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ATM strategies for, and impacts of, space launches

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Overview

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- Importance of space & the ATM interface
  - Space, spaceports and launches to date
  - Growth, congestion, challenges
- Strategies & impacts
  - How ATM manages space launches
  - Towards a cost impact methodology for aviation and ATM
  - Selected case study
  - Enhancements needed in impact assessment
- Conclusions & next steps
- *Selected further resources*

Overview

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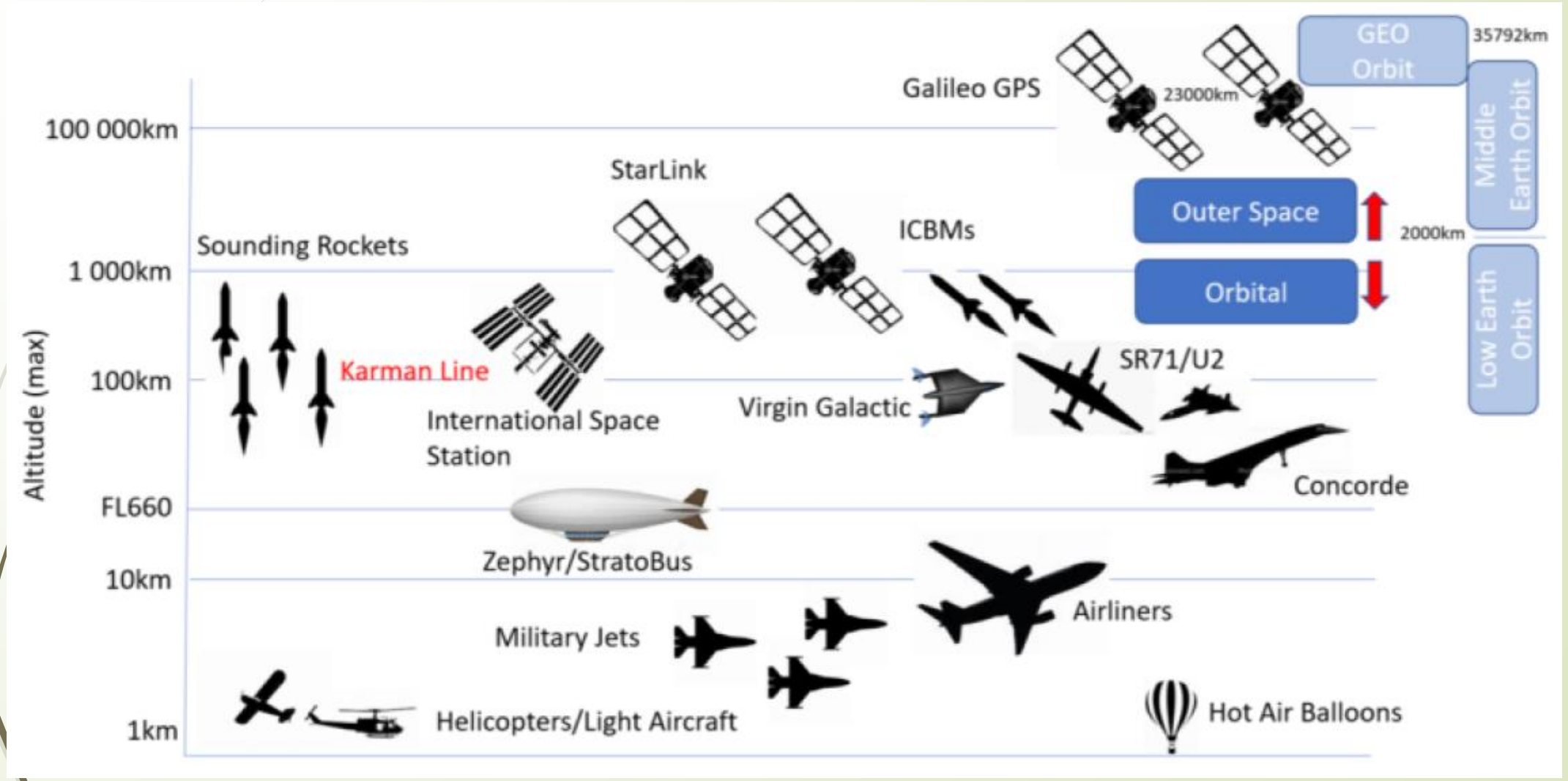

Importance of space & the ATM interface

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Importance of space & the ATM interface

- **Space, spaceports and launches to date**
  - **What is a 'spaceport'?**
    - "....transportation hub where all elements of spaceflight come together" (Seedhouse)
    - "…. location on Earth from which a launch takes place and necessary facilities are located" (US FAA)
    - "…. any site from which a spacecraft or carrier aircraft intended launch ….. (and) at which controlled/planned landings of spacecraft are to take place …. is considered a Spaceport" (UK CAA)
  - **Proliferation of spaceports - 43 spaceports across the world (state and non-state run)**
    - global growth (Aus, Brazil, China, French Guyana, India, Iran, Japan, Kazakhstan, N&S Korea, Sweden, Russia, and multiple sea-launched capabilities)
    - Europe alone has 21 activated or planned spaceports
    - launch profiles - 'traditional' vertical take-off & landing (VTOL); horizontal take-off & landing (HTOL); hybrid platforms, including sea-launched, aircraft-launched or balloon-launched
    - 2022 - 174 orbital space launches
    - 2023 so far - 138 orbital launches
  - **Virgin Orbit launch 2023 - Spaceport Cornwall via B747**
    - impact or required negotiation with 8 FIRs and Oceanic
    - 4-hour segregated airspace
      - approx 2000 nm x 100 nm N-S between Ireland and Canaries Island
      - surface to unlimited altitude - a 'wall' across the Atlantic

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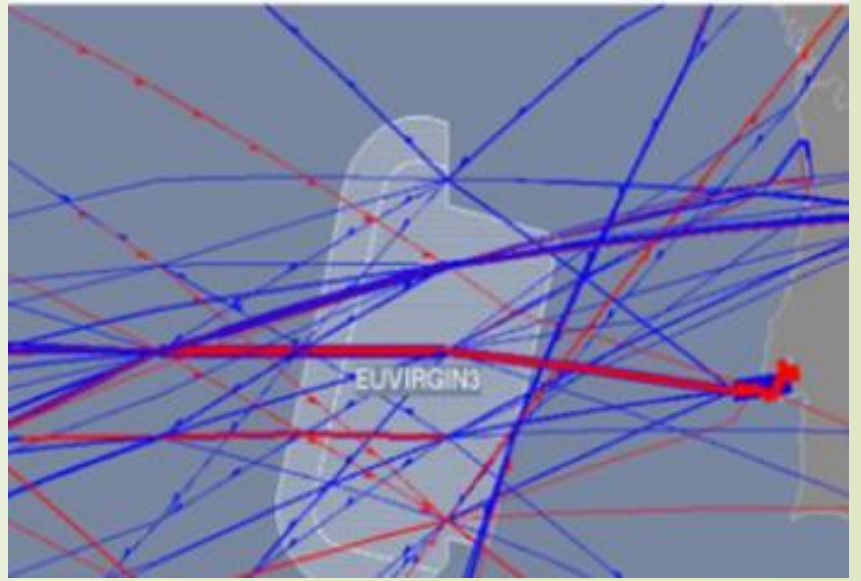
Importance of space & the ATM interface

- **Growth, congestion, challenges**

- Increased launches and congestion
  - more rocket and space launches in 2022 than any previous year
  - increasing number of satellites and debris in low-Earth orbit
  - main issue: uncontrolled re-entries (post-launch; and (later) orbital decays)
- Particular re-entry challenges
  - unpredictability of uncontrolled re-entries
  - lack of appropriate sensors: sensitivity, number and system integration
  - coordination of aviation/ATM response and data (esp. across international airspace)
    - strategically
    - (pre-)tactically

Strategies & impacts

Strategies & impacts



- **How ATM manages space launches**
  - utilise existing air structures (e.g. US military danger area)
  - create bespoke airspace (e.g. Virgin Orbit launch)
  - 'due regard' in the 'high seas' - fire and forget?
- **European nomenclature / processes:**
  - airspace design includes buffer zones
    - requirement: Airspace Utilisation Plan (AUP) -> Updated Use Plan (UUP); dynamic airspace management
    - strategic phase -> pre-tactical phase -> tactical phase
- **Timelines**
  - aligned with AIRAC cycle (3 months ahead of launch)
  - airspace Change Proposals in UK/EUROCONTROL - at least 2 years ahead
  - NOTAM v. Temp Danger Areas v. Temp Restricted Areas v. 'due regard'!
- **Impact**
  - even 'vertical launches' are not 'vertical' (obviously)
  - multiple airways, upper air routes and oceanic flow routes impacted
  - what goes up must come down - planned or unplanned!
    - plan for the worse - where do the bits go? (e.g. Virgin Orbit failed launch?)
  - operators must maintain a 'safe operating evironment' throughout the mission
- **Measuring the unmeasurable?**
  - NOTAM and ACPs provide details of where airlines must avoid and when
  - track miles/delays can be identified on the day, but…….
  - can cancellations or early rescheduling be identified and so costed?

Strategies & impacts

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- **Towards a cost impact methodology for aviation and ATM**

- Currently, a simplified approach:
  - treat the costs as strategic (cf. tactical, which are much higher)
  - in the absence of detailed trajectories, use a geometric 'fly-round' method
- Costs are based on the standard values produced by UoW, used by industry*
  - strategic costs are essentially unit costs - do not include passenger impacts
  - they do include fleet operation, fuel, maintenance and crew costs
  - for aircraft missing from the set of reported costs, MTOW is a good interpolation

- * See: University of Westminster (2015), at end of slides, for full details

Strategies & impacts

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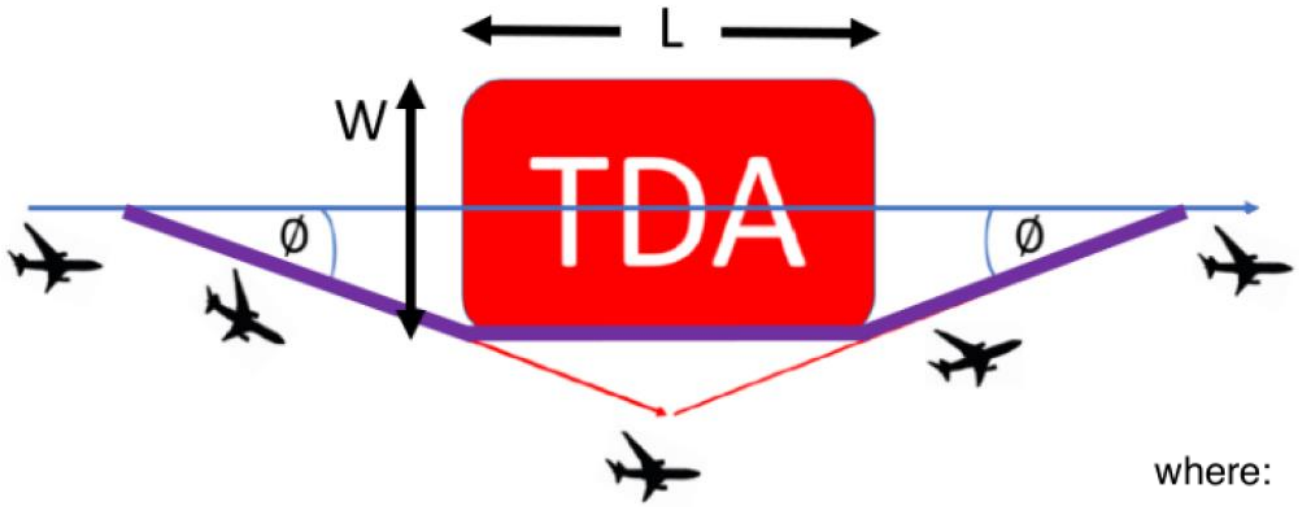
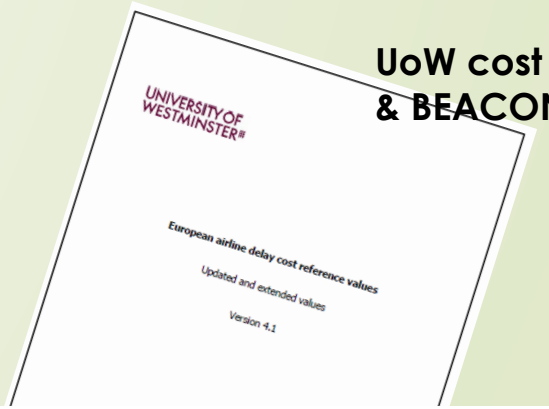
- **Towards a cost impact methodology for aviation and ATM**





UoW cost of delay (2015) & BEACON (2021)

$$T_e = (WT_o/L)(1-\cos(\theta))/\sin(\theta)$$

where:

T_e = extra time flown
T_o = original time flown inside TDA (time to fly length L)
L = Length of the rectangle representing the TDA
W = width of the rectangle representing the TDA
Θ = angle of the flight deviation (off the original trajectory)

Strategies & impacts

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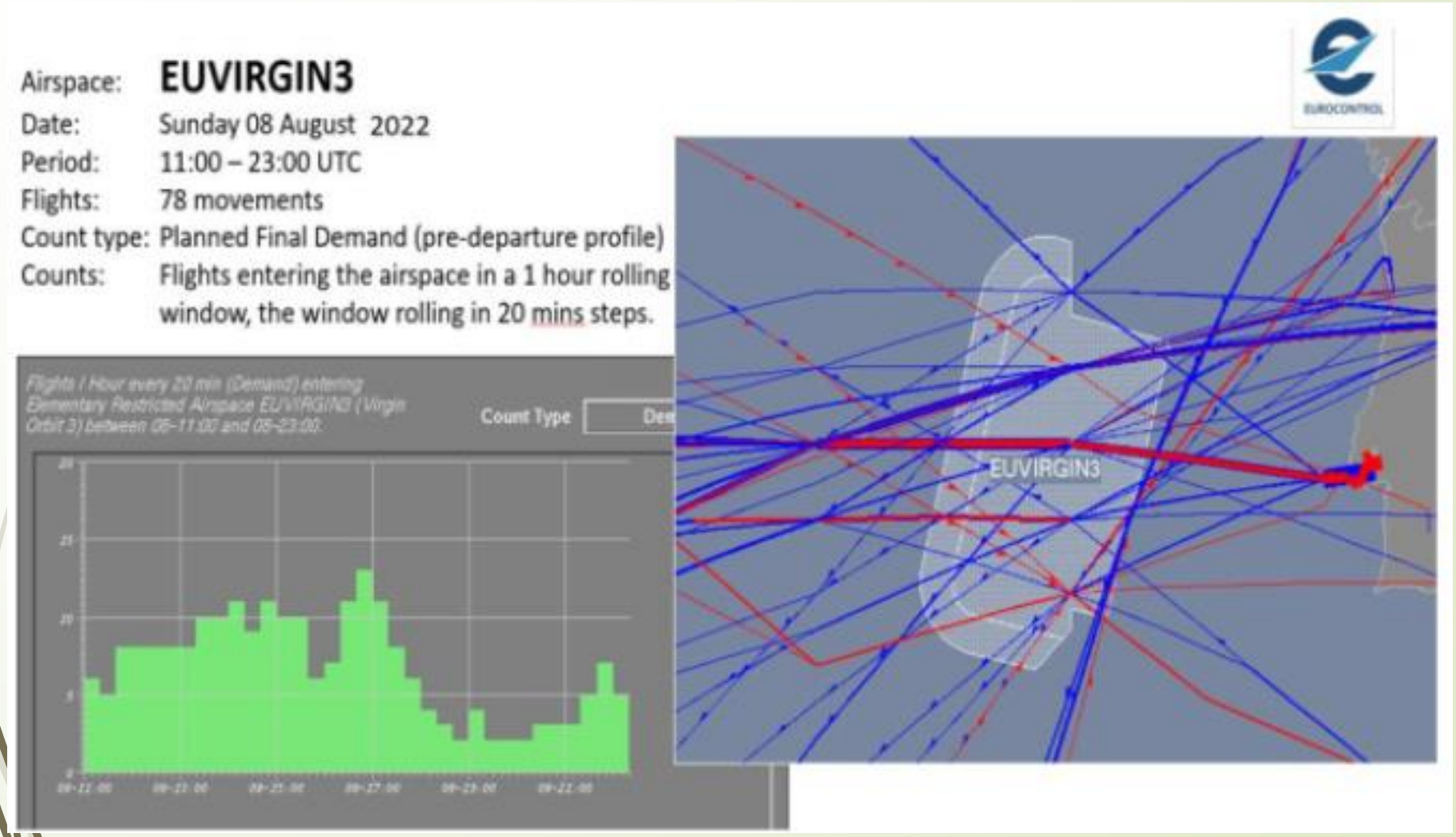
- **Selected case study**

- Case studies examined by UoW to date
  - Benbecular (Scotland) - vertical launch
  - Spaceport Cornwall (England) - horizontal launches: incl. **EUVIRGIN3**:
    - a launch TDA adjacent to Portugal
    - planning for Sunday 08 August 2022:
      - 1100-2300 UTC (but much shorter, e.g. 1- or 2-hour, tactical activation anticipated)
      - 78 flights impacted

Strategies & impacts



78 flights impacted
Red = eastbound
Blue = westbound

ATFM flow through EUVIRGIN3 (Source: EUROCONTROL NM)

Strategies & impacts

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- **Selected case study**

1.

Callsign	Departure airport	Arrival Airport	Departure Time	Time entering TDA (UTC)	Duration in TDA (mins)
BAW2780	EGLL	LPMA	08:26	11:01	12
TAP1827	LPPT	LPLA	10:33	11:05	21
AAL113	LEBL	KMIA	09:40	11:10	21

(sample of flights shown)

2.

Callsign	Duration in TDA (mins)	Size of TDA (NM)		Extra mins flown for heading change (Θ)		
	T_o	W	L	10°	20°	30°
BAW2780	12	310	35	9	19	28
TAP1827	21	310	35	16	33	50
AAL113	21	310	35	16	33	50

(sample of flights shown)

3.

(1-hour activation basis)

				Cost for additional mins flown EUVIRGIN3		
Callsign	Aircraft Type	MTOW	Weighted factor	10°	20°	30°
BAW2780	A20N	79000	95% of A321	€555.75	€1313.38	€2574.50
TAP1827	A21N	97000	117% of A321	€1099.80	€3170.70	€9602.78
AAL113	B772	247210	62% of B744	€1097.40	€4699.60	€10735.30

Strategies & impacts

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- **Enhancements needed in impact assessment**

- Regarding airline cost impact assessment
  - consideration of specific considerations not included in UoW generic model
  - better alignment of costs to the specific notification and response timing
    - e.g. if falls between our 'strategic' and 'tactical' cost points (similar for 'ADAPT' project)
    - potential changes to regulations (e.g. (EC) No 261/2004), whether airlines liable for delays etc.
- Regarding other stakeholders
  - cost impacts for ANSPs and Network Manager (e.g. ATCO provision, coordination)
  - impacts on military operations and cost impacts thereof (initial work at, e.g., UoW)
  - development, deployment and integration of (improved) sensors

Conclusions & next steps

Conclusions & next steps

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- **Key overall conclusions**
  - increasing launches ahead: value to economy but challenges to ATM
  - improved (ATM) integration required, esp. across international borders
  - certain levels of uncertainty will persist, at least into the medium term
- **Industry developments ahead**
  - significant shifts from state-managed to commercial activities (and spaceports)
  - work remains ahead on streamlining the regulatory and licencing aspects
  - challenge closing gap between strategic & tactical planning, with increasing traffic
  - challenges of improved data & sensor technologies to support integration & planning
- **Selected next steps for the University of Westminster**
  - enhance and update the costings for commercial aviation (incl. departure delays)
  - extend assessment to other stakeholders (e.g. ANSPs, military); build on ANSP reports
  - improve resolution of the actual flight trajectories (and thus impacts)
  - extend case studies and build a generic methodology for impact assessment
  - extend impact assessment to (current) non-cost KPIs (e.g. ENV, flexibility …)

Thank you
- questions?

Selected further resources (alphabetical)

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- Ailor W, **2022**. *Protecting the LEO environment*. Journal of Space Safety Engineering, 9, 449–454.
- BEACON Consortium, **2021**. *D3.2 - Industry briefing on updates to the European cost of delay*, June 2021. (www.beacon-sesar.eu/)
- EUROCONTROL Stakeholder Forum webinar, **2023**. *The real risk posed by uncontrolled space object re-entries to aviation*, May 2023. [link to webinar]
- Frodge R, Murray D, **2022**. *Space data integration*. Journal of Space Safety Engineering, 9, 182–188.
- Hussain KF, Thangavel K, Gardi A, Sabatini R, **2023**. *Autonomous optical sensing for space-based space surveillance*. IEEE aerospace conference, Montana, USA, March 2023.
- Outer Space Institute, **2023**. *Montreal recommendations on aviation safety and uncontrolled space object reentries*, March 2023. (www.outerspaceinstitute.ca)
- University of Westminster, **2015**. *European airline delay cost reference values - updated and extended values (Version 4.1)*, December 2015. (www.eurocontrol.int)