NOKIA

Nokia Compact Network for dedicated networks and remote hotspots

Solution Description

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Today, there is a growing demand for mission-critical and business-critical data applications in enterprise, industrial and public safety environments. These require mobile broadband connections for a mix of data applications such as video, database access, messaging, sensor connectivity, location tracking and voice services. Often, existing mobile services are either unavailable or cannot deliver the required level of broadband service in such areas.

Nokia Compact Network, comprising a Long Term Evolution (LTE) radio and Evolved Packet Core (EPC), allows operators to tailor communications in private and public environments for professional broadband applications. Low latency and high availability services with simple solutions based on Nokia Compact Network can be offered for demanding business customers. It also helps operators to utilize spectrum not widely used commercially in some countries, such as Time Division Duplex (TDD) LTE.

A Nokia Compact Network installed in a macro network can be used to recover from network failures. A vehicle mounted Nokia Compact Network can be deployed rapidly to any location when there is a sudden need for critical communication beyond the coverage of a wide area network.

LTE dedicated networks can be implemented with Nokia Compact Network for several industry sectors, including oil, gas, energy, mining and healthcare, to better meet their communication needs.

Nokia Compact Network use cases

Nokia Compact Network integrates the main mobile network functions into a small ‘box’. Nokia Compact Network for LTE includes the eNB and integrated evolved packet core (EPC) functions, as well as optional applications such as Voice over LTE (VoLTE).

Nokia Compact Network allows commercial mobile operators to develop their data services, creating dedicated networks based on their own spectrum or allocated resources, for example, for enterprise customers. Furthermore, operators can use Nokia Compact Network to deploy reliable mobile broadband to remote locations, perhaps in areas that frequently experience natural disasters such as tropical cyclones.

In some situations, industry sectors may prefer dedicated private networks instead of commercial services. Nokia Compact Network meets their requirements for secure wireless communication. For example, a private network for an oil platform could be justified by the need to use only certified safe mobile devices in the high risk environment and to guarantee reliable wireless connections for automation systems.

Public safety communication is a key market for Nokia Compact Network solutions. Public safety networks are expected to start migrating from current technologies, such as Terrestrial Trunked Radio (TETRA) and P25, to LTE in the coming years. Deployable Nokia Compact Network can provide communications in uninhabited areas without existing network coverage, while pre-installed Nokia Compact Network is an effective way to recover from network failures.

Figure 1. Nokia Compact Network, installed on a truck for mission critical services

Nokia Compact Network technology

Overview

Nokia was the first mobile network infrastructure vendor to add general purpose computing and storage capabilities to mobile base stations. In 2014 this concept was adopted by ETSI as Mobile Edge Computing (MEC).

MEC re-defines the role of the base station, from a purpose-built signal processing device to a programmable edge computing server that resides very close to mobile users and connected objects. With the architecture based closely on IT and private cloud principles, MEC enables a variety of use cases. These range from dramatic improvements in user experience to disruptive service innovations, as well as encouraging other ecosystem players to view the mobile network in a completely new way.

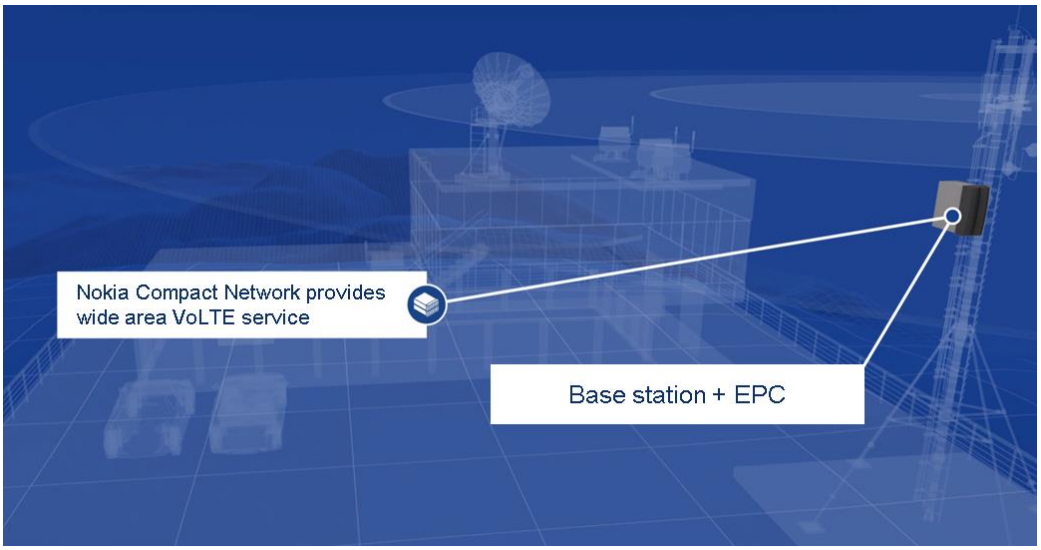
With Compact Network, Nokia extends the option of running applications to running the entire mobile network integrated in the base station. Nokia Compact Network provides standard EPC functions and, depending on use case requirements, additional core network services such as standard Voice over LTE (VoLTE).

Nokia Compact Network is a small, yet powerful solution for telecommunication service providers and enterprises where they need to deploy mission-critical telecommunications infrastructure in a geographically limited area. Nokia Compact Network's ability to deliver coverage anywhere without backhaul transmission will greatly assist in meeting critical communications needs.

Nokia Compact Network uses an application server platform that can provide computing resources, storage capacity and connectivity. Its platform is based on virtualization technologies that enable easy deployment of Nokia Compact Network functions to different hardware environments, like LTE base station modules or industrial Commercial off the Shelf (COTS) servers.

Network options based on Nokia Compact Network

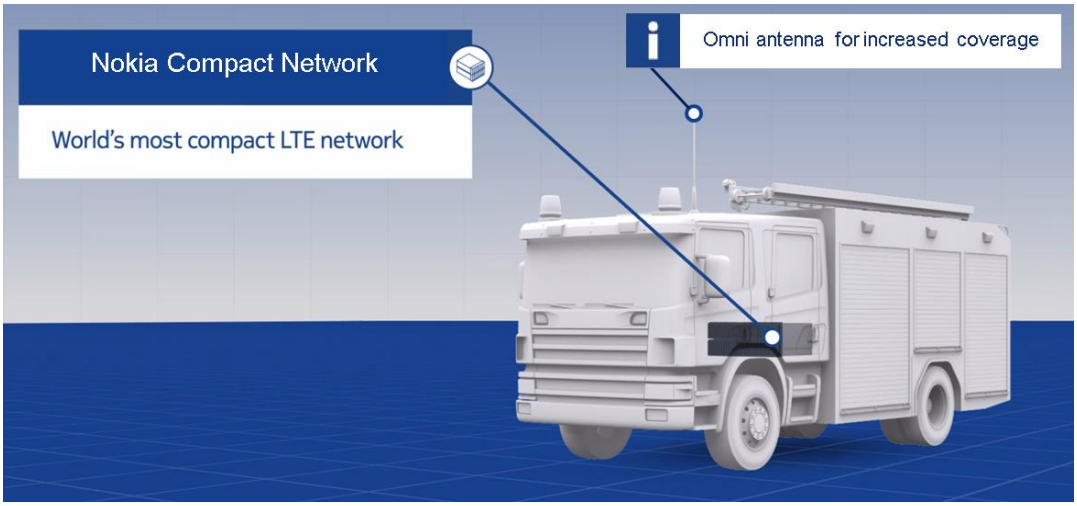
Figure 2. Example of Nokia Compact Network integration to macro site eNB



The key benefit of Nokia Compact Network is that a complete LTE network can be implemented in a highly compact solution as small as a LTE base station. A high capacity solution can be deployed based on macro-sized LTE base stations. Such Nokia Compact Networks can offer wide coverage with sectorized site solutions and output power in the range of 40 – 60 W per antenna port. The macro base station can also support the latest LTE-Advanced and in the future, LTE-Advanced Pro performance based, for example, on carrier aggregation. A high capacity Nokia Compact Network based on a macro base station can serve thousands of users.

Some Nokia Compact Network use cases benefit from low power consumption and the extreme small physical size of LTE base stations of micro class, typically using 5 – 10 W per antenna port or even smaller power levels of typically 0.2 – 1 W for pico class eNBs. The request to connect hundreds of subscribers to an EPC core network makes the outdoor micro base station a particularly useful option, as it makes available the necessary processing power for EPC core functions. Nokia Compact Network integrated to micro BTS is aimed at deployments with lower power and capacity needs and where space is restricted.

Figure 3. Nokia Compact Network – "light" infrastructure for deployable private LTE networks with omni antenna for a single cell coverage



Other Nokia Compact Network use cases connect tens of thousands of users to redundant EPC cores. In such cases, industrial COTS server hardware in a high-availability configuration can be used for LTE core network software. Network redundancy with clustering maintains communications in the unlikely event of failure. The S1-Flex mechanism ensures functionality and flexibility with no single point of failure because each eNB is connected to multiple Mobility Management Entities (MME) and Serving Gateways (SGW) in a pool.

Core network functions

Nokia Compact Network provides key EPC functions, Home Subscriber Server (HSS), MME, SGW and Packet Data Network Gateway (PGW), locally for authorized access, session and mobility management and Internet Protocol (IP) connectivity.

Local HSS in the Nokia Compact Network includes subscriber data for access authentication and authorization. Depending on the use case, the HSS subscriber data can be specific for local users or alternatively the local HSS includes replicated data from a master HSS in a centralized core network.

Local MME provides the S1 control plane interface to eNB and supports relevant MME functions such as session and mobility management. MME can serve numerous eNBs as long as there are S1 connections available to neighboring eNB sites.

Local SGW and PGW provide user plane data services and enables local device-to-device IP connections as well as IP connections to any local IP servers. SGW and PGW, together with MME, can also support handovers between neighboring eNBs when S1 connections are available.

Nokia Compact Network is fully compliant with standard Third Generation Partnership Project (3GPP) security features for authentication, integrity protection and encryption. It also supports 3GPP Quality of Service (QoS). QoS for default bearers are based on subscriber QoS settings in the HSS. Nokia Compact Network includes Policy and Charging Rules Function (PCRF), while dynamic QoS is supported for dedicated bearers.

Basic IP connectivity is adequate for accessing local servers and for local communication between mobile devices. Often voice communication is also mandatory and therefore VoLTE is required for Nokia Compact Network. In this case, it includes IP Multimedia Subsystem (IMS) i.e. Call Session Control Function (CSCF) together with Telecom Application Server (TAS). VoLTE requires PCRF for establishment of Guaranteed Bit Rate (GBR) dedicated bearers for VoLTE calls. Nokia Compact Network also supports push to talk (PTT) for mission critical group communication.

Content delivery can be optimized with LTE broadcast. LTE Multimedia Broadcast Multicast Service (MBMS) introduces a point-to-multipoint service, allowing efficient multimedia delivery from a single source entity to multiple recipients using broadcast over LTE radio. Nokia Compact Network supports MBMS by having a Multicell/multicast Coordinating Entity (MCE) function integrated in the eNodeB and by including MBMS gateway and Broadcast Multicast Service Center (BM-SC) as part of core network functions.

Rich suite of end-user services with Nokia Compact Network

Nokia Compact Network can be used as a standalone LTE network without connections to external networks. Alternatively, it can offer locally selected core functions while the remaining core functions are served by a centralized core network. The following services are typical:

- **Voice services:** A deployable Nokia Compact Network solution in remote hotspots can provide voice services without any transmission connection to external networks. This has the additional benefit of reducing the round trip time (RTT), as connectivity to a distant core network is not needed. This is particularly important for real-time or synchronous applications, such as voice, which require minimal end-to-end delay and jitter. In commercial use cases, voice service is based on standard VoLTE, which can be enhanced with standard video over LTE. In mission-critical use cases, push to talk group communication is supported.

Figure 4. Locally routed voice traffic with Nokia Compact Network in remote hot spots areas

- **IPTV and on-demand video streaming:** Asynchronous applications, like IP television (IPTV) and on-demand video streaming, may require high throughput. Supporting this high bandwidth requirement in remote areas can stress valuable satellite links. A Nokia Compact Network can support a local breakout solution to local content delivery networks, optimizing the use of satellite bandwidth.

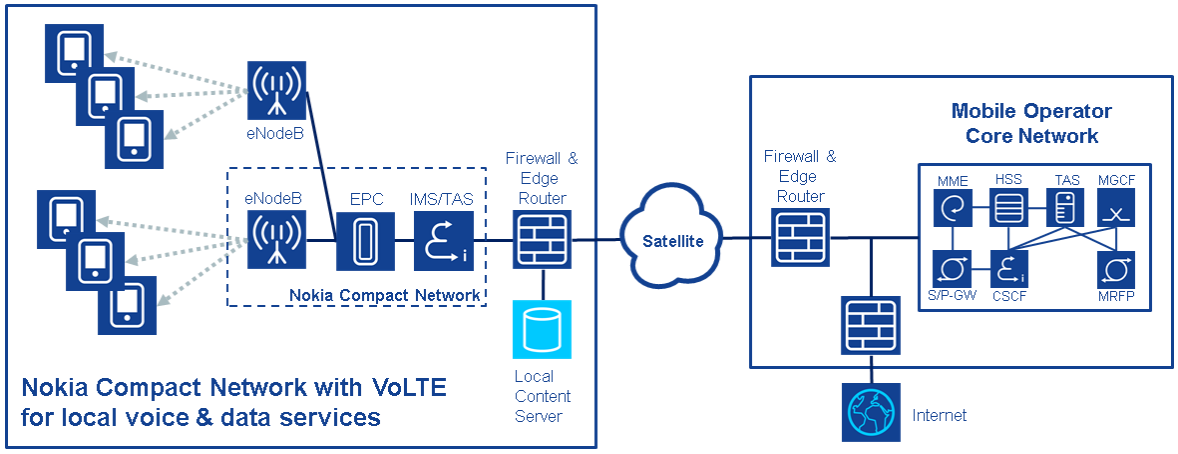
Figure 5. Locally provided IPTV and streaming services with Nokia Compact Network in remote locations connecting to local content delivery networks

- **Edge Video Orchestration (EVO) together with LTE Broadcast MBMS**: A revenue-generating use case is local video orchestration at an event. Video signals from cameras and/or production feeds are connected to hardware video encoders. Encoded video streams are forwarded to the EVO solution via Ethernet or LTE. Breakout of video streams from a public LTE network for distribution (unicast and/or broadcast) happens at the Nokia Compact Network. End users (typically spectators at an event) can select different video feeds and watch them in real-time. One option in event video transmission is to optimize content delivery with LTE broadcast MBMS.

Deployment considerations

Because of the many different Nokia Compact Network solutions, each with varying network architectures and functional requirements that differ from traditional network deployments, attention must be paid to design, implementation, integration, field verification and optimization.

Figure 6. Deployment of Nokia Compact Network to provide VoLTE service and coverage with multiple eNBs



Nokia Compact Network can be as small as one eNB with one LTE cell, but it also supports multiple eNBs connected with S1 interfaces, allowing network deployments with multiple base stations for adequate coverage over an area.

Nokia Compact Network can be used as the main service core in small dedicated networks or be pre-installed into selected macro base station sites to act as a back-up core network for a region, if, for example, transport connection to a central core site is lost.

Thus, network design and implementation based on Nokia Compact Network must consider all the use case aspects, such as LTE coverage and capacity, user applications, resilience and security.

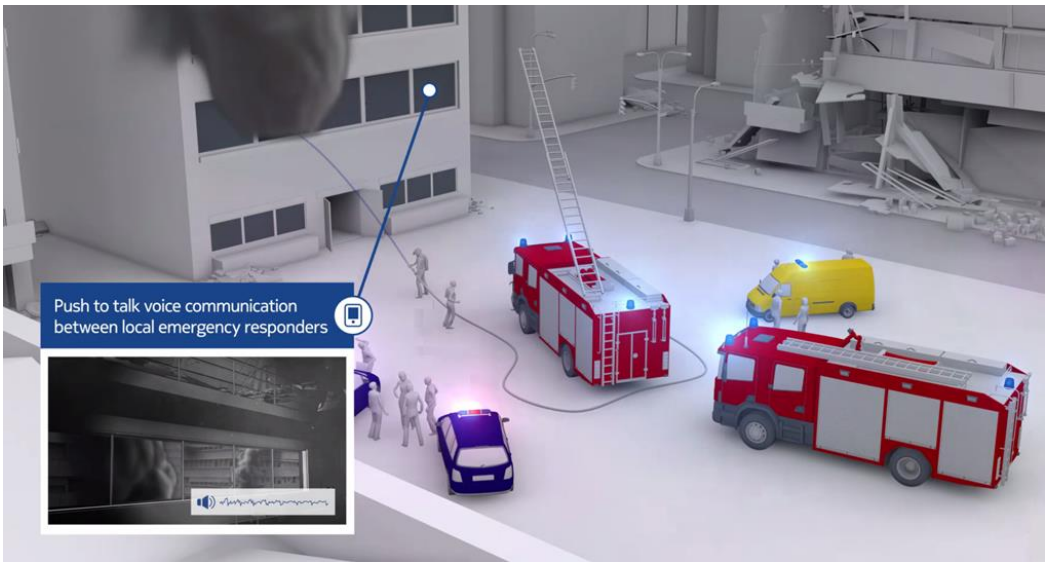
Nokia Compact Network for dedicated networks

Isolated operations for LTE public safety

Many public safety agencies and organizations are already investigating how to evolve from their existing networks to LTE-based solutions. Mission-critical communication during emergencies sets strict requirements on the network. Nokia Compact Network supports isolated operations with its local EPC function. Isolated operation enables public safety personnel to use communication services even if backhaul to the macro core is not available.

Nokia Compact Network's key feature, VoLTE, supports fast call setups and higher quality calls with latest audio codecs (beneficial in noisy environments). In isolated operation, it includes all the relevant core functions for a standard VoLTE service. For public safety organizations, Nokia Compact Network provides and integrated PTT application, which enables efficient group communication even in isolated operations.

Figure 7. Deployable Nokia Compact Network for public safety

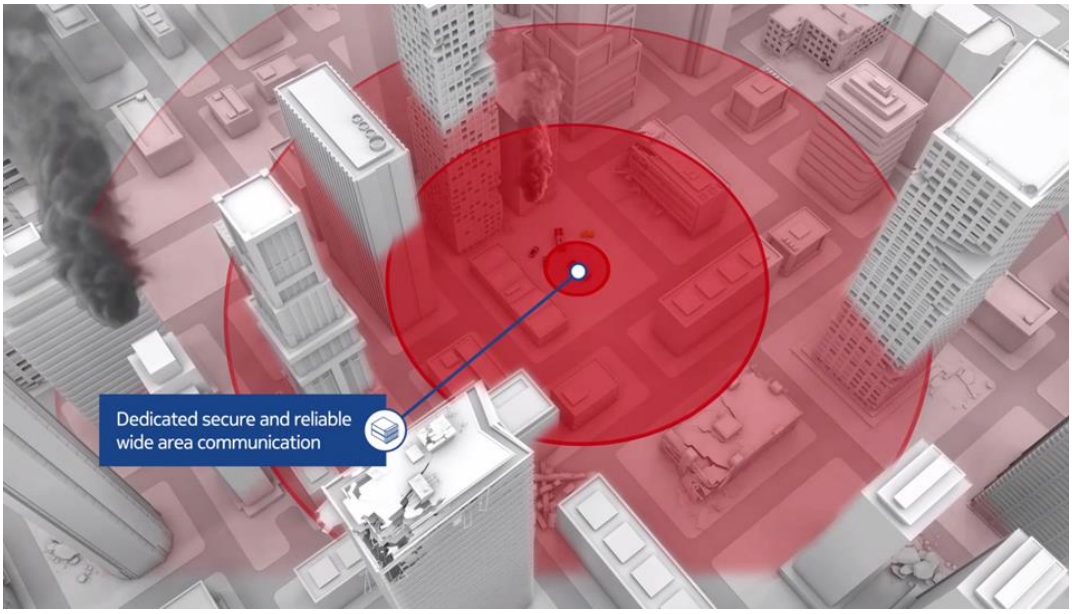


Nokia Compact Network supports public safety and defense-related scenarios that require a mix of data (e.g. group messaging, location data, video streams and sensor data) and voice services. Such advanced indoor and outdoor services must connect people and machines securely and reliably, as well as support mobility using a “light” infrastructure.

Nokia Compact Network addresses the following key requirements for public safety:

- Private LTE network as a deployable system for public safety forces (police, firefighters, disaster recovery)
- Compact and robust, can be mounted even in small vehicles
- Ready to operate within minutes and also covers larger areas when used with a telescopic mast
- Fully autonomous system, no backhaul required
- Secure mobile broadband communications - for example, increased situational awareness with video monitoring cameras and body cameras

Figure 8. Nokia Compact Network - close fit for public safety



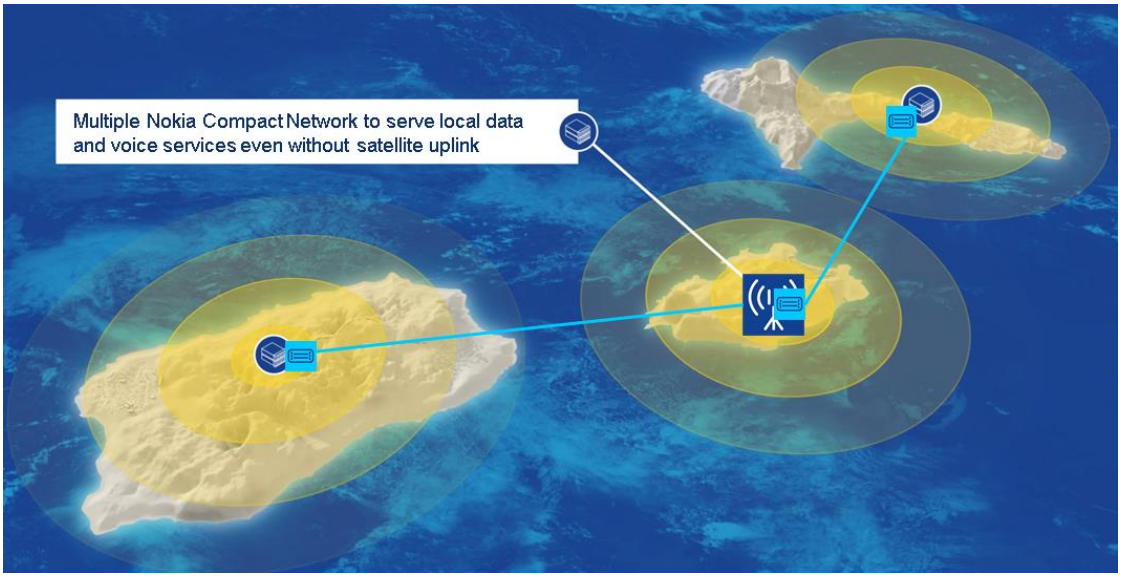
Nokia Compact Network for remote hotspots

Broadband communication services in rural areas and remote locations can be poor. There is quite often no fixed optical connectivity and external communication may rely on expensive satellite links. Substantial numbers of people live in regions affected by regular tropical storms that often damage telecommunication systems, leading to a need to improve telecom services in remote locations.

Nokia Compact Network can provide wireless communication in all conditions. LTE and Nokia Compact Network can be deployed to remote areas, like islands, to introduce local broadband services even in places served by satellite links. Nokia Compact Network optimizes the bandwidth used on these satellite links when offering online services for inhabitants via local content servers.

If remote locations require multiple eNBs for coverage of multiple islands, the backhaul connections may be implemented with traditional microwave links or alternatively with LTE. Such remote locations with multiple eNBs may be served by a single Nokia Compact Network. However, if backhaul failures are likely to happen, for example due to local weather conditions, resilience can be enhanced by including Nokia Compact Network with several eNBs.

Figure 9. Nokia Compact Network for remote hotspots



Another commercial opportunity for mobile operators is to offer LTE broadband and communication services on cruise ships. There are two service aspects.

An operator can offer private communication services for the crew working on the ships as well as for the passengers. The passengers can be the operator's own subscribers as well as others who would like to benefit from LTE access based on a normal roaming mechanism.

The crew can have special subscriptions, which are included in Nokia Compact Network's HSS database. This provides guaranteed communication services for the ship's crew even if there is no working satellite connection to external networks.

Other operators' subscribers could access services with their existing LTE devices and USIMs (Universal Subscriber Identity Module) as long as a satellite connection to the central core is available. Central HSS would allow network authentication and central IMS based VoLTE would allow voice services. For data connections, a local PGW could offer local breakout, which would allow high throughput connection to the ship's entertainment services, for example.

Roaming subscribers' LTE access and telco services would require a working satellite connection to the visited operator's core network and furthermore via the roaming interfaces to the home network.

- Nokia Compact Network extends commercial LTE services into geographical white spots such as rural areas, islands, deep valleys and cruise ships
- Nokia Compact Network allows for various transport options such as LTE carrier, microwave radio, satellite, or wireline connection

Enterprise data services

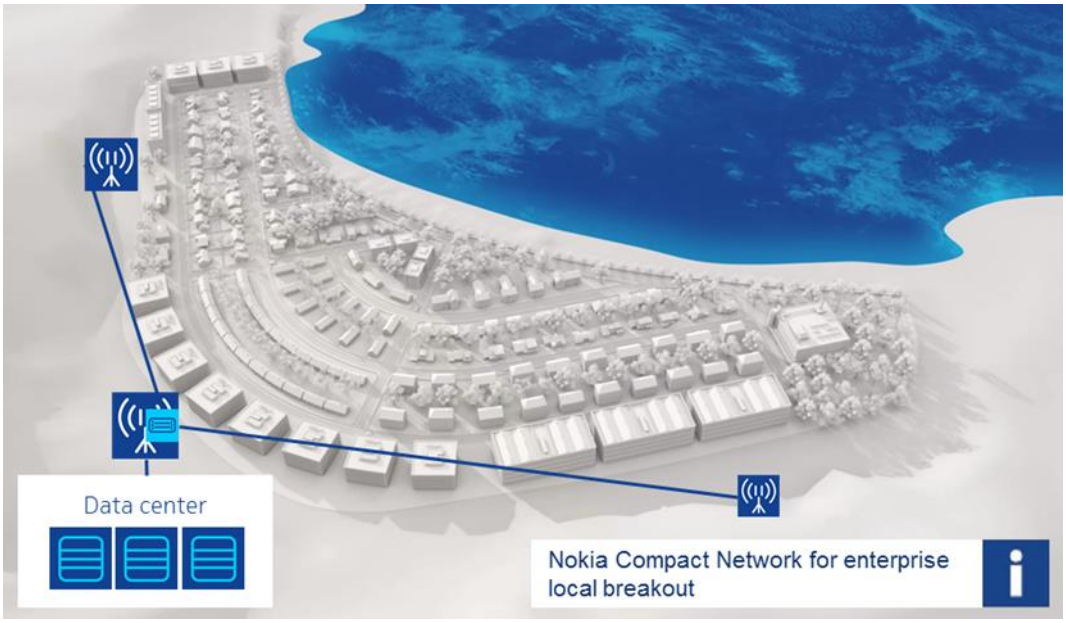
Mobile operators typically offer a large portfolio of services for businesses. These include mobile communication and mobile broadband, together with various value-adding options such as mobile devices, security and Virtual Private Networks (VPNs), applications and cloud services.

Many enterprises have migrated from fixed telephone lines to enterprise Voice over IP (VoIP) and mobile voice. However, mobile broadband has now reached a level of performance and cost that makes LTE a viable alternative to Wi-Fi and Ethernet for mobile employees. This makes it attractive for enterprises to realize dedicated networks that can be built up with their own LTE radio spectrum, or that use resources allocated by the Mobile Network Operator, limiting access to the network with, for example, specific Public Land Mobile Network Identities (PLMN-ID).

Nokia Compact Network is an attractive opportunity for mobile operators to offer wireless campus solutions for their business customers. Because a large portion of the data traffic generated by employee business mobile devices is internal to the enterprise, Nokia Compact Network provides local breakout in enterprise premises, offloading a significant amount of traffic from the operator's backhaul or centralized core network. This allows enterprises to save Wi-Fi and Ethernet infrastructure.

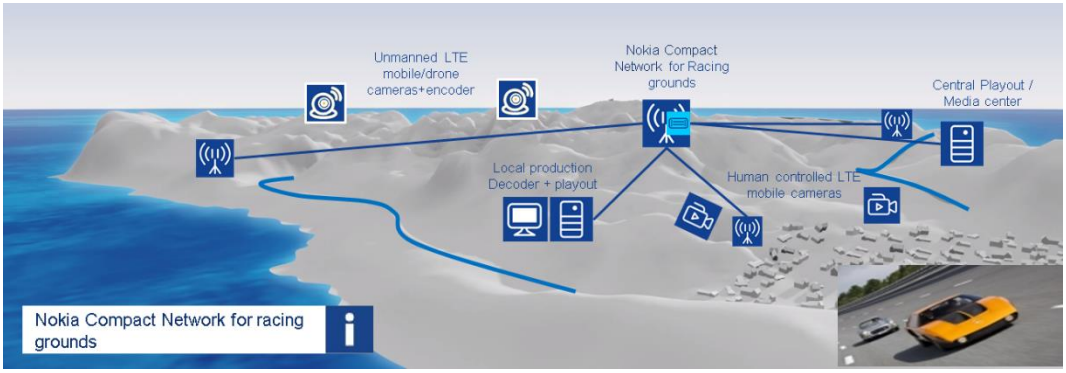
On the other hand, there are new business opportunities to cover isolated areas of enterprises with widespread testing grounds (e.g. car manufacturers), large area industrial plants, container terminals, or oil rigs. In such cases, private dedicated LTE networks with reliable coverage, very low latency and guaranteed broadband capacity and access and service control are the ideal choice. Nokia Compact Network can setup a dedicated bearer for mission critical QoS services. Nokia Compact Network, used for LTE services in car manufacturers' test fields, provides the reliable broadband data transmission for cars. It transports control services for autonomous driving and collision avoidance systems and allows vehicle steering from the control center.

Figure 10. Nokia Compact Network for enterprise local breakout



Nokia Compact Network allows operators to use a private dedicated LTE network for race courses to serve the high performance connectivity needs of broadcast service providers. LTE enables the transmission of high definition live video from TV cameras to the media center for further content delivery. Its rapidly deployed private LTE network can cover mass events in specific areas of interest when public networks may become congested.

Figure 11. Nokia Compact Network for race tracks



It is also possible to optimize content delivery to consumers with LTE broadcast. Nokia Compact Network with MBMS is ideal, for example, for mobile TV and radio broadcasting at racing events. With MBMS, there is an opportunity to better use the available bandwidth by intelligently managing and delivering content.

- The mobile operator can offer LTE based mobile connectivity for enterprise campuses
- Broadband data connection for smartphones, tablets and laptops and high quality VoLTE and enterprise VoIP with the same infrastructure
- Closed network meets tight security requirements as all traffic stays local
- Nokia Compact Network provides local breakout to enterprise IT solutions and even enterprise internal VoIP calls can be routed locally. Enterprise intranet traffic does not load the operator backhaul or centralized packet core. Nokia Compact Network based LTE access can be easily integrated with existing enterprise networks
- Suitable for latency-critical communications, for example for testing grounds and race tracks
- Private LTE network with Nokia Compact Network provides high performance connectivity for professional live video production, for example at race tracks, fairs and exhibitions. Furthermore, content delivery to consumers at those locations can be provided over LTE, including optimized live video broadcasting with MBMS

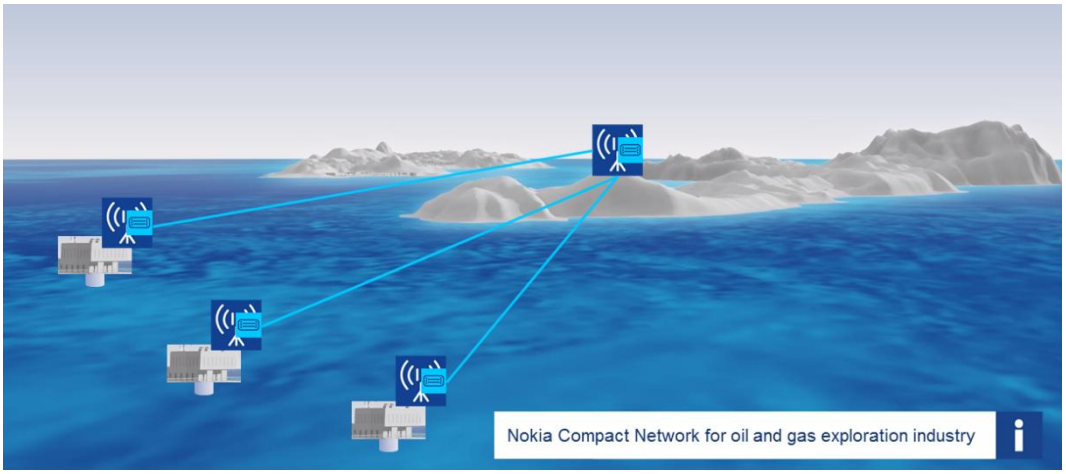
Oil, gas exploration and mining - Industry example

Data and voice communications between oil drilling platforms, floating production storage and offloading units, oil tankers and onshore communication stations are critical oil and gas industry areas needing high-bandwidth communications. A Nokia Compact Network onshore with the large coverage area of LTE could provide connectivity to the public network, while distributed Nokia Compact Networks on the oil rigs handle local communications. It supports high quality and reliable services based on the possibility of setting user profiles for user prioritization,

together with the use of dedicated bearers for prioritized applications. A dedicated network ensures protected system resources, best performance and minimum latency.

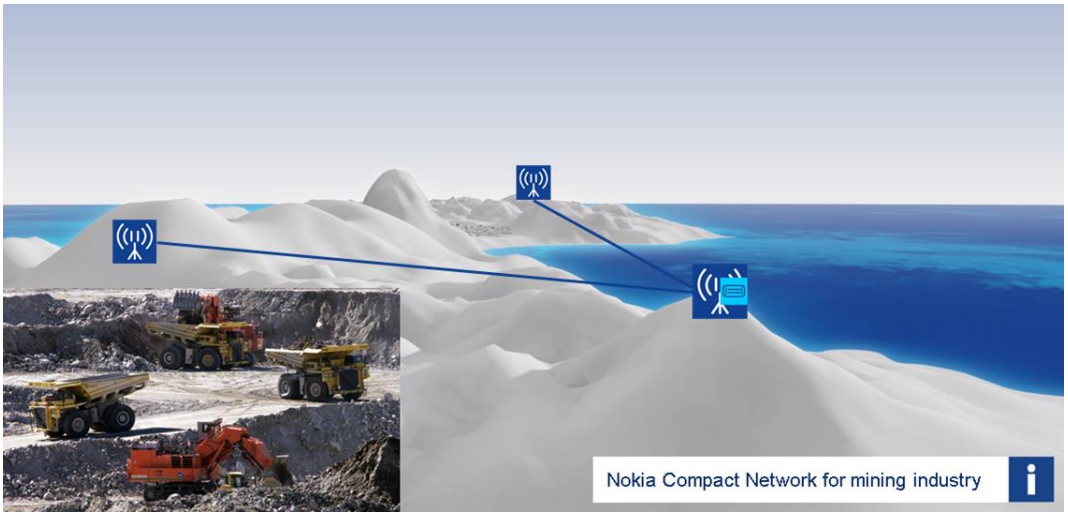
Large open-pit mines can be tens of square kilometers in size, which means that communications must reach over distances ranging from a few kilometers to tens of kilometers. A wide area communication solution based on LTE is more reliable than, for example, a wired network and Wi-Fi access points.

Figure 12. Nokia Compact Network for oil and gas exploration industry



Automation improves mine safety and requires wireless machine communications for autonomous drilling and haulage systems. Wireless communication is not only used to control systems remotely, but also for sending live video to a control room.

Figure 13. Nokia Compact Network fulfils all communication requirements in a mining area



Nokia Compact Network can provide the local connectivity and communications needed for managing autonomous mining systems, for collecting sensor data (e.g. vibration and pressure sensors) and for employee communications. It can serve multiple eNBs to support large sites and mining companies with multiple locations connected to centralized operations and control rooms. Large companies could centralize some Nokia Compact Network functions, but for operational continuity and safety would use local Nokia Compact Networks in the mining areas, with benefits including:

- Private LTE network for secure and reliable wide area communication in the oil, gas and mining industry
- Broadband data, VoLTE, messaging and industry specific applications for employees
- Improved security with live video monitoring and real time data from vibration and pressure sensors for autonomous drilling and haulage systems

Nokia Compact Network - flexibility, speed and security

Nokia Compact Network is a compact, powerful solution for service providers and for enterprises in situations where they need to deploy mission-critical telecommunications infrastructure over a small geographical area.

The solution scales from a small pico size eNB with embedded EPC, to wide area systems covering tens of square kilometers based on several macro size eNBs and Nokia Compact Network including EPC functions and relevant applications such as VoLTE. Optional redundant Nokia Compact Networks can be deployed for extremely high availability.

Thanks to extensive pre-integration and Nokia's optimized service work packages, Nokia Compact Network will enable service providers and enterprises to implement, at a moment's notice, a fully functional LTE network.

The solution is secure. For example, in a critical situation, all communications can be set up to remain within the local intranet.

One of the key advantages of Nokia Compact Network is the ability to deploy the solution very rapidly, with the system operational in as little as five minutes. This is a requirement in several professional applications, such as civil protection and government.

Nokia Compact Network is a fully transportable compact system that can be installed in vehicles or trailers. A high capacity deployable system can include an antenna system with a telescopic mast. Power can be supplied by a portable generator. If required, the deployable Nokia Compact Network system can be connected to the outside world via microwave, fiber or satellite links and even LTE macro coverage can be used as a backhaul connection. Nokia Compact Network will also be of value for commercial mobile operators and different industries.

Glossary

3GPP	3rd Generation Partnership Project
BM-SC	Broadcast Multicast Service Center
BTS	Base Station
COTS	Commercial off the Shelf
CSCF	Call Session Control Function
CSFB	Circuit Switched Fallback
eNB	Evolved NodeB (LTE base station)
EPC	Evolved Packet Core (includes MME, SGW, PGW, HSS)
EVO	Edge Video Orchestration
GBR	Guaranteed Bit Rate
HSS	Home Subscriber Server
IMS	IP Multimedia Subsystem
IP	Internet Protocol
IPTV	IP Television
IT	Information Technology
LTE	Long Term Evolution
MBMS	Multimedia Broadcast Multicast Service
MCE	Multicell/multicast Coordinating Entity
MEC	Mobile Edge Computing
MGCF	Media Gateway Control Function
MME	Mobility Management Entity
MRFP	Multimedia Resource Function Processor
P-/I-/S-CSCF	Proxy-/Interrogating-/Service-Call Session Control Function
PCRF	Policy and Charging Rules Function
PGW	PDN (Packet Data Network) Gateway
PLMN-ID	Public Land Mobile Network Identities
PTT	Push To Talk
QoS	Quality of Service
RTT	Round Trip Time
S1	Reference point between eNB and MME and SGW
SGi	Reference point from PGW to IP networks (e.g. internet)

SGW	Serving Gateway
TAS	Telecom Application Server
TDD	Time Division Duplex
TETRA	Terrestrial Trunked Radio
USIM	Universal Subscriber Identity Module
VoIP	Voice over IP
VoLTE	Voice over LTE
VPN	Virtual Private Network
Wi-Fi	Wireless fidelity, analog to Hi-Fi

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