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JaNI: JGN's Next Generation Network Information System

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Abstract **Traditional NICs (Network Information Centers), mainly a byproduct of the main stream networking operations have, to date, played a passive role. There has been neither a well defined vision or purpose, except for where it has been involved in the (commercial) operations directly, nor has there been the breadth of coverage which can aid or assist researchers and common-folks alike. We believe that a generation change is required in the concept of NICs. In this work we present the results of our work on a next generation network information system, its requirements, design, and operation. We discuss the depth and coverage of the system and explain how this system will aid in bridging the information divide, assist in research and development and, in network participation.**

Key words **N ext generation network infomation center, High resolution traffic monitoring, Network Management in the large. Network information warehouse.**

1. Introduction

The Internet has revolutionized the ways in which information is generated, processed, accessed, and distributed. Traditional NICs (Network Information Centers) have, to date, played a passive role in this context. The NIC has been mainly a byproduct of the mainstream operations. There has been neither a well defined vision or purpose, except for where it has been involved in the (commercial) operations directly, nor has there been the breadth of coverage which can aid or assist researchers and common-folks alike. We believe that a generation change is required in the concept of NICs. In this work we present the results of our work on a next generation network information system, its requirements design, and operation. We discuss the depth and coverage of the system and explain how this system will aid in bridging the information divide, assist in research and development and, encourage network participation.

2. The Japan Gigabit Network (JGN)

The 5-year, 57.3 billion yen Japan Gigabit Network (JGN)[1] of the Ministry of Administrative affairs is a prestigious national project that aims to spur research and development in next generation networking technologies and applications. It comprises of a very high-speed optical fiber backbone that spans the length and breadth of the country and connects all the major cities.

The network is open to the public for research and development purposes. A large number of research projects/ experiments/ demonstrations are being carried out using the state of the art networking facilities provided by JGN. Interestingly enough, the activities are not limited to networking technologies and communications systems. It covers a wide spectrum *including electronic commerce, related support systems,* public policies. legal systems, public events, entertainment, education, medicine, frameworks, industry strategies and user expectations.

JGN provides traditional network information service via its Champion system [2]

3. Requirements for a next gene ration NIC

The next generation network information service will need to be multifaceted. It will need to cater to information requirements of all people. The information requirements may be categorized as follows

- *Administrative* - information related to the operations and management of the network.
- *Technical* - information related to the connectivity, operations, performance, faults and maintenance of the network.
- *Social* - information related to the social aspects of the network.
- *General information* - the information that should be available and may be sought by the man on the street, The purpose of the network, the sponsors, the relation to people etc.

4. Outline of JaNI

JANI is JGN's Network Information system. It has the following components.

4.1 Data Collection

This is one of the most important functions of JaNI. The underlying principle of JaNI is that it is single window clearinghouse for all information. For that purpose JaNI's data collection system accesses or interfaces with every possible data source. In some cases the collection is in batch mode and at predefined intervals (daily, hourly, every ten minutes, etc.). In other cases it is online where the data collection directly interfaces with the data sources (network elements).

The data that is presently handled by JaNI can be categorized as follows:

Administrative Data: Project name, description, manager, region, assignments e.g. VP number, VC number, bandwidth, quality of service parameters etc belong to this category.

Operational Data: This is the raw data about the operations that is generally of interest to the network administrators, operators and researchers.

Performance Data: For network administrators, planners, managers and researchers, the interest more likely than not stretches beyond the current data. Past data is of paramount importance in understanding the networks performance, operation and utilization. For this purpose JaNI has an elaborate data archiving mechanism.

4.1.1 Network Monitoring Protocol

The raw data is obtained by directly interfacing with the network elements in a heterogeneous environment. Needless to say, the primary information access protocol needs to be a standard one. JaNI uses SNMP as the access protocol. The underlying network protocol may be IPv4 or IPv6 - JaNI supports both IPv4 and IPv6 network protocols.

4.1.2 Monitored Network Information

Multi-layer: The information of interest will widely vary depending on the purpose of the user. Some may be interested the number of cells in the link layer, others may be keen to know the number of connections at the transport layer. JaNI supports monitoring of all layers.

Multi-protocol: JGN will be supporting various protocols IPv4, IPv6 etc. Presently JaNI provides not only access to multi-protocol devices, it also provides information on the protocol stacks of these devices.

4.1.3 DataCollection Periodicity

There are two types of data collection mechanisms built into JaNI. These are explained below.

Routine Data Collection: Routine polling and archiving is carried out for the parameters of general interest on all the network elements of significance. The periodicity of the polling varies from intervals of 10 minutes to intervals of 1 minute.

On-demand data Collection: Depending on the special interest of researchers, short term on-demand data collection may be carried out by JANI. The node and managed object to be polled, can be specified by the user. JaNI supports two modes of polling.

(a) Coarse resolution: For intervals of 1 minute and above.

(b) High resolution: For intervals ranging from several microseconds to several seconds. But this polling is possible only at places where the specially developed High Resolution Traffic Monitors (HRTMs) [3] are deployed. In the following subsection we discuss about precision measurements in JaNI..

4.2 Precision measurements in JaNI

Taking traffic dumps and handling it offline to obtain the desired information is a regular practice among network researchers[4][5][6][7]. Among the online

measurement efforts the general focus has been on creating a scalable architecture [8] and on distributed management [9][10][11]. NeTraMet[12] has focused on traffic metering and flow monitoring. There has not been much work on improving the resolution of online measurements.

4.2.1 Definitions

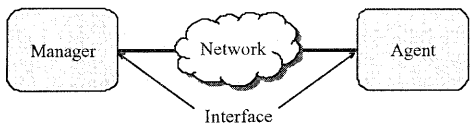

Fig. 1 Definitions

Manager: The entity that is carrying out the investigation by sending out queries.

Agent: The entity that has the information about the network traffic.

Network traffic: The traffic generated in the network by the applications and services that are operating on the network.

Management traffic: The traffic generated in the network by management applications. Note that management traffic is part of the network traffic.

Operational traffic: This is the network traffic minus the management traffic

Interface: The entity through which a network element connects to the network. Network traffic flows through an interface. This traffic includes operational traffic as well as management traffic.

Resolution of traffic measurement: Packets arrive at the interface at some random inter-packet intervals. These packets are observed by the agent, and some counter is updated. Though the counter may be updated in real time, as and when a packet arrives, the observation of the counter is carried out at discrete and often regular intervals. We define the resolution of the traffic measurement as the smallest interval at which the traffic counter is observed. Fig. 2 shows the effect of resolution on the measured traffic profile.

4.2.2 The issues involved in precision measurement

In [3] the issues related to precision measurements have been discussed. The polling

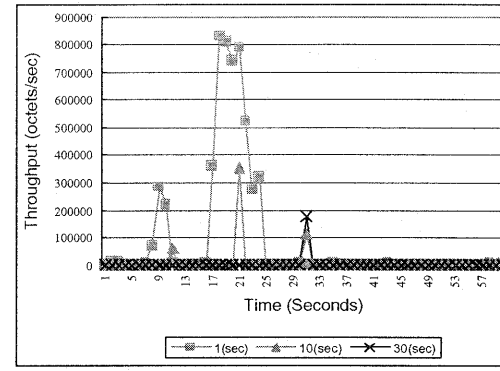

Fig. 2 Traffic Profile and Resolution

interval has an impact on the overall performance of the network elements hosting the polled agent, on the management traffic in the network, and on the performance of the manager itself. They have shown that there is a limit on the number of queries and responses that a manager can process. To over come the difficulties they have proposed

(a) Fetching the data, in bulk or, in a semi-online manner. Essentially, it envisages collecting information about several observations in a single query. This translates to lesser number of query packets and consequently- reduced packet processing overheads at both the manager and the agent ends and, lesser protocol header overhead (lesser bandwidth consumption).

(b) Using compression techniques to save on bandwidth, to avoid fragmentation and, to work with packets as small as possible. Data compression reduces the size of payload in the packet but it introduces extra processing overhead at both the manager and the agent end.

HRTM probes implementing the above technology are deployed in the JGN and provide high resolution traffic information on demand.

4.3 Data Processing

Significant effort has been put into processing the raw data collected to produce value added information. The data processing is important as it analyzes the data in

various contexts and generates various points of views. The various contexts are as follows:

- Administrative context: The utilization of the links, the spectrum of the projectsand participants the span and activity of each project.
- Communications research and development context: This concerns the, traffic, bandwidth, QoS parameters, congestion status, protocols used.
- Geopolitical context: The impact of the network in the different regions of the country, traffic vs population, traffic vs. region.
- Social context: The various projects that are being carried out on the network their impact and relationship to the respective regions. The relationship between regions and the projects (the research/application area).
- Network Context: The network backbone, the NOCs, the connectivity information and status. The connections between JGN and organizations. The network by region, by organization by project. The paths and channels that connect applications. In the case of JaNI this information is generated dynamically from the latest available information.

4.4 Data presentation

The data presentation is treated with great care. Everyday metaphors are used to utilize the familiarity to narrow the gap between users and the system. Wherever possible geographical and network maps are used. A "Weather map" is used to depict the traffic utilization of the entire Gigabit network.

4.5 Access control

The JaNI has access to a vast amount of information and not all of it can be made accessible to anybody and everybody. There is an elaborate access control mechanism in place whereby administrative policy related to information access can be enforced. It essentially uses secure protocols for authentication purposes. Presently there the three groups of users viz. administrators who have access to everything, researchers who have access to detailed information related to their respective projects and general public who has access to general information.

4.6 The user interface

A significant aspect of JANI's user interface is that it tries to be as knowledgeable, friendly and helpful as possible and does not assume that the user is knowledgeable technically or non-technically. Thus researcher or not, if one needs to view the traffic of one's project one needs to know the project name not the VPI or VCI or the switch name and address. In case the user does not know the name of the project the user can browse the regions and from the participating organizations and thence the projects of the organization of interest.

5. JaNI in operation.

In the following we describe some of the major features of JaNI.

5.1 Project network map

The JGN network forms the backbone for several projects. Participants of a project can see the network configuration related to their project using JaNI. The following figure shows the network map of one such project. This "project network map" forms a useful starting point for further queries related to the network. The network connectivity aspects of the map are updated dynamically[13] and is itself presented in the geographical context.

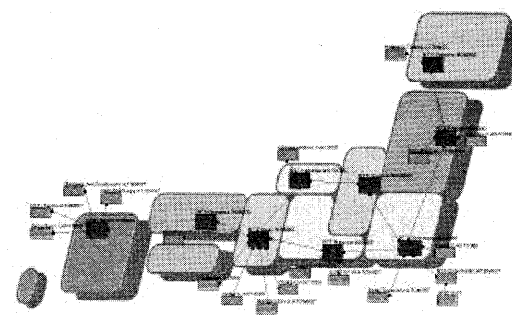

Fig. 3 Project Map (JB)

5.2 Project traffic information

An interested user may just click on some part of the network to see the traffic in that part of the network. The

user may chose to see the current traffic or historical traffic.

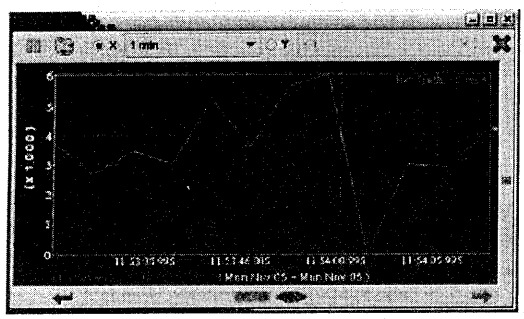

Fig. 4 Project traffic information

5.3 JGN Projects: Distribution

5.3.1 JGN Projects: Region-wise distribution

From the administrative point of view, to evaluate the impact of the JGN project on the various regions of the country it is necessary to have a birds eye view of the participation in the JGN project. One measure of the participation is the number of JGN-related projects that are reaching a region. Fig. 5 shows the graph shown in JaNI. JaNI provides a daily update of this figure based on the previous days administrative information.

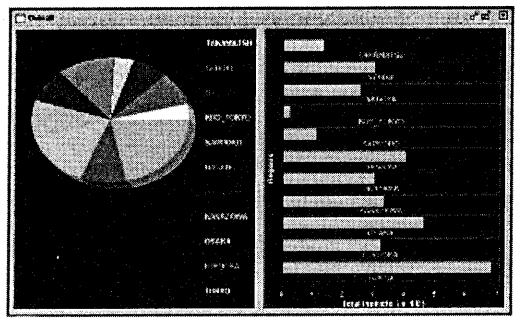

Fig. 5 Region-wise distribution

5.3.2 JGN Projects: Distribution by Research areas

Fig. 6 shows the JGN acticity from the areas of interest point of view. This graph is also updated on a daily basis. From this graph, researchers, demographers and administrators can understand the reach of the network among the various research communities. JaNI provides a daily update of this figure based on the previous days administrative information.

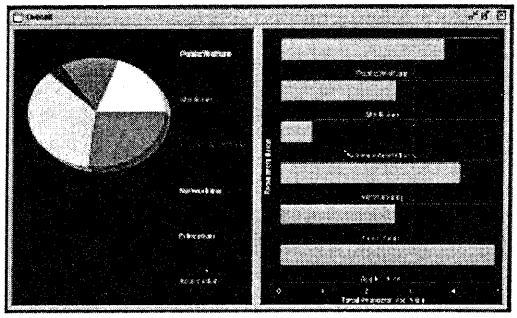

Fig. 6 Distribution by Research areas

5.4 Weather map

From the administrative and operational point of view it is important to have a birds-eye view of the current of operational state of the JGN network. This is nicely done in the "Weather Map" provided by JaNI as shown in Fig. 7. It shows a snap shot of the traffic in the backbone links of the JGN. This snapshot is updated at regular (default 10 minute) intervals.

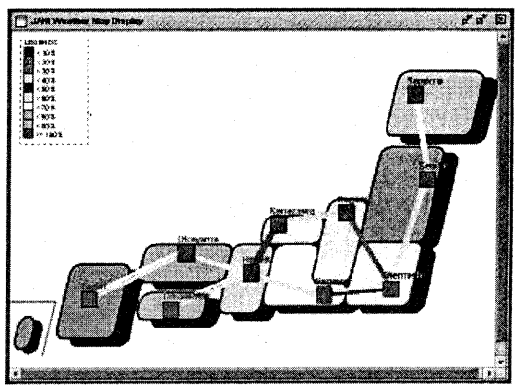

Fig. 7 The JGN Weather map

5.5 General information

For an interested person, JaNI provides several general information leads. The list of projects by geographical regions Fig. 8 and list of projects by research area Fig. 9 are two such examples.

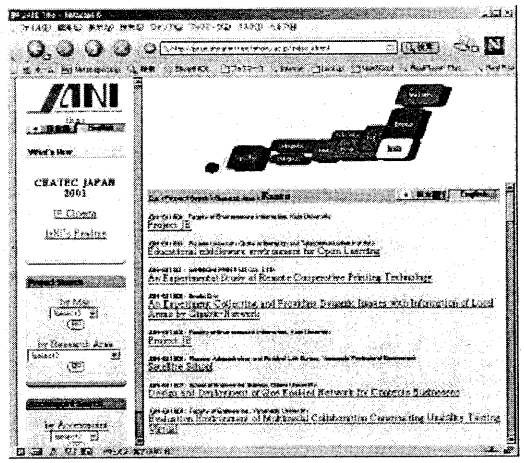

Fig. 8 List of Projects by region

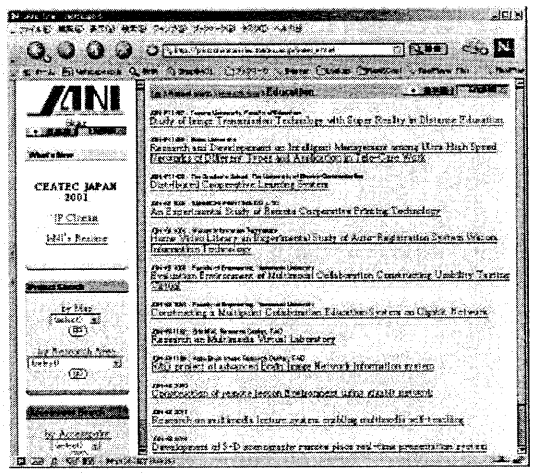

Fig. 9 List of Projects by Research areas

5.6 Project high-resolution traffic information

The ordinary traffic information available are in intervals ranging from a few seconds to several minutes and may not serve the purpose of a communications researcher or network engineer investigating occasional packet losses due to bursty traffic in the network. The High resolution network traffic information may be accessed gainfully in such cases. Of course, this requires that an HRTM probe is present in the right place for this purpose. Fig. 10 shows the the high resolution traffic from one such probe.

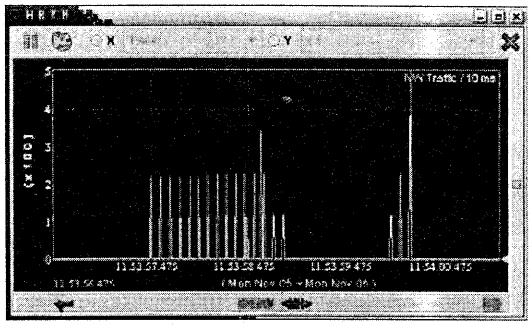

Fig. 10 High-resolution traffic information

6. Comparison with other Network Information Services.

JaNI is a new genre of proactive network information service. Its features are radically different from existing network information services and related projects. We have compared some of the features of JaNI with the those of some of the well known systems and services in Table. 1. JaNI stands out for its online, real-time, high-resolution information services.

Table. 1 comparison

	Traffic Information		On-line User Interface	On-demand Information Collection	Resolution	Other Information
	Real-time	Historical			High Mid. Low	
CAIDA CoralReef	x	○	x	x	(milliseconds)	○
MAWI Repository	x	○	x	x	(milliseconds)	x
MRTG	△ (every 5 minutes)	△ (aggregated info)	△ (for professional)	x	(30 seconds)	x
Champion	x (every 24 hours)	○	△ (for professional)	x	(10 minutes)	x
JaNI	○ (at few seconds intervals)	○	○	○	(milliseconds)	○

7. Conclusion

We presented our work on a next generation network information system that caters a wide spectrum of information to a wide spectrum of people. Technically, it offers online data from remote probes, on demand, using standard protocols at millisecond resolutions. We believe

that this feature is not matched by any other system and that the technology opens up a new possibility in network research and development. From the social point of view, the information that is being presented is likely to catalyze the awareness of people about the network itself bringing about greater participation and more ideas and applications. From the human angle several novel ideas have been incorporated to make the system intuitive, and friendly.

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