EURONONTROL Agency Research Team
Workshop “Validation/Measuring ATM Performance”

Validation Chain for ATM Concepts

Michael Roeder, May 2015, Bretigny
Validation chain for ATM Concepts (example A-SMGCS projects)

1st) Challenge / problem identification

2nd) Opportunities / Solutions

3rd) Concept definition

4th) Implementation

5th) Verification / Validation
1st) Challenge / Problem Identification

Before introducing of A-SMGCS the controllers and pilots got neither support under low visibility conditions nor in planning and guidance to increase safety and airport throughput.
2nd) Opportunities / Solutions

Airport operations:
- ground bottle-neck
- weather dependant

Problem solution:
Advanced Surface Movement Guidance and Control System
(A-SMGCS)
3rd) Formal Requirement for the Concept Definition

“An Advanced Surface Movement Guidance and Control System (A-SMGCS) is expected to provide adequate capacity and safety in relation to the specific weather conditions, traffic density and aerodrome layout by use of modern technologies and a high level of integration between the various functionality.”

4th) Concept Implementation

- A-SMGCS
- Surveillance
- Control
- Routing / Planning
- Guidance

Obstacles

Ground Movement Controller

Aircraft Vehicles

Information Management

ATC Systems
Airport Systems
Airline Systems

External Systems
Services & Functions implemented in EMMA

- Surveillance
  - Traffic Situation + Electronic Flight Strips
  - Non-Cooperative Sensors: SMR, Target Extractor, Other non-coop. Sensors
  - Cooperative Sensors: ASR, RDPS, Mode-S Multilateration, other coop. Sensors (e.g. ADS-B)

- Conflict Prediction, Detection, and Alerting
  - FDPS, MET, STAND

- Planning
  - D-/A-/S-MAN

- TAXI-CPDLC
- VDL2 Ground Radio
- VDL2 Ground Station
- TAXI-CPDLC (ATN)
- Mode A/C/S SSR ADS-B 1090ES

EMM, GTD TCD, SMA, HUD

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A-SMGCS Level I&II

Monitoring & Alerting

Surveillance

Apron & Tower Simulator, DLR FL

Cockpit Simulator, DLR FL

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5th) Iterative Approach

Definition of Operational Concept

Proof of Principles & Training

Operational Trials

Evaluation against the Concept

Review of existing Concepts

Equipment Development & Integration

Preparation of Infrastructure

Two Cycle Approach to ensure that all Partners work on the same Objectives and to improve the System by Lessons learned from the first cycle.
What is Validation

Yes, it certainly works technically – you may have built the system right, but it’s not the right system for me

Technical feasible?

Users’ requirements fulfilled?

... is the new concept acceptable?

Where are the benefits?

... less workload?

... more throughput?
E-OCVM

EUROPEAN Operational Concept Validation Methodology (OCVM, ...)

“Establishing fitness-for-purpose”

“The process by which the fitness-for-purpose of a new system or operational concept being developed is established”
# Validation Test Plan (EMMA example)

<table>
<thead>
<tr>
<th>Step</th>
<th>Activity</th>
<th>Description</th>
<th>2-D6.1.1a &amp; b sections</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1 “Set Validation Strategy”</strong></td>
<td>1.1</td>
<td>Identify stakeholders, their needs, and involvement</td>
<td>Section 5.1, 2-D6.1.1a</td>
</tr>
<tr>
<td></td>
<td>1.2</td>
<td>Identify the existing information, including current and target levels of maturity</td>
<td>Section 5.2, 2-D6.1.1a</td>
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<td></td>
<td>1.3</td>
<td>Describe validation expectations and outline cases – outcomes, products, what will success look like</td>
<td>Section 5.3, 2-D6.1.1a</td>
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<td></td>
<td>1.4</td>
<td>Identify programme validation objectives in key performance areas</td>
<td>Section 5.4, 2-D6.1.1a</td>
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<tr>
<td></td>
<td>1.5</td>
<td>Establish initial validation requirements, and draft validation strategy</td>
<td>Section 5.5, 2-D6.1.1a</td>
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<tr>
<td></td>
<td>1.6</td>
<td>Select validation tools or techniques</td>
<td>Section 5.5, 2-D6.1.1a</td>
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<tr>
<td></td>
<td>1.7</td>
<td>Define validation strategy</td>
<td>Section 5.6, 2-D6.1.1a</td>
</tr>
<tr>
<td><strong>Step 2 “Determine the Experimental Needs”</strong></td>
<td>2.1</td>
<td>Identify stakeholders’ acceptance criteria and performance requirements</td>
<td>Guidance for specific validation test plans in: Section 3.1, 2-D6.1.1b</td>
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<tr>
<td></td>
<td>2.2</td>
<td>Identify project and exercise validation objectives</td>
<td>Section 3.2, 2-D6.1.1b</td>
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<tr>
<td></td>
<td>2.3</td>
<td>Refine validation strategy</td>
<td>Section 3.3, 2-D6.1.1b</td>
</tr>
<tr>
<td></td>
<td>2.4</td>
<td>Identify indicators and metrics</td>
<td>Section 3.4, 2-D6.1.1b</td>
</tr>
<tr>
<td></td>
<td>2.5</td>
<td>Specify validation scenarios</td>
<td>Section 3.5, 2-D6.1.1b</td>
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<tr>
<td></td>
<td>2.6</td>
<td>Produce validation exercise plan</td>
<td>Section 3.6, 2-D6.1.1b</td>
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<td></td>
<td>2.7</td>
<td>Prepare the platform or facility</td>
<td>Section 3.7, 2-D6.1.1b</td>
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<tr>
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<td>2.8</td>
<td>Conduct pre-exercise testing and training</td>
<td>Section 3.8, 2-D6.1.1b</td>
</tr>
<tr>
<td><strong>Step 3 “Conduct the Experiment”</strong></td>
<td>3.1</td>
<td>Conduct validation experiment</td>
<td>Section 3.9, 2-D6.1.1b</td>
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<tr>
<td></td>
<td>3.2</td>
<td>Assess for unexpected effects or behaviours</td>
<td>Section 3.10, 2-D6.1.1b</td>
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<tr>
<td><strong>Step 4 “Determine the Results”</strong></td>
<td>4.1</td>
<td>Perform analysis specified in the analysis plan</td>
<td>Guidance for validation reports in: Section 3.11, 2-D6.1.1b</td>
</tr>
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<td></td>
<td>4.2</td>
<td>Prepare analysis contributions</td>
<td>Section 3.12, 2-D6.1.1b</td>
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<td>4.3</td>
<td>Prepare validation report</td>
<td>Section 3.13, 2-D6.1.1b</td>
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<tr>
<td><strong>Step 5 “Information for Dissemination to Stakeholders”</strong></td>
<td>5.1</td>
<td>Disseminate information to stakeholders and decision-makers</td>
<td>Section 5.1, 2-D6.1.1b</td>
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<td></td>
<td>5.2</td>
<td>Draw conclusions and decide on actions, feedback to validation strategy</td>
<td>Section 5.2, 2-D6.1.1b</td>
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Stepwise Approach - PRG Validation Trials of EMMA

<table>
<thead>
<tr>
<th>EFS + DMAN</th>
<th>RP + TAXI-CPDLC</th>
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<tbody>
<tr>
<td>RTS1</td>
<td></td>
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<tr>
<td>RTS2a</td>
<td></td>
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<tr>
<td>RTS2b</td>
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<tr>
<td>OST</td>
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During EMMA more than 40 test runs with 55 movements (á 60 min. duration) with 7 ATCOs and 11 airline pilots were performed.

- November 2007
- June 2008
- October 2008
- November 2008
Main Deliverables (EMMA example)

- 2-D111 Systems, Procedures and Op. Requirements (SPOR)
- 2-D611a&b Generic Validation Test Plan
- 2-D612 Specific Validation Test Plans
  2-D616 for CDG, PRG, TLS, MXP, Airborne
- 2-D631 Test Reports
  2-D661b for CDG, PRG, TLS, MXP, Airborne
- 2-D671 Validation Comparative Analysis Report
- 2-D672 Validation Recommendations Report
Verification & Validation

Validation:
Did we build the right system?

Verification:
Did we build the system right?

Technical feasibility
Operational feasibility
Operational improvements
Validation Chain

Operational feasibility of
- Modification of input devices
- Route generation
- Datalink device

Operational improvements
- Safety
- Throughput
- Efficiency
- Human Factors (SA, WL)
- Environmental Issues

Users questionnaires during debriefing after the trials

Statistical evaluation
Tailor-made questionnaires and debriefing preferred

204 op. Requ. from EMMA2 Concept

ATCO Questionnaire

Pilot Questionnaire

EMMA2 Checklist with feedback to 204 op. Requ.
Marriage of E-OCVM Levels of Maturity & EMMA Validation Chain

Operational improvements

EFS

GTD

DMAN

TAXI-CPDLC

ROUTING

RTS & OST

RTS only
Differences & Advantages of RTS and OST

After assuring an adequate performance in the verification phase of the ATM system, validation completes the cycle by including the user’s judgement about the right operation of the system.

Although many tests can be performed by field tests, some essential benefit criteria can only be validated by simulation runs. For example new defined procedures can only be tested in simulation due to safety aspects (e.g. low visibility operations, ‘forced incursions’ scenarios, ‘forced misunderstandings’ scenarios). To summaries these three different evaluation methods:

1. **Real time simulations**: Active controllers are operating with new systems / procedures in simulation

2. **Shadow mode trials**: Passive controllers are observing new systems / procedures on site without interaction with the real traffic

3. **Real operational field trials**: Active controllers are operating with the new systems / procedures on site, managing the real traffic
Use of distributed simulation facilities

ATS Tower Simulator

Controller WP 1...8

Pseudo Pilot WP 1...8

Supervisor WP

Image Generator 1 (200°)

Simulation Server

Image Generator 2 (300°)

Interface Server

Environment Database

ATM Systems

General Simulator Setup and Configuration at DLR

GECO Flight Simulator

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Make use of distributed simulation facilities

Distributed Simulation Setups *(here: ATCO-Pilot)* covers

- **Dynamic interaction** and **dependencies** between pilot and controller (→ time critical effects).

- **Interrelationship** between
  - operations at flight deck and ATC
  - visual perception and HMI interaction
  - voice- and data communication,
  - reaction time and situational awareness
  *at the same time onboard and at ground.*

... and facilitates the dialogue between ATCOs, pilots and developers!
Reaching HIGHER Levels of maturity

According to “European Operational Concept Validation Methodology”
Thank you for your attention!

Questions?