Radio Network Control | IP | Capacity Expansion

Technology Reports

3rd Generation Radio Network Control Equipment Realizing Further Capacity Expansions and Economies

Communication traffic volumes are increasing year by year impacted by flat-rate tariff plans for packet access and other factors. Against such a background network facilities are having to cope with this trend and so larger-capacity equipment and economization are anticipated. We have developed an E-IP-RNC that realizes further capacity expansion and cost reductions taking advantage of recent improvements in the general-purpose hardware used in existing IP-RNCs and the addition of new functions to its software.

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1. Introduction

It has become necessary in recent years to expand the capacity of network equipment due to the increase in communications traffic as a result of flat-rate tariff plans for packet access and increase in large volume contents such as video. It has also become necessary for all radio network equipment to be IP-based, as exemplified in new services such as femtocell[*1] using general-purpose IP circuits, and in the adoption of general-purpose hardware to achieve cost reduction.

The Enhanced-IP-Radio Network Controller (E-IP-RNC) was put into service in September 2009 as the expanded-capacity version of the IP-RNC[*2] which was introduced in April 2006 [1].

The network connection configuration of the E-IP-RNC is shown in **Figure 1**. In addition to the IP-based interfaces with the IP-Base Transceiver Station (BTS) (Iub[*3]) , the IP-RNC, the peer E-IP-RNC (Iur[*4]) and the core node (Iu[*5]) equipped also in the existing IP-RNC, it has an Asynchronous Transfer Mode (ATM)-based interface.

This article describes the purposes of introducing the E-IP-RNC, its equipment architecture and its software control technologies.

2. Background and Objectives of E-IP-RNC Development

We have succeeded in expanding the E-IP-RNC's capacity by adopting high-performance general-purpose hardware. In addition, reliability has been secured by taking various measures such as strengthening tolerance in the equipment against signal bursts[*6]. Furthermore, by guaranteeing network quality through the adoption of common hardware and software in the E-IP-RNC and the current IP-RNC, further effective development of enhanced services in the IP-RNC and E-IP-RNC in the future is made possible. Specifically,

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*1 **Femtocell**: A very small area with a radius of several tens of meters covering homes and/or small shops.

*2 **IP-RNC**: 3G node that performs functions such as radio resource control. Developed based on IP technologies and has IP and ATM interfaces.

*3 **Iub**: Logical interface between BTS and RNC defined in 3GPP standards.

*4 **Iur**: Logical interface between RNCs defined in 3GPP standards.

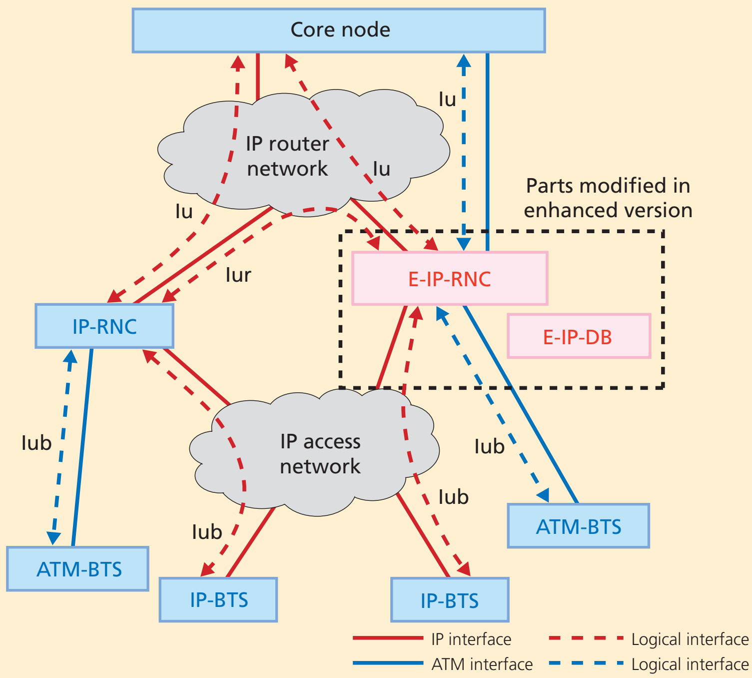


Figure 1 E-IP-RNC network connection configuration

regarding the hardware all the cards were made common except for the general-purpose Single Board Computer (SBC). As for the software, common general-purpose middleware and applications were adopted using OS compatibility functions. When expanding the network to cope with the increasing communication traffic, the E-IP-RNC will enable us to reduce network equipment introduction costs by more than 20% and will allow us to make big cost savings.

3. Equipment Architecture

The basic configuration of an E-IP-RNC is shown in **Figure 2**. New hardware was introduced for three types of cards, i.e. File Server (FS)[*7], Call Processing unit (CLP)[*8] and Resource Management Processor (RMP)[*9] (**Photo 1**). Other hardware is common with the current IP-RNC. Although the equipment capacity is doubled, the E-IP-RNC is implemented with three racks instead of two in the case of the current IP-RNC because the numbers of some of the cards remain the same even though the capacity is enlarged. Also, in order to enable the introduction of new hardware, functions were added to the ATM interface, the IP interface and the trunk part.

3.1 Functions for Smoothing Signal Processing

The performance of the hardware newly introduced in certain parts of the E-IP-RNC is significantly higher than that of hardware mounted on the current IP-RNC. Because the rest of hardware has the same performance as that in the current IP-RNC, it is necessary to have a function to absorb the performance differences between the high performance hardware and the conventionally performing hardware. In particular, because the new hardware has higher processing power, its signal output speed towards conventional hardware is increased. Therefore, firmware has been added to the conventional hardware so that reliable equipment operation can be maintained even after equipment capacity is increased. Specifically, tolerance against bursty signals is achieved by smoothing the received signal in the card by which stable operation is guaranteed even when there is a sudden change in traffic levels following the expansion in equipment capacity.

Efficiencies in development and production are enhanced through the adoption of common hardware in the IP-RNC and the E-IP-RNC. However, the number of cards increases as the maximum number of accommodated users increases, and therefore signaling between the chassis tends to increase. Nevertheless, the racks accommodating the cards and the Layer 2 Switch (L2SW) transferring signals between the chassis remain the same and since they have performance limitations, signals travelling between the cards have to be

*5 **Iu**: Logical interface between RNC and Mobile Switching Center (MSC) which is the circuit switching equipment, or between RNC and Serving General packet radio service Support Node (SGSN) which is the packet switching equipment as defined in 3GPP standards.

*6 **Burst**: Phenomenon where a multitude of signals get concentrated instantaneously in one part of an equipment.

*7 **FS**: Card that mainly has the function of managing files and interfacing operation system.

*8 **CLP**: Card that mainly has call processing functions.

*9 **RMP**: Card that has the function of managing common resources within the equipment.

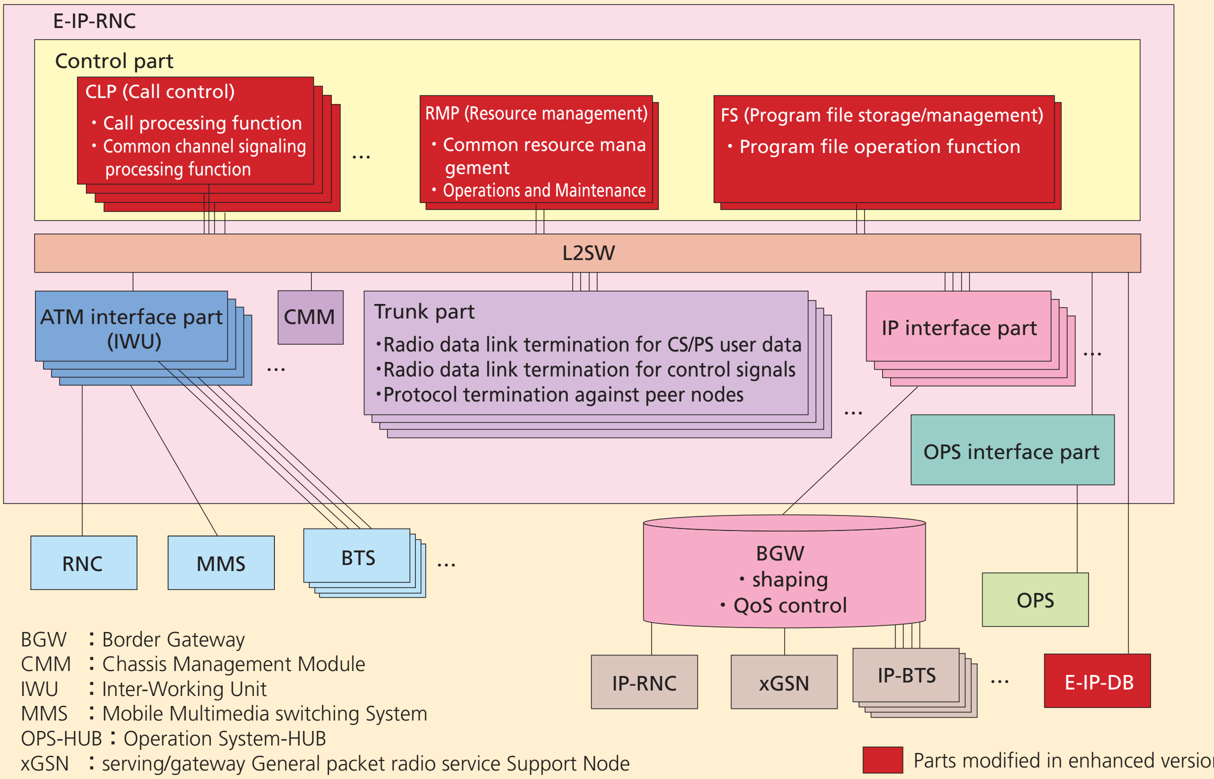


Figure 2 E-IP-RNC hardware configuration

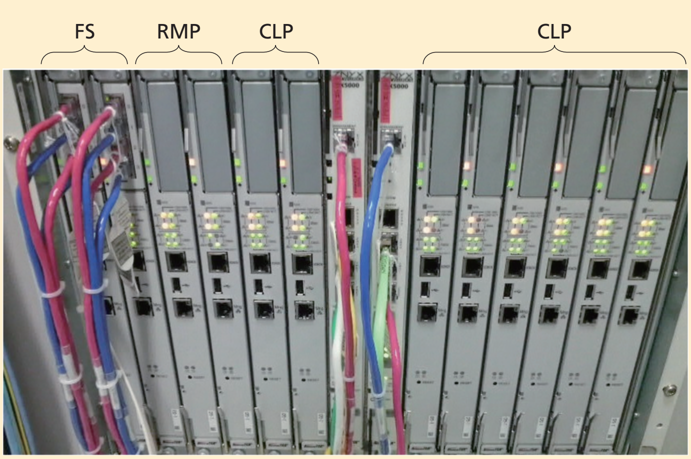


Photo 1 FS, RMP and CLP cards

reduced. Despite this, it is not possible to simply discard or suppress signals and therefore a function was provided to reduce signals of the same type within the permissible limits of the system so that there will not be problems even if some signals are delayed due to suppression. This function allows for trouble-free signal processing between the chassis and between racks.

3.2 Functions to Further Increase Reliability

In order to detect silent failures, i.e., failures that cannot be detected by the hardware itself but which impact service to the users, failed cards are discovered through maintenance work such as switching to standby or the plugging-in and unplugging of cards. Because the number of cards has increased due to the enlarged capacity, the number that needs to be checked through maintenance operations has also increased. This raises the anxiety that fault localization becomes more difficult and that once a failure occurs its impact will be large. In order to solve this issue statistical correlation between the impact on users and the hardware was studied and the following functions have been introduced to autonomously locate the fault when a silent fault is judged to have occurred.

- Function to localize suspected faulty points in chips that handle the same processing on a card
- Function to localize a suspected faulty card from those that have the same function
- Function to localize suspected faulty points by periodically monitoring traffic and detecting any abrupt traffic changes

Mounted on the system, these functions contribute to early fault detection and reliability improvement. They also contribute to the reliability of the entire RNC because they have also been introduced to existing IP-RNCs.

4. Software Architecture

The software architecture of the E-IP-RNC is shown in **Figure 3**.

The OS adopted is a later version of Carrier Grade Linux (CGL)*10 which is also used in the current IP-RNC. The basic middleware which is commonly used in other advanced Telecom Computing Architecture (aTCA)*11 equipment such as core nodes has been modified to take into account the differences in the CGL version. The general-purpose middleware specialized for use in the RNC and the application software which is unique to IP-RNC both utilize common source files with the current IP-RNC in order to improve efficiency. They build Load Modules (LMs) corresponding to each environment using the compile options (**Figure 4**).

4.1 OS Compatibility at Basic Middleware Level

Because the version of CGL used as the OS of the E-IP-RNC is 64-bit-based, we need to solve the OS compat-

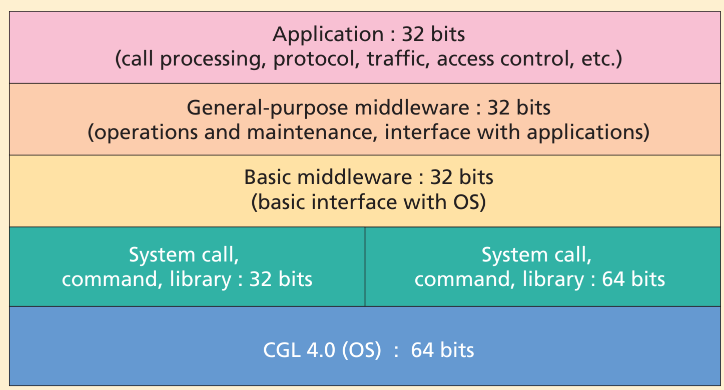


Figure 3 Software architecture

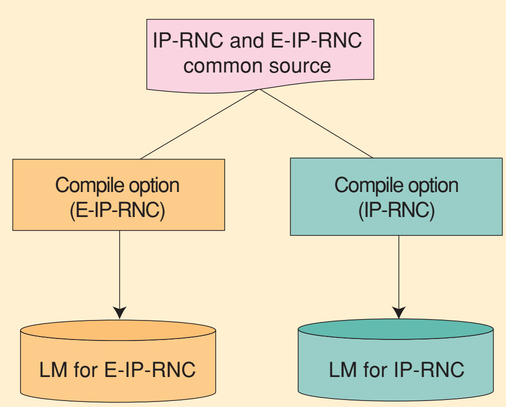


Figure 4 LM building by IP-RNC/E-IP-RNC

*10 **CGL**: High performance Linux applicable to communication business specified by Open Source Development Labs (OSDL), an organization promoting the application of Linux, a Unix®-based OS, to businesses.

*11 **aTCA**: Industrial standard specifications for carrier-oriented next-generation communication equipment defined by the PCI Industrial Computer Manufacturers Group (PICMG).

ibility issue so as to be able to run the general-purpose middleware and applications of the current IP-RNC which are 32-bit-based. We have aimed at achieving low-cost and high quality in developing the software for the E-IP-RNC and, in order to complete development in a short period of time, we have also made maximum use of the existing software resources for the IP-RNC. As a result, it has become possible to absorb the differences in the OS by achieving 32/64 bit compatibility in the basic middleware which has also led to the unification of middleware/applications used in the IP-RNC and the E-IP-RNC and helped to make the development work more efficient and effective.

4.2 Equipment Monitoring Function

Since the E-IP-RNC has a different hardware configuration from the current IP-RNC, changes have been introduced to the equipment monitoring functions in order to deal with the new hardware. In addition, the firmware for FS, CLP and RMP cards as well as LM are different from the ones for the current IP-RNC, and therefore a function has been added to enable separate management when updating files.

4.3 Call Processing Function

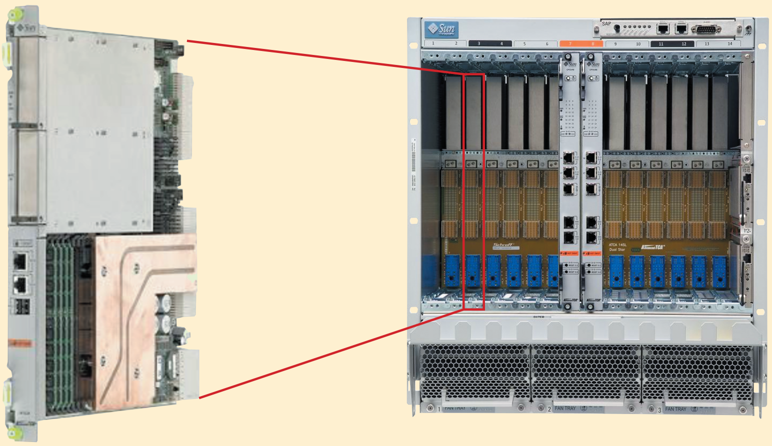
One of the functions of the RNC is to page the mobile terminal in the cells under its control in response to the request from the core network when there is an incoming call, i.e. the paging function. In WCDMA systems there is the concept of domain: the Circuit Switched (CS) domain for providing services like voice and the Packet Switched (PS) domain suitable for packet communication. The paging function is necessary for both domains. In the case of the IP-RNC, because of limitations in the processing power, when resource searching becomes necessary while paging an already communicating mobile terminal via a different domain, processing is shared between two paging processors: RMP when searching resource of the call in progress and CLP for all other cases. However, CLP is basically a processor for call-processing and there has always been a problem that call processing is delayed because of disturbance from paging process when the traffic was high. In the E-IP-RNC, because the processor power has been improved drastically it became possible to deal with paging with a single processor and thus the software was modified to concentrate the function to RMP. This led us to succeed not only in solving the processing delay problem but also to reduce the overhead in the communication between processors.

In the E-IP-RNC, optimization was achieved on call processing parameters such as the number of simultaneous sessions of call processing threads on CLP, various buffer numbers and queue length through detailed desk studies and evaluation using real machines. Furthermore, improvements in development efficiency was sought by achieving commonality with IP-RNC, and wherever parameters can be expanded on the IP-RNC side without any adverse effects, unification was sought by adopting those of the E-IP-RNC.

5. Log Collecting Equipment

The current IP-RNC collects logs in the equipment and utilizes them for improving quality and analyzing faults. The equipment that has the role of collecting the logs is the IP-RNC Debugger (IP-DB). This time, in order to cope with the increased capacity, we have developed an E-IP-RNC Debugger (E-IP-DB) which has improved log collection capabilities.

The E-IP-DB is configured by SBC which together with the chassis complies with aTCA specifications as in the case of IP-RNC and the logs are collected and stored in a card (**Photo 2**). It was not possible for the existing IP-DB to collect all the logs corresponding to the increased capacity and it was only possible for one IP-DB to keep the logs of one IP-RNC. Therefore, regarding the E-IP-DB we have made it possible to keep the logs of two E-IP-RNCs by enhancing hardware performance and also made it possible for maintenance personnel to check the logs through the GUI. Since a maximum of



(a) SBC (Netra* CP3220)

(b) Chassis (Netra CT900)

* Netra is the trademark or registered trademark of Sun Microsystems, Inc. in the United States and in other countries

Photo 2 E-IP-DB hardware

12 cards can be mounted on a chassis, the logs for 24 E-IP-RNCs can be simultaneously acquired when fully mounted. In case a fault occurs it will be possible to quickly locate the fault by analyzing the stored logs.

6. Conclusion

This article has described the introduction of the E-IP-RNC which is a version of the existing IP-RNC model having expanded capacity, and has provided information about its equipment architecture, software architecture and its log collecting equipment.

We will continue to make enhancements mainly in the area of developing general-purpose middleware and applications in order to further improve its reliability and service performance.

Reference

[1] Y. Watanabe et. al: "IP Radio Network Controller," NTT DoCoMo Technical Journal Vol.9 No.1, pp.14-21, Jun.2007.