PROJECT MANAGEMENT FOR CAPACITY UPGRADE OF SUBMARINE CABLE SYSTEMS

Kenichi Yoneyama, Yukihiko Kameyama, Mikio Yoshioka (NEC Corporation)

Email: k-yoneyama@bc.jp.nec.com

NEC Corporation, 29-23 Shiba 5-chome Minato-ku, Tokyo 108-8420 Japan

Abstract: Despite many attempts to predict macroeconomic demand for global IP services, it is quite difficult to predict specifically where, when and how much capacity is required. Therefore, immediate capacity upgrades are required once the capacity demand can be clearly identified. The project management team must be able to handle a lot of issues specific to capacity upgrade in a very short period of time. This paper discusses the project management challenges of capacity upgrades in a submarine cable system – compared with a new system construction – and then describes various aspects to be resolved and their management during the capacity upgrade project.

1. INTRODUCTION

One of the most remarkable features of the optically amplified submarine transmission systems is that they support significant increase in transmission capacity by installing or replacing terminal station equipment. Replacement of the submersible repeaters is unnecessary thanks to the elimination of repeaters' signal regeneration functions. This feature is a great advantage in a capacity upgrade compared with the construction of a new submarine cable system because it eliminates wet-plant cost and marine installation cost which represent a large proportion of the construction costs of a submarine cable system.

Figure 1 shows the features of submarine cable projects for new construction and capacity upgrades.

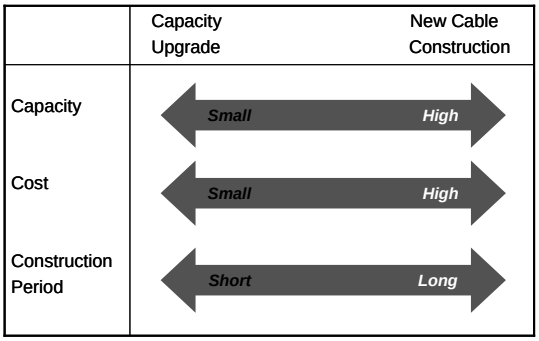

Figure 1: Features of Submarine Cable Project

One of the benefits of constructing a new submarine cable system is to provide a larger capacity enabled by the latest technologies of submersible repeaters, cables and terminal station equipment, however construction cost is high and it takes a long time to complete the construction of the new system.

On the other hand, the cost for capacity upgrade of a submarine cable system is low and its construction period is short. The available capacity may be limited by the characteristics of the existing submarine cable system.

Reflecting such features, the construction of a new submarine cable is planned and carried out based on long-term traffic demand forecasting, while the need for upgrade projects has been carried out based on the most recent actual traffic demand.

Another advantage of the capacity upgrade is that it is possible to provide larger capacity than the initially planned design capacity by adopting the latest transmission technology. As an example, now it is possible to increase the capacity of a 5Gb/s submarine cable system constructed in the mid-1990s several dozens of times (close to one hundred times) by applying the latest 40Gb/s or 100Gb/s WDM technologies in the terminal station equipment.

Figure 2 shows the capacity growth of submarine cable systems for new construction and capacity upgrade. The ultimate capacity in one fiber pair for newly constructed cable increased approximately one hundred times during last 20 years. In addition, applying the latest terminal equipment technology to an existing cable can dramatically increase its capacity.

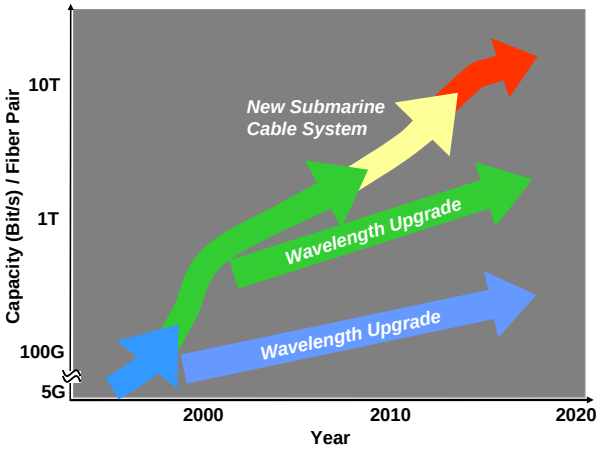

Figure 2: Capacity Growth of Submarine Cable Systems

2. PROJECT MANAGEMENT TEAM OF SUBMARINE CABLE SYSTEM

Requirements for project management skills and methodologies in the project management team for new construction and/or capacity upgrade have different characteristics due to the difference of such project features described above.

A comparison of four major skills required for the project management team for each type of project is summarized in Table 1.

Table 1: Project Management Skills for Submarine Cable Project

Knowledge & Skill	Capacity Upgrade	New Cable Construction
General Management	Needed	Needed
Human relation	Needed	Prioritized
Understanding of Project Environment	Needed	Needed
Knowledge of Discipline	Prioritized	Needed

1) General Management knowledge and skill

General Management knowledge and skill is required for the project management team for both new construction and capacity upgrade. In order to meet the project requirements, knowledge, skills and management tools are applied to the project activity.

2) Human Relation skill

Human Relation skill is the term referring to effective communication, the influence on the organization, leadership, motivation, negotiation skill, conflict management and problem solving skills. In new submarine cable construction projects, many types of equipment are applied, such as submersible repeaters, cables, terminal equipment, and installation of land and offshore plant are

conducted, which makes the scale of construction huge with many stakeholders involved. Therefore, human relation skill is especially prioritized in the project management team for a new submarine cable project to manage conflicts of interest in each party.

3) Understanding the Project Environment

The project environment is different project by project. The project management team has to manage the project, understanding the conditions specific for the project regardless of the types of project. In case of capacity upgrade projects, it is necessary to be well familiar with not only the upgrade system but the existing system, and not only technical issues but commercial terms and conditions. Since the upgrade equipment is integrated into the existing system in the capacity upgrade, terms and conditions such as warranty, maintenance and support issues must be carefully examined and determined between owner and supplier.

4) Knowledge of Discipline

Knowledge of each relevant technical discipline is important for both new construction and capacity upgrade project.

The project management team for a capacity upgrade is required to be well familiar with the latest terminal equipment technology, the former technology applied to existing systems and information related to the initial construction of existing system. The key to the success of an upgrade project is to involve project team members who participated in the initial construction of the existing system as well as specialists who are well familiar with the technical characteristics of the existing system, both dry equipment and wet plant.

3. STRUCTURE OF PROJECT ORGANIZATION

Generally, there are five main types of project organization structure: functional organization, promoter organization, coordinator organization, matrix organization and projectized organization. Among these types of structure, functional, matrix and projectized structures seem to be more familiar in submarine cable projects. Examples of the structure of these three organization types are shown in Figure 3.

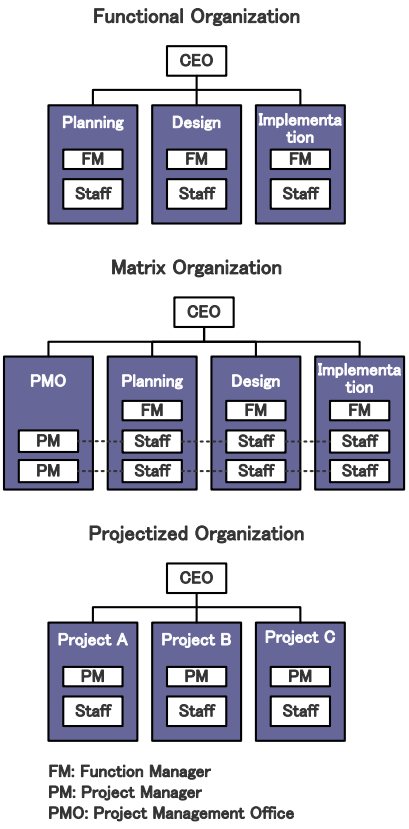

Figure 3: Example of project organization structures

The features of each project organization structure are summarized below.

1) Functional Organization

The Functional Organization is a structure where the organization is divided into

several sections by its function. A member of one functional section plays a role of project manager; however he is not entitled to control resources for the project management team.

2) Matrix Organization

A Matrix Organization is a mixture of functional type and projectized type. This organization type is further classified into weak matrix type, balanced matrix type and strong matrix type depending on the authority of the project manager in comparison with the functional division manager.

3) Projectized Organization

A Projectized Organization is a specialized organization headed by a full-time manager with dedicated project staff.

Table 2 shows the characteristics of each organizational structure and their suitability for new submarine system construction project and capacity upgrade projects respectively.

Table 2: Characteristics of Organization Structure for Submarine Cable Project

	Functional	Matrix		Projectized
		Weak	Strong	
Role of PM	Part time			Full-time
PM Staff	Part time			Full-time
Uncertainty	Low			High
Technology Duration	Normal			New
	Short			Long
Urgency	Low			High
Importance	Low			High
Difficulty	Low			High

Capacity Upgrade — New Construction

New construction of a submarine system costs several dozen million dollars even for a small project, thus a strong matrix organization structure is applied to smaller projects, while a projectized organization is applicable to bigger project costing hundreds of millions of dollars or more.

On the other hand, for capacity upgrade projects, a weak matrix or functional organization is applied to smaller and relatively simple projects, where the supplier has previous upgrade experience. Strong matrix or projectized organizations are applied to bigger and more complicated capacity upgrade projects, with costs on a scale of dozens of million dollars.

Figure 7 shows an example of project team organization for new submarine cable system construction.

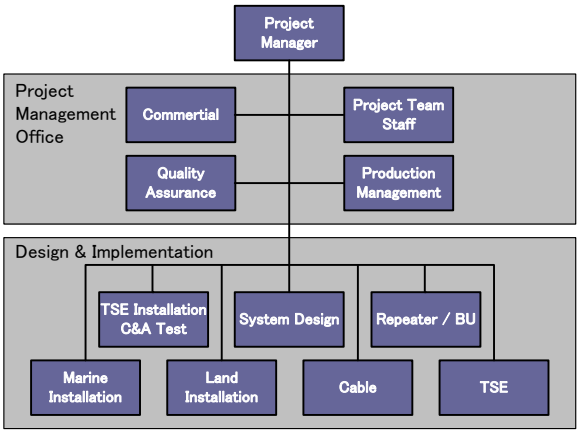

Figure 7: An example of Organization for new Submarine Cable Project Team

The project team for submarine cable system construction consists of a Project Manager, Project Management Office groups and Design & Implementation groups. The Project Manager is responsible for the entire project and maximizes the capabilities of the project team toward the goal of the submarine cable system construction. The Project Management Office is in charge of the project implementation and is an official contact point to the system owner. The Project Management Office typically consists of four groups such as Commercial, Project Team Staff, Quality Assurance and Production Management, and supports the

Project Manager and group members for the Design & Implementation work.

In general the groups for Design & Implementation are determined based on the responsible key products or key activities. The System Design Group is responsible for the entire system design, and there are technical groups responsible for design and control of key products, such as submarine cable, submersible repeater, and Terminal Station Equipment (TSE). The implementation groups are responsible for the land cable installation/testing, submarine cable installation/testing, TSE installation and C&A testing (Commissioning & Acceptance). They perform site/marine route surveys, design the installation materials and tools, and develop the installation/test procedures based on the survey results – taking into account the performance and quality of the entire system.

Figure shows an example of the project team organization for capacity upgrade projects. Since the installation of the TSE and the testing of the system are the main activities for a capacity upgrade project, the project team is considered to be organized with members who are familiar with the system design and/or TSE installation and testing. There are some cases when a designer from a technical group is assigned to project manager for a capacity upgrade project.

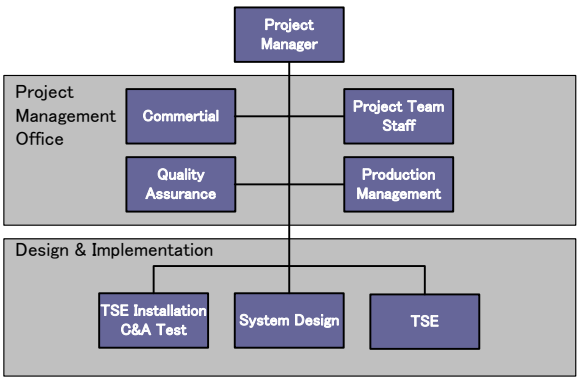

Figure 8: An example of Project Organization for Capacity Upgrade Project Team

4. SCOPE MANAGEMENT

In the early phase of the project, the project team plans and defines the Scope of the Work (SOW) including responsibilities and scopes of the cable system owner and the supplier.

In the case of new construction of submarine cable systems, any misunderstanding about the scope concerning the obtaining of construction approvals and/or the related permits may cause major problems, affecting the time and cost of the project, thus it is necessary to clearly clarify the details of the scope of work beforehand.

On the other hand, for capacity upgrade projects, it is most important to clarify the scope of work between the existing systems and upgrade system. In addition it is necessary to clarify the responsibilities and scope concerning the interface and inter-operability between the existing system owner and the upgrade system supplier.

The existing submarine system to be upgraded is the property of the owner, thus the owner is responsible for the performance and quality of the existing system, while supplier of the upgrade system is responsible for the performance

and quality of the upgrade system. In the case that the existing system and upgraded system might affect the performance and quality of one another, the owner and the upgrade supplier should discuss possible resolutions and define the scope of the work correspondingly.

The simplest way to minimize the risk concerning the interface between existing system and upgrade system is that the supplier of the existing system provides the upgrade system. The existing supplier is well familiar with the technology adopted in the existing system, its performance, configuration and interfaces, minimizing the technical risk and eliminating the need for detailed explanations to the upgrade supplier about the existing system.

5. TIME MANAGEMENT

Since the overall project schedule is determined by participants' scopes, the project team must carefully study the order of scopes and link them appropriately to make a comprehensive project POW (Plan of Work).

In new submarine system construction projects it takes a minimum of one year to complete the project, even for small projects, and in case of large-scale projects often more than two years. The critical path of the new cable project time schedule involves the concatenation of route survey, design, manufacture of cable and repeaters, acquisition of construction approval and offshore construction. Thus the project management team should pay particular attention mainly to the time management of these critical paths.

On the other hand, the project period for capacity upgrade projects is relatively short, about four to twelve months. The critical path of project time schedule is a function of the times for manufacture of upgrade equipment, station survey, procurement of installation material, transportation, installation and system testing. In this case, the project management team should study its plan of work (POW) precisely, focusing on the linkage between those activities, and then monitor and control the progress and of each activity very carefully.

Since the time period of each activity – and the entire project – is very short in capacity upgrade projects, due to the urgency of new capacity expansion to meet the rapid growth of capacity demand, lack of careful preparation causes delay in bringing the upgraded system into service. Therefore, the activities on the critical path must be managed more precisely. Regarding the transportation, local regulation for importation, such as tax, custom clearance and type approval etc., must be carefully studied and examined together with logistics arrangement in advance of equipment shipping.

At the phase of wavelength insertion of upgrade system into the existing system, the system owner sometimes needs to advise his traffic users of a possible traffic impact during the integration work. This announcement to the users must comply with the period agreed between owner and users. The system owner and supplier should have a common view of the POW, and they have to schedule the announcement of the upgrade work to the users at the appropriate timing.

In order to achieve a schedule margin as contingency, the project management team should request that the production group and the implementation group to make front loading of the equipment manufacturing and installation schedule in the beginning stage of project.

In the event of schedule delays due to unexpected problems, the project team should consider and take action to recover the schedule by adopting the techniques of crashing and/or fast-tracking depending on the situation.

6. COST MANAGEMENT

For new submarine cable construction projects, one major uncertain factor in cost management is the final construction cost. Since the marine operations cost is a large proportion of the total construction cost for new submarine cable installation, the construction cost could fluctuate largely reflecting the cable vessel operation period. This fluctuation can be caused by acquisition of construction approval delays and/or a stand-by period due to bad weather conditions.

On the other hand, for upgrade projects, the uncertain factors for cost management are the integration design to the existing system and the cost for installation and testing. If there are any unclear issues pertaining to the existing system at the system design stage, it might be a cause of system integration problems – leading to the modification or replacement of upgrade equipment – or additional materials costs may be incurred in solving the problem. Lack of station survey data and/or its analysis and incorporation into the design might be an additional cause of cost for materials and on-site remedies. Delay of customs clearance and transportation of equipment incur a waiting cost. In addition, delay of the announcement to the end users about the wavelength insertion schedule would also incur additional waiting costs for installation and test engineers.

7. QUALITY MANAGEMENT

In both new construction projects and capacity upgrade projects, the supplier implements quality management for the provided equipment and services. As described in the Scope Management section above, the interface between the existing system and upgrade system could be a risk for a capacity upgrade project. The project team in capacity upgrade projects implements quality management regarding the interface between the existing system and upgrade system, especially in case that the existing system is upgraded using newly developed technology. During the process of system design and evaluation, the upgrade system supplier has to verify that any new technology fits well or match to the existing wet plant without traffic impact on the existing traffic (wavelengths). There are a few ways to verify the upgradeability of the existing system by adopting the technologies:

1) numerical simulation
2) test bed evaluation
3) field trial

Numerical simulation is performed at the design stage for studying the feasibility of the capacity upgrade, and then transitional experiments are performed by test-bed evaluation or by a field trial on the existing system. The benefit of a test-bed evaluation is to be able to examine the upgrade performance without any interruption to the live traffic on the existing submarine cable system. Only the original system supplier can provide this benefit to the existing system owners.

8. CONCLUSIONS

The great advantage of optical amplifier technology to the owners of a submarine system is its capacity for upgradability. The submarine cable system can be upgraded simply by adding or replacing the new optical transponders in the cable landing stations.

Given such features, short timescale capacity upgrade projects have been carried out based on the most recent actual traffic demand.

This paper has provided an overview of the skills, scope and functions of the project management team for capacity upgrade projects of submarine cable systems. Furthermore we have contrasted these characteristics against those required in new construction projects.