

Impact of improved maintenance the CleanSky II projects AIRMES and DEMETER

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DLR

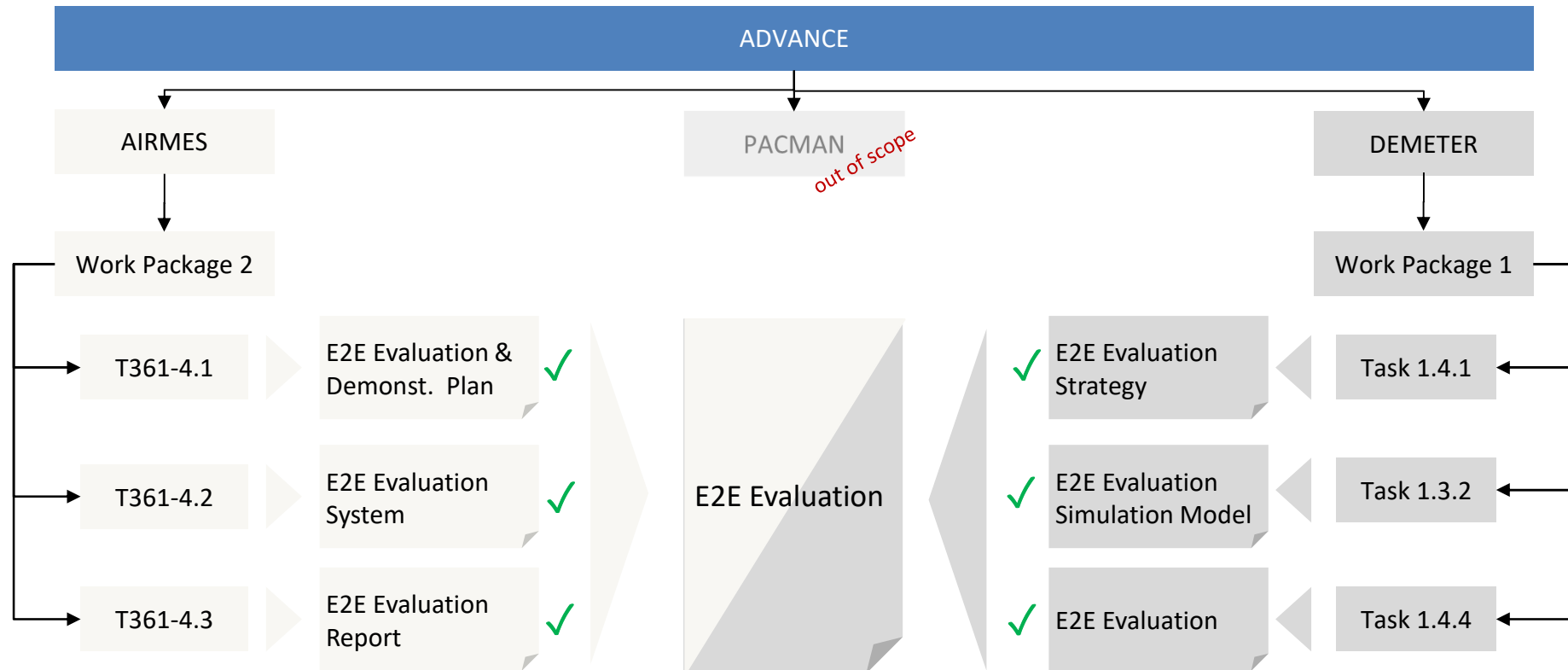
ICCBMA 2022, May 24, 2022



Agenda

1. Collaboration AIRMES & DEMETER
2. E2E Evaluation System
3. AIRTOBS
4. Tool Set-up
5. Single Technology Results
6. Consolidated Results
7. Qualitative Results
8. Discussion and Q&A

Collaboration AIRMES & DEMETER



✓ Finalized

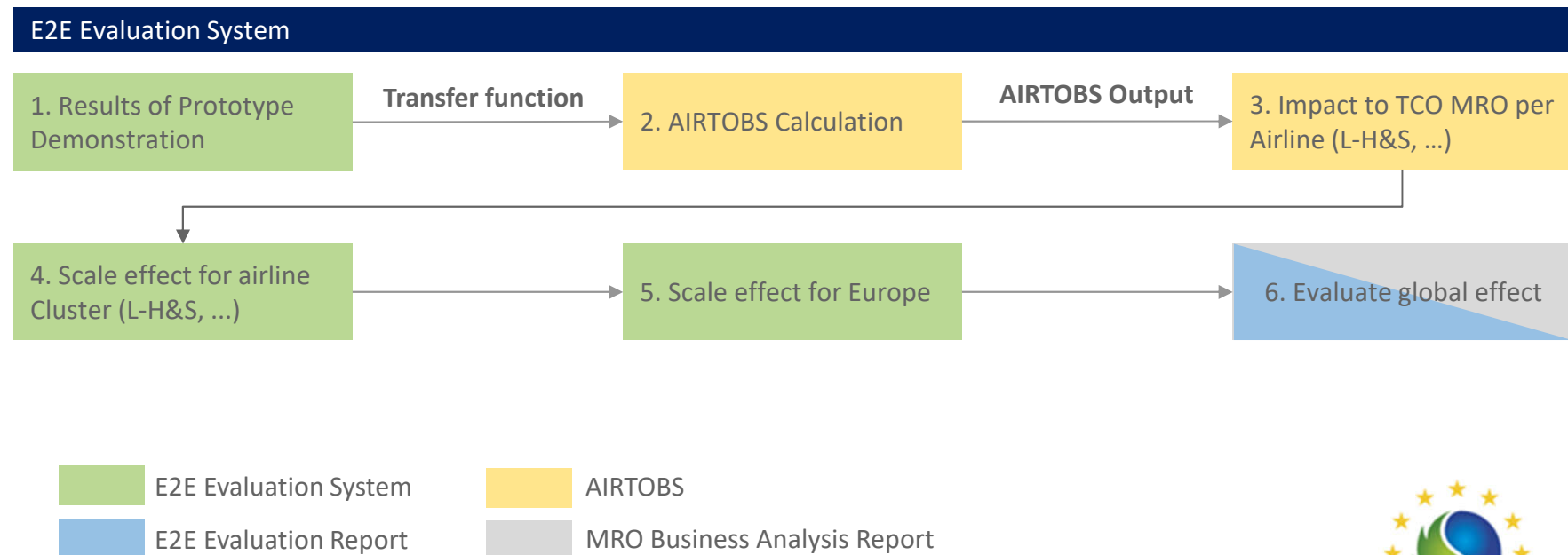
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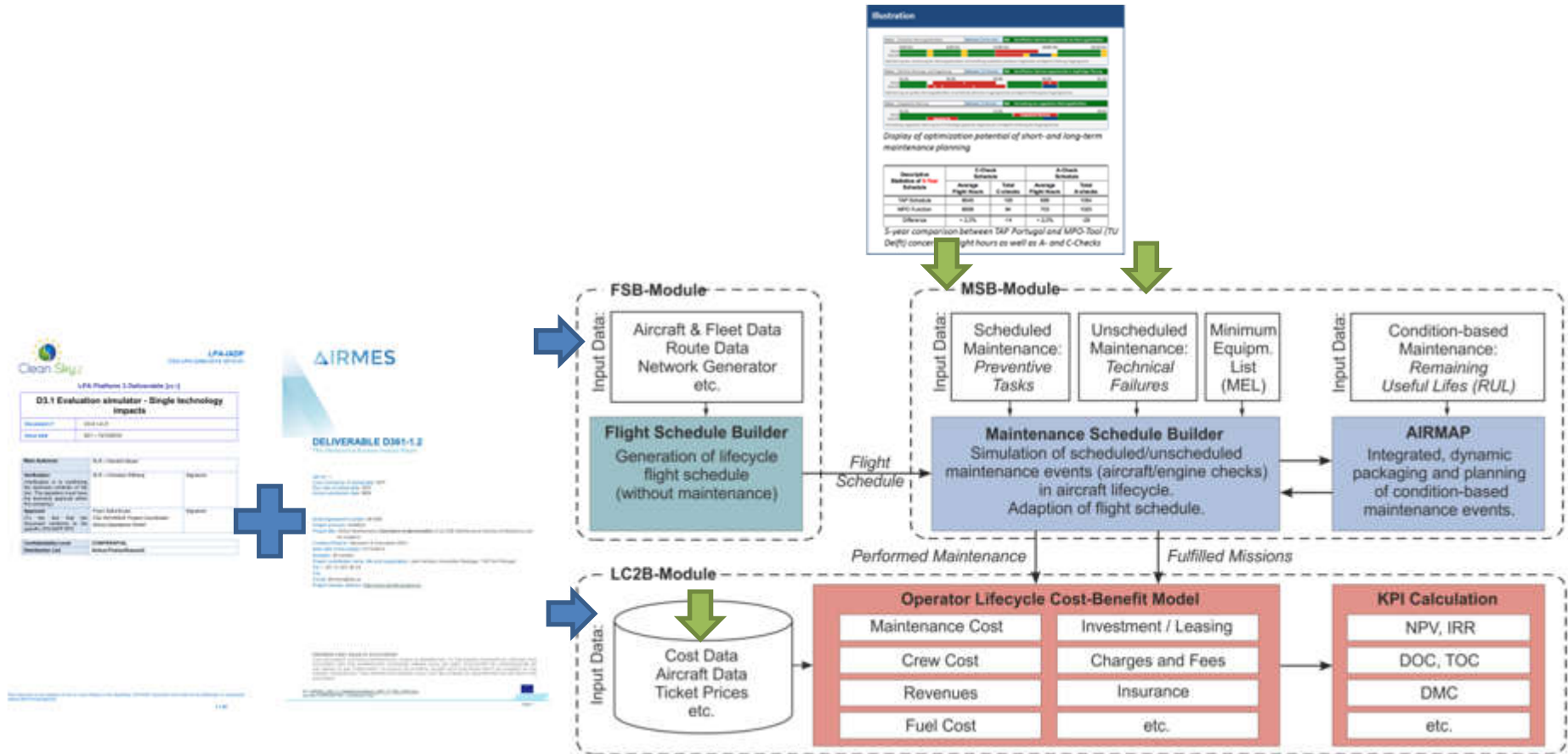
E2E Evaluation System

- To measure the input and influence of each SOA-Technology and to assess the impact on the MRO Value Chain it is necessary to develop and define an E2E Evaluation System
- The objective of this E2E Evaluation System is to quantify demonstration results and extrapolate the value chain impact



AirTobs

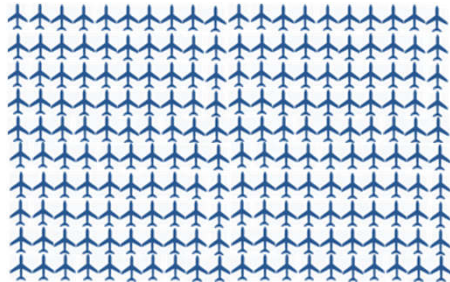
SOA Technology



Airline Cluster

Large Hub & Spoke

Fleet Size: 200 A/C



Legs/day per A/C



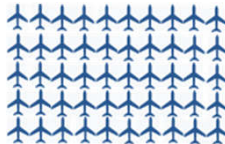
Legs/haul length



Average fleet age: 11,3 yrs

Small Hub & Spoke

Fleet Size: 50 A/C



Legs/day per A/C



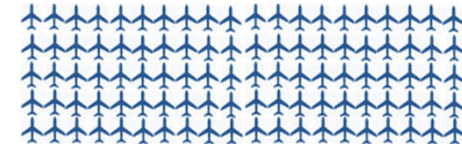
Legs/haul length



Average fleet age: 12,4 yrs

Point to Point

Fleet Size: 104 A/C



Legs/day per A/C



Legs/haul length



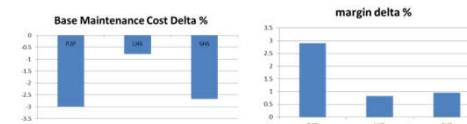
Average fleet age: 8,9 yrs

Cost Calculation

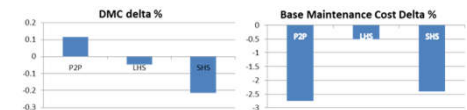
Build up of three generic Flight schedules

For each Cluster one reference Maintenance schedule

Building of KPI for one reference year



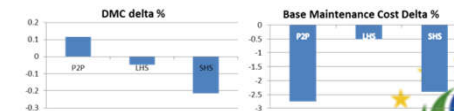
SOA Technology 1



SOA Technology 2

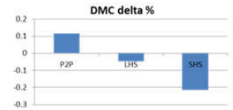


SOA Technology N

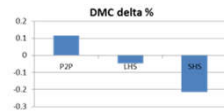


Consolidated Results

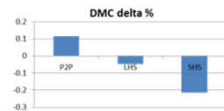
SOA Technology 1



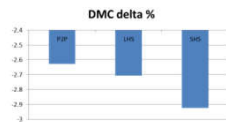
SOA Technology 2



SOA Technology N

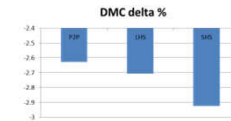


Consolidated Results



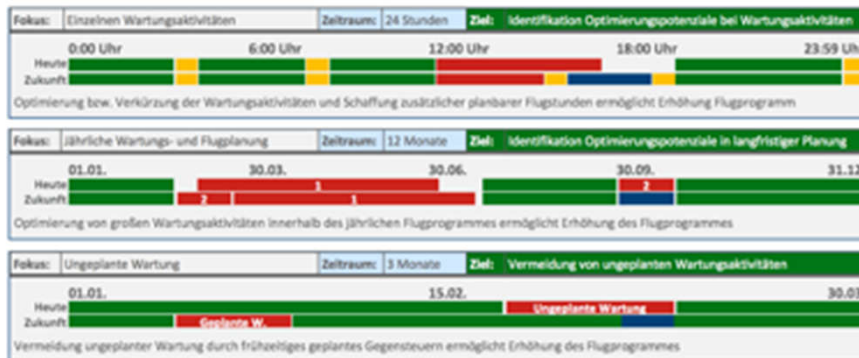
Reference

Consolidated Simulation



MPO intro & prototype demo results

Illustration



Display of optimization potential of short- and long-term maintenance planning

| Descriptive Statistics of 5-Year Schedule | C-Check Schedule | | A-Check Schedule | |
|---|----------------------|----------------|----------------------|----------------|
| | Average Flight Hours | Total C-checks | Average Flight Hours | Total A-checks |
| TAP Schedule | 6645 | 108 | 689 | 1054 |
| MPO Function | 6808 | 94 | 703 | 1025 |
| Difference | + 2,5% | -14 | + 2,0% | -29 |

5-year comparison between TAP Portugal and MPO-Tool (TU Delft) concerning flight hours as well as A- and C-Checks

Project partners and description



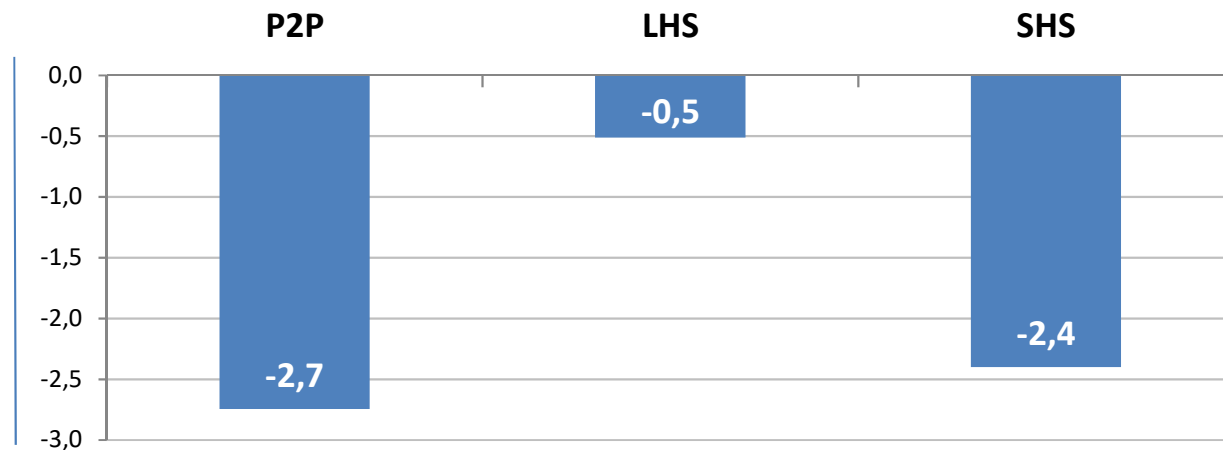
- **Technical Readiness Level (TRL): 6**
- Increase of airplane usage through more efficient short-, mid- and long-term maintenance planning
- Combination of new technologies (in particular short- and mid-term planning) as well as prognostics and data analytics (in particular long-term planning) to optimize the integrated planning chain
- Assignment: Increased utilization of aircraft fleet and maintenance resources (hangar, manpower, tools)
- First prototypes showing a reduction by 14 C-Checks within five years for medium sized European airlines

Results¹ for MPO per airline cluster

Cost saving potential base maintenance/year in % (MPO tool)

Assumptions:

- The results from the MPO tool are valid for each airline cluster
- The available aircraft performs additional flights
- The age of the fleet of the airline is equally distributed with the average given by the analysis



- **Significant potential for decrease of base maintenance cost by using the MPO tool**
- MPO tool **developed especially for SHS carriers.**
- **Higher aircraft utilization leads to increasing revenue**, especially for P2P carriers
- Aircraft utilization and fleet age are additional factors for good results at SHS and P2P airlines

¹ The shown results are potentials per year that need to be exploited.



Overview SOA-technologies & TRLs

Considered in quantitative consolidated E2E evaluation

TRL 6

Maintenance Planning Optimization

Increase of airplane usage through more efficient short-, mid- and long-term maintenance planning.

TRL 4

Prognostic

Reduce unscheduled maintenance by estimating the proportion of part replacements that could be planned on short-term rather than unscheduled

TRL 6

Mobile Tools

- Configuration Capturing
- Contextualized documentation
- Dispatch Assessment
- Defects Reporting
- Virtual Reality
- Maintenance Elapse Time Control

TRL 4

Structural Health Monitoring

Reduction of weight of the aircraft structure through changed certification for damage tolerance.

Not considered in quantitative consolidated E2E evaluation

Enabler

- Collaborative Environment
- Knowledge Database
- Workspace
- Software Infrastructure for Communication
- Integrated Health Monitoring and Management

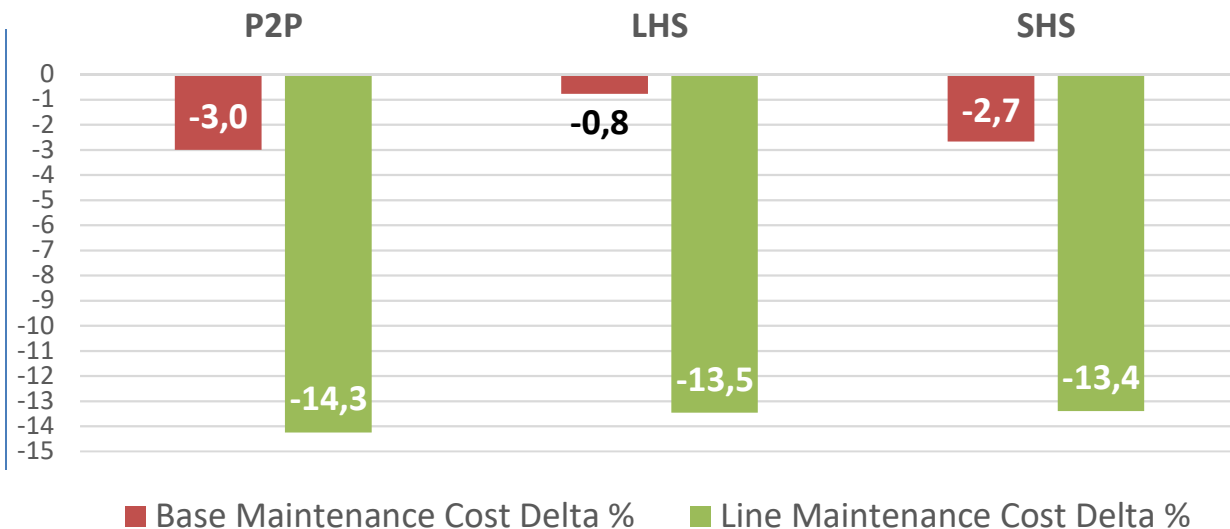
Consolidated E2E Evaluation results¹

Cost saving potential/year in maintenance in % (Consolidated E2E results)

Consolidated results for

- MPO Tool
- Mobile Tools
- Prognostics
- Structural Health Monitoring

considering all inter-dependencies between the tools



- **Line Maintenance savings due to usage of mobile tools.** Significant time savings are possible by speeding up the process of getting information and the decision process as well as a reduction of human errors.
- **Base Maintenance: Savings from Structural Health Monitoring tool (SUMPF).** Eliminates maintenance tasks and therefore man hours

¹The shown results are potentials per year that need to be exploited.

Qualitative results



- Approx. 7,5t paper saved per aircraft life span due to increased usage of mobile tools
- Savings¹ per year on European level:
 - 13,2 M – 44.2 M litres of water
 - 1,77 M. -4,42 M kWh electricity
 - 1.947 tons of wood



- Reduction of aircraft weight due to thinner aircraft structure (SHM-technology) leads to less fuel consumption
- Less maintenance events leads to less ferry flights



- MRO providers and aircraft manufacturers increase their importance as data providers
- Collected data to influence the future design process of aircraft and parts (IHMM platform)



- Mobile tools make daily work of MRO mechanics easier and increase their motivation.
- Reduction of human errors and makes daily work easier.

¹ Source: Own calculation based on data of the German federal environmental agency



Discussions and questions



Contacts and acknowledgements



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Thank You!