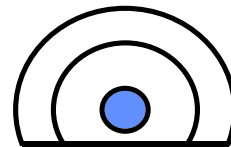




NRO PROFILE AND COMMERCIAL POLICY FOR SATELLITE IMAGERY

CSP Seminar Presentation

24 February 1999



CSP Associates, Inc.



Outline

Briefing Scope

Intelligence Community Structure

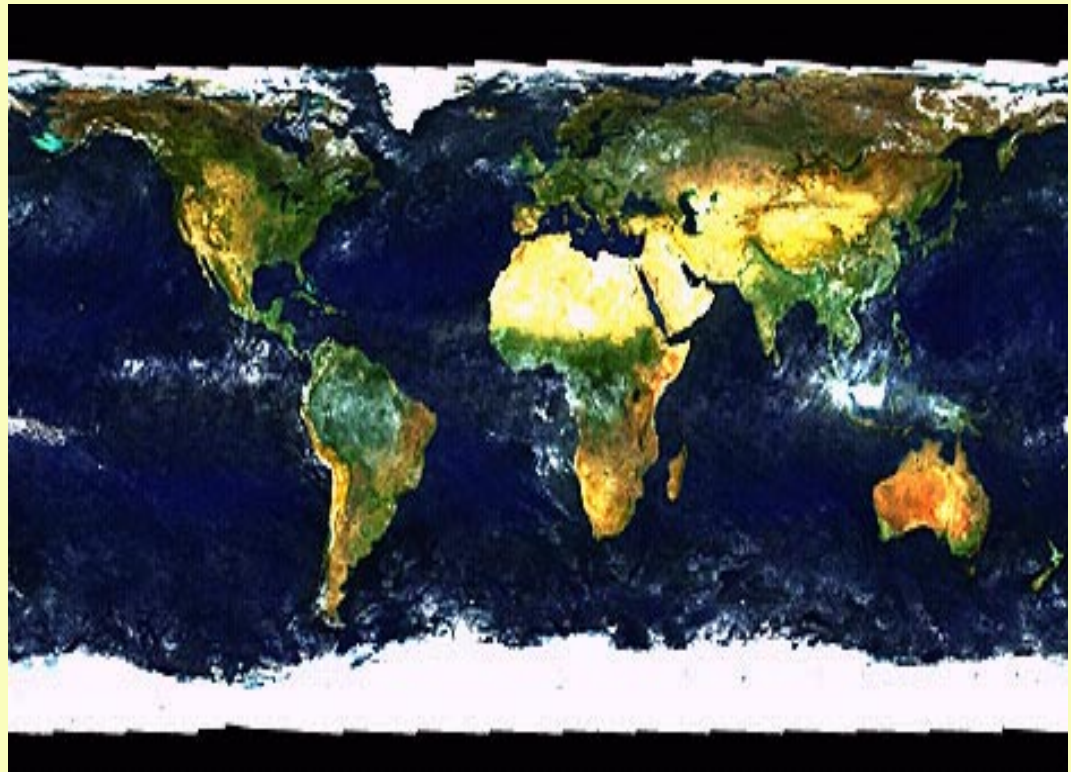
Overview of the NRO

Status of Commercial Imagery

– Appendix: Profiles of Commercial Providers

Scope

- λ **Profile of U.S. Reconnaissance Satellite activity**
 - U.S. Intelligence community and reconnaissance satellite structure
- λ **National Reconnaissance Office (NRO)**
 - Organizational structure
 - Budget
 - Future NRO operations
- λ **Policy for commercial satellite imagery**
 - Allowable imagery
 - Commercial leaders
 - Imagery and launch prospects



All information obtained from open sources and may not be precise



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Intelligence Community Structure

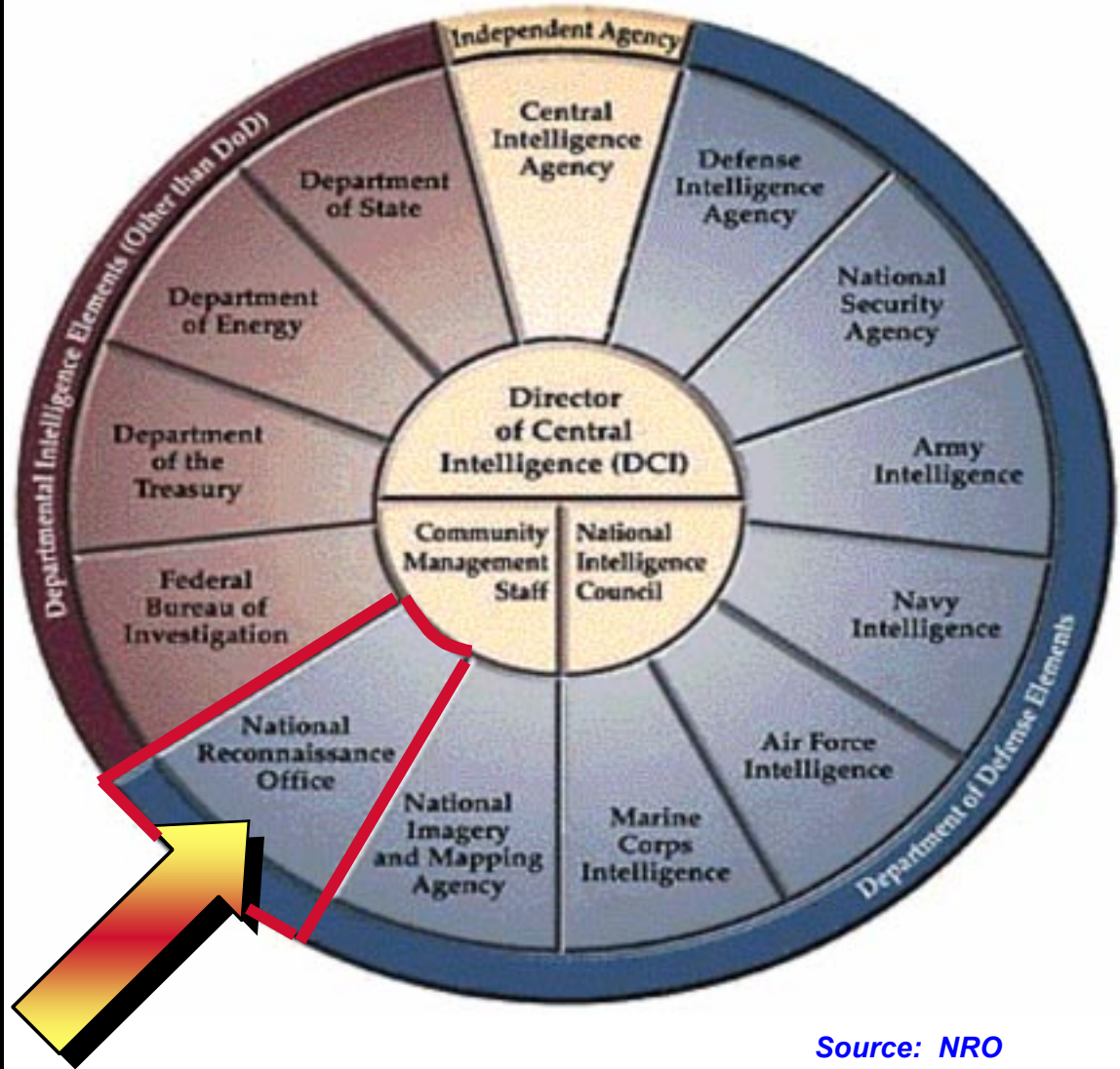
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U.S. Intelligence Community Structure

- λ Total of 13 agencies
 - NRO is operator of all national reconnaissance satellite assets
- λ Management reorganized in 1996
 - Attempt to better coordinate and integrate disparate intelligence assets
 - Executive management now held by the Director of Central Intelligence (DCI)
 - Support to DCI by dedicated management staff and advisory body composed of external experts
- λ Historic rivalry between CIA and USAF for control of satellite intelligence assets led to redundant systems and reduced support for analysis activity
 - Emphasis now on more efficient use of resources, centralization of intelligence asset operations, and partnering with commercial firms to reduce costs

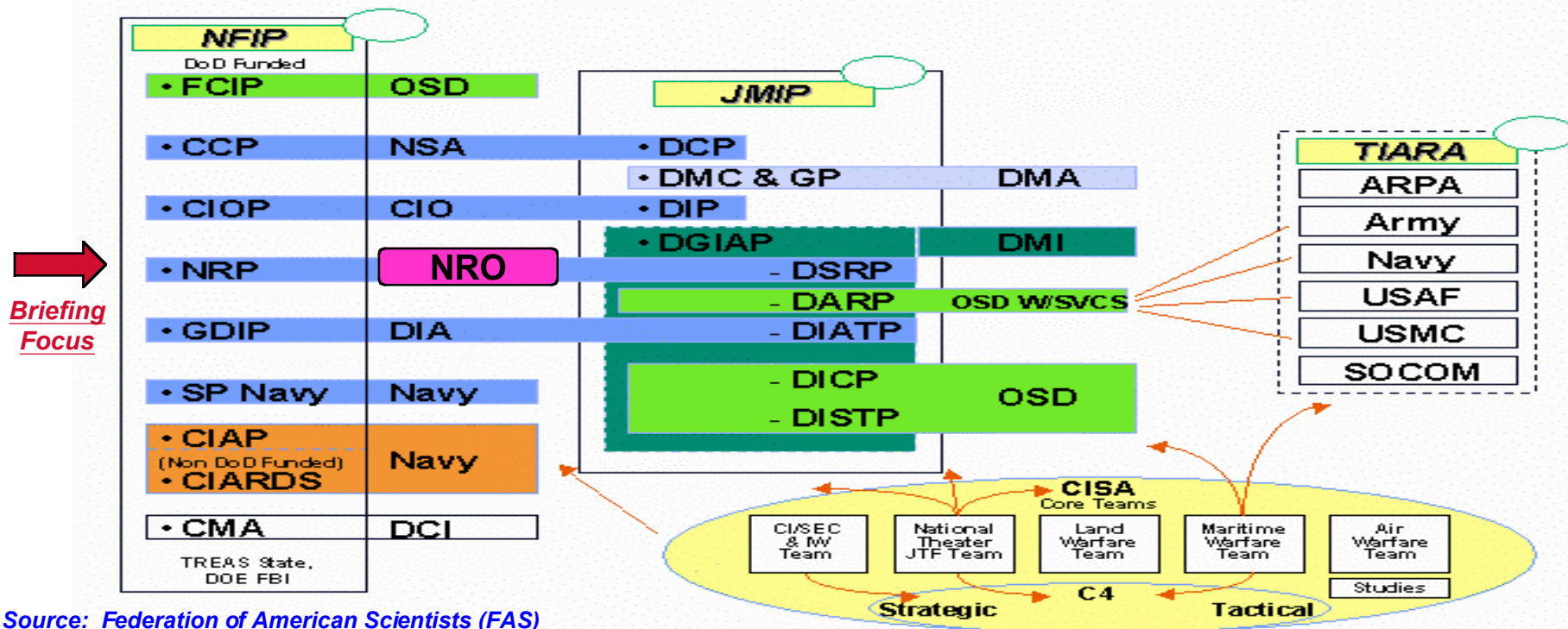


Source: NRO

U.S. Intelligence Community: Program Structure

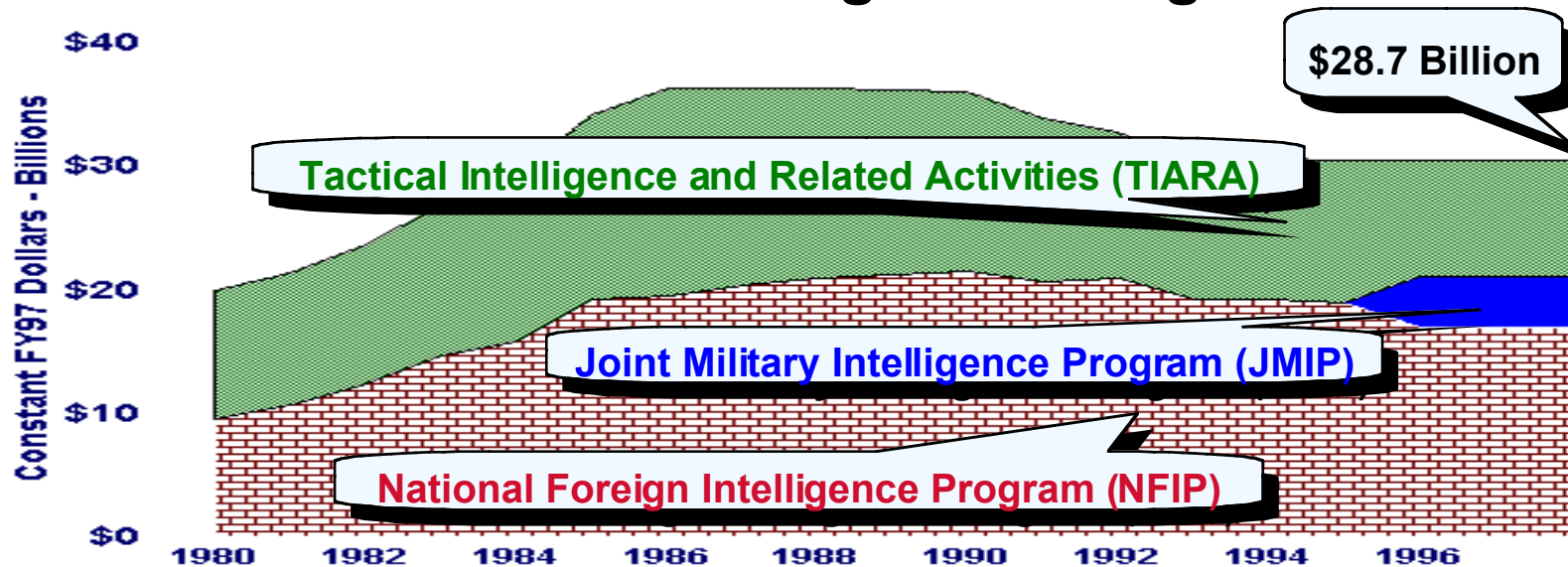
Intelligence Community Activity Divided into Three Major Programs:

- λ National Foreign Intelligence Program (NFIP): serves general national intelligence needs
- λ Joint Military Intelligence Program (JMIP): serves primarily defense-wide, theater activities and the Unified Commands
- λ Tactical Intelligence and Related Activities (TIARA): serves primarily a single service or agency



U.S. Intelligence Community Budget

Total U.S. Intelligence Budget

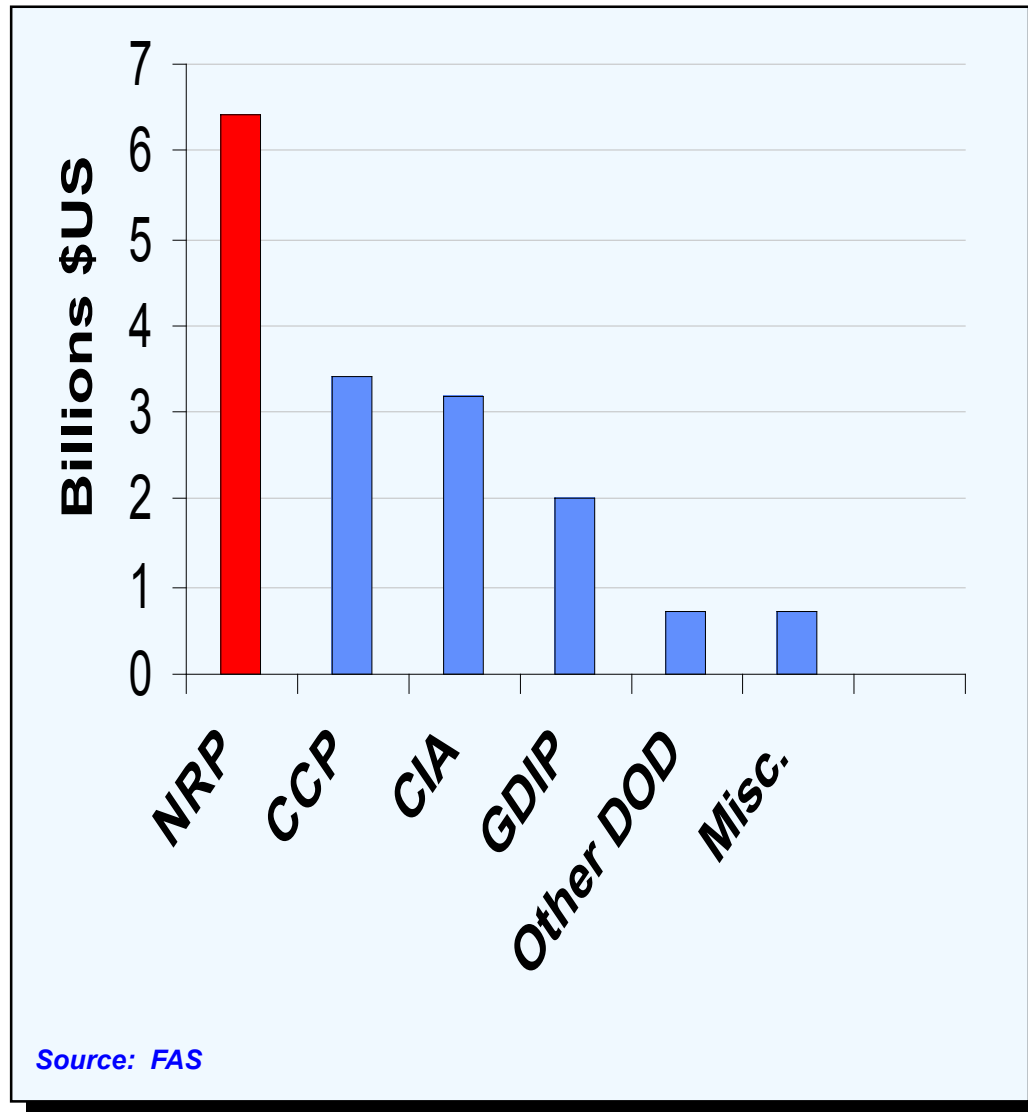


Source: FAS

- λ Intelligence budget has kept pace with inflation since 1992
- λ \$28.7 billion in FY 1998
 - └ Majority of funding is for reconnaissance satellites, eavesdropping and military intelligence
 - └ *NRO's activity is a subgroup within NFIP*



U.S. Intelligence Community: NFIP Budget Composition



National Foreign

Intelligence Program

λ NFIP constitutes the largest portion of Intelligence spending

- \$16.5 Billion Total (57%)
- NRP = National Reconnaissance Program
- CCP = Consolidated Cryptologic Program
- CIA = Central Intelligence Agency
- GDIP = General Defense Intelligence Program

λ *NRP receives the largest allocation of NFIP funding*

- *\$6.4 Billion (22% of total)*
- *Controlled by NRO*

Intelligence Community Composition

λ NRO funded within NFIP

λ Relatively small staff reflects focus on hardware acquisition

λ Tracking intelligence spending is difficult due to secrecy

↳ Values are best estimates

#1- Included in NRO budget total

#2- Included in Office of Naval Intelligence

Organization		Budget	Staff
Total	FY97	~\$27B	~100,000
National NFIP →	Community Management Staff	\$0.1B	278
	Central Intelligence Agency (CIA)	\$3.1B	16,000
	Defense Intelligence Agency (DIA)	\$0.85B	8,500
DoD NFIP →	National Reconnaissance Office (NRO)	\$6.4B	1,700
	National Security Agency (NSA)	\$3.6B	21,000
	Army Intelligence and Security Command	\$1.0B	13,000
	Office of Naval Intelligence	\$1.2B	16,000
	Naval Security Group Command	#1	#2
	Marine Corps Intelligence Activity	#2	#2
	Air Intelligence Agency	\$1.5B	15,000
DoD JMIP →	Assistant Secretary C3I		25
	Assistant to the Secretary Intell Oversight		15
	Defense Airborne Reconnaissance Office	\$0.77B	20
	Defense Support Project Office	\$0.09B	20
	National Imagery & Mapping Agency (NIMA)	\$1.2B	9,000
Other DoD →	Advanced Research Projects Agency (DARPA)	~	~
	Defense Investigative Service (DIS)	\$0.35B	3,000
	Naval Criminal Investigative Service	\$0.02B	350
Other NFIP →	Energy - Non-Proliferation and National Security	\$0.04B	300
	Justice - Federal Bureau of Investigation (FBI)	\$0.5B	2,500
	State - Bureau of Intelligence & Research	\$0.02B	300
	Treasury - Office of Intelligence Support	-	-
	Treasury - Financial Crimes Enforcement Network	\$0.02B	150
Other →	Treasury - Secret Service	\$0.03B	300
	Transportation - Coast Guard Intell Coordination Center	\$0.02B	220
	Justice - Drug Enforcement Administration (DEA)	\$0.25B	1,000

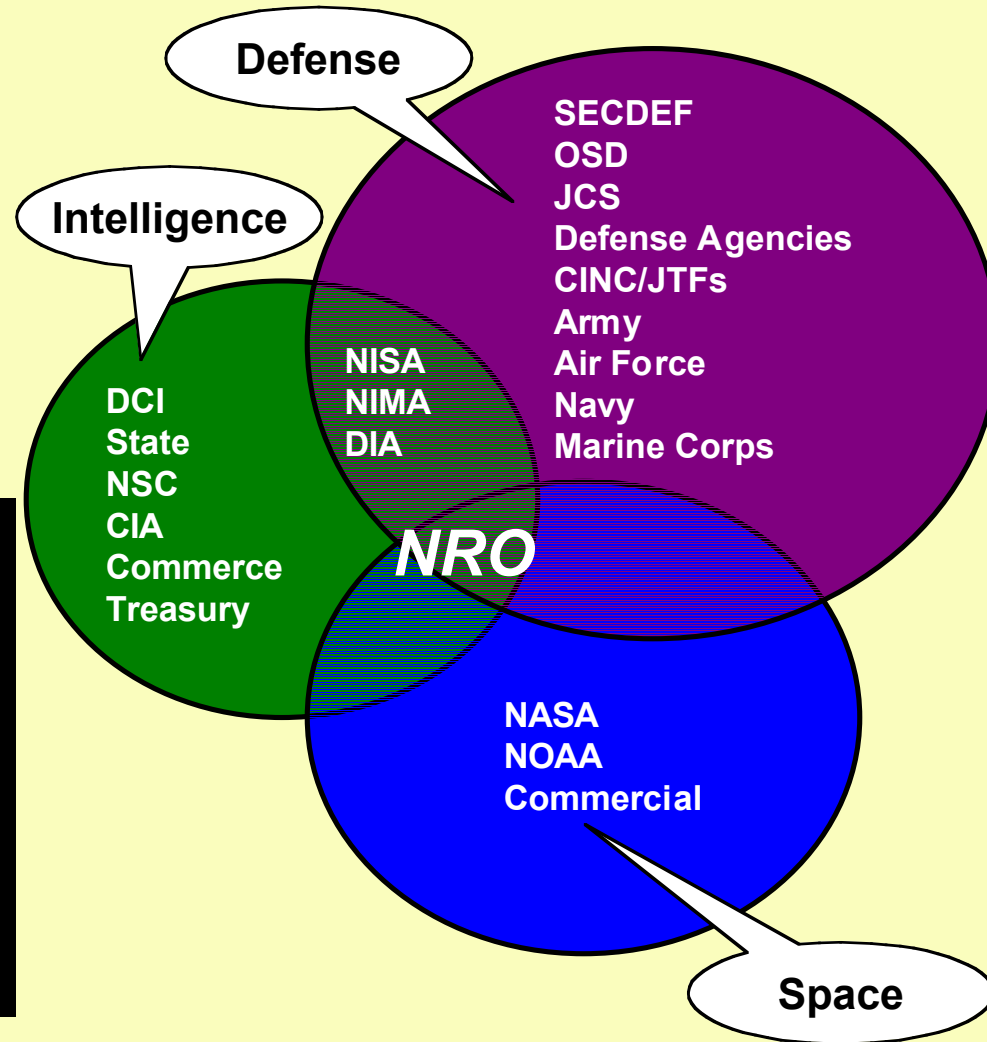
Source: FAS

NRO's Position Within the Intelligence and Space Community

NRO functions:

- * Intelligence**
- * Defense**
- * Space**

- λ NRO's large budget due to multidisciplinary tasking and hardware procurement responsibility
- λ Conducts reconnaissance and imagery tasks for many Intelligence agencies
 - Responds to customer requests as coordinated by DCI





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NRO: Overview

- λ The NRO designs, builds and operates America's reconnaissance satellites**
- λ NRO customers include**
 - Central Intelligence Agency (CIA)
 - Department of Defense (DoD) - all branches
- λ NRO satellite missions include**
 - Warning of potential global trouble spots
 - Helping plan military operations
 - Monitoring the environment



- λ As a DoD agency and part of the 13-member Intelligence Community, the NRO plays a primary role in achieving U.S. military and government information superiority**
 - NRO is staffed by DoD and CIA personnel, while receiving funding through the National Reconnaissance Program, part of the National Foreign Intelligence Program
 - The organization was declassified in September 1992 followed by the location of its headquarters in Chantilly, VA, in 1994
 - NRO may be flying as many as 4 “stealth” satellites in addition to ‘known’ systems

NRO: *Mission*

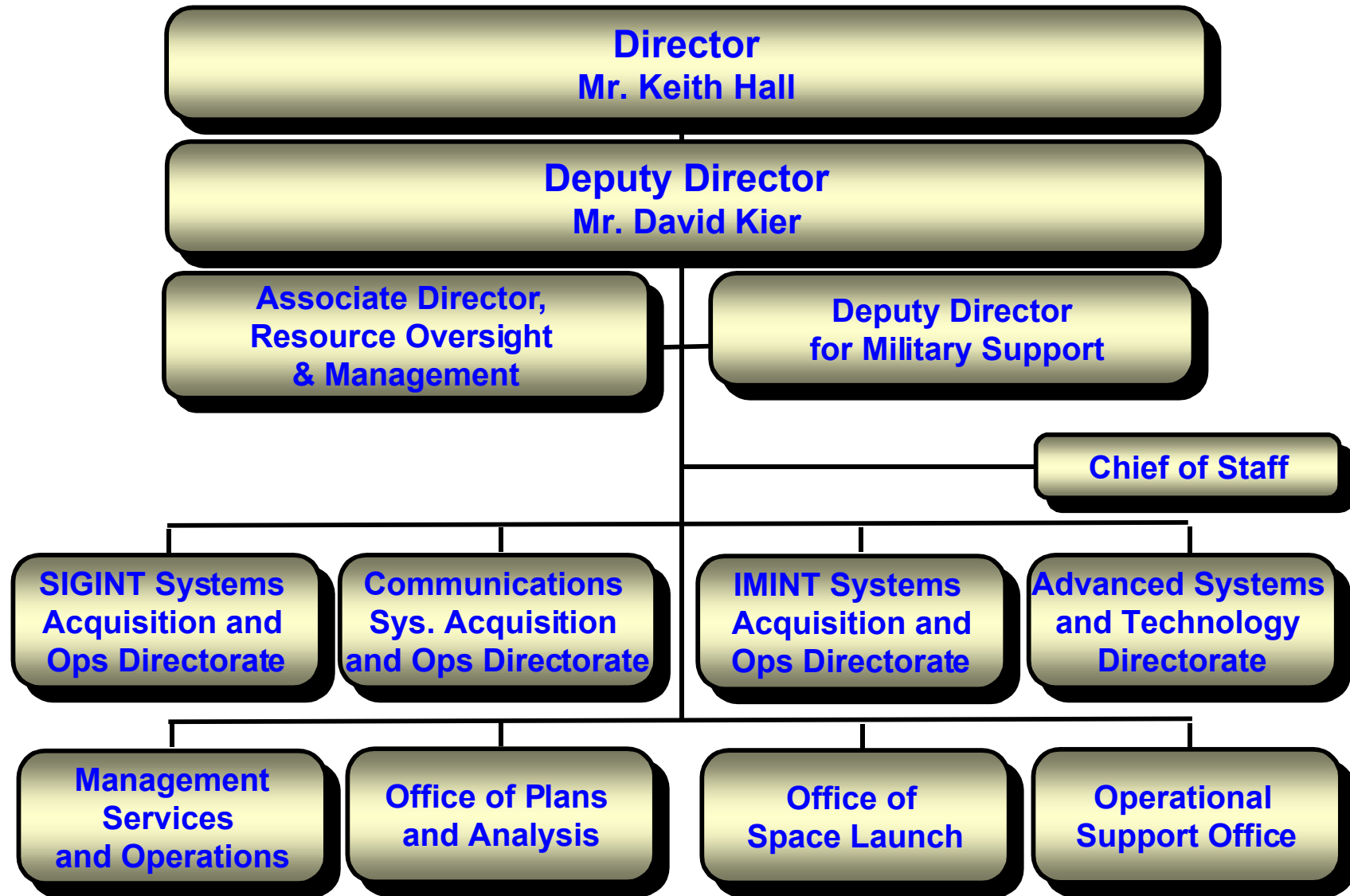


The primary mission of the NRO is to enable U.S. global information superiority in times of war and peace.

- λ The NRO is responsible for...**
- Unique and innovative imagery technology**
 - Large-scale systems engineering**
 - Development and acquisition**
 - Operation**

...of space reconnaissance systems and related intelligence activities needed to support U.S. global information superiority.

NRO: Structure and Organization



Source: NRO

Structure and Organization

λ Director (DNRO)

- Is responsible to the Secretary of Defense (SECDEF) and the Director of Central Intelligence (DCI) for:
 - 🍏 All national space and assigned airborne reconnaissance activities
 - 🍏 Fulfilling SECDEF and DCI requirements
- Assistant Secretary of the Air Force for Space also serves as DNRO
- The DNRO is appointed by the DCI and the SECDEF after being confirmed by the Senate as the Assistant Secretary of the Air Force for Space
- The Director reports to the Secretary of Defense who, in concert with the DCI, has ultimate management and operational responsibility for the NRO
- The DCI establishes collection requirements and priorities for satellite-gathered intelligence

Structure and Organization

λ Communications Systems Acquisition & Operations Directorate (COMM)

- Serves as the principal communications and computer element of the NRO. It is responsible for all space and ground infrastructure communications services and common information technology capabilities required in support of NRO systems and operations.

λ IMINT (Imagery Intelligence) Systems Acquisition and Operations Directorate

- Responsible for the development and operation of imagery satellites that serve the National Command Authority, the Intelligence Community and U.S. military forces. Specific Directorate functions include the development of reconnaissance technology for new systems capabilities; the acquisition of spacecraft and supporting ground-based systems; and the management of the day-to-day operations related to imagery collection, processing, production, and distribution.

λ SIGINT (Signals Intelligence) Systems Acquisition and Operations Directorate

- Responsible for the development of SIGINT satellites serving the National Command Authority, military forces, and the intelligence community by providing additional intelligence collection from space.

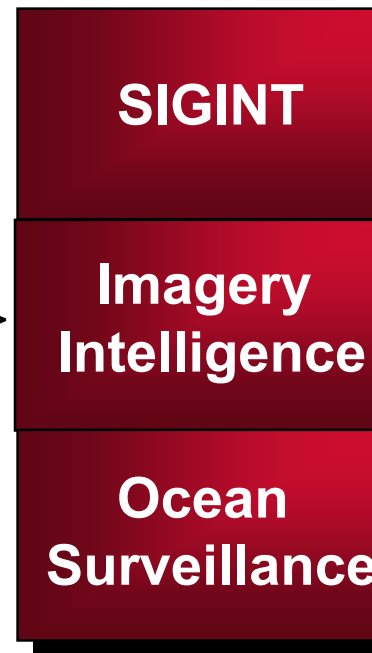
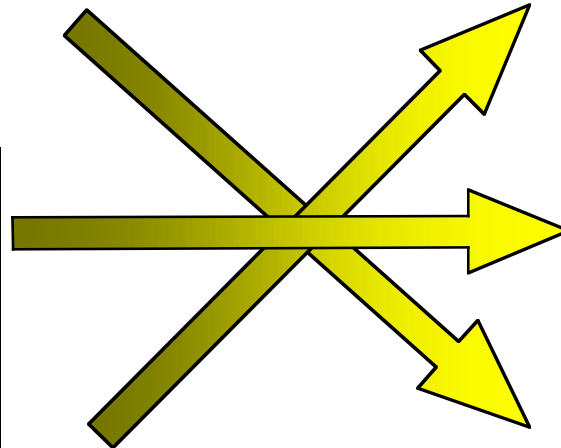
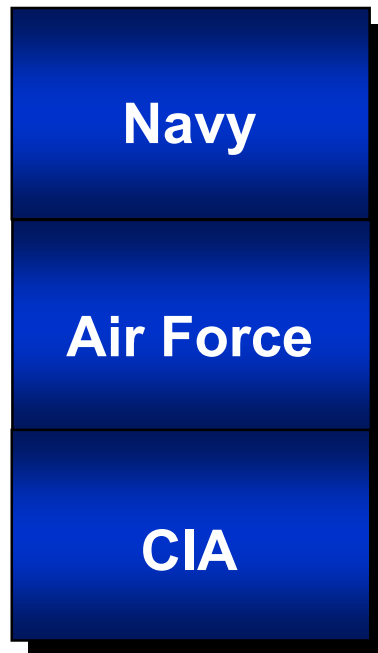
NRO Budget Structure

λ Traditionally, NRO funds were allocated through its executive agencies

- Navy
- Air Force
- CIA

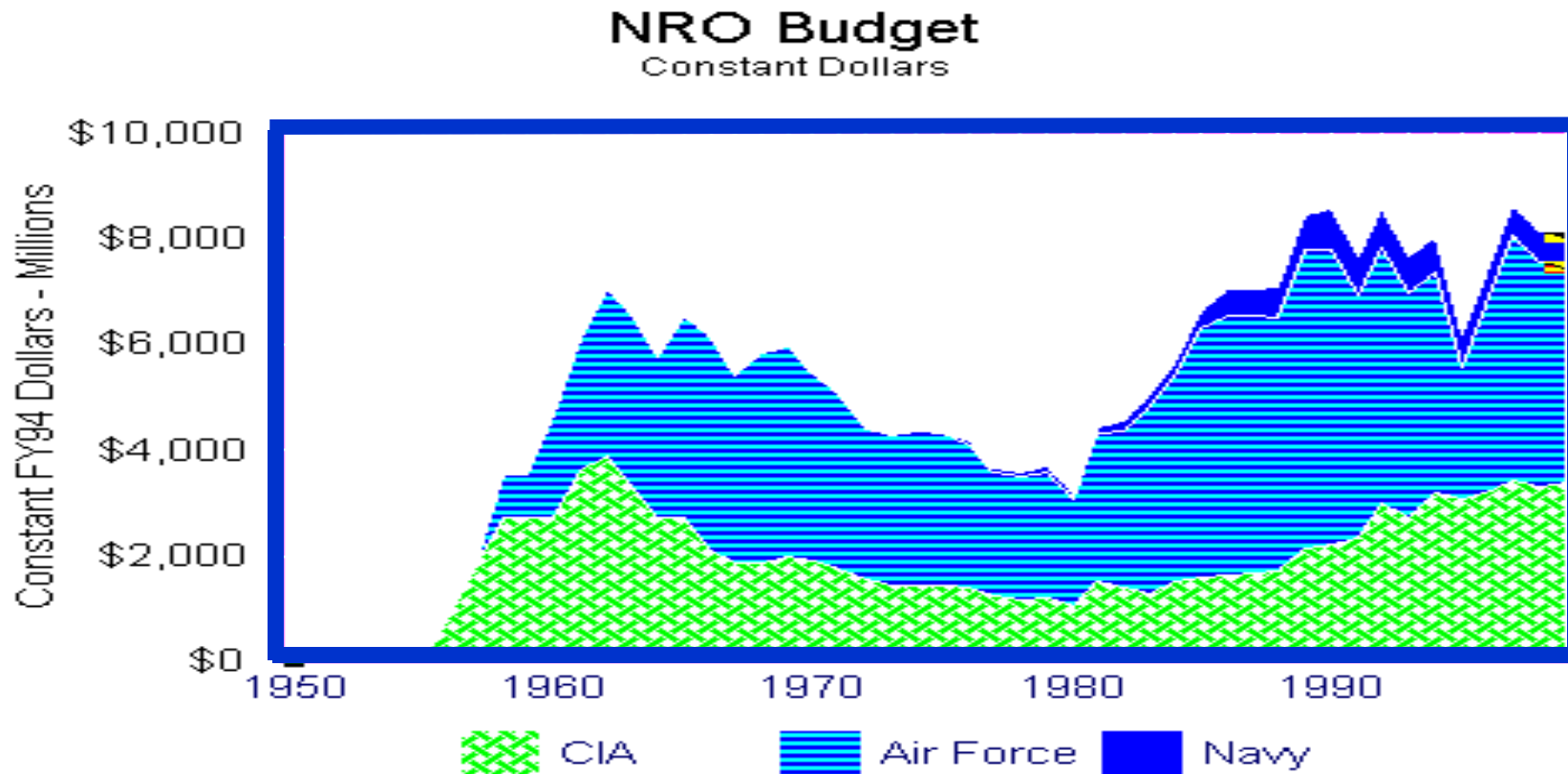
λ Currently, funds are allocated to NRO along functional lines

- Signals Intelligence (SIGINT)
- Imaging Intelligence (IMINT)
- Ocean Surveillance



Due to the technical complexity and limited number of intelligence satellites, there is no clear distinction between research, development, test and evaluation (RDT&E) funds, and procurement and operations funds

NRO: Budget



Source: FAS

- λ NRO recently switched funding groups from CIA, Navy, and Air Force to SIGINT, Imagery Intelligence and Ocean Surveillance
- λ NRO funding directed primarily towards SIGINT and Imagery Intelligence



Military Customer Applications of Reconnaissance Imagery

<i>Customer Requirement</i>	<i>Resolution</i>	<i>Spectral Bands</i>	<i>Image Size (km)</i>	<i>Revisit</i>	<i>Delivery</i>	<i>Confidentiality</i>	<i>Copyright</i>	<i>Comments</i>
Surveillance	<1m	Near Infrared, Panchromatic, Radar	6 x 6	Daily	Instant	Yes	No	Many targets require better than 1 meter
Planning	3m	Visible, Near Infrared, Medium Infrared	6 x 6	Weekly	2 days	Yes	No	Interferometry is important
Treaty Verification	1m - 3m	Panchromatic, Near Infrared, Medium Infrared	6 x 6	Daily	Instant	Yes	No	
Drug Enforcement	5m	Visible, Near Infrared, Medium Infrared	10 x10	Quarterly	<7 days	Yes	No	Focuses on growing regions (e.g., Columbia)

λ Historically, Surveillance and Verification requirements have driven satellite reconnaissance system designs

→ Need for high resolution, multispectral coverage, and rapid revisit rate have led to definition of highly capable, high-cost platform designs

NRO IMINT Systems: 'Eyes in the Sky'



	SYSTEM	Contractor	1st Launch Last Launch	Launch Vehicle	Image Resolution	Orbital Parameters		Total Mass (Wet)
						Altitude	Inclination	
Traditional Large Platforms	KH-11 Kennan/Crystal	TRW Lockheed Kodak	12/76 11/88	TITAN 34D	~14-10 cm Visible & IR	300 x 1000 km	98°	28,000 lbs.
	ADV. KH-11/12? (Improved Crystal)	TRW Lockheed Kodak	2/90 12/96	TITAN 4	<10 cm Visible & IR	800 km?	65-97°	36,000 lbs.
	Lacross	Lockheed Martin	12/88 10/97	STS TITAN 4	<1 meter radar	680 km	57-68 °	32,000 lbs.
	AFP-731 (Stealth, Adv. KH-11)	Lockheed Martin	2/90 12/95	STS TITAN 4	? Visible & IR	300 x 1000 km	65-98°	30-40,000 lbs.?
	8X/KH-13? (Stealth, Adv. KH-12)	Lockheed Martin	In Development	TITAN 4? Atlas IIAS? EELV?	? Visible & Radar	HEO/MEO ?	Molniya?	40-44,000 lbs.?
New Smallsat Concepts	Warfighter (OrbView-4)	OSC	1/01	Taurus	1 m Pan 4 m Multi, & 8 m Hyper	470 km	97.3° SSO	790 lbs.
	Discoverer II (STARLIGHT)	Study Phase	12/03 12/08	EELV	~1 meter SAR	770 km	53 °, 24 S/C constellation	2200-3300 lbs.

NRO systems have been very large, high resolution, expensive visible/IR and radar platforms

- Assumed that two each of the Lacross and KH-12 are in orbit
- May be as many as four 'stealthy' Advanced KH-11 spacecraft as well

New systems in development include both traditional large imaging spacecraft (KH-13 visible and radar), and new smallsat concepts

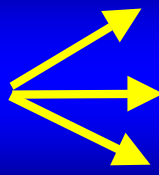
- Smallsats being jointly developed with other agencies and industry

Source: FAS and NRO

NRO: *Future*

ATTRIBUTE	PAST	PRESENT	21ST CENTURY
<i>Mission</i>	Provide Area Reconnaissance	Worldwide Intelligence	Information Superiority
<i>Systems</i>	Individual	Integrated	Fully Integrated
<i>Resources</i>	As Required	Budget Limitations	Increasing Budget Limitations
<i>Management</i>	Single Purpose	Integrated	Cost Effective
<i>Oversight</i>	Limited	Expanding	Joint SECDEF/DCI
<i>Acquisition</i>	Streamlined	Becoming Burdened	Best Practices
<i>Security</i>	Highly Compartmented	Greater Openness	Streamlined System
<i>Organization</i>	Air Force, CIA, Navy, Program Stovepipes	SIGINT, IMINT, Ocean Reconnaissance	Matched to Customers
<i>Requirements</i>	National Focus	Operational Focus	Near Continuous, Global Collection
<i>Customers</i>	Limited Set	Expanding Set	Continued Growth

Source: NRO

NRO must become  ***More cost effective***
More integrated
More commercially focused

NRO: *Future*

NRO will have an increased military role...

Greater reliance on satellite imagery for

Global Threat Awareness

Coordination of Military Activities

Precision Use of Smart Weapons

λ **Migration of Intelligence, Surveillance, and Recon (ISR) from terrestrial to space systems to allow:**

- **Delivery of firepower globally, day or night, all weather**
- **Global detection, tracking and targeting**
- **Forwarding of information to necessary units at any time**

λ **Improved space systems will allow U.S. to play a nonintrusive role globally with ability to target and direct concentrated power with minimal collateral damage**

NRO: *Future*

Preparing for continued U.S. space dominance...

- λ NRO will begin preparing for loss of U.S. space monopoly in 21st century
 - Strengthening of R&D to maintain distinct technological advantage
 - Strengthening partnerships with NASA and Air Force
 - 🍏 Warfighter with NASA
 - 🍏 Discover II with DARPA
 - Leveraging advances in the commercial space industry to lower costs and improve the capabilities of satellite systems
 - 🍏 Smallsat concepts
 - Conducting research on defense of space assets



NRO: *Future*

Researching to maintain absolute advantages...

λ Shift from evolutionary to revolutionary R&D efforts



λ In search of quantum leaps in ability

- To collect information on weapons proliferation
- Support military operations
- Counter foreign denial and deception efforts

λ NRO aiming to allocate 10% of its budget to R&D

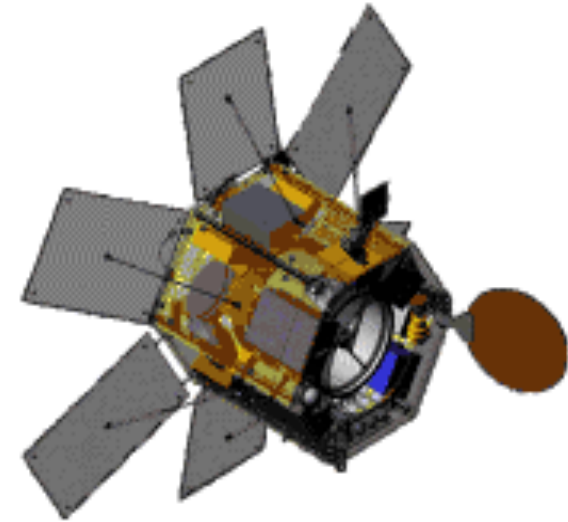
λ Improved coordination of R&D efforts with Air Force and NASA to avoid duplication and maximize use of funds

NRO: *Future*

Space partnerships...

λ In August 1998 efforts began to develop, coordinate, and integrate the DoD and Intelligence Community space architecture.

- Air Force-NRO Integration Planning Group founded to seek collaborative ventures, reduce costs, and improve support to the military
- Japanese plans to work closely with the U.S. Department of Transportation and DoD in promotion of Global Positioning System (GPS)



- Joint DoD and National Oceanographic and Atmospheric Administration (NOAA) effort in satellite meteorology systems (NPOESS)
 - 🍏 Will save U.S. \$1.3 billion and improve efficiency
 - 🍏 Will include European partner

NRO: *Future*

Leveraging Commercial Space...

- λ **NRO and DoD endorse the expansion of commercial satellites**
 - Opportunity for low-cost, mobile communications worldwide
 - Creation of a global information infrastructure
 - 1,800 commercial communications satellites in orbit by year 2000
 - Commercial remote sensing will improve to 1-5 meter standard
- λ **Closer collaboration between public and private space sector**
 - Will provide benefits to both sectors and the military
- λ **More sharing of technology between DoD, Intelligence and industry**
- λ **Commercial launch and satellite buses**
 - NRO is already using a commercial bus for some satellite systems

Eventual goal is to move production of satellites from a craft industry to a manufacturing industry that can deploy national security space systems better, faster, and cheaper



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Commercial Imagery Overview



**4-Meter
Resolution**



**1-Meter
Resolution**

- λ **1994 Presidential Decision Directive 23 allows 1-meter visible imagery**
 - ↳ Hyperspectral data subject to restrictions
- λ **Estimate of Earth observation industry revenues run from \$2 billion to \$20 billion within the near future**
 - ↳ Growing at 15-20% annually, with potential for further growth
 - ↳ Markets include agriculture, natural resource management, local and regional government, transportation, emergency response mapping, military and other commercial applications
- λ **Market applications for low-resolution imagery still exist**
 - ↳ Oceanographic and atmospheric research
- λ ***Resolution and technology improving to match secure systems***

Commercial Imagery

***As many as 31 Land Observation Satellites
Planned to be in Operation by the Year 2000...***

λ 13 Medium Resolution (5-30 m)

- 2 - U.S. Government, 1 with Japan
- 1 - France
- 4 - India
- 2 - China and Brazil
- 4 - U.S. commercial

λ 12 High Resolution (1-5 m)

- 8 color imagery satellites from 4 U.S. companies
- 4 Panchromatic only
 - 🍏 2 - U.S./Israel company
 - 🍏 1 - India
 - 🍏 1 - Russia

λ 4 Hyperspectral

- 3 - U.S. Government
- 1 - Australia

λ 3 Radar

- 1 - European Space Agency (ESA)
- 1 - Canada
- 1 - Japan

λ *As many as 14 will be privately funded by U.S. companies*



Commercial Imagery: Current Visible Imagery Suppliers

SYSTEM	Country	Spatial Resolution	Primary Market	Orbit	Data Format	Image Availability
Spot Image (1-3)	France	10 m	Military GIS	820 km 98.7 °	Digital	Assigned & Archived
KFA 1000	Russia	5 m	Novelty	275 km 82.5 °	Analog	Archived
KFA 3000	Russia	2 m	Novelty	275 km 82.5 °	Analog	Archived
KVR 1000	Russia	2 m *	Novelty	~220 km 65 ° - 70 °	Analog	Archived
Landsat 4-5	USA	30 m	GIS Agriculture	705 km 98.2 °	Digital	Assigned & Archived
OrbView 2	USA	1.1 km	Environmental Science	~705 km 98.2 °	Digital	Assigned & Archived

**GIS =
Geographic
Information
Systems**

* KVR 1000 images are degraded from 75 cm to 2 meters for commercial sale.

Limitations of Current Systems

Russian systems provide archived data only

- Ordering procedures cumbersome
- Reliability is poor
- Availability of images not known in advance and often subject to fickle and incomprehensible regulations

Targetable systems are not high resolution

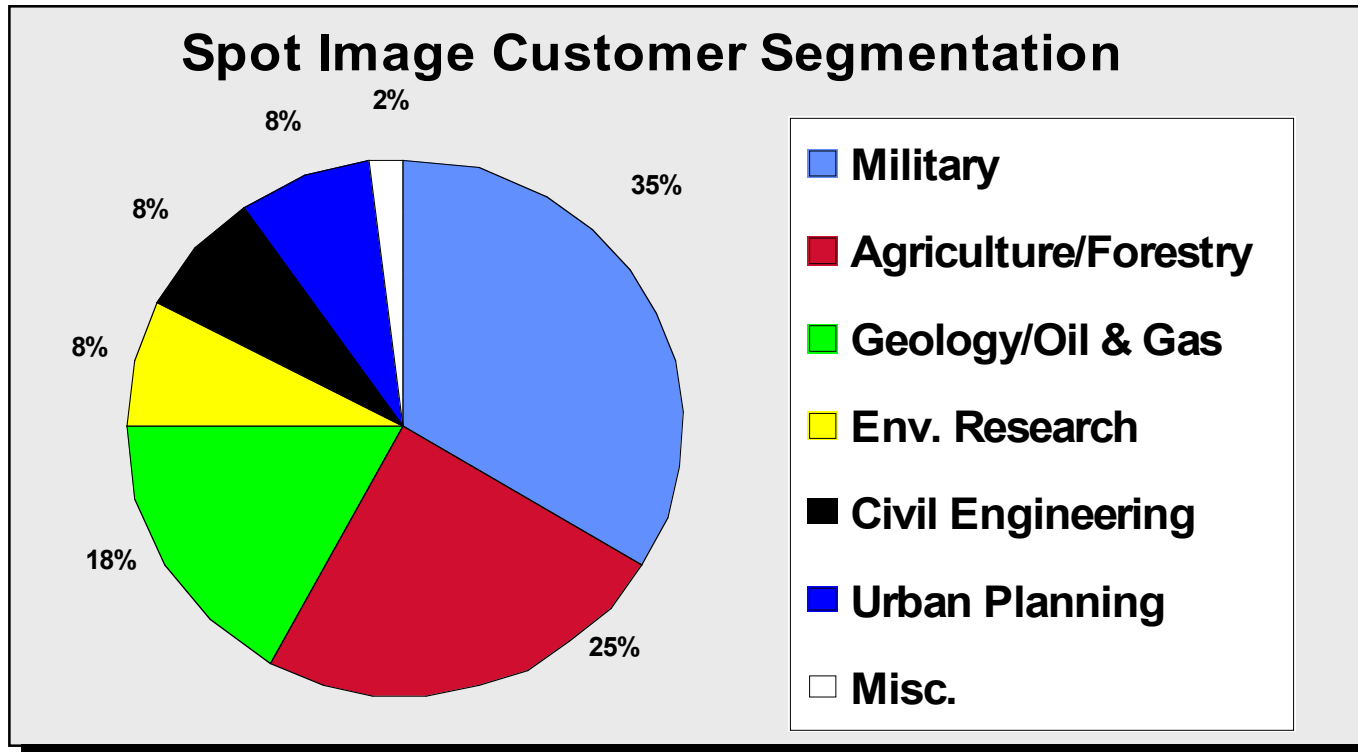
- Military is largest customer segment and requires high resolution, yet no current system truly addresses its needs
- New high resolution systems targeted largely at military market

Cloud cover is a serious problem

- Spot Image estimates that at least 75 percent of images returned are obscured by clouds
- Current and planned radar systems will address the problem



Commercial Imagery: Current Remote Sensing Customers



Customer mix reflects low resolution of SPOT and other current systems

- Agriculture and environmental applications require lower resolutions

Introduction of new higher resolution systems will drive demand in market segments that demand high resolution, especially military, civil engineering and urban planning customers

Space-Based Radar Systems

λ JERS

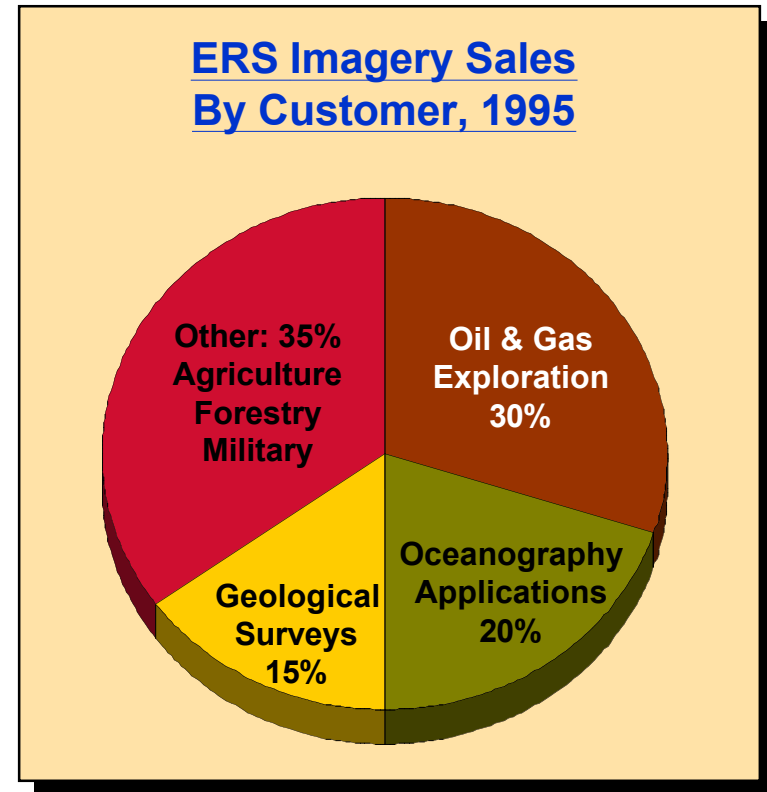
- Launched February 1992 to 568 km, 97.7 °
- Imagery is configured for Japanese consumers, not user-friendly to Western data purchasers
- Also only 18 meter resolution and 44-day revisit cycle

λ ERS-1, ERS-2

- Launched July 1991 and April 1995 to 780 km, 98.5 °
- Configured for ocean and coastal observations, ERS-1 and ERS-2 are not optimized for commercial use
- Disappointing commercial data sales

λ RADARSAT

- Launched November 1995 to 792 km, 98.6 °
- Concerted effort to commercialize (after the fact)
 - 🍏 Distributors in U.S., Japan and Europe
- U.S. National Imagery and Mapping Agency (NIMA) is most promising customer
 - 🍏 Estimate potential contract at \$30 million to \$50 million over five years





Commercial Imagery: New High Resolution Systems

SYSTEM	Primary Market	Launch Date	Launch Vehicle	Image Resolution	Orbital Parameters		
					Altitude	Inclination	Revisit Frequency
Space Imaging	Military	1999	LLV-2	1 meter	680 km	98.2° SSO	1.5-4 days
EarthWatch	Military GIS Agriculture	1999	Cosmos	1 meter PAN, 4 meter Multi	600 km	52°-54° SSO	2-3 days (EB) <5 days (QB)
OrbView 3	Military GIS	Summer 1999	Pegasus XL	1 meter	470 km	97.25° SSO	2-3 days
OrbView 4	Agriculture, Forestry, Military	2000	Pegasus- class	1 m, 4 m, & 8 m hyper	470 km	97.3° SSO	<3 days
RDL - Radar 1	Military	2001	N/F	1 meter SAR	N/F	N/F	1 day
Spot 5	Military Agriculture	2002	Ariane 5	5 meters	820 km	98.7° SSO	4 days

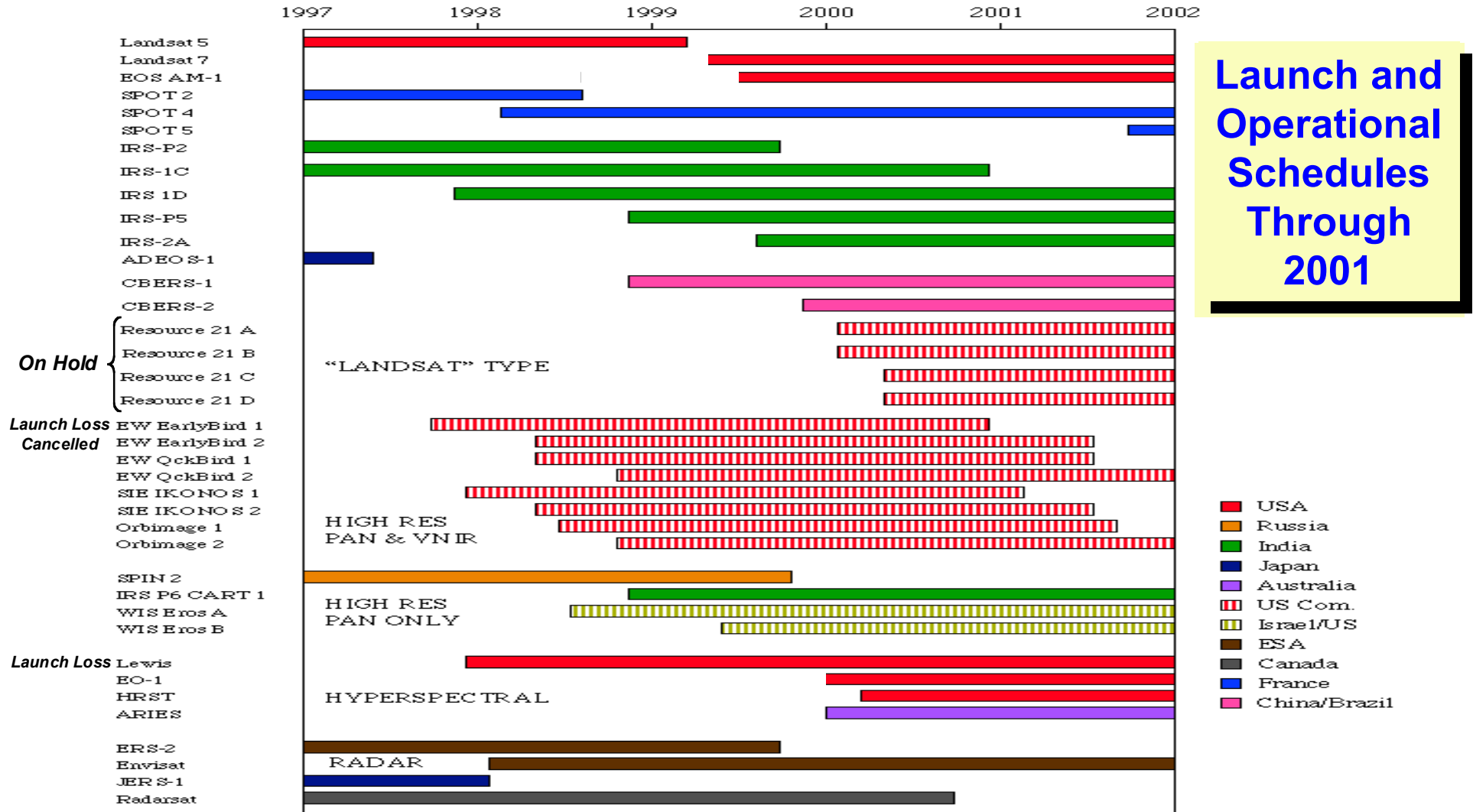
Space Imaging, EarthWatch and OrbImage racing for first launch of 1-meter resolution satellite

→ Space Imaging to launch soon

RDL preparing to have first 1-meter resolution radar system if DoD policy permits (currently limited to 5-meter for non-U.S. Govt. sales)



Commercial Imagery Systems



Source: NRO



Commercial Imagery: Prioritizing Needs by Market Segment

Service Elements	Military	Agriculture	Environmental Monitoring	Topo-Mapping	Mineral/Oil Exploration	Forestry Management	Water Management	Total Market Rank
Spatial Resolution	1	3	2	1	1	1	2	1
Spectral Resolution	6	1	1	3	2	2	1	2
Frequency of Acquisition	2	2	3	5	5	3	3	3
Image Size	3	4	4	2	3	4	4	4
Delivery	4	6	5	7	6	6	5	5
Confidentiality	5	5	7	6	4	7	7	6
Copyright Restriction	7	7	6	4	7	5	6	7

- λ Remote sensing user market analysis conducted by the National Remote Sensing Center in the UK indicated the prioritization of very high resolution (VHR 1-5m) product and service features
 - Entries are ranked from most (1) to least (7) important
- λ As expected, spatial and spectral resolution rank highest in demand, with repeat rate also of significant importance
 - Has driven definition of new systems, with priority on military demand as first major customer



Military Customer: *Surveillance Resolution Requirements*

λ A significant portion of military customer requirements can now be met with planned commercial high-resolution visible and radar systems

- Planned 1-5 meter systems can provide useful surveillance support to dedicated NRO systems
- Current and planned 5-10 meter systems can support mapping and planning functions
- Intent is to design a future systems architecture which takes maximum advantage of commercial capabilities

Object	Resolution Needed to Recognize (meters)	Resolution Needed to Identify Specifics (meters)
Military Airfields	9	4.5
Railroad Yards	15	6
Air Base Equipment	4.5	3
Land Mine Fields	6	0.9
Surfaced Submarines	6	1.5
Fishing Boats	4.5	1.5
Bridges	4.5	0.9
Aircraft	1.5	0.9
Radar	0.9	0.3
Antiaircraft Sites	1.5	0.6
Trucks	1.5	0.6
Tents	1	0.3



Appendix:

Profiles of Commercial Providers

Commercial Imagery: *RDL Space Corp.*



- λ A subsidiary of Research & Development Laboratories (RDL)
- λ Received first U.S. license to build and operate 1-meter resolution commercial radar (SAR) imaging satellite
- λ 100 Employees

- λ **Primary Market: Military Intelligence**
 - ↳ Designed entirely for commercial operation

- λ **RADAR-1 satellite:**
 - ↳ 1-meter resolution commercial SAR
 - ↳ Launch 2001?
 - ↳ LEO polar, revisit 1+ times per day; anywhere on earth, day or night, any weather, all cloud and smoke cover



Commercial Imagery: *EarthWatch*

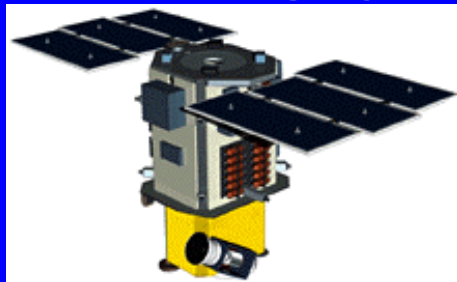


λ Markets:

- Land development, environmental monitoring and land management, oil and gas exploration, transportation, agribusiness, and other industries.
- One-stop shopping approach

λ Quickbird satellite provides 1-meter panchromatic and 4-meter multi-spectral imagery

- Scheduled for 2000 launch
- Digital Globe Database



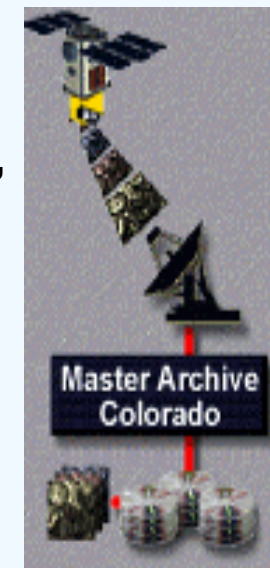
- λ EarthWatch is a joint venture of Ball Aerospace & Technologies Corporation and WorldView Imaging Corporation
 - Provides remote sensing satellites with high-resolutions previously available to only U.S. and Russian military and intelligence agencies.
 - 130 Employees

- λ MacDonald Dettwiler provides ground segment systems

- λ EarthWatch provides customers with new and unique digital imagery products of a resolution, quality, and clarity formerly available only to military and intelligence agencies.

- λ Developing capabilities in downlinking and storing data

- λ Lost EarlyBird last year



Commercial Imagery: *RADARSAT*

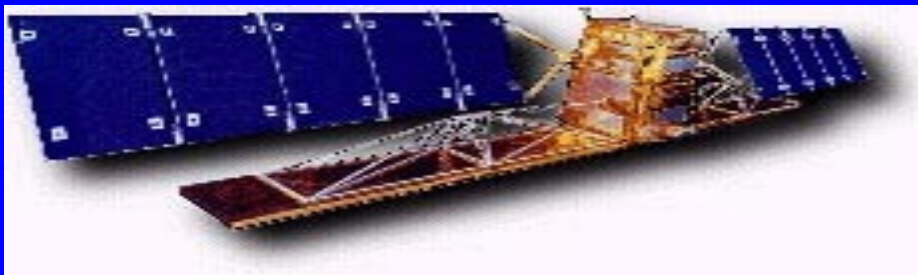


λ Markets:

- Resource management and environmental monitoring.
- All weather radar allows cloud free, timely data

λ RADARSAT is an advanced synthetic aperture radar (SAR) satellite with 10-100 meter resolution

λ RADARSAT 2 & 3 planned in future at 3-30 meter resolution



λ RADARSAT International (RSI) is the remote sensing data distributor for the RADARSAT satellite

λ Developed world's first radar remote sensing satellite solely for operational applications.

→ RADARSAT satellite owned and operated by Canadian Space Agency (CSA).

→ Owned by a consortium of four companies - MacDonald Dettwiler, SPAR Aerospace Limited, COMDEV, and Lockheed Martin.

λ Price for full scene image:

RADARSAT Standard	\$3,000
ERS	\$1,600
JERS	\$1,400
Spot Panchromatic	\$2,000
Landsat Thematic Mapper	\$3,700

Commercial Imagery: *ORBIMAGE*



λ ORBIMAGE is a subsidiary of Orbital Sciences

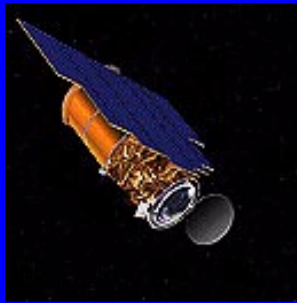
- Integrated global system of imaging satellites, ground stations and Internet-based sales channels to collect, process and distribute imagery products at low cost.
- Pre-launch contracts of \$125 million
- 80 Employees

λ Markets

- Commercial Markets - Fishing, farming, urban planning.
- Science and Research - Weather, environmental monitoring.
- U.S. National Security - High-resolution images as a supplement to current government capabilities.
- Allied Foreign Governments - Affordable high-resolution imagery to enhance their national security through border monitoring and other applications.

λ OrbView-3 satellite offers 1-meter panchromatic and 4-meter multispectral digital imagery

- Scheduled to launch this year



λ OrbView-4 satellite will offer 1-meter panchromatic, 4-meter multispectral and hyperspectral digital imagery

- Scheduled launch January 2001



Commercial Imagery: *Space Imaging*



λ Markets:

- Utilities
- **Governments**
- Natural Resources
- Mapping

λ Space Imaging EOSAT is the world's largest provider of Earth information products and services

- Chartered by Lockheed Martin and E.Systems (Raytheon)
- 200 Employees
- Sells 5 meter resolution space imagery and aerial-based one-meter resolution digital imagery from its proprietary systems
- Markets satellite imagery returned by LANDSAT 4/5, Spot, RADARSAT, and Indian IRS satellites

λ CARTERRA image dissemination system for widespread commercial use

λ Indian Remote Sensing (IRS)

- 5.8-meter resolution in C model (1995)
- 5-satellite constellation will grow to 7 by 2004

λ Landsat 4/5

- Launched in 1984
- Worldwide coverage
- 30-meter spatial resolution

λ IKONOS 1 satellite

- Will have 1-meter resolution black & white and 4-meter multispectral resolution

Commercial Imagery: *SPOT Image*



λ Markets:

- Agriculture, mapping, environment, urban planning, telecommunications, **surveillance**, natural resources, gas, oil & water management, geology, civil engineering

λ SPOT Image (France) is a leading supplier of geographic information from optical and radar earth observation satellites

- Markets satellite imagery returned by Spot, RADARSAT, and ERS satellites
- User services include: Spot image data bank, data acquisition programs, technical assistance and consultancy.
- Range of products includes geocoded and orthorectified images, DEM, and ad-hoc services.

λ SPOT is a series of satellites sponsored by the French government and managed by the French Space Agency (CNES)

- First launched in 1986
- Offers commercial multispectral imaging
- 3-D perspective
- 10 meter panchromatic resolution