Distributed Systems: Supervision 1

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Definitions

- 1. In just a few words, define each term and specify what it is useful for.
 - (a) idempotent

An operation is idempotent if applying it multiple times results in the same change as doing it once.

(b) location transparency

Location transparency is using a logical name to identify a network resource that is independent of physical location.

(c) marshalling

Marshalling is the process of transforming an object in memory into a format suitable for storage or transmission.

It is useful for sending arguments over RMI.

(d) pure, impure names

A pure name contains no information such as the location of the named object. In contrast, an impure name does contain such information. An example of a pure name would be a UID such as wngdc7mwad8128a9nxpctbc7j0tmvs6w. An example of an impure name would be dc584@cam.ac.uk.

(e) batching

Batching is where operations are delayed so that multiple operations can be sent together.

By batching operations overheads are minimised.

(f) middleware

Middleware is a layer between the OS and distributed applications. It hides the complexity of the system and bridges the gap between low-level OS communications and programming language abstractions.

(g) clock skew

Clock skew is the difference between the times on two clocks.

(h) clock drift

Clock drift is the rate at which a clock drifts from perfect time.

NFS

2. (a) Write a 300-word description of what NFS is, how it works, and when you might use it and why. Please read around the subject a bit. No cut-n-paste from other resources!

NFS is a distributed file system developed at Sun. It allows users to access files on a remote host in the same way they would access local files by providing an abstraction that makes the file access completely transparent to the client.

When someone accesses a file over NFS the kernerl will make an RPC call to the server machine, marshalling the arguments (user, file handle etc.).

NFS (v2 and v3) was stateless which meant that faul recovery was easy. If the server crashed then the client would simply have to wait for it to reboot and send the RPC again. If a client crashes, the server does not need to do anything at all - no cleanup is required.

By deciding to make the protocol stateless, no operation could have implicit arguments (e.g. a read call had to have the filehandler). This had the side effect of making those operations idempotent - rather than requesting the next x bytes, the client had to explicitly pass the offset. Idempotency means that the server natively tolerated network packet duplication and RPC retries for those operations.

There are many reasons why you would want to use NFS, but they all boil down to wanting to have some data on one machine be accessible from other remote machines. This is usually to reduce duplication, ensure consistency or facilitating network backups.

(b) What were the most important changes from NFS v2 to v3? Why were these changes significant, and what were their effects?

Version 3 added support for

- 64-bit file sizes and thus files larger than 2GB could be read.
- asynchronous writes (improved performance)
- a READDIRPLUS operation that returned additional data while scanning a directory to minimize the need for further calls.
- TCP was added as a transport which made using NFS over a WAN more feasible

Time

- 3. For each of the following uses of time, what does the time need to be measured relative to (e.g. UT1, UTC, an NTP server on a LAN, a local oscillator)?
 - (a) local process scheduling

A local oscillator

(b) local I/O

A local oscillator

(c) network protcols

UT1

(d) cryptographic certificate/ticket generation

UT1

(e) performance profiling

A local oscillator

NTP

4. Write a Java program which acts as an NTP client and prints the current time, as estimated from the NTP server, to the console whenever it is run. For example:

```
bash $ java -jar current-time.jar
Fri Feb 24 15:24:54 GMT 2012
bash $
```

You will need to send UDP packets in an appropriate format to an NTP server. The Computer Lab has a set of NTP servers which you may wish to use:

```
server ntp0.cl.cam.ac.uk
server ntp1a.cl.cam.ac.uk
server ntp1b.cl.cam.ac.uk
server ntp1c.cl.cam.ac.uk
server ntp1d.cl.cam.ac.uk
```

Please make sure your packets conform to NTP version 3 or later (see RFC 1305 or later) and that you don't send more than two packets to the server each time you run your program.

Vector clocks

5. (a) Given the sequence of messages below, show the value of the Lamport and vector clocks at each node at each send or receive event it participates in.

Daniel Chatfield

(b) Using the Lamport and vector clocks calculated above, state whether or not the following events can be determined to have a *happens-before* relationship.

- 1. $\mid A \rightarrow C \mid A \rightarrow D \mid no$
- 2. $\mid A \rightarrow D \mid B \rightarrow C \mid no$
- 3. $\mid B \rightarrow C \mid C \rightarrow B \mid yes$