Development of a prototype for the assessment of the Malaysian LADM Country Profile

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Commission No. 7

Outline

- Introduction
- Conceptual to technical model
  - ID, PK, FK and versioning
  - Constraints, derived and multiplicity attributes
  - Indexing and clustering
  - 2D topology structure
- Sample data conversion
- Prototype development
- Conclusion and Future Work

Introduction

- Many design decisions have been taken and documented, resulting in the Malaysian LADM country profile
- A prototype system was developed to assess and discover the limitations of the Malaysian LADM country profile.
- The steps in developing this prototype include:
  - deriving the technical model from the conceptual model,
  - convert some sample data into model, and
  - develop prototype (based on MicroStation) to view and edit.

Introduction (cont..)

- The prototype has limited functionality:
  i. not address multi-users aspect (locking, security, authorization, etc.)
  ii. not include large data sets
  iii. not include all tables (only most important tables and the tables for which there is data)
  iv. not develop a web-based interface for dissemination (just a desktop GIS interface)

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Conceptual to technical model

- Normal table
- Relationship table
- View on table (with derived attributes added)
- Code list table

Database Schema

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Conceptual to technical model

- *PK, FK and versioning*

- The important aspect is that the ID's have to be unique for objects.
- For a single object there may be multiple versions, which have the same ID with different timestamps.
- Each table has a Primary Key (PK), a combination of one or more attributes.
- Foreign Key (FK) is used to refer to the PK attributes within another table.
- In one table, we can have multiple FK attributes to refer to different tables.

Conceptual to technical model

- *Constraint attributes*

- There are many types of constraints: e.g. primary key must be unique, endDateTime > beginDateTime, boundary of lot must be closed, boundaries may not intersect (topology constraints), and so on.
- It would also be possible to use database built-in functionality; for example, Oracle's workspace manager to model and manage versions of objects.

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Conceptual to technical model
- *Derived attributes*

- To realize derived attributes, Structured Query Language (SQL) 'create view' was used.
- The function used in the 'create view' statement derives the attributes from another table or attribute.
- There are standard functions in Oracle to derive the attribute (i.e. SDO_GEOM.LENGTH function)
- If there is no standard function in Oracle to derive the attribute, we have to create our own function by programming.

Conceptual to technical model
- *Multiplicity attributes*

- As in LADM Malaysian country profile, we have multiple types of area/volume attributes (surveyed, official and calculated).
- There are at least 3 different ways to implement this:
    1) additional table for this multiple attribute,
    2) use varray to represent all values or
    3) have a fixed number of area/volume attribute (e.g. 3 or 4 and indicate in name of attribute which area/volume type is intended).

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Conceptual to technical model

- *Indexing and Clustering*

- An index is created for efficient searching based on selecting of attribute value.
- B-tree index is created on the attribute of administrative classes.
- R-tree index is created on the geometry attributes in the spatial tables.
- For administrative tables, the primary key is used for physically clustering.
- For spatial table, the (derived) geometry is used for spatially clustering the records in the table.

Conceptual to technical model

- *2D topology structure*

- The end points of an edge (node), play an important role in the topology of the model and therefore it is good to be able to differentiate them from intermediate points.
- The topology implementation is based on our own structure.
- The alternative would be to use the SDO_TOPO package from Oracle (available version 11 and higher).

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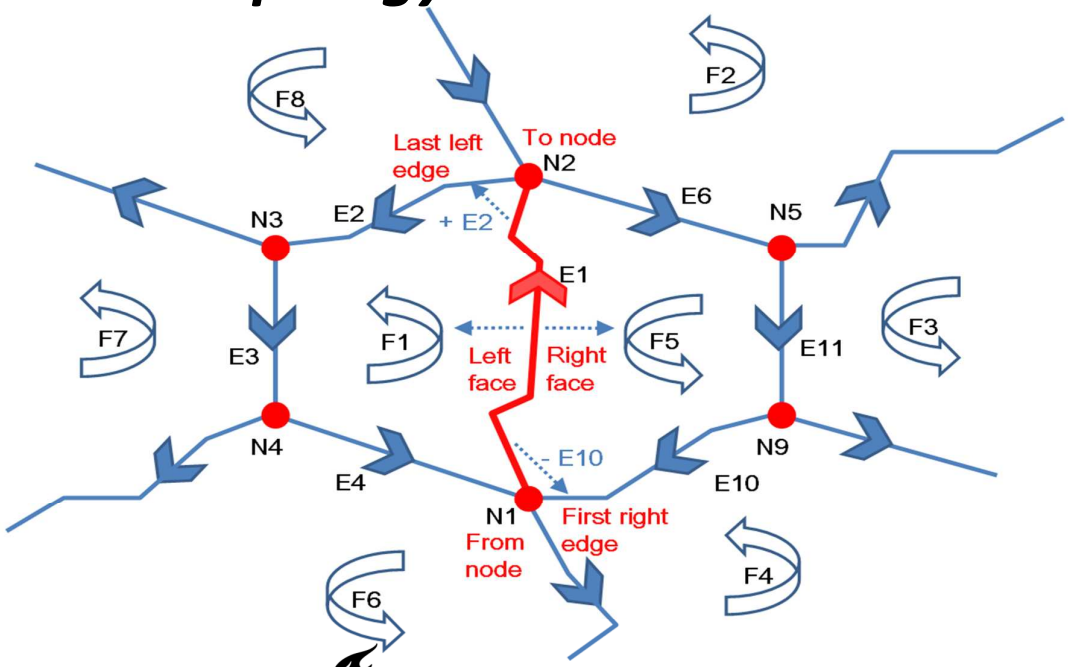
Conceptual to technical model

- *2D topology structure*



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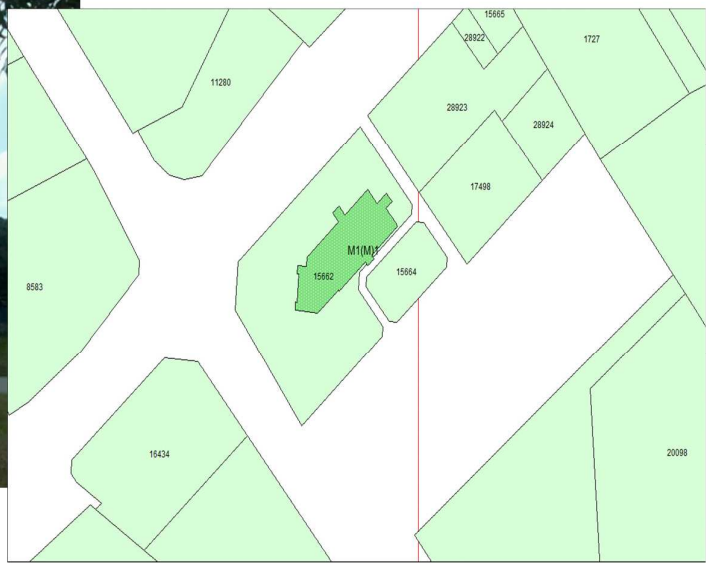
Sample data conversion

- Some sample data from JUPEM and land office are converted into the model.
- Database construction is based on Oracle spatial.
- The study area is at World Youth Foundation (WYF) building in the state of Melaka and some land parcels around that building.
- The building is for 3D cadastral registration system meanwhile, the land parcel around that building is for 2D cadastral system based on LADM.

Sample data conversion (cont..)

Pictures of WYF building



Building footprint

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Sample data conversion (cont..)

- Land parcel (e.g. MY_Lot2D) is based on 2D topology with references to shared boundaries.
- No topology structure used in 3D registration objects (e.g. MY_ParcelUnit).
- For MY_Lot2D, there are three important tables involve to represent 2D topology they are MY_Point, MY_BoundaryFaceString and MY_Lot2D.

Create table and insert data (MY_Point table)

```
CREATE TABLE  MY_POINT (
pid varchar2(10) primary key,
sid varchar2(25) REFERENCES my_spatialsource(sid),
survey_point mdsys.sdo_geometry,
transformation varchar2(250),
map_point mdsys.sdo_geometry,
type varchar2(5) REFERENCES la_pointtype(cid),
begin_date_time timestamp,
end_date_time timestamp);

--------------------------------------------------------------------------------------------------

INSERT INTO MY_POINT VALUES (
'N1',
'04-42351',
MDSYS.SDO_GEOMETRY (2001,24571,MDSYS.SDO_POINT_TYPE (23664.166398,12426.942536,NULL),NULL,NULL),
'NULL',
MDSYS.SDO_GEOMETRY (2001,24571,MDSYS.SDO_POINT_TYPE (23764.739732,12526.967747,NULL),NULL,NULL),
'PN01',
'01-JAN-14 08:10:04.20',
'');
```

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Create table and insert data (MY_BoundaryFaceString table)

```
CREATE TABLE MY_BOUNDARYFACESTRING (
bfsid varchar2(10) primary key,
first_right_edge_bfsid varchar2(10) REFERENCES my_boundaryfacestring(bfsid),
last_left_edge_bfsid varchar2(10) REFERENCES my_boundaryfacestring(bfsid),
right_face_suid varchar2(16) REFERENCES my_lot2D(suid),
left_face_suid varchar2(16) REFERENCES my_lot2D(suid),
begin_date_time timestamp,
end_date_time timestamp);

--------------------------------------------------------------------------------

INSERT INTO MY_BOUNDARYFACESTRING VALUES (
'E1',
'-E10',
'+E2',
'04010800015664',
'04010800015662',
'01-JAN-14 08:20:12.44',
'');
```


Create table and insert data (MY_Lot2D table)

```
CREATE TABLE MY_LOT2D (
suid varchar2(16) primary key,
sid varchar2(25) REFERENCES my_spatialsource(sid),
lid varchar2(25) REFERENCES my_level(lid),
state varchar2(2),
district varchar2(2),
mukim varchar2(2),
section varchar2(3),
lot_no varchar2(7),
type varchar2(5) REFERENCES my_lottype(cid),
use varchar2(5) REFERENCES my_lotusetype(cid),
status varchar2(2) REFERENCES my_lotstatustype(cid),
official_area_m2 dec(7,3),
calculated_area_m2 dec(7,3),
surveyed_area_m2 dec(7,3),
dimension varchar2(5) REFERENCES la_dimensiontype(cid),
begin_date_time timestamp,
end_date_time timestamp);

-------------------------------------------------------------

INSERT INTO MY_LOT2D VALUES (
'04010800015662',
'04-42351',
'04010800015662L2',
'04',
'01',
'08',
'000',
'15664',
'L01',
'LU02',
'99',
'15243',
'15242',
'15244',
'DT03',
'01-JAN-14 08:30:10.05',
'');
```

Sample data conversion (cont..)

- MY_Lot2D represent 2D cadastral area object (polygon, GTYPE = 2003)
- MY_ParcelUnit represent 3D cadastral volume objects (e.g MY_ParcelUnit) are stored by (multipolygon, GTYPE = 3007).
- Oracle spatial also has a solid type (GTYPE = 3008), which in theory is preferred above the multipolygon for handling the solid type, but only available in more recent versions of Oracle spatial.

Create table and insert data (MY_ParcelUnit)

```
CREATE TABLE MY_PARCELUNIT (
suid varchar2(73) primary key,
sid varchar2(25) REFERENCES my_spatialsource(sid),
lid varchar2(25) REFERENCES my_level(lid),
dimension varchar2(5) REFERENCES la_dimensiontype(cid),
type varchar2(5) REFERENCES my_parcelunittype(cid),
area_m2 dec(7,3),
volume_m3 dec(10,3),
geometry mdsys.sdo_geometry,
begin_date_time timestamp,
end_date_time timestamp);

--------------------------------------------------------------------------------------------------------------------------

INSERT INTO MY_PARCELUNIT VALUES (
'040108000015662(S)846(B)M1(M)1(T)1(P)1',
'PA(B)42350-01',
'040108000015662(S)846(B)M1(M)1(T)1(P)1L4',
'DT04',
'CBU7',
'206',
'803',
MDSYS.SDO_GEOMETRY(3007,24571,NULL,
MDSYS.SDO_ELEM_INFO_ARRAY(
1,1003,1,
16,1003,1,
31,1003,1,
46,1003,1,
61,1003,1,
76,1003,1),
MDSYS.SDO_ORDINATE_ARRAY(
23763.508701,12534.314343,0.193868,23763.508701,12534.314343,0,23763.238999,12534.084021,0,
23763.238999,12534.084021,0.193868,23763.508701,12534.314343,0.193868,23763.238999,12534.084021,0.193868,
23763.238999,12534.084021,0,23764.154808,12533.005249,0,23764.154808,12533.005249,0.193868,
23763.238999,12534.084021,0.193868,23764.42451,12533.235571,0.193868,23764.42451,12533.235571,0,
23764.154808,12533.005249,0,23764.154808,12533.005249,0.193868,23764.42451,12533.235571,0.193868,
23763.508701,12534.314343,0.193868,23763.508701,12534.314343,0,23764.42451,12533.235571,0,
23764.42451,12533.235571,0.193868,23763.508701,12534.314343,0.193868,23764.42451,12533.235571,0,
23763.508701,12534.314343,0,23763.238999,12534.084021,0,23764.154808,12533.005249,0,
23764.42451,12533.235571,0,23764.42451,12533.235571,0.193868,23763.508701,12534.314343,0.193868,
23763.238999,12534.084021,0.193868,23764.154808,12533.005249,0.193868,23764.42451,12533.235571,0.193868)),
'01-JAN-14 10:15:30.26',
'');
```

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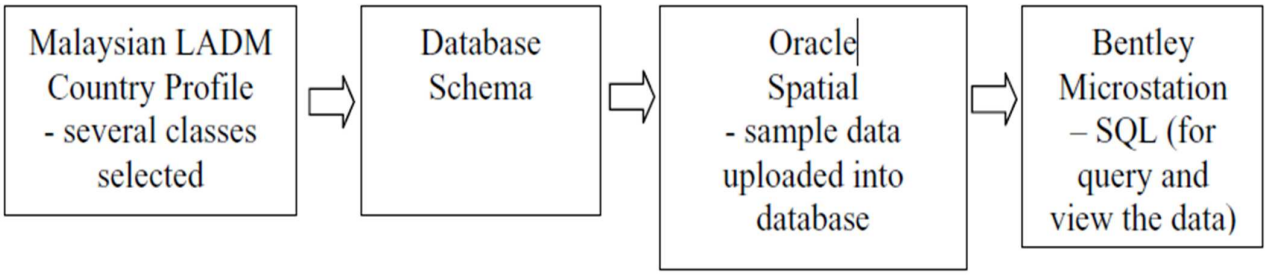
Prototype development

- The prototype frontend development is based on Bentley Microstation.
- Using this application, the query is conducted via the visual SQL Query Builder.



The four steps of the prototype development

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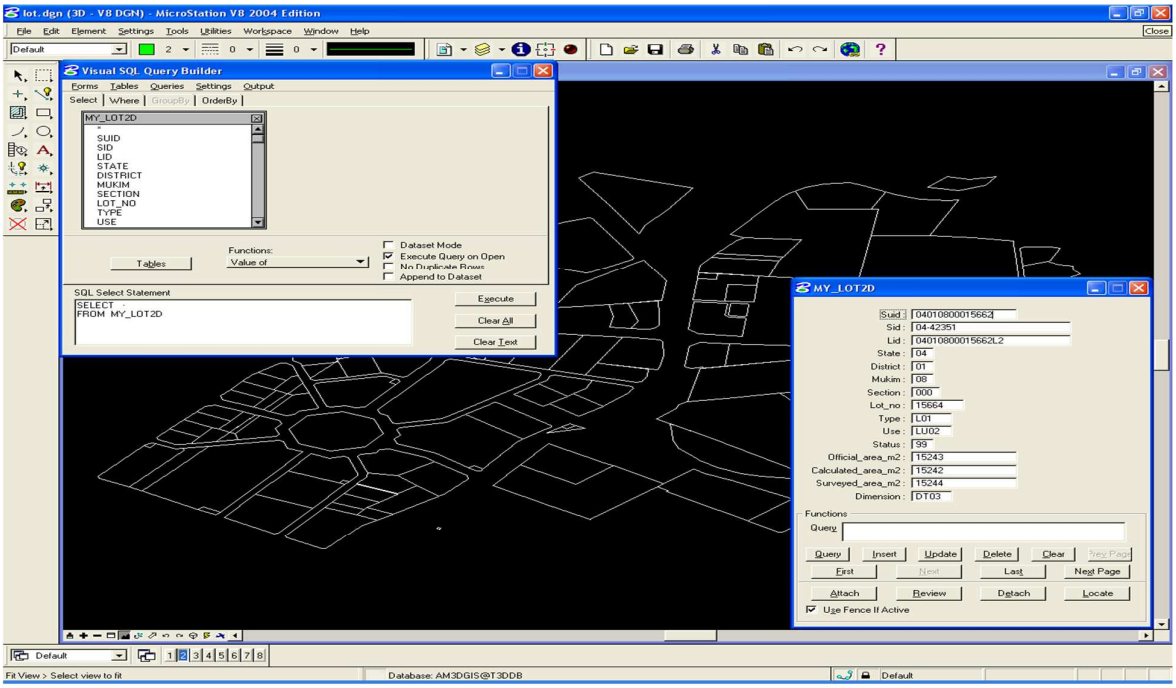
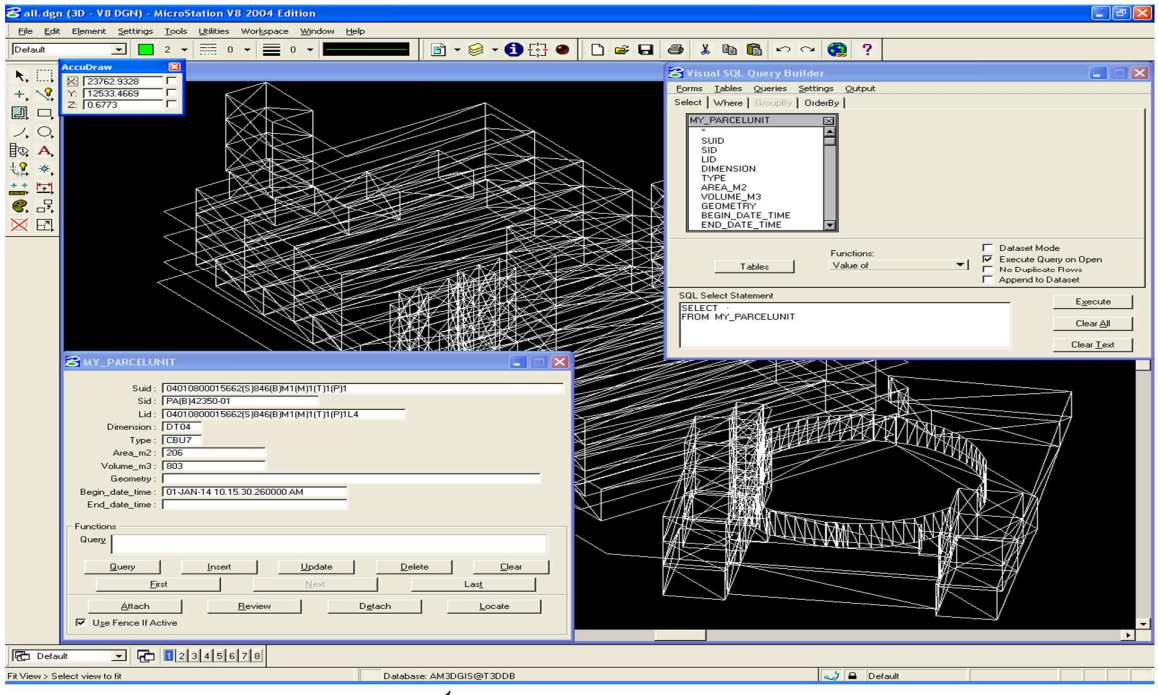
2D data query and visualization (MY_Lot2D)



3D data query and visualization (MY_ParcelUnit)



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Conclusion

- Many technical design and implementation decisions have been elaborated during the conversion of country profile to technical model.
- The current prototype only covers 2D lots and 3D strata objects and the remainder of the classes (tables) will be dealt with at later development stage due to the extensive nature of country profile.
- The overall assessment of the conceptual model based on the developed prototype is positive.

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Future work

- Realization of a near-future prototype that covers all functionalities with large area.
- Development of regulations/formats for digital certified plans with 3D objects.
- Redesign XML exchange formats for LADM based on Malaysian data.
- Creating prototype with appropriate web-interface for JUPEM/land office data accessibility.

Acknowledgement

- Financial assistance from Malaysian Peninsula Land Surveyors Board (LJT).

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June 2014

Thank you for your attention!

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