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INNOVATION IN AVIATION

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IPIC 2018

CREATING TOMORROW

INCREDIBLE INDUSTRY ACHIEVEMENTS IN 100 YEARS

Source: http://www.mojvideo.com/uporabnik/rikisuave/slika/flightradar24-in-suncalc/489614

City in the Sky:

Over 1 million passengers

Live in this city

Entrance via airports worldwide

AVIATION MAIN CHALLENGES: GLOBAL STRATEGIC OBJECTIVES

ICAO UNITING AVIATION
A UNITED NATIONS SPECIALIZED AGENCY

Source: https://www.icao.int/about-icao/Council/Pages/Strategic-Objectives.aspx

- Enhance **safety** global aviation
- **Increase the capacity** and **improve the efficiency** of the **global aviation system**
- Enhance global civil aviation **security** and **facilitation**
- Foster the development of a sound and **economically viable** civil aviation system
- **Minimize the adverse environmental effects** of civil aviation activities

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THE CAPACITY GAME:
FINDING WAYS TO UNLOCK AVIATION CAPACITY

Source: http://www.volkskrant.nl/economie/directeur-klm-wanbeleid-oorzaak-van-urenlange-wachtrijen-schiphol~a4490616/

Global developments:

- Aircraft on order
- Airport usage and limitation
- Traffic demand passengers and cargo
- Growth is mainly passengers; cargo is relatively small in volume

IMPRESSIVE CHANGE/INNOVATION AGENDA IN AVIATION

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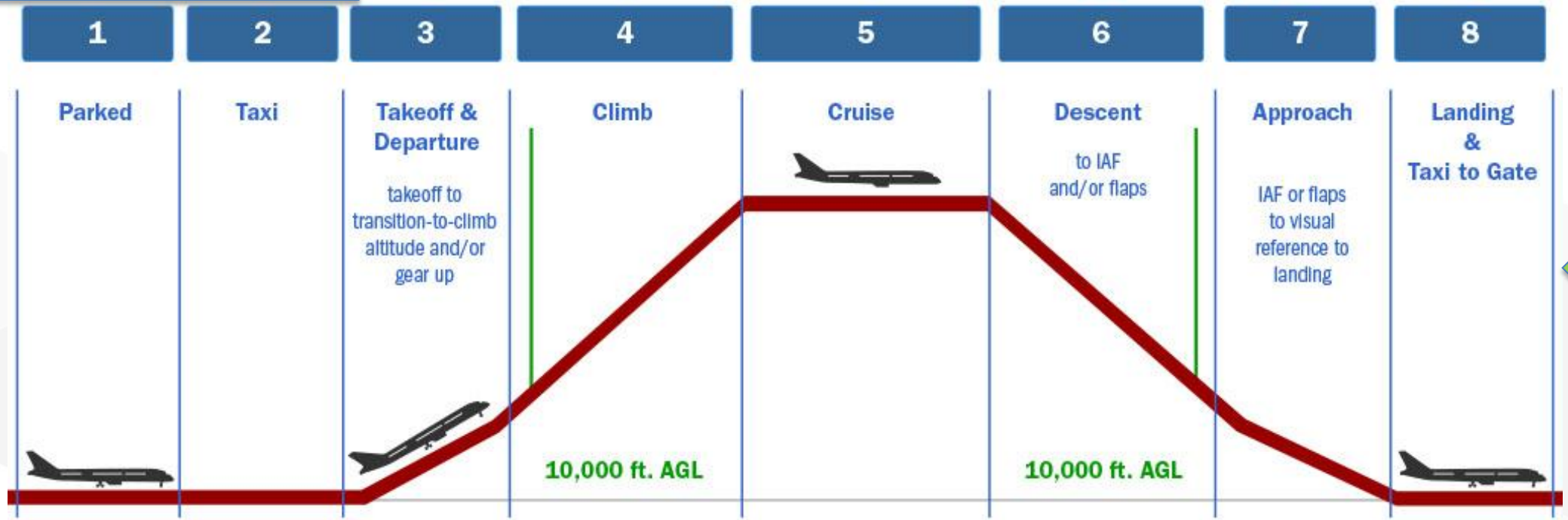
Innovation data analysis

Innovation flight

Sustainability/climate



Airport innovation

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IMPRESSIVE CHANGE/INNOVATION AGENDA IN AVIATION

Topics:

1. Air space capacity optimization (SESAR)
2. Airport capacity optimization (APOC, PASSME)
3. Aviation Network optimization (SWIM)
4. Security and safety
5. Process simulation and optimization
6. Aircraft design
7. Intermodal transportation
8. Unmanned Air Cargo
9. Big data analysis
10. Sustainability (Paris Climate Agreements)
11. Communication and data exchange

Remarks on air cargo innovation:

- *Strong focus on passengers and air traffic capacity*
- *Share of air cargo volume is limited (at Schiphol 4% ATM)*
- *Most cargo transported in passenger aircraft*
- *Challenges:*
  - *Ground transportation and intermodal transfer*
  - *Ground handling*
  - *Data exchange*
  - *Quality control*
  - *Parcel sizes and air containers/pallets*
  - *Predictability and control of cargo process*

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AIR CARGO INNOVATION

Objective:
Expansion of Air Cargo in Africa

1. Safe and secure UAS operations
2. Effective UAS operations
3. Integration in existing air space

Others:
1. Standard format packages
2. Data analysis
3. Exchange of data
4. Intermodal transportation

Source: http://www.aircargonews.net/uploads/pics/UNMANNED_CARGO_AIRCRAFT_001_V2.jpg

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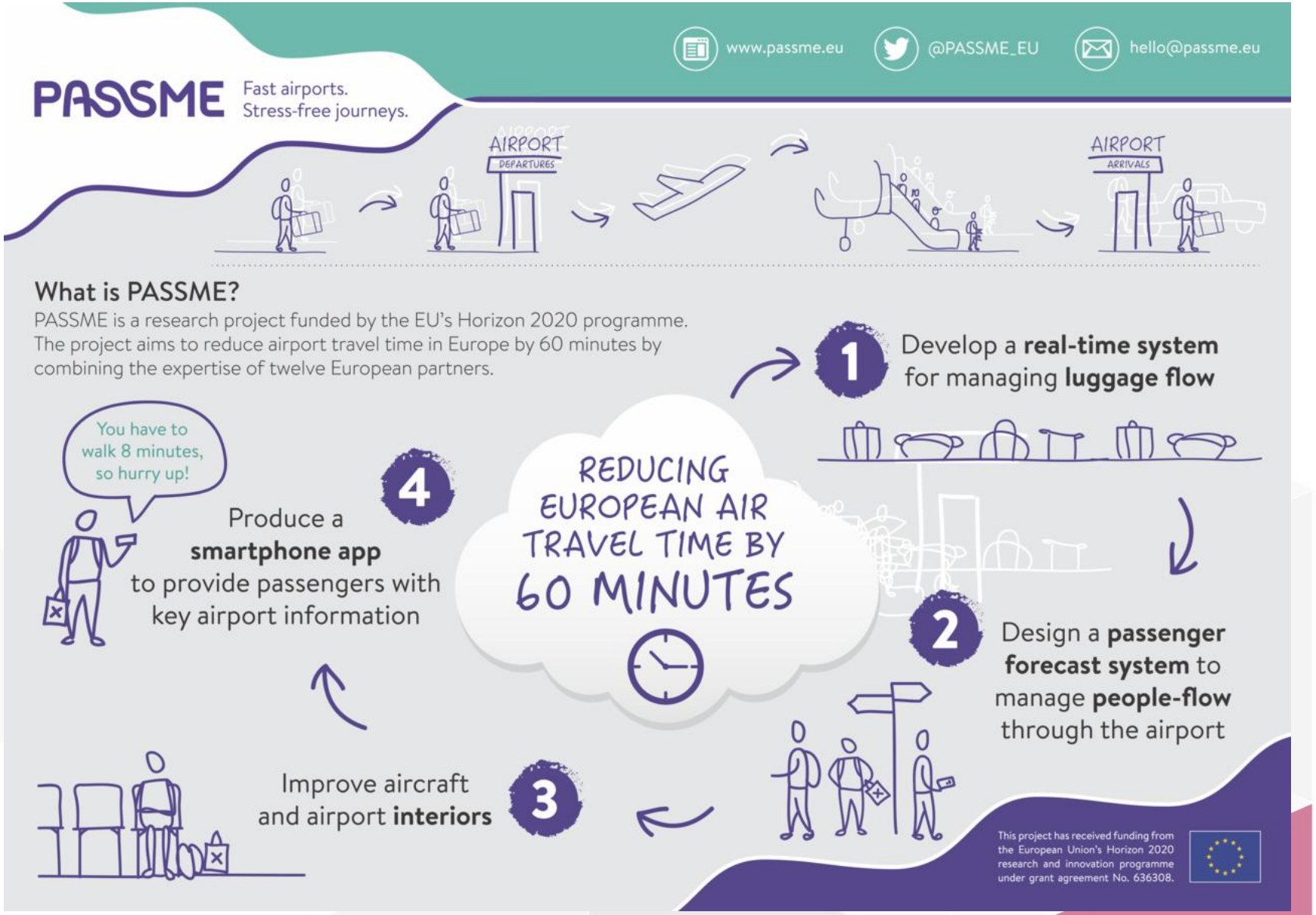
Objective: reduce travel time

Special interest:

1. Personalised device
2. Luggage handling
3. Forecasting data system
4. Customised interiors



Source: https://www.tudelft.nl/en/ide/research/research-labs/aviation/research/passme/

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TURNAROUND TERMINAL

The ultimate docking station

Objective:
Increased airport capacity

Special interest:
1. Standardization
2. Smaller footprint
3. Predictable handling
4. Reduced movements
5. Passenger centric
6. Machine that produces turnarounds

AVIATION: PACE OF CHANGE IS (OFTEN) SLOW

- How to implement Air Cargo innovation or Physical Internet in aviation?

Experience isn't very promising:

- Collaborative Decision Making (CDM) is fully implemented at 20 airports
  - The concept is introduced in 1998 and first trials in 2000
- Sesar has been defined in 2005
  - Scope to develop and implement technological changes for SES is 30 years
- Smart Security Checkpoint for the Future have been tested since 2012
  - Implementation from components as from 2014, 2017 and 2020

AVIATION: A TECHNOLOGY LEGACY SECTOR

Today disruptive innovations is a trend, but not all sectors can easily be disrupted

- Reason innovation resistance for legacy sectors
  - Locked-in
  - Path dependency
  - Well defined technological/economic/political/social paradigm that resists any innovation that might threaten to disrupt the business models of the stakeholders who benefit from it

Source: Technological Innovation In Legacy Sectors, : Bonvillian, Weiss (2015)

BARRIERS IN INNOVATION

1. ‘Perverse subsidies and prices that neglect externalities
2. Favoring existing technology or discourage of new entrants by government or institutions
3. Well-established and politically powerful vested interests
4. Financing support geared to incumbents and reluctant to finance disruptive new entrants
5. Public habits and expectations
6. An established knowledge and human resource structure
7. Aversion to innovation
8. Market imperfections
    1. Network economies
    2. Lumpiness (minimum required size) investments
    3. Split incentives (non-appropriability)
    4. Requirements for collective actions

Source: Technological Innovation In Legacy Sectors, : Bonvillian, Weiss (2015)

INNOVATION BARRIERS IN AVIATION

- Existing aircraft technology will be in use for the next 15 to 20 years
- Sesar: focus on development and implementation of new technology
  - Projects tend to stop in demonstrator or proof of concept phase
- The aviation systems operates at maximum capacity daily; hardly room for experiments or fundamental change
- Focus on safety and security (mentally) block innovation; the system is geared to be robust and bounce back into balance. *Disruptive innovation requires change and unbalance, thus 'unsafe' situations*
- Legacy in airport infrastructure limits the options for change
- Aviation is heavily regulated; regulations favors current situation
- Non-appropriability or split incentives airports won't invest if only airlines benefit, v.v.
- Limited incentives for individual partners to change: local monopolies from ATC, Airline, airport, etc. Best results when operating at maximum capacity
- Global – Local Paradox: global developments needs to be implemented locally
- Changes within the entire sector required

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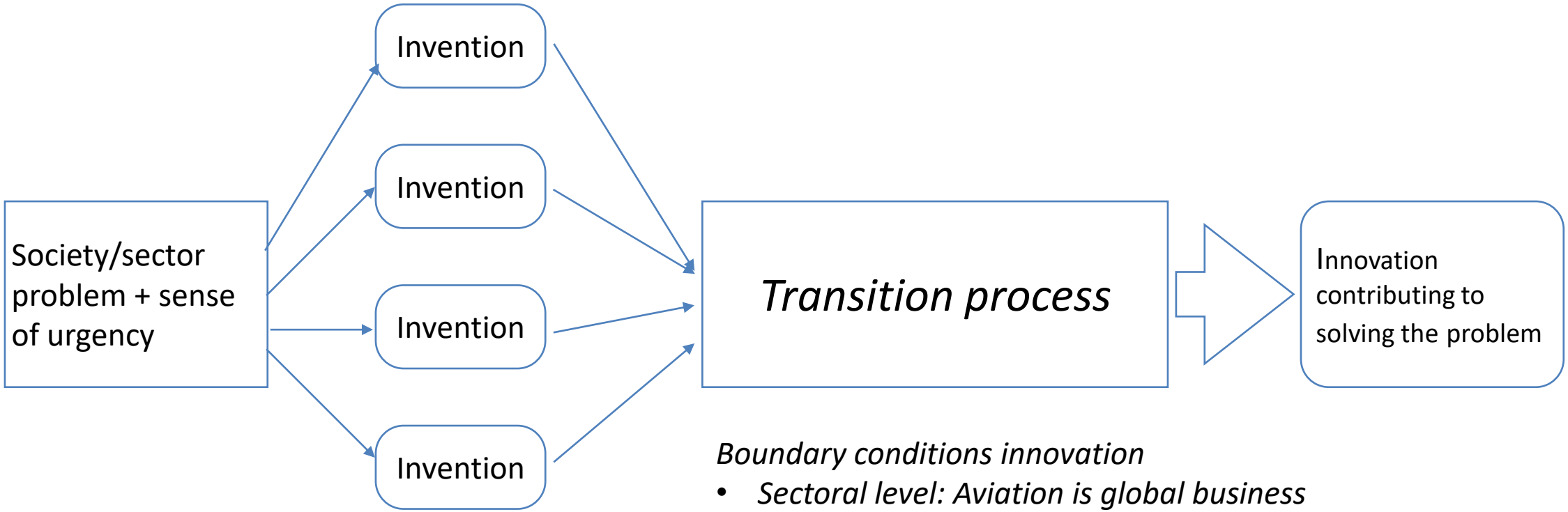
INNOVATION IN AVIATION



Boundary conditions innovation

- *Sectoral level: Aviation is global business*
- *Disruptive innovation*
- *Conceptual changes in sector*
- *Legacy defines starting point*
- *Transition path includes*
  - *social aspects innovation; often locally defined*
  - *Sabotage/hacking*

CONCLUSIONS AND FURTHER RESEARCH

- Massive innovation in Aviation is required to face the challenges ahead
- Legacy in technology, infrastructure, regulations and market limits pace of innovation in aviation
- Programs like Sesar/Nextgen focus on development and implementation of new technology and operating procedures and need to pay attention to the industry drivers to adapt this new technology
- High focus on the end result; there is growing insight in the importance of the transition path as a crucial part of the innovation process
- Innovation is a cyclic process. Implementation of an invention may require many iterations between stakeholders in order to identify and remove barriers
- Further research needed to understand the role of the transition path in innovation in Aviation

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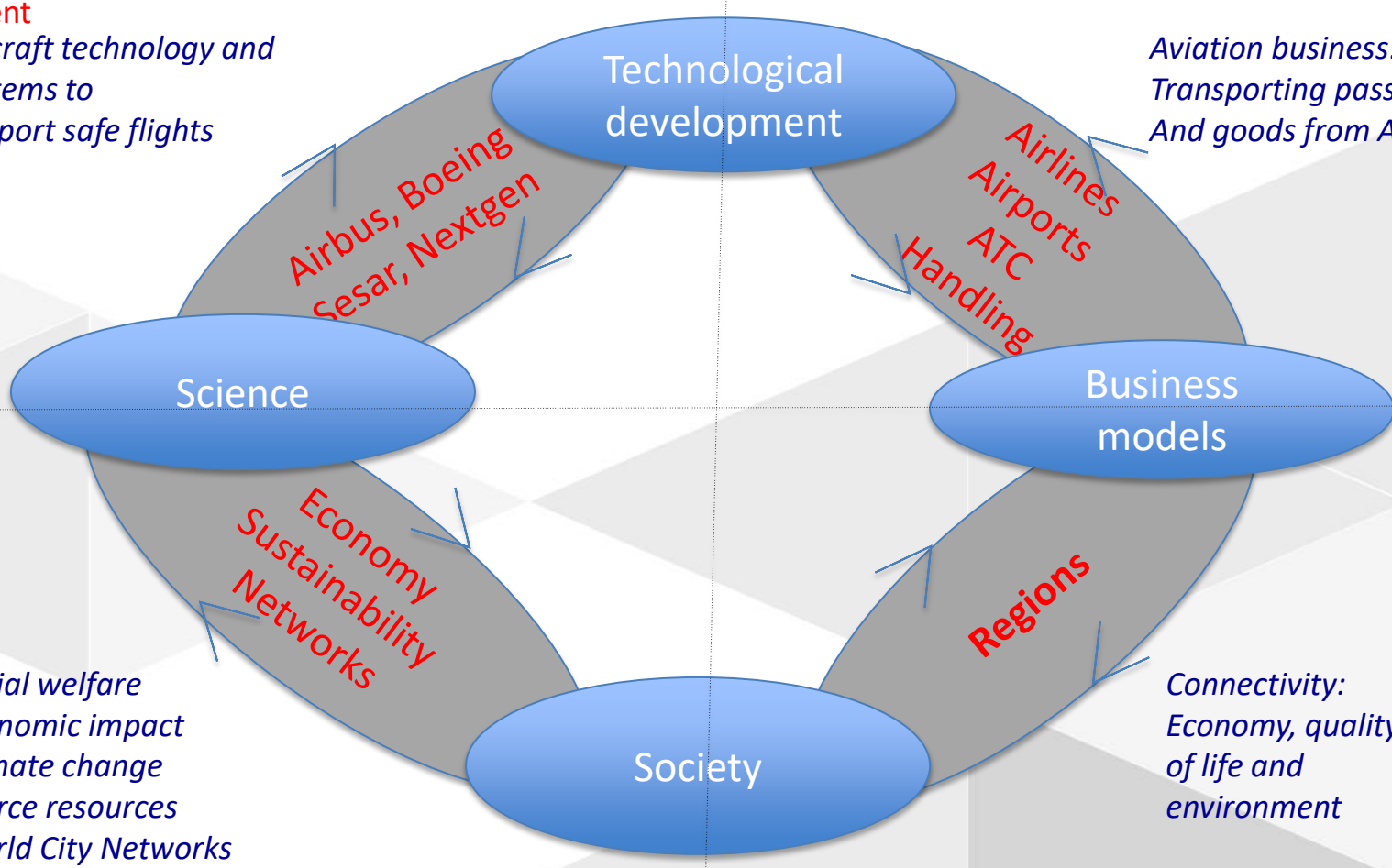
CIM AVIATION
BLENDED WITH TECHNOLOGY LEGACY

- Established interests
- Existing technology
- Established knowledge
- Market imperfections
- Financing support
- Government involvement

Aircraft technology and systems to support safe flights

- Past investments in infrastructure
- Business models airline and airports
- Fee structures
- Existing networks
- Ownership of slots
- Financing
- Vested interests

Aviation business: Transporting passengers And goods from A to B



- Established knowledge
- Vested interests
- Limited insights in impact of climate and emissions

Social welfare
Economic impact
Climate change
Scarce resources
World City Networks

- Regulations
- Public opinion
- Environmental concerns
- Security
- Regional interests
- Vested interests
- Perverse subsidies
- Financing existing knowledge

Connectivity: Economy, quality of life and environment

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THANK YOU FOR YOUR ATTENTION

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WHAT IS INNOVATION?

Innovation = Invention + Implementation

Source: Paul Trott

Basis= Schumpeter's principle of creative destruction is a driver for adaptation and growth (source: Schumpeter)

Main question for a company or organization: "how to ensure continuity or how to define the ability to adapt to (disruptive) innovation and to stay competitive (Source: Bonvillian and Weiss)

INNOVATION BARRIERS IN AVIATION

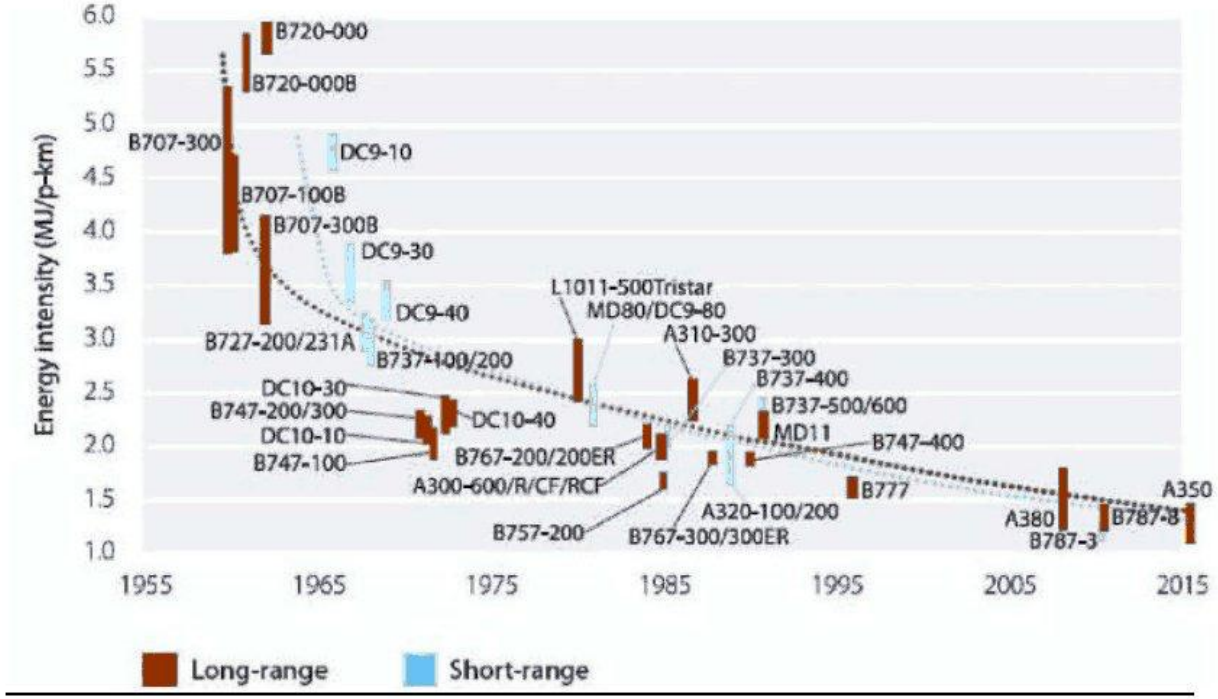
- Technology development in aviation is often spin-off of military innovation
- Lumpiness: large scale engineering intensive investments to develop advanced new air craft type
- Reduced investments in new military aircraft technology
  - No new technology flow to civil aircraft manufacturers, new aircraft based on existing technology
    (*see M. Mazzucato: the Enterpreneurial State)*
- Support scheme's for national carriers
  - Explicit or hidden subsidies and market barriers to support national carriers
- High barriers to enter the airport market
  - Lumpiness, financing , slots, regulations, security, local interests
- Past investments in fleet and airport infrastructure define today's options for change
- Regulation favors by definition todays practice and lacks behind new developments
- Innovation in aviation requires sector wide implementation

WHY IS TRANSITION PATH INCLUDED?

- Disruptive innovations in legacy sectors will result in fundamental changes in the entire sector *ie free flight in airspace or emissions reduction worldwide*
- The change cannot be implemented at once; safety and security in aviation and high operational pressure
- Small steps, including trial and error, are needed to explore the route to implement inventions
- We need to unbalance the current system and bring it towards a new (intermediate) equilibrium
- Many stakeholders involved, iterative/cyclic process to manage, role of incumbents (legacy airlines, ATC, etc)
- Managing the transition path for legacy sectors is hardly studied (*Bonvilian and Weiss*)
- Course of transition of sector cannot be predicted in advance (*Schot and Geels*)

AVIATION: FUEL EFFICIENCY AND SAFETY

The fuel efficiency of new aircraft has improved sharply …



Source: Lee, IATA