# Towards an E-Governance Grid for India (E-GGI):
# An Architectural Framework for Citizen Services Delivery

C. S. R. Prabhu[1]

## ABSTRACT

*The National e-Governance Plan (NeGP) proposes citizen service delivery up to the village level through various channels including village kiosks. The citizen services to be delivered are going to be web services (as against the present simply web enabled services) based on the Service Oriented Architecture paradigm. These Web Services expect adequate networking and computing resources for effective and efficient service delivery. Grid computing is the new computing paradigm. According to Gartner, computing (scientific, business and e-governance based) will be completely transformed in this decade by using grid enabled web services to integrate across the Internet to share not only information and application but also computing power. The latest grid computing standard OGSA (Open Grid Services Architecture) integrates the power of the grid with that of the web services – both stateless and stateful, based on Service Oriented Architecture (SOA). Leveraging the power of grid computing for e-governance takes us towards an e-governance grid for India. Towards this objective, the existing computing networks such as NICNET with all its SAN Data Centres connected with each other and also the other state owned Data Centres and SWANs (State Wide Area Networks) are required to be connected with each other to ultimately form the e-Governance Grid of India (e-GGI). Once this is achieved, the web services which offer citizen services will be effectively supported by the powerful resources of this e-ggI, ensuring nonstop, fast and efficient delivery, with all the due backup, mirroring and recovery features in place. Then we can successfully operationalise Web Services Repositories at the District, State and National levels on the e-governance grid of India, thereby delivering citizen services across the country. An architectural framework for citizen services delivery is also proposed based on e-GGI.*

## 1. Introduction

The National e-Governance Plan (NeGP) is an ambitious plan to achieve e-governance and deliver citizen services through the 100000 kiosks throughout the country including rural areas. These citizen services will have to be web services based on Service Oriented Architecture. This gigantic effort calls for extensive

---

[1] National Informatics Centre, Hyderabad – 500 063, India (E-mail: ddg@ap.nic.in)

computing and network infrastructure and resources so as to meet the requirements of NeGP. Conventional technological approaches such as client server model of architecture or the central server model of architecture will not be able to meet the requirements of NeGP. The Storage Area Network (SAN) based Data Centres being set up by NIC and also various state governments will be the first step towards a more recent technological advancement, popularly described as "grid computing". In a "grid" of computer systems all the Data Centres (SAN) will be connected into a grid where in all the computational resources such as the CPUs, disk storage system, specialized software systems, etc., will be shared by all the users connecting to the grid and the users are expected to draw adequate computational power from the grid just like they draw electric power from the Power grid, ubiquitously and unlimited or at least more than adequate required for any authorized user.

*The essence of the thesis is as follows:*
This paper aims at conceptualization of an e-governance grid for India (e-ggI). It also proposes a plan of action for this.

The National e-Governance Plan (NeGP) envisages large scale citizen service delivery through about 1,00,000 kiosks throughout the country upto the village level. This is possible only if these services are Web Services in the context of the Service Oriented Architecture, the latest architectural paradigm for large scale service delivery over a robust network connecting Data Centres and providing service delivery channel through the State Wide Area Networks (SWANs). NIC has established the National and State level Data Centres over the NICNET which is operational upto the district level (with plans to go below district level). In addition, the individual state governments also are setting up their own State Wide Area Networks connecting the state level Data Centres with the kiosks upto the village level (as in the case of Andhra Pradesh Government).

Grid computing is a new paradigm in distributed computing environments. Grid computing envisages resource sharing, exchange, discovery, selection and aggregation of resources over the grid of computer systems aiming at ubiquitous and adequate resource provision for any activities in the grid including file transfer, replica location service, etc., in addition to supporting Web Services (both stateful and stateless). The grid architecture called Open Grid Services Architecture (OGSA) integrates grid technology with Web Services.

In the e-governance context, citizen services, which are Web Services, can be effectively supported by a grid of Data Centres and networks which connect them upto the kiosks at village levels, thus enabling an "e-governance grid of India (e-ggI)". This enables us to conceptualize an e-governance grid for India as a backbone architectural framework for the purpose of effective citizen service delivery. The citizen services can be aggregated as Web Service Repositories at three tiers of the government administration: District, State and National, i.e., The District level Web Services Repository, the State level Web Services Repository and the National level Web Services Repository will respectively deliver citizen services at the respective district (sub-district) level, state level (for state services) and national level (for central services), nodes of the e-governance grid of India. This Paper proposes an architectural framework for citizen service delivery through an e-governance grid of India (e-ggI). It also gives insights into various aspects of the implementation of the proposed e-governance grid for India.

According to Gartner, in the current decade all computing (including e-governance) will be completely transformed by using grid enabled web services to integrate across the Internet to share not only information and application (as of now) but also computing power (through grid computing). Sooner or later all the computing function in the world is thus expected to become grid based – to share resources – so as to minimize the cost by optimizing the utilization of the resources. In a country like India, where the

government administration is structured in a 3 tier – Central, State and District levels – Web Services Repositories can be launched and operationalized in the same three levels in the grid.

## 2. OGSA (Open Grid Services Architecture) – integrating Web Services (based on SOA) with grid computing

While the earlier versions of grid computing technology were supporting predominantly applications of scientific domain and thus were not concerned with the concept of Web Services (based on Service Oriented Architecture), the current grid technology initiatives are based upon the new standard OGSA or Open Grid Services Architecture, wherein the Web Services are integrated with grid technology so as to result in a win-win situation both for the Web Services (by higher resource provision) and grid technology (extending to the commercial or e-governance domain). As Web Services are increasingly becoming standardized, the ability of the "grid" to support Web Services is a key provision for effective delivery of services in any application domain, especially e-governance domain, wherein citizen services are being launched as Web Services over the grid for better and efficient service delivery. In fact, without the grid computing approach, Web Services may not even be possible to be launched at a large scale.

OGSA (Open Grid Services Architecture) is the latest standard evolved by Global Grid Forum (GGF) to integrate Web Services with grid computing. This Architecture integrates the conventional grid computing features such as resource allocation and monitoring, mirroring, etc., with Web Services facility. Citizen services which are basically Web Services, will be supported by grid computing features and facilities to ensure adequate resources and background processes to effectively operationalize them. OGSA supports WSRF (Web Services Reference Framework) which provides standard architecture for Stateful Web Services (conventionally all Web Services are Stateless). Stateful Web Services will be useful for applications that require reference to data of past transactions, for continuity of processing (if such continuity is not essential, conventional (stateless) web services can be utilised).

Globus Toolkit (GT) is an open source, middleware software for the grid. It is the most popular and successful middleware evolved out of various experimental grids in the world. Today, it is almost the standard grid middleware software. Globus Toolkit Versions 1 and 2 did not support Web Services. From Version 3 onwards and the present Version 4 known as Globus Toolkit 4 or GT4 offers full fledged support for Web Services delivery in Java, C and Python. It provides various modules which are essential for grid computing, such as Grid Resource Allocation and Monitoring (GRAM), Grid File Transfer Protocol (GridFTP), data replication and monitoring (mirroring), Authentication and Authorization (through Public Key Infrastructure or PKI), etc. The Globus Toolkit Version 4 (GT4) has been installed and tested for its functionality in NICNET and can be utilized for any grid application in e-governance domain.

## 3. e-GGI (e-Governance Grid of India)

The proposed e-Governance Grid of India envisages to design and implement a grid in India for e-governance service delivery across the country. With an objective to implement the National e-Governance Plan (NeGP), SAN Data Centres have been established in all the 35 States/UTs, through NIC, as a part of NICNET or independently by the State Governments. Similarly, State Wide Area Networks (SWANs) are also set up in various States either through NIC, as a part of NICNET or by the State Governments themselves. However, as of now, even through the State SAN Data Centres and SWANs are individually connected there is no concept of grid computing being implemented. The State SAN Data Centres are independently operating without any resource sharing or even without replica/mirroring storage elsewhere (only for Delhi Data Centre, a DRC (Disaster Recovery Centre) is operationalized at Hyderabad). The grid technology implementation, utilizing the middleware (such as Globus Toolkit) software can result in better utilization of the resources, while also providing the backup recovery features along with mirroring and replication services (in the remote sites in the grid). Security is

also ensured through authentication and authorization for all users trying to access the grid, using the Public Key Infrastructure (PKI). This will result in overall productivity improvement, in addition to obtaining all the benefits of grid computing.

## 4. National eGov Plan (NeGP): Implementing Mission Mode Projects

The Govt. of India, Department of Information Technology, has initiated National e-Governance Plan (NeGP) for the execution of e-governance projects in the country, both at Central and State levels.  It had identified "Mission Mode" Projects at both the levels as follows:

A.  State Level:
   Land Records
   Road Transport
   Property Registration
   Agriculture
   Treasuries
   Municipalities
   Gram Panchayats
   Commercial Taxes
   Police
   Employment Exchanges

B.  National Level
   Income Tax
   Company Affairs
   Passport & Immigration
   Insurance
   National Citizen Database
   Central Excise
   Pensions
   Banking

Clearly, even though efforts are underway, it is a large task to complete the application software development for all these Mission Mode Projects.  After the software development is completed, it calls for great efforts of implementation of these projects all over the country.

After the completion of the implementation of all these application software projects, they are required to be converted to web services based on the Service Oriented Architecture (SOA).  After the completion of all the services being converted to web services in the Service Oriented Architecture paradigm, we will have a three tier architectural framework as shown in Figure-1.
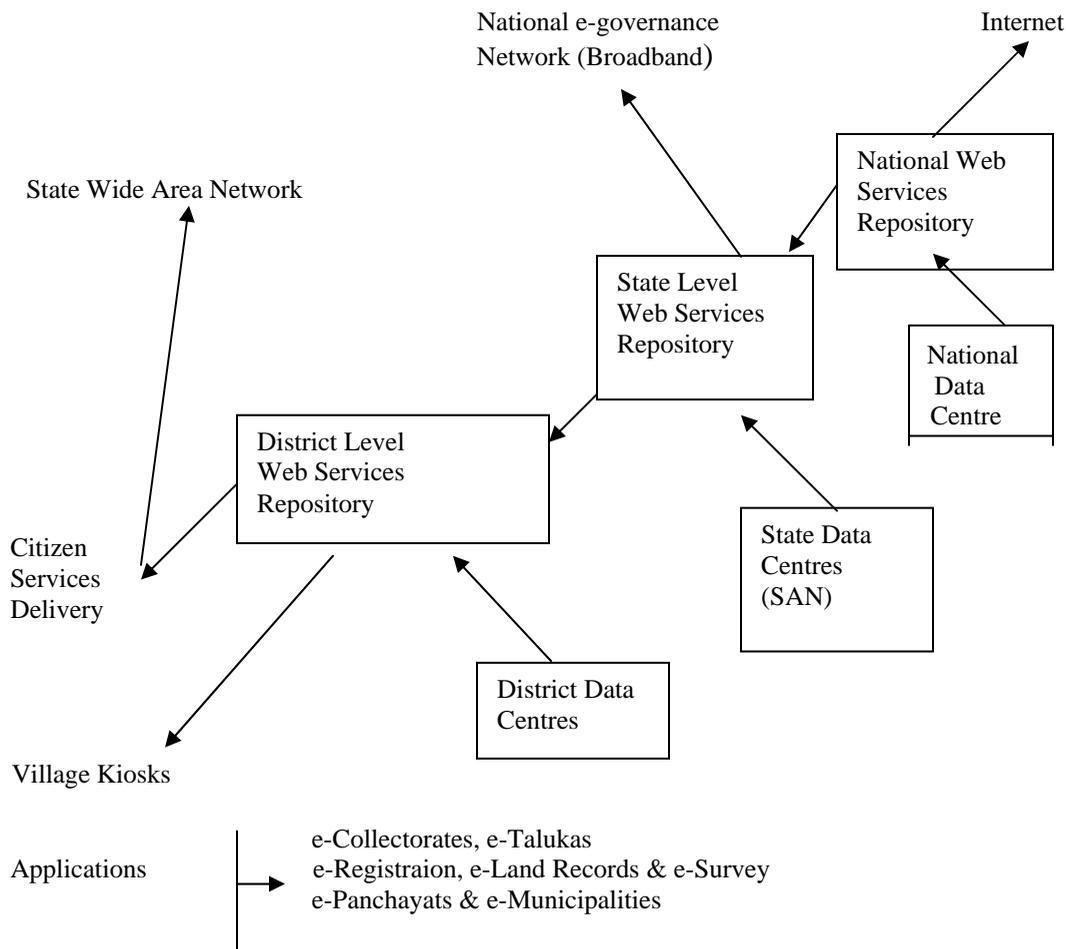
All the sub-district level web services such as e-Panchayat, e-Municipality, e-Land Records, e-Registration will be grouped together under the category of "District level Web Services Repository" to be managed at the District level with District Data Centres. All the State level applications (both as top level aggregation of district level applications and also independent state level applications) will be managed at the State Level Web Services Repositories located at State Data Centres.

Similarly, the aggregation at the National level and also nation-wide centrally controlled web services will be managed at National level Web Services Repository located at the National Data Centre. The e-Governance Grid of India (e-GGI), discussed in previous section, will be the backbone IT infrastructure for this purpose. All the Data Centres will have to be integrated with State Wide Area Networks into a grid (broadband) which will provide access to Internet/Intranet right from the village level. National portals and national web services will also be able to provide access to individual village portals. As an example, the National Panchayat Portal will be the aggregate level entry point which will permit access to individual Panchayat Portals across the country.

The above action Plan needs to be implemented in a period of atleast five years.  After the creation and integration of web services into web services repositories, a workflow interoperability plan can be executed using BPEL (Business Process Execution Language) which can enable process orchestration across diverse web services (based on Service Oriented Architecture. In the above lines, a pilot attempt is being made in

Andhra Pradesh State to integrate diverse web services such as Property Registration (CARD Project) and Land Records (LRMIS Project) with ePanchayat Project.

e-Governance Grid of India (e-GGI)

National e-governance
Network (Broadband)

Internet

State Wide Area Network

National Web Services Repository

State Level Web Services Repository

National Data Centre

District Level Web Services Repository

Citizen Services Delivery

State Data Centres (SAN)

Village Kiosks

District Data Centres

Applications

e-Collectorates, e-Talukas
e-Registraion, e-Land Records & e-Survey
e-Panchayats & e-Municipalities

These Repositories will reside on the e-Governance Grid of India (e-GGI)

**Figure 1:** Web Services Repositories on e-Governance Grid of India (e-GGI)

## 5. Web Services Repositories

Three Levels of e-governance Services can be identified and accordingly 3 level Web Services Repositories can be established:

    a. National level Web Services Repository (NWSR) for National level e-governance initiatives of NeGP

    b. State level Web Services Repository (SWSR) for the State level e-governance services, and

    c. District (or Sub district) level Web Services Repository (DWSR) for the district and sub-district (taluka or village)

All this will be possible only if adequate computing, network and data infrastructure is made available. What is the appropriate and adequate infrastructure for achieving this? The requisite infrastructure can be categorized into:

    a.   Computing infrastructure (including software infrastructure)
    b.   Network infrastructure
    c.   Data infrastructure

## 6. Pre-requisites for National e-governance architectural framework

What are the essential requirements for establishing a national framework for e-governance architecture?

The following can easily be identified as the essential pre-requisites:

    a.   Establishment of nation-wide broad band IP network, right upto the village level (by taking care of all the requirements such as power and bandwidth to form a National e-Governance Grid of India (e-GGI), described in the previous section)
    b.   A nation-wide unique citizen identification mechanism (using the latest technology such as Iris identification and smart cards)

With the above pre-requisites in place (which call for a concerted effort at the national level), the following e-governance architectural framework can be established.

The action plan for achieving this will be:

**Step 1:** Development and implementation of web services (based on SOA – Service Oriented Architecture) for all the e-governance applications (such as ePanchayat for Village Panchayats, eMunicipality for Municipalities) at various tiers of the government, as indicated.

**Step 2:** Establishing web services repositories at three levels
    a.   District level
    b.   State level
    c.   National level

Step 1 above includes the software development and implementation of information systems for various levels such as Villages, Municipalities, Talukas, Districts, State and National levels–all this being converted to web services based on Services Oriented Architecture (SOA). The National e-Governance Plan (NeGP) clearly envisages all these services in all its Mission Mode Projects as indicated above.

All these activities will take place on e-Governance Grid of India, comprising National Data Centre, all State Data Centres and the (proposed) District Data Centres, all connected in a grid of broadband network.

## 7. Concluding Remarks

In this paper we have presented the proposed e-Governance Grid of India (e.GGI) to support the Web Services Repositories at National, State and District levels for service delivery to citizens as per the National e-Governance Plan (NeGP).

The architectural framework given in this paper serves as the blueprint for the effective implementation of National e-Governance Plan (NeGP) in the country. In fact, without this framework of action and implementation, it may not be possible to implement NeGP to its completion with its large objectives of Citizen Services Delivery. This framework represents the state of the art technological architectural opportunity to implement NeGP. Without this approach (with continued status quo approach) the effective

and efficient utilization of national computing resources all over the country will not be possible, thereby making it difficult to achieve the successful implementation of NeGP in its full scope, content and objectives.

In comparison with the successful architectural framework of e-governance in other advanced countries such as the United States and other European Union, it may be noted that the grid technology has not yet been applied to e-governance framework projects in any country in the world. The U.S. Federal Enterprise Architecture (FEA), based on which the bulk of e-governance service delivery (for example FirstGov.gov) has taken place, was built several years ago before the grid computing paradigm could be applied to e-governance. Similarly, in the European Union, the e-governance projects as Eu-Publi.com, e-Gov, FASME have their own architectural frameworks to deliver citizen services across Europe successfully. Even though they are successful projects, grid computing paradigm had not been used even in the European Union, due to the recent nature of grid computing technology and its application to e-governance. (Earlier grid computing technology was applied only in scientific research). In fact, if implemented, the e-governance grid of India will be the first ever national level e-governance grid architectural framework in the world which will leverage the technological benefits and strengths of grid technology for the effective delivery of e-governance services to the citizens at large.

## References

1.  Tierney, B., Johnston, W., Lee. J., Thompson, M. (2000)  A data intensive distributed Computing architecture for "grid" applications. *Future Generation Computer Systems*, Volume 16, Issue 5, March 2000.
2.  The Globus Security Team: Globus Toolkit Version4 Grid Security Infrastructure: *A Standards Perspective*. September, 2005.
3.  Ian Foster, Carl Kesselman. Globus: A Metacomputing Infrastrcuture. http://www.globus.org/
4.  eGov Project:  http://www.egov-project.org/
5.  The FASME Project Website:  http://www.fasme.org/index.org.html

*About the Author*

*Chivukula Sree Rama Prabhu*, Deputy Director General (Scientist "G"), National Informatics Centre (NIC), Hyderabad (Ministry of Communications and Information Technology) obtained his Masters Degree in Electrical Engineering with specialization in Computer Science from the Indian Institute of Technology, Bombay in 1978 after a Bachelors Degree in Electronics and Communication Engineering from Jawaharlal Nehru Technological University, Hyderabad in 1976. He has worked in various capacities at Tata Consultancy Services, CMC, TES and TELCO before joining NIC. He also has teaching and research experience at the University of Central Florida, Orlando, Florida. He has guided a large number of student research projects at masters level and has several papers to his credit. He has authored six text books in  frontier  areas in Computer Science. He was awarded the Oracle eGovernance Excellence Awards -2006. Presently he is the Head of NIC's Disaster Recovery (DR) Centre at Hyderabad and is involved in designing and implementing an e-governance grid for India, covering all the States and District Centres over the NICNET.