



SWINBURNE
UNIVERSITY OF
TECHNOLOGY

COS10004 Computer Systems

Lecture 3.5: Shift Registers

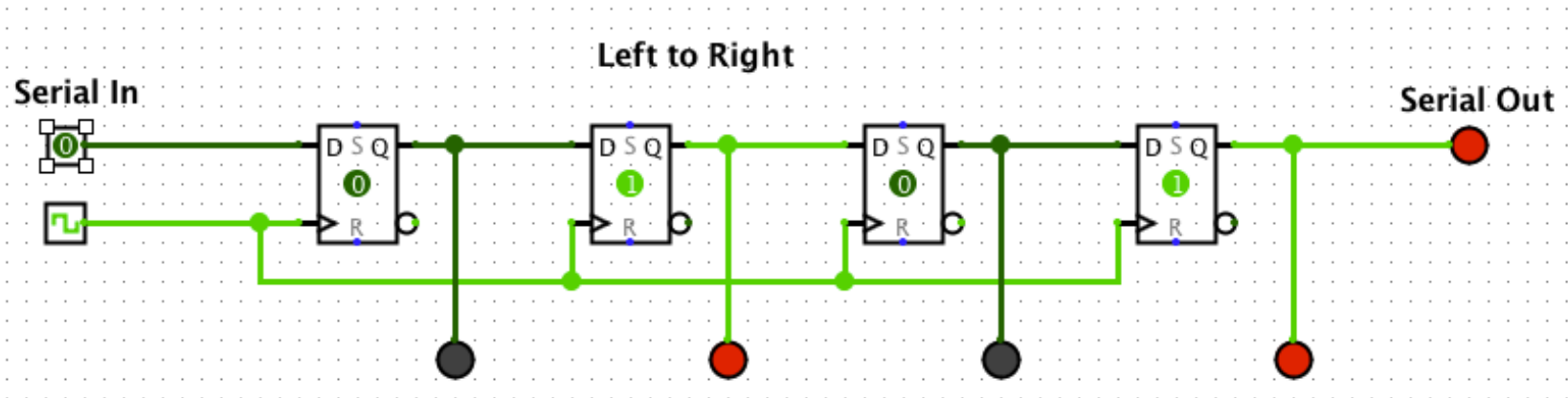
CRICOS provider 00111D

Dr Chris McCarthy

SHIFT REGISTERS

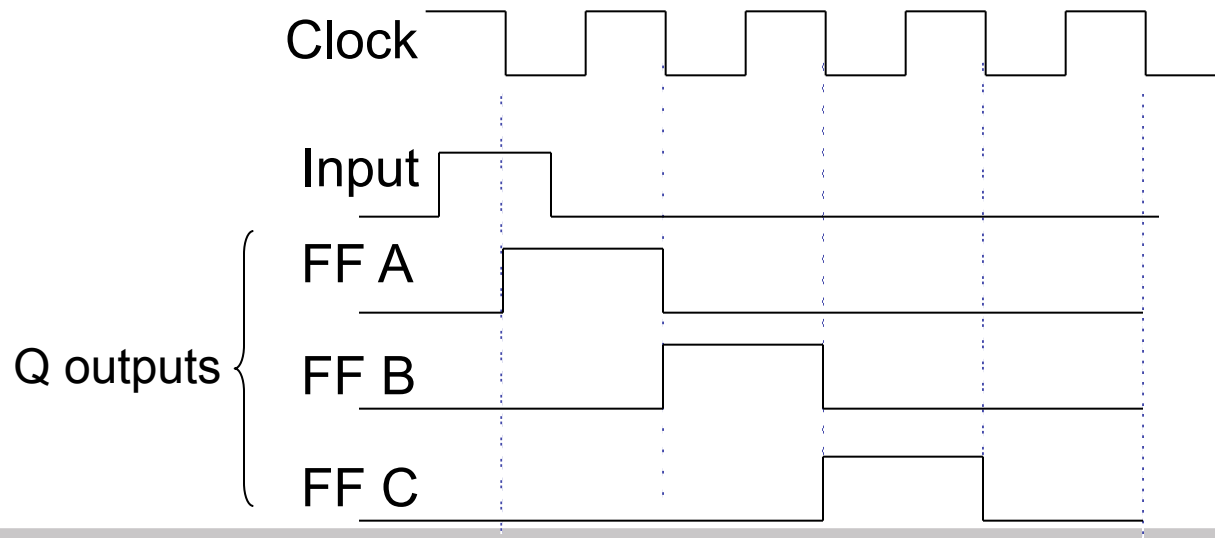
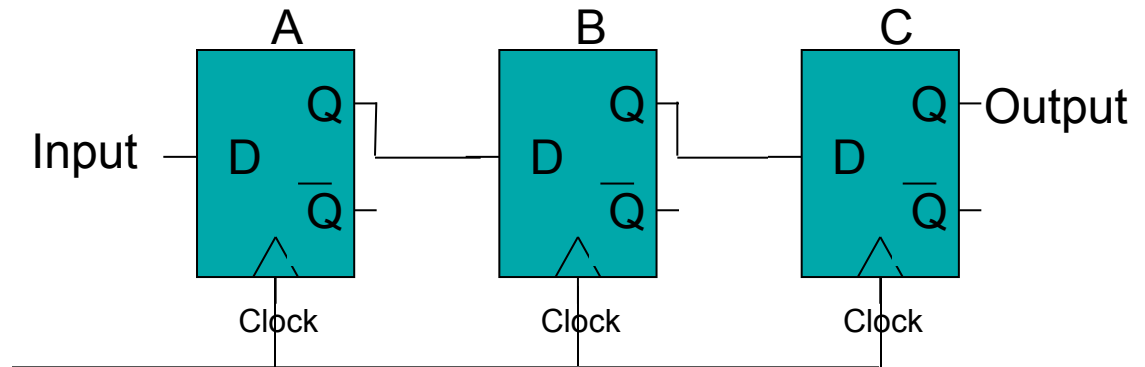
A shift register takes input from one end, and at each clock change this value is moved to the next D-Flip-Flop.

This is used in serial data transfer when a byte (say) of data sent on a cable one bit after another can be collected in a series of D Flip-Flops to rebuild the whole data byte. This is called *serial-to-parallel* conversion.



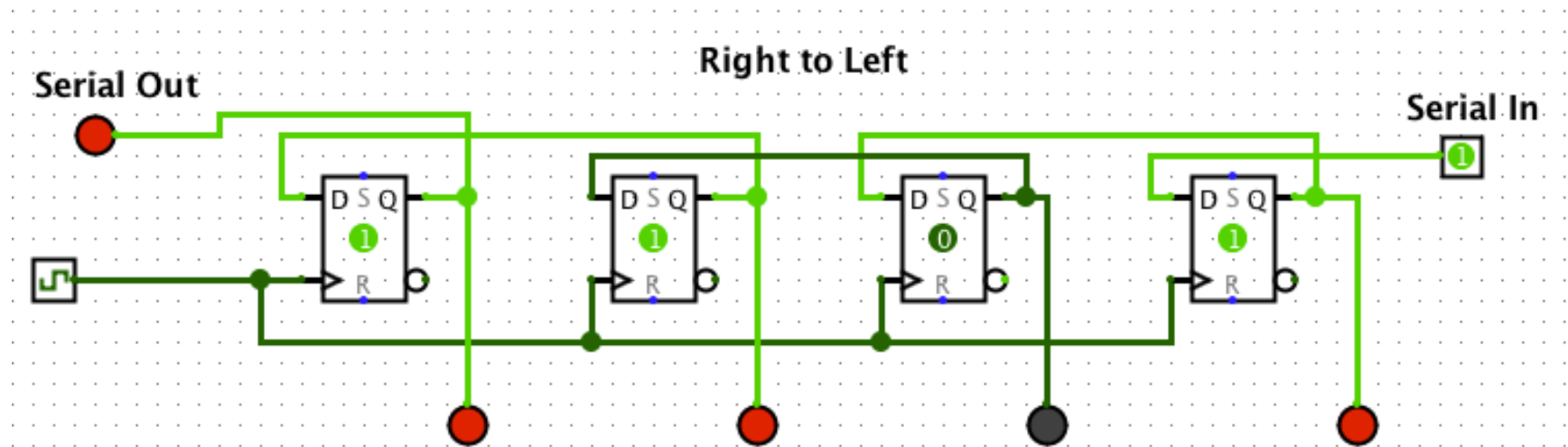
SHIFT REGISTERS

Here is how a *high* travels through a 3 bit shift register. For this example we assume that each of the shift register bits is cleared at the start.



SHIFT LEFT SHIFT REGISTERS

- > The shift registers shown so far shift data to the right. A simple rewiring gives a shift register that can move data left. Of course these may also have the ability to parallel load.

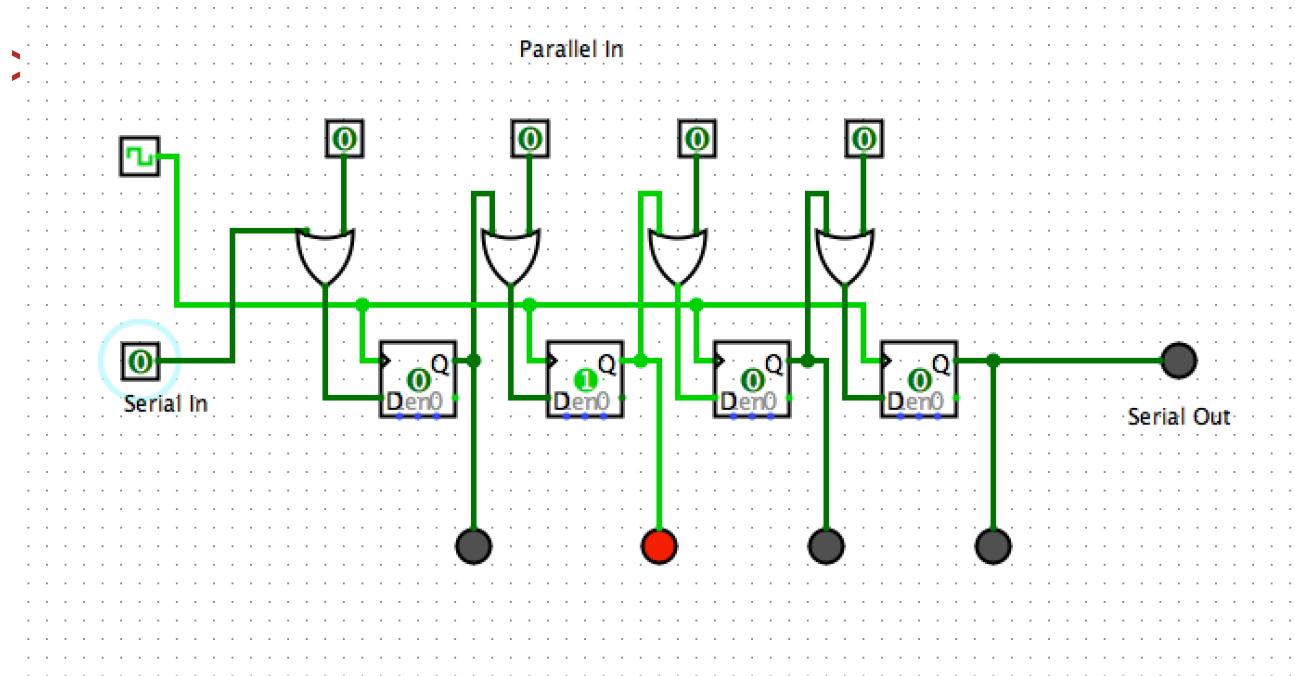


WHAT DOES A SHIFT REGISTER DO?

- > Moves a state (number such as 0, 1) from a low order bit to a higher order bit.
- > Multiplies a (binary) number by two.
 - Number of "shifts" depends on number of clock cycles.
- > Level counter (e.g. volume control)
- > Can use a counter to enable/disable clock, thereby programming the amount of shift.
- > Can shift in the other direction - divide numbers by 2.
 - Can have two clocks - one for left-shift, one for right-shift, or use gates to determine the shift direction.
- > A 1-bit stack – we'll come back to this

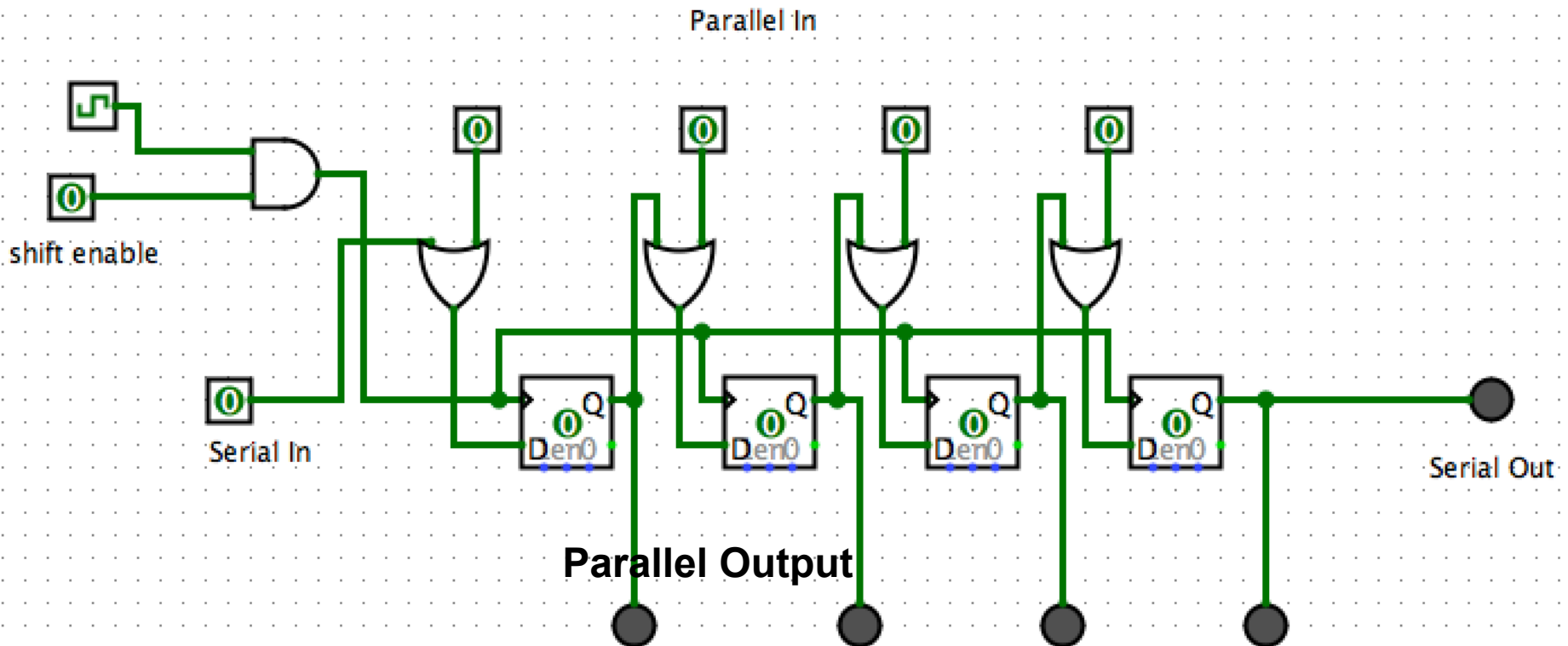
SERIAL-TO-PARALLEL CONVERSION

- > Some shift registers allow all flip-flops to load at once,



- > This gives *parallel-to-serial* conversion

RIGHT-SHIFT SERIAL OR PARALLEL INPUT: 4-BIT



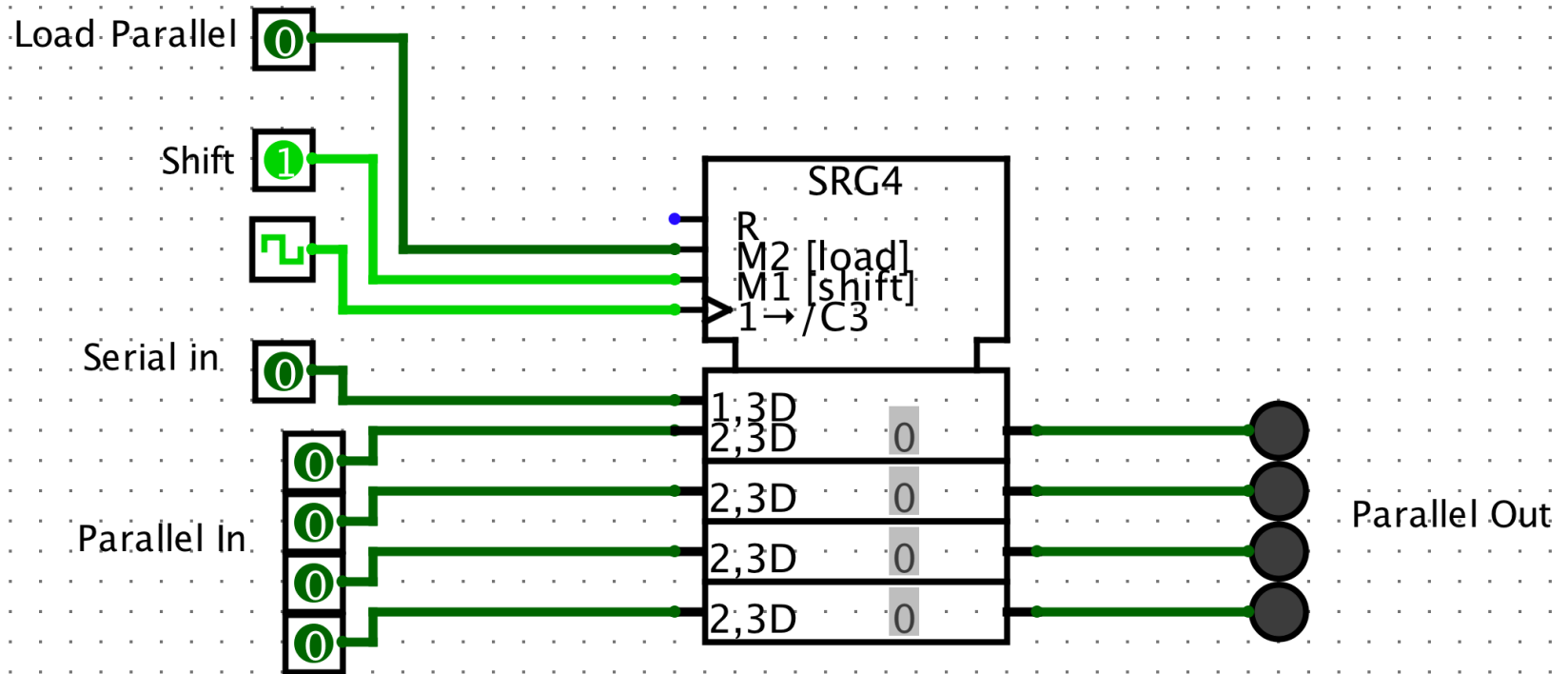
- > Flip-flops are connected (output to input) with a common clock to cascade input from high bytes to low bytes.
- > Each flip-flop has a parallel bit OR-ed to the input to allow PReset.

WHAT ABOUT BI-DIRECTIONAL SHIFTING (SELECTABLE) ?

- > This takes some thinking!
- > You need a pin to select which direction
- > You need to allow inputs to any D Flip Flop to come from either direction
- > Try and design a 2 bit selectable direction Shift Register !
 - Serial input only
 - You will probably need some OR gates ,AND gates, and a NOT gate

THE LOGISIM SHIFT REGISTER (NOT FOR USE IN ASSIGNMENTS!)

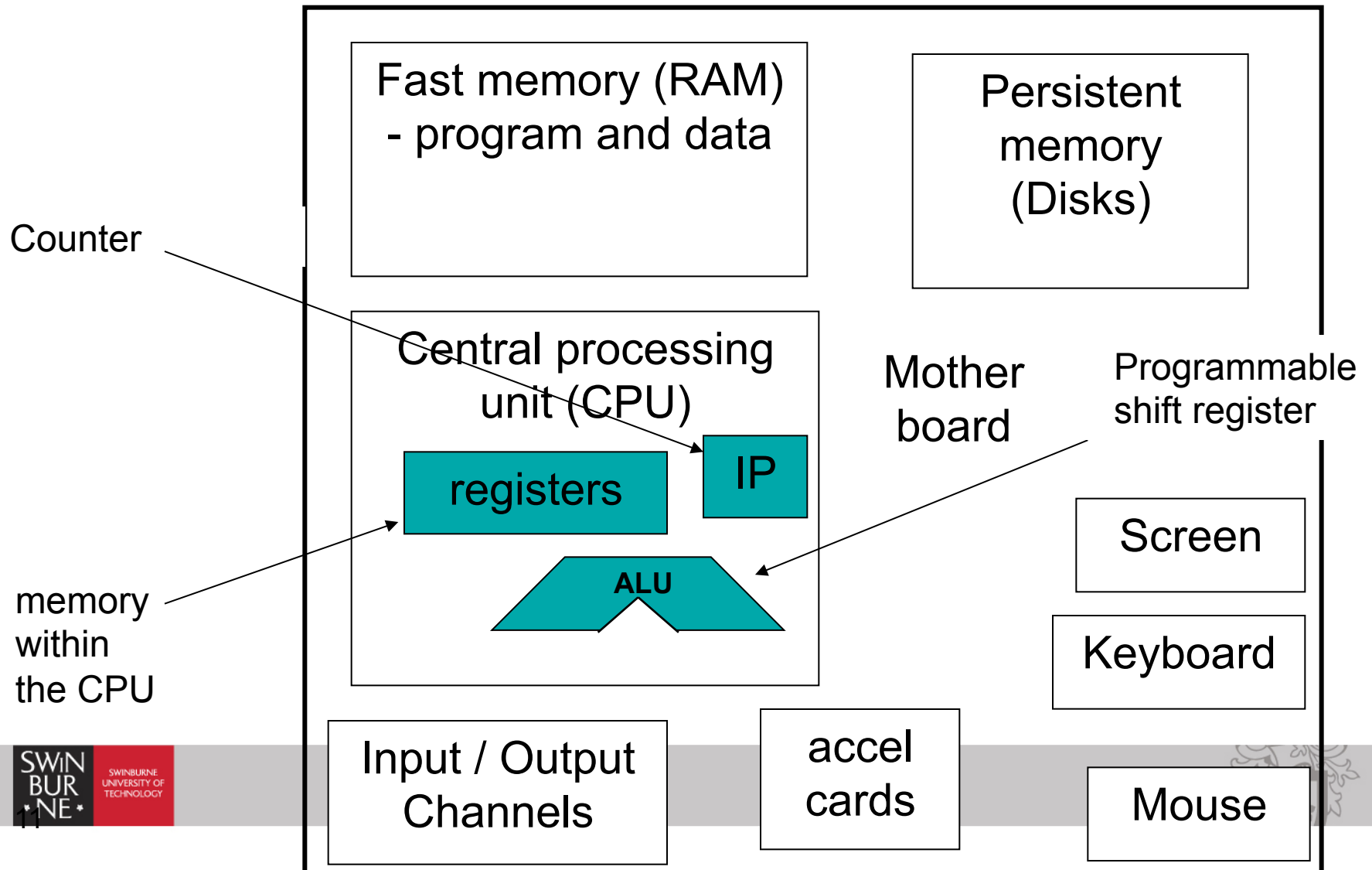
4 bit Shift Register



THINGS TO TRY

- > Parallel Load a value and Shift to see it halve.
- > Implement both directions and see it double or halve.
- > Hold down SI to inject a bit - see it halve or double.

WHERE ARE WE?



THINGS TO REMEMBER (FILL THIS IN)

ALU Component	Types of Flip Flops	Inputs	Clock type	Extra Circuit Elements (Gates)
Register (n-bit latch)		Required state	Common clock	
Ripple Counter				none
Decimal Counter	D Flip Flops			
Mod n Counter			Cascading clock	AND gate
Mod 6 Counter			Common clock	
3-bit counter		Enable		AND gate
Shift Register				AND, OR gates to program behaviour

WEEK 3 SUMMARY

> Counters:

- Ripple counter (asynchronous)
- Common clock counters (synchronised)
- Mod 6 counter
 - Use logic to detect illegal state and reset FFs
 - Use D FFs to buffer output and stabilise
- Shift Registers with connected D FFs
 - Extremely useful for multi/div, bit shifting, level setting, serial/parallel data conversion.