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5G and 6G Broadband Cellular Network Technologies as Enablers of New Avenues for Behavioral Influence with Examples from Reduced Rural-Urban Digital Divide

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Abstract: Two of the key information technologies with very high expectations to change our contemporary society are the fifth generation broadband cellular network technologies, which are already emerging to markets, and the foreseen sixth generation broadband cellular network technologies currently under research and development. The core promise of these next generation technologies lies especially in lower latency for providing users feedback on their behavior; thus, growing opportunities for influencing users in their everyday contexts. This viewpoint article seeks to discuss how these opportunities may impact future information technology in general and especially persuasive design and research before 2030. In addition, we will address challenges regarding the promise of 5G and 6G technologies. Information and communication technology can support individuals' behavioral change only if they can access the technology. In this article, we will exemplify this by presenting possible ways to minimize the digital divide between rural and urban areas, wherein lies a general danger that the divide would increase further.

Keywords: telecommunication; network technologies; radio technologies; 5G; 6G; persuasive technology; digital divide

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1. Introduction

Information and communication technology as a field keeps progressing fast with new software platforms and business ecosystems frequently introduced. Many of these are market-driven and may end up generating fundamental effects on our everyday lives. Two of the key technologies with very high expectations to change our contemporary society is fifth generation broadband cellular networks (5G) and sixth generation broadband cellular networks (6G). The 5G is hyped by commercial markets, but it also holds promise for analyzing user behavior, as well as influencing both online and offline behavior. What the 6G constitutes is yet to be determined, but it serves as a mental model of what lies ahead in the roadmap to 2030 [1–3].

For 5G, possible use case scenarios include asset tracking and asset management, intervention planning and intervention follow up, remote surgery, cloud service robotics, remote monitoring, the Internet of Things (IoT), smart homes and smart cities, smart medication [4], automated passenger cars [5], autonomous driving, and intelligent manufacturing [6]. Furthermore, 5G as a connectivity solution is the first universal solution that could cover all existing traffic profiles, thus enabling smart logistics to be cost-efficient: Massive Machine Type Communications (mMTC), Ultra Reliable Low Latency Communications (URLLC), and Enhanced Mobile Broadband (eMBB) enable smart logistic applications such as object tracking, automated guided vehicles and drones, remote assistance, monitoring and control of machines and robots, intrusion and/or hazard surveillance, and ambient sensors [7]. As for applications requiring very high data rates, e.g., multiple-view holographs, 5G may not be enough [8]. Therefore, it could be possible that more advanced use case scenarios would rather require 6G instead of 5G.

As of 2020, smartphones generally act as bottlenecks for data transfer rates; therefore, 5G may not be visible yet with regard to user experience [9]. We do not yet properly know what 5G finally has potential for, thus it may be difficult to fathom the possibilities of 6G.

However, as technological advances during the past decade have indisputably shown, next generation broadband cellular networks hold promises for even greater advances for the coming decade. The need for contemplating applications for potential major use cases would then not only apply for 5G, but for 6G as well.

In this viewpoint article, we seek to discuss both the promises and challenges of 5G and 6G for information technology in general, and more specifically for persuasive systems regarding design and research. There is all the reason to believe that mobile technologies will serve as important elements for Internet connectivity also in the future, and that 5G and 6G will enable individuals and communities to change their behavior towards what is more sustainable in the long term. Furthermore, one of the core principles of the United Nations Agenda 2030 is to "leave no one behind" [10] (p. 23). With respect to this principle, technological innovations should not be planned to be usable only in modern urban cities.

In Section 2, we briefly introduce next generation broadband cellular network technologies. In Section 3, we discuss the already emerging 5G technologies and the predicted 6G technologies from the perspectives of market-driven scenarios and the challenges to fulfill the scenario. Section 4 exemplifies how the rural-urban digital divide could be reduced with the next generation broadband cellular networks. In Section 5, we outline predictions for influencing human behavior in the future.

2. Background for Next Generation Broadband Cellular Network Technologies

Fifth generation broadband cellular network technology aims to provide new high-quality wireless services to meet the rigid case-specific needs of vertical sectors beyond what has been previously possible. 5G is expected to play a pivotal role in telecommunications with a low barrier for market entry and traditional mobile network operators being transformed to compete with new players, such as function developers and facility managers, who enter the market [11]. Much more advanced applications and services than are available today, with demanding technical requirements, are supposed to be provided by vertical industries. Due to growing network deployment and traffic demand in the future, energy consumption will be increased; thus, there is also growing demand for green mobile networks [12]. 5G is expected to disrupt the mobile communication business ecosystems and open the market to new sharing-based operational models. Matinmikko et al. [13] suggest a micro-licensing model for mobile markets, which would allow different stakeholders to deploy local small cell networks with locally issued spectrum licenses for vertical sectors' case specific needs. For example, in the European Union (EU27), only three countries have yet to launch 5G services as of the end of March 2021 [14]. However, the real value for 5G networks even in advanced countries could still be limited, because many consumers may lack adequate equipment such as 5G smartphones to take advantage of next generation broadband cellular networks.

According to Polese et al. [15], machine learning, software-defined networks, and edge clouds will be key components of 5G, and they propose using these elements jointly in designing systems for next generation broadband cellular networks. As for applications that are available for users, enhanced mobile broadband offerings, e.g., mixed reality (elements of real world and digital world combined), may become the closest in the timeline of use case realizations [16]. Improving existing applications should not be considered a major breakthrough for 5G use case realizations, as the improvements may be based on technological solutions suitable for previous generation broadband cellular networks, e.g., smartphones. Instead, next generation applications should be designed for more flexible use. Similarly, IoT, regarding both small and large scale implementation, has also been discussed for years, and gradually household items are beginning to have wi-fi connections, ranging from washing machines to decorative outdoor lamps. More advanced massive scale IoT use cases are still a few years away, and as for services such as autonomous vehicles or connected vehicles, the timeline is rather long term [16].

Whereas 5G, due to different network configurations, will most likely be a compromise on latency, energy, cost, hardware complexity, throughput, and end-to-end reliability, 6G will be developed holistically, taking potential use cases for 2030 and beyond into consideration [17]. According to Akyildiz et al. [18], emerging use cases for 6G systems could be, for example, remote healthcare, smart environments, industrial automation, precision agriculture, holographic teleportation, autonomous vehicles, smart infrastructure, and unmanned aerial vehicles.

When considering the deployment of 5G networks, it would be cheaper to integrate the 5G spectrum into existing microcellular networks, even though "average speed" could not be delivered to all users everywhere [19]. Therefore, leaving the decision regarding the network deployment solely to commercial operators might not be the best solution. The cost for small cell deployments could be higher overall, but it would be very low in dense urban environments, when compared to less populated and rural areas [19]. For universal broadband access in both urban and rural areas, government policy choices can reduce the costs [20]. In densely populated urban areas, the 5G business case for mobile broadband services can be positive (especially with network sharing), with less than a year for the payback period, but there may be risks for later years [21].

3. Emerging and Predicted Broadband Cellular Network Technology

3.1. Promise: Market-Driven Scenarios

5G is expected to support the Internet of Everything (IoE), with both wired and wireless communications using the same infrastructure [11]. Connectivity addresses not only separate users, but also Internet-connected objects, and *keeping user experience at satisfactory levels would then become a key for success*. At the same time, a paradigm shift is needed to establish next generation broadband cellular network frameworks to achieve reliable, omnipresent, ultra-low latency broadband connectivity that is capable of providing and managing critical and highly demanding applications and services. The IoE in a single hub is the related future development of 5G applications and use cases [22].

Added value comes through infrastructure being provided "as a Service". For instance, Bega et al. [23] describe Amazon Web Services and Microsoft Azure as 'Infrastructure as a Service' (IaaS) providers, who sell their computational resources such as CPU, disk space, or memory space for virtual network function purposes, and who would be the role models for future IaaS providers. However, while the IaaS approach follows a similar business model to network resources provision, the latter is an intrinsically different problem as spectrum is a scarce resource [23]. *The actual capacity of the system depends on the mobility patterns of the users*, such as growing nomadic user behavior [24] (p. 150). Moreover, service level agreements may put stricter requirements on the quality of the experience perceived by the users.

Table 1 presents the offerings of 5G network technologies based on Neokosmidis et al. [25].

Offering the abovementioned would accommodate the increasing traffic and demand stemming from the IoT and communication between machines. Yet, according to Neokosmidis et al. [25], *5G is even more importantly expected to bring significant socioeconomic benefits.* Indeed, the previous generations of mobile technologies have been designed to meet mainly the needs of mobile network operators and final consumers, whereas the fifth generation broadband cellular networks would be the first to include socioeconomic benefits among its main targets and priorities, rather than only including technical telecommunication and marketing goals.

Table 1. Anticipated offerings of 5G network technologies.

Type of Promise	Promise	Explanation or Example
Technological improvement	High data rate (i.e., 1–10 gigabytes per second for end-users).	Through integration of high frequency technologies such as 60 GHz and optical wireless.
	Low latency (i.e., less than 1 milliseconds).	Through hierarchical routing such as 6tree IPv6 routing.
	Increased reliability.	High reliability even with high density of heterogeneous devices.
Service and/or societal level impact	Improved quality of service and quality of experience.	Through edge computing capabilities, such as acceleration, optimization, and virtualization.
	Higher quality of content delivery services.	Higher level of personalization in services; through caching.
	Increased cost-effectivity.	Reduction of network deployment cost; no need for highly specialized devices via softwarisation and virtualisation.
	Reduced rural-urban divide and creation of new market opportunities.	Leasing 5G network capacity via neutral host operator to service providers for fair competition.

Vertical industries, such as manufacturing, automotive industry, eHealth, energy, and media and entertainment are expected to be able to develop advanced applications using 5G networks and service capabilities. Automation, autonomous systems, and different kinds of sensors, as well as modern and more intelligent software and information systems, may enable a wide variety of new types of software applications. Connections beyond personalized communication to machine-type communication connecting people, data, devices, and sensors could be expected to emerge.

These developments are expected to bring about much higher societal impacts than the previous generations [25]: (1) decentralization of work, (2) better social inclusion, (3) reduced rural-urban divide, (4) reduced need for physical mobility, (5) reduced levels of carbon dioxide emission, (6) increased security levels, (7) increased wellbeing of people, (8) enhanced medical support with fewer accidents, (9) enhanced experience of life for the elderly, and (10) advanced levels of entertainment (whatever it may mean).

3.2. Challenges to Meet with the Promise

A healthy criticism towards the high expectations set by marketing people for 5G, however, is provided by Giordani et al. [17]. They suggest that, at the end of the day, many of the proposed near-future 5G application deployments will fail either due to technological limitations or because the market will not be mature enough to support them. Rather, they will become available for the general audience a lot later than expected. The risk is that massive scale communications with quality of service would not comply with the requirements of a society, which becomes extremely data-driven with a need for very high connectivity. Table 2 shows the maturity of contemporary 5G networking technologies, based on Giordani et al. [17].

Table 2. Maturity of contemporary 5G networking technology.

Application or Technology	Explanation or Example	Challenge
eHealth	Digital therapeutics and remote surgery.	Lack of true real-time feedback (e.g., tactile feedback) and quality of service expectations.
Augmented and extended virtual reality	Immersive environments, such as educational content for students to virtually inspect objects in their environments (e.g., an animal in its natural habitat).	Unprecedented challenges with increased quality of immersion, increased needs for capacity, submillisecond latency, and uniform quality of experience (especially at cell edge).
Drones and other flying vehicles	Unmanned flight to increase productivity of rural businesses, improve access to goods, and reduce production and delivery costs.	Need for improved capacity for ever-expanding Internet connectivity.
Autonomous vehicles	Safer traveling, improved traffic management, and support for infotainment applications.	Challenges with the design and deployment of connected vehicles and autonomous vehicles, unprecedented levels of communication reliability, low end-to-end latency required; demand for increasing data rates for an ever-growing number of sensors.
Holographic telepresence	Real holograms, such as holographic maps, to be used in crisis situation to plan rescue missions.	Severe communication challenges with 3D holographic display and data transmission requirements; all human senses would be needed for a fully immersive remote experience.
Pervasive systems	Smart systems, such as sustainable smart cities.	Scalable, low-cost deployment networks with low environmental impact and better coverage needed; increased indoor connectivity required.
Industrial work	Improvement of robotics and automation to enhance productivity.	Real-time operations, guaranteed extremely low latency, boundaries existing between factory and cloud environment.

Therefore, the promises of 5G applications are great, but the challenges are many, and the elevated expectations and slower-than-expected pay-off may quite likely bring a feeling of disappointment for the general audience, at least in the beginning of the 5G era.

5G networks have been available for a while in some (developed) countries and are becoming rapidly more available in North America, Europe, and Asia, despite COVID-19 slowing down the deployment [14]. However, it may not be certain how many of these new networks have been deployed as non-standalone 5G networks, which require 4G networks to support the 5G. It should be noted that full functions and features of 5G will only be available with standalone networks that do not require 4G for support.

4. Reducing Rural-Urban Digital Divide with 6G Telecommunication Networks

Persuasive technologies can be helpful for individuals, but only if they can be reached. From the behavioral influence perspective, one of the most considerable risks of 6G is that it could become technology for the few or for the elite only. The central question is, how can we avoid new technological innovations being developed solely for people living in modern cities with a sufficient socioeconomical status? It is important to not increase the digital divide between rural and urban areas any further, but to look at decreasing it in the future.

Technology is never neutral; rather, it affects people's lives whether it is purposefully designed to do so or not [26]. The United Nations' Sustainable Development Goals (UN SDGs) and the commercial launch of 6G are both targeted for 2030. The UN SDGs cover themes as broad as fighting climate change, building gender equality, ending poverty, and developing smart cities, whereas 6G communications are expected to change societies through new business models, boosting global productivity, and boosting growth [1]. The relationship between these forces can potentially be mutually reinforcing, since the core principle of the UN Agenda 2030 is to "leave no one behind" [10] (p. 23), while mobile technologies form the core of modern connectivity and access to the Internet (Matinmikko-Blue et al. 2020). UN SDGs can be used as a beacon to prioritize development. According to Matinmikko-Blue et al. [1], these technology standards should be advanced first, which supports protecting the environment and improving lives, and the 6G ecosystem enables creating solutions that empower communities and individuals to adopt self-correcting activities and guides behavior towards what is sustainable in the long term.

Remote and rural areas all over the world are missing proper connectivity, which increases the digital divide [2]. According to the United Nations, already 55% of the global population lives in urban areas [27]. According to the International Telecommunication Union, in 2018, 3.9 billion of the world population of 7.6 billion used the Internet [28], leaving 3.7 billion non-users, whereas 5.1 billion (67%) had a mobile subscription.

Rural areas attract less investments (than urban areas) because of low population densities, which mean the inhabitants are also often significantly poorer than people living in cities. Additionally, rural areas can have difficult terrains without existing infrastructure, such as power grids [2]. In "*6G White Paper on Connectivity for Remote Areas*", it is argued that 6G could be the first broadband cellular network generation that truly closes the digital divide [2]. Technically, a so-called "digital oasis" could be built in rural areas, where people live and work using various backhaul solutions including large cells, relay technology, and satellite technology. Such solutions should be affordable and provide sufficient data rate and availability, which requires more than merely technical engineering. Their design should happen in cooperation with various stakeholders to ensure that they are adaptable to different cultures while being easy to use.

Most likely, novel regulations are needed when targeting affordability and sufficient services. This may differ radically from targets in high-population urban areas with high data rate solutions [2]. Governments could be expected to take an active role when terminating digital inequality, since it requires changes in policies and changes in investment support strategies. Companies are most likely not keen to invest into rural areas, when the calculated average revenue per user (ARPU) is low [29]. New local micro-operators may be needed, if operators are unwilling to invest into these oases. This would mean that a property owner could run its own network to provide connectivity for the local area. Micro-operators are more likely to succeed in this, since they can easily engage with the community while meeting local needs, while also leveraging their infrastructure to reduce capital and operation costs to become profitable [2]. The micro-operator concept has been illustrated by its deployment in Peru to improve rural connectivity [30]. Micro-operators need to be able to dynamically adjust bandwidth to guarantee the functionality of the most important applications for locals (e.g., eHealth and e-learning) to ensure, for example, the number of visitors will not completely block the system. This can be managed by having network slices for locals and for visitors to ensure that possible limited backhaul can be used efficiently [2].

The OECDs [31] digital economy article, "*Bridging the Rural Digital Divide*", raises the challenges of broadband accessibility, as well as the approaches, for measuring the quality of services offered in rural areas. The paper notes that focusing on download speed is not sufficient because people in rural areas are increasingly becoming producers of content, and they too need to be able to benefit from services such as cloud computing and big data. During the 6G development processes, special needs like safety and rescue missions should not be forgotten, and new systems should fulfill the authorities' requirements for security, availability, and robustness. Other factors to be considered are low power consumption and smart usage of materials and resources, as well as sufficient lifespan and recyclability [2]. Finally, it is not only us humans who may need connectivity. Production-related machine-to-machine IoT communications will be highly important in rural areas, when considering the future of farming, forestry, and mining, for example.

It is estimated that in 2030, 90% of people globally will be able to have access to the Internet [1]. According to Matinmikko-Blue et al. [1], 6G will therefore transform urban and rural life, while at the same time global society may become torn between the growth of nationalism and geopolitics, and information transparency and information citizenry. Important questions are: who will own the accumulating data, who will decide on technology, and who will set the rules? The "I own my data" approach is growing particularly in Europe, based on General Data Protection Regulation (GDPR), whereas there are severe differences in the data privacy laws globally [1]; for discussion of how GDPR relates to design for behavioral influence, see Shao et al. [32] and Agyei et al. [33].

Optimistically, by 2030, a greater societal focus on sustainability is expected to have been found, as well as on values, creativity, and self-empowerment, which require a human-centered approach to computing and 6G development; it has also been envisioned that, in the future, 6G technology will penetrate most parts of the world, and IoT devices and sensors controlled by artificial intelligence will be an integrated part of everyday life [1]. In such an era, data would be collected automatically from various sources, and the sensors would be miniaturized to the extent that they can be sustained on power generated through everyday human activities, such as walking and jogging. The way humans are able to interact across digital and physical worlds would be expanded in the future, and, according to most futuristic visions, even questions related to humanity from behavioral and human-machine-interfacing perspectives could be studied.

It would be crucial to respect the variety of humankind and concern different future users of technologies: who they are, what matters in their inclusion or exclusion, how we can empower them to reflect their everyday life, and, finally, what role technology plays in it. A wide variety of values, opinions, and lifestyles with the polarizing effects of social media and absence of togetherness exist [1], which may easily lead into eTribalism [24] (p. 86).

6G could also have a fundamental impact on business possibilities in the future. It has been envisioned that towards 2030, platform ecosystems will not only offer e-commerce, social media, and tools for information search, but they will also provide an environment in which innovation and transaction platforms can be built [3]. Open value configuration could enhance value cocreation and value cocapture to increase the ecosystem value overall. This could improve the shared and acquired value not only by a focal business, but by all actors within the ecosystem. Radically novel decentralized business models could be created, where, for example, local businesses and citizens could create their own frugal adaptations of products and systems to suit their living environment. This could be supported by the global do-it-yourself culture, which would encourage the sharing of working processes and blueprints. Small manufacturers could create crowdsourcing production ecosystems to ensure independence, assurance, and resilience. Utilizing blockchain technology for supply chain management, smart contracting, and transactions may become a cornerstone for making the ecosystem trustful, transparent, and fair to all participants [3].

5. Predictions for Influencing Human Behavior in 5G Era

Indeed, modern societies have already started exploiting 5G networks and, if everything goes as expected, will start using the 6G technologies a decade later. What then can information technology as a field expect to gain from 5G and 6G, especially for influencing both online and offline behavior? To seek the answer to this question, we utilized the Persuasive Systems Design (PSD) model [26] as our conceptual lenses.

In this viewpoint article, we recognize six implications—or, perhaps it is better to say, predictions—for persuasive technology to take place by 2030. All of these have been derived from the promises and challenges of the next generation broadband cellular network technologies (presented in Sections 3 and 4) and the PSD model [26].

#1. Opportunities for influencing user behavior will keep growing massively. In spite of the extent that the promise of 5G and 6G technologies realize (or do not realize), it seems clear that with the next generation broadband cellular technologies, the opportunities for influencing *user behavior* will only keep growing. The key enabler is that, with latency down, things which were not possible before may become possible. When feedback or guidance comes in nanoseconds, it could have a profound effect on online user behavior, even in areas where positive outcomes have already been found from persuasive efforts with current approaches. This could provide huge business opportunities. In a similar manner, one of the game-changing events in favor of Google's success was an originally crazy-sounding idea to store the Internet in their servers; that, however, enabled return of search results much quicker than before, and most importantly, before the users lost their attention [24] (p. 101). New types of technological platforms, user experiences, and business ecosystems may be provided, and new types of applications or perhaps even whole new application domains may appear. Another idea, which might also be crazy-sounding as it's more common in science fiction, and which Google recently presented (with a functioning prototype), is Project Starline, a "video booth" that turns users into holograms [34]. With disruptive technologies, nowadays it seems that only the sky is the limit.

#2. Better understanding of user context will lay the basis for new technologies. The need for understanding *user context* could be expected to become more prominent with the emerging next generation broadband cellular network technologies. Tighter coupling of the analysis of user behavior and the design of persuasive influences may enable stronger support for personalized software features. This would be a much-expected step of progress as most personalized features thus far have been rather "weak" [35], i.e., merely tailored towards "people-like-this-user" rather than really personalized for "this-very-user". More detailed analysis of user behavior on an individual level would enable true personalization.

#3. Primary task support features such as self-monitoring, virtual rehearsal, and true personalization will gain growing prominence. *Self-monitoring* is very common already now for tracking user behaviors, but with an increasing amount of data from sensors, opportunities for self-monitoring should keep growing. Based on self-monitoring, true *personalization* could have tremendous opportunities to grow in importance (see also #2 above). In addition to these, software and computation-heavy features, especially *virtual rehearsal*, may become much more common than they currently are, especially in mobile and ubiquitous environments.

#4. Social influence features will benefit from real-time social presence. Practically, all features should benefit from lower latency. However, with an increased level of computation, new ways for *social influence*, including social learning, social comparison, and social facilitation, as well as competition and cooperation, may become available. Even if it may look like a small difference compared with what is already widely available via contemporary technologies, this is where any progress with response times plays a huge role (see also #1 above). The aforementioned features seem to be very common with all contemporary online games, thus could also open opportunities for gamification, which could be seen as another technique for persuasion.

#5. The fight against obtrusiveness will become even more important than it currently is. The flip side of the IT always being present and at our use is that some of the new solutions may be highly *obtrusive*. Paradoxically, even if we tend to think about these technologies as tools or aids when we need to do something, these technologies may suddenly require a very high cognitive attention without our control. Some of the "tools" could even require immersion into their platforms. However, even lesser demand that consumes users' cognitive resources or users getting messages in inopportune moments could be very distracting. One recent example of this was Amazon's Alexa, with unprompted and sudden laughter from Alexa-enabled devices that disturbed or even scared some users, eventually leading to several unplugging their devices [36].

#6. The need to employ high ethical standards will become ever more important. With increased possibilities to influence people's lives, coupling *ethical considerations* on a par with systems design should be extremely important. This includes seeking transparency in persuasive efforts and revealing the biases behind the designs. Through tracking user behavior and aggregating pieces of information from different sources, service providers (and others) could analyze users in ways they might find difficult to even imagine, not to mention the possible data breaches. Lower latency will also likely lead to subtler ways of persuasion, perhaps indirect and incremental, which are more difficult to notice by users of such technologies. The darker side of influence, manipulative, and subliminal attempts will likely grow, too [37].

6. Discussion

This viewpoint article sought to assess the user-facing technological promises and challenges of next generation broadband cellular network technologies, and the implications of those capabilities to user experiences. The 5G technology is already known reasonably well, but given the embryonic state of 6G, the features and functionality of it are vague and highly uncertain. Technological promises include high-data rates, low-latency, availability, and ubiquity, whereas technological challenges include the practical problems of deploying products and systems that demand high reliability and availability for areas such as healthcare, robotics, and in more general real-time experiences.

Undoubtedly, advances in 5G and eventually 6G will affect other downstream technologies, including those used for persuasion. The speculative futures presented include six broad predictions derived from the Persuasive Systems Design model [26]. We believe that opportunities for influencing user behavior will keep growing massively, and that better understanding of user context will lay the basis for taking advantage of these new technologies. Primary task support features such as self-monitoring, virtual rehearsal, and true personalization, which have already been found to be important facets of many contemporary applications, will gain even greater prominence in the future, and already popular social influence features will keep benefiting from growing real-time social presence. The downside of the discussed enabling technologies is that the fight to safeguard an unobtrusive everyday life will become ever more important. Finally, application designers will have to pay growing attention to high ethical standards in their designs.

It is evident that a pivotal point in the 6G development has been reached, where help for designing solutions that benefit everyone, not just citizens of urban cities, is needed. If our future innovations, whether technical or business, can lower the deployment costs of mobile data connections, they can also have a positive impact on equality and fairness. This article portrays some of the possible solutions to shrink the digital divide by, e.g., supporting micro-operators in rural areas. If this challenge is won, rural areas can contribute as equal collaborative partners in developing new opportunities in persuasive technology. Trustful, transparent, and fair ecosystems can change the direction of new business and innovations, so that there exists no longer only a one-way street from urban to rural. Academics and technological innovators should see their role as part of the solution of the future. Decision makers often value their opinions and some of them hold positions where even direct impact is possible. They should not see themselves merely from the viewpoint of a particular and distinct research field, but rather as one important chain in a global network that affects everyone.

In this article, we have sought to stimulate discussion regarding the dimension of persuasive technologies and networking capabilities, which has not been well treated in literature. With many persuasive technologies relying more and more on the IoT and being deployed on mobile devices, the capacity and quality of the networking infrastructure is an important component of almost any persuasive system. This article was based on analyzing telecommunication technologies rather than focusing on user experience design or speculative futures *per se*. The next step would be naturally to look at the same research question(s) from these viewpoints.

7. Conclusions

This viewpoint article sought to raise interest and facilitate discussion on the role of next generation broadband cellular networking technologies for information technology in general and persuasive design and research especially. With lower latency for providing feedback, new types of user behaviors and new ways for influencing them may be found. For instance, growing possibilities for self-monitoring could open new means for analyzing user behavior data and utilize already common social influence features in a much more sophisticated manner. A particularly exciting expectation may be to finally see digital interventions, which are truly personalized, as well as new means for computation-heavy virtual rehearsals of both online and offline behaviors supporting the change of one's own behavior.

As always, these technological advancements would not have only positive impact on people and society. Subtler ways of persuasion, perhaps subliminally or even in a manipulative manner, may become more common. Bad design easily leads into technologies becoming highly obtrusive or otherwise harmful. In any case, the general audience should become better educated about the powers that contemporary and emerging information technologies have on influencing our behaviors. Technology developers should bear social responsibility in mind and seek to employ very high ethical standards in their designs. For researchers, all these developments should open new research opportunities, which in turn demand an active approach from researchers to try to be ahead of time.

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