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Design and Implementation of A Real Time Process Management System for Telecom Operations and Management

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To face with the fast and ever changing telecommunication environments, we need a real time process management system that can detect abnormal events in real time and warn the suspicious events to operations personnel. Additionally, a real time process management system can be adapted fast to various services that are developed by telecom companies. In this paper we develop a real time process management system to monitor and analyze telecom operations and management processes in real time. Toward this, we design application and database architectures of telecom operations and management processes based on Enhanced Telecom Operations Map (eTOM) that is business process framework in telecommunication operations and management field and recognized as an international standard in ITU-T M.3050. With these application and databasearchitectures we implement eight main functions for the real time process management system based on service oriented architecture. Therefore, new services can be applied to these functions fast. Also, the functions can detect abnormal event fast. Finally, since the functions are developed along with the international standard, the system has the flexibility for the development in various situations. Overall, this research can be a good guideline of developing a process management system regarding the telecom operations and management field or other fields that need to manage the processes in real time.

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1. Introduction

Real Time Enterprise (RTE) is a company model that manages core business processes using the latest information, minimizes business process delay factors and maximizes the busi-

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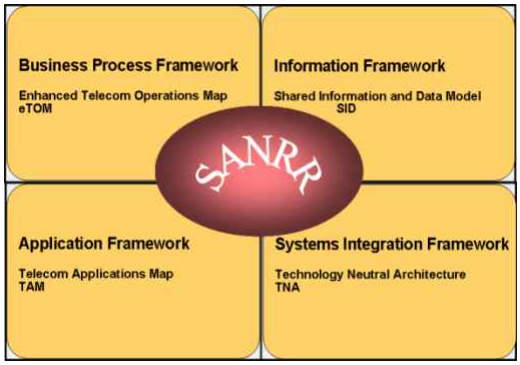
ness competitiveness with increasing decision-making speed. So, if a company implement RTE concept, it has the core business competitiveness and is promised to survive in the fast and ever changing business market.

In this research we apply RTE concept into telecom operations and management domain. Toward this, we design and implement a real time process management system to monitor and analyze telecom operations and management processes in real time. The real time process management system manages [Problem Handling], [Service Problem Management], [Resource Trouble Management] processes in Enhance Telecom Operations Map (eTOM) (TM Forum, 2005) that is business process framework in telecommunication operations and management field and recognized as an international standard in ITU-T M.3050.

Since the real time process management system is developed based on the international standard processes of telecommunication operations and management field and Next Generation Operations Systems and Software (NGOSS) principles (Reilly, J. P. and M. J. Creaner, 2005; TM Forum, 2004), it can adopt various new telecommunication services such as VoIP, IPTV and be adapted to different situation such as different companies or network system. NGOSS is business solution framework for the next generation Operations Support System (OSS) and Business Support System (BSS) with industry agreement which is driven by Telemanagement Forum (TM Forum). It has four core frameworks as in <Figure 1>.



<Figure 1> Fore core NGOSS frameworks

This research studies eTOM, NGOSS principles and RTE concept. Then based on NGOSS principles (Ok, K. et al., 2008) we develop the real time process management system to detect abnormal event earlier and respond faster. To develop the system, we analyze some business processes in the telecom operations and management domain and design application and database architectures. With these architectures we implement the real time process management system of eight main functions that are comprehensive process status monitoring function, process error status monitoring, real time task status monitoring, organization order status monitoring, service order status monitoring, order status monitoring by receipt type, individual order status monitoring, and automatic screen changer for managers. The NGOSS core principles of Common Communication Vehicle (CCV), Externalized Process Control (EPC) and Contract Defined Interface (CDI) can be realized by the software technology such as Enterprise Application Integration (EAI), Business Process Management (BPM), and Service Oriented Architecture (SOA). By these eight fun-

ctions we can monitor key business processes in real time, and when abnormal events occur we can detect them and find root cause of the problems and solve them in real time.

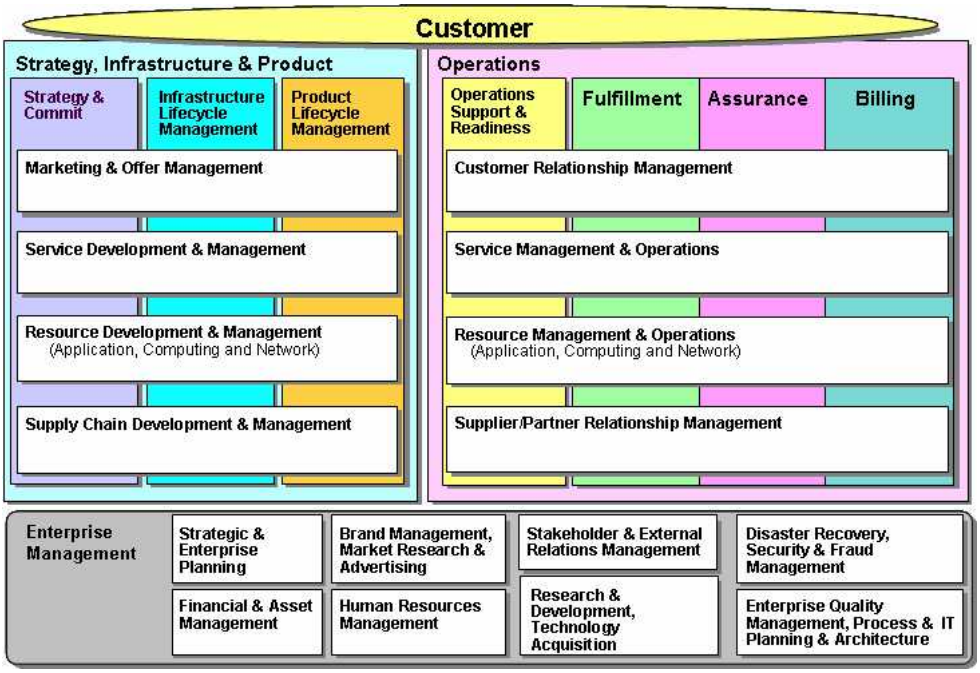
The organization of the remainder of this paper is as follows. In the next section we review the background knowledge of eTOM and RTE concept. In the section 3 we design the application and database architectures of the real time process management system. In the section 4, we implement the real time process management system and explain the eight functions of it. In the final section we summarize the research and suggest topics for future research.

2. Backgound

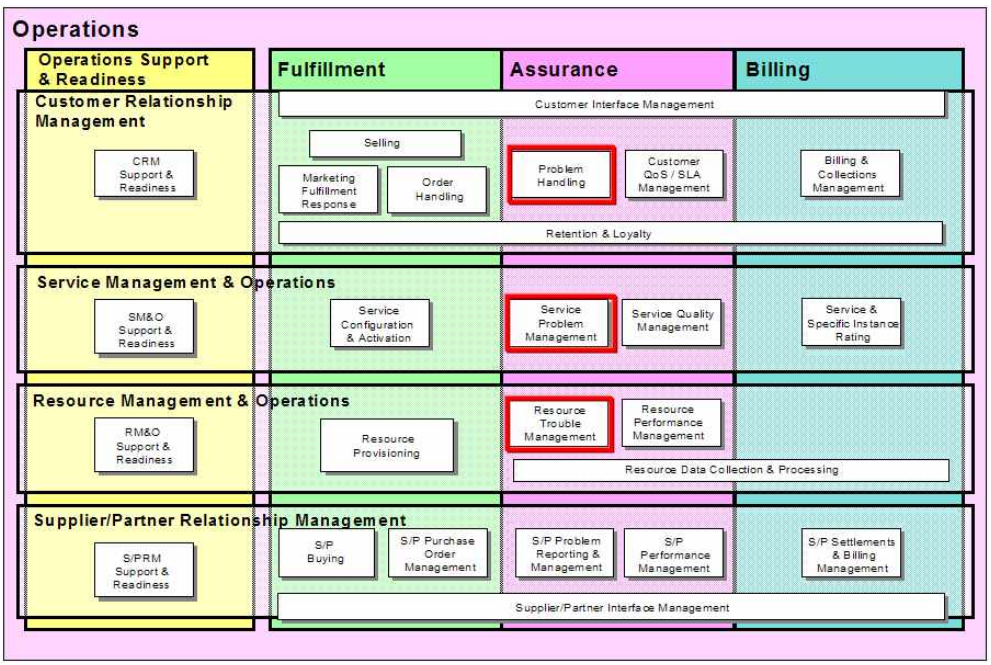
In this section we review eTOM and the concept of real time enterprise. eTOM defines all major business processes in service providers. Real time enterprise is a company model for maximizing the business competitiveness with increasing decision-making speed. The real time process management system in this paper considers some business processes in [Problem Handling], [Service Problem Management], [Resource Trouble Management] processes in eTOM.

2.1 Enhanced Telecom Operations Map (eTOM)

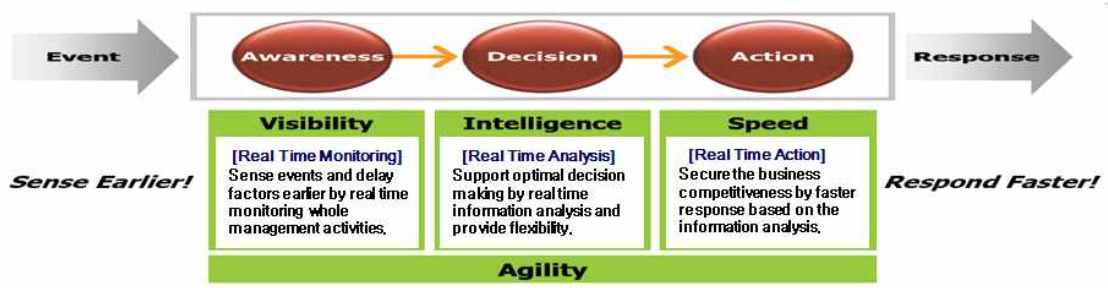
NGOSS is business solution framework for the next generation OSS/BSS with industry agreement. NGOSS selects items which could be automated in the telecommunication business and proposes the methods that implement the system with the existing technology, tools and software. It provides business process, the integration map of system and software, development architecture, documents, models and reference code repository. eTOM is one of NGOSS frameworks as in <Figure 1>. It defines all major business processes in service providers [TM Forum, 2005; Reilly, J. P. and M. J. Creaner, 2005]. In the framework of eTOM level 1, Fulfillment, assurance, billing (FAB) is the core processes of operation processes. The following <Figure 2> in the next page is the eTOM level 1 processes. In the <Figure 2>, the horizontal processes represent functional view points and vertical processes represent business view points. Operations process shows flow and business elements for service fulfillment, assurance, billing and operations support readiness. Strategy, infrastructure and product (SIP) process for management and strategy of infrastructure and product life cycle supports this operations process. Since eTOM is recognized as an international standard in ITU-T M.3050, we can use eTOM as a guideline when analyzing network operations and management processes. In the articles [Chang, B.-Y. et al., 2007], authors used eTOM to improve service problem management, resource trouble management, service quality management and resource performance management in a telecommunication network operations and management processes. In the article (Chang, B.-Y. et al., 2008), authors built the field operations support system to improve the network operations and management



<Figure 2> eTOM Business Process Framework - Level 1 Processes



<Figure 3> eTOM level 2 processes



<Figure 4> RTE framework

processes.

The <Figure 3> is the eTOM level 2 processes that are derived after decomposing the eT OM level 1 operation processes.

Among the assurance processes in <Figure 3> [Problem Handling], [Service Problem Management] and [Resource Trouble Management] processes are managed by the real time process management system.

2.2 Real Time Enterprise (RTE)

Real Time Enterprise is a company model that manages core business processes using the latest information, minimizes business process delay factors and maximizes the business competitiveness with increasing decision-making speed.

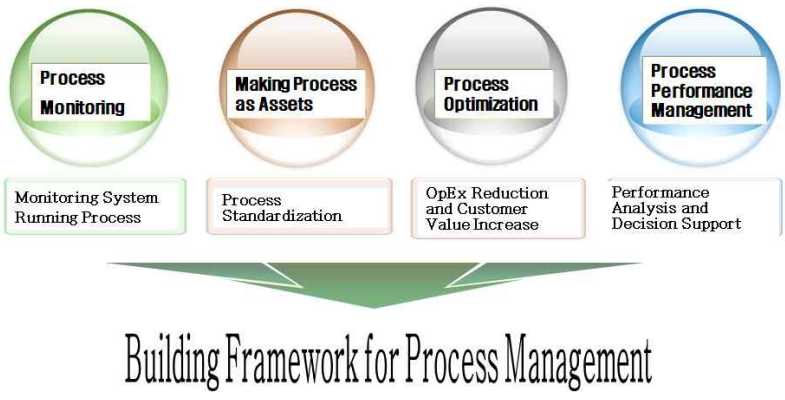
To become a RTE company, we need to acquire business agility that consists of the following three elements.

- **Visibility (Real Time Monitoring)** : Sense events and delay factors earlier by real time monitoring whole management activities based on process and information integration within/outside of a company.
- **Intelligence (Real Time Analysis)** : Support optimal decision making by real time information analysis and provide flexibility with which a company can adopt to changing environments faster.
- **Speed(Real Time Action)** : Secure the business competitiveness by faster response based on the plan by the real time information analysis

The <Figure 4> describes RTE framework that sense abnormal events earlier and respond faster. RTE's real benefits come together through value added processes' changes and innovation and operational transformation of the business itself (Chang, B.-Y. et al., 2008; Finger, P. and J. Bellini, 2004).

3. Architecture Design of a Real Time Process Management System

In this section we design the architectures of a real time process management system for telecommunication operations and management processes. We also describe the objectives of the process management system, work steps for de-



<Figure 5> The objectives of process management system

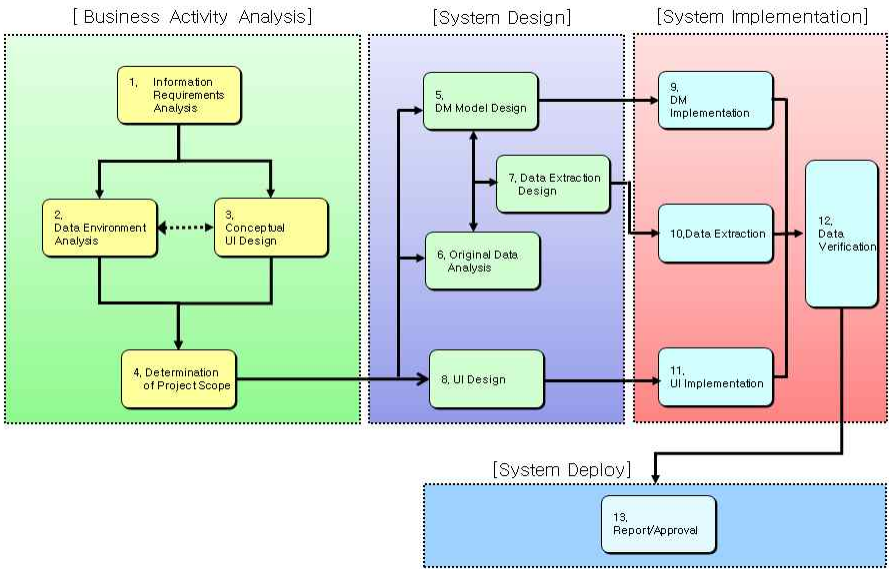
veloping the system and related outputs of the work steps.

Before developing the real time process management system we decide the objectives that the system should have. Therefore, the four objectives, real time process monitoring, making process as assets, process optimization and process performance management should be realized in the real time process management system. Toward this we decide to develop a framework for process manage. With this framework the real time process management system can adopt new telecommunication services such as VoIP and IPTV or it can adapted to different countries or companies.

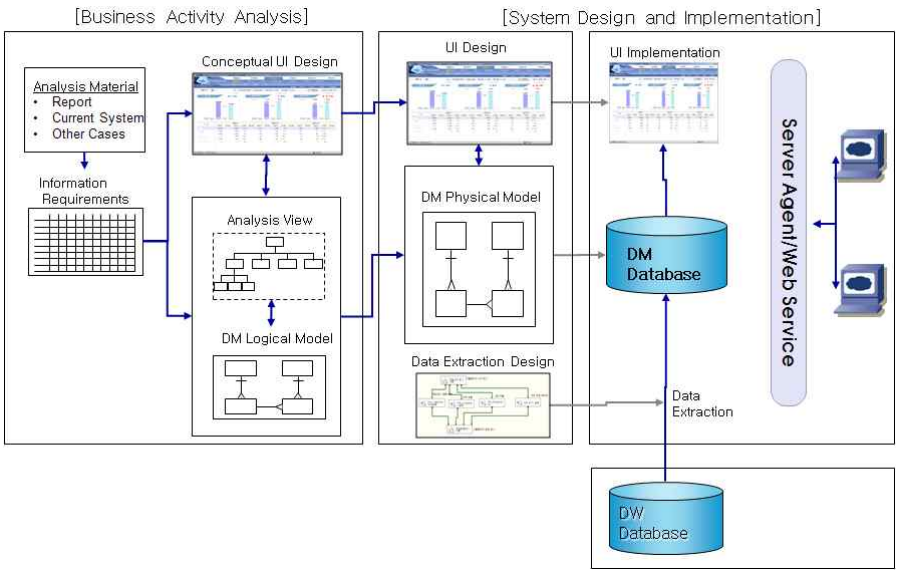
The <Figure 5> shows the four objectives of the real time process management system. These four objectives are achieved through monitoring running processes on the system, process standardization, operation expenditure reduction and customer value increase and performance analysis and decision support by building the real process management system.

To develop the real time process management system we decide to follow four steps of Business Activity Analysis, System Design, System Implementation and System Deployment. In the business activity analysis, we explore and analyze information requirements and data environments and make conceptual user interface design. Then we determine the entire project scope. After the business activity analysis, we design a data mart model, how to extract data and user interfaces in the system design step. After that, we implement the data mart, data extraction and user interfaces in the system implementation step. Then, in the system deploy step, we will document our results and get approval from the management level. The <Figure 6> and <Figure 7> show these steps and related expected outputs of the work steps.

After we make a decision about the work steps, we face that we have to decide whether to buy Business Intelligence tools or develop in house. The <Table 1> in page 100 shows advantage and disadvantage of two choices. Because



<Figure 6> The objectives of process management system



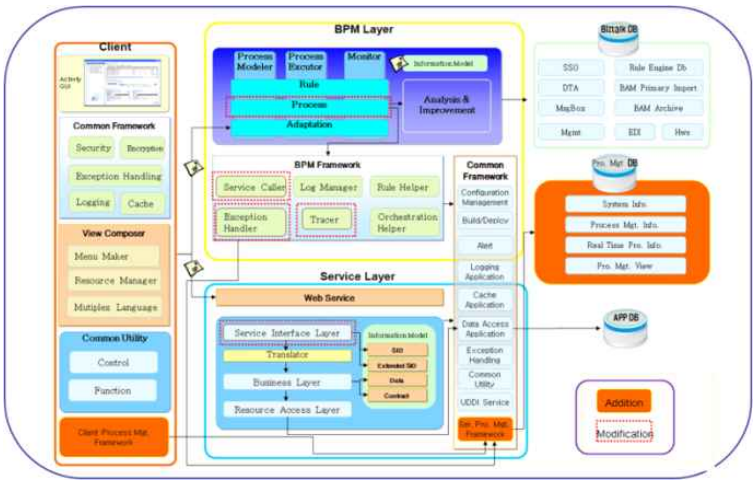
<Figure 7> The objectives of process management system

the ultimate goal of the real time process management system is for sale to other companies in different countries, therefore the most important factor is the maintenance cost of the system. Thus, we decide to develop the system in house. In both cases, we need to design data mart and

<Table 1> Analysis of buying BI Tools vs. Self Development

Case	Benefits	Disadvantage	Remarks
Buying BI Tools	◦ Faster Implementation of Application ◦ Various Visual display ◦ Easy to Implement various requlrement by manage meta data	◦ Need training for development tools ◦ Increasing maintenance cost ◦ Occurrence of mismatch with our operations environments	
Self Development	◦ Low of maintenance cost ◦ Easy interoperability with other system	◦ Longer deveiopment time ◦ Relatively low quality of visual display	

◦ Common Activity.
- DM inplementation.
  • Design Data Mart by analyzing bushess activity requirements
  • Customize the Global OSS system for real time requirements.
  • Develop APIs for reporting.

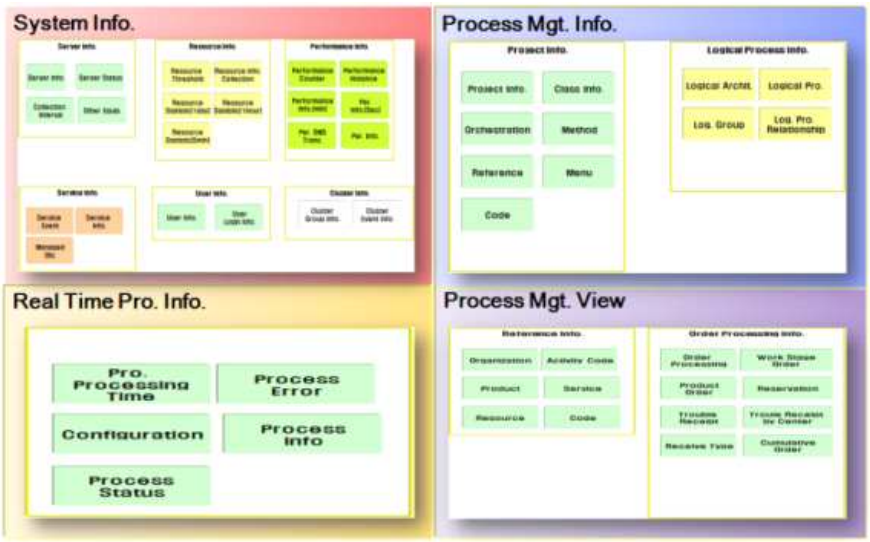


<Figure 8> Application architecture

customize the existing operations support system called GOSS, and develop APIs for reporting.

Following the work steps, we develop the application architecture and conceptual, logical and physical DB architectures. The <Figure 8> shows the application architecture.

In application architecture, the process management system has three layers. The first layer is client side that includes activity user interfaces, common framework, view composer, common utility and client process management framework. The second layer is server side that includes BPM sub-layer and Service sub-layer. The third layer is DB side that includes Biztak DB, process management DB and Application DB. In the application architecture of <Figure 8>, the client process management framework, service process management framework and process manage DB are primarily developed for the process management system.



<Figure 9> Conceptual DB architecture

The <Figure 9> shows the conceptual DB architecture among all DB architectures including logical and physical DB architectures. In the conceptual DB architecture, we design four main functions that include system information, process management information, real time process information and process management view. System Information part has information about servers, resources, performance services, users and customers. Process Management Information stores information about projects such as classes, methods, menu and logical processes. Real Time Process Information has information about process processing time and process error, configure information and so on. Process Management view gives information about organization, work code, product, order status and so on.

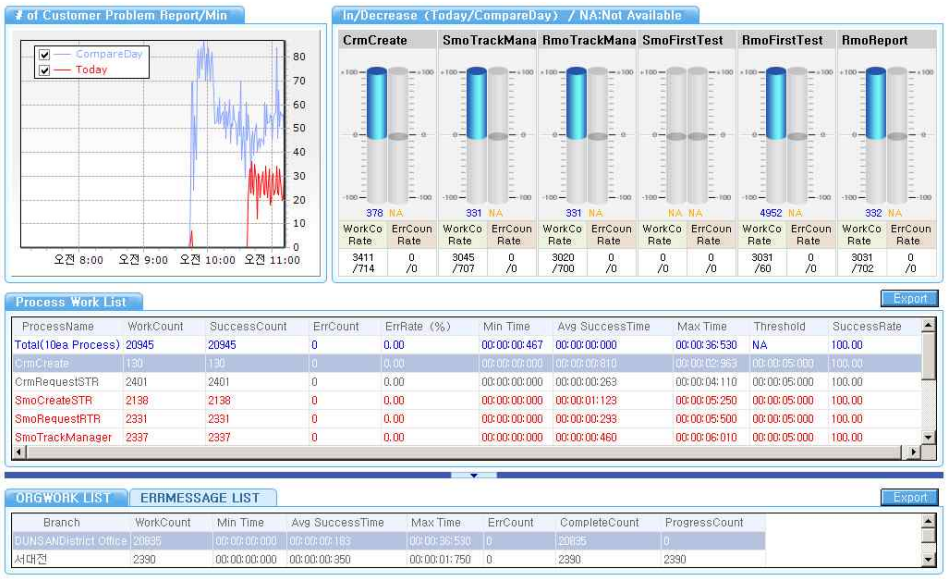
Finally, we develop eight main functions of comprehensive process status monitoring function, process error status monitoring, real time task status monitoring, organization order status monitoring, service order status monitoring, order status monitoring by receipt type, individual order status monitoring, and automatic screen changer for managers for the process management system based on work steps and application and DB architectures. To decide to develop the eight main functions, we consider our objectives in <Figure 5> and balanced score card (BSC). In terms of BSC the eight functions include all four perspectives of financial, customers, internal processes, and learning and growth. The <Table 2> in the next page shows all eight functions of the real time process management system and its evaluation by BSC. In term of strong points, these functions consider all BSC perspectives but, in terms of weak points these functions do not have fault prediction function

<Table 2> Evaluation of main functions by BSC

No.	Main Function	Detail Explanation	Strong Points	Weak Points	View
1	Real Time Process Status	◦ Work status by each process, Over-threshold process inquiry ◦ Work status by each organization ◦ Selecting Conditions, Increment ration inquiry ◦ CPU, memory, network usage	Monitoring assurance process and current number of trouble (Customer, Internal Business Process)	◦ No fault prediction function ◦ No direct connection between process and financial information	Manager/ Operator
2	Real Time Task Status	◦ Work processing status and on-going order processing status inquiry by each work stage ◦ Work no. inquiry and generating graphs by each work stage ◦ Detail work information inquiry ◦ Generating excel	Monitoring real time work processing status and on-going order status (Customer, Internal Business Process)		
3	Organization Order Status	◦ Work no. inquiry and generating graphs by each organization ◦ Order increment ration inquiry by organization ◦ Order status inquiry by each receive type/time/delay ◦ Generating excel	Monitoring order status by each organization (Internal Business Process)		
4	Service Order Status	◦ Work no. inquiry and generating graphs by each service ◦ Service order increment ratio inquiry ◦ Service order status and on-going order inquiry ◦ Generating excel	Monitoring order status by each service(Customer, Internal Business Process)		
5	Receive Type Order Status	◦ Receive type work no inquiry and generating graphs ◦ Receive type order increment ratio inquiry ◦ Generating excel	Selection and focus by inquiring order status(Customer, Internal Business Process)		
6	Process Error Status	◦ Error occurrence no. inquiry and generating graphs ◦ Error increment ratio inquiry ◦ Error occurrence inquiry by each process ◦ Generating excel	Improvement plan by monitoring and investigating error status by each process (Financial, Customer, Internal Business Process)		Operator
7	Individual Order Status	◦ Organization list inquiry ◦ Individual work status inquiry ◦ Generating excel	Measuring individual performance (Learning and Growth)		Manager
8	Automatic Screen Changer	◦ Automatic screen change function for managers ◦ UI selection for manager	Increasing Convenience		Manager /Operator

and there is no direct connection between processes and financial information.

In the following section, we implement all these eight functions and explain the two main functions in detail among the eight main functions of the real time process management system. These



<Figure 10> Comprehensive process status monitoring

1. Setup the graph from the Select Condition popup window : Set the work status by the processes grid: Select the work status for each process.
2. The main graph shows the entire progress of the finished process.
3. The sub-graph shows the rate of increase/ decrease of the average process time and errors generated in each process.
4. The work status by process grid displays the total number of works, number of successes, number of errors, exception rate (%), average work time (seconds), and the average process time and work rate (%). When the maximum process time exceeds the target process time, the time is displayed in red. Double-clicking the data pops up the list of processes that exceeded the target process time.
5. The work status by organization grid shows the process data in brief for each branch and the error event grid shows the error event data in brief.

two functions show comprehensive process status information in real time and order status information by each service such as VoIP, IPTV and leased line. When abnormal events occur, the system detects them and informs managers by changing the color of the process information into red.

4. Implementation of a Real Time Process Management System

In this section we explain how to implement the real time process management system based on the work steps, application architecture and DB architectures discussed in the section 3. We also describe user interfaces of the process management system.

In order to develop the real time process management system we use visual studio .NET 2005 as a programming tool and SOAP as distribution protocol. For presentation tier technologies, we use IIS that is included in Windows operating system and ASP.NET for Web Form and Window Form for C/S. For data tier technologies, we use ADO.NET as Relational and

<Figure 11> The order status monitoring by each service

1. The main graph and sub-graph are displayed for selected services.
2. The number of orders by service grid shows the number of received failures for each service type, number of completions, and the increase/decrease of completed orders compared to that of the reference date.
3. The order in process by service grid shows the number of orders waiting for testing, commissioned domestically, received domestically, completed domestically, commissioned overseas, received overseas and completed overseas for each service type.

Structural DB architectures and SQL Server 2005 as database storage. We also use BizTalk Server as EAI. The hardware specifications for developers are CPU AMD™ 64 CPU and RAM 1G.

With those development tools we developed eight main functions for the real time process management system comprehensive process status monitoring function, process error status monitoring, real time task status monitoring, organization order status monitoring, service order status monitoring, order status monitoring by receipt type, individual order status monitoring, and automatic screen changer for managers for the process management system as in <Table 2> Among eight main functions, we describe two main functions in detail since it is tedious task to describe all functions and these two functions show key functions of the system that are real time process management and when abnormal events occur the system can detect the task having problems.

The <Figure 10> shows comprehensive process status monitoring screen. The description is as follows.

The <Figure 11> shows order status monitoring by each service screen. The description is as follows.

In the real time process management system,

<Table 3> Improved Effects

Improved Area	Improved Effects
Shortening Service Development Period	40%
Shortening Service Assurance Time	20%
Realizing Order Tracking by each service and organization	100%

we also provide real time process analysis information. However, we did not apply automated sophisticated optimization or statistical methodology. Since the system is developed based on NGOSS principles, it can easily adopt new services fast such as VoIP and IPTV. And, it can track all order processing by services and organization. So, if the system detects problems it can find the root cause of the problems. These characteristics can increase telecommunication companies' service quality for customers. <Table 3> shows improvement effects by developing the real time process management system based on NGOSS principles.

Since the system is developed based on NGOSS and SOA principles, the average of service launching time is shortened by almost 40%. That is, average one year of service conception to launching becomes almost seven months with the system. Also the system can reduce service assurance time by almost 20%. By real time monitoring and analysis of abnormal events, we can reduce average 6 minutes of service assurance time from average 30 minutes to 24 minutes in telecom operations and management field. Without this system, we cannot track the order of each service and the order allocated to each organizations. With this system, we monitor in real time the order of each service and the order allocated to each organization.

5. Conclusions and Future Research

This research studied eTOM, NGOSS principles and RTE concept. Then based on NGOSS system development principles we designed the real time process management system architecture to realize the real time enterprise model for telecom operations and management processes. We also implemented the real time process management system and showed and explained comprehensive process status monitoring and order status monitoring functions as examples. By constructing a real time enterprise management system a company can detect abnormal event earlier and respond faster so that it increases customer satisfaction and ultimately increases its profit.

This research, we believe, is the first step for real time enterprise realization based on eTOM and NGOSS principles. Therefore, it can be a good cornerstone for practitioners and researchers who are interested in process innovation and real time enterprise design and implementation especially for telecom operations and management processes.

For further research, we consider two points. One is for developing a real time enterprise system for other processes in eTOM such as customer QoS/SLA management, service quality management and resource performance management. The other is for including efficient optimization and statistical techniques in the real time enterprise

system for real time information analysis such as finding optimal number of operators in operations and management department and predicting error processes by analyzing past error data.

References

TM Forum : Enhanced Telecom Operations Map (eTOM). GB 921, Release 6.0, (2005).

TM Forum : Enhanced Telecom Operations Map (eTOM). GB 921D, Release 6.0, (2005).

Reilly, J. P. and M. J. Creaner, "NGOSS distilled", Cambridge University Press, (2005).

TM Forum : NGOSS Lifecycle and Methodology. GB927, Release 4.5, (2004).

Ok, K., J. W. Hong, and B-D. Chung, "The Design of Operations Supporting System based on TMForum NGOSS", JCCI, (2008).

Chang, B-Y., H-S. Kim, and S-J. Ko, James W. Hong, "A study on service problem management and resource trouble management on a telecommunication network", LNCS 4773, Springer, (2007).

Chang, B-Y., H-S. Kim, and S-J. Ko, James W. Hong, "Next generation network trouble management", KNOM Review, (2007).

Chang, B-Y., J. W. Hong, and B.-D. Chung, "Analysis of network operations management processes", KNOM Review, (2008).

Finger, P. and J. Bellini, "The Real Time Enterprise", Meghan Kiffer Press, (2004).

Hugos, M. H., "Building the Real Time Enterprise," Wiley, (2004).

Abstract

통신망 운용관리를 위한 실시간 프로세스 운용관리 시스템의 설계 및 분석

장병윤* · 박병주** · 황승준***

계속적으로 빠르게 변화하는 통신환경에 대처하기 위하여 통신 기업은 운영상에 일어날 수 있는 이상 event들을 빠르게 발견하고 이를 운영요원에게 실시간으로 알려주는 시스템의 도입이 필요하게 되었다. 이러한 실시간 프로세스관리 시스템은 또한 통신회사들이 제공하는 다양한 새로운 서비스들을 빠르게 수용할 수 있어야 한다. 본고에서는 실시간으로 통신망 운용관리 프로세스를 모니터링하고 분석할 수 있는 프로세스관리 시스템을 설계 및 개발한다. 이러한 목표를 이루기 위하여 본고는 통신망 운용관리 분야의 국제표준으로 인정된 Enhanced Telecom Operations Map (eTOM)을 기반으로 하여 application 및 database 구조를 설계하며 이를 바탕으로 실시간 종합 프로세스 상태 모니터링, 실시간 작업상태 모니터링, 조직별 오더 모니터링 등 총 8가지 기능을 구현한다. 이 8가지 기능은 서비스 지향구조로 개발되었으며 따라서 다양한 새로운 서비스들이 이전보다 빠른 속도로 개발될 수 있게 설계 되었다. 또한 실시간으로 프로세스를 관리함으로써 이상 event들을 빠른 속도로 발견할 수 있게 되었다. 마지막으로 이 시스템은 국제 표준기반으로 설계되어짐으로써 다양한 환경 즉 통신망 운용환경이 다른 지역이나 회사에서도 빠르게 개발될 수있는 flexibility를 가지고 있다. 본 연구는 통신망 운용관리나 또는 다른 분야의 실시간 프로세스관리 시스템을 도입할 필요가 있는 연구자나 실무자에게 좋은 지침이 될 것으로 기대된다.

Keywords : 실시간 프로세스 관리 시스템, 통신망운용관리, Enhanced Telecom Operations Map (eTOM), 실시간 기업

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저 자 소 개

장병윤

현재 아주대학교 경영대학 경영학부 조교수로 재직 중이다. 성균관대학교 산업공학에서 학사, Georgia Institute of Technology의 Operations Research 석사, Applied Statistics 석사, Industrial and Systems Engineering에서 박사학위 취득 및 Postdoctoral Fellow로 근무하였으며, 한국통신(KT)에서 Senior Research Engineer로 재직하며 네트워크 운영 관리 프로세스를 연구하였다. 주요 관심분야는 정보통신경영, 경영과학, 시뮬레이션, 응용통계학 및 Intelligent Business Process 설계 및 구축 등이다.

박병주

현재 한남대학교 멀티미디어공학과 전임강사로 재직 중이다.
연세대학교 기계전자공학부(전기전자전공)에서 학사, University of Florida 전기컴퓨터공학과에서 석사 및 박사학위를 취득하였으며, KT 네트워크 연구소에서 2년간 선임연구원으로 재직하였다. 주요 연구분야는 Mobility Management, Proxy Mobile IPv6, IEEE 802.11, IEEE 802.16e, Seamless Handover, Mobile IPTV, NGN, IMS, Service Oriented Architecture 등이다.

황승준

현재 한양대학교 경상대학 경영학부 조교수로 재직 중이다. 한양대학교 산업공학과에서 학사, Georgia Institute of Technology의 산업공학 석사와 박사 학위를 취득하였으며 현대전자에서 4년 간 반도체 연구소에서 연구원으로 재직하였다. 주요 연구관심 분야로는 Operation Research Technique과 Simulation을 적용한 생산시스템의 최적화 방법론과 물류 최적화 방법론의 개발 및 Business Intelligent System 구축 등이다.