Fundamentals of Cable Redeployment

Alan Proudfoot, Steve Bladen, Gordon Mathers, Kevin Willoughby, Tony Frisch, Joerg Schwartz (Xtera Communications), Stephen Dawe (Vodafone)

Email: alan.proudfoot@xtera.com

Xtera Communications, Bates House, Church Road, Harold Wood, Romford RM3 0SD, United Kingdom

Vodafone, 32-43 Chart Street, London, N1 6EF, United Kingdom

Abstract: Re-configuration of an existing system (cable and/or repeaters) has been done in different ways to date, either performing this operation on a cable laying vessel, or by taking the recovered cable system, to a suitable depot for reconfiguration on land. The former may save time (particularly where the recovered span lengths can be used in the new application as this minimises any cable transfers between tanks) but requires a cable ship with sufficient cable storage capacity and jointing resources, whereas the latter needs more transits and loading to the lay vessel. On the other hand this approach offers more flexibility in handling, adjustment of cable lengths/types and subsequent system testing. We discuss practical aspects and advantages of these methods, and also consider hybrid and alternative approaches.

1. INTRODUCTION

Submarine systems, including the cable and repeaters, are specified and manufactured to operate for a life span of around 25 years, with less than 3 repairs [2] although with overdesign and new or upgraded terminal equipment, this lifetime can be extended much longer. In general, other than random faults, most ageing happens within the early years of a systems operational lifetime. A commonly used model for the failure of a submarine cable system is the use of a bath-tub curve, which begins with a fairly high failure rate, followed by a longer period of stability (the useful life span of the system), with the failure rate again increasing as the cable reaches the end of its life. Other than through unanticipated faults, such as cable or fibre breaks, the performance of a system can be predicted many years after commissioning, and its future degradation and subsequent performance calculated. Experience has shown in the past that recovered cable and repeaters have been reliable – for example on one redeployed system, there were no unexpected signs of ageing after 15 years in service.

In our experience, almost one third of the budget of a new regional cable system can be attributed to the cost of the new cable [1]. This makes redeployment viable from an economic viewpoint, but there are still many technical details to consider. There are various options to reconfiguring and redeploying a recovered cable. One of the main Questions that needs to be answered before deciding on cable route is whether it is more efficient to pick up the whole system, or to replace each individual repeater? These methods of redeployment can include reconfiguration off-site or at sea for a relayed system, or reconfiguration in-situ, if only replacing the wet-plant.

Option	Take recovered cable back to factory/depot for reconfiguration 	Reconfigure on vessel during recovery and transit 
Pros	• Flexibility during reconfiguration, less time pressure • Easier to integrate cable and wet-plant from different sources	• Less transiting and loading • More time efficient
Cons	• Higher loading and transiting costs • But: can be mitigated by using 'cheap' recovery vessel	• Weather dependent/risk • Lots of jointing at sea • Requires full cable ship, with at least 3 cable tanks for reconfiguration

Figure 1: Comparison of Recovery and Reconfiguration options.

2. COMPARISON OF REDEPLOYMENT METHODS

Reconfiguration Off-Site

For longer systems, with many additional repeaters, it is usually required to recover the system, reconfigure and relay. There are two options in doing this, as shown in Figure 1. For the first option, taking the recovered cable back to a depot for reconfiguration, a cable vessel does not necessarily have to be used – it is possible to use a freighter which has been modified to perform deep sea cable recovery, having been fitted with a bow roller, cable engines, main drum winch, and repeater recovery routes and storage.

Reconfiguration at Sea

In the second option, the cable is recovered and reconfigured on the vessel, using a dedicated cable ship.

Benefits from cable redeployment:

- Lower Project cost
- Shorter lead time
- Greener approach
  - The manufacture of a new cable requires a great deal of energy and new materials, which can be costly to produce. A redeployed system, however, requires less energy, the amount of which can vary from system to system.
- Cheaper

For this technique to be cost-effective there needs to be a hard cut-off for the project at 50 days of ship time – if the ship needs to resupply, then it is more economical to reconfigure the cable in a factory. This corresponds to around 10 repeaters (including the transiting times), which can probably be done quicker on a relayed system.

Experience shows that although typically most of the recovered cable is in a

condition suitable for re-use, a significant amount of re-configuration work, such as jointing or adding other sections of recovered or new cable, may be required. This is due to the fact that (over)crossings prevent recovery of some sections of cable, dispersion needs to be adjusted, or because different armouring types are required on the new route.
One of the main disadvantages of this approach, the cost of transfers, can be mitigated if a freighter is used which has been customised for deep sea cable recovery; the conversion process involving the addition of a bow roller, cable engines, drum winch, cable tanks, and repeater recovery routes and storage.

Where possible, existing landings should be used. This can avoid the potentially costly and time consuming permitting process, as well as the installation activities required. As installation work will be done in shallow water depths, armoured cable is required for the shore ends, although this will generally be of a new build [5].

Reconfiguration In-Situ

For a wet plant upgrade on an existing system that is not being redeployed, instead being kept in the same location, it is possible to upgrade in-situ. This is done in the same style as a wet-plant repair, but with the added benefit that it can be planned in advance, as the logistics are much more complicated, involving additional work and testing. This technique is preferable for shorter systems (less than 5 repeaters), due to the time involved per repeater. An example of this technique is shown in [Figure 2].

1. Localise the cable at the relevant region
2. Cut the cable using the cutting grapnel (or ROV)
3. Retrieve one end of cable at cut with lifting grapnel/ROV, test to station, seal end
4. Fit pick-up rope and lay down on seabed
5. Retrieve cable on the other side of the cut, test to station, splice tailed component onto this end
6. Deploy tailed component onto seabed back to first sealed end, recover and make final splice
7. Drop cable, and if required, re-bury using ROV

For both shallow and deep water, a grapnel can be used for cutting and then grappling both cable ends. This technique can be used in almost any weather conditions, but lifting grapnels are much more likely to damage the existing cable, requiring more cable to be replaced, and more post lay burial, if required. Another method, for shallower water depths, is the use of a ROV, which offers many advantages over a grapnel, such as causing less damage to existing cable, and better operation in more confined areas, such as busy areas with more cables. Unfortunately, this system is very weather dependent, and a lot slower, with the added ROV launch and recovery operations.

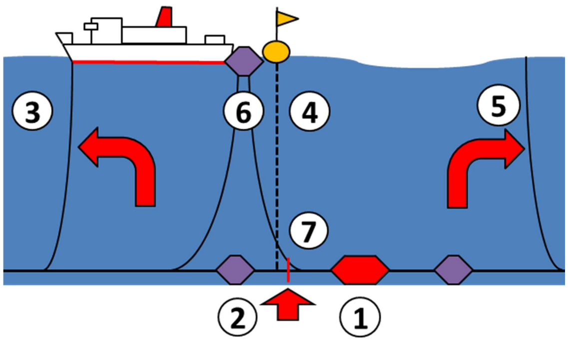

Figure 2: In-situ reconfiguration steps

There are a few other disadvantages or issues related to recovering and relaying a cable. These can include:

- the system having a lower capacity when using recovered repeaters and cable, as opposed to a new system.
- Management issues can also arise due to the different repeater types used,with various bandwidths. When reusing repeaters in a redeployed system, they must be monitored in the new system. If new repeaters are also used, this can mean large differences in the repeater spacing, and potentially the insertion of attenuators in UJs at cable interfaces. Performance can vary in different directions due to the variances in the repeater bandwidths. The line monitoring and management equipment will therefore have to be designed to talk to various different types of repeaters.
- In certain areas, the recover and laying of cables can only be undertaken at particular times of the year, due to weather conditions and permitting issues, such as fishing licences, which can cause long delays.

Another advantage to redeployed and reconfigured systems is the shorter lead time for the project, compared to a new build system.

3. RECONFIGURATION PROCEDURES

Once the cable is on-board the vessel or taken to the reconfiguration depot, factory, or other facility, the reconfiguration would involve the following steps:

- Visual inspection of recovered cable during off-loading. With any damage or faults noted
- OTDR and loss measurements of sections
- Potential tank transfers to match RPL
- Integration of repeaters and any newly manufactured cable
- Overall system testing (supervisory/loss measurements)

4. REDEPLOYMENT CASE STUDIES

Based on the above, we are now reviewing a few real-life redeployment projects and reflecting on why the different methods have been used for these specific cases.

CBUS and East-West

Recovery and reconfiguration on ship because the system was used largely ‘as is’, with few crossings to be cut out, spans unchanged, and repeaters re-used

GOKI

Reconfiguration was done on land because the cable came from different donor systems picked up in different campaigns, as well as some new cables. The wet plant was largely re-used, but some new parts had to be integrated

HUGO

Reconfiguration ‘in situ’, i.e. at sea with cable left in place and only certain parts picked up and re-configured (repeaters added), as shown in Figure 3. This was because the cable was already in the right place (after redeployment and Gemini repeaters removed) but needed boost in capacity.

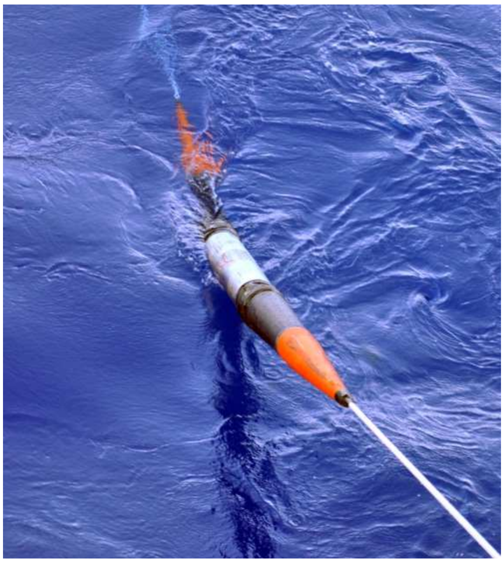
Figure 3: Deployed repeater

5. CONCLUSION

In this paper we have outlined and reviewed options for re-utilisation of submarine cable systems. Although the inherent risk in a project involving a redeployed system is higher than a new build cable system, a cheaper solution can be found if the customer is willing to be flexible and suitably experienced project teams established to design, engineer and implement a reliable system.
There are many challenges to redeploying an existing system, but the cost and manufacturing time savings are immediately clear. There are many available options,

There is no 'one-for-all' solution for a relayed system project. This includes the method of redeployment, the relative locations of the original marine installation and relayed system, amount and types of cable re-used, and whether it needs to be reconfigured, as well as if the wet plant is to be a new-build, re-used, or isn't required entirely. Because of this, each project will need to be assessed and carried out on a per-project basis.

6. REFERENCES

[1] "Recovering and Relaying Cables for Building New Subsea Systems," Bertrand Clesca, Submarine Telecoms Forum, Issue 79, November 2014.
[2] "Submarine Salvage, a Second Life for Old Cables", B Clesca, Fibre Systems - Xtera - September 2015
[3] "Undersea Fibre Communication Systems," Jose Chesnoy, 2002
[4] "Extending the Lifespan and Capacity of Submarine Systems by Wetplant Modification", J Schwartz, Submarine Cable Forum, Miami – 5 November 2012
[5] "Shore Ends to Re-Use or Not to Re-Use," Steve Dawe, Tony Frisch, Barbara O'Dwyer, Denise Toombs, SubOptic 2004