Technical Report on MainOne Submarine Cable Restoration

July 2017

MainOne

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1.0 Background:

This report provides specific details on the outage of the MainOne Submarine Fiber Cable System that occurred at 5:18am on Sunday June 18, 2017 and the path to full restoration which occurred in the early hours of July 3, 2017.

Initial investigation conducted into the failure of communications on the fiber pairs into Portugal indicated a fault on the submarine cable system, which was further localized to a location about 3000km South off Portugal, where the cable is at 3400 meters water depth. This assessment suggested that the outage was not a likely outcome of external human factors such as a dropped ship anchor or trawler fishing or sabotage since such activities generally do not take place at such ocean depths.

This initial assessment led the company to determine that the rectification would likely be of some prolonged duration and led the deployment of restoration services to customers where feasible and immediate engagement of the Atlantic Cable Maintenance and Repair Agreement on the possible requirement for a cable repair vessel.

The repair was successfully completed as indicated and this report provides further details of activity leading to full restoration of services on the network.

2.0 Repair work with Atlantic Cable Maintenance and Repair Agreement (ACMA):

After isolating the cable fault to 3000km offshore Portugal through various tests, at approximately 4pm on Sunday the 18th of June, 2017, the technical team executed submarine fault management operational processes and disaster recovery plans and immediately called upon our membership in the Atlantic Cable Maintenance and Repair Agreement (ACMA) with possible need for a repair.

Given the risk of a submarine cable fault, MainOne has participated in such agreements since inception in order to gain access via a cooperative type arrangement to a submarine cable layer vessel for repairs, even though for almost seven years we never experienced any such faults.

Following review of the test data by our technical team and by our cable supplier under our technical support agreement, we confirmed an underwater fault and commissioned a vessel for the repair at approximately 8pm that Sunday night. The Vessel, a cable layer ship "Pierre De Fermat", measuring 100.1m × 21.5m and constructed in 2014 with Maritime Mobile Service Identity 228041600, departed its home port in Brest, France by 8am on Monday, the 19th day of June, 2017.

Figure 1: Front of Vessel - Pierre De Fermat

Figure 2: Back of Vessel - Pierre De Fermat

The vessel travelled to Portland, United Kingdom, where it picked up MainOne spares including cables, a spare repeater and jointing materials and then journeyed from Portland, UK to the repair location which had been further isolated to a location in international waters in the Atlantic Ocean, outside the territorial waters of Senegal.

This made for quicker access and scheduling since no permits were required for the vessel to operate at that location. The location also indicated geological subsea floor activity which could have resulted in disruption of the seabed since the area extending west of Senegal through Cape Verde is known to have more complicated geology with ridges of quite significant lateral spans in the continental shelf from previous surveys.

3.0 Cable Repair:

Once the vessel set sail, the Engineer in Charge provided a plan of work for the repair activity through to demobilization and started issuing daily reports on various activities of the previous 24 hours and weather forecasts for the days ahead. In addition, the team was able to track the progress being made by the vessel through various trackers online including http://www.marinetraffic.com/en/ais/details/ships/shipid:180626/mmsi:228041600/imo:9694505/vessel:PIERRE_DE_FERMAT.

The extended travel time also allowed sufficient time for the repair team on the vessel to engage with the MainOne technical team in order to agree a detailed plan of work and also to contemplate different cable replacement scenarios (cable length, light dispersion, losses, cable types etc) in readiness for whatever repair scenario the vessel would find. The vessel arrived onsite on Tuesday, the 27th day of June, 2017 at 23h40 and immediately started work trying to grapple the cable from the seabed starting with the Lagos facing end.

The cable was successfully grappled and cut off and the vessel turned around and did the same with the Portugal facing end. Following the cutting runs, the vessel executed the holding runs to lift the cable ends on board. This provided evidence of the specific nature of the fault and the cable was successfully retrieved save for one kilometer cable length which broke off under tension. Visual inspection of the retrieved cable then confirmed the probable cause of some sort of landslide on the sea bed which unfortunately trapped and crushed the cable thus resulting in a cut to both the fiber and power cables within the cable enclosure. This point of breakage is shown in a picture of the end of the retrieved cable below.

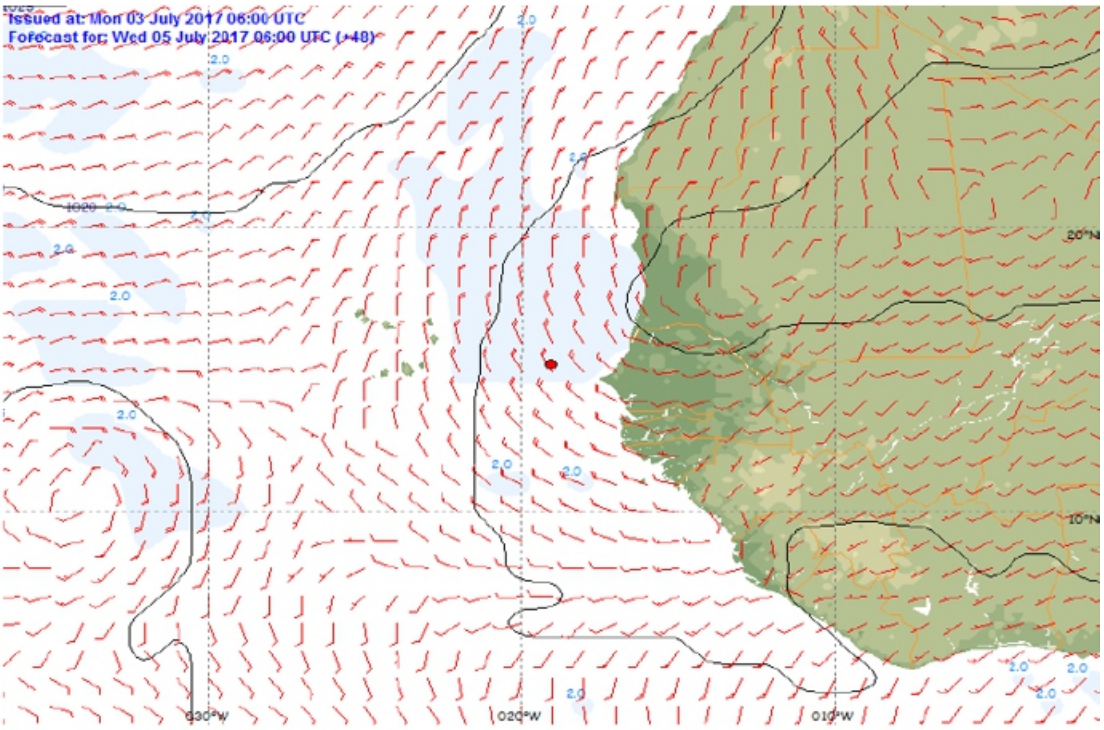

Figure 3: Red dot - location of cut

Figure 4: Cut Cable end

To complete the repair, the engineers now needed to replace the damaged section of cable with properly matched fiber cables for effective performance and also added length to compensate for placement of the cable back on the seabed at such water depths. The engineers did the initial splice of the replacement fibers to the existing cable and performed ship based testing to ensure performance.

Following this, the repair vessel conducted the final round of splice. Thereafter the engineer in charge of the repair issued a specific set of instructions for the terminal stations to take power control of the cable, along with associated safety precautions in order to perform both power and transmission tests on the system. Following this round of tests, the system was again shut down and control passed to the repair vessel to set in place molds to protect the delicate fibers before being placed back into the water. Again, a set of specific activities were initiated to test the cable performance and compare it to the baselines that were originally obtained when the cable was initially deployed and the initial set of tests following the repair.

On favorable review by all parties, the repair was deemed as having passed the test. In addition, x-ray images of the final spliced cable were captured and shared with the technical team to ensure good quality joints with no inclusions in the molds thus ensuring longevity of the cable system underwater as expected going forward. On confirmation of approval by the MainOne Submarine lead, Mr. Bernard Logan, the cable system was again powered down by the terminal stations and the vessel started the process of lowering the submarine cable back to the seabed and guided into position.

Once the cable traveled within 2000 meters of the seabed, the vessel again released power control of the cable system to the terminal stations for testing and once those tests were confirmed successful, the stations confirmed control and declared that the repair was satisfactory at 12:37am on July 3rd and that the vessel could be released from the cable ground.

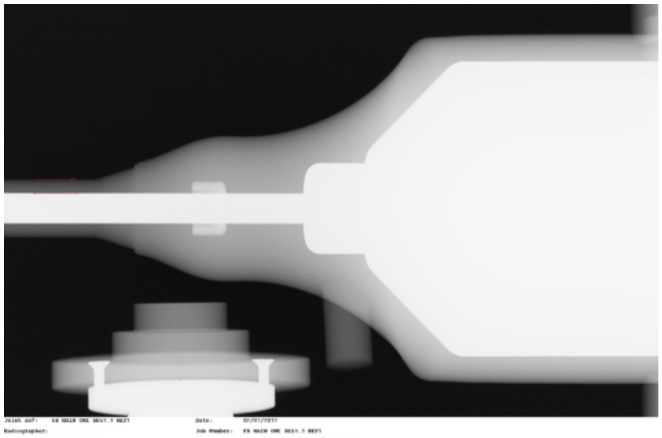

Figure 5: X-ray of spliced cable

4.0 Service restoration and Lit Capacity:

MainOne engineers continued testing of the cable system to ensure performance and adequate baseline data to compare with original performance and to set a new baseline performance standard going forward. The team was especially pleased that the repair resulted in almost negligible increases in optical losses and also power increases, all well within the design margins of the cable system.

After a few hours of testing, all the active wavelengths carrying traffic on the system were again activated and verified and traffic started being restored onto the cable system. MainOne engineers who had been on the sidelines in recent weeks were delighted to have the system back in working order and within a few hours, all services were restored back onto the cable system.

Since the rebirth of the cable system early this morning, the cable has been tested to be in good operating condition and we have restored all services to normal operating conditions and provisioned additional capacity wavelengths to address increased demand for Internet connectivity from our wholesale and Enterprise customers across West Africa.

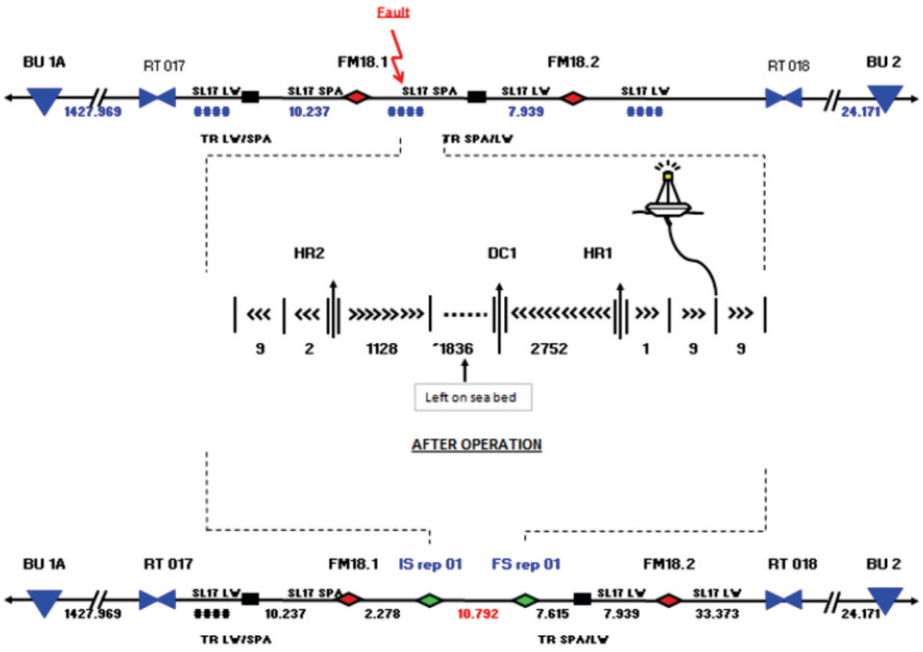

Figure 6: Straight line diagram (meters)

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