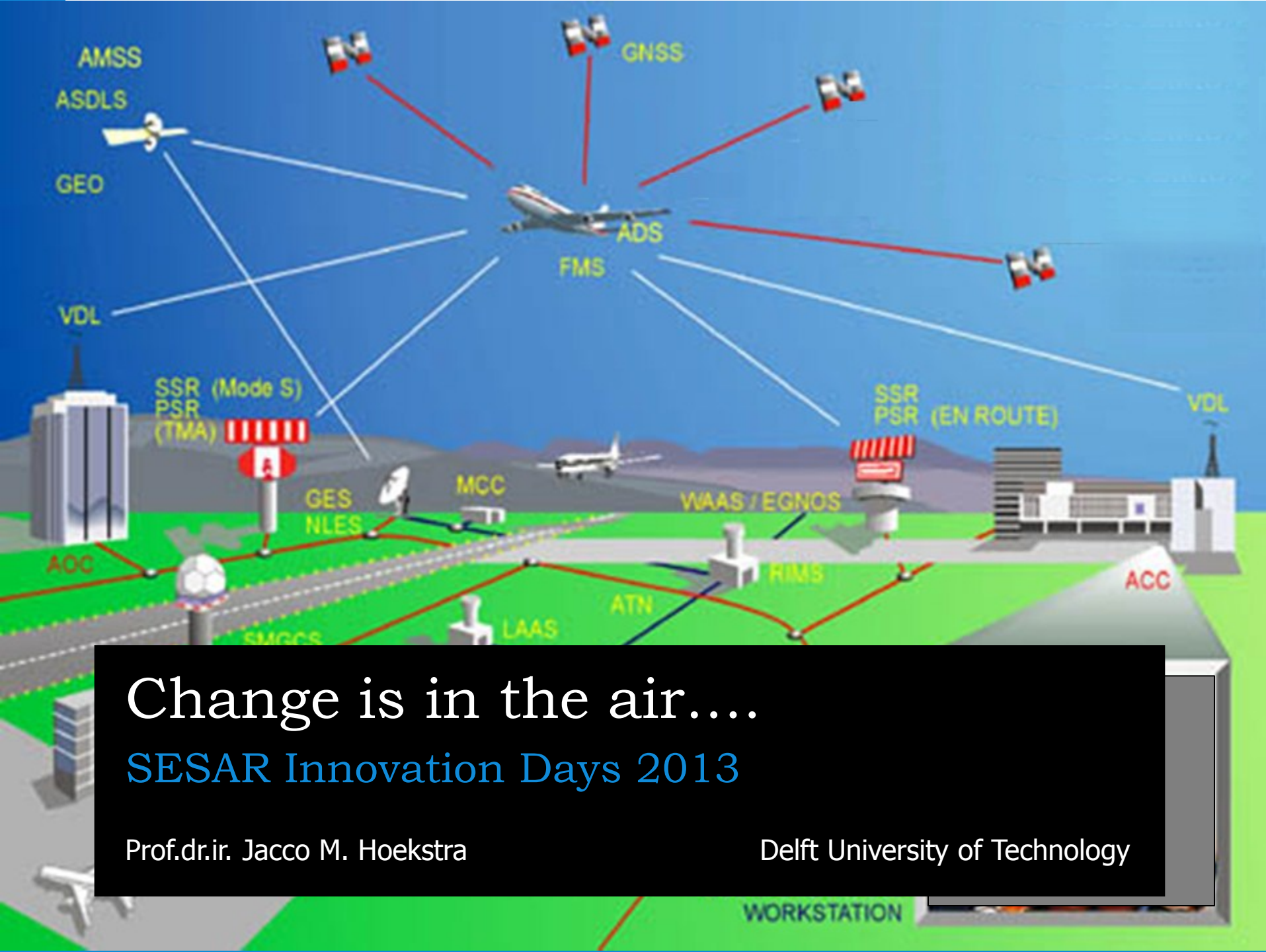




Change is in the air....

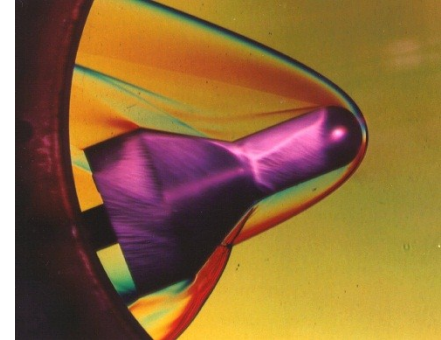
SESAR Innovation Days 2013

Prof.dr.ir. Jacco M. Hoekstra

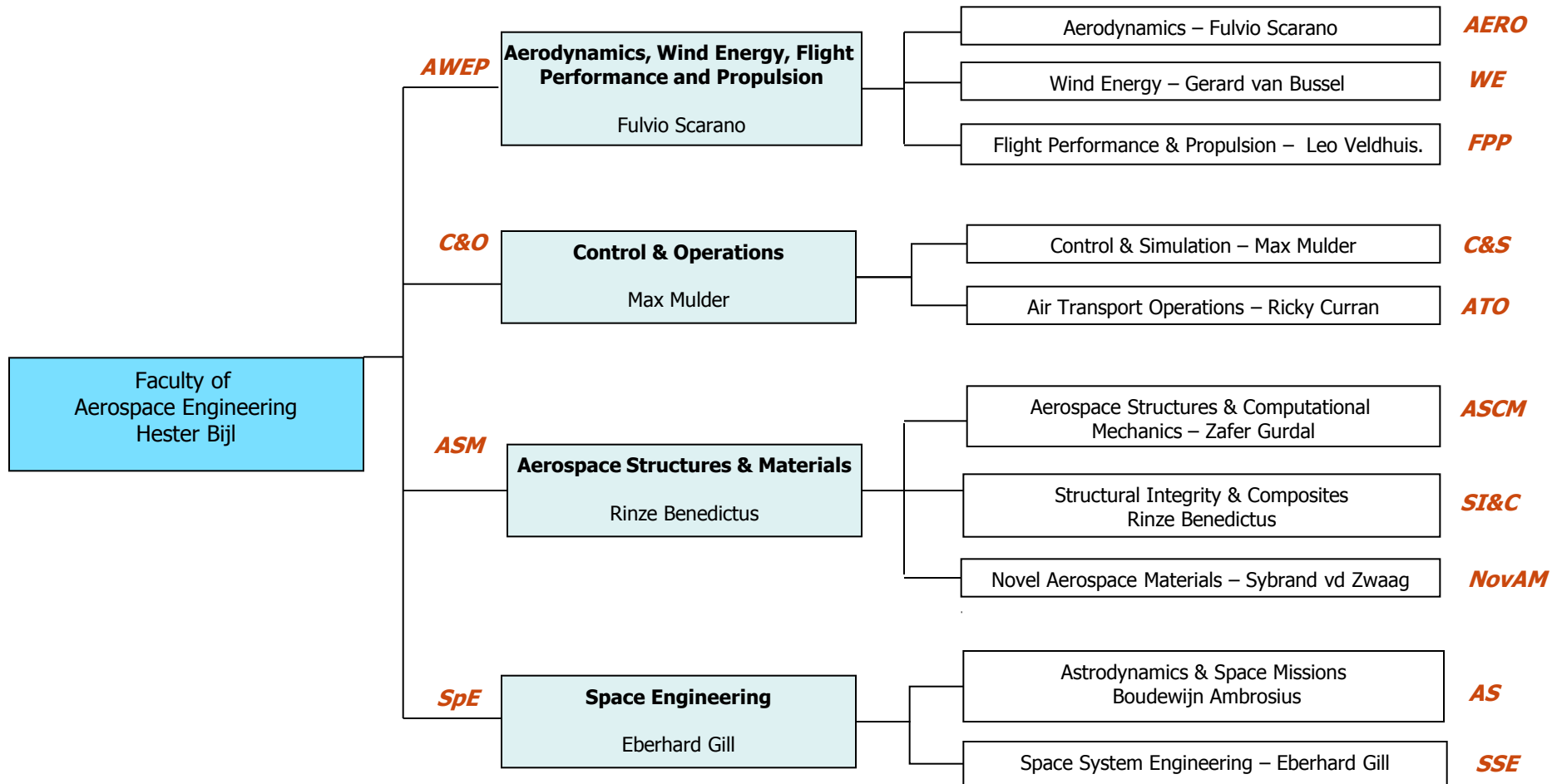
Delft University of Technology

TU Delft & Faculty of Aerospace Engineering

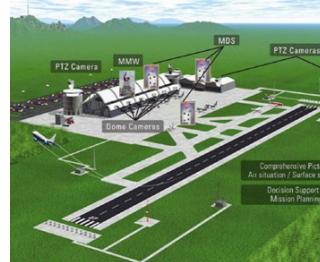
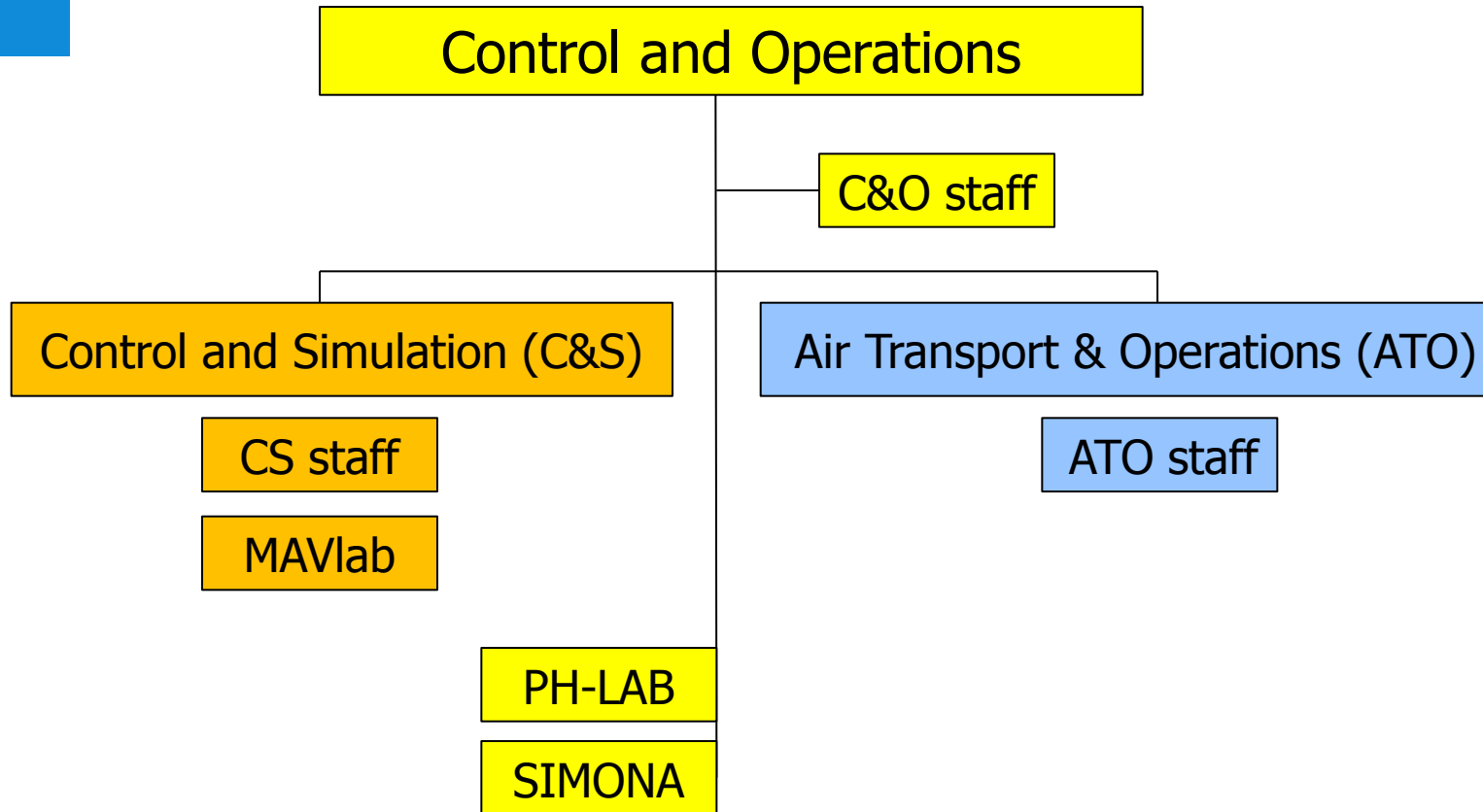
- TU Delft : 19,000 students BSc+MSc
- TU Delft – AE : 2,600 students BSc+MSc
- AE is international faculty, international staff:
 - Fully English taught Bsc, MSc program
- 300 fte faculty staff, 20 full professors
- Research facilities also used in education (incl. BSc):
 - Clean room, Structures, Materials & Chemical labs, Cubesats, Lab aircraft, Flight Simulator, Wind tunnels



Departments of Aerospace Engineering



Organigram C&O Department



Overview section

Control and Simulation (C&S)

- 3 chairs:
 - Aerospace Human-Machine Systems - Max Mulder
 - Communication, Navigation & Surveillance/Air Traffic Management - Jacco Hoekstra
 - Aerospace Guidance, Navigation & Control - Bob Mulder (Em.)
- 16 fte permanent scientific staff
- Facilities:
 - PH-LAB laboratory Aircraft
 - Simona flight simulator
 - MAVlab
 - Calibration lab



Control and Simulation

Aerospace Human-Machine Systems

Prof. Max Mulder, Dr. M.M. van Paassen

Research

Cybernetic approaches to manual control system design

- model multi-modal pilot perception and control
- haptic interfaces, biodynamics, shared control

Cognitive systems engineering to design for situation awareness

- ecological flight deck, ecological air traffic control working positions

Projects

VIDI project “Cybernetic approach to simulator fidelity”; STW “Pilot Task Demand Load”; Cleansky JTI “energy management”, EUROCONTROL “separation assurance”, NISSAN “steer-by-wire”, BOEING “balked landing”, ACROSS “reduction of pilot stress”

Collaborations

3ME (Biomech. Eng.), NLR, TNO, LVNL, Max Planck IBC, BOEING, NASA, NISSAN, HONEYWELL, EUROCONTROL, To70, GA Tech, Wright State



Control and Simulation

Communication, Navigation, Surveillance / Air Traffic Mgt

Prof. Jacco Hoekstra

Research

1. Foundations of ATM research

- data mining to study traffic flow dynamics
- common open tools, scenarios and metrics in ATM

2. Exploitation of potential benefits of ASAS/ADS-B/CNS

- concepts and systems prototypes development and validation
- improved trajectory prediction techniques or e.g. CD&R

3. Safety of growing general aviation

- improved CNS/ATM devices for today and future GA

4. Mature UAV systems and applications

- pioneer use cases and prototype systems development
- integration into current and future ATM environments

Projects

METROPOLIS, Future traffic scenarios, SELFLY, GA radar, UAV sense & avoid

Collaborations

NLR, DLR, LVNL, EUROCONTROL, To70, ENAC, NASA LaRC/Ames, NTSB

Challenge the future

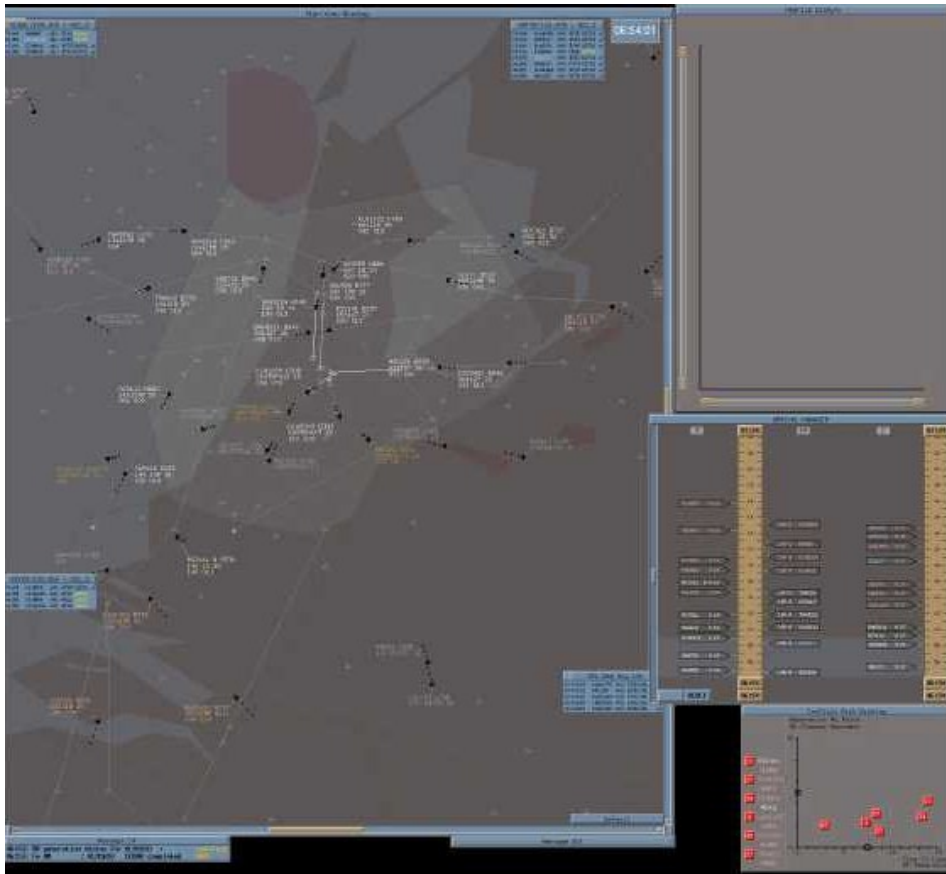


PHARE project

testing the EFMS in the simulator



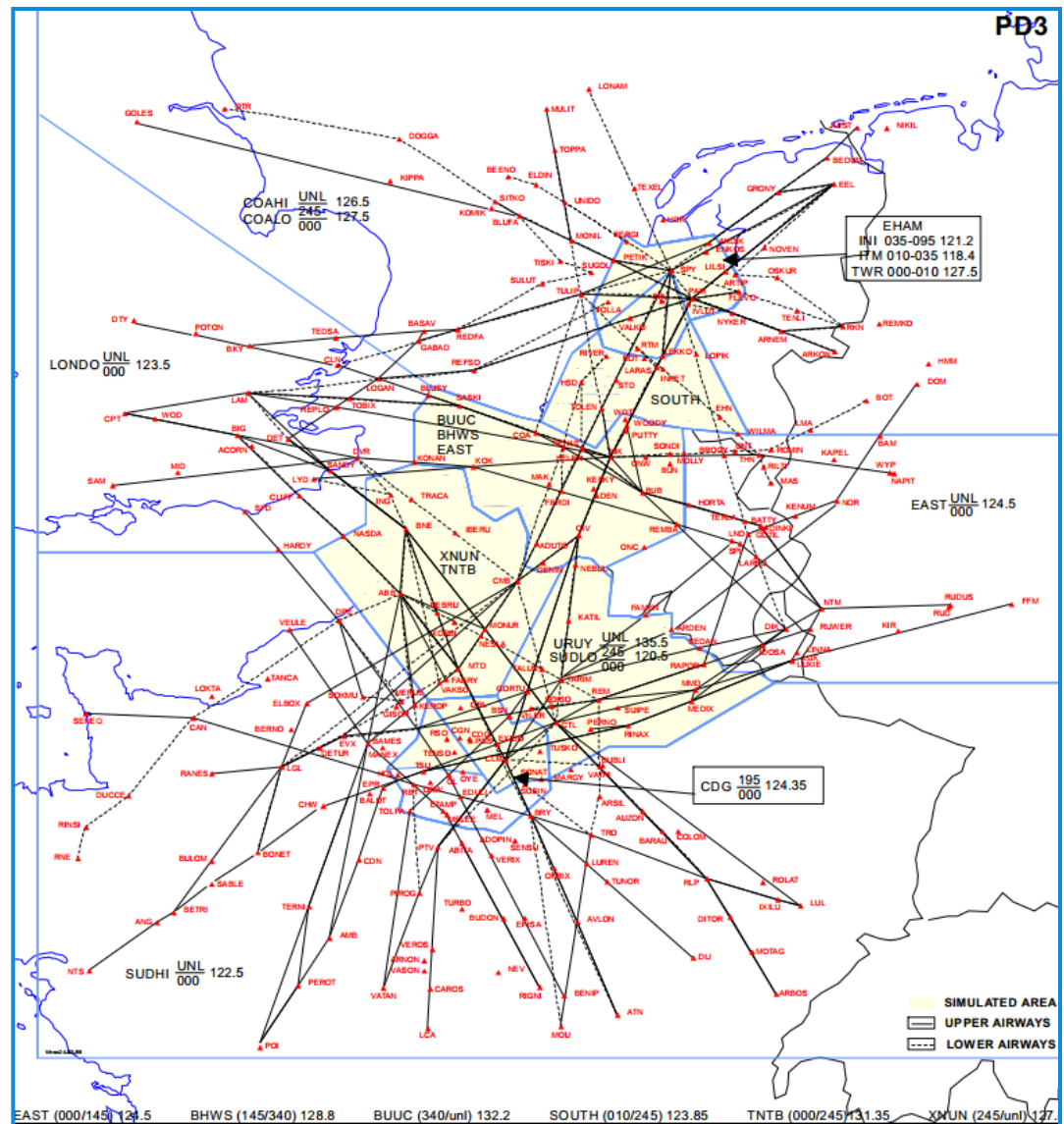
Start of my ATM work: PHARE research

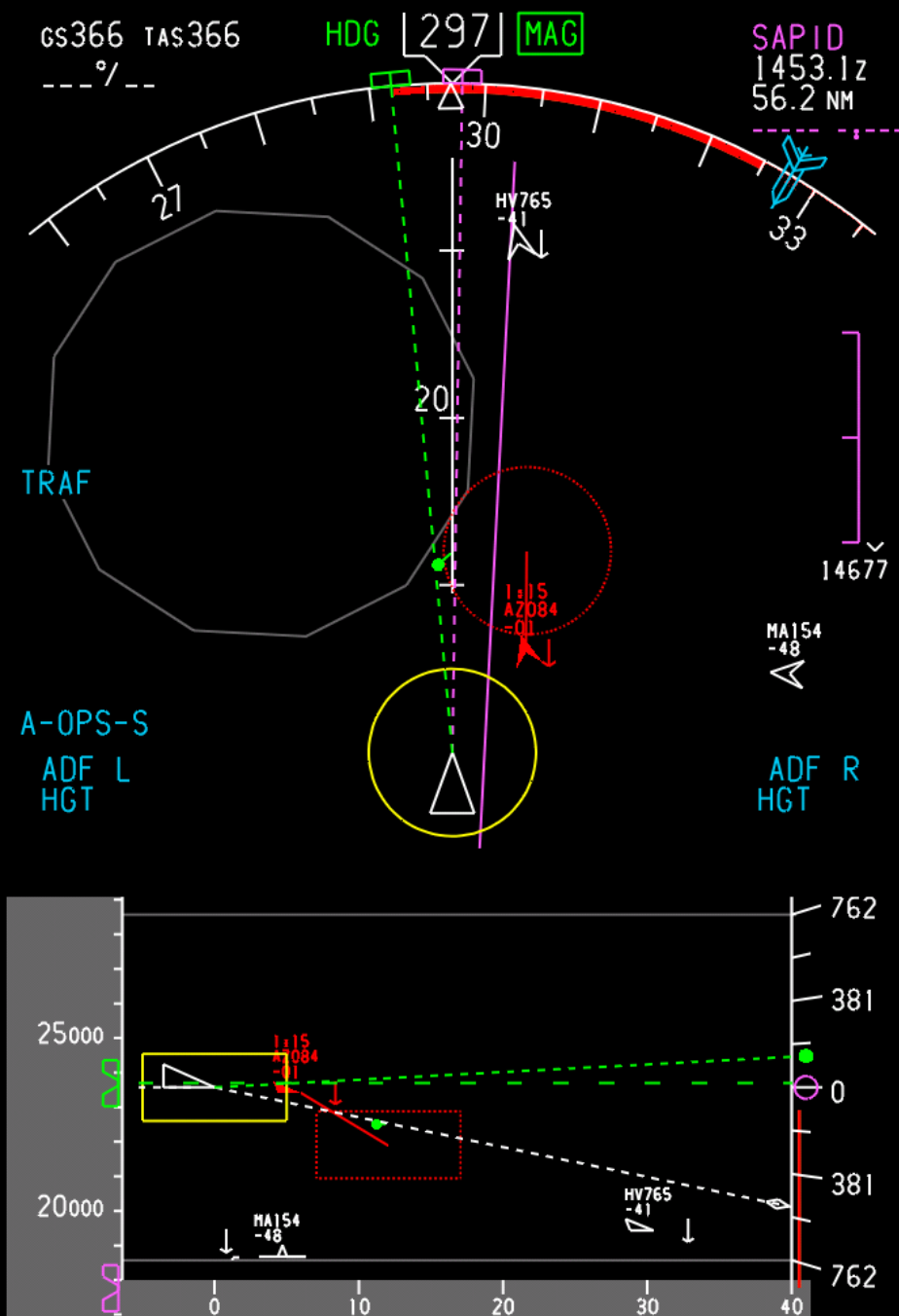


- Conflict free 4D trajectory (HIPS, TEPS, CRD)
- Negotiated safe 4D bubble
- Special FMS: EFMS



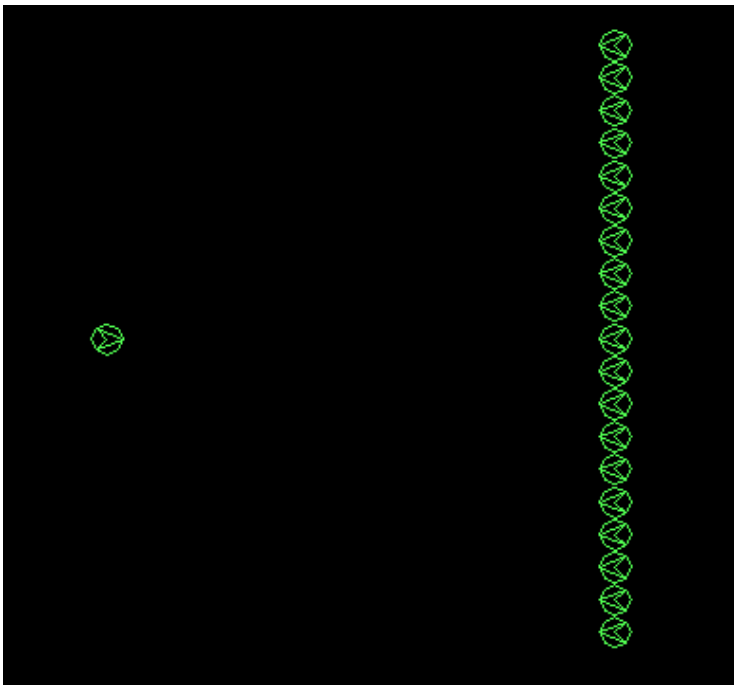
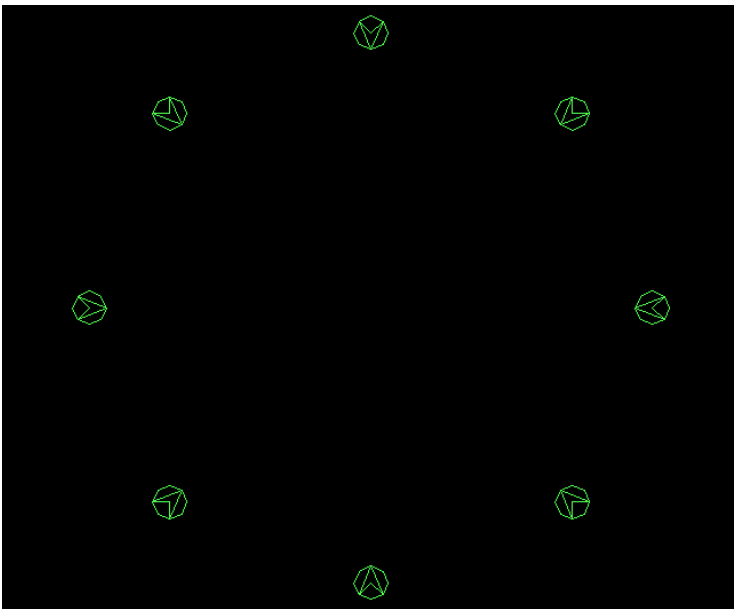
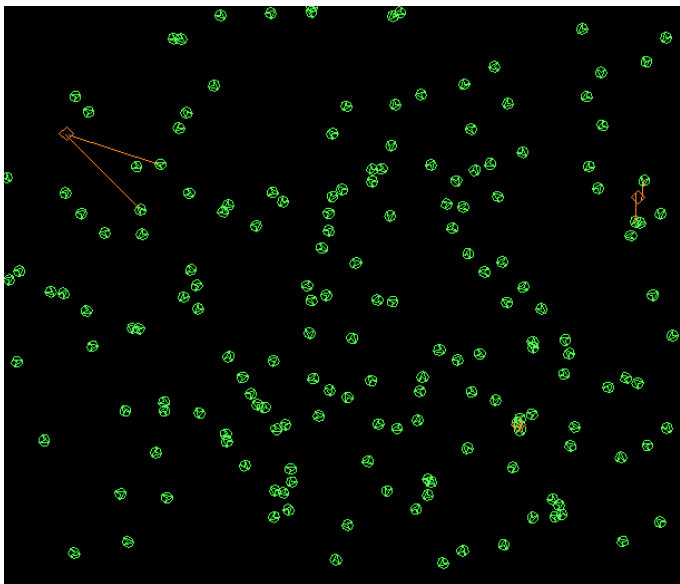
PD/3 trials





ASAS & Traffic display

- ASAS: 5nm, 5 min, 1000 ft
- Conflict symbology
 - red circle & track
 - yellow circle own zone
 - traffic symbol always
 - label time to l.o.s.
- Resolution symbology
 - horizontal
 - vertical
- Predictive ASAS
- If conflict => first check vertical reso!



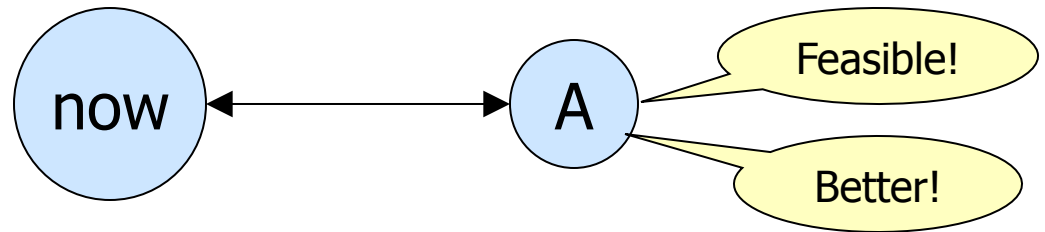
Flight tests:

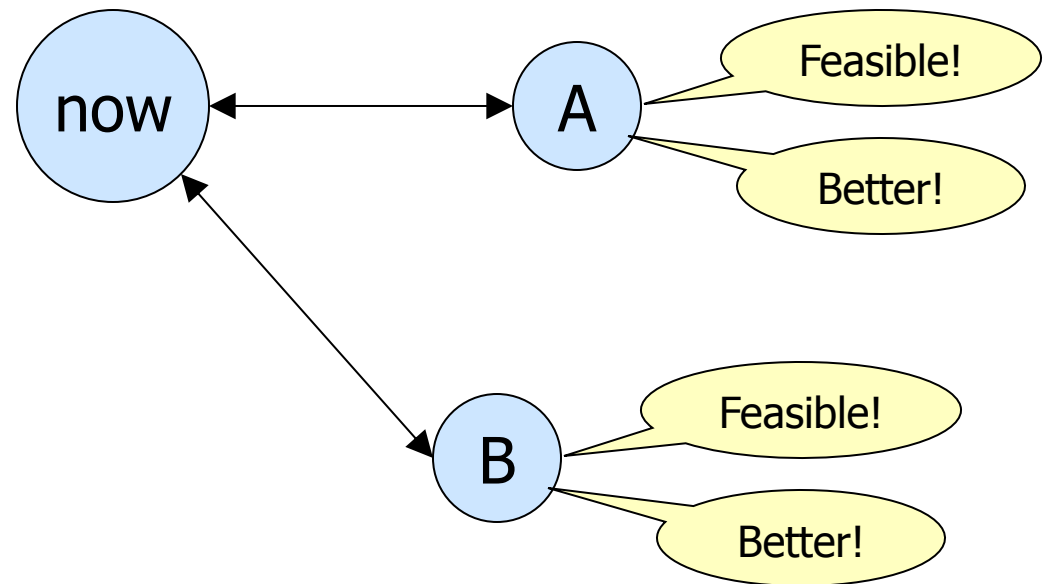
Mediterranean Free Flight (MFF)

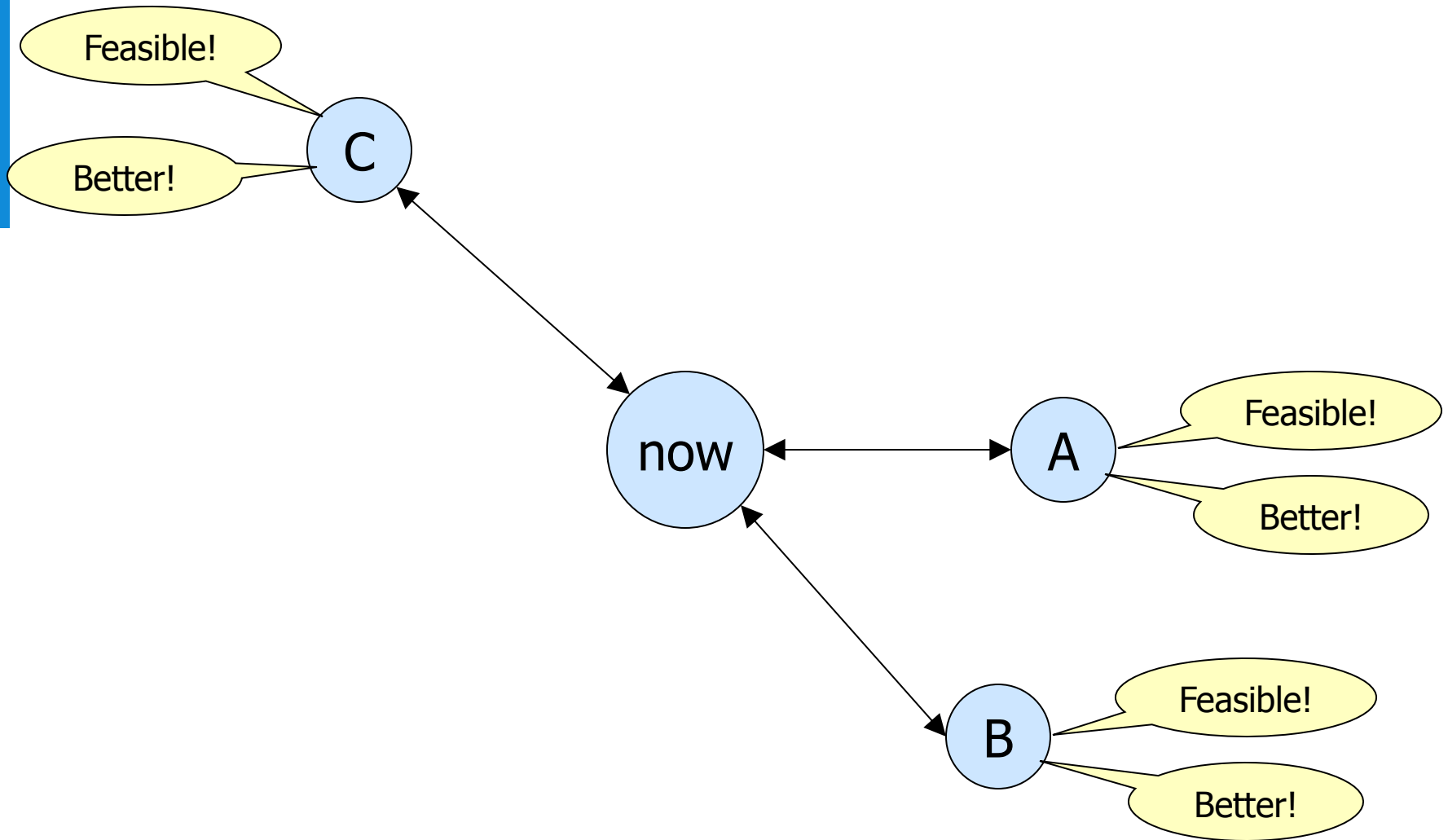
- ASAS packages I - III
- Safety analysis
- Air-ground human-in-the-loop simulations
- Multiple ac flight tests of all applications

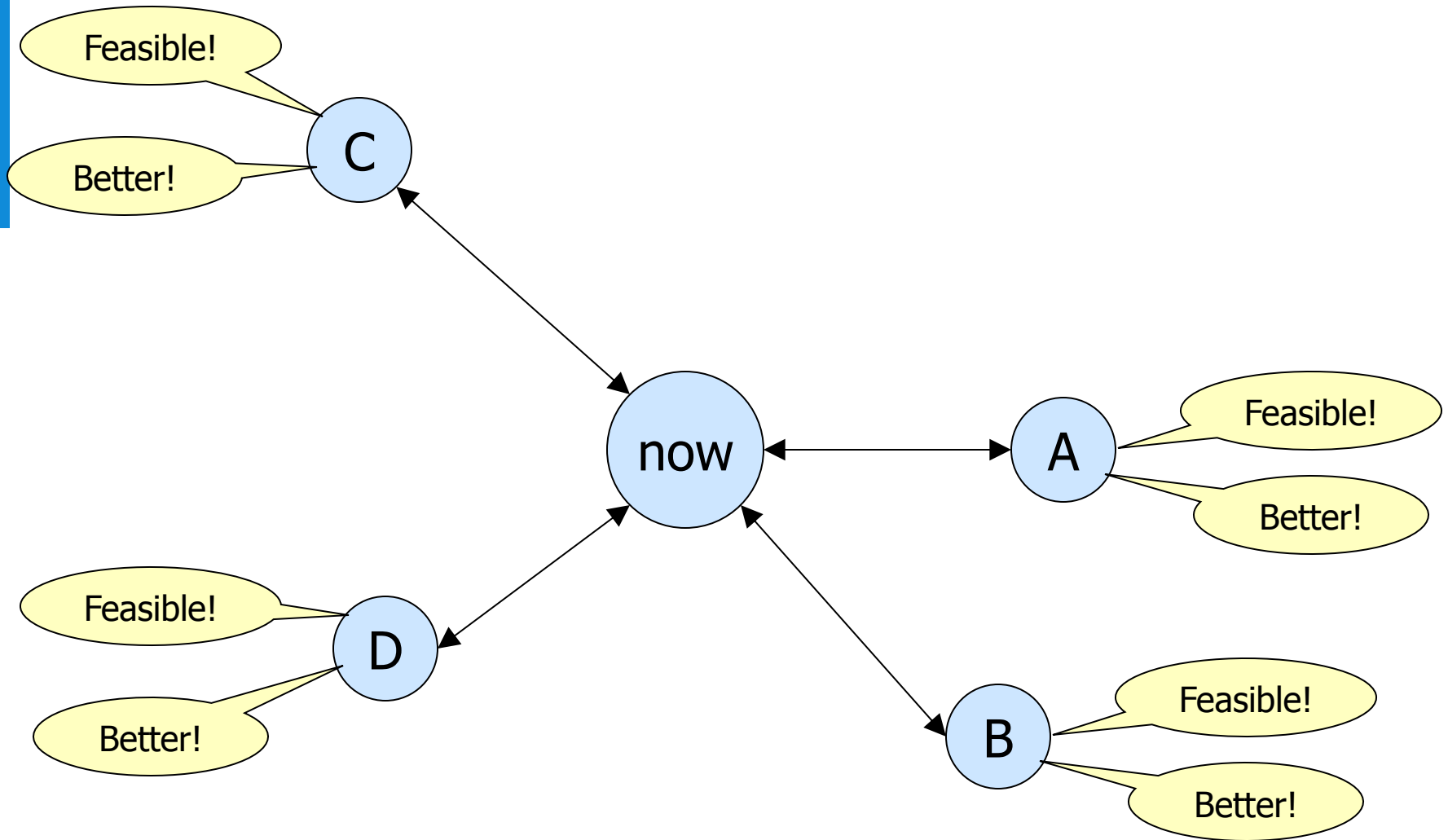


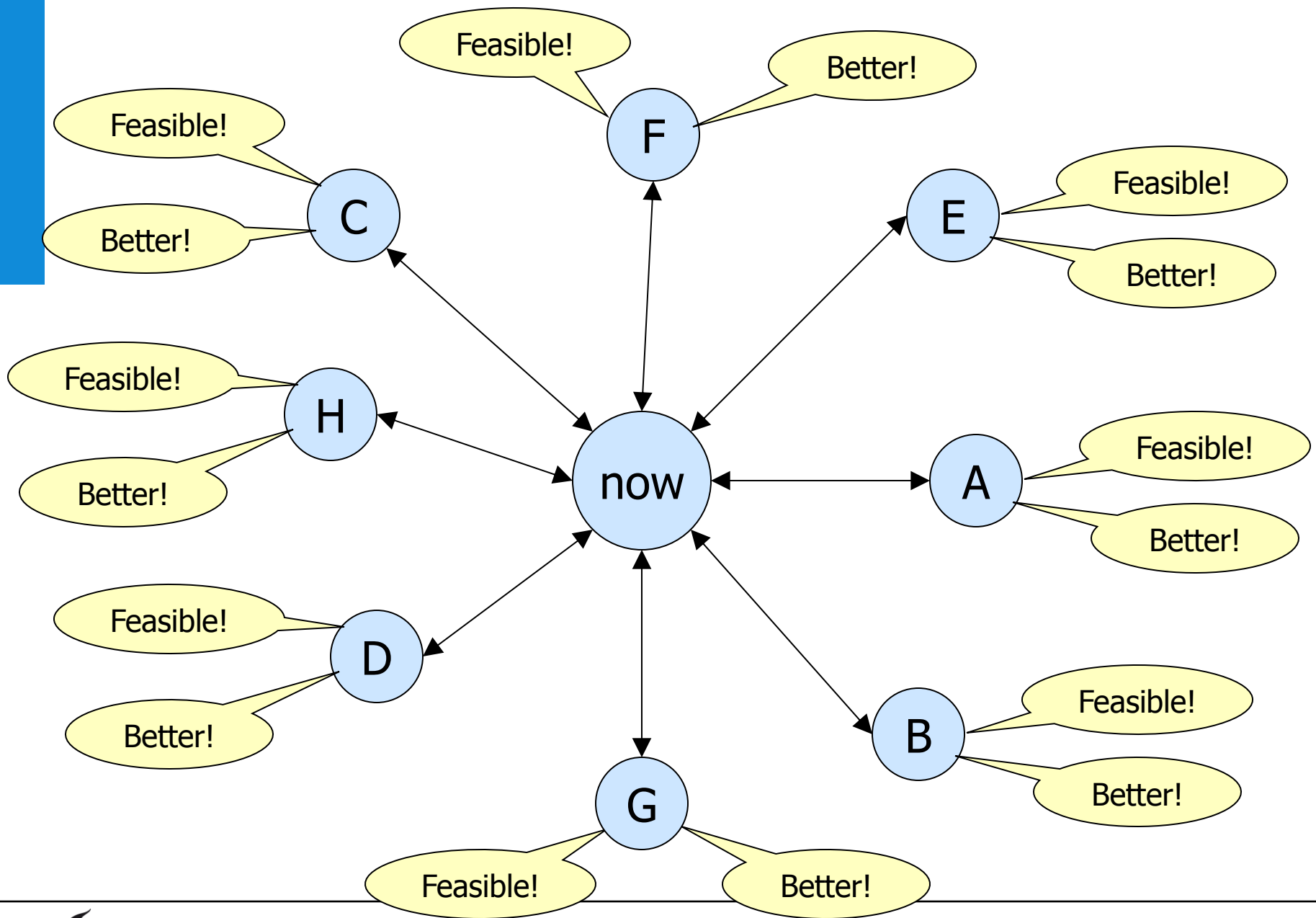
Both en-route concepts worked,
now what.....?



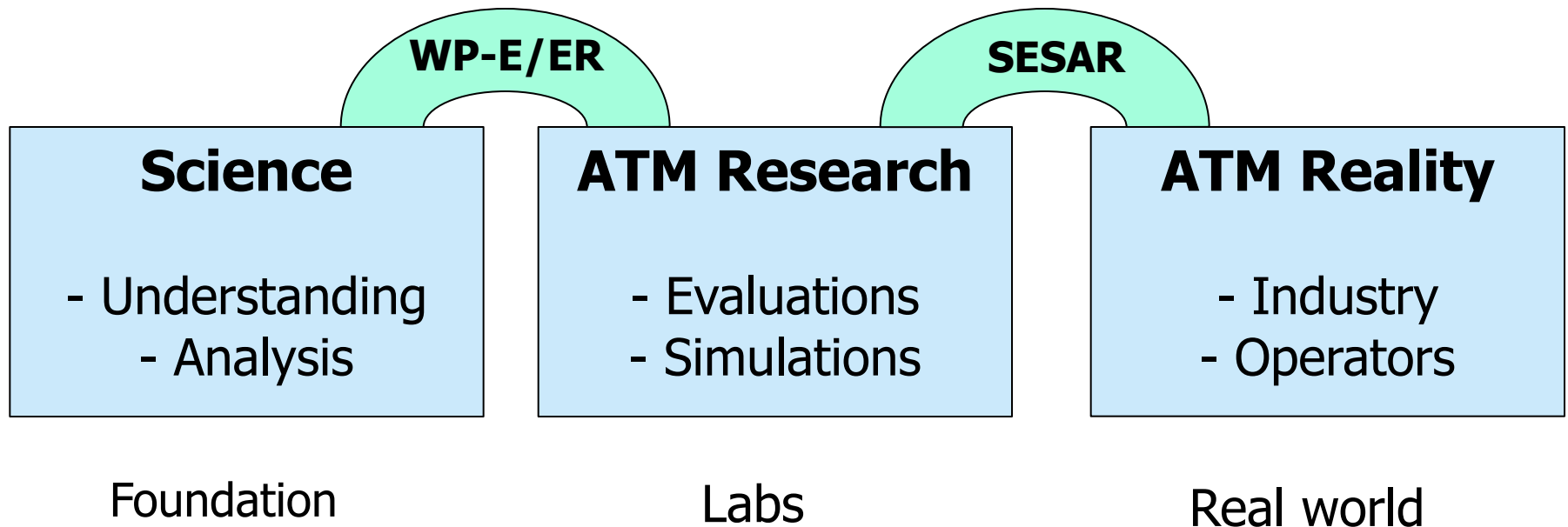








So we simulate a concept and it works, now what?

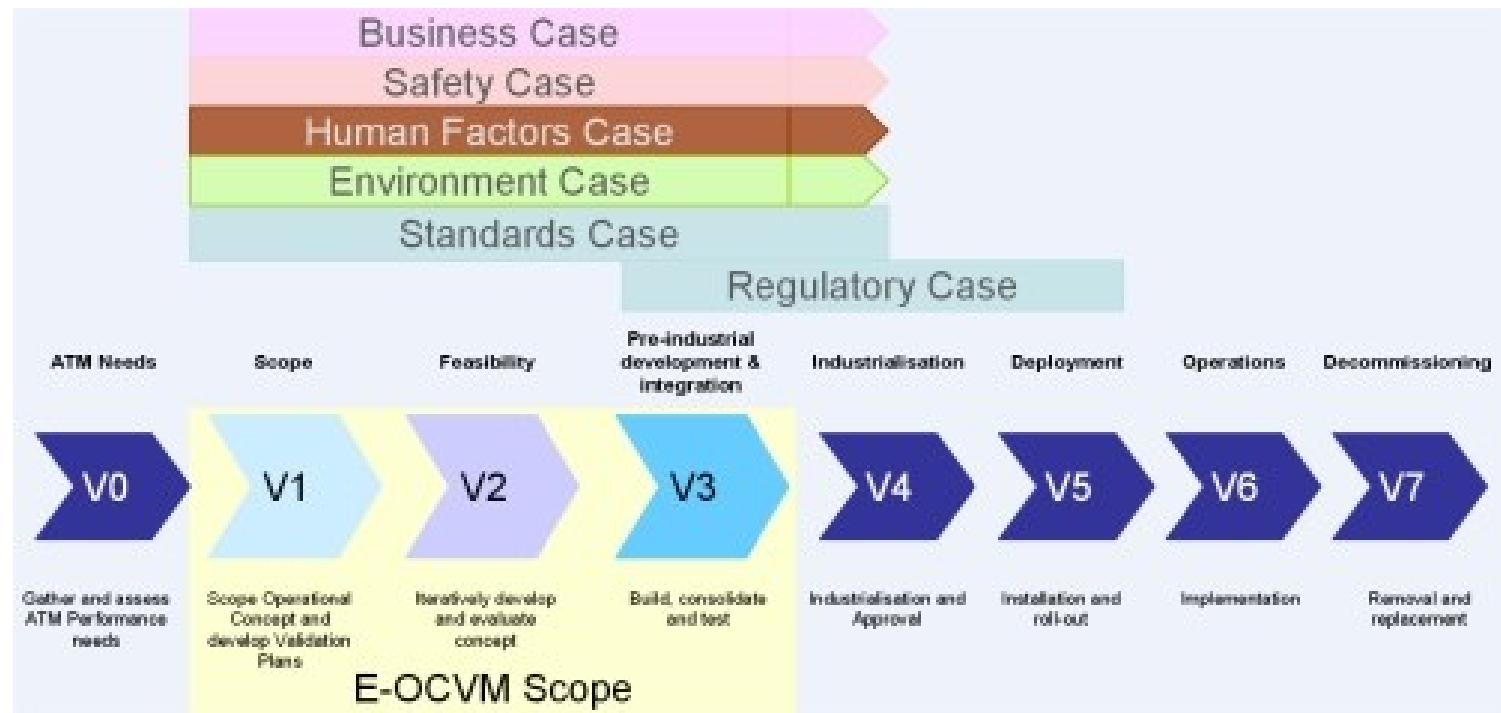


Two elements of a foundation

- Perform Evaluations in a scientific way:
 - Thorough experimental design
 - Testable hypotheses
 - Alternatives, options
 - Repeatable (repeated) experiments:
 - Comparable scenarios
 - Comparable metrics
 - Open research
- Increase our understanding of the ATM system

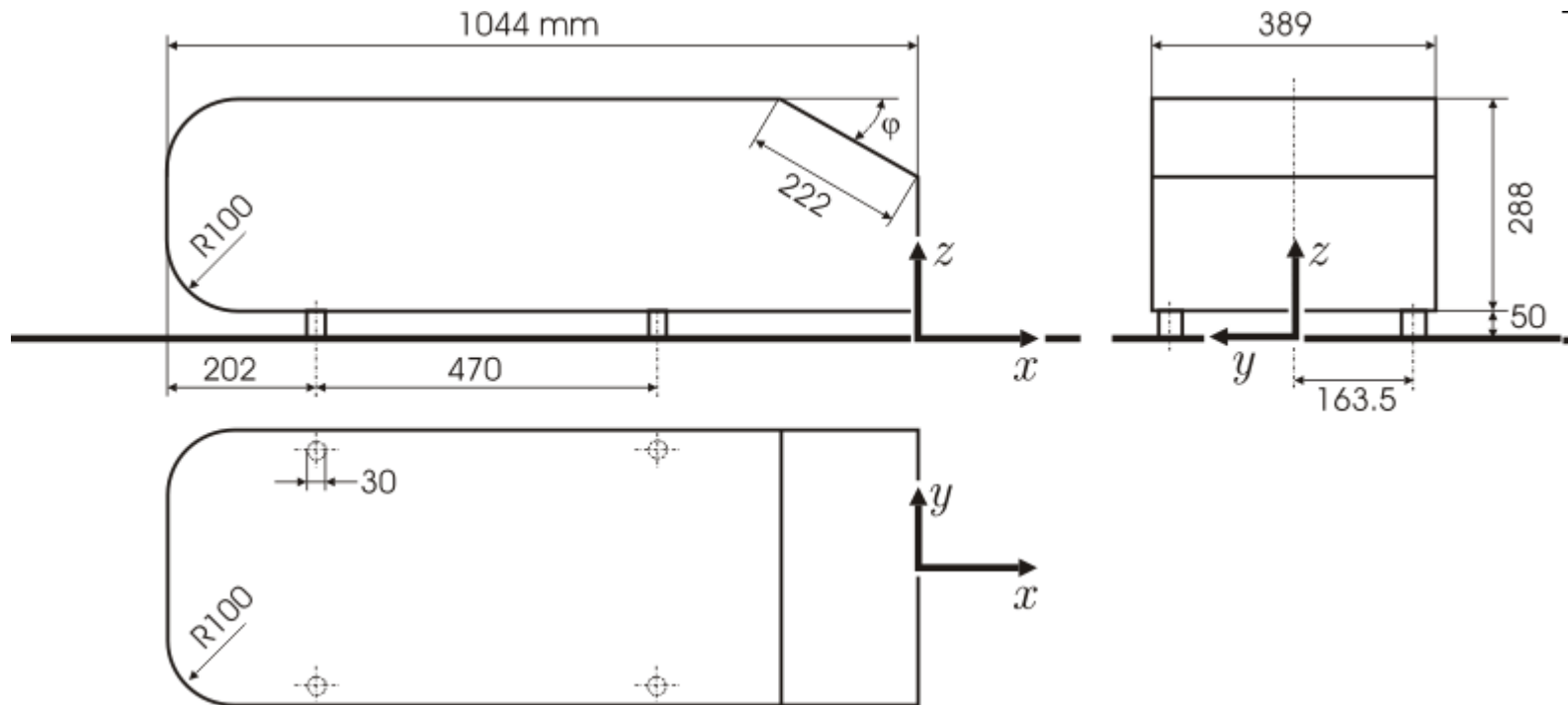
Demonstrations vs Evaluations

- EOVCM



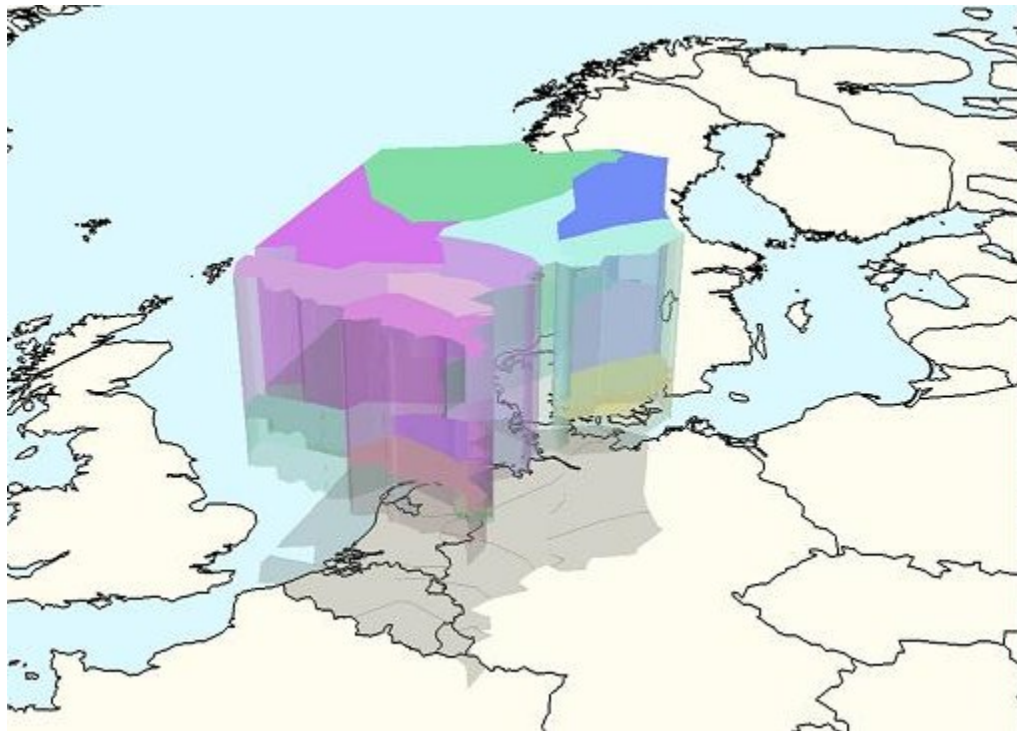
Aerodynamic evaluations: Ahmed reference body

- “Ahmed body” used in wind-tunnel testing of road vehicles



Ahmed body for Air Traffic Management

- “Ahmed body” needed: standard sector, could be imaginary or real day of busy traffic of Europe for which all data is available



“Sector X”

Some days in
Europe in 2020

One enabler: BlueSky Open ATM simulator



One enabler:

BlueSky Open ATM simulator

- **Radical Open ATM Simulator**
- **Public navigation data**
- **Public performance data**
- **Open Source included**
- **Independent of third party software/compiler**
- **Realize via community**
- **Features (batteries included):**
 - Open source language, multi-platform (Windows, Mac OSX, Linux): Python 2.7
 - Open IDE Spyder
 - Public Navigation data
 - Performance models based on public data
 - Downloadable incl. source, data, scenarios
 - Scenarios compatible with AT-One, NASA TMX
 - Metrics, analysis package included
 - Scenarios, both realistic as well as generic, included
- **Launched in 2014**

Traffic flow dynamics:

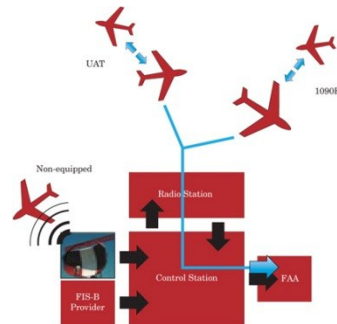


- Uncertainties: Limits of predictability, no speed brakes after a tail wind
- How to systematically investigate inter-actions between different aircraft trajectories ($n=2, \dots, N$)
- Which approach, actor and method for which horizon of trajectory operations/planning?
- Global vs. local optimisation
- Interaction between separation assurance, weather and planning per flight phase

CNS/Signals & Systems: Air-Ground Integration



- Quality of ADS-B surveillance: high-densities, variation in quality
- Using ADS-B as information gathering on weather
- ADS-B IN and safety benefit of increased traffic awareness
- More inter-action with airborne data from FMS

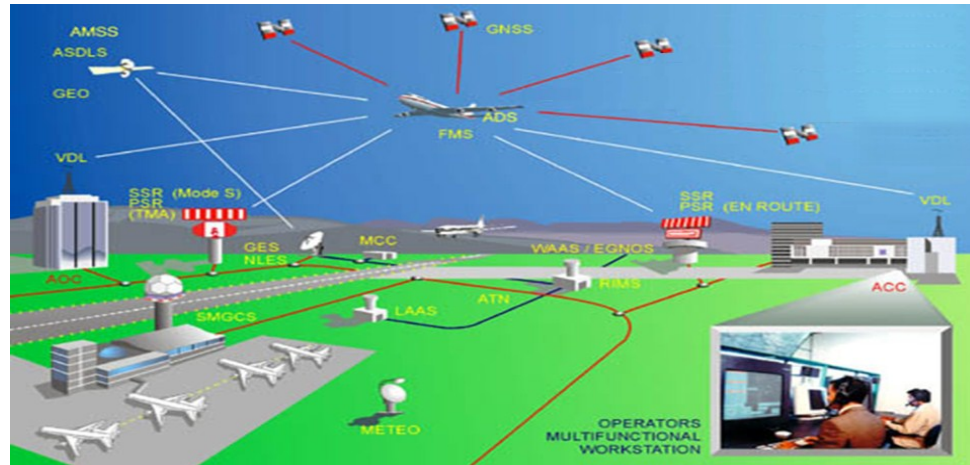


Radical Innovation:

Changes in future ATM context

- Increase in UAVs:
 - Ongoing
 - New operations
 - Automatic/Semi-automatic
 - Unmanned cockpits?
- Increase in GA:
 - Pioneering technology to democratize air travel
 - More energy efficient or energy transitions
 - Can lead to sudden increase in vehicles
 - Unstructured
- Sectors have disappeared/merged into super-sectors





**CNS/Sign & Syst
Info Mgt**



Economics/Legal



Safety Science



Security



**Traffic Flow
Operations rsrch**

Human Factors/ HMI

Meteo / Noise / Emissions

SESAR Work Package E

- Example of real research in SESAR:
 - ComplexWorld
 - HALA
- Managed by Eurocontrol Experimental Center Brétigny:
 - Open calls
 - A-political
 - Quality of proposal rules
- Flagship of SESAR research
- Continued in SESAR-2 in a similar way?



Research in SESAR 2

- Larger (scope) than WP-E
- Open Calls stimulate real innovative research
- A debate of one is no debate, allow an academic debate and challenging of established parties
- Involve younger generation like PhDs across Europe
- Sharing of reproducible results



ASDA: ATM Research Think Tank

ENAC - France

CIRA - Italy

DLR - Germany

ISDEFE - Spain

NLR - Netherlands

ONERA – France

TU Braunschweig _ Germany

TU Darmstadt – Germany

Politecnico di Milano - Italy

SINTEF ICT - Norway

SICTA - Italy

TU Berlin - Germany

TU Dresden - Germany

Univ. Autonoma de Barcelona- Spain

Univ. di Napoli "Parthenope" - Italy

TU Hamburg -Germany

TU Muenchen - Germany

Lisbon University Instituto Superior Tecnico
Portugal

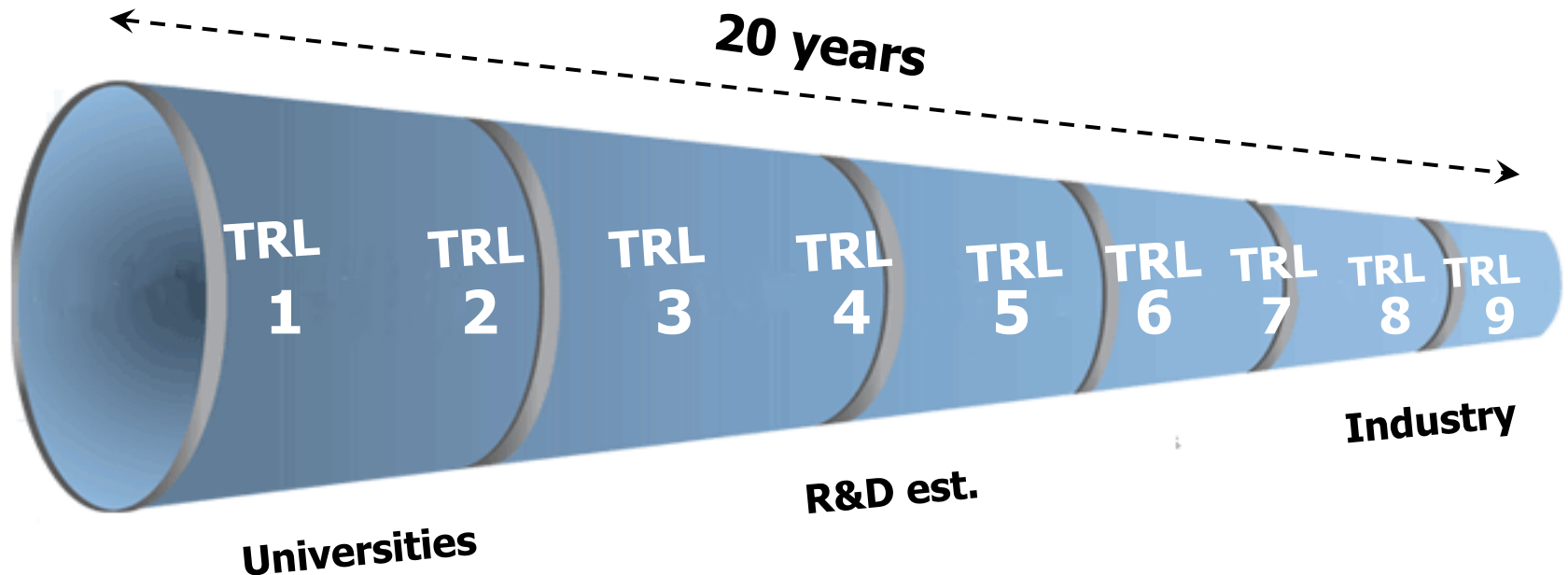
Prof. Castelli, (Univ. of Trieste)

Prof. Hauf, (Univ. of Hannover)

Prof. Attaianese (Univ. Frederico II of Naples)

TU Delft - Netherlands

TRL pipeline is only a part of the story



- It's not a one-way street: new insights should lead to iterations and changes
- Deeper understanding required in all steps up to validation

Change is in the air....



Change is in the air....

.....but it needs a strong foundation



