
Welcome!

Overview

- Introductions
- Schedule
- Background
- Objectives
- Approach
- Industry Segment
- Action!

Introductions

- Name
- Career Background (School/Company)
- Interests/Goals
- Experience with commercial space

Overview

- Introductions
- **Schedule**
- Background
- Objectives
- Approach
- Industry Segment
- Action!

Schedule

DRAFT SCHEDULE FOR THE THIRD EMERGING SPACE INDUSTRY LEADERS WORKSHOP - ESIL-03

Tuesday, November 6, 2012			Wednesday, November 7, 2012			Thursday, November 8, 2012		
9:00		9:00	Welcoming Addresses <i>Various Folks</i>	9:00	Working Group Session #3	9:00		9:00
9:30		9:30	Overview of FAA AST & COE CST <i>Ken Davidian, AST</i>	9:30				9:30
10:00		10:00	Commercial Space Industry Introduction <i>Brad Cheetham, CU & COE CST</i>	10:00				10:00
10:30		10:30	Break	10:30	Break			10:30
11:00		11:00	Strategic Planning Introduction <i>Ken</i>	11:00	Final Presentations Discussion (60 min)			11:00
11:30		11:30	Game Theory - PARTS Introduction <i>Ken</i>	11:30				11:30
12:00		12:00	Task Description <i>Brad and Ken</i>	12:00	Closing Remarks <i>Ken & Brad</i>			12:00
12:30		12:30	Lunch	12:30				12:30
13:00		13:00	Working Group Session #1	13:00				13:00
13:30		13:30		13:30				13:30
14:00		14:00		14:00				14:00
14:30		14:30	Break	14:30				14:30
15:00		15:00	Working Group Session #2	15:00				15:00
15:30		15:30		15:30				15:30
16:00		16:00		16:00				16:00
16:30		16:30	Break	16:30				16:30
17:00		17:00	Working Dinner	17:00				17:00
17:30		17:30		17:30				17:30
18:00		18:00		18:00				18:00
18:30		18:30		18:30				18:30
19:00		19:00		19:00				19:00
19:30		19:30		19:30				19:30
20:00	Welcome Reception	20:00		20:00				20:00
20:30		20:30		20:30				20:30

Schedule: Objectives

- Inform – perspective, background, context
- Perform – group analysis
 - Game Theory Value Net
 - Commercial human training/preparation segment
- Network – internal and external to industry

Overview

- Introductions
- Schedule
- **Background**
- Objectives
- Approach
- Industry Segment
- Action!

Background: ESIL

- Emerging Space Industry Leaders Workshop
- Supported by a Grant from FAA-AST through FAA Center of Excellence for Commercial Space Transportation to CU Boulder
- Objectives
 - Inform – perspective, background, context
 - Perform – group analysis on identified market
 - Network – internal and external to industry

Background: ESIL-01



Background: ESIL-02



Background: ESIL-03

Background: ESIL-04+

- Looking for hosts and managing volunteers
- Next Generation Suborbital Researchers Conference #4 in Colorado (6/2013)
- West Coast?
- Financial Sector?
- Other?

Background: FAA AST

- Presentation by Ken Davidian
- Director of Research, FAA Office of Commercial Space Transportation

Background: Commercial Space

- Presentation from Brad Cheetham
- Overview what is commercial space

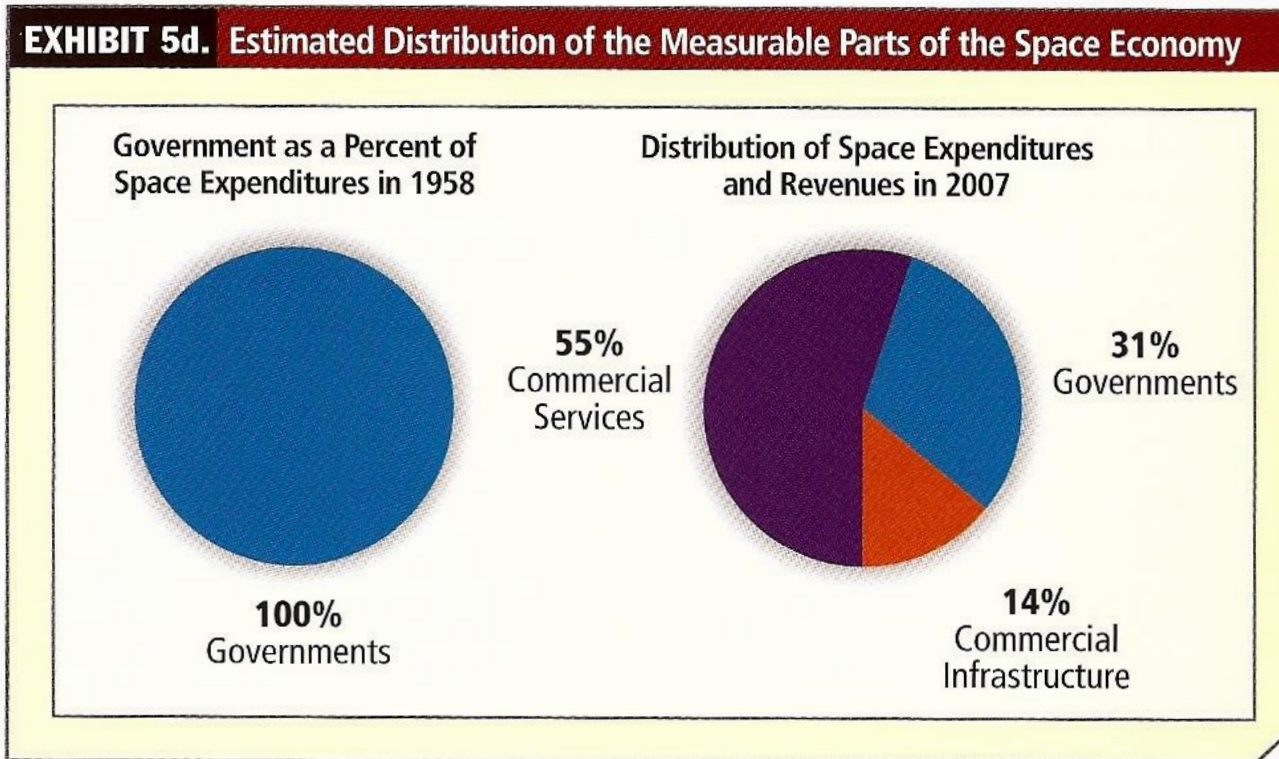
Commercial Space: Defined

Defined by U.S. National Space Policy:

“refers to space goods, services, or activities provided by private sector enterprises that bear a reasonable portion of the investment risk and responsibility for the activity, operate in accordance with typical market-based incentives for controlling cost and optimizing return on investment, and have the legal capacity to offer these goods or services to existing or potential nongovernmental customers.”

National Space Policy of the United
States of America, June 28, 2010

Commercial Space: In Context



Commercial Space

- Scope
- Industry/Sector Development History
- Major Players
- Demand/Customers/Applications

Commercial Scope

- **Communications = established**
- Navigation = established
- Remote Sensing = established
- Launch = established
- Manufacturing = established
- Suborbital = emerging
- Cargo = emerging
- Crew = emerging
- Interplanetary = emerging

COMSATS



Communications: Context

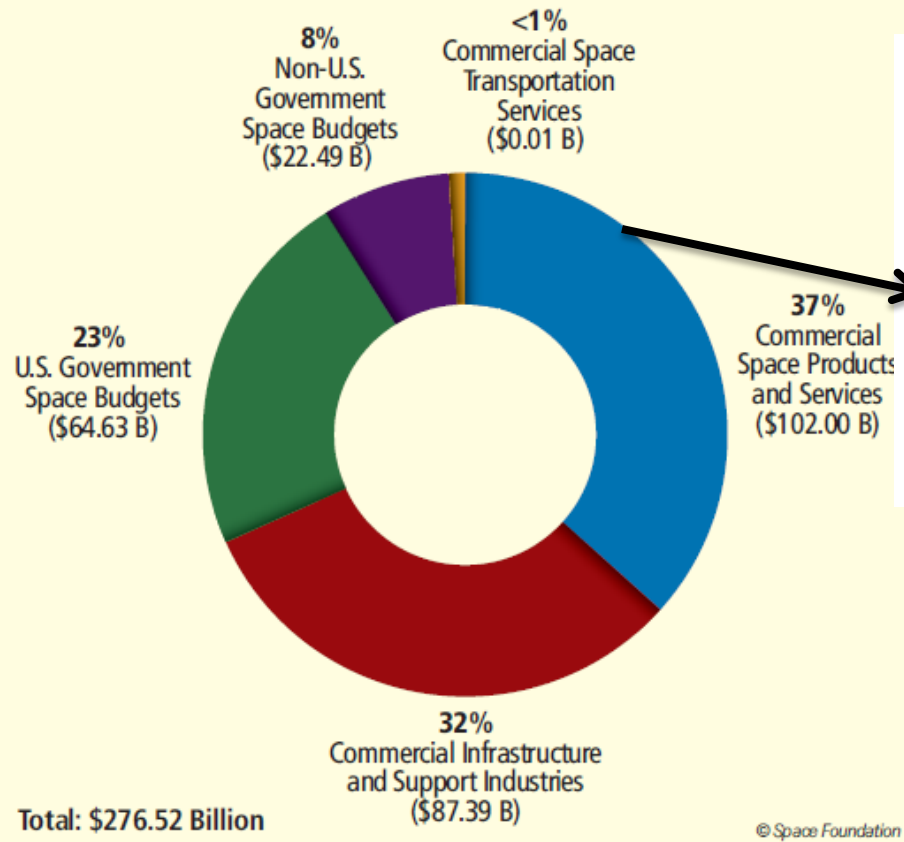


EXHIBIT 2h. Revenues for Commercial Space Products and Services, 2010

Category	Revenue	Source
Direct-to-Home Television	\$79.22 B	SIA/Futron analysis
Satellite Communications	\$17.92 B	SIA/Futron analysis
Satellite Radio	\$2.84 B	SIA/Futron analysis
Earth Observation	\$2.01 B	Northern Sky Research
Total	\$102.00 B	

Company	2008	2009	2010*
DIRECTV	\$17.45 B	\$18.67 B	\$20.94 B
DISH Network	\$11.62 B	\$11.66 B	\$12.64 B
Total	\$29.07 B	\$30.33 B	\$33.59 B

*Estimated annual revenue

Source: The Space Report 2011

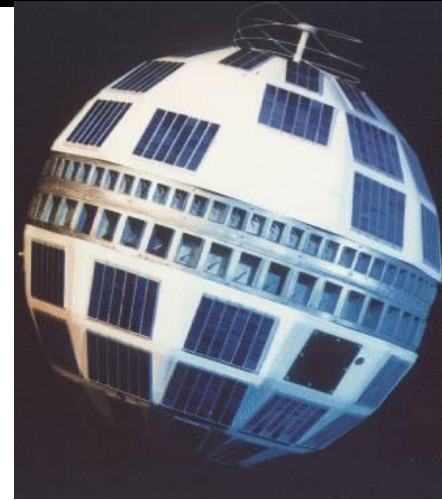
Communications: History



- 1945 – Arthur C. Clarke writes “*Extra-Terrestrial Relays, Can Rocket Stations Give Worldwide Radio Coverage?*” in *Wireless World*
- 1954 – writes Chief of US Weather Bureau regarding satellite applications for weather forecasting
- 1964 – contributes to “2001 a space odyssey” with Stanley Kubrick

Content thanks to Clay Mowry

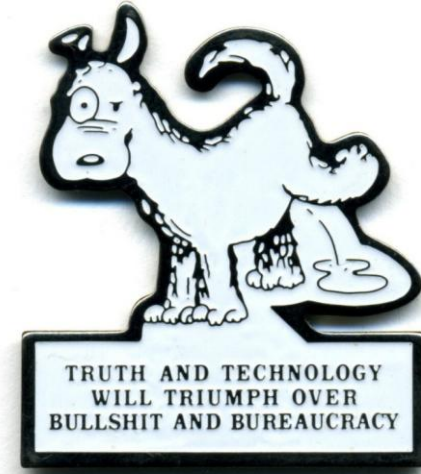
Communications: History



- John R. Pierce – Chief Engineer at AT&T Bell Labs
 - Developed and named 1st transistor
 - Collaborated with Rudolf Kompfner to develop first traveling wave tube amplifier (TWTA) that enables satellite communications
 - Developed Telstar – 1st communications satellite
 - Launched by NASA on July 10th, 1962 for \$3 million

Content thanks to Clay Mowry

Communications: History



- Renee Anselmo
 - Founder/Owner of Spanish International Network (SIN)
 - Sold SIN for \$80 million and started PanAmSat in 1984
 - First privately owned commercial satellite company
 - Later sold for \$4.3 billion

Content thanks to Clay Mowry

Communications: History

Power & Mass Trends



SYNCOM 1

1963

39 kg.

2 transponders

2 Watts



WESTAR 2

1974

574 kg.

12 transponders

300 Watts



GE-1

1996

2783 kg.

48 transponders

2 kW



ECHO 14

2010

6379 kg.

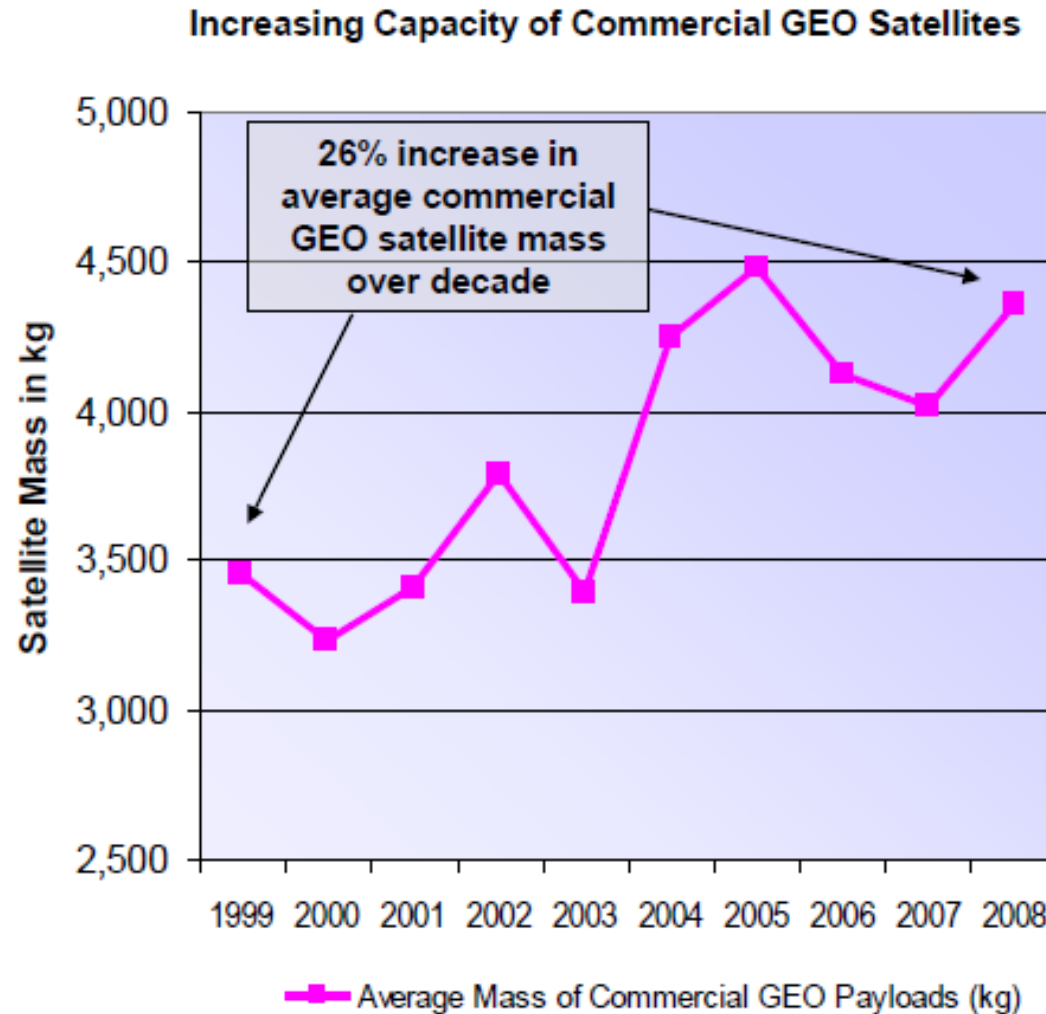
103 transponders

16 kW

+ Digital compression technology and the use of higher frequency bands allow each transponder go carry more data more efficiently

Content thanks to Clay Mowry

Communications: History



Source: The Tauri Group

Communications: Players

Operator Customers



 CNES (France)	 ARSAT (Argentina)	 Telenor (Norway)
 DGA (France)	 Satmex (Mexico)	 Shin Satellite (Thailand)
 ESA (European)	 Yahsat (UAE)	 Telecom (Taiwan)
 Eumetsat (European)	 Star One (Brazil)	 SingTel Optus (Singapore)
 DIRECTV (USA)	 Telesat (Canada)	 Arabsat (Arab League)
 Eutelsat (France)	 ViaSat (USA)	 IAI (Israel)
 Echostar/Dish (USA)	 Binariang (Malaysia)	 Nilesat (Egypt)
 Hisdesat (Spain)	 BSAT (Japan)	 Avanti (UK)
 Hispasat (Spain)	 Indostar (Indonesia)	 Inmarsat (UK)
 Italian MoD (Italy)	 ISRO (India)	 Intelsat (USA/Luxembourg)
 Hughes (USA)	 JAXA (Japan)	 AsiaSat (Hong Kong)
 SES (Luxembourg)	 SkyPerfect JSAT (Japan)	 Thaicom
 Paradim (UK)	 Kari (Korea)	 Globalstar (USA)
 Turksat (Turkey)	 Korea Telecom (Korea)	 Xtar (USA)
 Vinasat (Vietnam)	 PT Telkom (Indonesia)	 ABS (Hong Kong)

Source: Clay Mowry

Communications: Players

Rank	Company	Country of Origin	2009 Revenue (\$ in millions)	FSS Satellites in Orbit
1	Intelsat	Luxembourg	\$2,500	50
2	SES	Luxembourg	\$2,440	44
3	Eutelsat	France	\$1,410	26
4	Telesat	Canada	\$750	12
5	Sky Perfect JSAT	Japan	\$363	13
6	SingTel Optus	Singapore/Australia	\$237	5
7	Hispasat	Spain	\$216	4
8	Russian Satellite Communications Company	Russia	\$200	11
9	Star One	Brazil	\$193	7
10	Arabsat	Saudi Arabia	\$189	6
11	Telenor Satellite Broadcasting	Norway	\$177	3
12	AsiaSat	Hong Kong	\$150	4
13	Indian Space Research Organisation/Antrix	India	\$141	10
14	Nilesat	Egypt	\$119	4
15	Thaicom	Thailand	\$105	3
16	Satmex	Mexico	\$102	3
17	KT	South Korea	\$92	1
18	APT Satellite Holdings	Hong Kong	\$75	3
19	Gazprom Space Systems	Russia	\$72	2
20	AMOS-Spacecom	Israel	\$70	3
21	Broadcasting Satellite System	Japan	\$68	4
22	MEASAT Satellite Systems	Malaysia	\$68	4
23	EchoStar	United States	\$53	1
24	TELKOM	Indonesia	\$51	2
25	Indosat	Indonesia	\$12	1

Sources: Space News, Union of Concerned Scientists database

Source: The Space Report 2011

Communications: Players

Operator	Orbit	Coverage	Number of Operational Satellites	Current System	Planned Development
Iridium	LEO	Global	66	Inter-satellite links providing full global coverage from pole to pole	Thales Alenia Space to build Iridium NEXT satellites, expected to launch starting in 2015
Globalstar	LEO	Near-global	40	Voice service limited due to severe satellite anomalies	First six replacement satellites launched in 2010, 18 more to follow in 2011
ORBCOMM	LEO	Near-global	29	Provides global data services similar to two-way paging or email, targeting data applications and machine-to-machine communications	18 ORBCOMM Generation 2 satellites, constructed by Sierra Nevada, scheduled for launch starting in 2011
Inmarsat	GEO	Near-global	11	Provides voice and broadband data, including video	Announced contract with Boeing for three Inmarsat-5 Ka-band satellites planned for launch between 2013 and 2015
LightSquared	GEO	North America, Northern portion of South America	3	Provides low-rate data and voice with push-to-talk	SkyTerra-2 planned for launch in 2011
Thuraya	GEO	Asia-Pacific	2	Provides voice and broadband data with services tailored to region	No new satellite plans announced
TerreStar	GEO	North America	1	Provides voice, data, and video	Terrestar-2 under development; ATC to be added; company undergoing financial restructuring
ICO Global Communications	GEO	North America	1	Provides voice, data, and video	DBSD North America, ICO's North American subsidiary, owns the ICO G1 satellite and is currently in Chapter 11 restructuring

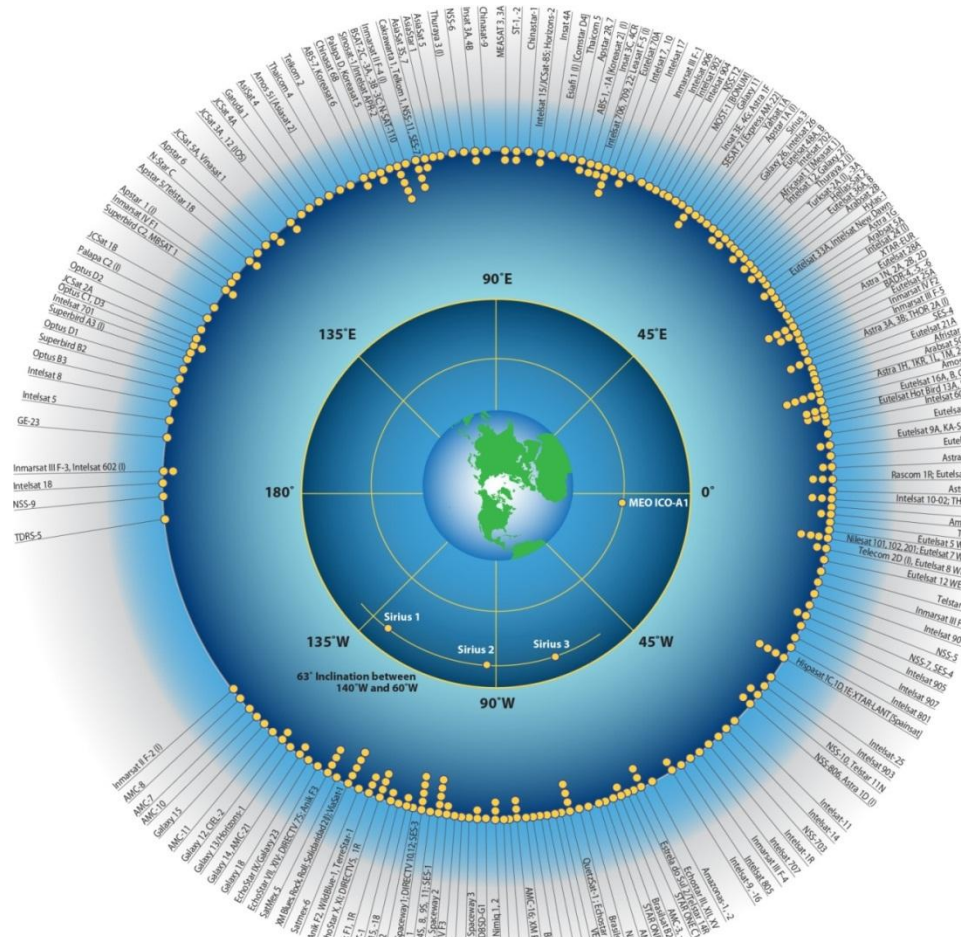
Source: Futron

Source: The Space Report 2011

Communications: Demand



Communications: Demand



Notes:
 Drifting satellites: Eutelsat 4A, LMI AP 2 (Gorizont 30)
 (i) = Inclined orbit

Commercial Scope

- Communications = established
- **Navigation = established**
- Remote Sensing = established
- Launch = established
- Manufacturing = established
- Suborbital = emerging
- Cargo = emerging
- Crew = emerging
- Interplanetary = emerging

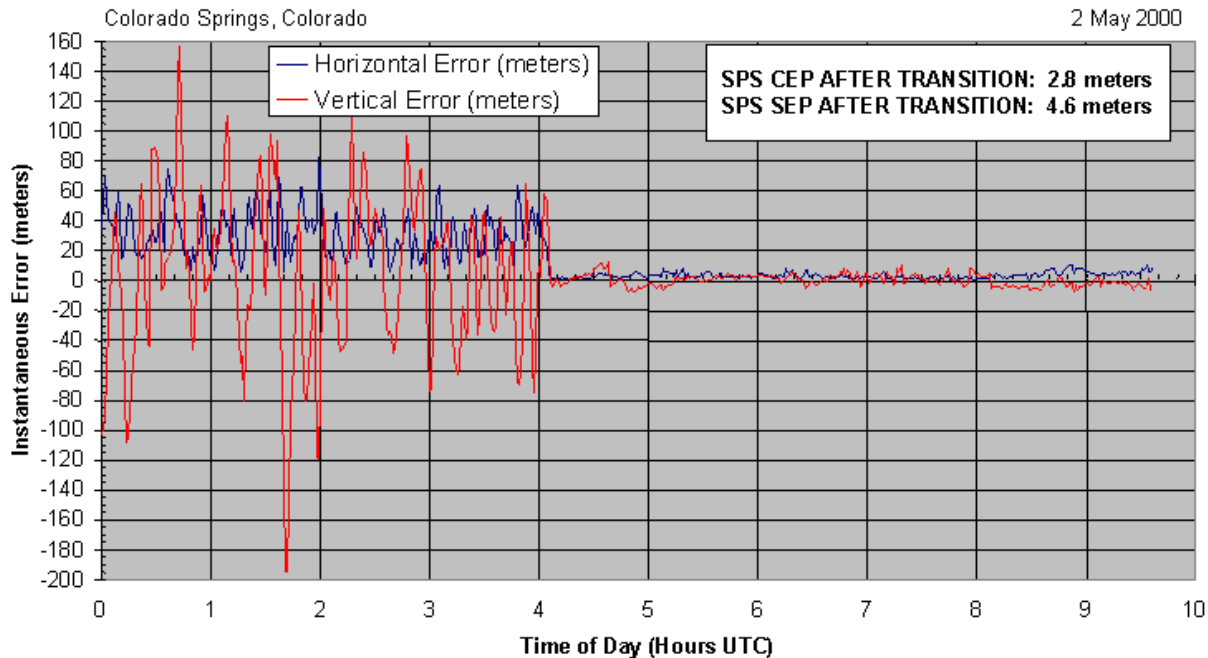
Navigation: Context

- 2010 global market revenue (est) \$71 billion
 - Source GNSS Market Report
 - European GNSS Agency (GSA) October 2010
- Enabled by end of Selective Availability
 - May 2000
- Addition of international systems

Navigation: History



SA Transition -- 2 May 2000



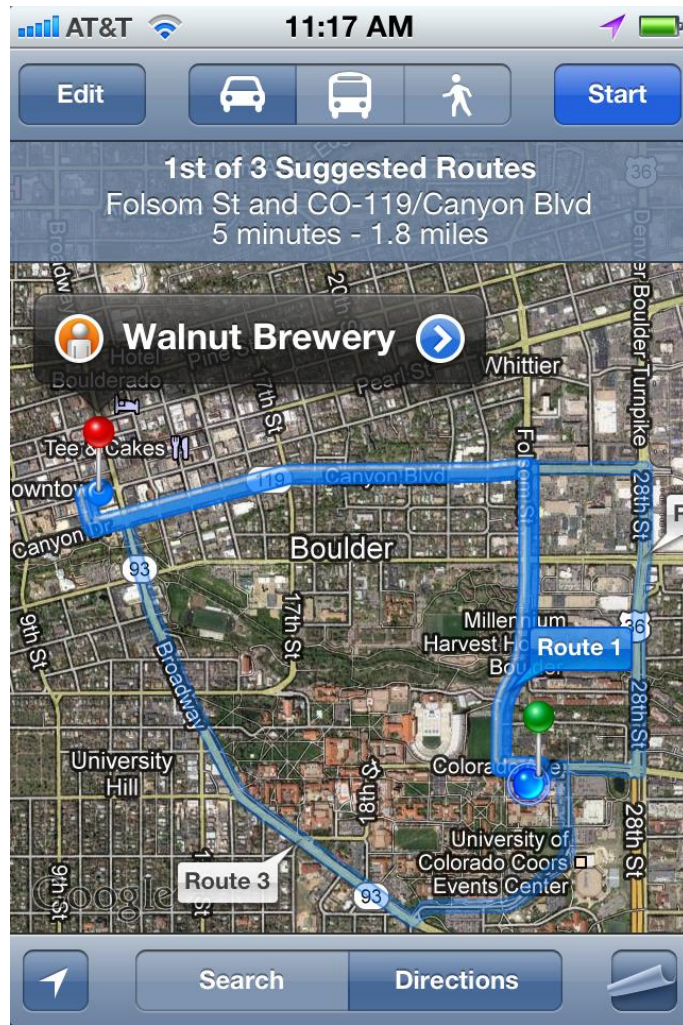
Source: <http://www.gps.gov/systems/gps/modernization/sa/>

Navigation: Players

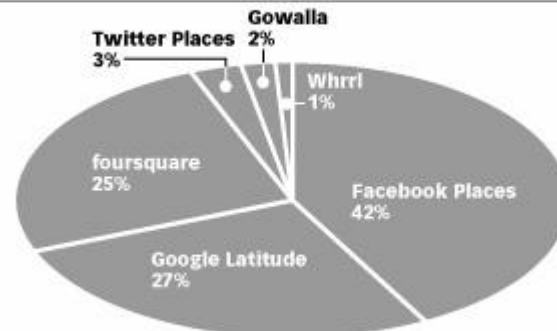
	China	Europe	India	Japan	Russia	United States
Positioning, Navigation, and Timing Systems						
System Name	Compass (Beidou)	Galileo	Indian Regional Navigation Satellite System (IRNSS)	Quasi-Zenith Satellite System (QZSS)	Global Navigation Satellite System (GLONASS)	Global Positioning System (GPS)
Minimum Constellation	30	30	7	3	21 (plus 3 in-orbit spares)	24
Current Constellation	6	2	0	1	22	30
Operational Date	2012	2014	2014	2013	1995	1995
Coverage	China by 2012; Global coverage between 2015-2020	Global	South Asia	Japan	Global	Global
Augmentation Systems						
System Name		European Geostationary Navigation Overlay Service (EGNOS)	GPS-Aided Geo Augmented Navigation (GAGAN)	MTSAT (Multi-functional Transport Satellite) Satellite-based Augmentation System (MSAS)	System of Differential Correction and Monitoring (SDCM)	Wide Area Augmentation System (WAAS)
Minimum Constellation		3	3	2	3	2
Current Constellation		3	0	2	3	2
Operational Date		2009	TBD	2006	2013	2003
Coverage		Europe	South Asia	Asia/Oceania	Near-Global	North America

Source: The Space Report 2011, Futron

Navigation: Demand



Most Frequently Used Location-Based App Among US Location-Based App Users, Feb 2011
% of respondents



Note: n=169 smartphone users ages 14+
Source: White Horse, "Lost in Geolocation: Why Consumers Haven't Bought It and How Marketers Can Fix It," April 13, 2011

127322

www.eMarketer.com

Navigation: Demand



<http://www.teejet.com/english/home/products/precision-farming-products/gps-guidance.aspx>



<http://www.farmworld.ca/precision-farming.aspx>

Commercial Scope

- Communications = established
- Navigation = established
- **Remote Sensing = established**
- Launch = established
- Manufacturing = established
- Suborbital = emerging
- Cargo = emerging
- Crew = emerging
- Interplanetary = emerging

Remote Sensing: Context

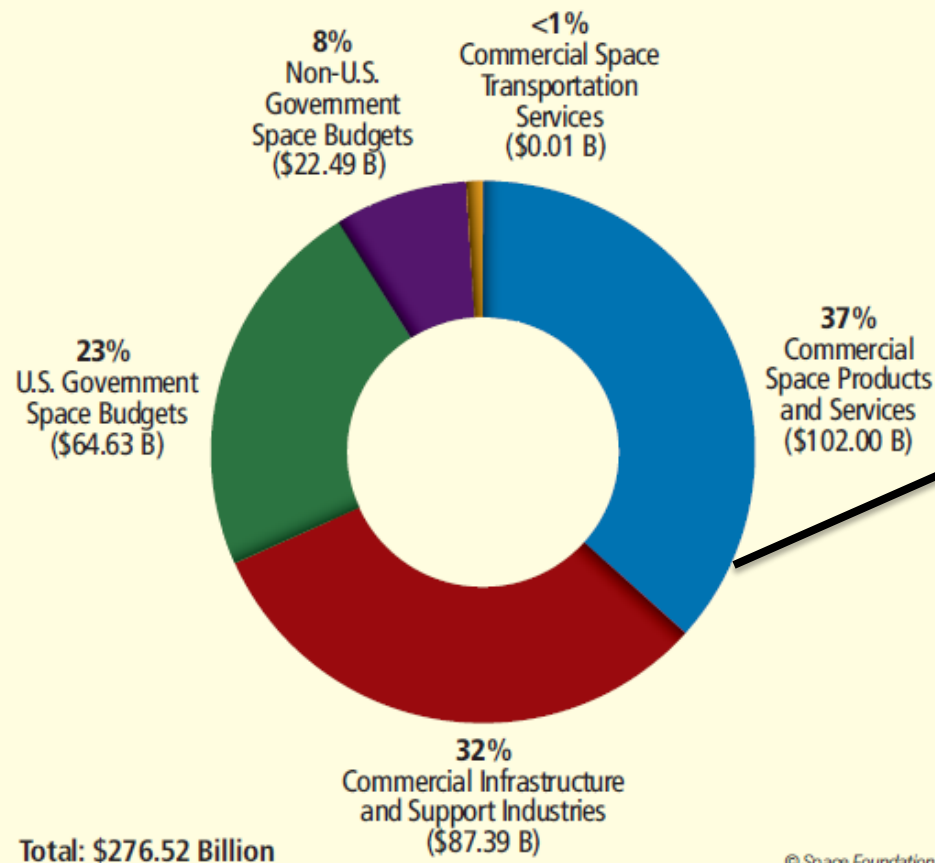


EXHIBIT 2h. Revenues for Commercial Space Products and Services, 2010

Category	Revenue	Source
Direct-to-Home Television	\$79.22 B	SIA/Futron analysis
Satellite Communications	\$17.92 B	SIA/Futron analysis
Satellite Radio	\$2.84 B	SIA/Futron analysis
Earth Observation	\$2.01 B	Northern Sky Research
Total	\$102.00 B	

Revenue Source	2009	2010	2019
Data Sales	\$0.83 B	\$0.89 B	\$1.80 B
Value-Added Services	\$1.06 B	\$1.12 B	\$2.00 B
Total	\$1.89 B	\$2.01 B	\$3.80 B

Source: Northern Sky Research

Source: The Space Report 2011

Remote Sensing: History

- August 1959 – Explorer-6: First space photograph of the Earth
- 1960 – 1997: Remote sensing data provided by civil/military satellites (i.e. Landsat)
- 1984 – Congress Authorizes NOAA to look for commercial operator of Landsats
- 1992 – US Congress permits private remote sensing systems
- 1997 – 1st Commercial Space Venture (EarlyBird -1)

<http://www.isprs.org/publications/highlights/highlights0402/fritz.html>

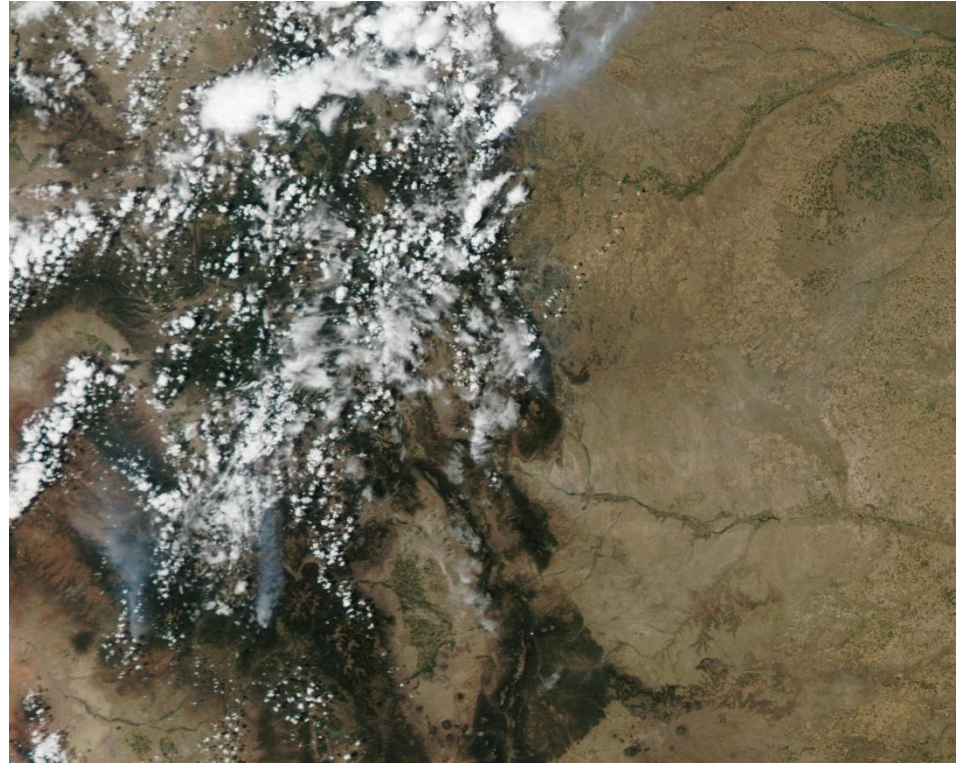
Remote Sensing: Players



Remote Sensing: Demand



Satellite imagery of Walmart parking lots and analysis provided by Remote Sensing Metrics have been used to predict company earnings, providing financial analysts with insight into customer traffic at individual stores. Credit: Remote Sensing Metrics



<http://activefiremaps.fs.fed.us>

Remote Sensing: Demand



Credit: Satellite Sentinel Project

Commercial Scope

- Communications = established
- Navigation = established
- Remote Sensing = established
- **Launch = established**
- Manufacturing = established
- Suborbital = emerging
- Cargo = emerging
- Crew = emerging
- Interplanetary = emerging

Launch: Context

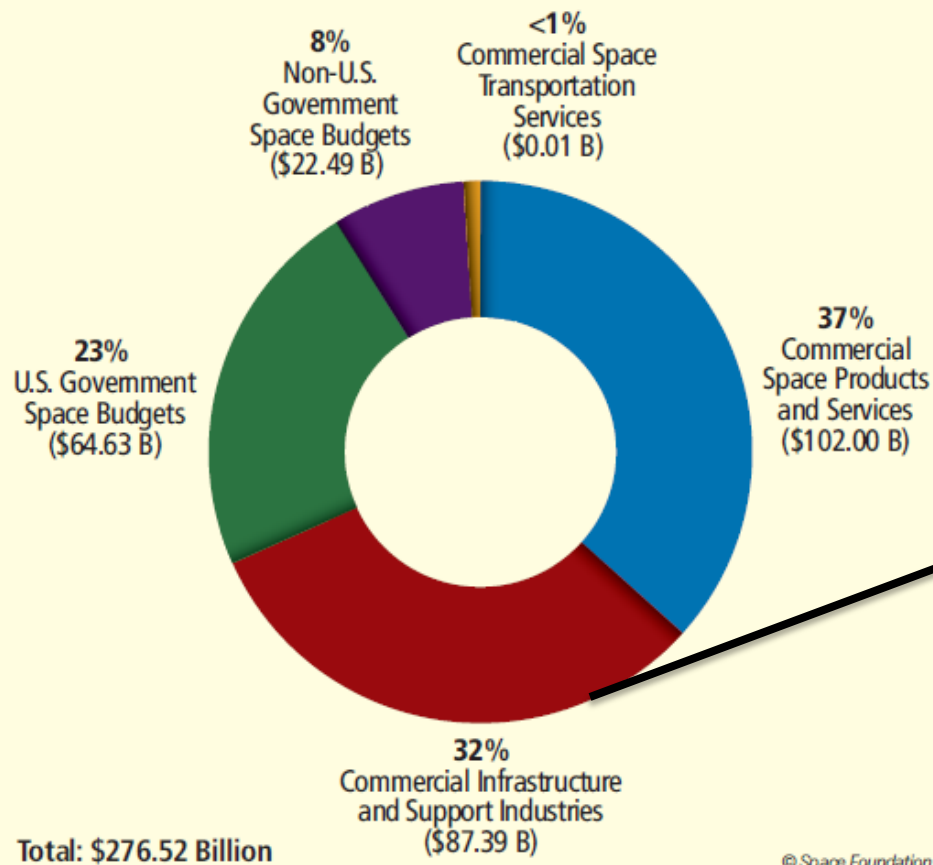


EXHIBIT 2d. Revenues for Space Infrastructure, 2010

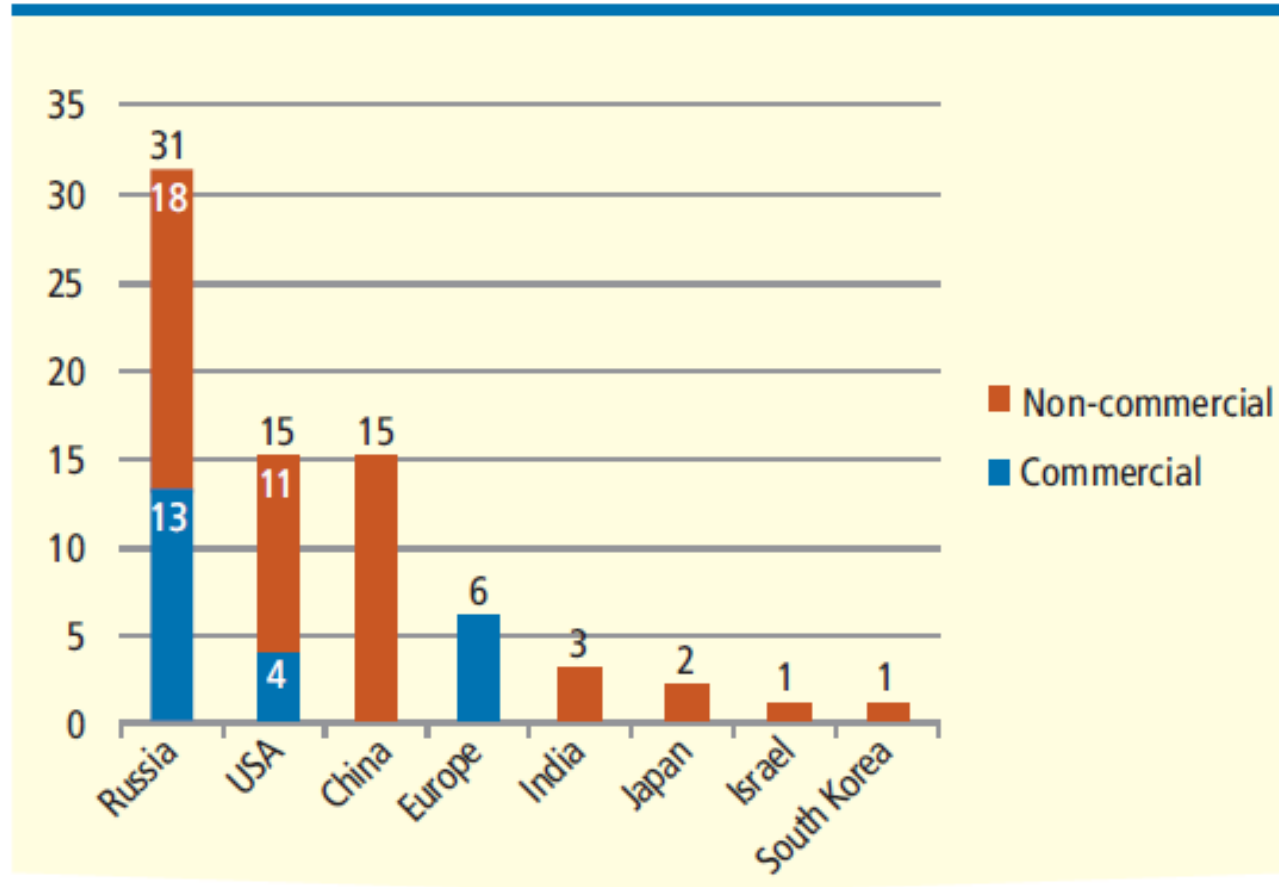
Commercial Infrastructure and Support Industries	Revenue	Source
Ground Stations and Equipment	\$80.47 B	Satellite Industry Association (SIA)/Futron analysis
Satellite Manufacturing (commercial)	\$3.41 B	SIA/Futron analysis
Launch Industry (commercial)	\$2.45 B	Federal Aviation Administration (FAA)
Insurance	\$0.88 B	XL Insurance
Independent Research and Development	\$0.18 B	Futron
Total	\$87.39 B	

Launch: Players



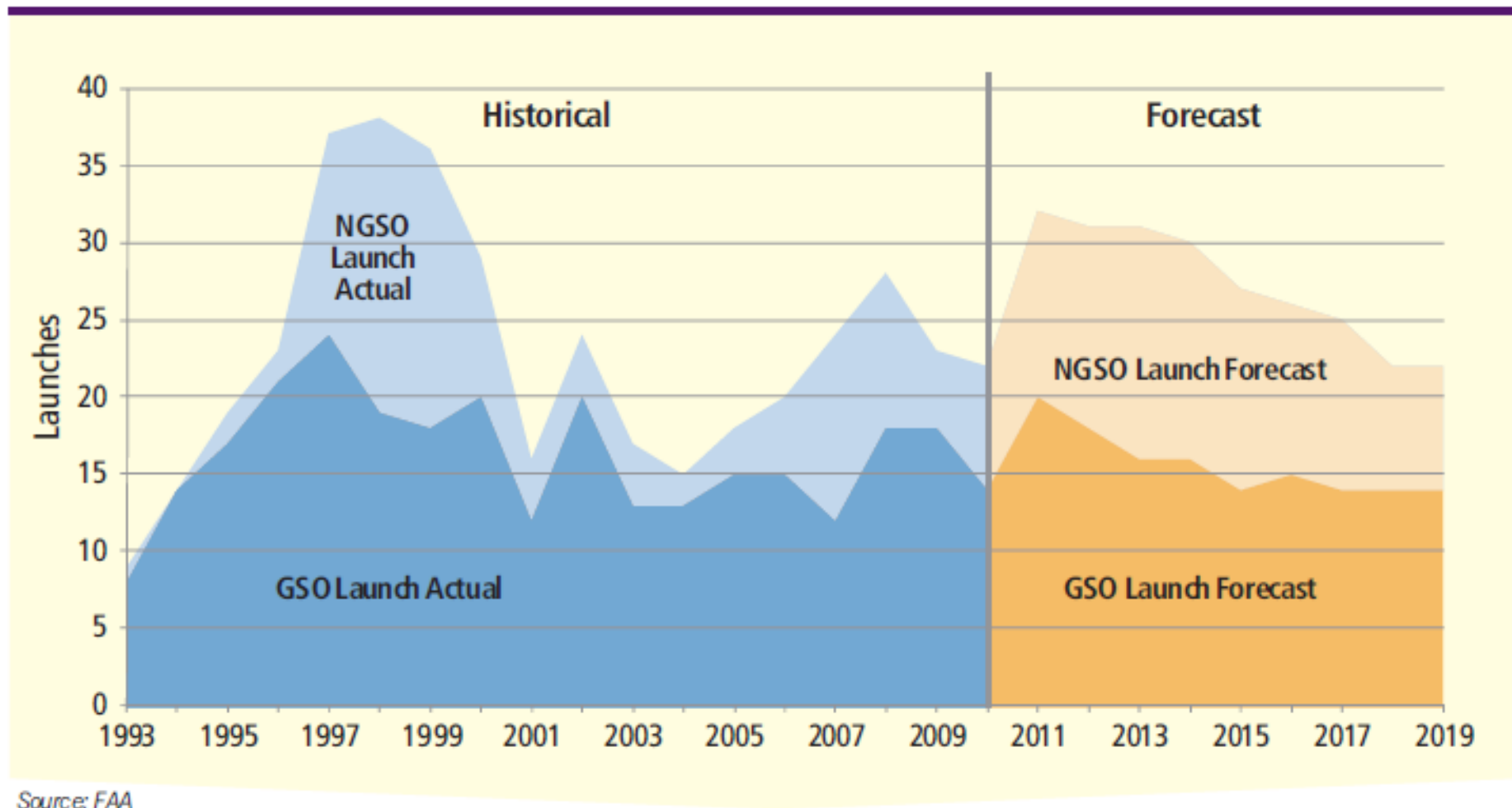
Launch: Demand

EXHIBIT 2e. Orbital Launches, 2010



Source: Federal Aviation Administration

Launch: Demand



Commercial Scope

- Communications = established
- Navigation = established
- Remote Sensing = established
- Launch = established
- **Manufacturing = established**
- Suborbital = emerging
- Cargo = emerging
- Crew = emerging
- Interplanetary = emerging

Manufacturing: Context

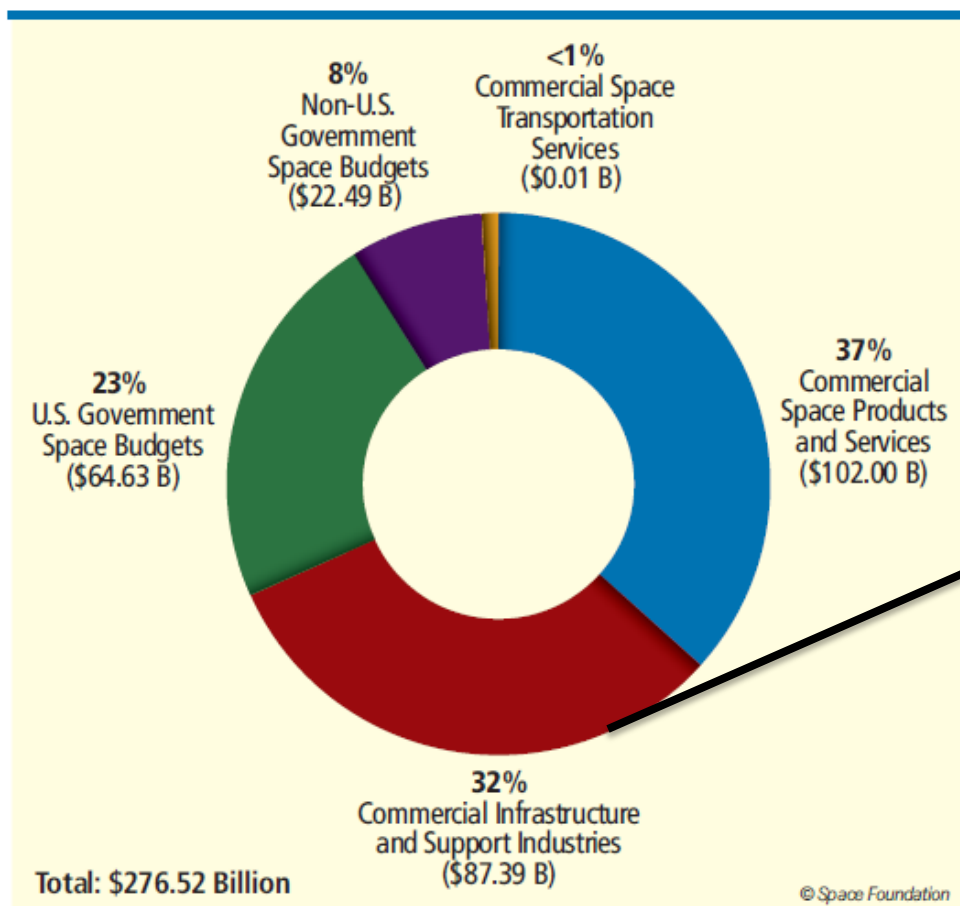




































































EXHIBIT 2d. Revenues for Space Infrastructure, 2010

Commercial Infrastructure and Support Industries	Revenue	Source
Ground Stations and Equipment	\$80.47 B	Satellite Industry Association (SIA)/Futron analysis
Satellite Manufacturing (commercial)	\$3.41 B	SIA/Futron analysis
Launch Industry (commercial)	\$2.45 B	Federal Aviation Administration (FAA)
Insurance	\$0.88 B	XL Insurance
Independent Research and Development	\$0.18 B	Futron
Total	\$87.39 B	

Type	Revenue
Government	\$7.14 B
Commercial	\$3.41 B
Total	\$10.55 B

Source: The Space Report 2011

Manufacturing: Players

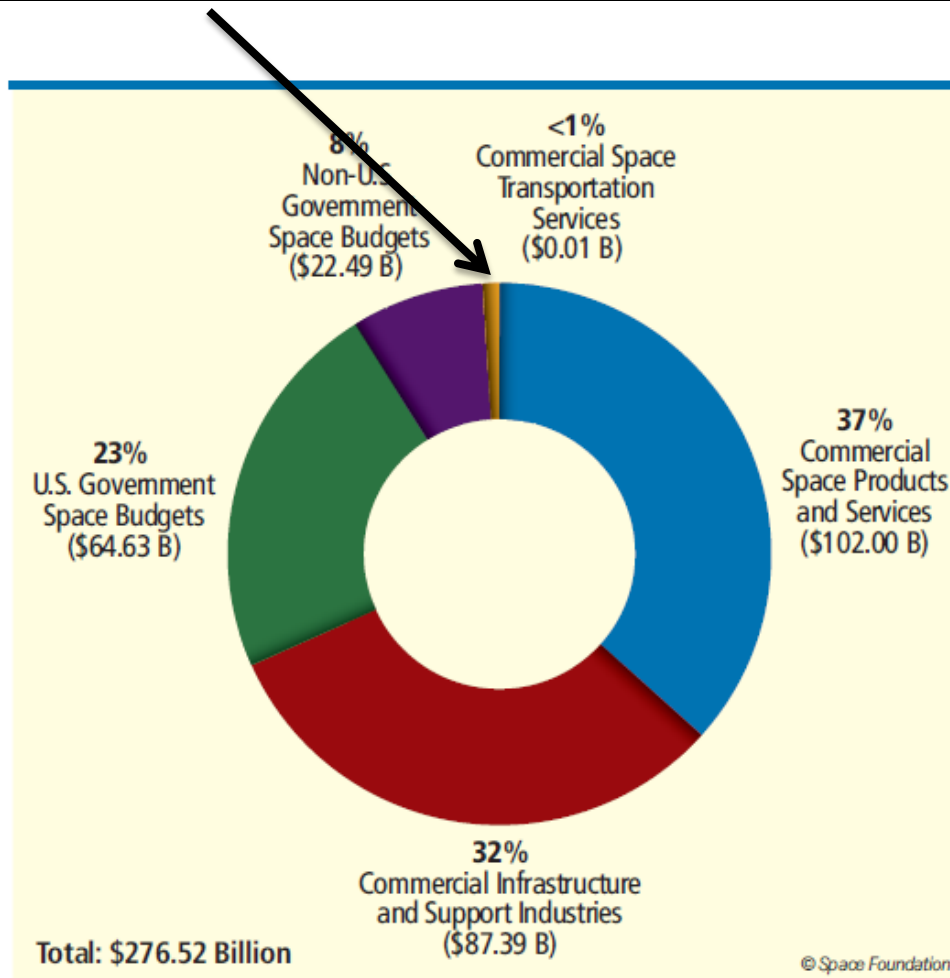
SPACE SYSTEMS LORAL	ASTRIUM	BOEING	Orbital	THALES	MITSUBISHI ELECTRIC	LOCKHEED MARTIN	MDA
 ABS-2	 Arabsat 6B	 ABS-3A	 Azersat 1	 Apstar 7B	 Turksat 4A	 Jabiru-1	 Lybid
 Amazonas 3	 Astra 2E	 ABS-TBD	 Amazonas 4A	 Turksat 4B			
 Anik G1	 Astra 2F	 Inmarsat-501	 HYLAS 2	 Europasat			
 AsiaSat 6	 Astra 2G	 Inmarsat-502	 Amazonas 4B				
 AsiaSat 8	 Astra 5B	 Inmarsat-503	 Intelsat 23	 Eutelsat 21B			
 CMBStar	 DIRECTV 15	 Intelsat 21	 MEXSAT-3	 Eutelsat 7B			
 DIRECTV 14	 Eutelsat 3B	 Intelsat 27	 OHO-1	 Turkmenistansat			
 Echostar XVI	 Eutelsat 70B	 Intelsat-TBD	 SES-8	 Yamal 402			
 EUROBIRD 2A Es'Hail	 Express AM4R	 MEXSAT-1	 Star One C3				
 Intelsat 20	 Express AM7	 MEXSAT-2	 Thaicom 6				
 Intelsat DLA-1	 Inmarsat XL	 Satmex 7					
 Intelsat DLA-2	 Measat 3b	 Satmex X					
 NBN Co 1A	 SES 6	 SkyTerra-2					
 NBN Co 1B							
 Optus-10							
 Satmex 8							
 Sirius FM-6							
 Star One C4							
 TerreStar-2							
 THOR 7							

Credit: Space Systems/Loral NewSpace 2012 Presentation

Commercial Scope

- Communications = established
- Navigation = established
- Remote Sensing = established
- Launch = established
- Manufacturing = established
- **Suborbital = emerging**
- Cargo = emerging
- Crew = emerging
- Interplanetary = emerging

Suborbital: Context



Virgin Galactic:

- \$70 million – deposits
- \$107 million – commitments

To date:

- 925 reservations have been made for suborbital trips
- Comprised of partial/full deposits

Suborbital: History

October 2004



November 2006



October 2009

Northrop Grumman Lunar Lander Challenge

- Prize = \$1 million
- Funded by NASA
- Operated by XPRIZE
- Sponsored by NG



December 2009



August 2010

- Awarded ~\$500k in CRuSR Awards





October 2010

October 2010



August 2011

- NASA Announces awards for Flight Opportunities Program
 - Total of \$10 million
 - Two-year contracts
 - Seven selected companies
 - Armadillo Aerospace
 - Near Space Corp.
 - Masten Space Systems
 - Up Aerospace
 - Virgin Galactic
 - Whittinghill Aerospace
 - XCOR

Suborbital: Players

Planning and Design



XCOR: Lynx III



Armadillo Aerospace:
Hyperion



Armadillo
Aerospace: STIG B



XCOR: Lynx I & II



Armadillo
Aerospace: STIGA



UP Aerospace:
SpaceLoft XL

SRVs in Early Planning Stages

Booster Space Industries – Name TBD

Copenhagen Suborbitals – Tycho Brahe

Dassault Aviation – DSH

EADS Astrium – Spaceplane

Rocketplane Global – XP

Talis Enterprise – Project Enterprise

Whittinghill Aerospace – mCLS



Masten Space
Systems: Xaero



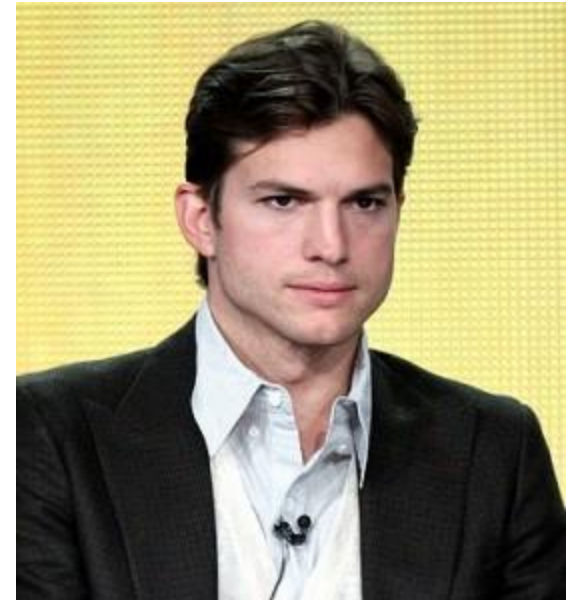
Virgin Galactic:
SpaceShipTwo



Blue Origin:
New Shepard

Source: Tauri Group

Suborbital: Demand



Suborbital: Demand



Suborbital: Demand

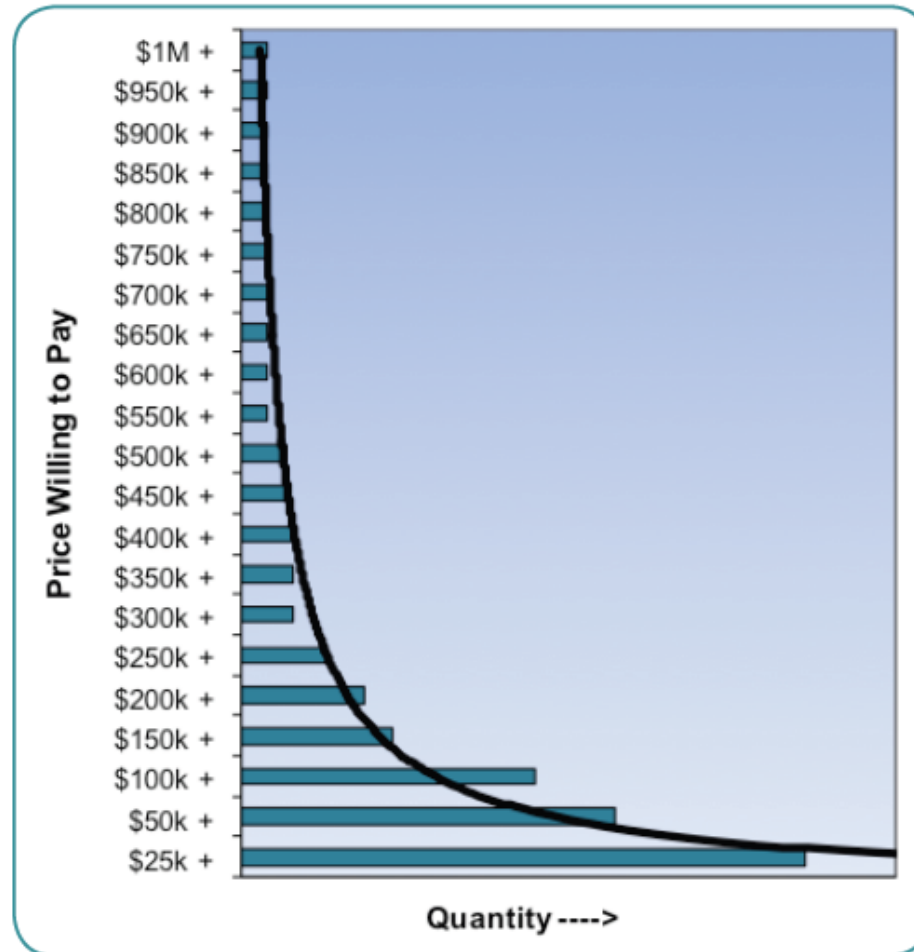


Figure 19: Price elasticity of suborbital tickets for individuals with \$5M in investable assets

Source: Tauri Group

Suborbital: Demand

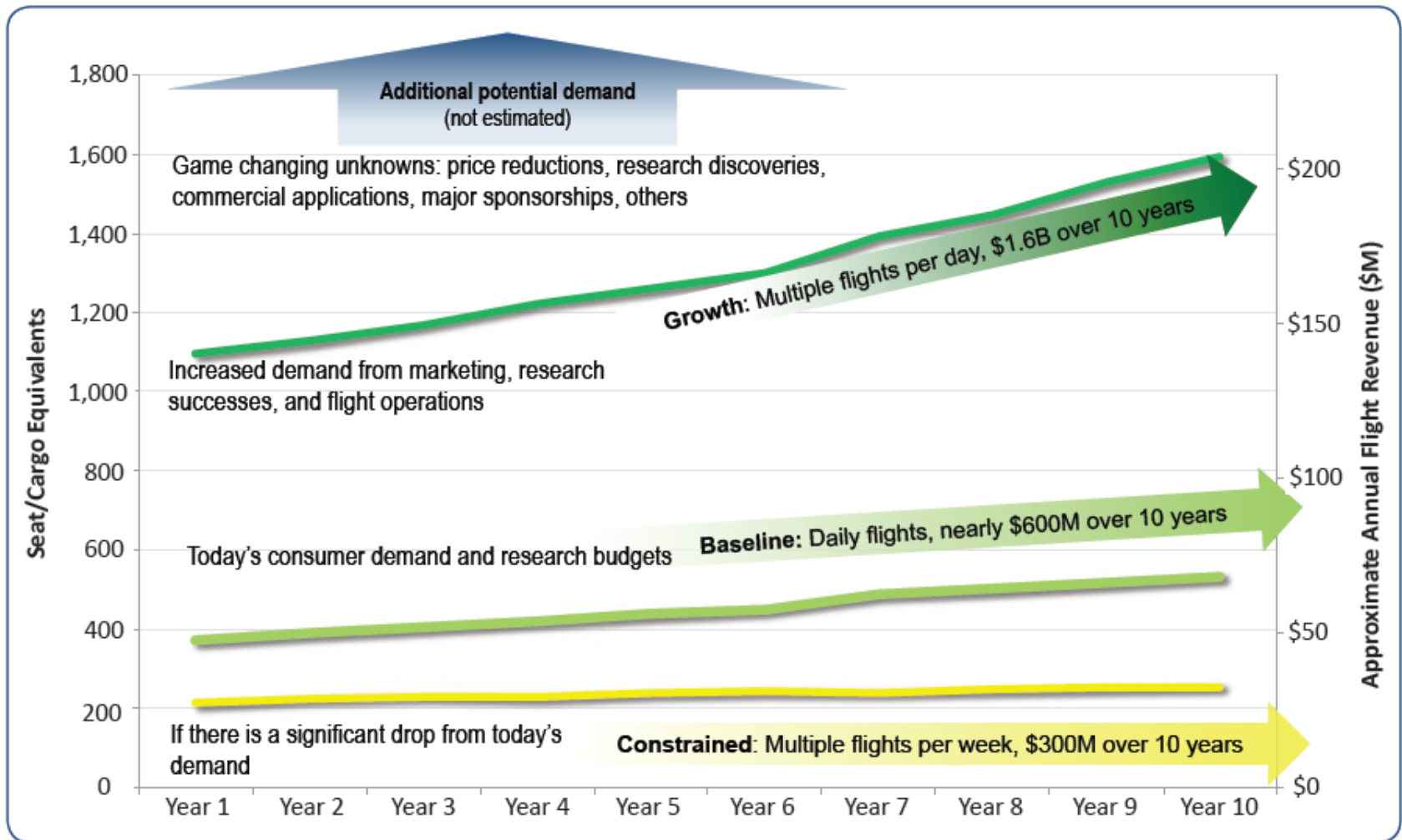


Figure 8: 10-year SRV demand forecast

Source: Tauri Group

Commercial Scope

- Communications = established
- Navigation = established
- Remote Sensing = established
- Launch = established
- Manufacturing = established
- Suborbital = emerging
- **Cargo = emerging**
- Crew = emerging
- Interplanetary = emerging

Cargo: History

Commercial Orbital Transportation Services (COTS)

- A, B, C, D
- Round 1 (August 2006):
 - SpaceX + Rocketplane-Kistler
- Round 2 (February 2008):
 - SpaceX + Orbital Sciences
- Total ~ \$500 million

Cargo: History

Commercial Resupply Services

- Awarded December 2008
- To deliver cargo to the International Space Station
- 12 missions to resupply from SpaceX
 - Worth up to \$1.6 billion
- 8 missions to resupply from Orbital
 - Worth up to \$1.9 billion



June 2010

December 2010



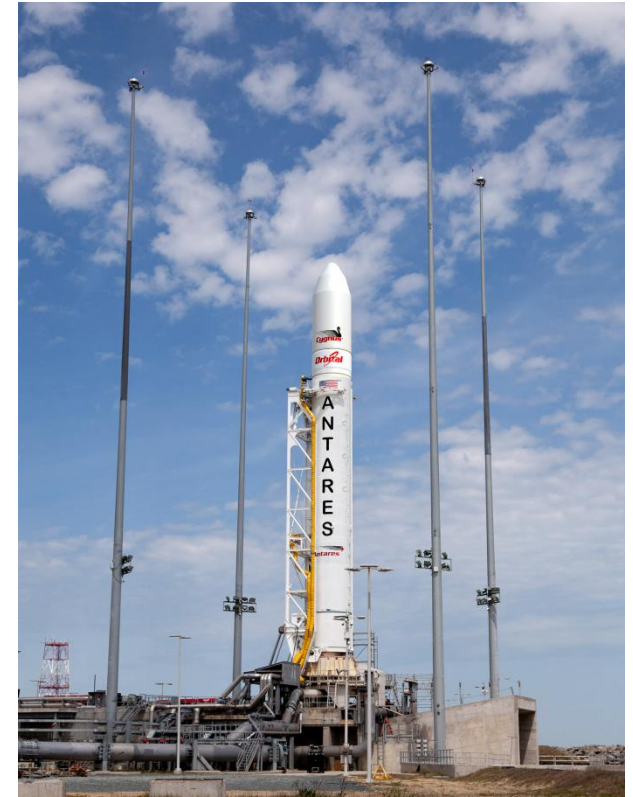


May 2012

Cargo: Players

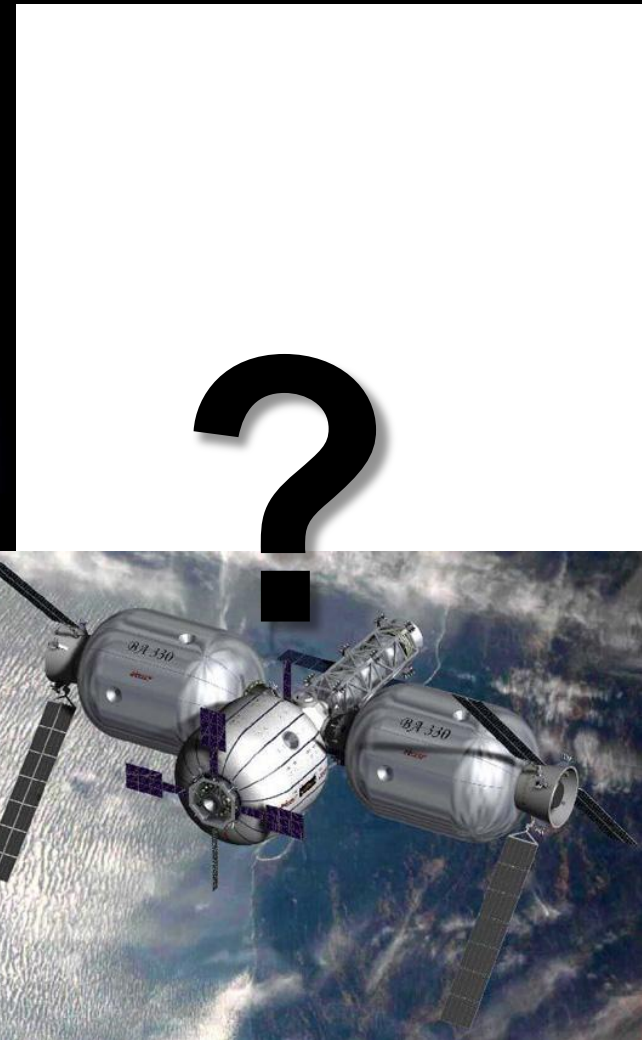
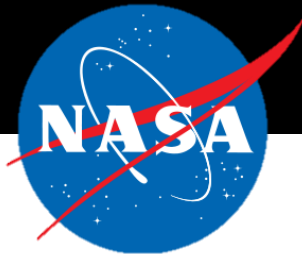
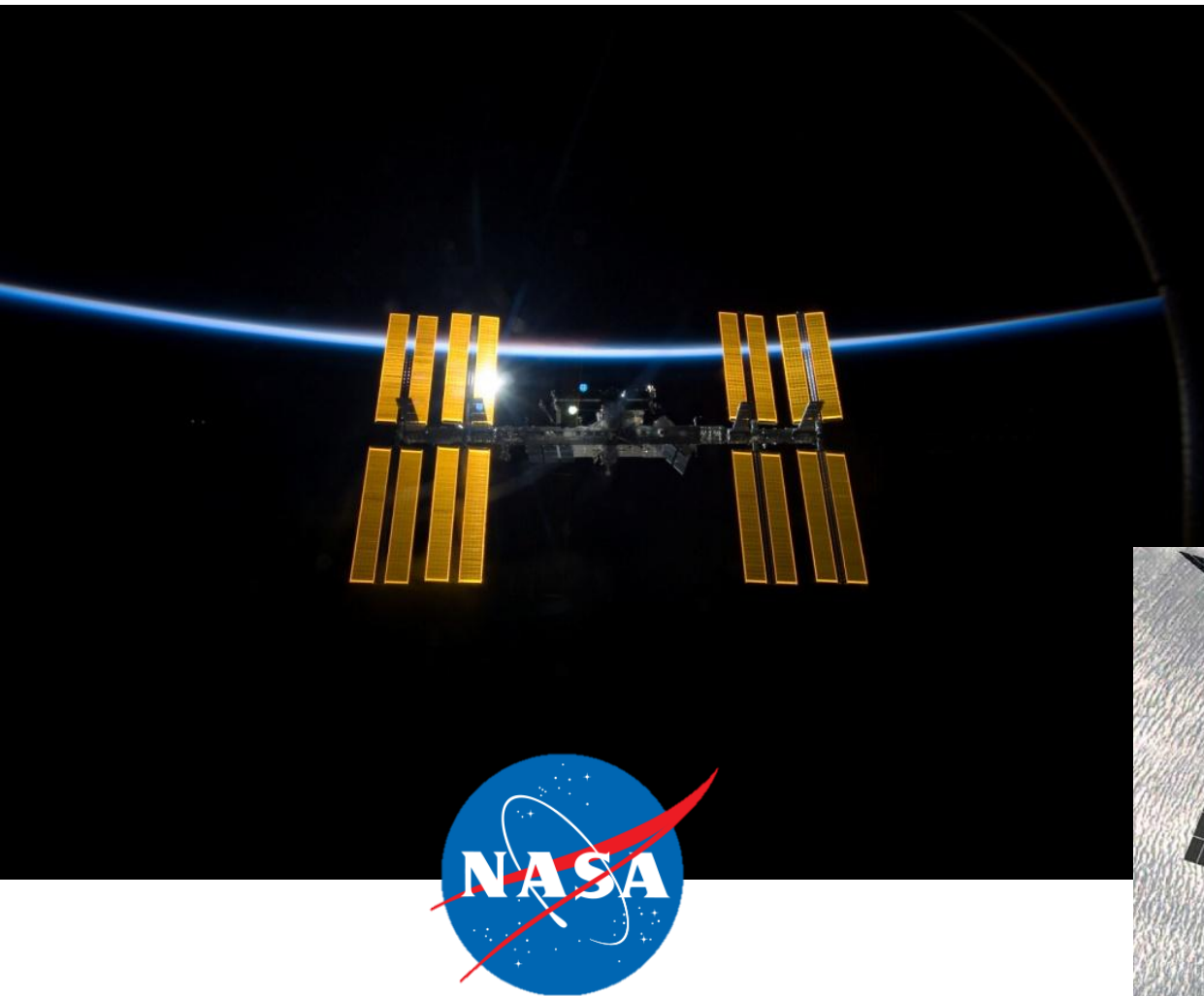


credit: SpaceX



credit: Orbital Sciences

Cargo: Demand



Commercial Scope

- Communications = established
- Navigation = established
- Remote Sensing = established
- Launch = established
- Manufacturing = established
- Suborbital = emerging
- Cargo = emerging
- **Crew = emerging**
- Interplanetary = emerging

Crew: History

- COTS – D [not exercised]
- February 2010 NASA Awarded \$50 million through Commercial Crew Development (CCDev) to:
 - Sierra Nevada Corporation
 - Paragon Space Development Corporation
 - United Launch Alliance
 - Blue Origin
 - Boeing



September 2010



December 2010

Crew: History

CCDev II - Second Round of Commercial Crew Development Funds

- Awarded February 2011
- Totaled almost \$270 million
- 4 Companies
 - Boeing
 - SpaceX
 - Sierra Nevada Corporation
 - Blue Origin



March 2012

April 2012





May 2012

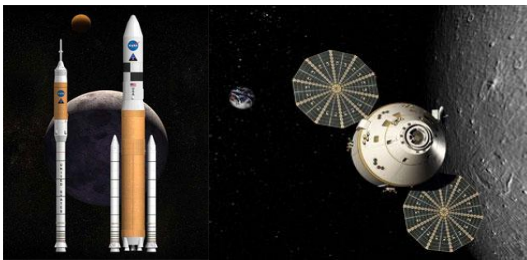
Crew: History

- Commercial Crew Integrated Capability (CCiCap) Awarded August 2012
 - 21 month award for \$1.1 billion
 - Boeing = \$460 million
 - SpaceX = \$440 million
 - Sierra Nevada Corporation = \$212.5 million

Crew: Approach

Traditional NASA Development

Goal: ISS Crew Mission
Extensive Government Involvement
No Cost Sharing
Government Owns IP
Detailed Design Requirements
Unlimited Data and Lots of Deliverables
Higher Costs



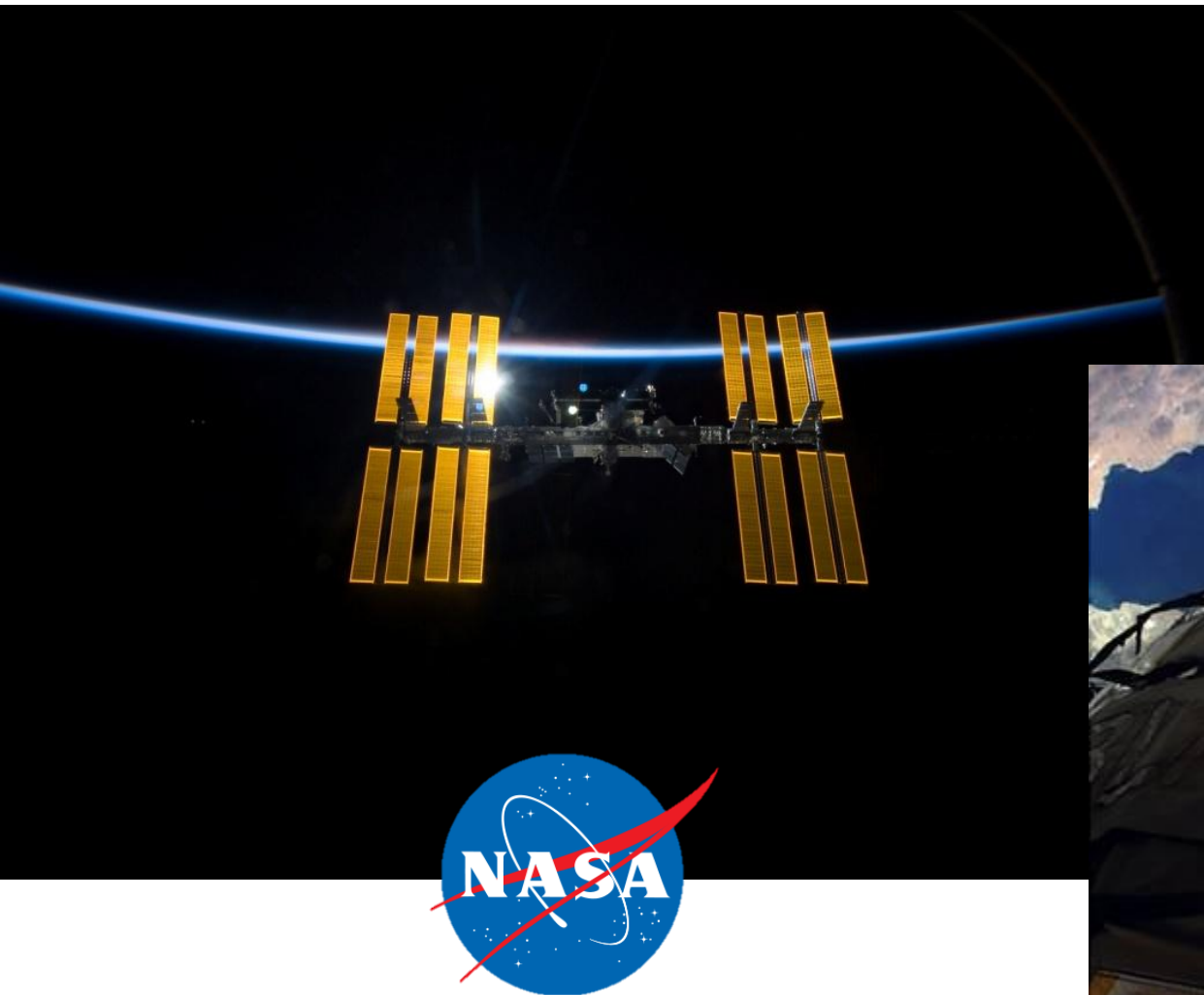
Non-Traditional Development

Goal: Commercial Human Transport
Limited Government Involvement
Cost Sharing
Commercial Partner Owns IP
Tailored Human-Rating Requirements
Pay-for-Performance Milestones
Lower Costs



Source: NASA, Director of Commercial Spaceflight, NewSpace 2012 Presentation

Crew: Demand



Crew: Demand



Commercial Astronauts & Private Space Explorers:

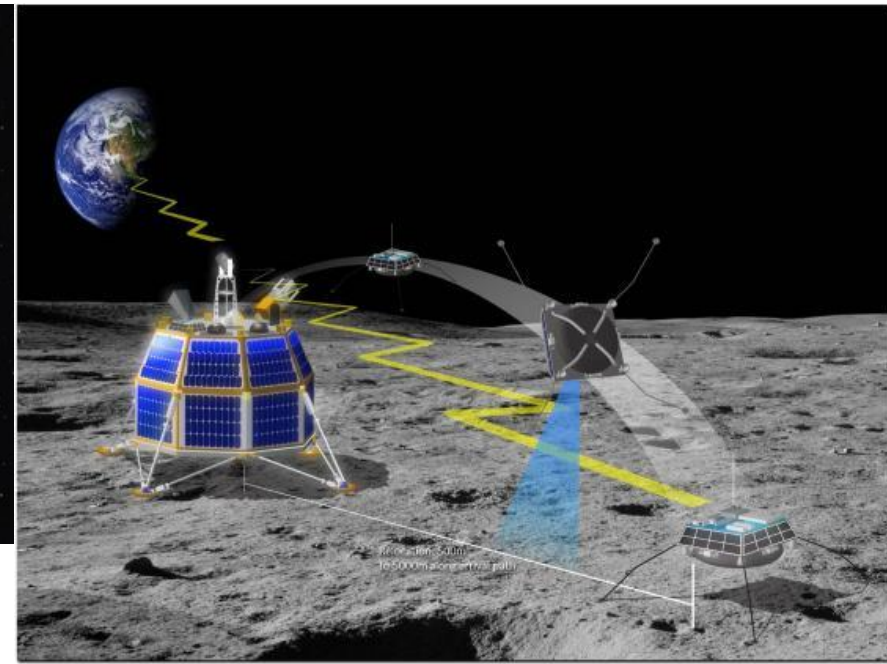
- Space Adventures x 8
- Commercial research



Commercial Scope

- Communications = established
- Navigation = established
- Remote Sensing = established
- Launch = established
- Manufacturing = established
- Suborbital = emerging
- Cargo = emerging
- Crew = emerging
- **Interplanetary = emerging**

Interplanetary: Context



Interplanetary: Opportunities

Asteroid Value

- “A single 500 meter Platinum-rich asteroid contains more Platinum Group Metals than have been mined in humanity’s history”
- Science Data = \$100s of millions/year
 - Time capsules from early solar system
 - More than \$1 billion has been spent on asteroid missions over the last decade
- Material Resources = \$100s of billions/year
 - Rare metals required for high tech industries
 - Water for in-space activities
- “Survival of the Species – Priceless!”

Source: Planetary Resources, Eric Anderson

Interplanetary: Opportunities

Lunar Value

- Scientific exploration enabled
 - Payload delivery for any applications
- Rare resource development
 - In-space or Earth utilization

Non-Profit Space

- \$500 million-class activities are not uncommon
- Extensive history of philanthropic development of terrestrial astronomy systems
 - Galileo, Hale Observatory, Keck Observatory, etc.

Overview

- Introductions
- Schedule
- Background
- **Objectives**
- Approach
- Industry Segment
- Action!

Objectives

- ~~Inform – perspective, background, context~~
- **Perform – group analysis**
 - Game Theory Value Net
 - Commercial human training/preparation segment
- Network – internal and external to industry
 - On-going

Objectives: Output

- Evaluate industry segment using value net
- Outline key areas for win-win partnerships
- Assemble/document group analysis
- Refine post-workshop as needed
- Prepare publication/presentation for industry conference

Overview

- Introductions
- Schedule
- Background
- Objectives
- **Approach**
- Industry Segment
- Action!

Approach: Strategic Planning

- Introduction to Strategic Planning
- Ken Davidian

Approach: Game Theory

- Introduction of Game Theory and PARTS
- Ken Davidian

Overview

- Introductions
- Schedule
- Background
- Objectives
- Approach
- **Industry Segment**
- Action!

Industry Segment

- Overview on segment of interest
- Brienna Hennwood

Overview

- Introductions
- Schedule
- Background
- Objectives
- Approach
- Industry Segment
- **Action!**

Action!

- Questions on task?
- Identify approach
 - Participant directed
 - Sub-divide and conquer?
- Outline workshop product format
 - i.e. powerpoint presentation, document, other?
 - Use to identify required deliverables
- Work hard, play harder!