nCore Communications, Inc.

LTE-W
Private LTE Platform

September 2018

LTE core (EPC) has been selected for many private networks by utility companies, public safety and defense industries. However, an LTE network operating in licensed band alone, will not meet all the requirements of all private networks. Private networks differ from a commercial public network in several ways:

1- Private LTE networks have to operate in any geographical areas or conditions that is required by the private operator, while mobile networks need only to cover the majority of the population that are in urban and suburban areas with well-planned scenarios. As a result, many coverage scenarios that are not considered with public networks, now has to be considered for private networks.

2- Private operator devices are much more varied than those supported on commercial networks, which are predominantly Smartphones with Android and iOS operating systems. Private network may wish to connect equipment, laptops, sensors and other devices to their private LTE network.

3- The range and nature of service requirements such as, latency, link robustness, QoS and data rates for private LTE networks are different and more demanding than commercial mobile networks.

Therefore, private LTE networks require more than what is possible with commercial LTE networks. Ideally, private LTE networks should include a variety of access technologies, integrated and operational from a single broadband core such as LTE EPC, as depicted in Figure 1. However, currently, only LTE licensed band radios (eNBs) can be coupled to an LTE core network directly, leaving out other access technologies such as WiFi, Satellite or even Ethernet. Equally, to connect a device to LTE core network, a SIM card is needed on the device for authentication and encryption. SIM-card support in all types of devices cannot be guaranteed.

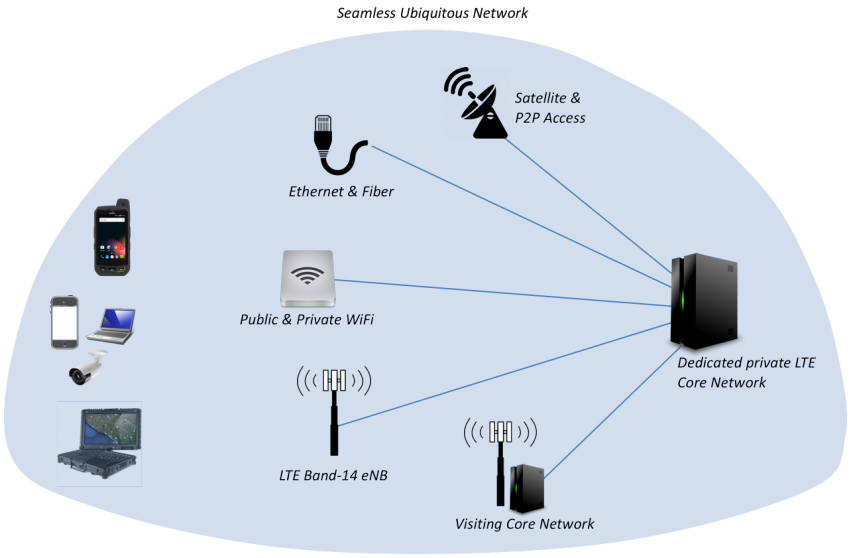

Figure 1: Seamless Multi-Connectivity Single-Core Private LTE Network

To realize multi-connectivity core such as the one shown in Figure 1, nCore has developed a new solution that allows direct coupling of any access technology into an LTE core network over standard LTE interface (S1). With nCore solution, a single broadband core such as LTE EPC can support any device over any access scheme, without the need or an LTE modem. This has given rise to benefits such as:

1- A single unified device identity, based on USIM, throughout network.
2- A single unified Security procedure and protocol (LTE AKA) over all access technologies.
3- Multi-connectivity roaming and mobility throughout the network.
4- LTE QoS and connectivity procedures.
5- Single-core operation.

Realizing that not all devices will support SIM card, nCore has also developed a SW-SIM implementation of the physical SIM. The SW-SIM can be provisioned automatically over the air, alleviating the need for a physical SIM-card or manual SIM provisioning procedure.

nCore solution should not be confused with existing LTE-WiFi integration solutions such as Hotspot 2.0 and others. For example, Hotspot 2.0 requires additional AAA and Proxy AAA servers for authentication with HSS, which ultimately only provides a localized security between the device and the WiFi access point. In contrast, nCore solution will provide an end-to-end security

tunnel between the application servers and the device, through the LTE core (EPC). Perhaps the most noticeable difference between current integration and nCore solution is that the current solutions are mostly for WiFi and Smartphone operating systems, while nCore solution is for any operating systems (currently, Linux, Windows 10 and Android are available), and any access technology (Ethernet, Satellite, Bluetooth, etc).

As shown in Figure 2, nCore solution is based on two SW agents, one residing in the device (above the high-level OS), and with the other one placed somewhere in the network. Together these two agents provide a tunnel for LTE protocols and procedures to propagate over any access technology.

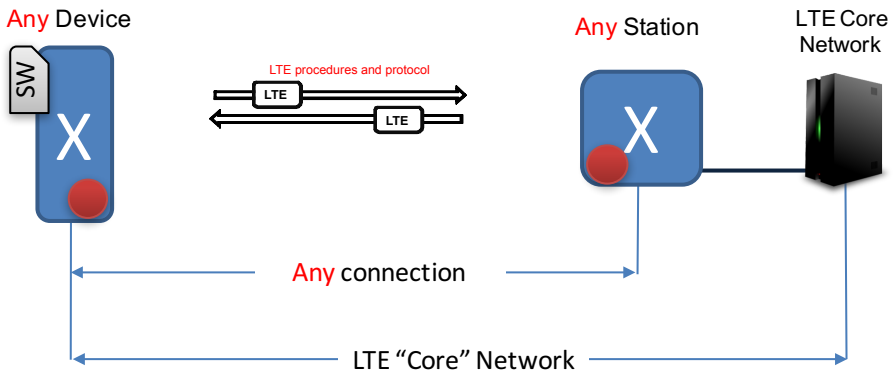

Figure 2: nCore solution with SW agents shown as RED blocks

Example deployment of nCore solution with WiFi Access Point (AP) are shown in Figure 3. On the infrastructure side, it is possible to have nCore SW agents in the WiFi AP, or in a WIFi controller (WLC) or at the edge of the network in a stand-alone gateway that can also be integrated with either EPC or AP.

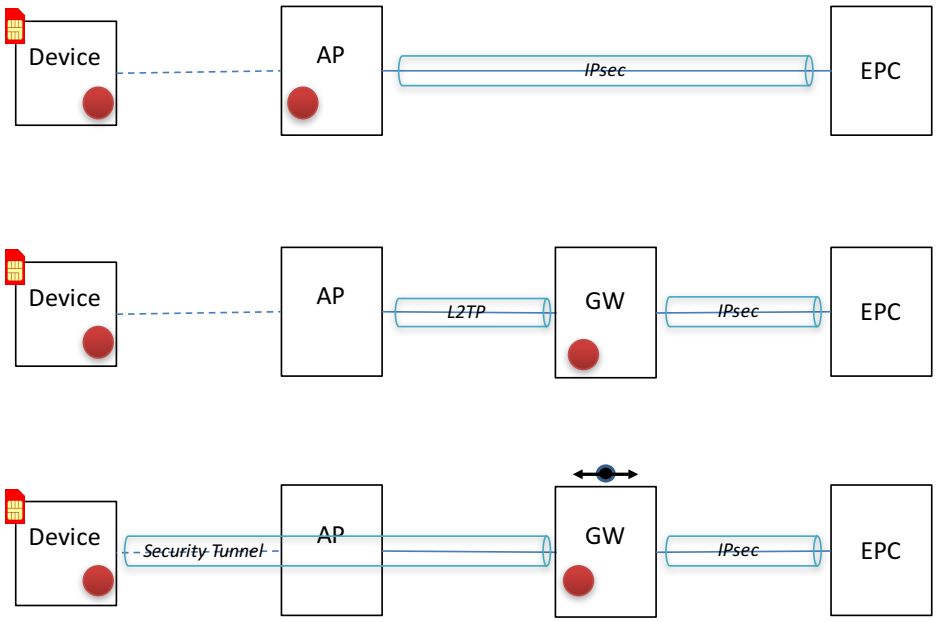

Figure 3: nCore solution with WiFi AP and deployment options

In private LTE network operation, there are scenarios where there is no access to the Wide-Area Network (WAN) or the Internet, (i.e. no LTE network). For such scenarios, nCore GW can be integrated with a Collapsed EPC into a single box, which is used in the field to provide a network "Bubble", connecting all operational devices together through the collapsed EPC, without the need for WAN connectivity. Figure 4 shows such deployment, which can be used for public safety, with nCore option #3 gateway. The gateway will not only connect all devices to the collapsed EPC, it also has the ability to synch with the master HSS (when WAN is available), maintaining current SIM database and issuing new SW-SIMs on demand.

In the event there is no WAN connectivity, the local collapsed EPC is used to provide the network connectivity for the localized devices. nCore Gateway will ensure that all devices, regardless of their access method, can connect and authenticate with the EPC. nCore GW is also capable of issuing new SW-SIMs on-the-fly, to add individual or devices that need to be supported on the localized network.

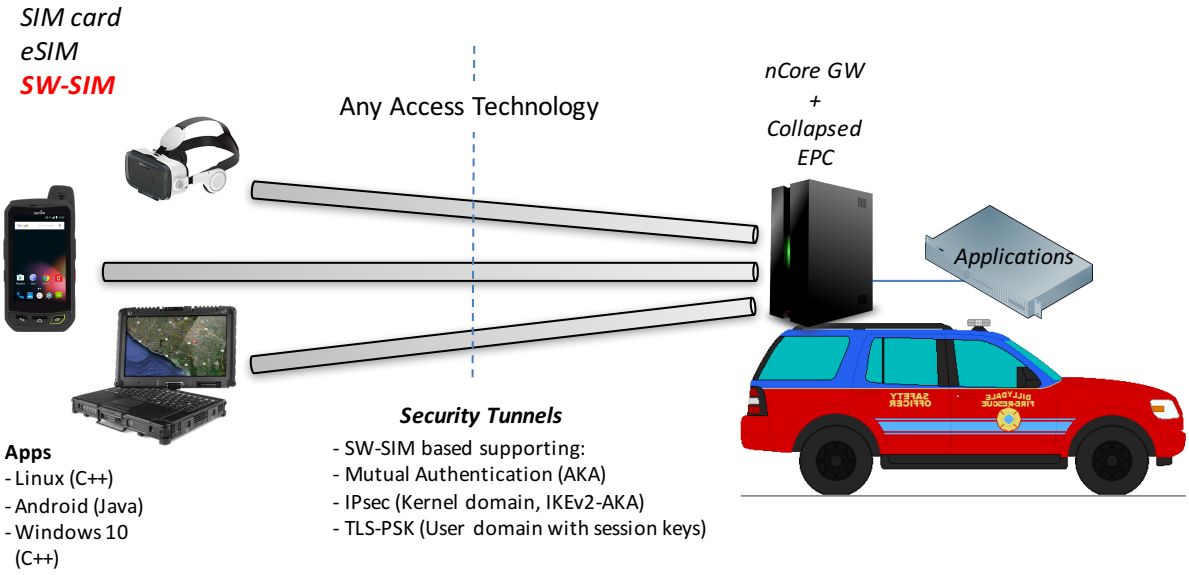

Figure 4: nCore GW with Collapsed EPC for a localized network

Another example is to replace LTE base stations (eNB) with a WiFi Access Point (AP). As shown in Figure 5, the simple replacement of LTE eNB by WiFi AP allows many types of Smartphones and computing devices to attach to LTE core network (via WiFi and other access technologies), and enjoy the same features offered by an LTE core (EPC) such as security, mobility/roaming, Quality-of-Service guarantees, PCRF etc. For an operator, LTE-W offers the possibility of seamless integration of a WiFi network with LTE network, and operate a WiFi network as a carrier-grade cellular network, such as LTE network.

In order to enable attachment of WiFi-only devices to the LTE core (EPC), nCore has developed a technology known as "SW-SIM Auto Provisioning", that allows a device to securely download and use a USIM in a SW format. All other devices, be it single-SIM or Dual-SIM capable, can also use a SIM-card via LTE-W to attach to LTE Core network through a WiFi AP.

Figure 5: LTE-W Network Setup

nCore technology's, LTE-over-WiFi, can also be used to simplify and cost reduce current WiFi-LTE integration solutions. For example, figure 6 shows a typical WiFi ISP network, where a WiFi network, with a comprehensive backend, is integrated into a 4G (LTE) core network by additional network functionalities such as ePDG, MAG, MLA and ANDSF.

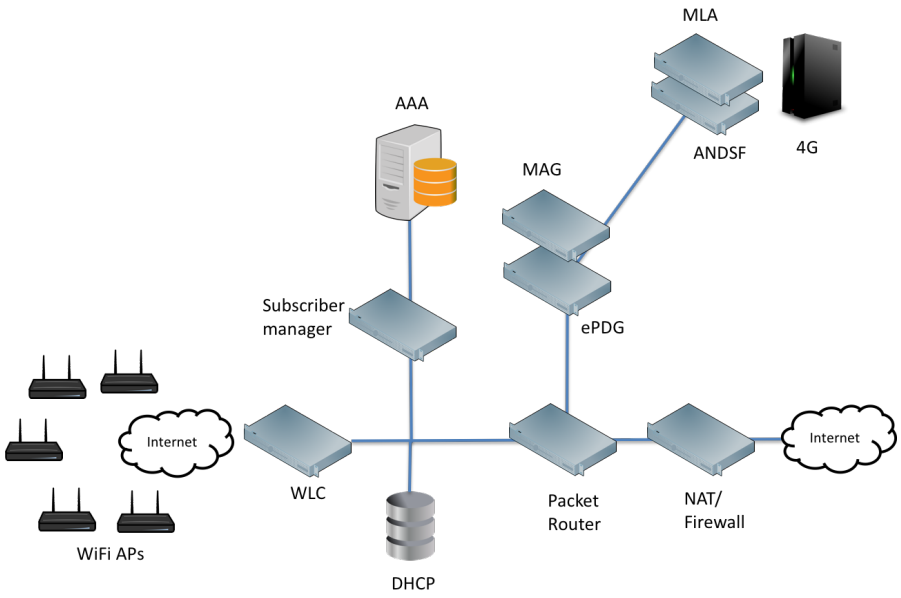

Figure 6: Cisco WiFi ISP Solution

This integration can be substantially cost and complexity reduced by nCore LTE-WiFi solution, as shown in Figure 7. In this solution, nCore SW is placed in the WiFi AP, turning WiFi AP into a simple, cheap eNB, operating with WiFi technology in the unlicensed band.

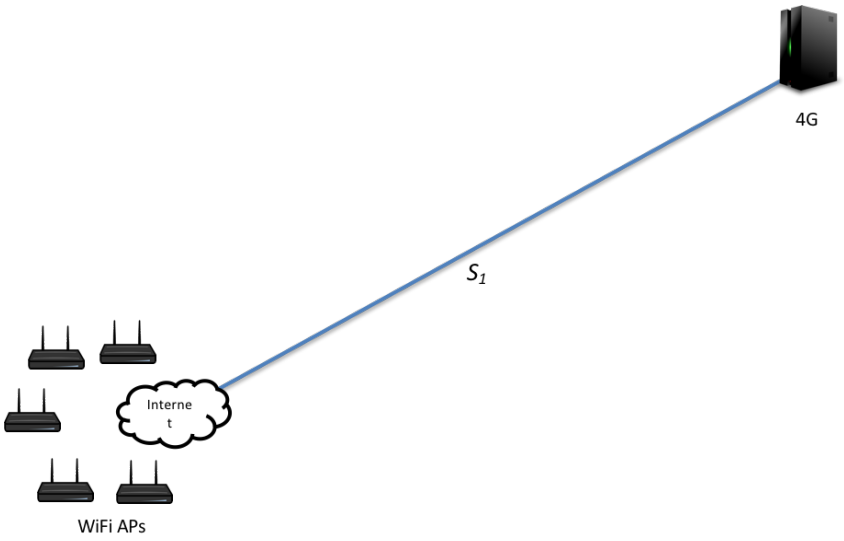

Figure 7: nCore LTE-over-WiFi integration solution