



SPACE & AIR TRAFFIC MANAGEMENT FOR A SUBORBITAL SPACE TRANSPORTATION SYSTEM

Sandra Cabrera Alvarado

cabrera.sandra@masters.isunet.edu

Cian Curran

cian.curran@masters.isunet.edu

International Space University



Who we are

*“Take nothing on its looks; take everything on evidence.
There’s no better rule”*

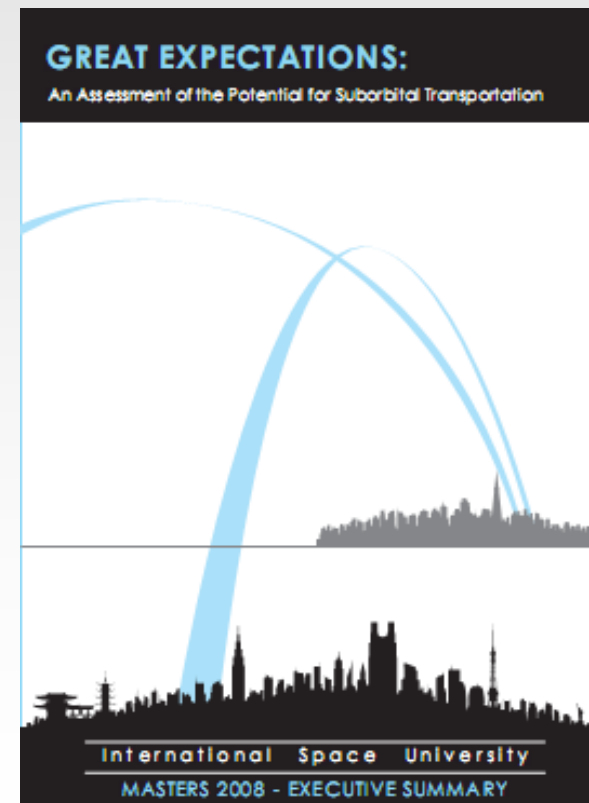
– Mr. Jaggars, *Great Expectations*

Goal: To assess the development
of a Suborbital Point-to-Point (PTP)
Transportation System

Masters Programme 2008

Executive Summary available at

www.isunet.edu





Scope

Highlights

Policy and Law

Management

Flight Stages

Technical Considerations

Conclusions

Overview



Source: Virgin Galactic



Source: ESA



Source: Doule



Scope

Ensuring safety and security in Space and Air Traffic Management (SATM) Architecture related to suborbital transportation systems

An interdisciplinary recommendation for a safer SATM

SATM will likely evolve from the existing Air Traffic Control (ATC)



Highlights

Before looking forward,
we must know where we are



Highlights

Air Traffic Management

Airspace is generally divided into **controlled and uncontrolled**.

Controlled airspace normally requires vehicles to **gain permission** under a regulatory framework to **enter and operate**

Aircraft and airports are subject to **international regulation and management**

Operations around airports under **ICAO**

GOAL: protection of life and property of the aircraft

Space Traffic Management

Deals with objects in orbit or that are at high enough altitudes that they **can conflict with other space objects**

US launch licenses oblige the spacecraft operator to conduct a **conjunction assessment**

Orbital Debris Mitigation & Tracking

No Supervision under any organism

GOAL: protection of life and property of third parties

Air and Space Traffic Management

Enhanced **communications, navigation, information sharing, and surveillance** services

Reconcile the boundaries between **airspace** (under an ATC regime) and **space** (under an STM regime)

Suborbital point to point spacecraft will likely have to operate out of **dual function air & spaceports**



Policy and Law

Who are the main actors?
Which regulatory framework is
applicable?



Strategic objectives



▪ Safety

▪ Security

▪ Efficiency

▪ Rule of Law

	1 International Body	2 Governments	3 Suborbital companies	4 Satellite operator
▪ Safety	<ul style="list-style-type: none"> •Multilateral •Harmonize international standards for <ul style="list-style-type: none"> -airworthiness permission -operational process -rescue -incident process 	<ul style="list-style-type: none"> •Bilateral •Integrate air and space operations •Spaceways in case of contingency •Space Corridor •International routes and trajectory design 	<ul style="list-style-type: none"> •Followed harmonized standards 	<ul style="list-style-type: none"> •Innovative technology for safer management of skies
▪ Security	<ul style="list-style-type: none"> •Space Surveillance System •Track, predict and publish orbital objects trajectories -Space Debris -Spacecraft 	<ul style="list-style-type: none"> •Notification and exchange of information of TLE, and orbital objects •Emergency landing procedure. •Communication 	<ul style="list-style-type: none"> •Provide passenger data and detailed information flight 	<ul style="list-style-type: none"> •Tracking system of orbital space objects
▪ Efficiency	<ul style="list-style-type: none"> •Harmonize operations plan •Implementation of language proficiency •Space Corridors Admin 	<ul style="list-style-type: none"> Navigation and Surveillance Global System •Standardized Mission Plan 	<ul style="list-style-type: none"> •Controllers and pilots standard flight plan 	<ul style="list-style-type: none"> •Facilitate communications to avoid collisions •New technology for a real time display
▪ Rule of Law	<ul style="list-style-type: none"> Liability in case of damage •Aerodromes and Spaceport supervision •Certification and supervision for operational safety 	<ul style="list-style-type: none"> •Liability and indemnization 	<ul style="list-style-type: none"> •Safety waivers 	<ul style="list-style-type: none"> •Services provided under each governmental administration



Policy Action Plan

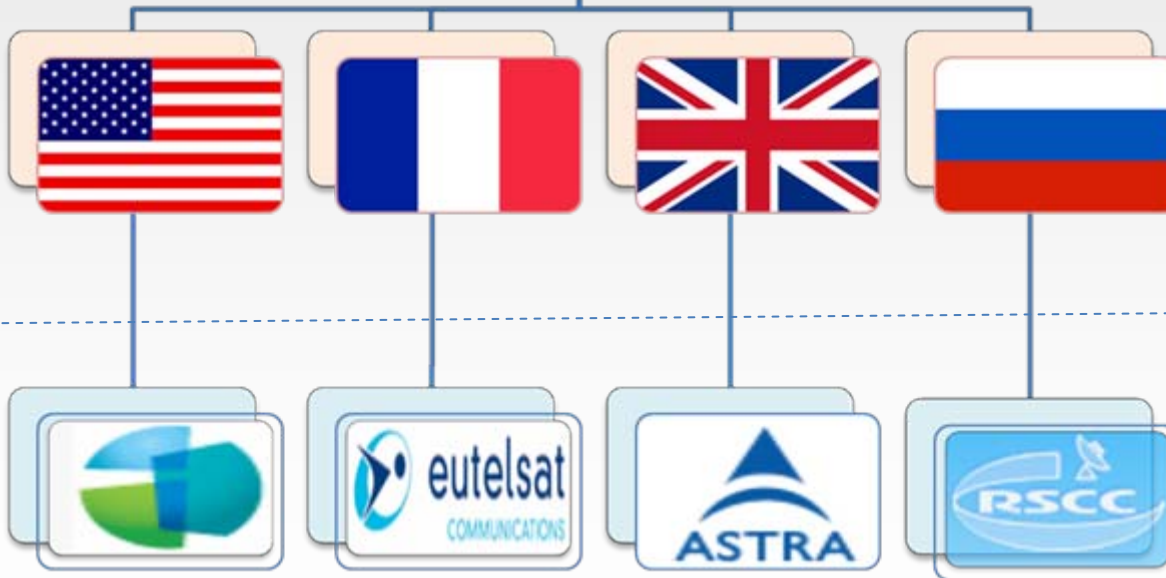
International Level



1

- Safety standards
- ASTM systems and procedures integration
- Aircraft and space vehicle system control
- Search and rescue

National Level



2

3

- Space Transition Corridors
- Routes and trajectories
- Spaceways in case of contingencies
- Operational air and space phases unification
- Notification

4

- Real time display
- Space vehicle and aircraft precise position
- Accurate information distribution
- Tracking routes of ocean traffic



Management

Integration of space vehicles under
traditional air traffic operations



Management considerations

Actions

- Collaboration with Aviation Procedures through space transition corridors
- Use corridors that are less travelled by aircraft
- Improvement of a CNS Systems by integrating Space operation centres & Air traffic control
- Vehicles that comply with air traffic control clearances are more likely to be used for PTP transportation

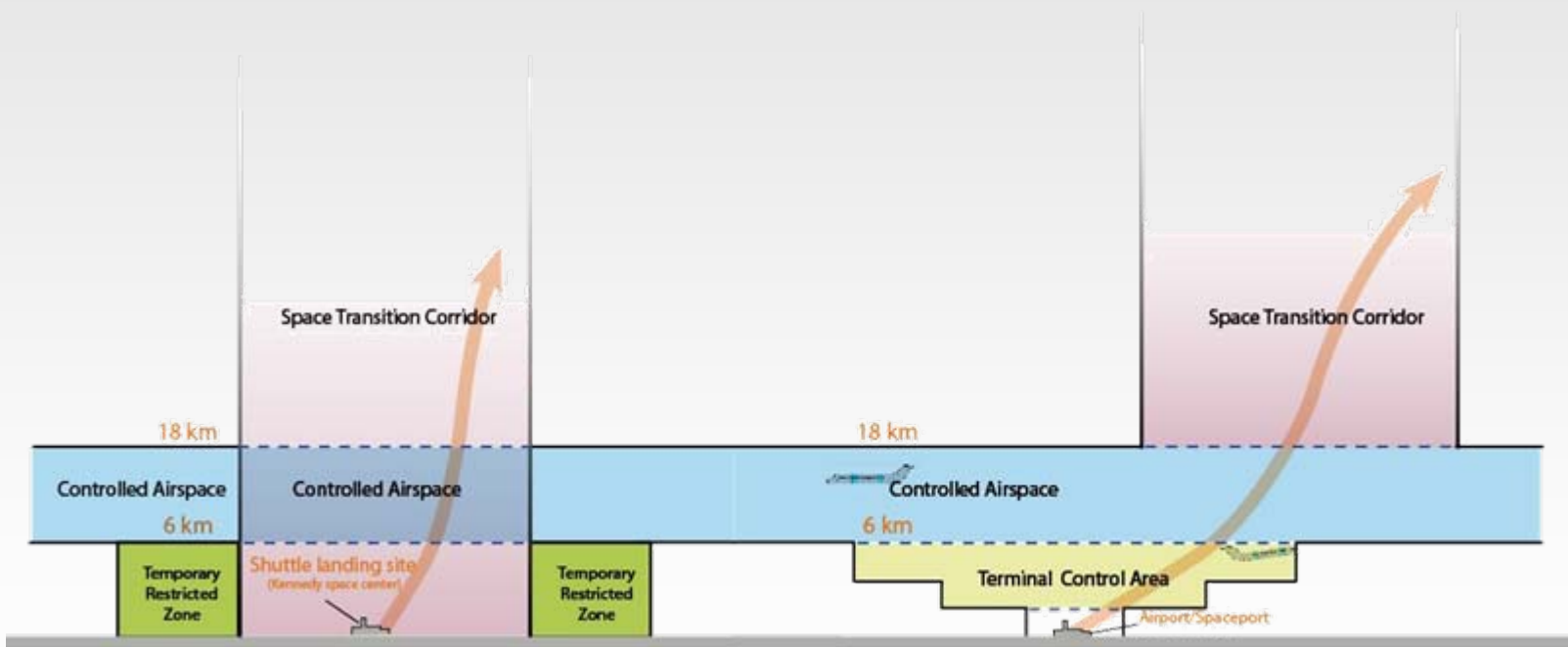
Results

- An international code of conduct, risk criteria and mitigation response
- Decision Tool Support (DTS) software should be developed
- Interoperability standards for aid and rescue
- Space debris generated of a spacecraft failure would still endanger aircraft safety
Overflight fees and code-shares



Space Traffic Corridor

Spacecraft will be under ATC clearances leading **integrated** concepts of **operation**



Current (KSC)

Proposed

ISU, 2008



Legal Implications

The *launch* phase

- Notification and coordination for an accurate control and coordination of space vehicles (pre launch)

The *suborbital flight* operation phase

- Reliable exchange of information to avoid collision probabilities

The *re-entry* phase

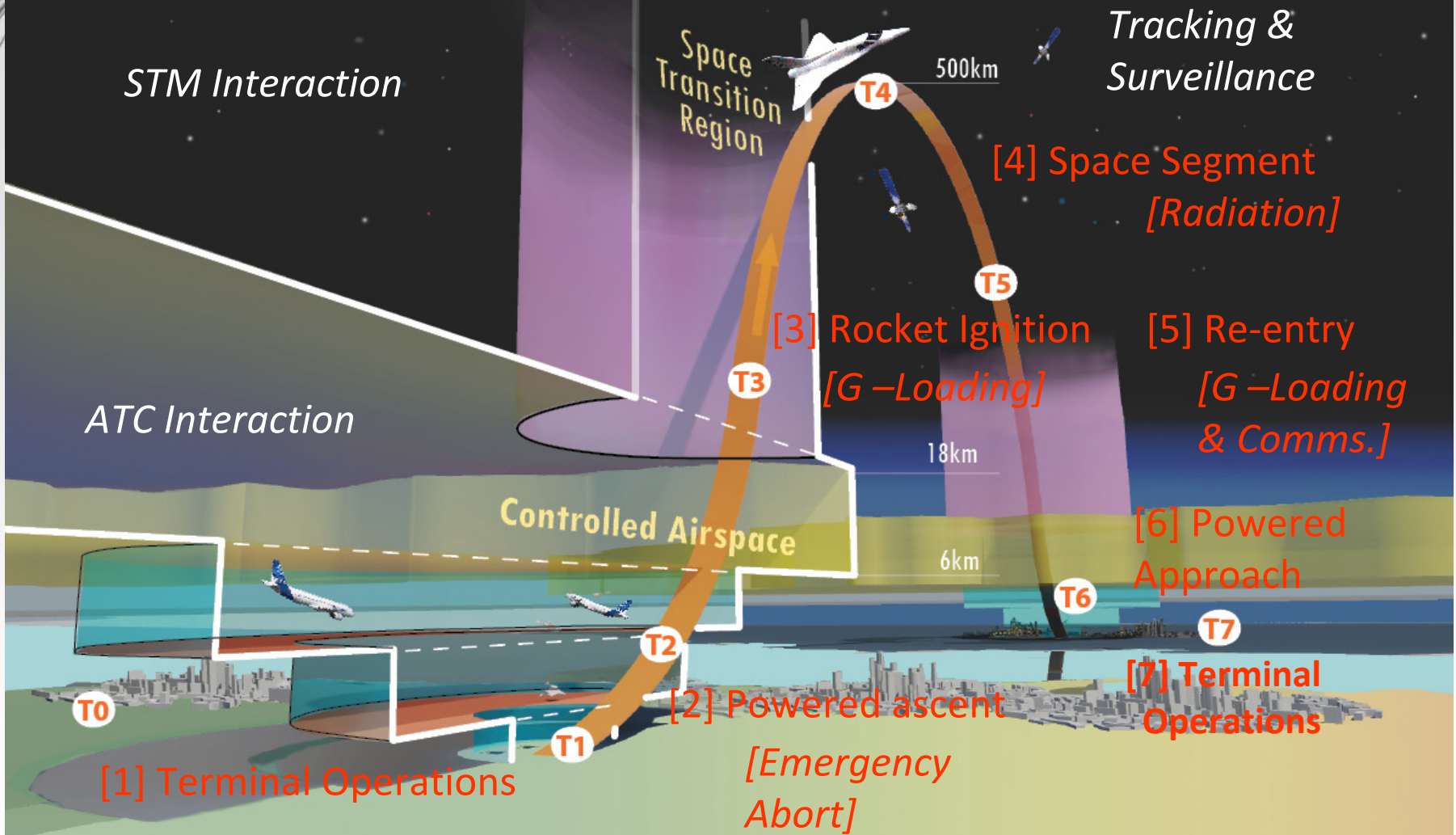
- Responsibility and liability in case of damage under national law
- Free passage under Chicago Convention only in Air Law
- Specific safety provisions



Flight stages

SATM as it applies per flight profile stages

Flight Profile Stages



Space Transition Corridor



Controlled Airspace



Terminal Control Area



Technical Considerations

Likely requirements and obstacles to be overcome.



Technical considerations

- The key to safe suborbital travel is to **predict and track** orbital debris, micrometeorites and other spacecraft using evolution of current surveillance systems
- New tools will include enhanced **communications & navigation** systems
- Capability for spacecraft **obstacle detection & avoidance**

It is also observed that for ricochet trajectory flights (of distances between 7,000 km and 20,000 km) the necessity to cross between air and space multiple times will have to be integrated into SATM



Technical considerations

Spacecraft will likely have to operate out of **dual function air & spaceports**, demanding:

- *The ability to make a **powered approach and landing***
- *The ability to execute **satisfactory abort procedures***

[Vertical Take Off & Landing systems will likely have to launch out of dedicated or restricted spaceports]

Other factors likely to affect development of SATM:

- Communications at **hypervelocity** and **blackout on re-entry** to be overcome for Inclusion in ATC systems (TRL 4)
- Vehicle design to **overcome Sonic Boom** over land



Conclusions

Our findings for suborbital
transportation safety



Conclusions

Policy and Law

- 1° Bilateral
- 2° Multilateral-Binding?

Division within ICAO for PTP

Harmonization of safety procedures

Code of Conduct

International Inspections

Technical

Vehicles design for integration into conventional airspace and air traffic control

Technology development to mitigate against Sonic Booms

Continuous Communication with ATC

Management

Cross air/space management boundary condition

Space Traffic Corridor Management

Environmental solutions

International Surveillance System

Standard Mitigation Procedure

Infrastructure

Suborbital Transportation should make use of the existing airport network

Integration of spaceports with commercial airports desirable for PTP transport



Thank You..
Questions