

SERVICE ORIENTED LAYERED APPROACH FOR IMPLEMENTING E-GOVERNANCE SYSTEMS

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ABSTRACT

Service Oriented design and software development has gained much importance in the area of e-Governance applications. The main focus is to design and implement web services for efficient realisation of service interoperability and reuse. In this paper, we have proposed a layered service oriented design approach with government department wise abstraction levels for uniform service specification and composition mechanism. For our case study we have considered seven web services of different departments, which are interdependent. The service identification, service composition and service interaction pattern of all these services are done as per the principles of service oriented design. A generalised framework is also proposed to develop any complex web service, which can use and reuse services of multiple departments seamlessly. It provides flexible and dependable solution for developing agile e-Governance applications as the complexity of web services increases.

Key words: e-Governance, SOA, Service Composition, Service Orchestration, Service Design.

1. INTRODUCTION

The increasing complexity of the software systems has constantly led to the evolution of new programming paradigms: from functional, to object-oriented, to component-oriented, to service-oriented to name a few. Typically each successive paradigm has introduced new design approaches at a higher level of abstraction. In recent years, service-oriented design approach are rapidly becoming the de-facto standard for distributed systems like e-Governance application which support collaborative business processes. The main objective of e-governance is to allow different departments in Government to provide citizens with information based on their need, hence increasing their effectiveness, efficiency, and quality of live. The Service Oriented design approach to e-governance combines, Information Communication Technology (ICT)

with service delivery goals and enables various government departments to re-use, already developed services. The goal is to provide a flexible Service Oriented solution for governing, integrating, deploying, securing, and managing services, irrespective of the platforms on which they were created and running. It needs to rapidly transform existing applications, data, and content into web services using a completely non interfering approach that requires no changes to the existing applications. Different e-Governance Portals are built based on Service Oriented design approach, where a group of services communicate with each other through data-passing or two/more services coordinating some activity. Services typically implement functionality, which most citizens would recognize as a service, such as filling out an online application for a driver's license, viewing an online electronic form, or submitting a grievance or query. To meet an existing or new business requirement, services are linked and sequenced in a process known as orchestration. Web services make these functional building blocks accessible over standard internet protocols independent of platforms and programming languages. These services can be new applications or just wrapped around existing legacy systems to make them network-enabled. The departments that are to be integrated with the e-Governance Portal need to interact with the portal and to each other for seamless delivery of information/services to citizens. The interactions between these departments are proposed to be done through Service Oriented Architecture (SOA) framework. The interoperability is built by using Middleware on XML (eXtensible Markup Language) and web services standards. E-Governance Portal allows the citizens to access government information easily and to enjoy one-stop government services. It enhances the customer focused service delivery channels. These e-Governance Portal allows a department to present information, applications, and services in a single consolidated browser view. It offers a single access point to critical information and the primary applications necessary for an individual to avail the services. In the following sections our paper is trying to explain the interaction of services within the same department and among different departments, for implementing through a single window e-Governance portal.

2. RELATED WORK

In practice E-governance systems are inherently incremental in nature and it is hard to foresee all future requirements at a much early stage of development. Therefore, one really finds it difficult to integrate applications developed by different parties using varieties of technologies. Typical characteristics of E-governance systems includes, they are highly interoperable, large-scale, distributed, and heterogeneous systems cutting across geographical boundaries and administrative domains. Therefore, achieving interoperability among E-governance applications towards seamless integration and information exchange is of paramount importance. The above characteristics of E-governance systems necessitate the choice of a suitable design approach to build different applications to realize a pragmatic system[1] Ioana Sora et al[2] address the composition problem of a whole system according to a set of requirements by dividing it into sub-problems of layered compositions. The composition strategy is driven mainly by the dependencies established between components by their requirements. Fábio Zaupa et al[3]. present a development environment that focuses on application development process based on services. This environment supports the generation of Web applications based on the Service oriented Architecture (SOA) and the product line approach. The main features are abstractions to represent the capabilities of Web applications. Each high-level feature is realized through a domain service. Each service encompasses the operations and data needed to realize the associated feature. Jaejoon Lee et al[4] propose an approach that identifies reusable services at the right level of granularity. They present how reusable services can be identified and specified based on features: these features identify variations of a family of products from a user's point of view and thus will be the subjects of reconfigurations of service-centric systems at runtime. Kevin Jin et al[5] present a business-oriented service design and management methodology. The methodology integrates software engineering techniques, such as design patterns to develop IT solutions from a service business perspective.

3. WEB SERVICE EXAMPLES FOR THIS PAPER

The following web services of different Government departments of Odisha province in India, are considered for our case study using the proposed layered architecture.

3.1. BPL Service

A database is created for all the citizens of India who are Below Poverty Line (BPL), based on thirteen parameters like land holding, type of house, clothing, food security, sanitation, consumer durables, literacy status, labour force, means of livelihood, status of children, type of indebtedness,

reasons for migrations, etc.[6] This database prepared by Government of India is updated each five years through a BPL census/survey conducted by Govt. machinery, and a BPL card is given to all the eligible Citizens. There are several citizen centric poverty alleviation schemes provided by both federal and provincial Government for the BPL card holders. We are discussing some of the scheme as discussed below for our case study

3.2. NREGA Service

Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) aims to guarantee the 'right to work' and ensure livelihood security in rural areas by providing at least 100 days of guaranteed wage employment in a financial year to every BPL household. This scheme is implemented and monitored under Panchayat Raj (PR) Department, Govt. of Odisha.[7]

3.3. IAY Service

Indira Awaas Yojana (IAY) is a social welfare program, funded by the Government of India, to provide free pucca houses for the rural BPL card holders in India. It ensures that financial assistance worth Rs.70,000/- in plain areas and Rs.75,000/- in difficult areas (high land area) is provided for construction of houses.[8] This scheme is implemented and monitored under Panchayat Raj (PR) Department, Govt. of Odisha.

3.4. AAY Service

Antyodaya Anna Yojana (AAY) is a food security program, partially funded by the Government of India to the rural BPL card holders. It to ensure to provided 35 KG. of food grains(25kg wheat and 10 kg rice) a month, wheat at Rs.2/- per KG. and rice at Rs.3/- per KG throughout India. The Odisha provincial Government further gives subsidy and provides 35 KG of rice at Rs 1/- per KG.[9] This scheme is implemented and monitored by Food and Civil Supply Department, Govt. of Odisha.

3.5. MAMATA Service

The scheme will provide monetary support to all the BPL pregnant and lactating women, which will enable them to seek improved nutrition and promote health seeking behavior. The beneficiary will receive (for first two births) a total incentive of Rs. 5000/- in four instalments, subject to the fulfilment of specific conditions. Payment will be made by e-transfer from the Child Development Program Officer (CDPO) to the beneficiary account.[10] This scheme is implemented and monitored by Food and Civil Supply Department, Govt. of Odisha.

3.6. KJY Service

Kutir Jyoti Yojana (KJY), this programme envisages for extending a single point light connections to all IAY households of rural BPL families. It ensures that the beneficiaries will get electricity connection with one point wiring, meter and one Compact fluorescent Light (CFL) of 18 to 20 watts in his IAY hut.[11] This scheme is implemented and monitored by Energy Department, Govt. of Odisha.

3.7. RSBY Service

Rashtriya Swasthya Bima Yojana (RSBY), is a government-run health insurance scheme for the BPL poor families enrolled under NREGA scheme, the insurance amount is paid by Government. It ensure that the beneficiaries are insured and are entitled to hospitalization (public as well private hospitals), for a coverage up to Rs. 30,000/- for most of the diseases that require hospitalization.[12] Coverage extends to five members of the family which includes the head of household, spouse and up to three dependents. This scheme is implemented and monitored by Labour Department, Govt. of Odisha.

4. SERVICE COMPOSITION

Service Composition encourages the design of services that can be reused in multiple solutions that are themselves made up of composed services. The ability of the service to be recomposed is ideally independent of the size and complexity of the service composition. This principle is directly responsible for the agility promised by SOA as it promotes composing new solutions by reusing existing services. For our case study the overall service composing is shown in the following figure-1, which shows the reusable policy. The arrows shows which service can access other services. The service composition of individual services is discussed in the following section in detail.

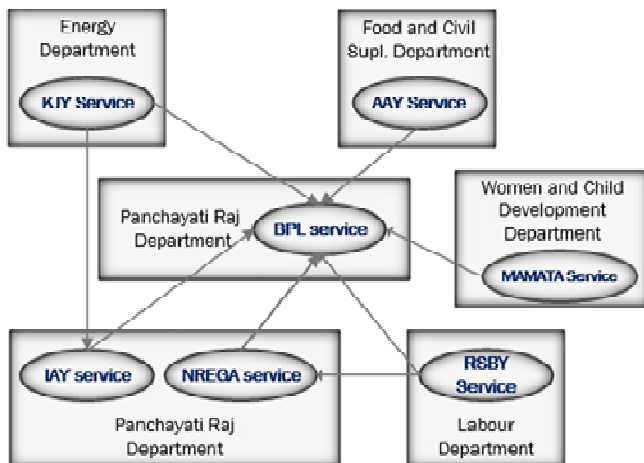


Figure 1. The overall Service composition diagram for the web services

4.1. To Add Citizen into NREGA

Figure 2 shows how to add a new citizen to the NREGA database, the NREGA web service invokes the BPL web service to find either the citizen has enrolled under BPL category or not. If found enrolled in BPL then the BPL web service returns the detail parameters including the BPL_ID_NO of the BPL family to the NREGA web service, else the BPL web service send a rejection message to the Citizen with reason. The NREGA web service checks whether the BPL_ID_NO is already enrolled in the NREGA database or not. If not enrolled, NREGA web service adds the family into NREGA database to ensure 100 days of work with minimum wages and furnishes a NREGA_ID_NO to the family. If the BPL_ID_NO is already enrolled in the NREGA Database, then the NREGA web service rejects the entry and informs the citizen the reason of rejection. Here both the web services are interacting with the databases of the same department that is Panchayat Raj Department.

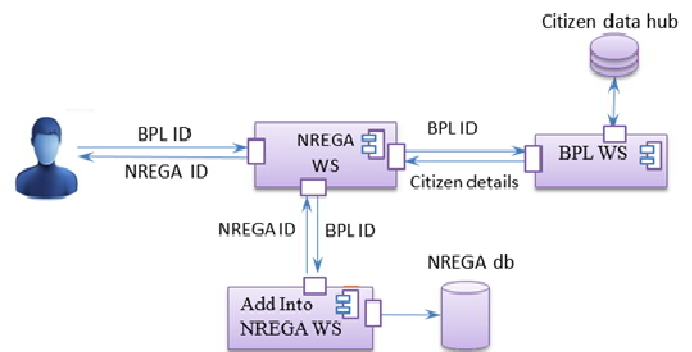


Figure 2. The Service composition diagram for NREGA web services

4.2. To Add Citizen into IAY

Figure 3 shows how to add a new citizen to the IAY database, the IAY web service invokes the BPL web service to find either the citizen has enrolled under BPL category or not. If found enrolled in BPL then the BPL web service returns the detail parameters including the BPL_ID_NO of the BPL family to the IAY web service, else the BPL web service send a rejection message to the Citizen with reason. The IAY web service checks whether the BPL_ID_NO is already enrolled in the IAY database or not. If not enrolled, then as per the Government sanction for number of IAY to be given for the financial year, per District/ per Block/ per GP/ per Village on population ratio, the family is added to the IAY Database through the IAY web service, which furnishes a IAY_ID_NO to the family. If the BPL_ID_NO is already enrolled in the IAY Database, then the IAY web service rejects the entry and informs the citizen the reason of rejection. Here both the web services are interacting with the databases of the Panchayat Raj Department of Govt. of Odisha.

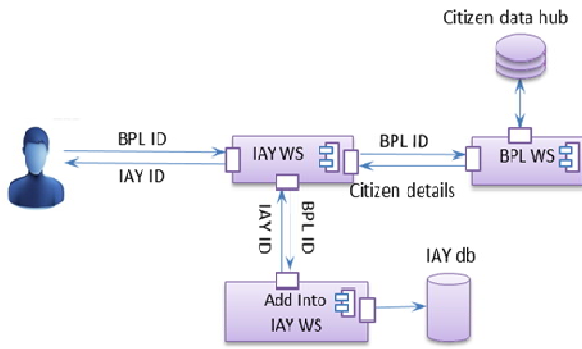


Figure 3. The Service composition diagram for IAY web services

4.3. To Add Citizen into MAMATA

Figure 4 shows how to add a new citizen to the MAMATA database, the Mamata web service invokes the BPL web service to find either the citizen has enrolled under BPL category or not. If found enrolled in BPL then the BPL web service returns the detail parameters including the BPL_ID_NO of the BPL family to the Mamata web service, else the BPL web service send a rejection message to the Citizen with reason. The Mamata web service checks whether the BPL_ID_NO is already enrolled in the Mamata database or not. If not enrolled, Mamata web service adds the pregnant lady information of the BPL family into Mamata database to ensure institutional delivery and provide monetary support to the pregnant and lactating women which will enable them to seek improved nutrition and promote health seeking and furnishes a Mamata_ID_NO to the pregnant member of the family. If the BPL_ID_NO is already enrolled in the Mamata Database, then the Mamata web service crosschecks the name of the female member, if not matches issues a new Mamata_ID_NO for the same BPL_ID_NO otherwise rejects the entry and informs the citizen the reason of rejection. Here the web services are interacting with the databases of two separate departments that is Panchayat Raj Department and Women and Child Development Department of Govt. of Odisha.

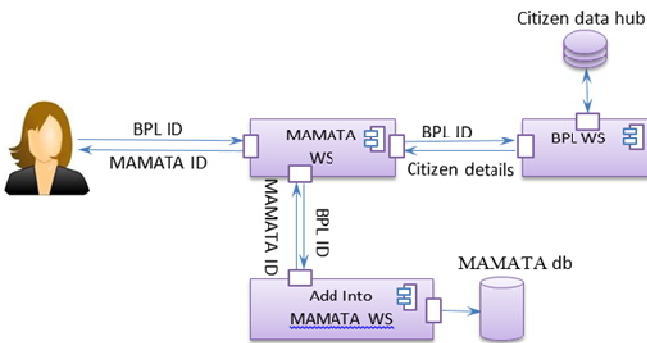


Figure 4. The Service composition diagram for MAMATA web services

4.4. To Add Citizen into AAY

Figure 5 shows how to add a new citizen to the Antyodaya Anna Yojana Database, the AAY web service invokes the BPL web service to find either the citizen has enrolled under BPL category or not. If found enrolled in BPL then the BPL web service returns the detail parameters including the BPL_ID_NO of the BPL family to the AAY web service, else the BPL web service send a rejection message to the Citizen with reason. The AAY web service checks whether the BPL_ID_NO is already enrolled in the AAY database or not. If not enrolled, AAY web service adds the family into AAY database, and furnishes an AAY_ID_NO to the family. If the BPL_ID_NO is already enrolled in the AAY Database, then the AAY web service rejects the entry and informs the citizen the reason of rejection. Here the web services are interacting with the databases of two separate departments that is Panchayat Raj Department and Food and Civil Service Department of Govt. of Odisha.

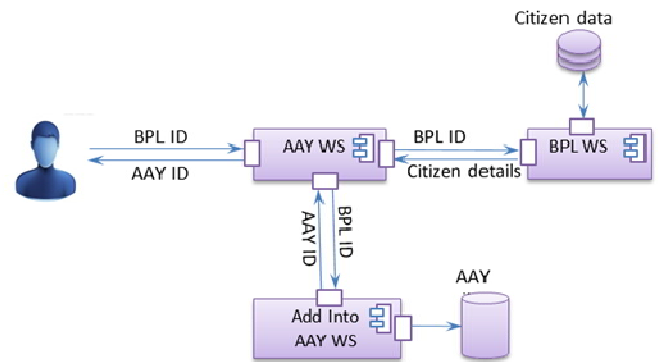


Figure 5. The Service composition diagram for AAY web services

4.5. To Add Citizen into RSBY

Figure 6 shows how to add a new citizen to the RSBY Database, the RSBY web service invokes the NREGA web service which in turn invokes the BPL web service to find either the citizen has enrolled under BPL category or not. If found enrolled in BPL then the BPL web service returns the detail parameters including the BPL_ID_NO of the BPL family to the NREGA web service, else the BPL web service send a rejection message to the Citizen with reason. The NREGA web service checks whether the BPL_ID_NO is already enrolled in the NREGS database or not. If not enrolled, then the NREGS web service sends the BPL details with BPL_ID_NO to the RSBY web service. If the BPL_ID_NO is already enrolled in the NREGA Database, then the NREGA web service rejects the entry and informs the citizen the reason of rejection. The RSBY web service checks whether the NREGA_ID_NO is already enrolled in the RSBY database or not. If not enrolled, RSBY web service adds the NREGA details of the family into RSBY database. Also RSBY web service furnishes different RSBY_ID_NO to the

family members as per the norm. If the NREGA_ID_NO is already enrolled in the RSBY Database, then the RSBY web service rejects the entry and informs the citizen the reason of rejection. Here there are three web services are in action, two of them interacting with the databases of the Panchayat Raj Department (State Govt.) and the third one interacting with the databases of the Ministry of Labour and Employment, Government of India.

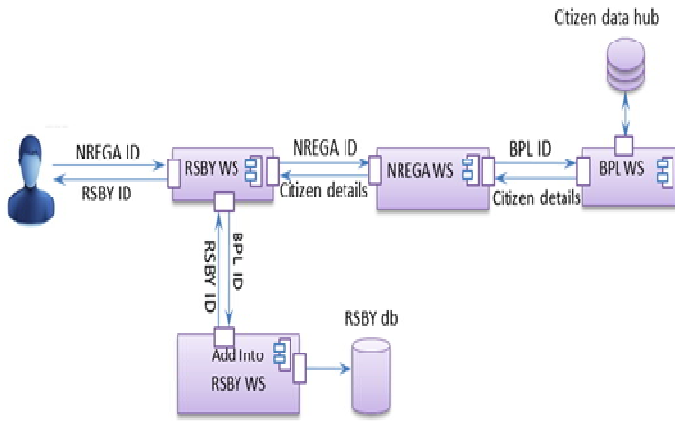


Figure 6. The Service composition diagram for RSBY web services

4.6. To Add Citizen into KJY

Figure 7 shows how to add a new citizen to the KutirJ Database, the KJY web service invokes the IAY web service which in turn invokes the BPL web service to find either the citizen has enrolled under BPL category or not. If found enrolled in BPL then the BPL web service returns the detail parameters including the BPL_ID_NO of the BPL family to the IAY web service, else the BPL web service send a rejection message to the Citizen with reason. The IAY web service checks whether the BPL_ID_NO is already enrolled in the IAY database or not. If not enrolled, then the IAY web service sends the BPL details with BPL_ID_NO to the KJY web service. If the BPL_ID_NO is already enrolled in the IAY Database, then the IAY web service rejects the entry and informs the citizen the reason of rejection. The KJY web service checks whether the IAY_ID_NO is already enrolled in the KJY database or not. If not enrolled, KJY web service adds the IAY details of the family into KJY database and

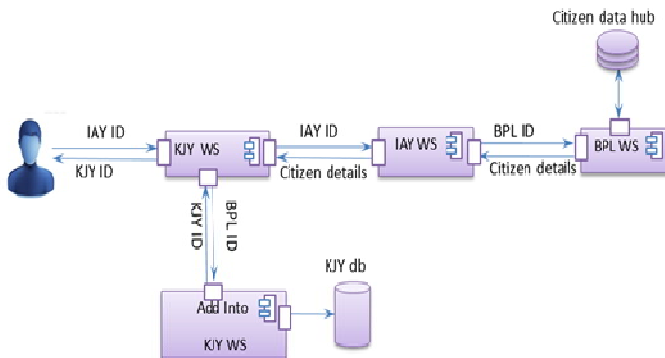


Figure 7. The Service composition diagram for KJY web services

furnishes a KJY_ID_NO to the family. If the IAY_ID_NO is already enrolled in the KJY Database, then the KJY web service rejects the entry and informs the citizen the reason of rejection. Here there are three web services are in action, two of them interacting with the databases of the Panchayat Raj Department and the third one interacting with the databases of the Energy Department of Govt. of Odisha.

5. SERVICE ORCHESTRATION

Orchestration describes the work flow of how services interact, including the business logic and order of interactions. In our case study, we clearly described how service orchestration is working (for some particular cases), as for example: for adding a citizen into Kutir Jyoti Yojona (KJY), workflow starts from BPL service, to IAY service and then to KutirJ service. The overall service orchestration for our case study is described below in figure-8. The figure below explains the orchestration that can be generated from different business processes as depicted. The orchestration is composed of three composite services. The IAY service orchestrates KUTIRJ service and the NREGA service orchestrates the RSBY service. The BPL service orchestrates the rest of remaining services.

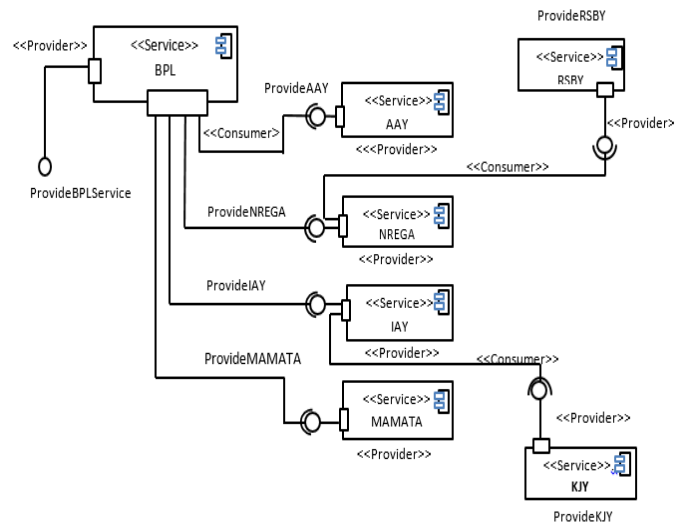


Figure 8. The Service orchestration diagram for the web services

6. SERVICE REGISTRY

The service registry contains all the information about service deployments, their locations, and the policies associated with invocation at each location. The service provider creates a web service and publishes its interface and access information to the service registry. Each provider must decide which services to expose. The service consumer or web service client locates entries in the broker registry using various find operations and then binds to the service provider in order to invoke one of its web services. Whichever service the service-consumers need, they have to take it into the brokers,

bind it with respective service and then use it. They can access multiple services if the service provides multiple services. For our case study all the seven services described above in section 3 are published by the respective departments into a private registry as shown in Figure 9. In Figure 9, the curved dotted lines show the communication between services, the dotted straight lines shows the publishing of the service by a department and the solid lines show the access of the services.

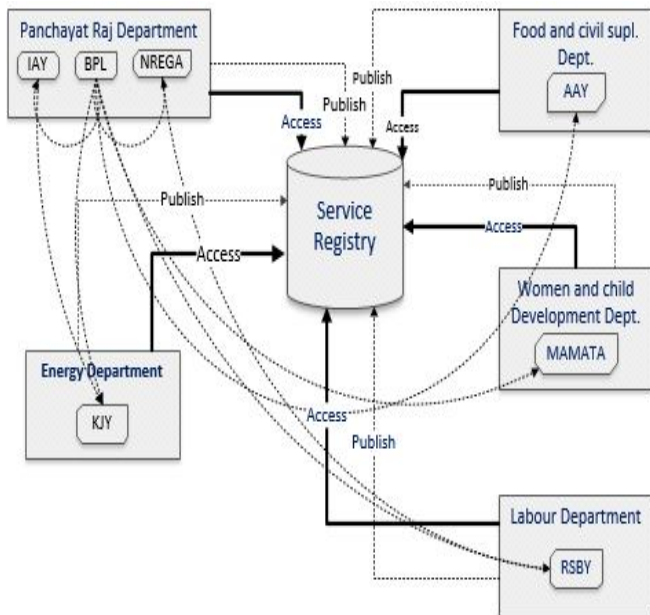


Figure 9. The Service registry diagram for the web services

7. PROPOSED LAYERED APPROACH

For explaining the layered approach, we are considering the services we have taken in section 2. In this section we are trying to describe the layered approach taking two scenarios 1) Simple Case: Where services are interacting within the same department/ Ministries. 2) Complex Case: Where services are interacting among different departments/ Ministries. For both the cases we are discussing the service interaction algorithm, service interaction diagram and the layered diagram. Finally we are discussing the generalised service interaction algorithm and the layered diagram, where services require to interact among several departments/ Ministries.

7.1. Simple Case

Once the Citizen request the Panchayat Raj Department to enroll into National Rural Employment Guarantee Scheme. NREGA web service invokes the BPL web service to find either the citizen has enrolled under BPL category or not. The NREGA web service checks whether the citizen has already enrolled in the NREGA database or not. If not enrolled, NREGA web service adds the family into NREGA database. The detailed algorithm to add a citizen into NREGA database is given in Table 1.

TABLE 1. ALGORITHM FOR ADDING CITIZEN INTO NREGA

(1)	SEARCH service registry of NREGA service
(2)	SEND input data to NREGA service
(3)	IF (citizen is under NREGA) THEN
(4)	REJECT request
(5)	TERMINATE
(6)	ELSE //BPL service required
(7)	SEARCH service registry of BPL service
(8)	SEND required data to BPL service
(9)	IF (citizen is under BPL) THEN
(10)	GRANT request
(11)	ACCESS BPL info for that citizen
(12)	SEND required BPL info to NREGA service
(13)	ADD citizen to NREGA database
(14)	ELSE
(15)	REJECT request
(16)	TERMINATE
(17)	END_IF
(18)	END_IF

The service interaction diagram to add a citizen into NREGA database is shown below as in figure 10. The user sends request to NREGA service which checks the user is already enrolled in NREGA or not, otherwise sends a request to BPL service to check the BPL status of the user.

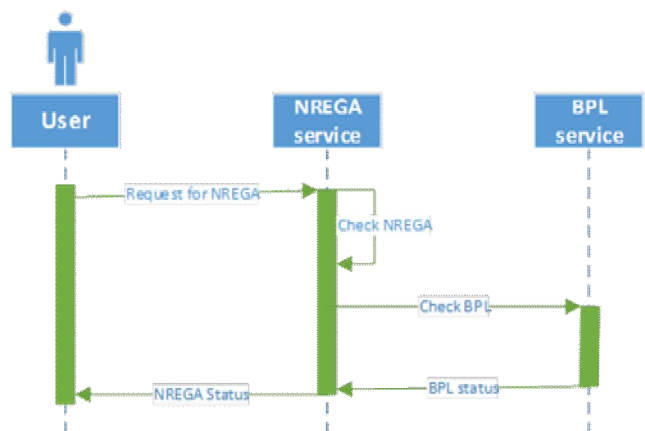


Figure 10. The interaction diagram to add a citizen into NREGA

The service layered diagram to add NREGA is shown in figure

11. When the user requests the NREGA service of Panchayat Raj department to add the user to get NREGA benefits, then the NREGA service checks the user is already enrolled in NREGA or not. Otherwise invokes the BPL service of the same department and gives the appropriate response.

7.2. Complex Case

It is about using services from different departments (some time of the same department), which needs to refer its own department's service registry as well as service registry from other departments and interacts with the required services. For example, once a Citizen requests the Energy Department

to enroll into Kutir Jyoti Yojana (KJY), KJY web service checks if the citizen is already in KJY database or not. If not, it invokes the IAY web service to check whether the citizen has already enrolled into IAY. If yes, the IAY web service

stores the reply messages from several services which will be

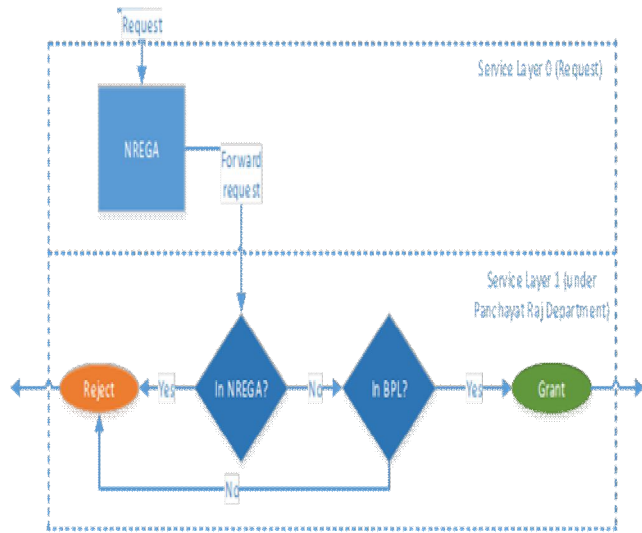


Figure 11. The Service layered diagram for NREGA web service

invokes the BPL web service to get the detail parameters of the citizen. After getting the detail parameters from IAY web service, KJY web service adds the citizen to KJY database. All the alternative cases above, will lead to rejection of the request. In this case the service interaction is among Energy Department, Panchayat Raj Department and Rural

TABLE 2 ALGORITHM FOR ADDING CITIZEN INTO KJY

Development Ministry. The detailed algorithm to add a citizen into KJY database is given in Table 2.

- (1) SEARCH service registry of KJY service
- (2) SEND input data to KJY service
- (3) IF (citizen is under KJY) THEN
- (4) REJECT request
- (5) ELSE //IAY & BPL service required
- (6) SEARCH service registry of IAY service of PR Dept.
- (7) SEND required data to IAY service of PR Dept.
- (8) IF (citizen is not under IAY) THEN
- (9) REJECT request
- (10) TERMINATE
- (11) ELSE
- (12) GRANT request
- (13) SEND required data to BPL service of PR Dept.
- (14) ACCESS BPL info for that citizen
- (15) SEND required BPL info to KJY service
- (16) ADD citizen to KJY database
- (17) END_IF
- (18) END_IF

The service interaction diagram to add a citizen into KJY database is shown in the figure 12 and the service layered diagram is shown in figure-13

7.3. Generalised Case

We generalise the above layered approach for complex service requests and responses. The generalised algorithm is shown in Table 3. In the algorithm, REPLY[] is an array which

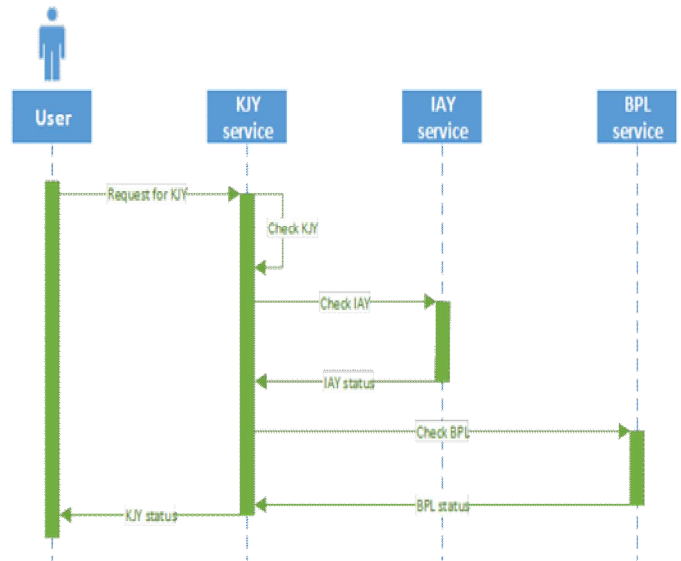


Figure 12. The interaction diagram to add a citizen into KJY

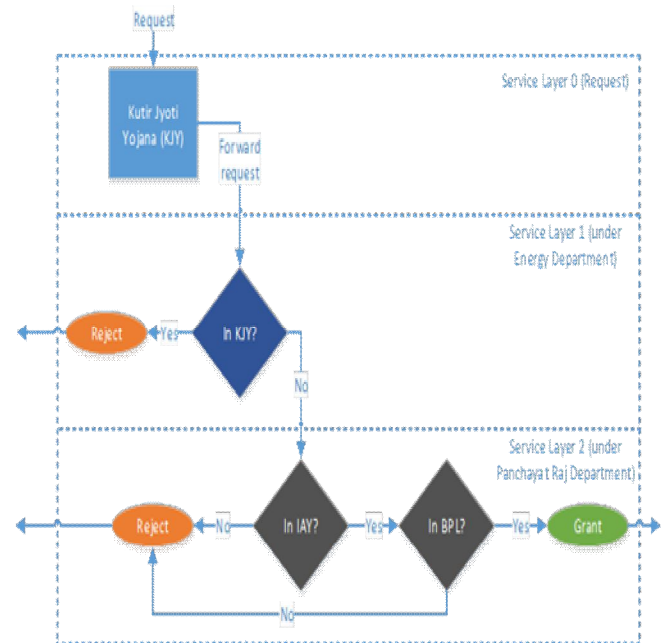


Figure 13. The Service layered diagram for KJY web services

TABLE 3 ALGORITHM. THE GENERALISED ALGORITHM

accessed during the process.

- (1) S SERVICE Sk:
- (2) WAIT for service request
- (3) IF (incoming request = FOUND) THEN
- (4) RECEIVE data from Citizen
- (5) IF (received data = INSUFFICIENT or INCORRECT) THEN
- (6) reject request
- (7) RETURN error
- (8) ELSE
- (9) PROCESS the request
- (10) IF (records for the data = NOT FOUND) THEN
- (11) reject request
- (12) RETURN error
- (13) END_IF
- (14) IF (NEED to access other services = TRUE)
- (15) IDENTIFY the required services

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(16) FIND required services from service registry
(17) FOR EACH (required services)
(18)     REPLY [] = access service []
(19) END_FOR EACH
(20) END_IF
(21) PROCESS the reply, REPLY []
(22) END_IF
(23) SEND REPLY to Citizen
    
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The generalised interaction diagram will look like as shown in figure 14. When the user requests a service S_1 , in turn it requests service S_2 , and so on up to service S_n . The response pattern starts from S_n to S_{n-1} and so on up to S_1 .

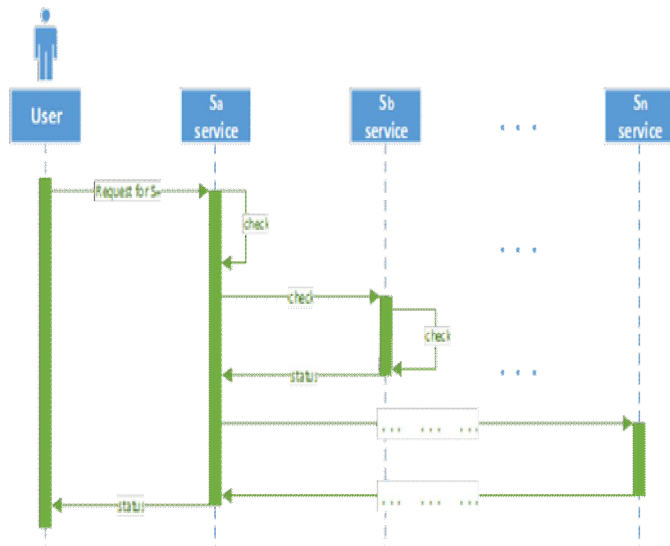


Figure 14. The Generalised Service Interaction Pattern

The generalised service layered diagram is shown in figure 15. When the user requests service S_k (where k is from 1 to n), it checks the service in department D_1 . If found, the request is rejected, else the request moves to the next below layer and checks the services of the department D_2 . The same procedure of moving to the below layer follow up to the n^{th} department D_n depending upon the complexity of the service.

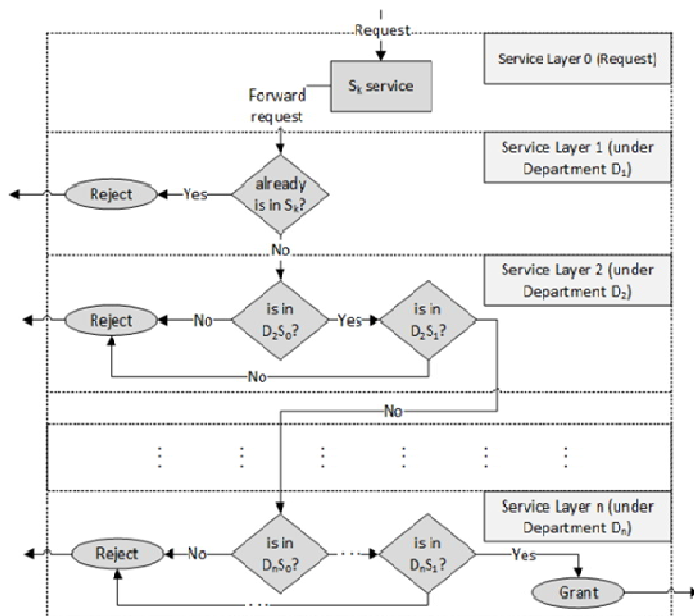


Figure 15. The Generalised Service Layered Approach for many departments

8. CONCLUSION

Developing e-Governance applications has been a daunting task because of the inherent complexity, dynamic requirements and need for interoperability. The service oriented approach has emerged as a viable alternative to address the intriguing issues in the implementation of e-Governance systems. In this work, we have proposed a layered service oriented design approach to build a service hierarchy corresponding to various services offered by different government departments. We have shown how services can be dynamically composed on-the-fly while provisioning services at higher-level of granularity. The concepts developed are also explained through different case studies. In future work, the authors plan to implement the above described design approach to develop different new services to help the provincial and district administration to prepare the unbiased beneficiary list for different social and food security schemes, from the suggested list by the new services. The application will also help the citizen in quick decision making to apply for the most eligible services applicable for him/ her.

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