Digital Highways

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#ENRTech

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U.S. Department of Transportation
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The End In Mind ➡️

Enterprise Asset Management

[Tierney]/stock.adobe.com

Utilizing openBIM = the best tool

DIGITAL TWIN

leowolfert/stock.adobe.com

U.S. Department of Transportation
Federal Highway Administration

Transportation Industry Vision to Leverage Data Across the Project Lifecycle

U.S. Department of Transportation
Federal Highway Administration

FHWA/Stakeholder National Initiatives

U.S. Department of Transportation
Federal Highway Administration

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Advancing BIM for Infrastructure

National Strategic Roadmap

U.S. Department of Transportation
Federal Highway Administration

Turner-Fairbank
Highway Research Center

Global Benchmarking Study

U.S. Department of Transportation
**Federal Highway Administration**

Turner-Fairbank
Highway Research Center

Ongoing BIM Pooled Fund Studies

BIM for Infrastructure TPF-5(480)

BIM for Bridges and Structures TPF-5(372)

Key objectives:

- Advance BIM for Infrastructure collaboratively

- Build off the foundational work in *Advancing BIM for Infrastructure: National Strategic Roadmap* (Mallela and Bhargava 2021)

- Conduct capacity-building activities

- Provide a forum to share experiences

Legend

- BIM for Infrastructure
- BIM for Bridges and Structures
- Both
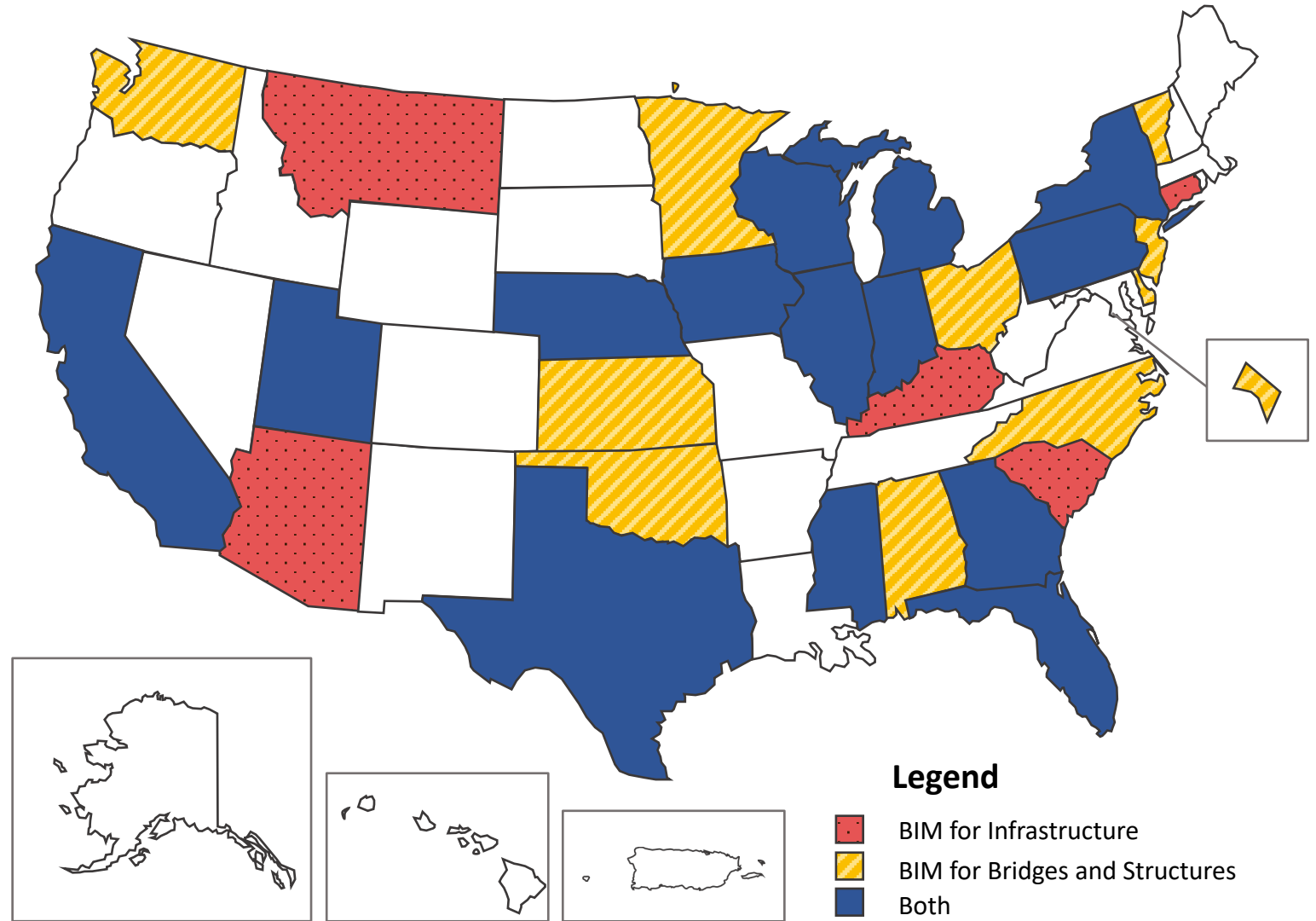
Building Information Modeling (BIM) for Infrastructure
BIM Launch Alliance to TPF

U.S. Department of Transportation
Federal Highway Administration

Pooled Fund Study Teams

Work Area:

A. Digital Workflow Development

Work Area:

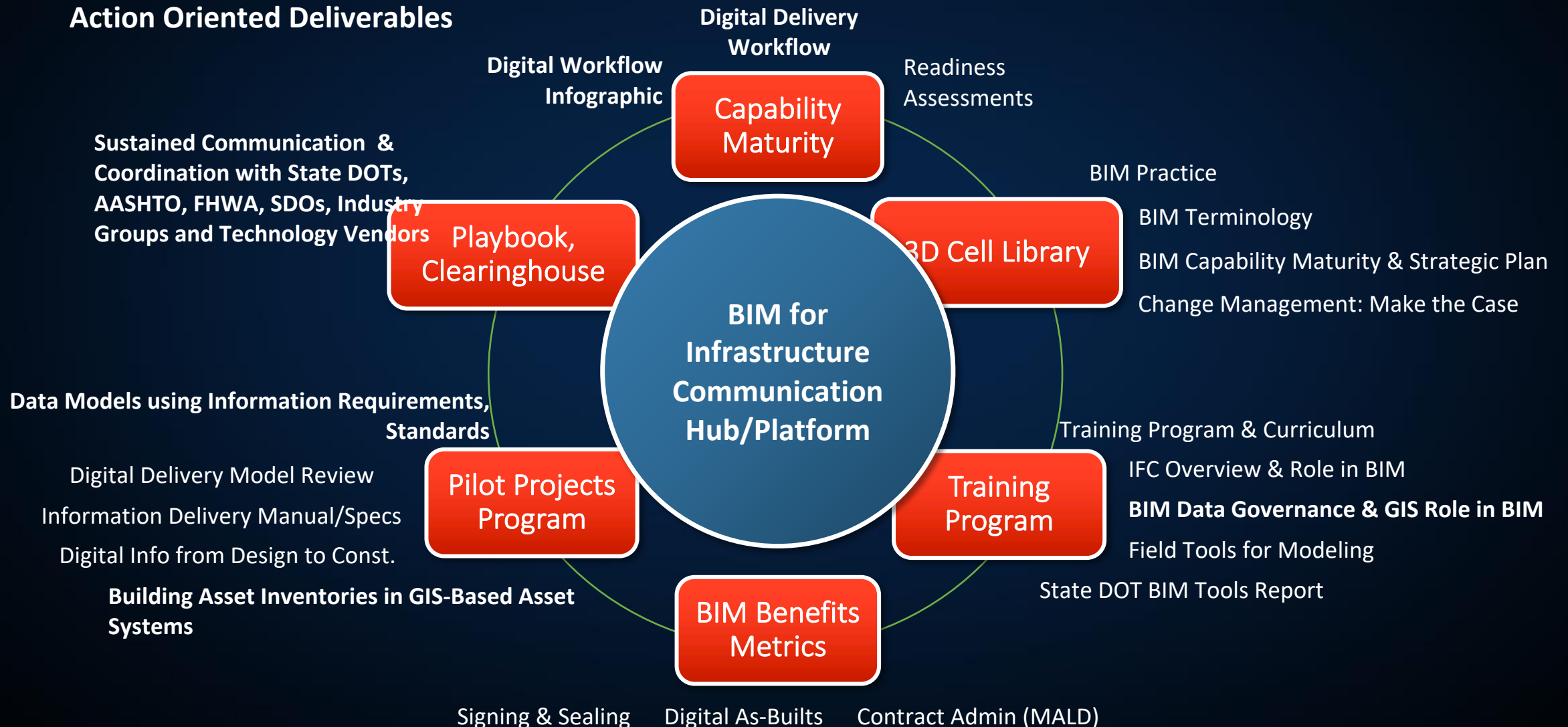**B. Digital Data Flows and Information Management**

Work Area:

C. Stakeholder Outreach and Engagement
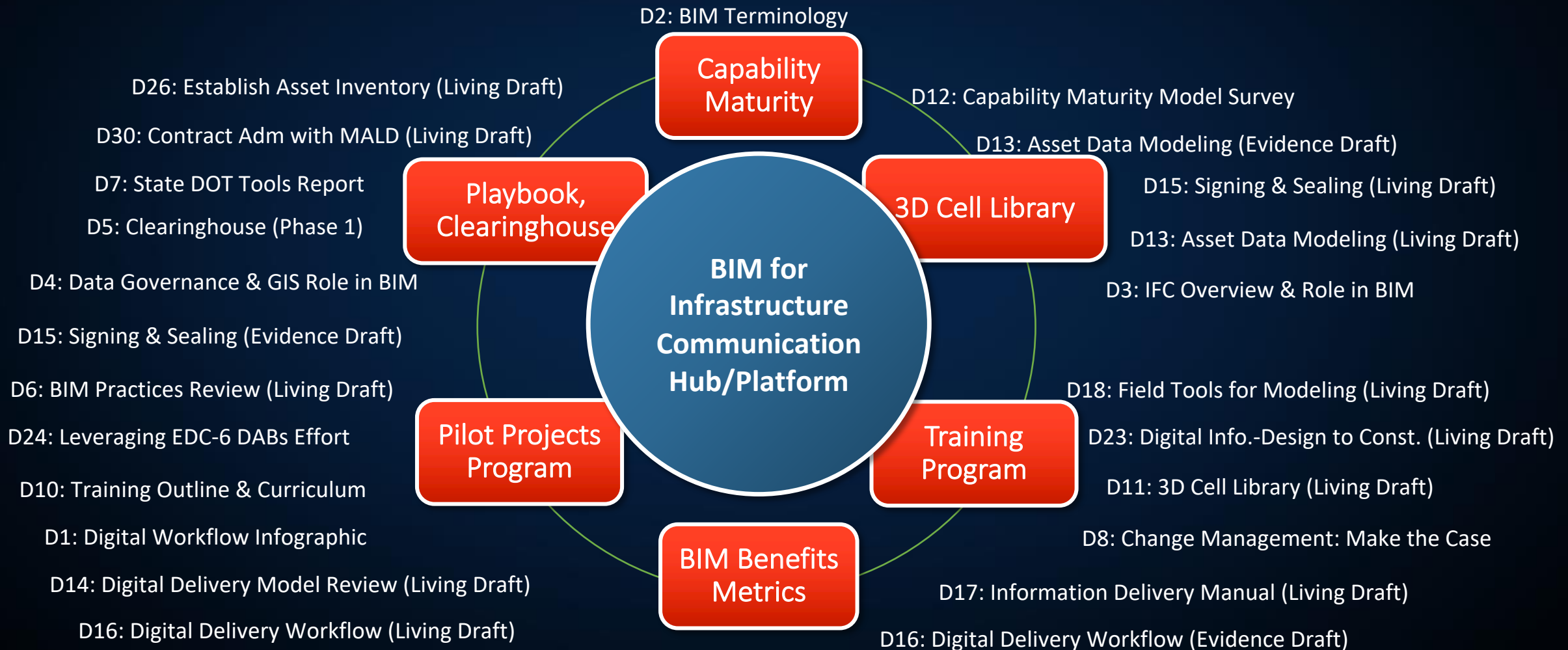
Work Area:

D. BIM Deployment Enabler Development

U.S. Department of Transportation
Federal Highway Administration

BIM Deployment Enablers

D2: BIM Terminology

Capability Maturity

D26: Establish Asset Inventory (Living Draft)

D30: Contract Adm with MALD (Living Draft)

D7: State DOT Tools Report

Playbook, Clearinghouse

D5: Clearinghouse (Phase 1)

D4: Data Governance & GIS Role in BIM

D15: Signing & Sealing (Evidence Draft)

D6: BIM Practices Review (Living Draft)

D24: Leveraging EDC-6 DABs Effort

Pilot Projects Program

D10: Training Outline & Curriculum

D1: Digital Workflow Infographic

D14: Digital Delivery Model Review (Living Draft)

D16: Digital Delivery Workflow (Living Draft)

BIM for Infrastructure Communication Hub/Platform

BIM Benefits Metrics

D12: Capability Maturity Model Survey

D13: Asset Data Modeling (Evidence Draft)

D15: Signing & Sealing (Living Draft)

3D Cell Library

D13: Asset Data Modeling (Living Draft)

D3: IFC Overview & Role in BIM

D18: Field Tools for Modeling (Living Draft)

D23: Digital Info.-Design to Const. (Living Draft)

Training Program

D11: 3D Cell Library (Living Draft)

D8: Change Management: Make the Case

D17: Information Delivery Manual (Living Draft)

D16: Digital Delivery Workflow (Evidence Draft)

EDC Used with permission.

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Federal Highway Administration

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Stakeholder Engagement

- **FHWA & National Programs:** Two other FHWA TPFs, EDC-6, TRB programs, NIBS, IHEEP
- **State DOTs:** Practices – Information Requirements, Models Created, Exchanges Specifications, Processes, Software Tools & Technology, Policies and Change Management Needs
- **Owner Reps**: FHWA, AASHTO Committees, Pooled Funds
- **Industry**: ACEC, ARTBA, AGC
- **Software/Technology Vendors**: Design, Construction, Asset Management, GIS
- **SDOs**: AASHTO, buildingSMART, OGC, ISO

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Federal Highway Administration

BIM for Bridges and Structures Pooled Fund Update

Presentation from BIM for Infrastructure Week, Washington, DC March 13, 2023

U.S. Department of Transportation
Federal Highway Administration

Combined AASHTO Efforts

Key Milestones Advancing Data Standardization

2017
- T-19 Creates BIM for Bridges and Structures Pooled Fund

2019
- AASHTO AR-1-19 issued

» Adoption of IFC Schema as the national standard for AASHTO States

» Form the Joint Subcommittee on Data Standardization (J-STAN)

» https://data.transportation.org/jstan/

2021
- JTCEES creates BIM for Infrastructure Pooled Fund

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AASHTO Bridge Vision

Develop a National Standard for open exchange of bridge and structure data utilizing IFC.

Focus of pooled fund project

BIM FOR BRIDGES AND STRUCTURES TPF-5(372)

Model-Based Approach

Fabrication

Design

Asset Management

Construction

BIM FOR BRIDGES AND STRUCTURES TPF-5(372)

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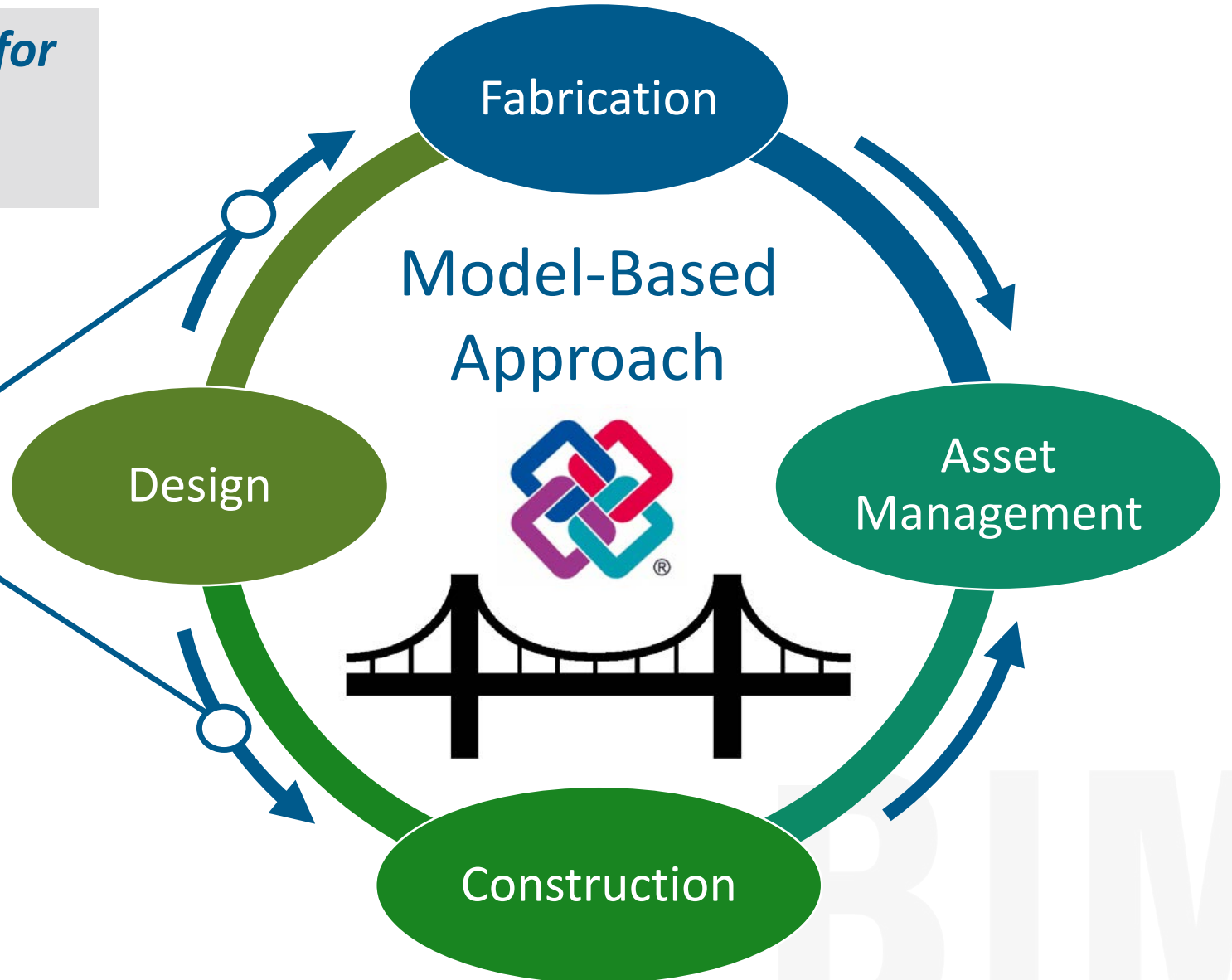
Project Objective

Adoption of Industry Foundation Classes (IFC) for the US Bridge Industry
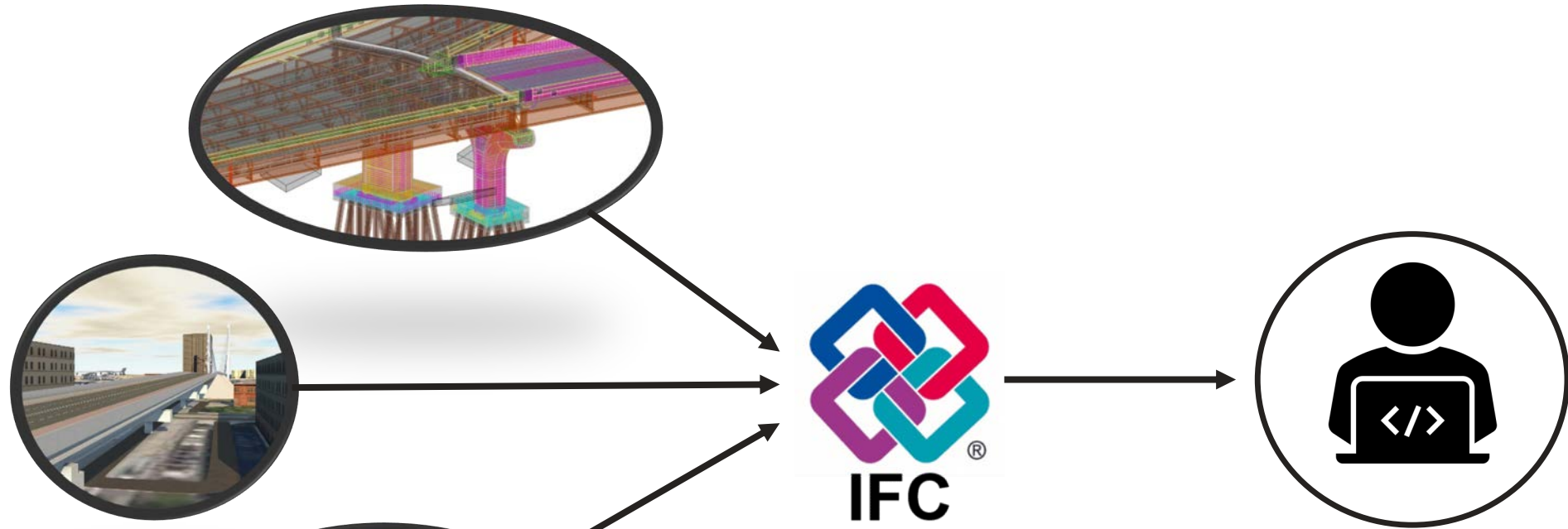
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IFC = Solution for exchanging 3D models & associated digital data

BIM FOR BRIDGES AND STRUCTURES
TPF-5(372)

ISO 16739

19

IFC for Software Interoperability
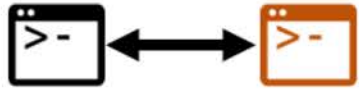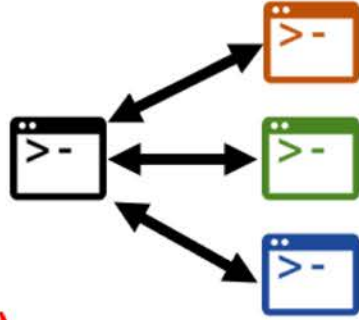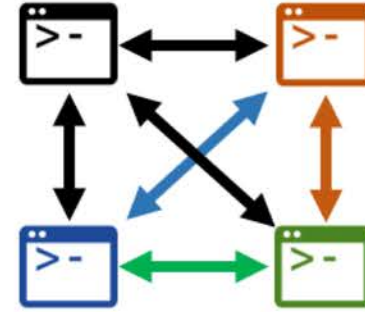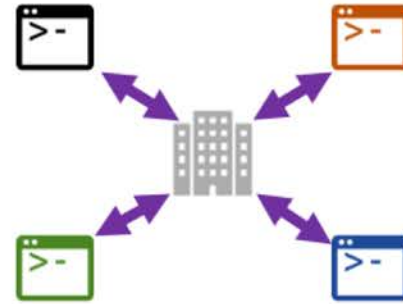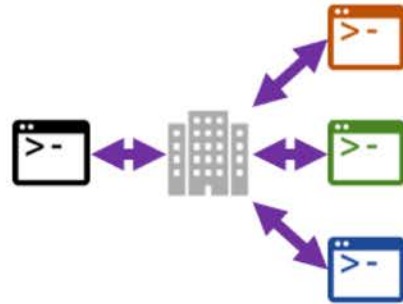
IFC for Information Interoperability

Open | Closed

Content/Data | Tools/Apps
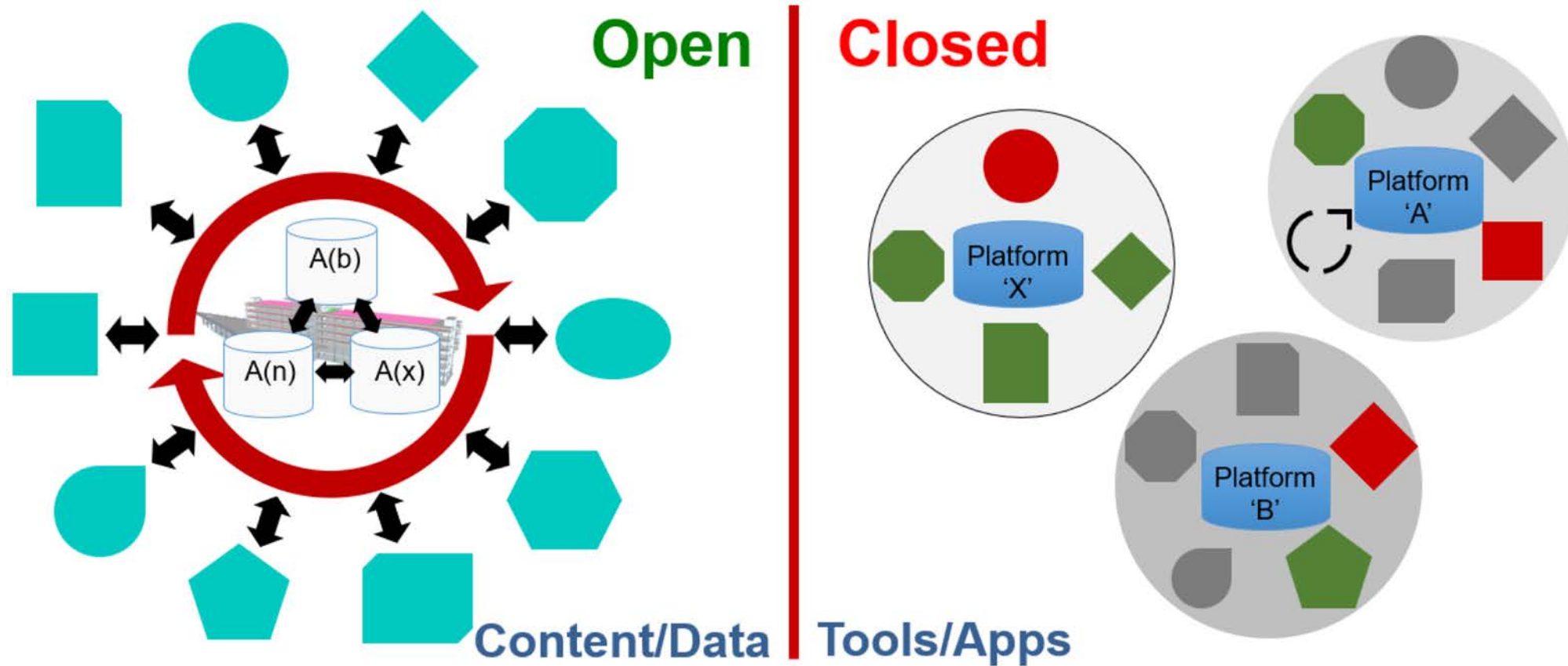
BIM FOR BRIDGES AND STRUCTURES TPF-5(372)
ROADMAP

BACKGROUND

The desired outcome of the work under the TPF-5(372) Project is to establish a standard for bridge semantic and geometric information that is common in the United States, which is a continuation of a previous effort known as the IFC Bridge project to create international standards. The resulting products from the TPF-5(372) may be used by States as a baseline for future projects to further refine standards at the local level. The work under this project will be conducted in a series of activities in a five-year timeline to accomplish four major goals:

OUTCOME 1: Development of Information Delivery Manual (IDM)

OUTCOME 2: Creation of Model View Definition (MVD) — IDS

OUTCOME 3: Development of Software Certification Materials

OUTCOME 4: Deployment of Stakeholder Training

PROJECT SPONSORS

Total Commitments Received: $2,545,000.00*

*As of January 2023

https://www.pooledfund.org/Details/Study/624
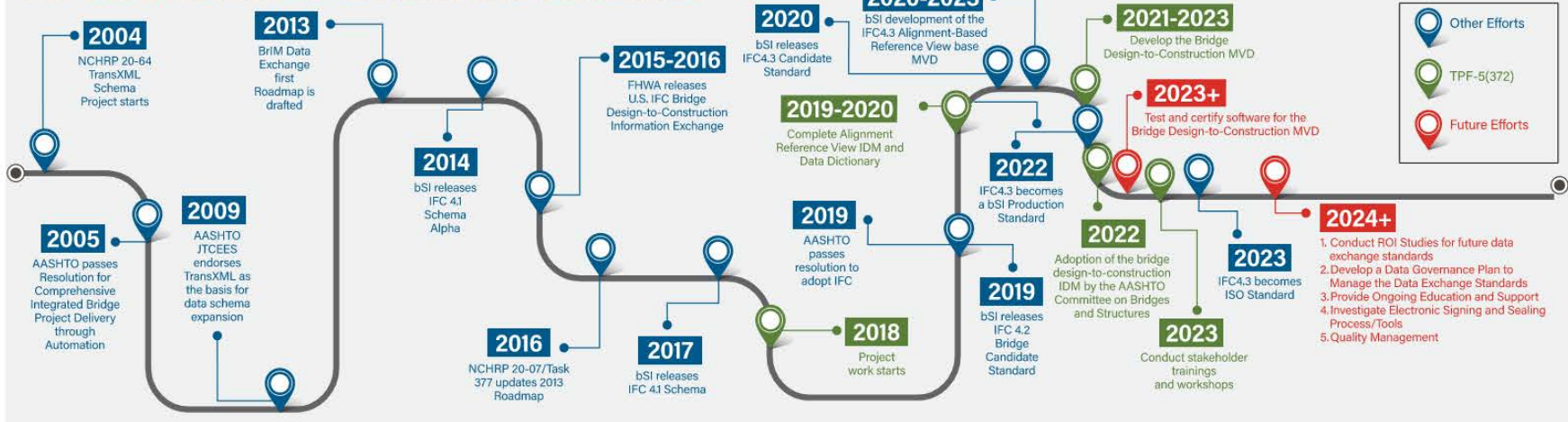
https://www.bimforbridgesus.com

24 PARTICIPATING STATES PLUS FHWA*

Potential AASHTO Publications
- BIM for Bridges IDM
- BIM for Bridges MVD
- BIM Guide for MVD certification

TPF-5(372) ADVANCES U.S. NATIONAL STANDARDS

2004 NCHRP 20-64 TransXML Schema Project starts

2005 AASHTO passes Resolution for Comprehensive Integrated Bridge Project Delivery through Automation

2009 AASHTO JTCEES endorses TransXML as the basis for data schema expansion

2013 BrIM Data Exchange first Roadmap is drafted

2014 bSI releases IFC 4.1 Schema Alpha

2015-2016 FHWA releases U.S. IFC Bridge Design-to-Construction Information Exchange

2016 NCHRP 20-07/Task 377 updates 2013 Roadmap

2017 bSI releases IFC 4.1 Schema

2018 Project work starts

2019 AASHTO passes resolution to adopt IFC

2019 bSI releases IFC 4.2 Bridge Candidate Standard

2019-2020 Complete Alignment Reference View IDM and Data Dictionary

2020 bSI releases IFC4.3 Candidate Standard

2020-2023 bSI development of the IFC4.3 Alignment-Based Reference View base MVD

2021-2023 Develop the Bridge Design-to-Construction MVD

2022 IFC4.3 becomes a bSI Production Standard

2022 Adoption of the bridge design-to-construction IDM by the AASHTO Committee on Bridges and Structures

2023 Conduct stakeholder trainings and workshops

2023 IFC4.3 becomes ISO Standard

2023+ Test and certify software for the Bridge Design-to-Construction MVD

2024+
1. Conduct ROI Studies for future data exchange standards
2. Develop a Data Governance Plan to Manage the Data Exchange Standards
3. Provide Ongoing Education and Support
4. Investigate Electronic Signing and Sealing Process/Tools
5. Quality Management

- Other Efforts
- TPF-5(372)
- Future Efforts

Key Activities to Create IDM
- Validate FHWA Bridge Lifecycle Process Map
- Develop IDM
- Evaluate current data dictionary
- Develop engagement plan

Key Activities to Create MVD
- Research common terms for bridge taxonomy for naming elements
- Evaluate proposed data structure and LOD requirements
- Generate exchange requirements

Key Activities to Test Software
- Create a software vendor engagement plan
- Create manuals and guidance documents to support software vendors in the initial certification process

Key Activities for Stakeholder Involvement
- Create product-specific BIM Guides on how to use the standards
- Conduct an ROI study
- Host seminars, conferences, and workshops to educate on the standards
- Develop a collaboration forum to gather feedback on standards

| Year 1 | Year 2 | Year 3 | Year 4 | Year 5 |

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Task 2: IFC Development

- Objectives
  - To create software tools necessary to export, import and validate IFC files
- Deliverables
  - Updated *FHWA Bridge Lifecycle Process Map*
  - Information Delivery Manual
  - Design-to-construction use case specific export/import software tools
  - Documentation for software developers
  - *AASHTO Bridge Domain Data Dictionary* configured for bSDD service
  - Unit test suite to assist software developers with bSI certification
  - Implementation and certification technical memorandum

BIM FOR BRIDGES AND STRUCTURES TPF-5(372)

Task 3: Economic Analysis (ROI)

- ## Objectives
    - Develop guidance that will help State DOTs create the business case for implementing BIM for Bridges using IFC

- ## Deliverables
    - ROI White paper
    - Technical memorandum: Guidelines document

Task 4: Industry Involvement

- Objectives
  - To assist TPF-5(372) pooled fund with industry involvement

- Deliverables
  - Roadmap infographic (and updates)
  - Governance and stewardship technical memorandum
  - Executive committee updates on bSI engagement efforts
  - Software vendor engagement plan
  - Workshops and webinars with software vendors

BIM FOR BRIDGES AND STRUCTURES
TPF-5(372)

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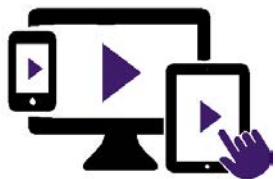
Task 5: Education & Engagement

- Objectives
  - Provide a collaboration forum to share information
- Deliverables
  - Stakeholder engagement plan
  - Website with calendar of events & resources
  - FAQ handout (key terms)
  - Training style presentations for 3 different audiences
  - 2 Video interviews to capture project significance and outcomes
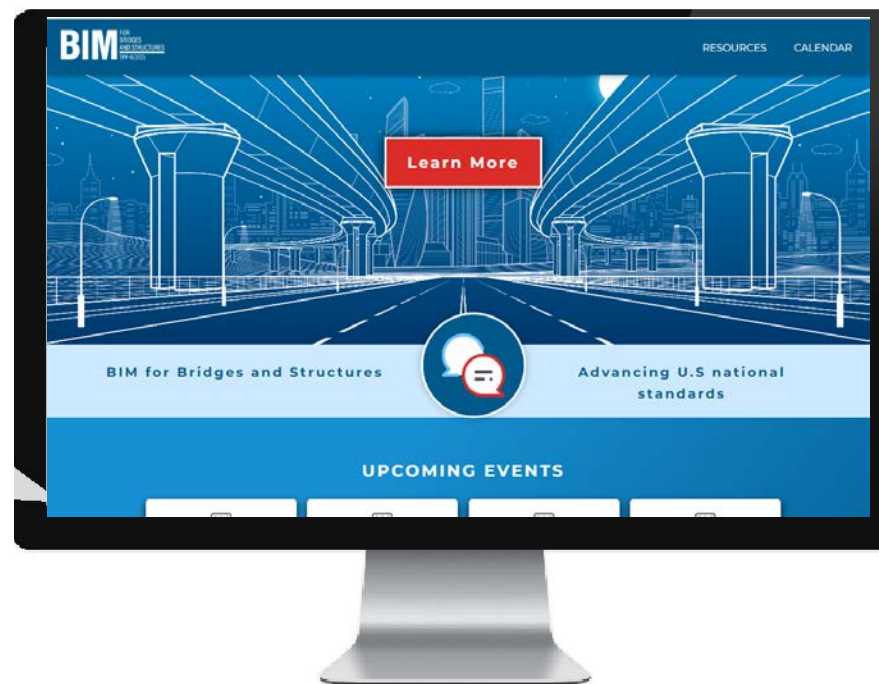
Summary of Project Accomplishments

Industry Involvement

bSI Collaboration and involvement enabled TPF-5(320) to provide input into the IFC 4.3 schema early on in the project

2019 (Y1) – 2023 (Y5)

Investigation & Exploration

2019 (Y1)

Completed Products
- Software Vendor Engagement Plan and Annual Workshops
- Tech memo: Governance & Stewardship

In-Progress Products
- Annual Workshops

Economic Analysis (ROI)

2022 (Y4) – 2023 (Y5)

Completed Products
- Investigation and Exploration Report
- Glossary Memorandum

Completed Products
- Technical Memo

In-Progress Products
- Whitepaper

IFC Development

2020 (Y2) – 2023 (Y5)

Completed Products
- Updated Bridge Lifecycle Process Map
- Bridge Construction Process Map
- Example Unit Test Instructions
- AASHTO IDM Publication
- Data Dictionary

In-Progress Products
- Model View Definition (MVD)
- Information Delivery Specifications (IDS)
- Detailed Unit Test Instructions
- Software Certification Support
- Implementation Training Workshop

Education & Engagement

2019 (Y2) – 2023 (Y5)

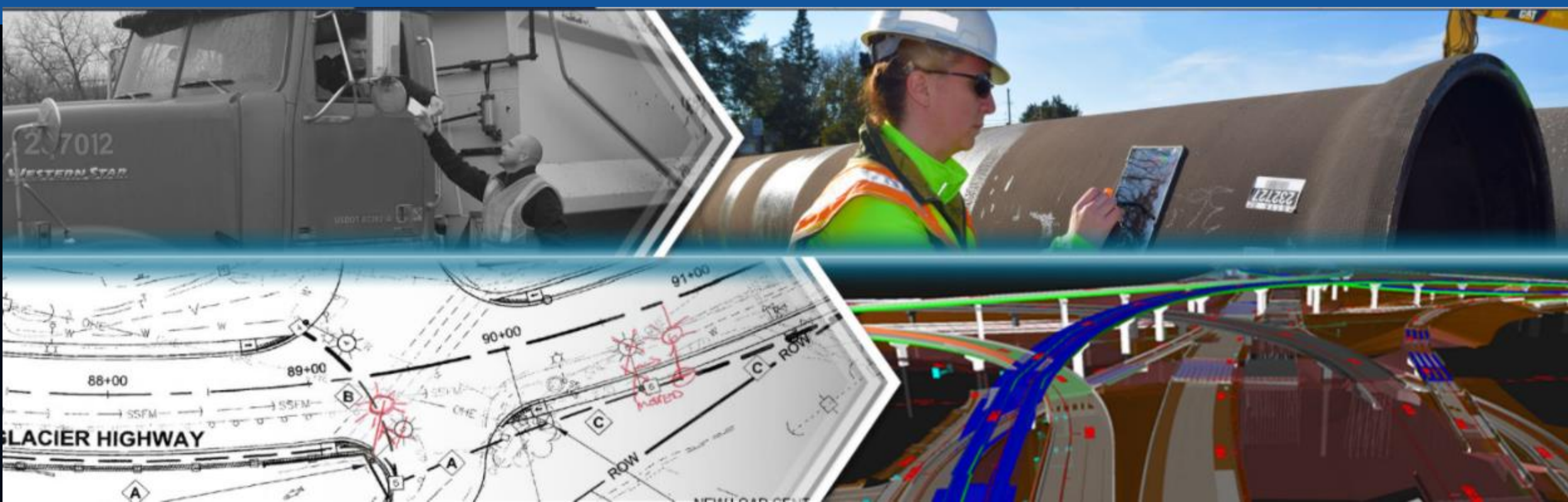**BIM FOR BRIDGES AND STRUCTURES**
TPF-5(372)

Completed Products
- Stakeholder Engagement and Communication Plan
- Collaboration Forum (bimforbridgesus.com website)

In-Progress Products
- Website Updates
- Educational materials

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On-Going and Future Collaboration & Coordination

AASHTO Committees

- Data Management and Analytics (J-STAN)
- Design (JTCEES)
- Bridges and Structures (T-19)
- Construction (Innovative Constr Technologies)
- Performance-Based Management
- AASHTOWare

TPF-5(372) BIM for Bridges and Structures

Industry

- Software Vendors
- Fabricators
- NSBA and NCBC
- ACEC, AGC, ARTBA
- buildingSMART, NIBS

Other Pooled Funds

- TPF-5(480) BIM for Infrastructure

BIM FOR BRIDGES AND STRUCTURES TPF-5(372)

e-Ticketing
A paperless process for tracking, documenting, and archiving materials information, accessible in real time via mobile devices.

Digital As-Builts
Valuable asset information gathered during digital project delivery for future business needs, and which is often geolocated.

U.S. Department of Transportation
Federal Highway Administration

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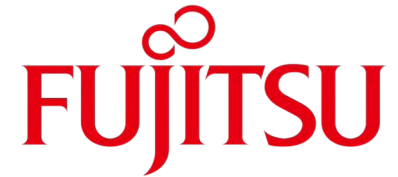
Imagine our lives **without open standards...**

600+ Participants

580 Qualified individuals
(Global qualified individuals: 18,000+)

35+ Colloquium sessions

Over 92% *professionals passed the 1st attempt*

~15% professionals got full mark
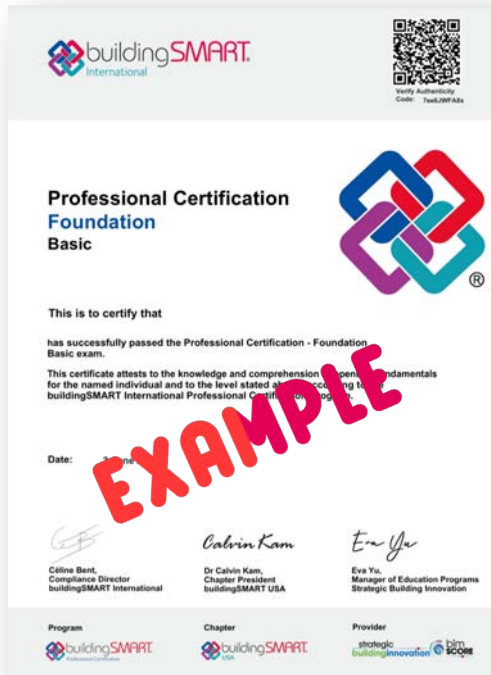
Professional Certification
Foundation
Basic

This is to certify that

has successfully passed the Professional Certification - Foundation Basic exam.

This certificate attests to the knowledge and comprehension of open... fundamentals for the named individual and to the level stated above... cco...ng to buildingSMART International Professional Certif...

EXAMPLE

Data as of April 2023 from buildingSMART USA Chapter and Hong Kong Chapter

Our participants are from 15 countries and regions!

buildingSMART PCERT Foundation openBIM®

Fundamental terminology and value of openBIM® providing a shared basis of knowledge for **decision makers** and those who will take further courses
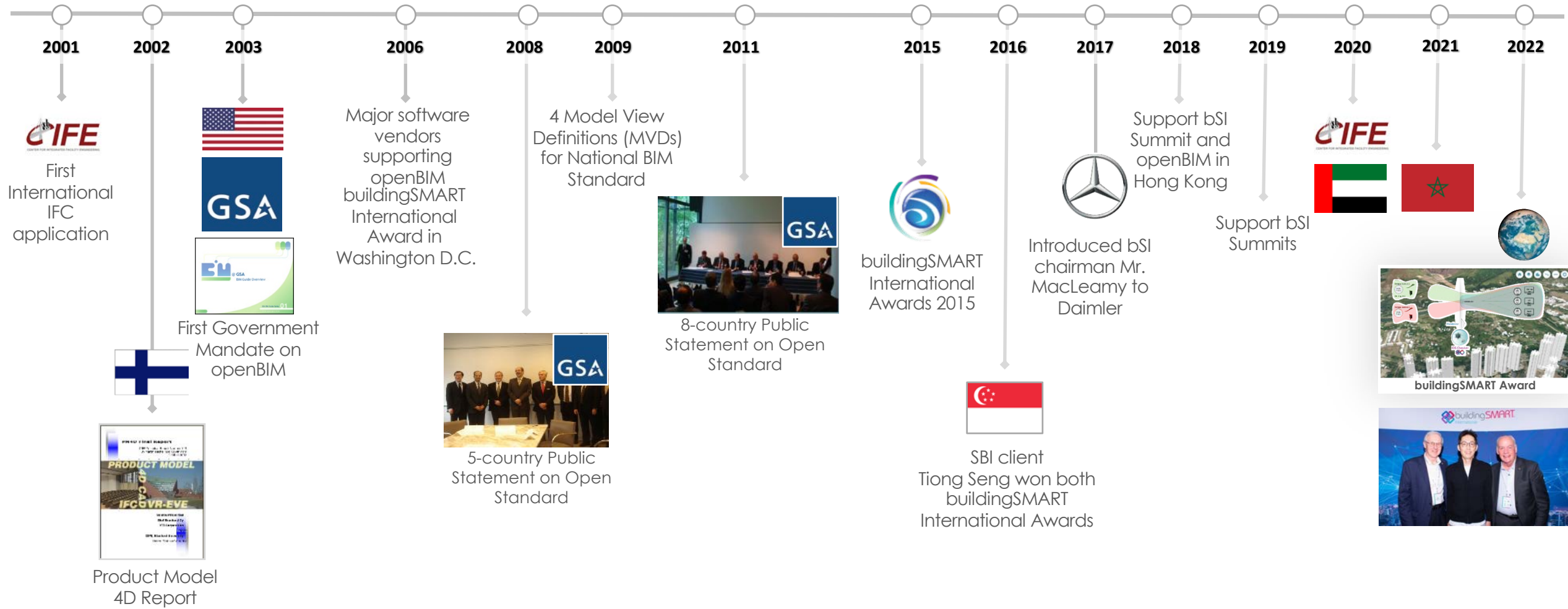
Part of the buildingSMART Professional Certification (PCERT) program.

openBIM® for Project & Contract Management

Specific practical knowledge for those who will manage projects that employ BIM

openBIM® for Applications

Survey of several openBIM® related applications and a guide to selecting tools

20+ years of buildingSMART

2001 — First International IFC application

2002 — First Government Mandate on openBIM

Product Model 4D Report

2003

2006 — Major software vendors supporting openBIM buildingSMART International Award in Washington D.C.

2008 — 5-country Public Statement on Open Standard

2009 — 4 Model View Definitions (MVDs) for National BIM Standard

2011 — 8-country Public Statement on Open Standard

2015 — buildingSMART International Awards 2015

2016 — SBI client Tiong Seng won both buildingSMART International Awards

2017 — Introduced bSI chairman Mr. MacLeamy to Daimler

2018 — Support bSI Summit and openBIM in Hong Kong

2019 — Support bSI Summits

2020

2021 — buildingSMART Award

2022

buildingSMART USA

Seeing is Believing

- Accelerated development of pilot projects using openBIM
- From concept to realization in 300 days
- Build on global best practices & develop openBIM-USA use cases

buildingSMART USA

Seeing is Believing

- Accelerated development of pilot projects using openBIM
- From concept to realization in 300 days
- Build on global best practices & develop openBIM-USA use cases

Sensors + IoT

smartBRIDGE Hamburg → US example

Solution Seekers — *Progress*

- May 11 ✅ Identified Use Cases & Value of openBIM
- By June Share IFC/Native Models

Solution Facilitators — *Progress*

- May 11 ✅ Organized and Facilitated Workshop
- By June Create a Repository for Sharing Resources

Solution Providers — *Progress*

- May 11 ✅ Provided Overview of Solutions & Capabilities
- By June Review IFC Models and Quality

Proving Ground

buildingSMART International
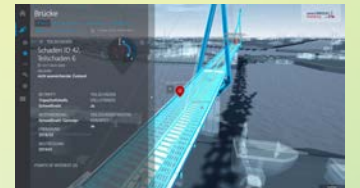**openBIM® Workflow**

1 — 2 — . . .

buildingSMART USA
Sandbox

Crowd/In-kind Funding/Sourcing

Test

ESG Dashboard

Vancouver Airport → US example

openBIM + openGIS

SBI IDS → US example
(IDS: Information Delivery Specification)

- Revenue
- Knowledge
- Changes to Industry
- Business Value
  - Repeatable Process
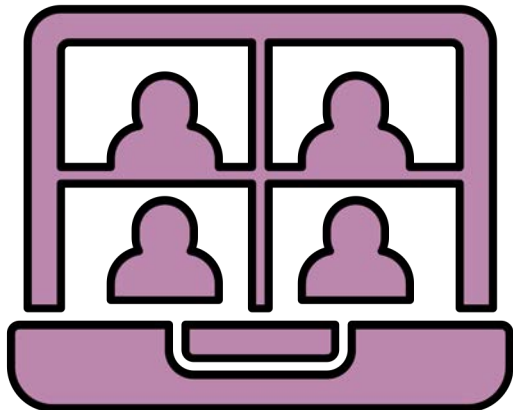 - Interoperable BIM Specs (IDS)
  - . . .

Production

Iterative Improvement
(E.g., feedback on openBIM requirements)

Pilot Project Opportunities

- Demonstration
- Proof of Concept

Seeing is Believing, May 11-12 at Stanford Univ.
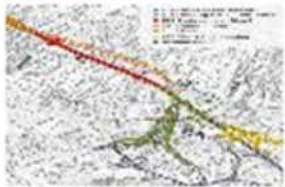

15 countries

~250 registered

30+ Asset Owners

Demands from Owners – Norway, Trimble

TRADITIONAL METHODOLOGY

AVERAGE FOR ROAD ADM 2012: 19%

18,9%	18,1%
RV 150, E03; Ring 3 Ulven-Sinsen	Fellesprosjektet Dovrebanen-E6 Skaberud-Kolomoen, firefelts E6 m/midtdeler

BIM/3D METHODOLOGY

Suggested solutions to reduce errors for Road Projects

- Set quality requirements for as-is data
- 3D modeling instead of drawing production
- Clear requirements for documentation in each project phase, focus on standardization
- The documentation should contribute to better plans and faster implementation

AVERAGE 7,5%

9,8%	8,3%	7,6%	4,2%
RV 150, E22; Ring 3 Ulven-Sinsen	Fellesprosjektet Dovrebanen-Firefelts E6 og dobbeltsporet jernbane	E6 - Nordre avlastningsveg, Trondheim	FV 456, Vågsbygdveien, Kristiansand

Ref: Norwegian road administration and Vianova Systems AS 2013

"Participated in a pioneering BIM-based project in **2012** where model was a legal document. On that project, the model took precedence over drawings. I actually printed that out, framed it, and put it on the wall.."

p5bllab
problem::project::product::process::people::based learning

buildingSMART. USA

IFE
CENTER FOR INTEGRATED FACILITY ENGINEERING

Integrating openBIM and openGIS – The Netherlands, Future Insight

"Integrated with open standards: **openBIM, openGIS, 3D Tiles**. IDS is under development and will be implemented in the future."

Transforming openBIM to GIS Digital Twin – Italy, ACCA

"User can see live data acquisition from **IoT sensors**. Data are returned in real time and real-time notifications are triggered by dangerous conditions."
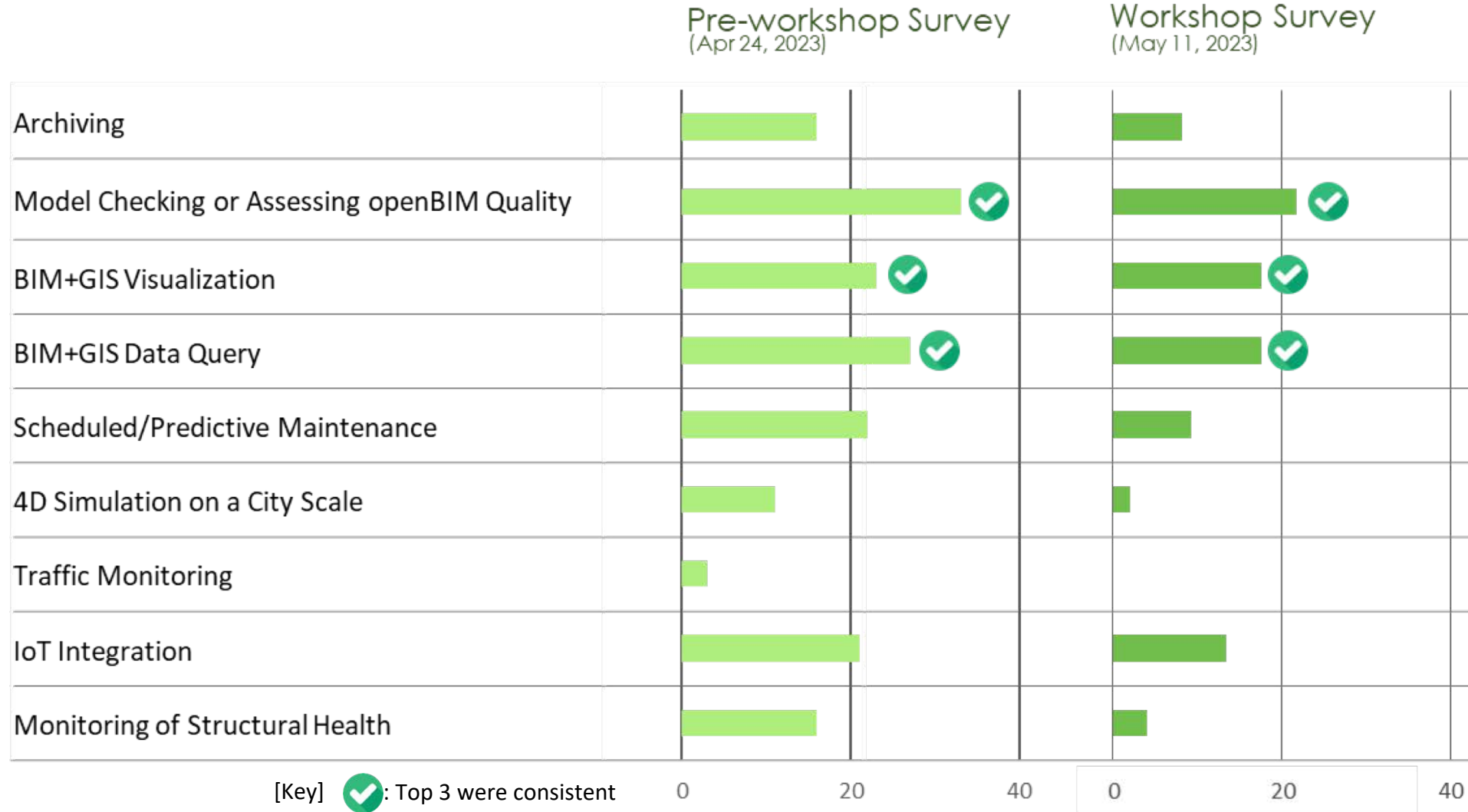
Connection between

ArcGIS & **usBIM**
ESRI ACCA

openBIM®

100% **IFC models** (version 2.3 - 4.0 - 4.3)
Buildings & Infrastructures
Asset Management
Asset Operations
Facilities Management
IoT (Internet of Things)

openBIM for Infrastructure: Use Cases for USA

Which openBIM-USA use cases are you most interested in? (Select three)

Pre-workshop Survey (Apr 24, 2023) and Workshop Survey (May 11, 2023)

Use Case	Pre-workshop Survey (Apr 24, 2023)	Workshop Survey (May 11, 2023)
Archiving	~16	~10
Model Checking or Assessing openBIM Quality ✓	~33	~22
BIM+GIS Visualization ✓	~23	~18
BIM+GIS Data Query ✓	~27	~19
Scheduled/Predictive Maintenance	~21	~10
4D Simulation on a City Scale	~11	~2
Traffic Monitoring	~3	
IoT Integration	~21	~14
Monitoring of Structural Health	~16	~4

[Key] ✓ : Top 3 were consistent

(Answered: 47)   (Answered: 33)

Proven Applications of City-Scale IDS Checker – International, SBI

openBIM + openGIS

"Used **8** open standards, developed **10** machine-readable specs, checked **102** infrastructure IFC models with the IDS, and each check took around **12** seconds"

openBIM + IDS

Check	Errors	Passes	Pass%	Weight
01. Geo reference	0	0	100%	15%
03. Simplification	0	0	100%	5%
04. Identify exterior objects	0	0	100%	10%
06. Project Information	0	0	100%	5%
07. Completion date	0	0	100%	5%
09. Object naming convention	0	0	100%	10%
11. Object	0	0	100%	10%

Model Quality Score Based on IDS
0%

openBIM for Infrastructure: Use Cases for USA

Which openBIM-USA use cases are you most interested in? (Select three)

Workshop Survey
(May 11, 2023)

Others (Workshop Survey, May 11, 2023)

- Model as a legal document
- MALD standard certification process
- Model as legal document
- MALD for infrastructure projects
- Model as Legal Document (MALD)
- Relationship between openBIM and Project Delivery Methods

MALD

- Infrastructure digital twins
- Digital Twin (system data)
- Integration of ROI data in terms of human performance and health
- Scheduling based on openBIM
- Bridge Inspection
- Road Maintenance
- Smart bridge health monitoring using 3D model and sensor data
- IoT integration

Digital Twin

- openCDE, "Golden Thread," data flows through the entire life cycle. How to bring data into the model
- Data integration with legacy CDEs like SAP

openCDE

- Optimization and Risk Management
- BIM Maturity Index
- Carbon footprint reduction
- BIM and manufacturing models interoperability through IFC
- openBIM validation
- Capture and integrate the constituent materials properties, certifications, testing results and data, into the model to tie with asset performance and model and predict performance.
- Has anyone been able to classify a Midel as a capital asset?
- More private sectors?
- Efficiency from pre-design to post-occupancy ROI
- Private sector examples
- Efficiency start to finish

Use Case Priorities Identified from Seeing is Believing
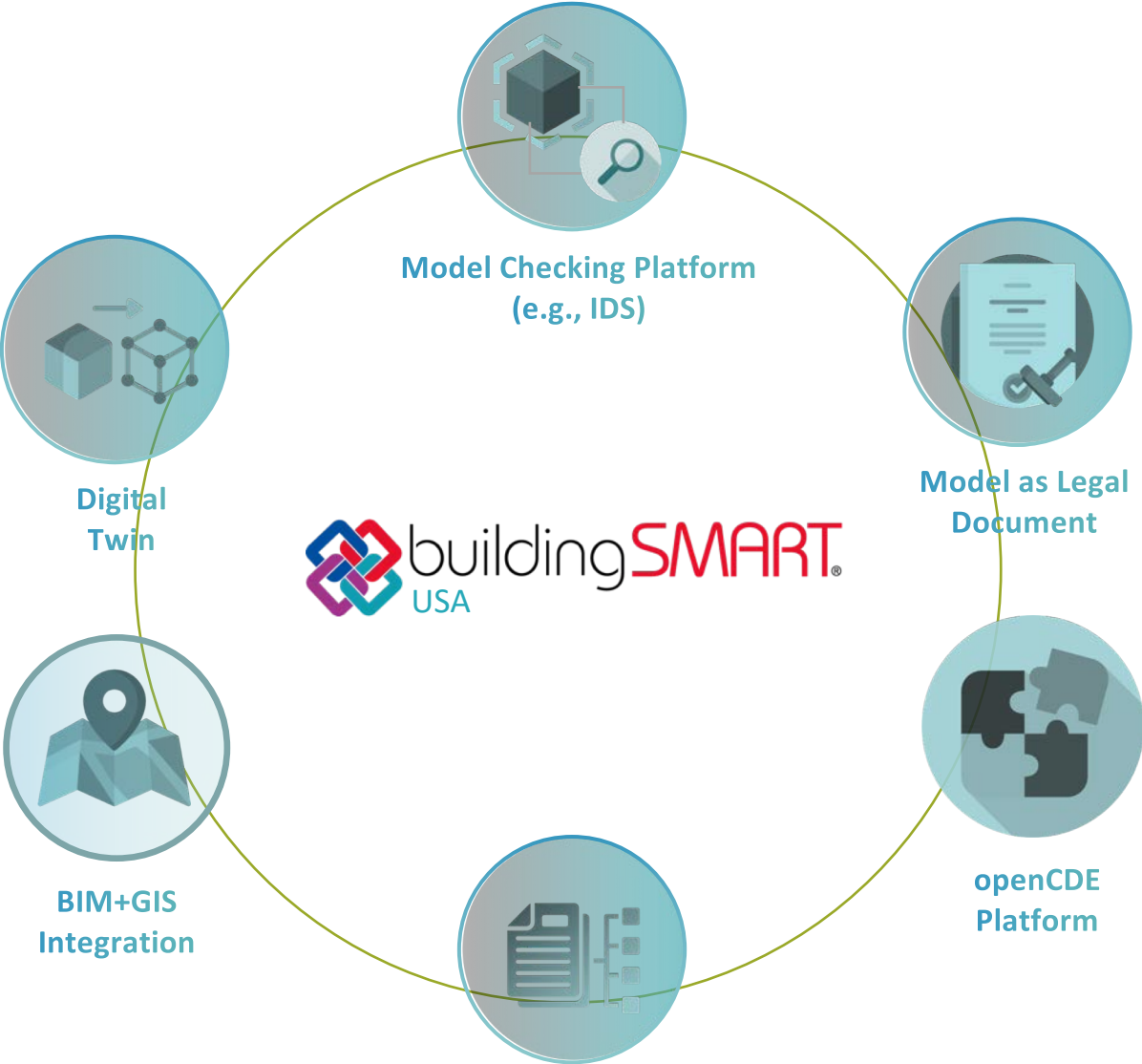
buildingSMART USA
Seeing is Believing

- Accelerated development of pilot projects using openBIM
- From concept to realization in 300 days
- Build on global best practices & develop openBIM-USA use cases

Call for Participation

1
Prioritize openBIM-USA use cases and share challenges

- Participate in scheduled workshop/event (e.g., May 11 Seeing is Believing event)

    OR

- Contact

    usa@buildingsmart.org

    for inquiry and participation without joining the workshop or event

2
Assess, align, scope, and match solutions

- Assess your data, use case, and requirements

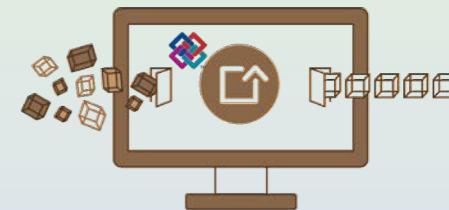- Review and match solutions, seekers, and openBIM workflows

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openBIM® Workflow

[1]—[2]—[...]

3
Normalize IFC models and early prototyping

- Correct/update/enrich your IFC models

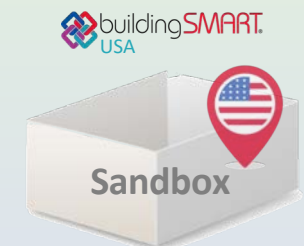- Start early prototyping for the defined use case

(Image source: Simplebim)

4
Pilot and test use case in sandbox

- Deploy use case in a test environment

- Receive feedback, assess feasibility, identify room for improvement

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Sandbox

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