Fighting Pandemics By Exploiting 5G, AI and Bigdata Enabled Technologies

How 5G can help contain the spread of COVID-19

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Abstract: In context, this paper starts by referencing best practices adopted globally to counteract COVID-19, through such means as *testing, tracing, diagnosing and treating* infections. It then presents relevant examples demonstrating where 5G, AI and Bigdata technologies have been successfully deployed via policy measures and resulting processes to keep people safe, through physical distancing and various other arrangements to slow and contain the spread of COVID-19. Beyond this, examples of unique 5G characteristics, such as improved throughput, latency and reliability, and 5G resilient network configurations (including all layers and domains supporting standard security and related enhancements) are described in detail. This is followed by illustrating particular opportunities achievable on secure and resilient 5G systems incorporating digital spill-over capability. Beyond this consideration and responding to some unfounded concerns, the paper reaffirms that 5G will not have the negative effect on people's health about which a few individuals have speculated. Picturing all this together, conclusions are drawn on a possible way forward in which policy makers' focus can now advance from current Smart City concepts towards a more extensive Smart Society approach.

Keywords: 5G, AI, Bigdata, Pandemic, COVID-19.

Introduction

Currently, COVID-19 is being counteracted by a regime including *testing, tracking, diagnosis* and *therapeutic treatment of the infection*. Countries dealing with COVID-19 have concluded that early identification of positive subjects is crucial for the purposes of treatment and containment of infection.

The COVID-19 test is effective when associated with a clear path of contacts, and the tracking is effective as long as it is combined with an appropriate communication system for collecting

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and disseminating information about the movements of potentially infected people and other necessary information.

To this end, 5G, AI and Bigdata technologies can help increase diagnostic abilities in areas at risk by locating infected subjects as early as possible and promptly tracing their contacts and identifying the origin of the infection, thus minimising future propagation of the virus through subsequent interactions.

Through high-speed and low-latency 5G technology – not supported by earlier generation networks – the exchange of high resolution images, videos and other information in digital form, sometimes in almost real time, related to successful and unsuccessful cases, could take place in just fractions of a second, across an entire country or around the world.

5G technology could also help us monitor in real time patients with mild symptoms, particularly those who remain undiagnosed in their home, as well as health workers, who are the most exposed staff and therefore at greater risk. These people represent a strong risk for the transmission of the infection in their families and in the community, especially in the post-emergency phase or "phase two", i.e. when the social distancing will be relaxed because the curve of new deaths will have turned the corner: see e.g. Financial Times (2020) and Johns Hopkins University (2020).

Such near seamless transfer of information would enable knowledge and experience sharing between hospitals, laboratories and research organisations scattered widely throughout the area or world, and therefore further facilitate accurate and timely diagnoses of COVID-19.

In turn, such a shift towards using 5G technology would allow a shift *from patient-centred care models to a community-based approach*, offering solutions for the whole population (Pisano, Sadun & Zanini, 2020).

For example, in Italy, the evidence shows that different policies followed in different regions towards dealing with COVID-19 produced very different results despite the regions sharing many similarities. Had these different regions been able to take advantage of the benefits offered by 5G technology as outlined in this paper, it would have been possible to implement these across the whole of Italy and subsequently achieve a better outcome.

For many years now the healthcare sector has considered the usage of robotics to deliver more efficient care for patients – COVID-19 saw robots deployed to actually achieve this. Following this real-world, experience we now have evidence to show that the use of service robots, remotely controlled or with a high degree of autonomy and associated with 5G networks, can amplify the diagnostic capabilities of existing laboratories, limiting the number of human resources currently necessary to reach conclusions, such as for ensuring appropriate social distancing from potentially infected people.

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In addition, artificial intelligence can be used "on top" of 5G for analysis of images and data aimed at capturing the temperature of people at risk, clarifying the severity of the infection, and could even be adopted as a general purpose technology to produce data aimed at clarifying, for example, the correlations between antibody levels in the blood and the presence of an infectious virus in respiratory secretions as well as in other areas of the human body. For example, the latter application would help us clarify the idea of using antibody positivity (Australian Government, 2020; Blackman, 2020) as the only useful indicator for the decision about the resumption of an individual's work activity without risks.

The advantages offered by the use of cutting-edge technologies in the fight against the epidemic are manifold, and some pertinent examples are from China, as illustrated in Figure 1 – but the same could be achieved in any country with 5G network availability.

As fever is one of the main symptoms of COVID-19 in China, they are using artificial-intelligence-based systems in transport junctions, office buildings and communities to identify high body temperatures from a flow of people on the move. Based on body shape and other facial information, the intelligent system can help staff identify and monitor people with abnormal body temperature quickly. In addition, in compliance with relevant regulations and standards, Chinese cities are using big data analytics platforms to track close contacts of patients or suspect cases.

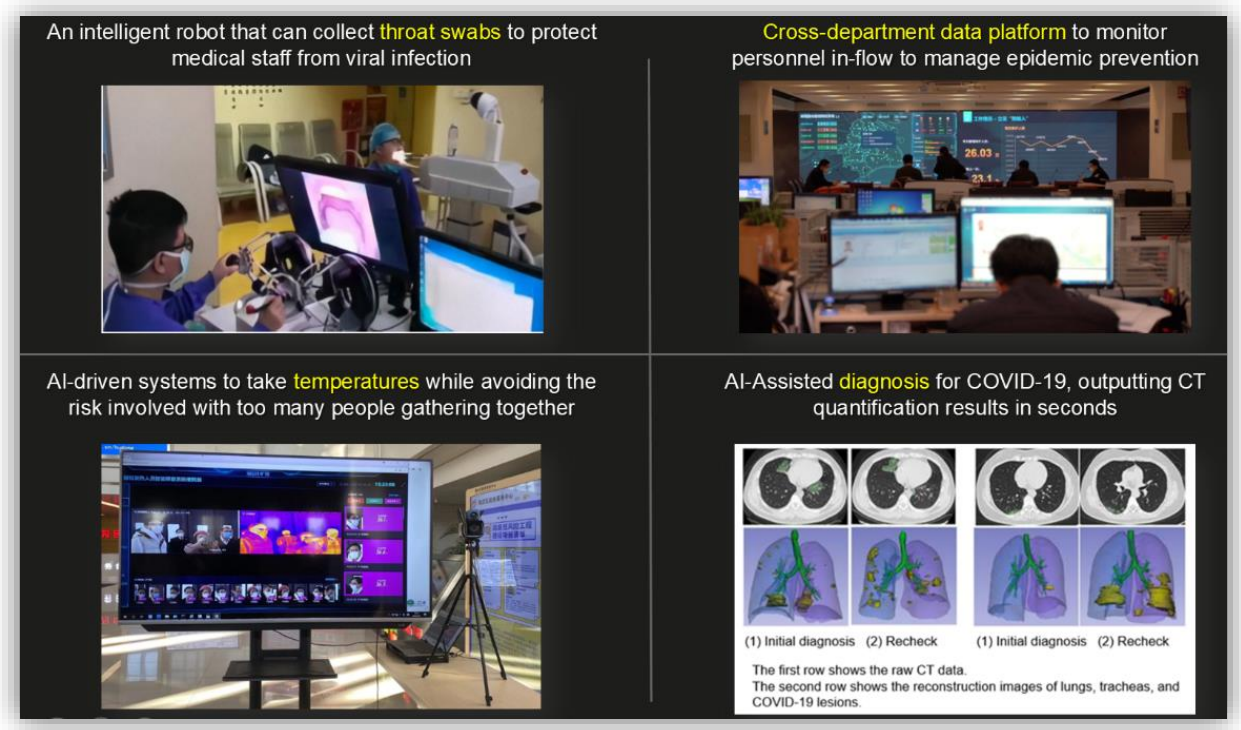

Figure 1. Examples of cutting-edge 5G, Big Data and AI technologies for fighting COVID-19 (CGTN, 2020a)

Intelligent robotic platforms with different functions have been developed to relieve pressure on doctors and nurses. A smart robot, controlled at a safe distance by medical personnel, is able to collect a patient's swabs, without injuring the subject's throat, and with a success rate of over 95% (CGTN, 2020a). In some hospitals, most of the activities normally carried out by medical personnel are currently converted into tasks performed by robots, which go around the departments to deliver drugs, measure the temperature of patients, serve meals, and inform the patients of important medical precautions to be taken.

Also in China, 5G has been widely applied in the tele-medicine sector, playing a crucial role in the treatment of severe cases of COVID-19 and in the sharing of information and experiences at national and world level. For example, the 5G network has made remote computed tomography (CT) scanning more viable, allowing specialized personnel to control CT scanners in hospitals from a distance in real time (National Telemedicine Centre of China, 2020): see Figure 2.

(It should be noted that CT scans give the best diagnosis for COVID-19 and scan results can be shared in real time with doctors across the country – they do not have to be at the hospital.)

The massive deployment of 5G will allow governments to set up a *systemic decision-making approach*, which gives priority to learning and is able to quickly scale successful experiments and identify and close ineffective ones.

Figure 2. Examples of 5G healthcare services on air with digital indoor system (DIS) in China (Soldani, 2020a)

In What Situations Can 5G Network Technologies Be Readily Exploited?

A 5G system is necessary for all those communications that require high-speed data transmission, especially from the user equipment (UE) to the network (uplink), very low latency between peer entities end-to-end, and very high reliability (Soldani & Innocenti, 2019). With a much faster and more reliable connection on offer, 5G will support many more use cases than Wi-Fi, likely co-exist with WiFi6 in our urban environments, but it will largely complement the need for that. Moreover, 5G supports network slicing, supplementary uplink, super massive MIMO (mMIMO), multi-access edge computing (MEC), more devices and seamless mobility; offers higher bandwidths – using licensed and licence-exempt spectrum in low-bands (e.g. sub-3 GHz), mid-bands (e.g. C-band) and high-bands (e.g. mmWave spectrum); provides widespread indoor and outdoor coverage in all areas; and, especially, lower latency for end users (Soldani, 2017; Soldani *et al.*, 2018; Soldani, 2019; Soldani & Innocenti, 2019).

The use of *self-driving or remote-controlled vehicles* (*unmanned cars*) can reduce contact between individuals. Specifically, these cars can be used to deliver supplies, critical medical equipment and disinfect contaminated places or areas at risk. For safe remote control, the images, captured by the many cameras installed on vehicles on the road, must be transferred to the control station in real time. In practice, this requires at least 50 Mb/s in the uplink direction and end-to-end delay – including the time required to capture images, process and render them, and exchange commands between the two communicating parties (application platform and onboard unit) – of less than 150 ms, so that vehicles can avoid obstacles and stop immediately when required from a remote control distance (Soldani *et al.*, 2018).

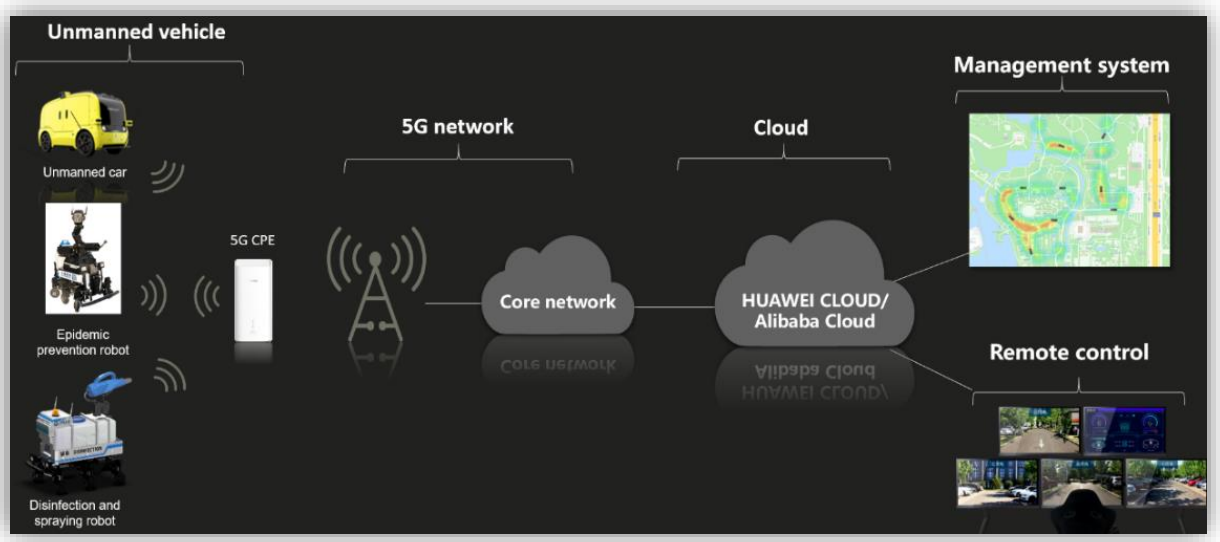

Figure 3. Example of 5G solution for unmanned vehicles: car and service robots (Soldani, 2020a)

In addition to these autonomous or semi-autonomous transport systems, *epidemic prevention robots* and *disinfection and spraying robots* have been introduced for:

- *Prevention* of COVID-19 epidemic, as means for measuring body temperature, disinfection, sterilization and spraying, and communication via a remote intercom;
- *Security* patrol, with facial recognition and license plate recognition.

The network requirements, to support applications and machines of this kind, are more or less the same as those required for the management and control of automated guided cars, especially in terms of throughput and latency (Soldani *et al.*, 2018).

An example of a 5G solution for connecting unmanned vehicles (car and service robots) is shown in Figure 3. Figure 4 reports examples of service applications for verticals and related network performance requirements.

The solution – meeting optimal end-user experience and public safety requirements – for the use, control and management of unmanned vehicles consists of a 5G network that connects the automaton to the cloud by means of a CPE (customer premises equipment, similar to a fixed broadband modem) and a management and control system for the operator.

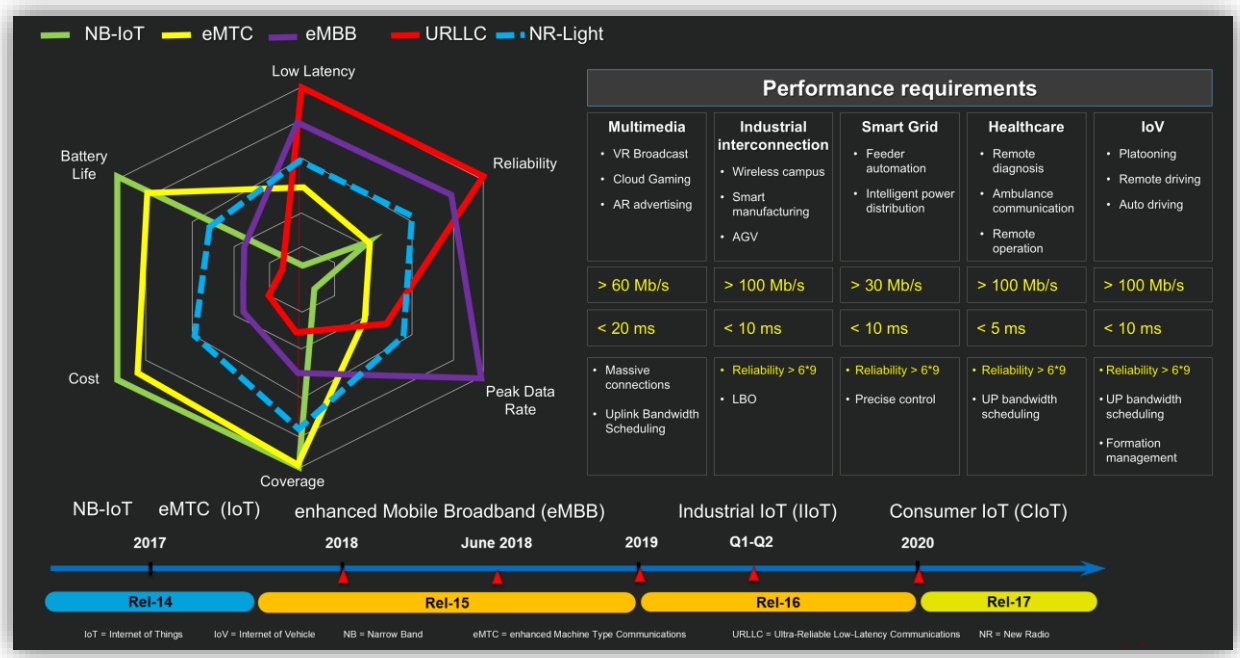

Figure 4. Example of performance requirements for vertical applications (Soldani, 2020a)

What Other Potential Opportunities Exist for Now and in Future Using New 5G Network Technologies?

The drama of the COVID-19 pandemic cannot be overlooked. In the world, there have been millions of infected people, loss of lives, loss of jobs, and economic consequences whose

vastness is impossible to evaluate at present. However, the COVID-19 crisis actually presents itself as an interesting challenge for the information and communication technology (ICT) and industry. China, having been the first nation hit hard by the virus and the first one on its way out, has already defined its post-COVID-19 plans to foster economic recovery.

To this end, investments will be placed on the following seven sectors (CGTN, 2020b):

- "First of all", the distribution of the 5G network; and consequently:
- The development of artificial intelligence;
- Construction of data centres;
- Industrial Internet;
- Inter- and intra-city railway systems;
- New energy charging stations for electric vehicles; and
- High voltage electric grids.

Most of these investment areas will adopt 5G and its related technologies. In focusing on those fields and related infrastructures, China aims at stimulating itself towards new economic and social development, especially in areas currently less developed, where trade and industry growth would be needed.

Figure 5. Example of 5G solution to enable mobile UHD (4K) live broadcast (Soldani, 2020a)

The same opportunity now presents itself in any country adversely affected by the COVID-19 pandemic, which should take advantage of the current crisis to build next generation infrastructures, to be used in the imminent future and, above all, to be left to future generations – also in order to be further modernized. Countries should not find themselves

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still unprepared to face a probable future "war" with the same "weapons" used in this very moment.

What Is the Way Forward?

Leaving aside the problem of the COVID-19 pandemic for a moment, I would like to add that the 5G infrastructure allows other revolutionary applications based on virtual reality (VR) and augmented reality (AR) and also using artificial intelligence (AI).

AR and VR can be used in a wide range of entertainment, industrial and educational applications. All these services are currently constrained and limited, because bandwidth (50 Mb/s for 4K/Basic 3D AR/VR; and 100 Mb/s for 8K/Immersive 3D AR/VR) and latency (below 20 ms) are not available on 4G (LTE) networks. (A 4G network would support up to 1080P (~2K) VR/AR with limited applications.)

The 5G network will allow the instant transmission of 4K UHD live from a mobile location (or camera operator, as shown in Figure 5), intelligent public transport (see Figure 6 for an example of a smart bus), and will ensure greater public safety.

Figure 6. Example of 5G for smart buses, making travellers safer (Soldani, 2020a)

For example, as depicted in Figure 7, a police officer wearing wireless AR glasses could easily identify a suspect in the crowd. The glasses worn by the agent upload 4K videos to the network, the cloud renders the objects and compares them with other images stored in a facial database and returns alarms information to the glasses. The latter displays the alarm information on the virtual screen in real time, so that the policeman may take all necessary actions.

If 5G allows applications of this type after a year of its introduction, let us imagine what it can do in three, five or ten years. The faster countries are able to build and use 5G infrastructures, the sooner they will be able to get the benefits that this technology already offers. In our opinion, nations that do not invest heavily in this direction will lag behind and be the last to benefit from revolutionary applications (Soldani, 2019).

Conclusions

I would like to highlight that, once the COVID-19 emergency has been addressed, with the involvement of other policies and decision makers, our political leaders will enable the deployment and exploitation of new 5G technologies offering substantial benefits.

It would be desirable that our political leaders – once this current crisis has been dealt with – focused on helping to knit-together our homes, schools, hospitals, universities, government services and so much more into more than just a *Smart City* (Soldani, 2018): we should be aiming to use this horrible pandemic to bring about the *Smart Society* (Soldani & Manzalini, 2015).

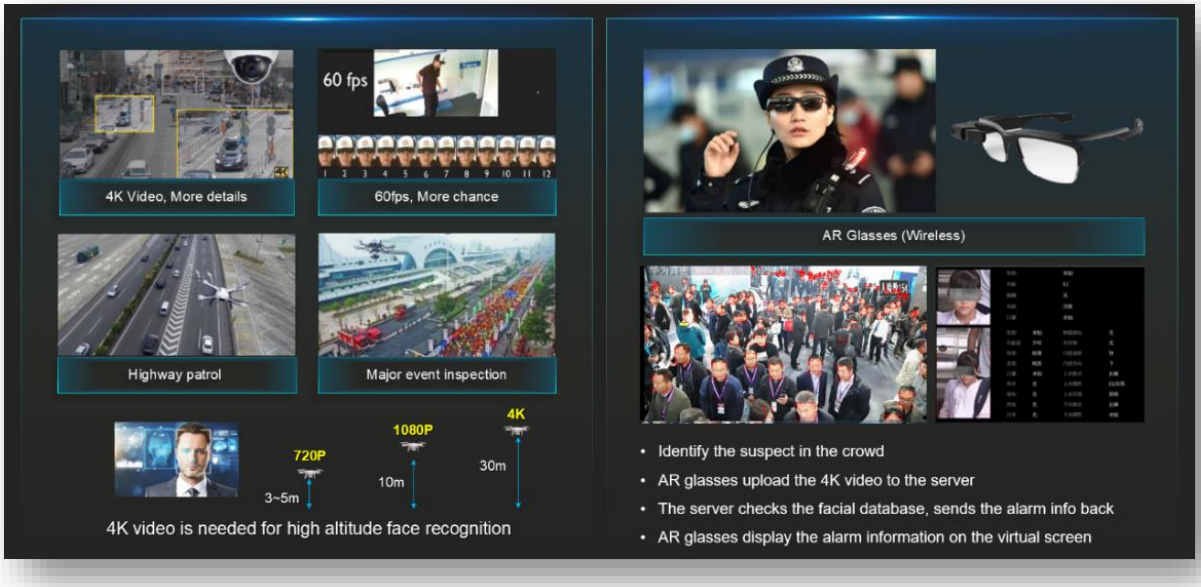

Figure 7. Example of 5G services for public safety using UHD video and AR wireless glasses (Soldani, 2020a)

It is, of course, recognized that new developments in all cloud, AI, industrial (IIoT) and consumer (CIoT) applications, and software-defined everything are posing an unprecedented challenge to the *cybersecurity* of ICT infrastructures. There are growing security risks that are significant threats to a future *Digital Society* and cannot be ignored.

To address and ultimately solve those rising challenges requires a *strong collaboration between industry and governments, security agencies, regulators and other relevant*

organizations to embed trust in all telecoms business processes and supply chains, and to enhance cybersecurity through research and innovation at global scale (Batas, Men & Smitham, 2020). Trustworthy equipment, resilient networks and verification shall be all based on standards and further enhanced, for instance, as depicted in Figure 8. This must be a collaborative effort between *private* (industry, SME, and research organizations) and *public* (policy makers, regulators) *parties*, as no single government, vendor, or carrier can do it alone (Soldani, 2019; 2020c).

In Soldani (2020d), it is recommended to work closely with the European Commission (EC) and other Member States, their partner cybersecurity agencies – such as the EU Agency for Network and Information Security (ENISA), the Federal Cyber Security Authority in Germany (BSI), and the National Cybersecurity Agency of France (ANSSI) – and establish a close collaboration with international industry partners – such as the 3rd Generation Partnership Project (3GPP) and GSMA Mobile for Development Foundation (GSMA) – on 5G *security specifications* (3GPP, 2020) and *network equipment security assurance scheme* (GSMA, 2020b).

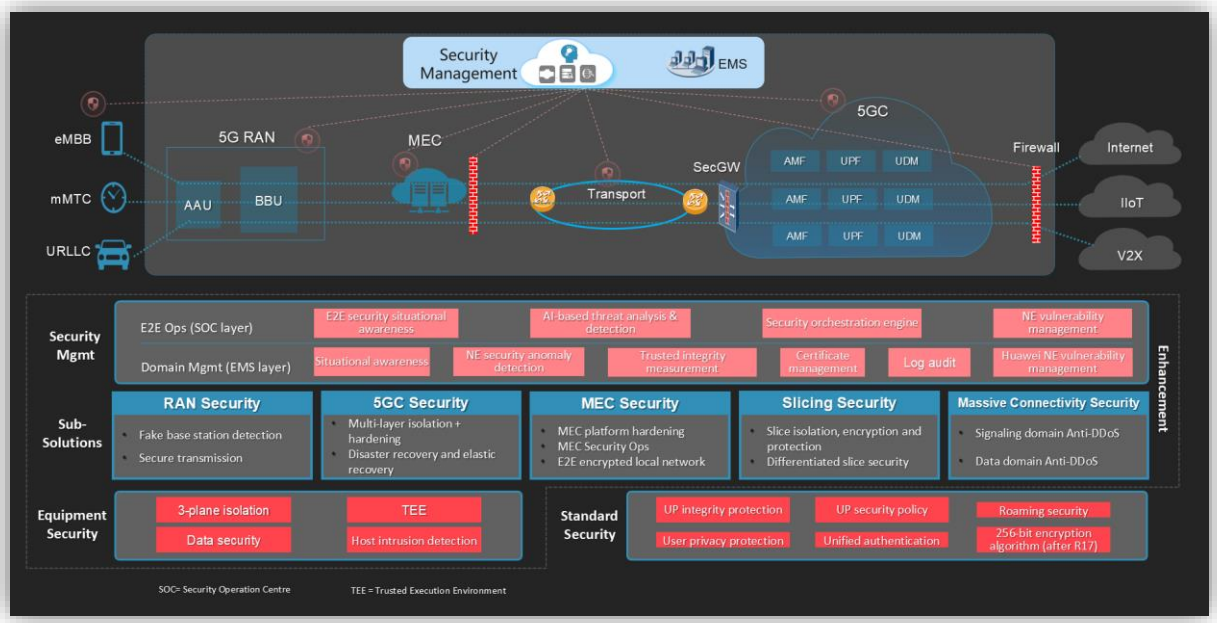

Figure 8. Example of 5G trustworthy products and resilient networks (Soldani, 2020b)

An example of a flagship project aimed at demonstrating how commercial and open-source products can leverage cybersecurity standards and recommended practices for each of the 5G use case scenarios, as well as showcase how 5G security features can be utilized, can be found in Bartock, Cichonski & Souppaya (2020). This iterative approach will provide the flexibility to take advantage of newly introduced 5G security capabilities. This project will result in a freely available cybersecurity practice guide.

The 5G (and future 6G) networks will use much smaller antennas and thus generally lower exposure levels to *electromagnetic fields* (EMF) compared to the current 2G, 3G and 4G networks, but altogether achieve much better quality of service and higher connection speeds (European Commission, 2020). Many of these smaller antennas could, to a certain extent, be compared to Wi-Fi installations. All new specificities of 5G technology have been taken into account in the definition of the revised ICNIRP guidelines (ICNIRP, 2020).

Therefore, following all the existing recommendations, the deployment of *5G will not have a negative effect on people's health* (European Commission, 2020). Conspiracy theories around 5G and health have been circulating globally for the past 18 months or so, but have recently morphed into claims that COVID-19 is being caused by 5G. This *fake news* has resulted in physical attacks on base stations and engineers working on installations, particularly in the UK (GSMA, 2020a).

From a cybersecurity perspective, a quick search reveals that organised campaigns and actions around fake news and other disinformation are taking place across social media, which are fanning the flames, resulting in increased action in the physical world (GSMA, 2020a).

However, while social media companies are taking action, there are still many groups and individuals promoting 5G conspiracy theories, including theories that "*you cannot mitigate the risk of untrusted vendors in 5G networks by placing them in the 'edge' because there is no distinction between the edge and the core*", which has been proved to be incorrect (Soldani *et al.*, 2018; Soldani, 2019). The NG-RAN functions run on proprietary hardware and software and cannot "blur" with a 5G core made by another vendor (Soldani *et al.*, 2018; Soldani, 2019).

Instead of watering our thoughts with lies or fake news to inspire fright, gain power or attain any sort of commercial advantage, we should fuel our views with win-win solutions to cultivate success, and turn the current challenging situation into an opportunity for emerging from COVID-19 much more resilient and prosperous (Soldani, 2020a; 2020b).

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