Integrated 3D Information model (3DIM)

Database load and retreival



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Delft University of Technology



3DIM development - initial iteration 2007

- 1. Studies of existing models CityGML + subsurface information models
- 2. Conceptual modelling (UML) top-level objects of 3DIM
- 3. Database implementation (UML)
- 4. Collection and preparation of test data (TU Delft Campus)
- 5. FME Data processing to reach 3DIM structure on test data
- 6. Database import of test data (to Oracle Spatial)
- 7. Verification and retrieval in CityGML (without subsurface features)

Two implementation alternatives compared

Input data





Polygons

- Buildings
- Classified earth surface parts
- Below surface space
- Construcion work
- Water Body
- Geology

Lines

- Utilities
- Vegetation
- Cityfurniture

Points

- Vegetation
- City Furniture

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Database structure Alt II

class THEMATIC

CONSTRUCTION WORK VEGETATION BUILDING *PK ID: NUMBER *PK ID: NUMBER PK ID: NUMBER CONSTRUCTION_USAGE_CLASS: VARCHAR(50) PLANT_CLASS: VARCHAR(50) NAME: VARCHAR(256) CONSTRUCTION_FUNCTION: VARCHAR(50) LODO SURFACE GEOMETRY ID: NUMBER FUNCTION: VARCHAR(256) UCIOUT: NUMBER PLANT DISTANCE: NUMBER YEAR_OF_CONSTRUCTION: NUMBER LOD1_SURFACE_GEOMETRY_ID: NUMBER IS_SOLID: NUMBER(1) DWNER: VARCHAR(255) LOD2_SURFACE_GEOMETRY_ID: NUMBER TRANSFORMATION_MATRIX: VARCHAR(255) ROOF TYPE NUMBER LOD0_EARTH_SURFACE_GEOMETRY: MDSYS.SD0_GEOMETRY LOD1_EARTH_SURFACE_GEOMETRY: MDSYS.SD0_GEOMETRY LODO_GEOMETRY: MDSYS.SDO_GEOMETRY LOD1_GEOMETRY: MDSYS.SDO_GEOMETRY MEASURED HEIGHT: NUMBER NO_OF_STOREYS_ABOVE_GROUND: NUMBER LOD2 EARTH SURFACE GEOMETRY: MDSYS.SD0 GEOMETRY LOD2 4 GEOMETRY: SYMBOL NO_OF_STOREYS_BELOW_GROUND: NUMBER REPEATED TEXTURE: TEXTURE LOD1 SURFACE GEOMETRY ID: NUMBER PK CONSTRUCTION WORK(NUMBER) TEXTURE_COORDINATES: MDSYS.SDO_GEOMETRY LOD2 SURFACE GEOMETRY ID: NUMBER LOD3_SURFACE_GEOMETRY_ID: NUMBER PK POINT PLANT(NUMBER) 0 * LOD1_EARTH_SURFACE_GEOMETRY: MDSYS.SDO_GEOMETRY ۰× LOD2_EARTH_SURFACE_GEOMETRY: MDSYS.SDD_GEOMETRY LOD3_EARTH_SURFACE_GEOMETRY: MDSYS.SDD_GEOMETRY CONSTRUCTION WORK SURFACE 1 SOLID_GEOMETRY: MDSYS.SDO_GEOMETRY CITYFURNITURE 1 *PK ID: NUMBER *PK ID: NUMBER SURFACE ID: NUMBER PK BUILDING(NUMBER) CITYFURNITURE CLASS: VARCHAR(50) FRONT TEXTURE: TEXTURE HEIGHT: NUMBER FRONT_TEXTURE_COORDINATES: MDSYS.SDO_GEOMETRY ő..* ń lő.× LODO_GEOMETRY: MDSYS.SDO_GEOMETRY FRONT_COLOR_RED: NUMBER LOD1 4 GEOMETRY: SYMBOL FRONT COLOR GREEN: NUMBER BUILDING SURFACE REPREATED_TEXTURE: TEXTURE FRONT COLOR BLUE: NUMBER BACK_TEXTURE: TEXTURE *PK ID: NUMBER PK POINT CITYFURNITURE(NUMBER) SURFACE ID: NUMBER BACK TEXTURE COORDINATES: MDSYS.SDO GEOMETRY FRONT TEXTURE: TEXTURE BACK COLOR RED: NUMBER BACK COLOR GREEN: NUMBER FRONT_TEXTURE_COORDINATES: MDSYS.SDO_GEOMETRY BACK_COLOR_BLUE: NUMBER FRONT COLOR RED: NUMBER FRONT COLOR GREEN: NUMBER FRONT_OPACITY: NUMBER FRONT_COLOR_BLUE: NUMBER BACK OPACITY: NUMBER IS CLOSURESURFACE: NUMBER BACK_TEXTURE: TEXTURE BACK_TEXTURE_COORDINATES: MDSYS.SDO_GEOMETRY BACK_COLOR_RED: NUMBER POLYGON GEOMETRY: MDSYS.SDO GEOMETRY BACK_COLOR_GREEN: NUMBER PK CONSTRUCTION WORK SURFACE(NUMBER) BACK_COLOR_BLUE: NUMBER FRONT_OPACITY: NUMBER BACK OPACITY: NUMBER IS_CLOSURESURFACE: NUMBER(1) POLYGON_GEOMETRY: MDSYS.SDO_GEOMETRY PK BUILDING SURFACE(NUMBER) «DATATYPE» SYMBOL LANDCOVER TRANSPORTATION ID: int GEOMETRY: BLOB *PK ID: NUMBER *PK ID: NUMBER TRANSPORTATION_CLASS: VARCHAR(50) LANDCOVER_GROUND_CLASS: VARCHAR(50) «DATATYPE» TRANSPORTATION_S_MATERIAL: VARCHAR(50) EARTH SURFACE GEOMETRY: MDSYS.SDO GEOMETRY USAGE CLASS: VARCHAR(50) TEXTURE EARTH_SURFACE_GEOMETRY: MDSYS.SDO_GEOMETRY THEMATIC LANDUSE: VARCHAR(50) THEMATIC LANDUSE: VARCHAR(50) ID: int REPEATED_TEXTURE: TEXTURE REPEATED_TEXTURE: TEXTURE IMAGE: BLOB PK_LANDCOVER(NUMBER) PK_TRANSPORTATION(NUMBER) BELOW SURFACE SPACE WATER i UTILITY 1 PK ID: NUMBER *PK ID: NUMBER *PK ID: NUMBER USAGE_CLASS: VARCHAR(50) WATER CLASS: VARCHAR(50) UTILITY_CLASS: VARCHAR(50) SPACE_CLASS: VARCHAR(50) WATER FUNCTION: VARCHAR(50) DIAMETER: NUMBER EARTH_SURFACE_GEOMETRY: MDSYS.SDO_GEOMETRY GROUND_SURFACE_GEOMETRY: MDSYS.SDO_GEOMETRY TRANSFORMATION_MATRIX: VARCHAR(255) SURFACE GEOMETRY ID: NUMBER EARTH_SURFACE_GEOMETRY: MDSYS.SDO_GEOMETRY LODO_4_GEOMETRY: MDSYS.SDO_GEOMETRY REPEATED_TEXTURE_IMAGE: TEXTURE CLOSURE_SURFACE_GEOMETRY: MDSYS.SDO_GEOMETRY LOD1_4_SURFACE_GEOMETRY: MDSYS.SD0_GEOMETRY SOLID_GEOMETRY: MDSYS.SDO_GEOMETRY SOLID GEOMETRY: MDSYS.SDO GEOMETRY LOD1_4_SYMBOL_GEOMETRY: SYMBOL IS_ABOVE_SURFACE: NUMBER(1) PK UNDERGROUND SPACE(NUMBER) PK WATERBODY(NUMBER) REPEATED_TEXTURE: TEXTURE HEIGHT: NUMBER 0..* 0..* 0..* MUDTH: NUMBER 1 GEOLOGY PK_UTILITIY(NUMBER) PK ID: NUMBER BELOW_SURFACE_SURFACE := GEOLOGY CLASS: VARCHAR(50) EARTH_SURFACE_GEOMETRY: MDSYS.SDO_GEOMETRY *PK ID: NUMBER LOD1_4_GEOMETRY: MDSYS.SDO_GEOMETRY SURFACE ID: NUMBER LODO_GEOMETRY: MDSYS.SDO_GEOMETRY FRONT TEXTURE: TEXTURE FRONT_TEXTURE_COORDINATES: MDSYS.SDO_GEOMETRY DEPTH: NUMBER SOLID_GEOMETRY: MDSYS.SDO_GEOMETRY FRONT_COLOR_RED: NUMBER REPEATED_TEXTURE: TEXTURE FRONT COLOR GREEN: NUMBER FRONT COOR BLUE: NUMBER PK_GEOLOGIC_FEATURE(NUMBER) BACK_TEXTURE_COORDINATES: MDSYS.SDO_GEOMETRY BACK_COLOR_RED: NUMBER BACK_COLOR_GREEN: NUMBER BACK_COLOR_BLUE: NUMBER FRONT_OPACITY: NUMBER BACK_OPACITY: NUMBER IS CLOSURESURFACE: NUMBER(1) POLYGON_GEOMETRY: MDSYS.SDO_GEOMETRY PK_BELOW_SURFACE_SURFACE(NUMBER)

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Structures implemented in Oracle Spatial

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Imported from Enterprise architect

- Tables
- Keys
- Constraints

Manually modelled

User defined data types

- texture type
- image type

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Division into loading processes

Multiple access to geometry tables

Alt I

AltI - DATABASE_FILL_ABOVE_BELOW.fmw	Buildings BelowSurfaceSpace Water ConstructionWork
AltI - DATABASE_FILL_EARTH_SURFACE.fmw	Transportation Landcover
AltI - DATABASE_FILL_GEO&UTIL.fmw	Geology Utility
AltI - DATABASE_FILL_TIC&TIP.fmw	Vegetation CityFurniture

	AltII - DATABASE_FILL_ABOVE_BELOW.fmw	Buildings BelowSurfaceSpace Water ConstructionWork
Alt II	AltII - DATABASE_FILL_ABOVE_BELOW_WATER.fmw	Water
	AltII - DATABASE_FILL_EARTH_SURFACE.fmw	Transportation Landcover
	AltII - DATABASE_FILL_GEO&UTIL.fmw	Geology Utility
	AltII - DATABASE_FILL_TIC&TIP.fmw	Vegetation CityFurniture

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Scripts Alt I (18 outputs)















Scripts Alt II (less complex 14 outputs)

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● road_par... [FFS]]



















Verification



Java servlet from Marian de Vries: Oracle >GML

>XSLT >X3D



Choosen objects in CityGML output

CityObjectsMembers in CityGML that could be exported from the 3DIM example scene (no subsurface)

- TINRelief
- Building
- PlantCover
- CityFurniture
- SolitaryVegetationObject
- TrafficArea
- WaterBody









SQL Views: Mapping from Database to CityGML

Example views alt I

create or replace view VIEW_BUILDING_LOD1 as (
SELECT a.ID, a.NAME, b.GEOM AS LOD_1_SURFACE_GEOMETRY,
c.MULTIPOLYGON_GEOMETRY AS LOD_1_EARTH_SURFACE_GEOMETRY
FROM BUILDING a, VIEW_BUILDING_AGGRE_SURFACE b,
EARTH_SURFACE_GEOMETRY c
WHERE a.LOD1_TIS_E_S_GEOMETRY_ID = c.SURFACE_ID AND
a.LOD1_SURFACE_GEOMETRY_ID = b.SURFACE_ID
);
create or replace view VIEW_BUILDING_AGGRE_SURFACE as (
SELECT SURFACE_ID as SURFACE_ID, SDO_AGGR_UNION(
SDOAGGRTYPE(d.POLYGON_GEOMETRY, 0.005)) AS GEOM
FROM SURFACE_ID IN (SELECT LOD1_SURFACE_GEOMETRY_ID FROM
BUILDING)
GROUP BY SURFACE_ID

);

Example views alt II

create or replace view view_solitary_vegetation as (
SELECT * FROM VEGETATION c WHERE c.LOD0_GEOMETRY.Get_GType()
='1');
create or replace view view_point_city_furniture as (
SELECT * FROM CITYFURNITURE c WHERE c.LOD0_GEOMETRY.Get_GType()
='1');

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GO Publisher database-xml mapping

Name	Enabled	DB type or const value	XML path	Type in XML
Database	V		gml:FeatureCollection	gml:FeatureCollectionType
B	~	Table	cityObjectMember/TINRelief	TINReliefType
□ <u>Π</u> □	V	NUMBER	@gml:id	xs:ID
		NUMBER		
LOD		NUMBER		
THEMATIC_LANDUSE		VARCHAR2		
IS_CLOSURE_SURFACE		NUMBER		
MULTIPOLYGON_GEOMETRY	Image: A start a st	SDO_GEOMETRY	tin/gml:TriangulatedSurface	gml:TriangulatedSurfaceType
TEXTURE_ID		NUMBER		
TEXTURE_DRAPING_PARAMETERS		VARCHAR2		
IS_REPEATED_TEXTURE		NUMBER		
. VIEW_BUILDING_LOD1	V	Table	cityObjectMember/Building	BuildingType
	~	NUMBER	@gml:id	×s:ID
mame name		VARCHAR2		
UOD_1_SURFACE_GEOMETRY		SDO_GEOMETRY	lod1MultiSurface	gml:MultiSurfacePropertyType
LOD_1_EARTH_SURFACE_GEOMETRY	V	SDO_GEOMETRY	lod1MultiSurface	gml:MultiSurfacePropertyType
		Table	cityObjectMember/PlantCover	PlantCoverType
I I II	V	NUMBER	@gml:id	xs:ID
T LANDCOVER_GROUND_CLASS	~	VARCHAR2	class	PlantCoverClassType
USAGE_CLASS		VARCHAR2	function	PlantCoverFunctionType
MULTIPOLYGON_GEOMETRY	V	SDO_GEOMETRY	lod1MultiSurface	gml:MultiSurfacePropertyType
. VIEW_POINT_CITY_FURNITURE	Image: A start and a start	Table	cityObjectMember/CityFurniture	CityFurnitureType
	Image: A start and a start	NUMBER	@gml:id	xs:ID
CITYFURNITURE_CLASS	V	VARCHAR2	class	CityFurnitureClassType
TIP_POINT_GEOMETRY_ID		NUMBER		
POINT_GEOMETRY	~	SDO_GEOMETRY	lod1Geometry/gml:Point	gml:PointType
- TIEW_POINT_VEGETATION	V	Table	cityObjectMember/SolitaryVegetationObject	SolitaryVegetationObjectType
	V	NUMBER	@gml:id	×s:ID
PLANT_CLASS	Image: A start a st	VARCHAR2	class	PlantClassType
TIP_POINT_GEOMETRY_ID		NUMBER		
POINT_GEOMETRY	~	SDO_GEOMETRY	lod1Geometry/gml:Point	gml:PointType
. VIEW_TRANSPORTATION	V	Table	cityObjectMember/TrafficArea	TrafficAreaType
	V	NUMBER	@gml:id	×s:ID
TRANSPORTATION_CLASS	Image: A start and a start	VARCHAR2	function	TrafficAreaFunctionType
TRANSPORTATION_S_MATERIAL		VARCHAR2		
MULTIPOLYGON_GEOMETRY	V	SDO_GEOMETRY	lod2MultiSurface	gml:MultiSurfacePropertyType
- VIEW_WATER	Image: A start and a start	Table	cityObjectMember/WaterBody	WaterBodyType
T ID	Image: A start of the start	NUMBER	@gml:id	xs:ID
WATER_CLASS	V	VARCHAR2	class	WaterBodyClassType
WATER_FUNCTION		VARCHAR2	function	WaterBodyFunctionType
WATER_GROUND_SURFACE_GEOMETRY		SDO_GEOMETRY	lod1MultiSurface	gml:MultiSurfacePropertyType
WATER EARTH SURFACE GEOMETRY		SDO GEOMETRY	lod1MultiSurface	gml:MultiSurfacePropertyType

Database			oml:FeatureCollection	gml:FeatureCollectionType
		Table	citvObjectMember/PlantCover	PlantCoverType
		NUMBER	@aml:id	xs:ID
ANDCOVER GROUND CLASS		VARCHAR2	class	PlantCoverClassType
USAGE CLASS		VARCHAR2	function	PlantCoverFunctionType
EARTH SURFACE GEOMETRY		SDO GEOMETRY	gml:priorityLocation/gml:TriangulatedSurface	gml:TriangulatedSurfaceType
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		NUMBER	@aml:id	×s:ID
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TRANSPORTATION 5 MATERIAL	Ħ.	VARCHAR2		
EARTH SURFACE GEOMETRY		SDO GEOMETRY	gml:location/gml:TriangulatedSurface	gml:TriangulatedSurfaceType
THEMATIC LANDUSE	Ë.	VARCHAR2		
REPEATED TEXTURE	H	TEXTURE		
- WATER		Table	cityObjectMember/WaterBody	WaterBodyType
T T n D		NUMBER	@aml:id	×s:ID
WATER CLASS		VARCHAR2	class	WaterBodyClassType
WATER FUNCTION		VARCHAR2	function	WaterBodyFunctionType
GROUND SURFACE GEOMETRY		SDO GEOMETRY	lod1MultiSurface	gml:MultiSurfacePropertyType
EARTH SURFACE GEOMETRY		SDO_GEOMETRY	lod1MultiSurface	oml:MultiSurfacePropertyType
	Ë.	SDO GEOMETRY		
SOLID GEOMETRY	H	SDO GEOMETRY		
- TI VIEW SOLITARY VEGETATION		Table	cityObjectMember/SolitaryVegetationObject	SolitaryVegetationObjectType
- R D		NUMBER	@aml:id	xs:ID
PLANT CLASS		VARCHAR2	class	PlantClassType
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PLANT DISTANCE	Ë.	NUMBER		
IS SOLID	Ħ.	NUMBER		
TRANSFORMATION MATRIX	H	VARCHAR2		
LODO GEOMETRY		SDO GEOMETRY	aml:location/aml:Point	aml:PointType
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	H	SYMBOL		
REPEATED TEXTURE	H.	TEXTURE		
TEXTURE COORDINATES	Ë.	SDO GEOMETRY		
- VIEW POINT CITY FURNITURE		Table	cityObjectMember/CityFurniture	CityFurnitureType
T T ID		NUMBER	@aml:id	×s:ID
CITYFURNITURE CLASS		VARCHAR2	class	CityFurnitureClassType
		NUMBER		
LODO GEOMETRY		SDO GEOMETRY	gml:location/gml:Point	aml:PointType
	Ĕ.	SYMBOL		
REPREATED_TEXTURE	Ē	TEXTURE		
- TI VIEW_BUILDING_LOD1		Table	cityObjectMember/Building	BuildingType
		NUMBER	@gml:id	xs:ID
- NAME	Ē	VARCHAR2		
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YEAR OF CONSTRUCTION	Ē	NUMBER		
	Ĕ.	VARCHAR2		
	Ē	NUMBER		
LOD1 SURFACE GEOMETRY	V	SDO GEOMETRY	lod1MultiSurface	gml:MultiSurfacePropertyType
LOD1_EARTH_SURFACE_GEOMETRY		SDO_GEOMETRY	lod1MultiSurface	gml:MultiSurfacePropertyType
- II VIEW_TIN		Table	cityObjectMember/TINRelief	TINReliefType
THEID	 Image: A start of the start of	NUMBER	@gml:id	×s:ID
CLASS	Ē	VARCHAR2		
EOM GEOM	V	SDO_GEOMETRY	tin/gml:TriangulatedSurface	gml:TriangulatedSurfaceType

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Conclusion

Comparision results

- More complex to load data into Alt I constraints > geometry first. Also more destination datasets
- More complex to retreive data into CityGML using views in Alt I

Conclusion

- None of the alternatives have a strong advantage
- All geometry in the same table not an advantage for e.g. buildings but for earth surface
- A combination of Alt I and Alt II could be the solution

