

FIG WORKING WEEK 2019

22-26 April, Hanoi, Vietnam

Presented by the FIG Working Week 2019,
April 22-26, 2019 in Hanoi, Vietnam

"Geospatial Information for a Smarter Life
and Environmental Resilience"



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A Multi-dimensional Cadastral Topological Data Model: Design and Implementation

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What are multi-dimensional cadastral objects?

Type code	Type	Description	Dimension
o_1	$v+t$	A boundary point embedded in 3D/4D space-time	0
o_2	$e+t$	A boundary line embedded in 3D/4D space-time	1
o_3	$v+(t_i, t_j) \ t_i \neq t_j$	The change of a boundary point in a specified time interval	1
o_4	$f+t$	A boundary face embedded in 3D/4D space-time	2
o_5	u^2+t	A 2D spatial unit embedded in 3D/4D space-time	2
o_6	$e+(t_i, t_j) \ t_i \neq t_j$	The change of a boundary line in a specified time interval	2
o_7	u^3+t	A 3D spatial unit embedded in 4D space-time	3
o_8	$f+(t_i, t_j) \ t_i \neq t_j$	The change of a boundary face in a specified time interval	3
o_9	$u^2+(t_i, t_j) \ t_i \neq t_j$	The change of a 2D spatial unit in a specified time interval	3
o_{10}	$u^3+(t_i, t_j) \ t_i \neq t_j$	The change of a 3D spatial unit in a specified time interval	4

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What are their topological relations?

Type code	o_1	o_2	o_3	o_4	o_5	o_6	o_7	o_8	o_9	o_{10}
o_1	ADJ	IN	IN	IN	IN	IN	IN	IN	IN	IN
o_2		ADJ	ADJ	IN	IN	IN	IN	IN	IN	IN
o_3			∅	∅	∅	IN	∅	IN	IN	IN
o_4				ADJ	∅	ADJ	IN	IN	∅	IN
o_5					ADJ	ADJ	∅	∅	IN	∅
o_6						ADJ	∅	IN	IN	IN
o_7							ADJ	ADJ	∅	IN
o_8								ADJ	∅	IN
o_9									ADJ	∅
o_{10}										ADJ

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Two common ideas for designing the multi-dimensional cadastral topological data model (MDCTDM)

(1) Record all the adjacency and incidence relations for cadastral objects

(2) Record the adjacency relations and the incidence relations between i D and $(i+1)$ D cadastral objects

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Three conditions for the ideal MDCTDM

- (1) The time should be modeled as a geometric dimension that is the same as the other three geometric dimensions.
- (2) The topological relation between any two cadastral objects can be obtained without computing the topological relations of other cadastral objects.
- (3) Record the topological relations of as few cadastral objects as possible.

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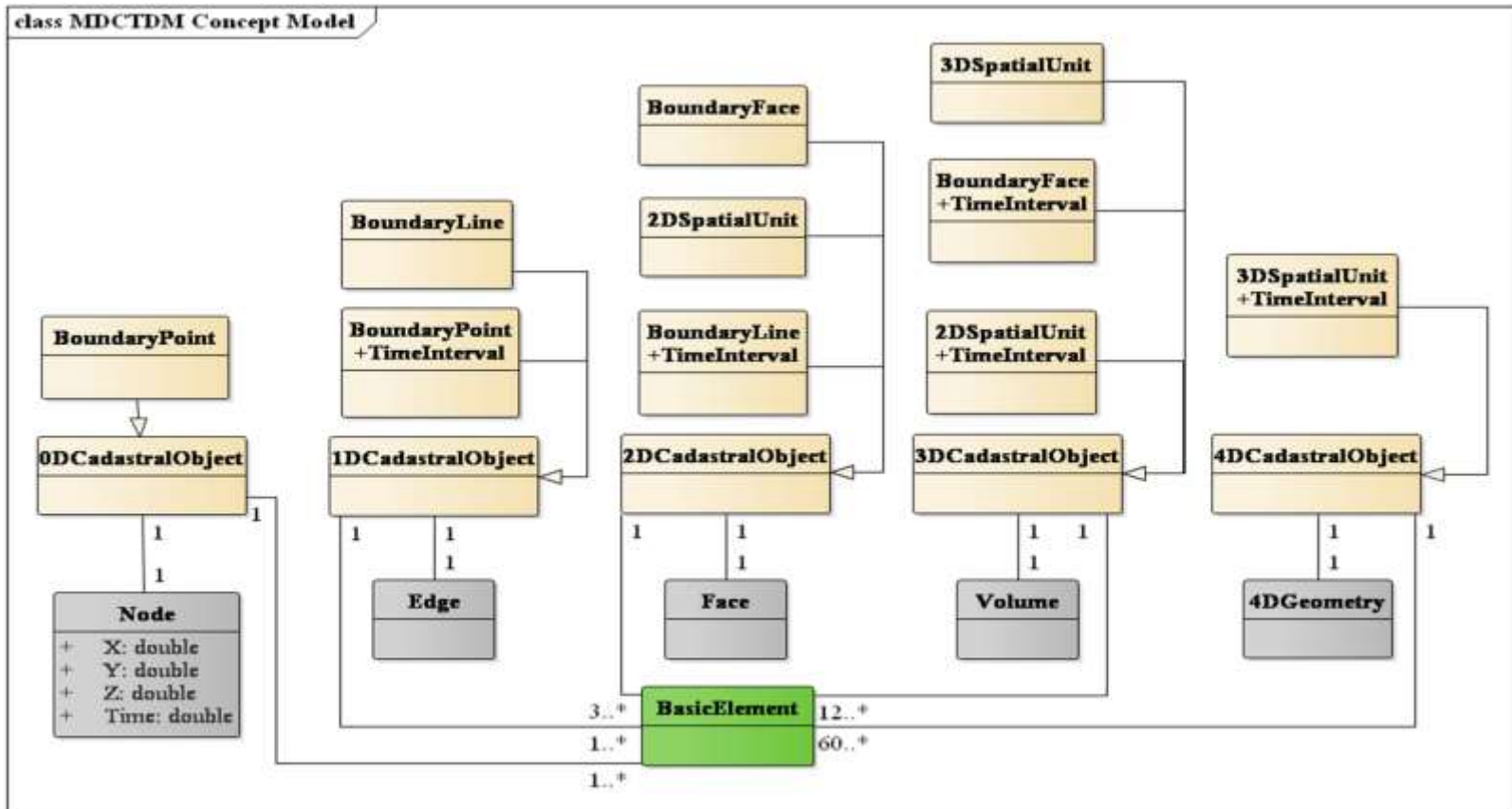
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Conceptual design of the multidimensional cadastral topological data model(MCTDM)



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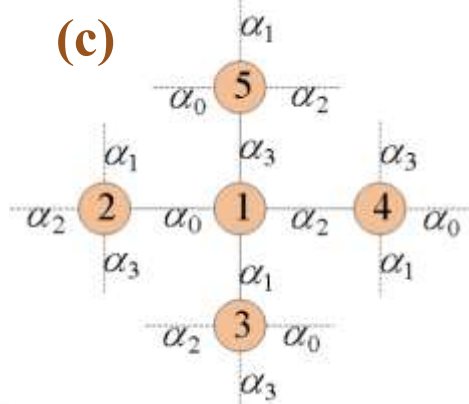
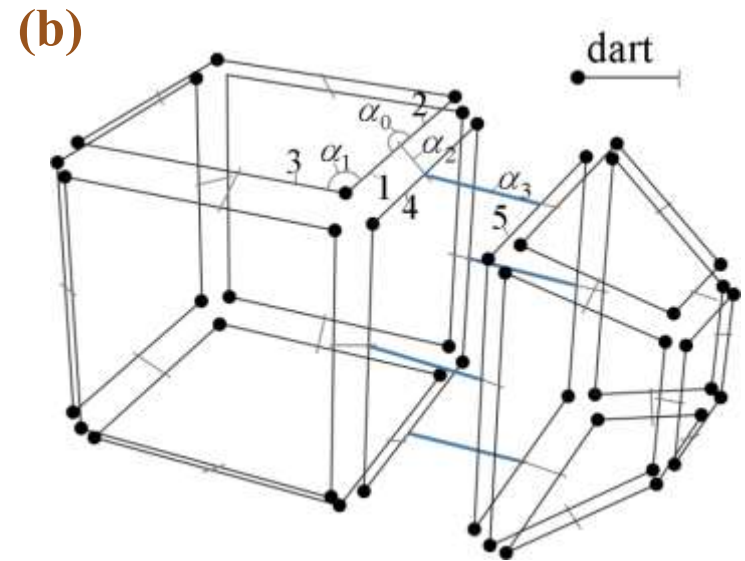
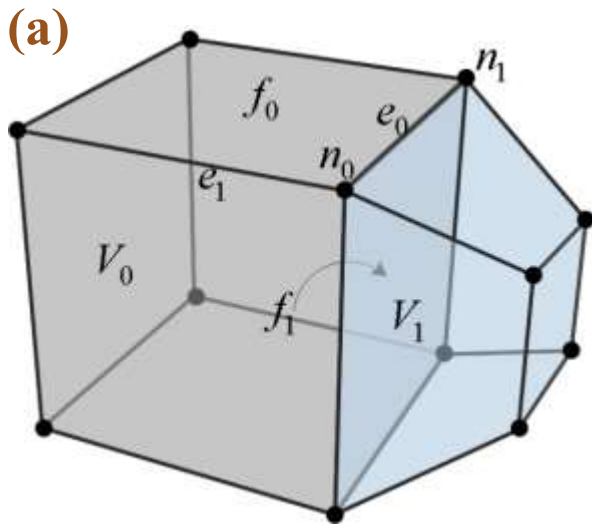
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Represent cadastral objects by generalized maps



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Realizing generalized maps by object-tuple structures

$$\alpha_0: (n_0, e_0, f_0, V_0) \leftrightarrow (n_1, e_0, f_0, V_0)$$

$$\alpha_1: (n_0, e_0, f_0, V_0) \leftrightarrow (n_1, e_1, f_0, V_0)$$

$$\alpha_0: (n_0, e_0, f_0, V_0) \leftrightarrow (n_1, e_0, f_1, V_0)$$

$$\alpha_0: (n_0, e_0, f_0, V_0) \leftrightarrow (n_1, e_0, f_0, V_1)$$

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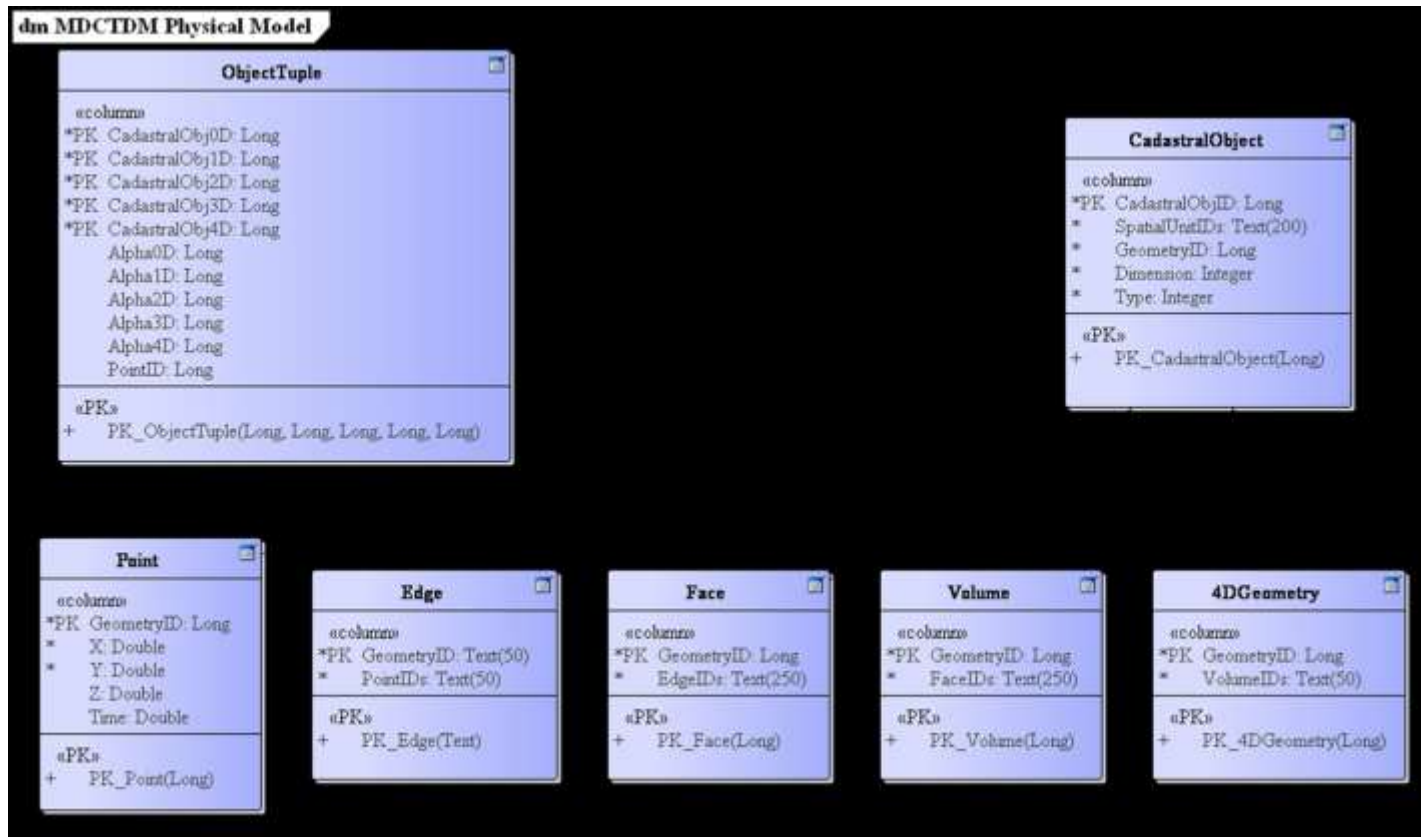
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Physical model of MDCTDM



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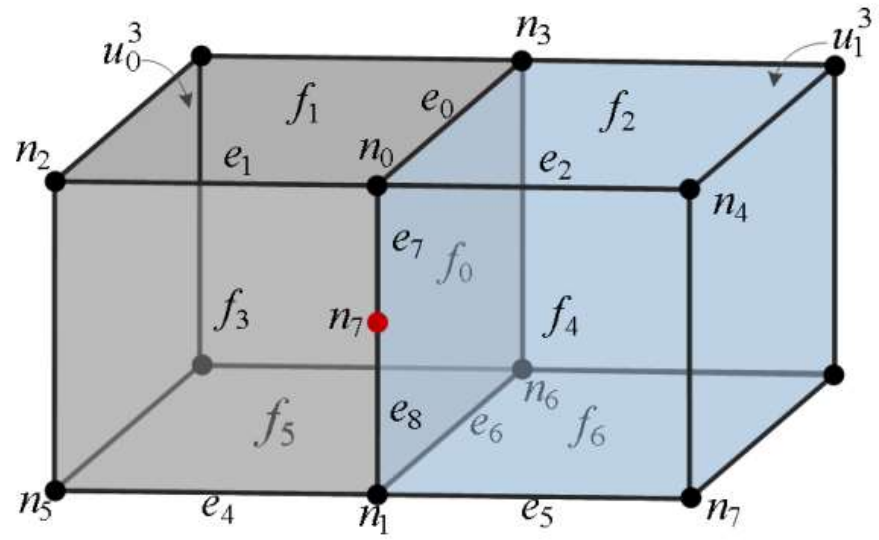
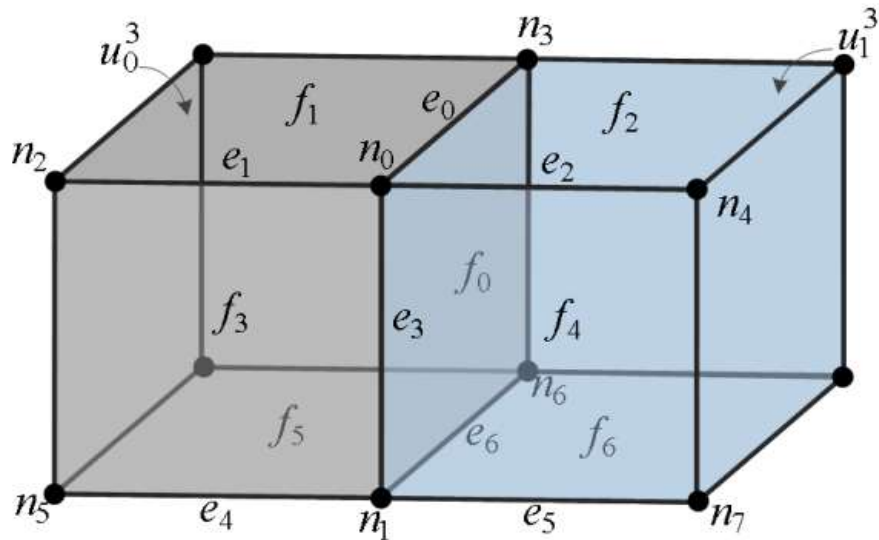
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Case Study



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SET TRANSACTION NAME 'InsertBoundaryPoint';

INSERT ObjectTuple VALUES (n_7 , e_7 , f_3 , u_0^3 , NULL, n_0 , e_1 , f_0 , NULL, NULL, ID $_{n7}$)

INSERT ObjectTuple VALUES (n_7 , e_7 , f_0 , u_0^3 , NULL, n_0 , e_0 , f_3 , u_1^3 , NULL, ID $_{n7}$)

INSERT ObjectTuple VALUES (n_7 , e_7 , f_0 , u_1^3 , NULL, n_0 , e_0 , f_4 , u_0^3 , NULL, ID $_{n7}$)

INSERT ObjectTuple VALUES (n_7 , e_7 , f_4 , u_1^3 , NULL, n_0 , e_2 , f_0 , NULL, NULL, ID $_{n7}$)

INSERT ObjectTuple VALUES (n_7 , e_8 , f_3 , u_0^3 , NULL, n_1 , e_4 , f_0 , NULL, NULL, ID $_{n7}$)

INSERT ObjectTuple VALUES (n_7 , e_8 , f_0 , u_0^3 , NULL, n_1 , e_6 , f_3 , u_1^3 , NULL, ID $_{n7}$)

INSERT ObjectTuple VALUES (n_7 , e_8 , f_0 , u_1^3 , NULL, n_1 , e_6 , f_4 , u_0^3 , NULL, ID $_{n7}$)

INSERT ObjectTuple VALUES (n_7 , e_8 , f_4 , u_1^3 , NULL, n_1 , e_5 , f_0 , NULL, NULL, ID $_{n7}$)

UPDATE ObjectTuple SET CadastralObj1D= e_7 , Alpha0D= n_7 WHERE CadastralObj1D= e_3

AND CadastralObj0D= n_0 ;

UPDATE ObjectTuple SET CadastralObj1D= e_8 , Alpha0D= n_7 WHERE CadastralObj1D= e_3

AND CadastralObj0D= n_1 ;

UPDATE ObjectTuple SET Alpha1D= e_7 WHERE Alpha1D= e_3 AND CadastralObj0D= n_0 ;

UPDATE ObjectTuple SET Alpha1D= e_8 WHERE Alpha1D= e_3 AND CadastralObj0D= n_1 ;

COMMIT;

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Thank You!

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