ภาคผนวก ก. แหล่งข้อมูลเพิ่มเติม

แหล่งข้อมูลเพิ่มเติมบางส่วนสำหรับการทำวิทยานิพนธ์ฉบับนี้ ซึ่งสามารถสืบค้นจากฐานข้อมูลคอมพิวเตอร์หรือระบบอินเตอร์เน็ต

ก. เทศบาลนครหาดใหญ่

http://www.hatyaicity.go.th/

ข. ศูนย์เตือนภัยอุตุนิยมวิทยา ร่วมรัฐและเอกชน จังหวัดสงขลา

http://www.songkhla-met.org/

ค. Thailand Integrated Water Resource Management

http://tiwrm.hpcc.nectec.or.th/

ง. คลังข้อมูลน้ำ

http://www.thaiwater.net/

จ. Asian Disaster Preparedness Center (adpc)

http://www.adpc.net/

ฉ. DISASTER RESOURCE GUIDE

http://www.disaster-resource.com/

ช. Federal Emergency Management Agency (FEMA)

http://www.fema.gov/fhm/fm_main.shtm

ซ. Emergency Management

http://www.newport-news.va.us/eoc/index.htm

ฌ. Government Food Safety Information

http://www.foodsafety.gov/

ญ. International Symposium on Flood Defense

http://www.irtces.org/isshhu/isfd10.htm

ฎ. Parallel and Distributed Simulation System

http://fivedots.coe.psu.ac.th/~pichaya/pdss/pdss-web.htm

ฏ. HLA Foundation Class Framework

http://www.jhuapl.edu/programs/modsim/rfd/hfc13.htm

ฐ. Light-weight Run-time Infrastructure

http://netlab.gmu.edu/rti.htm

จ. Defense Modeling and Simulation Office

https://www.dmso.mil/public/ หรือ https://www.dmso.mil/public/transition/hla

ฉ. Pitch Kunskapsutveckling AB

http://www.pitch.se/

ช. Simulation Interoperability Standards Organization (SISO)

http://www.siso.org/

ซ. Institute of Electrical and Electronics Engineers (IEEE)

http://www.ieee.org/

ฌ. WebHLA

http://www.hpcmo.hpc.mil/Htdocs/UGC/UGC98/papers/5a/

ภาคผนวก ข. เอกสารตีพิมพ์

เอกสารที่ตีพิมพ์ระหว่างการทำวิทยานิพนธ์ ประกอบด้วยเอกสาร 2 ฉบับคือ

ก. DESIGN OF A DECISION SUPPORT SIMULATION SYSTEM IN CASE OF FLOODING WITH HLA ตีพิมพ์ในงานประชุมวิชาการ ICEP2003 (3rd Information and Computer Engineering Postgraduate Workshop 2003) ที่จังหวัดสงขลา จัดโดยภาควิชาวิศวกรรมคอมพิวเตอร์ มหาวิทยาลัยสงขลานครินทร์ ระหว่างวันที่ 30 – 31 มกราคม 2546 เอกสารหน้าที่ 94 -98

ข. DISTRIBUTED SIMULATION OF AN EMERGENCY SYSTEM FOR THE FLOOD DIASTER IN HATYAI, THAILAND ตีพิมพ์ในงาน ESM2004 (18th European Simulation Multiconference) ที่เมือง Magdeburg ประเทศเยอรมันจัดโดยองค์กร SCS (Society for Modelling and Simulation International) ระหว่างวันที่ 13 -16 มิถุนายน 2547 เอกสารหน้าที่ 187 - 192

DESIGN OF A DECISION SUPPORT SIMULATION SYSTEM IN CASE OF FLOODING WITH HLA

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ABSTRACT

In this paper, the principle of the design of the simulation system in the case of flooding by using High Level Architecture (HLA) is discussed. HLA is a distributed simulation framework that enables simulation of big models and on-line decision aids. Our distributed simulation system focuses on enhancing the efficiency of the assisting operations amongst of working units and to reduce redundancy.

KEYWORDS

Simulation, HLA, Flooding, RTI and Federation

1. INTRODUCTION

Flooding is an uncontrollable situation. Usually, flooding can not predicted before a certain time due to many factors. However, preparation can be done beforehand. In Thailand, flooding occurs frequently and is often a main disaster. Notwithstanding that, the emergency system for helping in case of flooding still has several shortcoming such as in case of flooding in Hat Yai during 21 – 25 November 2000. The emergency system in case of flooding in Hat Yai was reported delay and low performance. The help had usually been received after the level of the water had decreased (52.1%). Only 22.9% reported help reception within 3 days after the flooding occurred. There was flooding for five days before the water level had actually returned to normal. This shows that in some areas people were left on their own meanwhile there were also problems of help redundancy.

In the research done by Dr. Arkom Jaikeaw [1], most people required faster help, more numbers of life support system and modern equipment for evacuation. Better cooperation amongst work units and efficiency the emergency aids were suggested for improving the emergency system.[1]

No report of using computer simulation in assisting and cooperating the organization involved. Therefore, this research project proposes to create a distributed simulation system that represents a decision support system in order to enhance the efficiency of the assisting operations amongst of working units and to reduce redundancy by offering on-line case studies or simulated situations in corporation with live data.

2. BACKGROUND

2.1 High Level Architecture (HLA)

The HLA (High Level Architecture) is a software architecture that allows creating distributed computer models or simulations out of component models or simulations. The HLA has been adopted by the United States Department of Defense (DoD) in order to integrate all its modeling and simulation activities. The HLA was approved as an open standard by the Institute of Electrical and Electronic Engineers (IEEE) - IEEE Standard 1516 - in September 2000. Concurrently, the HLA framework has been adopted to full commercial applications since mid 2002. [5,6]

2.2 HLA Network

The legacy military simulation model view a physical system as a collection of element that had simple connection (see Figure 1a) because it was built for particular purpose and work in a private simulated network. [4] HLA integrates simple models by using *Object Model Template (OMT)* to encapsulate simulation objects into a single simulation node called a *federate* (see Figure 1b). By using OMT, HLA can integrate many individual models to form a collection of virtual objects (see Figure 1c). A collection of federates is called a *federation*.

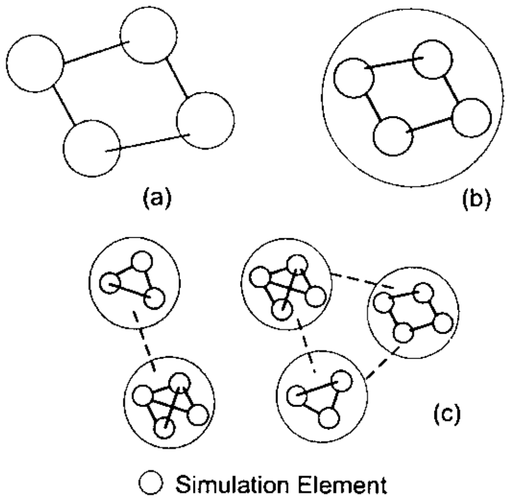

Figure 1 Diagram of federates and federations in HLA

(a) a simulation
(b) a federate (a simulation node)
(c) two federations: each consists of federates

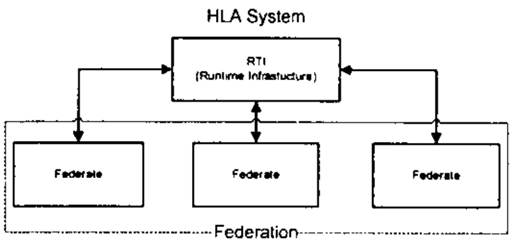

Figure 2 HLA System

Federates can not contact one another directly. The communication must be done through *RTI (Runtime Infrastructure)* that is the HLA middleware. The RTI software allows federates to cooperate together, to synchronize federate events and to form a federation as shown in Figure 2. Information of every federate must be sent to RTI first. Then, RTI will send the information to the destination or desired federates by the mechanism of publication and subscription. [2,4,5,6]

2.3 Components

The HLA standard consists of three parts:

(1) *Rules* describing HLA principles that explain about interaction of federates during a federation execution. [2,9]

(2) *Interface Specification* describing the functional interface between federates and the RTI. [2,7]

(3) *Object Model Template (OMT)* specifying a common format and structure for documenting HLA object models. [2,8]

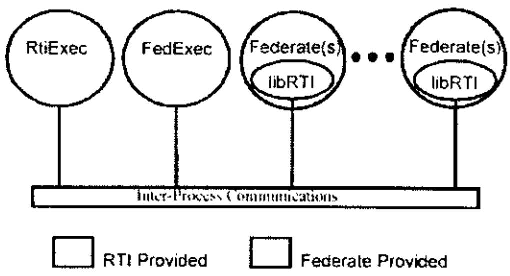

Figure 3 Logical view of an executing HLA federation [6]

2.4 Executing a federation in HLA

The HLA system consists of several parts as shown in Figure 3.

- *Federate*: a simulation program plus SOM (Simulation Object model)

- *Federation*: a set of federations interacting via the RTI services plus a FOM (Federation Object Model)

- *FEDExec*: a simulation executive that manages the federation

- *FED File (Federation Execution Data File)*: a file that contains information derived from the FOM and used by the RTI during runtime

- *RTIExec*: a global process that manages the FEDExecs

- RID File (RTI Initialization Data): RTI vendor-specific information needed to run an RTI

- *libRTI*: the RTI library that makes HLA service methods available to federates [5,6]

2.5 Classes in HLA

Classes in HLA are divided into two types:

- *Object class*: comprised of *attributes* and used to describe types of things that can persist.

- *Interaction class*: comprised of *parameters* and used to describe types of events.

Suppose that we are interested in flight characteristics of an airliner and the dynamics of the flight. That should be modeled as an object. If the simulation is interested in the number of tourists that are arrived on a given flight and the characteristics of the fight are not important, it should be modeled as an interaction. [6]

2.6 Implementation

Federates can form a federation by using the RTI as a middleware. To do that, we must complete the RTI service routines following the Interface Specification to interface federates with RTI. The service routines can be divided into:

(1) *RTI Ambassador*: it is a class with methods corresponding to the federate-initiated services (the service operation on the interface that is invoked by the federates to request services from RTI , for instance, a request to update the value of an attribute of an object)

(2) *Federate Ambassador*: it is an abstract class with abstract methods corresponding to the RTI-initiated service (the service operation that is invoked by RTI when it must call the federate, for instance, to pass to the RTI a new value of an attribute)

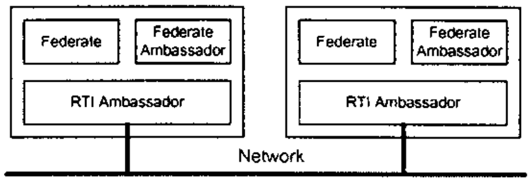

Figure 4 The Internal Structure of HLA federates [6]

In Figure 4, when the federation is implemented, the federate code must contain the simulation code which defines and creates simulation objects, and request services of RTI by using the *RTIAmbassador class*. At the same time, the federate code must create class derived from the *abstract class of the FederateAmbassador* class. The classes of RTIAmbassador and abstract class of FederateAmbassador are contained in *libRTI* as demonstrated in Figure 3, 4 and 5. [3,5]

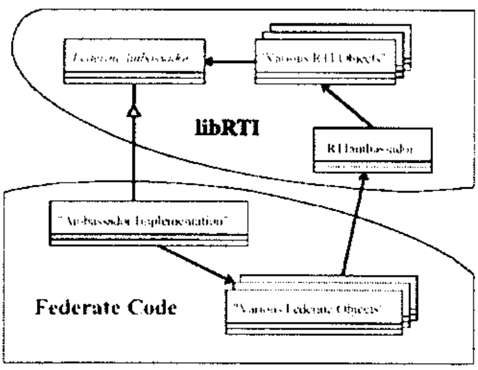

Figure 5 The relationship between Federation and RTI Ambassadors [6]

3. SYSTEM DESIGN

3.1 Overview

In case of flooding, the roles of involving units can be considered in 3 phases:

(1) Before flooding: in this case, the Information Unit plays the most important role that people are informed and prepared to deal with the coming situation by the Information Unit.

(2) During flooding: the Working Unit takes the main part supported by the information from the Information Unit.

(3) After flooding: The Working Unit still plays the important role supported by the Information Unit.

The simulation will focus on the phases 2 and 3 and the cooperation of the involved organizations by comparing the results of the reactions of different connections and situations.

3.2 Federates

In this project, the simulation consist of 3 groups of federates:

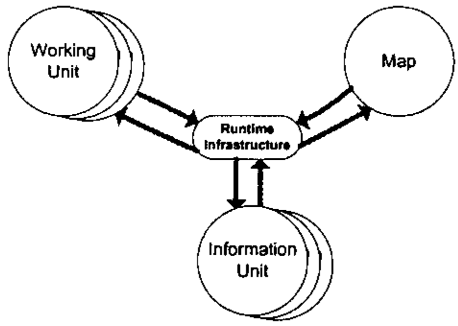

Figure 6 Federates in the designed support simulation system in case of flooding

- *Working Unit* is categorized into 3 types as follows:

(1) *Aid Unit*: holds a direct responsibility.

(2) *Hospital Unit*: is a unit that treats patients.

(3) *Other Unit*: is a unit that has indirect responsibility and operates from time to time.

Specification	Aid Unit	Hospital Unit	Other Unit
Status (Permanent/Temporary)	P	P	T
Resident Status: - Patients - Peoples Stay at the unit.	 N Y	 Y Y	 N N
Number of control areas	Many	Many	One
Mobility	N	N	Y
Distribution of helping packages	Y	N	Y

Table 1 Function comparison of Working Units

- *Information Unit* is a unit that informs the water level.

- *Map* is a single unit that collects detail of the interested areas such as size of the focus area, population, building and water levels

3.3 Object Class Hierarchy

In HLA, data exchange amongst federates is done through the exchange of attributes from the instances of object classes. In the project, we design the object class hierarchy as shown in Figure 7 .

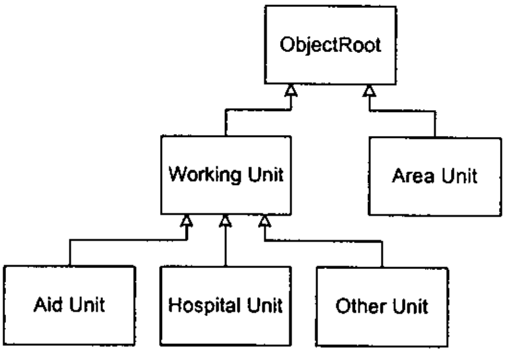

Figure 7 Object Class Hierarchy

Area Unit is an object class that concerns an interested area such as information in a village or a town.

From Figure 6 and 7 we can map federates with object classes as follows:

- Federate *Working Unit* publishes all attributes of Working Unit, Help Unit, Hospital Unit and Other Unit object classes. There can be more than one Working Unit federate and each federate can have a different number of object instances.

- Federate *Information Unit* publishes attributes of Area Unit object class for areas under control or gives information of the flood level in that area. There can be more than one federate Information Unit and they can also contain the different number of object instance. However, the same object instances are referred.

- Federate *Map*, a single federate, publishes all attributes of Area Unit object class to interested listeners. Except the federate Map, there can be more than one federate representing objects of the designed classes, Working Unit or Information Unit.

Federate Information Unit publishes some attributes of Area Unit objects for updating the flood level and in the areas under its control. Federate Map publishes all attributes of Area Unit objects, creates instance for all areas and updates information for all areas. Federate Map acts as a database but federate Information Unit and Working Unit act as the user interface that concern data read/write data at the database.

The designed federation for the simulation system in the case of flooding is shown in Figure 6.

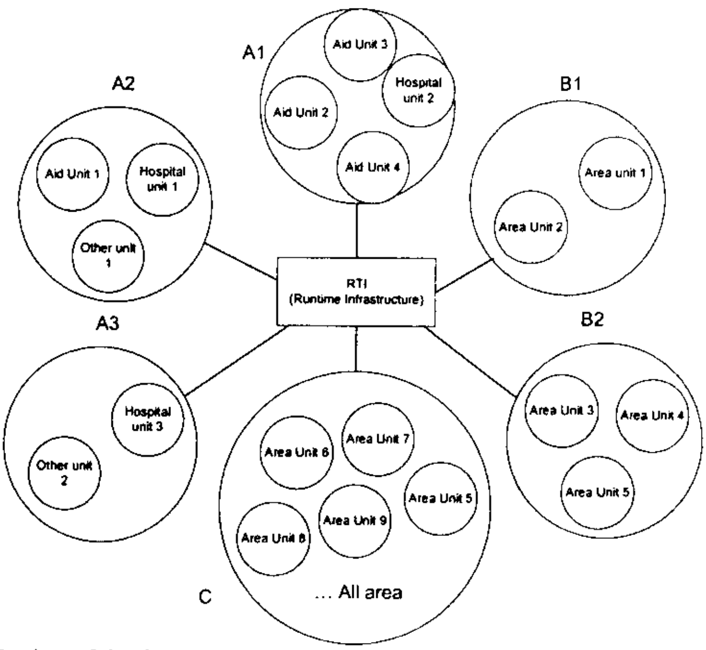

Figure 8 Design of the federation
A: Federate of Working Unit
B: Federate of Information Unit
C: Federate of Map

3.4 The contribution of HLA in the simulation system

First, in Figure 8 the key is how to manage the changing relationship of Working Unit. Some areas are controlled by more than one related Working Unit. We must decide which should control that area. For example, A is the Working Unit federate that consists of Help Unit A1 (control area: 1, 2, 3) and Hospital Unit A2. And B is the Working Unit federate that consists of Help Unit B1 (control area: 4, 5, 6) and Help Unit B2 (control area: 1, 7). If A1 and B2 are related and control the same area (area 1), We decide which Help Unit should control area 1 by comparing the ability parameters of A1 and B2. But if A1 and B2 are not related, area 1 are controlled by A1 and B2.

Second, HLA supports interactions among during the federation execution. This implies that users can control the simulation. For example, users can input the simulation events that they want to test or adapt the ability parameters of Working Units.

Third, HLA synchronizes simulation time by applying HLA's time management.

Forth, HLA allows federates to join and leave from the federation arbitrarily so that the number of federates can be changed during the federation execution.

Finally, also in HLA, new classes containing new properties or functions can be added on the fly without affecting the whole system.

4. CONCLUSION AND FUTURE WORK

The design focuses on the efficiency enhancement of the Working Unit in order to reduce redundancy by alternating the operations of the involved Working Unit. A simulation system in this project consist of 3 groups of federates, Working Unit, Information Unit and Map federate, and consists of 4 object classes, Working Unit, Aid Unit, Hospital Unit, Other Unit and Area Unit. In this project, Working Unit federates are main federates to manage the working units supported by Information federate and Map federate but a decision will be made at the Map federate that acts as a database because the Map federate has collected the information of all areas and all federates. The decision may lead to a result of Working Unit alternation.

Currently, the implementation is on progress. More detail information of the existing object classes or add the new object classes or new federates to complete the decision support simulation system in case of flooding are to be included.

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DISTRIBUTED SIMULATION OF AN EMERGENCY SYSTEM FOR THE FLOOD DISASTER IN HAT YAI, THAILAND

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KEYWORDS
Flood, Distributed Simulation, Emergency System, Rehearsal, HLA

ABTRACT
The paper presents an approach to create a training simulation system for emergency rehearsal in case of flooding at Hat Yai municipality, Thailand. The simulation system applies the concept of demand and supply as well as distributed interactive simulation using High Level Architect Framework.

INTRODUCTION

In many areas, flooding is a natural disaster that causes enormous damage both physically and economically. It has been the cause of catastrophes in the past and at the present. No community areas are absolutely free or safe from flooding. There are still flood problems occurred in many countries including Thailand. It is also not practical to evacuate communities or industrial sites out of the locations in order to avoid the flooding problems when the flooding does not really occur every day. Therefore, human beings need to learn to prepare, prevent and deal with flooding situations.

There are many ways to prevent or reduce damage caused by flooding, for example; on engineering issues such as building dams, installing water pumps, surveying risky areas; and on social issues such as giving knowledge of self care in flooding situations and rehearsing aid units or related organisations. In this paper, we present work on preventing and reducing damage to communities after flooding occurred, focusing on virtual rehearsals of related aid units.

BACKGROUND

High Level Architecture(HLA)

HLA is a software architecture that allows creating distributed simulation. The HLA has been adopted by the United States Department of Defense (DoD). In September 2000, the HLA was approved as a open standard by IEEE and in mid 2002, the HLA framework has been adopted to full commercial application.

In HLA, a simulation node called a *federate*. By using *OMT (Object Model Template)*, HLA can integrate many individuals models or federates to form a complex system that called a *federation*. Federates can communicate with one another through *Runtime infrastructure (RTI)* that is the HLA middleware. The RTI software allows federates to cooperate together, to synchronize federate events and to form a federation as shown in Figure 1. Information of every federate must be sent to RTI first. Then, RTI will send the information to the destination or desired federates by the mechanism of publication and subscription.

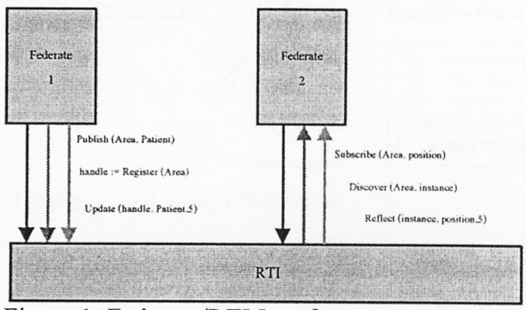


Figure 1. Federate/RTI Interface

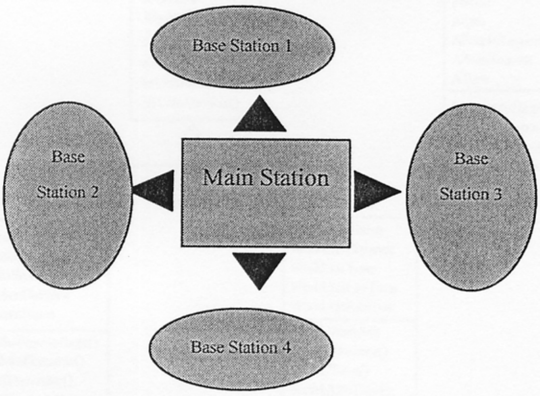
Publication and subscription mechanism is analogous to newsgroups because the publishing federate or producer of information must define a means of describing data it is producing and the subscribing federate or receiver must define a means of describing the data it is interested in receiving in form of OMT. (Wyne 1999, Kuhl et al 1999, Fujimoto et al 2000, IEEE STD 1516)

Physical system

This work concerns a case study of Hat Yai municipality in Thailand where there were two recent big floods considered a century case occurred successively in only about a decade (1988 and 2000). Hat Yai municipality with the area of thirty one square kilometers is located in the Intertropical Convergence Zone. 80% of the area is a flat basin. There are two canals called Uhtapao and Toey. The flood type is a flash flood that once the soil is saturate with water, water can be collected and floods the municipality rapidly in a few hours. It normally happens after several days of heavy rain.

The structure of Hat Yai municipality in aiding flooding situations is shown in Figure 2 and consists of the followings.

Figure 2. Physical System.



1) Director centre (Main Station) and coordinating centres (Base Stations)
2) Three types of work units contacting with the inhabitants including parking centre, shelter centre and healthcare centre.
3) Specially organised centre for coordinating between other centres and the inhabitants such as flood preventing unit, public relation unit, welfare unit, rescue unit, first aid unit, evacuation unit, security or guarding unit, healthcare unit, aid unit, restoring unit and donation unit.
4) Four areas of inhabitants and thirty local communities. (http://www.hatyaicity.go.th/)

SIMULATION SYSTEM

From the physical system mentioned above, we modified it by adding and removing some details in order to create a simplified simulation system that can integrate the components together in a better way. Therefore, the simulation model consists of the following.

1) Three simulation models including the *control models* that concerns general control of simulated situations at all communities together, the *main station model* or the director centre that acts as the main part for commanding helps and aids for all areas, and *base station model* or coordinating centres for the four areas of inhabitants that helps and aids inhabitants in the area in charge and cooperate with the control model or the main station.
2) Three kinds of work units as appeared in the physical system including parking centre, shelter centre and healthcare centre. These are under supervision of its base station.
3) Simplified other units including repairing unit, transportation unit, rescue/guarding unit, first aid unit, evacuation unit, aid unit, restoring unit and resource finding unit.
4) Four areas of inhabitants and thirty local communities as appeared in the physical system.

The overall of the simulation system is shown in Figure 3. The hierarchy of the simulation models is shown in Figure 4.

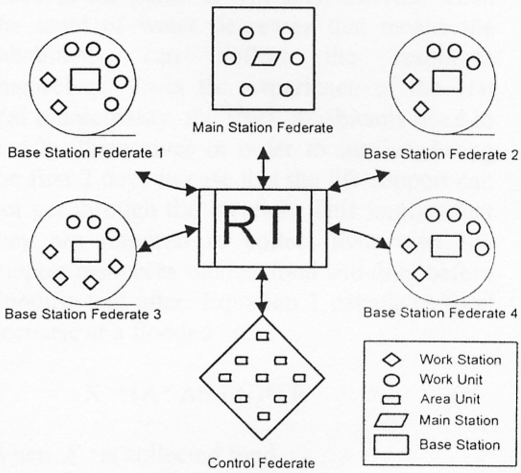


Figure 3. Federation Overview

The control model works as a simulation executive and involves all simulation models. It randomises situations occurring in the simulation as a whole. The controller or the user who works on the control model can add/schedule events at run-time. The main station is also needed in a federation to coordinate works done by the four base stations. However, at a time, there can be at least one base station or more, for more flexibility in increasing or decreasing the number of participating base stations according to the simulation.

Table 1. Interactions in the federation.

	Main Station	Base Station	Work Station	Work Unit	Local Unit
Control Model	S	S	S	S	PS
Main Station Model	PS	S	S	PS	S
Base Station Model	S	PS	PS	PS	S

P: Publication S: Subscription

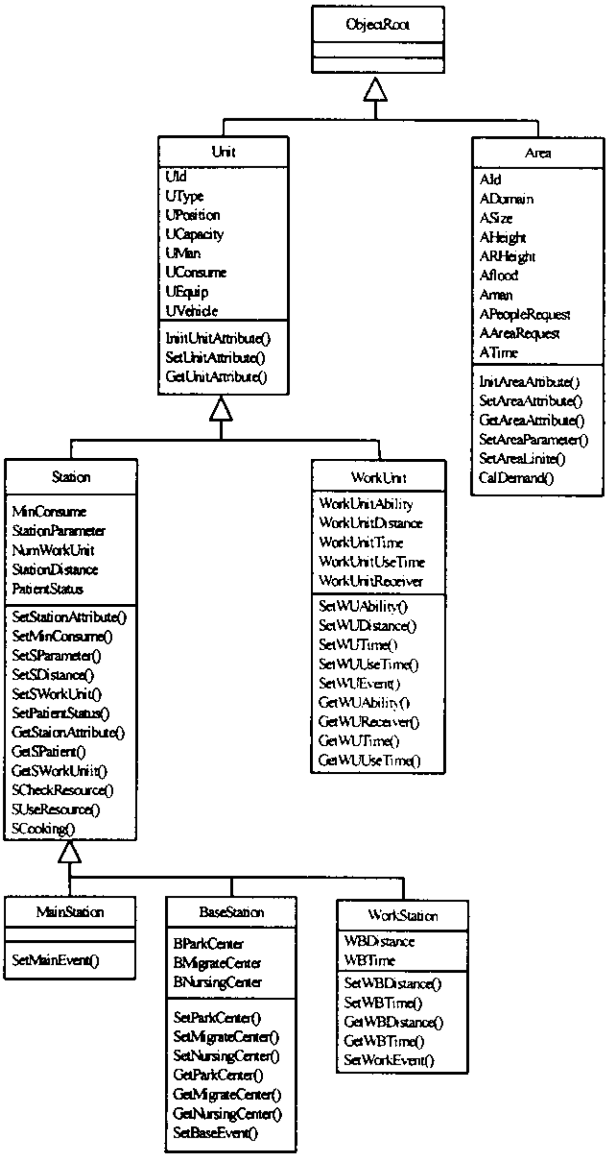


Figure 4. Class Hierarchy

Table 1 shows the interactions in the simulation models in terms of publication and subscription. About exchanging information, the simulation models also have the following relationships.

1) The main station directly connects to the control model.
2) Each base station connects to the main station.

Therefore, the main station work as an agent or a middle person in connecting each base station to the control model. There is no direct connection from a base station to another base station, as happened in the real organisation, due to authority in distributing work and resources.

RESOURCE MANAGEMENT

Resources exchanged in the simulation can be divided into four different types; human resources or workers, consumable resources, equipment and vehicles. Entities in the consumable group are to be deleted after being used or consumed, and require replacement. The resource management for this group is such that the requiring centre or unit asks for resources from other centres.

1) In case of the stock for the inhabitants, an automatically decreasing stock has been made for simulating real simulations. The stock of consumable resources decreases continuously when it still floods and the inhabitants are stuck in the place. It will soon increase when the level of water decreases that means the inhabitants can collect the resources themselves. From the experience of the Hat Yai municipality, the stuck inhabitants need to live by themselves in order to survive during the first 2 days in case that the life support can not get through the location. This implies that they are required to collect their own life support resources such as food and drug before flooding and after. Equation 1 calculates food decrease at a flooded area.

$$X = (A * AS/PN)*FR \qquad (1)$$

When X is collected food
A is a coefficient
AS is the size of the affected area
PN is the number of inhabitants in the area
FR is a food-consuming ratio that has been set of a constant at the begining of flooding simulation and automatically decreases as time advances. When there is no flood anymore, it will then increase.

Note These parameters are adaptable. The food-consuming ratio is added because different areas can have different consuming rates.

2) The decrease of consumable resources in the simulated centres or units is caused by distributing resources to community areas, transferring resources to other centres or units and local consumption. However, the change of resources in the consumable group does not occur in case of dry food for distribution. From

our observation, cooked food has a relationship with raw ingredients and the amount of water used for cooking. To simplify the model, we do not consider seasonal ingredients and oil. Therefore, Equation 2 is used for calculating food transforming.

$$Ax = By + Cz \qquad (2)$$

When x is the amount of processed food
y is the dry food
z is water
A, B, C are adaptable coefficients

EMERGENCY SERVICES IN FLOODING SIMULATION

The service simulation is considered in terms of demand and supply. The simulation is driven in two patterns. First, it is stepped by simulation time which is a normal working simulation. Second, it is driven by events happening during the simulation. The first case concerns with all centres and the latter concerns with changes in each community while it is flooding.

Demands for aids

Time advance in the simulation typically sets demands according to the increasing demands of the inhabitants, and leads to more damage at the areas. This can be put into the calculation of local demands in Equation 3.

$$D = D + ((A*People)+(B*Patient))*(C*T) \qquad (3)$$

When D is the demand from local people that can be divided into demands of food, dry food, water, drug, life vests and life bags. The specific demands lead to different coefficients in the equation.
A, B, C are adaptable coefficients.
People is the number of inhabitants at the considered area.
Patient is the number of patients at the location.
T is the period that the location has not been visited, calculated from the last time that this location receives help.

Demands of local people increase when time steps. In other words, when time advances and the community has not yet received supplies responded to the demand, the demand will increase, too.

Demands for restoring the area

Flood damage increases exponentially according to the flood height and the height of buildings (Berning et al 2001). Therefore, we take this conclusion to calculate the demands for restoring the affected area as shown in Equation 4.

$$Z = Z + (X*(AS/PN))*(Y*(FH-AH)) \qquad (4)$$

When Z is the demand for restoring the area that can be divided into solving the fuss, restoring building, demolishing ruin, and cleaning.
X, Y are coefficients that are adjustable according to the type of demands
PN is the number of inhabitants in the considered area
AS is the size of the considered area.
FH is the average flood height comparing to the sea level.
AH is the average height of the area considered.

Apart for computing the demands, computing the resource usage time is also another key issue. Some resources are available or to be used within a period of time due to some reasons such as expired date in case of food or availability in case of equipment.

Event driven simulation is adopted in the supplier site. The users need to control the main station and the base stations in order to response to the demands from the affected areas and to manage the resources at the centre and local units involved. If the resources are in sufficient, the users need to find resources from other sources. Demands can be randomed by the simulation or fed by the users at the controller. In addition, when a demand reach a threshold, it can cause some events to happen. The number or amount of resources when reduced below the threshold can trigger some events to happen, too.

LOOK AND FEEL

Situation reports in the simulation are both text and graph based. Figure 5 and 6 show examples of dialog views and simulation reports. In case of text based reports, user can trace the dialog display to check each event occurred during the simulation or the changes to the resources. The tracing commands can be saved into log files. The users can also set current parameters of the simulation.

After finishing the virtual rehearsal, the application will summarise the number of resources left and used, demands, damage, patients and death bodies found at each unit.

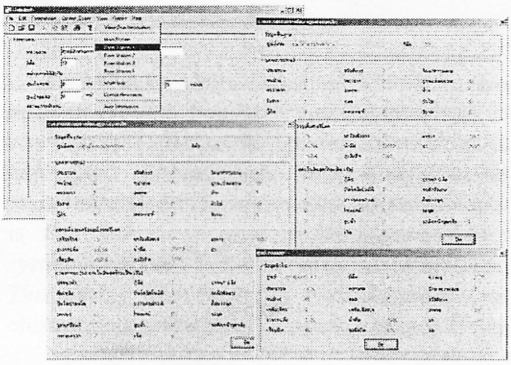


Figure 5. Dialog Views during the Simulation

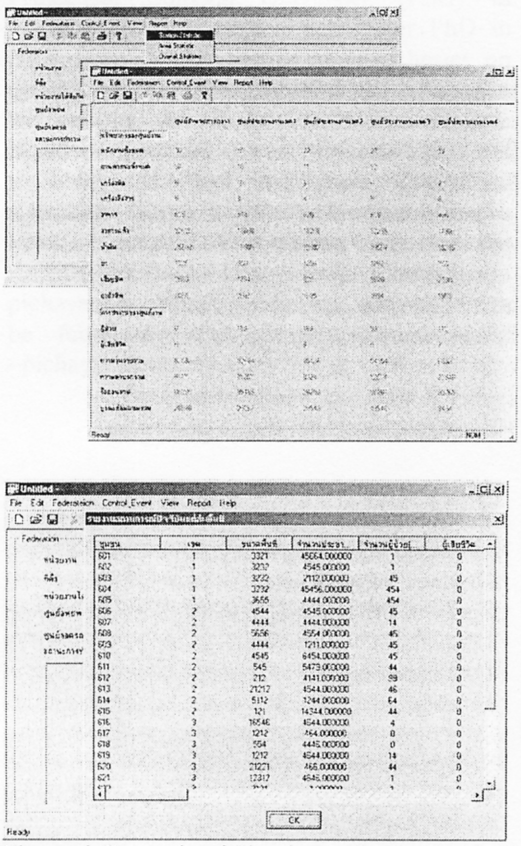


Figure 6. Example of Simulation Reports

CONCLUSION AND FUTURE WORK

This simulation concerns simulating emergency rehearsal in flooding situations in the case study of flooding in Hat Yai municipality, Thailand. The distributed interactive simulation focuses on preparing the work units involved, including staff and interest people, to deal with real situations. The simulation applies the concept of demand and supply. The simulation is simulated into three parts according to the structure of the physical system being simulated. First, the control model acts as a simulation controller that controls the overview of the simulation as a whole. This model concentrates on demands for serving people and demand for restoring the area. Each community has different demands for resources. Second, simulation model of the director centre called main station and the coordinator centres called base stations. These models concerns suppliers that manage existing resources and find additional resources to serve the demands of their communities. Third, the simulation is driven by both time stepping and events. When a simulations ends, summary of resources usage at each centre and unit, and demands from each community will be made.

Currently, this work is still on progress. More details are still required to serve real organisations.

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