Research on Management of Mobile Communication Network Centralized Alarm

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ABSTRACT: *This paper, starting from the level of mobile communication network alarm management, comes up with the alarm types and the six-stage model. The paper also discusses the step of recessive maintenance and management from the perspective of mobile communication in terms of the effective control of network alarms, and also extends the network equipment alarm logic correlation to the logical level of network equipment alarm correlation, at the same time, discusses the study and application of data mining algorithms in alarm correlation. Finally, the paper provides the plan for construction steps and function for stage target for the intelligent alarm analysis system.*

Categories and Subject Descriptors:
C.1.2 [Multiple Data Stream Architectures]: Cellular Architecture, **H.2.8 [Database Applications]**: Data Mining **K.6.2 [Installation Management]**: Computing Equipment Management

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1. Introduction

With the expansion of the scale of mobile information and communication networks, especially the mature and perfected 3G/4G technology as well as the promotion of commercial marketization, the trends of mobile information and communication networks demonstrate such characteristics as topology intensification, network equipment miniaturization, communication plates precision, and management tools diversification.

Therefore, to promote centralized network monitoring and management has great importance and value to the control over the whole network operation. At the same time, the huge network structure and multi-function device has also brought a massive amount of alarm data, which makes the effective management of the alarm become key aspects in the network operation and maintenance.

2. The Alarm Management Hierarchy

2.1 The Analysis of Different Types of Network Alarm

As telecommunications service provider transits from the "*traditional basic network communication carriers*" to "*modern integrated information service providers*", a variety of data services has become a breakthrough of growth. Usually, the equipment alarm, generated by the network equipment, is set as the foundation for alarm management, which has important value in network trend analysis and early warning. From the point of view of customers' perception, the overall performance of the communication link is a key indicator in determining the degree of customer satisfaction, while the performance alarm level indicator is relatively of more potential in terms of value than equipment alarm level. The gradual improvement of performance alarm level indicators will trigger and enhance the level and types of equipment alarm level. The timely treatment of performance degradation will be effective to avoid the upgrade of equipment failure; performance alarm level indicators not only have more holistic value compared

with the equipment alarm level, for instance, SMS / MMS end-to-end connection rate, voice service paging success rate, and network packet loss rate, which have reflected the operating status and the quality of the communication link, yet are also closer to the customers' perception of the quality of network service.

Perceived service alarm is a type of alarm that is correlated to performance level indicators. It comes into being when dialing the test system through an integrated call, and its alarm mainly reflects the service quality on the level of user service perception.

The capacity load alarms or indicators are usually not of real-time analysis value, but have a basic role in safeguarding the holiday scenes, hot or focused area scenes, etc. The change reflects the network's carrying capacity. For instance, VLR / HLR / CPU utilization, code resource utilization, and average peak bandwidth utilization, etc. Such indicators usually do not need real-time concern in the day-to-day network operation, and have potential "*bottleneck*" effects on mobile information and communication capabilities.

Abnormal network traffic analysis triggers and forms alarm that is timely and global, which is also a source of information for network resource scheduling. Abnormal network traffic requires comprehensive considerations of regionality of the spread and major events together, measuring data mining discriminating algorithm and network application environmental factors collectively to generate adaptive threshold, and realizing the accuracy and effectiveness of network traffic anomaly alarm. The sudden change of the early warning network traffic load impacts the mobile information communication network.

As the alarm system for the quality of mobile communication network operation and maintenance, the system has five types of integrated management system of equipment level alarm, performance level alarms or indicators, perception service alarm, volume overload alarms or indicators, and network traffic anomaly analysis (Figure 1). While the scientific and reasonable combinations of the different professional and interdisciplinary five types of alarms/indicators, as well as the construction of a warning system can determine the depth, breadth, and height of the comprehensive alarm management.

2.2 Stage Model for Alarm Management

Alarms come from the network element equipment, and alarms generated by each network element reflect the operating state of the equipment itself and of its link channel as well as the associated equipment, i.e. each alarm information contained in the alarm covers the operating state of a certain region. Therefore, the stage of the alarm management can be classified into six types as the following (Figure 2): network element layer at the same specialty, network regional at the same specialty, network element layer between the different specialties, network regional at the same specialty, network element layer at the full specialties, network regional at the full specialties, each of which discussed here remains as independent equipment level alarm.

3. Alarm Management Based on the Maintenance Perspective

As the foundation for alarm management system, the effective management and condense of mobile communication equipment alarm system have played a crucial role in the construction of the system as a whole. For equipment alarm management, the first is scientific control of the amount of alarm, including equipment alarm mechanism, alarm types classification, establishment of sending rules, efficient processing of failures,

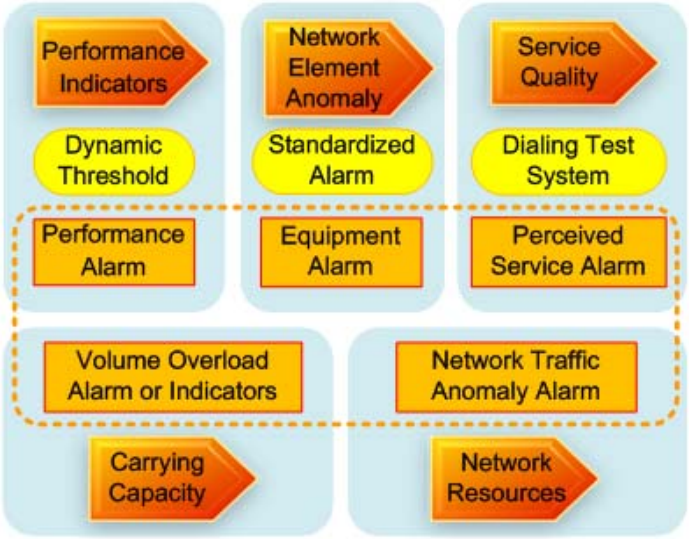

Figure 1. Mobile communication network alarm system

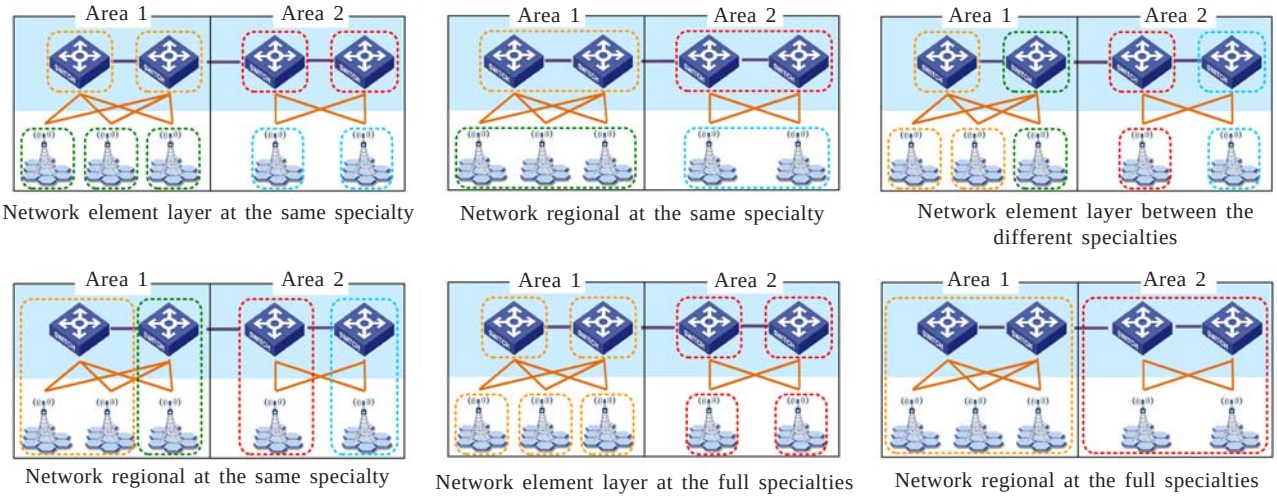

Figure 2. The six models of alarm management

comprehensive multi-angle analysis network element level, professional level, and regional level.

Some manufacturers adopt the rotational training mechanism for equipment network management alarms, leading to the situation where the single alarm repeats to report the case of integrated network management. The long fault processing period has become the primary factor for the fluctuation and changes of such alarms. Different equipment manufacturers of the same alarm types have differentiated parameters such as types, levels, equipment impacts, and service impact. There is a need to refine the classification under standard evaluation system, and then establishing a multi-equipment, multi-manufacturer, and objective network alarm assessment management. The alarm management above is based on the "*endpoint*" management aspect, while the "*net element*" management belongs to the "*endpoint*" collective management. "*Net element level*" management is based on the excess, ultra-short, ultra-long alarm analysis. These three types of alarms reflect the "*sub-healthy*" state of network element in the mobile communication network, and provide guidance information for the elimination of hidden faults and positioning analysis.

Comprehensive network alarms management derives from the element management system, and the timely processing of the historical garbage is the basic content of the alarm management system. The history garbage alarms include the commissioning of engineering equipment, circuit to remove the garbage data, the un-bearing service port or net element alarm, etc. The alarm analysis system expert is an intelligent management framework embedded in the comprehensive alarm network management platform, whose framework, management, and analytic applications take a qualitative leap in comparison to the traditional communication network management [1]. The integration of correlation rule of data mining technology with alarm analysis expert system is an effective support to the "*distribution of complex networks and centralized operation and maintenance management*" model [2].

Take communication network alarm management as an example, and analyze the alarm management brought by the hidden maintenance link:

3.1 Optical power attenuation threshold triggers the low power alarm

The optical distribution network, as the optical transmission channel between the optical line terminal and the optical network unit, will have reduced stability and reliability of the photoelectric signal when its channel transmission quality drops. Its loss usually includes the splitter loss, welding and cold contact loss, connector and adaptor loss, optical fiber transmission loss, and fiber and flange coupling loss. The optical fiber connector (ring flange) is an important part of the device in realizing optical fiber communication system connection. Especially the improvement of the degree of optical fiber in local communication network, flange has become a frequently used optical fiber part in optical fiber communication network. Thus, the optical power attenuation caused by such problems requires special attention.

3.2 Equipment plate failure leads to alarm strobe

The plate is a basic unit of a communication network. Its operation quality is directly related to the quality of the communication network service. Plate failure includes the two consists of hardware and software: hardware failure is the failure of the electronic components, the link (picture-board interface) of the plate, etc.; software refers to the failure of the plate protocol, and parameters and configuration, etc.

3.3 Network element and port for un-bearing service

Due to customer service changes and network structure adjustment, the change of equipment network element and whether the port carries service or not change to the time. Being not investigated and processed in time , the

ports that no longer bear service are about to cause large amounts of garbage alarm, even interfering the monitoring personnel's analysis and judgment, reducing monitoring work performance and efficiency, which would lay hidden peril for the stable operation of the communication network equipment. For the un-bearer service network element port, one can change the port state and delete unused circuits, to deal with such alarms. Such issues involve market service and other links, therefore, communication confirmation is particularly critical, in order to preventing lower customers perceived satisfaction brought by misuse.

3.4 Dynamic environmental factors for equipment

The dynamic environment for transmission equipment is the basis of reliable operation of the network, which involves all kinds of environmental parameters, such as power, oil machine, battery, UPS, inverter, other dynamic equipment and entrance guard for high and low voltage distributor, air conditioning, fire protection systems. The centralized monitoring of the equipment data achieves a "*point-type*" management. Dynamic environment alarms also become the source of wide-source, multi-frequency, high-potential failures.

In addition, due to the fact that network elements cutover trigger a lot of alarms in the communication network, the cutovers interactions between different professions are especially good at locating the failures.

Project reservation system should have the function of grading engineering reservation identification of regional level, network element equipment level, and plate port level. Intelligent project reservation system can achieve engineering network element's automatic mark analysis functions for end alarm, eliminating equipment alarms and error list brought by engineering cutover. Local network transmission cutover likely to cause the out-of-service alarm of a large area of the base stations, therefore, the development of inter-disciplinary cutover norms, and the construction of an intelligent all-profession project reservation platform will reduce the amount of alarm caused by the project and enhance the accuracy of dispatching.

The number of alarm appeared significant downward trend with above-maintenance pattern, by the example of a certain district (Figure 3).

4. Alarm Management Techniques and Methods

Mobile communication transmission network has such features as complex, hierarchical networking and full end-to-end. Take SDH transmission network as an example, its basic types of network element include terminal multiplexer, add-drop multiplexer, regenerative repeater, and Synchronous Digital Cross Connect Equipment, etc. These network elements have certain physical and logical correlation, and the independent network element failure will result in "*click alarm, multi-click dissemination*" effect on related network element. While there is correlation of occurrence time and logical name between these alarms [3].

In the correlation analysis, the first thing to do is to manually remove the interference alarm. For instance, remove a large amount of non-related alarms (open entrance guard alarm, un-matching plate alarm). During the screening process, it must be taken into account that the repeated alarms may be caused by different failures in different time periods to avoid blindly deleting the repeated alarm. Instead, one must consider the actual fault for analysis and screening [4]. Therefore, the classification and combination of such alarms for process will greatly enhance the centralized monitoring performance.

The alarm logical correlation on the network equipment itself as follows [5] (Figure 4): 1) Alarm compressing, taking the simultaneous multi-alarm which have same attributes (adjacent cells, same network element or light path, etc) into an alarm; 2) Filtering mechanism, alarm which does not conform to the attribute correlation will be to delete; 3) Calculating accumulatively, a number of concurrent alarms will be converted to an alarm with new name; 4) Suppressing shielding, low priority alarm will be suppressed when high priority to be generated; 5) Boolean operation, making a group of alarm that accord with some

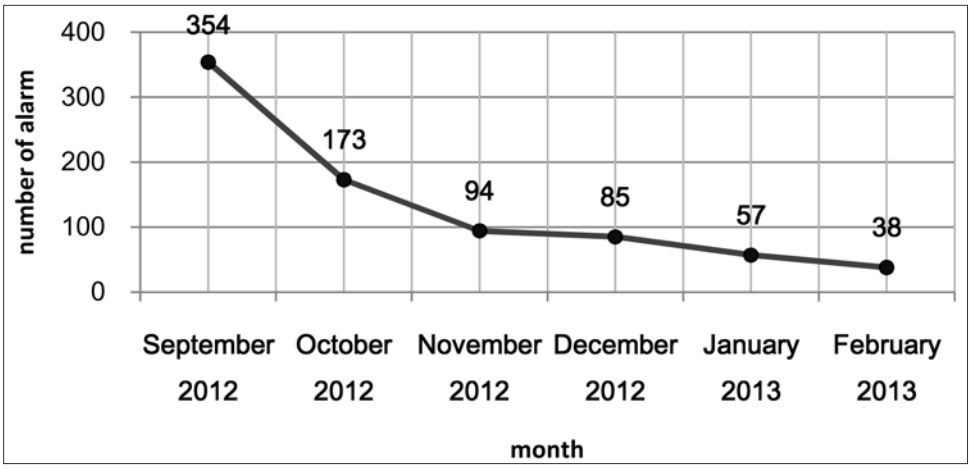

Figure 3. Alarm number of single network equipment

rule of boolean operation into an alarm; 6) Universalization, network element alarm be instead of the more general alarm; 7) Specialization, using the more detailed alarm information to replace network element alarm; 8) Temporal relation, the different alarms to be generate by certain time sequence.

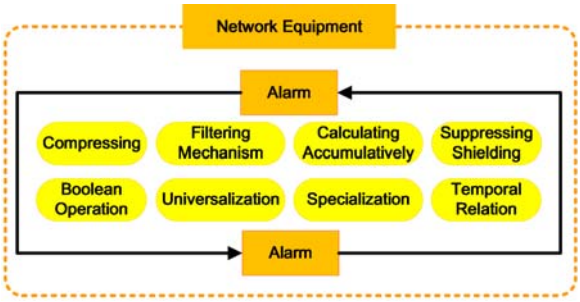

Figure 4. The logic relation between alarms inside the network Equipment

Alarm correlation among groups of network equipments as follows (Figure 5): 1) Derivative correlation, the network equipments alarm is divided into root alarm and derivative alarm; 2) Topology correlation, the network equipments alarm contains home terminal alarm and opposite end; 3) Timing correlation, the same fault point generates alarms that have the same time trigger characteristic; 4) Causal correlation, the alarm B happens that be caused by the alarm A, i.e., element management system has out of management because of optical cable break; 5) Link correlation, convergence line fault will trigger the network equipments alarm of the entire path, and send unification orders.

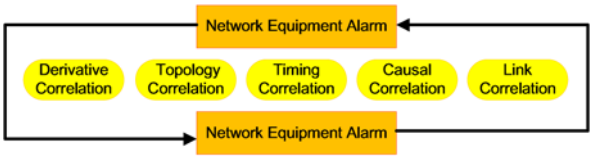

Figure 5. Logic correlation among groups of network equipments

In conclusion, the alarm will be correlated based on characteristic attributes, For instance, topology, type of alarm, alarm level, occurrence time, classification, the alarm be analyzed by alarm correlation with the crytic status information of communication network, and evaluation and forecast of network operating status has gained. The alarm correlation analysis algorithm contains neural network algorithm, fuzzy logic algorithm, rule-based approach, data mining algorithm, etc [6].

Apriori algorithm is the core algorithm of discovering association rules based on data mining algorithm, whose significant part is put forward by Rakesh Agrawal [7]. Frequent episodes discovering algorithm in time series (WINEPI algorithm) be proposed based on Apriori algorithm by Heikki Mannila. the research and application of alarm correlation achieved valuable results; LING Xu-xiong [9] compared the frequent patterns (Apriori algorithm, FP-Growth algorithm, NHTFPG algorithm) with the sequential pattern (WINEPI algorithm), the algorithm performance are analyzed by Ericsson equipment alarm of MSC, MGW, BSC; AN Huan[10] analyzed alarm information value by combination of correlation model and sequential pattern with confidence measure, but the alarm degree coefficient of importance and real-time analysis still have room for improvement; XU Qian-fang created alarm association (MTAP algorithm, mining telecommunication alarm pattern) by exploiting correlation and confidence framework based on graph theory, and it has the higher efficient in compression ratio and the number of rules; the dynamic algorithm of mining fuzzy associate rules be applied to optical network fault management that can shorten fault analysis time by WU Jian.

5. Conclusion

Alarm management requires not only the support of the alarm correlation techniques but also constraints of the specification of alarm verification and troubleshooting. Alarm stems from failure. The fault should be positioned and processed timely and accurately to avoid the alarm storm in the centralized monitoring. On the massive alarm analysis processing front, intelligent alarm analysis system construction is divided into two stages: the alarm logic combed by experts and the intelligent system management operations.

The alarm logic combed by experts refers to that all alarm correlation analysis should consider equipment performance, power, natural environment and other factors according to different factories. Namely, several single alarms are set to become the overall alarm system which is similar to the clustering pedigree; the seemingly independent alarms are integrated into the interactional alarms clustering pedigree. At the same time, the alarms impacting affect network performance and user satisfaction will extend to index of correlation at the customer level. For instance, CPU load alarm threshold value exceeded → Over packet loss rate exceeded → Connection rate decreased by 3%, then the single network element alarms convert into the system of network alarms finally. In order to make the assessment result of correlation analysis have referenced value, the weights coefficient should be assigned dynamically integrating intelligent system management operation with consolidated range class (link level, topological level, or regional level) and factors such as whether the hot spot area, whether important customers, whether working hours, whether holidays, on the basis of the above-mentioned alarm system.

Alarm management is a systematic project which needs the joint of multi-sectoral such as equipment manufacturers, maintenance offices, the monitoring team, and IT support. The hierarchical division of '*Performance degradation-network alarms*' and '*network alarms-communication performance*' requires not only research on algorithm theory but also actively exploring for

engineering practice. The professional alarm management is just like pruning trees. The whole network across professional alarm management is equivalent to forest conservation. The pioneering ideas and methods, reasonable and prudent process planning, and multi-faceted supportive participation in alarm management will certainly escort for the future mobile information network.

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