COBS 2022: Software Vendor Workshop

Wednesday, 22 June 2022, 8:00 am – 12:00 pm
Allegheny Room, Omni William Penn Hotel

Jeffrey W. Ouellette
Sr. Advisor, Software Vendor Engagement

BIM FOR BRIDGES AND STRUCTURES
TPF-5(372)

Agenda

Time	Duration	Topic
8:00	15 min	Welcome and introductions
8:15	30 min	bSI IFC4.3 and Alignment-based Reference View development updates, including Q&A
8:45	30 min	TPF-5(372) MVD and Data Dictionary development updates, including Q&A
9:15	30 min	Unit Test Suite update
9:45	45 min	Coffee and networking break (Sponsored by Trimble)
10:30	90 min	Design-to-Construction Workflows Deep Dive: A look at how the proposed IFC MVD, as well as and other complementary bSI standards, can support various project delivery subprocesses between stakeholders and their platforms.
12:00		Adjourn

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Welcome and Introductions

BIM FOR BRIDGES AND STRUCTURES

Attendance / Roll Call

WELCOME!!!

HDR Project Team
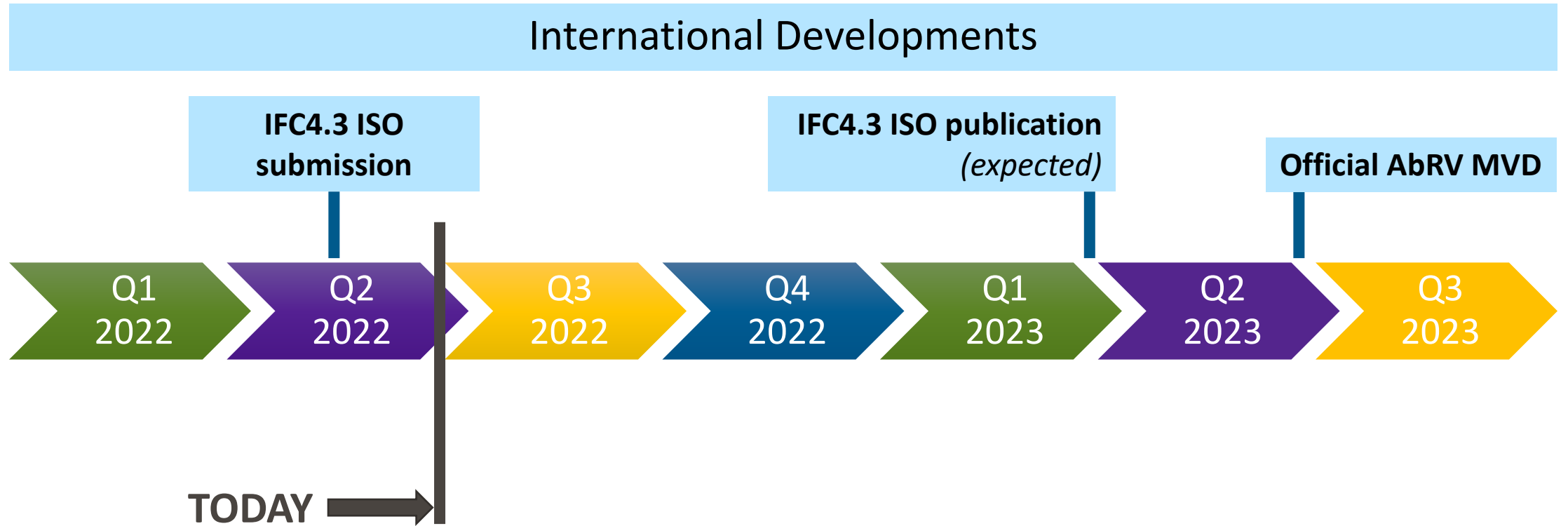
SVAG Member Reps

Pooled Fund Member Reps

Other Guests

Online sign in:
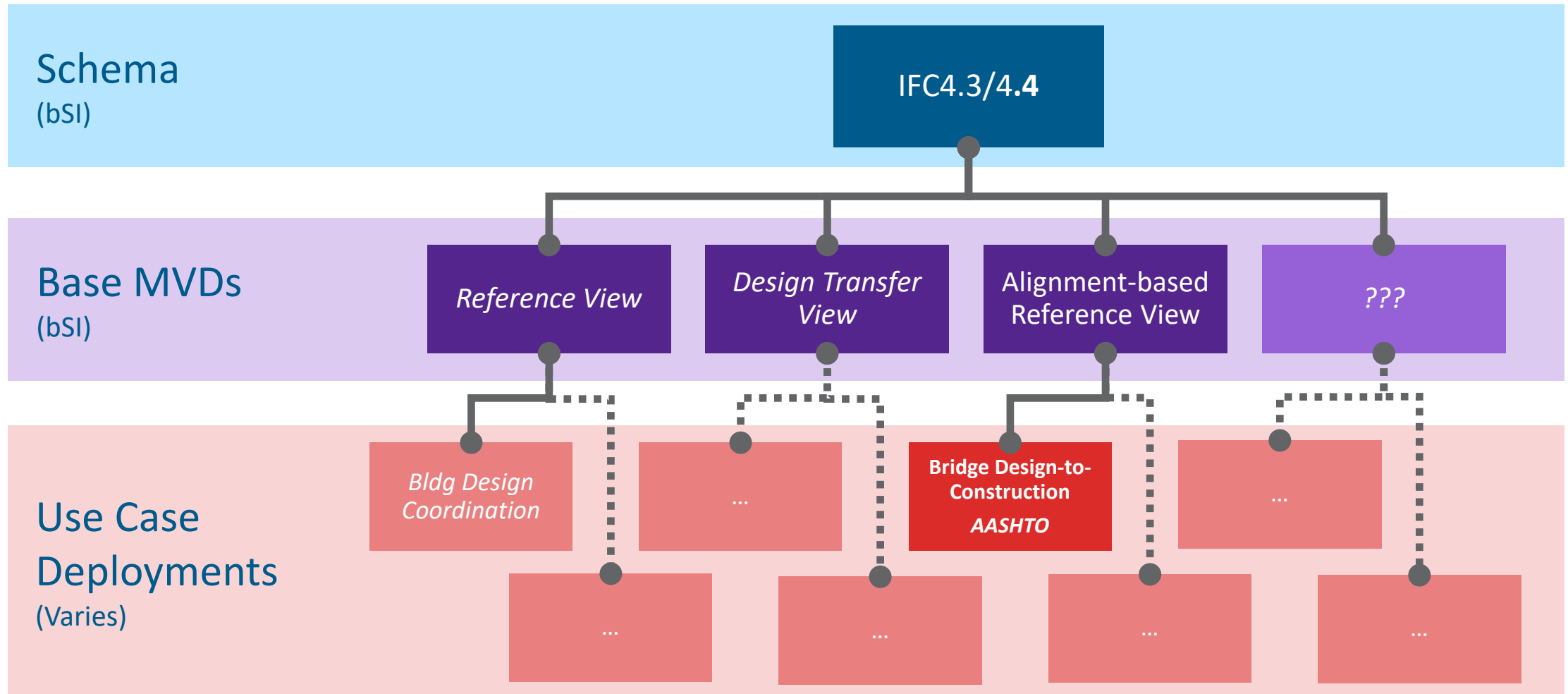
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bSI IFC4.3 & ARV Updates

bSI/ISO Dev & Publications Timeline

International Developments

IFC4.3 ISO submission

IFC4.3 ISO publication *(expected)*

Official AbRV MVD

Q1 2022	Q2 2022	Q3 2022	Q4 2022	Q1 2023	Q2 2023	Q3 2023

TODAY →

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IFC4.3/4.4 MVD & Exchange Strategy

Schema (bSI): IFC4.3/4.4

Base MVDs (bSI): *Reference View*, *Design Transfer View*, Alignment-based Reference View, *???*

Use Case Deployments (Varies): *Bldg Design Coordination*, **Bridge Design-to-Construction** *AASHTO*

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Questions?

TPF-5(372) MVD & DD Updates

TPF-5(372) MVD Dev Timeline

International Developments

IFC4.3 ISO submission

IFC4.3 ISO publication *(expected)*

Official AbRV MVD

| Q1 2022 | Q2 2022 | Q3 2022 | Q4 2022 | Q1 2023 | Q2 2023 | Q3 2023 |

TODAY →

IDM

Exchange Requirements

Pre-Final Bridge Design-to-Construction MVD

Final Bridge Design-to-Construction MVD

DD + IFC4.3 + Unit Tests

Software Dev & Testing w/ Unit Test Suite

Project Developments

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TPF-5(372) MVD Dev & Deliverables

Workflow Stakeholders

Creation and use of model-based information

Bridge Engineer
- Design
- Modeling

General Contractor
- QTO & Costing
- Scheduling

BIM Manager
- QA/QC

Optional role
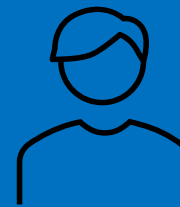
Fabricator / Detailer
- Detailing of components

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TPF-5(372) MVD Dev & Deliverables

Generalized Workflow Components & Process
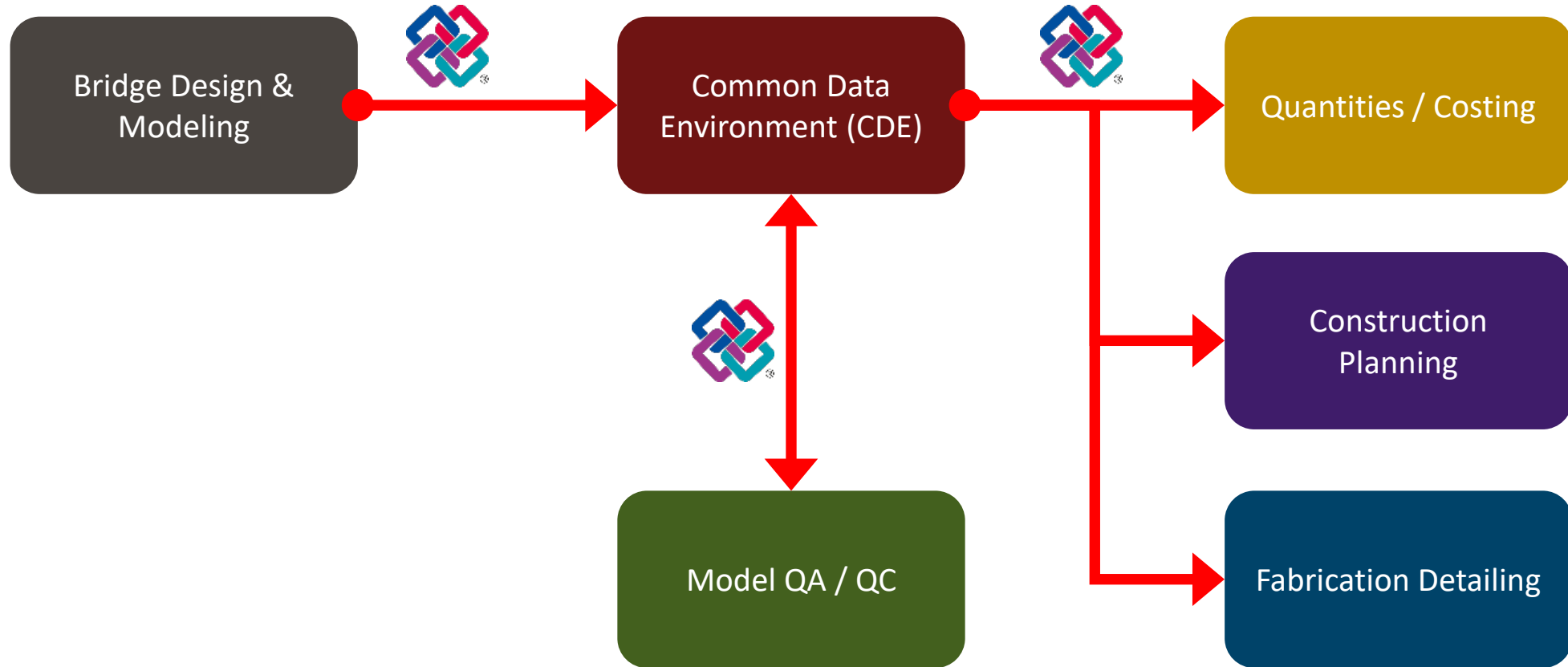
TPF-5(372) MVD Dev & Deliverables

General goals for IFC-based data exchange

K.I.S.S.

- Standardized output/exchange
- Limit (but not eliminate) customization
- Reduce confusion
- Manage expectations
- Simplify digital delivery

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TPF-5(372) MVD Dev & Deliverables

Bridge Design-to-Construction MVD

- bSI IFC4.3 ARV is baseline

- Additions per specific IDM IERs

- Leverage data dictionary for specificity/customization

- Simplify software implementation

In Bridge Designer's BIM software:

1. Open project model
2. Select IFC Export
3. Select MVD (IFC4.3 AASHTO Bridge Design-to-Construction)
4. Save .ifc (ifc-stp) file

Future: *MVD + IDS*

IDS+

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TPF-5(372) MVD Dev & Deliverables

Project Deliverables

1. MVD (mvdXML) for software implementation

2. MVD documentation (html, EXP, XSD) for reference

3. Data Dictionary content (delivered via bSDD)

4. Implementation Guide (for end users)

5. *Deployment Guide (for Software Vendors)*

6. *Vendor-specific configuration files*

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MVD vs. Data Dictionary

MVD

Provides ability to share the data

Data Dictionary

Provides possible content of the data and its unique definitions

Software vendors/ developers

Automation Engineer/ DOT CAD/BIM Manager

IFC export option in software

Apply data templates to CAD workspace

Create object libraries

Bridge Engineer

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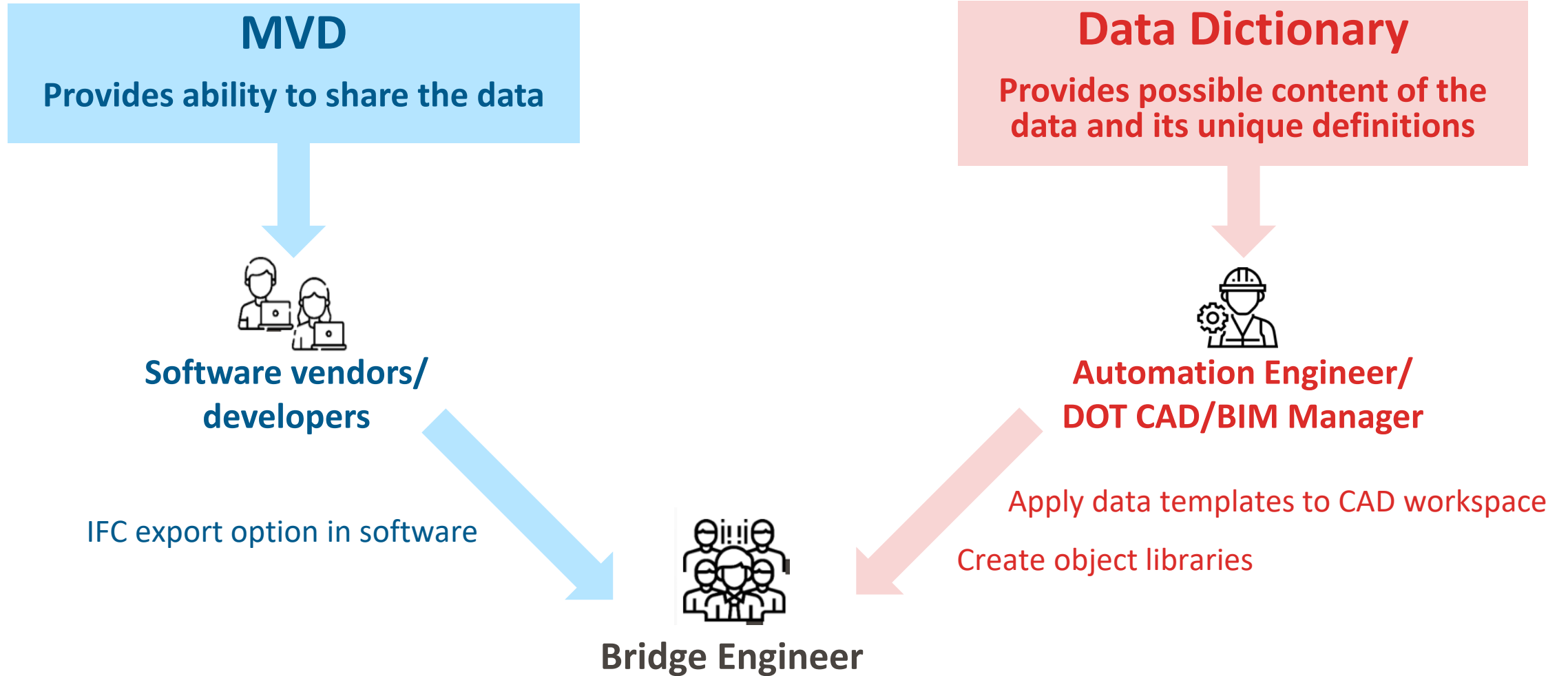
Questions?

Unit Test Suite Update & Ledger Review

Unit Test Suite

Instructions for modeling bridge elements and designs to enable software developer/vendor implementation testing and validation of IFC-based exchange requirements.

OPTION A

SECTION AT PIER CAP

Type 1: I-Girder

(a) AASHTO (b) Bulb Tees

Type 2: Trapezoidal tub

Type 3: Precast Box Girder

(a) Trapezoidal (b) Rectangular

Type 4: Hybrid

I-Girders: for span CIP Boxes: over the pier

Type 5: Tee
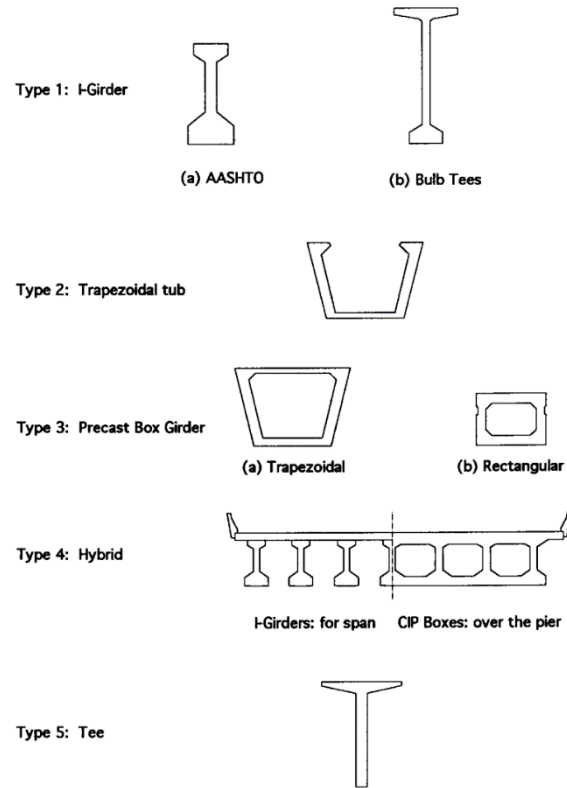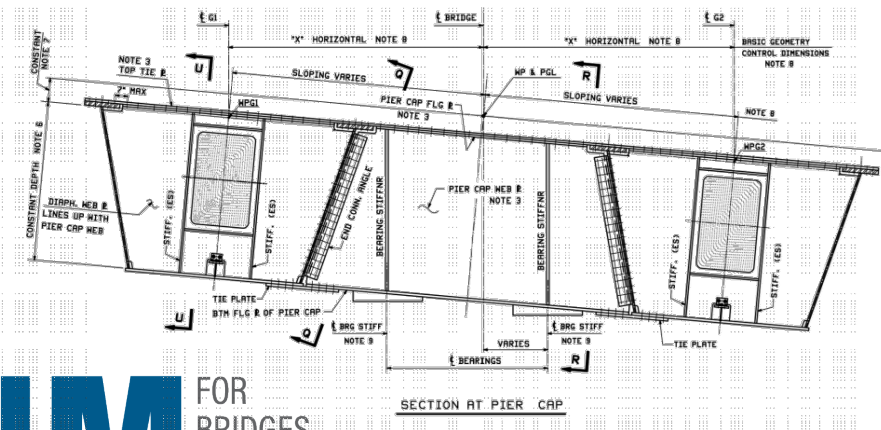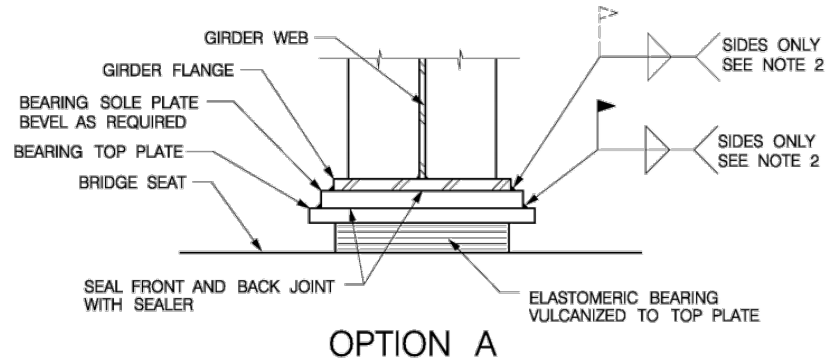
FIGURE 4. Common cross section shapes used in spliced girder bridge applications.

additional bars in the overhang:
#4 @ 8 in., bundle to main reinforcement

#5 @ 8 in.
top main reinforcement
across the entire deck

3'-0"

2.5" cl.

haunch

1" cl.

#5 @ 7 in.
bottom reinforcement
across the entire deck

#6 @ 5.5 in.

#6 @ 8.5 in.
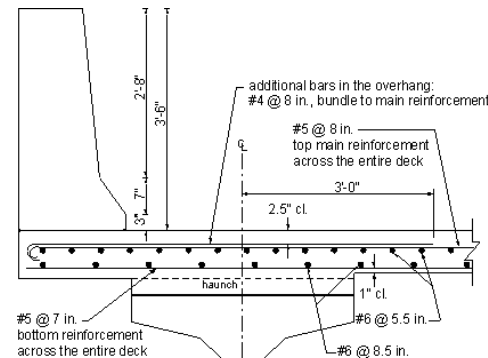
IFC4.3 Schema Properties

Property Set	Property	Value
Information	Name	Pier 01
Information	Type	B
Information	Material	Concrete

Data Dictionary Properties

Property Set	Property	Value
AASHTO Info	Custom Property 01	Value 01
AASHTO Info	Custom Property 02	Value 02
AASHTO Info	Custom Property 03	Value 03

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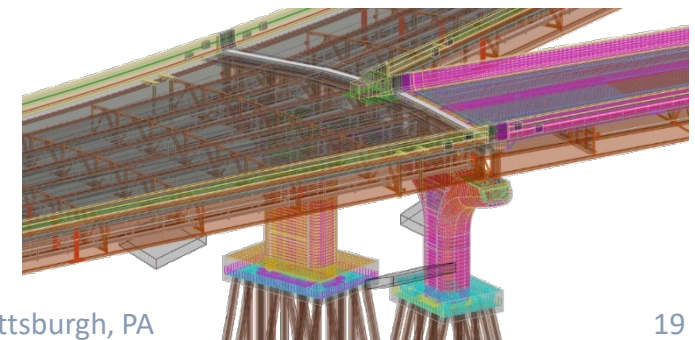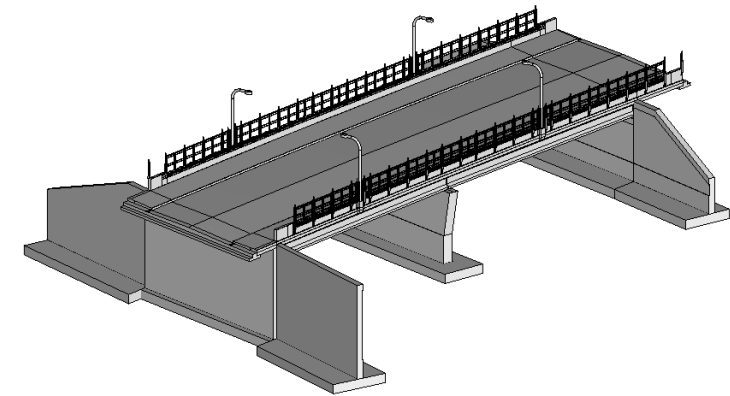
Unit Test Suite: Update

Scope

- 7 bridge designs identified
- Actual projects
- Additional Level 1 Element tests based on state standards

Timeline for Vendors

- Level 1 outline completed beginning of May 2022
- Circulate ledger to Software Vendor Advisory Group in June for review
- Level 1 & 2 Unit Test instructions delivered to vendors at end of July, with prelim MVD requirements
- Levels 3 & 4 and revisions by end of August

Hulton Bridge

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Unit Test Suite: Review by T-19/Pooled Fund

Suggested Review Process

- June 27 - Team to provide ledger w/ illustrations
- Week of July 11 - Orientation
- August 12 - Comments due

Purpose of review is to make sure that we are covering all reasonable permutations for conventional workhorse bridge components.

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Summary:

The Unit Test Suite is designed to provide software developers/vendors with a series of instructions to create and export models of various elements, systems, and conditions across the breadth of expected supported use cases. It uses the common software development methodology of reducing complex software to the most basic operational "unit" that can be objectively judged as to being correct or not. These unit tests start at simple, single elements and then aggregate in various configurations and growing size and complexity at each level. This enables the developer to quickly test the quality of IFC output and more easily troubleshoot basic issues before moving onto the next level of complexity. Ideally, by the time the developer reaches the level of a complete bridge design, there are few issues to correct and none are explicitly related to prior unit test cases.

The baseline "Level 1 - Elements" list is based on the "National Bridge Elements (NBEs)" and "Bridge Management Elements (BMEs)", as defined in the "Manual for Bridge Element Inspection, Second Edition, 2019" by AASHTO, including prestressed concrete-, reinforced concrete-, masonry-, and steel-based material configurations, as well as "Chapter 3 - Scope" of Part One: Industry Use Narrative of the "Information Delivery Manual (IDM): Construction Contract Model, Representing the Handoff from Design to Construction for Highway Bridges". All other lists are logical aggregations of the elements growing in complexity. The "IFC Concepts Tested" for each entry in each list is defined by the exchange requirements of the IDM and resulting Model View Definition (MVD).

Exclusions:
The following elements, elements types, system types, and bridge designs are explicitly excluded from
 - Timber-based elements and bridges
 - Cable-stayed, or suspension, bridges
 - Movable bridges
 - Steel Truss bridges
 - "Other" materials, unless explicitly noted
 - Agency-Defined NBEs and BMEs
 - Independent Agency-Defined Elements

Level	Name	Description	
Level 1	Elements	Basic elements of bridge construction i ... relevant geometric permutations	... m profiles
Level 2	Arrays	Simple arrays of similar basic elements	
Level 3	Aggregations	Aggregation of elements and needed c ... superstructures subsets/bays/spans	e Properties
Level 4	Bridges	Examples of complete supported bridge designs	- Levels 1, 2, & 3, +... - IfcAlignment - Geolocation - Project hierarchy including Project, Site, Facility, ….

Level 1 – Elements *(69)*

Level 2 – Arrays *(39)*

Level 3 – Aggregations *(~20)*

Level 4 – Bridges *(7)*

~135 tests identified so far

General Notes:
1. PSC = Prestressed Concrete (aka Precast), RC = Reinforced Concrete (aka Cast-in-Place)
2. All concrete-based elements should include reinforcing, conduits, electrical boxes, and embedded plates.
3. Any integral supports for appertanances not included in the scope (e.g. sign lights) should be included.
4. The Level of Geometric Detail is based on previous construction documentation delivery standards.
5. Elements are modeled in their in situ, fully dead loaded state, no cambering is shown.

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Level 3	Aggregations	Aggregation of elements and needed c... superstructures subsets/bays/spans	- IfcRelConnects
Level 4	Bridges	Examples of complete supported bridge designs	- Levels 1, 2, & 3, +... - IfcAlignment - Geolocation - Project hierarchy including Project, Site, Facility, ...

Example

Level 1 – Element: Reinf. Concrete Pier

Level 2 – Array: RC Pier Wall(s)

Level 3 – Aggregation: Intermediate Span Support

Level 4 – Concrete Bridge

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Unit Test Suite: Ledger Review & Feedback

Let's take a look…

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Certification

Unit Test Suite = Certification

EXPORT → **IMPORT**

Based on MVD

Assumed design/modeling applications

Initially based on MVD, but broader IFC4.3 support is expected

Dependent on software purpose/functionality
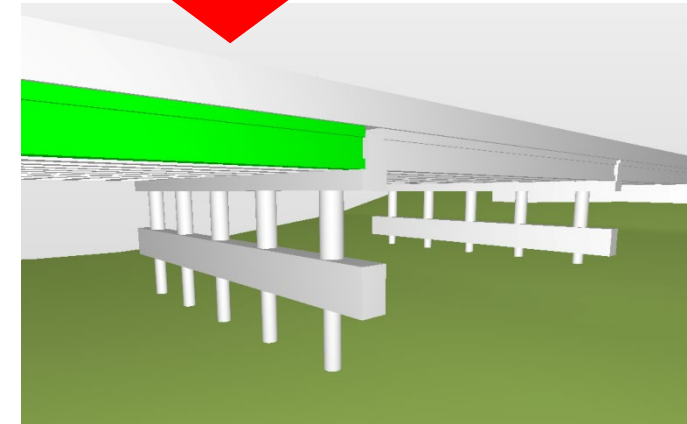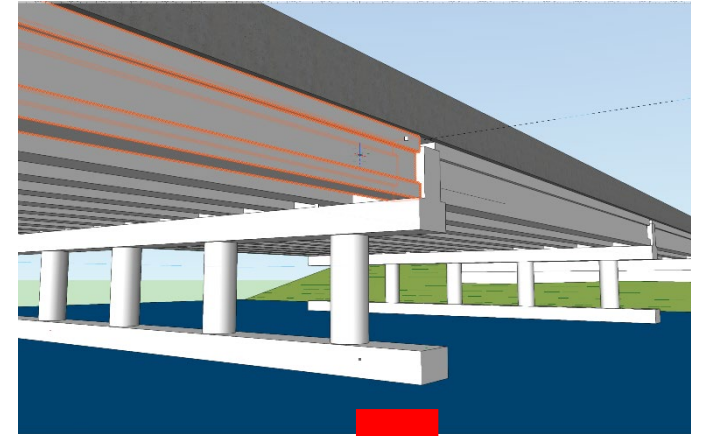
ALLPLAN
A NEMETSCHEK COMPANY

AUTODESK

Bentley

Trimble

IFC4.3
(IFC-STP = .ifc)

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Certification
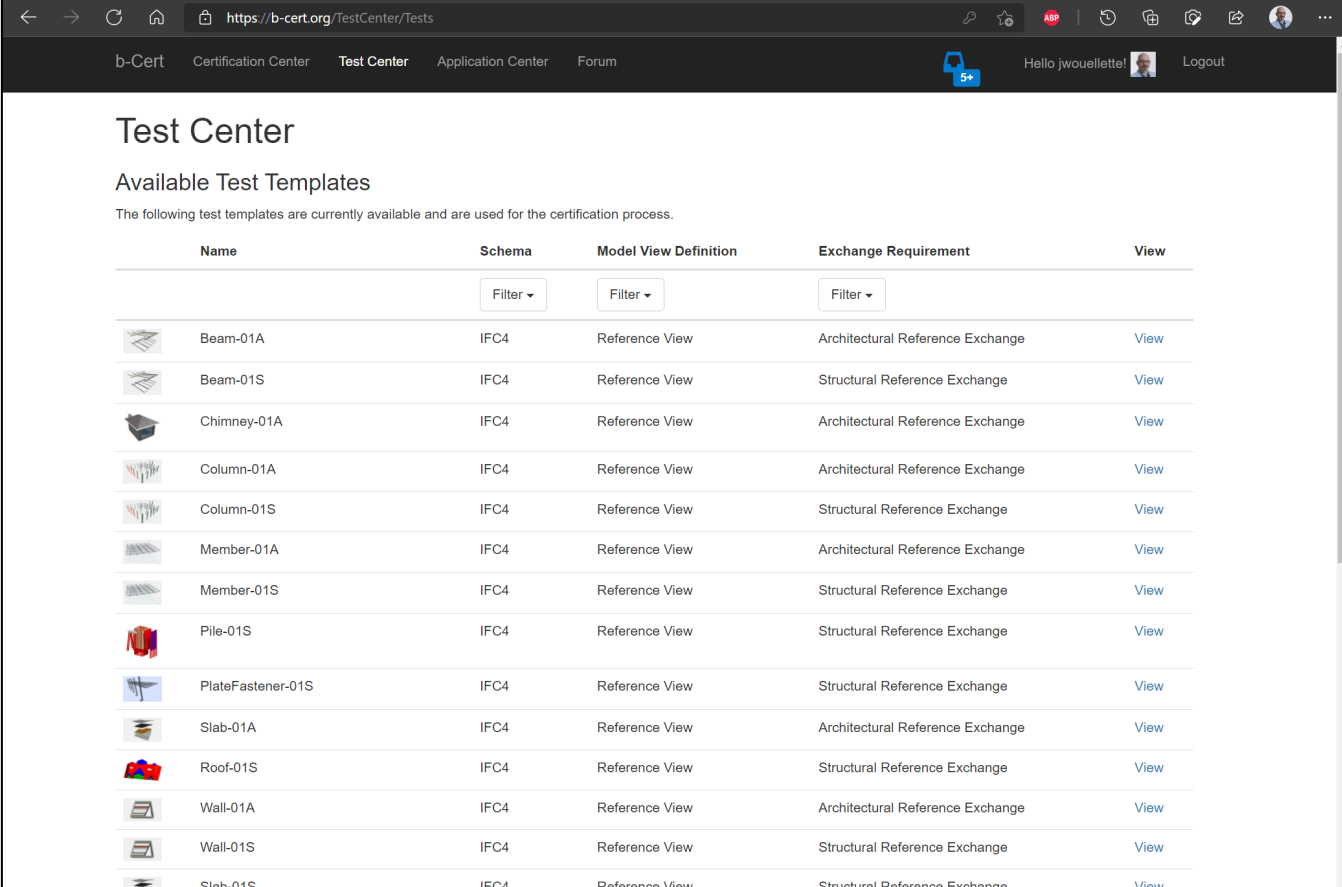
Officially validating software's implementation and support for the exchange standard

Leveraging:

> Unit Test Suite

> bSI b-cert platform

(Export 1st, Import 2nd)

Certification

Officially validating software's implementation and support for the exchange standard

Utilization:

bSI has agreed, in principle, to provide an online software certification platform for AASHTO MVDs.

bSI is currently investigating a new version of the platform for IFC4.3 purposes.

Unit Test Suite Update & Ledger Review

Questions?

Coffee & Networking Break

45 minutes

Courtesy of Trimble, Inc.

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Design-to-Construction Workflows Deep Dive

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Bridge Design to Construction Workflow

Generalized IFC model-based workflow of Bridge Design-to-Construction
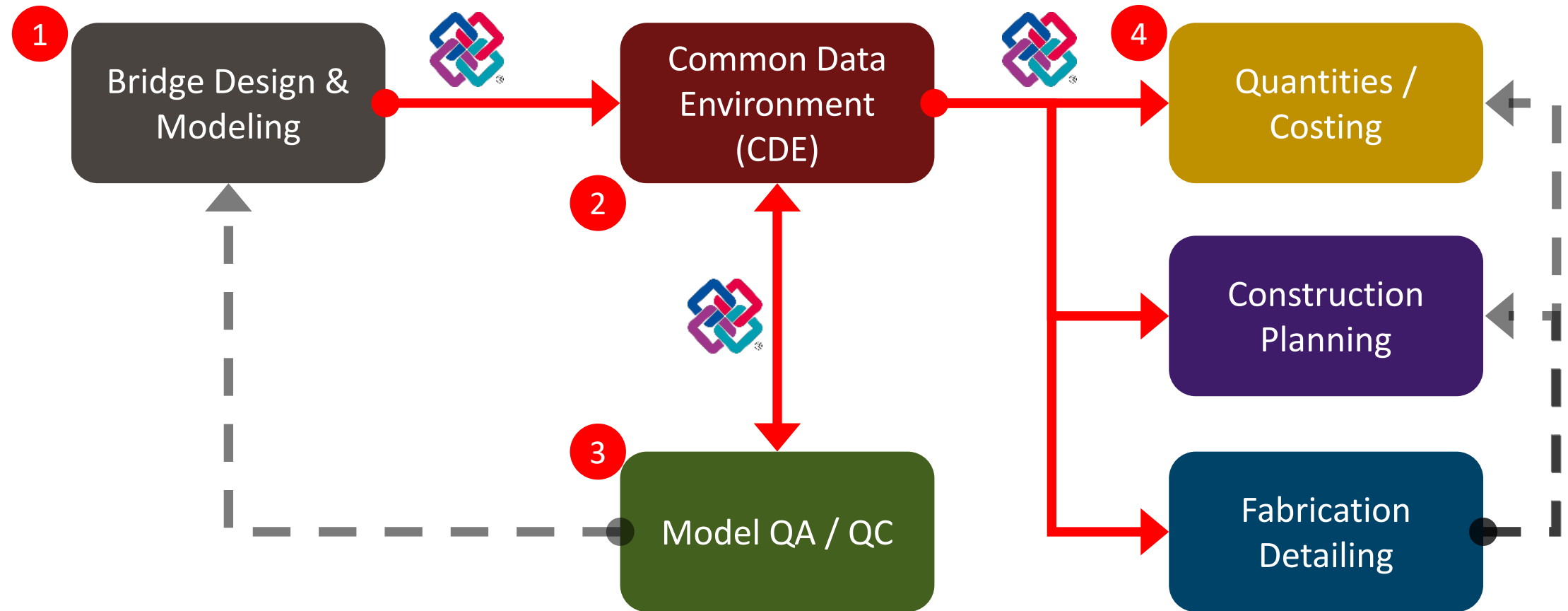
Bridge Design to Construction Workflow

Generalized IFC model-based workflow of Bridge Design-to-Construction

Bridge Design & Modeling

14 Companies
25 Products

Generating bridge design models & IFC files

Moderate-to-high level of geometric detail

Necessary design data

Analysis & Design vs. Design Modeling software

AASHTOWare	Bridge Design
	Bridge Rating
Allplan*	Allplan Bridge
Autodesk*	Civil3D
	InfraWorks
	Structural Bridge Design
	Robot
	Revit
	Inventor
Bentley Systems*	OpenBridge Modeler
	OpenBridge Designer
UFL Bridge Software Institute	FB-MultiPier

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Bridge Design to Construction Workflow

Generalized IFC model-based workflow of Bridge Design-to-Construction

Bridge Design & Modeling

14 Companies
25 Products

Generating bridge design models

Moderate-to-high level of geometric detail

Necessary design data

Analysis & Design vs. Design Modeling software

BridgeSight / WSDOT	BridgeLink Professional
	PGSuper Professional
	PGSplice Professional
Computers and Structures, Inc. (CSI)	CSiBridge
Eriksson	Culvert
	PSBeam
	ETPier
LARSA*	LARSA 4D Bridge
LUSAS*	LUSAS
MIDAsoft*	
OpenBrIM*	OpenBrIM
BEST Center UMD	Merlin-DASH
Trimble*	Tekla Structures

BIM FOR BRIDGES AND STRUCTURES

Bridge Design to Construction Workflow

Generalized IFC model-based workflow of Bridge Design-to-Construction

Common Data Environment (CDE)

10 Companies
12 Products

Storing/sharing bridge design models

IFC & native

Allplan*	bim+
Autodesk*	Construction Cloud/BIM360
Asite	
Bentley Systems*	iTwin
	ProjectWise 365
Catenda	
Glider Technology	gliderbim
InEight	
Procore	
OpenBrIM*	OpenBrIM
Trimble*	Quadri
	Connect

Bridge Design to Construction Workflow

Generalized IFC model-based workflow of Bridge Design-to-Construction

Model QA / QC

4 Companies
5 Products

Allplan*	Allplan Bridge
	bim+
Bentley Systems*	iTwin Design Review
Catenda	
Solibri	

Validating IFC model data

Reporting

Coordination

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Bridge Design to Construction Workflow

Generalized IFC model-based workflow of Bridge Design-to-Construction

Quantities / Costing

6 Companies
8 Products

Derive/report quantities from IFC model

Attach or formulate unit costs based on model elements

Allplan*	Allplan Bridge
Bentley Systems*	OpenBridge Modeler
	SYNCHRO
InEight	
Procore	
OpenBrIM*	OpenBrIM
Trimble*	Tekla Structures
	Connect

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Bridge Design to Construction Workflow

Generalized IFC model-based workflow of Bridge Design-to-Construction

Construction Planning

7 Companies
9 Products

Model-based planning

Sequencing, staging, managing, tracking

Allplan*	Allplan Bridge
	bim+
Autodesk*	Navisworks
Bentley Systems*	SYNCHRO
Computers and Structures, Inc. (CSI)	CSiBridge
InEight	
Procore	
Trimble*	Tekla Structures
	Connect

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Bridge Design to Construction Workflow

Generalized IFC model-based workflow of Bridge Design-to-Construction

Fabrication Detailing

5 Companies
5 Products

Allplan*	Allplan Bridge
Autodesk*	Revit
Bentley Systems*	ProStructures
Computers and Structures, Inc. (CSI)	CSiDetail
Trimble*	Tekla Structures

Development of fabrication details (2D/3D) for elements in IFC model

Feedback loop to Quantities/Costing

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Bridge Design to Construction Workflow

Generalized IFC model-based workflow of Bridge Design-to-Construction

Overall view (.xlsx)
26 Companies
48 Products

We know there are more out there
Who are they?
How do we contact them?
How do we motivate them?

Vendor	Product	bridge design/modeling	Common Data Environment / Project Collaboration	QA / QC of model data	Quantities / Costing	Construction Planning / Coordination	Fabrication Detailing
AASHTOWare	Bridge Design	X					
	Bridge Rating	X					
Allplan*	Allplan Bridge	X		X	X	X	X
	bim+		X	X		X	
Autodesk*	Civil3D	X					
	InfraWorks	X					
	Structural Bridge Design	X					
	Robot	X					
	Construction Cloud/BIM360		X				
	Navisworks					X	
	Revit	X					X
	Inventor	X					
Asite			X				
Bentley Systems*	OpenBridge Modeler	X			X		
	OpenBridge Designer	X					
	iTwin		X				
	ProjectWise 365		X				
	iTwin Design Review			X			
	SYNCHRO				X	X	
	ProStructures						X
UFL Bridge Software Institute	FB-MultiPier	X					
BridgeSight / WSDOT	BridgeLink Professional	X					
	PGSuper Professional	X					
	PGSplice Professional	X					
Catenda			X	X			
Computers and Structures, Inc. (CSI)	CSiBridge	X				X	
	CSiDetail						X
Eriksson	Culvert	X					
	PSBeam	X					
	ETPier	X					
Glider Technology	gliderbim		X				
InEight			X		X	X	
Infotech							
Invicara*							
LARSA*	LARSA 4D Bridge	X					
LUSAS*	LUSAS	X					
Mayvue							
Michael Baker International							
MIDAsoft*			X				
ODA							
Procore			X		X	X	
ProMiles							
OpenBrIM*	OpenBrIM	X	X		X		
Solibri				X			
BEST Center UMD	Merlin-DASH	X					
Trimble*	Tekla Structures	X			X	X	X
	AgileAssets						
	Quadri		X				
	Connect		X		X	X	

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Bridge Design to Construction Workflow

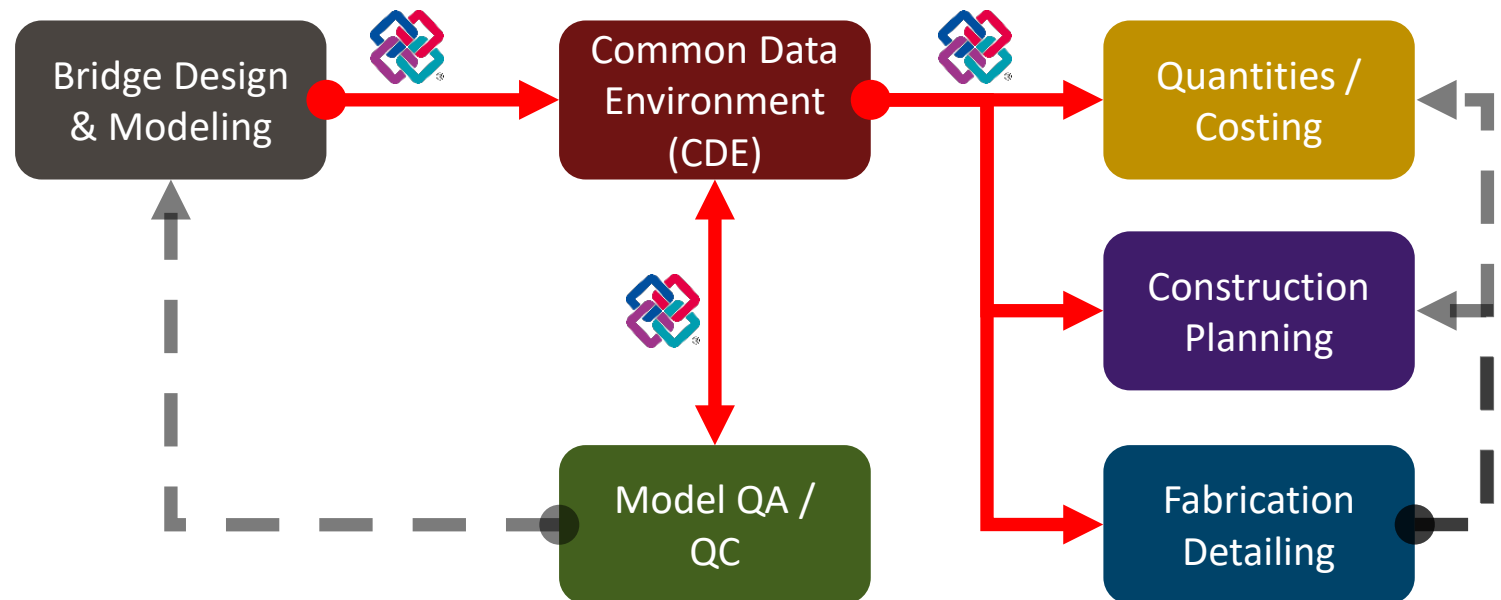**Generalized IFC model-based workflow of Bridge Design-to-Construction**

Model-based consistency
- Quantities
- Qualities

Validity of data
- Primary authorship
- Domain expertise
- Share vs. reconstitute

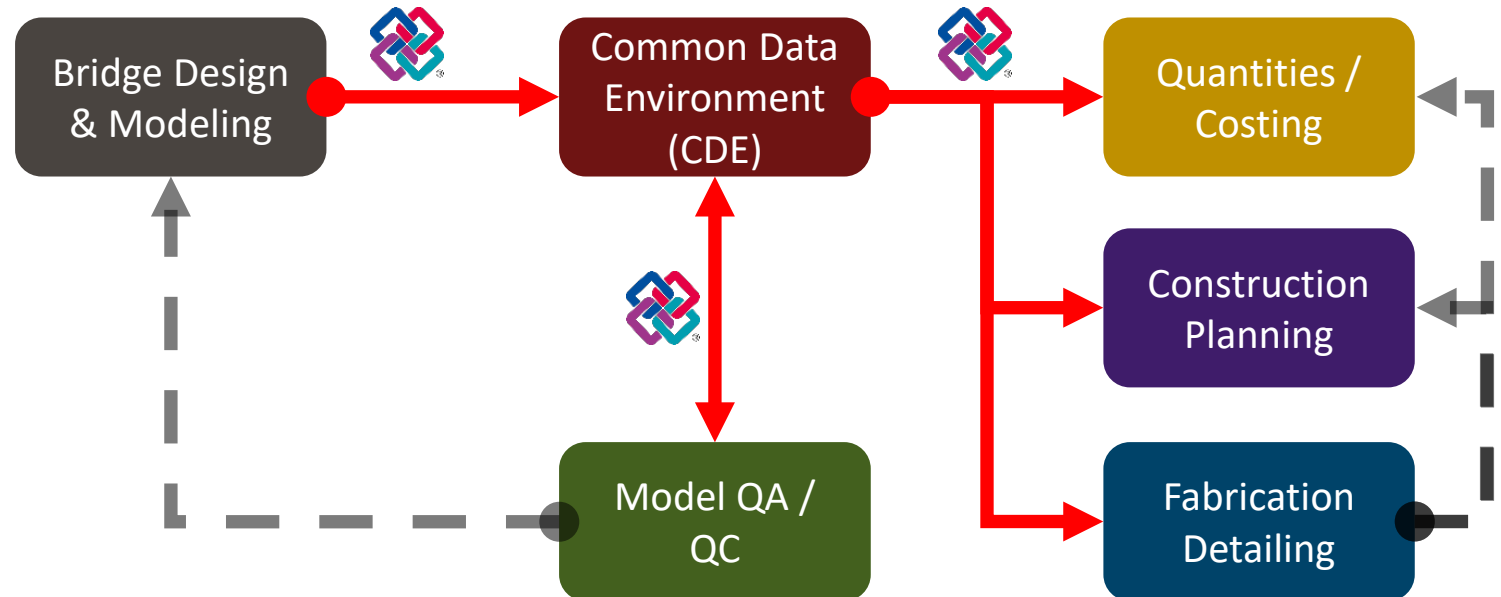Additive value

Bridge Design to Construction Workflow

Generalized IFC model-based workflow of Bridge Design-to-Construction

What information may NOT be able to be conveyed using the model format?

Is it necessary?

Is it view-dependent?

Is it there, but in a different form?

Questions?

Jeffrey W. Ouellette

TPF-5(372) Sr. Advisor, Software Vendor Engagement

jwouellette@gmail.com

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