

Engage – welcome & context; today's programme & recap



9th SESAR Innovation Days

Engage thematic challenge 2 *Data-driven trajectory prediction (2nd workshop)*

Andrew Cook, University of Westminster

Dirk Schaefer, EUROCONTROL

2 – 6 December 2019, Athens, Greece



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The Engage KTN



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– the SESAR Knowledge Transfer Network

UNIVERSITY OF
WESTMINSTER



FREQUENTIS



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Industry partners

Our doors are still open

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)
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
Ferrovia Agroman
Finnair
FlightGlobal
Flughafen München / Munich Airport
Gestair SL
Helios
HEMAV - High Endurance Multipurpose Aerial Vehicles
Honeywell Aerospace
HungaroControl
Icelandair
IFSTAR - 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)
International Federation of Air Traffic Safety Electronics Associations (IFATSEA)
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
skeyes
SWISS - Swiss International Air Lines
TÜBITAK - The Scientific and Technological Research Council of Turkey
Turkish Airlines

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Core activities

2018 – 2021

Thematic challenges

- ‘One-stop’ European knowledge hub, concepts roadmap, research repository
- 4x SESAR Innovation Days (non-disruptive; industry)
- 12 thematic challenge workshops
- 3 European summer schools (Belgrade ‘19, Luxembourg ‘20, Trieste ‘21)
- 10 PhDs (interdisciplinary); 16 catalyst fund projects (TRL pipeline)
- Future ATM skilled work-force; student mobility
 - under-/post-graduate teaching & training initiatives
 - internships & employer links
 - journal publication grants
 - travel grants

35% of €4m as
consortium effort

SESAR Digital Academy

Integrate IR and ER



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Thematic challenges

Background



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.



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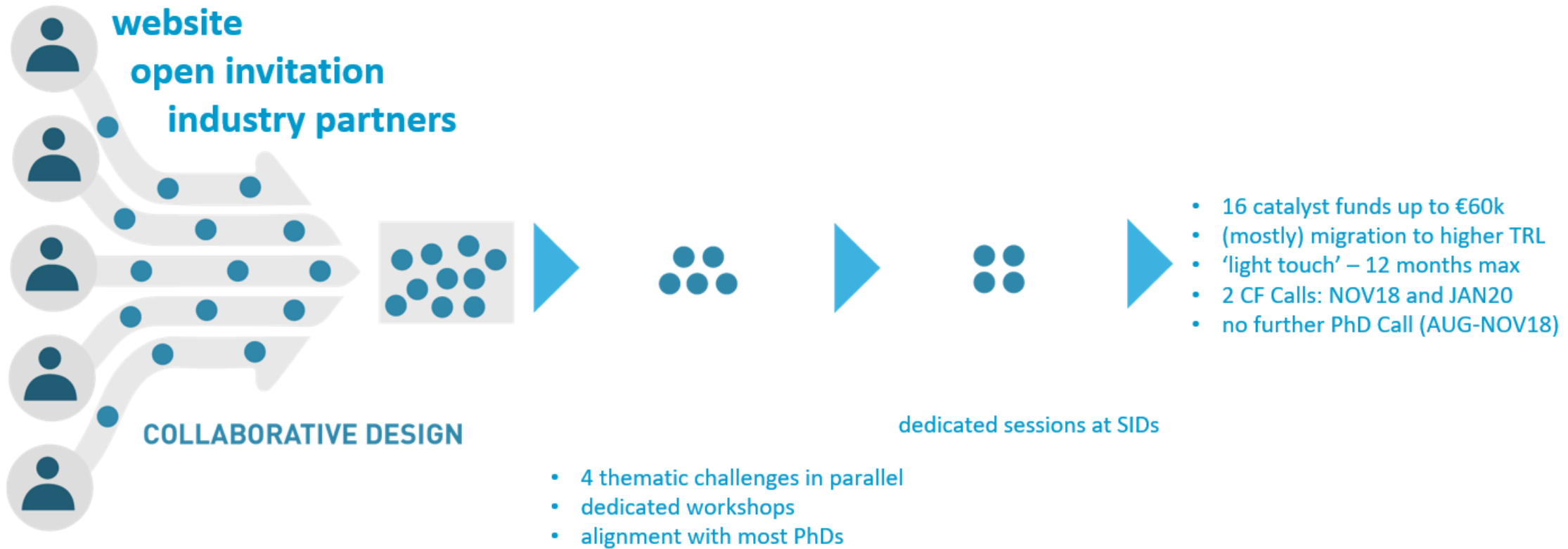


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Thematic challenges

Background



Thematic challenges

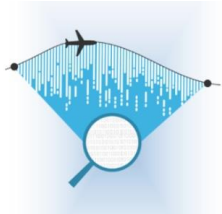
Workshops in current rolling window (by challenge number)



#1. CNS vulnerability and security *Paula López, Innaxis*
17 June 2020, Frequentis, Vienna

[NB. Updated after 02 December 2019 original slide]

Integrate: PhDs, CFs,
& wider community



#2. Data-driven trajectory prediction *Dirk Schaefer, EUROCONTROL*
02 December 2019, Athens (co-located with SIDs)



#3. Efficient use of MET data *Tatjana Bolić, Uni. Trieste*
05 November 2019, SJU, Brussels

Promotion since
August; SESAR e-news



#4. Novel market mechanisms in ATM *Andrew Cook, Uni. Westminster*
12 November 2019, Nommon, Madrid



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Engage PhDs

10 PhDs launched, up to €150k per thesis (not fees/supervision)



Title	TC1	TC2	TC3	TC4	Supervisor	Proponent	Inst. 2	Inst. 3	Inst. 4	Co-fund?
Decision support system for airline operation control hub centre ('DiSpAtCH')					Prof Dr-Ing Peter Hecker	TU Braunschweig	Jeppesen			✓
Trajectory planning for conflict-free trajectories: a multi agent reinforcement learning approach ('RL4CFTP')		✓			Prof George Vouros	University of Piraeus Research Center	CRIDA			
Detection, classification, identification and mitigation of GNSS signal degradations by means of machine learning					Prof Nicolas Couellan	ENAC	Uni. Oklahoma			✓
Machine learning techniques for seamless traffic demand prediction		✓			Dr Xavier Prats	Nommon	UPC			✓
Machine learning applications to extend agent's conflict resolution capabilities		✓			Dr Miquel Angel Piera	Autonomous Uni. of Barcelona	ASLOGIC			✓
Integrating weather prediction models into ATM planning ('IWA')		✓	✓		Dr Valentin Polishchuk	Linköping University	LFV	Uni. Sevilla		✓
Advanced statistical signal processing for next generation trajectory prediction		✓			Dr Xavier Prats	Universitat Politècnica de Catalunya	ISAE-SUPAERO			✓
A pilot/dispatcher support tool based on the enhanced provision of thunderstorm forecasts considering its inherent uncertainty ('STORMY')			✓		Dr Manuel Soler	Universidad Carlos III de Madrid	ETH Zürich	Spanish Met Office	GTD Systems	✓
Second generation agent-based modelling for improving APOC operations				✓	Prof Daniel Delahaye	Amsterdam University of Applied Sciences	ENAC	Uni. Paul Sabatier		✓
Stochastic control of tactical airline operations in hub airport networks				✓	Prof Dr-Ing Hartmut Fricke	TU Dresden				



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Catalyst funding

10 awards made, up to €60k per project (H2020 limit) – *high value*



Title	TC1	TC2	TC3	TC4	Lead contact	Coordinator	Inst. 2	Inst. 3	Inst. 4
Authentication and integrity for ADS-B	✓				Prof Dr-Ing Jens Schmitt	TU Kaiserslautern (DE)	SeRo Systems (DE)		
The drone identity - investigating forensic-readiness of U-Space services	✓				Dr Yijun Yu	Open University (GB)	NATS (GB)		
Data-driven trajectory imitation with reinforcement learning		✓			Prof George Vouros	University of Piraeus (EL)	Boeing RTE (ES)		
A Data-driven approach for dynamic and Adaptive trajectory Prediction (DIAPasON)		✓			Jose Manuel Cordero	CRIDA (ES)	Deep Blue (IT)	ZenaByte (IT)	
An interaction metric for an efficient traffic demand management: requirements for the design of data-driven protection mechanisms		✓			Dr Juan José Ramos	Aslogic (ES)			
Probabilistic weather avoidance routes for medium-term storm avoidance (PSA-Met)			✓		Prof Damián Rivas	University of Seville (ES)	MeteoSolutions (DE)		
Airport-sCALE severe weather nowcasting project (CARGO)			✓		Dr Riccardo Biondi	University of Padova (IT)	LMU Munich (DE)	GReD srl (IT)	Leonardo (DE)
Operational alert Products for ATM via SWIM (OPAS)			✓		Dr Hugues Brenot	Royal Belgian Institute for Space Aeronomy (BE)			
MET enhanced ATFCM			✓		Gladys Mercan	DSNA Services (FR)	MetSafe (FR)		
Exploring future UDPP concepts through computational behavioural economics				✓	Ricardo Herranz	Nommon Solutions and Technologies (ES)			



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Thematic challenges

Taking stock

	TC1	TC2	TC3	TC4
PhDs	-	5	2	2
Catalyst fund projects	2	3	4	1

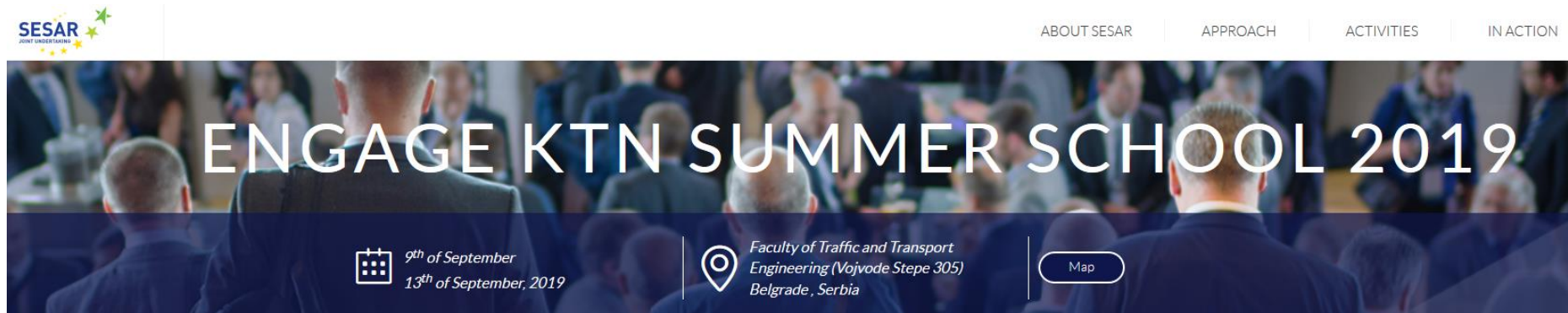


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Belgrade summer school

Dissemination for 2019



ENGAGE KTN SUMMER SCHOOL 2019

9th of September
13th of September, 2019

Faculty of Traffic and Transport
Engineering (Vojvode Stepe 305)
Belgrade, Serbia

Map

The first summer school of the Engage KTN will take place 09-13 September 2019.

vision of high quality education and
ment, by means of gathering
tutorials on
ologies, includi
laboratory research

Attendance to the summer school is free of charge, however, travel expenses are available to support student attendance. Interested participants should submit an application form no later than 20 June 2019. Notification of acceptance/rejection will be sent by 26 June 2019.

HIGH-PERFORMING
AVIATION FOR
EUROPE

SESAR JU E-News - May 2019

Project of the month - News - Events - Publications

Engage KTN summer school 2019

The first summer school organised by the Engage KTN will take place 09-13 September 2019, in Belgrade, Serbia. This will include tutorials on key ATM concepts and challenges as well as on research methodologies, including case studies and presentations of prominent SESAR exploratory research projects.

Read more



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Today's programme



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Today's programme

Content and housekeeping; vote of thanks

- Content

- Recap from previous workshop
- Presentations from catalyst fund projects and from PhDs
 - after each: challenges and opportunities
- Facilitated session
 - areas for collaboration
 - opportunities and needs, e.g. **technical workshops**

Wider inputs

- Housekeeping

- Slides will be put on Engage website (after approval from speakers)
- Expense claim forms for speakers / Engage students, where agreed
- Status re. 6-monthly reporting (PhDs; CF projects)



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Thematic challenge 2

Data-driven trajectory prediction



Workshop draft programme

Edition 1.2, 4 October 2018

Workshop date: **6 November 2018**
Host: **UPC Barcelona**
Address: **C. Esteve Terradas, 7. 08860 Castelldefels**



Programme

09:30-10:00 Registration and welcome coffee

10:00-10:15 Welcome and overview from the Engage KTN
(Dirk Schaefer, EUROCONTROL)

10:15-10:35 Foreword
(Franck Ballerini, Francis Decroly, EUROCONTROL Network Manager)

10:35-11:35 Research challenges in trajectory prediction

10:35-10:50 Trajectory prediction to assess ATM performance: Challenges and limitations identified in SESAR ER project APACHE
(Xavier Prats, UPC)

10:50-11:05 Challenges identified in the SESAR ER project DART
(Pablo Costas and Javier Lopez-Leonés, Boeing R&T Europe)

11:05-11:20 The challenge of inferring stakeholder behaviour from data
(Rodrigo Marcos, Nommon)

11:20-11:35 Challenges identified in the SESAR ER project PARTAKE
(Miquel Àngel Piera, UAB; Juan José Ramos, ASLOGIC)

11:35-11:55 Coffee break

11:55-12:15 Operational challenges in trajectory prediction
(Sebastian Wangnick, EUROCONTROL MUAC)

12:15-12:55 Promising research avenues

12:15-12:35 Signal processing
(Jordi Vilà-Valls, CTTC and Ramon Dalmau, UPC)

12:35-12:55 Contextual modelling
(Christian Verdonk, University of Cranfield)

12:55-14:00 Lunch break

14:00-16:30 Facilitated brainstorming

14:00-14:10 Briefing

14:10-15:45 Breakout session (including coffee break)

15:45-16:30 Plenary debriefing and Pareto voting

16:30-16:45 Wrap-up and closeout



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Stakeholder Airspace user Self-separation challenges

- This theme is mainly about:
 - Automation: pilot, A/C
 - Enabler technologies / capabilities
 - Coordination among TP (ontology)
 - TP requirements (accuracy, robustness)
- Measures of success could be used to assess progress of challenge:
 - short-term:
 - a common language framework among stakeholders to solve a conflict
 - longer-term:
 - increased capacity
- Likely barriers
 - Accuracy of TP (mainly vertical)
 - Liability for acceptance
 - Scalability

Stakeholder Network manager

Theme: AUs' behaviours & preferences

This theme is mainly about:

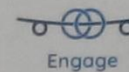
- Predicting/understanding preferences and behaviours
- Equity
- Trade-off flexibility-predictability

Measures of success could be used to assess progress of challenge:

- short-term:
 - approved/validated models by AU community
 - Quantitative validation
- longer-term: deployment of models

Likely barriers

- Validity of data
- Changing mindset/culture change of ATM community



SESAR
JOINT UNDERTAKING



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Stakeholder ANSP

Theme Capacity, demand, planning

This theme is mainly about:

- Match capacity to demand
- Control the “planning game”
- Retain appropriate buffers to cope with uncertainty
- Measure capacity demand w.r.t. ATCO workload
- Design sector configurations to match demands in cost optimal way
- Calculate demand (from uncertain trajectories) in a robust manner

Measures of success could be used to assess progress of challenge:

- Lowest AU costs
 - Flight cost (delays, efficiency)
 - Variable ANSP cost (cost for opening sector)
- No overloads

Likely barriers

- TE (TP, data)
- Capacity wall
- Agreed definition of workload



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Stakeholder ANSP
Theme CD&R

This theme is mainly about:

- Multi-sector collaborative CD&R
- ATCO tools proposing "optimal" (to be defined)
 - Clearances, instructions respecting the constraints

Measures of success could be used to assess progress of challenge:

- ANSP: Higher sector production
- AU: Value Flight better served (compromising others?!)

Likely barriers

- TE (TP, data)
- Risk of ATCO workload increase
- Needs buy-in from AU
- Nobody takes the lead (only scattered initiatives)

Stakeholder Network manager

Theme: Network integration of local planning activities

This theme is mainly about:

- Network effect
- Optimise local measures
- Common awareness

Measures of success could be used to assess progress of challenge:

- short-term:
 - approved/validated models by AU community
 - Quantitative validation
 - Gain acceptability of network metrics from community
- longer-term: effective cooperation between all actors

Likely barriers

- Changing mindset/culture change of ATM community
- Acceptance of data sharing
- Technical barriers/standardisation



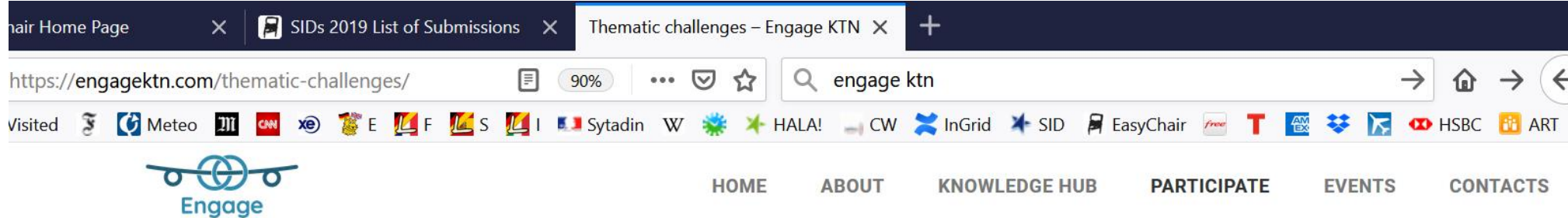
Stakeholder Airspace user Data Sharing

- This theme is mainly about:
 - Access to data (protocol, formats, nature, type)
 - Incentives for AUs (anyway to validate their expected benefits?)
 - Information shared (public / private)
 - Data providers
 - TP requirements on the info and access
 - Impact on hardware / software (avionics, EFB, data link)
- Measures of success could be used to assess progress of challenge:
 - short-term:
 - Transparent databases
 - longer-term:
 - An improved understanding of the needs and benefits for data sharing
- Likely barriers
 - Business model
 - Complexity to obtain meaningful information
 - Capacity, performance



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Thematic challenge 2 – Data-driven trajectory prediction

The **2nd Data-driven trajectory prediction workshop** is scheduled for 02 December 2019, Athens, Greece (co-located with SIDs). [Final programme](#) (registration now closed).

1st workshop: 06 November 2018, Barcelona, Spain – ATM stakeholders and data scientists discussing the airspace users' needs, methodologies and benefits of improved trajectory prediction. [Final programme here](#). Presentations: [zip file1](#) (9MB); [zip file2](#) (8MB updated).



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.



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Data-driven trajectory prediction

Example ideas for potential exploration

Presented at SESAR
Innovation Days 2018



1. Trajectory predictors supporting airborne self-separation: definition of requirements (accuracy, robustness, run time) & concept development of enabling technologies and capabilities
2. Improved matching of capacity to demand: enhanced TPs integrating uncertainty assessment, robust planning and cost-efficiency assessment allowing better demand assessment at network level – and better capacity planning
3. Data-driven approaches for understanding and prediction of AU preferences and behaviours enabling improved NM operations and flexibility-predictability trade-off
4. Collaborative multi-sector CD&R: requirements definition and concept development of data-driven TP in support of CD&R involving various sectors
5. Optimising and integrating local planning activities to assess, contain and communicate their network effects
6. Improving data-sharing and data access to satisfy AU, NM and ANSP technical and organisational requirements and expectations: data format and availability, incentives for data sharing, confidentiality issues

Thematic challenge 2: Data-driven trajectory prediction

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Engage Catalyst Funding Call
Closing date: 15/02/2019
Duration: max 12 months
Funding: up to 60k€

first Call for catalyst funding Ed. 1.0

1



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.



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Next steps



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Next steps

Next steps and further opportunities

- Next steps

- PDF updates from today, before next Engage catalyst fund Call
- we'll keep you posted (& re. slides)
- technical workshops
 - proposals/ideas during course of today
 - also welcome via Engage website



engagektn.com

- Further opportunities in 2020

- second Call for catalyst funding (January 2020)
- summer school (EUROCONTROL, Luxembourg (July))
- 'GEN-INTRO' training places – awareness of ATCO's job, 2 days
- TC1 workshop (CNS vulnerability and security)
- travel and publication (Gold Open Access) grants
- SESAR Digital Academy

Thursday



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