Federal Aviation Administration

Commercial Space Transportation (AST)

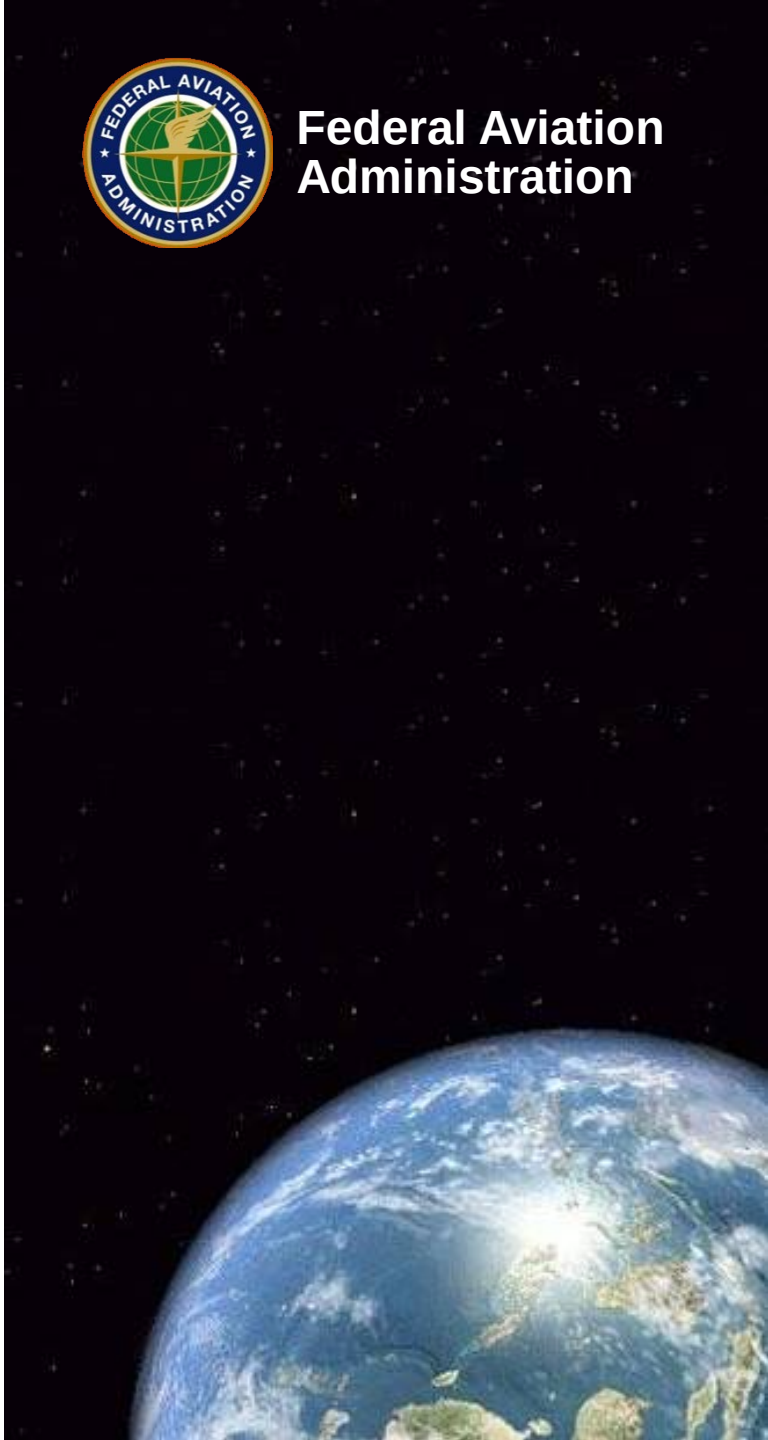
Overview of the Commercial Space Transportation RE&D Program

To: REDAC NAS Ops Subcommittee

By: Dr. Michael Romanowski
Director Commercial Space Integration

FAA Office of Commercial Space Transportation

Date: August 13, 2015



Agenda

- **Overview**
  - Commercial Space Transportation
  - FAA Authority & Regulatory Framework
  - Office of Commercial Space Transportation (AST)
  - Emerging Challenges
- **Commercial Space Transportation RE&D**
  - New Budget Line for FY16 & beyond
- **Summary & Discussion**

Commercial Space Transportation

- The U.S. space activity conducted over 3 sectors:
  - Civil
  - Military
  - Commercial
- The *commercial* sector had its official start in 1984 with Executive Order 12465
  - DOT designated as lead Federal agency for enabling private-sector launch capability
- Congress passed the Commercial Space Launch Act soon afterwards in 1984
- Regulatory oversight for the commercial sector was given to the Office of Commercial Space Transportation
  - Originally within DOT and the Office of the Secretary
- Today, the office is one of four lines of business within the FAA
  - Aviation Safety (AVS)
  - Air Traffic Organization (ATO)
  - Airports (ARP)
  - Commercial Space Transportation (AST)

Aviation and Space are Fundamentally Different

Aviation	**Space**
Mature industry	Nascent, emerging industry
***Daily* average:** 28,000 commercial flights, 25,000 air taxi flights, 2100 cargo flights, 27,000 general aviation flights (*82,000 flights daily average*)	**Totals:** 238 licensed launches since 1989, 39 launches under experimental permit since 2006, 10 licensed reentries since 2010 (*287 regulated launch/reentries total*)
Airports: 542 certificated, 5155 public, 14,009 private	**Spaceports**: 10 licensed sites, 2 private sites
Integrated certification framework (design, production, airworthiness, air carrier, pilot, maintenance, training, etc.) – for safe operations that protect the public, passengers and crew	**Licensing and permitting of operations** – for the *protection of public*
Passenger and crew expectation of occupant safety	Space flight participant and flight crew acknowledgment and acceptance of risk
Operations at low altitude (within the National Airspace System (NAS))	Operations at high altitude above the NAS with the intent to exit and reenter Earth's atmosphere
Aviation is the safest mode of transportation	Space is inherently risky

Office of Commercial Space Transportation (AST) Mission Statement

"…To protect the public, property, and the national security and foreign policy interests of the United States during U.S. commercial launch and reentry activities."

"…To encourage, facilitate, and promote U.S. commercial space transportation."

Title 51 U.S. Code Subtitle V, Chapter 509

- **Commercial Space Launch Act (CSLA) –1984, most recently amended in 2004**
- **51 U.S.C. § 50901 (b) Purposes –**

  (3) to provide that the Secretary of Transportation is to oversee and coordinate the conduct of commercial launch and reentry operations, issue permits and commercial licenses and transfer commercial licenses authorizing those operations, and ***protect the public health and safety, safety of property, and national security and foreign policy interests of the United States****; and,*

  (4) to facilitate the strengthening and expansion of the United States space transportation infrastructure, including the enhancement of United States launch sites and launch-site support facilities, and development of reentry sites, with Government, State, and private sector involvement, to support the full range of United States space-related activities

CSLA – *Licensing*

- ***Launches and reentries*, and the operation of *launch and reentry sites* as carried out by U.S. citizens or within the United States must be authorized by the FAA**
  - Only exception is for missions *conducted by and for* the government (such as launches by performed by NASA or the U.S. Air Force)
- **The FAA's primary means to authorize these activities is through licensing**
  - The FAA authorizes those activities if it determines they are consistent with public health and safety, safety of property, and the national security and foreign policy interests of the United States
- **By law, determinations on licenses must be made within 180 days of acceptance of an application.**
  - FAA must notify Congress if these deadlines are missed

Commercial Space Launch Amendments Act (CSLAA) 2004 – *Experimental Permits*

- **Outgrowth of SpaceShipOne (Ansari X-Prize) licensing in 2004**
- **Congress enacted the experimental permit regime to streamline the authorization process for developmental reusable suborbital rockets.**
  - Commercial Space Launch Amendments Act of 2004, House of Representatives Committee Report 108-429, to accompany H.R. 3752
    - *"[T]he bill makes it easier for the industry to test new types of reusable suborbital rockets by allowing AST to issue experimental permits that can be granted more quickly and with fewer requirements than licenses."*

    Committee Views:
    - *"The bill urges the Secretary of Transportation to use the authority granted under Section 70105(c)(2)(C) of the CSLA, as amended by the bill, to the greatest extent practicable to waive requirements of law when issuing permits."*
- **By law, determinations on Experimental Permits must be made within 120 days of AST acceptance of an application**

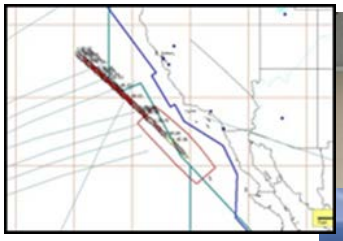
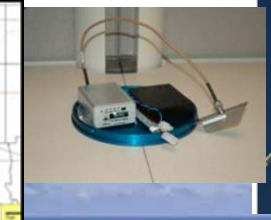
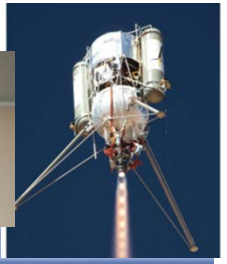
CSLAA- Human Spaceflight Regulation

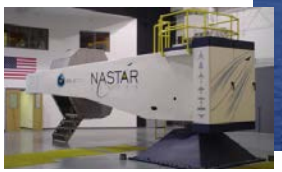
- **Commercial Space Launch Amendments Act 2004**
  - Notice of Proposed Rulemaking 2005[1]; Final Rule 2006[2]
  - Establish requirements for crew qualifications, training and vehicle systems, in the interest of **ensuring public safety**
  - **Informed consent** requirement for space flight participants and crew
  - Moratorium put in place on regulation of occupant safety – "learning period"
  - Moratorium on regulations for occupant safety extended until Oct. 1, 2015 (FAA Reauthorization 2012); further extension likely
  - Tasked to "*encourage, facilitate, and promote* the continuous improvement of the safety of launch vehicles designed to carry humans"

- **AST Issued Recommended Practices for Human Space Flight Occupant Safety – Published August 2014**
  - Work on recommended practices initiated in 2012; Commercial Space Transportation Advisory Committee (COMSTAC) recommendation
  - Starting point for voluntary consensus standards

[1] Federal Register Vol. 70, No. 249, Thursday Dec. 29, 2005
[2] Federal Register Vol. 71, No. 241, Friday Dec. 15, 2006

AST Responsibilities, Products & Services

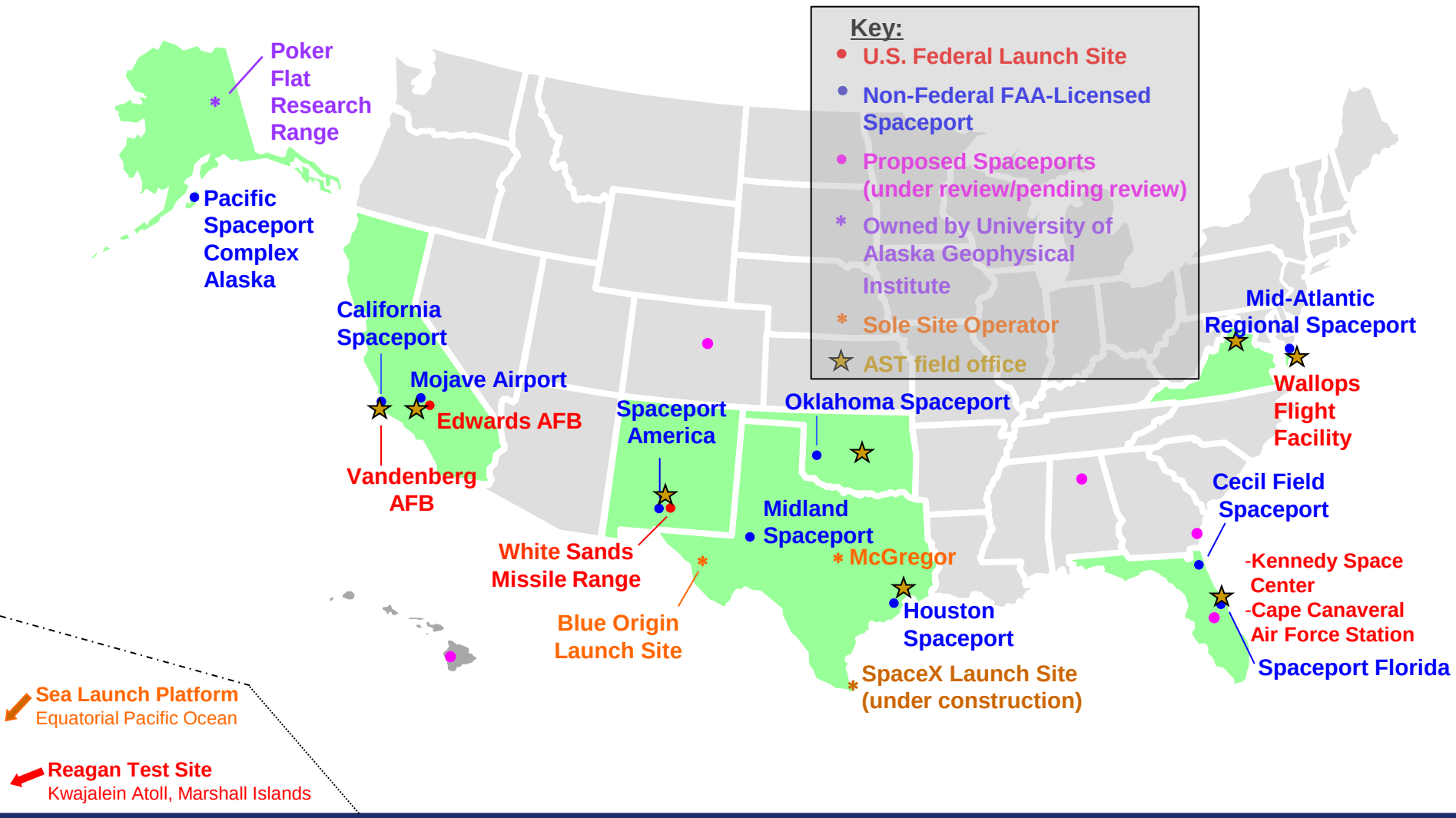






- **Licensing**
  - Launch and reentry vehicle operations
  - Launch and reentry site operations
- **Experimental Permits**
  - Suborbital Reusable Launch Vehicle (RLV) operations
- **Safety Approvals**
  - Systems, subsystems, and processes
- **Safety Inspections & Oversight**
  - Inspections and compliance monitoring for AST-issued licenses and permits
  - Mishap response & oversight

- **Environmental Review** (NEPA compliance)
- **Liability Determination** (e.g., “Maximum Probable Loss”)
- **Rulemaking**
  - Development and publication of regulations, guidelines, and Advisory Circulars
- **Infrastructure Development**
  - Spaceport (STIM) Grants (prior years)
  - Air-Space integration/coordination
  - Government partnerships
- **Research**

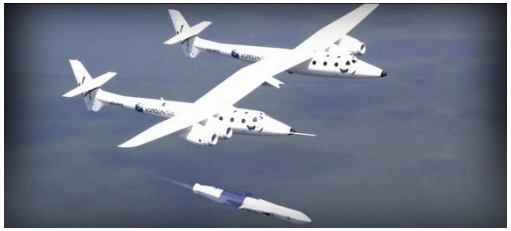
Growing Spaceport Network Reflects Industry Growth & Migration from Federal Ranges



Expanding Commercial Capabilities

Industry Responding to Growing Market Demand

Virgin Galactic
"SpaceShipTwo"



Virgin Galactic
"LauncherOne"

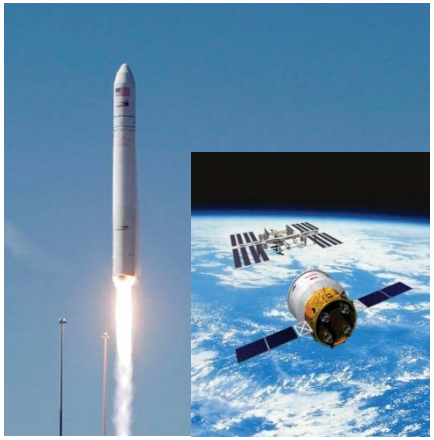
Boeing

XCOR Aerospace

Firefly

Rocket Lab

Blue Origin



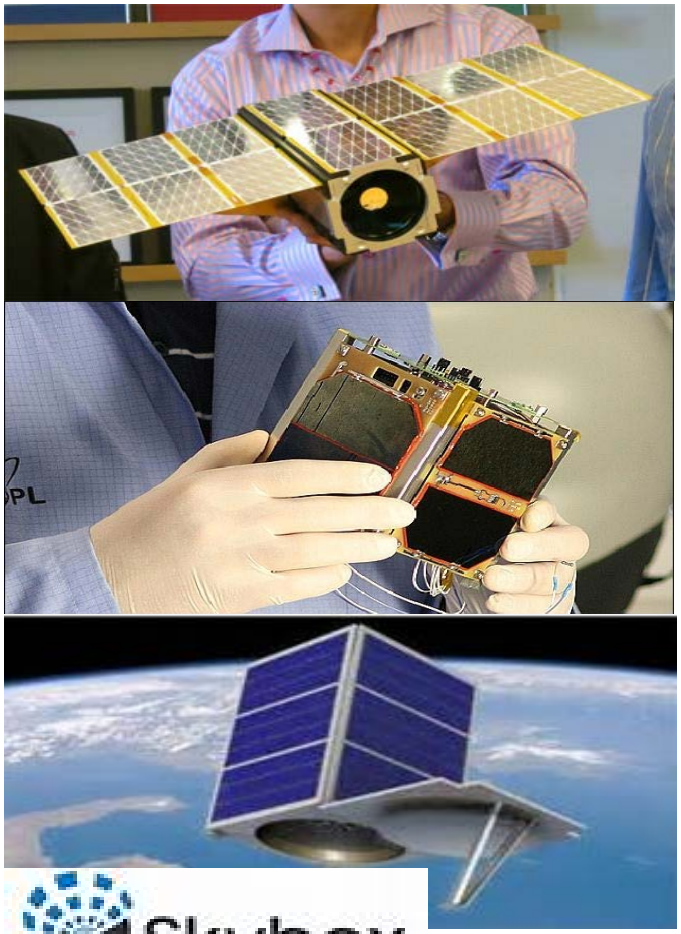
Orbital Sciences

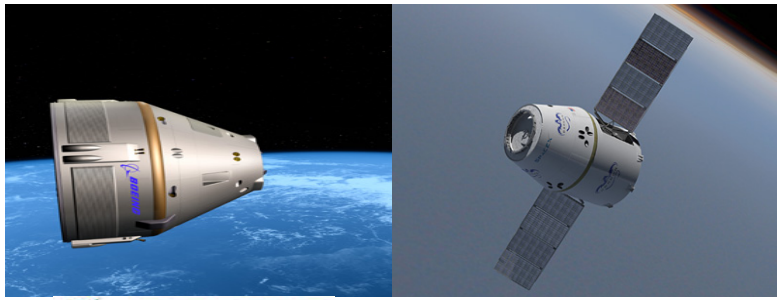
Space X

Sierra Nevada Corp

Drivers of Real Commercial Space Market Growth

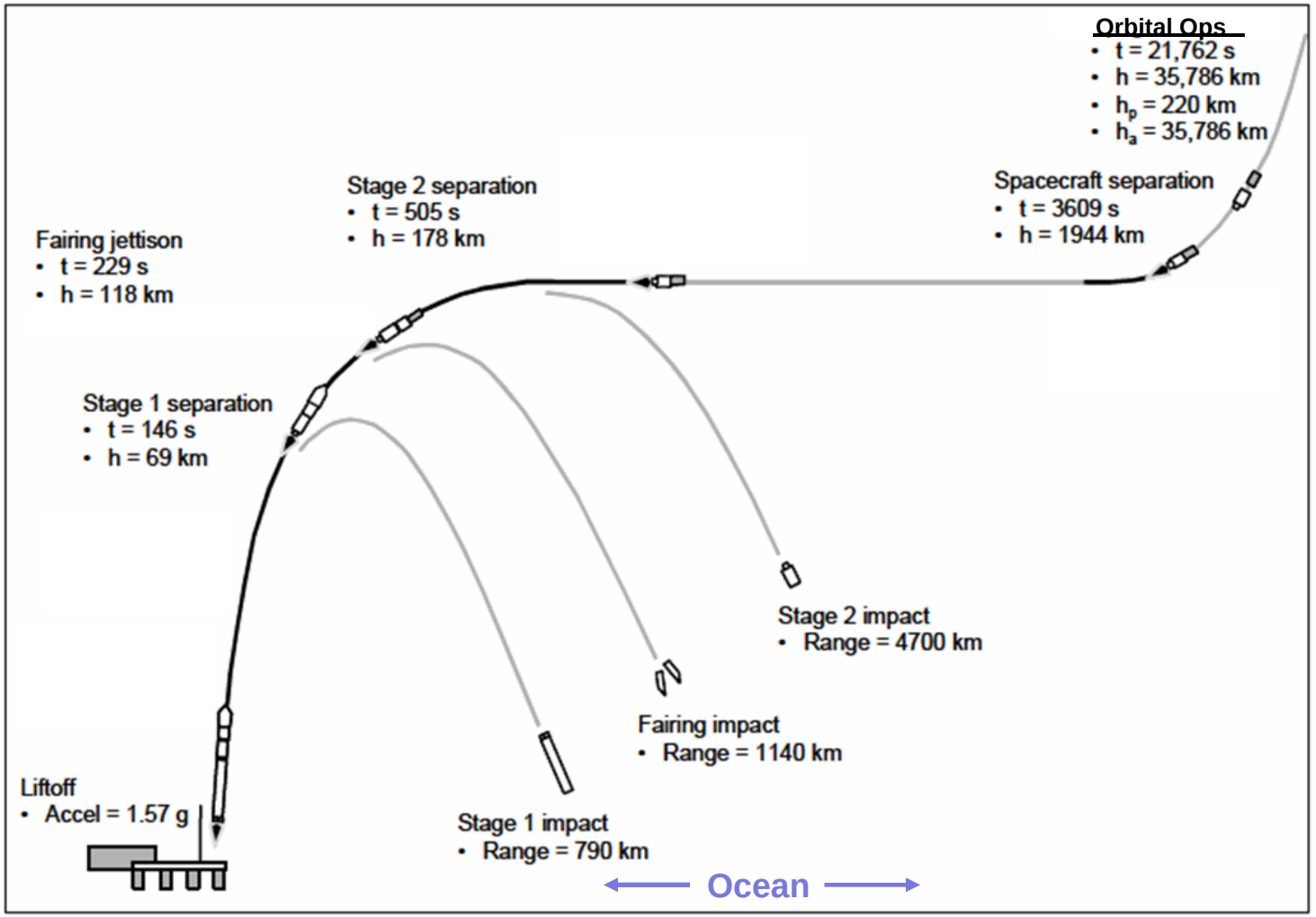
Onset of Small-Sats & Cube-Sats



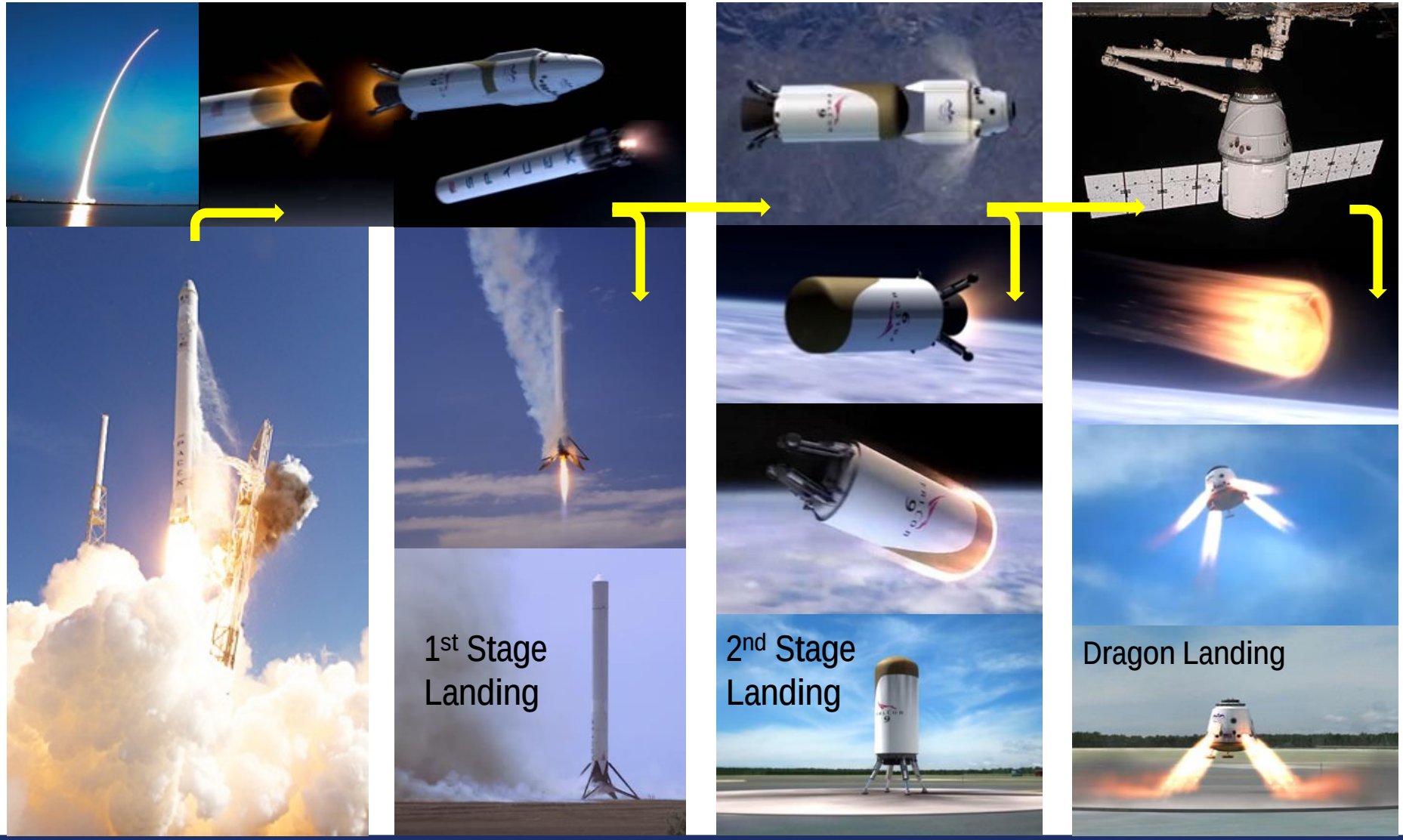


Increased federal use of commercial contracts (NASA, DARPA, etc.)

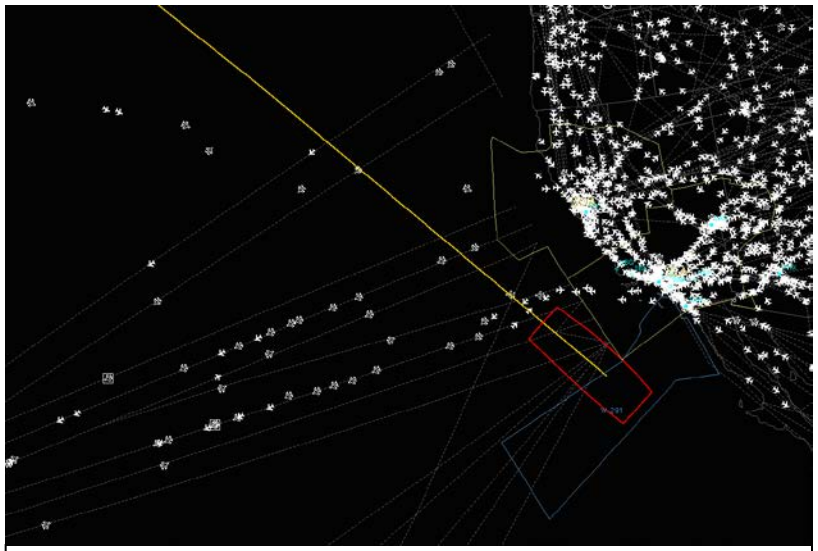
Typical Expendable Launch Vehicle (ELV) Mission Profile



Increasing Complexity Example – SpaceX Reusable Falcon 9 (Return to Launch Site Boosters & Inland Capsule Landing)



Increasing Complexity Example – Reentry over CONUS

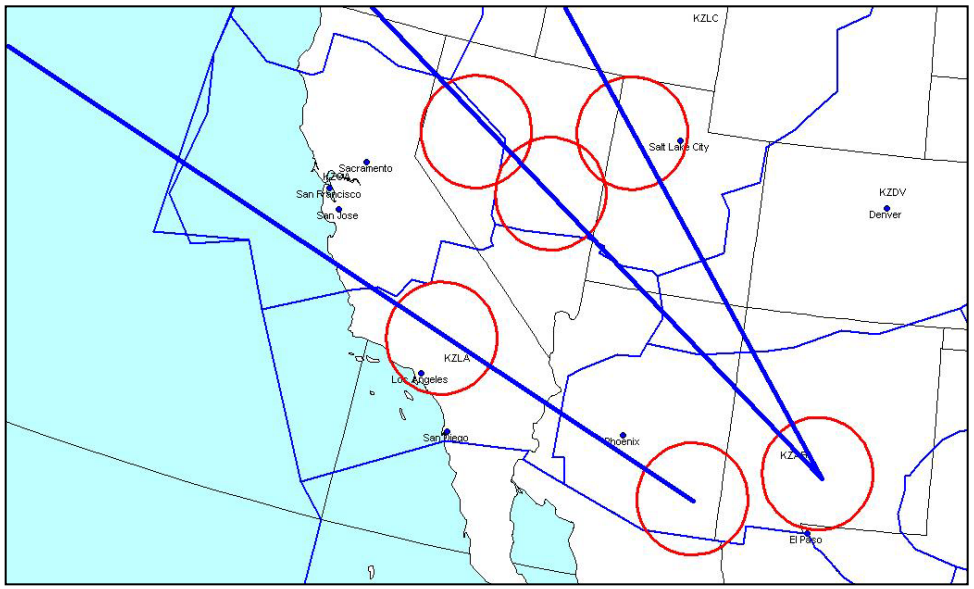


Today

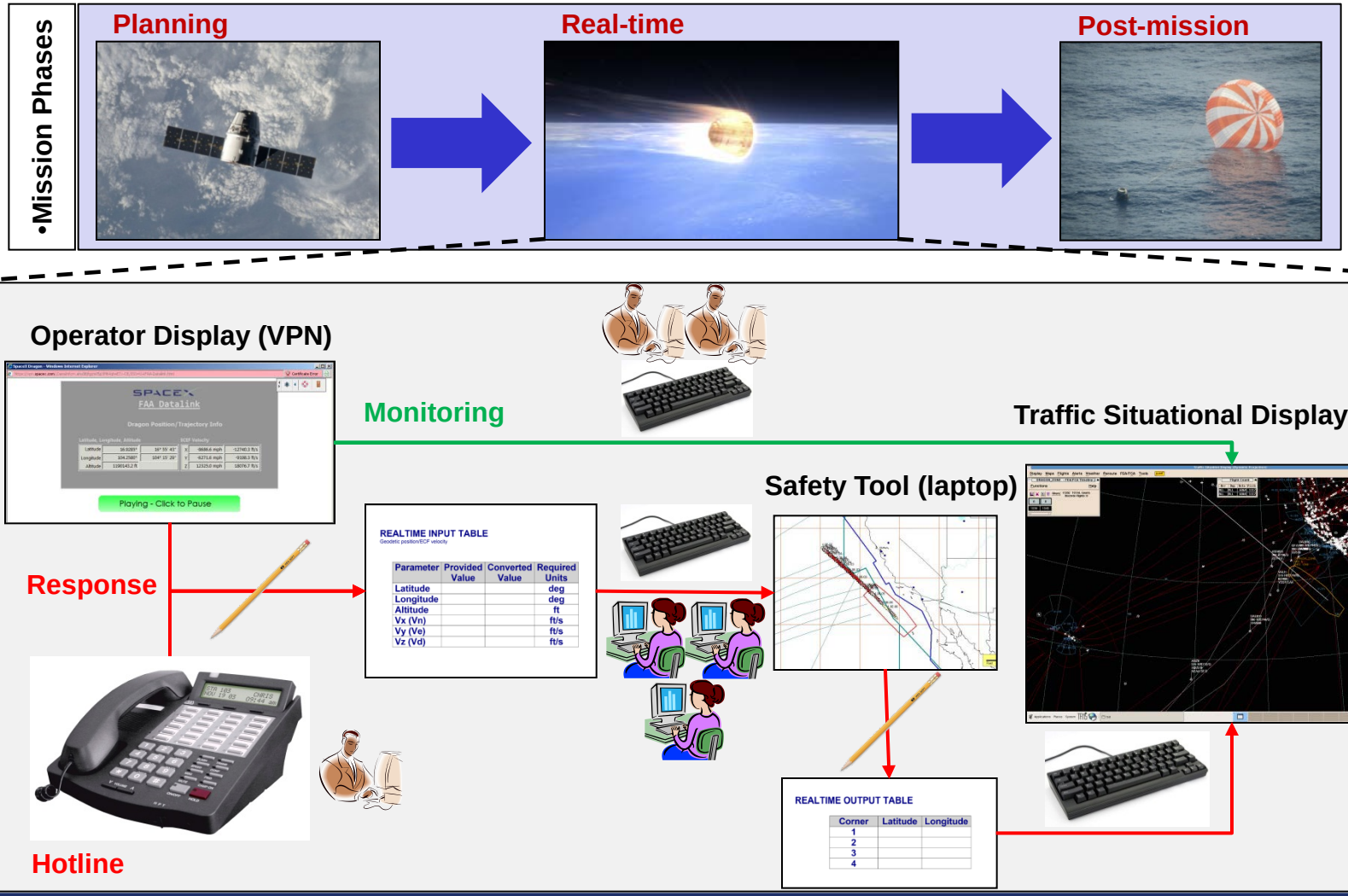
- Cargo missions to ISS; test flights
- Oceanic splashdown areas
- Single deorbit opportunity/landing location per reentry trajectory
- Oversized hazard areas can accommodate some failure scenarios

Tomorrow (2017 – 2018 Timeframe)

- Crew missions to ISS; commercial stations
- Land landings near populated areas
- Multiple reentry trajectories
- Multiple deorbit opportunities/landing locations on a single reentry trajectory

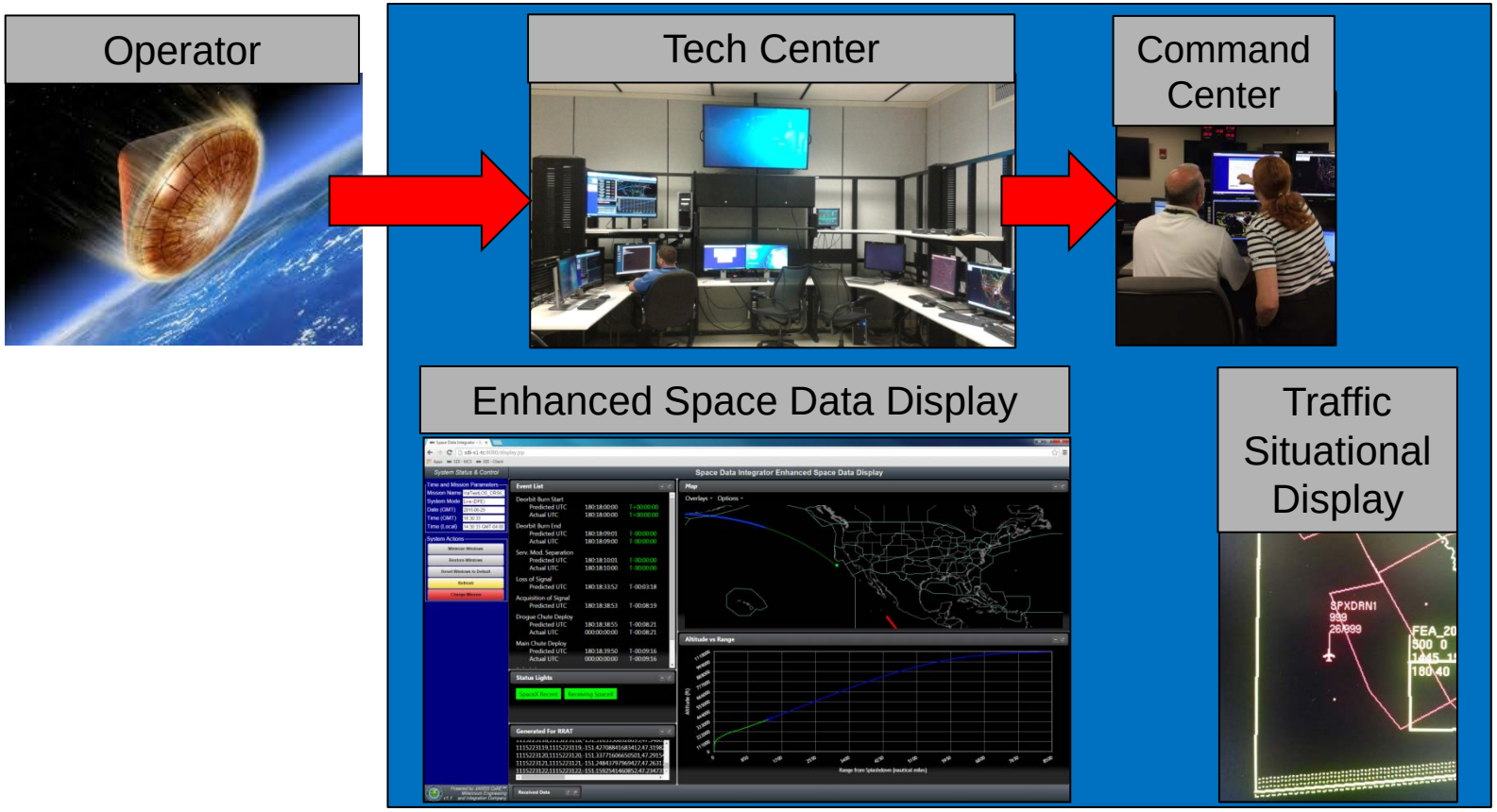


Real-Time Operations Example: Dragon Reentry
Challenges of a Manual Process



FAA Demonstrated Automated Space Data Integrator Operational Prototype in 2015

- *FY15 SIG Target: AST/ATO develop an operational demonstration of launch/reentry vehicle data suitable for routing to FAA automation systems to facilitate implementation of special activity airspace*
- *Advancing AMS activity under FY16 Capital Investment Plan ($2M F&E) to build into NAS Systems*



Increasing Operational Efficiency –
Integrating Launch/Reentry Collision Avoidance into Mission Planning

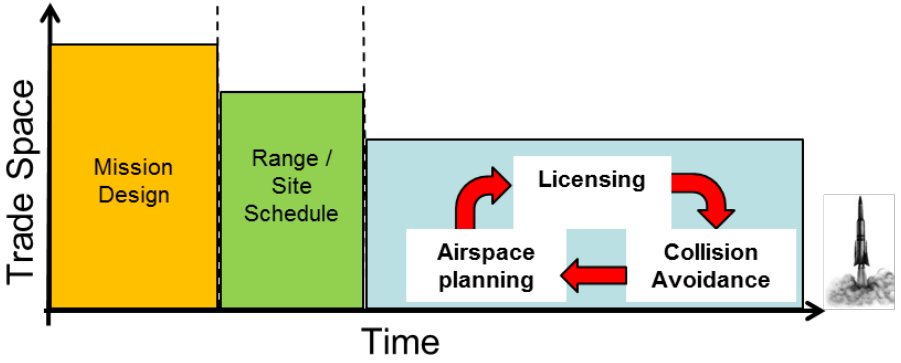
AST working with DoD, NASA, and others to gain capability to conduct collision avoidance assessments for orbital entry and exit (using DoD – supplied data)

Current Processes
- Serial, executed in isolation

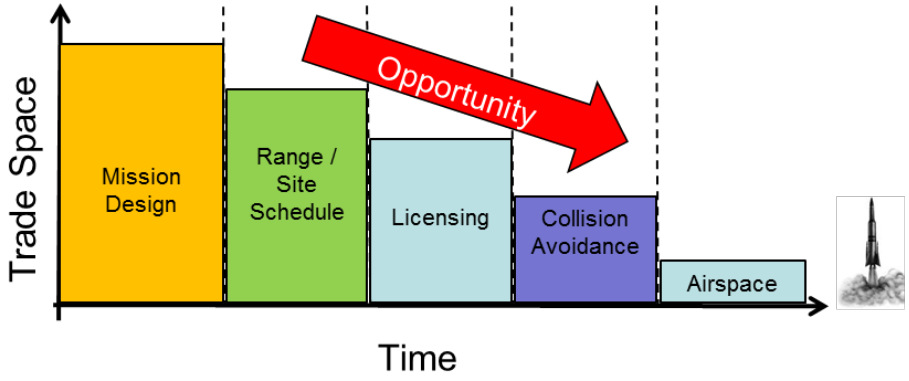
Effects
- Limited options for accommodating launch/reentry opportunities while minimizing effect on other stakeholders
- Other stakeholders brought in very late, limiting their planning abilities

Outcomes
- Increased reroutes, delays
- Reduced launch/reentry opportunities

Future Processes: Launch to Orbit



Current Processes: Launch to Orbit

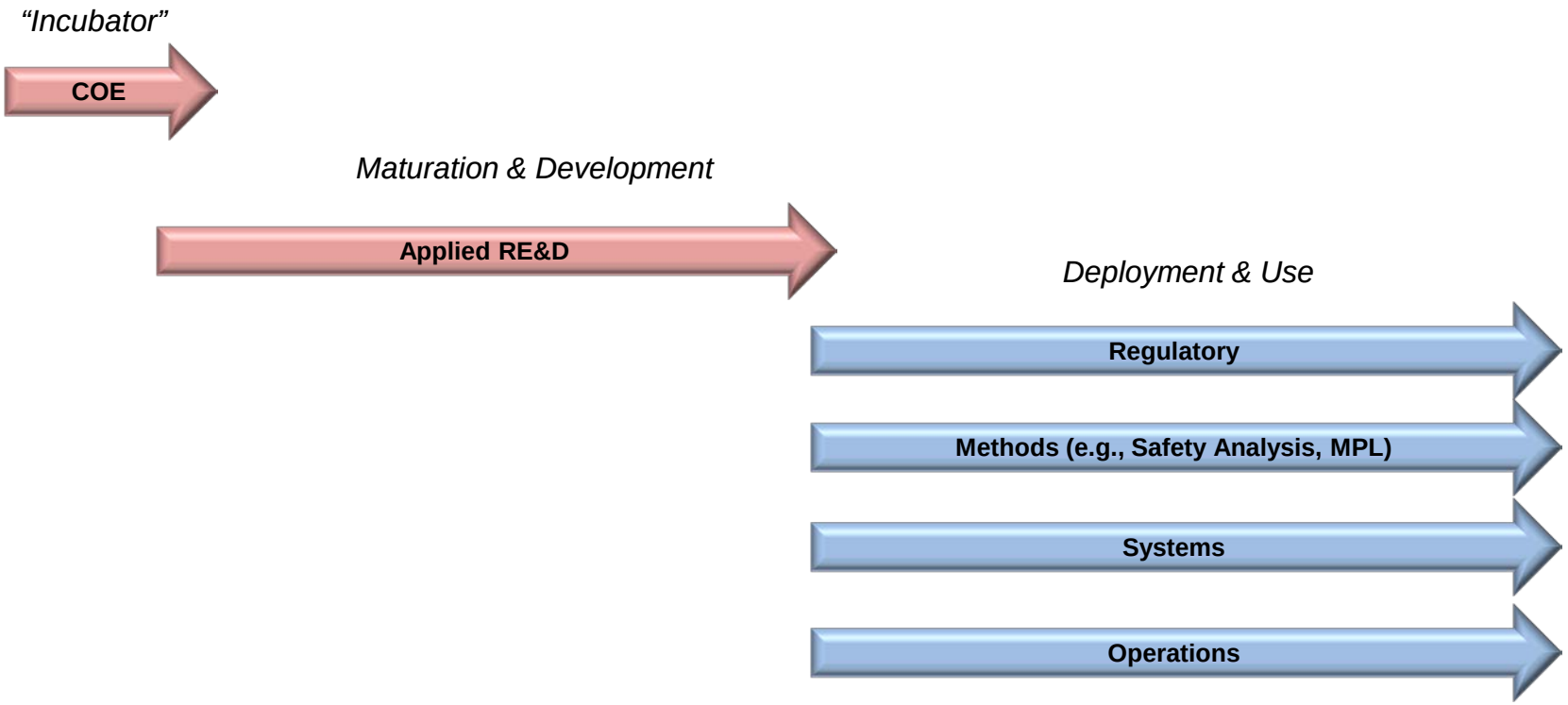


Future Processes
- Integrated, executed in parallel

Effects
- Earlier insight into and influence over process
- More options for managing airspace and opportunities for successful outcomes
- Better management of stakeholder expectations

Outcomes
- Increased planning horizon
- Reduced reroutes, delays
- Additional launch/reentry opportunities

Pursuing Enhanced R&D Portfolio to Impact High Priority Areas



RE&D Funding

Capital & Ops Funding (FAA)
FAA & Industry Use

PPT Portfolio Overview

- **The Commercial Space Transportation RE&D portfolio will enable advances in critical areas such as:**
  - Safe and efficient integration of increased commercial space launch and reentry activity in to the national airspace
  - Advanced safety assessment methods
  - Advanced vehicle safety technologies and methodologies, and
  - Human space flight safety and physiology factors
- **Funding enables maturation of concepts for follow-on use in methods, systems, operations and the regulatory framework**
- **Funding also sustains cooperative, innovative R&D within the FAA's Commercial Space COE**

NARP BLI Milestone Summary

- **FY2016 President's request included Commercial Space Transportation Safety RE&D budget line for the first time**
- **Detailed planning for specific FY16 milestones and beyond continues based on appropriations uncertainty**
- **Funding profile:**

	FY16 PBR	FY17	FY18	FY19	FY20	FY21
Funding Target ($000)	3,000	4,000	5,000	5,000	5,000	5,000

NARP BLI Milestone Development

- **Research projects within *Safe and Efficient Integration* may include:**
  - **Improving integration of launch sites (i.e., spaceports) into the NAS and its system of airports**, including sites in the vicinity of major airports or complex airspace.
  - **Exploring the development of separation standards** for improved airspace management of launch/reentry vehicles during non-explosive phases of flight.
  - **Improving airspace integration planning** for return to land-based sites to decrease the amount of airspace closed to air traffic operations by using higher fidelity input data and models.
  - **Improving real-time monitoring of launch/reentry vehicle operations for airspace integration**, to decrease the amount of airspace closed to regular air traffic operations and expedite response to off-nominal scenarios.
  - **Developing and validating improved noise models for commercial space launch operations at inland launch sites**, including spaceports co-located with airports.
  - **Improving methods for launch and reentry collision avoidance analysis** to produce more efficient launch and reentry planning and NAS integration.

NARP BLI Milestone Development

- **Research projects within *Advanced Safety Assessment Methods* may include:**
  - **Exploring advanced commercial space flight data sharing and mining capabilities** to inform safety assessments and identify emerging safety issues.
  - **Improved methods to evaluate failure probabilities for launch and reentry vehicles.**
  - **Advanced study and model development of break-up characteristics of space vehicles**, such as hybrids or other new concepts currently under consideration.
  - **Improved safety analysis methods to assess and manage hazards to dynamic population clusters,** such as for the public on roads and rail.
  - **Improved understanding of aircraft vulnerability to space-vehicle-breakup debris**, including model development and refinement to reduce over-conservatism applied to airspace “keep out” areas used to protect against a launch or reentry vehicle failure.

NARP BLI Milestone Development

- **Research projects within *Advanced Vehicle Safety Technologies* may include:**
  - **Improved understanding of emerging autonomous flight safety systems** and exploring mitigation factors to address their potential vulnerabilities.
  - **Exploring the repetitive use considerations for high utilization reusable space vehicles**, to include assessing the use of integrated vehicle health monitoring technologies and reentry breakup recorders when applicable.

NARP BLI Milestone Development

- **Research projects within *Human Spaceflight and Physiological Safety Factors* may include:**
  - **Improved crew safety systems** for proposed space flight vehicles, including **systems to monitor the cabin environment and support safety actions** in the event of contingencies.
  - **Voluntary physiological data collection from both human spaceflight participants and crew**, including those participants who may possess common disease states (such as high blood pressure, diabetes, lower back injury, respiratory disease, etc.), to identify potential areas of concern and additional focus.
  - **Identifying best practice considerations for crew human factors** for small winged commercial spaceflight vehicles.

Summary

- **US Commercial Space Transportation industry is dynamic and growing**
  - Increased demand for services, operational tempo
  - Increased complexity and innovation drive critical research needs
- **FAA initiated a new Commercial Space Transportation Safety RE&D BLI in the FY2016 Presidents Budget Request**
- **A robust Commercial Space Transportation RE&D program will allow the FAA to keep pace**
  - Continued public safety
    - Improved analysis methods and evaluation of applications
    - Responsive and effective regulatory and policy framework
  - Safe and efficient integration of operations
  - Continued industry innovation and safety improvement