Advanced in Control Engineering and Information Science

Research on monitoring technology of Iu-PS interface in WCDMA network

Yang Lixiang\textsuperscript{a*}, Zhang Zhizhong\textsuperscript{a}, Li Yong\textsuperscript{a}, Zhang Tao\textsuperscript{a}

\textsuperscript{a}Key Lab. on Communication Networks and Testing Technology, Chongqing University of Posts and Telecommunications, Chongqing 400065, China

Abstract

This paper describes the overall design framework and functions reality of Iu-PS interface monitoring in WCDMA network, and proposes an Iu-PS interface monitoring solution which divides the Iu-PS interface monitoring module into three sub-modules. Then, the paper analyzes the decoding methods of RANAP, GMM, and SM protocol. The synthesis technology of CDR and statistical method of all the statistical indicators are proposed to solve the technological problems in the process of Iu-PS interface testing. The solution has been implemented in the WCDMA network analyzer and monitoring system and performed excellently in the real network testing.

© 2011 Published by Elsevier Ltd. Open access under CC BY-NC-ND license.

Selection and/or peer-review under responsibility of [CEIS 2011]

Keywords: WCDMA network; Iu-PS interface; decoding; synthesis; statistics

1. Introduction

With the release of 3G license, WCDMA networks were established nationwide on a large scale. The operation and maintenance process of WCDMA network were carried forward constantly. As the important pillar of networking technology, the research and development and the application of WCDMA network monitoring technology will be having a very important role in experimental research and development, the network construction and optimization, the operation and maintenance of WCDMA system, which is of great significance for research\textsuperscript{[1][2]}

As one of the important interfaces of WCDMA network, the monitoring module research of Iu-PS interface occupies the indispensable status in the monitoring of WCDMA network. Through message

\footnote{* Yang Lixiang. Tel: 13608364248
E-mail address: ylx880202zht@126.com.}
decoding, call synthesis and statistics of the key protocol of Iu-PS interface, we can analyze the current network performance effectively, and master the current network state and features timely, which has important guiding significance to meet the requirement of better monitoring function and matching up other interfaces to complete the all-round performance test of WCDMA network.

2. Overview of Iu-PS interface

Iu-PS interface is the PS domain interface connecting UTRAN and CN, which can also be seen as a reference point between SGSN and RNC. Iu-PS interface is very important in the WCDMA network. Its functions include: RAB(wireless access bearing) establishment, maintenance and release process; changing-over inside the system, changing-over between systems and SRNS reorientation process; community radio service process; series of general process irrelevant with specific UE; specific signal management for users and separation process on protocol level for each UE; the transmission process of NAS signal message between UE and CN; the location service requested from UTRAN to CN, the transfer process of position information from UTRAN to CN and resources reserve mechanism.[3]

The monitoring of Iu-PS interface mainly analyses the basic process of the application part of wireless access network, service process of mobility management, service process of conversation management and statistical values of related KPI indicators. The first one is realized by RANAP protocol; the second one is realized by GMM protocol; the third one is realized by SM protocol.

3. Overall design and analysis of Iu-PS monitoring project

According to the demand of relevant test specification, Iu-PS interface monitoring module ought to complete the functions as follows: data information decoding of RANAP, GMM and SM protocol; father CDR synthesis of Iu-PS interface, and son CDR synthesis of sub-service; statistics of adherence success rate, authentication success rate, PDP context activation times and relocation reasons based on signal point; and the output of the statistical results. Decoding, synthesis and statistics are divided into three sub-modules. The integral function of Iu-PS interface is realized through the integration of the three sub-modules. The framework design of Iu-PS interface monitoring process shows in Fig. 1.

As mentioned above, integral module can be divided into decoding module, synthesis module and statistic module. The decoding module completes the PDU basic decoding of RANAP, GMM and SM protocol. Data captured by acquisition card is stored in message buffers after the message filtering of Iu-PS interface. Decoder gets message from message buffer, and then decode each one by level, in order to achieve call information of every message.

According to different protocol categories, call information is sent to corresponding protocol analyzer for call synthesis and statistics. Each call synthesis result recording the CDR sets and self-defined call statistic results is saved in the disk as files. Synthesis module combines the inter-related messages into the call process to form a completed CDR process. Simultaneously, statistic module finishes the statistics of relocation, routing update and PDP activation etc. The two modules accomplish all the test-relevant senior functions. Finally, the monitors display synthesis statistic results according to user's requirements.

Data Collecting card → Message filter of Iu-PS interface → Messages cache → Decoder → Extract detailed decoding results and summary parameters → Protocol analyzer (process call synthesis and statistics) → CDR cache → Statistics cache → Results display

Fig. 1. Monitoring process of Iu-PS interface
4. Monitoring analysis and implementation of Iu-PS interface

4.1. Protocol decoding analysis of Iu-PS interface

Protocol decoding is the fundamant of Iu-PS interface monitoring, is also the premise of call synthesis and statistic. GMM and SM protocol bear on the RANAP protocol. So, for Iu-PS interface decoding, the first is the RANAP protocol decoding.

RANAP protocol has four kinds of data unit: initiating message, successful outcome, unsuccessful outcome and outcome \(^4\). In the decoding process, first, the decoder parses out the data element type, then determine the specific message type on the basis of process code in each data unit \(^5\).

Every RANAP message consists of message type and one or more information elements (IE), stored as an IE list. Each IE corresponds to a different ID number. According to ID number, which IE in the list node can be determined. Different messages may have the same IE. And each IE may be composed of other IE. Therefore, in order to avoid code duplication, each IE decoding can be packaged as an individual function to provide public entrance for each message decoding. In this way, no matter what the message is, the analytic function can be called directly as long as the existence of IE, which greatly improves the code’s readability and robustness.

If the RANAP message type is initiating message or direct message, then the decoder determines the top protocol is GMM or SM or others based on the message protocol type field of NAS PDU. Further, the decoder decodes the third layer protocols.

GMM and SM protocol message format is similar, composing of jump instruction, protocol discriminator, message type, and a number of information elements (IE). All the GMM, SM messages, jump instructions, protocol discriminator and message type can be analyzed and processed directly. While the decoding method of IE is the same with RANAP protocol as mentioned above.

4.2. Call synthesis monitoring implementation solution

Message process synthesis also known as CDR (call data record) synthesis, is the key of network monitoring function. It classifies messages by signal process, and links these messages together with index, in order to complete advanced performances such as call tracking and call loss statistics \(^6\).

The service of Iu-PS interface is based on the connection of SCCP. But there are often more than one the same or different services in an individual SCCP connection. And the services are interconnected. Iu-PS interface synthesizes not only global CDRs but also various sub-service CDRs, in order to observe and analyze all the services better. These include: GMM attaching process CDR, GMM isolation CDR, GMM authentication CDR, GMM routing update CDR, PDP activation CDR, PDP secondary activation CDR,
PDP modification CDR, PDP deexcitation CDR, RAB assignment CDR, and relocation CDR. The synthesis of the sub-service is completed by the Iu-PS sub-service CDR synthesis module. According to different protocols bear on different services, the sub-service synthesis module can be divided into: RANAP protocol synthesis, GMM protocol synthesis and SM protocol synthesis. As shown in Fig. 2. (a).

Iu-PS synthesis is based on the successful extraction of basic call synthetic information. The CDR attribute extracted by global CDR and sub-service CDR is different. Global CDR attribute is public attribute of all services in one SCCP connection. There is no distinction between services but users for global CDR. While sub-service CDR attribute is the specific attribute of service process. For example, the attributes in routing update include routing update timing, routing update status and so on. After the establishment of CDR, CDR attribute information will be saved to disk, and each CDR will be assigned a unique ID.

Iu-PS synthesis introduces efficient hash technologies and establishes a data structure management mode using a specific keyword as index, CDR ID as mapping value. The synthesis of different CDRs has different key values. The key values of global CDR, RANAP protocol-related CDR and GMM protocol-related CDR is SCCP-connect provided by lower layer. The key values of SM protocols-related CDR are SCCP-connect and service label. When a message arrives, first, find whether the CDR corresponding to the key value exists or not. If not, create a new CDR, and set the new CDR attribute. If the key value exists, move the CDR out and modify its attribute then move it back to buffer. Determine whether the message is the last one, if yes, finish synthesis, remove the keys corresponding to hash table out, and save the CDR to disk. CDR extraction algorithm establishes secondary index: keywords map the corresponding CDR ID, and obtain the required CDR information through the corresponding ID. As a result, the key words, call information and CDR synthetic data can be separated, which can enhance the search flexibility and improve search speed, also propose guarantee for dynamic memory reuse.

4.3. Statistics monitoring analysis of Iu-PS interface

Statistics is one of the most central parts in network monitoring. Providing accurate, detailed and critical statistical data plays an irreplaceable role for understanding and judging the current network status, analyzing network service features and solving network problems.

The indicator statistics of Iu-PS interface includes: the traffic load of Iu-PS, attaching acceptance rate, the success rate of routing update, authentication success rate, acceptance rate of PDP context activation, relocation acceptance rate and relocation failure cause and other core indicators. Among them, the statistics of traffic load is based on message statistics, that is, each message arrival will be statistic. But other statistics is based on the CDR statistics. The statistics proceeds when CDR finished its synthesis or is closed because of overtime. Generally, every CDR statistic item is one or more. So, all the statistic item of each CDR will be packaged into a statistical term structure \[^7\].

Sub-service statistics of Iu-PS interface is mainly for signal point pairs. Whenever a sub-service CDR finishes synthesis, the same statistic item of the same signal point pair will be cumulated. Thus, the statistical monitoring function needs defining a statistics keyword and a map container mapping between statistic items. Find the appropriate statistic list according to key value and modify the statistic item information corresponding to key value, and then accomplish the CDR-related statistical functions.

The statistics module of Iu-PS interface calls statistical function of one-time result and records the value in one-time CDR process of all the statistical variables, then search whether there exists corresponding statistical item in the map container through the statistics of key values. If not, add a new map pair mapping key and statistical node. Or else, one-time statistical result will be accumulated to statistical node corresponding to statistical key, through calling cumulative statistical function. Specific processes are shown in Fig. 2. (b).
5. Result proof of Iu-PS interface monitoring solution

This monitoring technology has been applied to the WCDMA network tester and WCDMA monitoring system. Fig. 3 is the implemented results tested by WCDMA Network Tester in the real network, which shows global CDR synthesis process of Iu-PS interface and detailed decoding information of RANAP message. The testing results have demonstrated that both the decoding and synthesis are correct.

Fig. 3. Decoding and CDR statistics results display

6. Conclusion

Iu-PS interface monitoring is one of the most important parts of WCDMA network monitoring. This paper introduces the Iu-PS overall design of monitoring solution, and then analyzes the specific implementation of decoding module, synthesis module and statistics module to solve some technical problems the Iu-PS interface testing process, which has certain reference value for the testing and development of other interfaces. At last, the monitoring solution has been tested and simulated in real network. The testing results show that the program are stable and reliable, effective and feasible, which meets the monitoring requirements absolutely.

References


