SUBSEA NETWORK OPERATION CENTER – A NEW MODEL

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Abstract: Recently the Submarine Cable Network Operation Center (NOC) concept has adapted to better support the changing subsea industry, beginning with innovative ways for monitoring network equipment and alarms. As a natural evolution of the closed-cable turnkey support model, the new open cable environment demands vendor-neutral services and the ability to support a panoply of equipment domains where multiple vendors are participating. In the new paradigm, the NOC provides a central role, facilitating communications and sharing of operational and design details between the various vendors, customers and suppliers on behalf of system owner(s). This enables work plans to be developed for successful integration, maintenance and operation of the system. Key to the new NOC service model is the presence of experienced staff, trained on multiple Submarine Line Terminating Equipment (SLTE) platforms and cable systems. The successful NOC also oversees network operation along with maintenance coordination adapted to each customer while ensuring joint operational agreement compliance. The resources made available to the NOC include technical support group, researchers, designers, manufacturing engineers, system testers, commissioning and testing personnel, outside plant and marine installers, which provides NOC customers with considerable extra added value

1. INTRODUCTION

The internet content providers referred to as 'OTTs' have had a great influence on the subsea industry, changing the system ownership models from several members to few members and sometimes only a single OTT member.

Because the OTT customers are focused on their core business of content and end-to-end network operations, they have tended to outsource their subsea system operations to existing network operators and more recently to the entities who best understand the technology details: the subsea system supplier itself.

In a similar fashion to the OTTs, the re-emergence of coherent technology has had a huge impact causing a market shift to the open cable paradigm where transmission equipment is acquired independently from the undersea wet plant.

The implementation of the 'open cables' concept, by itself, has forced the Network Operations Center (NOC) to assume a centralized, highly technical and administrative role. New governmental regulations have also influenced how the NOC functions.

New shared spectrum, flexible baud rates SLTE technology available from many suppliers, as well as increasingly complex subsea network designs enabled by high fiber count cables and reconfigurable undersea nodes has further added considerable complexity to network operations and maintenance.

This paper describes how these elements have led to the creation of a new subsea supplier provided NOC model.

2. TRADITIONAL NOC ROLES

Traditional NOCs are comprised of tier-1 and tier-2 personnel. Tier-1 support is characterized by 24/7 coverage and is often outsourced to a 3rd party. In general, the tier-1 personnel have a broader understanding of a system and its equipment but may not understand the detailed inner workings.

Tier-1 personnel focus on identifying a customer's needs, gathering information, opening trouble tickets and providing guidance in resolving more common issues that might be documented in a FAQ list or knowledge base.

When a tier-1 support employee is not able to resolve an issue, the problem will be classified and escalated to the appropriate tier-2 employee who has deeper knowledge and troubleshooting skills.

Traditional NOCs perform real time equipment and circuit monitoring, analysis, control and triage of the transmission equipment as well as wet plant monitoring including daily review of system status, alarm, events and performance data.

Supporting standards often used by traditional NOCs include those from the International Telecommunication Union (ITU) which summarize the roles of telecommunication network management functional areas using the 'FCAPS' acronym describing the following list [1]:

- Fault management
- Configuration management
- Accounting management
- Performance management
- Security management

ITU-T recommendations series E and M also provide general operational and maintenance guidance for telecommunication network, but recommendations such as ITU-T M. 3060 'Principles for the Management of Next Generation Networks' dated of 2006 and 'Routine Maintenance' dated of 1993 are no longer up to date with the new subsea paradigms.

3. KEY CAPABILITES FOR THE SUBSEA NOC

A subsea NOC operates and maintains an undersea network with or without: Submarine Line Terminal Equipment (SLTE), the front haul, and any terrestrial backhaul between the landing point and the Point-Of-Presence (POP). At times, a subsea NOC may operate under the umbrella of a higher level NOC that oversees data transmission between POPs and/or data centers.

A subsea NOC differentiates itself from a traditional terrestrial NOC by providing additional capabilities pertinent to the management of large undersea systems. The assignment of subsea NOC responsibilities to any organization lacking the requisite expertise would have serious technical and economic impact on the system owner and the subsea network itself.

The following enhanced capabilities must be provided by a subsea NOC:

- A NOC Power Safety Officer (PSO) that maintains electrical power control of the subsea network at all times - except when transferred to a marine repair vessel. The PSO ensures Cable Landing Station (CLS) personnel safety and minimizes the chance of

avoidable network outages due to inappropriate powering of the subsea network;
- Continuous wet plant monitoring that provides expedited detection, classification, and localization of unexpected wet plant faults. The use of subject matter experts for line monitoring avoids mistakes in locating faults that might lead to repair delays and higher costs;
- Open-Cable terminal equipment integration coordination, support and management. These activities enable turn-up of SLTE while ensuring proper operation of the Line Monitoring and Command Response systems;
- Compliance with governmental regulations specifically for subsea networks;
- Deep technical knowledge of the wet plant including subsea elements, dry plant including multiple SLTE supplier equipment and network management systems; and
- Regular O&M coordination meetings with CLS engineers, System Owners and O&M officers.

4. SUBSEA NOC ROLES & SERVICES

Various roles have been assigned to the subsea NOC. Namely:

- Primary NOC (PNOC) with a broad scope of extended services;
- PNOC with basic services focused on monitoring and maintaining the operational status of the Wet Plant
- Secondary NOC;
- Network Administration (SLTE Operation, Administration, Maintenance and Provisioning); and
- Front Line NOC services.

Nineteen tasks have been identified for the PNOC with extended services:

Task	Description
1	24x7 real time monitoring
2	Expedient triage of system issues
3	Daily system TT & status review
4	Marine fault location and repair
5	Processes development and review
6	DCN monitoring & maintenance
7	O&M meetings orchestrator
8	Contacts, security & escalation list
9	System status & outage reporting
10	Fronthaul monitoring & repair
11	CLS system routines
12	Repair & return
13	Documentation centralization
14	Security access control
15	CLSs maintenance coordination
16	Maintenance windows coordination
17	Joint O&M agreement adherence
18	Platforms security administration
19	Governmental adherence

Table 1: Extended Subsea NOC services

A PNOC with basic services will perform tasks 1 to 9. PNOC customers may, however, choose selected services 'à la carte' that best meet their needs.

The secondary NOC role mirrors the role of the PNOC, using the PNOCs own tools and characteristics. The secondary NOC may be activated on-demand, under the following typical situations:

- Disaster recovery;
- Disaster recovery exercises; and
- As requested by governmental authorities.

Regarding the 'Network Administration' role, the NOC functions correspond to the following Table 1 tasks (1, 2, 3, 5, 6, 7, 8, 9, 11, 12, 13, 14, 16, 18, 19), to which circuit provisioning and testing must be added.

As for the Front Line NOC (FLNOC) role, this consists of providing a single point of contact and support to the capacity or fiber pair user(s) of a subsea network that is owned and/or controlled by another party.

5. THE OPEN CABLE CHALLENGES

A new crucial responsibility assigned to a subsea NOC is to operate and maintain the undersea wet plant with various Submarine Line Transmission Equipment (SLTE) connected to it.

This responsibility requires the NOC to orchestrate installation work between all parties (system owner, SLTE provider and the wet plant provider).

Improper spectrum loading on a fiber pair user can impact the ability to monitor and control the wet plant. This brings a need for increased NOC supervision during SLTE installation and upgrades. A key aspect of this supervisory role is to facilitate the SLTE integration on each fiber pair in term of loading for future upgrades and continued operation of the Line Monitoring and Command Response Systems.

For a continued operation and maintenance after SLTE installation or upgrade, the subsea NOC must ensure that:

- the optimum optical power is delivered to the wet plant at each site to avoid undesired system gain tilt affecting not only data transmission, but possibly the wet plant line monitoring and command response systems;
- the SLTE spectrum does not overlap with wet plant monitoring channels and respects recommended guard bands;
- the SLTE spectrum is loaded evenly as would be provided at full capacity;
- channel allocation changes are communicated to the NOC so that wet plant monitoring can be suspended and reinitiated with adjustments if needed;
- the SLTE is properly tested for operating when the line monitoring and command response systems are operating;
- out-of-service OTDR procedures are developed with the SLTE equipment before the commissioning confidence trial, to ensure no fiber disconnect occurs once the confidence trial is completed;
- in-service baseline line monitoring data is obtained immediately after final spectrum loading is established to establish wet plant reference data sets;
- adequate as-built SLTE records are kept facilitating future troubleshooting by the NOC.

6. SECURITY, CONFIDENTIALITY AND NOC RESILIENCY

Security, confidentiality and resiliency are key to the operation of a subsea system. These are governed by several rules among which a few are highlighted below.

A security plan must be established with strict directives regarding non-disclosure and safeguard of information.

Security officers/representatives must also be elected who are in turn responsible for screening all pre-approved personnel at the NOC and at the CLS(s). Regular and independent security audits are also mandatory.

Regarding the NOC DCN resiliency, diverse ISP providers and routers must connect the NOC to remote CLS(s) through the internet cloud. Secondary links between the CLSs are also put in-place on the subsea cable itself.

For DCN security, DMVPN tunnels and/or firewalls are used to connect the NOC to all monitored locations. The DCN infrastructure devices must combine firewall, antivirus, intrusion prevention, and virtual private network (VPN) capabilities. These devices must also be constantly monitored, maintained and upgraded to the latest threat protection.

Regarding NOC functions resiliency, secure VPN access must be provided to allow the NOC personnel to connect to designated CLS without using any part of the NOC facility infrastructure. NOC tools such as the OSS, trouble ticket system, phone system, must be either accessible in the cloud, or on the business laptop of each NOC staff member. These remote connection services eliminate the need to have a secondary dedicated NOC at considerable savings for the system owner(s).

7. A NEW NOC MODEL: VERTICALLY INTEGRATED

To address the new NOC roles and responsibilities, the open cable challenge, the increased network security and IT platform redundancy requirements, as well as a need for an 'all-in-one/turnkey' contract scope, SubCom has created a novel subsea NOC service that meets the emerging needs of today's undersea systems market.

The primary facility for the new subsea NOC is located within the same building housing most of the SubCom core departments, enabling the NOC to have direct access to experts who have designed, manufactured, installed, commissioned and tested the very system being maintained by SubCom's subsea NOC operation staff.

This co-location benefit provides an important added value to the subsea system owner(s) which significantly surpasses the traditional NOC support level as presented in section 2.

SubCom's NOC has continuous access to the support of in-house tier-2, tier-3 and tier-4 experts. This technical support team oversees more than one third of all subsea networks in the world. Additionally, the NOC has access to a marine faults database and marine experts for crucial fault location.

At times of trouble when system owners are more often stranded, this new NOC model provides a direct communication link with subject matter experts, which can shorten and optimize repair time and cost. This capability has already been put into practice on several occasions, e.g. during the open cable system integration (fault location and marine repair, MOP generation, SLTE adjustments, software patch implementation, tier-3 troubleshooting, etc.).

8. CONCLUSION

Subsea networks are the foundation of the world's telecommunication systems [2]. They are a crucial part of global fiber optical networks and have been listed as critical infrastructures by the US Department of Homeland Security.

The current NOC models from existing operators or terrestrial NOC providers, lack many of the key capabilities needed to meet the challenges present in the today's undersea systems.

This paper presented a new subsea NOC model, adapted to the roles, responsibilities and challenges of the new subsea network era.

REFERENCES

[1] ITU-T Rec. M.3400, 2006
[2] 'Submarine Cables, The Handbook of Law and Policy', Douglas R. Burnett, Robert C. Beckman and Tara M. Davenport, Introduction p.1, Martinus Nijhoff, Boston, USA, 2014.

