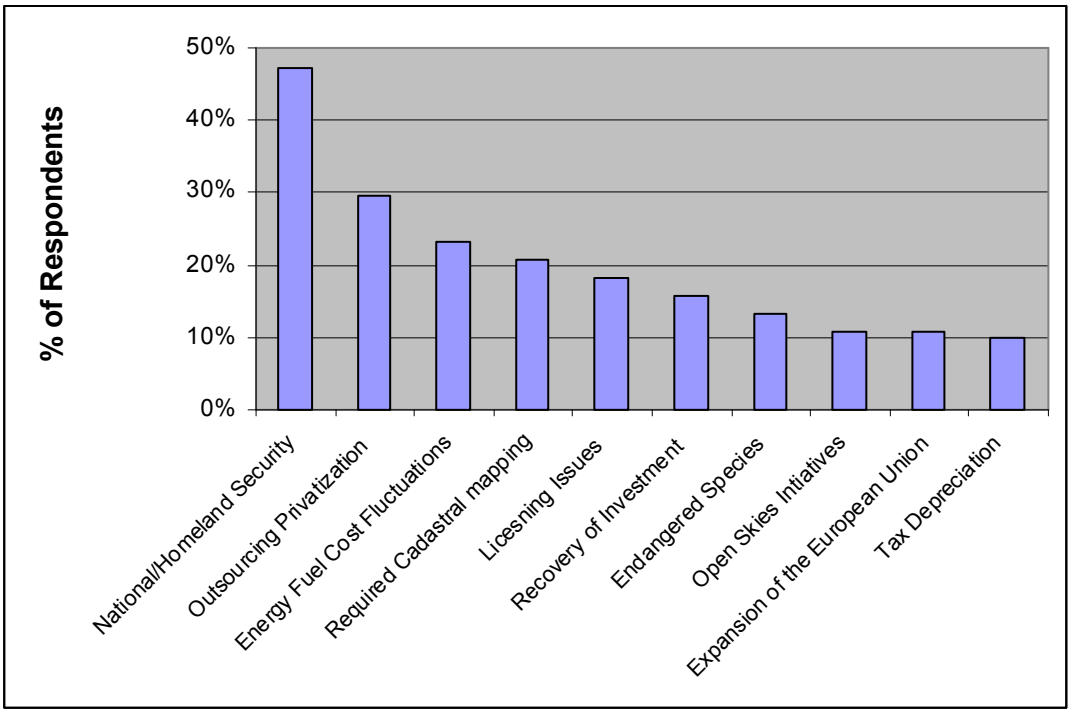
2015 Technical Advances by Sector	%
Aerial Digital	
Even Greater Ground Resolution	96%
Even Greater On-board Storage Capacity	57%
Even Better Processing Software	50%
Continued Increased Bit Levels	50%
Aerial Sensor	
Virtual Sensor Operators	41%
Even Greater Ground Resolution	39%
Even Better Processing Software	36%
Even Greater On-board Storage Capacity	20%
Aerial Film	
Greater Vertical & Horizontal Accuracy	43%
Greater On-Board Storage Capacity	43%
Digital Aerial Cameras	41%
Stereo Imagery	39%

The analysis of the aerial sector technical trends over the next 10 years indicates that there will continue to be expectations for increased ground resolution of imagery. In addition, the aerial market is driven by computer hardware issues, such as Even Greater Onboard Storage Capacity, and Virtual Sensor Operators, and software issues, such as Even Better Processing Software.

16 Analysis of Political, Economic, and Environmental Trends-Aerial Sector

Aerial Sector respondents were asked to select Political, Economic, and Environmental trends that may impact their businesses in the next five to ten years (2010 and 2015). As depicted in Figure 29, National Defense/Homeland Security, Outsourcing/Privatization, Energy/Fuel Cost Fluctuations, and Required Cadastral Mapping are seen by the respondents as the driving political and economic trends over the next five years.

Figure 29: 2010 Political, Economic, and Environmental Trends (Aerial Sectors)



It is also important to note two items of particular interest to the Aerial Film, Aerial Digital and Aerial Sensor sectors, as shown in 32, were Outsourcing/Privatization and Energy/Fuel Cost Fluctuations. Both of these trends can significantly impact their cost structure in an increasingly cost-competitive market.

Table 32: Political, Economic, and Environmental Trends 2010 (Aerial Sectors)

2010 Political, Economic, and Environmental Trends by Sector	%
Aerial Digital	
National Defense/Homeland Security	50%
Outsourcing/Privatization	46%
Energy Fuel Cost Fluctuations	32%
Required Cadastral Mapping	29%
Aerial Sensor	
National Defense/Homeland Security	70%
Outsourcing /Privatization	39%
Required Cadastral Mapping	25%
Energy Fuel Cost Fluctuations	23%
Aerial Film	
National Defense/Homeland Security	68%
Energy Fuel Cost Fluctuations	41%
Outsourcing/Privatization	39%
Required Cadastral Mapping	32%

The analysis of Political, Economic, and Environmental trends indicates that respondents believe security issues, such as National Defense/Homeland Security, are and will continue to be important to the aerial market. Also the aerial market will be pushed by governmental requirements to continue to supply high quality and accurate property and tax map data and services, i.e. Cadastral Mapping. Thus, it is likely that there will be continued investment in higher resolution aerial cameras (likely digital), and better processing software and hardware that will improve computer storage space and processing speed, which is necessary to store and manipulate the huge amount of data generated when imaging and/or mapping very large geographic areas.

National Defense/Homeland Security is still expected to be a major impact on all sectors of the aerial market in 2015, followed by Outsourcing/Privatization, Energy/Fuel Cost Fluctuations, and Required Cadastral Mapping. The top ten Political, Economic, and Environmental trends selected in 2015 are very similar to those in 2010, with the remaining selections showing a continuing awareness of the importance of international trade and environmental trends in the global marketplace.

Figure 30: 2015 Political, Economic, and Environmental Trends (Aerial Sectors)

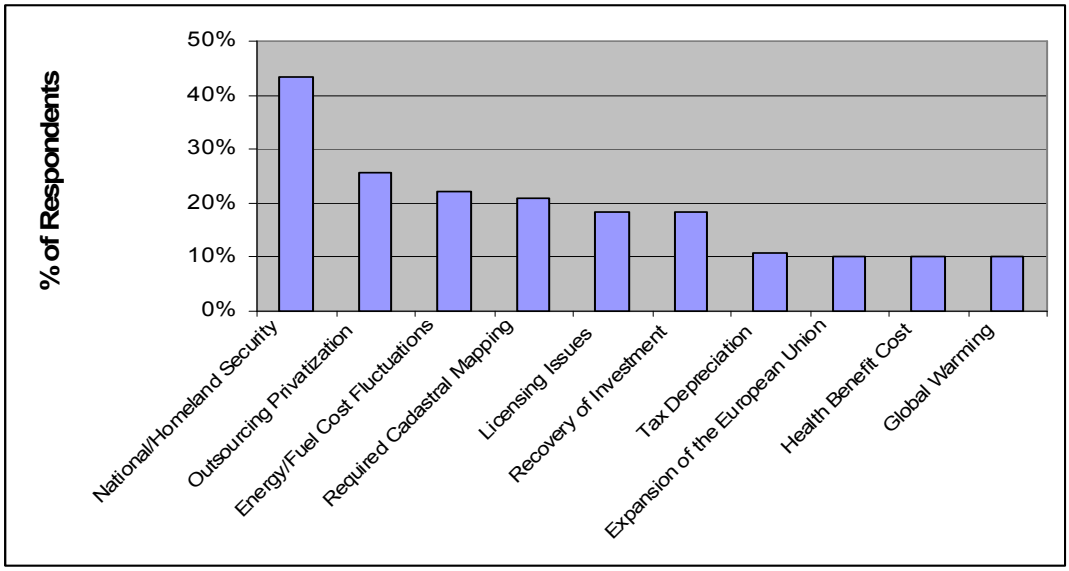


Table 33 presents the top four trends selected by each sector. Clearly they have similar concerns and will continue to be impacted by National Defense/Homeland Security in 2015, as well as Outsourcing/Privatization and the Energy/Fuel Cost Fluctuations.

Table 33: Political, Economic, and Environmental Trends 2015 (Aerial Sectors)

2015 Political, Economic, and Environmental Trends by Sector	%
Aerial Digital	
National Defense/Homeland Security	68%
Outsourcing/Privatization	46%
Required Cadastral Mapping	32%
Energy/Fuel Cost Fluctuations	32%
Aerial Sensor	
National Defense/Homeland Security	52%
Energy/Fuel Cost Fluctuations	27%
Required Cadastral Mapping	27%
Outsourcing/Privatization	27%
Aerial Film	
National Defense/Homeland Security	61%
Outsourcing/Privatization	36%
Licensing Issues	32%
Energy/Fuel Cost Fluctuations	32%

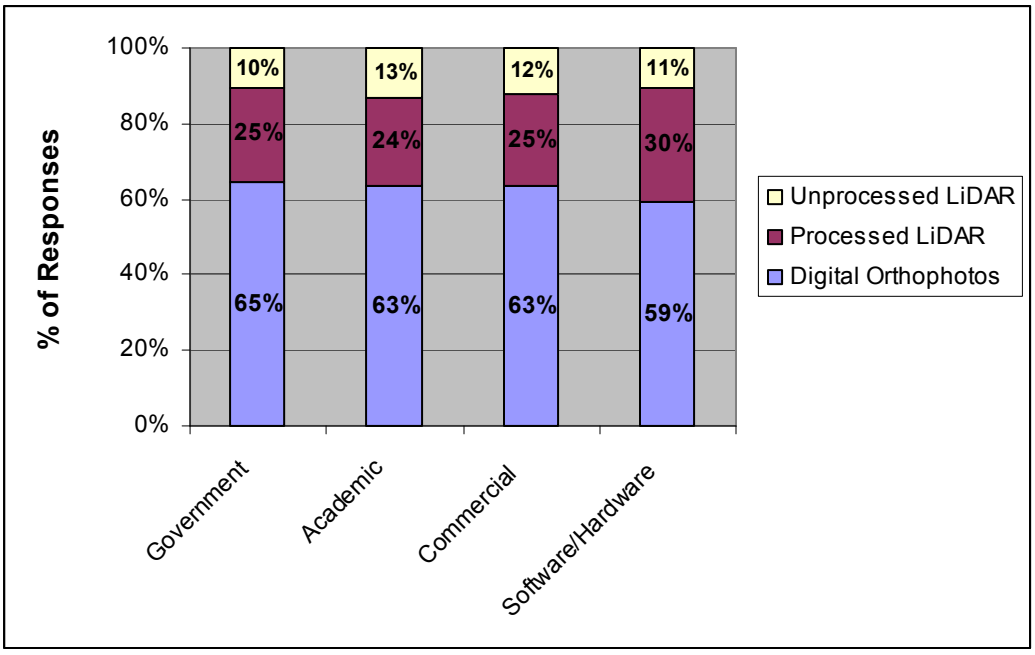
The analysis of Political, Economic, and Environmental trends for 2015 shows continuing interest in the same trends as in 2010, with National Defense/Homeland Security being the major driver of the aerial market. Outsourcing/Privatization issues and Energy Fuel Cost Fluctuations are also a concern for aerial companies due to the impact on their cost structure in an increasingly competitive global market. The Political, Economic, and Environmental

trends selected by respondents for 2015 indicate that these same issues will continue to be major influences on the aerial sector in the US marketplace during the coming decade.

17 Aerial Products Purchased – Government, Academic, Commercial, and Software/Hardware Sectors

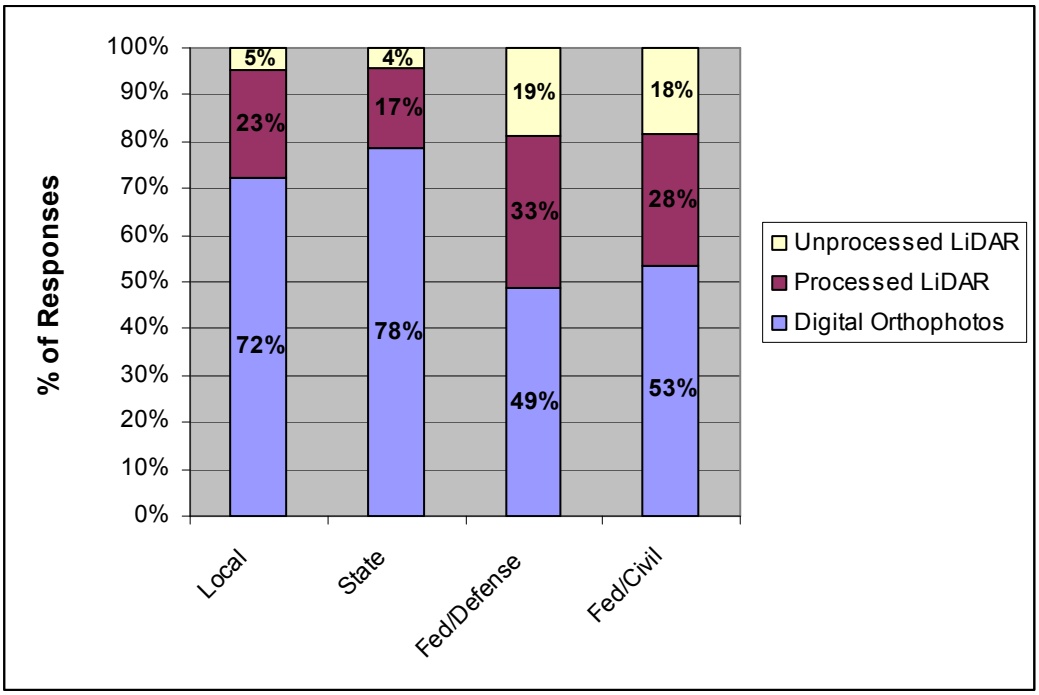
Respondents in the Government, Academic, Commercial, and Software/Hardware sectors were asked to select the types of remote sensing products they utilized. The products that relate to the aerial industry have been extracted from the data to analyze activity in the aerial market. Digital Orthophotos are used most frequently in each of the sectors surveyed. From 59% to 65% of the respondents in each of the sectors selected Digital Orthophotos, compared to 24% to 30% of the respondents selecting Processed LiDAR, and only 10% to 13% using Unprocessed LiDAR.

Figure 31: Remote Sensing Product Usage (Other US Sectors)



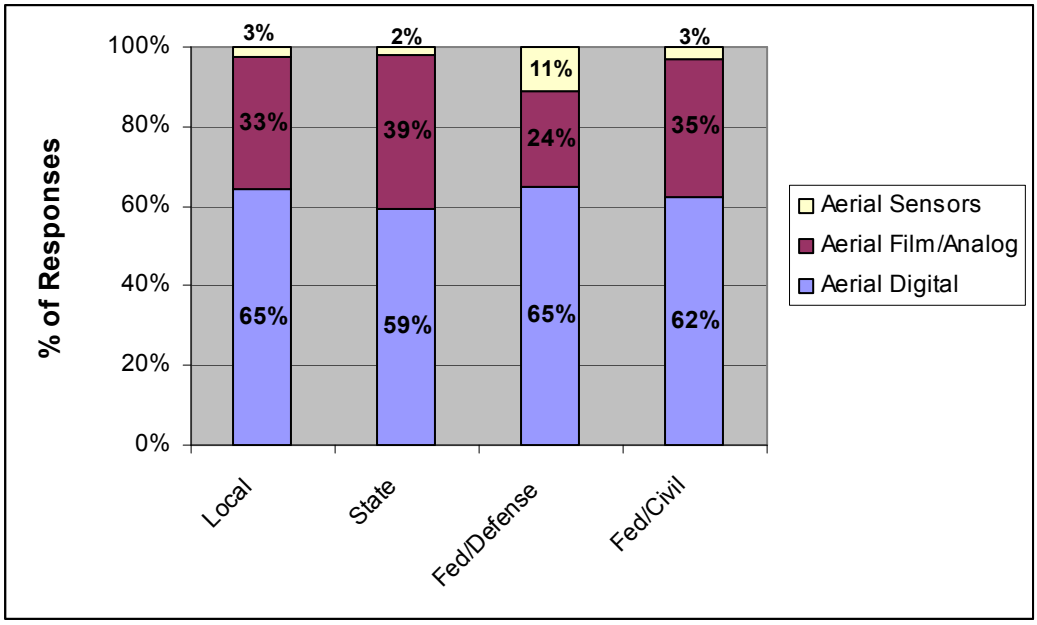
The Government sector respondents can also be identified as Local, State/Provincial, Federal Defense, and Federal Civil units. These units also show a very high usage of Digital Orthophotos (from 49% to 78%), compared to Processed LiDAR (17% to 33%) and Unprocessed LiDAR (4% to 19%). This can be explained in part by the history of the existing government aerial programs which are now exploring greater potential applications of LiDAR data. Keep in mind the government respondents overall selected processed imagery as their top choice for the type of remote sensing products most often purchased. The government users want processed imagery which provides immediate use in their applications.

Figure 32: Remote Sensing Product Usage (US Government Units)



Government units were also asked to identify which kinds of aerial data they most often purchased. As shown in Figure 32, Aerial Digital data was selected the most often by all of the units, followed by Aerial Film Data, and Other Aerial Sensor data (such as LiDAR, hyperspectral, SAR, etc.). We would expect there to be a further shift over time from film to digital data, although it is highly unlikely that film will be 100% replaced in the next decade.

Figure 33: Remote Sensing Data Purchased (US Government Units)



18 Summary-Aerial Sector

The 159 surveys that were completed worldwide by the aerial market sectors have provided insight into the concerns and issues facing the industry over the next ten years. Respondents indicated the primary Technology Advance in 2010 that will impact their businesses is Technology Integration (LiDAR, Digital Camera, Airborne GPS, IMU, etc.). The aerial market will desire to improve both the Accuracy and the Ground Resolution of aerial-derived data to meet user needs. Technology trends in 2015 indicate a continued expectation of Even Better Processing Software and Greater Ground Resolution. The aerial market is being driven both by computer hardware-type issues and data and software issues. As sensor capabilities are improved and are able to collect higher quality data of all kinds and at greater volumes, there will be a need for greater data storage, and better processing capabilities. All of these issues are inter-related, and having one without the others will limit the usefulness of aerial data.

The Political, Economic, and Environmental trends in the aerial industry run the gamut from National Defense/Homeland Security to Licensing Issues to Global Warming. There is some variation among the sectors on the ranking of these trends, due to special interests, but Homeland Security, ranked highest in 2010 and 2015, is the common thread throughout all the sectors. Homeland Security is a significant catalyst for growth in all parts of the industry stimulating a greater need for current, high-quality data, with improved software required to use the data as well as, hardware improvement necessary to store the data.

The other survey results point to expectations of growth in revenue and employees over the next ten years. The responses from the Aerial Digital, Aerial Sensor, and Aerial Film sectors indicate a future shift from small and medium-size companies (based on revenue) to larger companies.

The Aerial Digital respondents predicted particularly strong revenue growth, with 26% of the respondents selecting the US company revenue category of greater than $10 million in 2005 compared to 58% selecting the same category for 2015. In the international category, 25% of the Aerial Digital respondents selected the company revenue category of greater than $10 million in 2005, increasing to 44% selecting the same category in 2015.

The top four applications selected by the US respondents: Engineering, Transportation, Land Management/Development and Utilities are all traditional areas for aerial data to be used. The types of data most commonly used or purchased by the respondents are Digital Orthophotos and other Digital Aerial data.

The aerial industry is significantly impacted by government policies that determine the volume, quality, and areas of interest for aerial data, the speed and quality of data processing, and the efficiency and effectiveness of hardware and software. Projections for the future indicate growth in the industry, closely tied to interest in National Defense/ Homeland Security issues. It is to be expected that the industry will develop the tools it needs to meet the demands of its customers in all sectors, and the companies that are able to integrate this new technology into their businesses will continue to succeed.

Study Detail and Analysis Available for Each Sector

In addition to the analysis contained in this study document concerning the years 2005, 2010 and 2015 Technical, Political, Environment, Economic, Employment and Revenue Trends impacting the study sectors, in-depth data was also collected to acquire the specific information pertinent to that sector area. This data has been collected from 1547 respondents globally and is available for analysis by sector, geographic region, etc. and includes the following data topics:

Aerial Digital

- The type and number of Camera Manufacturers, Models, Cost and Methods of Housing the Camera Utilized
- The type of Airborne GPS and IMU Specifications Utilized
- Most Popular Data Delivery Method
- Application of Data and Use by Market Type
- Average Number of Projects and Size in Kilometers
- Revenue and Employment Data

Aerial Film

- The type and number of Camera Manufacturers, Models, Cost, Area Weighted Average Resolution (AWAR), Maximum Aperture, Forward Motion Compensation and Cone Size Utilized
- The type of Airborne GPS and IMU Specifications Utilized
- Film Types Utilized and Gyro Stabilized Mount Utilized
- Methods of Housing the Camera
- Application of Aerial Camera and Use by Market Type
- Average Number of Projects and Size in Kilometers
- Revenue and Employment Data

Aerial Sensor

- The type of Sensor Specifications Utilized, Average Age, Maximum Pulse Rate and Cost of Units
- They type Multi-Hyper Spectral Manufacturer/Model, Number of Units Utilized
- Operating Spectral Channel and/or Band(s) including imaging radar
- Maximum Pulse Rate and Maximum Ground Resolution
- Most Popular Data Delivery Method
- The type of Airborne GPS Specifications, Manufacturers, Cost, Average Age of Units and Methods of Housing Sensor
- Application of Aerial Sensor Data and Use by Market Type
- Average Number of Projects and Size in Kilometers
- Revenue and Employment Data

Satellite

- Radiometric Sampling Resolution, Band Width in Nanometers, Data File Format Available, Best Ground Pixel Resolution
- Data Delivery Media Available, Operating Spectral Channel and/or Band(s) Utilized and Ground Station Locations and Number of Staff
- Market Sector Involved Most Served
- Application of Satellite Data and Use by Market Type
- Average Number of Projects and Size in Kilometers
- Revenue and Employment Data

Commercial End User

- Software Employed, Number of Licenses, Applicable Maintenance Fees and RAM (mb) Required
- Average Purchase Cost of Remote Sensing Software and Projected Purchases
- Application of Satellite Data and Use by Market Type
- Number or Workstations (PC's) Employed, Number of Data Storage Devices Available and Gigabytes Available
- Data File Formats Utilized, Preferred Data Delivery Media and Data Compression Technique Utilized

Government

- Unit Membership, i.e.; Federal-Defense, Federal Civil, State Provincial or Local Defined and Projected Remote Sensing Funding
- Software Employed, Number of Licenses and RAM (mb) Required
- Average Annual Purchase Cost of Remote Sensing Software and Projected Purchases of Software and Data and Applicable Maintenance Fees
- Application of Satellite Data and Use by Market Type
- Number or Workstations (PC's) Employed, Number of Data Storage Devices Available and Gigabytes Available
- Data File Formats Utilized, Preferred Data Delivery Media and Data Compression Technique Utilized

Software Hardware

- Software Employed, Number of Licenses and RAM (mb) Required
- Average Annual Purchase Cost of Remote Sensing Software and Applicable Maintenance Fees
- Application of Satellite Data and Use by Market Type
- Number or Workstations (PC's) Employed, Number of Data Storage Devices Available and Gigabytes Available
- Data File Formats Utilized, Preferred Data Delivery Media and Data Compression Technique

Academic

- Type of Institution, Software Employed, Number of Licenses and RAM (mb) Required
- Average Annual Purchase Cost of Remote Sensing Software and Applicable Maintenance Fees
- Application of Satellite Data and Use by Market Type
- Number or Workstations (PC's) Employed, Number of Data Storage Devices Available and Gigabytes Available
- Data File Formats Utilized, Preferred Data Delivery Media and Data Compression Technique
- Type of Remote Sensing Products Used
- Market Value of the Commercial Remotely Sensed Data Utilized in US Dollars Per Year
- Major Funding Sources and Projected size if Remote Sensing Funding for 2005, 2010 and 2015

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