Follow-the-Greens: The Controllers' Point of View

Results from a SESAR Real Time Simulation with Controllers

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Preface: Taxiing at any major hub airport constitutes a workload intense navigation and monitoring task

- Signage, markings and lighting might not be enough when taxiing on the airport surface.
- This can ultimately result in safety critical situations.
- Negative impact on:
  - Capacity
  - Punctuality (increased delay)
  - Waiting times (congested radio frequencies)
  - Environment (fuel burn)

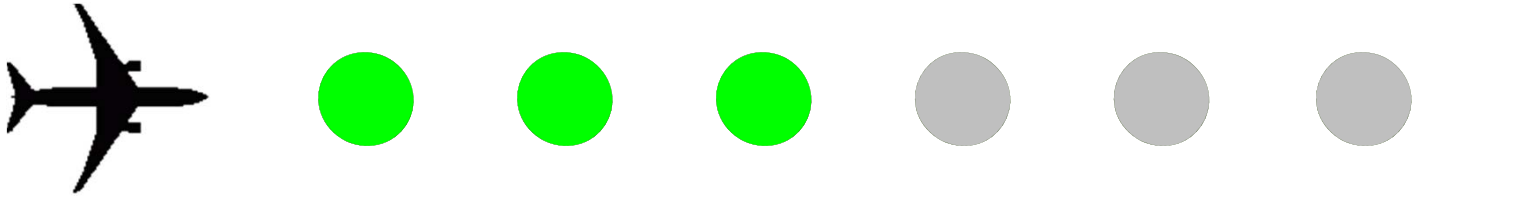
→ **Pilots and air traffic controllers should be supported by concepts which increase their situation awareness.**

Solutions are developed within the European research program SESAR

= Single European Sky Air Traffic Management Research

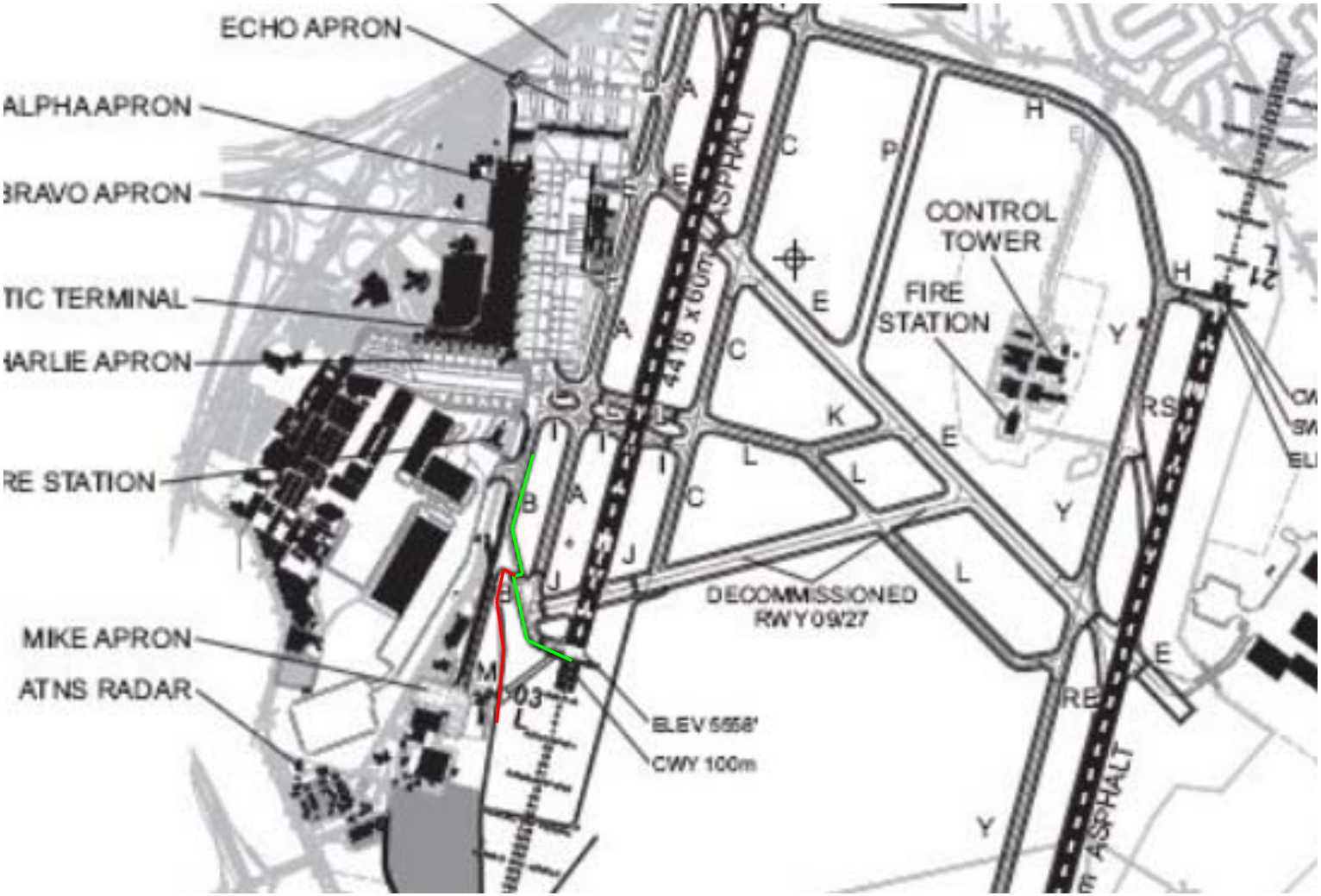
- The European aviation research program!
- Aims at modernizing and harmonizing the European Aviation network
- One of the most ambitious research and development projects ever launched by the European Union

One of SESAR's solutions:



Clarification

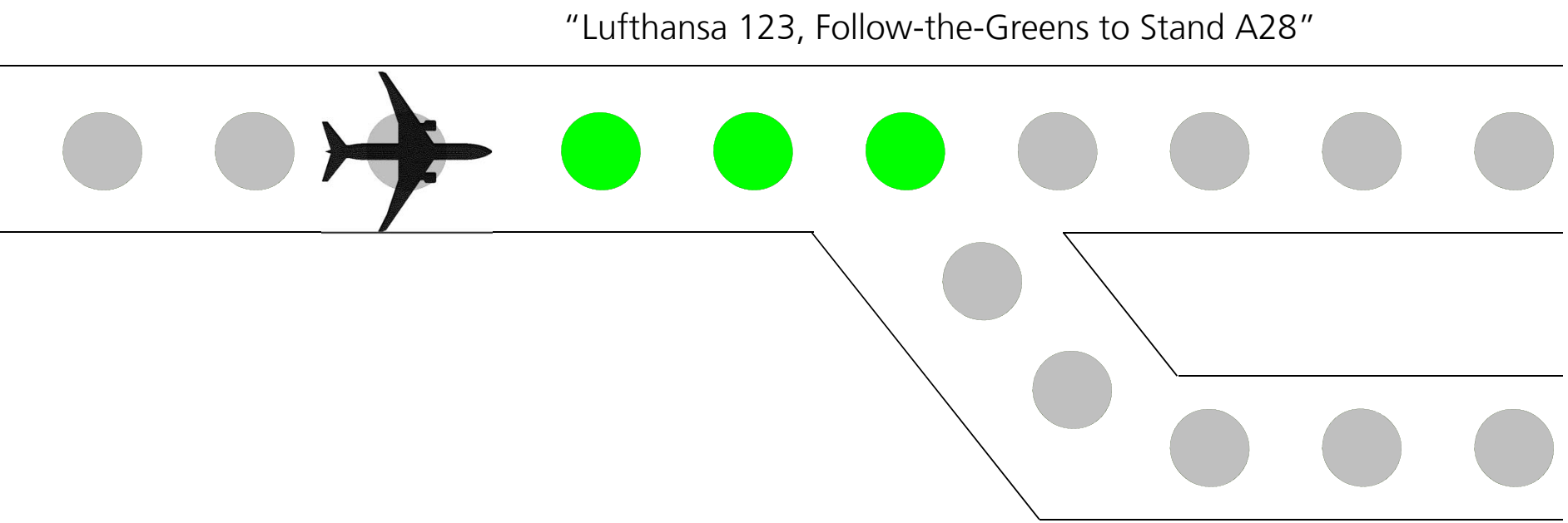
- Concept and prototypes: SESAR programme
- Co-Finance: European Community and EUROCONTROL
- *The results which have arisen of the* **EXE-06.03.01-VP-759 D153 Validation Report** *have been created within the frame of the SESAR programme co-financed by the EU and EUROCONTROL.*
- The sole responsibility of this paper lies with the authors.
- The SJU and its founding members are not responsible for any use that may be made of the information contained herein.


ECHO APRON
ALPHA APRON
BRAVO APRON
TIC TERMINAL
HARLIE APRON
RE STATION
MIKE APRON
ATNS RADAR
CONTROL TOWER
FIRE STATION
DECOMMISSIONED RWY 09/27
ELEV 5558'
CWY 100m
4418 x 60m ASPHALT

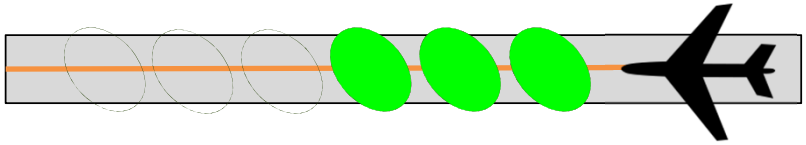
http://avherald.com/h?article=46d6e18c&opt=0

2. Follow-the-Greens: The concept

- Airfield Ground Lighting (AGL) service with the Follow-the-Greens (FtG) procedure.

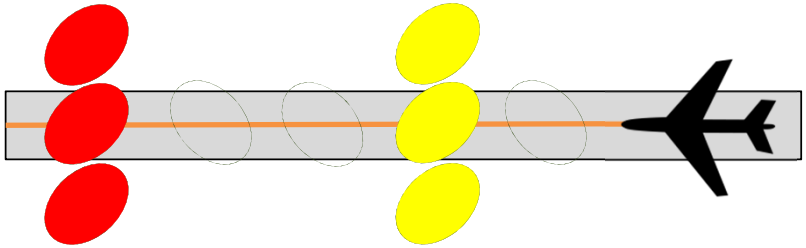


ICAO Doc 9830: Providing visual aid instructions



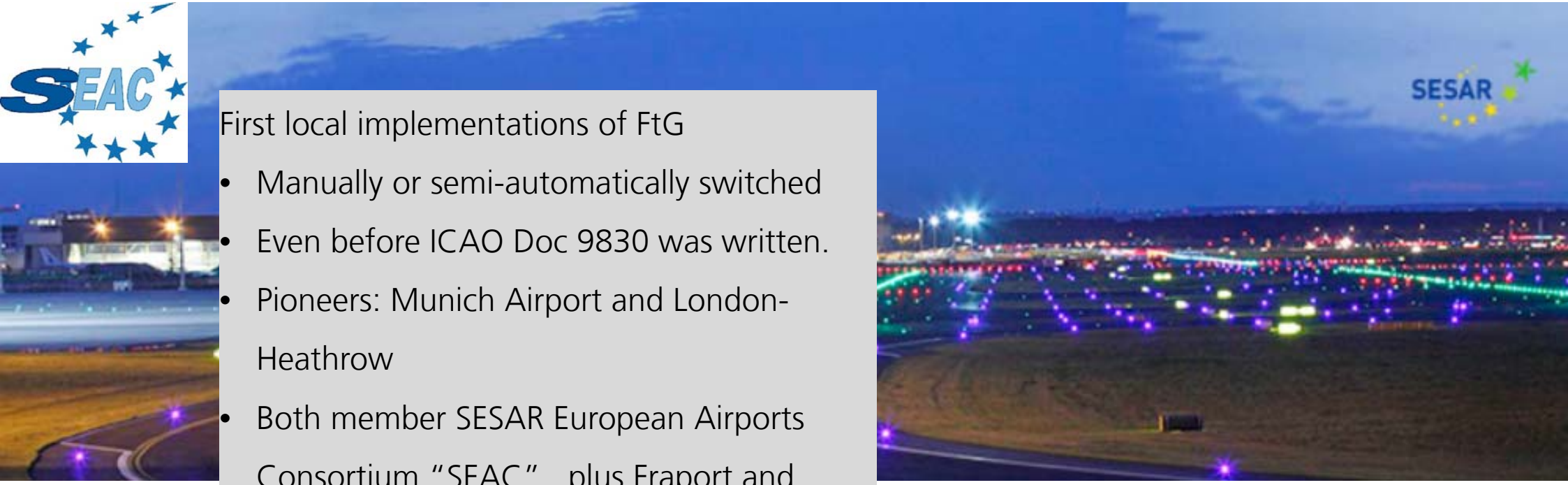
Using taxiway centre line lights:

- **Green lights in front of the mobile** represent the instruction to follow



- **Absence of activated green lights** or the presence of activated red lights indicate the instruction to stop the mobile
- **Yellow or flashing lights** mean caution

Providing visual guidance instructions via AGL



First local implementations of FtG

- Manually or semi-automatically switched
- Even before ICAO Doc 9830 was written.
- Pioneers: Munich Airport and London-Heathrow
- Both member SESAR European Airports Consortium “SEAC” , plus Fraport and many others

2.1 Expected Results

- **Purpose**: To gain reliable figures on the operational feasibility and benefits of the new system in terms of…
- *Operational feasibility*
  - To be validated according to controllers' and pilots' feedback in terms of a complex airport environment as a first step.
- *Operational improvements*
  - Increased **safety**
    - Less route deviations and holding position overruns during taxi procedures with AGL
  - Increased **situation awareness,**
  - Decreased **workload** (i.e. low visibility conditions)
  - Increased **capacity** and reduced **fuel burn and CO_2 emissions**

3. Method

- Validated the new concept under the leadership of Munich Airport GmbH
- 20th - 24th April 2015
- With its partners Fraport AG, DFS Deutsche Flugsicherung GmbH (with DLR acting as sub-contractor), Flugsimulator Frankfurt and ATRiCS.
- Validation process was executed on the basis of the layout and traffic characteristics of Munich Airport

3.1 Participants: ATCOs

Highly experienced Munich Airport controllers

- Several training sessions on the ATRiCS CWP prior to the execution (8 hours total)
- Plus one hour of refresh immediately before the exercise.

3.2 Scenarios

	Pre-SESAR World (Reference)		Follow-the-Greens World (Solution)							
	Reference VMC	Reference LVC	Solution 1	Solution 2	Solution 3	Solution 4	Solution 5	Solution 6	Solution 7 Apron Merge 1	Solution 8 Apron Merge 2
Number of controllers per Apron	2	2	2	2	2	1	1	1	1	1
Weather	VMC	LVC	VMC	LVC	LVC	VMC	LVC	LVC	VMC	LVC
Follow-the-Greens Navigation Support	No	Today's MUC ops	Single Lamp Switching	Smallest available TCL unit	Single Lamp Switching	Single Lamp Switching	Smallest available TCL unit	Single Lamp Switching	Single Lamp Switching	Single Lamp Switching
Spacing Concept	No	Manual Block	No	Auto Block	Floating	No	Auto Block	Floating	No	Floating

3.3 Test Environment

- SASIM-2 Simulator at Frankfurt Airport
  - With configurable traffic and weather conditions (good vs. low visibility)
  - Configured to simulate Apron 2 and Apron 3 of Munich Airport
- SASIM-2 comprises four highly integrated CWPs from ATRiCS, acting as the map-based HMI for a Surface Management System
- The view out of the window onto the aprons was simulated with professional 3D software from ATRiCS (plus traffic simulation software).
- Linked to an Airbus A320 cockpit simulator (provided by Flugsimulator Frankfurt)

3.4 Measurements

- Observations
  - Supported by an observation grid build
- Tailor-made questionnaires
- Standard questionnaires:
  - NASA-TLX and 3D SART
- Data logging aspects like
  - Average and maximum taxi times
  - Taxi speeds
  - Number of stops and re-starts during taxi of all aircraft movements
- Debriefings after a specific number of runs and at the end of the entire validation.

4. Results

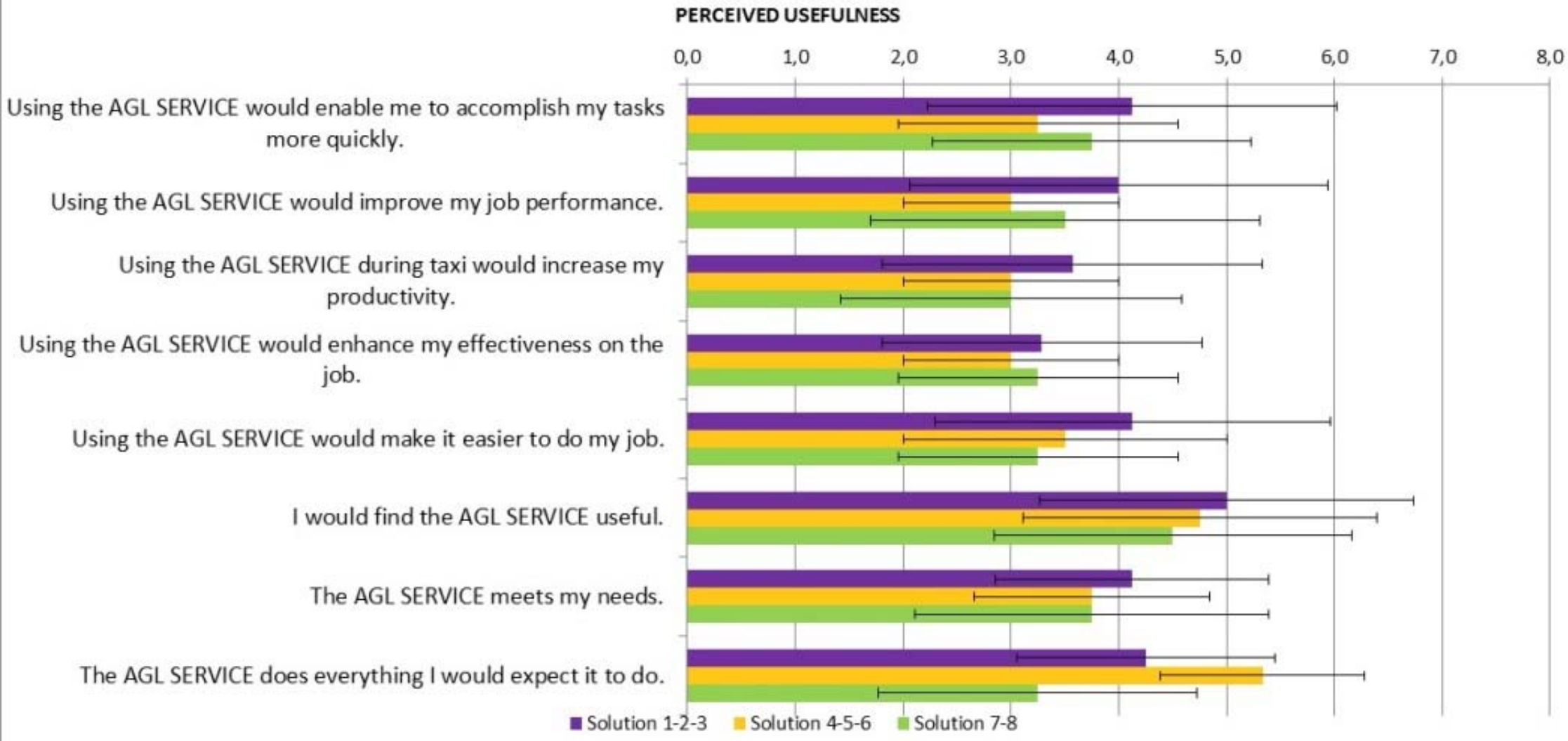
4.1 Controller‘s Perceived Usefulness

4.2 Controller‘s Perceived Safety

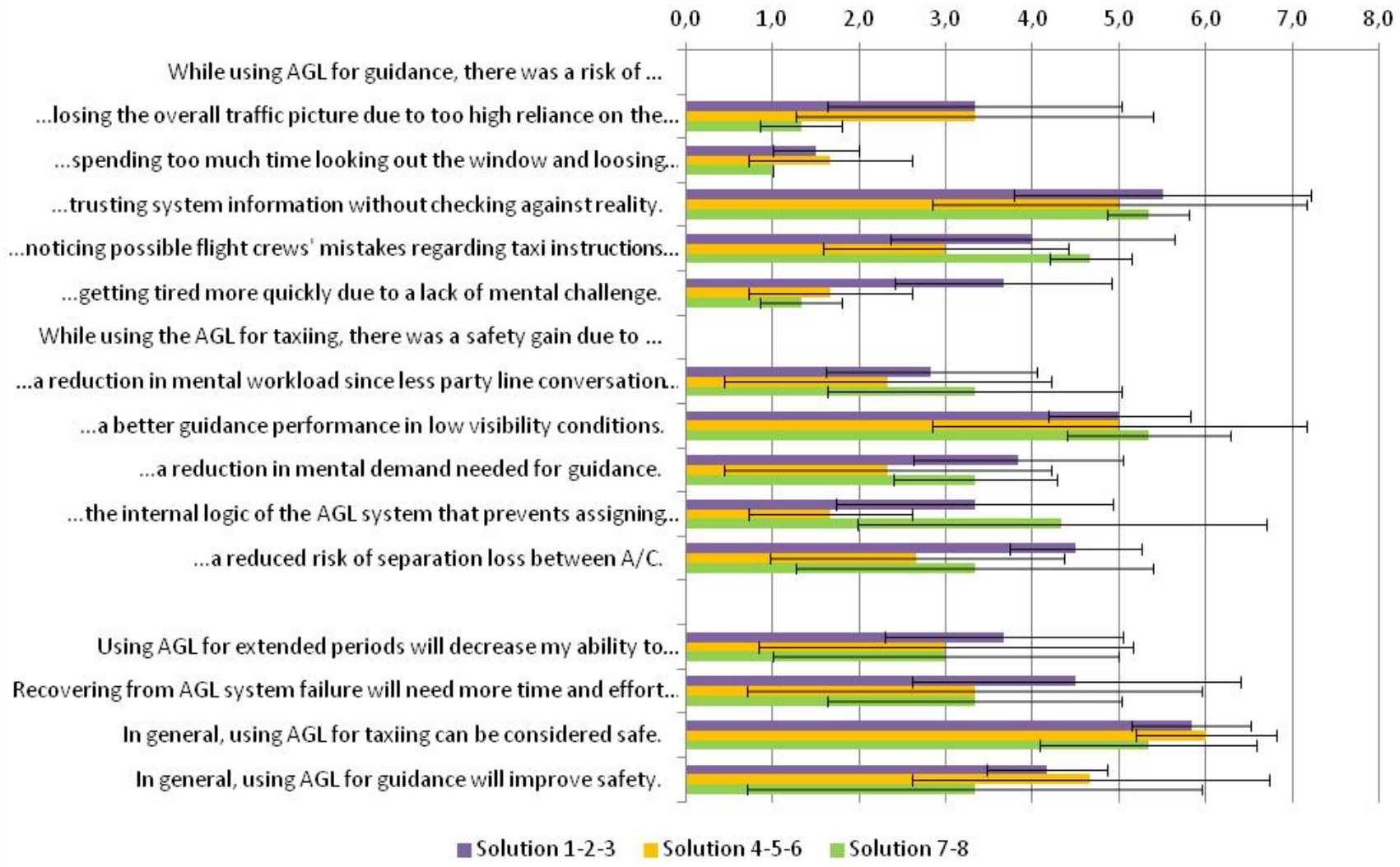
4.3 Operational Improvements in terms of Human Performance: Situation Awareness

4.4 Operational Improvements in terms of Human Performance: Workload

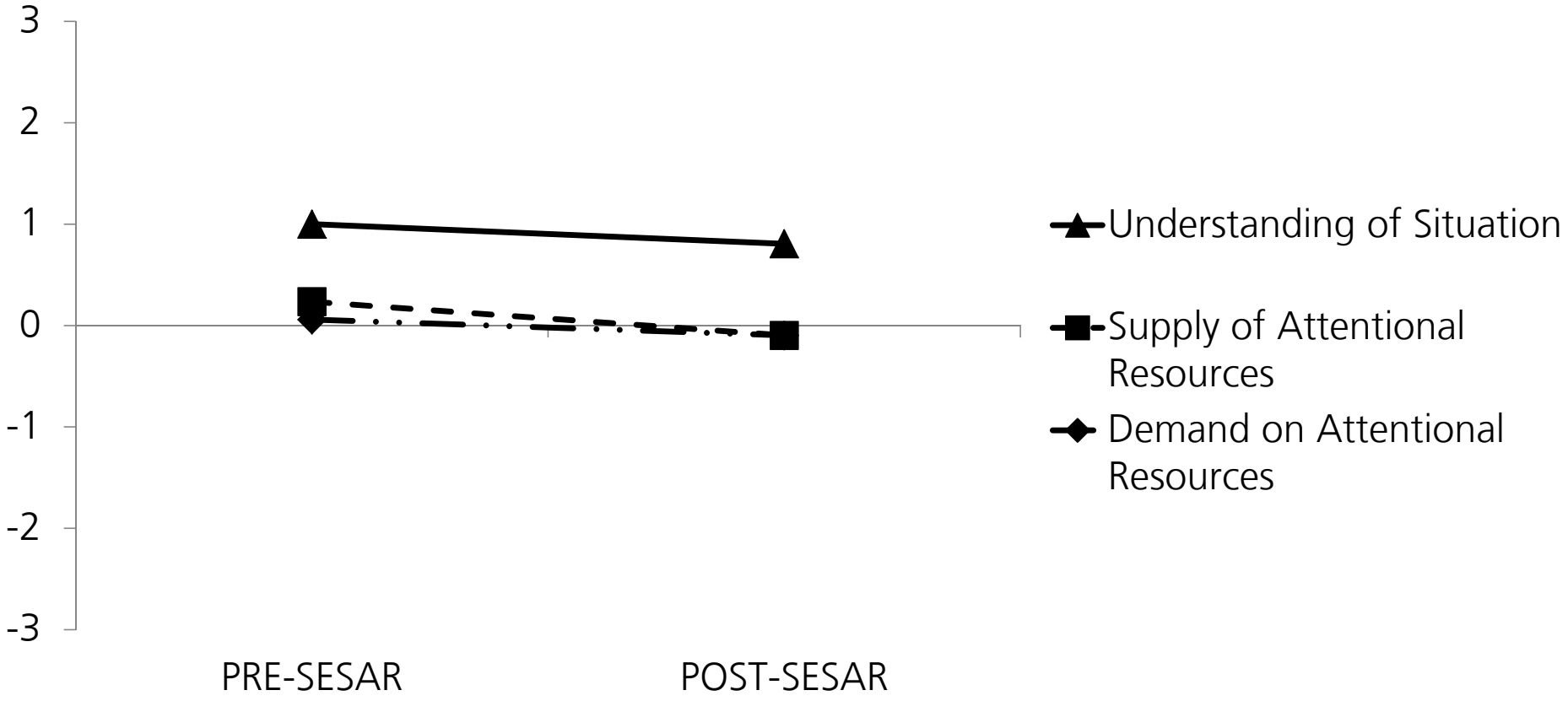
4.1 Controllers' Perceived Usefullness



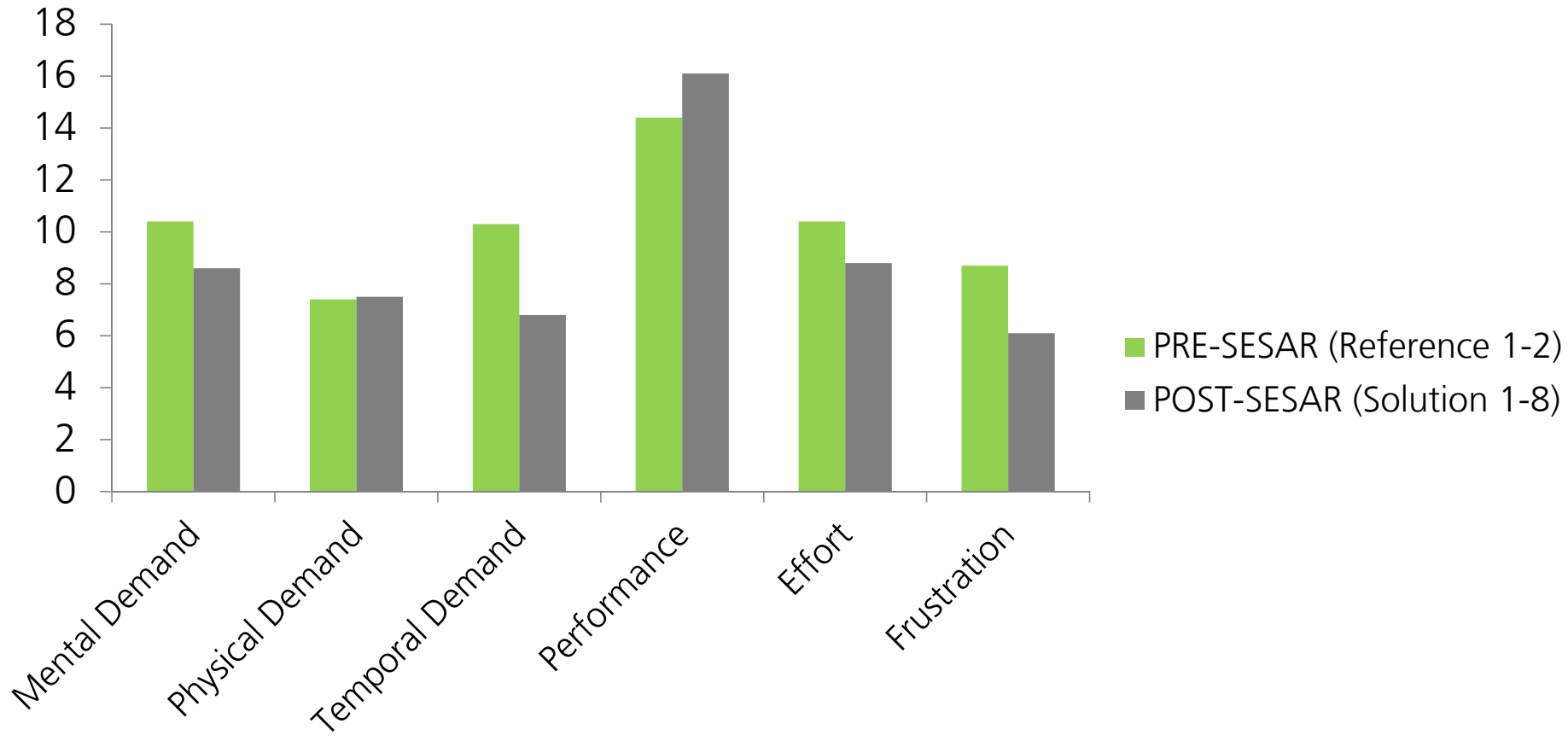
4.2 Controllers' Perceived Safety



4.3 Operational Improvements in Terms of Human Performance: SA



4.4 Operational Improvements in Terms of Human Performance: WL



5 Discussion

- FtG was **successfully validated** on a large, complex and congested hub airport.
- FtG is a **clear improvement** compared to today's procedures from the **controllers' point of view**.
- It was demonstrated that FtG **qualifies for the guidance of future traffic** on complex airports with **very high traffic loads** and also for **very bad visibility** conditions during fog and darkness.

5 Discussion

- The simulation proved **operational feasibility** and demonstrated the scale of the **operational improvements** inherent in the concept.
  - In terms of safety, responses as given by the controllers clearly indicate that FtG will lead to **safer airport operations**.
  - These results are supported by **increased Situation Awareness** and **reduced Workload** of controllers.
  - The validation showed that the **merge of aprons 2 and 3** during off-peak situations **would be possible**.

5.1 Recommendations

- The FtG concept and its system environment have **successfully reached V3 maturity → ready for industrial applications**.
- a significant number of airports are **highly interested in implementing the concept,** because
  - On a European and global scale, an **adequate standardization** covering all aspects from technical requirements and parameters to procedural standards up to issues like the phraseology is **still missing**.
  - The **lack of standardization** is currently seen as a **major roadblock** in Europe and an advantage in competition for other regions of the world.
  - To put **additional pressure** on the initiatives aiming at developing of standards for "Follow-the-Greens" such as the EUROCONTROL A-SMGCS Task Force.

5.2 Outlook

- Further research activities should **focus on special operational procedures**
  - E. g. in case a part of a taxiway (temporarily) cannot be equipped with centerline lights.

  → In this case the wording “Follow-the-Greens to xyz” seems inappropriate.
- Clarify the latest possible point in time for a route change in front of a mobile.

5.2 Outlook

- The **visualization of warnings and alerts** via AGL should be elaborated as well as instructions to not pass traffic on parallel taxiways in case of wingspan restrictions.
- How to hand over the traffic during shift changes?
  - Nowadays, the **decisions and guidance instructions** given by the previous controllers **can be reproduced** by the use of the pre-SESAR technologies. Using the FtG procedures, it might be **impossible to reproduce the instructions** given by the previous controllers.

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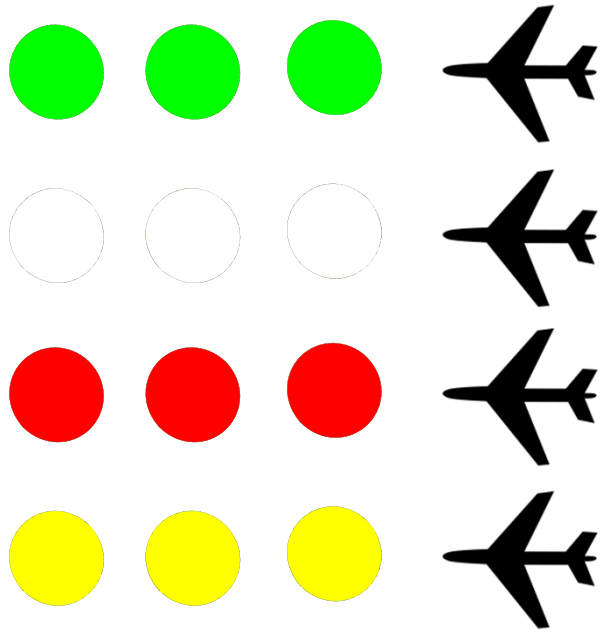
Clarification:
DLR performed this task as a fully paid sub-contractor for the German Air Navigation Service Provider DFS in the context of SESAR.

Back-up

ICAO Doc 9830: Providing visual aid instructions



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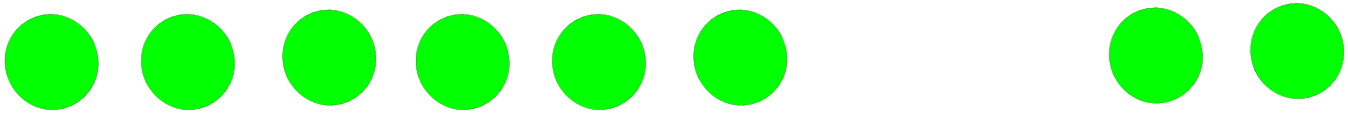
- **Yellow or flashing lights**
  - Mean caution

Providing visual guidance instructions via Airfield Ground Lighting

- NOT depending on on-board installations!
  - guidance via AGL is a purely ground based service
  - does not require investments on the airspace user side.

- Automated (!) guidance via AGL has the following features at the current stage in SESAR:
  - Taxiway centreline lights are switched in **segments of lights** each containing a minimum of two and a maximum of six lights.



  - entirely on or off
  - as short as possible close to intersections, turns, or slopes in order to make the visual indication for the flight crew as precise as possible.