Proactnes II: Visualization for Next Generation Networks

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The voice telephony, video distribution, and data transmission services provided over independent legacy networks are being progressively integrated into Internet protocol (IP) networks by telecommunications carriers around the world. Each integrated next-generation all-IP network, which handles data for services having different quality requirements, will provide a multitude of services. Proactnes II is a system for supporting the operational management of network services by providing network visualization. It will contribute to the provision of safe and reliable services and networks. In this paper, we outline the network sensing, voice quality control, failure analysis, and dashboard technologies incorporated into Proactnes II.

1. Introduction

Telephony, video-distribution, and data-communications services have traditionally been provided over independent networks, but telecommunications carriers around the world aim to integrate these separate networks into an Internet protocol (IP) network. An integrated next-generation all-IP network (hereafter, next-generation all-IP network) will carry data having different quality requirements, such as real-time content typified by voice communications and bandwidth-consuming content like video delivery, so it will be able to provide many services of various kinds.

Providing safe and secure services via a next-generation all-IP network requires network "visualization" to enable operators to understand service quality, ascertain the state of provided services in real time, identify and respond quickly to the effects of service faults, and maintain high-quality services and network operations. Fujitsu is developing solutions for the operations management of next-generation all-IP networks through its Proactnes series[1] of solutions that already has a proven track record in the operations management of many commercial carrier networks.

In this paper, we describe some key technologies of Proactnes II for achieving the visualization of next-generation networks: network sensing technology, voice quality management and fault analysis technologies using sensor-derived information, and dashboard technology for achieving advanced network operations.

2. Network sensing technology

These days, the mainstream method of monitoring IP networks is agent monitoring in which information (about faults, traffic, etc.) stored by network equipment is collected by dedicated monitoring equipment and presented as an overlay on top of information portraying the network layout. A next-generation all-IP network features a mixture of services having different quality requirements, but the network equipment making up the IP network stores no information from layers above the IP layer despite the fact that such upper layers affect service quality requirements. Consequently, the agent monitoring technique cannot provide service quality visualization for a next-generation all-IP network.

In response to this problem, Fujitsu has developed a probe-type monitoring system. Its core functionality is made possible by network sensing technology, which enables the system to capture all traffic being transmitted in the IP network, extract information about traffic that deviates from the quality required for each service, clarify the origin and destination of that traffic, and detect quality degradation in each service. Fujitsu's system differs from the probe-type monitoring systems of other companies (**Figure 1**). Other companies' systems not only require the capture of all traffic, but also require a huge amount of disk capacity to store that information. Furthermore, to detect quality degradation in each service, they must search through all traffic data that has already been stored and extract data that deviates from the required quality of each service—a very time-consuming process. Fujitsu's system also captures all traffic, but it analyzes and detects quality degradation in each service in real time prior to data storage through the use of network sensing technology, so only the analysis results are stored. This approach significantly reduces the required disk capacity and enables service quality degradation to be detected in real time. Since it might also be desirable to have unprocessed traffic data saved during of the monitoring process the unprocessed data is given a structure that allows it to be accessed on a temporary basis and used for acoustic analysis (based on technology used for real-time detection of echoes and noise that can be picked up by the human ear). The structure of unprocessed data is extensible so that new services can be provided quickly.

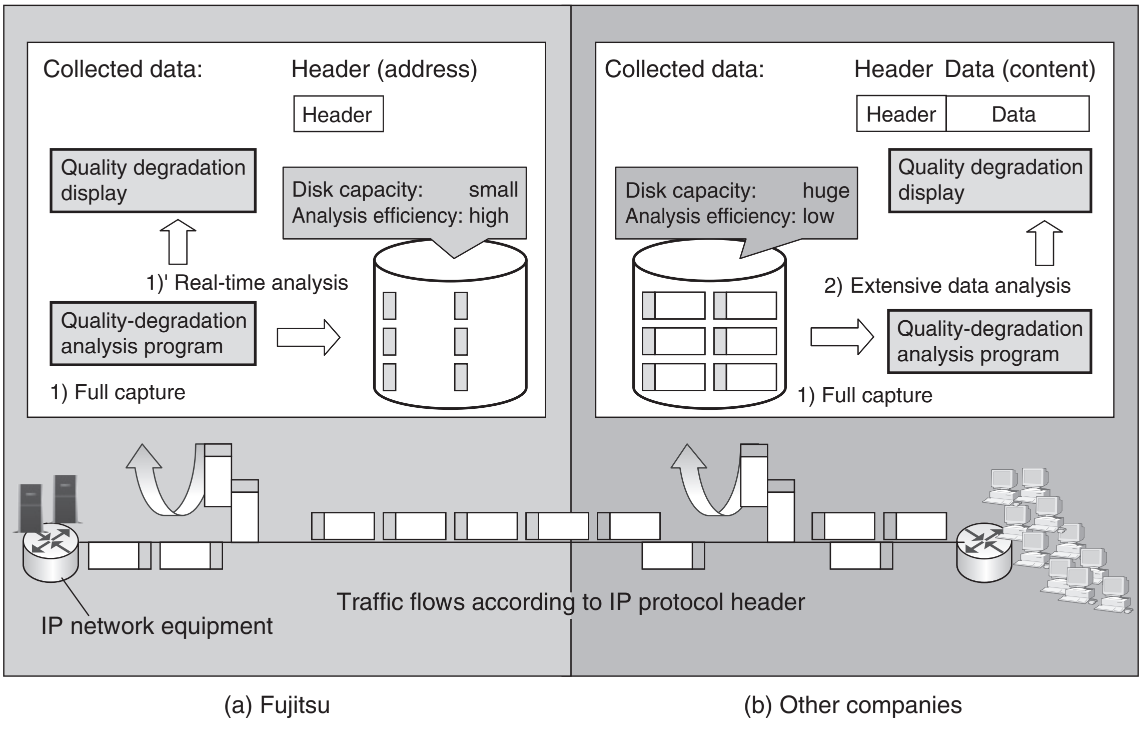


Figure 1
Difference on probe-type monitoring systems.

3. Voice quality management technology

In existing voice communication networks, voice quality is monitored by switches, and voice quality management is achieved by evaluating their alarms. In next-generation all-IP networks, the fact that call-control traffic and voice traffic will have different transmission paths means that voice quality management cannot be achieved by monitoring performed at switch servers. Fujitsu will achieve voice quality management in next-generation all-IP networks by analyzing the information obtained by its probe-type monitoring system in real time.

The distribution of probe-type monitoring devices for the IP Multimedia Subsystem (IMS) architecture based on the 3rd Generation Partnership Project (3GPP) is shown in **Figure 2**.[2] Here, an active probe-type monitoring device is installed at each carrier office and a passive probe-type monitoring device is installed at each location where user traffic can be collected such as the interrogating, serving, and proxy call session control functions (I-CSCF, S-CSCF, and P-CSCF) to capture all user traffic. Furthermore, the Proactnes II Integrated Manager is deployed centrally to manage the state and measurement results of the probe-type monitoring devices. The information obtained by the passive probe-type monitoring devices is subjected to real-time analysis at the voice-protocol (call) level as opposed to the IP-packet level. This makes it possible to display the traffic density for adjacent servers, individual telephone numbers, and each fault factor and to identify suspicious locations and surmise the extent of impact at the time of a network abnormality. The above technology can reduce the man hours needed for operating and maintaining a next-generation all-IP network.

In addition, the analysis results obtained

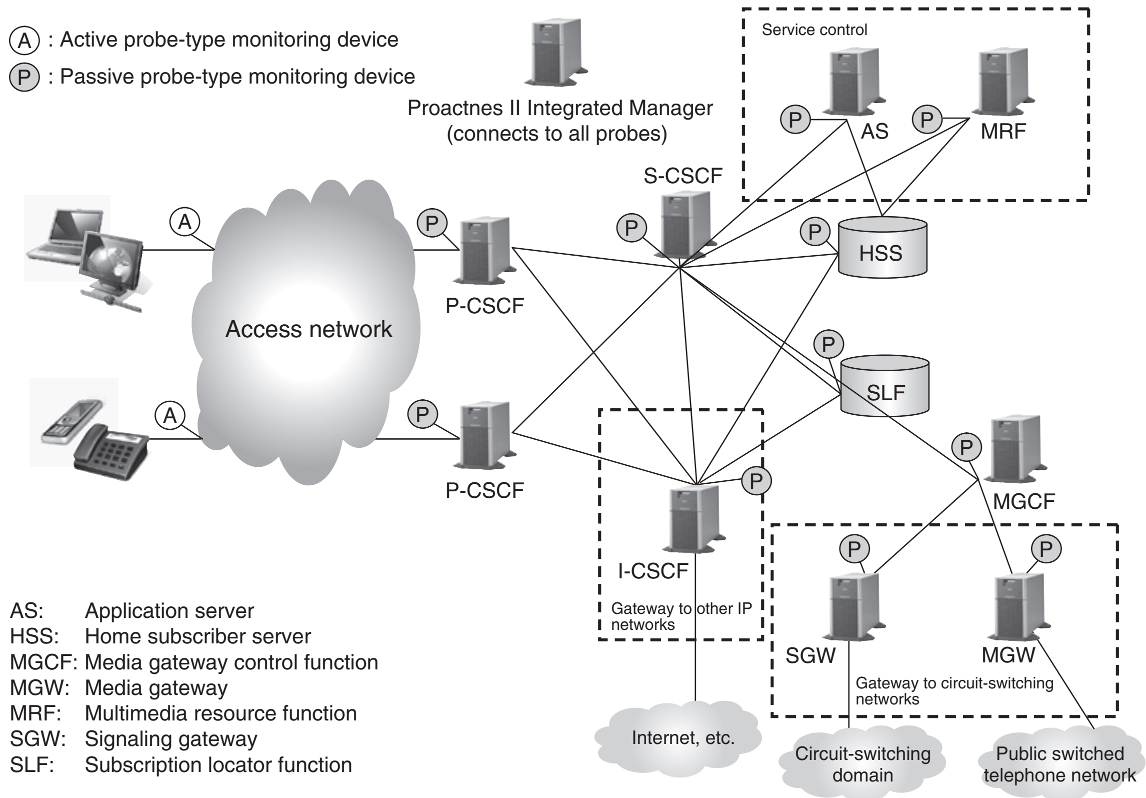


Figure 2
Distribution of probe-type monitoring devices.

from passive probe-type monitoring devices can be used by active ones as a basis for transmitting and receiving pseudo measurement packets within a carrier's office or between carrier offices. In this way, the system can comprehensively observe measurement results between various communication bases and make a more accurate inference about faulty points, and it can measure the R-value (conforming to Recommendation G.107 of ITU-T [International Telecommunication Union, Telecommunication Standardization Sector] and standard JJ-201.01 of Japan's TTC [Telecommunications Technology Committee]), which indicates user perceived quality in real time.

4. Fault analysis technology

The next-generation all-IP network has an important social role to play in providing advanced and diversified services. It can be used to achieve rapid penetration of IP telephony, video delivery, and other advanced services, but at the same time, it could increase the impact that network problems can have on society. In conventional networks, network equipment itself detects alarms, and the occurrence of an alarm prompts the system to switch to a backup network to maintain services and restore faulty equipment. However, there is also the possibility of "silent alarms" in which no alarm is sounded by the equipment despite the occurrence of a fault. This can prevent the system from switching to a backup network, with the result that services suffer an interruption. Furthermore, silent alarms may cause a single fault to propagate to other equipment, giving rise to multiple faults for which faulty point identification and equipment restoration will take even longer. Such an advanced, complex network must be managed appropriately so that network faults can be detected and dealt with at an early stage.

Three processes are required to identify faulty points: 1) visualization of routes taken by IP packets, 2) detection of deterioration or interruption of IP-packet-based services, and 3) comprehensive identification of faulty points. However, in a next-generation all-IP network that is continually developing and expanding, the route taken by IP packets changes from one moment to the next, and it is difficult to determine the route on which service deterioration or service interruption is occurring. Fujitsu has created a fault analysis system that can follow changing routes and achieve early detection and handling of faults through the use of probe-type monitoring devices.

The visualization of routes taken by IP packets is outlined in **Figure 3**. Here, network sensing based on passive probe-type monitoring devices is used to gather up link-state advertisement information on an open shortest path first network, and route information analysis makes it possible to compute and visualize the links and routes throughout a next-generation all-IP network.

Next, to detect deterioration or interruption of IP-packet-based services, the system uses active probe-type monitoring devices to perform path-verification (ping) tests with actual traffic on an end-to-end basis. This reveals routes that fail the ping test or ones on which transmission and service quality are degraded.

Finally, to achieve comprehensive identification of faulty points, the system first marks a route link table with visualized route information and the ping-failed and quality-deteriorated routes detected by active probe-type monitoring devices, and then, through topography analysis, identifies segments with quality problems (**Figure 4**).

In conventional topography analysis, the computational cost increases in proportion to the square of the number of end routers, which makes it necessary to use a high-performance server or distributed processing on multiple servers. Moreover, route abnormalities are calculated by majority decision logic, so duplicate faults can go unidentified. In contrast, Fujitsu's system

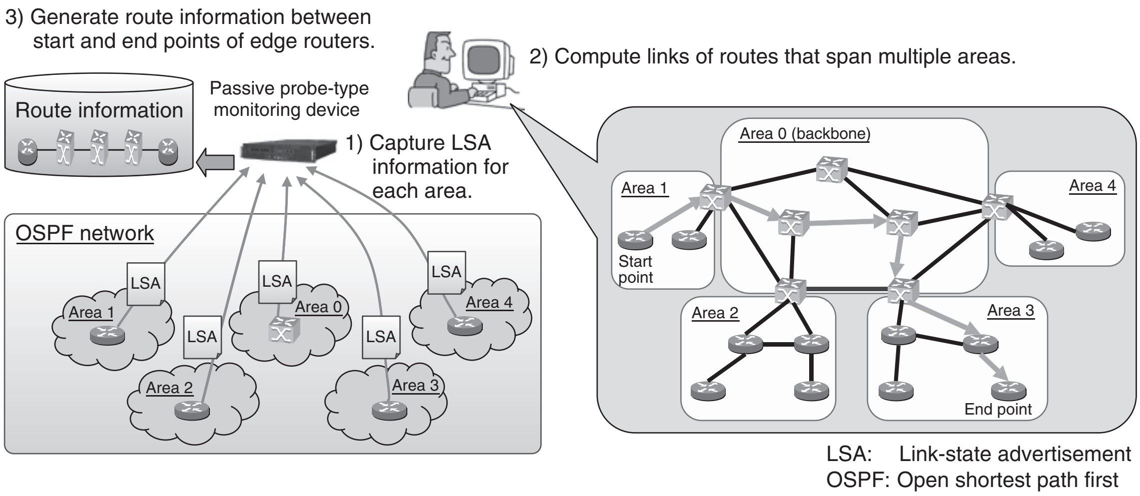
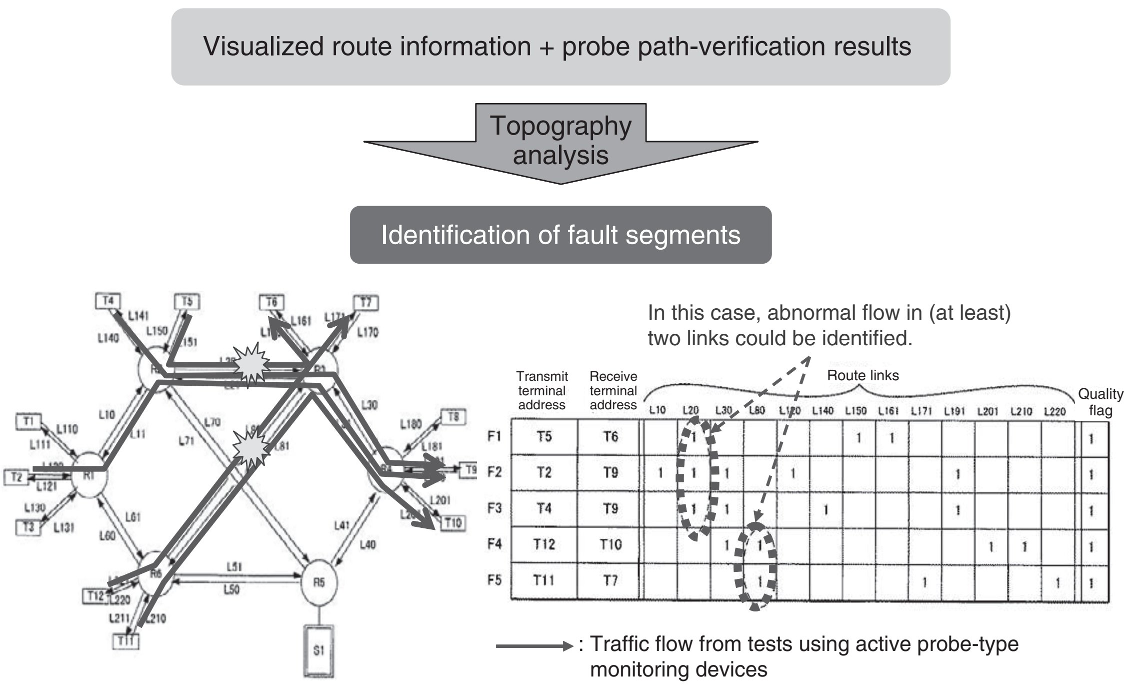


Figure 3
Visualization mechanism of topology and route information in OSPF network.



	Transmit terminal address	Receive terminal address	L10	L20	L30	L80	L120	L140	L150	L161	L171	L191	L201	L210	L220	Quality flag
F1	T5	T6		1					1	1						1
F2	T2	T9	1	1	1		1					1				1
F3	T4	T9		1	1			1				1				1
F4	T12	T10			1	1							1	1		1
F5	T11	T7				1					1				1	1

Figure 4
Identifying faulty point from visualized route and path-verification result.

identifies abnormal routes from the transmission results for actual traffic. Consequently, its performance is more than ten times that of conventional topography analysis and it can identify faulty points in real time without missing any faults.

5. Dashboard technology

A next-generation all-IP network that is becoming increasingly complex and growing in scale will have faults that are likewise more complex in nature and larger in scale. Accordingly, to minimize downtime, operations managers must be able to isolate the causes of faults and the points where faults are occurring by intuitive operations. In other words, the problem here is how to visualize quality management information collected from the network in a form conforming to on-site operations management scenarios. However, an operations management scenario is an accumulation of various kinds of on-site know-how, and what is needed is the ability to customize this visualization on the basis of conversations with operators and not on the basis of a single format. In short, we need a mechanism that can develop operations screens quickly and inexpensively.

In Proactnes II, individual screens are called "gadgets", and the use of a dashboard architecture consisting of a platform section common to all gadgets provides both flexibility in customization and fast, low-labor development. The key mechanisms of this platform section are for managing common variables and controlling events, as shown in **Figure 5**.

5.1 Common variables management

When the user modifies a certain variable via a certain gadget, this mechanism reports the change to other gadgets registered for that variable. For example, if the date/time variable of gadget A is modified, the platform section notifies other gadgets that have declared that they use that variable (here, gadgets B and D) of that change. As a result, gadgets B and D both perform individual processing based on that modified variable.

5.2 Event control

This mechanism controls events that span multiple gadgets. For example, if it detects that gadget A has been double-clicked, it will activate the window for gadget B based on settings made beforehand. In this way, the platform section uniformly controls the behavior that takes place

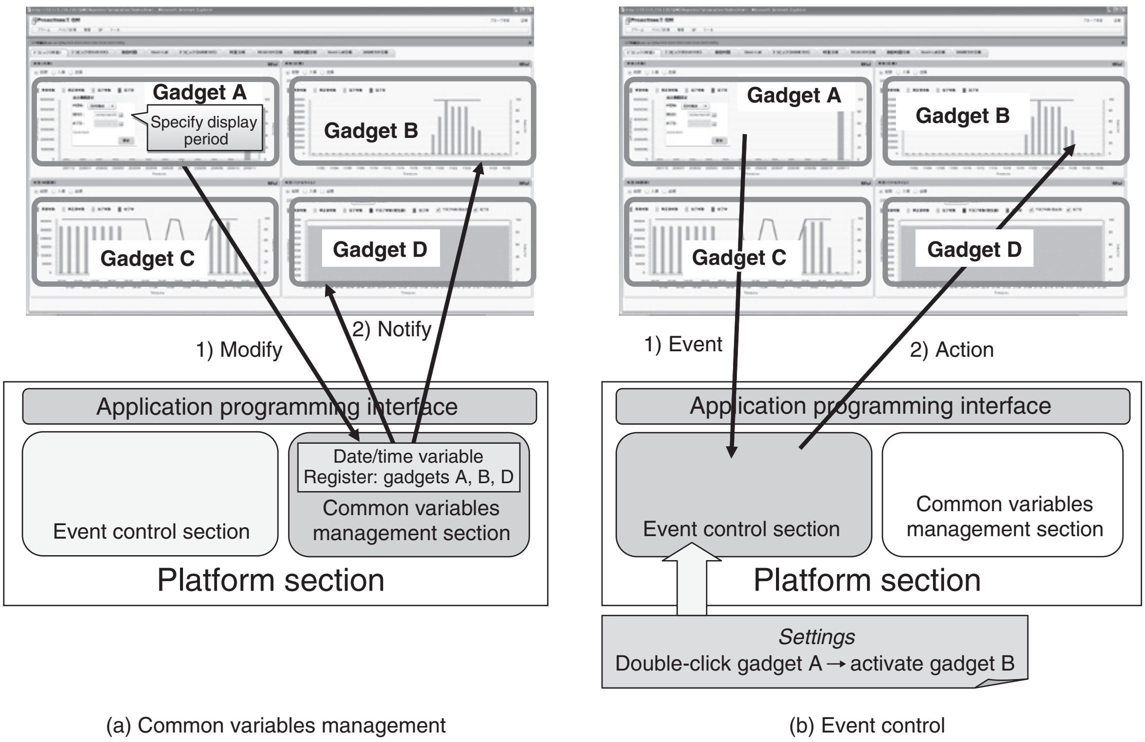


Figure 5
Common variables management and event control.

among gadgets, and each gadget itself performs only closed processing. Thus, gadgets can be reused and an application-service-provider-type of business can be developed. Looking forward, the plan is to enhance and release the application programming interface of the platform section in this dashboard architecture to allow customers to develop their own gadgets.

6. Conclusion

Proactnes II meets an urgent need for visualization of next-generation all-IP networks. As telecommunications carriers around the world work to integrate existing networks into IP networks, we can expect both services and the demands on network operations management systems to diversify. To deal with these changes, we will continue to develop network operations management technologies in the Proactnes series of solutions, which we see as evolving into an operations system that can support the creation of new business fields and respond quickly to customer needs.

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