# Identification of 5G Network Complexity Using SDN


**Neetu Faujdar, Ruchi Agrawal, and Ankush Agarwal**

**Abstract** The massive increase in communications technology creates a distributed network, which will be creating a massive quantity of data in billions of network devices. Digital and broadband networks are a significant contributor to this transition which calls for different technological paradigms in a resource-driven world that provides low latency with high efficiency. The full IP-based application launch is planned for 2020. There is, still, no framework for 5G technologies developed, and a standardized 5G specification is being sought out. In the same way, the best choice is changing infrastructure, for instance, software-defined network (SDN). The unified control board is used to separate SDN from the data plane and to monitor the network. This paper provides a state-of-the-art analysis of 5G deployment for the SDN.

**Keywords** Software-defined network · 5G · Cellular networks · Integrated cellular SDN

## 1 Introduction

Exponential advancement toward development plus networking creates a hyper-connected ecosystem with millions in linked products. The new cellular innovations like 3G/4G are introducing IP networking that assures to delivery of fast broadband, interactive technology, and a wide variety of facilities with better capacity, versatility in delivery, and lower cost impact. Though, the market for connectivity and the traffic habits of globalization is increasing exponentially, with an unprecedented mobile network increase of 4000-fold over the past decade and membership of 150 million in the first quarter of 2016, with 1.2 billion wired smartphones in the third quarter of 2016 [1].

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Owing to this increasingly growing number of network/submission and interconnection tools, the existing wireless 3G/4G network is not adequately satisfying the planned demands of the 5G wireless system/mobility network for convergence, low latency, and high capacity. The 5G offers user-centered networking, including connections to different devices easier, greater bandwidth, and a 1 ms delay. 5G is an essential tool for the Internet of Things (IoT) framework that connects billions of users as it supports low cost, low power communication machine to machine (M2M), guaranteeing high service quality (QoS). The standardization attempts for 5G are only at an early level, nevertheless, and 5G is expected to be completely realized in "2021 in South Korea, Japan, China," and the USA [2].

To incorporate and operate the 5G wireless networks, current networking and network infrastructure will be reconfigured. That is because of the current 3G/4 G system. We cannot have farsighted stability and cost savings in handling billions of wired devices. In the light of the M2M networking, vehicular access, smart grids, and industrial automation, as anticipated from the 5G IoT network framework, the current spectrum is still inadequate to fulfill planned improvements and efficiency criteria. The software-defined networks (SDNs) and network function virtualization (NFV) allowed innovations are included [3].

The SDN redefines network design by the isolation of the control plane and offers protection for heterogeneous network relationships with constantly evolving complexities through the use of programmable planes. Around the same time, NFV provides many applications effortlessly linked with the network free of the inherent complexities and sharing of capital. SDN network convergence facilitates creativity more efficiently and versatility in delivery resulting in faster connections to emerging IP-based networks [4].

Yet the nuances of 5G, cell network specification and deployment are continuing to be abstracted an active issue in the telecom network. Therefore, the numerous current cellular network structures are envisaged in the sense of SDN and argue for the likelihood of an SDN-based cellular infrastructure reshaping cellular communication. This article highlights different studies that include a cellular SDN-based cellular IoT development approach, in particular, the implementation of 5G in SDN background. Between 2010 and 2016, we review the literature, concentrating on various cellular systems utilizing the freedom of the SDN core router [5].

## 2 SDN-enabled Wireless World

SDN innovation is a unique methodology into network executives that empower automatically effective organization structure. It is an advanced organization model, in which separation of the control plane from the information plane offers seller freedom, user autonomy, and protection for diverse networks. SDN is normally related to network filtering and functions as a network-level control orchestrate. SDN control airplane is technically a hierarchical organization with a regional network perspective. Network maintenance and setup on the control plane are carried out. The

network supporting the switching system is separated from software and customer facilities. In the data center and cloud infrastructure, SDN is the most commonly used architecture [6].

## *2.1 SDN Architecture and Protocol*

SDN is essentially a three-network architecture. (1) Stage of data plan, (2) stage of pilot and plane power, and (3) stage of operation. Data plane consists of dumb transmitting machines, i.e., routers, which only transmits data on the controller directions. The controller functions as a brain and controls the network from a global network view. Customer specifications are decoupled via applications that, for example, through northbound APIs, are transmitted to the dispatcher. API for RESTful. The manager administers the entire system and has a regional network vision. Many modern sensors, like OpenDaylight, Floodlight, NOX/POX, are on the marketplace from their inception. For incoming data plane flows, the SDN controller determines the law. Northbound interface (NI) API and southbound interface (SI) API enable SDN layers to connect over accessible APIs [7].

The SDN system delivers configuration and adaptive monitoring for the propagation of the meditative state on the regional level with a regional network vision. To satisfy the increasing requirements of customers, SDN will provide high data transmission spectral performance, capital allotment, and management of data for IoT equipment. Many monitoring programs are often meant to operate on the unified device for cell phone networks like the self-organizing networks (SON) program. By tuning the control plane using the SON algorithm, SON generates an efficiency advantage in the RAN [8].

The SDN architecture offers a national network framework for setup and proactive control for the dissemination of the meditative mind. SDN can include fast data transfer, spectral efficiency, capital assignment, and data management for IoT devices to meet the growing requirements of customers [9]. Many control schemes for cellular networks such as the SON software are also configured to run on single devices. SON produces a performance benefit within the RAN system by adjusting the control plane using the SON algorithm [10]. The SDN architecture consists of two types of networks, namely SDN-enabled wireless network and SDN-based cellular network architecture [11].

### 2.1.1 SDN-Enabled Wireless Network

Wireless networking and SDWN-based optimized SDN wireless networks have also been accomplished with SDN advantages. The wireless network operation is enabled in an economical and fine-grain channeling way via the unified SDN controller design with a strong data rate, with lower latency. The SDWN frequency control is associated with baseband virtualization. A wireless data plane control system is resented to

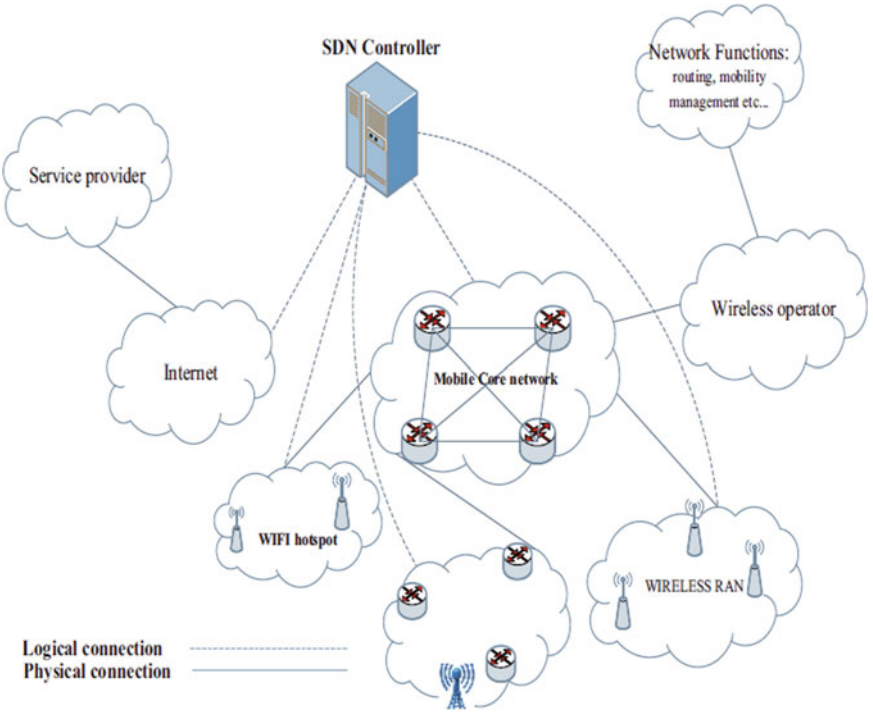


**Fig. 1** Mobile wireless network architecture based on SDN [12]

decouple the data plane of the MAC protocol. Data plane management is carried out through proclaimed and flexible programmable device and network protocol (Wi-Fi, LTE) refactoring. To configure the MAC and PHY layers of the data transmission plane, a code application framework is used. Mobile flow is a system with the user modeling the transport grade delivery for the cellular network and the construction of test beds plus the central controller offers security, permission, and the delivery of QoS services. Figure 1 shows a general framework for SDN-based handheld wireless [12].

### 2.1.2 SDN-*B*ased Cellular *N*etwork *A*rchitecture

QoS for hyper-wired network wirelessly linked over a wide spectrum of networking environments, and cellular network evaluations from first generation (1G) to the fifth level (5G) seek to test the cellular network. A broadband network with a differing spectrum and building a heterogeneous network with various areas including Wi-Fi, LTE, WiMAX, and 3G/4G are the key ingredients of the mobile network. The other approach is to utilize the 4G and 5G networks rather than operator-driven, namely the specifications for infrastructure and standards are different and need production

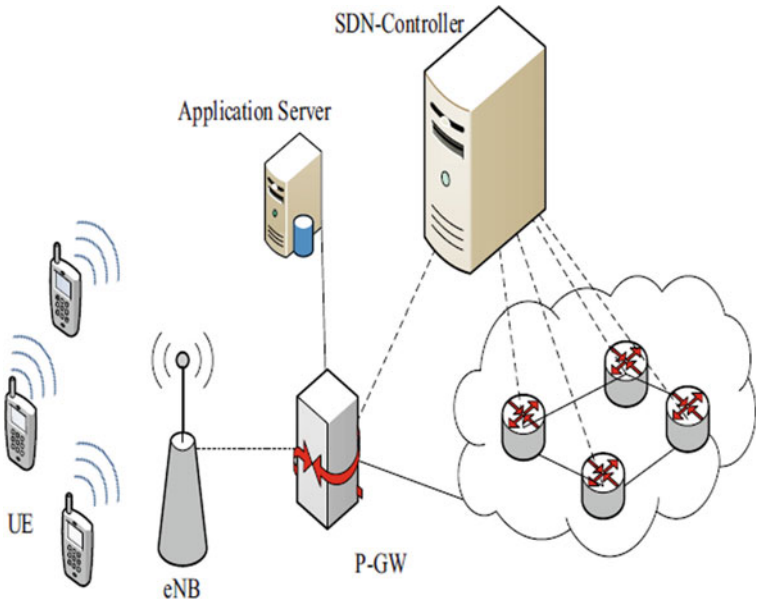


**Fig. 2** SDN-based cellular network [12]

and scalable design and installation of the new networks. The hyper-connected 5G network M2M modules involve the convergence of current and new technologies [12].

5G systems comprise the device interface and a varied array of radio access network (RAN) and independent networks. The RAN applications are connected to the outside Internet environment over an Ethernet interface which is handled with a control device policy center. A general cellular network design is presented in Fig. 2.

## *2.2 Architectural Characteristics of 5G*

The expected dreams of 5G organization innovation are centered around a few forecasts, including developed traffic limit, more prominent information rate for every client, diminished inertness, and higher versatile application. Heterogeneous organization sending in 5G is a fundamental plan with a uniting network also.

### 2.2.1 5G Data Volume and Route

The estimated volume of data from cellular data users is 30.6 exabytes and is averaging 3Mbps link levels up to 2017. This data load is 1000-fold greater than the current level of traffic and 100-fold larger. Therefore, the 5G network's capacity

management aims to revamp the PHY technology and bandwidth performance. 5G manages all oncoming traffic with a single unified system. The SDN theory relates to flow change and control. The software is built with network computation and a genetic algorithm. Flow uses the identical node assets, and this division of labor in this design optimizes the system.

### 2.2.2 Reduced Latency in 5G

The decreased latency called 1 ms latency, particularly in M2M networking, is an essential feature of 5G technology. The 5G apps will cash local material, e.g., products via EPC, and eNBs decrease reaction time throughout the 5G network. However, eNBs small storage space are not enough to cache and constantly update information, thereby growing the cache impact ratio as opposed to a missed ratio and increasing overall link latency.

### 2.2.3 Improved Energy Efficiency

As energy-constricted machines, M2M connectivity is generalized. Therefore, energy usage management is important for the higher and longer existence of the energy restraining network. Sleep/wake processes and timing for idle channels may be used as energy-saving nodes.

### 2.2.4 Key Points of 5G Architecture

In the direction of outlining the essential advantages of the 5G mobile network, dynamically integrated applications that can offer high rate, low latency as well as versatile and configurable software will meet the following criteria. The SDN and NFV definitions will be used for the design of the 5G technology/cellular network.

## 3 Cellular Network Integration in SDN

Boundary functionality in the telecommunications network is challenging to obtain the intended effect and will actively interfere with radio technology, despite the enhanced sophistication and combined technology. Differentiated control efficiency will improve network output by offering program control and radio control.

### *3.1 SDN-Based Cellular Network Architecture*

Li made the primary suggestion toward an SDN-based mobile network [13]. Wrong and. In s. S, they named it cell SDN, in which the rules for specific LTE network consumers dependent on characteristics are established and the network is managed. Local agents conduct deep packet inspection on-turn in cell SDN and reduce unnecessary controller load [14].

As the transmitter set in which cross-functionalities is challenging to achieve owing to centralized communication algorithm, radio access network (RAN) is managed independently as the network. Different control functionalities can improve network efficiency by offering technology-based radio modulation.

S. is indicated by Soft-RAN. Throughout, Tomovic et al. utilized the 4G LTE network SDN concept. The entire RAN is resumed into the geographical region through a hierarchical control plane. In a grid of three dimensions, a wide base station with centralized power, i.e., size, time and bandwidth slots, is allocated resources. In the field of size, time, and energy, the planner determines to assign capital. Radio aspects/BS wants to tackle disruptions at the local stage [14].

### *3.2 SDN-Based Cellular Network Management*

It is incredibly challenging to set up, redefine, distribute the capital, and also to use the inter-communication model. When controlling the heterogeneous network, SDN has a significant function to play.

D Wu et al. introduced UbiFlow that offers powerful flow management and flexibility administration in urban multi-network via centralized SDN controls. Throughout UbiFlow design, a dynamically dispersed SDN device is used to separate IoT systems into tiny network fragments/clusters. For various data demands, the IoT devices of each partition may be linked to a separate entry point [15].

M. Boussard et al. suggested an IoT system monitoring and control structure based on SDN in an intelligent world. In order to require consumer facilities, the control system, dubbed software-defined LANs (SD-LAN), organizes systems and classes. In order to explore and build a computer topology for device specifications, the Universal Plug and Play (UPnP) and the Standard Network Discovery Protocol (SSDP) architectures are used [16].

## 4 Proposed Methodology

5G organization comprises of three gatherings of administrations whose necessities ended up being the justification improvement, i.e., massive machine type communication (mMTC), helping bunches of IoT gadgets with inconsistent activity and

correspondences of little information bundles. Expanded circumstances contain a large number of gadgets, robotization of cycles, similar to transportation, shrewd removal of waste, resource following, and so forth. These facts when considered provide a very likely idea that will help us to design the beyond 5G (B5G or so-called 6G) architecture that is seen as ultra-dense networking (UDN) implying a density of hundreds of nodes per square kilometer. To offer improved coverage for every user, a UDN is used which works based on the implementation of moving or static, flying radio access (RA) nodes or ground. To be more precise, the transmission distance is lowered in the UDNs, which results in a better quality in linking and leads to the reusing of frequency to be maximized and increased capacity. For instance, in a crowded event (Fig. 3a), like a trade-fair or a music festival, surplus connectivity is necessary, specifically at remote locations that are not near central areas; typically, the access network nodes are not able to cope with the excess amount of connections by the event watchers.

A strategy to build a network office for helping such occasions can be dispersal of robots, put deliberately for better-quality organization and additional transfer speed

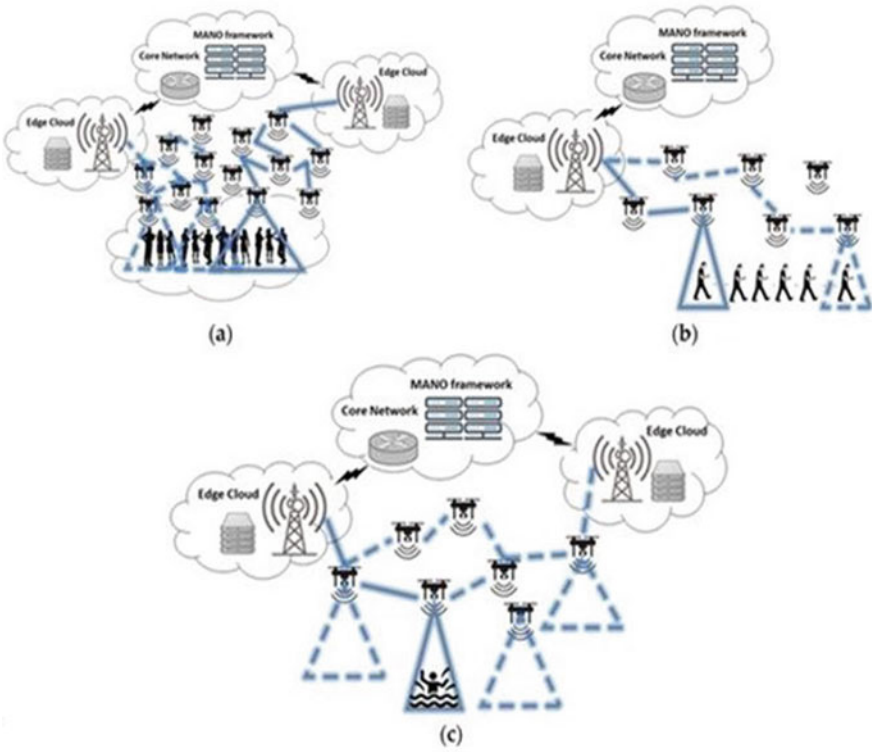


**Fig. 3** Fifth-generation network demanding typical use case scenarios: **a** Crowded event; **b** Moving users; **c** Network recovery after a natural disaster

to the space, and simultaneously the transmission of fast associations, the versatile information traffic between center organization and the clients. Moreover, edge content reserving might have the option to facilitate the tension on backhaul connects and further develop client experience.

Looking at a similar situation, several outdoor dwellings of attention for clusters of visitors remain located to some extent outside the range of outdated telco arrangement, comprising of trips on the sea toward coasts, site visits to historical places by individuals, jungle safari trips to view the animals and vegetation, etc. Network coverage may be provided to individual sight-seeing (Fig. 3b), using radio-controlled drones, hovering over places of tourism. The connection among the main network and aerial random access (RA) nodes will need a type of medium to long-range network transmitting equipment. A few RA nodes would be following visitors for the duration of their visit. Lastly, after huge calamities, for instance, hurricanes and earthquakes, network connectivity may be lost, resulting in the isolation of people and leaving disaster management teams without proper communication with the outside world. In these situations, some type of network providing equipment must be set up immediately (Fig. 3c), concentrated on the affected regions, allowing the disaster management teams and individuals in the region to be able to communicate and enabling them access to the Internet or other resources, like voice. The deployed network needs to be mobile for it to follow the disaster management teams, recognizing signals and noises coming from the rubble by using FLIR cameras or other sensors. Consequently, it develops superficial from the overhead that many external challenges can recognize the development of mobile 5G networks, based on real-life usage. The presence of multiple usages with varied abilities leads toward the harmonized practice of connectivity nodes, to provide services and network connectivity for the other facilities, with clashing goals on quality of service (QoS) and freedom of movement for the sustenance of the different networks. Henceforth, the handoff is further complex, so it needs additional study. Finally, impedance organization can be viewed as more troublesome and not reachable by the current clarifications given in the writing. The air of portable hubs, stable BSs, and gadgets/clients produce a complex meddling model which would be further equivalent to a wireless sensor network).

## 5 Discussion and Open Issues

SDN model may be used on multiple mobile network levels. But, the WSDN currently is still in the early stages, and several concerns remain unresolved. Low-cost systems are resource controlled; those need a service cycle to allow reserve resources communication, long-range communications through several hop communications, data accumulation, and optimization of cross-layers. The proposed implementation is, therefore, not completely implemented using SDN, and a complete design specification has not been developed till date. Few initiatives are genuinely exemplary such

as software-defined radio access network (Soft-RAN), software-defined networking architecture (SoftAir) open road, and mobile flow.

The SDN operator must be able to accommodate compact network node versatility, self-setup, and flow management. The traffic management of every system absorbs bandwidth and thus degrades the spectral efficiency of the cell network. Due to low latency namely the latency of 1 m in the network of 5G routing and flow management is needed through in-network storage that does not yet know what flow will except for the hierarchical control. SDN unified control aircraft can often profit from operation assaults and mid-attack denials. Data protection is a big concern because of the large amount of data generated inside the IoT cellular network. The enormous scope of hyper-connected networks renders it impossible to build the SDN-based wireless network effectively.

## 6 Conclusion

In 2021, 5G is a technology priority to include modern networking and communications standards that allow an intelligent ecosystem. It affects the way we think of connectivity in an object and increases the quality of life in our community. In any case, 5G conditions have still not been perceived, even though genuine exploration is being taken on to produce an intelligible 5G foundation that can oblige monstrous amounts albeit solid data transfer capacity given by the cell organization. On account of the huge number of associated gadgets and information produced, a cell network needs completely programmable, versatility, assurance, and information preparation.

To meet consumer desires, scripting and unified management are strongly awaited. In this article, the latest mobile network development system for the SDN control plane has been checked.

The core aspects of the 5G network and attempts to reach fast wireless data speeds are being addressed in this article. Finally, SDN will flexibly alter mobile network types and gain consistency in reshaping the wireless infrastructure to meet the required features for the 5G mobile network.

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