

A System for Education by Visualizing Network Processing Based on Virtual Environment Software



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Recently the training of a network engineer is important, because the computer networks have been spread in society. TCP/IP is one of the most important knowledge for network engineers, but includes difficult fields for learners such as Internet layer and Transport layer. Learning these fields through books or lectures is not effective because such books or lectures cannot show many examples and cannot give actual feeling for the learners. One of the most popular methods to support this is network experiment that learners execute familiar telecommunication, for example sending mail and watching web pages, and watches packet contents by packet dumping program. This method is moderate effective because it can show many examples and give actual feeling. But this method has a few problems that learners cannot set experiment condition freely and learning information is difficult to understand. The reason for experiment condition is that a learner is not network administrator, and free network setting may cause network trouble. The reason for learning information is that packet dumping program shows only character based packet contents.

Therefore we have developed a learning support system following books or lectures. This system has two functions: One is that it can construct a virtual network freely. The other is that it enables learners to visualize network processing based on a telecommunication simulation result.

This system employs many Virtual OS User-mode Linux as virtual network machine to create a virtual network. User-mode Linux has two features such as light operation and open source software. In this system, learners can use virtual computer and virtual router which comes true User-mode Linux and virtual switching hub which comes true User-mode Linux tools to create network. By the way, User-mode Linux is controlled by many commands, and this fact is burden to learners. For this reason, we have developed GUI controller to control virtual network consisted of User-mode Linux and connected it

to User-mode Linux with pseudo-terminal.

Data for visualization comprise network processing records and telecommunication data in the Virtual OS. The required data is packet, routing table, packet construction and so on. These data are inside data of User-mode Linux, but User-mode Linux has no function to output these data.

Thus we have developed the function by changing the source code of User-mode Linux and utilizing a packet dumping program. When User-mode Linux execute telecommunication, packets are handled in network procedure which has routing table, ARP table, packet queue and so on. First, we have added “printk function” to every points of network processing in network procedure and have given processing record as parameters to that function. Usually “printk function” is used for kernel debugging, and outputs received parameter to debugging memory. Secondary, we have developed the program to acquire the data from debugging memory by using “sysctl function” used to control debugging memory. That program outputs the data got from debugging memory to “hostfs” which shares hard disk drive between User-mode Linux and OS hosted User-mode Linux. Thirdly, we have developed the program to acquire the packet data from network interface by “libpcap” used to packet dumping program, for example “tcpdump” and “ethereal”. This program watches network interface and output packets got from it to “hostfs”. In this way the system collects data for visualization, and generates learning information from it.