RoboCup-Rescue Simulator FAQs
from version 0 to vresion 1
selection from RoboCup-Rescue Manual

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Contents

1 FAQ

1.1 Architecture

1. Hi, I have two concerns:

   1)It says that all communication between agents goes through the kernel. Won't this become a bottleneck when the number of agents increase? Especially since the next step is to make each individual an agent and not a team as an agent as it is now

   2)Also kernel waits for a fixed time to get back the commands issued by the agent. It filters these and send them to the simluators. What about those commands that come in late? Also when the simulators return their results to the kernel it integrates these results and returns it to the GIS and to the simulators. Here to it waits for only a fixed period of time. What happens if the simulator's reply reaches the kernel after it has begun integrating the rsults from the other simulators. Won't a incorrect picture of the world be created and sent to both the gis and the individual agents? Thanks for your time.

   (Ranjit Nair, Jan. 2000)

   - Yes, we also have these concerns. These problems about distributed kernel and asyncronous simulaton will be central issues of the next kernel (version 1). Join us for discussion!

     (Ikuo Takeuchi)

   - For the short term plan, rescue simulation project will proceed.

     Phase 0 (— 2000.3)
     Feasibility study of a disaster-agent simulator for a very simple agents and environments.

     Phase 1 (— 2001.4)
     Simulator development of limited disaster and limited agents. The 1st research evaluation conference.

     Phase 2 (— 2005.4)
     Simulator development of larger-scale disaster simulator, heterogeneous agents.

     This manaul is a document at Phase 0. Designing the simulation at Phase 1 must take care of the problems. They invole your suggested points, Ikuo's points and, GIS format, viewer, time-management among simulators....

     (Tomoichi Takahashi)

1.2 Viewer

1. This is a snapshot of what I obtained on running the sample simulation(kernel-unix-0.17). Please confirm that this was what it was supposed to look like? I was expecting fancier graphics. Isn't the simulation supposed to be modelled on a city block in Kobe? Will future releases have this? When can we expect these releases.

   (Ranjit Nair, Jan. 2000)

   - The snapshot is correct. In kernel-unix-0.17, the kernel is official, but the other modules are just sample to test the kernel. We released version 0.19. It contains a semi-official GIS and displays a small area in Kobe. But it has a bug about endians and needs little endian architecture machine.

     (Tetsuhiko Koto)

1.3 Performance

1. Where can I get test Environment?

   - There are four test GIS data of different scales. at URL:

     http://ne.cs.uec.ac.jp/~koto/rescue. The GIS data are Nagata area with 1/1000, 1/100, 1/10 and 1/1 scale (Table 1).

     Figure 1 shows the 2-D viewer of 1/10 model. The entries in the first row is the length of displayed area. The edge of displayed area is 521m. The second group of rows in Table 1 are static objects, and the third group is autonomous agents.

     The green spots are buildings, the yellow spots show the ignition pointes and the white lines are roads. The color of buildings turns to red when the building burns, and turns to blue when fire brigades extinguish the fires. The points on the lines represent autonomous agents.

     The numbers in the entry are the numbers of objects, and the byte size (in parentheses). (Tomoichi Takahashi)

2. How much machine power is necessary to run test environment?

   - I don't know exactly. Table 2 shows the machine specifications that we tested at 3/5/2000. We used seven machines connected through 100M network. (Tomoichi Takahashi)

3. What about the test ? Did it work smoothly?

   - At 1/1000, 1/100, 1/10 scale, it worked as we expected. At 1/1 scale, it did not work. The followings are the reasons:

Table 1: Objects in test environments [number (byte size)]

scale	1/1000	1/100	1/10	1/1
area size (m)	31	160	521	2217
static objects				
road	4(60)	125(1,875)	818(12,270)	9,776(146,540)
node	5(35)	119(833)	765(5,355)	9,143(64,001)
building	1(13)	99(1,287)	778(10,114)	9,357(121,641)
subtotal	10(108)	343(3,995)	2,361(27,739)	28,276(332,282)
autonomous agents				
Civilian	1(8)	8(64)	76(608)	934(7,472)
Ambulance Team	1(8)	2(16)	5(40)	5(40)
Fire Brigade	1(10)	2(20)	10(100)	10(100)
Police Force	1(8)	2(16)	10(80)	10(80)
subtotal	4(34)	14(116)	101(828)	959(7,692)
total sum	14(142)	357(4,111)	2,462(28,567)	29,235(339,974)

Table 2: machine environments for test

	components	CPU	Memory	OS
1	kernel	P3-600x2	512	WindowsNT/FreeBSD
2	GIS	P3-733	512	WindowsNT
Simulator				
3	Fire	P3-733	512	WindowsNT
4	Road blockade	P3-733	512	WindowsNT
5	Building blockade	P3-733	512	WindowsNT
6	Traffic	P3-733	512	Turbo Linux
Agents				
7	Civilian	P3-600	512	FreeBSD
	Fire			Linux
	Ambulance			Linux

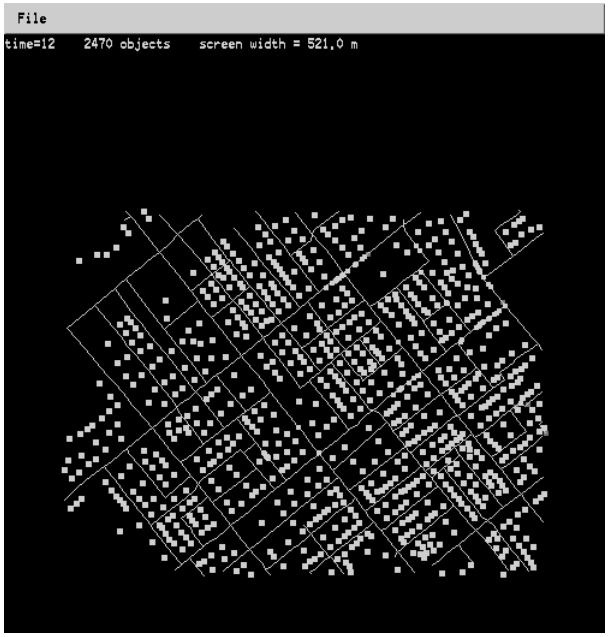


Figure 1: 2D viewer of 1/10 scale.

(a) At the initialization phase, every module gets the GIS data. The GIS data of 1/1 scale is 330KB, and is sent via UDP/IP. This causes packet lost during receiving them. And as the number of modules plugged in, the total transmission time and the number of lost packets increase. And the time for initialization becomes more than 30 minutes.

(b) During simulation, kernel sends the changes of circumstances to agents by calculating within the limited area. At present, the cost of this calculation is proportional to the number of agents. The increase from 76 agents to 934 agents is hard for the present kernel.

- For the above problems, the followings are commented:

(a) As far as the initial step, the transmission of GIS data should be via TCP instead of UDP in order not to miss packets. (Tadokoro, Aida, March/2000)

(b) The modules are divided into two categories. The one category is disaster simulator, and the other is agent. The disaster simulators change the world itself under the complete data, while the

agents move in the world with incomplete data. The number of disaster simulators is fixed, and the number of agents is variable. In order to keep the cost in spite of the increase of the agent's number, there is a proxy between kernel and agents. (Ituki Noda, March/2000)

2 Discussion toward Version. 1

2.1 Architecture

1. Time management: fixed RTK [1] or flexible RTK? (Yoshitaka Kuwata, 2000/2/13)
   At version0, one simulation step corresponds to one minute in the simulated world. 4,320 = 60 * 24 * 3 simulation steps become 3 days. Agents or simulators calculate according to their own models, and the required times are different from each other. For example, one minute is good for fire simulations, while it is too long for traffic simulations. Because a car moves more than one block in one minute. RTK(60) may make impossible to transfer protocols among agents and simulators within one minute. It causes the simulation is out of the real one.

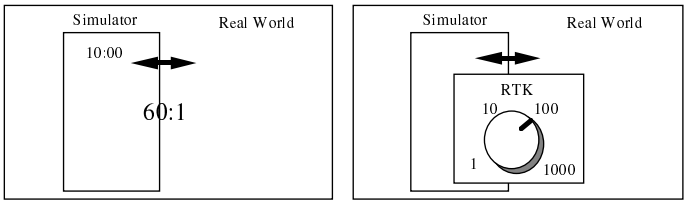


Figure 2: Real-Time Knob(RTK)

2. is calculation guaranteed to complete ? (Yoshitaka Kuwata, 2000/2/13)

   (a) why guarantee to complete within one step is necessary?
   Under RTK(60) system, calculation of both agents and simulators are expected to finish within one step. Agents in RoboCup soccer simulation leagues are soccer players. In the soccer games, whether the players run after deliberation, dash for the ball at first, or else are the problem of soccer agents themselves. This situation applies also to agents of Rescue project simulation.

   However, disaster simulations in rescue simulation should complete its calculation in one simulation step to keep the simulated world consistent. If a fire simulator does not finish in one step, the simulated fire does not spread out. Is it possible for disaster simulators to complete their calculation in one simulation step when the simulated world becomes larger than the assumed world at version 0 ?

[1] The ratio of simulation time and real time is referred to Real-Time Knob (RTK) after this. Version 0 is RTK(60) system, it means that the ration is 60.

Incremental algorithm or anytime algorithm are proposed for real time simulations. Applying these algorithms to simulators that have been developed already is difficult. At least, some efforts including the computer power up should be made that the modules of disaster simulation return the result.

(b) real-time / non real-time simulators ? (Yoshitaka Kuwata, 2000/2/13) Real-time disaster simulators are important. On the other hand, logistics planning or city-reconstruction planning by government offices require precision of simulation rather than its speed.

In future, the non real-time simulators will be plugged in. The rescue simulation should support interfaces for both real-time and non real-time simulators.

Question Is it possible for kernel to control the RTK of simulators? If so, given a table where the granularity of simulators are listed, the kernel indicates RTK's value to simulators. When a simulator fails to return its results in one simulation step, the value of RTK will be set larger one. (Kento Aida, 2/15)

Answer As mechanism of simulators, I think it is possible to control the RTK, although programming simulator takes efforts. For example, see Boddy, M., & Dean, T. "An analysis of time-dependent planning.", in proceedings of the sixth national conference on Artificial Intelligence(AAAI) , pp. 49-54, 1988 or Boddy, M. & Dean, T. "Solving time-dependent planning problem", in eleventh international joint conference on Artificial Intelligence (IJCAI), pp. 979-984, 1989.

When more people enter the community of rescue project, I think it is a good policy to make their existing simulation programs plugged in easily. So, the realistic and simple way is that kernel or some module will manage the characteristics of the newly plug in simulator, isn't it ? But it does not solve our problem, because we must set all RTK to the highest value. (Yoshitaka Kuwata, 2/15)

3. Communication cost, performance of kernel(Yoshitaka Kuwata, 2000/2/13) The communication size of GIS data and the amount of kernel computation will be bottleneck of execution. (Ranjit's comment in page 2.) The followings will be considered:

   - distribution of GIS functionally and/or regionally,
   - distribution of kernel module,
   - event driven type kernel. (Takeuchi's commnet in page 10, Kuwata's comment in page 11).

Question One of distribution ways is to divide them into domains like DNS. There will be one kernel and one GIS within one domain. In this case, the division that makes dependence among domains little is desired. (Kento Aida, 2/15)

Answer I agree with your suggestion basically, however, there are many kinds of information linked over domains. (The followings are my guess:) When a fire occurs at the boundary of domains, a fire simulation must send data to both kernels of domains. In a domain, there is usually one kernel. When fires occur at the domain, the kernel divides the domain dynamically into smaller ranges and forks other kernels to manage the small ranges. This is an interesting research theme, but this seems to be difficult. Anyway, more detailed analysis will be needed. (Yoshitaka Kuwata, 2/15)

Question Next idea is to use simulators more than one that simulate the disaster of the same kind in a domain. By using some simulators, when the load of simulating one disaster, for example fire, in one domain, the load will be distributed to each simulator. By this method, distributed simulation inter-domains and intra-domain will be done. (Kento Aida, 2/15)

Answer In HLA(High Level Architecture), Federation architecture defines dynamic hierarchical structure. (Can anyone follow ?) (Yoshitaka Kuwata, 2/15)

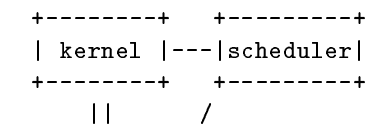
Question The other idea is to assign simulators flexibly according to the demand of simulation power. One kernel of a domain that thinks the power of simulation insufficient asks kernels of other domains to support it. (Kento Aida, 2/15)

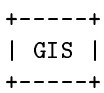
Answer For that, a meta-controller that manages kernels is required. Implementation using CORBA is a practical solution, isn't it? (Yoshitaka Kuwata, 2/15)

Question The kernel will do the following functions to realize the above functions.

- synchronization and communication among domains,
- segmentation of a domain and allocation of simulators.

The kernel needs the data-sheet on the speed of machine-computation, the amount of simulation-time, etc. Adding these functions makes the kernel big, so it may be good that adding functions are separated from kernel.





(Kento Aida, 2/15)

Answer This figure is a similar to my figure (cf. Fig. 3). The scheduler in the above figure manages kernel tasks, while the scheduler in my figure controls RTK. (Yoshitaka Kuwata, 2/15)

2.2 GIS

1. More GIS ? (Yoshitaka Kuwata, 2000/2/13)
   At version 0, the GIS module maintains geographical data as a whole, and other modules acess the data via the kernel. At future versions, there will be requests to make use of GIS data at more detailed levels or from different points. For satisfying these requests, GIS data will increase in size and types. Distributed GIS modules must be considered for the increase of data. Of course, distribution of data will need consistency among them.

2. Management of agents such as civilian, cars (Yoshitaka Kuwata, 2000/2/13)
   The GIS module keeps record of not only static objects such as buildings but also civilian agents, car agents that move. Management of objects that move or don't move should be separated from computation efficiency. This separate management of building objects and civilian will be useful when several GIS modules will be used.

2.3 Utilities / Tools

1. Snapshot, rollback, rerun:
   The following functions are desired to debug programs, to analyze behaviors:

   Snapshot / Rollback : save all data on agents, simulations, GIS data, and kernel status at a specified time point.

   Rerun : restore the save data and start the rescue simulation from the point. In this case, persistence of objects should be managed. (2) (Yoshitaka Kuwata, 2000/2/13)

2. interoperabilty:
   Rescue project simulation is executed on computers connected to network. Protocol data format and data structure are desired to be independent of programming languages and machines.

   Compatibility is desirable for version upward. (Yoshitaka Kuwata, 2000/2/13)

2.4 performace

1. network
   At the interface test at Feb.13, the simulation environment (computers and network) seems to work as hard as possible even to simulate 1/10 model of Nagata ward. I think a network traffic team necessary to check what kind of packets are on the network. (Ikuo Takeuchi, 2/14)

2. kernel load:
   Think a fire occurs at a mesh. Is it sufficient to notify the fire to agents in the neighbor meshs ? The fire event should be announced more widely than 8m, especially for fire agents, vision range is insufficient for fire agents. The points that I think more important than the previous one are (1) the load in kernel seems to be high, and (2) fire agent can see only 8m ahead.

   At present, Kernel divides the simulated world into meshes with 10m grid, and calculates eight neighbor meshes around each agent at every step. It is better to program that the changes in the world should be notified from agents. Then there is no need for kernel to check eight neighbor meshes around an agent that says nothing. (Ikuo Takeuchi, 2/14)

3. event driven programming style is better than object based programming style :
   When several fires occur in a mesh, the events are sent respectively or together ? The events occurred in a mesh should be unified and selected according to the world model of kernel. Kernel will send the information to agents in farther mesh according to the model. For example, explosion event will be announced simultaneously to agent in wide range, while moving cars may be within a few meshes.

   In RoboCup rescue simulation where at most fires occurs at 10,000 points (the number of buildings), the event driven programming style requires less computation than agents based programming style by that a lot of agents look around every time. (Ikuo Takeuchi, 2/14)

3 Proposals to Version 1

3.1 Architecture

1. management of simulation time & separation of objects management: (Yoshitaka Kuwata, 2000/2/13)
   Kernel is divided into two modules, RT-scheduler and Command(Protocol)-Interpreter to reduce the amount of communication.

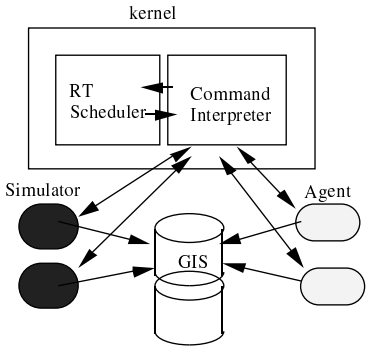


Figure 3: Division kernel's role into two modiles

   - Command(Protocol)-Interpreter
     Command-Interpreter will handle communication between agents and modules.
   - RT-scheduler
     Kernel will pass message to the GIS module with event driven scheduler. The basic flow is shown in fig 5.
     Event-Queue will be manipulated to gurantee the simulation,
     (a) limit the number of requests from agents,
     (b) give priority of events,
     (c) cut down the evens.

2. Management of distributed objects (Yoshitaka Kuwata, 2000/2/13)
   CORBA?

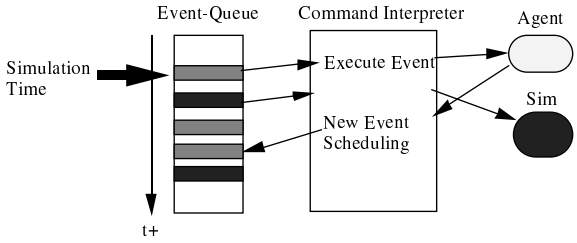


Figure 4: Model of event-driven simulation

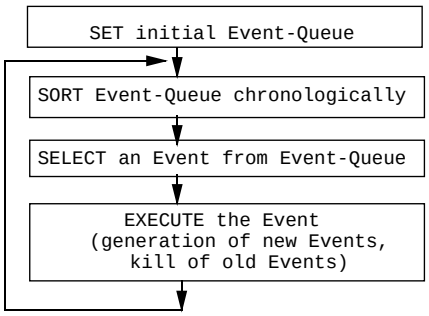


Figure 5: Basic handling of event-queue

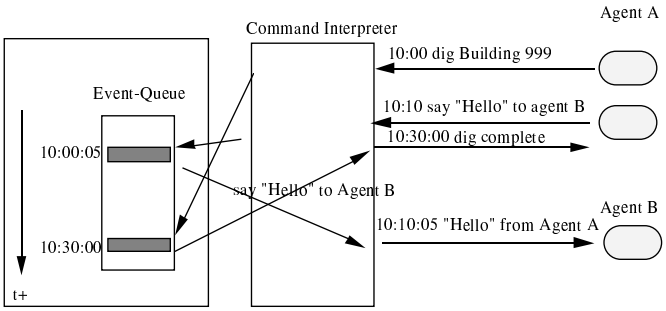


Figure 6: Communicaiton between agents via. Command Interpreter