500 10th Street NW
Atlanta, Georgia 30332-0620
Phone: 404.385.4614
Fax: 404.385.0269

www.cacp.gatech.edu

Via Email: iotrfc2017@ ntia.doc.gov

March 13, 2017

National Telecommunications and Information Administration (NTIA)
U.S. Department of Commerce
1401 Constitution Avenue, NW., Room 4725
Washington, DC 20230

Re: [Request for Comments on the Benefits, Challenges, and Potential Roles for the Government in Fostering the Advancement of the Internet of Things [170105023-7023-01]

Enclosed for filing in the above referenced Public Notice are the comments of the Georgia Institute of Technology (Georgia Tech), Center for Advanced Communications Policy (CACP) and the Rehabilitation Engineering Research Center for Wireless Inclusive Technologies (Wireless RERC).

Should you have any questions concerning this filing, please do not hesitate to contact me via email at helena.mitchell@cacp.gatech.edu.

Respectfully submitted,

Helena Mitchell, Ph.D.
Principal Investigator, Wireless RERC
Executive Director, Center for Advanced Communications Policy
Georgia Institute of Technology
Enclosure

National Telecommunications and Information Administration (NTIA)
Washington, D.C. 20230

COMMENTS OF
GEORGIA INSTITUTE OF TECHNOLOGY (GEORGIA TECH), CENTER FOR ADVANCED COMMUNICATIONS POLICY (CACP)
AND THE REHABILITATION ENGINEERING RESEARCH CENTER
FOR WIRELESS INCLUSIVE TECHNOLOGIES (WIRELESS RERC)

Georgia Tech's Center for Advanced Communications Policy (CACP) in collaboration with the Rehabilitation Engineering Research Center for Wireless Inclusive Technologies[1] (Wireless RERC) hereby submits comments in the above-referenced Public Notice released on January 13, 2017. CACP is the home of the Wireless RERC. CACP is recognized as a neutral authority that monitors and assesses technical developments, identifies future options, and provides insights into related legislative and regulatory issues. CACP evaluates technological trends that can impact issues as diverse as wireless accessibility for people with disabilities, emergency communications, and current and emerging advanced technologies, and social media. The mission of the RERC for Wireless *Inclusive* Technologies is to promote the integration of established wireless technologies with emerging wirelessly connected devices, sensors, and services for an inclusive, transformative future where individuals with disabilities achieve independence, improved quality of life, and enhanced community participation. We believe it is essential that the accessibility and usability of Information and Communications Technologies (ICT) and services be improved for people with disabilities. In concert, the Internet of Things (IoT) promises to broaden the availability of life-enhancing services; and the range of passive sensors, environmental monitors, and alerting devices and displays, make the promise of increased social and economic participation, as well as independent living, exponentially more feasible for people with disabilities, and aging adults. For more than 15

[1] The **Rehabilitation Engineering Research Center for Wireless Inclusive Technologies** is funded by a grant from the National Institute on Disability, Independent Living, and Rehabilitation Research (NIDILRR grant number 90RE5025-01-00). NIDILRR is a Center within the Administration for Community Living (ACL), Department of Health and Human Services (HHS). The contents of this document do not necessarily represent the policy of NIDILRR or ACL, HHS, and you should not assume endorsement by the Federal Government.

years both CACP and the Wireless RERC have been actively involved with research, development and regulatory activities concerning the accessibility of current and emerging advanced technologies. The comments respectfully submitted below are based on subject matter expertise and findings from our research portfolio.

Overall, we believe that the NTIA's green paper did a very thorough job of capturing a number of key elements associated with the advancement of the IoT. This task is not simple given the complex nature of the conceptual and technical architecture of the IoT as well as the observation that there is "no consensus among commenters on a formal definition of IoT, or even on whether a common definition would be useful" [Page 5, Paragraph 2]. We agree that at this point in the development of the IoT that it is more important to "foster an innovative and adaptive environment to realize the full potential of technology" [Paragraph 3, Page 4]. We also agree that the broad areas of engagement (listed below from Page 3)

- ***Enabling Infrastructure Availability and Access***
- ***Crafting Balanced Policy and Building Coalitions***
- ***Promoting Standards and Technology Advancement***
- ***Encouraging Markets***

are important in that they support the principle of the IoT being "inclusive and widely accessible to consumers, workers, and businesses" [page 2]. CACP and the Wireless RERC strongly recommend that given the historic lagging levels of digitally related social engagement and participation by people with disabilities[2], that the NTIA specifically articulate policy recommendations that support early stage inclusion, accessibility, and usability of IoT technology and services prior to development and deployment of the same. This would be a significant contribution toward addressing technological barriers for people with disabilities.

[2] See for instance: Dobransky, K., & Hargittai, E. (2016). Unrealized potential: Exploring the digital disability divide. *Poetics*, 58, 18-28; G3ict (2015). *Internet of Things: New Promises for Persons with Disabilities*. Retrieved from http://g3ict.org/resource_center/publications_and_reports/p/productCategory_books/subCat_2/id_335; Dobransky, K., & Hargittai, E. (2006). The disability divide in internet access and use. *Information Communication and Society*, 9, 313–334; Domingo, M. C. (2012). An overview of the Internet of Things for people with disabilities. *Journal of Network and Computer Applications*, 35(2), 584-596; Paul T. Jaeger, 2012. *Disability and the Internet: Confronting a digital divide*. Boulder, Colo.: Lynne Rienner Publishers.

In the following questions, the NTIA requested "comment on the full range of issues that may be presented by this inquiry, including issues that are not specifically raised… Commenters are encouraged to address any or all of the questions… Comments that contain references to studies, research, and other empirical data that are not widely published should include copies of the referenced materials with the submitted comments." The four identified questions are listed below in bold.

1) **Is our discussion of IoT presented in the green paper regarding the challenges, benefits, and potential role of government accurate and/or complete? Are there issues that we missed, or that we need to reconsider?**

For the purposes of these comments, we adopt the NTIA's use the of term "Internet of Things" as an umbrella term to reference technological development in which a greatly increasing number of devices are connected to one another and/or to the Internet. As noted above, IoT is surrounded by definitional challenges. We focus on the use of the term in a way which captures IoT as a new approach to interactivity that defines how we relate to the physical world as (suggested by Castro and Misra[3]). At the Wireless RERC at Georgia Tech, we believe it is essential that increased accessibility of information and communications technologies (ICT) and services in general, and IoT, specifically, be encouraged given that access to these key technologies can enhance inclusive and independent living for people with disabilities. Properly designed and developed, the IoT can realize its potential to empower all citizens, including people with disabilities to achieve an improved quality of life and greater social and economic inclusion. IoT technologies, such as environmental sensors, smart objects, and wearables, are powerful tools because they can provide the user with a variety of inclusive and assistive information services in real-time[4]. The actualization of this objective is somewhat complicated by the fact that while in recent years, improvements have been achieved, many IoT designers and developers do not have a clear understanding of (a) the technical requirements of accessibility, (b) the needs, preferences, experiences and expectations of

[3] Castro, D., & Misra, J. (2013). *The Internet of Things.* Washington D.C.: Center for Data Innovation, November. Retrieved from http://www2.datainnovation.org/2013-internet-of-things.pdf

[4] Domingo, M. C. (2012). An overview of the Internet of Things for people with disabilities. *Journal of Network and Computer Applications, 35*(2), 584-596. doi:10.1016/j.jnca.2011.10.015.

persons with disabilities, and (c) are not aware of design approaches to address these needs[5]. This diverse demographic includes those with sensory, cognitive, physical, perceptual disabilities, as well as elderly, aging, and those aging into disabilities. This diversity of users increases the challenge, and the need for inclusive policy approaches to the development and deployment of IoT. As with the general U.S. population, those with disabilities have become significant users of the Internet and wireless technologies, and hence, by extension, constitute a critical population of IoT users[6].

An approach emphasizing inclusivity (as noted in the principle of the IoT being "inclusive and widely accessible to consumers, workers, and businesses" [NTIA 2017, page 2], can be achieved in a number of ways, but specifically seeking input from people with disabilities and encouraging other stakeholders to do the same, signals to designers, developers, manufacturers, and service providers of IoT the importance of accessibility in the creation of connected devices and services. There has been much research seeking to understand the relationship between disability status and ICT, and to explore the use of policy to enhance digital accessibility for people with disability[7]. With the growing importance of ICT in everyday life and going beyond ensuring equal *access* to electronic information and services, lays the opportunity to create technologies that enhance usability and inclusive features. Such features become a critical area for innovation both for persons with disabilities and for the society as a whole.

Many challenging issues remain to be addressed, both technological and social in nature, before the IoT concept is effectively adopted. It is vital to draw attention to the fact that input from people with disabilities is also needed in the design stages including surveys of user preferences and creation of prototypes that benefit a wide range of potential users. This is especially pertinent given the fact that people with disabilities are often early adopters of

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[5] Baker, P. M., Gandy, M., & Zeagler, C. (2015). Innovation and wearable computing: A proposed collaborative policy design framework. *IEEE Internet Computing*, 19(5), 18-25.

[6] Pew Research Center (2010). *Americans living with disability and their technology profile*. Retrieved from: http://www.pewinternet.org/2011/01/21/americans-living-with-disability-and-their-technology-profile/

[7] see: Goggin, G., & Newell, C. (2003). *Digital disability: The social construction of disability in new media*. Lanham, MD: Rowman & Littlefield; National Council on Disability. (2011). *The Power of Digital Inclusion: Technology's Impact on Employment and Opportunities for People with Disabilities*. Washington D.C.: National Council on Disability (NCD); Goggin, G. (2015). Disability and mobile Internet. *First Monday*, 20(9).

technology. Inclusive IoT integrates design thinking and policy development approaches to generate more flexible, responsive technology outcomes for people with disabilities[8].

In section B. **Describing IoT** (Page 7 Paragraph 3), the green paper notes:

> *"Other commenters did not focus on connectivity in their proposed definitions. The American Bar Association Section of Science & Technology Law argued that "IoT is not itself a 'thing,' device or product," but rather "it is a conceptual structure consisting of tangible things (e.g., commercial and consumer goods containing sensors), real estate and fixtures (e.g., roads and buildings containing sensors), plus intangibles (e.g., software and data), plus a range of services (e.g., transmission, development, access contracts, etc.)." The Center for the Development and Application of Internet of Things Technologies at Georgia Tech stated that "of all the many facets of the Internet of Things as it is understood today, the one single groundbreaking element is not the connectivity ... [but] the smartness of things."*

We agree with much of the above, and would like to observe that we believe that in order to achieve the fullest potential for IoT inclusivity, the construct be thought of as more than simple connectivity, or even the "smartness of things," but a framework which ideally fosters innovative and adaptive environments that realize the full potential of the technologies. The Federal government should consider focusing future policy initiatives as well as technological design in a manner which addresses the ability of IoT to apply "on demand" contextually aware information. This display of consumer-digestible information, coupled with the intelligence of devices and applications can meet and anticipate the needs of users with disabilities in ways which increase user independence, opening new opportunities in areas as broad as education, workforce participation, safety, e-health and social engagement.

In section C**. Benefits of IoT** (Page 9, Paragraph 2), the paper comments that:

> "*Consumers are likely to see benefits from IoT in their homes. The Consumer Technology Association suggested that from the consumer perspective, Internet-enabled appliances, home automation components, and energy management devices are moving us toward a vision of the "smart home," offering more security, energy efficiency, and convenience."*
>
> And (Paragraph 3): *"The Internet Society stated that IoT will be beneficial for people with disabilities and the elderly, improving levels of independence and quality of life at a reasonable cost by reducing the number of in-person visits needed to provide the required care."*

[8] Baker, P. M., Gandy, M., & Zeagler, C. (2015). Innovation and wearable computing: A proposed collaborative policy design framework. *IEEE Internet Computing*, 19(5), 18-25.

The green paper's emphasis on health-related issues (The IoT green paper referenced remote health monitoring, for instance) are pertinent especially as they address issues of cost-effective delivery of health care, and the provision of technology-enabled assistance for individuals with health and age-related limitations. Further, IoT device interoperability, especially related to smart home technologies and healthcare have the potential to open new pathways for accessible services. Thinking more broadly, in terms of inclusivity, the technology used to build smarter cities and smarter homes can help create not just more accessible environments for people with disabilities, but most importantly, applying principles of inclusive usability and personalization, offers people with disabilities the opportunity to participate in social and civic life on their own terms. The key challenge of personalization for people with disabilities is the necessity of matching developer awareness, with stakeholder-engaged design. Since people with disabilities have varied needs and experiences, IoT must be able to adapt to individual circumstances, a central aspect of universal design. Another significant challenge to IoT, specific to people with disabilities, is self-management; here, we refer to the process by which IoT manages its operation without human intervention. By promoting inclusive design and active feedback loops during every stage of IoT development, it will be possible to gain a deep understanding of the digital divide experienced by people with disabilities and to design appropriate measures to bridge it.[9]

Smart environments can meet the needs of people with disabilities in several different ways: (1) specific interfaces are designed to manipulate home (or for that matter, work) devices for automation and control, (2) special IoT-connected assistive devices are specifically designed to improve living conditions at home, and (3) smart, context-aware devices reconfigure to meet the perceived need of the user, via sensors, and adaptive intelligence. Accessibility and usability are core themes in the development of smart homes and cities. Traditional (preconfigured) universal design has demonstrated its success to address users with similar features and needs, but if technology is not capable of adapting to meet the changing needs and context of the user, it may be perceived as inadequate which would likely have a negative impact on consumer acceptance and adoption. In these cases, adaptation

[9] Vicente, M. R., & Lopez, A. J. (2010). A multidimensional analysis of the disability digital divide: some evidence for Internet use. *The Information Society*, 26(1), 48-64.

techniques have proved to be very effective in providing personalized services and enabling accessibility to people with special needs[10]. Smart home initiatives are getting more and more attention from consumers, industry, and government on a global scale,[11] which then particularly calls for stakeholder participation from individuals who could especially benefit from these inclusive technologies, including people with disabilities. A wide range of sectors – such as education, health, security, public safety, business, government administration, and civil society – are taking advantage of technology to reduce costs, bring agility to medical services, achieve a more efficient management and obtain a better quality of life.

2) Is the approach for Departmental action to advance the Internet of Things comprehensive in the areas of engagement? Where does the approach need improvement?

We strongly support the NTIA's stakeholder-driven policy approach (Page 13 ii. Stakeholder-Driven Policy Processes) which is critical to ensure a wide range of perspectives, as well as the detailed objectives of section **4. Areas of Engagement, iv. Issues of Equity in IoT.** (Page 20), The NTIA observes:

> *"Connected devices have the extraordinary potential to improve the health, economic, and personal welfare of underserved communities. Wearable devices can closely monitor a patient's health, which is critical for certain illnesses. Heath care providers can do this remotely, which helps rural patients or patients with mobility problems. Because of this, it is essential that government and the private sector work together to ensure that all Americans have an opportunity to reap the benefits brought by IoT.*
>
> *While IoT has the ability to improve the lives of consumers and citizens, a lack of access to the Internet, and thus many IoT applications, could also make things worse for underserved communities. The Center for Data Innovation commented that if "the public sector does not implement policies to encourage equitable deployment, the Internet of Things could exacerbate existing inequalities by providing the benefits of data-driven decision making only to some, and placing already underserved communities at an even greater disadvantage. In general, the concern is the cumulative impact of inequality (e.g., economic status plus other factors), and how some consumers may be left out of the benefits of IoT. The growth in IoT device use and the resulting data analytics from their use has been significant, and government should be conscious of issues of social inclusion and equity."*

[10] Martín, E., Haya, P. A., & Carro, R. M. (Eds.). (2013). *User modeling and adaptation for daily routines: providing assistance to people with special needs*. London: Springer Science & Business Media, p304.

[11] de Oliveira Neto, J. S., & Kofuji, S. T. (2016, September). Inclusive Smart City: Expanding design possibilities for persons with disabilities in the urban space. In *2016 IEEE International Symposium on Consumer Electronics (ISCE)* (pp. 59-60).

We strongly support the objective of recognizing the needs and disadvantages of many underserved populations, but underscore the importance of specifically addressing the needs of people with disabilities who currently face a range of social, technological, and awareness barriers to full participation in society, not just because of their disability-specific limitations, but also because of attitudinal barriers that perpetuate socioeconomic disparity and underemployment in the workforce.

It is in this latter area, the workplace, that assistive, and more broadly, *inclusive* digital technologies including IoT devices, are among the most promising productivity enhancements available to help people with disabilities obtain employment and succeed in the world of work.[12] IoT technologies are generating a huge amount of data that enable new ways of communication between people and objects as well as objects themselves[13]. Modern, inclusive digital technologies, including smartphones, tablet computers, and wearable technologies, have demonstrated facilitative utility to job seekers and workers with disabilities. Different community-based scenarios, such as shopping, at school and educational applications, and in the home environment, show how using IoT (sensors, smartphones, wearables, etc.) can improve the lives of people with disabilities and the aging.

Employers can harness these IoT technologies to enable their employees to be more efficient and effective, boosting productivity and lessening stigma related to the accommodations needs of people with disabilities.[14] Furthermore, if a workplace is designed and implemented taking into account the needs of people with disabilities, it is most likely it will also meet the expectations of non-disabled individuals[15]. While IoT-enabled technology

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[12] *Employer Policies' Impact on Employees with Disabilities: Comparative Analysis of Industry Publications and Academic Literature* (September, 2016), Georgia Institute of Technology, Center for Advanced Communications Policy (CACP), produced for the Employer Policy, Research & Technical Assistance Center (DBA, Employer Assistance and Resource Network on Disability Inclusion (EARN), operated by the Viscardi Center under a cooperative agreement with the U.S. Department of Labor (DOL), Office of Disability Policy Employment (ODEP) (Grant Number OD-26451-14-75-4-36).

[13] Tan L, Wang N. Future internet: the internet of things. In: *Proceedings of third international conference on advanced computer theory and engineering (ICACTE'10)*. Chengdu, China; August 2010.

[14] *Employer Policies' Impact on Employees with Disabilities: Comparative Analysis of Industry Publications and Academic Literature* (September, 2016),

[15] J. S. Oliveira Neto. (2016). "Inclusive Smart City: an exploratory study," in *Universal Access in Human-Computer Interaction. Access to Interaction*, M. Antona and C. Stephanidis, Eds. Springer International Publishing.

may be especially useful to employees with disabilities, the broader impact is that everyone gains assistive information that will make them more productive in their job.

When implemented in the workplace, IoT technologies can profoundly change the experience of persons with disabilities, providing tools for independence and autonomy while at work. But implementation is to some extent dependent on availability and suitability of current (or in development) devices and services. It is here that the NTIA could provide formidable leadership in driving the development of the IoT framework by supporting multi-stakeholder engagement, not only formally in terms of policymaking, standards setting and regulation, but also by supporting the formation of public-private partnerships and multi-stakeholder collaborations to envision innovative types and uses of IoT. In the past, NTIA has sponsored workshops and showcases that bring end-users, industry and other stakeholders together to demonstrate successful partnerships and collaborative activities. A key take-away has been attendees leaving with an awareness of potential solutions. It might be timely for NTIA (maybe in partnership with the FCC) to hold a seminar/conference and showcase that uses the green papers as the anchor to explore IoT challenges, benefits, pathways to solutions and innovations for an inclusive future.

3) Are there specific tasks that the Department should engage in that are not covered by the approach?

In section V. **Planned Activities, current initiative "Empowering Communities to become SmartCities**," (page 21) the green paper comments:

> *"NTIA assists in the development of the broadband infrastructure necessary for the use of IoT both directly through toolkits and indirectly through work with the Broadband Opportunities Council (BOC). Private- sector partners can be an important source of capital, technical knowledge, continuing innovation, and workforce development. To assist communities looking to embed new digital technologies into municipal infrastructure, NTIA released Using Partnerships to Power a Smart City: A Toolkit for Local Communities for local officials and citizen groups to use as a guide for building successful public-private partnerships."*

Toolkits have played an important role in assisting cities, counties and local government in how to integrate Broadband services into their communities, especially given cost factors. Your toolkit has especially been important because of its objective and factual presentation of materials. However, our anecdotal experience shows that any toolkit still

requires an "expert" to walk through the steps and spend time with leadership before any implementation could be undertaken. Hence, we believe that while toolkits are extremely useful in achieving policy objectives and optimal deployment strategies, that it is critical to ensure the materials explicitly address and define what is meant by inclusion. One cannot assume that all stakeholders' concept of inclusion incorporates people with disabilities and aging adults. Without specific mention of these user groups, we run the risk of exclusion via benign neglect. Since Smart cities and environments are still emerging, there is a real opportunity to get it right the first time and not have to retrofit, craft add-ons, or be reactive to litigation. This once again underscores the need to ensure fully inclusive collaborative consultations with the range of stakeholders including public sector officials, vendors and manufacturers, and citizens. This broad engagement will allow for a range of perspectives to be heard, increasing the possibility that inclusive solutions come to the table. While these are important objectives, it is necessary to note that inclusion starts with guaranteeing that not just the process, but the materials themselves are accessible as well as the communication processes of seeking input and engagement including through social media and online communities. To be considered "smart," a community/home must reinforce the participation of everyone recognizing diversity, struggling against the segregation of minorities, and trying as much as it can to eliminate, not only physical but also digital barriers.[16]

This is especially vital in non-standard situations when time becomes a critical element such as situations requiring emergency communications[17]. Operating optimally in emergency situations is another potentially powerful application of IoT. In the bullet point "**Enabling IoT Functionality for First Responders"** (page 22, paragraph 1) the green paper states:

> *"An anticipated key driver of the benefits of IoT for public safety is the First Responder Network Authority's (FirstNet) Nationwide Public Safety Broadband Network (NPSBN). FirstNet is deploying the necessary infrastructure to allow for transfers of data wirelessly, real-time in the field, without potential congestion from commercial network traffic. This will be crucial during routine day-to-day incidents, large planned events or unexpected disasters. In 2012, Congress*

[16] de Oliveira et al., 2016.

[17] See: Bennett, D., Baker, P.M.A., and Mitchell, H. (2016). "New Media and Accessible Emergency Communications: A United States-Based Meta Analysis" In K. Ellis, & M. Kent (Eds.), *Disability and social media: Global perspectives*. New York: Routledge.; and LaForce, S. (2016). "Optimizing Accessibility of Wireless Emergency Alerts: 2015 Survey Findings," for the Law and Policy session. Presentation at the 2016 CSUN Conference in San Diego, CA from March 21-26, 2016.

allocated $7 billion and 20 megahertz of spectrum to FirstNet to partner with the private sector to build the NPSBN, an LTE-based wireless broadband network dedicated to public safety. Once operational, the FirstNet network promises to transform the way first responders communicate, providing public safety personnel with dedicated access over a prioritized, reliable, and secure mobile connection. This will enable first responders to send and receive text, voice, video, images, location information, and other data in real time to help increase situational awareness and operational capability in the field.

In addition to revolutionizing emergency communications, the FirstNet network will be an incubator and proving ground for public safety focused IoT solutions by linking more first responder data sources, such as their gear, emergency vehicles, fingerprint scanners, databases, and more. The constant transfer of data over a dedicated, mission critical network will enable faster decision making that can help coordinate responses and save lives. By focusing on public safety needs first, FirstNet seeks to drive industry to continue to innovate to improve public safety activity to save lives, improve responses to incidents and disasters, and better anticipate future responses."

In emergency situations, first responders receive and act on relevant information about the nature of the emergency, response efforts, relevant data streams, and available resources through the First Responder Network Authority (FirstNet). FirstNet streams necessary information through a broadband network to mobile devices worn by first responders. First responders will use the incoming information to tailor their actions and responses with the most up-to-date information available and specific to their current location and circumstance. The FirstNet network capitalizes on information available from IoT devices as well as information provided by mobile devices utilized by people with disabilities and others. It is in this latter capacity that the IoT opens new possibilities to ensure the safety of highly vulnerable populations such as people with disabilities.

First responders could utilize these integrated information streams to determine the location and needs of individuals with disabilities *prior* to entering the building or area. People with disabilities requiring special equipment or additional assistance during an evacuation could be identified, so that first responders bring the necessary equipment with them to complete the rescue. Conversely, first responders could use the FirstNet network to provide instructions or status updates to IoT devices in the possession of people with disabilities in their preferred accessible formats in real time. IoT technologies carried by first responders could read medical treatment warnings and information electronically carried by people with disabilities, older adults, or other vulnerable individuals (e.g., youth and pregnant women), so

that they are aware of special circumstances enabling the provision of the most relevant care possible.

Much of the components and technologies to enable this to function currently exist, or is in prototyping stages. The key components to ensure implementations are 1) top-down coordination coupled with 2) bottom-up information (such as real-time information relayed back by first responders), 3) multi-stakeholder engagement *well in advance* of potential need, 4) the use of bidirectional digital technologies, social media and information alerting, to both inform and advise in an accessible manner, as well as to collect vital information from individuals with a firsthand perspective, 5) Leveraging the assets found in Wireless Emergency Alerts (WEAs) on mobile devices to better inform the public on taking proactive and timely responsiveness to emergency warnings and alerts[18].

4) What should the next steps be for the Department in fostering the advancement of IoT?

We agree with the NTIA that it is especially important that 1) proactive Federal policy be developed, and 2) regulatory bodies provide broad-based accessibility provisions that can deliver a flexible, applicable architecture as IoT evolves, with the ability to guide industry and engage an inclusive and diverse range of stakeholders in developing accessible products and services that also promote usability of the same (NTIA green paper, page 14-15). We encourage NTIA to also bring the stakeholders together at the conclusion of your green paper series. As noted earlier in our response to question 2, NTIA is the appropriate government entity to host a seminar/conference and showcase that uses the green papers as the anchor to explore IoT challenges, benefits, pathways to solutions and innovations for an inclusive future. Encouraging government wide, White House and legislative involvement would also lead to greater understanding and engagement with the critical issues surrounding IoT in its societal placement.

In summary, perhaps NTIA could also promote inclusive elements through its programs, international activity and its role(s) in intergovernmental committees. From the Wireless RERC perspective, the most significant consideration for persons with disabilities being able to take

[18] CACP Collaborative (2014). Emergency response for the 21st century: Enabling two-way communications with the public. Unpublished manuscript, Center for Advanced Communications Policy, Georgia Institute of Technology, Atlanta, Georgia.

full advantage of the inclusive potential of Internet of Things, is to ensure that all of the stakeholders in the ecosystem address both accessibility and usability when developing new products and services. There are a wide variety of companies and organizations, in many industrial sectors, that influence or are influenced by the Internet of Things in some way, including device manufacturers, handset manufacturers, networks and application developers, extending even to adjacent industries such as the fashion and automotive sectors. To create a fully inclusive Internet of Things that works for everyone, accessibility and usability must be a consideration at every stage of the design and development process. This principle holds true for policy, regulatory, and standard setting processes. Active user involvement becomes particularly important when designing applications to be used by people with special needs, because of their specific requirements[19] and because of their unique perspectives on use and applicability.

Important aspects of a universal and inclusive design process include: (a) holistic and interdisciplinary, (b) based on user-centered design, (c) adopt and apply accessibility guidelines and standards, (d) iterative development, (e) focus on users with diverse accessibility needs and their usage contexts early and throughout the development process, (f) empirical evaluations with the elderly and people with disabilities, and (g) focus on the whole user experience[20]. Even as the universal *design* process should be holistic and included in each part of a project[21], so too, should be the interdisciplinary/multi-stakeholder planning, follow-up, implementation, and assessment, as critical components of the *policy* approach aimed at advancing IoT. At a minimum, all parties involved in the development of IoT devices and applications should commit to upholding the principles of universal design, accessibility, and usability. Significant challenges remain before the IoT can fulfill its promise to revolutionize the lives of its users—particularly users with disabilities. Many factors will have to evolve, including guidelines for standardization and interoperability of devices, the extension of

[19] Newell, A. F., Gregor, P., Morgan, M., Pullin, G., & Macaulay, C. (2011). User-sensitive inclusive design. *Universal Access in the Information Society*, 10(3), 235-243.

[20] Aslaksen, F., Bergh, S., Bringa, O. R., & Heggem, E. K. (1997). Universal design: Planning and design for all. Chicago 1997. [Online]. Available: http://home.online.no/ bringa/universal.htm

[21] Schulz, T., Fuglerud, K. S., Arfwedson, H., & Busch, M. (2014). A Case Study for Universal Design in the Internet of Things. *Universal Design 2014: Three Days of Creativity and Diversity*, 45-54.

broadband Internet networks, protection of privacy, improved security of data and a commitment to accessibility by all parties in the IoT ecosystem. Notwithstanding these factors, attention to the affordability of IoT will lead to greater adoption rates by people with disabilities, and hence, a more inclusive future.

In closing, despite the challenges discussed above, it is important not to lose sight of the significant benefits the IoT can bring. If industry stakeholders incorporate inclusive design approaches and policy participation from the disability community into their development, the IoT will facilitate more independent living, personalized care, flexibility and mobility, and better employment and education outcomes. The future of IoT should be one in which all persons are able to participate as creative and productive members of their communities. It is more important than at any time in the past to ensure that current and future policies foster an innovative, adaptive and inclusive environment to realize the full potential of the Internet of Things.

Respectfully submitted,

Helena Mitchell, Ph.D., Center for Advanced Communications Policy/Wireless RERC

Paul M.A. Baker, Ph.D., Center for Advanced Communications Policy/Wireless RERC
Nathan C. Moon, Ph.D., Center for Advanced Communications Policy/Wireless RERC
Brad Fain, Ph.D., Center for Advanced Communications Policy/GTRI
Salimah LaForce, Center for Advanced Communications Policy/Wireless RERC

Georgia Institute of Technology
500 10th Street, 3rd Fl. NW
Atlanta,
GA 30332-0620
Phone: (404) 385-4640 Dated this 13th day of March 2017