THE USE OF SUBAQUATIC OPTICAL CABLES IN THE AMAZON RIVER SYSTEM OF SOUTH AMERICA

Michael Stanton, Eduardo Grizendi (RNP, Brazil), Jorge Garcia L. (Telemediciones, Colombia)
Email: michael@rnp.br

RNP – Rede Nacional de Ensino e Pesquisa (Brazilian Research and Education Network),
Rua Lauro Muller 116 sala 1103, Botafogo, Rio de Janeiro, RJ, Brazil 22631-370

Abstract: In 2013, the authors published two separate and independent proposals for laying subaquatic optical cable systems in the great rivers of tropical South America, most especially in Brazil, Colombia and Peru. This choice of providing broadband telecommunications access was preferred to the usual alternative of terrestrial cabling, due to the lack of highways or railways in a major part of the region, which also confines both population centres and the movement of goods and travellers to the rivers. The third author proposed to build a 1,900 km link between Iquitos, Peru, and Leticia, Colombia, to the Brazilian city of Manaus, using the Peruvian Amazon and the Brazilian Solimões (Upper Amazon) rivers. The other two authors presented a proposal to build five sub-fluvial links within Brazil, one of which would follow the Solimões between Manaus and the border of Colombia at Tabatinga (Brazil) – Leticia (Colombia).
The aim of this article is to describe how these projects are developing into real sub-fluvial optical infrastructure in this region. In Brazil, between 2016 and 2017 the Amazonia Connected initiative has begun to lay cables along several of the routes initially identified in 2013, notably from Manaus to Tefé along the Solimões, and to Novo Airão along the Negro, with a total of 850 km, already partially reported. Meanwhile, the Peruvian Government, which has been building the terrestrial national optical backbone network (RDNFO) to connect the entire country, intends to launch a tender in 2019 to build a sub-fluvial connection of more than 400 km as part of the link from Yurimaguas to Iquitos in the heart of the Peruvian Amazon. Our paper plans to describe these recent actions and speculate on the wider benefits made possible by the interconnection of the national initiatives in Brazil and Peru to aid regional integration in South America.

1. INTRODUCTION

This article seeks to integrate the descriptions of several separate initiatives dealing with an alternative approach to the problem of extending broadband connectivity to equatorial Amazon region of South America which is densely forested and where surface communication is until today mostly dependent on waterborne transport traversing the rivers of the Amazon basin. The almost total absence in a great part of the region of infrastructure, both for terrestrial transport, by road or rail, or for overhead power lines has prevented the adoption of the conventional means of installing long-distance optical fibre infrastructure. As a result, the remaining alternatives usually depend on satellite-based radio communication, at a much higher cost. The aim of this article is to describe recent advances in the use of sub-fluvial optical fibre infrastructure on a continental scale.

Before describing recent initiatives, it is also important to recognise that a historical precedent exists for the use of sub-fluvial telegraph cables in this same environment, which was adopted at the very end of the 19th Century! At that time, the use of electrical telegraphy was revolutionising communications around the world. Brazil had been connected in 1874 to the "Victorian Internet" (an appropriate name recently

introduced in [1] to describe the then rapidly expanding worldwide network of telegraph cables).

By the 1890s, the Amazon region of Brazil had become economically interesting due to natural rubber production there. After the failure of efforts to build a terrestrial telegraph cable to Manaus, on the Amazon River, around 2000 km from its estuary, in 1895 the Amazon Telegraph Company (ATC), registered in London, was granted an initial 30-year concession to provide a telegraph service to Manaus, using sub-fluvial cable technology. Between 1895 and 1896, Siemens Brothers of London installed a sub-fluvial telegraph cable system, following for the main part the principal stream of the (lower) Amazon River, between the cities of Manaus and Belém, where international connectivity was already available (fig. 1). An account of this innovative work has been provided by Alexander Siemens, then CEO of Siemens Brothers

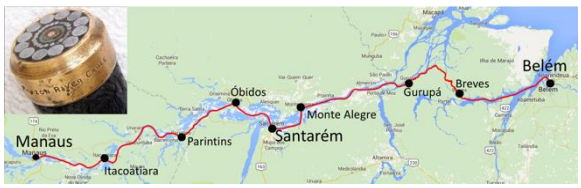

Figure 1: The route of the 1896 connection between Belém and Manaus.

A description up to 1921 of the ATC cable system installed at this time can be found in in [3]. On p.22 there is mentioned the duplication of the original single cable, to improve the availability of the service. With this additional investment, the original 30-year concession of 1895 was extended to 50 years.

The remainder of this article concentrates on initiatives using fibre optic (FO) technology, widely employed in long-distance communications since the 1990s, in the form of sub-aquatic cables. In particular, we concentrate of the use of sub-fluvial cable connections in the Amazon region.

2. THE CONSTRUCTION OF FO INFRASTRUCTURE IN EQUATORIAL SOUTH AMERICA

Around the year 2000, a number of new international submarine cable systems were built to provide broadband connectivity to the countries of South America, and extensive terrestrial FO networks began to be built out, with the notable exception of the equatorial Amazon region. In the case of Brazil, for example, by 2012 all state capitals had already been included in the national FO footprint. However, large areas of northern Brazil, within the Amazon basin, were without any long-distance terrestrial connectivity, and depended on low-bandwidth satellite communications (fig. 2).

Figure 2: FO routes in Brazilian Amazonia in 2012

In Peru, one of the other major Amazonian countries, widespread adoption of FO cables only occurred after 2013, when the government launched a project to build a national FO backbone network – RDNFO – to integrate the whole country through a common communications infrastructure. This is being financed through FITEL – Telecommunications Investment Fund of MTC - Ministry of Transport and Telecommunications. By 2018, the RDNFO footprint covered much of the country, except for the Amazon rainforest region of Loreto where the map shows lack of FO

connectivity between the cities of Iquitos and Yurimaguas (fig. 3) [4].

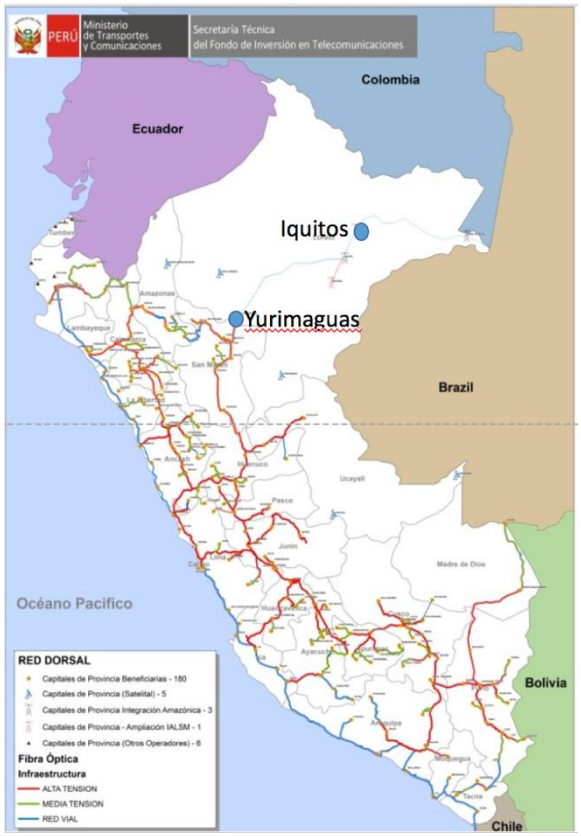

Figure 3: Peruvian government project for building the RDNFO in 2013.

3. SUB-FLUVIAL FO CABLES

In 2012, the second author of this paper encouraged his students at the Brazilian National Institute for Telecommunications – INATEL – to investigate the deployment of a subaquatic cable across the mouth of tha Amazon River, whose estuary is up to 330 km wide, in order to provide connectivity to the northern bank (Brazilian state of Amapá). This was the starting point for the investigation by the first two authors into the use of subaquatic cables following, rather than crossing the course of the river. This investigation was joined by a number of people from the Brazilian optical communication equipment provider, Padtec, including the then-president, Jorge Salomão Pereira, and the engineer, Mario Roberto Vassallo.

The contributions of the team from Padtec led to the proposal published as section 4 of [5], with the building of 5 sub-fluvial routes along the rivers Amazon (A), Negro (B), Branco (C), Solimões (D) and Madeira (E), as well as a submarine route from Macapá to the border of French Guiana, along the Atlantic coast (F), serving a population of 7 millions, and 29 higher-education and research clients of RNP (fig. 4).

Figure 4. The sub-aquatic routes proposed in 2013 [2]

Reference [5] also cited [6], a paper presented some months earlier at SubOptic 2013. Written by our third author, [6] proposed to build a single sub-fluvial cable route between Iquitos in Peru and Letícia in Colombia (immediately adjoint to Tabatinga, Brazil), to reach Manaus in Brazil, for most of the distance following exactly the same Solimões River as proposed in [5]. The objective in this case was to provide a high-capacity FO route from cities in the Amazon regions of both Peru and Colombia to the terrestrial broadband FO network already available in Manaus.

Unfortunately, communication between the 3 authors of this paper was only first established in January, 2017, after the publication of [7] by the first two authors, but has since been fruitful.

4. THE AMAZONIA CONNECTED PROGRAMME

The network of sub-fluvial cables in Brazilian Amazonia, proposed in [5], was

well-received in Brazil, and a coalition of national and state government agencies, headed by the Army, created the Amazonia Connected programme, concentrating on the western part of the Brazilian Amazon, mainly within the state of Amazonas [8]. In this new configuration a new set of river courses was chosen, maintaining from [5] the rivers (lower) Amazonas, Negro, Solimões and Madeira, and newly including the Purus and Juruá (fig. 5).The first connections to be built would be from Coari to Tefé, by the Solimões (2016), and from Manaus to Coari, by the Solimões, and to Novo Airão, by the Negro (2017). The website [8] includes videos of some of the 2016 operations and [7] has further details, and provided wider dissemination.

Figure 5: The rivers involved in the Amazonia Connected programme.

The 24 strands armoured FO cable used in these connections was supplied by Nexans. The technical operations of cable-laying, assisted by their own divers, were carried out by Aquamar of Manaus, using rivercraft provided and operated by Navegação Prates of Iranduba, Amazonas. The optical transport equipment and long-distance transponders installed were provided by Padtec, and overall management and logistics provided by the Brazilian Army.

Cable-laying in the Solimões, as in most other rivers of Amazonia, is made more complicated by the almost total lack of transparency of the riverwater. The major exception in this part of the Amazon region is the Negro river, with great transparency.

In the operations carried out in 2016 and 2017, a total length of around 800 km of cable was installed, and future priorities are to complete the route along the Solimões as far as the triple border with Peru and Colombia at Tabatinga, which is 991 km upstream of Tefé.

5. A SIMILAR INITIATIVE IN PERU

Figure 6: Integration of FO routes in the Peruvian Amazon

Fig 6 shows part of the Peruvian stretch of the Amazon river system, as well as the RDNFO connection to Yurimaguas following the IIRSA Norte highway from the Pacific coast. In [7] there was mentioned a survey carried out of a sub-fluvial connection between Iquitos and Yurimaguas in the Loreto region. This information was provided by one of the companies involved in laying the Amazonia Connected cable in the Solimões river in Brazil. In 2018, the Peruvian government declared that the building of such a sub-fluvial connection between Yurimaguas and Nauta would be a feasible way of extending the RDNFO to Iquitos [9]. In principle, such a project should be put out to tender in 2019.

The pieces of the jigsaw are beginning to fit into place, in order to integrate into the national broadband network the Amazon region of of Peru, in this case the important city of Iquitos. However, we are of the opinion, already expressed in [7], that broader and better integration is possible at a continental level by linking together the separate initiatives of Peru and Brazil. This

was of course the original proposal presented in [6], to link Iquitos to Manaus. Now that Iquitos will soon have a connection to the Peruvian RDNFO, a connection from Iquitos to Manaus could provide redundancy to all intermediate points between Manaus and Yurimaguas, as well as a new route linking the Atlantic and Pacific Oceans, thus providing continental scale redundancy for communications, as shown in Figure 7.

Figure 7: International integration of FO routes across the Amazon basin.

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