INDOT Intelligent Road Design and Construction Using 3D Models

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Mission Statement

- The use of <u>intelligent</u> 3D CAD models to support the lifecycle of transportation assets (roads and bridges) that provides predictive analysis and reporting capabilities that is data driven and allows the agency to make better operational and strategic management decisions.

2019 e-Construction Accomplishments

- e-Ticketing for Materials Delivery
  - Demonstration HMA project on SR15, Contract RS-40919-A
    - May/June 2019
    - Phend & Brown contractor
    - Fleetwatcher system by Earthwave Technologies
    - Mainly provided INDOT personnel opportunity to get hands experience with electronic data
    - Comparison of paper tickets and digital data were the same quantities
- INDOT Hosted FHWA Digital Construction Inspection Workshop
  - July 2019
  - Utah DOT – Digital Construction efforts
  - Ohio DOT – AASHTOWare Project implementation
 - Parsons – Digital Design and 3D models

Digital Design and Construction Inspection

- Bentley OpenRoads Designer (ORD) Connect Edition Pilot Project
  - "Work In Progress" Workspace
  - Pilot for road design and survey Spring/Summer-'20
    - Determine workflow changes
    - Find any issues with tools in new software
  - Implement Item Types
    - Workflow for adding pay items attributes to design features
    - Investigate possibility of using for quantity calculations
  - Potential roll-out of ORD CONNECT internally Fall-'20

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Bentley OpenRoads Designer Connect
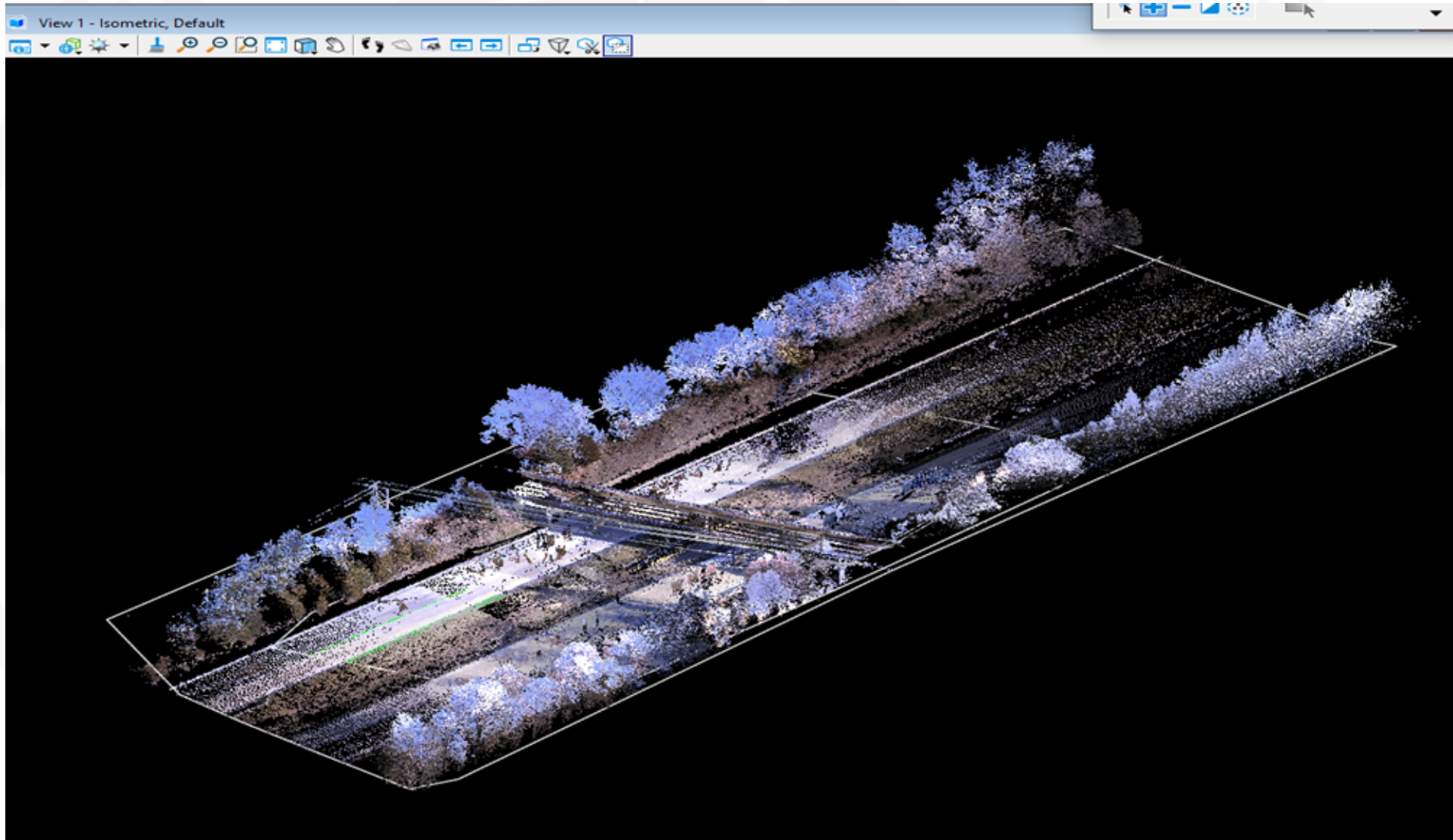
Bentley OpenRoads Designer Connect (cont.)
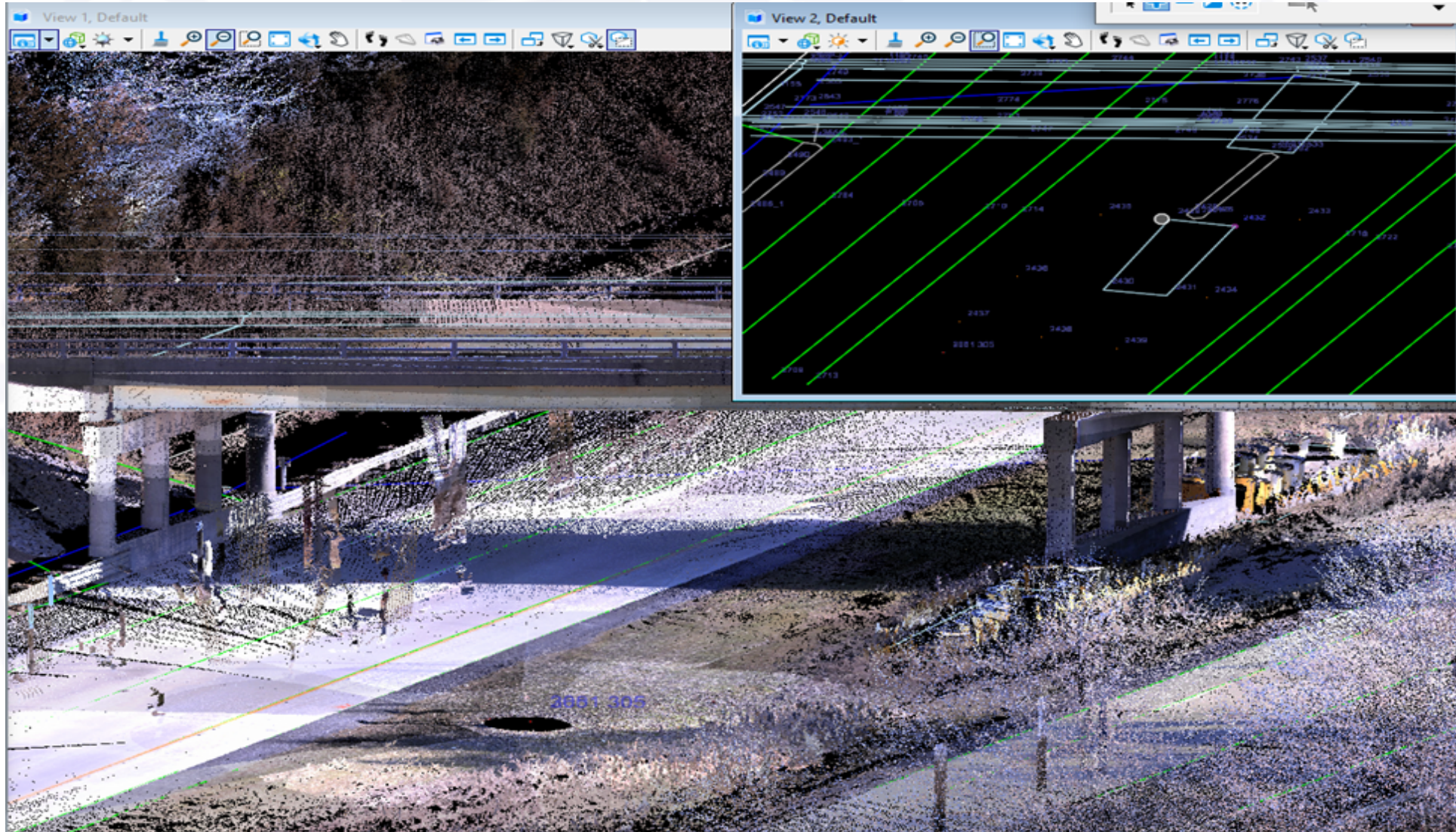
Digital Design and Construction Inspection - 2

- Bentley Construction Inspection App (SYNCHRO)
  - Field Testing April 2019
  - Form based app
    - Commercial release with issue/notification tracking October-'19
    - Commercial release/update to add Field Inspection February-'20
  - Adding 3D Model design to SYNCHRO under development
    - Potential Proof of Concept on I-69 in Martinsville
      - Design > Inspection Workflow
      - Design consultant provided CAD files
      - Pick a few asset types
      - Add Item Types for pay items
      - Test workflow of using pay items as key for passing data to SYNCHRO

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Bentley SYNCHRO (pg.2)

- Form Based Workflow (non-3D model)

Bentley SYNCHRO (pg. 3)

- 3D CAD Model Based Workflow

Bentley SYNCHRO (pg. 4)

Bentley SYNCHRO (pg. 5)

Bentley SYNCHRO (pg. 6)

Bentley SYNCHRO (pg. 7)

Bentley SYNCHRO (pg. 8)

Bentley SYNCHRO (pg. 9)

Bentley SYNCHRO (pg. 10)

3D Modeling

| SPR 4421 Life Cycle Integration of Infrastructure Information Modeling | 3D Modeling with Bentley SYNCHRO App Demonstration | 3D Modeling Deliverable Pilot | UAS | Primavera P6/Synchro |

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SPR 4421 Infrastructure Information Modeling
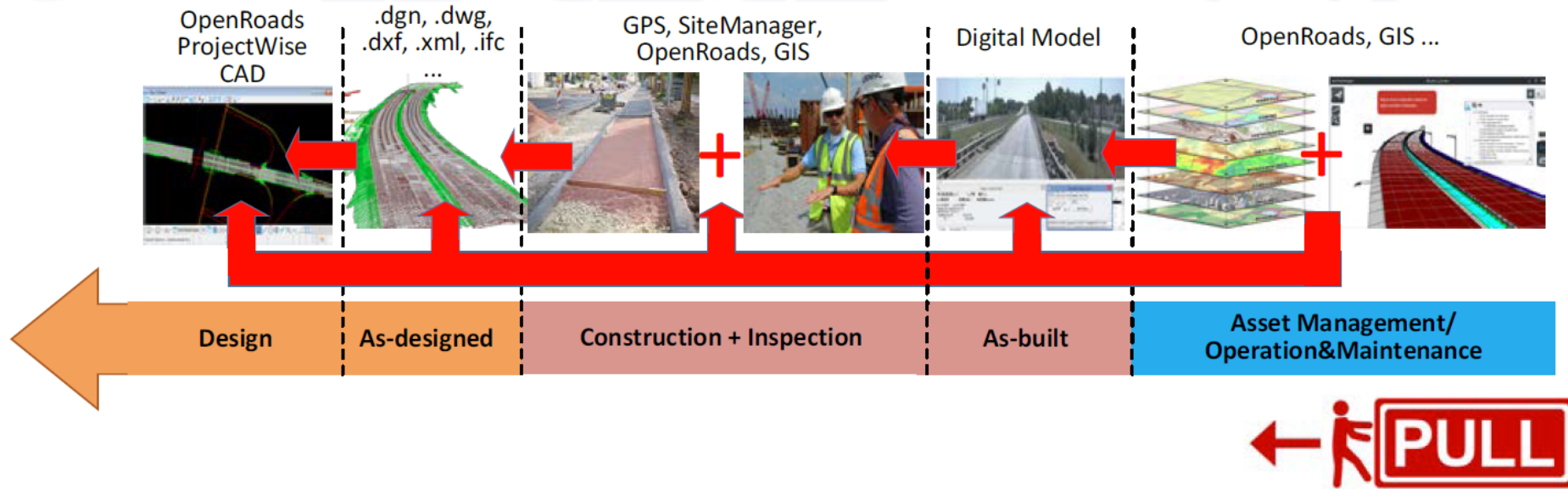
Figure 2. Recommended Pull-Type Data Flow for INDOT (Cai et al., 2015; Fuller, 2018)

Ideal Technology	Ideal Process
Compatibility of project software and apps	Sharing of files (e.g., 3D models) among designers, contractors, and INDOT
	Clear definition of business process and workflow
	Accurate infrastructure asset information

Integration of BIM and GIS for facility management
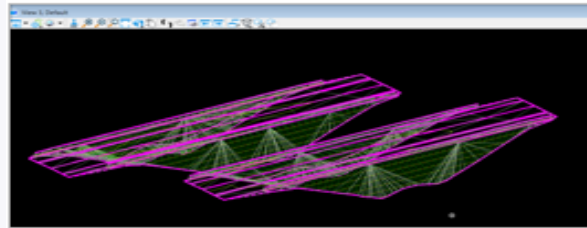
Figure 1. Bridge decks in .DGN

The .DGN data can be exported to .STP file.

Figure 2. Bridge decks in .STP

The .STP file can be exported to .IFC file.
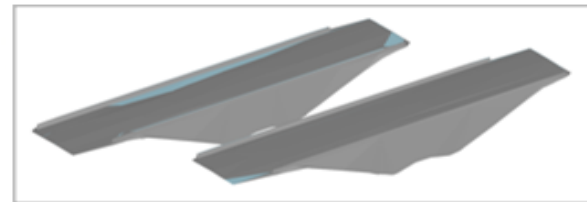
Figure 3. Bridge decks in .IFC

The .IFC file can be integrated with GIS file.

Figure 4. GIS data

SPR 4421 Infrastructure Information Modeling - 3

Required Files

- Models and documents that are required to be delivered to the contractor and INDOT but are not part of the documents or files defined as the legal document.
File types to be filled by INDOT
(Example) Roadway design layout file - DGN, DXF

Legal Document

- Models and documents that are required to be delivered to the contractor and INDOT which the engineer of record (EOR) certifies as a correct and accurate representation of the design intent. Legal Document and required format(s) to be delivered are as follows:

For Information Only

- Additional helpful files, some required and some not required, to be delivered to the contractor and INDOT. For Information Only files and required format(s) to be delivered are as follows:

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SPR 4421 Infrastructure Information Modeling - 4

EN-Environmental Areas					
Erosion Control-P	DWG/DGN	0.50'+/-	2D	N/A	N/A
Wetlands Surveyed-E	DWG/DGN	0.50'+/-	2D	N/A	N/A
Hazmat-E	DWG/DGN	0.50'+/-	2D	N/A	N/A
EW-Earthworks/Non-roadway Surfaces					
Surfaces-E	DWG/DGN/XML	varies*	3D	3D	3D
Grading/Non-Road Surfaces-P	DWG/DGN/XML	0.06'+/-	3D	3D	3D
Cut/Fill Areas Isopachs-P	DWG/DGN	0.06'+/-	2D	N/A	N/A
Longitudinal Breaklines/Points-E	DWG/DGN/XML	varies*	3D	3D	3D
Longitudinal Breaklines/Points-P	DWG/DGN/XML	0.06'+/-	3D	3D	3D
Slope Intercepts-P	DWG/DGN	0.06'+/-	2D	N/A	N/A
Surface Limits-E	DWG/DGN	0.06'+/-	2D	N/A	N/A
Surface Limits-P	DWG/DGN	0.06'+/-	2D	N/A	N/A
RD-Roadways/Surfaces-Proposed					
Road Pavement-Top Surfaces-P	DWG/DGN/XML	0.02'+/-	3D	3D	3D
Road Pavement-Base Course Surfs-P	DWG/DGN/XML	0.06'+/-	3D	3D	3D
Road Pavement-Subgrade Surfs-P	DWG/DGN/XML	0.06'+/-	3D	3D	3D
Road Curb & Gutter-P	DWG/DGN/XML	0.02'+/-	3D	3D	3D
Road Barriers-P	DWG/DGN/XML	0.06'+/-	3D	3D	3D

SPR 4421 Infrastructure Information Modeling - 5

- **Panel Discussion**: We wish to get feedback and insight from experts (**designers, consultants, contractors, and INDOT staff**) about the current process, organization structure, information formats, and technologies in design, construction, and O&M.

- **Survey**: We wish to survey current information users at **INDOT O&M** about their evaluation of current processes and technologies in documentations of design and construction.

- The time we expected to conduct activity will be between April and September 2020.

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CONTACT US TO JOIN THIS STUDY

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LIFE CYCLE INTEGRATION OF INFRASTRUCTURE INFORMATION MODELING

INTRODUCTION

A successful implementation of IIM requires an integration from all aspects of a business, including technology, process, and information. Current practices reflect issues such as: isolation of project phases, incompatibility of project software and apps, unclear definition of business process and workflow, and inaccurate infrastructure asset information.

To solve the problem, this research will answer following questions:
(1) What data are needed for the assets that INDOT have?
(2) What is the best time and methodology to collect asset data?
(3) Who is responsible to collect, check, update, and maintain asset data in what format?
(4) How to convert data needs during O&M to construction & design requirement or documentations?

JOIN US

(1) Panel Discussion: We wish to get feedback and insight from experts (designers, consultants, contractors, and INDOT staff) about the current process, organization structure, information formats, and technologies in design, construction, and O&M.

(2) Survey: We wish to survey experts (designers, consultants, contractors, and INDOT staff) about their evaluation of current processes and technologies in design, construction, and O&M.

WHEN

Apr. to Sep. 2020

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3D Modeling Demonstration

3D Model Information

Bentley SYNCHRO Testing

Shared with Contractor

SPR 4421 gap analysis
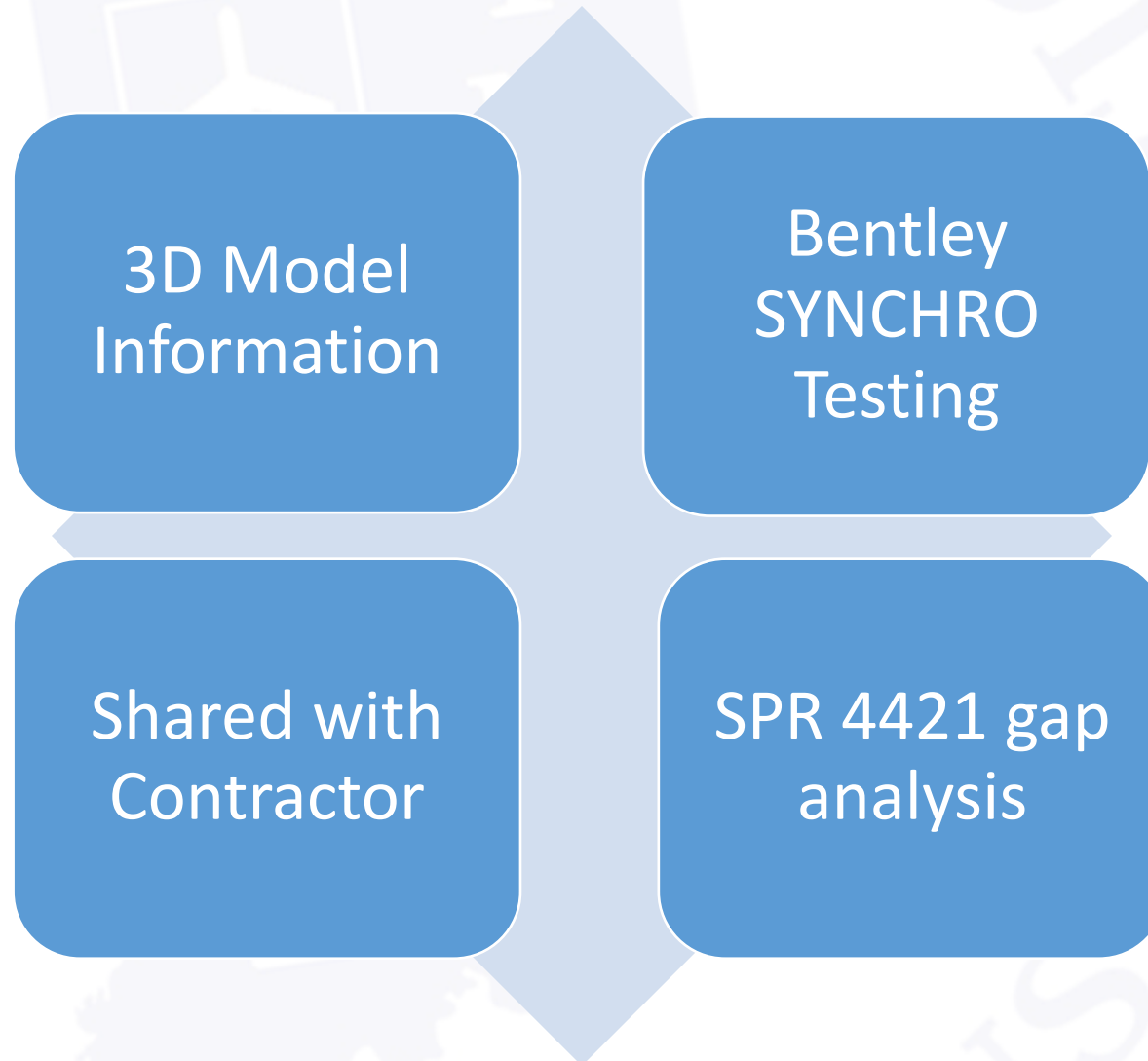
3D Modeling Demonstration - 2

Mobile - Field UX
One Experience, Multiple views, Easy to use
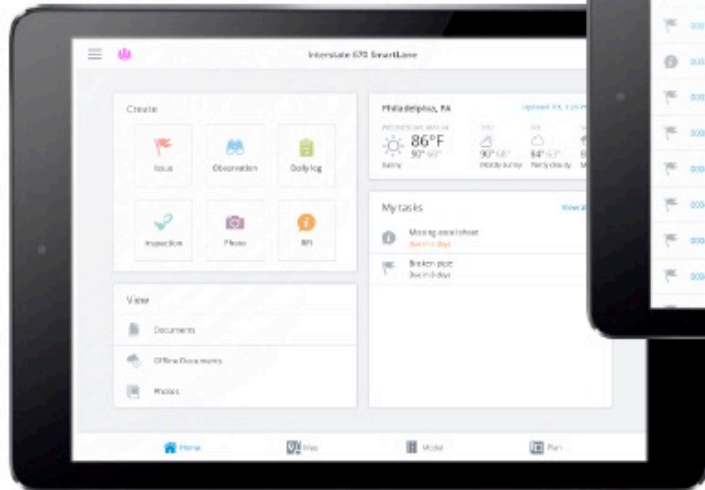
2D plan view

Map view

Task view
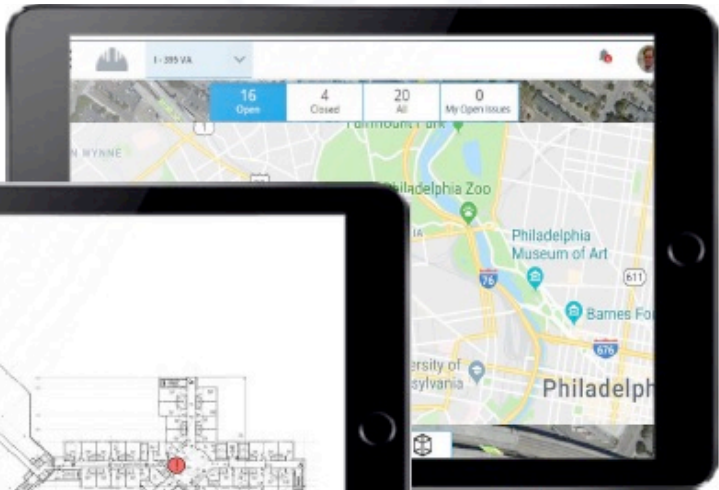
Report view
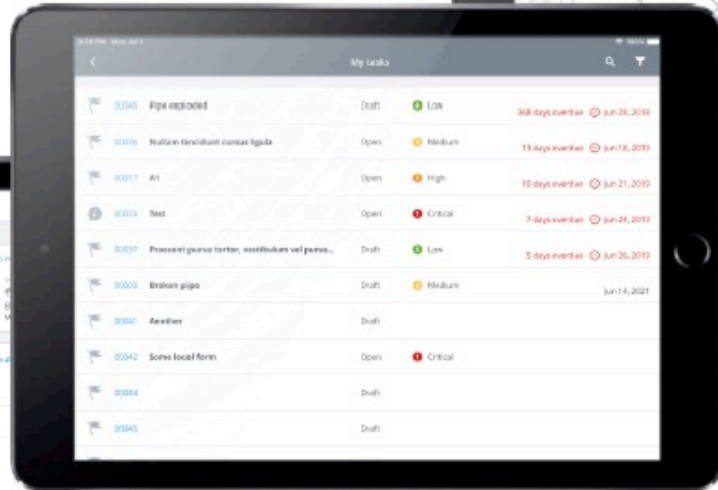
Model view

Inspections by Item Extensions

611E99500
611E98180
611E04600
511E43512
611E05900
511E34450
442E10100
511E34446
611E98150
unspecified
511E41012
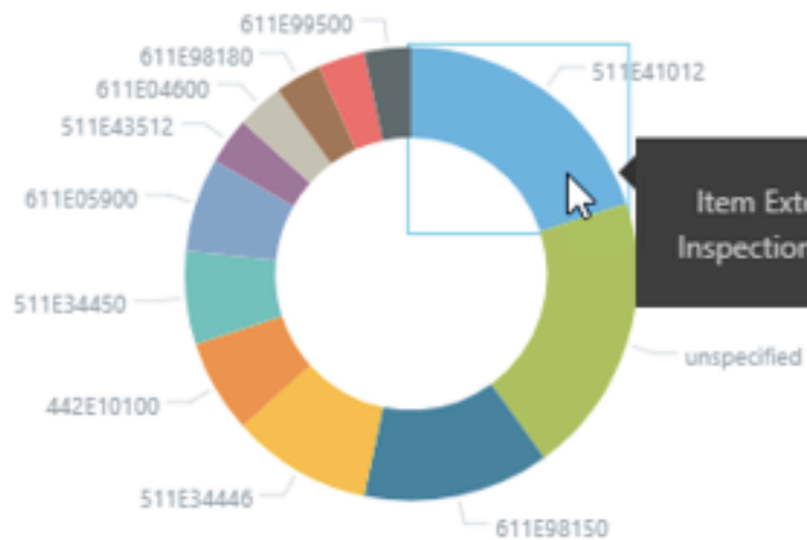
Item Extensions **511E41012**
Inspection Status **6 (20%)**

Inspection Status by Item Extensions

Status ● Fail ● Pass ● Pending

6

4

2

0

511E41012
unspecified
611E98150
511E34446
442E10100
511E34450
611E05900
511E43512
611E04600
611E98180
611E98540
611E99500
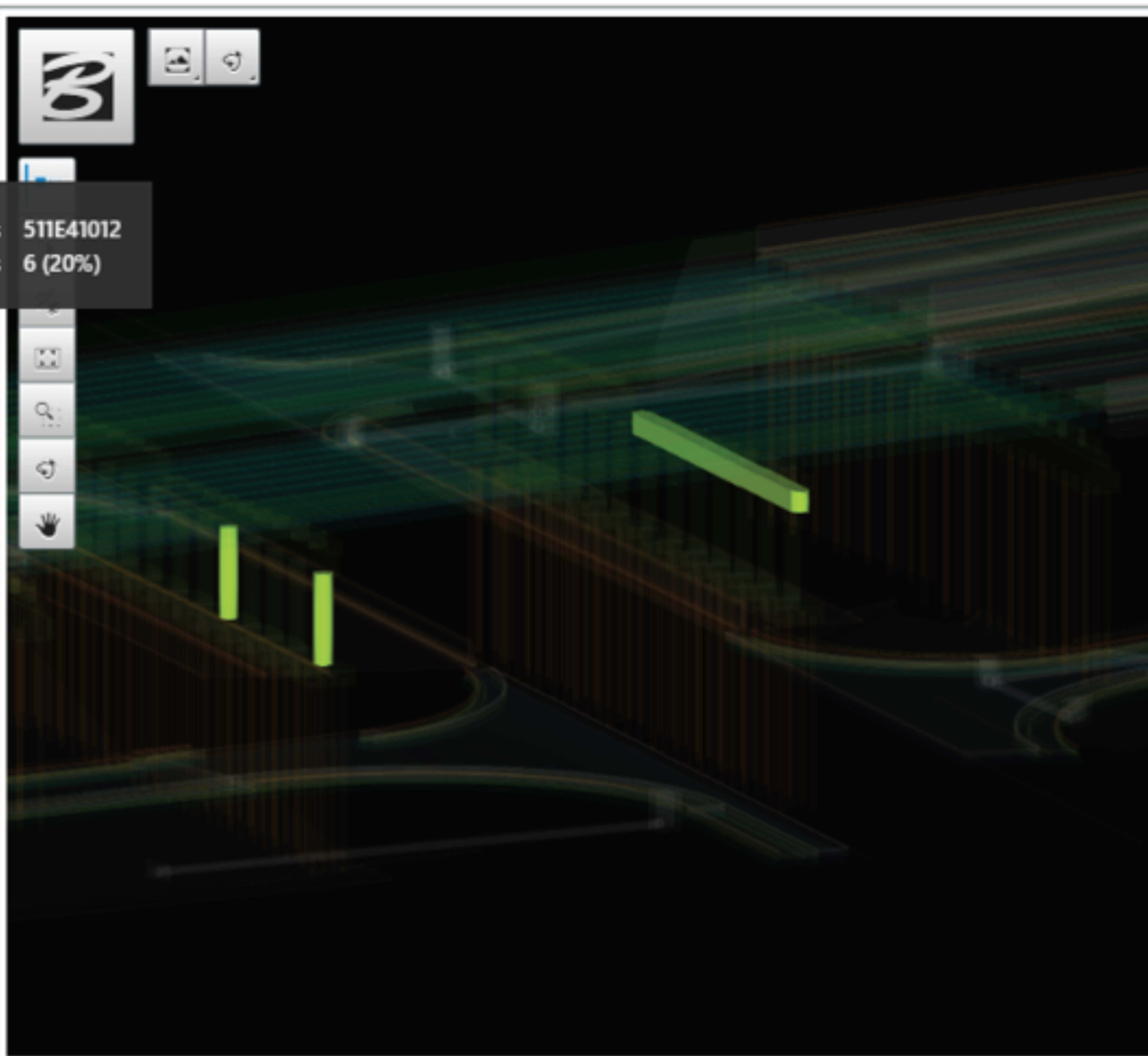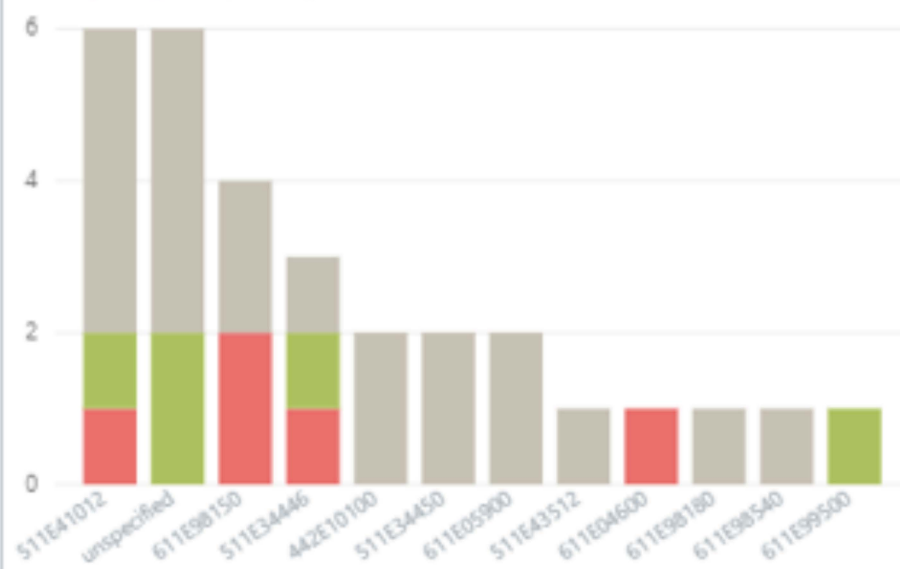
3D Modeling Demonstration - 3

Job Selection
- Major projects complexity

Overall Risk$$$
- Setting a standard
- Expectations

Collaboration
- Design, Contractors, INDOT

Monitoring
- Real time to help decision making

Reporting

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3D Deliverable Pilot

Design-Build Contractor shall capture the as-built coordinates of all new assets listed in Table 2-1 (As-Built Data List), including those new assets placed within existing conduits.

…shall collect coordinates of existing assets if they are modified or connected to any new assets (e.g., storm sewers, traffic barriers, or other features).

All x, y coordinates shall be sub-foot accurate. All z coordinates shall be 0.1-foot accurate. Coordinates and data shall be collected using the coordinate system (format to be provided)

Design-Build Contractor shall submit the data in (format to be provided) using the template provided at (to be provided).

Prior to backfilling any trenches, Design-Build Contractor shall obtain x, y, and z location of underground facilities.

3D Deliverable Pilot - 2

Table : As-Built Data List

Data No.

Asset
1 Drainage/Stormwater
2 Traffic Management Systems
3 Lighting
4 Signing
5 Traffic Signals
6 Traffic Barrier
7 Retaining Walls
8 Sound Barriers
9 Hazardous Material Management

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UAS Pilot

UAS Implementation Plan

- a. Supporting communications and public involvement coordination efforts;

- b. Documenting construction progress;

- c. Estimating quantities;

- d. Monitoring the location of construction workers and equipment;

- e. Evaluating and reviewing MOT within the Work zone; and,

- f. Assisting in Change Requests, Change Orders, and Dispute Resolution

UAS Pilot - 2

- a. Develop existing asset condition documentation prior to commencement of Construction Work, including LiDAR level 3D imagery and models

- b. Document existing pavement conditions on official detour routes

- c. Develop as-built asset condition documentation for post-Project retention, including LiDAR level 3D imagery and models.

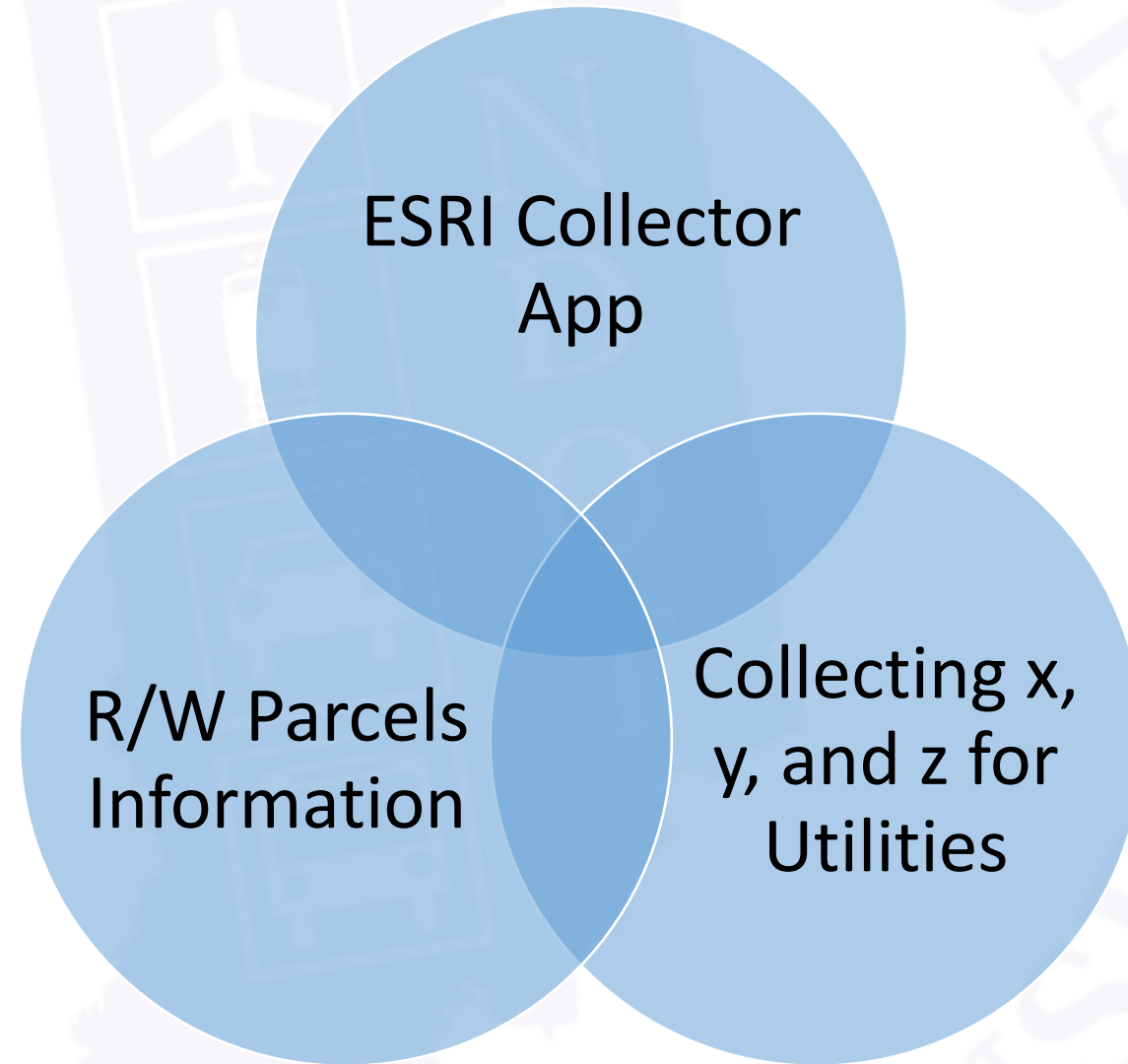# 4D Model P6/SYNCHRO
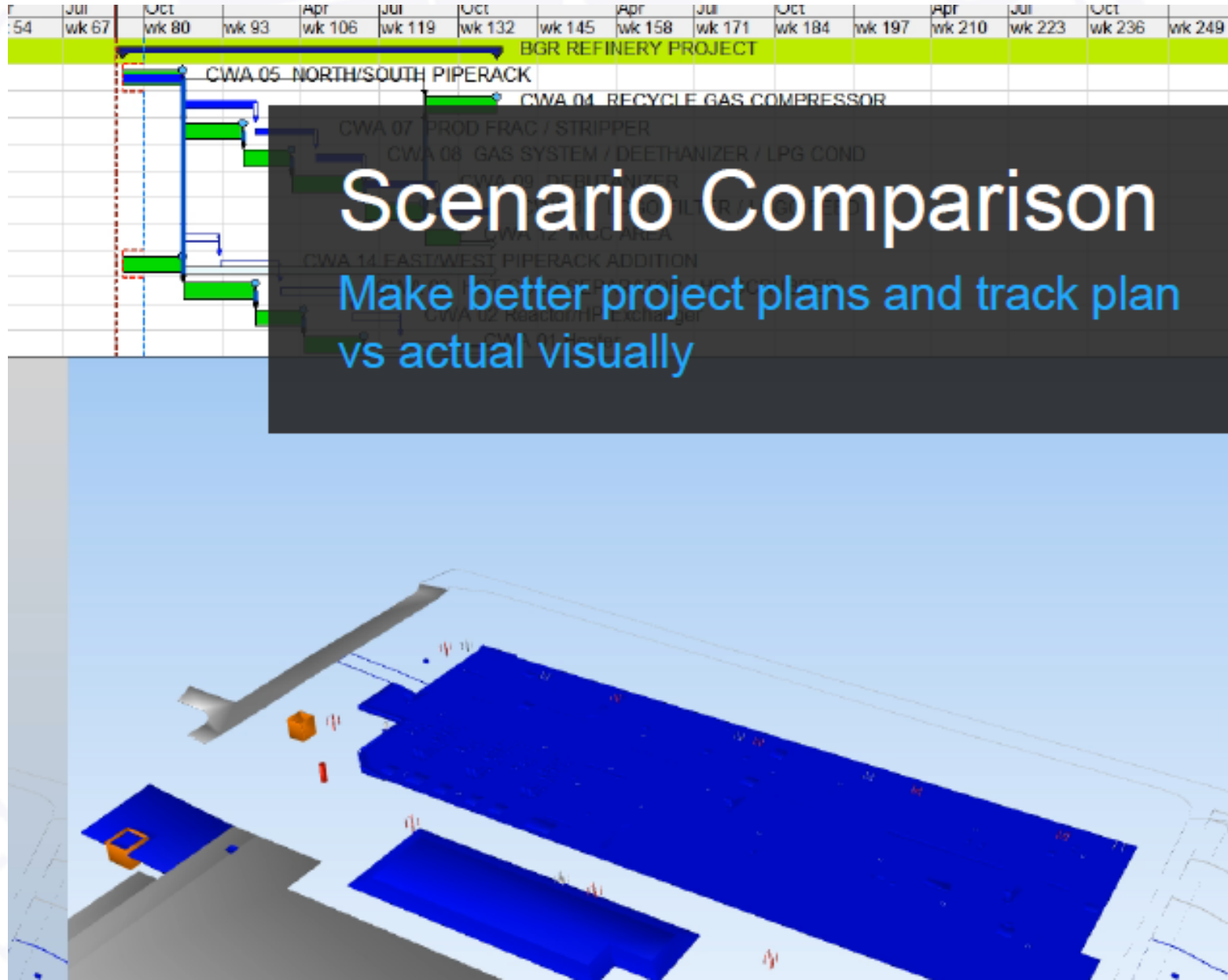
Pilot/Demonstration GIS
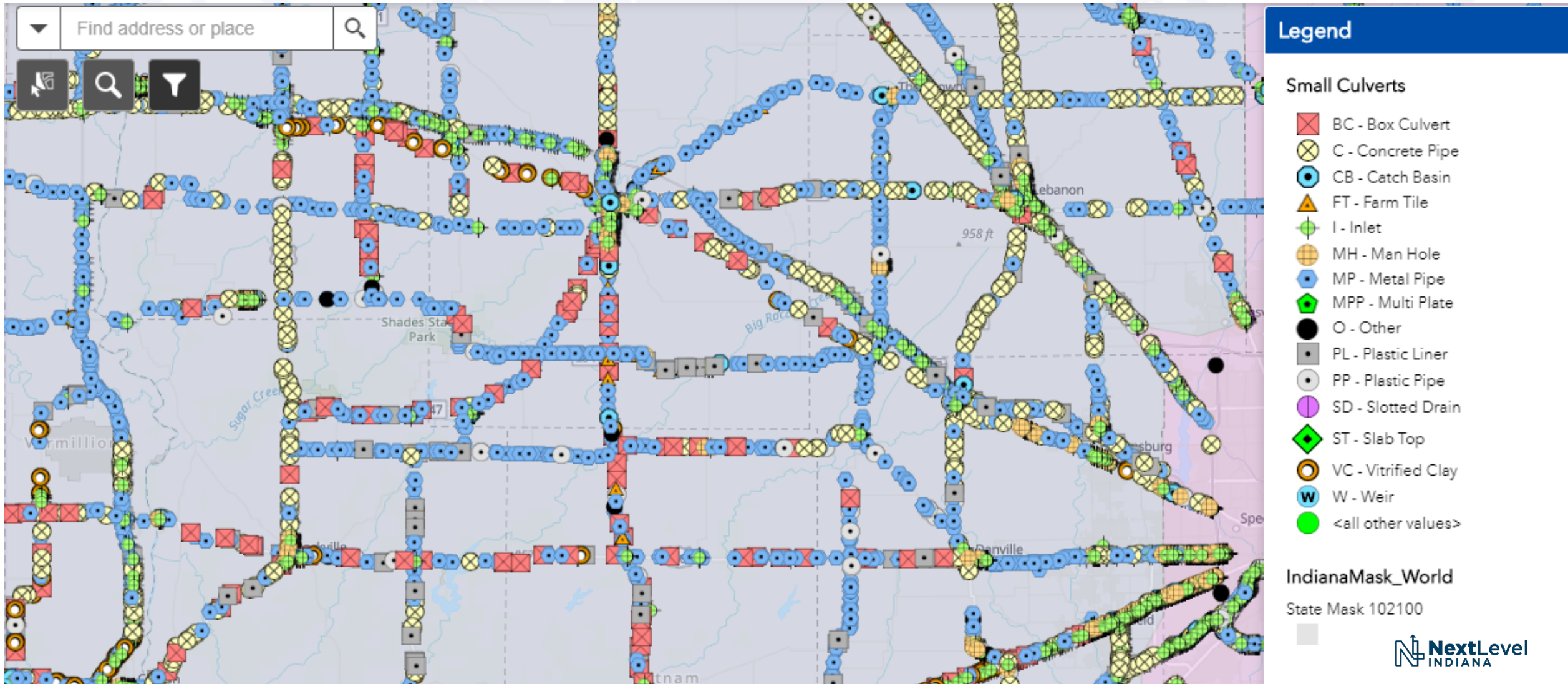
GIS Initiative

GPS Rover

Collector App

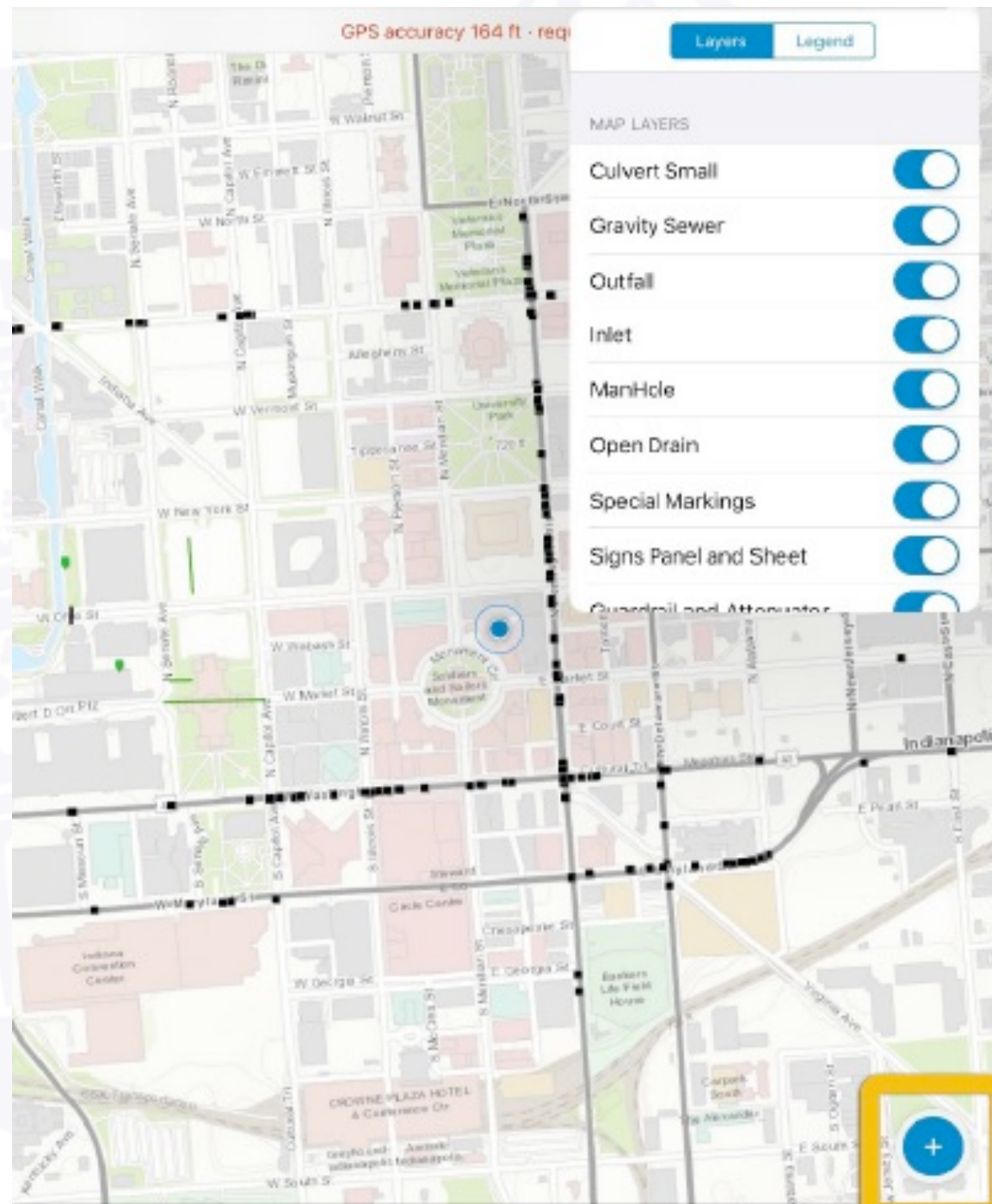Intelligent FCR

eTicketing

GIS Initiative

GIS Initiative - 2

ESRI Collector App

GPS Rover or other device
to boost accuracy

iFCR and other Apps

- Under Development

- SWIM

Field Assistant	**Lab Testing**	**DMF Entry**	**HMA Pay Wizard**	**CPMS**	**SWIM**
Construction Reporting Module	Materials Management Module	HMA Mix Design Solution	HMA Quality Assurance Solution	Contractor Payroll Management Solution	Storm Water Inspection Management Solution
Manual 📄	Manual 📄	DTE 📄 | P/S 📄	Open P/S Beta Dec 2019	PE/S 📄 | Contractor 📄	Tentative: Late 2020
Site Link 🔗	Site Link 🔗	App Link 🔗	Coming March 2020	App Link 🔗	CFA (current) Site Link 🔗

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Questions?

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