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SUBMERGED EQUIPMENT – THERE FOR THE LONG RUN?

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Introduction

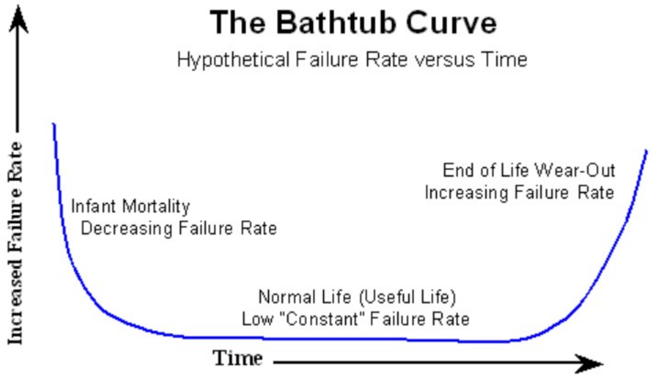
- Subsea repeaters and cables are designed and manufactured for a 25-year lifespan, which comes at a significant cost.
- However, some systems are retired well before their time is up, whereas others that are operated for many years longer.
- This begs the question: How future proof does submerged equipment need to be?

What is required for system to have 25-year lifetime?

- To enable a 25-year system lifetime requires very low failure rate of the system components
  - Cable
  - Repeaters
  - BUs

Usually expressed as 0.1 ship repairs per 1000km per 25 years

- To achieve this low failure rate, stringent engineering needed -
  - Component choices
    - Critical components must have well-understood aging behavior
    - Screening
    - Burn-in to eliminate infant mortality
  - Design choices
    - Redundancy of key components and sub-systems
    - Well-understood designs to minimize failure modes
  - Rigorous manufacturing tests such as HALT/HASS
  - Extensive qualification programs



- Result is a very reliable system, but at the expense of cost, long development times and relatively conservative design

How long do systems really last?

- Given the requirement to guarantee min of 25-year lifetime, it follows that, in practice, systems can continue to operate for much longer than that without any failures.

- Some systems do continue to be operated well beyond their design lifetime -
  - CANTAT-3 (RFS 1994, partly)
  - Americas I North (RFS 1994, partly)
  - Columbus IIb (RFS 1994, partly)
  - ECFS (RFS 1995, full service)

- However, the majority of systems are retired close to their 25-year design lifetime and some significantly earlier
  - Gemini (RFS 1998, Retired 2006)

  - Recent Telegeography study showed that for cables retired between 2010 and 2022, the average lifespan was 17 years

So why are working cable systems put out-of-service?

- Over the lifetime of a system, changes occur that can make cable systems uneconomic to operate compared to a new system
  - New technologies emerge that mean newer systems can support orders of magnitude more capacity for similar OPEX
    - E.g. Optical Amplifiers vs. regenerators, WDM vs single channel systems
  - Commercial agreements expire and are expensive to renew
    - E.g. consortium builders and owners, Operating licenses
  - Maintenance agreements expire and/or expensive to extend beyond 25-year design lifetime
- Consequence is that expensively designed (money and resources), fully functional cable systems are put OOS and replaced with new

How to resolve?

- Two options to consider

A. Find ways to extend the commercial lifetime of a cable system beyond the 25-year design life

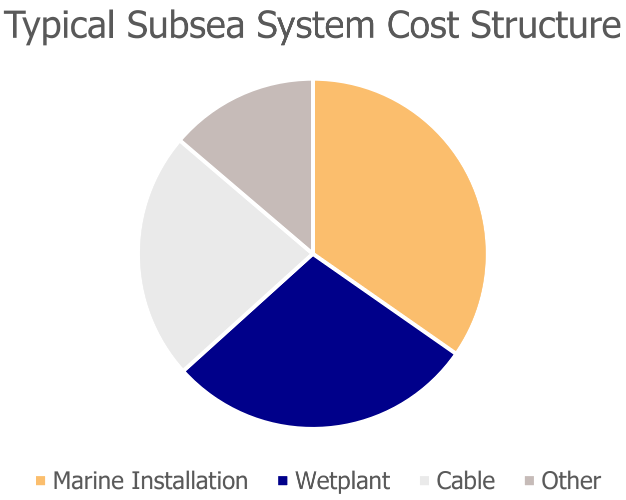
  - Has been explored in past via continued upgrade via improved terminal equipment; repurposing cable for lower capacity requirement applications; or recovery and redeployment to new location.

B. Relax cable system design life requirements to better match commercial lifetime of real systems -

  - No need for hi-rel components => potentially cheaper repeaters etc.
  - Less stringent qualification requirements? => faster development
  - New technologies introduced => more innovation

Where is the cost – and how much of it is for extending the life?

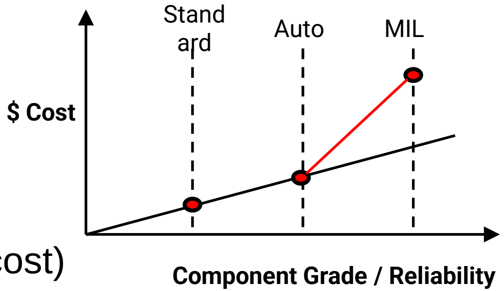
- Cost buildup of a cable system
  - Cable and Marine dominate the hardware cost
  - Each contribute to about a quarter of the system cost



- Repeaters and cable are the main elements that could have a lifetime dependent cost
  - All dry plant elements can be replaced and are not designed for a 25 year system life

What are the opportunities to reduce repeater cost?

- Potential cost-savings :
  - Sea-case material: e.g. steel vs. titanium
  - Use of reliable, but not MIL/Subsea grade components
  - Avoiding/reducing duplication (also reducing assembly cost)
  - Avoid/reducing assembly testing and screening



Is there a business case for a less-reliable repeater?

- Usual contractual requirement today is 0.1 ship repairs per 1000km per 25 years
- What if that would increase by a factor of 10, i.e. 1 ship repair per 1000km over 25 years?

- Assumed cost of a 25-year lifetime repeater — $500k
- Repeater with reduced design objectives
  - Avoiding/reducing duplication (also reducing assembly cost)
  - Use of reliable, but not MIL/Subsea grade components
  - Use of cheaper materials
- Estimated cost saving potential – 30% — $150k

Rough estimates!

- => Cost-saving per 1000km – 10 repeaters — $1.5m
- Compare to: Typical cost of a repeater replacement — $1m

- NET COST SAVING — $500k per 1000 km

Space Division Reliability?

- It is worth noting that except for a few items (repeater mechanics and powering) most items that could fail based on a reduced lifetime requirements would only affect <u>one fibre pair.</u>
  - This gives the opportunity to mitigate the increased chance of repeater failures coming from reduced lifetime requirements by having a redundant FP in an N+1 arrangement
- Assume $20k for additional FP in repeater
- Assume $30/km for additional FP cable
- => Additional cost for redundant FP $230k
  - 1000km, 10 repeater system
- Compare to: Cost-saving per 1000km, 10 repeaters $1.5m
- NET COST SAVING ~$1.25 per 1000 km

Conclusions

- Subsea repeaters and cables are designed and manufactured to ensure a very low chance of requiring a marine repair during a 25-year lifespan, which comes at a significant cost.
- This in turn means that cable systems have a real operational lifetime well beyond their 25-year design target, although the vast majority are put OOS well before this for economic and commercial reasons

- Have explored whether it is feasible to reduce the repeater lifetime requirements without impacting the commercial lifetime of the system
  - There are opportunities to trade off repeater cost vs. increased chance of marine repairs
  - Alternatively, it could be possible to use FP redundancy to mitigate the increased chance of marine repairs

- Benefits of a lower repeater lifetime requirement
  - Lower cost
  - Faster development / manufacture
  - More innovation

- Is our industry too risk-adverse to take advantage of these trade-offs?

Thank you for listening

Any questions?

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