WHICH TECHNOLOGY FOR YOUR OFFSHORE NETWORK: UNREPEATERED OR UNRELENTINGLY REPEATERED?

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Abstract: Communications networks may be the one challenge facing the Oil and Gas industry in exploiting deepwater and remote fields. What is lacking are long distance communication solutions based around high reliability, real time and undersea connectivity. Now the industry is pondering about the respective merits of the unrepeatered and repeatered technologies to build up their offshore network solutions.

This paper will provide all the necessary pieces of information in order for one to run their tradeoffs and decide on the best technology for their application. It will thoroughly go over the performance versus costs tradeoffs for each solution. Finally a decision grid guideline will be offered so as to match the solution to the customer criteria.

1 INTRODUCTION

The Oil and Gas industry seems poised to seize benefits of new technologies to enhance their business processes, knowing the oil demand is expected to grow from 80 Millions Barrel per day in 2005 to 130 Millions Barrel per day in 2020. As for the production from deep water, the production of both oil and gas is expected to have doubled from 2005 to 2010, the deep water contribution shifting from 10 % of the total production today to about 25 % in 2015. Therefore deepwater expenditures match a substantial increase in activity. From a CAPEX standpoint, it is expected that deep water spending will amount 20 Billion $/year in 2010, with an accumulated $94 Billion in 2006-2010 [1],[2].

From a communication standpoint, the deep water environment can be best characterized by extended reach, well over 100 km between any two points, sometimes in excess of 500 km away from shore. The environment may be severe, for example through hurricanes, like in the Gulf of Mexico, or seasonal ice on the artic margin. Consequently, there is a trend to implement more and more subsea processing. Therefore more and more control will be located subsea around the well heads.

For the offshore network interlinking strategically located hub plat-forms, the capacity requirement is over 2.5 Gbit/s of aggregated traffic per node. The system should offer independence in such a way that the communication can be maintained even if the node on one platform shuts down entirely or is lost. Additionally the system should maintain operation even if a single fault has occurred and provide open, standard, interfaces while being self sustained.

The new real time processes that maybe managed over these new networks will put a premium on availability. The proven technology and fault tolerant duplicated systems should aim at enabling quality of service towards a 99.99 % availability.

Figure 1 displays a typical offshore network interlinking a number of different hub nodes in the field.

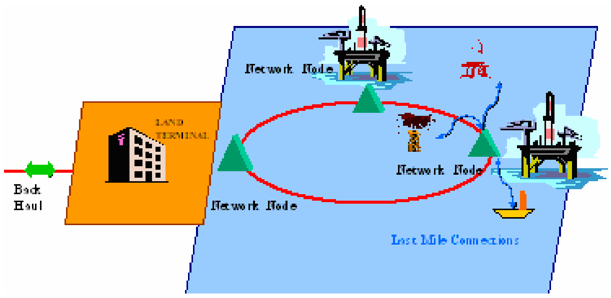

Figure 1: The offshore network and associated hub nodes

While there may be simple point to point link applications when the need is simply to link a single platform and the shore end, deep water applications will call for redundant paths to shore for a number of hub nodes in the field. The paper will concentrate on offshore networks encompassing a number of hub nodes and not a simple point to point links.

Some last mile connections can be implemented around each hub node so as to connect temporary facilities

2 UNREPEATERED OFFSHORE NETWORK

2.1 Solution key features

In the case of the unrepeatered network, there are two alternatives.

2.1.1 Transit at every node

The trunk line transits through every hub node and each fiber pair is terminated at each and everyone of the hub nodes.

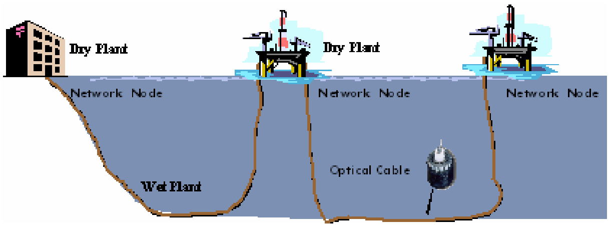

Figure 2: Unrepeatered network with hub transit

The maximum distance in between any two nodes is limited by the unrepeatered technology and is currently about 400 + km for a wavelength division multiplexing capability.

There is no need for the cable to sustain or carry electrical power. The backbone can be implemented as a ring. Nevertheless, in this case, there is no platform independency since the traffic goes through every platform and the shutdown (or drift, or sinkage,…) of any single platform will open up the ring, leaving the traffic unprotected. There is no limitation to the platform count. Each platform can benefit from one protected 10 GigE as long as the ring is closed. The network can be expanded by connecting new hub nodes to the existing ones within the limits of the unrepeatered technology.

2.1.2 Node independency

The trunk line transits in front of every hub nodes which is served by a dedicated fiber pair acting as a spur off the trunk to the node. The trunk can be implemented as a ring and there is platform independency in this case. Each platform has its dedicated fiber pair whose traffic is secured back to the landing points. Worth noting is the fact that a platform shutdown will not affect the trunk line and consequently the traffic of the other platforms won't be affected. Nevertheless the design of the trunk design is constrained by the reach of the unrepeatered solution. The distance between any node and the farthest landing point cannot exceed the limit of the unrepeatered solution. Each platform can benefit from one protected 10 GigE.

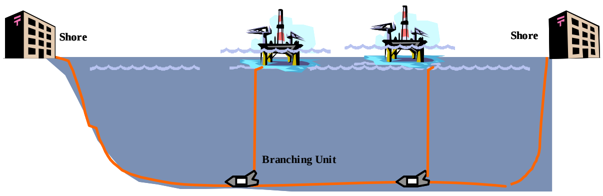

Figure 3: Unrepeatered network with spur to the hub

The number of platform is limited by the fibre pair capability of the cable. Further network extensions would therefore have to be planned up front and not all future hub positions could be accommodated, stemming from the distance limitations.

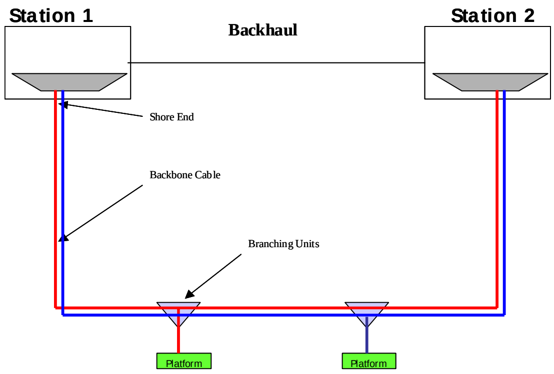

Figure 4: Connectivity on a fiber pair basis

Each platform receives the same signals from the west and east sides using a ring architecture, based on the usage of alternate path to shore.

For all intended purposes, most potential customers have ruled out the first option and would only consider the second one, featuring node independency.

The design flexibility is driven by:

- The connectivity on a fiber pair basis;
- The limited reach of the unrepeatered solution;
- The limited extension capability.

2.2 Interfaces

A submarine solution is usually terminated at a beach man hole where a land cable provides for optical and electrical continuity up to the land station. From there, a back haul connection has to be established to the customer's Point of Presence (POP).

The solution will be based upon standard open interfaces.

At the land station, the power feeding equipment necessary to electrically feed the repeaters in line can be either powered from – 48 V DC or from the AC mains.

The recommended input and output communication data are Ethernet signals in order provide IP network connections. Other standards could be used such as SDH or SONET. In any case, the optical transport solution is transparent to the input and output communication signals.

2.3 Key product

A vaulted cable is recommended that can provide the fiber with a very good protection. A 14 mm design whose optical core is inherited from the repeatered cable technology is best. It can accommodate up to 12 fp of any type and will yield very low attenuation. A robust but yet simple range calling for LW, LWP, SA and DA cable types will suffice.

A simplified Branching Unit is necessary to enable the spurs off the trunk. This is a fully passive BU since no electrical power has to be called for.

A dynamic riser is also necessary to effect spur connectivity from the sea bottom to the top side. A torque balanced design of the DA type appears as a technically sound choice.

2.4 Technology status

All these products are qualified, readily available and there are consequently no technology gaps.

2.5 Reliability

The reliability of this solution is that of a ring architecture, leaning towards a 99.999 % figure.

3 REPEATERED OFFSHORE NETWORK

3.1 Solution key features

The repeatered network comprises a backbone and spurs off the backbone to the hub nodes.

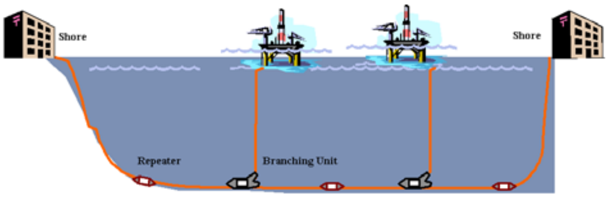

Figure 5: Repeatered network

It is yet again a full ring structure. The difference with the unrepeatered network is that of the spur connectivity and principle. There is no need for a dedicated fiber pair per platform since the connectivity is achieved on a wavelength basis. There is no need for high voltage on the spurs and the power feeding equipments are located ta the shor ends. Each platform is assigned with a dedicated set of two wavelengths. Each platform receives the same signals from the west and east sides using a ring architecture, based on the usage of alternate path to shore. Each platform can benefit from one protected 10 GigE. A typical solution would rely on a 2 fp trunk with no practical limitation in platform count.

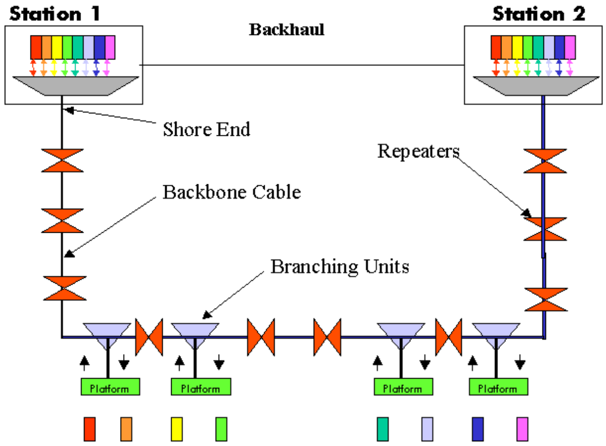

Figure 6: Connectivity on a per wavelength basis.

Further network extensions are an easy proposition since there is no distance limitations with the repeated technology and idle branching units located at strategic locations are sufficient.

The design flexibility is driven by:

- The connectivity on a per wavelength basis;
- The unlimited reach of the repeatered solution;
- The limited extension capability.

3.2 Interfaces

The interfaces are the same as those described in 2.1 with the same rationale.

3.3 Key product

A repeatered cable is mandatory indeed and there is a case to use a 14 mm design whose design is optimized for regional size repeatered networks.

The branching units benefit from an optically commanded power switching capability. The BU electrical state is therefore stable in between any of the three configurations possible and only the optical command can modify its electrical state.

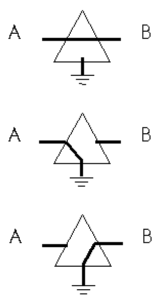

Figure 7: BU electrical states

The standard configuration would be A to B, along the trunk line while either A or B could be grounded for operation and maintenance purposes.

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4 REPEATERED VERSUS UNREPEATERED TRADEOFFS

4.1 Performances

The main performances that the customers will take into account are the solution reliability, the design flexibility (including the number of platforms) and the easiness of potential extensions.

While the reliability of both solutions can arguably be considered as identical, the repeatered solution is much more flexible. There are no reach issues nor practical limitations on the platform count. As far as future extensions are concerned, there is again an edge with the repeatered solution which can benefit from idle branching units with no reach limits and no issues with fiber pair count.

4.2Cost

As usual, the CAPEX and the OPEX have to be thoroughly understood. A study case will be looked at in 6. The OPEX cost should be about the same since they will be driven by the Marine Maintenance agreement whose scope is going to be identical for the two solutions.

4.3 Time to implementation

For regional scale networks such as those, the schedule would be driven by the cable manufacture. Therefore, there is no lead time difference between the two solutions.

5 DECISION GRID

5.1 Criteria

The purchasers's buying criteria will be the CAPEX, the OPEX, the solution reliability, the design flexibility and its future proofness.

5.2 Proposed grid

The following decision grid is proposed with its associated weighting, from least important faring at 1 and most important faring at 5.

Criterion	Weight
CAPEX	5
OPEX	4
Reliability	5
Design flexibility	4
Future Proofness	4

A weighted average is then used in order to make out the best choice.

The paper will look at the following study case:

- 1000 km length
- 10 platforms
- 10 fp unrepeatered backbone
- 1 f repeatered backbone

This is even a bit of a stretch for an unrepeatered system but the paper aims at concentrating on a regional scale network.

Parameter	Repeatered	Unrepeatered
CAPEX	9	10
OPEX	10	10
Reliability	10	10
Design flexibility	10	7
Future Proofness	10	5
Weighted average	215	188

This is a significant sway towards the repeatered solution and a clear indication that despite being slightly more expensive, the repeatered solution should be favored in light of the selection grid.

6 CONCLUSION

A thorough analysis of the offshore network requirements has shown that the repeatered technology is best suited to effect offshore connectivity on a regional scale, in a single or muti-customer environment. This technology will yield much more flexibility in the design and planning phases of the project allowing decisions to be taken much later in the procurement process. Future proofness is also a built-in feature of this technology which seems of great interest to the customers.

The unrepeatered technology can show its merits in single point to point or small scale project. It is worth noting that it can also be used for last mile extension off a hub node.

7 REFERENCES

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