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Research Article
Making a Smart Government: Lessons from Government Cloud Development

[1]Sheng-Chi Chen and [2]Cheng-Chieh Wu

[1]Department of Management Information Systems, National Chengchi University, Taipei, Taiwan
[2]IDEAS, Institute for Information Industry, Taipei, Taiwan

Abstract
The governments around the world have gradually adopting cloud computing as the new way of public services provision. The primary research question is how the national cloud computing strategy leads to make a smart government. By using the ethnographic research method, this study will discuss the evolution process of government clouds (G-Clouds) development and the cloud strategy shift in Taiwan. The findings can provide lessons learned from adopting cloud computing in public sector, which will shed light for future researches on cultivating a smarter government.

Key words: Cloud computing, e-government, ethnography research, smart government, program management office

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Corresponding Author: Sheng-Chi Chen, Department of Management Information Systems, National Chengchi University, Taipei, Taiwan

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INTRODUCTION

The utilization of Information and Communications Technologies (ICT) to construct a smarter government is one of the rising topics in nowadays. The government gradually utilizes ICT to improve the national development as well as the quality of people living (Bughin *et al*., 2010). Smart government refers to apply and integrate ICT as well as public facilities for generating sustainable public value (Howard and Maio, 2013). The e-government fosters the needed foundation and collaborative environment for cultivating smart government (Paskaleva, 2009; Yang *et al*., 2012). According to an investigation, there are 143 undergoing smart government projects around the world (Lee, 2012). The prevalent adoption of mobile devices, cloud computing and internet of things enables government to increase responsiveness as well as to decrease manage costs by the confluence of commoditization and socialization.

Cloud computing has been regarded as an innovative IT infrastructure for the development of public services (Chandrasekaran and Kapoor, 2010). Forming a national level cloud computing project has been viewed as an important strategic movement for developing sustainable advantage for the country (Jaeger *et al*., 2008; Shin, 2013; Vouk, 2008; Weinhardt *et al*., 2009). For instance, the U.S. federal government proposed a "Cloud First" strategy to lead the national level adoption and development of cloud computing. Through initiating "The G-Cloud Program" the U.K. government put emphasis on establishing sustainable capability to exploit and manage cloud-based public service. As to Asia Pacific countries, South Korea has initiated a national cloud project (i.e., the "Next-generation Digital Service in a Cloud Computing Environment") and Japan constructed the Kasumigaseki Cloud under the "Digital Japan Creation Project" (Shin, 2013). The main purpose of this study is to investigate what extent do the national, cloud-related policy support the national innovation systems for cloud industry development.

The National Innovation Systems (NIS) perspective is widely adopted to elaborate how national level innovative policies support technologic and economic development of a certain country (Lee and Park, 2006; Lo *et al*., 2013; Marxt and Brunner, 2013; Xiwei and Xiangdong, 2007). The NIS refers to a interactive system for innovations production, diffusion and exploitation at national level (Lo *et al*., 2013; Wonglimpiyarat, 2014). In recent years, NIS has been utilized in various issues in national innovation, such as the policy formation (Xiwei and Xiangdong, 2007; Wonglimpiyarat, 2014), supporting industrial development (Lee and von Tunzelmann, 2005; Lo *et al*., 2013; Zhang and Liang, 2012), national development (Lee and Park, 2006; Marxt and Brunner, 2013; Mowery, 1998). This study will focus on the system structure and interaction among key factors.

This study aims at understanding how the national cloud strategy formed and further leads to make a smart government. The main objectives are:

- To elaborate the development of national level cloud strategy in Taiwan
- To describe the preliminary outcomes of cloud-related public service
- To discuss how and what extent do NIS support the development of cloud eco-system

MATERIALS AND METHODS

This study refers to participant observation-based case where the authors with active participation in the situation to observe and describe the conditions in a practical work setting, wherein participate in the change and continue to evaluate the process. To investigate the evolution process of cloud policy in Taiwan, this research process followed the market-oriented ethnography which puts emphasis on explicating the patterns of focal action through the participation and observation of the researchers (Korkman *et al*., 2010). The market-oriented ethnographic research process has the following four features: data is collected in natural settings, the need of extended, experiential participation of the researchers; the interpretations of actions, the incorporation of multiple sources of data (Arnould and Wallendorf, 1994).

To strengthen the validity and reliability of research model, multiple sources of evidence (i.e., triangulation) were employed (Yin, 2003). The case study was developed by using the research techniques (Korkman *et al*., 2010). First, the authors serve as officers of Executive Yuan Cloud Computing Program Management Office (CCPMO) which is in charge of giving suggestions to the development of G-Clouds. Informal conversations, discussions and meetings were addressed to the quality of data collected accordingly. Second, a set of reports (both published and unpublished) were retrieved from the government, research institution and firms who participated the development of G-Clouds. Third, data was collected through semi-structured interviews and workshops participation. A purposive sampling was adopted to select relevant interviewees (Wengraf, 2001).

The triangulation of these multiple source of information was carried out through the discussion among the authors.

These research procedures allowed the researchers to build a complete picture and rigor evaluation of the G-Clouds evolution process.

RESULTS

Evolution of cloud policy: In 2009, the Government started to allocate resources to construct an environment for developing cloud computing. Based on the foundation of playing as OEM, ODM manufacturers, firms were encouraged to invest in developing cloud-related equipments and innovative applications. The Ministry of Economic Affairs (MoEA) hosted the Cloud Computing Development Strategy Forum and proposed a draft of cloud developing strategy in September 2009. In April 2010, the Executive Yuan (Cabinet) declared the "Cloud Computing Industry Development Program", selecting the 12 promotional sub-programs in the cross-ministry cloud computing development project for promotion and execution. Calling for the spending of NT$24 billion (US$827 million) within the next 5 years, the program's aims include the stimulation of NT $12.7 billion (US $438 million) of corporate investment in cloud computing industrial R and D and the generation of NT $100 billion (US$3.45 billion) more investment in manufacturing and services as well as the creation of NT $1 trillion (US $34.5 billion) in production value.

The main strategy is developing G-Clouds to attract investment as well as to provide test-bed for developing cloud solutions. The Department of Industrial Technology under MoEA was responsible for cloud techniques development and promotion, while the Council for Economic Planning and Development (CEPD, which is reorganized as the National Development Council in 2014) was responsible for providing strategies of cloud application development. Simultaneously, the CCPMO had been organized to coordinate and manage the progress cloud program. The main functions of CCPMO are to help domestic companies participate in government projects, link the cloud computing industry and government application services together and carry out the inter-ministerial integration of services to businesses and the people as well as the use of government resources.

In June 2012, by evaluating the outcomes of the program and the worldwide trend, the Cabinet request CEPD and MoEA to modify the program. The CCPMO drew up the draft of new program. To strengthen the value of application, a dual value model was proposed (i.e., value for citizens and industries).

The bridging role of CCPMO was also emphasized. After cross-ministry negotiation, the Cabinet approve the "Cloud Computing Application and Industry Development Program" in November, 2012. Figure 1 presents the organization of new cloud program. In the new program, the Cabinet set up a Steering committee for development of the Cloud Computing Industry to handle coordination as well as the implementation of integration and management policy. In addition, the two teams were grouped into CCPMO for applications promotion and industry development to be managed, respectively by MoEA and CEPD. The developing focus was put on the Ten G-Clouds. Table 1 presents the comparison between old and new programs.

Initially, Institute for Information Industry is appointed to undertake CCPMO role and to set up "The Cloud Open Lab" (COL), which is an IT governance service launched in September, 2012. The COL provides a matchmaking platform for both G-Clouds and industry cloud business services. Figure 2 shows the role of COL. Testing service is provided for cloud service providers to examine the maturity of their solutions.

At the present, there are 80 cloud service providers joined to COL and totally 150 solutions. The COL provides matchmaking and testing services for 9 ministries. For

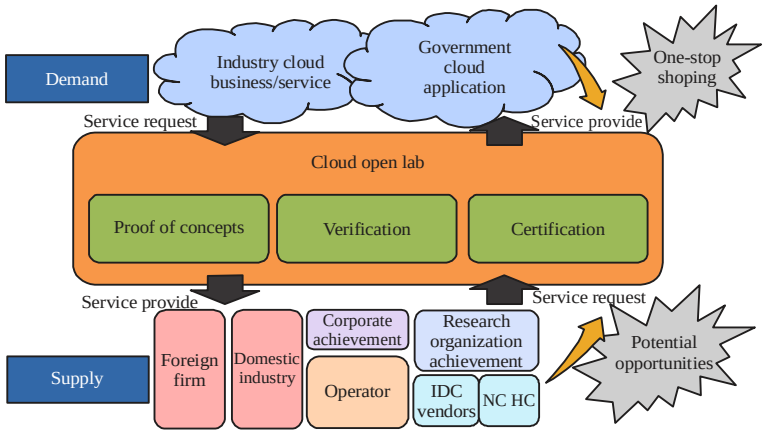

Fig. 1: Organization of new cloud program

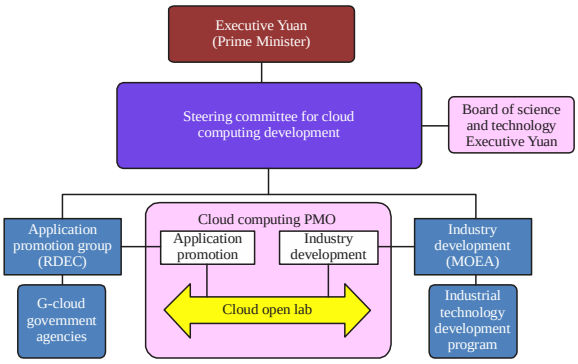

Fig. 2: Role of the Cloud Open Lab

Table 1: Comparison between old and new national cloud programs

Name	Cloud computing industry development program (old program)	Cloud computing application and industry development program (new program)
Period	2009.4-2012.10	2012.11-present
Strategy	Increase government efficiency	Promote the valuable applications for citizens
	Increase life quality of citizens	Build the foundation for the system software
	Increase added value of hardware	Energy efficiency
	Stimulate investment and accelerate industrial transformation	Develop the expertise for applications
	Develop advanced technology and infrastructure	Leverage local infrastructure
Competitive actions	Committee and CCPMO established	Dual value model (value for citizens and industries)
	Utilizing the foundation of e-Government to create G-Cloud services	The bridging role of CCPMO
	12 cloud development project	Focusing on the Ten G-Clouds
		Cloud Open Lab for matchmaking

instance, COL assists Education Cloud to verify and adopt local cloud solutions (such as LEO, ASUS Cloud and III CAFÉ appliance) to solve huge data access and rapid elasticity of online dictionary. The COL also offers verification environment and service for food safety cloud. Through 3 year effort, cloud computing has been flourishing in public services.

G-Clouds: After proposing of new program, CCPOM focused on assisting the planning and implementation of Ten G-Clouds. The applied domains include food safety, agriculture, geographic information, disaster prevention, transportation, police, education, culture, environment and healthcare. In 2013, the government had released 49 cloud-related projects amounted to NT$ 1.3 billion. There were 33 firms participated, 15 of them are domestic cloud service providers. Adapting the cloud migration stage (Wyld, 2010), it categories the status of G-Clouds into four phases, including assessment and planning, pilot testing, rollout, continuous improvement. As shown in Fig. 3, four G-Clouds have provided cloud-based public service, including E-Invoice, health, agriculture and TGOS. Five G-Clouds are providing Application Programming Interface (API) for other public sectors or companies to create value-added applications (i.e., E-Invoice, transportation, environment, TGOS and food safety). Since E-Invoice Cloud has proposed next generation big data application, it is not included in so-called the Ten G-Clouds. Table 2 presents the summary of each G-Cloud.

Smarter public service: To better utilize the G-Clouds, the central government agencies started to open their data and to develop mobile applications (i.e., App) for providing smarter public service. The main strategy is to encourage both central and local government to release their data to enable companies to create valuable applications. Therefore, a government open data website has been established (http://data.gov.tw) which provide 1,846 datasets and five categories (i.e., life-map, tourism, disaster prevention, life quality and artistic events). There are five local governments also offers their open data for value added.

- 1,390 datasets from Taipei City (http://data.taipei)
- 259 datasets from New Taipei City (http://data.ntpc.gov.tw/)
- 154 datasets from Taichung City (http://data.taichung.gov.tw/GipOpenWeb/wSite/mp?mp=1)
- 113 datasets from Yilan County (http://opendata.e-land.gov.tw)
- 236 datasets from Kaohsiung City (http://data.kaohsiung.gov.tw/Opendata)

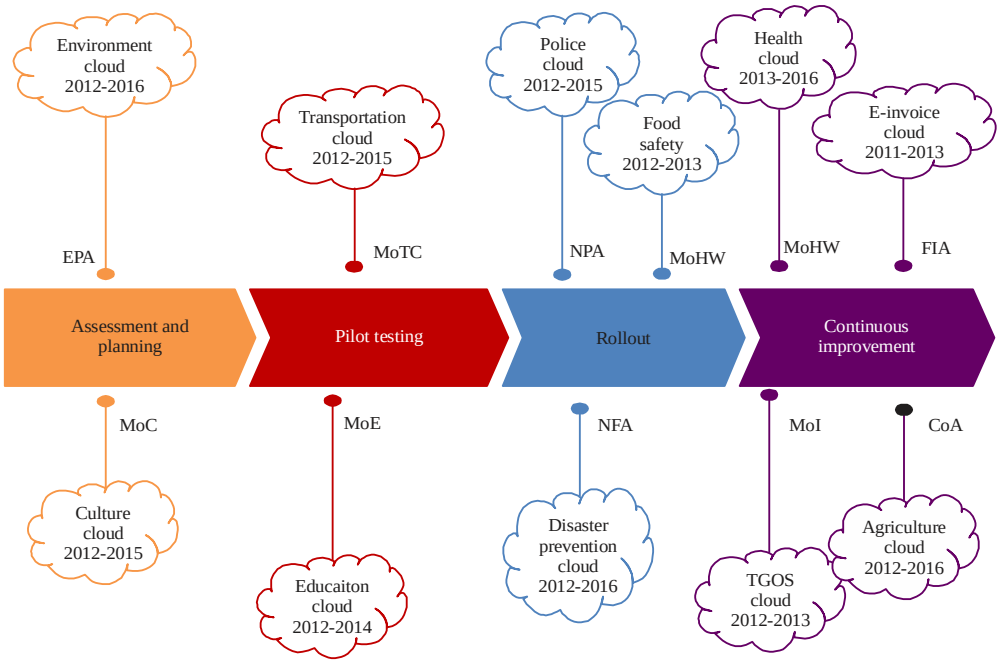

Fig. 3: Progress of G-Clouds

Table 2: Summary of G-Clouds

G-Cloud	Competent authority	Status	Purposes	Key features	Outcomes
E-Invoice cloud[1]	Fiscal Information gency, Ministry of Finance (FIA)	Continuous improvement	To establish E-Invoice systems, promoting the development of paperless invoice systems	E-Invoice exchange (B2B, B2C and B2G) Invoice management Auditing APIs for value-added	Received awards form Future Gov and 2011 eASIA Award 52,882 business entities 3.6 billion E-Invoices
Transportation cloud	Ministry of Transportation and Communications (MoTC)	Pilot testing	To provide integrated and immediate transportation information To improve service quality	Combining traditional traffic detectors (fixed VD, CCTV) with emerging techniques (GVP, EVP, CVP) Providing on-demand open data, APIs for value-added providers	Traffic condition information coverage: 100% freeway, 90% highway, 70% primary road
Police cloud	National Police Agency, Ministry of the Interior (NPA)	Rollout	To enable smart investigation capabilities To increase satisfaction level of policing service	The video exchange standards, based on ONVIF have been developed Device-free policing systems are released	Integration more than 22,000 policing surveillance of 6 cities Announced three policing service apps
Health cloud	Ministry of Health and Welfare (MoHW)	Continuous improvement	To provide better service of healthcare, disease prevention and public health	To establish a cloud-based patient records for inter-hospital exchange	142 hospitals can support remote access of patient records through a cloud-based gateway
Environment cloud	Environmental protection administration (EPA)	Assessment and planning	To integrate cross-agency environmental data To better control over carbon emissions	To provide environment information, tour guide and immediate video information To provide APIs for organization to feedback carbon information	Four Apps are used for providing environmental information To set up 100 carbon information indices under 14 categories
Education cloud	Ministry of Education (MoE)	Planning	To create a smart environment for students, teachers and parents	To provide single sign-on service Focusing on seven	Cloud-based on-line dictionary serve 70,000 people per day The alliance with education

Table 2: Continue

G-Cloud	Competent authority	Status	Purposes	Key features	Outcomes
				education applications	clouds of 10 local governments
Culture cloud	Ministry of Culture (MoC)	Planning	To use ICT to enable culture To leverage culture to enrich ICT	To integrate cultural resources To provide shared and mobilized service To combine with community-related service	Six Apps are used to provide information about artistic and cultural activities
Disaster prevention cloud	National Fire Agency, Ministry of the Interior (NFA)	Rollout	To provide early warnings to citizens To enhance the effectiveness of disaster prevention and response management	Integrating different types of information to provide weather, disaster, traffic, evacuation and other information	Pilot emergency response system has been established and went live
TGOS cloud	Information center, Ministry of the Interior (MoI)	Continuous improvement	To make standardized, reliable, usable, frequently updated GIS information for other government agencies	To provide Map APIs for further value-added To establish 9 major subject-related databases	Supplying 491 GIS data sets for other government agencies
Food safety cloud	Ministry of Health and Welfare (MoHW)	Rollout	To increase the traceability of food and food supply chain To prevent the abuse of adulterant	To establish a PaaS service Providing APIs for value-added Three major functions: food tracing, food checking and food service	Food safety information standards (i.e. GTP) has been established It has connected with 13 major food manufacturers and 927 firms in food supply chain Catering food service has gradually promoted to 321 schools
Agriculture cloud	Council of Agriculture (CoA)	Continuous improvement	To implement IT-enabled agricultural management To enhance the competitiveness of the agricultural sector	To establish agricultural production traceability To provide agricultural tourism service	Beef tracing has gone live in November, 2012 Seven Apps were announced for supporting agricultural tourism

1: Since E-Invoice Cloud has proposed next generation big data application, it is not included in so-called the Ten G-Clouds

Table 3: Summary of public App announced by the central government agencies

Public Apps	MoI	MoC	MoTC	FIA	MoE	CoA	MoHW	EPA	NPA	Total	Percentage (%)
Year of announcement											
2012	3	1	6	0	0	1	2	0	0	13	16.7
2013	7	4	1	4	1	4	6	1	1	29	37.2
2014	7	1	12	4	0	2	5	3	2	36	46.2
Total	17	6	19	8	1	7	13	4	3	78	100.0
Download count											
>50000	0	0	7	1	0	0	0	0	2	10	12.8
10000-50000	2	0	3	3	0	1	3	1	0	13	16.7
5000-9999	2	1	1	1	0	1	0	2	0	8	10.3
1000-4999	5	0	4	1	0	1	4	0	0	15	19.2
<1000	8	5	4	2	1	4	6	1	1	32	41.0
Total	17	6	19	8	1	7	13	4	3	78	100.0
Public app maturity level[2]											
Level 1	6	5	8	2	1	1	8	0	2	33	42.3
Level 2	8	1	8	2	0	6	4	3	0	32	41.0
Level 3	0	0	1	1	0	0	1	1	0	4	5.1
Level 4	0	0	2	0	0	0	0	0	1	3	3.8
Level 5	3	0	0	3	0	0	0	0	0	6	7.7
Total	17	6	19	8	1	7	13	4	3	78	100.0
Comments ave.	34.29	10.83	435.68	68.25	N/A	24.00	34.62	73.75	611.67	155.48	144.86
Average rating[3]	3.77	3.48	3.79	3.75	N/A	3.44	2.98	4.15	4.40	3.59	3.34

1: Information of each public App was retrieved from Google Play website, 2: Public App maturity level is adopted from Eom and Kim's work, 3: Rating scale is one to five, while five represent very good

As shown in Table 3, the nine competent authorities provided a total of 78 public Apps through the Android Market during 2012-2014. The MoTC announced most Apps, 12 out of 19 Apps are provided in 2014. According to the download

count, the Apps provided by MoTC also have widely been adopted. It has advocated six-level of public App maturity as follows: simple demonstrations, complex demonstrations, simple interactions, complex interactions, transaction and transformation (Eom and Kim, 2014). Most Apps fall into level one and level two. It means that most public Apps only provide needed information and slightly add one-way interactive service through using techniques such as Location Based Service (LBS) and Quick Response code (QR code). Although, the applications in transportation have received much attention, the environmental and policing service Apps comparatively have higher rating.

DISCUSSION

This study conducted participant observation-based ethnography research to echo with Yildiz (2007) suggestions about remedies of e-government research. This study provides some insights drawing from comparison to previous researches.

First, though elaborating the evolution process of national level cloud-related program and the promoting structure, the findings provide a complementary viewpoint for national innovation policy making. Wonglimpiyarat (2014) found that financing mechanisms are important for supporting technology developing in Taiwan. Our findings indicate the key leading role of central government in developing industry through making policy, such as industrial program. Lee and Park (2006) advocated that various innovation policies are needed to sustain national innovation. The cloud program provides national level support by setting guideline for both central and local government to develop cloud-related public service.

Second, the linkage among NIS stakeholders are formed through executing the program. For example, industries formed several special interest groups, such as Cloud Computing Association in Taiwan (CCAT) to enhance the interactions among firms across industries. Like promoting the photovoltaic industry, Taiwan government utilizes policy instruments, funding and procurement to stimulate the cooperation among key stakeholders (Lo *et al*., 2013).

Finally, sectoral innovation systems can be transformed by infusing the energy from national industrial policies. As to Malerba (2002) suggestions, public policy will affect the transformation of sectoral system, which also change the way of innovation and diffusion. In addition, For example, the cloud program puts emphasis on "The Ten G-Clouds," which pinpoints the cloud-related innovation for each application domain.

Lessons from G-Clouds in Taiwan: After 4 years executing the cloud program, the government set up the CCPMO and COL to support cross-ministry coordination and matchmaking the G-Clouds and cloud solution providers. The national cloud development strategy has shifted from focusing on cultivating domestic cloud industry to put emphasis on deriving value for citizens and industries. The findings provide lessons and suggestions for government officers and policy makers and shed light for further national-level e-government project.

There are several lessons learned from the G-Clouds development in Taiwan. First, the Cloud Computing Project Management Office, as a key role is assisting vendors in participation of the government project to accelerate the development of the industry chain and launch e-government cloud services. Second, the cloud program, as a guiding principle, outlines the implementation of cloud computing in Taiwan to create a smart lifestyle and kick start the nation onto the path of becoming a technological powerhouse. The cloud industry has received strong official support with the government setting the pace for private investment and vendor to follow with the proprietary cloud computing infrastructure as the model platform.

Third, the development of G-Clouds stimulates the domestic cloud industry development. The Executive Yuan requests two research institutions (i.e., Institute for Information Industry and Industrial Technology Research Institute) to develop related cloud techniques, such as III iServ Cloud, III CAFÉ, ITRI Cloud OS, etc. These cloud techniques are further licensed to the domestic companies for developing cloud total solutions and service. Moreover, focusing on developing specific domain cloud also enables the proliferation of innovative cloud applications. In contrast with old program, the new cloud program puts emphasis on the Ten G-Clouds and to develop the cloud-related public service. For example, the Transportation Cloud integrated traffic information and provide immediate traffic condition for road users. Therefore, users can make better decision before to be caught in the traffic jam. As to policing service, after constructing the Police Cloud, now the citizen can report the case to the police through specific App, which also has location-based tracking function as smarter policing service. Finally, the government starts to open data and leverage emerging techniques, such as big data analysis, wearable electronics, Internet of Things (IoT) and Online to Offline (O2O), for improving the G-Cloud continuously. For instance, the e-Invoicing data of 29,992 firms can be uploaded in 48 h. It will annually produce about 4 billion B2C e-invoice. The FIA has utilized big data analysis to filter out different characteristics of each business district.

Suggestions for further research: The findings in this study provide preliminary understanding of the policy evolution and outcomes of the adoption of cloud computing in Taiwan's public sector. This study sheds light on the future works on national cloud computing promotion and implementation. First, since Taiwan is the leading country of implementing G-Clouds, the following evolution of G-Clouds in Taiwan still worthy to keep track on it, especially on the issues of developing cross-cloud applications. Second, since we found that some G-Clouds have moved to continuous improvement stage, some are still in the assessment and planning stage. Further researches can try to figure out the obstacles and enablers of G-Cloud development. Finally, based on the techniques trends, big data analysis and smart government will be combined for next generation of G-Clouds. How does the new G-Cloud enable a government more smart is needed further works on it.

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