

DEVELOPING FORMAL DESIGN GUIDELINES FOR SPACEPORTS

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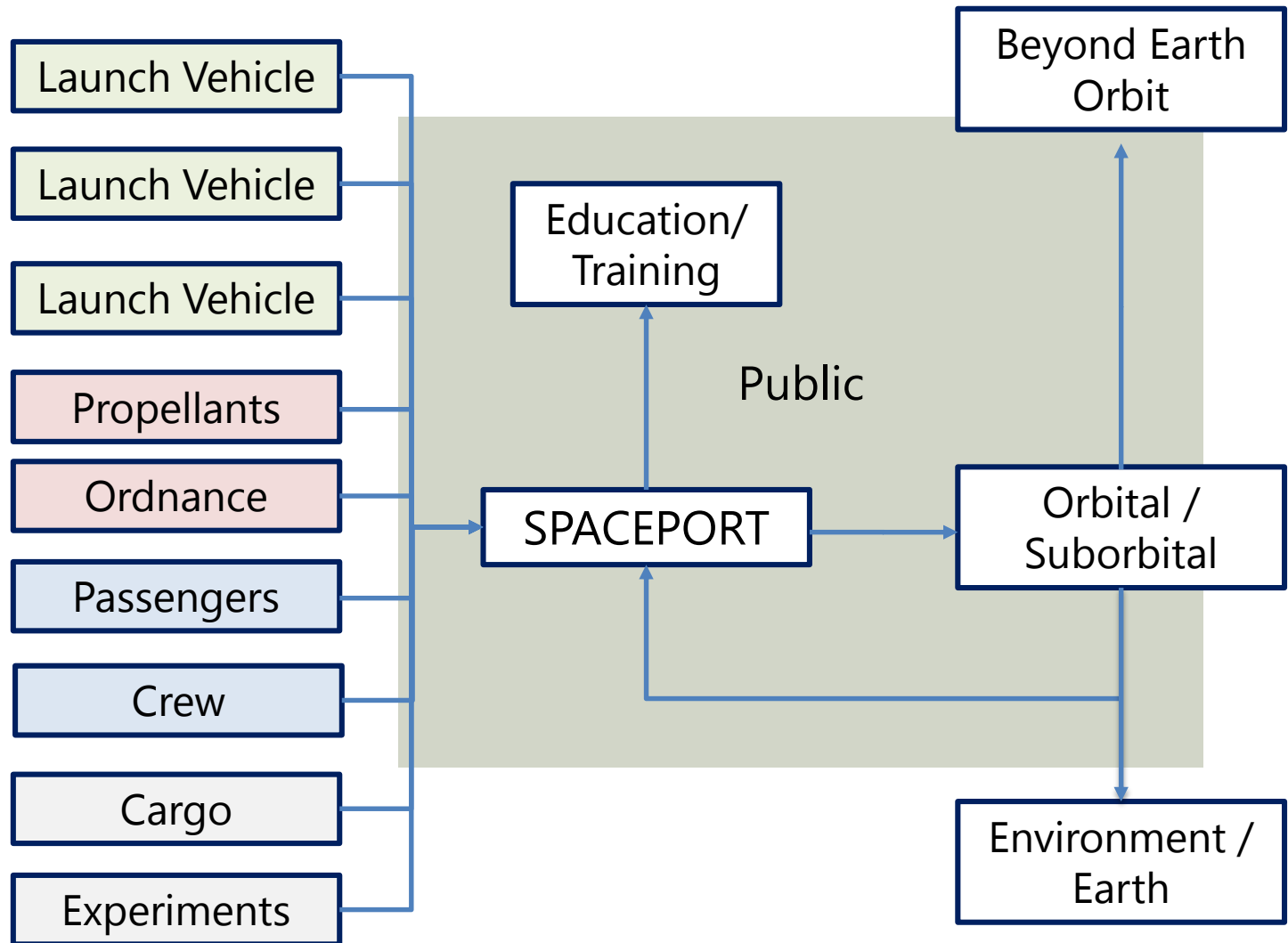


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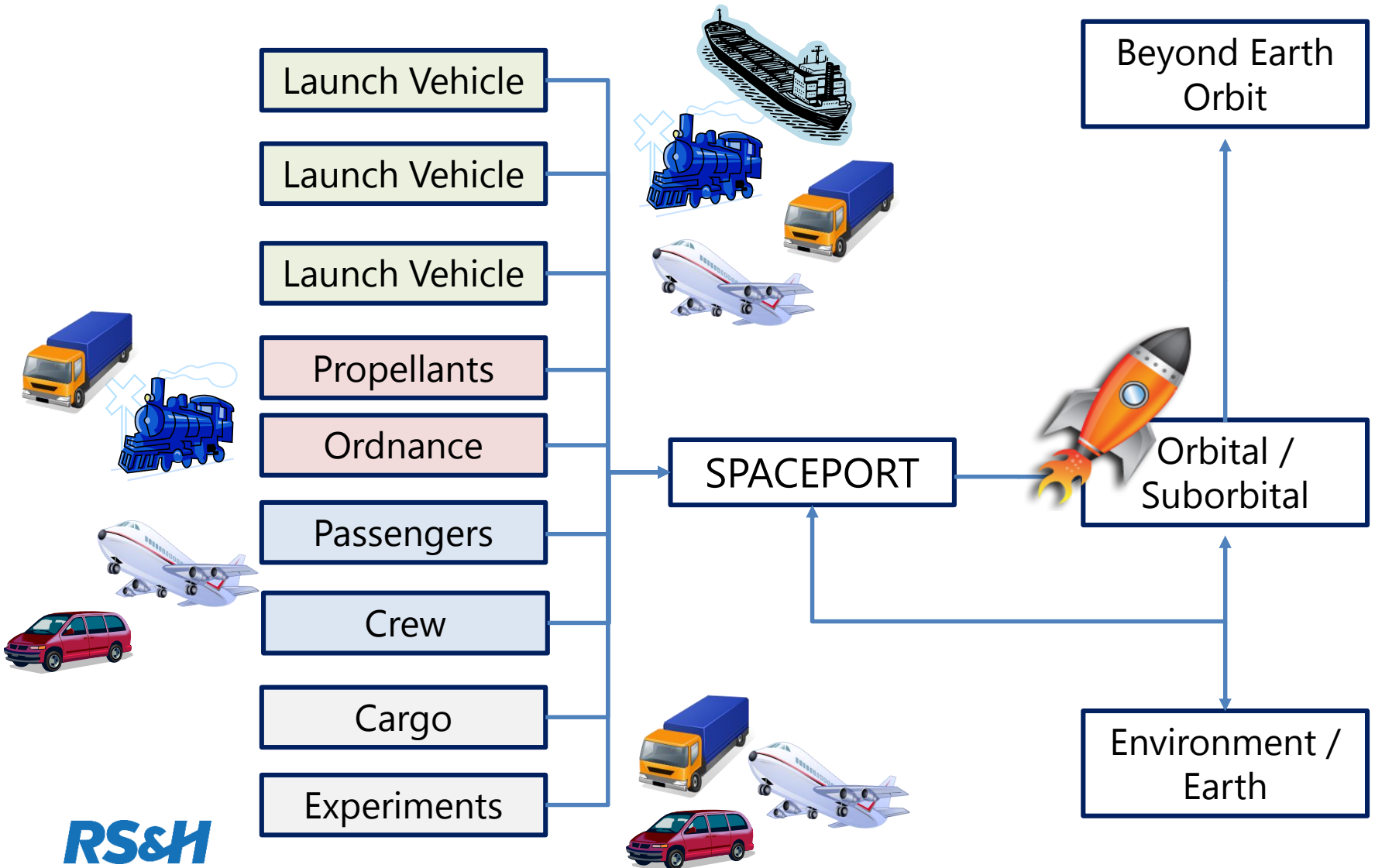
Agenda

- » Overview of Spaceports
 - Concept and Functions
 - Multimodal Aspects
 - Current Governing Regulations
- » Background and Challenges
- » Spaceport Research Needs
- » Summary

Spaceport Concept and Functions



Spaceport Multimodal



Governing Regulations

- » Commercial Launch Sites and Spaceports
 - 14 CFR Part 420 – FAA - License to Operate a Launch Site
 - Environmental analysis
 - Explosive site plan
 - Launch site operations
 - Flight corridor and risk analysis
- » Federal Launch Sites and Spaceports
 - Numerous regulations depending on the operator/user and are derived from range safety requirements
 - Eastern and Western Range requirements
 - Range Commanders Council requirements
 - NASA specifications, standards, and handbooks
 - DoD regulations

Agenda

- » Overview of Spaceports
- » Background and Challenges
 - Types of Spaceports / Vehicles
 - Transportation interactions Spaceports require
 - Coordination areas with different organizations
 - Integrating horizontal spaceport ops with airports
 - Experience with integrating spaceport ops with air traffic
- » Spaceport Research Needs
- » Summary

Types of Vehicles

Operations variability challenges:

- » Vertical Takeoff / Horizontal Takeoff
 - (Antares / Pegasus)
- » Rocket Powered takeoff / Aircraft Powered takeoff
 - (Lynx / SpaceShipTwo)
- » Reentry: with/without recovery ; at /remote
 - (Cygnus, CST-100, SpaceX Grasshopper)



Types of Spaceports

Variety of Vehicles is Enabling and Challenging!

» Specialize:

- Suborbital, Horizontal Launch Spaceports (Cecil Field, Ellington Field), usually combined with operational airport.
- Vertical launch spaceports, (Kodiak Launch Cx; MARS)

» Full Service:

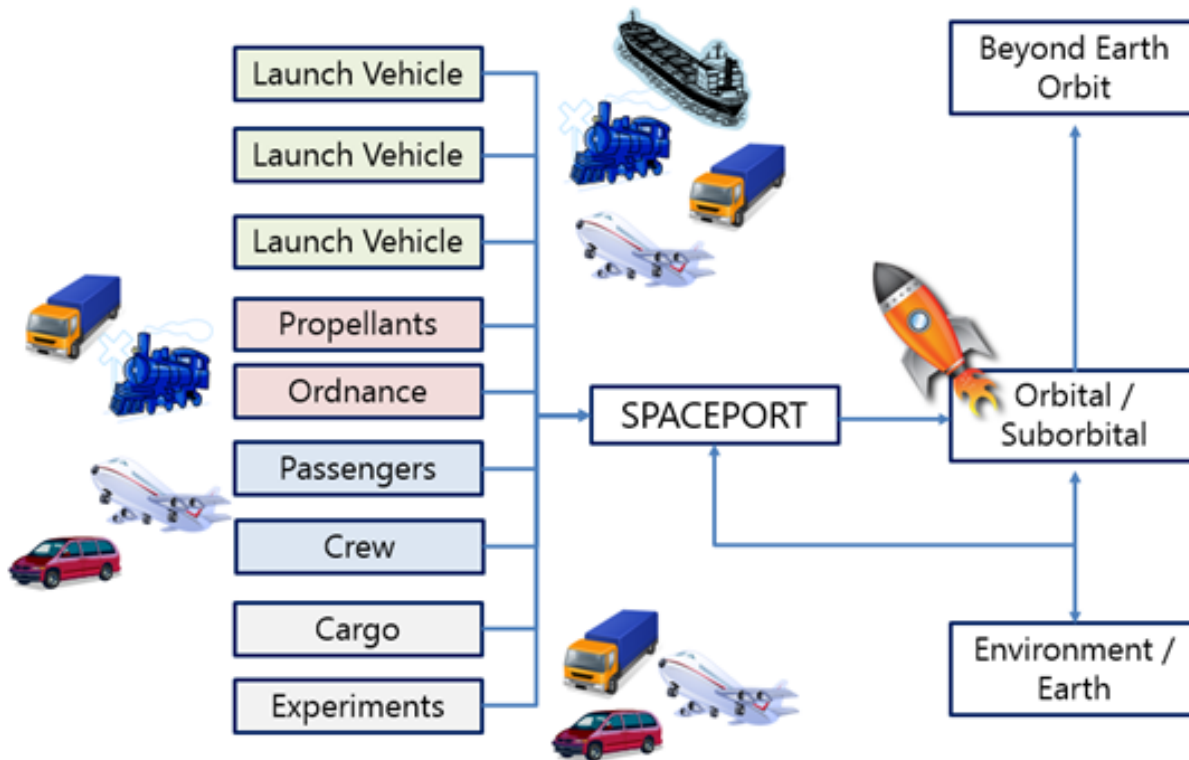
- Purpose built Spaceports which serve all type of vehicles, "Spaceport America".
- Multi use Government built facilities, KSC, WFF, Space Florida, CCAFS, Vandenberg



Multimodal Challenges

Ideal Modes Available:

- » Rail
- » Port
- » Highway
- » Air
- » Space



Organization Coordination

Coordination with both federal and local government agencies is required.

» FAA Offices

- Commercial Space (AST)
- Office of Airports (ARP)
- Air Traffic Control (ATC)
- Airline Dispatch Office (ADO)

» U.S. Coast Guard

» Other (as required)

- Local government organizations
- Federal organizations
 - NASA
 - DoD

» Licensure

- License
- Airport Layout Plan
- Airspace
- Regional Dispatch

» Letters of Agreement

Spaceport/Airport Ops Integration

It is especially challenging to integrate spaceport and airport operations at airports as spaceport operations are typically considered secondary to airport operations.

- » At first glance horizontal RLVs operate similarly to traditional aircraft
- » Complications of integration
 - RLV may not have taxi or loiter capability
 - Less frequent flights for horizontal RLVs
 - Hazardous propellant storage and building locations
 - Hazardous propellant combinations on takeoff and during flight
 - Operational weather conditions
- » FAA Airport grants may exclude facility use by spaceports

Spaceport/Airport Integration

- » No operational experience yet integrating spaceport ops with Part 139 airport operations
 - Midland International Airport first Part 139 airport with spaceport operator license granted September 2014
 - Proposed Spaceports: Ellington Airport & Kona International
- » Limited experience integrating spaceport flight operations with air traffic
 - Cecil Spaceport, Jacksonville, FL
 - Generation Orbit captive carry test flight ([July 2014](#))
 - Mojave Air and Space Port
 - Scaled Composites SpaceShipOne test flights
 - Virgin Galactic SpaceShipTwo test flights
 - XCOR Aerospace EZ-Rocket test flights

Agenda

- » Overview of Spaceports
- » Background and Challenges
- » Spaceport Research Needs
 - Aircraft and horizontal RLV separation standards
 - Integrating spaceport and airport operations
 - Impacts / learnings from investigations of recent commercial failure investigations
 - Explosive Siting Standards Comparison
 - Summary of research topics and benefits
- » Summary

Aircraft and Horizontal RLV Separation Standards

- » To ensure the safety of the uninvolved public, policy updates and/or research into standardizing the separation distances between aircraft and spacecraft in flight should be performed
 - Currently, airspace around and below flight trajectory of RLV must be sterilized to ground level
 - Temporary Flight Restriction +/- 1 hour before and after RLV flight
 - Includes carrier aircraft, such as WhiteKnightTwo
 - Updating separation standards will ease the integration of spaceport with airport flight operations:
 - Provide real time separation
 - Reduce TFR pre/post period
 - Establish dynamic altitude separation

Integrating Spaceport/Airport Operations

- » Typical spaceport operations are often similar to airport operations. Conducting operations with compatible standards that satisfy both spaceports & airports should be researched.
 - Spaceport impact on airport design standards
 - Lightning detection and weather monitoring
 - Propellant loading procedures and equipment
 - Spaceport scheduling process
 - Aircraft Rescue and Fire Fighting

Aircraft Rescue and Fire Fighting Operations

- » An effort is needed to equip and train airport Aircraft Rescue and Fire Fighting to prepare for the hazards associated with spaceport operations.
 - ARFF services required at Part 139 airports
 - ARFF services now classified based on size of aircraft
 - Expand for propellant types & quantities
 - Include the local fire and police departments near spaceports



Impacts of 2014 on Data Gathering:

- » Now underway are investigations of two recent commercial launch failures from commercial spaceports.
- » These investigation may also be used to bring to light opportunities for spaceports to collect and record certain data, images, etc. which will enhance and improve future commercial spaceport operations.
- » Post investigation analysis of the spaceport data and information gathering requirements



Explosive Siting Standards Comparison

- » Aircraft and RLVs each can contain fuels and oxidizers.
 - Are aircraft held to different standards than RLVs?
- » Use of DOD explosive Safety Standard
 - DODM 6055.09 vs. Quantitative Risk Analyses
 - HAZEX/SAFER type analyses
- » Hybrid and some solid propellants are underrepresented in the DODM
- » Research Opportunities:
 - Develop FAA acceptance criteria for QRA analysis
 - Establish applicability for assigning explosive risk to RLVs
 - Supplement DODM to quantify and establish new hybrid propellant combination's hazards

Research Topic Benefits

Research Topic	Safety	Costs	Operations	Flight Frequency	Spaceport Development Schedule
Aircraft and Horizontal RLV In Flight Separation Standards		✓	✓	✓	
Integrating Spaceport and Airport Operations	✓	✓	✓	✓	✓
Enhanced Data Gathering	✓		✓	✓	
QD Standards & guidelines	✓	✓	✓	✓	✓

Agenda

- » Overview of Spaceports
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- » Spaceport Research Needs
- » Summary
 - Recommended Research Priorities

Recommended Research Priorities

1. Integration of Spaceport and Airport Operations
 - Lightning detection and monitoring
 - ARFF guidelines revision
2. QD Standards and Guidelines
 - Enabling for integrated operations
3. Enhanced Data Gathering
4. Aircraft and Horizontal RLV In Flight Separation Standards

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