Novel and more effective allocation markets in ATM
Overview from the Engage KTN

Andrew Cook, University of Westminster

Engage thematic challenge 4 workshop
University of Westminster, 25OCT18

SESAR JOINT UNDERTAKING

Founding Members
EUROPEAN UNION EUROCONTROL

Novel and more effective allocation markets in ATM
Overview

- Background on Engage and thematic challenges
  - interdisciplinary collaboration warmly welcome
- Context for thematic challenge 4
  - some air traffic management basics
  - scope of the thematic challenge
  - heads-up for the discussion session
- Wrap-up and next steps
  - funding opportunities

Background on Engage and thematic challenges

Engage – the SESAR Knowledge Transfer Network

UNIVERSITY OF WESTMINSTER

EUROCONTROL

EASA European Aviation Safety Agency

FREQUENTIS

innaxis

TU Delft Delft University of Technology

UNIVERSITY OF BELGRADE

UNIVERSITY OF TRIESTE

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Industry partners

Advanced Logistics Group (ALG)
AGIFORS - Airline Group of the International Federation of Operational Research Societies
Air Traffic Controllers European Unions Coordination (ATCEUC)
airBaltic
Airport Regions Conference (ARC)
American Airlines
ANS CR
Aslogic
Association for the Scientific Development of ATM in Europe (ASDA)
Autoridade Nacional da Aviação Civil (ANAC)
Barcelona Supercomputing Center (BSC)
Belgocontrol
Boeing Research and Technology Europe (BR&T-Europe)
Bundesaufsichtsamt für Flugsicherung (BAF)
Civil Aviation Authority (CAA)
COOPANS Consortium
Department for Transport (UK)
Direction des Services de la Navigation Aérienne (DSNA)
Direktorat civilnog vazduhoplovstva Republike Srbije (DCV)
European Meteorological Services Network (EUMETNET)
European Passengers' Federation (EPF)
Executive Airlines
Ferrovial Agroman
Finnair
FlightGlobal
Flughafen München / Munich Airport
Gestair SL
Helios
HEMAV - High Endurance Multipurpose Aerial Vehicles
Honeywell Aerospace
HungaroControl
Icelandair
IFSTTAR - Institut Français des Sciences et Technologies des Transports, de l'Aménagement et des Réseaux
INFORM - Institut für Operations Research und Management GmbH
International Air Transport Passenger Association (IATPA)
International Federation of Air Traffic Controllers' Associations (IFATCA)
Irish Aviation Authority (IAA)
LFV - Luftfartsverket
London Luton Airport
Lufthansa Systems
Manchester Airport
NATS
Naviair
Network Manager - nominated by the European Commission
NEXTOR II Consortium - University of California, Berkeley and University of Maryland
PACE Aerospace Engineering & Information Technology
Pegasus Airlines
QinetiQ Ltd
Raytheon UK
Sabre Airline Solutions
SWISS - Swiss International Air Lines
Thomas Cook Airlines
TÜBİTAK - The Scientific and Technological Research Council of Turkey
Turkish Airlines

The Engage KTN

Overview

Key features and objectives (2018-2021)

- Better integrate more applied/industrial & exploratory research (two-way process)
    - mutual benefit, integrated into the fabric, funded; interdisciplinary
- Education and training: future ATM skilled workforce
    - “develop new talent with a deep knowledge of the future ATM scientific research needs ... stimulating the next generation of ATM staff”
    - PhD and graduate thesis Call (appx. €1m, open until 01NOV18)
    - 3 summer schools (2019: Belgrade); ATC training courses; lecture progs
    - SESAR Innovation Days (03-07DEC18, University of Salzburg)
- Knowledge hub as a ‘go-to’ source, single point of entry for ATM knowledge
    - popular demand: improved search functionality; consolidated repository
- Not only larger concepts, but sum of large number of support actions
    - multiple grants; ‘light touch’

free of charge

thematic challenges

Thematic challenges and workshops

Overview

Engage

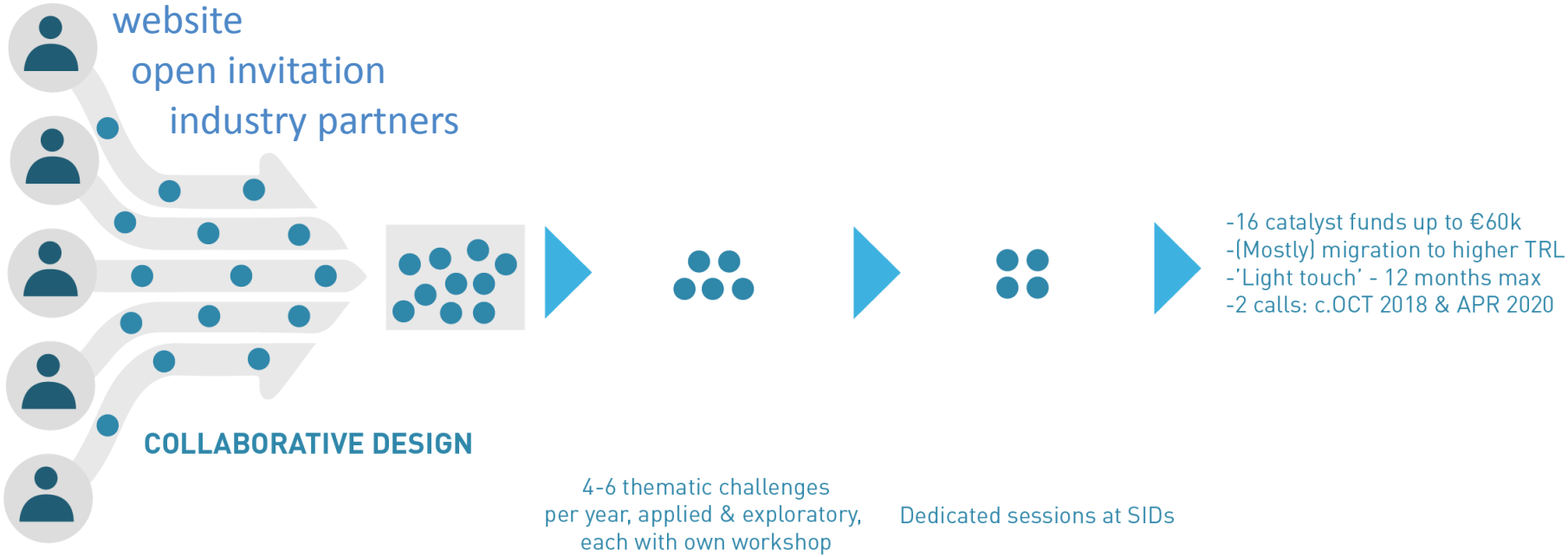
HOME ABOUT KNOWLEDGE HUB PARTICIPATE EVENTS CONTACTS

Engage Thematic Challenges

At the core of the KTN is the definition of various thematic challenges: new ideas suggested by the research community, not already included within the scope of an existing SESAR project. They are developed along with the ATM concepts roadmap and complementarily with some of the network's PhDs and theses.

Thematic challenges and workshops

Overview



- Thematic challenges at core: applied-orientation; help to mature exploratory research
- Industry partners: willingness to share information and data
- Each challenge has (a) dedicated workshop(s)
- Selected challenges may be investigated further through, e.g.:
  - **(1)** **Engage catalyst funding** (NB. consortium members ineligible), Call published by 16NOV18
  - **(2)** Engage PhDs/theses

Thematic challenges and workshops

Thematic challenge 1 – Vulnerabilities and global security of the CNS/ATM system

Workshop: Date/location TBC – Bringing together the ATM community and security experts to enable a more privacy-preserving, cyber-resilient, fault-tolerant and secure ATM system.

Draft programme available shortly.

CNS/ATM components (e.g., ADS-B, SWIM, datalink, Asterix) of the current and future air transport system present vulnerabilities that could be used to perform an 'attack'. Further investigations are necessary to mitigate these vulnerabilities, moving towards a cyber-resilient system, fully characterising ATM data, its confidentiality, integrity and availability requirements. A better understanding of the safety-security trade-off is required. Additional security assessments for legacy systems are also needed to identify possible mitigating controls in order to improve cyber-resilience without having to replace and refit. Future systems security by design is essential: a new generation of systems architectures and applications should be explored to ensure confidentiality, cyber-resilience, fault tolerance, scalability, efficiency, flexibility and trust among data owners. Collaborative, security-related information exchange is essential to all actors in aviation. This is specially challenging in a multi-stakeholder, multi-system environment such as ATM, where confidentiality and trust are key.

Fuller text here

Brussels 15NOV18 ??

Thematic challenges and workshops

Thematic challenge 2 – Data-driven trajectory prediction

Workshop: 06 November 2018, Universitat Politècnica de Catalunya (UPC), Barcelona, Spain – ATM stakeholders and data scientists discussing the airspace users' needs, methodologies and benefits of improved trajectory prediction.

Draft programme here. Please use the **contacts** page to register.

Accurate and reliable trajectory prediction (TP) is a fundamental requirement to support trajectory-based operations. Lack of advance information and the mismatch between planned and flown trajectories caused by operational uncertainties from airports, ATC interventions, and 'hidden' flight plan data (e.g., cost indexes, take-off weights) are important shortcomings of the present state of the art. New TP approaches, merging and analysing different sources of flight-relevant information, are expected to increase TP robustness and support a seamless transition between tools supporting ATFCM across the planning phases. The exploitation of historical data by means of machine learning, statistical signal processing and causal models could boost TP performance and enhance the TBO paradigm. Specific research domains include machine-learning techniques, the aggregation of probabilistic predictions, and the development of tools for the identification of flow-management 'hotspots'. These could be integrated into network and trajectory planning tools, leading to enhanced TP.

Fuller text here

Thematic challenges and workshops

Thematic challenge 3 – Efficient provision and use of meteorological information in ATM

Workshop: 13 November 2018, SESAR Joint Undertaking (SJU), Brussels, Belgium – Atmospheric scientists and ATM stakeholders shaping a more efficient provision and use of meteorological information in future aviation.

Draft programme here. Please use the **contacts** page to register.

The main objective of this challenge is to improve overall ATM system performance by providing better user-support tools based on improved meteorological ('met') products. The focus is on the synergy of several methods and techniques in order to better meet the needs of operational users and to support aviation safety (e.g., through creating early warning systems) and regulation-makers (e.g., moving from text-based to graphical information provision). All stakeholders may benefit from this synergy: ANSPs (e.g., sector reconfiguration and separation provision), airlines (e.g., storm avoidance), airport operators (e.g., airport management under disruptive events), and the Network Manager (e.g., demand-capacity balancing). The challenge is, therefore, to bring the following perspectives closer: (a) for meteorological/atmospheric science, the development of products tailored to ATM stakeholders' needs, which are unambiguous and easy to interpret; (b) for stakeholders, the identification of the most suitable information available and its integration into planning and decision-making processes.

Fuller text here

Thematic challenges and workshops

Thematic challenge 4 – Novel and more effective allocation markets in ATM

Workshop: 25 October 2018, University of Westminster (UoW), London, UK – A range of speakers from the behavioural sciences, economics, and ATM, debating approaches to improved modelling and methods in this new interdisciplinary area.

Final programme here. Please use the **contacts** page to register.

This research explores the design of new allocation markets in ATM, taking into account real stakeholder behaviours. It focuses on designs such as auctions and 'smart' contracts for slot and trajectory allocations. It seeks to better predict the actual behaviour of stakeholders, compared with behaviours predicted by normative models, taking into account that decisions are often made in the context of uncertainty. Which mechanisms are more robust against behavioural biases and likely to reach stable and efficient solutions, equitably building on existing SESAR practices? The research will address better modelling and measurement of these effects in ATM, taking account of 'irrational' agents such as airline 'cultures'. A key objective is to contribute to the development of improved tools to better manage the allocation of resources such as slots and trajectories, and incentivising behaviour that benefits the network – for example by investigating the potential of centralised markets and 'smart' contract enablers.

Fuller text here

Context for thematic challenge 4

Context for thematic challenge 4

Some air traffic management basics (1/6)

The steps in getting an aircraft from A to B

- key bottlenecks: runways and en-route airspace

- Airport (schedule or '**strategic**') slots are allocated twice yearly, a **season in advance**
  - e.g. SAS has the right to operate an 0800 from Rome (to Stockholm)
  - complicated process, balancing grandfather rights v. new entrants
  - further background / context in later presentations
  - good body of existing work, and *not in the scope of this challenge*

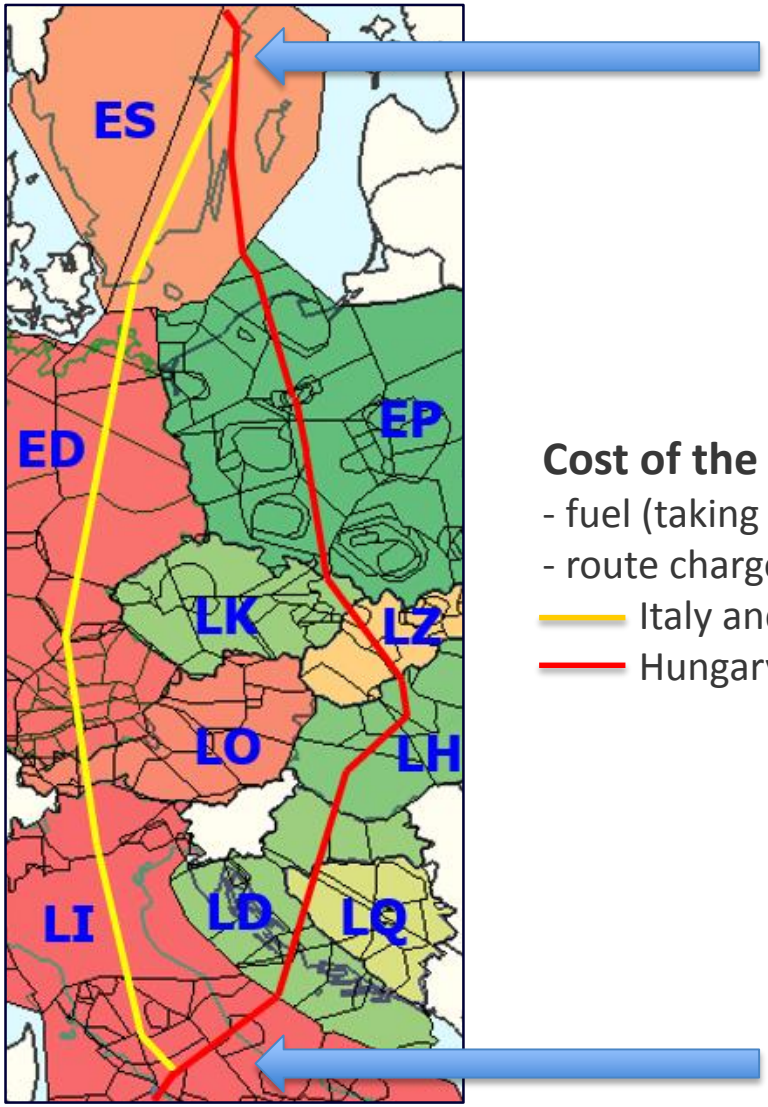
secondary slot trading

- Airline then files its flight plan on the day, typically a **few hours in advance**
  - demand often exceeds capacity – aircraft thus wait at the origin
    - limitation normally due to en-route or destination congestion
    - flight is issued with a (**tactical**) take-off slot (**CTOT**)
    - this process is called air traffic flow management (**ATFM**)
    - allocation algorithm (**CASA**) = 'First-Planned, First-Served'

no slot trading

Context for thematic challenge 4

Some air traffic management basics (2/6)



Stockholm (Arlanda) (e.g.)

- arrival management increasingly reaching back into en-route airspace to improve the final flow in the terminal area (target times, time to lose/time to gain advisories) HARRIS | Orthogon

Cost of the planned route depends on:

- fuel (taking winds into account) (plus: performance, weight, CI)
- route charges (rates vary by state)
  - Italy and Germany: more expensive route charges: **+€460**
  - Hungary and Poland: 70NM longer route, fuel: **+€250**

(Delgado, 2015)

Rome (Fiumicino) (e.g.)

- could be delayed with take-off slot (CTOT)
- enhanced slot-swapping in place since 2017
- other prioritisation approaches being developed

Context for thematic challenge 4

Some air traffic management basics (3/6)

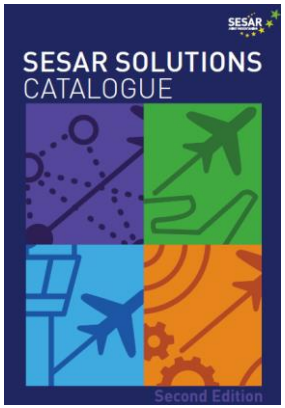
- **Single European Sky launched by the European Commission in 2004, to:**
  - reform the architecture of European ATM
  - currently 37 air navigation service providers (ANSPs) in Europe
  - address issues at a European, rather than local, level
  - *legislative* approach to meet future capacity and safety needs
- **Key objectives, to:**
  - "restructure European airspace as a function of air traffic flows"
  - "create additional capacity"
  - "increase the overall efficiency of the ATM system"
- **High-level, ambitious goals ("political targets"), aka SES '2005 vision' for 2020:**
  - **x3** increase in capacity (reducing delays)
  - **x10** improvement in safety
  - **10%** reduction of flights' impact on environment
  - **≥ 50%** reduction in costs of ATM services to airspace users

through all four pillars + 'indirect' effects

Context for thematic challenge 4

Some air traffic management basics (4/6)

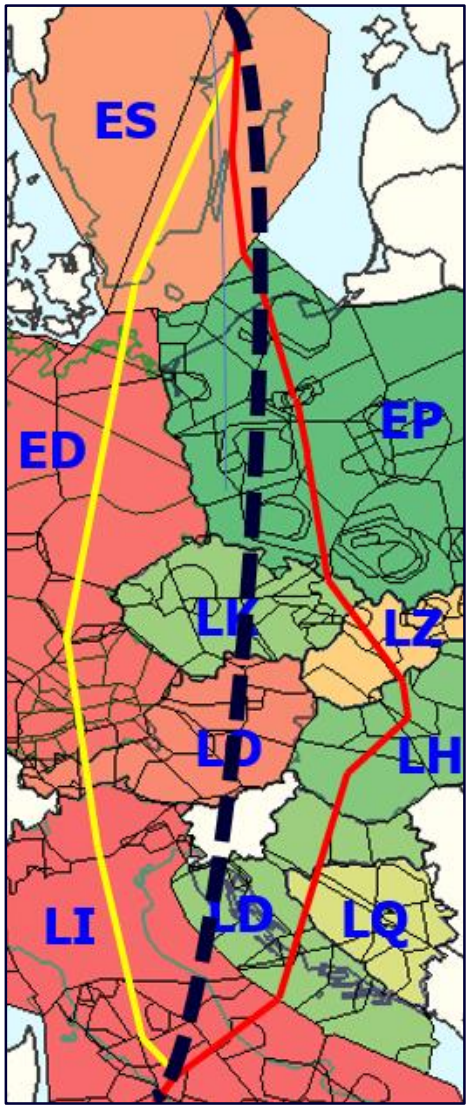
- **First pillar: regulating performance; three measures:**
  - establish an independent performance review body (PRB)
  - functional airspace blocks: targeted by end of 2012*
  - strengthening network management function (e.g. slot coord.)
- **Second pillar: single safety framework**
  - extend role of European Aviation Safety Agency (EASA)
- **Third pillar: new technologies – SESAR** (SES ATM research):
  - **define, develop & deploy that which needed to increase ATM performance**
- **Fourth pillar: managing capacity on the ground**
  - investment in airport capacity to remain aligned with air transport capacity



* Still only 2/9 in operation (UK-Ireland; Denmark-Sweden); may become voluntary

Context for thematic challenge 4

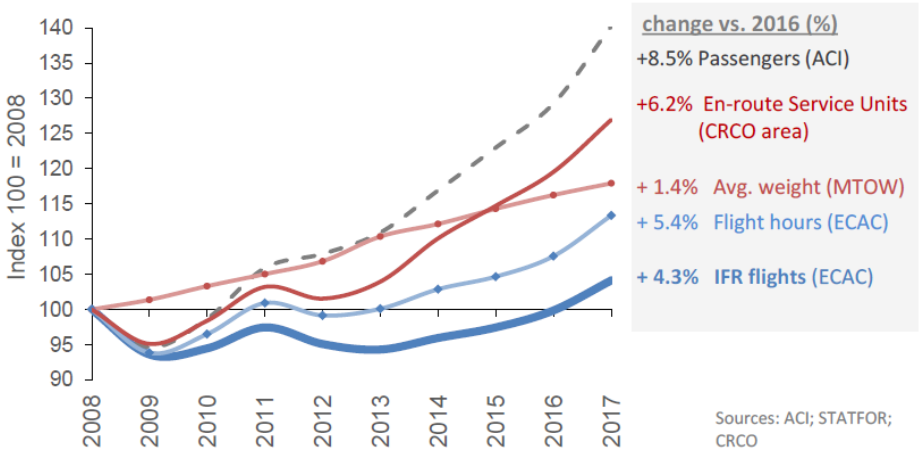
Some air traffic management basics (5/6)



- Ultimate plan: free routes airspace across Europe (by 2022)
  - allow airline to file preferred route rather than following current fixed waypoints / routes
  - horizontal efficiency (flown) already appx. 97%
  - MUAC offers > 250 user-preferred routes during certain times; plans 24/24 by spring 2020
  - more stable trajectories; greater spread conflicts
- Trajectory-based operations ('flow-centric' network)
  - better datalink comms & knowledge of intent => better ATC predictability (t/o: flexibility)
  - air-ground exchange universally applied, 2025+
  - move from statistical (e.g. D-1) predictions due to 'late' filing, to 'shared' trajectories in advance
  - reduces ATC monitoring tactically (aircraft report if they deviate)
  - NATS (e.g.) bid to supply these three routes on LHS?

Context for thematic challenge 4

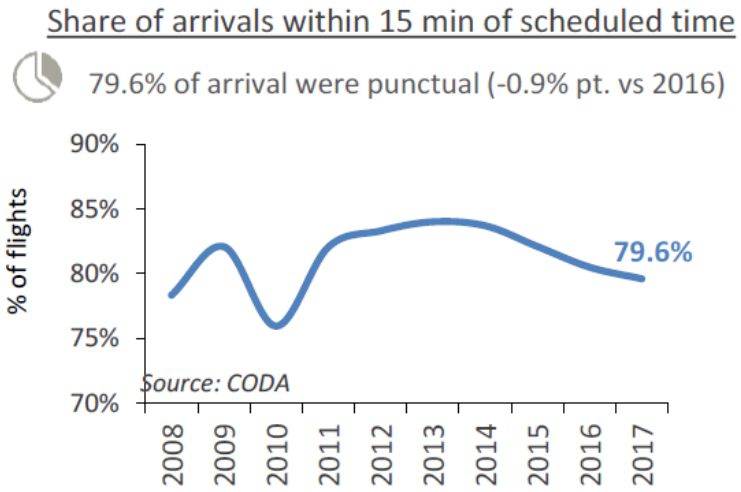
Some air traffic management basics (6/6)



- Highest-ever traffic levels in 2017 (i.e. now passed 2008)
- Four years of growth (from 2014 incl.)

Sources: PRR 2017

- 2017: fourth consecutive year that punctuality has fallen
- 2018: considerably worse



Heads-up for the discussion session

Heads-up for the discussion session

- **Series of presentations follow**
  - air traffic management perspective
  - interdisciplinary (economics, behavioural science) perspectives
  - clarificatory questions only, please save your hot topics for discussion session

- **We are going to ask you to suggest:**
  - what specific follow-up research likely to be useful to mature the state of the art (especially addressed by catalyst funding)
  - what measures of success could be used to assess progress of challenge:
    - **short-term:** wholly within catalyst funded project
    - **medium-term:** progress (made or) identified within project
  - what are likely barriers to prevent progress towards maturing challenge – how might we overcome them?

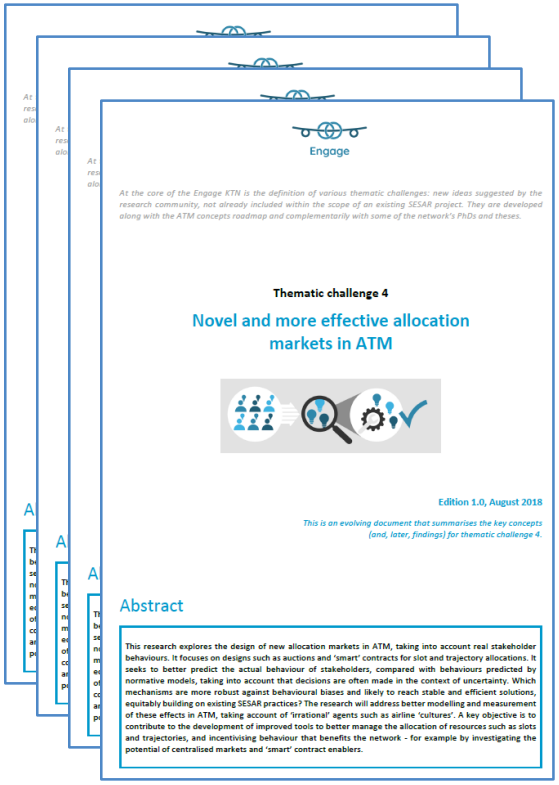
please see programme

- **listening mode:** to refine (dynamic) challenge text

Housekeeping

Wrap-up and next steps

Wrap-up and next steps



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Conclusions from discussion

Next steps

- refresh the challenge text and re-publish
- presentations on the website

- catalyst funding Call (by 16NOV18; SESAR e-news)
- maturing from exploratory to applied-orientation
- up to €60k, 12 months, 'light touch' (also 'open')

- presentation at the SESAR Innovation Days
- posters; consortium members available
- feeds final stages of ER4 Call (appx.€40M; Q1 2019)

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Thank you

This network has received funding from the SESAR Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No 783287.

SESAR JOINT UNDERTAKING

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