MINI PROJECT REPORT

Time Synchronization In LANs Based On Network Time Protocol (NTP)

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by

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Certified that this Mini Project entitled

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Abstract

The Network Time Protocol (NTP) is used to synchronize the time of a computer client or server to another server or reference time source, such as a radio or satellite receiver or modem. It provides accuracies typically within a millisecond on LANs and up to a few tens of milliseconds on WANs relative to Coordinated Universal Time (UTC) via a Global Positioning Service (GPS) receiver, for example. This project is an implementation of a slightly restricted version of Network Time Protocol(NTP). It includes the following features :

- It synchronizes system clocks in LANs.
- It handles issues related to new nodes joining the network.
- Messages/packets are exchanged based on the connectionless User Datagram Protocol(UDP).
- It handles issues related to message/packet integrity.

In a nutshell, messages with timestamps are exchanged between the server and the clients. The messages have sequence numbers incorporated in them to take care of message integrity. Clients respond to messages only if the sequence numbers match. The time stamped messages are broadcasted by the server at regular intervals. The clients receive the messages and update their time. New clients wishing to join the network do so by sending a 'WHO IS THE HOST' messages. Both the server and the clients are capable of message broadcasting .

Contents

1 Introduction

Time Synchronization in Networks is an issue that has gained utmost importance over the years. Its impact on the functioning of networks is manifold. We need time synchronization for intrusion detection, isolation and logging; network monitoring; cryptographic key management, etc. This project is based on the Network Time Protocol (NTP) but a slightly restricted version of it. In short time synchonization in networks find applications in the following areas:

- Distributed database journal and transaction ordering.
- Stock market buy and sell orders.
- Cryptographic time stamping services.
- Intrusion detection, isolation and logging.
- Network monitoring, measurement and control.
- Distributed multimedia stream synchronization.
- Research experiment setup, measurement and control.
- Cryptographic key management and lifetime control.

1.1 What is Network Time Protocol (NTP)

The Network Time Protocol (NTP) defines a set of procedures for synchronizing clocks on hosts connected to a network with access to the Internet.

NTP is a tiered time distribution system with redundancy capability. NTP measures delays within the network and within the algorithms on the machine on which it is running. Using these tools and techniques, it is able to synchronize clocks to within milliseconds of each other when connected on a Local Area Network.

This protocol relies on time servers, which are categorized in different layers that are called strata. Time servers in stratum 1 have the most exact notion of time with the time servers in stratum 2 having a less exact notion and so on. The servers synchronize with servers in their own stratum or in the stratum directly preceding theirs, that are given a higher priority.

Network distances between servers are taken into account when synchronization messages are exchanged between the servers in the different strata.

In NTP, we actually make use of a Coordinated Universal Time (UTC) clock source for clock synchronization. We connect to any one of the many time servers stationed all over the world through the Internet, obtain the clock from that server and synchronize to that clock. Time synchronization can also be achieved through radio, satellite and modem. We?ll have daemons running on each of the host in the network that take care of synchronization.

2 The Actual Time Synchronization Protocol

Here we have considered a slightly restricted version of the Network Time Protocol(NTP). The protocol has been applied to a Local Area Network(LAN) where there is a central server that acts as a synchronization master and clients that synchronize their clocks to the synchronization master. This is slightly different from the actual Network Time Protocol(NTP) where we have time servers positioned all over the world and different strata where servers and clients are located.

2.1 Network Requirements

For the successful implementation of the time protocol, the network in consideration must have the following characteristics :

- Ethernet token-based technology is made use of in the network. This is because this technology is cheap and dependable.
- Real-time traffic exists in the network.
- The network is open for non-real-time traffic.
- Fault-recovery?the network should be robust against failing nodes.
- Plug-and-play? client nodes need to be able to join and leave the network at will.
- Broadcast capable network.

2.2 Assumptions Made During Implementation of Protocol

A few assumptioms are made during the implementation of the time protocol. the important among them are:

- The time protocol is an internal clock synchronization protocol, i.e., only nodes participating in the protocol agree upon a certain clock.
- The clocks may drift in the network.
- All the processes are reliable and trusted and no security mechanisms like authorization are needed.
- Al the messages are reliable ? no messages get lost.

2.3 Stages Involved In The Protocol

The time protocol implemented involves the following main stages:

- Initialization
- Message exchange and time synchronization
- Time adjustment
- Finalization.

2.3.1 Initialization

In this stage the protocol is concerned with issues that relate to new nodes wishing to join the network. In this stage, each time a node wishes to join the network it broadcasts a message to the network seeking its corresponding server. Once the server responds with another message, the client joins the network.

2.3.2 Message exchange and time synchronization

In this stage, time stamped messages are exchanged between the server and the client and as soon as a client receives a time stamped message from the server it starts synchronizing its clock to the time stamp value in the time stamped message.

2.3.3 Time adjustment

In this stage, the clocks of all the clients are made to synchronize with the server clock.

2.3.4 Finalization

This stage deals with further rounds of synchronization of system clocks within the network. This is accomplished by scheduling the synchronization process at regular intervals of time called the broadcast interval.

3 Protocol Implmentation Details

3.1 Message Format

The time stamped messages are exchanged within the network based on the connectionless User Datagram Protocol(UDP). The message has the following seven fields:

- HEADER This filed contains the header of the message. It is used for verifying the message integrity.
- PROTOCOL VERSION This field contains the protocol version number. It is also used for verifying the message integrity.
- IP This field contains the IP address of the sender of the particular message.
- GROUP ID This field contains the group identification number of the group to which the sender of the message belongs.
- OPERATION This field indicates the operation that is to be performed once the message is received.
- SEQUENCE NUMBER This field contains the sequence number of the particular message. This is to preserve the integrity of the messages transmitted over the network.
- TIMESTAMP This field contains the timestamp value, i.e., the clock value of the server. It is to this timestamp value that the system clocks are synchronized.

3.2 Message Field Values

The values of the different fields of a message are as under:

- HEADER = netsync
- PROTOCOL VERSION = 1.0
- IP = IP address of the sender
- GROUP ID = Group identification number of the group to which the sender belongs
- OPERATION = host/ hostresponse/ timebroadcast/ resetsequence
- SEQUENCE NUMBER = Identifier of the message
- TIMESTAMP = Time stamp value inserted by the sender ? here the server.

4 Basic Operations Involved in the Protocol Implementation

4.1 Operations at the Server

Initially, at the server, connections are established through the connectionless User Datagram Protocol(UDP). For this sockets that are capable of broadcasting and that can be reused are created and used for communication. The server program is made to run as a daemon so that it will be able to run as a background process.
In the server real time timers are set to a value equal to the broadcast interval. As the timer expires a signal, 'SIGALRM', is generated and passed on to the running server process. When the server receives the signal it transfers control to the signal handler, 'timebcast', which takes care of broadcasting the time stamped messages.
Log messages are recorded in the log file. Messages that are received from the clients are processed by the 'process message' routine.

4.1.1 The 'timebcast' routine

The 'timebcast' routine obtains the current time of the server using the 'gettimeofday()' function, timestamps a message with the server time and sends/broadcasts that message to all nodes in the network.

4.1.2 The 'process message' routine

In this procedure, the server scans all the messages that are received by it and decomposes the messages received into seven entities and starts analysing the message.
At first, the messages are checked for integrity by verifying the header and the protocol version. Then, the server performs some action based on the value in the field 'OPERATION' :

- if OPERATION = 'host', the server checks the GRIOUP ID field and if the group identification numbers are the same the server sends a message containing the server information to the clients.
- if OPERATION = 'timebroadcast', the server checks the GROUP ID field and if the group identification numbers are the same the server realizes that some other host has broadcasted the time and powers itself down. It also synchronizes its time to the time on the received message using the 'settimeofday()' function.

4.2 Operations at the Client

Initially, at the client, connections are established through the connectionless User Datagram Protocol(UDP). For this sockets that are capable of broadcasting and that can be reused are created and used for communication. The client program is made to run as a daemon so that it will be able to run as a background process.
The client starts collecting information about itself and starts logging messages in the log file. The client then sends a 'WHO IS THE HOST' message to obtain information about the server in the network. The client then waits for the receipt of any message. The messages that are received by the client are processed by the ?process message? routine.

4.2.1 The 'process message' routine

In this procedure, the client scans the message that it receives, decomposes the message received into seven entities and starts analysing the message.
At first, the messages are checked for integrity by verifying the header and the protocol version. Then, the client performs some action based on the value in the field 'OPERATION' :

- if OPERATION = 'hostresponse', the client recognizes that it is a message from the server and checks the GROUP ID field and if the group identification numbers are the same, the client updates the ?client config? structure which contains the client status.
- if OPERATION = 'resetsequence', the client checks the GROPU ID field anf if the group identification numbers are the same the client resets its sequence number. These numbers are used for ensuring the message integrity. These numbers are reset periodically.
- if OPERATION = 'timebroadcast', the client checks the GROUP ID field and the SEQUENCE NUMBER field and if the values are matching, the client sets the time to the value in the time stamped message using the 'settimeofday()' function.

5 Conclusion

This project has dealt with issues relating to Distributed Computing Environments and Networking. Time synchronization in networks is indeed an issue that has gained utmost importance in recent times owing to the increasing relevance of security in networks. Further improvements can be made by synchronizing system clocks in a network to either a Coordinated Universal Time (UTC) clock Source or to time servers positioned all over the world via the Internet.Synchronization could also be achieved using a radio source, satellite or modem. Care should be taken that the messages or packets that are exchanged within the network do not get corrupted and that their integrity is preserved for the successful implementation of the Time Protocol.

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