

IFC Rail Project

Storyline (SL) Implementation Report (IR)

***New High-speed Line (NHL) -
Signalling(SL)***



Detailed Design Phase (DD)

SL-IR-SLNHL-DD-CRBIM

Contents

1	Storyline documentation update	4
1.1	Updated Storyline Synthesis	4
1.2	Updated Storyline Description	5
2	Exchange Scenario (ES) and Tests	6
2.1	Exchange Scenario: SLNHL-DD-ECM-ES1.....	6
2.1.1	Updated Exchange Scenario	6
2.1.2	ES Test description and results.....	7
2.2	Updated Exchange Scenario: SLNHL-DD-ICM-ES2.....	8
2.2.1	Updated Exchange Scenario	8
2.2.2	ES Test description and results.....	9
2.3	Updated Exchange Scenario: SLNHL-DD-3DV-ES3.....	10
2.3.1	Updated Exchange Scenario	10
2.3.2	ES Test description and results.....	10
2.4	Updated Exchange Scenario: SLNHL-DD-QTO-ES4	11
2.4.1	Updated Exchange Scenario	11
2.4.2	ES Test description and results.....	11
3	Supporting Files and Storyline Archives	12
3.1	Exchange Requirements (ER)	12
3.2	SL Data archives.....	12
3.3	Test Dataset(s).....	12
4	Appendices	12
4.1	Storyline Documentation	12
4.2	Business and business process related findings.....	12

Room: Railway Room

Project/Activity: IFC Rail Phase 2

Document Title: WP1: Storyline (SL) Implementation Report

Version: 1.0

Date: 2021.10.31

Test Leader: WANG Huaisong

ID: SL-IR-SLNHL-DD-CRBIM

Stakeholder: CRBIM

Intellectual Property Rights for Data provided for Unit Tests (including Dataset)

As far as the data for the Unit Tests (Data) has been provided by the IFC Rail Consortium members (Stakeholder) either directly or on behalf of a IFC Consortium member by a 3rd party the following regulations apply to the Intellectual Property (IP) Rights of the data:

The IP of the data is entirely owned by the Stakeholder.

The Data is provided and can be used only for the purpose of testing to implement the IFC Rail Standard by Software Developers.

Any other utilization of the Data beyond the scope of the implementation of the IFC Rail Standard needs prior written approval of the IP owner of the Data.

In course of performing the services of the tests or providing advice pre-existing invention, discovery, original works of authorship, development, improvements, trade secret, concept, or other proprietary information or intellectual property right owned by the Software Developer who performs the tests are not affected and remain in the ownership of the Software Developer

By participating in the project IFC Rail Phase 2 and using the Data the Software Developer acknowledges the above IP rights for the Data.

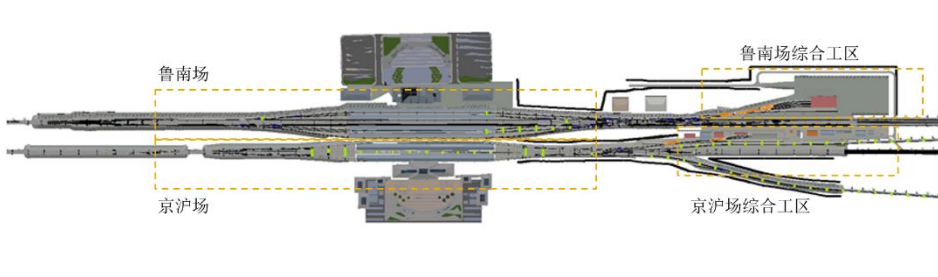
1 Storyline documentation update

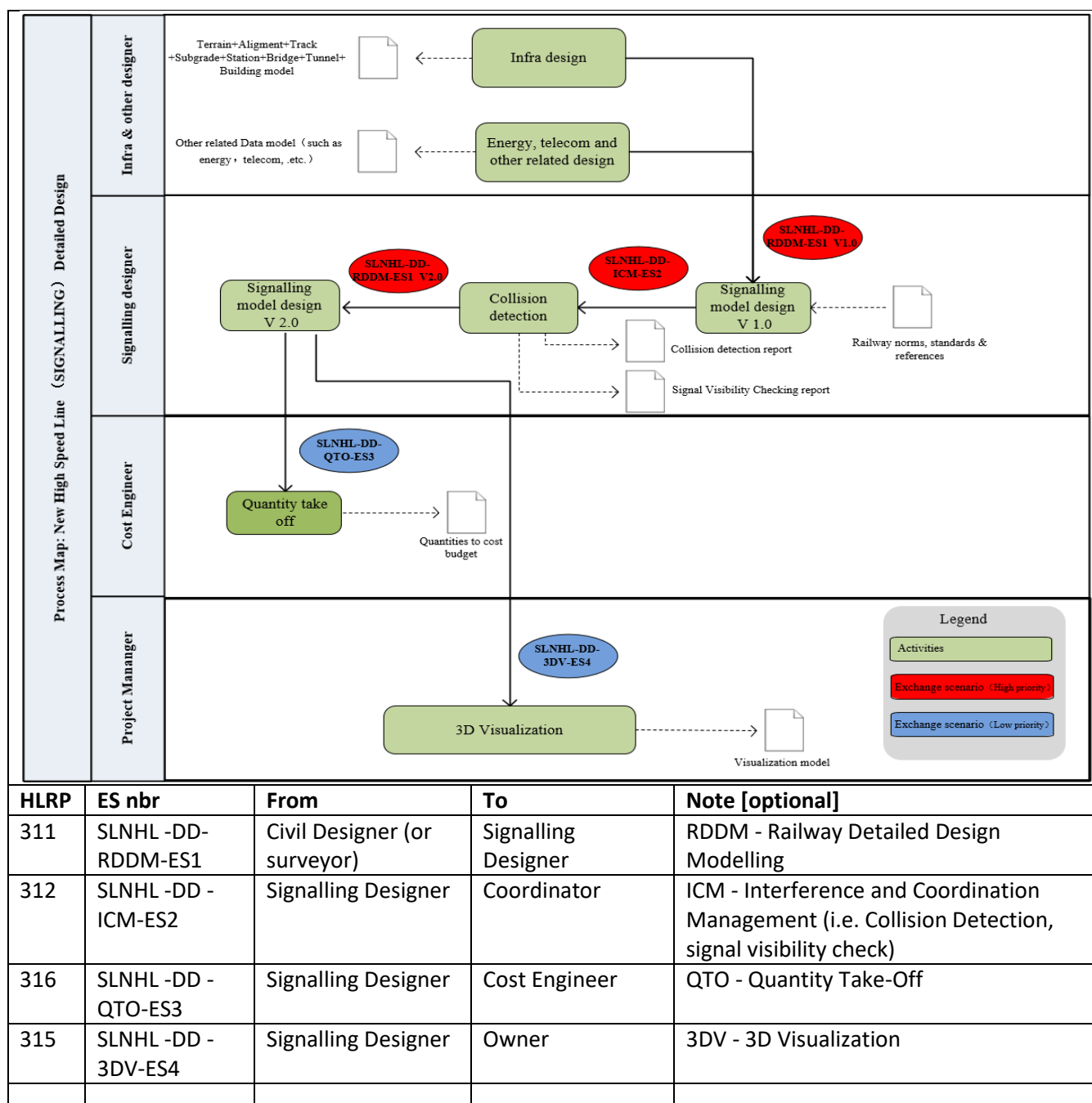
1.1 Updated Storyline Synthesis

Room:	Railway Room	Author: Domain Expert	WANG Huaisong FRAIOLI DOMENICO
Project/Activity:	IFC Rail Phase 2	Verification: Technical Expert	LIU Houqiang
Document Title:	Storyline: New High-speed Line-Signalling	Approbation: Test leader	
Version:	1.0	PMO checker:	Chi Zhang
Date:	2021.10.31	ID:	SLNHL-DD
Description (a)			
Project Phases (b)	<input type="checkbox"/> PL - Planning <input type="checkbox"/> Build <input type="checkbox"/> ID - Intermediate design <input type="checkbox"/> Operation & Maintenance <input checked="" type="checkbox"/> DD - Detailed design <input type="checkbox"/> Dismiss		
Use Cases (c)	<input type="checkbox"/> ECM - Existing Condition Modelling <input type="checkbox"/> RDM - Railway Design Modelling <input type="checkbox"/> RDM.DD - Feasibility Study for Railway <input type="checkbox"/> RDM.RIDM - Railway Intermediate Design Modelling <input checked="" type="checkbox"/> RDM.RDDM - Railway Detailed Design Modelling <input checked="" type="checkbox"/> ICM - Interference and Coordination Management (i.e. Collision Detection, including signal visibility check(SVC)) <input checked="" type="checkbox"/> 3DV - 3D Visualization <input checked="" type="checkbox"/> QTO - Quantity Take-Off <input type="checkbox"/> INMP - Handover from Builder to Maintainer (Information Needed for Maintenance Perspective)		
Domains	<input checked="" type="checkbox"/> Track (*) <input checked="" type="checkbox"/> Signalling (*) Interlocking system, Blocking system, CTCs, TDCS/CTC <input type="checkbox"/> Energy (*) <input type="checkbox"/> Telecom (*) <input checked="" type="checkbox"/> Alignment (*) <input checked="" type="checkbox"/> Other (*) Station yard, Bridge, Subgrade, Building (technical room)		
Tested Concepts (d)	alignment, linear placement, indoor and outdoor placement, signalling elements (signal, sign, point machine, cable...), positioning and geo-referencing, exchange requirements, physical elements breakdown, Railway Detailed Design Modelling (RDDM), Collision Detection (CD), Signal Visibility Check (SVC), Quantity Take-Off (QTO)		
Test Leader TL (e)	WANG Huaisong, CREEC(CRBIM), 18381079166@163.com		
Domain Experts DE (e)	CRBIM: WANG Huaisong ,18381079166@163.com; WANG Xuelin, 574529428@qq.com; WANG Yong , abaoji2005@126.com; WANG Lin, 731001406@qq.com; XU Yue, 2210078283@qq.com; RFI: FRAIOLI DOMENICO, d.fraioli@rfi.it; MERLO ROBERTO r.merlo@italferr.it; PUGLISI DANIEL d.puglisi@italferr.it; CRISTOFORI ENRICO E.Cristofori@rfi.it		
Technical Experts TE (e)	WANG Huaisong, Evandro Alfieri, WU Danqi, LIU Houqiang		
Software Vendors SW (e)	Bentley		
Test Dataset (e)	CRBIM		

(a) 2 lines description (b) chose maxi 1 phase and 4 use cases (c) list only domains for the test (d) indicate Covered Unit Test Topics (e) specify names and companies
 (*) specify further sub-disciplines

1.2 Updated Storyline Description

Description of the Business case	<p>During this design phase, Signalling Eng. will design a new signalling system by implementing the placement of outdoor and indoor Signalling equipment, cables and wires. In this test case of IFC RAIL, signalling Eng. will exchange with other domains (mainly with civil, alignment, track, and energy engineers). All interface exchange data requested by Signalling or to be provided to other rail domains should be exchanged.</p> <p>The storyline will be based on the existing BIM project of China Lu-nan high-speed railway.</p>  <p style="text-align: center;">One station of Lu-nan high-speed railway</p>
Duration	<p>The design phase of the Signalling project usually lasts more than 1 year but it depends on the project specifications, technical constraints, project site requirements, etc.</p>
Aim	<p>The aim of the study is to:</p> <ul style="list-style-type: none"> • Define the signalling elements (equipment or devices) and properties which fit to high-speed railway; • Define the exchange data between Signalling domain and other related domains; • Produce datasets as test data based on the selected 4 Use cases; • Implement IFC import and export interface base on the 4 exchange scenarios; • Layout/Positioning the lineside equipment (signal, point machine, balise, etc.); • Detect collision with other domains; • Produce accurate Quantity take-off's (QTO) based on the BIM model; • 3D visualization of outdoor and indoor signalling elements, check the visibility of signals (the signal coverage areas), identify and locate the signalling elements, simulate the routes of cables from outdoor to indoor. <p>Some existing and projected information are also required:</p> <ul style="list-style-type: none"> • Previous data (or model) from intermediate design phase; • Existing horizontal & vertical alignment data; • Existing data (or model) of Civil, Track, Telecom, Energy and other related domains
In Scope	<ul style="list-style-type: none"> • Physical Signalling elements & properties covered by the 4 Use cases, as well as the related exchange data from other domains which has interface with Signalling; • Subsystems: Interlocking, Blocking, CTCs, CTC/TDCS, mainly including outdoor engineering
Out of Scope	<ul style="list-style-type: none"> • Non-physical elements (e.g., signalling circuit, interlocking logic, train control data); • Build and maintenance data
<p style="text-align: center;">Specific Detailed Process Map for this Storyline</p> <p><i>[process map that defines realistic exchange scenarios between software applications ; reference to general processes defined in the IFC Rail Requirements analysis report Chapter 2 : IFC Rail Process Map also called High-level Reference Process Map (HLRP)]</i></p>	



2 Exchange Scenario (ES) and Tests

2.1 Exchange Scenario: SLNHL-DD-ECM-ES1

2.1.1 Updated Exchange Scenario

Id	SLNHL-DD- (Signalling) RDDM-ES1
Exchange Scenario Description <i>[please describe the ES and define In/Out of Scope topics]</i>	
The whole process shall be broken down in the following main steps:	

- Prepare component library (3D models of equipment) and attach basic properties/attributes to the components in advance.
- **Import the civil (layout) model** (e.g., subgrade, track, alignment, bridge, station yard, building (technical room) etc.);
- **Implement Signalling system design by placing outdoor and indoor Signalling equipment, cables and wires** (comply with the norm and principles of railway signalling system. During this phase, it requires data exchange and coordination with other related domains. The exchanged requirements include cable routes, cable trench, rail crossing tube, the size of technical room, communication requirement, etc.) This step could be **implemented automatically** by BIM software based on location data (e.g., excel, ifc, xml)

In Scope:

- Physical Signalling elements & properties covered by the 4 Use cases (exchange scenarios);
- The related exchange data (or model) from other domains which has interface with Signalling domain.

Out of Scope:

- Non-physical elements (e.g. signalling circuit, interlocking logic, train control data);
- Build (Technical room) and maintenance data.

Geometry and positioning requirements

[General description / concepts => specific on Excel sheets]

- Outdoor placement: take the alignment as the reference coordinate system to place signalling outdoor equipment, laying out cables along the cable trench model.
- Indoor placement: select a reference point for installation and arranging the cabinets in technical room. The cabinets shall meet the requirements of horizontal and vertical limits between the adjacent cabinets or the walls;
- Positioning: Installation mileage, installation height, horizontal distance, vertical distance, installation limits, etc.

Spatial requirements

[General description of spatial element requirements => specific on Excel sheets]

- Outdoor placement: installation limits;
- Indoor placement: select a reference point for installation and arranging the cabinets in technical room. The cabinets shall meet the requirements of horizontal and vertical limits between the adjacent cabinets or the walls; installation limits.

Physical and functional requirements

[General description of physical elements, functional elements and important information => specific on Excel sheets]

- Alignment data and the model of track, station yard, turnout, subgrade, bridge, tunnel, etc.
- Identification information, coordinate information (installation reference point, mileage information, vertical distance with alignment), technical information (working voltage, current, equipment function description), layout information (e.g. Subgrade, bridge, tunnel, etc.), installation foundation information, etc.

Covered Unit Test: to be filled by Technical Expert(s)

ID	Unit Test
1	Signalling elements breakdown
2	Linear Placement (Point)
3	Linear Span Placement (From-To)
4	Linear placement "broken chainage"
5	Railway spatial structure/spatial zone

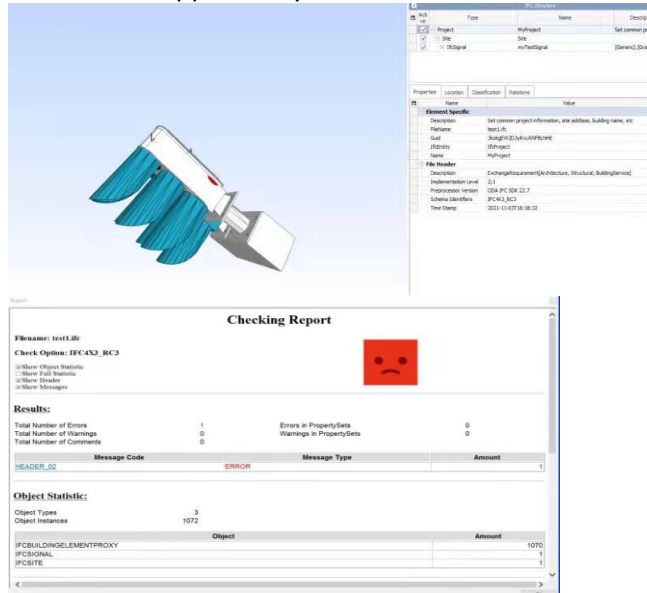
2.1.2 ES Test description and results

Test Completion

(Specify level of completion and if reserves/punchlist opened, additional TS works....)

1. Create the 3D models of Signal elements including all of the ifc properties in dgn (Bentley format) file.
2. Convert dgn file to BIM file use iTwin Synchronizer or iTwin Snapshot.

3. Export the whole model of the Signal into the ifc 4x3 RC3 file.
4. Open the ifc file and check Signal model and Psets by using BIMvision and usBIM (ACCA).
5. Check the validity of BIM files by IFC Checking tool.
6. Check the applicability of the standard at a real BIM project (China Lu-nan high-speed railway).



Test Team and Test Leader Satisfaction

(Specify the Box/Github links to find the test results or documents....)

- 1.The exported model was complete without geometry or information loss, and the IFC 4.3 mapping of Signal is correct. The test team are satisfied with the test.
- 2.Due to the test method is the same for different signalling equipment, therefore the detailed design model is simplified and only signal model is selected for this test.

Tests and Results Archives

(Specify the Box/Github links to find the test results or documents....)

The test results are produced by Bentley software. Here is the link to the files:

- ✓ **Signal.ifc**
- ✓ **Signal_testModel.dgn**
- ✓ **Signal_ifc_test.bim**

BOX link: <https://app.boxcn.net/folder/119147956872?s=261pvo8xf5c5vyis2abjb87emokdlko8>

Github link: [https://github.com/IFCRail/IFC-Rail-Unit-Test/tree/master/8_Storylines%20Test%20\(SL/SL04_Design%20a%20New%20HS%20Line%20-%20Signalling](https://github.com/IFCRail/IFC-Rail-Unit-Test/tree/master/8_Storylines%20Test%20(SL/SL04_Design%20a%20New%20HS%20Line%20-%20Signalling)

2.2 Updated Exchange Scenario: SLNHL-DD-ICM-ES2

2.2.1 Updated Exchange Scenario

Id	SLNHL-DD-ICM-ES2
Exchange Scenario Description <i>[please describe the ES and define In/Out of Scope topics]</i>	
<p>In the process of signalling design, there is a lot of interference and coordination between signalling domain and other domains, so, in this case, we mainly focus on Collision Detection which is based on the assembly model to identify and coordinate the potential conflicts before the construction phase. For Signalling domain, this case also includes the use case of "Signal Visibility Check".</p>	
<p>By 3D Coordination, we can find the potential conflicts as "differences, errors, omissions, collisions" and other</p>	

issues that are difficult to be found in conventional 2D design. It helps to solve the design issues and makes signalling design more reasonable, and finally cuts down the cost and time before construction.

In scope: signalling and other related elements which need to be checked and coordinated.

Geometry and positioning requirements

[General description / concepts => specific on Excel sheets]

- Signalling model and other models should be in the same coordinate system;
- The location of signalling design model references the layout civil model as well as other related domains' model.

Spatial requirements

[General description of spatial element requirements => specific on Excel sheets]

- The outdoor signalling equipment shall meet the requirements of clearance;
- The indoor Signalling equipment shall meet the requirements of installation limits.

Physical and functional requirements

[General description of physical elements, functional elements and important information => specific on Excel sheets]

- Alignment data;
- Coordinates of installation of indoor and outdoor signal equipment (e.g. signal, point machine, boxes, cabinets, etc.);
- The clearance/installation requirements;
- The type and location of turnouts, location of fouling post, etc.;

Covered Unit Test: to be filled by Technical Expert(s)

ID	Unit Test
1	Signalling elements breakdown
2	Linear Placement (Point)
3	Linear Span Placement (From-To)

2.2.2 ES Test description and results

Test Completion

(Specify level of completion and if reserves/punchlist opened, additional TS works....)

1. Check if the trackside signaling elements (e.g., signals, point machines, makers) intrude into the railway structure gauge;
2. Check if the trackside signaling elements are installed reasonably.
3. Check the applicability of the standard at a real BIM project.
4. The signaling models are modified and optimized according to the ICM report.

Test Team and Test Leader Satisfaction

(Specify the Box/Github links to find the test results or documents....)

By collision detection, we find the potential conflicts and other issues that are difficult to be found in conventional 2D design. It helps to solve the design issues and makes signalling design more reasonable.

Tests and Results Archives

(Specify the Box/Github links to find the test results or documents....)

The test results are produced by Bentley software. Here is the link to the files:

BOX link: <https://app.boxcn.net/folder/119147956872?s=261pvo8xf5c5vyis2abjb87emokdlko8>

Github link: [https://github.com/IFCRail/IFC-Rail-Unit-](https://github.com/IFCRail/IFC-Rail-Unit-Test/tree/master/8_Storylines%20Test%20(SL)/SL04_Design%20a%20New%20HS%20Line%20-%20Signalling)

[Test/tree/master/8_Storylines%20Test%20\(SL\)/SL04_Design%20a%20New%20HS%20Line%20-%20Signalling](https://github.com/IFCRail/IFC-Rail-Unit-Test/tree/master/8_Storylines%20Test%20(SL)/SL04_Design%20a%20New%20HS%20Line%20-%20Signalling)

2.3 Updated Exchange Scenario: SLNHL-DD-3DV-ES3

2.3.1 Updated Exchange Scenario

Id	SLNHL-DD-3DV-ES3
Exchange Scenario Description <i>[please describe the ES and define In/Out of Scope topics]</i>	
<p>First, use BIM modeling software to build the 3D models by placing the signalling equipment along the railway line or in the technical room. Second, assemble models with other railway engineering (such as track, subgrade, bridge, tunnel, etc.). Third, perform scene roaming (visual tour) demonstration or construction sequence simulation based on the assembly model. (including visualizing the outdoor and indoor signalling elements, checking the visibility of signals (the signal coverage areas), identifying and locating the signalling elements, simulating the routes of cables from outdoor to indoor, etc.)</p> <p>The 3DV could show the overall situation of the project to the owner as well as realize the construction simulation which can be used to guide the construction sequence. The 3DV also can be used for the later operation & maintenance phase.</p>	
Geometry and positioning requirements <i>[General description / concepts => specific on Excel sheets]</i>	
Location: Installation mileage, installation height, horizontal distance, vertical distance, etc.	
Spatial requirements <i>[General description of spatial element requirements => specific on Excel sheets]</i>	
Precondition: the detailed design model is completed.	
Physical and functional requirements <i>[General description of physical elements, functional elements and important information => specific on Excel sheets]</i>	
Indoor and outdoor 3D models and properties	
Covered Unit Test: to be filled by Technical Expert(s)	
ID	Unit Test
1	Signalling elements breakdown
2	Railway spatial structure/spatial zone
3	Linear Placement (Point)
4	Linear Span Placement (From-To)

2.3.2 ES Test description and results

Test Completion (Specify level of completion and if reserves/punchlist opened, additional TS works....)
<ol style="list-style-type: none"> Integrate all signalling 3D models in detailed design phase. Export the IFC file and open it in other 3D visualization softwares (e.g., LumenRT, CityMaker) Check the applicability of the standard at a real BIM project.
Test Team and Test Leader Satisfaction (Specify the Box/Github links to find the test results or documents....)
The exported IFC model is complete without geometry or information loss. The scenario of 3DV has been completed, the test team are satisfied with the test.
Tests and Results Archives (Specify the Box/Github links to find the test results or documents....)
The test results are produced by Bentley software. Here is the link to the files: BOX link: https://app.boxcn.net/folder/119147956872?s=261pvo8xf5c5vyis2abjb87emokdlko8 Github link: https://github.com/IFCRail/IFC-Rail-Unit-Test/tree/master/8_Storylines%20Test%20(SL)/SL04_Design%20a%20New%20HS%20Line%20-%20Signalling

2.4 Updated Exchange Scenario: SLNHL-DD-QTO-ES4

2.4.1 Updated Exchange Scenario

Id	SLNHL-DD-QTO-ES4
Exchange Scenario Description <i>[please describe the ES and define In/Out of Scope topics]</i>	
<p>Quantity take-off is calculated based on the attribute information which attached to the signalling model (or elements). It can be performed by BIM software automatically. We wish this test will allow:</p> <ul style="list-style-type: none"> • Output the type of signalling equipment; • Output the number of different signalling equipment and the length of different cables and wires; • Output the cost or budget of signalling engineering. <p>In Scope: Signalling equipment. Out of Scope: Non-Signalling equipment.</p>	
Geometry and positioning requirements <i>[General description / concepts => specific on Excel sheets]</i>	
Spatial requirements <i>[General description of spatial element requirements => specific on Excel sheets]</i>	
Physical and functional requirements <i>[General description of physical elements, functional elements and important information => specific on Excel sheets]</i>	
<ul style="list-style-type: none"> • The related information/attributes used for calculating quantities and cost; • The cost of different type of signalling elements (used for signalling engineering budget); 	
Covered Unit Test: to be filled by Technical Expert(s)	
ID	Unit Test
1	Signalling elements breakdown

2.4.2 ES Test description and results

Test Completion (Specify level of completion and if reserves/punchlist opened, additional TS works....)
Calculate the quantity of signaling elements (such as the signals, point machines) automatically based on the Psets which attached to the signaling models.
Test Team and Test Leader Satisfaction (Specify the Box/Github links to find the test results or documents....)
The quantity of the signalling elements was calculated accurately.
Tests and Results Archives (Specify the Box/Github links to find the test results or documents....)
The test results are produced by Bentley software. Here is the link to the files: BOX link: https://app.boxcn.net/folder/119147956872?s=261pvo8xf5c5vyis2abjb87emokdlko8 Github link: https://github.com/IFCRail/IFC-Rail-Unit-Test/tree/master/8_Storylines%20Test%20(SL)/SL04_Design%20a%20New%20HS%20Line%20-%20Signalling

3 Supporting Files and Storyline Archives

3.1 Exchange Requirements (ER)

The Exchange Requirements are available in BOX at the following link:

<https://app.boxcn.net/folder/119147956872?s=261pvo8xf5c5vyis2abjb87emokdlko8>

3.2 SL Data archives

The SL Data of the Signalling Design is archived in the following BOX directory:

- **Storyline documentation :**
<https://app.boxcn.net/folder/119147956872?s=261pvo8xf5c5vyis2abjb87emokdlko8>
- **Storyline Datasets:**
BOX Link: <https://app.boxcn.net/folder/119147956872?s=261pvo8xf5c5vyis2abjb87emokdlko8>
Github Link : [https://github.com/IFCRail/IFC-Rail-Unit-Test/tree/master/8_Storylines%20Test%20\(SL\)/SL04_Design%20a%20New%20HS%20Line%20-%20Signalling](https://github.com/IFCRail/IFC-Rail-Unit-Test/tree/master/8_Storylines%20Test%20(SL)/SL04_Design%20a%20New%20HS%20Line%20-%20Signalling)

3.3 Test Dataset(s)

All the Test Datasets utilized in this Storyline to achieve the SL Tests.

Dataset Title
Dataset for storyline of Signalling
Dataset description
The dataset describes a series of parameters about the placement of different Signalling elements. The dataset takes “China Lu-nan high-speed railway” as an example. so as to help the software vendors to implement the import and export of IFC files, and verify the relevant exchange scenarios of the storyline.
Dataset links
Github: https://github.com/IFCRail/IFC-Rail-Unit-Test/tree/master/7_Domain%20Physical%20Elements%20(DPE)/UT_DPE_3 BOX: https://app.boxcn.net/folder/119147956872?s=261pvo8xf5c5vyis2abjb87emokdlko8

4 Appendices

4.1 Storyline Documentation

See Appendix 4.1

The storyline documentation for Signalling has been well documented, and the documentations are available in the following BOX directories:

- **Storyline documentation :**
<https://app.boxcn.net/folder/119147956872?s=261pvo8xf5c5vyis2abjb87emokdlko8>
- **unit test_Linear Placement-Signalling**
<https://app.boxcn.net/folder/119147956872?s=261pvo8xf5c5vyis2abjb87emokdlko8>

4.2 Business and business process related findings

See Appendix 4.2

The Signalling process is available in the following BOX directories:

- **Signalling process:**
<https://app.boxcn.net/folder/119147956872?s=261pvo8xf5c5vyis2abjb87emokdlko8>