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# ServiceNet: An Agent-Based Framework for One-Stop E-Government Services

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# SERVICENET: AN AGENT-BASED FRAMEWORK FOR ONE-STOP E-GOVERNMENT SERVICES

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## Abstract

*One-stop provision of Web-based services is a major goal of e-government. Often service delivery requires several steps cutting across multiple departments or agencies, each with separate eligibility and other rules, data requirements, and processes. For this complex setting, we develop a tiered, intelligent-agent-based framework called ServiceNet. The layers include client problem diagnosis, service planning, and service provision. The central contribution of our framework are corresponding client problem diagnostic, client advocate, and service facilitator agents. We define a service plan to be the steps that a citizen client can take to meet a need. Each service has 1) a rule base of entry requirements, including predecessor and successors steps, that must be satisfied before a client can register for the service; 2) one or more processes; 3) associated database record sets; and 4) a facilitator agent, which provides information on meeting eligibility rules, finding service capacity, scheduling, etc. The client advocate communicates with service facilitator agents to build, execute, monitor, and report on service plans.*

**Keywords:** E-Government, one-stop, intelligent agent, service delivery

## Introduction

*Jim Smith's predicament: "I live in Pittsburgh and have an elderly aunt, Aunt Molly, who also lives in town. Yesterday, Aunt Molly fell and broke her hip. I'm Aunt Molly's only living relative. Aunt Molly has next to no financial resources, except for Medicare and Social Security. She'll be in the hospital for four weeks and then will be discharged but can't go back to her apartment. What can I do? I have no clue, but I'm all that she has."*

Government provides many valuable direct services for citizens; for example, human services for the less fortunate or vulnerable members of society, such as Aunt Molly, providing sufficient food, shelter, healthcare, protection from abuse, etc. for a decent living. Unfortunately, along with government services, typically there also comes much bureaucracy, inconvenience, and wasted time for citizens in obtaining those services, if they can be located at all. In contrast, in the future, Jim Smith should be able to go to an e-government Web site, key in *"My Aunt Molly broke her hip ... What can I do?"* and get the services he and Aunt Molly need.

E-government and its one-stop government objective is the first really promising approach for reducing bureaucracy and increasing the access to and quality of services (e.g., Newcombe 2000, Robb 2000). The basic idea is that a citizen should be able to approach an e-government Web site on his/her own terms. Then a computer program should guide him/her through one or more steps, cutting transparently across agencies as needed to provide services (DiCaterino & Prado, 1996)

## Unique Features of E-Government

E-government can benefit from the experiences of e-commerce (Traunmüller & Lenk, 2000; Wimmer et.al, 2001). At the same time, unique characteristics of public agencies preclude any one-to-one mapping of such experiences. The list of unique features of government is long (e.g., lack of incentives, democratic decision processes, political cycle, civil service employment, etc.), but

one of the most promising targets for e-government is in reducing the high "friction" of obtaining government services. Two major causes of friction are:

(a) *Government bureaucracy* – a multitude of complex, often redundant, and often conflicting eligibility and other rules. Problem solving often requires the services of multiple agencies. Each agency generally maintains its own culture, terminology, requirements, and islands of data. The result for clients is a often a crazy-quilt of unintelligible, impenetrable programs and services.

(b) *Red tape* – many layers of approval and restrictions to provide accountability and protections against misuses of government resources. This part of government adds intentional friction.

One-stop government would benefit much from electronic representation and processing of rules and red tape. Much of one-stop government, however, needs to be decentralized. No central unit could master all of the details of all services. At the same time, there needs to be a means of searching for appropriate services and getting help in assembling a plan of action for a client and his/her problem.

## Three-Tiered Framework

We propose a three-tiered framework based on intelligent agents (Woodridge & Jenning, 1995) to provide one-stop services (see Figure 1). The layers move from a diagnosis of the client's problem (Client Problem Diagnostic Layer), to determining steps for a good solution to the problem (Service Planning Layer), to provision of services across one or more agencies (Service Provision Layer). Our primary contribution is in the middle layer of Service Planning, for which we propose an intelligent agent, drawing heavily on DecisionNet [Bhargava, et.al., 1996, 1997; Gunther et al, 1997]. DecisionNet provides agents that devise computational plans for using decision support software components over the Internet, paying particular attention to inputs and outputs of each such component. In contrast, our Client Advocate Agent devises a *service plan* consisting of feasible steps to meet entry rules and gain services across one or more agencies. Also new in ServiceNet, is a Service Facilitator Agent for each service, designed and maintained by individual agencies. The Client Advocate Agent communicates with Service Facilitator Agents when devising service plans.

The Client Problem Diagnostic Layer is one that will likely retain human servers (e.g., social workers) as well as use computerized support such as expert systems. The client states his/her problem in a minimally structured format. The Client Problem Diagnostic Agent translates this problem statement into a more structured format in terms of a set of problem objectives. In Jim Smith's predicament, the social worker/expert system combination can determine that Aunt Molly needs to be in a nursing home with good physical therapy for approximately six weeks, and then she can return to her apartment. In her apartment, she can get home delivered services for an additional recovery time.

The Client Problem Diagnostic Agent communicates the set of problem objectives to the Client Advocate Agent. The Advocate Agent serves as an intermediary (Sakar et.al., 1996; Krishnan & Padman, 1997) between the clients and the agencies providing services. The Advocate Agent maintains a database of services available (together with service characteristics). This database is populated and updated when Service Facilitator Agents register their services and corresponding requirements with the Advocate Agent. In response to the query from the Diagnostic Agent, the Advocate Agent queries its database, communicates with the Service Facilitator Agents, and constructs and evaluates alternative service plans that will meet the set of problem objectives (Allen et.al., 1991, Asvanund et.al., 1998). The set of alternative service plans are communicated to the Client Diagnostic Agent. The Client Diagnostic Agent (with input from the client and social worker) selects a service plan which the Advocate Agent implements. The Advocate Agent also monitors the execution of the plan and reports on results.

Next, it is the Client Advocate Agent's turn. The Client Advocate Agent serves as an intermediary (Sakar et.al., 1996; Krishnan & Padman, 1997) between the clients and the agencies providing services. The agent maintains a (virtual or real) database of services available (together with service characteristics), searches the services database in response to a query form a client, queries Service Facilitator Agents, assembles and evaluates alternative service plans (Allen et.al., 1991, Asvanund et.al., 1998), helps select a service plan, implements the plan, monitors its progress, and reports on results.

There are several alternative ways in which the client advocate agent could be realized. One would be to function like a sophisticated comparison shopping engine. Currently, comparison shopping engines are unintelligent (see www.dealtime.com for an example) and search through a fixed (usually 30 or so) set of vendor sites in response to a query (say for the price of a book). The retrieved offers are far too many – demanding a cognitive cost from the user to process them – and the retrievals take

much longer (usually of the order of 40-50 seconds) than it takes to retrieve an offer from a single vendor (less than 4 seconds). Intelligent comparison search engines (see Montgomery et. al, 2001) can use knowledge of prices at vendors and response times of their sites to decide on the optimal set off vendors to query for a price of a book. The offer set retrieved by these engines maximizes consumer utility. In a similar manner, a client advocate agent could conduct searches among the set of e-government services available to maximize utility to the citizen client.

While a utility maximizing approach provides a decision theoretic underpinning to our agent design, new advances in computing architectures can also be adapted to the needs of our e-government context. In particular, we believe that the agents in

**Client(1), Client(2), …, Client(n)**

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┌─────────────────────────────────────┐  ┐
│   Client Problem Diagnostic layer    │  │
│   [Client Problem Diagnostic Agent]  │  │
└─────────────────────────────────────┘  │  External to agencies
           ⇕                              │
┌─────────────────────────────────────┐  │
│      Service Planning Layer          │  │
│      [Client Advocate Agent]         │  │
└─────────────────────────────────────┘  ┘
           ⇕
┌─────────────────────────────────────┐  ┐
│     Service Provision Layer          │  │
│   [Service Facilitator Agents]       │  │  Agency level
│                                      │  │
│  Agency(1), Agency(2), …, Agency(m)  │  │
└─────────────────────────────────────┘  ┘
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**Figure 1.  The ServiceNet Framework**

ServiceNet can be designed as a self organizing community of utility maximizing agents. These self-organizing communities will consist of intelligent computer agents that aid in relaying information and actively seeking out other community members that are similar to themselves. A new network protocol called Gnutella (Oram, 2001; Wego.com, 2001) can be adapted for this purpose. A computer agent using Gnutella can monitor its local network topology and traffic. Our proposal is to embed intelligent decision-making and learning capabilities in these agents to enable them to process information that they collect or may otherwise be able to obtain about the network. Using the learning capabilities, the agent can develop knowledge about the other computer agents in the network to which it is connected. Using the decision making capabilities, it can decide which other agents it should connect to and when faced with an information retrieval task, determine the agents it should query to maximize the utility to the citizen client of the response.

In ServiceNet, a service consists of four parts: 1) *rule base* of eligibility requirements, predecessor and successor requirements, etc., 2) *service processes* that deliver services (e.g., screening, registration, treatment, follow-up, etc.), 3) *database* for recording client, service provider, transactions, etc.), and 4) *Service Facilitator Agent* which provides information on meeting eligibility rules, making exceptions to rules, finding service capacity, scheduling, suggesting subsequent services, etc. The Service Facilitator Agent registers it's service with the Client Advocate Agent. Communication between the layers in the framework is via XML documents (Khare, 1997, Asvanund, 1998).

The Service Facilitator Agent's design must follow two important principles that allow the Client Advocate Service Agent place faith in it: 1) it must implement the policies and SOPs of the agency and 2) it must serve the client's best interests. In regard to these principles, it may be desirable to conduct periodic audits of Service Facilitator Agents, to ensure that they are faithful and not covering up agency wrongs or limitations. With faith established, the Client Advocate Service Agent can benefit from decentralization and be free of the details of service provision. The Client Advocate Service Agent merely passes needed inputs to the Service Facilitator Agent, and gets back results as needed for then next phase of the service plan.

## Revisiting Aunt Molly

In Aunt Molly's case, the Client Advocate Agent adds the expertise that the nursing home should be within the vicinity of Jim Smith's residence, so that he can easily visit Aunt Molly regularly. The agent finds one within two miles of Jim's house and the corresponding Service Facilitator agent responds that the nursing home has a suitable bed expected to be available at the time of Aunt Molly's planned hospital discharge date. The agents also determine that Aunt Molly qualifies to have Medicare pay entirely
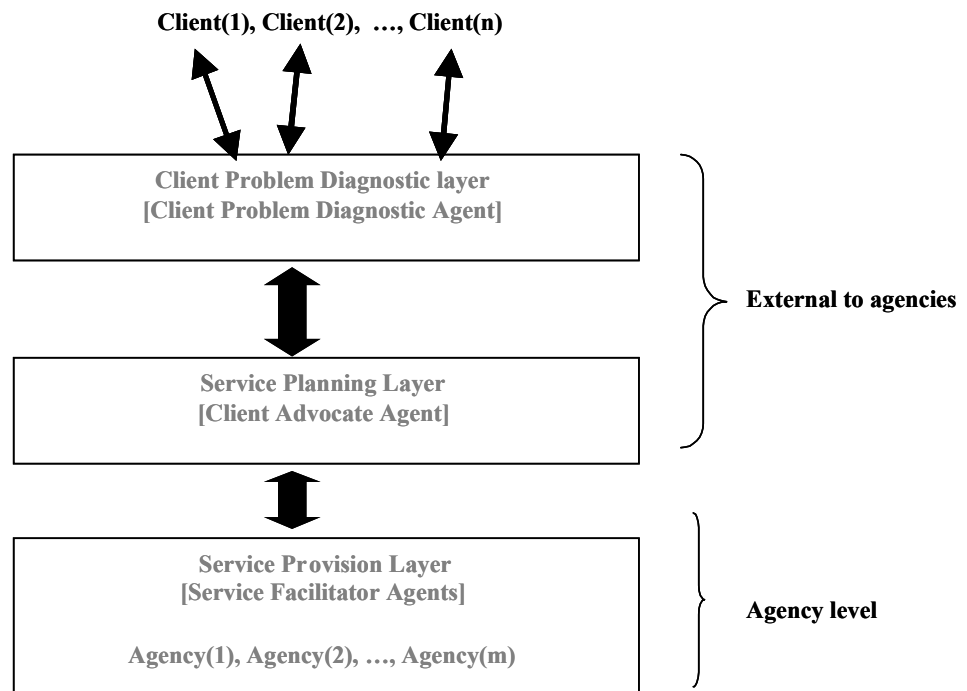
for the nursing home visit and physical therapy, based on her limited financial resources, schedules the necessary interview of Aunt Molly by the nursing home admissions staff nurse, and has Aunt Molly registered for admission with all paperwork done electronically.

Next, the Client Advocate Agent determines that Aunt Molly meets income, age, and home-bound requirements of home delivered services; that there are two meals on wheels kitchens that can serve Aunt Molly; and suggests one kitchen that has a menu meeting Aunt Molly's special dietary needs. The Service Facilitator Agent of the selected kitchen determines that while the kitchen is currently at capacity, a slot on the delivery schedule can be reserved for Aunt Molly and is expected to become available by the time she returns home. Even if a slot is not available, the kitchen will take her on a temporary, overload basis. Easier to find by the Client Advocate Agent are good home nursing and home cleaning services. The agent finds that the county will pay for all of these services, except the nominal cost of the meals, which Aunt Molly can afford.

## Related Issues

Two related issues worthy of discussing are the potential for a fourth agent and the issue of representing services in databases.

One potential agent not discussed until now is the ombudsman, who has the role of representing clients who have complaints against government agencies or staff. The ombudsman provides accountability and redress of wrongs, and thus provides valuable feedback. Some electronic agent-based capabilities may facilitate this role.

In regard to service databases, the hierarchy of services is: Organization.Agency.Service.Process. Ultimately, it will desirable to have one-stop government cut across not only agencies within a government, but also across governments and even non-profit and private organizations as well; hence, the root of the hierarchy is organization and then agency. Next below agencies are services and processes. Clearly, each service needs to be registered with a unique ID and descriptive attributes at the organization level for the Client Advocate Service Agent to search. Then within an agency, there needs to be records of services and processes for the Service Facilitator Agent to process, including collections of rules and other attributes. These processes and services will be referenced in transaction records that record the client, the predecessor process or service, the date/time of the start and finish of a process or service, the server, etc. These data, at the level of granularity that is practical or useful, serve as the basis of a management information system. Uses for the data include tracking status of a client, identifying bottlenecks, estimating service volumes and trends, providing outcomes performance measures, identifying targets for re-engineering, etc.

## Conclusion

This is a great deal of activity on e-government. With the Y2K problem solved, governments everywhere have pent-up demand for new computer systems development, and to meet a lot of this demand have the new-to-government, enabling technology of the Internet. Much good, but ad hoc system design is taking place. We propose ServiceNet as an overarching framework and ultimate target of the one-stop, e-government movement. ServiceNet integrates government, non-profit, and even private-sector services, with coordination by a community of interacting electronic agents that address the special bureaucratic and red tape features of government.

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