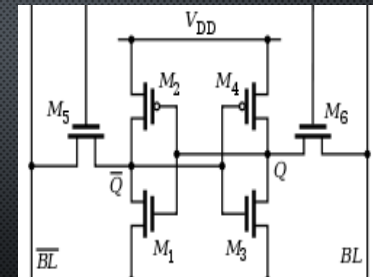


COMPUTER MEMORY PART II

JEFFREY GRANGE AND KONRAD McCLURE

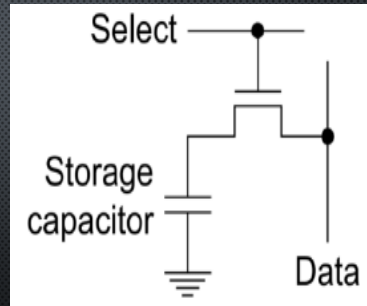
(MOS) SRAM

- STATIC RAM (IBM - 1965)
 - ALTERNATIVE TO MAGNETIC CORE MEMORY
 - EXPENSIVE, 4-6 TRANSISTORS PER A FLIP-FLOP
 - FAST
 - STILL RELEVANT



(MOS) DRAM & SDRAM

- DYNAMIC RAM (INTEL - 1970)
 - A LOT CHEAPER AND SMALLER
 - SLOW, NEEDS TO BE RECHARGED PERIODICALLY
- SYNCHRONOUS DYNAMIC RAM (SAMSUNG - 1993)
 - INCREASED PERFORMANCE BY USING A CLOCK



RDRAM

- RAMBUS DRAM (RAMBUS - 1996)
 - IMPLEMENTED DOUBLE DATA RATE TECHNOLOGY, ALLOWING OPERATIONS ON BOTH RISING AND FALLING EDGES OF CLOCK.
 - INCREASED LATENCY, HEAT, COMPLEXITY AND COST, MAKING IT HARDLY WORTH IT...

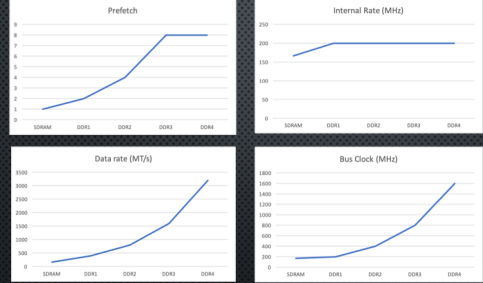


DDR SDRAM

- DOUBLE DATA RATE SDRAM (SAMSUNG – 1998, 2003, 2007 & 2014)
 - USES BOTH RISING AND FALLING EDGE OF CLOCK TO ACHIEVE HIGHER EFFICIENCY
 - EACH ITERATION IMPROVED VARIOUS ASPECTS, SUCH AS POWER EFFICIENCY, BUS CLOCK RATE AND PREFETCH BIT COUNT.



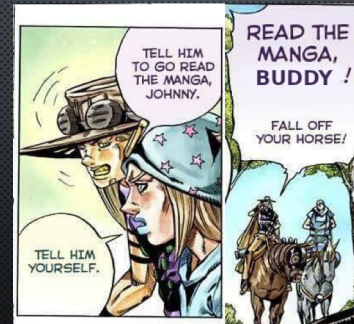
DDR BONUS DATA



STORAGE

We're skipping it

READ-ONLY MEMORY (ROM)



MROM

- MASK ROM
 - FIRST ITERATION OF ROM
 - INEXPENSIVE
 - PRE-PROGRAMMED AT MANUFACTURE



PROM - 1956

- PROGRAMMABLE ROM
 - CAN BE WRITTEN TO ONCE BY THE USER
 - FUSES
 - REQUIRES "BURNER"

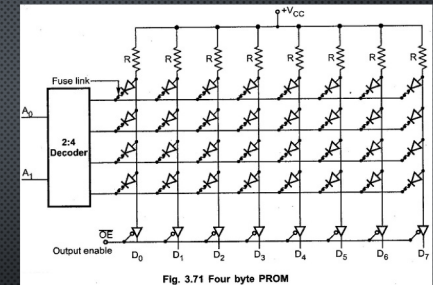
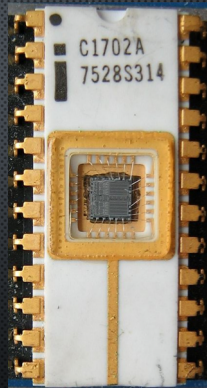


Fig. 3.71 Four byte PROM



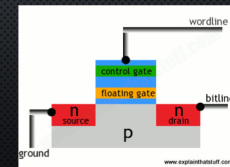
EPROM -1971

- ERASABLE PROM
 - PROGRAMMED BY THE USER
 - ERASED USING UV LIGHT.
 - SLOW
 - LIMITED WRITES



EEPROM -1978

- ELECTRICALLY ERASABLE PROM
 - ELI HARARI AT HUGHES AIRCRAFT
 - ELECTRICAL REPROGRAMMING
 - FASTER, BUT SLOW
 - TWO-TRANSISTOR STRUCTURE
 - LOTS OF WRITES!



FLASH MEMORY - 1984

- MODERN EEPROM
 - FUJIO MASUOKA AT TOSHIBA
 - SSDs, SD CARDS, **FLASH** DRIVES, GAME CARTRIDGES
 - MILLIONS OF WRITES



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