I/O

The I/O entity:

- the medium
- the transducer electronics
- the device

Basic types:

- Interrupt-driven
- polling
- I/O controller (e.g. DMA)
- I/O processor — e.g. compression encryption

Disk storage:

1. track, cylinder, aerial density
2. Rotation, seek
3. disk block
4. I/O processor mechanism: e.g., elevator
5. Disk arrays -- RAID levels, performance vs. redundancy

Buses:

1. Signals: A, D, C
2. Separate A,D lines vs. Multiplexed A,D lines
3. Pending bus vs. Split-transaction bus
4. Asynch vs. Synch
5. Arbitration: Centralized vs. Distributed

I/O Notes (Sht 1)

EE 460N
Spring 2015

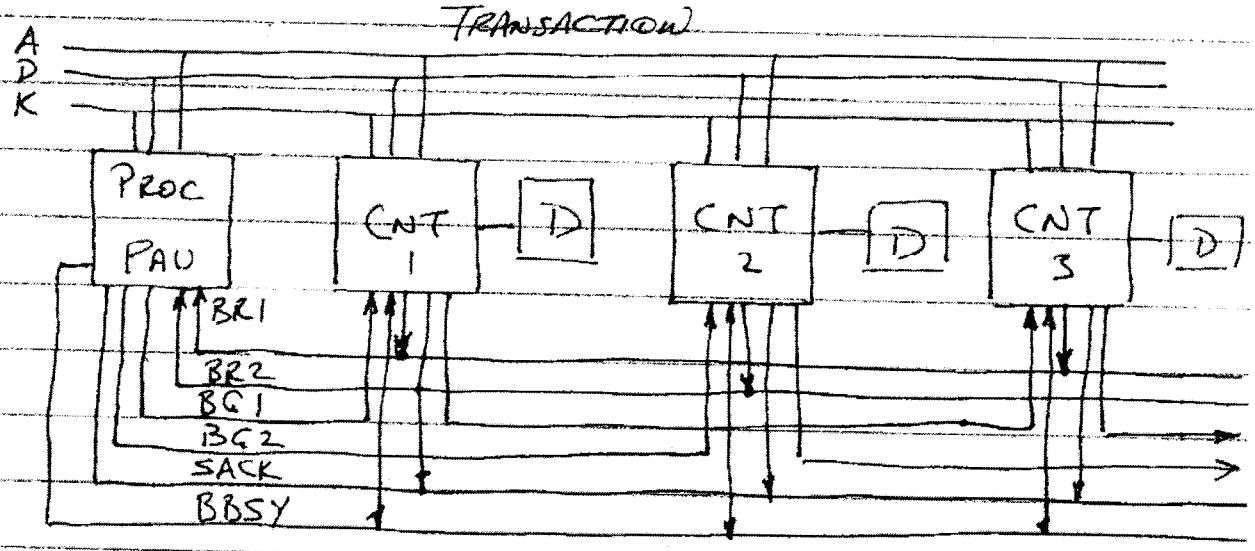
* Characteristics
  - Parts: Medium, Device, Controller
  - How: Poll, Interrupt, DMA, I/O Proc
  - Instructions: Memory-Mapped, Special
  - Synch/Asynch

* Buses
  - Wires: Data, Address, Control
    - Multiplexed
  - Arbitration
    - Central: PAU
    - Distributed: "Dinner Table"
  - Transfer
    - Asynch/Synch (Sharlot)
      - Asynch (Slow) - Handshaking, No Clock, Everything Explicit
      - Synch (Fast) - Most Implicit, Fast if Short Distance
    - Pending/Split-Transaction
      - Pipelined Vs. Tagged

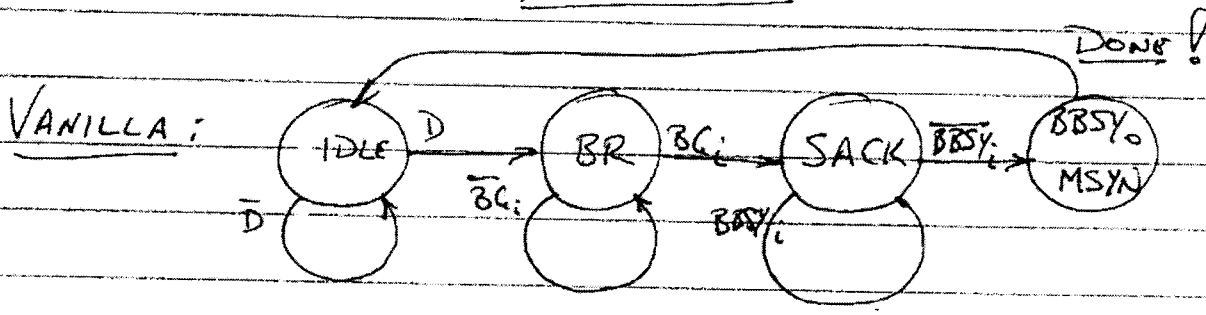
~~* Disc Arrays - (Sht 3)~~

I/O Notes (Sht. 2)

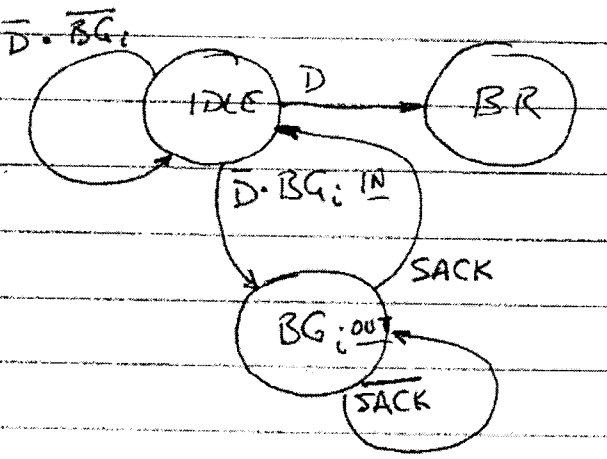
An Asynchronous Bus



ARBITRATION



1. Does Not Want BG:



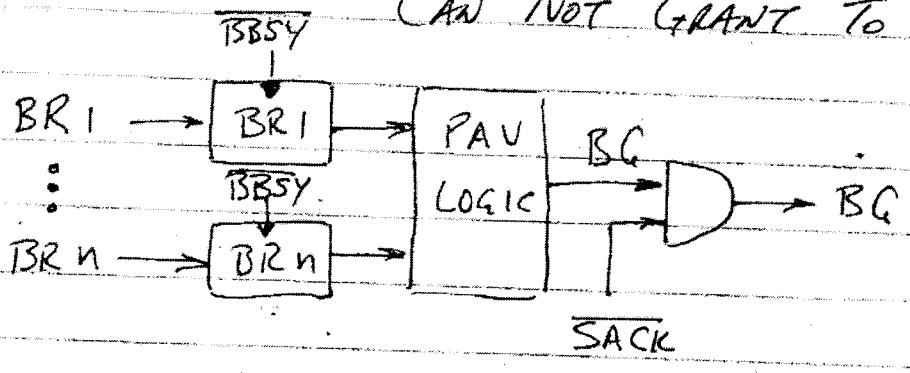
I/O Notes (Set 3)

2. What If Dev Wants Bus After Grant

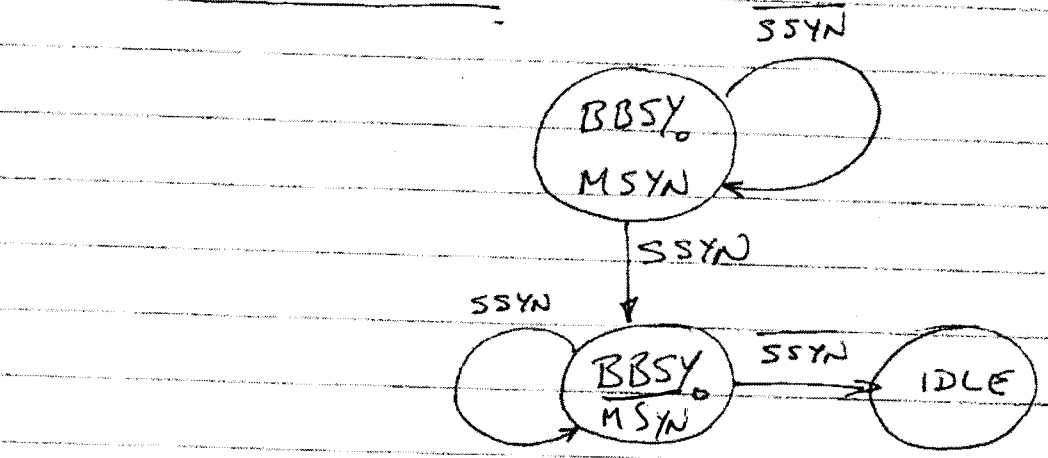
a. At This Priority Level, Touch !

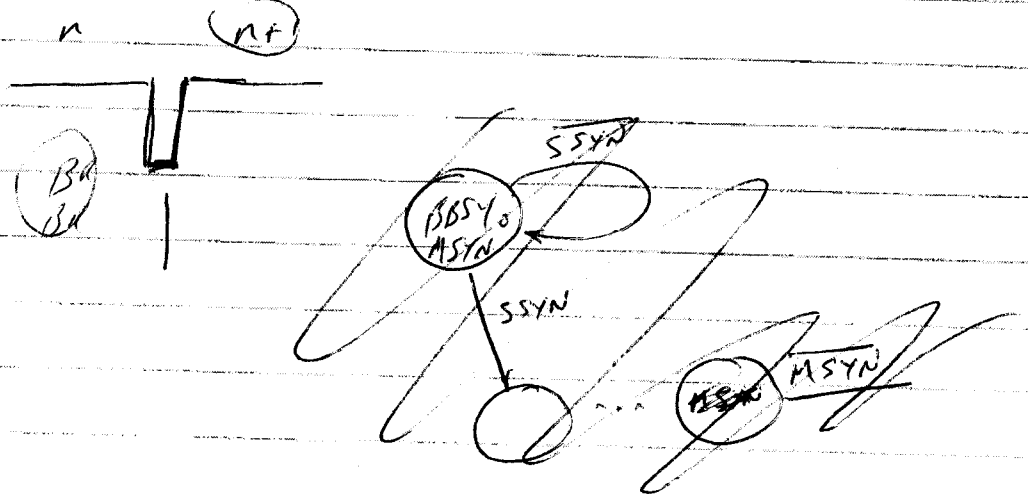
b. At Higher Level: PAU Must Not

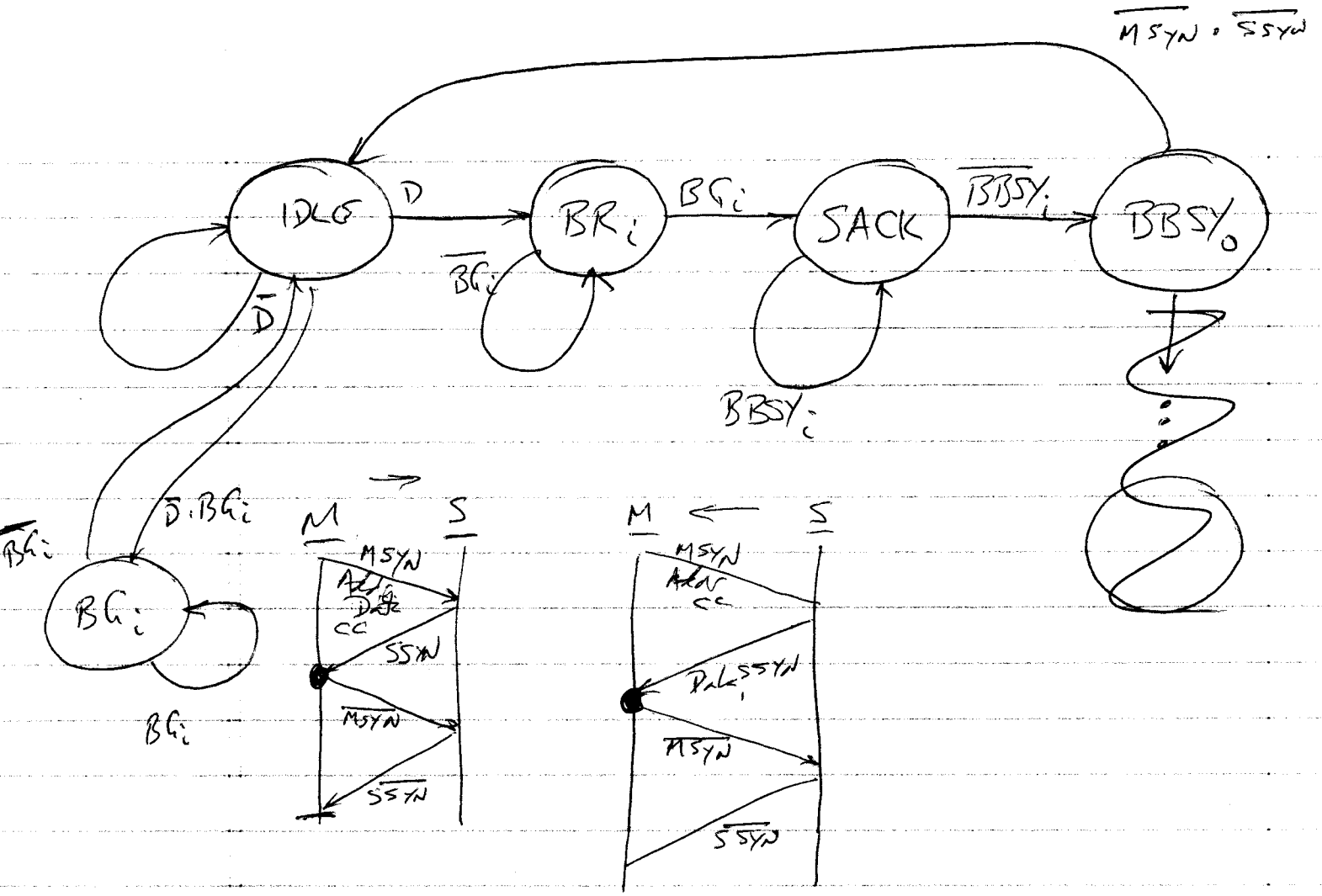
Answer: Once PAU Has Granted, Can Not Grant To Latecomer



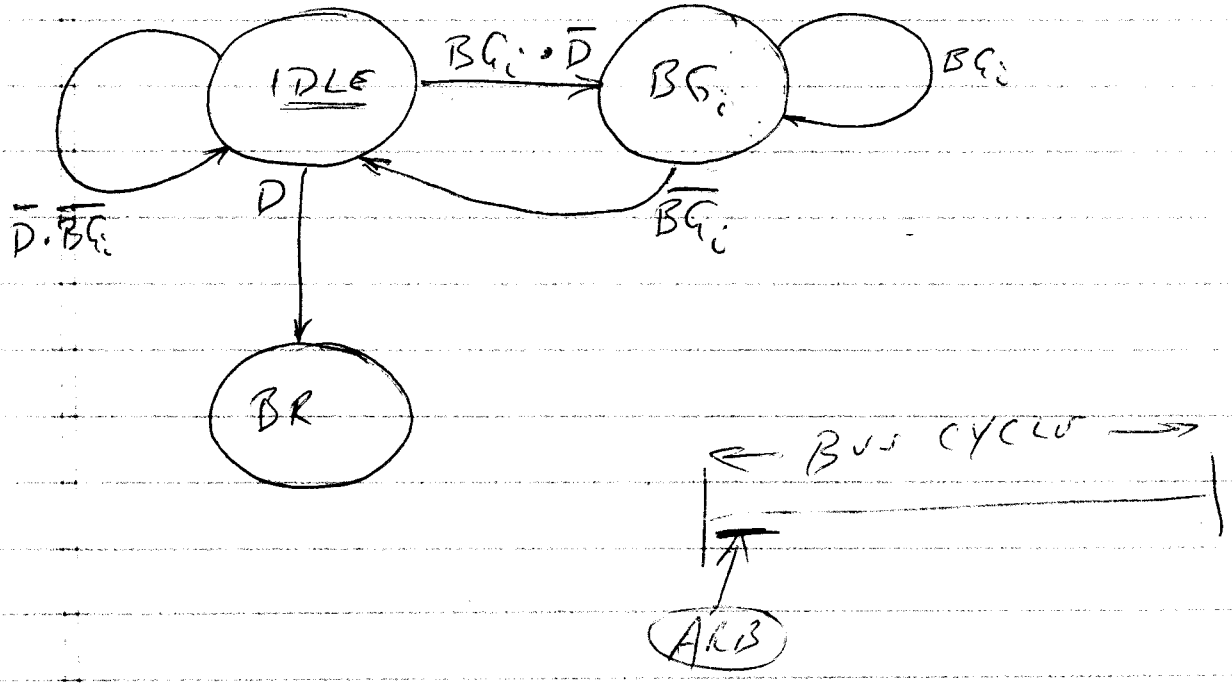
8. What Is "Done"?

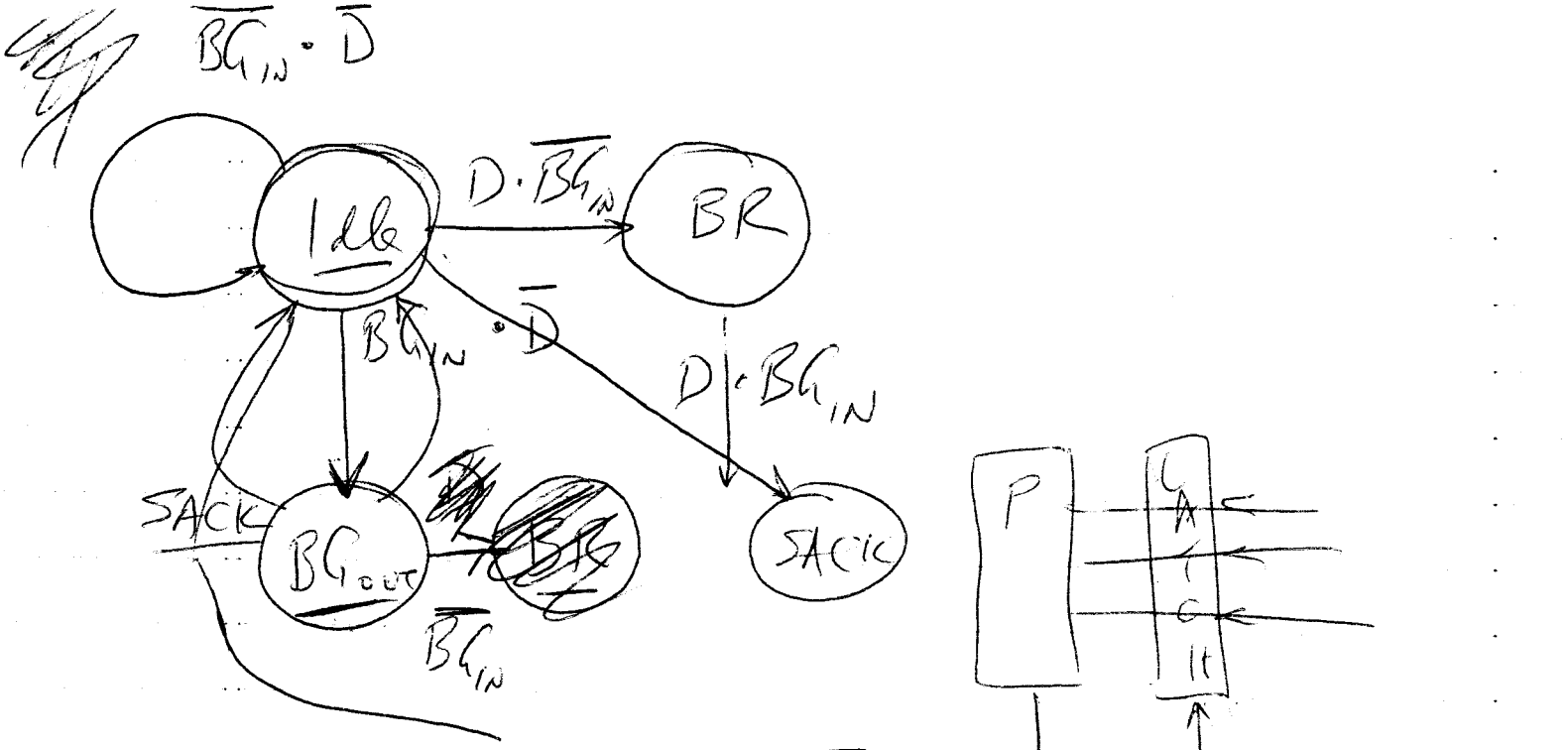






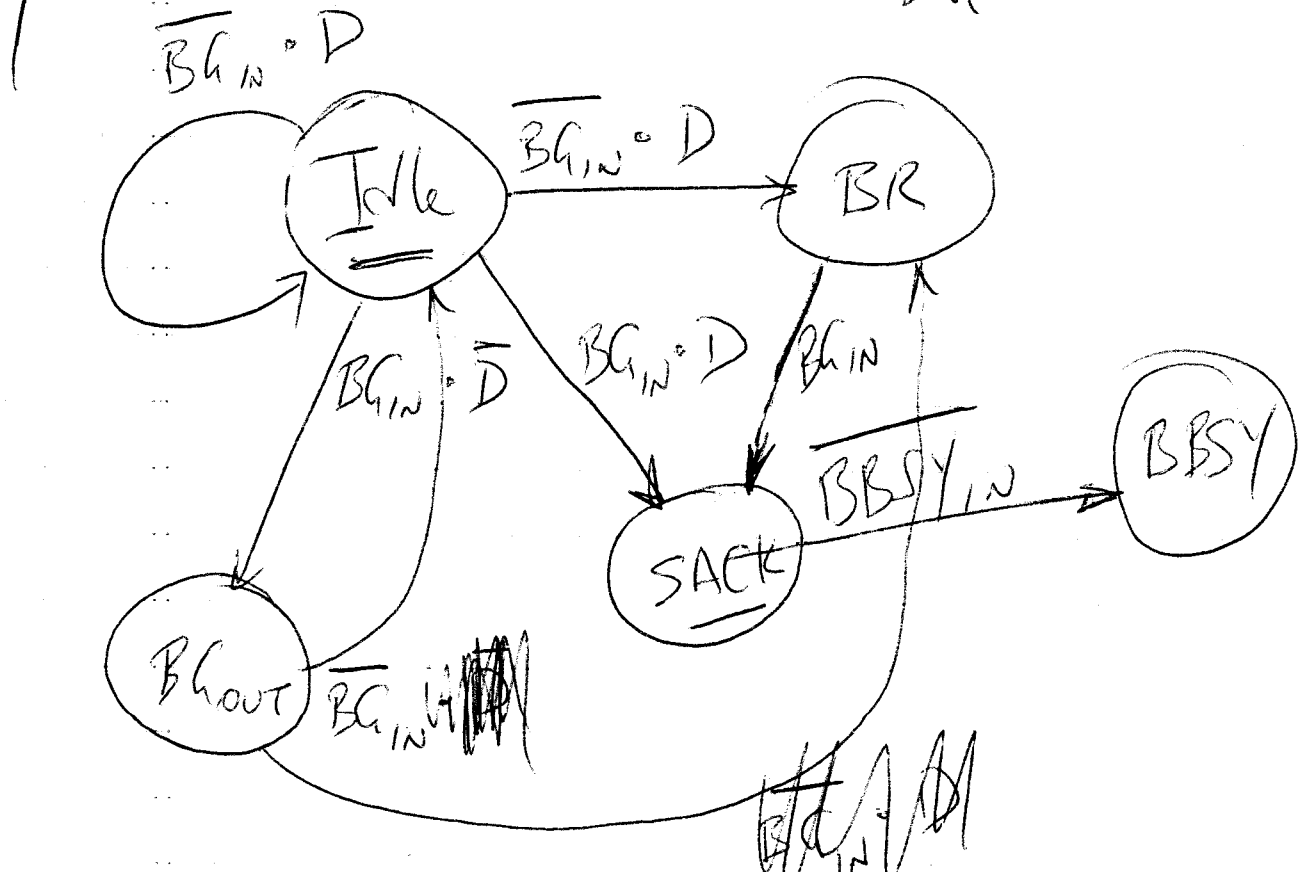
1. Don't want bus





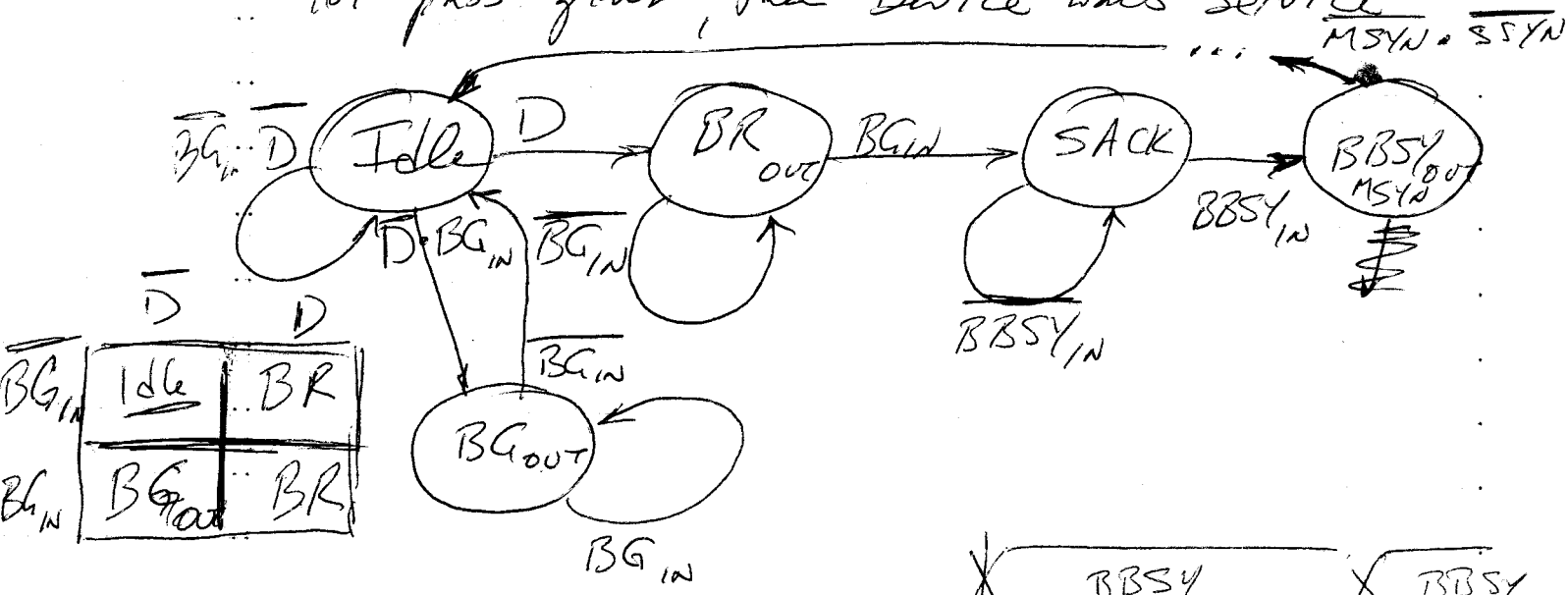
Problem

1. You pass BG, the device

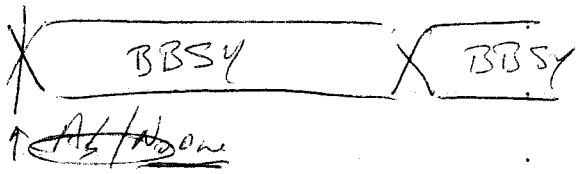


Race 1

You pass grant, then Device wants service ...

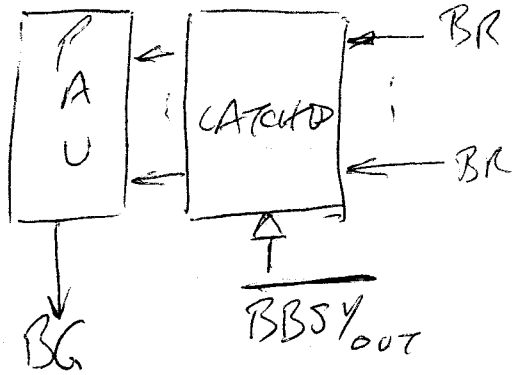


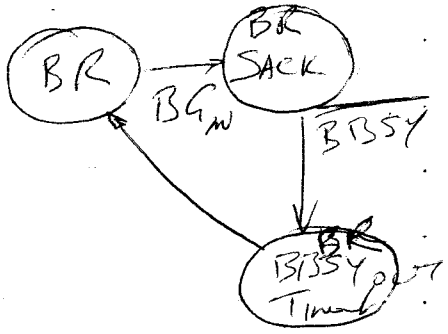
	D	D
BG IN	Idle	BR
BG IN	BG OUT	BR

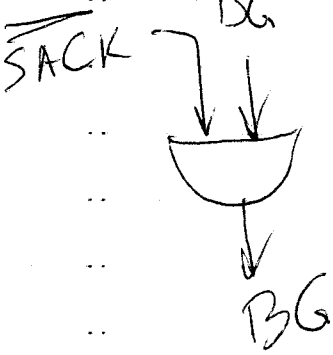


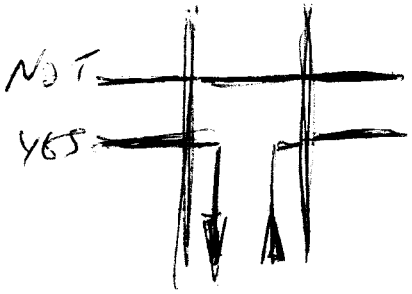
Race 2

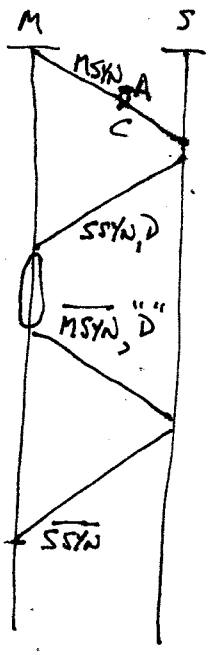
PAU granted bus, High priority req. come in

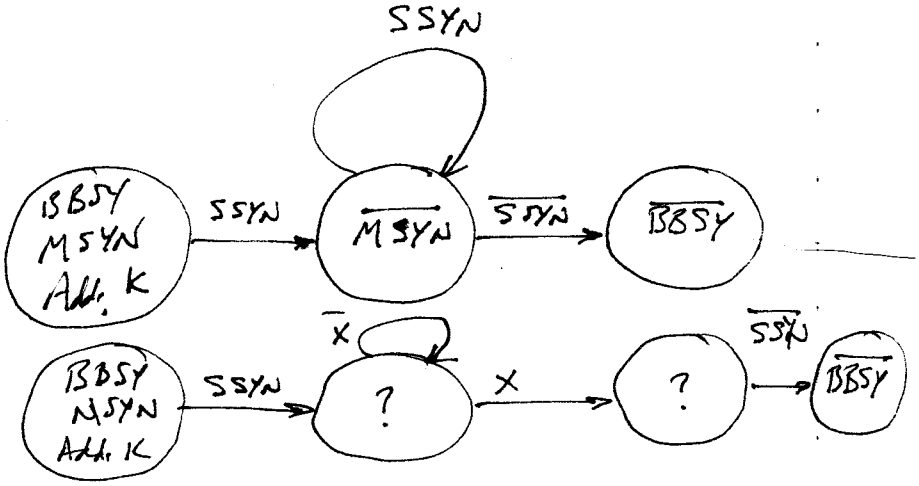


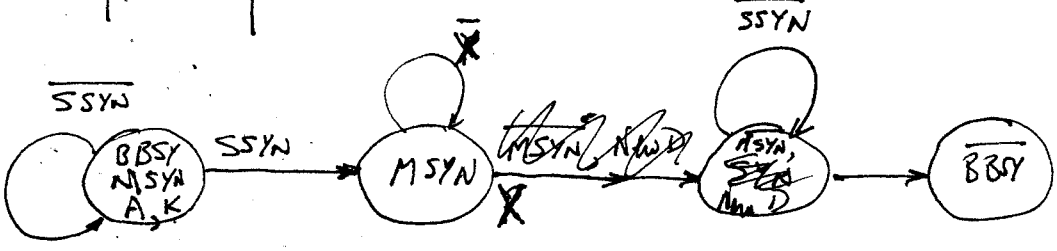


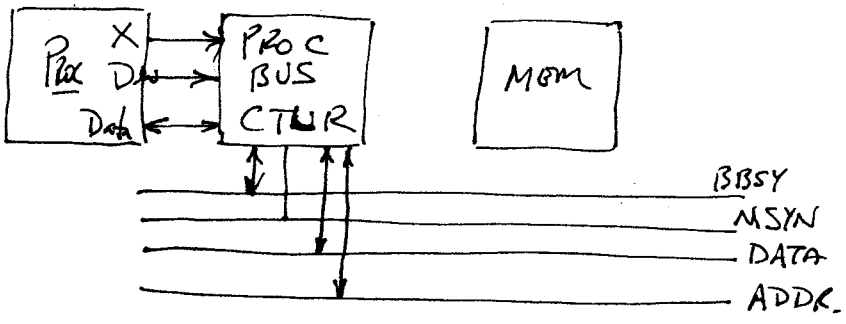


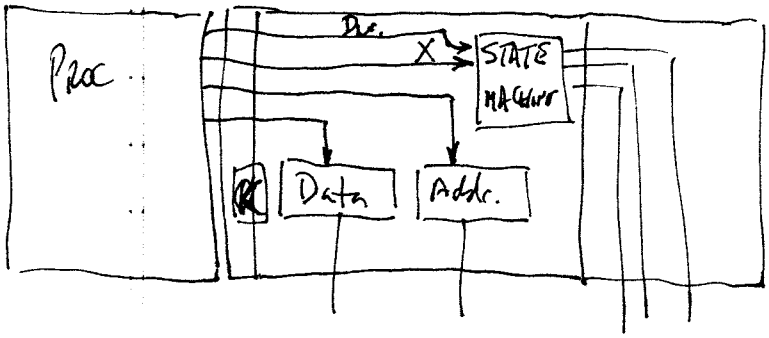


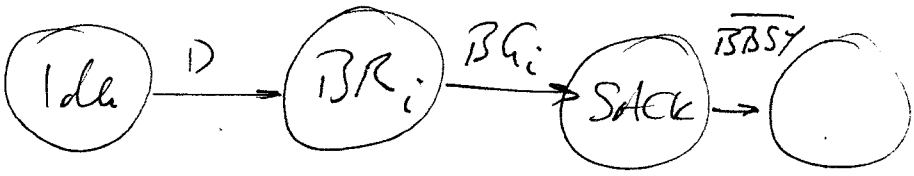

M
S
MSYN
A
C
SSYN, D
MSYN, "D"
SSYN

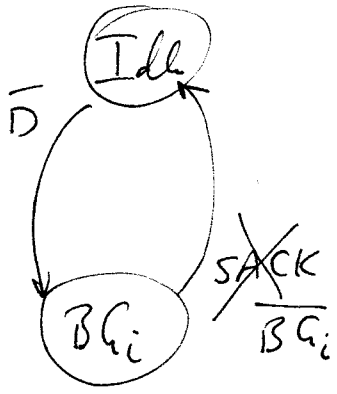

SSYN
ISBSY
MSYN
Add. K
SSYN
MSYN
SSYN
BBSY
X
BBSY
MSYN
Add. K
SSYN
?
X
?
SSYN
BBSY

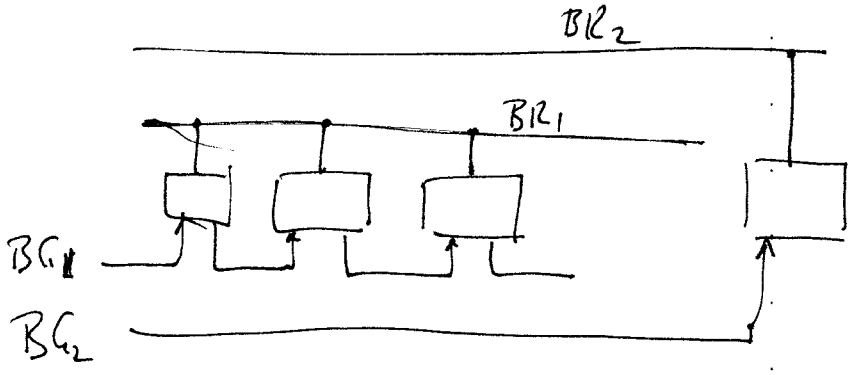

SSYN
BBSY
MSYN
A, K
SSYN
MSYN
SSYN
BBSY

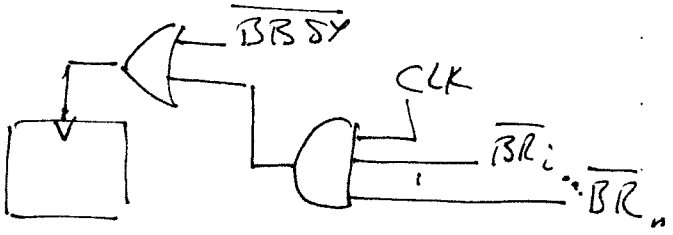

Proc
X
D
Data
PROC
BUS
CTLR
MEM
BBSY
MSYN
DATA
ADDR

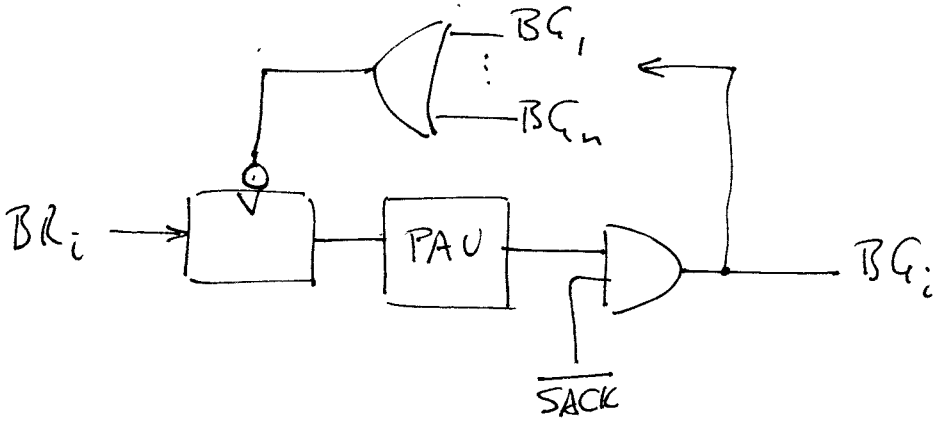

Proc
Dec.
X
STATE
MACHINE
Data
Addr.


Idle
D
BR_i
BG_i
SACK
BBSY


Idle
D
BG_i
SACK
BG_i


BR_2
BR_1
BG_1
BG_2

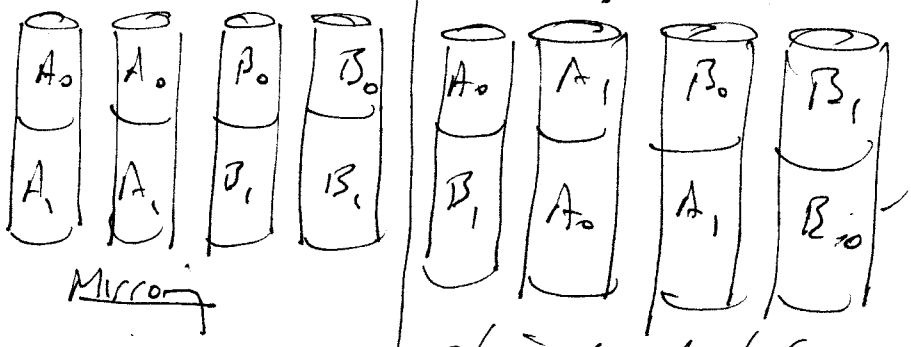

BBSY
CLK
BR_i
BR_n


BG_1
BG_n
BR_i
PAU
BG_i
SACK

RAID
9 Apr 2011

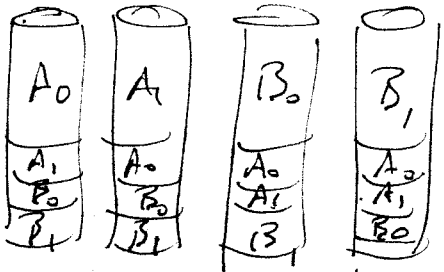
Original
1. Distribute
2. Redundancy

Dual copy



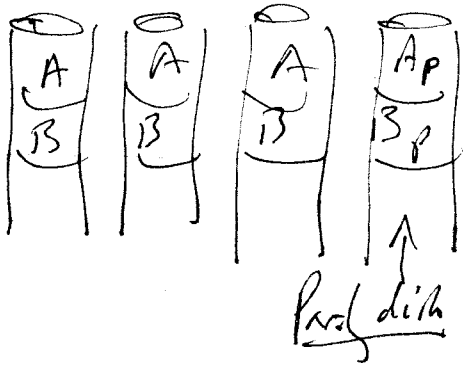
Mirroring

Chained declustering

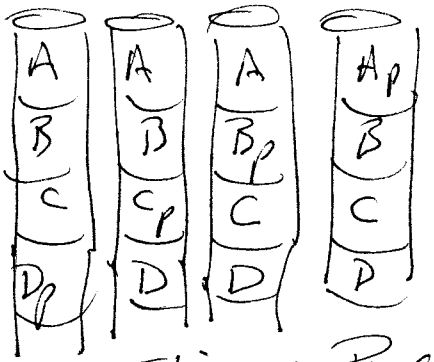


~~Interleaving~~ Interleaved declustering

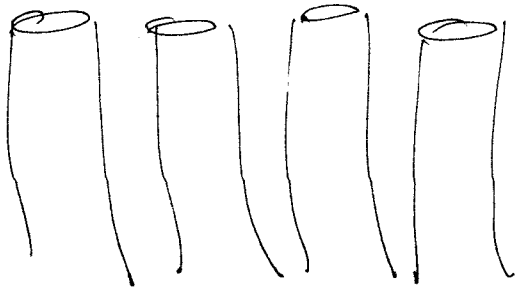
Parity



Parity disk

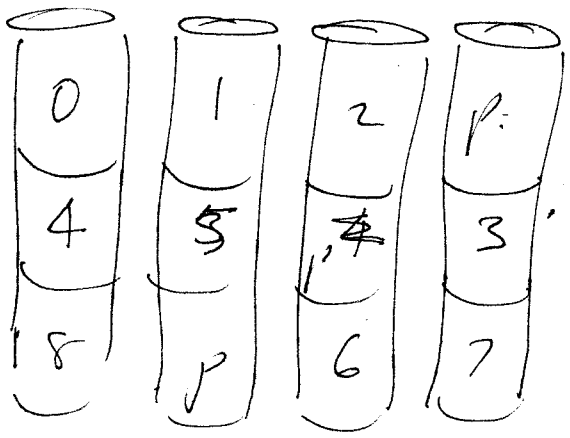


Striped Parity



Raid (striped)

RAID 5



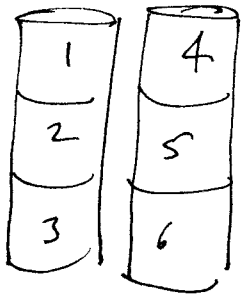
RAID 3 Fine grained striping — Parity disk
4 Coarse grained Striping — Parity disk
5 Fine grained striping — Striping parity

RAID 2, Fine grained striping — ECC
1 Mirroring
0 Coarse grain — no redundancy.

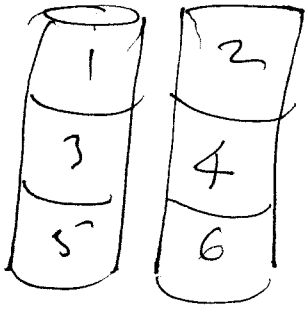
RAID

~~RAID 0~~	No redund	~~Striping~~ Independent	Fine-gr ×	Coarse-gr RAID 0
~~Replication~~	~~Replication~~ Two copies	Mirror RAID 1	×	RAID 0+1
~~Ring~~	Parity	~~Striping~~	RAID 3	RAID 4 RAID 5
	Hamming		RAID 2	

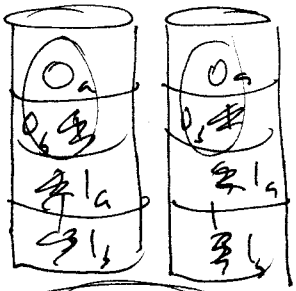
Conventional



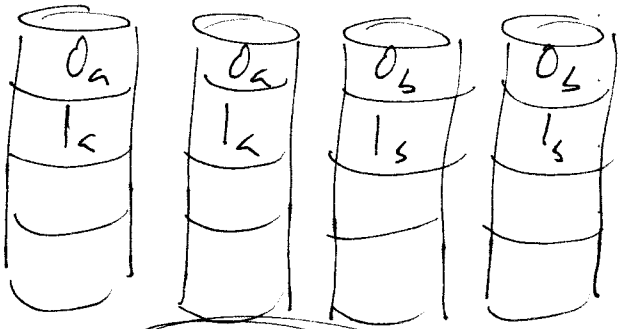
RAID 0
No redund striping



Mirroring

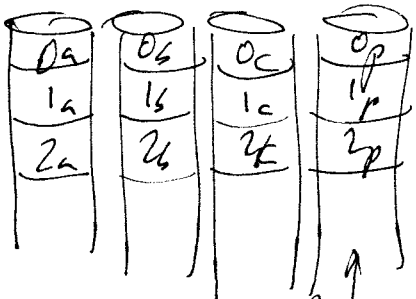


RAID 1
No striping



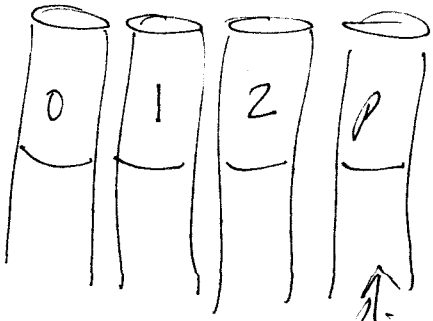
RAID 0+1
with striping

Parity (disk)



RAID 3

Parity disk



Ring