The Architecture Of Mobile Traffic Map Service
BJ JANG, Hayan Shin
Total Traffic Information Service

Sponsored by NTIC (National Transport Information Center)

Mobile Traffic Map Service
Background

- About NTIC (our customer)
  - National Transport Information Center is a national organization belonging to the Ministry of Land, Infrastructure, and Transport
  - Role: Traffic Information Collection, Processing, Providing

- Collected content
  - Wide-area (whole Korea) traffic information
  - Traffic cast CCTV
  - Vehicle Message Content Service (VMS)

- Provided Information
  - Real-time road flow information
  - Standardized Node/Link data of roads (for ITS)
  - Short/long distance travel route information
Background

- NTIC’s Requirements
  - Deliver Real-Time Traffic Information to Users
  - To Disperse Traffic on major national holidays
    - Lunatic New year’s first day, Chuseok

- Environment at System Peak Times
  - About 30 million people move to visit hometowns and families
  - Most of them have Smartphone
Overview of Main Features

- Traffic status on roads and highways up on geographical map
  - Support interactive zoom in/out
  - 3 Steps colorized traffic data
  - Updates every 5 minutes

<table>
<thead>
<tr>
<th>Road</th>
<th>&gt;40km/h</th>
<th>20~40 km/h</th>
<th>&lt;20km/h</th>
</tr>
</thead>
<tbody>
<tr>
<td>City highway</td>
<td>&gt;40km/h</td>
<td>20~40 km/h</td>
<td>&lt;20km/h</td>
</tr>
<tr>
<td>Highway</td>
<td>&gt;80km/h</td>
<td>40~80 km/h</td>
<td>&lt;40km/h</td>
</tr>
</tbody>
</table>
Overview of Main Features

- Traffic status on roads and highways up on geographical map (continue)
  - Traffic accidents information
  - CCTV on roads (over 1000 points)
  - KMA Weather Forecast/Warning
Architecture(2011)

- 30,000 users
- adopt Open Source GIS
- request one-size image non-tiled
- don’t consider cache

<table>
<thead>
<tr>
<th>Info Server</th>
<th>Map Server</th>
<th>Geo DB Server</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobile Data Provider</td>
<td>GeoServer2.0.3</td>
<td>PostGIS</td>
</tr>
<tr>
<td>MobileManager</td>
<td>WAS(Tomcat7)</td>
<td>1.5.3</td>
</tr>
<tr>
<td>WAS(Tomcat7)</td>
<td>Windows Server</td>
<td>PostgreSQL 8.4</td>
</tr>
<tr>
<td>Windows Server</td>
<td></td>
<td>Windows Server</td>
</tr>
<tr>
<td>Oracle</td>
<td></td>
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</tbody>
</table>
Problems on Existing System

- Absence of Cache Server
  - Request for same region data
  - So, Frequent GeoServer Down at Peak Times

- Reliability issue
  - Take lots of time to import traffic data into PostgreSQL
  - Doubt on GeoServer, PostGIS, PostgreSQL about low performance
System Improvement Goals in 2012

- NTIC’s Requirements
  - Support 200,000 Users Per Day
  - Change DBMS to SQL Server
  - Consulting about Open Source GIS

- Our Solutions
  - Reconstruct System Architecture and Redevelop SW
  - Change Mobile Client Request to Tiled Map base
  - Adopt Squid proxy server with SSD as Cache Server
  - To determine Effective Tiled Map Time and Region: Using
    - WMTS interface
    - content expire time
    - custom Time tag
  - Produce Tiled Map data every 5 minutes in advance
Architecture (2012)

- Support 200,000 Users
- 256x256 tiled map
- Apply OpenLayers Cache Structure into Mobile App (Android and iPhone App)
- Apps Polling traffic map every 5 minutes
- Compliance to Cache flow of HTTP 1.1

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</table>
| Mobile Data Provider
MobileManager
Tomcat 7 (WAS)
Windows Server | Squid Proxy Server 2.7
Windows Server | GeoServer 2.1.4
Tomcat 7 (WAS)
Windows Server | SQL Server 2008 R2
Windows Server |
Results

- System Endured at Peak Times but, Not Satisfied Level
  - Sometimes Response Time went slowly
  - Transaction increased 10 times per User owing to tiled map
  - Polling Map Strategy causes unnecessary requests
  - Squid had in trouble when it reaches to over 100,000 Connections

- Impossible to update tiled traffic map data within 5 minutes
  - Traffic Map Data consist of 10 levels (Zoom level) ~over 1 million tiled maps.
  - So, within 5 minutes, only 8 level-map data can be updated.
Results

Scalability Issue

- Cache Server UP → GeoServer & SQLServer UP
- Cost UP
- Cache Maker requests UP
- SQLServer Load UP (n times)
Improvement Strategy

- GeoServer connects to PostGIS instead of SQL Server -> Cost Down, Speed up Spatial Query
- Adopt Memory Disk for Cache Server instead of SSD
  -> Cost Down
- Push Tiled Traffic Map data into Cache Server
  -> Reduce Transaction time
- Drop Polling method every 5 minutes to update traffic map -> Reduce Transactions
Support 300,000 users per day
- PostGIS to Query Spatial data
- Request map only when client’s map view changing
- Push tiled traffic data into Cache server

Traffic Data Streaming Replication

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<th>Map &amp; GeoDB Server</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobile Data Provider</td>
<td>Squid Proxy Server 2.7</td>
<td>GeoServer 2.3</td>
</tr>
<tr>
<td>MobileManager</td>
<td>NGINX (Web Server)</td>
<td>PostGIS 2.1</td>
</tr>
<tr>
<td>Tomcat 7 (WAS)</td>
<td>Windows Server</td>
<td>PostgreSQL 9.2</td>
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<tr>
<td>Windows Server</td>
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</table>
Tile Generation Manager

- Divide jobs for each GeoServer clearly
  To Produce map tile data in parallel
- Push Tiled Traffic Map data into Cache Server

For more connection, just add cache server ➔ more scalable
TileMap Update Idea!

- Changing data are only roads
- # of Map Tiles that roads across is Not Much!

- So, Update Map Tiles Passing roads Only When Traffic Condition Changed, Instead of All the tiles!

Mobile Apps can get Changed TileMap Only
## Improvements

<table>
<thead>
<tr>
<th></th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial (Total) tile</td>
<td>90 minute</td>
<td>6~7 minute</td>
</tr>
<tr>
<td>Generation</td>
<td>(empty tile included ~over 1,437,000 tiles)</td>
<td>(road tile only ~183,000 tiles)</td>
</tr>
<tr>
<td>Update interval of Tile</td>
<td>5 minute</td>
<td>1 minute</td>
</tr>
<tr>
<td>Generation</td>
<td>(8 levels, not modified or empty time</td>
<td>(10 levels, modified tile only)</td>
</tr>
<tr>
<td></td>
<td>included)</td>
<td></td>
</tr>
<tr>
<td>Users per day</td>
<td>200,000</td>
<td>&gt;300,000</td>
</tr>
<tr>
<td>Scalability</td>
<td>Not good</td>
<td>Very good</td>
</tr>
</tbody>
</table>

In Service Now!
Lessons Learned

- To persuade customer to adopt OpenSource GIS
- Need confidence of Performance about OpenSource GIS
  - Make sure that OpenSource GIS has equivalent performance to commercial products
Q&A