Τμήμα Μηχανικών Η/Υ και Πληροφορικής, Πανεπιστήμιο Ιωαννίνων

Introduction to low-power microprocessor design – Microprocessors Performance

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Outline

1: Overview of microprocessors manufacturing process

2: Motivation: Why to care about power efficient microrprocessors?

3: Performance of microprocessors

4: Dynamic power and dynamic power reduction design techniques

5: Static power and static power reduction techniques

6: The future, Introduction to IoT applications!!!

Performance of Microprocessors

What about performance?

What is performance?

Components of performance	Units of measure
CPU execution time for a program	Seconds for the program
Instruction count	Instructions executed for the program
Clock cycles per instruction (CPI)	Average number of clock cycles per instruction
Clock cycle time	Seconds per clock cycle

CPI=(clocks #)/(Instructions #)

The BIG Picture

$$\text{Time} = \text{Seconds/Program} = \frac{\text{Instructions}}{\text{Program}} \times \frac{\text{Clock cycles}}{\text{Instruction}} \times \frac{\text{Seconds}}{\text{Clock cycle}}$$

The only reliable measure of computer performance is time!

What about performance?

The BIG Picture

$$\text{Time} = \text{Seconds/Program} = \frac{\text{Instructions}}{\text{Program}} \times \frac{\text{Clock cycles}}{\text{Instruction}} \times \frac{\text{Seconds}}{\text{Clock cycle}}$$

The only reliable measure of computer performance is time!

Check Yourself

A given application written in Java runs 15 seconds on a desktop processor. A new Java compiler is released that requires only 0.6 as many instructions as the old compiler. Unfortunately, it increases the CPI by 1.1. How fast can we expect the application to run using this new compiler? Pick the right answer from the three choices below:

a. $\dfrac{15 \times 0.6}{1.1} = 8.2 \text{ sec}$

b. $15 \times 0.6 \times 1.1 = 9.9 \text{ sec}$

c. $\dfrac{15 \times 1.1}{0.6} = 27.5 \text{ sec}$

Million instructions per second (MIPS)

$$\text{MIPS} = \frac{\text{Instruction count}}{\text{Execution time} \times 10^6}$$

Relationship between MIPS, clock rate and CPI:

$$\text{MIPS} = \frac{\text{Instruction count}}{\dfrac{\text{Instruction count} \times \text{CPI}}{\text{Clock rate}} \times 10^6} = \frac{\text{Clock rate}}{\text{CPI} \times 10^6}$$

$$\text{Time} = \text{Seconds/Program} = \frac{\text{Instructions}}{\text{Program}} \times \frac{\text{Clock cycles}}{\text{Instruction}} \times \frac{\text{Seconds}}{\text{Clock cycle}}$$

MIPS Limitations

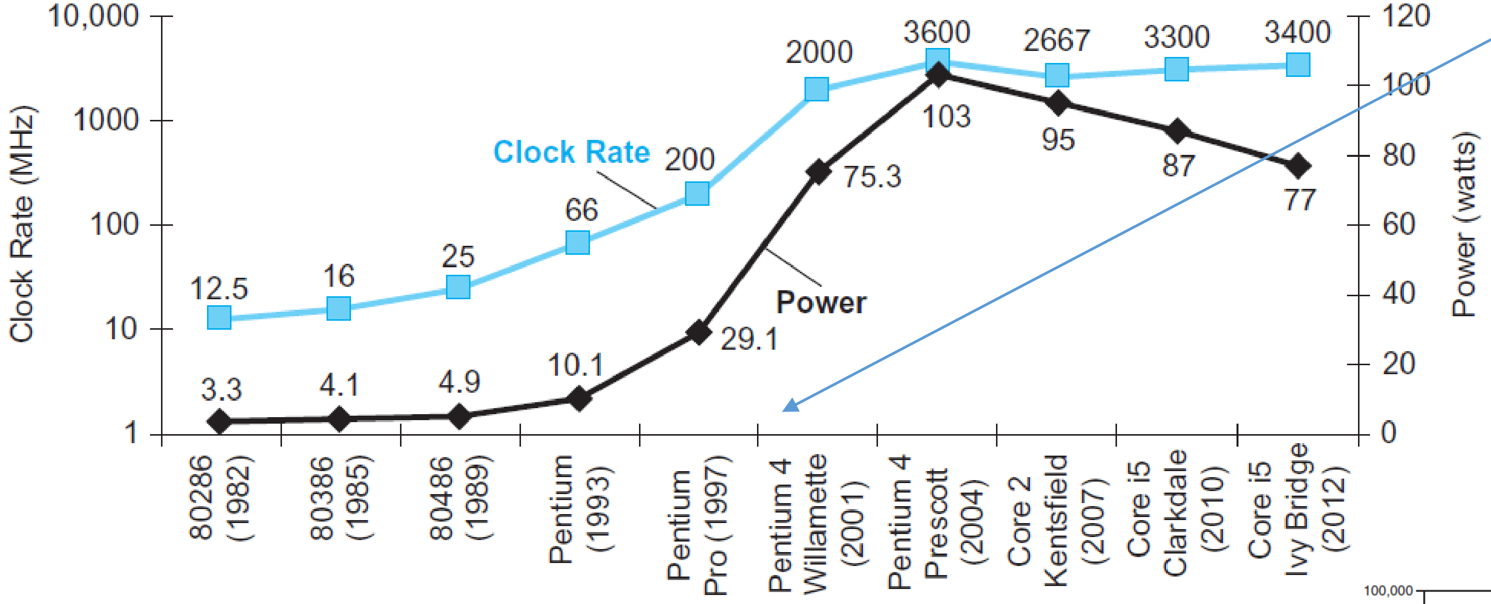
- It cannot compare computers with different instruction sets using MIPS, since the instruction counts will certainly differ and MIPS does not consider time.
- It varies between programs on the same computer; thus, a computer cannot have a single MIPS rating.

Measurement	Computer A	Computer B
Instruction count	10 billion	8 billion
Clock rate	4 GHz	4 GHz
CPI	1.0	1.1

a. Which computer has the higher MIPS rating?

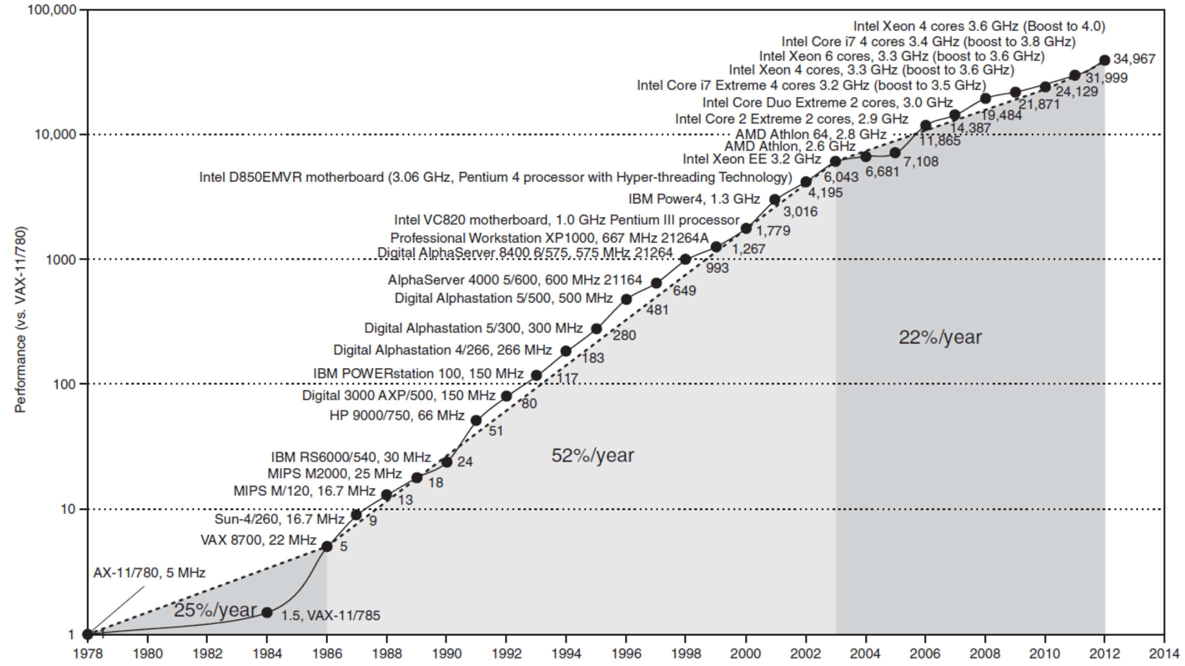
b. Which computer is faster?

The power Wall! (Power Wall # 1)

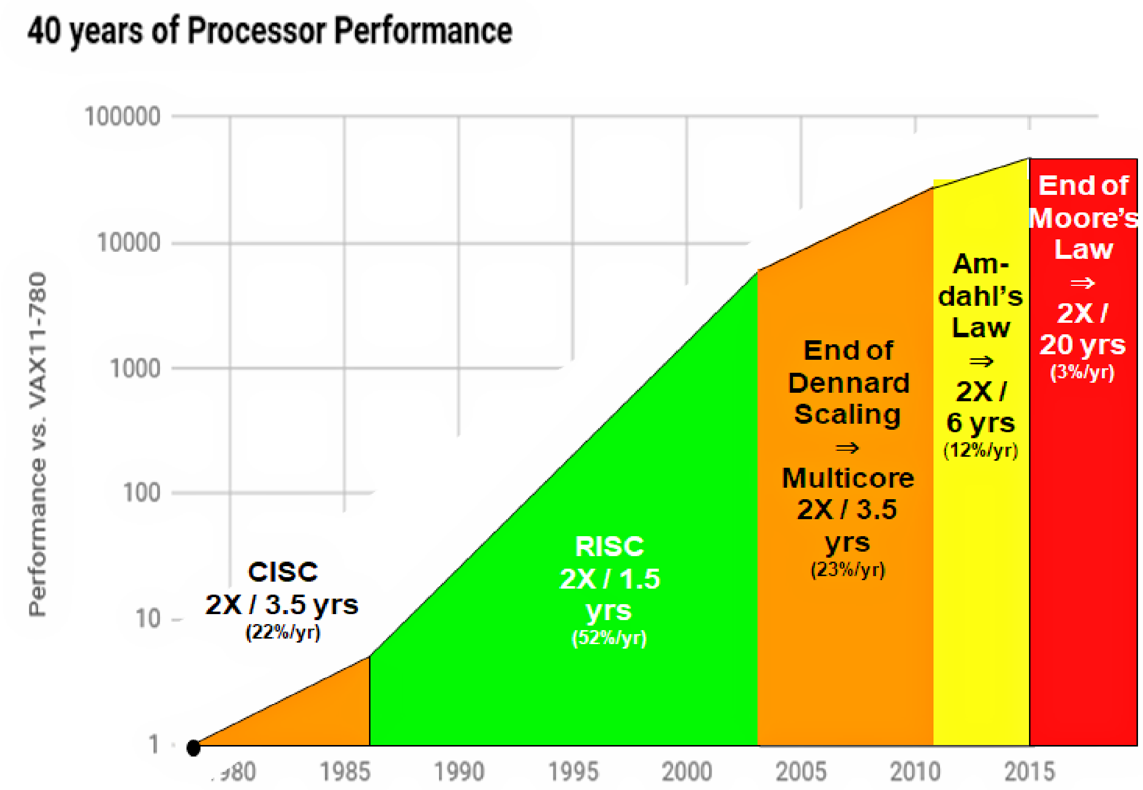


Pentium 4 made a dramatic jump in clock rate and power but less in performance

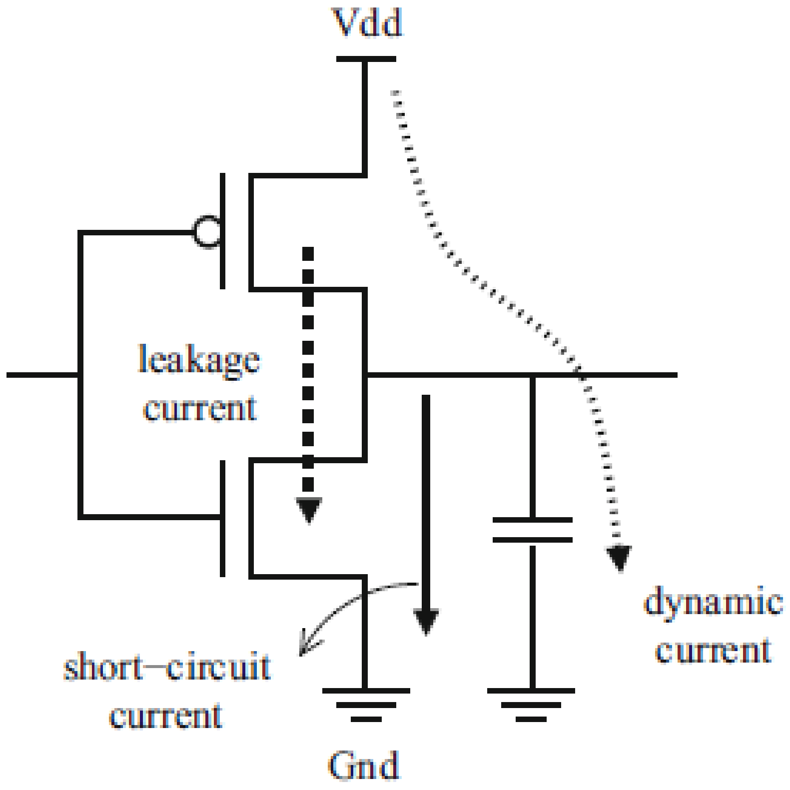
Multi-core microprocessors maintained performance increase for few years



Today…

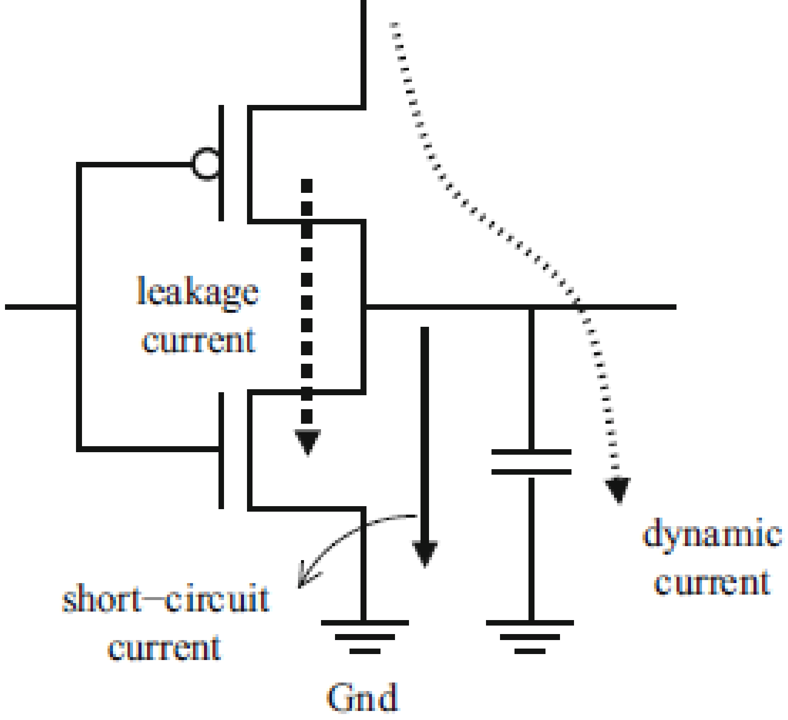


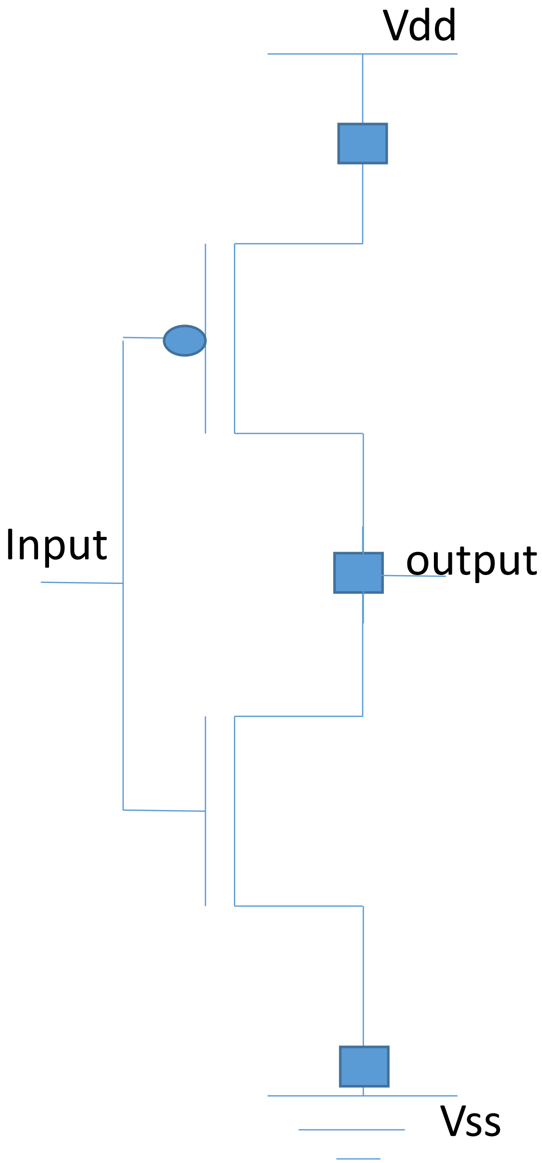
We will discuss the future during our next course. For now let's speak about the main problem: **power and energy**



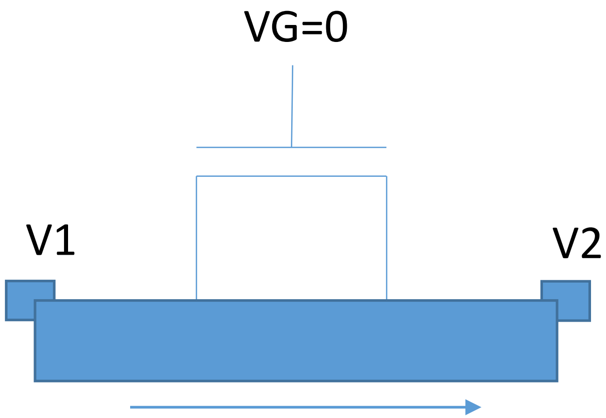
What about the future?

Hello world CMOS


leakage
current
short–circuit
current
Gnd
dynamic
current


Vdd
Input
output
Vss


V1
V2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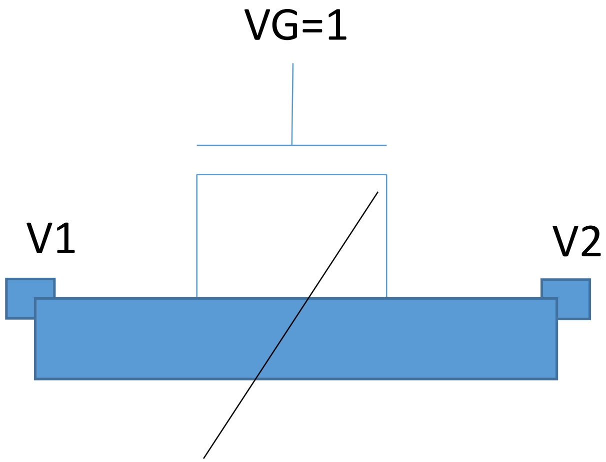
V1
V2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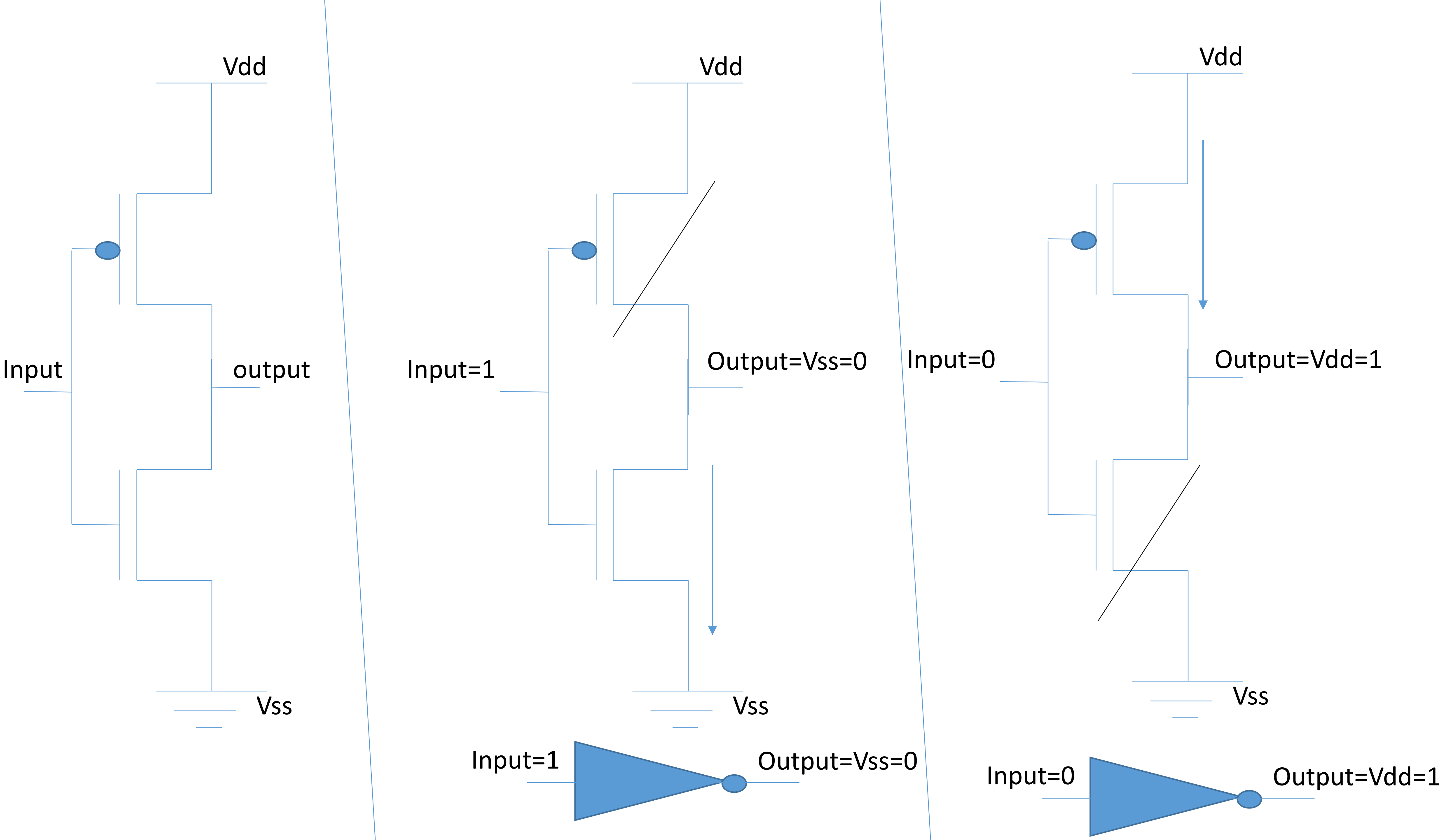
V1
V2


Vdd
Input
output
Vss
Vdd
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Vss
Input=1
Output=Vss=0
Vdd
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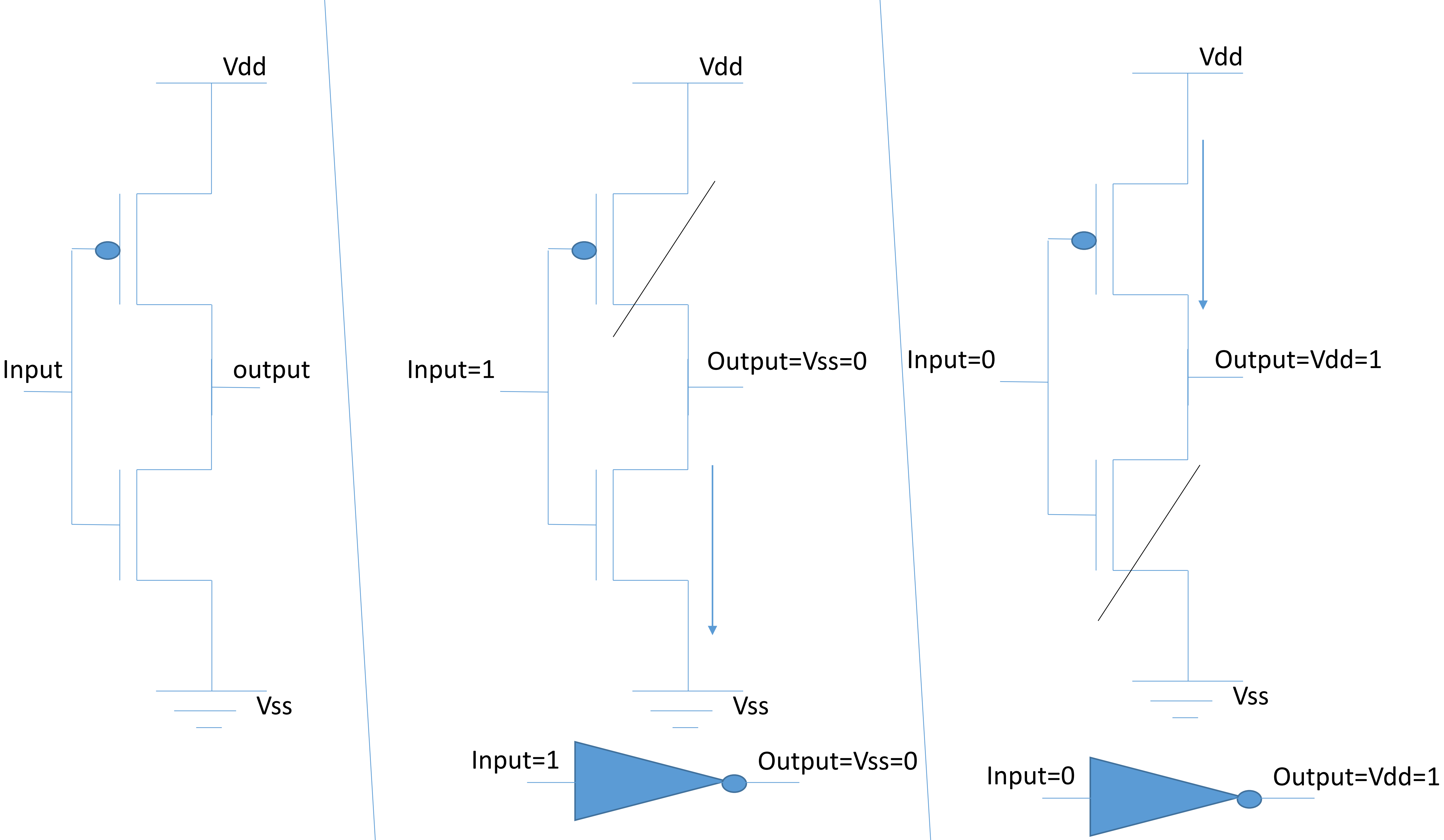
Output=Vdd=1
Vss
Input=0
Output=Vdd=1


Vdd
Input
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Input=1
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Input=1
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Vdd
Input=0
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Vss
Input=0
Output=Vdd=1