GeoDesign – Concept for Integration of GIS / BIM in Landscape Planning

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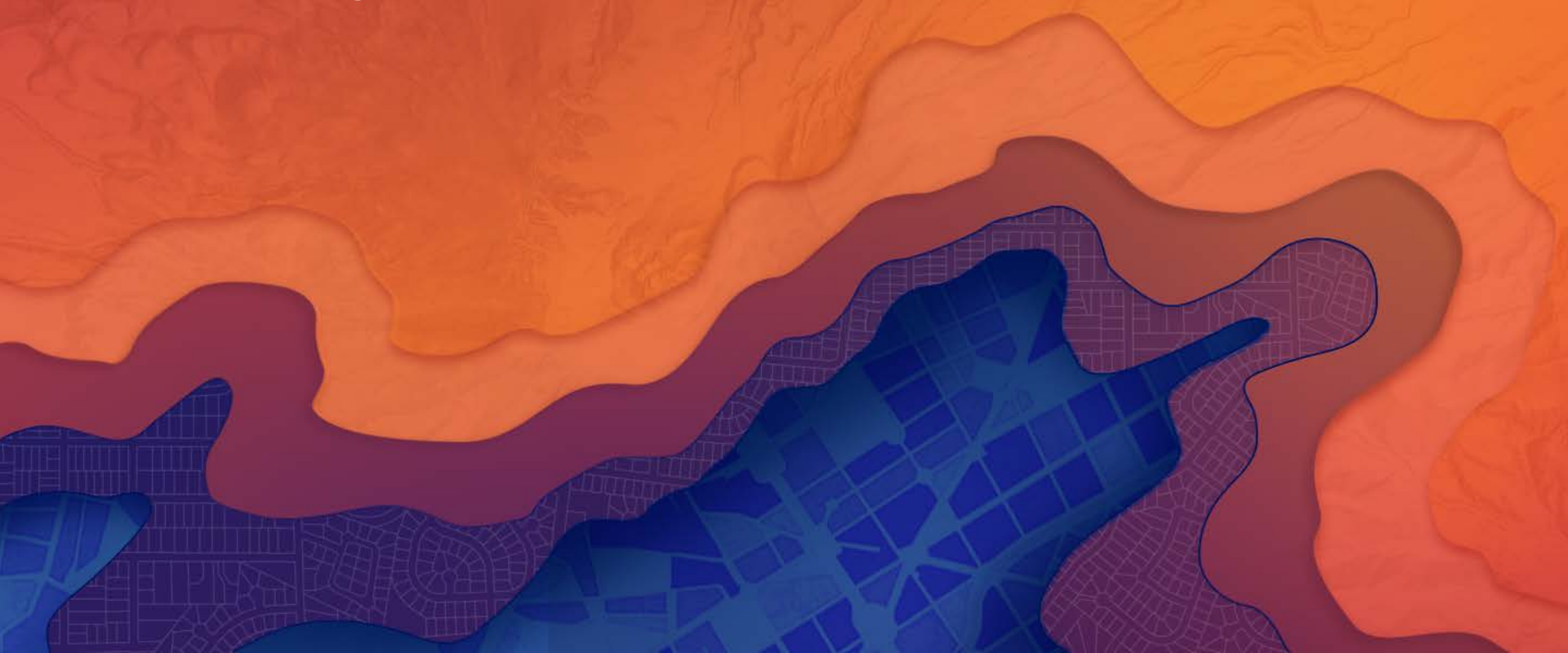
- The GeoDesign Concept
- The GIS Concept
- The BIM Concept
- The BIM and GIS Integration

Application Examples:

- 3D A99 motorway expansion and environmental planning in Munich
- Construction site monitoring with drones

Introduction

- Digitization
- BIM and GIS in AEC Infrastructure Lifecycle



BIM regulations by the BMVI (Germany)

Federal Ministry of Transportation (BMVI)

- BIM Decree 2015 for better management of big infrastructure projects (roads, rail, waterways, public buildings)
- Optimizing time, cost, communication and cooperation
- Transitional period from 2017 – 2020
- Design, plan and construction of big infrastructure projects must be BIM compliant as from 2020

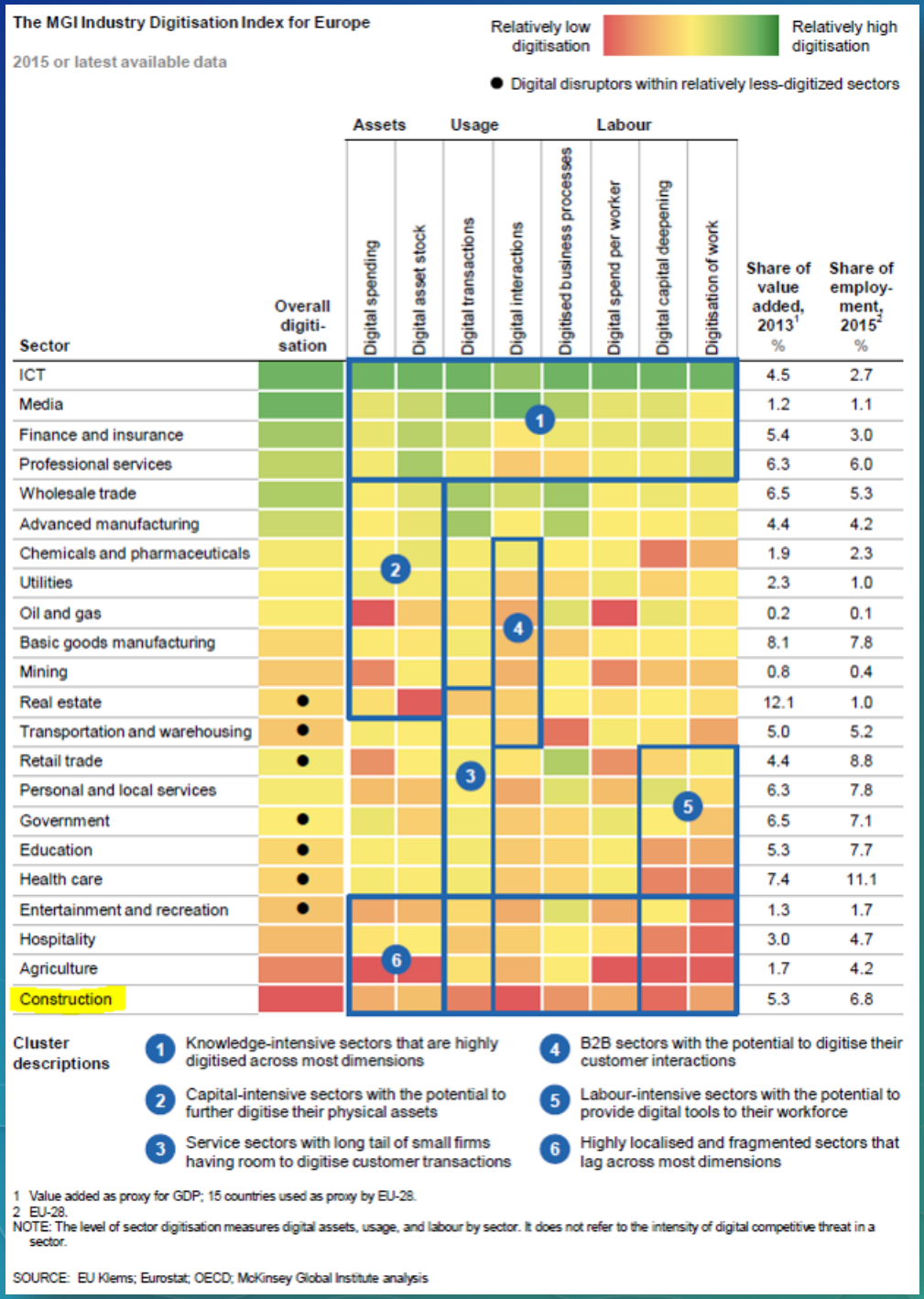
- Master Plan
  - Approx. 30 pilot-projetcs
  - Use of drones
  - Platform of components
  - Competence center BIM
  - Construction cluster

Digitization of Industries in Europe

MGI Index

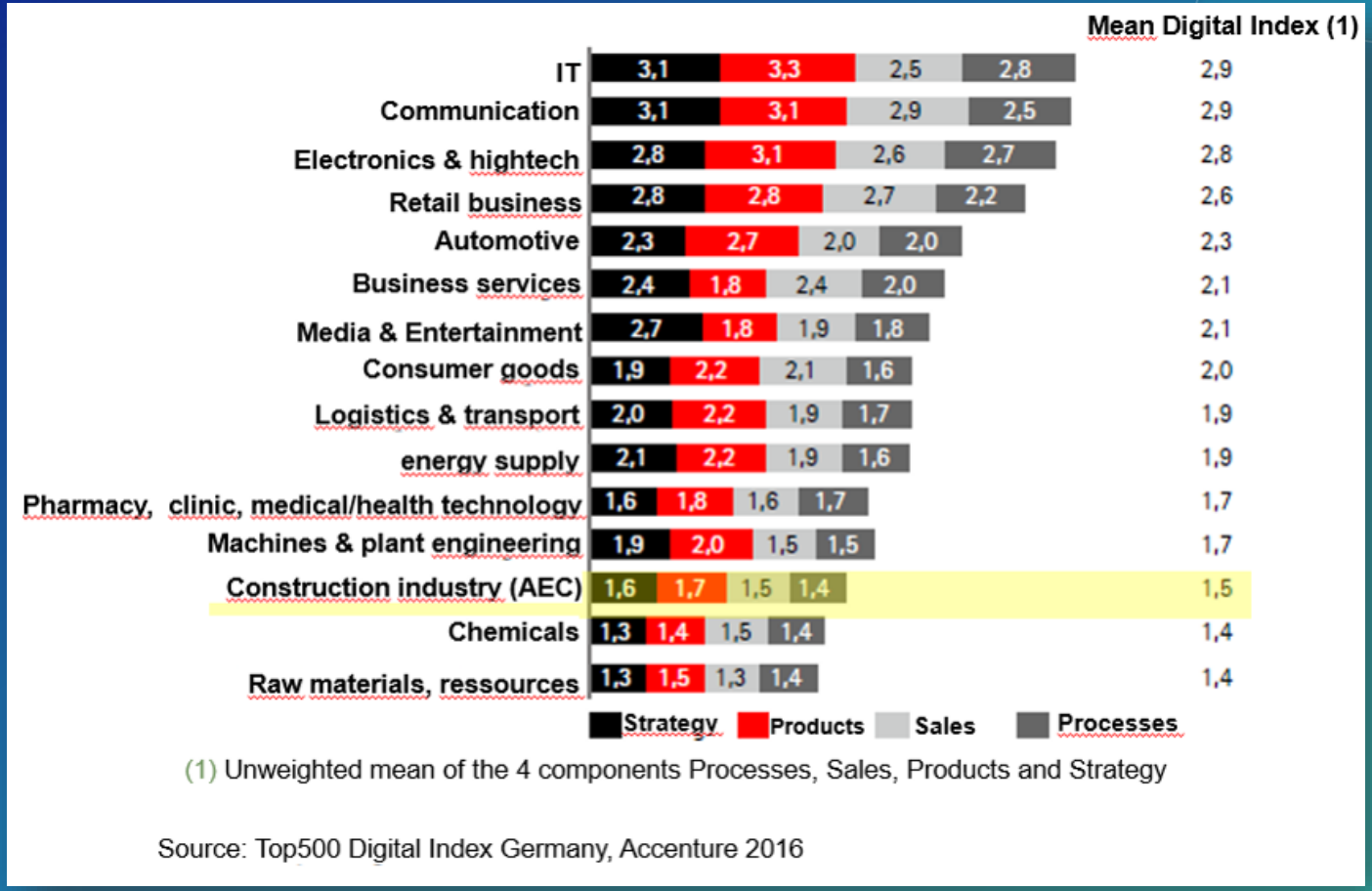
Construction / AEC

Source: http://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/digital-europe-realizing-the-continents-potential



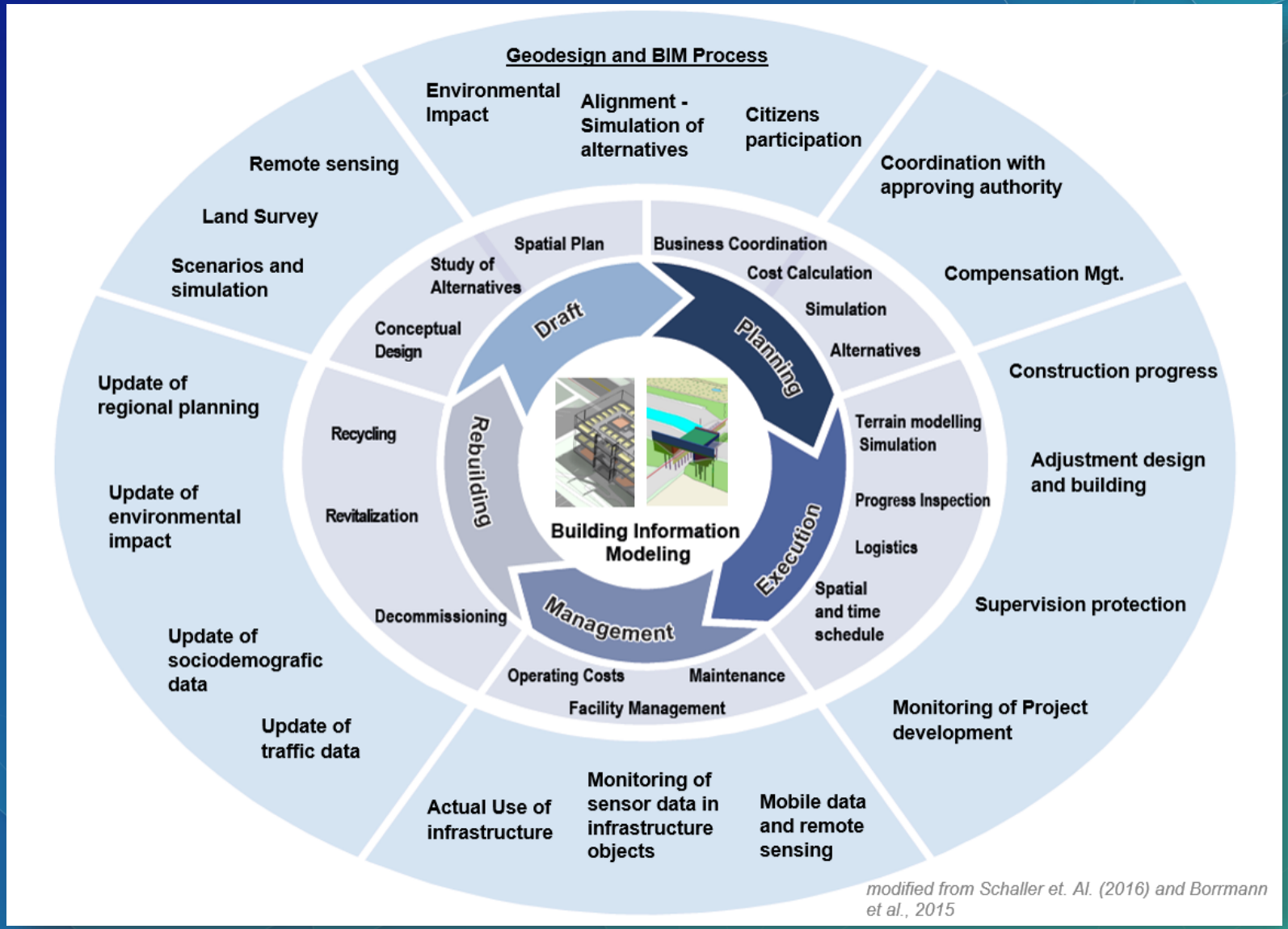
Digitization of Industries in Germany

MDI Index



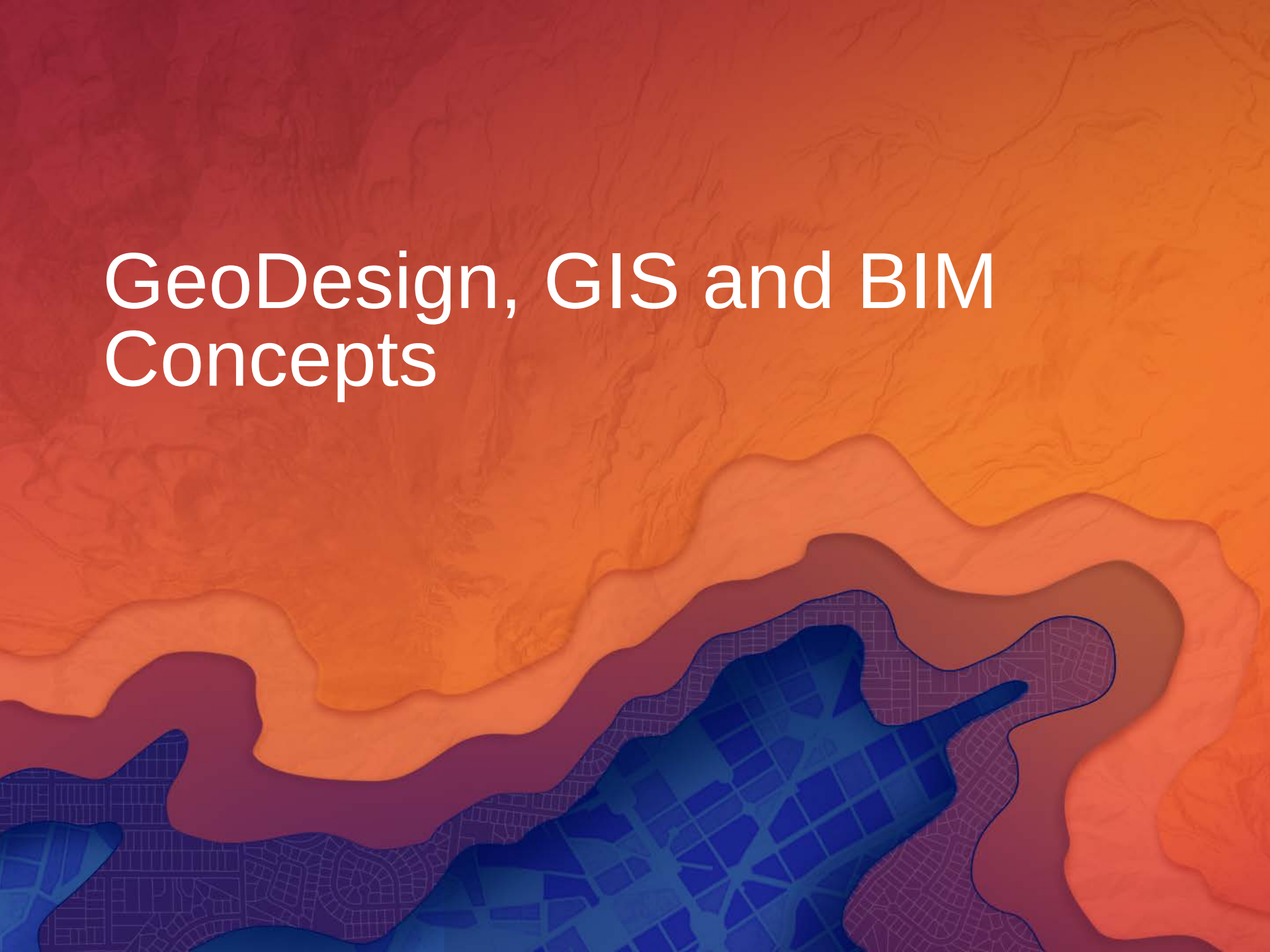
Source: https://www.accenture.com/_acnmedia/PDF-5/Accenture-Top500-DE-Executive-Summary-Final-Web.pdf

BIM and GIS in AEC Infrastructure Lifecycle



modified from Schaller et. Al. (2016) and Borrmann et al., 2015

GeoDesign, GIS and BIM Concepts



The GeoDesign Concept

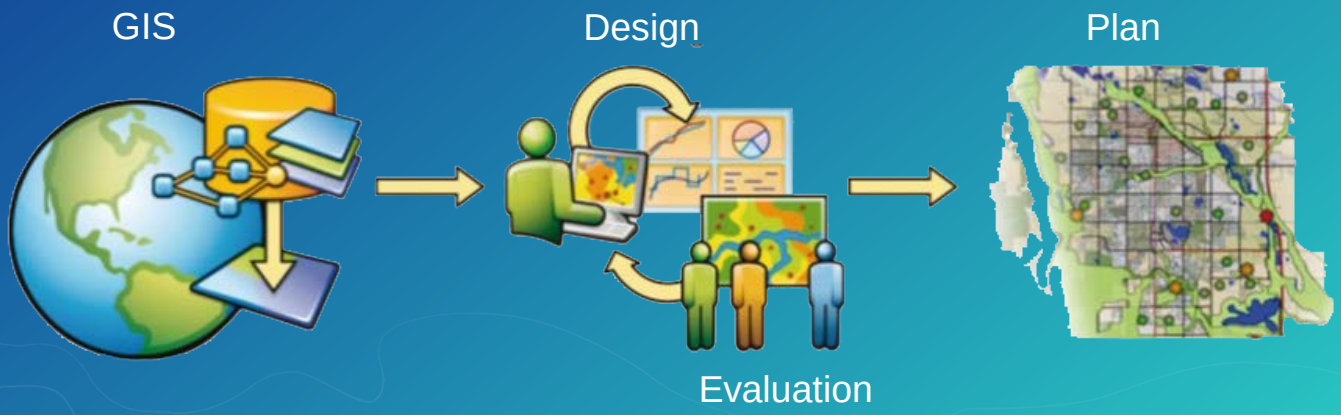
"GeoDesign is a design and planning method
which tightly couples the creation of design proposals
with impact simulations informed by geographic contexts"

Michael Flaxman

The GeoDesign Concept

GeoDesign Requirements

- 2D / 3D / 4D Geo-Reference System – Context / Content
- Attribute Management – Context / Content / Relations
- Topology – 2D / 3D
- Geo-Spatial-Temporal Analysis – 2D / 3D / 4D



The GIS Concept

GIS

2D GIS

3D GIS

Planning Process

- Planning
- Spatial Data Compilation
- Data Management
- Spatial Analysis
- Modeling / Visualization
- Assessment Alternatives
- Decision Support
- Implementation Monitoring

The BIM Concept

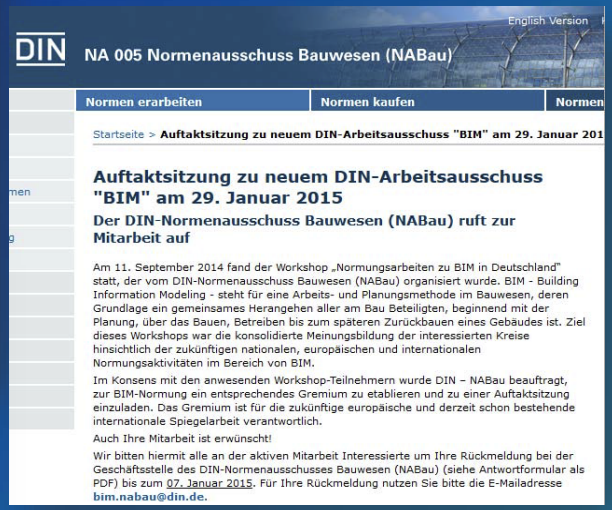
BIM Phases

„BIM is based on the idea of a continuous use of a 3D digital CAD building or infrastructure model over the entire life cycle of an engineering or architectural construction project - from the design, through the planning and execution, to the operation and decommissioning of the project”

Source: Borrmann et. al, 2015

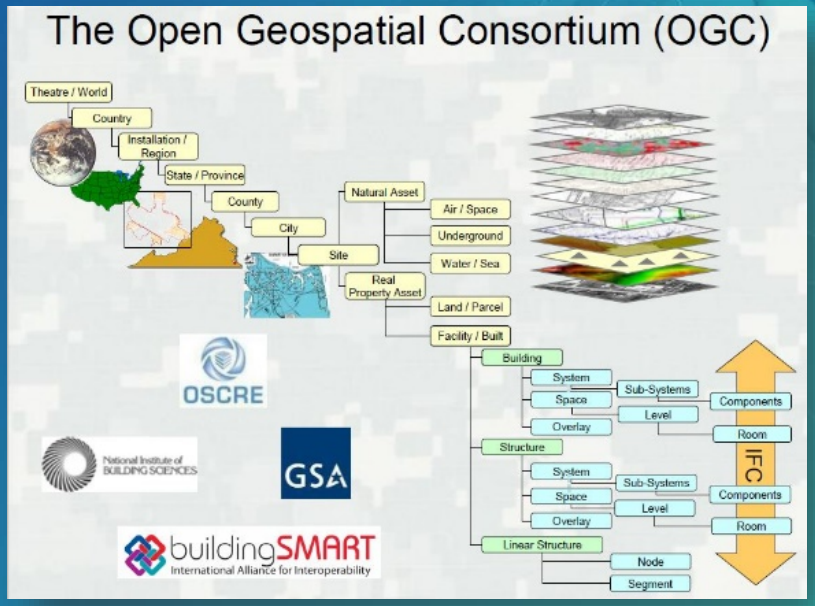
GIS and BIM Standards

BIM Standards – Germany



- DIN Work Committee
- VDI Guidelines 3805
- ISO 16757
- BIM Guidelines

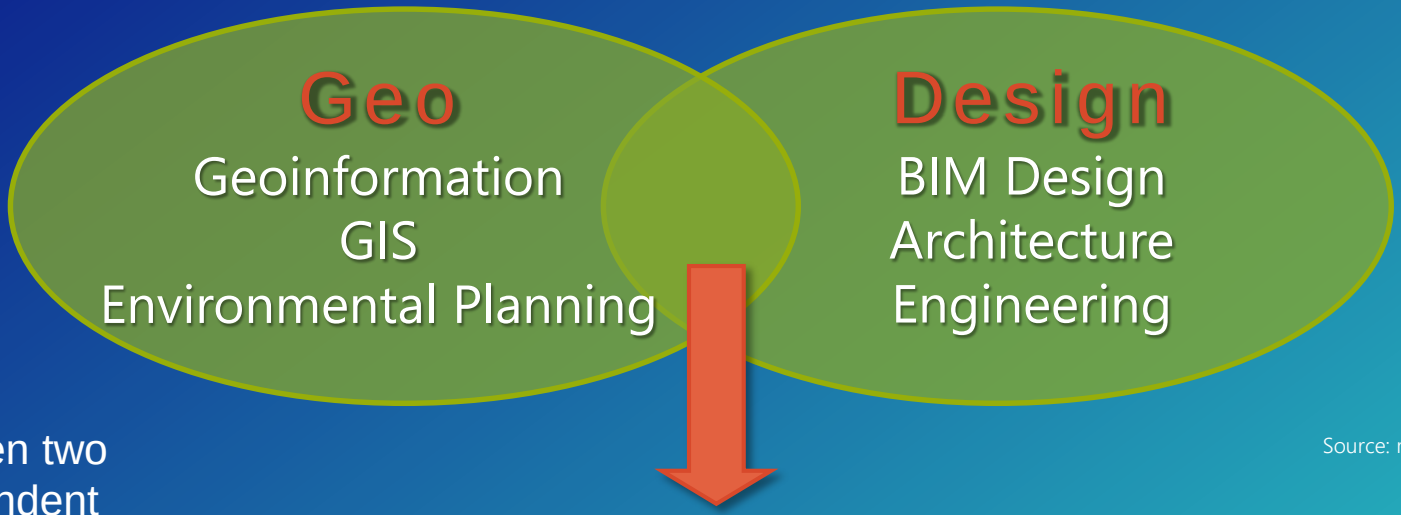
GIS/BIM Standards – International



Source: Hutsell & Bush, 2016

- buildingSMART
- IFC-Road & IFC-Rail
- IFC-Bridge
- CityGML
- OGC

The GeoDesign Concept – GIS and BIM Synopsis

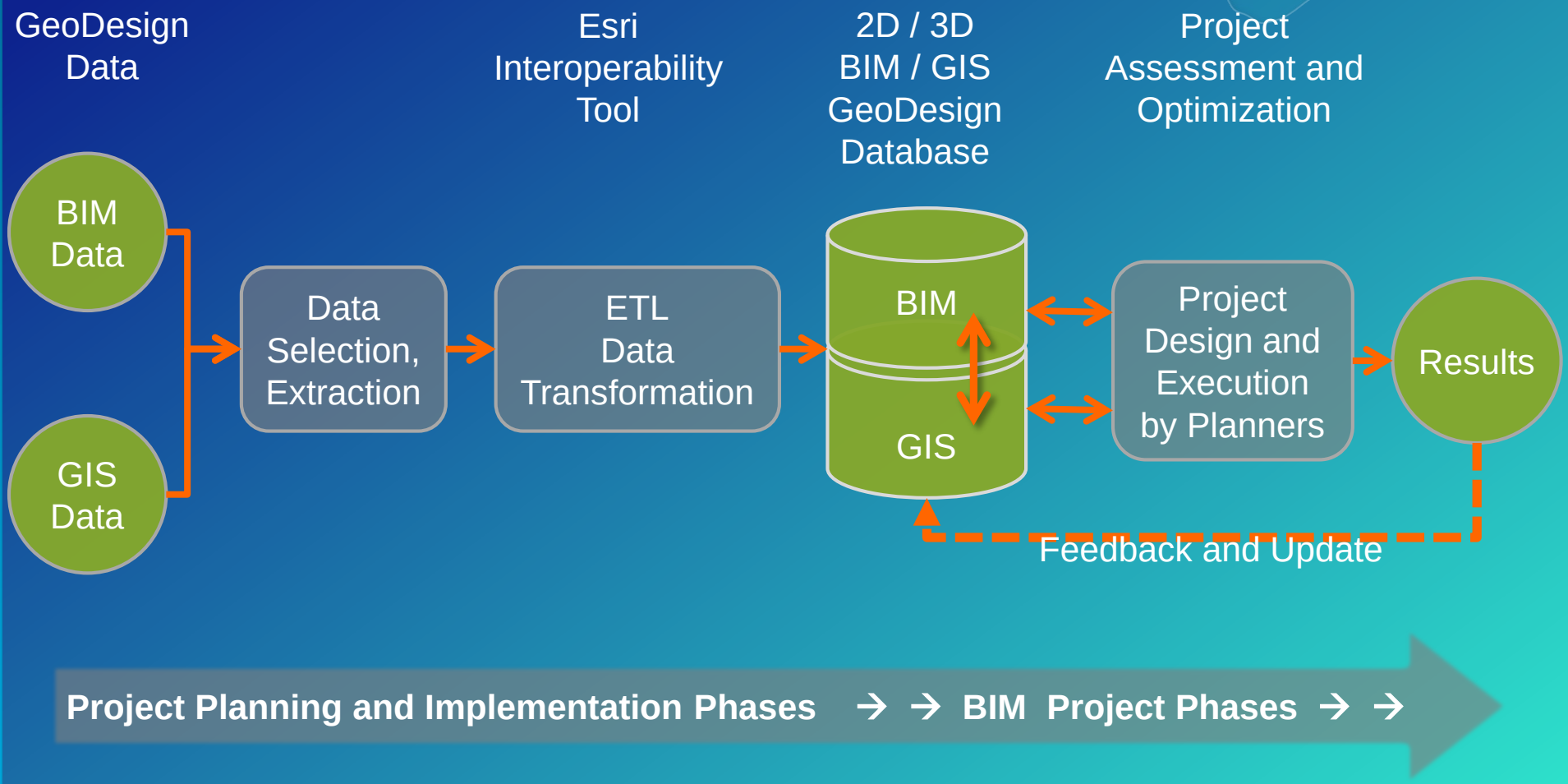


"Creativity is the synopsis between two normally independent ways of thinking "

Arthur Koestler

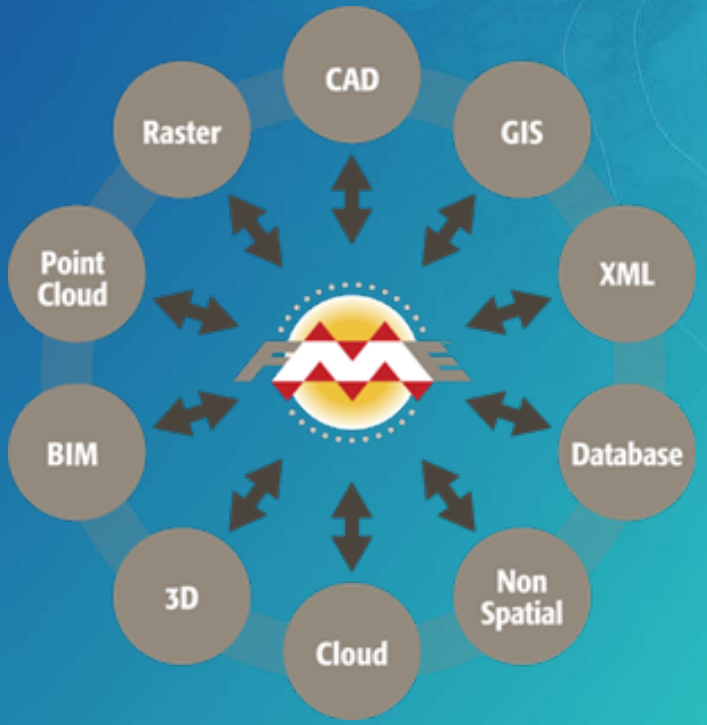
Source: modified from Bill Miller, esri

The Integrated BIM and GIS GeoDesign Concept



The Technical BIM and GIS Integration

ETL – FME Transformation



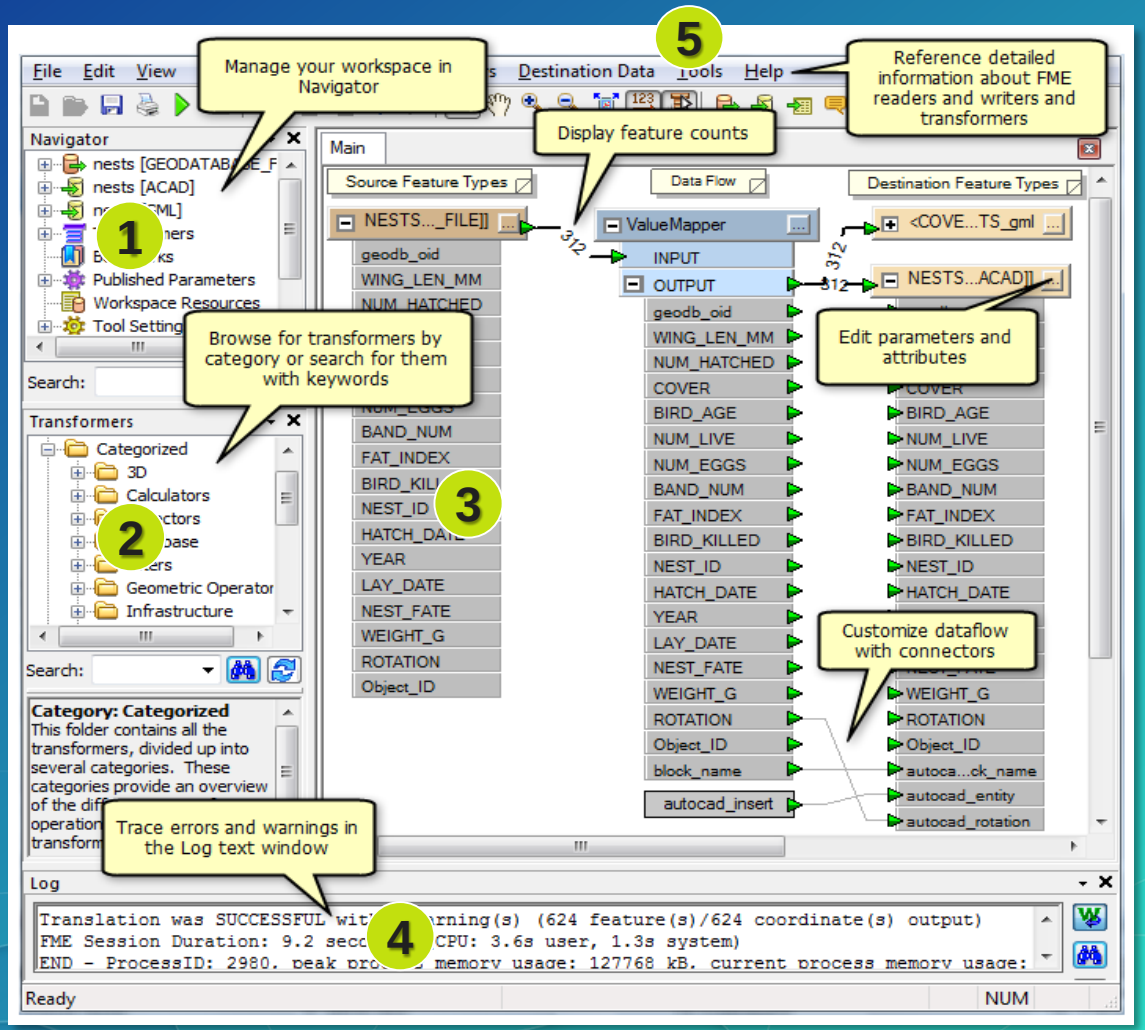
Source: esri

The Technical BIM and GIS Integration

ETL – FME Transformation from BIM to GIS

Esri's Interoperability Extension

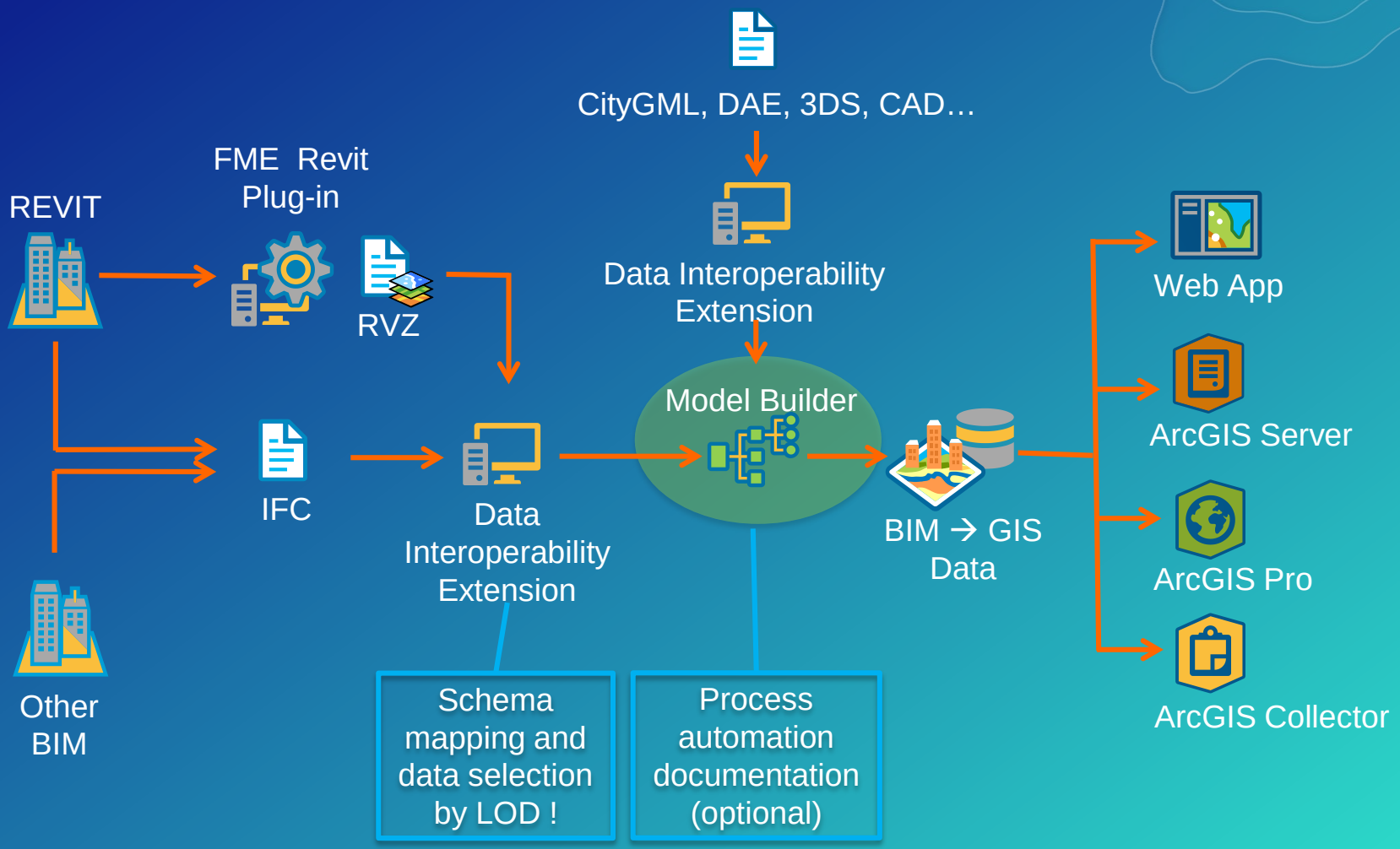
1. Navigator: hierarchical view of the workspace objects
2. Transformer Gallery: over 500 transformers to restructure functions between source and target data
3. Canvas: graphical workflow objects and connections, representing data and its transformations
4. Translation Log: details about the workspace translation
5. Help: help text about the selected object



Source: ArcGIS Help

The Technical BIM and GIS Integration

ETL-Based Workflow (FME)



Source: esri 2016

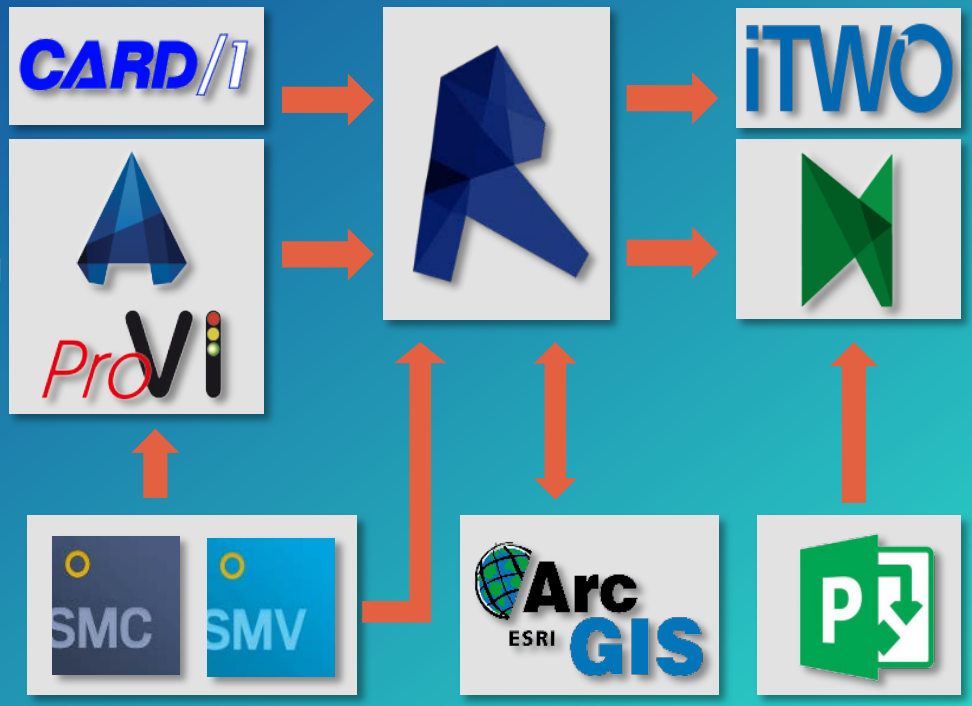
BIM Data Exchange Formats

Interfaces:

- RVT, IFC (Revit), DWG, DWF, OKSTRA (AutoCAD + ProVI)

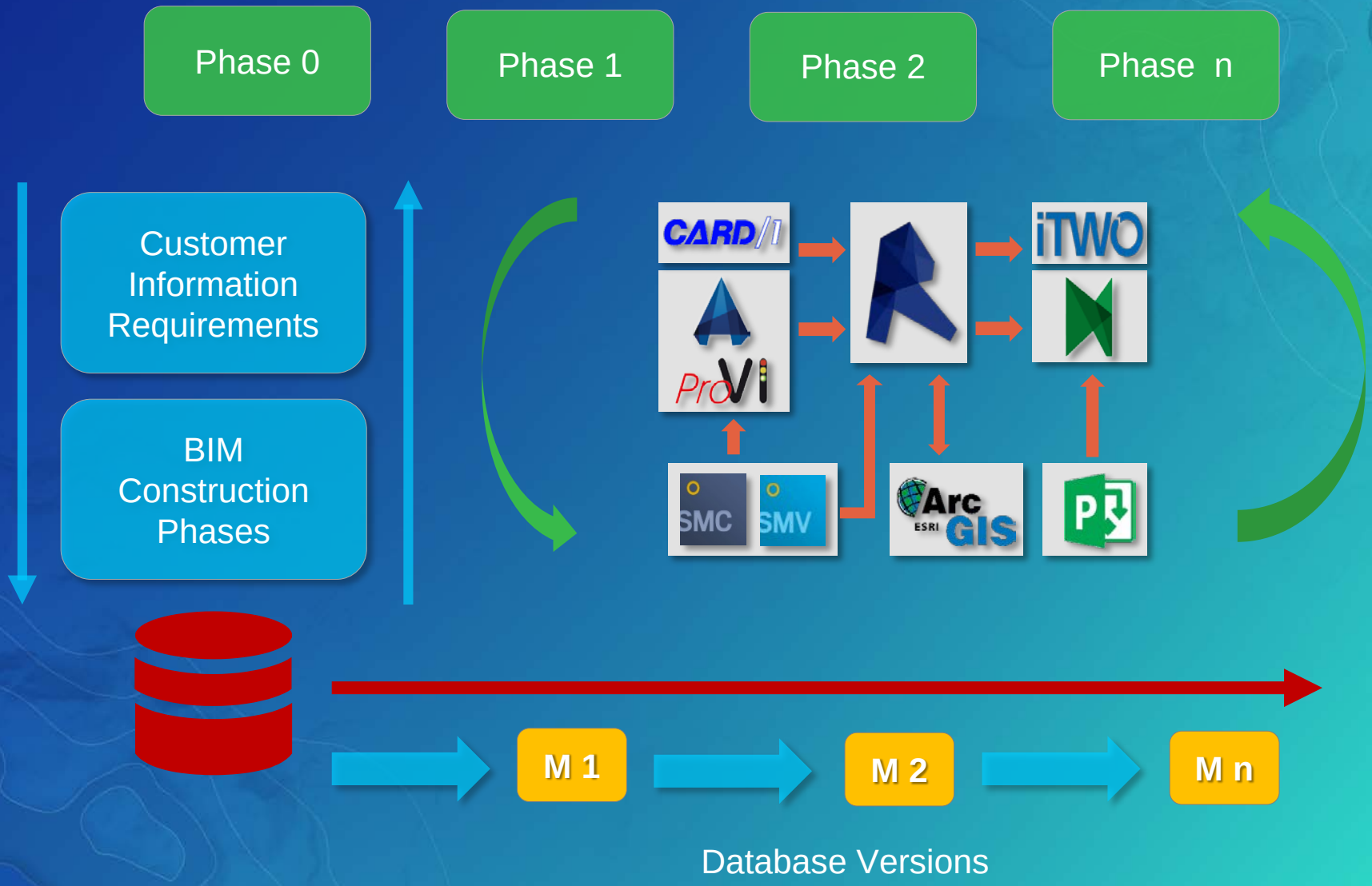
CAD Software used:

- CARD/1 - Traffic planning / civil engineering
- Autodesk Revit - Building planning
- iTWO - Construction management incl. 5D planning
- Autodesk Naviworks - Project / model review
- MS-Project - Project Portfolio Management PPM
- Solibri Model Viewer - collision check
- Solibri Model Checker
- ProVI / AutoCAD Civil 3D - Traffic and infrastructure planning
- Esri ArcGIS Platform - GIS data management, analysis and communication



Source: SSF and PSU

BIM Digital Planning Process

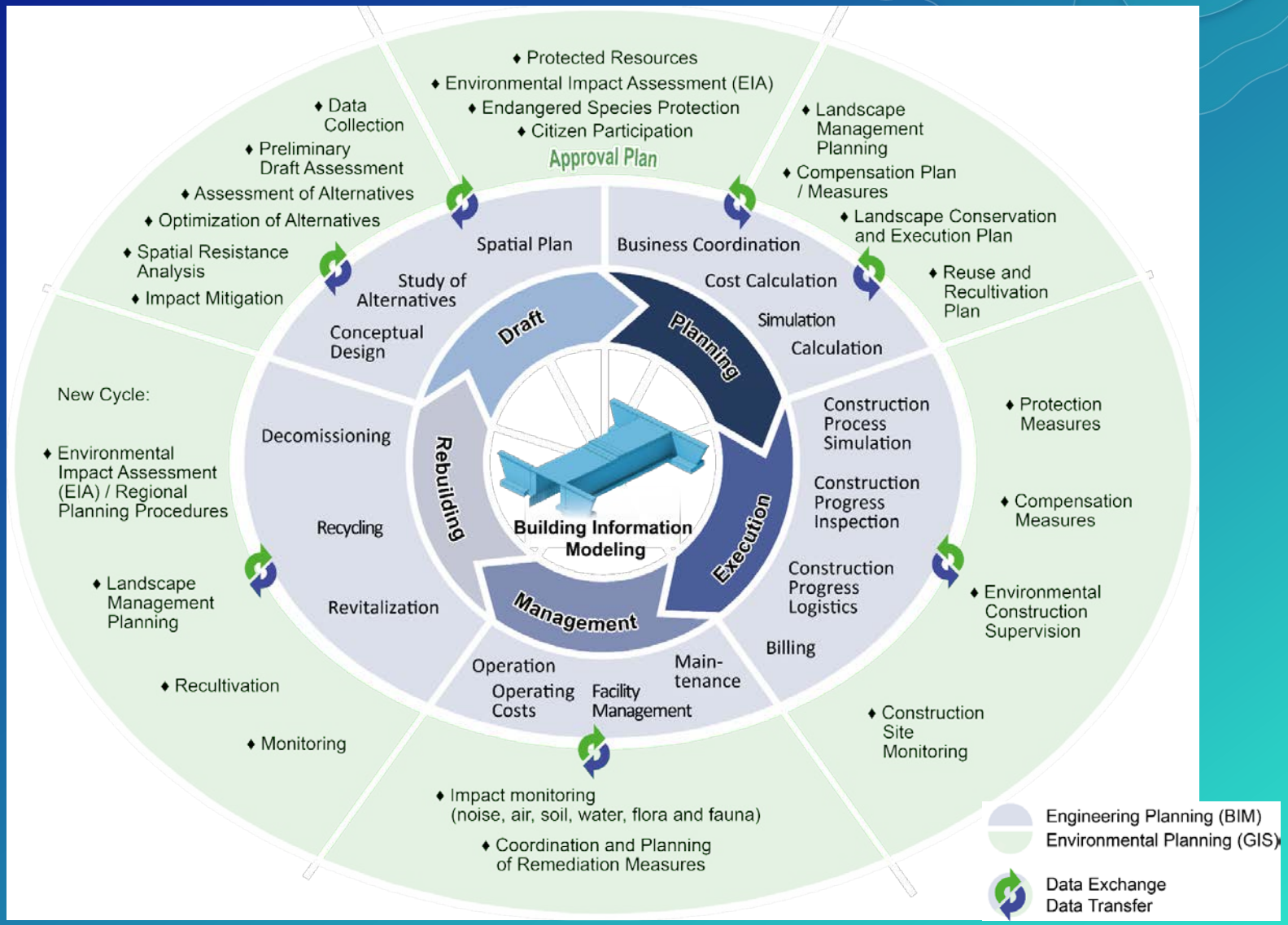


The BIM and GIS Integration Requirements

BIM and GIS data exchange, integration and assessment:

- Simple transfer of BIM data to the GIS database with the ETL process, geo-referencing
- Data exchange between BIM and GIS
- Construction of a shared 2D and 3D geodata structure for the involved engineers, environmental planners, and stakeholders
- Integration of elevation models and surveying data
- Integrated environmental analyzes and visualization of the structure in the landscape
- Visualization of the structure in the GIS environment

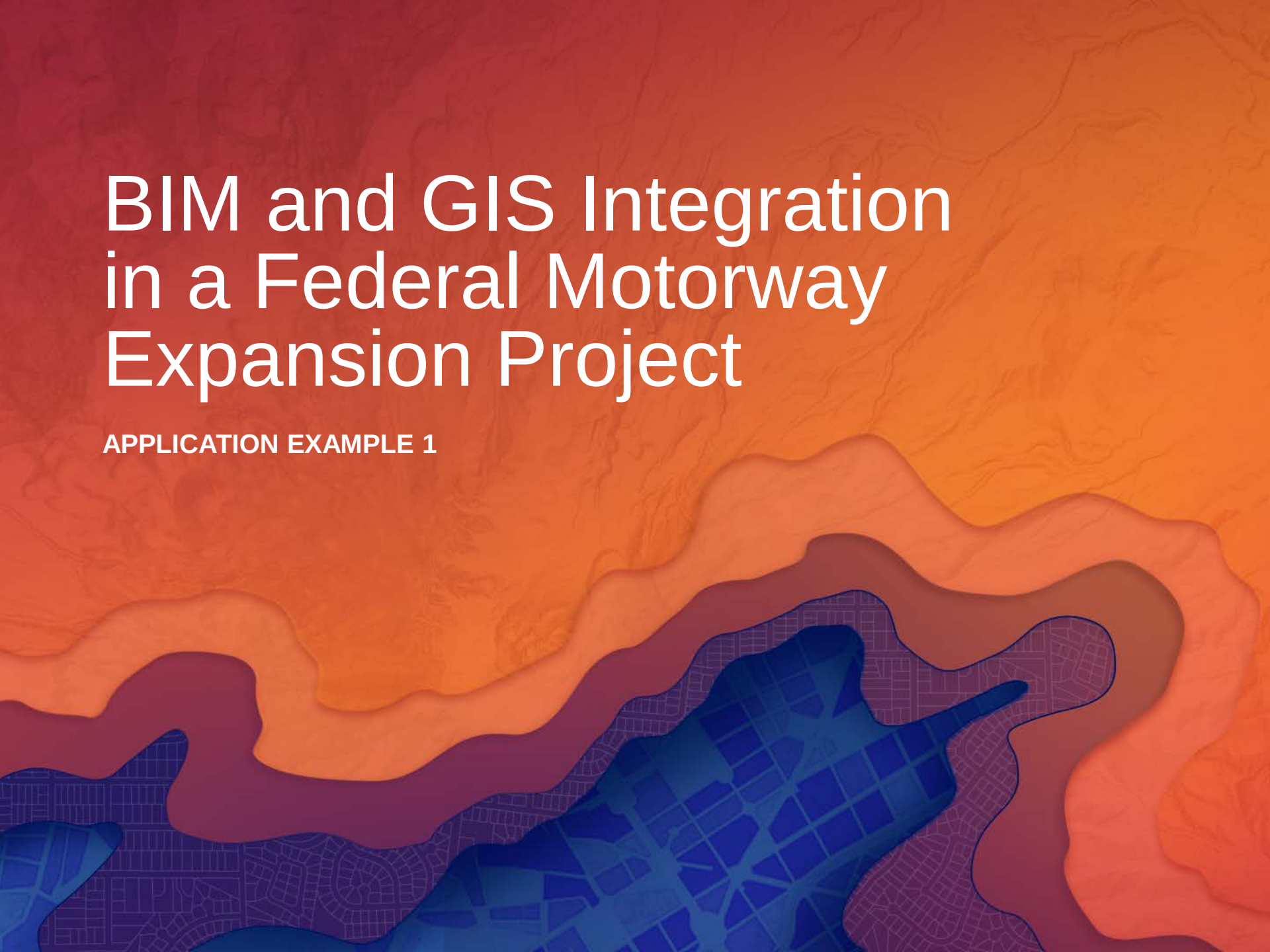
Integration of Engineering & Env. Planning in the BIM / GIS Cycle



Source: Schaller et al., 2016, modified from Borrmann et al., 2015

BIM and GIS Integration in a Federal Motorway Expansion Project

APPLICATION EXAMPLE 1



BIM and GIS Integration in a Federal Motorway Expansion Project

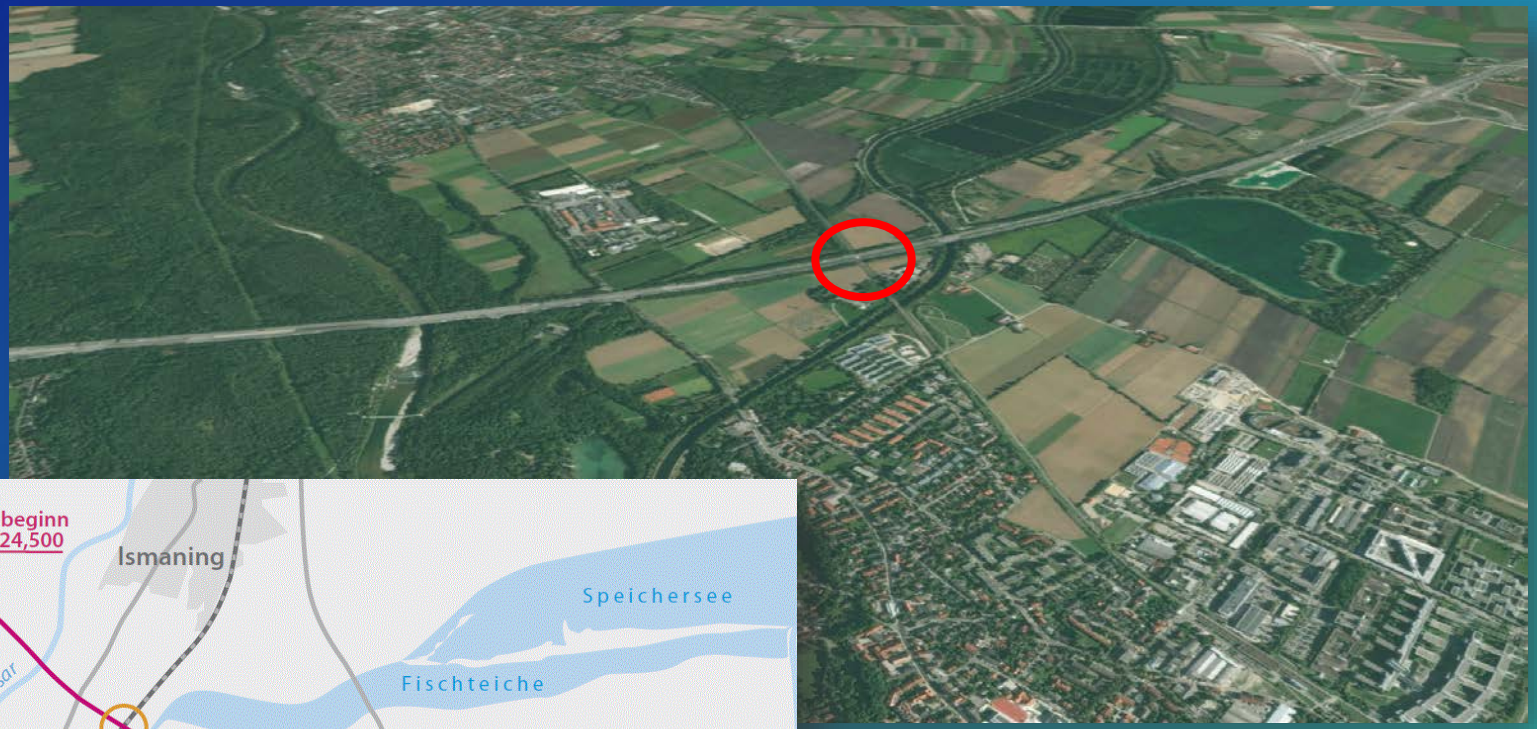
- BIM Pilot Project of the Federal Ministry of Transportation (BMVI)
  Eight-lane expansion of Autobahn A99 in the Munich Region
  Replacement of the structure 27/1 over the railway line 5556

- Project Partners:
  - PSU
  - SSF Ingenieure AG

- Client: Motorway Authority of Southern Bavaria

BIM and GIS Integration – A99 Expansion

Project Area

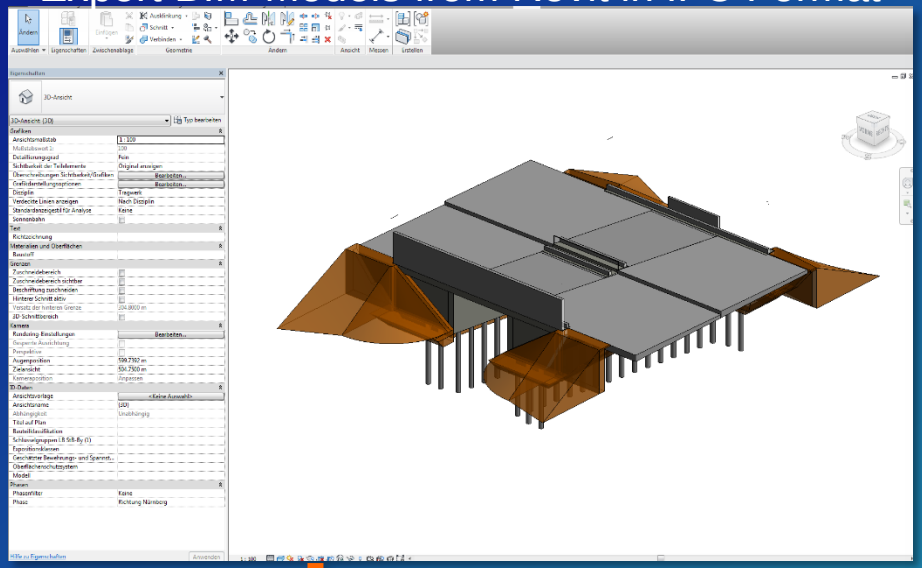


Source: ArcGIS Earth

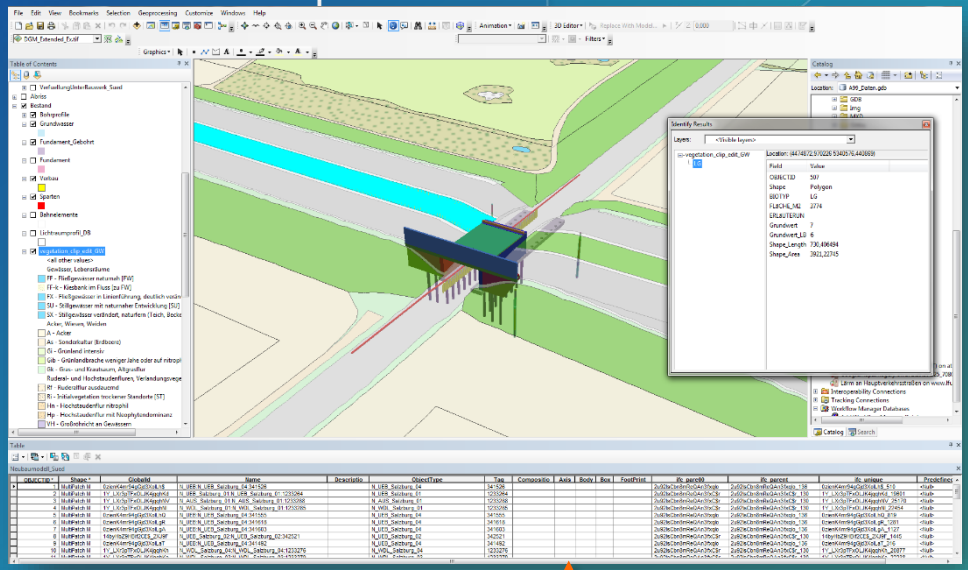
BIM and GIS Integration – A99 Expansion

Data Conversion

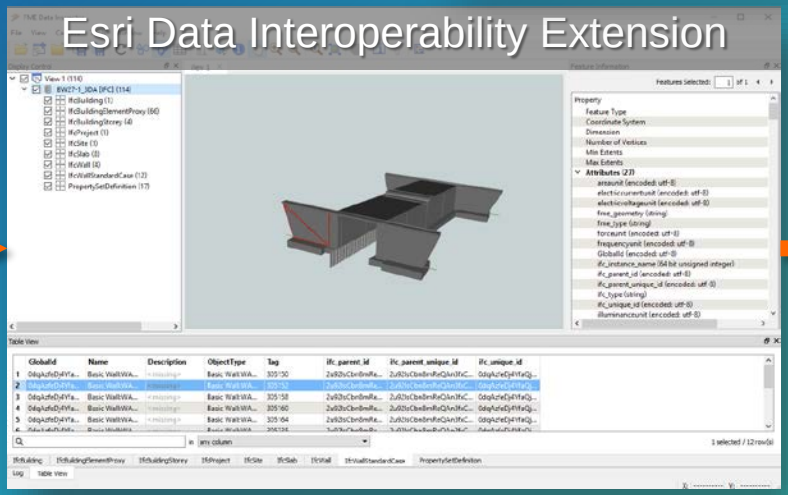
Export BIM-Models from Revit in IFC Format



Import from BIM in GIS

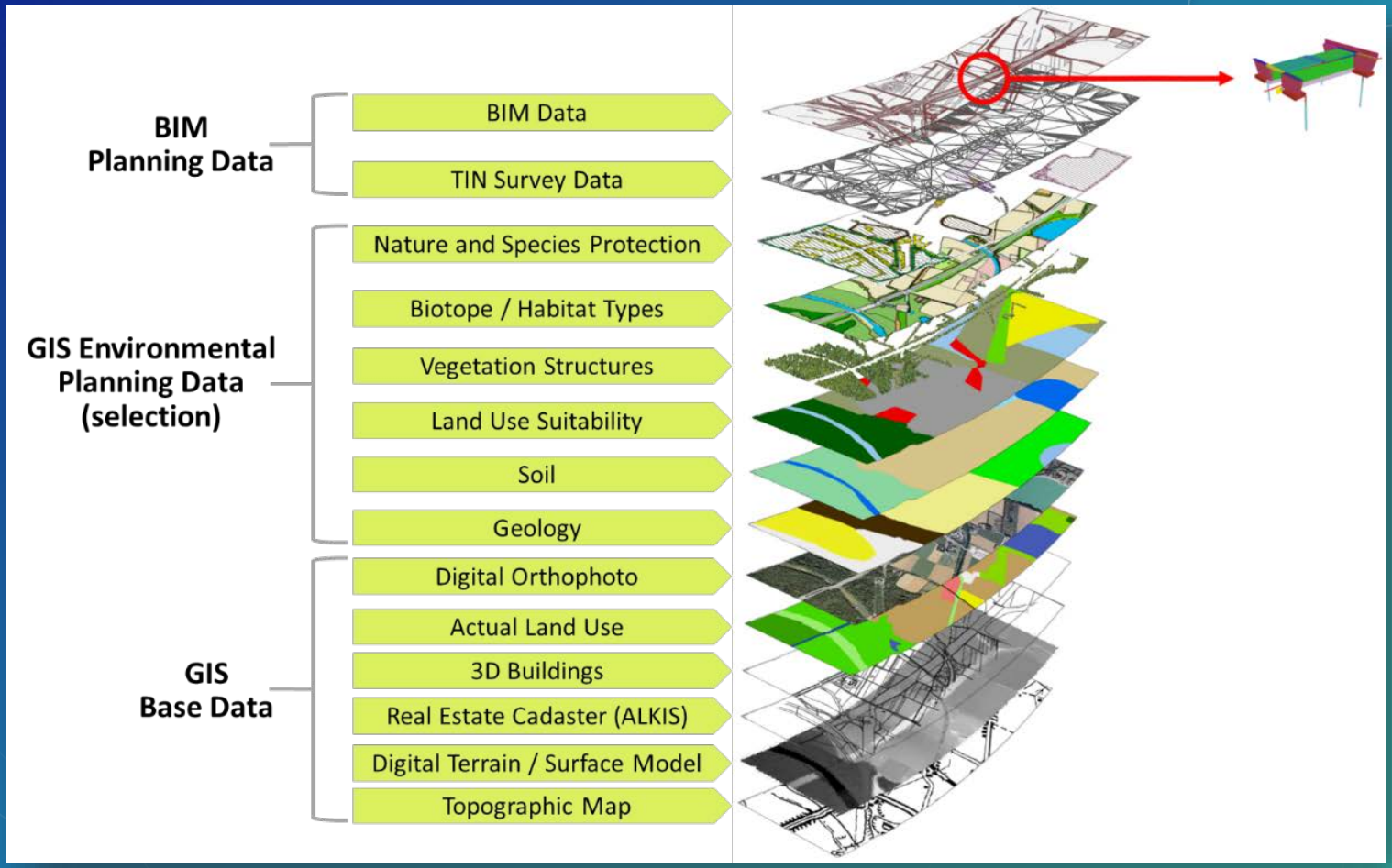


Esri Data Interoperability Extension



BIM and GIS Integration – A99 Expansion

ETL – FME Transformations from BIM to GIS



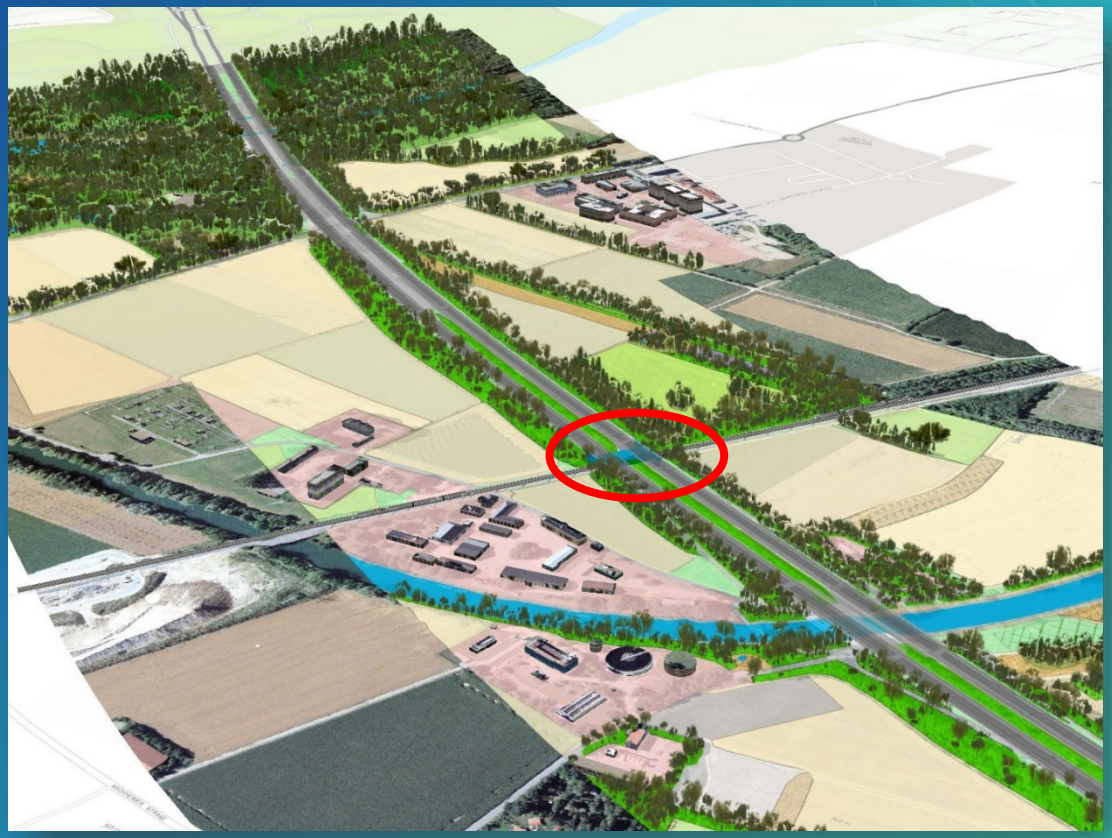
VIDEO

BIM and GIS Integration – A99 Expansion

Integration of the structure into the 3D-GIS-Geo and environmental data model

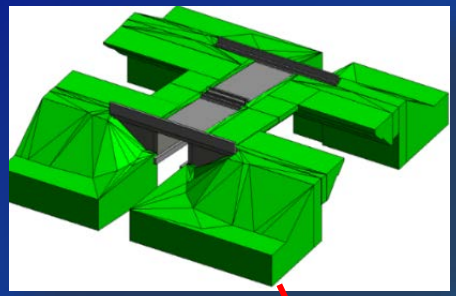
The BIM / GIS integration allows:

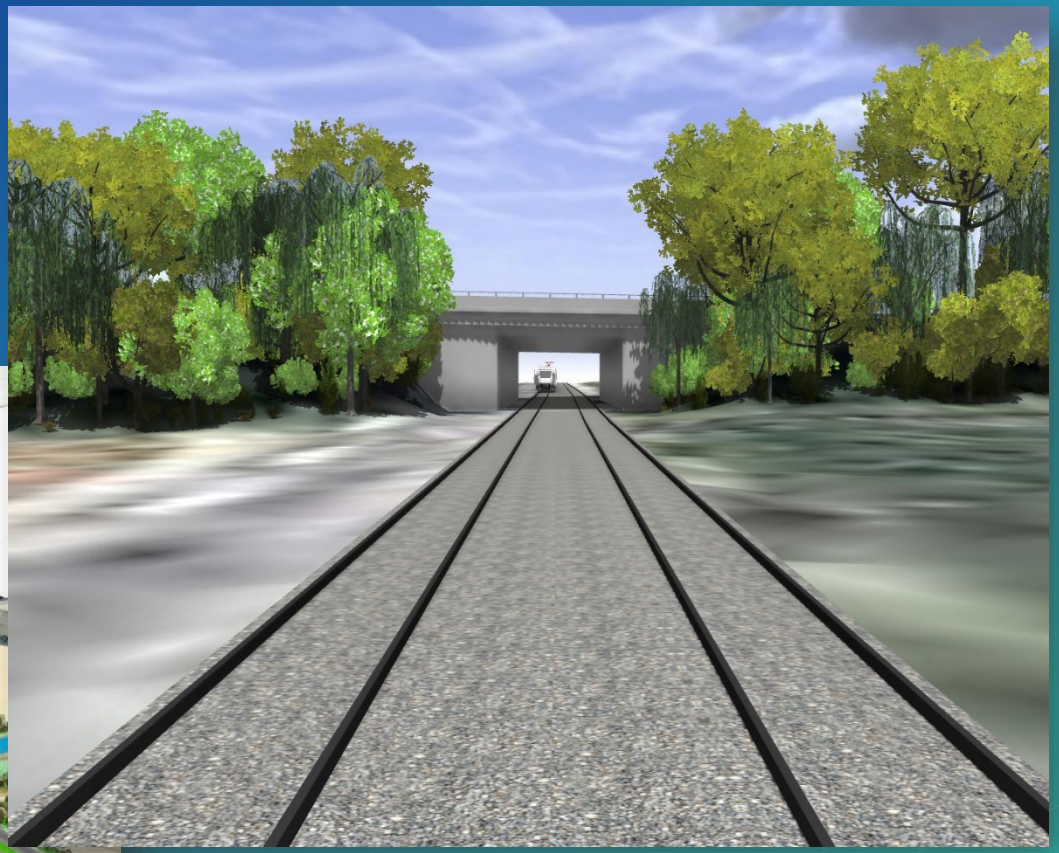
- Environmental Impact Assessment
- Nature and Species Protection Requirements
- Landscape Management Planning & Execution Planning
- Landscape Compensation Measures
- Ecological Construction Monitoring & Environmental Monitoring



BIM and GIS Integration – A99 Expansion

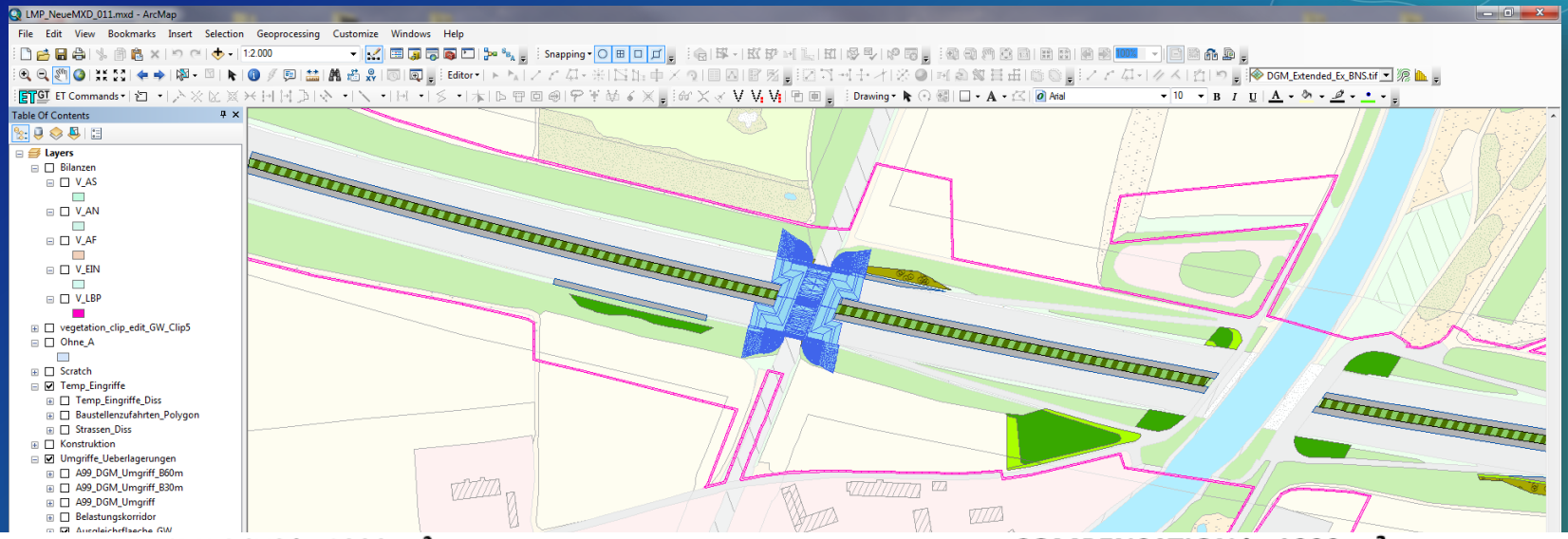
3D visualization of the bridge structure in the landscape

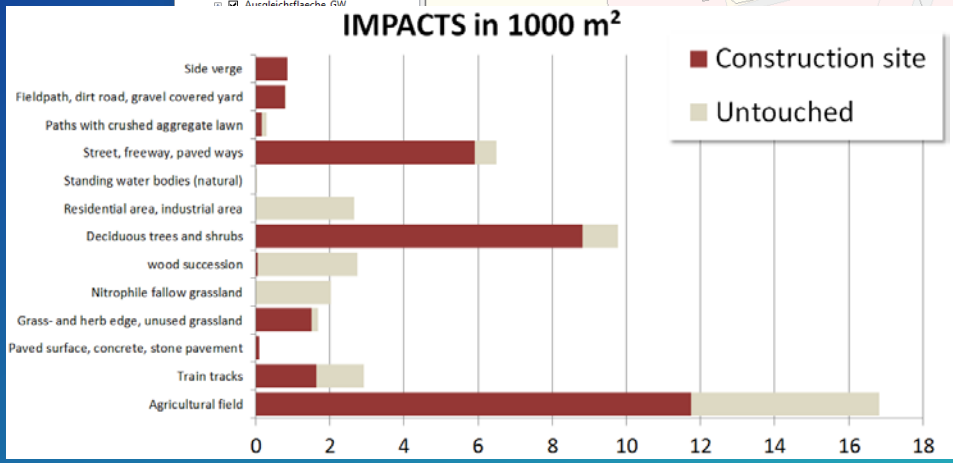


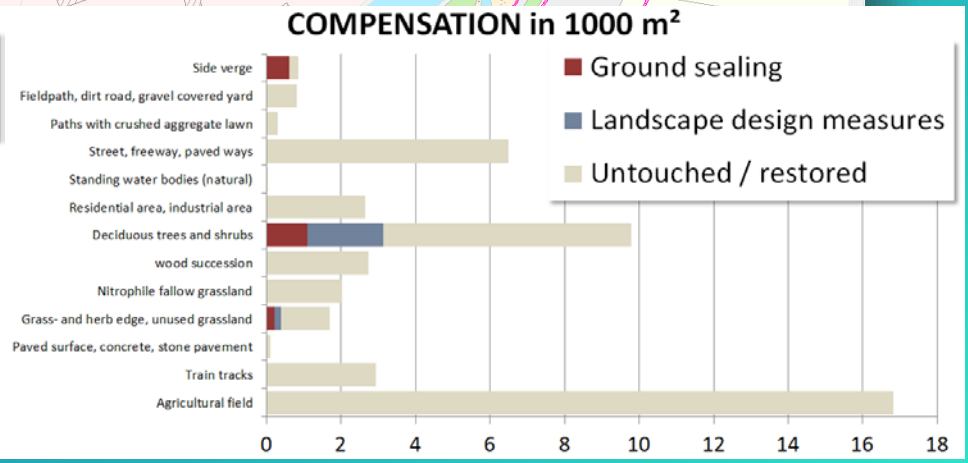


BIM and GIS Integration – A99 Expansion

Impact Assessment of the Bridge (LBP)

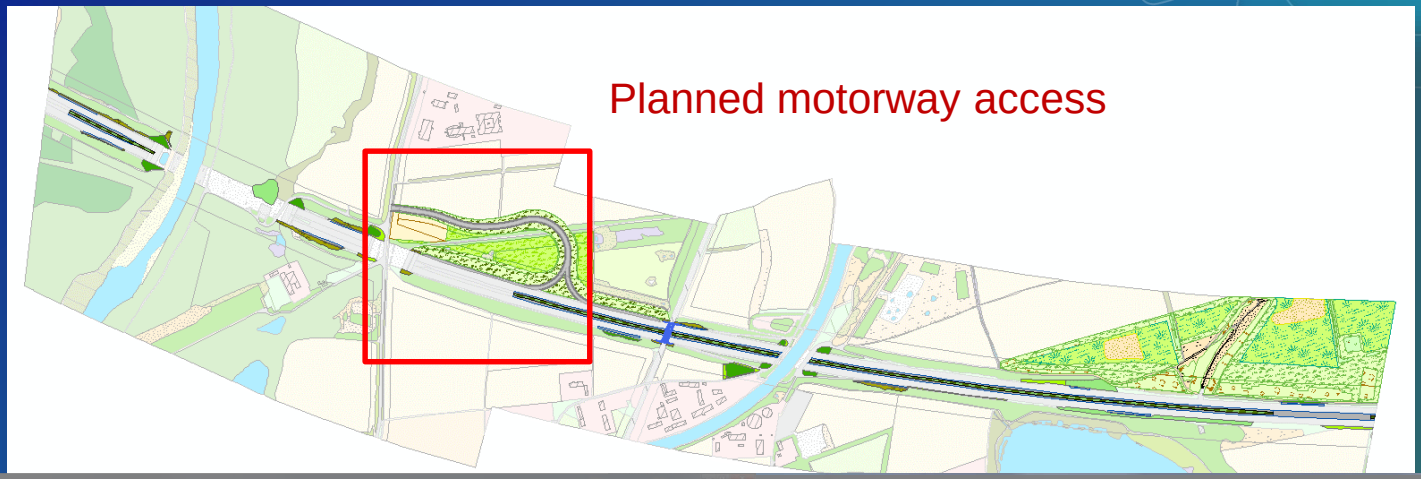




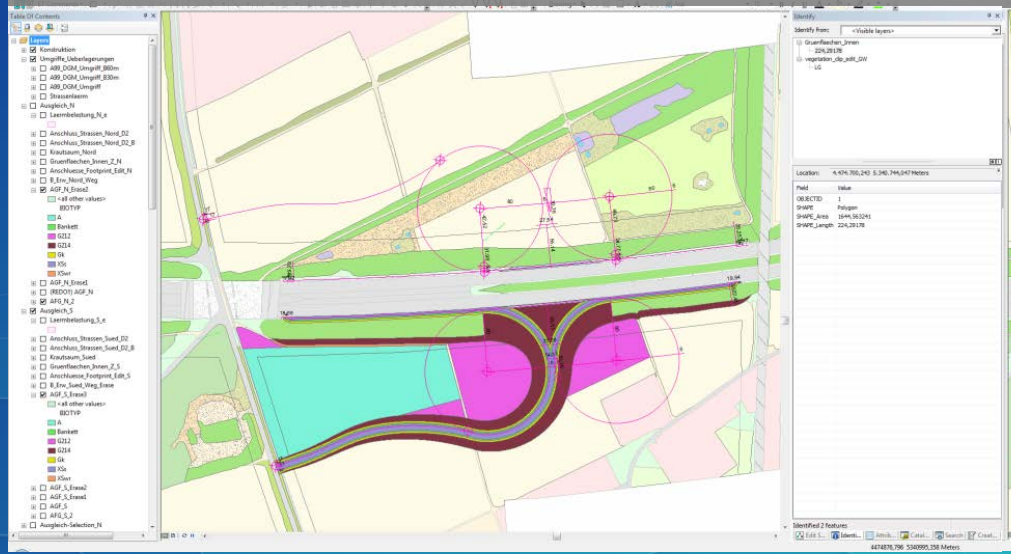


BIM and GIS Integration – A99 Expansion

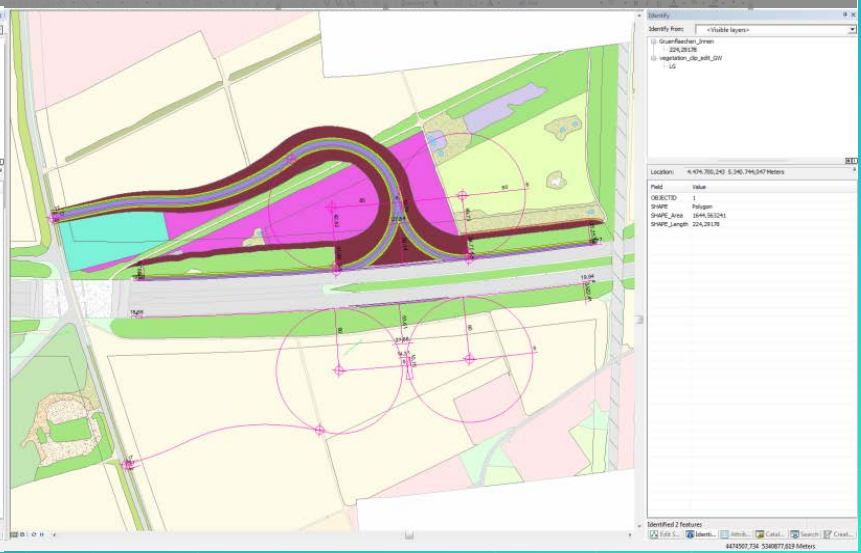
Impact Assessment of Access Alternatives (LBP)



Alternative North

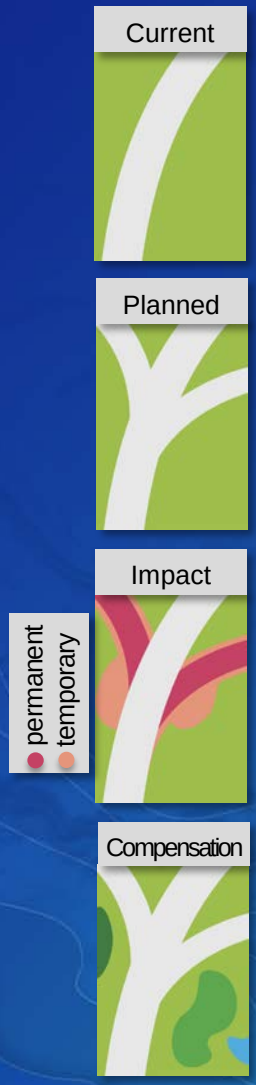


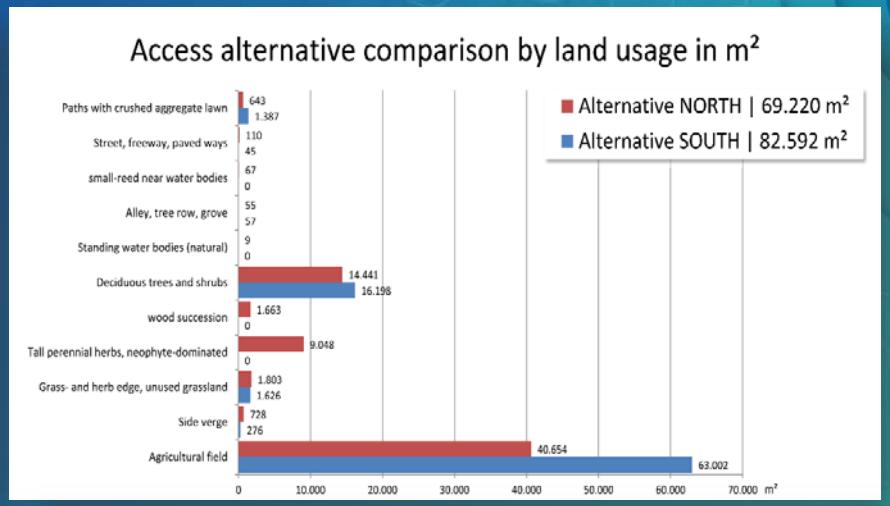
Alternative South

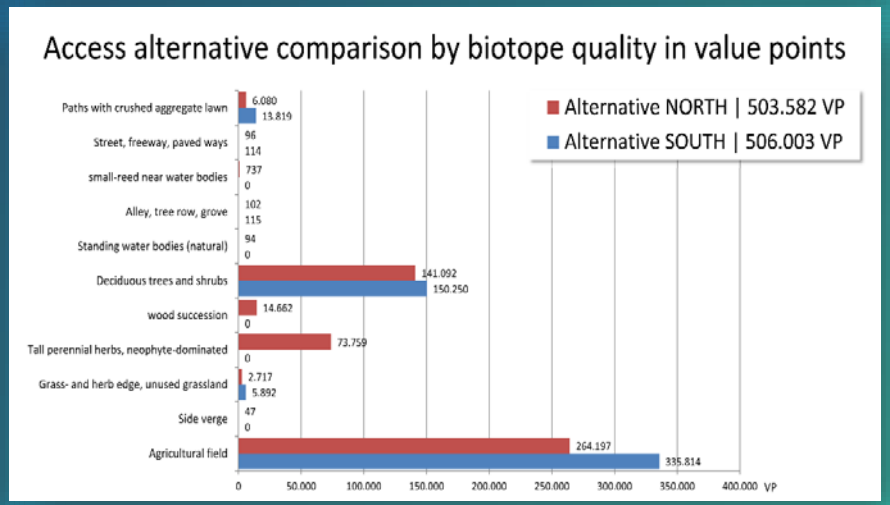


BIM and GIS Integration – A99 Expansion

Impact Assessment of Access Alternatives (LBP)

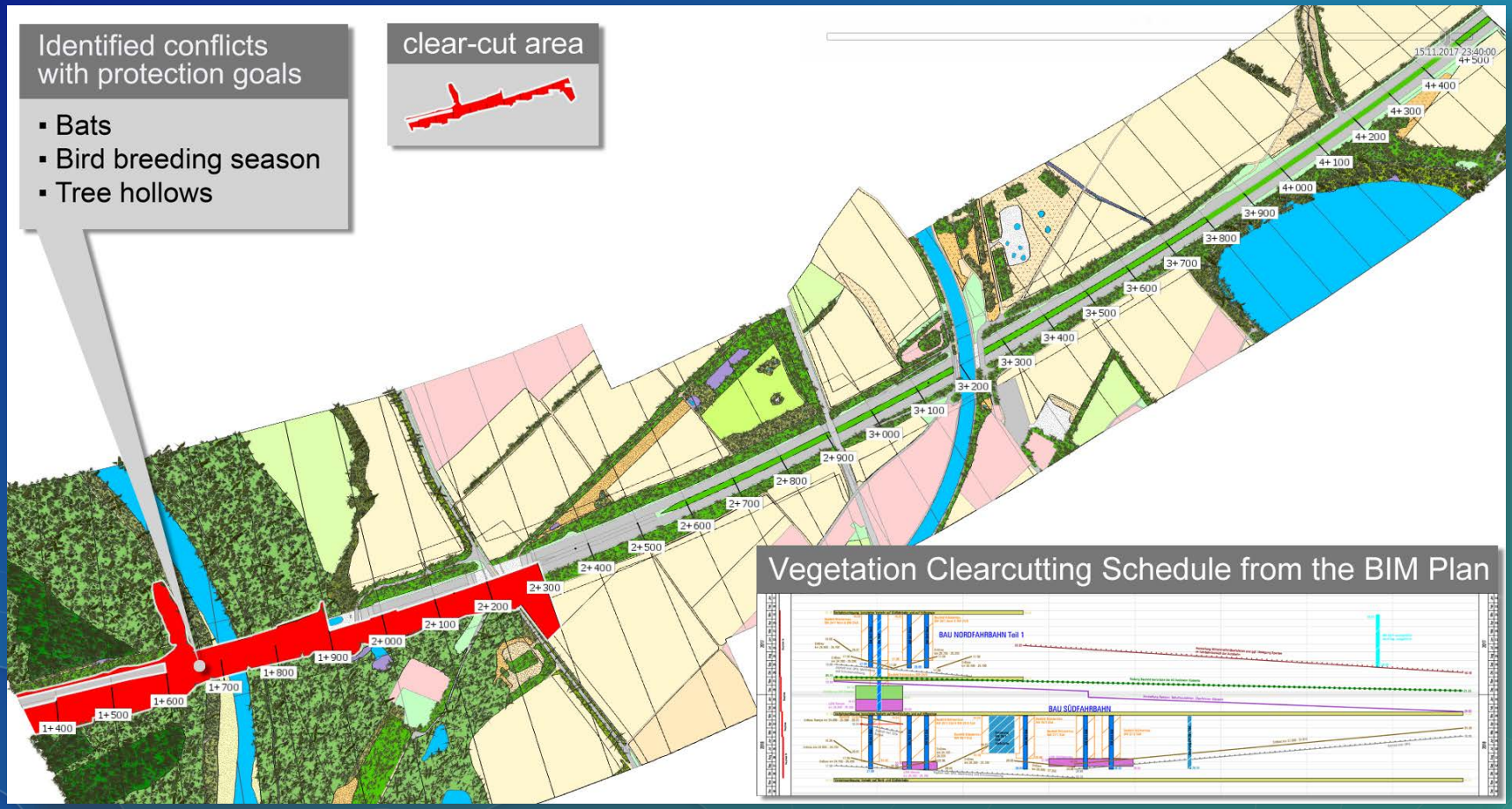






BIM and GIS Integration – A99 Expansion

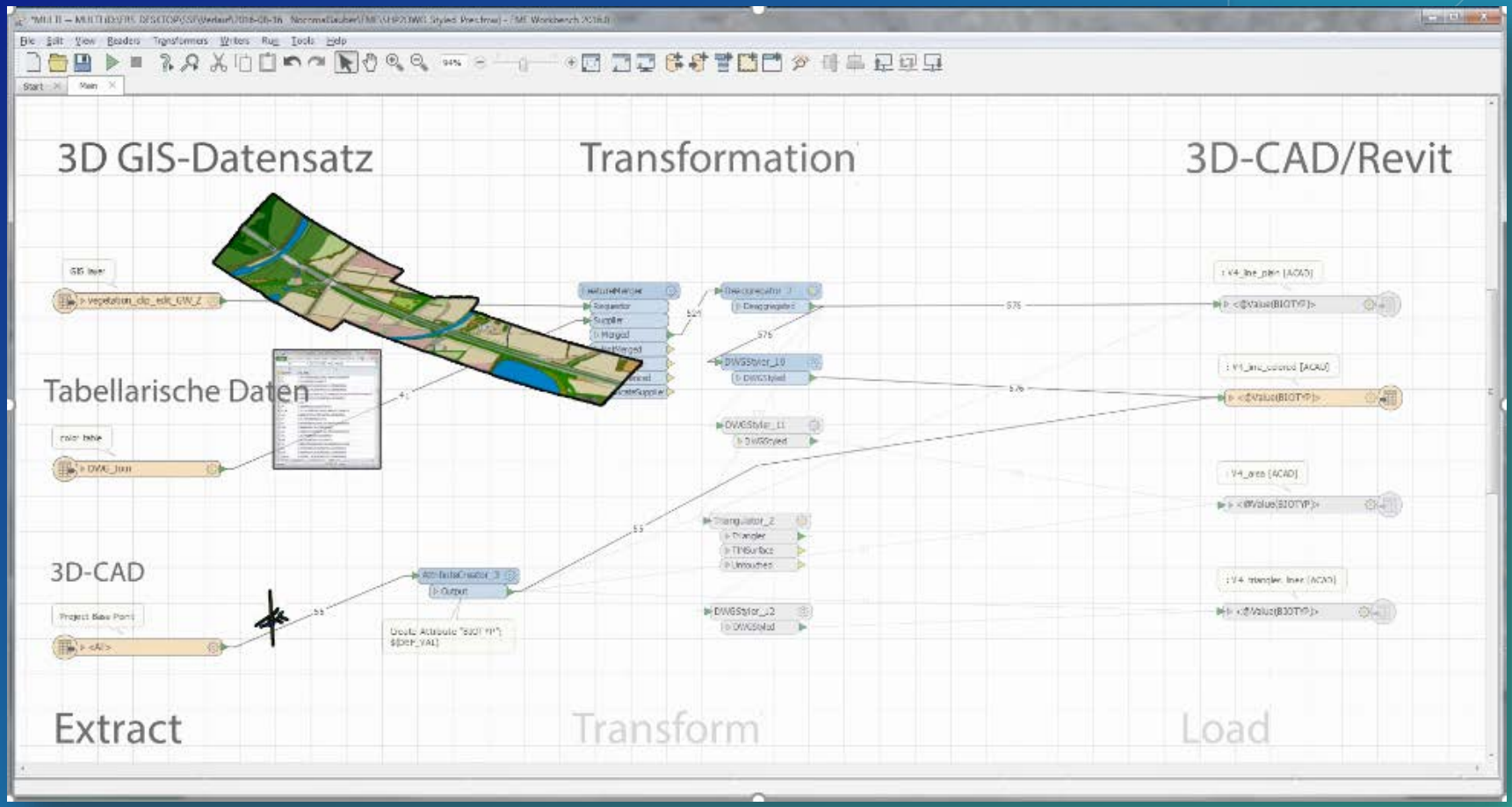
Assessment of Conflicts: Clearcutting Plan vs. Environmental GIS Data



VIDEO

The Technical BIM and GIS Integration

ETL – FME Transformations from GIS back to BIM

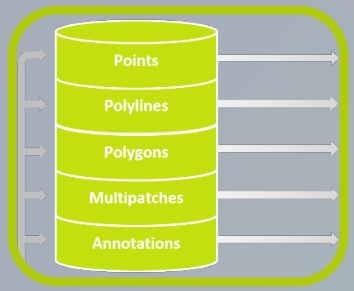


VIDEO

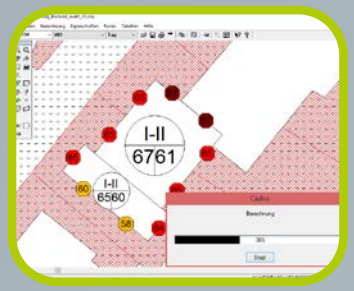
BIM and GIS Integration – A99 Expansion

Integration of Noise Propagation Models – Workflow

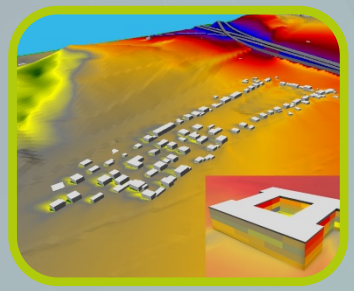
Filtering the necessary CAD data / parameters for emission and immission calculation



Geodatabase creation
Data processing
Assigning attributes



Emission and immission calculation



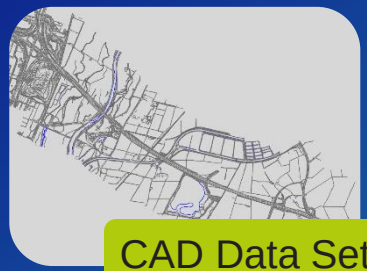
Traffic noise processing using 3D-GIS

Extract–Transform–Load → Automated 3D Import → Re-Import

BIM and GIS Integration – A99 Expansion

Integration of Noise Propagation Models – Workflow

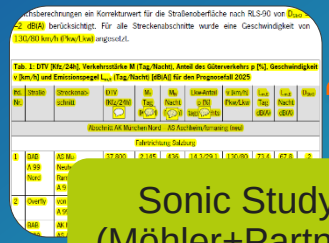
CAD Data



CAD Data Sets

PDF Documents

- Explanatory Reports
- Plan Amendments
- Building Directories
- Traffic Forecast Report



Sonic Study (Möhler+Partner)

Validation

Filtering the data necessary for emission and immission calculation

Extract, Transform, Load

Geodata-base

Geodatabase creation processing, assigning attributes, Informationsanreicherung

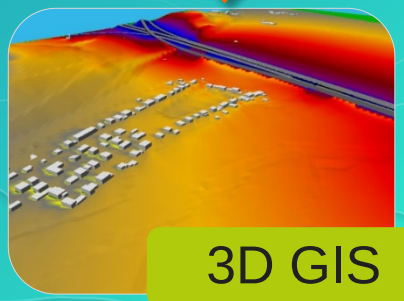
Automated Attribute Import

3D Import

Cadna A®

Emission and immission calculation of traffic noise

- Advanced processing
- Public participation
- Augmented/Virtual reality
- Online webscene
- Comparison of scenarios
- Presentation video

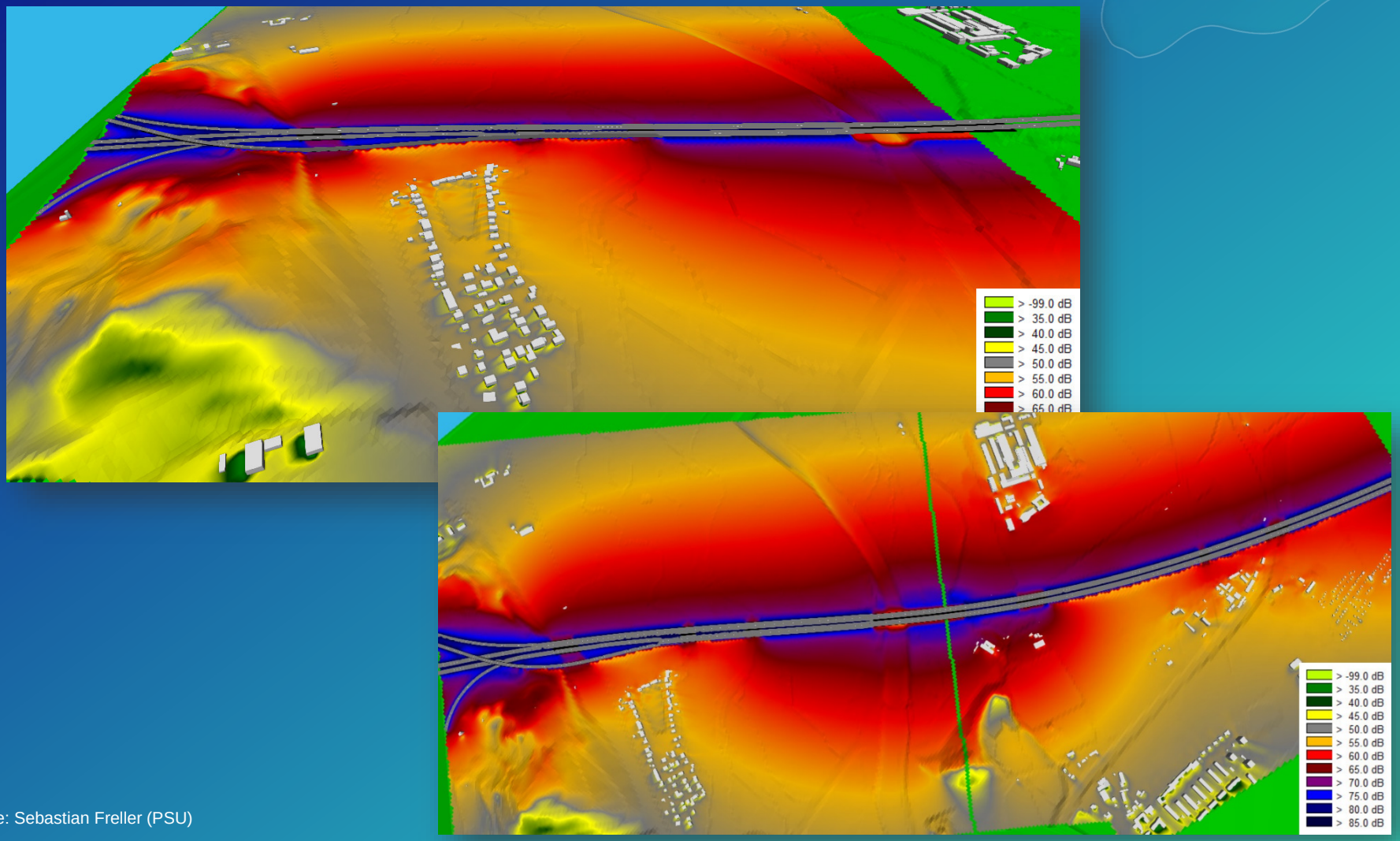


3D GIS

Source: Sebastian Freller (PSU)

BIM and GIS Integration – A99 Expansion

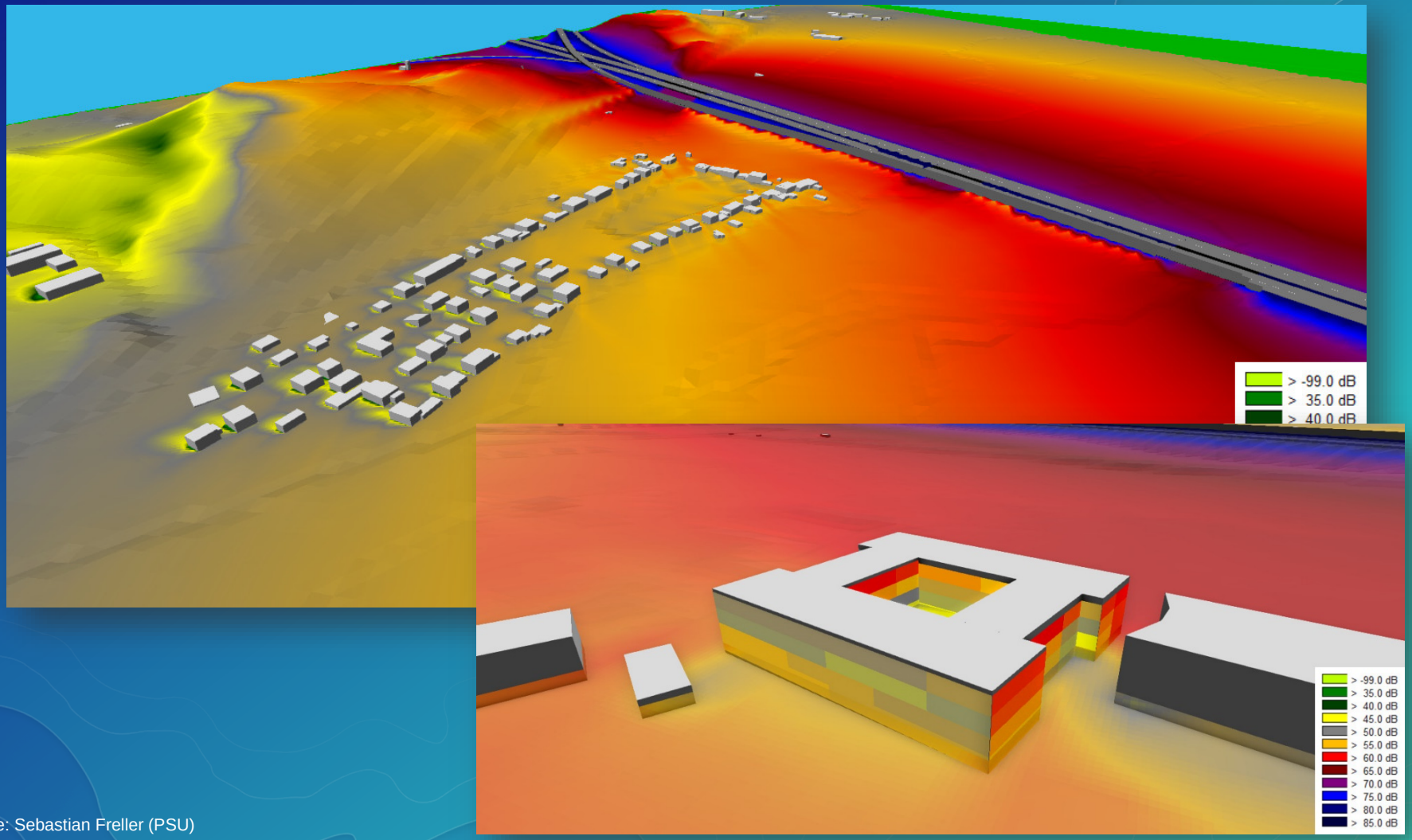
Integration of Noise Propagation Models – Workflow



Source: Sebastian Freller (PSU)

BIM and GIS Integration – A99 Expansion

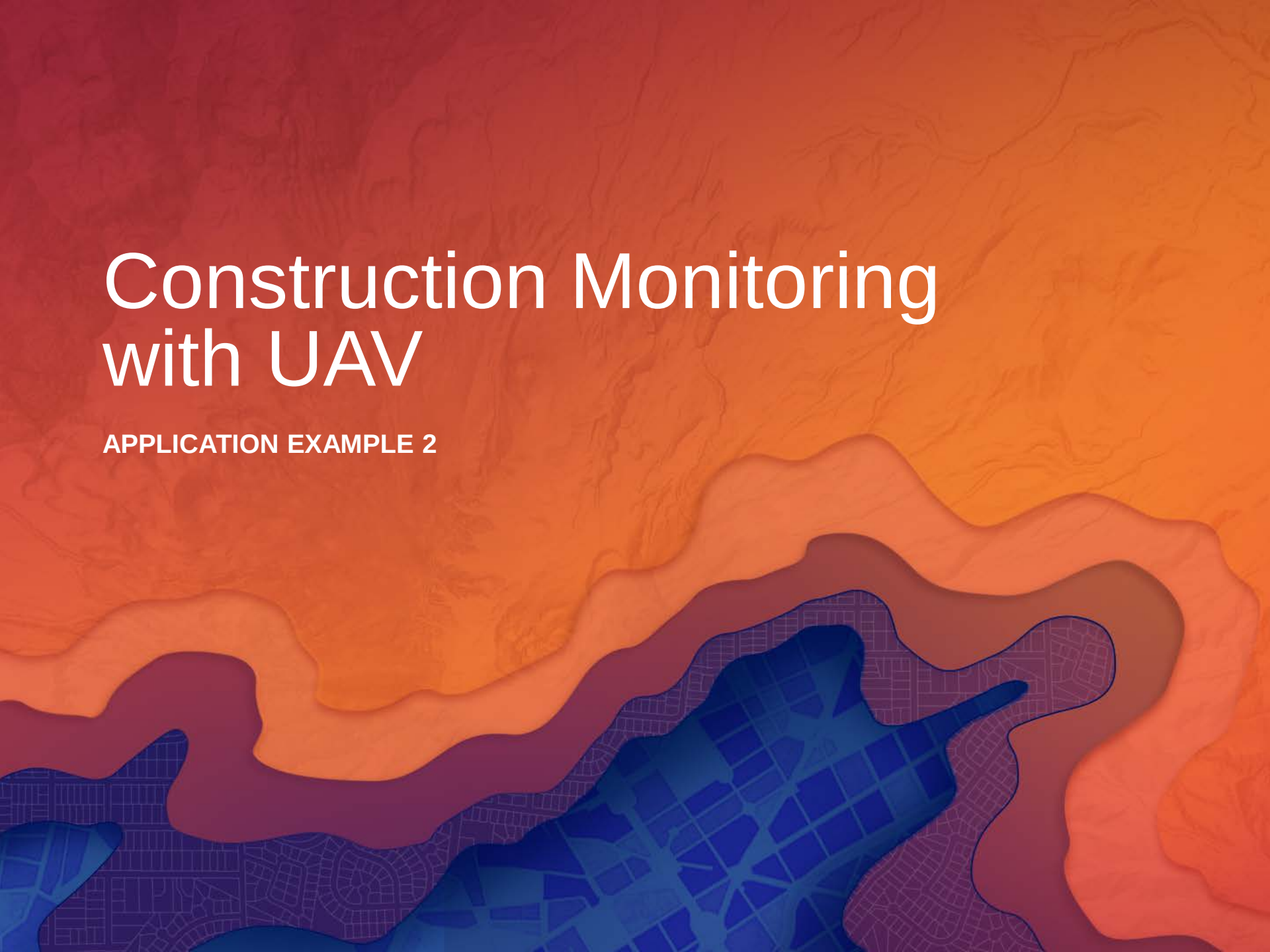
Integration of Noise Propagation Models – Workflow



Source: Sebastian Freller (PSU)

Construction Monitoring with UAV

APPLICATION EXAMPLE 2



Construction Monitoring with UAV

A99 Motorway Expansion

Bridge Construction

Autobahn Access Construction

A99 Expansion – Construction Monitoring with UAV

Construction Monitoring with Quantum TRON & Esri Drone2Map

quantum systems

esri
Emerging Business Partner

A99 Expansion – Construction Monitoring with UAV

TRON

quantum systems

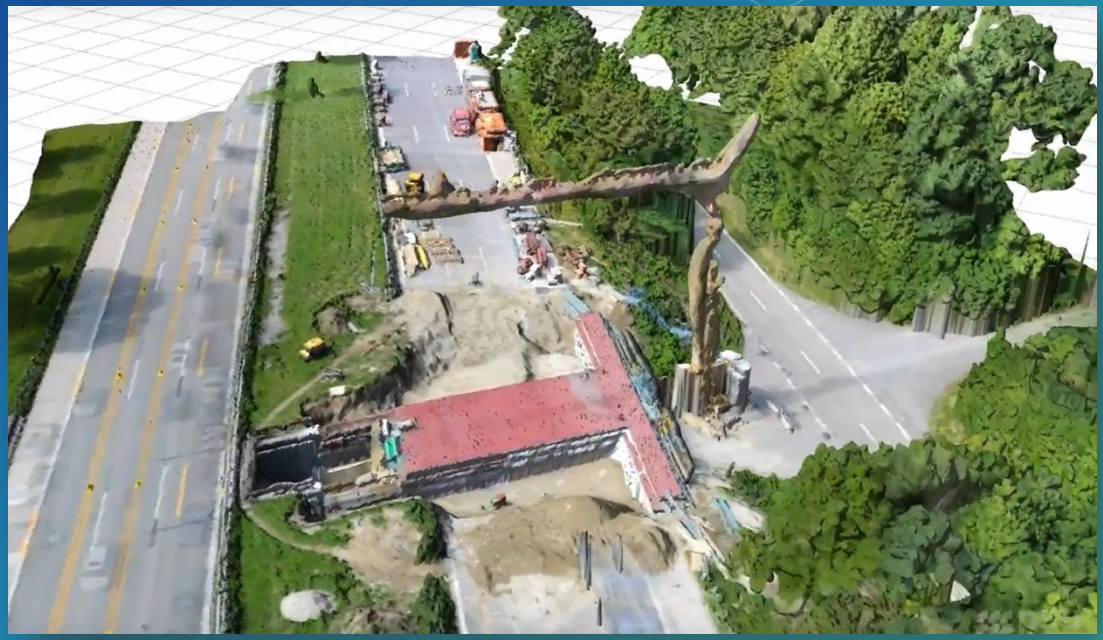
VIDEO

A99 Expansion – Construction Monitoring with UAV

Assessment with Esri Drone2Map

- Orthophotos
- Surface Models
- Point Clouds
- 3D Mesh

- Application Scenarios
  - Construction progress monitoring, billing support
  - Profile analysis
  - Single tree extraction
  - Measurements of single objects, thickness, etc.
  - Volume calculation
  - Monitoring of mass removal



VIDEO

A99 Expansion – Construction Monitoring with UAV

Assessment with Esri Drone2Map

VIDEO

A99 Expansion – Construction Monitoring with UAV

Project Team

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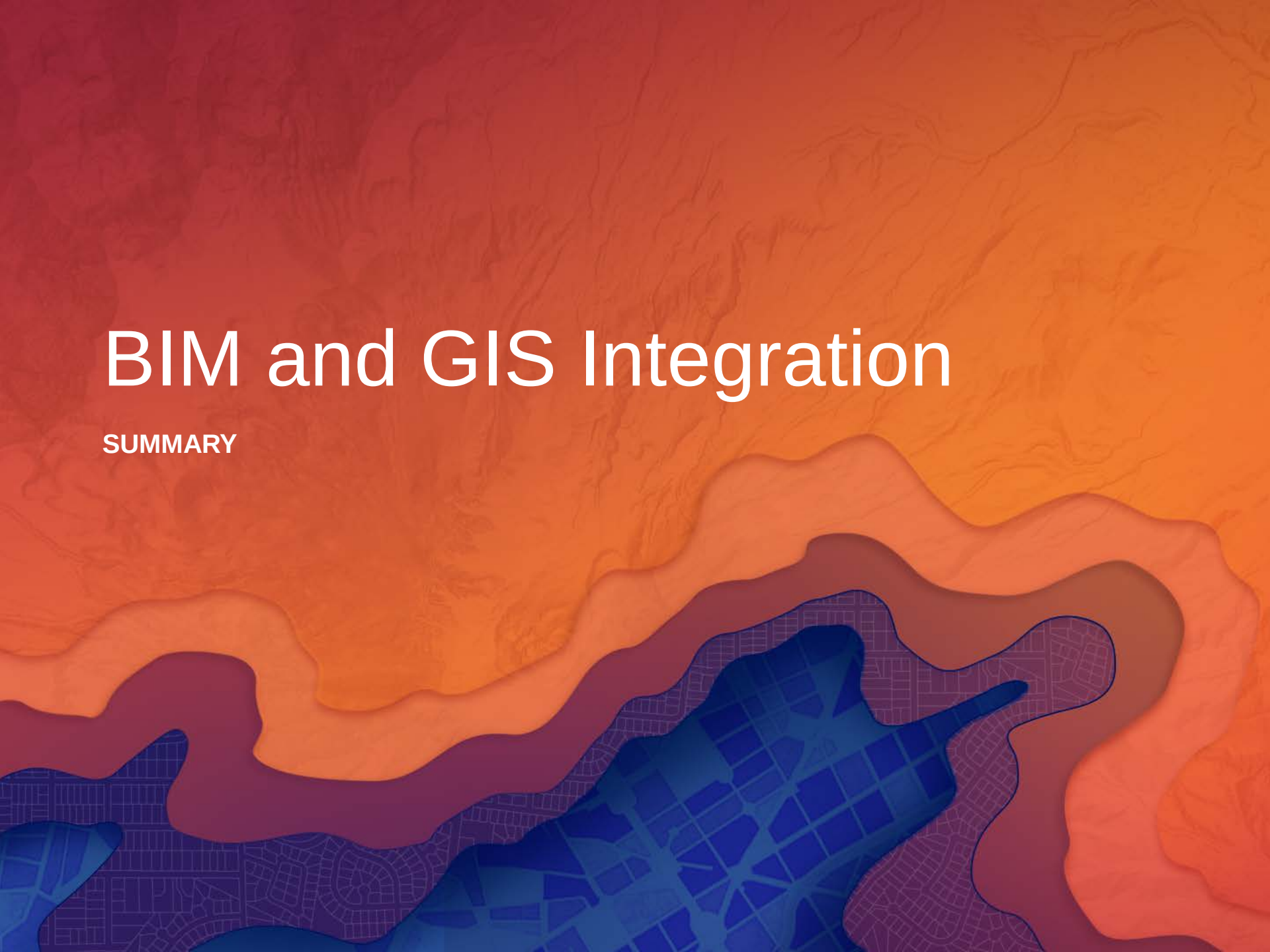
BIM and GIS Integration

SUMMARY



BIM and GIS Integration

Summary

- BIM and GIS data exchange, integration and information preparation:
- Integration of the BIM data into the 2D/3D-GIS database
- Simple transfer of the BIM data to the 3D-GIS environmental and planning database
- Bilateral data exchange between BIM and GIS
- Integration of BIM elevation models and surveying data
- Integration of existing geospatial data
- Integration of the BIM construction data in the BIM cycle
- Establishment of a shared 2D and 3D geodata structure for engineers, technical planners and other stakeholders
- Integrated analysis and visualization of the structure and the respective states in the project phases in the 3D-GIS environment
- Model coupling (e.g., noise, flood, energy, power lines, etc.) for public participation
- Interactive Web-based citizen participation

Thank you for your attention !

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