

November 1st, 2017

Space: Investment Implications of the Final Frontier

[Space: Investment Implications of the Final Frontier \(12 Oct 2017\)](#)



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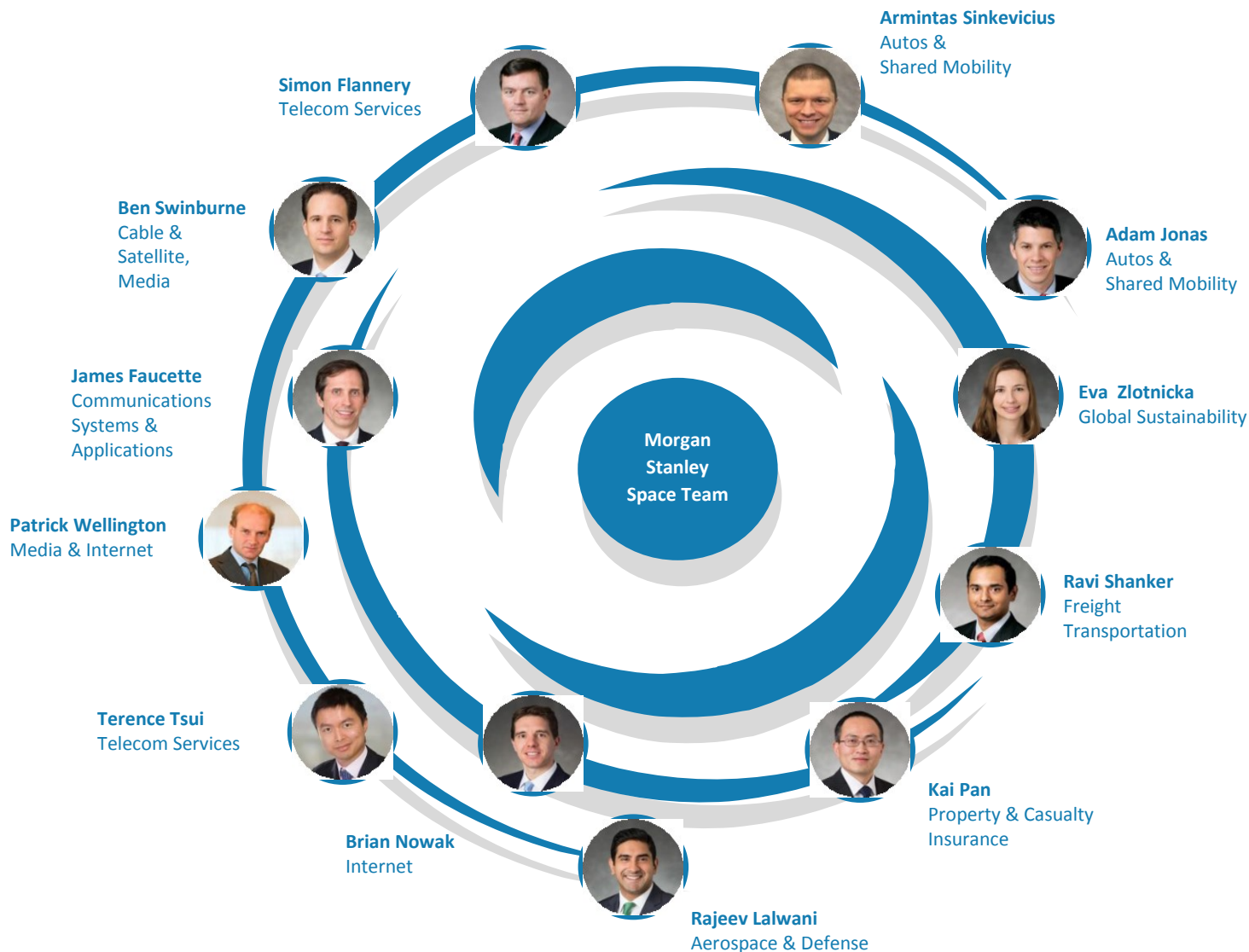


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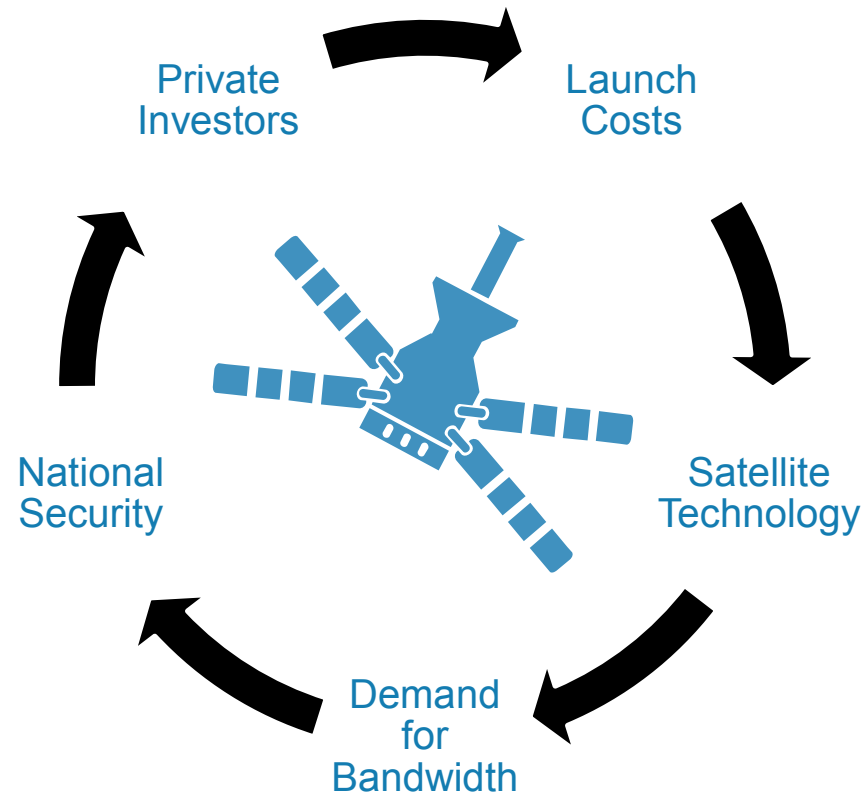
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The Morgan Stanley Space Team



Why Space?

A Confluence of Factors is Driving a New Space Race



The Reusable Rockets as an 'Elevator' to Low Earth Orbit...

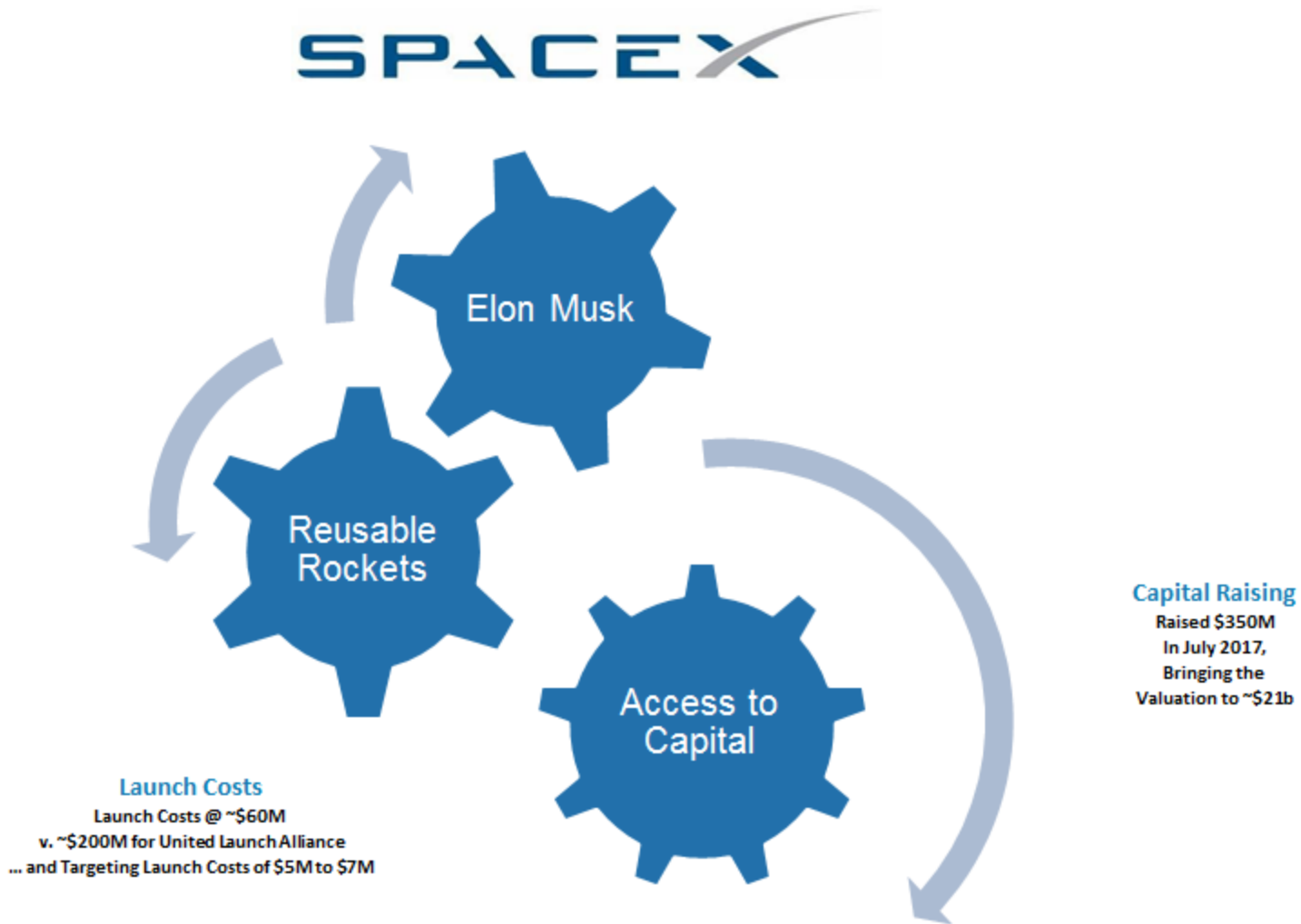
New York City Before the Elevator



New York City After the Elevator

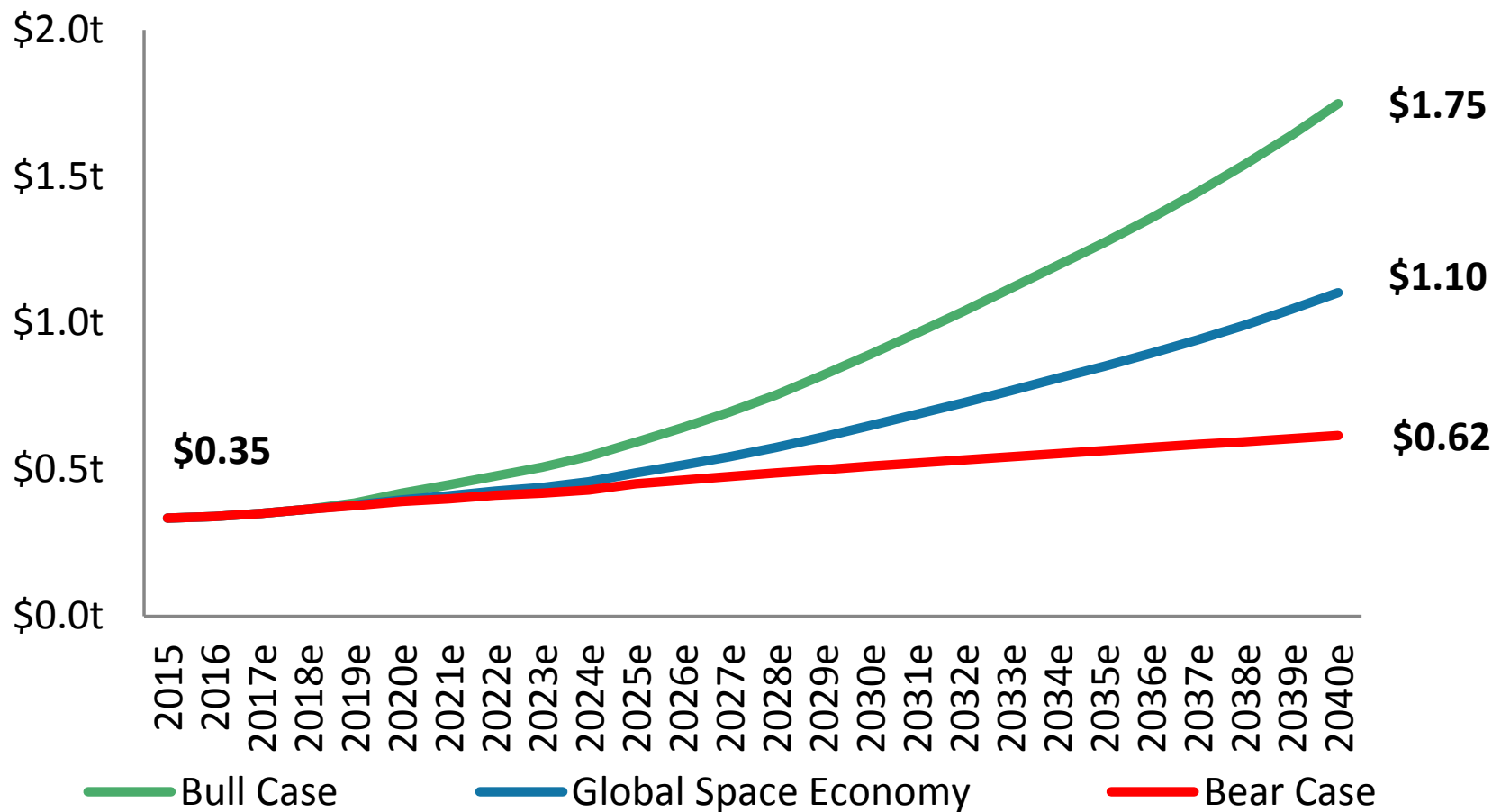


SpaceX Sits at the Epicenter of the Disruption

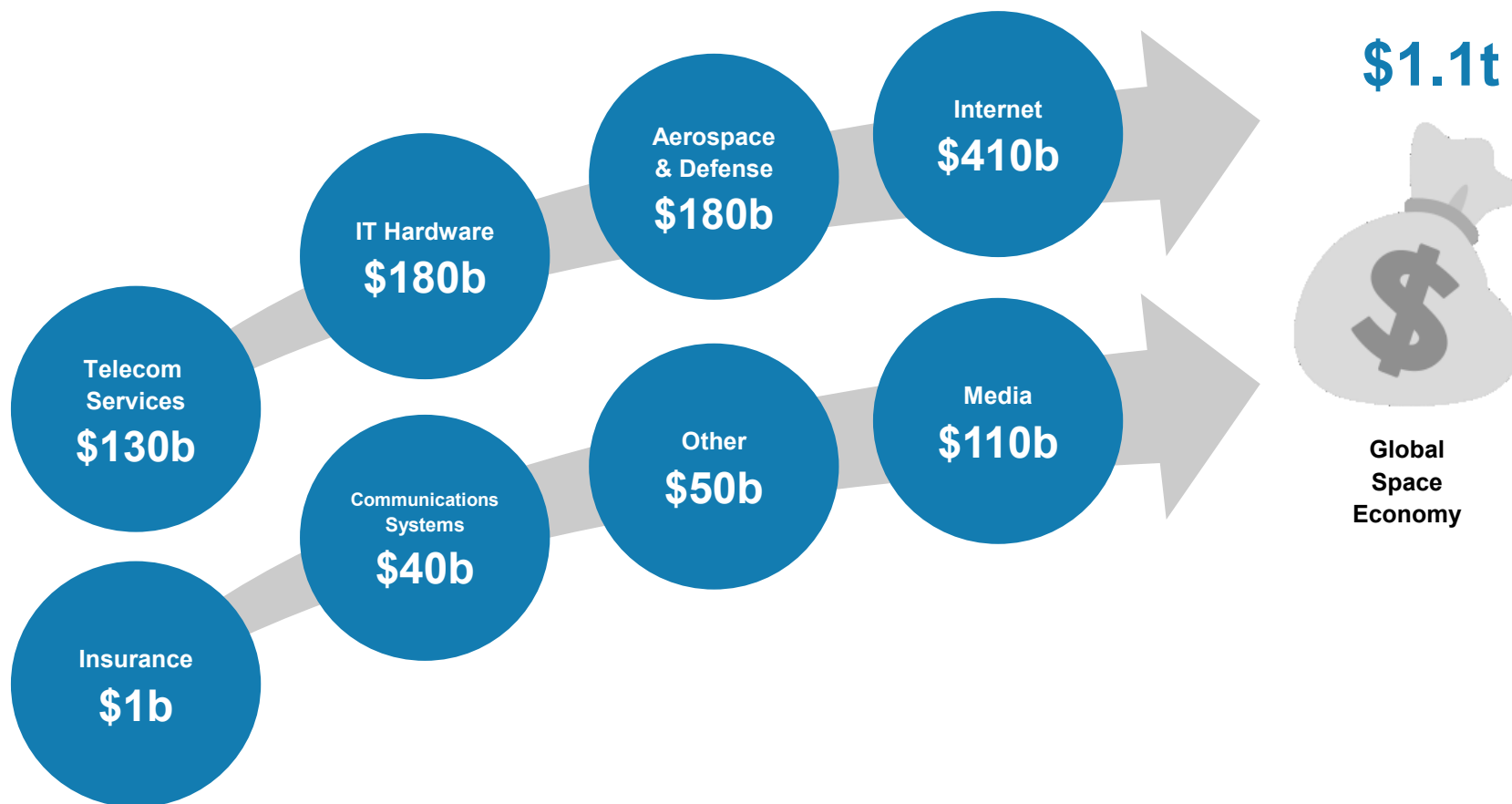


Global Space Economy: ~\$350b → \$1.1t+, Bull Case of ~\$1.75t

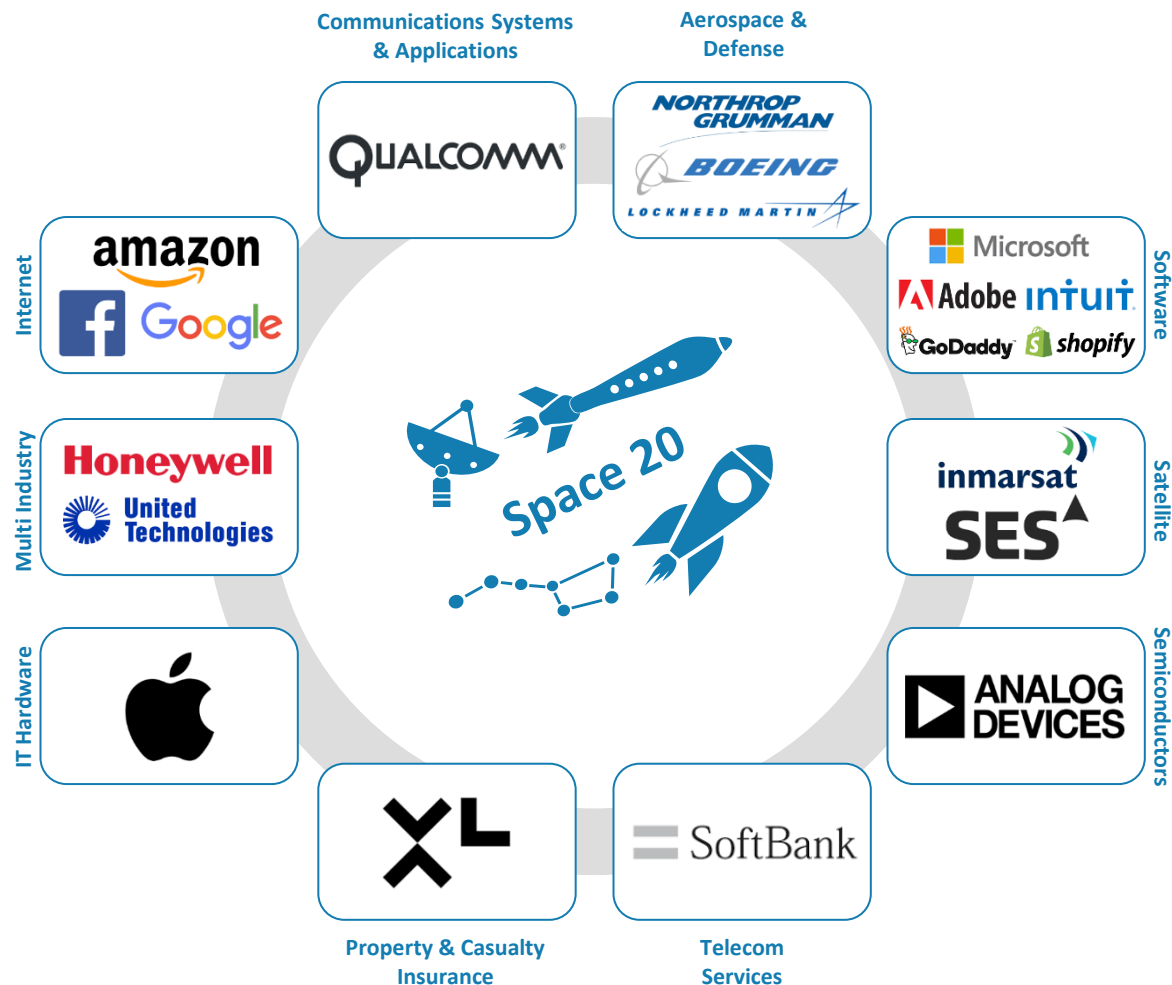
Global Space Economy (\$t)



Most of the Value is Linked to Internet Bandwidth



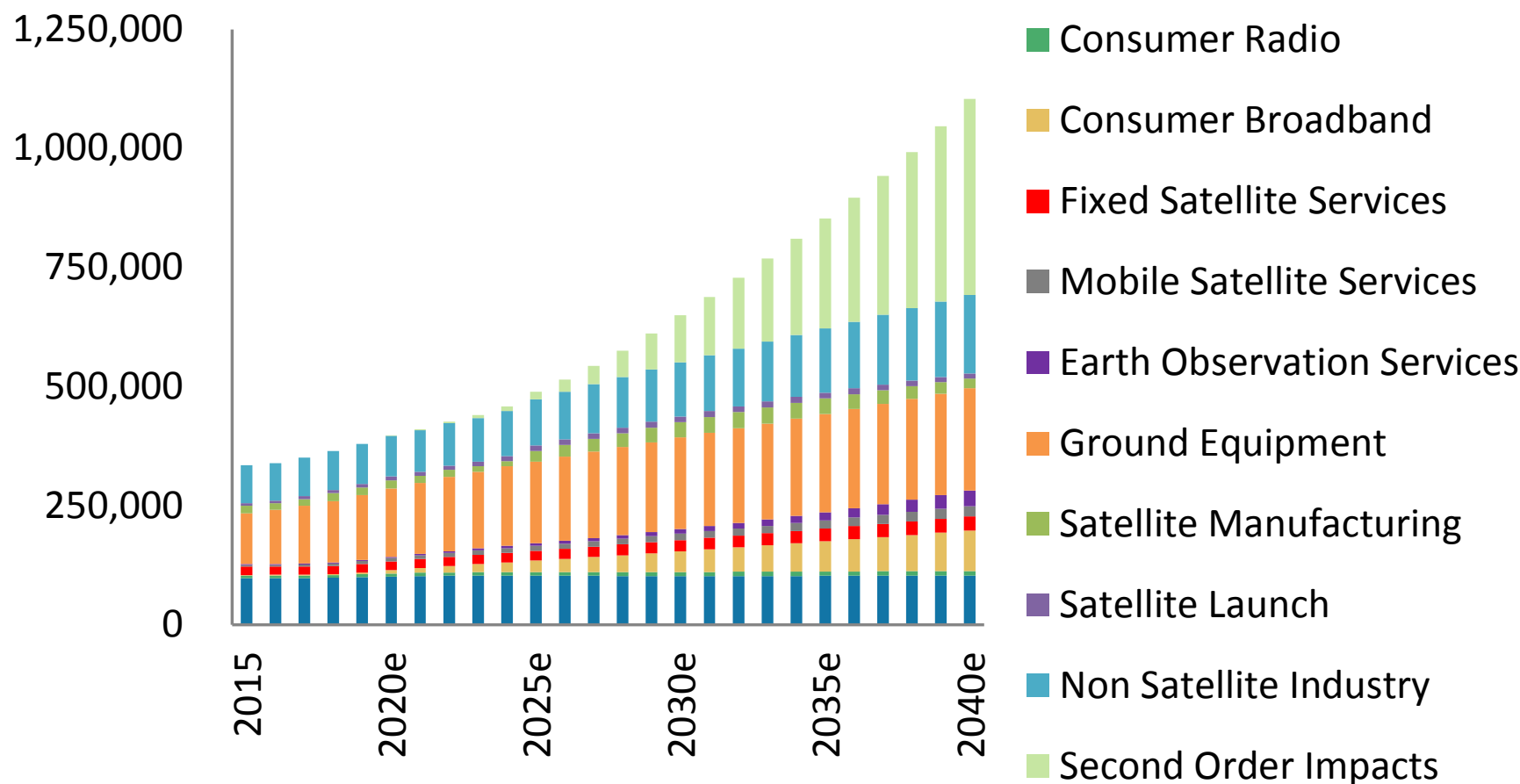
A Diversified Approach to Space: The Morgan Stanley “Space 20”



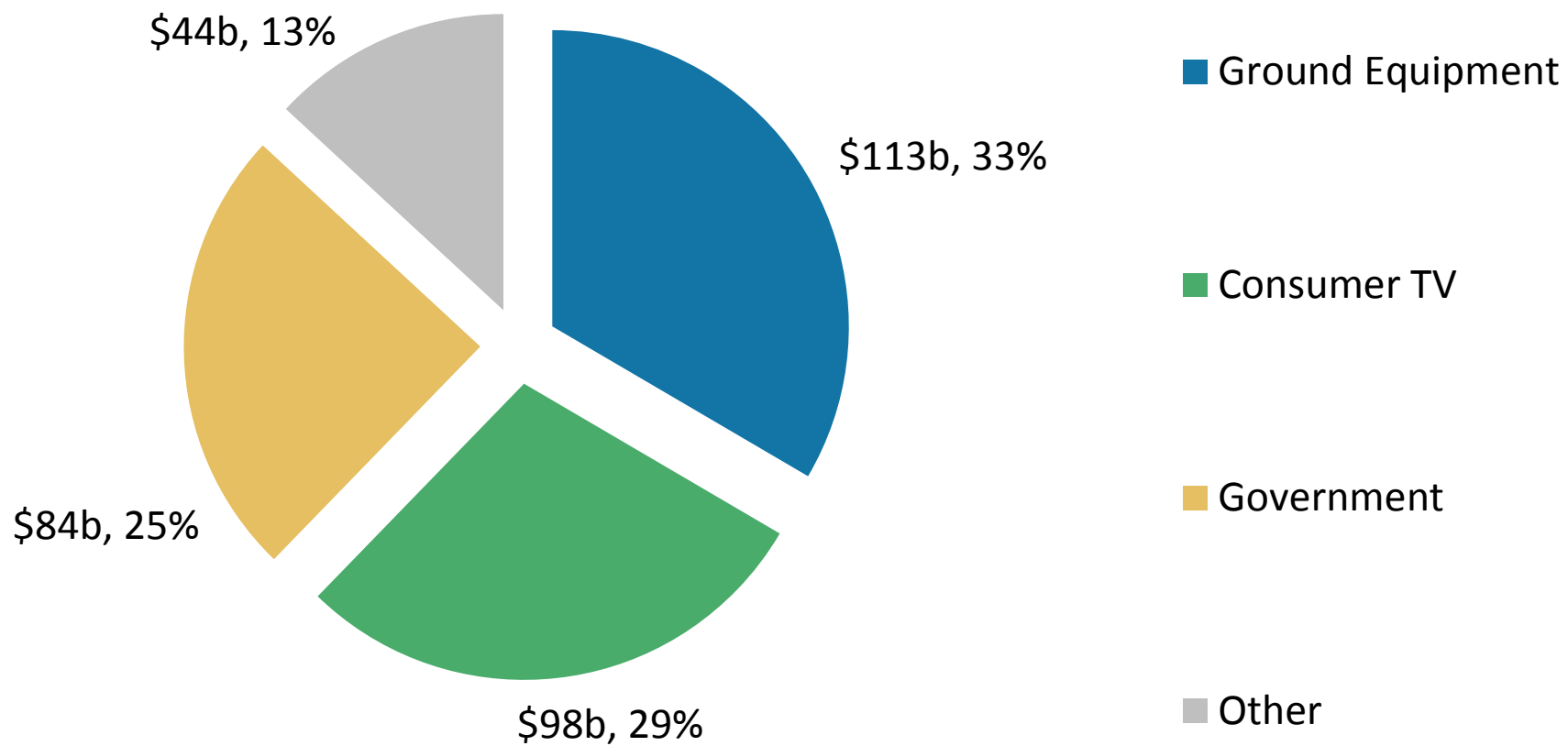
Global Space Economy

Base Case for Global Space Economy Growing at ~5.0% CAGR

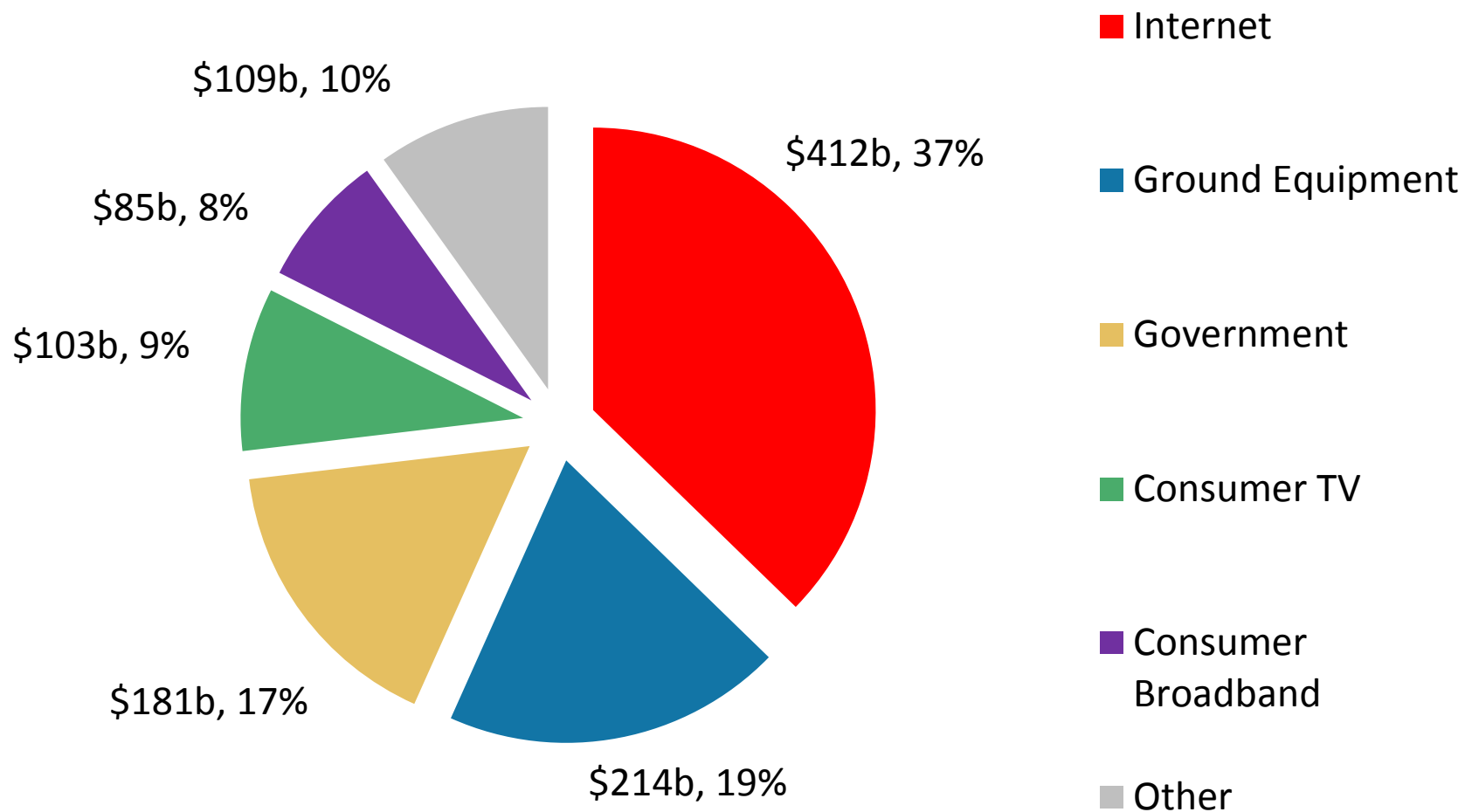
Global Space Economy (\$MM)



Today's Global Space Industry is Dominated by Consumer TV

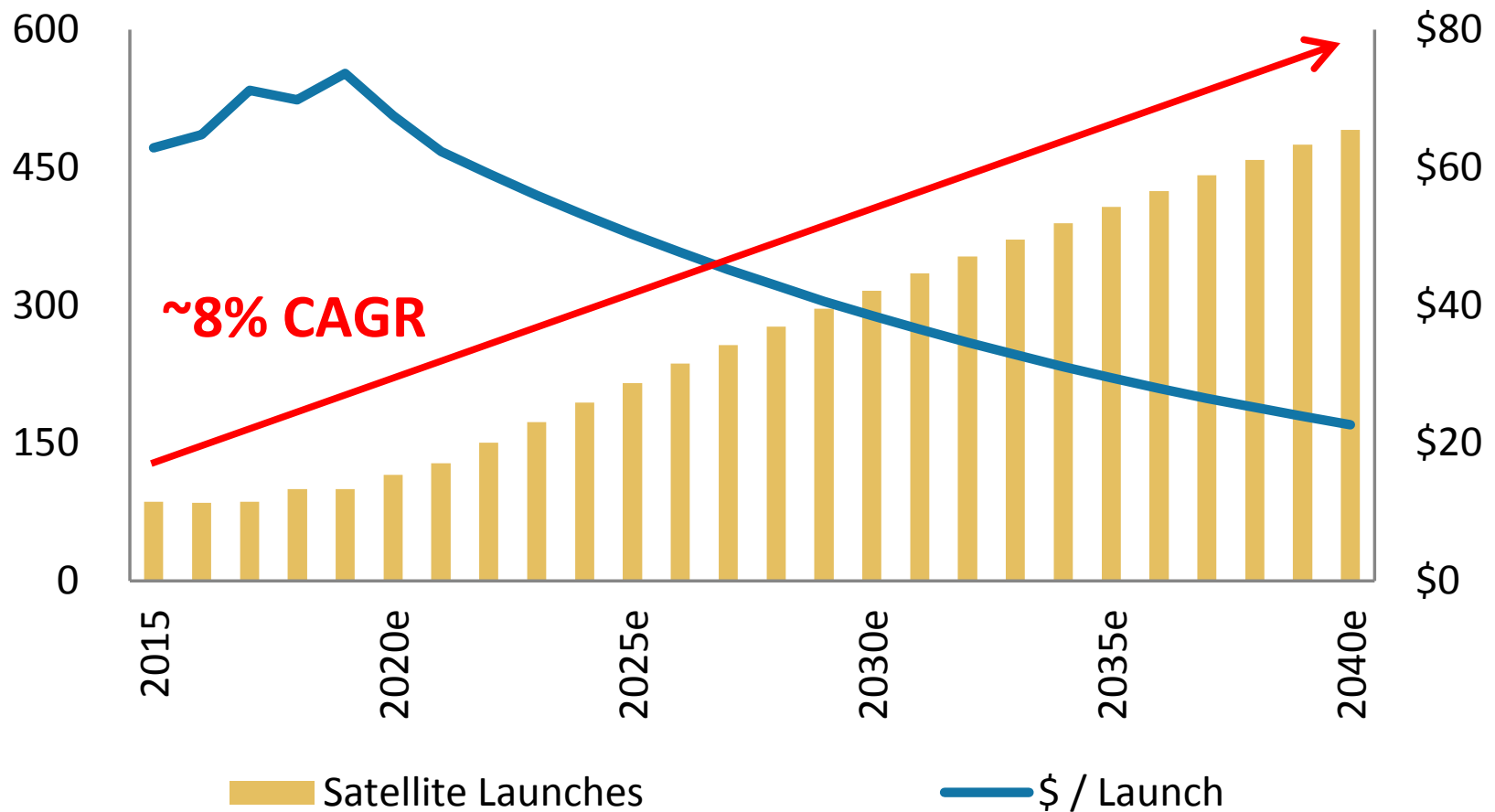


2040 Global Space Economy Driven by Consumer Broadband



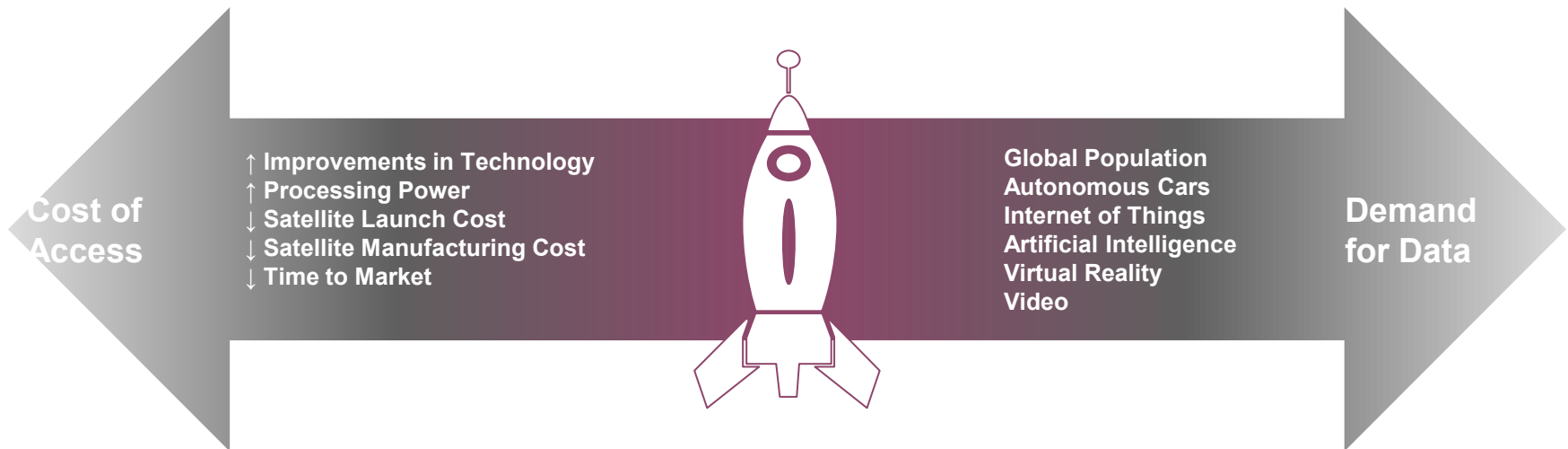
Estimate ~10 Launches / Week at ~\$20M / Satellite by 2040

Satellite Launches v. Cost to Launch



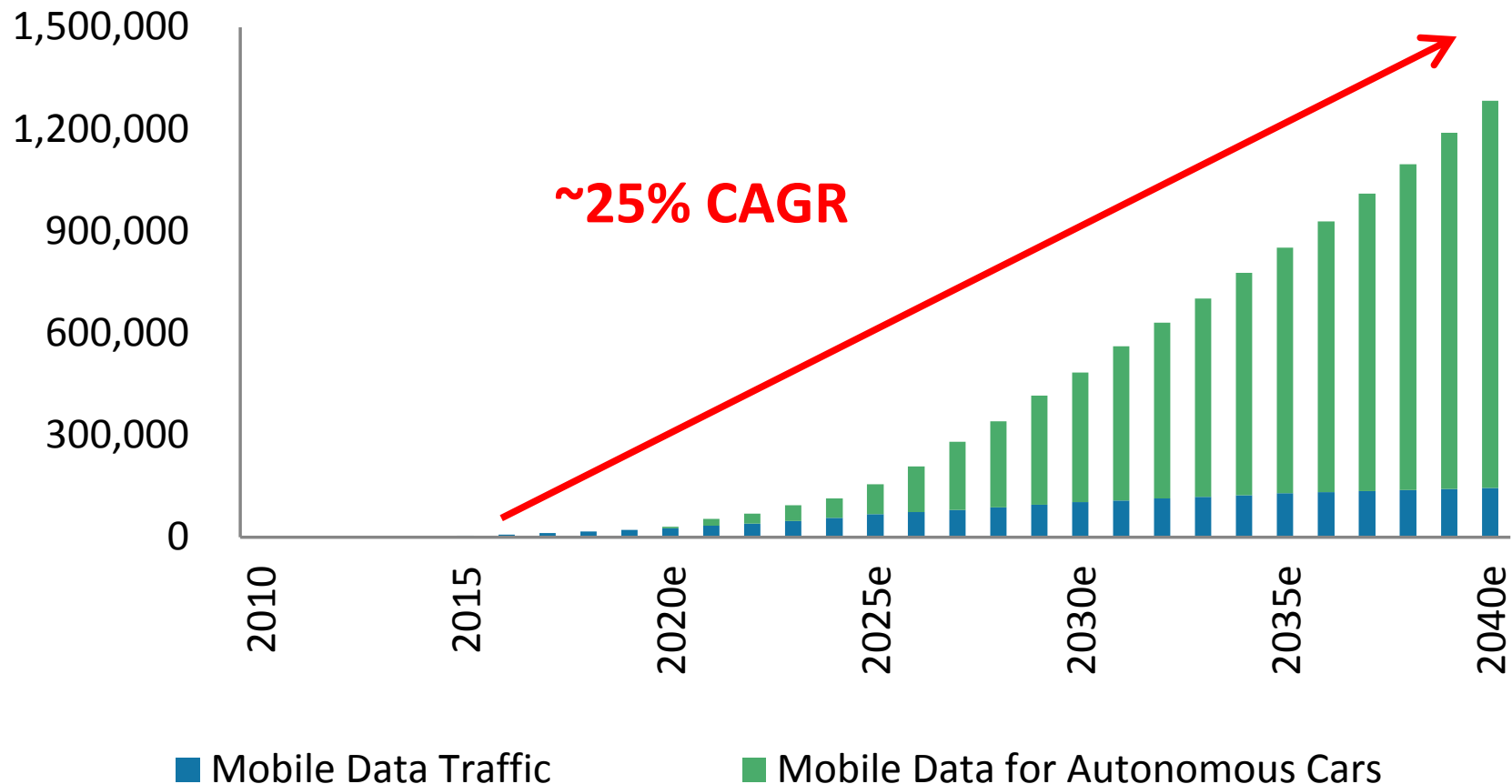
The Demand for Bandwidth

Demand for Data Growing at Exponential Rate v. Cost of Access to Space Is Falling by Orders of Magnitude



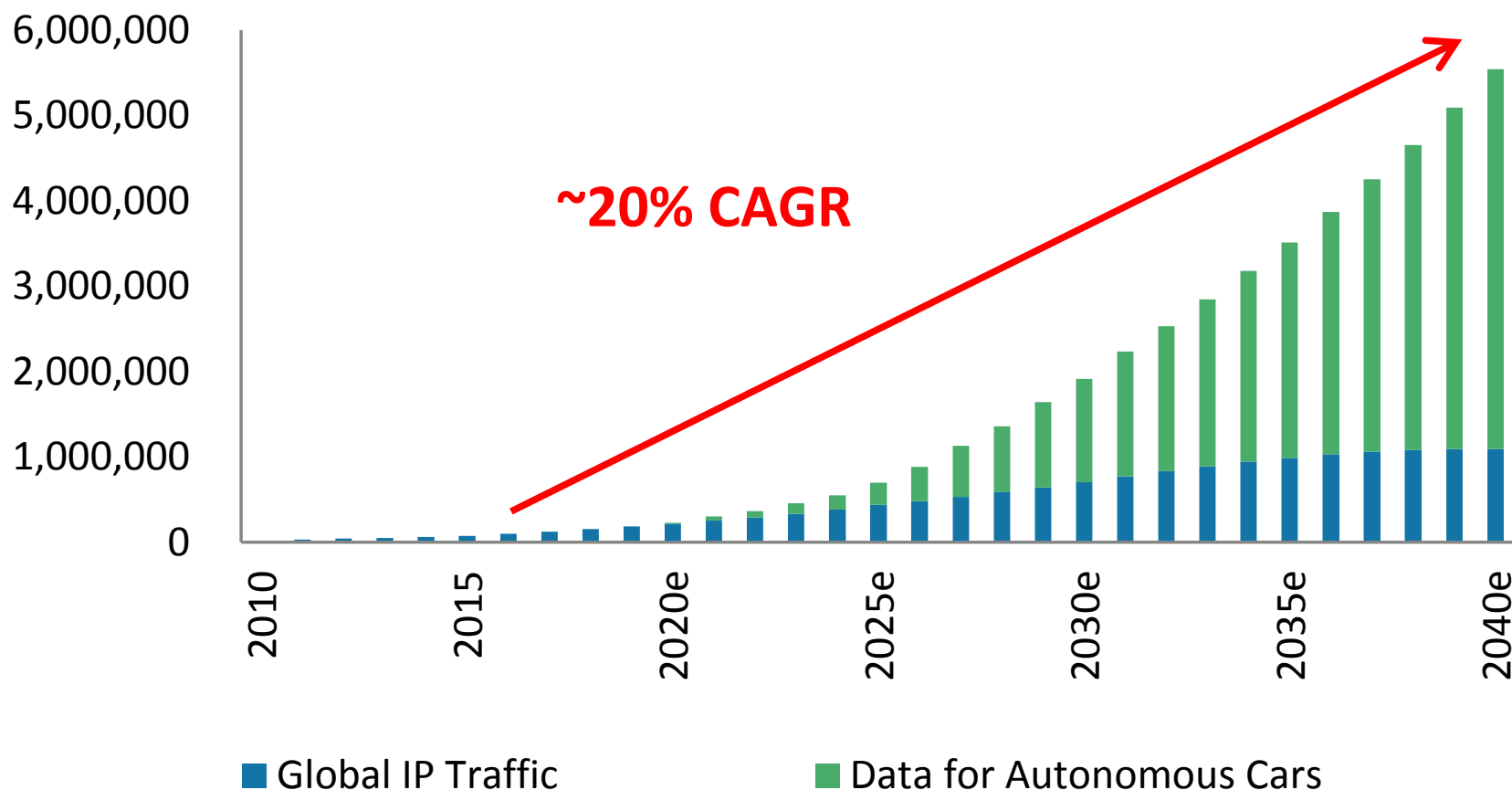
Global Mobile Data Traffic in 2040 Will Be ~200x v. 2016

Global Mobile Data Traffic (PB / Month)



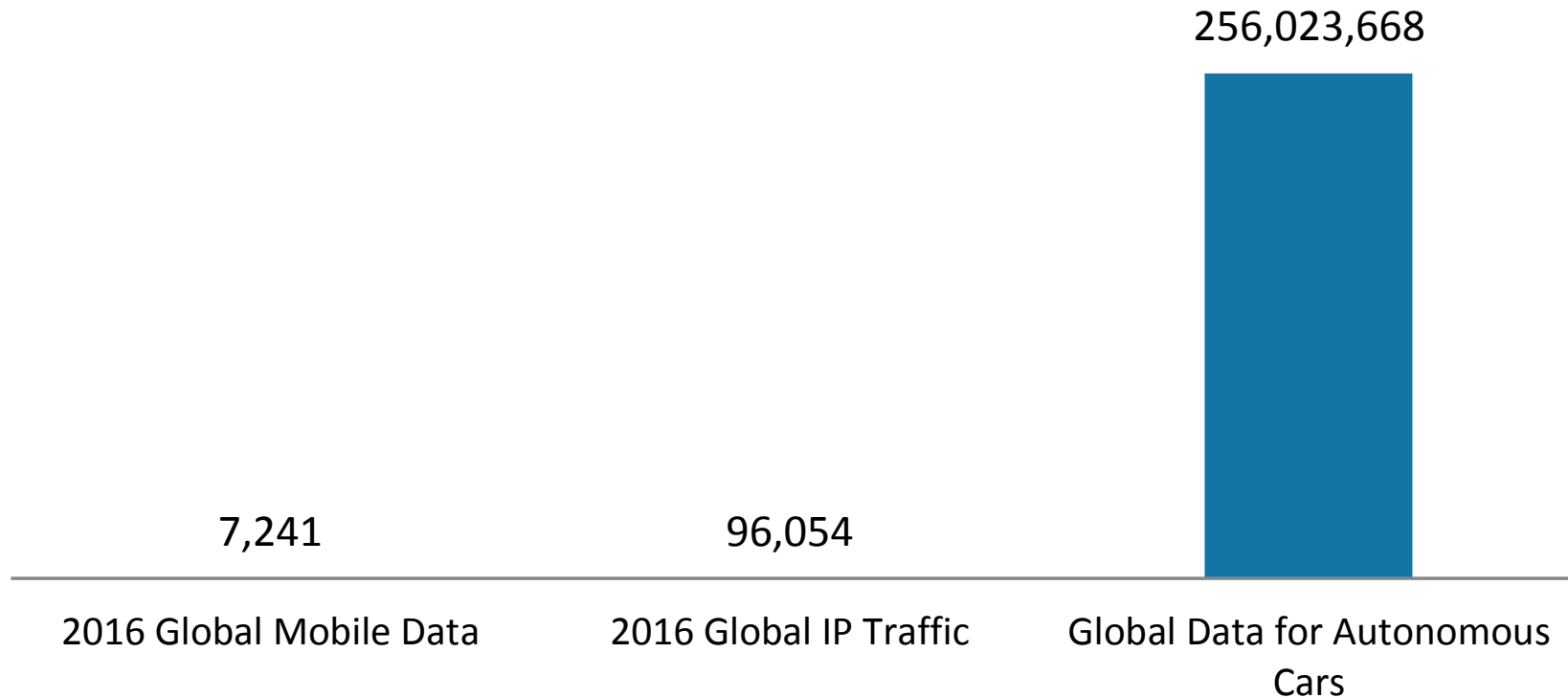
Global IP Traffic in 2040 Will Be ~60x v. 2016

Global IP Traffic (PB / Month)



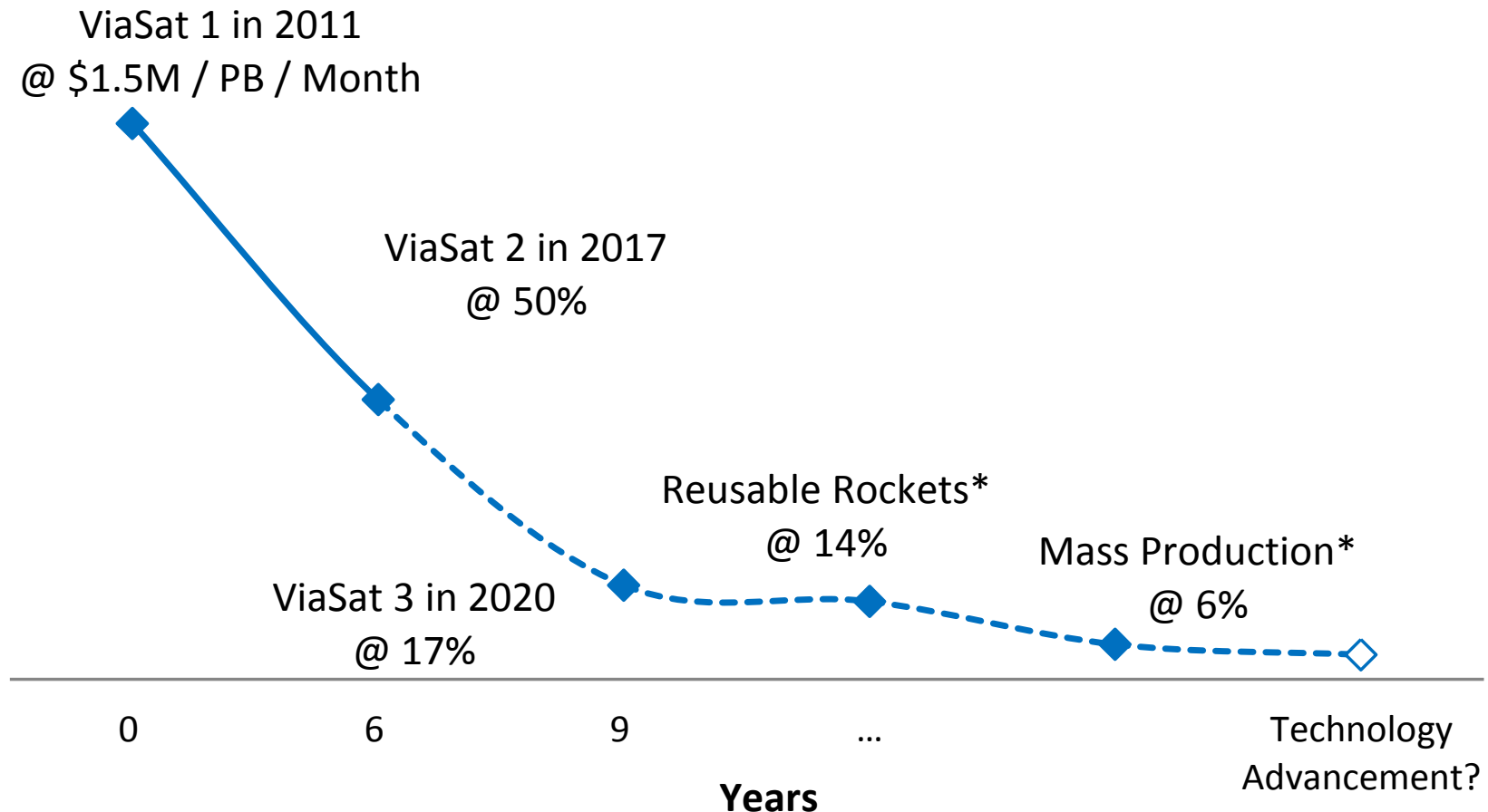
Internet of Things Are a Key Driver of Future Data Demand

Demand for Data in the World (PB / Month)



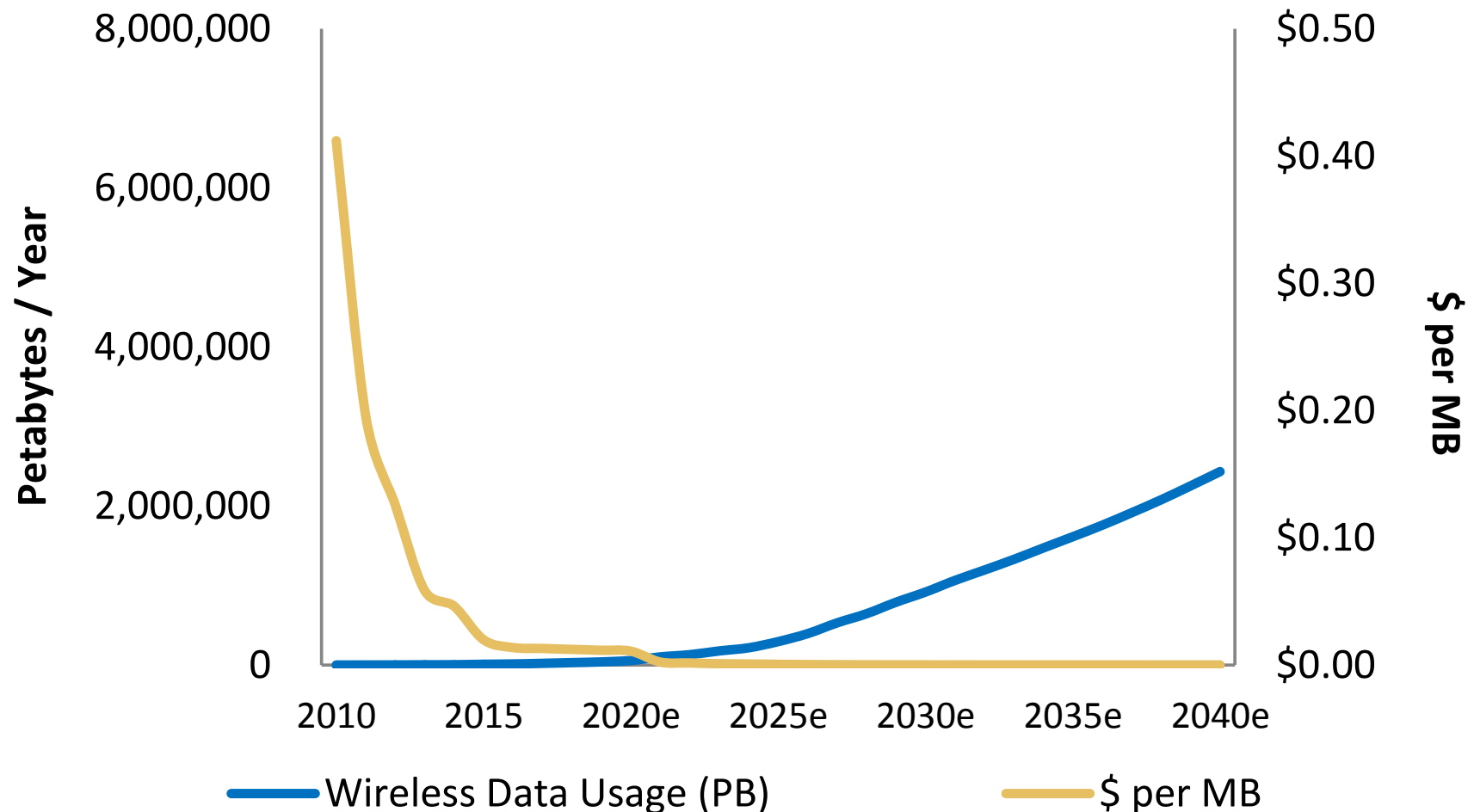
Improvements in Technology Lowering the Cost to Access Space

Cost Curve for Improvements in Satellite Technology



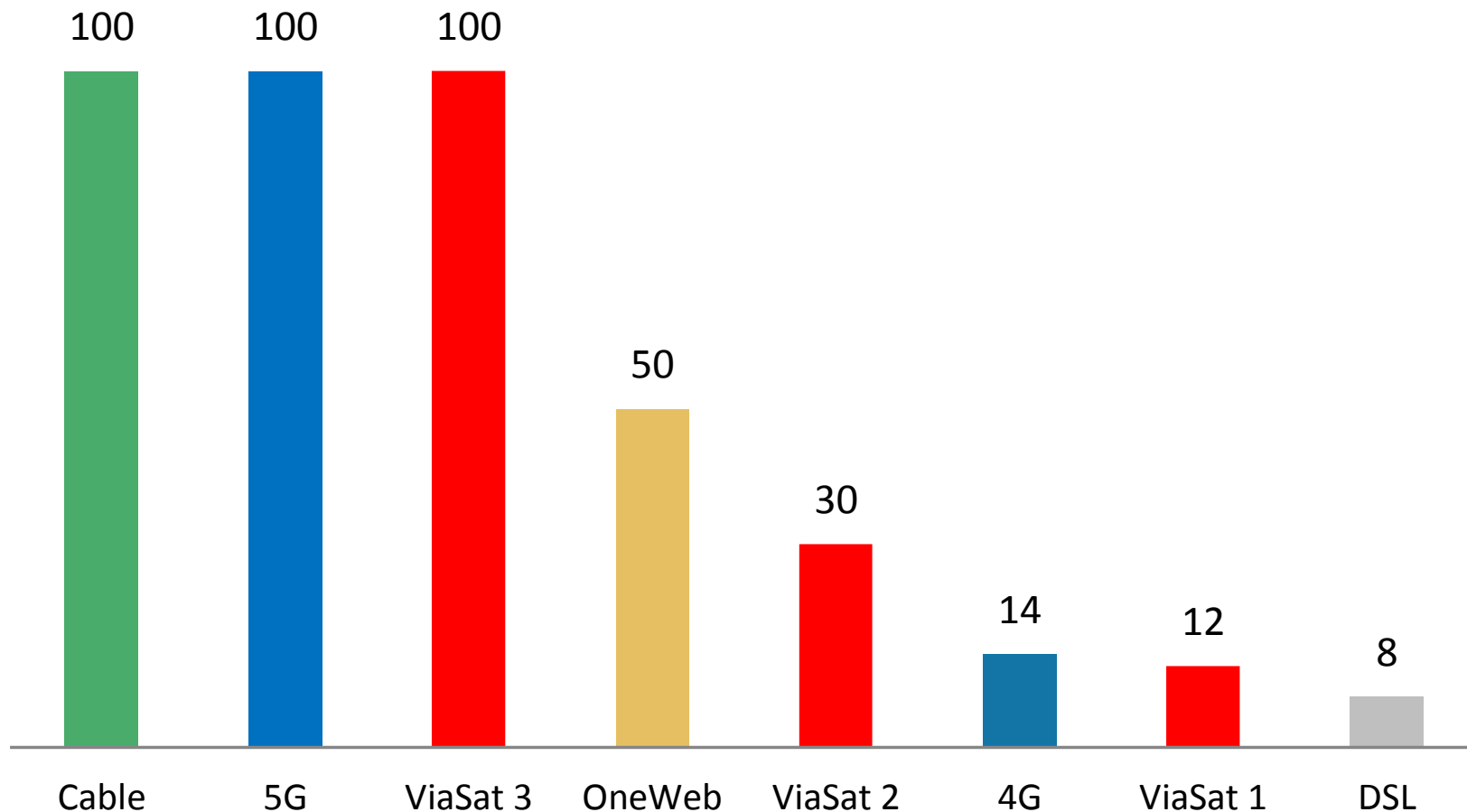
By 2040, the Cost of Wireless Data Will be <1% v. Today

US Demand for Mobile Data v. \$ for Data



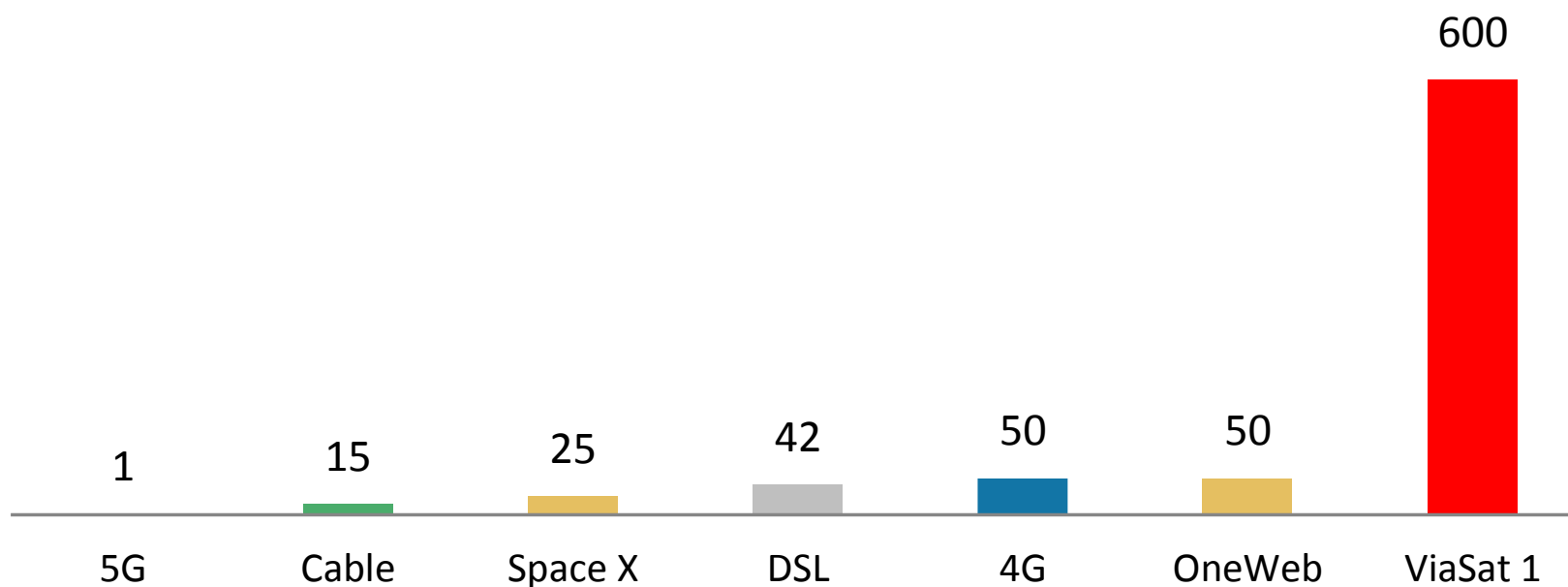
New Satellites Faster v. Legacy Wireline and Legacy Satellites

Advertised Network Speeds (Mbps)



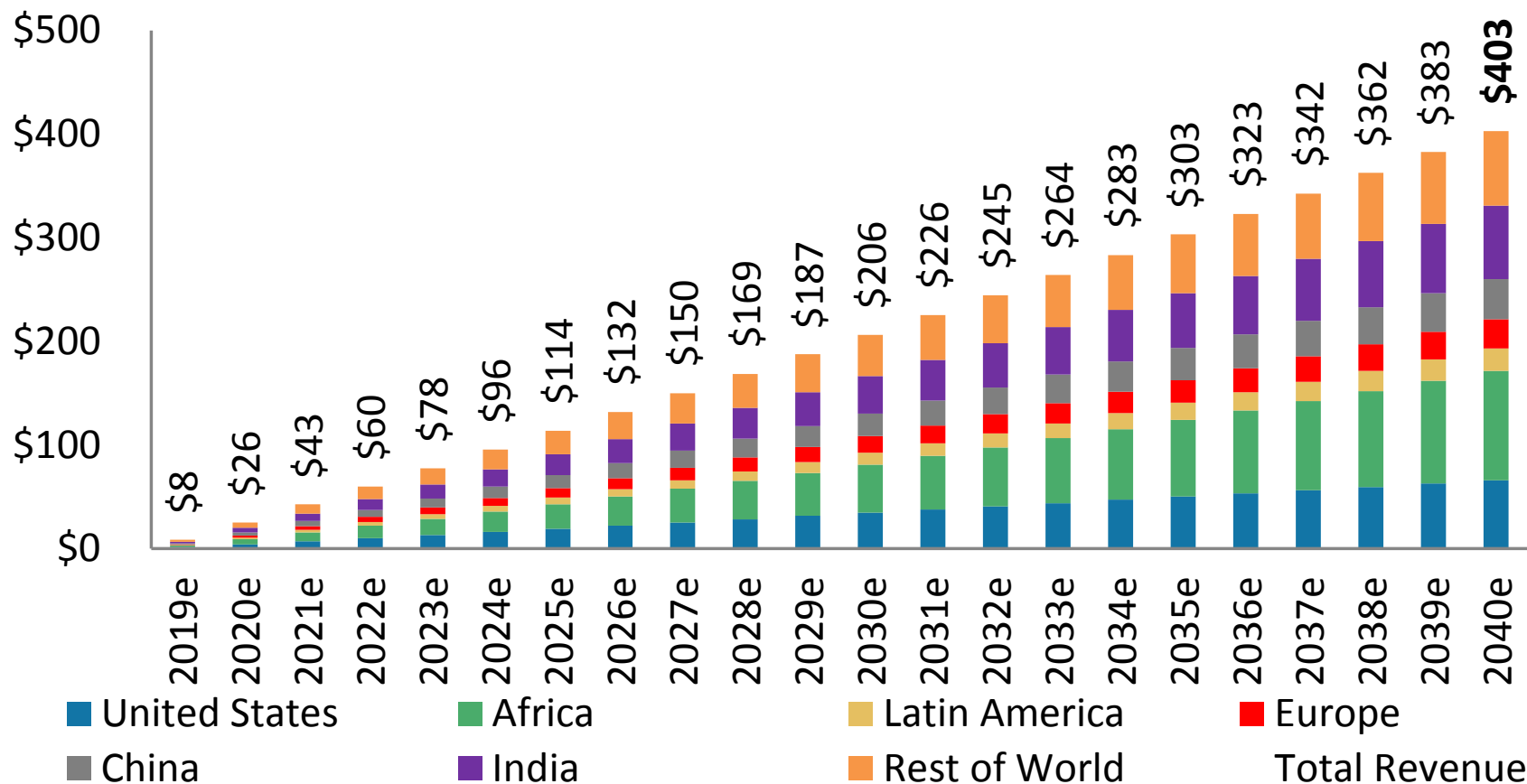
New Satellites Have Lower Latency v. Legacy Satellites

Network Latency (ms)



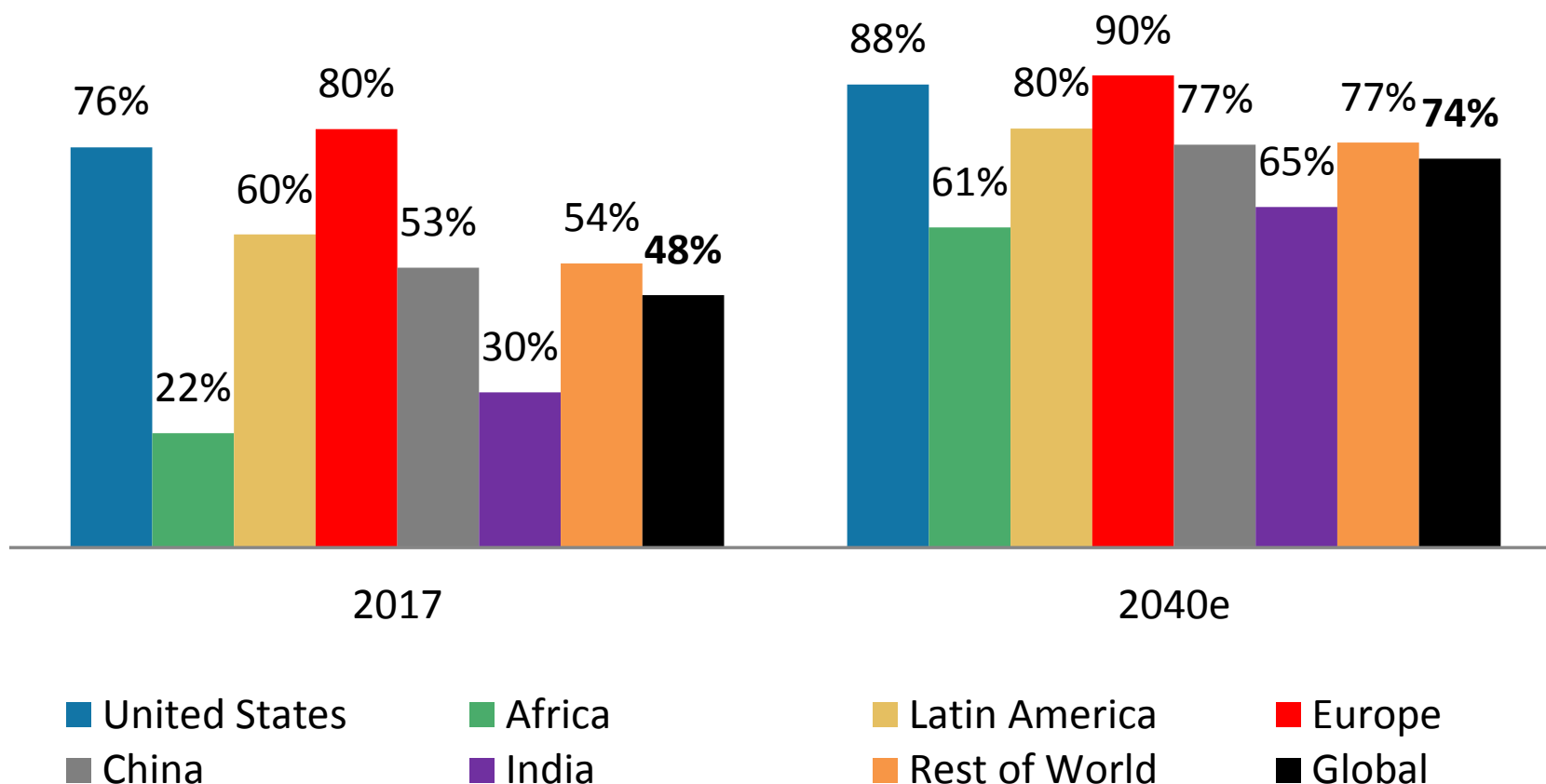
Expanding the TAM with Additional Bandwidth: New Geographies

Incremental Revenue Opportunity for Broadband (\$b)



Global Broadband Penetration Goes From ~50% to ~75%

% Broadband Penetration



Expanding the TAM with Additional Bandwidth: New Products & Services

Planes



Maritime



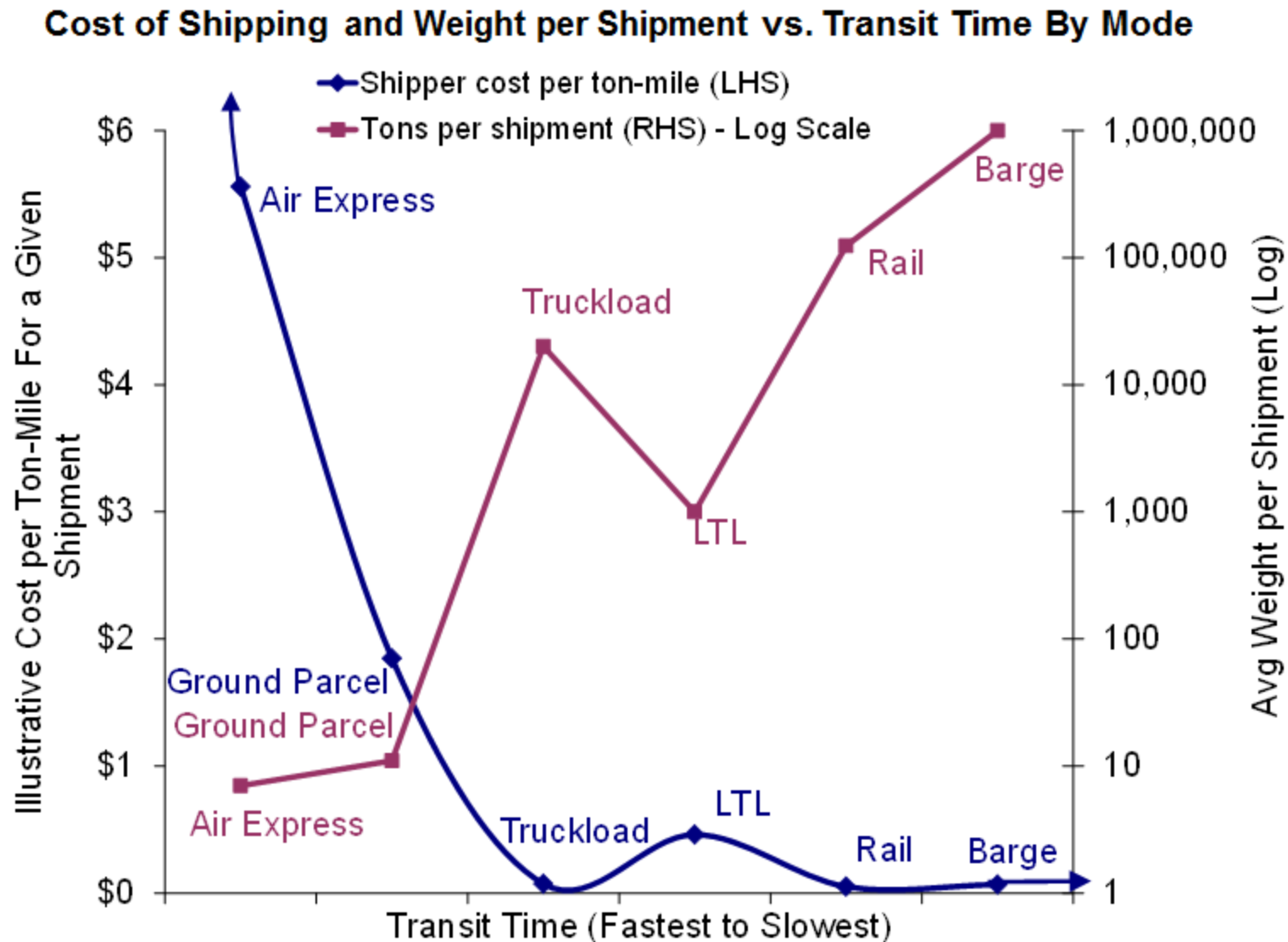
Trains & Trucks



Automobiles



































Potential Disruption for Space Freight Transportation



The Key Players

The Key Players

Consumer Television	Consumer Radio	Consumer Broadband	Fixed Satellite Services	Mobile Satellite Services	Low Earth Orbit Satellite Networks
 DIRECTV	 SiriusXM	ECHOSTAR	 eutelsat	 inmarsat	 OneWeb
 dish		 ViaSat	 INTELSAT	 iridium	 SPACEX
 sky			 SES	 Globalstar	 BOEING

Satellite Manufacturing		Satellite Launching		Earth Observation	Megatech
 United States	 France	 United States	 France	 planet.	 amazon
 United States	 Germany	 United Launch Alliance United States	 China	 Radiant Earth Imagery for Impact	 f
 United States	JSC Information Satellite Systems Russia	Proton Russia	Satellite Launch Vehicle India		 Google
 United States	 France	Soyuz Russia	 BLUE ORIGIN		 SoftBank

Getting to Know OneWeb and SpaceX



720 Low Earth Orbit Satellites @ Ka + Ku Band (Approved by the FCC) @ 150kg @ 1,200km

- **Investors**
 - \$1b from Softbank
 - \$700M from Airbus + Bharti Enterprises + Grupo Salinas + Hughes Network Systems (Echostar) + Intelsat + Qualcomm + Coca Cola + Virgin Group + MacDonald, Dettwiler and Associates
- **Timeline**
 - 10 Satellites in May 2018 + 32 Satellites Before the End of 2018
 - Low Latency Broadband Access in 2019?
- **Cost**
 - < \$500,000 per Satellite
- **Launch**
 - Ariespace: 21 Soyuz Rockets for \$1 billion+
 - Virgin Orbit: 39 Launches to Replenish Satellites + Optionality for 100 Additional Launches
 - Blue Origin: 5 Launches
- **Network**
 - Satellite Capacity: 7.5 Gbps
 - Download: Up to 50 Mbps
 - Upload: Up to 25 Mbps
 - Latency: ~50ms

+ **720** Low Earth Orbit Satellites @ V Band

+ **1,280** Medium Earth Orbit Satellites @ V Band

= **2,740** Satellites



7,518 Low Earth Orbit Satellites @ V Band

4,425 Low Earth Orbit Satellites @ Ka + Ku Band @ 850 lbs. / 386kg @ 1,150km to 1,275km

- **Investors**
 - \$1b from Google + Fidelity
- **Timeline**
 - 2019 to 2024
 - 12 to 15 Years for Full Capacity
- **Cost**
 - \$10b to \$15b
- **Launch**
 - SpaceX: 50 Satellites per Rocket
- **Network**
 - Satellite Capacity: 17 Gbps to 23 Gbps
 - Broadband Speeds: Up to 1 Gbps
 - Latency: 20ms to 30ms

= **11,943** Satellites

Interest From Megatech Companies & Billionaires



"We're also making progress on our efforts to connect people living in some of the most remote communities on earth. Our connectivity lab is working on new technologies for connecting communities that include drones, satellites, and laser communication systems." – Facebook CEO Mark Zuckerberg, July 2015

- Satellite: SpaceX rocket explosion destroyed the Amos-6 satellite in September 2016.
- Express WiFi: Connected 50M+ people by partnering with carriers, internet service providers, and local entrepreneurs.
- Aquila Unmanned Aircraft



"The long-term vision is millions of people living and working in space." – Amazon Founder Jeff Bezos, March 2017

Blue Origin

Amazon Founder Jeff Bezos is selling ~\$1 billion of Amazon stock / year to finance Blue Origin.

- 5 Successful Suborbital Flights in 2015 / 2016
- Commercial Flights in 2018
- New Glenn Rocket in 2020
- OneWeb @ 5 Launches w/ New Glenn
- mu Space Launch in 2021
- Eutelsat Satellite Launch in 2021 - 2022



- \$900M investment in SpaceX in January 2015.

Project Loon

"More than half of the world's population is still without internet access. Project Loon is a network of balloons traveling on the edge of space, designed to extend internet connectivity to people in rural and remote areas worldwide."

- Up to 10 Mbps
- @ 65,000 Feet
- 100+ Durations
- "... tens of thousands of dollars..." per Balloon

Billionaire	Source of Wealth	Space Investment	Net Worth (\$b)
Bill Gates	Microsoft	Kymeta	\$87
Jeff Bezos	Amazon	Blue Origin	\$85
Mark Zuckerberg	Facebook	SETI	\$73
Larry Page	Google	Planetary Resources	\$50
Sergey Brin	Google	SpaceX	\$48
La Ka-shing	CK Hutchison	Windward	\$34
Sheldon Adelson	Las Vegas Sands	SpaceIL	\$33
Paul Allen	Microsoft	Stratolaunch	\$23
Elon Musk	Tesla	SpaceX	\$21
Eric Schmidt	Google	Planetary Resources	\$13
Ricardo Salinas	Grupo Elektra	OneWeb	\$9
Richard Branson	Virgin Group	Virgin Galactic	\$5
Lynn Schusterman	Samson Investment	SpaceIL	\$5
Yuri Milner	DST Global	Planetary Resources	\$5
Marc Benioff	Salesforce	Taranis	\$5

SpaceX

Hypothetical DCF Based Valuation Range for SpaceX

BEAR CASE

Satellite Launch

Terminal Value	10,019
NPV of Terminal Value	1,119
NPV of Cash Flows	2,182
NPV of Satellite Launch	\$3,301

Add: Cash 1,350

NPV \$4,651

DCF Assumptions:

% WACC	10.0%
% Terminal Growth Rate	1.5%

DCF VALUATION

Satellite Launch

Terminal Value	3,283
NPV of Terminal Value	367
NPV of Cash Flows	627
NPV of Satellite Launch	\$993

Satellite Internet

Terminal Value	215,126
NPV of Terminal Value	24,025
NPV of Cash Flows	32,150
Less: Investment	(12,500)
NPV of Satellite Internet	\$43,675

Add: Cash 1,350

NPV \$46,018

DCF Assumptions:

% WACC	10.0%
% Terminal Growth Rate	3.0%

BULL CASE

Satellite Launch

Terminal Value	3,283
NPV of Terminal Value	367
NPV of Cash Flows	627
NPV of Satellite Launch	\$993

Satellite Internet

Terminal Value	455,815
NPV of Terminal Value	50,905
NPV of Cash Flows	79,868
Less: Investment	(12,500)
NPV of Satellite Internet	\$118,273

Add: Cash 1,350

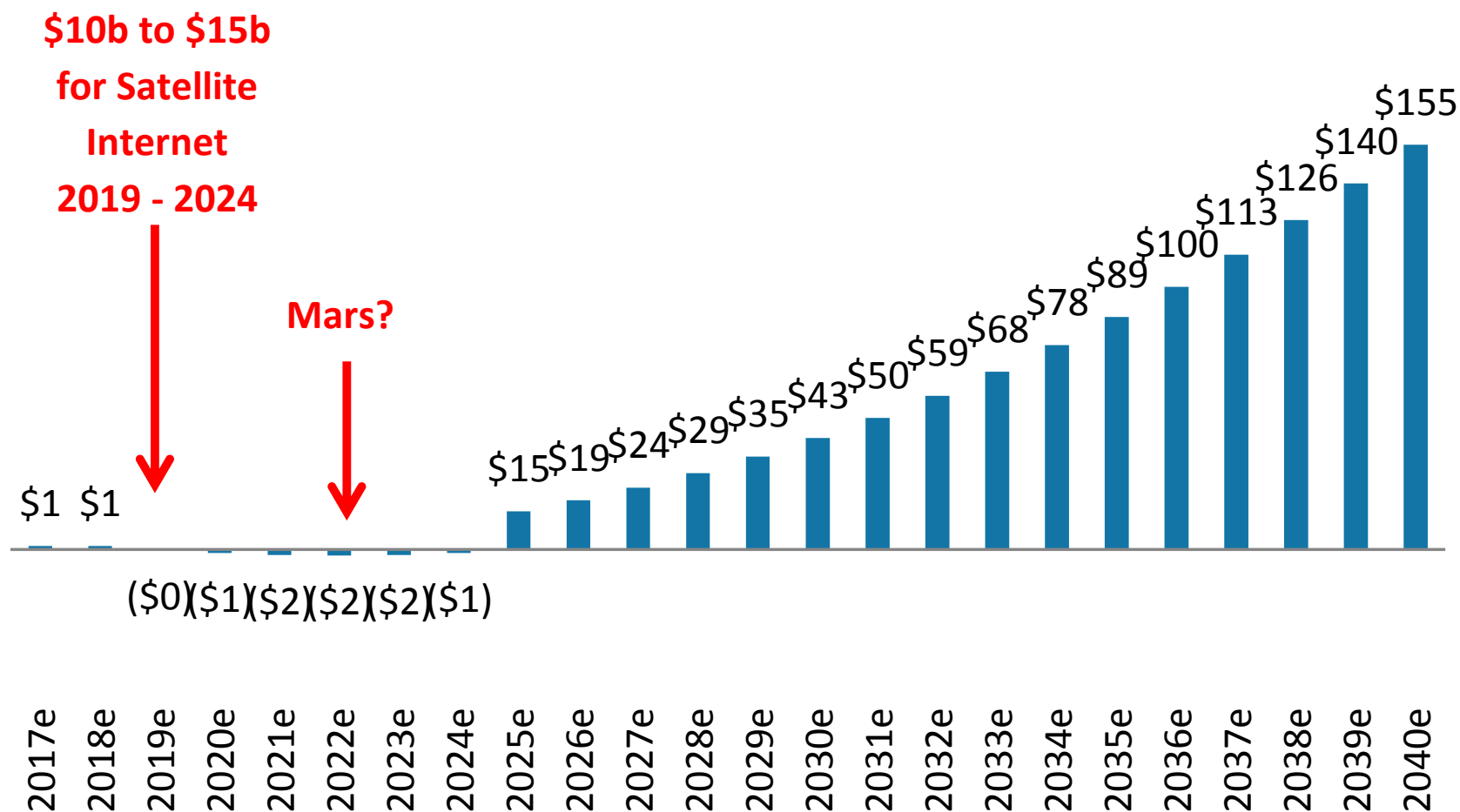
NPV \$120,616

DCF Assumptions:

% WACC	10.0%
% Terminal Growth Rate	3.0%

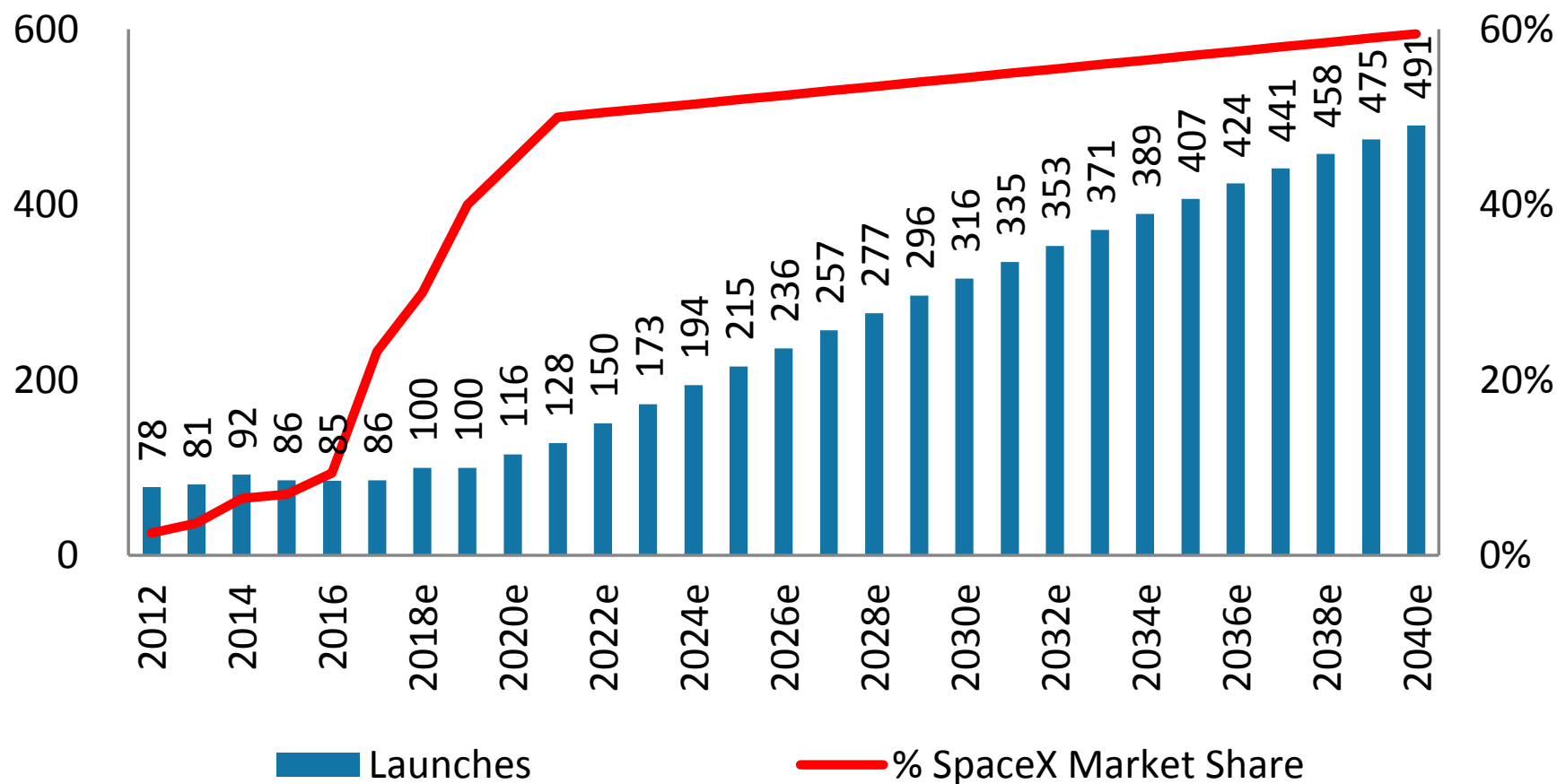
Monitoring SpaceX Cash Balance for Potential Capital Raise

Cash Balance (\$b)



Estimate SpaceX Represents ~60% Market Share of Launch by 2040

Satellite Launches / Year



SpaceX: Launch Log

Date	Satellite
2010	
June 4, 2010	Dragon
December 8, 2010	Dragon C1
2011	
2012	
May 22, 2012	Dragon C2+
October 7 / 8, 2012	SpaceX CRS 1
2013	
March 1, 2013	SpaceX CRS 2
September 29, 2013	Cassiope
December 3, 2013	SES 8
2014	
January 6, 2014	Thaicom 6
April 18, 2014	SpaceX CRS 3
July 14, 2014	Orbcomm OG2
August 5, 2014	AsiaSat 8
September 7, 2014	AsiaSat 6
September 21, 2014	SpaceX CRS
2015	
January 10, 2015	SpaceX CRS 5
February 11, 2015	DSCOVR
March 1 / 2, 2015	Eutelsat 115 West B & ABS 3A
April 14, 2015	SpaceX CRS 6
April 27, 2015	TurkmenAlem52E/MonacoSat
June 28, 2015	SpaceX CRS 7
December 21 / 22, 2015	Orbcomm OG2
2016	
January 17, 2016	Jason 3
March 4, 2016	SES 9
April 8, 2016	SpaceX CRS 8
May 6, 2016	JCSAT 14
May 27, 2016	Thaicom 8
June 15, 2016	ABS 2A & Eutelsat 117 West B
July 18, 2016	SpaceX CRS 9
August 14, 2016	JCSAT 16

Date	Satellite
2017	
January 14, 2017	Iridium Next 1-10
February 19, 2017	SpaceX CRS 10
March 16, 2017	EchoStar 23
March 30, 2017	SES 10
May 1, 2017	NROL-76
May 15, 2017	Inmarsat 5 F4
June 3, 2017	SpaceX CRS 11
June 23, 2017	BulgariaSat 1
June 25, 2017	Iridium Next 11-20
July 5, 2017	Intelsat 35e
August 14, 2017	SpaceX CRS 12
August 24, 2017	Formosat 5
September 7, 2017	OTV-5
October 9, 2017	Iridium Next 21-30
October 11, 2017	SES 11 / EchoStar 105
October 30, 2017	Koreasat 5A
November 15 / 16, 2017	Zuma
December 4, 2017	SpaceX CRS 13
December 2017	Hispasat 30W-6
Late 2017	Falcon Heavy
December 22 / 23, 2017	Iridium Next 31-40
2018	
Mid January 2018	SES 16 / GovSat 1
January 30, 2017	Paz
February 9, 2018	SpaceX CRS 14
1Q18	Iridium Next 41-50
February 2018	SES 12
February 2018	Bangabandhu 1
Early 2018	Arabsat 6A
March 20, 2018	TESS
April 2018	Crew Dragon Demo 1
April 30, 2018	STP-2

National Security

AFSPC, NRO, and NGA Are the Key US Government Players



Air Force Space Command (AFSPC):

AFSPC provides space capabilities for the joint fight through the operational missions of space lift; position, navigation and timing; satellite communications; missile warning and space control.



National Reconnaissance Office (NRO):

NRO develops and operates unique and innovative overhead reconnaissance systems and conducts intelligence-related activities for U.S. national security.



National Geospatial-Intelligence Agency (NGA):

NGA provides imagery, geospatial, and targeting analysis, along with image sciences and modeling for U.S. national defense, disaster relief, and safety of navigation.

US Government Sponsored VCs and Investments in Space



IQT.
IN-Q-TEL

"IQT is the non-profit strategic investor that accelerates the development and delivery of cutting-edge technologies to U.S. government agencies that keep our nation safe. Our work bridges the gap between the challenging technology needs of the national security agencies, the rapidly changing innovations of the startup world, and the venture community that funds those startups."

Space Focus: CosmiQ Works, an IQT lab, focuses on commercial space technology from reliable sensor



Orbital Insight

Orbital Insight leverages satellite, UAV, and other geospatial data sources. The company's goal is to understand and characterize socioeconomic trends at global, regional, and hyperlocal scales.



**DEFENSE INNOVATION
UNIT EXPERIMENTAL**

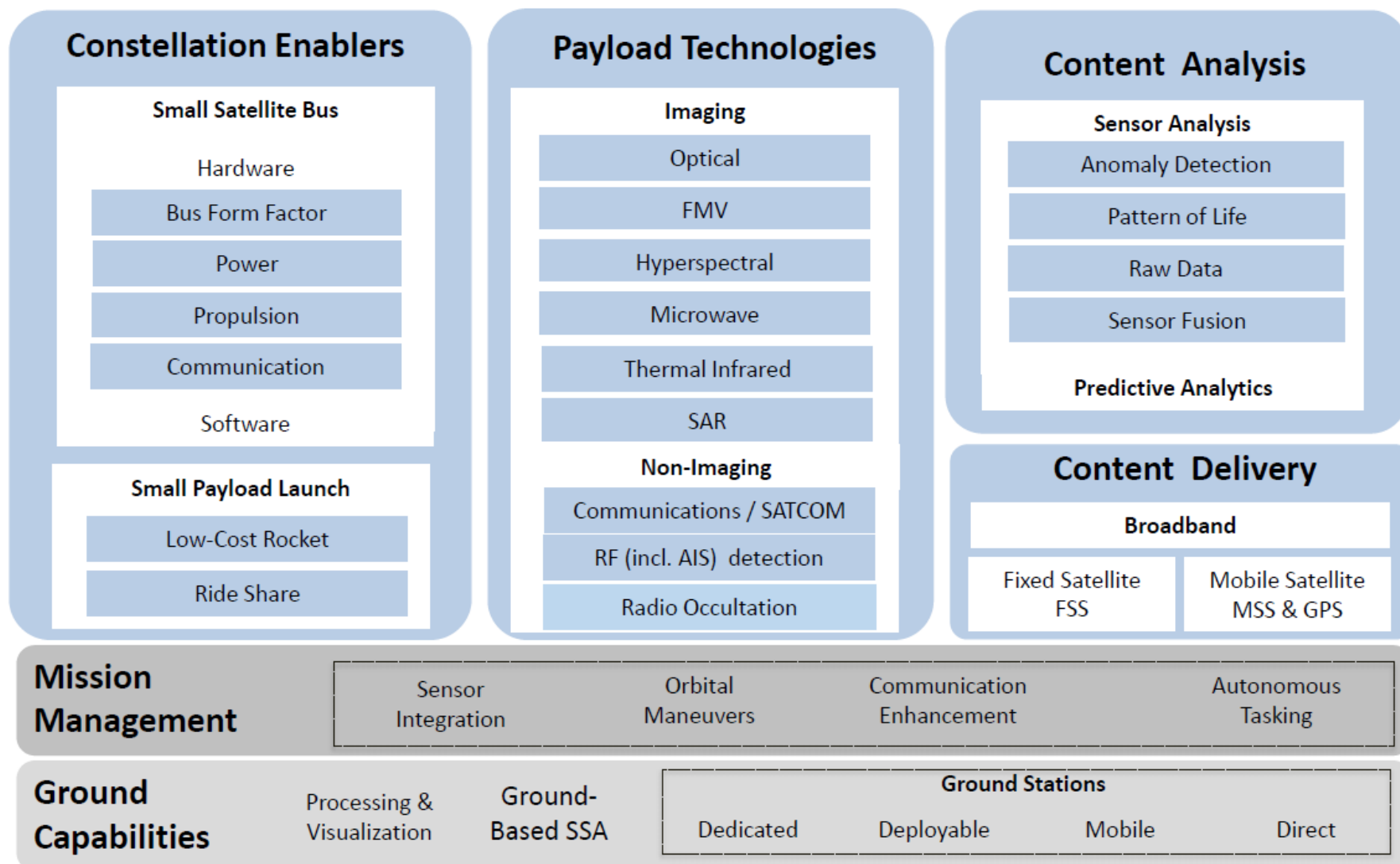
"DIUx is a fast-moving government entity that provides non-dilutive capital to companies to solve national defense problems. And we do so quickly, usually in under 90 days. Pilot contracts can include hardware, software, or unique services. More importantly, after a successful pilot, the company involved and any DoD entity can easily enter into follow-on contracts, just as fast."

Space Focus: Developing on demand access to space, persistent satellite capabilities, and broadband space data transfer.



Capella Space: Department of Defense is using Capella Space's SAR micro satellite persistent Earth imagery for near real time awareness of natural and manmade threats.

The CosmiQ Works Framework for Commercial Space

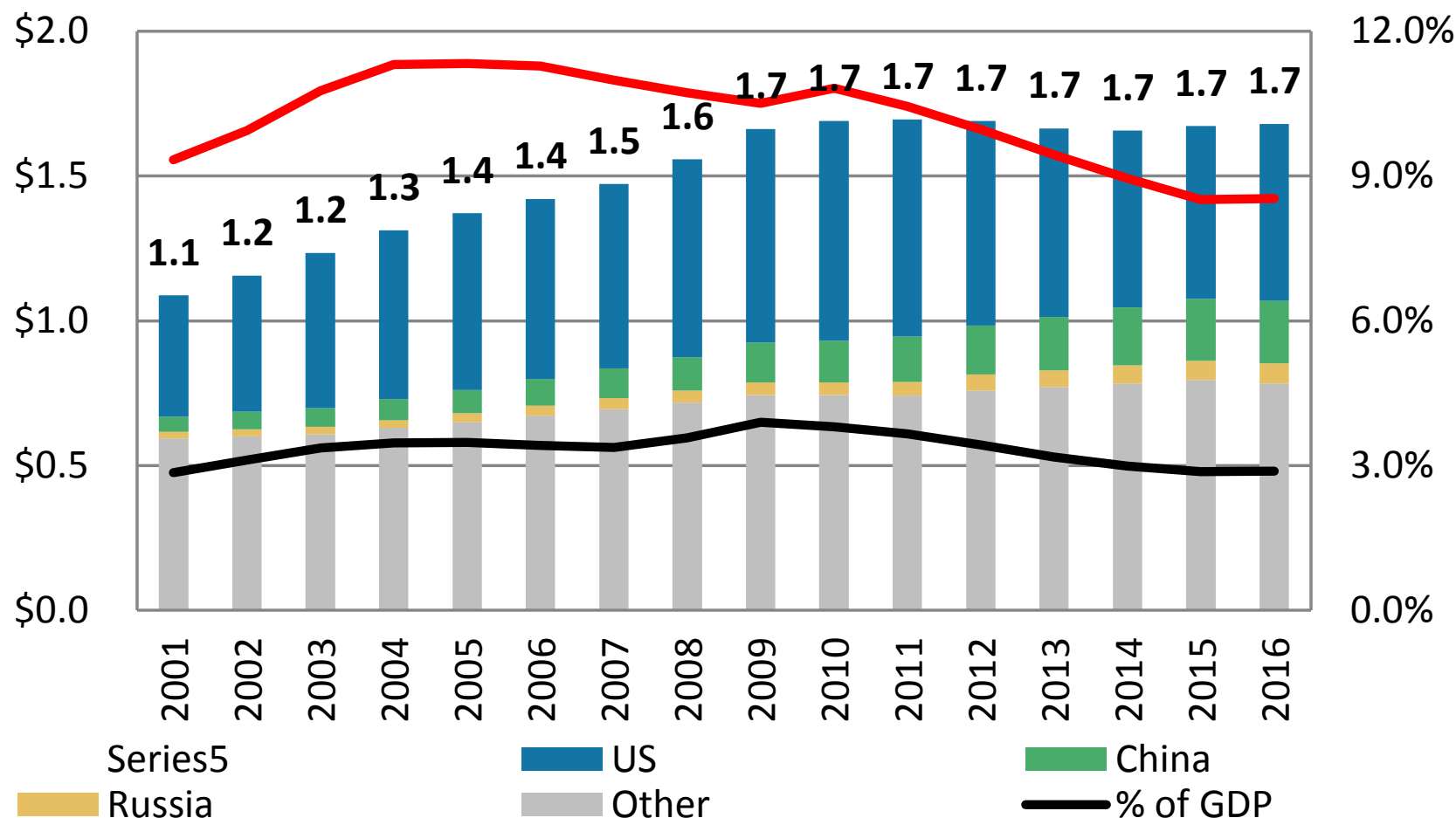


Major US Domestic Unclassified Programs

Programs	Agency	Contractor	FY18 Budget
Advanced Extremely High Frequency (AEHF)	Air Force	Lockheed Martin (Bus); Northrop Grumman (Payload)	\$203M
Evolved Expendable Launch Vehicle (EELV)	Air Force	United Launch Alliance; SpaceX	\$1.9B
Global Positioning System (GPS) III	Air Force	Lockheed Martin (Bus); Harris (Payload)	\$329M
GPS Next Generation Operational Control Systems (GPS OCX)	Air Force	Raytheon	\$510M
Space Based Infrared System (SBIRS)	Air Force	Lockheed Martin (Bus); Northrop Grumman (Payload)	\$1.4B
Experimental Spaceplane One (XS-1)	DARPA	Boeing	\$60M
Robotic Servicing of Geosynchronous Satellites (RSGS)	DARPA	MacDonald, Dettwiler and Associates	\$79M
James Webb Space Telescope	NASA	Northrop Grumman	\$534M
Orion Multi-Purpose Crew Vehicle	NASA	Lockheed Martin	\$1.3B

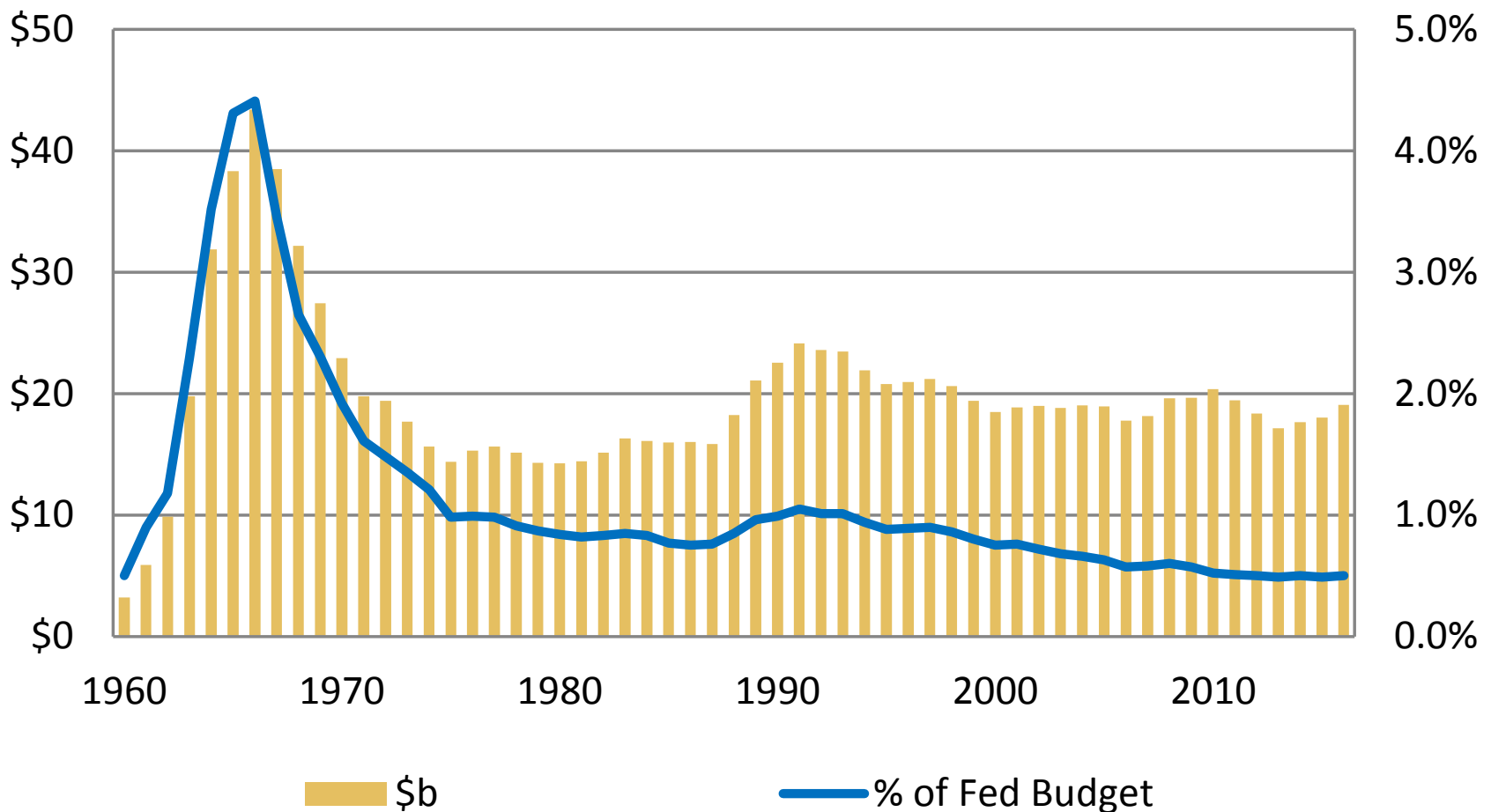
United States Annual Military Expenditures at \$600b+

Military Expenditure (Based on 2015 \$s, \$t)



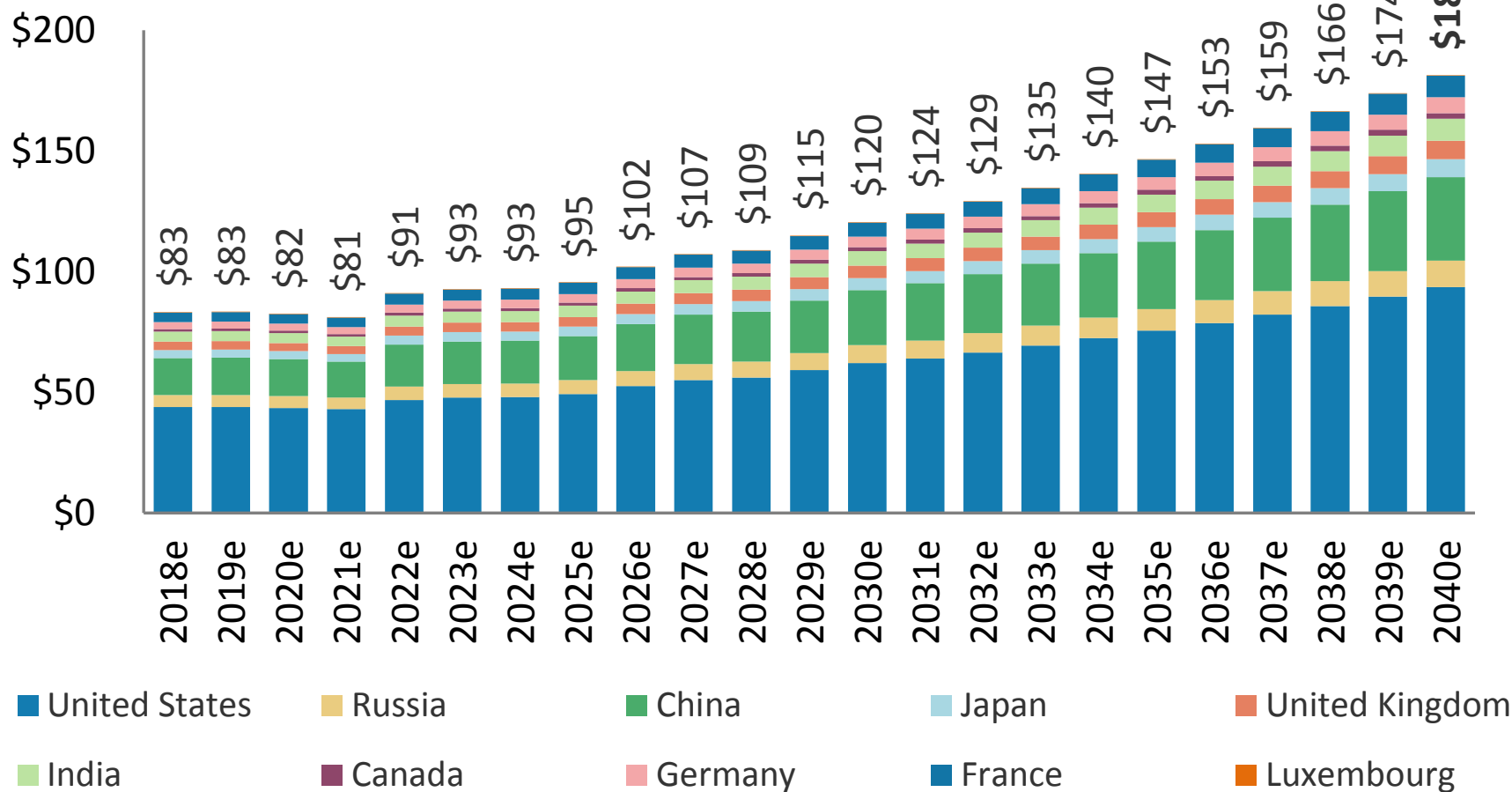
v. NASA Annual Budget Currently at ~\$20b

NASA Budget (Based on 2015 \$s, \$b)



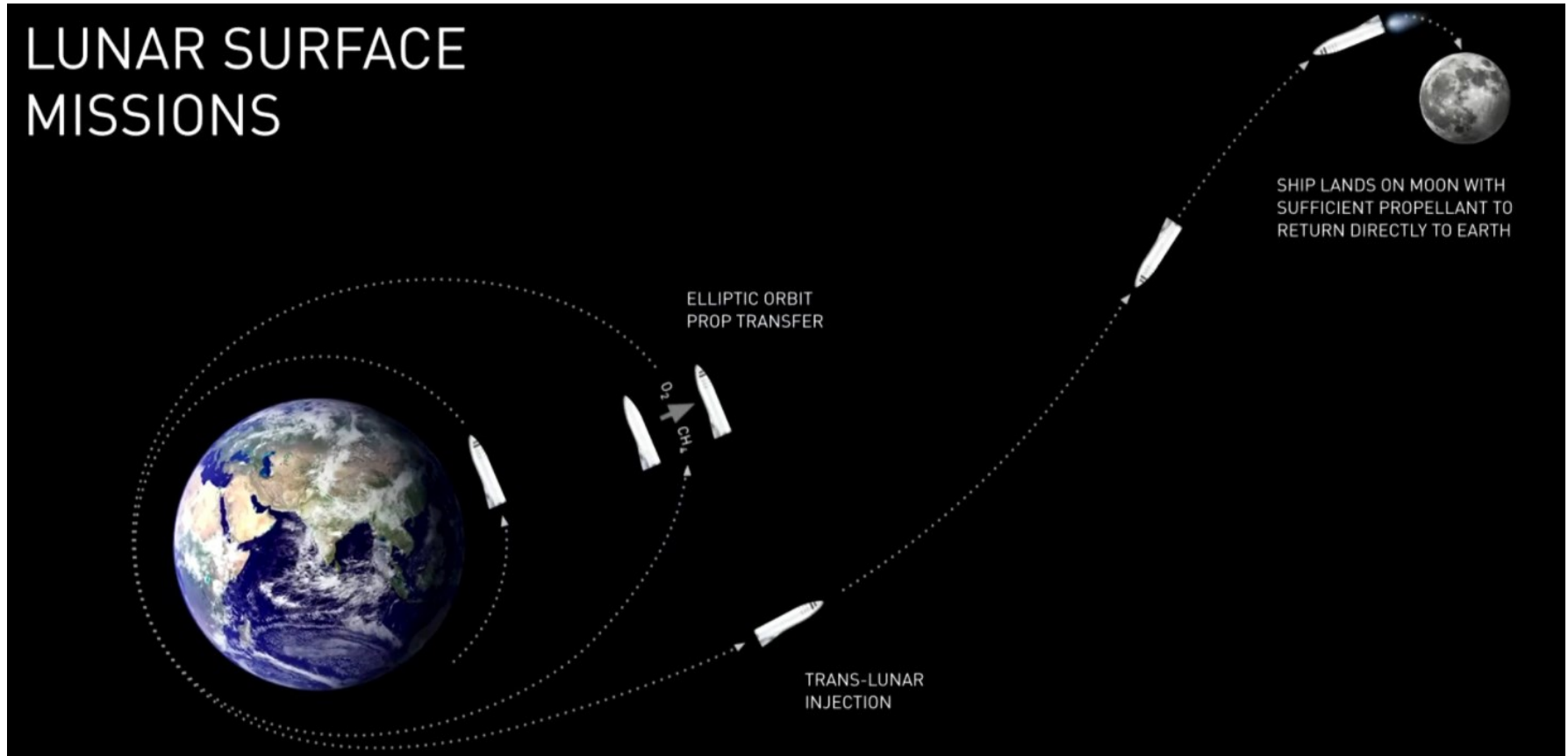
US Government Spending Will Increase ~2x to \$90b+, or 50%+ of Global Government Spending on Space by 2040

Global Government Spending on Space (\$b)

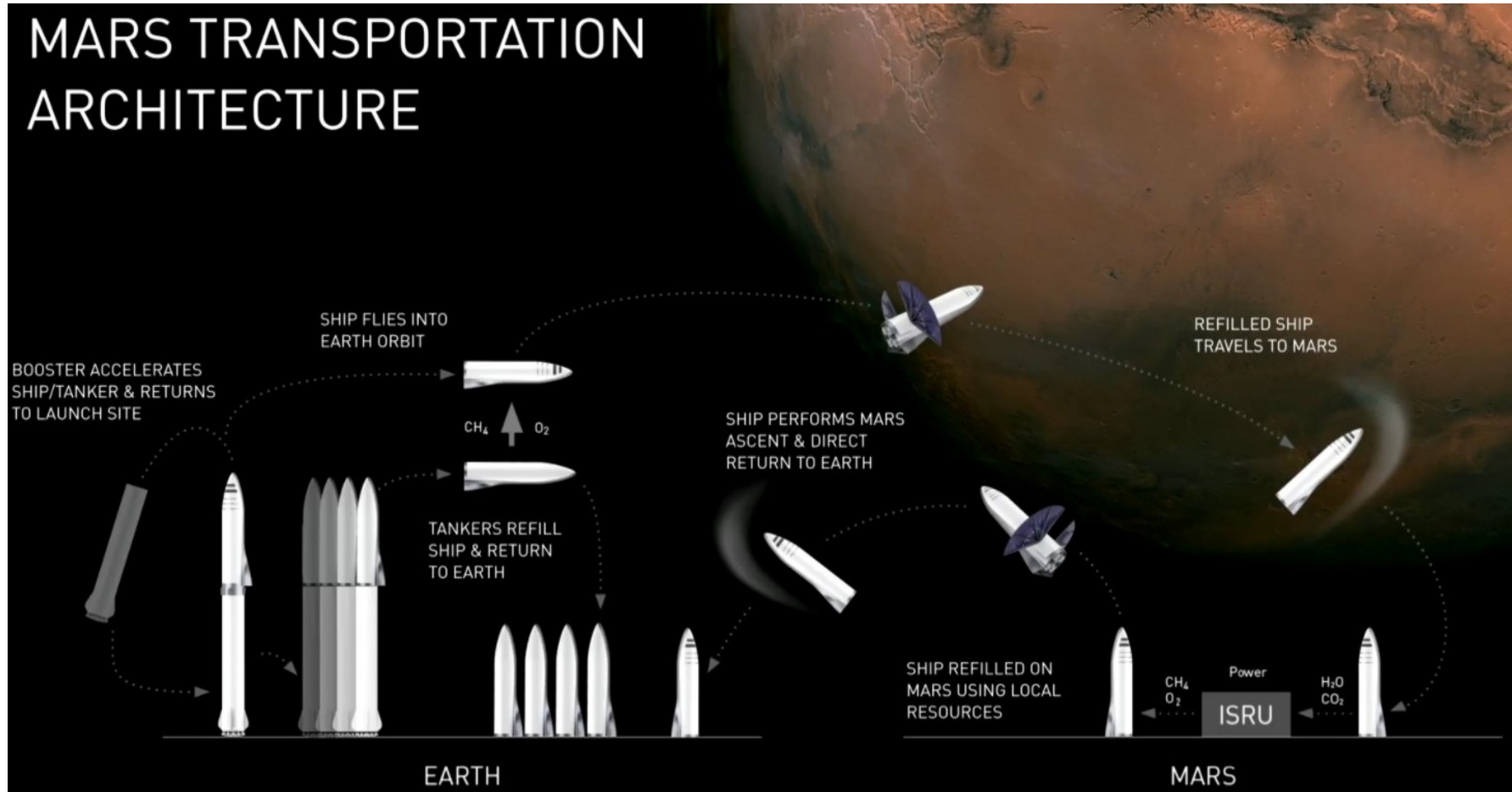


Deep Space Exploration

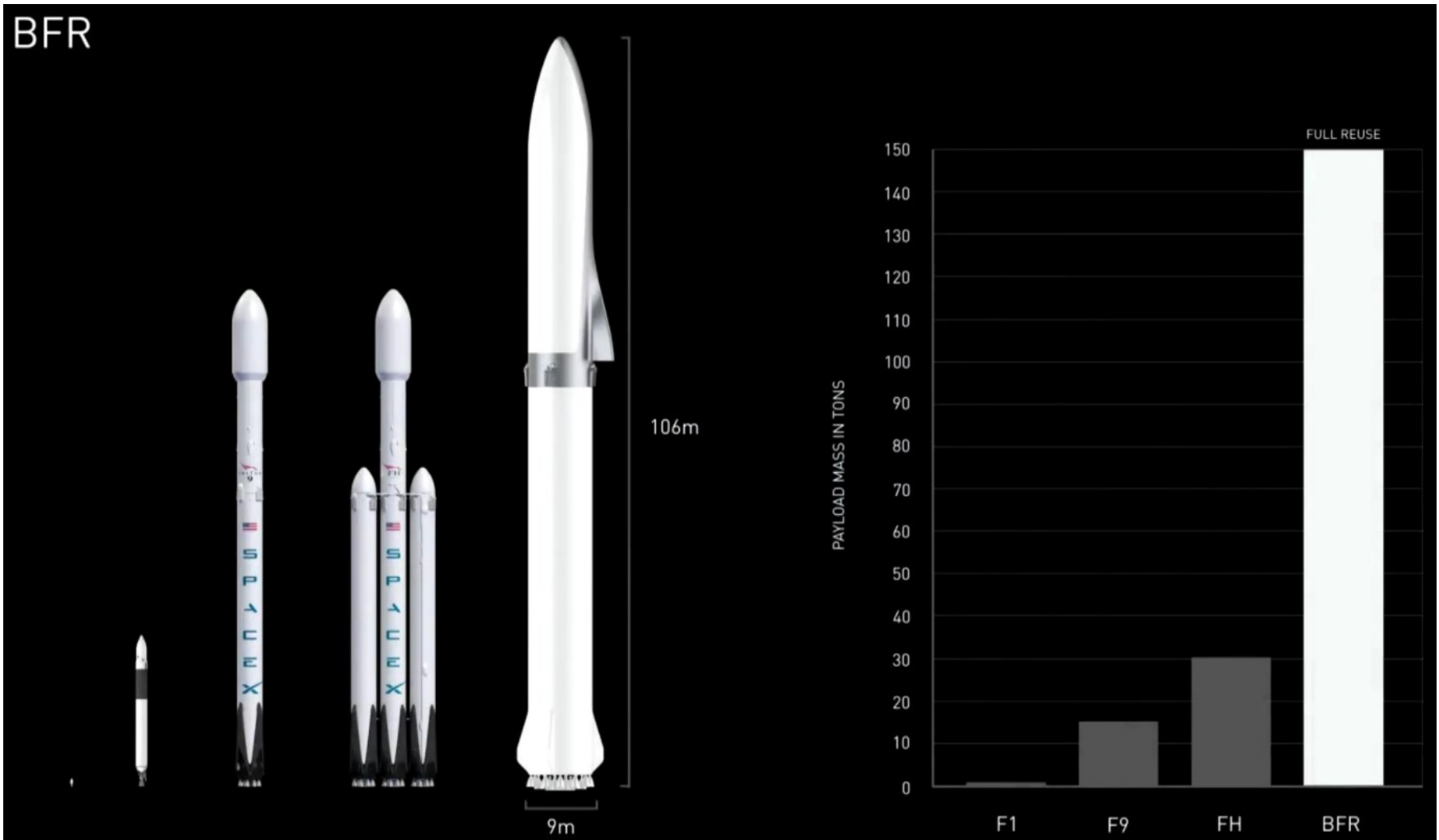
SpaceX Design for Travel to the Moon



SpaceX Design for Travel to Mars



SpaceX Design for BFR Rocket

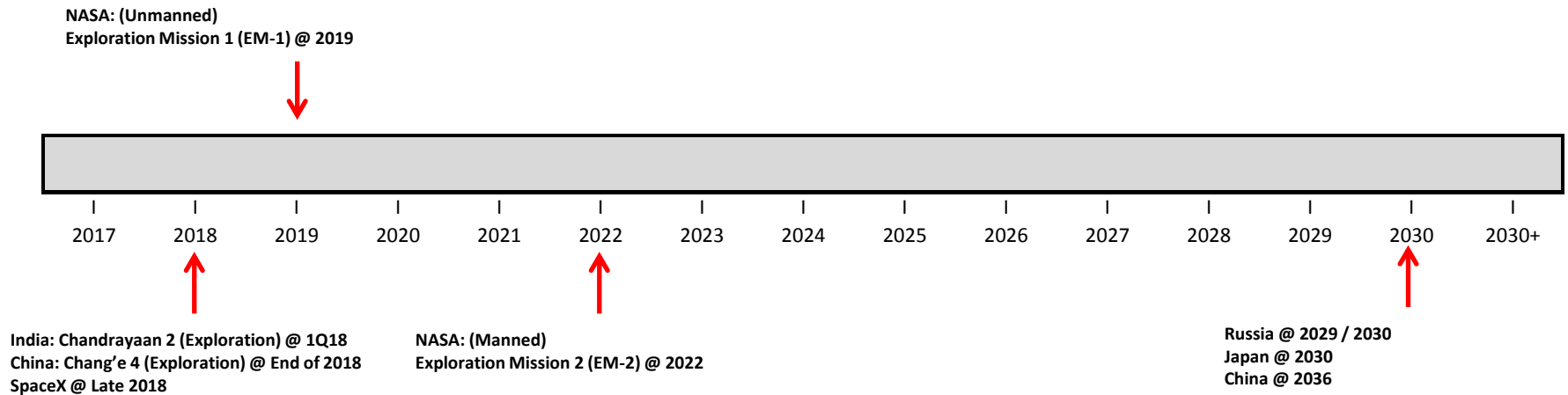


Mars Science City in UAE

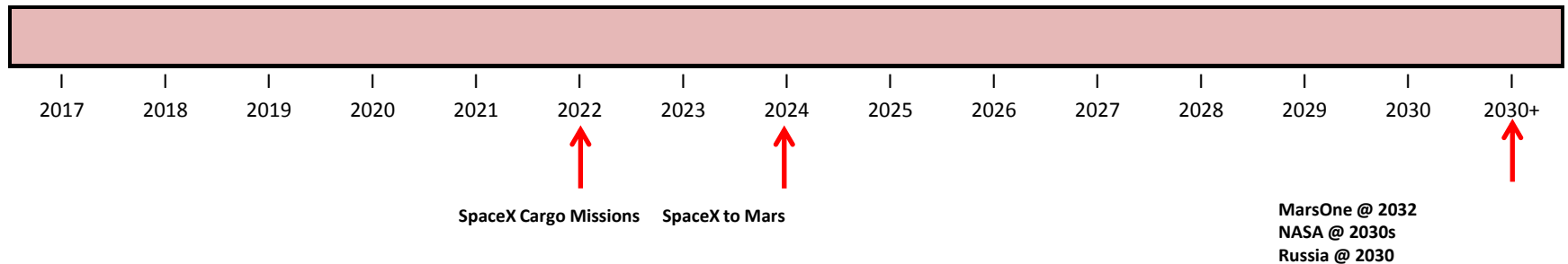


Key Projects for the Moon and Mars

Moon



Mars

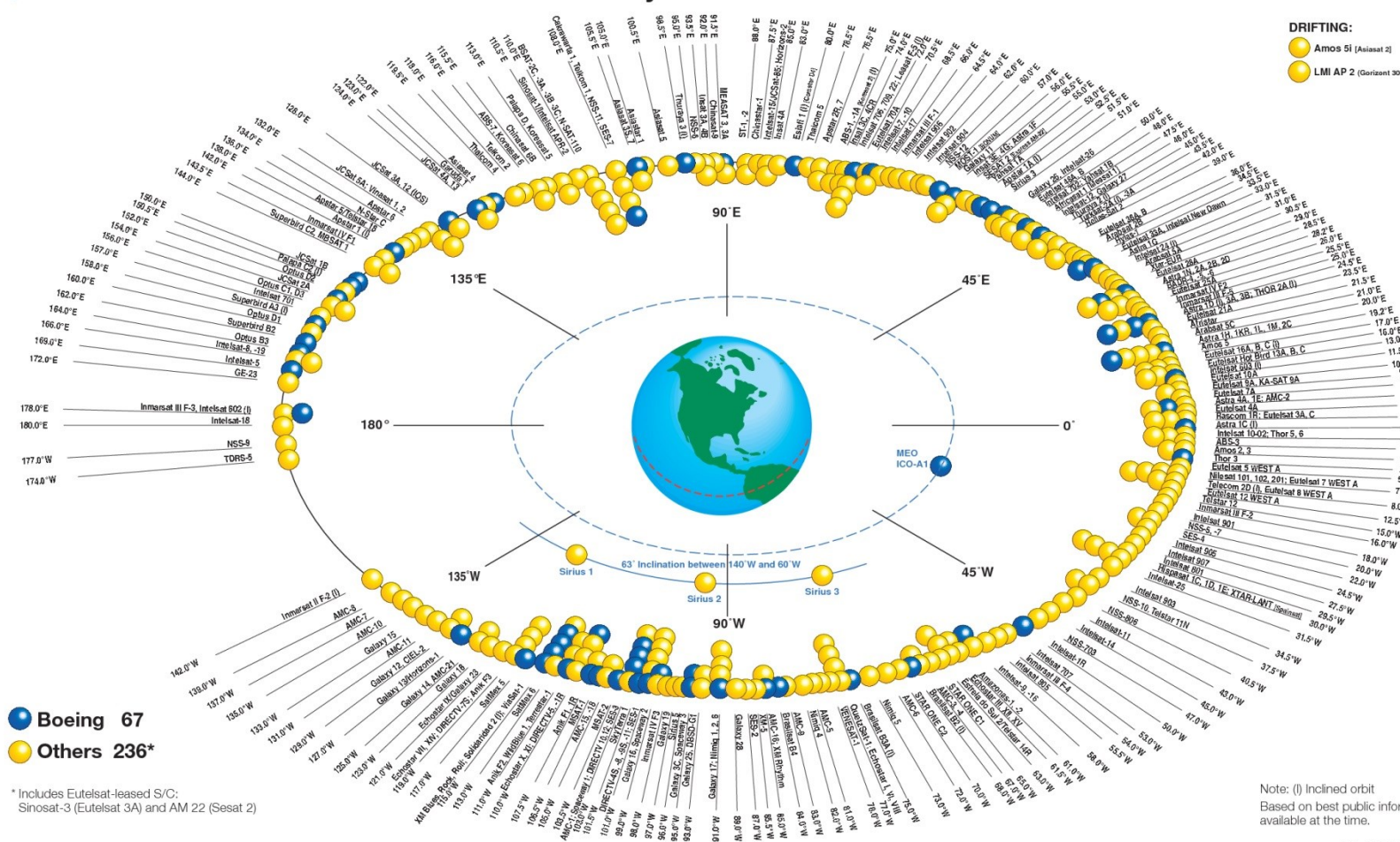


Appendix

Geo Stationary Orbital Slots

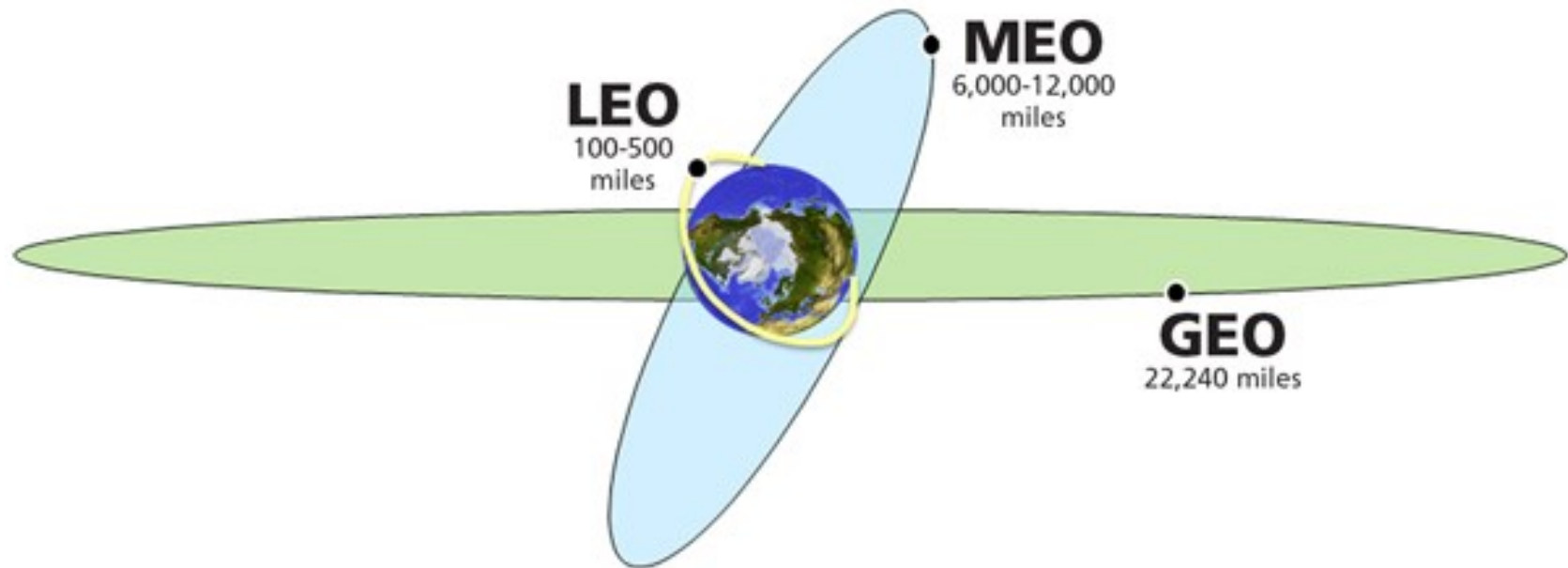


Commercial Communications Satellites Geosynchronous Orbit

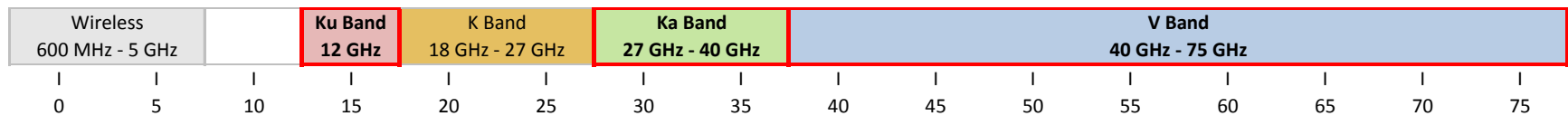


Spectrum Bands

Low Earth Orbit v. Medium Earth Orbit v. Geo Stationary Orbit

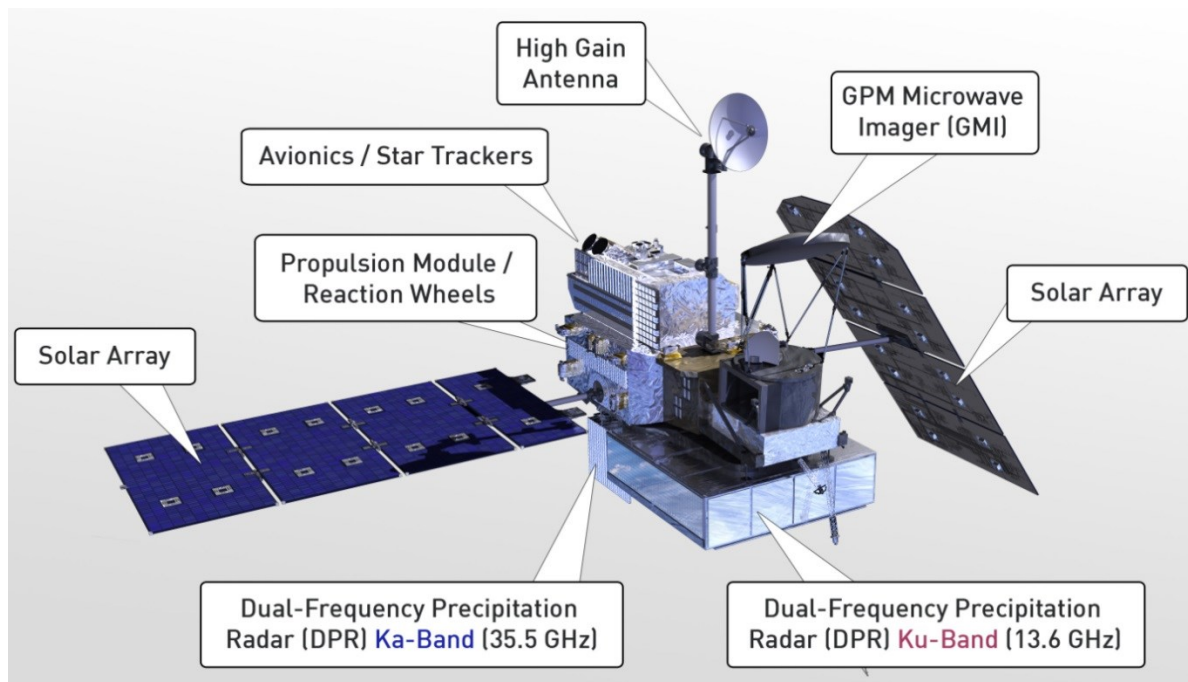


Spectrum Bands



Types of Satellites

Anatomy of a Satellite

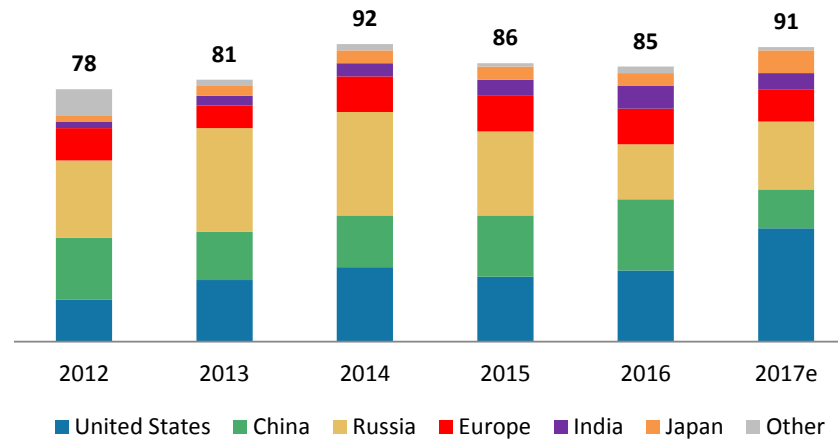


What Are Small Sats?

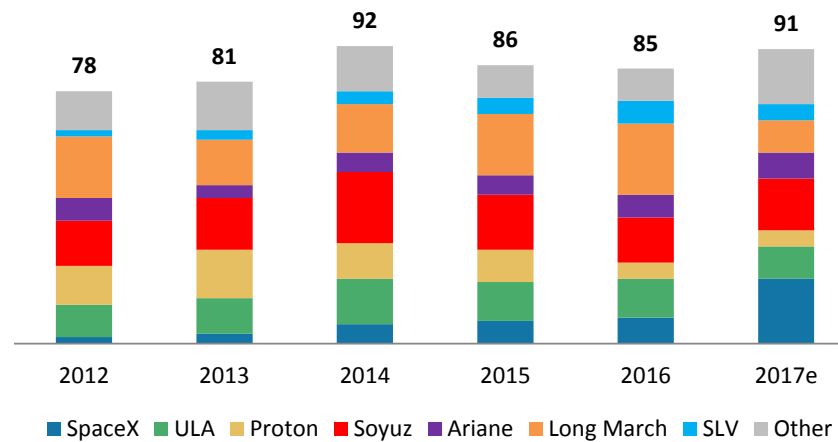
- Femtosatellite @ 10g to 100g
- Picosatellite @ 100g to 1kg
- Nanosatellite @ 1kg to 10kg
- Microsatellite @ 10kg to 100kg
- Minisatellite @ 100kg to 180kg

Satellite Launches

Satellite Launch Events (By Country)



Satellite Launch Events (By Rocket)



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(as of October 31, 2017)

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STOCK RATING CATEGORY	COVERAGE UNIVERSE		INVESTMENT BANKING CLIENTS (IBC)			OTHER MATERIAL INVESTMENT SERVICES CLIENTS (MISC)	
	COUNT	% OF TOTAL	COUNT	% OF TOTAL IBC	% OF RATING CATEGORY	COUNT	% OF TOTAL OTHER MISC
Overweight/Buy	1154	36%	293	39%	25%	562	38%
Equal-weight/Hold	1413	44%	359	48%	25%	682	46%
Not-Rated/Hold	56	2%	6	1%	11%	9	1%
Underweight/Sell	606	19%	92	12%	15%	237	16%
TOTAL	3,229		750			1490	

Data include common stock and ADRs currently assigned ratings. Investment Banking Clients are companies from whom Morgan Stanley received investment banking compensation in the last 12 months. Due to rounding off of decimals, the percentages provided in the "% of total" column may not add up to exactly 100 percent.

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Adam Jonas, CFA		
Alient PLC (ADNT.N)	O (02/21/2017)	\$84.36
American Axle & Manufacturing Holdings Inc (AXL.N)	U (09/08/2011)	\$17.79
Asbury Automotive Group Inc (ABG.N)	U (09/12/2012)	\$61.40
AutoNation Inc. (AN.N)	O (07/13/2015)	\$47.40
Avis Budget Group Inc (CAR.O)	U (03/19/2013)	\$41.25
BorgWarner Inc. (BWAN)	U (10/19/2015)	\$52.72
Carmax Inc (KMX.N)	U (02/01/2017)	\$75.10
Delphi Automotive PLC (DLP.N)	U (11/29/2016)	\$99.38
Ferrari NV (RACE.N)	U (09/07/2017)	\$119.68
Fiat Chrysler Automobiles NV (FCHAM)	O (02/24/2016)	€14.84
Fiat Chrysler Automobiles NV (FCAU.N)	O (02/24/2016)	\$17.35
Ford Motor Company (F.N)	U (09/08/2014)	\$12.27
General Motors Company (GM.N)	E (10/25/2017)	\$42.98
Goodyear Tire & Rubber Company (GT.O)	O (06/01/2017)	\$30.59
Group 1 Automotive, Inc (GPI.N)	U (10/08/2013)	\$78.57
Harley-Davidson Inc (HOG.N)	O (05/06/2013)	\$47.34
Hertz Global Holdings Inc (HTZ.N)	U (09/14/2017)	\$24.87
Lear Corporation (LEAN)	U (06/08/2017)	\$175.59
Lithia Motors Inc. (LAD.N)	O (10/15/2014)	\$113.18
Magna International Inc. (MGAN)	E (08/28/2017)	\$54.55
Mobileye NV (MBBYF.PK)	E (02/01/2017)	\$62.68
Penske Automotive Group, Inc (PAG.N)	O (09/06/2011)	\$46.62
Sonic Automotive Inc (SAH.N)	O (09/29/2014)	\$19.85
Tenneco Inc. (TEN.N)	U (09/23/2010)	\$58.11
Tesla Motors Inc. (TSLA.O)	E (05/15/2017)	\$331.53
Visteon Corporation (VC.N)	O (05/12/2017)	\$126.04

Stock Ratings are subject to change. Please see latest research for each company.

* Historical prices are not split adjusted.

Disclosures (cont.)

INDUSTRY COVERAGE: Telecom Services

COMPANY (TICKER)	RATING (AS OF)	PRICE* (10/31/2017)
Simon Flannery		
American Tower Corp. (AMT.N)	O (08/06/2015)	\$143.67
AT&T, Inc. (T.N)	++	\$33.65
BCE Inc. (BCE.TO)	E (12/17/2015)	C\$59.57
CenturyLink, Inc. (CTL.N)	O (03/29/2017)	\$18.99
Cincinnati Bell Inc. (CBB.N)	++	\$19.10
Crown Castle Corp. (CCI.N)	O (11/11/2009)	\$107.08
CyrusOne Inc (CONE.O)	O (05/28/2013)	\$61.39
Equinix Inc. (EQIX.O)	E (05/13/2009)	\$463.50
Frontier Communications Corp (FTR.O)	E (07/18/2016)	\$12.11
Gogo Inc (GOGO.O)	U (11/15/2013)	\$9.94
Intelsat S.A. (I.N)	U (05/12/2015)	\$4.35
Level 3 Communications, Inc. (LVL.T.N)	E (03/29/2017)	\$53.63
QTS Realty Trust Inc (QTS.N)	E (11/04/2014)	\$57.85
Rogers Communications, Inc. (RCIb.TO)	E (12/17/2015)	C\$66.94
SBA Communications (SBAC.O)	O (03/28/2011)	\$157.18
Sprint Corp (S.N)	U (10/19/2009)	\$6.54
Telephone & Data Systems (TDS.N)	E (05/30/2014)	\$29.15
TELUS Corp. (T.TO)	E (03/25/2014)	C\$46.72
T-Mobile US, Inc. (TMUS.O)	O (10/20/2014)	\$59.77
Uniti Group Inc (UNIT.O)	O (10/06/2015)	\$17.50
US Cellular Corporation (USMN)	E (12/14/2016)	\$36.59
Verizon Communications (VZ.N)	O (02/27/2014)	\$47.87
Windstream Corp. (WIN.O)	E (07/01/2015)	\$1.88
Zayo Group Holdings, Inc. (ZAYO.N)	E (12/14/2016)	\$36.06

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Disclosures (cont.)

INDUSTRY COVERAGE: Cable/Satellite

COMPANY (TICKER)	RATING (AS OF)	PRICE* (10/31/2017)
Benjamin Swinburne, CFA		
Altice USA Inc (ATUS.N)	E (07/17/2017)	\$23.68
Charter Communications Inc. (CHTR.O)	O (06/14/2016)	\$334.17
Comcast Corporation (CMCSA.O)	O (04/30/2015)	\$36.03
DISH Network (DISH.O)	O (01/23/2017)	\$48.54
Liberty Braves Group (BATR.K.O)	U (04/19/2016)	\$23.61
Liberty Broadband Corporation (LBRDK.O)	E (12/12/2014)	\$87.29
Liberty Formula One (FWONK.O)	E (01/26/2017)	\$38.14
Liberty Global plc (LBTYA.O)	E (01/23/2017)	\$30.85
Liberty SiriusXM Group (LSXMK.O)	E (01/23/2017)	\$41.65
Sirius XM Radio Inc. (SIRI.O)	U (04/19/2017)	\$5.44

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INDUSTRY COVERAGE: Aerospace & Defense

COMPANY (TICKER)	RATING (AS OF)	PRICE* (10/31/2017)
Rajeev Lalwani, CFA		
AerCap Holdings NV (AER.N)	U (04/06/2017)	\$52.64
Air Lease Corp (AL.N)	E (04/06/2017)	\$43.45
Arconic Inc (ARNC.N)	E (06/13/2017)	\$25.12
Boeing Co. (BA.N)	E (03/13/2017)	\$257.98
General Dynamics Corp. (GD.N)	U (08/07/2017)	\$202.98
Lockheed Martin Corp. (LMT.N)	O (08/07/2017)	\$308.16
Northrop Grumman Corp. (NOC.N)	E (08/07/2017)	\$295.53
Raytheon Co (RTN.N)	O (08/07/2017)	\$180.20
Rockwell Collins Inc (COL.N)	++	\$135.60
Spirit AeroSystems Holdings Inc (SPR.N)	O (06/22/2016)	\$80.10
Textron Inc. (TXT.N)	U (06/22/2016)	\$52.74
TransDigm Group Inc. (TDG.N)	E (06/22/2016)	\$277.50

Stock Ratings are subject to change. Please see latest research for each company.

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Disclosures (cont.)

INDUSTRY COVERAGE: Communications Systems and Applications

COMPANY (TICKER)	RATING (AS OF)	PRICE* (10/31/2017)
James E Faucette		
A10 Networks, Inc. (ATEN.N)	E (08/28/2014)	\$7.31
Arista Networks (ANET.N)	O (09/20/2017)	\$199.89
BlackBerry Ltd (BB.N)	E (07/28/2015)	\$10.94
Brocade Communications Systems (BRCD.O)	E (07/12/2016)	\$11.65
Cisco Systems Inc (CSCO.O)	O (05/15/2017)	\$34.15
Corning Inc (GLW.N)	E (12/11/2014)	\$31.31
F5 Networks Inc (FFIV.O)	E (06/17/2014)	\$121.27
Juniper Networks Inc (JNPR.N)	U (11/01/2016)	\$24.83
MobileIron (MOBL.O)	E (04/23/2015)	\$3.85
Qualcomm Inc. (QCOM.O)	E (11/10/2016)	\$51.01
Trimble Inc. (TRMB.O)	E (09/21/2015)	\$40.88
Zebra Technologies Corporation (ZBRA.O)	E (05/31/2017)	\$115.99
Meta A Marshall		
Acacia Communications Inc (ACIA.O)	E (05/11/2017)	\$42.31
Arris International plc (ARRS.O)	O (09/20/2016)	\$28.50
Calix Inc. (CALX.N)	E (05/20/2015)	\$5.50
Ciena Corporation (CIEN.N)	E (09/02/2016)	\$21.27
CommScope Holding Company Inc (COMM.O)	O (08/17/2017)	\$32.14
Infinera Corp (INFN.O)	E (02/22/2016)	\$8.37
Lumentum Holdings Inc (LITE.O)	U (08/11/2016)	\$63.15
Viavi Solutions Inc (MAV.O)	E (05/20/2015)	\$9.28

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Disclosures (cont.)

INDUSTRY COVERAGE: Internet

COMPANY (TICKER)	RATING (AS OF)	PRICE* (10/31/2017)
Brian Nowak, CFA		
Activision Blizzard Inc (ATVI.O)	O (09/23/2016)	\$65.49
Alphabet Inc. (GOOGL.O)	O (08/11/2015)	\$1,033.04
Amazon.com Inc (AMZN.O)	O (04/24/2015)	\$1,105.28
Blue Apron Holdings Inc (APRN.N)	E (07/24/2017)	\$4.77
Care.com Inc (CRCMN)	E (06/29/2016)	\$15.37
Criteo SA (CRTO.O)	E (01/26/2016)	\$41.77
Despegar.com Corp (DESP.N)	E (10/16/2017)	\$30.80
eBay Inc (EBAY.O)	U (04/19/2016)	\$37.64
Electronic Arts Inc (EA.O)	O (09/23/2016)	\$119.60
Etsy Inc (ETSY.O)	E (05/11/2015)	\$16.70
Expedia Inc. (EXPE.O)	E (01/10/2017)	\$124.66
Facebook Inc (FB.O)	O (04/27/2016)	\$180.06
Groupon, Inc. (GRPN.O)	U (04/23/2017)	\$4.77
GrubHub Inc. (GRUB.N)	O (08/06/2017)	\$61.02
Priceline Group Inc (PCLN.O)	O (06/30/2016)	\$1,911.96
Rubicon Project Inc (RUBI.N)	U (09/12/2016)	\$3.56
Snap Inc. (SNAP.N)	E (07/11/2017)	\$15.34
TRIVAGO NV (TRVG.O)	E (09/28/2017)	\$7.31
TrueCar Inc (TRUE.O)	E (10/01/2017)	\$16.18
Twitter Inc (TWTR.N)	U (10/21/2015)	\$20.62
Yelp Inc (YELP.N)	E (07/29/2015)	\$46.72
Zillow Group Inc (Z.O)	E (01/13/2017)	\$41.28
Zynga Inc (ZNGA.O)	O (06/08/2017)	\$3.90

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Disclosures (cont.)

INDUSTRY COVERAGE: Freight Transportation

COMPANY (TICKER)	RATING (AS OF)	PRICE* (10/31/2017)
Ravi Shanker		
ArcBest Corp (ARCB.O)	E (10/06/2011)	\$32.60
C.H. Robinson Worldwide Inc. (CHRW.O)	U (06/09/2013)	\$78.53
Canadian National Railway Co. (CNR.TO)	O (02/23/2016)	C\$103.81
Canadian Pacific Railway Ltd. (CP.TO)	O (06/03/2016)	C\$223.68
CSX Corporation (CSX.O)	U (10/02/2017)	\$50.43
Echo Global Logistics Inc (ECHO.O)	E (08/07/2017)	\$24.05
Expeditors International of Washington I (EXPD.O)	E (02/25/2015)	\$58.38
FedEx Corporation (FDX.N)	E (06/20/2013)	\$225.81
Genesee & Wyoming Inc. (GWR.N)	E (02/23/2016)	\$71.78
Heartland Express Inc. (HTLD.O)	U (05/06/2011)	\$21.33
Hub Group Inc (HUBG.O)	E (07/16/2012)	\$43.30
J.B. Hunt Transport Services Inc. (JBHT.O)	E (05/06/2011)	\$106.39
Kansas City Southern (KSU.N)	E (02/23/2016)	\$104.22
Knight-Swift Transportation Holdings Inc (KNX.N)		\$41.45
Landstar System Inc (LSTR.O)	U (02/23/2016)	\$98.75
Norfolk Southern Corp. (NSC.N)	U (06/03/2016)	\$131.42
Old Dominion Freight Line Inc (ODFL.O)	O (10/06/2011)	\$121.13
Saia, Inc. (SAIA.O)	U (02/23/2016)	\$64.80
Schneider National Inc. (SNDR.N)	O (05/01/2017)	\$26.19
Union Pacific Corp. (UNP.N)	E (10/02/2017)	\$115.79
United Parcel Service (UPS.N)	U (02/23/2016)	\$117.53
Werner Enterprises (WERN.O)	O (02/23/2016)	\$35.65
XPO Logistics, Inc. (XPO.N)	O (11/16/2015)	\$69.35

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Disclosures (cont.)

INDUSTRY COVERAGE: Insurance - Property & Casualty

COMPANY (TICKER)	RATING (AS OF)	PRICE* (10/31/2017)
Kai Pan		
Allstate Corporation (ALL.N)	E (07/06/2010)	\$93.86
American Int'l Grp (AIG.N)	O (05/16/2017)	\$64.61
Aon PLC (AON.N)	E (05/31/2012)	\$143.43
Arch Capital Group Ltd. (ACGL.O)	E (07/06/2010)	\$99.64
Arthur J. Gallagher (AJG.N)	E (05/31/2012)	\$63.33
Axis Capital Holdings (AXS.N)	E (08/14/2015)	\$54.39
Berkshire Hathaway Inc (BRKb.N)	E (03/20/2017)	\$186.94
Brown & Brown Inc. (BRO.N)	U (01/27/2016)	\$49.84
Chubb LTD (CB.N)	O (11/12/2015)	\$150.82
Everest Re Group, Ltd. (RE.N)	E (05/16/2013)	\$237.45
Hartford Fin. Services Grp. (HIG.N)	E (07/28/2017)	\$55.05
Intact Financial Corp (IFC.TO)	O (05/23/2016)	CS105.45
Marsh & McLennan Cos (MMC.N)	E (02/09/2015)	\$80.93
National General Holdings Corp (NGHC.O)	E (11/18/2016)	\$20.18
Progressive Corp (PGR.N)	E (01/05/2017)	\$48.65
RenaissanceRe (RNR.N)	E (03/09/2015)	\$138.36
The Travelers Companies, Inc. (TRV.N)	U (01/05/2017)	\$132.45
Third Point Reinsurance Ltd (TPRE.N)	E (01/06/2014)	\$16.70
W.R. Berkley Corp. (WRB.N)	E (01/21/2016)	\$68.58
Willis Towers Watson PLC (WLTW.O)	O (02/12/2015)	\$161.08
XL Group PLC (XL.N)	O (05/12/2015)	\$40.47

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Disclosures (cont.)

INDUSTRY COVERAGE: Multi-Industry

COMPANY (TICKER)	RATING (AS OF)	PRICE* (10/31/2017)
Jiayan Zhou, CFA		
Fastenal Co. (FAST.O)	E (07/07/2016)	\$46.97
HD Supply Holdings Inc (HDS.O)	E (06/07/2017)	\$35.39
W.W. Grainger Inc. (GWW.N)	U (01/11/2016)	\$197.70
Watsco Inc. (WSO.N)	U (12/19/2016)	\$166.57
WESCO International Inc. (WCC.N)	O (05/02/2017)	\$63.15
Nigel Coe, CFA		
3M Co. (MMM.N)	U (12/02/2013)	\$230.19
Ametek Inc. (AME.N)	E (10/03/2012)	\$67.49
Dover (DOV.N)	O (04/03/2017)	\$95.49
Eaton Corp PLC (ETN.N)	O (09/09/2013)	\$80.02
Emerson Electric (EMR.N)	E (01/08/2013)	\$64.46
Fortive Corp (FTV.N)	E (05/02/2017)	\$72.26
General Electric Co. (GE.N)	U (10/23/2017)	\$20.16
Honeywell International (HON.N)	O (01/04/2012)	\$144.16
Hubbell Inc. (HUBB.N)	O (12/19/2016)	\$125.82
Illinois Tool Works (ITW.N)	E (01/13/2016)	\$156.52
Ingersoll Rand (IR.N)	E (10/27/2017)	\$88.60
Johnson Controls International (JCI.N)	O (07/01/2013)	\$41.39
Lennox International (LII.N)	U (12/19/2016)	\$191.13
Pentair plc (PNR.N)	E (10/15/2015)	\$70.46
Regal Beloit Corp (RBC.N)	E (05/11/2016)	\$81.15
Rockwell Automation (ROK.N)	E (01/09/2017)	\$200.82
SPX Flow (FLOW.N)	E (11/25/2015)	\$41.23
Stanley Black & Decker (SWKN)	O (10/02/2017)	\$161.55
United Technologies Corp (UTX.N)	++	\$119.76

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Disclosures (cont.)

INDUSTRY COVERAGE: Software

COMPANY (TICKER)	RATING (AS OF)	PRICE* (10/31/2017)
Brian Essex, CFA		
AppFolio Inc (APPF.O)	E (05/13/2016)	\$45.90
CDK Global Inc (CDK.O)	E (02/03/2017)	\$63.56
Descartes Systems Group Inc (DSGX.O)	E (11/25/2014)	\$29.05
Ellie Mae Inc (ELLI.N)	E (01/12/2017)	\$89.95
Endurance International Group Holdings, Inc. (EIGI.O)	U (02/21/2017)	\$8.20
GoDaddy Inc (GDDY.N)	O (05/11/2015)	\$46.70
Instructure Inc (INST.N)	O (09/18/2017)	\$34.80
MINDBODY INC (MB.O)	E (09/28/2015)	\$32.25
Q2 Holdings Inc (Q2WON)	E (07/22/2016)	\$42.55
Sabre Corp (SABR.O)	E (04/06/2017)	\$19.56
Shopify Inc (SHOP.N)	E (09/28/2016)	\$99.49
SS&C Technologies Holdings, Inc. (SSNC.O)	O (09/27/2016)	\$40.20
Travelport Worldwide Limited (TVPT.N)	E (01/23/2017)	\$15.69

Keith Weiss, CFA

Adobe Systems (ADBE.O)	E (09/10/2010)	\$175.16
Akamai Technologies, Inc. (AKAM.O)	U (04/27/2017)	\$52.25
Autodesk (ADSK.O)	O (05/01/2017)	\$124.96
Check Point Software Technologies Ltd. (CHKP.O)	E (04/18/2017)	\$117.71
Citrix Systems Inc (CTXS.O)	U (01/19/2016)	\$82.61
Intuit (INTU.O)	U (09/13/2016)	\$151.02
Microsoft (MSFT.O)	O (01/13/2016)	\$83.18
Oracle Corporation (ORCL.N)	E (11/11/2015)	\$50.90
Palo Alto Networks Inc (PANW.N)	O (10/10/2017)	\$147.20
Red Hat, Inc. (RHT.N)	E (07/07/2016)	\$120.83
Salesforce.com (CRMN)	O (05/23/2011)	\$102.34
ServiceNow Inc (NOW.N)	O (09/18/2013)	\$126.37
Symantec (SYM.C)	E (10/10/2017)	\$32.50
VMware Inc (VMW.N)	O (07/25/2016)	\$119.69
Workday Inc (WDAY.O)	E (11/06/2012)	\$110.99

Melissa Franchi

Barracuda Networks Inc (CUDAN)	E (01/08/2016)	\$23.31
Box Inc (BOX.N)	E (02/17/2015)	\$21.95
CyberArk Software Ltd (CYBR.O)	E (03/30/2017)	\$42.37
FireEye Inc (FEYE.O)	O (09/07/2017)	\$16.92
Fortinet Inc. (FTNT.O)	O (11/15/2016)	\$39.41
Imperva Inc. (IMPV.O)	U (04/21/2016)	\$42.70
Proofpoint Inc (PFPT.O)	O (09/10/2015)	\$92.41
Qualys Inc (QLYS.O)	E (10/10/2017)	\$52.90
Rapid7 Inc (RPD.O)	E (08/11/2015)	\$18.08
Secureworks Corp (SCWX.O)	O (05/17/2016)	\$10.02
Splunk Inc (SPLK.O)	E (10/02/2017)	\$67.30
Varonis Systems, Inc. (VRNS.O)	E (06/21/2017)	\$43.60

INDUSTRY COVERAGE: Software

COMPANY (TICKER)	RATING (AS OF)	PRICE* (10/31/2017)
Meta A Marshall		
8x8 Inc (EGHT.O)	E (04/11/2017)	\$13.35
Five9 Inc (FIVN.O)	E (04/11/2017)	\$25.23
RingCentral Inc (RNGN)	E (07/19/2017)	\$42.15
Sanjit K Singh		
Appian Corp (APPN.OQ)	E (06/19/2017)	\$23.10
Atlassian Corporation PLC (TEAMO)	O (07/25/2017)	\$48.37
Cloudera Inc (CLDR.N)	E (05/23/2017)	\$15.13
New Relic Inc (NEWRN)	E (07/19/2017)	\$51.33
Nuance Communications Inc. (NUAN.O)	E (05/01/2013)	\$14.74
Tableau Software (DATAN)	E (02/08/2016)	\$81.09

Stan Zlotzky, CFA

Bazaarvoice Inc (BV.O)	E (09/02/2015)	\$4.83
Coupa Software Inc (COUP.O)	E (10/31/2016)	\$34.75
HubSpot, Inc. (HUBS.N)	O (09/10/2015)	\$86.55
Veeva Systems Inc (VEEV.N)	E (06/05/2017)	\$60.94
Workiva Inc (WK.N)	E (01/23/2017)	\$22.35
Yext Inc (YEXT.N)	E (05/08/2017)	\$11.48
Zendesk, Inc (ZEN.N)	O (09/10/2015)	\$31.00

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Disclosures (cont.)

INDUSTRY COVERAGE: Semiconductors

COMPANY (TICKER)	RATING (AS OF)	PRICE* (10/31/2017)
Craig Hettenbach		
Amphenol Corp. (APH.N)	E (09/10/2014)	\$87.00
Analog Devices Inc. (ADI.O)	O (07/27/2016)	\$91.30
Broadcom Ltd (AVGO.O)	O (07/02/2013)	\$263.91
Cypress Semiconductor Corp (CY.O)	U (03/30/2017)	\$15.86
Impinj Inc (PI.OQ)	E (06/19/2017)	\$34.14
Maxim Integrated Products Inc. (MXIM.O)	U (07/30/2014)	\$52.54
Microchip Technology Inc. (MCHP.O)	O (01/19/2016)	\$94.80
NXP Semiconductor NV (NXPI.O)	E (10/28/2016)	\$117.05
ON Semiconductor Corp. (ON.O)	E (09/22/2016)	\$21.32
Qorvo Inc (QRVO.O)	E (06/27/2016)	\$75.81
Sensata Technologies Holding N.V. (ST.N)	E (09/10/2014)	\$48.91
Skyworks Solutions Inc (SWKS.O)	U (06/27/2016)	\$113.86
Te Connectivity Ltd (TEL.N)	O (09/10/2014)	\$90.97
Joseph Moore		
Advanced Micro Devices (AMD.O)	U (10/30/2017)	\$10.99
Ambarella Inc (AMBA.O)	O (03/29/2016)	\$56.44
Cavium Inc (CAVM.O)	O (09/26/2013)	\$68.99
Inphi Corporation (IPHI.N)	O (08/17/2015)	\$40.98
Intel Corporation (INTC.O)	E (01/27/2017)	\$45.49
Marvell Technology Group Ltd (MRVL.O)	E (09/14/2015)	\$18.47
Micron Technology Inc. (MU.O)	O (12/17/2015)	\$44.31
NVIDIA Corp. (NVDA.O)	E (10/30/2015)	\$206.81
Quantenna Communications Inc (QTNA.O)	O (11/22/2016)	\$15.49
Texas Instruments (TXN.O)	E (05/30/2012)	\$96.69
Xilinx (XLNX.O)	O (12/14/2016)	\$73.69

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Disclosures (cont.)

INDUSTRY COVERAGE: IT Hardware

COMPANY (TICKER)	RATING (AS OF)	PRICE* (10/31/2017)
Katy L. Huberty, CFA		
Apple, Inc. (AAPL.O)	O (05/26/2009)	\$169.04
CDW Corporation (CDW.O)	E (08/06/2013)	\$70.00
Electronics for Imaging Inc (EFII.O)	U (08/03/2017)	\$30.86
Hewlett Packard Enterprise (HPE.N)	E (11/11/2015)	\$13.92
HP Inc. (HPQ.N)	O (03/18/2013)	\$21.55
IBM (IBM.N)	O (02/18/2016)	\$154.06
NCR Corp. (NCR.N)	E (09/25/2011)	\$32.09
NetApp Inc (NTAP.O)	U (03/24/2014)	\$44.42
Nutanix Inc (NTNX.O)	E (05/10/2017)	\$28.50
Pure Storage Inc (PSTG.N)	E (05/18/2017)	\$16.43
Seagate Technology (STX.O)	E (07/11/2016)	\$36.97
Teradata (TDC.N)	U (12/03/2013)	\$33.45
Tintri Inc (TNTR.O)	E (08/23/2017)	\$3.87
Western Digital (WDC.O)	O (04/28/2017)	\$89.27
Xerox Corp (XRX.N)	O (01/12/2017)	\$30.31
Yuuji Anderson		
Fitbit Inc (FIT.N)	E (07/30/2017)	\$6.14
Garmin Ltd (GRMN.O)	E (01/07/2015)	\$56.61
GoPro Inc (GPRO.O)	E (07/30/2017)	\$10.43

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Disclosures (cont.)

INDUSTRY COVERAGE: Media & Internet

COMPANY (TICKER)	RATING (AS OF)	PRICE* (10/31/2017)
Patrick Wellington		
Axel Springer SE (SPRGn.DE)	E (01/08/2014)	€57.90
DMGT (DMGOa.L)	E (10/01/2014)	694p
Eutelsat Communications (ETL.PA)	O (02/20/2017)	€21.51
Havas (HAVA.PA)	E (03/31/2015)	€9.23
Informa (INF.L)	E (11/10/2016)	697p
ITV (ITV.L)	O (06/23/2017)	165p
JCDecaux (JCDX.PA)	U (01/06/2016)	€32.85
Lagardere (LAGA.PA)	E (01/08/2013)	€28.28
M6 (MMTP.PA)	E (10/03/2011)	€19.85
Mediaset (MS.MI)	E (05/08/2013)	€3.15
Mediaset Espana Comunicacion SA (TL5.MC)	E (08/03/2017)	€9.33
Modern Times Group (MTGb.ST)	E (10/17/2017)	SKr 319.40
Pearson (PSON.L)	E (10/26/2016)	704p
ProSiebenSat.1 Media SE (PSMGn.DE)	O (01/10/2017)	€29.95
Publicis Groupe (PUBP.PA)	E (11/23/2015)	€55.96
RELX (RELN.AS)	O (07/14/2015)	€19.39
RELX (REL.L)	O (07/14/2015)	1,733p
RTL Group SA (RRTL.DE)	E (03/09/2015)	€63.69
SES (SESFd.PA)	U (10/11/2017)	€13.96
Sky plc (SKYB.L)	++	943p
Stroer SE (SAXG.DE)	O (05/21/2015)	€54.90
TF1 (TFFP.PA)	U (01/10/2017)	€12.21
UBM plc (UBML)	E (07/11/2016)	704p
Vivendi (VIV.PA)	O (10/06/2015)	€21.33
Wolters Kluwer (WLSNc.AS)	O (01/07/2016)	€42.08
WPP Group Plc (WPP.L)	E (09/26/2017)	1,334p

Stock Ratings are subject to change. Please see latest research for each company.

* Historical prices are not split adjusted.

Disclosures (cont.)

INDUSTRY COVERAGE: Telecommunications Services

COMPANY (TICKER)	RATING (AS OF)	PRICE* (10/31/2017)
Emmet B Kelly		
Altice NV (ATCAAS)	E (10/26/2015)	€16.20
Bouygues (BOUY.PA)	NA (03/06/2014)	€41.22
Cellnex Telecom SA (CLNX.MC)	O (06/16/2015)	€21.32
Deutsche Telekom (DTEGn.DE)	E (11/30/2015)	€15.64
Iliad (ILD.PA)	NA (07/31/2014)	€214.35
Orange (ORAN.PA)	O (01/27/2016)	€14.09
Telefonica Deutschland Holding AG (Q2Dn.DE)	U (12/17/2015)	€4.36
Vodafone Group (VOD.L)	O (03/20/2017)	216p
Luis Prota		
KPN (KPN.AS)	O (10/14/2014)	€2.96
OTE (Hellenic Telecoms.) (OTEr.AT)	O (05/12/2016)	€10.20
Proximus (PROX.BR)	U (01/27/2017)	€28.51
Sunrise Communications Group AG (SRCGS.S)	O (08/08/2017)	SFr 83.00
Swisscom (SCMN.S)	U (09/16/2015)	SFr 504.00
Telecom Italia (TLIT.M)	O (07/08/2015)	€0.75
Telecom Italia (TLITn.M)	O (07/08/2015)	€0.61
Telefonica (TEF.MC)	E (05/06/2015)	€9.01
Ricard Boada		
Euskaltel SA (EKTLMC)	O (02/17/2017)	€6.88
Infrastrutture Wireless Italiane SpA (INWT.M)	E (10/24/2016)	€5.87
MasMovil Ibercom SA (MASMMC)	O (07/19/2017)	€70.92
Nos SGPS SA (NOS.LS)	O (12/17/2015)	€5.14
Rai Way SpA (RWAY.M)	E (05/18/2017)	€5.21
Telenet Group Holding (TNET.BR)	U (12/15/2016)	€59.38
Terence Tsui		
BT Group plc (BT.L)	E (05/31/2017)	260p
Com Hem Holding AB (COMH.ST)	O (03/20/2015)	SKr 125.70
DNA OYJ (DNAO.HE)	E (09/12/2017)	€14.80
Elisa Oyj (ELISA.HE)	E (09/14/2016)	€34.59
Inmarsat (ISAL)	E (05/23/2016)	621p
TalkTalk Telecom Group PLC (TALK.L)	E (10/28/2015)	214p
TDC AS (TDC.CO)	E (12/15/2016)	DKr 37.77
Tele2 (TEL2b.ST)	U (06/15/2016)	SKr 106.50
Telenor (TEL.OL)	O (03/04/2013)	Nkr 173.50
Telia Company AB (TELIA.ST)	E (06/15/2016)	SKr 38.75

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* Historical prices are not split adjusted.

INDUSTRY COVERAGE: Telecommunications

COMPANY (TICKER)	RATING (AS OF)	PRICE* (10/31/2017)
Tetsuro Tsusaka, CFA		
KDDI (9433.T)	E (07/24/2014)	¥3,024
NTT (9432.T)	O (11/17/2012)	¥5,473
NTT DOCOMO (9437.T)	E (07/23/2015)	¥2,741
Softbank Group (9984.T)	E (11/10/2014)	¥9,947

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