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FORTUGAL

BIM-based Data Mining System Framework to support an Effectiveness Decision-making for Energy Usage Management of Building Space

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Ph.D, Hyun sang, choi. Research fellow, KICT

Interests – BIM, GIS, Vision, Interoperability

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KICT – Korea Institute of Construction Technology

Introduce

Name - Tae Wook, Kang

Ph.D, Senior Research, ICT Lab, Korea Institute of Construction Institute (Current)

https://sites.google.com/site/bimprinciple/

Specialty – Civil Engineering, Software Engineering

Experiences

- Writing book
  - IFMA, BIM for FACILITY MANAGERS, Translator (2014.5)
  - Architectural collaborative design, Author (2014.2)
  - Civil BIM, Author (2013.11)
  - BIM interoperability and platform, Author (2013.1)
  - BIM principle, Author (2011.6)

- Research
  - BIM on GIS (Part 1 and 2) Research, KICT (Current)
  - Point cloud-based architectural MEP object reverse engineering research, KICT(Current)
  - BIM-based railway system planning project, MLIT (2013)
  - VDC support system development planning Project, KICT (2013)
  - World best software BIM modeler and check development, Ministry of Knowledge Economy (2012)

- Career
  - BIM division head manager, Hangil IT (2011)
  - Adjunct Professor, Chung-Ang University (2010)

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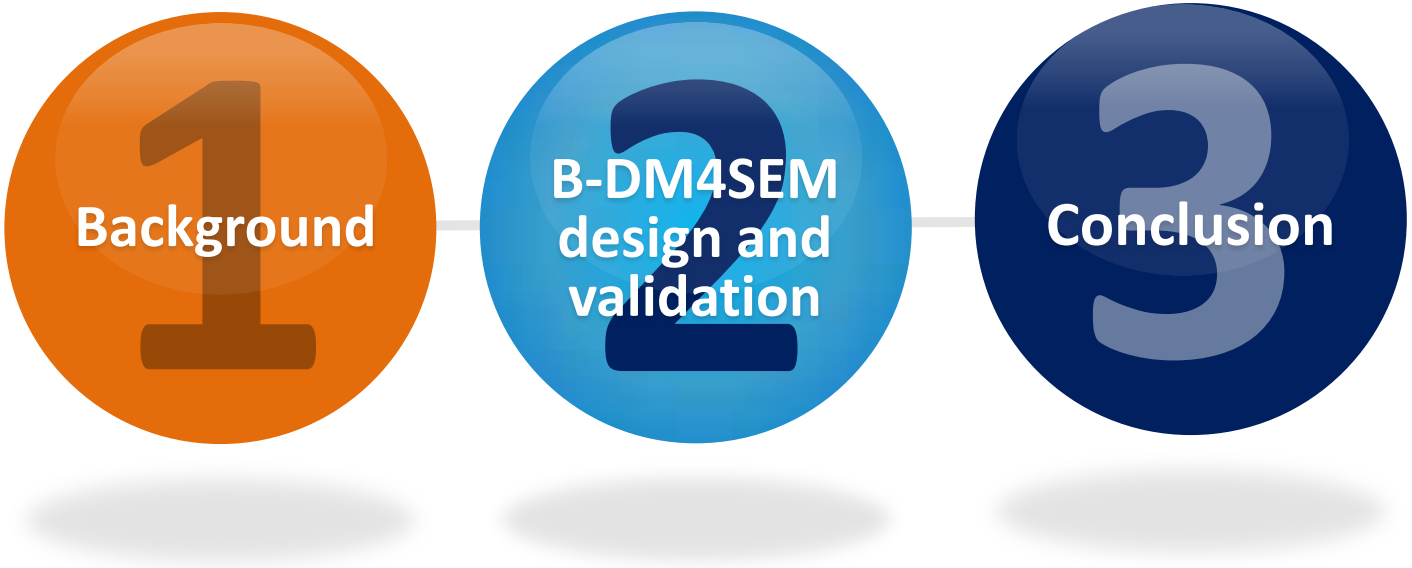
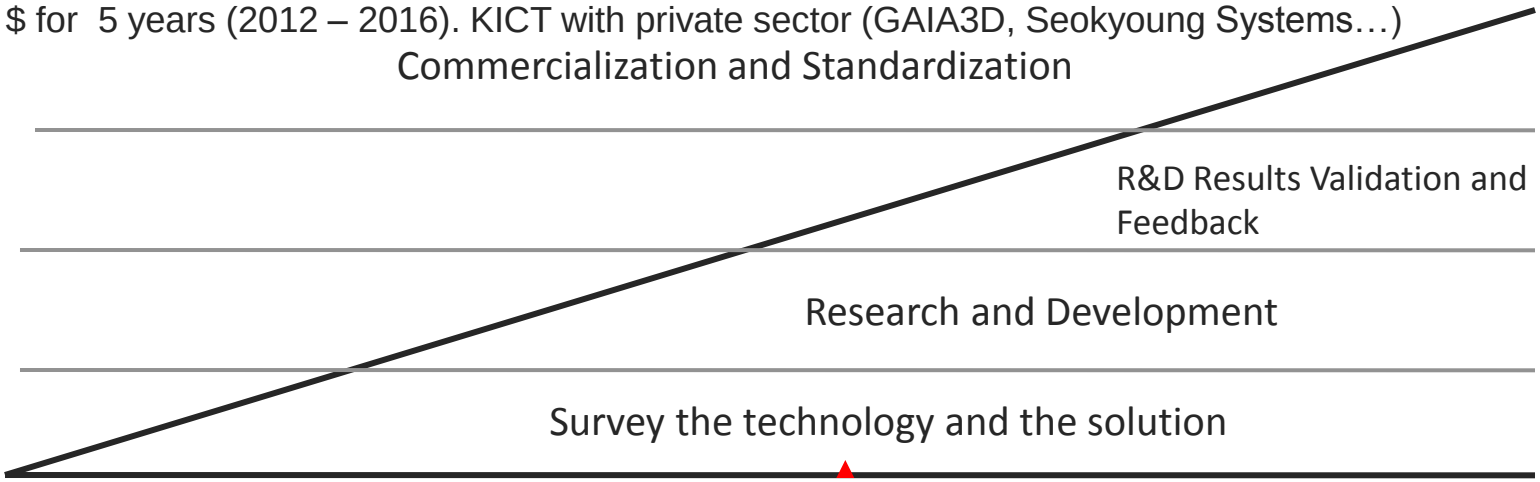


Background

Background - BIM on GIS project overview

-This study is the part of BIM on GIS platform development project

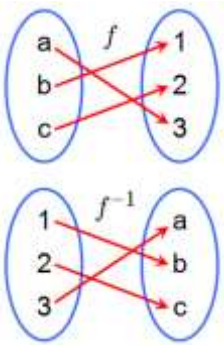
-Developing BIM on GIS platform which has interoperability, application including various use-cases, standard/policy platform. Fund 8 M $ for 5 years (2012 – 2016). KICT with private sector (GAIA3D, Seokyoung Systems…)

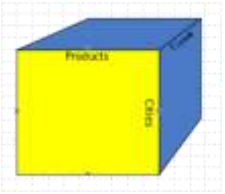


Part	2013	2014	2015	2016
Application	Use-cases and scenario ex – O&M	Develop it ex – FM, BEMS …	Validate it	Improve it
SW Platform	Interoperability Support Platform Design between BIM and GIS	Develop it Open API. Linkage. Mapping Rule	Validate it using the pilot project	Improve it
Standard Model	IFC4 analyze and Infra-BIM IFC design	Infra IFC draft version, Converting Tool	Infra-BIM IFC completion	Infra-BIM IFC Standardization
Policy system	IPDish design	IPD guideline development	IPDish validation	Collaboration System like IPD Suggestions for Public Sector

Background - BIM on GIS issue survey results

GIS-BIM Object Visualization	GIS-BIM Data Integration	GIS-BIM Data Mining	Context-based Application
•GIS-BIM visualization •IFC Parsing / Converter •LandXML Converter •CityGML mapping •LOD generator •Spatial Indexing	•Query Language •BPD / ETL •Mapping Ruleset •LOD Mapping •Coordination Mapping •Topology Linkage •CityGML-BIM Extension •Sensor / Actuator Node Management •Data View Definition •Open API with Security	•Data Quality Validation •Data Mining •Data Analysis (ex – Trend, Decision Tree, Classification etc) •GIS-BIM Data Cube (OLAP. Online analytical processing)	•Model View Definition for Application - MBP Layers (Model + Business Logic + Presentation Layer) •Context-based App •Semantic Query and Analysis

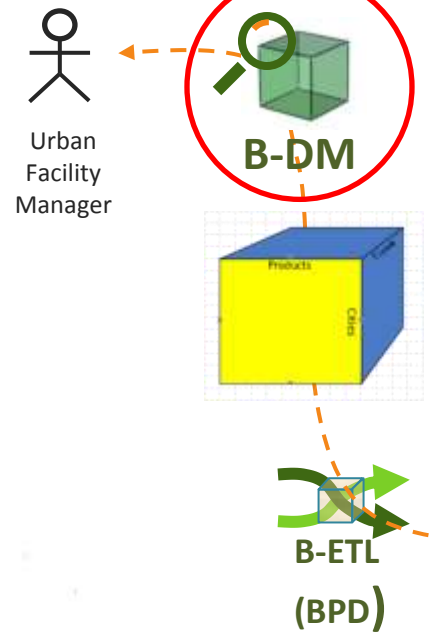




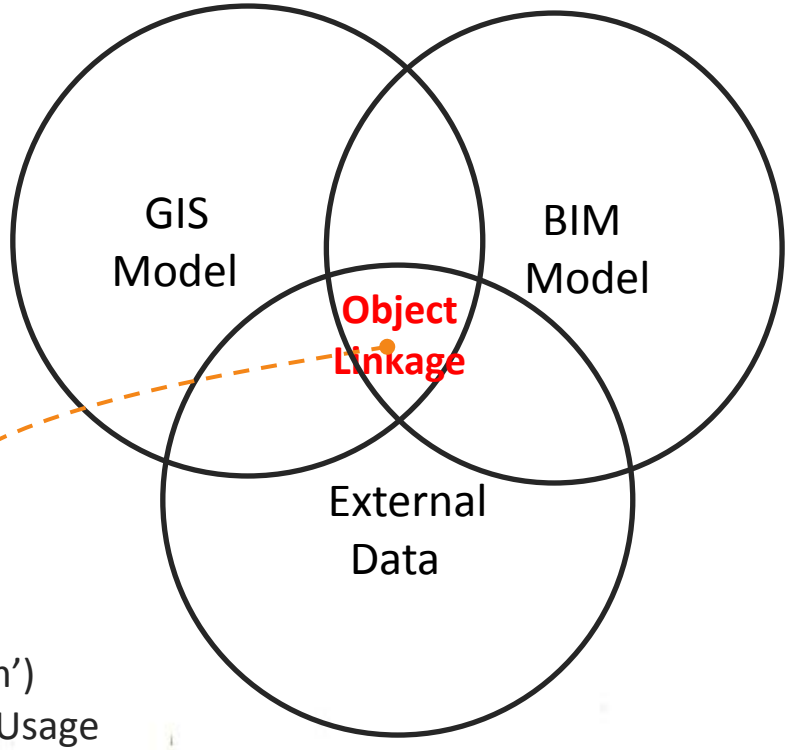
Objective

BIM-based Data Mining system framework for supporting building **Space Energy Management (B-DM4SEM).** The proposed **framework** considers functional variability and extensibility.

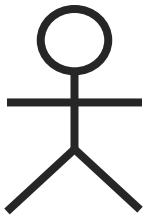
Which spaces and users of those spaces exceed the specific reference amount of annual energy usage ?



SELECT SpaceObject(*) FROM Alignment, Building WHERE Buffer(Alignment, Building, '1km') AND Building.Pset('EM').EnergyUsage < '500 kWh'

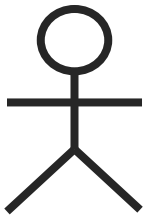


Objective



Which spaces of those spaces exceed the specific amount of annual energy usage ?

Energy manager



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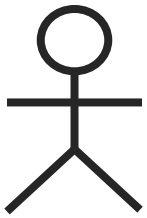
Facility manager



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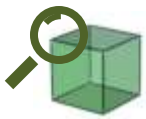
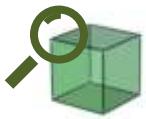
B-DM 4SEM



B-DM 4SFM



B-DM 4AM

...

Plugins

B-DM concept framework

Data transform, binding, integrity validation, service extensibility

BIM data

IFC, Revit ...

Energy usage data

Excel, Xml ...

Sensor data

Xml, Text ...

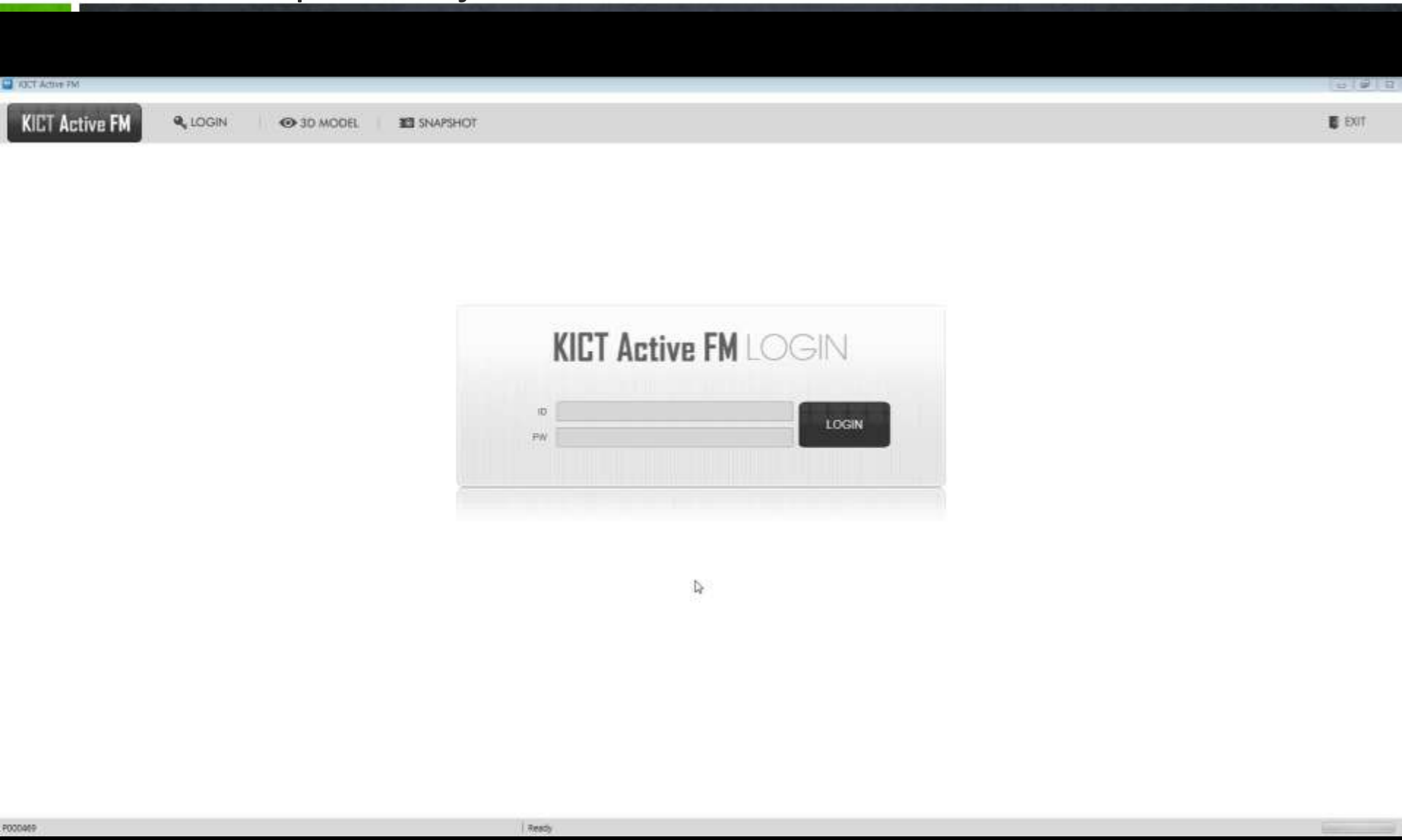
Motivation – How to obtain the needed data from BIM on GIS

In previous study related to BIM on GIS platform development (part 2), the difficulty in finding and identifying the needed information depending on the context related to specific use-case w ere founded.

The needed data depending on the use-case should be extracted from BIM database by using da ta mining to support the decision making.

KICT & GAIA3D

Motivation – How to extract the information from energy data related to spatial object



KICT & Suk young systems

BIM-based Data Mining System and prototype

Identification of framework structure

Before developing BIM-based DM, to identify considerations for ensuring the support functions such as data transform, binding, integrity, extensibility is needed.

Data / Service perspective

Data

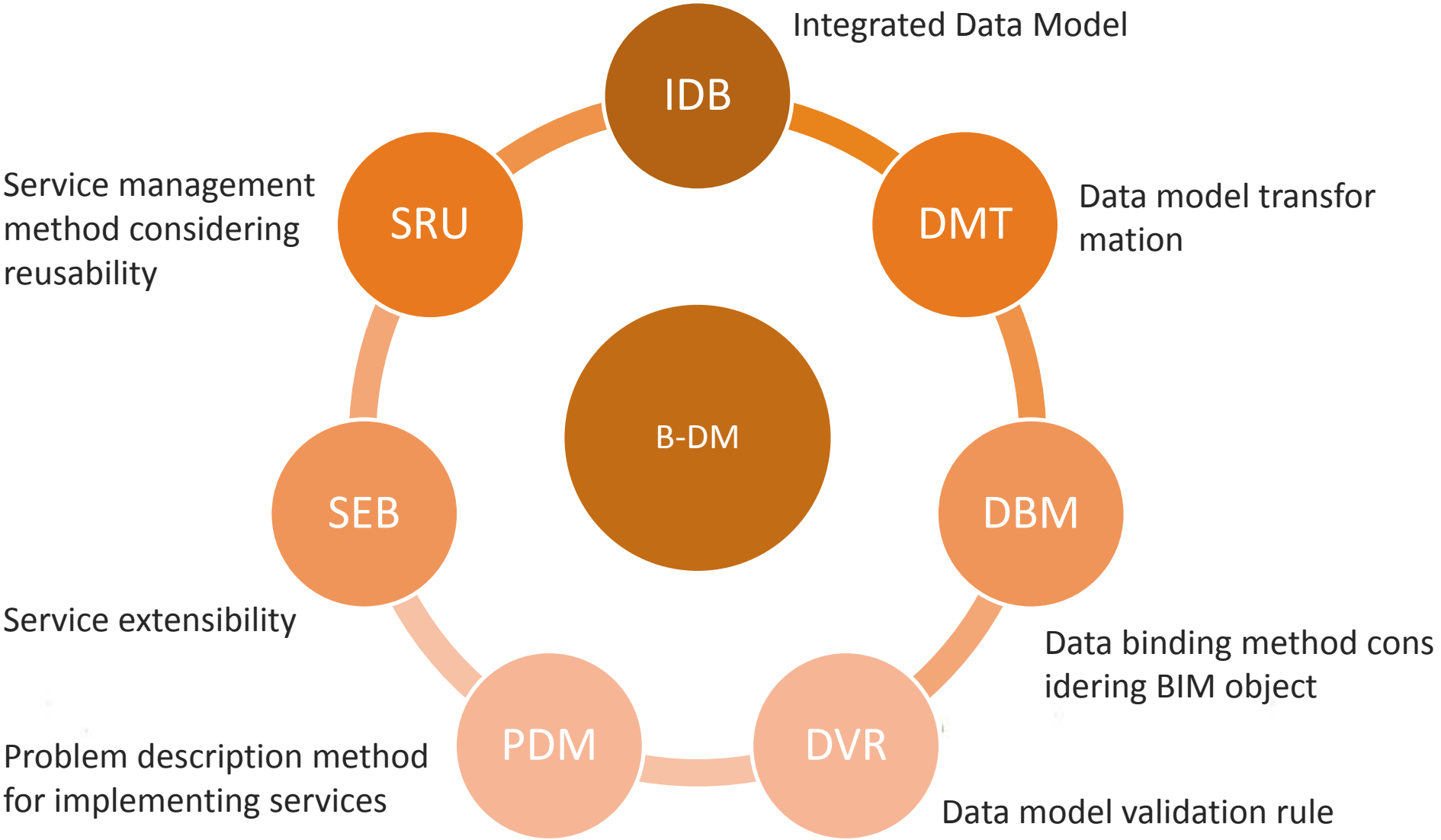
Flexible and simple forms of Integrated Data Model (IDB)
Data model transformation (DMT)
Data model validation rule (DVR)
Data binding method considering BIM object (DBM)

Service

Service extensibility (SEB)
Service management method considering reusability (SRU)
Problem description method for implementing services (PDM)

Identification of the framework structure

The B-DM framework structure is identified based on the considerations



Identification of the framework structure

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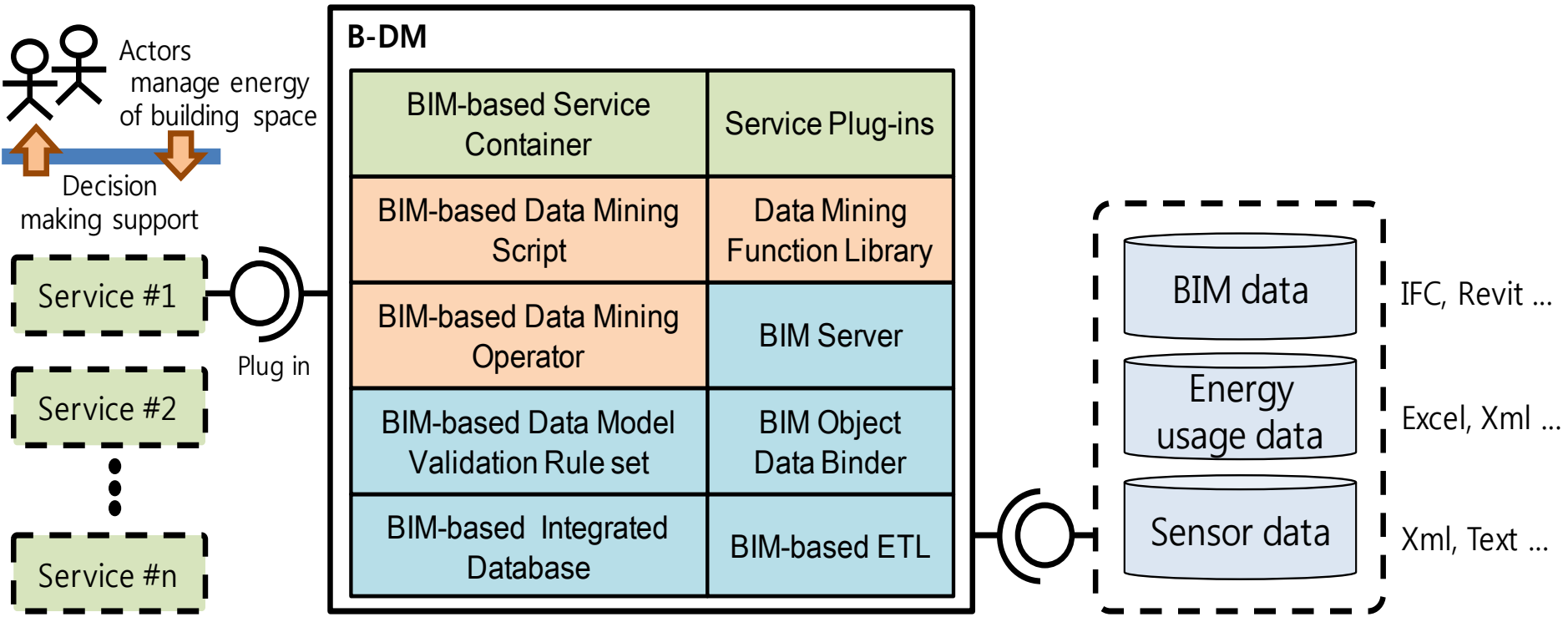
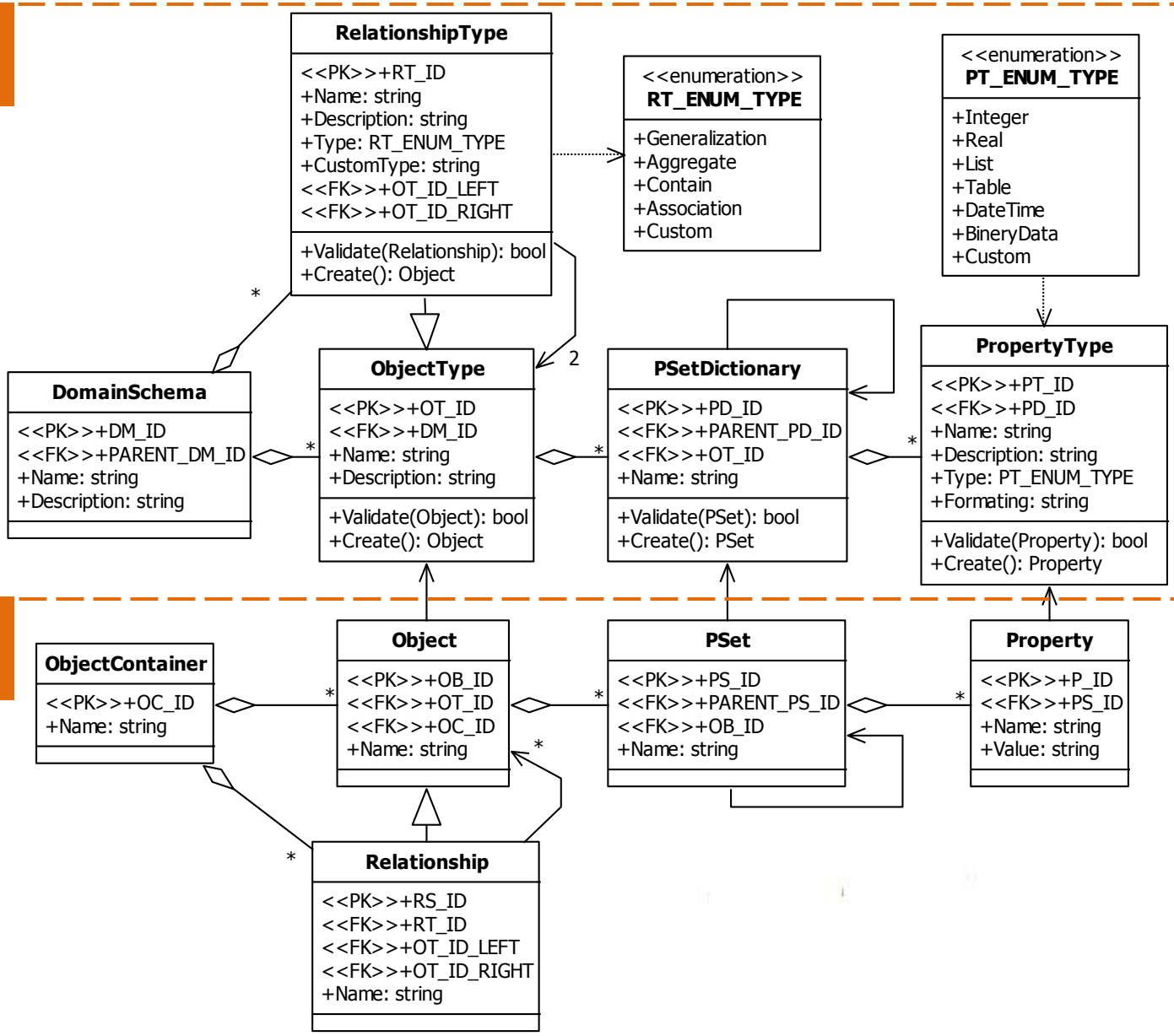


Block diagram of B-DM4SEM framework

Integrated Data Model (IDM) for B-DM

IDM Schema model

IDM object model



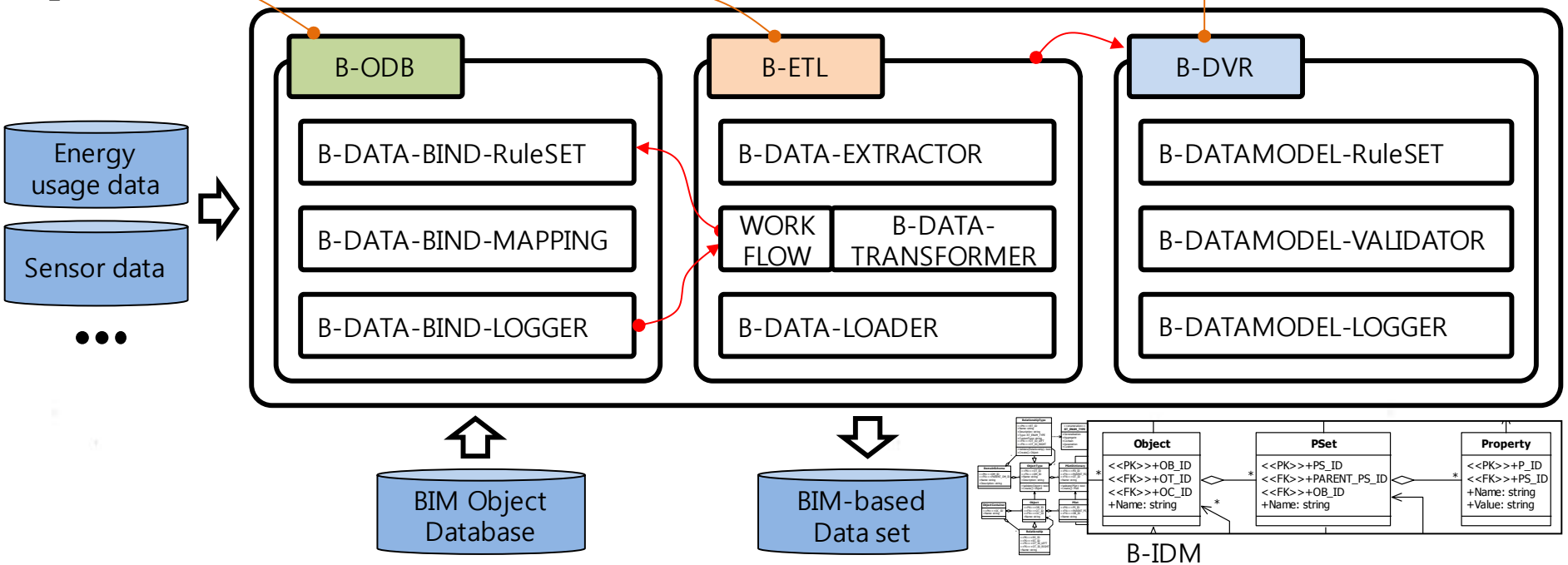
Process definition concept of B-DM

In example, ODB, ETL and DVR can be defined as rule set.

```
<B_ODB>
 <Rule name='Space object binding'>
  <Object name='Space' PK='GUID'>
   <Dataset name='E#1.Space' PK='GUID'
    Pset='Identity' />
  </Object>
 </Rule>
</B_ODB>
```

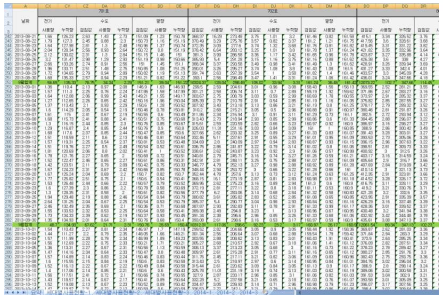
```
<B_ETL>
 <Module>
  <Element type='extract' name='E#1 Dataset' datasource='...'/>
  <Element type='transform' name='T#1' program='...'/>
  <Element type='load' name='L#1' datasource='...'/>
 </Module>
 <Workflow name='Space Energy Usage ETL'>
  <Step name='S#1' input='E#1, E#2, E#3...'
   execute='T#1' output='L#1'/>
  <Step name='Validate data model'
   execute='B_DVR.B_IDM schema Rule' />
 </Workflow>
</B_ETL>
```

```
<B_DVR>
 <Rule name='B_IDM schema Rule'
  method='schema' option='all'/>
 </Rule>
 <Rule name='GUID check Rule'
  method='sql'>
  WHERE Object.Pset.Property.GUID
        IS NOT NULL
 </Rule>
</B_DVR>
```



Operational concepts and correlations of DMT, DBM, and DVR in B-DM4SEM

Process definition concept of B-DM



The heterogeneous EM data from the external legacy system

B-ETL
B-ODB

Extraction & Binding

Facility
Story
Classification Code
Object name
Object GUID
Manager
Space No
Manager
Space No
Space area
Date
Space area
Space perimeter
Space volume
Space height
Floor maintenance =
{Floor finish, Partial repair, Repair rate, Date}
Wall maintenance =
{Wall finish, Partial repair, Repair rate, Date}
Ceiling maintenance =
{Ceiling finish, Partial repair, Repair rate, Date}

B-ETL
Filtering

Facility
Story
Classification Code
Object name
Floor maintenance =
{Floor finish, Partial repair, Repair rate, Date}
Wall maintenance =
{Wall finish, Partial repair, Repair rate, Date}
Ceiling maintenance =
{Ceiling finish, Partial repair, Repair rate, Date}

B-ETL
Styling

Facility = B199
Storey = S05
Code = B199.S05
Name = Main research building
Floor finish history =
At 2005.3.2, Tile#024 replacement, 0.5 year
At 2006.7.5, Tile#024 replacement, 0.5 year
At 2006.10.9, Tile#099 replacement, 0.5 year
At 2007.12.5, Tile#099 replacement, 0.5 year

Query the perspective data

Facility = B199
Storey = S05
Code = B199.S05
Name = Main research building

View and Use the data

Subcontractor Perspective

KICT

Definition of operators for B-DM

The operator definition is divided into CRUDE in consideration of MECE conceptually. Here, CRU DE and the "*" mark have the following definitions.

C, create; R, read query; U, update query; D, delete; E, execute; and *, plural indicator of an object

Operator	Namespace	Operator-Supported Object
CRUDE	B-ODB-OP	Data Binding Rule (BRU), Data Binding Logger (BLG)
	B-DVR-OP	Data Model Validation Rule (MRU), Data Model Validator (MVA), Data Model Validation Logger (MVL)
	B-DM-OP	Classification Model (DMCF), Prediction Model (DMPD), Clustering Model (DMCL), Association Model (DMAS)
	B-ETL-OP	Data Extractor (TDE), Data Transformer (TDT), Data Loader (TDL)
CRUD	B-DMS- OP	DomainSchema (BDS), ObjectType (BOT), RelationshipType (BRT), PSetDictionary (BPD), PropertyType (BPT), ObjectContainer (BOC), Object (BOJ), Relationship (BRS), PSet (BPS), Property (BPR)

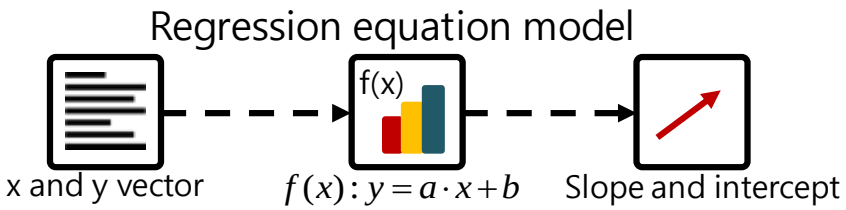
Case study

Use cases for the defined building-space energy management applied in this study are as follows.

1. Which spaces exceed the annual energy usage criteria (EUC)?

2. When was the first time this annual EUC was exceeded, and what is the space and the annual energy consumption trend?

The EUC value for use case 1 was 1,000 kWh, and that for use case 2 was 5,000 kWh.

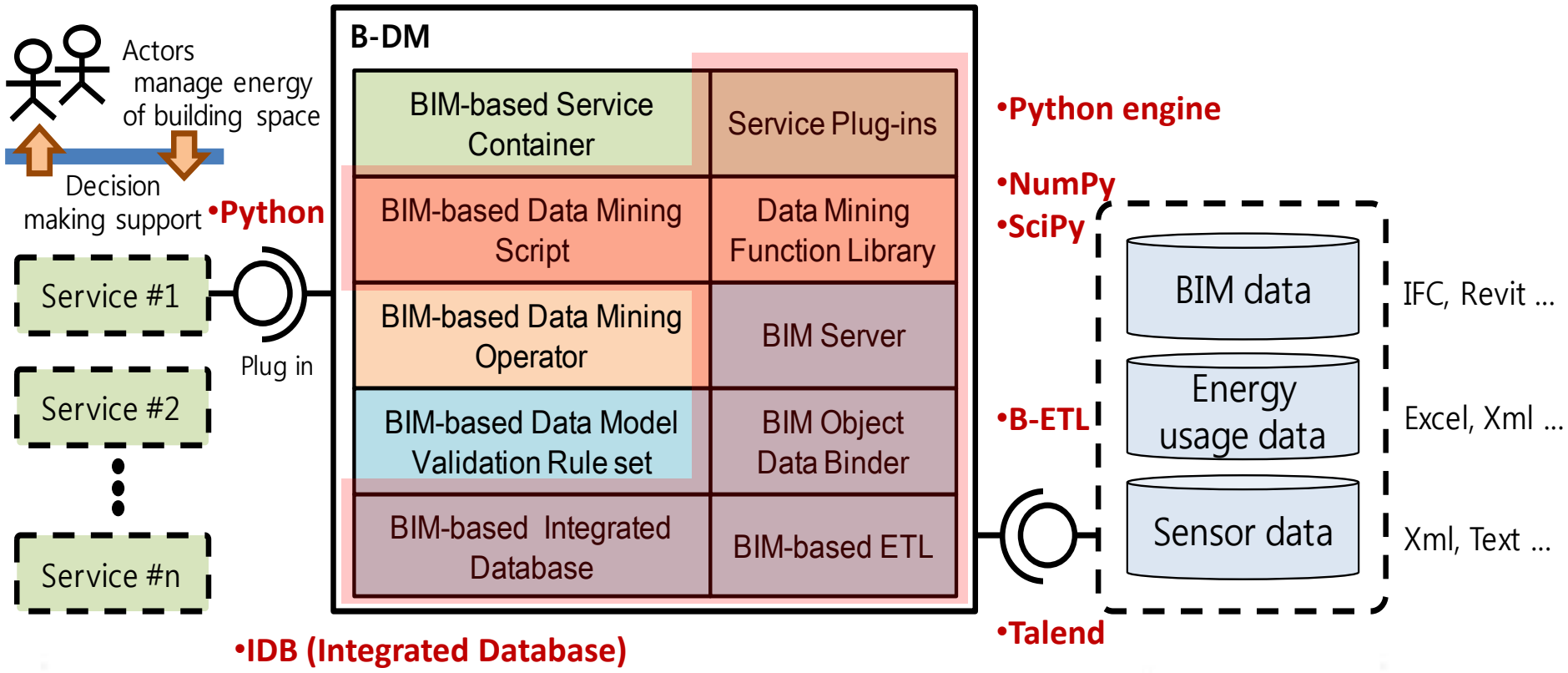


Case study – test data set

KICT energy usage data set from 2013 to 2014 year which has 32850 records about 45 spaces

	A	CX	CY	CZ	DA	DB	DC	DD	DE	DF	DG	DH	DI	DJ	DK	DL	DM	DN	DO	DP	DQ	DR
1		701호								702호												
2	날짜	전기		수도			열량			전기			수도			열량			전기			
3		사용량	누적량	검침값	사용량	누적량	검침값	사용량	누적량	검침값	사용량	누적량	검침값	사용량	누적량	검침값	사용량	누적량	검침값	사용량	누적량	검침값
242	2013-08-21	1.66	126.23	2.63	1.43	2.73	151.09	1.23	150.78	368.37	16.28	273.48	3.75	1.01	3.2	161.46	0.82	161.58	415.1	3.34	326.52	3.76
243	2013-08-22	1.79	127.3	2.45	0.88	2.3	150.73	1.16	151.19	370.49	3.29	275.76	3.57	0.82	3.37	161.2	1.21	161.75	417.56	3.6	328.61	3.68
244	2013-08-23	1.64	127.98	2.81	1.3	2.48	150.96	1.37	150.74	372.35	3.09	277.6	3.74	1.32	3.68	161.76	0.81	161.82	419.45	3.31	331.22	3.62
245	2013-08-24	2.04	128.34	2.56	0.93	2.64	150.72	0.8	151.19	378.42	6.64	283.12	3.25	1.01	3.8	161.78	1.37	161.24	421.82	3.95	332.96	3.64
246	2013-08-25	2.12	130.02	2.31	1.3	2.84	151.15	1.45	151	381.3	3.99	286.58	3.36	1.17	3.42	161.65	0.96	161.78	423.87	3.27	335.88	4.14
247	2013-08-26	3.2	131.47	2.98	1.29	2.93	151.19	0.98	150.66	385.93	5.4	291.28	3.15	1.16	3.75	161.16	0.88	161.62	426.38	3.6	338	4.27
248	2013-08-27	2.66	133.26	2.74	0.91	2.56	151	1.45	151.1	388.34	3.37	293.58	3.49	0.98	3.41	161.49	1.3	161.62	428.91	3.25	339.94	3.69
249	2013-08-28	1.96	133.71	2.51	1.48	2.75	150.85	1.08	151.25	390.01	3.26	295.27	3.74	1.08	3.8	161.43	1.08	161.5	431.27	3.33	342.4	4.01
250	2013-08-29	1.72	134.65	2.79	0.94	2.89	150.82	1.19	151.13	391.74	2.63	297.39	3.54	1	3.58	161.82	1.4	161.46	433.57	3.3	345.09	4.28
251	2013-08-30	1.68	135.33	2.57	0.94	2.29	151.21	0.82	151.22	393.1	2.56	298.49	3.47	1.41	3.31	161.24	1.06	161.42	436.01	3.24	347.66	4.18
252	8월합계	56.69	135.33	78.75	34.34	2.29	151.21	39.04	151.22	10324.37	128.04	298.49	105.02	33.94	3.31	161.24	36.46	161.42	12073.22	102.7	347.66	114.45
253	2013-09-01	1.36	110.4	2.13	0.97	2.08	146.9	1.63	146.93	299.5	2.59	204.61	3.01	0.96	3.08	158.43	1.56	158.13	369.55	2.52	281.21	3.55
254	2013-09-02	1.57	111.3	2.25	0.76	2.24	147.85	1.58	147.99	301.21	2.58	206.74	3.11	0.7	2.89	159.19	1.92	159.62	371.86	2.67	283.27	3.16
255	2013-09-03	1.64	112.08	2.06	0.99	2.43	149.21	1.55	149.17	303.67	2.75	208.79	3.03	0.59	2.99	160.69	1.78	160.55	373.97	2.91	285.32	3.37
256	2013-09-04	1.27	112.65	2.26	0.65	2.42	150.16	1.96	150.04	305.39	2.79	210.79	2.91	0.54	2.85	161.19	1.16	161.05	375.82	2.85	287.55	3.27
257	2013-09-05	1.37	113.43	2.1	0.93	2.29	150.6	1.28	150.52	307.92	3.43	213.18	3.13	0.86	3.21	161.19	0.8	161.25	378.17	2.79	289.32	3.52
258	2013-09-06	1.6	114.29	2.05	0.54	2.19	150.46	0.78	150.81	310.2	2.68	215.21	3.05	0.5	2.96	160.88	0.91	160.97	380.46	2.81	291.87	3.26
259	2013-09-07	1.61	115	2.41	0.67	2.19	150.55	0.6	150.49	311.86	2.34	216.94	3.1	0.91	3.11	161.29	0.73	161.1	382.5	2.72	293.94	3.12
260	2013-09-08	1.68	115.73	2.41	0.88	2.41	150.51	0.75	150.69	313.43	2.73	218.94	2.93	0.85	2.99	160.86	0.6	161.33	384.45	2.88	296.07	3.22
261	2013-09-09	1.3	116.15	2.44	0.85	2.3	150.76	0.85	150.67	315.61	2.59	220.59	2.82	0.66	3.23	160.97	0.92	160.9	386.97	3.16	298.27	3.27
262	2013-09-10	1.29	116.87	2.4	0.85	2.44	150.76	0.9	150.8	326.03	11.31	231.16	3.03	0.84	3.09	161	1	160.85	388.9	2.96	300.42	3.49
263	2013-09-11	1.68	117.6	2.37	0.85	2.44	150.47	0.85	150.6	327.66	2.62	233.32	3.25	0.89	3.27	161.33	0.83	161.07	391.43	3.28	303.01	3.27
264	2013-09-12	1.51	118.59	2.11	0.6	2.13	150.46	0.81	150.64	332.46	5.11	237.61	2.91	0.55	3.29	161.01	0.95	161.09	393.53	2.73	305.06	3.28
265	2013-09-13	1.57	119.31	2.25	0.54	2.37	150.81	0.53	150.48	334.69	2.8	240.09	2.97	0.94	2.83	160.87	0.93	161.15	396.15	2.96	307.63	3.22
266	2013-09-14	1.51	119.76	2.27	0.5	2.49	150.54	0.52	150.61	336.76	2.86	241.87	3.22	0.79	3.14	161.02	0.8	161.06	398.51	2.81	309.73	3.33
267	2013-09-15	1.81	120.69	2.06	0.8	2.02	150.41	1	150.52	338.61	2.62	243.87	3.23	0.92	2.9	161.06	0.57	160.99	400.92	3	312.5	3.26
268	2013-09-16	1.78	121.76	2.27	0.65	2	150.68	0.72	150.51	340.81	2.79	245.71	3.16	0.74	3.27	161.26	0.59	161.21	403.17	3.16	314.59	3.24
269	2013-09-17	1.52	122.47	2.46	0.65	2.27	150.61	0.86	150.31	342.91	2.81	248.11	3.25	0.75	2.88	161.07	0.82	161.09	405.64	2.9	316.7	3.66
270	2013-09-18	1.42	123.51	2.11	0.79	2.09	150.42	0.75	150.33	346.77	4.79	252.13	3.27	0.98	2.88	160.92	0.89	161.28	407.69	2.94	319.09	3.42
271	2013-09-19	1.67	124.23	2.31	0.67	2.42	150.66	0.85	150.78	348.44	2.94	253.72	3	0.66	3.22	161.28	0.66	161	410.14	3	321.13	3.73
272	2013-09-20	1.67	125.24	2.04	0.69	2.2	150.7	0.82	150.7	352.44	4.78	257.6	3.13	0.73	3.12	161.24	0.63	161.25	412.35	2.91	323.81	3.66
273	2013-09-21	1.77	125.82	2.51	0.75	2.1	150.6	0.54	150.41	368.15	16.1	273.19	2.87	0.81	2.83	160.98	0.91	161.18	414.52	3.28	326.17	3.72
274	2013-09-22	1.53	126.48	2.44	0.66	2.22	150.57	0.79	150.52	369.95	2.62	275.23	3.16	0.89	2.94	161.3	0.6	160.9	416.75	3.11	328.11	3.29
275	2013-09-23	1.6	127.39	2.3	0.86	2.2	150.78	0.58	150.69	372.19	2.81	277.11	3.22	0.8	3.18	161.11	0.53	160.9	419.2	3.21	330.76	3.71
276	2013-09-24	1.3	128.35	2.31	0.58	2	150.61	0.82	150.56	377.79	5.2	283.06	3.14	0.68	2.84	161.32	0.58	160.83	421.28	3.2	332.6	3.35
277	2013-09-25	1.94	129.48	2.19	0.88	2.46	150.54	0.94	150.79	380.82	3.61	285.82	2.83	0.52	2.85	161.08	0.65	160.85	423.95	2.91	335.39	3.57
278	2013-09-26	2.64	131.25	2.04	0.67	2.25	150.54	0.53	150.79	385.37	5.4	290.77	3.04	0.98	2.93	160.84	0.92	161.16	426.29	3.16	337.48	3.39
279	2013-09-27	2.46	132.49	2.35	0.69	2.1	150.36	0.71	150.68	387.87	2.93	292.83	3.11	0.78	2.91	161.33	0.99	161.17	428.36	3.01	339.52	3.37
280	2013-09-28	1.95	133.53	2.32	0.53	2.25	150.64	0.59	150.41	389.38	2.49	294.8	3.23	1	3.13	160.96	0.67					
281	2013-09-29	1.73	134.33	2.39	0.62	2.19	150.37	0.93	150.45	391.34	2.38	296.6	2.96	0.85	3.26	161.33	0.68					
282	2013-09-30	1.35	134.93	2.01	0.64	2.31	150.76	0.68	150.4	393.08	2.61	298.6	3.16	0.53	3.17	160.97	0.59					
283	9월합계	48.7	134.93	67.62	21.71	2.31	150.76	25.69	150.4	10312.31	117.05	298.6	92.23	23.2	3.17	160.97	26.17					
284	2013-10-01	1.54	110.43	2.27	0.81	2.34	146.97	1.7	147.19	299.52	2.82	204.66	3.05	0.9	3.05	158.44	1.92					
285	2013-10-02	1.44	111.27	2.2	0.79	2.35	148.05	1.66	148.21	301.34	2.56	206.64	3.07	0.68	2.89	159.54	1.79					
286	2013-10-03	1.57	111.99	2.28	0.79	2.34	148.93	1.89	149.23	303.55	2.88	208.62	3.13	0.83	3.01	160.43	1.91					
287	2013-10-04	1.56	112.69	2.22	0.75	2.33	150.21	1.71	150.21	305.27	2.68	210.57	2.92	0.67	3.18	161.06	1.41					
288	2013-10-05	1.36	113.31	2.27	0.67	2.31	150.56	1.13	150.59	308.13	3.37	213.23	3.05	0.68	3	161.16	0.73					
289	2013-10-06	1.47	114.16	2.34	0.64	2.33	150.47	0.8	150.48	309.97	2.61	215.28	2.91	0.77	3.11	161.16	0.65					
290	2013-10-07	1.57	114.89	2.14	0.83	2.24	150.46	0.83	150.44	311.76	2.45	217.11	3.21	0.82	3.06	161.09	0.83					
291	2013-10-08	1.6	115.55	2.15	0.84	2.19	150.6	0.83	150.58	313.43	2.5	218.97	2.97	0.6	3.14	160.95	0.84					
292	2013-10-09	1.52	116.13	2.22	0.67	2.22	150.49	0.84	150.59	315.44	2.61	220.62	3.09	0.84	3.05	161.13	0.9					
293	2013-10-10	1.4	117.06	2.14	0.85	2.21	150.6	0.6	150.43	325.78	11.01	231.19	3.19	0.74	3.13	161.03	0.62					
294	2013-10-11	1.56	117.51	2.41	0.72	2.1	150.66	0.74	150.55	327.9	2.87	233.17	2.96	0.85	3.1	161.05	0.82					
295	2013-10-12	1.43	118.57	2.14	0.67	2.17	150.41	0.89	150.64	332.28	5.2	237.58	3.21	0.65	3.18	161.03	0.76					
296	2013-10-13	1.52	119.08	2.13	0.67	2.23	150.52	0.89	150.42	334.47	3.05	239.93	3.14	0.71	2.96	160.98	0.79					
297	2013-10-14	1.42	119.97	2.31	0.72	2.2	150.59	0.6	150.69	336.53	2.22	242.1	3.21	0.79	3.19	160.99	0.85					

Prototype development for case study



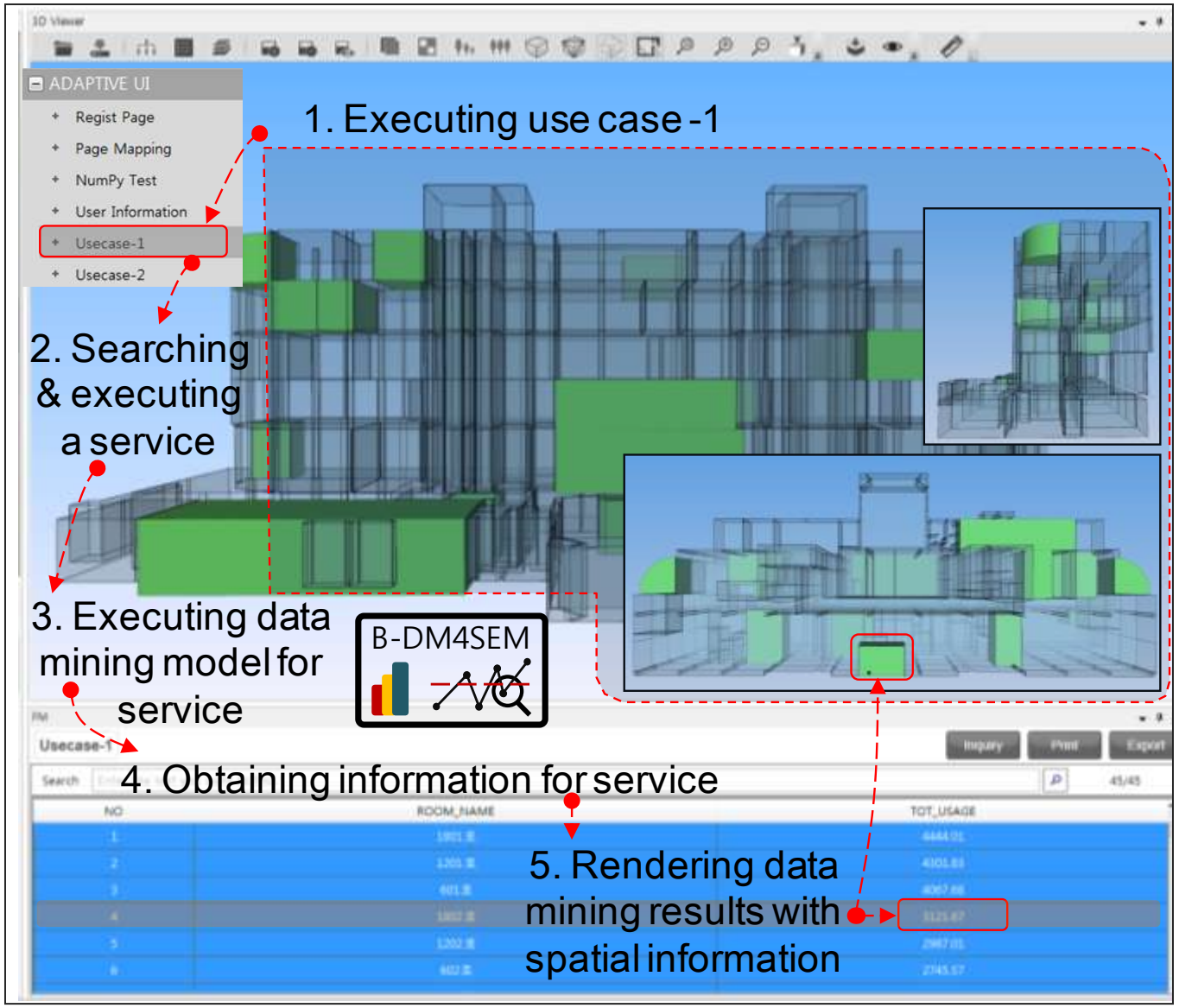
Block diagram of B-DM4SEM framework

Case study: use-case #1

```
class BPAL:
    def GetMiningData(self):
        # Query the data set from IDB
        miningBaseTable = B_IDB.SelectDataTable("SELECT * FROM BIMOBJECT, ENERGY_OBJECT,
ENERGYUSAGE_RECORD WHERE (BIMOBJECT.PK = ENERGY_OBJECT.FK AND
ENERGY_OBJECT.PK = ENERGYUSAGE_RECORD.FK) AND
SUM(ENERGYUSAGE_RECORD.USAGE, ...) ")

        # Obtain DataTable
        miningHeader, miningBaseData = self.DataTableToList(miningBaseTable)

        # Execute data mining prediction model(DMPD)
        npData = B_DMPD.LinearRegressionModel(miningHeader, miningBaseData)

        # Display the data mining results
        miningData = self.NumPyArrayToList(npData)
        miningData = self.ListToDataTable(miningHeader, miningData)

        UI.AddChart(drawGrid, drawChart, miningData, axisXLabel, axisYLabel, axisXColumn, axisYColumns)
BPAL()
```

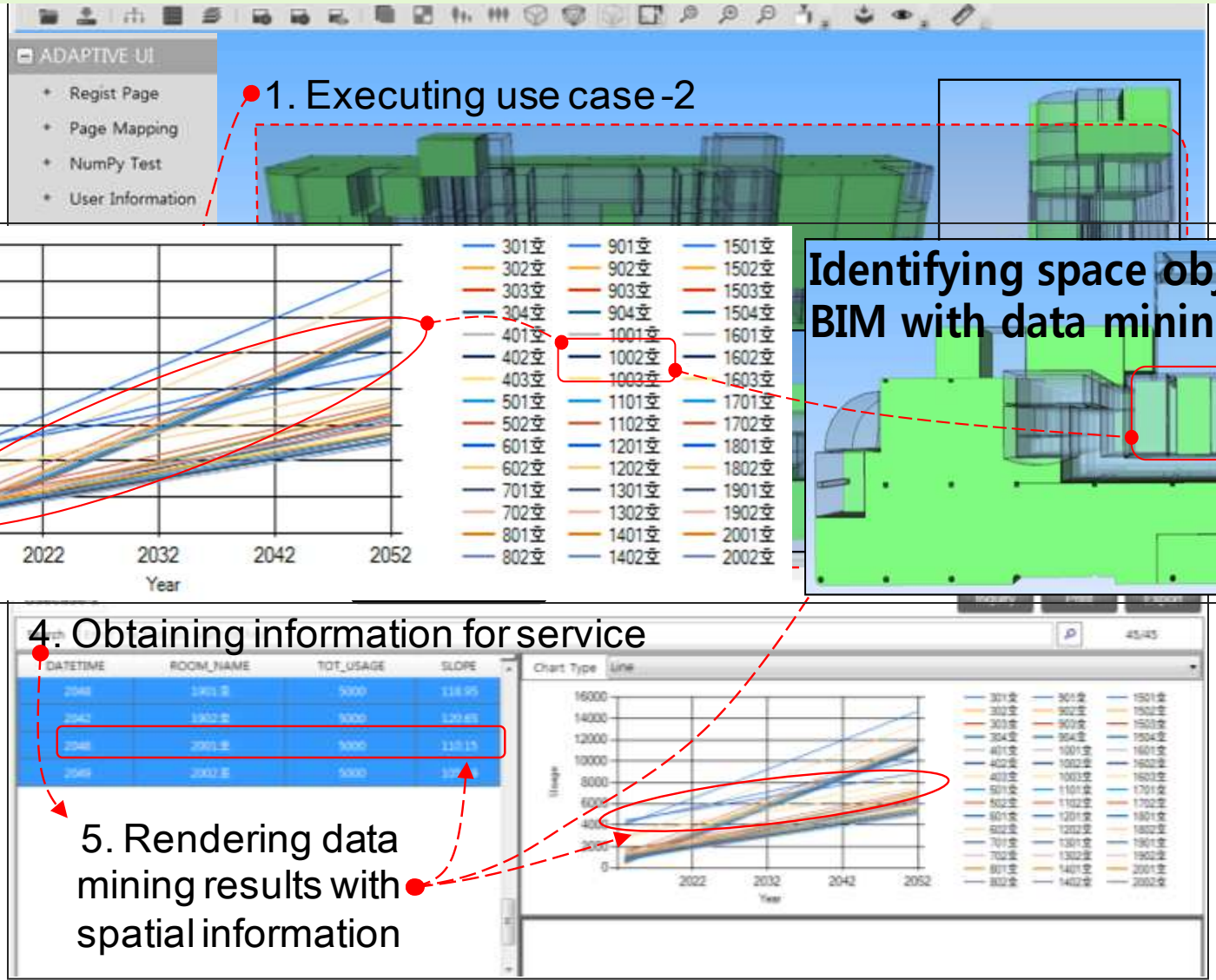
Case study: use-case #1

Which spaces exceed over 1,000 kWh (annual EUC)?



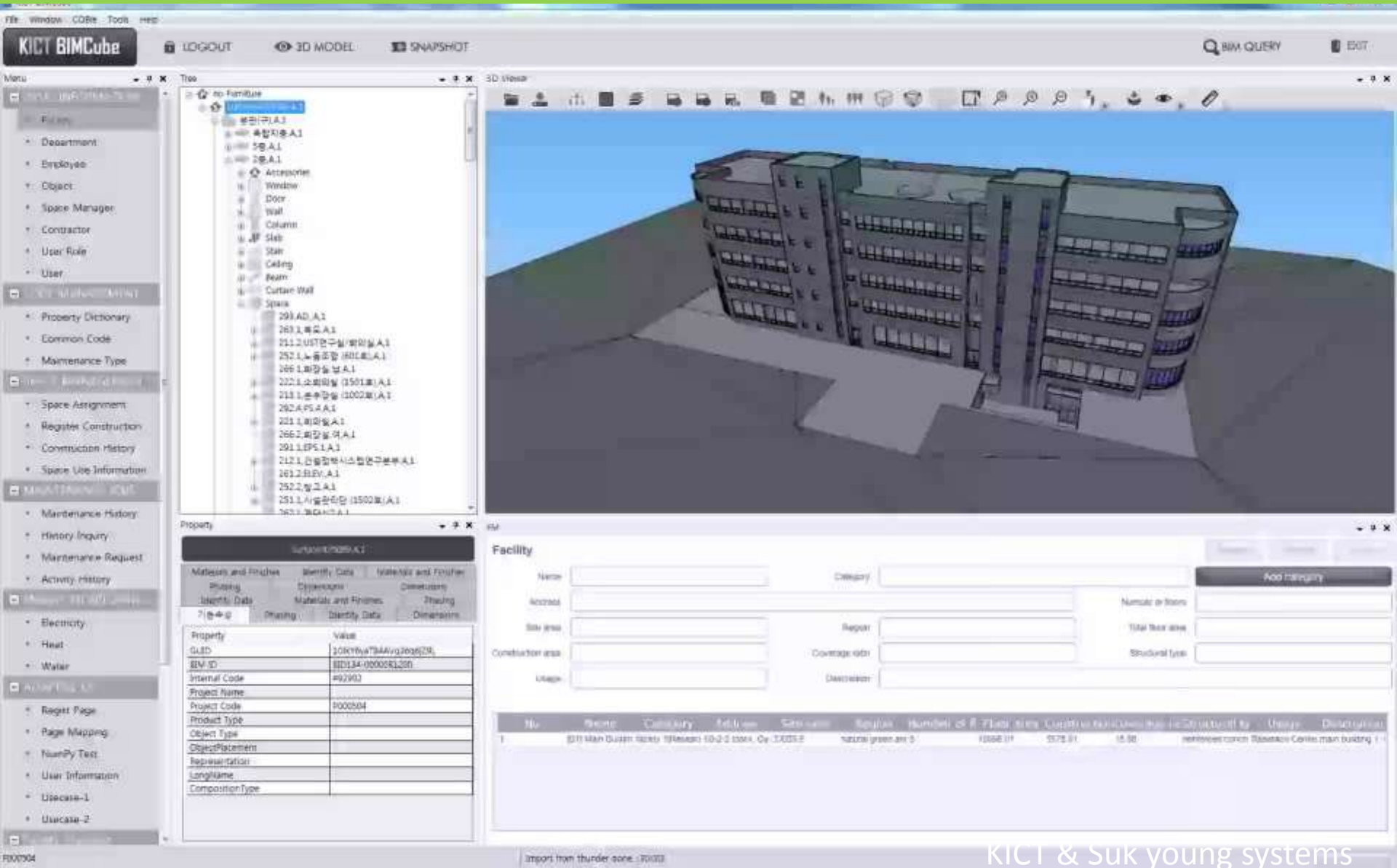
Case study: use-case #2

When was the first time this annual EUC (5,000 kWh) was exceeded, and what is the space and the annual energy consumption trend?



Case study: prototype

Which spaces exceed over 1,000 kWh (annual EUC)?



Experiment result

Results of the work performance time (min) for each case (manual)

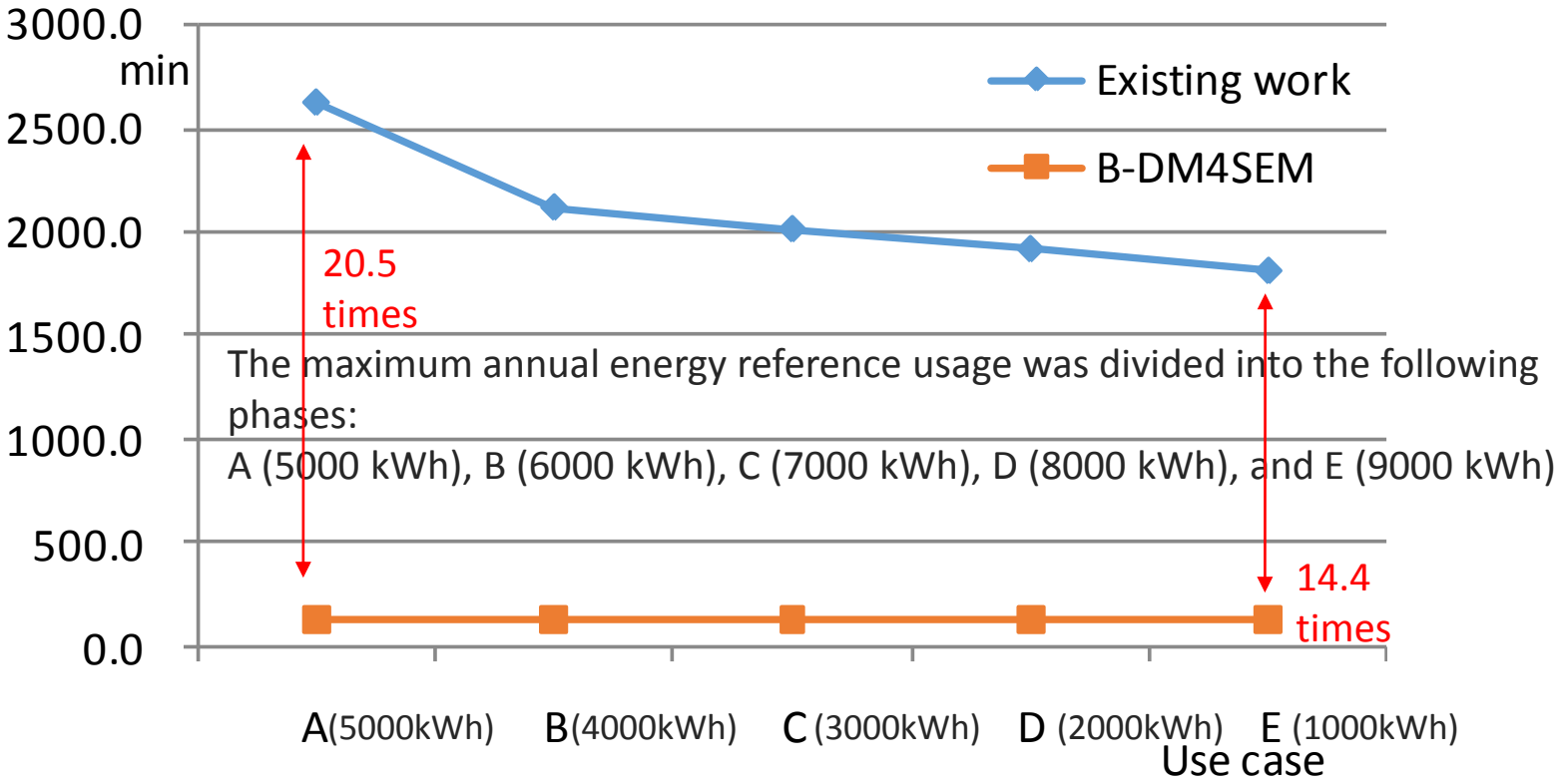
Test method division and phase			Work performance time				
			A (1000)	B (2000)	C (3000)	D (4000)	E (5000)
Existing work method (manually)	Related data processing time	Search	827.7	620.1	578.6	537.1	495.5
		Collect	185.6	167.4	160.2	161.3	154.1
		Integration	1200.8	996.0	955.1	914.1	873.2
	Work performance/Report generation		405.0	336.3	322.5	308.8	295.0
	Total work time A		2619.0	2119.7	2016.3	1921.2	1817.8
B-DM4SEM method	Work performance/Report generation B		12.0	10.5	11.0	11.5	11.0
Work time difference D = A – (B + C)			2491.5	1993.7	1889.8	1794.2	1691.3
Improved performance ratio	**R = A / (B + C)**		20.5	16.8	15.9	15.1	14.4

B-DM4SEM data integration rule development time

Related data integration rule development time	DB extraction	3.0
	BIM integration time	65.0
	B-DM script development time	47.5
Total work time C		115.5

Experiment result

B-DM had an improved performance of up to 14.4 to 20.5 times



Comparison of work performance time for each case

Conclusion

Conclusion & Future research

Conclusion

•B-DM4SEM framework concept was proposed to support effective decision-making depending on the use-case perspective such as building-space energy usage management.

•The proposed framework considers functional variability and extensibility.

•To implement B-DM, B-DM4SEM prototype system was developed and some use-cases was con ducted effectively.

•The proposed method makes it easier to re-define a data-mining model when the use cases cha nge as compared to existing methods.

- •Because defining the parameter values or logic applied in the proposed method can be achieved base d on XML or scripts, improvements and modifications of the model can be easily conducted.

Future research

•B-DM framework development in more detail

•Effectiveness deduction of B-DM in detail

•N-screen & Web-based prototype development

Thanks for your interest

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