

# ***IFC Rail Implementers Forum Report***

Overview and results of IFC Rail Implementers Forum of IFC Rail Phase 2 Project.

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## Contents

|   |    |
|---|----|
| List of Figures.....  | 4  |
| 1 Introduction.....   | 5  |
| 2 IFC Rail Implementers Forum .....                         | 6  |
| 2.1 Objectives and responsibilities.....                    | 7  |
| 2.2 Software Vendors participation .....                    | 7  |
| 2.3 Timeline .....  | 8  |
| 2.4 Meeting structure.....                                  | 8  |
| 2.5 Testing process.....                                    | 9  |
| 2.6 Scope of test.....                                      | 10 |
| 2.7 Tooling.....  | 12 |
| 3 Results .....   | 14 |
| 3.1 Unit tests results.....                                 | 14 |
| 3.1.1 Investigated Topics .....                             | 14 |
| 3.1.2 Overall Software Vendors' responsiveness .....        | 16 |
| 3.1.3 Topics coverage from Software Vendors.....            | 17 |
| 3.1.4 Unit Test coverage from vendors .....                 | 18 |
| 3.1.5 IFC 4.3 reference files produced by the Project ..... | 19 |
| 3.1.6 IFC 4.3 files produced by software vendors .....      | 21 |
| 3.1.7 Issues collected and resolved on GitHub.....          | 23 |
| 3.1.8 Overall engagement during Unit Test phase .....       | 25 |
| 3.2 Storylines results .....                                | 26 |
| 3.2.1 Railway concepts instantiated .....                   | 26 |
| 3.2.2 IFC files produced by SV for Storylines .....         | 27 |
| 3.3 Rail-IF workshop .....                                  | 29 |
| 3.3.1 Methodology .....                                     | 30 |
| 3.3.2 Summary of the rounds .....                           | 30 |
| 4 Conclusion .....  | 32 |
| Appendix.....   | 33 |
| A. Export of MIRO board .....                               | 33 |
| B. Resolved Issues and Decisions.....                       | 33 |



## List of Figures

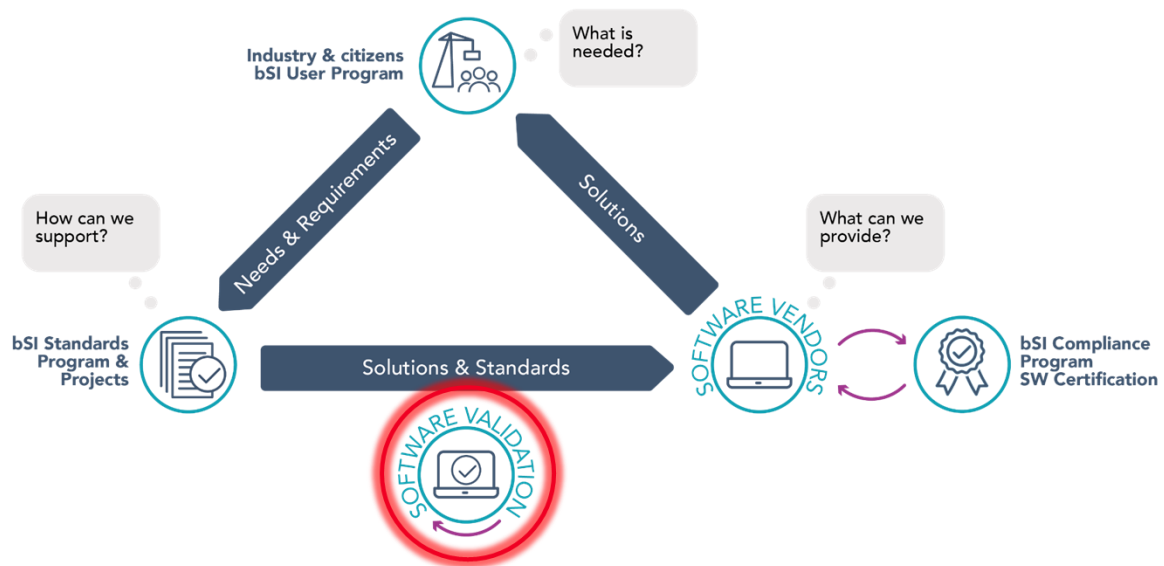
|  |    |
|--|----|
| Figure 1 Position of the IFC Rail Implementers Forum in the processes of bSI.....  | 5  |
| Figure 2 Rail-IF place in Project's organisation.....  | 6  |
| Figure 3 Participation of IFC Rail Implementers Forum .....  | 6  |
| Figure 4 Distribution of meetings of IFC Rail project .....  | 8  |
| Figure 5 The structure of meetings directly related to Unit Test activities.....   | 9  |
| Figure 6 The V&V model for the high-level structure of the work in the entire process.....                                 | 10 |
| Figure 7 - Unit Test case topics.....  | 11 |
| Figure 8 - The 11 Storylines with their respective leaders .....   | 11 |
| Figure 9 - IFC file validation tools used by the Forum .....   | 12 |
| Figure 10 A screenshot of the usBIM viewer developed by ACCA software.....   | 13 |
| Figure 11 - Infographic of the tested Topics and related Unit Tests .....  | 15 |
| Figure 12 - Overall engagement of software vendors and their direction of preference .....                                 | 16 |
| Figure 13 - Topics coverage by software vendors .....  | 17 |
| Figure 14 - Topics requested by the Test Leaders for their Storylines.....   | 17 |
| Figure 15 - Total number of IFC 4.3 reference files available, per priority .....  | 19 |
| Figure 16 - Number of IFC 4.3 reference files, per Topic .....   | 20 |
| Figure 17 - Number of IFC 4.3 reference files, per Unit Test.....  | 20 |
| Figure 18 - IFC 4.3 compact cases reference files available .....  | 21 |
| Figure 19 - IFC 4.3 files exported by vendors .....  | 22 |
| Figure 20 - IFC 4.3 files exported by vendors, per Topic .....   | 22 |
| Figure 21 - IFC 4.3 files exported by vendors, per Unit Test .....   | 23 |
| Figure 22 - Overall engagement during Unit Test phase.....   | 25 |
| Figure 23 – Entities of the IFC 4.3 schema of interest for railway .....   | 26 |
| Figure 24 – Entities of interest for railway which have been instantiated in Storylines or Unit Tests (82% of total) ..... | 27 |
| Figure 25 - Storylines for which IFC 4.3 files were provided, per-vendor view.....   | 27 |
| Figure 26 - Envisioned engagement VS IFC 4.3 files produced .....  | 28 |
| Figure 27 – Overview of the Rail-IF workshop on MIRO .....   | 29 |
| Figure 28 - A quantitative (and qualitative) example of the delivered results .....  | 32 |

## 1 Introduction

One of the challenges for a buildingSMART Project is to get its work validated, through software, during the development phase of the standard. To address this challenge, the IFC Rail Project has created the **IFC Rail Implementers Forum** (Rail-IF, in brief).

The Rail-IF has been responsible for organising the onboarding of, and managing the communication with, the Software Vendors (SV) during the testing and validation phase, of IFC Rail Phase 2.

The Forum has been first of all a big opportunity, for everyone involved in the Project, to experiment with the newly created Candidate Standard – to fine-tune it and make it Final. There is no other environment where Software Vendors can get in contact both with railway stakeholders (and their business requirements) and with the IFC technical experts (and their knowledge of IFC 4.3 standard). Therefore, as envisioned by bSI, the Forum has a key role inside the *demand-driven standard* philosophy of the community (see Figure 1 **Error! Reference source not found.**).



Source: bSI Processes, Richard Kelly

Figure 1 Position of the IFC Rail Implementers Forum in the processes of bSI

With its work, the Rail-IF proved that the IFC 4.3 standard can be implemented by software solutions, and used in realistic business cases. Railway stakeholders are grateful to those Software Vendors that allowed all the desired IFC concepts to be tested.

The outcomes, and the evidence of work collected, are summarised in this final report – to be available to railway stakeholders' organizations and to the entire bSI community.

## 2 IFC Rail Implementers Forum

The Implementers Forum had a specific place inside the Project's organisation. It reported to the Steering Committee, via the PMO, and gathered 3 major subjects: Test Leaders; Software Vendors; Technical Service.



Figure 2 Rail-IF place in Project's organisation

The IFC Rail Implementers Forum has been a global initiative, involving 10 railway stakeholders and 28 software vendors, across 16 countries. The figure below captures the participation of the Rail-IF and its cross-continental coverage.

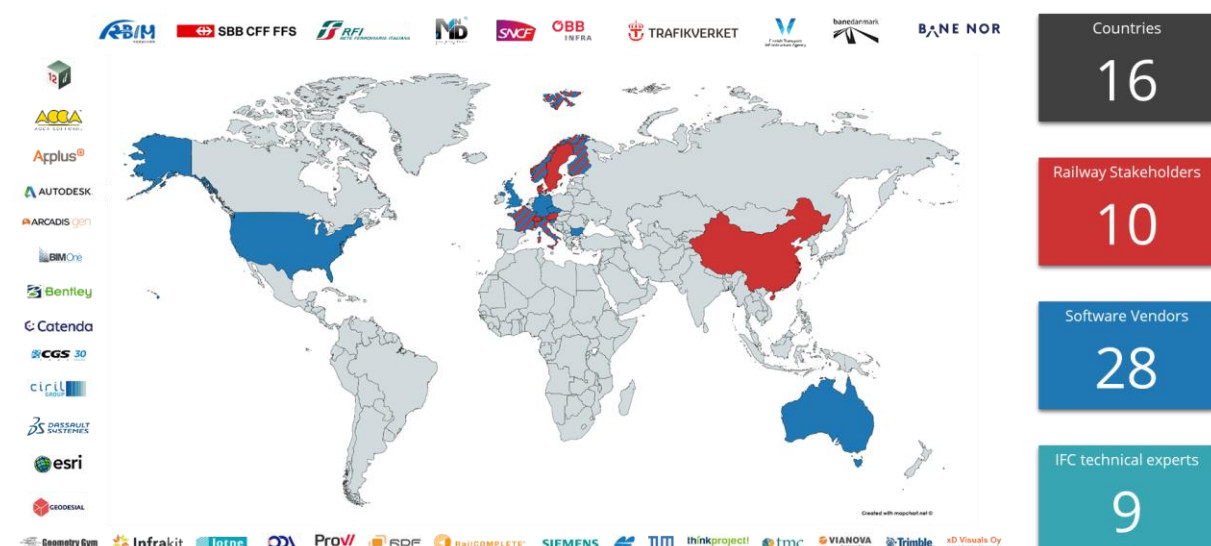


Figure 3 Participation of IFC Rail Implementers Forum

## 2.1 Objectives and responsibilities

The Rail-IF has the following objectives:

- Provide processes and tools to support the testing activities;
- Coordinate all the parties involved in this phase;
- Give visibility of the testing activities and results, across the actors of the Forum;
- Inform the Stakeholders' Steering Committee about the overall performance of the Forum.

As requested by the Stakeholders of the Project, the activities of the Forum are monitored through some **key performance indicators** (KPIs), to derive the **level of engagement** and the **level of success**. Thanks to the above mentioned setup, the Forum has been able to consistently produce:

- a monthly report for the Steering Committee of the Project;
- a final report (the present document).

The goal of the Forum is to **engage in a collaborative process** with the software vendors that are willing to test the IFC 4.3 standard. This collaboration included the following **responsibilities**:

- **participating** in meetings;
- **raising questions** and doubts;
- **proposing changes** and improvements;
- (for writers) **exporting IFC files**, to be validated;
- (for readers) **importing the export-tests** and sharing feedback.

The first part of this webinar, from a bSI summit, is a good high-level summary of what the Rail-IF is and what it does: <https://vimeo.com/540017271>

## 2.2 Software Vendors participation

In total, there are 28 software vendors from Europe, US and Australia that have subscribed to participating in the Forum. They are listed (alphabetically) below:

|                 |                            |                                |
|-----------------|----------------------------|--------------------------------|
| 12d Solutions   | Dassault Systèmes          | Siemens Mobility GmbH          |
| A+S             | Esri                       | Technische Universität München |
| ACCA Software   | Goeodesial Group           | Thinkproject                   |
| Arcadis Gen     | GeometryGym                | Topcon Technology Finland      |
| Autodesk        | Infrakit                   | Track Machines Connected       |
| Bentley Systems | Jotne                      | Trimble                        |
| BimOne          | Open Design Alliance (ODA) | Trimble-Vianova                |
| Catenda AS      | ProVi                      | xD Visuals                     |
| CGS Labs        | RailCOMPLETE               |                                |
| Cirilgroup      | RDF Ltd.                   |                                |

## 2.3 Timeline

The effort of the Forum spanned across 14 months, and can be seen in two periods:

- **Uni Test phase:** from June 2020 till April 2021
- **Storyline phase:** from April 2021 till November 2021

The chapter on results reflects this division.

## 2.4 Meeting structure

With more than 100 people involved in the project, and a wide variety of backgrounds, the IFC Rail project pursued its objectives through a set of well defined processes and a robust plan of regular meetings. The diagram below counts the number of meetings (per category of meeting) held by the project, from its kick-off (4<sup>th</sup> June 2020) till the time of writing (March 2022). In twelve months, more than 200 meetings have taken place.

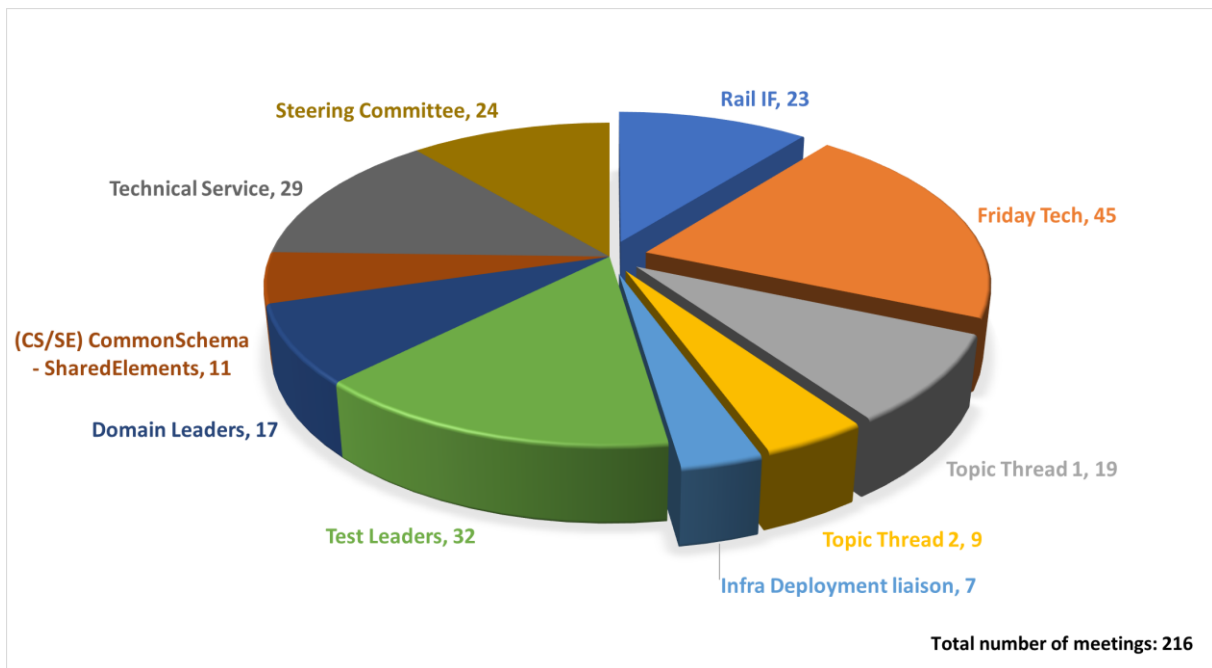


Figure 4 Distribution of meetings of IFC Rail project

Meetings that are directly related to Unit Tests are described as follows. The right-hand half of the diagram in Figure 4 Distribution of meetings of IFC Rail project captures these meetings:

- **23 Rail Implementers Forum meetings**, every three weeks;
- **45 In-depth Technical Discussions about IFC 4.3**, every week;
- **19 Thread 1 Unit Test Topic meetings** (AWC, LP, SAS), by-weekly;
- **9 Thread 2 Unit Test Topic meetings** (RSS, SYS, PCC, DPE), by-weekly;
- **7 Infra liaison meetings**.

For a total of 103 meetings (50% of the total).



These meetings are structured to serve the goal of testing the IFC 4.3 standard (see Figure 5):

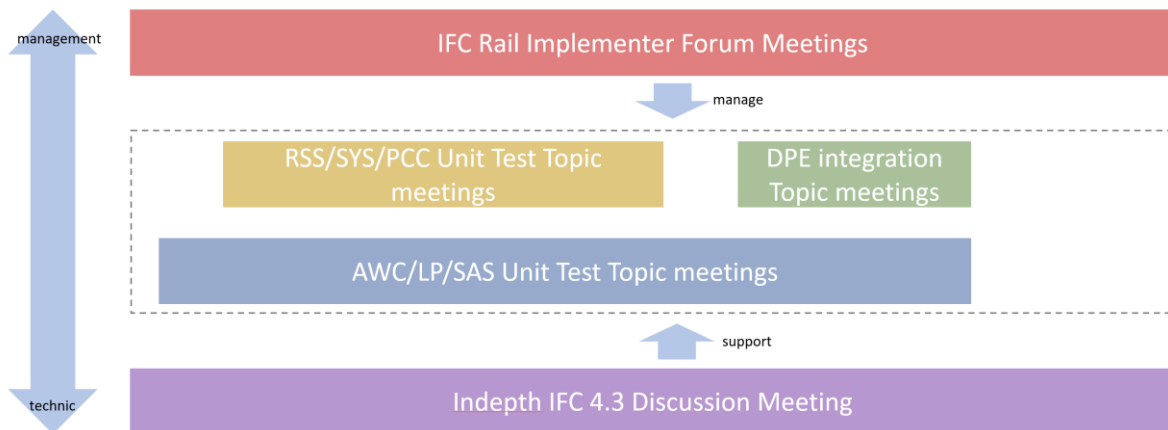


Figure 5 The structure of meetings directly related to Unit Test activities

- **IFC Rail Implementers Forum Meeting:** focuses on coordination and communication with software vendors to identify common interests, communicate general progress and facilitate organizations. It is meeting on high level that manages testing activities performed by software vendors.
- **Unit Test Topic Meetings:** focus on specific topics and cases for Unit Tests. Unit Test Topic meetings are grouped into three series of meetings.
  - **AWC/LP/SAS Topic meeting:** focuses on fundamental geometry and positioning topics including Alignment with Cant (AWC), Linear Placement (LP) and Swept Area Solid (SAS).
  - **RSS/SYS/PCC/DPE Topic meeting:** focuses on essential semantic structural topics including Railway Spatial Structure (RSS), System Breakdown Structure (SYS) and Port Connectivity (PCC). This meeting is organized every other since November 25th 2020 till March 24th 2021.
- **In-depth Technical Discussion on IFC 4.3:** focus on technical issues identified in the implementation of IFC 4.3, participated by software vendors and technical services from IFC Rail and IFC Infra Extension Deployment project.
- **Infra liaison meeting:** focus on planning and process for updating the IFC 4.3 standard based on collected issues.

NOTE: the *In-depth Technical Discussion on IFC 4.3* (aka, Friday meetings), among the TS team and Software Vendors, are still undergoing at the time of writing. These proved to be one of the greatest resources for vendors implementing the standard.

## 2.5 Testing process

The high-level structure of all the work is established through the V-model to bridge Domain Experts and Software Vendors and clarify all the terms used. The structure is illustrated in Figure 6.

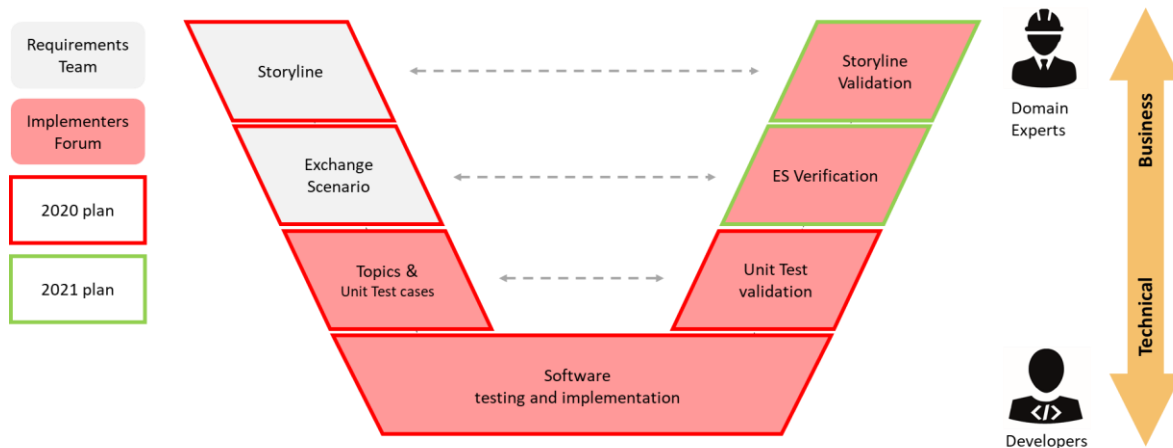


Figure 6 The V&V model for the high-level structure of the work in the entire process

- A Storyline is a realistic process in a railway project, that consists of one or more Exchange Scenarios;
- An Exchange Scenario can support one or more Use Cases;
- A Use Case may be supported by one or more Exchange Scenarios;
- An Exchange Scenario covers one or more Unit Test Topics that can be performed by IFC 4.3;
- A Unit Test Topic can be covered by one or more Exchange Scenarios;
- The evaluation whether IFC 4.3 can meet the requirement of a Unit Test Topic is conducted by Unit Tests;
- The evaluation whether IFC 4.3 can support the requirements defined for an Exchange Scenario is conducted by Verification;
- The evaluation whether IFC 4.3 can support operation in a Storyline is conducted by Validation.

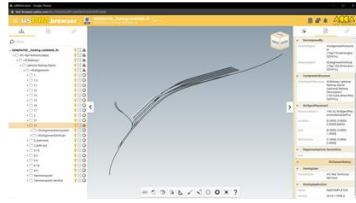
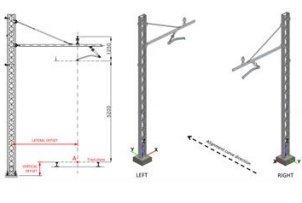
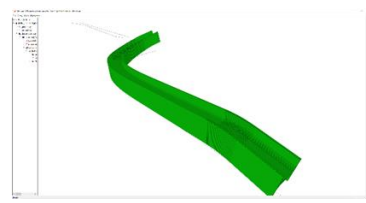
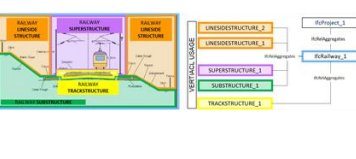
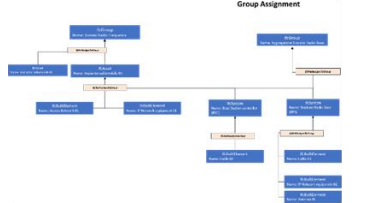
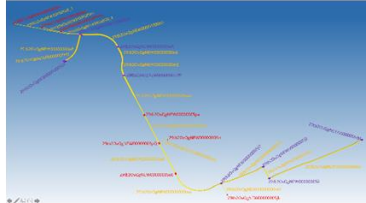
## 2.6 Scope of test

The focused topics of Unit Tests case are the following:

1. *Alignment with Cant (AWC)*
2. *Linear Placement (LP)*
3. *Swept Area Solid (SAS)*
4. *Railway Spatial Structure (RSS)*
5. *System Breakdown Structure (SYS)*
6. *Port Connectivity (PCC)*

Also visually summarised by the following figure.

### THREAD AWC-LP-SAS

| 1 – AWC   | 2 – LP  | 3 – SAS  |
|---|---|--|
| Alignment with cant   | Linear Placement  | Swept Area Solid   |
|  |  |  |
| 4 – RSS   | 5 – SYS   | 6 – PCC  |
| Railway Spatial Structure   | System breakdown and usage  | Port and Connectivity  |
|  |  |  |

Source: Acca (AWC), RFI (LP), RDF (SAS), Rail TS (RSS), RFI (SYS), MINnD (PCC)

### THREAD RSS-SYS-PCC

Figure 7 - Unit Test case topics

Many of these topics and unit test case are then reused by the Storylines, to fulfil the real business case. The 11 Storylines, and their leaders, are captured in the following figure.













| ID   | Stakeholder  | Storyline  | Test Leader                         | Technical Service              |
|------|--|--|-------------------------------------|--------------------------------|
| SL01 |   | Track Renewal  | Ali TATAR                           | Claude MARSCHAL                |
| SL02 |   | Design a new HS Line - Track                               | Feng YAN                            | Feng YAN                       |
| SL03 |   | Design a new HS Line - Telecom                             | Lihai LIU + Qing ZHONG              | Qing Zhong, Ping Chen          |
| SL04 |   | Design a new HS Line - Signalling                          | Huaisong WANG                       | Huaisong WANG                  |
| SL05 |   | Design a new HS Line – Energy                              | Jin GUANG                           | Jin Guang, Jin Song            |
| SL06 |   | Acquisition and upgrade of an existing railway line        | Palma ZAIRA LATERZA                 | Evandro ALFIERI                |
| SL07 |   | Substructure Renewal                                       | Heidi CASTELLANOS LEYRA             | Florian HULIN                  |
| SL10 |   | Urban railway infra-system integration                     | Vincent KELLER                      | Matthieu PERIN & Sylvain MARIE |
| SL11 |   | System ERTMS + Design of Technical Rooms and wired network | Achraf DSOUL                        | Florian HULIN                  |
| SL08 | <br> | Level Crossing   | Jitka HOTOVCOVA & Marion SCHENKWEIN | Lars Wikström                  |
| SL09 |   | BIM2FIELD2BIM (Tamping Machine)                            | Agnes SCHÖPP                        | Andreas Pinzenöhler            |

Figure 8 - The 11 Storylines with their respective leaders

## 2.7 Tooling

This section contains a summary of the tools used by the Rail-IF. For a detailed description refer to the *Tooling* chapter of the *IFC 4.3 Implementation & Validation Report*.

### File repository and versioning

- **GitHub** is used as the major working environment for documenting Unit Test Topics and Storylines, sharing results (IFC files), and collecting issues;
- **Box** is used by some Test Leaders to distribute additional dataset and other documentation useful for Storylines.

### IFC file creation

For producing IFC reference files, Technical Service of project team have used a set of tools based on skillset of each member. They are listed as follows:

- **IfcOpenShell**: open source library that provides a Python programming interface and a late binding approach to quickly adapt to the updates in the IFC EXPRESS schema
- **IfcEngine**: IFC geometry engine provided by *RDF Ltd* that can be used to create IFC files
- **GeometryGym**: library provided by *GeometryGym* that has an open source version, which can be used to create IFC files

Besides these third-party tools for creating IFC files, the project has provided a tool to create geometry of alignment based on design parameters that are defined in the semantic layer of IFC.

### IFC file verification and validation

Verification and validation of IFC files has been carried out with a diverse set of tools, depending on the objective of the checking activity.

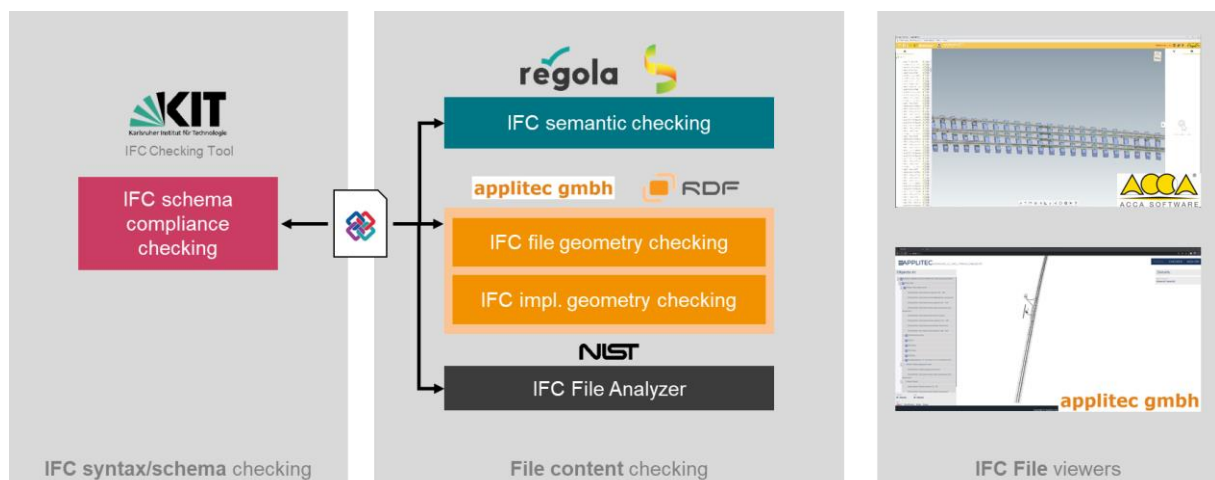


Figure 9 - IFC file validation tools used by the Forum

- **IFCCheckingTool**: developed by Karlsruher Institut für Technologie (KIT) is used by the project team to check the produced IFC files against the IFC EXPRESS schema.



## 3 Results

The result chapter is divided in three parts:

- **Unit Test results:** capturing KPIs mainly from the Unit Test phase;
- **Storyline results:** capturing KPIs mainly from the Storyline test phase;
- **Rail-IF workshop:** containing a summary of the virtual workshop held as a closing event of the Forum, in December 2022.

### 3.1 Unit tests results

As requested by the Stakeholders of the Project, the testing activities have been monitored through some **key performance indicators** (KPIs), to derive the **level of engagement** and the **level of success** of all the parties involved.

The following paragraphs illustrates the major KPIs capturing the results of the testing and validation phase. These are:

- Investigated Topics;
- Overall Software Vendors' responsiveness;
- Topics coverage from Software Vendors;
- Unit Test coverage from vendors;
- IFC 4.3 reference files produced by the Project;
- IFC 4.3 files (export tests) produced by Software Vendors;
- Issues collected and resolved on GitHub;
- Overall engagement during Unit Test phase

#### IMPORTANT:

- The measurement period is: 4<sup>th</sup> June 2020 – 30<sup>th</sup> June 2021
- The sources for the KPIs' measurement are: the GitHub repository of the Project; the MIRO board of the Forum; the meeting minutes and recordings; some direct communications held with software vendors.

#### 3.1.1 Investigated Topics

The testing activities covered **7 Topics**, these are fully described in Chapter 4, and summarise below:

1. Alignment with Cant (**AWC**)
2. Linear Placement (**LP**)
3. Swept Area Solid (**SAS**)

4. Railway Spatial Structure (**RSS**)
5. System Breakdown Structure (**SYS**)
6. Port Connectivity (**PCC**)
7. Domain Physical Elements Integrated Test (**DPE**)

These 7 Topics are further broken down into Unit Test cases, to ease the testing activities. In total, **37 Unit Test cases are created by the Project**, 24 of which (65%) are in priority 1. Below an infographic capturing the relationship between the Topics and the Unit Test cases – with indications on the priority levels and the Stakeholders providing dataset for such tests.

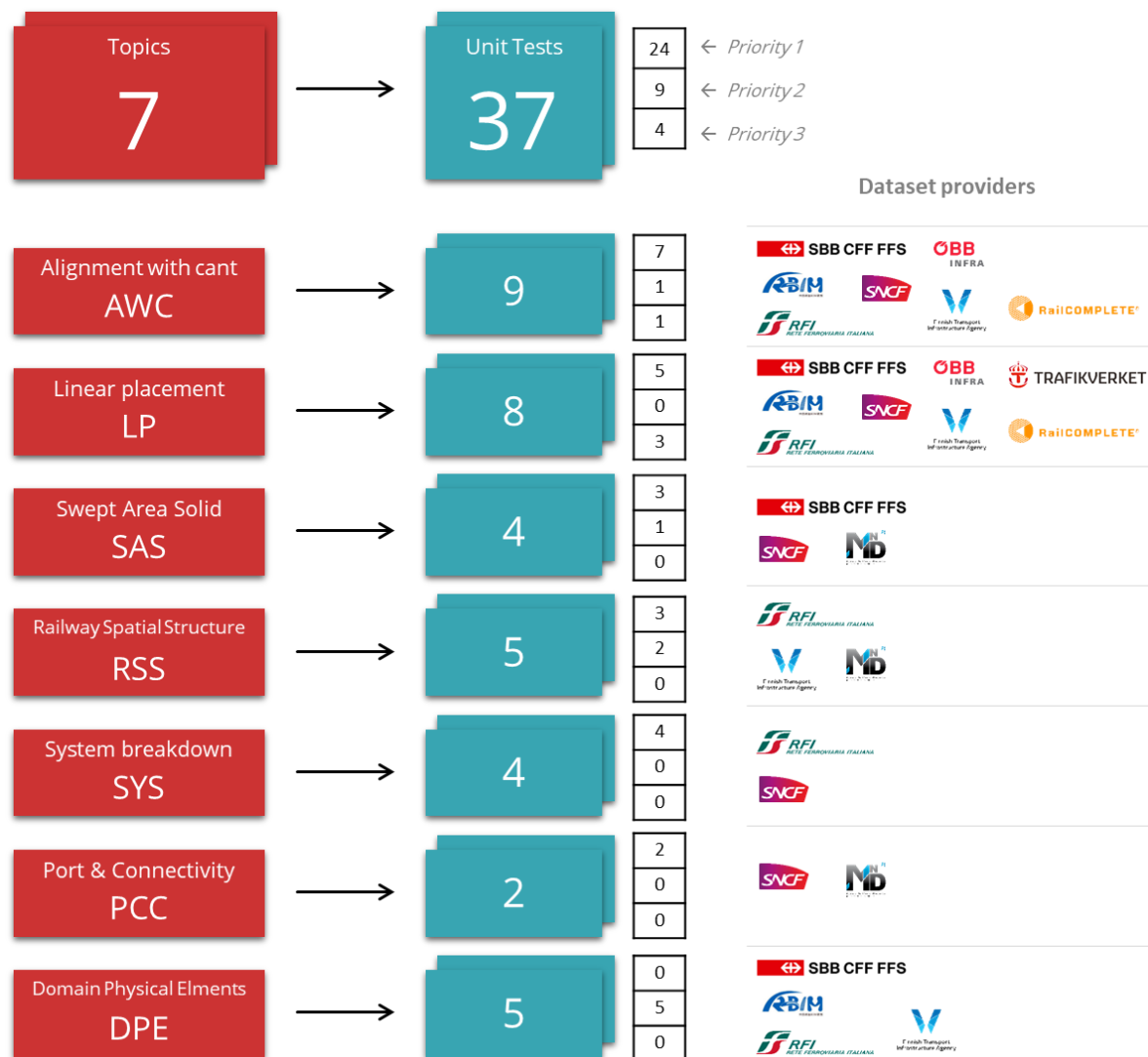


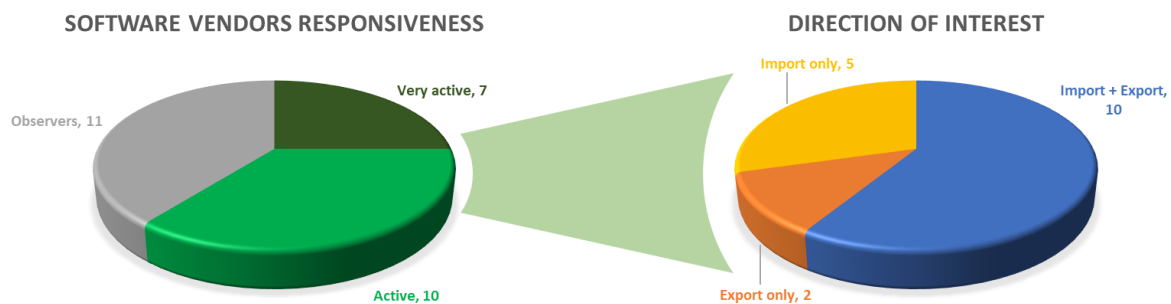
Figure 11 - Infographic of the tested Topics and related Unit Tests

### 3.1.2 Overall Software Vendors' responsiveness

The goal of the Forum is to engage in a collaborative process with the software vendors that are willing to test the IFC 4.3 standard. This collaboration includes:

- participating in the Forum-related meetings;
- raising questions and doubts;
- proposing changes and improvements to the standard;
- (for writers) exporting IFC files and uploading them on GitHub;
- (for readers) importing the export-tests and sharing feedback.

Based on the criteria above the following charts are derived, capturing the overall responsiveness (left) and the preferred direction of (import or export) for the active vendors. The majority (**60%**) of the subscribed vendors proved to be active or very active. Within these active vendors, more than half (**59%**) is interested both in reading and writing IFC files; 5 vendors are focusing only on import; 2 only on export.



*Figure 12 - Overall engagement of software vendors and their direction of preference*

NOTE: in the following paragraphs, when metrics are referred to *active vendors* this considers both "Active" and "Very active", so a total of 17 Software Vendors.



### 3.1.3 Topics coverage from Software Vendors

The Topics of **Alignment** (AWC) and **Linear Placement** (LP) have seen the interest of more than **60%** of the **active vendors**. With all (100%) the active vendors being interested in Alignment. **Less than 4** (<20%) of the active vendors were effectively involved in the Topics of Railway Spatial Structure (RSS) and System breakdown & usage (SYS).

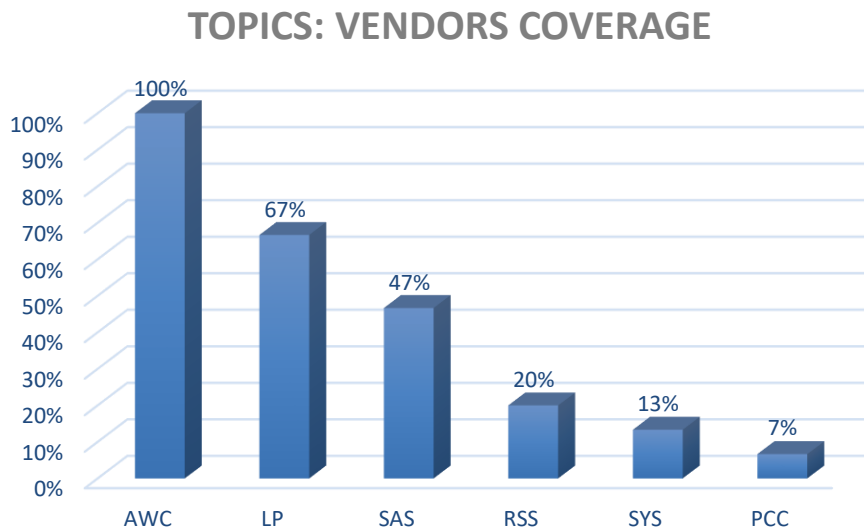


Figure 13 - Topics coverage by software vendors

This coverage is not fully aligned with the need of Storylines for the same Topics. In fact, the Topics of **Railway Spatial Structure** (RSS) and System breakdown & usage (SYS) are requested respectively by **10** (91%) and **8** (73%) of the **11 Test Leaders** – for their Storylines.

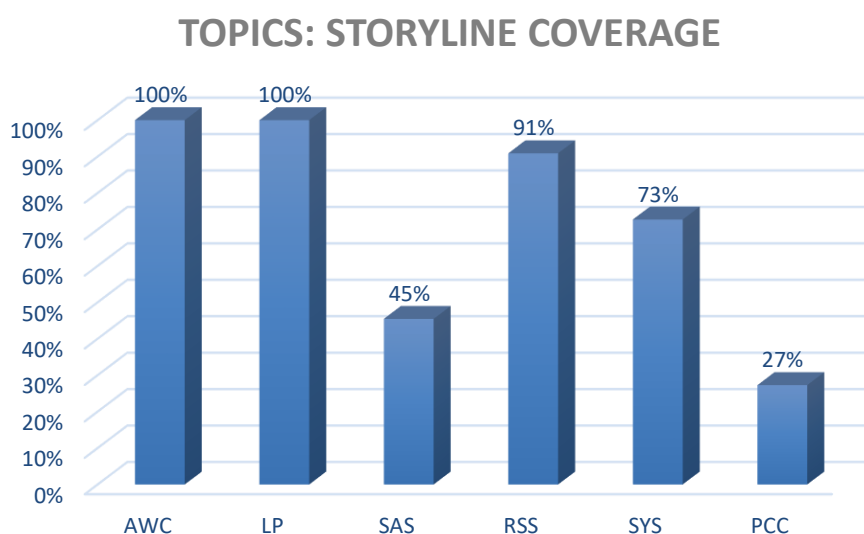
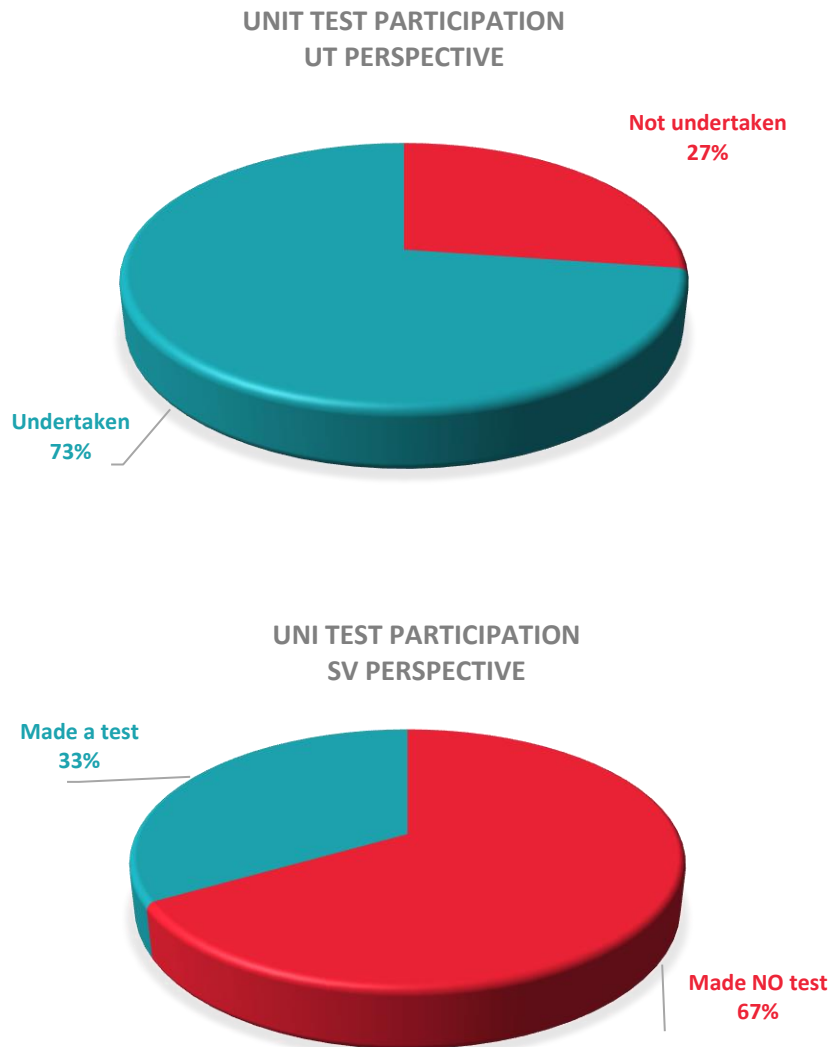


Figure 14 - Topics requested by the Test Leaders for their Storylines

### 3.1.4 Unit Test coverage from vendors

Of the 24 Unit Tests identified as “Priority 1”, almost **three quarter (73%)** have been **undertaken by one or more Software Vendors** (diagram below, on the left). However, concerning the software vendors’ contribution to the Unit Tests, only one third (33%) of the active vendors has undertaken at least one Unit Test (diagram below, on the right).

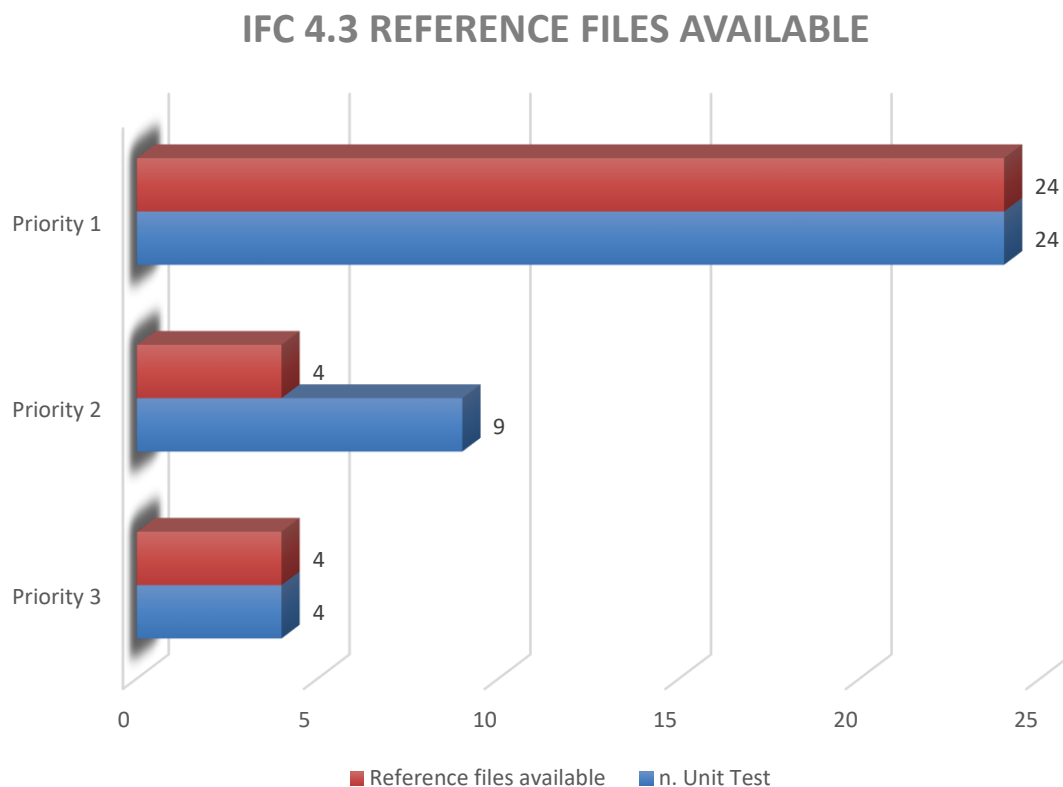


Note that among the **5** vendors (the 33%) which took at least one test, **3 are SDK providers** (they provide software libraries, mainly for geometry, which enable other vendors to implement IFC).

### 3.1.5 IFC 4.3 reference files produced by the Project

Reference files for IFC 4.3 are essential to prove that the standard can be implemented in software applications. These are provided by the Project for each Unit Test case, and made available to all the engaged vendors – for supporting their testing activities. The diagrams below depict the number of reference files produced: i) per priority; ii) per Topic; iii) per Unit Test.

For all the 24 test cases identified as “Priority 1” an reference IFC file is produced by the Project.



*Figure 15 - Total number of IFC 4.3 reference files available, per priority*

Among all the IFC 4.3 reference files available, for the Unit Test cases of all priority levels, almost half (48%) is provided for the Topics of Alignment with cant (AWC) and Linear Placement (LP).

## IFC 4.3 REFERENCE FILES, PER TOPIC

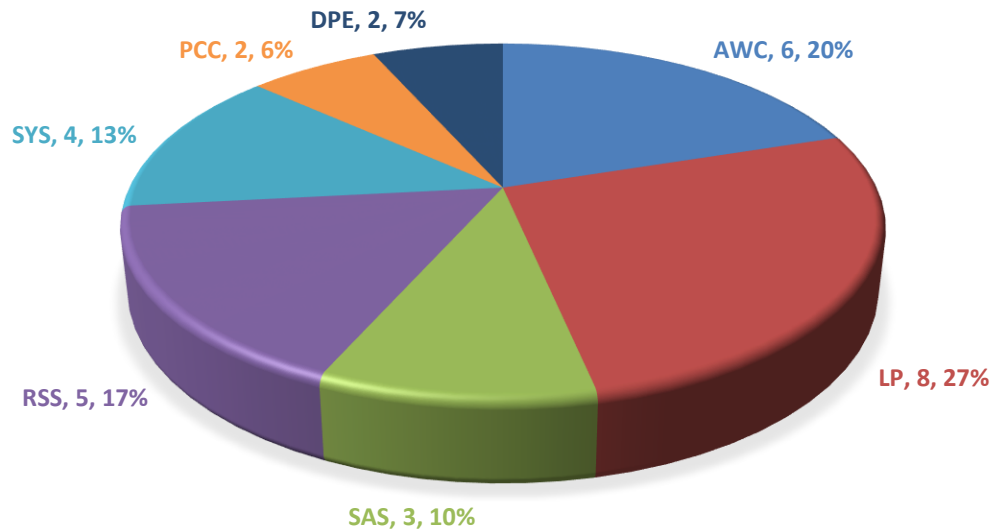


Figure 16 - Number of IFC 4.3 reference files, per Topic

It worth mentioning that 80% (16/20) of the times a reference file has been provided for a Unit Test case, at least on vendor provided an export test for such case. This is depicted in the diagram below.

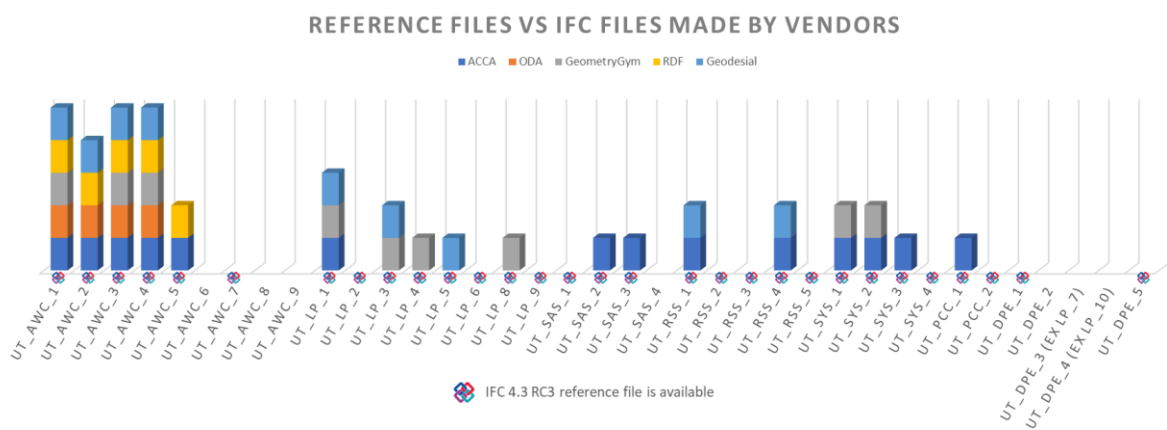


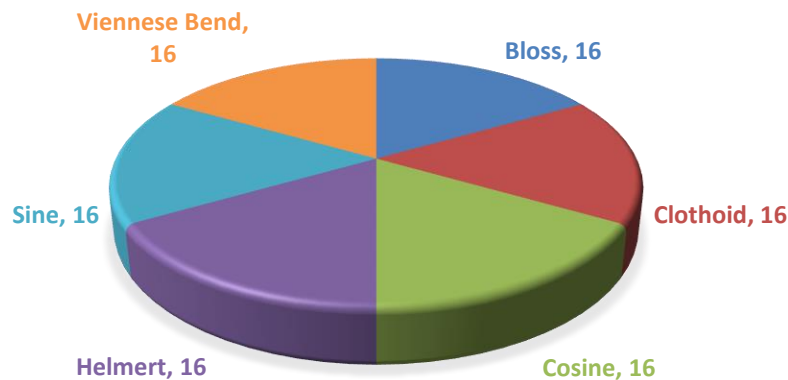
Figure 17 - Number of IFC 4.3 reference files, per Unit Test

## COMPACT TEST CASES

In addition to the above mentioned reference files, the Project provided also a set small IFC reference files. These are called compact test cases, and focus on one specific type of alignment segment. Namely: blossom, clothoid, cosine, Helmer curve, sine, Viennese Bend®. For each of six types of curve there are 8 cases, and for each of this 8 cases the Project provided 2 IFC files, one just with the business-

logic part of alignment and the other including the geometry. In total, **96 compact IFC reference files**, all validated by the Technical Service. **This brings the total number of available IFC 4.3 reference files to more than 120.**

### NUMBER AND TYPE OF IFC 4.3 COMPACT CASES REFERENCE ALIGNMENT FILES



*Figure 18 - IFC 4.3 compact cases reference files available*

#### 3.1.6 IFC 4.3 files produced by software vendors

Another significant indicator is represented by the number of IFC 4.3 files produced by some of the engaged vendors. This helps proving that the standard can be implemented in the software applications used by the Stakeholders in their daily business. The Project appreciated the commitment of those implementers who kept providing export tests, even if adjustments and changes were happening. In fact, most of the improvements made to the schema are the results of this early iterative collaboration between the Technical Service and the Software Vendors.

Below is a diagram showing the total number of IFC 4.3 export test (41) available, grouped by the producing vendor.

## IFC 4.3 EXPORT TESTS MADE BY VENDORS

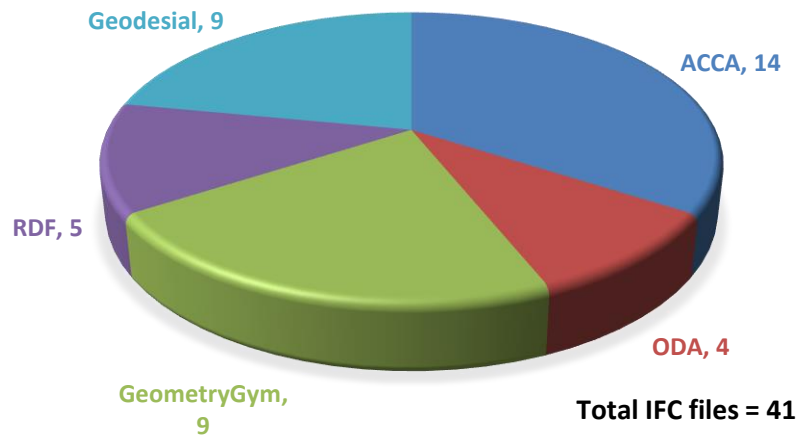


Figure 19 - IFC 4.3 files exported by vendors

Again, note that almost half (**43%**) of the IFC 4.3 export tests are created by **SDK providers** (companies that provide software libraries, mainly for geometry, for other vendors to implement IFC). For this reason, the great effort of **ACCA software & Geodesial group** (that together made **57%** of the files) must be recognised even more.

The same data are presented below under a different perspective: the Topics for which the export tests are made.

## IFC 4.3 EXPORT TESTS MADE BY VENDORS, PER TOPIC

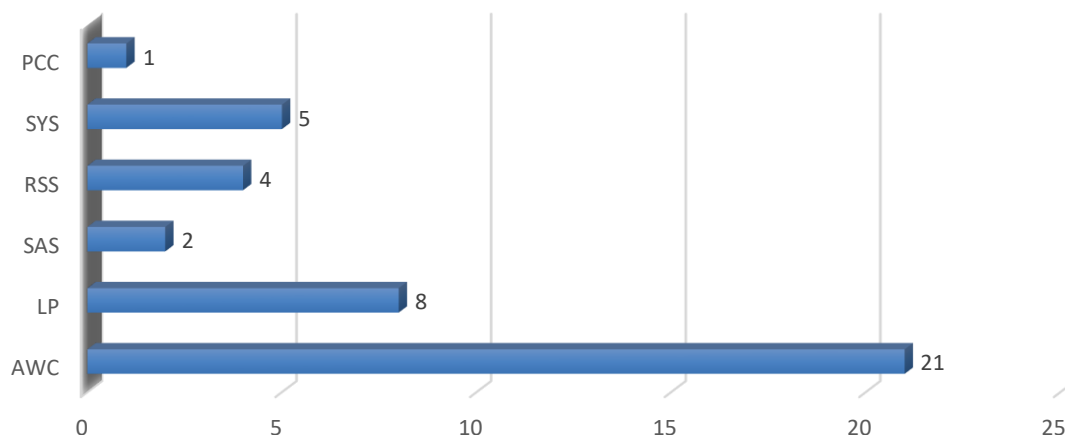


Figure 20 - IFC 4.3 files exported by vendors, per Topic

Finally, another perspective: the number of IFC 4.3 files exported by the vendors for each Unit Test.

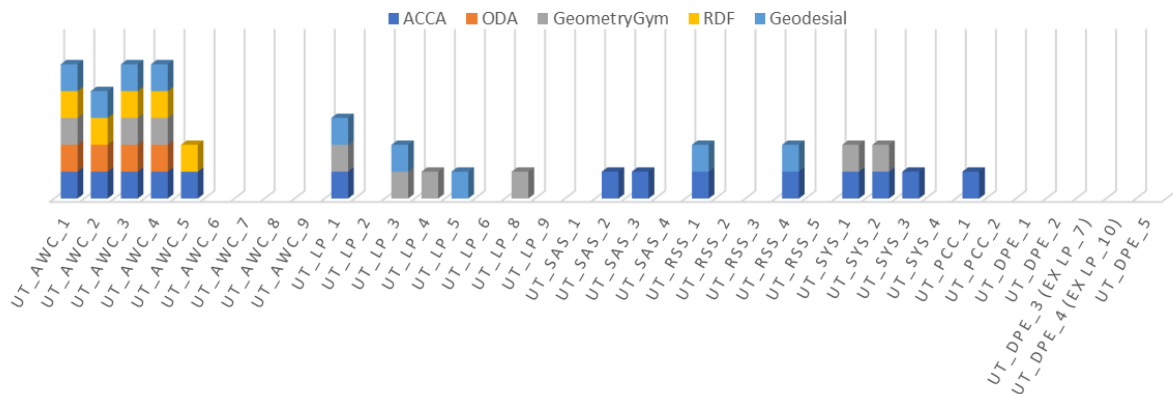


Figure 21 - IFC 4.3 files exported by vendors, per Unit Test

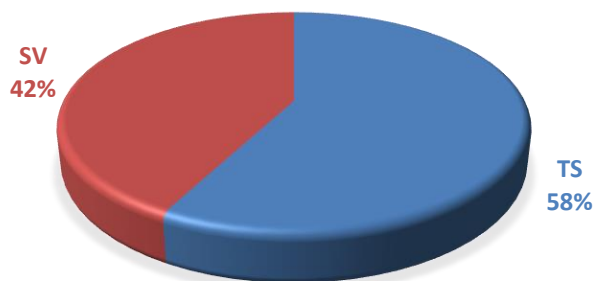
### 3.1.7 Issues collected and resolved on GitHub

This last KPI is summarising the status of the GitHub issues raised, managed, and resolved during the testing phase. The tracking mechanism offered by this kind of platforms is key to preserve the knowledge around the evolution of the standard, and to understand the rationale behind every change made to the schema, for future reference.

The total number of issues raised in the measurement period is 77, divided as follows:

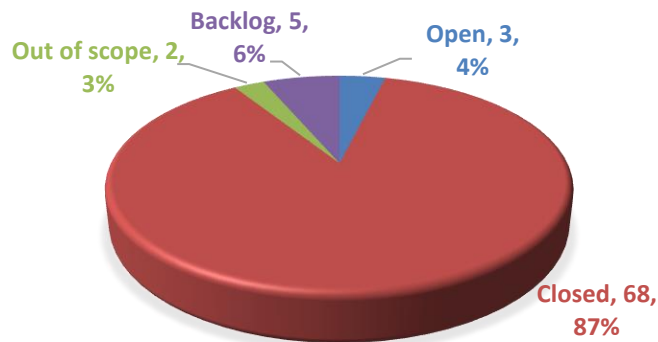
- 56 are questions, bug reports, feature requests, improvements to the documentation
- 21 are Unit Test trackers, used to track but the evolution of a Unit Test case

### SOURCE OF THE ISSUES



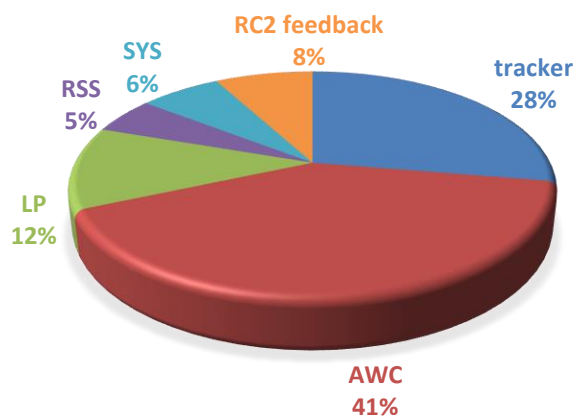
The first diagram divides the issues by the party who created it, namely a software vendor (SV) or an expert from the Technical Service (TS) team.

## STATUS OF THE ISSUES



The second diagram identifies the number of issues which are: Open; Closed; Out of scope; or Backlog, for the Unit Tests' related issues that can potentially be solved in the future.

## SCOPE OF THE ISSUES



The third diagram illustrate the scope of the issues. Excluding the Unit Test trackers, the majority (53%) of the issues are raised for the Topics of Alignment with cant (AWC) and Linear Placement (LP).



### 3.1.8 Overall engagement during Unit Test phase

The figure below captures the overall engagement of software vendors during the Unit Test phase. In one diagram, more KPIs are merged. These are: meeting attendance (%; blue bars); number of issues posted on GitHub (n; black squares); number of questions or discussions raised during meetings (n; magenta ticks); number of IFC files, either RC1 or RC2, produced for test (n, respectively yellow and green dots); finally the red crosses indicate if the software vendor provided explicit feedback on the RC2 release, which has been the major release due, also, to their precious feedback.

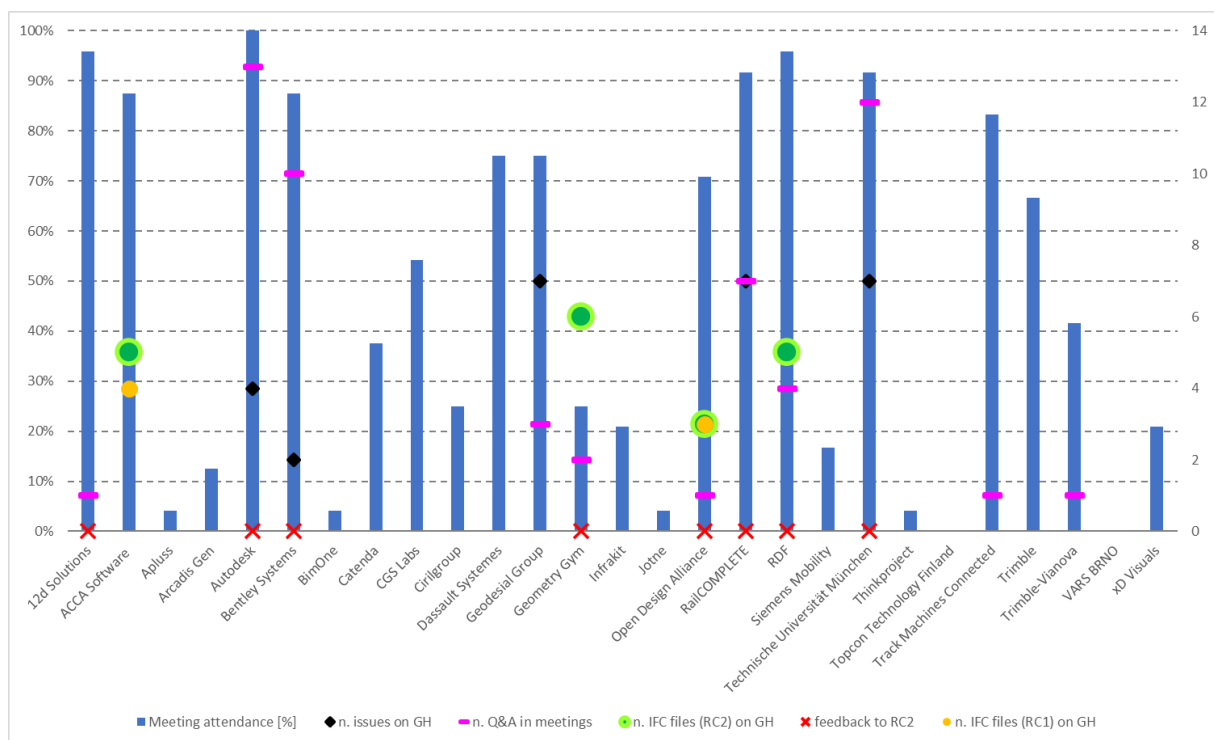


Figure 22 - Overall engagement during Unit Test phase

## 3.2 Storylines results

After the Unit Test phase, the focus of the Forum shifted on the Storyline test. Here, all stakeholders asked Software Vendors to fulfil more comprehensive cases – leveraging on the work done on the Unit Tests.

The following paragraphs illustrates two major results of this phase. These are:

- Railway concepts instantiated;
- IFC files produced by SV for Storylines.

### IMPORTANT:

- The measurement period is: April 2021 – November 2021
- The sources for the KPIs' measurement is the GitHub repository of the Project.
- 

### 3.2.1 Railway concepts instantiated

One of the objectives of the tests on Storylines was to instantiate as many as possible entities just introduced in IFC 4.3 – specifically railway related ones.

How many of the entities in the schema can be considered “of specific interest for railway”? To answer this question refer to the following diagram. To be read from bottom-right, form top-left: out of the +800 entities of the IFC schema, only around 200 are objects (aka, rooted entities). Of these 200, 85 (42%) are considered of interest for railway use case. And of these 85, **70 (82%) have been tested** and instantiated.

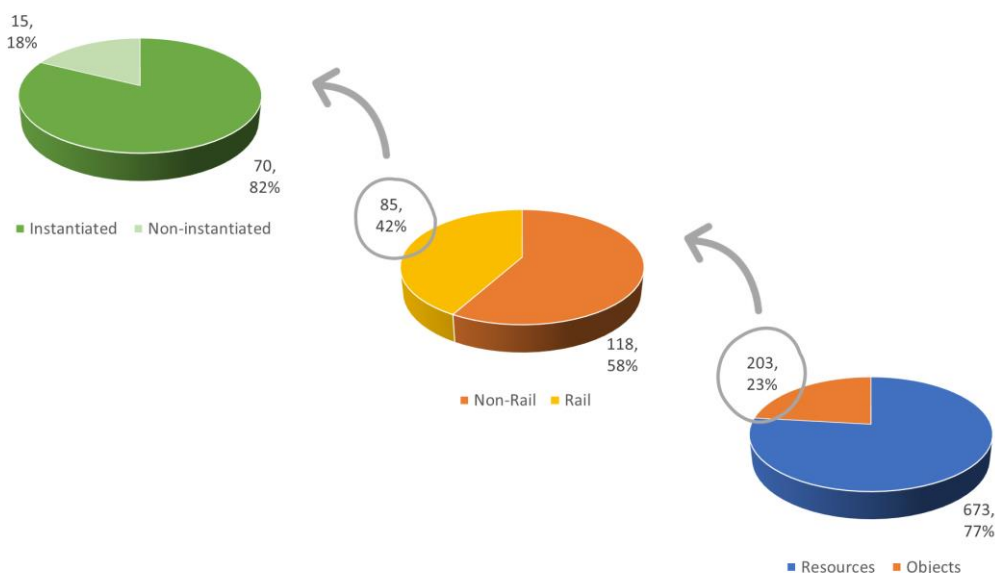


Figure 23 – Entities of the IFC 4.3 schema of interest for railway

Some minor entities (15, 18% of the overall railway entities) have not been instantiated, due to the scope of Storylines.

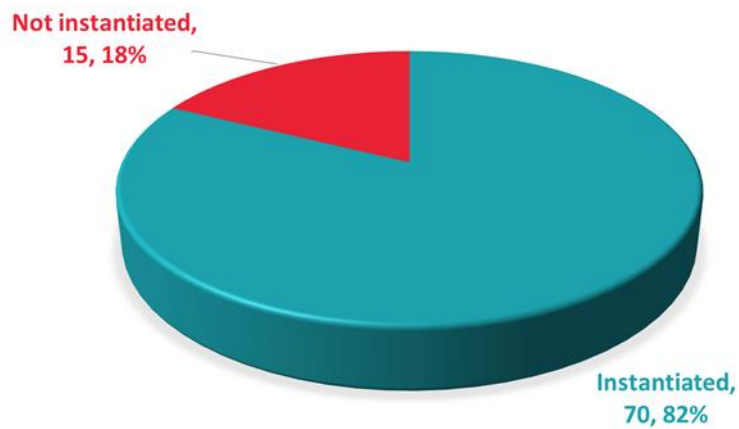


Figure 24 – Entities of interest for railway which have been instantiated in Storylines or Unit Tests (82% of total)

### 3.2.2 IFC files produced by SV for Storylines

Amongst the Software Vendors considered active during the Storyline test phase, 5 of them were able to submit one or more IFC 4.3 file – sometimes for more than one Storyline. The diagram below captures the Storylines for which the vendors have submitted at least one (but sometimes more) IFC 4.3 files.

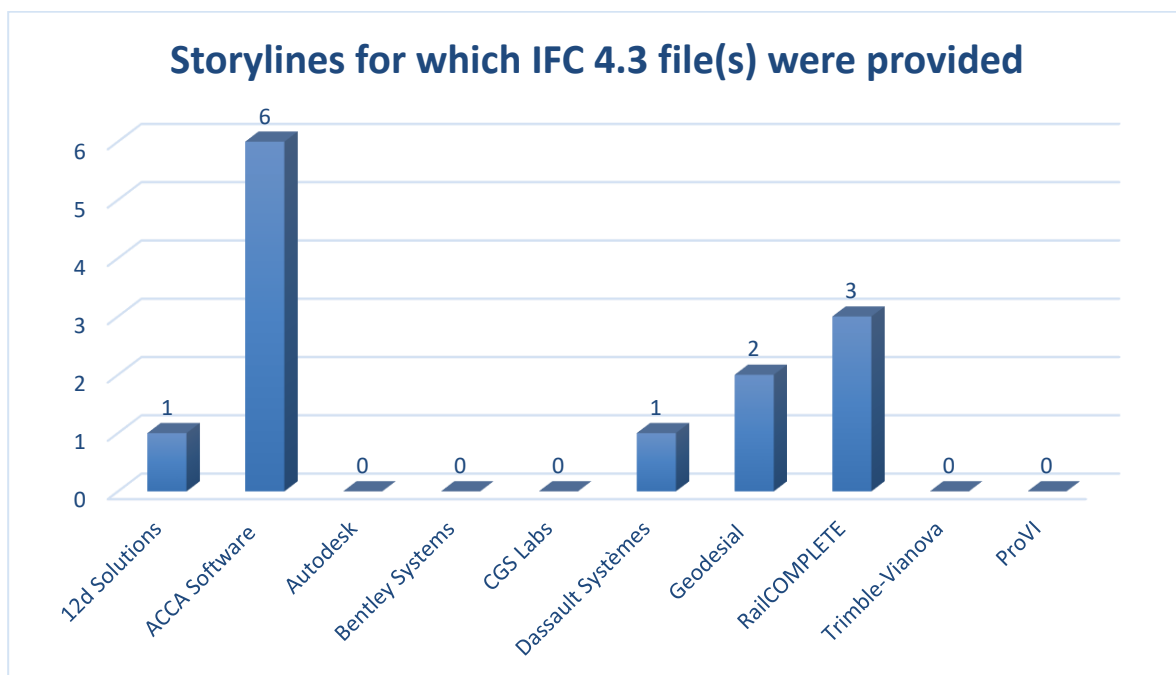


Figure 25 - Storylines for which IFC 4.3 files were provided, per-vendor view

**Note:** RDF, ODA, GeometryGym, TUM and toolkit providers are not listed in the table above. However, their engagement is considered active and their contribution essential to the success of other vendors.

Not every Software Vendors had the resources to follow every Storyline. For this reason, the Forum asked the vendors to provide an estimation on the Storylines for which they intended to play an active role – and the ones for which they would have been “observers only”. Given this context, the outcomes (for 4 out of 5 of these vendors), matched the envisioned engagement. In fact, four vendors were able to submit at least one file for more than 75% of the Storylines they have applied for. This is reflected in the diagram below.

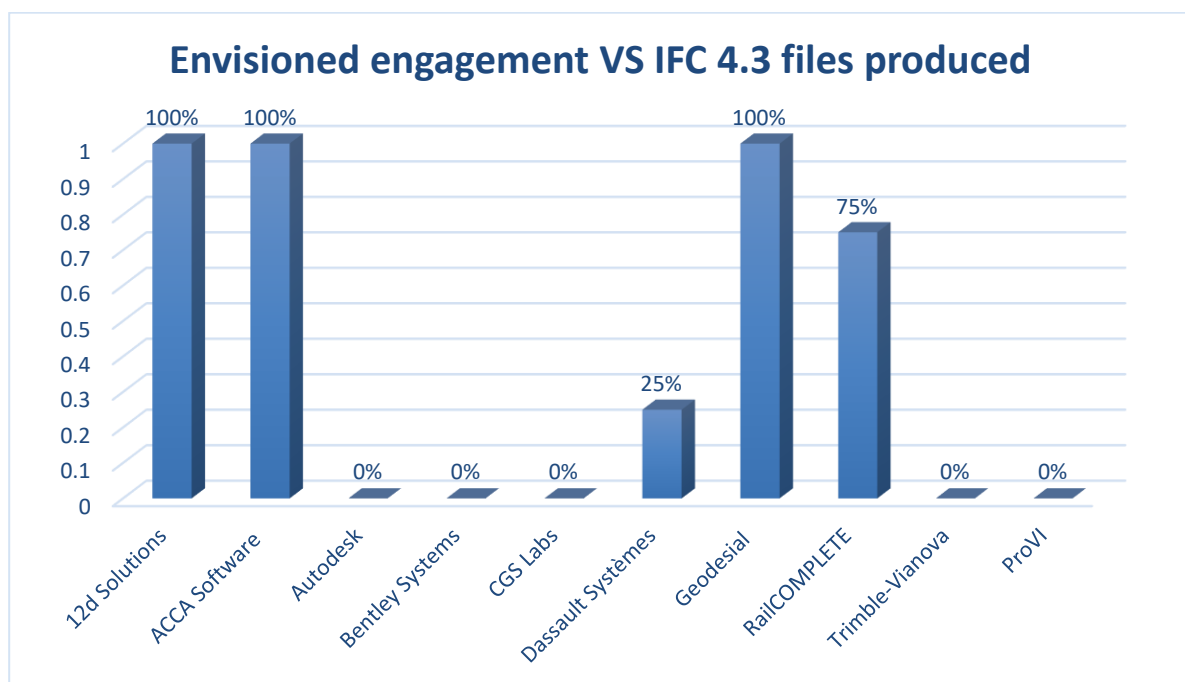


Figure 26 - Envisioned engagement VS IFC 4.3 files produced



### 3.3.1 Methodology

The workshop was articulated in a set of *speed-rounds*, in which participants had to provide an answer or complete a sentence on a specific topic – in a relatively short time (2-4 minutes per question). The topics were divided by areas of investigation. The areas (identified by colours) are the following:

- Collaboration between SH and SV
- Acquired knowledge on IFC 4.3
- Added value / issues / future of the Forum
- SW certification
- Suggestions to speed-up IFC 4.3 adoption & to support IFC 4.3 certification
- Modelling use cases required by experts VS supported by vendors
- SV needs & priority to start / accelerate IFC 4.3 implementation

### 3.3.2 Summary of the rounds

Below is a one-sentence summary of the *speed-rounds*.

#### Round 1-7

##### Round 1 – Testing phase expectations

Expectations met in terms of trust and confidence in the standard. Expectation not met for complex use cases

##### Round 2 – Collaboration between software vendors and domain experts

Collaboration definitely a plus for everybody

##### Round 3 – How to improve collaboration

Domain experts would like to improve the specification of the info requirements, pilots and real cases. Software vendors would like to tackle the problem in small chunks.

##### Round 4 – How are you going to use IFC 4.3?

I am going to use IFC4.3 for exchange requirements for model coordination definitely a plus

##### Round 5 and 7 – Forum added value and future

The forum is definitely good for both parties and it shall continue

##### Round 6 – Topics that required more discussion

The forum could improve by being inserted in the bSI strategy and in a path that goes beyond the project

## Round 8-12

### Round 8 – Current software certification program

Certification problems not appreciated: lack of transparency and lack accessibility for small/specialized SW. Way forward in Round 9

### Round 9 – Input for SW certification program

To be: open to new cases put forward by stakeholders; modular; more transparent; clearer (process); affordable (price). Support multiple applications (of the same SV).

### Round 10 – SDK certification

Topic to be escalated to bSI.

### Round 11 – Facilitate adoption of IFC 4.3

RR: prioritize MVDs, create templates+platform for

specifying modelling use cases

SH: requires it in contracts; use it

bSI: communicate clearly about status. Let the industry use it for a while before making major changes

SV: (sdk) support if, even if not officially announced

### Round 12 – Support bSI SW certification program

RR: process for qualification of tool's capability for IFC4.3

SH: complete modelling use cases w/formal criteria

bSI: defines it; make it modular

SV: challenge the standard during test, not after

## Rounds 13 + Use Case Round

### Use Case Round – Demand / Supply

Top 3 modelling use cases required (supported):

1. Alignment and track design (1)
2. Cabling network design (4)
3. Earthwork design (4)

Top 3 viewer/gis capabilities required:

1. 3D viewer incl. cross section (1)
2. 3D viewer incl. alignment layouts (1)
3. GIS incl. alignment layouts (3)

Top 3 analysis capabilities required:

1. Model checking 1D (1)
2. Model checking 3D (1)
3. Visibility checking (1)

### Round 13 – SV needs/priority for implementation

Absolut Prio 1:

- Use case ER and MVDs
- Use case modelling requirements

Between Prio 1 and 2

- IFC reference files
- Simplified certification process per use case (assess capability)
- Validation/acceptance criteria per use case

Prio 2:

- Use case test plans

Between Prio 2 and 3:

- Use case Visualisation requirements

## 4 Conclusion

The **objectives** of the IFC Rail Implementers Forum were:

- Engage in a collaborative approach with Software Vendors;
- Provide support for implementation of IFC 4.3;
- Measure engagement and success;
- Ultimately, prove that the IFC 4.3 standard can be implemented by software solutions, and used in realistic business cases.

The major **outcomes** of the Rail-IF are:

- A fruitful collaboration between Stakeholders, Software Vendors, Technical Service Team;
- A high level of engagement;
- A diverse level of success;
- An exhaustive test of core concepts.

Additionally:

- Some stakeholders will start asking IFC 4.3 in public contracts, which can further speed up adoption;
- The tools to specify & validate models proved to be helpful both for Clients & Software Vendors.

In the conclusive workshop of the Rail-IF, most of its participants valued the Forum as a positive experience that should definitely continue – ore even enlarged to include other bSI stakeholders.

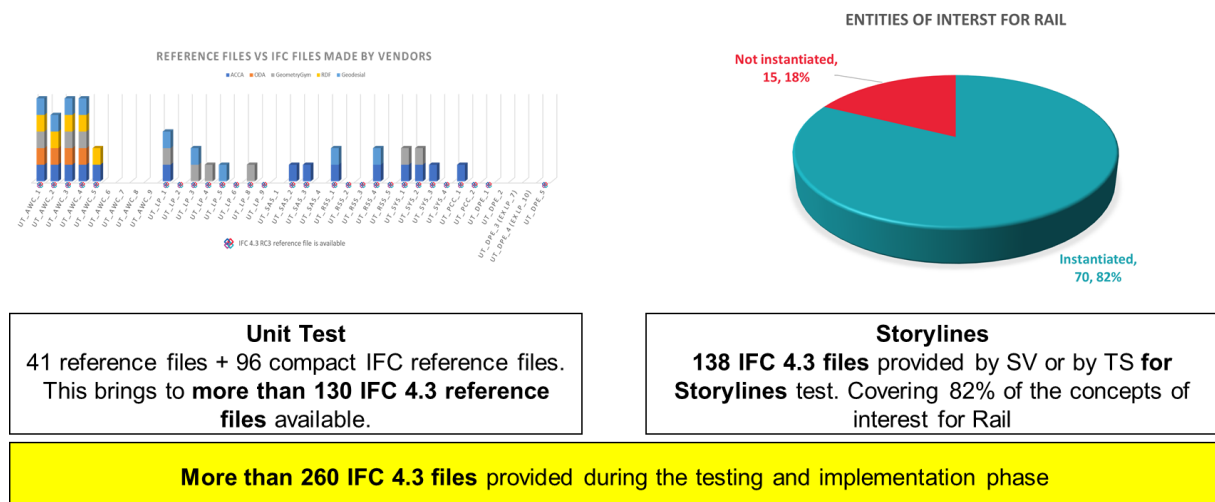


Figure 28 - A quantitative (and qualitative) example of the delivered results



## Appendix

### A. Export of MIRO board

Add export here

### B. Resolved Issues and Decisions

This chapter lists the resolved issues and agreements regarding the standard. The sources of these issues are:

- 1 GitHub issues in IFC-Rail-Unit-Test<sup>1</sup>
- 2 Indepth Technical Discussion Meeting
- 3 Unit Test Meeting
- 4 Closed GitHub issues in IFC-Specification that are relevant to Rail

| No. <sup>2</sup> | Source | Topic <sup>3</sup> | Description  | Conclusion   |
|------------------|--------|--------------------|--|--|
| #1               | 3      | AWC                | Missing the approach to flexibly define properties for alignment layouts and segments.   | IfcAlignmentSegment is derived from IfcProduct, so IfcAlignmentHorizontal, IfcAlignmentVertical and IfcAlignmentCant. Two Psets are defined for IfcAlignmentSegment. |
| #2               | 1      | AWC                | Formulae for transition curves in the specification shall be specified.  | Formula for all types of segments are redocumented and tested  |
| #3               | 1      | AWC                | Rotation point for cant and its impact for resulted geometry.  | With attributes in IfcAlignmentCantSegment, rotation point has no impact for geometry  |
| #4               | 3      | AWC                | Require generic definitions for cant based on different vertical references; vertical alignment is measured from center line, head of lower rail, bottom of lower rail or other possibilities. | Cant is defined by left cant and right cant, which is generic to cover all types of scenarios  |
| #5               | 3      | AWC                | Require three layouts as traditional representation for alignment.   | The three layouts (IfcAlignmentHorizontal, IfcAlignmentVertical and IfcAlignmentCant) are derived from IfcProduct,   |

<sup>1</sup> This chapter only lists resolved issues regarding the standard thus many issues posted on GitHub that are related to specific Unit Test cases or datasets are not listed here.

<sup>2</sup> For reporting purpose, this No. is only relevant for this document. It has no relationship with number of issues or pull requests in other places.

<sup>3</sup> A issue usually has impact for more than one Topics. This column only indicates the most relevant one.

|     |   |     |   |  |
|-----|---|-----|---|--|
|     |   |     |   | which can have its own geometric representation  |
| #6  | 3 | AWC | How to define Viennese bend in alignment?   | VIENNESEBEND is defined as a predefined type for IfcAlignmentHorizontalSegment; in geometry part, IfcSevenOrderPolynomialSpiral can be used to defined Viennese bend.  |
| #7  | 4 | AWC | IfcSine and IfcCosine attribute   | The schema is updated for all the terms and data types of these two entities   |
| #8  | 4 | AWC | Data type of ConstantTerm for all IfcSpiral subtypes  | It is updated to IfcLengthMeasure  |
| #9  | 4 | AWC | Inconsistency of data types for RadiusOfCurvature for IfcAlignmentHorizontalSegment and IfcAlignmentVerticalSegment                                     | The IfcAlignmentVerticalSegment.RadiusOfCurvature is updated to IfcLengthMeasure   |
| #10 | 2 | AWC | IfcAlignment/IfcLinearPositioningElement.Axis is redundant with IfcAlignment/IfcProduct.Representation  | IfcLinearPositioningElement.Axis is removed  |
| #11 | 1 | AWC | Requires end point or end position for curves that are defined based on segments as redundant information to e.g. check accuracy                        | Schema is updated for this   |
| #12 | 2 | AWC | Ambiguity on "Placement" on different levels for alignment segments: IfcAlignmentSegment.ObjectPlacement; IfcCurveSegment.Placement; IfcCircle.Position | The documentation is updated and plenty of sample files are created for this   |
| #13 | 3 | AWC | The convention for defining CW and CCW  | CW and CCW are not defined as explicit attributes, but depend on position or negative of radius of curvature   |
| #14 | 2 | AWC | Confusion between IfcAlignmentHorizontal.StartDistAlong and Station   | StartDistAlong is removed from the schema. The agreed convention is that all types of "distance along" is considered as geometric measurement that is in the schema, which "station" is a semantic concept that is in Psets. |

|     |   |     |   |   |
|-----|---|-----|---|---|
| #15 | 2 | AWC | IfcAlignmentCantSegment: StartDistAlong should be IfcLengthMeasure instead of IfcPositiveLengthMeasure to allow negative offset | It is updated since RC2   |
| #16 | 2 | AWC | The required shape representation identifier and type for IfcGradientCurve and IfcSegmentedReferenceCurve in Alignment          | It is agreed to use 'Axis'  |
| #17 | 2 | AWC | The required segment types and how to represent them using IfcCurveSegment together with IfcCurve as the ParentCurve            |   |
| #18 | 2 | AWC | The detailed meaning and illustration update for IfcSegmentedReferenceCurve   | The documentation is updated  |
| #19 | 4 | AWC | The confusion caused by the image in the IfcAlignmentVerticalSegment. It mixed Station and StartDistAlong                       | The image is updated  |
| #20 | 3 | AWC | The confusion caused by attributes in vertical segment in RC1   | IfcAlignmentVerticalSegment: Change StartCurvature and EndCurvature to StartGradient and EndGradient  |
| #21 | 2 | AWC | The step-by-step instruction to curve semantic part of alignment to geometry part of alignment                                  | The source code for doing this is shared on IFC-Rail-Unit-Test-Reference-Code repository (see Chapter 3.4.1)                                  |
| #22 | 2 | AWC | The confusion between Cubic Parabola, Cubic and Cubic Spiral  | Only Cubic is in the schema, which is an approximation of Clothoid  |
| #23 | 2 | AWC | The confusion between Helmert and Biquadratic Parabola  | Biquadratic Parabola is an approximation of Helmert Curve. Only Helmert Curve is in the schema  |
| #24 | 3 | AWC | The confusion caused by transition curves in cant segment in RC1  | CLOTHOID is made as LINEARTRANSITION in cant segment  |
| #25 | 3 | AWC | What does StartRadius mean in IfcAlignment2DCantSegTransition in RC1  | This part is remodelled since RC2 and this attribute is removed.  |
| #26 | 2 | AWC | How to model 'Doucine' in Alignment?  | Doucine is not required in geometry in design documents in France, so it is modelled as a property SmoothingLength of IfcAlignmentCantSegment |

|     |   |     |  |   |
|-----|---|-----|--|---|
| #27 | 2 | AWC | IfcLinearElement subtypes violate general agreement imposed in IFC 4, that is to remove all direct attributes                                    | This is updated in RC2 and further in RC3 that IfcRelNests is used in the decomposition structure of alignment. Only IfcAlignmentSegment an direct attribute to entities in Resource Layer  |
| #28 | 1 | AWC | Should AdverseCant in LandXML be modelled in IFC as properties?  | It is redundant with horizontal and cant information and can be derived, so it is not in the standard.  |
| #29 | 1 | AWC | StartHeight in vertical alignment shall be defined as StartElevation, which is measured from mean sea level?                                     | StartHeight defines the height in the context of alignment, so it is not measured from mean sea level. StartElevation is defined as a property of IfcAlignmentVerticalSegment, so is EndElevation.                                  |
| #30 | 1 | AWC | How to interpret the redundant information in IfcAlignmentVerticalSegment  | HorizontalLength as a mandatory attribute should drive the interpretation for geometry; RadiusOfCurvature is an OPTIONAL attribute.   |
| #31 | 1 | AWC | An error in IFC4.3_RC1 regarding IfcLinearAxisWithInclination that it is not possible to be linked with IfcLinearPositioningElement through Axis | Not relevant anymore since RC2, as this part is remodelled and IfcLinearAxisWithInclination is removed.   |
| #32 | 2 | LP  | Parameterization of new curve types  | The parameterization of a IfcGradient, IfcSegmentedReferenceCurve and IfcOffsetCurvebyDistances are all based on parameterization of the BasisCurve. The parameterization of IfcSpiral subtypes is documented in the specification. |
| #33 | 3 | LP  | How to model broken chainage in IFC?   | A Pset Pset_Stationing is defined to capture the  |

|     |         |    |  |  |
|-----|---------|----|--|--|
|     |         |    |  | explicit information for broken chainage.  |
| #34 | 2 and 3 | LP | Require generic definition for linear placement and clarify the meaning of each attributes by improving documentation.                                   | The schema and documentation has been updated since RC2  |
| #35 | 2       | LP | The offset direction of IfcPointByDistanceExpression, especially when it is used on IfcSegmentedReferenceCurve   | The documentation and sample files clarify this question (specifically the file for UT_LP_3)   |
| #36 | 2       | LP | The default direction of IfcAxis2PlacementLinear.Axis and IfcAxis2PlacementLinear.RefDirection, especially when it is used on IfcSegmentedReferenceCurve | The documentation and sample files clarify this question (specifically the file for UT_LP_3)   |
| #37 | 3       | LP | How to associate an IfcReferent and the IfcAlignment that it is positioned on  | IfcRelNests shall be used. The ordering of the list shall follow the order of Station  |
| #38 | 2       | LP | How to trace from the element back to the alignment it is placed based on  | IfcRelPositions can be used between an IfcElement or an IfcSpatialElement and the IfcAlignment that it is positioned on  |
| #39 | 1       | LP | How can the the Linear Referencing Methods defined?  | A new Pset Pset_LinearReferencingM method is defined   |
| #40 | 1       | LP | How to define measurement along horizontal for DistanceAlong in linear placement   | It is agreed that regarding DistanceAlong for IfcGradientCurve and IfcSegmentedReferenceCurve, the measurement is done based on its BasisCurve, which will be an IfcCompositveCurve in most cases. In this case, DistanceAlong can be defined as horizontal measurement. |
| #41 | 1       | LP | How to define "Span Placement" in IFC since the update in RC2?   | An IfcProduct is allowed to associate more than one IfcRelPositions. For "span placement", one IfcProduct can be related to two IfcRelPostions, each of which is related to an   |

|     |   |     |  |  |
|-----|---|-----|--|--|
|     |   |     |  | IfcReferent. The schema is updated for this.   |
| #42 | 2 | LP  | How to define “Linear Properties” like speed in IFC. They should be attached to a concept that has start station and end station                             | IfcLinearElement is defined as non-abstract for this purpose.  |
| #43 | 3 | SAS | What is meaning of FixedReference of IfcFixedReferenceSweptAreaSolid   | The FixedReference defines the local-x axis, which is the projection onto the normal plane to the directrix at the point. Documentation is updated and sample files are created  |
| #44 | 2 | SAS | How to interpret FixedReference for a sweeping considering cant  | A new entity IfcDirectrixDerivedReferenceSweptAreaSolid is extended for this purpose   |
| #45 | 3 | RSS | How to use IfcRelInterferenceElements.RelatingElement and IfcRelInterferenceElements.RelatedElement and the direction of interference implied in this entity | The documentation is updated   |
| #46 | 3 | RSS | IfcRelInterferenceElements.InterferenceType should have predefined types as enumeration or at least clearly documented in the entity                         | The documentation is updated   |
| #47 | 1 | SYS | IfcGroup cannot relate to IfcRelReferencedInSpatialStructure   | The schema is updated to support this  |
| #48 | 3 | SYS | How to link Group to the project breakdown structure   | Either through IfcRelReferencedInSpatialStructure to an IfcSpatialStructureElement or through IfcRelDeclares to IfcProject   |
| #49 | 3 | SYS | How to define “Group of groups”  | A group (IfcGroup or subtypes) can be part of multiple groups. The relationship to be used is IfcRelAssignsToGroup. Some restrictions applies (follows) a. Circular reference (e.g., cyclic relationships) is not allowed, neither direct nor indirect; b. Only direct |

|     |   |        |  |  |
|-----|---|--------|--|--|
|     |   |        |  | inclusions allowed (if A includes B and B includes C, A cannot include C) c. Same-level grouping is not allowed. Meaning, If two or more Group are part of the same Group, they cannot include each others   |
| #50 | 3 | DPE    | Base Transceiver Station (BTS) as a "container" for all the elements inside it cannot be modelled as an IfcElement subtype | BTS has two meanings in railway, either as site based "spatial container" for elements, as BTS cabinet. In the first case, it shall be defined as a spatial structure element. This can be generalized for substation and other site-based facilities along railway. |
| #51 | 4 | DPE    | Requires more PDTs for the Signalling domain   | RECORDINGEQUIPMENT and LINESIDEELECTRONICDEVICE are added as new PDTs for IfcCommunicationsAppliance   |
| #52 | 4 | DPE    | Requires more PDTs for the Telecom domain  | The schema is updated. New PDTs are added for IfcMobileTelecommunicationsAppliance, IfcCommunicationsAppliance, IfcAudioVisualAppliance, IfcDistributionBoard, IfcUnitaryControlElement and IfcDistributionSystem  |
| #53 | 4 | OTHERS | Entities and types in IfcRail subschema need to be reorganized   | The IfcRail subschema is updated to IfcRailDomain. Entities are reorganized  |
| #54 | 1 | OTHERS | IfcLengthMeasure documentation should remove "Usually measured in millimeters"?  | The documentation is updated   |
| #55 | 4 | OTHERS | Empty Psets from Rail are in the specification   | Empty Psets are removed  |