UDC 621.316.925:519.68
Professional paper
Received: 06.11.2008.

A plug and play model for JINI based on-line relay control for power system protection

Kannan Nithiyananthan[(1)] and **Velimuthu Ramachandran**[(2)]
[(1)]Department of Electrical and Electronics Engineering, Birla Institute of Technology and Science,
Knowledge Village, Dubai, P.O. Box 500022, UNITED ARAB EMIRITATES
e-mail: nithi@bitsdubai.com
[(2)]Department of Computer Science and Engineering, College of Engineering, Guindy,
Anna University, Chennai 600 025, INDIA
e-mail: rama@annauniv.edu

SUMMARY

The main objective of this paper is to construct a distributed environment through which the on-line relay control of power systems can be monitored and controlled. A single-server/multi-client architecture has been proposed which enables the neighboring relays to access the remote relay control server at any time, with their respective identity to enable to get the plug and play service of on-line relays. A JINI based distributed model has been developed in such a way that for every specific period of time, the remote relay control server obtains the system data simultaneously from the neighboring relays with which the clients are registered so that the server sends back the response to the respective clients. The relay control server creates a new thread of control for every client request and hence a complete distributed environment has been exploited.

***Key words**: distributed computing, power system protection, digital relay, JINI, client-server model.*

1. INTRODUCTION

For the proper operation of the power system, an effective, efficient and reliable protection scheme is desirable. The power system component, which includes synchronous machines, bus bar, transformer, transmission line and distribution system consisting of complex and composite loads are designed to operate under normal conditions of voltage, frequency, power factor etc. However, due to some fault, if any of these quantities such as voltage, current and power factor becomes abnormal there should be a fast acting device which takes care of the security of the power system components [1]. It is necessary because power system components can never be designed to withstand the worst possible conditions, since the whole system will be uneconomical. The protection scheme includes both the protective relay and the switching circuit. The protective relays are the brain of the entire power system protection. Today power system protection has become more complicated and complex because it has to carry out much more functionality in order to ensure protection. Although in modern power system protection digital computers and microcomputers are involved greatly but there exists lagging of interoperability between the various relays. Service oriented architecture for the relay control is very much required in order to ensure fast and smooth control of power system protection [2].

This paper outlines a new approach to develop service oriented JINI [3] based architecture for on-line digital relay control in a distributed environment. The proposed architecture has several advantages over the traditional protection systems such as mobility of

the algorithms, flexible design pattern object orientation, easy to use, better interoperability accepting the legacy protection systems [4]. Since JINI uses built in java security mechanisms that allow the relay data control system to be safe and secure. In addition it uses the security manager defined to protect systems from hostile applets to protect the network from potentially hostile downloaded code.

2. JINI BASED ARCHITECTURE FOR AUTOMATED RELAY CONTROL

In this work, a distributed environment has been set up using JINI to estimate and to monitor relay control evaluation for different relays of an integrated power system protection [2]. Each relay has been considered as a client and hence multi- relay clients - single relay control server model is implemented. The various relay clients are interconnected with a relay control server as shown in Figure 1.

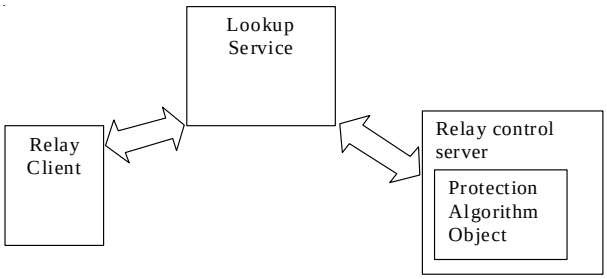

Fig. 1 JINI based client-server architecture for power system protection

The digital relay client basically executes the power system protection algorithms for every specific period of time by frequently exchanging the system data with the server. The server executes the relay algorithm for the particular fault and then distributes the results. Chronologically the server process should be started first, so that it can take initiative to setup a connection link. Then it starts waiting until it receives a connection request from the client. A client can register itself with the lookup service, just by invoking the registration procedure on the server object, when it needs its service. The remote object obtains the necessary data from the registered client objects and it responds back to them respectively with the results. This total process can be automated by the server to get the input data in case of every kind of fault. Transaction of data among clients and server takes place several times so the possibilities of errors may be high. Therefore, it must be handled properly.

2.1 JINI data flow model

Data flow model of the proposed JINI based architecture [5] comprises the lookup service, the protection algorithm service provider framework and the relay client framework. In the proposed model, each relay is considered as a remote relay client. The relay client calls a method on an object that represents the remote server object through a look up service as shown in Figure 2.

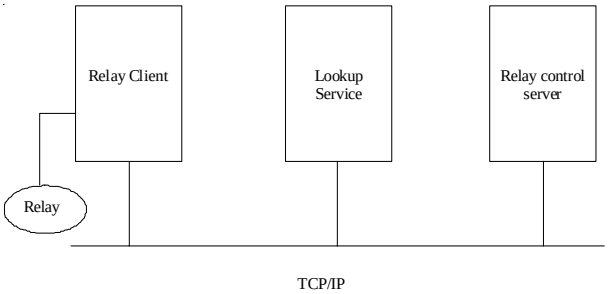

Fig. 2 JINI relay architecture

The lookup service has the task to accept any registrations made by a relay service provider and it has to check the validity of any registration as shown in Figure 3. The lookup service has to give the relay clients the details about the relay algorithm services they have registered.

The protection algorithm service provider is a server connected to it. The relay service provider runs a program to find out the location of the lookup service and the service *id* of the lookup service. After finding the lookup service *id* the service provider can register the service it provides in the lookup service so that any relay client could access the service from a remote place as shown in Figure 3. The relay service provider at first has to enquire about the location of the lookup service by sending a UDP Broad cast message if any of the lookup service has been found in the federation. The most important ability of the proposed model is to access easily any system within the network without knowing the IP address of the system.

3. JINI BASED AUTOMATIC RELAY CONTROL SELECTION ALGORITHM

When a remote client object registers an object with remote relay control server, the server uses the remote client reference to invoke its method to obtain the system data from that client and then provides the service through its methods [6]. Both client and server objects are considered as remote objects, hence inter-remote object communication is achieved. The server object uses a single thread of control to distribute the code simultaneously to the clients registered with it. The proposed model is dynamic which allows a new relay client to be registered with the relay control server object at run-time and it is serviced. Relay control

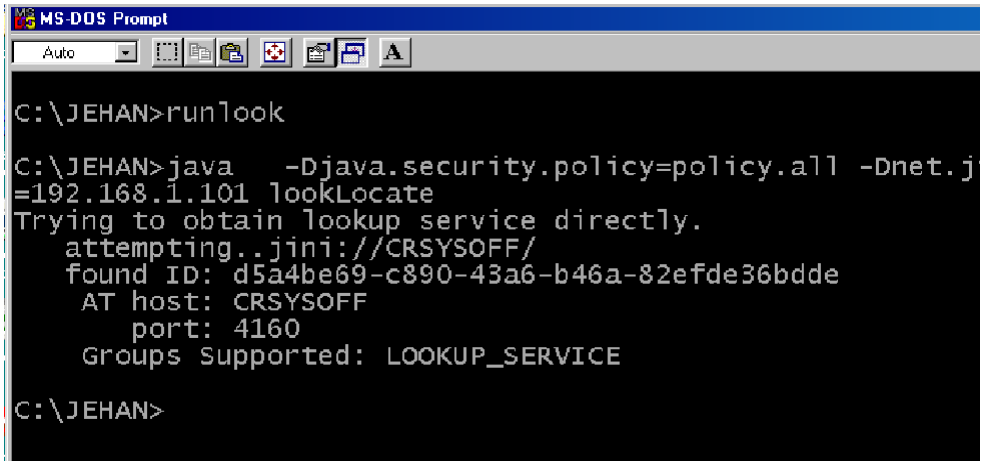

Fig. 3 Relay server discovers lookup service

server and its clients have to store in them the necessary object codes required for relay control based security analysis. Subsequently, the following steps should be carried out:

i. Start relay control server.
ii. The server should invoke its own registry service and it has to run lookup service.
iii. Relay control server discovers lookup service and registers the relay computation algorithm service.
iv. Register a relay client and discover the lookup service at a common location.
v. The server executes the relay control algorithm based and returns it to the client.
vi. The client obtains the result through a look up service stub.
vii. For every specific period of time, the server automatically receives system data from the relay client, thereby providing automatic relay control evaluation.

4. RESULTS

The above distributed algorithm has been implemented in Windows NT based HP workstations connected to an Ethernet LAN. The relay client discovers the lookup service as given in Figure 4.

Once client identifies the look up service and it is registered with lookup service then it can be viewed in the relay server side service register. Server side service register will do the matching service and the list of matched lookup service can be viewed in the lookup service registry.

The window shows the relay code service is accessed by the client relay, Figure 5. Once relay client accesses, the relay socket will be provided between relay control servers. The relay code will be downloaded dynamically and through it. The relay client sends the request and receives the output. Using this approach, different relays can access the relay server continuosly through lookup server at regular intervals of time.

5. CONCLUSION

An effective JINI based distributed model has been developed to enhance multi-area power system protection. It has been tested out to overcome the overheads associated with sequential power system relay control execution through this service oriented architecture. Although, the conventional architecture for relay control ranking is well established, this paper emphasizes a unique methodology based on JINI to serve a large number of clients in a distributed power

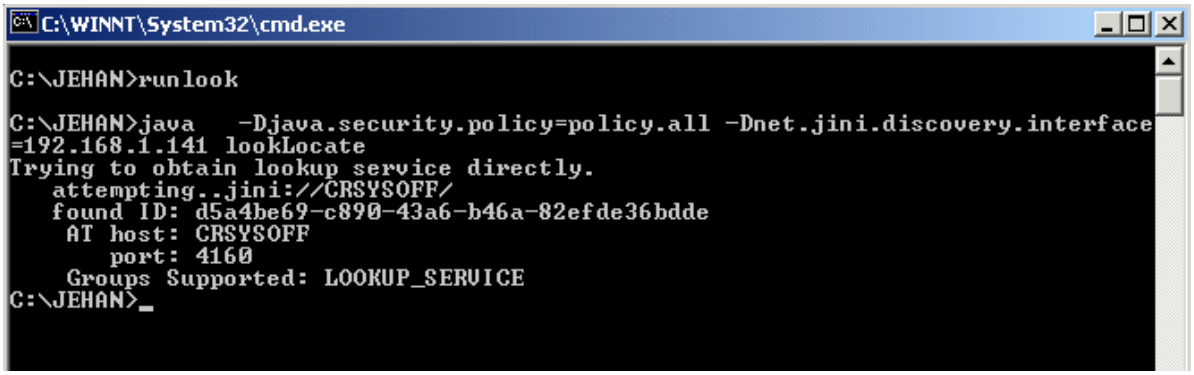

Fig. 4 Client discovers the lookup service

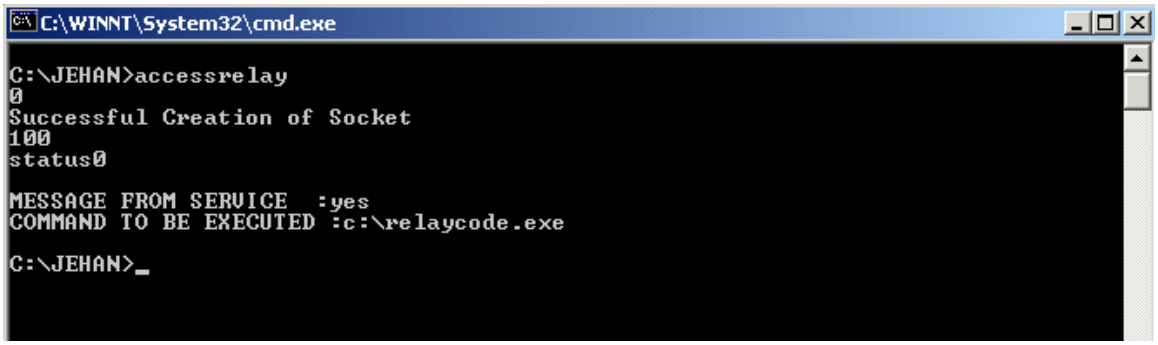

Fig. 5 Client relay accessing the relay code

system environment, across various platforms based on communication between virtual machines. A practical implementation of this approach, suggested in this paper, was assessed based on over current relays performing over current protection. Accordingly, the proposed model can be implemented for large power system protection network spread over geographically.

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MODEL "UKLJUČI I RADI" ZA ON-LINE KONTROLU RELEJA ZA ZAŠTITU ENERGETSKOG SUSTAVA BAZIRAN NA JINI MREŽNOJ ARHITEKTURI

SAŽETAK

Glavni cilj ovog rada je napraviti distribuirani okoliš pomoću kojeg se može pratiti i kontrolirati on-line kontrola releja energetskog sustava. Predlaže se jedan-server/više-klijenata arhitektura, koja omogućava susjednim relejima pristup udaljenom serveru kontrole releja u svako doba. Ti isti imaju određene karakteristike koje im omogućavaju da se servis "uključi i radi" dobije na on-line relejima. Jedan distribuirani model, baziran na JINI mrežnoj arhitekturi, razvijen je na način da u svakom posebnom vremenskom periodu server udaljene kontrole releja dobiva podatke sustava simultano od susjednih releja preko kojih su klijenti registrirani tako da server šalje natrag odgovor dotičnim klijentima. Server kontrole releja stvara novu nit kontrole za svaki zahtjev klijenta, te se tako iskorištava čitavi distribuirani okoliš.

***Ključne riječi**: distribuirano računanje, zaštita energetskog sustava, digitalni relej, JINI, model klijent-server.*