Dynamically Reconfigurable Optical-Wireless Backhaul/Fronthaul with Cognitive Control Plane for Small Cells and Cloud-RANs

Introducing H2020, 5G-PPP Project *5G-XHaul*

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***Abstract* —Small Cells, Cloud-Radio Access Networks (C-RAN), Software Defined Networks (SDN) and Network Function Virtualization (NVF) are key enablers to address the demand for broadband connectivity with low cost and flexible implementations. Small Cells, in conjunction with C-RAN, SDN, NVF pose very stringent requirements on the transport network. Here flexible wireless solutions are required for dynamic backhaul and fronthaul architectures alongside very high capacity optical interconnects. However, so far there is no consensus on how both technologies can be most efficiently combined.**

Keywords—backhaul, fronthaul, optical networks, SDN, NFV, C-RAN, localization, mm-Wave.

I. INTRODUCTION

5G-XHaul proposes a converged optical and wireless network solution able to flexibly connect Small Cells to the core network. Exploiting user mobility, our solution allows the dynamic allocation of network resources to predicted and actual hotspots. To support these novel concepts, we will develop:

1) Dynamically programmable, high capacity, low latency, point-to-multipoint mm-Wave transceivers, cooperating with sub-6-GHz systems;

2) A Time Shared Optical Network offering elastic and fine granular bandwidth allocation, cooperating with advanced passive optical networks;

3) A software-defined cognitive control plane, able to forecast traffic demand in time and space, and the ability to reconfigure network components.

The well balanced 5G-XHaul consortium of industrial and research partners with unique expertise and skills across the constituent domains of communication systems and networks will create impact through:

a) Developing novel converged optical/wireless architectures and network management algorithms for mobile scenarios;

b) Introduce advanced mm-Wave and optical transceivers and control functions;

c) Support the development of international standards through technical and techno-economic contributions.

5G-XHaul technologies will be integrated in a city-wide testbed in Bristol (UK). This will uniquely support the evaluation of novel optical and wireless elements and end-to-end performance.

II. TECHNICAL CONCEPTS

The main concepts underpinning the design of 5G-XHaul are:

1. Programmable optical and wireless network elements that enable a tight control of the transport network.

2. An SDN architecture, where the control plane is decoupled from the individual transport network elements and logically centralized to achieve a holistic view of the network.

3. A cognitive control plane, able to measure and forecast spatio-temporal demand variations and accordingly, configure the transport network elements.

5G-XHaul will design and demonstrate a flexible network architecture that will be able to transport future RAN architectures, whether these will be shaped as distributed and dense small cells networks, as centralized Cloud-RAN deployments, or as an hybrid combination of both. For this purpose a converged wireless optical network is considered.

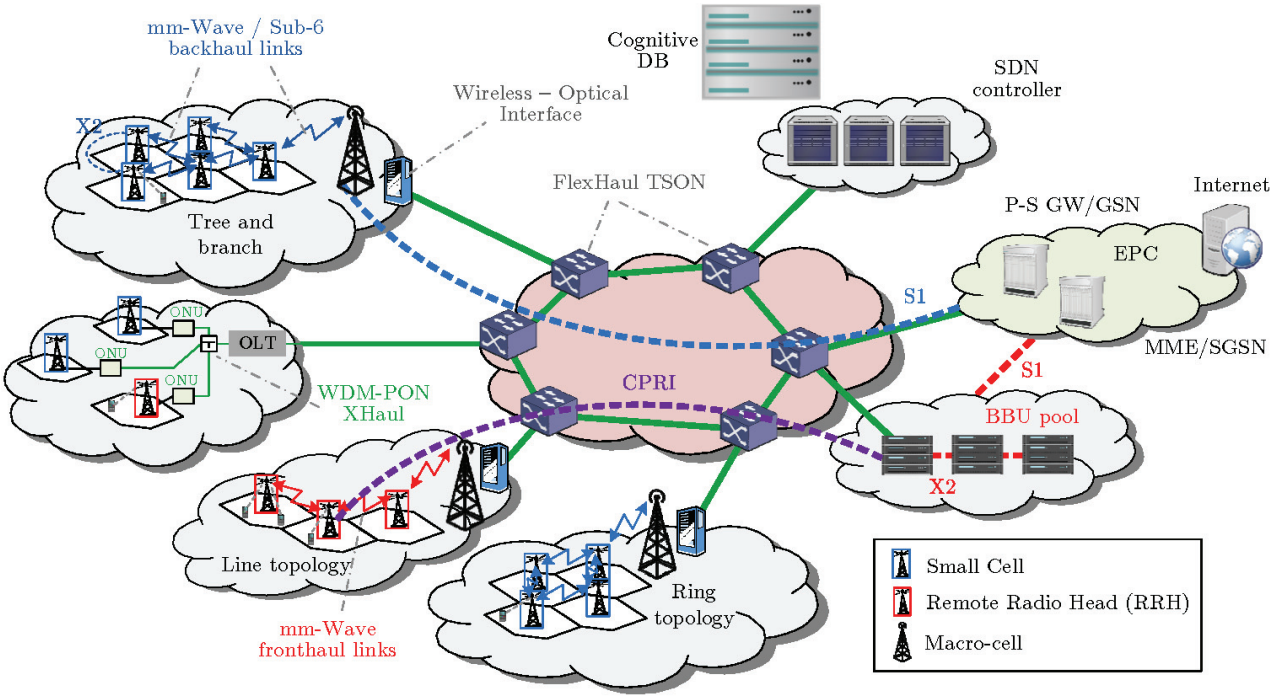

Fig. 1 5G-XHaul network deployment.

Fig. 1 illustrates a possible 5G-XHaul deployment that comprises several domains. A dense layer of Small Cells located 50-200 metres apart and 2-6 metres above street level, e.g. mounted on lamp posts, bus shelters, building walls, or vehicles. The Small Cell layer is composed of the access part, which can be RRHs in the case of a Cloud-RAN architecture, or full BSs in the case of a dense and distributed RAN architecture, and is backhauled using a combination of mm-Wave and Sub-6-GHz wireless technologies. In addition to the Small Cell tier, a macro cell layer delivers ubiquitous coverage. Macro-cell sites are usually located at building tops with inter-site distance around 500 metres in urban scenarios.

In a typical deployment, the Small Cell tier may be wirelessly backhauled until the macro-cell site, where usually optical fibre is available, or in some cases Small Cells could be connected to a central office node using WDM-PON.

However, in 5G-XHaul, the higher levels of the X-Haul network comprise Time Shared Optical Network (TSON) nodes, which deliver connectivity between macro-sites or central offices (CO) and the regional data centres that host BBUs, in case of a Cloud-RAN architecture, or core network gateways in case of a distributed RAN architecture. We will now introduce the principles of operation for all the key components of 5G-XHaul.

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