

# SVAR – Systematic Verification and Acceptance of Requirements

**Project Kick-Off**

November 6-7, 2023



# Agenda

- Round table
- What is the goal of SVAR?
- Objectives and work-packages: overview
- What do we need to achieve the objectives?
- Mode of collaboration
- Next steps

# Round table



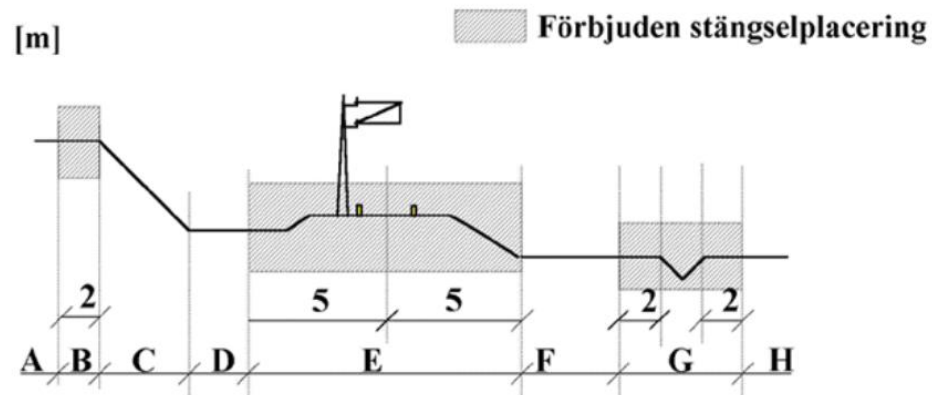
# What is the goal of SVAR?



# Systematic Verification and Acceptance of Requirements

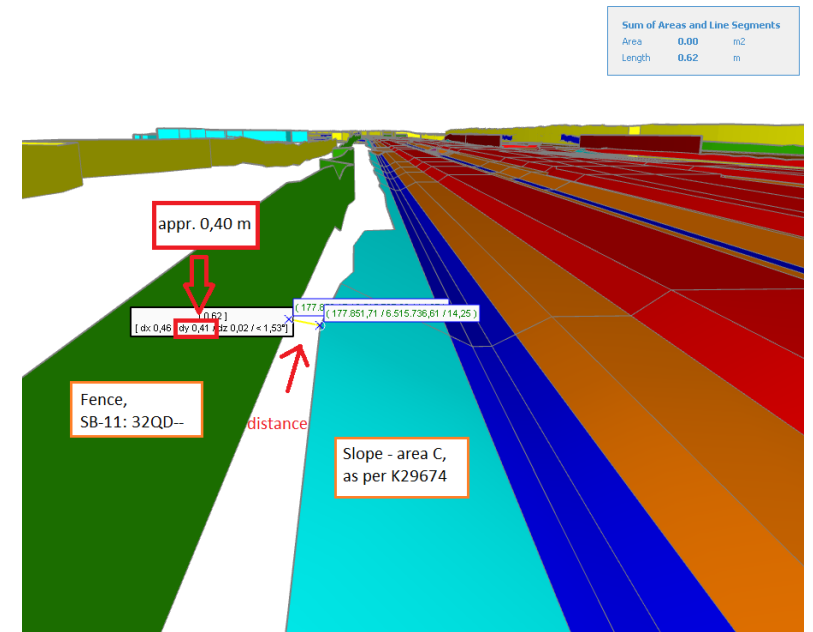
K29674

Stängsel ska sättas upp i område A, D, F eller H enligt figur K5.1, undantagsvis kan område C användas om stängselfunktion och effektivt underhåll kan säkerställas.



Figur K5.1 Schematisk bild över tillåten stängselplacering i spårmiljö.

Source: Ban- och stationsutformning – Ren och viltstängsel (TRV/Infra-00009)



Source: Ostlänken (OLP2)

# Project overview

Duration: October 1, 2023 – September 30, 2025

Three objectives, each with three work packages.

- **Objective 1:** Development of an Automated Compliance Checking Capability Maturity Model (ACC-CMM)
- **Objective 2:** Understand to what degree the compliance checking of requirements (TRVInfra, project-specific) is automatable
- **Objective 3:** Develop procedures for automated, reusable, verification of requirements

		Time- & Milestone Schedule																																									
		Project:			SVAR			Draft by			HOCHTIEF ViCon			Date:	16.10.2023	Version:	Ver. 1.0																										
Phase	WP	WP Title	Quartile		Q3			Q4			Q1			Q2			Q3			Q4			Q3			Q4			Q3			Q4											
			Year		2023									2024									2025																				
			Month		Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mär	Apr	Mai	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mär	Apr	Mai	Jun	Jul	Aug	Sep	Oct	Nov	Dec									
			Milestone											M1			M2			M3																							
Objective 1	WP 01	Prepare ACC-CMM development				0,6	0,6	0,6	0,6																																		
		Trafikverket				0,1	0,1	0,1	0,1																																		
		HOCHTIEF ViCon GmbH				0,2	0,2	0,2	0,2																																		
	LEAD	Blekinge Tekniska Högskola				0,3	0,3	0,3	0,3																																		
	WP 02	ACC-CMM development													0,6	0,6	0,6	0,6	0,6	0,6	0,6	0,6	0,6	0,6																			
		Trafikverket													0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1																			
		HOCHTIEF ViCon GmbH													0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2																			
	LEAD	Blekinge Tekniska Högskola													0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3																			
	WP 03	ACC-CMM application																						0,6	0,6	0,6	0,6	0,6	0,6	0,6	0,6												
Trafikverket																							0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1													
HOCHTIEF ViCon GmbH																							0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2													
LEAD	Blekinge Tekniska Högskola																						0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3													
Objective 2	WP 04	Requirements' verifiability				0,6	0,6	0,6	0,6	0,6	0,6	0,6	0,6	0,6																													
		Trafikverket																																									
		HOCHTIEF ViCon GmbH																																									
	LEAD	Blekinge Tekniska Högskola																																									
	WP 05	Requirements' verifiability analysis procedure																						0,6	0,6	0,6	0,6																
		Trafikverket																						0,1	0,1	0,1	0,1																
		HOCHTIEF ViCon GmbH																						0,2	0,2	0,2	0,2																
	LEAD	Blekinge Tekniska Högskola																						0,3	0,3	0,3	0,3																
	WP 06	Assessment of TRVinfra requirements w.r.t. machine readability																						0,6	0,6	0,6	0,6	0,6	0,6														
Trafikverket																							0,1	0,1	0,1	0,1	0,1	0,1															
HOCHTIEF ViCon GmbH																							0,2	0,2	0,2	0,2	0,2	0,2															
LEAD	Blekinge Tekniska Högskola																						0,3	0,3	0,3	0,3	0,3	0,3															
Objective 3	WP 07	Demonstration of verification methods of models																						0,6	0,6	0,6	0,6	0,6	0,6	0,6	0,6												
		Trafikverket																						0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1												
		HOCHTIEF ViCon GmbH																						0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2												
	LEAD	Blekinge Tekniska Högskola																						0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3												
	WP 08	Evaluation of verification methods																															0,6	0,6	0,6	0,6	0,6	0,6	0,6	0,6			
		Trafikverket																															0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1			
		HOCHTIEF ViCon GmbH																															0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2			
	LEAD	Blekinge Tekniska Högskola																															0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3			
	WP 09	Roadmap and recommendations for implementation																															0,6	0,6	0,6	0,6	0,6	0,6	0,6	0,6			
Trafikverket																																0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1				
HOCHTIEF ViCon GmbH																																0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2				
LEAD	Blekinge Tekniska Högskola																															0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3				
Efforts	Total monthly efforts				0	0	0	1,2	1,2	1,2	1,2	1,2	1,2	1,2	1,2	1,2	1,8	1,8	1,8	2,4	2,4	2,4	3	3	3	2,4	1,8	1,8	1,2	1,2	1,2	0	0	0									
	Trafikverket				0	0	0	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,3	0,3	0,3	0,4	0,4	0,4	0,5	0,5	0,5	0,4	0,3	0,3	0,2	0,2	0,2	0	0	0									
	HOCHTIEF ViCon GmbH				0	0	0	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,6	0,6	0,6	0,8	0,8	0,8	1	1	1	0,8	0,6	0,6	0,4	0,4	0,4	0	0	0									
LEAD	Blekinge Tekniska Högskola				0	0	0	0,6	0,6	0,6	0,6	0,6	0,6	0,6	0,6	0,9	0,9	0,9	1,2	1,2	1,2	1,5	1,5	1,5	1,2	0,9	0,9	0,6	0,6	0,6	0	0	0										

### Project Milestones

<b>M1</b>	<b>ACC-CMM:</b> Maturity model development method defined, and development started	<b>M2</b>	<b>ACC-CMM:</b> Maturity model development completed	<b>M3</b>	<b>ACC-CMM:</b> Maturity model applied and report in development
	<b>Requirements' verifiability:</b> TRVinfra requirements classified. Improvement suggestions formulated		<b>Requirements' verifiability:</b> Analysis procedure described and packaged for handover		<b>Requirements' verifiability:</b> Comparison of standards for machine readable requirements done
			<b>Verification library:</b> Verification checks implemented and evaluation in progress.		<b>Verification library:</b> Evaluation of verification checks done and roadmap for implementations in development

# Nyttiggörande (Benefits)

How to ensure that the results of the project are transferred to Trafikverket?

- **20%** (883 tkr) of requested projects funds are allocated to Trafikverket
- Finances reference group, **champions** and operative contacts
- Champions: a person at **Trafikverket** that **supports the realization** of a **particular objective** and **actively spreads the results** during and after the project has finished.



# Work package details



# O1:WP01 - Prepare ACC-CMM development

**Purpose:** Review literature on the empirical development of maturity models and grids and design a method for ACC-CMM development. In addition, we collect requirements from the potential users of the model to ensure its fitness for purpose.

**Needs:** User interest group from Trafikverket (client role) and HOCHTIEF ViCon (supplier role).

**Leader:** BTH

**Deliverables:** A methodological description and requirements for ACC-CMM development that ensures that the maturity model is fit for purpose.

TABLE III  
ROADMAP FOR THE ADOPTION OF ACC (ADAPTED FROM BEACH ET AL. [3])



No.	Capability	Category
Stage 1 - Research		
1	Cataloguing and prioritizing regulations that are suitable for automation	T
2	Engaging policy makers/implementors in the digitisation agenda	P
3	Presentation of the case for digitisation of compliance checking to establish funding to conduct proof of concept prototype	P
Stage 2 - Development of pilot or proof of concept		
4	Development of rule processes to track decisions, feedback, and uncertainty	T
5	Detailed mapping of digitised regulation/requirement/standards processes	T
6	Digitisation to be given voice with policy-implementors to ensure future support	P
7	Development of an understanding of parallel regulations	P
Stage 3 - Industrialisation of pilot or proof of concept		
8	Persistent data linkages between requirements and supplied product to prevent variation on specification	T
9	Chain of custody of materials and data	T
10	Accommodate multiple data models and multiple data dictionaries	T
11	Specification of a continual feedback loop process to incorporate appeals/derogations/determinations data in reviewing regulations	T
12	Production of audience specific guidance on digitisation of regulations or requirements	C
13	Detailed evidence-based business model for digitization of regulatory compliance	C
14	Explore routes to export developed toolchains to international audience and exploit international developments	C
15	Creation of standard data and criteria for social, environment and economic impact assessments	P
16	Conducting Impact assessment of digitisation of regulations	P
Stage 4 - Scaling of industrialized product or process		
17	Investigation of relationship between regulations and identification of overlaps and gaps	T
18	Enabling development of generative design based on regulations and requirements	T
19	Consistent/Structured data models and APIs (Application Programming Interface) for compliance checking	T
20	Continuously checking the quality of assets using calibrated instrumentation along with other data sources	T
21	Definition of precise digitised regulation clauses	T
22	Calculation method validation services	C
23	Develop robust inspection methods/rules to reduce dependence on human inspectors	C
24	Professional development and training in compliance checking for all that interface with it - including clients and supply chain.	C

# Research questions

1. All the listed capabilities necessary and sufficient?
2. What are the objective criteria for establishing the presence of a capability?
3. Are there dependencies between capabilities?
4. What is the progression towards achieving high ACC capability maturity?

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No.	Capability	Category
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1	Cataloguing and prioritizing regulations that are suitable for automation	T
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Stage 2 - Development of pilot or proof of concept		
4	Development of rule processes to track decisions, feedback, and uncertainty	T
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7	Development of an understanding of parallel regulations	P
Stage 3 - Industrialisation of pilot or proof of concept		
8	Persistent data linkages between requirements and supplied product to prevent variation on specification	T
9	Chain of custody of materials and data	T
10	Accommodate multiple data models and multiple data dictionaries	T
11	Specification of a continual feedback loop process to incorporate appeals/derogations/determinations data in reviewing regulations	T
12	Production of audience specific guidance on digitisation of regulations or requirements	C
13	Detailed evidence-based business model for digitization of regulatory compliance	C
14	Explore routes to export developed toolchains to international audience and exploit international developments	C
15	Creation of standard data and criteria for social, environment and economic impact assessments	P
16	Conducting Impact assessment of digitisation of regulations	P
Stage 4 - Scaling of industrialized product or process		
17	Investigation of relationship between regulations and identification of overlaps and gaps	T
18	Enabling development of generative design based on regulations and requirements	T
19	Consistent/Structured data models and APIs (Application Programming Interface) for compliance checking	T
20	Continuously checking the quality of assets using calibrated instrumentation along with other data sources	T
21	Definition of precise digitised regulation clauses	T
22	Calculation method validation services	C
23	Develop robust inspection methods/rules to reduce dependence on human inspectors	C
24	Professional development and training in compliance checking for all that interface with it - including clients and supply chain.	C

# To complete Objective 1

## WP2 - ACC-CMM development

**Purpose:** Design ACC-CMM and develop an assessment instrument that can be used to direct projects as well as suppliers in terms of their efforts of improving automated compliance checking.

**Needs:** User interest group from Trafikverket (client role) and HOCHTIEF ViCon (supplier role).

**Leader:** BTH

**Deliverables:** A methodological description for how to apply the ACC-CMM assessment instrument and how to identify improvement opportunities.

## WP03 – ACC-CMM application

**Purpose:** Apply ACC-CMM in the context of a particular project type of Trafikverket to establish a baseline capability for automated compliance checking of the organization.

**Needs:** Process descriptions and samples of project documentation from Trafikverket. Access to project to perform assessment.

**Leader:** BTH

**Deliverables:** A report that determines Trafikverket's baseline in terms of automated compliance checking.

# O2:WP04 – Requirements' verifiability

**Purpose:** Apply existing analysis methods to Trafikverket's regulatory requirements (TRVInfra) w.r.t. their verifiability to understand the potential for automated compliance checking.

**Needs:** Content of all TRVInfra requirements, i.e. an export to xml or CSV of the requirements from DOORS NG (not in PDF format as this unnecessarily complicates the analysis).

**Leader:** BTH

**Deliverables:** A classification of all TRVInfra requirements w.r.t. verifiability. This includes also an assessment of the requirements that are not verifiable and suggestions on how to improve the formulations of those requirements.

# Examples of unverifiable requirements

TRVINFRA-00224 Vägöverbyggnad / Överbyggnad väg, Dimensionering och utformning

7 Komfort / 7.1 Jämnhet i längdled, mätt med mätbil

K109662: Väg ska konstrueras och utföras så att den får ***acceptabel*** jämnhet.

How would a supplier verify that this requirement is fulfilled? What is the yard-stick?

The requirement is incomplete.

# Examples of unverifiable requirements

TRVINFRA-00233 Tunnel / Tunnelbyggande

7 Järnvägstunnlar - generell utformning / 7.4 Järnväg i tunnel

K43886: Bankroppen ska utformas så att bånan eller dräneringen inte skadas genom *frysning*.

Freezing of what? Does this refer to air temperature or to the temperature of the terrain?

The requirement is ambiguous.



# Examples of unverifiable requirements

TRVINFRA-00008 Ban- och stationsutformning / Personskydd mot järnväg

5 Dimensionering och utformning / 5.1 Allmänt

K29206: Fundament ska dimensioneras så att det klarar ***alla förekommande belastningsfall*** från stolpe, utan att det uppstår kvarstående förflyttning, deformation eller sprickor.

Scope of the requirements not clear. Where are the possible load cases defined?

Requirement scope is not defined.

# To complete Objective 2

## WP05 – Requirements' verifiability analysis procedure

**Purpose:** Package the analysis procedure such that Trafikverket, as well as the scientific community, can reapply it on requirements collections beyond TRVInfra.

**Needs:** none

**Leader:** BTH

**Deliverables:** Guidelines and software to conduct the analysis independently, without support from the researchers.

## WP06 – Assessment of TRVInfra requirements w.r.t. machine readability

**Purpose:** Review the literature on the development of machine-readable standards and provide an analysis for the feasibility of representing the verifiable requirements in a machine-readable format.

**Needs:** none

**Leader:** HOCHTIEF ViCon

**Deliverables:** A report that outlines and compares different representations of machine-readable standards.

### WP06 – Assessment of TRVInfra requirements w.r.t. machine readability

*Purpose:*  
representing the

Review the literature on the development of **machine-readable standards** and provide an analysis for the **feasibility** of verifiable requirements identified in WP04 in a machine-readable format.

*Data / resource requirements:*

none / **Deliverable from WP04**

*Leader:*

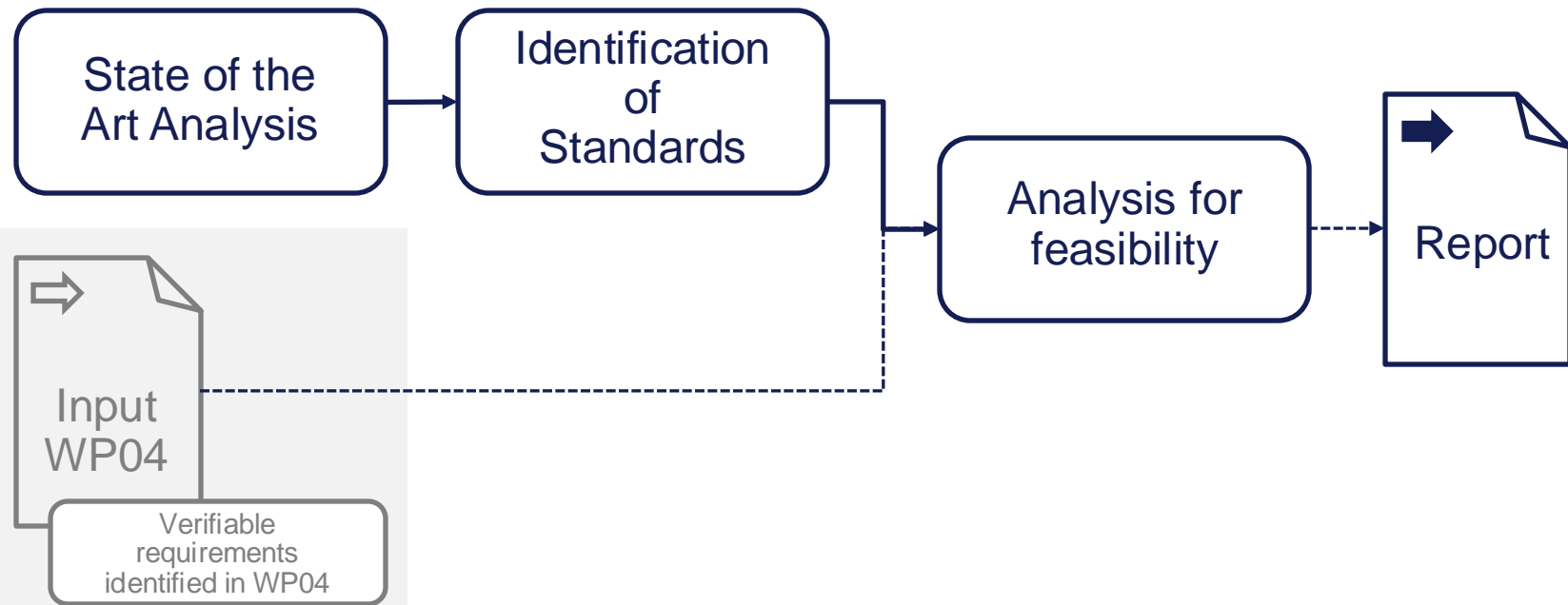
HOCHTIEF ViCon

*Deliverables:*

A report that outlines and compares different representations of machine-readable standards

*ToDo:*

Research about standardized machine-readable formats



#### **Deliverable WP04:**

A classification of all TRVInfra requirements w.r.t. verifiability. This includes also an assessment of the requirements that are not verifiable and suggestions on how to improve the formulations of those requirements.

# SVAR

## Work Packages & Objectives

### WP07 – Demonstration of verification methods of models

**Purpose:** Transfer of the theoretical approaches into an **Information Delivery Manual (IDM)** to provide overview about all exchange information requirements. To enable automated verification, **Information Delivery Specifications (IDS)** will be developed. For automatization. While **specific model concept** for a particular demonstration purposes. These demonstrators serve as prototypes for the automatization of verification methods for model format (e.g. IFC). These demonstrators will be used to elaborate an evaluation concept.

**Data / resource requirements:** None

**Leader:** HOCHTIEF ViCon

**Deliverables:** Demonstration Verification  
Accompanying report

Requirement K122148

Logical Syntax

Model Check

Superstructure thickness shall be selected to meet the requirements of Table 19-1 and Table 19- 2 while meeting the dimensions of the gravel wear layer and support layer shown in Figure 19-1.

When PDS09 is 31BJ-- based on climate zone and material of the objects the least thickness of the layers should be derived by the table

DCAT Properties		
Attribute/Property	Unit	Value
PDS09	text	31BJ--;...
DCAT_ClimatezoneReq	integer	1;2;3;4;5
DCAT_MaterialTypeReq	integer	1;2;3;4;5
DCAT_Thickness	number (mm)	200;300;...

G0	Klimatzon				
	1	2	3	4	5
Total överbyggnadstjocklek på terrass av materialtyp:	1	2	3	4	5
1	200	200	200	200	200
2	300	300	300	300	300
3	350	350	350	400	400
4	500	500	500	550	550
5	500	500	550	600	600

Only allowed combinations will be considered "verified"

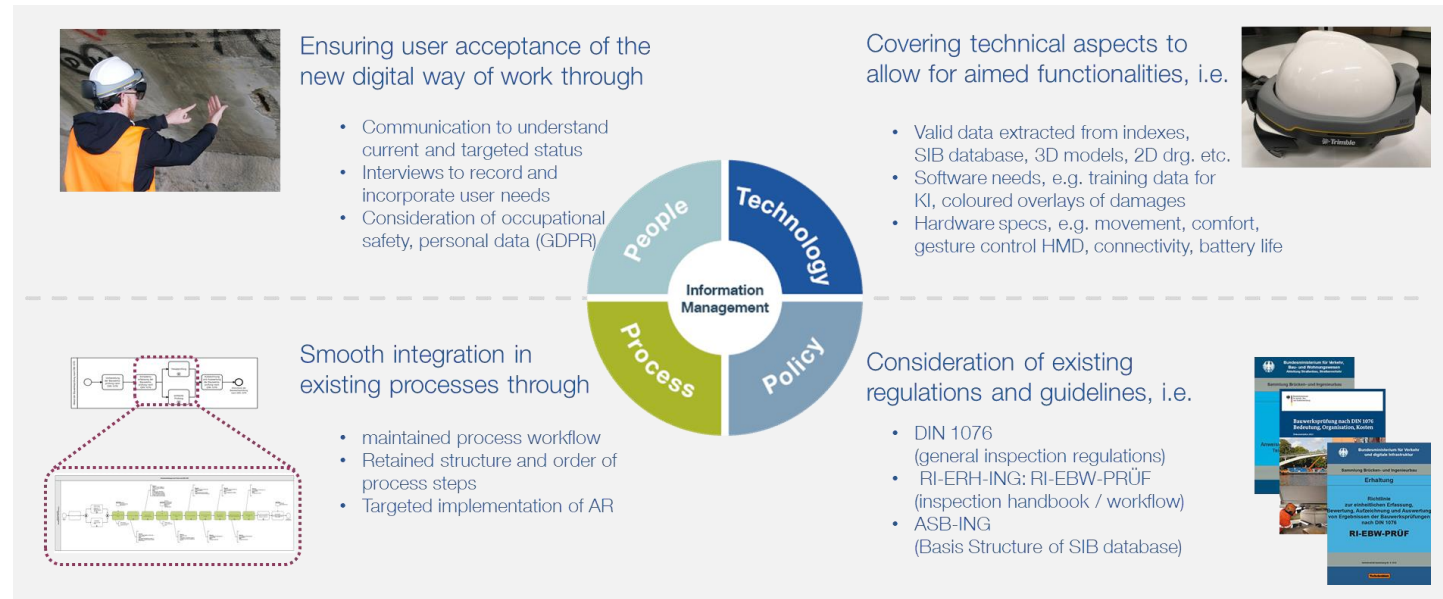
Successful approach from D-CAT project to transfer general requirements specification via machine-readable syntax into an automatized model check.

# SVAR

## Work Packages & Objectives

### WP08 – Evaluation of verification methods

- Purpose:** To verify that the developed verification methods are according to the **needs of the stakeholders**, an evaluation concept should be developed. The evaluation concept will cover the **main aspects to implement new technologies** (e.g. people, technology, processes and policies). Feedback from stakeholders involved will be gathered, evaluated and used to **define a roadmap** to optimize
- Data / resource requirements:** samples of models from projects, addressed stakeholders, IDM and IDS from WP07
- Leader:** HOCHTIEF ViCon
- Deliverables:** Evaluation concept, questionnaire, stakeholder feedback, optimization roadmap



Transfer successful Evaluation approach from another Research Project „Bridge Inspect“

# SVAR

## Work Packages & Objectives

### WP09 – Roadmap and recommendations for implementation

*Purpose:*  
requirements,  
elaborated on how to  
create verification

To create a starting point for developing a **verification library**, which enables stakeholders to verify different kinds of several examples of optimized verification checks will be combined. **Guidelines** as well as **templates** will be define a suitable **Information Delivery Manual**, how to derive the Information Delivery Specification and how to methods.

*Data / resource requirements:*

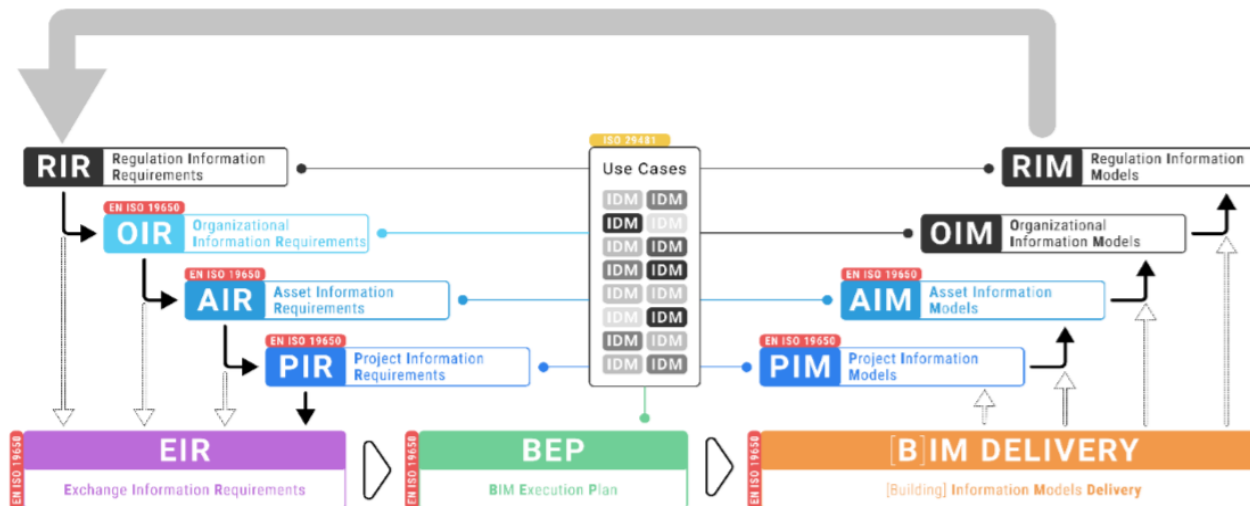
stakeholder feedback, optimization roadmap

*Leader:*

HOCHTIEF ViCon

*Deliverables:*  
implementation

several verification checks for different kinds of requirements / accompanying report that outlines a roadmap for the on organizational and project level.



Interaction of IDMs and information management according to ISO 19650.  
Source: WD WI 442023 CEN/TR Guidance for understanding and using EN ISO 29481-1

# How to make the project a success?



# What do we need to achieve objectives?

General need:

- Champion that provides support for access to resources and spreading results

Specific for starting with O2 and O3:

- TRV/Infra requirements (complete export, in machine readable format)
- TRV software overview, TRV processes, Demo Project



# Mode of collaboration

## Ensure transfer of results to Trafikverket

- Identify "champion" (from reference group or outside) for each objective that enables BTH/HOCHTIEF ViCon to achieve objectives
- Disseminate results within Trafikverket

## Regular synchronization

- Operative contacts (Martin, Göran, and whoever works with us closely in a WP): bi-weekly calls (30-60 minutes) to sync on activities
- Reference group + "champions": bi-monthly calls (60-90 minutes) to summarize progress, changes in plans, roadblocks

# Next steps

- Summary of action points for All
- Agree on responsible
- Next reference group meeting?

