Temporal Databases

Temporal DBs – Motivation

- Conventional databases represent the state of an enterprise at a single moment of time
- Many applications need information about the past
  - Financial (payroll)
  - Medical (patient history)
  - Government
- **Temporal DBs**

A system that manages ***time varying data***

Database that stores information about the state of real world across time.

Comparison

- Conventional DBs:
  - Evolve through transactions from one state to the next
  - Changes are viewed as modifications to the state
  - No information about the past
  - Snapshot of the enterprise
- Temporal DBs:
  - Maintain historical information
  - Changes are viewed as additions to the information stored in the database
  - Incorporate notion of time in the system
  - Efficient access to past states

Temporal Database Models

- Temporal Data Models: extension of relational model by adding temporal attributes to each relation
- Temporal Query Languages: TQUEL, SQL3
- Temporal Indexing Methods and Query Processing

Taxonomy of time

- Transaction time databases
  - Transaction time is the time when a fact is stored in the database
- Valid time databases:
  - Valid time is the time that a fact becomes effective in reality
- Bi-temporal databases:
  - Support both notions of time

Example

- Sales example: data about sales are stored at the end of the day
- Transaction time is different than valid time
- Valid time can refer to the future also!
  - Credit card: 03/01-04/06

Example : Queries

- Queries:
  - Timestamp (timeslice) queries: ex. “Give me all employees at 05/94”
  - Range-timeslice: “Find all employees with id between 100 and 200 that worked in the company on 05/94”
  - Interval (period) queries: “Find all employees with id in [100,200] from 05/94 to 06/96”

What is time varying data?

- You want a reprint of a customer's invoice of August 12, 1999.
- What was the stock value of the Oracle shares on June 15th, last year?
- What was the lowest stock quantity for every product last year? How much money will you save, if you keep the stocks at those levels?
- Where do you enter the new address of this customer as from the first of next month?
- What will your profits be next month, given the price list and cost prices by then?

What is time varying data?

Examples of application domains dealing with time varying data:

- Financial Apps (e.g. history of stock market data)
- Insurance Apps (e.g. when were the policies in effect)
- Reservation Systems (e.g. when is which room in a hotel booked)
- Medical Information Management Systems (e.g. patient records)
- Decision Support Systems (e.g. planning future contigencies)
- CRM applications (eg customer history / future)
- HR applications (e.g Date tracked positions in hierarchies)

What is time varying data?

In fact, time varying data has ***ALWAYS*** been in business requirements – but existing technology does ***not*** deal with it elegantly!

Temporal DB Design Approaches

Several implementation strategies are available

- Use a date type supplied in a non-temporal DBMS and build temporal support into applications (*traditional*)
- Implement an abstract data type for time (*object oriented*)
- Provide a program layer (*API*) above a non-temporal data model.

Implementation Approaches

- Generalise a non-temporal data model into a temporal data model (*Temporal Normal Form*)
- Re-design core database kernel (*pure Temporal Database*)