

The cover features a night-time photograph of a telecommunications tower with multiple satellite dishes. The tower is silhouetted against a dark sky, with some lights visible on the structure. In the background, a city is illuminated with warm yellow and white lights. A large, semi-transparent blue circle is positioned in the upper right, and a smaller, semi-transparent circle with a network diagram overlay is in the lower right. The text is white and positioned on the left side of the tower.

5G MOBILE TELEPHONY FACT SHEET

5G Mobile Telephony Fact Sheet

There has been a lot of speculation linking 5G mobile telephony and data networks to a range of health threats. Some claims even go as far as attributing the current COVID-19 pandemic to the initial rollouts of 5G networks.

In response, CSIR experts have put together this document to dispel some of the myths around 5G mobile telephony. It is based on their best understanding of the interactions between radio frequency signals and human tissue, as well as epidemiological evidence of the effects of current mobile phone networks.

1. Frequently Asked Questions

a) What are the typical sources of electromagnetic signals in a mobile phone network?

In a mobile phone network, there are two emitters of electromagnetic waves, namely base stations and handsets and they have different characteristics.

Large base stations can produce up to 100 000 times more power than a cell phone. Furthermore, because there are usually many users served by a single base station, the base station emits signals nearly continuously.

However, as the signal propagates through the air, its power drops as the square of the distance between the base station and the cell phone. For example, the power at 100 m from a cellular tower will be $(100 \div 1)^2 = 10\,000$ times less than the power in the same direction at 1 m from the same tower. This quick decay helps to prevent unsafe exposure to these signals, as users cannot come very close to the elevated base station antennas.

Guidelines from the International Commission on Non-Ionising Radiation Protection (ICNIRP) define levels of electromagnetic signals that are considered safe, as well as methods of estimation. Prior to commissioning, each base station in South Africa must be evaluated to ensure compliance with the ICNIRP safety norms. Compliance to health and safety is usually ensured by lowering the transmit power level, adjusting the antenna tilt/pattern and restricting access to “unsafe” zones.

Handset emission characteristics have their own peculiarities. In South Africa, a typical mobile phone is allowed to emit up to 23 dBm (i.e. around 200 mW) of power. The actual amount of radiated power varies with time and depends on the distance to the base station and need to switch between the base stations. Global System for Mobile Communications (GSM) phones transmit most power while establishing a call and somewhat less during the call. Most mobile phones start to increase their transmit power (up to the 200 mW limit) as the distance to the base station increases. The phones may also be expected to transmit more power during hand-over from one base station to another, as the user moves around, and the cellular network tries to find the tower offering the best connection for the handset.

Just like base stations, mobile phones must also be tested and certified for compliance to health and safety regulations.

b) Is it dangerous to live near a cell phone tower?

Because base stations are allowed to transmit far more power than handsets, concerns have often been voiced that mobile phone towers may have negative effects on people living nearby.

Directional antennas concentrate the signals in a specific direction, making the signal more powerful, much like a reflector improves the brightness of a car's headlamps. For this reason, regulations governing mobile phone signals specify the maximum effective isotropic radiated power (EIRP) that the device may transmit, as well as the actual power it may transmit. For directional antennas, the transmitted power must be reduced to ensure that the EIRP limits are not exceeded. Radio signals get weaker as the square of distance between the source and the destination. If you double the distance from the source, the signal reduces to a quarter of its previous level.

The ratio between the maximum permissible EIRP from the base station tower and that from the handset is about 40 dB (or 10 000 times). Accordingly, if the handset is 500 mm from the user and the tower is 50 m away, the signal strength from the base station and the handset experienced by the user would be similar.

The handset is typically very close to the user. Depending on how the handset is held and exactly where its antenna is located, the antenna could be as close as 5 mm to the user. On the other hand, the distance to the base station is typically tens or hundreds of metres, or up to tens of kilometres away in rural areas.

Clearly, users can expect to experience stronger signals from their handsets than from base stations.

Mobile phone and broadcast towers use sophisticated antennas (such as cosecant-squared arrays) that suppress signals at ground level close to the tower, giving a similar signal strength at all distances within the coverage area. This type of pattern optimises network performance and is in the operator's interest. Accordingly, someone near the base of the tower should not receive significantly more signal strength than someone at the outer edge of the coverage area.

c) What about cellular access points like femto and pico base stations¹?

In the European Union, European Telecommunications Standards Institute (ETSI) standards and technical reports² differentiate between four different base station classes, namely macro, micro, pico and femto. They also place smaller base stations in categories separate from the larger base stations and handsets, allowing for separate, yet standardised, specifications for transmit power levels. The small devices, like femto and pico base stations, are intended as 'gap-fillers' and are restricted to around 0,1 to 1 W, not very different from mobile phone handsets.

Unfortunately, such categories do not appear to exist in South African regulations. It is unclear whether such devices are sold as "base stations" or "mobile phones" and which transmit power

¹ See for example <https://www.waveform.com/pages/femtocell-and-microcell> and https://mobilenetworkguide.com.au/mobile_base_stations.html

² See for example ETSI EN 301 502 V12.5.1 (2016-07) and ETSI TR 103 117 V1.1.1 (2012-11)

restrictions they need to comply with. Therefore, all such applications for compliance must be processed individually.

Nevertheless, the safety of such devices, like any other commercial communication devices, is subject to the ICNIRP Guidelines, and must always be certified for compliance.

d) How can people who want to be extra safe reduce exposure to electromagnetic signals from a mobile phone?

From the preceding discussion, it is clear that distance, power and exposure time all play a role. Decrease the time of exposure, increase the distance between you and the handset and only use your mobile phone in areas of good coverage, so that it does not increase power beyond the minimum necessary. Some practical hints include:

- Increase the distance between the mobile phone and your body, by using a headset or speakerphone.
- Do not carry a mobile phone tightly against your body, such as in pockets or tucked into underwear.
- Do not sleep with the phone near your body or head. Place it at least a metre away.
- Use flight mode when you do not need phone connectivity, such as when asleep or when using the device for reading or games. It does not transmit radio signals when in flight mode.
- When available, use landline telephones.

Use lower-power alternatives, such as Wi-Fi³. As many users move away from traditional cellular networks onto Voice over IP applications, like WhatsApp, and as 5G continues to integrate with Wi-Fi, it may become viable to keep phones in flight mode and only enable Wi-Fi, which emits half the power of traditional mobile phones. However, the question of the overall exposure of Wi-Fi versus cellular technologies has not been studied. Keep in mind that the base station is typically much closer to the user than in traditional mobile networks.

e) What is the CSIR's view on the alleged link between the introduction of 5G and the current COVID-19 pandemic?

There is no evidence to suggest a link between 5G technology and SARS-CoV-2, the virus causing COVID-19. The claims that we have come across do not provide any credible scientific evidence to substantiate them. Those that do provide some substantiation refer to possible effects of signals emitted by 5G devices as the likely cause of the virus.

5G technology, like all other wireless communication technologies that we use in our daily lives, uses radio signals to enable communication. Examples include existing mobile devices, Wi-Fi, Bluetooth and remote controls for car and garage doors.

Only one early 5G rollout coincided with a disease outbreak. Many other rollouts, including earlier ones in Korea, did not result in disease.

There is no credible scientific evidence that shows a link between the SARS-CoV-2 virus and mobile phone signals.

Even claims of influences of 5G signals on SARS-CoV-2 are unlikely. Mutations in the genome of a virus, including SARS-CoV-2, occur as the virus replicates. During replication, mutations

³ 2, 4 GHz Wi-Fi is restricted to 100 mW. Other bands may have higher limits.

occur randomly in the genome, since the enzymes involved in replication make mistakes, which can then result in mutations occurring in the viral genome, often resulting in different strains of the virus. This process could be influenced by external factors, including ionising radiation, such as gamma rays and X-rays. However, mobile phone signals are non-ionising and do not have enough energy to affect mutation. In addition, the very short wavelengths used do not significantly penetrate skin or other human tissue and cannot exert influences in the intestines, where the virus replicates.

f) Have you conducted studies on the effects of 5G signals to allay customer concerns?

Not at the CSIR, apart from consulting with researchers within the organisation with the necessary radio frequency and biology skills.

We concur with opinions expressed by the World Health Organisation (WHO) and the International Telecommunications Union (ITU), both agencies of the United Nations. Three examples are cited below.

ITU-T, “*Guidance for assessment, evaluation and monitoring of human exposure to radio frequency electromagnetic fields*”, Recommendation ITU-T K.91 (05/2012), 2012. <http://emfguide.itu.int/pdfs/T-REC-K.91-201205.pdf>

E. I. Edeh (World Health Organization - WHO). “*Electromagnetic fields (EMFs) and public health: shaping research agenda in the wake of 5G Tech*”. Presentation at 1st Digital Africa Week, 27 – 30 August 2019, Abuga, Nigeria. Retrieved from: <https://www.itu.int/en/ITU-T/studygroups/2017-2020/20/sg20rgafr/20190827/Documents/s1-p1-edeh-EMF.pdf>

Mike Repacholi, Emilie Van Deventer and Paolo Ravazzani (ed.). “*Base stations and wireless networks: exposures and health consequences*”, in *Proceedings International Workshop on Base Stations and Wireless Networks: Exposures and Health Consequences*, Switzerland, Geneva, June 15-16, 2005, World Health Organization. <https://apps.who.int/iris/handle/10665/43698>

Our view is that the radio frequencies of 5G networks are not high enough to break chemical bonds or remove electrons in human tissue. Therefore, it is highly unlikely that 5G may cause mutations in the SARS-CoV-2 virus in-vitro or in-vivo. However, even if it did cause mutations under carefully controlled laboratory conditions in-vitro, this would not be relevant in the real world, as the millimetre-wave signals used by 5G do not significantly penetrate the skin. 5G signals cannot influence the virus, as it replicates internally.

g) How did the alleged link between 5G and COVID-19 come about?

It is unclear how this link is being made, as most of those making the link do not provide any basis for such claims.

Prophets of doom often associate new technologies with catastrophes. 5G rollouts are commencing in several countries, and the world’s worst health crisis in a century made its appearance around the same time.

What made this event different from previous ones is the availability of social media, enabling individuals to propagate untested wild speculations on a massive scale. With the atmosphere

of fear induced by the COVID-19 pandemic, people are easy victims of such conspiracy theories.

h) Have you heard concerns from consumers and what have they been saying?

We have only heard concerns on a personal basis. However, we have noticed considerable coverage in the media. Much of the coverage has been sensational, with no real evidence to support the claims.

Concerns have been raised by some industry associations about the safety of millimetre-wave signals. Based on our understanding of the effects of radio signals on living organisms, we do not anticipate such problems. However, as the new networks become operational, more epidemiological studies will have to be conducted to ensure that their operation does not result in health problems in the populace.

The ICNIRP Guidelines cite nearly 200 credible scientific references. These Guidelines were compiled by a large team of international experts, based on peer-reviewed research and used in over 80 countries to regulate health and safety compliance. The current international scientific opinion is that as long as the base stations and cell phones comply with such Guidelines, their operation is safe.

i) Why are there concerns even though we are not yet on 5G?

Excellent question and perhaps it best illustrates how tenuous the claims really are.

The claims we have seen in the media do not appear to rely on a solid understanding of mobile networks. None of the claims that we have seen have offered scientifically credible supporting evidence.

j) When will 5G arrive fully in South Africa?

The candidate 5G technologies are currently being evaluated by the ITU. Detailed specifications of 5G technologies, officially known as IMT2020, are envisaged to be finalised within a year. Only then will smart device manufacturers and network operators start investing in a full-scale rollout.

According to the policy direction on High Demand Spectrum that was gazetted in July 2019, the roadmap will be developed after the study the Independent Communications Authority of South Africa (ICASA) has been directed to do within six months of the conclusion of the ITU World Radiocommunication Conference 2019. We believe that the required spectrum will be fully licensed soon after that. We must also highlight that some operators (e.g. RAIN in South Africa) already have licences for spectrum that can be used for 5G. All existing trials in Africa have used existing bands allocated and used for 4G, under similar power restrictions, and may thus be expected to be as safe as the existing mobile networks.

k) Was there a similar fuss with previous generations of mobile networks?

Yes. Some consumers claim terrible effects from every new technology. South Africa, for example, deliberately did not introduce television services until almost half a century after their introduction in other countries!

l) If a gadget is marketed as '5G', will it use 4G for the moment, until 5G networks have been built?

Because 5G has not been fully defined, any product sold now is probably an adaptation of an existing product, and will probably retain its existing functions. Specialised equipment, such as routers, which will be used to build 5G networks, may not support older technology.

m) The 5G-COVID-19 conspiracy theory has manifested itself globally, despite the fact that 5G is only active in a few countries. How did the claimed correlation between COVID-19 and 5G grow so big in the face of this limited rollout?

Concerns about the safety of mobile technologies have existed since the beginning⁴. It is likely that a series of unrelated events, especially the atmosphere of fear, following the COVID-19 outbreak a few months ago, gave rise to undeserved mistrust and false accusations.

For example⁵, in July 2019, scientists sent a letter to the European Commission requesting the commission to stop 5G deployments until the investigations have been concluded. The letter became a subject of news worldwide. One issue mentioned in the letter was “potential effects on wildlife of increases in electromagnetic radiation”. Even though the concern was raised, it was stated rather vaguely.

Most likely, the false link between 5G and the SARS CoV-2 virus could have come about due to a combination of factors:

- 1) Wuhan was the location of an early 5G rollout, and the origin of the COVID-19 outbreak.
- 2) Some science fiction movies have shown virus infections associated with mobile networks. A prime example is *The Cell* (2016).
- 3) Some articles, e.g. <https://www.newstatesman.com/science-tech/social-media/2020/04/how-celebrities-became-biggest-peddlers-5g-conspiracy-theory-coronavirus-covid-19> indicate that celebrities may have added to the growth of the misinformation.
- 4) 5G is the first mobile technology standard that uses two very different frequency ranges; the traditional signals below 6 GHz and much higher frequencies known as millimetre-wave. Some fear that the higher frequencies may have undesirable effects, despite the fact that many specialised systems have been running on millimetre-waves for many years.
- 5) Overall, 5G has raised large expectations and equally large marketing campaigns promoting the technology and its uses. As more people learned about this new “nearly magical” technology, existing concerns were amplified.
- 6) The widespread availability of social networks. For the first time, any individual can widely publish an opinion worldwide, without the burden of having to support that opinion with facts.

None of these effects can be regarded as solid grounds for concern. Wuhan is a large city with a large population of 11 million people, the sixth biggest in China⁶. Therefore, it was an obvious choice for a new technology rollout that promises increased capacity and new applications. Such a large and densely populated city is also a fertile environment in which a virus can spread.

Science fiction is just that – fiction. Celebrities are not necessarily in a good position to formulate informed opinions. Millimetre-wave systems do not pose proven health hazards and

⁴ See for example, https://ec.europa.eu/health/sites/health/files/scientific_committees/scheer/docs/scheer_s_002.pdf

⁵ <https://en.wikipedia.org/wiki/5G#Health>

⁶ <https://www.worldatlas.com/articles/20-biggest-cities-in-china.html>

most of the existing 5G rollouts do not use millimetre-wave. Finally, existing concerns have been proven to be unfounded by decades of mobile phone operations that have not resulted in a decrease in population health.

The WHO has stated^{Error! Bookmark not defined.}, “Currently, exposure from 5G infrastructures at around 3.5 GHz is similar to that from existing mobile phone base stations. With the use of multiple beams from 5G antennas, exposure could be more variable as a function of the location of the users and their usage. Given that the 5G technology is currently at an early stage of deployment, the extent of any change in exposure to radiofrequency fields is still under investigation.”

This statement advises that the 5G technology using sub-6 GHz spectrum is about as safe as all previous generations of cellular technologies.

For 5G using millimetre-wave, the statement may indicate that, at the time, uncertainty was raised around the ability to fully control the exposure to fields emitted by 5G in millimetre-wave bands. Scientists would be cautious to state categorically that no danger exists from millimetre-wave technologies, as a decades-long record, such as that of existing mobile networks, is not there to back them up. Such caution could be misinterpreted, and may have led to suspicion around the entire suite of 5G technologies. Ironically, China has not used millimetre-wave in its 5G deployment⁷. Indeed, only a few countries have used these frequencies so far.

Concerning any health issues in respect of telecommunication in South Africa, guidance is obtained from the Directorate: Radiation Control reporting to the South African Department of Health (DoH). The national DoH heavily relies on the recommendations developed by the ICNIRP. The recommendations are available in the “ICNIRP Guidelines on Limiting Exposure to Electromagnetic Fields”⁸, prepared by a team of international experts and used in over 80 countries. These ICNIRP Guidelines are for the protection of humans exposed to radiofrequency (RF) electromagnetic fields in the range 100 kHz to 300 GHz, including all current and future 5G bands.

In March 2020, for the first time since 1998, ICNIRP updated field strength requirements for mobile phones using 5G. The Guidelines cover many applications, such as 5G technologies, Wi-Fi, Bluetooth, mobile phones and base stations. The updated Guidelines restrict whole-body exposure, permitting somewhat greater exposure of small parts of the body to frequencies above 6 GHz. The new restrictions may be expected to help to curb the controversy.

The CSIR reiterates that no plausible link between 5G and the Coronavirus could be established.

n) In the argument against the conspiracy theories regarding 5G and the Coronavirus, what is the primary piece of evidence that is or could be used to discredit them?

There is no evidence of any link between the novel Coronavirus and 5G. Here are some facts that support this statement:

⁷ https://en.wikipedia.org/wiki/List_of_5G_NR_networks

⁸ <https://www.icnirp.org/en/activities/news/news-article/rf-guidelines-2020-published.html>

- 1) The Coronavirus spreads from one person to another, typically through tiny droplets of saliva when a sick person coughs, sneezes or breathes. It then multiplies inside the victim. Radio waves from 5G or any other commercial wireless communication equipment do not have any visible physical form and cannot transmit a virus. The signals also do not have sufficient energy to meaningfully influence a virus.
- 2) The virus has spread within many countries without any 5G networks⁹.
- 3) Research articles suggest that the novel Coronavirus came about through natural evolution/mutations¹⁰.
- 4) There is no credible scientific evidence showing a link between the SARS-CoV-2 virus and mobile phone signals.
- 5) Mutations in the genome of a virus, including SARS-CoV-2, occur as the virus replicates. Mutations occur randomly in the genome, as enzymes involved in viral replication make mistakes, resulting in different virus strains. At the frequencies at which 5G networks operate, the energy of radio signals is not high enough to noticeably break chemical bonds or remove electrons. Therefore, it is highly unlikely that 5G may cause mutations, even in laboratory conditions. 5G signals do not significantly penetrate through human skin. The virus replicates internally, therefore it is even less likely that 5G signals could influence the virus in those conditions.
- 6) The first country to adopt 5G on a large scale was South Korea, in April 2019. There were many 5G installations across the world, including Britain, Germany and the United States of America before the COVID-19 outbreak. Even in China, many cities had such installations: "5G commercial services are now available in 50 cities, including Beijing, Shanghai, Guangzhou and Shenzhen, according to Chinese state news agency Xinhua. In Shanghai, nearly 12 000 5G base stations have been activated to support 5G coverage across the city's key outdoor areas"¹¹. Nevertheless, the virus started in only one city located in China.

The WHO states, "5G mobile networks **do not** spread COVID-19"^{Error! Bookmark not defined.}. The US Federal Emergency Management Agency (FEMA) and Federal Communications Commission (FCC) and many other key organizations around the world state very clearly: "5G technology does **not** cause coronavirus."

The CSIR fully agrees with the WHO.

o) Is it coherent to say that the theories are an evolution from past concerns that cellular technology and cellular towers were responsible for causing cancer in users?

Most likely, yes. However, the evidence is very sparse and disproportionate to the global usage of the mobile phones. Despite four decades of widespread mobile phone usage, there has been no demonstrated link with a deterioration in population health.

p) Is South Africa in a position to double down on 5G infrastructure in the wake of many businesses opting for online correspondence and working remotely?

The South African mobile phone industry has conducted many trials and has been ready for 5G for a long time. Some operators have already deployed non-standalone or pre-5G networks in South Africa. Authorities will have to allocate more radio frequency spectrum for use by 5G networks. This process is being given high priority, and was expedited when issued

⁹ <https://www.who.int/emergencies/diseases/novel-coronavirus-2019/advice-for-public/myth-busters>

¹⁰ <https://www.sciencedaily.com/releases/2020/03/200317175442.htm> referring to the journal article Kristian G. Andersen, Andrew Rambaut, W. Ian Lipkin, Edward C. Holmes, Robert F. Garry. *The proximal origin of SARS-CoV-2*. Nature Medicine, 2020; DOI: 10.1038/s41591-020-0820-9

¹¹ <https://edition.cnn.com/2019/11/01/tech/5g-china/>

temporary spectrum “in an effort to deal with COVID-19 communication challenges”¹². For the moment, most ‘5G’ networks use existing spectrum allocations.

The possibility of setting up private 4G and 5G networks is also raising significant interest. Such networks require significant capital, but avoid paying for data or subscription fees to an operator.

Thus, there is a strong interest in 5G, thanks to its exceptional performance and feature set.

The lockdown related to COVID-19 has brought about a number of emergency measures, including in the ICT arena^{13,14}. The need to work remotely has increased the load on mobile networks by 25 to 60%. The network operators state that this increased demand does not saturate their networks. Yet, new ways of working and new online opportunities enforced on employers and employees by the lockdown are likely to produce more demand for speed, convenience and reliability. Once this demand grows and the pricing on 5G equipment decreases due to larger volumes, operators will be forced to start large-scale upgrades to 5G.

q) Could conspiracy theories such as these hamper the global rollout of 5G technology in the long term?

Yes, but fortunately only to a limited extent. There are already examples of people applying drastic measures to avoid the introduction of 5G, as shown by the recent torching of 5G towers in the UK. This kind of radical action is likely to remain limited, as most people are not inclined to such radical action. Even their resistance will dwindle as experience shows that the networks do not result in the envisaged harm.

Most people understand these conspiracy theories to be spurious and will not object to rollouts of 5G. Also, the speed of the rollouts is mainly defined by economic factors, including whether 5G brings value for money and it is affordable at all. 5G user handsets and networks are still expensive. While many business people will not be deterred by the high cost, many low-income users will not be able to afford a 5G handset for another few years.

Operators with national-scale networks spread the costs of upgrades between all users, through data charges. Therefore, the operator decides when to roll out 5G. The availability of spectrum is an important constraint, as rolling out a 5G network whose bandwidth is shared with 3G and 4G networks may not be able to offer 5G users the promised super-high speeds, creating negative first impressions and slowing down the uptake by users.

r) How will 5G networks impact education and health in South Africa?

5G supports the wide distribution of a practically unlimited amount of information. It also has very high capacity, ensuring that no user should be denied fast access to the desired information. This capability offers exciting opportunities for online learning. Apart from existing online opportunities, such as online courses, and even information sources, like YouTube videos, it is, in principle, possible to conduct real-time classes countrywide or even worldwide.

¹² <https://www.icasa.org.za/news/2020/temporary-radio-frequency-spectrum-issued-to-qualifying-applicants-in-an-effort-to-deal-with-covid-19-communication-challenges>

¹³ <https://www.ellipsis.co.za/national-lockdown-south-african-telecommunications-sector/>

¹⁴ <https://ict.fttxcouncil.com/>

Thus, 5G will also play an important social equalisation role, as even the lowest-income students will have better access to the world's best teachers.

5G is not a substitute for personal attention in the classroom, so its effects are more likely to be felt in higher-level education (secondary and especially tertiary) than in basic education (pre-school and primary). However, it can definitely play a role in empowering teachers, even in basic education, with new techniques and more advanced training.

In the medical arena, the ability to view multiple cameras and access other sensors in real time can contribute significantly to accurate diagnosis, especially in cases where a long-term on-body measurement is required or a relevant specialist is not present where the patient is. 5G also offers services that provide for low latency (the delay between transmission and reception) and practically error-free operation. These services are intended to facilitate things like remote surgery, where a surgeon can operate on a patient far away, while being able to see exactly what is going on and being able to precisely control robotic surgical instruments.

In future, rural clinics with nothing more than nursing staff should be able to make use of specialised staff in major centres to perform advanced diagnostic and surgical procedures. City hospitals should be able to solicit specialised skills from anywhere on earth where those skills are not available locally.

5G can also play a role in drone-based deliveries of medicines and medical samples, both in rural and urban environments. 5G provides a ubiquitous communications infrastructure to enable drones to maintain mutual separation and receive precise instructions.

s) How will 5G networks contribute to smart cities?

5G networks offer services that accommodate very large numbers of simple sensors. The service is designed to minimise power consumption in those sensors, allowing long-term operation off batteries. Millions of such sensors can be deployed in an urban environment, making it possible to monitor things like air quality, traffic flow and weather very precisely. Knowing exactly what is happening should enable local government to analyse and control the environment with great precision, to the advantage of all their inhabitants.

Many new technologies, such as driverless cars, can also use 5G to allow vehicles to communicate with others. This communication is essential in the ability to reliably separate vehicles from one another, as each vehicle must be able to anticipate the position, speed and intentions of other vehicles and advise others of its own intentions.

t) What role can the media play in the roll out of 5G?

Media content can offer exciting incentives to adopt 5G. One example is that of real-time sports coverage, offering multiple simultaneous camera angles, inside and outside the stadium.

In the short term, the media can help to provide a healthy perspective on 5G and its advantages, by also helping to allay fears raised by false claims of nefarious effects.

u) What are the most exciting applications that 5G will bring?

The most exciting part is that we do not know. Experience has shown that the availability of ever-increasing processing power and bandwidth has consistently led to applications that few could have envisaged. Many of the applications available on a smart phone today would have

been unthinkable even 20 years ago, and were certainly not all envisaged by the designers of the networks that have enabled them to come into widespread use.

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