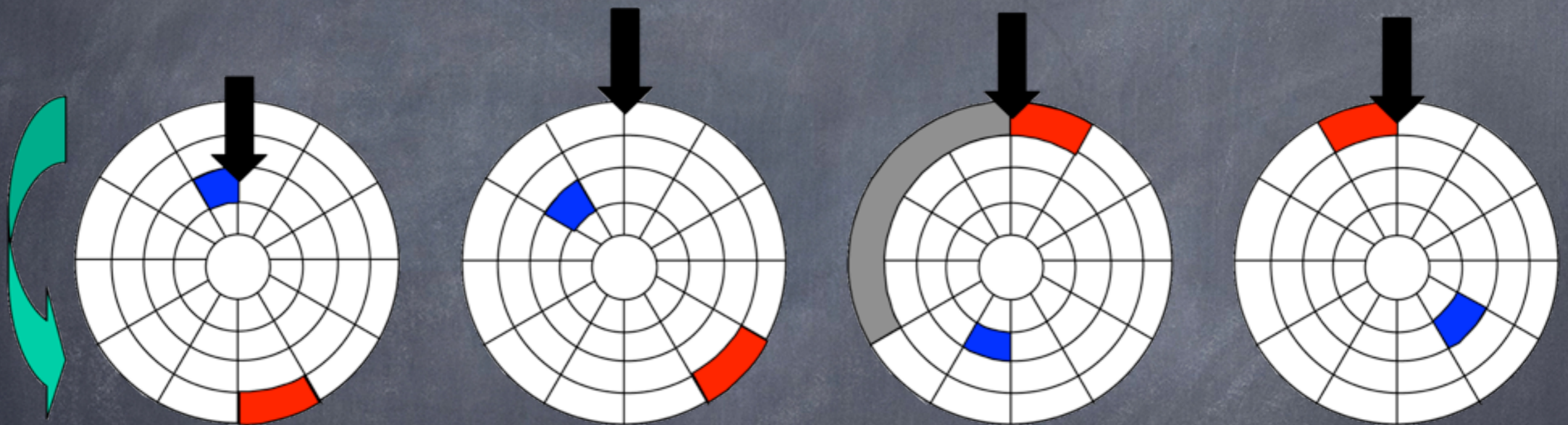


Announcements

???

Delays in disk accesses



Complete
accessing
blue

Seek to
cylinder
for red

Rotational
latency to
access red

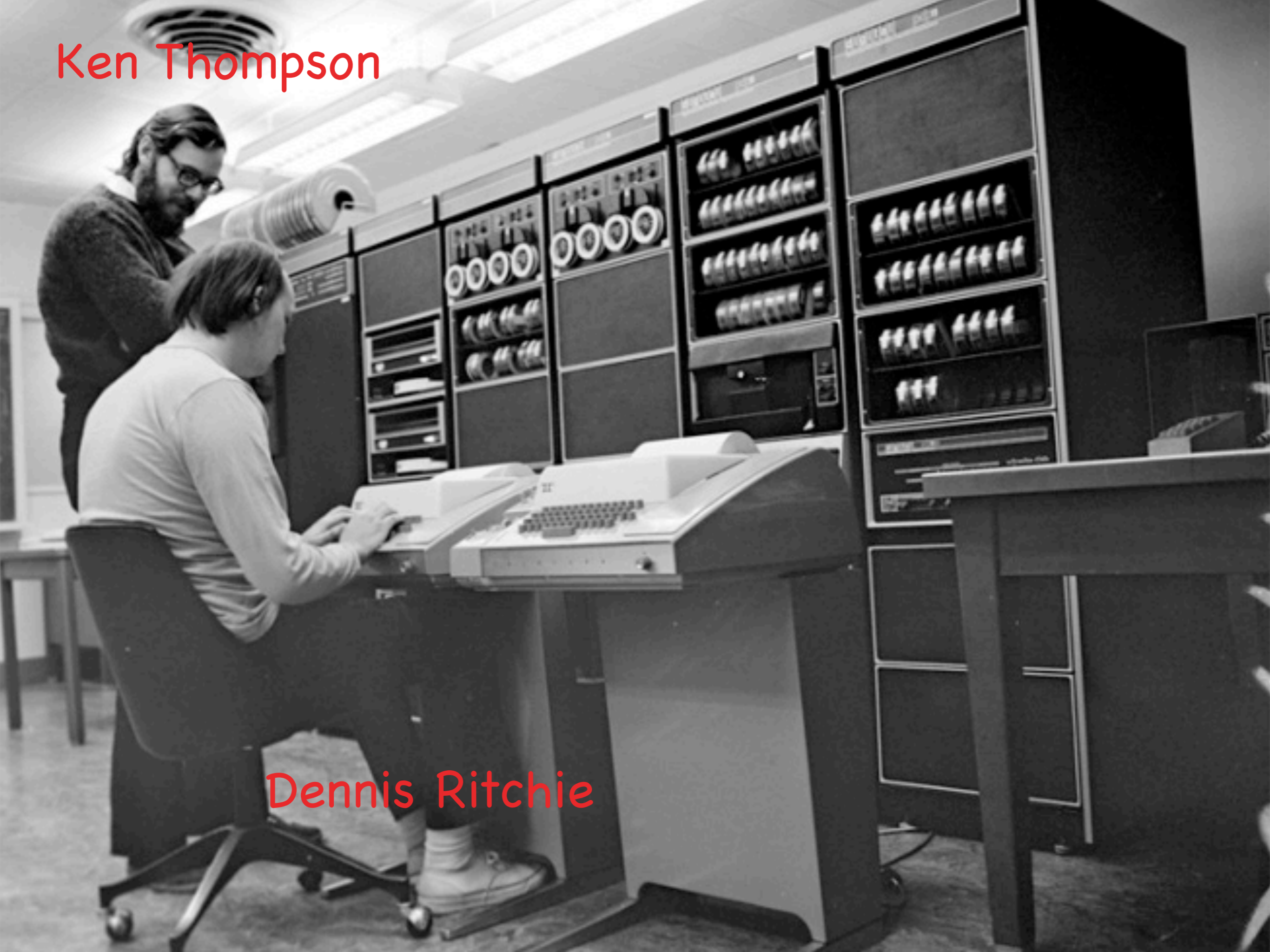
Access
red

Seagate Cheetah Specs

Specifications	600GB¹	450GB¹	300GB¹
Model Number	ST3600057SS ST3600957SS ² ST3600857SS ³ ST3600057FC ST3600957FC ^{2,4} ST3600857FC ^{3,4}	ST3450857SS ST3450757SS ² ST3450657SS ³ ST3450857FC ST3450757FC ^{2,4} ST3450657FC ^{3,4}	ST3300657SS ST3300557SS ² ST3300457SS ³ ST3300657FC ST3300557FC ^{2,4} ST3300457FC ^{3,4}
Capacity			
Formatted 512 KB/Sector (GB)	600	450	300
External Transfer Rate (MB/s)			
4Gb/s Fibre Channel	400	400	400
6Gb/s Serial Attached SCSI	600	600	600
Performance			
Spindle Speed (RPM)	15K	15K	15K
Average Latency (ms)	2.0	2.0	2.0
Seek Time Average Read/Write (ms)	3.4/3.9	3.4/3.9	3.4/3.9
Transfer Rate			
Internal (Mb/s, OD-ID)	1450 to 2370	1450 to 2370	1450 to 2370
Sustained (MB/s, 1000 x 1000)	122 to 204	122 to 204	122 to 204



Ken Thompson



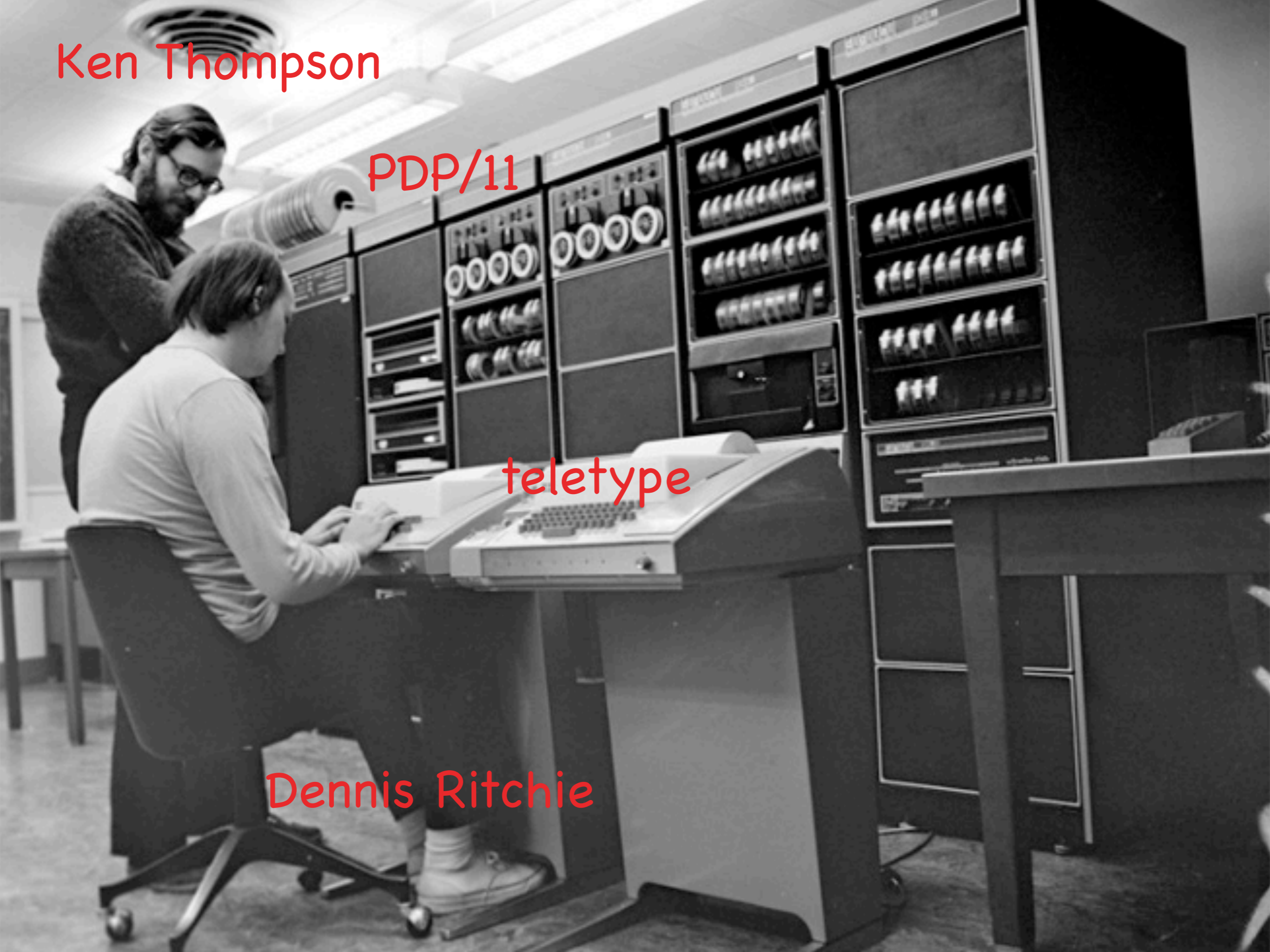
Dennis Ritchie

Ken Thompson

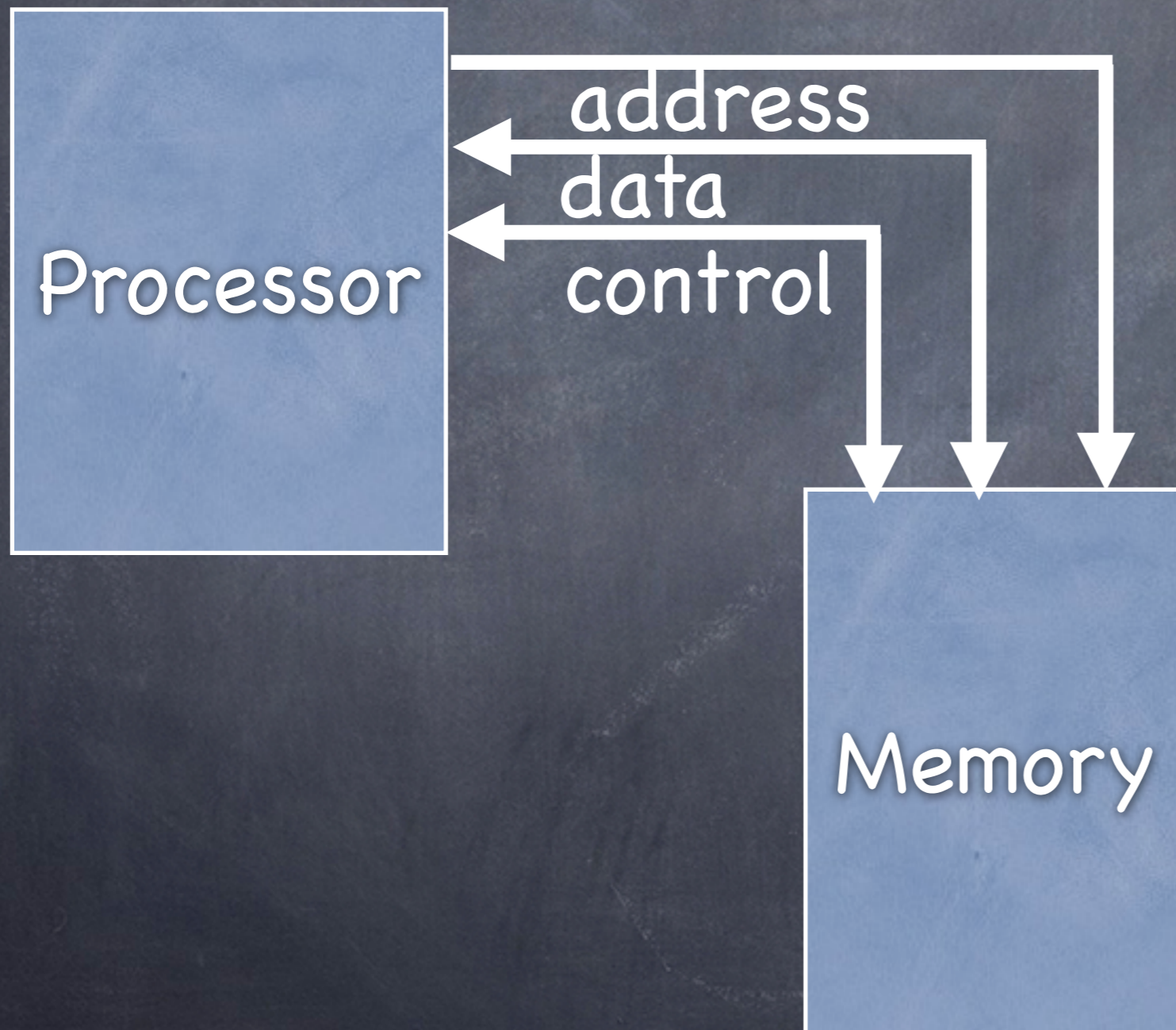
PDP/11

teletype

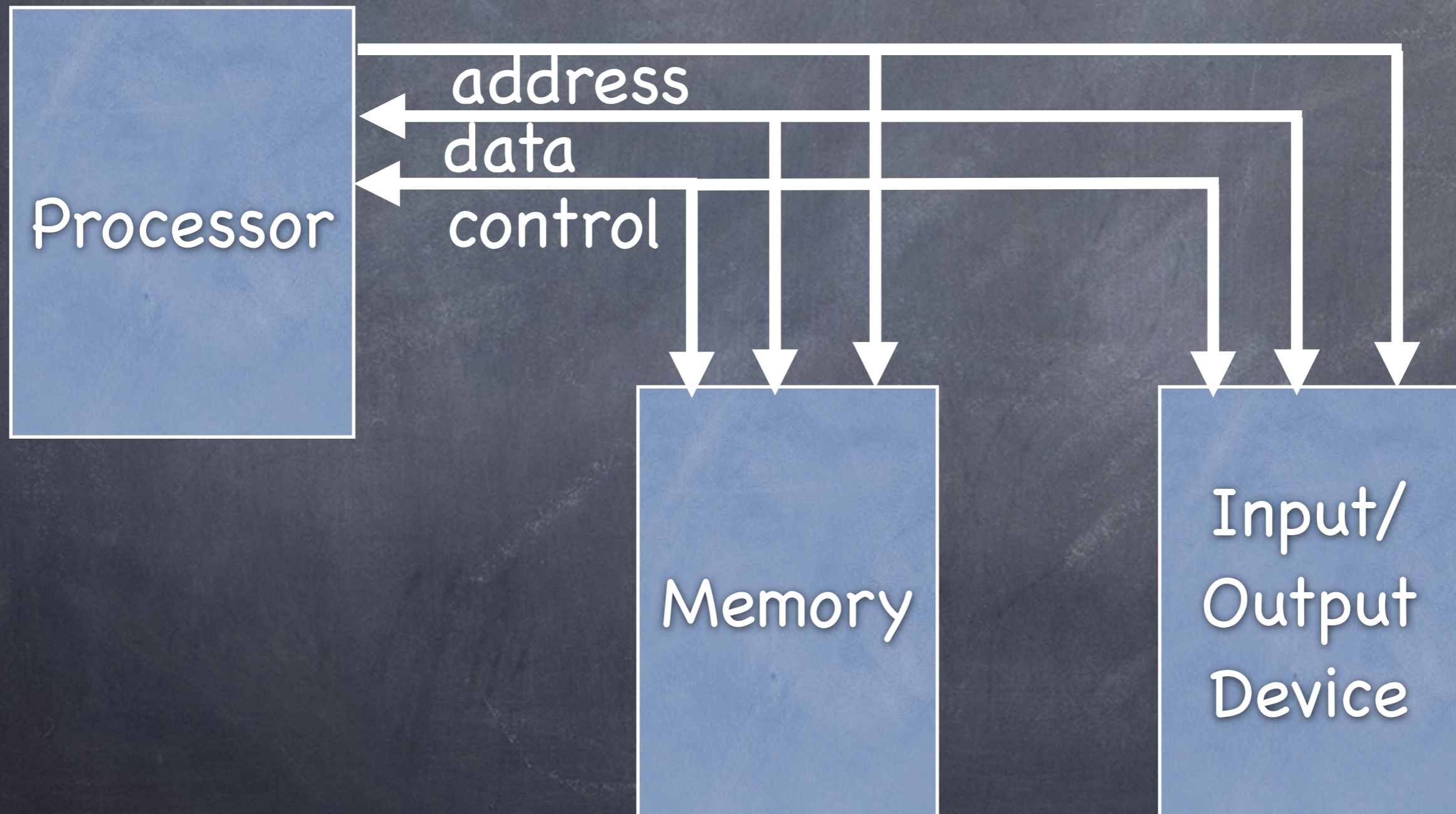
Dennis Ritchie



Memory



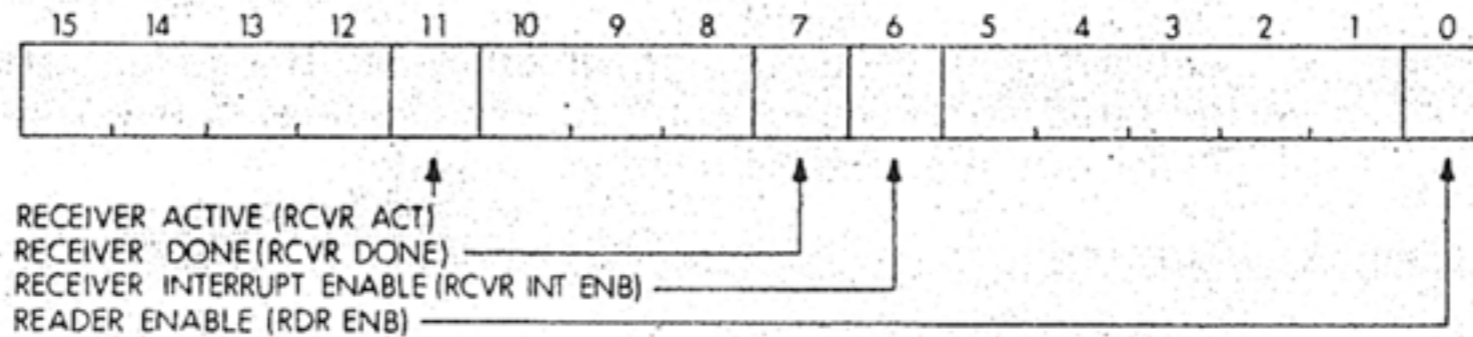
Memory Mapped Input/ output



Ancient (PDP-11) Serial Port I/O Details

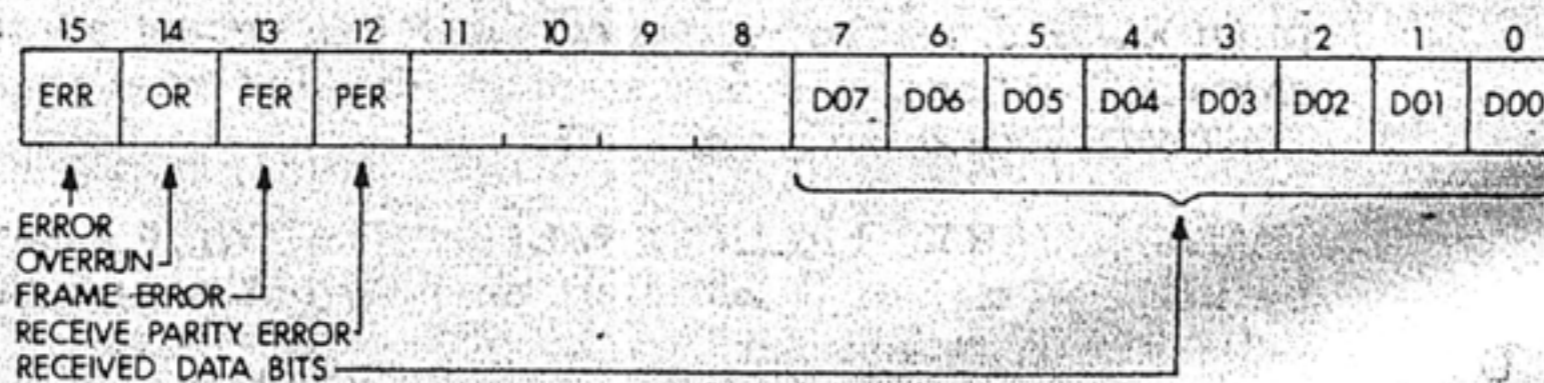
REGISTERS

Receiver Status Register (RCSR)



BIT	MEANING AND OPERATION
15-12	Unused.
7	RCVR DONE—Read Only. Set when an entire character has been received and is ready for transfer to the UNIBUS. Cleared by setting RDR ENB, addressing (READ or WRITE) RBUF or INIT. Starts an interrupt sequence when RECEIVER INTERRUPT ENABLE (bit 6) is also set.
6	RECEIVER INTERRUPT ENABLE—Read/Write. Cleared by INIT. Starts an interrupt sequence when Receiver DONE is set.
5-1	Unused.
0	READER ENABLE—Write Only. Cleared by INIT or at middle of a START bit. Advances paper tape reader of ASR teletypes. Clears RCVR DONE. 20 mA current loop circuit output associated with this bit.

Receiver Data Buffer (RBUF)

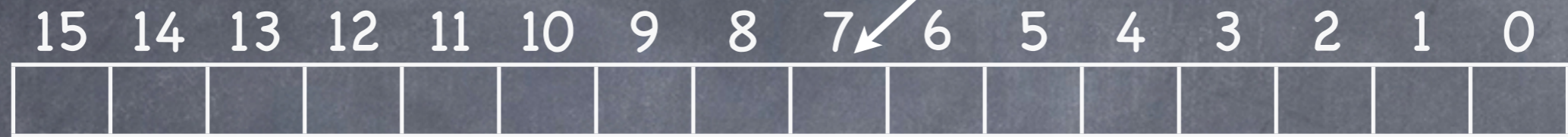


BIT	MEANING AND OPERATION
15	ERROR—Read Only. Logical "OR" of OR, FER, and PER. Cleared by removing the error conditions. ERROR is not tied to the interrupt logic, but RCVR DONE is.
14	OVERRUN—Read Only. Set if previously received character is not read (RCVR DONE not reset) before the present character is read.
13	FRAMING ERROR—Read Only. Set if the character read has no valid stop bit. Also used to detect break.
12	RECEIVE PARITY ERROR—Read Only. Set if received parity does not agree with the expected parity. Always 0 if no parity is selected.
NOTE: Error conditions remain present until the next character is received, at which time, the error bits are updated. INIT does not necessarily clear the error bits. Error bits may be disabled via a switch.	
11, 10, 9, 8	Unused.
7-0	RECEIVED DATA BITS—Read Only. These bits contain the character just read. If less than 8 bits are selected, the buffer will be right justified into the least significant bits with the higher unused bit or bits, reading as 0's. Not cleared by INIT.

Ancient (PDP-11) Serial Port I/O Details

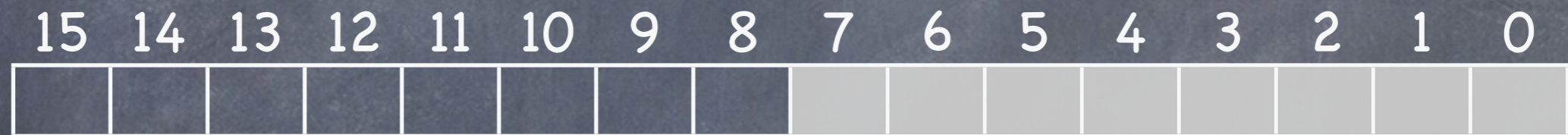
	ADDRESS	VECTOR	PRIORITY
LINE CLOCK	777546 777560	100	BR6
CONSOLE	777662 777564 777566 776XX0	60/64	BR4

Receiver Status Register: RCVR DONE



Receiver Data Buffer:

Received Data Bits



```
short *RSR = (short *) 0777564;
```

```
short *RDB = (short *) 0777566;
```

```
#define RCRVDONE 0x0080
```

	ADDRESS
LINE CLOCK	777546 777560
CONSOLE	777662 777564 777566 776XX0

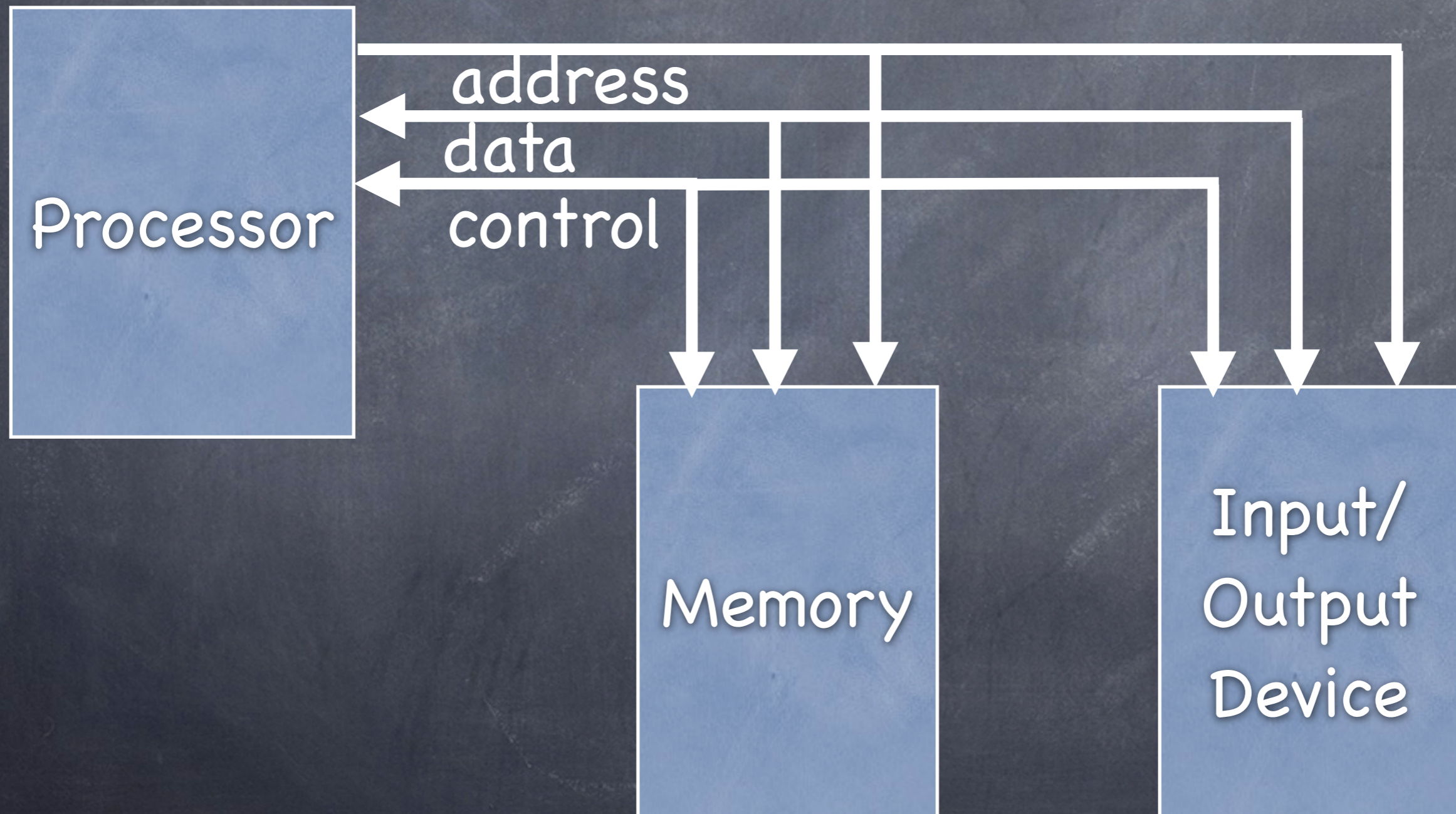
```
int readLine( char * buffer, int len ) {
    int pos = 0;
    do {
        while (! (*RSR & RCVRDONE )) {
            // wait for a character
        }
        buffer[pos] = (char) (*RDB & 0x00FF);
        pos++;
    } while ( pos < len && buffer[ pos-1 ] != '\n' )
    return pos;
}
```



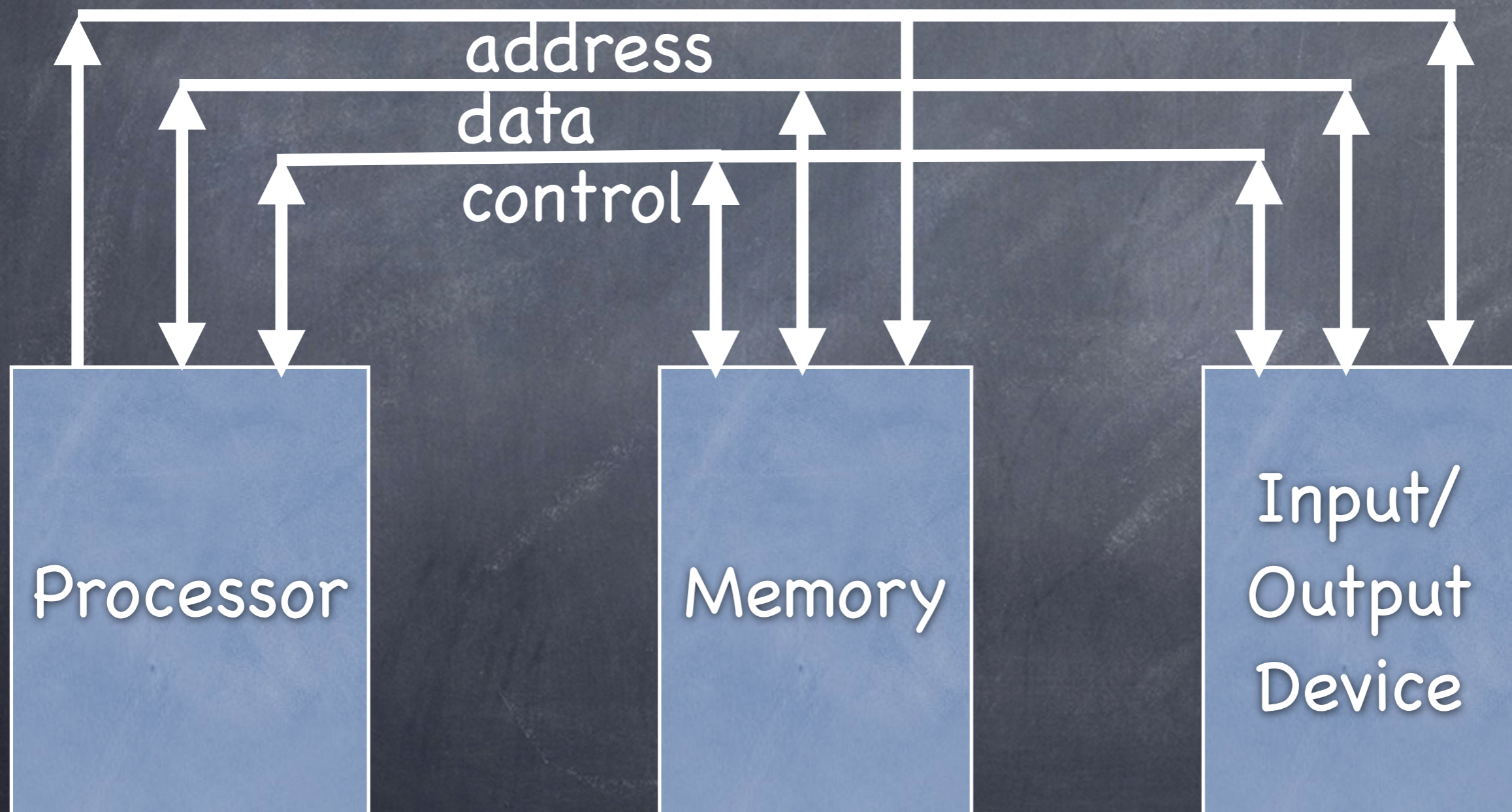
Seagate Cheetah Specs

Specifications	600GB¹	450GB¹	300GB¹
Model Number	ST3600057SS ST3600957SS ² ST3600857SS ³ ST3600057FC ST3600957FC ^{2,4} ST3600857FC ^{3,4}	ST3450857SS ST3450757SS ² ST3450657SS ³ ST3450857FC ST3450757FC ^{2,4} ST3450657FC ^{3,4}	ST3300657SS ST3300557SS ² ST3300457SS ³ ST3300657FC ST3300557FC ^{2,4} ST3300457FC ^{3,4}
Capacity			
Formatted 512 KB/Sector (GB)	600	450	300
External Transfer Rate (MB/s)			
4Gb/s Fibre Channel	400	400	400
6Gb/s Serial Attached SCSI	600	600	600
Performance			
Spindle Speed (RPM)	15K	15K	15K
Average Latency (ms)	2.0	2.0	2.0
Seek Time Average Read/Write (ms)	3.4/3.9	3.4/3.9	3.4/3.9
Transfer Rate			
Internal (Mb/s, OD-ID)	1450 to 2370	1450 to 2370	1450 to 2370
Sustained (MB/s, 1000 x 1000)	122 to 204	122 to 204	122 to 204

Memory Mapped Input/ output



Direct Memory Access (DMA)



WORD COUNT (RPWC) REGISTER (776702)

15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
WC 15	WC 14	WC 13	WC 12	WC 11	WC 10	WC 09	WC 08	WC 07	WC 06	WC 05	WC 04	WC 03	WC 02	WC 01	WC 00

BIT	NAME	FUNCTION
WC	(15:00) (Word Count) Read/write	Set by the program to specify the number of words to be transferred (2's complement form). This register is cleared only by writing 0s into it. Incremented for each data transfer.

UNIBUS ADDRESS (RPBA) REGISTER (776704)

15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
BA 15	BA 14	BA 13	BA 12	BA 11	BA 10	BA 09	BA 08	BA 07	BA 06	BA 05	BA 04	BA 03	BA 02	BA 01	0

BIT	NAME	FUNCTION
01-15	BA(01:15) (Unibus Address) Read/write	Loaded by the program to specify the starting memory address of a transfer. Cleared by Unibus A INIT or by Controller Clear. The BA register is incremented by 2 after each transfer of a word to or from memory.

DESIRED SECTOR/TRACK ADDRESS (RPDA) REGISTER (776706)

15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
0	0	0	TA5	TA4	TA3	TA2	TA1	0	0	0	SA5	SA4	SA3	SA2	SA1




```
void putLine( char * buffer ) {  
    int pos = 0;  
    while ( buffer[ pos ] != 0 ) {  
        while ( ! (*TSR & XMITRDY ) {  
            // wait until printer ready  
        }  
        *TDB = buffer[pos];  
        pos++  
    }  
}
```

```
int main( int argc, char * argv[] ) {  
    ...  
    int i  
    while ( happy ) {  
        i++;  
        // compute contents of line[i]  
        ...  
        putLine( line[i] );  
    }  
}
```


I/O Delays

