

Adoption of Business Continuity Planning Processes in IT Service Management

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Abstract— For any fault of the same severity level, traditional fault discovery and notification tools provide equal weighting from business points of view. To improve the fault correlation from business perspectives, we proposed a framework to automate network and system alerts with respect to its business service impact for proactive notification to IT operations management. This paper outlines the value of business continuity planning (BCP) during the course of service impact analysis, placing particular emphasis on the business perspective in the processes of IT service management. The framework explicitly employs BCP relevant processes in order to identify the relationships between business services and IT resources. A practical case in IT operations to illustrate the concept was then conducted.

Keywords- ITSM, ITIL, BCP, service event correlation

I. INTRODUCTION

Today, business continuity planning (BCP) is no longer a luxury, but an essential element of the organization's risk management program. The aim of BCP is to keep the organization in business in the event of a disaster by maintaining its critical core processes in the delivery of products and services to its internal and external customers.

Business continuity management process incorporates both a technology element - IT service continuity management and a business element - BCP. Achieving effective management of IT service continuity requires a balance of risk reduction measures in tally with the business continuity planning. In the IT Infrastructure Library (ITIL) Service Delivery [1], IT service continuity management forms one of the management modules in daily IT service management (ITSM). IT service continuity management is concerned with managing an organization's ability to continue providing a pre-determined and agreed level of IT services to support the minimum business requirements following an interruption to the business.

Historically, business continuity was focused on protection against unlikely but large events such as fire, flood, natural disaster. However, even with the interruptions like minutes or hours outage of a critical business system, interruption in service from a critical supplier or outside service provider, or the potential business impact caused by the economy and its

effects on critical customers/suppliers can have serious business consequences.

IT is one of many dependencies the organization has in the delivery of its products and services. It is a tool to support business functions for an organization. Bridging the gap between business and IT services is one of the hot topics in the management perspective where separated management disciplines have to be collaborated. In today's highly competitive and service oriented business environment, organizations regard well managed IT service delivery and support as one of the prerequisites to achieve business goals.

The primary focus of this paper is how the BCP processes adoption helps an organization to improve ITSM in the area of service impact analysis. The issue of this paper is to provide a framework to improve the identification of resources being responsible for a service quality problem. The framework utilizes the steps in BCP to identify the organizational business services, mapping the underlying IT infrastructure for these business services, and prioritizing the recovery alerts. The structure of this paper is as follows. The next section reviews extant literature on BCP and service impact analysis in ITSM frameworks. Then we discuss the deficiencies associated with the common service management processes and tools. Research methodology will be followed for the proposed framework adopting BCP processes to improve the situation. Finally, the conclusion of this study presents the effectiveness of the framework in service event correlation.

II. LITERATURE REVIEW AND FRAMEWORK

A wide variety of models and processes are available in the extant literature on ITSM. However, some of the existing approaches could be improved to address numerous and diverse problems. With the commercially available tools nowadays from most of the management software vendors to help IT managers with incident prioritization, the activities in incident prioritization and service impact analysis are not anymore just well-studied problems in the IT management literature.

In the area of improving the responsiveness to network / system alerts in IT operations, [2] presented a service fault management framework, which identified the relevant components and their interactions between them to provide a

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service-quality-based fault management. The authors also presented a framework in [3] to automatically determine the impact of resource failures with respect to services and service level agreements by monitoring the service quality from inside and outside the service provider and also by incorporating information about the current and expected future service usage. The research in [4] aims at addressing the issues with respect to the service orientation in the IT management industry. The developed approach aims to build a repository of all information needed that is required for business-oriented service management. None of the previously mentioned however makes use of BCP concept to deal with the service-oriented fault correlation and service impact analysis as we do in this work.

For the activities in BCP, [5] made clear that BCP and plans did not mark the end of business continuity activities. They are the pivot between planning and the ongoing management of increased resilience from and response to business interruptions. Many people equate BCP with IT disaster recovery planning in [6]. BCP should contain a detailed specification of system and network infrastructure. Such documentation should make it clear which key business processes and functional activities are dependent on each of the systems. In fact, the purpose of BCP not only documents backup and recovery procedures along with details of any off-site storage arrangements for data/media in response to significant premises-based incident (power outage, fire, flood, etc.), but also provides the full understanding of the key business processes/activities/systems to react service-based incident (e.g. email, venue facilities, network services, etc.). [7] reviewed the development phases for BCP and highlighted that BCP had evolved from simple reactive disaster recovery planning, to crisis management principally driven by information technology, and finally to a more proactive comprehensive approach. The use of BCP in aiding service impact analysis for fault management is therefore cited as the effective way to help organization for better IT service management.

Several ITSM process frameworks such as ITIL [1] & [8] & Enhanced Telecom Operations Map (eTOM) [9] were developed in the IT / Telecom industries. ITIL provides a comprehensive, consistent and coherent set of best practices for ITSM processes, promoting a quality approach to achieving business effectiveness and efficiency in the use of information systems. In the ITIL ITSM hierarchy, service support and service delivery form the basis for service management. Service support aims to deal with day-to-day operational support of IT services while Service delivery provides long term planning and improvement of IT service provision. ITIL subdivides service support into the areas of incident management, problem management, change management, release management and configuration management. Service delivery is subdivided into the areas of service level management, financial management, IT service continuity management, capacity management and availability management. Detailed description of these processes is not included here. One can refer to [1] for details.

On the other hand, although IT service continuity management process in [1] is part of the service delivery set,

the process primarily considers continuity plans development and those IT assets and configurations that support the key business processes rather than the activities in service-oriented fault correlation and business service impact analysis. Today, business services are supported by IT services and sub-services which in turn depending on the underlying IT resources. There are not only situations where an IT service is available or not, but it can be available with a low quality. Although software tools with respective management modules are available in the market for ITSM, solutions for managing IT services, customers and operational processes are not sufficiently developed nor integrated with other management applications following IT services daily processes [10].

To provide agile response to service event which is derived from resource event, we propose to adopt BCP processes to structure the correlation matrices for service impact analysis in IT service management. By making use of the structured process in BCP development, the IT operation management can realize the linking properties amongst business services, IT services, IT sub-services and IT resources. This knowledge framework acts as the supplementary process for fault management in the existing ITIL processes.

III. SERVICE IMPACT ANALYSIS

The effects on service interruption are not limited to financial—revenue or investment loss, overtime, or extra (renting or replacing equipment or staff) expenses. Other types of results can include goodwill, liability and contractual obligation. In order to achieve the strategic alignment between business and IT, prompt response in the management system to discover and prioritize incident from its business objective and user importance for service continuity is essential. As suggested in [3], it is desirable to determine the impact onto services and Service Level Agreement (SLA) when problems with resources or sub-services are detected.

The case recovery target achievement corresponds to one of the measurement criteria in SLA. SLA becomes a basic measurement for gauging the performance of operation team. In [11], the organization achieves significant service target improvement after the adoption of ITIL processes. However, while meeting SLA is the primary target, the prioritization of alerts with respect to business objectives and user importance during the course of service impact analysis could improve further the customer satisfaction. The traditional habit in handling resource event incidents with respect to severity level ranging from low impact of a 48-hour recovery period to very high impact of a 2-hour recovery period are not applicable for service event incident. Severity level normally determines its impact to the entire operation of IT infrastructure in the real world of IT operation environment. Consider a scenario that ten alert cases arrive in which eight cases exhibit higher severity level than the others. The latter two alerts, however, carry higher business impact than the others. The traditional process by the resource-based event monitoring system will weights these ten alerts according to their severity level and obviously the latter two alerts are responded in lower priority. From the business point of view, the minimization of response and turnaround time for these two latter alerts in fact could

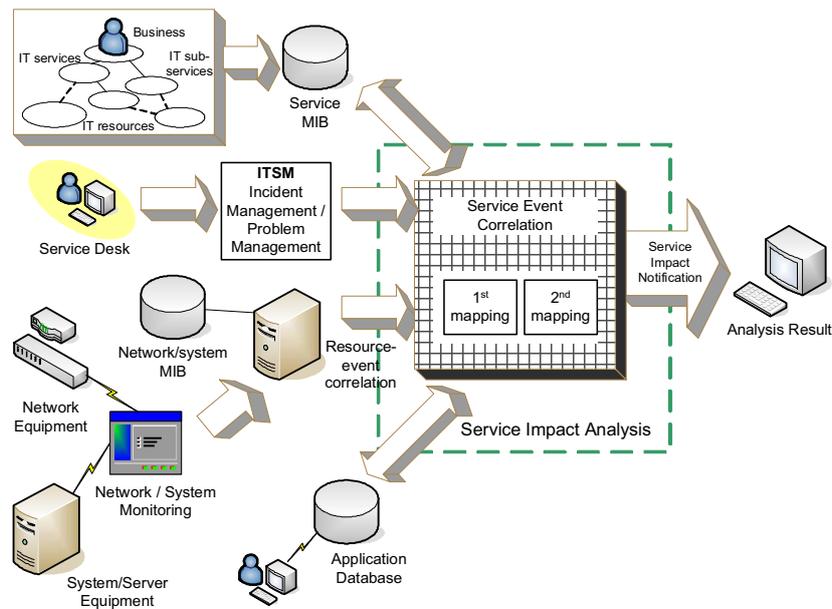


Figure 1 Service Impact Analysis Architecture

bring up the appreciation level of the customer and business service management.

Figure 1 illustrates the architecture for service impact analysis in which we adopted the business continuity planning processes to realize the linking properties amongst business services, IT services, IT sub-services, and IT resources. The service impact analysis provides service impact notification to the operation team in reaction to network / system alerts. By using the notified information, from the perspective of business services, the operation team knows what “in used” or “provisioned” services are affected with their respective prioritized impacts. The first step in assuring the continued delivery of mission-critical services in the event of an Information and Communications Technology (ICT) infrastructure interruption is to identify what are the delivered services, to whom these services are delivered, and to rank each service in terms of its priority/severity. After identifying the mission-critical services, consider what types of ICT infrastructure interruptions are likely to affect these services, and which are unlikely to affect them. The information created will be stored in a knowledge-base, called service management information base, which will be used and reviewed from time to time before retirement. The business criticality level is the first dimension in mapping the service impact while the user importance level, which is not covered in this paper, is the second dimension to map out the service impact notification.

A. Event correlation processes

Types of event

There are two main groups for event classification namely: service event and resource event. Service event comes from Service Desk via customer’s call or service comment email and from the running of simulation tests in regular time intervals, while a network and system management component reports the device-level resource event directly.

Resource event correlation

A network and systems management component like HP OpenView or IBM Tivoli is required to handle the resource management. It contains a monitoring and probing component to get information about the underlying infrastructure and uses information about the configuration stored in the network and system Management Information Base (MIB). This component uses the reasoning approach, such as rule-based, for dealing events on the resource level by making use of its resource event correlator, [12] [13].

Service event correlation

Figure 2 shows the relationships and dependencies for a generic service scenario. The organization offers different services which depend on other services called sub-services. Another kind of dependency exists between services/sub-services and resources. These two kinds of dependencies are not used for event correlation performed today in most cases. Regarding the service event correlation, with the same token as the correlation process for resource event, it requires the

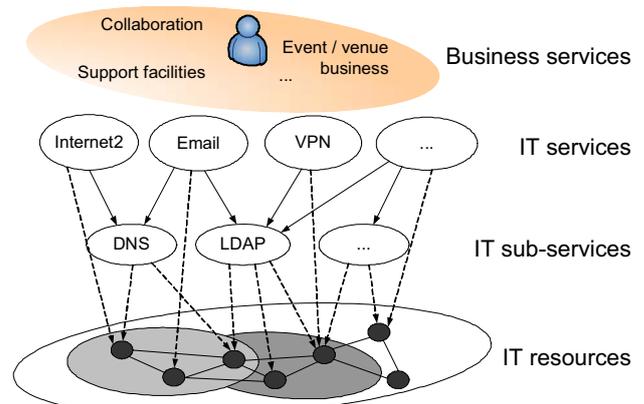


Figure 2 Relationship and dependencies for a generic service scenario

management information base, which resides the full understanding repositories from the business service delivery, its sub-services and the relevant underlying infrastructures for making correlation. With such an information base, the running of simulation tests could provide meaningful service event correlation due to system/network fault.

The process to build up the service management information base requires structured approach and procedures in order to have the full understanding of the interrelations amongst organizational business services and their corresponding infrastructure underlying. The primary objectives are to identify the business relationships with the underlying infrastructure; to prioritize the most critical business impact services; and to ensure service continuity for organization business.

B. Service Management Information Base

The service management information base aims at specifying business-oriented service management information. Traditionally, the MIB employed contains information pertaining to IT resource (systems and network) elements. These management systems for IT facilities do not take into account services or dependencies between services and resources. That knowledge has to be deduced by system administrators and maintained separately. With the formalized establishment of service-resource dependencies as mentioned previously, a comprehensive service management repository can be built to enable consistent management. The maintenance for each resource component in the repository includes the following information:

- Asset / Component ID
- Business services
- Impact level derived from BCP
- Service criteria / relation (AND/OR)
- Alert message
- Service physical coverage

IV. BUSINESS CONTINUITY PLANNING

BCP is a methodology used to develop a plan to maintain or store business operations in the required time scales following interruption to, or failure of, critical business processes (BSI,2001)[14]. Having the BCP in place before the business interruption occurs is critical or the organization may not be able to respond quickly enough to the service interruption. There are several BCP methodologies and models available [5], [6], [7] & [15]. Except for the project initiation stage in BCP development, these models are not exactly the same in the other stages but they can be summarized into five main phases: analysis, solution design, implementation, testing and organization acceptance, and maintenance. Traditionally, BCP serves as a preventive and corrective control measure during the course of business continuity management. In this proposed architecture, BCP processes help the service impact analysis to act as detective measure for the IT service supported business functions. During the course of BCP

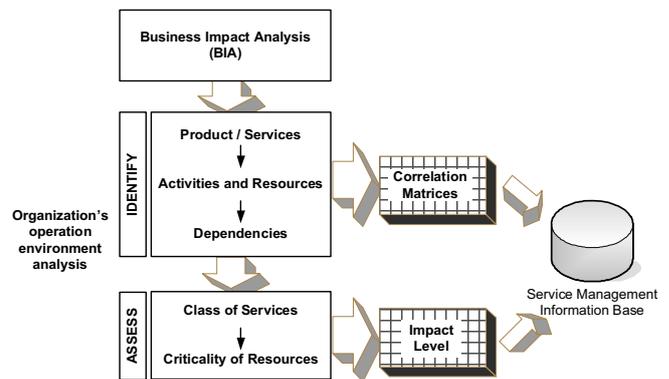


Figure 3 BCP processes in service impact analysis

development exercise, an organization would understand more on their business service offerings with their potential impact to the organization's business due to the failure of respective IT operations in supporting such business process services. From the bottom up perspective, it is useful to link the previously not directly considered relationship from the underlying IT infrastructure (i.e. IT resources) to the business goals of an organization. It helps the organization to provide business-driven IT management by transforming device-oriented management to service-oriented management. Figure 3 portrays the model to adopt BCP processes in service impact analysis.

A. Business Impact Analysis

The business impact analysis (BIA) is a critical part of the planning for business continuity. Widely acknowledged as the originators of business impact analysis, [16] recommended that the generic BIA process should involve the following nine steps:

1. Define assumptions and scope of project for which BIA is being conducted
2. Develop a survey or questionnaire to gather necessary information
3. Identify and notify the appropriate survey recipients
4. Distribute the survey and collect responses
5. Review completed surveys and conduct follow-up interviews with respondents as needed
6. Modify survey responses based on follow-up interviews
7. Analyse survey data
8. Verify results with respondents
9. Prepare report and findings to senior management

The BIA offers a preliminary analysis of some of the idiosyncrasies of every organization's resources, systems and operations. During the BIA process, it helps the organization to evaluate the risk of business process failures and to identify critical and necessary business functions and their IT services and resources dependencies. This will determine priorities which in turn influence many of the financial and operational

commitments to business continuity provisions. The BIA process allows IT / Information Services to have a recovery-time objective (RTO) determined for applications that supports the critical business units. The RTO is the amount of time allowed for the recovery of a business function. If the RTO is exceeded then severe damage to the organization would result.

B. Analysis of the Organization's Operation Environment

The next step is to build on the preliminary analysis through a systematic analysis of the organization's operation environment and a detailed examination of its outputs, activities and dependencies amongst services and resources. This analysis comprises stages of identification and assessment. The identification should be done in three ways and in the order of 1) products and services; 2) activities and resources; and 3) linkages and dependencies. In so doing, it should provide the three important aspects: 1) what does the organization do? 2) who and what is involved in the creation of services? 3) how are the activities linked? This process echoes the view of [17], that "in order to carry out the BIA efficiently, it is first necessary to identify business functions / processes".

The analysis first identifies the organization's product and services. This starting point indicates what is likely to be affected by a business services interruption and who will be the affected customers. This information helps to identify those services which, in the event of failure of IT resources, would have the greatest impact on organizational performance and survival. The analysis is then to identify all resources which contribute to the services. These include those resources which lead to the development, manufacture and sale of the service. By working back from the final business service, all key IT services and resources leading to the final output should be identified. The contribution of each of these resources will vary according to the nature of the organization's business. The degree to which these resources contribute to the final service will determine the provisions that are chosen for their continuity. To determine how an interruption in one part of IT resources could affect the ability to provide business services, we need to identify the dependencies amongst them. Dependencies are important linkages in which one activity must be preceded by another. If one activity fails, all other activities that are dependent upon it will fail. Such information in form of correlation matrices will be resided in the repository. The analysis will then proceed to a stage of assessment to classify the service class for respective business services. This process assesses also the criticality of resources in respect of the business services. Again such information in form of correlation matrices for scoring the impact level will be resided in the repository.

V. A PRACTICAL CASE

We took a case to illustrate the steps in adoption of business continuity planning process for service impact analysis and service event correlation in IT service management. A campus is located in Hong Kong and built as a hub providing not only rentable floor space for research and

development (R&D) offices and laboratories, but also a variety of supporting facilities / services for tenants to foster their R&D works in innovation and technology clusters of IT and telecommunications, electronics, bio-technology, and precision engineering. It is a non-labor-intensive campus for research and development industries which comprises 3 development phases. There will be 30 buildings upon completion in which 18 buildings have been completed with occupancy of 187 companies and over 5,000 employees as of the submission date of this paper.

A. Identify the business process services

Referring to the model as illustrated in Figure 3, the first step in assuring the continued delivery of services is to identify what the delivered services to meet business goals are. From the business management point of view, through the help of questionnaires and interviews, we can carry out BIA for identifying business services and relationships with IT services. Data collection is required for BIA. Questionnaires method was used initially while analysis workshop was carried out in later stage to ensure key information for each system/business function not overlooked and it was the mechanism for collecting baseline data in the development of the Business Continuity Plan.

B. Business process and IT services mapping

We then determine critical and necessary business functions/processes and their IT services dependencies. In most cases, a single business service would require more than one IT service in order to support the service delivery. Table 1 put such information together with the IT services to form a matrix relationship.

C. IT resources and IT services mapping

Another matrix is formed as illustrated in Table 2 which identifies the IT infrastructure (or the IT resources) to support the IT services / sub-services as defined. With these two matrix relationships, it defines the management of IT services (which involves operation and maintenance management of application, network and systems) with respect to the business goals.

D. Classification of business process service levels

[18] suggested to classify business process services and their respective service levels into 4 levels. In this paper, we adopted this classification model which is elaborated in Table 3. Class 1 services are those with a real-time enterprise (RTE) strategy, short recovery-point objective (RPO) / RTO and are those that an organization / enterprise would suffer irreparable harm from if they were unavailable. Class 4 services, on the other hand, are comparatively less important to the key business of the organization. With this relationship, we also obtained the relevant service class for each of the IT services as illustrated in Table 2.

Business process	IT services	Nature of services	BIA class	Disaster Recovery	Structured Cabling Service	Wireless Internet Services	Video Cast Service	VC (Virtual Meeting Room)	VC (Help Desk)	Tenant Web Presence	Tenant Directory	Server Monitoring	Online Reservation	Office Automation System	Network Monitoring (incl. WLAN management)	Multi-Media Content Display Service (MMCD)	IT Service Management	IP Telephony	Intranet Portal (Web Applications)	Internet2	Internet Services	Interactive Office Directories	Interactive Kiosk Services	Indoor Mobile System	HARNET	Email / UM	
Event / venue business (conferences, exhibitions, seminars)		Customer facing	1			X	X	X					X	X					X								
Industry & university collaboration		Partner facing	1				X									X				X							
Incubation program		Less critical business revenue generation function	2			X		X			X										X						
Support facilities for tenants (info, facilities, IT & T services)		Customer facing	1				X	X			X										X						
Other services for tenants subscription		Less critical business revenue generation function	2																		X						
Technology support and lab services (IC design, development, photonics center etc)		Customer facing	1																						X		
Senior executive administration support (CEO, CIO etc)		Senior executives (CEO, CFO, CIO etc)	1						X										X							X	
Billing, settlements		Less critical business revenue generation function	2											X					X							X	
Leasing / tenancy administration		Less critical business revenue generation function	2											X					X							X	
Equipment loaning for tenants (office automation)		Less critical business revenue generation function	2											X					X							X	
Service Apartment		Customer facing	1																X							X	
Building management services (BMS)		Second line technical support	3																X							X	
Network operations center (NOC)		Second line technical support	3																X							X	
Business development and marketing		Departmental functions	4																X							X	
HR, accounting/finance, administration		Logistic / administrative support	4																X							X	
Business Continuity and Disaster Recovery		Second line technical support	3																								X

Table 1 Business Process Service Classification

Class	Business Process Services
Class 1 (RTE)	<ul style="list-style-type: none"> Customer-/Partner-Facing Functions critical to revenue production 7x24 service
Class 2	<ul style="list-style-type: none"> Less- critical revenue producing functions Senior executives support Supply chain
Class 3	<ul style="list-style-type: none"> Second-line technical support Back-office functions
Class 4	<ul style="list-style-type: none"> Departmental functions Logistic / administrative support

Table 3 Business Process Service Classification

E. Resources criticality assessment

The underlying IT infrastructure provides system and network resources to support IT services. Depending on the design configurations, these resource components might be critical for the delivery of respective IT services. We therefore base on the tolerant and redundancy characteristics to score them as below:

Code	Description
K	Key component, non-tolerant, slightest failure can cause major impact.
R	Key, but with some kind of resilience, but will have service impact felt at partial failure. Impact of total failure is significant.
N	Non-key, usually with redundancy or in group (e.g. wireless local area network access point) where failing a few have no significant impact, or it is not critical even without resilience.

To derive the impact levels with respect to the criticality of components; class of service; and the scale of failure (i.e. partial or total), we use the matrices in Table 4.

The matrix relationships amongst business process services, IT services and IT resources we developed in Table 1, 2 and 4 will be stored in the service management information base as portrayed in the model of Figure 3. With the service impact level derived from the Table 4, the next step is to map out the alert level by mapping the resource alerts and service alerts in the Service Impact Analysis architecture for notification, as

Service Impact of PARTIAL failure to component				Service Impact of TOTAL failure to component				
Class of Service	1	Criticality of Component			1	Criticality of Component		
		N	R	K		N	R	K
Class of Service	1	MEDIUM	MEDIUM	HIGH	HIGH	HIGH	DAMAGING	
	2	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	HIGH	
	3	LOW	LOW	MEDIUM	MEDIUM	MEDIUM	HIGH	
	4	LOW	LOW	LOW	LOW	LOW	MEDIUM	

Table 4 Impact Level Mapping Matrix

		Resource Alerts (from IBM TEC)			
		Warning	Minor	Critical	Fatal
Service Alerts	Damaging	Level 2	Level 3	Level 4	Level 4
	High	Level 2	Level 2	Level 3	Level 4
	Medium	Level 1	Level 2	Level 2	Level 3
	Low	Level 1	Level 1	Level 2	Level 3

Table 5 Mapping Table for Service-Resource Alerts

illustrated in Table 5.

We used six illustration cases to demonstrate the difference in handling probed resource alerts by the service impact analysis architecture, as shown in Table 6. The proposed framework analyzes and correlates the resource alerts with its affected business process services with the help of service management information base. The service impact notification contains the information of the affected business service, service coverage, location and impact level. For clarity, we assume the same resource alert level received from the network / system management console for these six cases. Under the traditional approach, the prioritization will normally base on the scale of impact to the entire infrastructure and operations and hence cases '2' and '5' will regard as the top priority for attendance. Compare with traditional approach, service-oriented approach in handling resource alerts enables business aligned IT management for an organization. From the business point of view, resumption of customer-facing services regard as the top priority. In case 1, although the impact is comparatively small to the entire organization's operation, because its service class is '1' and the component criticality is "Key", the service impact is therefore top prioritized.

VI. CONCLUSIONS AND FURTHER WORKS

Effective IT service continuity requires a balance of risk reduction measures such as resilience systems and recovery options including back-up facilities. Traditional BCP and service continuity process provide preventive and recovery solutions to reduce risks in business operations. We see such processes could have synergy in service impact analysis in fault management to facilitate the achievement of service-oriented IT management goals. To minimize the disturbance to organizational business service offerings and proactively respond to service-oriented event, we propose the Service Impact Analysis framework utilizing BCP processes to

establish the dependencies amongst business processes, IT services and IT resources. The interaction with BCP development for prioritizing business importance demonstrates the concept of business aligned service management. While maintaining the predetermined SLA, the proposed framework in ITSM enables IT service support more dynamically with appreciation from the business service with the establishment of service information management base.

The prototypical implementation work is currently carried out which will be put into production environment in the 1st quarter of 2008. With the fine-tuning in system and sufficient working data for building the repository in the coming months, its performance and practical concerns in operational environment will be addressed.

REFERENCES

[1] ITIL (2001), *IT Infrastructure Library (ITIL) – Service delivery (ISBN 0113300174)*, Office of Government Commerce (OGC), London, UK.

[2] Hanemann, A. et al. (2005a), “Towards a framework for IT service fault management”, *Proceedings of the European University Information Systems Conference (EUNIS 2005)*, Manchester, England, June, 2005.

[3] Hanemann, A. et al. (2005b), “A framework for failure impact analysis and recovery with respect to service level agreements”, *Proceedings of the IEEE international conference on service computing (SCC05)*, Orlando, Florida, USA, July, 2005.

[4] Sailer, M. (2005), “Towards a service management information base”, *Proceedings of the IBM PhD student symposium at the 3rd international conference on service-oriented computing (ICSOC 2005); IBM research report no. 23826*, December 2005.

[5] Elliott, D. et al. (2002), *Business continuity management-a crisis management approach*, Routledge, 2002

[6] Savage, M. (2002), “Business continuity planning”, *Work study*, Vol. 51, No. 5, 2002, pp 254-261.

[7] Pitt, M. and Goyal, S. (2004), “Business continuity planning as a facilities management tool”, *Facilities*, Vol. 22, No. 3/4, 2004, pp 87-99.

[8] ITIL (2000), *IT Infrastructure Library (ITIL) – Service support (ISBN 0113300158)*, Office of Government Commerce (OGC), London, UK.

[9] eTOM (2006), “Enhanced Telecom Operations Map (eTOM)”, *Telemanagement-Forum*. <http://www.tmforum.org>

[10] Mayerl, C. et al. (2005), “SOA-based integration of IT service management applications”, *Proceedings of the IEEE International Conference on Web Services (ICWS’05)*, pp. 785-786.

[11] Wan, Stewart H. C. and Chan, Yuk-Hee (2007), “IT service management for campus environment – Practical concerns in implementation”, *Proceedings of the 10th IFIP/IEEE International Symposium on Integrated Network Management 2007. IM2007*, Munich, Germany, IEEE, pp 709-712.

[12] Lewis, L. (1993), “A Case-based reasoning approach for the resolution of faults in communication networks”, *Proceedings of the 3rd IFIP/IEEE symposium on integrated network management*, pp.114-120.

[13] Lewis, L. (1999), “Service level management for enterprise networks”, Artech house, pp.165-190.

[14] BSI (2001), *Information technology – Code of practice for information security management BS ISO/IEC 17799:2000*, BSI, pp.56-60.

[15] BCPG, (1998), *PACE - Business Continuity Planning Guide (BCPG)*, Office of Government Commerce (OGC), London, UK, May 1998.

[16] Strohl Systems (1995), *The business continuity planning guide*, King of Prussia, PA: Strohl Systems, 1995.

[17] Lee, Y., Harrauld, J. (1999), “Critical issue for business area impact analysis in business crisis management: analytical capability”, *Disaster Prevention and Management: An International Journal*, Vol. 8, Issue 3, pp. 184-189, 1999.

[18] Scott, D. (2002), *Best Practices and Trends in Business Continuity Planning, Gartner Symposium ITxpo 2002*, Gartner, Inc., 2002.

Case	Case Description	Service	Service Impact Level	Resource Alert Level	Correlated Service-oriented Prioritization	Traditional Prioritization
1	Network switch node down (floor access level)	Meeting room	Damaging	Critical	4	1
2	Network switch node down (core level)	Half of the entire network	Medium	Critical	2	4
3	Email server '1' down	Email service	Medium	Critical	2	2
4	Content management server down	MMCD service	Medium	Critical	2	1
5	Internet DNS '1' down	VPN, Internet2	Medium	Critical	2	3
6	WLAN AP node down	Wireless LAN	Medium	Critical	2	1

Table 6 Comparison of Prioritized Approach