



Emerging Developments & Issues - Suborbital Commercial Spaceflight

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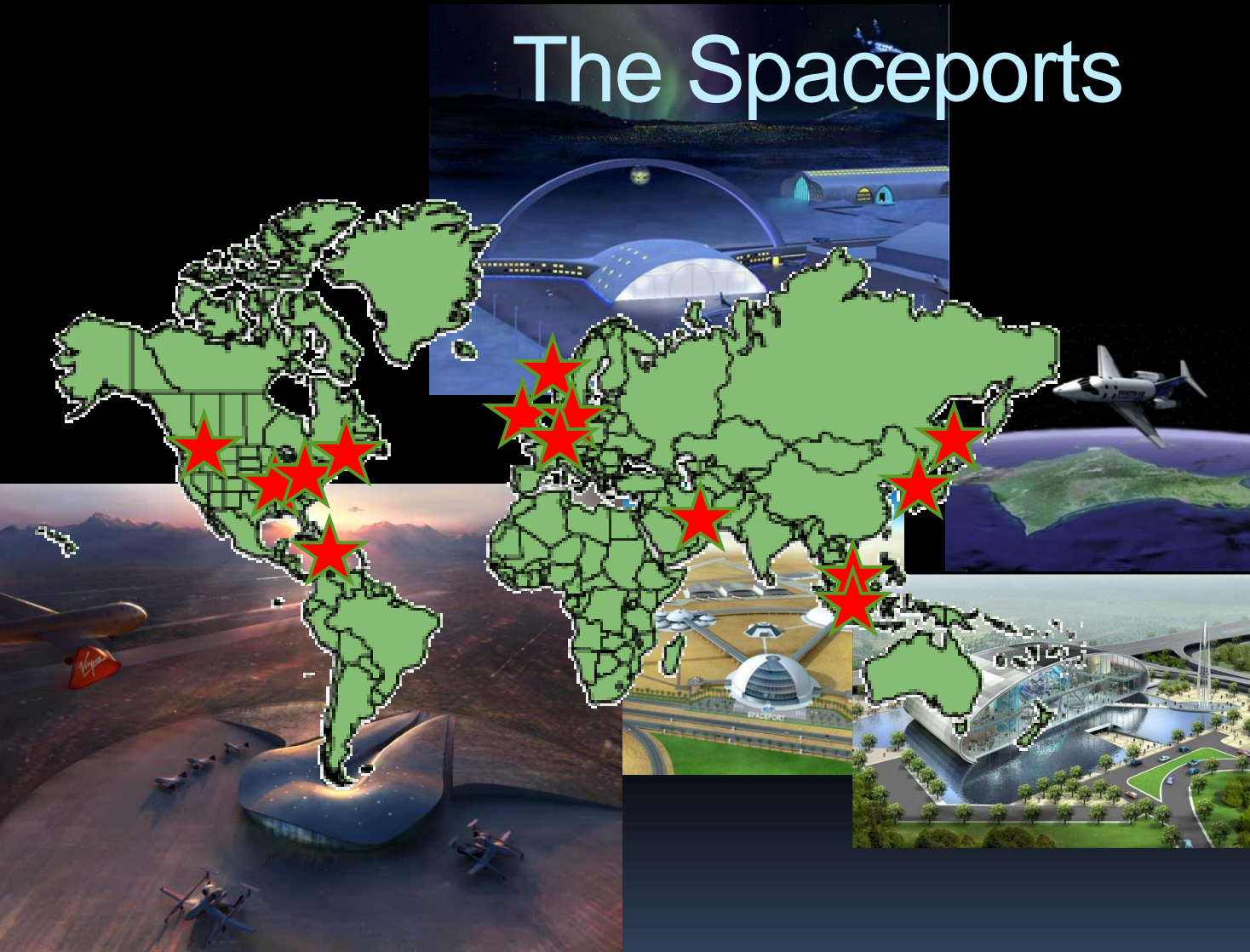
Introduction

- Suborbital Players, Spaceports & P2P
- The problem
- The Issue – how to Regulate
- Aviation Acceptable Level of Safety (ALOS)
- Previous NASA Spaceflight Levels of Safety
- UAS Levels of Safety
- Relevance to Commercial Spaceflight
- Proposed standards & ALOS (IAASS)
- Conclusions

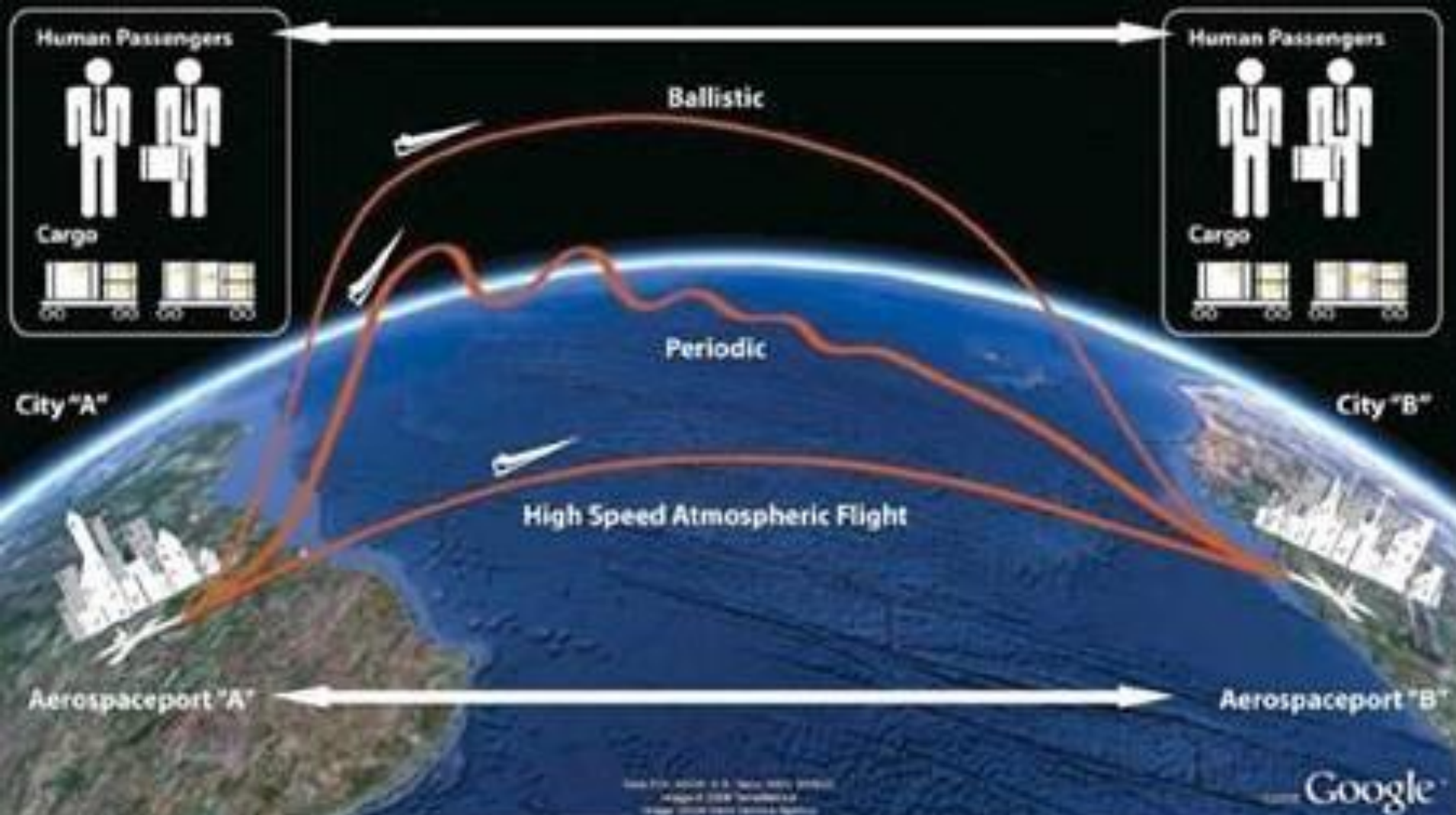
The Players



The Spaceports



Point to Point

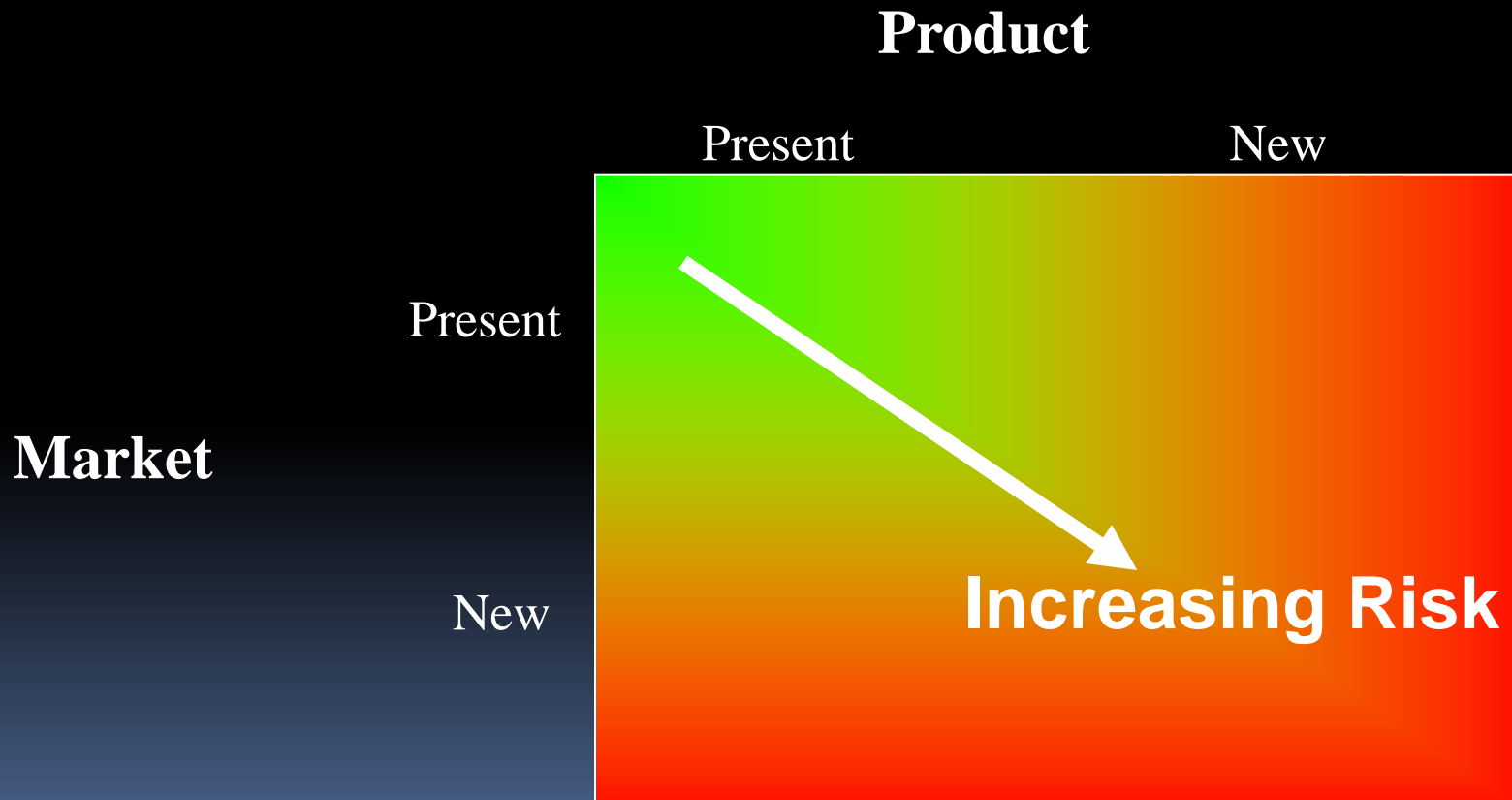


The Problem

(with new industry with complex & novel technology)

Risk

- A new product, a new market



How Safe is Safe Enough?



The Issue - How to Regulate

- Current debate on Launch Licensing versus Certification i.e. the US way or the (possible) European way
- Regulation should accommodate the types of suborbital vehicles and **understand the risks**
 - US and other Nations with remote/restricted areas can accommodate Vertical Launch as well as others
- **Harmonization** with **safety requirements** & **safety targets** should be answer – this would be suitable **Internationally** for suborbital players

Aviation Acceptable Levels of Safety (ALOS)

Aviation ALOS



- Commercial Aviation historical accident rates derived a **worldwide** accident rate of 1×10^{-6} (1 in 1 million) **per flying hour** – this is the **ALOS**
- Current achieved rate is 0.1×10^{-6} pfh
- IATA figures say current rate is 2.7 accidents per million **flights**



UAS ALOS



- UAS regulatory framework is complex and immature BUT still demands certification to an Equivalent Level of Safety (ELOS) to that of aircraft for platforms above 150kg
 - This means for the **Remote Piloted Aircraft (RPA)** that they must meet requirements per AC23.1309 - the **ALOS** for Part 23 aircraft is 1×10^{-4} per flying hour (for GA aircraft) and 1×10^{-5} for newly built Class I aircraft (under 2751kg) – noted that the RPA is only part of the System

Previous Spaceflight Achieved Rates

- Space Shuttle – at the last flight the achieved accident rate was 1 in 90 (1.1×10^{-2} per mission)

US Commercial Spaceflight Safety Criteria

- The Expected Casualty (Ec) 'acceptable objective' probability value is 30×10^{-6} per mission
 - This is **30 times worse** than the AC 23.1309 (**implicit**) safety target (ALOS) for aircraft-based vehicles (noted that the Ec is based on exposure over populated flight path and relates to safety of the non-involved public on the ground)
- So, is this ALOS applicable to the Operators such as Virgin Galactic or indeed Blue Origin **today**? (who will **not fly over populated areas**) – what about the safety of those on board?
- FAA-AST looking at **future requirements** for **crew & participants** – hopefully hear about that progress later in this REMAT conference

NASA ALOS

- NASA's new CCTS Programme has provided safety targets (ALOS):
 - *a. The Loss of Crew (LOC) probability distribution for the **ascent phase** of a 210 day ISS mission shall have a mean value no greater than **1 in 1000***
 - *b. The LOC probability distribution for the **reentry phase** of a 210 day ISS mission shall have a mean value no greater than **1 in 1000***
 - *c. The LOC probability distribution for a 210 day ISS mission shall have a mean value no greater than **1 in 270** (3.7×10^{-3})*
 - The NASA Aerospace Safety Advisory Panel said **this is a concern** (3 times **less safe** than the Constellation program)

IAASS Spaceflight Safety Target

- The International Association for the Advancement of Space Safety (IAASS) comprise members from Industry and have provided an IAASS-ISSB Space Safety Standard manual:
 - Safety Risk target for Orbital - probability of catastrophic event 1×10^{-3} per mission (ALOS)
 - Safety Risk target for Sub-Orbital - probability of catastrophic event 1×10^{-4} per mission (ALOS) – this target was further rationalised and accepted within the Suborbital Safety TC proposed standards & guidelines



3.7×10^{-3}

- NASA Orbital safety target (per total mission)

1×10^{-2}

- Space Shuttle



1×10^{-4}

- Suborbital

1×10^{-6}

- Aviation



Conclusions

- The regulators should have a **harmonized** approach (between US and Europe) for international suborbital players
- The regulators of new vehicles within new or existing domains (orbital, suborbital, P2P & UAS) should derive an **ALOS** based on existing methods and statistics **BUT rationalised** and **tailored** to their industry..... and tailored to the **vehicle types** and **areas of operation**
- We are looking forward to hearing about progress from the FAA-AST later in the REMAT conference



Thank you

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