Case Study about BIM on GIS platform development project with the standard model
- 2013.5.28

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   BIM on GIS R&D (1, 2) Project, KICT  
   BIM-based Railway System Planning Project, MLIT  
   VDC Support System Development Planning Project, KICT  
   World Best Software BIM Modeler and Check Development, Ministry of Knowledge Economy (2012)  
   BIM Division Head Manager, Hangil IT (2011)  
   Adjunct Professor, Chung-Ang University (2010)  
   Civil Project 3D - Civil Engineering Modeler Development and Management
CONTENTS

1. Overview
2. BIM on GIS with Standard
3. Lesson & Learn
Overview
To realize BIM on GIS technology for productivity of AEC industry, we should have some questions like these.

**Questions**

- What is the benefit from the fusion between BIM and GIS as the viewpoint of the public sector?
- What do we should do first?
- What is the barrier to realize it?
- How to develop it?

**Research and try to**

- find the useful use-cases
- define the technology and the organization including people etc
- survey the issues and define the considerations
- collaborate and research it with the institutes and the industries
### BIM on GIS project overview

- Developing BIM on GIS platform which has interoperability, application including various use cases, standard/policy platform. Resource 9 M $ for 5 years (2012 – 2016). KICT with Gaia3D, SeokYoung system etc

#### Commercialization and Standardization

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Application</td>
<td>Use-cases and scenario ex – O&amp;M</td>
<td>Develop it</td>
<td>Validate it</td>
<td>Improve it</td>
</tr>
<tr>
<td>SW Platform</td>
<td>Interoperability Support Platform Design between BIM and GIS</td>
<td>Develop it</td>
<td>Validate it using the pilot project</td>
<td>Improve it</td>
</tr>
<tr>
<td>Standard File</td>
<td>IFC4 analyze and Infra-BIM IFC design</td>
<td>Support Tool Development and Design</td>
<td>Infra-BIM IFC completion</td>
<td>Infra-BIM IFC Standardization</td>
</tr>
<tr>
<td>Policy system</td>
<td>IPDish design</td>
<td>IPDish development</td>
<td>IPDish validation</td>
<td>Collaboration System like IPD Suggestions for Public Sector</td>
</tr>
</tbody>
</table>
BIM on GIS project overview

1. Urban facility management (INFRA / EM)
2. Env. energy mngt (LID, Sewage)
3. Project management with B/C analyze
4. Ex - ONUMA or GERMANIUM3D

Application Operation System
Application support to realize each use-case (USECASE model and scenario support including facility management HW/SW, IFC VIEWER…)

OPEN API (SDK)

SW Platform / BIM GIS interoperability platform
(3D VIZ, QUERY ENGINE, ADP LOD, GEO SERVER, IFC–CITYGML CONVERTER, Web Service)
Ex - ONUMA or GERMANIUM3D

Policy PLATFORM / INFRA BIM information model standard
(Law / Delivery system–IPD, Estimation, drawing system. Standard information, Validation/RULE SET)

Standard IFC model

Actor
Public sector
VDC center (maybe)

Service
Application OS
SW Platform
Standard Platform

Information Exchange
Flow to realize usecase
BIM on GIS project overview

- **Use case**
  - BIM-based Urban facility mngt (INFRA / FM)
  - Navigation (Indoor – Outdoor)
  - Model validation & management ex> Core-net
  - Road / energy / env (LID, water utility)

- **UI with style**
  - (CityGML / IFC Viewer, Open API, Script Language)

- **Service OS**
  - External DBMS
  - Ex> Inventory = {ID, Name, Format, Value, Survey sheet, Performance Model}

- **UX**
  - Navigation service
  - Data model & logic
  - Submit / check service
  - Data model & logic

- **App OS base**
  - FM / USN service
  - Data model & logic

- **Service**
  - BIM/GIS Service Operation System Language (Service Module)

- **Interface / Protocol**
  - (Web-service, Lightweight BIM/GIS Format etc)

- **Standard Platform**
  - OPEN API (Web-Service, Query Language)

- **Public sector**
  - Guideline and Neutral Format with Infra-BIM Information Validation Support to the useful information from Private Sector

- **VDC center**
  - BIM GIS SERVER

**Notes**
- User Profile: Urban Facility Manager ...
- External DBMS: Inventory: {ID, Name, Format, Value, Survey sheet, Performance Model}
## BIM on GIS project overview

### Use Case

<table>
<thead>
<tr>
<th>User</th>
<th>Modeler</th>
<th>SW Platform</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Use Case Diagram

**Client**
- **Model database**
  - Solid Engine (CSG, OCC etc)
  - Rendering Engine (OSG etc)
  - Mesh / Geometry process

**Server**
- Model Viewer with style(layer etc) / metadata
- Model Propertylizer
- Model Service Executor

**Model File**
- Model File (Compression / binary format)
- Property File (XML, JSON, Binary etc)
- Query Language Script (Python, NoSQL etc)

**Query Interface with Open API**
- Service manager (Load/Unload, Execute query, Transaction etc)

**Model manager**
- Spatial Indexing / VMM
- LOD creator (Static / Dynamic)
- Light weight processing
- Session manager
- Data Resource manager

**Data Resource manager**

**Ontology rule Modeler**

**Geographic Information Modeler**

**Building Information Modeler**

**Converter & Mapper**
- CityGML
- IFC, Vendor Format(Automation) etc

**BIM GIS SERVER**
- (Geoserver, BIM server etc)

---

### Code Example

```python
def serviceA(Input, Output):
    query = queryModel(Input)
    calculate(query)
    return description(query)
```
BIM on GIS project overview

- Strategy to develop it

- BIM on GIS Platform
  - KICT

- Standard Format
  - OGC & building SMART

- Pilot Project
  - ICT in KICT

- BIM-based Railway System Planning Project
  - KRRI

- VDC Support System Development Planning Project
  - ICT in KICT

- ICT in KICT Pilot Project
BIM on GIS with Standard
BIM on GIS with Standard

Defining Use-cases for BIM on GIS First Pilot Project

GIS Use-cases

BIM Use-cases

Common Use-cases

BIM-GIS based FM in KICT
BIM on GIS with Standard Legacy FM System in KICT

Drawings
Papers
Excel
...

KICT
BIM on GIS with Standard

Scenario and consideration about the use-cases about BIM-GIS based FM

Part 4
Information Validation System

Part 3
Standard Format Use

Part 2
BIM UI FRAMEWORK

Part 1
DATA SOURCE

USER INTERFACE

SW Platform

BIM UI FRAMEWORK
BIM PLATFORM
BIM PLATFORM
(OPEN API, META DATA, STYLE ...)
BIM DATA SOURCE
Linkage Middleware
ID
BIM DB

DATA SOURCE CONNECTER

FM Server

EM Server

FM

EM

CM

OM

Explore BIM object

Urban Facility Detail

Perform ance

BIM-GIS Modeling & Upload

Civil3D plugin
Revit plugin
Inroad plugin
자체개발 모델러
Information Validation System

IFC LANDXML MODEL

FM Server

DB

EM Server

DB

PROTOCOL(QUERY LANGUAGE)

FM Server

DB

EM Server

DB

Scenario and consideration about the use-cases about BIM-GIS based FM

BIM-GIS Modeling & Upload

Civil3D plugin
Revit plugin
Inroad plugin
자체개발 모델러
Information Validation System

IFC LANDXML MODEL

FM Server

DB

EM Server

DB

PROTOCOL(QUERY LANGUAGE)
BIM on GIS with Standard

• Building smart technology - IFC

IFC

Building smart technology

IFD

IDM

ISO/PAS 16739

IFD(International Framework for Dictionaries, ISO 12006-3)

Process map
Exchange Requirement
Function part

Concept diagram
BIM on GIS with Standard

IFC2x3
Building Oriented Format

IFC4
GIS CRS
NURBS

but
Heavy Complex
ambiguous

3개 기본 확장 패키지
5개 AEC/FM 공통 패키지
AEC/FM 도메인별 9개의 패키지
26개의 리소스 패키지

IfcProject – Activity to make product
IfcProcess – Process and activity in project
IfcResource – Used resource object definition in process
IfcActor – Human resource definition in process
IfcProduct – Physical representation object
IfcControl – Control object
IfcGroup – Object set

Fig. IFC (http://www.iai-tech.org/)
BIM on GIS with Standard

• Developed by OGC
• Open 3D urban object model for interoperability (ISO TC211)
• Shape, material, feature information support
• Focusing city Infrastructure object model
• Model abstraction support (LOD)

CityGML
GIS Oriented Format
LOD Features
But Detailed Building Information
BIM on GIS with Standard

- Developed by Autodesk & US DOT EAS-E
- Integrated as LandGML (Geography Markup Language) in OGC (Open Geospatial Consortium, 1994)
- Civil engineering Industry Standard
- Engineering object (DTM, Alignment, Profile, X-section etc) model support
- Open API SDK and converter (ex - LandXML to SVG) support

DTM surface (Autodesk Civil 3D)  IHSDM (Interactive Highway Safety Design Model, FHWA)
BIM on GIS with Standard

**LandXML**

Civil Engineering Oriented Format

But

Detailed Building Information

GIS Topology Element

- Detailed object information related to civil engineering
  - ex - superelevation
## BIM on GIS with Standard

<table>
<thead>
<tr>
<th>Item</th>
<th>IFC</th>
<th>LandXML</th>
<th>CityGML</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use</td>
<td>Architecture</td>
<td>Engineering</td>
<td>3D urban object representation</td>
</tr>
<tr>
<td>Limitation</td>
<td>Architectural Object Model</td>
<td>No asset information</td>
<td>BIM &amp; engineering information shortage</td>
</tr>
<tr>
<td>Development</td>
<td>BuildingSmart</td>
<td>Autodesk</td>
<td>OGC</td>
</tr>
<tr>
<td>Characteristic</td>
<td>Detailed architectural element / material / parameter set</td>
<td>Civil engineering information representation</td>
<td>GIS object information representation as LOD</td>
</tr>
<tr>
<td>Support object</td>
<td>Product, Process, Organization object(ex - Wall, Door, Beam, Relationship etc.)</td>
<td>Digital Terrain model, Alignment, Profile, X-Section, superelevation etc.</td>
<td>CityModel, Abstract Building, Tin, Road, Surfaces(ex - Wall, Floor) etc.</td>
</tr>
<tr>
<td>Format</td>
<td>STEP, XML</td>
<td>XML</td>
<td>GML</td>
</tr>
</tbody>
</table>

### Issue based on file format specification
- Information usage viewpoint dependency
- Performance (ex - Heavy size)
- Commercial product compatibility
Unified BIM-GIS-Engineering Format?

Model Fusion
= \{\text{Geometry, Service, Topology, Property}\}

Unified BIM-GIS Format is

Heavy
Complex
Ambiguous in perspective

Extension with metadata = \{\text{GUID, Model Reference, Coordination system, Style, etc}\}
BIM on GIS with Standard

- Perspective Definition (LOS) Needs with LOD about use-cases

Standard Format (IFC, KMZ, CityGML), Lightweight Format, Data from heterogeneous System using ETL
BIM on GIS with Standard

- Information Exchange
  Methodology to realize UC

DIAGRAM:

- Owner
- Manager
- BIM on GIS Platform
  - BIM Ex - IFC
  - Meta-Data
  - Light-weight Format
  - Geo-Data
  - ETL
  - Heterogeneous System

- Ex - IFC
- Light-weight Format
- Geo-Data
- ETL
- Heterogeneous System
BIM on GIS with Standard

- Designing the use-cases
## BIM on GIS with Standard Use-cases

### Description about the use-cases

<table>
<thead>
<tr>
<th>Use-cases</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Login server</strong></td>
<td>1. Login server with the account which has the perspective meta data</td>
</tr>
<tr>
<td></td>
<td>2. Perspective Decision</td>
</tr>
<tr>
<td></td>
<td>3. Load GIS and BIM objects (converted format with performance consideration)</td>
</tr>
<tr>
<td><strong>Render BIM and GIS object</strong></td>
<td>Rendering the objects on the client program</td>
</tr>
<tr>
<td><strong>Query information related to object</strong></td>
<td>Obtain the properties by using Open API and Query Language</td>
</tr>
<tr>
<td><strong>Execution application</strong></td>
<td>Such as FM, EM, OM plugin application module etc</td>
</tr>
<tr>
<td><strong>Logout server</strong></td>
<td>Logout server</td>
</tr>
</tbody>
</table>
BIM on GIS with Standard

- We don’t need to consider the modeling with parametric the viewpoint of O&M use-cases
- Remove the heavy information from the IFC
- Extract the O&M property and the shape from the IFC
- Transform IFC to Lightweight File Format
## BIM on GIS with Standard

### Comparison between IFC and Lightweight File Format

<table>
<thead>
<tr>
<th>Format and Performance</th>
<th>Sample #1</th>
<th>Sample #2</th>
<th>Sample #3</th>
</tr>
</thead>
<tbody>
<tr>
<td>IFC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Data Volume (MB)</td>
<td>67</td>
<td>26</td>
<td>12</td>
</tr>
<tr>
<td>Loading Time (Second)</td>
<td>22.05</td>
<td>217.22</td>
<td>5.99</td>
</tr>
<tr>
<td>Memory (MB)</td>
<td>499</td>
<td>1,029</td>
<td>156</td>
</tr>
<tr>
<td>LBSF</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Data Volume (MB)</td>
<td>32</td>
<td>213</td>
<td>11</td>
</tr>
<tr>
<td>Loading Time (Second)</td>
<td>1.28</td>
<td>8.69</td>
<td>0.44</td>
</tr>
<tr>
<td>Memory (MB)</td>
<td>177</td>
<td>890</td>
<td>75</td>
</tr>
<tr>
<td>LBSF with the external surface</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Data Volume (MB)</td>
<td>7</td>
<td>66</td>
<td>4</td>
</tr>
<tr>
<td>Loading Time (Second)</td>
<td>0.30</td>
<td>2.59</td>
<td>0.20</td>
</tr>
<tr>
<td>Memory (MB)</td>
<td>56</td>
<td>286</td>
<td>43</td>
</tr>
</tbody>
</table>

- IFC: 25 times faster
- LBSF: 3.5 times faster
BIM on GIS with Standard

- Considering Data or Property from Heterogeneous system using ETL

Heterogeneous systems such as CMMS, OM, EM - don’t support the Standard File
BIM on GIS with Standard
BIM on GIS with Standard

- Component Architecture with the considerations
BIM on GIS with Standard

- Component Architecture with the considerations

<table>
<thead>
<tr>
<th>Stereo type</th>
<th>Component</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viewer</td>
<td>BIM Explorer</td>
<td>BIM object shape and properties rendering</td>
</tr>
<tr>
<td>Client</td>
<td>WWJ</td>
<td>Geographic Information Rendering</td>
</tr>
<tr>
<td>BIM-GIS Platform</td>
<td>BIM-GIS Platform</td>
<td>Handling the sub modules with Open API and Query Language</td>
</tr>
<tr>
<td>ETL</td>
<td>Talend</td>
<td>ETL with Open source Talend</td>
</tr>
<tr>
<td>GIS Server</td>
<td>GeoServer</td>
<td>GIS information service to client</td>
</tr>
<tr>
<td>BIM Server</td>
<td>BIM server</td>
<td>BIM object information service to client</td>
</tr>
<tr>
<td>Heterogeneous System</td>
<td>DBMS</td>
<td>External system to realize UC</td>
</tr>
</tbody>
</table>
BIM on GIS with Standard

- Screen shot from the pilot project results
BIM on GIS with Standard

- Other Topic – seamless BIM-GIS information rendering and exchange
Lesson & Learn
Lesson & Learn

• To obtain the user satisfaction, the pilot system using the standard file format MUST ensure
  • the scenarios about the use-cases to realize the business value
    ex – interview with the owner or the user
  • the data process performance (they disliked the low speed)
    ex – lightweight format using the LOD, the compression strategy like JT format
  • the data exchange between the heterogeneous system (they disliked the missing data or the low information compatible between the commercial system)
    ex – ETL
Lesson & Learn

UseCase #1 Application  UseCase #2 Application  UseCase #3 Application

Application Operating System

Software Platform

Hardware Platform

VDC Center

Official

Maturity Model  Validation System  Motivation Policy  Code System  Library  Education System  Project Delivery System

National Standard Policy Platform
Lesson & Learn

- Functions of VDC

- 해외 건설 경쟁력 강화 목표에 부합하는 VDC 로드맵 및 실행체계

- BIM on GIS 성숙도 수준 평가 체계 (예) BIM Maturity Model (미, CIFE)
- 생산성 성과 지표 마련

- 한국형 통합 발주 체계 (예) IPD(Integrated Project Delivery).

- Performance Measurement

- Project Delivery System

- Education System

- Validation System

- Service Compensation System

- Roadmap

VDC POLICY PLATFORM

• 프로젝트 결과물 납품 / 검증 / 관리 체계 마련
• 납품 결과물 검증
Thanks for your interest

2013.5.28. Tae Wook, Kang (www.facebook.com/ touruta999)
Ecosystem for AEC industry

Value Engineering based on Ecology
(Dr. Jae Yun, Woo)
National R&D – World Best Software KBIM

- Researching and developing BIM modeler including Architectural and MEP and checker which is similar to Solibri

- Resource: X.0 M $ for X years (201X – 201X)

- Consortium: Virtual Builders, Hangil IT, Intelli Korea, KICT, Yonsei university, Hanmi Pasons, RP architect etc
National R&D - World Best Software KBIM

IFC Object Model
Revit Object Model
Archicad Object Model
Solibri Object Model + Civil engineering object model consideration

Developed by Virtual Builders, Hangil IT, Intelli Korea,
National R&D - Virtual Construction

- Developing virtual construction platform such as CPLM (Construction Project Lifecycle Management), IFC server (ORDB), quantity estimator, temporary work modeler (ABIM Temp), education program, consulting program related to BIM, BIM execution guideline etc
- Resource: XXX.0 M $ for 5 years (2006 – 2011)
- Consortium: Dual tech, Hangil IT, GeoNT, SungkyunKwan University, Hanyang University, Yonsei University etc

<table>
<thead>
<tr>
<th>Year</th>
<th>1 year</th>
<th>2 year</th>
<th>3 year</th>
<th>4 year</th>
<th>5 year</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>1 year</td>
<td>2 year</td>
<td>3 year</td>
<td>4 year</td>
<td>5 year</td>
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<tr>
<td>2007</td>
<td>2008</td>
<td>2009</td>
<td>2010</td>
<td>2011</td>
<td></td>
</tr>
</tbody>
</table>

### Research
- Organizing research group
- Developing prototype system
- Pilot test execution
- System development
- Test bed execution

### P.R.
- Introduce and educate BIM concept

### Industry
- Policy development
- Oversee project contract

---

- **Rivers BIM project**
- **BIM Forum**
- **Civil Expo 2008**
- **Assembly Public hearing**
- **Civil Expo 2009**
- **Civil Expo 2010**
- **Land and Marine expo**
- **Korea Arch Society MOU**
- **BIM Camp 2009**
- **Korea BIM Society MOU**
- **2010 BIM Camp**
- **BIM Forum 2011**
- **Tech Forum 2011**
- **ARCH expo KAFF 2011**

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- **CAU BIM education MOU**
- **BIM Camp 2009**
- **Korea Arch Society MOU**
- **2010 BIM Camp**
- **Korea BIM Society MOU**
- **2011 BIM Society Academy conference**
- **Assembly Public hearing**
- **Civil Expo 2008**
- **Civil Expo 2009**
- **Civil Expo 2010**
- **Land and Marine expo**
- **Korea Arch Society MOU**
- **BIM Camp 2009**
- **Korea BIM Society MOU**
- **2010 BIM Camp**
- **BIM Forum 2011**
- **Tech Forum 2011**
- **ARCH expo KAFF 2011**
National R&D - Virtual Construction

-BIM education and publication for industry and government
National R&D - Virtual Construction

- First BIM project execution in Korea – Youngin Stadium (developed by Daerim GC, RP architect) and military building project (Hanyang university)

- Dong dae mun design plaza park BIM consulting (Yonsei university)
National R&D - Virtual Construction

- Software: Estimation system (BE-Estimator), 4D simulator, CPLM (Collaboration system), IFC server, Civil engineering drawing generation program, BIM guideline e-book
Setting the sequence

### Phase

<table>
<thead>
<tr>
<th>Phase</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schematic activity analysis</td>
<td>Review schedule and activity sequence through simulation per each month</td>
</tr>
<tr>
<td>Concept design simulation</td>
<td>Review landscape by using 3D simulation of bridge structure</td>
</tr>
<tr>
<td>Structure installation plan</td>
<td>Supporting the optimized installation plan</td>
</tr>
<tr>
<td>Structure type validation</td>
<td>Analysis and selection of slab, pier etc by generating 3D model of structure library</td>
</tr>
</tbody>
</table>

**Milestone Schedule**

- **After 6 Months**
- **After 12 Months**
- **After 18 Months**
- **After 24 Months**
Korea BIM Society

- Korea BIM Society Foundation at 11.24. 2010

Founder - 김재준, 최철호, 이광명, 신태송, 강인석, 김길채, 심창수, 윤석현, 전한종, 조영상, 진상윤, 김용한, 지상복, 황규환 etc

창립총회 (2010. 11. 24)  2011년 정기학술발표대회