5DV118
Computer Organization and Architecture
Umeå University
Department of Computing Science

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Topic 3aux: Logic Design

A Ridiculously Brief Overview of Combinational Logic Design

- These slides provide a brief overview of combinational logic.
- They are limited to the ideas absolutely needed for the course.
- For a more detailed presentation consult Appendix C on the CD which comes with the course text.

Types of Logic Circuits

- *Combinational logic* is used to realize memoryless functions.
- *Sequential logic* is used to realize functions which have an internal state.
- These slides focus upon combinational logic.

Basic Gates

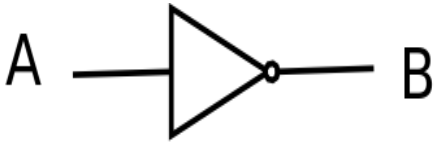
The AND gate

A	B	C
0	0	0
0	1	0
1	0	0
1	1	1

The OR gate

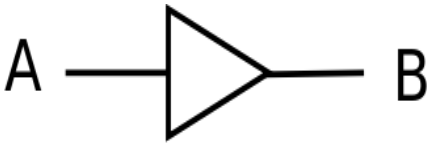
A	B	C
0	0	0
0	1	1
1	0	1
1	1	1

The Inverter



A	B
0	1
1	0

The Buffer



A	B
0	0
1	1

Further Gates

The NAND gate

A	B	C
0	0	1
0	1	1
1	0	1
1	1	0

The NOR gate

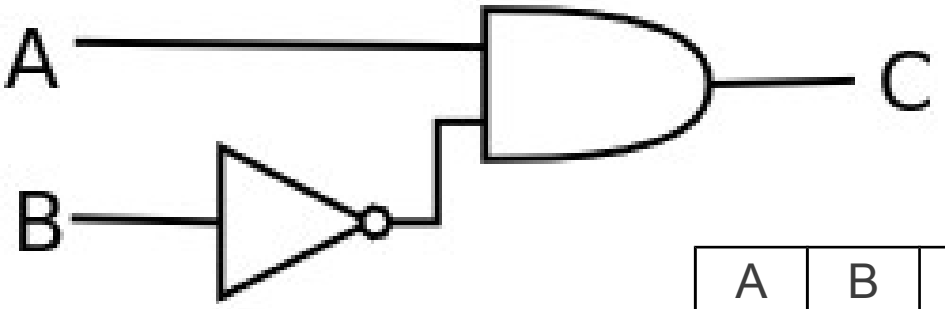
A	B	C
0	0	1
0	1	0
1	0	0
1	1	0

The XOR gate

A	B	C
0	0	0
0	1	1
1	0	1
1	1	0

Compact Representation of Negation

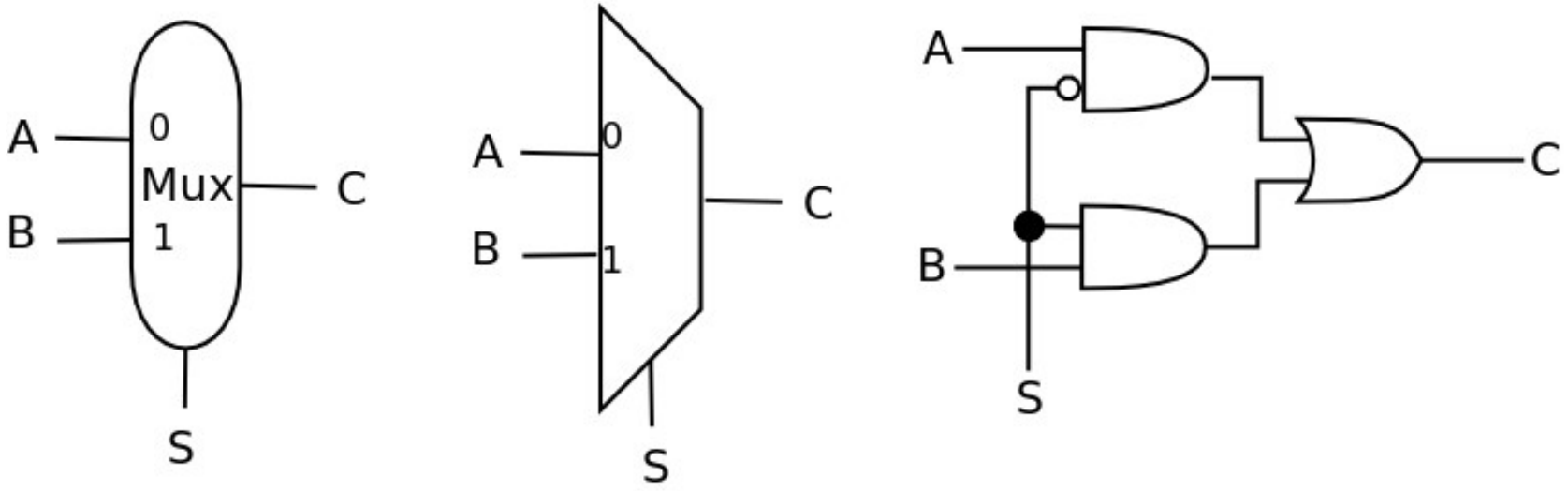
- Negation may be represented as a circle on another gate.
- The following two circuits are equivalent.



A	B	C
0	0	0
0	1	0
1	0	1
1	1	0

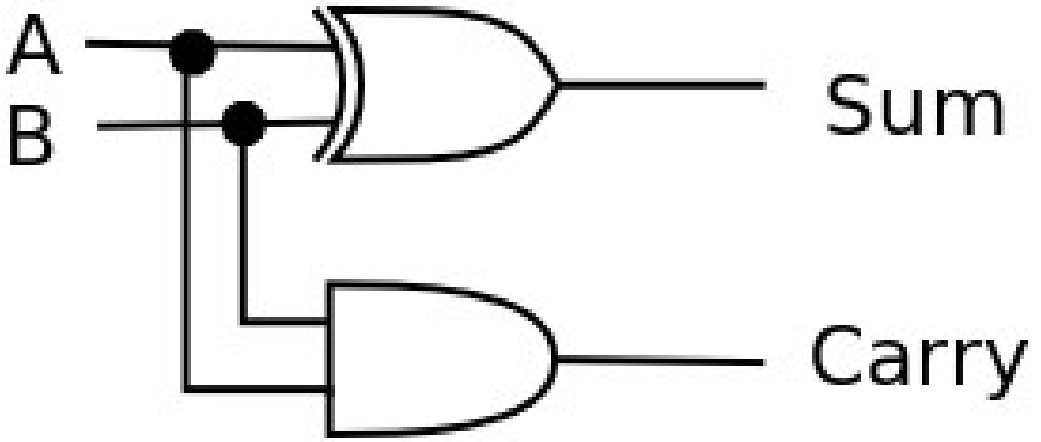
The Multiplexer

- A *multiplexer* selects between two (or more) inputs.
- S is the *select line*.
- Shown is a two-input multiplexer.



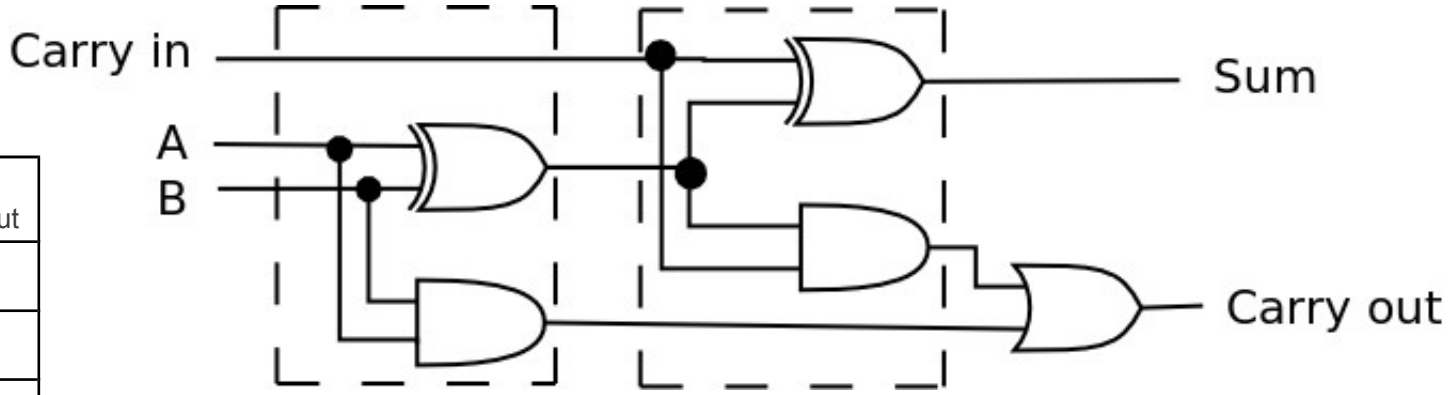
A One-Bit Half Adder

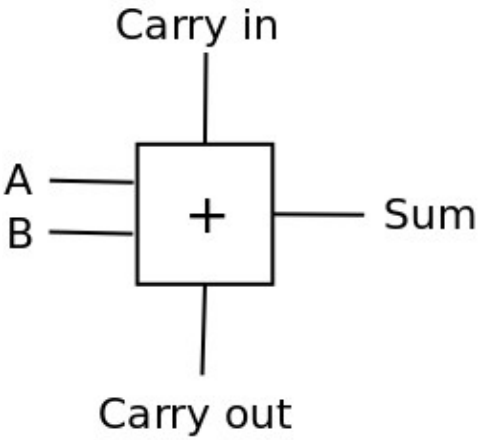
A	B	S	C
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1



A One-Bit Full Adder

A	B	C_{in}	S	C_{out}
0	0	0	0	0
0	1	0	1	0
1	0	0	1	0
1	1	0	0	1
0	0	1	1	0
0	1	1	0	1
1	0	1	0	1
1	1	1	1	1





A Sequential Adder

- An n-bit sequential adder may be realized by gluing n one-bit adders together.
- This is not the best design because the *critical path* is proportional to n.