Taking Measure

maddog pulls out his old HP-35, brushes up on reverse Polish notation, and takes the measure of modern storage on old technology. *By Jon "maddog" Hall*

People with long grey beards often talk about the systems they used to work on, how those systems had only "four kilobytes of memory," and the wonderful things they used to be able to do with them.

Recently I came across a small (44.5-inch/113-cm) segment of paper tape that I used to store programs on one of the first computer systems I ever used: a PDP-8 computer from Digital Equipment Corporation (DEC). That system had four thousand 12-bit words of memory and no disk or magnetic tape drive. All data had to be read in and punched or printed out to an ASR-33 teletype at the blinding speed of 10 bytes (i.e., 10 printed characters) per second.

The paper tape was able to record 10 bytes per inch of its length, so my piece of paper tape could hold 445 bytes of data when full. When I bought a new external USB disk drive that holds 2TB, I wondered how much the paper tape capable of holding that much data would weigh, how long the tape would be, and how long it would take to read that amount of data on an ASR-33 teletype.

I took the paper tape to Rite Aid Pharmacy in Westboro, Massachusetts, and asked the druggist to weigh it on their most sensitive scale. It weighed exactly 2.25 grams. For scientists, engineers, mathematicians, and other people who really care about numbers, be warned that I am using what are known as "manufacturer's terabytes," wherein a terabyte is actually 2,000,000,000,000 bytes and not multiples of 1024. I also recognize that with a scale that is accurate to three significant digits, having large numbers of significant digits gives an air of accuracy that is not justified. However, rather than round off, I kept the digits and leave it to the reader as to where to truncate.

Assuming I'm concerned with the weight of the paper tape after the data is punched in, and not the weight of unused paper tape, that means the 2TB of paper tape data storage would weigh 10,112,359,550 grams (10,112,360 kilograms) or 22,293,937 pounds (11,147 tons).

The density of the paper tape neatly worked out to 10 bytes per inch, so 2TB of storage would be 200 billion inches long, or about 3,156,566 miles (5,080,000 kilometers), and reading in that paper tape at the rate of 10 characters per second would take 200 billion seconds, or approximately 6,337 years (with a year of 365.25 days).

And probably before that paper tape was read, either the tape would rip or the ASR-33 Teletype would fail, and you would have to start over again.

How does this relate to the Linux systems of today? Reading my 2TB disk drive into my new computer system (even using USB 3.0) is slower than I would like, but it does not take anywhere close to the length of time in which the ASR-33 would be clacking away. If digital cameras had been around in the era of the PDP-8, manipulating an 8MB image in 4K words of RAM with no disk drive would have been very difficult. And if you were magically able to expand the PDP-8's architecture to accommodate the extra RAM, you would not have been able to afford the RAM at that time.

The size of memory desired for a system to work properly is not decided just by the size of the code. The size is determined by a combination of factors, including the size of the data you are manipulating, the speed at which your peripherals are inputting and outputting data, and whether you want the CPU to have the data "buffered" or wait for the data devices.

I recently bought my first new laptop in six years. It has four cores and 16GB of RAM because I want to run multiple virtual machines at the same time and I want to model a server system running the Linux Terminal Server Project (LTSP). I could have gotten a less capable machine, but because of how much I travel, this is both my "laptop" and my "desktop" machine.

Some day I will look up the dimensions and weight of the old PDP-8 and write about how much a modern-day desktop would weigh if built with PDP-8 technology and how much electric power it would use. ■■■