



National Applied Research Laboratories Taiwan

FLOOD MITIGATION GRID IN TAIWAN

*Whey-Fone Tsai
Hsi-Ching Lin, Jen-Gaw Lee
Jyh-Horng Wu, Mulderyu Yu and Stoca Chang*

*National Center for High-performance Computing
National Applied Research Laboratories, Taiwan*

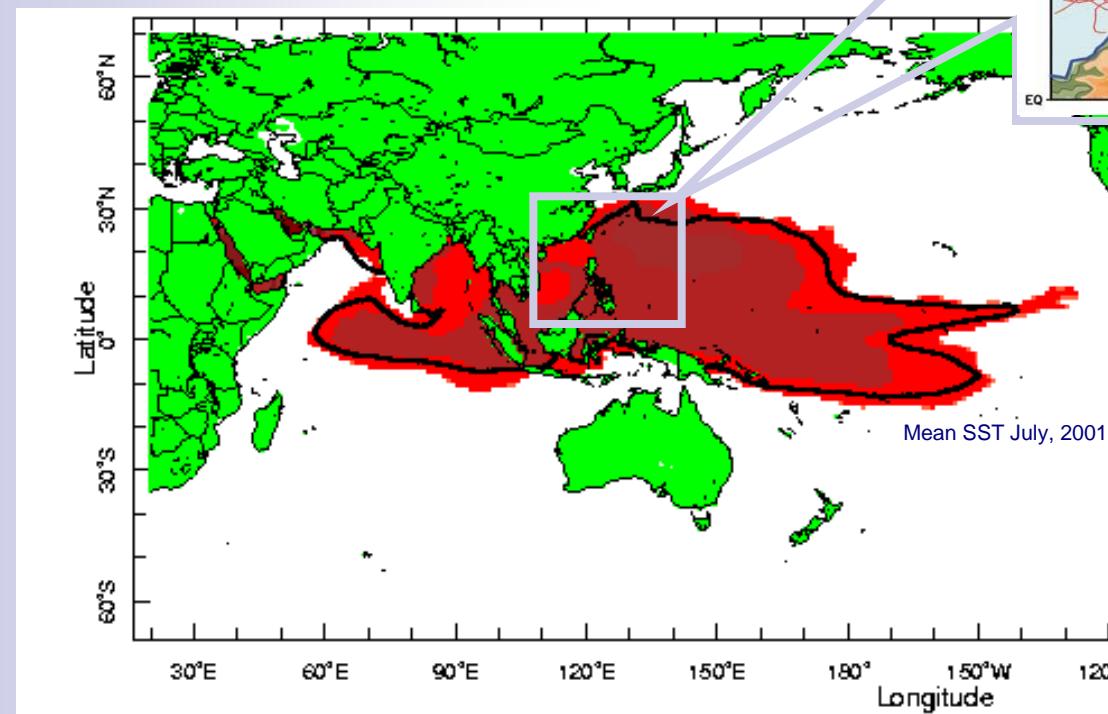
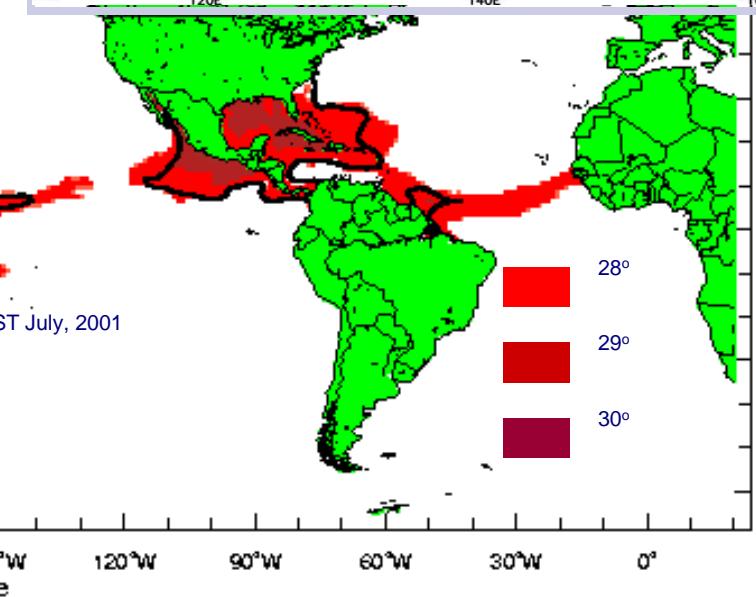
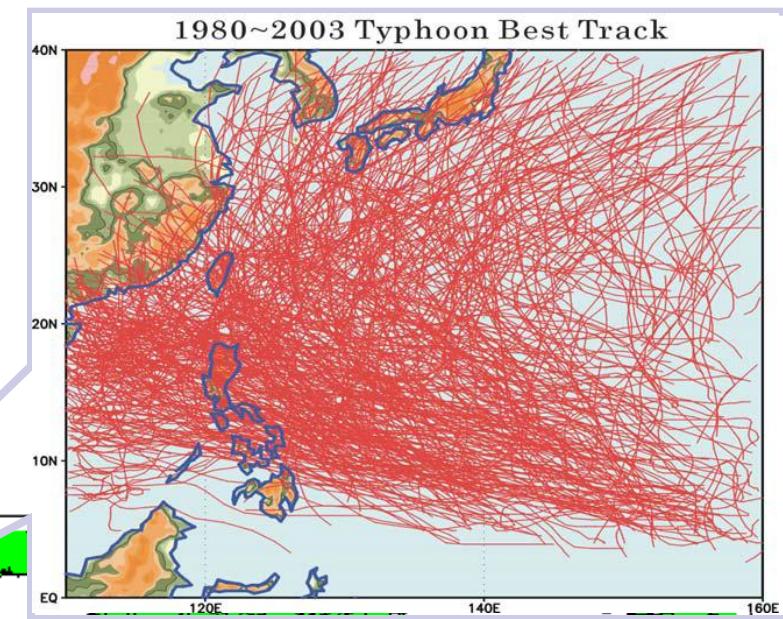
Outline

- Typhoon & Flood in Taiwan
- Flood Mitigation Grid in Taiwan
 - Human Centric Cyberinfrastructure
 - Co-life Collaborative & Communication System
 - Flood Forecast System
 - Flood Monitoring Sensor Network
 - 3D GIS Taiwan Platform
- Demo from Taiwan
- Summary

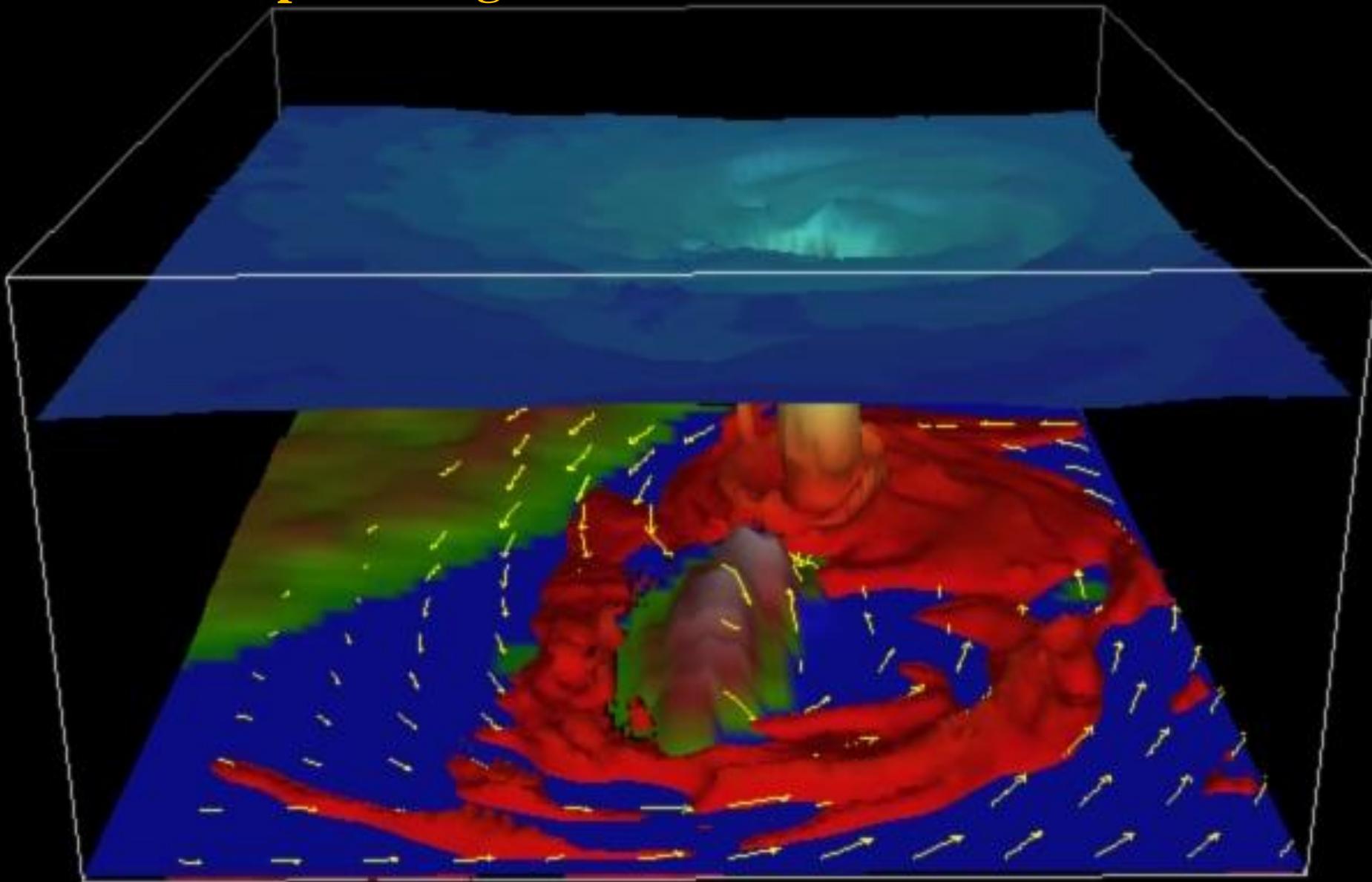
Hydrometeorology Challenges

On the average, Taiwan is struck by 3.5 typhoons/year

Warm NW Pacific sea surface temperature produces the highest Typhoon Maximum Potential Intensity on earth.



Diameters of typhoon may be Larger than the length of Taiwan Island, which means the circulation is unblocked and can keep drawing moist air from sea surface

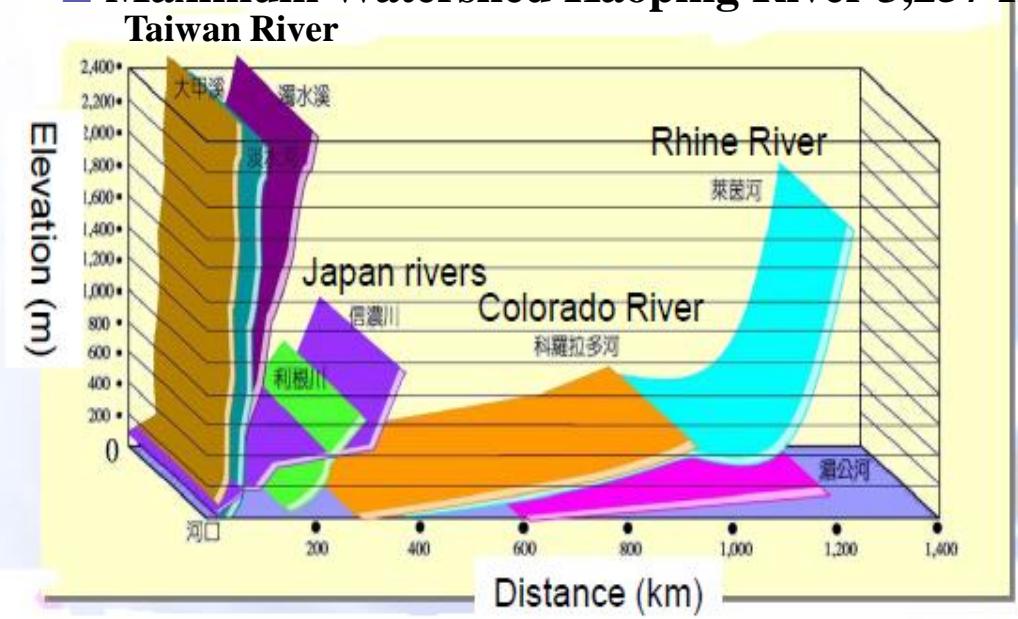


Flash Flood in Taiwan

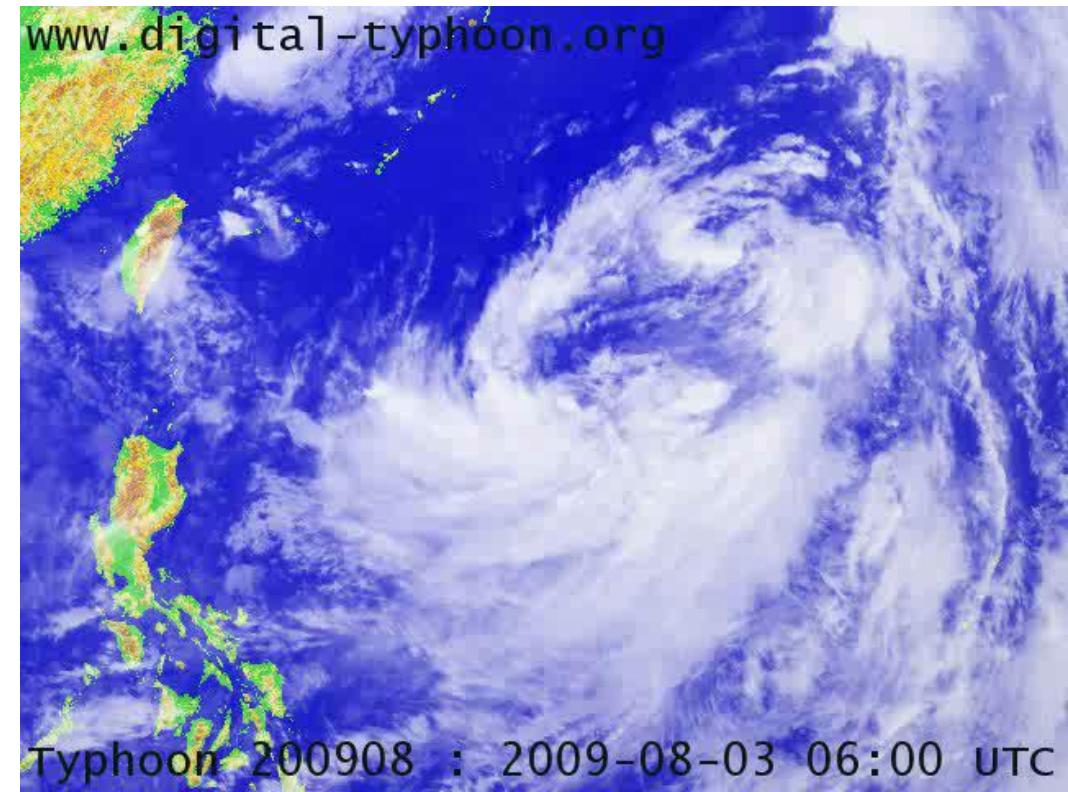
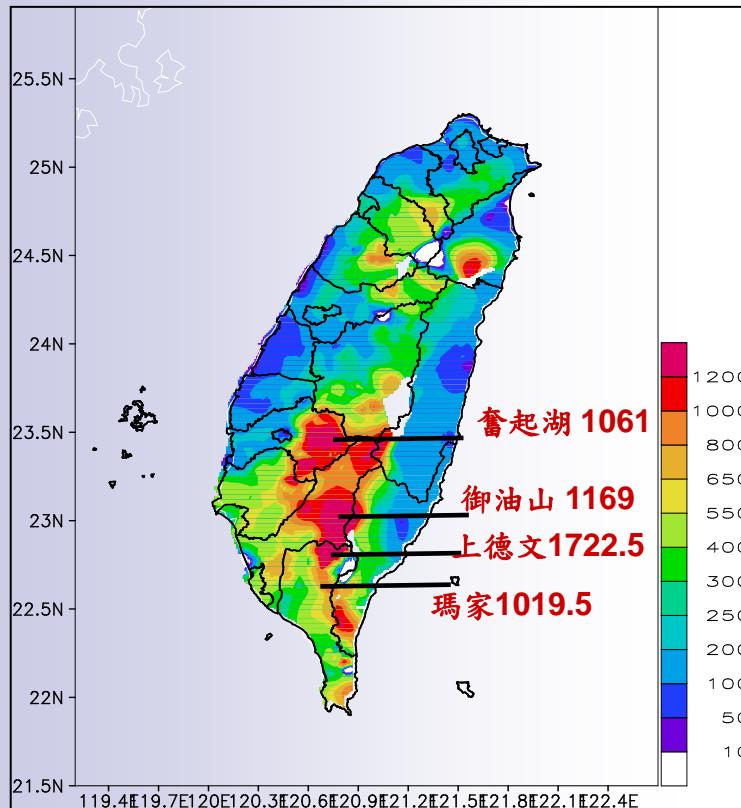
- River with steep slope feature
- Typhoon-induced rainfall



- Only 6 rivers longer than 100 KM;
- the longest Jhuoshuei River 186.4 KM
- Maximum Watershed Kaoping River $3,257 \text{ K}^2$

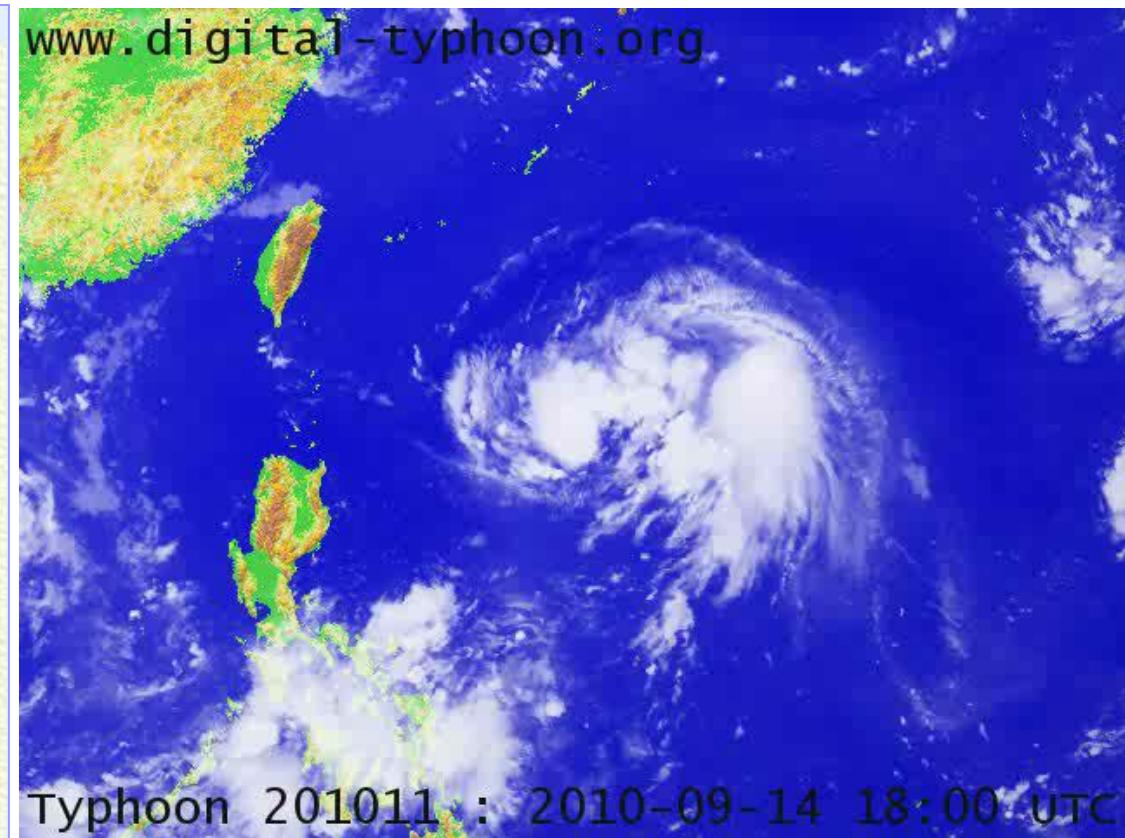
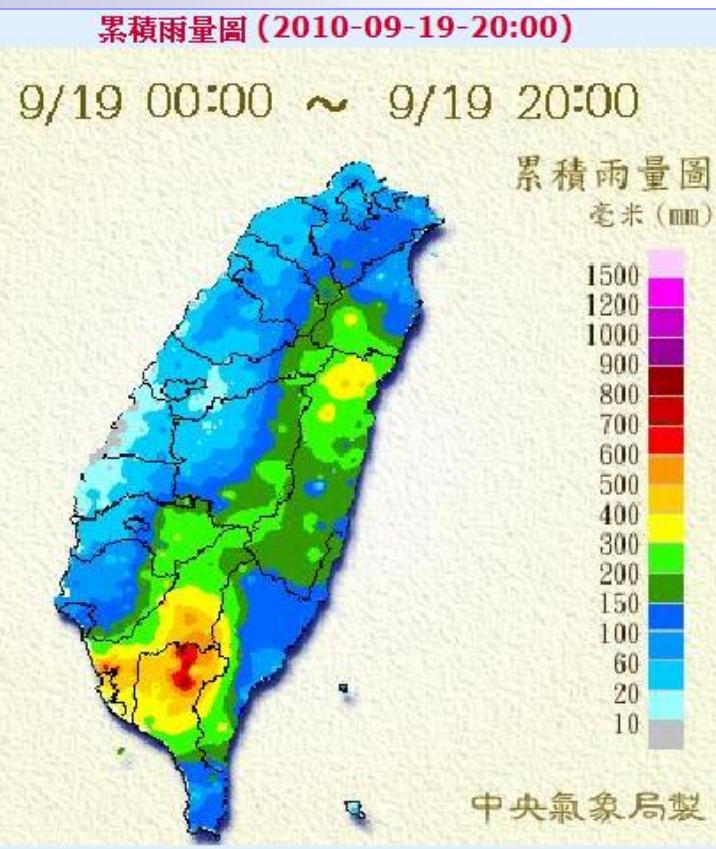


Typhoon Morakot 2009



Accumulated Precipitation 2500 mm in Southern Taiwan, a historical record, caused serious inundation and landslide

Typhoon Fanapi 2010



Typhoon Fanapi caused serious inundation in Kaohsiung area; especially in Nantsu area of Kaohsiung City accumulated rainfall 618mm in couple of hours, approached 200 years of return period

Typhoon Megi 2010

10/21 00:00 ~ 10/21 16:00

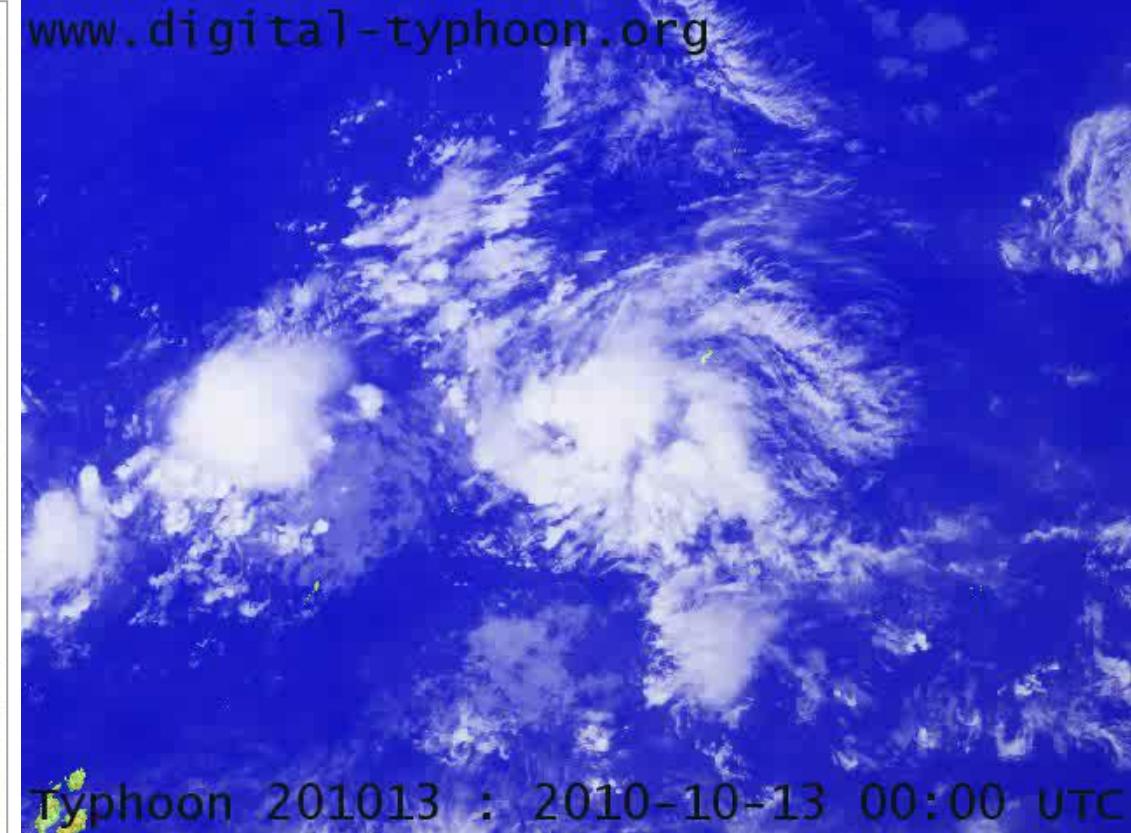
累積雨量圖
毫米 (mm)



Accumulated
Rainfall
1000mm

中央氣象局製

www.digital-typhoon.org



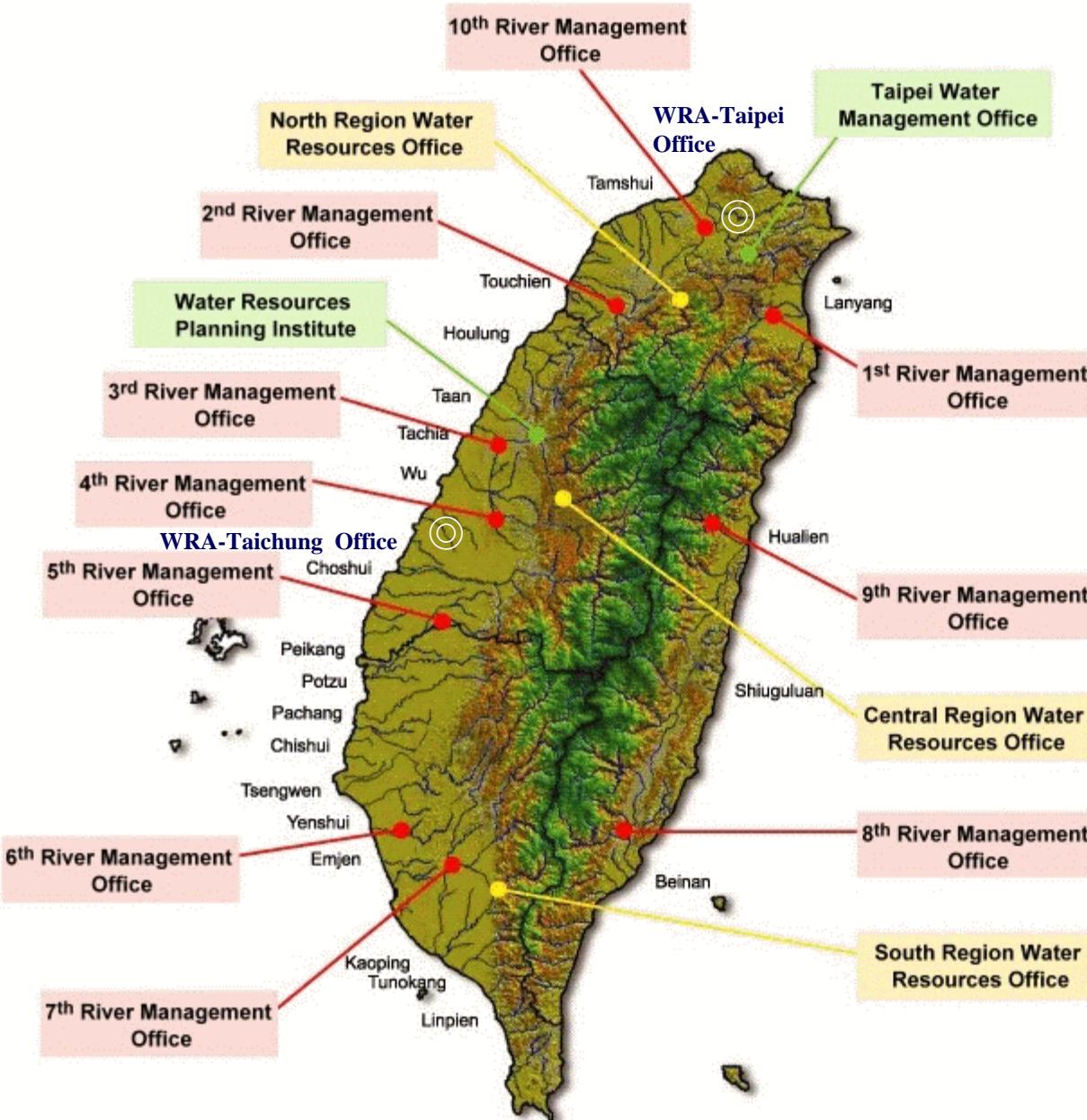
Typhoon Megi brought intensive rainfall, caused serious inundation and landslide in East Taiwan

Flood, Landslide, and Damage Caused by Typhoon



Flood Mitigation Grid-Goal

- The modern decision support system (DSS) for flood mitigation comprises of the knowledge from different disciplines, such as forecasting models, GIS models, visualization systems, communication and sensor network systems.
- The development of DSS requires, due to the heterogeneity of models and systems, a friendly user interface or platform to hide the complexity of various tools from users.
- DSS is expected to increase decision effectiveness of decision-makers. Due to advance of CI and associated network bandwidth and computing resources, DSS is applicable to the real-time problems, especially for hazard-related issues.
- To increase the user satisfaction and regret avoidance, Water Resource Agency (WRA) has included above requirements in the development of flood mitigation grid, through the collaboration with national laboratories, such as NCHC, and universities in Taiwan, as well as international partners.



- WRA-Taipei Office
- WRA-Taichung Office
- 10 River Management Offices
- 3 Region Water Resources Offices

Collaboration, communication, and share real-time information among distributed agencies are very crucial for disaster mitigation decision support

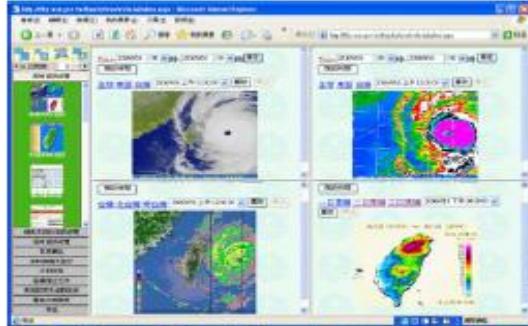
Geographically Distributed Water Resource Agency & Affiliated Agencies

Flood Emergency Information System in WRA, Taiwan

- Development of DSS comprises of heterogeneity of models and systems
- A friendly user interface or platform is required to hide the complexity of various tools from users
- Easily to let geographically distributed people working together



雨量 水位 灾情 洪情



Weather Information

Role of Flood Mitigation Grid?



Precipitation Monitoring



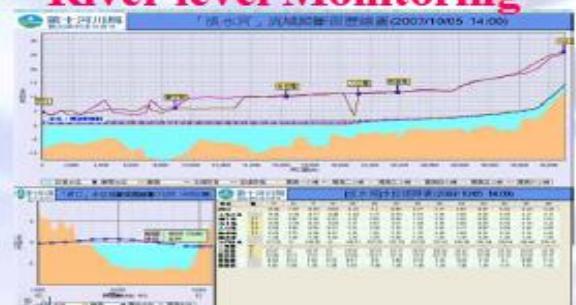
River level Monitoring



Reservoir Monitoring



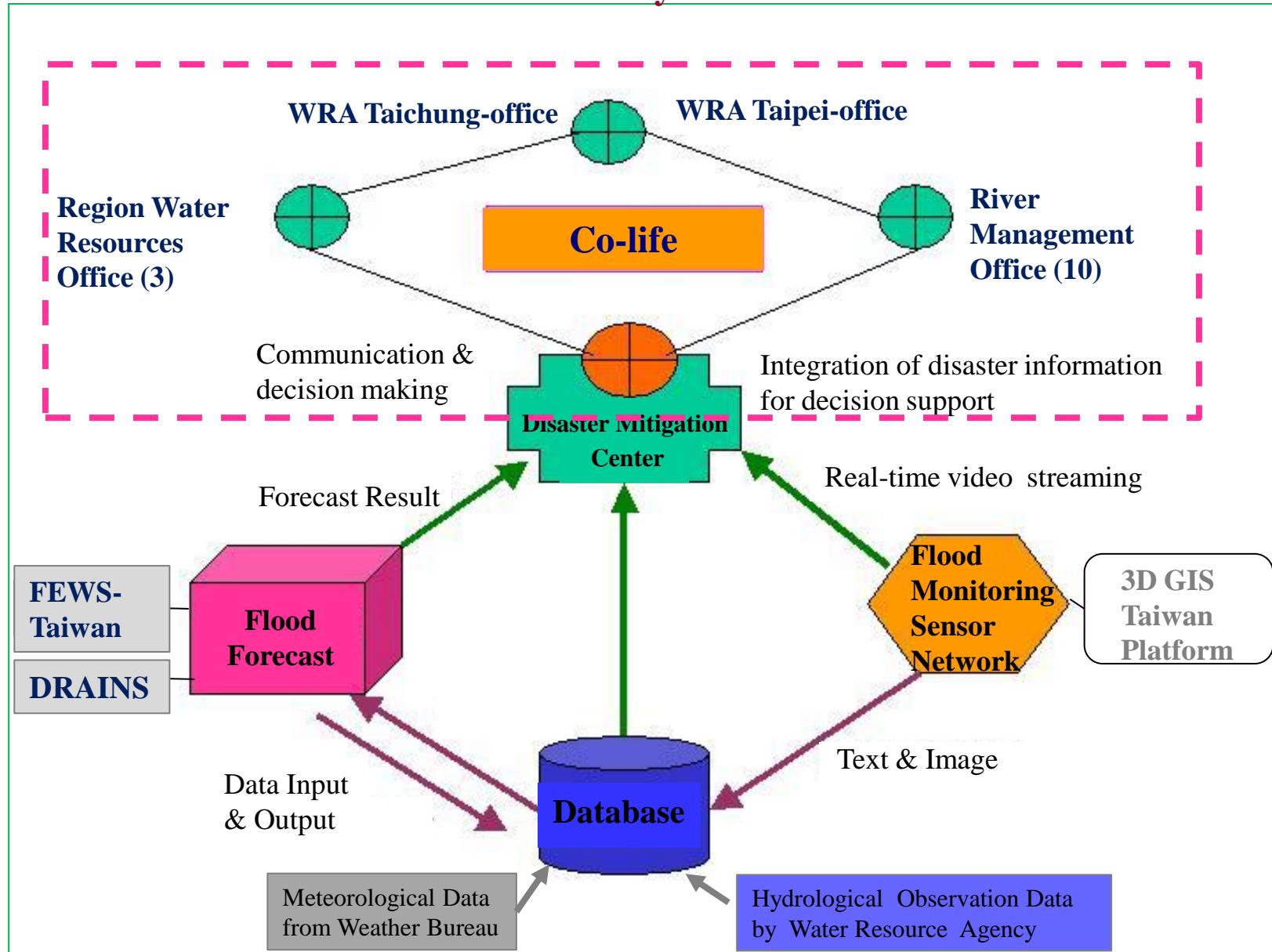
Coastal Monitoring



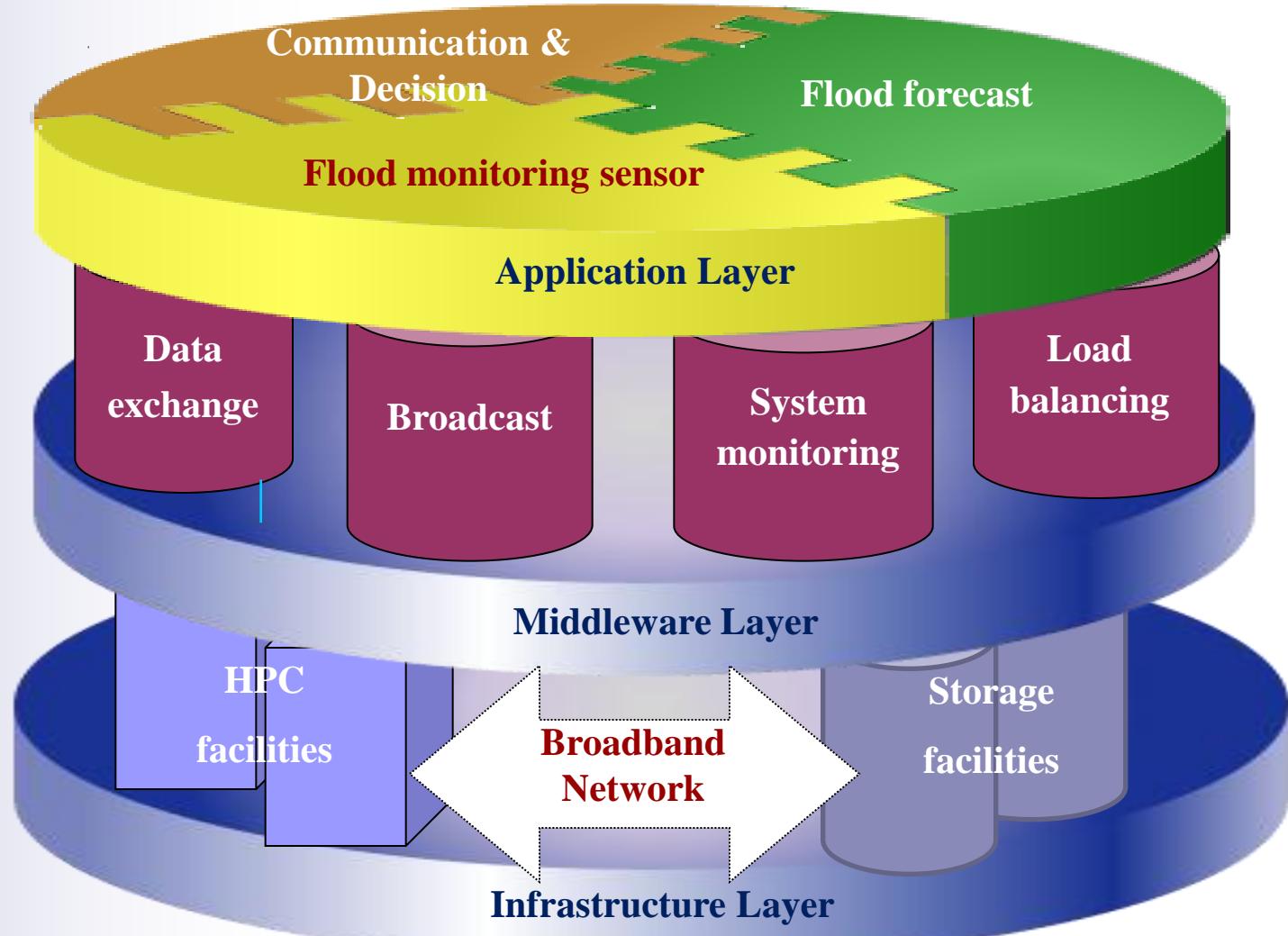
Flood Forecasting

Flood Mitigation Grid in WRA

Human Centric Cyberinfrastructure



Layers of Flood Mitigation Grid



Co-Life: Collaboration Through Life

Developing Grid Middleware Co-life: Real-time Communication, Collaboration and Information (data image, video) Sharing

The collage consists of four screenshots:

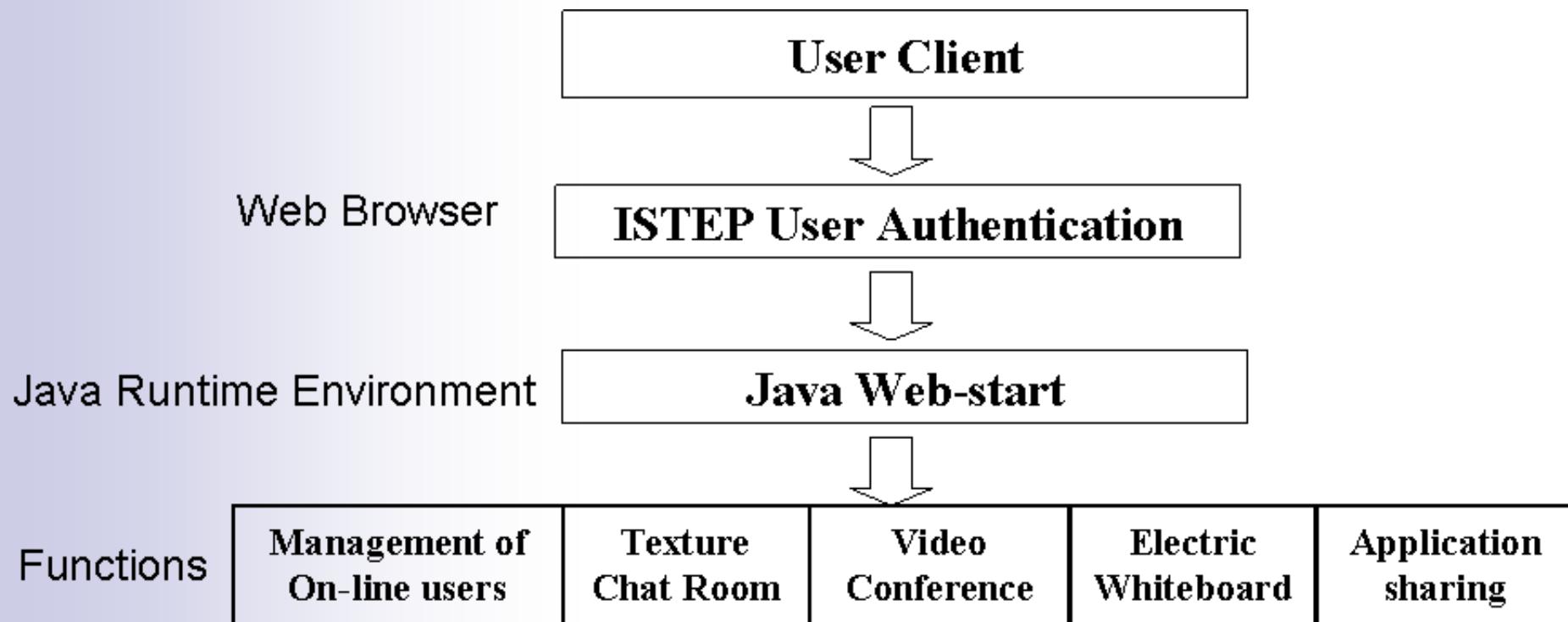
- Top Left (Yellow Border):** A video conference interface showing multiple participants in a room. The timestamp is 00:11:04.01.
- Top Right (Red Box):** A remote collaborative diagnosis interface for SARS patients. It shows a chest X-ray and a video call interface between NCHC Taiwan and NCHC, Chia-Chen. The timestamp is 00:10:58.00.
- Bottom Left (Pink Border):** An emergency response decision support interface. It includes a video conference list, a desktop sharing window showing a map of Taiwan with event monitoring, and a chat room. The timestamp is 00:08:24.01.
- Bottom Right (Blue Box):** A multidisciplinary courses/training interface showing a classroom full of students. The timestamp is 00:10:58.00.

Emergency Response Decision Support

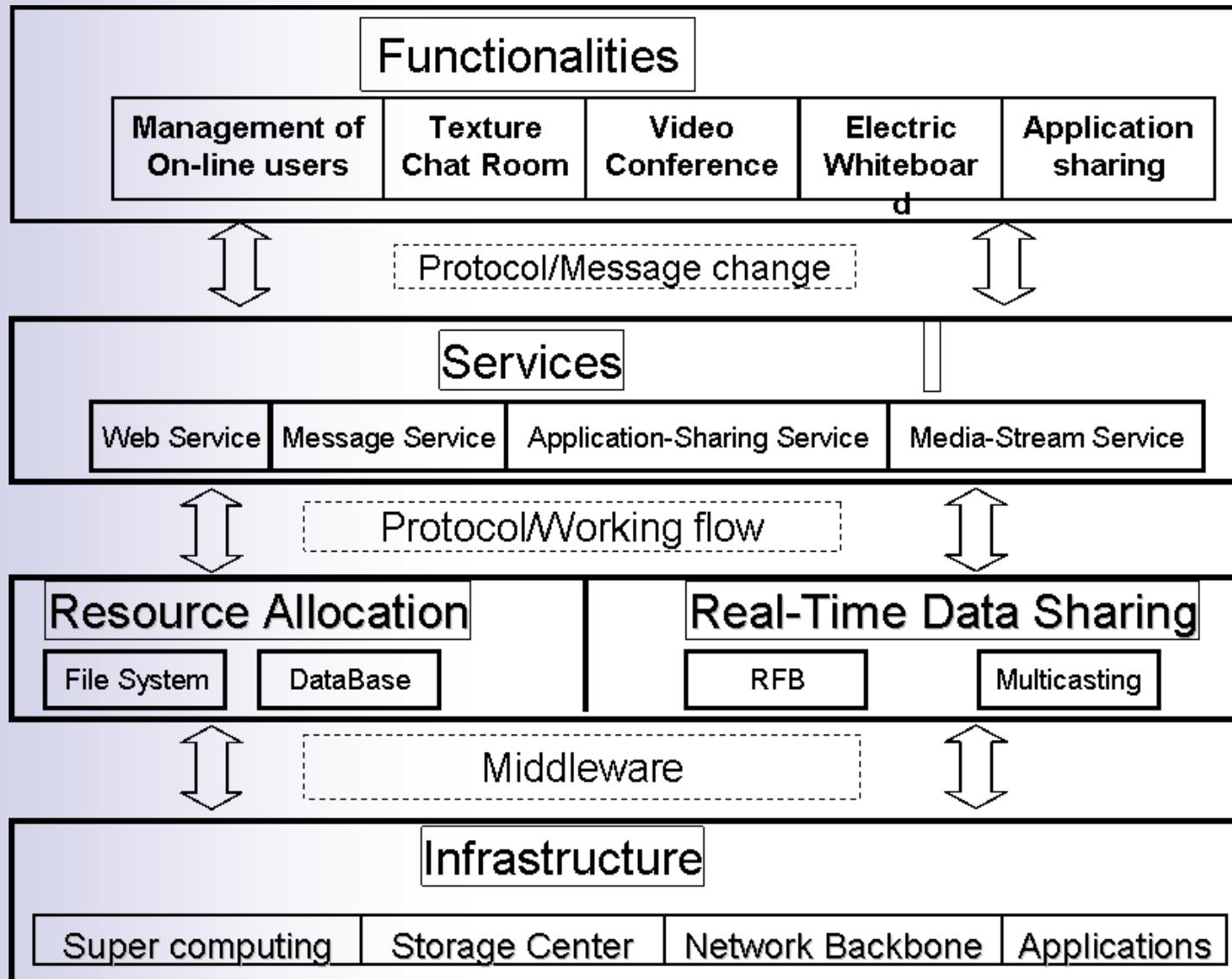
Remote Collaborative Diagnosis on SARS Patients

Multidisciplinary Courses/Training

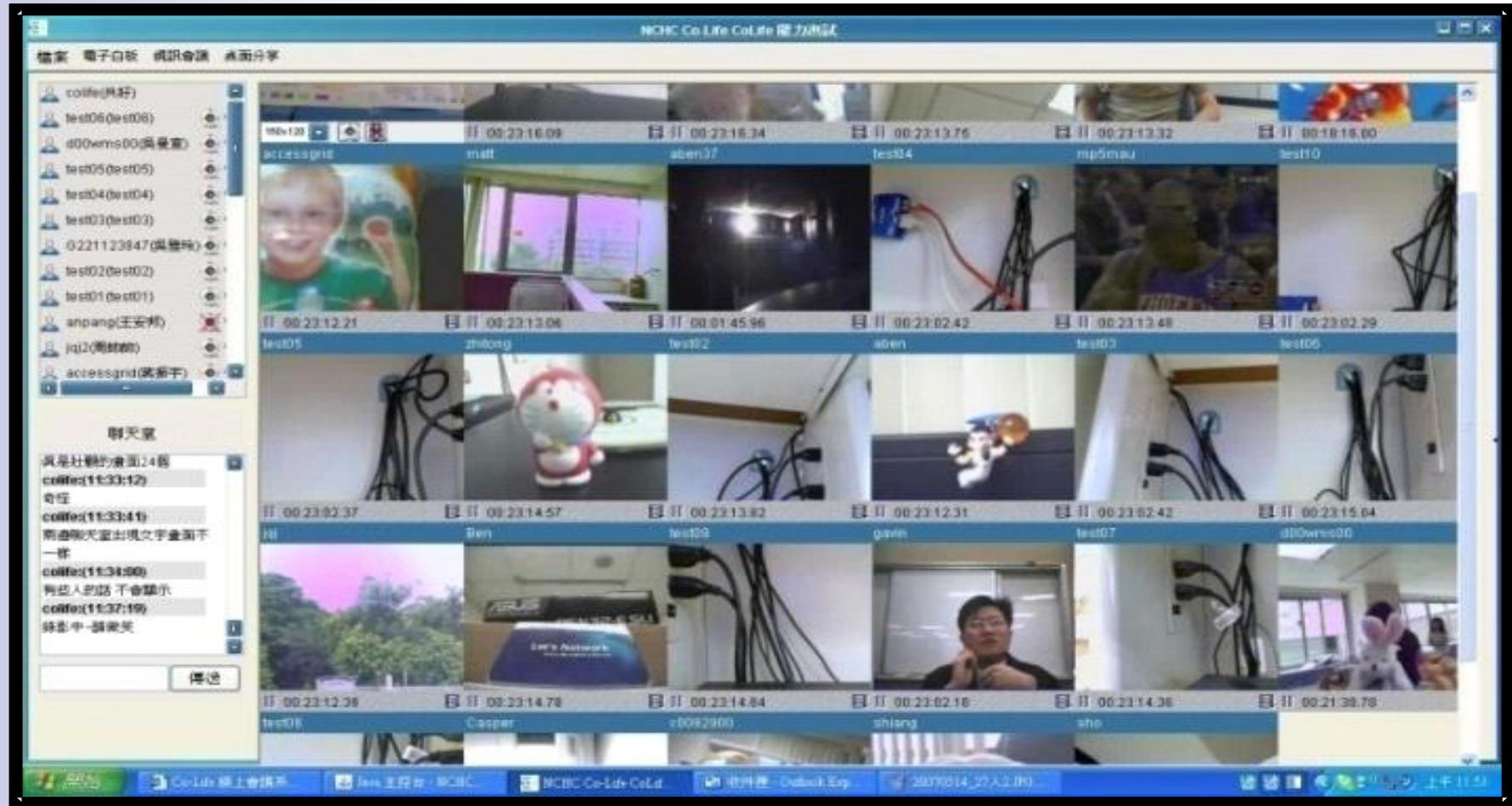
Co-life System Architecture



Co-life System Architecture (Cont'd)



Pressure Test: 29 Participants on-line



User Interface

Participants

Desktop Sharing by VNC

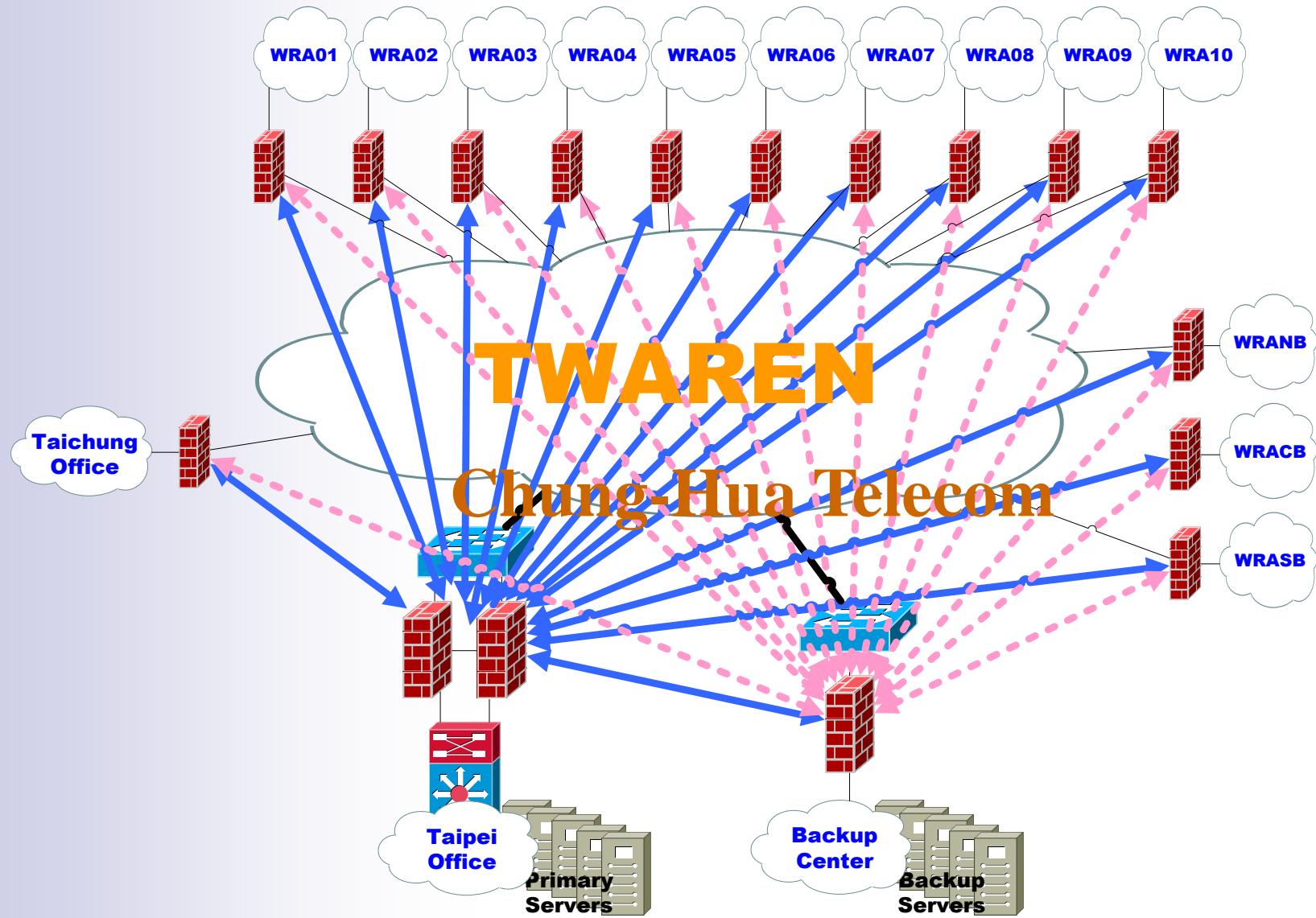
Video

The screenshot displays a video conference interface with multiple windows:

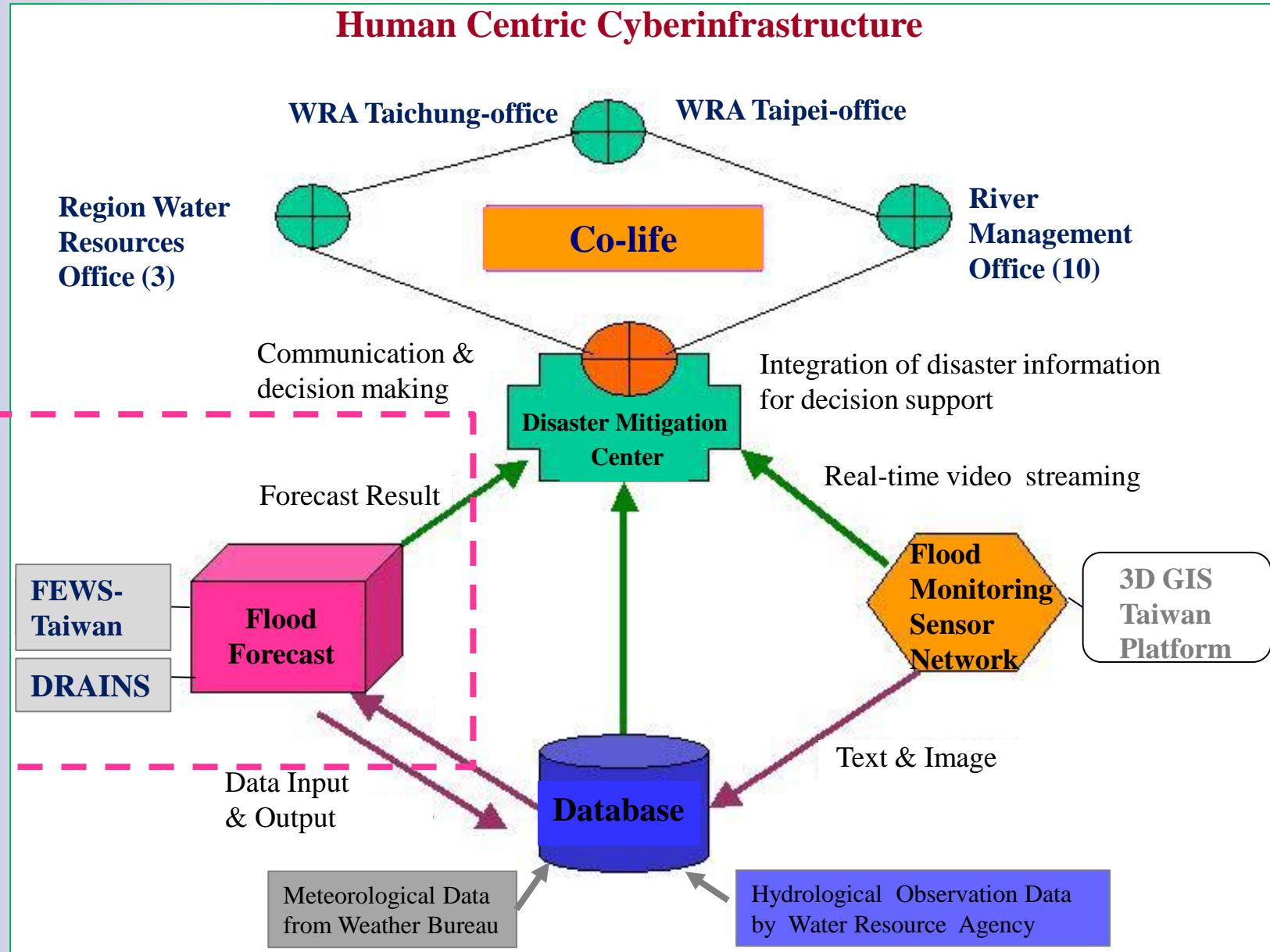
- Top Left:** A list of "線上使用者" (Online Participants) including "共好 (colife)", "科學大師演講者 (science2007-speaker)", "093711 (093711)", "講者畫面 (speaker)", "北源北源社區 (nttu-a...)", "李正國 (jglee)", "林忠誠 (Morris)", "蔡孟諺 (morpheus)", "台東大學 (nttu1)", "台東大學 (nttu2)", "094434 (094434)", and "101313 (101313)".
- Top Center:** A main window titled "桌面分享 science2007-speaker-講者畫面的桌面" showing a presentation slide with the title "妙趣橫生的回文 anagram" and the subtitle "語序靈活 但有嚴格的語法限制或章法". The slide lists various Chinese anagrams:
 - 茶可清心也
 - 茶也可清心
 - 可以清心也
 - 以清心也可
 - 清心也可以
 - 心也可以清
 - 也可以清心
 - tokyo --- kyotoA photograph of a traditional tea set (teapot and cups) is displayed on the right side of the slide.
- Top Right:** A "視訊會議" (Video Conference) window titled "我的畫面" showing three video feeds:
 - Top: 科學大師演講者 (science2007-speaker)
 - Middle: 科學大師演講者 (science2007-speaker)
 - Bottom: 北源北源社區 (nttu-a...)Each feed shows a different view of a lecture hall or meeting room.
- Bottom Left:** A "聊天室" (Chat Room) window showing a transcript of the session, including messages from participants like "蔡孟諺: (10:50:32)" and "可以切到主講者的嗎？".
- Bottom Right:** A taskbar showing various icons and the system tray.

Text Chat

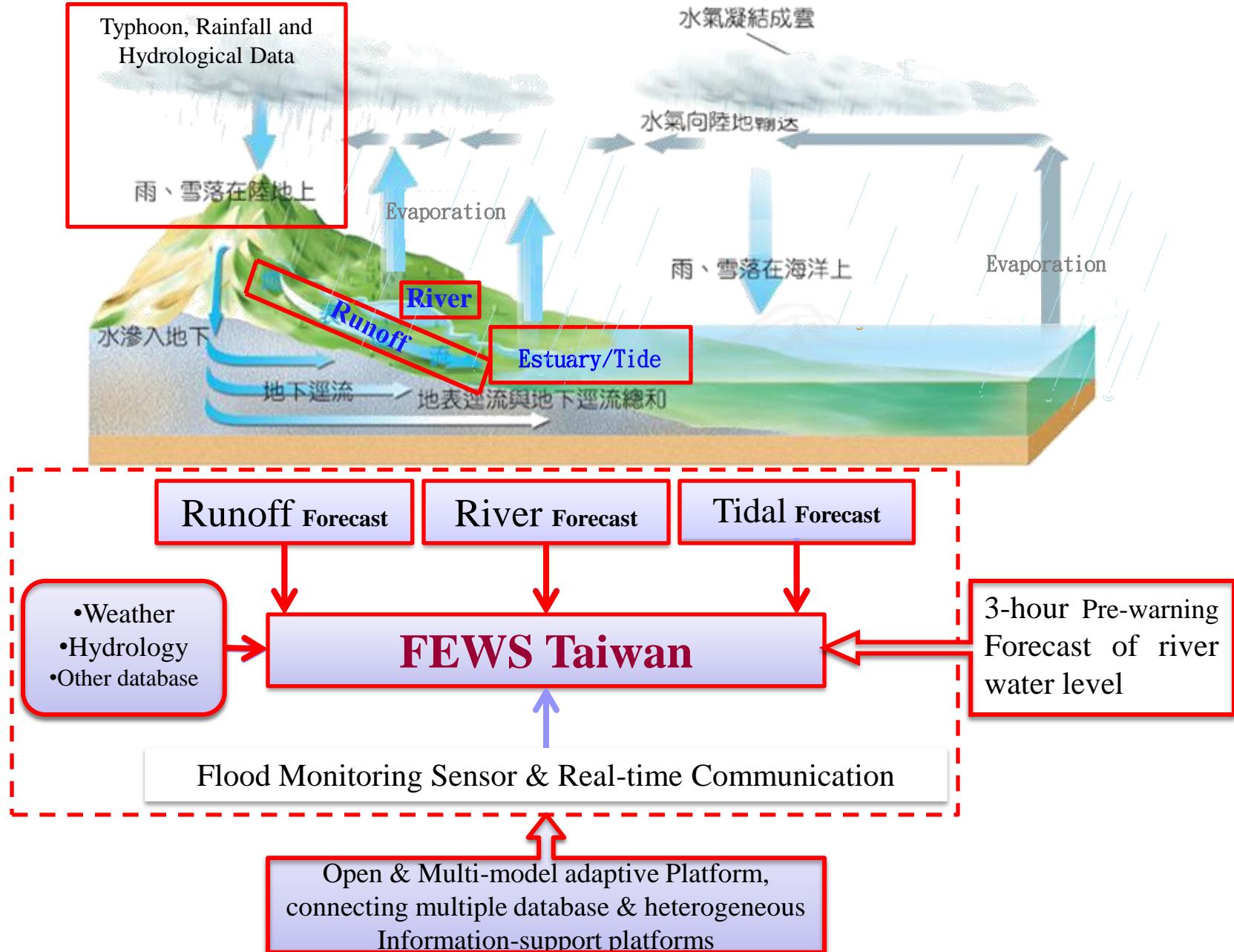
Network Infrastructure of WRA for Co-life Application



Flood Mitigation Grid in WRA

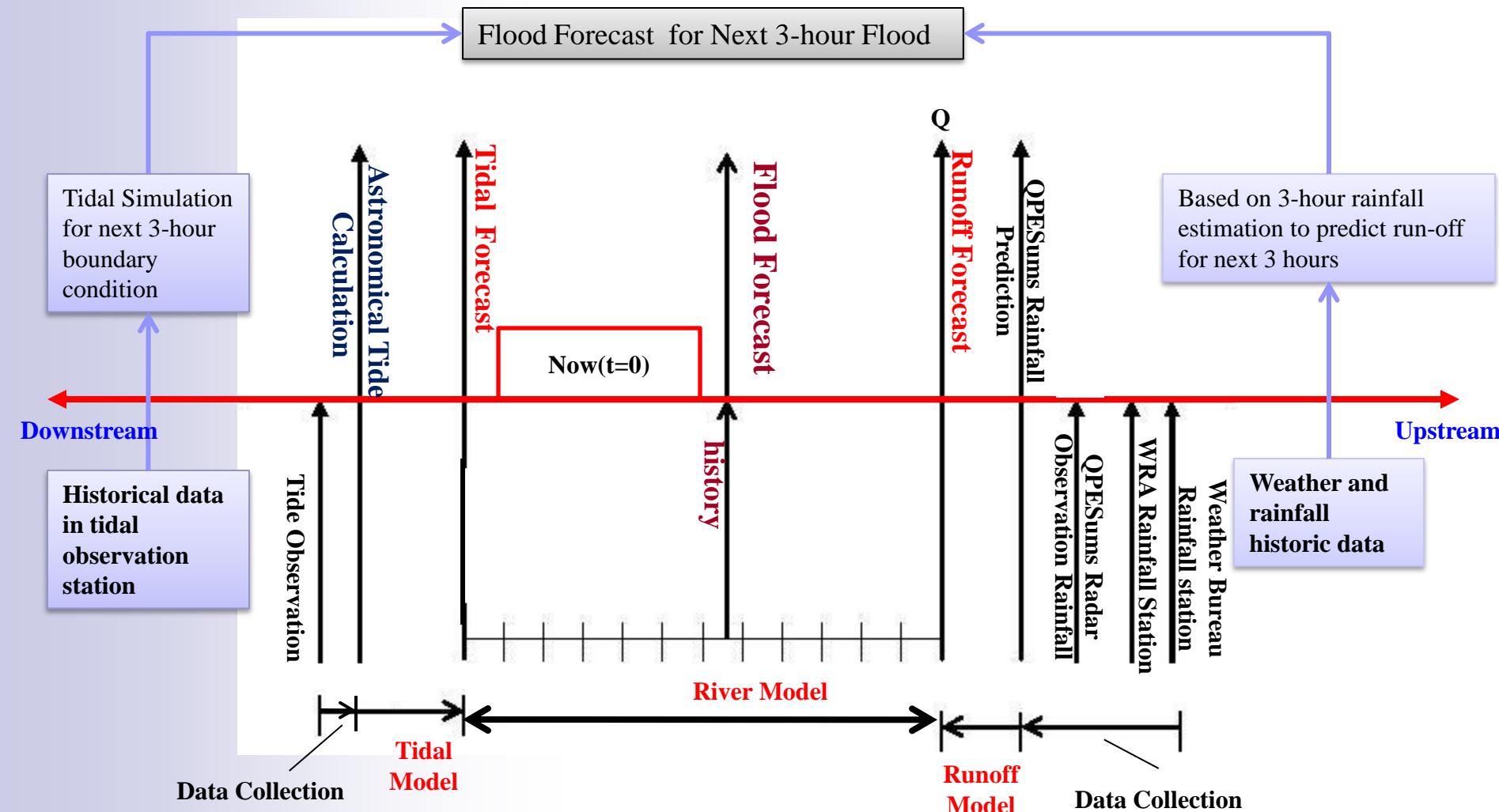


Schematic Flood Forecast in Watershed

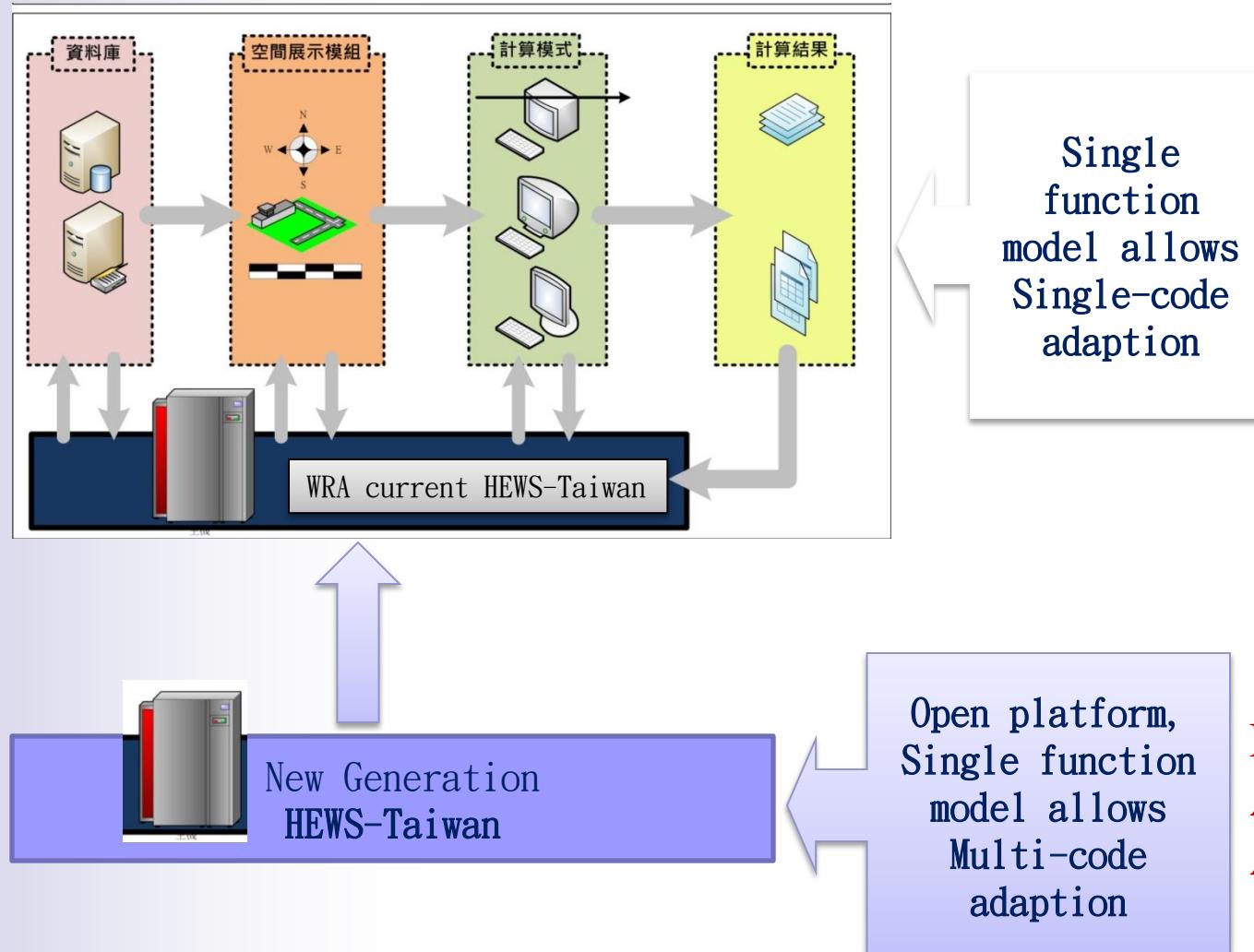


Flood Forecast linked with Disaster Information System

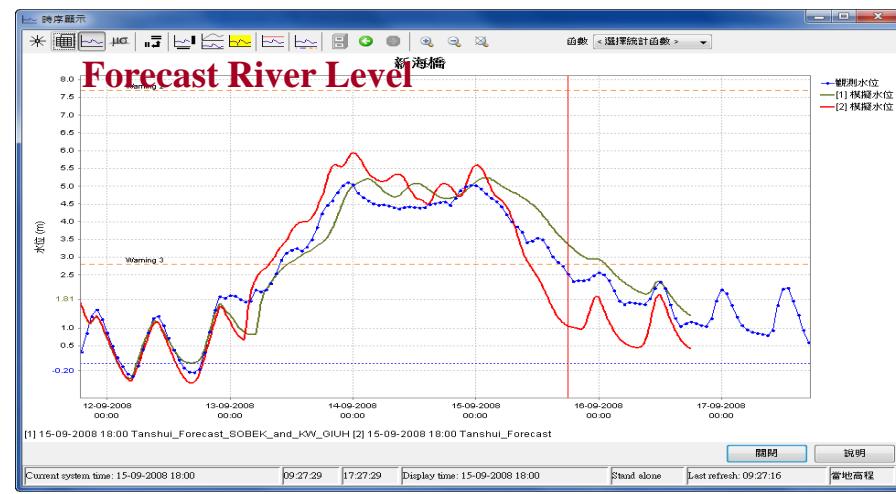
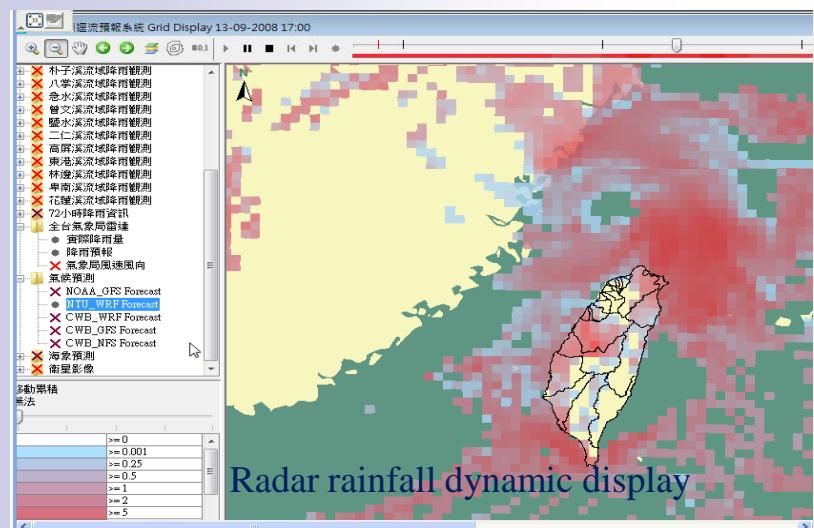
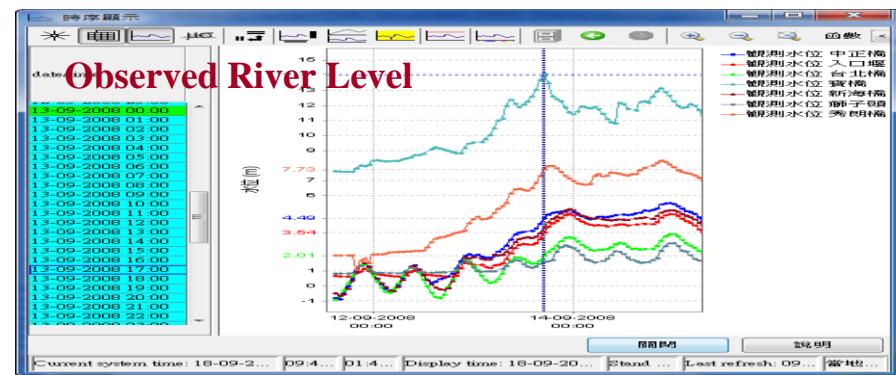
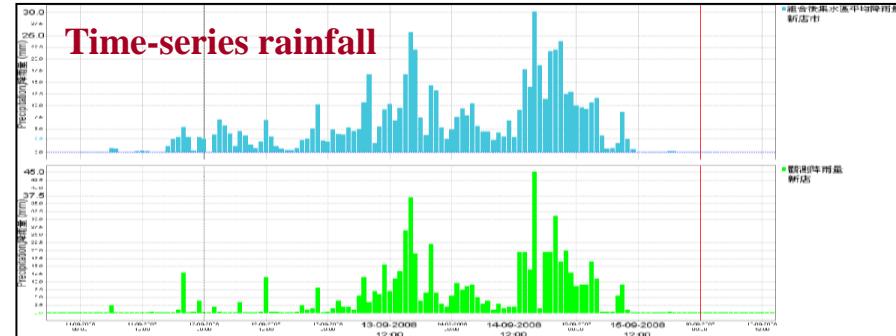
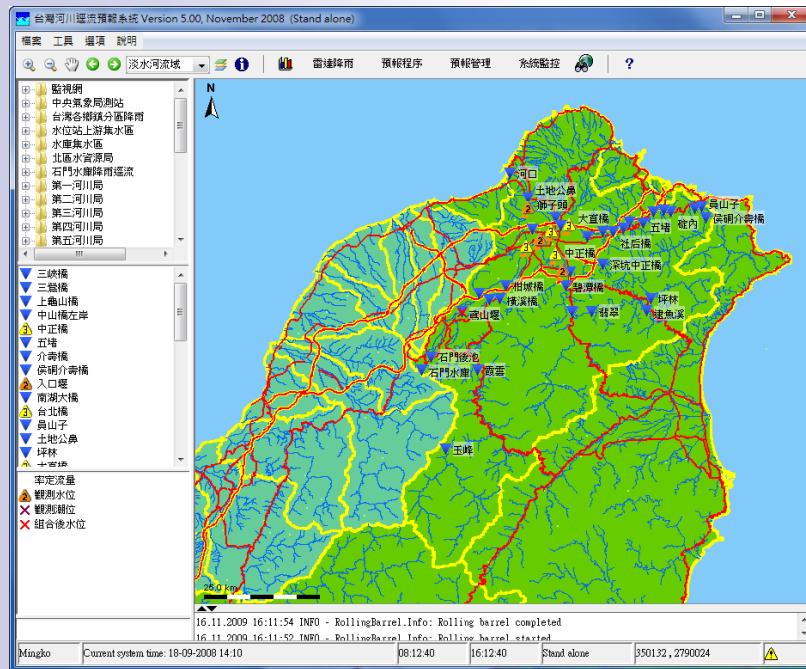
Flood Early Warning System-Taiwan



Flood Early Warning System-Taiwan



HEWS-Taiwan User Interface



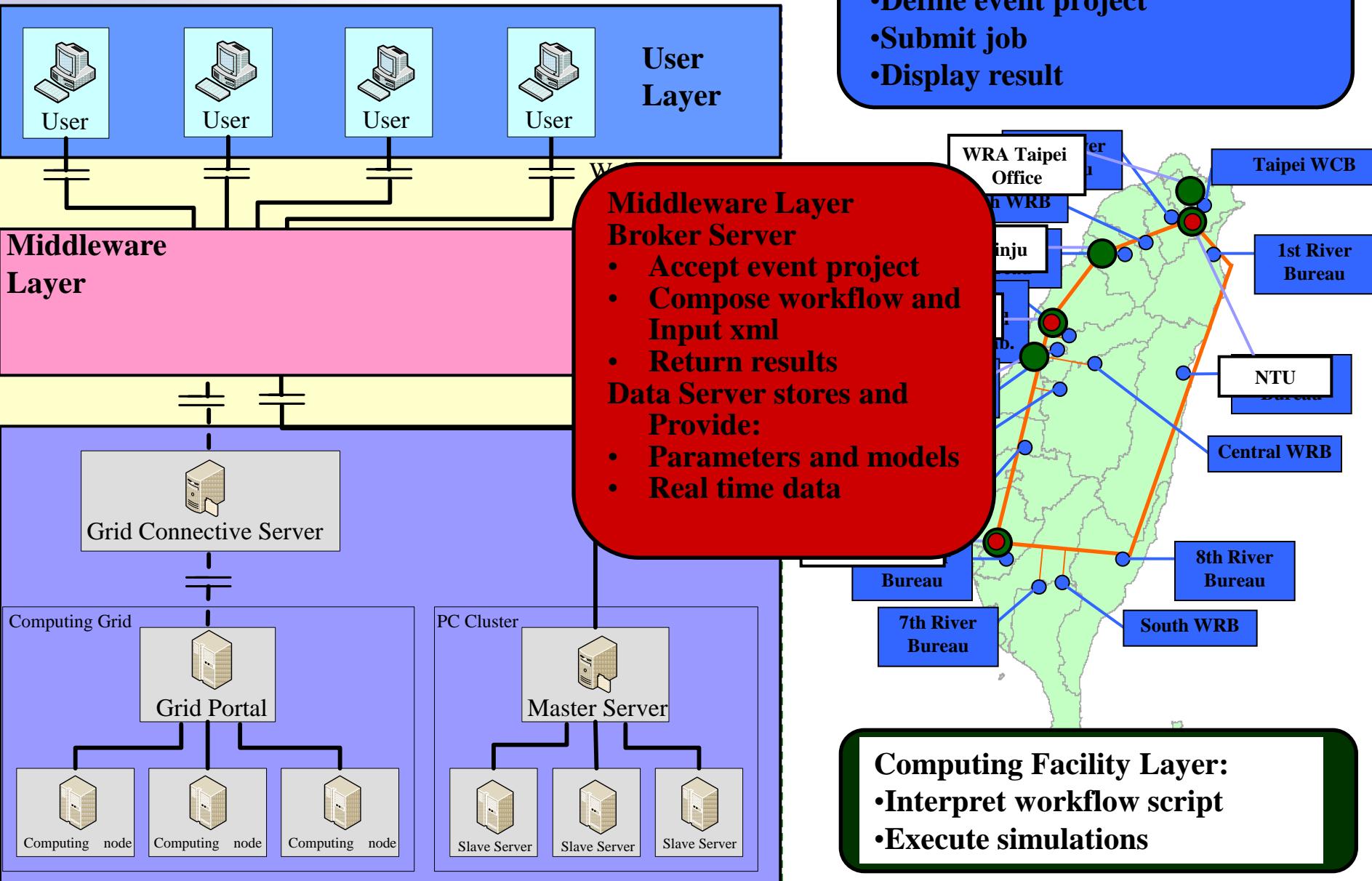
DRAINS, Distributed Runoff And Inundation Nowcast System

Single function model single code, but multi watersheds

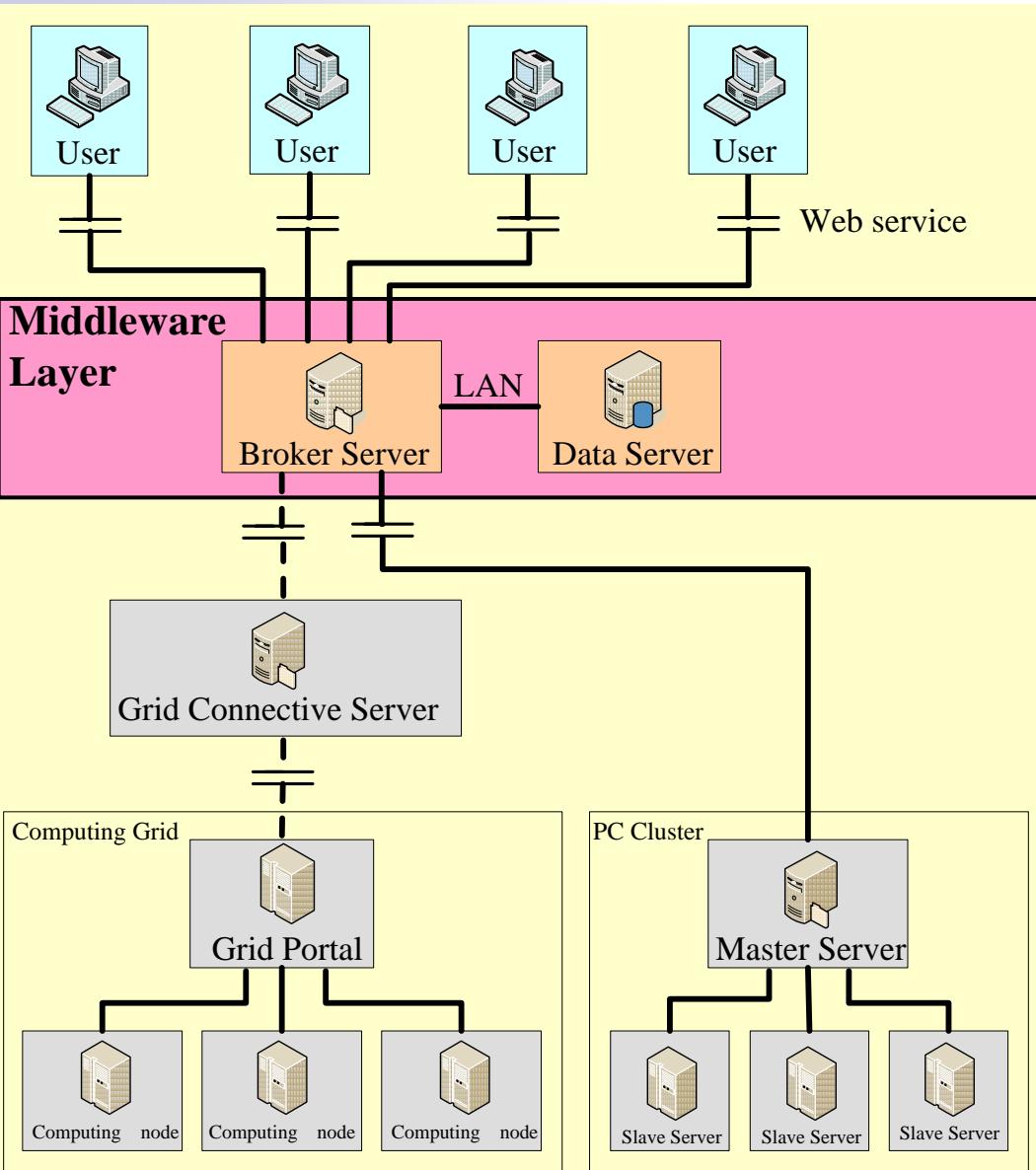
- **System Design**
- **Climatologic Typhoon QPF Module**
- **Two-reservoir Flood Discharge Decision Support System (DSS)**
- **Variation of Typhoon Route (DSS)**
- **Geomorphologic Runoff Module**
- **NewC Channel Routing Module**
- **XML-Based I/O files, Adapters & Workflows**

Contact: Prof. Tim-Hau Lee, Dept. of Civil Engineering, National Taiwan University
Email: thlee@ccms.ntu.edu.tw

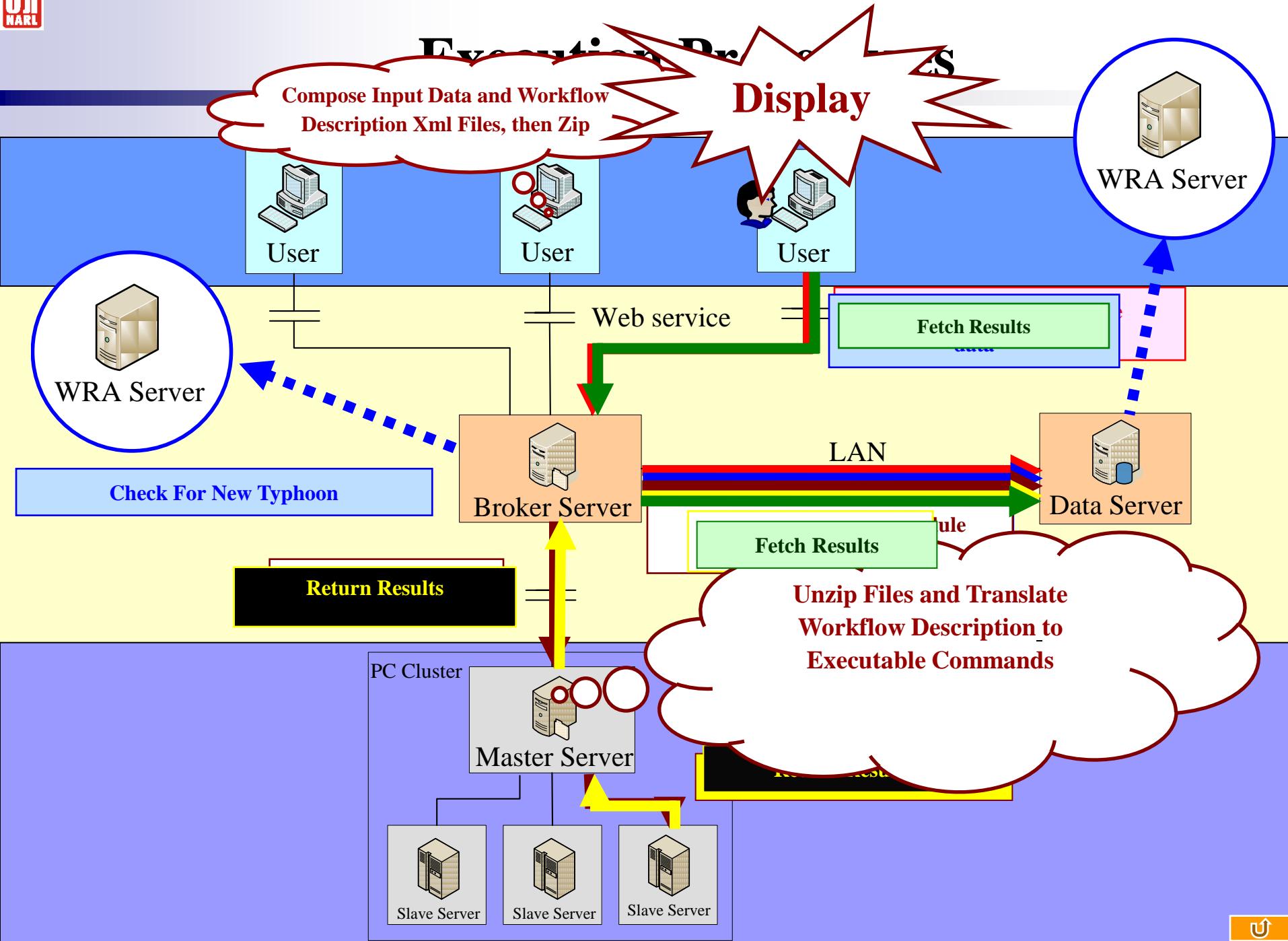
System Design



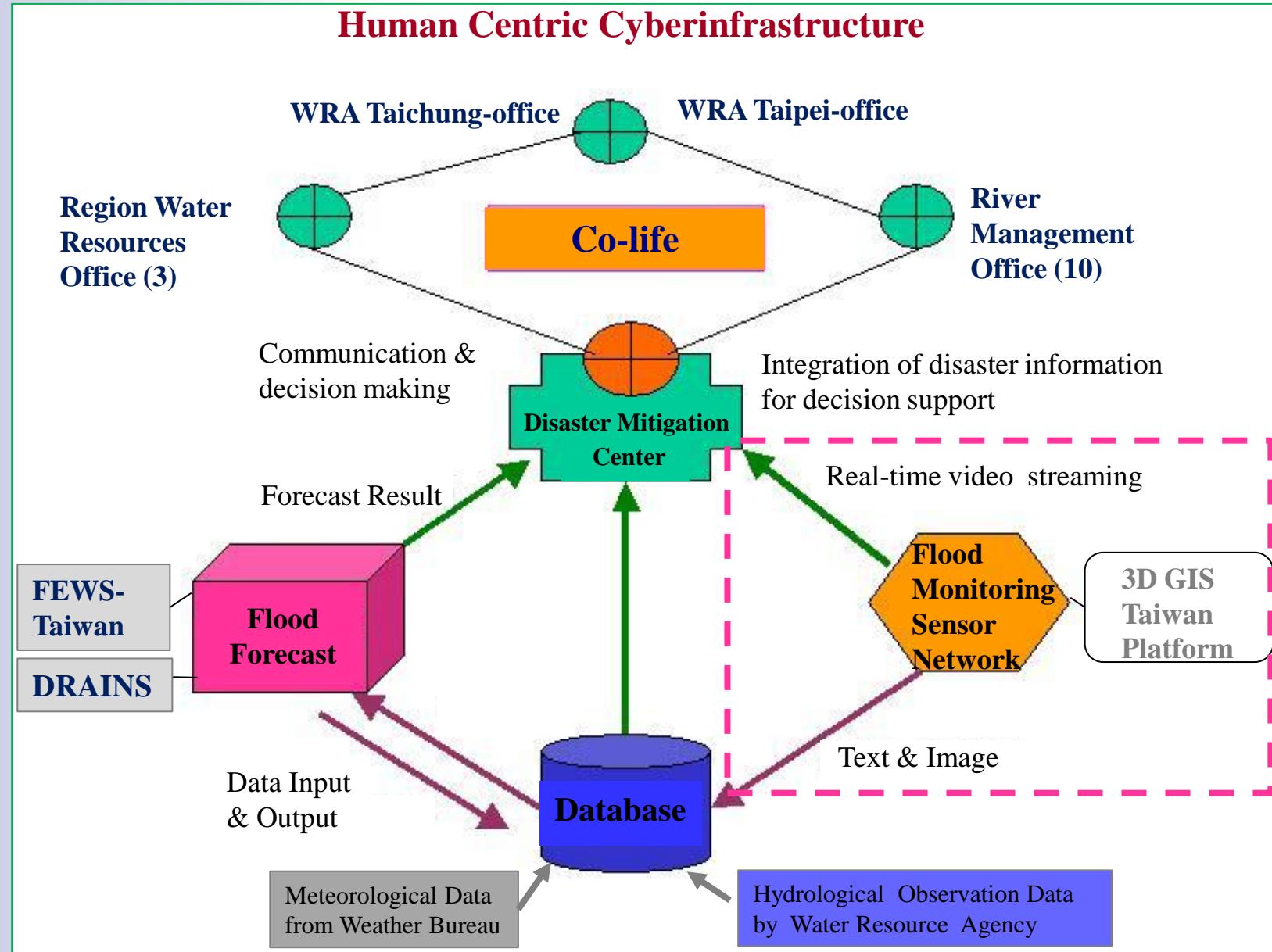
System Design (2/2)



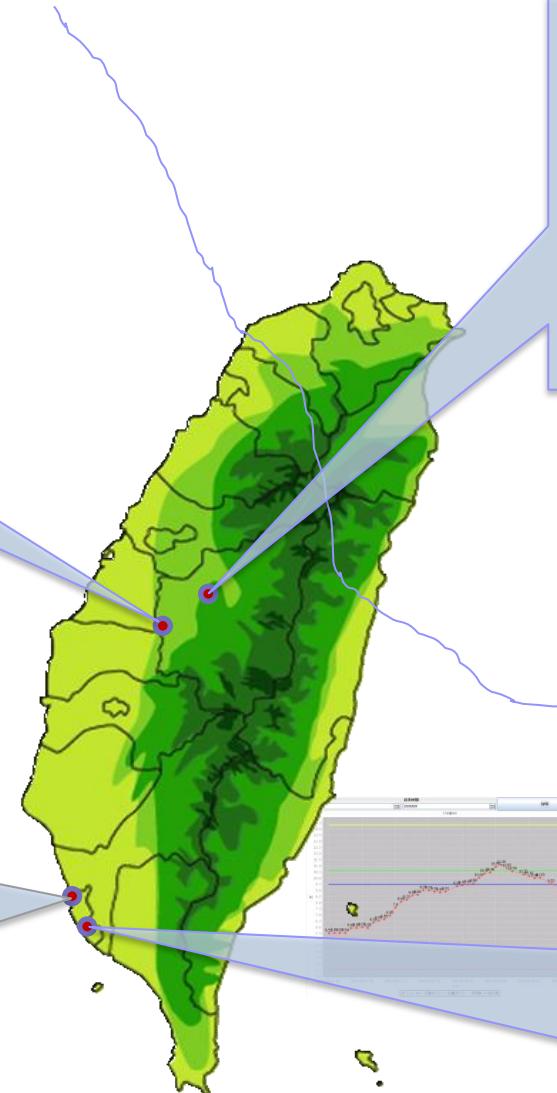
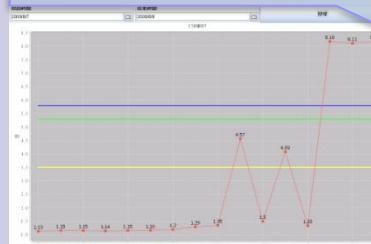
- The **middleware, Broker Server and Data Server**, are connected via **LAN** (Local Area Network) for efficiency.
- The **XML-based Web Service** protocols are used for inter-layer communication.



Flood Mitigation Grid in WRA



Flood Monitoring Sensor Network



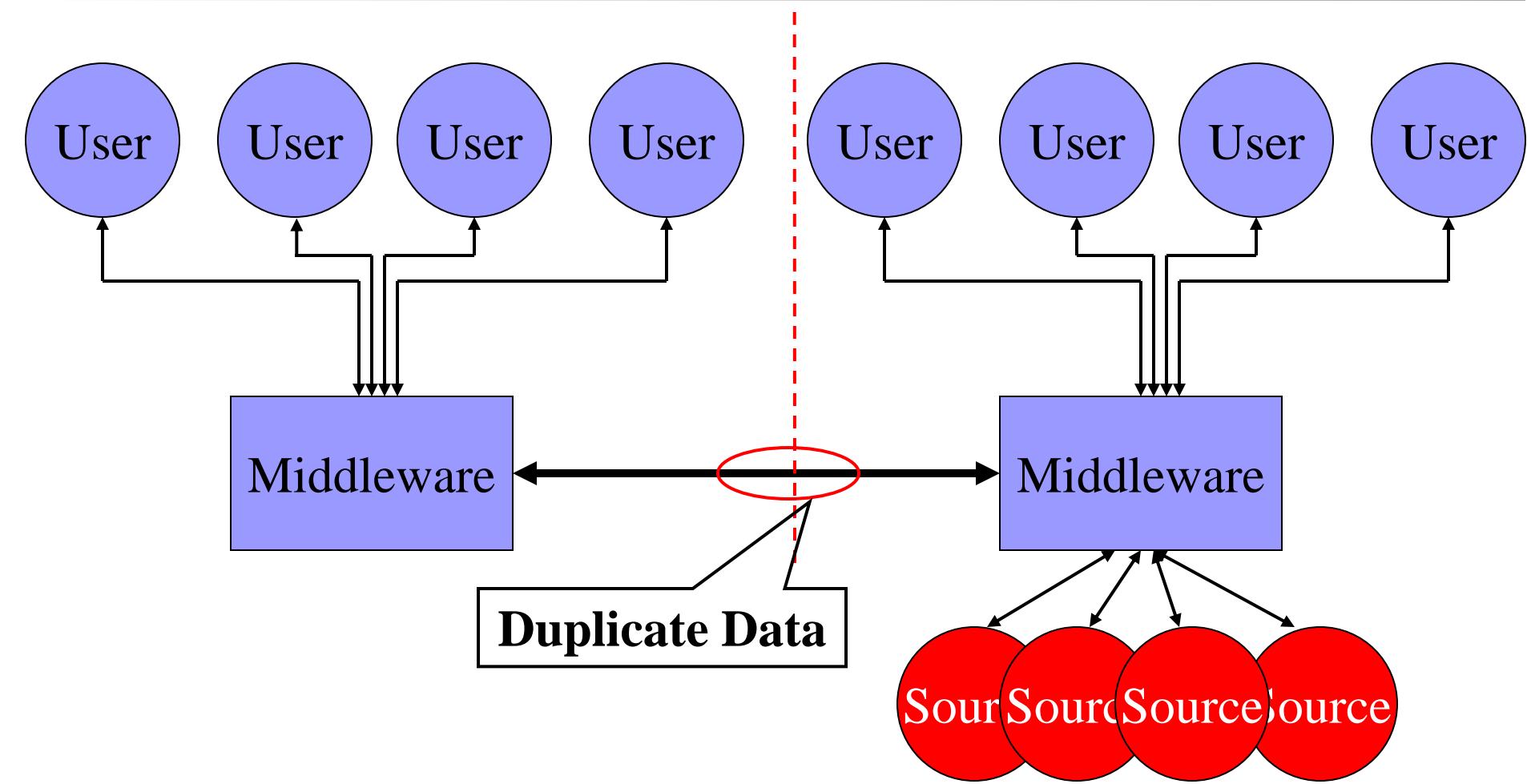
Flood Monitoring Sensor Network

(WRA) Mission oriented, NOT open to public yet

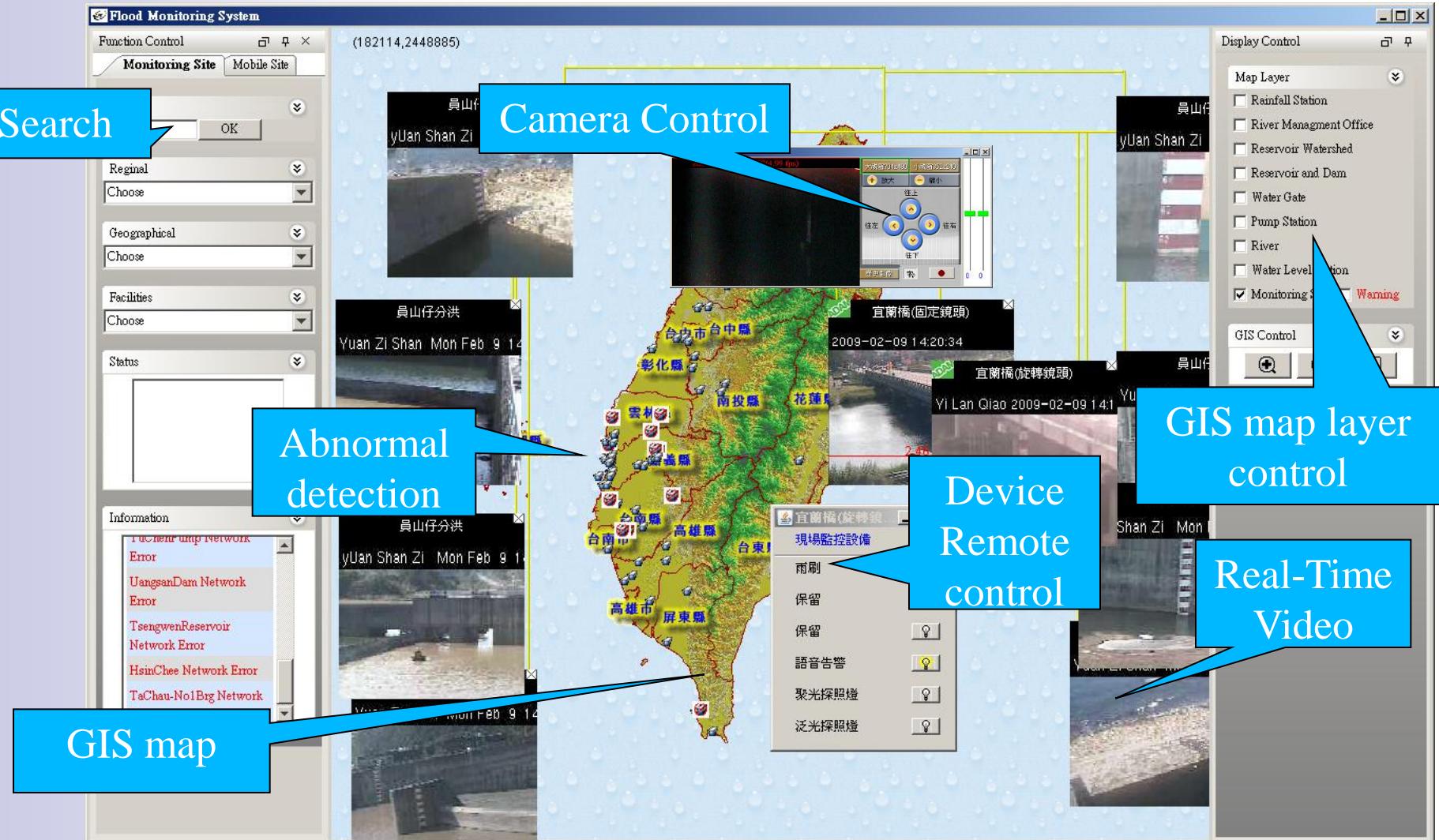
The screenshot displays the Flood Monitoring System interface. On the left, there are several panels: 'Function Control' (Monitoring Site selected), 'Search' (Search bar, OK button), 'Regional' (Choose dropdown), 'Geographical' (Choose dropdown), 'Facilities' (Choose dropdown), 'Status' (empty box), and 'Information' (User Info: ncho (國網中心預設帳號), Network Error: YanShueiRiverSpout&AnShui Network Error). The main area features a central map of Taiwan with various monitoring sites marked by red icons. Yellow lines connect specific sites to their corresponding video feeds on the right. The video feeds include: 菲翠水庫 (multiple feeds), 石門水庫 (multiple feeds), 谷關橋照下游, 谷關橋照上游, 義里橋, 乾峰橋, 豐洲堤防, 美濃三夾水, 萬巒大橋, and 立山站. Each video feed shows a timestamp at the bottom.

Multicasting – improve the loading of data source

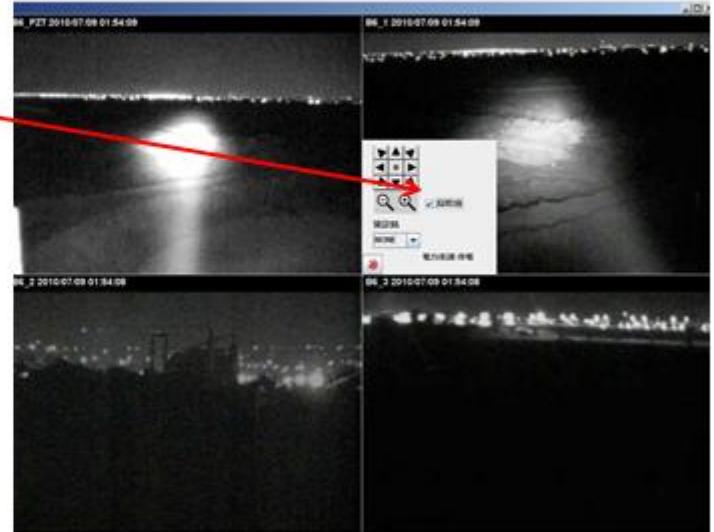
P2P - share middleware's loading



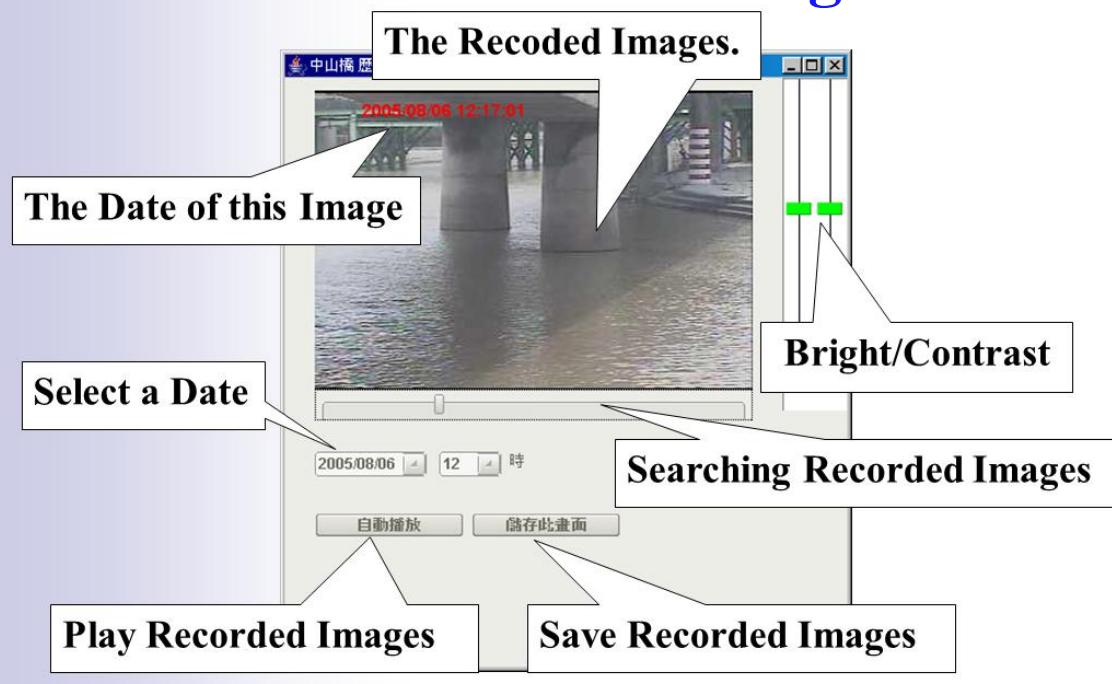
Real-Time Flood Monitoring System



Device Remote Control



Historic Recorded Images



Auto-Recognition of Water Level

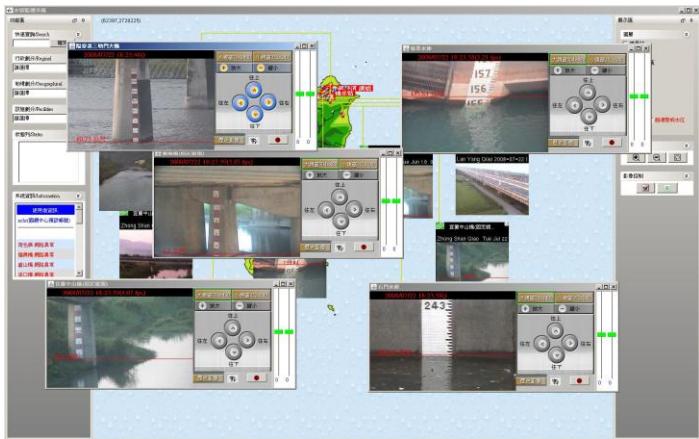
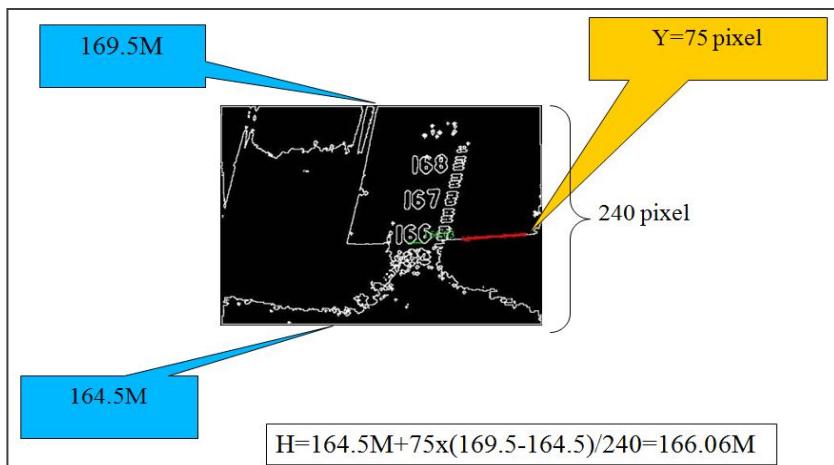
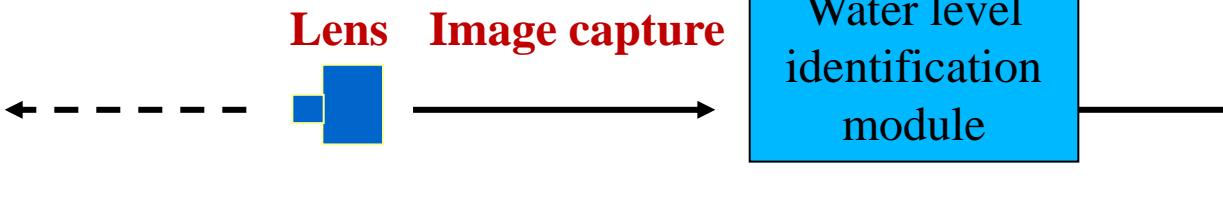
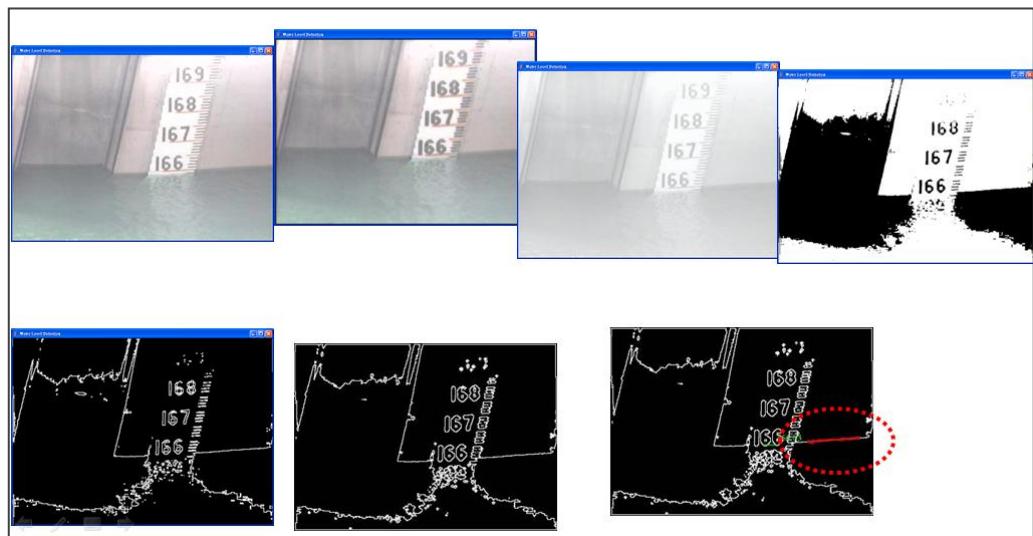


Image of water level

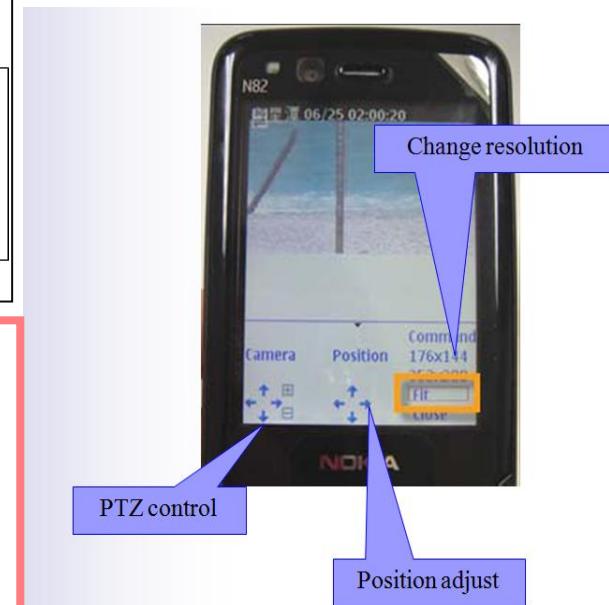
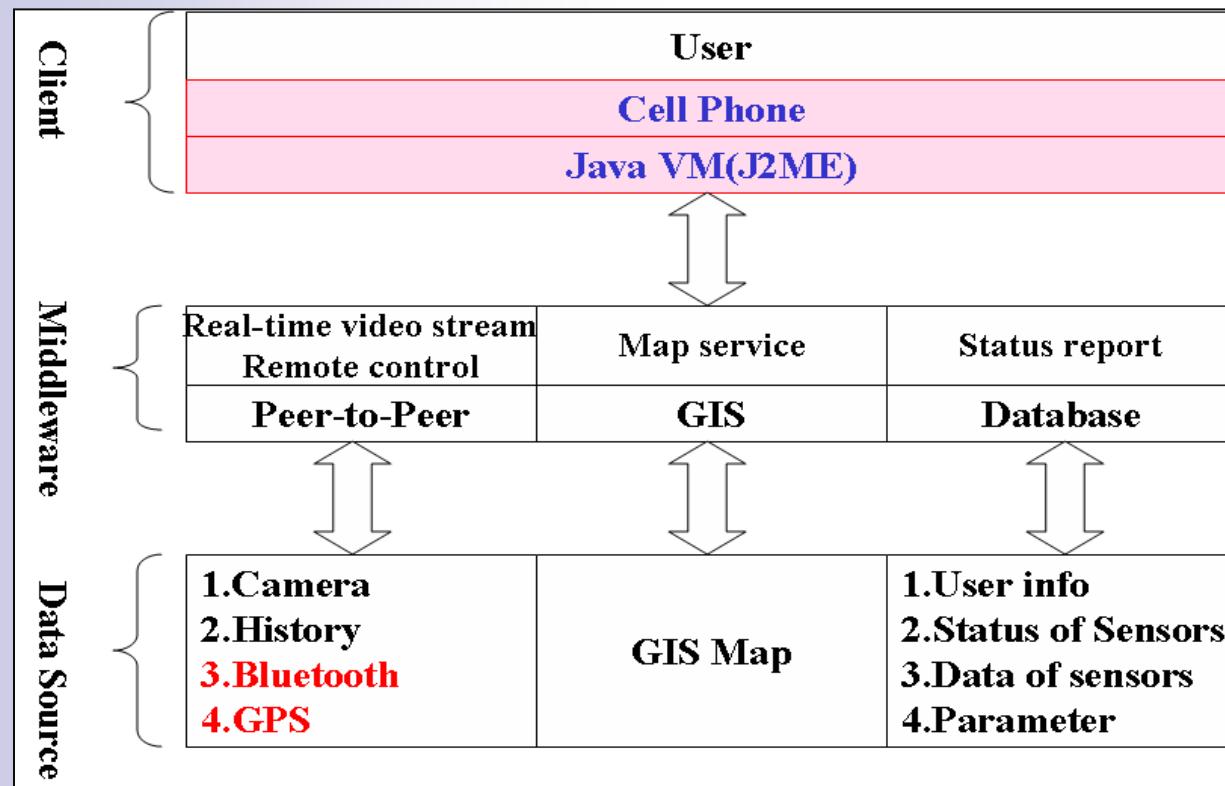


Architecture

Water Level
Interpolation

Mobile Real-time Flood Watching System

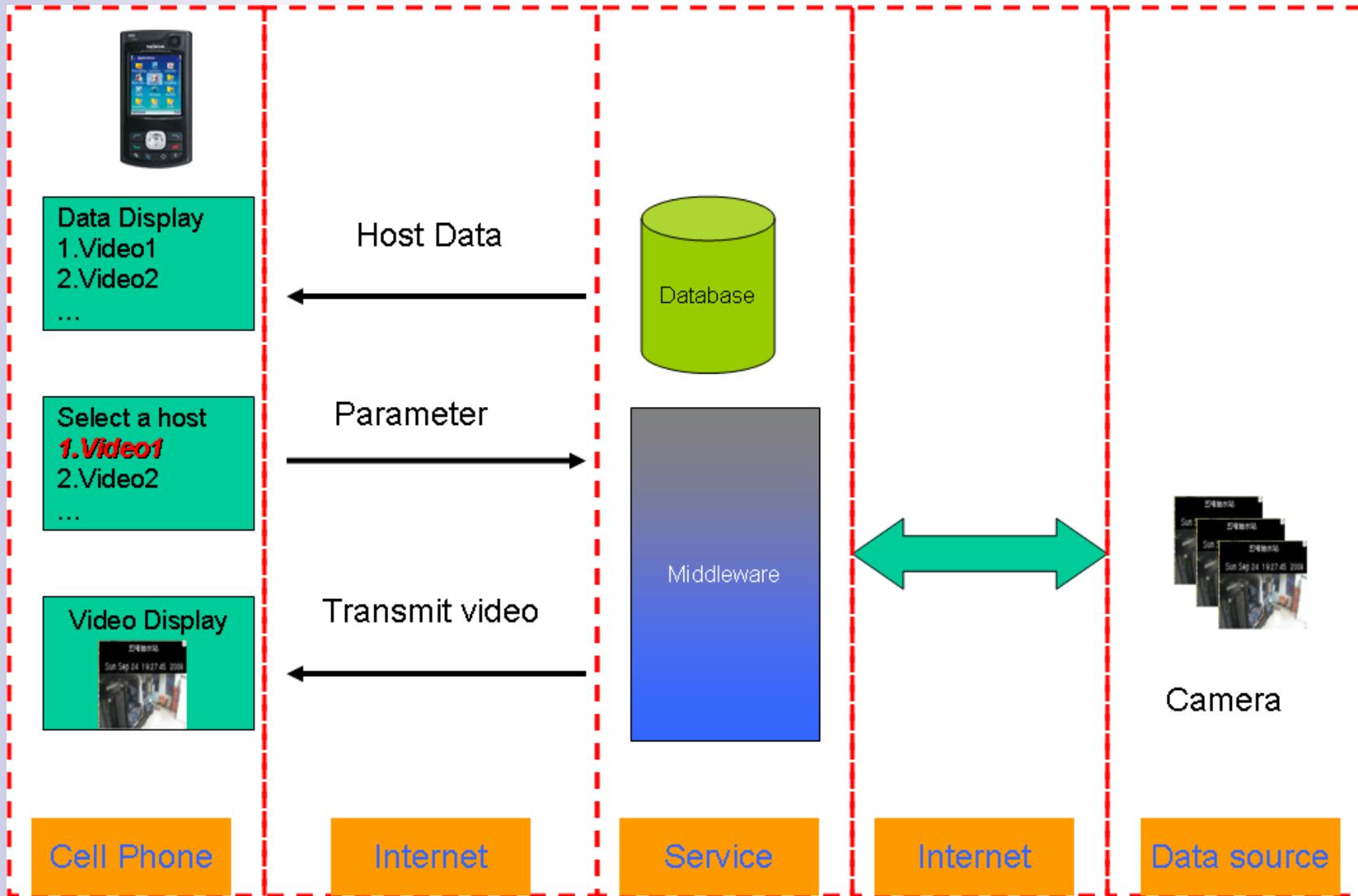
Architecture



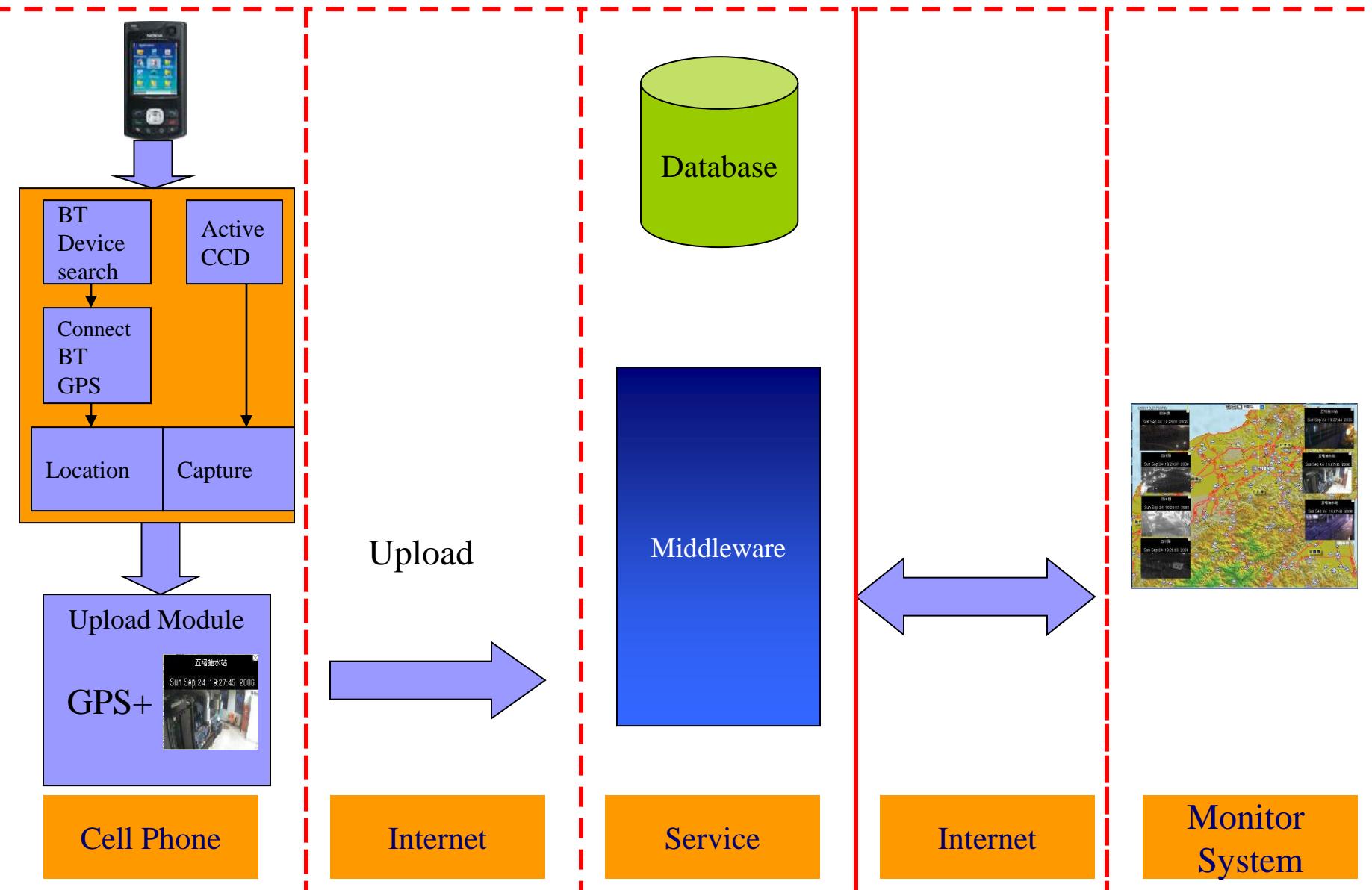
Advantages

- Small size
- Computing is more and more powerful
- Mobility
- LCD,CCD, Bluetooth, Internet, GPS
- Popularity

Workflow of Mobile Flood Watch



Workflow of Flood Report

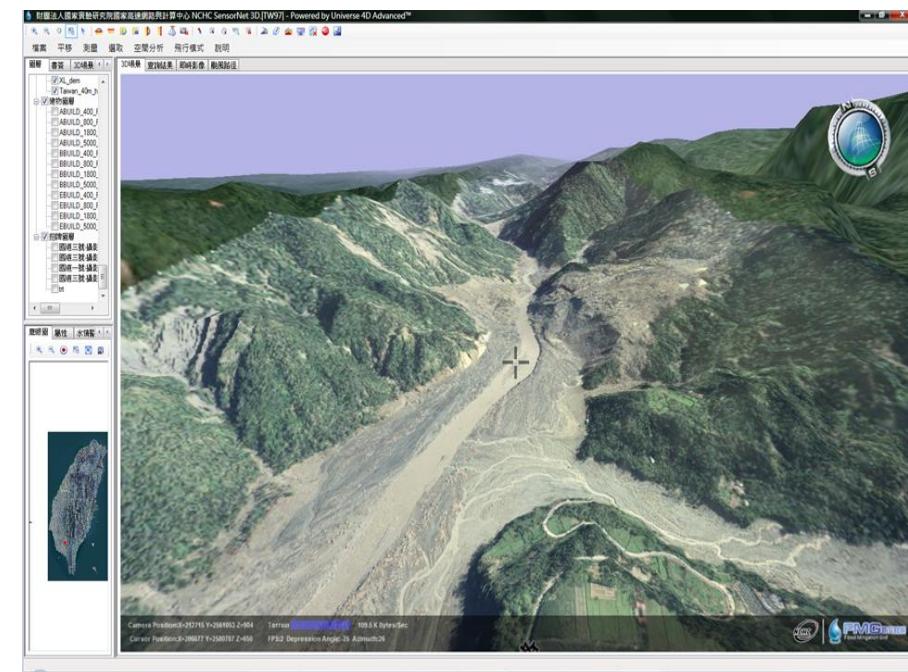
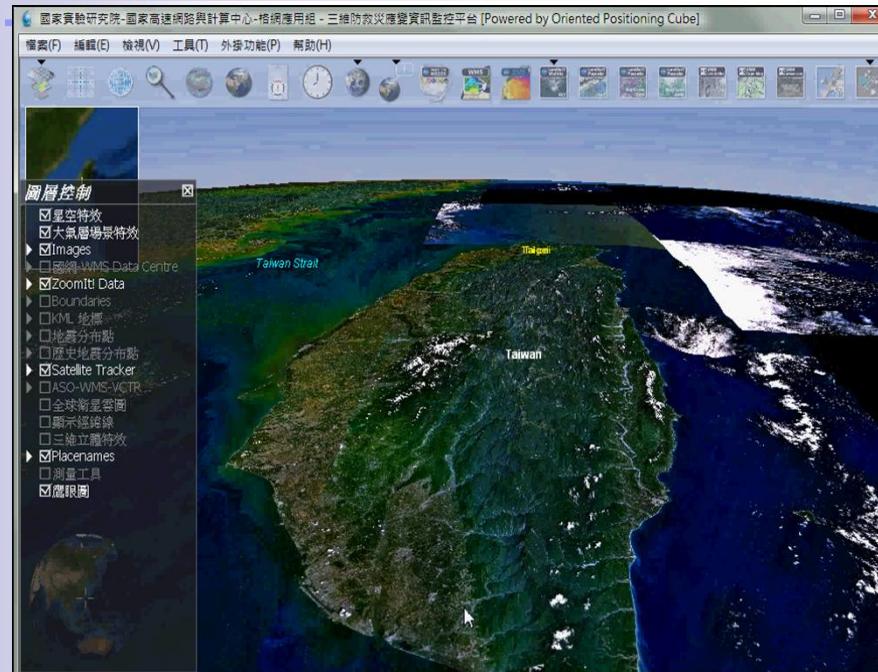


Watch Mobile Data via Flood Monitoring Sensor Network

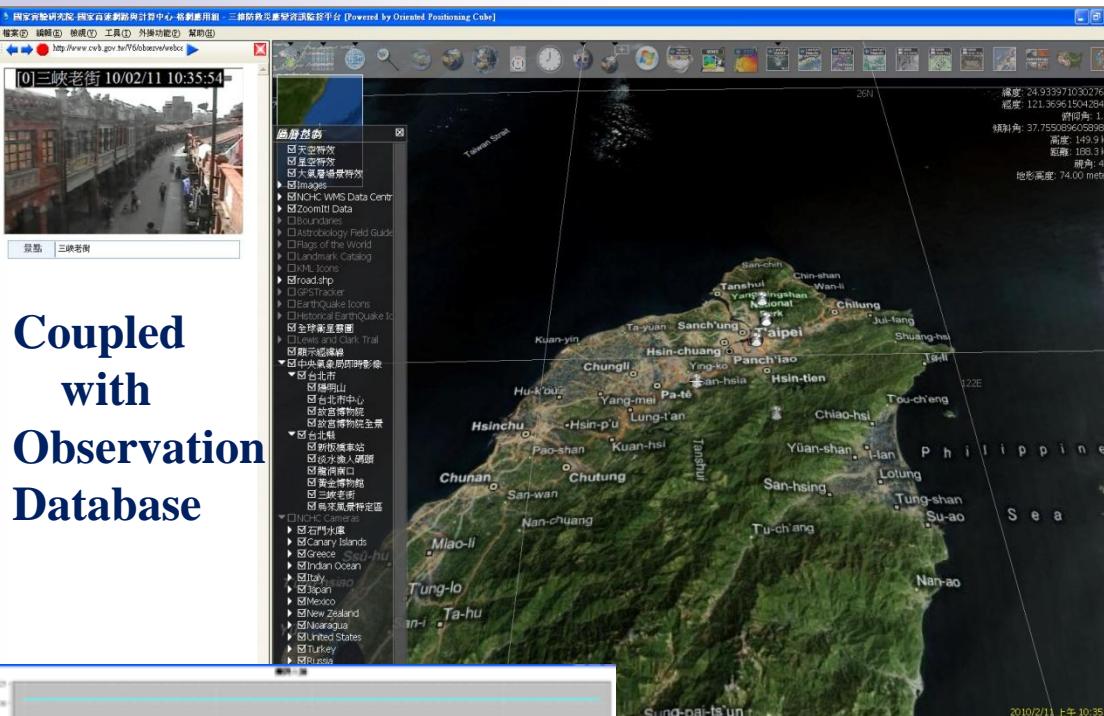


The Web 3D GIS Taiwan Platform

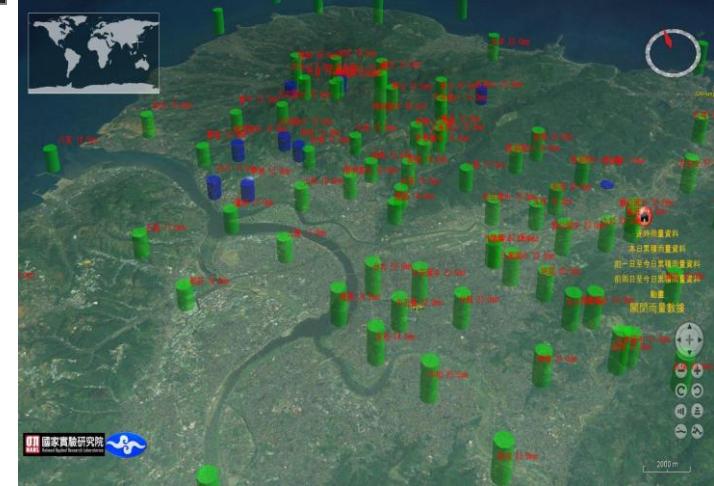
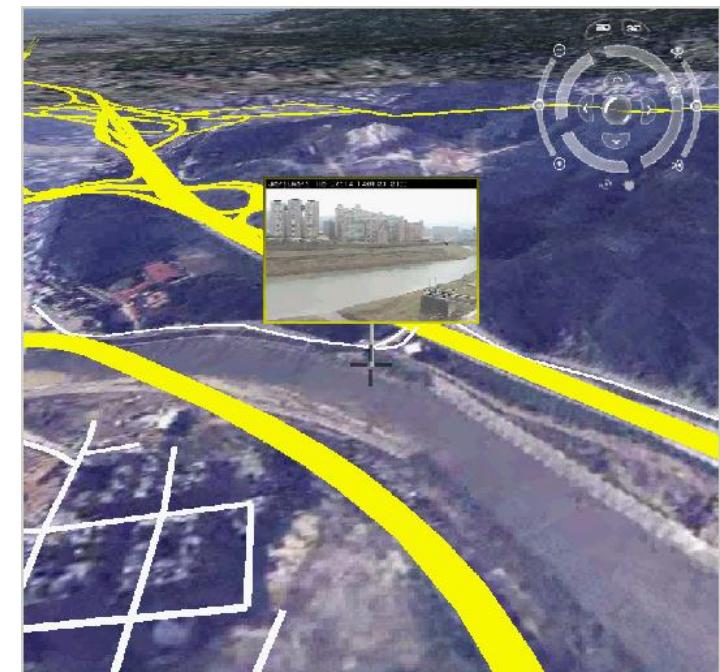
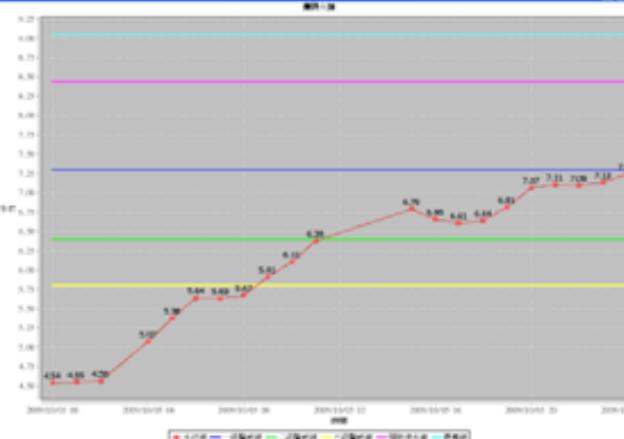
- Developed by modification of NASA World Wind system
- Encompassing Formosat-2 space borne and airborne images incorporated with data warehouse/fusion and high-performance visualization technologies.
- Linking with end-user disaster prevention database, sensor network, and analyzed model for decision support to disaster assessment and scenario identification



Integrated with Flood Monitoring Sensor Network

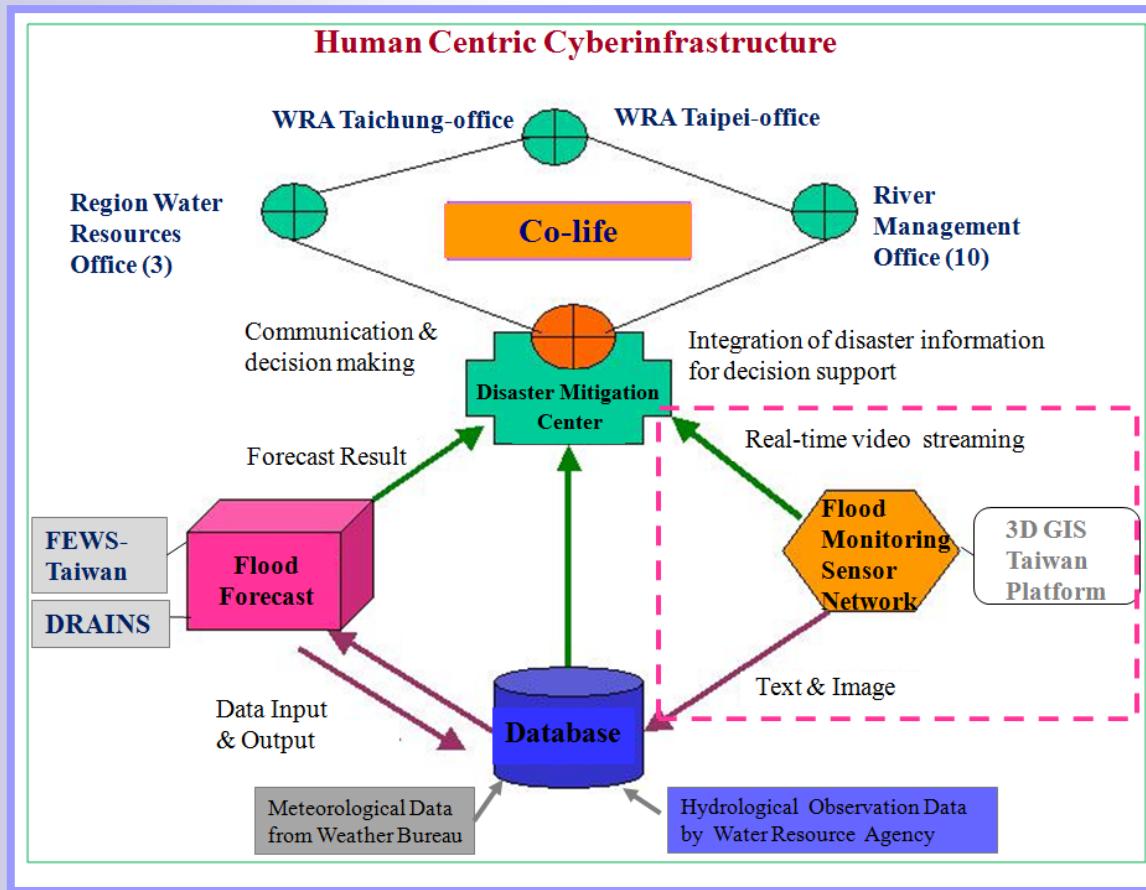


Coupled
with
Observation
Database



DEMO from Taiwan

Using Co-life for real-time communication and disaster scenario information sharing to support decision making in a flood event



Demo By

- Hsi-Ching Lin*
- Jen-Gaw Le*
- Mulderyu Yu*
- Stoca Chang*



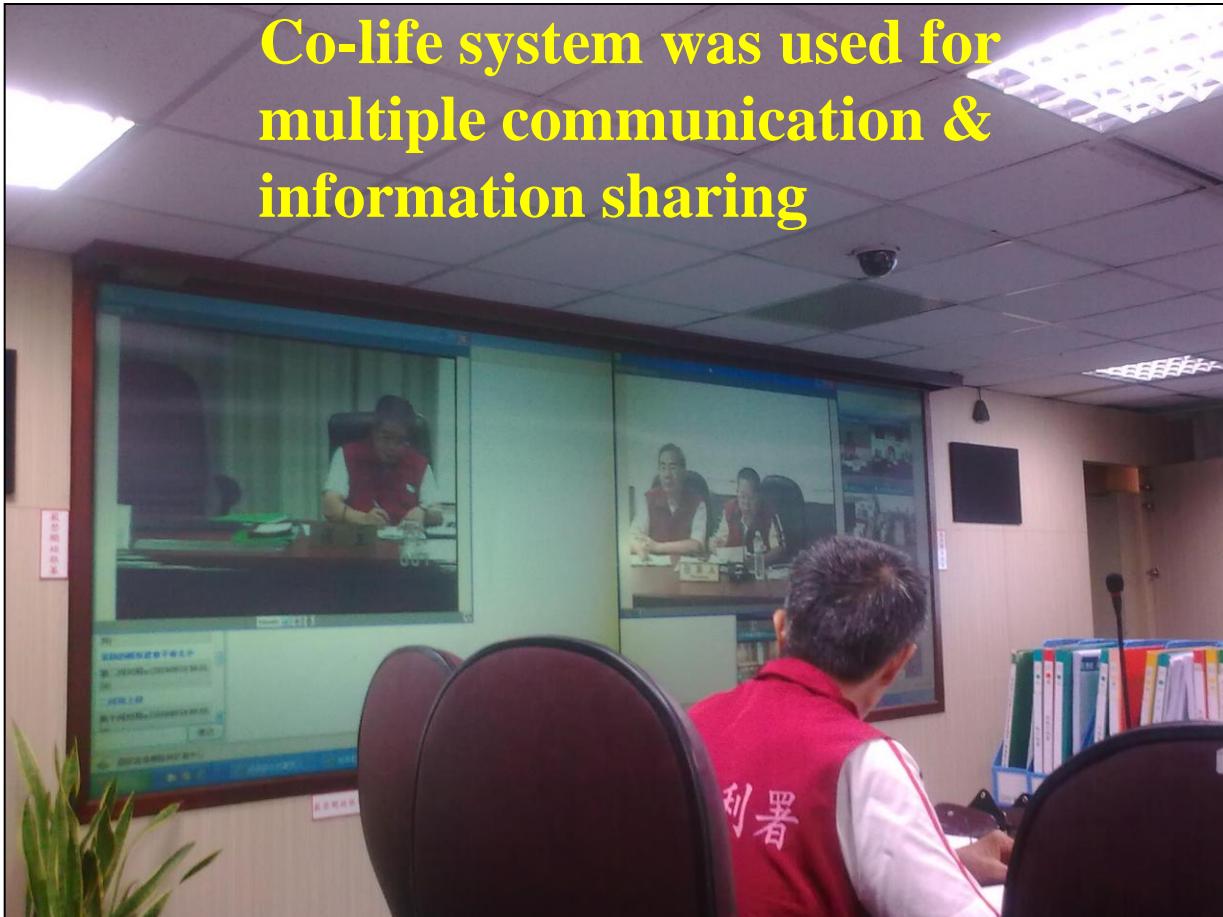
Flood Mitigation Operation in WRA during Typhoon Fanapi

Operation Sequence

1. WRA Chair attended the National Disaster Prevention & Rescue meeting (chaired by president) and brought back assignment.
2. WRA Chair calls a decision making meeting using Co-life system, WRA-Taipei office is the headquarter, WRA-Taichung office, 10 river management offices and 3 region water resource offices joint the communication meeting.
3. Meantime, all local-office members watch the real-time flood monitoring sites located in areas of duty.
4. WRA Chair first announces the assignment with support of relevant documents, and flood monitoring web directs to associated emergency sites
5. Local offices (River & water resource management offices) feed back to WRA chair, and report local disaster situation through documents (ppt, Word,..) and flood monitoring web.
6. After receiving message from local offices, WRA Chair makes decisions for necessary response to the flood event.

Flood Mitigation Operation in WRA during Typhoon Fanapi

Co-life system was used for multiple communication & information sharing



WRA Taipei Office



Decision Making Using Co-life Collaboration System

The screenshot shows a video conference interface with a grid of video feeds. The top row includes feeds from the Water Resources Agency's Taipei Office and seven River and Water Resource Management Offices. A cyan arrow points from the text below to the feed of the Director-General of the Water Resources Agency. The bottom row shows feeds from two more River and Water Resource Management Offices. To the right of the video grid is a map of Taiwan with red lines indicating flood routes and several video feeds showing flood scenes at specific locations like Yilan Shan Zi. The interface includes a legend for various hydrological features, a toolbar for operations, and a status bar at the bottom.

錄影回播 wra20080722

檔案 視訊會議

錄影資料

(wra05a) (tlchung) (wracb) 台北辦公室a(wratpa) 第七河川局a(wra07a) (wra04a)

8.0 fps 8.0 fps 8.0 fps 8.0 fps 8.0 fps 8.5 fps

第一河川局a(wra01a) 第九河川局a(wra09a) (wra06a) 第三河川局a(wra03a) (wranba) (wrasba)

8.0 fps 8.0 fps 8.5 fps 8.0 fps 8.0 fps 8.0 fps

(wra08a) (wra10a)

8.0 fps 8.0 fps

Chair of decision meeting, Director-General, Water Resources Agency; plus 13 River and Water Resource Management Offices

鳳凰颱風期間員山仔分洪情況

37% | 下午 02:04:39 | 95M of 254M

Flood Mitigation Operation in WRA during Typhoon Fanapi



Summary

- **Features of current Flood Mitigation Grid (FMG)**
 - Highly available (Mission oriented)
 - Scalable
 - Dynamic
 - Real-time (monitoring & communication)
 - Integrity and the synergy of all above
- FMG is a **human-centered synthetic system**, a full-scale FMG has been adopted as DSS for practical flood mitigation, although robustness of overall components in FMG can be continuously improved.
- The **usefulness and benefit of the Flood Mitigation Grid is ratified by Water Resource Agency in each flood event**. Extensive research on improvement of system automation is still on going.

Contacts

1. Over all

Whey-Fone Tsai, NCHC, wftsaic@nchc.narl.org.tw

2. Co-life System

Hsi-Ching Lin, NCHC, b00lsc00@nchc.narl.org.tw

3. HEWS-Taiwan (Flood Forecast)

Wen-Yi Chang, c00wyc00@nchc.narl.org.tw

4. DRAINS (Flood Forecast)

Tim-Hau Lee, Dep. Of Civil Engineering, National Taiwan University,
thlee@ccms.ntu.edu.tw

5. Flood Monitoring Sensor Network

Jyh-Horng Wu, c00jhw00@nchc.narl.org.tw

6. Web 3D GIS Taiwan

Stoca Chang, c00jyc00@nchc.narl.org.tw

A photograph of a high-speed train, likely a Shinkansen, positioned at a station platform. The train features a white and orange livery. It is set against a backdrop of a modern architectural structure with a complex steel framework and glass panels. The platform edge is visible on the right, marked with a yellow tactile paving strip.

Thank you for Your Attention