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WHEN CONNECTIVITY IN HEALTH REALLY MATTERS

How challenges in health, care and cure can be relieved by state of the art wireless connectivity

JUNE 2021

Connectivity in health

Health and cure sectors are subject to astounding challenges; ranging from ever increasing costs and tightness of budgets to staff shortages and from an ageing population to increasingly demanding patients and visitors. From cloud data to tele-diagnostics; technology is everywhere. Innovation and rapid technological development come to rescue for at least some of the many challenges health is facing. One such a rapidly developing field of technology and innovation is wireless services, new wireless networks and innovative wireless health care concepts. The most eye-catching development is the introduction of 5G networks, the latest standard in mobile technology; which promises to serve professional usage like the health sector even more than consumers.

This white paper examines the extent to which wireless technology can facilitate defiance in health sectors and alleviate the strain on staff and budgets. In this paper we will focus on the challenges and developments in the health sector and will take these as the starting point. We will dwell on wireless developments but only to enable the reader to attribute facilitation by wireless to health issues and challenges; not as an aim in themselves.

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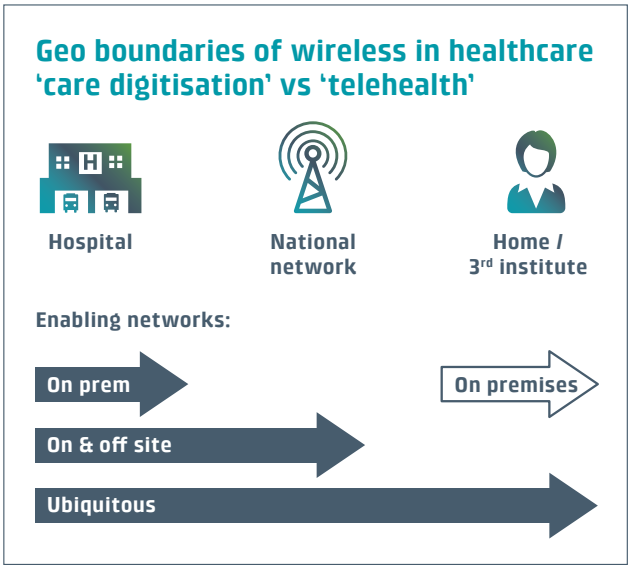
1. Challenges in health and cure sectors

From a variety of studies from reputed agencies and sources as much as the hospitals and care partners we work with, we have derived the below overview of developments and challenges in health. They fall into large clusters of health and cure developments, like process optimisation, remote diagnostics and medication, big data, hospitability of the care environment, IoT and smart building, track and trace and robotics. We will explore these clusters and the underlying health developments below.

1.1 Geographical boundaries of health services

When looking more closely one can discriminate between developments that take place within the health institute – hospital, elderly home, cure institute – and developments that affect both the health facilities and a wider area, most often up to the patient's home; notably a country of even vaster.

This distinction is relevant. Relating to wireless as an enabler of improved processes, the more local or on site developments can be catered for by on premises networks such as Wi-Fi, private LTE/5G or an enhanced local service from an mobile operator. Services and processes that take place between institutes or stretch all the way to the home of the patient will require wireless presence also at that alien or 3rd party's facility and/or at the patients' home. Here, other players may be at stake to facilitate with wireless; notably national mobile operators or wireless networks at the 'other end' of a service or process.



1.2 Macro economic health challenges

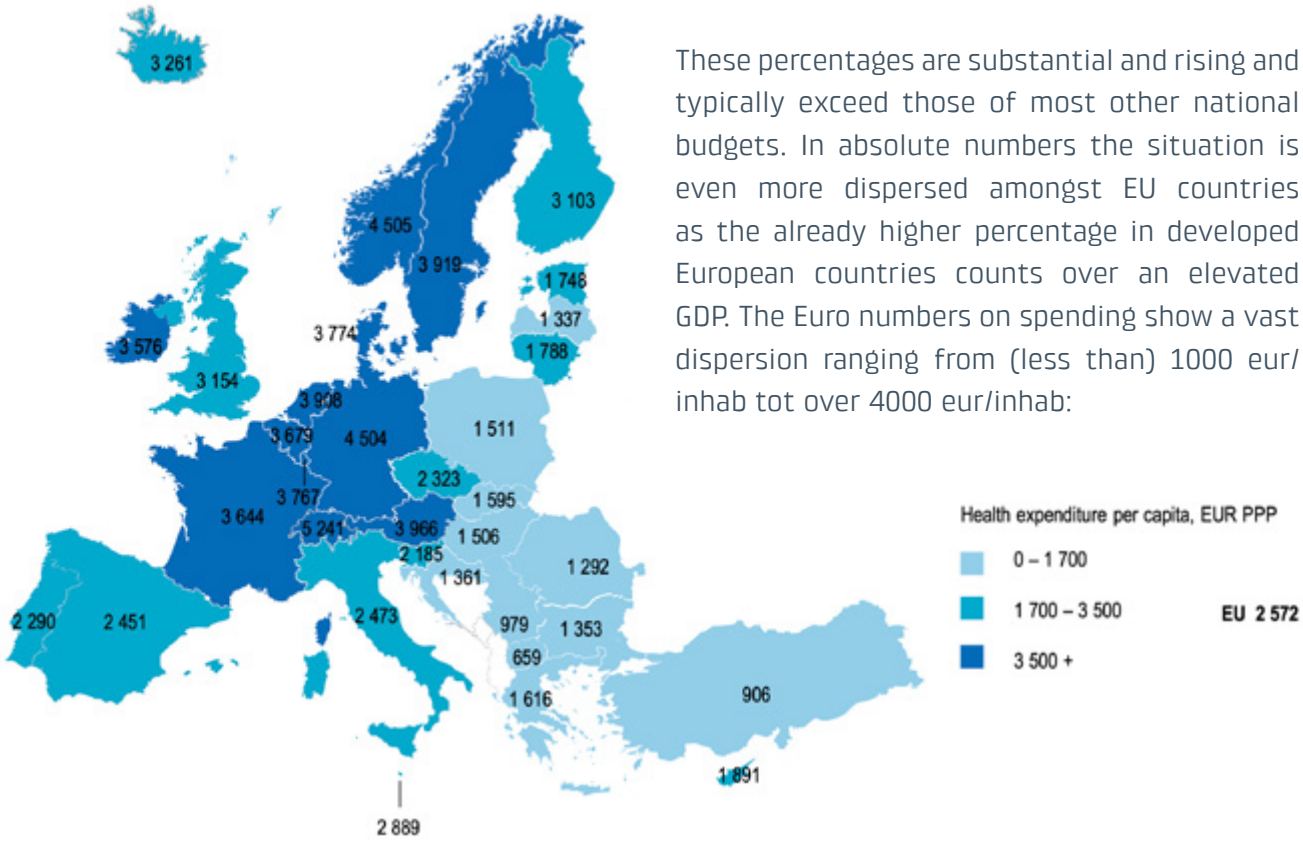
Clearly, there are some overlying developments and challenges that hoover over the entire health sector without discriminating between local or regional/nationwide. Some of these challenges are.

Cost constraints and ageing population

Just about every western country struggles with the rapidly rising – if not exploding – costs of national healthcare. One definite trend that affects costs of the health sector in every country is ageing. According to the Eurostat 2019 Edition of the Ageing Europe report, the proportion of the population aged 65 years and over will increase significantly, **from 101 million in 2018 to 149 million by 2050**. During this

period, the number of people in the EU aged 65-74 is projected to increase by 17.6% whilst the population of those aged between 75-84 years is forecast to expand by 60.5%. In addition, from 2018 to 2050, the population of those aged 85 years and over is expected to increase by 130.8% to 31.8 billion by 2050. This, in combination with the fact that we tend to cause the bulk of our medical expenses in the last years of our lives, is an alarming statistic.

These number pose a dramatic burden on the solidarity within western societies.
Interestingly, the increase in care expenses is also attributable to technology developments like new medicines, better treatments, new equipment and robotics. The same technology is also likely to contribute to savings, with wireless being one of those remedies.

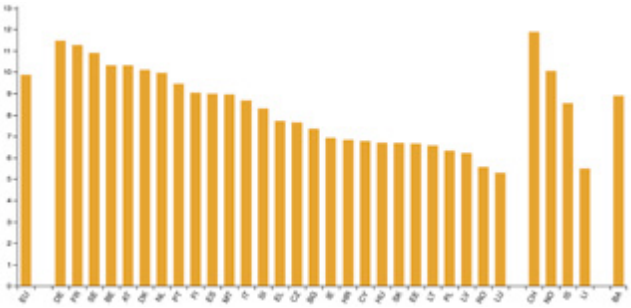


Source: OECD Health Statistics 2020; Eurostat Database; WHO Global Health Expenditure Database

Wireless developments and notably 4 and 5G services can bring some relief to this worrying macro-economic development. With wireless availability everywhere and notably within the care institute and with managed and controlled service and performance levels of these networks, economic relief can be provided as we'll demonstrate at the end of this section.

Cost of health sector and GDP

Already, the health sector consumes a large proportion out of any countries' GDP; ranging from around 6% in so called new member states to around 9% in developed western European countries[1]:

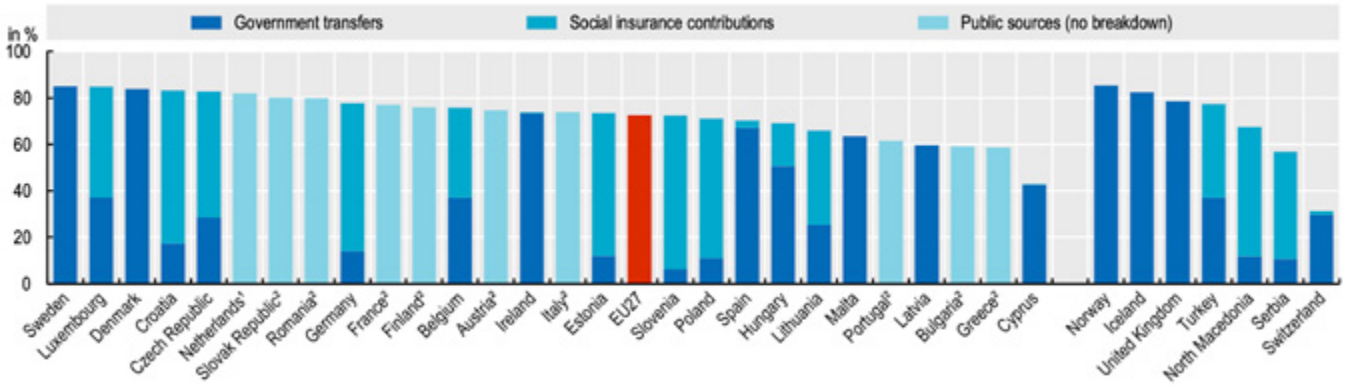


Source: Eurostat (online data codes: hlth_sha_11_hf, demo_gind and nama_10_gdp)

These percentages are substantial and rising and typically exceed those of most other national budgets. In absolute numbers the situation is even more dispersed amongst EU countries as the already higher percentage in developed European countries counts over an elevated GDP. The Euro numbers on spending show a vast dispersion ranging from (less than) 1000 eur/inhab tot over 4000 eur/inhab:

[1] Deloitte: 'shaping the future of European health care'

The difference in spending and notably the high expenses in the most developed countries are likely to yield a tendency towards cost saving such as implementation of IT that helps streamline the – typically staff intensive – health processes.
The way the health sector is funded also varies vastly over member states:



Health at a Glance: Europe 2020 state of health in the EU cycle', OECD, European Commission

Again, differences in funding are likely to impose different drives towards efficiency and use of (wireless) IT. In the Netherlands for instance, the system heavily relies on individual insurance schemes and the insurance companies are known to be very keen to steer towards efficiency and apply care and cure wherever it is cheapest.

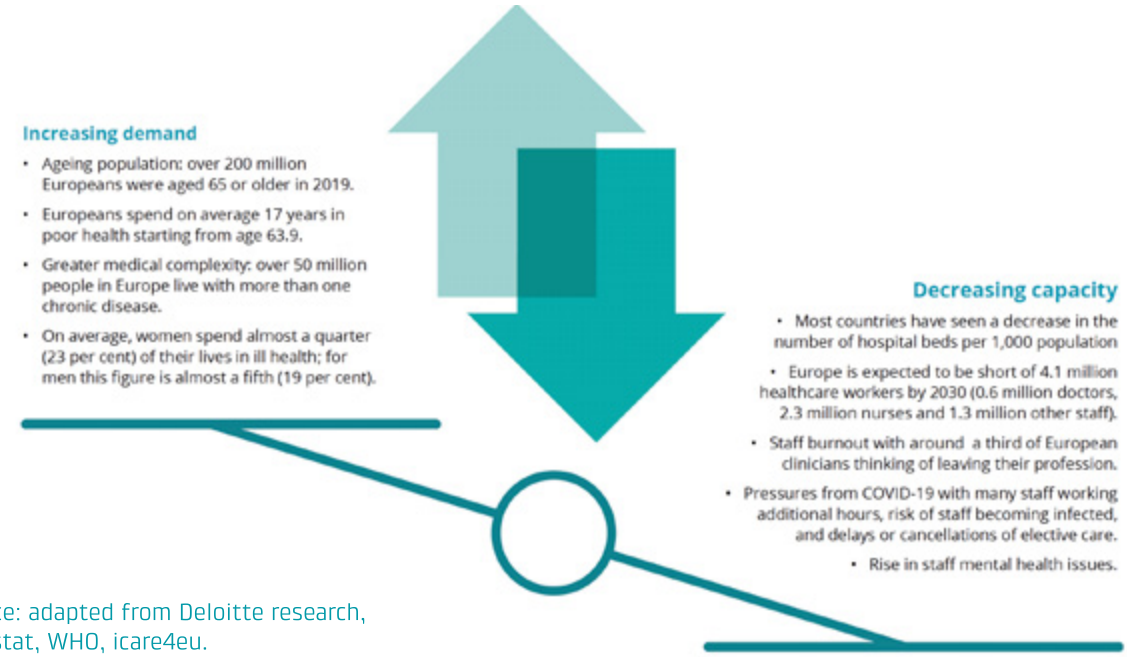
Scarcity of staff

With on the one hand the rise in demand for care and on the other hand the decreasing number of working people vs the retired and elderly, there is a worrying shortage of staff to be expected in the health sector.
Here, wireless development can enable the smarter processes and efficiency enhancements in workflow as previously identified.

Specialization, externalisation and efficiency

In the light of the trend identified there is a permanent need to control cost, enhance efficiency and wherever possible outsource care and cure to the 'lowest cost possible production method' in the value chain, often an external entity. In recent decades, outsourcing of services such as clinical analyses, diagnostic medical imaging, physical therapy, and mental health, among others, has increased.

The tension between ever rising demand, more capable yet costly treatment on the one hand and strain on staff and expenses on the other hand can be visualised as follows[2]:



Source: adapted from Deloitte research, Eurostat, WHO, icare4eu.

As we'll elaborate further down, increase of use of IT and wireless is inevitable in a drive to contain these challenges that will face all EU countries for decades to come.

There is a manifest need to transform health organizations with a more holistic health concept in which prevention, health education, early diagnosis, clinical decision support, therapeutic follow up and remote monitoring will play a key role. This transformation will be possible thanks to digital technologies and especially Artificial Intelligence.

For instance, the insurance companies who primarily pay for treatment are a driving force behind process optimisation and externalisation of care to the most affordable yet well-equipped level.

Externalisation and commoditisation in care & cure

Academic hospitals
Specialised care. Care innovation and development of novelties into 'standard' treatments at academic hospitals.

Regular hospitals
Affordable, standardised care and medical treatment, nearer to patients through 'general' hospitals and clinics.

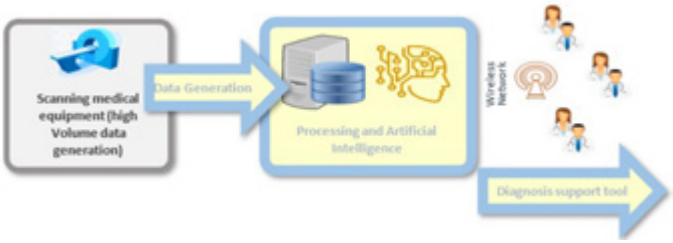
Physicians and care institutions
Local, affordable and dispersed treatment and diagnosis at or close to patients' premise. Connectivity inherent.

Wireless connectivity as we will elaborate further in par. 3 enables many of these externalisation trends. Without wireless enabling many of the external developments, process improvements and costs savings would simply not materialize.

For the comprehensive macro trends and economic challenges addressed in this section, wireless provides supportive elements such as:

[2] Deloitte: 'shaping the future of European health care'

- Asset tracking. Through IoT and sensors, staff will always know where crucial devices and objects are.
- AI/VR (Artificial Intelligence, Virtual Reality). This will allow staff to 'take a look' at patients, diagnostics, care processes and notably those located elsewhere without having to displace themselves.
- Automation and robotics, even in personal care will relief staff of time consuming tasks.
- Big data, EPD and cloud will bring patient information and treatment intelligence to the health worker as the situation requires. Mobile devices will cater for availability of such data anywhere and ubiquitously.
- Remote diagnostics and telemedicine, enabled by omnipresent wireless networks will reduce time spent on patient contact and diagnosis.



> *For reasons of affordability and patient comfort, care will increasingly be provided at the patient's home. Insight into the patient's situation is necessary in order to provide care close to home. We are using more and more monitoring in near real-time to achieve this. And it leads to a saving in beds in hospitals, including UMCs.*
>
> *Ronald Kerremans, Enterprise Architect IT, Radboudumc*

1.3 At a glance: Facilitating wireless networks and services

Further down, in chapter 4, we will examine more closely how wireless networks and developments can facilitate health developments. Here, we will just provide a glimpse (see box) for the reader to understand what wireless enablers we may refer to in the following sections. These networks can be facilitated by managed service providers, system integrators and full service providers.
For wireless connectivity between institutes or across regions or countries; often other networks and players will come to mind as visualised in 2.1. The networks to be used are most often the national mobile networks, either from the licenced mobile operators or service providers[3] that run services over those operators networks. Note that there are also such service providers that cater for data between devices only, the so called IoT providers. IoT is likely to play a big role in health as it provides connected devices, asset tracking, remote diagnostics etc.

Facilitating wireless networks

For the more local and on premises processes, the wireless developments that facilitate health processes can be enabled by for instance:

- **Private wireless networks with superior performances.** In the Netherlands there are 100's of so called 'private GSM' systems in use in care institutes, replacing incumbent voice systems and facilitated by availability of spectrum ('frequencies') for private networks.
- **In building wireless networks** that enhance the reception of mobile networks from operators within the hospital premises.
- **Enterprise grade Wi-Fi networks** that meet tight requirements.
- **And many other wireless networks** that the health sector has used already for decades: paging, nurse call, DECT, private radio's etc.
- **Smart building and smart campus networks**, notably composed of sensors and actuators for IoT purposes that cater for measurement, sensing and controlling of many parameters on environment, processes and well-being.

[3] Called MVNO's: Mobile Virtual Network Operator.

2. Investigation of health challenges and developments

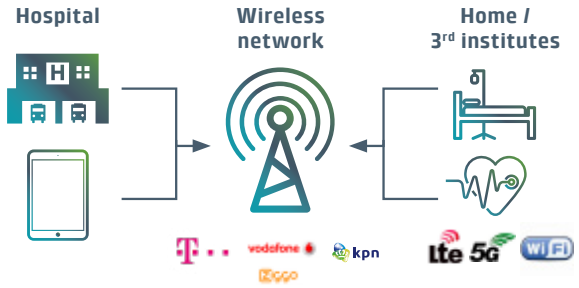
From here onwards we will take a closer look at a multitude of developments in the health arena and attribute them to wireless innovations that might serve or alleviate them. We will use the distinction introduced between on premises and wide area challenges, as the consequences for wireless enablement may differ.

2.1 Distinction between local and wide area health developments

With the above-mentioned distinction between confined, local developments within a health facility versus wide area developments involving other locations or nationwide presence; we can distinguish between a variety of health developments and the extent to which they are either local or geographically more dispersed:

The relevance for the purpose of this paper and investigation is that these distinct kinds of geographical setting are likely to involve very different players:

Local or wide area wireless for care applications



Players and networks:

On prem private wireless network and Enterprise Service Provider	Wide area mobile networks, operators and IoT service providers	Local wireless network or In building mobile coverage

On premises vs wide area applications

	On premises	Macro network	At home, other institute
Smart hospital & IoT | Way Finding	✔		
Ambulant med. equipment & devices	✔		
Care automation & in house robotics	✔		
VR/AR training and guidance	✔		
Device convergence	✔		
Cost control; ERP, workflow optimisation	✔	≈*	≈
Smart & connected campus | Facility management	✔	✔	
EPD, big data (patient file cloudification)	✔	✔	
AR for automated diagnosis	✔		✔
Asset tracking	✔	✔	≈
Remote surgery	✔	≈	✔
Externalisation & commoditisation of care; specialisation	✔	≈	✔
VR/AR remote therapy	✔	≈	✔
Telemedicine; remote diagnostics + Wearables	✔ ✔	≈ ✔	✔ ✔
Drone delivery	✔	✔	✔
Privacy & security	✔	✔	✔

* partly applicable

2.2 On premises developments in health

As the table in par. 2.1. identifies, there are large amounts of health developments that take place on the premises of the health institute or hospital (as opposed to those that also involve 3rd party locations that we will address in par 2.3).
We will address a few here and will attribute the associated relevant wireless solutions.

Nomadic equipment; track and trace

Typically, the medical process involves a myriad of devices, equipment and materials; some of them straightforward likes beds, some sophisticated like advanced treatment and analysis devices. These are costly and having to search for them under time constraints is inefficient and costly. Typically, up to 20% of medical devices can be 'lost' at any given time in a hospital.

Increasingly, ambulant devices are equipped with a tag or sensor that allows to track and trace them. Inevitably, such sensors are wireless and need to be enabled by relevant infrastructure.

> *It happens regularly that up to more than 20% of mobile medical devices (e.g. infusion pumps) can be found in other departments, because they have to be borrowed temporarily. If there is a shortage in the department, finding the equipment takes a lot of time, which is detrimental to care. Track and trace helps greatly with reducing the search time and also leads to lowering the stock holding.*
>
> *Mark de Bruin, Enterprise Architect IT, Utrecht University hospital*

Smart hospital, smart campus.

The above development is facilitated by a smart hospital where a ubiquitous wireless environment caters for tagged devices. But the smart hospital caters for much more: it enables an environment that is perceived by patients and visitors as pleasant and hospitable; it allows for all sorts of care processes to be automated; it enables a building that 'talks' to its occupants. In health sectors in particular, the control of the ambient is of extreme importance, ranging from the more obvious candidate parameters such as temperature or moisture levels to more health related variables CO2 and aerosol constituents monitoring.
Over the next 5 years, the application of IoT devices in the health sector is expected to grow by 20+ % per annum[i].

Connected buildings / facility management

There is a lot to be gained in making buildings and facilities 'smart', controlling them centrally and remotely and avoid costly manual intervention in maintenance and upkeep. This trend is generic and not unique to hospitals; most buildings and facilities are subjected to Building Management Systems and Facility Management Automation; yet the ambient conditions in health are more demanding so the potential gain is large in health. Building Automation is likely to draw heavily on wireless devices and management thereof; but wired has long played a role here too and will continue to do so.

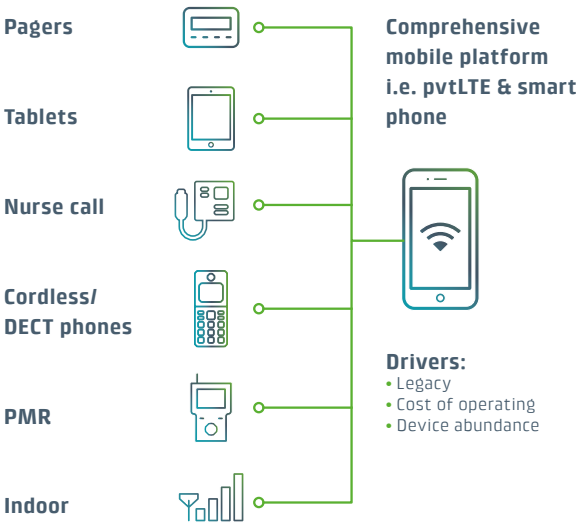
Device convergence

Historically; in health the staff would deploy a multitude of devices to be connected and reachable throughout the daily routine and processes.

Pagers, nurse call systems and DECT[4] handsets have traditionally been the mainstay of mobile devices for staff and many care processes still rely on them heavily. These systems have proven themselves over the years and decades and aren't easily replaced as – literally – life depends on them. Then again, there is anxiety amongst staff with the many devices they are to carry, track, keep charged and monitor. Gradually we see a tendency to carry less devices that are more generic and support multiple functions; typically the smartphone.

With this device convergence comes a related rationalisation of infrastructures, often still separate and single purpose.

Convergence of mobile infra and devices in healthcare



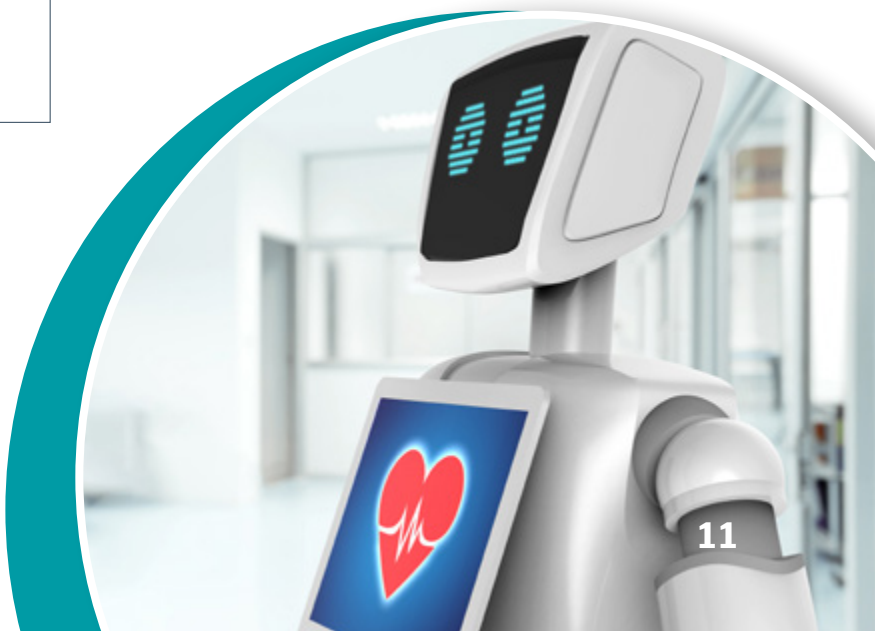
In health there are additional norms to comply with such as the NEN 2575[II] in the Netherlands that stipulates the accuracy and continuity with which some alarm signals[5] will be delivered at the terminal a designated member of staff carries. For generic platforms to replace such systems that requires accuracy, puts extra requirements on the enabling infrastructure such as availability, density, round trip connection guarantee and signalling.

The health sector is governed by tight norms and standards anyway, which poses additional requirements on many processes and devices, hence also on novel wireless applications.

Automation and robotics

As devices get smarter and processes are enabled by more ICT, there is growing opportunity to automate patient processes with automated devices and robots. In care, the robot that 'entertains' the resident has already been introduced. More day to day applications of robots can be the provisioning of medication multiple times per day with tightly controlled release thereof. Robots and automation are likely to adopt routinely work from medical staff, ranging from cleaning and bandaging to time consuming triages and treatments.

The 'far end' of this scale is remote surgery through robots, which is the most demanding and critical application. Already, surgery robots are used for precision treatments, yet mostly on location with the operator/doctor close by. However, the same



[4] Digital Enhanced Cordless Telecommunications

[5] E.g. in case of evacuation

operation with the specialist further away is the ultimate aim yet in its infancy stages still. The data- and control connections required in robotic surgery will demand extreme availability and close-to-zero latency on the connection.

Clearly, for any robot or automated device to do its work autonomously at random location, connecting it via wireless is almost a perquisite.

Artificial Intelligence

Historically, it was humans interpreting medical data, scans and test results. Increasingly though; software plays a role in interpreting and analysing vast and ever larger amounts of data. Modern diagnosis equipment and wearable devices can generate a stream of data that a human has difficulty interpreting, whereas software can do so tirelessly. AI can assess and scrutinise a video stream with relentless accuracy for anomalies and discrepancies. By comparing results with past data or relevant benchmarks and most of all deviations from averages and statistical data, software can do so to an extent that a human can no longer comprehend. These forms of health AI are supported by wireless to the extent that data are carried over ambulant devices.

> *AI will definitely contribute to remote diagnostics and telecare, then again the feeding of input and intelligence to that AI and ultimately the final decision will still come from medical specialists.*
>
> *Ferran Rodríguez.*
> *Director of Infrastructure and Biomedical Engineering*
> *Hospital Clínic, Barcelona*

Augmented reality, virtual reality

AR/VR is making its way into care and hospitals. Virtual Reality can be deployed for staff training and education; most of all in academic hospitals where education is an assigned task. VR can also be deployed in 'dry running' an operation or a treatment before actually performing it live, to gain insights, avoid mistakes and gain practice before damage can be done. This can be looked upon as the 'digital twin' often deployed in industry nowadays.

With AR/VR typically displayed on a screen in goggles, wireless connections are indispensable.

2.3 Remote and wide area developments in health

This is likely to be the most demanding set of developments, certainly when it relates to wireless connectivity. As visualised in the fig. in par. 2.1; these developments – when they are to be facilitated with wireless connectivity – will require excellent communication both on premises in the hospital, but also remotely: at the patients premises and/or at the remote care institute. The latter connections are beyond the control of the originating hospital and may well be the weak link in the chain. Since they are crucial to this cluster of wireless deployments, we will investigate them in some detail in par4.2.

AR/VR; remote therapy

We already identified the potential of these developments on premises. In the wider area domain, VR contributes significantly to process and health improvements too in that the patient can be monitored and scrutinised from remote at his premises if the right devices are provided. This option will off course draw heavily on the quality of the connection between device at the patient's and care provider at the hospital.

A potentially live saving application of VR is the forwarding of live feeds from an ambulance to the specialist to expedite care in an emergency.

Remote surgery

In par. 2.2 we already identified on premises remote controlled robotic surgery. The same procedure could be applied to very specialised treatments with the specialist being at another hospital than the patient being treated. This trend though, is likely to require a lot of facilitation legally and in terms of protocol plus will take its time to gain patients acceptance. The general expectation is for this to evolve and develop, but slowly. If at all; this will require extremely stringent KPI's (performances) for the connection.

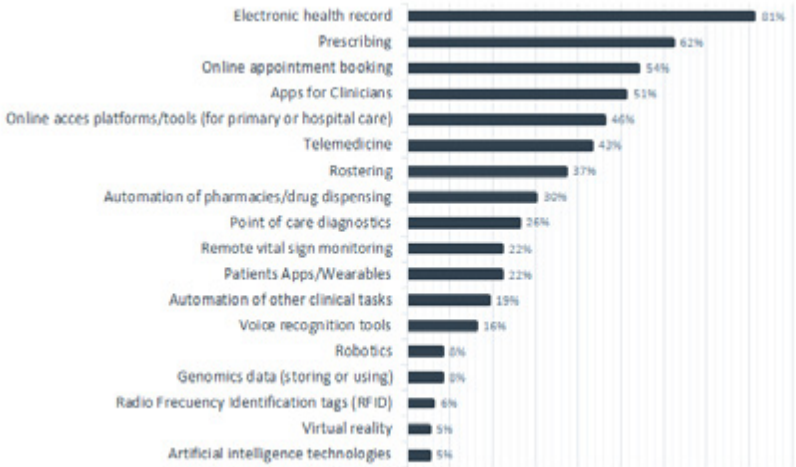
Telemedicine, tele diagnostics and wearables

For many short consultations, provisioning of medication, quick assessment etc a virtual visit is likely to be sufficient and much more cost effective for both care worker and patient; not to mention the comfort factor of a patient staying in his trusted environment. With standard IT a lot of this comes within reach and with wireless even more is enabled. This does though, draw on the quality of the connection at the patient's which we will explore further down.

[6] https://www.statista.com/statistics/1214262/share-of-clinicians-using-digital-technologies-in-europe/

[7] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7455864/

In a recent survey[6], medical staff indicated the following usage of IT; which strikingly shows how little of the potential of it is used other than a few 'obvious candidates' like remote consultations and use of cloud data:



In another study[7] medical student indicated they themselves find their abilities to work in a digitised health environment poor or even very poor.

Wearables are a trend here too. Increasingly, patients wear devices and sensors that both monitor their condition or trigger alarms when parameters exceed thresholds. A wearable though, inherently presumes wireless connectivity, at least in and around the house and most probably also when 'on the move'.

There is also a partly futuristic trend in wireless health that caters for implantable devices that permit radio communication from within the body, for applications such as cardiac devices, insulin pumps, neuro stimulators, swallowable diagnostic pills. For such health solution, wireless is an indispensable part of the formula.

3. Wireless developments and standards' enablement for health and cure

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Starting with 2G ('GSM') in the 90's and extending to the 4th generation (4G or LTE) as off 2010, wireless networks have undergone dramatic developments. Presently, the 5th generation (hence 5G) of networks is being introduced.

3.1 KPI's or performance for professional services

These 5th generation networks are expected to yield enormous benefits for – most of all – enterprises and professional processes, more so than for consumers. 5G will be the first league of networks that will enable an operator to guarantee the performance of the network for a designated user group. With the latest developments in mobile networks the operator of a network – nationwide or local – can specify and guarantee certain performances that may be crucial to the business or professional user. These performances or KPI's (Key Performance Indicators) can take a variety of forms:

- **Throughput:** how much data can a network process per user or per area in terms of Mbps. This may well be a crucial parameter in for instance access to patient files in the cloud or with VR images for remote surgery.

- **Density:** how many devices or IoT sensors can a network cater for per m^2 or per building. This may well be a relevant parameter if a hospital wants to equip many of its assets with tracking devices or when a building or campus is being developed into a smart building/campus by means of IoT, device steering, sensor reading and environmental control through wireless devices.

- **Time delay or 'latency':** this parameter comes to play when an application is extremely time sensitive or delay sensitive, such as many VR applications. The most demanding case is probably the often quoted case of remote surgery (patient and operating specialist at different locations). Such applications are going to demand very tightly controlled latency over the connection (in addition to excellent throughput for image resolution).

- **Availability or uptime:** this parameter, often expressed in number of '9's' indicates how continuous and uninterrupted a service is. With '6 9's' a service is available 99.9999% of time; which translates into a max downtime of max 50 minutes per year; guaranteed. These kinds of availabilities will be required by many processes in health, as they are in plant control for process industries, robot steering in factories etc.

- **Service restoration window** or MTTR[8]: how quick after an outage takes place can the service or network be restored and up and running again? This parameter is related to the one on availability but is not the same. The one on MTTR may apply on top of the one on availability. In (tele)care, the crucial question is for how long a patient can for instance be without permanent surveillance when the connection fails, which in turn heavily depends on his illness and condition.

[8] Mean Time to Repair. Mean time to repair (MTTR) is the average time required to repair a failed component or device

3.2 Remedies for the connectivity at the patient's end.

As identified in par. 2.3, the developments explored in that chapter all require excellent connectivity at both end of the chain. The on-premises quality of (wireless) connections is within the control of the hospital where a service/ treatment originates. That at the patient's end is usually either his own domain or that of his mobile provider. Depending on country and residential location, wireless connectivity close to the patient can be poor and unable to support an essential health functionality. The below measures may bring relief.

- **Wi-Fi.** Probably, a patient has Wi-Fi or it can be implemented through a 3rd party easily and affordably. Due to envisaged cost savings of treatment at home rather than in a hospital; it is not unlikely that insurance companies will be prepared to compensate for the required connectivity at home for the remote and cheaper treatment.

- **Repeater.** Technically there are ways to amplify the local mobile signal with a 'repeater', an effective and affordable solution that the patient can cater for or his provider. In some countries the use of these devices is not allowed other than by the operator.

- **National roaming.** Depending on the country mobile operators may allow roaming onto one another's network for improved availability or there may be service providers rendering that service.

- **Neutral Hosting.** Likewise, there may already be or may develop so called Neutral Host companies: providers that will establish a geographically confined network with enhanced coverage from all mobile operators. Though still rare in Europe, the players are already well stablished in the USA.

- **Aggregating or bonding.** Depending on country and networks, there may be ample opportunity to 'combine' the performances of multiple networks through smart routers, i.e. Wi-Fi with mobile or mobile with wide area IoT network.

- **Prerequisite on mobile operators.** As the demand increases and becomes a prerequisite for health and other essential domestic services, governments are likely to impose[9] coverage requirements on mobile operators and enforce minimum capabilities.

- **Wireline.** In addition to all the above wireless alternatives; off course wireline connectivity can also 'come to rescue' at the patient's premises to the extent that he is stationary or can (temporarily) be immobilised/ deprived of his mobility.

[9] Already, the EU regulators typically impose coverage and data rate requirements on mobile networks when they auction the required spectrum ('frequencies').

3.3 New: 'Slices' or designated network segments

As said, 5G allows the operator of a network, either nationwide or locally and private, to provide a business user with a partition or 'slice' of the network that meets the guaranteed parameters and agree on those with a Quality-of-Service level. With slicing, the operator – public as well as private! – can attribute a segment of the network with end to end guaranteed performances to a user, an application or an area. This enables very tightly controlled and guaranteed performances, needed for i.e. remote surgery or patient monitoring that impose strict requirements on connections.

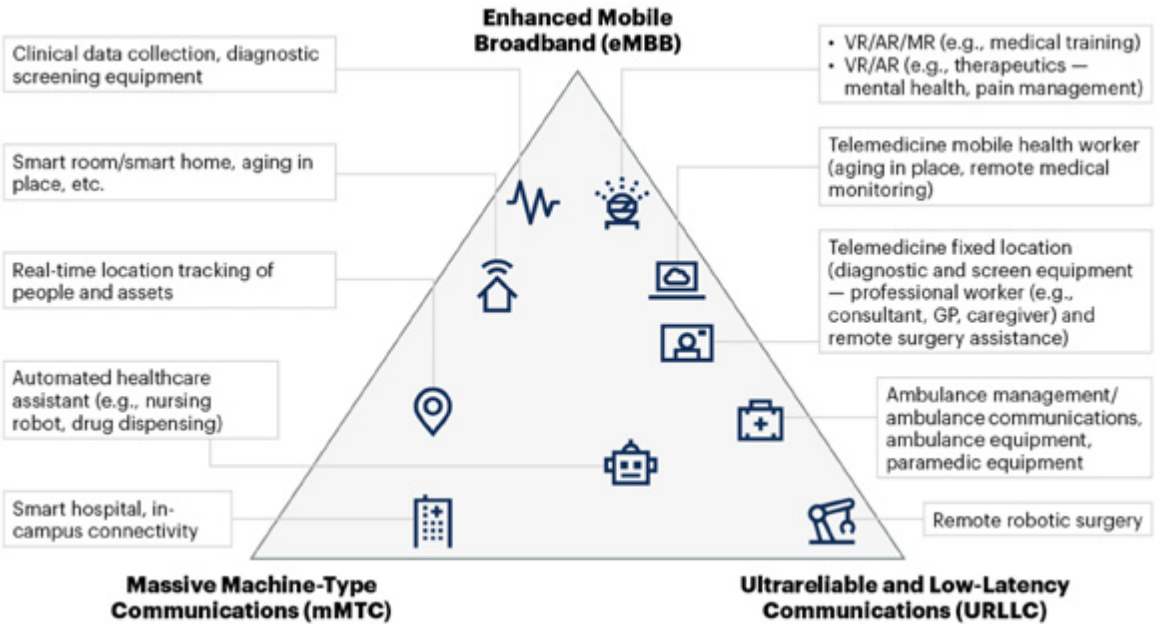
This ability of 5G - and to some extent already 4G - networks is enabled by the standardisation. The global standardisation body for mobile standards has described and developed three distinct 'clusters' of capabilities of 5G networks, that allow the operator to meet required KPI's. These three building blocks of service classes and KPI's are often depicted as the below well know '5G triangle':

Shallowly described, these key cluster entail:

- eMBB or enhanced Mobile Broadband: an ever-larger number of data the network can process.
- URLLC or Ultra Reliable Low Latency Communications: the parameters to be fulfilled in extremely critical operational processes.
- mMTC or massive Machine Type Communications: the ability of the network to handle the traffic of millions of sensors and wireless devices. Typically, this building block is required for IoT applications such as asset tracking and smart buildings

The current release[III] of the 5G standards enables eMBB or very capable, very data intensive broadband transmission. The standards will soon evolve towards inclusion of the URLLC and mMTC capabilities; the performances these new releases will enable are typically envisaged for professional processes, such as health.

The above articulation of 5G enabling features may appear academic. The below figure is a direct translation from the mentioned 5G triangle to the very same substance yet in the realm of healthcare:

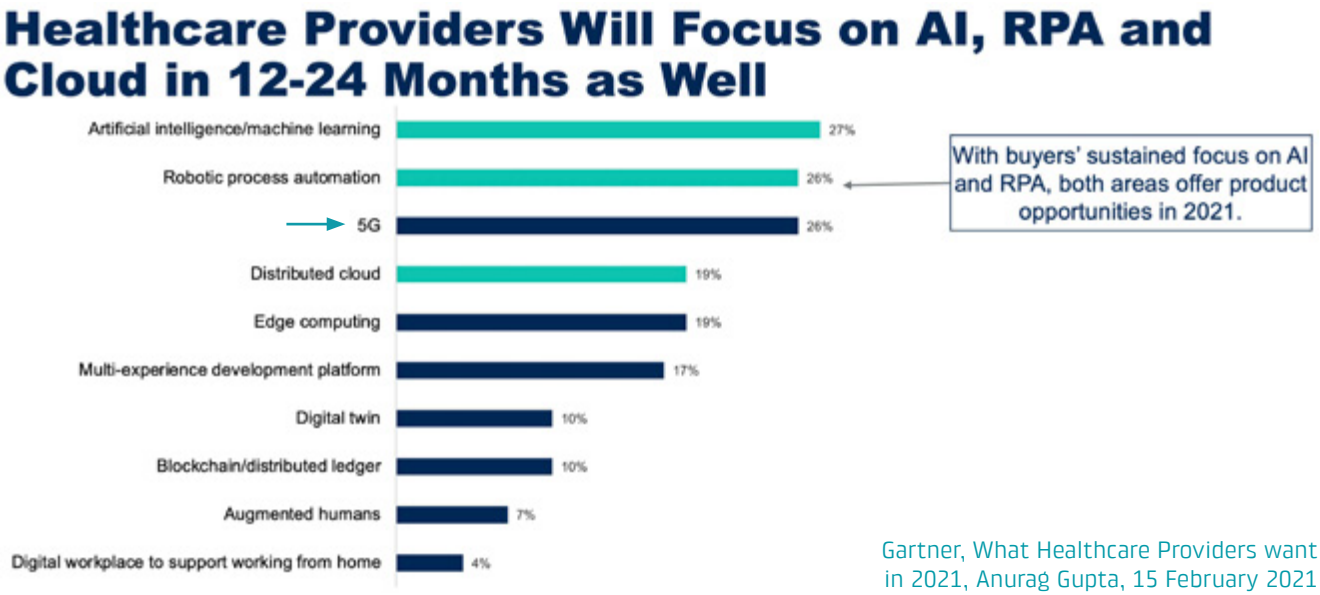


Source: Gartner, Market Trends: 5G for Healthcare, Lisa Unden-Farboud, Gaspar Valdivia, Pablo Arriandiaga, 29 May 2020

This analysis and translation of the wireless eco system to health, displays how applications like asset tracking and monitoring, AR/VR, telemedicine and automated nursing assistance/ robots will all draw on the constituents of the 5G wireless technology. It also reveals how remote robotic surgery heavily draws on ultra-reliable connectivity and is the envisaged most demanding wireless health application.

Another recent study[IV] reveals how much importance is attributed to wireless and 5G developments within their health institutes by respondents from the sector:

The expectations on wireless and notably 5G to facilitate transitions in the health sector are high and range third to only robotics and AI (artificial Intelligence).



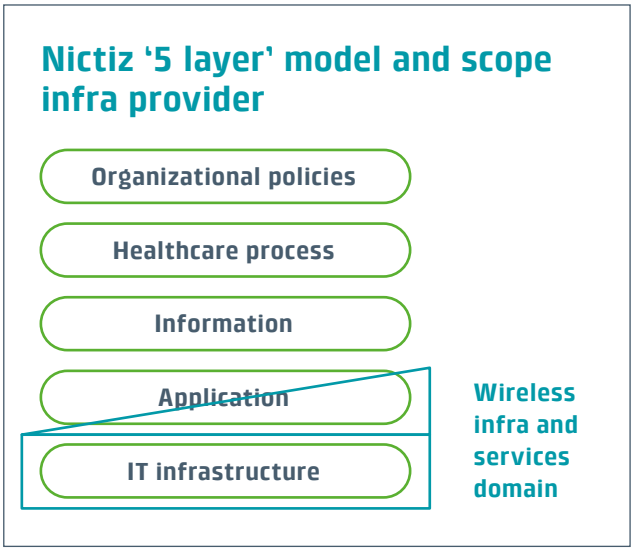
Gartner, What Healthcare Providers want in 2021, Anurag Gupta, 15 February 2021

4. Wireless networks and building blocks in the health ICT value chain

We have elaborated on the many challenges the health industry faces and the role wireless networks and services may play in relieving at least some of the strain on health organisations, processes and staff. On this however, some modesty is appropriate:

4.1 Wireless is transport layer

In the Netherlands, the national ICT institute for health NICTIZ deploys a model for ICT developments which comprises 5 layers ('5 lagen model'):



In this universal model the IT infrastructure is the transportation layer for any health-related data and information. That layer inherently comprises wired and wireless transport. It is here in this layer that wireless developments as sketched can contribute to health digitisation and process optimisation. Clearly, we see a gradual shift from wired to wireless transportation of data over time as wireless standards rapidly mature and become increasingly reliable.

It is in the layers above it however, that genuine health applications emerge and turn data into information with relevance for care processes and staff. These are the higher layers that a wireless network or service does not inherently provide or implicitly carries; they are different developments and provided by different players. It is fair to say that some wireless actors and providers are capable of offering services on the application layer above the transport layer, Cellnex being one of them. This applies to health enabling services like IoT and connected devices; smart building and ambient control; track and trace applications of devices and staff and more. Nonetheless it is fair to say too that the true health applications and information emerge in the layers above the transport layer and are the realm of other, niche specific players that have long track records in care and cure and are entrenched into health processes. The polygon in the above picture discriminates the scope and role that a full service provider of wireless services such as Cellnex may have in the health ICT value chain.

4.2 Building blocks for wireless in the health domain

There are a couple of fundamental offerings or building blocks within wireless that can facilitate all the above improvements in health sector.

- **In Building Wireless or Indoor:** these are networks throughout a venue, building or hospital, that facilitate that the signals from all mobile operators' networks can be brought into the building by means of a densifying or extension system; notably those from all mobile operators but also those of public safety, building automation and IoT, private wireless networks. 10's of hospitals already have such Indoor systems in the Netherlands.
- **Private Wireless Networks:** nowadays it is possible for an organisation and a hospital to operate its own, designated wireless network, on LTE or 5G or other. There are frequencies available for those networks in multiple European countries[10] already and regulators are still contemplating on more. Alternatively, the required frequencies can be 'rented' from existing licence holders such as mobile operators but also others. This network can then meet the specific requirements of the hospital itself and meet al the KPI's that the prevailing medical services require.
- **Wireless IoT networks:** increasingly, devices and building sensors communicate with one another and central systems through IoT (Internet of Things). This type of connectivity is likely to grow rapidly and facilitates many of the heath trends identified. IoT can make use of very many (up to 11!) different wireless standards in addition to wireline protocols.
- **Classical wireless options:** still of course, a hospital can also make use of its Wi-Fi network or mobile subscriptions for certain services. The option for providing guaranteed Quality of Service over such networks are significantly less than for private wireless networks and need scrutinising. These classical wireless alternatives are beyond the scope of this paper.
- **As a Service propositions:** all the above alternatives require establishing of networks. Instead of investing themselves and having such networks on its balance sheet; health institutes and hospitals may want to source the entire functionality of the network as a service and incur periodical expenses instead.
- **Remote access at patients' premises:** in order for many of the medical services to perform end-to-end, there is a need for wireless connectivity at home at the patient's. This is rather a critical bit as it is to a large extent beyond the reach and scope of the health institute. In par. 3.2 we elaborated and already identified some measures that can be taken to provide adequate connectivity at the patient side of remote health applications and tele medicine propositions. Also refer to the images in par. 2.; where we identify potential players that can complement the end-to-end solutions for remote diagnostics and telehealth.

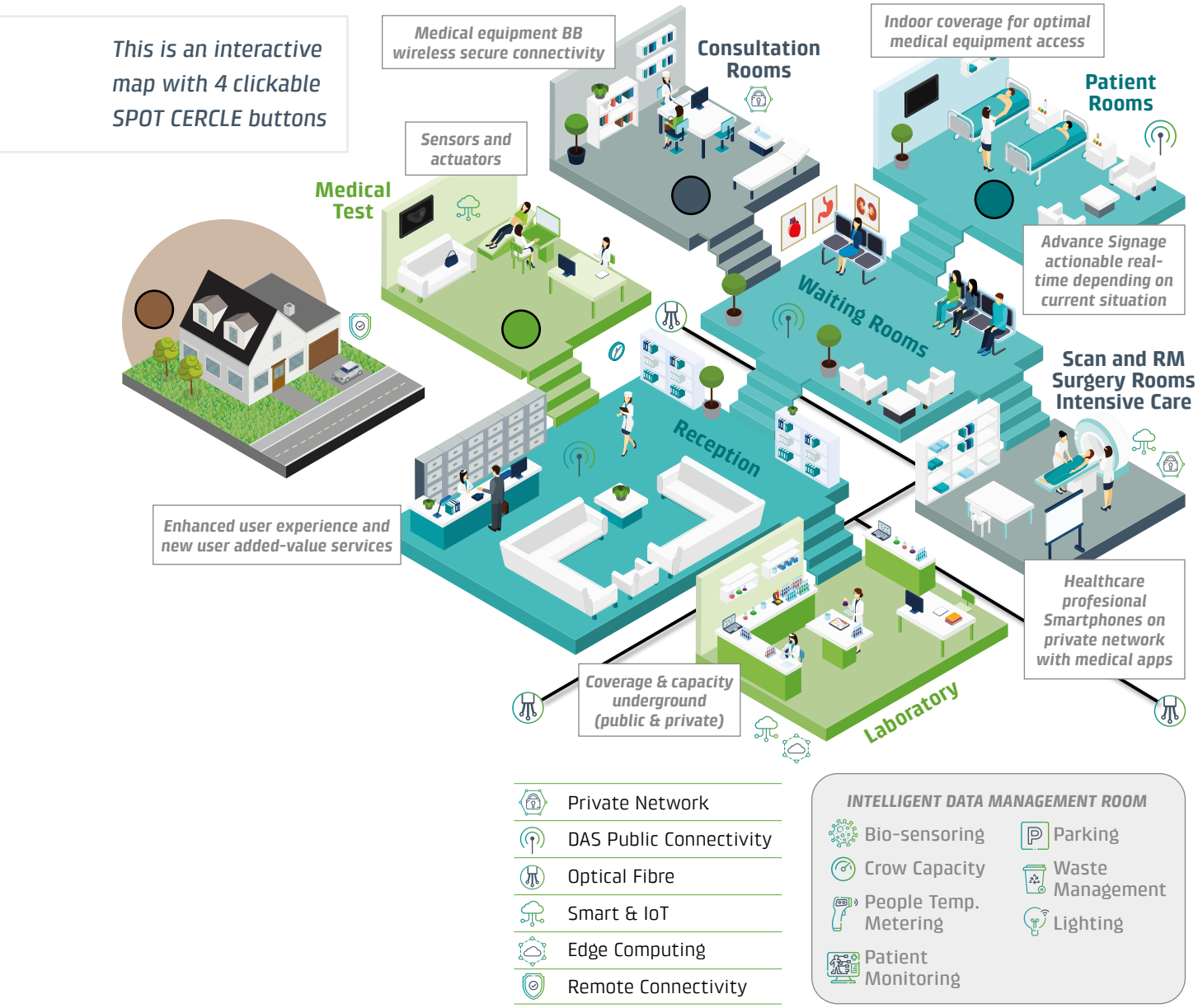
[10] Such as in UK, Netherlands, Germany, France, Sweden.

5. Summary

This paper has looked at a variety of developments in cure and care and has investigated where and to what extent wireless developments can contribute to the challenges in the health sector. Wireless technology develops at an overwhelming pace and is likely to bring a lot of relief to cost threats, to tele health applications, to efficiency drives, to health innovations and many on premises medical applications. We have globally identified what elements of the wireless proposition can contribute in health. There is off course much more to be said as to every one of those developments and elements, for which we refer to our website www.cellnextelecom.com or solicit an encounter with our specialist.

Comprehensive Graphic

In order to summarise the medical and health issues and challenges identified and relate them to facilitating wireless propositions, we provide the below graphic of a typical health situation and the associated wireless networks or 'clouds' that facilitate health processes.



About Cellnex Telecom

Cellnex Telecom is Europe's leading operator of wireless telecommunications and broadcasting infrastructures with a portfolio of more than 128,000 sites, c. 71,000 of which are already operative, and the rest in the process of finalisation or planned roll-outs up to 2030. Cellnex operates in Spain, Italy, Netherlands, France, Switzerland, the UK, Ireland, Portugal, Austria, Denmark, Sweden and Poland.

Cellnex's business is structured in four major areas: telecommunications infrastructure services; audiovisual broadcasting networks, security and emergency service networks and solutions for smart urban infrastructure and services management (Smart cities and the "Internet of Things" (IoT)).

The company is listed on the continuous market of the Spanish stock exchange and is part of the selective IBEX 35 and EuroStoxx 600 indices. It is also part of the FTSE4GOOD and CDP (Carbon Disclosure Project) and "Standard Ethics" sustainability indexes. Cellnex's reference shareholders include Edizione, GIC, ADIA, Canada Pension Plan, CriteriaCaixa, Blackrock & Wellington Management Group.

For more information: www.cellnextelecom.com

[I] IoT enterprise Insights white paper 'digital change in health', dec. 2020

[II] NEN 2575-1:2012+C1:2021 nl

[III] The 5G standards presently entails so called release 15 (eMBB); release 16 (URLLC) is frozen and about to be launched in networks and release 17 (mMTC) is to follow in 1½ year time

[IV] Gartner: Gartner, What Healthcare Providers want in 2021, Anurag Gupta, 15 February 2021

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