Chapter 9
Optical Networking Technologies for 5G Services

Baskaran S.
SASTRA University (Deemed), India

Srinivasan A.
https://orcid.org/0000-0003-1171-5573
SASTRA University (Deemed), India

Mardeni Bin Roslee
Multimedia University, Malaysia

ABSTRACT

The chapter provides information as a first step for individuals who are thriving to get a bird's eye view of the aspects underlying the optical networking in the context of 5G technology. Apart from capacity requirement challenges targeted by 5G coverage, it requires a lot of fibers to be successfully provisioned to achieve formidable performance goals of 5G such as diversified capacity requirements, availability, and coverage issues. The goals could be achieved by the underlying optical network with a greater number of interconnected fiber paths. In 5G, the requirements of reliable and ultra-low latency services required at the access side of a network shape up the research and evolution of underlying optical segments spanning from core to access part of the network. The reconfigurability and security issues of the present mode of optical communication need to be addressed, and the proposals given by the researchers are summed up. The chapter includes a general framework and theoretical concepts behind machine learning and software defined networking paradigms.

INTRODUCTION

The key challenges for the communication networks been thriving since few years have been to satisfy the burgeoning demands and enhance the capability for the network operations to integrate the state of the art technologies pertaining to different domains of wireless communications and highly promising optical communication technologies. Driven by mobility of devices, proliferation of IoT technology, the

DOI: 10.4018/978-1-7998-9266-3.ch009

rampant demand for communication resources has given rise to research areas that attempt to provide seamless interaction of radio access and optical communications. There has always been a requirement to cater to the needs of 5G services such as low latency to support real time communications coupled with energy efficiency and delivery of services that inherently involve traffic variability. With increasing dynamic traffic changes where frequent and complex reconfigurations of resources in networks spanning over multiple segments, the allocation of resources of varying capacities and highly dynamic utilization patterns are involved. To ensure satisfactory level of quality of service, the transport networks evolve with incorporation of automation for provision of connectivity and resource allocation.

Covering the aspects, the chapter presents a summary of optical networking technologies enabling 5G communications with focus on spatial multiplexing, propositions of optical distribution network in the front haul required by 5G services based on usage metrics and area of deployment, investigations regarding survivability and resilience issues pertaining to outage of fiber cables/ switching equipment in the back haul network. Excerpts on techniques deployed to ensure secure communication by sharing quantum keys to assist encryption, the enabling technologies to accomplish spectral multiplexing with high entropy by way of holographic techniques mimicking the Multiple Input Multiple Output(MIMO) are presented. The application of machine learning for management and control of optical communication network to ensure service guarantees invoking protection mechanisms have been covered. Software Defined Network aspects for control and management of dynamically varying connectivity, spectrum resources driven by the requirement of 5G services are also included.

SPACE DIVISION MULTIPLEXING IN OPTICAL NETWORKS

A highly flexible, adaptive high-capacity front haul with desirable power conservation becomes necessary attributes to be supported to cater to the requirements of 5G specifications. The optical spatial multiplexing is a promising member proposed to be included in the Next Generation Passive Optical Networks NGPON. Lagkas et al. (2020) have proposed a minimized energy consuming 5G front haul with an emphasis on assignment of optical resources. The work approaches spatial multiplexing incorporating the optical beamforming (OBFNs), Multicore fibers (MCFs) and Spectrally Spatially Flexible optical network propositions modelled as optimization problems and evaluated through simulations for their effectiveness.

In 5G architecture, the functionality of Baseband Unit (BBU) in a BBU pool is taken care of centrally by the Cloud Radio Access Network (C-RAN) by integrating the front haul, backhaul telecommunication infrastructures and radio access. Wireless connectivity for the mobile devices are provided by the Remote Radio Heads (RRHs). As a convergence of C-RAN, the traffic collected is delivered through the PON of the Optical Distribution Network (ODN) front haul. This enables the system to have high scaling capabilities with better adaptation to dynamic traffic situations. The Central Office (CO) where BBU pools are resident supports multiple operators and multiple services, while supporting Optical Line Terminals also. Through Remote Nodes (RNs), with dedicated fiber links the RRHs are reached. Other options of front haul design are also proposed to lower energy consumption, end to end delay and complexity by migrating the tasks carried out at the RRH to the Central Office. By adopting Digital Radio over Fiber (DRoF) evolved as eCPRI and Next Generation Front Haul Interface (NGFI), processing of wireless data at baseband and transmitted over optical fibers with addition of Medium Access Control layers processes to RRH sites.