

# Step toward to a Cloud Computing Based Spatial Data Infrastructure

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# Spatial Data Infrastructure

- A framework of spatial data, metadata, users and tools that are interactively connected
- In order to use spatial data in an efficient and flexible way
- *The technologies, policies, standards, human resources, and related activities necessary to acquire, process, distribute, use, maintain, and preserve spatial data*

# Software components

- » A SDI should enable the discovery and delivery of spatial data from a data repository, via a spatial service provider, to a user. As mentioned earlier it is often wished that the data provider is able to update spatial data stored in a repository. Hence, the basic software components of an SDI are
- ▶ a software client - to display, query, and analyze spatial data (this could be a browser or a Desktop GIS),
  - ▶ a catalogue service - for the discovery, browsing, and querying of metadata or spatial services, spatial datasets and other resources,
  - ▶ a spatial data service - allowing the delivery of the data via the Internet,
  - ▶ processing services - such as datum and projection transformations,
  - ▶ a (spatial) data repository - to store data, e.g. a Spatial database,
  - ▶ GIS software (client or desktop) - to create and update spatial data
  - ▶ International Standards- to facilitate an interoperable framework across nations

# Taiwan

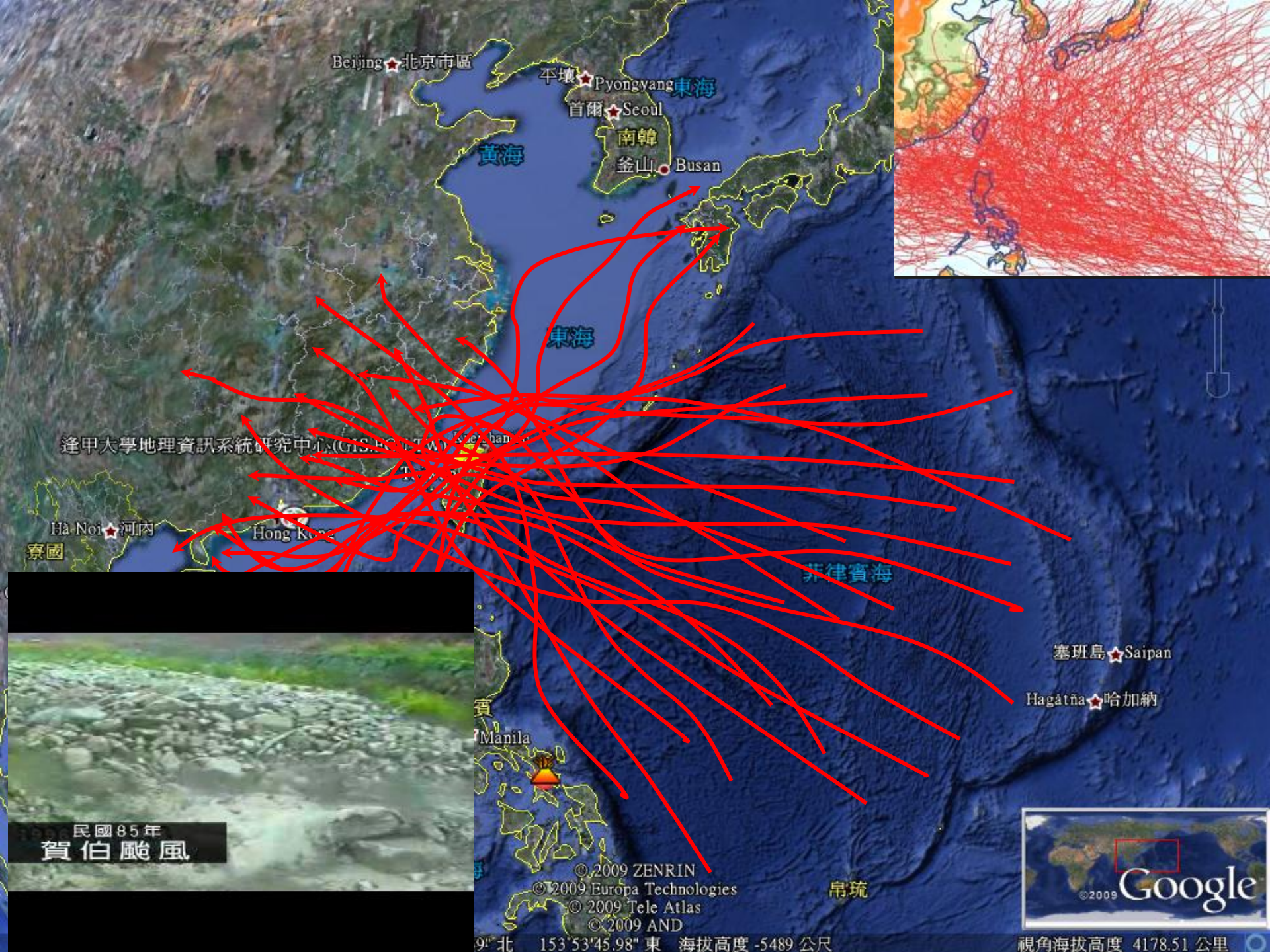
- Terrian :
  - 36,000 Km<sup>2</sup> with 26,000 Km<sup>2</sup> slope land (73%)
  - peak: 3952 m
- Population :
  - 23 million
- Land use :
  - Flat land: 24%
  - permanent crops: 1%
  - forests and woodland: 55%
  - other: 20%
- Natural hazards :
  - earthquakes and typhoons.







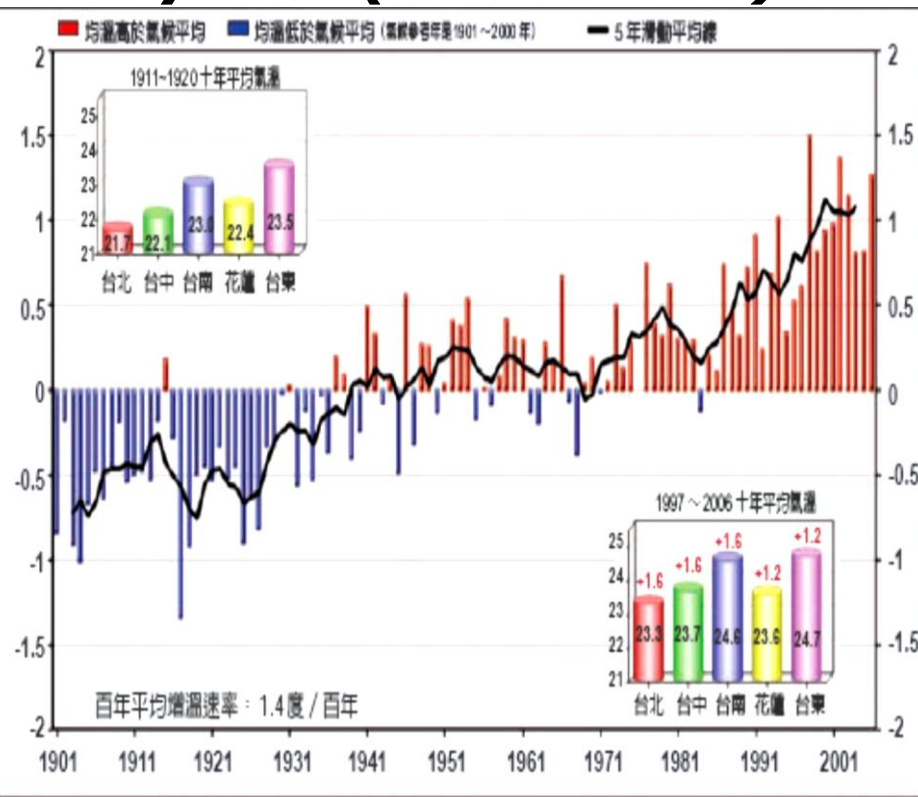




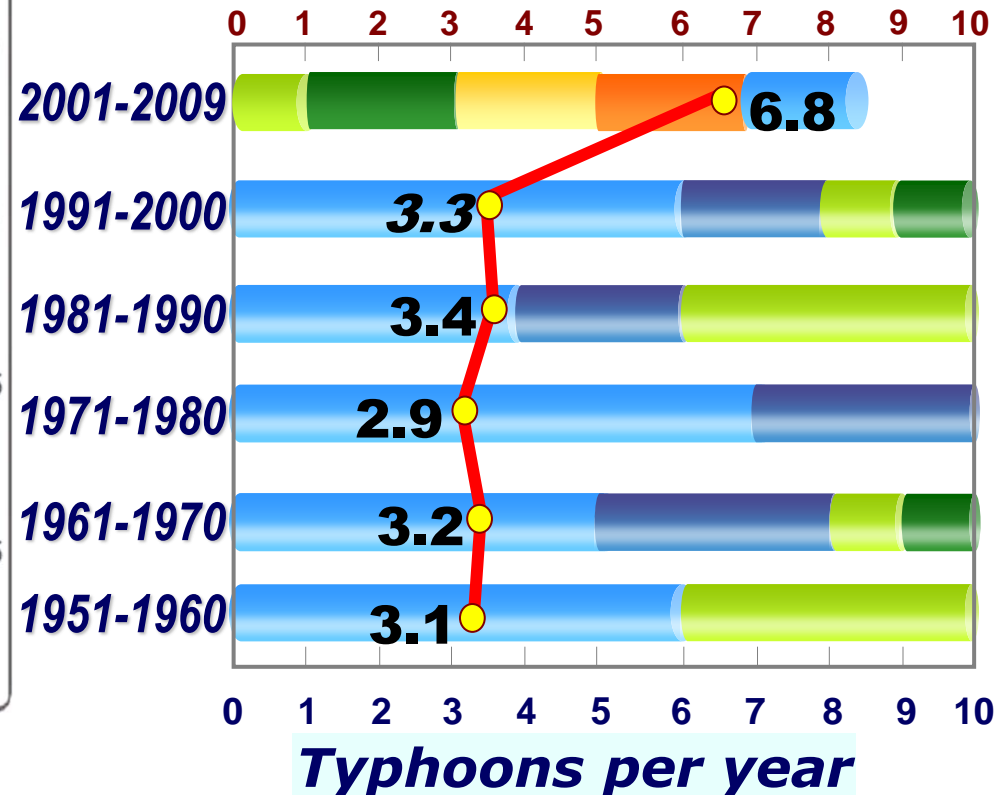


# ✓ *Climate Change in Taiwan*

**Temperature increases about  $1.4^{\circ}\text{C}$  in the last 100 years (1901-2006).**



**Number of typhoons increased dramatically after 2000.**



# Multi-Scale & Multi-Dimensional



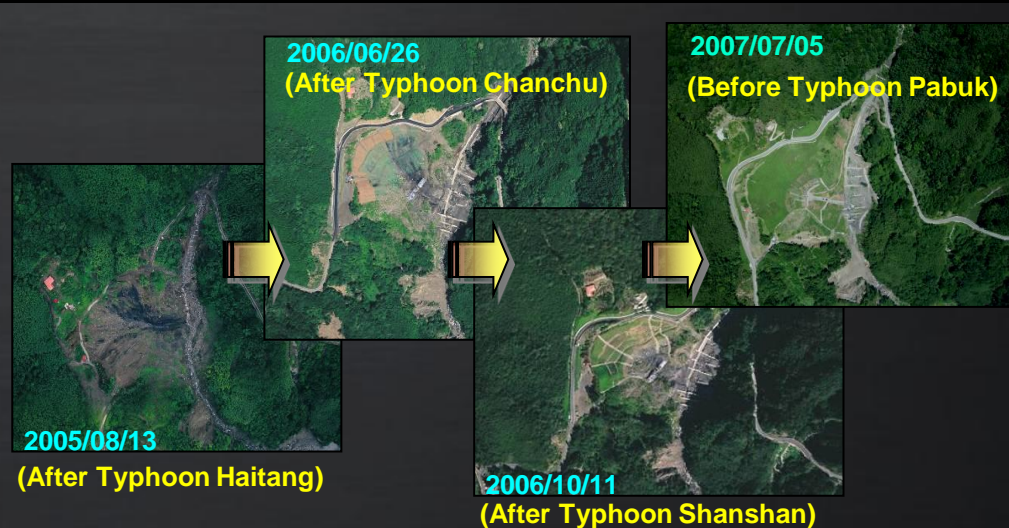
2005/09/09  
福衛二號(2M)



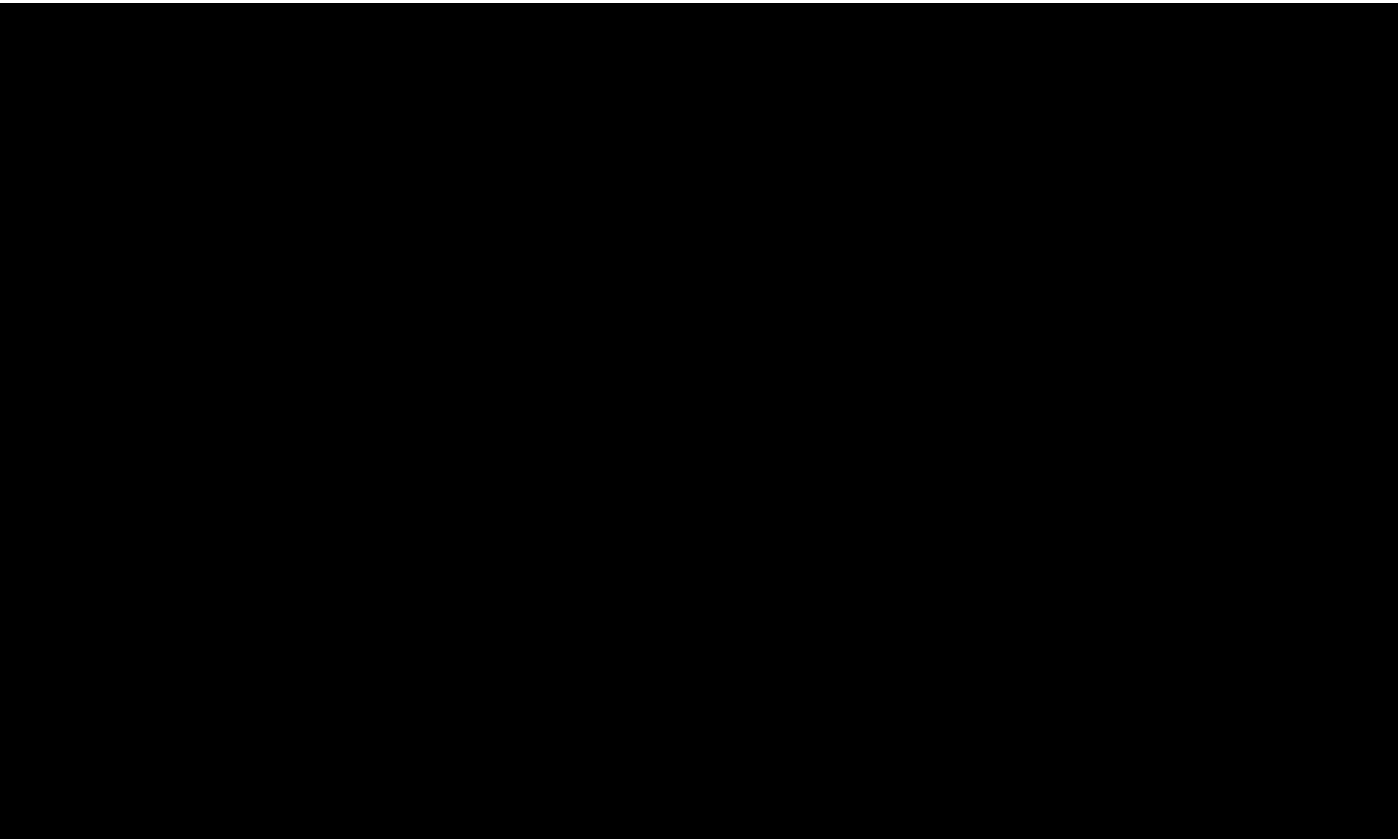
2005/12/23  
SPOT 5(10M)



2006/03/11  
SPOT5 (10M)



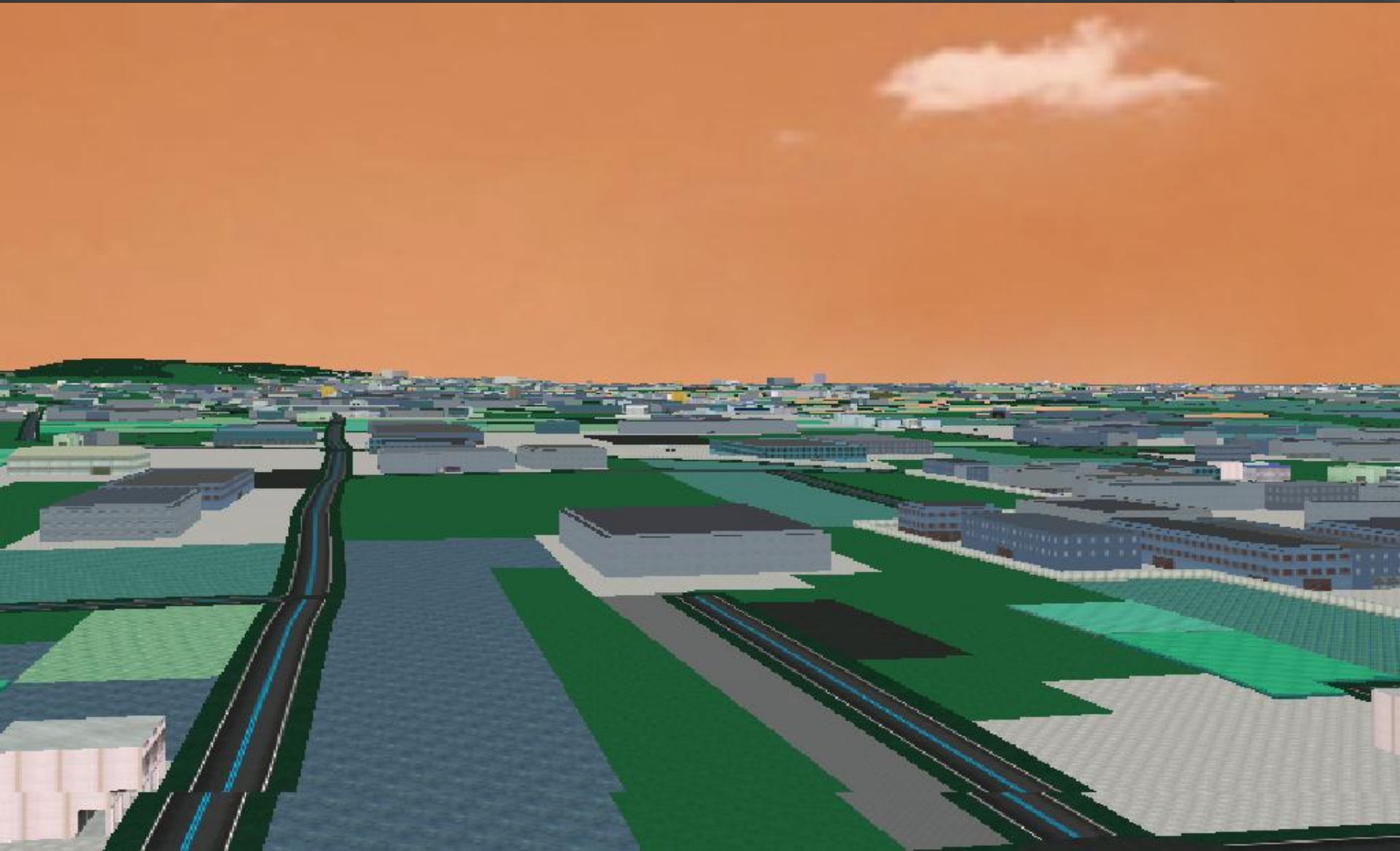
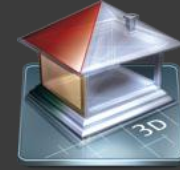








# 3D GIS



# SDI in real-world applications

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# Monitoring Stations

- 01.白布帆站 (Baibufan Station)
- 02.九份二山站 (Jiufen-Ershan Station)
- 03.神木站 (Shenmu Station)
- 04.上安站 (Shang-an Station)
- 05.郡坑站 (Jyunkeng Station)
- 06.豐丘站 (Fongciou Station)
- 07.大粗坑站 (Dacukeng Station)
- 08.鳳義坑站 (Fongyikeng Station)
- 09.射馬干站 (Shemangan Station)
- 10.華山站 (Huashan Station)
- 11.大興站 (Dasing Station)
- 12.豐山站 (Fongshan Station)
- 13.松鶴站 (Songhe Station)
- 14.坪頂站 (PingDing Station)
- 15.蘇樂站 (Suru Station)
- 16.玉峰站 (Yufong Station)
- 17.下田埔站 (Shiatainpu Station)
- 18.羌黃坑站 (Cianghuangkeng Station)
- 19.集來站 (Jilai Station)
- 20.來義站 (Laiyi Station)
- 21.大鳥站 (Daniao Station)



Debris Flow Monitoring Station × 17  
 Landslide Monitoring Station × 3  
 Sediment Concentration Monitoring Station × 3  
 Mobile Debris Flow Monitoring Vehicle × 3  
 Portable Unit × 14

# Debris flow monitoring

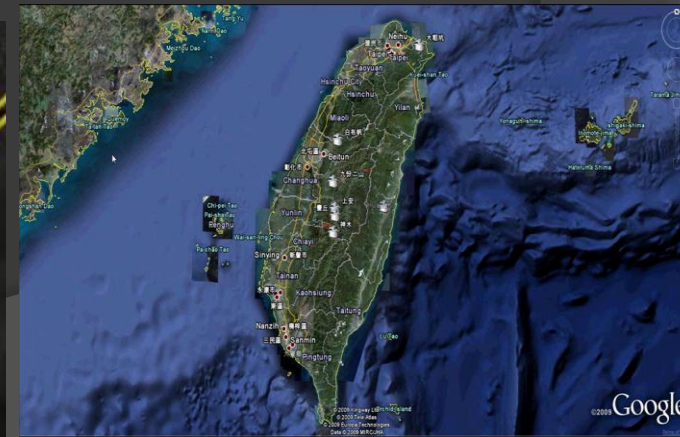
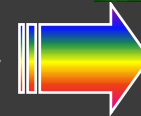
## Satellite communication



## Debris Flow Information System



## Information-receiving center





# Mobile debris flow monitoring station

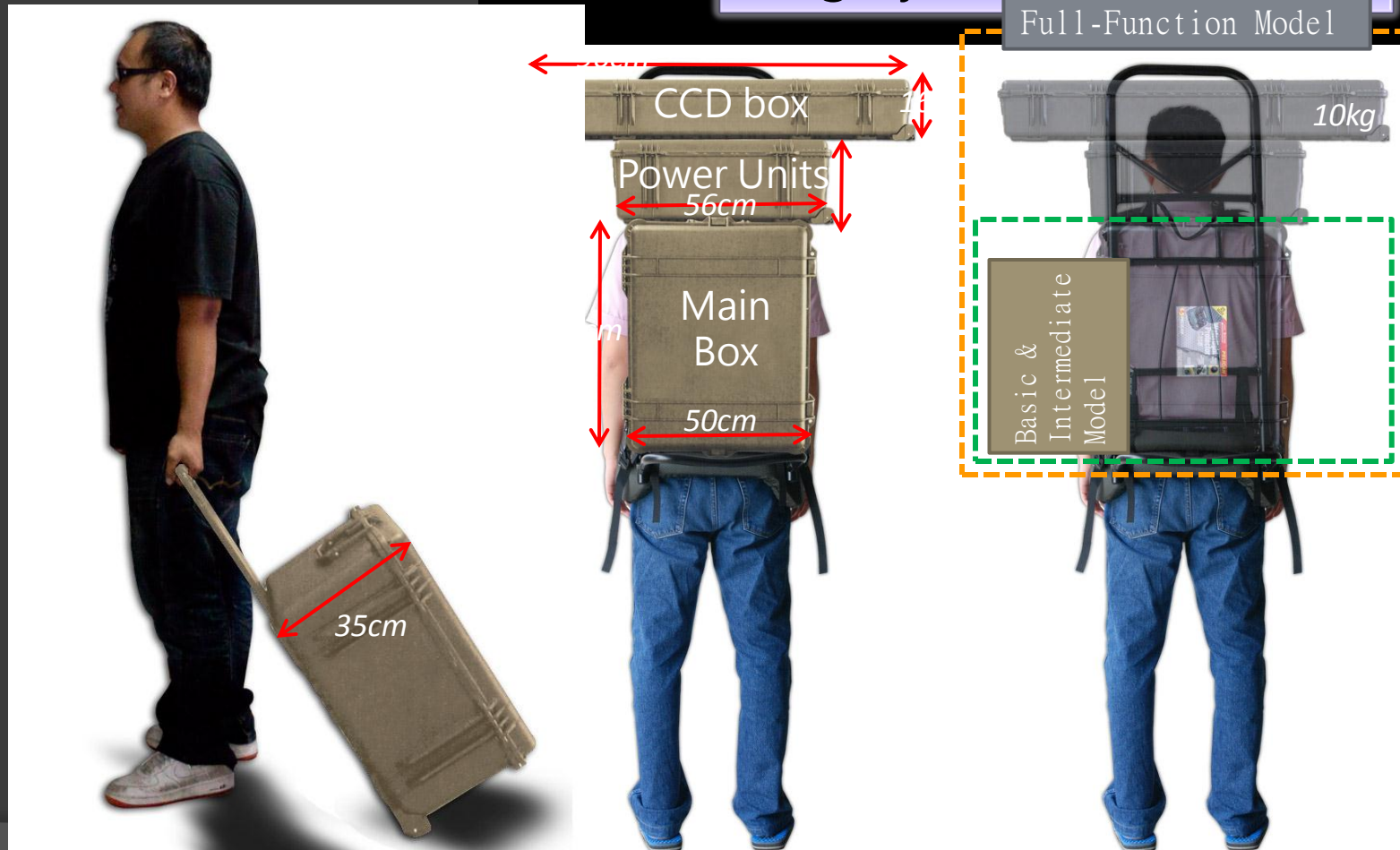


# Portable Unit

## Container and Carrier Design

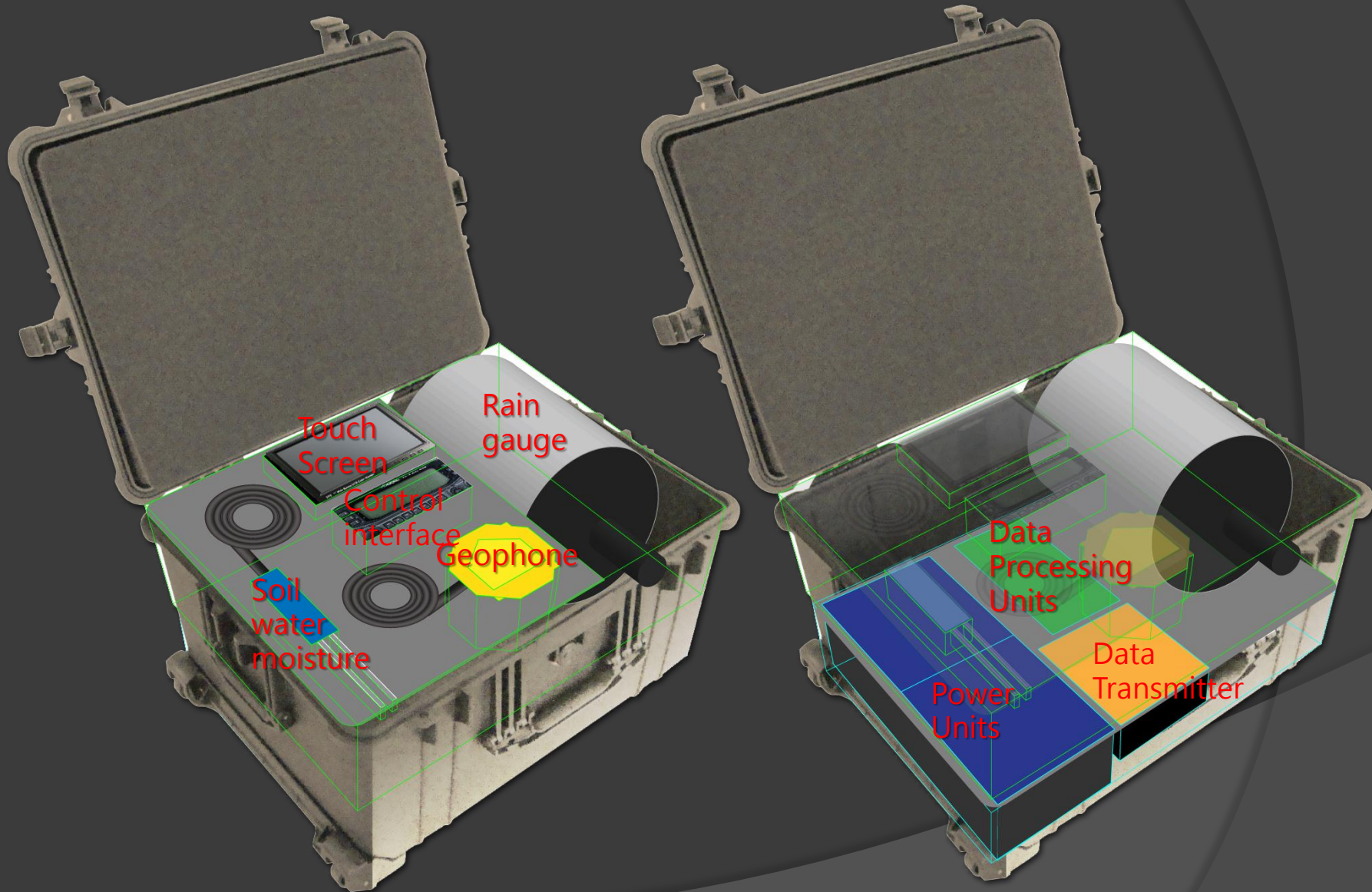
- ◆ Military-standard box
- ◆ Use cables and nails to fix the box.

- ◆ Aluminum-alloy carrier
- ◆ Carry on shoulder or drag by hand





# Portable Unit



Upper Layer

Bottom Layer



# Landslide Monitoring



Setup Mobile Station



Carry on portable unit



security



Carry down to top of the landslide



# Landslide Monitoring

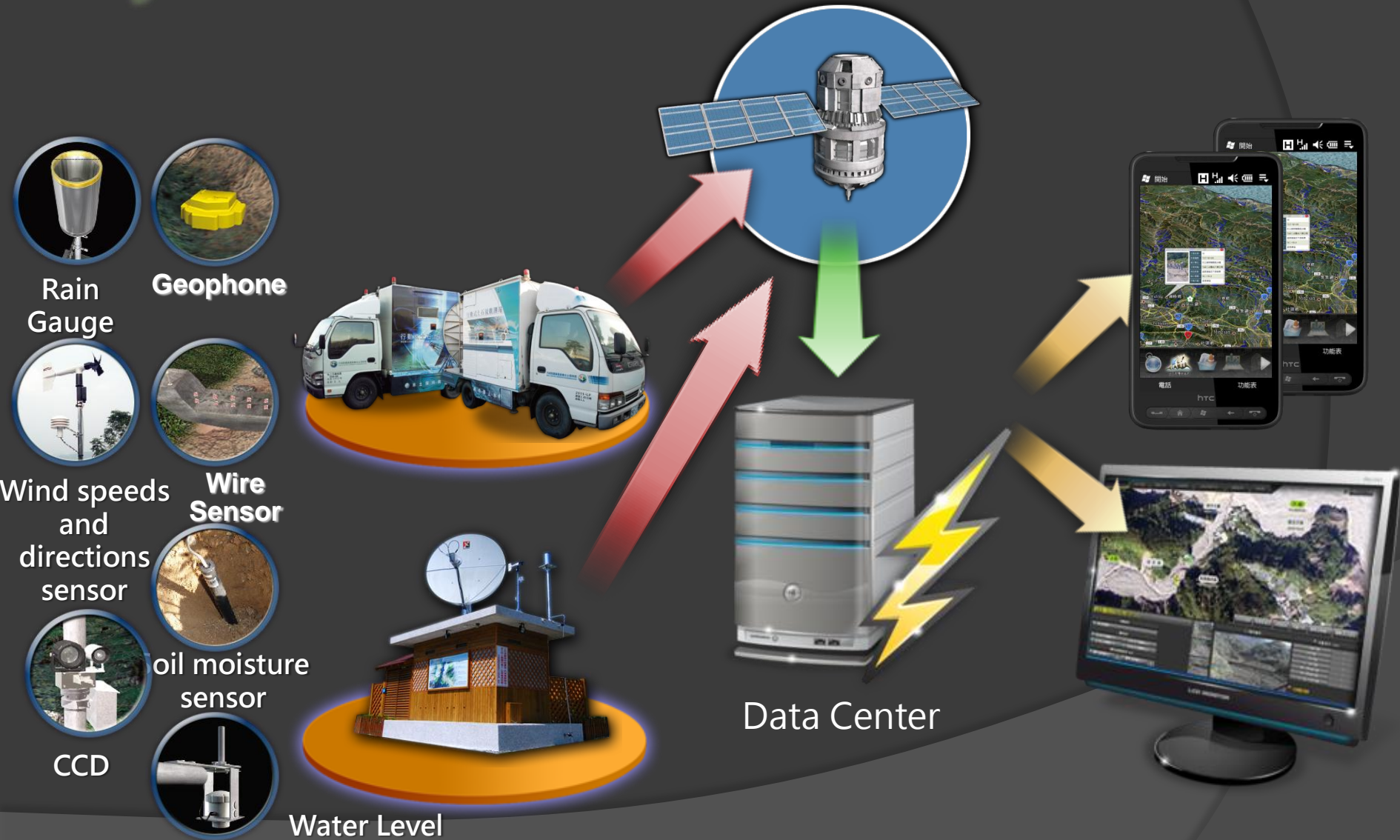


Setup portable unit



Working

# System Framework





# UAV for field Survey

## Main Equipments of UAV



Flight Information  
console

Flight Records

Signal Enhancement  
module



Real-time flight  
video monitors

Power  
management

Flight Information  
console



Agency1



Agency2



Agency3



Agency4



Agency5



SAS

GeoSMS



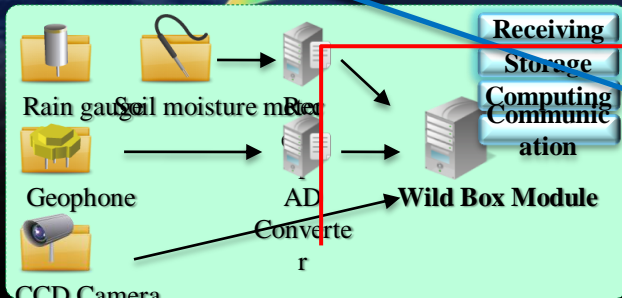
WFS  
O&M  
SOS

SensorML

GetObservation()

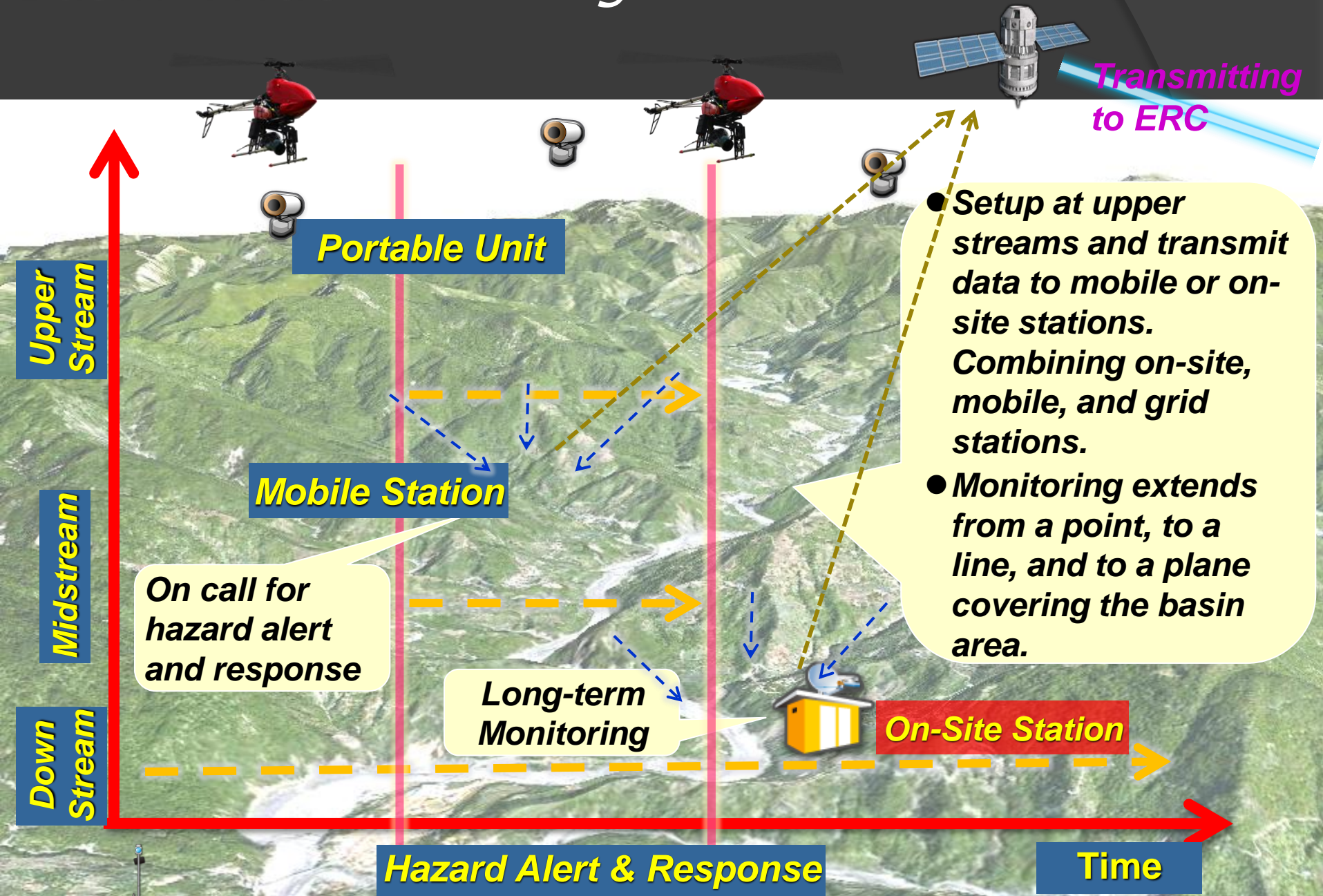


SPS



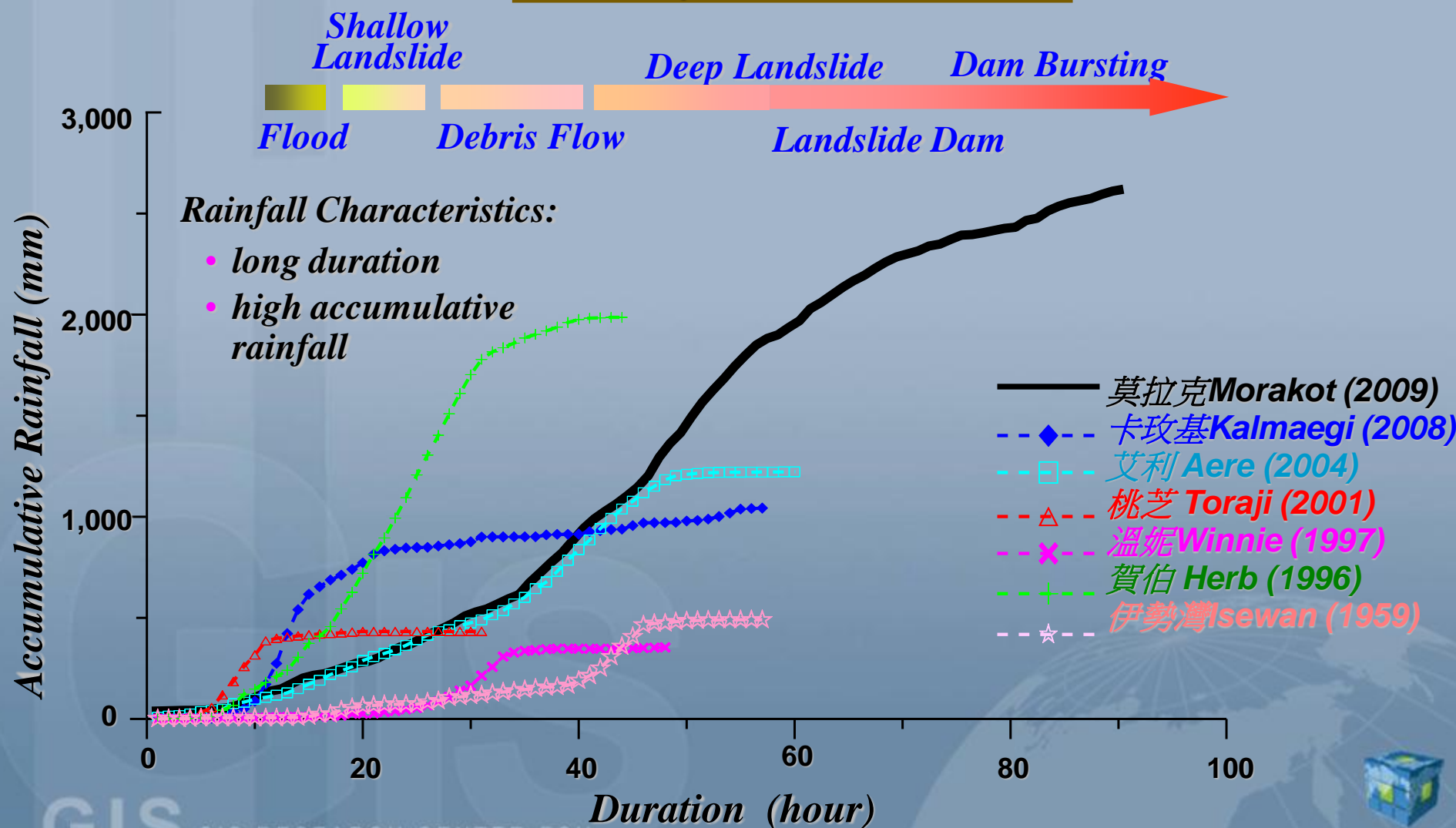


# Basin-Wide Monitoring Network



# Rainfall-Duration Curve of the Morakot & Recently Typhoons

## Compound Hazards





# Debris Flow Event of ShenMu Village (8/8 16:57)



CCD image (front)



CCD image (side)

# Typhoon Morakot (Aug. 2009)

ShiaoLin village





# Monitoring System - Watershed Management



- Establish remote monitoring system by setting up digital devices to prevent illegal activities in the watershed area.
- The monitoring system can also be used as flood monitoring system.





# Integrate Sensors with Expert Systems



mission impossible for long term real time monitoring



# Debris Flow Image Analysis System

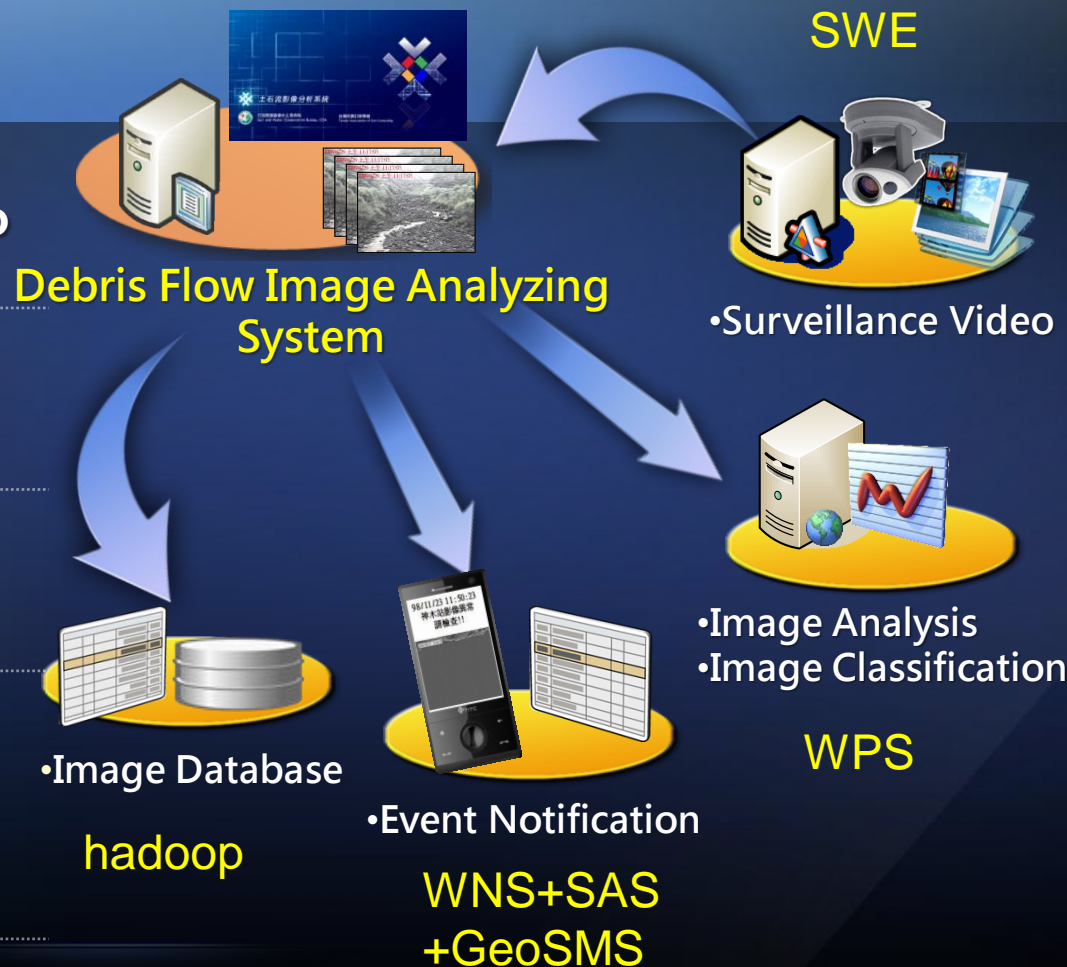
● Get images from surveillance video

● Event analyzing and classifying

● Event notifying

● **Decision making**

- Scale
- Velocity
- Difference



# Watershed Monitoring and Management System

## Security for equipments



## Vehicles monitoring on the river bed



## illegal quarrying monitoring



Image sequences



Motion Detection



Object Tracking



Event?

Y



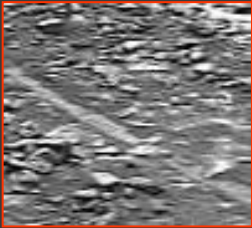
Send email and SMS





# Auto images change detection

Raw image

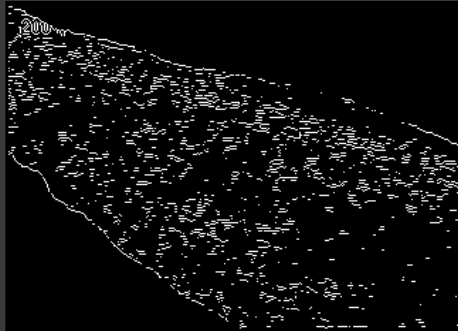


|     |     |     |     |     |     |     |     |     |     |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 137 | 74  | 32  | 9   | 24  | 39  | 51  | 100 | 158 | 225 |
| 86  | 135 | 165 | 216 | 222 | 144 | 62  | 89  | 172 | 154 |
| 8   | 23  | 17  | 37  | 74  | 87  | 58  | 25  | 11  | 31  |
| 87  | 14  | 21  | 17  | 7   | 18  | 54  | 86  | 98  | 54  |
| 90  | 91  | 100 | 117 | 114 | 84  | 64  | 98  | 151 | 171 |
| 109 | 66  | 48  | 35  | 33  | 34  | 55  | 117 | 180 | 210 |
| 231 | 255 | 219 | 165 | 130 | 114 | 116 | 140 | 171 | 157 |
| 158 | 95  | 74  | 61  | 70  | 83  | 85  | 86  | 88  | 100 |
| 12  | 30  | 37  | 58  | 90  | 117 | 124 | 120 | 113 | 100 |
| 83  | 80  | 80  | 77  | 74  | 69  | 65  | 57  | 51  | 100 |
| 66  | 75  | 81  | 79  | 78  | 84  | 99  | 109 | 112 | 93  |
| 77  | 55  | 64  | 68  | 68  | 72  | 77  | 77  | 71  | 82  |
| 0   | 37  | 43  | 53  | 63  | 74  | 82  | 89  | 94  | 93  |
| 121 | 117 | 115 | 111 | 107 | 103 | 100 | 99  | 99  | 93  |
| 78  | 123 | 122 | 120 | 118 | 113 | 105 | 97  | 91  | 85  |
| 107 | 28  | 31  | 40  | 57  | 79  | 99  | 113 | 120 | 129 |
| 112 | 130 | 128 | 129 | 135 | 146 | 154 | 156 | 155 | 141 |
| 89  | 134 | 142 | 154 | 158 | 143 | 105 | 56  | 21  | 33  |
| 121 | 71  | 83  | 103 | 120 | 121 | 96  | 57  | 27  | 6   |
| 143 | 162 | 143 | 121 | 113 | 121 | 137 | 149 | 154 | 128 |

Image texture

No incident

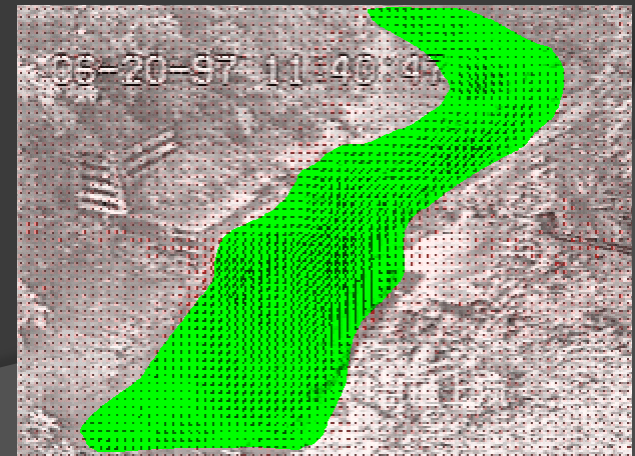
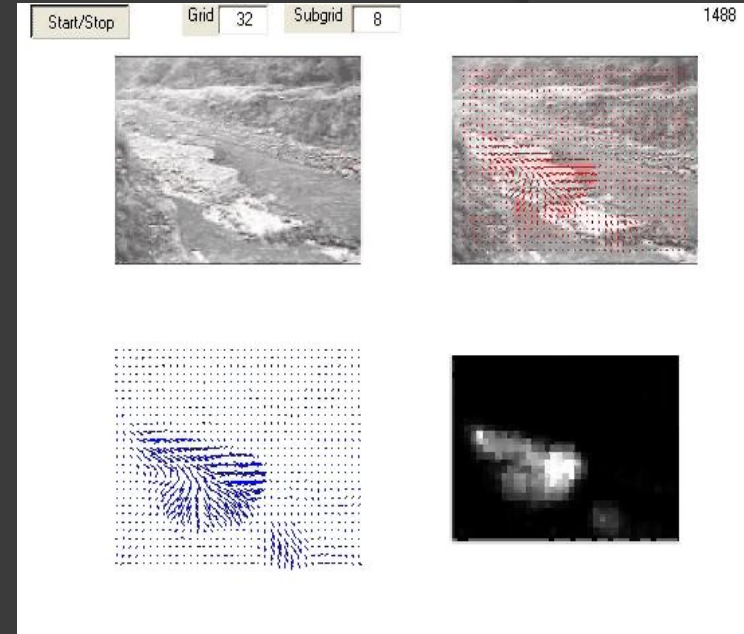
Debris flow



Texture voices



Image model



# Real-time video computing

Image



Speed : 15m/s

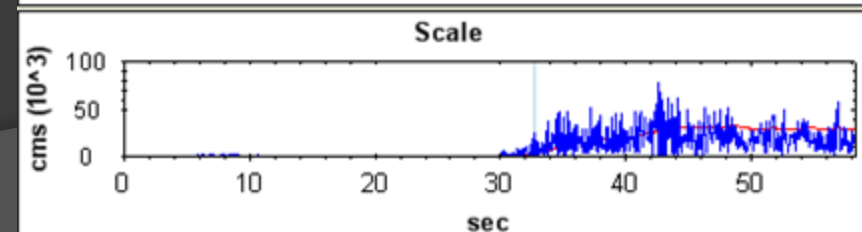
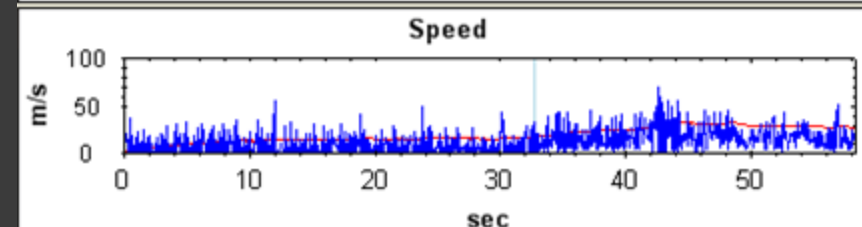
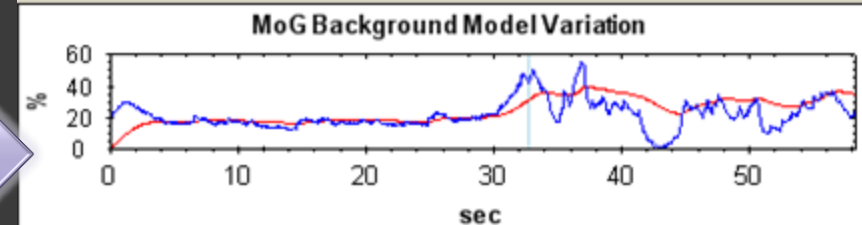
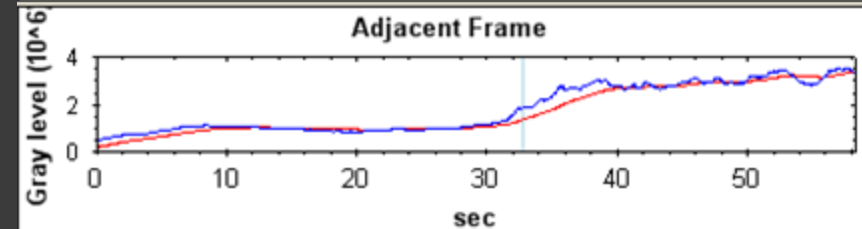
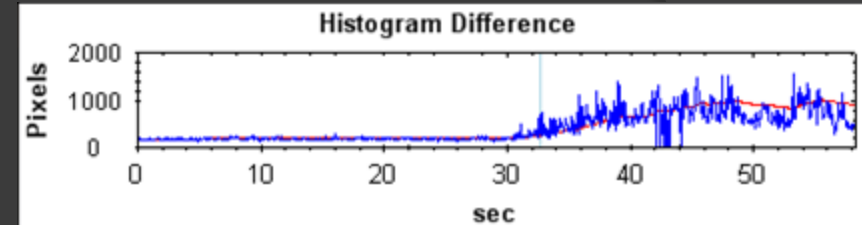
System estimates : 18m/s

Geophone estimates : 17m/s



Speed : 13m/s

System estimates : 13.5m/s





# Debris Flow Motion Detection System



# Debris Flow Image Analysis System

※ 土石流影像分析系統

選擇來源

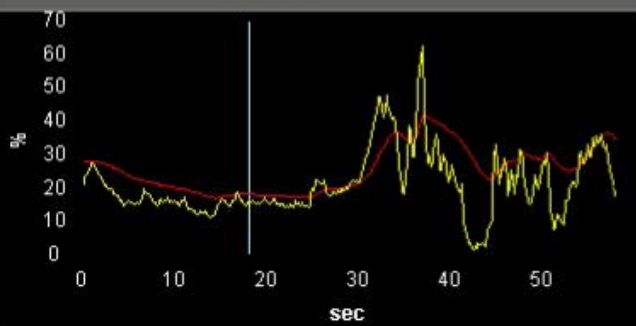
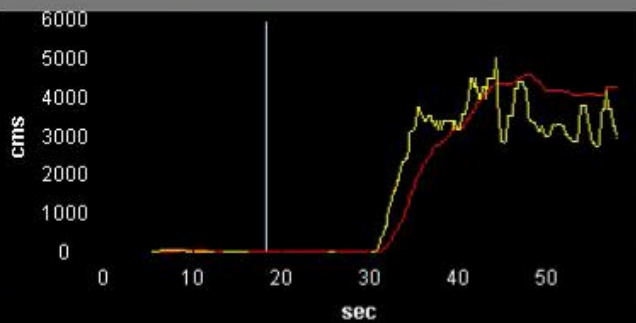
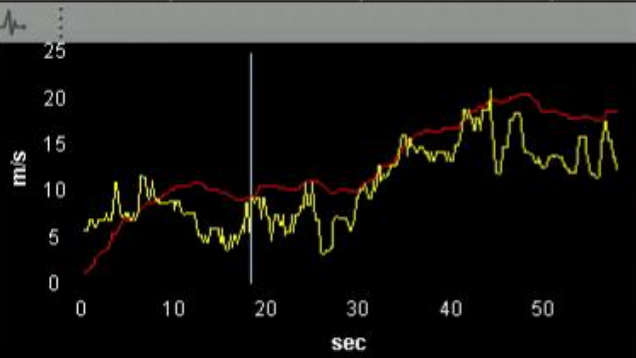
開啟影像

異常通報

輔助資訊

離開系統

警戒燈號



估計流速

8.61m/s

估計規模

0.000000cms

平均流向

225°

平均變化量

15.33%

拍攝地點

南投神木村

事件名稱

88水災

拍攝日期

2009/08/08

X座標點位

-

Y座標點位

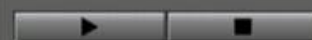
-

影像格式

jpg

影像大小

320\*240





# Water Quality Monitoring



經濟部水利署  
臺北水源特定區管理局  
Taipei Water Management Office, WRA, MOEA



經營管理 應用平台

水文水質監測管理

水資源保育管理

都市建物管理

污水下水道管理

土地使用管理

計畫進度經費管控

距離測量

面積測量

清除圖徵

列印地圖

屬性查詢

關聯圖層

電子地圖

衛星影像

航照圖

電子地圖底圖

測站資訊

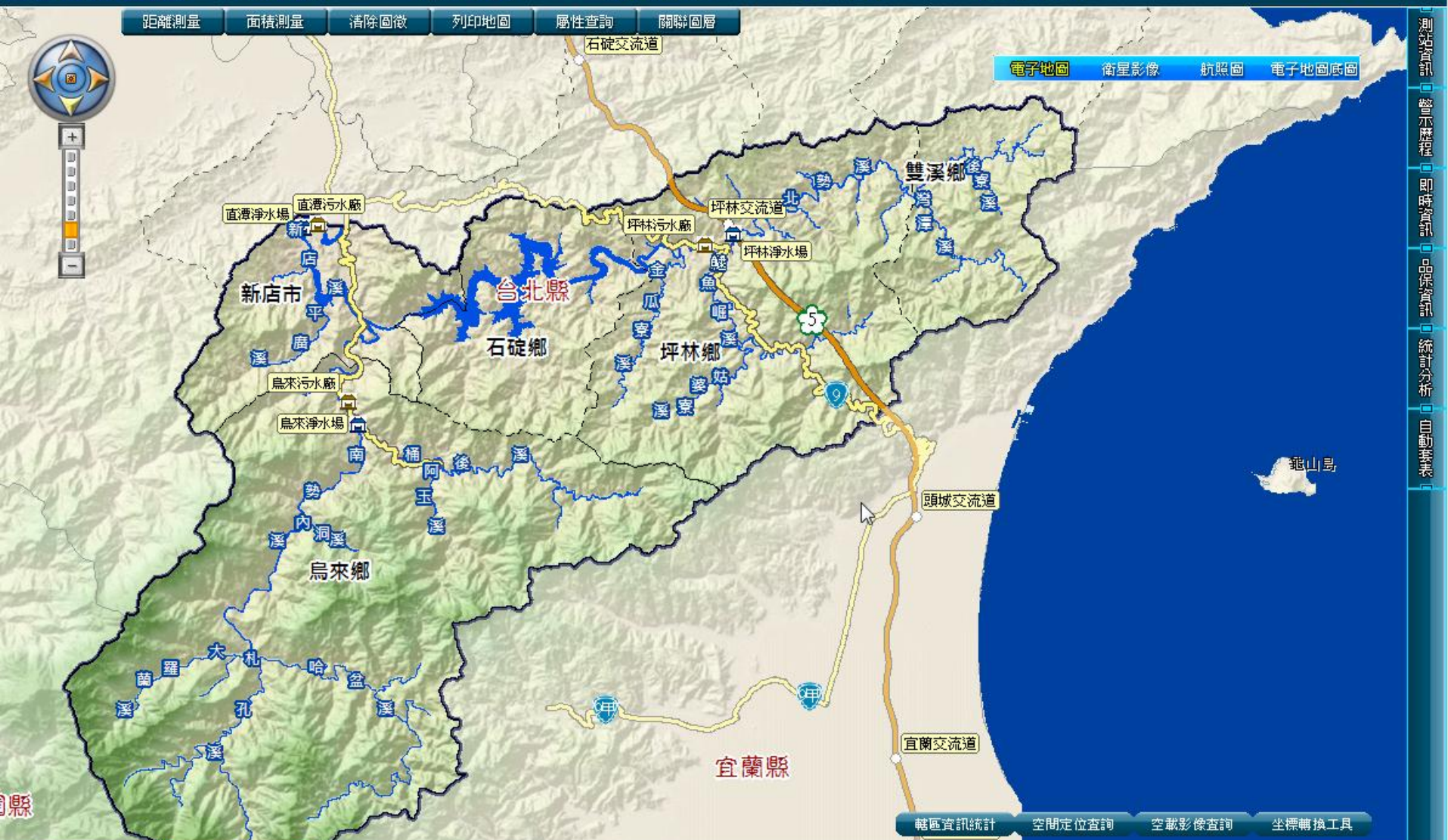
警示歷程

即時資訊

品質資訊

統計分析

自動套表



轄區資訊統計

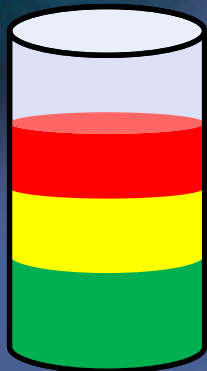
空間定位查詢

空載影像查詢

坐標轉換工具



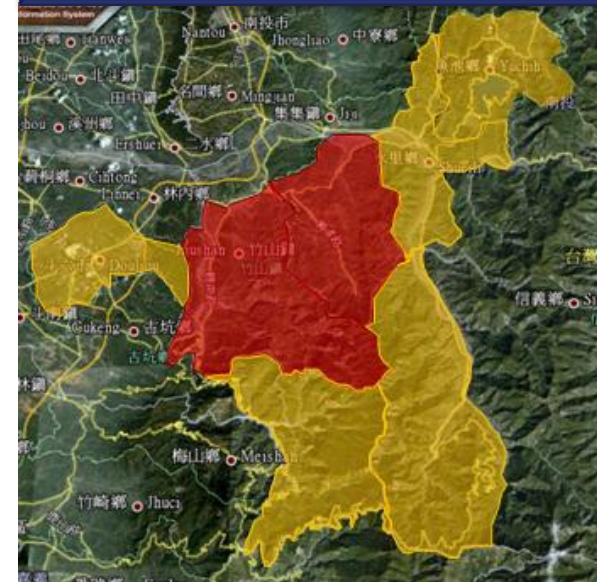
2D 3D 30/20 田



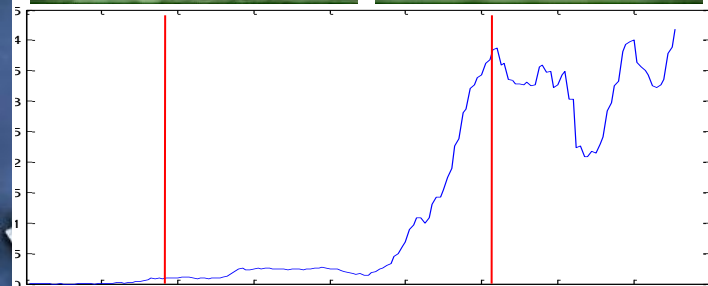
300mm

Real-time Rainfall

## Rainfall distribution map



## Image sequences analyzing



## Ranking of danger villages

| 序位 | 縣市  | 鄉鎮  | 村里  | 子集水區 | 鄰近地標         | 鄰近道路 | 崩塌      | 潛勢溪流編號        | 警戒雨量 | 全保戶數 | 定位 |
|----|-----|-----|-----|------|--------------|------|---------|---------------|------|------|----|
| 1  | 南投縣 | 信義鄉 | 豐丘村 | 濁水溪  | 豐丘國小         |      | 山坡地     | 投縣DF190 (豐丘站) | 250  | 5戶以上 |    |
| 2  | 南投縣 | 信義鄉 | 自強村 | 濁水溪  | 自愛橋、寶明寺、活動中心 |      | 山坡地及林班地 | 投縣DF192       | 250  | 5戶以上 |    |
| 3  | 嘉義縣 | 番路鄉 | 龍口村 | 八掌溪  | 慈雲寺          | 台8   | 山坡地     | 嘉縣DF029       | 500  | 5戶以上 |    |
| 4  | 南投縣 | 鹿谷鄉 | 竹林村 | 濁水溪  | 田頭、山豬湖產業道路   |      | 山坡地     | 投縣DF135       | 350  | 5戶以上 |    |
| 5  | 台北市 | 北投區 | 秀山里 | 貴坑坑  | 量竹坑球場        | 復興三路 | 山坡地及林班地 | 北市DF011       | 500  | 5戶以上 |    |
| 6  | 台北市 | 北投區 | 秀山里 | 貴坑坑  | 政戰學校         | 秀山路  | 山坡地及林班地 | 北市DF012       | 500  | 5戶以上 |    |
| 7  | 南投縣 | 信義鄉 | 東埔村 | 濁水溪  | 東埔二號橋        |      | 林班地     | 投縣DF207       | 250  | 5戶以上 |    |





## Assign response tasks to local governments

| Case No. | Disaster        | Date       | County | Town    | Agency                   | Assign |
|----------|-----------------|------------|--------|---------|--------------------------|--------|
| T090801  | Typhoon Morakot | 2009/08/08 | Nantou | RenAi   | Nantou Branch, SWCB      |        |
| T090802  | Typhoon Morakot | 2009/08/08 | Nantou | RenAi   | Nantou County Government |        |
| T090803  | Typhoon Morakot | 2009/08/08 | Chiayi | Alishan | Alishan Township Office  |        |
| T090805  | Typhoon Morakot | 2009/08/08 | Chiayi | Alishan | Chiayi County Government |        |
| T090806  | Typhoon Morakot | 2009/08/08 | Yunlin | Linnei  | Linnei Township Office   |        |
| T090807  | Typhoon Morakot | 2009/08/08 | Yunlin | Linnei  | Yunlin County Government |        |

## Report the status of hazards to central emergency operation center

| Case No. | Agency                   | Report time         | Disaster Description | Report status |
|----------|--------------------------|---------------------|----------------------|---------------|
| T090801  | Nantou Branch, SWCB      | 2009/08/08 13:15:00 | .....                |               |
| T090802  | Nantou County Government | 2009/08/08 15:20:31 | .....                |               |
| T090805  | Chiayi County Government | 2009/08/08 13:00:10 | .....                |               |
| T090807  | Yunlin County Government |                     |                      |               |

# The urgent need for Interoperability between agencies



Forest Bureau

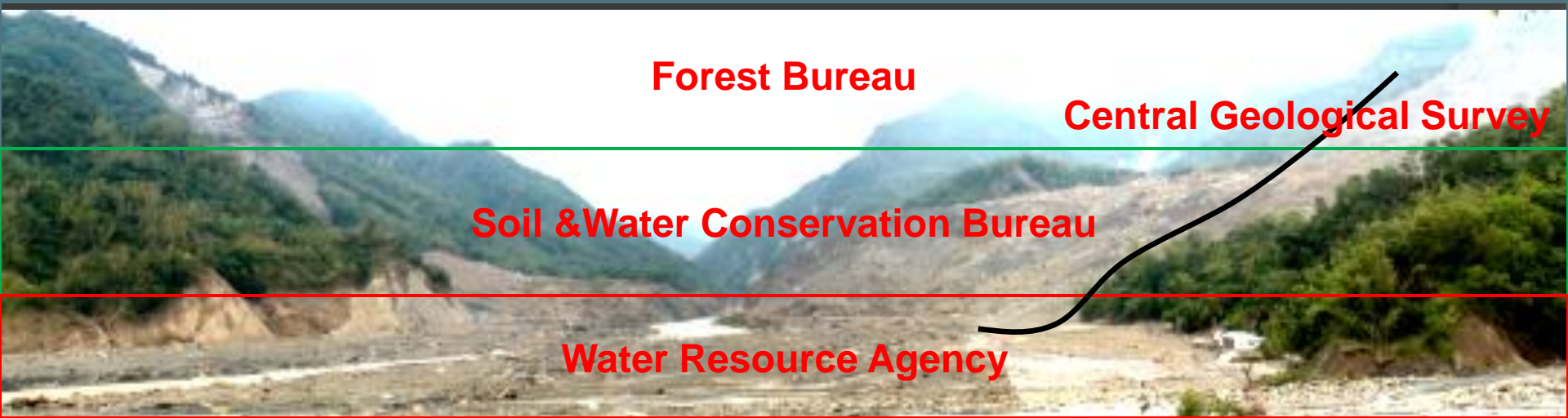
Soil & Water  
Conservation  
Bureau

Water Resource  
Agency

Central  
Geological  
Survey



# Disaster does not matter that much...



**Forest Bureau**

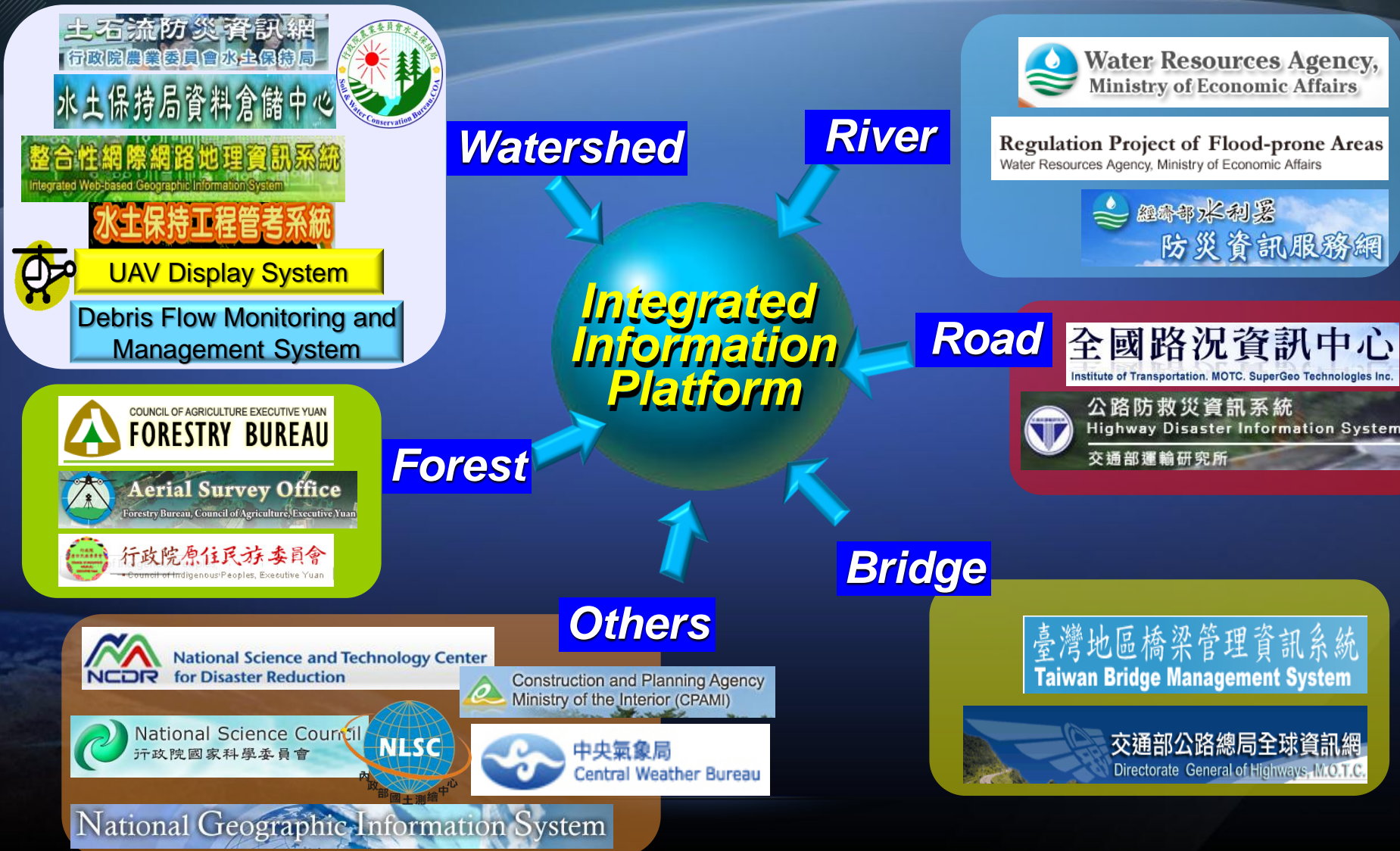
**Central Geological Survey**

**Soil & Water Conservation Bureau**

**Water Resource Agency**

# Pre-Warning Decision Support System

## Information sharing & integration between agencies





### Administrative interfaces

1. Forest Bureau
2. SWCB
3. WRA

### Publishing Interface

1. CSV(various schema)
2. Database
3. OGC SOS
4. Data logger
5. ....

### Maps Interfaces

1. Shape file
2. Geo-database
3. DWG/DGN
4. WMS/WFS

Why don't you speak in  
the same  
**LANGUAGE???**

### Sensors Interface

1. Rain Gauge
2. Camera
3. Water level
4. Geophone...

Give me nothing  
But **Standards**



# OGC SWE implemented in monitoring information service platform



- Monitoring information service has integrated to debris flow forecasting system.
- User can click on sensor location and inquire observation data directly.



Image © 2009 DigitalGlobe

© 2009 Kingway Ltd.  
© 2009 Mapabc.com





# OGC SWE implemented in monitoring information service

## Service

按一下[這裡](#)以取得完整的作業清單。

## RequestSOS

### 測試

若要以 HTTP POST 通訊協定測試作業，請按一下 [叫用] 按鈕。

| 參數          | 值                    |
|-------------|----------------------|
| requestXML: | <input type="text"/> |

### SOAP 1.1

下列是 SOAP 1.1 要求與回應的範例。預留位置顯示之處必須代入實際的值。

```
POST /FCU_GIS_SOS/Service.asmx HTTP/1.1
Host: 210.241.45.102
Content-Type: text/xml; charset=utf-8
Content-Length: length
SOAPAction: "http://www.gis.fcu.edu.tw/RequestSOS"

<?xml version="1.0" encoding="utf-8"?>
<soap:Envelope xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns:xsd="http://www.w3.org/2001/XMLSchema"
  <soap:Body>
    <RequestSOS xmlns="http://www.gis.fcu.edu.tw/">
      <requestXML>string</requestXML>
    </RequestSOS>
  </soap:Body>
</soap:Envelope>
```

```
HTTP/1.1 200 OK
Content-Type: text/xml; charset=utf-8
Content-Length: length

<?xml version="1.0" encoding="utf-8"?>
<soap:Envelope xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns:xsd="http://www.w3.org/2001/XMLSchema"
  <soap:Body>
    <RequestSOSResponse xmlns="http://www.gis.fcu.edu.tw/">
      <RequestSOSResult>xml</RequestSOSResult>
    </RequestSOSResponse>
  </soap:Body>
</soap:Envelope>
```

- Monitoring information has integrated to debris flow forecasting system.
- User can click on sensor location and inquire observation data directly.
- External AP can request observed data published in service platform

Cite observed data



External AP



# Feature Fusion with Sensors, Geosynchronization and Spatial Processing

Execute a buffer process



Emergency Management Agent

req



Web Processing Service (WPS)

req

Subscribe to



re



Sensor Alert Service (SAS)

[GeoRSS] [GeoRSS GML Profile] [GeoRSS Application Schema]  
[GetCapabilities] [DescribeProcess] [WPS Execute Sample 1] [WPS Execute Sample 2]  
WPS Execute POST URL: <http://140.134.48.12/Ows7Wps/Wps.svc/>  
**GeoATOM received from the SAS radiation alert:**  
<entry>  
<link href="http://example.org/2003/12/13/atom03" />  
<title>ALERTS\_AlertId</title>  
<id>http://ows-7.computul.net/sub3981/ALERTS\_AlertId</id>  
<summary>NN000019971</summary>  
<updated>2010-05-05T13:48:18Z</updated>  
</entry>  
<entry>  
<link href="http://example.org/2003/12/13/atom03" />  
<title>Mode</title>  
<id>http://ows-7.computul.net/sub3981/Mode</id>  
<summary>Normal</summary>  
<updated>2010-05-05T13:48:18Z</updated>  
</entry>  
<entry>  
<link href="http://example.org/2003/12/13/atom03" />  
<title>READGS\_Sensor</title>  
<id>http://ows-7.computul.net/sub3981/READGS\_Sensor</id>  
<summary>NA</summary>  
<updated>2010-05-05T13:48:18Z</updated>  
</entry>  
<entry>  
<link href="http://example.org/2003/12/13/atom03" />  
<title>READGS\_ReadingID</title>  
<id>http://ows-7.computul.net/sub3981/READGS\_ReadingID</id>  
<summary>NA</summary>  
<updated>2010-05-05T13:48:18Z</updated>  
</entry>  
<entry>  
<link href="http://example.org/2003/12/13/atom03" />  
<title>READGS\_Detect</title>  
</entry>  
☐ POST to the Geosynchronization Service

- To execute a buffer process on the GeoATOM entry point, modify the GeoATOM above and click the 'Generate a buffered radiation point' button. An 'ExecuteResponse' encoding will then be responded on a new window.
- To execute a buffer process on the GeoATOM entry point AND POST the buffered GeoATOM to the GSS, modify the GeoATOM above, check the 'POST to the Geosynchronization Service' checkbox and click the 'Generate a buffered radiation point' button. An 'ExecuteResponse' encoding will then be responded on a new window.

CHANGEFEED

req

res

net/ogc  
<Result>  
<tor>INSERT

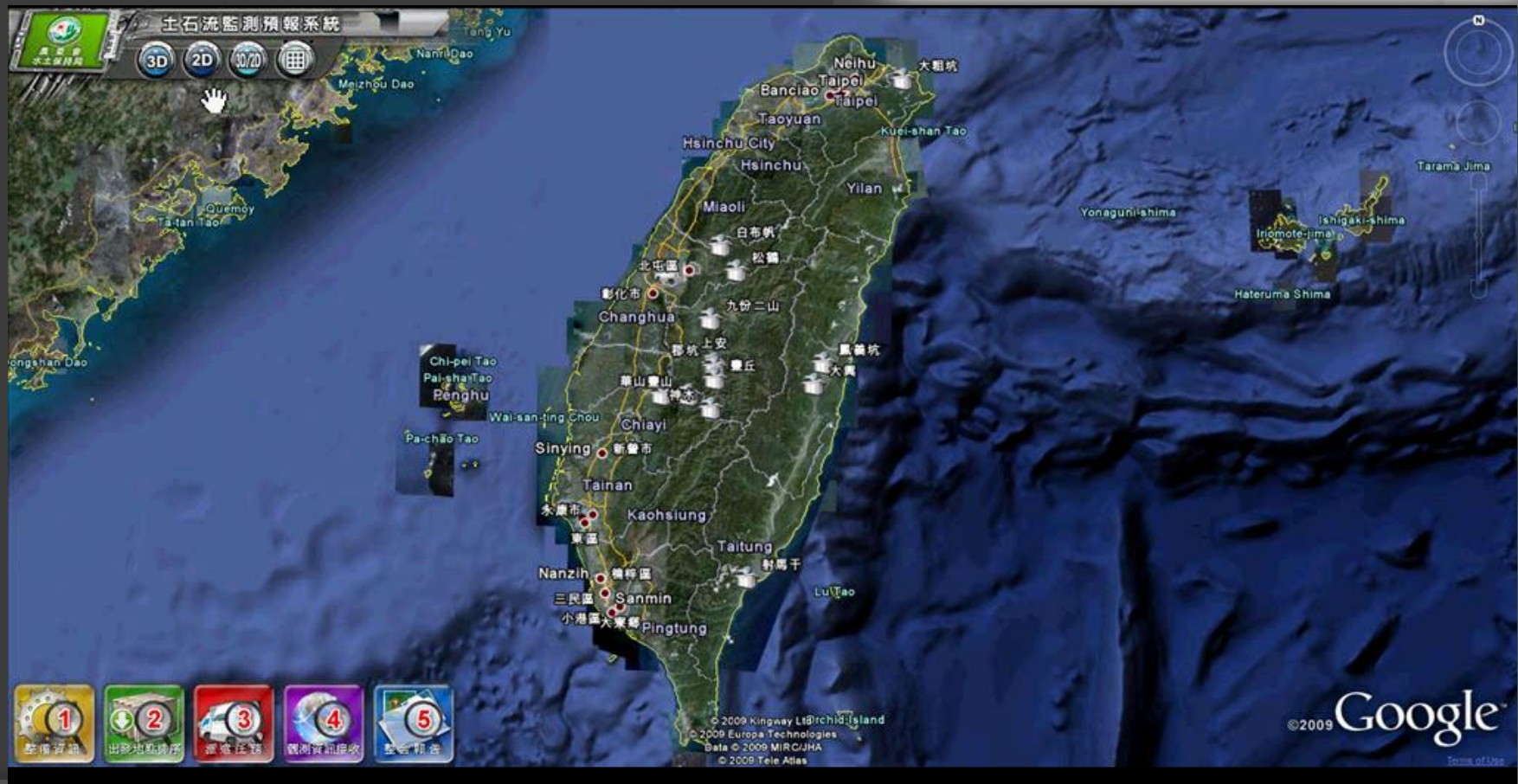


Geosynchronization Service (GSS)



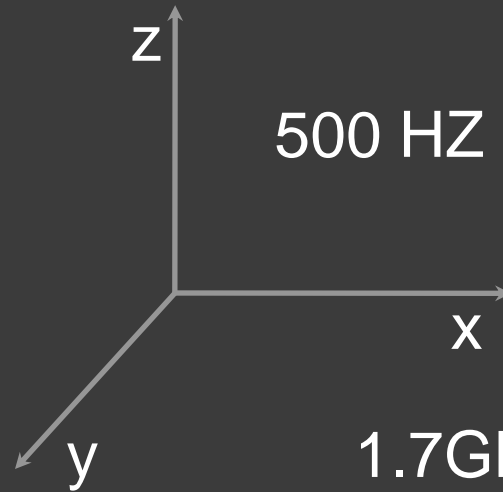
# OGC SWE implemented in our monitoring information service platform

- Monitoring information service has been integrated into debris flow pre-warning system.

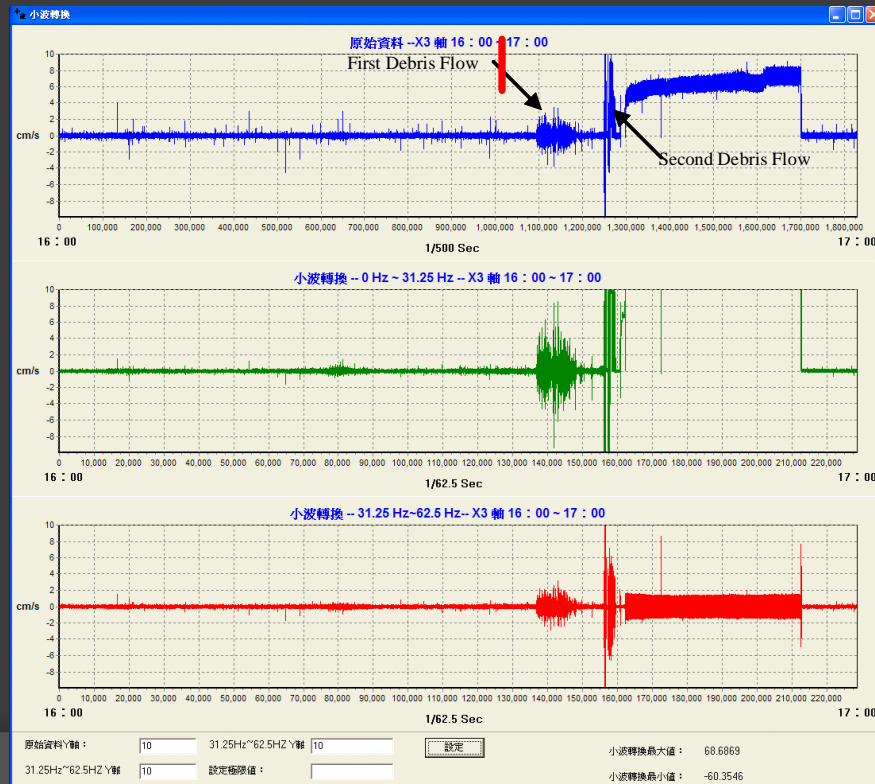




Geo phone sensor



1.7GB/Sensor/Station/Day



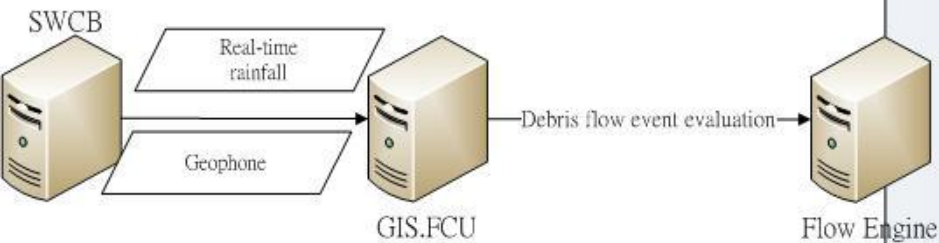
X

Y

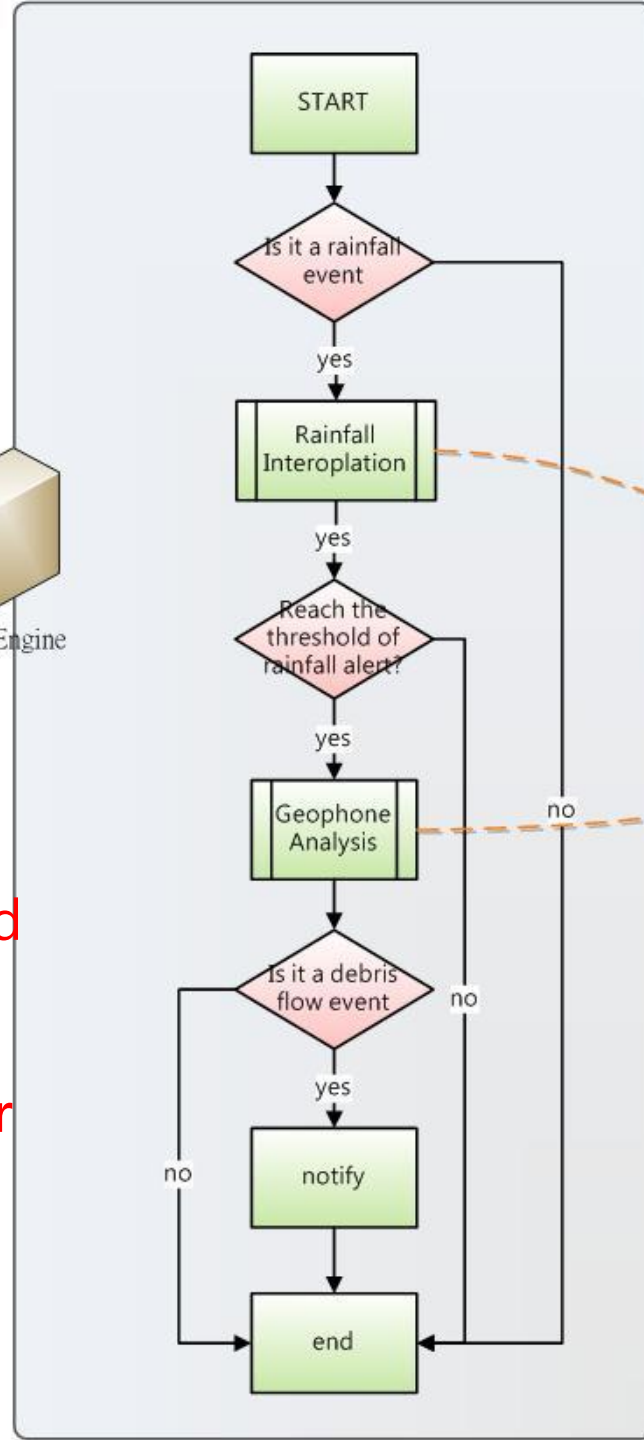
Z



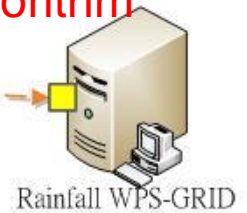
# Feng Chia University+ University of Muenster



- 52° North WPS (WPS Specification 1.0.0)
- full support for UNICORE 6 grid middleware
- processing is done in GRID at **Jülich Supercomputing Center (JSC)**, Germany
- input data is dynamically transferred into GRID



By IDW or  
Kriging  
algorithm



By wavelet  
algorithm

Co-op with ifGI,  
University of  
Muenster

## Scenario 1

### GPW-Grid processing demonstration of debris flow disaster management

Time

00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 00



#### Geo Processing Workflow

Start

Is it a rainfall event?

Rainfall interpolation

Reach the threshold of rainfall

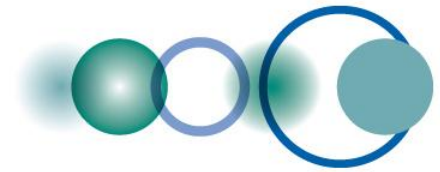
Geophone analysis

Debris flow event?

Notify

End





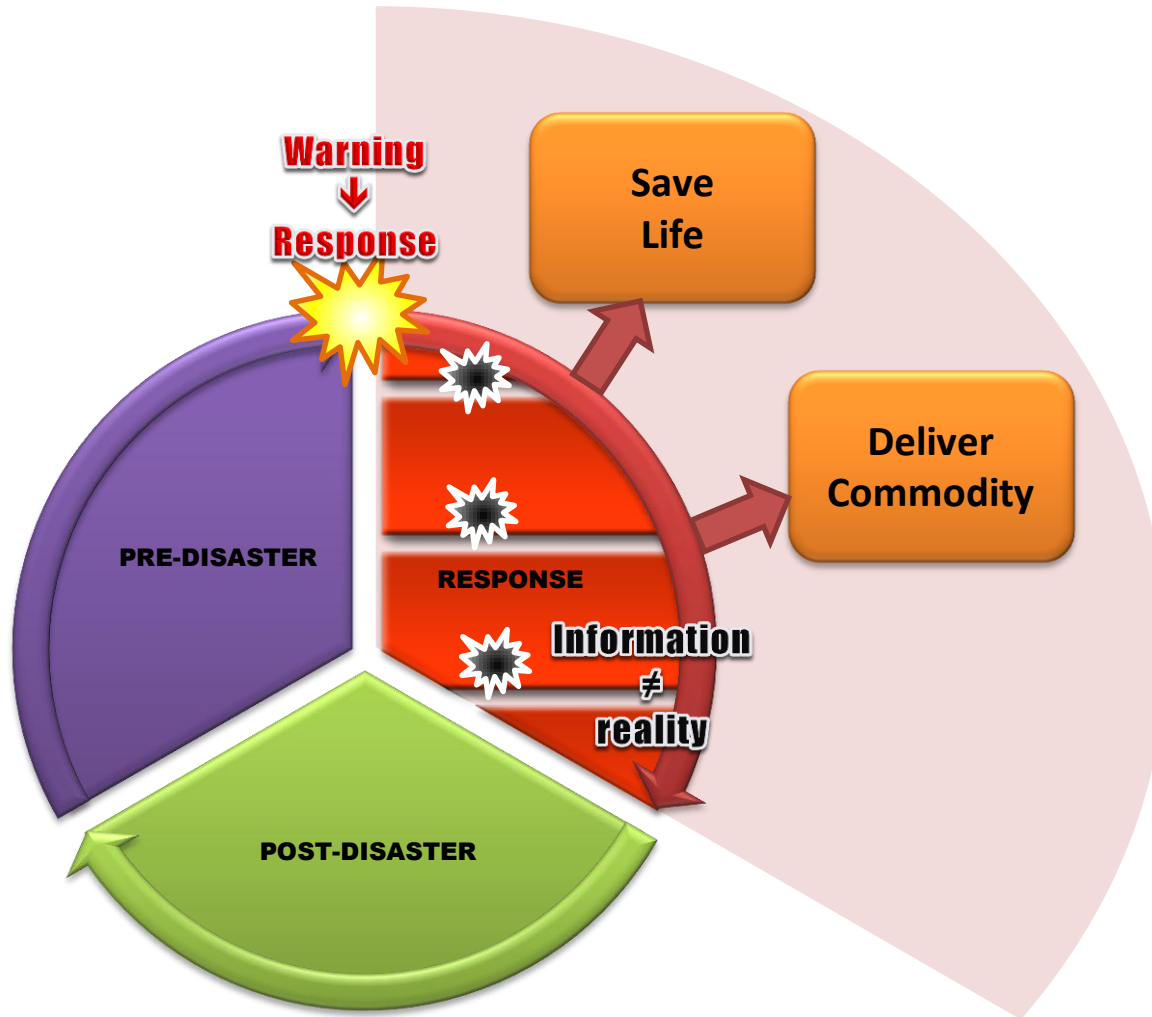
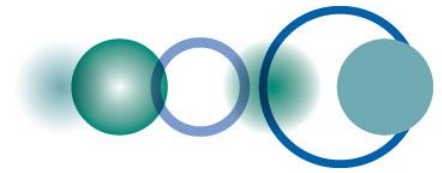
# Disaster Management SBA Scenario

## Near-real time vehicle dispatching

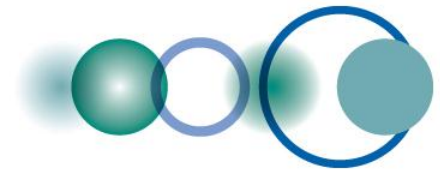
GEOSS Architectural Implementation Pilot-3  
Disaster Management Working Group



GIS Center, Feng Chia University(GIS.FCU), Taiwan  
Infoterra, SPOT Image, France  
University of Heidelberg, Germany



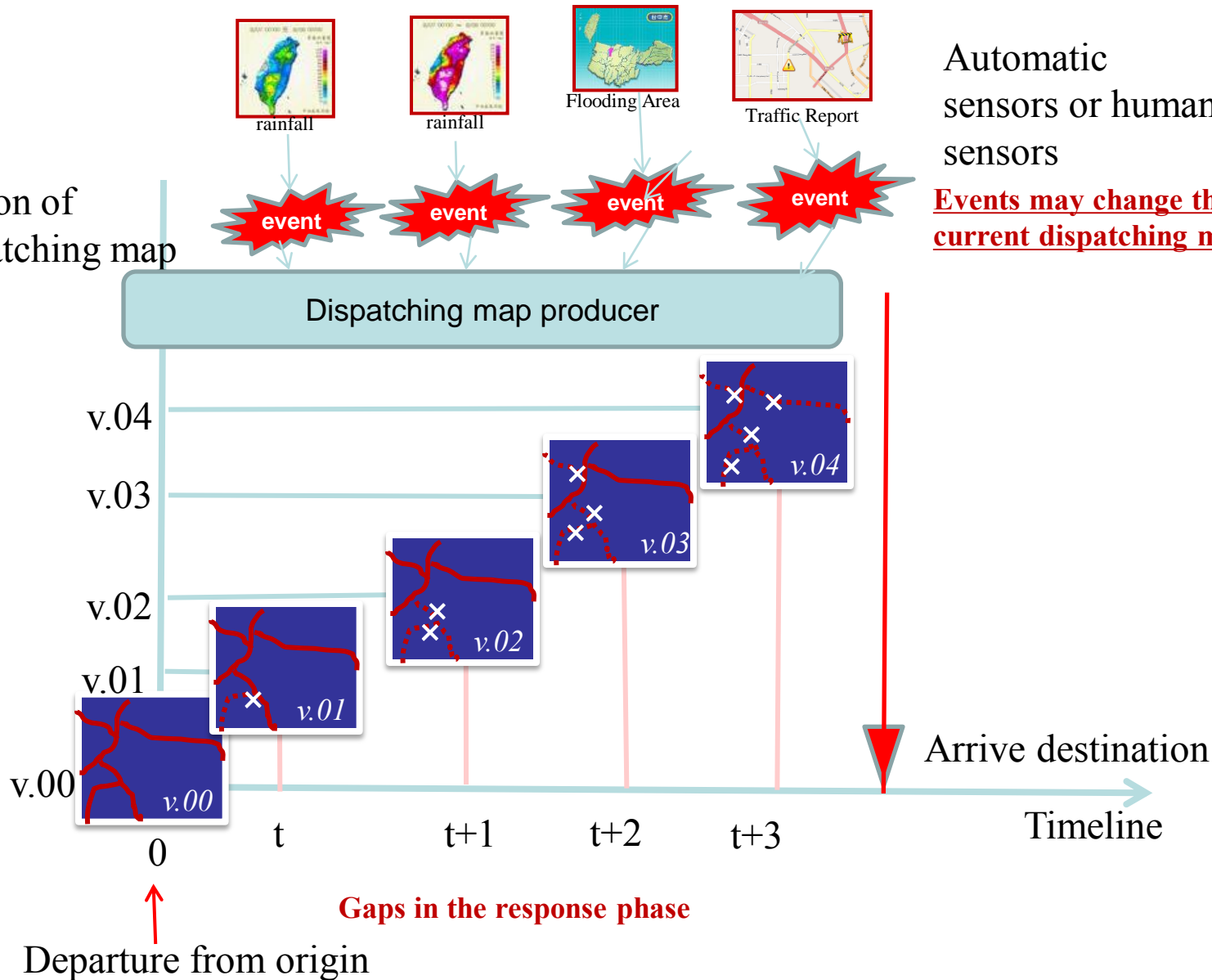




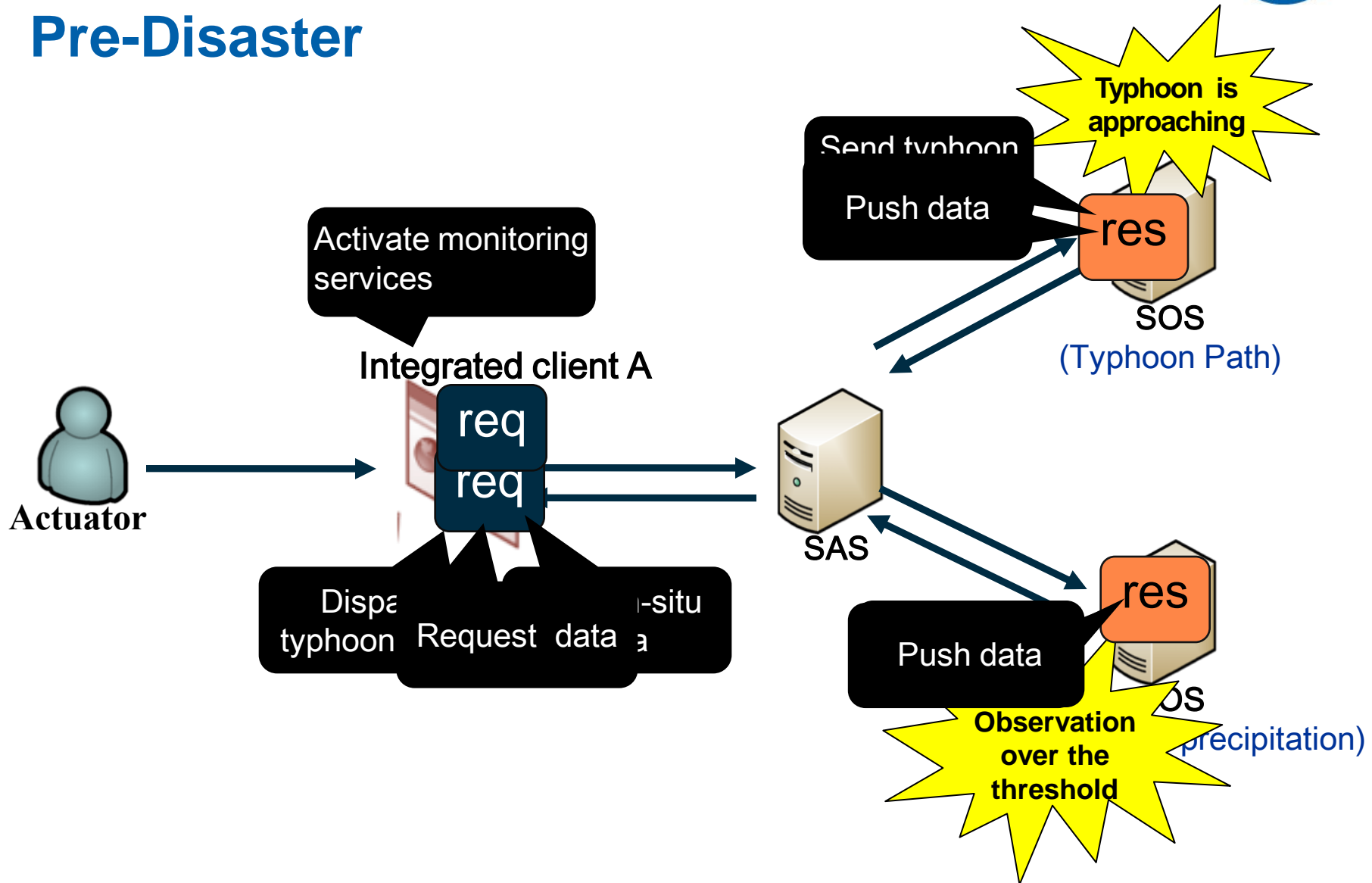
Automatic sensors or human sensors

Events may change the current dispatching map

Version of Dispatching map



# Pre-Disaster





網站導覽 | 土石流警戒基準值 | 防災簡訊 | 土石流防災行動網 | Google Earth 災情管理 | Google Earth 簡介說明 | iGoogle 簡介 | RSS 服務 | 回首頁



# 土石流防災資訊網

行政院農業委員會水土保持局

土石流警戒基準值 | 防災簡訊 | 土石流防災行動網 | 回首頁

Google Earth 災情管理 | 簡介說明 | Google | RSS

即時雨量 累積雨量 衛星雲圖 雷達回波 颱風現況 氣象綜合報告 天氣預報

表格顯示

Google Earth 顯示

資料更新時間: 99年9月30日18時30分

縣市: 全部 雨量站類型: 全部 排序: 依10分鐘雨量 第1頁 自動更新 列印 下載

| 排名 | 行政區    | 站名   | 10分鐘 | 1小時  | 3小時  | 6小時   | 12小時  | 24小時  | 本日    | 設置單位 |
|----|--------|------|------|------|------|-------|-------|-------|-------|------|
| 1  | 台北市松山區 | 民生國中 | 9.0  | 16.0 | 30.0 | 44.5  | 44.5  | 44.5  | 44.5  | 台北市  |
| 2  | 宜蘭縣大同鄉 | *牛鬥  | 8.5  | 23.5 | 29.0 | 30.0  | 30.0  | 30.0  | 30.0  | 氣象局  |
| 3  | 台北市南港區 | 舊莊   | 8.5  | 9.5  | 18.0 | 19.5  | 19.5  | 19.5  | 19.5  | 台北市  |
| 4  | 台北縣平溪鄉 | 火燒寮  | 6.5  | 24.0 | 45.0 | 82.5  | 87.0  | 90.0  | 87.5  | 氣象局  |
| 5  | 台北市南港區 | 玉成   | 5.5  | 16.5 | 38.5 | 47.5  | 47.5  | 47.5  | 47.5  | 台北市  |
| 6  | 台北市南港區 | 九如   | 5.5  | 7.5  | 15.5 | 17.5  | 17.5  | 17.5  | 17.5  | 台北市  |
| 7  | 基隆市七堵區 | *五堵  | 5.0  | 15.0 | 71.0 | 152.0 | 155.0 | 157.0 | 156.0 | 十河局  |
| 8  | 台北市信義區 | *信義  | 5.0  | 11.0 | 15.5 | 18.0  | 18.0  | 18.0  | 18.0  | 氣象局  |
| 9  | 台北縣汐止市 | 社后橋  | 4.0  | 21.0 | 62.0 | 90.0  | 90.0  | 90.0  | 90.0  | 十河局  |
| 10 | 台北縣石碇鄉 | 石碇   | 4.0  | 10.0 | 16.0 | 18.0  | 19.0  | 19.0  | 19.0  | 十河局  |
| 11 | 台北市信義區 | 市政中心 | 4.0  | 8.5  | 12.5 | 13.5  | 13.5  | 13.5  | 13.5  | 台北市  |
| 12 | 台北市南港區 | *南港  | 3.5  | 17.5 | 39.5 | 53.5  | 54.0  | 54.0  | 54.0  | 氣象局  |

\*雨量資料擷取時間:



氣象資訊

土石流資訊

土石流學堂

災害紀實

防災業務

防災教育訓練中心

重要事紀

下載區

防災宣導

親子學習

留言板



歡迎索取

小熊種樹說故事比賽將於10/2上午10點於台中科博館進行決賽!! 99年災害性天氣降

觀測站影像

土石流警戒

土石流分布

即時雨量

衛星雲圖

分布圖

Google Earth顯示



2010/10/1 下午 02:23:49



集來

土石流潛勢溪流：高縣DF069  
溪流長度：3653m  
溪流型態：溪流型  
溪流名稱：火山溪

保全對象

保全戶數：5戶以上  
公共設施：火山橋  
道路：台20線

土石流分布圖

宜蘭縣 顯示

宜縣DF001 顯示

土石流警戒基準值

宜蘭縣 顯示

三星鄉 顯示

避難路線圖

宜蘭縣 顯示

潛勢溪流新舊編碼查詢

宜蘭縣 顯示

新編碼查詢：

宜縣DF001 顯示

舊編碼查詢：

宜蘭T006 顯示

本日累積雨量排序

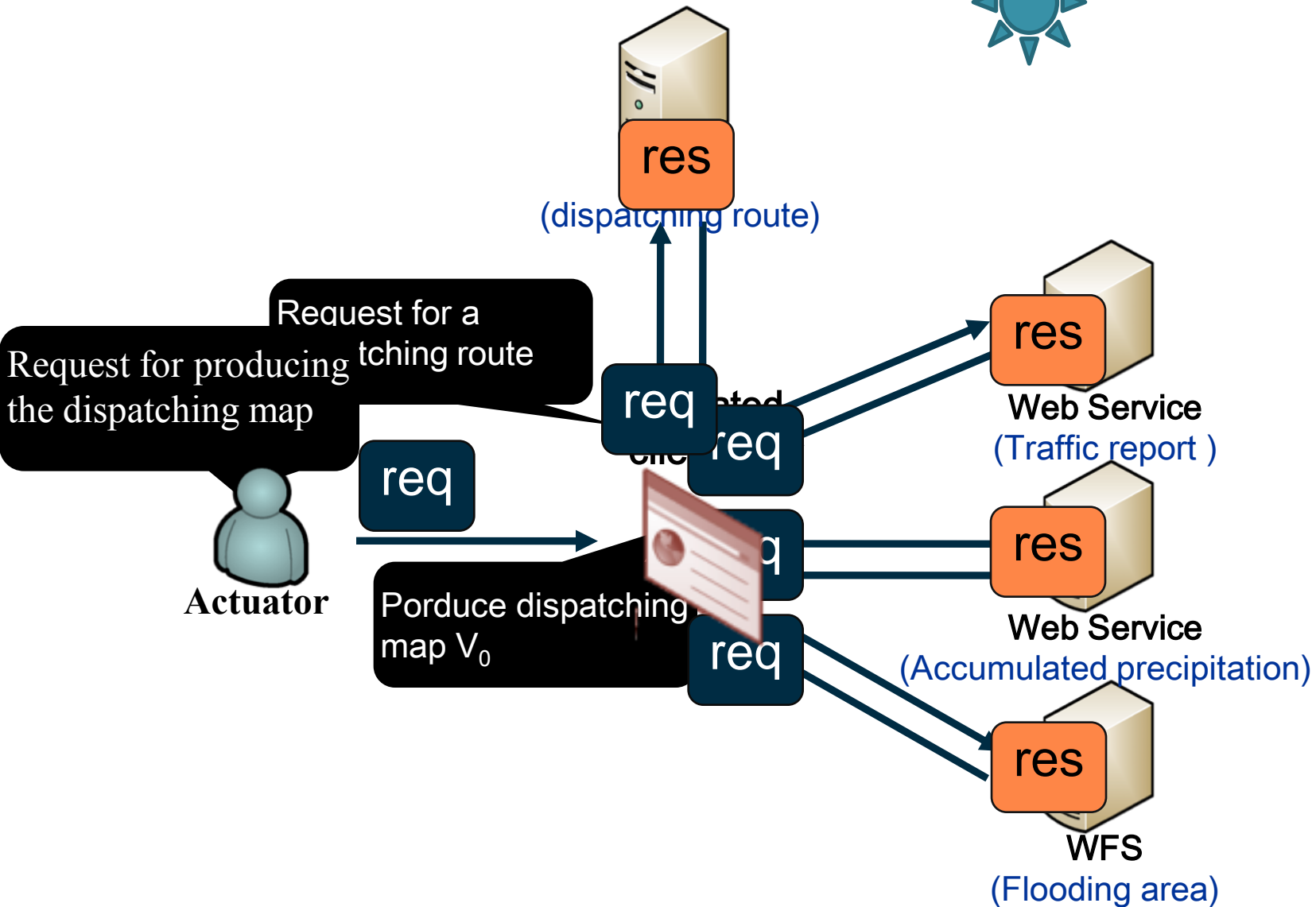
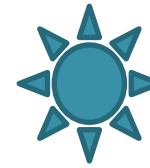
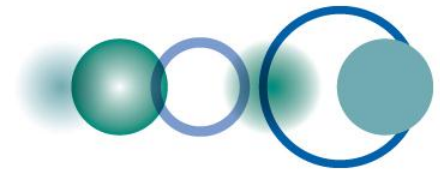
| 行政區 | 站名  | 本日累積 |
|-----|-----|------|
| 台北市 | 擎天  | 173  |
| 台北市 | 士林區 |      |
| 台北市 | 北投區 | 162  |
| 台北市 | 觀音山 |      |



最新消息

小熊種樹說故事比賽將於10/2上午10點於台中科博館進行決賽!! HOT





# Cloud Computing

» SaaS

» PaaS

» IaaS

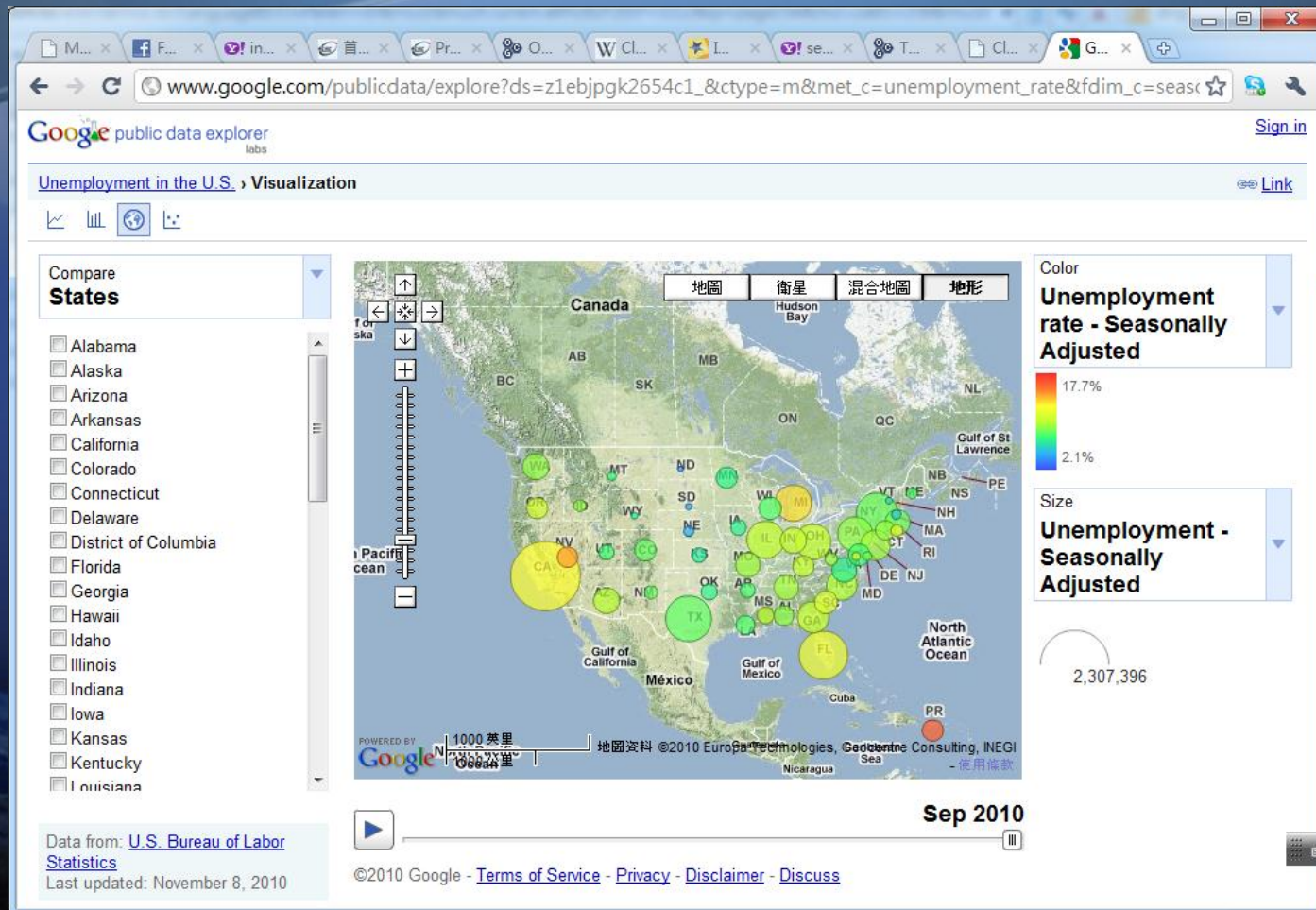
» DaaS

- ▶ Spatial Data as a Service
- ▶ is a recent invention that is not resident in the cloud IaaS/PaaS/SaaS service stack
- ▶ does not have a clear definition
- ▶ DaaS is actually SaaS that delivers data

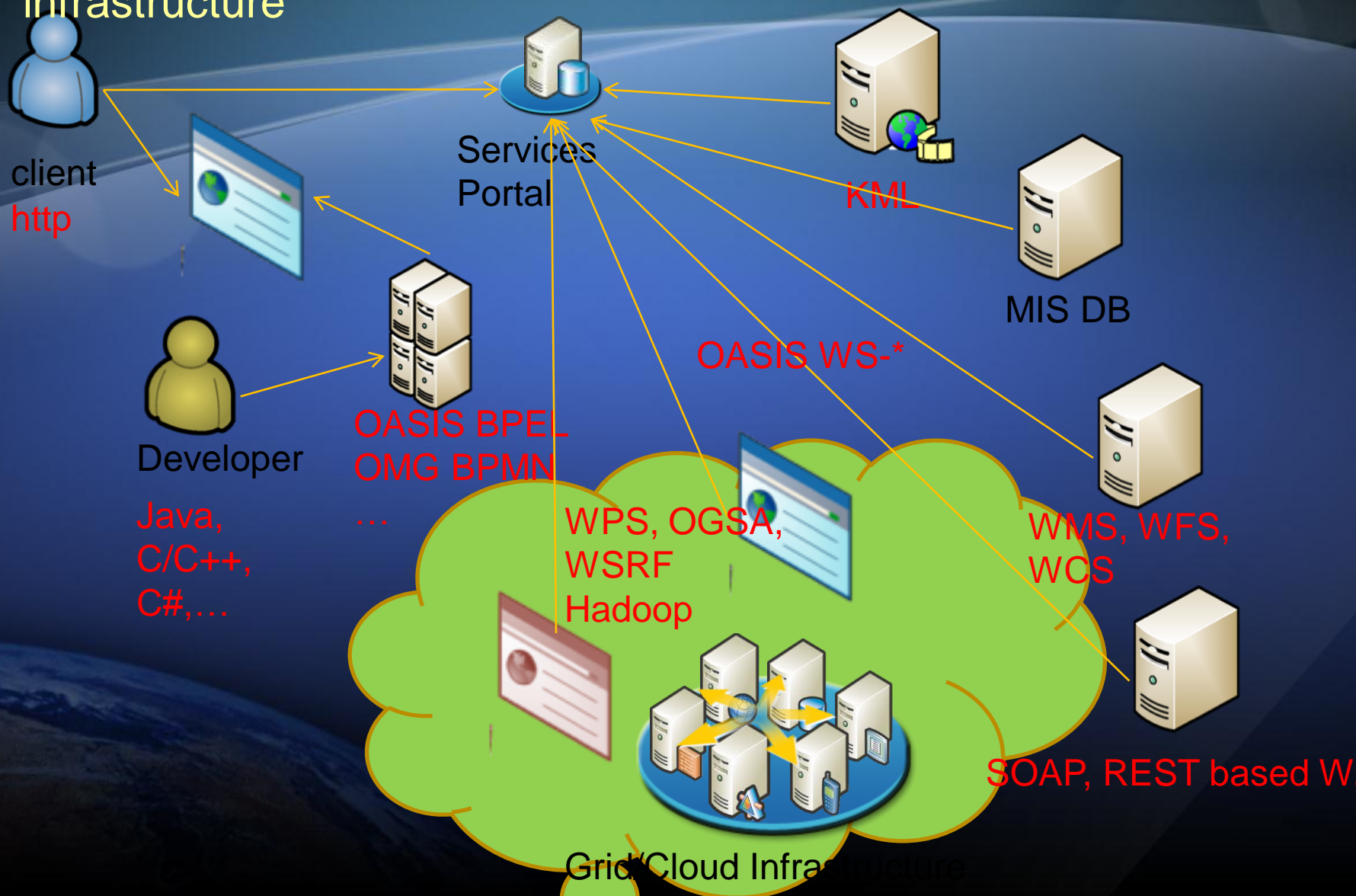


# Example of DaaS

- » provide ways to utilize a wide range of free Web-accessible datasets in various ways, including map displays and limited spatial analysis

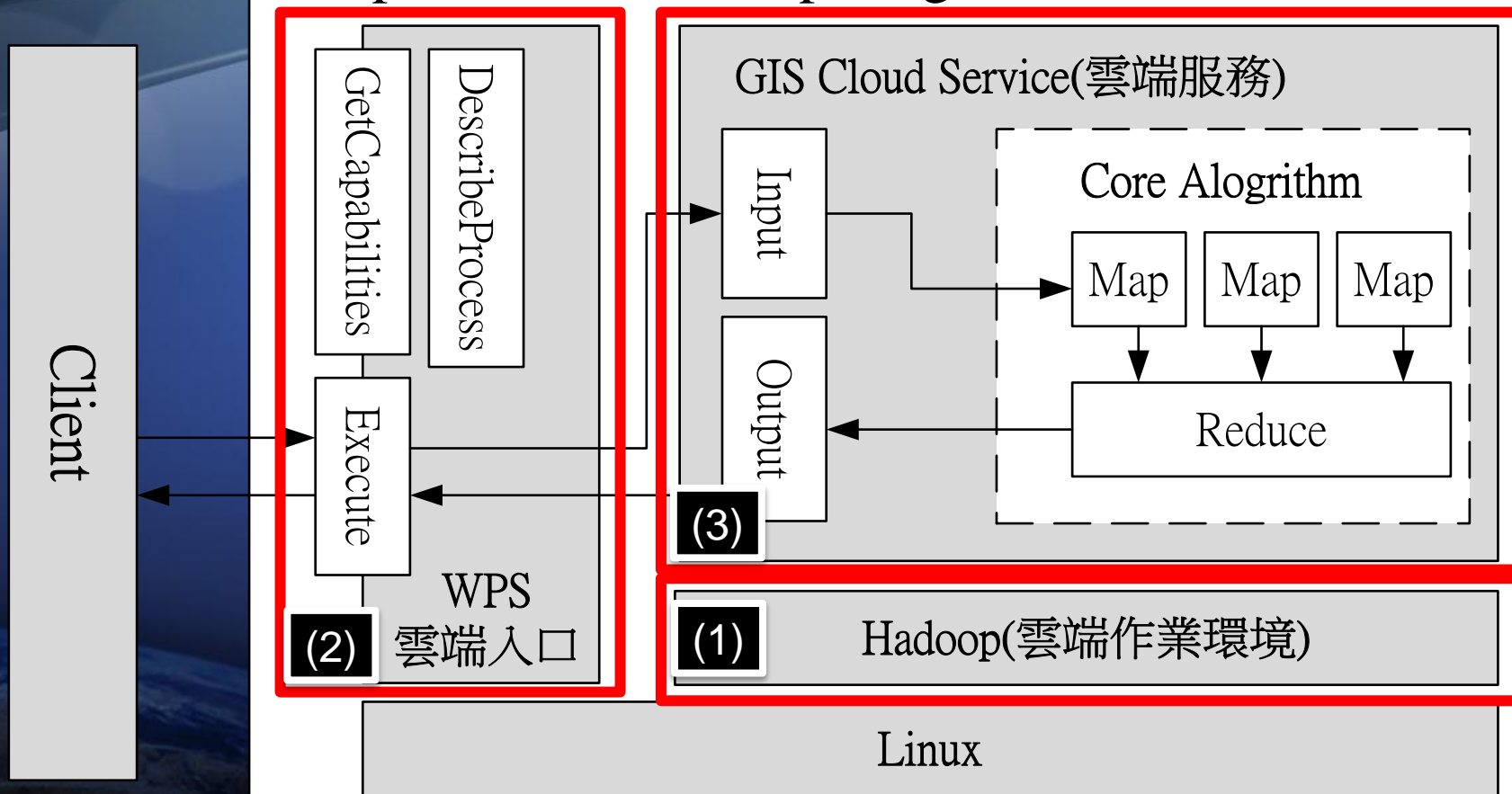


# A cloud/grid computing enabled disaster decision infrastructure





## Spatial Cloud Computing Platform



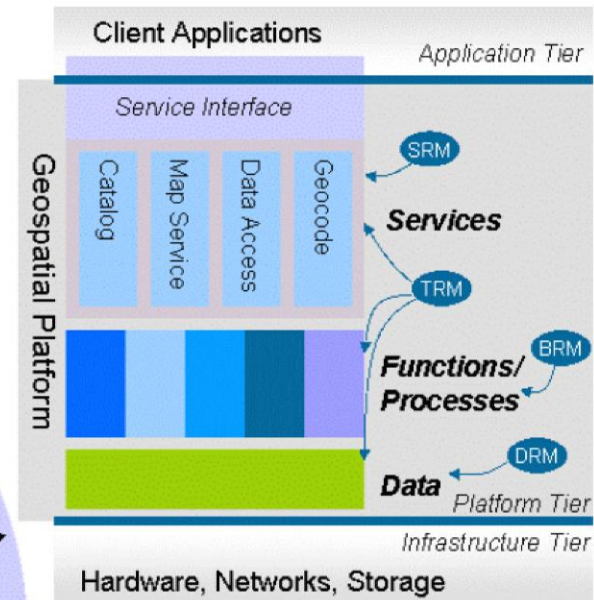
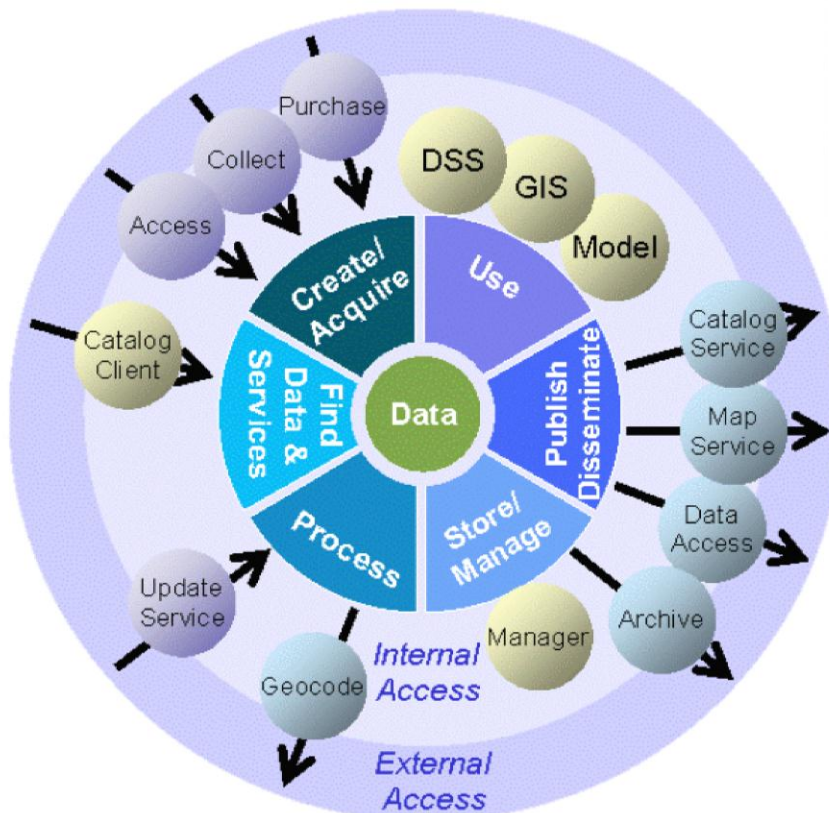
# Examples of Cloud Enabled SDI

---

FGDC GeoCloud, USA  
SkyEyes Cloud, Taiwan



# FGDC(Federal Geographic Data Committee) GeoCloud



# GeoCloud Sandbox Initiative

- » One-year hosting of geospatial data and applications, funded by FGDC, in external Cloud environments
- » Anticipated outcomes:
  - ▶ Identify requirements-driven solution architectures for various sized deployments of geospatial data and services
  - ▶ Document and assess cost models to support scalability, reliability, and redundancy
  - ▶ Expedite FISMA certification and accreditation for agency adoption of packaged solution architectures
  - ▶ Support and collect cost comparison information from agencies for existing and externally-hosted Cloud solutions



# Timeline

- » Jan 2010 – Identify geospatial solutions to be hosted (data, compute, applications)
- » April 2010 – Begin acquisition of leased Cloud resources for deployment
- » June 2010 – Deploy agency data/apps into Cloud envt and begin monitoring
- » Feb 2011 – Hold workshop on mid-term Best Practices and capabilities
- » June 2011 – Complete hosting cycle
- » October 2011 – Publish best practices, observations, and recommendations

# Candidate Geospatial Applications

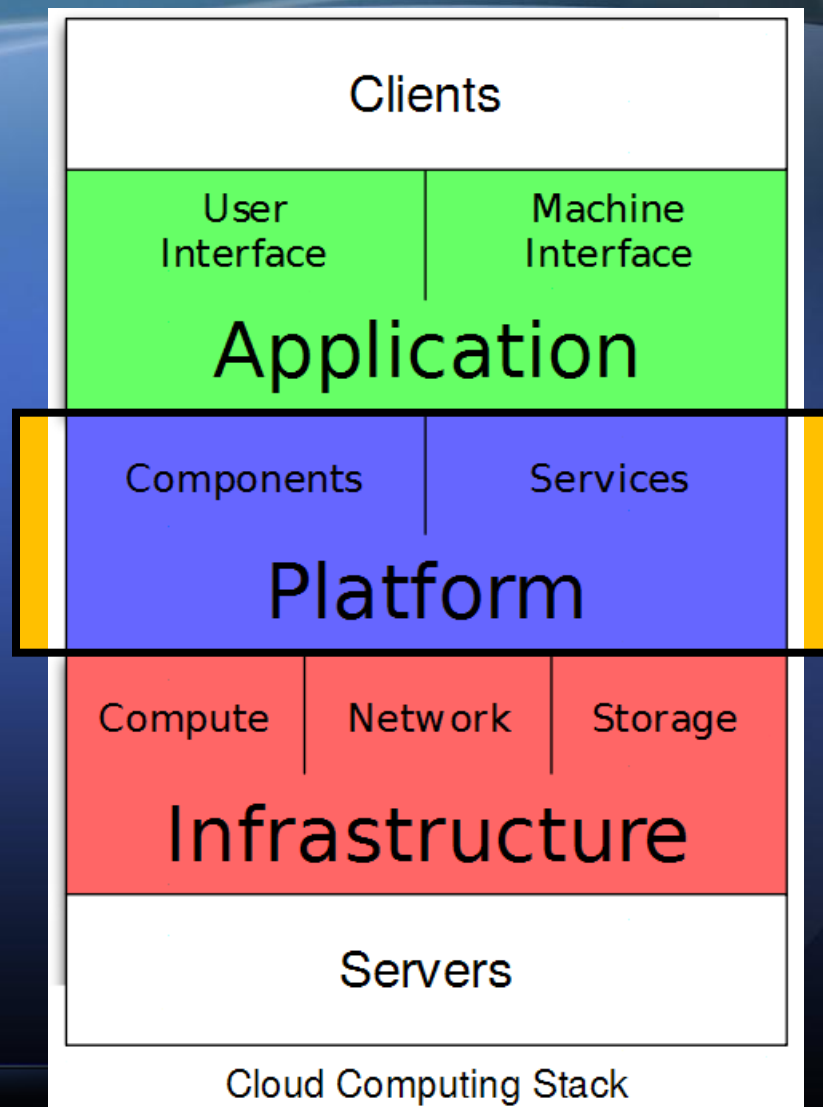
- » USFWS National Wetlands Inventory
- » Census Bureau TIGER/Line data
- » NOAA IOOS Catalog
- » NOAA ERDDAP Service
- » USGS National Elevation Dataset
- » USGS TNM tiled data and viewer
- » EPA Region 1 Lakes and Ponds data
- » NOAA Particle Tracking Model



# Notional Cloud Computing Stack

[http://en.wikipedia.org/wiki/Cloud\\_computing](http://en.wikipedia.org/wiki/Cloud_computing)

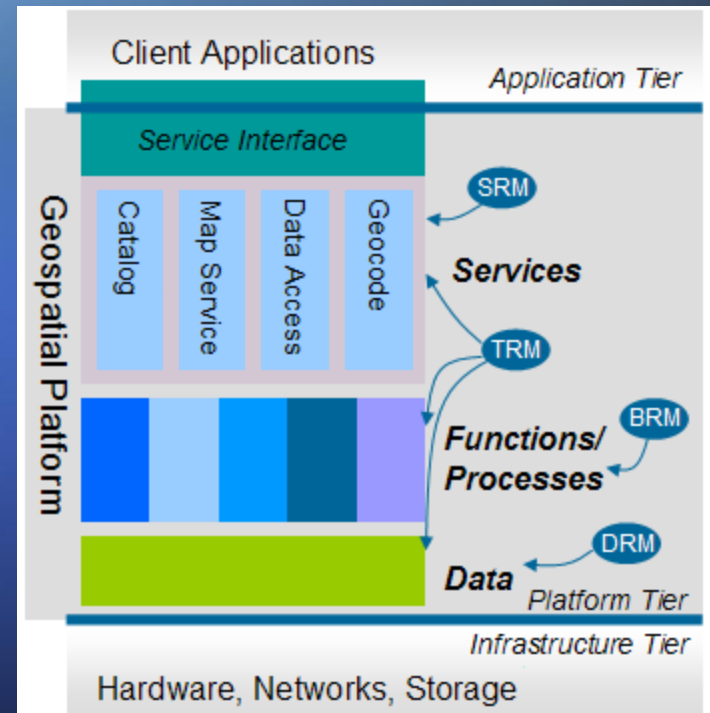
- GSA(General Service Administration) apps.gov will be offering Infrastructure as a Service (IaaS) solutions for acquisition
- This is roughly equivalent to “shared-hosting” of raw computers with an operating system in the Cloud domain



# Platform as a Service (PaaS)

“A *cloud platform* (**PaaS**) delivers a computing platform and/or solution stack as a service, generally consuming *cloud infrastructure* and supporting *cloud applications*. It facilitates deployment of applications without the cost and complexity of buying and managing the underlying hardware and software layers.”

The GeoCloud intends to pilot the deployment of candidate services or solutions architectures (suites of software) on top of the GSA IaaS to provide common geospatial capabilities. GSA will venture into PaaS next.



GSA IaaS



# Fleet Management-Probe Vehicles



Tanker Trucks



Freight Trucks



Refrigerator Vans



Tourist Buses

Fire Trucks



Ambulances



Trash Trucks



Tow Trucks

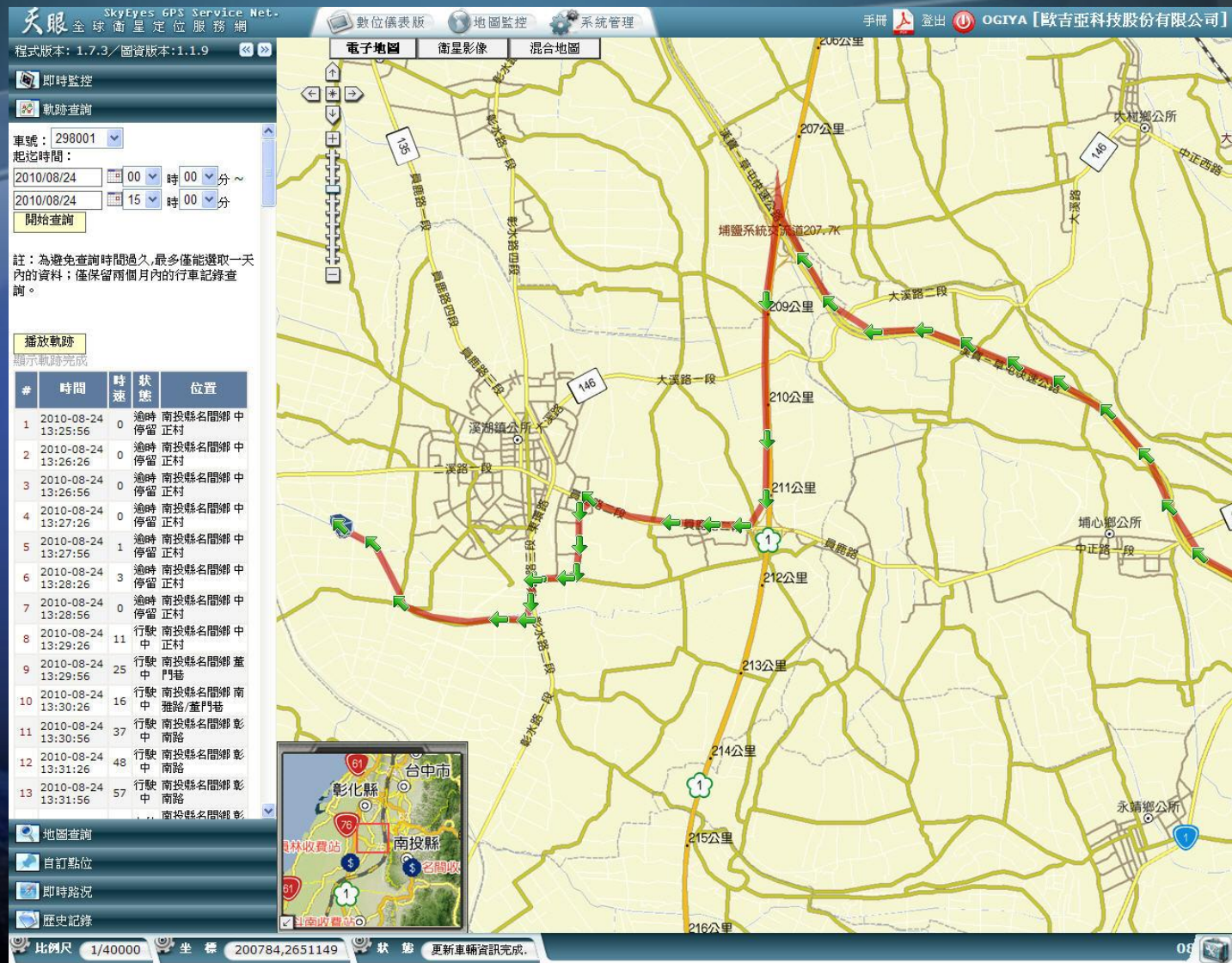


Police Cars





# Probe Vehicles





# SkyEyes Cloud

69









Sensor Data

Replicate

**HDFS**

**Traffic Information Processor**

**HBase**

**Hadoop**

Web Services



Clients

**Probe Vehicle Tracking System**

Plate Number:

Log Period: From:  To:

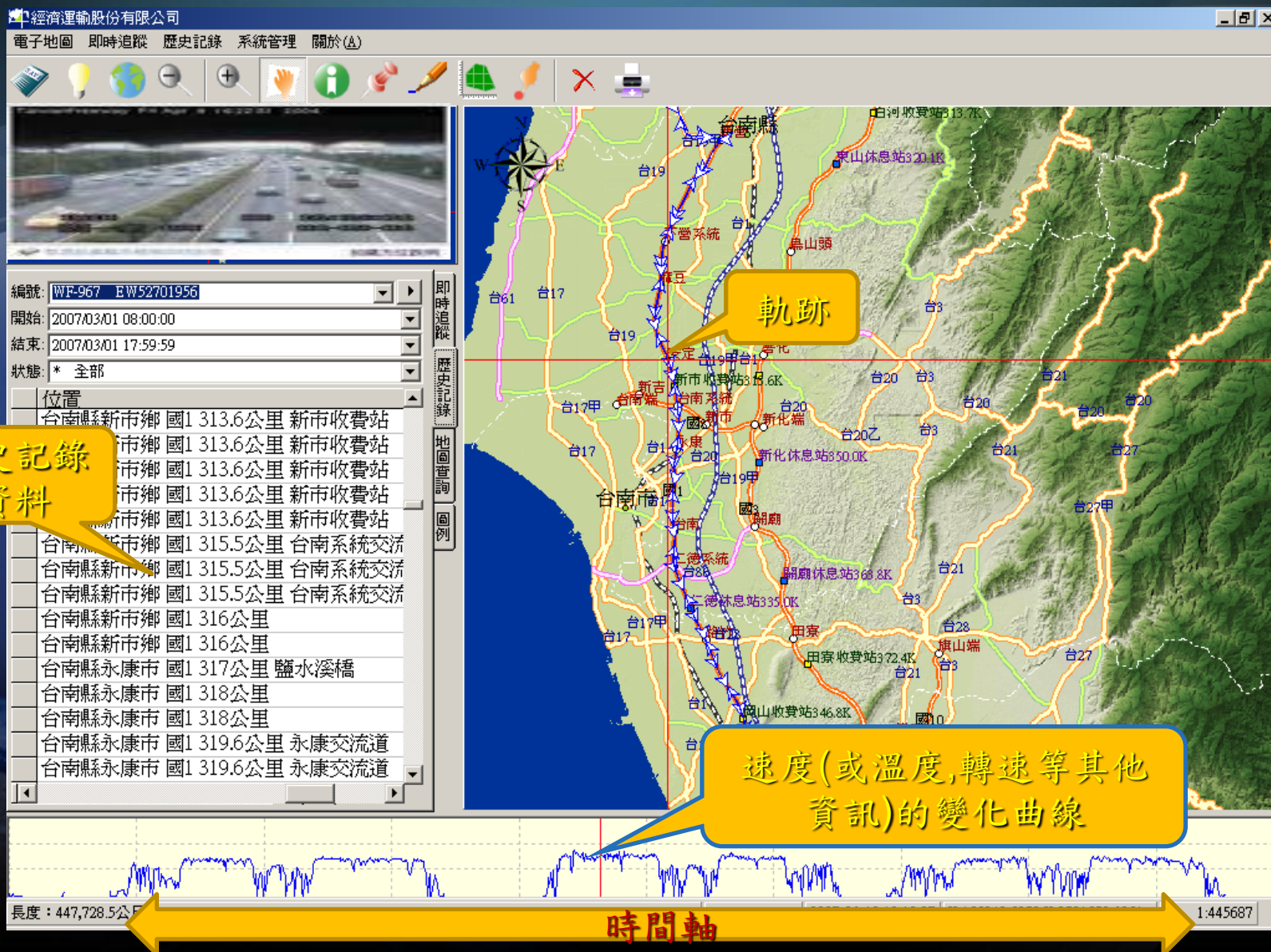
Query

```

<?xml version="1.0" encoding="utf-8" ?>
- <SkyEye>
- <Row>
  <Log>OG697373,2010-08-01
    00:00:20,,181073.93371723476,2593861.9459652021,False
  </Row>
- <Row>
  <Log>OG697373,2010-08-01
    00:02:19,,181074.27517360024,2593862.1289443765,False
  </Row>
- <Row>
  <Log>OG697373,2010-08-01
    00:04:19,,181074.78951989027,2593862.8648501704,False
  </Row>
- <Row>
  <Log>OG697373,2010-08-01
    00:06:20,,181074.78951989027,2593862.8648501704,False
  </Row>
- <Row>
  <Log>OG697373,2010-08-01
    00:08:19,,181073.42888279574,2593863.2403823179,False
  </Row>
- <Row>
  <Log>OG697373,2010-08-01
    00:10:19,,181073.42282975157,2593861.9483586662,False
  </Row>

```

# Real-time log analysis



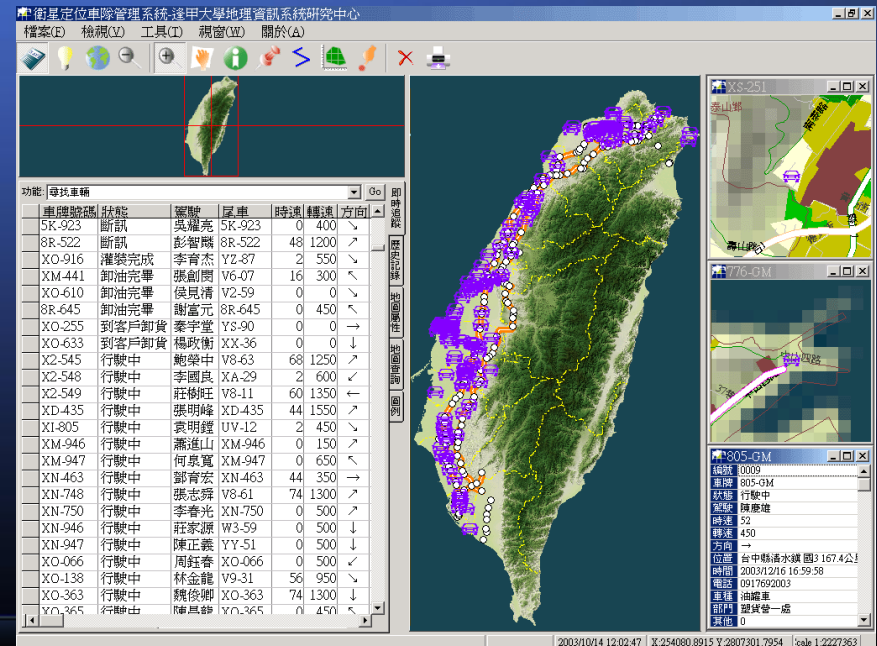


# Status

- » Vehicles under controlling : 5000+
- » Data capacity(per day) : 3 M records
- » RDBMS :Microsoft SQL Server 2005
- » Total historical data :
  - ▶ From 2002
  - ▶ 3.6 Billion Records

# Challenges

- Database payload
- Only 3 months data can be stored





# Solution

- Cloud Computing
- Distributed database
- High Availability
- High Scalability
- High Extensibility



# HBase

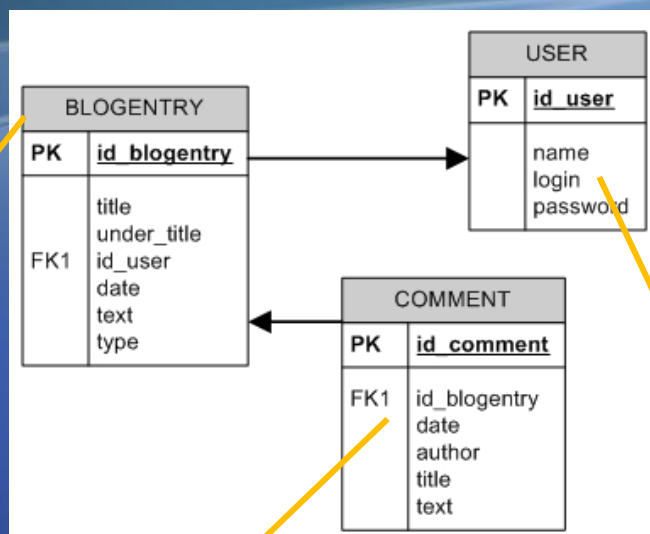
» **HBase** is an open source, non-relational, distributed database modeled after Google's BigTable and is written in

» Features

- ▶ Distributed
- ▶ Column-Oriented
- ▶ Multi-Dimensional
- ▶ High-Availability
- ▶ High-Performance

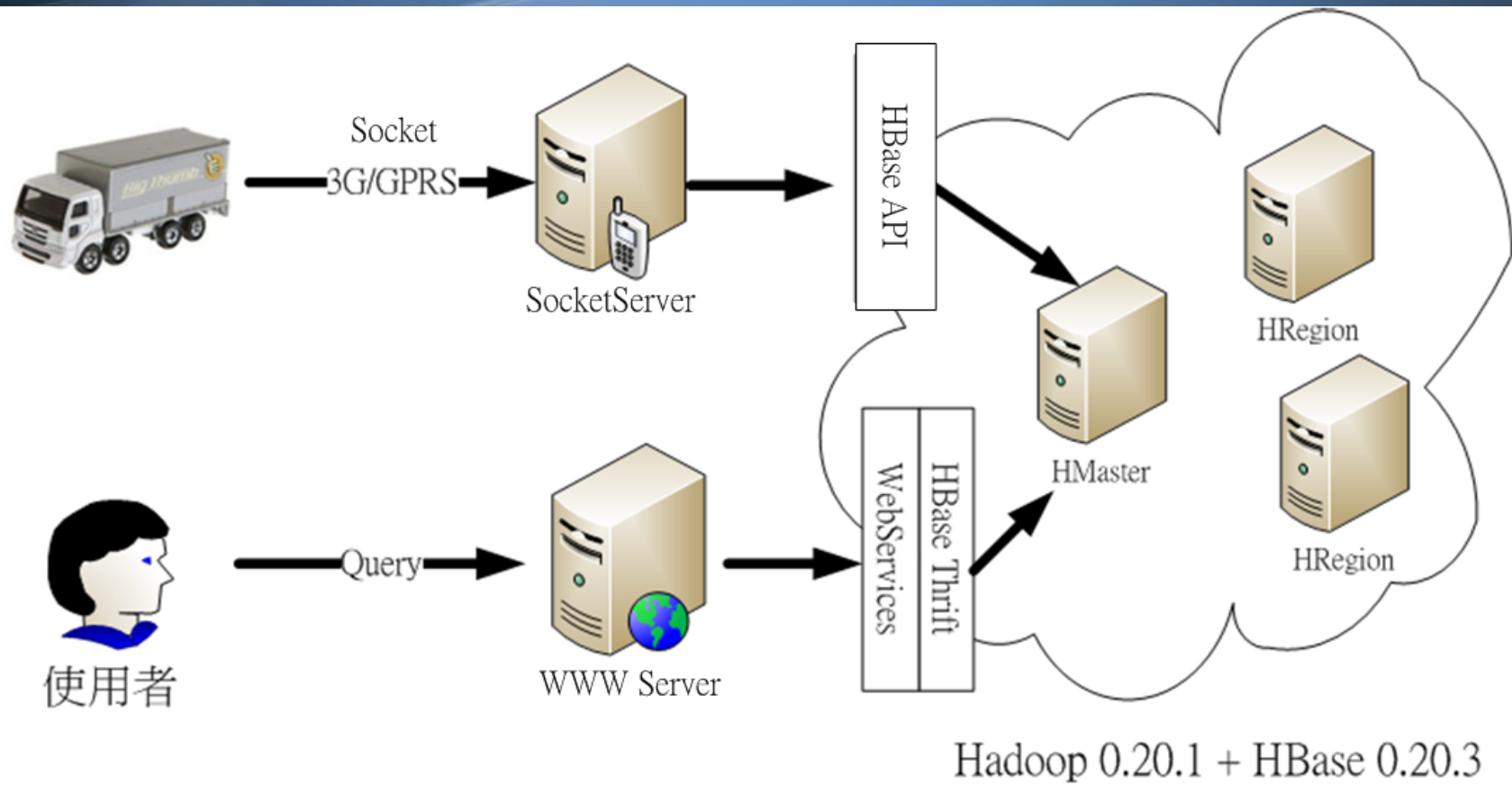


# Data Model



| Table     | Row Key         | Family          | Attributs  |
|-----------|-----------------|-----------------|--|
| blogtable | TTYYYMMDDHHmmss | info:           | Always contains the column keys author,title,under_title. Should be IN-MEMORY and have a 1 version |
|           |                 | text:           | No column key. 3 versions  |
|           |                 | comment_title:  | Column keys are written like YYMMDDHHmmss. Should be IN-MEMORY and have a 1 version                |
|           |                 | comment_author: | Same keys. 1 version   |
|           |                 | comment_text:   | Same keys. 1 version   |
| usertable | login_name      | info:           | Always contains the column keys password and name. 1 version                                       |

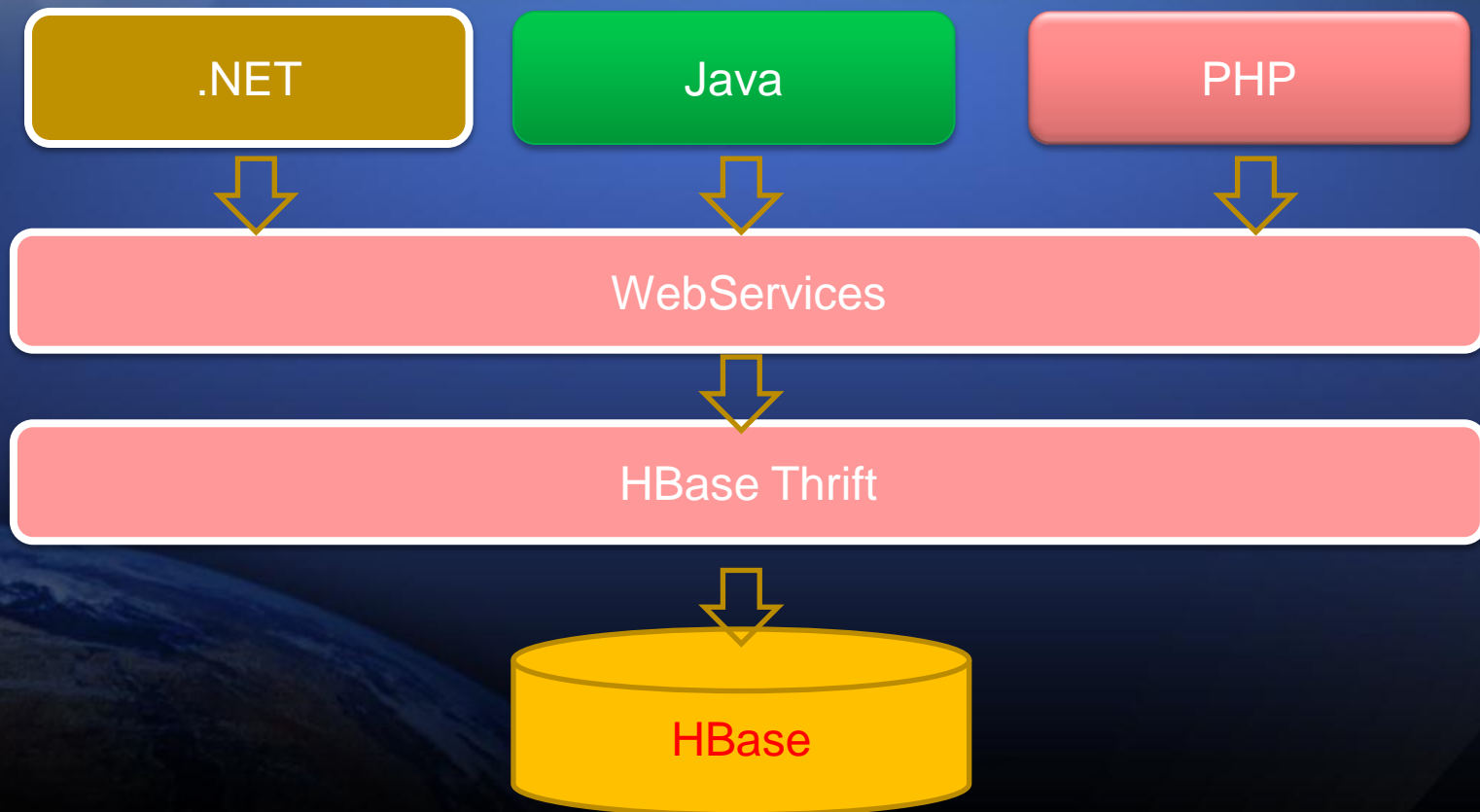
# System Architecture





# Heterogenous data service

- By using web service



# A simple client

## HBase on Vehicle Fleet Management

Corporation:

台塑貨運

CarID:

OG698002

Query Date:

2010-08-01

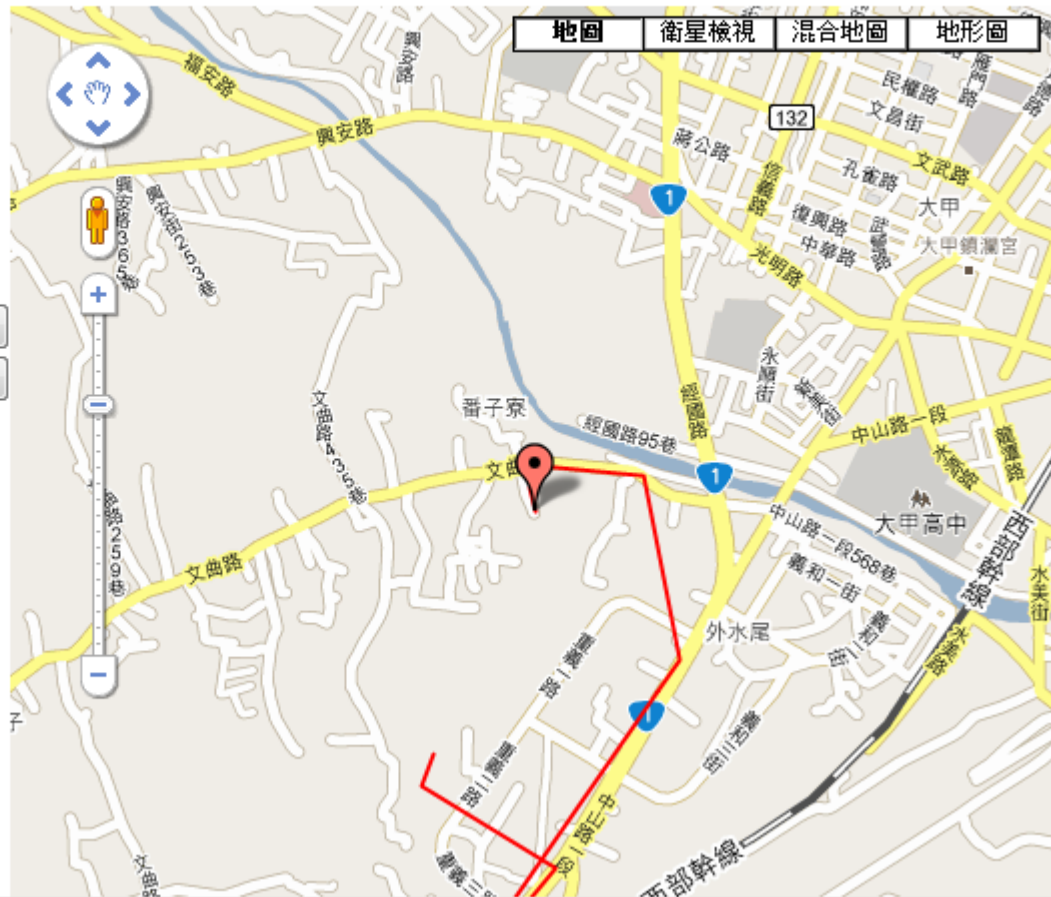
ReadLog

基本資料管理

☒ 自動放大地圖

歷史行車記錄

2010-08-01 00:39:12





http://10.0.0.51/SkyEye/default.php - Windows Internet Explorer

http://10.0.0.51/SkyEye/default.php

我的最愛 | Chapter 1 | OGC Test Engine | Open Source Geospacia... | EIP飲料店 | 建議的網站 | 自訂連結 | 取得更多附加元件

http://10.0.0.51/SkyEye/default.php

# HBase on Vehicle Fleet Management

Corporation: 請選擇

CarID: 請選擇

Query Date: 2010-04-01

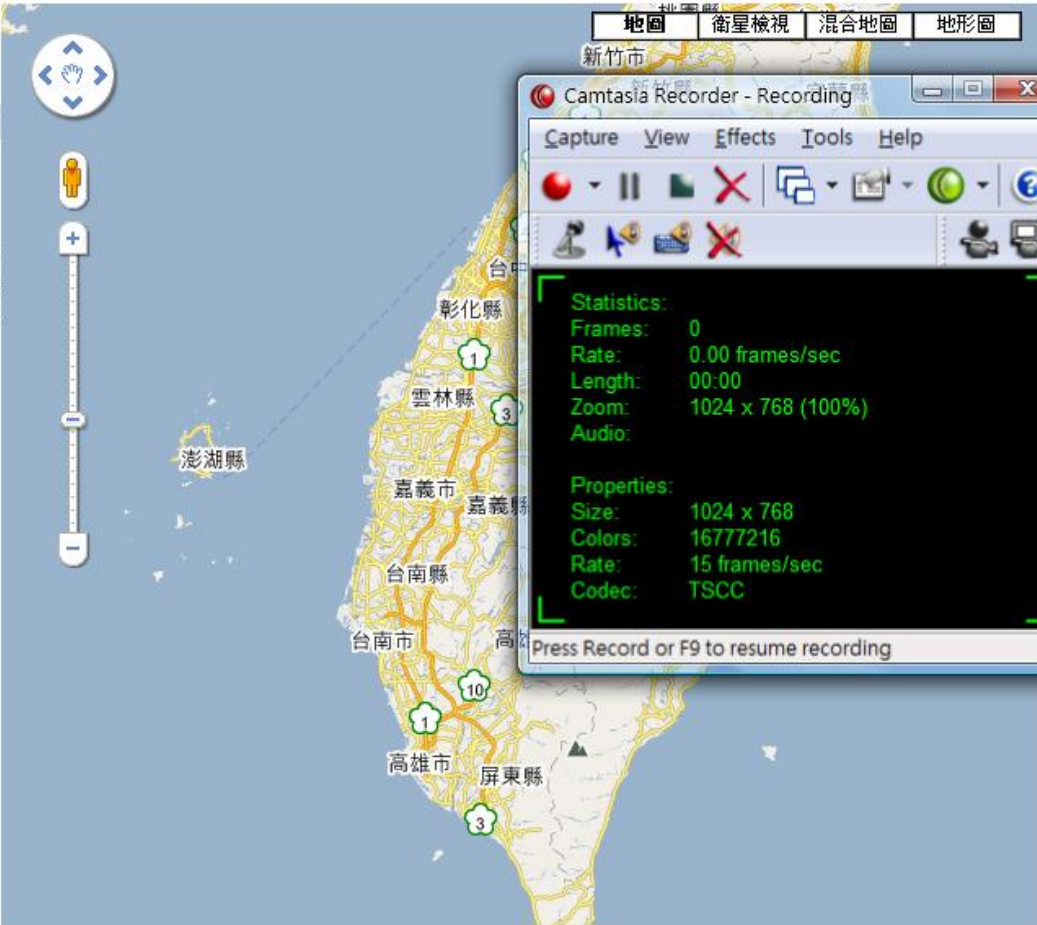
ReadLog

基本資料管理

☐ 自動放大地圖

歷史行車記錄

<<無>>



地圖 | 衛星檢視 | 混合地圖 | 地形圖

新竹市

彰化縣

雲林縣

嘉義市

嘉義縣

台南縣

台南市

高雄市

屏東縣

澎湖縣

Camtasia Recorder - Recording

Capture View Effects Tools Help

Statistics:

- Frames: 0
- Rate: 0.00 frames/sec
- Length: 00:00
- Zoom: 1024 x 768 (100%)
- Audio:

Properties:

- Size: 1024 x 768
- Colors: 16777216
- Rate: 15 frames/sec
- Codec: TSCC

Press Record or F9 to resume recording

完成

網際網路 | 受保護模式: 關閉

16:38 星期三

100%

# Conclusion

- » Cloud computing will be pervasive
- » Conquer the challenges of incredible huge data storage and processing
- » OGC web services are ready-made for cloud computing
- » Much remains to be done
  - ▶ Science, commerce, government, education can't benefit fully from state-of-the-art technologies until the social, institutional, behavioral and commercial parts of the information infrastructure have matured.