February 2023 | FAA Air Traffic Organization

Airspace Integration of Launch and Reentry Operations

Federal Aviation Administration

FAA Air Traffic Organization

Airspace Integration of Launch and Reentry Operations

February 2023

Overview

Operator Operational Onboarding and Letter of Agreement

Risk Assessment and Aircraft Hazard Area Development

Mission Planning

Traffic Flow Management

Real Time Mission Support

Post Operations Analysis

Federal Aviation Administration

Office of Commercial Space Transportation (AST)

License/Permit, Regulate and Inspect United States commercial space industry

Air Traffic Organization (ATO)

Integrate launch and reentry operations, commercial and non-commercial into the National Airspace System (NAS)

ATO System Operations (AJR)

ATO Space Operations (AJR-1800)

FAA Air Traffic Organization Space Operations

Our Mission: Ensure space launch and reentry operations are safely and efficiently integrated into the National Airspace System (NAS)

- Notification
- Evaluation
- Decision
- Airspace Management Plan (AMP) Development and Distribution

Planning and Coordination

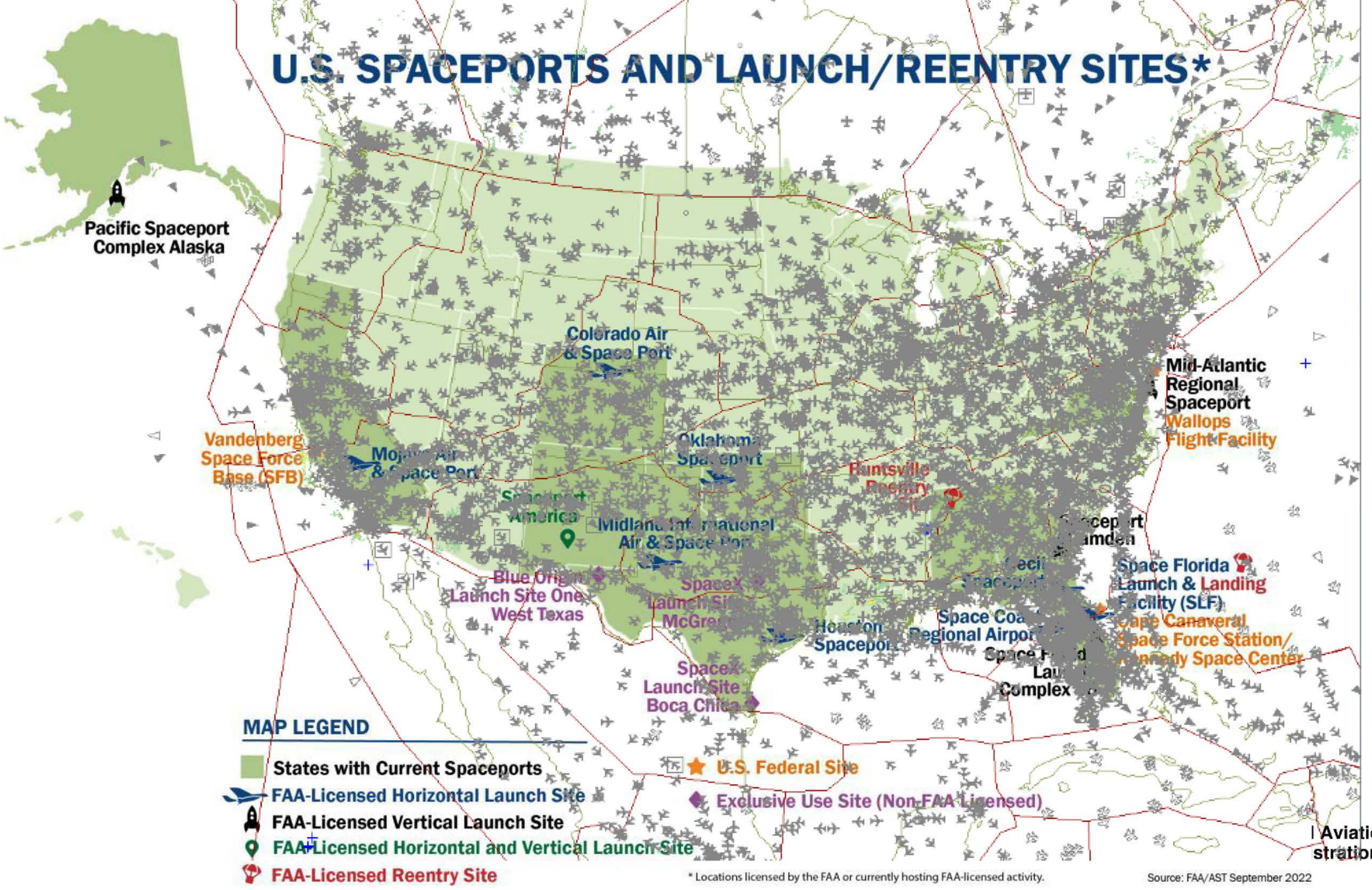
- Monitor and support

Real-Time Operations

- Post Operations Analysis

Post-Event and Future Planning

Federal Aviation Administration


U.S. SPACEPORTS AND LAUNCH/REENTRY SITES*
Pacific Spaceport Complex Alaska
Colorado Air & Space Port
Vandenberg Space Force Base (SFB)
Mojave Air & Space Port
Oklahoma Spaceport
Huntsville Reentry
Spaceport America
Midland International Air & Space Port
Blue Origin Launch Site One West Texas
SpaceX Launch Site McGregor
Houston Spaceport
SpaceX Launch Site Boca Chica
Mid-Atlantic Regional Spaceport
Wallops Flight Facility
Space Florida Launch & Landing Facility (SLF)
Cape Canaveral Space Force Station/ Kennedy Space Center
Space Coast Regional Airport
Complex
MAP LEGEND
States with Current Spaceports
FAA-Licensed Horizontal Launch Site
FAA-Licensed Vertical Launch Site
FAA-Licensed Horizontal and Vertical Launch Site
FAA-Licensed Reentry Site
U.S. Federal Site
Exclusive Use Site (Non-FAA Licensed)
* Locations licensed by the FAA or currently hosting FAA-licensed activity.
Source: FAA/AST September 2022

Common Themes

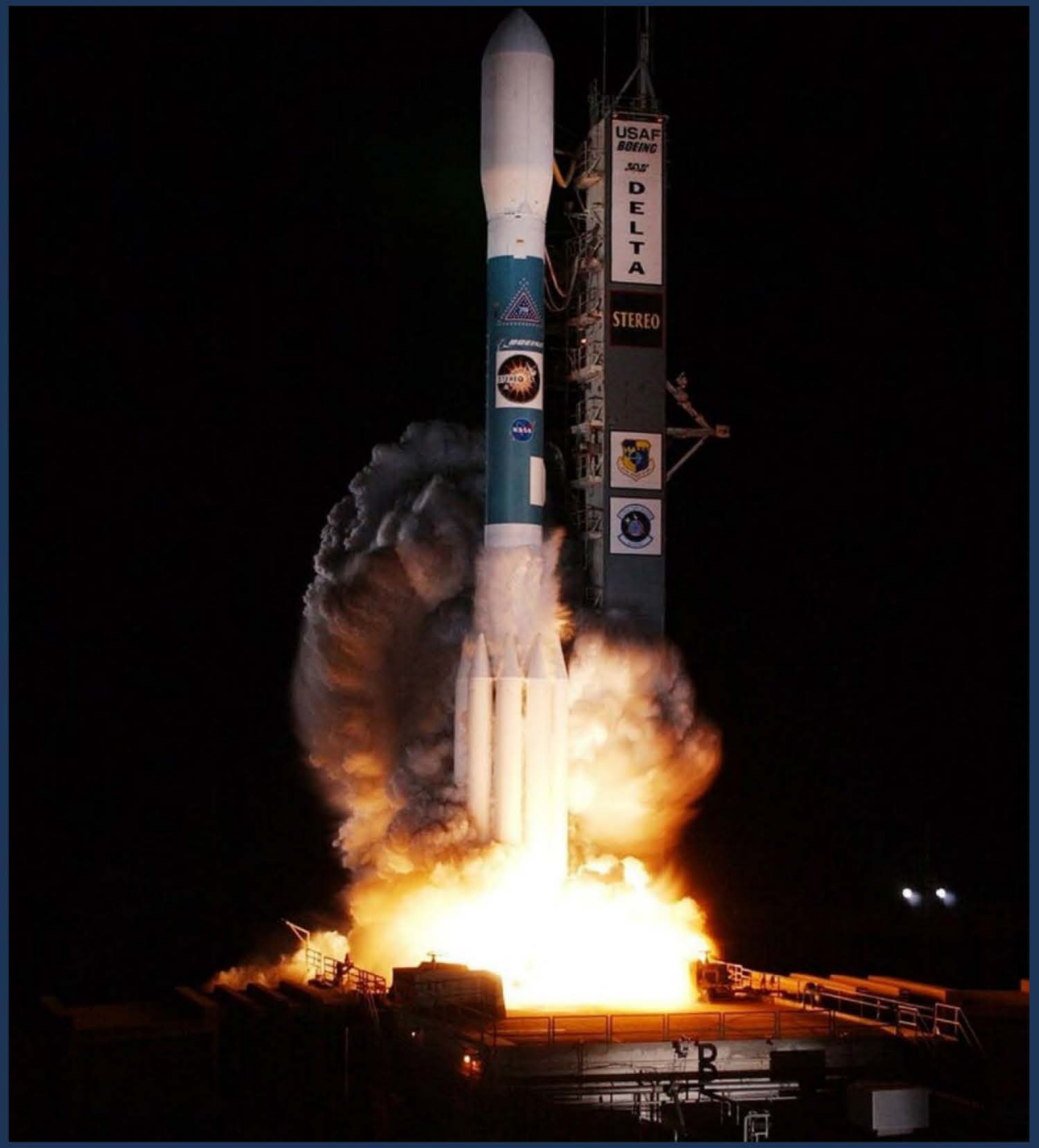
- Shared situational awareness among operator, range/spaceport and Air Traffic Control (ATC)

- Collaboration between operator, range/spaceport, ATC, and international stakeholders

Federal Aviation Administration

Airspace Integration | Module 6

Operator Operational Onboarding



Operator Operational Onboarding

Operator Licensing:

- Pre-Application Process includes;
  - Requirement for the establishment of a Letter of Agreement with the overlying Air Traffic Control facility

Operator Operational Onboarding

Letters of Agreement (LOAs):

Operator, ATC, Range/Spaceport roles and responsibilities

1. Responsibilities (Operator, ATO Space Operations, Air Traffic Facilities)
    - Points of contact
    - Personnel training
2. Procedures
    - Mission planning process
    - Notification of mission and timelines
    - Mission information including hazard areas
    - NOTAM processing; including International NOTAMs
    - Real time conduct of mission
        - Hotline use
        - Mission event call outs
        - Mission close out
4. Contact information

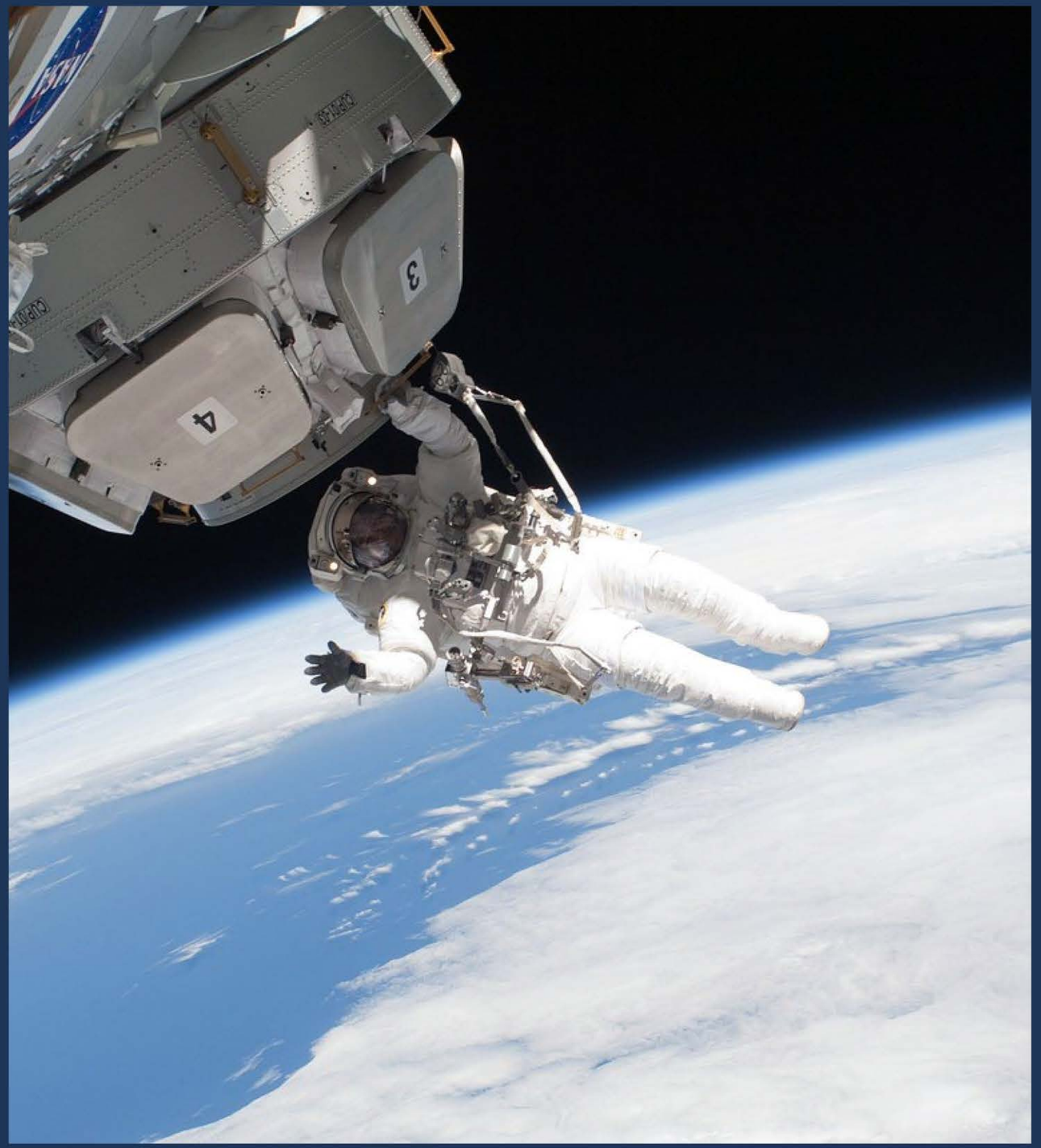
Operator Operational Onboarding

Collaborative Engagement:

- Mission description and goals
- Notional Hazard Areas
- Exchange of contact information

Airspace Integration | Module 1

Risk Assessment and Aircraft Hazard Area Definition



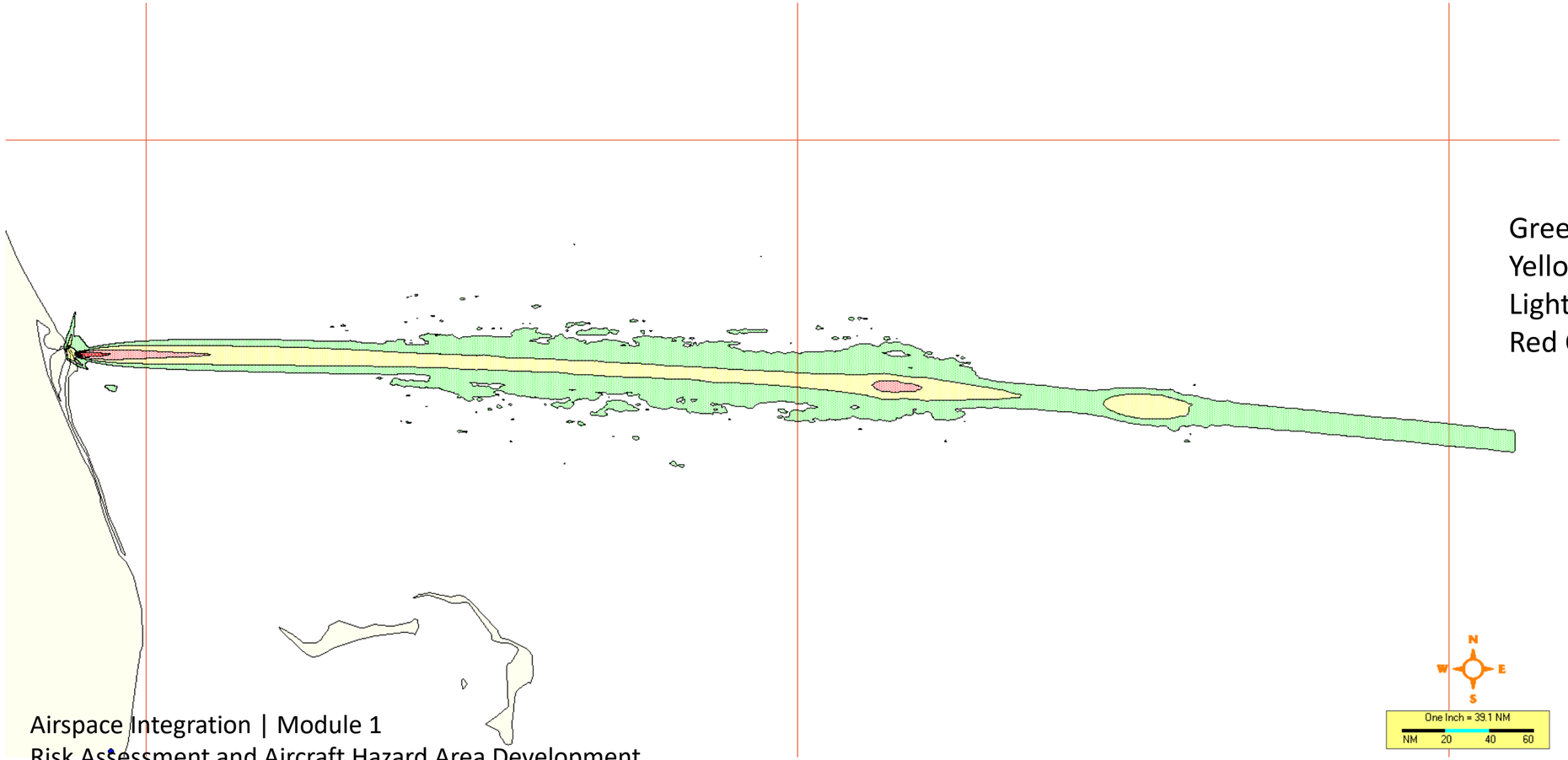
Risk Assessment

Risk assessment performed by operator, range/spaceport and/or regulator

- **Air, Sea and Land** risks are assessed and have different thresholds
- **Aircraft Hazard Areas (AHAs)** defined by regulation and policy as $1x10^{-6}$ for casualty producing collisions
- FAA ATO adds additional non-regulatory requirements associated with space operations **"Acceptable Level of Risk (ALR)"**
  - ALR was added to bridge the gap between regulatory requirements $1x10^{-6}$ and ATO target level of safety of $1x10^{-9}$
- **Risk Assessment also includes debris fall times** associated with nominal and malfunction

Risk Assessment

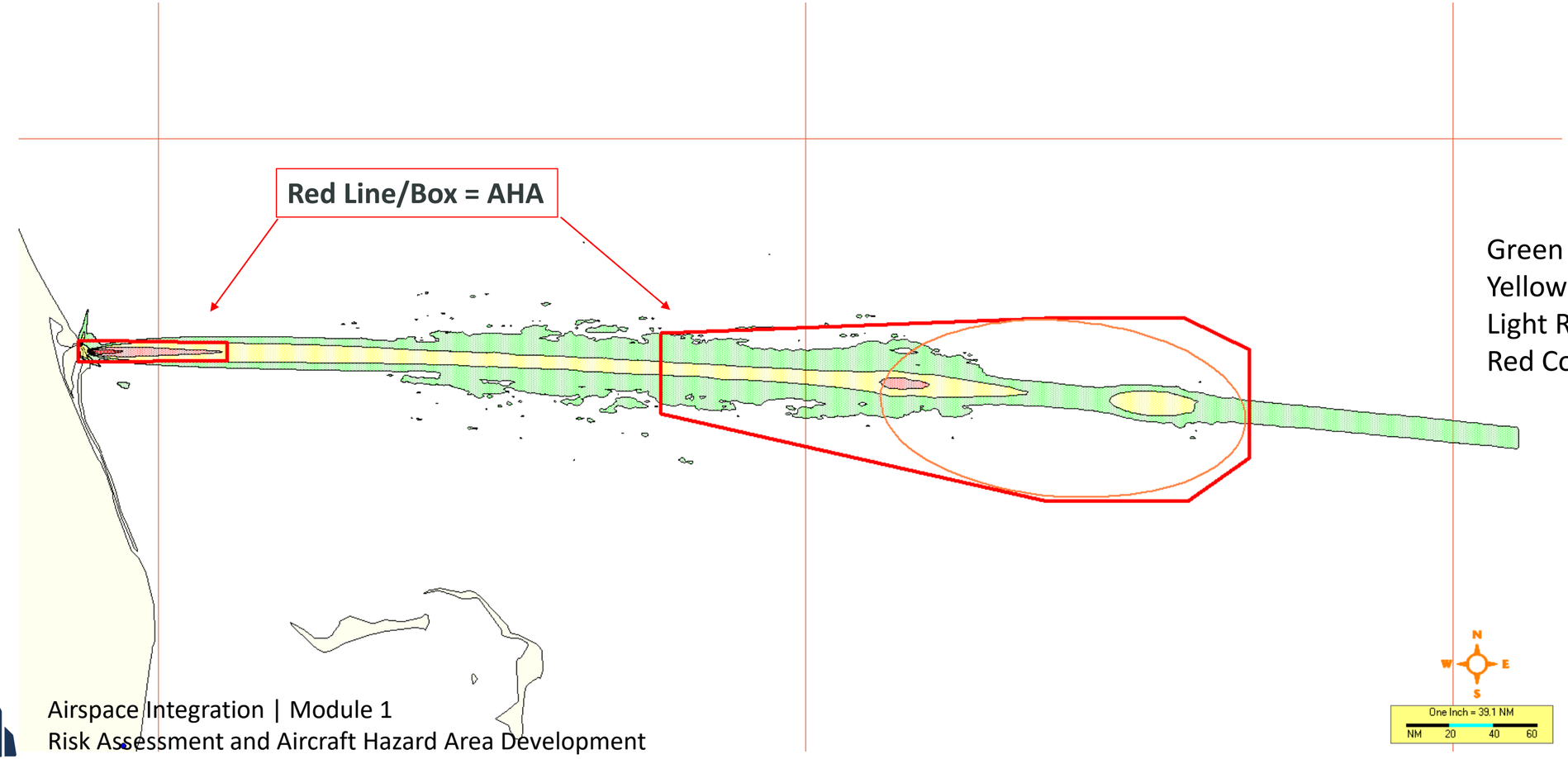
Risk Analysis: Risk contours are developed representing the risk to aircraft operations in the vicinity of launch or reentry operations



Green Contour = $1x10^{-8}$ Risk
Yellow Contour = $1x10^{-7}$ Risk
Light Red Contour = $1x10^{-6}$ Risk
Red Contour = $1x10^{-5}$ Risk

Risk Assessment

Aircraft Hazard Areas (AHAs): AHAs are developed to contain the risk contours that represent $1x10^{-6}$ risk to aircraft operations

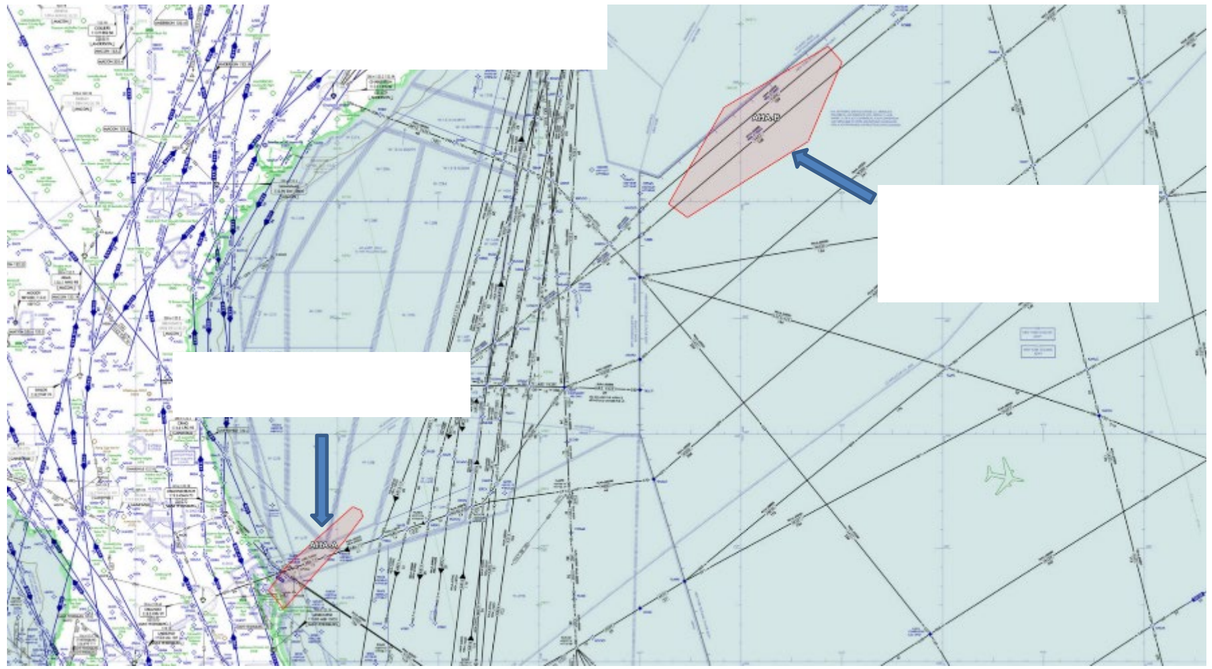


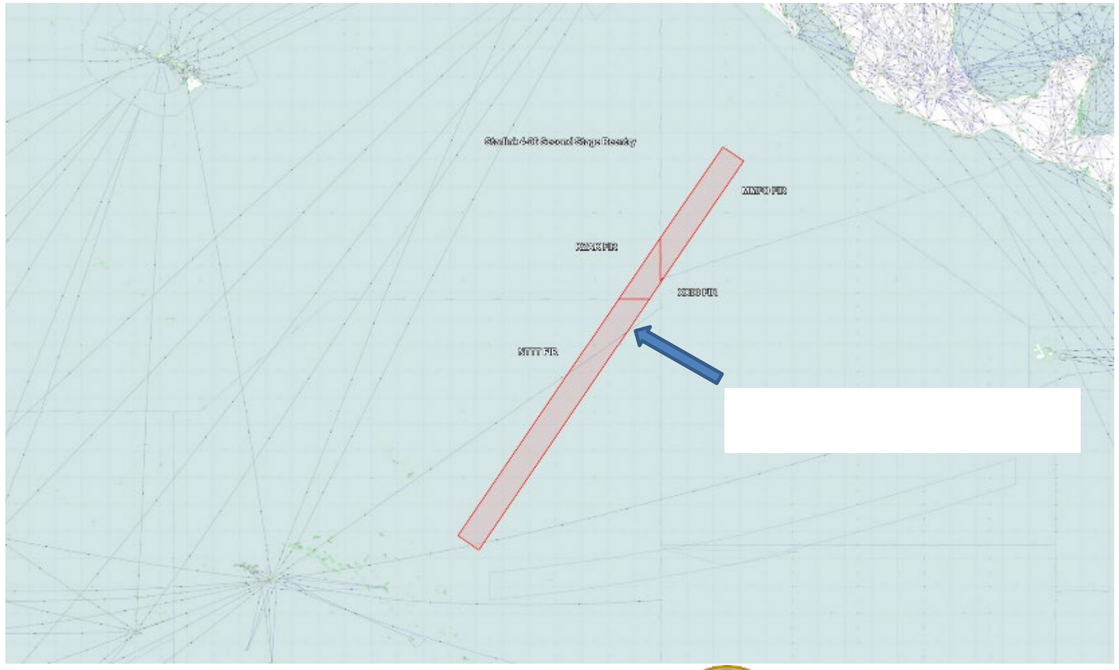
Federal Aviation Administration

Risk Assessment

AHAs: AHA are implemented for different stages of a launch operation

- Vehicle launch and ascent area
- Jettison item area
- Stage reentry area

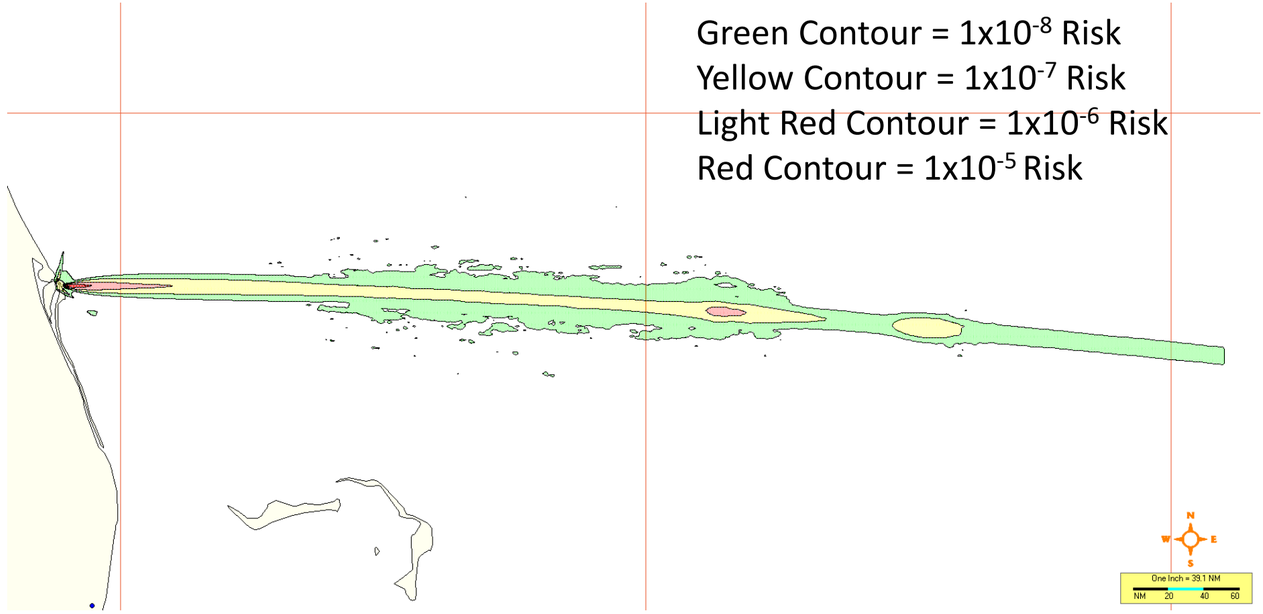


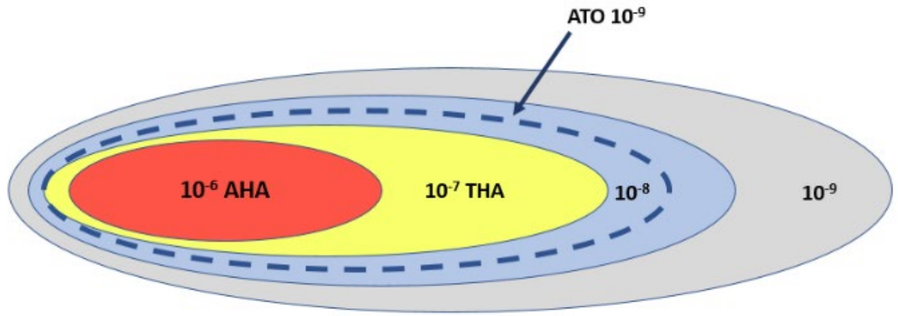


Risk Assessment

Acceptable Level Of Risk (ALR):

- ALR was added to **bridge the gap** between regulatory requirements and ATO target level of safety of $1x10^{-9}$
- $1x10^{-7}$ Hazard Areas are used as **Debris Response Areas (DRAs), contingency areas**, used in the event of a launch malfunction. DRA activation times are calculated using the risk analysis malfunction times
- $1x10^{-8}$ Hazard Areas are used for data collection associated with **annual collective risk thresholds**



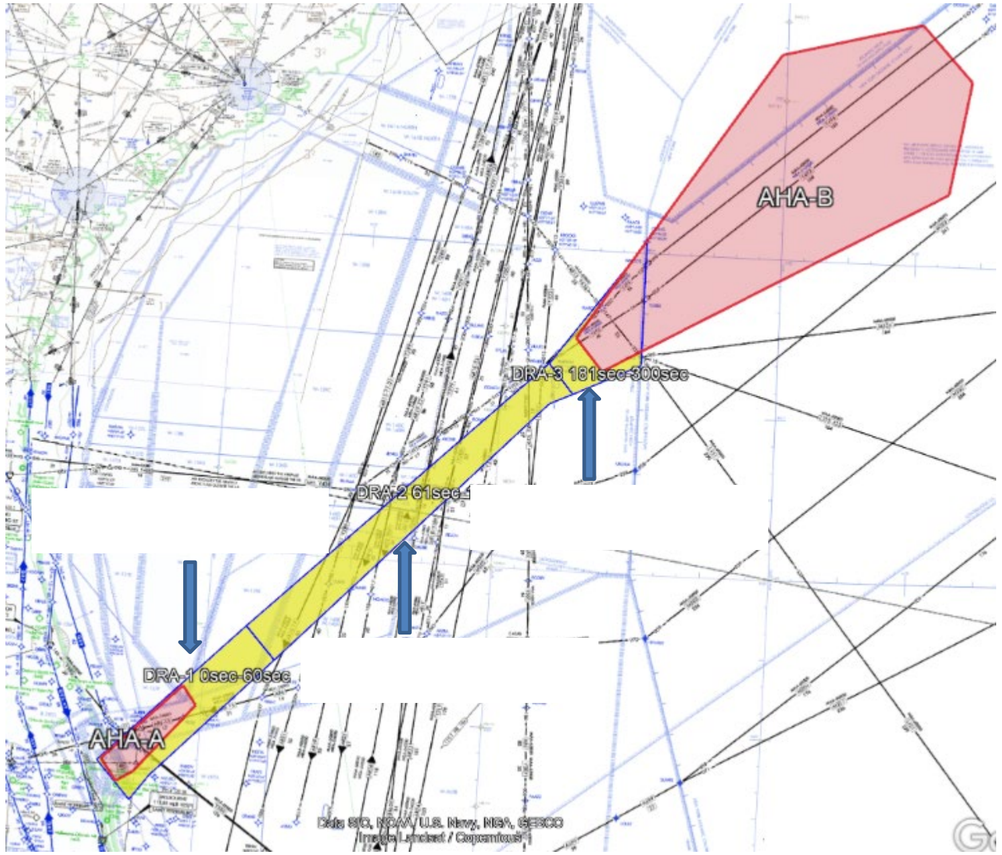


Element	AST	ATO[7]
Safety Standard	1×10^{-6} for casualty-producing collisions	1×10^{-9} for catastrophic hazards
Period	Per aircraft, per launch/fly-back operation	Per affected flight hour or air traffic control operation
Consequence	Casualty of an aircraft occupant	Fatality of an aircraft occupant

Risk Assessment

New Procedures – Debris Response Areas (DRAs):

- **Real-time ATO response** to a debris generating event:
  - Appropriate DRA will be **activated based on time of the vehicle malfunction**
  - DRA will be **evacuated and remain sterile** until all debris has fallen to earth
  - **DRA durations are pre-calculated** and known prior to launch
  - Applied in **radar-controlled airspace only**



Risk Assessment

Risk Analysis:

AHA Activation Times

- Nominal operations
- Malfunction operations
  (debris fall time)

Nominal

Malfunction

Description (Area Number)	Hazardous Area (Area enclosed by connecting following points in order:)	Closure Time (Minutes From Liftoff, Nominal)	Closure Time (Minutes From Liftoff, Malfunction)
(1) Launch Danger Zone (LDZ) Aircraft Hit Probability Contour	28° 40' N 80° 38' W 28° 39' N 79° 40' W 28° 36' N 79° 40' W 28° 34' N 80° 08' W 28° 34' N 80° 36' W and to the beginning.	3	19 (if malfunction occurs during flight)
(2) Stage 1 Landing Zone & Jettisoned Items (MVAC Skirt Ring, and PLF) Impact Area (b,c)	28° 33' N 75° 30' W 28° 33' N 74° 08' W 28° 21' N 71° 43' W 28° 13' N 71° 43' W 28° 19' N 74° 07' W 28° 29' N 75° 32' W and to the beginning.	25	25

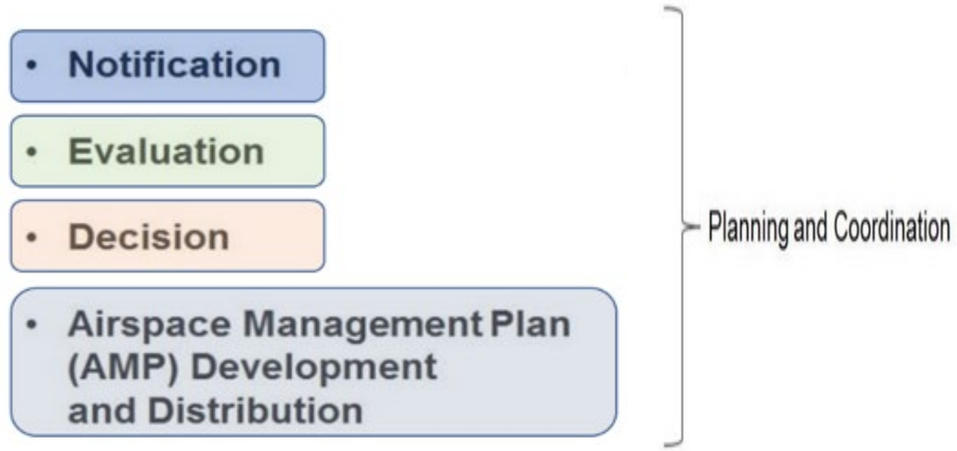
Airspace Integration | Module 2

Mission Planning

Mission Planning

4 Step Process:

1. Operator notification of intent to operate
2. Evaluation of mission specifics
3. Decision
4. Airspace Management Plan (AMP)



Mission Planning

Notification:

Operator intent
- Dates
  - Primary
  - Back up
- Launch window
- Intended launch time(s)

Risk analysis products
- AHA definition
- Nominal closure times
- Malfunction closure times
- Reentry times

Operator Intent to Launch

Launch Date (UTC)		Window Open (UTC)	Window Close (UTC)	Target Instantaneous Launch Time (UTC)
Primary	15 September 2021	00:00:00	12:00:00	TBD
Backup	16 September 2021	00:00:00	12:00:00	TBD

Range Safety Analysis

Description (Area Number)	Hazardous Area (Area enclosed by connecting following points in order:)	Closure Time (Minutes, Nominal)	Closure Time (Minutes, Malfunction)
(1) Aborts Enabled Vessel Hit Probability Contour	28° 38' 0.62" N 80° 36' 58.76" W 28° 39' 0.00" N 80° 35' 0.00" W 28° 38' 0.00" N 80° 33' 0.00" W 28° 37' 0.00" N 80° 33' 0.00" W 28° 36' 0.00" N 80° 35' 0.00" W 28° 36' 0.00" N 80° 35' 11.05" W	**T-40 min** to launch	**6 min** if malfunction occurs during propellant load **T+50 min** if launch scrubs and vehicle de-tanks
(2) Launch Danger Zone (LDZ) 1-Ship Hit Probability Contour	28° 39' 13.48" N 80° 37' 50.56" W 28° 41' 0.00" N 80° 34' 0.00" W 28° 51' 0.00" N 80° 21' 0.00" W 28° 48' 0.00" N 80° 17' 0.00" W 28° 36' 0.00" N 80° 25' 0.00" W 28° 33' 38.31" N 80° 34' 2.89" W	T+3	T+25 (if malfunction occurs during flight)
(3) LDZ 1-Boat Hit Probability Contour [1]	28° 38' 7.96" N 80° 37' 4.43" W 28° 39' 0.00" N 80° 31' 0.00" W 28° 37' 0.00" N 80° 30' 0.00" W 28° 35' 25.35" N 80° 34' 44.05" W	T+3	T+25
(4) 1st Stage Landing/Jettisoned Items (MVAC Skirt Ring) Impact Area (b)	31° 38' 0.00" N 77° 28' 0.00" W 32° 14' 0.00" N 77° 2' 0.00" W 32° 39' 0.00" N 76° 19' 0.00" W 32° 27' 0.00" N 76° 7' 0.00" W 31° 53' 0.00" N 76° 38' 0.00" W 31° 29' 0.00" N 77° 17' 0.00" W and to the beginning.	T+25	T+25

Mission Planning

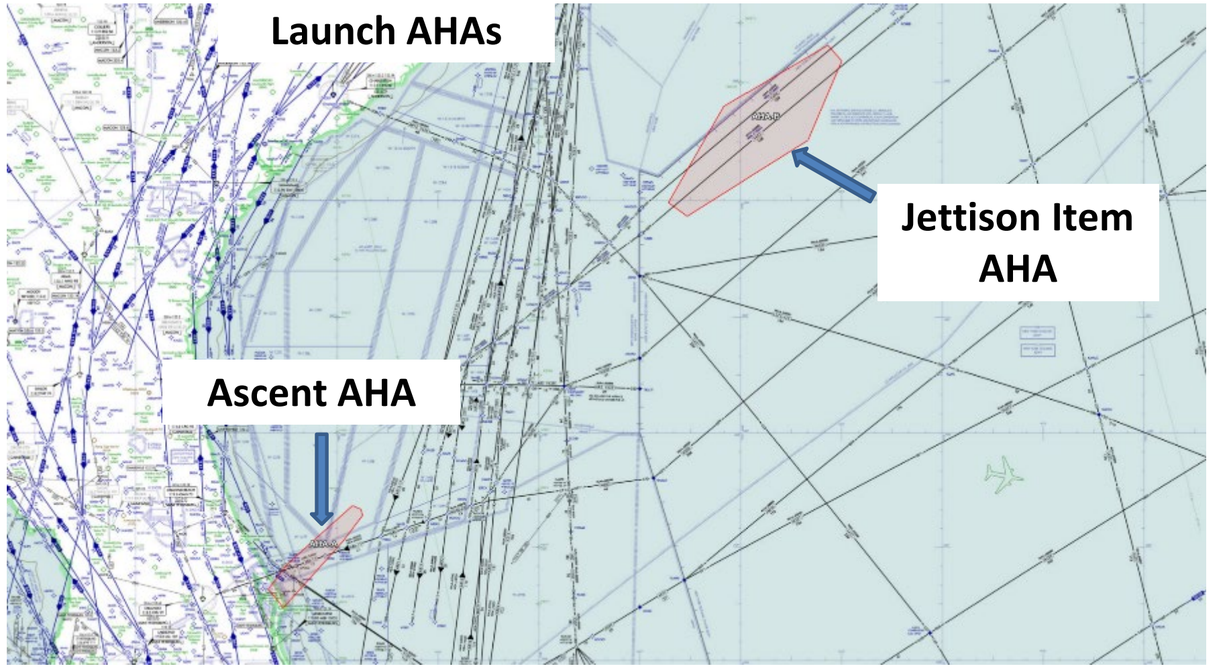
AHA Definition:

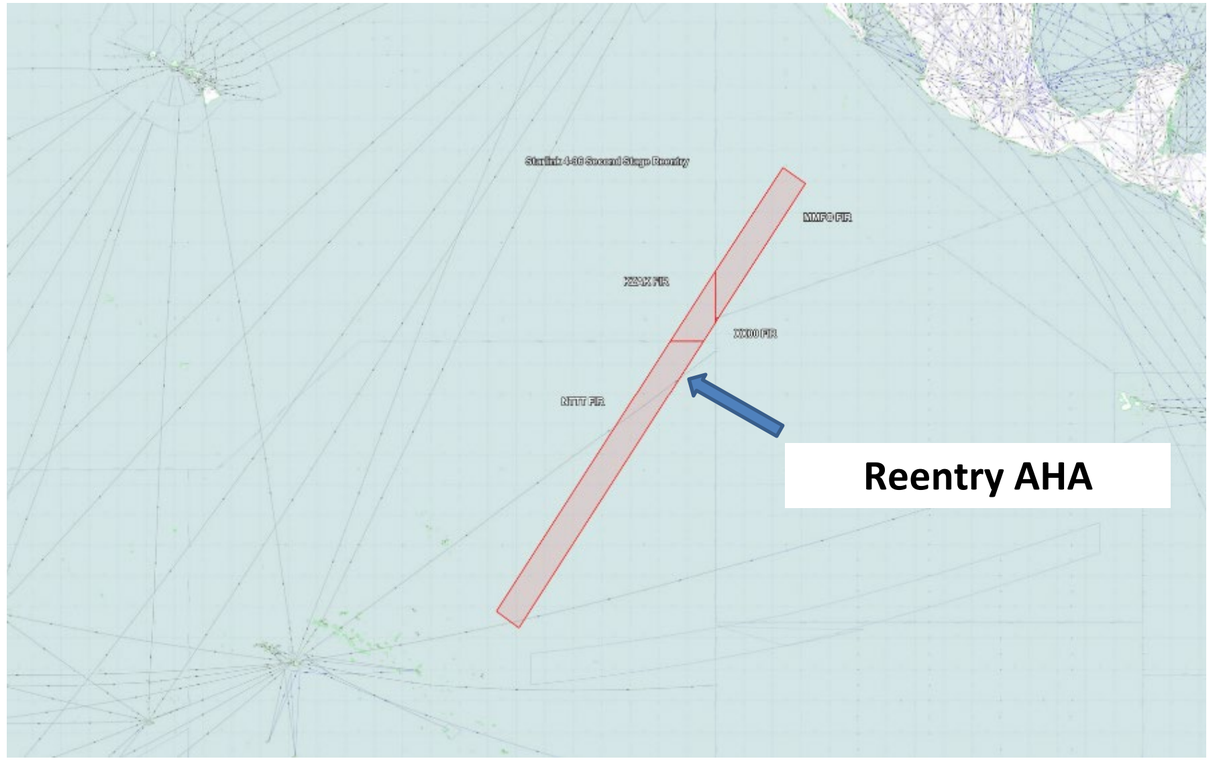
- Lateral AHA dimensions
- Launch window
- Malfunction times

Launch window = 0205-0432 UTC
Malfunction times: AHA A = 25 mins
AHA B = 47 mins

Activation Time = Launch Window + Malfunction Time

AHA A activation = 0205-0457 UTC
AHA B activation = 0205-0519 UTC

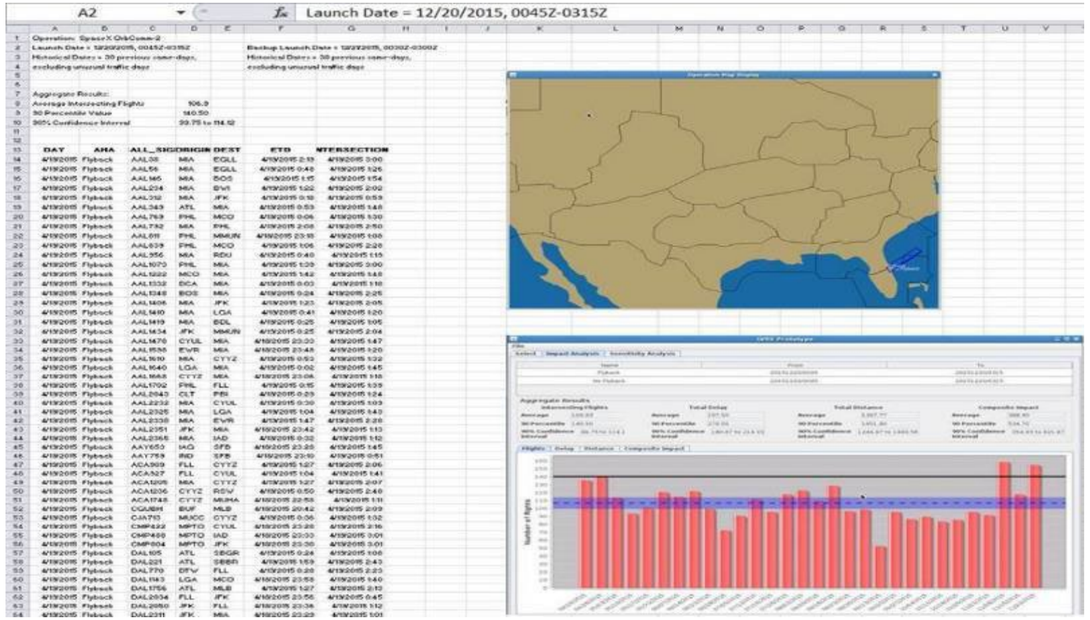




Mission Planning

Evaluation: Assessment of impacts on airspace system is performed using

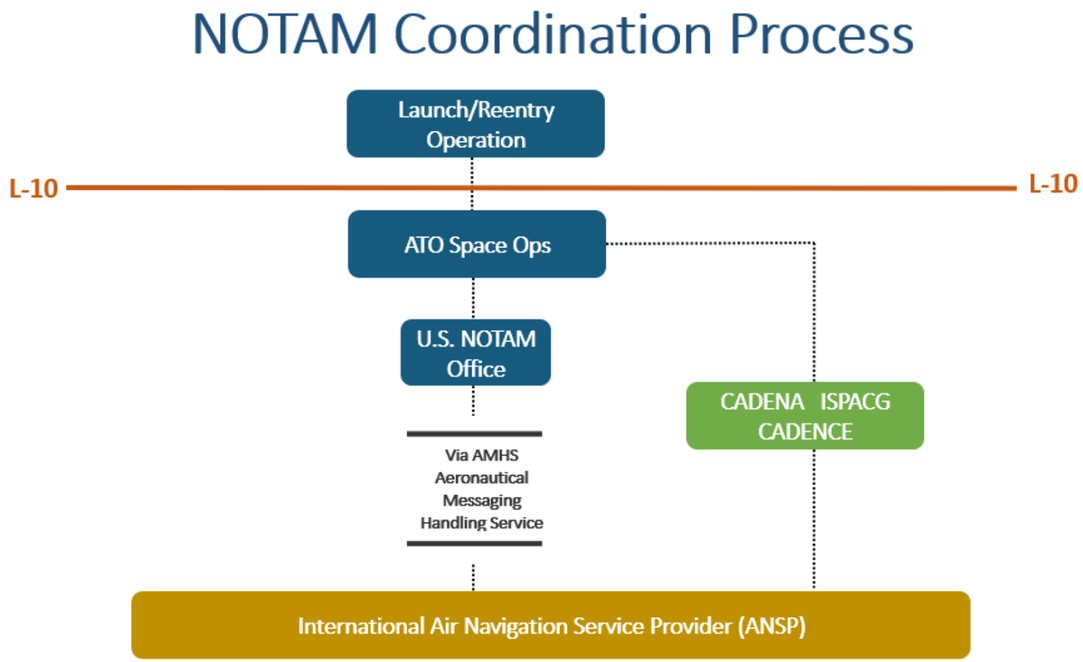
- AHA definition
- Historical aviation traffic data



Mission Planning

International Coordination

- Process initiated at 10 days prior to launch
- ATO Space Operations initiates coordination with International Air Navigations Service Providers (ANSPs) and U.S. NOTAM Office
- Danger Areas published for hazard
- Aeronautical Messaging Handling Service (AMHS) preferred method of coordination



Mission Planning

Airspace Management Plan:

- Mission Overview
- Mission Schedule
- Traffic Management Initiatives
- Distribution:
  - LRO
  - Range
  - ATC Facilities
  - Aviation Community
  - Other Stakeholders

Airspace Management Plan

NAS Impact of the Proposed SpaceX Falcon 9,

SpaceX CRS-25 Rocket Launch, Kennedy Space Center (KSC), FL

Background: SpaceX CRS-25, is a Commercial Resupply Service mission to the International Space Station. The mission is contracted by NASA and will be flown by SpaceX using a Cargo Dragon.

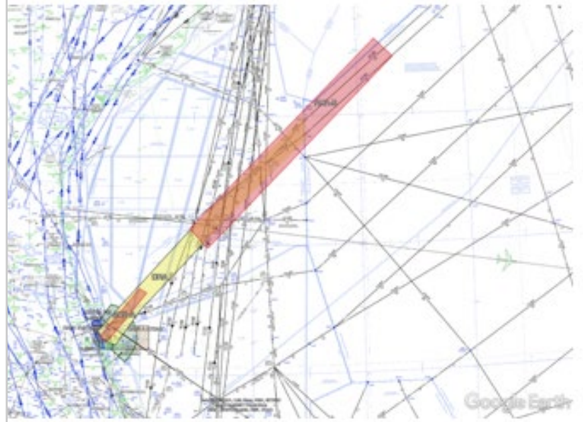
Impact Evaluation: The NAS impact evaluation examined two Launch Aircraft Hazard Areas (AHA), Special Use Airspace (SUA) and a TFR, associated with the launch of the CRS-25 mission. The first, AHA-A extends from the launch site to approximately 59nm north-eastward. The second, AHA-B, extends from approximately 129nm northeast of the launch site to 372nm northeast. All AHAs are within Miami ARTCC, Jacksonville ARTCC and New York ARTCC airspace. A third AHA safeguarding the second stage reentry south of Australia is located in the Indian Ocean in the Melbourne FIR.

Operational Impact: The AHA length and location does impact the Atlantic Routes. Affected airspace also includes Cape Restricted Areas, Cape ALPHA and BRAVO ATCAAs, and portions of Warning Areas. Traffic Management Initiatives (TMIs) will include reroutes.

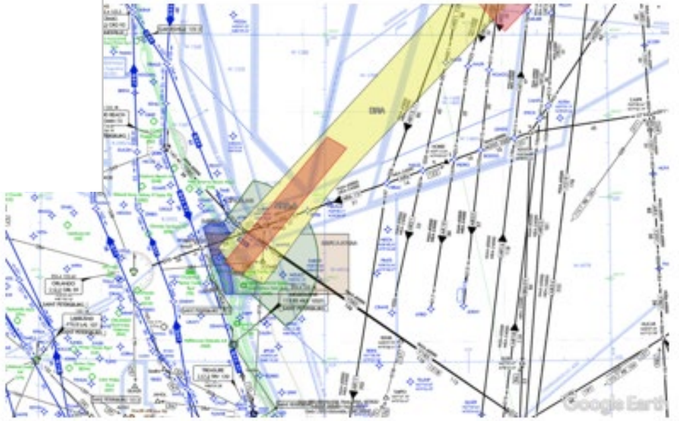
Conclusion: Reroutes to protect the AHAs may result in an average mileage of 46nm / 7 minutes.

Additional Info: AHA-A, and the SUAs surrounding the launch site may be released for ATC use 3 minutes after liftoff with a nominal launch.

CRS-25 Associated Hazard Areas

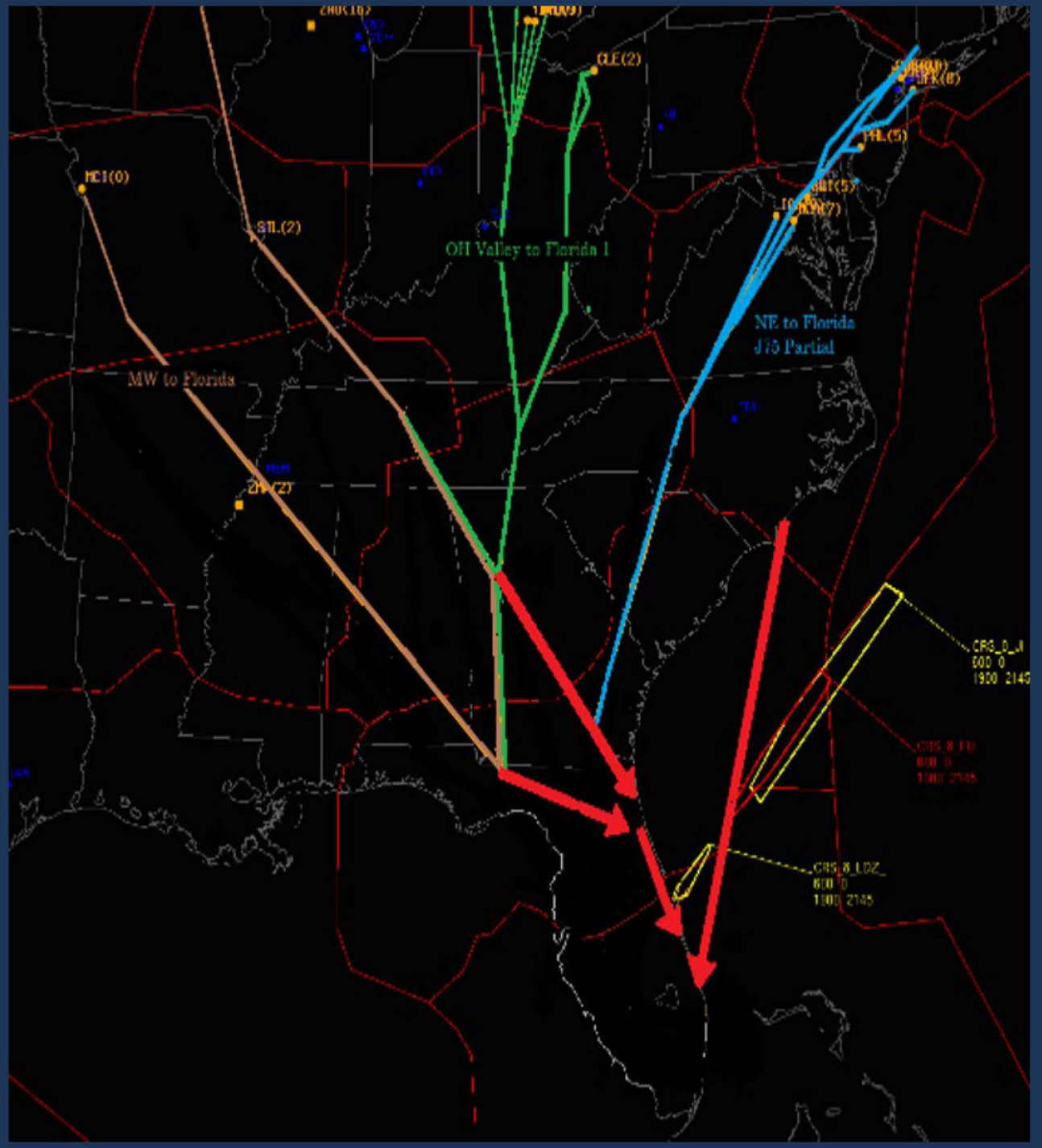


CRS-25 Launch Airspace



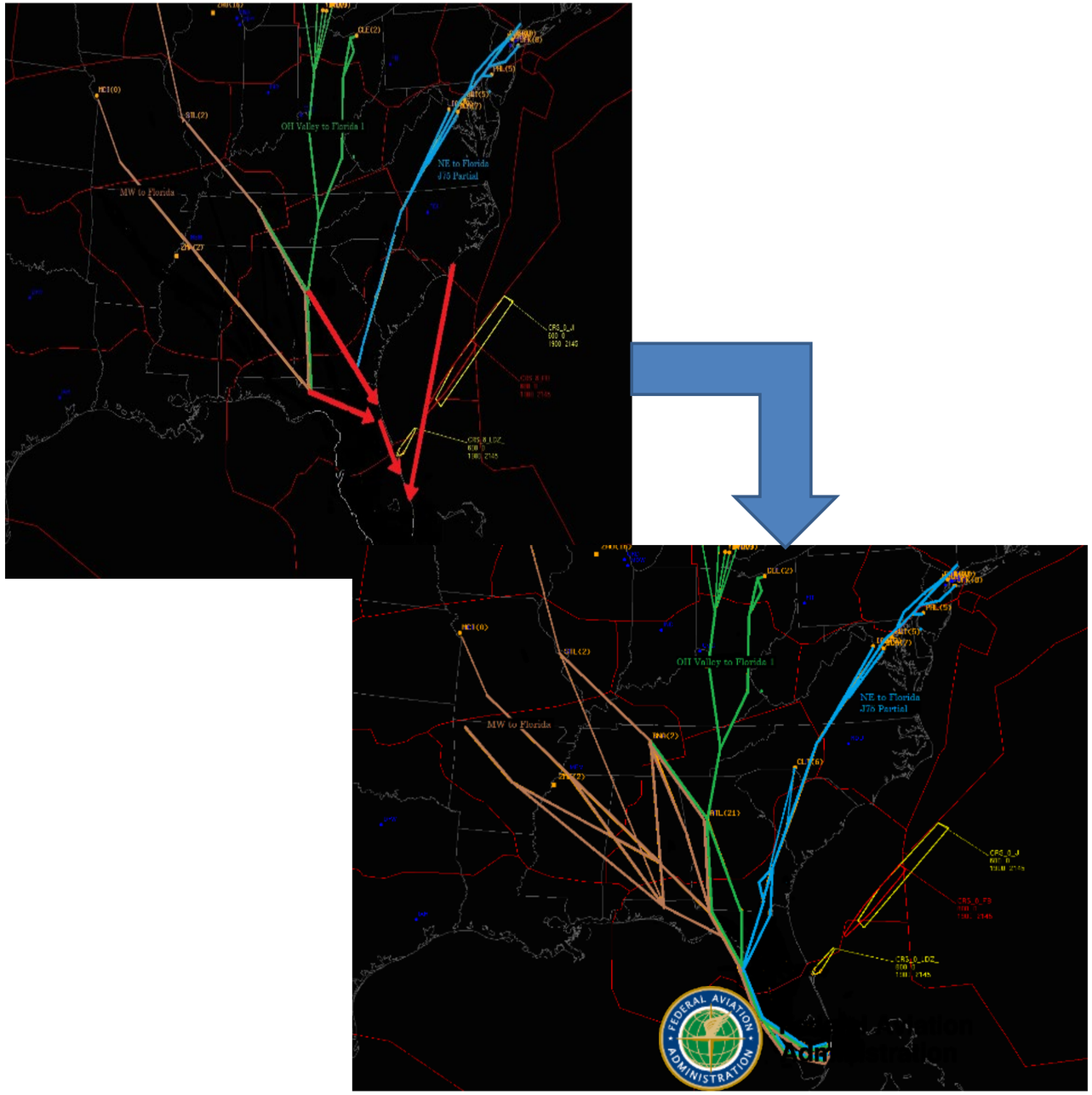
Airspace Integration | Module 3

Traffic Flow Management



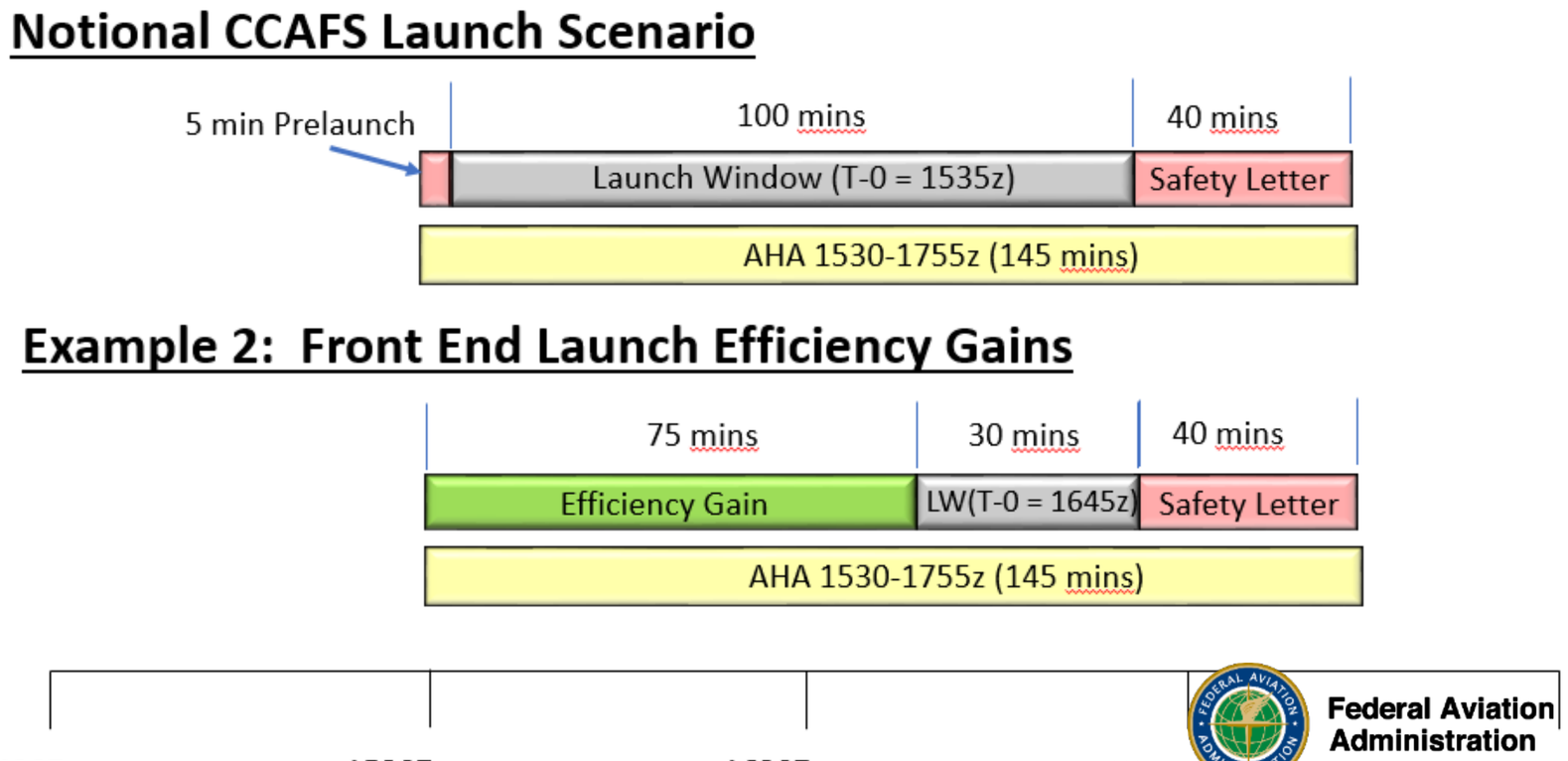
Traffic Flow Management:

- Traffic management predominately consists of route management
- Use of time-based procedures minimizes the total impact of operations
- Real time situational awareness is key to tactical management of airspace and aircraft during operation
- Collaborative discussions with space industry have been critical to understanding operations and the development of dynamic airspace management procedures
- Early communication of traffic management plan to aviation industry is important



Traffic Flow Management:

- Use of time-based procedures minimizes the total impact of operations
- Importance of hotline in tactical management of aircraft during operation
- Collaborative discussions with industry have been critical to understanding operations and the development of dynamic airspace management procedures



Traffic Flow Management:

- Use of time-based procedures minimizes the total impact of operations
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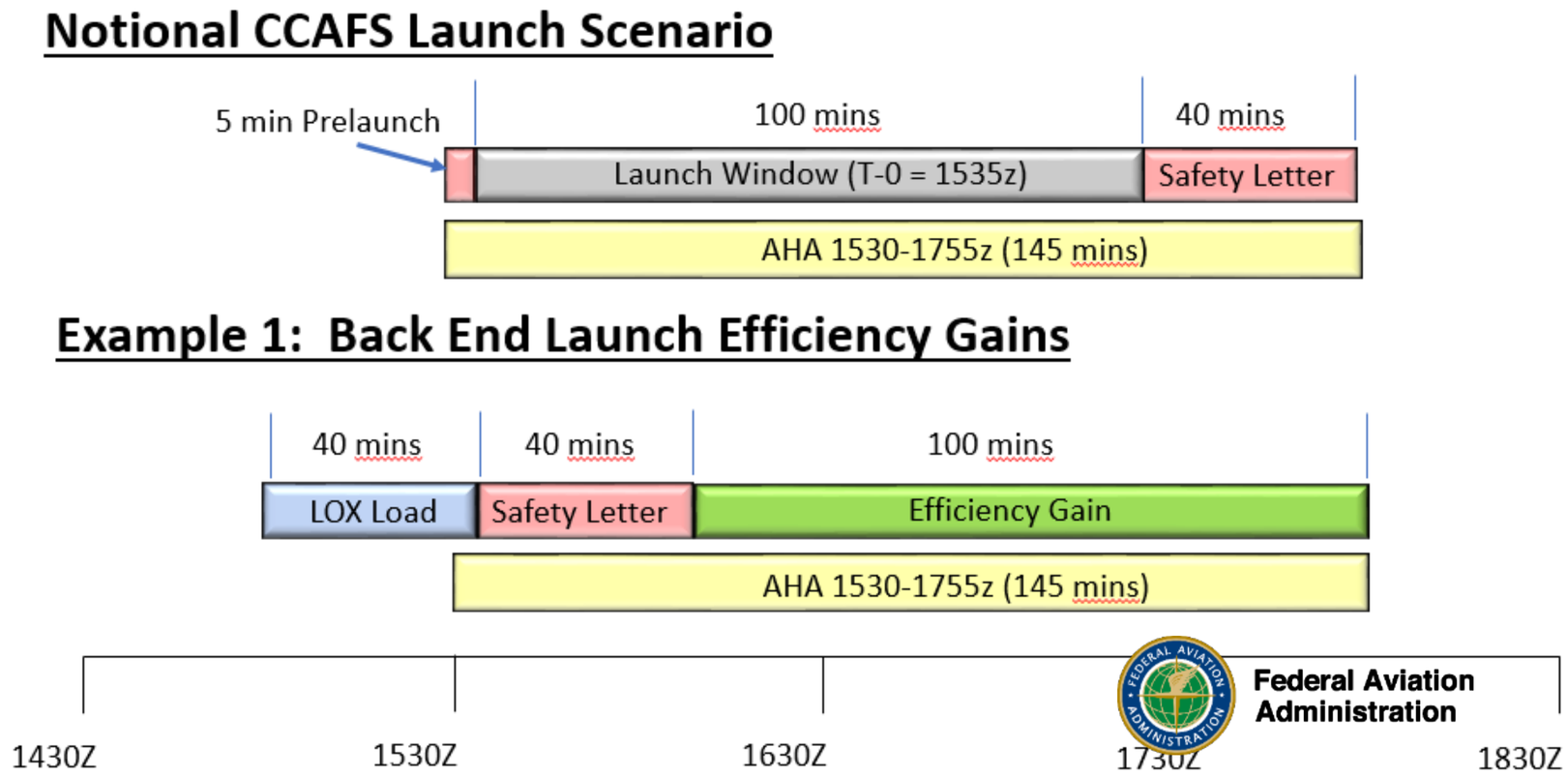
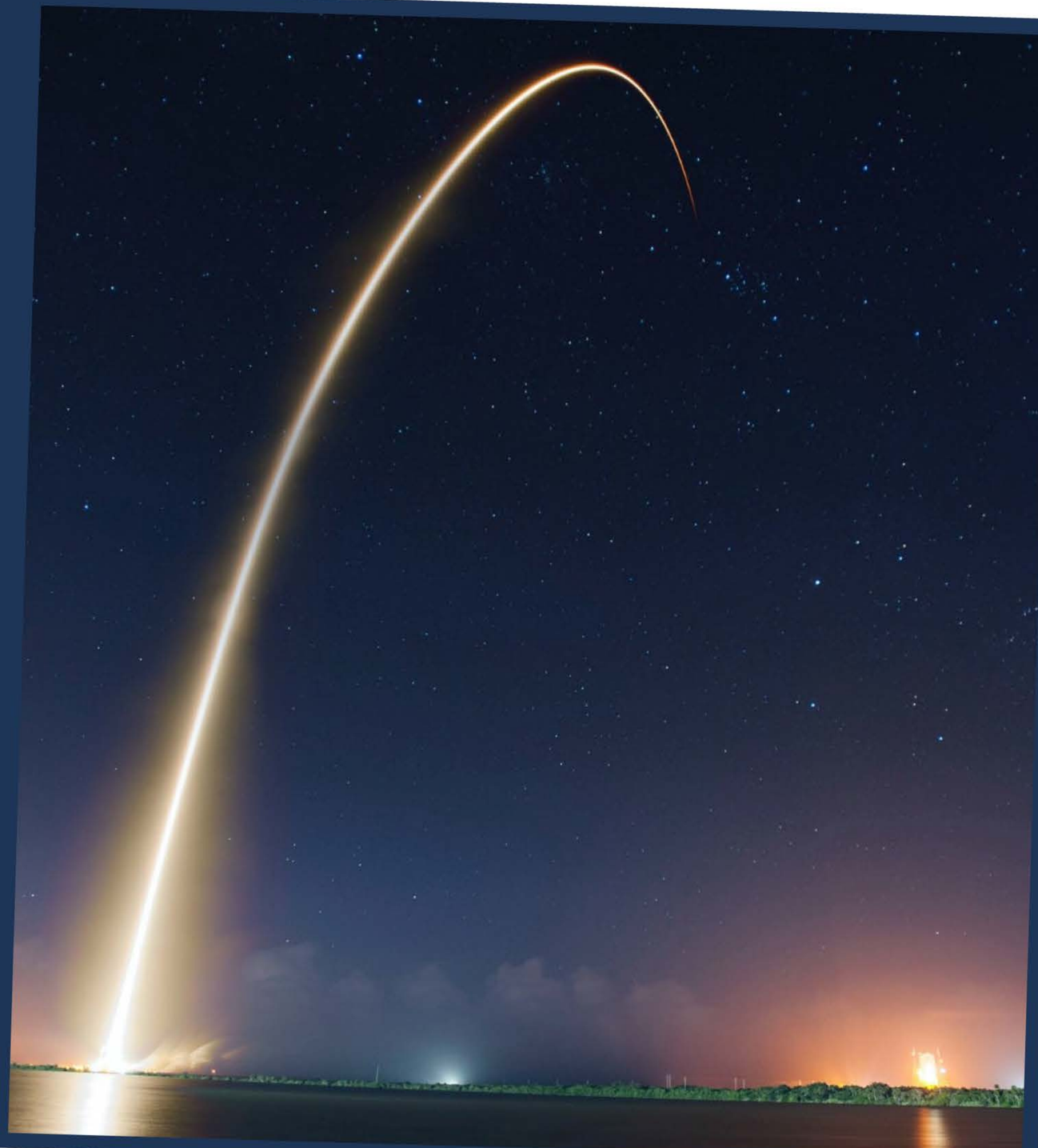


Airspace Integration | Module 4

Real Time Mission Support



Real Time Mission Support

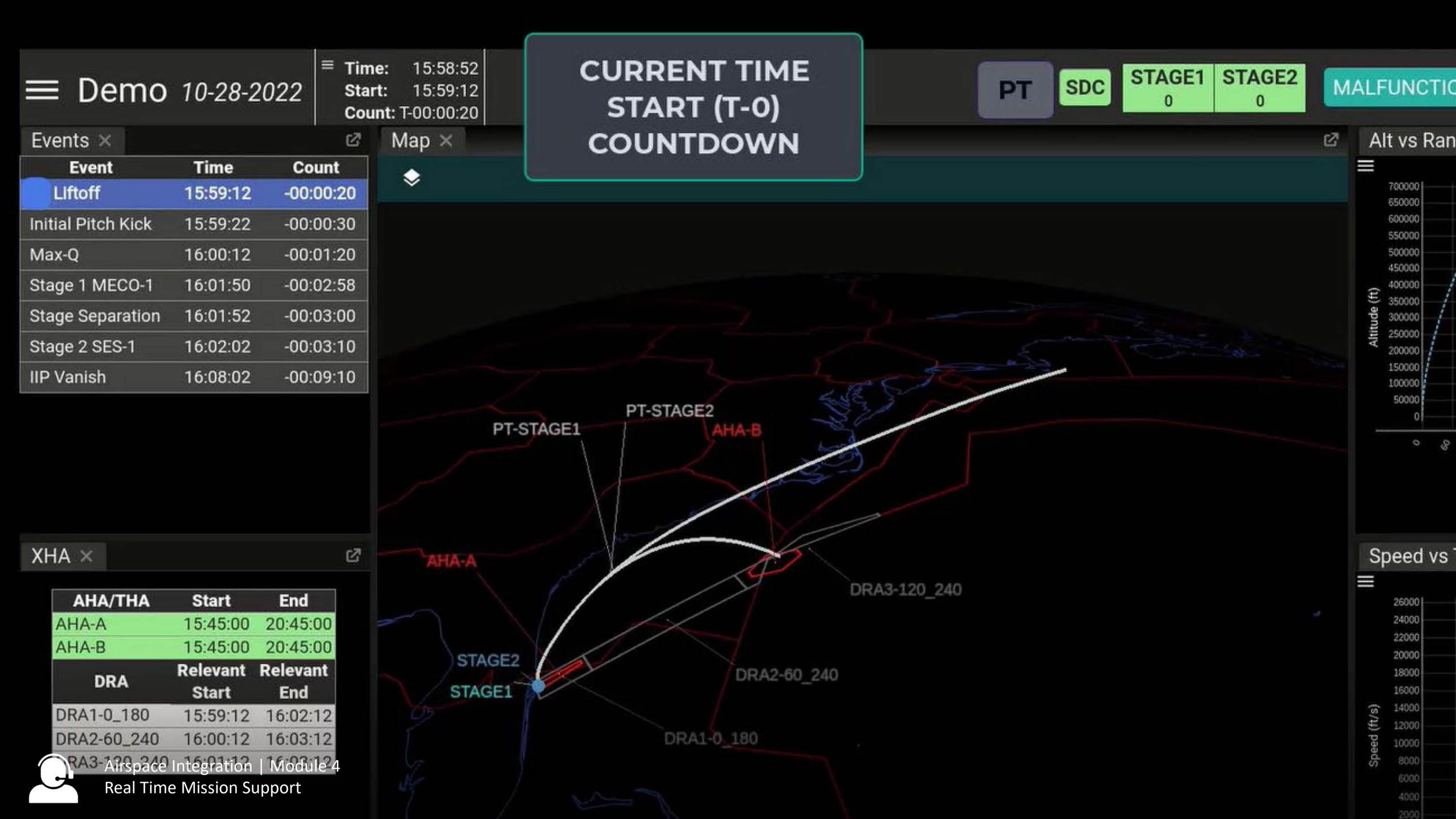
Mission: Ensure space launch and reentry operations are safely and efficiently integrated into the National Airspace System (NAS)

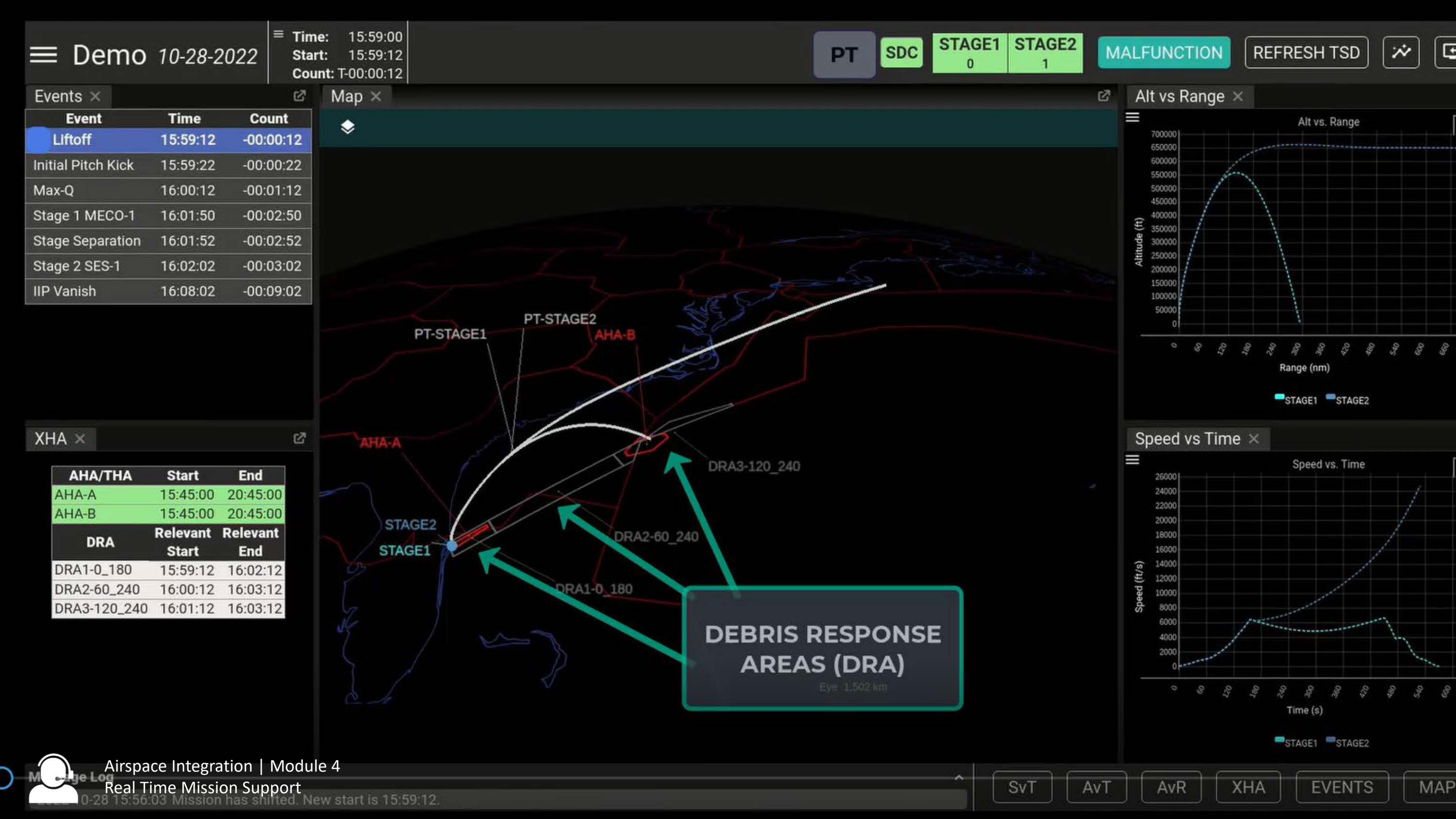
- Conducted from the Challenger Room at the FAA Air Traffic Control System Command Center in Warrenton, Virginia.
- Key Tools:
  - Space Data Integrator (SDI)
  - Traffic Flow Management System
  - Hotline

Real Time Mission Support

Hotline Actions:

- The **hotline is key to real-time shared situational awareness**
- **Operator call out** of key mission events
- **Airspace is tactically managed** and deactivated
- **Traffic Management** initiatives are cancelled
- In the event of a launch malfunction, **Debris Response Areas (DRAs)** are activated and cancelled

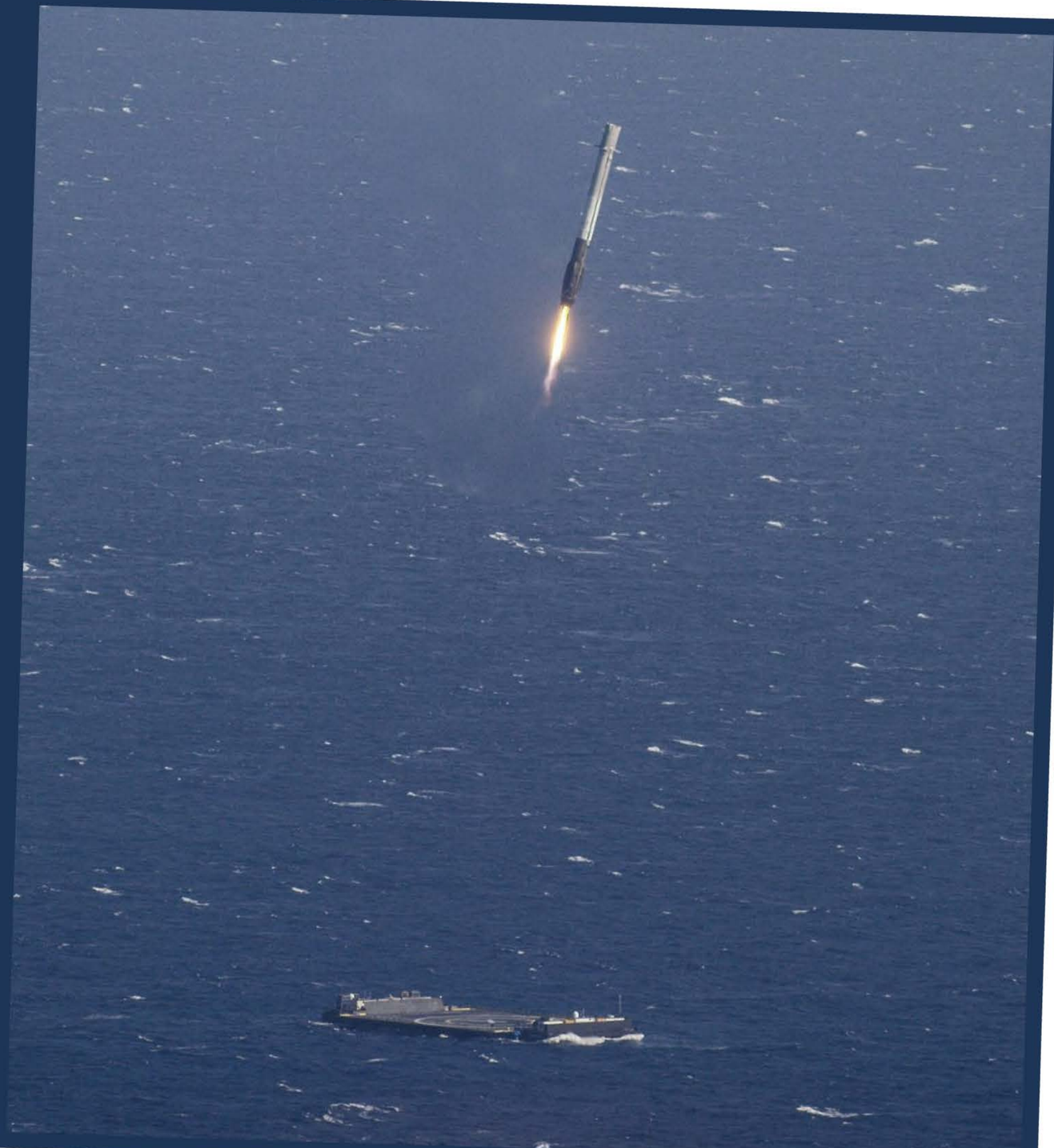

Demo 10-28-2022
Time: 15:58:52
Start: 15:59:12
Count: T-00:00:20
CURRENT TIME
START (T-0)
COUNTDOWN
PT
SDC
STAGE1
0
STAGE2
0
MALFUNCTIO
Events
Event Time Count
Liftoff 15:59:12 -00:00:20
Initial Pitch Kick 15:59:22 -00:00:30
Max-Q 16:00:12 -00:01:20
Stage 1 MECO-1 16:01:50 -00:02:58
Stage Separation 16:01:52 -00:03:00
Stage 2 SES-1 16:02:02 -00:03:10
IIP Vanish 16:08:02 -00:09:10
Map
Alt vs Ran
Altitude (ft)
700000
650000
600000
550000
500000
450000
400000
350000
300000
250000
200000
150000
100000
50000
0
PT-STAGE1
PT-STAGE2
AHA-B
AHA-A
DRA3-120_240
STAGE2
STAGE1
DRA2-60_240
DRA1-0_180
XHA
AHA/THA Start End
AHA-A 15:45:00 20:45:00
AHA-B 15:45:00 20:45:00
DRA Relevant Start Relevant End
DRA1-0_180 15:59:12 16:02:12
DRA2-60_240 16:00:12 16:03:12
Speed vs
Speed (ft/s)
26000
24000
22000
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000



Airspace Integration | Module 4
Real Time Mission Support

Airspace Integration | Module 5

Post Operations Analysis



Post Operations Analysis

- Data Analysis
- Lessons Learned
- Best Practices