OGC 3D Portrayal Interoperability Experiment (3DPIE)
Insights and Results

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Web 3D 2012

Los Angeles, August 4, 2012

Agenda

Introduction OGC 3DIM

3D PIE

3D Portrayal Services

Experiments

Results

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OGC 3D Information Management (3DIM) Domain Working Group – Overview

Background

"A great deal of technical innovation has been accomplished in the **areas of CAD, AEC, geospatial, 3D visualization, and urban simulation**. A variety of products, information and services abound in each of these environments. A framework of data interoperability should exist **across the lifecycle of building and infrastructure investment: planning, design, construction, operation, and decommissioning**. This work is of interest to the geospatial community in that there is a growing need for technologies and information to effectively interoperate between these domains to support a range of vital services and decision support needs. The working group was formed in 2005 to **identify and act on opportunities to improve interoperability of geospatial data and services across these domains**."

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3DIM DWG – History

Formed as **CAD/GIS**
Domain Working Group

2005

CAD/GIS/BIM-Thread in
OGC Web Services Initiative
Phase 4 (OWS-4)

2006

Changed name to
3D Information Management
Domain Working Group in 2007 to better
reflect the diversity of work in the group

2007

Initiated **CityGML**
Standards Working Group

2009

Initiated **Oblique Imagery**
Domain Working Group

2011

3D Portrayal
Interoperability
Experiment (3DPIE)

IndoorGML
Standards Working Group

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3DIM DWG – Activities

- **Forum** and incubator for 3D-related topics
- Devise **Architecture** for open interop. 3D services
- Advance Discussion Papers and **Best Practices**
- Participate in **Testbeds**
- Build on industry **Partnerships**

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3DIM DWG - Relationships

- 3DIM relationships include, e.g.,
  - **buildingSMART alliance** (MoU)
    - Development of IFC, the major open standard for Building Information Modeling (BIM)
    - AECOO-1 Testbed: OGC Discussion Paper released
    - BIM-GIS Information Exchange Project
  - **Special Interest Group 3D** (MoU)
    - German organization resp. for initial CityGML format
  - **Web 3D Consortium** (MoU)
    - X3D: ISO standard for 3D graphics on the Web
  - **W3C Point of Interest Working Group**
    - Mission is to develop a technical specification for the representation of "Points of Interest" information on the Web

OGC Domain Working Groups (Aug-8-11)

Name	Lead **
3DIM DWG (3DIM DWG)	Scott Simmons, CACI International Inc.
Architecture DWG (Arch DWG)	Doug Nebert, US Geological Survey (USGS)
Aviation DWG (Aviation DWG)	Navin Vembar, FAA System Operations Airspace and AIM Office
Catalog DWG (Cat DWG)	Doug Nebert, US Geological Survey (USGS)
Coordinate Reference System DWG (CRS DWG)	Victor Minor, Blue Marble Geographics
Coverages DWG (Cover DWG)	Peter Baumann, FORWISS (Bavarian Research Centre for Knowledge-Based Systems)
Data Preservation DWG (PreservDWG)	Steve Morris, North Carolina State University
Data Quality DWG (DQ DWG)	Matt Beare, 1Spatial Group Ltd.
Decision Support DWG (DS DWG)	Stan Tillman, Intergraph Corporation
Defense and Intelligence DWG (D and I DWG)	Lucio Colaiacomo, European Union Satellite Centre
Earth Systems Science DWG (ESS WG)	Phillip Dibner, Ecosystem Research
Emergency & Disaster Management DWG (EDM DWG)	Lewis Leinenweber, Evolution Technologies, Inc.
Geo Rights Management (GeoRM) DWG (GeoRM DWG)	Roland Wagner, BHT-Berlin (Beuth Hochschule für Technik Berlin)
Geography Markup Language (GML) DWG (GML DWG)	Ron Lake, Galdos Systems Inc.
Geometry DWG (GeometryDWG)	John Herring, Oracle USA
Geosemantics DWG (Semantics)	Joshua Lieberman, Deloitte Financial Advisory Services, LLP
Hydrology DWG (Hydrology DWG)	David Lemon, CSIRO
Location Services DWG (LS DWG)	Marwa Mabrouk, Esri
Mass Market DWG (MassMarket DWG)	Ed Parsons, Google
Metadata DWG (Metadata DWG)	David Danko, Esri
Meteorology & Oceanography DWG (Met Ocean DWG)	Chris Little, UK Met Office
Oblique Imagery DWG (ObliqueImageryD)	Shayne Urbanowski, Lockheed Martin
Security DWG (SecurityDWG)	Andreas Matheus, University of the Bundeswehr - ITIS
Sensor Web Enablement DWG (SensorWeb DWG)	Mike Botts, Botts Innovative Research
University DWG (Univ DWG)	Chris Higgins, Open Grid Forum
Web Feature Service DWG (WFS DWG)	Martin Daly, cadcorp (Computer Aided Development Corp.) Ltd.
Workflow DWG (Workflow DWG)	Stan Tillman, Intergraph Corporation

** - There may be Co-Chairs or Vice-Chairs that are not listed in this table

An interest or focus in 3D content modeling, sharing, and integration/fusion

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OGC 3D Data Standards

- **OGC Geography Markup Language**
  - XML-based language for encoding geographic information to be stored and transported over the Internet
  - Defines both the 2D and 3D geometry and properties of objects that comprise geographic information.
- **CityGML** Format
  - Application independent geospatial information model and exchange format for 3D city models comprising different thematic areas (buildings, vegetation, water, terrain, traffic etc.) and dimensions
- **KML** Encoding Standard
  - XML for geographic visualization on 2D and 3D Earth browsers
  - Ex. of display features: placemarks, images, polygons, 3D models

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Other 3D Data Formats and Standards

- **Collada** (Collaborative Design Activity)
  - Model and Format for 3D graphics data
  - Developed and managed by the Khronos Group
- **X3D** (Extensible 3D Graphics Format)
  - Successor of VRML; ISO standard for 3D graphics data
  - Geospatial support through various GeoNodes
  - Developed and managed by Web 3D Consortium
- **X3DOM**
  - Approach for the integration of HTML5 and declarative 3D content
  - Integrates X3D elements as part of HTML5 DOM tree
  - Currently developed by Fraunhofer IGD

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CityGML

application-
independent
NOT only for visualization

object-oriented
information model +
geo data exchange format

CityGML

4 LODs
Levels-of-Detail, e.g.,
simple blocks to indoor models

semantics
topology
3D geometry
multidimensional
thematic data
appearance

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3DPIE

In mid **2011**, the OGC **3DIM** Working Group **initialized** and launched the OGC **3D Portrayal** Interoperability Experiment **(3DPIE)** to **test, demonstrate, and bring forward** different approaches and standards for service-based ...

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3D Portrayal

“presentation of information to humans” [ISO 19117]

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3DPIE

- **Missing Link: Open Services for 3D Portrayal**
  - Proprietary 3D portrayal solutions available for Perspective Street Views, Virtual Globes (commercial and open source)
  - However, extensibility and interoperability are limited and projects (e.g. 3D City Models) **depend on the business model** of existing platforms
  - By opening the 3D portrayal interfaces it becomes possible to **exchange servers and clients** in a flexible way
  - Service based 3D visualization systems have different requirements than full desktop GIS

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We need a

“Map Server for 3D”

3DPIE – Participants

Fraunhofer IGD

RUPRECHT-KARLS-UNIVERSITÄT HEIDELBERG EXZELLENZUNIVERSITÄT

GIScience

HPI Hasso Plattner Institut
IT Systems Engineering | Universität Potsdam

CACI EVER VIGILANT

Bitmanagement INTERACTIVE WEB3D GRAPHICS

Institute for Geodesy and Geoinformation Science berlin

Fraunhofer IGD
GIScience at University Heidelberg
Hasso-Plattner-Institut at University Potsdam
Bitmanagement
CACI
IGG at Technical University Berlin
Institute Geographic Nationale (IGN)
LSIS at Aix-Marseille University
MOVES at the Naval Post Graduate School
Virginia Tech

IGN INSTITUT GEOGRAPHIQUE NATIONAL

Laboratoire des Sciences de l'Information et des Systèmes

THE MOVES INSTITUTE

VirginiaTech 1872

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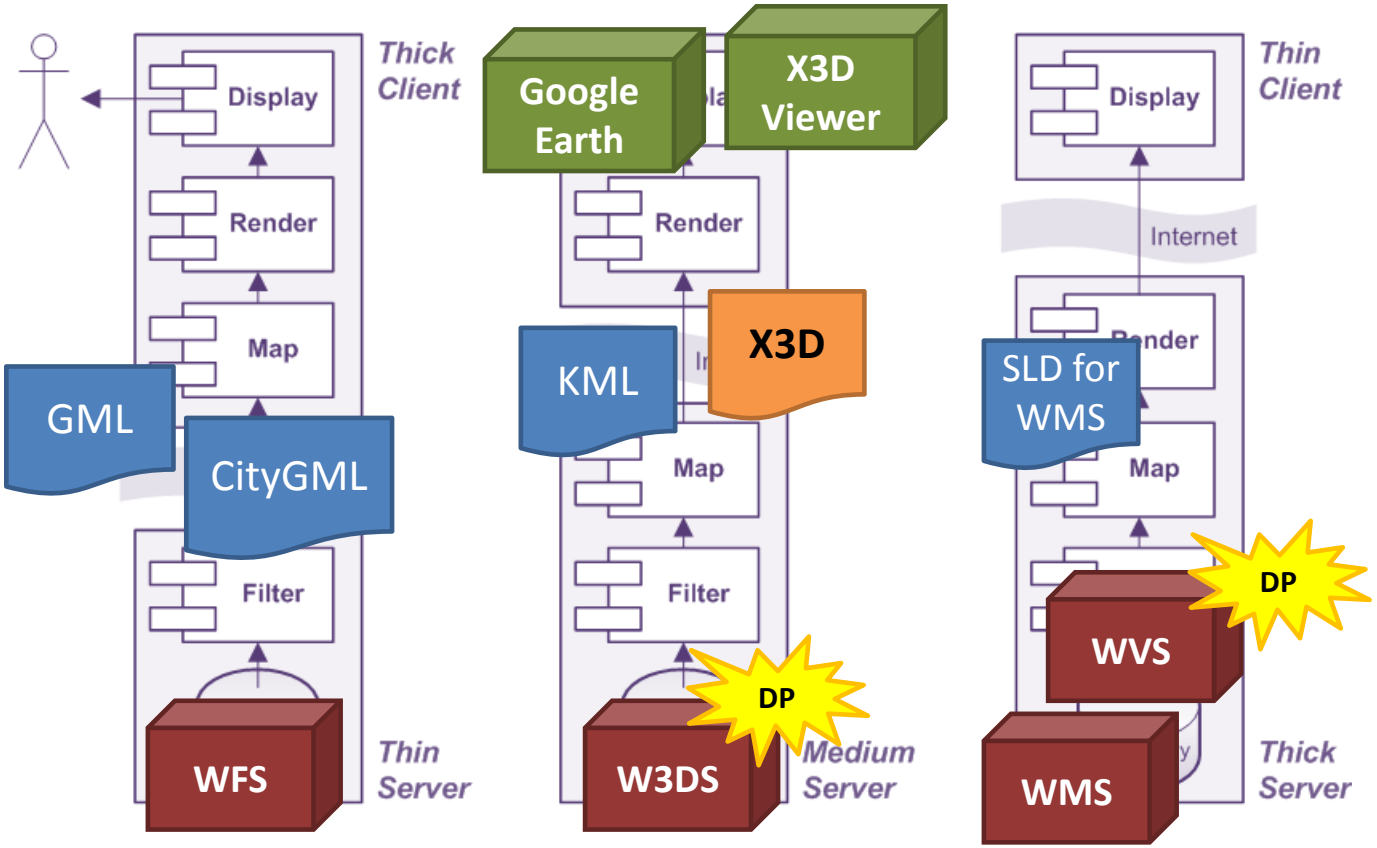
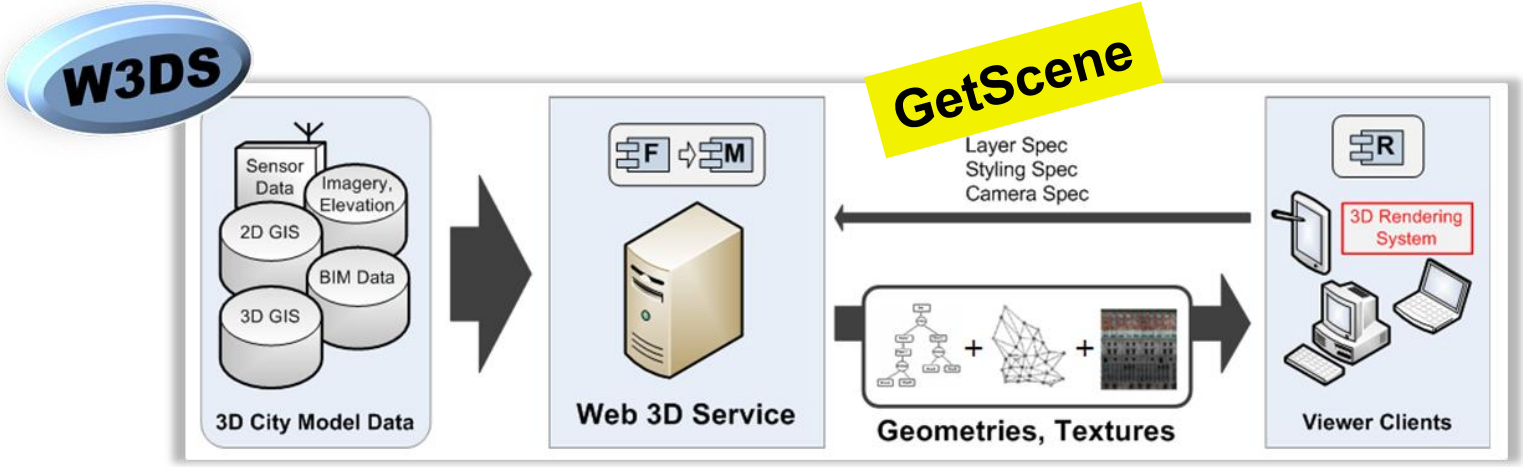
3D Portrayal Services

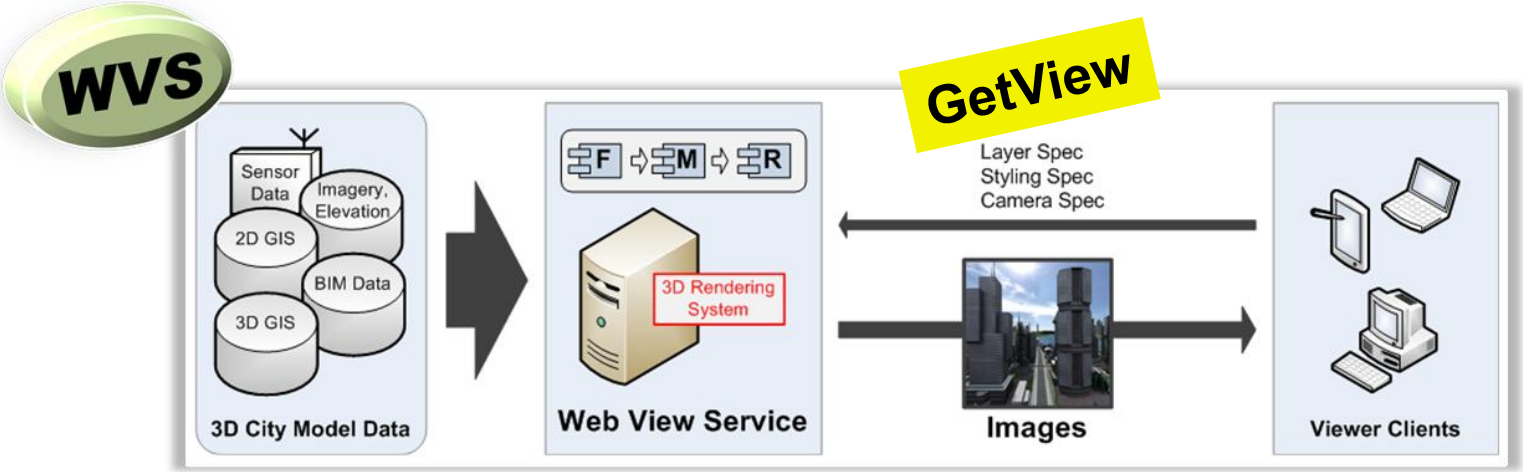
- Separation of rendering concerns; examples of services and formats:



3D Portrayal Services

- **Web 3D Service and Web View Service**





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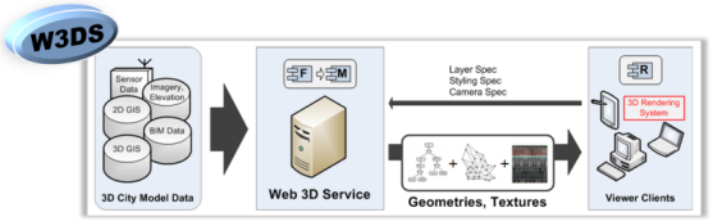
OGC Candidate Standard: Web 3D Service

- Web-based, **Graphics-Based** Provision of and Access to Virtual 3D Worlds
  - Geodata is delivered as scenes that are comprised of display elements, optimized for efficient real time rendering at high frame rates
  - It can be used for web applications and datasets that are too big for being stored in single files.
  - Streaming allows effective fly-throughs.
  - All features supported by web 3D standards (VRML, X3D, COLLADA, KML) can be exploited.



www.w3ds.org

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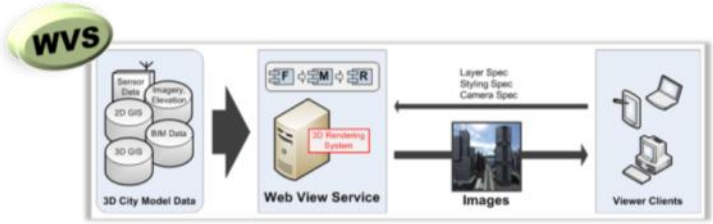
OGC Candidate Standard: Web View Service

- Web-based, **Image-Based** Provision of and Access to Virtual 3D Worlds
  - Server-side model management and 3D rendering
  - Generation of images of views on the 3D model and transfer to viewer clients
  - Provides visual, thematic, and geometric information as images
  - Reduces data complexity and rendering complexity for clients
  - WVS is a 3D equivalent of 2D map services



www.webviewservice.org

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3DPIE – Focus

- Main focus on **Web 3D Service** and **Web View Service**
  - Can the WVS and W3DS adequately **support the web-based management, portrayal, and exploration** of urban 3D geodata?
  - Can the W3DS and WVS specifications **be further harmonized** to provide a more common interface to 3D portrayal capabilities and to support their potential integration and combination?
  - What are **best practices** for the application of the various **3D portrayal approaches,** including graphics-based 3D portrayal through W3DS and image-based 3D portrayal through WVS?
  - What are **best practices** for the application **of the various 3D geodata formats** and 3D graphics data formats including CityGML, X3D, KML, COLLADA, and others?
  - How to exploit **W3DS and WVS from various client platforms**, including thin-clients, web-based clients, and mobile clients?

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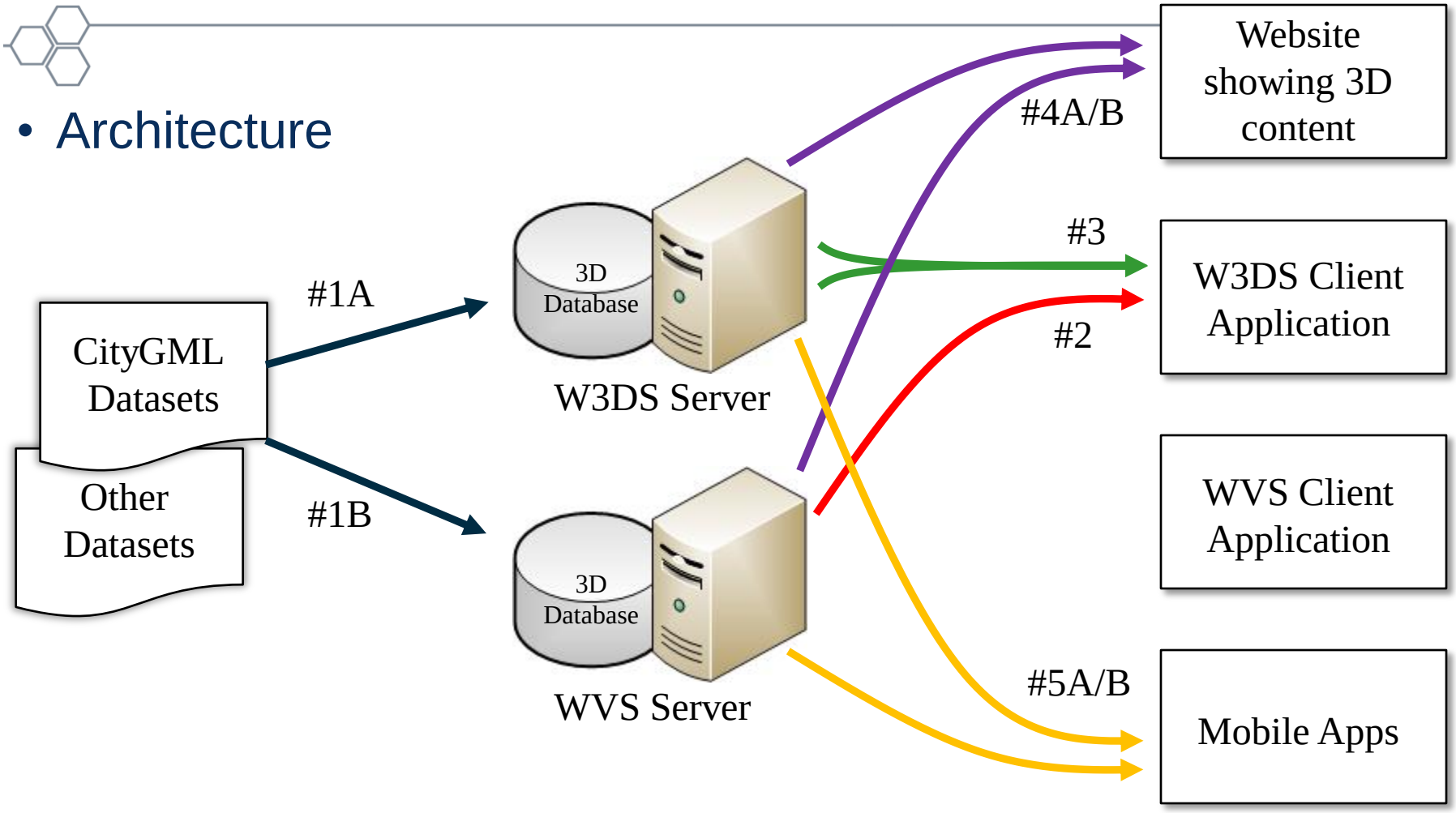
3DPIE – Architecture

- Architecture



WI-1: Data Integration

WI-2: Service Integration
WI-3: Service Delivery

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3DPIE – Datasets

Paris

Mainz **Berlin**

OSM

Blacksburg

LARGE

textured

buildings, terrain

CityGML/X3D

LOD1/2

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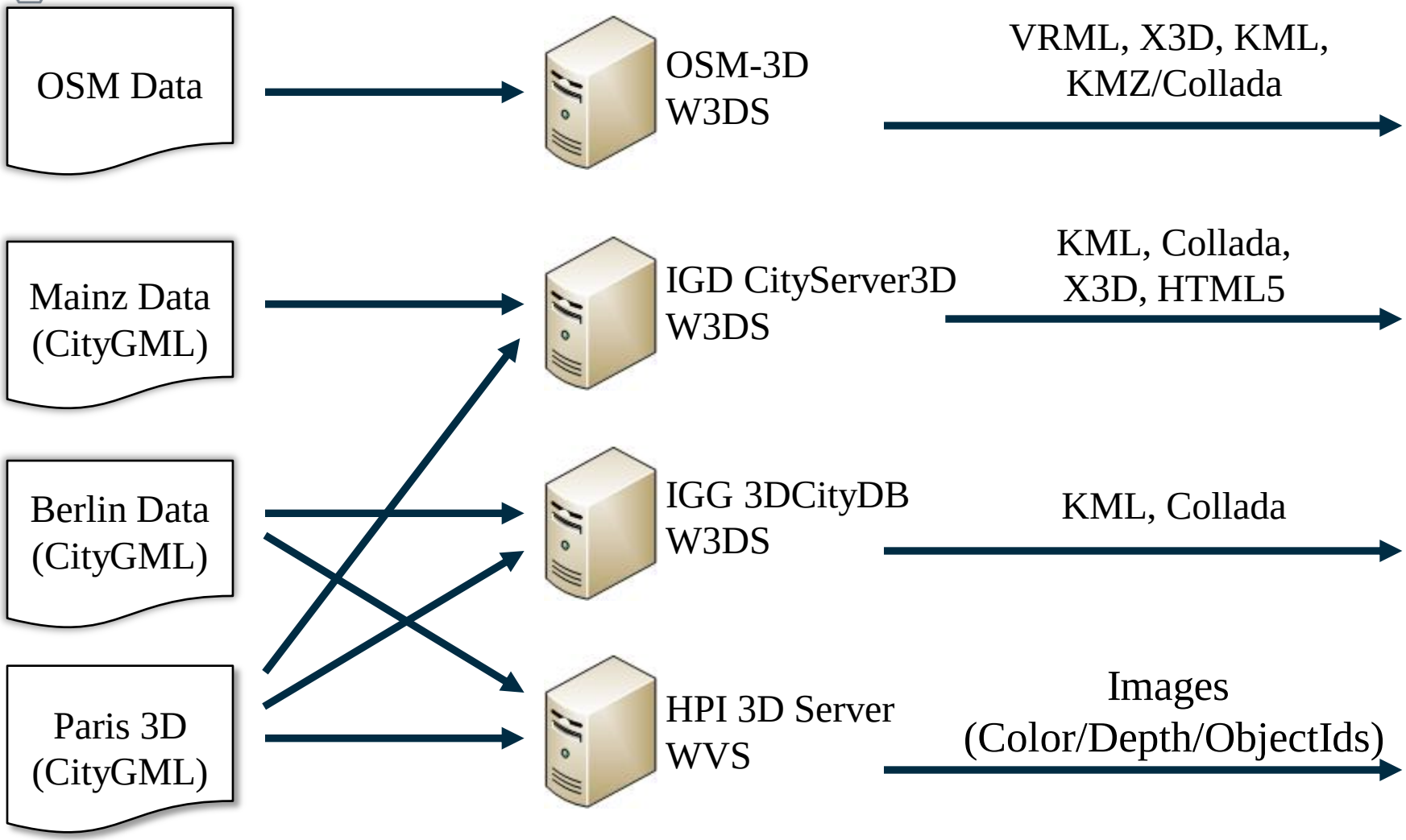
3DPIE – Servers and Clients



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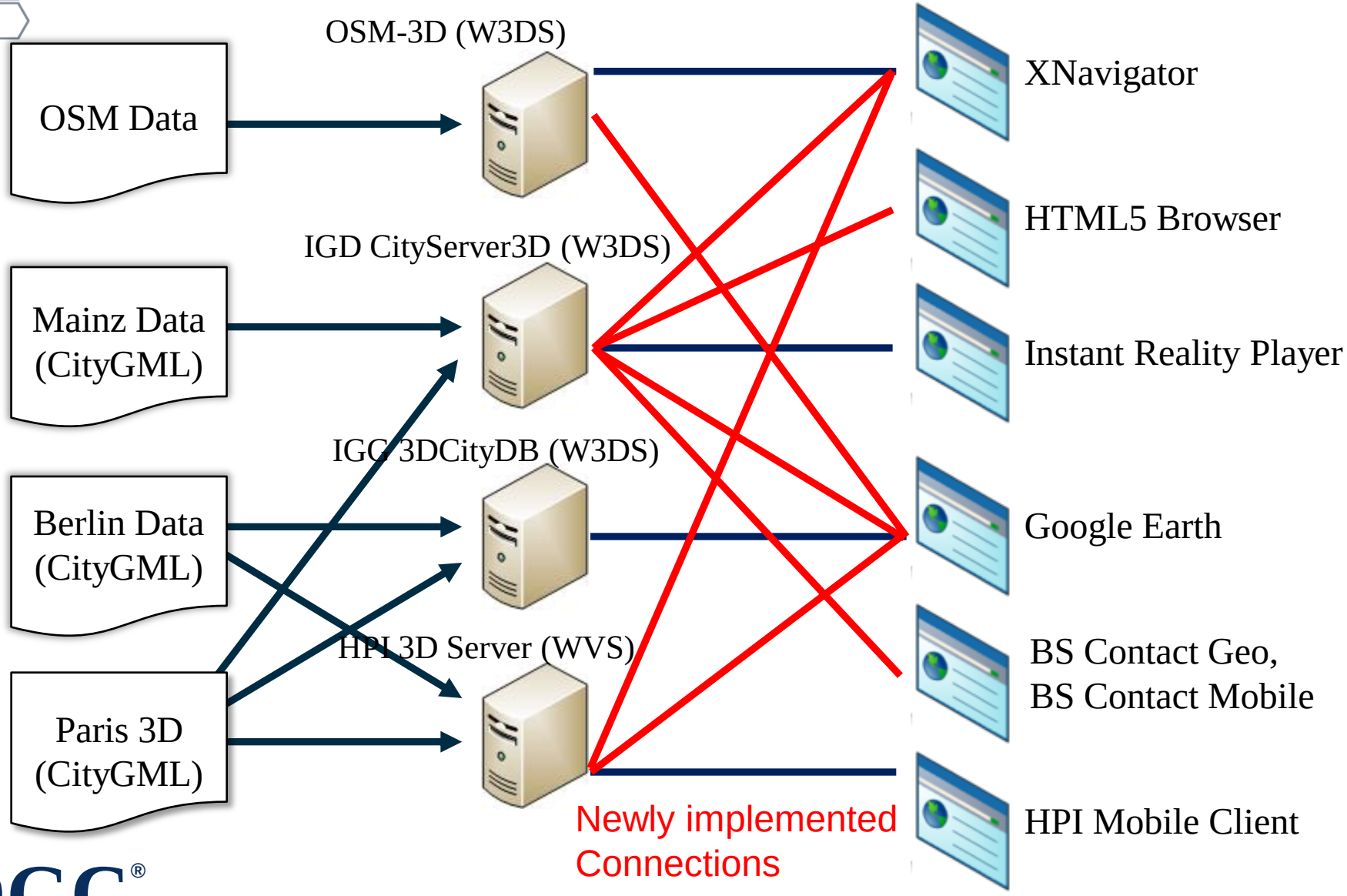
3DPIE – Servers and Clients



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3DPIE Experiment Activities

- Data integration
  - Importing Paris data into IGG Web 3D Service
  - Importing Berlin data into IGG Web 3D Service
  - Importing Mainz data into CityServer3D
  - Importing Paris data into CityServer3D
  - Importing Paris data into HPI Web View Service
  - Importing OpenStreetMap data into OSM-3D Web 3D Service
- Service Integration + Service Delivery
  - Displaying KML from W3DS in Google Earth
  - Accessing X3D
  - Merging data from multiple Web 3D Services in XNavigator
  - Merging 3D models from W3DS and imagery from WVS in XNavigator
  - Sharing and displaying WVS imagery in web browsers
  - Displaying WVS imagery on mobile clients
  - Rendering CityGML data in the web browser
  - Rendering W3DS data in the web browser
  - Rendering W3DS data on mobile devices
  - Extended LOD concept for X3D

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Result

Examples

- W3DS in Google Earth
- Integrated W3DS client
- W3DS for Web and Mobile
- WVS for Web and Mobile
- W3DS + WVS

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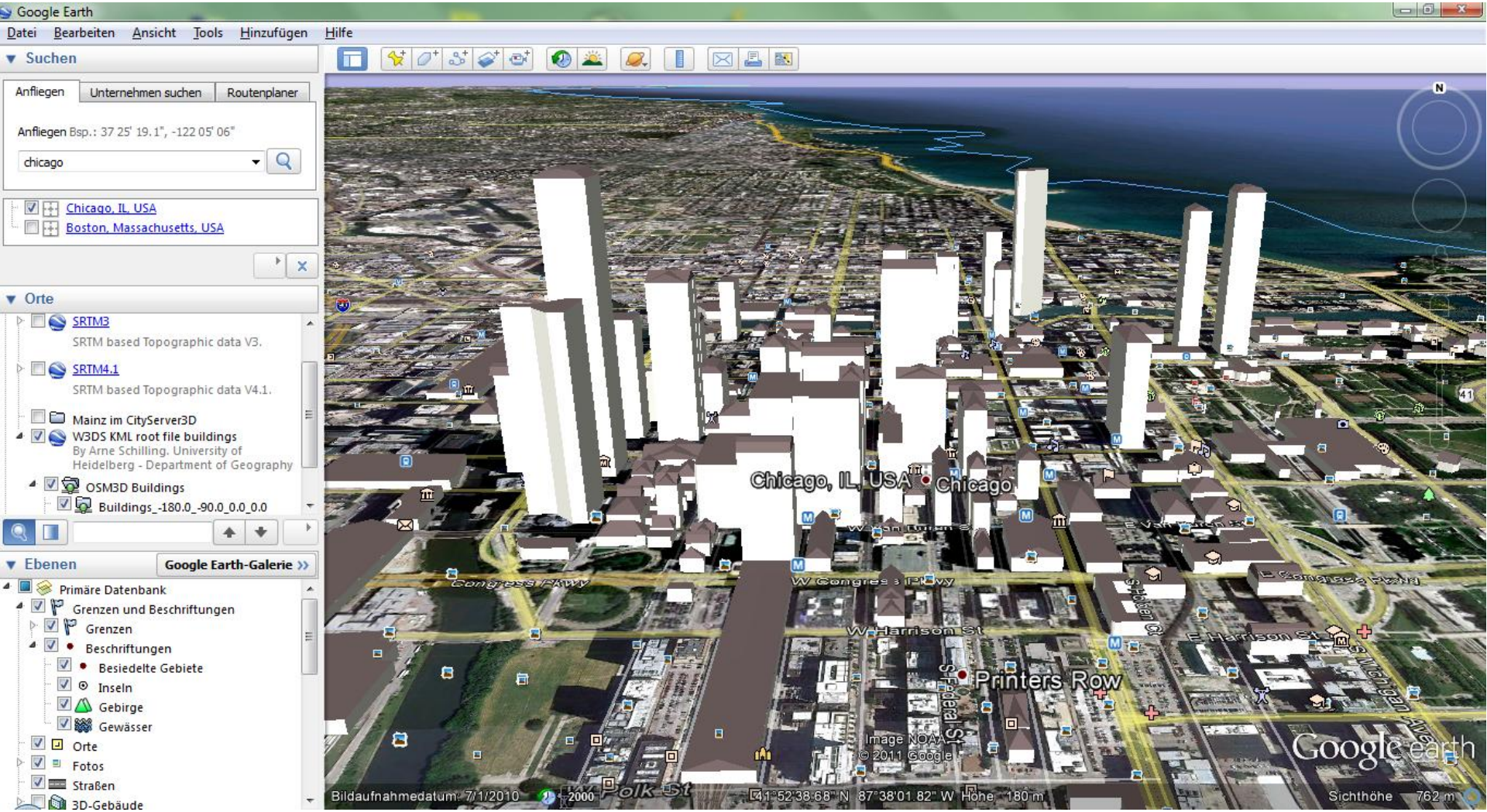
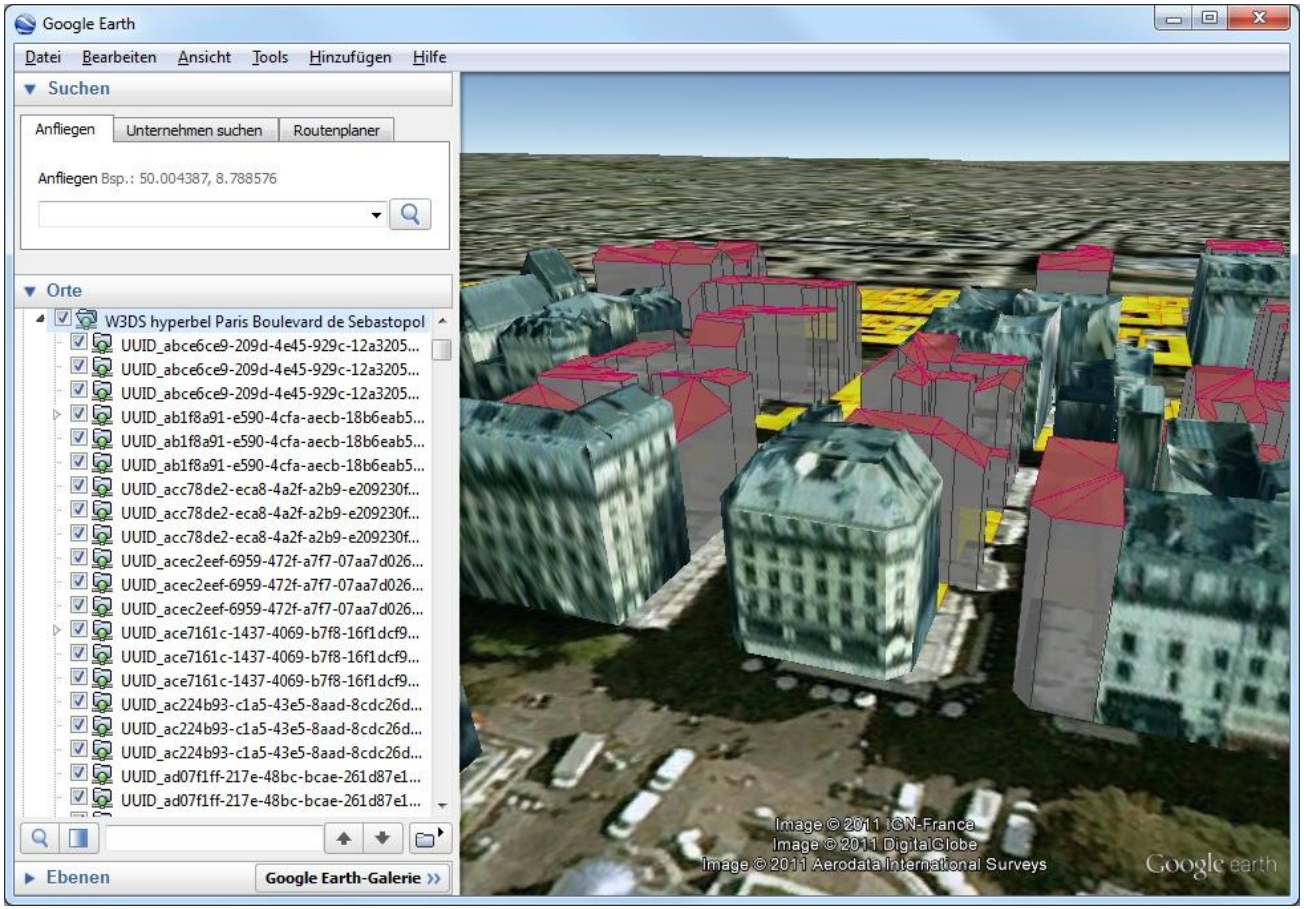
Results: W3DS in Google Earth (1)

- OSM-3D W3DS in Google Earth



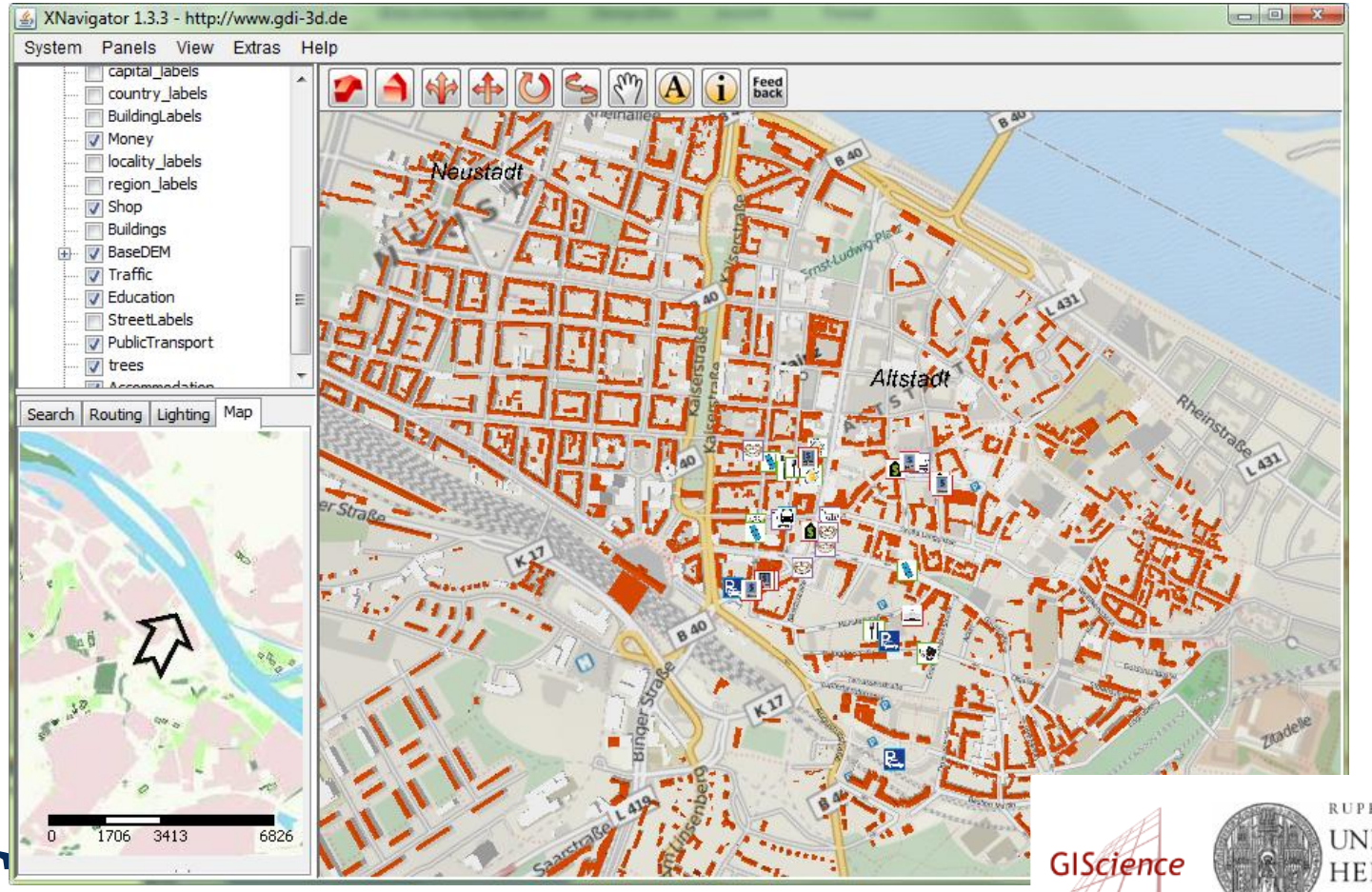
Results: W3DS in Google Earth (2)

- IGG‘s W3DS serves Paris data (from CityGML) to Google Earth



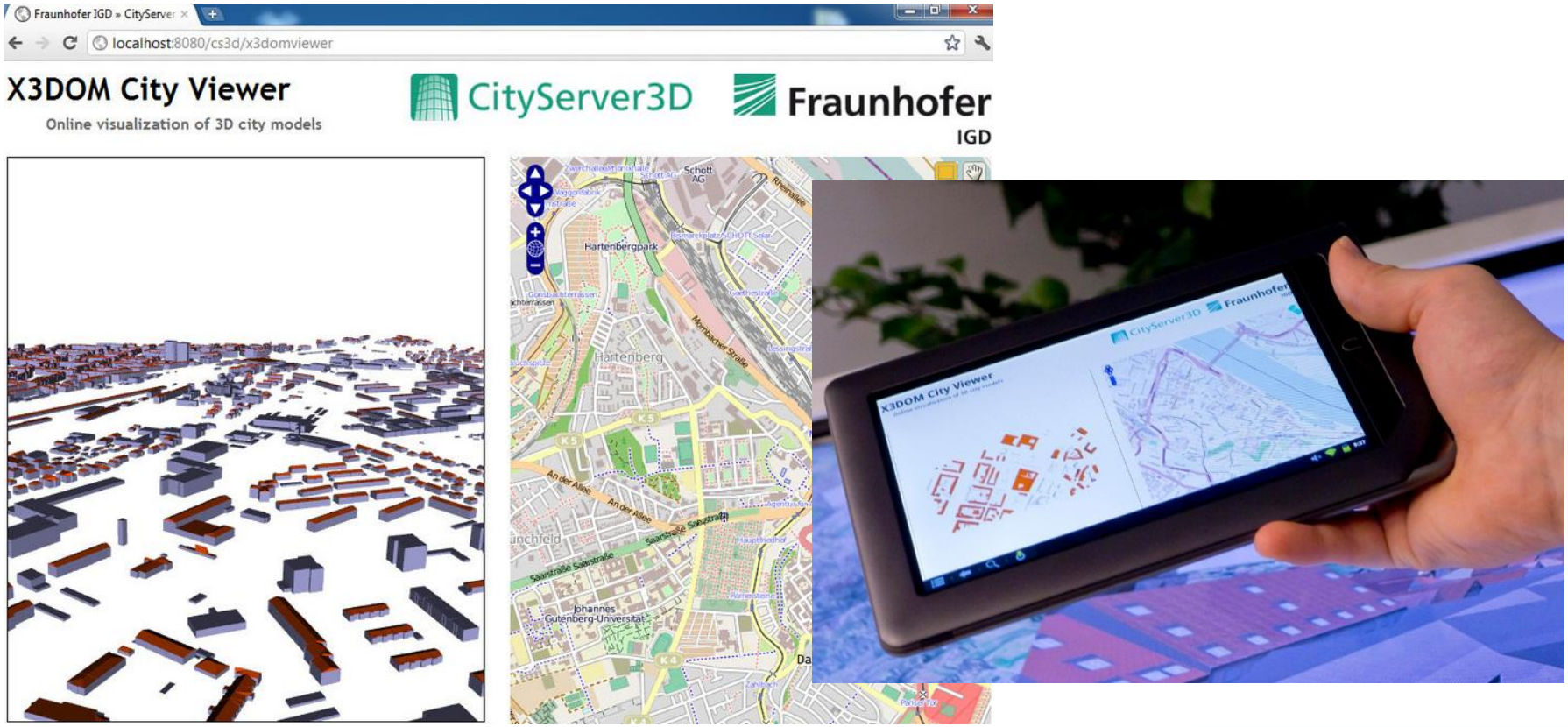
Results: Multiple W3DS in an integrated client

- Integrating data from OSM-3D (textured terrain) + Mainz-W3DS (building model)



Results: W3DS for Web and Mobile

- Fraunhofer's X3DOM City Viewer in the Web browser and on mobile device



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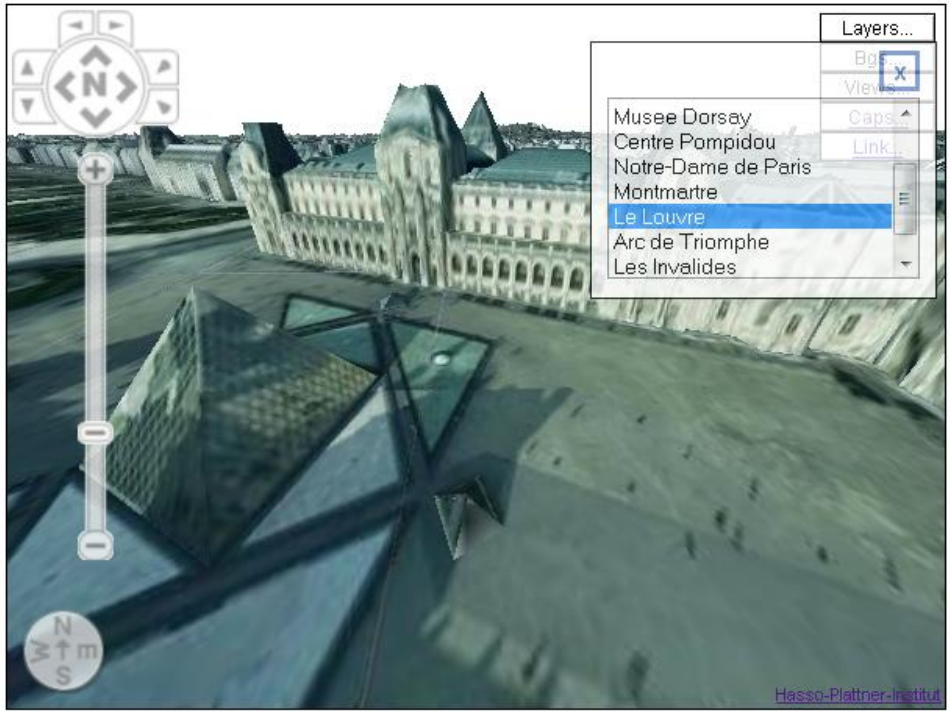
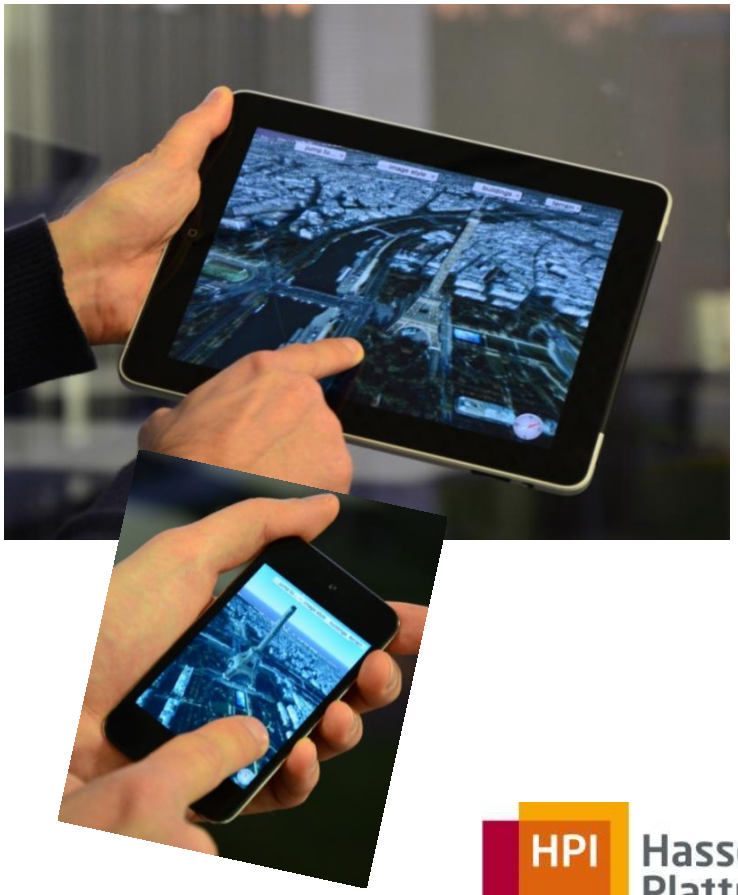
Fraunhofer IGD

Results: WVS for Web and Mobile

- HPI‘s WVS serves Paris city model to a web and mobile client





HPI Hasso Plattner Institut
IT Systems Engineering | Universität Potsdam

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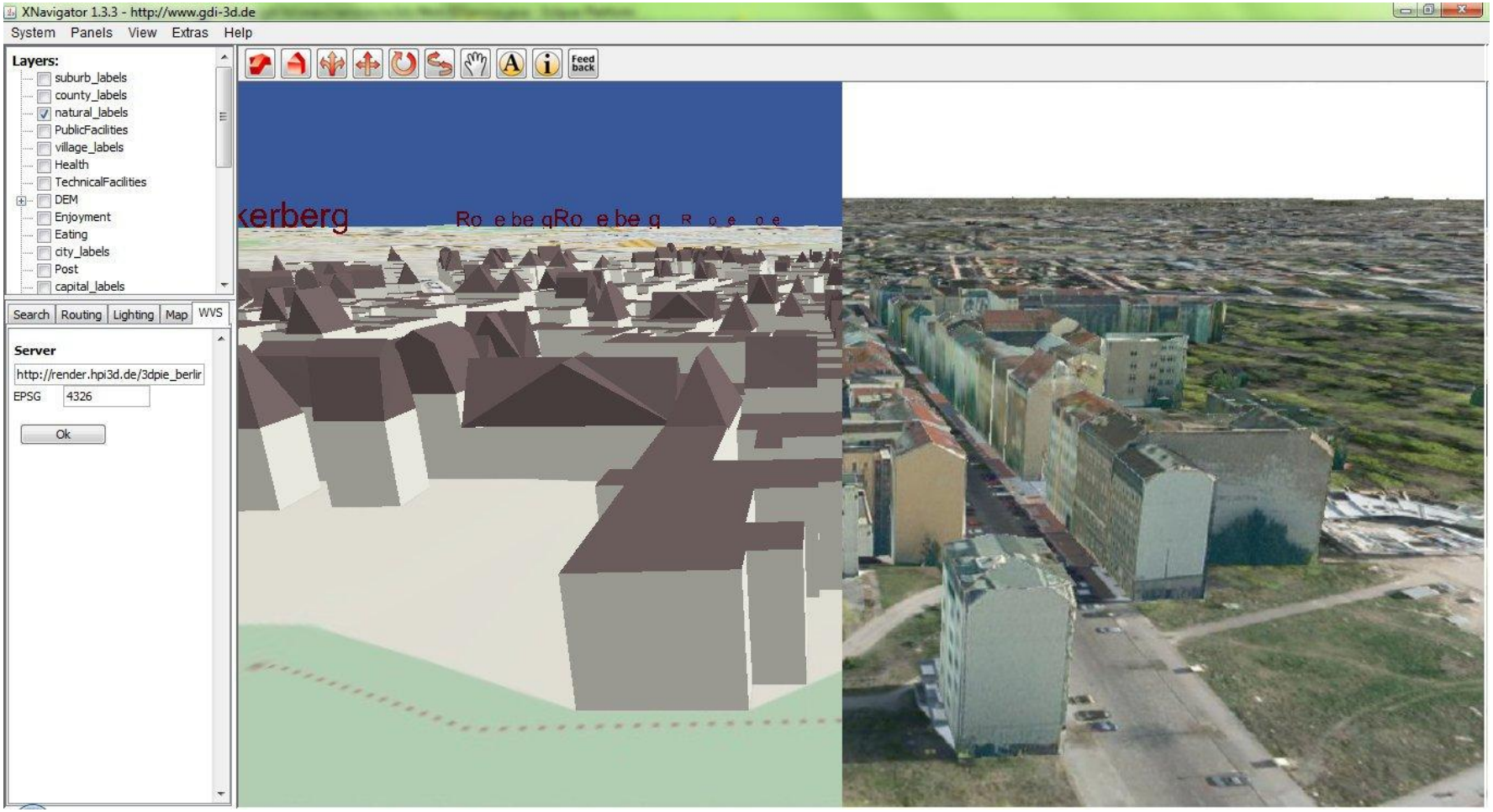
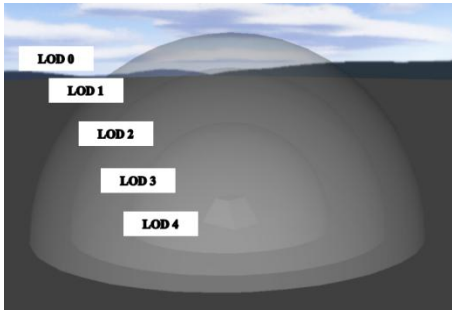
Results: Combining W3DS + WVS

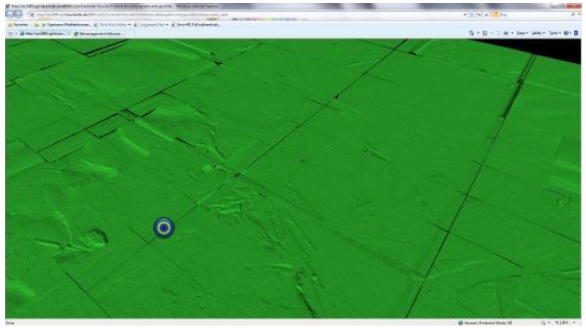


Other Experiments

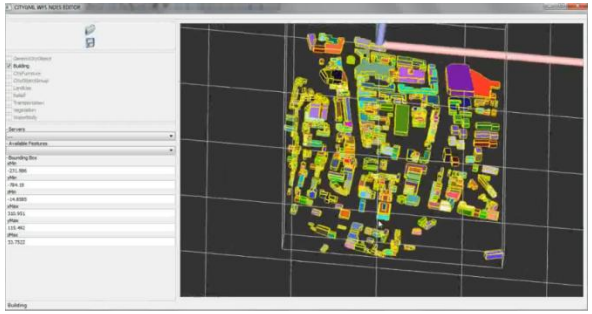
- Virginia Tech: Advanced Level-of-Detail mechanism for X3D



- Bitmanagement: Rendering CityGML and X3D in the Browser



- LSIS: CityGML for the Web



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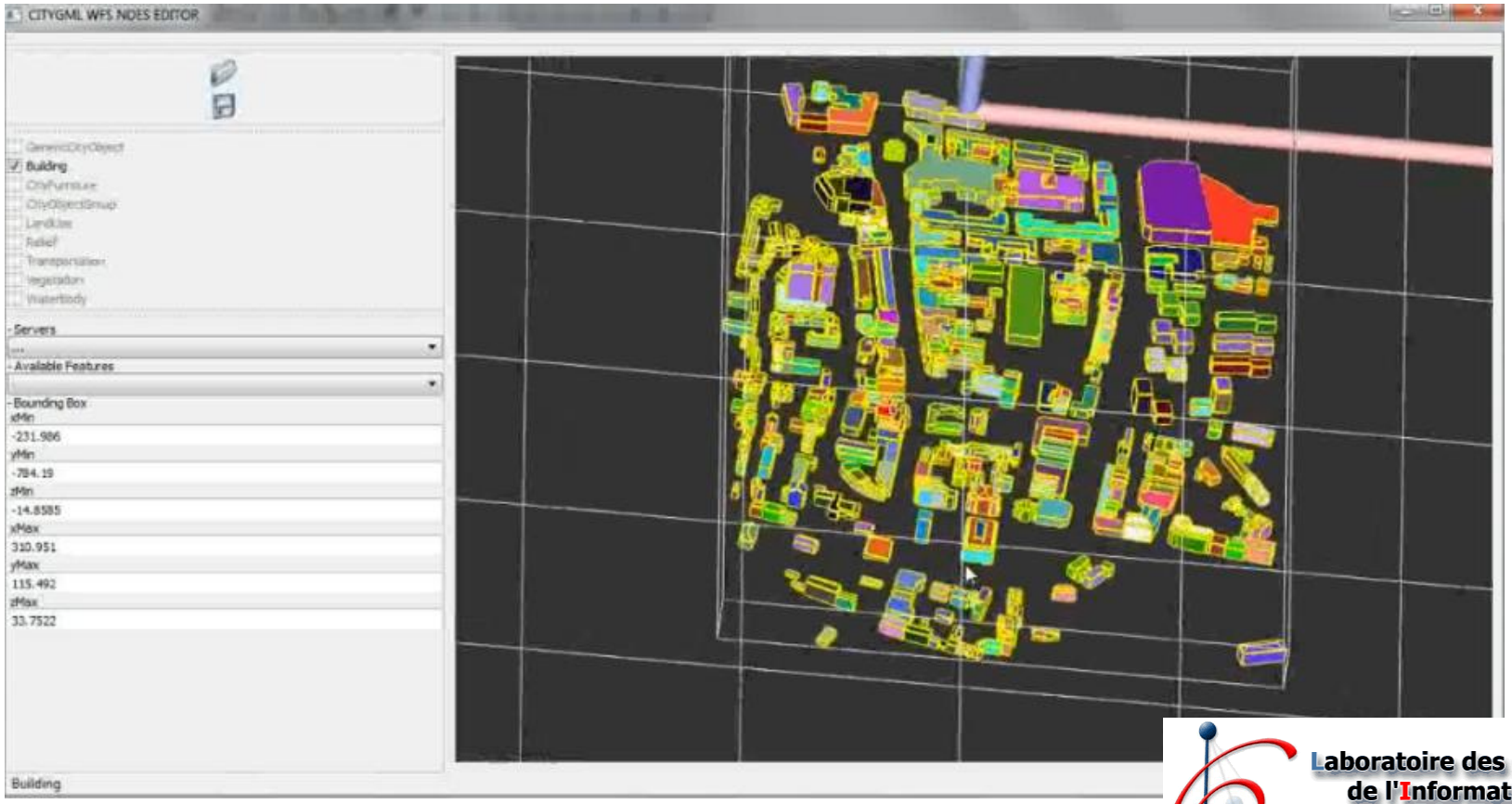
Results: Web-based Rendering of CityGML

- Experiments on serving CityGML and JSON and rendering in the borwser based on WebGL – W3DS-like approach



Laboratoire des Sciences de l'Information et des Systèmes

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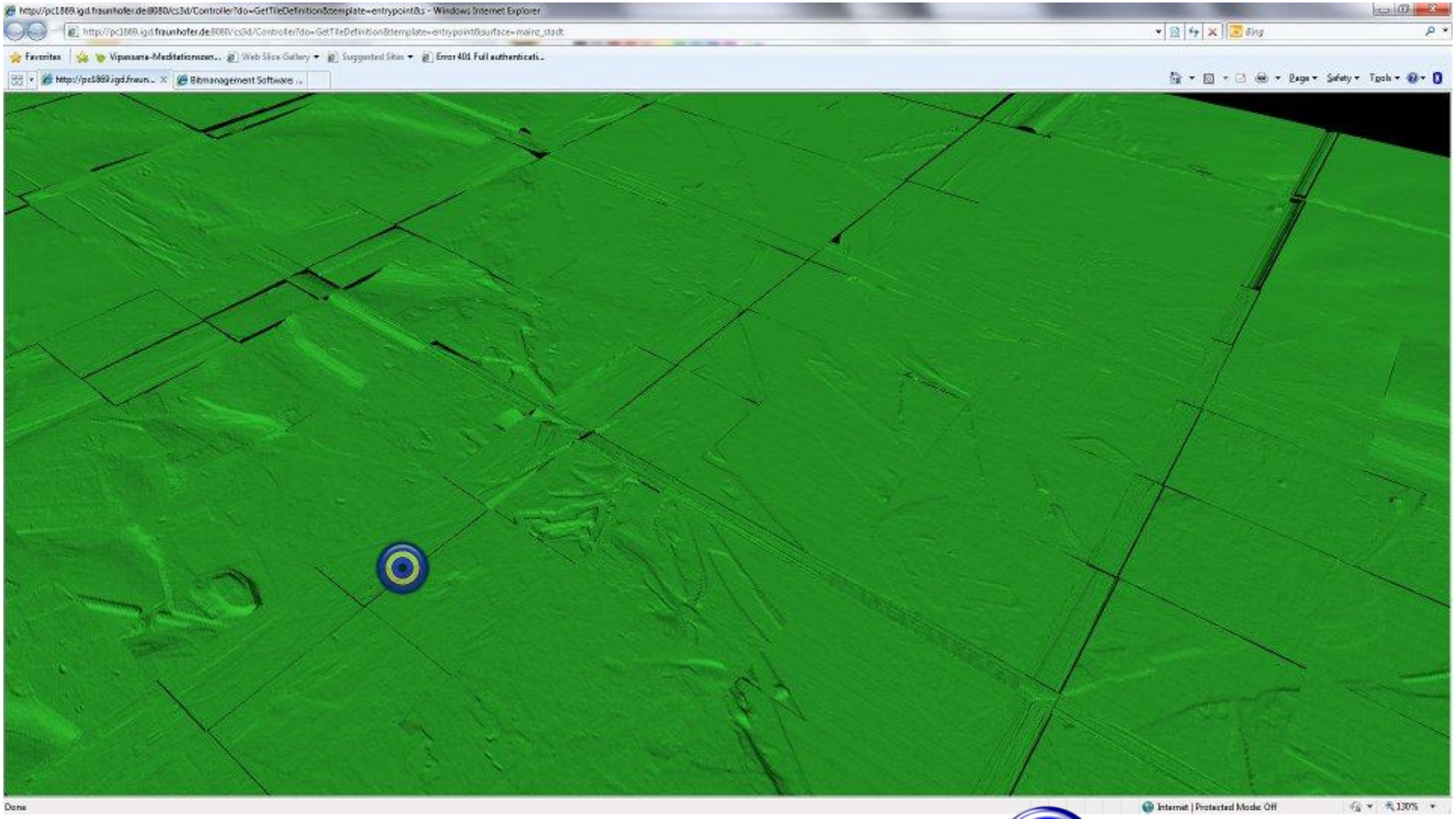
Results: Using W3DS in BS Contact Geo



Bitmanagement
INTERACTIVE WEB3D GRAPHICS

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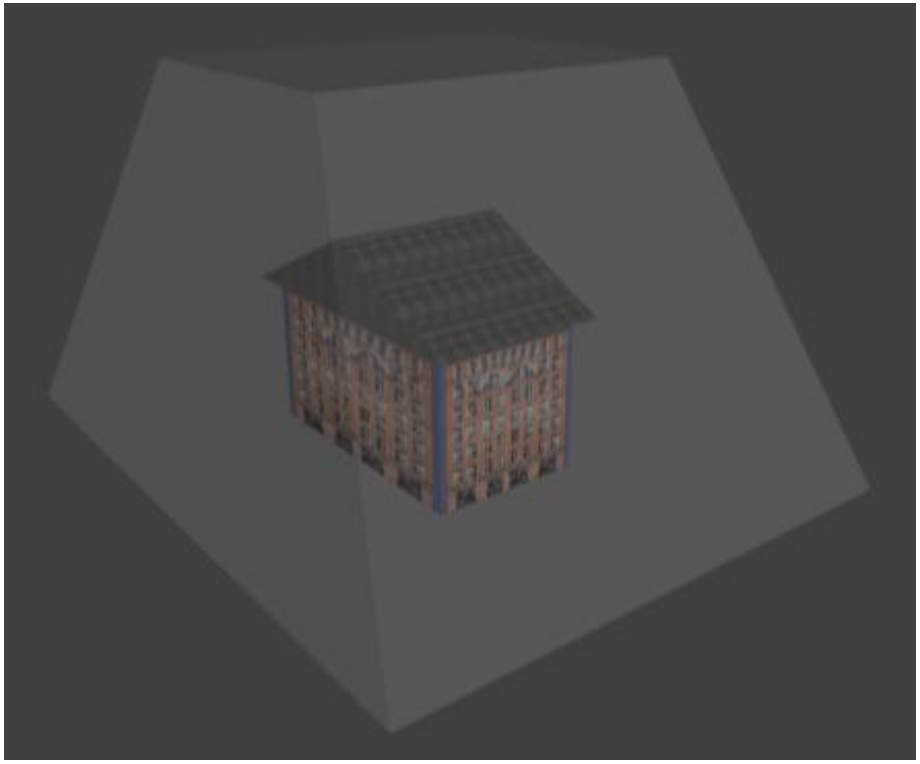
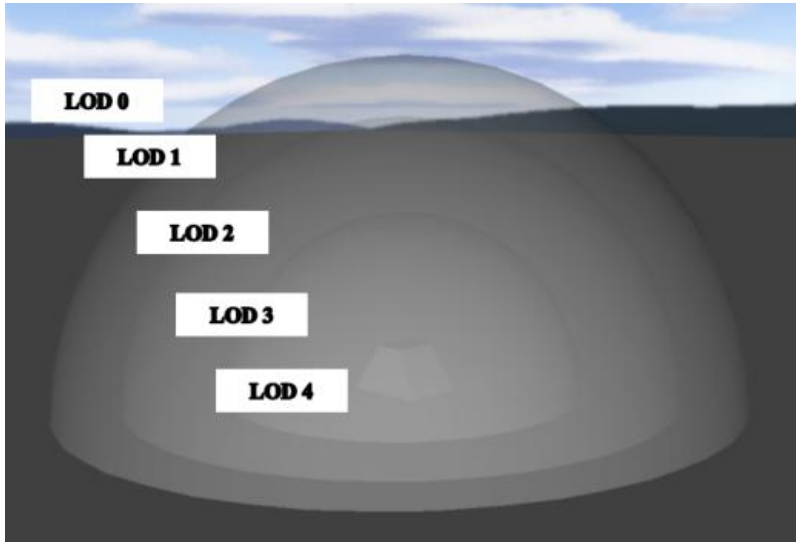
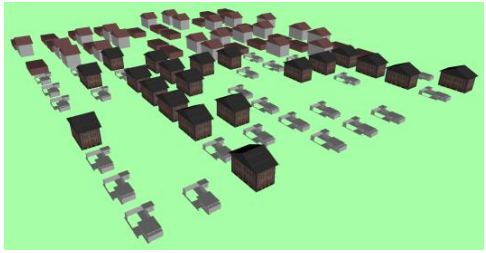
Results: Advanced LOD mechanism for X3D

- Optimized distance computation for LOD3/LOD4-transitions based on a bounding prism







WVS

... some more **details**

W3DS

3DPIE

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Web View Service (WVS)

WVS

- Approach
  - A WVS renders and provides G-Buffers (color, depth, object-ids, normals, etc) to a consumer
  - WVS provides additional service operations for navigation, feature data retrieval, and analysis (GetPosition, GetFeatureInfo, GetMeasurement, GetCamera)
- Major Characteristics of Service-Based 3D Rendering
  - Complexity of the transferred G-buffers is independent from original 3D scene's complexity
  - 3D rendering takes place in controlled server environment
  - No specialized 3D hardware or software required at the client side
  - Web-based access is provided, while original 3D content is kept protected

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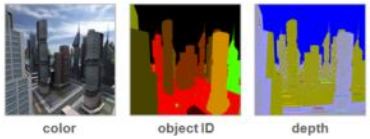
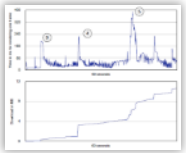
HPI3D Server – Overview

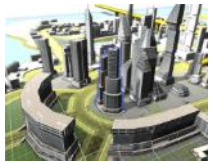


Service interface, images

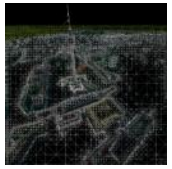


Scalability, CPU/GPU parallel

Supporting massive, complex models

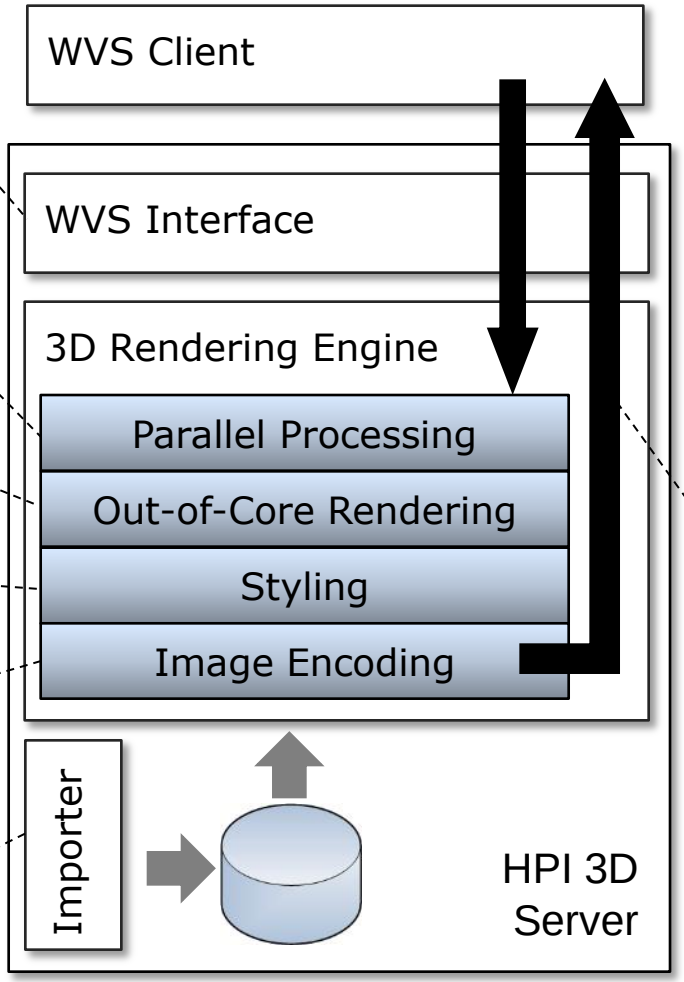


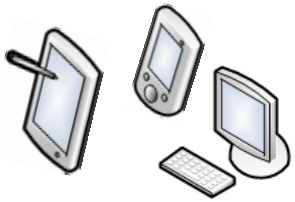
Styling according to application, task, user

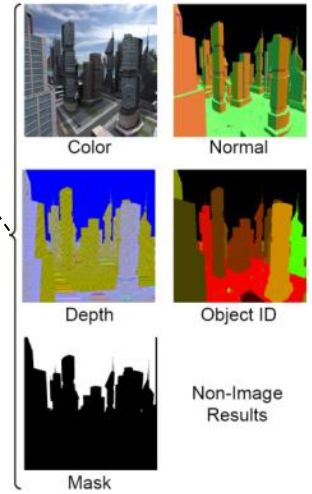


Space/time efficient transmission

Massive data (CityGML, 3DS, dae, shp, dxf, VRML, ...)





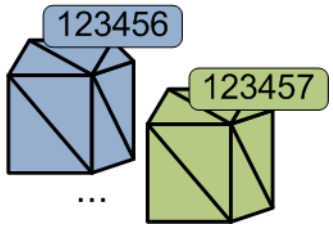


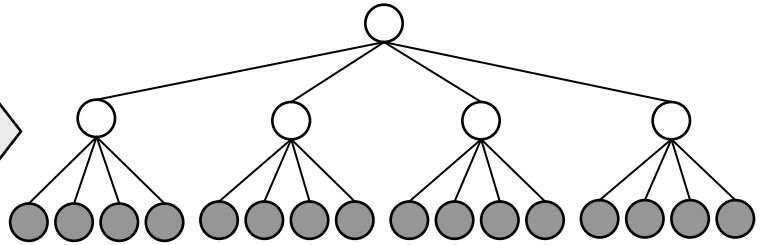
WVS – Preprocessing massive 3D geodata

- Conversion of 3D geodata to an efficiently renderable scene graph representation

CityGML
- Semantics
- Geometry
- Appearance

1

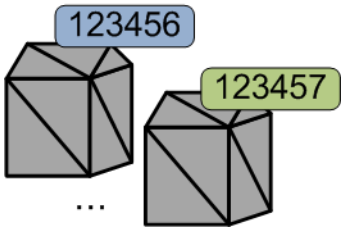




1. Data Extraction
- Feature Extraction
- Geometry Triangulation
- Object-Id Assignment
- Spatial Organisation

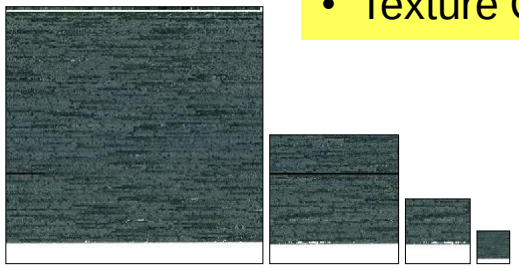
2. Geometry Optimization
- Geometry Batching
- Serialization

2



3

3. Texture Optimization
- Texture Atlas Computation
- MipMap Generation
- Texture Coordinate Adjustment



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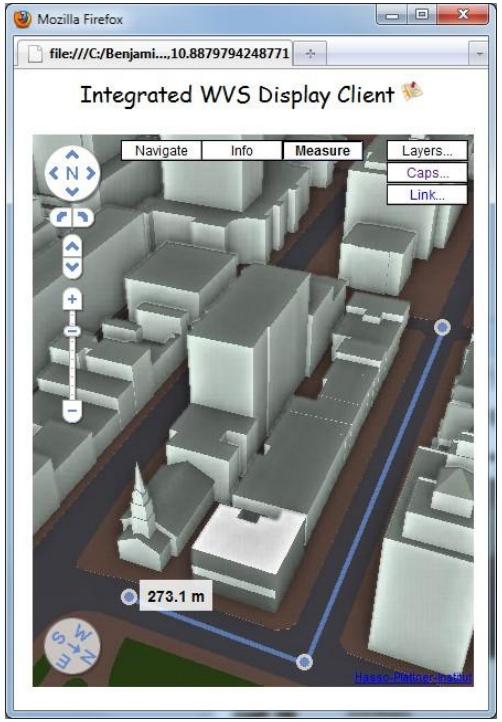
HPI3D Web-Client

- Lightweight JavaScript-Based Web Client
  - displays mainly images retrieved from the WVS

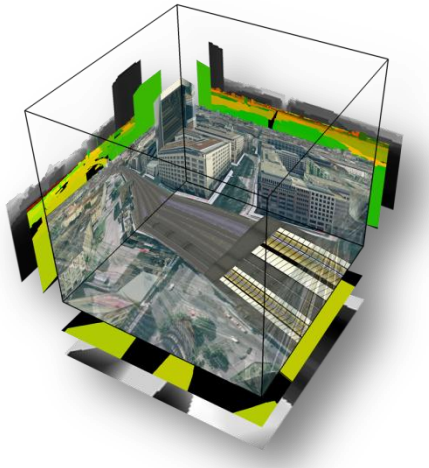


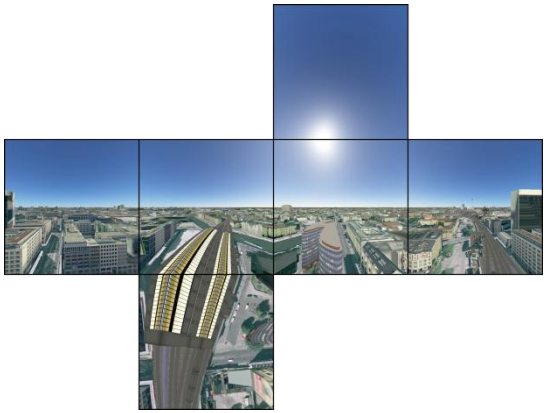
HPI3D Mobile Client

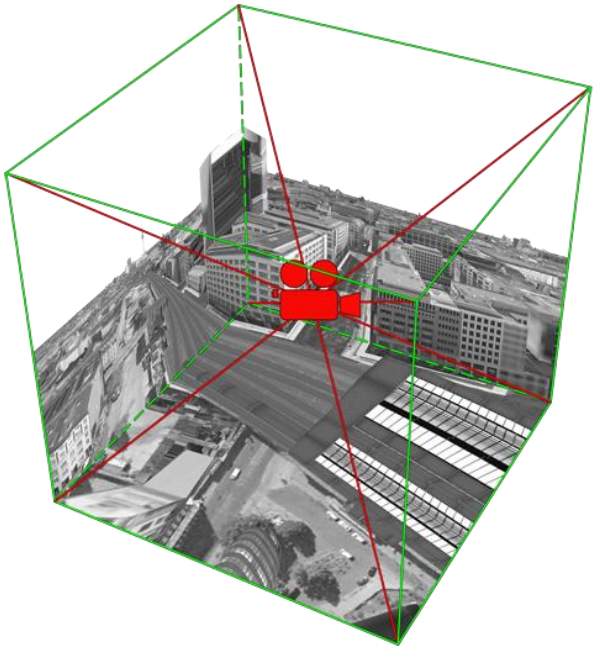
- Real-Time 3D Viewer Client
  - Creating the illusion of a 3D environment by partial reconstruction of the scene from a cubemap retrieved from WVS

HPI3D Mobile Client

- Real-Time 3D Viewer Client
  - Creating the illusion of a 3D environment by partial reconstruction of the scene from a cubemap retrieved from WVS
  - Method 1: 3D illusion by placing the virtual 3D camera in a textured cube that is created and rendered at the client side

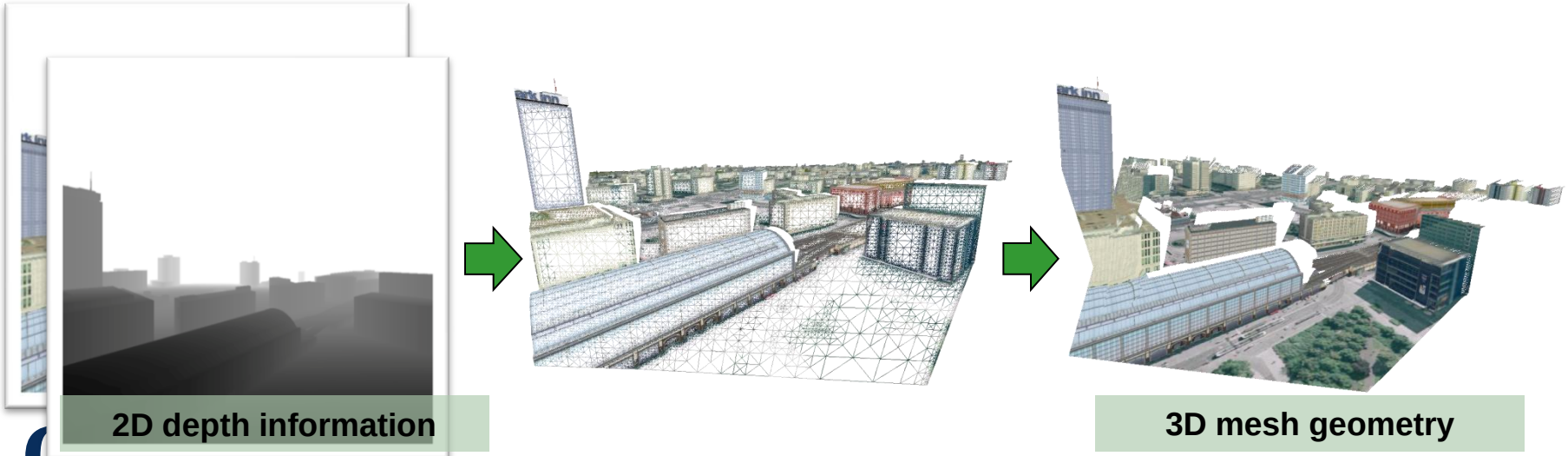






HPI3D Mobile Client

- Real-Time 3D Viewer Client
  - Creating the illusion of a 3D environment by partial reconstruction of the scene from a cubemap retrieved from WVS
  - Method 1: 3D illusion by placing the virtual 3D camera in a textured cube that is created and rendered at the client side
  - Method 2: Client-side reconstruction and rendering of a textured 3D mesh from the retrieved depth information

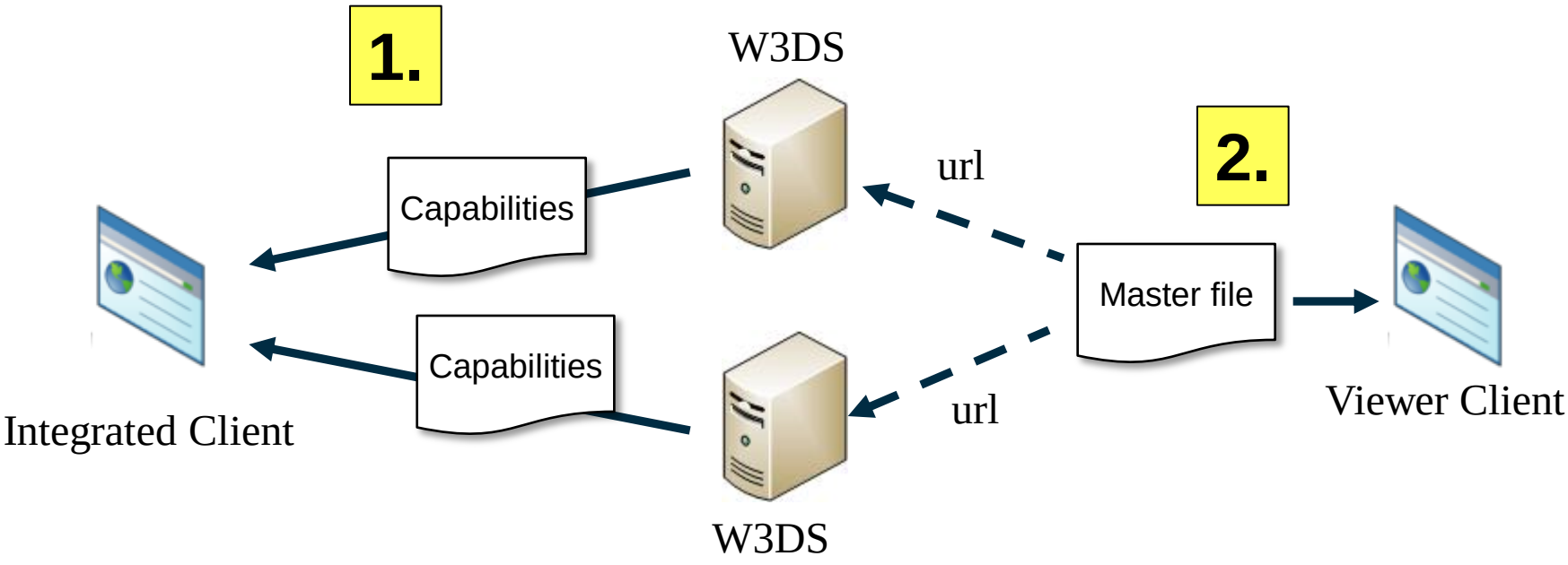


HPI3D Mobile Client

- Demo

Delivery of 3D Graphics Data (W3DS)

- Approaches for delivering 3D Graphics Data
  1. **Integrated 3D clients** consume services‘ capability documents
  2. **3D Viewer clients** receive a master file that contains valid service getdata requests (file-based integration/combination)



Delivery of 3D Graphics Data (W3DS)

- 3D Graphics Formats must support
  - High precision Geo-coordinates
  - Group nodes and transformation matrices
  - View or distance dependent rendering (LOD)
  - Possibility to represent Icons/placemarks and labels
  - (Inlining / loading remote data via URLs)

- Suitable Formats
  - X3D with Geo-Extension
  - KML/COLLADA combination

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Generating and Displaying KML

- W3DS delivery to Google Earth
  - Google Earth does not understand W3DS (or WVS) syntax
    - ➔ no plugin, no content negotiation
  - In order to support GE, a root KML file must be created
  - NetworkLink elements are used for dynamic loading of 3D content from service
- Approaches:
  1. Additional Service Operation GetTileDefinition provides KML including all NetworkLinks using GetScene requests
  2. GetScene request generates KML including NetworkLinks pointing directly to resources
  3. A root KML is provided. Quadtree is generated recursively using GetScene requests.

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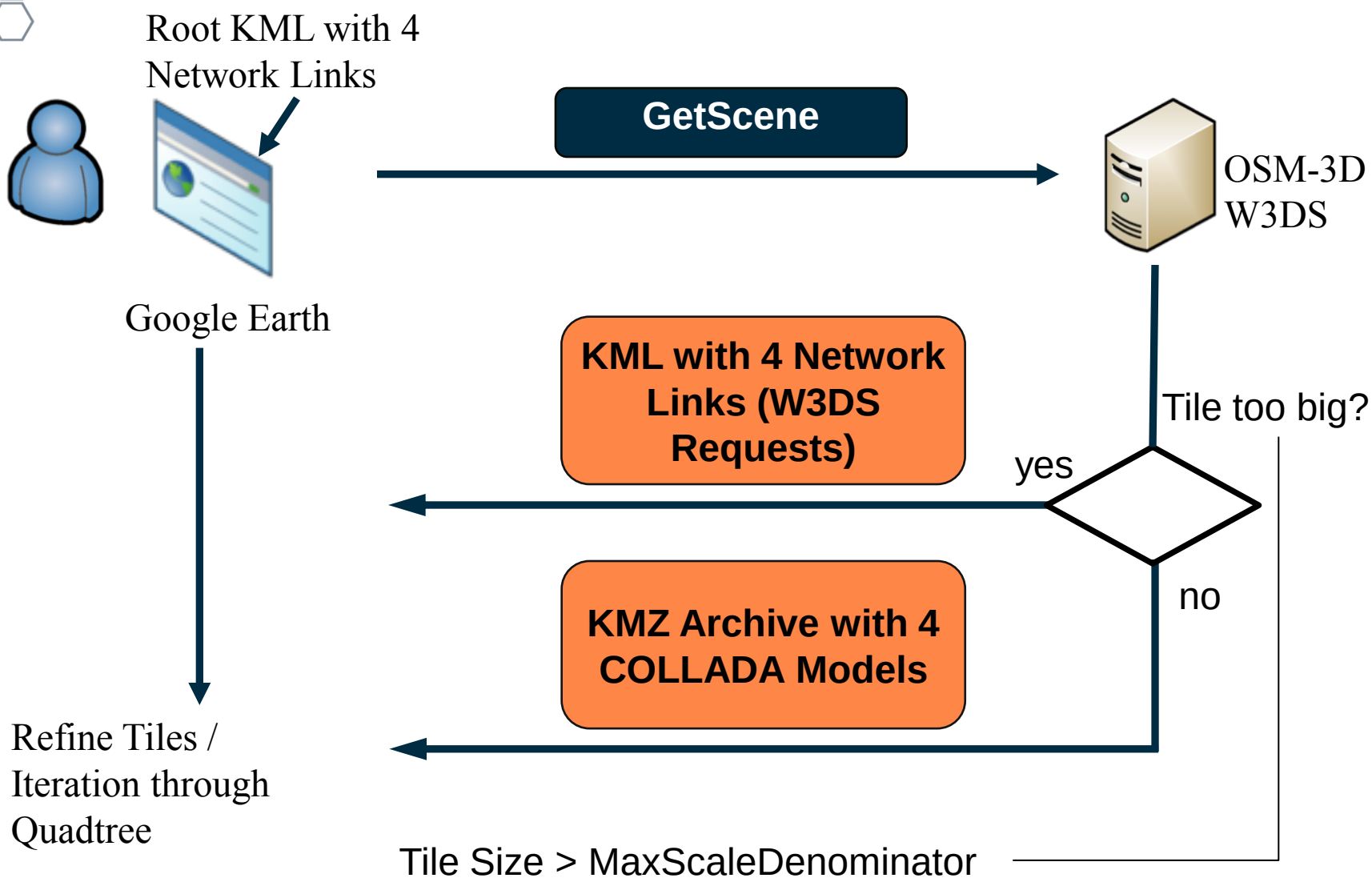
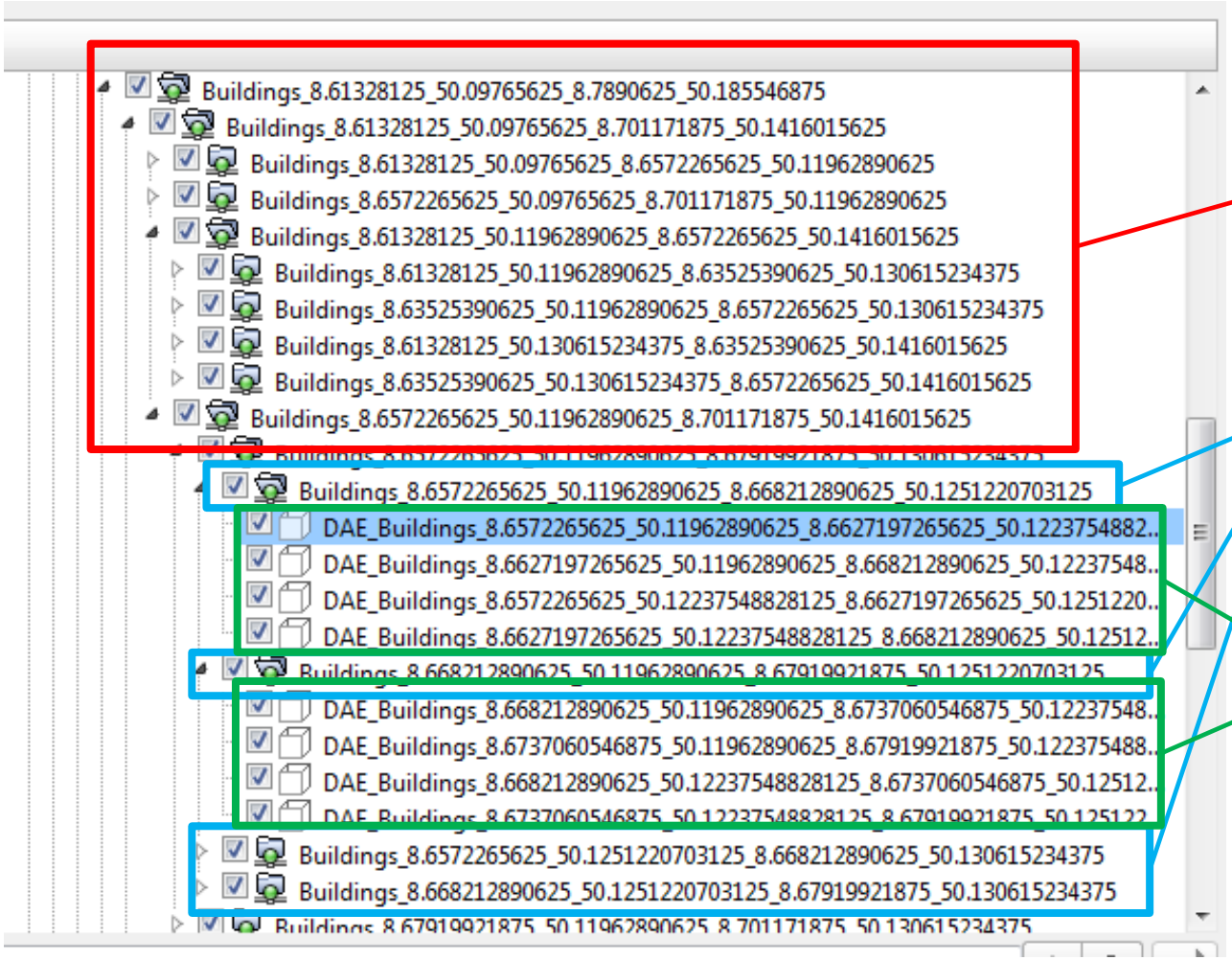
Root KML file provides Quadtree Structure



Root KML file provides Quadtree Structure

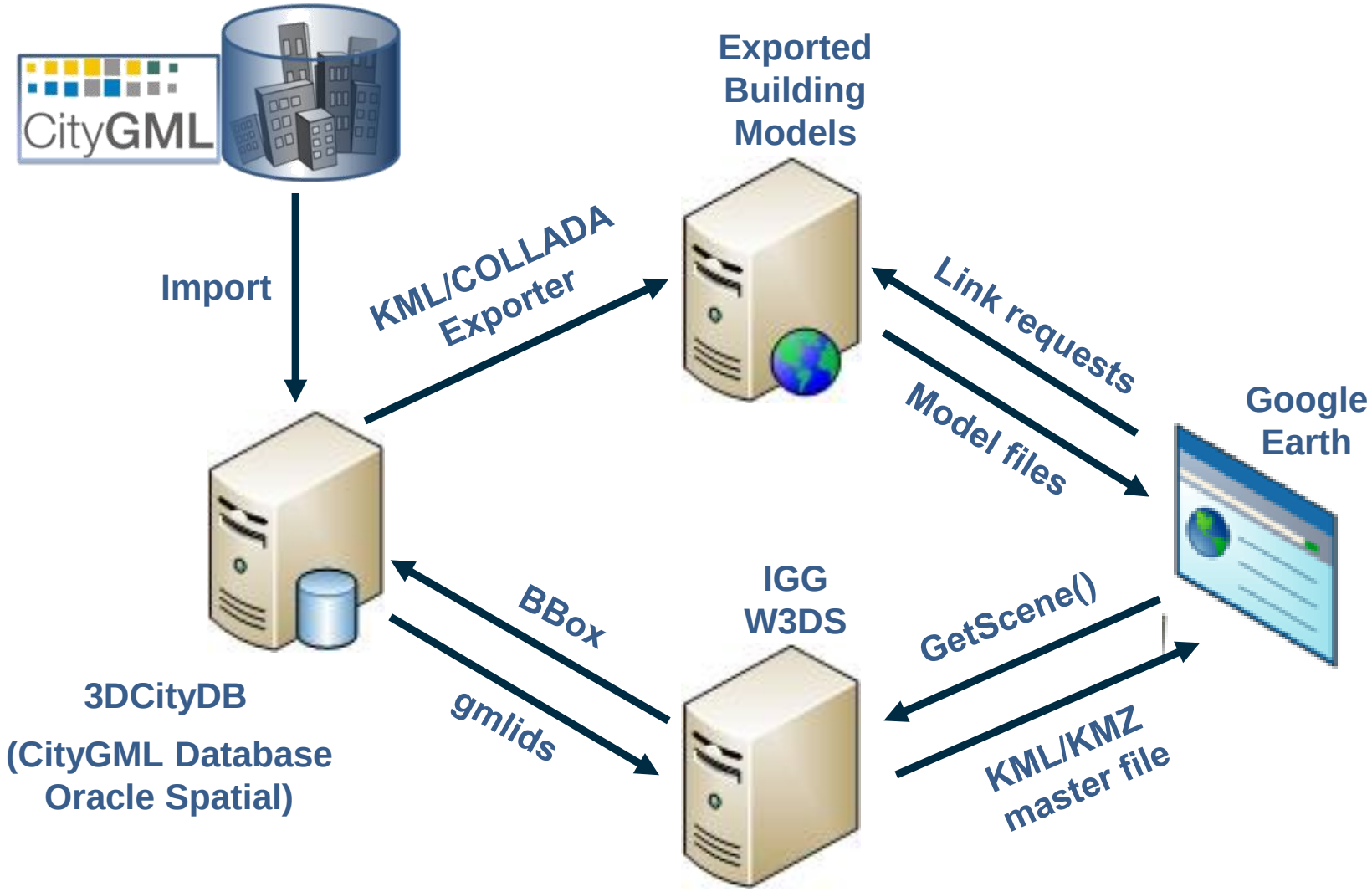


Pure KMZ/KML with NetworkLinks (KMZ/KML Requests)

KMZ Archive with NetworkLinks (COLLADA Requests)

Group of 4 COLLADA Models contained in KMZ Archive

W3DS based on 3D CityGML Database



Overall 3DPIE Results

- **Successful** test and demonstration of how to set up **3D portrayal pipelines based on open formats and services** for various client platforms and devices
- Identification of challenges and solutions, e.g., for **serving large 3D city models** or dealing with height references
- Identification of **potential changes** for the W3DS and WVS specification
- **3DPIE Report** to be made publicly available

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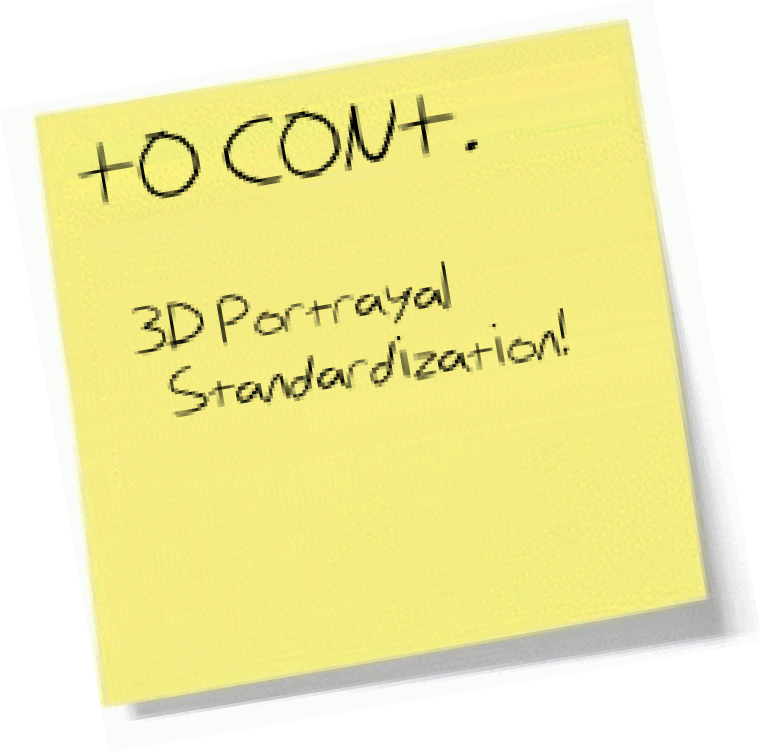
Next Steps for 3DPIE/3DIM



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Thank you for your attention!

Thank you for your Attention.

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benjamin.hagedorn@hpi.uni-potsdam.de

OGC 3D Information Management Working Group
http://www.opengeospatial.org/projects/groups/3dimwg

OGC 3D Portrayal Interoperability Experiment
http://www.opengeospatial.org/projects/initiatives/3dpie