Time mapping system

A research on building map system with additional time dimension

Viet Vu

UET, VNU

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Supervisor: Assoc. Prof. Nguyen Viet Ha

Outline

Introduction

- Understanding History is difficult
  - Hard to image
  - Missing
- History are featured by events
  - What, when, where it happened?
  - These events are related
  - To understand, need to consider the connections
- The data changes
  - New data is found
  - To make a conclusion: Need to review the new events set

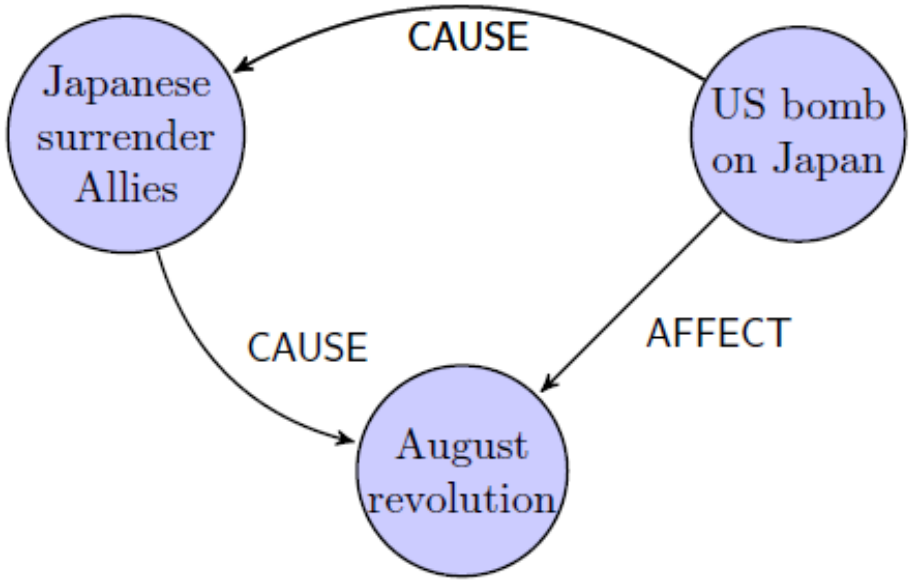


Figure: August revolution events relationships

Overview

- Need a method to modeling data
  - Data is featured by: Location, time
  - There are relationships between data
- Mechanism to visualizing data for better understanding
  - Show changes of data through time
  - Show relationships of event on the map
- Purpose of the thesis is to build
  - Method to model map with time data
  - Propose mechanism to visualize these data
  - Implement a framework for building map system on top of it

Data model

- Events are related to each other
  - It is appropriate to use graph to model these data
  - Reasonable, easy to image
- Events and relationships are modeled by a directed graph
- Events are **nodes**
- Relationships are **edges**

Graph

Field name	Meaning
id	id of the node
name	name of the event
lon	longitude
lat	latitude
time	time when event happened
description	description of the event
keywords	keywords featured the event

Table: Attributes of nodes

Field name	Meaning
id	id of the relationship
type	type of relationship
name	name of the event
from	id of start node
to	id of end node

Table: Attributes of egdes

Types of relationships

- Connected events
- Are edges in graph. Divided in 2 groups
- **Change attribute relationship**: Node's attribute are different
  - *CHANGE_LOCATION*
  - *CHANGE_NAME*
- **Connecting relationship**
  - *CHILD*

VNU timeline

A sample of modeled data on VNU and its member, on a timeline.

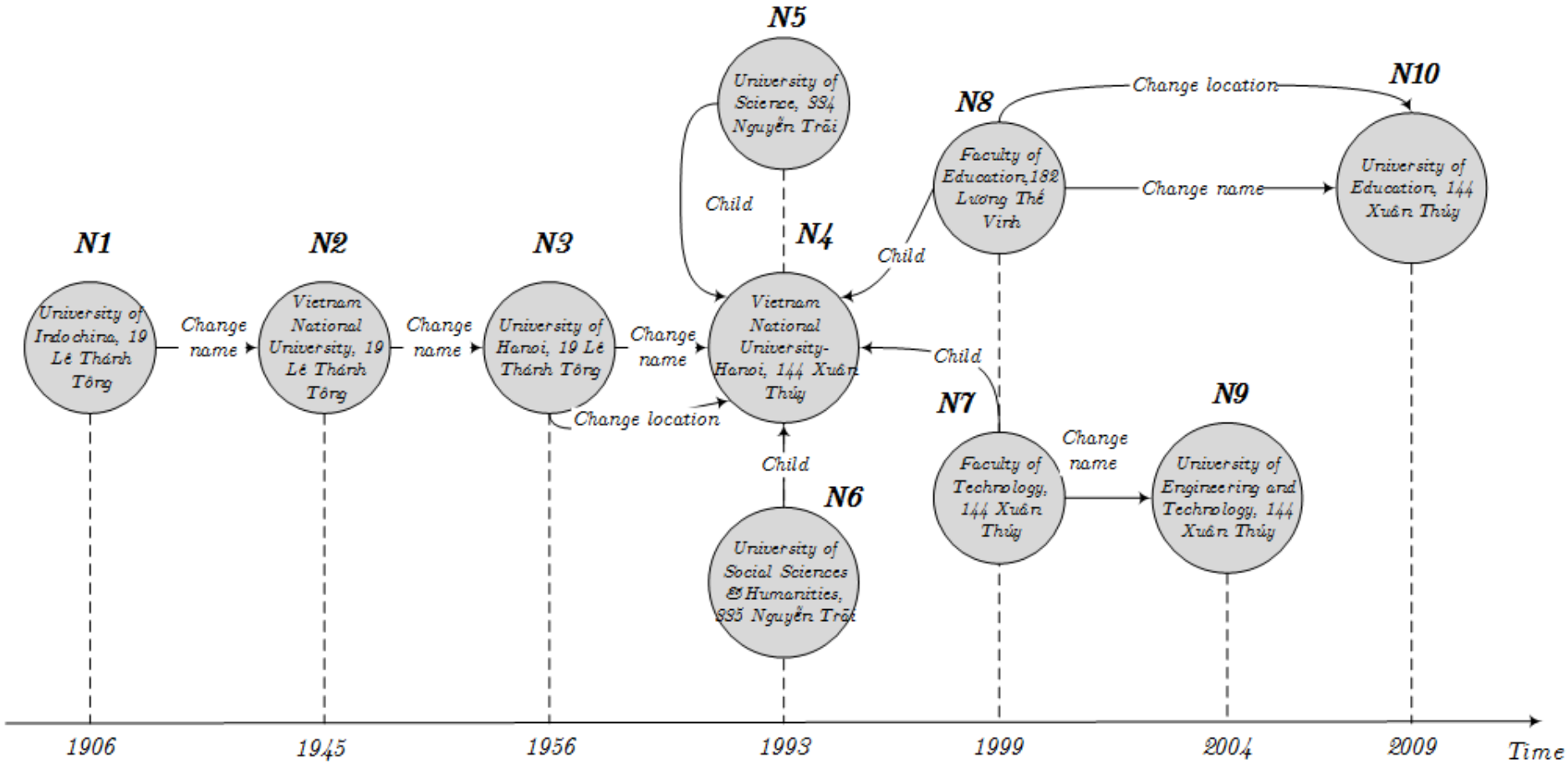


Figure: Timeline of VNU and its members

Definitions

- **Object:** set of nodes: connected to each other, have different attributes, and describe the same thing.
- **Current time:** with given time t, *current_time* greatest value of attribute *time* in all nodes of an object o, and $time \leq t$.
- **Window_time**: Define the range of *current_time*. The size of *window_time* is *window_size*.
- **Current state:** Set of nodes represents for objects in database, at *current_time*, with *window_time*.

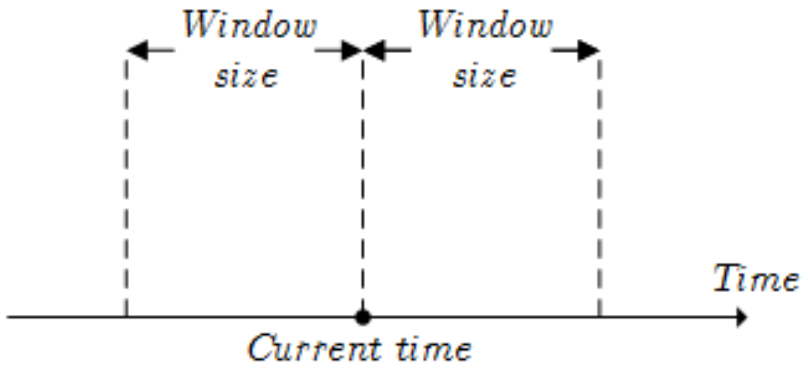


Figure: *window_time* with *current_time* and *window_size*

Queries sets

Set of queries performed on database

- **Query current view:** Get nodes corresponding to *window_time* of the database.
- **Query object:** Get nodes represent an *object*.
- **Query related object:** Get related nodes to given *node*.

Visualizing mechanisms

- Purpose
  - visualize modeled data for better understanding
  - show changes of data corresponding to time on the view
- Map each node to a marker on the map
- Change view on map based on current time

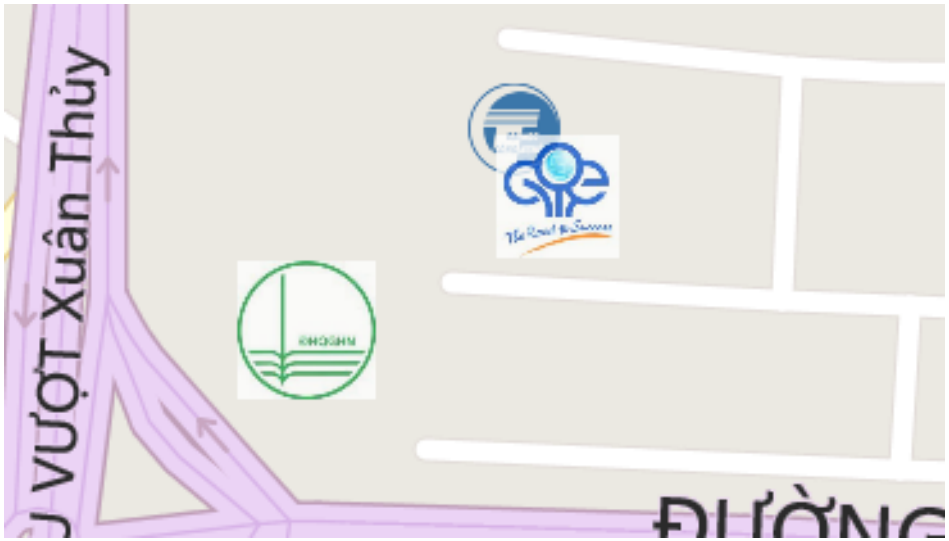


Figure: Node view on map as layer

Visualizing mechanism

- Change current view based on time
  - Query new current state, redraw
- View timeline of a object
  - View the change of specific location through time.
- View related object
  - View the related nodes on view.

System architecture

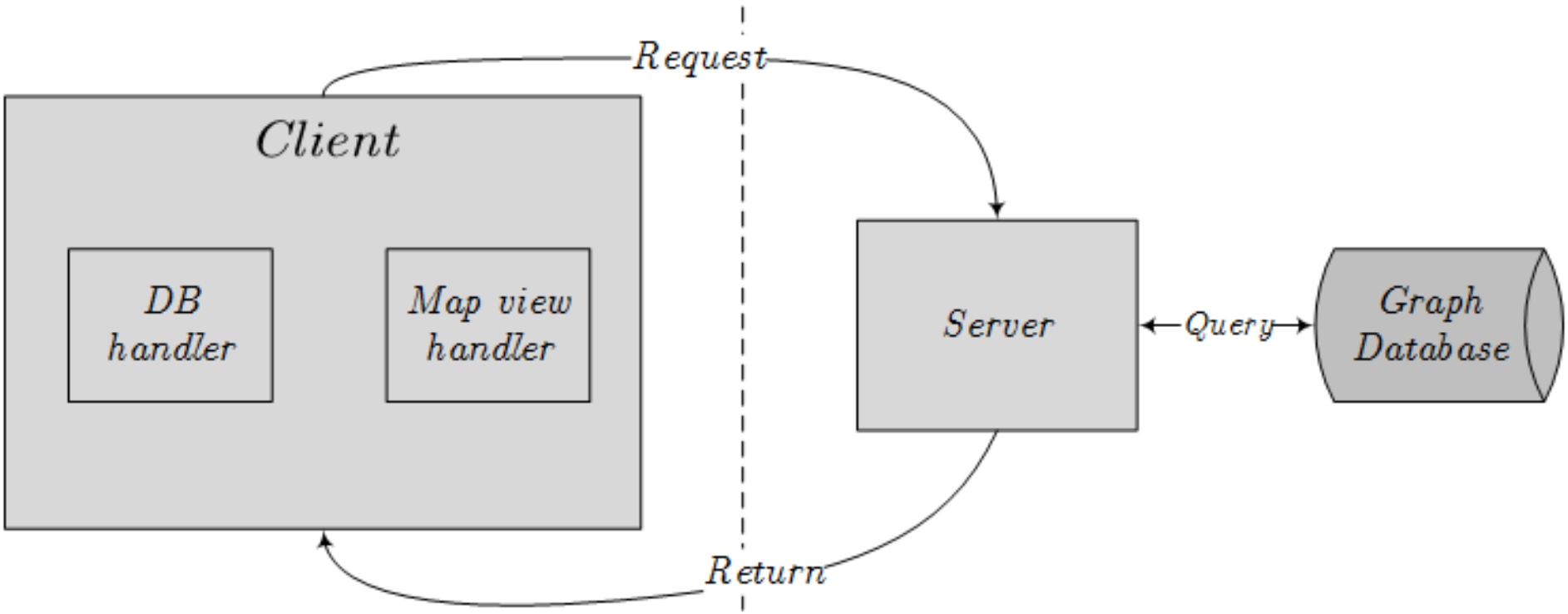


Figure: System architecture

Expriments specifications

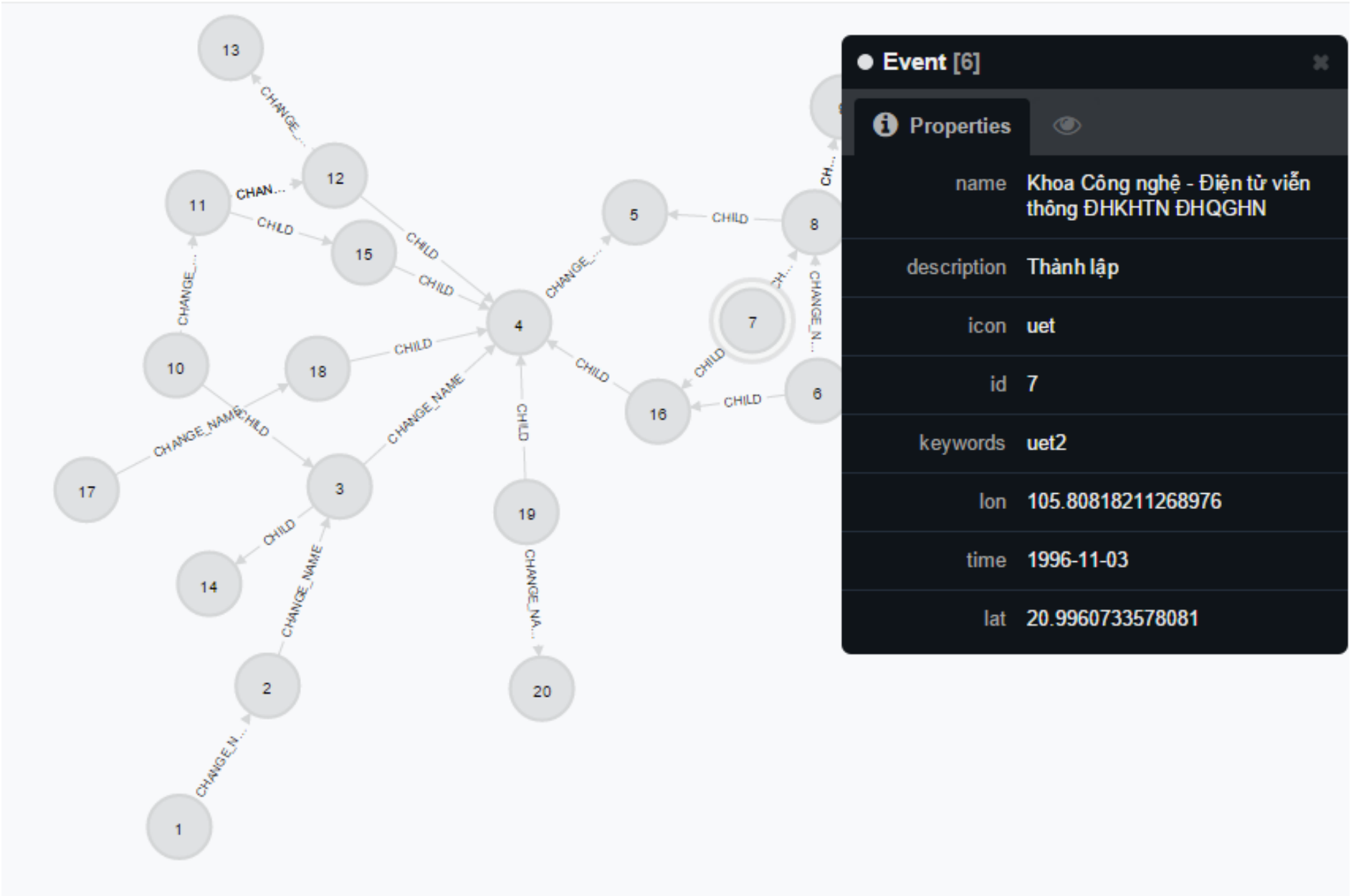
- Implemented
  - Data model on graph database
  - Client run on web browser
- Demo data
  - 20 events of VNU and its members since 1906
  - 26 relationships between events

Name	Details
Client	Laptop HP 4530s on Windows 8.1. CPU: 2x2.3GHz. Memory: 4GB.
Webserver	Apache 2
Tools & verions	Openlayers 3.0; Neo4j 2.1.6; JQuery 1.11
Network	Local area network

Table: Experiments environment

Table: System specification

Database view



Client view

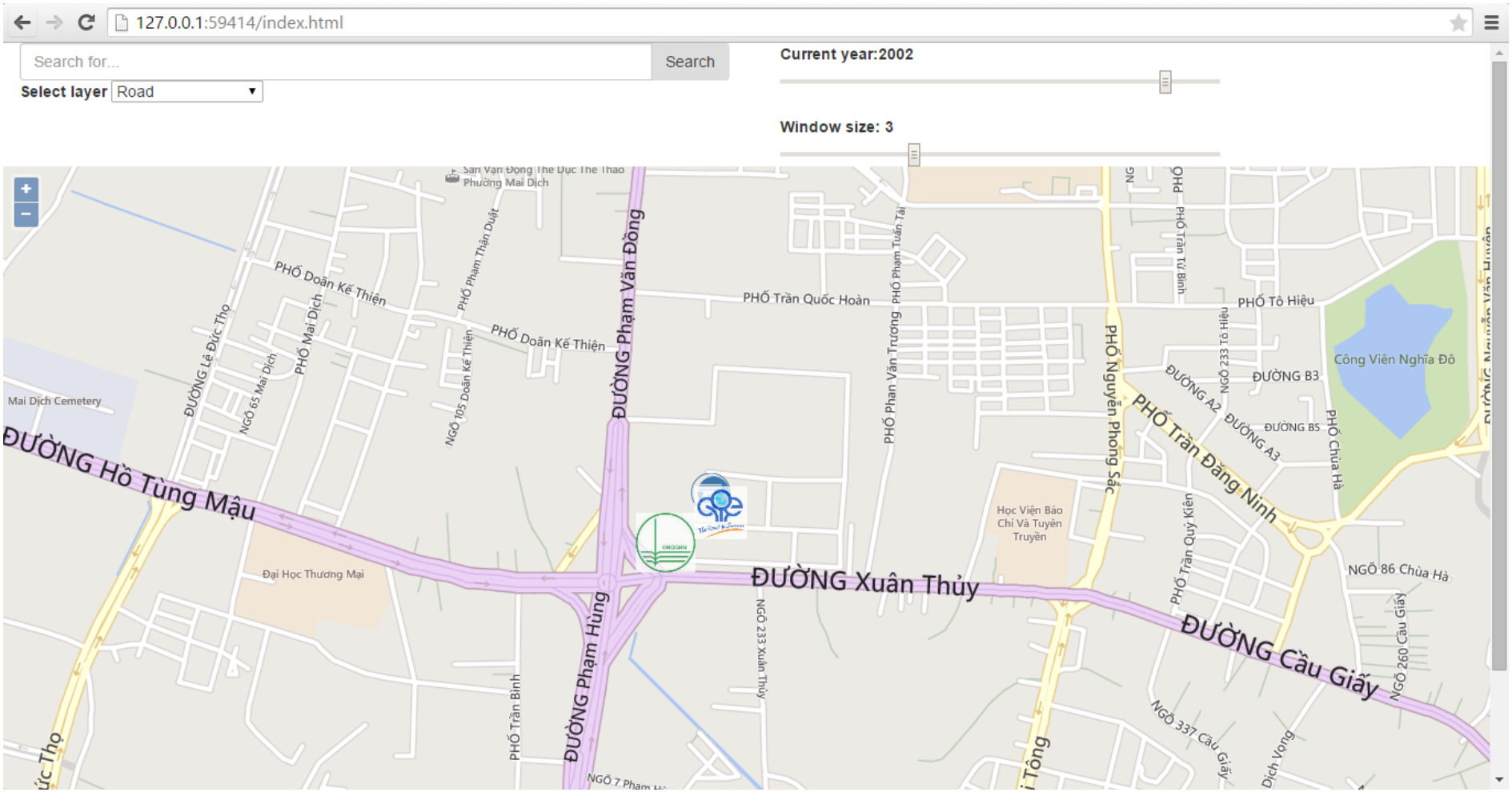


Figure: Data in graph DB

Conclusions

Achievements

- Proposed method for modeling map data with time information using Graph theory
- Proposed mechanisms for visualizing the data, user interaction
- Implementation experiments using Graph Database and Web technology
  - The system showed the feasibility of the approach

Drawbacks

- Data size is too small
- Too few relationships between events
- Only working with point data, haven't considered regional data

Future work

The work in this thesis can be improved in the future:

- Work on a larger data set
- Work on regional data, not just point
- Refine data model
  - Provide more relationships between events
  - Add weight for relationships for path selection
  - Method to determine type of relationships and weight automatically

Thank you for your attention

Get current node algorithm

Algorithm 1 Get current nodes procedure

```
function GET_CURRENT_NODES(nodes, time, window)
    if exist c_nodes in nodes and node.time in [t − s, t + s] then
        return c_nodes
    else
        return node with greatest node.time in nodes
    end if
end function
```

Figure: Get current nodes

Get current state algorithm

Algorithm 2 Query *current_state* with *current_time*, *windo_time*

```
function QUERY_TIME(t, s)
    results := []
    fetch nodes in database
    while empty not nodes do
        fetch first node in nodes
        get object_nodes of node, same object in nodes
        remove object_nodes from nodes
        object_nodes = get_current_nodes(object_nodes, t, s)
        results := results + object_nodes
    end while
    return results
end function
```

Figure: Get current state

View timeline

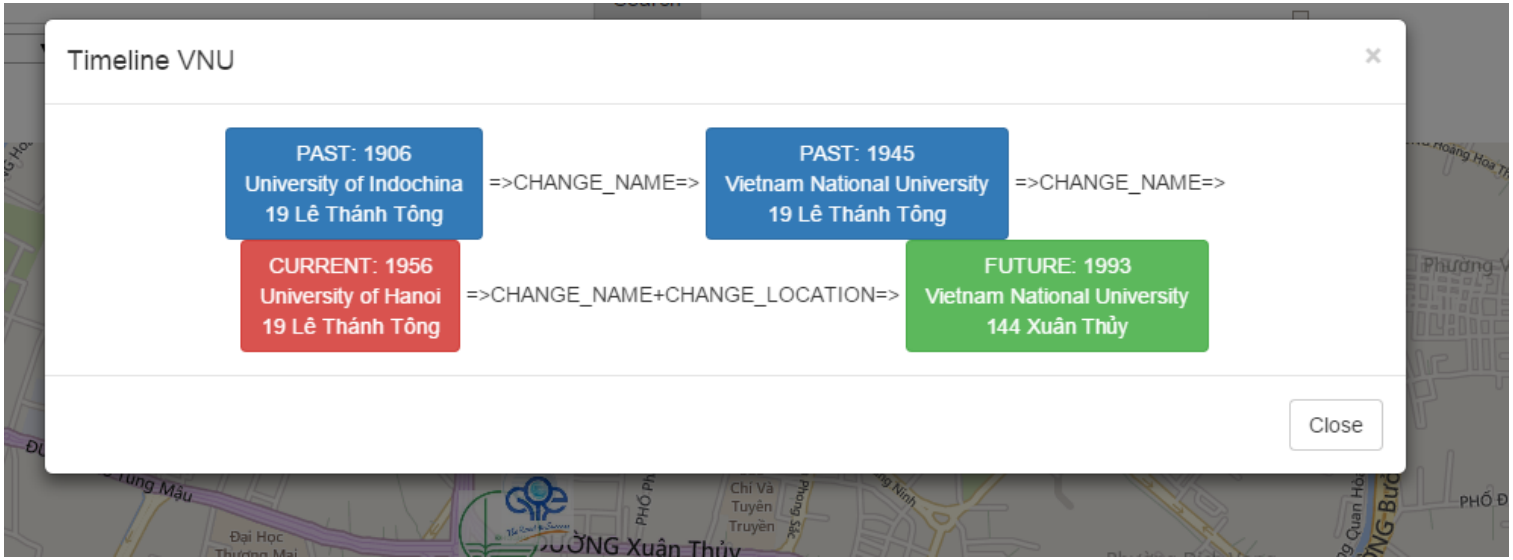


Figure: View timelime