Optical Fiber Technology 26 (2015) 2–11

Contents lists available at ScienceDirect

Optical Fiber Technology

www.elsevier.com/locate/yofte

Invited Papers

Fixed Access Network Sharing

Bruno Cornaglia [a,*], Gavin Young [b], Antonio Marchetta [c]

[a] Vodafone Group Services, Via Jervis 13, Ivrea, TO, Italy
[b] Vodafone Group Services, Smale House, 114 Great Suffolk Street, Borough, London, UK
[c] Reply, Via Robert Koch 1/4, Milan, Italy

ARTICLE INFO

Article history:
Available online 29 July 2015

Keywords:
NFV
SDN
FANS
FTTx
NGA
Fixed access

ABSTRACT

Fixed broadband network deployments are moving inexorably to the use of Next Generation Access (NGA) technologies and architectures. These NGA deployments involve building fiber infrastructure increasingly closer to the customer in order to increase the proportion of fiber on the customer's access connection (Fibre-To-The-Home/Building/Door/Cabinet... i.e. FTTx). This increases the speed of services that can be sold and will be increasingly required to meet the demands of new generations of video services as we evolve from HDTV to "Ultra-HD TV" with 4k and 8k lines of video resolution. However, building fiber access networks is a costly endeavor. It requires significant capital in order to cover any significant geographic coverage. Hence many companies are forming partnerships and joint-ventures in order to share the NGA network construction costs. One form of such a partnership involves two companies agreeing to each build to cover a certain geographic area and then "cross-selling" NGA products to each other in order to access customers within their partner's footprint (NGA coverage area). This is tantamount to a bi-lateral wholesale partnership.

The concept of Fixed Access Network Sharing (FANS) is to address the possibility of sharing infrastructure with a high degree of flexibility for all network operators involved. By providing greater configuration control over the NGA network infrastructure, the service provider has a greater ability to define the network and hence to define their product capabilities at the active layer. This gives the service provider partners greater product development autonomy plus the ability to differentiate from each other at the active network layer.

1. Introduction

Implementing an open and sharable access infrastructure [1] facilitates new business models to make Fiber-To-The-x (FTTx) network construction more economically viable. FTTx networks deliver high bandwidth to customers, and thus are future-proof solutions. However, they require a high initial investment to deploy fiber in the field and it is often not possible to recoup the investment within a moderate depreciation periods, within say 10 years. Hence, a natural solution is to consider sharing the costs and resulting network infrastructure (fiber and equipment) among multiple network provider entities. Such a partnership approach ensures that each participating network provider partner doesn't have to completely (and solely) fund the entire capital expenditure (CapEx) to achieve full geographic coverage of a region before being able to serve users. This reduces the barrier for network entry, encourages infrastructure investment and consequently reduces the cost of service delivery.

In order to be successful, 'open access' requires the network sharing to be non-discriminatory, requires new business models and revenue flows and also necessitates novel architectures to stimulate a multitude of services for users in a seamless way. In this article we focus on architectural challenges to implement an open and sharable network. Fixed broadband access network sharing can be offered at different layers depending on how a user selects a specific network entity, for example, by selection of a fiber or wavelength (known as Passive Infrastructure Access – PIA) or a packet field such as Ethernet address, VLAN tag, MPLS, IP (Active Line Access – ALA). The two PIA examples of open access implement a physical separation of the access network among different entities and they are largely described and explained in [2]. The latter active access examples can be implemented by providing a "slice" of network resources to a network entity. This slicing can be implemented at layer 2 (VLAN), layer 2.5 (MPLS), or layer 3 (IP) and facilitated by emerging cutting-edge technologies like Software Defined Networking (SDN) and Network Function

* Corresponding author.
E-mail addresses: bruno.cornaglia@vodafone.com (B. Cornaglia), gavin.young2@vodafone.com (G. Young), a.marchetta@reply.it (A. Marchetta).

http://dx.doi.org/10.1016/j.yofte.2015.07.008
1068-5200/

Virtualization (NFV), [3]. Introducing such new and advanced information technologies poses some challenges in the context of fixed access network deployment and implementation. Using a physical separation of the network introduces new requirements to be addressed in order to facilitate the sharing [4]. Access network "slicing" offers an additional approach with the potential to decrease costs using off-the-shelf compute hardware as network equipment.

In this article we propose a novel architecture for implementing Fixed Access Network Sharing (FANS) by using virtualization mechanisms for slicing the access network among different "virtual" network operators. The paper is organized as follows: In Section 2 we describe the business drivers that encourage consideration of a new access network concept for sharing a single access network infrastructure among different operators. In Section 3 we provide a short description of the operational impact using an eTOM (enhanced Telecom Operations Map) business process framework. Finally, in Section 4 we propose an innovative approach based on equipment virtualization that allows slicing of the physical resources of active equipment for multiple virtual operators, based on the concept of Network-as-a-Service (NaaS).

FANS is currently being studied in the Broadband Forum [5]. Access Node equipment that includes new capabilities to facilitate improved virtualisation for FANS is starting to become available in 2015.

2. Business drivers

FTTx represents the most future proof technology deployment approach to enhance data rates to end customers. This is because the "end-game" is Fibre-To-The-Home (FTTH) so any partial fibre deployment for other FTTx scenarios is a step towards the end-state architecture. However, the deployment of FTTx has a very long RoI (Return on Investment) even for high take-up rates. FTTx requires a huge effort not only in financial terms but also in terms of resources for its deployment. For example, deploying a FTTH network in some geographies can have a RoI of 12 years or more for 40% take up rate considering a generic European country, as illustrated in Fig. 1.

Many operators have recognised the need to pool resources (financial and deployment expertise) to help overcome the challenges of FTTx deployment. There are several examples of partnerships and joint ventures being formed between operators specifically for FTTx deployment. For these reasons, sharing the network infrastructure (in particular the access network) is the only way to substantially and sustainably improve network costs, expand the network and achieve an efficient and effective NGA roll-out using new technologies. This can offer a network operator the opportunity to control costs and achieve market advantage in the years ahead, significantly accelerating service deployment speed, plug coverage gaps and grow revenues.

In practise network operators can decide to cover different geographic areas with NGA and to give access to other network operators via a mutual agreement. Fig. 2 shows an example where operator 1 is covering Area 1 with its own infrastructure and it is also delivering access to it for operator 2. The same approach is undertaken by operator 2 in area 2. A possible generic collaboration model can be extrapolated from Fig. 3 where n operators share the same infrastructure offered by operator k in a specific area.

The main drawback with this scenario today is that the only possible collaboration model is based on a "bitstream" approach. This means that the architecture and all service designs have to be agreed in advance between all network operators and the one owning the infrastructure. This is typically a long requirements capture and development process that impacts the time to market for new services and features and therefore inhibits new service creation and evolution of the network. Consequently, in practice only basic service offerings with minimal scope for differentiation can be delivered. A new collaboration model is needed that allows hosted operators (VNOs – Virtual Network Operators) to have better control of resources rented from the operator owning the infrastructure in a specific area (InP – Infrastructure Provider) and an higher degree of influence over the network design and service model.

The tables below summarise the drivers for improving business models that have resulted in this new collaborative model, called FANS (Fixed Access Network Sharing). The drivers can be grouped in categories:

- Business innovation
- Network efficiency
- Customer experience

Of the range of drivers, the main ones are:

- FANS creates a business model for providing competitive network services to other operators and direct customers without the inherent constraints of bitstream services.
- The FANS model offers the ability to reduce the financial burden and risk associated with launching and scaling up new fixed access technologies.
- Operator differentiation can be focused on the individual operator's unique marketing targets, retail product development and expansion plans, allowing operators to focus on services rather than on wholesale infrastructure issues. (see Tables 1–3)

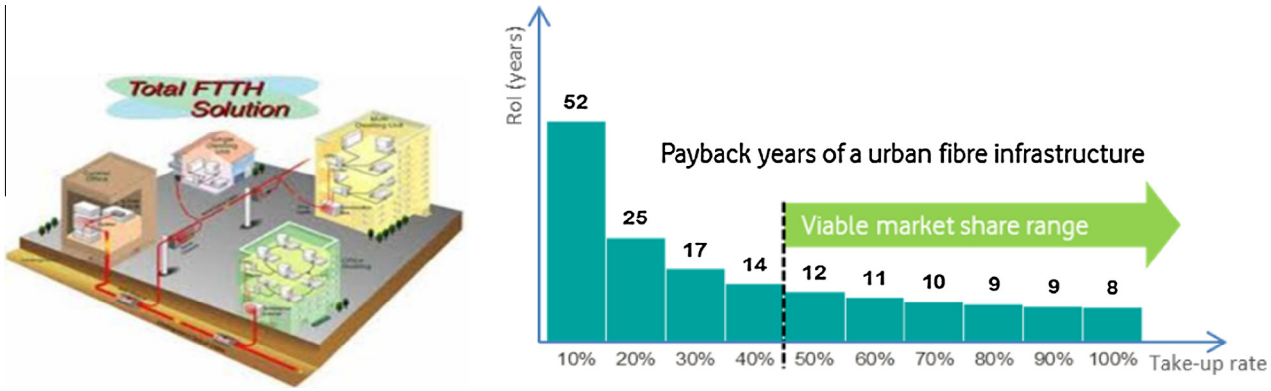

Fig. 1. Illustrative scenario of potential FTTH return on investment.