

REACTION ENGINES



Evolutionary Commercial Spaceflight

Doing it Safely

Dr Andy Quinn

**Reaction Engines Ltd
&
Saturn SMS Ltd**



ICAO

SPACE2015

The ICAO/UNOOSA AeroSPACE Symposium
ICAO Headquarters, Montréal, 18-20 March 2015

UNOOSA



TOPICS

- **Suborbital Players, Spaceports & Future P2P**
- **Acceptable Level of Safety (ALOS)**
- **Regulatory Frameworks & Standards & Guidelines**

THE PLAYERS



THE PLAYERS



THE PLAYERS



THE PLAYERS



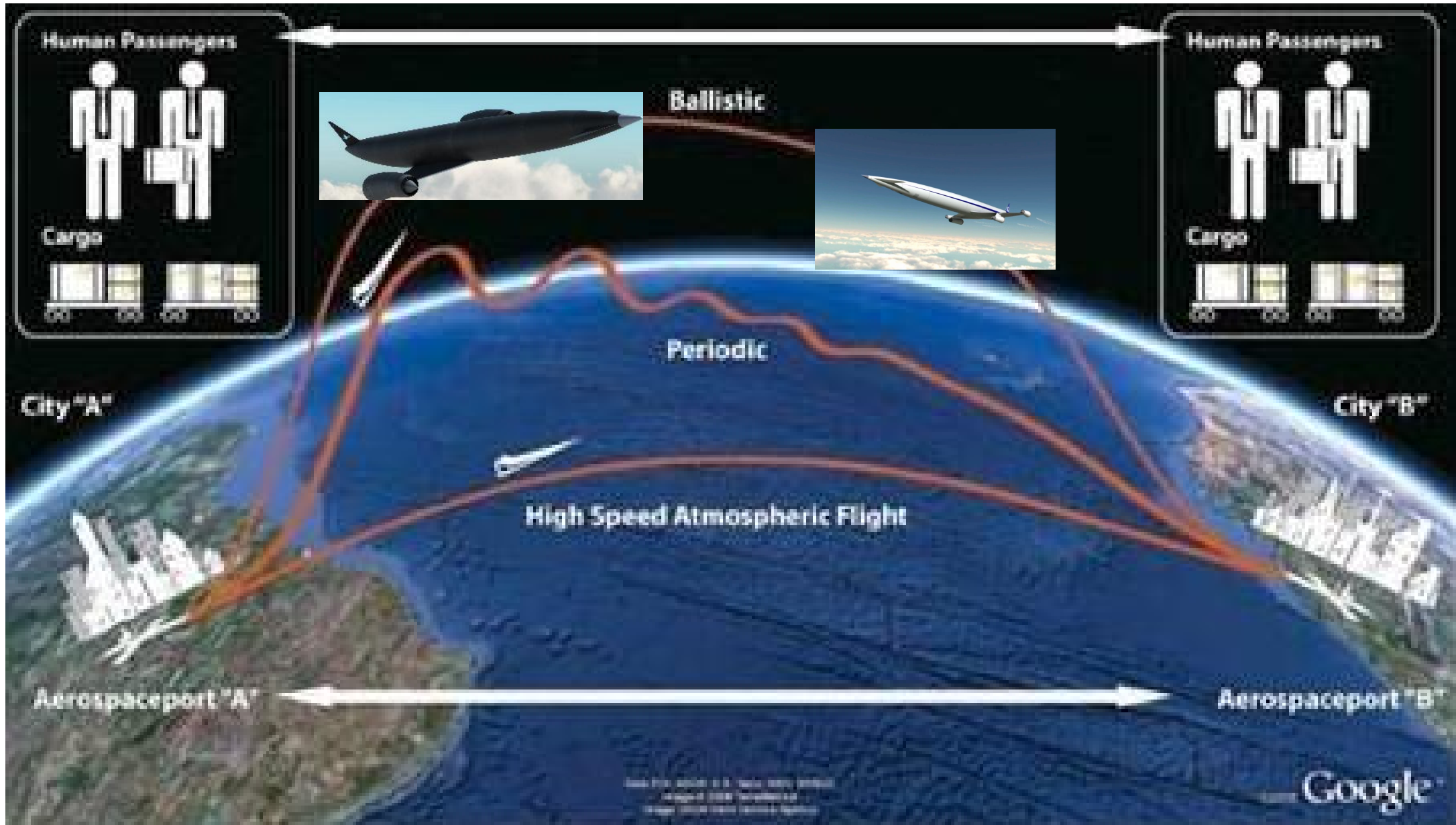
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SPACEPORTS

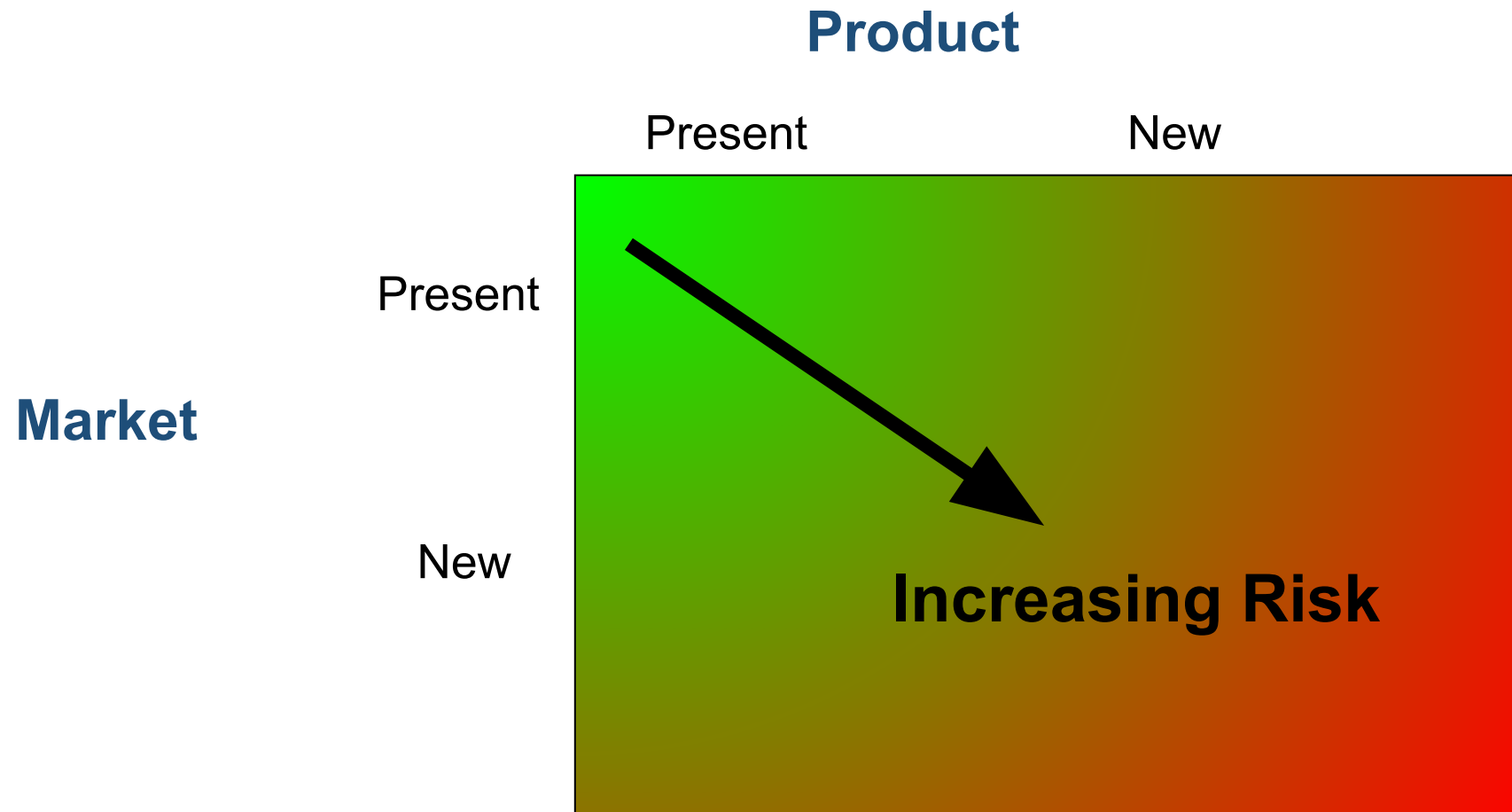


POINT-2-POINT GAME-CHANGERS



RISK

- A new product, a new market



RISK



ACCEPTABLE LEVELS OF RISK



ACCEPTABLE LEVELS OF RISK 1

- **Acceptable Levels of Safety (public perception of acceptable risk)**
 - Aircraft: Hull Loss Rate – 1 in 10 million per flight (equivalent of 0.01 accidents per 100,000 flights)
 - North Sea Helicopter Ops (transportation of workers) – 1.35 accidents per 100,000 flights
 - Military Fast Jet Target – 2 per 100,000 flights; (was much higher until 2010 and reliability and less low level ops and combat missions)
 - UAVs (Reaper/Predator) – 3 to 5 accidents per 100,000 flights (was 30 per 100,000 initially and reliability now better)

ACCEPTABLE LEVELS OF RISK 2

- **P2P (like SKYLON derivative /JAXA HST Spaceplane) – initially somewhere here?**
 - Equivalence for 1 in 20,000 would be 5 accidents per 100,000 missions (is this acceptable?)
- **Current Suborbital Vehicles – somewhere here?**
 - Equivalence for 1 in 10,000 would be 10 accidents per 100,000 missions (is this acceptable)
- **Orbital SKYLON Spaceplane – somewhere here?**
 - Equivalence for 1 in 2,000 would be 50 accidents per 100,000 missions (is this acceptable?)
- **NASA CCP – targets**
 - 1 in 1000 (ascent/re-entry), equivalence 100 accidents per 100,000 missions during ascent/re-entry
 - 1 in 270 overall for 210 day mission 370 accidents per 100,000 missions
- **Space Shuttle – 1 in 90 per mission (1000 accidents per 100,000)**

- **These must be:**
 - International; relevant for those presenting at this conference (US, EU & JAXA based vehicles)
 - Inclusive; so point A-to-A and also Point A-to-B
 - Practicable and rationalized; hence achievable
 - Providing **Safety Targets/Objectives and Safety Requirements**

- **The Industry needs proper oversight:**
 - ICAO/UNOOSA -
 - Symposium great start to listen, to learn, to debate in order to move forward together, safely
 - A separate Space Safety Institute?

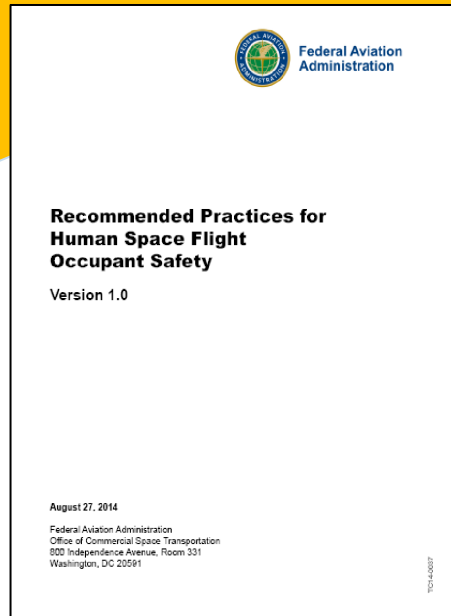
- **The SKYLON (& SABRE) approach:**
 - Engaging with the UK CAA for the engine
 - Already engaged with ESA
 - Safety Management & Safety Engineering able to influence design from beginning (based on understanding of **aviation + space requirements/targets** to rationalize what is appropriate to reach an acceptable level of safety); so an example derived safety requirement could be that for failure modes leading to Inadvertent operation of safety critical systems resulting in Catastrophic Loss shall have 3 inhibits

OVERSIGHT

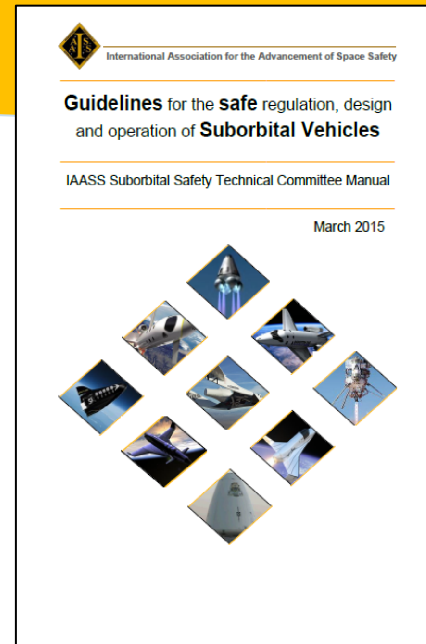
ICAO ----- Space Safety Institute??

SARPs -----Role??

FAA-AST



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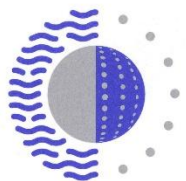


ACCEPTABLE MEANS OF COMPLIANCE

GUIDANCE MATERIAL

HOW SAFE IS SAFE ENOUGH?

To achieve an **Acceptable Level of Safety** we need regulators providing appropriate safety targets & safety requirements and we need designers/operators doing this the **RIGHT WAY** and not just relying on the **RIGHT STUFF**



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THANK YOU

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