Virtual Memory

- Virtual memory – separation of user logical memory from physical memory.
  - Only part of the program needs to be in memory for execution.
  - Logical address space can therefore be much larger than physical address space.
  - Need to allow pages to be swapped in and out.
- Virtual memory can be implemented via:
  - Demand paging
  - Demand segmentation

Demand Paging

- Bring a page into memory only when it is needed.
  - Less I/O needed
  - Less memory needed
  - Faster response
  - More users
- Page is needed ⇒ reference to it
  - invalid reference ⇒ abort
  - not-in-memory ⇒ bring to memory
- Page fault if page not in memory

If no free frame

- Page replacement – find some page in memory, but not really in use, swap it out.
  - algorithm
  - performance – want an algorithm which will result in minimum number of page faults.
- Same page may be brought into memory several times.

Page Replacement Algorithms

- Want lowest page-fault rate.
- Evaluate algorithm by running it on a particular string of memory references (reference string) and computing the number of page faults on that string.

Page replacement algorithm

- Demand paging system with three frames
- Page reference sequence is

A D B E A E F G A G E F

LRU

LRU	A	D	B	E	A	E	F	G	A	G	E	F
F1	A	A	A	E	E		E	E	A		A	F
F2		D	D	D	A		A	G	G		G	G
F3			B	B	B		F	F	F		E	E

12 – 2 = 10

FIFO

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FIFO	A	D	B	E	A	E	F	G	A	G	E	F
F1	A	A	A	E	E		E	G			G	
F2		D	D	D	A		A	A			E	
F3			B	B	B		F	F			F	

12 – 4 = 8

MIN

MIN	A	D	B	E	A	E	F	G	A	G	E	F
F1	A	A	A	A			A	A				?
F2		D	D	E			E	E				?
F3			B	B			F	G				?

12 – 5 = 7

Hw 5

- B = Bytes
- b = bits
- 1 byte = 8 bits
- 1 KB = 1024 bytes = 2^10
- 1 MB = 1024 KB = 2^10
- 1 GB = 1024 MB