

1.

(a) The first reason is that it involves resource sharing, through which we can save a lot of money and which is accepted by distributed systems. The second reason relates to the geographically distributed environment, which in many cases is itself geographically distributed in nature. The third reason has to do with fault tolerance. In a computing system consisting of a single computer, a failure will produce a total failure. In a distributed system, however, when a small number of computers fail, the remaining computers take over the tasks of the rest of the failed computers and stay up and running.

(b) The first example is Large Hadron Collider (LHC). It cannot use the non-computer paradigm because the volume of data is too large to be stored on a separate computer. The second example is SETI@home. Again, as with the example above, the volume of data is too large to be analysed on a single computer.

(c) An example of a timing fault is the watch, which makes it difficult to ensure that the clocks are synchronised. An example of a crash failure is an operating system stoppage. An example of an omission fault is when the server is not listening. An example of a Byzantine failure is that the server may send a message that is falsely reported. An example of a response failure is when the connection between the client and the server is not established correctly, which may occur.

(d) SHA-1 is a function that does not have this property. This hash function maps a variable input to a fixed output. That is, both hashes on this slide contain the same number of characters.

2.

(a) One potential benefit of having a thin client is reduced hardware and software maintenance. One of the benefits of having a fat client is that a high performance server is not required, which means that it is cheaper to buy, install and maintain a high performance server.

(b) One real-world application of edge computing is self-driving cars. The advantage of edge computing over using a centralised computing paradigm is that the client does not need to send messages to the server, which saves time as the client does not need a response from the server, only the client performs the computation itself.

(c) The network topology used by the algorithm is a ring topology. The motivation for using this algorithm is to quickly find the shortest shortcut between any vertices, so that it takes less time to locate data items. The purpose of a quick link is to quickly locate a data item from one vertex to another and find that path.

(d) The way to achieve transparency of access is that different servers in the Internet may have different operating systems. Different servers on the Internet may have different operating systems, each of which stores and accesses the grid pages in a different way. If I access the If

I access the frames through my browser, the different ways in which they are stored and accessed on the respective servers are transparent to me. The way to achieve migration transparency is to make the location of the server hosting the grid transparent to me when I open a web browser and access the grid. The way to achieve replication transparency is that when I open a web browser and access the grid, the grid data I receive may be The fact that it is replicated to many different servers is transparent to me.

3.

(a) Two benefits of code migration are the ability to improve system performance by minimising communication or data transfer and the ability to move code between different computers. Two challenges to implementing code migration in distributed systems are computer security and heterogeneous distributed systems. A practical example of code migration in a distributed system is the Internet.

(b) The method is to broadcast a short pulse at the start of each second of UTC. Using a radio receiver this signal can be picked up and used to synchronise the clock with UTC time. Although it travels through the air, the actual time obtained by the receiver can be accurate to within about 10 milliseconds, so it is still very accurate.

(c) A potentially unwanted consequence is a timing attack, where information can be leaked from the system by measuring the time it takes to respond to certain queries. An attacker could then be able to steal information by accurately measuring the time of each operation, which can then be traced back to the input.

(d) Processes are copied because different processes are never in memory at the same time, so they do not affect the correctness of each other's actions. Data in data replication is stored at multiple sites, so that even if some copies are unavailable due to site failure, other sites can be used instead.

4.

(a) Examples of fabrication are email spoofing. Examples of interceptions are illegal copying of programs or data files. Examples of interruptions are the malicious destruction of hardware devices and the erasure of programs or data files. Examples of modifications are possible to modify the content of messages in the network.

(b) The advantage of processes is that different processes are never in memory at the same time, so they do not affect the correctness of each other's actions. The advantage of threads is that a program with multiple threads allows a subset of those threads to be blocked without blocking the entire program. A practical application of threads in a distributed system is the web browser. In this case, the advantage of using threads is that while waiting for a grid to be read from the server is blocked, other tabs and threads are not blocked and can continue to provide interactive grids, and processes have the advantage of being able to read results from the client faster.

(c) The reason for using a symmetric (keyed) cryptosystem is that the data is "scrambled" so that anyone who does not have the decryption key cannot understand it. Once the intended recipient with the key has the message, the algorithm reverses its operation so that the message is returned to its original readable form. Asymmetric (secret key) cryptosystems can be a solution where one-bit asymmetric encryption uses a pair of keys (one public and one private) to encrypt and decrypt the message, so it will be more stable and less prone to loss.

(d) function map (string name, string document):

    for each word w in document: emit (w, 1):

        if w.string document = string document:

            return 1

        else

            return 0

function reduce(String word, List partialCounts):

    sum = 0

    for each pc in partialCounts:

        sum += pc

    emit(word,sum).