Notations:

We denote JVM’s as M01, M02 etc.

Branch services have names 01, 02 etc.

Replica of branch service ‘xx’ on JVM ‘Myy’ is denoted as ‘xx_Myy’.

Failure detector services have names F01, F02 etc

Failure detector server which is part of the service ‘Fxx’ running on JVM ‘Myy’ has name denoted as Fxx_Myy

Each failure detector server has a corresponding failure detector sensor. Failure detector sensor is denoted as Rxx_Myy

Description of how phase 3 works:

We have rectified our mistakes from phase 3:

Now we have replicas of branch servers running on the existing JVMs. We now also have interesting topology in place.

In topology_file.txt represents how the processors (JVM’s) are inter-connected with each other, namely, the physical links between processors (JVM’s).

In a service, each replica is able to communicate with all other replicas of that same service. If one server ('a') of a service ('A') is able to communicate with another server ('b') of another service ('B'), server 'a' should also be able to communicate with any other servers of service 'B'. Thus, the communication between services won't be impacted by the re-configuration of any service. However, this doesn't necessarily mean that the topology graph is a complete graph.

Please look at the examples for such configurations which are attached as figures at the end.

Configuration management is being done by branch servers separately; each maintains the configuration of the interested parties and updates this when the FD service informs it of some failure/recovery.

The initial configuration as system start up is being entered through a file.

Configuration for FD service:

The initial configuration of FD service is specified at start up through a file. This configuration is maintained as a state variable in the FD server and gets updated with a consensus as failures are detected in the system.

Fate Sharing:

If there are any two processes running on the same machine then if the machine crashes then all of them fail simultaneously. Also, if one of them is detected as failed then it is assumed that all others have also failed.

So, if our FD sensor running on a machine has supposedly failed then the all other servers running on that machine have been assumed to have failed.

- **A description for the criterion used by the failure detection sensors.**

  Our Failure Detector (FD) sensor uses timeouts and TCP connection closings to detect failures in interested parties.

  Each process *p* periodically sends a "p-is-alive" message to all other processes. This is like a heart-beat message that informs other processes that process p is alive.

  If a process p does not receive a "q-is-alive" message from a process q within $T_p(q)$ time units on its clock, then p adds q to its set of suspects if q is not already in the suspect list of p.

  When a process delivers a message from a suspected process, it corrects its error about the suspected process and increases its timeout for that process. If process p receives "q-is-alive" message from a process q that it currently suspects, p knows that its previous timeout on q was premature – p removes q from its set of suspects and increases its timeout period for process q, $T_p(q)$.

  Initial values of $T_p(q)$ is estimated using experiments described below.

  The timeout interval is increased by small units (10%) very time there is a false detection.

  Heartbeat messages are sent at an interval of 500 ms.

- **A rationale to support this choice of criterion. Be sure to include:**
  - *An explanation of conditions that could lead to a failure detection sensor producing erroneous conclusions.*

    If the heartbeat message is delayed for some reason, then other FD sensors will timeout and erroneously detect a failure. This will be transient because as soon as the FD sensor receives the delayed heartbeat message or the new heartbeat message it will stop to suspect the correct sensor.

    Also, a failure will not be detected until a timeout occurs, so there is a small delay in which the a failure will not get detected. This is also a transient error in the failure detector.

  - *If the criterion involves some form of timing, then you should explain how you decided on any parameters that lead to the threshold(s) selected. If this threshold was selected based on experiments, then describe the experiments and include the data (presented in some easily understood form); if this threshold was selected based on deductions, then give that analysis.*

    Timeout is calculated as estimated RTT/2 + Hearbeat msg interval + small processing delay.

    RTT is estimated using experiments where ping messages are sent between the two machines. To get a real life estimates, we are pinging a machine www.inria.fr, which is a Web server of INRIA, a computer science research institute in France. The average RTT that we get is 113 ms, so we use 113/2 ms as an estimate of delay = 60 ms approx.

    We have added to this estimate some provision for varying interval time, we also add some variance in estimated RTT to get the estimate. The data is appended at the end.

- **A rationale for the following mappings used by your architecture:**
    - **The mapping from failure detection sensors to processors whose failure is being detected.**
    - **The mapping from failure detection sensors to failure detection services.**
    - **The mapping of failure detection servers to processors, with comments about any fate-sharing and other intended consequences of co-residences.**

The FD sensors and FD servers run on the existing JVM's (processors) along with other branch servers. There is a FD sensor associated with every FD server.

Every JVM has at least one FD sensor running on it. This FD sensor monitors the machines that host the FD servers that form a FD service.

A machine may host more than one FD servers depending on the topography.

A FD sensor detects all the processors on which the servers of the FD service are running of which the sensor is part of. All sensors thus have a same set of machined to agree on as a FD service forms a complete graph.

There is one-one mapping from FD sensors to servers and thus there are as many sensors in a service as there are servers.

FD servers and their corresponding FD sensors run on the same processor so they share the same fate.

Machines are suspected of crashing when FD sensors are suspected by its peers in the FD service. Also if any processor that has been sensed to have crashed, then all services on that processor crashes as well.

- **A specification of your definition for "work correctly" (in the presence of crash failures). Justify your definition by explaining why it cannot be made stronger.**
- **An explanation of why your system will "work correctly" even if one or more failure detection sensors suspect a processor that, in fact, has not failed.**

By "work correctly" we would ideally like to achieve a perfect failure detector with strong completeness and strong accuracy. Because such a failure detector does not factor out synchrony assumptions of the system so it cannot be implemented even in our approximate synchronous system. Thus we can at best have a failure detector with strong completeness and eventual strong accuracy only. We cannot make this assumption stronger.

To "work correctly" the rest of the system needs to detect any failure as accurately as possible. Also in case of erroneous detection be able to adapt itself to ensure that all replicated servers are consistent. At the same time the rest of the system should ensure high availability and throughput.

We have implemented an eventually perfect failure detector sensor, that is allowed to make false suspicions for transient period of time. The failure detector servers get information of crashes from its sensors. We have implemented a consensus protocol among the FD servers which takes the majority view. This does not ensure perfect failure detection but it is a good heuristic to avoid transient errors.

In case of failures suspected by the FD service the branch servers then reconfigure themselves. We follow a chain replication technique and the suspected server is deleted from the chain. If a new server comes up it is added at the end of the tail. The same protocol is followed in case of transient erroneous detection as well. We are paying the cost by having to do a recovery protocol even in the case of false error detections, but the possibility of this is small due to the consensus protocol. That is we force a failure in case of suspected failures. From phase 3 we know that our system works in case of such failures and recoveries.

- **An explanation of any assumptions about topology and configuration your system requires. Topology here refers to interconnection links; configuration here refers to the mapping from branch servers, failure detection servers, and failure detection sensors to processors.**

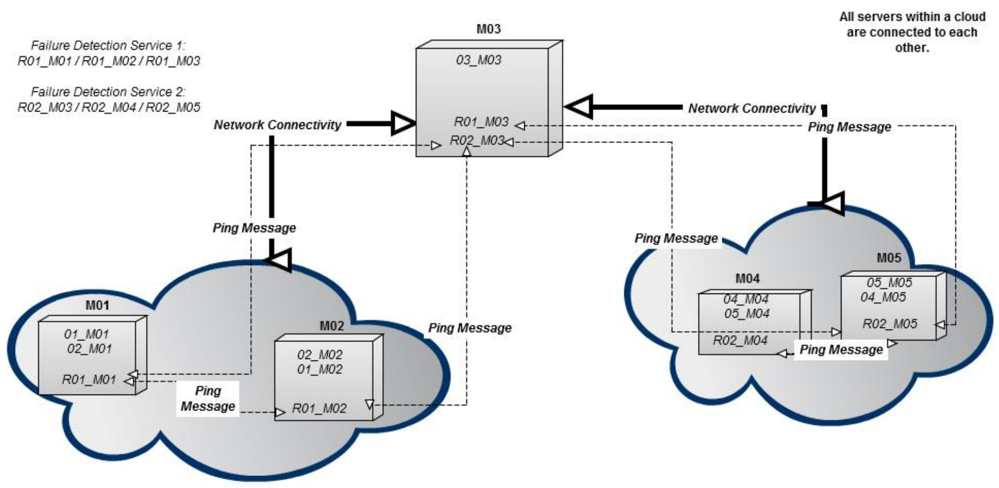
  Within any FD service, all FD servers would be connected to each other through direct bi-directional links. So, all FD servers would be able to contact each other. So they form a complete graph. We find the largest possible complete graphs in our topology and call it a service. We ensure that each machine has at least 1 FD server, so it has at least 1 FD sensor. These graphs may be intersecting and in that case each machine will have all the different FD servers that will constitute different FD services.

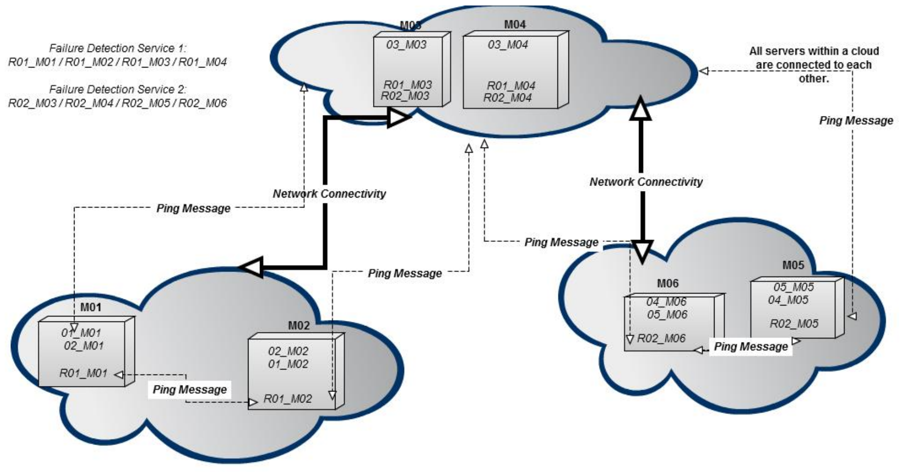
Extra Credit:

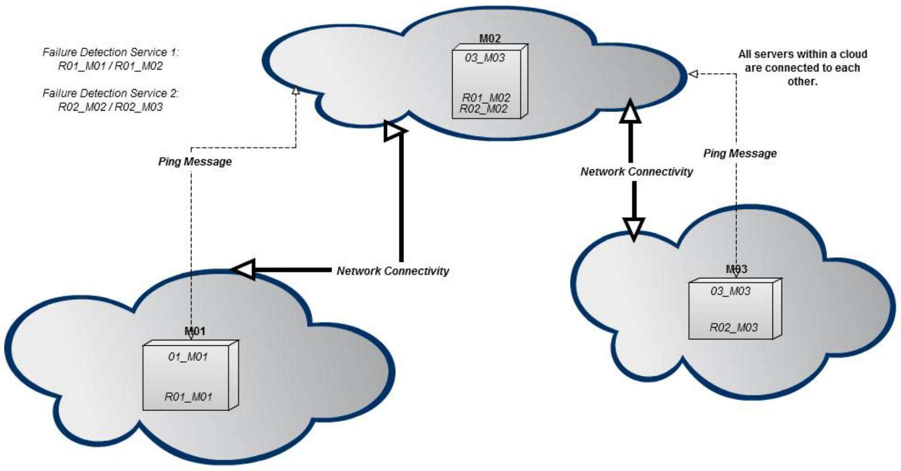
Configuration for FD services is maintained as a state in all the FD servers, these form a FD service that is state machine replicated. Whenever a consensus is reached on the suspect list, a consensus is also reached on the configuration of the members of this state machine. Members are either added or deleted depending on the consensus on whether that member has failed or not. Since FD servers and corresponding FD sensors are on the same processor so it is assumed that both will fail and recover together.

When a new machine comes up, the sensor sends out “Alive” messages to its peers which are picked up by others and they start believing that sensor is up. Along with the sensor, the corresponding FD server will also come up. As soon as new FD server comes up, there is a consensus protocol and the state of this server is updated after the consensus value that is consistent with the state of others.

Figures to explain configuration:







Data for estimating RTT

```
Reply from 193.51.193.149: bytes=32 time=    114   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    114   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    114   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    114   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    115   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    112   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    112   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=          113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=          113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=          113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=          113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=          112    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=          113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=          113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=          113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=          113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=          113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=          113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=          112    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=          113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=          113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=          113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=          113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=          113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=          112    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=          113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=          113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=          113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=          113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=          113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=          113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=          112    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=          113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=          114    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=          114    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=          113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=          113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=          113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=          113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=          113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=          113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=          112    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=          113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=          113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=          113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=          113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=          113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=          113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=          113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=          113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=          113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=          113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=          113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=          113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=          113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=          112    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=          112    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=          113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=          112   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=          113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=          113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=          113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=          113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=          113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=          113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=          113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=          113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=          114   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=          113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=          112   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=          113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=          113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=          113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=          113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=          112   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=          113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=          113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=          113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=          113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=          113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=          113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=          113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=          113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=          113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=          113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=          113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=          113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=          113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=          113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=          112   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=          113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=          113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=          113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=          113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=          113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=          113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=          113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=          113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=          114   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=          113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=          113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=          122   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=          113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=          113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=          112   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=          113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=          113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=          114   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=          113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=                113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=                113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=                113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=                113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=                113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=                113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=                113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=                113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=                114    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=                113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=                113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=                113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=                113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=                113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=                113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=                113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=                113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=                113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=                113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=                114    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=                113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=                113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=                113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=                112    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=                113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=                113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=                113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=                113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=                113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=                113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=                113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=                112    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=                113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=                113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=                112    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=                113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=                222    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=                113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=                114    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=                114    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=                115    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=                113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=                148    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=                113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=                114    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=                113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=                113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=                113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=                113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=                113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=                113    ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=    113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    114   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    114   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    114   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    114   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    114   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    116   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    112   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    112   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    116   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    153   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    112   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=    113   ms   TTL=52
Reply from 193.51.193.149: bytes=32 time=            113   ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=            113   ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=            113   ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=            113   ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=            113   ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=            118   ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=            113   ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=            113   ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=            113   ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=            113   ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=            113   ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=            114   ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=            112   ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=            113   ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=            113   ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=            113   ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=            113   ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=            114   ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=            113   ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=            113   ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=            114   ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=            113   ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=            113   ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=            113   ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=            115   ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=            113   ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=            114   ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=            113   ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=            112   ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=            115   ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=            113   ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=            113   ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=            114   ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=            112   ms    TTL=52
Reply from 193.51.193.149: bytes=32 time=            113   ms    TTL=52
Average                                            113.5
Std Dev                                      0.707106781
Ping statistics for 193.51.193.149:
Packets: Sent = 429, Received = 429,        Lost (0%)        = 0
Approximate round trip times in milli-seconds
                                                                 =
Minimum = 112ms, Maximum = 222ms, Average                        113ms
```