Digital Communities and EU/US ICT development collaboration

Final report

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Foreword

On January 1st, 2016, the project PICASSO was launched with two aims: (1) to reinforce EU-US collaboration in ICT research and innovation focusing on pre-competitive research in key enabling technologies related to societal challenges - 5G Networks, Big Data and the Internet of Things/Cyber Physical Systems; and (2) to support EU-US ICT policy dialogue related to these domains with contributions related to e.g. privacy, security, internet governance, interoperability and ethics.

PICASSO is aligned with industrial perspectives and provides a forum for ICT communities. It is built around a group of 24 EU and US specialists, organised into the three technology-oriented ICT Expert Groups and an ICT Policy Expert Group, working closely together to identify policy gaps in or related to the technology domains and to recommend measures to stimulate policy dialogue. This synergy among experts in ICT policies and in the three ICT technology areas is a unique feature of PICASSO. The Policy Expert Group we are chairing also includes Jonathan Cave, Dan Caprio, Avri Doria and Glenn Ricart and develops its insights in consultation with other specific experts in the field (depending on the topic).

This policy paper focuses on the impact and potential of “Digital” in local communities (hence: “Digital Communities”) in the EU and the US and how that affects and is affected by in particular ICT development collaboration related to 5G Networks, Big Data, and Internet of Things/Cyber Physical Systems. The content reflects the results of desk study and subsequent discussion, including the results of a PICASSO Webinar that took place on 8 May 2018 and written comments by experts collected via email.

It is the fifth of five thematic Policy Papers and accompanying Webinars scheduled for the coming two years. A Policy Paper on Privacy & Data Protection, Cybersecurity, Standardisation and Spectrum have already been published. It provides an overview of the most pressing and/or challenging policy issues that confront technological, business and policy collaborations and to develop valid and practical insights into how they can be addressed from a transatlantic multistakeholder perspective operating in a global context.

This paper was developed by Glenn Ricart, Maarten Botterman and Jonathan Cave. Our thanks go out to all and all those who contributed to our understanding of the issues related to digital communities in the EU and the US and of the specific policy issues related to the three PICASSO domains by their active participation in our meetings. We could not have done this without them.

Please feel free to share your thoughts via email to maarten@gnksconsult.com.
Looking forward to engaging with you all,

Best regards

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Introduction

One objective of the PICASSO project is to bring forward policy recommendations designed to improve EU/US ICT-orientated collaborations, specifically in the domains associated with 5G networks, Big Data, and IoT/CPS.

The aim of this paper is to establish a framework for the consideration of issues related to digital communities as they affect opportunities for future EU/US ICT-orientated research collaboration, specifically in the technological domains associated with 5G networks, Big Data, and the Internet of Things/Cyber Physical Systems (IoT/CPS). Communities are (real or virtual) places where people come together and may learn, share and/or collaborate together to build solutions to common problems and challenges, or existing communities that discover more can be done together thanks to digital solutions. The 'coming together' and the shared activities are connected, no matter which came first. If these shared activities or others arising from human interaction make use of digital technologies, we consider them "Digital". So our definition of Digital Communities is:

> *"Digital Communities are where people come together to learn, share and collaborate to build digital solutions to common problems and challenges"*.

To avoid confusion: this paper uses 5G in the 3GPP sense[1], as distinct from marketing labels and proprietary 5G-like schemes currently being deployed in the United States, where the closest equivalent term for the European 5G development is probably "Advanced Wireless".

Why focus on Digital Communities?

Digitalisation is both driven by "communities" (of interest), and a driver of the ways they interact and work together. Digitisation and the scalability it enables offer many opportunities for e.g.[2] people in less densely populated or remote areas or groups of people who share an affinity but do not live in the same geographic area to form innovative communities that were once technically or economically infeasible. In the USA, for instance, the Smart and Connected Communities movement applies advanced technologies to improve the lives and livelihoods of the residents in a region.

At the same time, digitisation weakens the need to live in proximity in order to form a community (the "death of distance"). While some challenges *and* opportunities are shared with urban cities, others are unique to more rural communities or indeed communities forming within any geographic proximity. Moreover, there is an imbalance – and a degree of inconsistency - between the attention currently

[1] see http://www.3gpp.org/release-15

[2] These are only examples, beneficial communities are not all geographic and their formation isn't always eased by population density. Individual isolation and fragmentation are often higher in densely populated areas and the same technologies that can bring people together can contribute to their isolation. Density (many people, 'close' to each other in ways that are important to them) can contribute to community by allowing people to find others with whom they agree and avoid others (leading sometimes to overly narrow communities and groupthink. Conversely, sparse connectivity can force people to accommodate others and make more 'broadband' social connections. Overall, the impact of digitisation on community depends on e.g. population density, the degree of shared identity or values, the degree and distribution of tolerance, the range of technology awareness and economic and environmental pressures. These factors are not monotone: people may fragment if environmental pressures are too great or too low or may form useful and sustainable communities if their connectivity or proximity are neither too sparse nor too extensive.

paid to digital communities as Smart Cities (where many people live in close geographic proximity), Smart Industry/Industry 4.0 (a community formed at and for "the workplace"), and rural digital communities (generally viewed through the lens of economic development and social inclusion policy). Less consistent attention has thus far been given to how digitisation transforms the idea of community and how community adoption affects the face of digitisation.

What are Communities?

People and organisations share characteristics that couple or link their interests, enable joint action and provide common or overlapping information. These 'areas' may be defined along lines of proximity or similarity, which may be: geographic (e.g. harbour cities); social and/or political (e.g. Facebook groups, NGOs), economic (e.g. sectors, supply chains or trade links); demographic or cultural; and technical (e.g. use of, familiarity with or reliance on shared technologies, services or infrastructures).

Proximity allows connections to form. When these become dense enough [3] we can speak of communities. Communities can provide benefits for themselves and for others arising from their shared interests, perspectives and activities, so community itself can be a local public good that contributes to social resilience, efficiency and welfare.

Often, these benefits can be attained in no other way – for example, contracted or automated services may attend to the *physical* needs of an ageing population, but rarely if ever provide the human contact necessary to provide the care and attention necessary to sustain or enhance *quality of life*.

'Communities' require proximity and connection in some not necessarily physical topology – yet proximity is not sufficient. There needs to be some sense of common interest. In this way, communities are a meso-structure between the microstructure of individuals and families and the macrostructure of societies and countries.

The effect of 'Digitisation'

Digitisation enables bridging of time and space and facilitates complex interactions that would otherwise be impossible. By using IoT, devices can add to the sensory awareness of communities and community members, and act – in obedience to instructions, autonomously in response to data processed by algorithms, or even (artificially) intelligently via machine learning.

Digitisation can help community formation by shrinking 'distance' and increasing the salience, frequency, etc. of community interactions. However, it can also endanger "community" by facilitating transient, anonymised, specialised and 'virtual' (weightless) communication and by providing superficial and unproductive outlets for the social urges that drive community and identity formation, socialisation and the collective solution of collective challenges.

It also changes the 'coverage' of communities. For instance, it enables overlapping communities to extend and sustain existing affinities, remaining coherent and manageable because digitisation can bridge time and geographic space and (partly) automate interaction. But again there is a dark side;

[3] including the clustering, symmetry, bi-directionality, importance and duration of these links.

fragmentation can be increased by the ease of forming communities along narrow and exclusive lines (including cyber-isolation and anomie).

Last but not least, it can also change the character and external impact of communities, both for the good and for the bad. It can catalyse the formation of 'virtuous' challenge-orientated communities of perspective, reflection and action (e.g. Internet Governance, Human Rights, Environment, etc.), but it also dangerous or toxic communities (hate speech, criminal enterprise, terrorism, etc.).

New technologies have always played a critical role in bringing improved communication to people and communities in rural and remote areas. Much of the early spread of telephones was driven by central government policy, e.g. Universal Service defined in terms of coverage at the time when the FCC was founded and the Rural Telephone Administration constructed along the lines of the Rural Electrification Administration. Now, this role is fading (in part because the spread of mobile telephony decreases apparent need) although we have not yet attained full connectivity, let alone ubiquitous and equitable quality of service. Nowadays, connectivity and service improvements are primarily provided by the private sector; first to commercially addressable markets but also via public-private partnership programmes. Gaps are sometimes filled by communities acting on their own initiative to address unmet demands for broadband services, because many forms of modern communications – and many essential community services - function best with availability of higher bandwidth. There is no single best way to expand broadband access; technologies keep evolving along with demand and different areas have differing inherited circumstances.[4]

Digital Communities integrate information and communication technologies (ICT) and physical devices connected to the network (the Internet of things or IoT) to optimise the efficiency of local availability and quality of services, operational efficiency of local organisations and connections among community members and organisations. Digital community technology encourages local officials to interact directly with community and local infrastructure and to monitor what is happening – and developing - in the community.

, There is an increasing prevalence of and reliance on sensors to collect data, actuators to perform routine actions, and "org-ware" (connections among people and institutions). Digital systems can summon help, control signals and valves and the brightness of street lights, manage waste pickup and inform public safety efforts. This perspective draws together the various policy strands considered in the project. As personal data are inevitably caught by these sensors and actuators respond to automated instructions that affect personal interests, we can apply the policy lessons of the Picasso policy paper on *Privacy*. As sensitive data are collected, accessed and used to provide critical community services, we can apply the policy lessons of the Picasso policy paper on *Security*[5]. To maintain coherence of data collection and management systems and interoperability of systems and applications providing community ecosystem services, we should heed the policy lessons of the *Standards* Picasso policy paper. Finally, since most of these sensors and many of the actuators are connected wirelessly, the policy lessons of the *Spectrum* Picasso policy paper can be applied. This policy paper aims to bring privacy, security, standards and spectrum together to illustrate how they

[4] Bridging the rural digital divide, OECD, February 2018 No. 265, at https://read.oecd-ilibrary.org/science-and-technology/bridging-the-rural-digital-divide_852bd3b9-en#page1

[5] The security lessons also cover control of access to sensitive data and ensuring that data and automated decisions and actions are reliable and understandable.

work collectively as means to public interest ends. Digital communities thus encompasses digitisation, the Internet and people – and drive change based on their needs and interests.

Much of the extensive discussion of Smart Cities concentrates on them as concrete and holistic initiatives intended as a model for the future; some are newly-designed while others are ‘brown-field’ modifications to existing cities, but all are communities from the outset. But the knitting together of people in the face of physical and other barriers brings its own issues and opportunities for digitisation. Therefore a focus on communities in less densely populated, more remote and even non-spatial areas is relevant; they have their own specific challenges – and opportunities. These can even be important, if not so visible, in Smart Cities. The unique needs and affordances of rural communities are complementary to those of urban areas. Scalability of ICT and IoT as well as increased network coverage of large areas make possible – even easy - things that were previously impossible. Even though the evidence is fairly clear that today’s broadband programmes are leaving remote (as opposed to sparsely-populated) areas and some urban not-spots behind, some rural communities have arranged for their own fibre coverage (e.g., B4RN) without waiting for government or industry. Paradoxically, this very lack of decent broadband has helped to mobilise and strengthen a digital community, both in the local area and via a network that reaches out to other underserved rural areas.

In the medium to long run, however, most rural coverage will rely on wireless connections; this will in turn require policy support and regulatory pressure. Compared to the wireless original customer or user base, digital communities in newly covered areas and among people newly reached by scale-up will be very different in terms of e.g. degrees of shared interests, perspectives and actions.

Access is key, and broadband matters. The European Union has set ambitious targets of universal coverage for all citizens by 2020, at 30 Mbps. In 2016, a new communication “Towards a Gigabit Society” raised this target to 100 Mbps by 2025. And so far, around 76% of EU citizens are covered by fast internet access. However, this number drops to around 40% for people living in rural areas. For now, fibre doesn’t penetrate as far in remote areas or offer as much in terms of speed, affordability and QoS.

In the United States, a National Broadband Plan called for all “anchors” in society to have gigabit connectivity by the year 2020. Anchors are organisations such as schools, libraries, health clinics, and community colleges. 95% of the US population is in the same zip code as on of those community anchors. For now, fixed terrestrial 25 Mbps/3 Mbps download/upload services are available to 92.3% of the population; 90.8% of the population have access to fixed terrestrial 50 Mbps/5 Mbps services. When we consider wireless services as well, 85.3% of all Americans have access to fixed 25 Mbps/3 Mbps and LTE 10 Mbps/3 Mbps services , including 61% in evaluated rural areas and 89.8% in evaluated urban areas. [6] The differential in rural access may be largely attributable to the Connect America Fund, which provides subsidies where needed to providing access[7] to a minimum of 10 Mbps service. Where copper infrastructures do not already reach, and population densities justify, there are clear reasons to use fibre, including higher bandwidth, less attenuation over long distances and less interference due

[6] Federal Communications Commission, 2018 BROADBAND DEPLOYMENT REPORT, FCC 10-18-10A1, 2 February 2018.
[7] Important to distinguish access from subscription rates, which are lower (mid-high 60s IIRC)

to nearby power lines. Even where copper does exist, the operating costs for fibre are generally lower and the falling costs of fibre increasingly justify replacement of copper lines.

However, suitable rights of way for fibre or copper may not always exist or be negotiable within reasonable time and cost parameters. For easy-to-understand economic and technical reasons, wireless connections and infrastructure will be increasingly important on both sides of the Atlantic for the foreseeable future. Point-to-multi-point wireless backhaul for data may become an important service for which spectrum and other technological innovations must be found and signals encrypted and secured. While urban telecommunications infrastructures are generally ISP-owned (except for the user equipment), it may be more realistic for rural organisations or communities to provide this as a 'local public good' by buying, maintaining and operating their own on-premise small-cell telecom infrastructure just as they maintain their own water, sewerage and even electricity services or share such systems with close neighbours, and sometimes farms or businesses that buy their own 4G repeaters, antennae/routers and resell connectivity to their neighbours. With regards to spectrum, new use of unregulated space (and Television White Space or TVWS) will play an important role here. Such locally-maintained but shared telecommunications system raise interesting questions of governance, privacy, security, and spectrum that help to pull together previous recommendations. In addition, they will need to secure access to the national infrastructure either commercially or via interconnection or must-carry regulation.

Delivering services to rural areas is often challenging raising new questions of effective in-home medical monitoring, tele-education services, facilitating access to democratic governance processes, and engaging Big Data analytics to optimise the in-the-soil equivalent of Industry 4.0. Extending services that are routinely available to urban users to those in rural locations from designing and providing services that are unique (or uniquely important) to rural users may require the engagement of new players or the design of new business and regulatory models. Access to markets for crops and livestock in real-time as well as financial services for hedging prices are important to a stable agricultural industry which is vitally needed to supply food, power, and water to metropolitan areas. Solutions exist around the globe, but are not known or accessible everywhere. Another vitally important 'uniquely rural service' is the IoT/CPS function of agricultural optimisation, which uses sensors to ensure that just the right amounts of water, fertiliser, pesticides, herbicides etc. are applied at just the right time. This brings enormous cost, biodiversity and environmental benefits, but requires both (local) spectrum and IoT/CPS devices to report on conditions and act on instructions.

As more of the economy becomes an information economy, it will become increasingly attractive to some to do their work from smaller, less-urban and closer to nature lifestyle communities. They can have lower ecological costs by tapping local water supplies, local solar and wind power, and have much lower need for the local transportation services needed in more densely-populated urban areas. In addition, for both water and power local matching of supply and demand results in lower losses due to transmission losses (electrical resistance, leakage). At the same time, there may be more need for transportation "backhaul" to larger urban areas for their medical and entertainment complexes. An important factor is that organising cogeneration and abstraction at local levels increases bargaining power vis-à-vis national operators (for example when selling power or water 'back to the grid') which lowers utility costs and produces a more resilient infrastructure on a national level (because local clusters are themselves more robust and better able to compensate for nearby outages).

Europe has been actively exploring support of lifestyle communities and has much to share with the United States in the policy space. Likewise, the highly efficient agricultural complexes of the United States may have useful policies to share with the European Union. And the U.S. “Digital Townsquare” initiative may well be able to inspire similar approaches in Europe. The technical underpinnings for both are of interest and will involve 5G, Big Data, and IoT.

Relation to other key policy issues

PICASSO has developed 4 policy papers on subjects relating to ICT collaboration on Research and Innovation (R&I), specifically related to 5G Networks, Big Data, and IoT/CPS. The insights from all 4 papers contribute to the policy thinking on ICT R&I collaboration opportunities to better address the specific problematique of less densely populated regions. Below, we present these insights and put them in context of the subject at hand.

Privacy & data protection

One of the most contested issue sets across the board concerns personal data protection and the closely-related but distinct issue of privacy. This issue set is not only a matter of deep concern to the private sector and to civil society, but is also an increasingly-fraught bone of contention in the government sphere, where national governments and supranational governance entities tussle over criminal justice, national security and other vital national (e.g. economic) interests. The increasing awareness by individuals of rights to privacy and to personal data protection put this even more directly at the heart of policy discussions and practical developments. In addition: laws and regulations on both sides of the Atlantic have to be respected and the concerns of non-government stakeholders have adequately to be addressed if ICT developments are to be <1> legally acceptable on both sides of the Atlantic and <2> trusted enough, for now and the years to come, to be adopted – and adapted – for wider use in society.

People within the EU and US – and around the world - want and deserve ICT products and services that serve their interests and can be trusted by them, and need ICT products and services to deal with ‘wicked’ societal challenges. Specifically in less dense regions, there is a challenge of access to broadband and services, as compared to the more densely populated regions. However, scalability of solutions increases the ability to put lower capacity (thus cheaper) equipment in less dense places, and new use of spectrum (5G networks, use of unregulated space and TVWS) make extension of services to anywhere less costly, more scalable and thus more affordable. The emphasis is on “constant communications” and sharing of data. When regions are going increasingly digital, more data become available, and it is relevant to consider that these may more easily related to private individuals – even if they are not mend to be collected as such. For instance, where location data in an area with a population density of 27,000 people per square mile (New York, 2015 data) may relate to anyone of those frequenting the area, in regions where density is much lower it may be relatable to one or a small group of individuals. In addition, data owned by certain bodies in the region may be seen by local people that know many of the other locals, which leverages the relatability to private individuals which is an important concern in a society where more and more “facts” become available in digitised format.

ICT Security

Cybersecurity is high on the agenda of policy makers throughout the world. The growing incidence of adverse and highly-publicised events, including massive distributed denial of service attacks on the Internet (e.g. the Dyne attack in 2016, and witnessing more recent attacks to continue to grow in capacity requiring better responses and more collaboration), malware (e.g. the WannaCry Ransomware attack in 2017 etc.), hacking (leading to data breaches and unauthorised use of services), man-in-the-middle attacks (MITM), and unauthorised penetration of critical services and sensitive data (including the many breaches of customer data at Yahoo and other organisations over the years) has seriously disrupted networks and compromised privacy and national information security.

There is no magic cure for the serious security issues that that have become endemic throughout the underlying infrastructures and services that have become so fundamental to the way we communicate, access information, and interact. Even more so: each 'cure' sets the stage for the next set of issues. Network security is not confined to the technical layer, but spreads to all layers and beyond to the user community. Progress made in one domain can be undermined by contagion or reinfection from others. The challenges are no different in rural areas or remote regions: they are global and need to be addressed head-on by all stakeholders; governments who have the monopoly on the coercive power of the law, end users who must act knowledgeably and responsibly, ICT developers who are responsible both for security 'by design' and for critical vulnerabilities and businesses using and/or deploying ICT and ICT-based or –enhanced services in more or less responsible ways. A proper balance between responsible action by individual entities and collaboration among stakeholders is essential for sustainable progress.

ICT Standards

The implementation of standards in industry and commerce grew in importance with the onset of the Industrial Revolution and its requirements for high-precision machine tools and interchangeable parts. Originally such standards were set at the level of specific sectors; in many ways, this focus continues. However, flows of information pervade most sectors and an increasing range of economic, scientific and societal activities; the 'generic' nature of information services means that same ICT technologies or services are used in multiple sectors and for diverse purposes. Standards setting and development within a single sector often does not keep pace with evolving business interests across sectors and standards competition.

To the extent that ICT-driven convergence is a real threat to existing standards, it is worth bearing in mind that it spans sector boundaries (e.g. aviation, logistics, health care, etc.), societal roles (commerce, science, civil society, administration) and subject domains (i.e. merging transmission protocol and encryption standard-setting). These "crossovers" argue for a networked (as opposed to a federated or hierarchical) structure of standardisation.

With regards to less densely populated and more remote regions, standards are needed that allow scalable solutions that make delivery of digital services affordable and effective. In this, it is clear that solutions need to relate to the privacy and safety sensitivity of the specific services to be delivered. For instance: disaster warning systems are less privacy sensitive (such as measuring of water levels) but should be reliable. And services such as road toll can be quite privacy sensitive, and at the same time incidental non-availability does not lead to big problems: some people may get away with free use of a road whereas otherwise they would have been tracked and charged.

Spectrum

The PICASSO technological domains rely on connectivity. Radio is an important part of this connectivity. Increasingly, users can obtain similar services on the move and in fixed environments (ubiquitous connectivity). We are also seeing more of today's 'fixed-line' connectivity via physical infrastructures (e.g. copper, cable) replaced by radio connections that do not require the same level of fixed capital investments (for both new settings and retrofitting) – and which, in consequence may be both often easier and cheaper to maintain, extend and update. PICASSO-relevant developments (including the core areas of 5G, Big Data, Internet of Things/CPS and derived areas such as Machine to Machine (M2M) communications, Broadcasting, Cloud Computing, Internet access and Smart Cities) all rely on connectivity that depends on various forms of radio and fixed communications based on new and innovative forms of wireless communication.

The resulting increased demand for spectrum will be partially met by using higher frequencies, multiple input multiple output (MIMO)[8] space diversity, and other innovations. But much of the demand will have to be accommodated by making better use of current spectral bands, many of which are idle most of the time. TV white space is one spectral domain that can be more efficiently exploited by means of Dynamic Spectrum Access (DSA) techniques, which facilitate flexible and controlled use of radio spectrum by giving individual users, uses, items of equipment, etc. just the connectivity required at a particular time and place. This gives users the impression of an almost infinitely wide channel; as soon as one use ends, the spectrum is available for something else. Particular frequencies may thus move from IoT to M2M to telephony etc. over a short space of time.

Both 5G and spectrum use such as TVWS facilitate better communications for specific purposes, and extend the ability for delivery of many digital enabled services to remote and less densely populated regions.

Digital Communities and PICASSO

Within PICASSO, the focus is on 5G networks; Big Data; and the Internet of Things, specifically Cyber Physical Systems. From the background reflected above, we focus on these three domains, below.

5G networks

5G networks will influence digital communities by facilitating communications among people, but even more among devices (IoT). M2M traffic between devices will likely manifest in two broad groups – massive applications and critical applications:

- Massive applications deploy many devices that require minimal data traffic, such as smart appliances. This massive IoT applications group currently represents about 70%

[8] MIMO is a way of expanding the capacity of a radio link using multiple transmit and receive antennas to exploit multipath propagation.

of IoT implementations. Normally, these applications restrict themselves to low-bandwidth connection technologies such as GSM, but some mobile operators are already rolling out low-power WAN (LP-WAN) networks to facilitate this group.[9]

- Critical applications require ultra-high reliability and availability with very low latency. Examples include health and medical monitoring devices, telepresence (e.g. remote surgery and remotely-controlled vehicles), industrial infrastructure command-and-control and autonomous cars. These applications need specialised, higher-bandwidth connection technologies such as LTE and Wi-Fi in order to function.

These same applications will drive the adoption of the 5G network, which will support and extend the transport layer, enabling new IoT technologies. The uptake of 4G and its increased data and services was incredibly fast, but there is a gap widening between 4G-based services and the needs of services that could benefit from 5G.

This development will significantly affect mobile networks in different ways. For less densely populated areas, investment to implement infrastructures is much less available, so real business cases will need to be made both to ensure their development and to forestall widening 'digital divides.'. Massive applications will not need much bandwidth or frequent communication, so data transport revenues will not replace the mobile revenues of old, even if there is a massive rise in connected and communicating objects. Moreover, operators will need to work closely with local stakeholders to ensure that necessary levels and types of communication services are identified and made available.

The necessary technologies already exist, and will become even more scalable with the roll-out of 5G networks. Yet, as with broadband, access can remain scarce unless positive action for implementation leads to increased 5G coverage, including in those areas that are less frequented by 5G providers' current customers – less populated and remote areas. Ensuring that digital divides are reduced or bridged and that broadband networks and services attain the greatest national coverage and use are priorities for both EU and US governments. Policies to promote competition and private investment, as well as independent and evidence-based regulation, have been tremendously effective in extending coverage, according to the OECD[10]. In doing so, they have developed and exploited synergies between market forces, public expenditure and regulation, thus extending the reach of these instruments. However, it should be stressed that coverage or access are not the same as subscription or use; these developments are removing or reducing technical barriers to the development of digital communities that connect and empower remote populations, but in some cases more is required to ensure effective and efficient uptake of these capabilities. This can be seen in the fact, noted by the OECD report, that most of these developments have been associated with

[9] http://telecoms.com/opinion/the-mnos-path-to-5g-and-iot-is-paved-in-the-cloud/, Fintan Lawler, 19 August 2016.

[10] Bridging the Rural Digital Divide, OECD Digital Economy Papers, Feb 2018, no 265, by Lorrayne Porciuncula and Sam Paltridge at: https://www.oecd-ilibrary.org/science-and-technology/bridging-the-rural-digital-divide_852bd3b9-en.

universal service obligations and coverage targets; usage or uptake targets are far less prevalent[11].

Big Data

Beyond the acknowledged and well-understood contributions of data analytics to facilitating the ordinary and innovative aspects of joint living (at scales ranging from Smart Homes through digital villages to Smart Cities), Many digital community services are enabled and enhanced by Big Data tools and techniques, from the automation of routine services (especially locally-critical service infrastructures) to the empowerment of local government on one side and local democracy on the other[12]. One critical aspect of this type of Big Data-led digitisation is the feedback between data use and data availability – this can be positive (visible benefits and trusted data analytics services leading to greater willingness to measure and share data) or negative (greater reliance on data-based decision-making leading to a perception that individuals don't matter or only matter in relation to their observable artefacts, leading to a decreased availability, reliability and quality of data and even greater dissatisfaction or distrust). This is closely-related to the ethics of Big Data in studying [13] and implementing[14] digital communities. Aspects of this ethical challenge that are being studied include algorithmic regulation, explicability of machine learning and the selection and incentive effects of data access and governance rules, which are gaining policy prominence with the entry into force of the EU's General Data Privacy Regulation and the US CLOUD Act.

Beyond this, Big Data and its affiliated technologies (e.g. analytics, machine learning, and algorithmic decision-making) are increasingly recognised as facilitating communitarian awareness and action in response to crises[15]. This not only extends the reach og digital communities, but also democratises the response far beyond the traditional 'humanitarian response elite' nations, institutions and people. This, in turn, can reduce the asymmetry and potential for corruption of e.g. disaster relief by increasing the density and responsiveness of human connections via the greater visibility, transparency and accountability of activities[16].

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[11] The disparities in uptake are not the same as those in access; the urban-rural uptake divide is particularly wide in e.g. Greece, Hungary and Portugal, while in Belgium, Luxembourg and the United Kingdom, higher proportions of rural households have Internet compared to urban households.
[12] See e.g. Sharma, R. S., Ng, E. W., Dharmawirya, M., & Keong Lee, C. (2008) "Beyond the digital divide: a conceptual framework for analyzing knowledge societies" *Journal of Knowledge Management*, **12**(5), 151-164 and Helbing, D., Frey, B. S., Gigerenzer, G., Hafen, E., Hagner, M., Hofstetter, Y., & Zwitter, A. (2017) "Will democracy survive big data and artificial intelligence?" *Scientific American*, **25**.
[13] See e.g. Fiesler, C., Wisniewski, P., Pater, J., & Andalibi, N. (2016, November) "Exploring Ethics and Obligations for Studying Digital Communities" in Proceedings of the 19th International Conference on Supporting Group Work (pp. 457-460). ACM.
[14] See e.g. Crawford, K., Faleiros, G., Luers, A., Meier, P., Perlich, C., & Thorp, J. (2013) "Big data, communities and ethical resilience: A framework for action" *Data Policy: Big Data, Communities and Ethical Resilience: White paper* at: https://blog.p2pfoundation.net/big-data-communities-and-ethical-resilience/2013/12/25.
[15] See e.g. Meier, P. (2015) Digital humanitarians: how big data is changing the face of humanitarian response CRC Press, Burns, R. (2015) "Rethinking big data in digital humanitarianism: Practices, epistemologies, and social relations" *GeoJournal*, **80**(4), 477-490 or (for a more critical view) Read, R., Taithe, B., & Mac Ginty, R. (2016) "Data hubris? Humanitarian information systems and the mirage of technology" *Third World Quarterly*, **37**(8), 1314-1331.
[16] E.g., where aid is needed, how it is used and what effects it has.

Internet of Things/Cyber-Physical Systems

IoT is a massive enabler of services in any community – whether smart city or digital community. In order to serve IoT environments, connectivity is key. With the emergence of 5G, much becomes possible in areas where 5G services are available and reliable. Where 5G coverage is not serving the needs of the community, alternative options to establish network links between objects and people are available, ranging from low latency networks using TVWS to satellite connections etc.

Scalability is particularly relevant when it comes to IoT; it is still an emerging technology in the sense of its continued development and finding its place within various industries. It also remains unknown how its traffic patterns might manifest themselves in future iterations of IoT applications and how that might impact mobile operators. Put simply, there's a lot we don't know about IoT. So investing in one particular aspect of the technology now is a huge risk, while an investment in a cloud platform that is ready to take on whatever ensues is significantly less risky. With local governments creating a space where innovation has low thresholds, yet takes into account a number of key success factors (including how it deals with data that can be connected to persons) can really boost uptake by business to experiment with new offerings to citizens and businesses.

Specifically in rural regions, IoT may focus on issues such as precision agriculture (water regime, nutrients, weather and possibly pests), water systems monitoring and management, and weather data collection, but also garbage collection and possible monitoring and improvements of electricity systems (street lights, etc.). And whereas a very high bandwidth application such as remote surgery may be not possible anywhere, health care can benefit from IoT supported solutions such as mobile devices combined with physiological sensors to gather casualty data and aid rural first responders in managing a patient before paramedic (ambulance) services arrive on scene. Or support in aftercare for operations: patients monitor their own wounds using an app which reminds them how and when to do it, and how to react if a concern arises. This includes telephone advice from a nurse specialist; the transmission of high quality photographs for assessment by a consultant; or a three-way web enabled consultation between a remote specialist and a co-located GP and patient.

In order to fully benefit from IoT, security of IoT is crucial. This is also recognised by the US Senate, following a specific hearing on this in 2017 on the importance and even possible implementation of IoT technology in rural areas of the United States, while recognising that connectivity is still an important issue they have to solve. At that point, there were no accurate data available on which areas have or lack reliable broadband internet. And all participants acknowledged the importance of cybersecurity in an IoT infrastructure and echoed concerns on the risks of DDoS attacks by corrupt IoT devices turned into botnets.

Perspectives towards the future

Digital communities will continue to evolve, via the progressive digitisation of existing communities, the intentional creation of explicitly digital communities and the emergence of new communities from the development, deployment and use of digital services. They will, in the process, transform the policy landscape, as well as the technology landscape. Communities have long been the source of policy demands (e.g. for collective solution to common problems) and he basis on which such problems are addressed (e.g. circular economies and local civil society activities). At the same time, such communities can distort the operation of existing policy mechanisms from political institutions to consultation and evidence-based regulation. In the process, some old problems may cease to require policy intervention (this is the aspiration of initiatives from 'digital humanitarianism' to 'Fix My Street' local initiatives); others may be resolved in new ways; and still other issues may arise exclusively in digital communities or as a direct consequence of digitisation. In order to assess policy, to ensure that the 'right kind' of digital community formation occurs and to understand recent and future history, appropriate data capture and analysis strategies must be implemented, and a range of research questions addressed.

Some of these are technical in nature. For example:

1. Future development of wireless access technologies[17], especially those that can provide gigabit+ class Internet with multiple classes of service in rural areas, thereby assisting the emergence of dispersed and diverse communities; of particular interest are advanced or wireless technologies, although the modes of provision and management may need to be adjusted to coexist with other uses.
2. To foster innovation and the emergence of ad hoc communities, it is also important to invest and conduct research into the extension of communication networks into unregulated or differently regulated spectrum bands (e.g. TVWS).

In order to support community development over these communication infrastructures, it is also necessary to develop further both individual and shared computational facilities. These 'edge computing' capabilities can provide local, low-latency, self-reliant, and resilient technology support to a wide range of data gathering and sharing, data processing and functional capabilities needed by digital communities. Unlike cloud resources in well-controlled and managed data centres, edge computing capabilities must be capable of wide environmental ranges, autonomous operation, self-association, self-healing, dynamic reconfiguration to match needs, ability to handle data securely, self-protecting against malware and attacks, and the ability to work cooperatively with other edge facilities placed by competitors or other jurisdictions – including a wider range of BYOD interoperability challenges than is usual in large-scale commercial applications. This draws on the linkage between IoT/CPS and digital communities – not only is it the case that digital communities may have to work with a lesser degree of standardisation, but the functional, security and related requirements may need more resilience and less robustness than 'closed' and purpose-orientated applications.

As noted, these computing facilities will need data on which to operate. Communities form when distances are reduced and common interests and opportunities become visible; the "sensorisation" of potential communities can help to shrink distances (especially in rural areas, but also in urban environments where the visibility of different groups is limited or biased) and raise awareness of common interests and complementary capabilities. In such settings, research into collaborative, cross-functional sensing meshes with multiple-application slicing, heterogeneous priorities, and self-protection will be especially valuable, as will social science research into e.g. the economics of such systems and the data they capture and the ethics of their use (which could in turn be folded into new policy designs).

Beyond this, there is scope for joint research into the services and functionalities needed to meet the needs and smooth the functioning of both nascent and mature digital communities "over the top" of

[17] This is further discussed in Policy Brief 4: Spectrum Policy

the communications infrastructure. Most of these, of course, are already being pursued from commercial or public service standpoints, but the needs of communities (especially new forms of community) may be different, and under-served by existing R&I. These include:

1. Healthcare, examples include:
    a. Inexpensive at-home sensors to give telehealth professionals objective information on short notice.
    b. At-home hospital-quality monitoring of chronic conditions.
    c. At-home physician-controlled medical drug synthesis and dispensing.
    d. Passive continuous health monitoring. (While applicable everywhere, continuous monitoring may help predict acute events which would help mitigate the longer rural response time to such events.)
2. Education; examples include:
    a. Access to learner-directed research resources.
    b. Richer forms of distance education such as being able to observe the reactions of other students in the class to make distance and computer-based education more of a social experience, and simultaneously being able to see the whiteboard, the instructor, and other objects / media / presentations.
    c. Real-time access to remote scientific and engineering instruments.
    d. Engaging cross-generational educational discussions, giving personal attention to students and an ability for seniors to contribute.
3. Public Safety; examples include:
    a. Better data sharing technologies that protect privacy while allowing cross-jurisdictional mutual aid efforts to be more effective.
    b. Just-in-time AI support for volunteer first responders, especially less-experienced volunteer first responders.
    c. Better remote-expert support for volunteer first responders (e.g., physicians to EMTs)
    d. Better resource awareness (of volunteers and other public safety assets) and more reliable communication among them.

Research needs to be done by collaborative teams representing the social, economic, cultural, safety, and technological dimensions of each research challenge. The end-users of applied research are especially important to involve from the beginning. For example, the on-demand trend is more difficult to execute outside of the densely-populated metro areas because sending a driver with a car on a two-hour drive to deliver a single package in a rural community will burn through the driver's time, gas and wear away at the delivery vehicle. However, the solution to the inefficiency in rural-area deliveries is removing the human factor and use drones and autonomous vehicles. These are efficient, low-cost and timely. Implementation of next generation technologies like driverless cars, trucks and drones will help make deliveries, even in sparsely populated areas, more efficient.

Recent examples show rural areas being favoured for early implementation of next generation delivery and transportation methods (e.g. Uber's successful cross-Colorado beer delivery and Amazon's drone delivery in rural U.K.). The wide-open spaces present fewer risks when trialling new delivery and transportation methods, whether it concerns drones or autonomous cars.

Conclusions

Communities with common interests will shape the future we want to live in. In return, the way they shape up will be co-determined by that is made possible by technologies such as 5G networks, Big Data, and IoT.

5G networks, Big Data and IoT hold great promises to further integration and facilitation of Digital Communities – whether they are in close geographic proximity, or consist of geographically dispersed groups with a common interest. However, in order to allow all communities to benefit from the new potential, it will be crucial to:

- 5G networks: Ensure that in regions with lower geographical density proximity of people and devices get adequate access to communication services that both serve low latency, high mass needs as well as critical communications, and high bandwidth communications. As we learned from the past, this may not go automatically. Different than in the past is that availability is not solely depending on major network operators, anymore: local networks can be set up and connected through backbones with the world, where needed.
- Big Data: Benefiting from the data driven economy as such is less related to access to networks as to access to data. For some applications, amounts of data will be such that high bandwidth is required, or time criticality will require high reliability of networks. But most of that is related to exchange of data between devices in IoT networks (Cyber Physical Systems). Big Data can support any community in enabling applications as well as feedback loops comparing data of activities within any Digital Community with data from other Communities. Geographic proximity is not an important factor here.
- IoT/CPS: the applications that would serve digital communities, both those in geographic proximity as more geographically dispersed communities, are many and more to come. Mostly, these applications will be developed for specific sectors, such as crop maintenance, disaster warning systems, health maintenance and home care, etc. etc. More research can be done how applications can be used across sectors, and across communities: i.e. learning from practice and innovation in application next to innovation of the underlying technologies itself.

All together it is clear that with the development of 5G networks, Big Data applications and IoT applications, geographic proximity matters less, and communities (community formation as well as coherence) matter more.

Research questions that are to be responded in the coming years, on both sides of the Atlantic, include:

- How to ensure all have access to sufficiently advanced wireless access, and how do we determine what "sufficiently" means?
    - How to make better use of "unregulated space"';
    - How to make better use of available space through intelligence in communications;
- Focus on edge computing / cloud sharing;
    - Cloud of data
    - Cloud of IoT devices
    - Secure, privacy supporting, and safe

Learning from practice in communities is a huge opportunity for both EU and US researchers, as is working together on the underlying technologies to ensure they are secure enough, allow interconnectivity, have privacy addressed from the outset and make good use of available spectrum. And in order to accelerate learning, space will be needed for experimentation – with explicit setting of framework conditions, and sharing the experiences.

Towards the Summer of 2018, we intend to deliver a White Paper on policy issues such as privacy and data protection, security, standardisation and spectrum that are most relevant to technological and commercial development in the PICASSO domains and conversely to identify the aspects of such policies that are most likely to be affected by 5G, Big Data and IOT/CPS development. This PICASSO Policy Paper and the ones that follow will feed in to this White Paper, therefore we invite you to share any comments and suggestions relating to these policy papers with the PICASSO Policy Expert Group either in person during one of our meetings (workshops or webinars) or via email to the Chairman of the Policy Expert Group at maarten@gnksconsult.com.