Network slicing: realising the benefits of 5G by tailored use of network capabilities

5G supports numerous and diverse use cases that will be served by the same physical network. To make this work, network slicing with tailored network capabilities is essential to fulfil the different users' requirements.

Historically, dedicated networks have been deployed to cater for specific use cases. This is costly and often leaves little flexibility to adapt to new services and use cases. With 5G this will change. 5G is designed to support billions of connected devices, numerous and diverse use cases, new levels of performance, multiple new vertical industries - through one common network. Using the same physical network for multiple purposes leads to higher resource utilisation, economies of scale and scope, shorter time to market and gives clear synergies and increased value and benefit to society.

Benefits of a common network to support multiple use cases

Examples of dedicated purpose-made networks using different technical standards and protocols are manifold: public mobile technologies (2G, 3G, 4G), short range communication (WiFi, Bluetooth), fixed wireless access (e.g. WIMAX), signalling system for railways (GSM-R), emergency networks (TETRA), proprietary networks for sensors and actuators (e.g. LoraWAN, Sigfox) and specific variants of broadcasting (DAB, DVB, etc.). Each of these networks provides a specific and often limited set of services.

5G will provide a rich and large ecosystem on which to build services and use cases. Myriad different devices are expected to use the 5G network including mobile handsets, weather sensors, power meters, remotely operated/autonomous vehicles, and so forth. Within a single country, we will see billions of devices being connected.

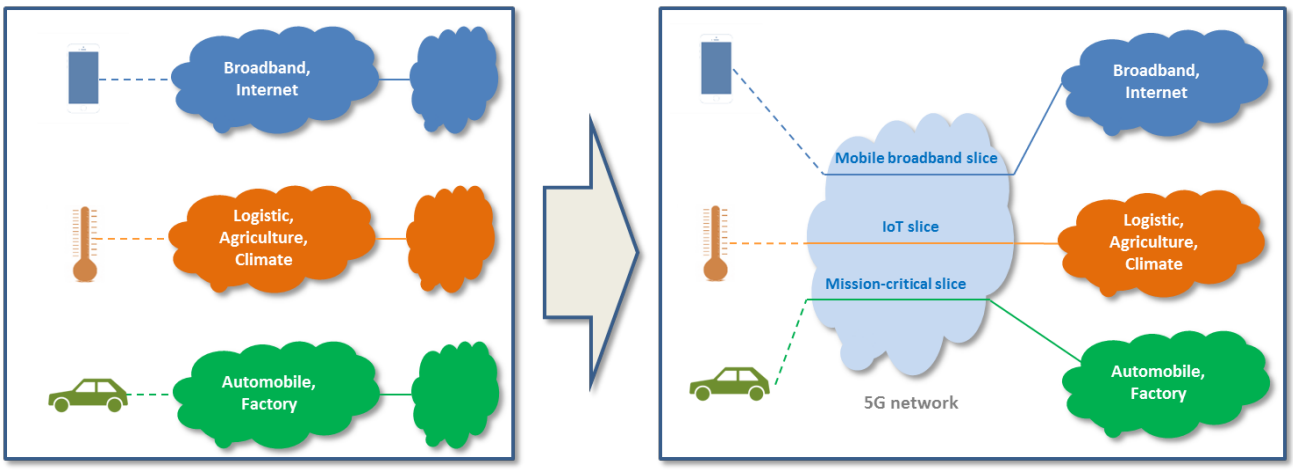
Use of common physical networks stimulates higher resource utilisation, lowers effort levels and shortens time to market for new services. Further, as the available base of users, devices and applications is larger and uses the same physical network, the threshold for innovation is lowered and will allow targeting of specific needs or demands. One example is enhancing spectators' experience during a sports event by selecting preferred viewpoints augmented with detailed information and hints. Another is augmented reality conferences for enterprises and consumers that reduce the need for travel, with corresponding benefits to the environment. At the same time we expect competition at both network- and service level to continue to drive network evolution and deliver benefits to society through affordable and attractive services.

Serving a diverse set of use cases over the same network will increase complexity. This complexity must be managed to ensure service levels that are acceptable. As the services related to different use cases can have very different characteristics, these will impose varying requirements on the network resources. Consider, for example, devices for utility metering and parking sensors. These devices hardly move and do not require mobility management, i.e. the need to track location. On the other hand, sensors related to freight management would commonly move also across countries' borders and would require mobility management including roaming agreements.

To implement and manage the diverse use cases over the 5G network in a flexible way, network slicing is required.

Service provisioning through network slicing

Network slicing is a mechanism for creating logical networks with tailored capabilities for specific needs over one common physical platform. Instead of rolling out separate networks designed for specific services, 5G combines them into one physical network and "slices" it to fulfil various user needs. This is shown using a simplified illustration with three slices.



In other words, network slicing allows multiple logical networks to be created on top of a common shared physical network. These logical networks are, through slicing, tailored to meet the specific needs of applications, services, devices, customers or operators.

Each network slice comprises an independent set of logical network functions that support the requirements of the particular use case. Capabilities such as data speed, latency, security and mobility will be defined to meet the particular demands of each use case. Further, each slice is logically separate so that no slice can interfere with the traffic in another slice. As a result they appear as separate networks to the users. This has several desirable outcomes, for example the ability to contain a cyber-attack in one slice or preventing extraordinary scenarios, such as preventing a misbehaving sensor in one slice from affecting a critical service running in another slice.

Network slices may be defined for a particular business customer or for multiple customers with similar service and quality requirements (e.g. specific utility metering devices). A person or device may use only one single slice or multiple slices at the same time for different uses.

Several 5G use cases have the potential of increasing safety and efficiency while at the same time reducing pollution and having other positive environmental effects. An example is emergency "blue-light" services or public protection and disaster relief (PPDR) services provided over public networks using slicing to provide guaranteed and prioritised access when needed. In addition, emergency services can use all network assets of the shared network which will improve coverage and quality.

From a practical perspective we foresee the introduction of new network slices to be performed stepwise and based on actual needs. While network slicing is inherent in the 5G standard, there is no need to wait to explore the opportunities. The introduction of networks slicing can start today by utilising the existing defined technologies as standardized by 3GPP, such as dedicated core networks, although the full flexibility will only be available with 5G.

Enhancing security and robustness through logical separation

As slicing logically separates network resources, it could serve as a tool to mitigate security attacks. In the event of a cyber-attack for instance, it is possible to isolate and limit the attack to one slice, leaving other slices unaffected. Similarly, if attacks are directed at certain parts of the network, other network resources could be utilised. Slicing will thus ensure that communication needs are catered for also during crisis situations and that multiple services within one network do not increase the vulnerability.

This enhanced protection against cyber-attacks and failures comes from the logically separation of network resources through slicing, which hinders that an attack on one network slice impacts other slices. The same argument is valid for robustness as overload of failures in one slice should not affect other slices. However, this requires that slices are properly defined and configured. Industry standards and best practice experience are instrumental in this respect.

Security and robustness mechanisms can also be set up differently within different slices. This is important since both security and robustness usually come with a cost in terms of additional capacity or capabilities needed. As an example, a public safety network slice might need ultra-high security and robustness whereas a non-time-critical sensor network slice provided by a start-up company might not need more than basic security and robustness.

Flexible regulatory conditions essential to drive innovation and social benefits

Providing the proper incentives for innovation is essential to fuel a creative and explorative approach in the use of 5G technology. As illustrated in the previous sections, with 5G there is great potential for tailoring network slices to cater for future societal needs.

For society to reap the full benefit from these use cases, regulators should focus on the advantages and outcomes of the services rather than placing restrictions on how an operator can use evolving technologies to deliver these benefits. One example of a regulation with a potential limiting effect is net neutrality regulation. Such a regulation can limit an operator's ability to use network slicing and thus restrict the provision of certain enhanced services and in some cases even make their provision impossible. The result is that society misses out on important benefits.

As 5G technologies evolve, more business and mission critical communications will likely be implemented on the same physical network and new capabilities added. This will lead to an increase in complexity, for example, through multiple levels of slicing across multiple network domains involving one or more physical/logical infrastructure owners and third-party buyers and providers. This increased complexity may in some cases challenge the adequacy of existing sector specific regulation. It is therefore important that existing regulation is reviewed to ensure it does not create competitive distortions. Regulation should be designed to ensure a well-functioning competitive market on similar terms (level playing field) between all actors in the value chain.