Adding Time Dimension to Business Information Systems: Why and How?

Pragmatic approach

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Topics

- Why temporal databases (TD) are not widely used?
- What is needed to make use of temporal information (TI)?
- Example of a business application with temporal features
- Minimum complexity temporal database
- Realization upon SQL DBMS
- Discussion

Prerequisites exist

- Low cost of disc storage
- Low cost of computing power

Even small companies can afford TD

- Long history of research – two decades
- Experience of use in certain areas

Why TD are not widely spread?

Where temporal databases are used?

- Special applications – stock exchange
- Special parts of ”ordinary” business applications – salary history

TD are used when the temporal information is extremely critical

i.e. costs of supporting TI are justified

Why TD are not used in other business applications?

- Considerable human overhead for maintaining TI (especially valid time)
- No obvious motivation for personal (doing it for somebody else)
- Complicated querying (SQL is difficult for a normal user, TSQL even more so)
- Technical difficulties for implementation of a full-scaled TD

What is to be done?

- Reduce overhead by not requiring all TI in all circumstances
- Show the advantages of having temporal information
- Simple visual querying of most important information
- Reduced functionality that can be implemented upon commercial DBMS

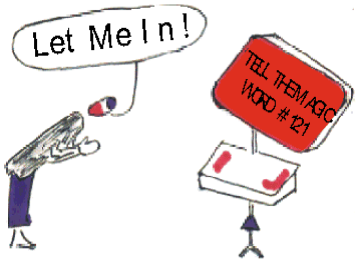
Example domain: Operational business support

Support of routine everyday activities

Paradigm shift in business applications

Old Generation

Human-Assisting System



Powerful Toolkit

New Generation

Human-Assisted System

Assembly Line

Aspects of system development

Aspect	Old Generation (Human-Assisting Systems	New Generation (Human-Assisted Systems)
Modeling	Data Modeling	Process Modeling
Data Base	Static and passive	Dynamic (***history-minded***) and active
User Interface	Functional (multilevel menus)	***Navigational***
Organizational aspect	Follow existing management schemes	Suggest new management schemes

Business process

is a set of partially ordered activities intended to reach a goal

- Discharging a patient from the hospital in a (relatively) healthy state.
- Closing a sale.
- Building a software system according to specifications.

Figure 1

Basic notions

- Goal
- Activity
- Time
- State
- Change
- Event
- History
- Chronicle

Simple application: iTeam – support of unstructured administrative processes

- Application world consists of Business Objects (BO) that can be:
- ”Static” objects - people, organizations, documents
- ”Dynamic objects” – processes, activities, plans, events
- Al objects are interconnected in current state and in the past

Demonstration: TI incorporated in the system along life-lines of business objects

- How TI is maintained
- How it is queried
- How it might be used

What is important in regards to TI?

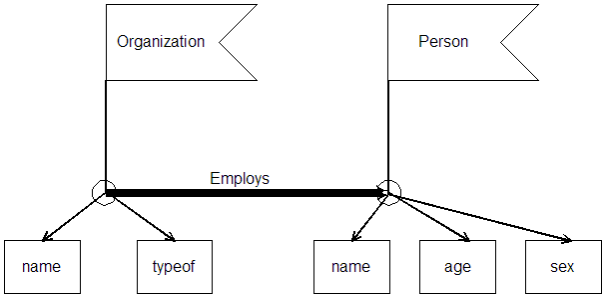
(for operational support)

a) Allow to add or change TI information at a later time
b) List all events - points of changes in the lifespan of a business object
c) Show how an object looked like at any particular point of time (e.g. after an event)
d) Show TI and other information connected to an event in the object's life

Minimum complexity TD: Static schema definition

- Domain - to represent a set of similarly structured business objects (*ORGANIZATION, PERSON*)
- Attribute - to represent properties (<*attr_name, set_of_values*>)
- Link - to represent relationship between business objects (<*link_name, source_domain, target_domain*>)

Graphical representation



State definition: basic notions

- Object – always belongs to some domain and has unique identifier or surrogate
- Attribute assignment:

  <o, attribute_name, atribute_value>
- Connection:

  <o, link_name, o1>

State definition: continue

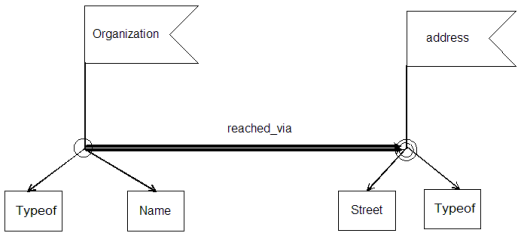
- DB state = set of all currently active attribute assignments and connections
- Immediate body (state) of an object *o* = all currently valid assignments and connections initiated from *o:*

  <o, attribute_name, attribute_value>

  <o, link_name, ox>

Representing complex object

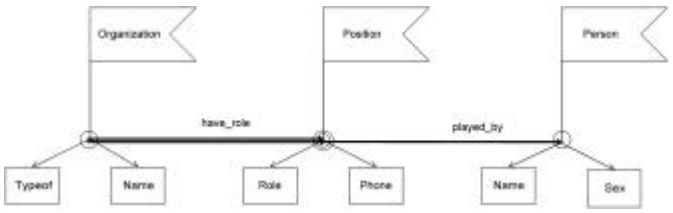
- Dependent domains



- (Extended through recursion) body

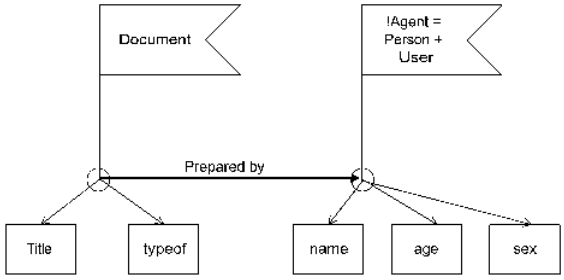
Representing properties of relationships

Relationship objectivization



Restriction: multiple link always leads to dependent domain

Extension: Superdomains



Dynamic notions for DB

- Valid DB history = sequence of DB states

  hist = <st0, st1,..., stn> such that the next state differs from the previous by the body of several (1) object
- *<0,1, 2, .., n>* internal time axes (ticks)
- *e = <tick, con_to_ext_world>* - (registered) event:
  - Transaction time, login – minimal
  - Valid time, actor, reason, comments
- *<e1, e2, …, en> - DB chronicle*

Dynamic notions for object

- Object lifeline = $lf = \langle b_{i1}, b_{i2}, \ldots, b_{in} \rangle$ sequence of object's bodies at ticks when it has been changed
- $\langle e_{i1}, e_{i2}, \ldots, e_{in} \rangle$ - *object's chronicle events that concern ticks when the object's body has been change*

What is important in regards to TI?
(for operational support)

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Solutions

a) Time stamping with ticks not with real time + Index: tick->event (e.g. transaction, valid time) + represent event as an object (valid time)

b) Index: object -> all ticks that lead to changes in its body

c) Index: tick <-> trans. time & Index: <object, tick> -> all elements of objects body at tick ()

d) Index: <object,tick>->event

Drawbacks

- TI will be consistent only if we accept a “monotonous” hypothesis (at least for each object)
- Only changes in standard neighbourhoods around objects are easily accessible
- Only prioritised tasks are easy to complete and they works fast
- All other queries requires special programming

Realization upon SQL DBMS

Tables & Views

- Meta-tables, e.g.:
  - Domain: <*domain*> -> <*last_surr*>
  - Link: <*link*> -> <*source_dmn, target_dmn*>
- System tables, e.g.:
  - Tick: <*tick*> -> <*transaction time, login*>
  - Object: <*object*> -> <*first_tick, last_tick, last_op*>
  - Event: <*object,tick*> -> <*event/NULL*>
  - Code: <*code*> -> <*text, explanation*>
  - Blob: <*blob_id*> -> <*blob_content*>

Realization upon SQL DBMS

Tables & Views

- Object tables:
  - oname: <*surr_id*> -> <*tick, deleted, [owner_surr], attributes and single links*>
  - oname_h: <*surr_id*> -> <*created_tick, close_tick, [owner_surr], attributes and single links*>
- Views
  - Superdomain: Union of object tables

Realization upon SQL DBMS

Introducing changes

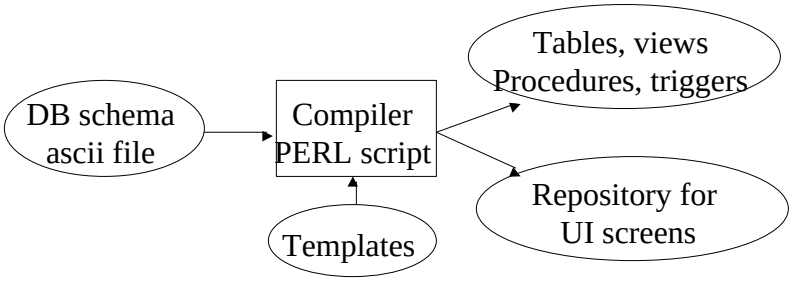
- System tables are updated by application through stored procedures, e.g.:
  - *start, end*
  - *create_object, update_object*
  - *close, revive*
- History tables (_h tables) are updated through triggers when object tables are updated
  - *tr_insert, tr_update, tr_delete*
- Locking strategy: *optimistic*

Realization upon SQL DBMS

Querying

- *Querying current state:*
  - *oname tables*
- *Listing events:*
  - *Event table* X *user_event*
- *Querying past states:*
  - *oname_h tables*
  - *Tick table*

Current implementation



Current support: MS SQLserver (from 7.0), Oracle (from 7.3)

UI – Prolifics (from Prolifics Inc, former JYACC)

Used in *ProBis – business process support system*

Project history

- First version: 1989-1990 upon Btrieve record manager under DOS Networks
- Used in:
  - *DealDriver* - sales and order processing
  - *SoftMotors* - administration of car service
- *SoftMotors* won OMDG Object Applications of the Year Awards 1997

Additional reading

From passive to active data models

Bider, I., Khomyakov, M. If You Wish to Change the World, Start with Yourself: An Alternative Metaphor for Objects Interaction.
www.ibissoft.se/English/tango/tango.pdf

More literature on the topic can be found on our website: ww.ibissoft.com/english/index.htm

Questions and Discussion

Thank You!

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