Role of Cloud Computing in Development of Smart City

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Abstract— With the help of cloud computing various services can be available on clouds and citizens of smart city can use these services very easily vie internet on their smart phones, laptops, PCs, tablets etc. In this paper some basic definitions of Smart city and cloud computing is included. What should the basic features, basic criteria, basic requirements of Smart city is also included. Now a days, Cloud computing is widely used in various fields. Cloud is just the metaphor of Internet. All things are available on clouds and users can use all applications, data as and when they need. How cloud computing is helpful for development of smart city and which network structure is good for maximum uses for infrastructure which is used for making the smart city with the help of cloud is also taken. The citizens of smart city can assess all application on their smart phones through clouds very easily. A contextual architecture is also given by which the structure can be understood for cloud computing and smart city development.

Key words: ICT, IoT, Smart City, Cloud Computing, Metaphor, Network Infrastructure, Smart Phone

I. SMART CITY

A city equipped with basic infrastructure to give a decent quality of life, a clean and sustainable environment through application of some smart solutions is a Smart City. In this the basic infrastructure means assured water and electricity supply, sanitation and solid waste management, efficient urban mobility and public transport, robust IT connectivity, e-governance and citizen participation, safety and security of citizens in terms of ICT.

Smart City means a developed urban area that creates sustainable economic development and high quality of life by excelling in multiple key areas; economy, mobility, environment, people, living, and government. Excelling in these key areas can be done so through strong human capital, social capital, and/or ICT infrastructure.

A smart city is an urban development vision to integrate multiple information and communication technology (ICT) and Internet of things (IoT) solutions in a secure fashion to manage a city's assets – the city's assets include, but are not limited to, local departments' information systems, schools, libraries, transportation systems, hospitals, power plants, water supply networks, waste management, law enforcement, and other community services.

The goal of building a smart city is to improve quality of life by using urban informatics and technology to improve the efficiency of services and meet residents' needs. ICT allows city officials to interact directly with the community and the city infrastructure and to monitor what is happening in the city, how the city is evolving, and how to enable a better quality of life.

A smart city may therefore be more prepared to respond to challenges than one with a simple 'transactional' relationship with its citizens.

A smart city is a designation given to a city that incorporates information and communication technologies (ICT) to enhance the quality and performance of urban services such as energy, transportation and utilities in order to reduce resource consumption, wastage and overall costs.

II. CLOUD COMPUTING

Cloud computing means storing and accessing data and programs over the Internet instead of your computer's hard drive. The cloud is just a metaphor for the Internet.

Cloud computing means that instead of all the computer hardware and software you're using sitting on your desktop, or somewhere inside your company's network, it's provided for you as a service by another company and accessed over the Internet, usually in a completely in proper way.

Cloud computing is a buzzword that means different things to different people. For some, it's just another way of describing IT (information technology) "outsourcing"; others use it to mean any computing service provided over the Internet or a similar network; and some define it as any bought-in computer service you use that sits outside your firewall.

Cloud computing lets you keep information on a remote server (the cloud), instead of trapped in a computer. You can access your data from a smart phone, a tablet, a laptop, or a desktop— wherever you have an Internet connection.

Cloud computing is an on-demand service that has obtained mass appeal in corporate data centers. The cloud enables the data center to operate like the Internet and computing resources to be accessed and shared as virtual resources in a secure and scalable manner. Like most technologies, trends start in the enterprise and shift to adoption by small business owners.

III. TYPES OF CLOUD

A. Public Clouds

A public cloud is basically the internet. Service providers use the internet to make resources, such as applications (also known as Software-as-a-service) and storage, available to the general public, or on a ‗public cloud. Examples of public clouds include Amazon Elastic ComputeCloud (EC2), IBM‘s Blue Cloud, Sun Cloud, Google App Engine and Windows Azure Services

1) Platform.

For users, these types of clouds will provide the best economies of scale, are inexpensive to set-up because hardware, application and bandwidth costs are covered by the provider. It‘s a pay-per-usage model and the only costs incurred are based on the capacity that is used.

B. Private Clouds

Private clouds are data center architectures owned by a single company that provides flexibility, scalability, provisioning, and automation and monitoring. The goal of a private cloud is not sell ―as-a-service‖ offerings to external customers but instead to gain the benefits of cloud architecture without giving up the control of maintaining your own data center.

C. Hybrid Clouds

By using a Hybrid approach, companies can maintain control of an internally managed private cloud while relying on the public cloud as needed. For instance during peak periods individual applications, or portions of applications can be migrated to the Public Cloud.

D. Structure of Cloud Computing:

Cloud computing, encompasses so many aspects of computing (from hardware to software) that a single solution is not able to provide it all. More likely, specific solutions address the user needs and are successful in delivering IT resources as a real utility. By leveraging different types of services provided by Cloud Computing, it is useful to satisfy the needs of everyone. Generally, it incorporates the combination of the following:

1) Infrastructure as a Service (IaaS):

Delivers the computer infrastructure, typically a virtualized computer as a service. The end user has full controls over the virtualized computer instance, and can customize the instance accordingly. The virtualization technology is used to provide multi-tenancy and isolation to the users as different virtual instances may be allocated to a single physical machine. Unlike purchasing the physical servers, IaaS is charged on a utility basis depending on the consumption of the resources.

2) Platform as a Service (PaaS):

Delivers a computing platform and solution stack as a service. It hides all the complexity of managing the underlying hardware, provides all the facilities required to support the complete lifecycle of building and deploying web applications and services entirely from the internet.

3) Software as a Service (SaaS):

Is a model of software deployment where in a provider delivers its software as a service to be used by customers on demand.

E. Role of Cloud computing in Smart City development

The smart city vision involves enriching quality of life by gaining data insight from interconnected sensors, devices and people. Continuous urban issues like security, waste management and traffic can be addressed by using data to gain efficiencies; but to do this all of the data needs somewhere to go where it can be easily accessed and used by all stakeholders, both private and governmental. To address this need, Smart+Connected Digital Platform.

The cloud service will help break down intergovernmental storage wherein different departments have no clear channel to communicate and understand data-based priorities of other departments – a factor seen as a major obstacle to smart city adoption. Security is also a major aspect of the new product, as the continued maintenance of the ―internet of things‖ has (and will) created demonstrable security concerns.

Smart cities can take advantage from cloud based solutions in infrastructure, platforms and application (IaaS, PaaS, SaaS), services with cloud platforms, obstacles and enablers in using cloud technologies, and changes to applications and e-services along their migration to cloud environments.

F. Characteristics of cloud computing:

1) On-demand self-service:

A consumer can unilaterally provision IT resources (e.g., storage, processing power, memory, bandwidth, etc.), as needed automatically without requiring human interaction with the cloud provider.

2) Broad network access:

IT resources are avail-able over the Internet and accessed through heterogeneous devices (e.g., mobile phones, tablets, laptops, and workstations). There is a sense of location independence because the customer gene-rally is not aware of the exact location of the provided resources.

G. Rapid elasticity:

A cloud environment offers to the consumer the ability to rapidly scale up or down the IT infrastructure commensurate with demand. To the consumer, the capabilities available for provisioning usually appear to be limit-less and can be reserved in any quantity at any time.

H. Measured service:

Cloud systems monitor, control and report the use of IT resources by lever-aging a metering capability at some level of abstraction suitable for the type of service. This leads to a transparent relationship between the consumer and provider of the cloud service.

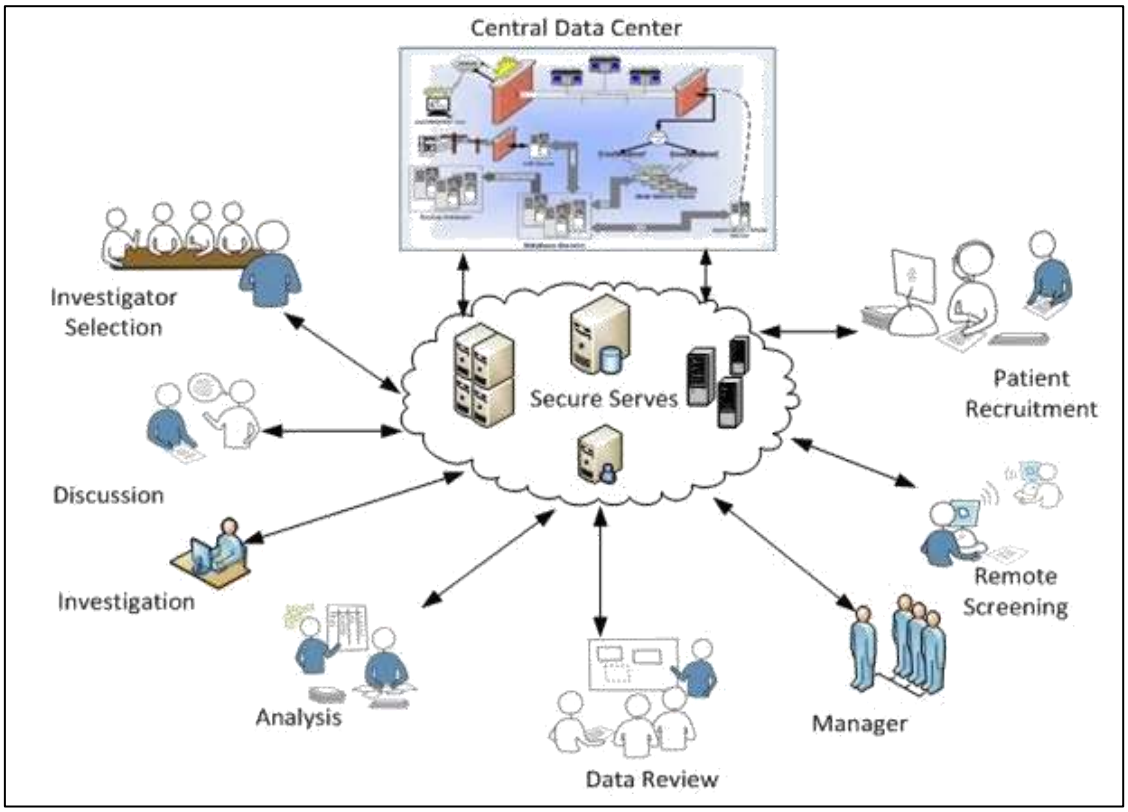

Fig. 1: Services of cloud computing

I. Proposed Architecture of cloud computing services for Smart City Infrastructure:

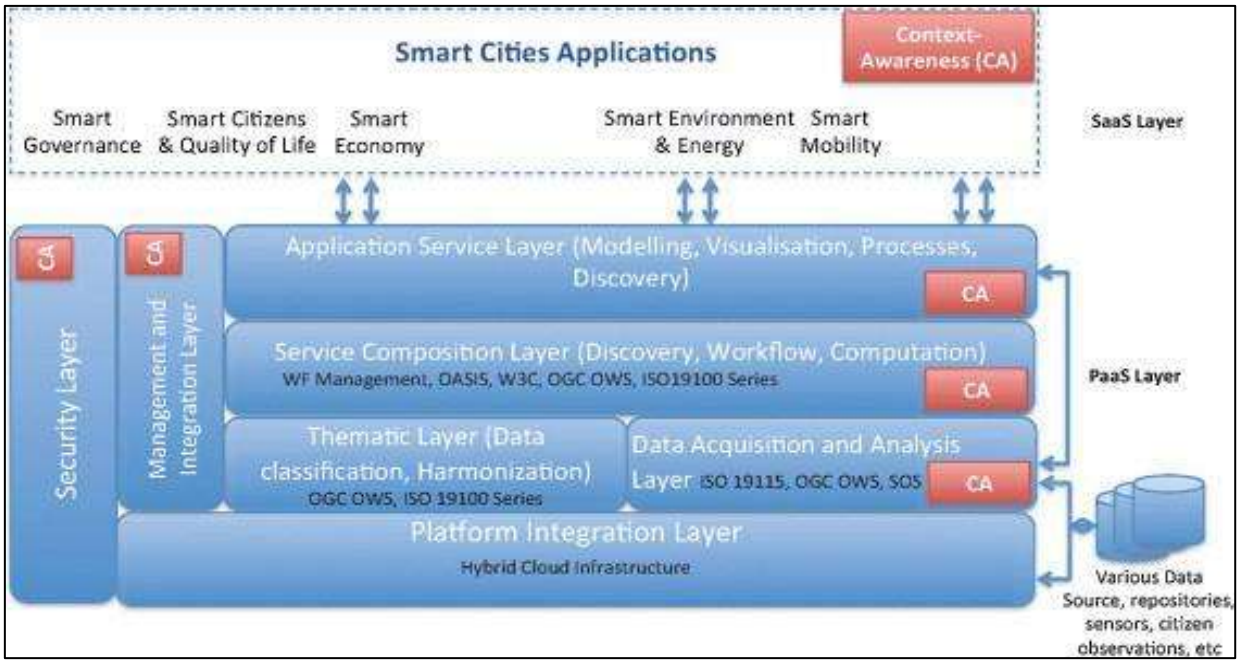

Fig. 2: Contextual architecture of cloud computing

This architecture has five horizontal and two vertical layers. In our bottom up approach, the Platform Integration, Thematic and Data Acquisition and Analysis layers output generic data, which can be modified to specific smart cities related application needs in the top three layers. One of the design principles here is to introduce context-aware components at different layers of the architecture in order to continually coordinate the vertical flow of data and retain or associate contextual information.

The platform integration layer represents a cyber-infrastructure based on a hybrid Cloud environment that ensures cross-platform accessibility of data.

The data acquisition and analysis layer is used to access environmental data from various sources including remote database repositories, sensor nets, and citizens‘ observations, e.g. using smart phones, in the Cloud environment. This layer also ensures the quality of data acquired and identifies the need for necessary data organization and data cleansing. A context-aware component is introduced here to filter out unrelated data and to perform quality check and organization only to contextually related data.

The thematic layer classifies the acquired data into application specific thematic categories and performs data organization and updates the data/service catalogues for further use of the data.

The service composition layer is required to design workflows, identify data sources, and link necessary processing components to pass the workflows. Furthermore, necessary analytical analysis of the workflow outputs can be performed in this layer. This layer also ensures that the origin of data and specific processes is maintained that can be utilized for analysis by different expert systems in the application layer. Again a context-aware component is introduced here to only utilize contextually related services for workflow composition and information generation.

The application service layer uses the outcomes from the service composition layer in application domain specific tools such as simulations and visual maps to perform contextual analysis for decision-making. Further, this layer enables stakeholders to use existing tools and develop new application domain specific components and services (at SaaS level) to satisfy contextual needs of end users.

The management and integration layer is used to automate the flow of filtered data and information between the horizontal layers. It ensures that processed outputs from one layer to another are contextually related and syntactically correct. It also aims to handle change management that occurs at different layers and to reduce the amount of data to which the layered architecture requires management overhead.

The security layer ensures the necessary authentication, authorization and auditing for the use of data and services by right users. Further, it ensures secure personalization and profiling of end users for processing and retrieval of contextual information from a Cloud environment.

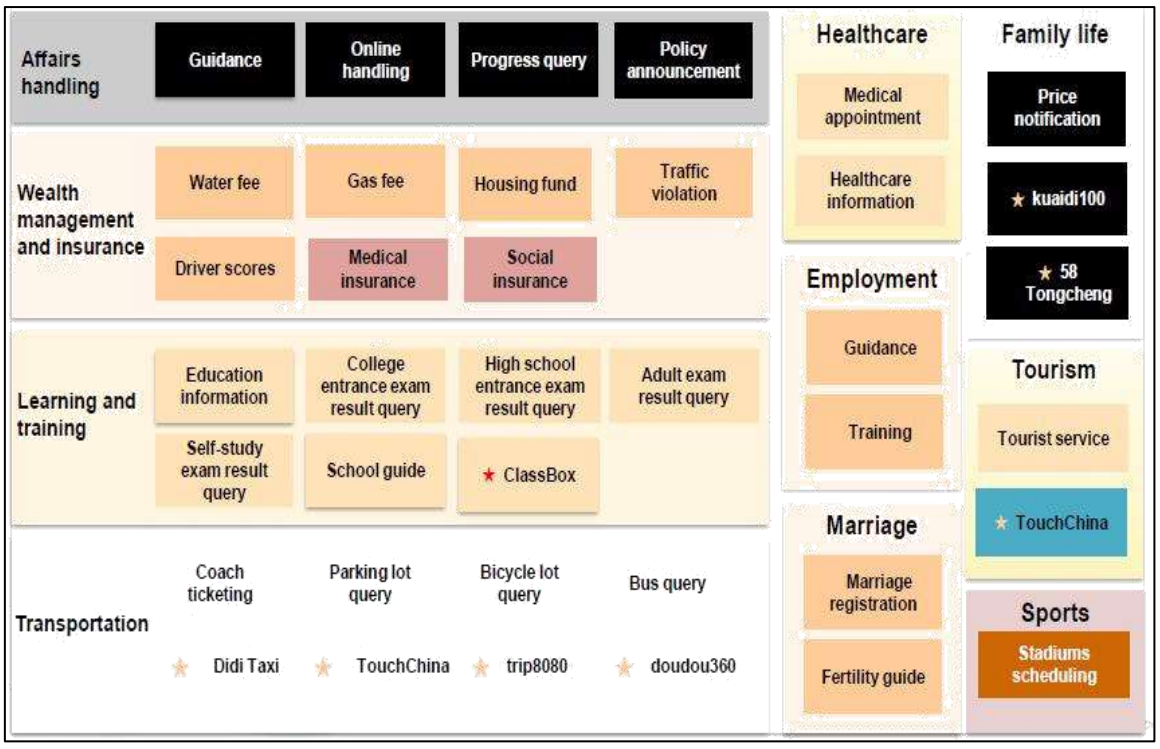

Fig. 3: Cloud based Applications for citizens of Smart City

In this figure we can see the various applications which are available on clouds and these applications are used in daily routine life. With the help of clouds and infrastructure these applications can avail anywhere and anytime because these can access through their smart phones, laptops, PCs, tablets where the Internet is available.

A figure is also mentioned below which shows the process of a medical application through various gadgets with the help of cloud.

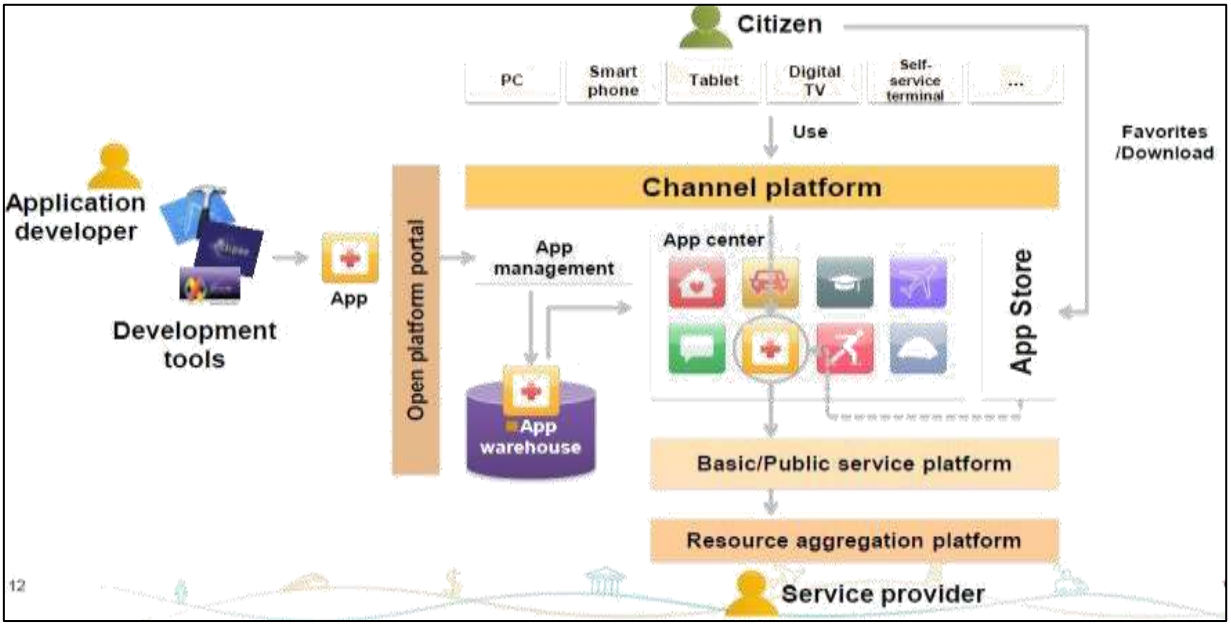

Fig. 1: The processing of an application available on cloud

IV. CONCLUSION

In this paper some basic definitions of Smart city and cloud computing is included. What should the basic features, basic criteria, basic requirements of Smart city is also included. How cloud computing is helpful for development of smart city and which network structure is good for maximum uses for infrastructure which is used for making the smart city with the help of cloud is also taken. A contextual architecture is given in this paper which has 7 layers and this architecture shows how the data can store on cloud in a huge amount, various platforms are available for data storage in right manner and these data can retrieve when needed. In this paper we have also seen the various services of cloud computing for daily routine life are available for citizens of smart city and they can use these services very easily vie internet on their smart phones, laptops, PCs, tablets etc. We can see with the help of cloud computing various applications can access anywhere and anytime.

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