submarine telecoms

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Recovering and Relaying Cables

For Building New Subsea Systems

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Why Cable Relay?

With the prevalence of submarine cable systems in international communications, two trends can be observed in the development of international subsea long-haul transmission infrastructure. The first one is the increase in capacity for existing busy routes, which can be achieved by either building new subsea cable systems or upgrading existing ones. The second trend is the building of new subsea routes in order to bring physical diversity to existing ones for increased resiliency, or to offer optical connectivity to small islands that do not have access to high-speed telecoms services.

In essence, the new subsea systems aiming to provide small communities with connectivity to the rest of the world do not require huge capacity but must offer a low price point to make the business case viable (keeping in mind the intrinsic small number of customers).

Two options are available: (i) building a new subsea cable system, using components carefully selected to minimize the cost, or (ii) recovering and redeploying a subsea system that has been decommissioned, most often because of the unfavorable ratio between capacity and operational expenses on highly competitive submarine routes.

In Xtera's experience, which includes the implementation of multiple cable redeployment projects, building regional low-capacity systems on new routes represents the application where a cable relay makes the most sense. On cable system operators' side, cable relay is a concept that is more and more accepted [1].

Lifetime of Recovered Cables

Both submarine cables and repeaters are designed, specified and manufactured to offer a nominal life span of 25 years. Practically speaking, this lifetime can be much longer due to system overdesign to ensure the lifetime requirements are met and to the fact that materials used in cables have a significantly longer life than what was originally thought [2].

In a recently worked example, Xtera looked at an opportunity where the decommissioned cable had been in use for just under 10 years. Taking the pessimistic n value of 3 [See papers by Davies et al., Southampton University] and given the reliability being proportional to kV to power n, we showed that if the cable was originally operating at 7kV and, subsequent to that, at 3kV in a shorter system, then the cable had in excess of 600 years left at these voltages.

For the wet plant, including repeaters, the major factor is that there are several elements which allow the status and expected lifetime to be assessed. These elements are: very few active optical elements in a repeater (in fact, only the semiconductor lasers), a well-documented fault history and, in general, access to the repeaters to indicate how well these were performing prior to decommissioning.

Taking the same system and knowing that the wear-out mechanism for lasers follows a

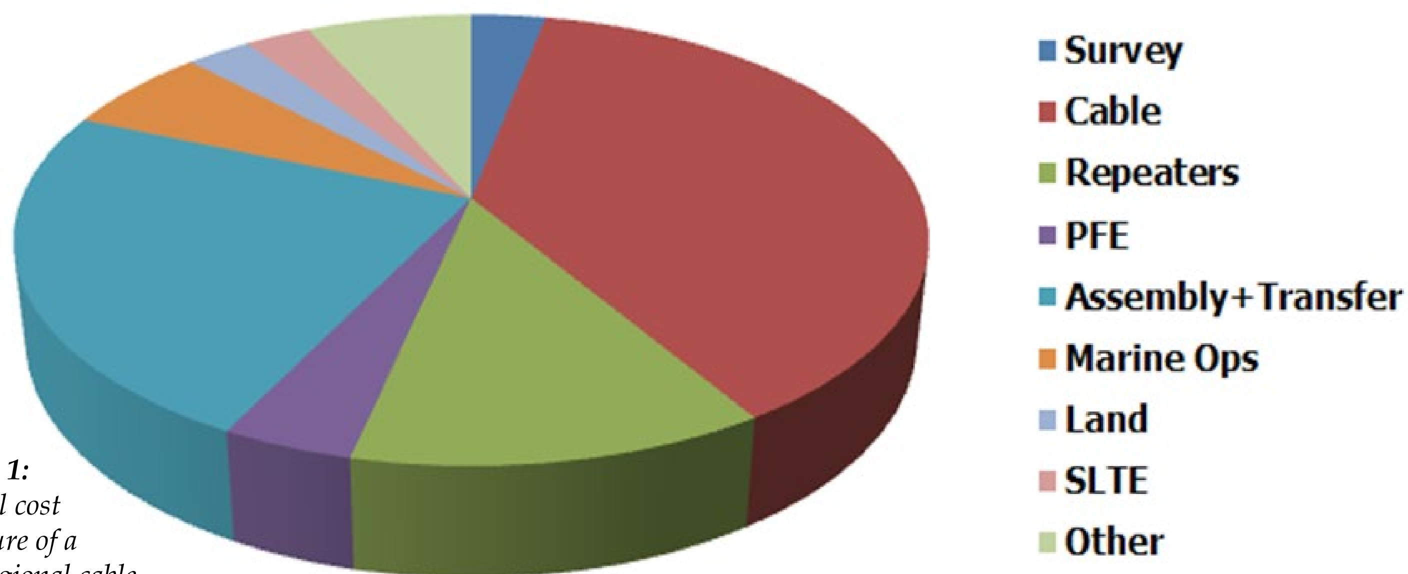

Figure 1: Typical cost structure of a new regional cable system.

lognormal distribution, the total laser (and associated electronics) failure rate increases from 85 FITs at 25 years to 128 FITs in a further 25 years. Xtera was able to show that this corresponded to 0.65 ship repairs over the next 25 years. As this rounds up to 1 then this is no different to a new build equivalent for the same link.

A further level of comfort can be gained from the understanding that, in general, most ageing occurs in the early life of a system. This means that, several years after commissioning, the subsea cable operators have a pretty good idea of the "physical shape" of their wet asset: either multiple, regular failures happened and a pattern can be deducted to predict degradation in the midterm, or no degradation happened after 1 or 2 years of commercial service and there is a high level of confidence that the subsea cable was properly designed, manufactured and installed, and that it will retain good characteristics and performances for the future.

Of course, there is an alternative scenario when there is some doubt. The solution is to reuse the cable and replace the repeaters, and this too has been shown to be cost effective and offer a capacity boost.

Benefits from Cable Redeployment

Lower Project Cost

The typical cost structure of a new regional submarine cable system is depicted in Figure 1. The largest portions are cable, repeaters, transfer to the deployment location, and marine operations. These portions also represent the biggest opportunities for cost savings.

On the one hand, cost is saved on the cable (and repeaters if they are recovered and re-used as well). On the other hand, some extra marine operations are required for this wet plant recovery. The cost of extra marine operations is primarily driven by level of difficulty required to recover the cable from the sea bed, and is dependent on the original installation (surface laid or buried). But in the end, and when the transportation costs of new cable from the few cable factories dotted around the world are factored in, the cable relay approach can lead to significantly lower system prices compared to new builds as represented in Figure 2.

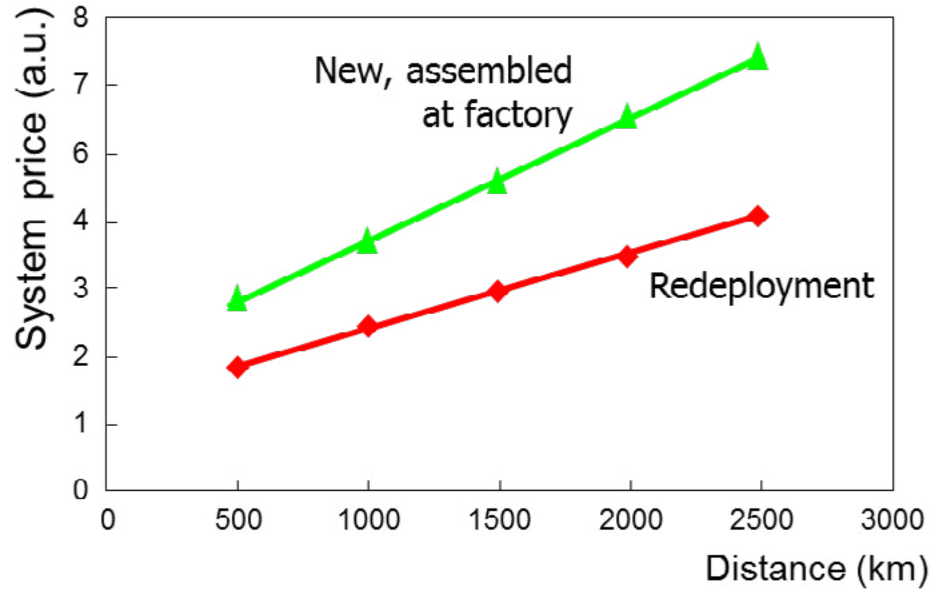

Figure 2: *Comparison of system price as a function of system length between new build and redeployment approaches.*

The price comparison in Figure 2 assumes a two fiber pair system, a short distance between recovery and redeployment locations, a system in deep water with little burial, and some new cable purchased for the shore ends.

Shorter Lead Time

Another key benefit of the cable relay approach is the shorter lead time for project execution compared to new builds based on new cable. While manufacturing a long optical submarine cable can take several months (a typical figure is 9 to 12 months), recovering an existing cable requires much less time (in general, Xtera targets the recovered cable to be in the region of the redeployed cable so general lag time is 3-4 months prior to redeployment).

Greener Approach

Manufacturing a new cable requires energy and multiple materials, some of them being scarce or costly to produce. On the other hand, recovering an existing cable requires minimal energy (namely cable ship fuel). A global comparative study about the potential environmental impacts of submarine cable systems has shown, however, that the recovery and relay of an existing submarine cable correspond to about 5% of the environmental impact caused by the manufacturing and deployment of a new cable [3].

Cable Considerations

In order to make a redeployment project viable from both the economic and technical perspectives, there is more to consider than simply the physical status of the cable that is candidate for recovery and redeployment.

Where Is the Cable Coming From?

Cable redeployment is an appropriate approach if the cable is recovered from a less or similarly benign seabed than the destination seabed. Because recovery of extensively well buried armored cable can be a slow and risky process, the redeployment solution works best for a destination that needs a minimal amount of armored cable and a maximal quantity of deep water cable. When the existing cable is simply surface laid, cable recovery is fast and is very unlikely to degrade the cable characteristics.

Additional Technical Challenges

<u>Optical Line Design</u>

To optimize the optical line design, circulating loop and straight-line setups with the ability to use different types of line fibers and repeaters represent powerful test beds. These, coupled with accurate optical transmission modeling tools, enable the replication of the new subsea system and the maximization its performance.

<u>Cable Recovery Process</u>

The cable recovery process has to be well controlled in order to avoid applying mechanical tensions on the cable and repeaters which exceed the upper specified limits. Here, the challenge is to maximize the cable recovery yield, i.e. the amount of the existing wet plant that can be effectively re-used.

<u>Landings</u>

Where possible, existing landing should be re-used in order to avoid cost of permits, lead time to obtain them, and all the installation activities needed for the landing itself. Armored cable is required for shore ends and shallow water. In general, this will be a new build.

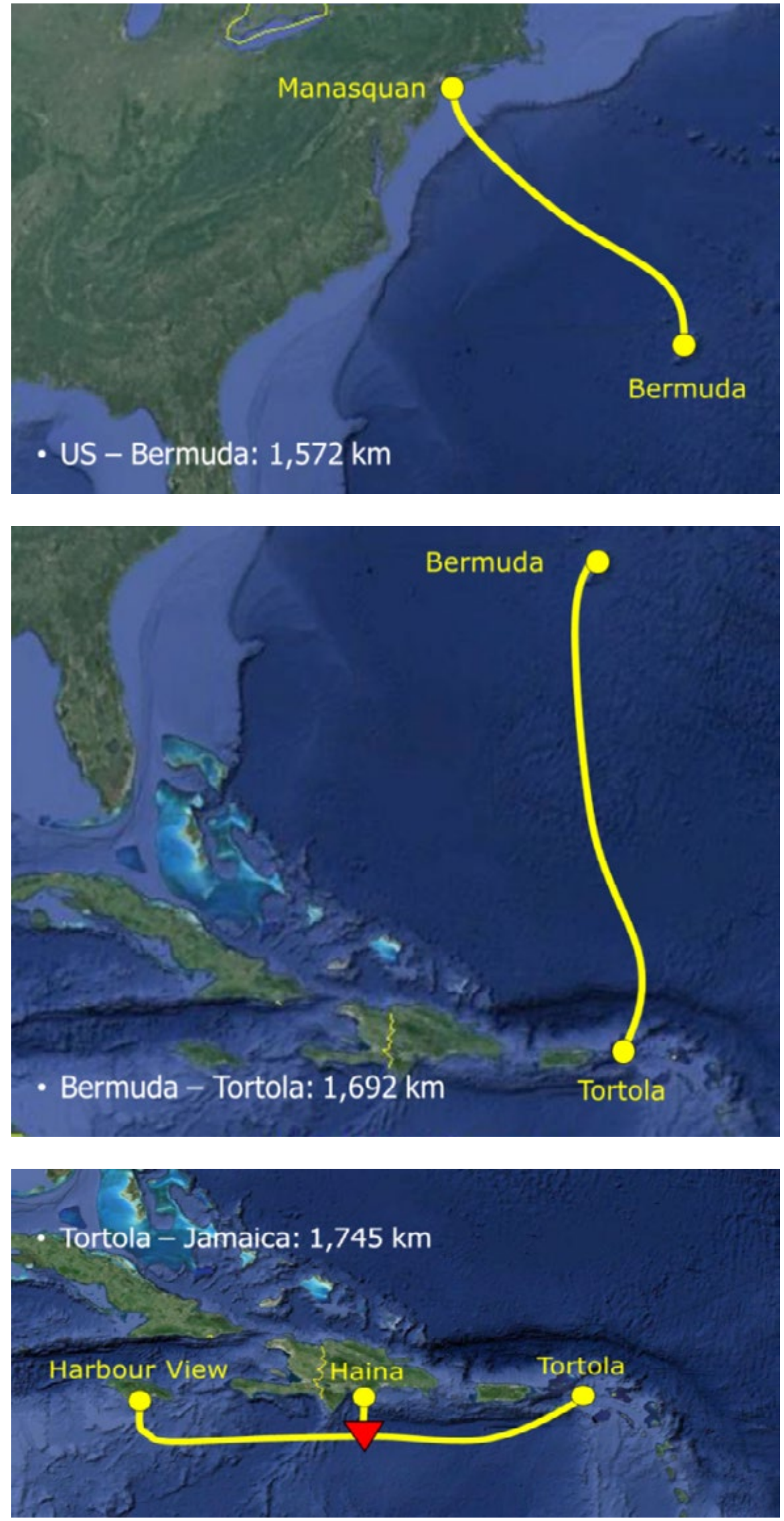

Figure 3: *Three redeployment projects based on decommissioned Gemini cable.*

Line Monitoring

If repeaters are re-used in the redeployed cable, they must be monitored in the new system. The line monitoring equipment is therefore required to generate and detect the test signals appropriate to the system and locate the fault to within one repeater section.

Project Management

Management of a redeployment project is quite different from a new cable project as many more boundary conditions need to be taken into account. As one does not start from scratch, with brand new, clearly specified wet components, cable redeployment project are typically more challenging projects to execute.

Redeployment Examples

Starting in as early as 2007, Xtera has been developing its expertise and has gained an unrivalled experience in cable relay projects. Below are three examples of cable relay projects based on the recovery of the Gemini cable. The Gemini system was a two-leg transatlantic cable system that was phased out only 6 years after its commissioning in 1998 due to its obsolete terminal transmission technology. Pieces of the decommissioned Gemini cable were recovered and redeployed for the three relay projects depicted in Figure 4.

Conclusion

There are many compelling reasons to use recovered cables around the world. Compared with new builds, using a cable relay offers the following benefits:

- It can be significantly quicker to get the system up and running with funding in place;
- In some cases, we can see savings close to 50% when compared with new build;
- There are massive environmental savings upwards of 95%.

Recovering a phased out cable system with the objective of building a new system in another location is a challenging endeavor requiring additional skills with respect to standard new builds based on brand new wet plants from the factory. Also, the commercial benefit the purchasers can expect from the relay approach is strongly driven by multiple factors, including original marine installation of the cable to be recovered, relative locations of existing and new systems, and project requirements. As such, relay project assessment shall be carried out on a per project basis, and requires a high level of expertise in order to correctly identity, quantify and optimize all the factors impacting the project cost and performance.

References

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