C2017/3-8 RELIANCE

Deliverable 2.4 – RELIANCE business innovations – final version

WP2 – Verticals, Use Cases, Requirements, Architecture and Business Models

Working Version of Deliverable

.....

Dissemination level:	Public
Version:	1.0
Authors:	KEYLAND
Contributors:	RELIANCE CONSORTIUM

C2017/3-8 RELIANCE
REsiLIent ANd scalable sliCing over multiplE domains
https://projectreliance.com/

Supported by

Spain – CDTI

Sweden – VINNOVA

Turkey – TÜBITAK

Project coordinator: Elio Saltalamacchia, SII CONCATEL

Participants in project (RELIANCE) are:

- SII Concatel S.L. (CCTL)
- Keyland Sistemas de Gestión S.L. (KEYLAND)
- Saint Patrich Technology S.L. (TyP)
- RISE Research Institutes of Sweden AB (RISE)
- Bombardier Transportation Sweden AB (BOMBARDIER)
- Westermo Network Technologies AB (WESTERMO)
- Eduro AB (EDURO)
- Turkcell Teknoloji (TURKCELL)
- Netas Telecommunications A.S. (NETAS)
- ULAK Communication Inc. (ULAK)

1. Executive Summary

The purpose of WP2 is to compile a portfolio of use cases originating from Verticals using the RELIANCE infrastructure, to infer from them the functional and non-functional requirements for offering slicing services -, and finally to define the high-level architecture for the RELIANCE project. Besides, WP2 will perform a techno-economic analysis of the business models derived from the interrelation of all the actors in the RELIANCE value chain.

This document, Deliverable D2.4, is linked to **Task 2.3 RELIANCE business model innovations**. The objective of T2.3 is to investigate the potential implications of RELIANCE in terms of novel business model innovations. Based on the identified use cases, the first objective is to analyse the existing business models relevant to RELIANCE stakeholders and to determine where the new concepts could have an impact on existing businesses and/or might enable new business opportunities. Especially, this task is focused on studying the different business relationships that can be established between producers/consumers of the RELIANCE ecosystem. Besides, this task aims at figuring out how existing businesses could successfully improve through RELIANCE and how new market entrants could capture its economic potential. The objective is to determine which parts of business models could be changed, renewed or invented from scratch, enabled by the disruptive and innovative nature of RELIANCE concepts and technologies.

This document: *D2.4 RELIANCE business innovations – final version* summarizes the research activities performed in Task 2.3. This document is the final version based on *D2.3 RELIANCE business innovations – initial version*. As a first step, there is a summary of key outcomes expected from RELIANCE. Secondly, an updated rationale for the project is provided. This includes a review of the use cases. The next section provides a summary of the analysis that has been carried out related to different techniques to build the business models. Then, a detailed Market Analysis is provided. Finally, an initial outline of the strategic relevance of RELIANCE is provided.

2. Table of Contents

3. Introduction

The key motivation of RELIANCE is to develop highly innovative technological and architectural solutions for a dynamic, flexible and scalable slice management plane that enables the offering of vertical-tailored slices “as-a-Service” and research on multi-domain slice choreography framework. The opportunity to rely on third-party infrastructures introduces further challenges to guarantee a uniform level of reliability for supported services. The research areas and the activities carried out in RELIANCE, such as the protocols for deployment and runtime adaptation of the software services related to any type of infrastructure node, position the project and its consortium on the leading edge of research.

3.1. Key Outcomes of RELIANCE

RELIANCE extends the 5G network architecture with new functionalities needed for multi-service management, with the related abstractions, interfaces, and mechanisms to support needed resilience, security, and scalability. A key innovation of the project is the highly scalable and robust slice choreography plane that enables the offering of vertical-tailored slices “as-a-Service”, ensuring the required scalability, security, and resilience features. It facilitates the mapping of service requirements from the verticals with their predicted traffic demands into dedicated networking and cloud resources through automated multiparty negotiation. Scalable slicing is complemented with protocols for deployment and runtime adaptation of resilience and security mechanisms over heterogeneous infrastructures, so to enable a unified reliability framework.

3.1.1. New business models

RELIANCE enables the creation of a marketplace where vertical services and data assets can be traded with defined interfaces and mechanisms in a trustworthy fashion. The introduction of network slices serving multiple vertical applications creates new business opportunities and markets for service providers and operators to package and resell their service components (e.g., data analytics, authentication, low latency transport) to vertical industries that customize the offerings into a dedicated end-to-end service. This requires the implementation of new types of business to business as well as consumer to business interfaces.

3.1.2. Extension of 5G core network functionality

RELIANCE extends the 5G core network functionality with multi-service control and management plane with needed abstractions for network slicing and supporting interfaces. The main contribution of the project is a multi-service orchestration plane complemented with unified and seamless connectivity management. Added to this, the research activities on slice federation capabilities will provide initial insights on services management if they cross multiple administrative domains. These insights will be the basis for future R&D activities beyond the project.

3.1.3. Novel connectivity paradigms

The project will research slicing that addresses decentralized services and supports them through automatic multi-party negotiation and contracting, provisioning of composite 5G services for different business relationships including inter-carrier, service provider to service provider (SP-to-SP) and brokerage. The slicing-based service model goes well beyond the classical client-server model. For instance, the location of services and even related resources may change dynamically by the slice optimization taking into account domain topology and end-users localities.

3.1.4. Advanced network OS capabilities

The project develops an advanced network operating system for a unified connectivity management system and an advanced virtual resource orchestration and management system for a unified compute and storage resource management system across multiple administrative domains.

3.1.5. Trustworthy interoperability across multiple domains

The project will research a contracting environment aligned with the federation models, whereby parties discover each other, establish trust, define and negotiate SLAs, and trade their services or service components. This will allow the expansion of the operator networks towards enterprise networks and in-enterprise network services, with the required resilience levels. Through this objective, such frameworks propose the means for the operators to reach specific private network areas where telecom was not able to enter (e.g., factories and smart offices).

3.1.6. Provide the missing resilience mechanisms for the software-based networks to become viable in real deployments

Resilience is the heart of the non-functional features in any network. RELIANCE's strategic impact is to provide a comprehensive set of resilience mechanisms to be gracefully integrated into the slice orchestration workflows. We plan to achieve this through the following actions:

- Addressing the reliability of software and the perception of software resilience. This is materialized by an overall increase of the subjective feelings of efficiency.

- Researching synergies between the software development and the heterogeneous infrastructure providers for responding appropriately to the use case requirements in terms of service resilience, especially by establishing the relationship that the software networks are intrinsically consuming and the resilience features provided by the heterogeneous infrastructures, no matter if these are exposed or not.

3.1.7. Vertical-specific enhanced services

The project will design and develop concrete vertical-specific enhanced components, services and functionalities derived from the use cases, having a direct impact in three domains:

- Train control and management.
- Industry 4.0 and Smart Facility Management
- Multimedia Broadband

Added to this, the RELIANCE consortium will define guidelines for enabling 5G-ready new verticals able to fully exploit the advantages of the RELIANCE framework.

4. Rationale for the Project

Providing a range of services with varying requirements on a common mobile operator platform is considered a crucial factor to maximize the addressable markets. The capability to stretch service provisioning across multiple technical and administrative domains further enables operators to increase the coverage and capacity of such services.

To meet the specific requirements of verticals, 5G systems have to be highly scalable and customizable, providing at the same time high-reliability levels, regardless of the heterogeneous underlying infrastructures. RELIANCE extends the 5G network architecture with new functionalities needed for multi-service management, with the related abstractions, interfaces, and mechanisms to support needed resilience, security, and scalability.

A key innovation of the project is the highly scalable and robust slice choreography plane that enables the offering of vertical-tailored slices “as-a-Service”, ensuring the required scalability, security, and resilience features. It facilitates the mapping of service requirements from the verticals with their predicted traffic demands into dedicated networking and cloud resources through automated multiparty negotiation. Scalable slicing is complemented with protocols for deployment and runtime adaptation of resilience and security mechanisms over heterogeneous infrastructures, so to enable a unified reliability framework.

The architectural work of the project is driven by the diverse needs and requirements stemming from vertical industries (industry 4.0, enhanced multimedia broadband, train control & management, and smart facility and building management). The RELIANCE framework will be implemented and validated on selected use-cases through proofs-of-concept, aiming at demonstrating the envisioned benefits of the RELIANCE framework.

4.1. Technical Innovation of RELIANCE

RELIANCE aims to create a dynamic market place whereby multiple stakeholders, including infrastructure providers and operators, will provide end-to-end slices for different verticals. The flexibility and agility offered by RELIANCE in the provisioning and management of slices will encourage vertical industry actors to access this new network slice market place, thus bridging the gap between verticals and telco industries. Besides, the creation of these novel business interactions and models will enable verticals to either deploy new customized services or improve existing ones, thus strengthening their positions in their respective markets.

This is also reflected on the telco industry side, whereby operators will have opportunities to engage new customers from the vertical sectors with more appealing service offerings. Moreover, the extremely flexible and agile RELIANCE approach, based on recursive abstraction and virtualisation of resources, will enable network operators to improve their products portfolio beyond network connectivity services.

RELIANCE is an innovative project which will certainly have a strong strategic impact in the industry including verticals beyond the communications industry. The innovation potential of the project spans across multiple complementary areas, involving different stakeholders which would benefit from the different innovations RELIANCE aims to develop. The following is a list of the main technical innovations envisaged in RELIANCE with the relevant R&D areas of the project.

4.2. System design

- Novel agile architecture for vertical-tailored slice “as-a-Service” provisioning in a single domain.
- Automatic multi-party negotiation, service contracting and brokerage among multiple independent stakeholders for automated slice creation.
- Novel interfaces and schemes to combine slice choreography and slice orchestration for agile slice run-time operations.

- Powerful resource abstraction enabling the combination of single-domain slates into multi-domain slices, recursive slicing, and control & management by design.

4.3. Slate production

- Dynamic abstraction, composition, decomposition and partitioning of single provider heterogeneous resources into slates.
- Active management and orchestration of slates by enhancing NFV and SDN platforms in support of resource recursiveness.
- Algorithms for dynamic slate lifecycle management, including elasticity, reliability, redundancy and failure-recovery.

4.4. Resilience mechanisms

- Extensions to the network's functions themselves, supplying a new design, specification and tools on how to implement the software network functions in a resilient-aware manner.
- Enhance connectivity over the network between different network functions in a reliable and resource-effective manner.
- Novel strategies to orchestrate VNFs over different heterogeneous infrastructures to implement a resilient service according to the use case requirements.
- Framework for traceability of system failures for providing operators a means to assess which of the components is damaging the reliability and the impact on services and specific users.

4.5. Design and definition of new services and components for verticals

- Vertical-specific enhanced components, services and functionalities that will take advantage of RELIANCE capabilities (management, control, service provisioning) in three domains:
    - Train control and management.
    - Industry 4.0 and Smart Facility Management
    - Multimedia Broadband

4.6. Reliance Use Case Review

The RELIANCE architecture is driven by the consolidation of requirements from multiple vertical industry segments. In this section, we will highlight briefly the use case proposed by each member of the consortium with a focus on and its overall relevance to the RELIANCE project and the impact this use case will have in the development of new business models.

4.6.1. Train control and management (Bombardier)

Bombardier is the problem owner of the MITRAC TCMS local testbed (shown Figure 1). It is essential for Bombardier to boost the investment in emerging technologies like 5G technology, Cloud computing, SDN, and new Big Data methods, to exploit the value of the vast amount of data generated on the trains (GB/h).

To fully deploy all possibilities also tight requirements in terms of latency, resilience, coverage, and bandwidth must be satisfied for the On-board and Off-board train communication infrastructure – in all different environments from crowded cities and tunnels to rural areas.

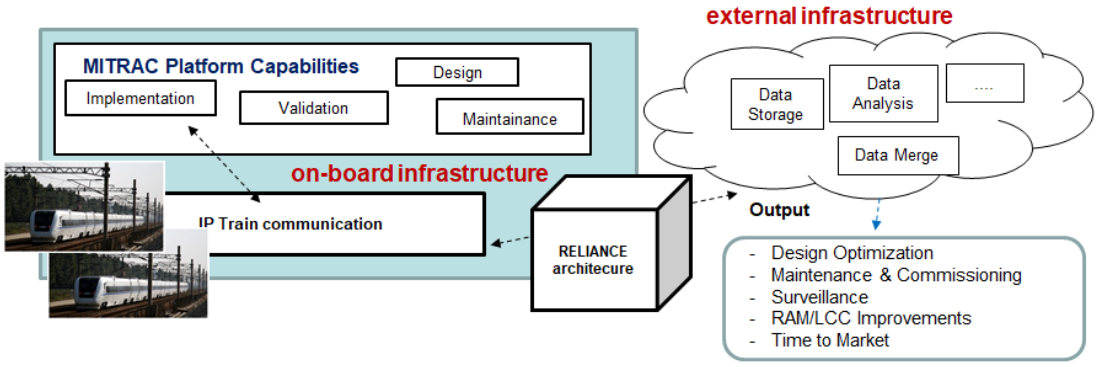


Figure 1 MITRAC Train Control and Management System testbed

The RELIANCE framework will represent a breakthrough in supporting these challenges by establishing end-to-end network slicing tailored to the data exchange requirements in train control management. By this it is possible to collect and analyze data in an intelligent way which will also open for a lot of new services to Bombardier customers as further defined below.
As shown in Figure 1, Bombardier aim to use the data in order to:

- Shorten reliability growth period by remote commissioning capabilities
- Optimize maintenance scheme – limit scheduled maintenance and grow predictive maintenance
- Monitor equipment utilization and performance.
- Monitor infrastructure status.

As shown in Figure 2 and Figure 3, the train propulsion systems consist of different technical components (such as Motor, Transformer, and DCU train control engine), which generate vast amounts of different types of data (e.g., diagnostic data, propulsion data, event logs, position, electric data). Today only a limited share is used remotely for diagnostics, maintenance, reliability growth and other upcoming business opportunities. The main scope of Bombardier is to exploit the value of such data volume and variety – beneficial to several users. Expected users are:

- Train owners, operators and maintenance staff.
- Infrastructure owners and maintenance staff.
- Bombardier engineers, warranty managers and maintenance staff.

To this end, it is essential to assess emerging technologies (5G, Cloud computing, and new Big Data methods). As illustrated in Figure 2, data collection and analysis could be achieved through a cloud-based architecture implementing a Digital Twin for creating living digital simulation models (of propulsion systems technical components) to update and change as the components Input/output signals change. Monitoring all the (important) components requires the collection and transfer of a vast amount of data (GB/h) - needing high-performance data connectivity. Other than such improved mobile connectivity, there is also a need to explore future possibilities of internal train data communication architectures, i.e., to provide a scalable and efficient train internal network supporting and securing the exchange of data.

--

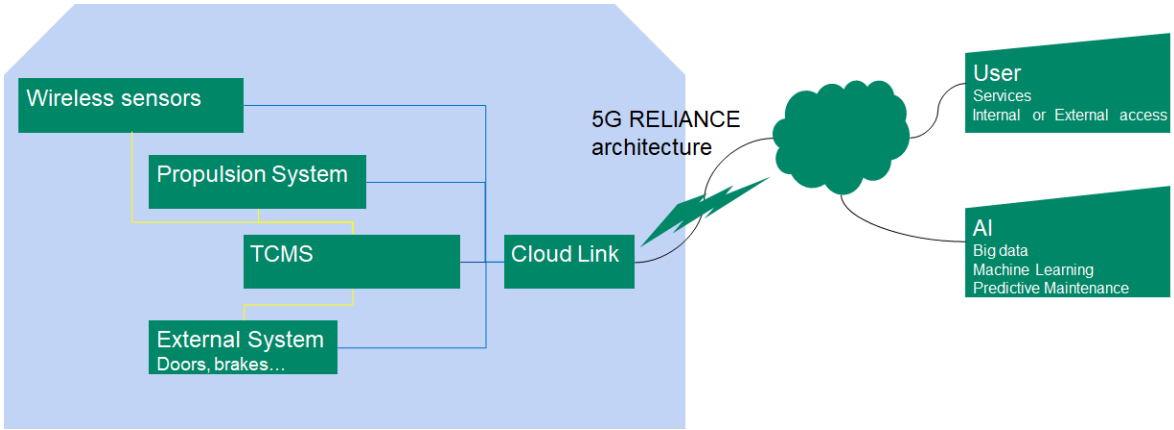
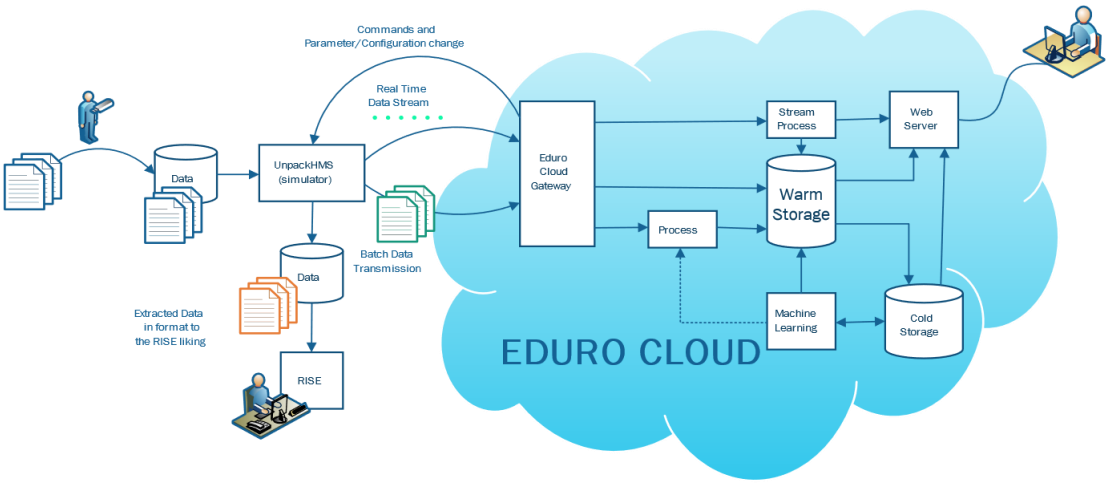


Figure 2 RELIANCE framework and MITRAC TCMS architecture


Commands and
Parameter/Configuration change
Real Time
Data Stream
Data
UnpackHMS
(simulator)
Batch Data
Transmission
Data
Extracted Data
in format to
the RISE liking
RISE
Eduro
Cloud
Gateway
Stream
Process
Web
Server
Warm
Storage
Process
Machine
Learning
Cold
Storage
EDURO CLOUD

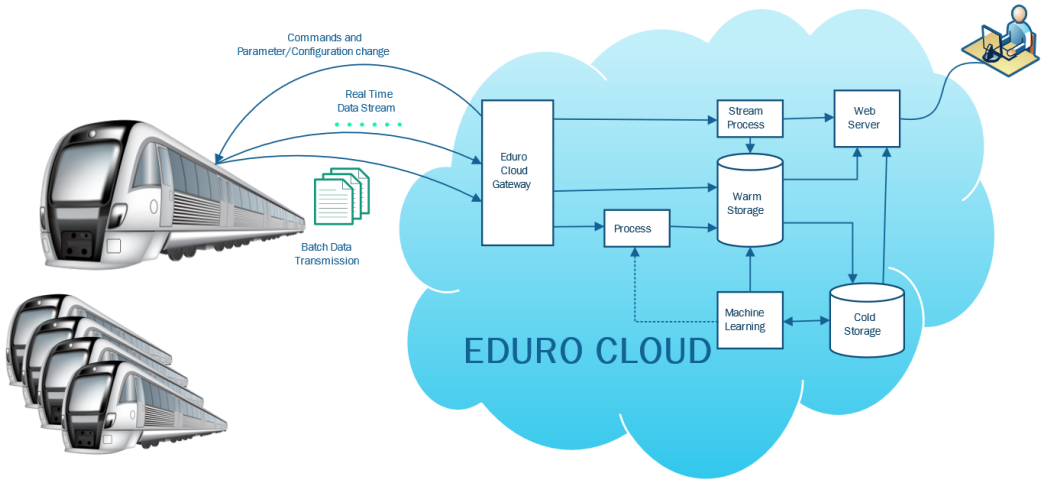

Commands and
Parameter/Configuration change
Real Time
Data Stream
Batch Data
Transmission
Eduro
Cloud
Gateway
Stream
Process
Web
Server
Warm
Storage
Process
Machine
Learning
Cold
Storage
EDURO CLOUD

Figure 3 MITRAC TCMS Cloud-based architecture for data collection and analysis

4.6.2. Industry 4.0 & Smart Facility Management (Spain)

4.6.2.1. *Industry 4.0*

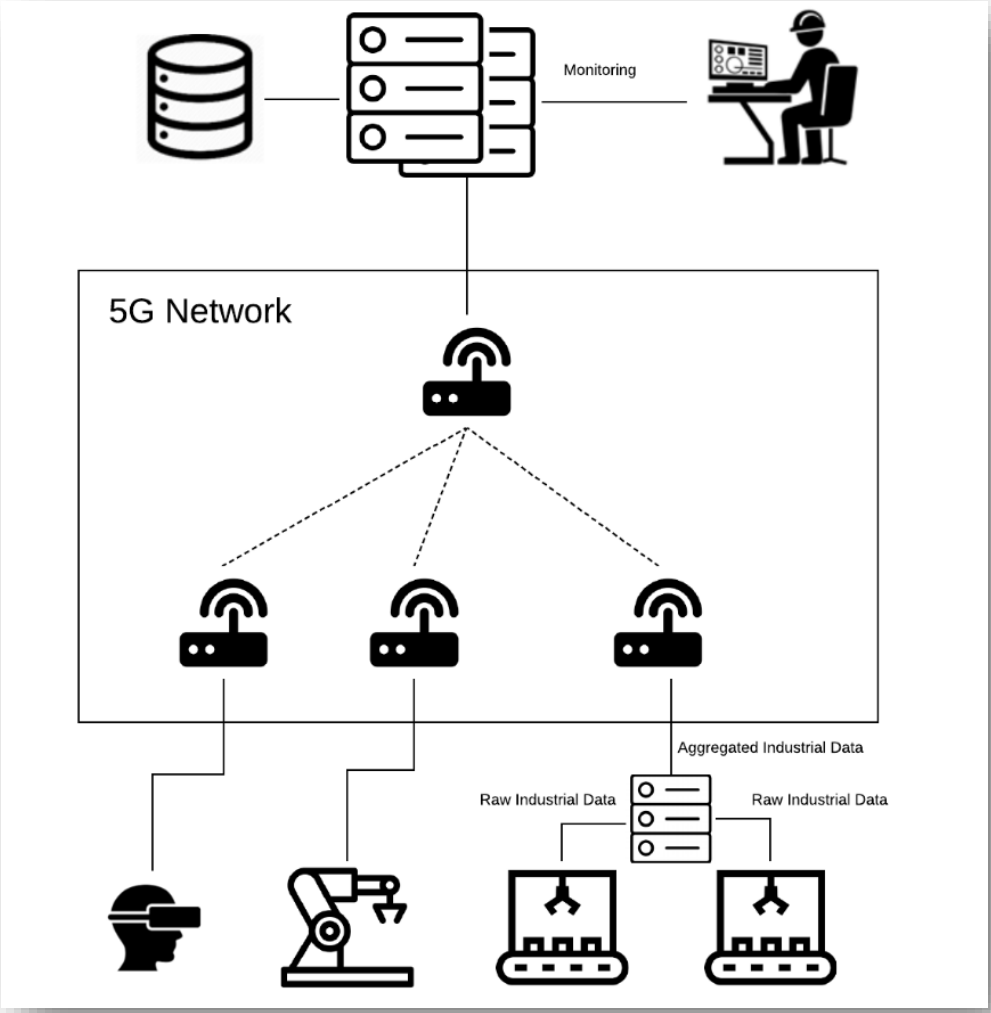
Although new capabilities and initiatives in the IIoT sector and in the Collaborative Robotics context have the potential to cause major changes in the entire industrial value chain, the current infrastructure is not able to offer the requirements in terms of communication (reliability, security, minimum latency and QoS across different domains with different SLAs).

In this sense, RELIANCE offers a golden opportunity and associated benefits for the globalization of resources and the relocation of production centres and factory cells, including new concepts related to production systems reconfiguration models[1]. The design and composition of new solutions based on RELIANCE would allow, for example, the coordination of different resources from different centres (and even from different suppliers), facilitating fully distributed production chains and establishing a frame of reference for deploying new models, even in the theoretical plane, of interaction between robots and humans in an IoT environment; exploring the opportunities and limitations of the deployment of new solutions connected in a comprehensive environment, with already established workflows and machines.

However, there are currently serious technological problems that prevent their real deployment in IIoT environments. The main problem is the need to be able to deploy services in different countries, which implies the need to establish effective security and interconnection mechanisms, with minimum latency.

On the other hand, the need to be able to operate different machines remotely, for example, a factory in China from a control system in Germany operated by a group of robots and coordinated humans implies a great level of complexity at different levels. There must be a real-time orchestration of the central system and the remote controls. It is therefore much more complex than deploying a set of services, requiring a comprehensive proposal taking into account not only new network topologies but much more agile deployment and operational management models that can respond to the needs of latency, communication and scalability in a globalized IIoT environment, with innumerable devices, sensors and components. Added to this, there are different projects and initiatives associated with providing sufficient autonomy for robots to perform tasks for humans. Collaborative work between humans and robots has the potential to improve the quality, efficiency and safety of the goods manufacturing process.

[1] Feno M.R, Cauvin A., Ferrarini A., “A production system reconfiguration model based on repair approach”



1.1.1.1.1 Current Status and Challenges

There are great technological challenges that prevent robots from being fully functional and capable of working in a human environment: real-time location; models of interaction with humans; symbiotic autonomy, in which robots improve their capacities through proactive interaction with humans ... Telepresence and remote element control for Smart Factories is another technological challenge that is not currently solved.[2][3]

KEYLAND will provide enhanced services for Sensor Control & Maintenance and Collaborative Robotics to validate the potential of RELIANCE for a fully distributed multi-domain production chain. Specific R&D activities related to human-robot interaction, intuitive human-machine interfaces, and interaction between different robots and machines will be performed, exploring the opportunities and constraints to deploy new connected solutions in very different domains (IoT, Smart Cities, Industry 4.0 etc.) in an integrated environment with pre-existing machines and workflows. Several variables related to the safety of human workers, reliability, availability and enhanced services for fully distributed multi-domain production chains will be defined and assessed as KPIs.

4.6.2.2. *Smart Facility Management*

[2] The Economist Intelligence Unit, "Manufacturing and the data conundrum Too much? Too little? Or just right?"
[3] Burke R., Mussomeli A., Laaper S.,"The smart factory: Responsive, adaptive, connected manufacturing".

As part of the Spanish consortium CCTL and TYP will study the impacts of 5G technologies, as well as IoT and Machine Learning, on the Smart Facilities Management (SFM) sector and in particular, HVAC.

As new legislation comes into force, greener solutions are being sought to make buildings more energy-efficient and cost-effective. One way to achieve greater efficiencies is to automate building control through building automation. This is in essence a computer-controlled system that relies on a network of sensors throughout the building to detect and effect changes in the building's numerous systems. The building automation system communicates with the various systems in the building and provides a central control hub for analysis and optimization.

As shown in Figure 4, SFM falls under the general heading of Smart Buildings, which is itself a rather ambiguous term which at its most basic, is applied to describe buildings that use: Automated systems, intelligent building management systems, energy efficiency measures, wireless technologies, digital infrastructure, adaptive energy systems, networked appliances, data gathering devices, information and communications networks, assistive technologies and remote monitoring.

Figure 4 Building Management System (BMS) Error! Reference source not found.

SFM systems are focused on controlling and optimizing the building with the defined goal of increasing its overall performance concerning energy consumption, carbon footprint & C02 emissions, the comfort level of inhabitants and cost. Systems that aim to achieve this in an automated manner are often termed Building Management Systems but the literature contains a growing list of nomenclature for such systems: Building Automation Systems (BAS), Building Management and Control System (BMCS), Direct Digital Controls (DDC) and Building Controls etc.

1.1.1.1.2 Overall Current Status and Challenges

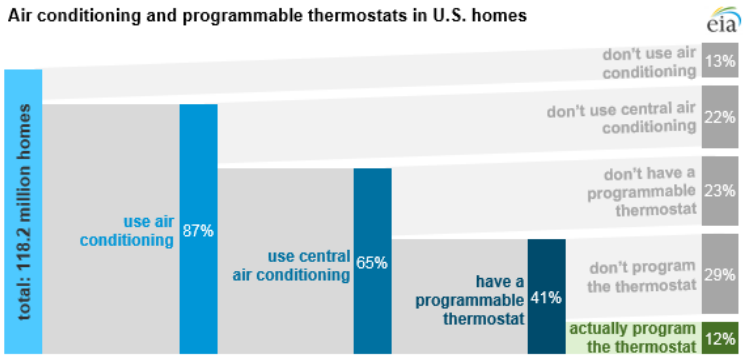
In the Energy Roadmap 2050, the European Union details its vision for energy consumption patterns to be implemented in EU wide by the year 2050. This document highlights the fact that buildings consume up to 40% of the total energy we generate and lists this as a major challenge to reducing energy consumption and greenhouse gas emissions. Given the immediate and pressing nature of climate change and the contribution of buildings to overall carbon emissions, it is evident that any changes in the building management sector towards greater energy efficiency and a reduction in

CO2 can have a massive and lasting impact on this looming global crisis, not to mention welcomed reductions in operating costs.

Heating, Ventilation and Air Conditioning (HVAC) is a sub-branch of mechanical engineering and is focused on the thermal comfort and quality of air inside enclosed spaces - such as office buildings, shopping centres, conference spaces etc. In the 21st century, HVAC systems are becoming more and more important, not just in terms of user comfort and safety but also in terms of cost and energy savings as well as reducing environmental impact and as such, are increasingly being included in a wide variety of situations from family homes and apartment buildings to hotels, hospitals and assisted living facilities, from industrial complexes and office buildings to vehicles such as cars, trains, aeroplanes, ships and submarines.

Whether industrial, commercial or residential, one of the primary functions of any building is to provide comfort and safety for its inhabitants. By optimising the living conditions of its occupants, a more comfortable environment is produced where inhabitants can be happier and therefore more productive.

Although almost half of 118 million homes using air condition in 2012 had a programmable thermostat, only 12% programmed their thermostats, highlighting the need for more customizable solutions that do not reply to user intervention.

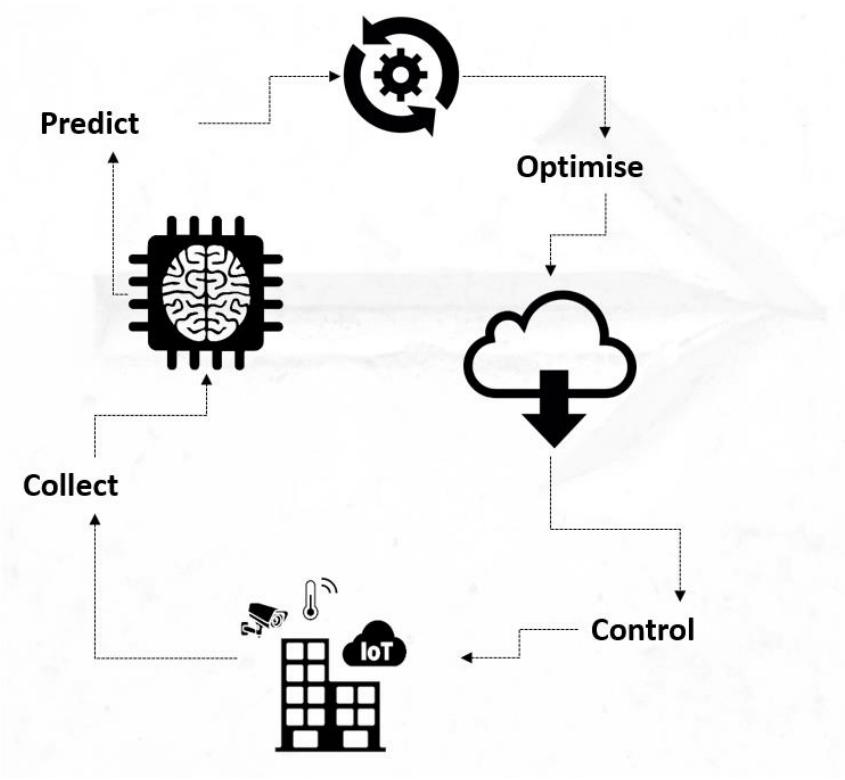


In summary, the application of customizing user comfort, workspace optimization, energy consumption and predictive maintenance offers huge savings in terms of costs and GHG emissions. In order for these savings to occur not only does the hardware need to be in place, a solid, robust and high-speed network infrastructure needs to be in place to deal with the data volume generated.

The IoT in conjunction with technologies such as AI, 5G, Mobile Edge Computing and Crowdsensing are allowing us to customise and optimise our vital spaces on an individual basis, tailoring the spaces we live, work and play in to increase our comfort and reduce costs and environmental impact.

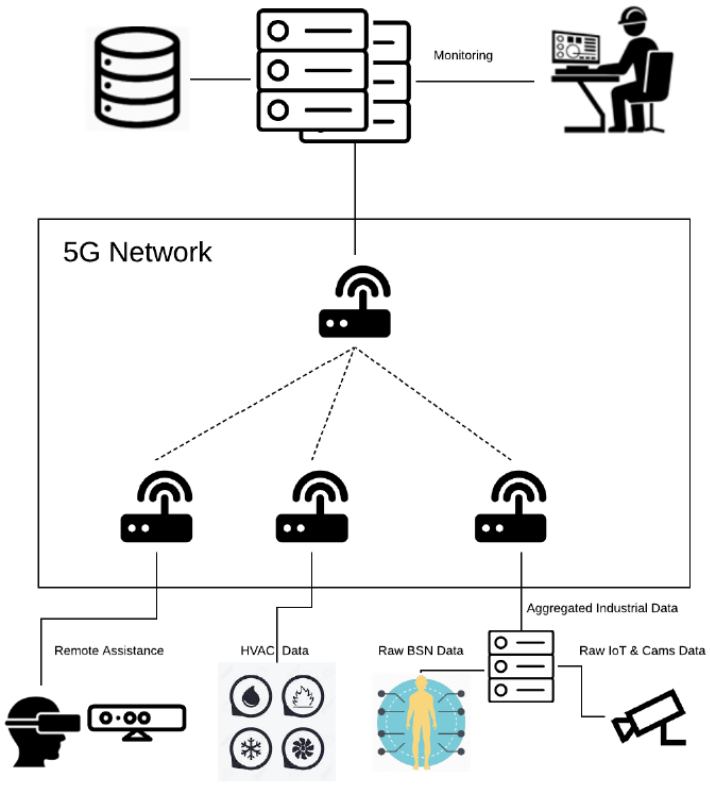
Smart connected devices, which provide unprecedented levels of visibility into workers' environments coupled with intelligent wearables (watches, helmets, vests…) which capture vital physical metrics like heart rate, skin temperature, movement, activity, and location in parallel with environmental sensors can create a complex and highly detail record about employees' working conditions and their exposure to physical and psychosocial risks in real time.

Through the networks of sensors that give connected buildings their name, facility managers can gain essential insights into the running of their buildings, monitoring equipment based on data collected and evaluated allowing closer measurement against key performance indicators (KPIs) leading to detection of deviations from the norm more quickly. This in turn helps reduce service costs though predictive or just in time maintenance and optimised work orders. Live data on buildings can be accessed at any time, from anywhere resulting in malfunction detection and incident resolution before substantial damage can occur.



The parts of any physical system are subject to “wear and tear” and as such, need to be maintained and or repaired throughout their lifetime. If parts are left to operate until they fail, this can result in long delays in providing service, knock-on delays with other dependent services unable to run and spiraling repair costs. One way to prevent this it to schedule maintenance at set intervals in order to check how systems and components are running and, if necessary, effect repairs. Through the use of vibration sensors moving parts can be constantly analysed for changes in vibration, indicating wear patterns, and replacement can be scheduled at an optimal time in terms of costs and disruption to other systems...

Furthermore, the unprecedent network capabilities offered by 5G-enabled environments will allow remote maintenance to leverage on new technologies, as volumetric streaming in real-time, combined with digital twinning techniques. This approach has been largely analysed during the second half of the project. The COVID19 outbreak has brought to light the needs to provide enhanced solution for remote assistance in all the sectors.



Volumetric video is a field of media production technique that captures a three-dimensional space such as a place, person or any object. The increasing popularity of Virtual Reality (VR) and Augmented Reality (AR) technologies has especially triggered the furthering of volumetric video capturing and streaming system as a key technology. The main challenges are related to the high requirements in terms of bandwidth and data rate of this new technology. The unexpected acceleration of demand has led SII CONCATEL and TYP to focus on this use case, updating and detailing key aspects of the business model.

4.6.3. Enhanced Multimedia Broadband Use Case

Turkcell is the leading converged communications and digital service player in Turkey. Digital apps such as BiP, TV+ (online broadcasting), fizzy (music), lifecell (storage) have to use the same infrastructure as the traditional voice and data services as well as services such as superbox (WTTx). Service level requirements of all these apps differ significantly, e.g. BiP requires very low delays, TV+ plus needs broadband data with minimal channel switching delays for live broadcasts, fizzy can tolerate delays but high data is required to maintain uninterrupted streaming.

NETAS is currently offering web-based video conferencing service for its enterprise customers, which requires adaptive video streaming with low latency to ensure each participant receives the maximum quality of service and experiences. One of the main problems decreasing the quality of experience level is instant network congestion.
RELIANCE framework will enable slicing for both internal and external services to maintain end-to-end service level agreement and mimimize instant network congestion for services. Framework will make it easy to deploy such slices for new services as well as from third-party content/service providers.

Currently Turkcell digital services are prioritized at the scheduler of the radio access network (RAN) based on their classes (QoS Class Identifiers or QCI). Operators statically assign different QCI's for different services and these assignments are rarely modified. There is no real-time monitoring of the service quality; thus these services may be underperforming due to lack of resources and hence cause customer dissatisfaction or underutilized the scarce radio resources. Only bandwidth reservation is used for current service differentiation. However, latency is also becoming important with new services. This type of mechanisms are only applied for internal services making it hard to

adapt to third party applications due to their static nature. RELIANCE makes it easy for operators to offer slice “As-a-service” to external enterprise customers. Finally, this type of bandwidth reservation is focused only on the RAN, rather than reserving resources end-to-end.

Multimedia services has a range of delay and bandwidth requirements. It is important to have a uniform customer experience across the network while using these services. A resilient end-to-end slicing provides uninterrupted voice/video call over BiP or TV broadcasting over TV+ at the same time. Operators can also provide third party content providers to access to such slices to ensure certain quality of service for the offered services. NETAS web-based video conferencing service (VIO) would be an example to those services that benefits from resilient and scalable slices offered by operators.

Turkcell will test the performance of digital apps over the proposed RELIANCE architecture. Running the proposed RELIANCE architecture on a testbed will allow Turkcell to study the impact and benefits esp. to its digital services. This will help planning to upgrade its current network to slicing.
Certain key performance indicators (KPI) will be focused:

- Satisfying service level requirements (such as bandwidth, latency, and coverage) of internal and external services (BiP, TV+, fizzy, NETAS VIO, etc.)
- Ease of deployment of in-house and third-party multimedia services
  - o APIs developed for service configuration
  - o APIs developed for charging third-parties based on provided service quality

5. Analysis of Business Model Generation Techniques

5.1. Business model definition

A business model is a company's plan for making a profit or generating value for that organisation. It lays out the products or services the business will sell, who the target market is for those products or services and the overall expenses it anticipates in order to reach this market. The literature shows a wide range of definitions of a business model, many of these are summarised in the next table.

A business model will start by identifying a value proposition. This is the identified final value to the key players in any given industry, niche or marketplace. The value proposition is what makes the business model successful.

A selective overview of business model definitions	
Author(s)	**Definition**
Timmers[4]	Definition of a business model: (a) an architecture for the product, service and information flows, including a description of the various business actors and their roles; and (b) a description of the potential benefits for the various business actors; and (c) a description of the sources of revenues. (p.4)
Mahadevan[5]	A business model is a unique blend of three streams that are critical to the business. These include the value stream for the business partners and the buyers, the revenue stream, and the logistical stream. (p. 59)
Rappa[6]	In the most basic sense, a business model is the method of doing business by which a company can sustain itself -- that is, generate revenue. The business model spells-out how a company makes money by specifying where it is positioned in the value chain.
Afuah and Tucci[7]	A business model is the method by which a firm builds and uses its resources to offer its customers better value than its competitors and make money doing so. It details how a firm makes money now and how it plans to do so in the long-term. The model is what enables a firm to have a sustainable competitive advantage, to perform better than its rivals in the long term. (p. 3-4)
Amit and Zott[8]	A business model depicts the content, structure, and governance of transactions designed so as to create value through the exploitation of business opportunities. (p. 511)
Tapscott[9]	A business model refers to the core architecture of a firm, specifically how it deploys all relevant resources (not just those within its corporate boundaries) to create differentiated value for customers. (p. 5)
Chesbrough and Rosenbloom[10]	The business model provides a coherent framework that takes technological characteristics and potentials as inputs, and converts them through customers and markets into economic inputs. The business model is thus conceived as a focusing device that mediates between technology development and economic value creation. (p. 532) It "spells out how a company makes money by specifying where it is positioned in the value chain" (p. 533)
Morris et al. [11]	A business model is a concise representation of how an interrelated set of decision variables in the areas of venture strategy, architecture,

[4] https://peoi.org/Courses/Coursesen/emarket/Resources/Business%20Models%20for%20Electronic%20Markets.pdf
[5] https://www.researchgate.net/publication/228718351_Business_Models_for_Internet-Based_E-Commerce_An_Anatomy
[6] http://home.ku.edu.tr/~daksen/mgis410/materials/Business_Models_on_the_Web.pdf
[7] https://www.researchgate.net/publication/37408327_Internet_Business_Models_and_Strategies
[8] https://onlinelibrary.wiley.com/doi/pdf/10.1002/smj.187
[9] https://faculty.darden.virginia.edu/Ebusiness/Tapscott%20Article.pdf
[10] https://www.hbs.edu/faculty/Publication%20Files/01-002_07351ae8-58be-44e5-a6d8-205cbf5b4424.pdf
[11] http://businessmodels.eu/images/banners/Articles/Morris_Schindehutte_Allen_Richardson.pdf

	and economics are addressed to create sustain- able competitive advantage in defined markets. (p. 727)
Shafer et al.[12]	We define a business model as a representation of a firm's underlying core logic and strategic choices for creating and capturing value within a value network. (p. 202)
Chesbrough[13]	At its heart, a business model performs two important functions: value creation and value capture. First, it defines a series of activities that will yield a new product or service in such a way that there is net value created throughout the various activities. Second, it captures value from a portion of those activities for the firm developing the model. (p. 108)
Johnson, Christensen, and Kagermann[14]	A business model, from our point of view, consists of four interlocking elements that, taken together, create and deliver value. The most important to get right, by far, is the customer value proposition. The other elements are the profit formula, the key resources and the key processes. (p. 52-53)
Demil and Lecocq[15]	Generally speaking, the concept refers to the description of the articulation between different BM components or 'building blocks' to produce a proposition that can generate value for consumers and thus for the organization. (p. 227)
Osterwalder and Pigneur[16]	A business model describes the rationale of how an organization creates, delivers, and captures value. (p. 14) Teece (2010) In short, a business model defines how the enterprise creates and delivers value to customers, and then converts payments received to profits. (p. 173)
Zott and Amit[17]	A business model can be viewed as a template of how a firm conducts business, how it de- livers value to stakeholders (e.g., the focal firms, customers, partners, etc.), and how it links factor and product markets. The activity systems perspective addresses all these vital issues [...]. (p. 222)
George and Bock (2011)	[...] a business model is the design of organizational structures to enact a commercial opportunity. (p.99) [...] three dimensions to the organizational structures noted in our definition: resource structure, transactive structure, and value structure. (p.99)

Although business models are nothing new, *having been intrinsically linked to business since humans started trading*, the concept of the business model became prevalent with the internet boom in the 1990s and the need for companies to innovate and adapt to the changing situations presented to them by the technology. The authors of a 2010 paper entitled "The business model: theoretical roots, recent developments and future research"[18] conducted a survey shown the explosion of this term in the literature since 1975.

[12] http://businessmodels.eu/images/banners/Articles/Shafer_Smith_Linder.pdf
[13] https://books.google.de/books/about/Open_Business_Models.html?id=FzWqNyPtC38C&redir_esc=y
[14] https://hbr.org/2008/12/reinventing-your-business-model
[15] https://www.sciencedirect.com/science/article/abs/pii/S0024630110000105
[16] https://profesores.virtual.uniandes.edu.co/~isis1404/dokuwiki/lib/exe/fetch.php?media=bibliografia:9_business_model_generation.pdf
[17] http://www.bmcommunity.sitew.com/fs/Root/8jif5-AmitZottMassa.pdf
[18] http://www.bmcommunity.sitew.com/fs/Root/8jif5-AmitZottMassa.pdf

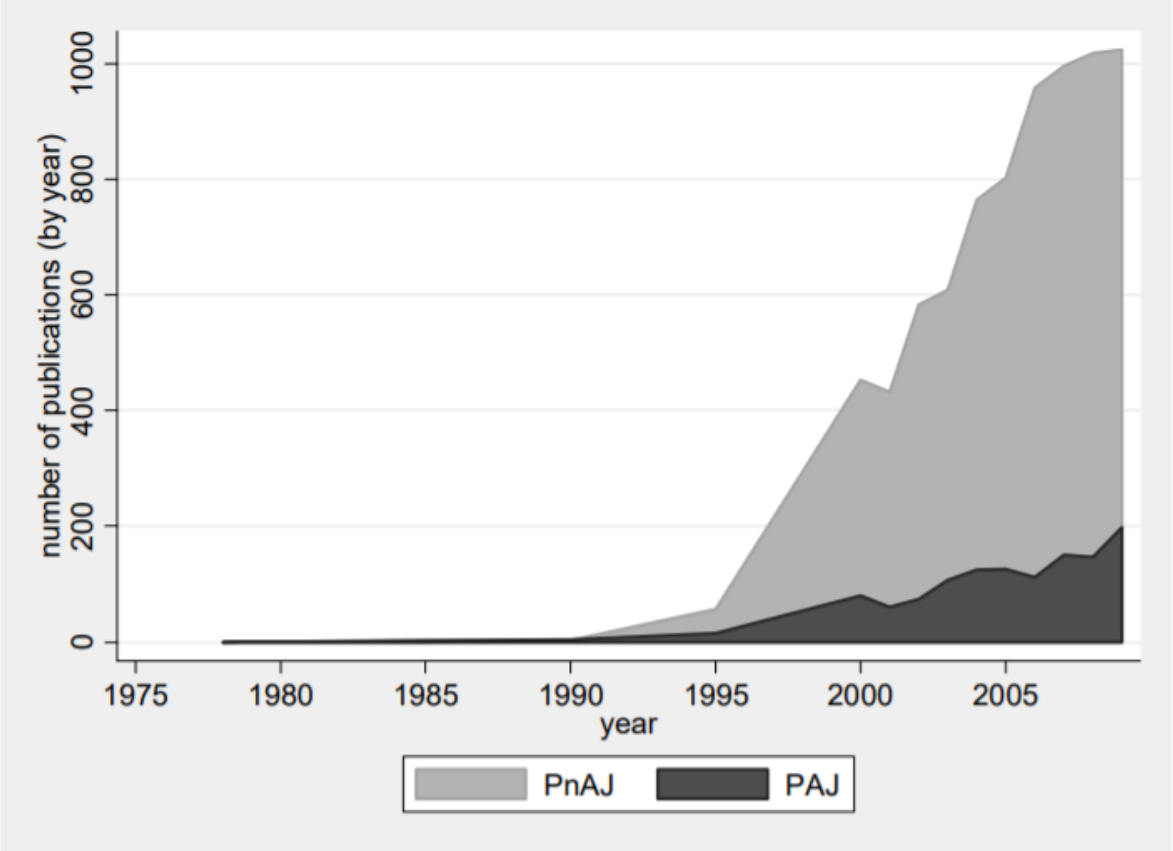


Figure 5 - Business models in the Business /Management Field over time[18]

5.2. The Business Model Innovation Construct

The concept of business model innovation itself was studied as a follow on the definition of business model creation.

Just as product or service innovation is vital to the continued growth and profitability of a company, business model innovation is also a vital factor in the continued success of a company. Given the fact that technological innovation often leads to new business model generation, the two are not the same. Where technological innovation looks to find new products, new services or a new way to produce these, business model innovation looks to find new ways to generate income for companies and in the end, can be much more profitable than product innovation.

Business model innovation (BMI) is not a new concept and a study released in the Journal of Management entitled “Fifteen Years of Research on Business Model Innovation: How Far Have We Come, and Where Should We Go?” suggests that although the topic has received a great amount of research and interest, the resultant literature addresses an important phenomenon but lacks theoretical underpinning, and empirical inquiry is not cumulative[19].

Rarely successful at first attempt, business model innovation is often created through a trial and error process. Modern markets can be described as fast-evolving and with high levels of uncertainty, so it is increasingly difficult to predict the exact business environment the product will face during the development process. Another important factor to consider is the manager´s judgment and interpretation skills, as this can effect an enterprise’s ability to adapt and predict based on existing organizational routines and behavioural norms and values[20].

[19] https://pdfs.semanticscholar.org/91c4/779101ca230c8d3730f222ef4df9795c7789.pdf?_ga=2.39759584.276440365.1567965173-2093441951.1567965173

[20] https://journals.aau.dk/index.php/JOBM/article/view/1877

The authors in [19] identified 4 overlapping streams to business model innovation, namely:
Conceptualizing BMI - which focuses on issues such as the minimum meaningful definition of "business model innovation" and the dimensions along which companies can innovate the BM

BMI as an Organizational Change Process – which relates BMI to organizational change processes, emphasizing the capabilities, leadership, and learning mechanisms needed for successful BMI.

BMI as an Outcome – which focuses on the outcome of the organizational change process— in particular new and innovative BMs, which are usually contextualized in some way, for example the emergence of new BMs in a particular industry or vertical.

Consequences of BMI - addresses organizational performance implications of BMI and can be divided into studies that link the "act," or process, of BMI to outcome implications on the one hand and studies that examine the effects of different types of BMs on firm performance on the other.

The authors conclude that the BMI literature is characterized by conceptual ambiguity and disconnected research efforts – as characterised by quantity of definitions of Business model innovation shown in Figure 6 below.

The authors concluded by offering a model for further research into the area of BMI, as shown in Figure 7.

Authors	Definitions
Mitchel and Coles (2004a: 17)	"By business model innovation, we mean business model replacements that provide product or service offerings to customers and end users that were not previously available. We also refer to the process of developing these novel replacements as business model innovation."
Markides (2006: 20)	"Business model innovation is the discovery of a fundamentally different business model in an existing business."
Santos et al. (2009: 14)	"Business model innovation is a reconfiguration of activities in the existing business model of a firm that is new to the product service market in which the firm competes"
Aspara et al. (2010: 47)	"Initiatives to create novel value by challenging existing industry-specific business models, roles and relations in certain geographical market areas."
Gambardella and McGahan (2010: 263)	"Business-model innovation occurs when a firm adopts a novel approach to commercializing its underlying assets."
Yunus et al. (2010: 312)	"Business model innovation is about generating new sources of profit by finding novel value proposition/value constellation combinations."
Sorescu et al. (2011: S7)	"As a change beyond current practice in one or more elements of a retailing business model (i.e., retailing format, activities, and governance) and their interdependencies, thereby modifying the retailer's organizing logic for value creation and appropriation."
Amit and Zott (2012)	Innovate business model by redefining (a) content (adding new activities), (b) structure (linking activities differently), and (c) governance (changing parties that do the activities).
Bucherer et al. (2012: 184)	"We define business model innovation as a process that deliberately changes the core elements of a firm and its business logic."
Abdelkafi et al. (2013: 13)	"A business model innovation happens when the company modifies or improves at least one of the value dimensions."
Aspara et al. (2013: 460)	*Corporate business model transformation* is defined as "a change in the perceived logic of how value is created by the corporation, when it comes to the value-creating links among the corporation's portfolio of businesses, from one point of time to another."
Berglund and Sandström (2013: 276)	"A BMI can thus be thought of as the introduction of a new business model aimed to create commercial value."
Casadesus-Masanell and Zhu (2013: 464)	"At root, business model innovation refers to the search for new logics of the firm and new ways to create and capture value for its stakeholders; it focuses primarily on finding new ways to generate revenues and define value propositions for customers, suppliers, and partners."
Khanagha et al. (2014: 324)	"Business model innovation activities can range from incremental changes in individual components of business models, extension of the existing business model, introduction of parallel business models, right through to disruption of the business model, which may potentially entail replacing the existing model with a fundamentally different one."

Figure 6 - Chronological ordering of Selected Definitions of Business Model Innovation[19].

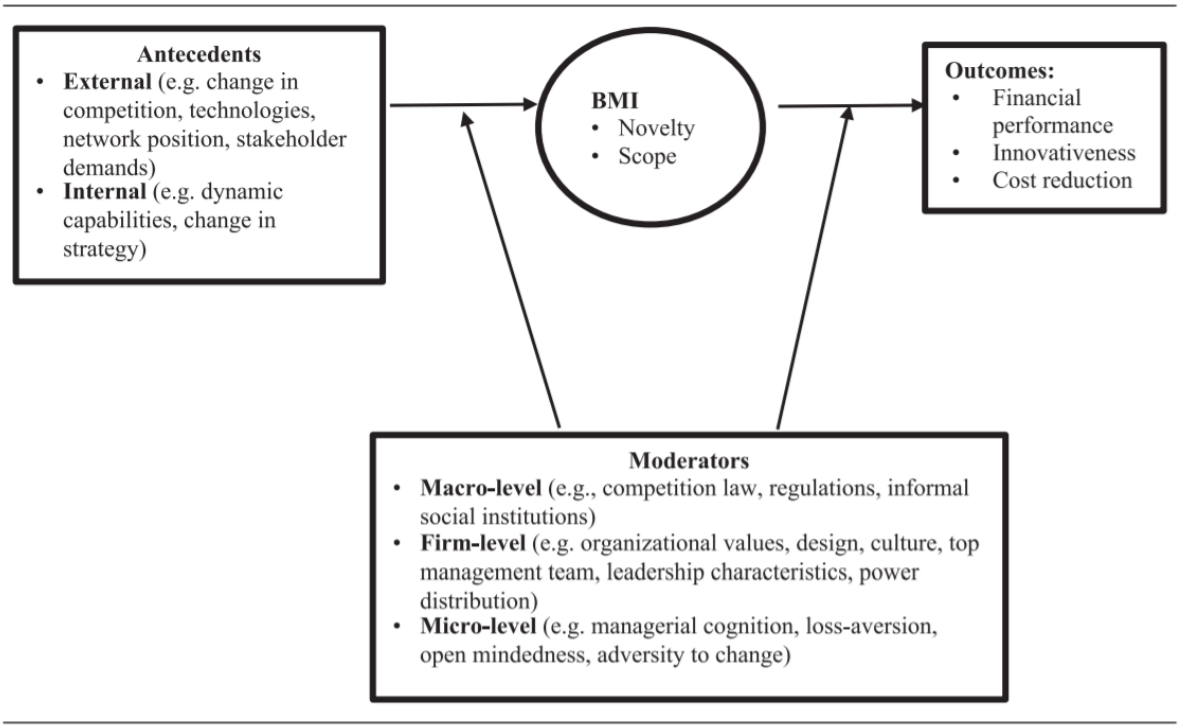


Figure 7 - Research Model for Future Business Model Innovation (BMI) Research[19]

5.3. Business Model Tools

There exist many tools to help with the process of developing a business model, both available online and to available to print for offline usage. Below we highlight some of the key methods utilised during the project and an exhaustive list of methods, resources and tools can be found in Section 8 below.

5.3.1. Fluid Minds 6 Step Approach

The FluidMinds think tank, started in 2008 by Patrick Stähler[21], present the fluidminds' 6 step approach to business model innovation.

Summarised it contains the following steps:

- **Understand** – get a deeper understanding of the customer through market insights, customer interviews and trends analysis.
- **Unlearn & Mobilize** – rethink the process by unlearning assumptions, from the top of the company down.
- **Ideate** – Generate as many ideas a possible for Value Proposition, Value Architecture, Revenue model as well as values and culture.
- **Design** – Pick 3 or 4 strategic directions and plan out business model canvases for each
- **Select & prototype** – Select the best business model(s) and begin building prototypes to test this(ese) model(s).

[21] http://www.fluidminds.ch/en/home.htm

- **Build & Learn** – Execute the business model, learn what is going right, what is going wrong and adapt plans to suit.

Figure 8 below show this process in greater detail.

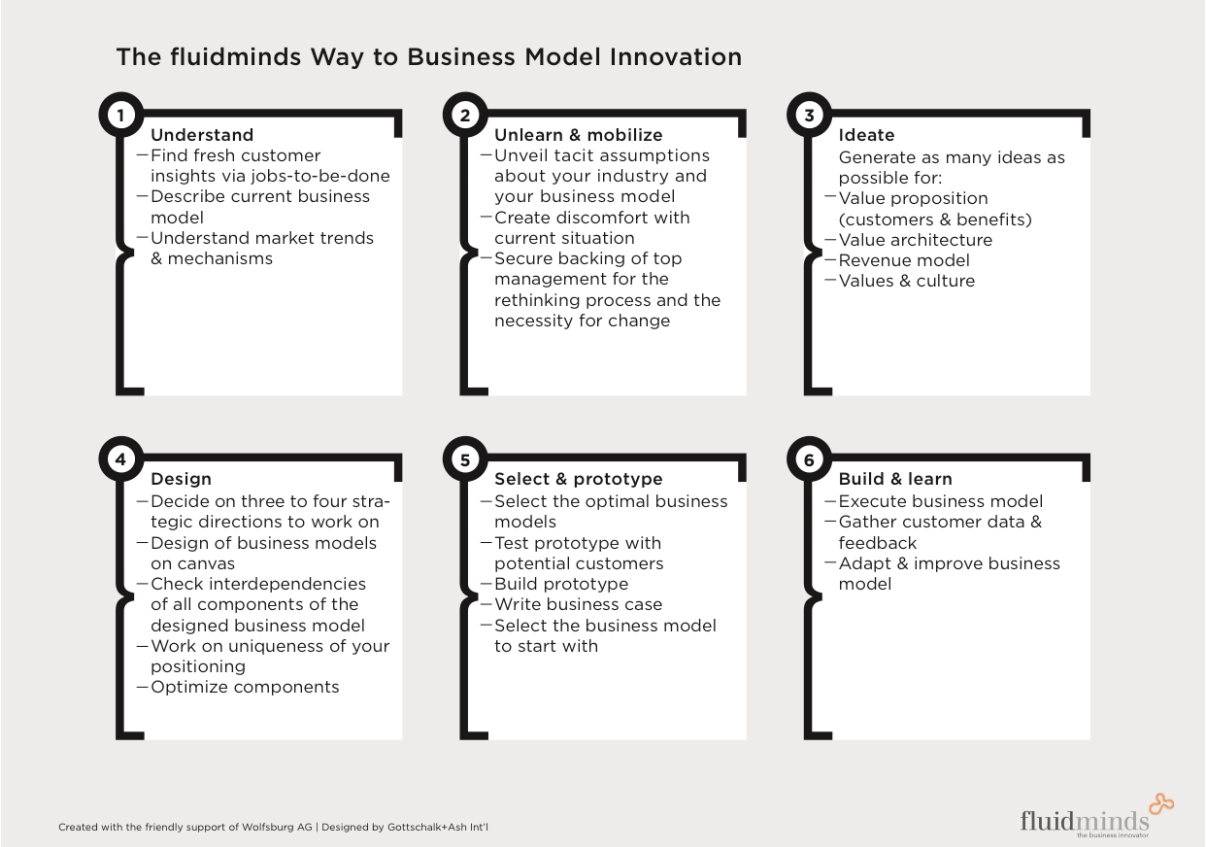


Figure 8 - Fluidminds 6 Step Approach to Business Innovation - Source, Fluidminds

5.4. Business Model Navigator

The St. Gallen Business Model Navigator[22] identifies 4 key constructs with which anyone can forming a business model. They form the start of the process and a base point for management to take action. They can be summarised as the following:

1. WHO are the target customers?
2. WHAT benefit will customers or partners get from the value creation?
3. HOW does the company create and or deliver this benefit to the customers/partners?
4. What VALUE does the company get from this business?

[22] https://www.thegeniusworks.com/wp-content/uploads/2017/06/St-Gallen-Business-Model-Innovation-Paper.pdf

Figure 9 - University of St Gallen 4 Dimensional Business Model Navigator[22]

By answering the four questions in this model we can get a deeper understanding of who the target customer is, the value proposition for them, the value chain behind this and the revenue model that captures the value. The business model of any company then becomes something tangible and then can be actioned upon.

5.5. Business Model Canvas

The Business Model Canvas was initially proposed by Alexander Osterwalder back in 2005 based on his work on business model ontology[23]. In 2009, Osterwalder released a book called Business Model Innovation Since which highlights this approach and cemented the concept of the Business Model Canvas. Since then various new canvases have been created.

The BMC identified 9 building blocks to describing business models and is designed with the characteristics of any other type of model, for example in architecture or engineering in that it is a simplified description and representation of a complex real-world object. In the same line of thought we can define a business model as a simplified description of how a company does business and makes money without having to go into the complex details of all its strategy, processes, units, rules, hierarchies, workflows, and systems[24].

In essence, the Business Model Canvas (BMC) gives you the structure of a business plan without the overhead and the improvisation of a 'back of the napkin' sketch without the associated "fuzziness".[25]

The canvas itself can be seen in Figure 10 below.

[23] http://businessmodelalchemist.com/blog/2005/11/what-is-business-model.html
[24] http://businessmodelalchemist.com/blog/2005/11/what-is-business-model.html
[25] https://www.alexandercowan.com/business-model-canvas-templates/

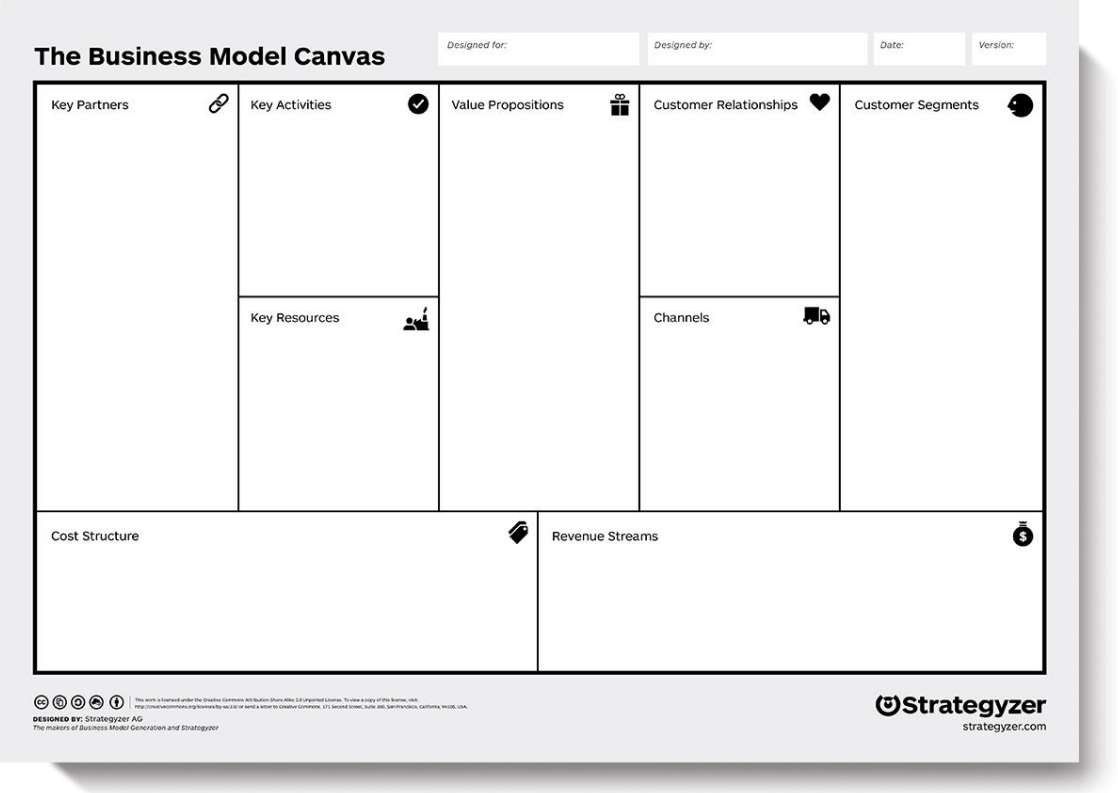


Figure 10 - the Business Model Canvas

The Business model is comprised of 9 section at which case the user asks themselves important questions in order to create clear answers to each section, there building up a clear picture, or mode, of the business.

5.5.1.1. *Customer Segments*

This involves identifying who the customer actually is for the product or service you are proposing and to try to get a better understanding of how they think and feel in order to better position the product as to be most desirable for them.

The following questions were studied in order to identify the customer:

- Who are the customers?
- What do they think?
- What do they see?
- How do they feel?
- What do they do?

5.5.1.2. *Value Propositions*

The Value Proposition defines the exchange of value from your goods, products or services to your customer and is therefore foundational to any business/product.

In general, solving a customer's problem or pain point is considered an exchange of value.

The following questions were studied in order to identify the value proposition:

- What is the problem that needs solving?
- What's compelling about this proposition?
- Why do customers buy, use similar services/products?
- Why would someone want to have this problem solved?

- What is the underlying motivator for this problem?

In order to get a deeper understanding of the customer, further techniques can be used such as Maslow's Hierarchy of Human needs, summarised in 5.5.2 below.

5.5.1.3. *Channels*

The channels are the ways through which a business can reach its customers and are vital for the success of the business. In order to be successful and reach the right customers, a business must understand the channels it needs to use and how to use them.

Identifying the correct channel is essentially like identify where your customers are at.

Some examples of the channels covered in the work are:
Social media, Electronic mail (email marketing), Networking, SEM (Search Engine Marketing), SEO (Search Engine Optimisation), Engineering as marketing, Viral marketing, Blogging or Targeting others blogs, Sales and promotions for commissions, Affiliate Marketing, Utilising Existing platforms, PR, Social media advertising, Trade shows (presence and networking), Content marketing, Community building and Offline advertising (billboards, TV, radio).

The following questions are examples of the questions posed in order to identify the channel:

- How can we tell our customer about our value proposition?
- Where are our customers to be found?
- Are they on social media?
- What time to they interact with social media so as to find the best time to reach them?
- Are they listening to the radio (perhaps on a long commute to work)?
- Are they best reached at events or conferences?

5.5.1.4. *Customer Relationships*

The customer relationship is a follow on from the value proposition and how a business will reach the customer as thoses factors will influence how the business and the customer will interact.

Examples of customer relationships include:

- In person relationships (one-to-one)
- As third party contractors
- Online relationships (many-to-one)
- At events (one-to-many)
- Through the phone

The customer journey map is an example of one of the techniques used to identify the customer relationship.

5.5.1.5. *Revenue Streams*

Revenue Streams are in essence how the business converts the Value Proposition or solution to the customer's problem into financial gain.

The revenue model can be different depending on the product and can be a mixture of one or more different models. Examples of revenue models include:

- Pay per use (pay per view)
- Charge a set Fee for service
- Set a fixed rate
- Subscription
- Dividends
- Referral feeds
- Freemium or Equity share.

5.5.1.6. *Key Activities*

These are defined as the actions that the business/product will need to undertake in order to achieve the value proposition for their customers.

These activates can be varied and are dependent on each business. Examples of activities include: Consulting, Designing, Web development, Building, Driving, Planning etc.

I defining these activities the key questions to ask are

- What activities does the business need to undertake to achieve the value proposition for the customer?
- What resource is used in achieving this?
- What are the time constraints or needs?
- What level of expertise is required?
- How will the final product be distributed?
- What level of technical development is required?
- What is the strategy behind it?

5.5.1.7. *Key Resources*

This section identifies what practical resources are needed to achieve the business model goals – the resources required for your business to do business.

Resources to consider are the following: Office space, Computer hardware, Hosting for web services, People (staff), Internet connection, phones, Electricity, specialised lab equipment, specialised hardware etc.

5.5.1.8. *Key Partnerships*

Key Partnerships form a list of external companies, suppliers, partners that your company might need in order to deliver value to the customer. This investigates the concept of how else can your business use to deliver the value proposition if it can't do this on its own.

An example my include resellers who need the Amazon platform in order to reach new customers and deliver their goods.

5.5.1.9. *Cost Structure*

The business cost structure is simply the monetary cost of operating as a business. This can be easily overlooked in the planning stage leading to nasty surprises down the line.

Questions asked to examine this are the following:

- How much does it cost to achieve the key activities of the business?
- How much do the key resources and key partnerships cost the business?
- How much does achieving the value proposition for customers/users cost?
- What are the additional costs to running this business?
    - Legal?
    - Insurance?
    - Staff? etc
- What is the monetary value the time spent planning and developing the project befre it makes money?

5.5.2. User Journey Map

A user journey is a concept from User Experience (UX) design and consists of a series of steps (typically 4-12)[26] detailing the ways in which a user could interact with the product or service being developed. They are normally used to demonstrate how users currently interact with the service, goods or product, and to demonstrate how users could interact with the service, goods or product.

The user experience starts off with a definition of a "persona" - a representation of a particular audience segment for the product or service you are designing. The persona is based on various types of qualitative and quantitative research with the goal of capturing a person's motivations, frustrations and the "essence" of who they are[27].

[26] https://theuxreview.co.uk/user-journeys-beginners-guide/
[27] https://theuxreview.co.uk/personas-the-beginners-guide/

From exercises like creating a persona, a business can then continue to map out the user journey. For this is it important to have a clear understanding of the user's goals, their motivations, their current pain points, their overall character and the main tasks they want to achieve.

The user journey should contain the following 5 elements:

- Context – Where is the user? What environment are they in? Are there any distractions or external factory to take them away from your product?
- Progression – The business should have an understanding of how each step helps the customer to the to the next step
- Devices – In terms of technological products, what devices are they using and what is there level of experience with these devices?
- Functionality – What is the functionality they expecting from your product and can this be achieved?
- Emotion – At each step, identify their emotional state. For example, are they engaged, bored, annoyed, frustrated or happy?

The following is an example from the LEGO Company and was used to show the level of detail needed to fully understand the customer journey.

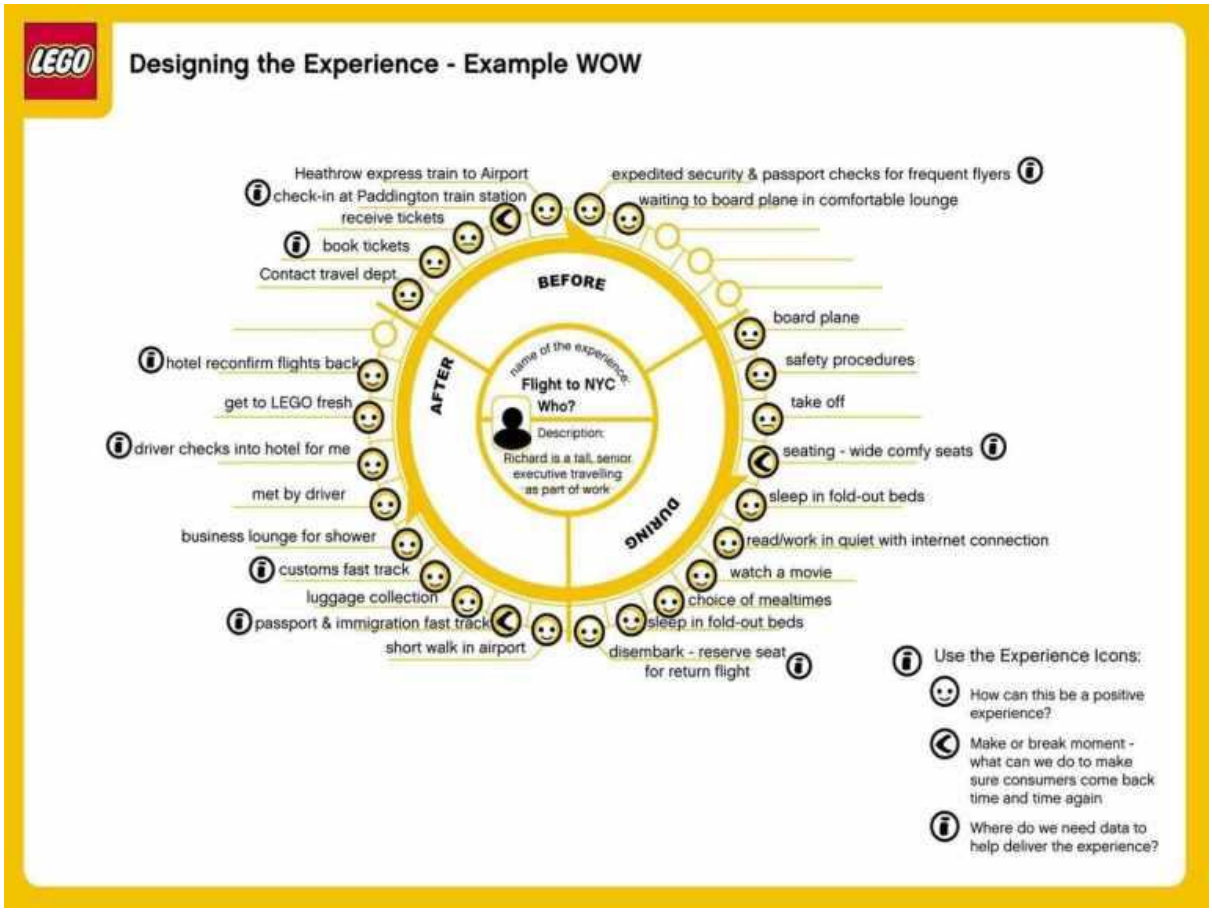


Figure 11 - Lego customer journey example

5.5.3. Maslow's Hierarchy of Needs

Often used in gaining a greater understanding of a business's customers, Maslow's hierarchy of needs is a theory in psychology comprising of a five-tier model of human needs. These needs are often depicted as hierarchical levels within a pyramid. The triangle represents a scale where needs lower down in the hierarchy must be satisfied before individuals can attend to needs higher up.

Figure 12 shows these needs in their hierarchal form, being: physiological, safety, love and belonging, esteem and self-actualization.

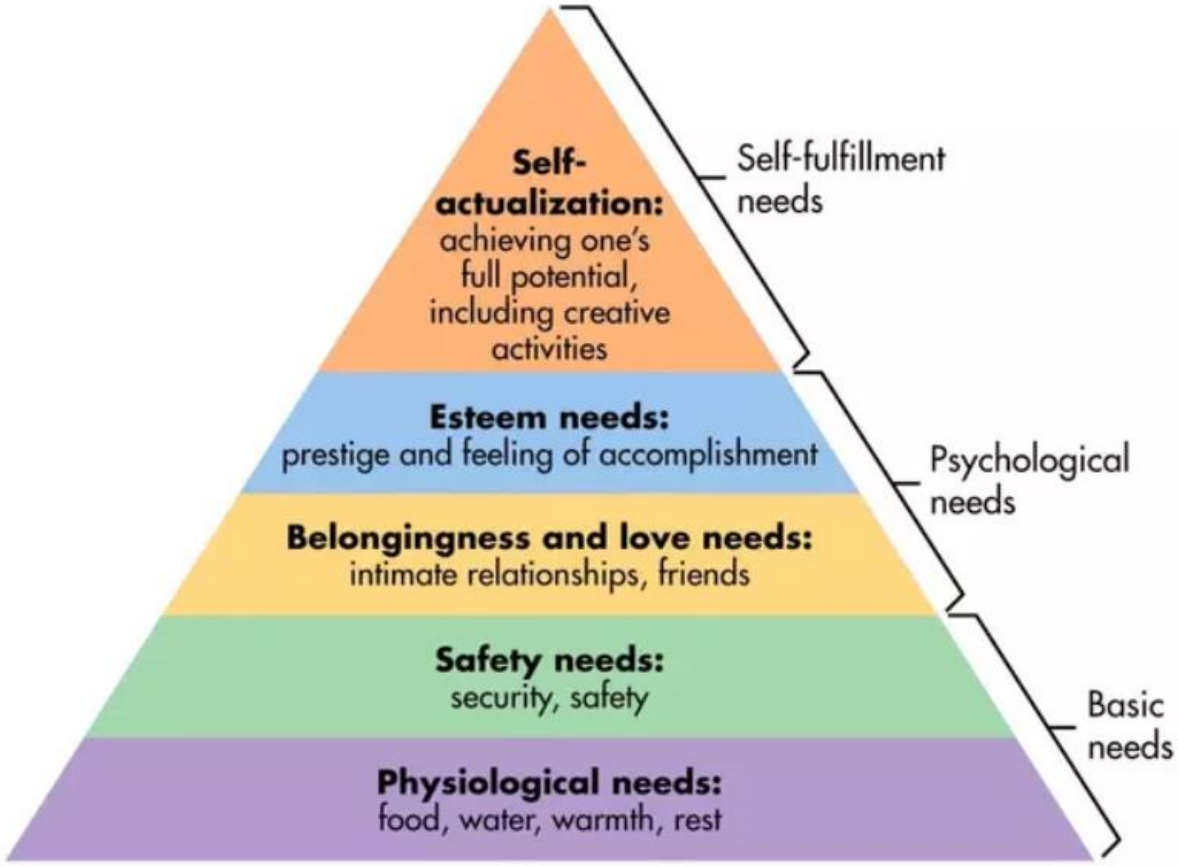
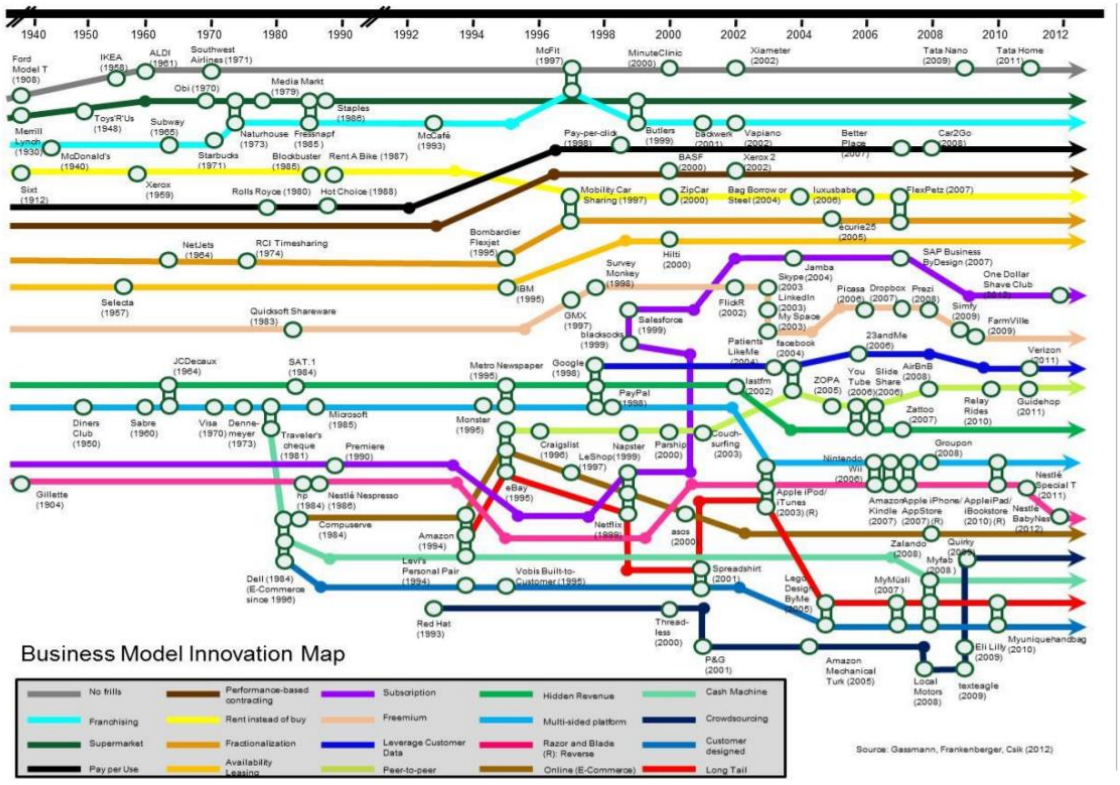


Figure 12 - Maslow's Hierarchy of Human Needs

5.6. Types of Business Model

In practice, business models are varied and are entirely dependent on the service of the product being offered. Although there is a certain amount of mixing models, generally business models cannot be mixed and matched that easily. For example, if a user is paying for a subscription, they may not react positively to seeing advertising in that paid subscription service.
Advertising my also eliminate trust in a service (important if trust is one of the key elements of that service) as users may perceive the content or service to have been skewed in favour of the advertisers ends and no longer impartial – in the case of news or other similar "impartial" services.

The Tube Map shows you a visual representation of the research that has been done by the creators of the Business Model Navigator. It depicts which companies have used specific patterns at what time to disrupt their industry



The paper draws on previous studies in the field of technology and innovation management and develops a framework – " The Business Model Innovation Map " – that distinguishes between different types of business model innovation according to their degree of novelty. The framework is illustrated by several real--life examples of business model innovation. The paper adds to our understanding of innovation management as it allows for a better understanding of business model innovation as a distinct type of innovation. More specifically, it helps differentiating transformative business model innovations from mere incremental ones, and, as such, it presents a novel approach to categorize different types of business model innovation. The framework can serve as a basis for future in--depth empirical investigations of different types of business model innovation that can help firms to better understand how to manage such innovations.

The following is a summary of the extensive analysis of business models carried out during this research, considered to be models most related to technology focused businesses.

5.6.1. Hidden revenue business model

A hidden revenue business model is one where the user is not immediately aware of the business model. Examples of this include websites like Google, Facebook, Instagram, YouTube etc. The end users can access these services for free, uploading content, searching or consuming content without charge. Each service provider is collecting data on the user which can be sold at a later date o advertisers in order to personalise advertising, making it more relevant to the user and increasing revenue for the advertiser.

5.6.2. One-for-one business model

The one-for-one business model[28] involves the business donating one product to a charity of “good cause” for every product purchased from them. It was made popular by Santa Monica based retailer Toms, who made this business model popular by committing to donating one pair of shoes to children in the developing world for every pair of shoes purchased from them. This type of business model appeals to our altruistic nature and ads an incentive to purchase through this retailer.

[28] https://www.entrepreneur.com/article/307932

Toms have expanded their model[29] and now with the sales of TOMS Shoes, Eyewear, Coffee and Bags, a person in need is helped with sight, water and safer births.

This model is not unique to Toms and is also implemented by eye ware manufacturer Warby Parker with their "Buy a pair, give a pair" program[30], through which they have distributed over five million pairs of glasses (and sold as many in the process).
Acting through their charity partner Midwives for Haiti[31], baby blanket manufacturer Wildflower & Oak[32] are another company who have adopted this business model.

5.6.3. Razor and blade revenue model

The Razor and Blade business model was made famous by razor company Gillette and involves selling one item at a low price (or even at a loss), in order to sell complementary or consumable products at a profit later[33]. The Gillette Company used this model to sell their hand-held razors at cost price, however once users had a Gillette razor they had to buy the blades for it, which Gillette sold at a high margin of profit.

The Sony PlayStation is a modern version of this model whereby they sold their PlayStation at a below Cost price in order to create a critical mass in the market. Once this was achieved, they could charge more for Blue Ray licencing and through selling games. As a result, Sony has managed to build the strong two-sided platform with compelling direct and indirect network effects. They have been extremely successful in monetizing their customers through the hefty royalty fees from game units sold[34].

Social gaming services such as Zynga or Rovio, as well as streaming cloud platforms like Steam or OnLive have challenged Sony's model and they have evolved to offer gamers their online streaming service. PlayStation Now is a subscription service costing $15 per month and allows gamers to access content on the cloud, attracting gamers with popular titles and boosting less popular games by bundling them in with the more popular games.

5.6.4. Cash conversion cycle (CCC) business model

The cash conversion cycle is a business model that takes advantage of the gap between receiving a payment and paying suppliers back. If a payment is made to a merchant on the 1st of the month for a product, the merchant will receive the "cash" almost immediately. The merchant has, however, agreed with the product supplier to pay them in 30 days. This means that the merchant has almost 30 days to invest, repurchase or spend this cash before they have to pay the supplier back.

Amazon is one key example of this is Amazon. The website GuruFocus has a calculator which show how successful Amazon is at managing the time between receiving payment and the time it pays its supplier. Their figure reported for 2019 was -13.02 meaning they have almost half of a month worth of liquidity before they have to pay suppliers. In previous years this figure was as high as -26.92[35]

[29] https://www.toms.co.uk/improving-lives
[30] https://www.warbyparker.com/buy-a-pair-give-a-pair
[31] https://midwivesforhaiti.org/
[32] https://wildflowerandoak.com/pages/midwives-in-haiti
[33] http://www.businessdictionary.com/definition/razorblade-model.html
[34] https://www.hbs.edu/openforum/openforum.hbs.org/goto/challenge/understand-digital-transformation-of-business/sony-playstation-now-evolution-of-gaming-business-models.html
[35] https://fourweekmba.com/cash-conversion-cycle-amazon/

Amazon.com's Days Sales Outstanding for the three months ended in **Jun. 2019** was **24.1**.

Amazon.com's Days Inventory for the three months ended in **Jun. 2019** was **35.03**.

Amazon.com's Days Payable for the three months ended in **Jun. 2019** was **72.15**.

Therefore, Amazon.com's Cash Conversion Cycle (CCC) for the three months ended in **Jun. 2019** was **-13.02**.

Figure 13 - Amazon Cash Conversion Cycle acoring to gurufocus.com

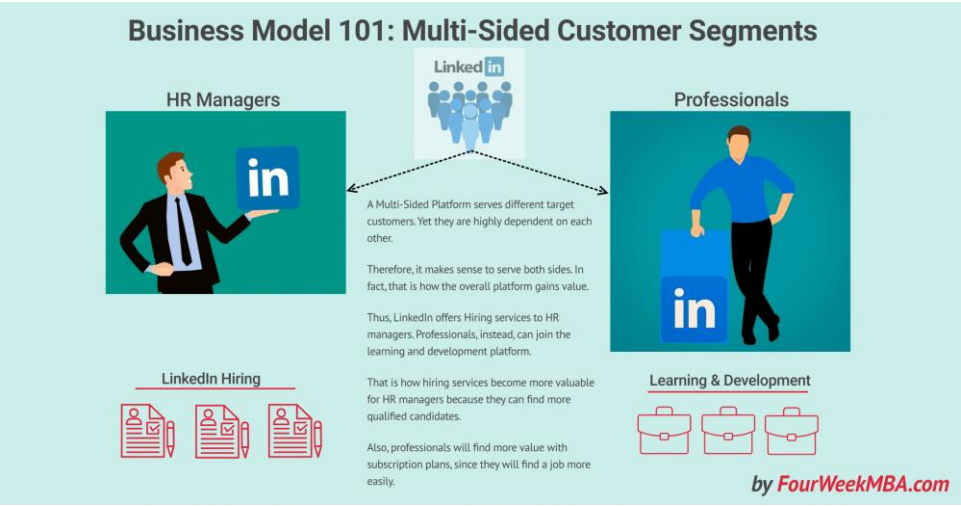
5.6.5. Peer-to-peer business model

A peer-to-peer (P2P) business model is one which creates value for its peers. It has a demand side and an offer side and in any transaction, both sides get value from it. These services are often facilitated by a middle-man, a platform or service which monetizes this action through commission on each transaction at one or both sides.

This is a popular model and has been adopted by companies like AirBnB where technology has enabled them to become facilitators in a smooth and almost seamless way. AirBnB enable individuals to generate income from their properties be renting them to users. Airbnb charges guests a service fee between 5% and 15% of the reservation subtotal and hosts a commission of approx. 3%. Airbnb have recently opened up AirBnB experiences and charges experience hosts - who offer AirBnB' users unique experiences - a 20% service fee on the total price.

5.6.6. Multi-sided platform business model

Although similar to a peer-to-peer business model, Multi-sided Platforms (MSPs) have a sublte difference. In the P2P model the platform is almost invisible but in the MSP model, the platform sells its services to both parties. LinkedIn is a key example of this where it sells access to job searchers through premium memberships, whilst on the other side, selling recruiters access to potential applicants[36].



5.6.7. Direct sales business model

Direct sales involves selling one-to-one or through the multi-level markting model. The FTC describes it as:

"Direct selling is a blanket term that encompasses a variety of business forms premised on person-to-person selling in locations other than a retail establishment, such as social media platforms or the home of the salesperson or prospective customer.

[36] https://fourweekmba.com/multi-sided-segment-business-model/

Multi-level marketing is one form of direct selling. Generally, a multi-level marketer (MLM) distributes products or services through a network of salespeople who are not employees of the company and do not receive a salary or wage. Instead, members of the company's salesforce usually are treated as independent contractors, who may earn income depending on their own revenues and expenses. Typically, the company does not directly recruit its salesforce, but relies upon its existing salespeople to recruit additional salespeople, which creates multiple levels of "distributors" or "participants" organized in "downlines." A participant's "downline" is the network of his or her recruits, and recruits of those recruits, and so on."[37]

5.6.8. Freemium business model

The Freemium model is a strong driver of growth and involves offering a limited version of the product for free and charging for access to support or more advanced features. This type of business model is very common in SaaS where users are brought on board with the free product, meaing they do not have to pay fees up front, and once they get used to the product they are more willing to pay for the advanced features.

The music streaming service Spotify[38] is an example of a Freemium product where users can listen to music on their platform for free. However in order to download and listen offline, or to get rid of advertising, users have to pay for the Premium service.

Another example is Dropbox[39] where users can store files for free up to a limit of 2Gb. Dropbox then offers a tiered plan with access to 2TB or 3TB for €9.99 or €16.58 respectively.

5.6.9. Affiliate marketing business model

Affiliate marketing works by featuring a product or service on your website, podcast, YouTube vide (etc) and earning a commission each time a user makes a purchase. It can be a powerful source of revenue however it needs large audiences in order to drive substantial revenue.

The affiliating marketing companies sit between the advertiser on one side, and the affiliate on the other and enable this service by tracking user actions on any given platform, then attributing the "sale" to a particular affiliate.

The affiliate marketing industry has been around for many years and in recent years has seen a shift from web to mobile and more recently, cross-platform marketing. The market is dense with providers of services and technology, as can be seen in …therefore any business attempting to enter this market should do so with a solid value proposition.

[37] https://www.ftc.gov/tips-advice/business-center/guidance/business-guidance-concerning-multi-level-marketing

[38] https://www.spotify.com

[39] https://www.dropbox.com/individual/plans-comparison

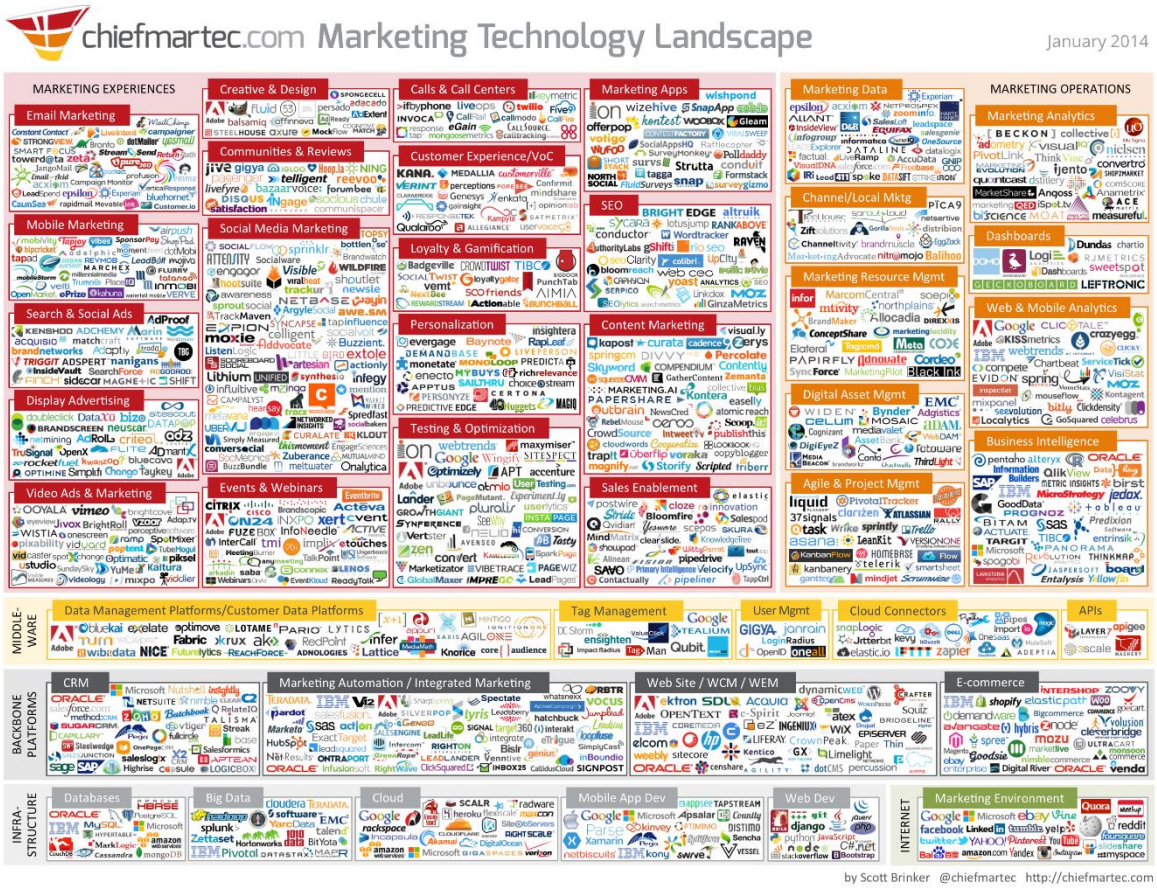


Figure 14 - The density of the affilite marketing landscape[40]

5.6.10. Subscription business model

A subscription-based service is a business model where users pay a recurring fee (usually monthly) to access a service, rather than paying an upfront charge. In the case of a software manufacturer, they can sell a licence once and make a profit on that but then they need to invest resource and time in looking for more sales to make more profit. By offering a subscription model, the same company can continue to profit from it users and could end up with a much higher life-time value from each user than they would achieve with a one off sale.

One difficulty with this model is that the company offering it has to ensure continued level of quality and service. For example, Netflix is an obvious example of a company with this business model. In order to ensure they have a low a churn rate (the ratio of subscribers unsubscribing from the platform) as possible they have to ensure a smooth service and enough new content to keep users engaged. This can also be expensive in terms of resources.

An extension of this model is the On-Demand Subscription Model made popular by Netflix. This changed the entertainment paradigm made popular by TV where consumption was set by TV scheduling or movie theatre times and move control of scheduling to the user. Nowadays, most content is consumed in this way and it has become the norm amongst consumers.

5.6.11. (Management) consulting business model

A consulting business model is a one where clients pay for access to expert knowledge. It involves a company hiring an expert in a particular field and having them work on one or more of the client's

[40] https://cdn.chiefmartec.com/wp-content/uploads/2014/01/marketing_technology_jan2014.png

projects. In return for access to the expert, the client pays a fee that is often daily or hourly and is normally in excess of what an employee of the company would earn.

Consulting giants like Atos and Accenture were able to build a multi-billion dollars businesses based on offering consulting services across the globe.

One drawback to this model is that it is not very scalable as there is a limited amount of work each consultant can do and scaling is dependent on hiring more expert talent.

5.6.12. Vertically integrated supply chain business model

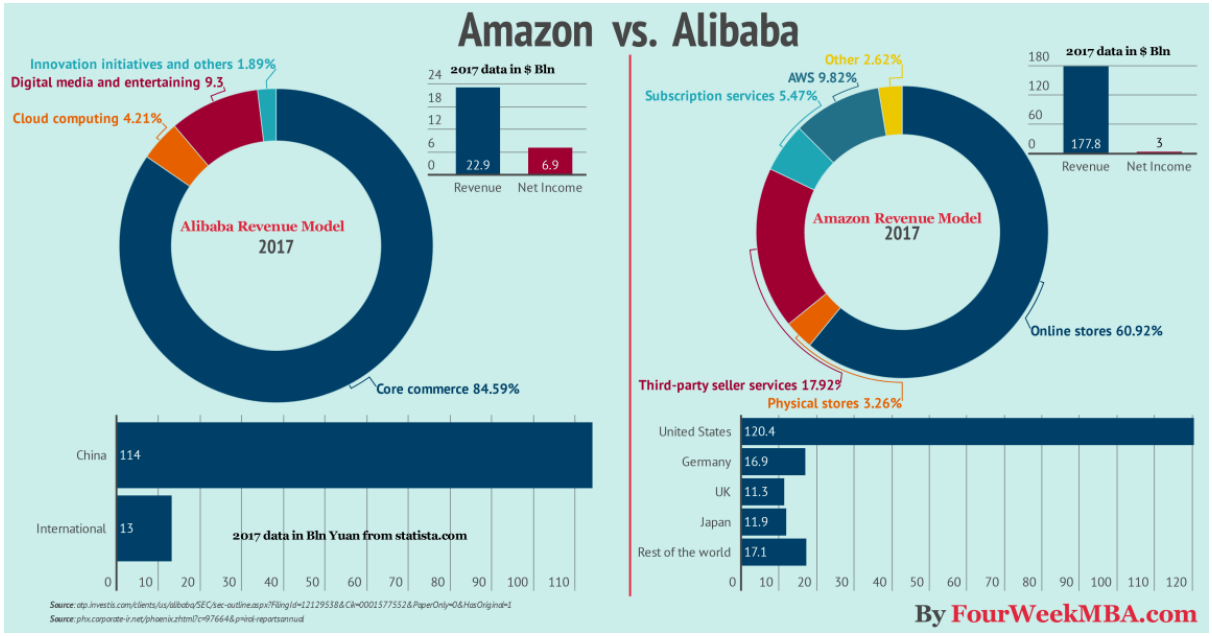
A vertically integrated business model is one where multiple steps in the typical distribution process are consolidated so that instead of operating solely as a manufacturer, distributor or retailer, a business which is vertically integrated company can performs tasks commonly carried out by suppliers or trade buyers.[41]

One key benefit of vertical integration is that it offers the business more control as they are in control of each step in the process.

A potential downside to vertical integration is that one company has to have expertise in multiple steps in the manufacturing or development chain.

5.6.13. E-commerce marketplace business model

E-commerce offers merchants the promise of low overheads, massive reach, 24 hour availability and increased profitability as consumers are switching more and more to online shopping models. Amazon and Alibaba are two example of how successful the e-commerce paradigm has become.



E-commerce platforms have severely damaged the profits of traditional high-street shops and are becoming the go-to place for consumer purchases. News outlets are quick to blame online retailers for the decline and even closure of traditional bricks-and-mortar shops[42],[43],[44], however outdated formats, lack of investment or bad management are also factors in the decline of traditional shopping.

[41] https://smallbusiness.chron.com/vertically-integrated-business-model-68292.html
[42] https://www.theguardian.com/business/2018/jul/08/high-street-digital-economy-business-rates
[43] https://econsultancy.com/digital-experts-future-high-street-retail/
[44] https://www.bbc.com/news/business-43240996

Rather than killing traditional shopping, the e-commerce marketplace is forcing traditional retails to innovate their business models and offer their customers more than just products on shelves. A report in the Financial Times covered this topic stating that shops are no longer just stores:
Apple stores offer coffee, Patagonia hosts yoga classes and Nike lets you try trainers out on their in-store basketball court. As Roelant Prins, chief commercial officer at global payment company Adyen, put it in a recent sector report: “In a world where anything can be a shop, and a shop can be anything, how do you evolve to serve today’s shoppers?”[45]

5.6.14. Privacy as an innovative business model

Privacy has become a major concern among consumers, It is well know that companies like Google and Facebook harvest users data but what becomes of that data is not so well know. Laws like GDPR[46] have arisen to offer consumers and internet users more privacy and more options with what happens to their data.

This presents a unique opportunity for business to exploit this fear and offer services based around privacy, such as the search engine DuckDuckGo[47], billed as “The search engine that doesn’t track you”, whose business model involves advertising based on keywords and affiliate marketing[48].

Apple is another company who have been positioning themselves against their rival Google (whose business is based around users data) by taking a firm stance on the privacy issues, creating hardware and software to ensure that user’s sensitive data stay on the device and not in the cloud[49].

5.6.15. User-generated content business model

Modern platforms like Quora, Wikipedia, twitter, YuoTube and Reddit, among others, are based on the user-generated content (UGC) model where they are depend on their users to constantly create content - and therefore value for other users.

Users are not usually paid for creating content and do so to gain social kudos or as a platform to reach another goal – I.e. becoming a professional writer.

5.6.16. Blockchain-based business models

Blockchain is a relatively new technology and was the technology that powered the Bitcoin phenomenon. The promise of blockchain lies in its powered to create decentralized systems which work on a global scale.

As blockchain is a relatively new technology, new innovative business models are being tested but it remains to be seen if one will emerge as an outright winner.

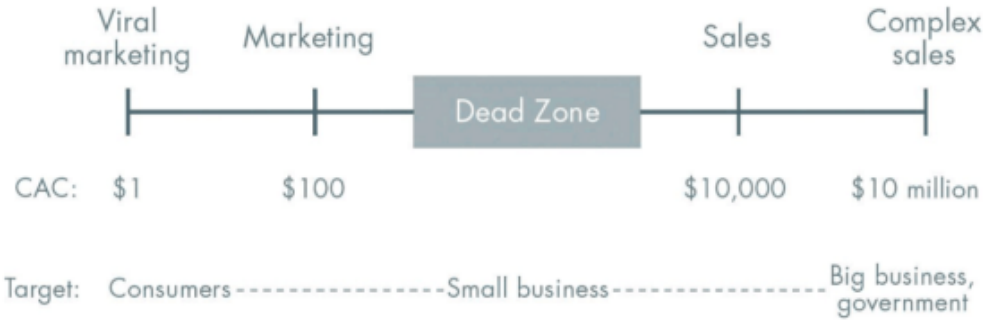
5.6.17. Complex sales

In many sales processes, the sale is closes between the seller and the decision maker. When considering sales to large corporations, (Enterprise Sales) the decision maker is usually not one person but many people spread across different branches or departments of the company.

For this reason, these types of sales are termed Complex sales.

[45] https://www.ft.com/content/f072a47e-2ebf-11e9-80d2-7b637a9e1ba1
[46] https://gdpr-info.eu/
[47] https://duckduckgo.com/?t=hp
[48] https://fourweekmba.com/duckduckgo-business-model/
[49] https://www.cheatsheet.com/gear-style/why-edward-snowden-supports-apples-stance-on-privacy.html/?a=viewall

A key aspect to successful complex sales is identifying the correct target for the sal and putting the right resources into achieving the goal, as large enterprises tend to have massive budgets, the payoff can be huge for any sales business.



5.7. Threats to Business Models – Porter's Five Forces

In essence, Porter's Five Forces, first laid out in his 1980 publication Competitive Strategy: Techniques for Analysing Industries and Competitors50 provides a framework for analysing a company's competitive environment, particularly the number and power of a company's competitive rivals, potential new market entrants, suppliers, customers, and substitute products which influence a company's profitability. Through analysing these key elements a clear guide to a business strategy aimed at increasing competitive advantage can be produced.

With a deeper understanding of Porter's Five Forces as well as how they apply to a particular industry enables a company to adjust its business strategy and model to generate higher earnings for its investors through better use of its resources and assets.

The 5 forces are the following:

5.7.1. Bargaining power of buyers

This deals with a customer's ability drive down prices and is affected by how many buyers or customers a company has, how significant each customer is in the buying chain and how much it costs a company to find new customers or markets.

The smaller and the more powerful a client base is, the more power each customer has to negotiate for better deals and lower prices. A company will be able to increase profitability by charging higher prices much easier if they have many, smaller, independent.

5.7.2. Bargaining power of suppliers

This tackles how easily suppliers can drive up costs and is affected by the number of suppliers of key goods or service, how unique these inputs are and how much it would cost a company to switch from one supplier to another.

When there are fewer suppliers and a company is highly dependent on one supplier, that supplier has much more leverage to drive up input costs and push for advantage in trade. Conversely, with a market saturated with suppliers or when switching from one supplier is easy and cost effective, the company has more power in the negotiation in order to keep input costs lower, therefore increasing profits.

50 https://www.researchgate.net/publication/321007042_Competitive_Strategy_Techniques_for_Analyzing_Industries_and_Competitors

5.7.3. Competitive rivalry

Competitive rivalry refers to the number of competitors a company has and the ability of those competitors to undercut the company. If the number of competitors is greater, and the number of equivalent products and services they offer is also greater, the company ultimately has less negotiating power. If the competition can offer lower prices then suppliers and buyers will naturally go to the competition. On the other hand, when there is not much competitive rivalry between competitors, a company has greater power to increase its prices and set the terms of deals to increase sales and profits.

5.7.4. Threats of new entrants

Just how forcefully a new entrant can enter into the market will affect a company's power. The lower the barriers to entry, i.e. the less time and money it costs for a competitor to access a company's market and be an effective competitor, the weaker the company’s position will be. Companies can charge higher prices and negotiate better terms in a market with high barriers to entry, which is therefore a much more attractive market for them.

5.7.5. Threats of substitutes

A company faces a real threat when its goods and or services can be substituted by others. When a company has no close substitutes for its goods or services then it has a much strong position in the market and can, as a result, charge more for those goods and services. They can also lock buyers into term that are more favourable for the company. Conversely, when substitutes are available the company’s position can be weakened significantly.

6. **Market Analysis**

In this section, we review the emerging 5G market in three markets where the consortium members are based. This review will start with an overview of the market itself and then focus on the telecommunication industry analysing factors such as market penetration of the fixed and mobile communications. Finally, we will discuss the strategic relevance of the project for each market, highlighting the comparison of this market with other EU markets and the impact of the project in that particular market.

How technology is commercialized ultimately determines the economic results. In a new environment such as that proposed by RELIANCE, with a new ecosystem based on new 5G capabilities, it is necessary to establish lines of research and development that allow the identification of new business models associated with the different innovations of the project.

From the different use cases, the first step will be to analyse existing business models, relevant for the different RELIANCE actors and determine the impact of the new concepts and new technological environment, as well as analysing new opportunities. During this task, an exhaustive analysis of potential new relationships between producer and consumer roles will be carried out, and how new entrants in the new market will be able to generate new business channels.

The objective is to identify which relationships could be modified, which ones renewed or generated from scratch, and the impact on the design of key aspects of RELIANCE associated with the contracting and dynamic negotiation of services and resources, based on the disruptive nature of an innovative set of technologies and concepts encompassed in RELIANCE.

6.1. The impact of COVID19 in EU 5G Roadmap

The magnitude of the impact of COVID-19 has been severe for major sectors. The telecom industry, though, has been resilient during the crisis with the industry's flexible digital core pressed into action as an immediate alternative.

The much-awaited launch of 5G, including the use of innovative new radio and millimetre-wave technologies, is seeing a temporary deceleration in many parts of the globe. This delay in 5G commercialization is inherently linked to the collective lag in regulatory timelines, spectrum issuance and auctioning, and technological developments. The coronavirus' near-term impact on these stages of 5G commercialization point towards an unforeseen downshift of the initial action stages. However, it also presents an untapped opportunity for the recalibration of the 5G market and its applications such as 5G connected robots for supporting medical professionals.[51] The same diagnosis is done by wipro[52], that remarked some short-term delay but an increased demand due to the more than likely shift to remote working after the pandemic. The reduction in spends, and limited workforce to roll-out has created -as predicted by Viswanathan Ramaswamy, Vice President & 5G Business Head- impacts such as:

- Consumer and enterprise move to 5G will be delayed due to limited coverage.
- Telecom providers are expected to opt for focused capacity coverage for now, rather than large population coverage.
- Shortage of components supply due to the current situation regarding supply chain enablement, hence delaying the 5G rollout.
- 2020 would largely be about 5G readiness or "Run up to 5G" and the 2021 will now likely be the year of inflection.
- CSP should continue their focus on readiness – orchestration, automation, network modernization, cloud adoption, NFVi and edge, and so on.

Ramaswamy also outlined that once the economy comes out of the COVID-19 situation, CSPs are expected to invest in service offerings that will enable the new ways of working across industries.

[51] https://www.netscribes.com/insights/the-impact-of-covid-19-on-global-5g-deployments/
[52] https://www.wipro.com/innovation/the-impact-of-covid-19-on-5g/

There will be a renewed focus on IoT, AR/VR, SD-WAN and the likes, all of these powered by a strong 5G network.

Added to the expected opportunity of 5G-enabled services, European Commission has put forward its proposal for a major recovery plan. To ensure the recovery is sustainable, even, inclusive and fair for all Member States, the European Commission is proposing to create a new recovery instrument, Next Generation EU, embedded within a powerful, modern and revamped long-term EU budget. The Commission has also unveiled its adjusted Work Programme for 2020, which will prioritise the actions needed to propel Europe's recovery and resilience[53].

Relaunching the economy is not meaning back to the status quo before the crisis, but bouncing forward. The goal is to repair the short-term damage from the crisis in a way that also invests in our long-term future; strengthening the Single Market and adapting it to the digital age by investing in more and better connectivity, especially in the rapid deployment of 5G networks.

6.2. 5G Market Rollout

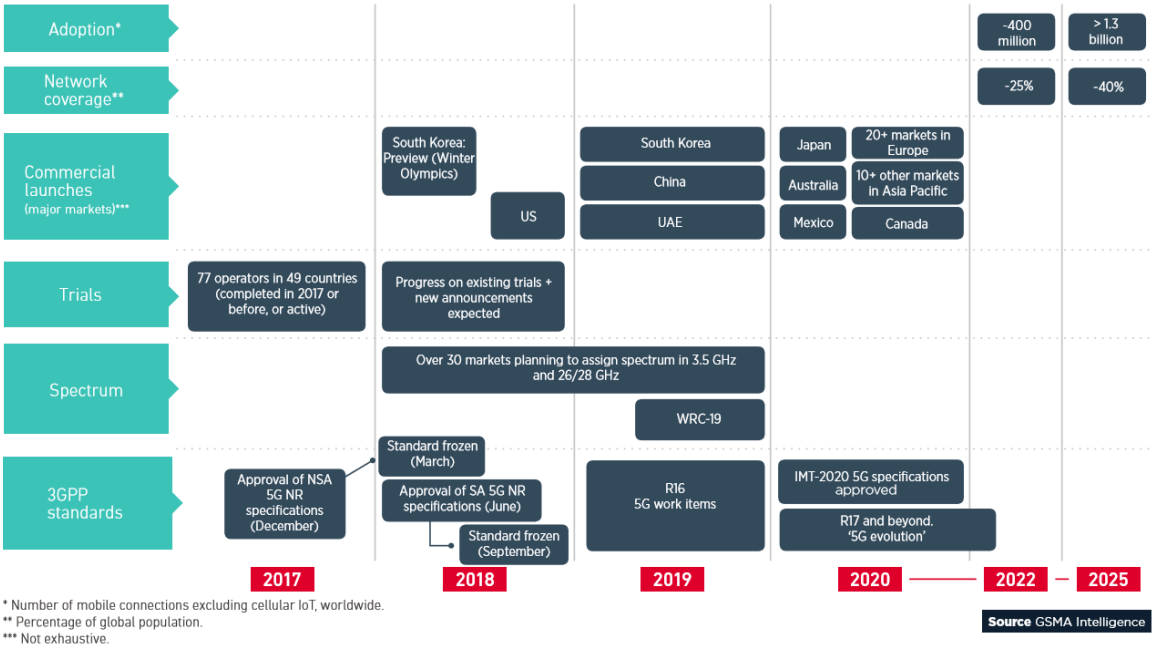
In order to "ensure that all industrial sectors make the best use of new technologies and manage their transition towards higher value digitised products and processes"[54], an EU wide strategy for the digitisation of European industry had been formulated. This strategy relies on four key areas of actions:

- Digital innovation hubs which are accessible for any European business. These hubs will facilitate access to digital technologies and expertise in order to support ongoing digital transformation,
- Leadership in next generation open and interoperable digital platforms,
- A European workforce prepared for digital opportunities
- Regulation fit-for-purpose for the digital world.

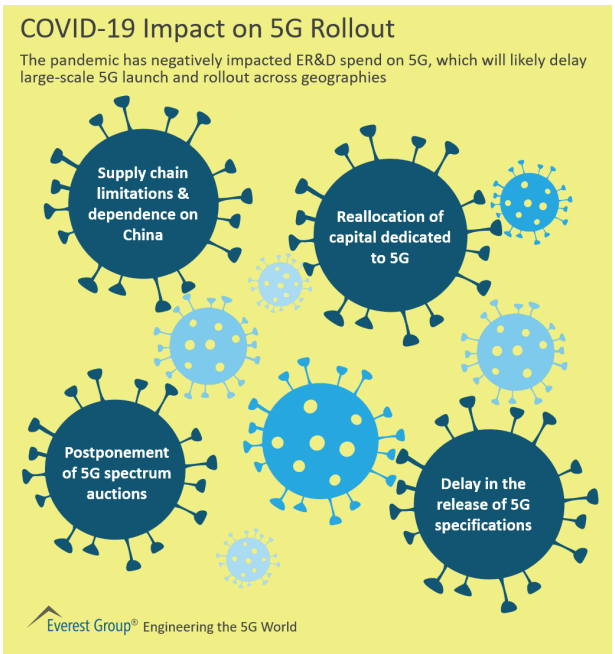
5G technologies are particularly exciting as they have the potential to usher in major opportunities for the support and global operation of next generation of digital platforms. Such platforms will be key to driving factories of the future when it comes to operations, embedding CPS in machines, vehicles, infrastructure, and so on.

[53] https://ec.europa.eu/commission/presscorner/detail/en/IP_20_940

[54] Europe's future is digital. Speech by Commissioner Oettinger at Hannover Messe http://europa.eu/rapid/pressrelease_SPEECH-15-4772_en.htm



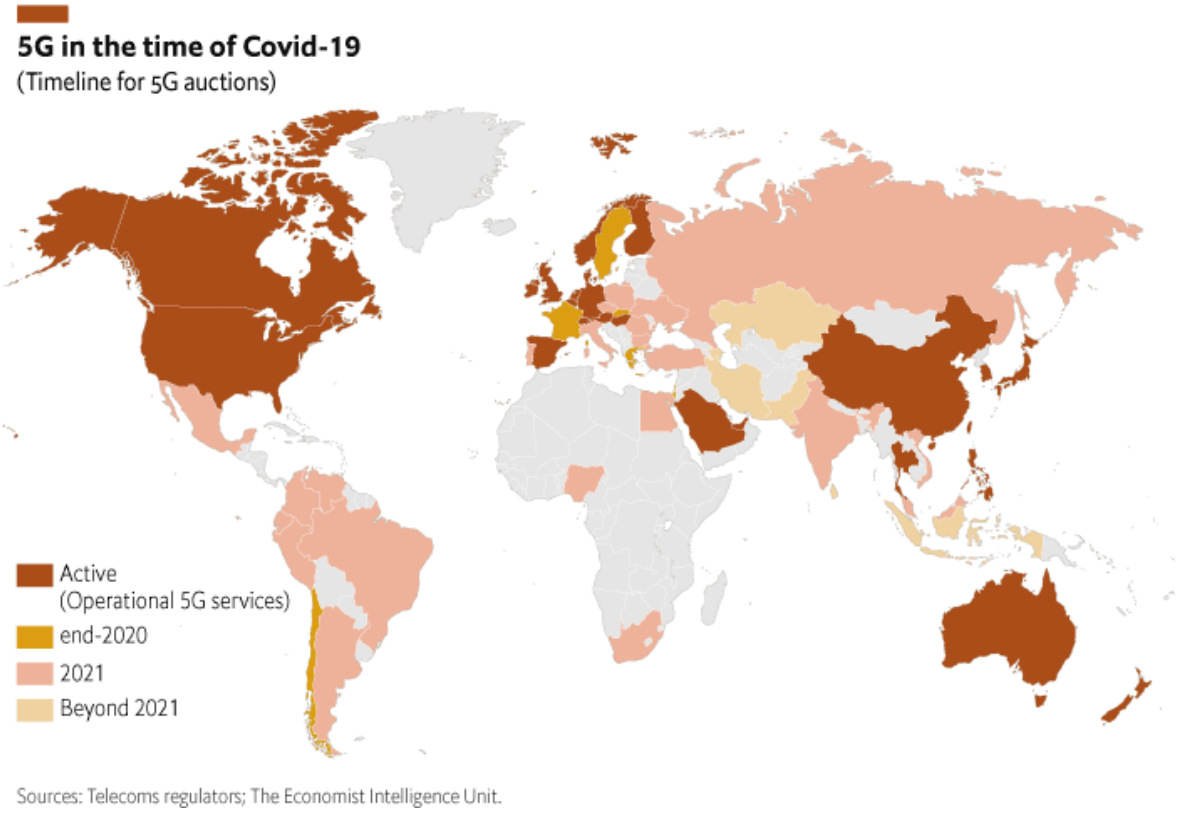
Even though the COVID19 has impacted the rollout in short-term, 5G is still on track to roll out extensively. According to a report published by PwC[55], European telcos' investment spending over the next two years will fall by €6bn-€9bn ($7.1bn-$10.6bn), and pandemic is expected to delay the rollout of 5G networks by 12 or 18 months. In fact, some regulators postponed[56] auctions of spectrum that would enable operators to launch or expand 5G networks.



Nevertheless, despite the uncertain state of the global economy, companies remain keen to forge ahead with 5G investment. Even though there have been some delays to 5G auctions, it is expected

[55] https://www.strategyand.pwc.com/de/en/insights/2020/europe-5g-rollout.html
[56] https://www.lightreading.com/5g/5g-auctions-delayed-across-europe-due-to-covid-19/d/d-id/758606

that many of the countries will be operating a 5G network by end-2020. Some of the remaining countries will try to make up for lost time by carrying out auctions during 2021.[57]



6.3. 5G Use Cases Groupings

As part of the s part of its SMARTER (Study on New Services and Markets Technology Enablers)[58] project, 3GPP defined high level use cases for its technology with objective of identifying what features and functionality 5G would need to deliver to enable them.

The project began 2015 and resulted in more than 70 use cases. Each of these use cases were grouped under 5 initial categories but have since been reduce to 3 categories. Each category aims to characterise the performance attributes each use case will require (with some overlapping).
The three sets of use cases are

- **Enhanced Mobile Broadband (eMBB)**: the key requirement for these use cases are high data rates across a wide coverage area.
- **Ultra Reliable Low Latency Communications (URLLC)**: mission critical communications are included in this category thereof strict requirements on latency and reliability are required. Examples invluce such as remote surgery and autonomous vehicles.
- **Massive Machine Type Communications (mMTC)**: these types o use cases involve supporting huge numbers of devices in any given small area. The devices may be in constant contact or may only send data sporadically, such as sensors from the Internet of Things (IoT).

Mobile vendor Ericson released a mobility report detailing several use cases across numerous verticals, how they are being presented today, how 5G will affect that and what the user's experience will be with 5G services.

[57] http://www.eiu.com/industry/article/180246601/things-to-watch-in-telecoms-in-2021/2020-10-07_1
[58] https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=2897

	Current services	On the road to 5G	5G experiences
Enhanced mobile broadband	Browsing, social media, music, video	Fixed Wireless Access, interactive live concerts and sport events	4K/8K videos, mobile AR/VR gaming, immersive media
Automotive	Wi-Fi hotspots, on-demand GPS map data	Predictive vehicle maintenance, capturing real-time sensor data for different services	Autonomous vehicle control, cooperative collision avoidance, vulnerable road user discovery
Manufacturing	Connected goods, intra-inter enterprise communication	Process automation and flow management, remote supervision and control of machines and materials	Remote control of robots, augmented reality support in training, maintenance, construction, repair
Energy and utilities	Smart metering, dynamic and bidirectional grid	Distributed energy resource management, distribution automation	Control of edge-of-grid generation, virtual power plant, real-time load balancing
Healthcare	Remote patient monitoring, connected ambulance, electronic health records	Telesurgery, augmented reality aiding medical treatment	Precision medicine, remote robotic surgery

Figure 15 - 5G use case examples - Source Ericson Mobility Report[59]

In order to deliver these requirements, 5G is expected to support:

- Over10Mbps of traffic capacity per square metre (hotspot areas). In terms of speed, over 1Gbps data transfer rates are expected for end users.
- Peak data transfer rates are expected to be in the tens of Gbps (but this is not expected to be experienced by every end user) and the entire traffic volume will be of at least 1Tbps per square kilometre.
- Overall latency will drop to 1ms for user experienced data exchange.
- Connecting density will be greatly increased, expected to be at one million connections per square kilometre.
- It will also need to offer enhanced user experience with high mobility rates (up to 500km/hour in high-speed trains and up to 1,000km/hour in airplanes)[60].

[59] https://mavenir.com/sites/default/files/2018-12/Mavenir-5G-Business-Models-Resource.pdf
[60] https://5g.co.uk/guides/what-is-enhanced-mobile-broadband-embb/

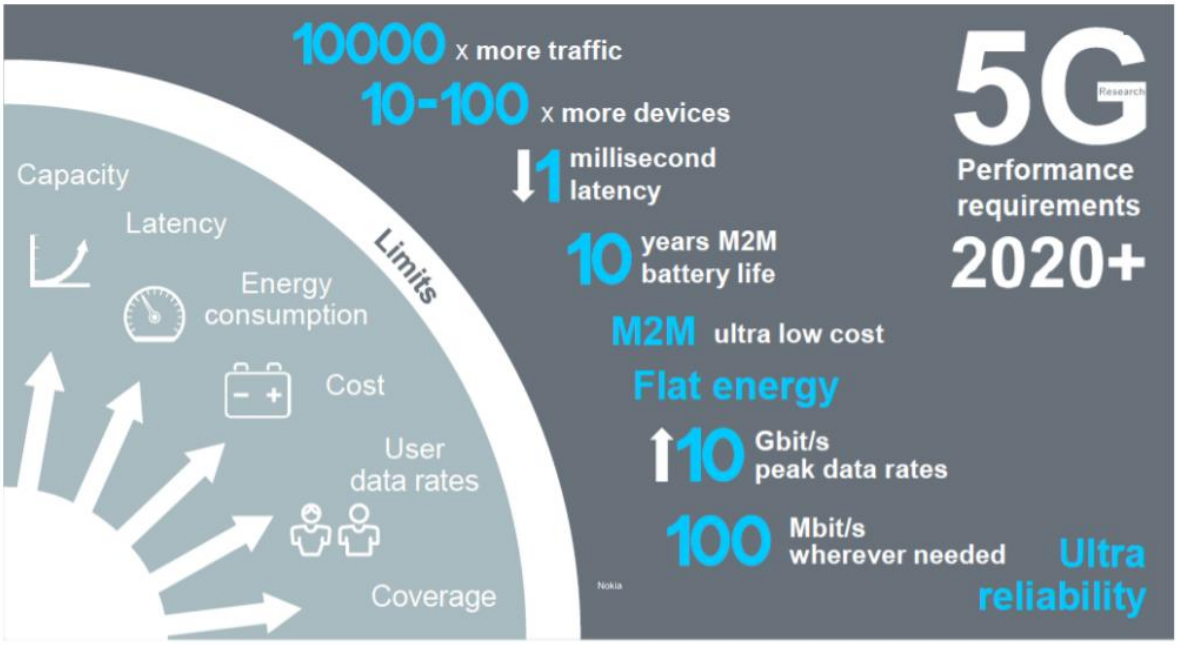


Figure 16 - 5G performance targets - Source Nokia

6.3.1.1. *Horizontal Vs Vertical*

Previous generations of mobile communications have focused on voice, data and Internet where as 5G also has a focus equally on industrial communications. The driver behind this is this digitalisation of the economy will contribute towards global digital transformation. The market is often broken down into key verticals who are seen as the early adopters and who will drive forward the technology.

These sectors include transport, media and manufacturing as the most likely leading adopters. Although some are widely mentioned in one publication or another almost every sector of society has been named in the literature as a driver for 5G, however in reality many of the use cases are not so mature and the role of the Communications Service Provider (CSP) does not extend much beyond connectivity services. The range of stereotypical use cases that have come to light have not so much been driven by demand as much as have been proposed by the telecoms sector to get users to adopt the 5G technology[61]. In this case, vendors, developers and industrial consumers are most likely to come up with other key use cases that will drive the technology.

The “Vertical” use cases proposed by the telecoms sector offer a tidy package to get around the complexity of the situation, however in a paper entitled “Are You Ready for Profitable 5G Monetization?”[61], research agency Ovum proposed that a horizontal model - concentrating on the common requirements that span different industries, processes, size classes, and geographical markets - could also work to scale 5G.

One example of this concept, directly related to RELIANCE, will be explored in section 6.5 below.

[6161] https://ovum.informa.com/resources/product-content/are-you-ready-for-profitable-5g-monetization-spt001-000071

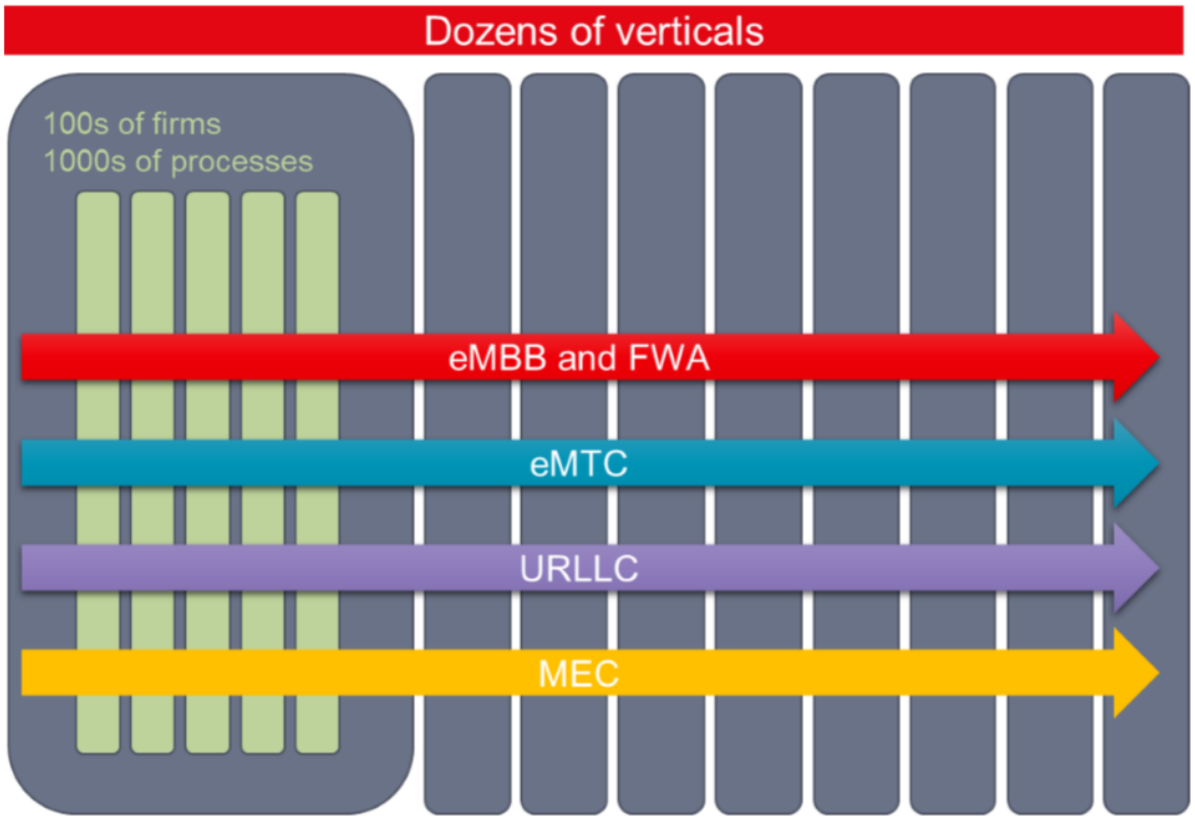


Figure 17 - A horizontal strategy permits CSPs to apply the 5G core capabilities at scale - Source Ovum

The next section of this review will summarise the investigations into the 3 key groupings of 5G technologies and how the relate to the RELIANCE project.

6.3.2. Enhanced mobile broadband (eMBB)

The progression from 3G to 4G LTE saw an increase in data rates to enable broadband capabilities on mobile networks. In this sense, Enhanced Mobile Broad Band (eMBB) is a natural evolution of existing 4G networks in that it will bring much faster data rates. The goal of this enhancement is a much improved user experience for the end user when compared to current mobile broadband services.

The goal of eMBB is not just to increase the data speed but to also to create a seamless user experience that will provide a much better experience than users currently get from fixed broadband technologies. 360º video streaming and truly immersive VR and AR applications are some of the driving use cases for eMBB. In order to achieve this, there are certain requirements that 5G will need to enhance.

Densely populated areas must be able to provide broadband access both indoors and outdoors meaning 5G will need a much higher capacity than 4G. Scenarios include city centres, office buildings or stadiums and conference centres.

In order to provide a consistent user experience, broadband access must be available everywhere. This enhanced connectivity will make the user experience seamless.

As more and more of us are travelling in our daily lives, in order to provide the highest levels of service, eMBB will also have to be able to travel with us. This means that users should expect the same high levels of service whilst on moving vehicles such as cars, buses and trains.

Giving these varying eMBB usage scenarios, different categories of use cases will have to provde different services to meet there differing requirements. For example:

- **High Capacity** – music fans at a sell out concert or spectators at a sporting event will present the situation where a high number of users are demanding a high level of service in densely packed area. This creates a requirement for very high traffic capacity in order to meet the needs of all of the connected users. As the users are not moving, or are moving relatively slowly, there will be no great need for mobility services.
- **High Mobility** - In contrast to this scenario, passengers in high-speed trains will require greater degrees of mobility, however due to the lower density of users, the traffic capacity would be much lower than that of a hotspot scenario.
- **Seamless Coverage** – under other situations where density is not abnormally high and users are not on fast moving trains, a medium level of mobility is required with a data throughput which is higher than is currently possible. Although not as demanding as a hotspot or high mobility situation, they key criteria here is seamless coverage.

In a survey conducted by Statista, “Top use cases for 5G enhanced mobile broadband (eMBB) in 2019 and beyond” 48% of respondents said the top 5G use case would be “lightning-fast” browsing. The same number mentioned that never having to log onto a public Wi-Fi service again would be a key feature[62]. This highlights the fact that early eMBB use cases centre on the need for better and faster connectivity in the consumer market in order to handle higher quality video content, the growth in user-generated content and our expectations of on demand streaming, no matter where we are.

Although the entertainment industry is a strong use case for eMBB, there are a number of compelling use cases presented from industry. For example, through eMBB, staff working remotely in the field can communicate with the back office through high speed streaming, VR or AR services, including telepresence and volumetric streaming. Workers commuting but still needing access to cloud apps and data can connect seamlessly from moving trains and entire smart offices can be created where all devices and users are wirelessly and seamlessly connected.

This will bring about a change in the way we work by enabling applications that are almost here now, but suffer due to limitations in current technology. These include fully immersive VR and AR as well as real-time video monitoring and virtual meetings with 360º video: Real-time interaction for training and remote presence situations will also be available and even real-time translation for participants speaking different languages will become a possibility.

The number of devices that will take advantage of eMBB grow beyond just smartphones and is likely to include the increasing range of video-capable devices such as VR and AR glasses which are poised to become pervasive equipment in our daily lives.

6.3.3. Machine-to-machine communications (mMTC)

Often know as Massive Machine-to-Machine Type Communications (mMTC), this grouping is focused primarily on IoT. mMTC technologies are inherited wholesale from the latter revisions of LTE and cover two key classes: the low-power, narrowband NB-IoT and the medium power, medium bandwidth LTE-M.

NB-IoT is aimed primarily at the standard IoT model of static, embedded sensor and control nodes. The second considers more flexible users such as supply chains. 5G adds new core network capabilities to these standards to add more custom network slices for different use cases as well as adding new bands for greater capacity.

5G's IoT will have to compete range of already available technologies such as LoRa, Ingenu (formerly OnRamp), Sigfox, Telensa, among other.

[62] https://www.statista.com/statistics/867967/5g-embb-use-cases/

One of the strengths of the 5G models is that operators hope that for IoT they can provide competitive services on the back of infrastructure that's already in place and already has a great deal of flexibility. Another strength of 5G is that it uses a licensed spectrum: This spectrum is therefore managed and not susceptible to any interference from third-parties whilst inheriting levels of authentication and security expected of cellular technology.

IoT is also changing operators pricing models Currently, operators, device makers and service providers use a range of cost and benefit-sharing revenue models where the operator get paid for how the user accesses defined ports, capacities and bands.

The models is known as connectivity-as-a-service (CaaS) and consists of a mixture of subscriptions, permanent licences and other mixtures of support as IoT revenue models.

Once again we see 5G's ability to create new service types on existing infrastructure as advantageous to creating new revenue models. The latest worldwide market study by Juniper Research claims that the total number of cellular machine-to-machine (M2M) connections will reach 1.3 billion by 2022, representing a 220% increase from an estimated 400 million in 2017[63].

The same research forecasts that Smart Cities (with a 66% CAGR) will see the largest growth rates in terms of cellular M2M connections, followed by Agriculture (37% CAGR) and then Smart Meters (34% CAGR)[63]

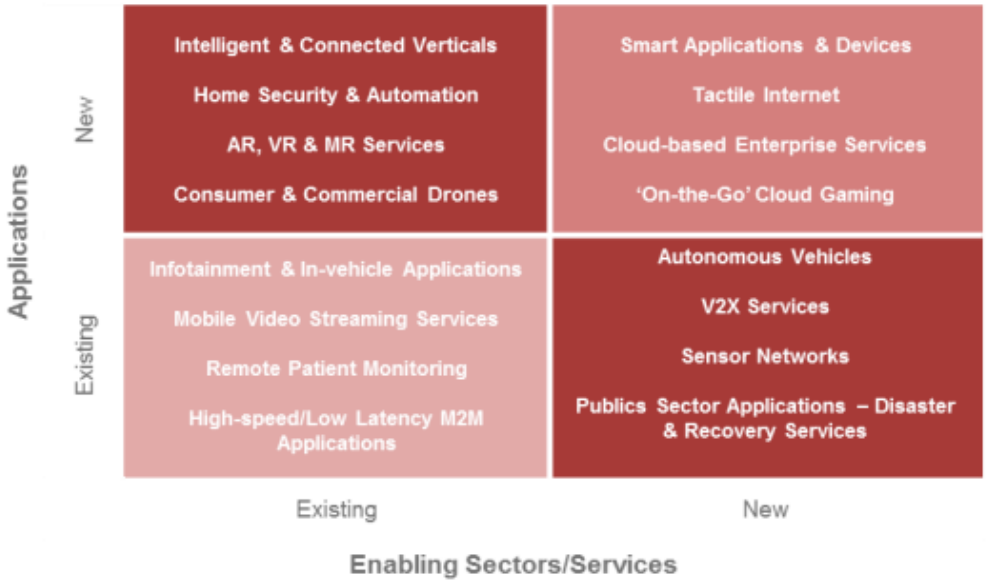


Figure 18 - Juniper Strategy Quadrant - 5G & M2M

The Machine-to-Machine Communications paradigm can be subdivided into two further sub-classes, Narrowband IoT and LTE-M, both of which are examined in the following section.

6.3.3.1. *NB-IoT*

Narrowband IoT (NB-IoT) is a low power wide area (LPWA) technology that has been standardised by 3GPP to enable a wide range of new IoT devices and services. NB-IoT is especially useful in locations that can't easily be covered by conventional cellular technologies as it minimises the power consumption of connected devices while increasing system capacity and spectral efficiency. NB-IoT connected devices can have a battery life exceeding 10 years[64].

[63] https://www.telecomstechnews.com/news/2018/feb/08/how-5g-mobile-services-enable-new-m2m-apps/
[64] https://www.gsma.com/iot/mobile-iot-technology-nb-iot/

The demanding requirements of extended coverage in rural areas and deep indoors are met by NB-IoT through a physical layer with signals and channels. The cost of NB-IoT modules is expected to decrease dramaticalls with increasing demand and the underlying technology is much simpler than that of GSM/GPRS modules.

NB-IoT services are being rolled out by a number of operators across the world; in Asia, the Middle East, Latin America and Europe and some even have commercial launches underway. China Mobile, China Telecom, China Unicom, Deutsche Telekom, Etisalat, KT, NOS, TDC, Telefónica, Telia and Vodafone are now deploying NB-IoT after successfully piloting the technology in use cases requiring large numbers of low cost and low maintenance connected devices, such as smart metering, smart parking and smart agriculture.

6.3.3.2. *LTE-M*

3GPP standardised its eMTC LPWA technology in the Release 13 specification. LTE-M is the simplified industry term for this and it specifically refers to LTE CatM1, designed to support the IoT. LTE-M is described as a low power wide area (LPWA) technology which provides low device complexity and extended coverage, while allowing the reuse of existing LTE base stations[65].

The technology reduces costs and increases battery life opening up a wide range of use cases. Connected devices can have a battery life of at least 10 years and modem costs can be reduced to 20-25% of the current EGPRS modems. Relatively fast data throughput, high mobility, roaming and (potentially) voice services are also supported by LTE-M.

AT&T, KPN, Orange, Telefónica, Telstra and Verizon rolling out LTE-M at present. Previous pilots of the technology have included use cases requiring low cost mobile connectivity such as: individuals' location and vital signs monitoring using wearable devices, smart shelving solutions, asset management, logistics and fleet management among others.

6.3.3.3. *Alternatives for IoT - 802.11 ah - HaLow*

At this point it is worth adding a subsection for the 802.11ah wi-fi standard (HaLow, pronounced "hey-low") defined in 2016 and aimed at IoT Sensors. Most of the existing 802.11 standards operate on the 2.4 GHz or the 5GHz spectrum and although they offer relatively high data rates, they also have low sensitivity.

802.11ah was introduced specifically to increase the relatively short range of WiFi – operating in the 900 megahertz WiFi spectrum means is is perfect for long-range data transmission; ideal for IoT devices that need longer ranges but don't require high data rates.

HaLow is also competing with 5G in the low power consumption aspect as it uses target wake time to reduce the amount of energy a device needs to stay connected to the network. This means that devices only wake up for very short times at pre-defined interval to accept messages.

HaLow is finds its niche in companies using sensors that need to be WiFi-enabled as it penetrates through walls and obstructions much better than 802.11ad – e.g high frequency networks. It is also ideal for short, "bursty data" which doesn't have high power requirements but where the signal needs to travel long distances. In this instance is useful for smart building applications like smart lighting, smart HVAC, and smart security systems. This could then obviously be extended to the smart city paradigm through applications in smart parking garages and parking meters[66].

The drawbacks are that there is currently no global standard for 900 MHz leaving HaLow as a very U.S.-centric technology.

[65] https://www.gsma.com/iot/mobile-iot-technology-lte-m/
[66] https://www.link-labs.com/blog/future-of-wifi-802-11ah-802-11ad

6.3.4. Ultra-Reliable Low-latency Communications (URLLC)

Ultra-Reliable Low-Latency Communications (URLLC) the final of the three groupings and is focused on enabling wireless automation and control applications. URLLC is a service category to support the latency sensitive services such as remote control, autonomous driving, and tactile internet[67].

In order for mission critical applications to function, packet transmission time needs to be in the order of tens~hundreds of microseconds (μs). 4G LTE networks have significantly improved in terms of latency from 3G networks, however their end-to-end latency is still in the 30 ~ 100 ms range of usually due to the fact that the 4G backbone network uses the best-effort delivery mechanism. For this reason it is not optimized for the mission-critical services. A fundamental change in both wireless link and backbone network is required in order to reduce latency. Software defined network (SDN) and virtual network slicing can be used to create a dedicated network and construct the private connection to the dedicated URLLC service in the backbone network[67].

A large portion of the transmit latency in the wireless layer is due to the control signaling (e.g., grant and pilot signal) and it takes almost 0.3 ~ 0.4 ms per scheduling. Current LTE systems are not efficient at incorporating low-latency packet transmission. The authors of 68 designed a short packet whose transmission latency 5 is 0.5 ms and observed that more than 60% of resources would be wasted for the control overhead, concluding that to support URLLC many parts of the physical layer should be re-designed.

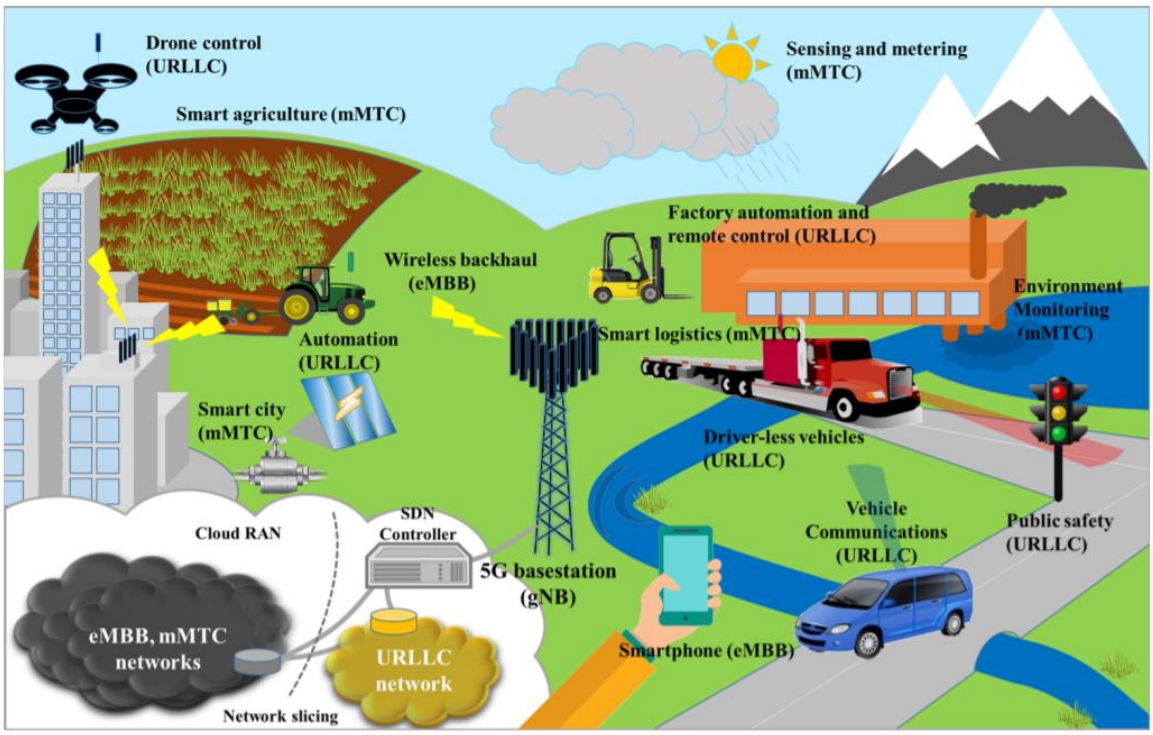


Figure 19 - Overview of URLLC in conjunction with eMBB and mMTC in a Network Slicing Paradigm[68]

Examples of these are autonomous vehicles both singularly and networked (platooned), that need a wireless communication link for data exchange especially in rural environments like city centres, to achieve the safety level of current road traffic with human drivers.

Another key application domain is Industry 4.0 automation and control scenarios, to replace cables with wireless links for robot-to-robot communication links or for collaborative human-robot production scenarios.

[67] https://ieeexplore.ieee.org/abstract/document/7842415
[68] https://arxiv.org/pdf/1704.05565.pdf

According to the timeline for rollout of URLLC, we should be sineg a stable integration of URLLC for IoT towards the end of 2019:

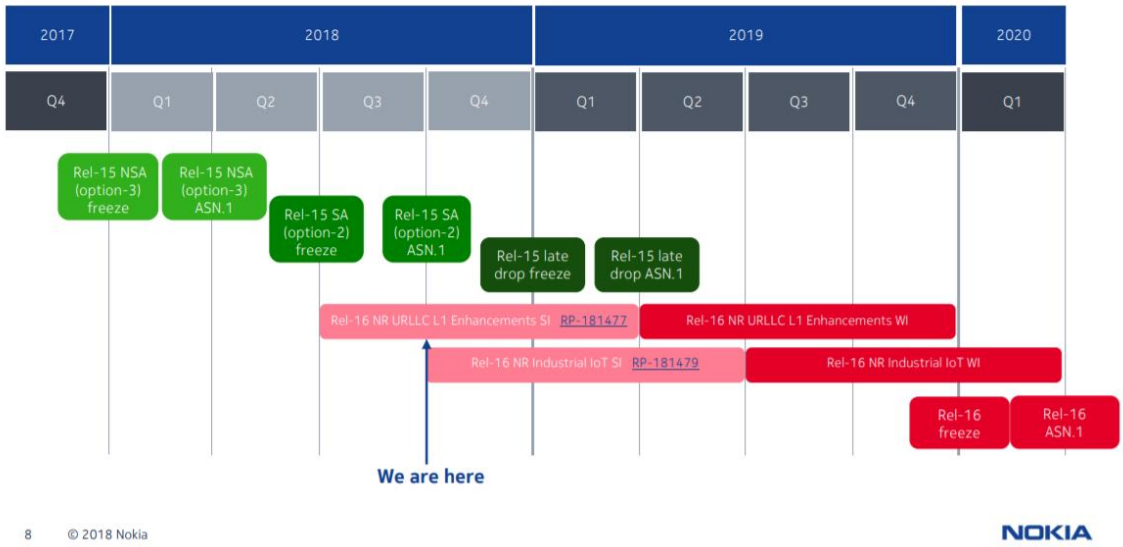


Figure 20 - URLLC Rollout timeline - Source Nokia

6.3.4.1. *Industrial Automation*

One of the drivers of IIoT and the Industry 4.0 paradigm, URLLC will provice the low latency requirements needed for industrial automation. Networks within factories that will allow devices be able to communicate and issue controls with 0 latency will lead to the vision of fully automated factories.

End-to-end latency lower than 0.5ms[69] (along with exceedingly high reliability) is one of the que requirements in use cases involving communication transfers enabling time-critical factory automation. Most industries across a wide spectrum will be able to take advantage of this technology including metals, semiconductors, pharmaceuticals, electrical assembly, food and beverage production etc.

6.3.4.2. *Intelligent transportation*

Automated driving, road safety and traffic efficiency services are some of the technological transformations that will be brought to life in the transportation industry by URLLC. These transformations will lead to fully connected vehicles enabling them to cooperate with other vehicles (rather than relying on their local information) in order to react to increasingly complex road situations by - which requires information to be disseminated among vehicles within extremely low latency and very high reliability.

The 5G Americas with paper on URLLC services and applications[70] describes it as:

“In fully automated driving with no human intervention, vehicles can benefit by the information received from roadside infrastructure or other vehicles. The typical use cases of this application are automated overtake, cooperative collision avoidance and high-density platooning, which require stricter end-to-end latencies and high reliabilities….

“Several applications and use cases are already under research and development, the most representative being automated driving…, road safety and traffic efficiency services…, digitisation and transport logistics…, [and] intelligent navigation systems.”

[69] https://enterpriseiotinsights.com/20190114/channels/fundamentals/three-5g-urllc-use-cases
[70] http://www.5gamericas.org/files/5115/4169/8314/5G_Americas_URLLLC_White_Paper_Final_11.8.pdf

6.3.4.3. *Remote Monitoring*

In a number of scenarios, including Smart Facilities Management and Health Care, remote monitoring relies of very high reliability connections to monitor mission critical equipment in real time. In terms of remote presence for procedures such as Remote surgery or remote mantainance, the requirement for ultra-low latency also beomces apparent. The report from 5G Americas describes the scenario as follows:

"In a remote surgery scenario, the entire treatment procedure of patients is executed by a surgeon at a remote site, where hands are replaced by robotic arms. In these two cases, the communication networks should be able to support the timely and reliable delivery of audio and video streaming."

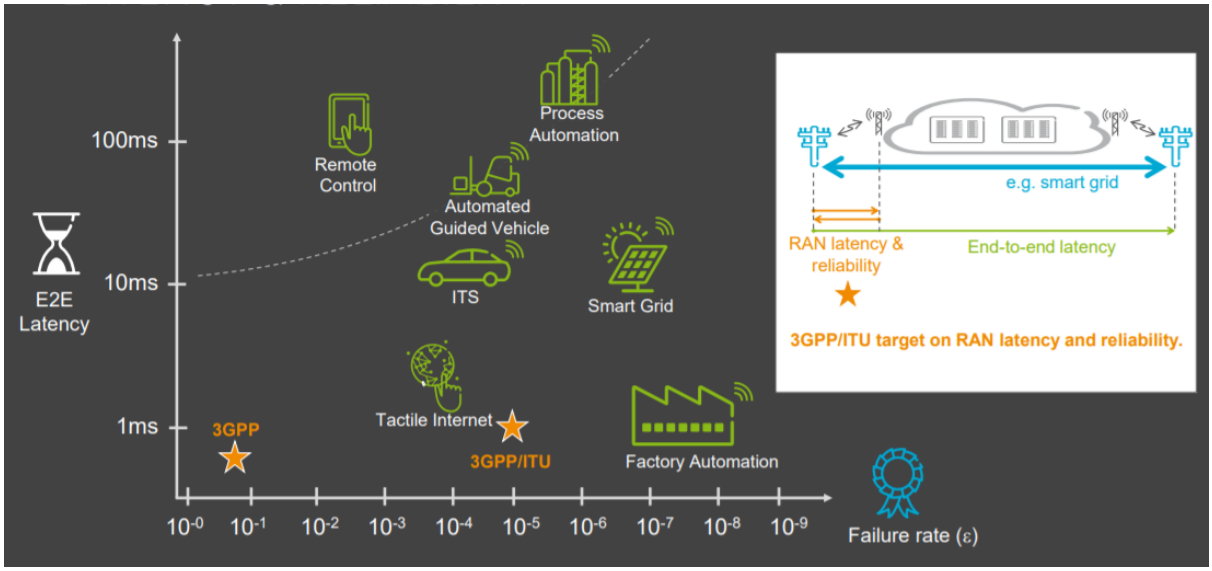


Figure 21 - Ultra Low Latency Requirements - Source Ericson[71]

6.4. Industry 4.0

The manufacturing sector is a key driver of growth in the economy, accounting for about 60% of productivity growth and 67% of exports in Europe in the period 2010-2012[72]. On a global scale, the manufacturing sector represents 16% of the global GDP employing close to 45 million persons in advanced economies[72].

The impact that 5G will have – and is having - on Industry 4.0 will be unique. 5G won't do much to redesign production lines however it will bring about new operating models, offering manufacturers the opportunity to build smart factories that can fully take advantage of the emerging tech that's changing the industry.

6.4.1.1. *Connected systems*

Many manufacturers have already integrated IoT solutions into their factories in order to complete tasks such as asset tracking, control room consolidation and improvements in analytics (including installation of predictive maintenance systems with the integration of ML techniques).

Connectivity becomes a key issue with so many devices without which, Industry 4.0 defiantly not reach its potential.

There already are low power wide area networks (LPWAN) which are currently sufficient various connected devices and sensors (for example: low data transmission smart meters). The story is very

[71] http://cscn2017.ieee-cscn.org/files/2017/08/Janne_Peisa_Ericsson_CSCN2017.pdf

[72] https://5g-ppp.eu/wp-content/uploads/2014/02/5G-PPP-White-Paper-on-Factories-of-the-Future-Vertical-Sector.pdf

different in manufacturing where IoT deployment can involve huge numbers of data-intensive sensors used within close proximity to other machines loaded with more such sensors.

6.4.1.2. *Real-time communications*

Network latency improvements are a huge factor with 5G offering applications, devices and machines to communicate in (near) real time. This opens up applications that were not possible in the past, such as remote operations and autonomous driving, both involving applications which have to communicate constantly with their ever-changing environments.

6.4.1.3. *Networking*

Networks are having to change the way they operate in order to live up to their promise of unrivalled wireless speed and ultra-reliable connections. Software Defined Networks (SDN) and splicing are one way that 5G will change networking to maximise throughput capabilities and scalability.

SDN allows operators to add new functionalities on a software-based timeline as opposed to the hardware timeline currently used resulting in networks that are more agile and more efficient. When considering that the IoT is predicted to have more than 50 billion connected devices by 2020 it looks like SDN is the only viable way to manage the additional traffic whilst ensuring security.

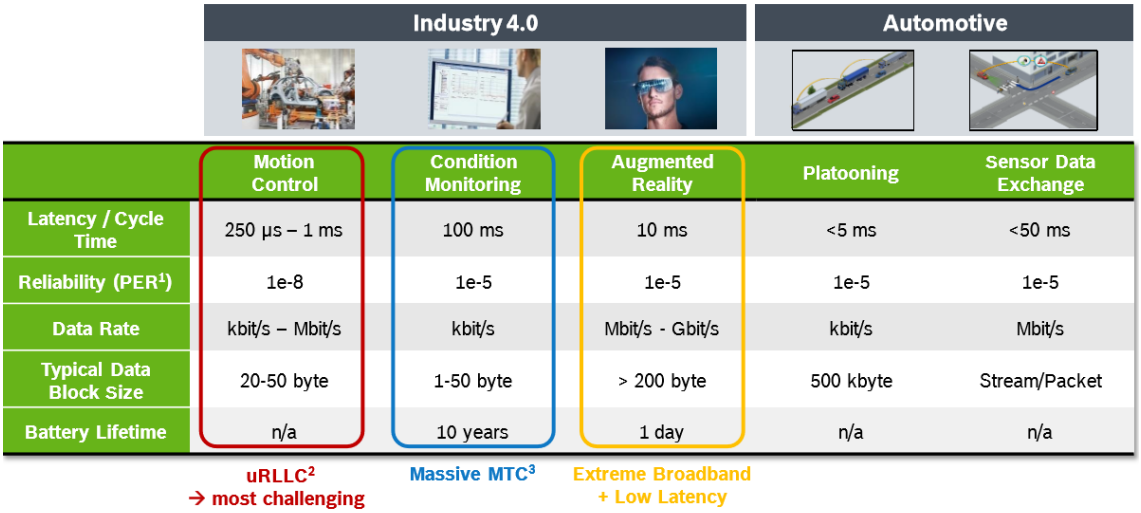


Figure 22 - Industrial 5G Key Requirements - Source Bosch

6.5. Private Wireless for Industry 4.0

Private Wireless for Industry is a big talking point and was the focus of many discussions and meetings, given its potential to the industry, throughout the research.

Private wireless involves the customer setting up, and therefore owning, some or all of the infrastructure with the added benefit of controlling the spectrum involved. The benefit of this model is that it allows the enterprise customer much more flexibility with network permissions, usage and protocols, and offers a degree of customised service that would be almost impossible for a traditional operational platform to provide. The provider can tailor the network to their specific needs, for example time-sensitive, multiprotocol networking required for industrial applications. Onsite infrastructure and integration between local and wide-area networking become important. Revenue management needs to support managed services, cloud resources, and outcomes-based business models

6.6. Smart Facility Management

In the Energy Roadmap 2050, the European Union details its vision for energy consumption patterns to be implemented in EU wide by the year 2050. This document highlights the fact that buildings consume up to 40% of the total energy we generate and lists this as a major challenge to reducing energy consumption and greenhouse gas emissions. Given the immediate and pressing nature of climate change, and given the contribution of buildings to overall carbon emissions, it is evident that any changes in building management sector towards greater energy efficiency and a reduction in CO2 can have can have a massive and lasting impact on this looming global crisis, not to mention welcomed reductions in operating costs.

As commented previously, as new legislation comes into force, greener solutions are being sought in order to make buildings more energy efficient and cost effective. One way to achieve greater efficiencies is to automate building control through building automation. This is will be, in essence, a Machine Learning-enabled system that relies on a network of sensors throughout the building to detect and effect changes in the building's numerous systems.

The application of customizing user comfort, workspace optimization, energy consumption and predictive maintenance offers huge savings in terms of costs and GHG emissions. In order for these savings to occur not only does the hardware need to be in place, a solid, robust and high-speed network infrastructure needs to be in place to deal with the data volume generated.

The IoT in conjunction with technologies such as AI, 5G, Mobile Edge Computing and Crowdsensing will allow us to customise and optimise our vital spaces on an individual basis, tailoring the spaces we live, work and play in to increase our comfort and reduce costs and environmental impact.

Smart connected devices, which provide unprecedented levels of visibility into workers' environments coupled with intelligent wearables (watches, helmets, vests…) which capture vital physical metrics like heart rate, skin temperature, movement, activity, and location in parallel with environmental sensors can create a complex and highly detail record about employees' working conditions and their exposure to physical and psychosocial risks in real time.

Through the dense networks of sensors that give connected buildings their name, facility managers can gain essential insights into the running of their buildings, monitoring equipment based on data collected and evaluated allowing closer measurement against key performance indicators (KPIs) leading to detection of deviations from the norm more quickly. This in turn helps reduce service costs though predictive or just in time maintenance and optimised work orders.

The impact of pandemic has leveraged new approaches, that were initially positioned in a research plane. The need to provide enhanced solutions for remote maintenance has put the spotlight on emerging technologies as volumetric streaming. Volumetric video is the technique that captures a three-dimensional space, such as a location. 5G rollout is allowing to set solutions to stream such a large amount of data, creating co-working spaces where telepresence is a reality.

As stated by Maureen Ehrenberg, IFMA Board of Directors chair, 2016 : "There is a technology tsunami underway. As buildings are digitized, connected and "learn" to adopt their behaviour to changing circunstances (like weather and occupancy patterns), it is important to acquire a deeper understanding of technology and obtain the ability to deploy constantly evolving technologies."

6.7. Transport

The rail sector is no exception when it comes to technology driven disruption resulting in opportunities for new services due to the emerging new technologies as 5G and digitalization.
For the rail industry, fleet reliability is a major key to encrease efficiency and reducing the total cost of ownership. Hence a natural focus area is on technologies for predictive maintenance and condition-based maintenance taking advantage of the evolving "Cloud" sollutions as AI/ML, big data and data analytics.
There is a big opportunity here to increase efficiency in maintenance e.g.:

- reducing number of failures.
- reducing the amount of unplanned maintenance.

- optimize scheduling of planned maintenance and logistics around this.

In general, the new technologies around 5G connectivity, big data and data analytics will provide the base for a number of revenue-generating services.

Estimated efficiency gains on moving towards predictive and condition-based maintenance, are around 10-15%. This would mean savings, on a global scale, over €7 billion/year and on a European level approximately €2-2,5 billion/year

6.8. Multimedia Broadband

Enhanced Multimedia Broadband are one of the key use cases that is predicted to massively deployed with 5G. This can imply what is defined as Quick deployment and/or temporary connectivity, as it is described in some studies [73]. In this context, it is related to cases where it is required the provision of non-stationary and dynamic capacity to respond in real-time to demand at specific locations. These could be special events, with one-way distribution of multimedia content. Also, it can be applied to the specific use case provided by Turkey, aiming to ensure all video conference participants have network slices to allocate requested bitrates or other QoS parameters maximizing QoE of the participants. Sustainability of initially provided bitrates or other QoS paramaters is another vital topic that can be ensured by dynamic orchestration of network slices. The are clear benefits to be explored with RELIANCE:

- Satisfying service level requirements (such as bandwidth, latency, and coverage) of internal and external services (BiP, TV+, fizzy, NETAS VIO, etc.)
- Ease of deployment of in-house and third party multimedia services
    - APIs developed for service configuration
    - APIs developed for charging third-parties based on provided service quality

As described by the study conducted but Ovum[74], The global media industry stands to gain $765bn in cumulative revenues from new services and applications enabled by 5G ($260bn in the US and $167bn in China). Thanks to the new network capabilities brought by 5G, annual mobile media revenues will double in the next 10 years to $420bn in 2028 ($124bn in the US). The transformative impact of 5G will go well beyond just enhanced mobile media. It will disrupt the industry on many levels, with new business models and new immersive interactive experiences to capitalize on. Video, gaming, music, advertising, AR, and VR will all see fundamental changes due to5G, bringing content and audiences closer. Ultimately, we expect 5G to help bring a new, tactile dimension to entertainment.

[73] Study on Socio-Economic Benefits of 5G Services Providedin mmWave Bands

[74] https://newsroom.intel.com/wp-content/uploads/sites/11/2018/10/ovum%E2%80%93intel%E2%80%935g%E2%80%93ebook.pdf

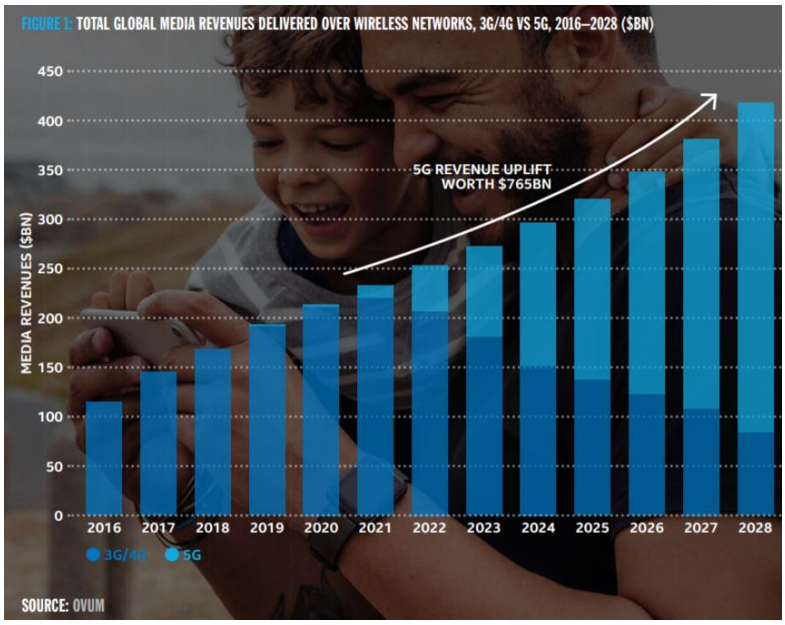


Figure 23 Media revenues. Source: ovum

6.9. 5G Test cases

As part of the research, various implementations of 5G were studied to discover how the technology has been implemented and what the results of this implementation were. What follows is a selection of some of the most relevant case studies.

An extensive list of test cases for 5G deployments across a number of verticals can be found in Annex 9 below.

6.9.1. Port of Hamburg

Hamburg Port: first 5G network slicing trial in large industrial environment

In 2018, after six months of preparation, a joint project between the Hamburg Port Authority (HPA) in Germany, Deutsche Telekom and Nokia was launched. The project itself will run from Jan 2018 until June 2019 and will form a testbed covering 8,000 hectares of port area in Hamburg with a base station installed on Hamburg's television tower, over 150 metres up in the air[75].

The project was designed to test the concept of "Network Slicing" - creating multiple virtual networks running simultaneously on the same common infrastructure. Examples of such a slice at the port of Hamburg is the rapidly instantiated priority circuit for emergency services in the port area during a storm surge[76].

Three key use-cases were tested in the port to try out three differing network requirement scenarios:

- Sensors were installed on three ships from the HPA subsidiary Flotte Hamburg GmbH & Co. KG which enabled real-time analsyis and monitoring of motion and environmental data from large parts of the port area.

[75] https://www.hafen-hamburg.de/en/news/new-communication-standard-5g-industrial-environment-trial-platform-launched-in-the-port-of-hamburg---35629

[76] https://www.telekom.com/en/media/media-information/archive/port-of-hamburg-is-ready-for-5g-574536

- Another case was traffic control through the port area in connection with the Port Road Management Center of the HPA. This centre remotely controls traffic flow in the port of Hamburg via a traffic light connected to the mobile network which will help guide traffic through the port area faster and more safely.

- The final example involved 3D information and Augmented Reality to test high bandwidth availability. In this instance, 3D information was transmitted to an augmented reality application. On site maintenance teams – using appropriate 3D glasses – were able to call up additional information such as building data or receive interactive remote support from an expert[76].

As a result of the joint project, part of the two-year research project "5G-MoNArch" (5G Mobile Network Architecture for diverse services, use cases, and applications in 5G and beyond) funded through Horizon 202, the project partners were able to demonstrate that complex industrial applications with diverging requirements can reliably work over a common physical infrastructure.

"We have gained valuable experience, which we have also shared with the port industry and other partners at several events. That was very important to us right from the start," says HPA project manager Hendrik Roreger. "Thanks to the experience gained, we now have a clear technological advantage in the Port of Hamburg. When 5G officially starts, we would be ready to implement even complex applications here."[76]

Figure 24 - 5G test case in the Port of Hamburg - Source[77]

6.9.2. Scalable Network Slicing for IoT – Ericsson

IoT has the potential to transform industry and society and in conjunction with 5G, will enivabitly present numerous possibilities for new business models. Networks will need to adapt to this

[77] https://www.itu.int/en/ITU-D/Regional-Presence/ArabStates/Documents/events/2019/ET/Nokia-Ghribi-%20Unlocking%20the%205G%20opportunity%20final%20ITU.pdf

huge amount of traffic and operators will need to invest in new technologies to address the efficiency and flexibility demands of these new service deployments. One solution to this is network slicing which appears to be have the capacity to enable new business models across a wide range of industries.

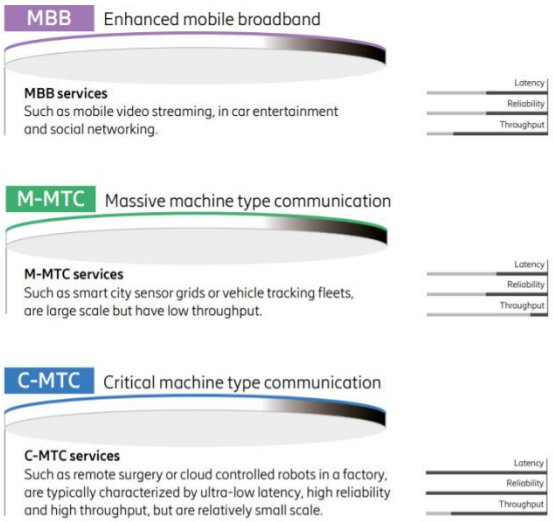


Figure 25 _ Suitablity of 5G for IoT Source Ericsson

Slicing allows segmentation of the network to support specific services as well as the capability of deploying multiple logical networks for different service types over one common infrastructure[78].

In a partnership between hardware manufacturer Ericsson and UK operator BT, the partners teamed up to investigate the actual economic impact of network slicing. An economic delta study was carried out over 4 months which compared network slicing with two alternative scenarios for IoT in new service deployments which the partners called “one big network” and “separate specialized networks”[78].

The Ericsson & BT study found that network slicing brings a significantly increased economic benefit for new service launches, enabling new revenue generation, lower opex (operating expense) and greater capex (capital expenditure) efficiency.

The study also showed that model becomes more economical with a greater number of slices, offering operators extensive opportunities to increase revenue and make cost savings.

The study concluded that Network slicing can be a driver for revenue generation through[78]:

- Market stimulation - improving business flexibility through customized Service Level Agreements (SLAs), billing and self-service opportunities.
- Time-to-market - enabling isolation during the service deployment process and reducing interoperability testing effort allowing for faster service launches with faster revenue generation.

78 https://www.ericsson.com/4a45a8/assets/local/digital-services/trending/scalable-network/executive_guide_network_slicing.pdf

- Small niche opportunities - providing value through sandboxing, temporary events and tailored business models.

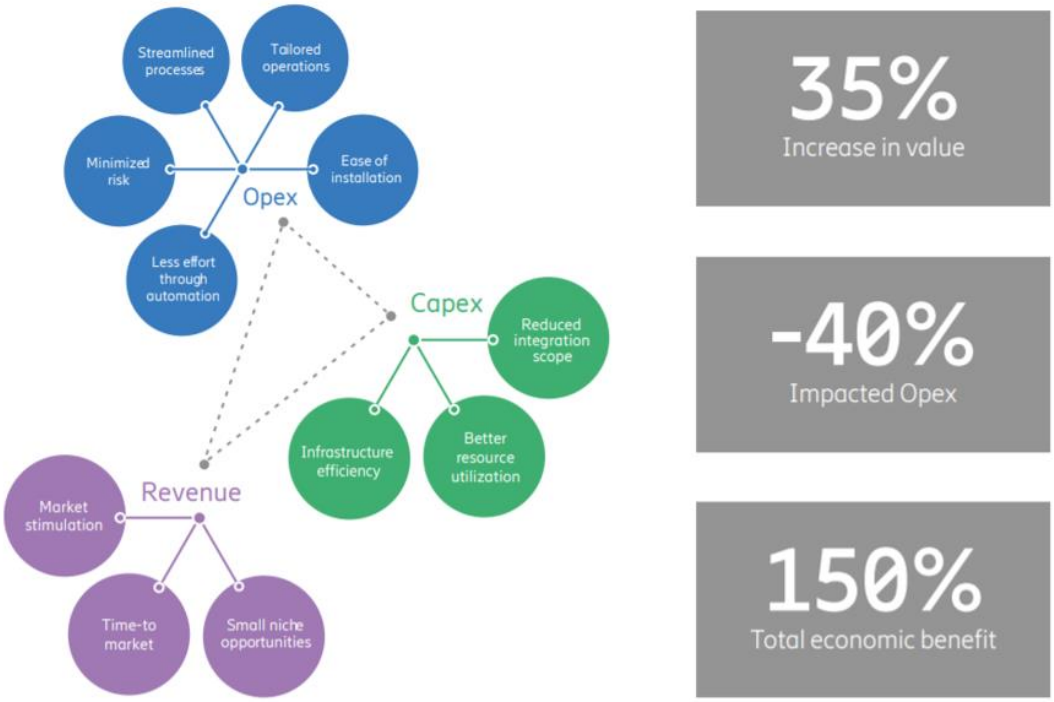


Figure 26 - Financial benefits of 5G Netowrk Slicing - Source Ericsson

6.9.3. 5G Manufacturing “Innovation Zone”

A joint collaboration between AT&T Business, Samsung Austin Semiconductor and Samsung Electronics America, the partners joined together to create America’s first manufacturing-focused 5G “Innovation Zone”[79] in Austin, Texas, with the goal of providing crucial insight into how smart manufacturing can evolve and strengthen the industry at large. The partners produced use cases for 5G which would test the technology over 5G networks for improving manufacturing environments and creating smarter factories.

- One test scenario is in **Health and Environmental Sensors**. Test cases include Demonstrating how 5G and sensors can help first responders locate employees faster as well as speeding up response time in emergency situations.

- The second test case involves **Automated Material Handling, Industrial IoT and Robotics** The partners are demonstrating how 5G, 4K live video and IoT sensor data can be used to improve the factory automation process.
  The automated processes and robotic equipment used throughout the production process in advanced manufacturing favcilities can be enhanced with 5G though large-scale, near real-time monitoring and proactive maintenance of factory automation equipment.
  In this test case the partners proposed an Automated Material Handling System fully equipped with IoT sensors and 4K wireless cameras to demonstrate remote monitoring of factory automation equipment. This type of automation could be equipped with a full range of devices and sensors in order to capture important data on acceleration, position, temperature, humidity, and gas flow rates using 5G Technology.

[79] https://about.att.com/story/2018/samsung_5g_innovation_zone.html

- The final test case involves Mixed Reality for Training
  The goal of this case is to test how 5G and mixed reality can be used to train employees using tools such as wireless Augmented Reality (AR) glasses and low latency content delivery from the edge. The team are testing to see if this technology, can successfully provide an untethered method to virtually train hundreds of employees, providing immersive and immediate access to equipment diagnostics, as well as directions for repairs.

6.10. 5g in Europe

In 2013 the European Commission established a Public Private Partnership on 5G[80] (5G PPP) to accelerate research and innovation in 5G technology. The European Commission has set aside public funding of €700 million through the Horizon 2020 Programme to support 5G activities. In parallel, EU industry is set to match this investment by up to 5x, totalling more than €3 billion.

These activities have been accompanied by an international plan[81] to ensure global consensus building on 5G. The global vision for 5G has been set out at International Telecommunication Union (ITU)[82] level, however the EU is now investigating standardisation with international bodies like 3GPP, the ITU and the Open Networking Foundation.

In order to support the traffic volume expected by 2025 and boost networks and Internet architectures, EU investment in 5G research and standards is necessary in emerging areas such as M2M communication and IoT.

One of the five priority areas of the Digitising European Industry[83] is the topic of 5G standards. EU research is aimed at utilising Europe's technological know-how and industrial leadership in 5G networks under the 5G-PPP. Investigating and developing new and emerging technologies that will arise as a result of the 5G era in another key aim. The EU hopes that the results of this research will shape 5G standards, validate relevant spectrum identification and support a global 5G vision[84].

[80] http://5g-ppp.eu/
[81] https://ec.europa.eu/digital-single-market/en/5G-international-cooperation
[82] http://www.itu.int/en/Pages/default.aspx
[83] https://ec.europa.eu/digital-single-market/en/digitising-european-industry

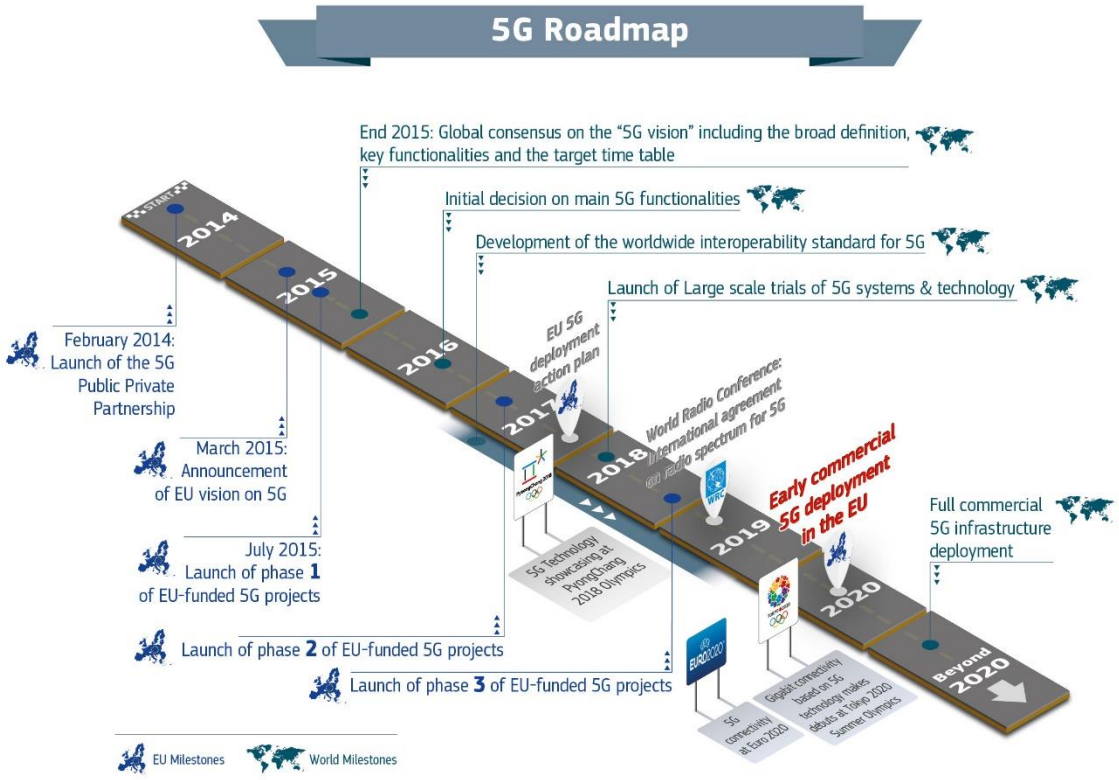


Figure 27 - EU 5G Roadmap[84]

In 2016, the Commission adopted the "5G Action Plan for Europe"[85]. The goal of this action plan is not only to ensure early deployment of 5G infrastructure in Europe but also to start launching 5G services in all EU Member States by the end of 2020. Once achieved, this will be followed by a rapid build-up to ensure that by 2025, EU citizens will experience uninterrupted 5G coverage in urban areas and along main transport routes.

Progress of the 5G Action Plan can be monitored in the European 5G Observatory[86]. Launched in 2018, the European 5G Observatory is a monitoring tool reporting on major market developments in Europe in a global context. It also covers preparatory actions taken by Member States, for example spectrum auctions and national 5G strategies.

For further reading, we direct the reader's attention the report[87] on the main aspects of national strategies from a European perspective - published in October 2018.

6.10.1. The impact of COVID19 in EU 5G Roadmap and European Market

As described earlier, the magnitude of the impact of COVID-19 in near-term stages of 5G delayed roadmap and initial action stages. However, it also presents an untapped opportunity for the recalibration of the 5G market. The recovery plan released by the European Commission is expected to relaunch the economy, bouncing forward by investing in our long-term future; strengthening the Single Market and adapting it to the digital age by investing in more and better connectivity, especially in the rapid deployment of 5G networks.

[84] https://ec.europa.eu/digital-single-market/en/research-standards
[85] https://ec.europa.eu/digital-single-market/en/5g-europe-action-plan
[86] https://ec.europa.eu/digital-single-market/en/european-5g-observatory
[87] https://ec.europa.eu/digital-single-market/news-redirect/639297

6.10.1.1. *Marco-economic overview of the European market.*

The mild scenario provided by the European Central Banks sees a notable rebound in the first half of 2021 and a further strengthening of economic activity in the remainder of 2021, triggered by the assumed swift implementation of medical solutions which gives rise to confidence effects. The negative effects of the pandemic are projected to largely fade out by the end of 2022 when GDP in the mild scenario returns close to the level of GDP envisaged in the pre-crisis December 2019 Eurosystem staff projections. Under the severe scenario, economic activity declines further at the start of 2021 before recovering moderately thereafter. Economic growth continues to be subdued in the severe scenario until the first half of 2022, owing to the assumed further tightening of containment measures in the first quarter of 2021 and greater stringency of these measures throughout the projection horizon, further compounded by significant ongoing uncertainty and financial amplification effects and only partly mitigated by policy support measures. A somewhat more vigorous recovery in growth, compared with the baseline, is projected in the severe scenario only from late 2022, given strong catch-up potential, while not all losses in real GDP compared with its pre-crisis level are expected to be recouped by the end of the projection's horizon.[88]

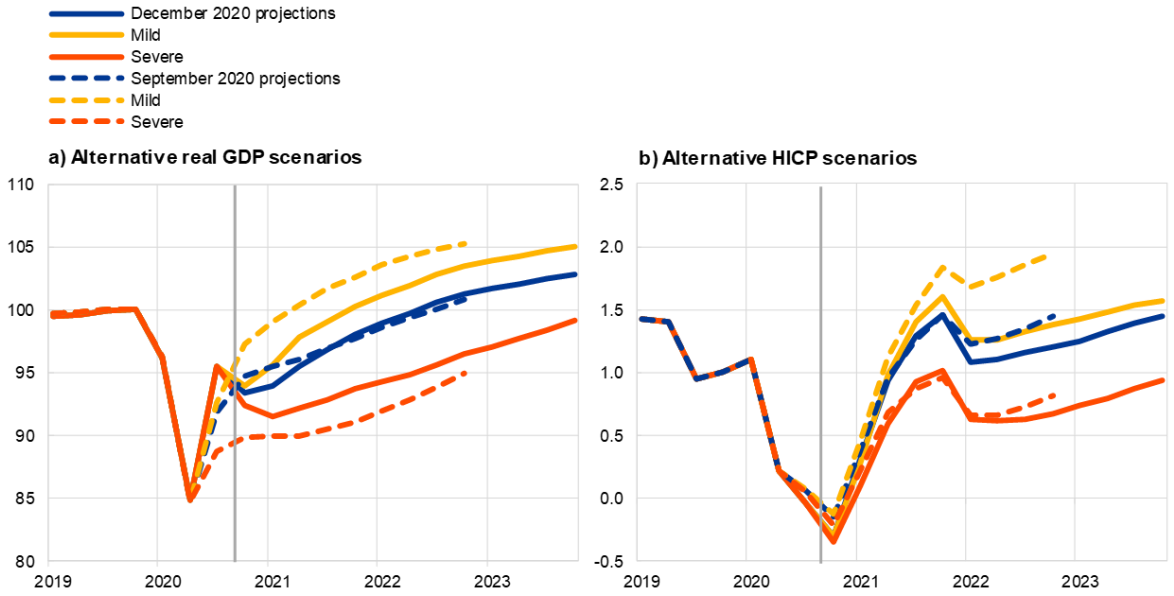


Figure 28 Alternative scenerios fro real GDP and HICP inflation in the euro area. source:ecb.europa.eu

6.10.2. Overview of the European telecommunications market

6.10.2.1. *4G*

4G migration in Europe continues to present opportunities in some markets. After years of investment in 4G technology, H2 2017 saw it overtaking 3G to become the region's dominant mobile network technology (population coverage reached 97% at the end of 2017)[89]

It is clear that the 4G lifecycle is not yet over and therefore investment is likely to continue until 2020. Most of the investment is not focused on network upgrades, mostly driven by technological evolution (e.g. LTE Advanced Pro). There are still opportunities for growth in the 4G market,

[88] https://www.ecb.europa.eu/pub/projections/html/ecb.projections202012_eurosystemstaff~bf8254a10a.en.html

[89] https://www.gsmaintelligence.com/research/?file=8535289e1005eb248a54069d82ceb824&download

namely taking advantage of the gap between 4G take-up and smartphone adoption in some markets (including Austria, Greece and Hungary).

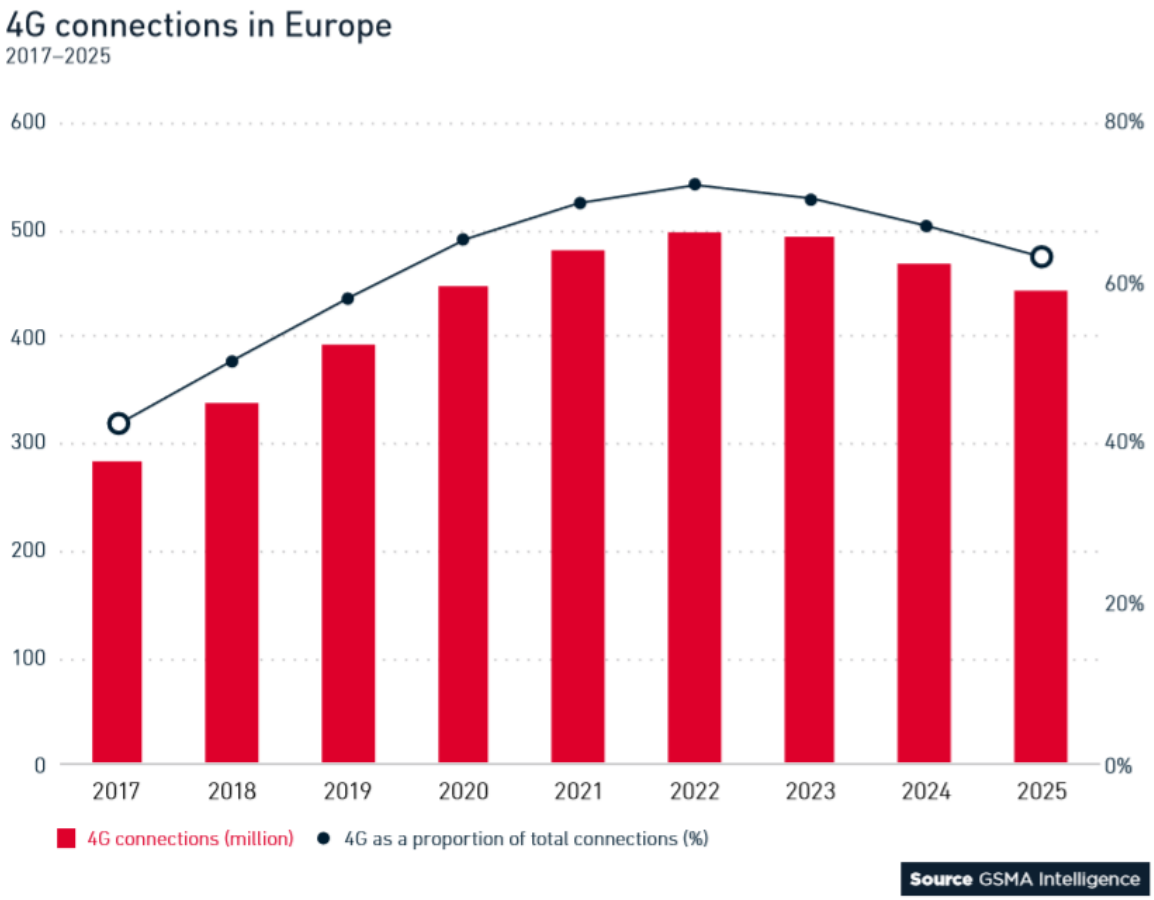


Figure 29 - Source GSMA Intelligence

6.10.2.2.5G in Europe

Funded through the EU's Horizon 2020 programme the more recently launched '5G Verticals INNovation Infrastructure (5G-VINNI)' project aims to accelerate 5G uptake in the region.

The Eu is predicted to lag behind the US, China, Korea and Japan in 5G penetration given their later launch dates. GSMA Intelligence predicts that Europe will reach 29% 5G penetration by 2025 (203 million connections), comparatively lower than the forerunners mentioned previously given later launch timelines and the slower pace of network rollout.

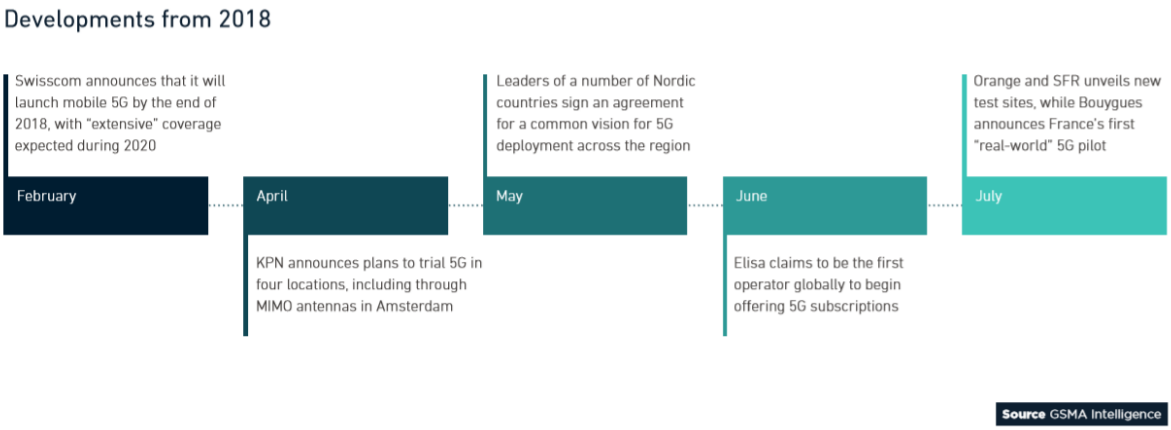
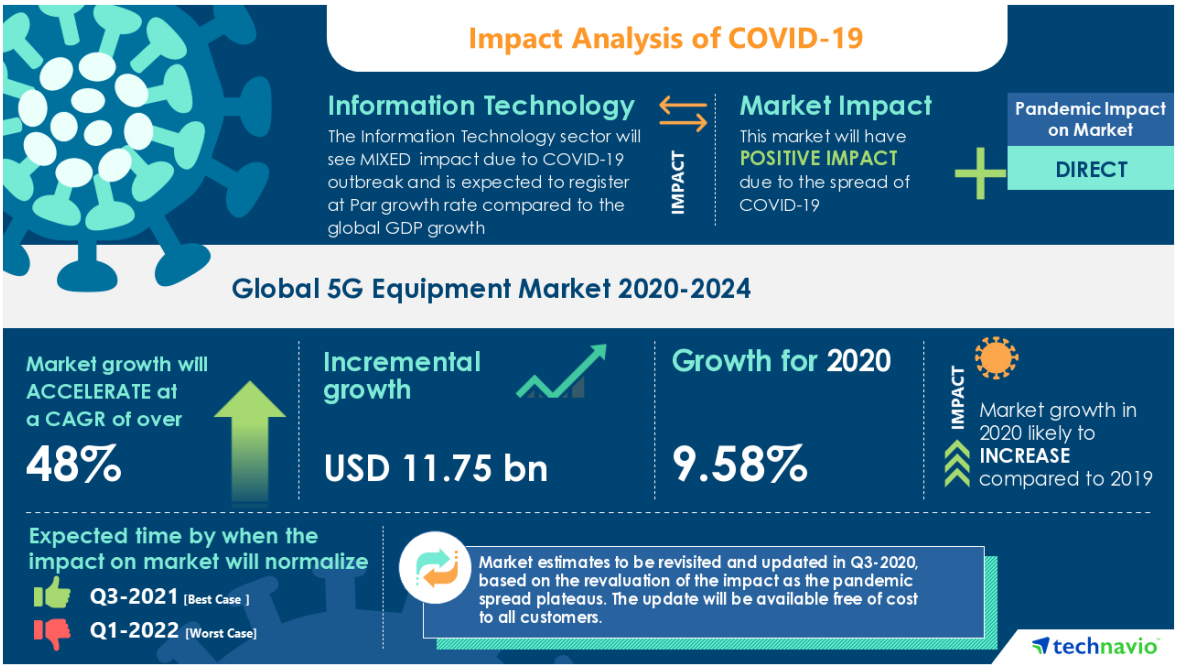


Figure 30 - Major 5G developnts in Europe - Source GSMA Inteligence

As mentioned previously in this report, EU has launched a comprehensive recovery plan (Next Generation EU) that will strengthen Europe as leader in 5G technology. The latest market research, provided by Technavio highlights the great opportunities related to 5G-enables solutions. Although the COVID-19 pandemic continues to transform the growth of various industries, the immediate impact of the outbreak was varied. While a few industries registered a drop in demand, numerous others continued to remain unscathed and show promising growth opportunities. Estimating the 5G equipment market to grow by USD 11.75 bn during 2020-2024, progressing at a CAGR of over 48% during the forecast period.

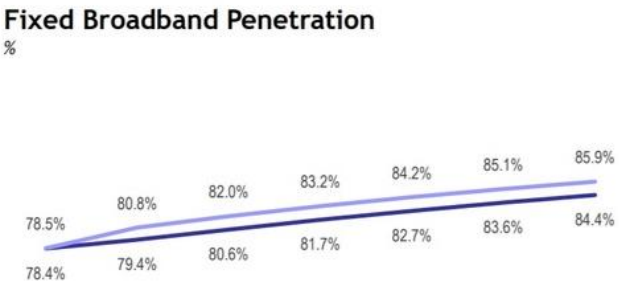


6.10.2.3. *Fixed*

The European market had seen a dramatic change over the previous 10 years featuring a predominance of fixed-mobile operators. 80% of operators in Europe are now integrated fixed-mobile players with very few remaining mobile only players.

Driving economies of scale in network and fibre builds is one of the main reasons behind this shift. Despite these convergences, growth in revenue has not been immediately obvious.

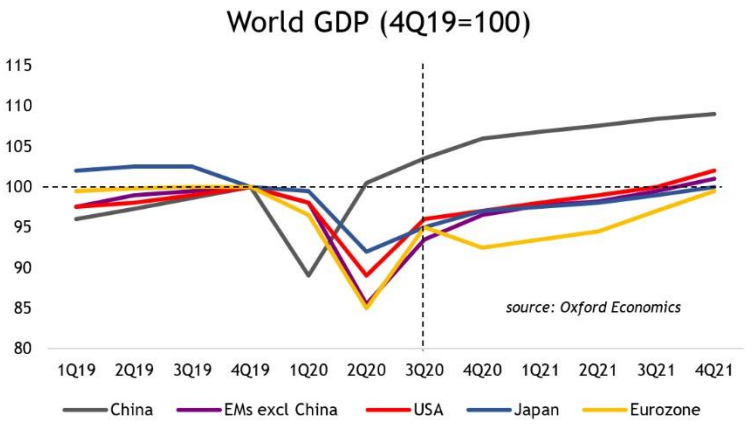
As office workers, students and others continue to seek shelter at home from COVID-19, demand for speedy and reliable Internet service appears to be at an all-time high. As remarked by Mike Dano[90], the demand is beginning to have serious effects on US telecommunications providers: Capgemini recently surveyed 6,300 US consumers and found that almost half (48%) felt their Internet connections didn't meet their needs. The firm also found that customers are increasingly looking at their connection's flexibility and network speeds, rather than just the reliability and price. And according to the financial analysts at New Street Research, this demand is pushing a growing number of US households to seek more reliable wired Internet connections. This situation is similar in Europe.



Besides the previous outlooks for the Spanish, Swedish and Turkish financial markets that can be found in the initial version of this document, we should remark that the policies enacted to counter the effect of the financial fragmentation during the coronavirus rely on an unprecedented amount of fiscal, monetary and prudential policy support.[91] Euro area policy responses to the crisis were decisive at both the national and supranational levels, and it is foreseen a fast recovery during 2021-2022.

[90]https://www.lightreading.com/opticalip/how-rising-broadband-demands-might-reshape-us-telecom/d/d-id/764382

[91]https://www.ecb.europa.eu/pub/economic-bulletin/articles/2020/html/ecb.ebart202007_02~b27e8089c5.en.html


World GDP (4Q19=100)
115
110
105
100
95
90
85
80
1Q19
2Q19
3Q19
4Q19
1Q20
2Q20
3Q20
4Q20
1Q21
2Q21
3Q21
4Q21
source: Oxford Economics
China
EMs excl China
USA
Japan
Eurozone

7. Outline of Strategic Relevance of RELIANCE

7.1. Strategic Relevance of RELIANCE for Spanish Consortium

5G opens new opportunities for connected solutions for industries & IoT. New customized, distributed, composite services will be provided to end users with better quality (QoS) and reduced cost. A framework to control and deliver services over different technical domains with specific SLAs becomes needed. RELIANCE allowed the Spanish consortium to explore the capabilities of vertical-tailored slices “as-a-Service” to deploy new services.

RELIANCE will allow the definition, prototyping and testing of different approaches for mission-critical applications. This will set the foundations for the provisioning of customized solutions to end users, with better QoE, based on the combination of dynamic “cross-domain” services. With RELIANCE, the Spanish Consortium will generate a new framework, with specific services that will provide disruptive business models in key domains: smart facilities and cities, industrial environments and real-time data analysis.

The pandemic has caused an earthquake in labour markets around the world in 2020. The short-term consequences have been sudden and often severe: millions of people have been impacted by temporary lay-offs of staff or lost their jobs, and others have been able to adapt quickly to work from home. Many other workers have been considered essential and have continued to work in hospitals, logistics, security ... but under new protocols to reduce the spread of the coronavirus. In the context of building and facilities management, the data indicates that actions aimed at reducing occupancy density are rapidly accelerating the needs for automation and the inclusion of artificial intelligence.

The business opportunities associated with the use cases defined in Spain: Industry 4.0 and Smart Facility and Building Management are extraordinary, especially those concerning remote operations. In March 2020, the FAA (Federal Aviation Administration) published a policy that recognizes the value of remote management technology for manufacturing and certification processes.

Helen Druet from Donecle Company, stated, as a future concept[92]: “We have seen the development of new use cases, such as the termination of the lease and all the aircraft transition issues, when the lessor inspectors cannot physically go to inspection”, she sums up. "We look forward to more solutions enabling remote inspections and remote collaboration tools, thus accelerating the digitization of maintenance activities." This is where RELIANCE will make a difference.

The developments carried out by TYP and SII CONCATEL have resulted in a comprehensive description of a new BI and ML model for SB&FM and a set of services for the provision of new energy efficiency and security solutions, as well as extraordinarily innovative remote maintenance, based on the concept of volumetric streaming combined with ML and AI. On the other hand, KEYLAND offered a solution to support operators that is having an extraordinary demand.

7.1.1. Strategic Relevance for Industry 4.0 (KEYLAND)

KEYLAND will work together with its main clients to provide specific enhanced services related to collaborative robotics and industrial sensoring control and management in distributed environments/factories. The impact of COVID19 has fastened the industry 4.0 transformations, and commercial demands for remote operation have been requested during 2020. RELIANCE has allowed to identify commercial approaches for the deployment of 5G, taking into account the 5G roadmap.

[92] https://www.aerospacetechreview.com/covid-19-driving-digital-and-remote-maintenance-charlotte-daniels/

The impact of the project remains as initially forecasted: 6% on personnel, an impact on annual turnover of 18% and a positive ROI estimated to be achieved in 15 months of commercial exploitation.

7.1.1.1. *Business Model Canvas*

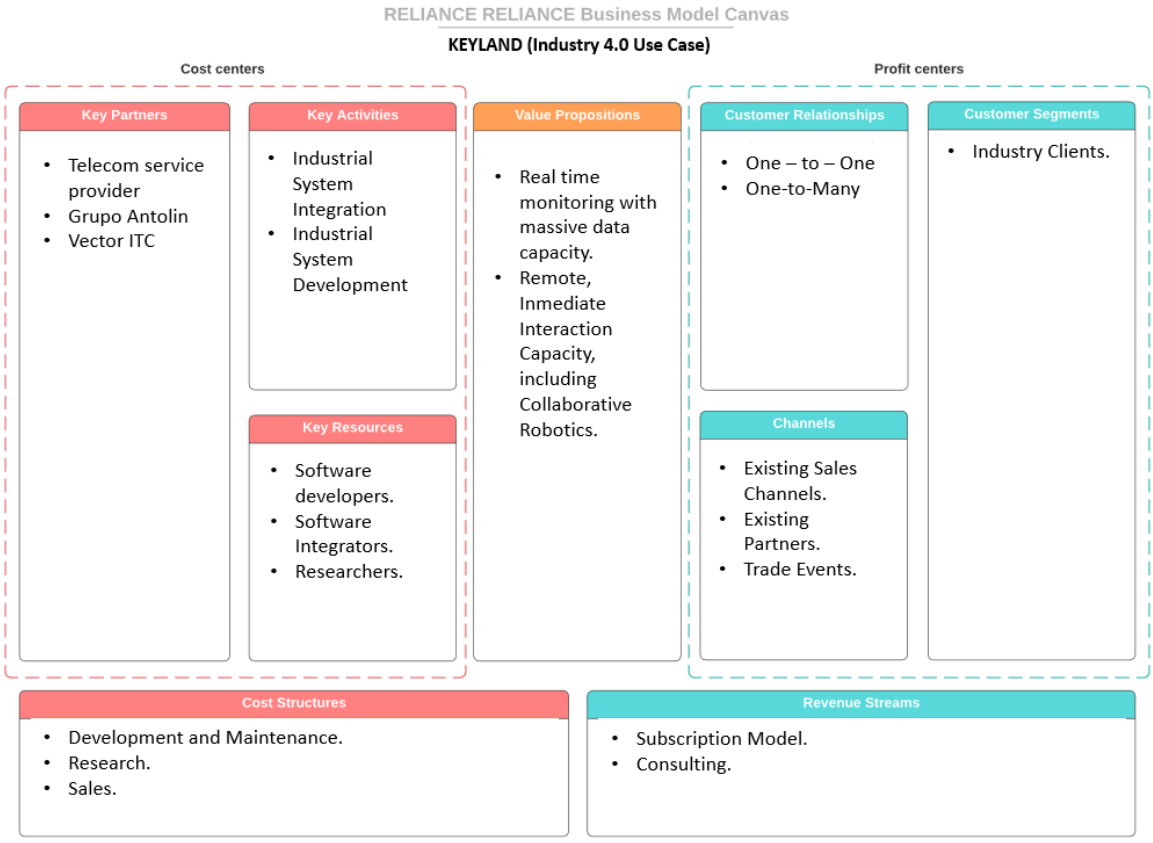


Figure 31 - Keyland Business Model Process

7.1.2. Strategic Relevance for Smart Facility Management (SII CONCATEL & TYP)

SII CONCATEL will include their new services as enhanced, added-value offering for Service ONE and 360 Solutions for Urban Transformation. CCTL estimates an expected employment growth as a result of the project of 5%, and an impact on annual turnover of 8%. A positive ROI is estimated to be achieved within 18 months of commercial exploitation.

TYP will provide new solutions for real-time data analysis, with enhanced machine learning algorithms and large data analysis, as springboard for smart cities management. TyP is forecasting an employment growth of 8%, an impact on annual turnover of 24% and a positive ROI within 14 months of commercial exploitation.

7.1.2.1. *Business Model Canvas*

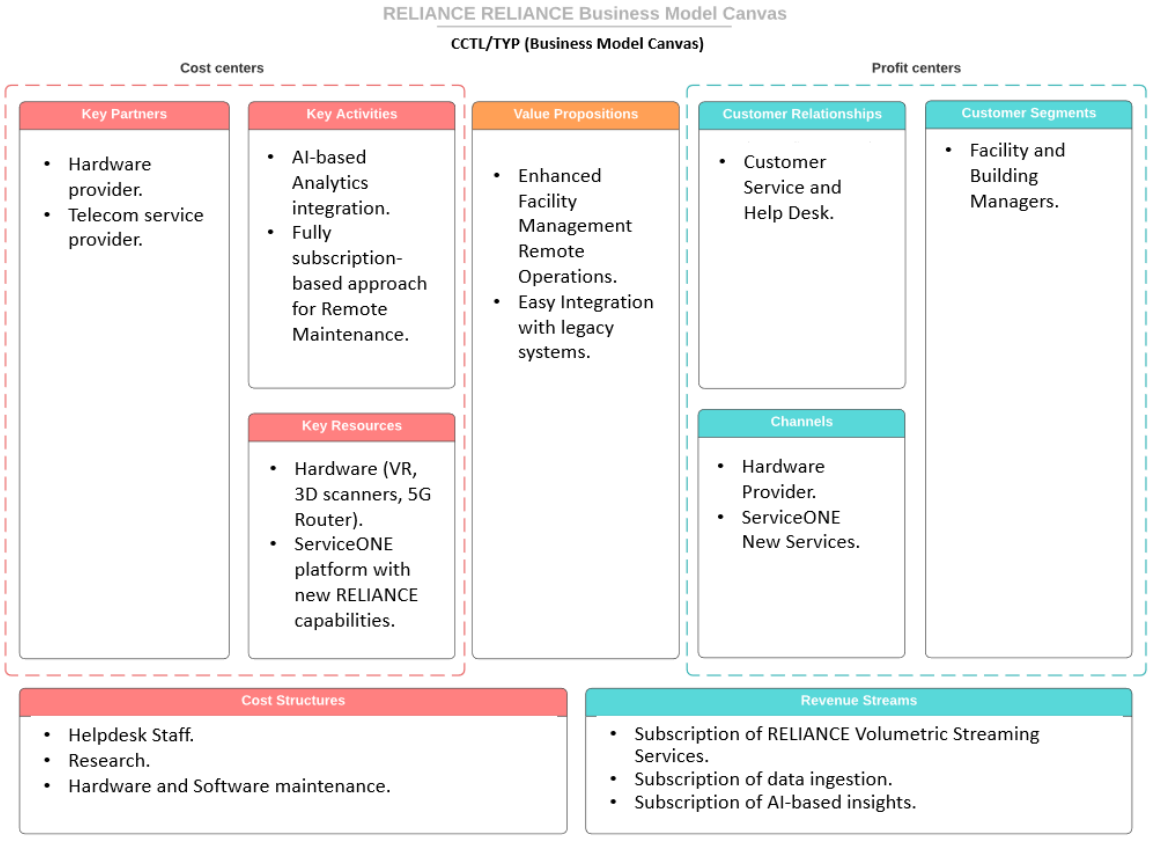


Figure 32 SII CONCATEL / TYP Business Model Canvas

7.2. Strategic Relevance of RELIANCE for Swedish Consortium

RELIANCE will improve the competitiveness of BOMBARDIER and Westermo by moving toward a highly innovative technological and architectural solutions with enhanced survivability/resilience support. BOMBARDIER is the problem owner of the MITRAC TCMS local testbed. BOMBARDIER will provide knowledge and experience on the international communication standards, data, and requirements as well as the simulation and testing of the (On board and Off board) train communication infrastructure. BOMBARDIER will exploit MITRAC testbed results (prototypes and demonstrators aimed to show the (i) 5G evolution of the existing communication system on-board and train to wayside communication and (ii) the research on 5G federated slices for the train to

wayside data communication to increase productivity and profit - in terms of new products and production methodologies and technologies.

BOMBARDIER will exploit the project results with the purpose of optimization, improved commissioning, maintenance, development and upgrading of MITRAC TCMS platform (one of the RELIANCE testbeds). MITRAC TCMS is in use in large number of different products and systems on all types of trains and applications all over the world (such as High Speed Trains, Locomotives, Intercity Trains, and Metros). Bombardier will exploit the MITRAC testbed results to increase productivity and profit - in terms of new products, services and network and communication technologies. More specifically, BOMBARDIER will exploit results for: (i) *Optimized future designs.* Analysis of actual operating conditions and system performance data from the full installed base can enable the railway equipment manufacturer to optimize design and dimensioning practices for cost, reliability and availability. (ii) O*n demand functionality.* Giving the customer the possibility to enable built in functionality for a defined fee.

RELIANCE will allow to boost the digital and data-driven innovation of Westermo and Eduro.

Westermo will bring the results into new products and services such as: (i) cloud connectivity for train builder and (ii) technical specification of 5G router prototype for train application/5G routers for onboard train usage. Westermo today has a large market share for switches and routers for onboard train usage (rough estimate 20% market share). For wireless products Westermo has a very low market share today. The goal is to achieve a similar market share as for switches and routers. Westermo today has one service called WeConnect. This is in early stages. This is currently used in market segments such as process automation and utilities. Westermo want to exploit the results from this project to have a cloud connectivity service for train builders.

Eduro will bring the results into new services for (i) Diagnostic Intelligence and (ii) Cloud solution for Data Management, Access to the Data, and Tools to view and analyse the data. Eduro will exploit RELIANCE results to boost innovation of its NOVA tool (for the development of the new Super NOVA product). NOVA is a tool for handling, collecting, transferring, transforming, making available, analyzes, etc. of diagnostic and operating data from customers' machinery. Currently, NOVA is targeted for the railway industry, although the NOVA approach could be generalized in other manufacturers industrial domains.

7.2.1.1. *Business Model Canvas*

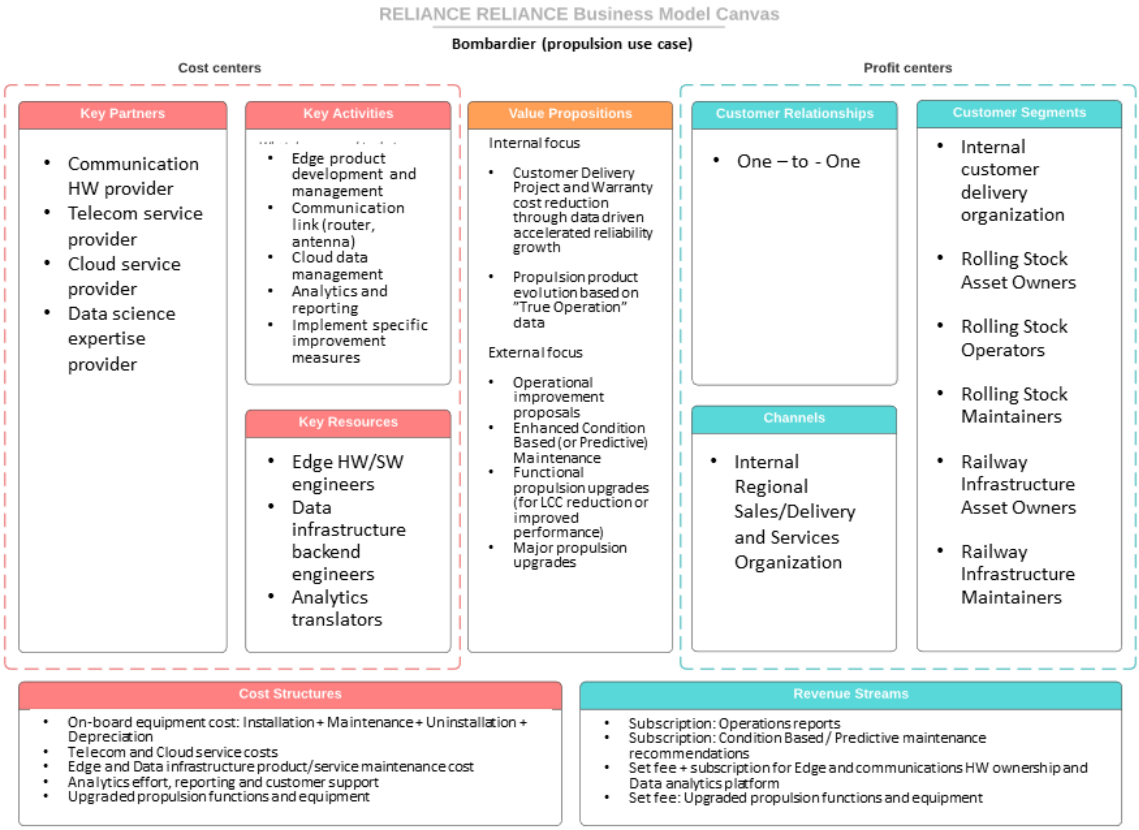
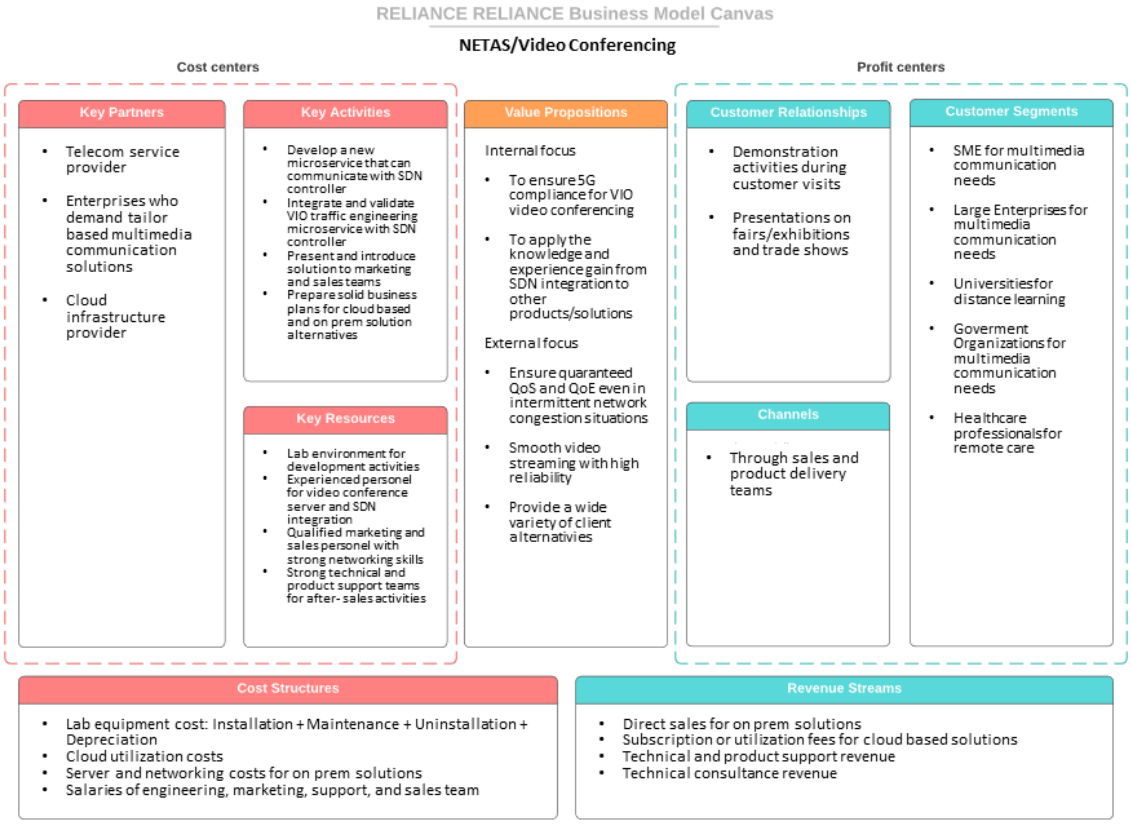


Figure 33 Swedish Use Case, Business Model Canvas

7.3. Strategic Relevance of RELIANCE for Turkish Consortium

Turkish government is ambitious in early adoption of 5G technologies in Turkey in order to tap into the economic benefits and technological advancements it is expected to offer. Information and Communication Technologies Authority (BTK), the regulator in Turkey, is leading the creation of a 5G testbed in Ankara with the inclusion of all three mobile operators (including Turkcell) and three prominent universities (Bilkent, METU, Hacettepe Universities) in the region. Turkcell is the largest mobile operator with more than 35 million subscribers and positions itself as a digital operator with a range of multimedia services such as BiP (WhatsApp like messenger), TV+ (online and offline TV content), fizy (music streaming), lifecell (online storage). RELIANCE will provide resilient and scalable slices to such multimedia services with disparate service requirements, which will be used by Turkcell for its own services and similar services provided by third party content/service providers.



7.3.1.1. *Netas/Video Conferencing Business Model Canvas*

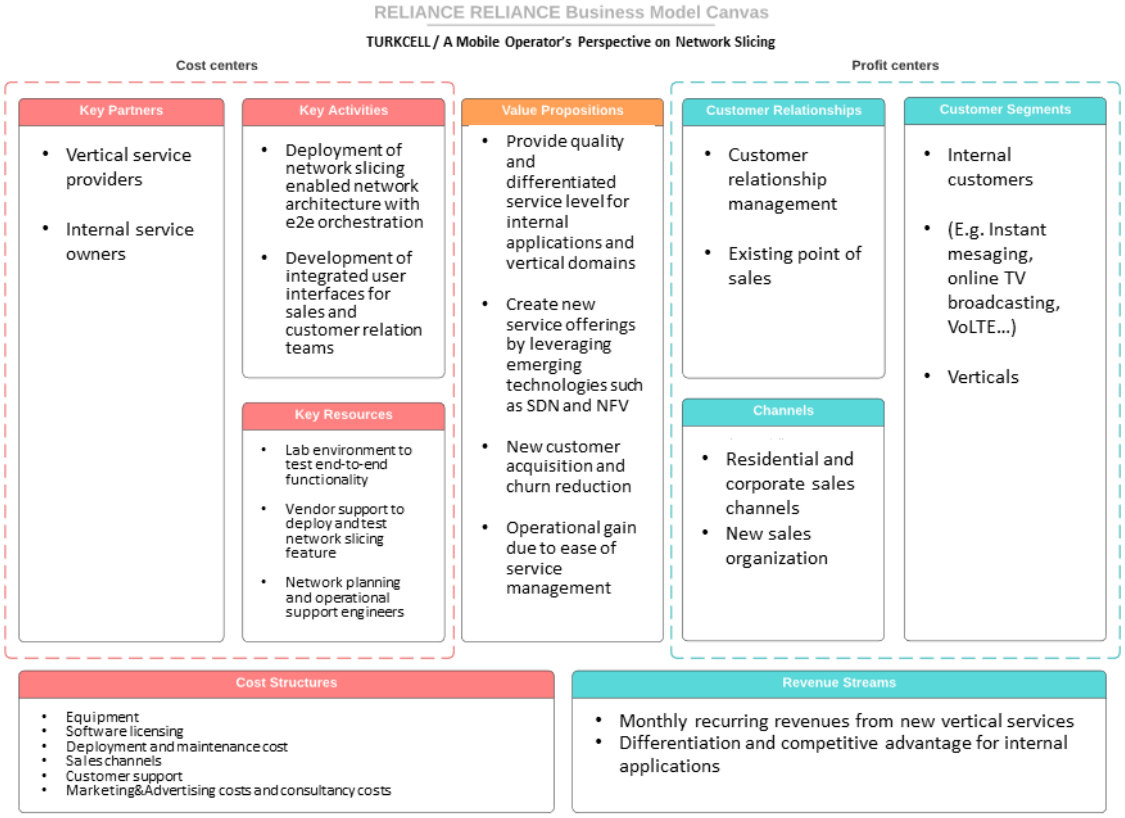
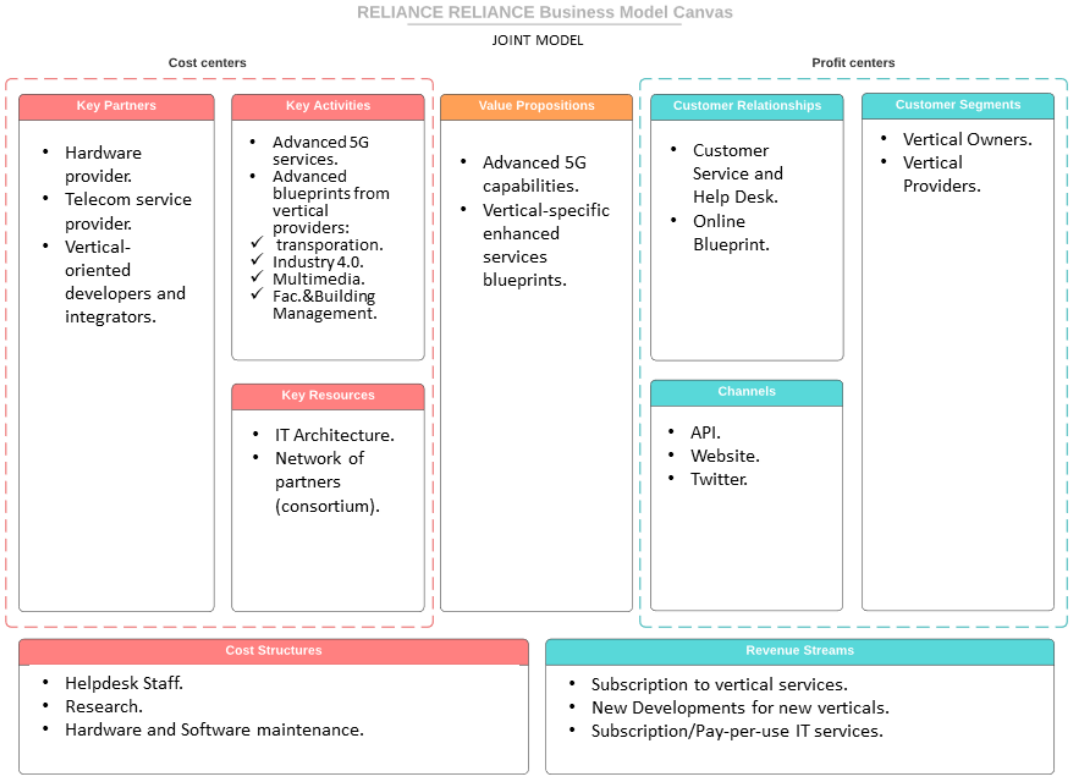


Figure 34 Turkcell Business Model Canvas

7.4. Strategic Joint Relevance of RELIANCE

7.4.1. Joint Business Model Canvas Outlined

The RELIANCE consortium has jointly carried out the analysis of the RELIANCE business model. This exercise has served to identify the different resources developed and generate a joint message. The generated Business Model Canvas is presented below:



The RELIANCE consortium has jointly carried out the analysis of the RELIANCE business model. This exercise has served to identify the different resources developed and generate a joint message. As Key partners, the consortium is having Hardware providers, Telecom Service Providers and Vertical-Oriented Developers and Integrators. We should highlight the Advanced 5G capabilities and Vertical-specific enhanced services as references that could be used as blueprints by third parties. The relation with potential customers in the commercialization phase could lead to the generation of a help desk and to provide the blueprints accessible through the main channel: the website. This could be a useful tool to extend the impact of the project beyond the consortium and current interested parties.

8. Annex – 1 Business model tools, online references and links

There exist many tools to help with the process of developing a business model, both available online and to available to print for offline usage. Section 5 highlights some of the key methods utilised during the project. What follows is an exhaustive list of methods, resources and tools identified during the execution of the task. The learn startup circle[93] has a more extensive list on their website wiki[94].

8.1. Customer development

8.1.1. Customer Development and the Business Model Canvas: How they Fit by Alex Osterwalder

http://www.businessmodelalchemist.com/2010/08/combining-business-model-prototyping-customer-development-and-social-entrepreneurship.html

8.1.2. Customer Development and the Business Model Canvas: Social Entrepreneurship Case Study by Alex Osterwalder

http://www.businessmodelalchemist.com/2011/01/methods-for-the-business-model-generation-how-bmgen-and-custdev-fit-perfectly.html

8.1.3. Entrepreneurship as a Science: The Business Model/Customer Development Stack by Steve Blank

http://steveblank.com/2010/10/25/entrepreneurship-as-a-science-%e2%80%93-the-business-modelcustomer-development-stack/

8.1.4. Turn Your Blog into a Business Model and Customer Development Tool by Tor Grønsund

http://torgronsund.com/2012/06/06/businessmodelpress/

8.2. Building a business model

8.2.1. How to Build Any Business Model with Only 10 Blocks by Nick De Mey

http://www.boardofinnovation.com/2009/03/19/how-to-build-any-business-model-with-only-10-blocks/

8.2.2. 3 Tools to Visualize Your Start-up's Business Model by Philippe De Ridder

http://www.boardofinnovation.com/2010/04/22/3-tools-to-visualize-your-start-ups-business-model/

[93] http://leanstartupcircle.com/
[94] http://leanstartup.pbworks.com/w/page/47250326/BusinessModelCanvas

8.3. Lean business model canvas

8.3.1. Why Lean Canvas vs. Business Model Canvas by Ash Mauyra

http://www.ashmaurya.com/2012/02/why-lean-canvas/

8.3.2. Digging Deeper Into Lean Business Model Canvases by Ben Yoskovitz

http://www.instigatorblog.com/deeper-lean-biz-model-canvas/2011/05/26/

8.4. User experience

8.4.1. Business Model Canvas for User Experience by Tristan Kromer

http://grasshopperherder.com/business-model-canvas-for-user-experience/

8.5. Further links to online tools

- http://www.alexandercowan.com/canvas/
- http://bmfiddle.com/
- http://businessmodelzen.com/
- http://businessmodelstudios.com/resource-guide/
- http://CanvasBM.com
- http://canvanizer.com/ supports BMC and Lean Canvas
- http://www.bmcanvas.com
- http://www.boardofinnovation.com/business-model-templates-tools/
- http://www.leanstack.com/ (includes LeanCanvas)
- http://lienzo.biz/
- https://strategyzer.com/
- https://www.stratnavapp.com/

9. Annex 2 – 5G Test Cases, *further study*

As part of the research, various current and past implementations of 5G were studied to discover how the technology has been implemented and what the results of this implementation were. An extensive list of test cases for 5G deployments across a number of verticals can be found below.

Section 6.9 goes into more detail on a selection of use cases considered more relevant to RELIANCE.

- AT&T and Samsung Create America's First Manufacturing-focused 5G "Innovation Zone" https://about.att.com/story/2018/samsung_5g_innovation_zone.html

- Private networks, guaranteed service, total control – "We are proving 5G for Industry 4.0," says Vodafone https://enterpriseiotinsights.com/20190307/channels/news/we-are-proving-5g-for-industry-says-vodafone

- T-Mobile launches next generation of mobile communications: Innsbruck is Austria's first 5G city https://www.telekom.com/en/media/media-information/archive/innsbruck-is-austria-s-first-5g-city-514808

- Telefonica will deploy 5G capabilities in two Spanish cities in cooperation with Nokia and Ericsson https://www.rcrwireless.com/20180122/5g/telefonica-launches-5g-project-in-spain-tag23

- Proximus and Huawei team up for first successful 5G outdoor trial in Belgium https://www.proximus.com/en/news/proximus-and-huawei-team-first-successful-5g-outdoor-trial-belgium-speeds-294-gbps-reached-end

- Deutsche Telekom claims European 5G first https://www.mobileworldlive.com/featured-content/home-banner/deutsche-telekom-makes-progress-on-5g/

- Telia, Nokia and Intel bring 5g to the factory floor https://www.teliacompany.com/en/news/news-articles/2018/telia-nokia-and-intel-bring-5g-to-the-factory-floor/ https://www.nokia.com/about-us/news/releases/2018/04/12/nokia-and-telia-conduct-industry-40-trial-in-finland-leveraging-low-latency-and-high-bandwidth-of-5g-technology/

- Italy's consortium unveils first 5G-based field applications https://www.rcrwireless.com/20180530/5g/italy-consoltium-unveils-first-5g-based-field-applications-ag23

- Deutsche Telekom showcases 5G, EAN, smart home applications at MWC https://www.telecompaper.com/news/deutsche-telekom-showcases-5g-ean-smart-home-applications-at-mwc--1233729

- 5g technology applied to ASTI mobile robotics' AVGS https://www.5tonic.org/news/5g-technology-applied-asti-mobile-robotics-agvs

- 5G network for industrial use launched at Volvo CE site in Sweden https://www.ericsson.com/en/networks/cases/5G-network-for-industrial-use-volvo-ce-sweden

- 5G ultra-low latency propels jet engine manufacturing https://www.ericsson.com/en/networks/cases/5g-ultra-low-latency-propels-jet-engine-manufacturing

- Case Study: Operators collaborate to drive mission-critical services globally using 5G https://www.ericsson.com/en/news/2018/2/case-study-bt-verizon-and-ericsson

- The 5G race is on https://www.ericsson.com/en/news/2017/5/ericsson-and-verizon-test-the-limits-of-5g

- You need to see what pro football players can do with 5G https://www.ericsson.com/en/blog/2018/2/you-need-to-see-what-pro-football-players-can-do-with-5g

10. References

https://peoi.org/Courses/Coursesen/emarket/Resources/Business%20Models%20for%20Electronic%20Markets.pdf
https://www.researchgate.net/publication/228718351_Business_Models_for_Internet-Based_E-Commerce_An_Anatomy
http://home.ku.edu.tr/~daksen/mgis410/materials/Business_Models_on_the_Web.pdf
https://www.researchgate.net/publication/37408327_Internet_Business_Models_and_Strategies
https://onlinelibrary.wiley.com/doi/pdf/10.1002/smj.187
https://faculty.darden.virginia.edu/Ebusiness/Tapscott%20Article.pdf
https://www.hbs.edu/faculty/Publication%20Files/01-002_07351ae8-58be-44e5-a6d8-205cbf5b4424.pdf
http://businessmodels.eu/images/banners/Articles/Morris_Schindehutte_Allen_Richardson.pdf
http://businessmodels.eu/images/banners/Articles/Shafer_Smith_Linder.pdf
https://books.google.de/books/about/Open_Business_Models.html?id=FzWqNyPtC38C&redir_esc=y
https://hbr.org/2008/12/reinventing-your-business-model
https://www.sciencedirect.com/science/article/abs/pii/S0024630110000105
https://profesores.virtual.uniandes.edu.co/~isis1404/dokuwiki/lib/exe/fetch.php?media=bibliografia:9_business_model_generation.pdf
http://www.bmcommunity.sitew.com/fs/Root/8jif5-AmitZottMassa.pdf
http://www.bmcommunity.sitew.com/fs/Root/8jif5-AmitZottMassa.pdf
https://pdfs.semanticscholar.org/91c4/779101ca230c8d3730f222ef4df9795c7789.pdf?_ga=2.39759584.276440365.1567965173-2093441951.1567965173
https://journals.aau.dk/index.php/JOBM/article/view/1877
http://www.fluidminds.ch/en/home.htm
https://www.thegeniusworks.com/wp-content/uploads/2017/06/St-Gallen-Business-Model-Innovation-Paper.pdf
http://businessmodelalchemist.com/blog/2005/11/what-is-business-model.html
http://businessmodelalchemist.com/blog/2005/11/what-is-business-model.html
https://www.alexandercowan.com/business-model-canvas-templates/
https://theuxreview.co.uk/user-journeys-beginners-guide/
https://theuxreview.co.uk/personas-the-beginners-guide/
https://www.entrepreneur.com/article/307932
https://www.toms.co.uk/improving-lives
https://www.warbyparker.com/buy-a-pair-give-a-pair
https://midwivesforhaiti.org/
https://wildflowerandoak.com/pages/midwives-in-haiti
http://www.businessdictionary.com/definition/razorblade-model.html
https://www.hbs.edu/openforum/openforum.hbs.org/goto/challenge/understand-digital-transformation-of-business/sony-playstation-now-evolution-of-gaming-business-models.html
https://fourweekmba.com/cash-conversion-cycle-amazon/
https://fourweekmba.com/multi-sided-segment-business-model/
https://www.ftc.gov/tips-advice/business-center/guidance/business-guidance-concerning-multi-level-marketing

https://www.spotify.com
https://www.dropbox.com/individual/plans-comparison
https://cdn.chiefmartec.com/wp-content/uploads/2014/01/marketing_technology_jan2014.png
https://smallbusiness.chron.com/vertically-integrated-business-model-68292.html
https://www.theguardian.com/business/2018/jul/08/high-street-digital-economy-business-rates
https://econsultancy.com/digital-experts-future-high-street-retail/
https://www.bbc.com/news/business-43240996
https://www.ft.com/content/f072a47e-2ebf-11e9-80d2-7b637a9e1ba1
https://gdpr-info.eu/
https://duckduckgo.com/?t=hp
https://fourweekmba.com/duckduckgo-business-model/
https://www.cheatsheet.com/gear-style/why-edward-snowden-supports-apples-stance-on-privacy.html/?a=viewall
https://www.researchgate.net/publication/321007042_Competitive_Strategy_Techniques_for_Analyzing_Industries_and_Competitors
Europe's future is digital. Speech by Commissioner Oettinger at Hannover Messe http://europa.eu/rapid/pressrelease_SPEECH-15-4772_en.htm
https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=2897
https://mavenir.com/sites/default/files/2018-12/Mavenir-5G-Business-Models-Resource.pdf
https://5g.co.uk/guides/what-is-enhanced-mobile-broadband-embb/
https://ovum.informa.com/resources/product-content/are-you-ready-for-profitable-5g-monetization-spt001-000071

https://www.statista.com/statistics/867967/5g-embb-use-cases/
https://www.telecomstechnews.com/news/2018/feb/08/how-5g-mobile-services-enable-new-m2m-apps/
https://www.gsma.com/iot/mobile-iot-technology-nb-iot/
https://www.gsma.com/iot/mobile-iot-technology-lte-m/
https://www.link-labs.com/blog/future-of-wifi-802-11ah-802-11ad
https://ieeexplore.ieee.org/abstract/document/7842415
https://arxiv.org/pdf/1704.05565.pdf
https://enterpriseiotinsights.com/20190114/channels/fundamentals/three-5g-urllc-use-cases
http://www.5gamericas.org/files/5115/4169/8314/5G_Americas_URLLLC_White_Paper_Final_11.8.pdf
http://cscn2017.ieee-cscn.org/files/2017/08/Janne_Peisa_Ericsson_CSCN2017.pdf
https://5g-ppp.eu/wp-content/uploads/2014/02/5G-PPP-White-Paper-on-Factories-of-the-Future-Vertical-Sector.pdf
https://www.hafen-hamburg.de/en/news/new-communication-standard-5g-industrial-environment-trial-platform-launched-in-the-port-of-hamburg---35629
https://www.telekom.com/en/media/media-information/archive/port-of-hamburg-is-ready-for-5g-574536
https://www.itu.int/en/ITU-D/Regional-Presence/ArabStates/Documents/events/2019/ET/Nokia-Ghribi-%20Unlocking%20the%205G%20opportunity%20final%20ITU.pdf
https://www.ericsson.com/4a45a8/assets/local/digital-services/trending/scalable-network/executive_guide_network_slicing.pdf
https://about.att.com/story/2018/samsung_5g_innovation_zone.html
http://5g-ppp.eu/
https://ec.europa.eu/digital-single-market/en/5G-international-cooperation
http://www.itu.int/en/Pages/default.aspx
https://ec.europa.eu/digital-single-market/en/digitising-european-industry
https://ec.europa.eu/digital-single-market/en/research-standards
https://ec.europa.eu/digital-single-market/en/5g-europe-action-plan
https://ec.europa.eu/digital-single-market/en/european-5g-observatory
https://ec.europa.eu/digital-single-market/news-redirect/639297
https://ec.europa.eu/info/sites/info/files/economy-finance/ip102_en.pdf
https://www.axa-im.com/en/content/-/asset_publisher/alpeXKk1gk2N/content/2019-outlook-it-s-getting-cloudy-the-ecb-won-t-take-back-the-umbrella/23818
https://www.gsmaintelligence.com/research/?file=8535289e1005eb248a54069d82ceb824&download
http://leanstartupcircle.com/
http://leanstartup.pbworks.com/w/page/47250326/BusinessModelCanvas