AN APPLIED ANALYTICAL FRAMEWORK FOR CONGESTED LANDING SITE ASSESSMENT AND ITS IMPLICATIONS ON FUTURE SHORE-END CABLE PLANNING

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Abstract: Shore-end analysis is an integral part of planning new cable systems and even more critical when those systems are planned to land at traditional, heavily congested landing sites. The distance from the shallow water approach to a beach manhole is the most heavily impacted zone affected by congestion of existing cables, as well as other factors, and can routinely lead to a compromise of international recommendations for new cable planning.

The development of an analytical framework designed to assess the implications of congestion at traditional landing sites involves criteria such as the number and status of existing in-service and out-of-service cables, the number and separation of existing beach manholes, terrestrial and maritime regulatory parameters, and offshore hazards, obstructions and available routing.

In this paper, a case study will be presented in which this analytical framework will be applied, in part to the traditional and heavily congested landing sites of Fortaleza, Brazil; Miami, Florida; and Alexandria, Egypt.

1. CABLE CONGESTION – ISSUES AND IMPLICATIONS

Cable congestion presents many issues that can affect the protection and security of an individual cable, as well as the protection and security of the global network. Congestion has resulted from too many cables being laid at traditional landing sites, as well as traditional route axes creating choke points and lack of available seabed routing for new cables, particularly in the shallow water approaches to landing sites.

For in-service cables, as well as planned cables, congestion leads to a compromise of industry standard recommendations for route design affecting both the security of cables, but also the ability to maintain and repair these cables should a fault occur. At the network level, however, cable congestion presents the risk that a singular event, whether it be an anchor drag, submarine landslide or otherwise, can damage multiple cables nearly simultaneously, effecting internet and phone traffic on a local, regional, or global scale.

With these issues in mind, it is very important to understand the criteria used to assess the availability (or lack thereof) of routing for new cables and the recommendations for route design. These factors not only analyse the current congestion level of a landing site, but also the risk implications for planned cables.

2. ASSESSMENT CRITERIA FOR AVAILABILITY OF SEABED ROUTING

One implication of cable congestion is the lack of available seabed routing and the subsequent potential compromise of

industry standard route design criteria. Below is a non-exhaustive list of general route design criteria, as outlined by the International Cable Protection Committee:

- Route should run perpendicular to slopes
- Minimize crossings of other systems, especially active ones
- Keep crossing angles as high as possible (>60°)
- Separation between cable systems should be 3 x WD or 9 km, whichever is lesser

General criteria used to assess the level of congestion and availability of seabed routing can include the following:

- Number of in-service and out-of-service cables and ability to maintain route design standards
- Other seabed infrastructure such as oil & gas, renewable, etc.
- Restricted areas such as anchorage zones, protected areas, dumping grounds, etc.
- Geologic factors including seamounts, cliffs, steep slopes, and trenches

If seabed routing is not available, it can also affect the design of a planned cable system. For example, congestion has a direct impact on whether a landing site can feasibly be utilized as a double landing for a planned system and can often lead to a redesigned branching unit configuration, requiring only one cable segment to be designed at a particular landing rather than two.

When cables are designed in congested areas, they may also have to be routed in a less optimum way often with more shallow water cable crossings, increased geologic risk, and lack of adequate spacing from other in-service cables as a result of trying to find available seabed space. This can also lead to a less direct and more circuitous route design resulting in longer cable lengths and increased project costs.

In summarizing the collection of these criteria, a basic framework can be developed to analyze the risk level at particular landing sites and includes the assessment of cable congestion (number of in-service and out-of-service cables), cable separation, fault history, shipping, fisheries, and geologic factors (i.e. slope, sediment thickness, seamounts, trenches, etc.) This framework is applied in the following sections to three congested landing sites: Fortaleza, Brazil; Miami, Florida; Alexandria, Egypt and reveals in each case that very different components of this framework cause risks for new cables due to congestion.

3. FORTALEZA, BRAZIL

Fortaleza, Brazil is a major connection point for submarine cables in Latin America. According to information available to the author at the time of this writing, there are five separate submarine cable systems going into Fortaleza, three of which utilize this location as a double-landing. As a result, there are eight in-service cables landing at this location. In addition, there are two out-of-service and up to eight currently planned cables.

In-Service Cables		
Cable	**Status (RFS)**	**Segments**
Americas-II	2000	1
Atlantis-2	2000	1
Globenet	2000	2
South America-1 (Sam-1)	2001	2
South American Crossing (SAC) / Latin American	2000	2

Nautilus (LAN)		

Aside from congestion at the landing site in Fortaleza, offshore submarine cable routing is largely constrained by a significant number of offshore seamounts. Existing cables take advantage of routing between these seamounts; however, the result is far less available seabed for other planned infrastructure, including the numerous cables currently being planned.

Out-of-Service Cables		
Cable	**Status (INSD/OOSD)**	**Segments**
St. Thomas-Brazil	1980/1997	1
Americas 1 South	1994/?	2

Future submarine cables are going to encounter difficulty in finding available seabed, likely resulting in increased shallow water crossings of active cables, increased proximity of new routing to submarine slopes, and possible inadequate separation from other active cables.

Planned Cables		
Cable	**Status (RFS)**	**Segments**
America Movil-1 (AM-1)	2013	n/a
South Atlantic Express (SAEx)	2014	n/a
WASACE Africa	2014	n/a
WASACE Americas	2014	n/a
Atlantic Cable System-Africa / South Atlantic Cable	2014	n/a
BRICS	2014	n/a
Seabras-1	2015	n/a

Fortaleza is a good candidate location to consider building out new Beach Manholes further south along the coast from the existing BMHs. Additionally, new routing should also be considered further south so as to avoid all other cables. If a new cable is to be installed into Fortaleza, a single landing (i.e. branching unit configuration) should be considered.

Below is a risk evaluation for Fortaleza, Brazil, taking into perspective the parameters discussed, as well as others that pose typical risks to submarine cables.

Risk Evaluation for Planned Cables			
Risk	**Low**	**Medium**	**High**
Cable Crossings		X	
Cable Separation		X	
Fault History	X		
Shipping		X	
Fisheries		X	
Geologic Conditions			X

While there is no significant fault history at Fortaleza, the problem of too many cables and limited available seabed routing exist as the main congestion parameters at this location.

4. MIAMI (HOLLYWOOD BEACH), FLORIDA

Miami, Florida is a major connection point into the United States for submarine cable systems extending throughout the Caribbean and South America. While there are several existing landing sites in the vicinity of Miami, Hollywood Beach has been selected for this paper.

According to information available to the author at the time of this writing, there are four in-service cable systems landing at Hollywood Beach. Of these, one cable system has two segments. Therefore, five in-service cables land at this location. Additionally, there are no out-of-service cables and only one cable currently

planned to land in Miami – not necessarily Hollywood Beach.

In-Service Cables		
Cable	**Status (RFS)**	**Segments**
Americas-II	2000	1
Columbus-III	1999	1
Maya-1	2000	1
Mid-Atlantic Crossing (MAC)	2000	2

Though there are a relatively limited number of cables going into Hollywood Beach, this location is a good example of congestion resulting from other parameters. For example, there is virtually no available space at Hollywood Beach resulting from a restricted area just north of the landing that has forced all cables to stay to the south of this area. Routing south of this restricted area and staying appropriately separated from existing cables will be very difficult. Inadequate cable separation and/or an increased number of shallow water cable crossings are a likely scenario for new cable installations at this location.

Planned Cables		
Cable	**Status (RFS)**	**Segments**
BRICS	2014	n/a

Routing of new cables offshore the Miami area also face congestion issues as there are significant areas of constriction between the United States and Bahamas, creating congestion as cables are forced to be routed north or south along the seabed.

Below is a risk evaluation for Hollywood Beach. Because of the lack of available routing, as well as congestion issues offshore, new cables should consider new BMH locations further north that allow for less congestion at the landing site and avoidance of the congested north-south oriented submarine cable axes between the United States and Bahamas. A recent and relevant example of this is the AM-1 cable system and the planned PCCS cable system landing in Jacksonville, Florida which is a good location to avoid the issues presented in this section.

Risk Evaluation for Planned Cables			
Risk	**Low**	**Medium**	**High**
Cable Crossings			X
Cable Separation			X
Fault History	X		
Shipping		X	
Fisheries		X	
Geologic Conditions	X		

5. ALEXANDRIA, EGYPT

Alexandria, Egypt is positioned in close proximity to the Suez Canal which has made it an ideal location to land submarine cable systems transiting from Europe, though the Middle East and on to India and Asia. However, similarly as this is a high traffic shipping axis, it is also a congested axis for submarine cable system resulting in major chokepoints offshore Egypt, as well as congestion at the landing site.

According to information available to the author at the time of this study, there are six in-service cable systems landing at Alexandria, two of which are double landings. Therefore there are eight cables landing at this location. Additionally, there are two out-of-service cable systems with up to four individual cable segments.

In-Service Cables		
Cable	**Status (RFS)**	**Segments**
Aletar	1997	1
FLAG Europe-Asia	1997	2

(FEA)		
Hawk	2011	1
IMEWE	2010	2
SeaMeWe-3	1999	1
SeaMeWe-4	2005	1

Though there are no planned cables being proposed into Alexandria, the current congestion issues have already created a significant fault history at this location. For example, the most notable recent faulting event occurred in 2008 when several cables were cut simultaneously. Although there has been speculation as to the cause of the faulting, it nonetheless points out a major issue in that the occurrence of multiple, simultaneous faulting has major implications for local and global connectivity, especially along major international axes.

Out-of-Service Cables		
Cable	**Status (INSD/OOSD)**	**Segments**
SeaMeWe-1	1986/1999	1
SeaMeWe-2	1994/2006	3

Alexandria is a location, both for geographical and political reasons, that has spurred consideration for route diversification (i.e. avoidance of Egypt) as well as landing site diversification. Both are valid points to consider for any new cable system being installed in Egypt and transiting the Mediterranean, Suez and Red Sea passages.

Below is a risk evaluation for Alexandria. Future submarine cable systems planned to land in Egypt should, at the very least, consider diversification of landing sites, opting for the build-out of new locations outside of Alexandria.

Risk Evaluation for Planned Cables			
Risk	**Low**	**Medium**	**High**
Cable Crossings			X
Cable Separation		X	
Fault History			X
Shipping			X
Fisheries		X	
Geologic Conditions	X		

6. CONCLUSIONS – IMPLICATIONS OF CABLE CONGESTION

Below are some conclusions drawn from the evaluation of each landing site presented in this paper as it relates to the implications of submarine cable congestion.

1. Congest influences the feasibility of a festoon (double landing) or branching (single landing) architecture, resulting from availability of seabed in the shallow water approaches to a landing site.
2. Other restrictions such as restricted area, existing submarine infrastructure and geologic conditions can affect availability and risk of potential new cable routing.
3. Congestion can lead to compromise of cable separation and cable crossing, among other criteria, in order to find available seabed for new cables.
4. The number of planned cables landing at the same location can increase congestion issues for other existing cable systems. Promoting awareness of congestion issues at an early planning stage for new cables is important.
5. Congestion can be improved by the removal of out-of-service cables to a specified distance or water depth offshore.

7. REFERENCES

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