

# **5G Network Slicing**

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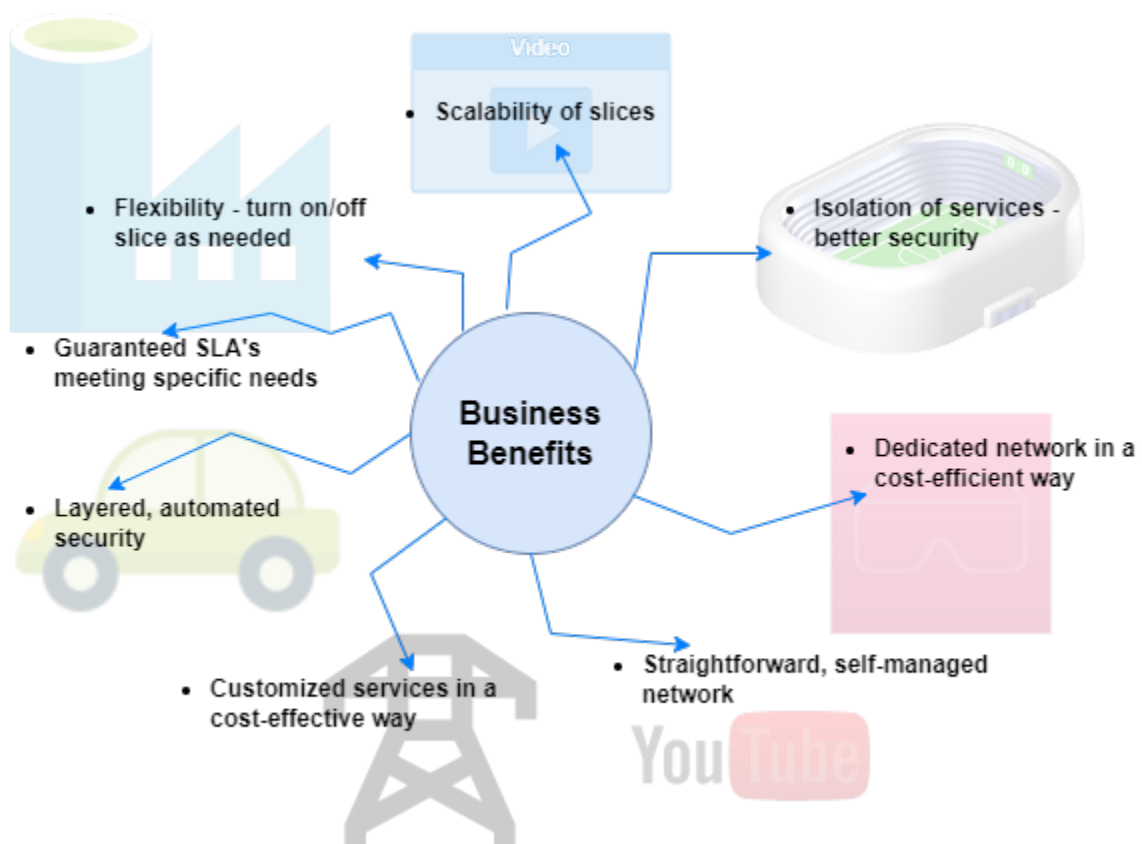
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# Chapter 1. Executive Summary

The following Executive Summary overviews the key information presented in each part of this report on Network Slicing in 5G mobile network. It introduces the basic **drivers and benefits of Network Slicing** as well as the **use cases** with the greatest potential to benefit from Network Slicing. This report also outlines the basic technological advancements enabling Network Slicing, that is **Recursive Model, Network Function Virtualization** and the **End-to-end Architecture of Network Slicing** with the emphasis on their role in delivering seamless, high-quality customer experience, in a cost-efficient way.

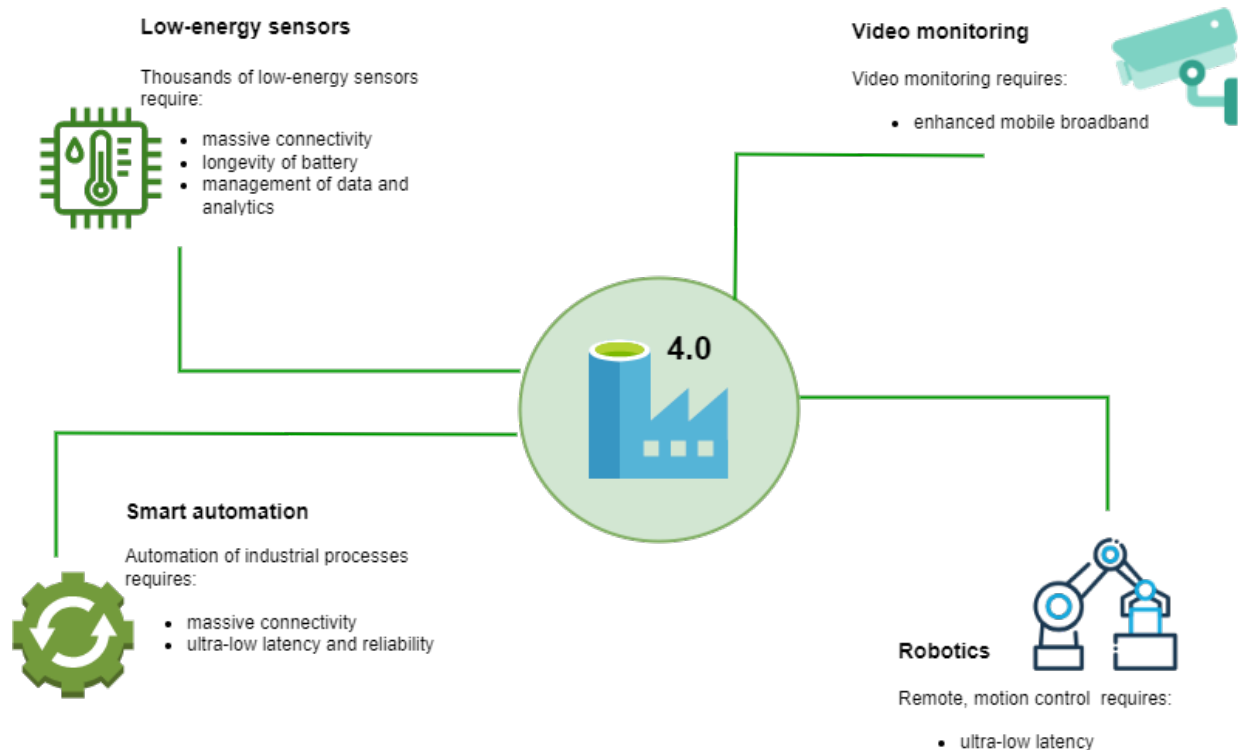
## Business Drivers and Benefits:

- Network slicing is the most prominent technological advancement in 5G mobile network technology.
- Network slicing is **the solution to the rapidly growing digitalization of the world, emerging new use cases, increasing number of smart devices and applications with specific requirements.**
- Network slicing gives operators capabilities of **creating specific, customized services in a cost-effective way**, introducing new services to old customers at the premium, address new customers and create new revenues.



### Use Cases:

- Network slicing manages the **growing complexity of Smart Factory networks** by assigning each part of the factory network to a single, customized slice.
- Network slicing enables **massive connectivity of sensor in Smart Cities** and an uninterrupted and reliable data flow by isolation of network slices.
- Network slicing provides **high level of integrity and security of autonomous vehicles** by automated orchestration of slices.
- Each network slice is designed as **highly programmable and scalable**.
- Each slice characteristics is **separately customized** to serve the purposes of the specific service in terms of throughput, latency and connectivity.



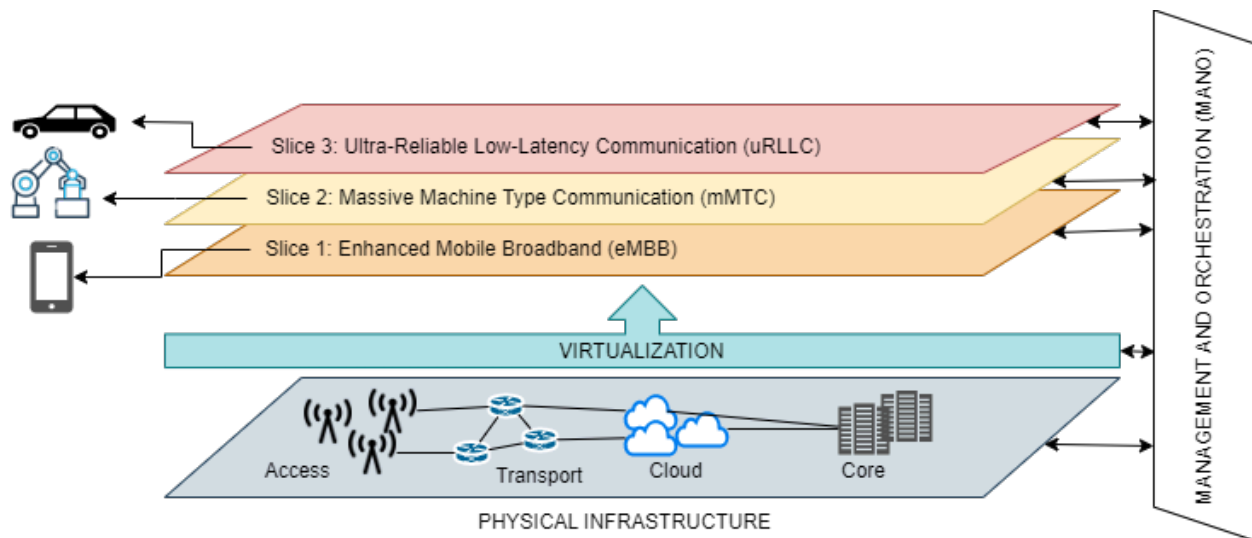
### Network Slicing Architecture

#### Recursive Model

- The architecture of network slicing is primarily based on the Recursive Model, in which **each part of the network can be instantiated and placed in a different location**.
- In the virtualized infrastructure, the Recursive Model allows the creation of the **customized and independent instances of the network, i.e. “slices”**.

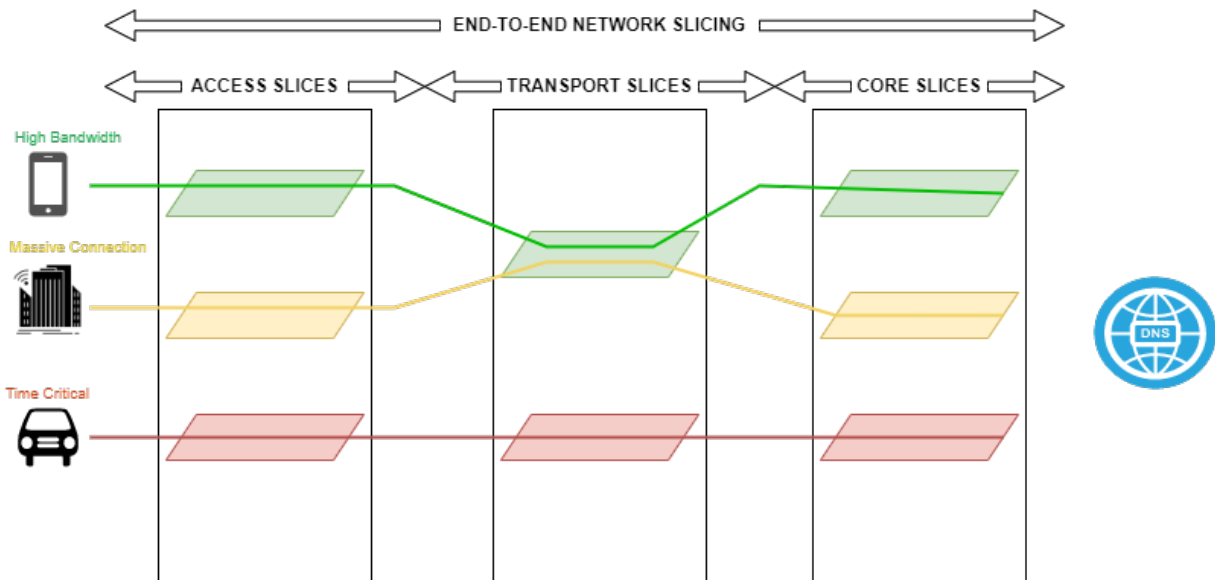
### Network Function Virtualization

- **The functions and resources on network slices are virtualized** (in the form of a software), which provides the possibility to dynamically configure them, turn them off/on, scale them up or down.
- The virtualized functions and resources are managed by **Software-Defined Networking (SDN)** (on page 34), which ensures more efficient use of resources, reduces costs and energy usage.
- Network slicing enables the creation of **multiple, virtualized, independent networks on the shared infrastructure**.



### End-to-end Network Slicing

- Network slicing is end-to-end, i.e. all the way from **user equipment (UE)** (on page 34) to **data center (DC)** (on page 31), **through separate and independent slices of access, transport and core**.
- The importance of end-to-end network slicing is mainly stressed for **extreme flexibility** in order to provide **Service Level Agreement (SLA)** (on page 33)-based quality of experience in a cost efficient way.



### Access Part of Slicing

- Slicing in [radio access network \(RAN\)](#) ([on page 33](#)) is envisioned as **extremely flexible and adjustable**. The resources in RAN can be shared among different network slices.

### Core Part of Slicing

- The most fundamental characteristics of [5G core](#) ([on page 31](#)) architecture is **Control and User Plane Separation (CUPS)** ([on page 31](#)). User Plane Function, (UPF) ([on page 34](#)) is separated from other network functions in [5G core](#) ([on page 31](#)) and located closer to UE ([on page 34](#)) for lower latency.
- **Network functions in 5G core can be either shared or dedicated**. In most use cases, [session management function \(SMF\)](#) ([on page 33](#)) and UPF ([on page 34](#)) are dedicated for a specific slice.

### Transport Part of Slicing

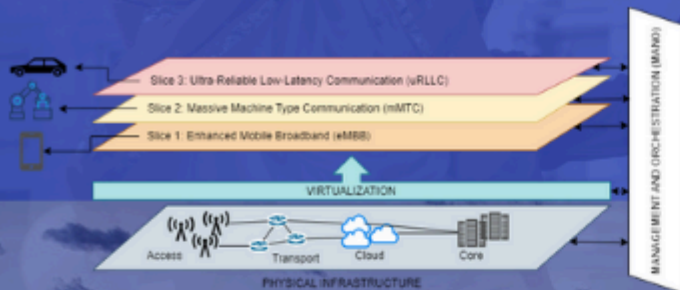
- **Transport network (from cell site to the core) is divided into 3 parts**, which provides higher level of flexibility, allocates the radio resources more efficiently, balances and optimizes the traffic load.
- Slicing at the transport layer mainly concerns **traffic routing and prioritization**, which is performed by the load balancer, such as [software-defined networking \(SDN\)](#) ([on page 34](#)).

To discover more about each aspect of Network Slicing **click on the corresponding part on the image below:**



# NETWORK SLICING

The most prominent technological advancement in 5G mobile network technology



## DEFINITION

Network slicing is a network architecture that enables creation of multiple, virtualized, independent networks on the shared infrastructure.

## DRIVERS

The development of Network Slicing has been driven by:

- rapid digitalization of the world
- growing number of smart devices
- new use cases and applications with specified requirements etc.



## USE CASES

The verticals with the greatest potential to benefit from Network Slicing:

- Smart Factory

1. [This link takes you to the definition of Network Slicing \(on page 9\)](#)
2. [This link takes you to the description of drivers of Network Slicing \(on page 13\)](#)
3. [This link takes you to the description of Use Cases in Network Slicing \(on page 17\)](#)
4. [This link takes you to the description of Business Benefits of Network Slicing \(on page 15\)](#)
5. [This link takes you the description of the Architecture of Network Slicing \(on page 23\)](#)
6. [This link takes you to the description of End-to-end Network Slicing \(on page 25\)](#)



## Chapter 2. Introduction to Network Slicing

Network slicing in 5G technology allows for the creation of multiple virtual networks on a shared infrastructure. Each network slice is customized independently **to serve the purposes of the specific service, business or application in terms of throughput (on page      ), latency (on page      ) and connectivity (on page      )**. The characteristics of a slice is stated in Service Level Agreement (SLA) (on page      ) and agreed between a service provider and a tenant. Moreover, the fact that it is **virtualized, makes it more scalable and flexible**.

### Definition of Network Slicing

Network slicing is based on the idea of creating multiple virtualized instances ("slices") of the shared physical network and customizing them in the specific way to fulfill the requirements of the service, business or application.

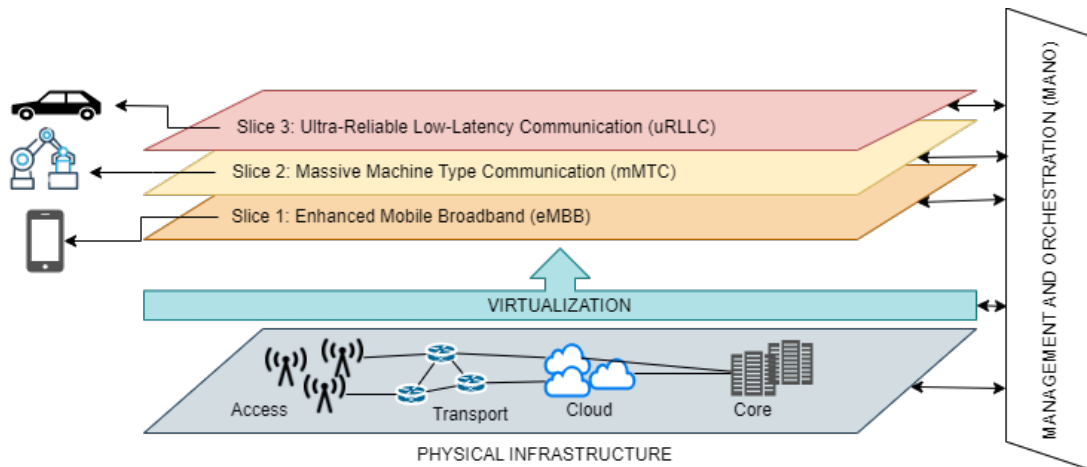
#### Definition of Network Slicing:

Network slicing is a network architecture in 5G technology that **enables the creation of multiple, virtualized, independent networks on a shared infrastructure**, as shown in Figure: Network Slicing Architecture. The basic idea behind network slicing is to **"slice" the existing infrastructure into multiple, virtual, end-to-end networks**, which are highly programmable and scalable.

#### Definition of Network Slice:

Thus, the **network slice (on page 33)** is a **separate, self-contained, and independently secured part of the underlying network infrastructure**. Each network slice is designed to **fulfill the specific requirements of the tenant (on page 34)** or a group of tenants, such as autonomous vehicle, smart factory or an application. Each network slice is highly programmable, scalable and has its own dedicated resources.

Figure: Network Slicing Architecture



### Benefits:

Network slicing proves to be the most fundamental enabling technology to **fulfil the divergent requirements of different types of use cases** in an efficient and **economically** sustainable way.

## Network Slice Characteristics

Network slice is independently, **separately customized to serve the purposes of the specific service in terms of throughput (on page 34), latency (on page 32) and connectivity (on page 32)**. The characteristics of a slice is stated in **Service Level Agreement (SLA) (on page 33)** and agreed between service provider and a tenant. Moreover, the fact that it is **virtualized, makes it more scalable and flexible**.

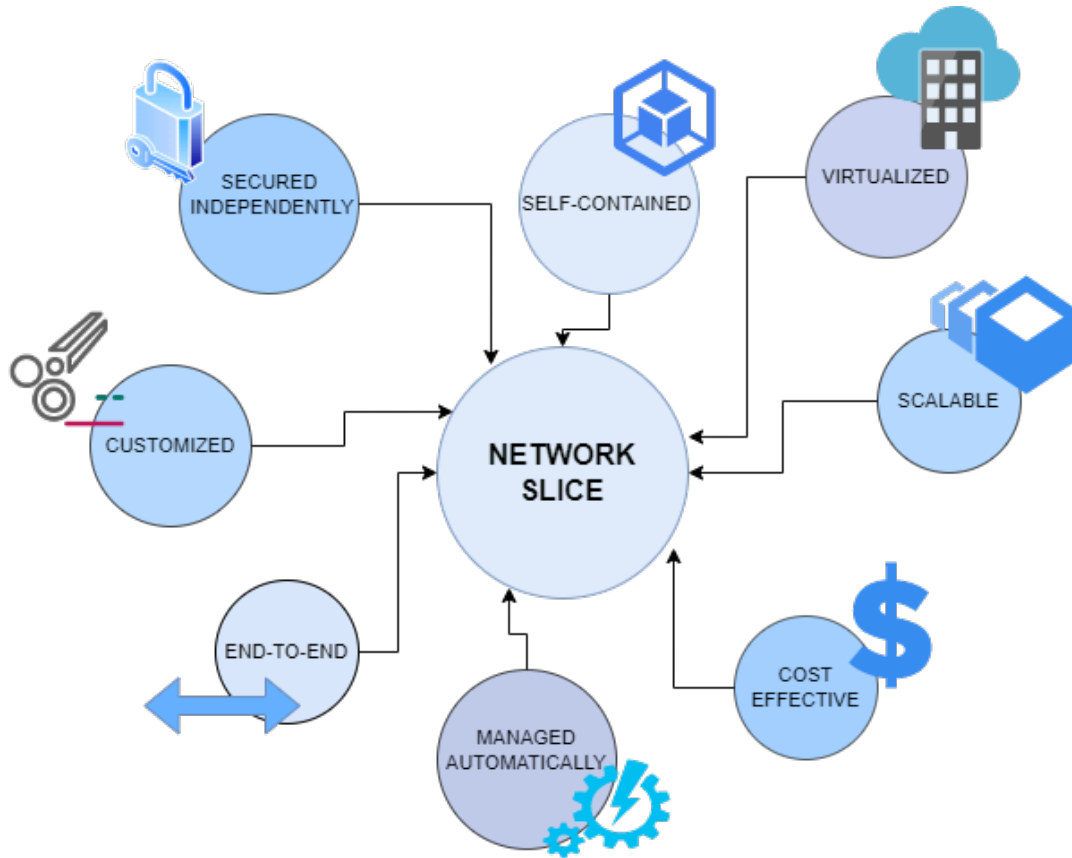
### Features of Network Slice:

Since each network slice is a **virtualized** part of the physical network, it is:

- **highly scalable and flexible** – can be configured instantly, on demand
- **isolated** from other network slices – the breakdown or overload of one slice does not affect the functioning of the others
- **independently secured** – each slice has its own security
- **end-to-end** – from Data Centre to User Equipment through separate access, transport and core slices
- **automatized** – the lifecycle of a network slice is automatically managed, which **reduces the costs**.

Therefore, operators are provided with the exclusive capability to satisfy customer's individual requirements and deliver them customized services in a **cost-effective way**.

Figure: Features of Network Slice



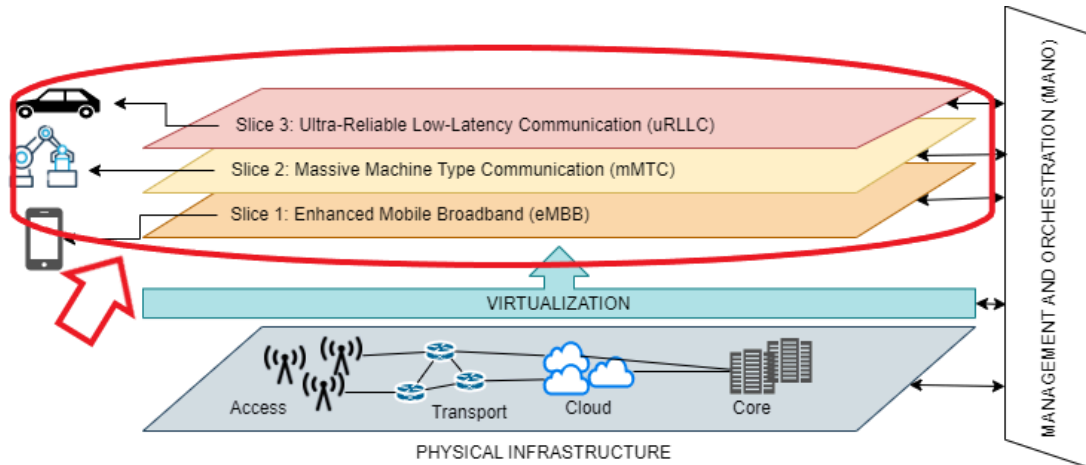
### Characteristics of Network Slice:

The network slice can be **customized in a specific way to fulfil the requirements of a business or a service**. The requirements mostly concern throughput, latency and reliability or massive connectivity.

As shown in Figure: Network Slices Characteristics, depending on the target use case, business vertical or a service, **network slice characteristics** can be:

- high bandwidth for a video streaming
- ultra-reliability, low-latency for autonomous vehicles
- massive connectivity for [Internet of Things \(on page 32\)](#)

Figure: Network Slices Characteristics



The specific characteristic of the slice is **agreed between a service provider and a tenant**, in a form of [SLA \(Service-Level Agreement\)](#) ([on page 33](#)). It is also important to note that each device, such as a mobile phone, can use up to 8 network slices concurrently.

# Chapter 3. Drivers of Network Slicing

The rapid digitalization of the world, growing number of smart devices, new use cases and applications with specified requirements have driven the development of new era 5G mobile network with network slicing as a key technological enabler.

## Why 5G Mobile Network?

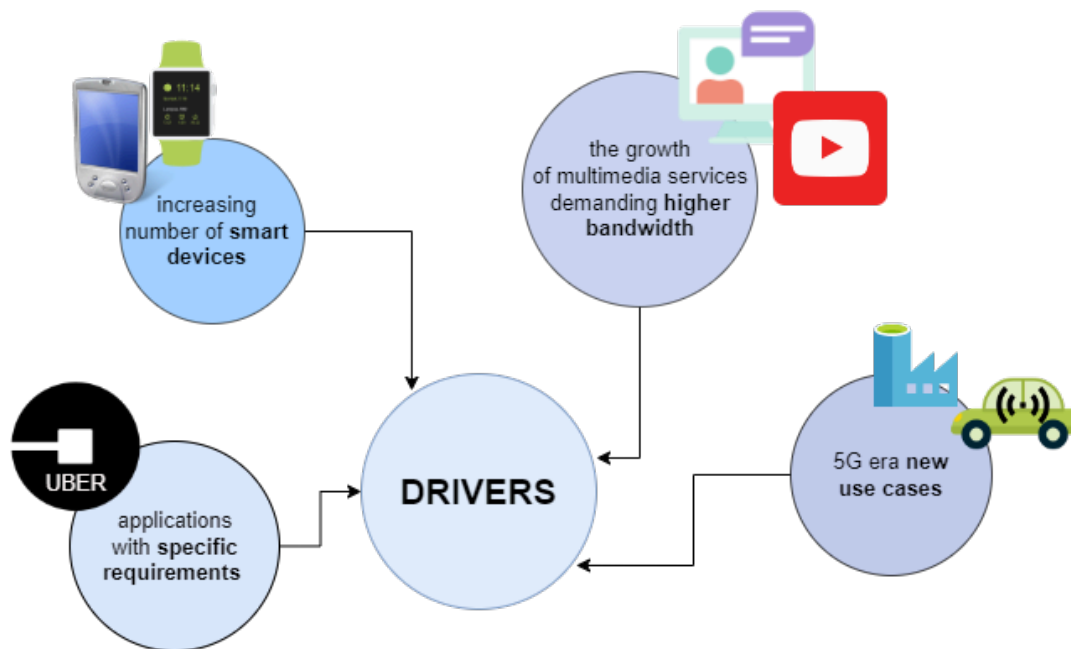
The previous monolithic network infrastructure (4G) proved to be largely inefficient in fulfilling the growing requirements of users or emerging use cases. The need for a new generation and technological advancements in mobile networks arose. It was envisioned to **overcome all the limitations of the previous mobile network generation in a cost-efficient way**. The 5G mobile network was designed with advanced technologies and has proved to be the most fundamental enabler of the digitalized world.

## Drivers of Network Slicing:

Network slicing is believed to be the most prominent technological advancement in 5G mobile network. The design and development of network slicing has been triggered in the face of the **rapidly growing digitalization of the world**, that is:

- the increasing number of **smart devices**
- the growth of multimedia services demanding **higher data rates**
- the emergence of **applications with specific requirements** concerning [throughput \(on page 34\)](#), [latency \(on page 32\)](#) and reliability
- the emerging **5G era new use cases**, such as autonomous vehicles, 4.0 industry, augmented reality

Figure: Drivers of Network Slicing



#### Benefits for Communication Service Providers:

Digitalization of the world provides incredible opportunities for [Communication Service Providers \(on page 31\)](#) to grow and increase their revenues. With the emergence of new 5G era use cases, Communication Service Providers have **new revenue opportunities**. They can offer new services to old customers at a premium or address new customers and create new revenues.

# Chapter 4. Business Benefits

Network Slicing allows service providers to offer customized services, introduce new services, and create new revenues. Businesses benefit from network slicing by getting the same services as a private, dedicated network, but in a more cost-efficient manner.

## Benefits for [Service Providers \(on page 33\)](#):

Network Slicing gives service providers the following capabilities:

- **creating specific, customized services**
- offering [SLA \(on page 33\)](#) meeting specific needs, **in a cost-effective way**
- introducing **new services to old customers** at the premium
- **addressing new customers** and creating new revenues

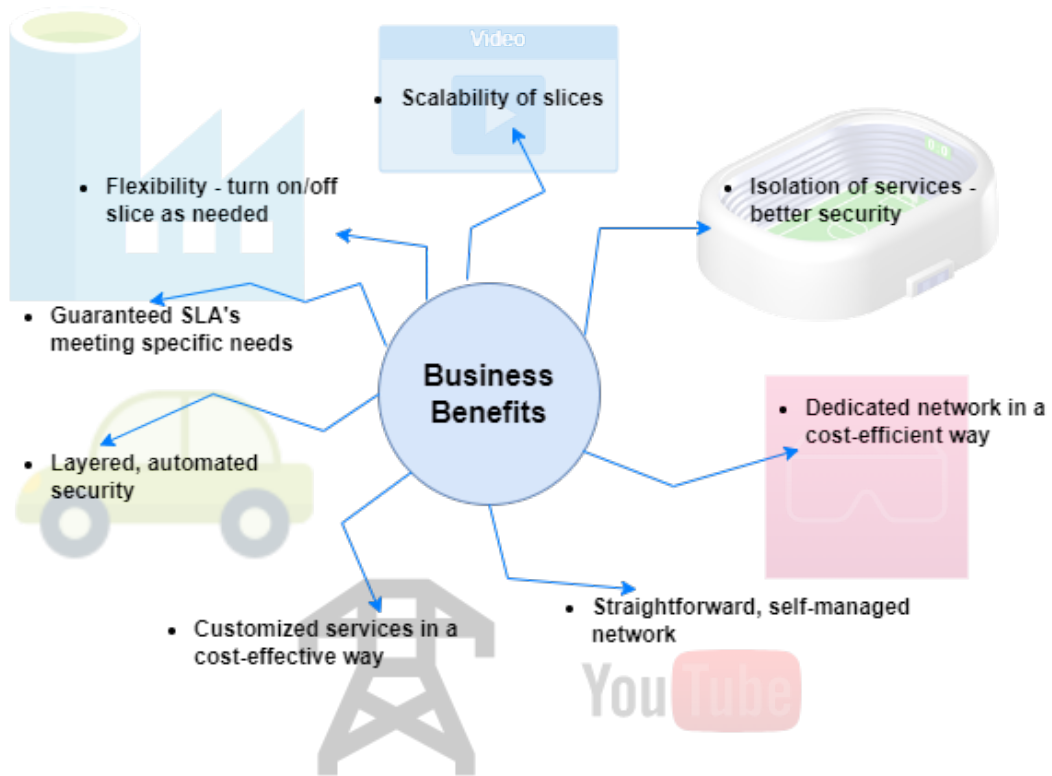
However, the efficient management and growth of revenues can be achieved only by **the automation of all processes throughout the life cycle of the slice**. Service Providers need to have, at their disposal, ready templates of slices, that can be deployed off-the-shelf.

## Benefits for Businesses:

Businesses are offered network slicing as a platform, which provides a variety of benefits. The Figure: Business Benefits below presents the most significant benefits of network slicing for businesses. Furthermore, network slicing offers the same services as a private, dedicated network, however, **in a more cost-efficient manner**.

Figure: Business Benefits





# Chapter 5. Use Cases

Network slicing plays the vital role in enabling mobile operators to offer new services to end consumers and [business verticals \(on page 31\)](#) . The following section presents **three verticals with the greatest potential to benefit from network slicing**, that is Smart Factory, Smart City and Autonomous Vehicle.

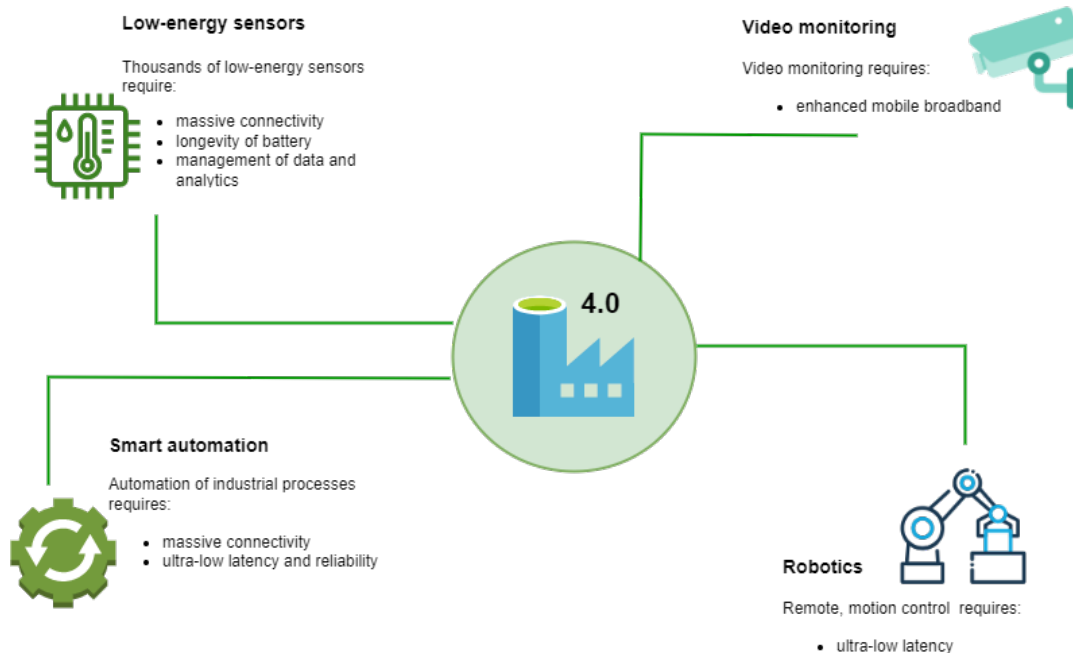
## Smart Factory

Network slicing provides industrial businesses with the ability to quickly respond and adapt to changes, allowing for the addition of new slices without disrupting existing ones. This technology is capable of embracing the complexity and heterogeneity of industrial networks, enabling digitalization and speeding up the fourth Industrial Revolution.

### Challenges of Smart Factory Network:

Recent **digitalization of factories** imposed a significant requirement on factory network to ensure high-performance and support critical process with a high speed and accuracy. As Figure: Smart Factory 4.0 shows, **each part of the factory** has been digitally transformed and **imposes divergent requirements** on a factory network.

Figure: Smart Factory 4.0



### Capabilities of Network Slicing:

Network slicing is a way to manage the growing complexity of the factory networks and fulfil those requirements by introducing **rapid programmability and scalability**. Table: Smart Factory: Challenges and Capabilities presents the main problems new generation of factories faces and the solutions to them provided by Network Slicing.

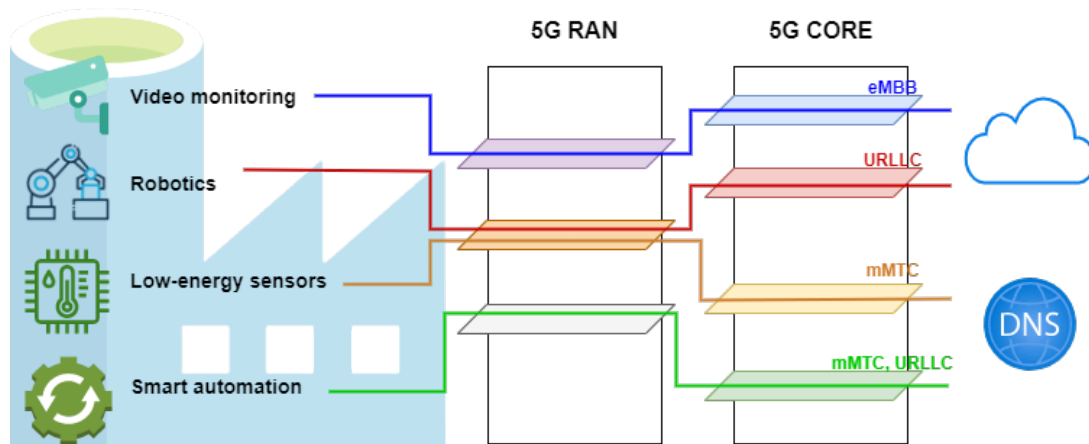
**Table 1. Smart Factory: Challenges and Capabilities**

Challenges	Solutions provided by network slicing
<ul style="list-style-type: none"> <li>• thousands of sensors require <b>connectivity and longevity</b></li> <li>• <b>massive amount of data</b> must be collected, analysed and managed</li> <li>• video monitoring requires <b>eMBB (on page 32)</b></li> <li>• remote control requires <b>URLLC (on page 34)</b></li> <li>• need for rapid <b>changeovers</b></li> <li>• need for <b>flexible</b> network environment</li> </ul>	<ul style="list-style-type: none"> <li>• <b>IoT (on page 32)</b> analytics servers enable <b>storage and analysis of the data at the edge</b></li> <li>• network slicing <b>offered as a service</b></li> <li>• network slices tailored in line with <b>guaranteed SLA (on page 33)'s meeting needs</b></li> <li>• <b>rapid network slice creation</b> and management</li> <li>• <b>automation</b> of slice lifecycle management</li> <li>• network slices <b>independently secured</b></li> <li>• <b>flexible sharing of the resources</b> among slices</li> </ul>

#### **Network Slices in Smart Factory:**

As the complexity of the factory network increases, **assigning each part of the network to a single, customized slice** seems to be the best solution to ensure efficiency and seamless performance of the factory. **Each part of the industrial site can be served by the specific, independent slice**, which is designed to satisfy the demands of a specific part of the factory network. For instance, one slice can provide high bandwidth and data collection of CCTV, another one can ensure seamless connectivity between multiple sensors, as shown in Figure: Smart Factory Network Slices.

Figure: Smart Factory Network Slices



### Management of Slices in Smart Factory:

Network slicing is offered to industrial businesses as a service: it provides the capability to **instantly respond and adapt to the emerging changes** at the factory site.

For instance, in case of installation of new monitoring system, the management of a factory can on-demand **add a new, autonomous slice without the disruption to the already existing slices**. It can specify the slice's features in such a way to meet the requirements of a monitoring system and ensure its efficient functioning within the network. It can also rapidly turn off/on other slices if needed.

## Smart City

A Smart City's network manages and analyzes data from millions of devices. It requires a consistent and reliable data flow. Network slicing enables the creation of separate network slices that can be managed independently, ensuring that an overload or problem in one slice will not affect the others.

### Challenges of Smart City Network:

Smart Cities deploy **millions of devices that collect data** on weather, energy usage, waste management, and traffic. The majority of this **data is collected in real-time, analyzed**, and used to predict future events or instantly respond and adapt to changing circumstances.

Thus, Smart Cities must rely on a **consistent and dependable data flow** to support a range of services on a shared physical network.

### Capabilities of Network Slicing

Table: Smart City: Challenges and Capabilities overviews the basic challenges Smart Cities face and solutions offered by network slicing.

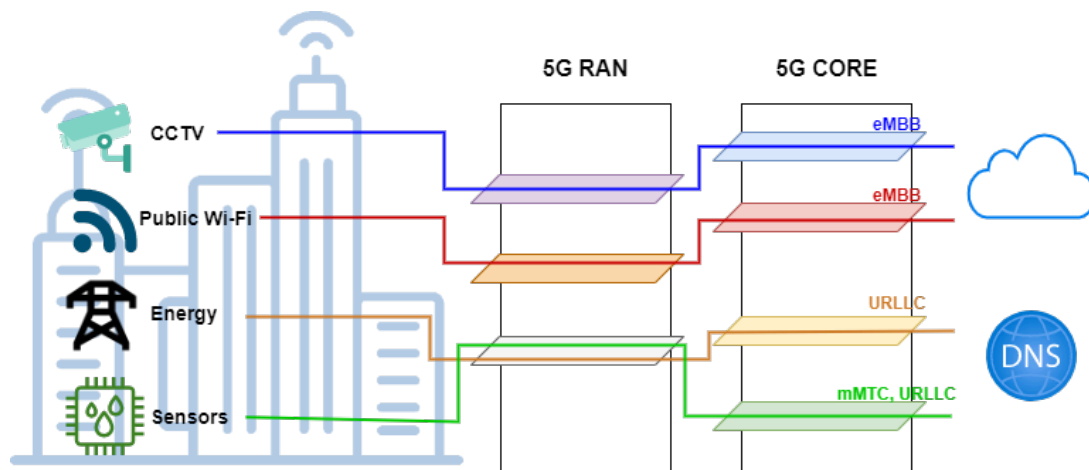
**Table 2. Smart City: Challenges and Capabilities**

Challenges	Solutions provided by network slicing
<ul style="list-style-type: none"> <li>• millions of <b>connected devices</b></li> <li>• massive amount of <b>data collected in real-time</b></li> <li>• automatic <b>analysis of data</b></li> <li>• uninterrupted, <b>reliable data flow</b></li> <li>• <b>isolation</b> of services</li> <li>• <b>diverse requirements</b> of different services</li> </ul>	<ul style="list-style-type: none"> <li>• enabling <b>different levels of quality, latency, security and priority</b> for each network slice</li> <li>• <b>IoT</b> (<a href="#">on page 32</a>) analytics servers enabling storage and analysis of data</li> <li>• separate, <b>dedicated network slices</b> deprived of any interference from one another</li> <li>• <b>automatic selection</b> of the most appropriate slice to meet <a href="#">service level agreement (SLA)</a> (<a href="#">on page 33</a>)</li> <li>• network slices <b>independently secured</b></li> </ul>

### Network Slices in Smart City:

Network slicing offers a solution by dividing a network into programmable slices that ensure optimal performance for various applications, as shown in Figure: Smart City Network Slices.

Figure: Smart City Network Slices



### Management of Slices in Smart City:

More importantly, the slices can be managed, customized and secured independently, and **not affect one another if one slice is overloaded or down**.

For example, in the event of a disaster, Smart City residents can utilize their mobile phones to upload videos, photos, send messages, and make video calls. **Despite the significant increase in data flow,**

**emergency calls are not impacted.** The emergency calls are part of a separate network slice that has its own network connection, ensured traffic load, priority, and security. **Mobile operators can ensure a connection for emergency calls, even if the public network is overloaded.**

## Autonomous Vehicle

Network slicing is crucial for autonomous vehicles, which demand ultra-reliable, low-latency communication, as well as a high level of security and the integration of multiple virtualized network slices.

### Challenges of Autonomous Vehicle Network:

Autonomous vehicles constitute the greatest challenge for 5G network. It has to secure ultra-reliable communication between **thousands of sensors in the time-critical way**, provide **high bandwidth (on page 31)** for GPS and maintenance applications. as well as maintain **high level of integrity** and **security** of the whole vehicular network.

### Capabilities of Network Slicing:

Table: Autonomous Vehicle: Challenges and Capabilities overviews the basic challenges faced by vehicles and the solutions provided by network slicing.

**Table 3. Autonomous Vehicle: Challenges and Capabilities**

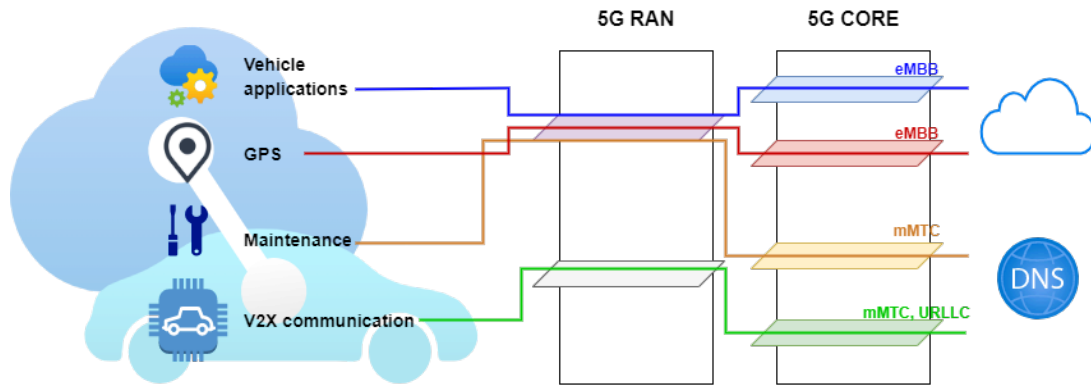
Challenges	Solutions provided by network slicing
<ul style="list-style-type: none"> <li>• thousands of sensors communicating in the <b>time-critical</b> way</li> <li>• <b>ultra-reliable</b> connection between sensors</li> <li>• <b>high bandwidth (on page 31)</b> for maintenance applications</li> <li>• <b>isolation</b> of services</li> <li>• separate security</li> </ul>	<ul style="list-style-type: none"> <li>• separate, <b>dedicated network slices for URLLC (on page 34) and eMBB (on page 32)</b></li> <li>• <b>automated orchestration</b> of <b>IoT (on page 32)</b> slices</li> <li>• <b>IoT analytics servers</b> enabling storage and analysis of data at the edge</li> <li>• <b>Enhanced security</b> with <b>isolated network slices</b> supporting different services</li> </ul>

### Network Slices in Autonomous Vehicle:

One single, physical network is incapable of fulfilling all the above requirements. Instead, we need **multiple, virtualized network slices**, where, for instance, on slice can be for **ultra-reliable, low-latency**

communication (on page 34) and separate one to support bandwidth-hungry applications, as shown in Figure: Autonomous Vehicle Network Slices. Thus, network slicing is the most fundamental enabler of autonomous vehicles.

Figure: Autonomous Vehicle Network Slices





# Chapter 6. Network Slicing Architecture

Implementing all the 5G requirements, that is extreme throughput, ultra-low latency and reliability, massive connectivity, called for the design of the network architecture as a **dynamic, flexible and consistent framework of advanced technologies**. The architecture of network slicing is primarily based on the **Recursive Model**, in which each part of the network can be instantiated and placed in a different location. Still, the essential technological advancement enabling instantiation of network functions is **Network Function Virtualisation (NFV)**. Both of these technological solutions are reviewed here, respectively.

## Recursive Model of Network Slicing

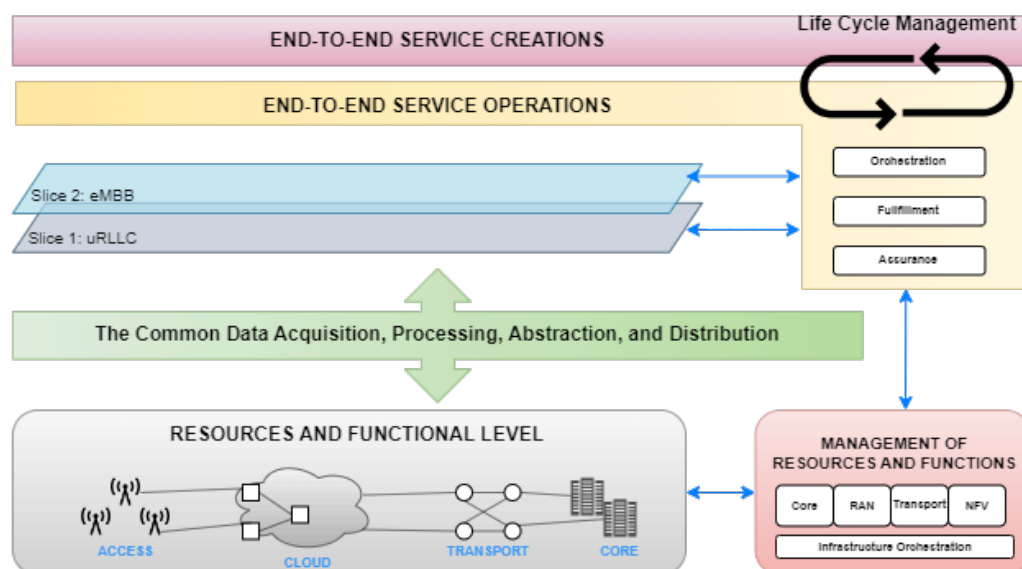
The 5G network architecture is based on a recursive model that allows for repeated instantiation and deployment of network services. This enables the creation of customized and independent network slices with dedicated resources and security.

### Recursive Model:

The architecture of 5G network is based on the recursive model, presented in Figure: 5G Recursive Model. It allows **each part of the network service to be instantiated and deployed repeatedly at different places**, at the same time.

In this way **one service can be created out of the instances of already existing services or their parts**. In the virtualized infrastructure, the recursive model allows the creation of the customized and independent instances of the network, i.e. "slices", with dedicated resources and their own security.

Figure: 5G Recursive Model



The following section reviews the underlying parts of the Recursive Model:

1. At **Resources and Functional Level**, network functions and resources are **virtualized**.
2. **Management of Domain Resources & Functions** orchestrates virtualized resources and allocates them on network slices.
3. **The Common Data Acquisition, Processing, Abstraction, and Distribution** platform allows the access of data from all different levels.
4. At the **Service Level**, operators map the customer's requirements to the network infrastructure, to ensure that customers' needs are fulfilled..

## Network Function Virtualization

The 5G communication networks manifest a strong dependency on software. Thus, network functions virtualization (NFV) is envisaged as a fundamental technology enabling fulfilment of the 5G requirements.

### Definition:

The major purpose of virtualization is to **abstract the resources from hardware and allocate them in a virtual environment**, which allows them to run in virtual machines or containers.

The virtualization of [network functions \(on page 33\)](#) offers the following benefits:

- ensures flexibility, scalability of network functions
- ensures rapidity of deployment of network functions
- provides efficient use of resources
- ensures rapid innovation and testing
- reduces cost and energy usage

### Network Slicing and Network Function Virtualization:

The virtualization of functions and resources is the fundamental technological solution that enables network slicing. Virtualized network functions (NFs) are highly scalable and programmable. More importantly, they can be accommodated on each network slice, isolated, and secured independently.

Therefore, operators are provided with the unique capability to deliver different types of services on the common infrastructure, in a cost-effective way.

# Chapter 7. End-to-end Network Slicing

Another significant feature of 5G network slicing is that it is **end-to-end**, i.e. all the way from **user equipment (UE)** (on page 34) to **data center (DC)** (on page 31), through separate and independent slices of access, transport and core.

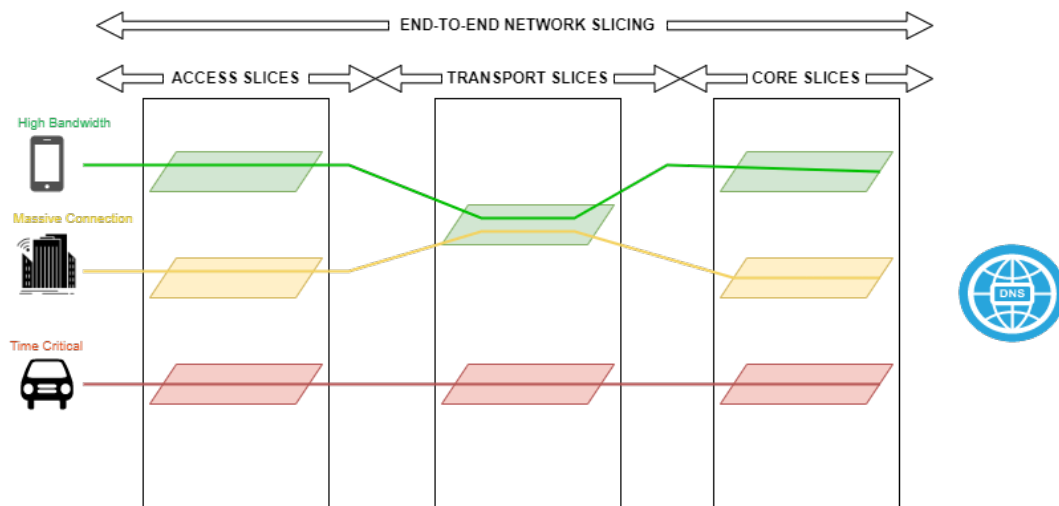
## Definition:

End-to-end network slicing means that **each slice is composed of three independent slices: access, transport, and core**, as shown in Figure: End-to-end Network Slicing.

For instance, one slice may consist of a dedicated resources in access, shared resources in transport and dedicated resources in core. Whereas, another slice may require dedicated resources in all three parts of network slicing.

This enables efficient management and flexible allocation and scalability of the resources of each part of the network.

Figure: End-to-end Network Slicing



## Benefits:

The importance of end-to-end network slicing is mainly stressed for **extreme flexibility** in order to provide **Service Level Agreement (SLA)** (on page 33)-based **quality of experience in a cost efficient way**.

More importantly, automating the creation and registration of network slices significantly reduces **Total Ownership Costs** (on page 34). With the increasing number of new use cases, manually creating, customizing, and managing the entire life cycle of slices would be expensive and time-consuming. Automating these processes essentially reduces TCO.

## Access Part of Network Slicing

The 3GPP specification Release 15 for [Next Generation-RAN \(on page 32\)](#) allows for flexible and adjustable slicing in [RAN \(on page 33\)](#) to meet tenant requirements such as [latency \(on page 32\)](#), data rate, and number of connections. Resources in RAN can be shared among different network slices while maintaining [QoS \(on page 33\)](#) requirements. One [PDU \(on page 33\)](#) session can be initiated for one slice instance, comprising of one or a number of QoS flows with mapped profiles and airtime.

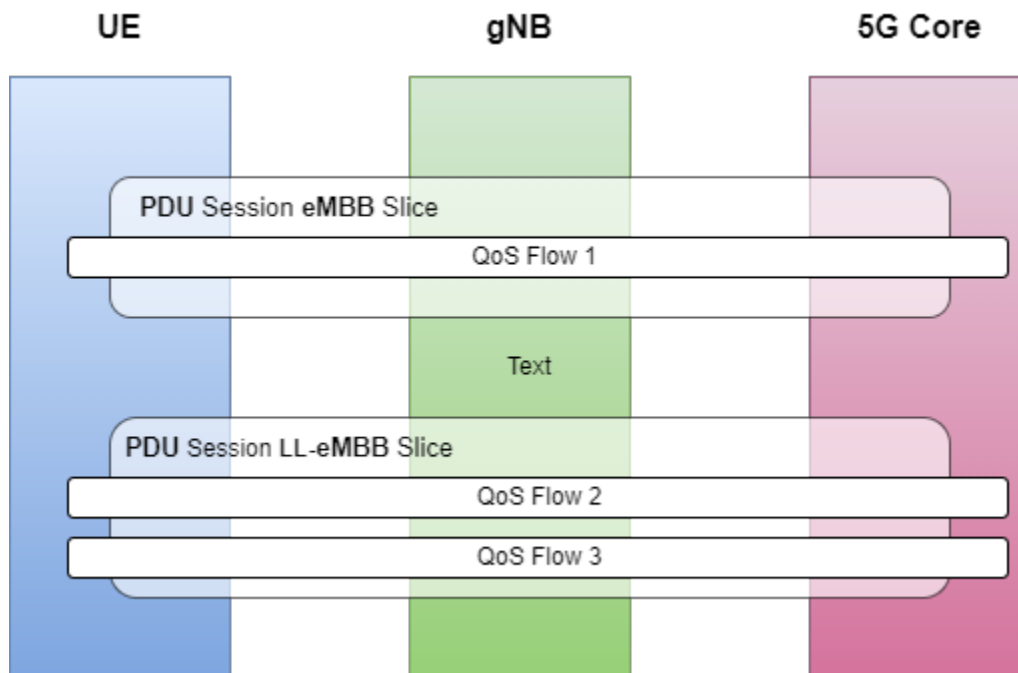
### Architecture of Network Slicing in RAN:

Slicing in RAN is highly flexible and adjustable. Depending on the situation, resources in RAN can either be shared among different network slices or dedicated to a specific slice.

As shown in Figure: Network slicing in RAN, **one PDU session can be initiated for one slice instance**, namely the [enhanced mobile broadband \(eMBB \(on page 32\)\)](#) and low-latency enhanced mobile broadband (LL-eMBB).

One PDU session can comprise of one or a number of QoS flows. **The incoming QoS flows, on the basis of their QoS profiles, are mapped to specific data radio bearers (DRBs) (on page 32) with assigned profiles and airtime.** It also provides mobility management and data encryption.

Figure: Network slicing in RAN



## Core Part of Network Slicing

5G core architecture features **Control and User Plane Separation (CUPS)** (on page 31) and **Service Based Interface (SBI)** (on page 33). User Plane Function (UPF) (on page 34) is separated from other network functions and located closer to user equipment. Slice registration is performed by the cooperation of specific network functions in 5G core (on page 31). **Network functions (on page 33) in 5G core can be either shared or dedicated** depending on the **SLA (on page 33)**-based requirements.

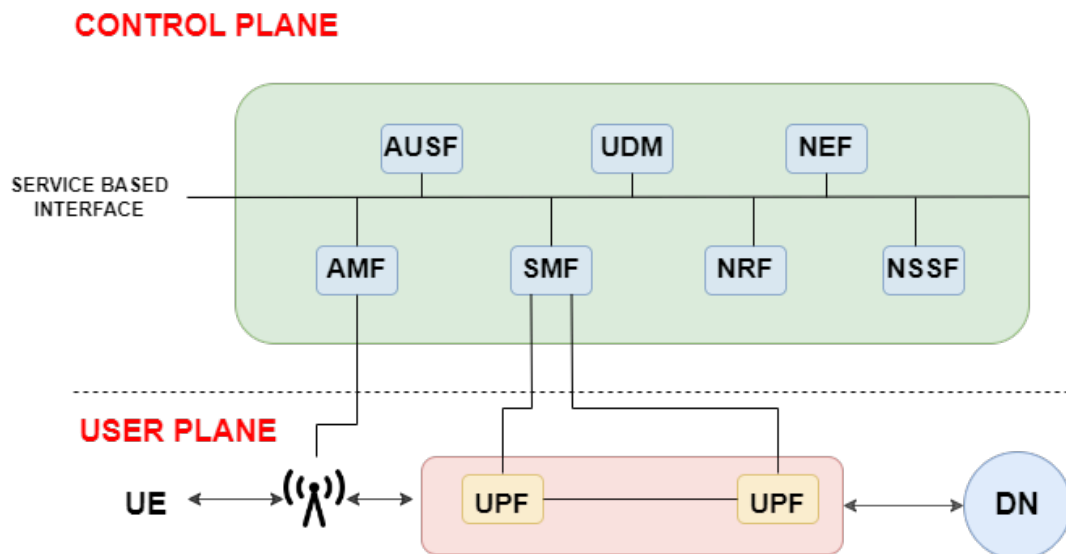
### Architecture of 5G Core:

One of the most fundamental characteristics of 5G core architecture is **Control and User Plane Separation (CUPS)** and **Service Based Interface (SBI)**.

More specifically, as shown in Figure: 5G Core Architecture, **User Plane Function, (UPF) is separated from other network functions in 5G core and located closer to UE (on page 34)**. The significance of UPF's location and proximity to UE lies in its responsibility for initiating a **protocol data unit (PDU) (on page 33)** session for incoming **QoS flows (on page 33)**. The closer UPF is to the UE, the faster its reaction time will be for incoming QoS flows, resulting in lower latency.

The remaining network functions provide rules and policies for PDU session, while **freely communicating with each other**.

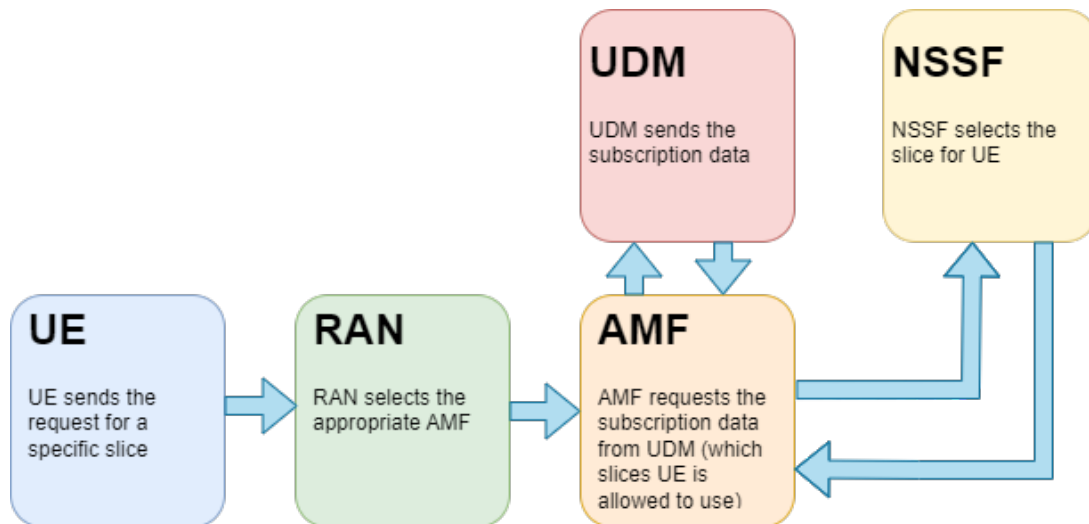
Figure: 5G Core Architecture



### Network Slice Creation and Registration:

Slice creation and registration is mainly performed by the mutual cooperation of such network functions as: [access and mobility function \(AMF\)](#) ([on page 31](#)), unified data management (UDM) and network slice selection function (NSSF), as shown in the Figure: Slice Registration.

Figure: Slice Registration



**Network functions in 5G core can be either shared or dedicated** depending on the SLA-based requirements. In most use cases, [session management function \(SMF\)](#) ([on page 33](#)) and UPF are dedicated for a specific slice.

## Transport Part of Network Slicing

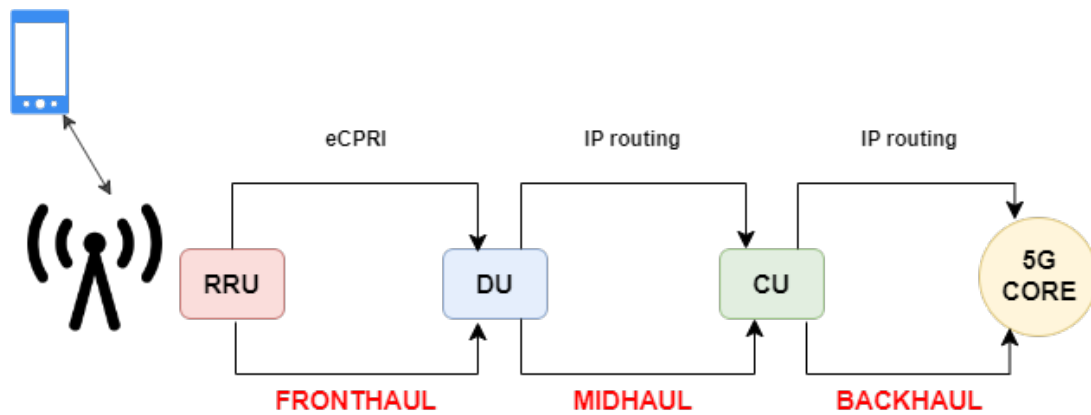
The transport network's high modularity and intelligent traffic steering system allow for efficient transport slice creation and management.

### Architecture of 5G Transport Network:

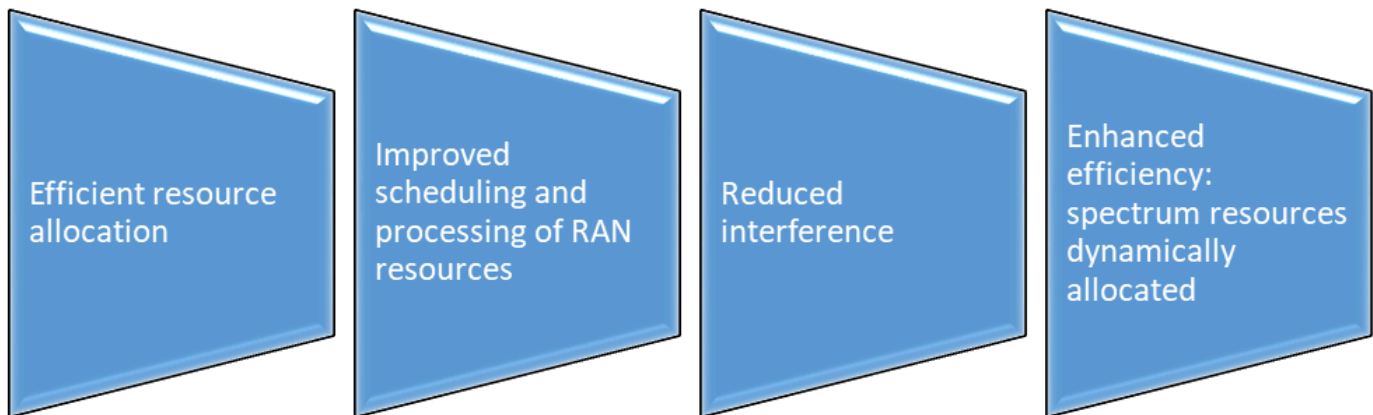
The transport network domain in 5G system must implement such technological solutions which **provide high level of flexibility, allocate the radio resources efficiently, balance and optimize the traffic load**. The proposed solution involves [functional split in RAN](#) ([on page 32](#)), which means dividing the [baseband unit \(BBU\)](#) ([on page 31](#)) into a [distributed unit \(DU\)](#) ([on page 32](#)) and a [centralized unit \(CU\)](#) ([on page 31](#)). This technological solution is the response to the densification of the traffic and need for the greater flexibility to serve diverse users.

The transport network becomes **more modular and scalable**. The single **backhaul is divided into fronthaul, midhaul and backhaul**, as shown in Figure: Transport Network Architecture, which enables greater flexibility and diversification.

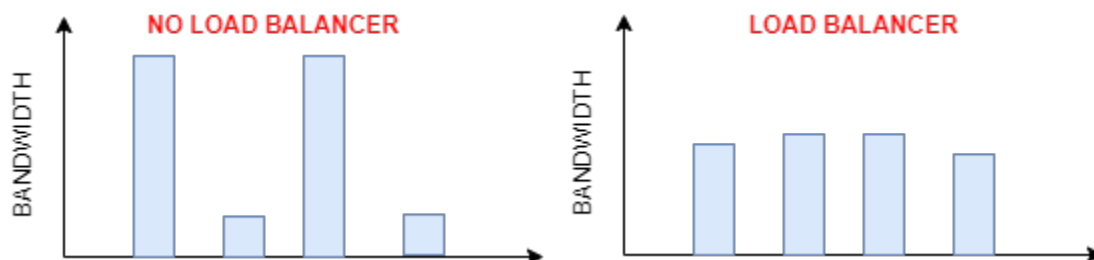
Figure: Transport Network Architecture

**Benefits:**

Higher level of granularity of the transport architecture offers the following benefits:

**Network Slicing in Transport Network:**

Since transport network management is primarily based on IP routing, **transport layer slicing** mainly involves traffic routing and prioritization. This is accomplished by the **load balancer**, such as [software-defined networking \(SDN\)](#) ([on page 34](#)).



**Software-defined networking (SDN)** ([on page 34](#)) not only intelligently steers, maintains and balances the traffic, but it is also responsible for:



- creating and managing the transport slices
- optimizing transport slices
- orchestrating services and allocating resources on transport slices

**Higher level of modularity** of transport network along with the **intelligent traffic steering system** enable efficient transport **slice creation and management**.

# Chapter 8. Glossary: Network Slicing Important Terms

**5G Core** - the heart of a 5G network, controlling data and control plane operations. The 5G core aggregates data traffic, communicates with UE, delivers essential network services and provides extra layers of security, among other functions.

**Access Mobility Function (AMF)** - a control plane function in 5G core network

**Backhaul** - portion of the network that connects a cell site with the core network

**Bandwidth** - a range of frequencies within a given band, in particular that used for transmitting a signal

**Baseband Unit (BBU)** - It is a device that interprets Baseband frequencies in telecom systems including computer networks, the internet, phone networks and radio broadcasting systems

**Business vertical** - are business niches where vendors serve a specific audience and their set of needs. Some broad examples of business verticals include insurance, banking, hospitals, retail, real estate, government, and more. Verticals can also be subcategorized into narrower niche markets.

**Centralized Unit** - It is a centralized unit connected between the 5G core network and the DUs. It provides the access control and coordinates high-level protocols including RRC (Radio Resource Control) from the control plane and IP, SDAP (Service Data Adaptation Protocol), PDCP (Packet Data Convergence Protocol) from the user plane

**Cloud Enabled Small Cell** - a miniature radio access point or wireless network base station with a low radio frequency power output, footprint and range.

**Common Public Radio Interface** – standard that defines an interface between Radio Equipment Control (REC) and Radio Equipment

**Communication Service Provider** - offers telecommunications services or some combination of information and media services, content, entertainment and application services over networks, leveraging the network infrastructure as a rich, functional platform.

**Control and User Plane Separation** - the complete separation between control plane functions (which take care of the user connection management, as well as defining QoS policies, performing user authentication, etc.) and user plane functions (which deal with data traffic forwarding)

**Data Centre** - a facility composed of networked computers, storage systems and computing infrastructure.

**Data Radio Bearer** - It defines how the UE data/signaling are treated when it travels across the network

**Digital Service Provider** - provides an online search engine, online marketplace or cloud computing service (either alone or in combination)

**Distributed Unit** - the main processing unit in Radio Access Network that is responsible for the High Physical, MAC, and RLC protocols in the RAN protocol stack

**Enhanced Mobile Broadband** - a concept that focuses on the speed, capacity and mobility to allow for new mobile uses such as high-definition video streaming and immersive augmented reality (AR) and virtual reality (VR) on the go

**Fronthaul** - the optical network that connects Remote Radio Units (RRUs) and Baseband Units (BBUs).

**Functional Split** - a new, flexible architecture for the 5G RAN, where the base station or gNodeB (gNB) is split into three logical nodes: the Central Unit, (CU), the Distributed Unit, (DU) and the Radio Unit, (RU), each capable of hosting different functions of the 5G NR stack

**gNodeB (gNB)** - a node in a cellular network that provides connectivity between user equipment (UE) and the evolved packet core (EPC). A gNodeB is the functional equivalent of a base station in a traditional cellular network

**Internet Protocol Routing** - a set of protocols that determine the path that data follows to travel across multiple networks from its source to its destination

**Internet of Things** - describes physical objects (or groups of such objects) with sensors, processing ability, software and other technologies that connect and exchange data with other devices and systems over the Internet or other communications networks.

**Latency** - the delay before a transfer of data begins following an instruction for its transfer

**Massive Machine Type Communication (mMTC)** - service in environment which has very high density of connected devices. mMTC focuses on applications that require a huge number of low-powered (IoT) devices operating over long-range with little to no human intervention. These autonomously communicating machine-to-machine (M2M) devices require low bandwidths and a long life.

**Midhaul** – portion of a network that connects DU and CU

**Network Function** - a functional building block within a network infrastructure which has well-defined external interfaces and behaviour

**Network Function Virtualization** - the replacement of network appliance hardware with virtual machines.

**Network Operator** - a company that provides its subscribers with internet and telecommunications services

**Network Resources** - any kind of device, information, or service available across a network. A network resource could be a set of files, an application or service of some kind, or a network accessible peripheral device

**Network Slice** - is a logically separated, self-contained, independent and secured part of the network, targeting different services with different requirements on speed, latency and reliability

**Protocol Data Unit** - a single unit of information transmitted among peer entities of a computer network

**Quality of Service** - any technology that manages data traffic to reduce packet loss, latency and jitter on a network, to guarantee its ability to dependably run high-priority applications and traffic under limited network capacity

**Radio Access Network** - is a major component of a wireless telecommunications system that connects individual devices to other parts of a network through a radio link.

**Radio Unit** - a mobile, stationary, or portable radio communications device, which communicates at certain air wave frequencies

**Service provider** - a vendor that provides IT solutions and/or services to end users and organizations

**Service-based Interface** - the control plane functionality and common data repositories of a 5G network are delivered by way of a set of interconnected Network Functions (NFs), each with authorization to access each other's services

**Session Management Function (SMF)** - the control function that manages the user sessions including establishment, modification and release of sessions, and it can allocate IP addresses for IP PDU sessions

**Service Level Agreement** - sets the expectations between the service provider and the customer and describes the products or services to be delivered

**Software-defined networking** - an approach to network management that enables dynamic, programmatically efficient network configuration in order to improve network performance and monitoring, in a manner more akin to cloud computing than to traditional network management

**Tenant** - a group of user in software and virtualization context

**Throughput** - the measurement of how much data is exchanged between the user and the server, over a given period.

**Total Cost of Ownership** - an estimation of the expenses associated with purchasing, deploying, using and retiring a product or piece of equipment

**Ultra-Reliable Low-Latency Communication (URLLC)** - a subset of the 5G network architecture, ensures more efficient scheduling of data transfers, achieving shorter transmissions through a larger subcarrier, and even scheduling overlapping transmissions. It supports highly important data transfer that requires low latency, such as self-driving cars and remote surgery

**User Equipment** - any device used directly by an end-user

**User Plane Function** - the function that does all of the work to connect the actual data coming over the Radio Area Network (RAN) to the Internet