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Remember: the more we make programmers do, the more likely they are going to make a mistake

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This concentrated the programmer's mind wonderfully!

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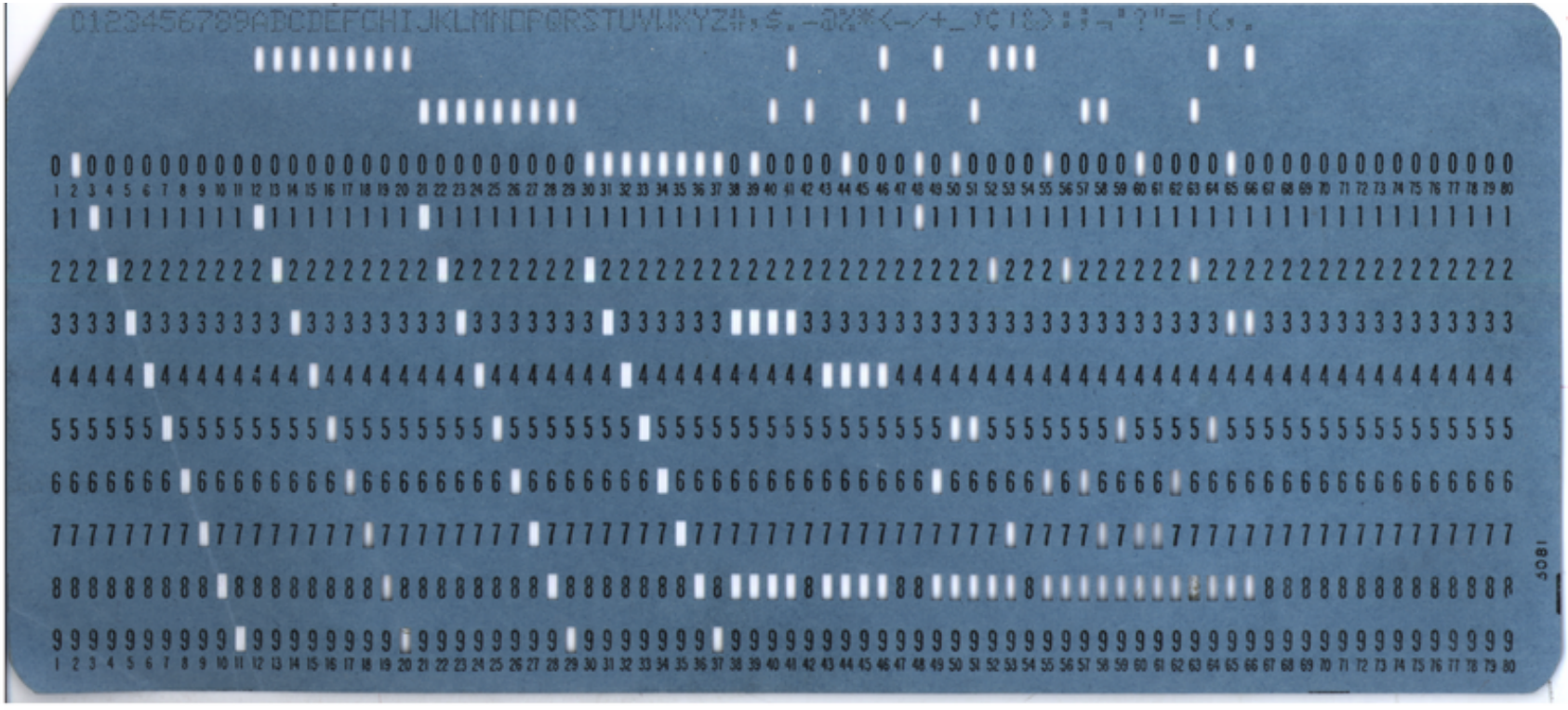

From Wikipedia. Encodes a single 80 character line

History

From Wikipedia. 5 and 8 hole paper tapes

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- Interfacing to hardware: I/O drivers (send file to printer, etc.)

This made programming and program management easier, but there was still lots of human intervention needed

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So the operators would load many programs on to a fast medium, such as magnetic tape, and the computer would load and run them as fast as hardware allowed

This was called *spooling*, the first instance of addressing the disparity between human and computer speeds

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Again, this was because printers are slower than computers

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Of course “JCL” means “Job Control Language”, but JCL was just one of a few job control languages

History

```
//IS198CPY JOB (IS198T30500),'COPY JOB',CLASS=L,MSGCLASS=X
//COPY01   EXEC PGM=IEBGENER
//SYSPRINT DD  SYSOUT=*
//SYSUT1   DD  DSN=OLDFILE,DISP=SHR
//SYSUT2   DD  DSN=NEWFILE,
//           DISP=(NEW,CATLG,DELETE),
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(From Wikipedia) Any guesses?

This copies OLDFILE to NEWFILE
This would be set on 9 punched cards

History

A Fortran program, with data:

```
//CONVERT JOB USER=UGA001,MSGCLASS=6,NOTIFY=UGA001
//*MAIN CLASS=NITE,LINES=40,ORG=UGAIBM1.LOCAL
// EXEC FORTVCLG,REGION=2000K
//FORT.SYSIN DD *
       READ(5,10) CENT
    10 FORMAT(F6.2)
       FAHR=(CENT*9.0/5.0)+32.0
       WRITE(6,20) CENT,FAHR
    20 FORMAT(F6.2,' CENT = ',F6,2,'FAHR')
       STOP
       END
/*
//GO.SYSIN DD *
100.00
/*
//
```

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Running in batches is more efficient, as we spend more time running our programs and less time messing around in the overheads of loading and unloading

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Exercise look up *Portable Batch System*, PBS and compare with JCL

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When the application finished, it would (be expected to) jump back to the monitor, so the monitor could deal with the next program

History

But if the application was badly written, it could overwrite the monitor

Machine memory

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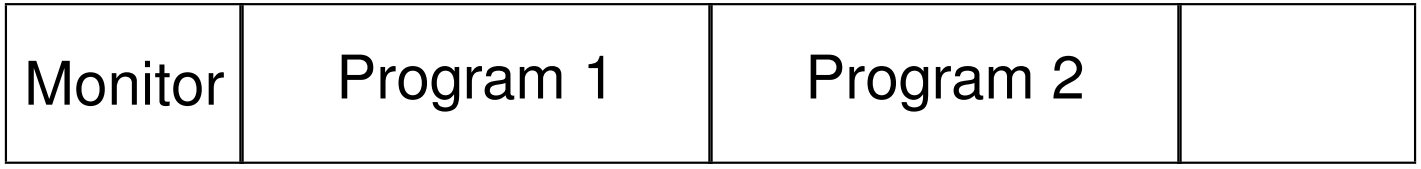
But there are other problems, too

History

It was soon found to be more efficient to load more than one program into memory (when there was space)



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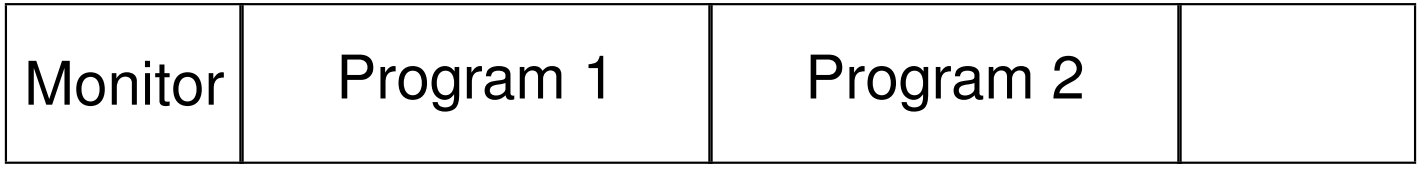

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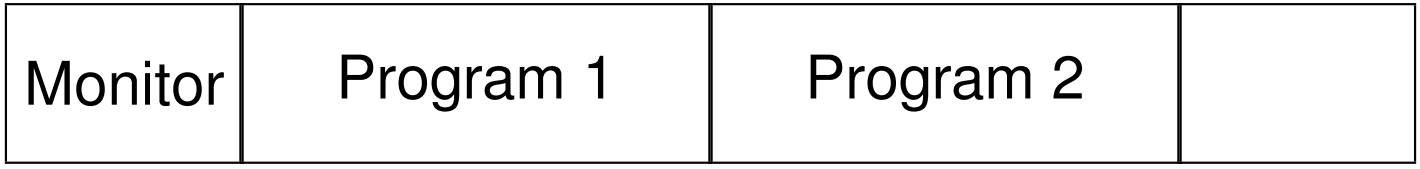

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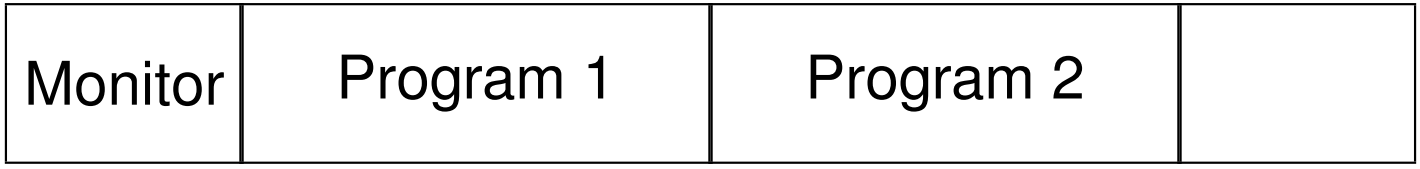

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When Program 2 pauses and Program 1 needs to run again, the computer could switch back to it

The decisions on what to run and actually doing the switching between programs was the job of the monitor

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Some means of curtailing runaway programs is needed

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Take care over this point: the monitor doesn’t sit and watch the program running, the monitor is *not* running while the program is running

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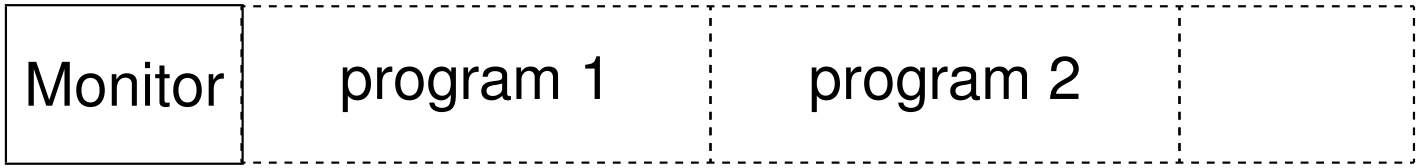
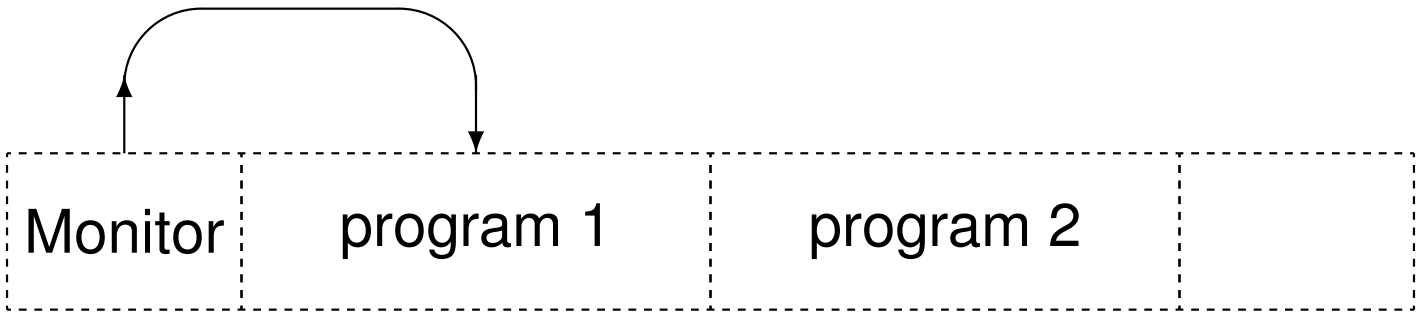


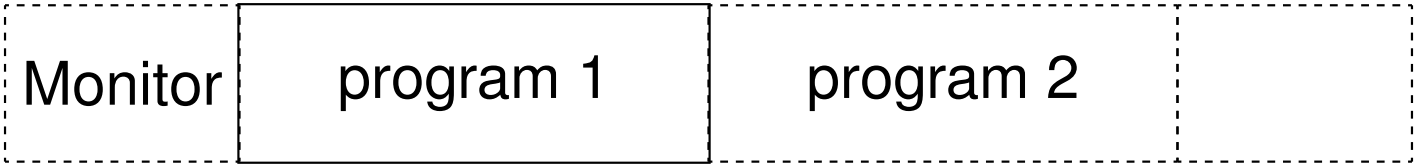
Monitor runs

History



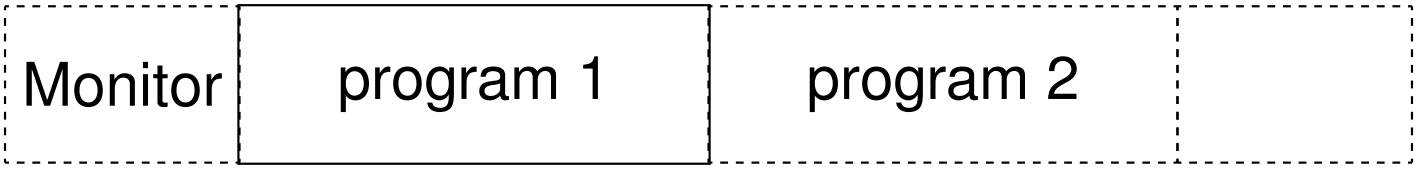
Monitor jumps to program 1

History



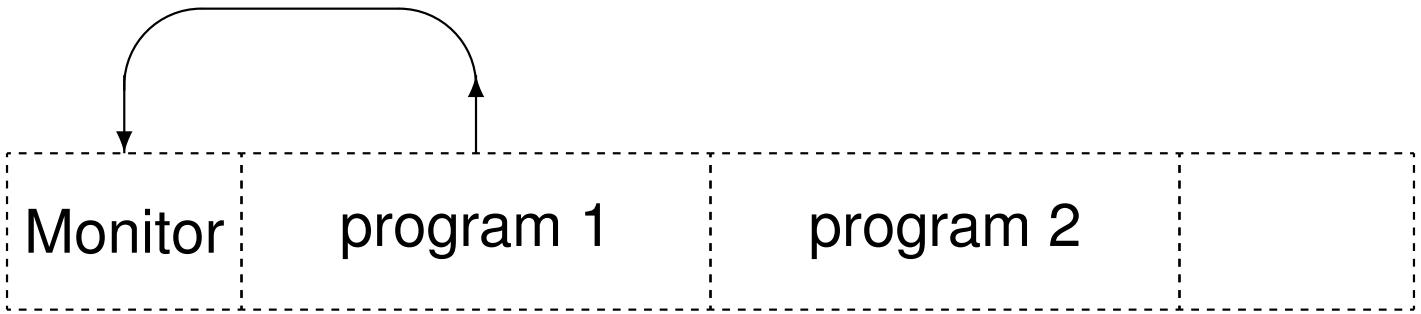
Program runs

History



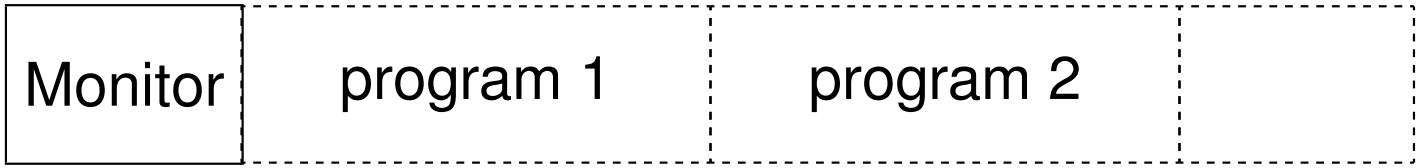
Tape needed

History



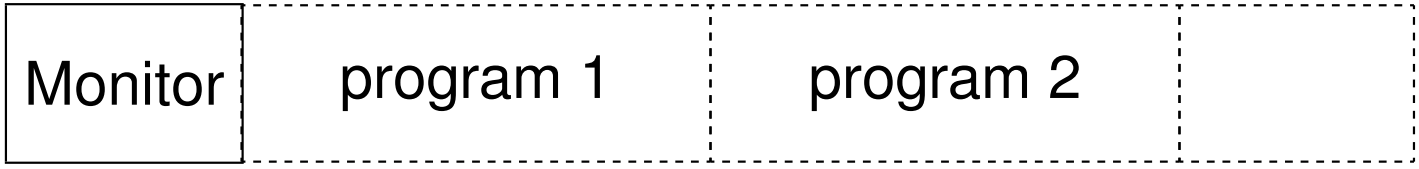
Program calls monitor

History



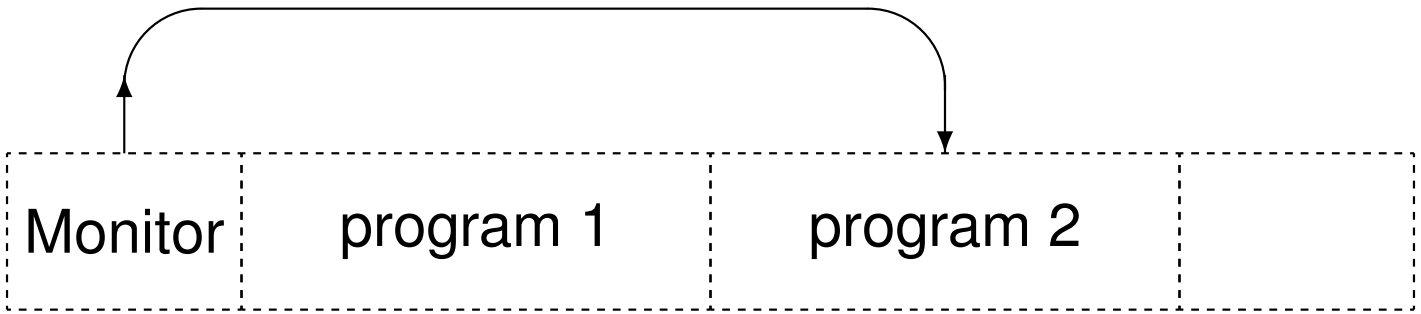
Monitor sets up tape

History



Monitor decides to run another program while waiting for the tape

History



Monitor jumps to program 2

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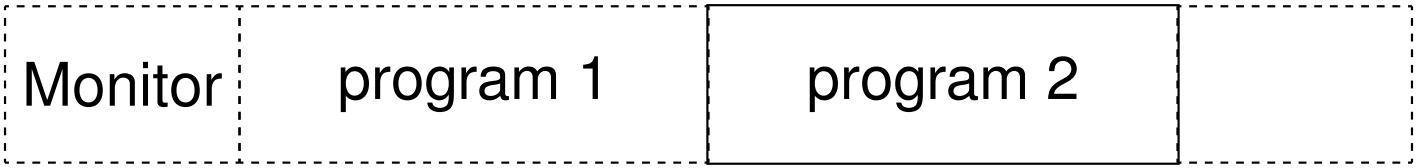
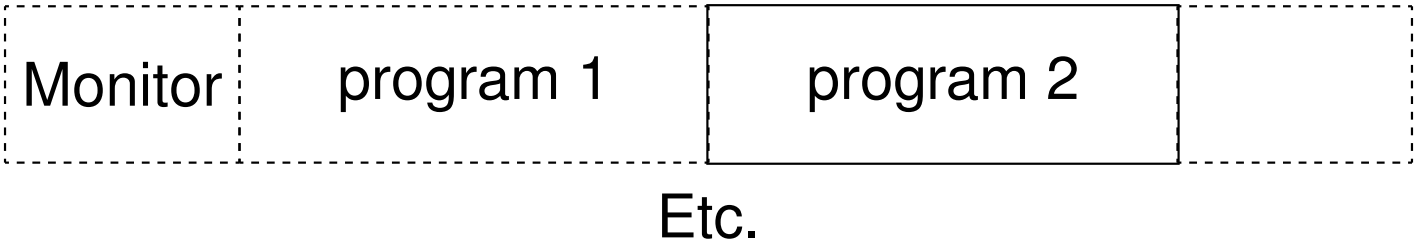


Program 2 runs

History



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The monitor is not running when a user program is running, and the user program is not running while the monitor is running

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This changing between multiple user programs is called *multitasking*. But only one thing is ever running

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Multitasking improves the efficiency of use of a computer since while one program waits for a slow peripheral another program can run

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- how much the owner of the program has paid
- And many more things

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So there is a trade-off of making scheduling *fast* but *fair*

This is still an issue today: we'll look a little into scheduling later