AUGUST 2016

WORKING GROUP 4A
SUBMARINE CABLE
RESILIENCY

Final Report – Clustering of Cables and Cable Landings

Table of Contents

1 BACKGROUND ON CSRIC V AND WORKING GROUP 4A

1.1 Objectives and Methods

The Federal Communication Commission ("FCC" or "Commission") tasked the Submarine Cable Routing and Landing Working Group of CSRIC IV ("WG8") with the responsibility of examining the risks posed to submarine cable infrastructure and how proximity to other marine activities, governmental permitting processes, and clustering of cable routes and landings can increase the risk of cable damage. This, in turn, has the potential to affect U.S. network reliability. In December 2014, WG8 submitted a final report on spatial separation. The Submarine Cable Resiliency Working Group of CSRIC V ("WG4A") continued the work begun during CSRIC IV. In June 2016, WG4A submitted a final report on intergovernmental and interjurisdictional coordination. This report examines the key factors that influence routing of submarine cables and landing site locations.

1.2 Membership

WG4A consists of approximately 22 members. They represent diverse interests including submarine cable operators, cable system customers, cable system suppliers, marine services consultants, federal energy agencies, and state regulators, all with subject matter expertise to accomplish WG4A's objectives.

WG4A MEMBERS AND PARTICIPANTS

NAME	ORGANIZATION
Kent Bressie, Co-Chair	Harris, Wiltshire & Grannis LLP, on behalf of the North American Submarine Cable Association
Catherine Creese, Co-Chair	U.S. Naval Seafloor Cable Protection Office
Denise Coca, FCC Liaison	Telecommunications & Analysis Division, International Bureau, Federal Communications Commission
Michael Connelly, FCC Liaison	Policy and Licensing Division, Public Safety and Homeland Security Bureau, Federal Communications Commission
Jerome Stanshine, FCC Liaison	Cybersecurity and Communications Reliability Division, Public Safety and Homeland Security Bureau, Federal Communications Commission
Steve Balk	Sprint
Stephen Bowler*	Federal Energy Regulatory Commission
Allan Creamer*	Federal Energy Regulatory Commission
Seth Davis	SRD Associates LLC
Jennifer Golladay	Office of Renewable Energy Programs, Bureau of Ocean Energy Management, U.S. Department of the Interior
Kurt Johnson	Pacific Crossing
Amy Marks	XSite Modular
Jennifer Miller	Office of Renewable Energy Programs, Bureau of Ocean Energy Management, U.S. Department of the Interior
Mikal Modisette	Verizon
Wayne Pacine	Federal Reserve Board of Governors
Ronald Rapp	TE SubCom
Neil Rondorf	Leidos (also Chairman, International Cable Protection Committee)
Nikki Shone	Southern Cross Cables
Rick Spencer	CenturyLink
Takahiro Sumimoto	Pacific Crossing
Robert Wargo	AT&T (also President, North American Submarine Cable Association)
Al Wissman	National Oceanic and Atmospheric Administration, U.S. Department of Commerce

* *As an independent regulatory agency, FERC and its personnel are not formal members of WG4A and participate only in an informal, advisory capacity.*

2 BACKGROUND

2.1 Significance of Geographic Diversity for Network Protection and Resilience

As explored in some detail in the CSRIC IV Report on Spatial Separation,[1] submarine cable operators and their customers have long sought to maximize geographic diversity of submarine cable routes and landings in order to enhance network resilience and reduce the risk of damage from a single event, whether a tsunami, a vessel anchor, fishing gear, or a terrorist attack. Nevertheless, submarine cable operators do not operate in a vacuum. They must account for a variety of factors in deciding where to route and land cables, and many of these factors remain entirely beyond their control. Moreover, they operate in a dynamic U.S. coastal and marine environment that is increasingly crowded and that lacks a single landowner or a single marine spatial planning regulator. Other activities and infrastructure are frequently authorized without regard to the potential to foreclose particular areas to future submarine cable development, increasing the potential for clustering of cables and landings, and the risks inherent in non-diverse infrastructure.

In this report, WG4A examines the factors that influence routing and landing of submarine cables and what the FCC might do within its statutory jurisdiction to enhance geographic diversity in order to promote network resilience.

2.2 Key Concepts

Diversity. Routing diversity is a fundamental concept in cable system construction. In fact, route diversity and all of its manifestations should be considered industry "Best Practices." Route diversity is generally defined as the routing between two points over more than one geographic or physical path with no common points. While there are cost and regulatory considerations to diverse paths as discussed in CSRIC IV Report on Spatial Separation, this report will focus on methods of increasing diversity at the landing point. End point separation, by adding diversity at the landing point, is ideal to reduce vulnerability.

When discussing diversity in cable system landing points there are several routing elements to achieve diversity including:

- Beach Manhole (BMH)
- Outside Plant (OSP)
- Cable Landing Station (CLS)

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1 Communications Security, Reliability and Interoperability Council, *Working Group 8 Submarine Cable Routing and Landing Final Report—Protection of Submarine Cables Through Spatial Separation* at 3 (Dec. 2014) http://transition.fcc.gov/pshs/advisory/csric4/CSRIC_IV_WG8_Report1_3Dec2014.pdf, ("CSRIC IV Report on Spatial Separation").

Redundancy. After all efforts have been made to provide redundancy using physically diverse routes, reliability may be further enhanced by including appropriate levels of redundancy within the CLS. While there is redundancy built into most systems within the CLS, the submarine cable industry has not adopted a standard set of redundancy criteria.

Resiliency. After diversity/redundancy strategies have been implemented, it is up to each system component to resist a particular threat. Methods of increasing a component's resiliency are critical to maintaining reliability. Use of the term "resiliency" in this context is the ability of the individual submarine cables, shore infrastructure, OSP, or CLS to resist damage or failure or else have the ability to be quickly (or quickly enough) repaired and returned to an operating status. "Network resiliency" makes uses of redundant segments to reroute telecom traffic if one segment has failed.

Physical Parts of a Submarine Cable System

Beach Manhole (BMH). The Beach Manhole is a concrete chamber, buried into the beach, or road behind the landing point, where the submarine cable is terminated and from where the OSP fiber cable and power cable are routed to the CLS. Most manholes are designed to take more than one cable, most commonly two. Additionally, landing points with clustered cables may see multiple beach manholes in proximity to each other. While these two situations are cost effective, it may not reduce the risk of failure as a single localized event could disrupt multiple cables such as a beach wash out due to a hurricane or due to backhoe damage across two cables at the same time. Risk may be mitigated with limiting the number of cables per manhole and requiring minimum distances between manholes.

Cable Landing Station (CLS). The cable landing station is a building that provides the enclosure, power and cooling required for the power feeding equipment and submarine line terminal equipment (together, dry plant). For enhanced reliability, diverse routing could also employ distinct termination equipment as this would mitigate the vulnerability of a common single point of failure at either end of the connections.

The decision to land a new cable into an existing CLS is heavily influenced by available station capacity, contracted landing party, and schedule due to permitting processes. However, this leads to system vulnerability as a station failure may cause catastrophic conditions. Outages may occur due to terrorist acts, natural disasters, power failures, and equipment failure within the station.

There are ways to mitigate risk including dedicated CLSs for each system or isolated space, power, and cooling for each system within a shared CLS.

The CLS is the primary means of protecting the dry plant from threats, below are the areas of the CLS that must be considered:

- Protection from physical threats (intrusion, ballistic, surveillance)
- Protection from natural disasters (fire, lightning, wind, flood, seismic)
- Quality of space within the station(suitability of building for use as a CLS, quality of construction)

Outside Plant (OSP). We define OSP as the conduits, fiber cable, and power cable between the BMH and the CLS. Diverse outside plant routes between the BMH(s) and the CLS(s) are valuable for reducing vulnerability either by human induced hazards (digging), or natural hazards (flooding or wash outs).

Wet Plant. The wet plant is the term for the submarine cable, along with its repeaters, joint boxes, and branching units. Techniques and equipment that make the wet plant "resilient" are cable routing to avoid hazards, cable burial and armor to protect it from anchoring or fishing gear, and cable awareness and charting efforts or cable awareness programs to prevent potentially damaging encounters in the first place.

3 Factors Influencing Routing of Submarine Cables and Landing Sites

3.1 Economic Opportunities

The submarine cable landing site is selected primarily on the basis of access to a carrier, content provider, or cloud services provider's point-of-presence (POP) or data center and on capacity demand. Other economic factors may also influence the landing site, such as negotiations with other economic stakeholders, including commercial fishermen and other government, tribal, and/or private landowners.

The demand may also result in several competing cables landing in the same metro area. Alternatively, private network operators may be driven by owning their own submarine cable or fiber pair in order to control costs and security. For these cable owners, access to their private data centers, which may be located away from a large metropolitan area, is the driving consideration.

Cost of construction is driven by submarine cable length from landing point to landing point, length of the continental shelf where cable must be armored and buried (which is more costly than cable and installation in deep water), access to existing terrestrial cable infrastructure including outside plant cable, CLS, and backhaul from CLS to POP or cloud exchange. A landing site resulting in a short OSP route to CLS or cloud exchange will be more economical. Many purchasers may choose sites with existing shore end infrastructure and network access. Thus cables are congregated at or near the same landing, if not in the same beach manhole, which is often the case.

If capacity demand is high enough in a region to support the business case, development of a new landing site may be undertaken requiring new investment in seabed leases, beach and OSP land leases, and OSP and CLS construction. Income must be sufficient to cover construction and operation and maintenance costs within the required payback period.

The business case on the investment is also driven by duration of the project. Projects undertaken in areas and states where regulatory and permitting times are long may be less attractive than sites that can be permitted more quickly.

Requirements for route redundancy (to provide network resilience and higher availability) drives requirements for multiple diverse routes.

Operational costs including long term annual lease of seabed, landing site properties, security, staffing, and maintenance and repair costs are also factors influencing the selection of a landing site and cable route. This is factored into the business case.

On the U.S. East Coast, existing landing sites are clustered in the Northeast including Massachusetts, Rhode Island, New York, New Jersey, and in the Southeast along the Florida coast in three primary locations. On the U.S. West Coast, existing landing sites are located in Northwest in Washington and Oregon and in the Southwest in Northern, Central, and Southern California. Landing sites connect Alaska and Hawaii to the U.S. mainland.

In almost all cases, landing sites are developed to support multiple submarine cables.

3.2 Regulatory Factors

Laws or regulation may bar the presence of undersea cables in certain areas thus leading to clustering in locations away from restricted areas. For example, the State of Florida prohibits the landing of cables in the Keys and certain Gulf coast counties. In other areas of the state, undersea cables are required to negotiate "reef gaps" to get to the landing point, these gaps themselves may serve to create a cluster of cables. In other places, the presence of a National Marine Sanctuary may prohibit the presence of an undersea cable or make conditions on its presence in a sanctuary so onerous that the cable proponents choose to go elsewhere. A more thorough treatment of National Marine Sanctuaries can be found in Section 4.6 of the CSRIC V Report on Interagency and Interjurisdictional Coordination.

In areas where there are no regulatory bars to the presence of a cable, the decision to land in one spot or another may come down to the ease of permitting (lower cost, shorter duration, less uncertainty) in each location. For example, like most other jurisdictions on the U.S. West Coast, the State of Oregon requires cable owners to become members of a Cable/Fishing Liaison Committee. However, in Oregon, once that step is complete, the remainder of the permitting process is relatively easy. California is typically more expensive and takes longer, as the permit and easement acquisition processes are not as clearly defined. Not only are durations and costs of initial permitting higher in California as compared to Oregon, ongoing costs are higher as well. The submerged lands easement in Oregon has no yearly fee while in California it is on the order of $5-6/linear foot within the 3 nautical mile state sovereign seabed (depending on the route of the cable on the order of $100K/year). Overall, the easier process and lower costs of one state make it a preferred landing choice. Finally, states that have not traditionally been landing sites for undersea cables may not have a fully developed permitting regime able to deal with them. In this case the cable owner may continue to avoid the state with no cable landing, preferring a known permitting regime over an uncertain one.

At the Federal level, the variation in application of regulations between various Army Corps' Districts is another factor that may influence choice of landing sites. As described in more detail in the CSRIC V Report on Interagency and Interjurisdictional Coordination, the Army Corps determines what form of permit is appropriate: individual, through a standard permit or letter of permission; or general, through a regional general permit ("RGP"), programmatic general permit ("PGP") or nationwide permit ("NWP").[2] Because this determination is conducted at a District level, there are variations in analysis of impacts. In addition, one District may place more onerous requirements on the survey and installation leading to higher costs and longer project durations. A proponent may therefore avoid one District in preference for more predictable or favorable permitting in a neighboring District.

As described in a later section of this report and in detail in CSRIC IV Report on Spatial Separation,[3] the siting and licensing of ocean energy projects can directly affect existing and proposed submarine cables. Similarly, installation of a submarine cable across existing energy infrastructure on the outer continental shelf would be detrimental to both and those effects would need to be addressed during the siting of the cable. Project proponents and agencies are currently working through the siting of proposed submarine cables and proposed wind energy infrastructure offshore of Virginia Beach, Virginia.

Environmental conditions such as the existence of endangered species will lead to mitigation measures that may play into the decision to land in one location or another. On the West Coast of the United States, it is unlikely that mitigation measures for the protection of marine mammals and other marine wildlife can be avoided no matter which state a cable owner chooses. Similarly, mitigation to avoid damage to corals, sea grass, and mangroves is unlikely to be avoided anywhere in Florida or the Caribbean. However, some mitigation measures lead directly to clustering. Off San Luis Obispo, California cables are required to avoid hard bottom to the maximum extent and all traverse an area which came to be known as the "sand channel" where cables can be buried, effectively clustering all the cables there in one small area.

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2 Communications Security, Reliability and Interoperability Council, *Working Group 4A Submarine Cable Resiliency Final Report—Interagency and Interjurisdictional Coordination* at 13 (June 2016) https://transition.fcc.gov/bureaus/pshs/advisory/csric5/WG4A_Report-Intergovernmental-Interjurisdictional-Coordination_June2016.pdf.

3 CSRIC IV Report on Spatial Separation at 36-41.

3.3 Seafloor Topology

In developing a route design for a new submarine cable, the topology of the seafloor plays an integral role in the final path chosen, and many elements known of from regional oceanographic charts, or found on the seafloor during the route survey, can lead to the clustering of cables into specific areas.

Cables that are laid in deep-water beyond the reach of bottom-trawling gear and anchors (approximately >1,500m) are several times cheaper to manufacture and install than cables that are laid on the continental shelf. They also tend to suffer fewer cable breaks over the life of the system. Cable routes therefore attempt to minimize their length in areas of shallow topology, or avoid it completely. By way of an example the majority of Trans-Atlantic cables divert south of the shortest "Great Circle" path to skirt the Flemish Cap and Grand Banks off Newfoundland. Such topographic features drive the clustering of cables, with separation distances at the minimum allowing them to be maintained.

Every trans-oceanic cable system must cross the continental shelf margin, an area characterized by steep slopes, submerged canyons, rocky ridges, and usually high levels of seismic activity. Submarine cables are vulnerable to breakage by abrasion, debris flows and rock-falls, so a route is chosen which avoids areas of potential instability. These areas can be few and far between, so cables can become clustered together at the known optimal locations to transition from the shallow sea to the deep ocean.

Once the approximate path of the cable has been decided, marine route surveys are conducted to create a survey chart that describes the seabed conditions and reveals the presence of, among other items, seamounts, steep slopes, rocky outcrops, and near shore, the presence of rocks or rock beds, which may hinder the ability to bury the cable.

Seamounts and steep slopes can create cable suspensions and possible complications during installation. Cables against any form of rock whether it be outcrops or simple flat rock beds, can lead to abrasion and possible failure over the life of the cable.

When near shore, in waters generally less than 1,500 meters of depth, there is often the need or requirement to bury the cable, either for its own protection or the prevention of disrupting the commercial fishing industry, or both. The requirement to bury a cable then further complicates the marine route survey to not only avoid geographic seabed reliefs and rock beds, but to locate suitable substrate (soft bottom), that will be conducive to cable burial.

The identification of seafloor obstacles and suitable soft bottom substrate, combined with what could be the desirability of a chosen landing area by multiple submarine cable systems due to other factors discussed within this report, can lead to the clustering of cables through the least obstructive paths possible.

3.4 Proximity to Other Marine Infrastructure

Generally, new cables are routed to avoid other existing (or planned) marine infrastructure that could impact either the initial installation or ability to perform long term maintenance on the cable or nearby infrastructure. A safety zone distance is normally determined by water depth, normally two or three water depths as a rule of thumb. In shallow water an absolute minimum distance of 500 meters is normally used. These distances, as discussed in more detail in the CSRIC IV Report on Spatial Separation[4], are derived by the ability to navigate and maneuver a cable ship when installing and maintaining the cables, and the ability to grapnel and recover cables for repair. If it is not possible to comply with these keep away distances, an agreement on procedures to be used should be reached between the owners prior to commencing construction so that each other's assets are protected from damage.

In addition to other telecom cables, marine infrastructure includes, among other things: power cables, oil and gas pipelines, sewer outfalls, docks, piers, renewable energy facilities, oil and gas drill and production facilities, artificial reefs, tidal flow energy turbines, wave power devices, deep sea mining leases, oil and gas leases, LNG terminals, and navy acoustic ranges.

It remains to be seen whether other marine infrastructure, such as oil and gas exploration or marine renewable energy will have a significant effect on the routing of submarine cables or the selection of landing sites for those cables. Elsewhere in the world submarine cables and other marine infrastructure coexist quite well in close proximity due to a well-established working relationship between industries, as well as the application of established industry recommendations and guidelines, such as those of the International Cable Protection Committee and the European Subsea Cables Association (formerly Subsea Cables UK). For example, in the North Sea submarine cables share the seabed with oil rigs, pipelines, electrical cables and—more recently—renewable energy facilities. The long working relationship between the multiple industries has led to the use of both crossing and proximity agreements which specify the technical and commercial details of the interactions of the various infrastructure throughout the life cycle of both projects. Unlike crossing agreements between telecom cable owners, which are typically by email, other infrastructure (particularly pipelines) require legal documents to determine liability if damage occurs. These documents are often lengthy and take months to negotiate. In addition, the engineering solution at the crossing point between a cable and pipeline—a more involved operation than a cable to cable crossing—will often require spacers, bridges, or mattresses.

In the United States, crossing agreements are only beginning to be used as there has not been a great deal of interaction between the various industries. The oil and gas industry is primarily located in the Gulf of Mexico, California, and Alaska, and there is little presence of submarine telecommunications cables in those locations. The marine

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[4] *Id.* at 9, 48-49, 57-58.

renewable industry is in its infancy in the United States and it is just beginning to affect the routing of submarine cables and the selection of landing sites. As the marine renewable industry grows in the United States, crossing agreements will certainly be used; for example, a formal crossing agreement was negotiated relating to the export cable for the Block Island Wind Farm.

3.5 Access to Terrestrial Networks

Access to terrestrial networks is one of the key considerations when planning a submarine cable landings site. Significant terrestrial cost can be avoided by landing at an existing submarine cable landing site with terrestrial network access already in place, provided that there is a market for the additional capacity. Alternatively, private network operators may be driven by owning their own submarine cable or fiber pair in order to control costs and security.

Terrestrial network cost includes the construction of OSPs, CLSs, and backhaul from CLS to POP or cloud exchange. A landing site resulting in a short OSP route to CLS or cloud exchange will be more economical.

A new terrestrial network access point may be driven by a requirement for route redundancy (network resilience) and diverse routes.

4 Recommendations

4.1 Recommendations

As an initial matter, it must be noted that these recommendations are necessarily limited, given the statutory jurisdiction of the FCC[5]. The FCC is not a marine planning agency with broad regulatory or policy authority over marine industries and activities. Neither is it a single coastal landowner (such as the Crown Estate in the United Kingdom), with the ability to enforce a consistent approach in all U.S. marine and coastal areas. Instead, the FCC is a communications industry regulator with particular expertise in submarine cables. With these limitations in mind, CSRIC V recommends that the FCC use its expertise to highlight for other government agencies concerns about, and potential measures to promote, geographic diversity of submarine cable routes and landings through implementation of the following recommendations.

1. **Encourage Interagency and Interjurisdictional Cooperation:**
   The FCC should encourage interagency and interjurisdictional cooperation to streamline permitting; adopt more transparent and consistent permitting processes, conditions, and timelines; and reduce permitting times. Timeframes for environmental permitting at federal, state, and local levels usually last more than a year and sometimes more than two years. These timeframes are too long for an activity that is essentially environmentally benign. With such lengthy

[5] See 47 U.S.C. § 151; Executive Order 10520.

permitting timeframes, any location that offers a slightly shorter permitting timeframe—so long as the permitting conditions are not too burdensome—becomes a much more attractive option in order to satisfy "time to market" concerns that confront new submarine cable developers—even the resulting location reduces geographic diversity of submarine cables. Streamlining across multiple jurisdictions would serve to reduce regional disparities, while reductions in overall permitting timeframes would render less critical any small variations in permit timing and burdens. As part of this process, the FCC should consult with the Army Corps of Engineers regarding variations in the processes and permit conditions employed by its various districts. Although the Army Corps is decentralized, it acts pursuant to statutes and regulations with nationwide applicability. The FCC should consider adoption of a **submarine cable permitting shot-clock** for state and local permitting for submarine cables as a means of highlighting the significant disparities in timing that submarine cable operators experience, and as a basis of potential future interjurisdictional discussions, including through the regional planning bodies.

2. **Encourage Other Agencies to Consider Impacts On Submarine Cable Diversity During Permitting Processes:**
   The FCC should encourage other federal, state, and local government agencies to consider impacts on cable diversity during permitting for other marine activities. As demonstrated in the CSRIC IV Report on Spatial Separation,[6] there already exists a problem in protecting existing submarine cable infrastructure from damage by other marine activities as authorized by other federal, state, and local government agencies. Similarly, there is a lack of awareness and/or focus on foreclosure of particular submarine cable routes and landings, and on reductions in geographic diversity of cables through authorization of other marine activities.

3. **Evaluate the Role of NEPA and CZMA as a Coordination Mechanism:**
   The FCC should decline to rely on the National Environmental Policy Act ("NEPA") or the Coastal Zone Management Act ("CZMA") as the principal means of coordinating with other federal, state, and local government agencies. NEPA exists to identify and evaluate potential environmental impacts of activities authorized by federal agencies. The CZMA exists to coordinate environmental protection efforts between the federal governments and the states, permitting the adoption of state coastal zone management plans approved by the Secretary of Commerce and consistency reviews by states regarding potential effects within state territorial seas. Neither of these laws is a marine spatial planning law designed to optimize the use of marine and coastal areas for particular activities of national importance, whether for telecommunications and Internet connectivity or development of renewable energy resources. Neither tasks government agencies with assessing the impact of proposed activities on telecommunications network resilience. In the absence of congressional action tasking a particular body with

[6] *See* CSRIC IV Report on Spatial Separation.

these responsibilities, the FCC should continue to coordinate with other federal, state, and local agencies, particularly in the regional planning body process, to address these issues.

4. **Promote Further Industry-to-Industry Cooperation:**
The FCC should promote further direct industry-to-industry coordination to enhance diversity of submarine cable routes and landings. The submarine cable industry has long engaged in direct consultations with other marine industries, particularly the commercial fishing industry and offshore oil and gas industries, to mitigate harmful impacts to their respective activities, equipment, and infrastructure. While such industry efforts are sometimes insufficient, they should not be supplanted entirely by governmental solutions. Consequently, in coordinating with other federal, state, and local government agencies, the FCC should recommend processes that encourage other marine industries to coordinate with submarine cable operators at the earliest stages of project planning, and vice-versa.

5. **Encourage Cable Protection Zones:**
The FCC should encourage the development of cable protection zones around existing submarine cable infrastructure, which may include clustered facilities. These zones would restrict within a defined proximity to existing submarine cables certain activities that pose a risk of cable damage. As noted in the CSRIC IV Report on Spatial Separation,[7] cable protection zones have been used in other jurisdictions—particularly Australia and New Zealand—to reduce the risk of damage from a variety of marine activities to submarine cables providing vital domestic and international telecommunications and Internet connectivity. Unlike the recommendations outlined above, the recommendation for cable protection zones would address the risks of existing infrastructure that cannot easily or cheaply be moved.

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[7] *Id.* at 10.