Government Information Quarterly 29 (2012) S121–S131

Contents lists available at SciVerse ScienceDirect

Government Information Quarterly

journal homepage: www.elsevier.com/locate/govinf

Digital Europe 2030: Designing scenarios for ICT in future governance and policy making

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ARTICLE INFO

Available online 11 September 2011

Keywords:
Information and Communication Technologies (ICTs)
Governance
Policy making
Research
Foresight
Scenarios
Modelling

ABSTRACT

The article outlines a set of visionary scenarios on how the European society could develop by 2030 by using advanced ICT tools and modelling techniques and integrating them into governance processes and policy making mechanisms. These scenarios have been designed through a foresight exercise conducted by the Institute for Prospective Technological Studies (IPTS) as part of the CROSSROAD Project, a support action of the European Commission's 7th Framework Programme. After presenting the conceptual framework and methodological approach followed, the scenario design framework developed and the resulting views of what the European Information Society might be by 2030 are presented. The article follows with a discussion of the implications of the scenarios design in terms of key areas of expected change and grand challenges to be addressed. It concludes by identifying policy challenges and proposing possible future research directions in the domain of ICT for governance and policy modelling needed to build a truly open Digital Europe twenty years from now.

1. Introduction

1.1. Background

This article is based on the findings of the Scenario Design exercise conducted by the Information Society Unit of the Institute for Prospective Technological Studies (IPTS)[1] as part of the CROSSROAD Project, an FP7 Support Action implemented during 2010.[2] The main goal of CROSSROAD was to build a roadmap for future research in the area of Information and Communication Technologies (ICTs) for governance and policy modelling.[3] This roadmap aims to provide: a shared vision that inspires collaborative and interdisciplinary research between academia, business, civil society and government; and a useful tool for the support and orientation of future policy-making. Overall, the research aimed to push the boundaries of traditional e-Government research and help resolve the complex societal challenges Europe is facing by applying ICT-enabled innovations and collaborative policy modelling approaches. For this purpose, it links very diverse research disciplines with practitioners' views and policy makers' concerns, through a multi-stakeholder and participatory approach (CROSSROAD, 2010a,b).

1.2. Justification

Today's internet is already a remarkable catalyst for creativity, collaboration and innovation, providing opportunities that would have been impossible to imagine just two decades ago. If one had predicted then that, in 2010, children would freely access satellite images of any place on earth, interact with people from everywhere and search trillions of data with a simple click on their PCs, one would have been taken for fool (European Commission, 2009b).

This research sets out to prepare a similar excursion into the future, by outlining a set of scenarios on how governance and policy making, supported and enhanced by the use of ICTs, could develop by 2030, in order to identify the policy challenges and research needs to be addressed. These efforts may also help the fool sound wise twenty years from now.

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[1] IPTS is one of the seven institutes of the European Commission's Joint Research Centre (JRC) (http://ipts.jrc.ec.europa.eu).

[2] CROSSROAD — A Participative Roadmap for ICT Research on Electronic Governance and Policy Modelling (http://www.crossroad-eu.net).

[3] According to the European Commission's 7th Framework Programme (Work Programme ICT 2009–2010) (European Commission and DG Research, 2009), ICT for governance and policy modelling joins two complementary research fields, which have traditionally been quite separate: the governance and participation toolbox which includes technologies such as mass conversation and collaboration tools; and the policy modelling domain which includes forecasting, agent-based modelling, simulation and visualisation. These ICT tools for governance and policy modelling aim to improve public decision-making in a complex age, enable policy-making and governance to become more effective and more intelligent, and accelerate the learning path embedded in the overall policy cycle (European Commission and DG-INFSO, 2008a).

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doi:10.1016/j.giq.2011.08.006

Four thought provoking scenarios are used to look at the future of ICT-enabled governance and develop a vision of the role of ICT research in shaping a digital European society in 2030.

2. Conceptual framework

2.1. Objectives and research question

The reasons for developing forward-looking analysis to support policy decisions stem primarily from the emergence of important science and technology applications and their wider implications for society. Science and technology interact with society in a complex way and their 'effects' are often neither immediate nor direct, but of second or third order and occur after a substantial time delay (European Commission, JRC-IPTS, and European Science and Technology Observatory (ESTO), 2001).

Policy-makers cannot afford to wait until situations are clarified and until the effects are evident before they take decisions. Though tomorrow's developments are uncertain they originate in conditions established today. Hence, there is an important need for policy-makers to scope the impacts of science and technology and how they may develop (Da Costa, Boden, Punie, and Zappacosta, 2003). Moreover, the growing knowledge-intensity, the pace of technological and societal change and the increasingly distributed and networked character of the economy and of governance processes cannot be explored using only technology-oriented future studies (Compañó and Pascu, 2005); a more comprehensive approach is required.

For this research, we therefore settled for scenario design aiming at exploring possible alternative futures in governance and policy making and to elaborate the possible impacts that future mainstreaming of ICT tools and policy modelling techniques may have on governance and policy making. Designing scenarios in fact relies on foresight methods, which calls upon a wide range of themes and stakeholder perspectives, in order to examine the social and economic aspects of future technological developments.

The aim of this article is to present and discuss the main findings of the scenarios analysis conducted by IPTS and based on a foresight exercise which included: 1) an analysis of the key areas of expected change in the domain of ICT-enabled governance and policy making to be placed in the context of various different future scenarios, and 2) envisioning, for each scenario, the risks and opportunities offered by ICT tools for governance and policy modelling techniques, as regards their contribution to overall EU policy goals.

Within this framework, the main research question underpinning this article is: *Taking into account the fact that possible future scenarios may be radically different, what ICT tools will be needed for future governance and policy making?*

The scenario design exercise resulted in four different scenarios which explore how governance and policy making could develop by 2030.

2.2. Methodological approach

Following the foresight tradition, CROSSROAD's scenarios design included an analysis of future needs, risks and opportunities under different conditions based on the current state of the art of the domain (CROSSROAD, 2010a). The resulting scenarios were then developed by means of narration (storytelling) of possible future outcomes in selected key domains of European society where the development of ICT tools for governance and policy modelling techniques are likely to have a major impact.

The scenarios, their formulation and interpretation, expose the gaps that exist today in research and what needs to be addressed in order to enable better governance and construct a more open, innovative and inclusive digital Europe tomorrow. Scenarios in fact are systematic visions of future possibilities. In foresight research, this usually means plausible possibilities that do not rely on extreme wild cards (Miles, 2003). They are used as tools for political or strategic decision making and to explore the future impact of particular decisions or developments (Janssen, van der Duin, Wagenaar, Bicking, and Wimmer, 2007). More specifically, Scenario building aims to identify uncertain developments in the future and include them as elements of the scenario narrative (van der Duin and Huijboom, 2008).

Scenarios serve the purpose of stimulating and informing the policy debate with reflections on possible, radical alternative scenarios. The scenarios method takes today's world and constructs images of possible future worlds, highlighting ways in which key uncertainties could unfold.

In addition to the description of the scenario context, for each scenario a specific 'storyboard' was developed in a structured manner. While a scenario describes an interaction example which illustrates the reference context that could develop in the future if a number of key dimensions and expected changes happen in a specific direction (i.e. a possible state of the future), storyboards (i.e. narrative representations of scenarios, like the ones used by film directors) may provide additional information that better describes possible real-life situations in which specific users (e.g. citizens, policy-makers, industry representatives, etc.) could find themselves. They provide a 'day-in-the-life' in the possible future contextual situations envisaged.

The approach to scenarios building rested upon a well consolidated 5-step methodology: 1) a trend analysis to determine the developments that could be key drivers for the future of ICT tools for governance and policy modelling techniques, 2) the selection of the scenarios by determining the main impact dimensions and key uncertainties, 3) writing of the scenarios, 4), identification of the implications of the scenarios by participants at the Experts' Workshop and by consulting the public and 5) deriving conclusions for policy implications and research challenges (European Commission, JRC-IPTS, FOR-LEARN, 2010).

In this regard, in order to formulate a set of key uncertain developments that may drive the future of governance and policy making, an analysis of main societal trends based on previous IPTS research (European Commission, JRC-IPTS, 2006, 2007, 2009a, 2009b, 2009c) was conducted. This trend analysis covers 5 main categories: social, technological, economic, ecological and public values, often abbreviated as STEEPV. The analysis includes an overview of stable and more uncertain trends (such as climate change, ageing and others) to provide the context for the scenarios.

This analysis was then complemented by a review f the main policy orientations on ICT for governance in Europe identifying relevant government trends and normative policy visions within Member States and across the EU as a whole on future public services (European Commission, JRC-IPTS, 2009c). This background information is needed in order to understand the societal and political context in which the more specific trends of ICT tools for governance and policy modelling techniques take place, and also to detect divergences and synergies between various ICT trends and current developments in the public sector.

Indeed, governments in Europe face an increasing number of challenges which are further reinforced by the financial crisis. The globalisation trend has limited governments' freedom to manage their national economies and new challenges such as ageing population and immigration seem to fundamentally affect the scope of public sector activities (European Commission, JRC-IPTS, 2009b, 2009c). At the same time, society's expectations of public service delivery have by no means diminished. Consequently, public administrations are under constant pressure to modernise their practices to meet societal demands on reduced budgets (Patrick et al., 2006).

In addition to this, based on the main findings of the review of the state-of-the-art of research in ICT for governance and policy modelling conducted as a preliminary component of the CROSSROAD project, the main impact dimensions and related emerging trends in the domain under investigation were identified (CROSSROAD, 2010a).

Overall, the trends analysis allowed us to define a list of impact dimensions which characterise the research domain and to identify common trends. These were clustered in broad cross-cutting categories across different research areas, defined as key impact dimensions and grouped into two main categories according to the contribution that the main elements of each research area are expected to provide in terms of opening up governance processes, while ensuring transparency; or in terms of integration of policy intelligence mechanisms and systems enabling a better data and knowledge management.

The reason for choosing these two broad categorizations is that the main assumption on which the overall domain of ICT for governance and policy modelling research is based is that novel ICT solutions could enable better governance and evidence-based policy making, through integrating and exploiting data and knowledge management capacities. This however also requires further advances in other complementary research areas, such as defining appropriate legal and regulatory frameworks and mechanisms, as well as more fundamental shifts in the organisational and societal structures which underpin the movement towards more open, transparent and integrated policy-making systems.

In sum, the Scenario Design adopted as part of the CROSSROAD's foresight exercise is: 1) evidence-based, as it builds on the trends emerging from a policy review and trends analysis and the assessment of the state-of-the-art of research in ICT for governance and policy modelling; 2) expertise-based, as it includes the views of experts gathered through a call for expert contributions and further discussion held during an Expert Workshop to validate the scenario design framework; 3) interactive, as it incorporates the inputs from the Expert Workshop and from online public consultation; and 4) creative, as it is based on the 'creative-thinking' that came out of a series of brainstorming activities by members of the IPTS lead team and other experts. As such it comprised the different kinds of source of knowledge (expert-based, creativity-based, and evidence-based) discussed by Popper (2008).

3. Scenarios design

3.1. Scenario design framework

The scenario design developed as part of the research aims to provide a structured framework for analysis of current and future challenges related to research on ICT tools for governance and policy modelling techniques (CROSSROAD, 2010b).

Instead of attempting to forecast several future ICT-enabled scenarios, we chose to define four internally consistent – but radical – views of what the future European Information Society might look like in 2030, and what the implications of each scenario could be for citizens, business and public services. The aim is to present clues and key impact dimensions, thus increasing the ability to foresee possible development paths for the application of ICT tools for governance and policy modelling techniques. Thus risks can be anticipated and better preparation can be made to take advantage of future opportunities. The pace at which the elements of the visions unfold will, however, be influenced by the speed of change of the overall technological landscape and societal context. More specifically, the uncertainties underlying the scenarios design are: 1) the societal value system we will be living in (more inclusive, open and transparent or exclusive, fractured and restrictive), and 2) the response (partial or complete, proactive or reactive) to the acquisition and integration of policy intelligence techniques in support of data processing, modelling, visualisation and simulation for evidence-based policy making. Accordingly, the key impact dimensions were classified on two axes: Degree of Openness and Transparency (Axis Y) and Degree of Integration in Policy Intelligence (Axis X) (see Fig. 1).

The vertical axis indicates the degree of openness and transparency in a society, in terms of democratic and collaborative governance that could be further enabled by ICTs. The most open and transparent society would be one where even traditional state functions are completely replaced by non-state actors, through opening-up and linking public sector information for re-use (Misuraca, 2009b). The openness paradigm is also expected to apply to the research and business community which could benefit from open innovation and social/business networks of collaboration, where users are co-creators of products and services delivered globally via peer-to-peer social networks based on reputation and trust (European Commission, JRC-IPTS, 2009a). An important aspect will be the regulatory and technological solutions, and also the socio-cultural attitudes to the basic digital rights underpinning the future Information Society. In fact, the concept of openness is not strictly related to technological solutions, but rather to socio-cultural and organisational aspects that can be enabled and supported by technological advancement (Misuraca, 2009a).

The horizontal axis concerns Integration in Policy Intelligence (i.e. the degree of integration of data and knowledge and the way in which collaboration between all stakeholders in policy-design and decision-making mechanisms is enabled). This involves the

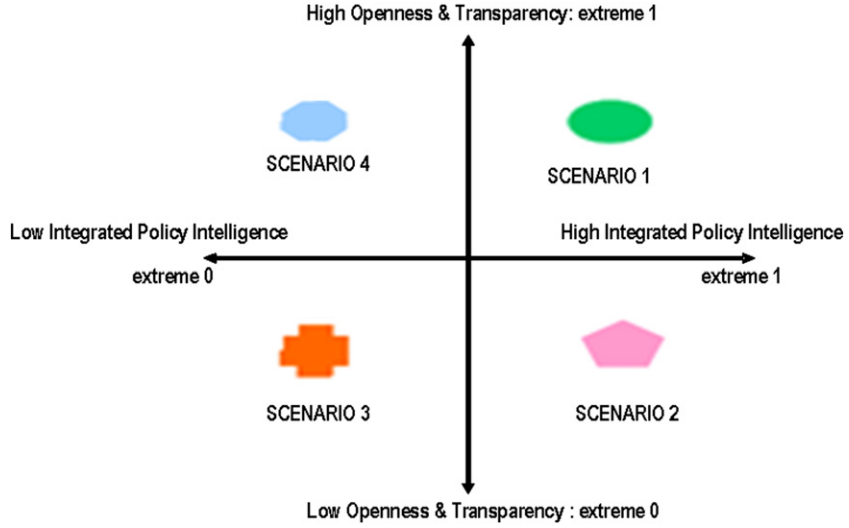

Fig. 1. Scenario design framework.

possibility to mash-up data and information available from different sources in an 'intelligent way' (meaning efficient, effective and able to generate public value). It also involves the extent to which users, individually or as members of formal and informal networks, can contribute to the co-design of policies, simulating and visualising the effects of legal and policy decisions, and engage in real-time monitoring and prior assessment of possible expected impacts at local, regional, national and pan-European scale. This axis is also associated with the capacity and willingness of policy actors to share power and change decision-making mechanisms in order to facilitate the redefinition of basic democratic freedoms in a collaborative fashion. This could go to the extreme of redesigning the traditional mission of the State and the role played by governance stakeholders. Again, ICTs are not the driving force; changes in social values, attitudes and shifts in terms of information management, knowledge sharing (experts vs. non expert networks, for example) and allocation of resources will guide this process.

3.2. Scenarios for Digital Europe 2030

The scenarios for the future of governance and policy making of Digital Europe 2030 are presented in Fig. 2. The four scenarios were named according to their positions on the two axes of the scenario design framework, as follows:

1) Open Governance: characterised by High Openness and Transparency and High Integration in Policy Intelligence.
2) Leviathan Governance: characterised by Low Openness and Transparency and High Integration in Policy Intelligence.
3) Privatised Governance: characterised by Low Openness and Transparency and Low Integration in Policy Intelligence.
4) Self-Service Governance: characterised by High Openness and Transparency and Low Integration in Policy Intelligence.

In the Open Governance Scenario, users are expected to enjoy unprecedented access to information and knowledge. By shifting cognitive capacities, the work of memorising and processing data and information will be passed onto machines, while humans could focus on critical thinking and developing new analytical skills (Williams, 2005). This may enhance collective intelligence (both human and ICT-enabled). Humans may be able to use policy modelling techniques to help solve global challenges. Possibilities for the provision of personalised and real-time public services shall be opened up (Misuraca, 2009a). The online engagement of citizens and various governance stakeholders could increase. Citizens, businesses and researchers would have direct access to data they need and this could create new opportunities for people to interact with and influence governance and policy-making processes and make progress in solving societal problems. Governance processes and policy-making mechanisms could benefit of ICT-enabled simulation and visualisation intelligent systems, able to find meaning in confusion and solve novel problems, independently of human-acquired knowledge. New, open ways of producing and sharing knowledge may radically change traditional governance and decision-making. Public, private and third sector institutions would start to listen more carefully to their stakeholders, and a sort of 'molecular democracy' (Kacser and Burns, 1979) may arise.

The Leviathan Governance Scenario assumes that an 'enlightened oligarchy' could emerge that uses high-tech tools and systems to

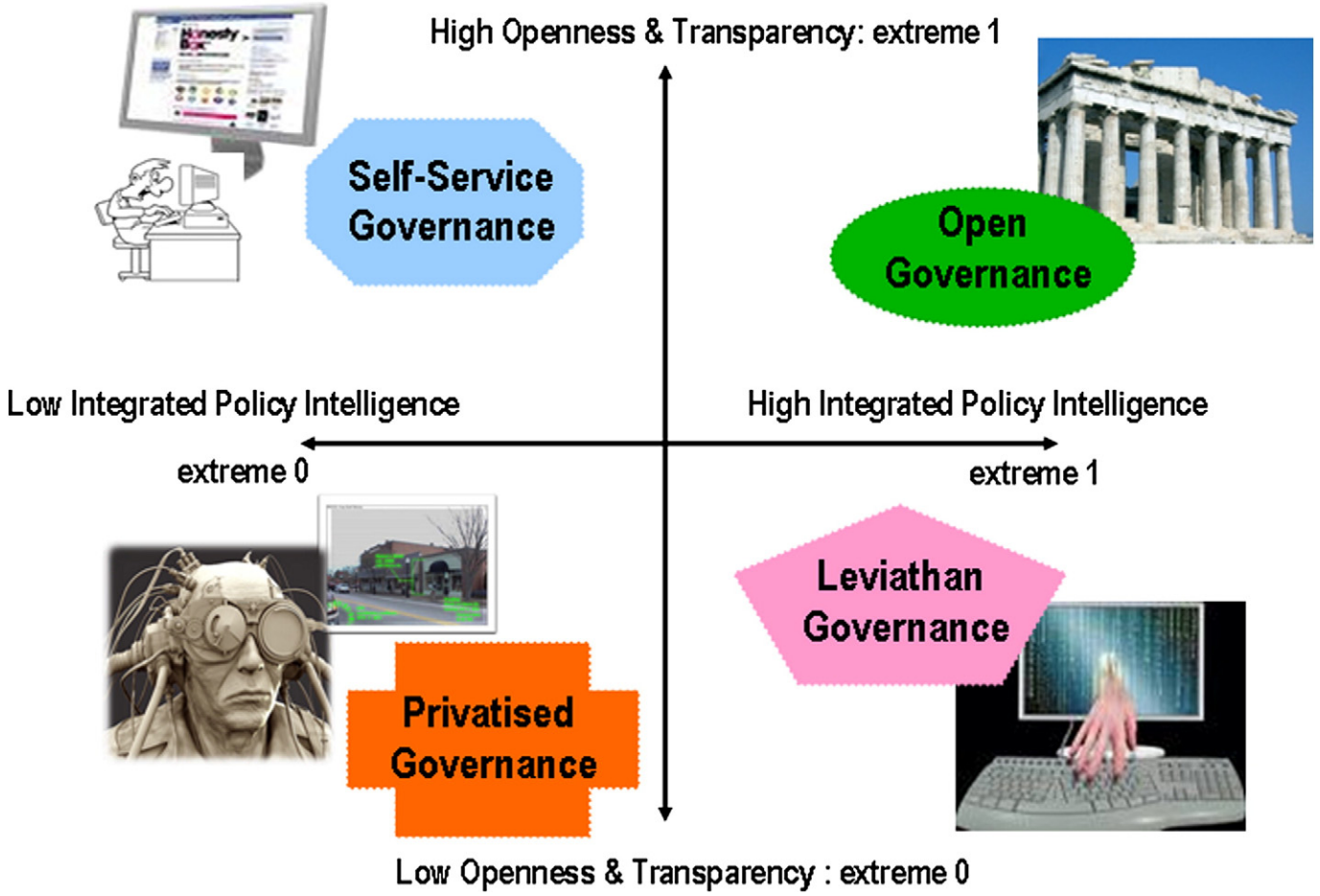

Fig. 2. Scenarios for Digital Europe 2030.

collect and manage public information and services. Judgement and decision-making would be based on analytical processing of factual information from the many by the few for the benefit of all (Slot, 2007). Full-scale 3D automatic simulations and policy intelligence tools may facilitate decision-making and the oligarchs could simply approve the recommendations of these tools for the best policy option for the majority of citizens. 'Real-time governance' would be possible, where the government/citizen relationship is under total control. Public service delivery may be personalised without people having to ask, thus saving a great deal of time. In this context, citizens would trust the government and could be willing to delegate their right of initiative. Generally, they may be persuaded to be happy with this situation, as no human-caused problems shall exist; emotions and thoughts could be controlled and directed towards the public good. However, citizens would be passive recipients of decisions taken by information systems (Rethemeyer, 2006); choice would be restricted by predefined and pre-calculated algorithms that optimise people's performance from the cradle to the grave. No active participation by citizens in everyday decision-making would be required or sought (Kerr and Mann, 2006). In this scenario, circulation within Europe and across its borders would be greatly limited. Information overload or potential failure of information systems to respond to critical, unforeseen situations may result in chaos, with humans and devices not knowing how to respond (Garfield, 2009; Wright, 2005).

In the Privatised Governance Scenario, society could be shaped by decisions taken by corporate business representatives. Discussion on social issues and about the role and behaviour of citizens may be muted, as people shall be pawns whose needs and desires would be managed by large corporations. Interactive and participatory governance mechanisms could be sidelined, along with democracy as we know it today (Rethemeyer, 2007). Decision making would depend on ICT-enabled modelling and decision-support systems, which could be highly developed by individual companies. Simulations based on data gathered by sensors and collected from continuous monitoring and analysing networks, businesses, customers and the environment could produce global information that would nonetheless be disjointed as it would be owned by individual corporations. Systems may be threatened by frequent attacks from independent groups and dissident communities. Misinformation and jamming campaigns could be launched, making it necessary to verify all information and data. In this scenario, there may be opportunities for high innovation and technological development due to the pressure of competition on a free market. However, risks may arise due to private interests of the public good, leading to a 'fragmented society' where social welfare services may not be guaranteed to all, thus exacerbating possible social tensions and conflicts.

The Self-Service Governance Scenario envisages a society where citizens could be empowered to play the role of policy makers. In small expert communities, citizens would devise policies according to the do-it-yourself principle; they may choose from a menu of public services those they need and consent to (Misuraca, forthcoming). This ICT-enabled, self-organised society would be able to address emerging problems faster than traditional government could. Its creative, contextual solutions could prove to be more robust and resilient in a crisis. Nevertheless, the diversity of opinions between discrete communities may result in the deepening of existing divides and a lack of social cohesion. Insularity may afflict migrant and ethnic minorities most severely, as they lack local social networks and may run into communication problems due to language and cultural differences. However, thanks to efficient translation tools, the dissipative communities may, in the end, create a vibrant cross-cultural and multi-language society. The difference between success and failure would be marked by the distinction between effective and creative group thinking and 'crowd stupidity' and lack of knowledge transfer. The process of gradual disappearance of institutions and lack of trust in government could result in the need for new trust providers. Reputation management, for content and people, would play a significant role in service provision. As the majority of citizens may not be interested in participating in governance due to the lack of engagement culture, new Caesars may emerge who unify disparate groups but damage the subtle equilibrium between self-serving and collaborative cultures.

4. Discussion

4.1. Key areas of expected change

The importance of scenarios design, it must be pointed out, does not rely on the characteristics of each scenario per se. Neither is of uttermost importance to assess which scenario is more likely to occur or which is the most desirable. No doubt there is always one scenario that appears to be more desirable than others. In the case of CROSSROAD the implicitly desirable scenario is that of open governance. From a more detached and scientific perspective scenarios must be taken as a way of framing uncertainties and of collectively identifying all the relevant impactful future developments. It would be naïve to believe that given a desirable scenario we then define specific action to make it happen. This would be a contradiction with respect to the epistemological premises of foresight. The future will occur in ways that will not match any of the four CROSSROAD scenarios or any other scenarios that might have been built. This future will have elements from all the four scenarios and the purpose of the latter is to increase the likelihood to capture collectively as many as possible of such elements. It is, thus, of no interest here to look individually at each of the scenarios and we are rather interested in considering them collectively to highlight some important dimensions of expected change, which in the next section we discuss critically before identifying the main policy challenges and future research directions.

4.1.1. Enabling technological conditions

The four scenarios collectively tell us that in 2030 society and governance structures could be radically different due to unprecedented growth and speed of ICT uptake in several fields and the impact of this uptake on policy making. The groundwork in place for years now should yield innovation in the near future (Pew Internet, 2010a). More powerful devices, even cheaper netbooks, virtualization and cloud computing, reputation systems for social networking and mass collaboration tools, as well as the proliferation of sensors, reporting and decision-support systems, sophisticated algorithms for processing data and performing statistical simulation and analysis, visualisation tools to report results of these analysis, affective technologies, personalised and location-aware services and others are expected to become reality and mainstream in the next 10–20 years. Predictable pathways of information are changing: the physical world itself is becoming a type of information system (European Commission, JRC-IPTS, 2003b). In addition to this, more objects are becoming embedded with sensors and gaining the ability to communicate. The resulting information networks promise to create new opportunities, improve governance processes, and reduce the costs and risks of policy decisions. In what is called the Internet of Things, sensors and actuators embedded in physical objects are linked through wired and wireless networks. These networks churn out huge volumes of data that flow to computers for analysis. When objects can both sense the environment and communicate, they become tools for understanding complexity and responding to it swiftly. What is revolutionary in all this is that these physical information systems are now beginning to be deployed, and some of them even

work largely without human intervention (European Commission, 2009b). Massive increases in storage and computing power, some of it available via cloud computing, make number crunching possible on a very large scale and at decreasing cost (Chui et al., 2010). Future applications are opening up huge opportunities for private and public sector organisations alike. Despite the fact that many of the technologies which underpin the future internet infrastructure are not new (e.g. Radio Frequency Identification, sensor networks, GRPRS, UMTS-HSDPA and Near Field Communication), the conditions for their application may result in innovative and disruptive usages (Pew Internet, 2010a). This innovation could support many public policies, such as logistics, security, transport, environment and energy, education and health, and others (Medaglia et al., 2010).

4.1.2. The openness and mass collaboration alleged consequences

The most important impact that the power of ICT may have (elicited from CROSSROAD scenarios) is in the increasing openness and possibility for mass collaboration and participation, which in turn is expected to – eventually – change radically governance models. As was already envisaged a decade ago (Kuhlman, 2001), CROSSROAD researchers and consulted experts and stakeholders picture a future of distributed policy-making and intelligence where it is assumed that openness of governance systems and integration of policy making mechanisms can harness collective intelligence, building on the knowledge, experience, and competence of various actors. Whichever scenario dominates in the future, in the coming years, conventional wisdom and familiar governance models will be challenged as ICT-based disruptions impinge on democratic and consultative policy-making processes. Evidence already gathered anticipates that the scope and scale of transformation could have a major impact on society (Broster, 2007). Since 2005, in fact, there has been a phenomenal growth in mass, on-line collaborative applications, which has captured the imagination and creative potential of millions of participants — particularly the younger generations. In addition to new forms of leisure pursuits, community-building activities have also entered the political arena as witnessed in a number of national elections (European Commission, JRC-IPTS, 2009a, 2009c). Online communities can leverage considerable human knowledge and expertise and rapidly build their capacity. Advanced tools – possibly building on gaming and virtual reality technologies – would enable citizens to track the totality of decision making processes and see how their contributions have been (or are being) taken into account. Opinion mining, visualisation and modelling into virtual reality-based outcomes and scenarios could help to shape, guide and form public opinion. It is now recognised that online collaboration has the potential to trigger and shape significant changes in the way future societies may function. Extrapolation of the present exponential growth leads to scenarios where a very large percentage of the population could, if equipped with the appropriate ICT tools and capacities, simultaneously voice opinions and views on major and minor societal challenges (Tapscott and Williams, 2006). Hence, these tools may herald the transition to a different form of dynamically participative governance models. At the same time increasing demand from the scientific and business community, and from civil society organisations and citizens groups, could drive the emergence of ICT applications to exploit the full value of the mass collaboration and the open and participatory paradigm underpinning the technological developments and governance directions in Europe.

4.1.3. The corollary: more data and better processing to improve policy-making

The corollary of the enabling conditions and their main impact is that there will be a growing amount of data and of computing power that, through advancement in modelling techniques, may produce a quantum leap in our capacity to support policy making with real time, robust, evidence bases insights. This could happen not simply as a result of the work of traditional 'experts' (scholars, policy analysts, and policy consultants) but as a collaborative and participative effort of potentially all citizens.

Governments traditionally collect, process and store significant quantities of data. In the future, the relationships may change and businesses and citizens could be in a position to 'authorise' access by governments to their own 'data spaces' that they control and update. Such a scenario would result in a 'private shared space' jointly accessed by data users and data providers (Reutter, 2005). These shared spaces will require extremely robust access rules and procedures and hence new technologies that ensure privacy and data protection (European Commission, DG-INFSO, 2009).

4.2. Grand challenges/uncertainties

CROSSROAD used the scenarios design to identify gaps in research and also in policy and institutional settings by comparing elements envisaged in the scenarios with the current state of play. Below we only selectively build on this gap analysis and add to it additional considerations in order to highlight challenges still to be solved for the future of ICT-enabled governance and policy modelling to take place.

We see three broad challenges. The first two relate to uncertain and unclear institutional settings that need to be investigated also through innovative analytical approaches (including new modelling techniques). The third is a meta challenge concerning the data gathering and processing in their own right.

4.2.1. Security and privacy issues

The internet was not originally designed to serve massive scale applications with guaranteed quality of service, security, and privacy (Zittrain, 2008). Legal and regulatory issues such as digital rights, privacy and data protection are of strategic importance for the actual unfolding of the various elements of the envisaged scenarios (Hildebrandt, 2009). For example, an ever-increasing openness of ICT-enabled governance and policy modelling mechanisms with large amounts of data and transactions processed may create incentives for malicious use of data and information. The challenges include, for instance, the design of identity management systems capable of dealing with billions of entities, and their different roles in the governance sphere, the trustworthiness and control of distributed applications based on services offered through open service delivery platforms, and the secure and trusted interaction with real-world objects and entities through sensors and actuator network infrastructures (Pew Internet, 2010a). More specifically, for example, the emergence of wireless networks could allow software applications and physical objects to be connected, opening up a wide range of stimulating new application scenarios in governance and policy making (Feijoo et al., 2009; Jaokar and Gatti, 2009). At the same time, however, the same openness underpinning their mass-development and usage will expose sensor networks and related information and content to possible attack and misuse. Security technologies exist but the challenges concerns identity management and privacy issues are above all a matter of regulation and of actual behaviours. The application of the insights of behavioural economics to issue of privacy and security has shown that individuals in this domain have inconsistent and non-transitive preferences and are forced to rational ignorance due to information overload and unclear understanding of costs and benefits (Acquisti and Grossklags, 2008). Traditional policy approaches focussed on information provision are ineffective and different interventions on the holders of data and on those engaged in secondary re-usage would be needed to ensure fundamental democratic rights are not violated. Simulations and modelling exercise using the insights of behavioural economics and

applying different policy intervention scenarios are needed to chart how the issue of security and privacy may evolve in the future and to what extent it can be conducive or not to the advent of a fully open and participative, but secure and privacy friendly, society.

4.2.2. Governance issues

Governance is above all a matter of institutional and quasi-institutional settings that cannot be radically changed only as a result of new ICT possibilities. In the 1990s internet enthusiasts heralded the advent of flat organisations and the fading way of vertical bureaucracy. In the 2000 with the mounting rhetoric of e-Government we were told about the advent of provisions of services around citizens needs instead of vertical silos, networked governance through ICT, and many more. With the exception of few successful cases of joined up delivery entailing institutional restructuring, governments and public administration in Europe are by an large still designed and functioning in exact the same way as the 19th century model of Weberian bureaucracy. The reason being that in a democratic system this remains so far the only codified manner of assigning accountability and responsibilities along well-defined vertical jurisdiction. Still today, no matter how much mass participation and collaboration there might be, if something goes wrong in the management of a public utility causing material damages and even loss of human lives those bureaucratically in charge remain accountable and, if need be, prosecutable according to law, and not the citizens that may have collaborated in gathering the wrong information. While this is just an exaggerated provocation, what we want to convey is that, it is one thing to imagine that ICT will challenge existing governance model, and it is a radically different thing still under-investigated to envisage what new institutional, quasi-institutional, and legal provisions may actually define and codify the new governance models that ICT does indeed make possible. In principle it is expected that the role of government will shift from being a central steering entity to that of a moderator of collective decision-making processes (Rossel et al., 2009). However, in order to perform this role effectively, all stakeholders should be able to contribute to the policy directions commonly agreed, and governments need to be capable of setting up a shared platform for policy intelligence, where modelling techniques – if actually supported by ICT – can be crucial for improving governance and policy making processes. But before such platform for policy intelligence is set up other important issues are still unclear and even little researched. Currently, we do not have appropriate governance models and supporting legal and institutional codification, process flows, or analytical tools with which to properly understand, interpret, visualise and harness the forces that could be unleashed. Present government processes (local, regional, national and EU level) provide laws and regulations, interpret and define societal norms and deliver societal support services. Their legitimacy is derived through democratic processes combined with a requirement for transparency and accountability. In a world that is increasingly using non-physical communication and borderless interaction, the traditional roles and responsibilities of public administrations will be subject to considerable change and classical boundaries between citizens and their governments will become increasingly blurred (Pew Internet, 2010b). The balance of power between governments, societal actors and the population will have to adapt to these challenging new possibilities. Inherent in this process is the definition and realisation of new, carefully crafted ICT-enabled governance models. These will have to demonstrate transparency, earn people's trust and be devoid of manipulation (Picci, 2011).

4.2.3. Data and models gaps

As we are considering developments that may change how policy making and decision making with implications for the collective good will take place we must remind ourselves that we are dealing with socio-economic issues far more important than network requirements and technological applications and pertaining to the broadly defined field of human and social sciences. The concept of distributed policy-making and intelligence (Kuhlman, 2001), with open governance and integration of policy intelligence to harness collective intelligence, realised into a 'distributed platform' based on ICT-enabled policy modelling (appropriately supported by participative and user-friendly simulation and visualisation tools), may prove to be instrumental to further implement policies and achieve socio-economic impacts. This would generate a 'cascade' of public and private decision-making on society's course of change and affecting the interactions that precede formal policy-making processes. Yet, socio-economics as a multi-disciplinary field, which cuts across all research areas of the ICT for governance and policy modelling domain has manifold research challenges. The first of these challenges is that availability of large amount of data and computational modelling are far less widespread than in the natural science. The much heralded shift in evidence-based policy making, which ICT for governance and policy modelling should further boost, in the domain of socio-economics hit against the hard wall of lack of data, and/or not consolidated approach to use and treat new sources of qualitative and quantitative data (i.e. from web 2.0 and social networking sites applications), and/or little integration between traditional modelling and quantitative analytical tools with the new modelling approaches that ICT make possible. Whereas the fast growth and massive uptake of Web 2.0 services are considered a source of deeper socio-economic impacts, the signs of these impacts are not clear yet. In fact, despite the rise of Web 2.0 applications and its fast growth and pervasiveness, it is still quite difficult to capture the phenomenon and 'measure it' or even just building an empirically sound case for assessing specific impacts and its potential policy-relevance. Evidence of impacts of Web 2.0 on our society is largely anecdotal and in most cases not systematically gathered and analysed. Existing metrics are not able to make sense of the transformations enabled by these emerging technologies as the changes they convey seem to be more behavioural and cultural than primarily ICT-driven (Misuraca et al., 2011).

5. Conclusions

5.1. Policy challenges

The scenarios developed aimed to define how the advancement of ICT tools for governance and the integration of policy modelling techniques could affect governance and policy making twenty years from now, so as to identify what research is needed and which policies should be promoted. Indeed, challenges in the emerging domain of ICT for governance and policy modelling are huge and complex and cannot be dealt with in isolation. In this regard, there is also a strict relationship with the broader task of envisioning and developing the future internet. Emerging technologies like streaming high quality video and running 3D applications, or, in our specific domain, applications that enable mass collaboration, data processing, simulation and visualisation through complex modelling, face severe constraints as regards running seamlessly anytime, anywhere, with good quality services.

European scientists have proved they are at the forefront of ICT research since the invention of the web and throughout the rapid technological developments of the last 20 years (European Commission, ISTAG, 2009). It is now time to bring together different research disciplines that could help us benefit from the opportunities of ICT for better governance and policy modelling, and at the same time overcome the possible risks to society of mainstreaming large scale applications in this domain. Additionally, and from a technological infrastructure perspective, we should remember that the current

internet, as a ubiquitous and universal means for communication and computation, despite being extraordinarily successful so far, has a series of inherent unresolved problems. It is expected that it will soon reach its limits as regards both architectural capability and capacity (European Commission, 2009b).

The future development of internet infrastructure will be supported by complementary advancements in technological applications that are now consolidated trends and expected to grow even faster. However, while technologies will be developed to address the technological challenges linked to security and privacy concerns, additional risks to trust arise, mainly due to its potential pervasiveness, large scale and involvement of users.

In brief, the opportunities provided by future ICT tools for governance and policy modelling for individuals, businesses and governments are huge but they could only be taken if appropriate conditions and 'governance models' are developed. In fact, it is expected that ICT tools for governance and policy modelling techniques will force change in institutions, no matter how resistant they are. And even if it could be predicted that governments that redefine their relationship with their stakeholders will be the ones to succeed, the market will still drive that process in the commercial domain, and tensions may emerge as stakeholders know more and more about the organisations that are trying to serve them (Pew Internet, 2010b).

In this connection, following the analysis of the underlying risks and opportunities of each scenario, we have depicted the key policy challenges that must be tackled if the benefits of ICT solutions for governance and policy modelling are to be fully realised. These include:

- Early adopters will need to prove that tools and applications support innovative business models and create public value.
- Government regulators and industry groups should strengthen data privacy and security, particularly for uses that touch on sensitive data belonging to citizens and government.
- Governments and industries, with the support of risk analysts, should devise legal liability frameworks for eventual wrongs generated by automated systems.
- The cost of such applications must fall to a level that sparks widespread adoption. Networking technologies and the standards supporting them must evolve to the point where data can flow freely and with minimum friction between real and virtual environments.

5.2. Needed directions for future ICT research

As a conclusion of our analysis, we identified the future research directions needed to harness the potential of ICT tools for governance and policy modelling techniques in support of the policy challenges defined above. These include the following:

- Information management and analysis to monitor and simulate in real time the behaviour of real and virtual entities (people, things, information and data): as future ICT networks will link data from any object and person, or the operating environment they are placed in, they will generate better information and analysis, which can enhance decision making significantly. Some organisations are starting to deploy these applications in targeted areas, while more radical and demanding uses are still in the conceptual or experimental stages. For example, when objects are embedded with sensors, companies can track the movements of these objects and even monitor interactions with them. ICT applications can be fine-tuned to take advantage of this behavioural data. Applications may be developed in various governance domains to support social care policies, transport, energy or others. In addition to this, ICT tools and technologies could be developed to animate large-scale societal simulations that forecast potential outcomes and impacts of proposed policy measures (Codagnone and Osimo, 2010). These could include simulating the impacts of the movement of people, commuters, goods and services, jobs, costs, benefits, social impact and resulting social burdens. The public sector could use these tools to examine options based on the simulated behaviour and wishes of individuals, groups or society as a whole to understand the possible outcomes of policy proposals, legislation, and implementation processes (European Commission, DG-INFSO, 2008b).
- Enhanced real-time situational awareness for tracking, policy modelling, and visualisation: data from large numbers of sensors, deployed in physical infrastructure (such as roads and buildings) can report on environmental conditions and give decision makers a heightened awareness of real-time events, particularly when the sensors are used with advanced display or visualisation technologies. In addition, the range of possible uses for tracing and tracking technologies is also expanding. For example, the use of advanced ICT tools for tracking could be used for security and to optimise transport planning and implementation, preventing and managing eventual disasters to reduce environmental impact. Security personnel can use sensor networks that combine video, audio, and vibration detectors to spot unauthorised individuals who enter restricted areas. Some advanced security systems already use elements of these technologies, but more far-reaching applications are being developed as sensors become smaller and more powerful, and software systems more adept at analysing and displaying captured information. Logistics managers for airlines and transport companies are already tapping into some of the early capabilities and are getting up-to-the-second knowledge of weather conditions, traffic patterns, and vehicle locations. In this way, these managers are increasing their ability to make constant routing adjustments that reduce congestion and therefore costs and increase a network's effective capacity. In particular, research in the area of processing and management of the vast reserves of Europe's public sector collective data and knowledge resources should be promoted (European Commission, DG-INFSO, 2009).
- Policy intelligence and ICT-driven decision analytics: the future internet infrastructure is expected to support longer-range, more complex human planning and decision making. The technology requirements -tremendous storage and computing resources linked with advanced software systems that generate a variety of graphical displays for analysing data increase accordingly. In health care, for instance, sensors and data links offer possibilities for monitoring a patient's behaviour and symptoms in real time and at relatively low cost, allowing physicians to better diagnose disease and prescribe tailored treatments. Patients with chronic illnesses, for example, have been fitted with sensors in a small number of health care trials currently under way, to monitor their conditions continuously as they go about their daily activities. One such trial has enrolled patients with congestive heart failure. These patients are typically monitored only during periodic visits to the physician's office for weight, blood pressure, and heart rate and rhythm. Sensors placed on the patient can now monitor many of these signs remotely and continuously, giving practitioners early warning of conditions that would otherwise lead to unplanned hospitalizations and expensive emergency care. Better management of congestive heart failure alone could reduce hospitalisation and treatment costs by a billion Euros annually in the EU (Codagnone, 2011). In this context, semantic web applications to access and visualise background knowledge repositories to the public, as well as the optimisation of ICT tools to facilitate automated translation, process modelling, data mining, pattern recognition and visualisation and other gaming-based simulation, forecasting and back-casting, and goal-based optimisation techniques should be promoted.

- Automated mass collaboration platforms and real-time opinion visualisation: here, ICT tools and technologies build on and extrapolate from social computing and future collaborative technologies, to facilitate bottom-up, user-controlled, massive social collaboration and networking applications. They incorporate mixed reality applications based on semantic cooperation platforms that traverse language and cultural interpretation thereby enabling multi-national groups to create, learn and share information and knowledge (European Commission, 2009a). Also ICT tools to embody structural, organisational and new collaborative governance models and processes that enable groups to form, engage, create, learn and share group knowledge creation should be promoted. Citizen participation implies the ability to track the whole public sector decision-making process and see whether and how their contributions have been considered. Complementary ICT tools to support virtual community opinion forming, incorporating: simulation, visualisation and mixed reality technologies, data and opinion mining, filtering and consolidation should also be developed. These ICT tools should, however, address identity management and authentication systems to ensure delineation of constituency domains where appropriate, in order to protect citizens' privacy (European Commission, ENISA, 2010). The scale and complexity of the governance action, and how it intertwines technically with various stakeholders in society, set quite unique requirements for trust and liability, prevention of unauthorised access, misuse and fraud. ICT tools must therefore be able to deal with multiple identities, pseudonymity, authentication, secure data disposal, and other issues related to our *Digital Personae*.
- ICT-enabled data and process optimisation and control: making data the basis for automation and control means converting the data and analysis collected through virtual machines into instructions that feed back through the network to actuators that in turn modify processes. Closing the loop from data to automated applications can increase the efficiency and effectiveness of governance processes and service delivery, as systems that adjust automatically to complex situations make many human interventions unnecessary. Early adopters are ushering in relatively basic applications that provide a fairly immediate payoff. Advanced automated systems will be adopted by organisations as these technologies develop further. For example, the deployment of the future internet infrastructure is opening up new frontiers for improving processes. Some industries, such as chemical production, are installing legions of sensors to bring much greater granularity to monitoring. These sensors feed data to computers, which in turn analyse them and then send signals to actuators that adjust processes — networked sensors and automated feedback mechanisms can change usage patterns for scarce resources, including energy and water, often by enabling more dynamic pricing. Utilities such as ENEL in Italy and Pacific Gas and Electric (PG&E) in the United States, for example, are deploying 'smart' meters that provide residential and industrial customers with visual displays showing how much energy they have used and the real-time costs incurred (Chui et al., 2010).
- Complex dynamic societal modelling systems: the most demanding use of computing capacities in the future will involve the rapid, real-time sensing of unpredictable conditions and instantaneous responses guided by automated systems. This kind of machine decision making mimics human reactions, though at vastly enhanced performance levels. The automobile industry, for instance, is stepping up the development of systems that can detect imminent collisions and take evasive action. Certain basic applications, such as automatic braking systems, are available in high-end cars. The savings that could be made through accident reduction, if this application were widely deployed, could exceed 100 billion Euros annually. Some companies and research organisations are experimenting with a form of automotive autopilot for networked vehicles driven in coordinated patterns at highway speeds. This technology would reduce the number of 'phantom jams' caused by small disturbances (set off, for example, by suddenly illuminated brake lights) that escalate into traffic bottlenecks. Scientists in other industries are testing swarms of robots that could maintain facilities or clean up toxic waste. They are also studying systems for the defence sector which would coordinate the movements of groups of unmanned aircraft. While such autonomous systems will be challenging to develop and perfect, they could improve safety, reduce risks, and cut costs. These experiments could also spur fresh thinking about how to tackle tasks in inhospitable physical environments (such as deep water, wars, and contaminated areas) that are difficult or dangerous for humans. Some of these technologies are expected to reach the adoption phase in the next few years. As they mature, the range of deployments to support governance and policy-making will increase. Research should therefore be promoted across various disciplines in order to structure ideas about the potential impact and opportunities likely to develop in the future. This will involve, for instance, the need to improve software to aggregate and analyse data, as well as graphic display techniques, to the point where huge volumes of data can be absorbed by human decision makers or synthesised to guide automated systems more appropriately (Thomas and Cook, 2005).

In conclusion, it can also be observed that the increasing demand from the scientific and business community, and from civil society organisations and citizens groups, could drive in the near future the emergence of 'experimentally-driven research', to address broad governance and policy-making challenges. This would eventually allow the testing of new ICT-based solutions and models for collaborative governance and participatory policy modelling, and socio-economic impact assessment of future societal changes.

This last issue entails building on the momentum that the domain of ICT for governance and policy modelling has recently gained, by further developing the research community. In order to bridge the gap between various stakeholders and long-term research and large-scale experimentation, enabling cross-fertilisation across different scientific disciplines and integration of resources, special emphasis should be put on fostering common research results.

This will create value for the EU, avoiding fragmentation of research efforts and it should also include the experiences gained at the international level. This requires developing a joint strategic research agenda, on ICT for governance and policy making to support the building of an open, innovative and inclusive Digital Europe in 2030.

Conflict of interest

The views expressed in this article are purely those of the authors and may not in any circumstances be regarded as stating an official position of the European Commission.

Acknowledgments

This article is based on research conducted by the Information Society Unit of IPTS as part of the CROSSROAD Project — A Participative Roadmap on future research on ICT for governance and policy modelling, an EU FP7 Support Action conducted by the consortium composed of: National Technical University of Athens, Tech4i2 Ltd, University of Koblenz Landau, EPMA and the European Commission's Joint Research Centre IPTS (http://www.crossroad-eu.net). The authors would also like to thank all partners of CROSSROAD and the members of

the Scientific Committee as well as other IPTS colleagues for their valuable support during the implementation of the project.

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