Principles of Computer Systems Design

Assignment 1

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1 Question 1: Fundamental Abstractionst

A simple solution would be to lay out the machines in one single address space. If we assume that all the machines have the exact same memory size and they are perfectly fault tolerant, a simple arithmetic calculation can be used in the translation of the addresses for each machine. We could find the machine with *address* **mod** *machineMemorySize* and the find the local address by subtracting the *offSet*.

Because we are not working with an ideal scenario, we must translate the address by doing a look-up for finding the machine that contains the page[1] in memory. The look-up should be either a mapping or a function that retrieves the *machine number* and *local address* of the page. By using this solution the memory can be spread out in different sizes.

In order to do these translations we would need to implement a centralized mapping system (a system similar to DNS for websites). In our case we use the **Central Server Algorithm** where a central-server maintains all the shared data. It translates the addresses and services the read requests from other nodes or clients by returning the data items to them. It updates the data on write requests by clients and returns acknowledgment messages. A timeout can be employed to resend the requests in case of failed acknowledgments. Duplicate write requests can be detected by associating sequence numbers with write requests. A failure condition is returned to the application trying to access shared data after several retransmissions without a response.

Although, the central-server algorithm is simple to implement, the central-server can become a *bottleneck*. To overcome this problem, shared data can be distributed among several servers. In such a case, clients must be able to locate the appropriate server for every data access. Multicasting data access requests is undesirable as it does not reduce the load at the servers compared to the central-server scheme. A better way to distribute data is to partition the shared data by address and use a mapping function to locate the appropriate server[2].

[1] A page, memory page, or virtual page is a fixed-length contiguous block of virtual memory, described by a single entry in the page table.

[2] `http://cs.gmu.edu/cne/modules/dsm/blue/ctr_ser_Al.html`

The API contains the address translations and the READ and WRITE functions that we assume as being atomic functions[3]. The READ and WRITE functions need to translate the address by calculating the address offset and machine identifier that has the page.

```
private {machineID, localOffset} translateAddress(address) {
       {machineID, offset} = lookup(address); // the offset represents the first address of the machine
       localOffset = address - offset; // get the local offset in the machine's memory
       return {machineID,localOffset};
       }
```

Figure 1: Translate function

Because printing is different from typewriting, there are a number of things that you have to do differently when preparing an input file than if you were just typing the document directly. Quotation marks like "this" have to be handled specially, as do quotes within quotes: " 'this' is what I just wrote, not 'that' ".

Dashes come in three sizes: an intra-word dash, a medium dash for number ranges like 1–2, and a punctuation dash—like this.

A sentence-ending space should be larger than the space between words within a sentence. You sometimes have to type special commands in conjunction with punctuation characters to get this right, as in the following sentence. Gnats, gnus, etc. all begin with G. You should check the spaces after periods when reading your output to make sure you haven't forgotten any special cases. Generating an ellipsis ... with the right spacing around the periods requires a special command.

LaTeX interprets some common characters as commands, so you must type special commands to generate them. These characters include the following: $ & % # { and }.

In printing, text is usually emphasized with an *italic* type style.

A long segment of text can also be emphasized in this way. Text within such a segment can be given additional *emphasis.*

It is sometimes necessary to prevent LaTeX from breaking a line where it might otherwise do so. This may be at a space, as between the "Mr." and "Jones" in "Mr. Jones", or within a word—especially when the word is a symbol like *itemnum* that makes little sense when hyphenated across lines.

Footnotes[4] pose no problem.

LaTeX is good at typesetting mathematical formulas like $x - 3y + z = 7$ or $a_1 > x^{2n} + y^{2n} > x'$ or $(A, B) = \sum_i a_i b_i$. The spaces you type in a formula are ignored. Remember that a letter like x is a formula when it denotes a mathematical symbol, and it should be typed as one.

[3]In concurrent programming, an operation (or set of operations) is atomic, linearizable, indivisible or uninterruptible if it appears to the rest of the system to occur instantaneously. Atomicity is a guarantee of isolation from concurrent processes.

[4]This is an example of a footnote.

2 Displayed Text

Text is displayed by indenting it from the left margin. Quotations are commonly displayed. There are short quotations

> This is a short quotation. It consists of a single paragraph of text. See how it is formatted.

and longer ones.

> This is a longer quotation. It consists of two paragraphs of text, neither of which are particularly interesting.
>
> This is the second paragraph of the quotation. It is just as dull as the first paragraph.

Another frequently-displayed structure is a list. The following is an example of an *itemized* list.

- This is the first item of an itemized list. Each item in the list is marked with a "tick". You don't have to worry about what kind of tick mark is used.
- This is the second item of the list. It contains another list nested inside it. The inner list is an *enumerated* list.
  1. This is the first item of an enumerated list that is nested within the itemized list.
  2. This is the second item of the inner list. LaTeX allows you to nest lists deeper than you really should.

  This is the rest of the second item of the outer list. It is no more interesting than any other part of the item.
- This is the third item of the list.

You can even display poetry.

> There is an environment for verse
> Whose features some poets will curse.
>
> For instead of making
> Them do *all* line breaking,
> It allows them to put too many words on a line when they'd rather be forced to be terse.

Mathematical formulas may also be displayed. A displayed formula is one-line long; multiline formulas require special formatting instructions.

$$(\Gamma, \psi') = x'' + y^2 + z_i^n$$

Don't start a paragraph with a displayed equation, nor make one a paragraph by itself.