Smart Government – The Potential of Intelligent Networking in Government and Public Administration

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Abstract— **Increasing numbers of devices are equipped with sensors, actuators and communication units. These smart object interact with humans as wells as with each other. If they are embedded in more complex, so-called cyber-physical systems (CPS), they can, often via apps, be accessed remotely and initiate processes, e.g. in smart homes. CPS intelligently network real and virtual objects and thereby become self-controlled ecosystems that not only assist in providing and analyzing information but also automatically steer and control processes. Governments need to adapt to these changes and become smart governments. They will then be capable of using the new possibilities of smart objects and CPS in the Internet of Things and the Internet of Services for an efficient and effective execution of public tasks.**

Keywords: smart government, intelligent networking, intelligent connection, smart objects, cyber-physical systems

Acknowledgement: This paper summarizes essential thoughts of the white paper "Smart Government - Wie uns die intelligente Vernetzung zum Leitbild „Verwaltung 4.0“ und einem smarten Regierungs- und Verwaltungshandeln führt" [10].

I. Research Question: Intelligent Networking For Smart Government

The word "smart" has developed into a globally recognized term for the next level of digital development. At its core, it is about the intelligent networking of existing objects and networks that receive enhanced functionality through IT systems. They receive a virtual identity with which can be communicated. In German, the adjective "smart" is conventionally used for "quick, clever and shrewd," "skillful, crafty, cute and brilliant" and "elegant, pretty and brisk"[7]. But the actual phenomenon behind the term "smart" can best be described with “increasing intelligent networking”. Currently the networking of diverse objects can be observed over time and space, using the most modern communication skills. These connected objects are accessible via the Internet. At the same time, they are able to communicate directly with other virtual objects. This small technical extension releases an enormous revolutionary potential for change that governments should not ignore. Until now however, definitions of smart government remain scarce. This paper thus addresses the question: What constitutes smart government? To answer this, the paper will firstly define smart objects and cyber-physical systems, the core components of smart government. It will then delimit this definition from other interpretations of the word “smart” and subsequently define smart government. One scenario will be presented to illustrate the potential of smart objects and CPS for administration. It will then conduct a SWOT analysis for smart government and describe in detail strengths and opportunities as well as weaknesses and threats. It will conclude with discussing an agenda for further research.

II. Smart Objects and Cyber-Physical Systems

"Smart" is not just about broadband, the latest hardware and software or new apps and information systems. It rather describes the creation of a vast network of diverse objects, overcoming borders of time and space, using the most modern communication technologies. Smart objects are advanced devices of everyday life, which are equipped with sensors, actuators and a communication unit. A unique identity on the Internet and a virtual representation make them addressable to humans or other smart objects. As soon as these objects interact with each other or with people, a "certain intelligence" or "smartness" is colloquially awarded towards them, even if thinking skills and wisdom are not present. This is the origin of the term "smart objects". In everyday life, an increased smartness of popular objects can already be observed. Former stand-alone devices are equipped with advanced functionality, better sensors, a variety of response options and a wireless broadband connection to the Internet. Cell phones become "smart phones", televisions "smart TVs" and watches "smart watches", and they are all networked. This intelligent networking of objects now already encompasses cars and trucks, ships, aircrafts, machines and factories.

If required, these smart things can embedded in so-called cyber-physical systems (CPS), which network real physical objects with digital information and communication systems. An intelligent networking of real smart objects and their interaction can be guaranteed this way [1:13][6:22]. CPS can gather data, analyze it and initiate task execution for which they use interconnected smart objects, embedded systems or sensor networks. Due to global interconnectedness, CPS can operate on large scales and overcome geographic distances. Powerful CPS almost instantaneously detect changes in the environment of

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their respective smart objects and adapt their behavior accordingly. CPS are thus able to react to specific situations, interact with users and controlling in this way their behavior [6:22]. Based on this concept, smart ecosystems can be developed, in which IT systems, people, data, things and services will equally be involved and which will be able to inform, analyze, monitor and control themselves. This networking via the Internet causes an increasingly seamless integration of the real world and the digital world [10].

Technically this "smart world" stands for the application of the Internet of Things and the Internet of Services in the real world. The Internet of Things is the result of the global "electronic networking of everyday objects" [2] via the IP-suite and the direct exchange of information between objects without human intervention in the sense of genuine machine-to-machine communication. In the Internet of Services, functionality and services are delivered as fine-grained software components and made available on-demand by providers over the Internet. Web services, cloud computing and standardized interfaces facilitate this. All this includes solutions with intelligently connected real and virtual objects in self-controlled (smart) ecosystems. This constitutes a significant difference compared to the previous approaches: Smart objects and CPS do not only support in information and analysis. They can also take over automation and control processes autonomously and independently from humans [3]. This gives rise to opportunities, but also risks and challenges that need to be taken into account.

The term "intelligent networking" should not be misunderstood with the terms "networked intelligence" or "artificial intelligence". Intelligent networking is defined by real or virtual objects communicating with each other over a distributed network. They evaluate sensor data and initiate actions on demand. The underlying decision logic is usually simple and not comparable to human intelligence. The term "networked intelligence" puts people and their intelligence in the center, joining a group to achieve common goals by means of computer networks and information systems. Thus it is about IT-based forms of collaboration such as crowd sourcing, open knowledge management or approaches for open societal innovation [11][14]. With the help of "artificial intelligence", IT systems should be put in a position to behave intelligently like a human being. Of course, all objects with artificial intelligence might be intelligently connected. So far, just a few IT systems like the cognitive WATSON (http://www.ibm.com/de/watson/) already have reached a high level of intellectual brilliance.

III. SMART GOVERNMENT IN THE CONVENTIONAL SENSE

Regarding the continuous development of smart objects and intelligent networks, it seems reasonable that “smart” is also used in combination with "government" to describe the next level of "digital public management modernization". In 2009, the Emirate of Dubai created the "Dubai Smart Government Department" (http://www.dsg.gov.ae), with responsibilities for the full range of government information management and electronic government services. Already since the year 2000, there have been experiments in Dubai in the smart government project with sustainable smart technologies for the urban environment, which should play a leading role in many public construction works. Meanwhile, the e-government activities in the Emirate were reoriented towards smart government.

In 2014, the market research firm Gartner describes "smart government" as the integration of information, communication and operational technologies to exercise the planning and management of operations across multiple domains, process areas and jurisdictions to generate sustainable public value [5]. It places the Internet of Things among the top ten of the most relevant technology trends.

However, much of the debate about smart governments neglects the aspects of smart objects and CPS. For example, the market research and consulting firm International Data Corporation (IDC) defines "smart government" as "the implementation of a set of business processes and underlying information technology capabilities that enable information to flow seamlessly across government agencies and programs to become intuitive in providing high quality citizen services across all government programs and activity domains" [15:2]. The associated "smart government maturity model" [15:10] rather deals with e-government and open government.

It is important to accentuate that smart government is not merely a new term to describe e-government and open government. It is also not meant to indicate "clever and shrewd government action", that means adapted to the situation rather than intelligent, as the former US President Bill Clinton formulates in his 2011 published book "Back to Work: Why We Need Smart Government for a Strong Economy" [4]. While using smart objects and CPS can certainly lead to better government decision-making and public policy, making better decisions does not qualify a government to be smart. A smart government or a smart state uses the capabilities of smart, networked objects to make smart decisions.

IV. DEFINING SMART GOVERNMENT

In Germany, the Federal Government has been promoting research activities on the Internet of Things and the Internet of Services for business and industry since 2006. But only since 2015, it is obvious that research is also needed for an intelligently networked government: The initiative "Intelligent Networking" for the sectors education, energy, health, transport and administration (http://www.bmwi.de/DE/Themen/Digitale-Welt/initiative-intelligente-vernetzung.html) and the contest "City of the Future" (https://www.wettbewerb-zukunftsstadt.de) were initiated to gather exemplary solutions together with citizens, develop visions and set up implementation concepts.

This shows clearly that while the term "smart government" is still not widely used in Germany, there is a need to define the concept. This holds true especially in the light of many confounding interpretations that present smart government as merely a new label to better, more innovative, open government. Germany and other countries need a common understanding of smart government that includes smart activities and smart technologies.

Based on these considerations, the author of this paper proposed a "Definition of Smart Government" ([10:4]; grounded on [12:1], Figure 1) in September 2015:

"*Smart Government should be understood as the management of business processes related to government and administration with the help of intelligently networked information and communication technologies (ICT). Intelligently networked governance uses the opportunities of interconnected smart objects and cyber-physical systems for the efficient and effective performance of public tasks. This includes the portfolio of e-government and open government, embracing big data and open data. At its core, it is about sustainable government and administrative actions in the age of the Internet of Things and the Internet of Services, whose technical foundation is on the Internet of Systems, the Internet of People and the Internet of Data. This definition includes the local or municipal level, the regional or provincial level, the national or federal level as well as the supranational and global level. Included is thus the entire public sector, consisting of legislative, executive and judiciary as well as public enterprises.* "

The central idea of smart government of Jimenez-Gomez et al. is reflected in this comprehensive approach to an intelligently networked public administration. Open government therefore should be seen as part of smart government. There can be no smart government without open government [8:391].

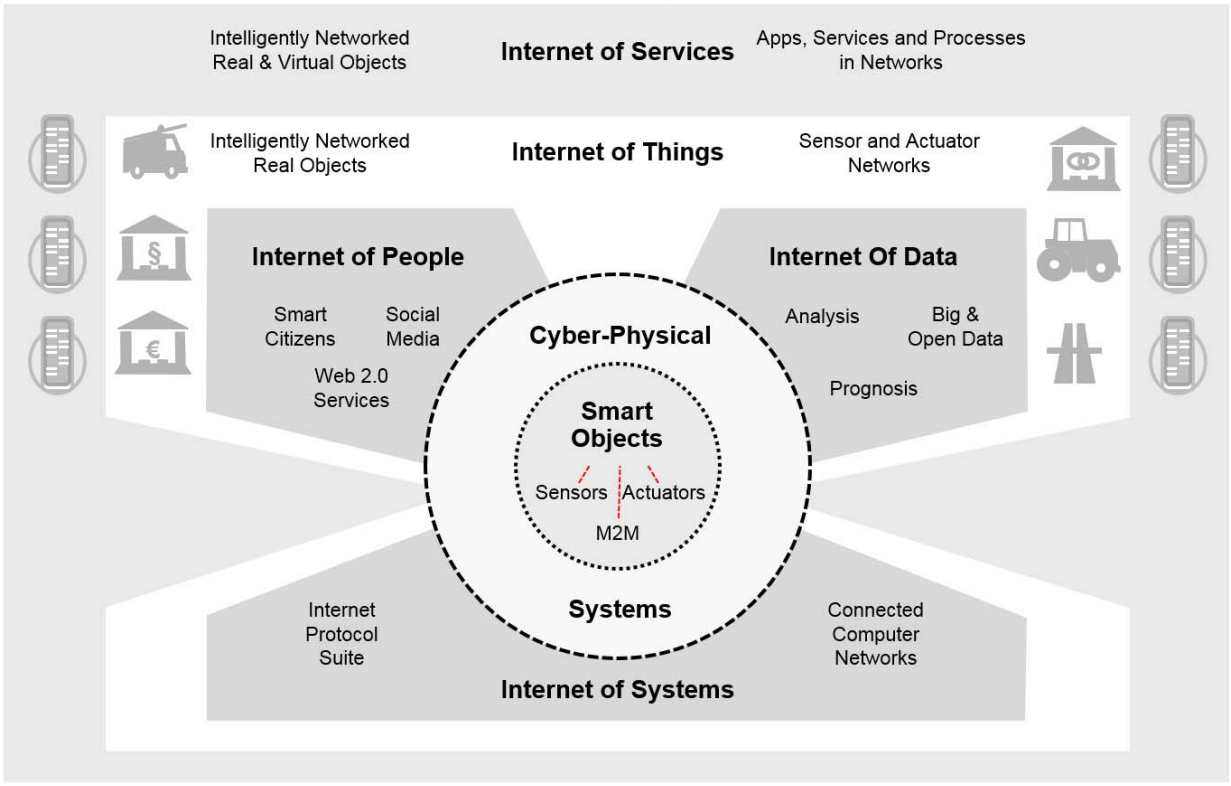

Figure 1: Smart Government arranged around Smart Objects and Cyber-Physical Systems

Intelligently networked objects, cyber-physical systems, the Internet of Things and the Internet of Services are new concepts emerging from the applied computer sciences, although they build on existing technical achievements. Their effects will substantially change politics, administration, economy and society. Many objects of everyday life can be enhanced and reshaped by the means of addressable processors, sensors and actuators. Most paper-based processes can be set up and handled much more efficiently via electronic files and workflow management systems.

This calls for a concretization of the possibilities that smart government entail for politics and administration. What are possible visions and scenarios for intelligently networked political activities ("Smart Politics", [13]), an intelligently networked legislation ("Smart Legislation") and intelligently networked state agencies ("Smart Administration"), for smart decisions and smart civil servants [9], but also about smart citizens and smart cities? In addition, it requires constructive guiding principles

for dealing with the Internet of Things and the Internet of Services in state, administration and society, roughly comparable to the German vision "Industrie 4.0" [2].

From the perspective of public sector informatics and business informatics, the related opportunities have so far neither been systematically captured nor comprehensively developed. Although in the context of "smart cities" there are already diverse thoughts about smartness in energy, health, transport and education networks [6], concrete applications of smart technologies are seldom proposed for the core areas of public administration. As one of the first examples a scenario for a smart construction administration [10:31] is presented below, showing the potential of the Internet of Things and the Internet of Services.

V. Smart Government Scenario: Smart Construction Administration

Roads, highways, railways, rivers, canals and bridges are key pillars for the transport infrastructure of a state. Unfortunately through the daily usage, their condition deteriorates over time. Therefore, they must be inspected on a regular basis, and if necessary be overhauled or replaced. This process is made vastly more efficient by using smart technologies and networking them: Sensors perfect the transport infrastructures by reporting automatically about its utilization and current condition. Sensor-generated information about the stress on roads, tracks, canals, bridges and tunnels helps civil engineering authorities to better estimate the condition of the infrastructure. They recognize and repair damages in the transport infrastructure in order to ensure an optimal traffic flow. This is supplemented by indications from citizens via apps. Strong vibrations registered by smartphones during car trips simplify the early identification and removal of road damages.

Data and information about these status updates or progress of construction sites are easily accessible and reusable via the Internet. This availability allows interested groups to develop new apps and public services for improving the existing infrastructure. With sensors and actuators, it is also possible to develop smart buildings, which control autonomous shutters, lighting, heating and household appliances. The construction administrations take care of the condition of smart public buildings, that facilitate more efficient management through sensor and actuator networks: Cyber-physical systems help to automate various manual tasks and to optimize the resource consumption of electricity, oil and gas.

Electronic communication opens up new opportunities for process workflows in a smart construction administration, based on collaborative, transparent and efficient building application processes. When auditors need to compare plans with reality and get an overview over technical standards in a single glance to approve constructions, they use smart glasses that augment reality with the necessary information. Flying drones are another option for the detailed examination of complex buildings. Auditors also appreciate automatically generated reports on statistics that are run in real time on data collected during the final construction approval process on the construction site.

Finally, tunnels are considered to be especially critical within the transport infrastructure. Disruptions due to malfunction or external factors threaten the operability of the entire infrastructure. At the same time, risks for people are high if accidents occur inside. Therefore, recovery measures must be carried out quickly and comprehensively with the appropriate instruments. A variety of robust and redundant sensor and actuator networks offer the possibility to improve the situational awareness significantly and to make the right, life-saving decisions on the spot.

Information and Analysis	Automation and Control
Tracking Behavior	**Process Optimization**
• Stress on roads and bridges • Identification of road damages based on vibrations of smartphones • Progress in building projects	• Automated data recording tasks • Semi-automated building control • Fast detection and removal of damages • Joint processing of building applications
Enhanced Situational Awareness	**Optimized Resource Consumption**
• Smart testing glasses for construction approvals, which combine plans, reality and standards for the auditor • Drones for the detailed examination of complex buildings	• Minimizing the consumption of electricity, oil and gas for a building • Optimized process-integration for building applications
Sensor-driven Decision Analytics	**Complex Autonomous Systems**
• Sensor-based stress tests of the transport infrastructure • Supportive statics checks during the approval process for civil engineering structures	• Automated electronic communication during the building application procedures • Smart & intelligently connected buildings • Smart & intelligently connected roads • Smart & intelligently connected tunnels

Table 1: Smart Construction Administration

VI. Consequences for Smart Government

The diverse smart approaches for building construction and civil engineering administrations outlined here refer to several new design options for the public sector, based on the intelligent networking via the Internet of Things and the Internet of Services. Looking at the wide variety of the public sector and the public tasks, there are numerous further scenarios for smart government in different sectors. Consequently on one hand, smart objects have to be designed with more innovative solutions compared to the previous simple objects. On the other hand, smart government is about the complete redesign of paper-based processes with digital record and workflow management systems, for example relying entirely on virtual objects. As part of his studies, the author has developed further scenarios for "Firefighters 4.0", "Court of Justice 4.0", "Tax Administration 4.0", "Registry Office 4.0" and "Agriculture Administration 4.0" [10:16-30] which are starting points for further discussions, detailed concepts, prototype developments and smart government solutions.

All this serves the purpose to raise awareness for the upcoming changes towards smart government that are triggered by the Internet of Things and Services. In a global context, this development can hardly be stopped. Consequently, it is more about when, in what areas, in what form and in what proportions cyber-physical systems will change the public sector. In the interest of an overall positive development, it is important to know the strengths and weaknesses, opportunities and threats (table 2 and chapter 7 and 8). This enables the selection of appropriate focus points in the public sector, realize where it makes sense to explore opportunities in pilot projects potentials to identify benefits, challenges and limitations and to design solutions for the benefit of the society.

Strengths	Weaknesses
• Integrative IP-based approach • Intensification of networking • Vision: Smart Agencies • Vision: Smart Politics • Vision: Smart Civil Officers • Vision: Smart Citizens	• Development needs effort and time • Required financial expenses • Insufficient scientific foundation • Research & development capacity • Sensor-data enables behavior tracking • Insufficient political prioritization
Opportunities	**Threats**
• Innovation potential and impulses • Novel intelligently networked objects • Novel intelligently networked services • Innovative cyber-physical systems • Increases in efficiency & effectiveness • Cost and fee reductions	• Lack of design readiness • Uncertainty vs. winning implementation • Disruptive nature of changes • Lack of permanent funding • Lack of acceptance and participation • Strategic exploitations of fears of transparency

Table 2: SWOT-Analysis for Smart Government

VII. Strengths and Opportunities of Smart Government

Indisputably, the Internet allowed that internet protocol based e-government solutions have spread. Smart Government solutions, being based on the same protocol, can integrate existing solutions. State, government and administration neither can nor want to refuse the functional possibilities offered by the Internet of Systems, the Internet of People (social media), the Internet of Data, the Internet of Things, and the Internet of Services. This leads to an intensification of the networking of systems, people, data, objects and services. States will rather see it as a strength if they develop in the context of smart government their own visions for "smart agencies", "smart politics", "smart civil officers", and "smart citizens" to steer society, economy and administration through these changes successfully. Such visions provide orientation and room for debates, even about ethical boundaries, ideas, objectives, implementation strategies and concrete actions. This possibility for design has to be used consequently.

The greatest opportunity lies indeed in the potential of smart government to trigger further innovations. Not only existing smart objects could be used for the performance of public tasks. Entirely new smart things and services, particularly cyber-physical systems, could be designed for the public sector, which offer public services more efficiently and to some extent even more effective. Administration, science and business need to be equally part of this development, combining engineering and public management knowledge. After all, it is about the design of smart objects, processes and services, their networking and smart control in their respective environment. Of course, politically predefined goals have to be considered such as the rule of law, increased efficiency, effectiveness and individualized services, reduced workload for public employees, cost reductions as well as improved control over tasks and expenditure. Citizens and enterprises can thus be provided with an improved range of public services, which should be characterized by a further acceleration, lower fees, individuality and reliability. The assistive features of many smart government systems also help to relieve the administrative staff's workload. However, these opportunities must be recognized and realized.

VIII. Weaknesses and Threats Looming on the Horizon

Right now, a major weakness of smart government is that there are neither comprehensive concepts nor detailed smart government solutions available, which introduce specific smart objects and cyber-physical systems for a more effective performance of public tasks. All upcoming sketches, designs, developments and implementations have to be associated with significant time, labor and financial investments. The scientific exploration of this new field of research has just begun worldwide. Another particularly critical point is that the sensor data generated by smart objects enables the global monitoring of people, objects, services or data. Movements and interactions could be evaluated at any time. Business models and monitoring systems could even be based on such behavioral data collections. These approaches do not only include search term inquiries, tracking services and reports by the users themselves. The Internet of Things also offers third parties innovative ways for exploiting anonymous or personalized data. States, wishing to regulate these activities, must consider various aspects, in particular the challenges of sensor-based decision analysis and an increasingly computer-controlled automation and control [3:3-10]. As soon as possible, politics and administration have to create a framework for a secure and trusted data, information and communication infrastructure, barring access for foreign intelligence services, criminals and the armies of potential

enemies. In times of tight budgets and human resources, these are important issues, which might hinder the discussion about smart government, the Internet of Things and related reforms, especially if governments do not attribute it a high priority.

The road to smart government is also associated with further threats that make a successful implementation more than uncertain. Despite the willingness to change, even creativity and willpower are limited resources. The state of science, technical limitations such as network coverage, bandwidth and standardization, the availability of competent thinkers and financing constraints will define short, medium and long-term limits for all states. Each implementation of a smart government concept for a specific department also has to deal with the typical legal, technical, organizational, financial, strategic and political challenges. There are also openly articulated concerns about risks and cultural difficulties caused by the disruptive nature of the changes that smart government causes. This might lead to a lack of acceptance and thus reduced use of smart government processes. Unions and parties will have to be factored in as an important player. They will want to enforce the interests of civil servants, workers and citizens. They might even use the looming fear of total transparency to improve their negotiating position. Therefore and already at an early stage, a comprehensive change management is required for a successful implementation of smart government.

IX. Research Agenda with Open Research Questions

Starting from the outlined understanding of smart government as an intelligently networked government, there still remains the challenge of a further substantive concretization of a smart government research agenda. What is needed are proposals by science to approach the central questions of smart government and to answer the multiple outstanding issues of implementation at its best. This needs to occur in partnership with public administration, the business community and citizens.

In terms of design science, the focus lies on the design of smart and intelligently networked objects, cyber-physical systems and application scenarios for the public sector based on its demands. The first step is to clarify which types and uses of smart objects are suitable for the public sector. Secondly, the question arises, which and especially how trustworthy and reliable cyber-physical systems for the public sector could be built, linked, controlled, supervised and maintained [1]. Thirdly, it needs to be considered which existing smart objects like smart watches, smart phones, smart pads or smart televisions are already suitable for the fulfillment of tasks in state and administration. At the same time, it should be discussed to which limits their use is acceptable and where a disconnection would have legitimate reasons. The same questions must also be answered regarding cyber-physical systems, for example as early warning systems for government. The awareness for the potential of the Internet of Things and the Internet of Services for improving the public sector might also be advanced with further smart government scenarios. In the Internet of Services, services and functionality are provided as fine-grained software components and made available by the providers on demand. Here it is necessary to design software modules for the public sector and to ensure their openness and interoperability from the beginning.

From a legal perspective, it is necessary to examine whether there is already a sufficient legal basis for smart government in general and for the specific use of smart objects in the public sector in particular, and which practices are already enabled. Also from the cyber-physical systems perspective there are IT law and data protection issues. In addition, a regulation for the Internet of Things and the Internet of Services is needed. Taking into account the numerous unresolved legal issues, it is also important to determine the legislative demand for new laws required by the legislature and to concretize these with constructive proposals. In particular, it must be clarified whether a legal basis must be laid early with a “Smart Government Infrastructure Act" to open public authorities’ real creative spaces for innovation.

For the empirical research, the question arises whether there are people and groups that are currently already dealing with the topic of smart government and how they can be connected. What are their views regarding the further development and their influence? With the help of literature studies, observations and expert interviews, social scientists will come to conclusions regarding the question in which directions smart government can and should develop. It would also be worthwhile to work out proposals for a citizen-centric smart government, actively shaped by the citizens themselves.

X. Conclusion

In the beginning of 2016, neither "intelligently networked government" nor "smart government" are established mottoes in Europe. The specification of the terms "smart agencies", "smart governance", "smart civil officers" and "smart citizens" is just getting started. Visions for state and government on how to tap the potential of the Internet of Things and the Internet of Services are still missing. Federal, state and local governments should consider these issues in a multilevel working group and perhaps in a smart government cooperation to work out their own definitions. This does not happen yet. The step towards a comprehensive intelligent networking can only succeed through the dialogue of politics and administration with science, business and civil society. Definitively, all groups will be affected by the intelligent networking in government and administration. Moreover, they all want to bring in their ideas. This path should be taken rapidly, as the technological development makes further progress. The disruptive potential of smart objects and cyber-physical systems urgently creates a need for more intensive and substantial discussion and social discourse about smart government.

Under these conditions, it is a challenge for politics, administration, business and science to create, to build, to link, to control, to supervise and to maintain trustworthy and reliable cyber-physical systems for the public sector. Based on the

definitions, visions and first scenarios supporters and partners have to be found, goals to be agreed upon, work packages for a working plan to be put together, resources to be provided and prototypes to be developed. Human and financial resources should be provided appropriately where these are required for support and realization. A fundamental discussion "at zero cost" will not be sufficient because it would leave the achievement of meaningful progress to chance, making it dependent on the commitment of individuals and on the hidden agenda of the few sponsors, without taking the citizens and their interests seriously.

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