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A3 Architecture Overviews – A Project Management Tool?

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The Author / Researcher

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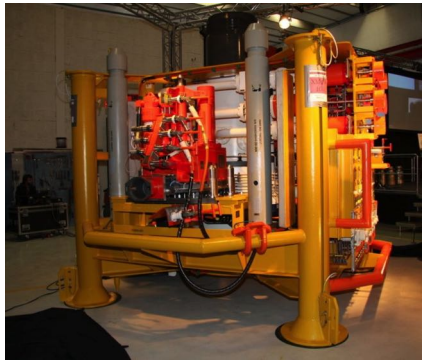
- Age: 32
- From: Bergen
- Education: Bachelor in Subsea Technology from Bergen University College (2010)
- Master in Systems Engineering University of Southeast Norway (2018)

Proffesional Background:

Aker Solutions 2010-2012
Project Engineer, X-mas tree refurbishment



Company 2012 – Present
Project Engineer, Offshore Manager, Project Manager

Thesis Case: Development of Autonomous Services

- Will it be possible to develop unmanned survey and inspection services, based on Autonomous, Unmanned solutions? The researcher was Project Manager for a pilot project where the goal was to prove this concept.

- Opportunity:
  Oil and Gas companies are working to cut cost, and reduce carbon footprint. Reduced vessel size and removal of offshore manning is therefore a very attractive.

Current solution

Future Solution?

Development Project Challenges

- Implicit (Expert) knowledge - not available for the rest of the organisation

Initial study of the project found that:

- No documentation beyond ConOps existed (28pages, 1 model)
- Documentation mostly used for promotion of future system externally,

focus on internal knowledge sharing was missing

- The researcher took over as PM for the pilot project and had that role during the research period.

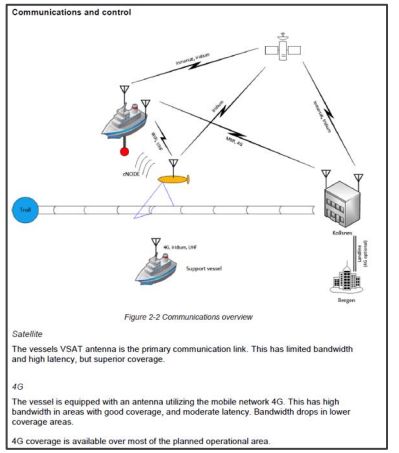

Communications and control

Figure 2-2 Communications overview

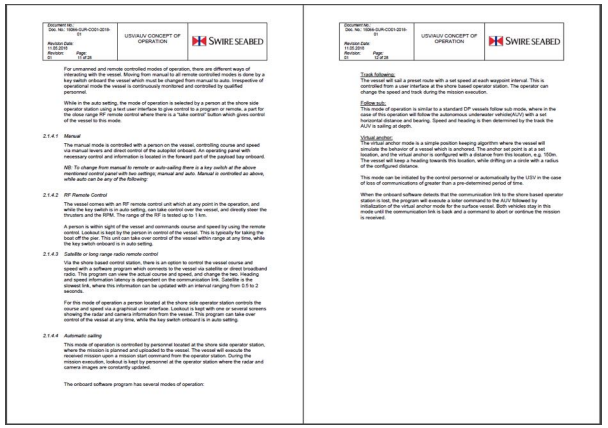
Satellite

The vessels VSAT antenna is the primary communication link. This has limited bandwidth and high latency, but superior coverage.

4G

The vessel is equipped with an antenna utilizing the mobile network 4G. This has high bandwidth in areas with good coverage, and moderate latency. Bandwidth drops in lower coverage areas.

4G coverage is available over most of the planned operational area.


USV/AUV CONCEPT OF OPERATION

SWIRE SEABED

Pages showing the ConOps created prior to start of research,

The ConOps was text-heavy with only 1 model

Systems Engineering Method

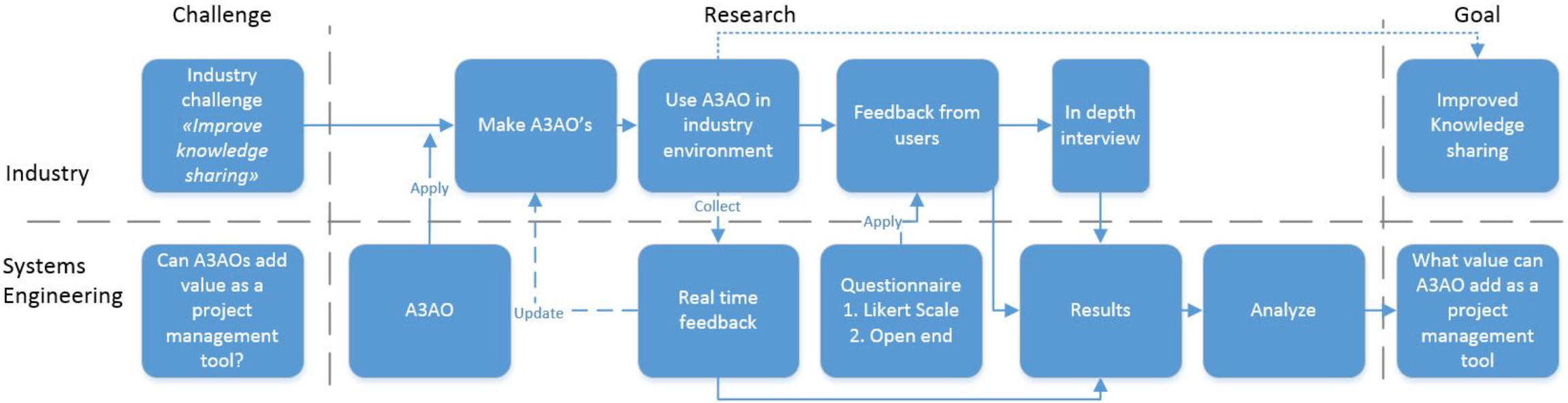
- There was a need for communication of the implicit expert knowledge in the project organisation.

- A3AO was presented and suggested as a possible solution.
- Company Operations Manager and Engineering Manager supported the approach, and the format.

Research Questions:

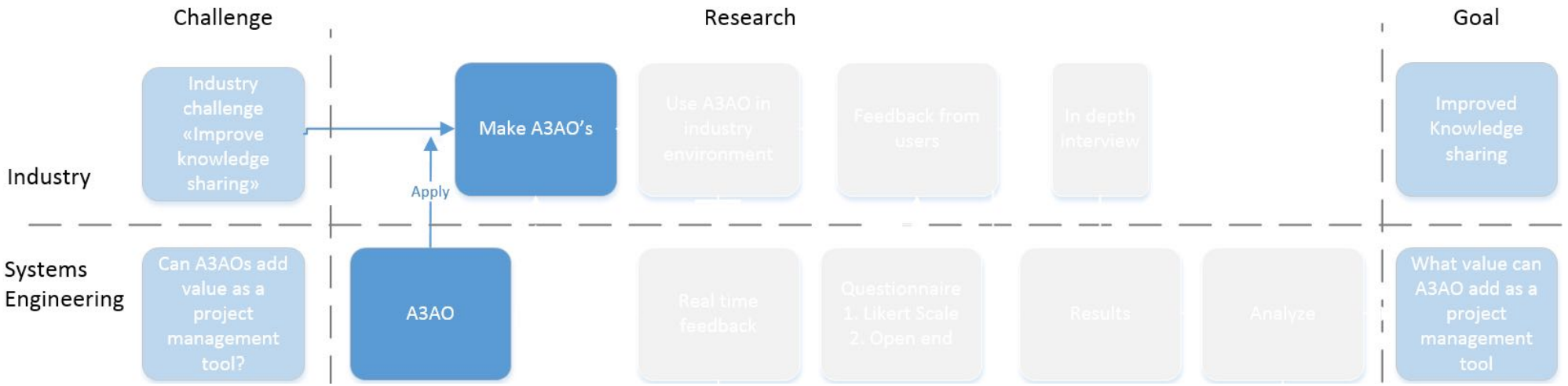
- What value can A3AOs add as a project management tool during the development of new services for subsea pipeline inspections?
- How do different parts of the organisation evaluate the A3AO as a tool for communicating implicit expert knowledge?

Research Method



Research Method – First steps

- A3AO format and approach based on previous research (Broches cookbook) Therefore limited space concerning A3AO in article.
- Informal interviews of system expert to extract knowledge
- Researcher created A3AOs



A3AO

QC–Quality Control
USV–Unnmanned Surface Vessel
MBE–Multibeam Echosounder
HOS–Hugin Operational System
MBR–Maritime Broadband Radio
VSAT–Very Small Aperture Terminal
AUV–Autonomous Underwater Vehicle

AUTONOMOUS ACOUSTIC PIPELINE INSPECTION SYSTEM Pilot 1

A3 Summary

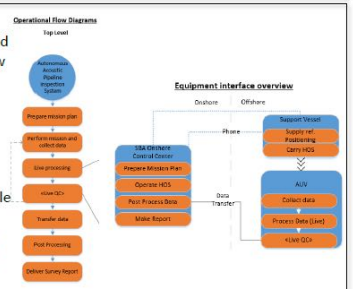
Author:	Tore Boge (Tbo)	**Status**	Issued for use
Technical rep:	Julian Bell (JBe)	**Doc ID**	Pilot 1 A3AO
Reviewers:	Frode Gaupås (Fgo), Lars-Kristian Trellevik (Lkt), Vidar Horneland		
Date:	Created: 10.07.2018	Last Change: 14.08.2018	Rev: 04

Introduction

The emergence of automated processes and machine learning is opening up for new opportunities within the subsea service industry.
aims to be at the forefront when it comes to utilising modern technology for safer, more environmental friendly, and more cost efficient operations.
This document show how new technology enables a modified Kongsberg Hugin AUV to perform data collection and parts of the processing required for acoustic pipeline surveys autonomously.
and has agreed to join forces to develop a method for unnmaned acoustic pipeline inspections, the architecture described herein is considered to be the first phase on the way to a fully unnmaned operation controlled from a control room onshore.

Top level views

The operational flow and the equipment overview of the Autonomous Acoustic Pipeline inspection system is shown on page 2.
The operational flow model (left) displays what is being done, while the equipment view (right) show where the functions are allocated within the system.



Functional View

The functional flow of Autonomous Acoustic Pipeline Inspections are very much similar to the flow of a conventional Acoustic Pipeline Survey. The main difference lies within the automated function of categorizing and intial processing of data combined with the live quality control. This new technology is enabled by an updated processing card that can automatically categorize data in structured manner (Create NaviEdit Project). The card also enables an initial cleaning of raw data collected, which limits the amount of processing to be done after the mission is complete.
Based on a predefined set-up for the NaviEdit Project structure a verification of collected data vs. Expected data can be done. Missing data indicates that the collection of data has not been successful.
Also the verification of collected data size vs. expected data size can be done to verify the quality of the data collected.
As a result of the two automated verification methods, feedback is given to the control room where operators can update the mission profile, and send the AUV back to areas where data collection has been poor or is missing.

Physical View

The physical view of autonomous acoustic pipeline inspection will have a significant difference from the conventional acoustic pipeline inspection. The automated processing done in the eliminates the need for initial offshore processing of data. As the need for offshore processing is eliminated the requiremnt for offshore data processors are eliminated. Data processors can remain onshore and wait for the mission to end before they start the post processing of data.
The support vessel will physically carry the AUV control system (HOS), but the operation of the AUV through the HOS will be controlled from an onshore location, this further eliminates the need for offshore personnel. Data strings will be sent via VSAT (primary), MBR (secondary) or 4G (optional) from the control room to the vessel. The data strings will be automatically unpacked in the HOS and commands are sent acoustically from the vessel to the AUV via HiPaP and cNode communication.
The AUV collects data with different sensors and the quality of the data is relayed to shore.

Pilot 1 – Content

Items to be verified during pilot

Technology	Environment	Deliverables	Business
1.Data quality	1.Weather	1.Data Ac qusition QC	1.Continued development
2.Remote AUV Ops	2.Low carbon	2.final report	2.Cost
3.Live Processing			3.Organisation

Acceptance Critereas Pilot 1

Environment
The operation is limited by the maximum weather critereat for recovery of the AUV by the support vessel. The carbon footprint have to be reduced compared to conventional operating method with a large ship.
Technology
The operation is at all times dependent on one communication link capable of handling data packages of XX Mbit/s to be able to remotely monitor and update mission profiles for the AUV.
The qyality of the data have to be of sufficient quality for the data processors to be able to deliver according to specification . This is achieved by calibration of all sensors prior to start of operation. These calibrations will be the same as for a conventional Acoustic survey.
The AUV have to be able to do live processing of data for the onshore operators to monitor what data is being collected
Deliverables
Main delivery for the test is pipeline inspection report.
Business
In addition to proving the technical concept we need to make sure the project show how we can achieve more cost efficient operations.

Assumptions and Challenges

Assumptions:
It is assumed that all readers of this document are familiar with the system domain and its intended use, details related to this is therefore not descried. If details are needed please contact the author.
Challenges
Requirements for subsea surveys and inspections have been developed over many years, and the number of requirements have increased as more and better equipment has been added to AUV's and ROV's. When developing a new consept for pipeline inspections it may be neccessary to take one step back and evaluate the actual need for each inspection to be performed, rather than having to comply with a full set of requirments that is based on today's method. Over time as this consept has proven itself, more features may be possible to add to fully comply with todays requiremnts.

Roadmap

Past:

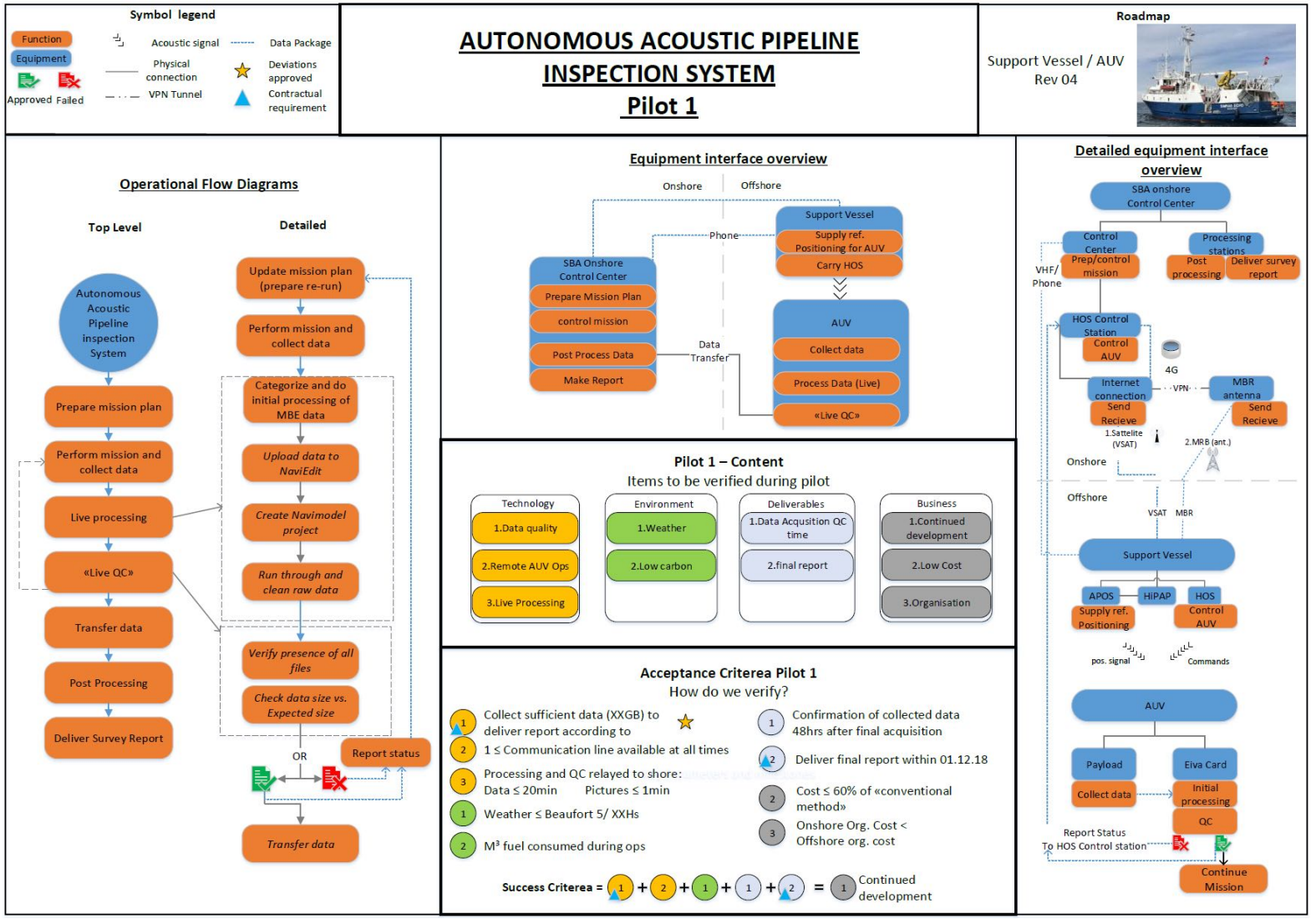
Present:

Future:

References:

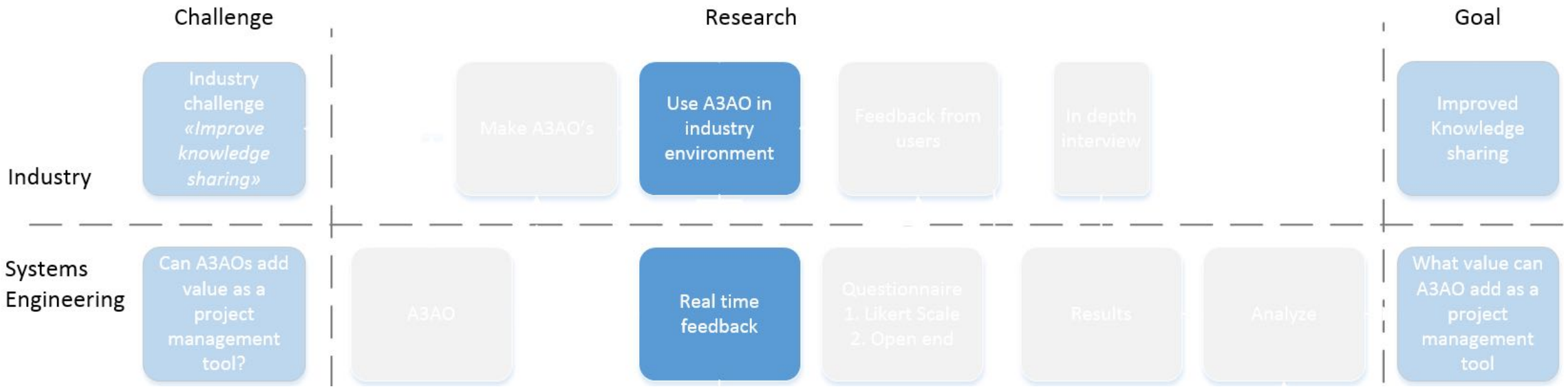
USV/AUV ConOps - 15066-SUR-CO01-2018-01
Pilot 2 A3AO

A3AO


Symbol legend
Function
Equipment
Approved
Failed
Acoustic signal
Physical connection
VPN Tunnel
Data Package
Deviations approved
Contractual requirement
AUTONOMOUS ACOUSTIC PIPELINE INSPECTION SYSTEM
Pilot 1
Roadmap
Support Vessel / AUV
Rev 04
Operational Flow Diagrams
Top Level
Detailed
Autonomous Acoustic Pipeline inspection System
Prepare mission plan
Perform mission and collect data
Live processing
«Live QC»
Transfer data
Post Processing
Deliver Survey Report
Update mission plan (prepare re-run)
Perform mission and collect data
Categorize and do initial processing of MBE data
Upload data to NaviEdit
Create Navimodel project
Run through and clean raw data
Verify presence of all files
Check data size vs. Expected size
OR
Report status
Transfer data
Equipment interface overview
Onshore
Offshore
Phone
Support Vessel
Supply ref. Positioning for AUV
Carry HOS
SBA Onshore Control Center
Prepare Mission Plan
control mission
Post Process Data
Make Report
Data Transfer
AUV
Collect data
Process Data (Live)
«Live QC»
Pilot 1 – Content
Items to be verified during pilot
Technology
1.Data quality
2.Remote AUV Ops
3.Live Processing
Environment
1.Weather
2.Low carbon
Deliverables
1.Data Acqusition QC time
2.final report
Business
1.Continued development
2.Low Cost
3.Organisation
Acceptance Criterea Pilot 1
How do we verify?
Collect sufficient data (XXGB) to deliver report according to
1 ≤ Communication line available at all times
Processing and QC relayed to shore:
Data ≤ 20min Pictures ≤ 1min
Weather ≤ Beaufort 5/ XXHs
M³ fuel consumed during ops
Confirmation of collected data 48hrs after final acquisition
Deliver final report within 01.12.18
Cost ≤ 60% of «conventional method»
Onshore Org. Cost < Offshore org. cost
Success Criterea = 1 + 2 + 1 + 1 + 2 = 1 Continued development
Detailed equipment interface overview
SBA onshore Control Center
Control Center
Prep/control mission
Processing stations
Post processing
Deliver survey report
VHF/ Phone
HOS Control Station
Control AUV
4G
Internet connection
VPN
MBR antenna
Send Recieve
1.Sattelite (VSAT)
2.MRB (ant.)
Onshore
Offshore
VSAT
MBR
Support Vessel
APOS
HiPAP
HOS
Supply ref. Positioning
Control AUV
pos. signal
Commands
AUV
Payload
Eiva Card
Collect data
Initial processing
QC
Report Status
To HOS Control station
Continue Mission

Research Method – Second step

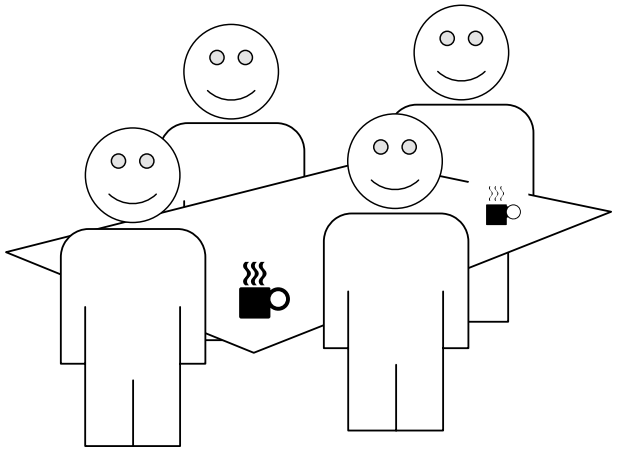
- A3AOs used in project meetings w. HSEQ, finance, management, engineering
- Observation of real time feedback from users

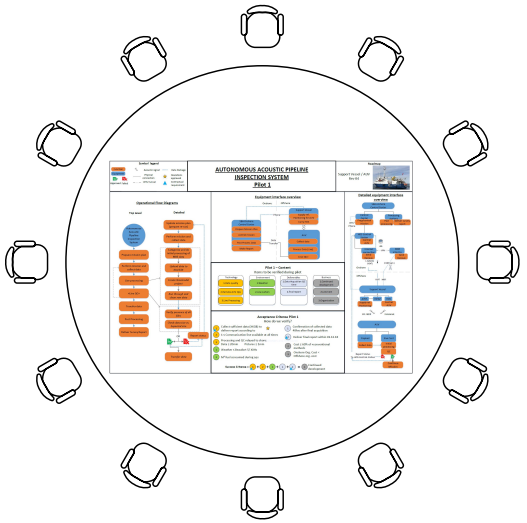


Use of A3AOs

- A3AOs used in Project meetings:

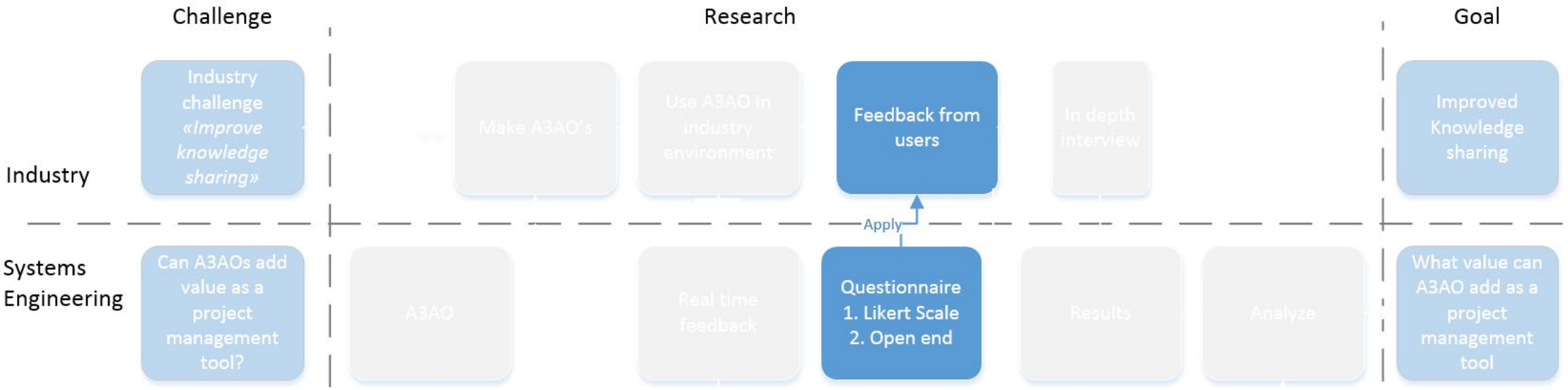
- Kick-Off meetings
- Weekly status meetings
- Internal system education meetings
- Risk Assessment meetings





Research Method – Third step

- Questionnaire issued to collect feedback from users



Questionnaire

- Likert Scale & Open ended

A3 Architecture overviews questionnaire.

Based on the use of A3 architectural overviews (A3AO's) made for the different pilot tests for autonomous AUV inspections, please answer the following questions. The research is performed to validate the use of A3AO's as a tool for interdisciplinary sharing of system knowledge.

(The questionnaire should take less than 10 minutes to complete)

1: Strongly disagree "No"	2: Disagree	3: Neutral	4: Agree	5: Strongly Agree (Yes)

No.	Statement	1	2	3	4	5
1	The A3AO is a good tool for sharing technical knowledge.					
2	The A3AO is a new format to me.					
3	The A3AO is easy to understand.					
4	The A3AO provides useful system information that is not captured in traditional documentation.					
5	I believe using A3AO could be beneficial to use in other projects we conduct					
6	The A3AO is challenging to understand as there are too many technical details.					
7	The Summary side (text side) of the A3AO is preferred over the overview side (models)					
8	The A3AO support me or others my job activities					

Open Questions.

1. How much time would you estimate/budget for making <u>one</u> A3 report (including reviews)?

   Circle around your selected answer

   5hrs 10hrs 15hrs 20hrs 25hrs 30hrs 35+ hrs

2. Which factors need to be in place for the A3AO format to be accepted in our company?

   Answer (1-3 sentences):

3. Which factors may block the use of A3AO's?

   Answer (1-3 sentences):

4. What do you see as the main benefits of the A3 format?

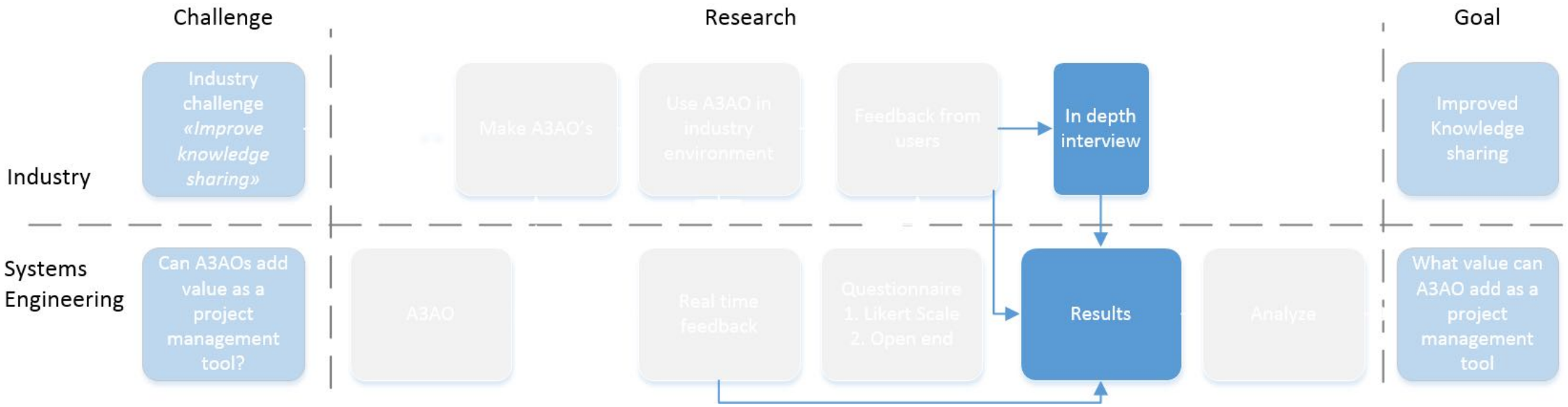
   Answer (1-3 sentences):

5. What do you see as the main challenges of the A3 format?

   Answer (1-3 sentences):

Research Method – Fourth step

- Collection of results
- Additional in depth interview of former project manager



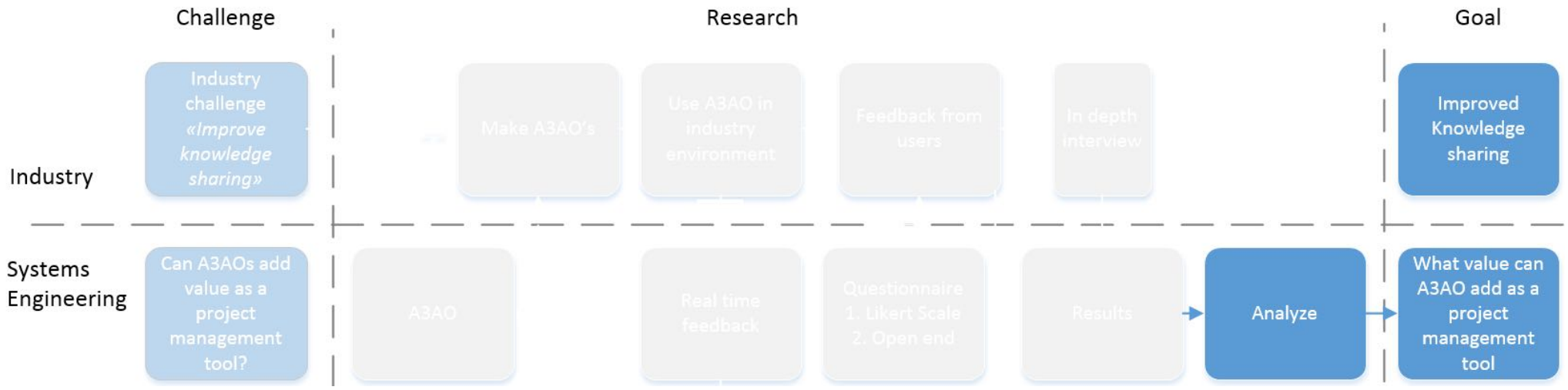
Results

No.	Statement	1: Strongly disagree "No"	2: Disagree	3: Neutral	4: Agree	5: Strongly Agree	NPS
		1	2	3	4	5	
1	The A3AO is a good tool for sharing technical knowledge.				2	7	7
2	The A3AO is a new format to me.		1	1	2	5	3
3	The A3AO is easy to understand.				6	3	3
4	The A3AO provides useful system information that is not captured in traditional documentation.			1	3	5	4
5	I believe using A3AO could be beneficial to use in other projects we conduct				5	4	4
6	The A3AO is challenging to understand as there are too many technical details.	4	4	1			-9
7	The Summary side (text side) of the A3AO is preferred over the overview side (models)		4	3	1	1	-5
8	The A3AO support me or others my job activities			2	5	2	0

		Average Scores			NPS Scores		
		Technical	**Non Technical**	**Management**	**Technical**	**Non Technical**	**Management**
Q1	The A3AO is a good tool for sharing technical knowledge.	4.5	5	5	1	3	4
Q2	The A3AO is a new format to me.	4	4	3.67	0	2	1
Q3	The A3AO is easy to understand.	4	4.33	4.67	0	1	2
Q4	The A3AO provides useful system information that is not captured in traditional documentation.	3.5	4.67	4.67	-1	2	3
Q5	I believe using A3AO could be beneficial to use in other projects we conduct	4	4.67	4.67	0	2	3
Q6	The A3AO is challenging to understand as there are too many technical details.	1.5	2	1.33	-2	-4	-4
Q7	The Summary side (text side) of the A3AO is preferred over the overview side (models)	2.5	3	2.33	-2	-1	-4
Q8	The A3AO support me or others my job activities	3.5	4	4.50	-1	-1	2

Research Method – Final step

- Analysis of results, Likert scale average scores, NPS
- Comparison of open question answers
- Analyse in depth interview to find trends towards earlier research and other results from this study



Quality of Research

- Consistency in results between NPS, averages and open questions.
- Few questions asked from participants – Uniform feedback
- Findings supported by other research
  - (Løndal & Falk), (Wee & Muller), (Kanter)
- Change Management, resistance towards change

- Lack of benchmarking, and grounds for comparison internally in company is a drawback
- Client not formally involved in the research
- Delay in development project resulted in limited project cycle exposure

Conclusions

- A3AO contribute to enhanced understanding of project goals for project personnel with limited system knowledge.

- Management and non-technical personnel are more positive to the use of A3AOs than technical personnel.

- Development projects have a wide range of stakeholders, the A3AO support communication on many levels in a project:
  - from development of business cases to daily project activities

Other Findings

- Clients are asking for models and schematics when working with develomnet projects.
- Strong indications of added value in development of business cases
- Industry common language should be used as far as possible to make the A3AO self explanatory for the users
- A3AOs are useful to create a common basic understanding of the project

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