Summary

Industry Foundation Classes (IFC) is an international open data standard for the capture, exchange, and use of information representing the built environment in the context of digitally-based information creation, sharing, and usage, also known as BIM, or Building Information Modeling. Its most recent version, IFC4.3, was revised and expanded to include infrastructure components and was accepted as an ISO standard (ISO 16739-1:2024) in April 2024. AASHTO's resolution to adopt IFC for BIM-based delivery of State DOT projects provides significant advantages in data interoperability, long-term data access, and freedom of choice for software. This in turn drives gains in efficiency, productivity, and sustainability across the infrastructure portfolio and throughout asset lifecycles.

The successful adoption and deployment of IFC 4.3 depends on:

- High-quality, consistent support in software, including the capture, encoding, export, import, and display of needed information, especially DOT requirements;
- User knowledge of openBIM standards (e.g., IFC, IDS, bSDD, etc.) and how preferred software supports them;
- Authoritative guarantees that the software being used properly supports IFC-encoding, regardless of end user capabilities;
- The ability to verify or validate the information being exported from BIM-authoring tools, ensuring users are creating good data with their preferred tools;

Currently, there are mechanisms in place or under development to address some of these issues, but also shortfalls in those proposed solutions. This includes:

- Work at buildingSMART International to engage and interact with software developers through the IFC Implementers Forum <https://www.buildingsmart.org/resources/ifc-if/>. This includes testing and validating support based on the IFC4.3 schema and the bSI Base MVDs (Alignment-based View [AbV] and Reference View [RV]). The buildingSMART USA chapter also has a Solutions Providers Group (SPG) to work on educating and supporting software and hardware vendors looking to provide IFC support. Active Pooled Funds, TPF-5(372), 5(480), and 5(523) have, or will be, actively provide software vendor support to ensure compliance with DOT requirements based on the IFC/openBIM framework;
- Ongoing development of end user-focused documentation of standards and tools, either by bSI, the Pooled Funds, or software vendors;
- The Global IFC Software Certification service <https://www.buildingsmart.org/compliance/software-certification/> by bSI which surveys the files submitted through the IFC Validation Service and provides a scorecard on how well a declared software application support various IFC concepts. The name "Software Certification" is not entirely accurate as the service is merely a survey of files produced by end users, submitted to the IFC Validation Service, and does not directly involve the software developers. It is possible for end users to create and submit error-filled (intentionally or unintentionally) files even if the software has the technical ability to create correct ones. There is no formal "certificate" granted to vendor's product or product version, merely a scorecard which estimates the software's ability to support the stated IFC concepts;
- Use Case-based IFC Software Certification – In the past, bSI did conduct and confer IFC certification upon software, in direct cooperation with software vendors, but has since stopped those efforts and deferred future efforts to other "approved" entities. This

included testing based on exchange requirements from a Model View Definition (MVD) and random specific requirements (e.g., values, types, geometry types, etc.) using a common set of testing files. bSI's discontinuation of this support means that there is no official determination (i.e., a "certificate") if a software is technical capable of producing a valid IFC file based on schema, exchange requirements (MVD and IDS), and context (e.g., "bridge" vs. "road", or "US bridges" vs. "Norway bridges"). bSI has indicated that this will be left to "approved" or "accredited" third parties. This may be daunting to software vendors as criteria for such certifications may vary per jurisdiction and use case;

- The IFC Validation Service <https://www.buildingsmart.org/users/services/ifc-validation-service/> by bSI to examine end user created files from various software tools and determine their validity, or compliance, with the IFC schema. This service is still under active development and not yet a fully functional "1.0" version to date. The IFC Validation Service feeds directly into the Global IFC Certification service.

Completing the development or addressing the shortcomings of each of these is the subject of ongoing work, but the pace of such delivery appears to be tied to financial support provided to the respective efforts. However, it is unclear that the current bSI efforts alone will ensure that the tools needed to support the use of IFC by State DOTs match the timescales of planned pilot and pooled fund projects or long-term adoption, deployment, and contractual needs.

This proposed new Pooled Fund Study would look at the viability and best means to significantly enhance the scale and maturity of the bSI services (i.e., IFC Validation Service and Global IFC Software Certification), as well as recommend any additional technical and procedural efforts (such as Use Case-based Certification), inside or outside of bSI, needed to support software implementation and US industry adoption and deployment.

The following two primary business objectives would be achieved:

- Enabling State DOTs to specify certified (IFC and US industry standard exchange requirement compliant) software for road and bridge projects; and
- Enabling State DOTs to validate deliverables from consultants and contractors to enhance project delivery and management quality.

This work would be separate but complimentary to the ongoing work of TPF-5(523) BIM for Bridges & Structures Pooled Fund and TPF-5(480) BIM for Infrastructure Pooled Fund, which are being developed in parallel. However, accelerating development of bSI and external services will be of benefit to the objectives of these Pooled Funds.

The proposed Pooled Fund Study would be a three-year program, with the bulk of the effort focused on initially verifying, supporting, and accelerating activities on the bSI Technical Roadmap (specifically validation and Global "certification"), before tackling needed, US-specific, additional use case-based certification platform. The bSI scope elements supported by this Pooled Fund Study would be structured broadly as follows:

- **Year 1** would focus on (1) firmly advocating bSI-vendor interactive engagement and communication to support vendors (through the bSI IFC Implementers Forum) on implementation of IFC4.3 and AbV base MVD, (2) finishing development of the IFC Validation Service, (3) satisfying US security compliance on the platform, (4) finishing development of the Global IFC Software Certification platform for exports, and (5) providing bSI-compliant educational workshops to reinforce DOT training efforts;
- **Year 2** would (1) continue with implementation support to software vendors, (2) add a Digital Certificate capability to the IFC Validation Service to help support MALD (model-as-legal-document), (3) add import certification to the Global IFC Software Certification, (4)

provide further bSI-compliant in-person workshops in support of DOT education and training efforts. Work would begin on specifying a US infrastructure industry use case-based software certification platform and requirements;

- **Year 3** would (1) provide for limited continued software vendor implementation support, (2) support further enhancements to the IFC Validation Service, (3) develop Use Case-based Software Certification based on US State DOT requirements, and (4) provide any final bSI-compliant in-person educational workshops.

Background

The role of buildingSMART International (bSI)

bSI exists to provide open data standards and services that improve digital interoperability and long-term access to project and asset data across the global built environment. In turn, this drives productivity, profitability and sustainability improvements throughout the sector.

bSI was established by a collaboration of AECO and BIM software companies, and operates as a not-for-profit, vendor-neutral organization. Today, it has over 70 member organizations supporting its work at the international level and has established 36 national Chapters with their own local members across six continents.

How interoperability and data access are achieved

bSI has created a neutral specification for BIM, known as the Industry Foundation Classes (IFC) standard. This has gained accreditation as ISO standard 16739-1:2024. IFC provides a standardized approach for the communication of BIM data between different software applications and gives users long-term data access without being locked-in with an individual software vendor or proprietary file formats.

The AASHTO Board in October 2019 adopted Administrative Resolution AR-1-19: "Adoption of Industry Foundation Class (IFC) Schema as the Standard Data Schema for the Exchange of Electronic Engineering Data".

The openBIM ecosystem

Along with IFC, bSI provides a suite of supporting standards and services, known collectively as openBIM®, to help the industry maximize the benefits of open digital workflows. Besides IFC, standards and services include the Information Delivery Specification (IDS), the use of the buildingSMART Data Dictionary (bSDD) service, the IFC Validation Service and Global IFC Software Certification service:

- The **IFC Validation Service** is a free-to-use means for users to easily check that their IFC files comply with the IFC standard before sharing the data with others. This important validation check increases confidence in the quality of model data and supports accurate data exchanges.
- The **Global IFC Software Certification service** provides the global industry with survey metrics on software support for IFC schemas and concepts through the analysis of files submitted to the IFC Validation Service. The metrics are conveyed as “scorecards” which display the level of success at supporting different functional parts of the IFC schema used to exchange data. The service does NOT provide a formal “certificate” to software vendors or their specific platforms/tools, not does it address specific use cases, such Reference View

(RV) or Alignment-based View (AbV) exchanges. bSI has indicated that such specific exchange certification be the responsibility of third-parties that have been "accredited" by bSI.

Current Status & Plans

Status of the IFC 4.3 Standard

IFC 4.3 was endorsed and published by ISO in March 2024 (ISO 16739-1:2024). IFC 4.3 marked a major leap forward for the IFC standard, bringing horizontal infrastructure into the IFC schema for the first time. IFC 4.3 is being widely implemented by major BIM software vendors.

However, bSI maintains an active program to support vendor implementation of the IFC standard, as well as to develop improved future versions of the standard based on user and vendor feedback. This includes, for example, work with representatives of AASHTO, State DOTs and ongoing Transportation Pooled Funds, TPF-5(523) and TPF-5(480).

Status of the IFC Validation Service

A working preliminary version of the IFC Validation Service has already been developed and deployed by bSI. This is an advanced proof of concept of the performance and benefits of the service, with extremely positive user feedback. Further significant work is needed in its development is to (1) capture all common schema and best practice requirements, (2) scale the infrastructure of the platform to handle a large number of submissions and project file sizes, and (3) introduce additional features of particular relevance to State DOTs, including:

1. **Digital Certificates**, to allow users to receive a formal certificate from bSI acknowledging that a file has passed the relevant IFC Validation Service checks. This will allow users to demonstrate the IFC-compliance of files, for example when submitting them as contractual deliverables. It is anticipated this could be a pre-requisite to using IFC models for MALD (Model as Legal Document) contractual deliverables. However, more information is needed to determine if such certificates will also reflect compliance with use-case exchange requirements based on AbV exchanges and further requirements specified in an IDS.
2. **Security Enhancement**, as it is expected that additional data security may be required for US-generated files submitted for validation. Two options are therefore under consideration:
    - The first option is introducing an offline operation capability, to allow organizations to perform IFC validation on their own hardware and without IFC files leaving their systems, thereby maximizing confidence in data security. However, this approach precludes the ability to receive signed digital file certificates from bSI.
    - Alternatively, an option may exist for bSI to operate the IFC Validation Service on their European servers, while relying on approved US-based cloud servers for the secure hosting and management of IFC files. While detailed investigation is required, this might deliver the combined benefits of Digital Certificates with enhanced national data security.

Status of the Software Certification Program

Two levels of software certification need to be considered for effective adoption and deployment:

1. **Global IFC Software Certification** provides the first level in specifying the appropriate software for information management needs. This will be rolled out in two phases:

    - Phase 1: this certification aggregates the global results from all IFC model files submitted to the IFC Validation Service, to assess and certify the ability of software applications to successfully export IFC files in compliance with relevant parts of the IFC schema. The certification will show which parts of the IFC schema are successfully supported by each certified software tool.
    - Phase 2: later developments will provide additional capabilities such as import certification. This could be of significant importance to State DOTs (and probably vital to support MALD).

    A basic version of Global IFC Software Certification (Phase 1) is currently in the pilot phase with a select few software vendors. Delivery of both Phases 1 and 2 would be accelerated by this proposed Pooled Fund Study.

2. **Use Case-based Software Certification** provides a second level of certification by assessing the ability of software tools to support the AbV base MVD and particular national, regional, or organizational use cases. This goes beyond generic compliance against the overall IFC standard, requiring further, more in-depth tests of the software, to ensure they can meet specific client-defined needs. Software applications will need to pass Global IFC Software Certification before being subjected to Use Case-based Software Certification.

    bSI has provided a Use Case-based Software Certification service for many years but is now deferring any future use case-based certification to third-parties.

Further details on the buildingSMART Software Certification Program can be found here: https://technical.buildingsmart.org/services/certification/

Analysis and Proposal

Resources for the development of IFC Validation Service and Global IFC Software Certification

As a small non-profit organization, bSI is reliant on financial and in-kind contributions from industry stakeholders to support the development of our standards and services. These contributions enable bSI to deliver the projects on its technical roadmap – such as these two important services – and thereby provide to industry stakeholders the capabilities that they need. In this instance:

- Supporting software implementation and addressing feedback on IFC 4.3 for future standards development is being supported through in-kind contributions from both users and software vendors. However, the pace of work is limited by a shortage of direct funding;
- Enhancement of the IFC Validation Service, as described above, requires – and is limited by a lack of – industry funding; and
- Deployment of the Global IFC Software Certification service is being supported by in-kind contributions from software vendors, but also requires direct funding which has not yet been secured.
- No Use Case-based Certification has been specified or funded at the present, but the previous bSI efforts could be studied for future planning.

Risks

As things stand, there are known risks to the successful implementation of IFC 4.3 by State DOT's, including:

- An inability to make use of the IFC Validation Service due to data security concerns, thereby preventing access to a key quality improvement mechanism;
- An inability for State DOTs to specify the use of IFC-compliant software due to the lack of a deployed Global IFC Software Certification service;
- An inability for State DOTs to specify the use of IFC-compliant software due to the lack of a deployed Use Case-based Software Certification service;
- An inability to implement MALD due to the absence of software import certification; and
- A lack of stakeholder knowledge around the capabilities and use of the latest openBIM standards and services, leading to flawed implementation and consequent performance shortfalls. This concern was cited by State DOT attendees as *the* most significant lesson from recent DOT/bSI workshops in Pittsburgh and Denver.

Taken together, these risks present a significant impediment to the ability to achieve the objectives of AASHTO's Administrative Resolution AR-1-19 to drive IFC adoption.

Opportunities

Conversely, an opportunity exists to establish a new Transportation Pooled Fund Study to support the coordinated and accelerated development of the IFC Validation Service and the Global IFC Software Certification service to meet the needs of State DOTs in a timely manner.

Furthermore, building on the lessons of the recent Pittsburgh and Denver DOT/bSI workshops, there is an opportunity to bolster adoption with a small number of bSI-led in-person education and training workshops to promote a better understanding within DOTs on how to implement IFC for road and bridge projects.

Together, these outcomes would allow State DOTs to benefit sooner from the advantages of openBIM: primarily data interoperability without the risk of being locked into proprietary formats, ensuring DOTs retain long term control over their data, and providing their supply chains with the freedom to use the best software tools for the job.

Pooled Fund Outcomes

This Pooled Fund Study would result in the following:

- **IFC 4.3 Implementation Support** – assisting software vendors in the implementation of the standard within software applications;
- **IFC Validation Service** – enacting agreed security enhancements;
- **IFC Validation Service** – accelerated deployment of Digital Certificates;
- **Global IFC Software Certification** – accelerated deployment of Global IFC Software Certification, covering key IFC functional parts required by DOTs;
- **Global IFC Software Certification** – accelerated addition of import certification;
- **Use Case-based Software Certification** – identification and preparation of agreed Use Case-based tests required by DOTs; and

- **Education and Training** – through in-person workshops on the latest openBIM tools and processes.

Proposed Timeline

Anticipating a Transportation Pooled Fund with a three year duration, the following high-level schedule is proposed:

Area	Scope	Year 1	Year 2	Year 3
IFC Implementation	Vendor implementation support	X	X	X
IFC Validation Service	Security enhancements	X		
IFC Validation Service	Digital Certificates		X	
Software Certification	Global IFC Software Certification	X		
Software Certification	Global IFC Import Certification		X	
Software Certification	Use Case-based Certification		X	X
Education and Training Workshops	Upskilling	X	X	X

This timeline may adjust slightly to synchronize with ongoing vendor implementation and the inter-dependent deliverables that are being produced by the two existing BIM pooled funds TPF-5(480) and TPF-5(523).

Proposed Funding

Proposed seed funding by FHWA = $200,000.

20 x States @ $30k per year = $600,000 x 3 years = $1.8m.

Total Fund Value = $2.0m.

Initial minimum threshold to commence work = $1.0m.