

Introduction to CMOS

Introduction to Circuit Design

– Lecture Series by Intel



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Lecture Series

Introduction to CMOS

APR 30th

Static CMOS Design

APR 30th

CMOS Logic Styles

MAY 21st

Sequentials & Memory

MAY 21st



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Introduction to CMOS

What will we learn?

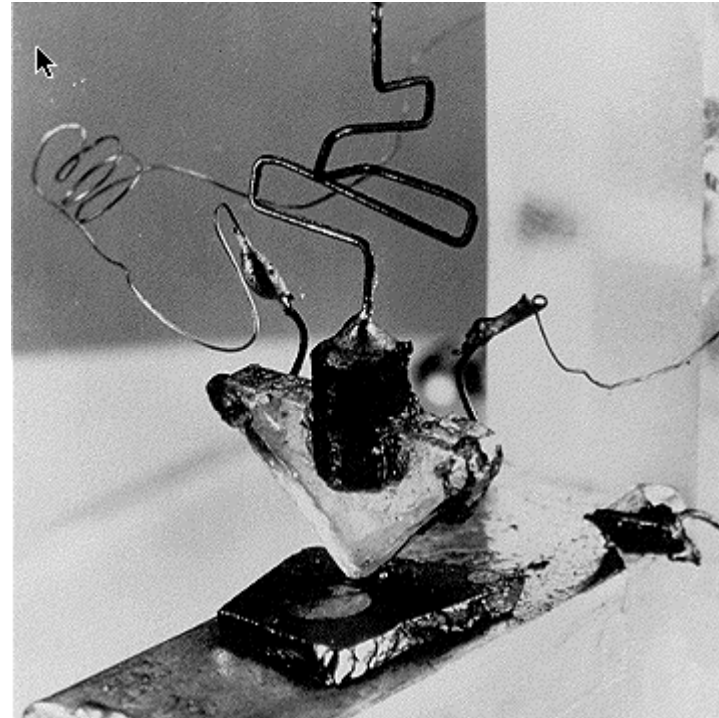
- ❑ Evolution of Integrated Circuits
- ❑ Scaling trends
- ❑ MOS transistor fundamentals
- ❑ CMOS Inverter characteristics



The Journey

First transistor

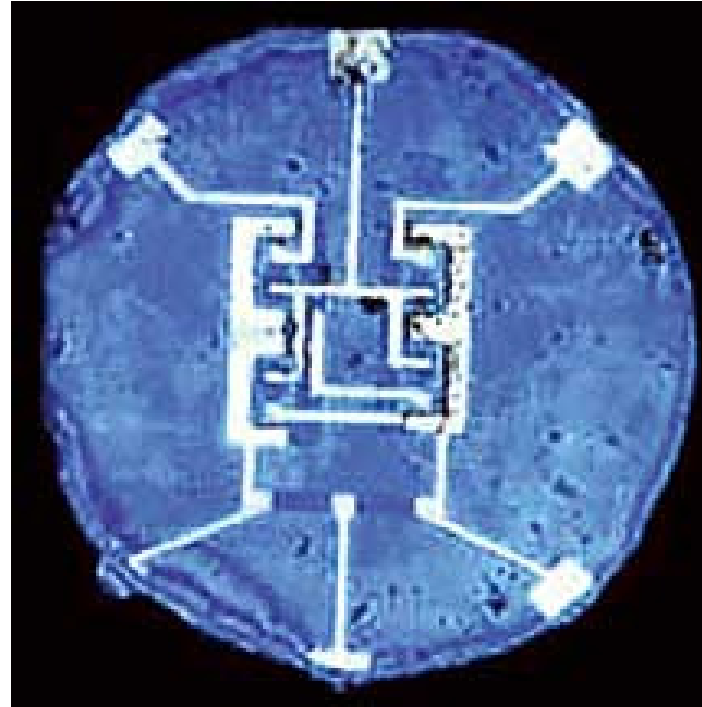
Bell Labs, 1948



The Journey

First Integrated Circuit

Fairchild Semi, 1961

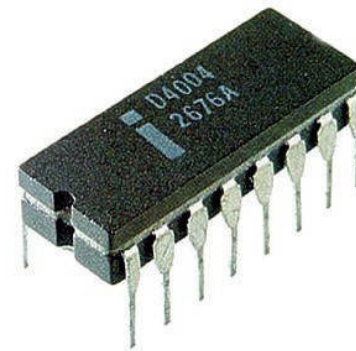
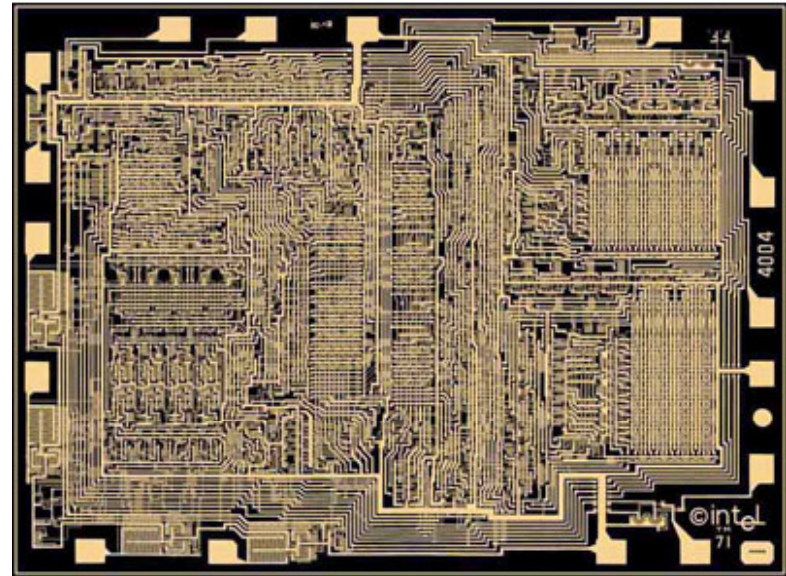


The Journey

Intel 4004 Microprocessor

Intel, 1971

- * ~2.3K transistors
- * ~700 Khz
- * 10um technology



The Journey

Intel Pentium 4 Processor

Intel, 2005

- * ~125,000K transistors
- * ~3.8 Ghz
- * 90nm technology

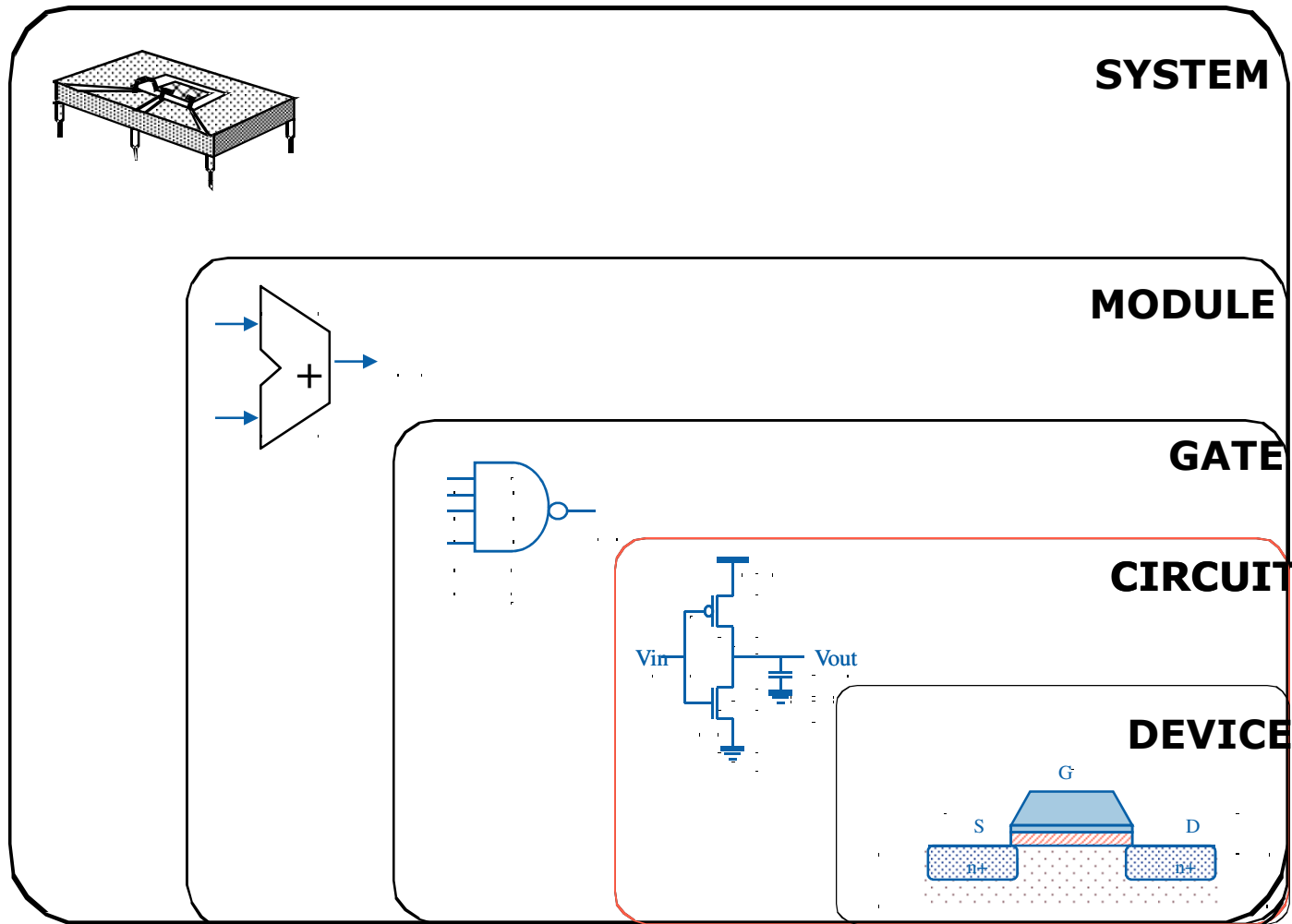


Why Scaling?

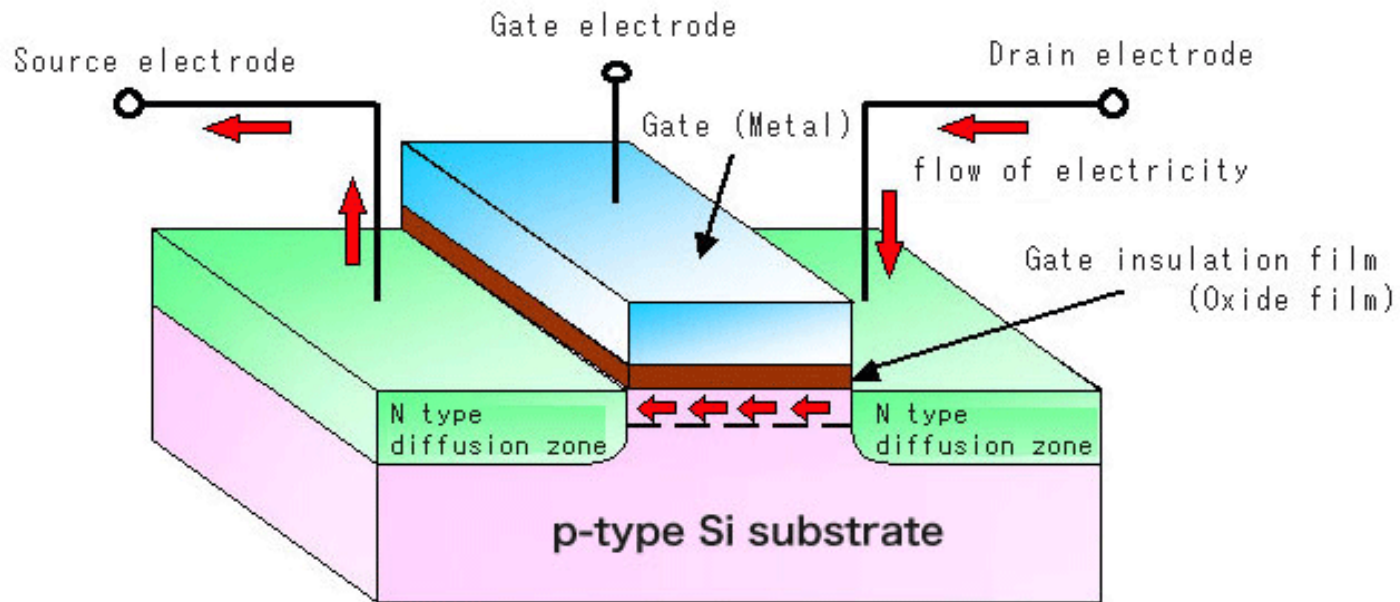
- Technology shrinks by 0.7 every generation
- We can integrate 2x more devices
- Translates into $\sim 2x$ cost reduction of a function
- Hence semiconductors is one of those rare industries which gives us more for the same cost as time goes by
- There have been design challenges as we have scaled down technology



Design Abstraction Levels



MOS Transistor

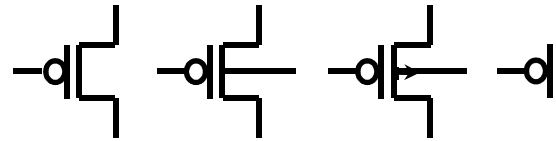


Construction of MOSFET

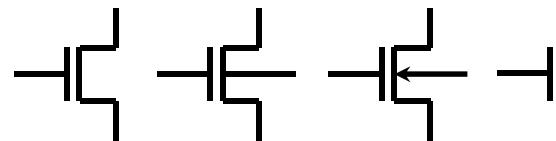
NMOS & PMOS

Symbols

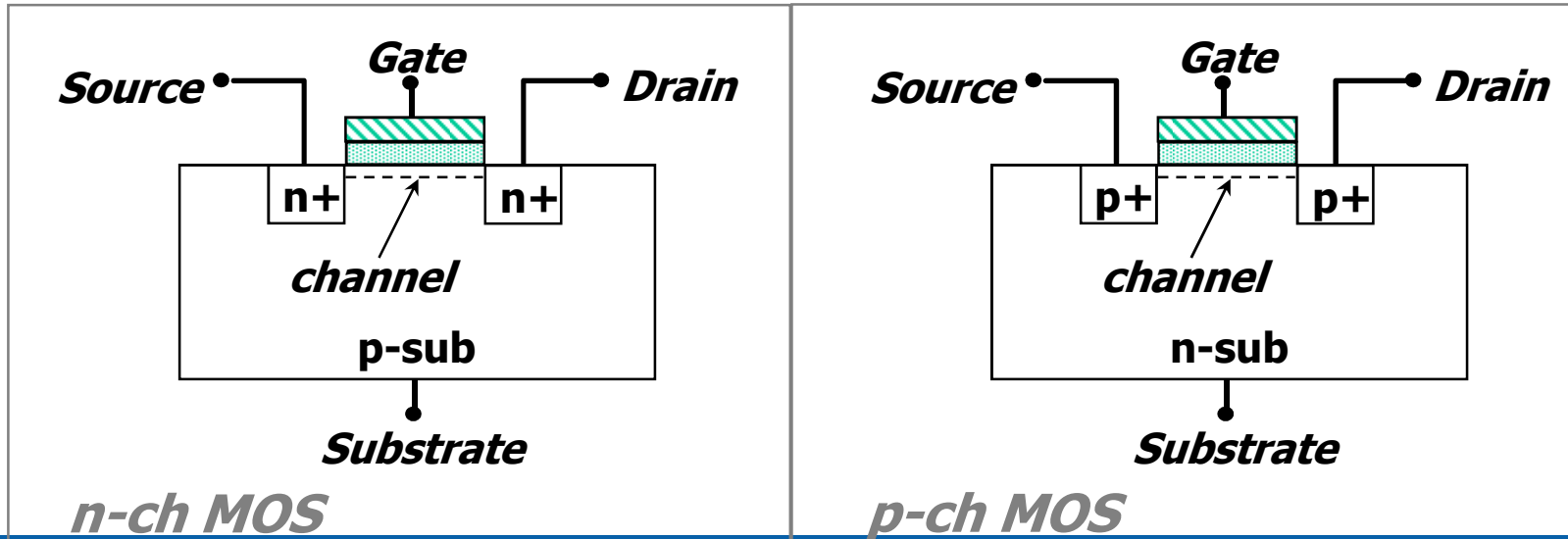
p-ch



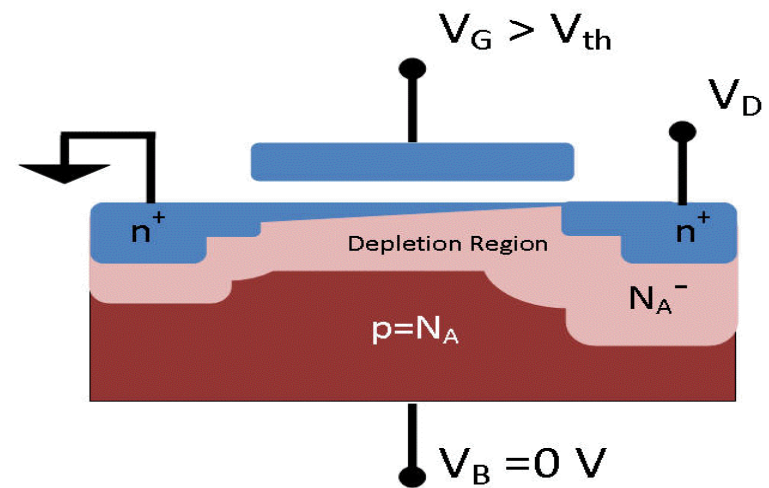
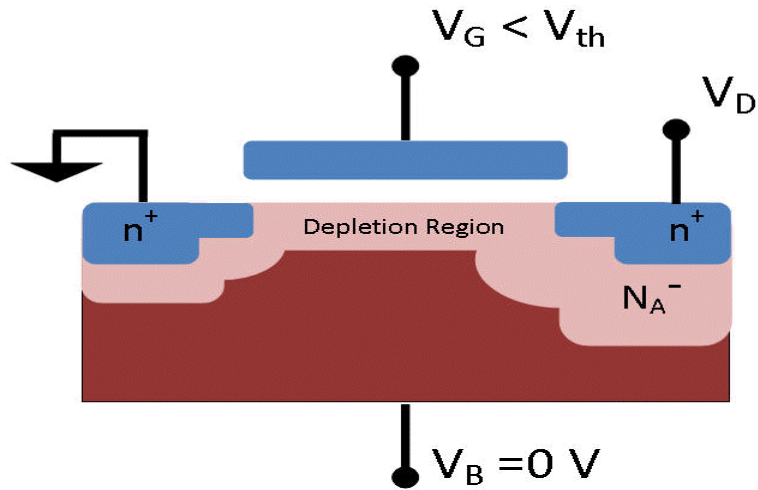
n-ch



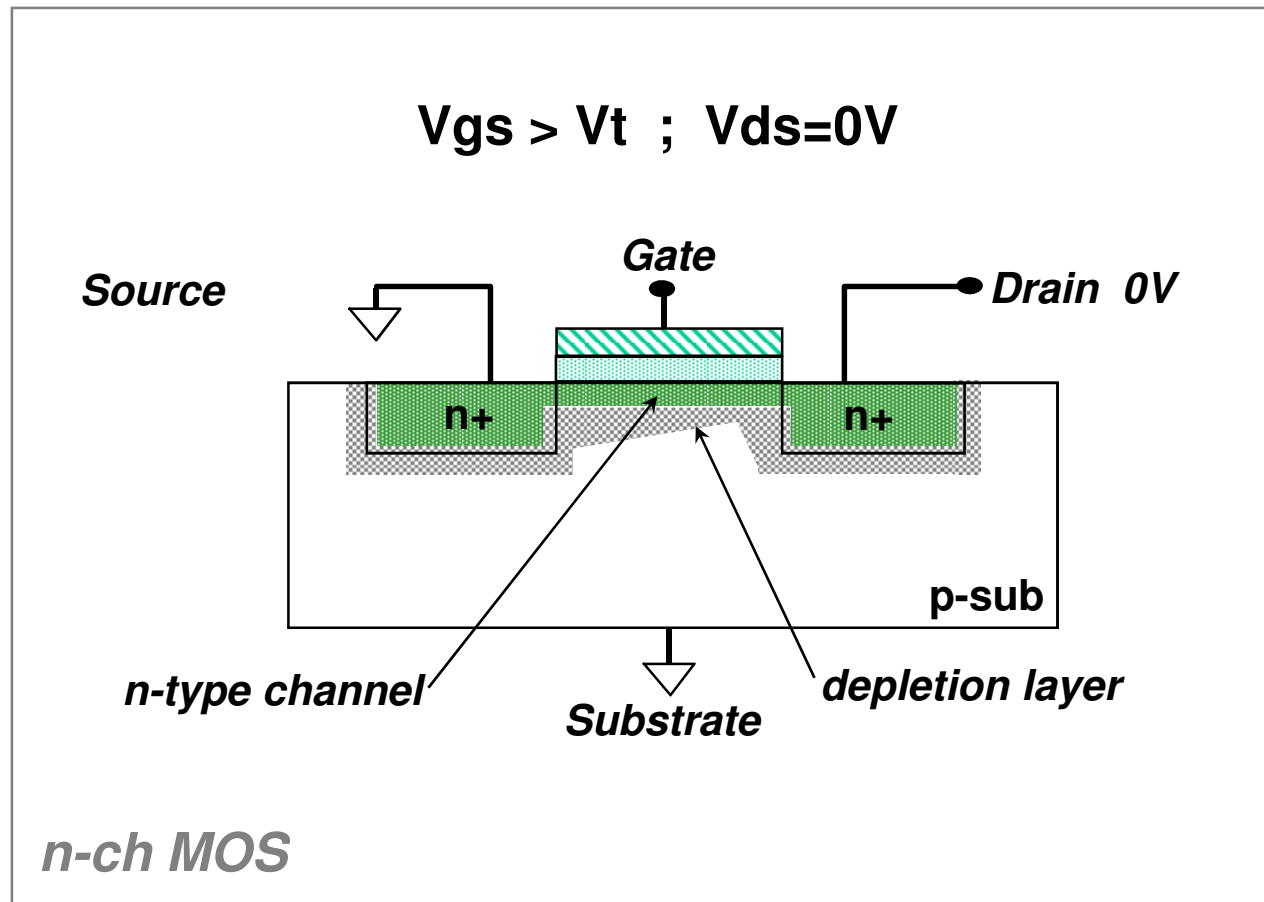
Physical Structure



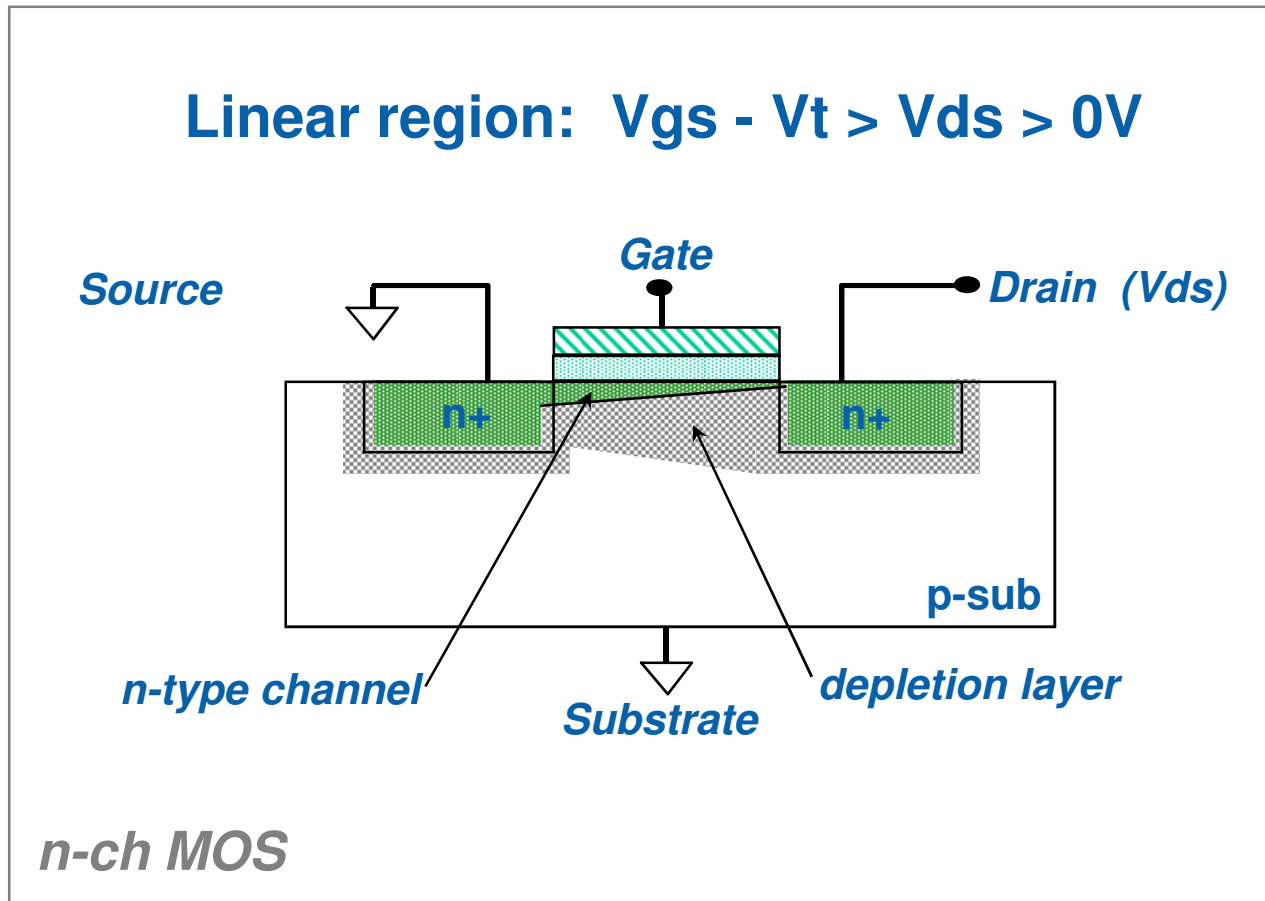
Threshold Voltage



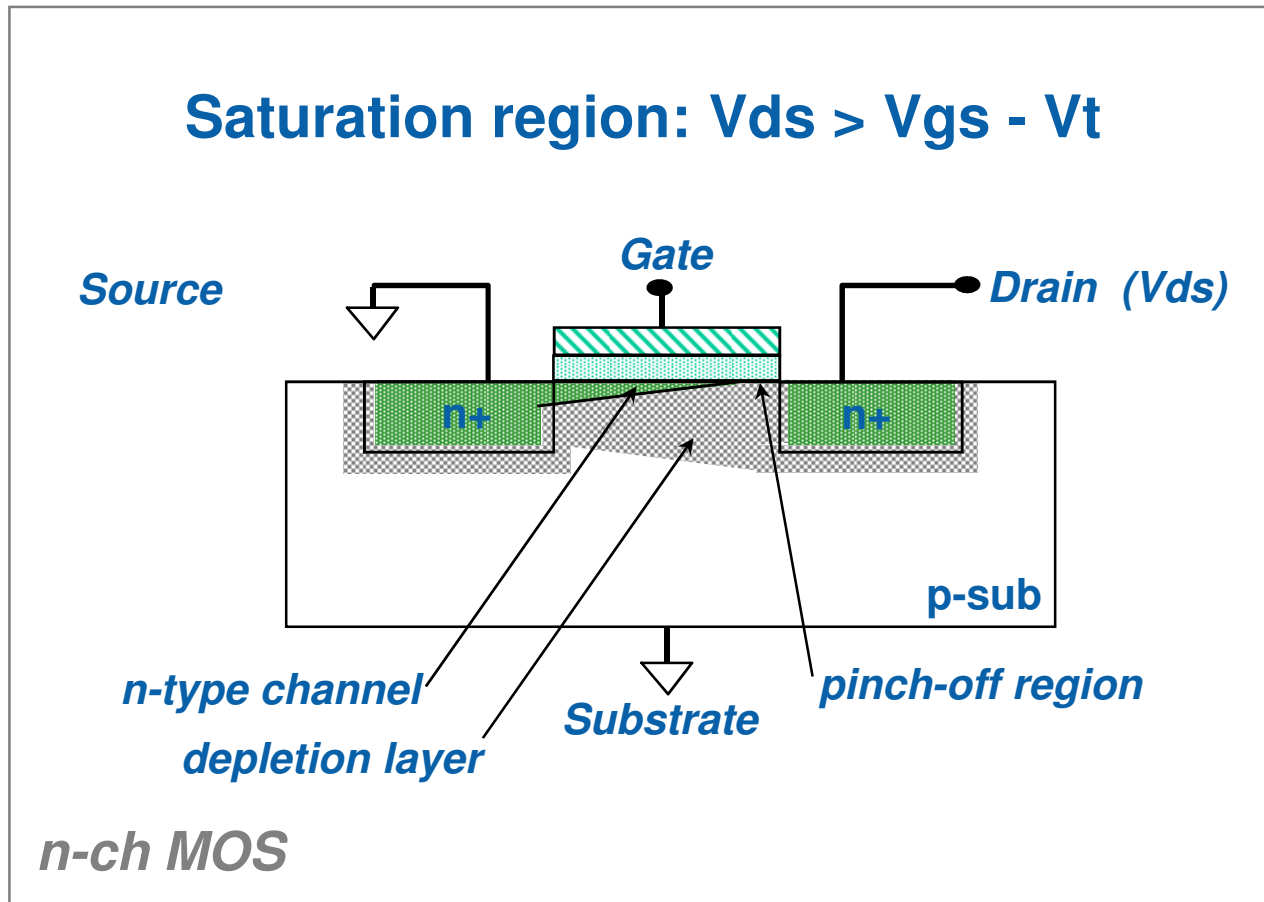
Modes of Operation



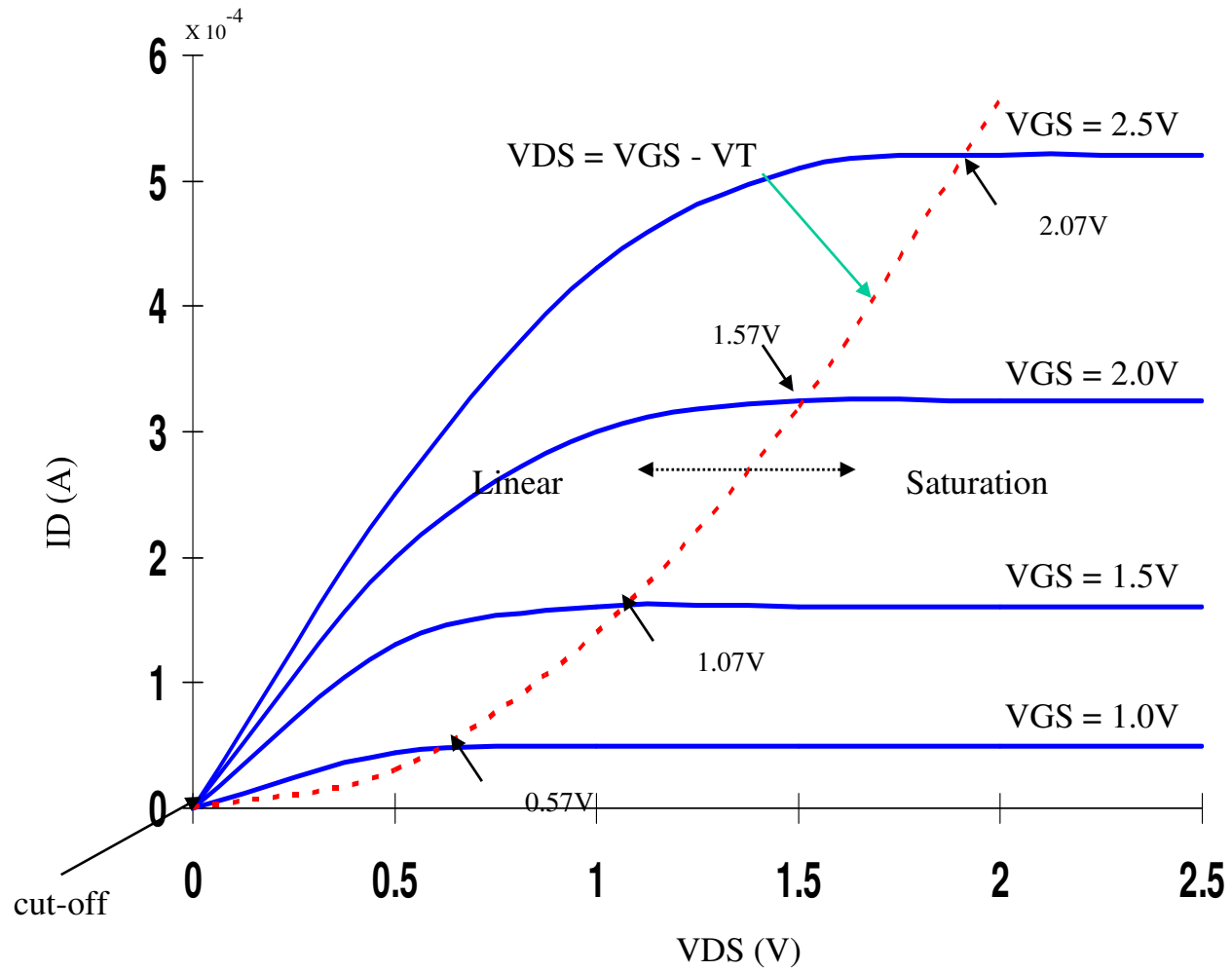
Modes of Operation



Modes of Operation

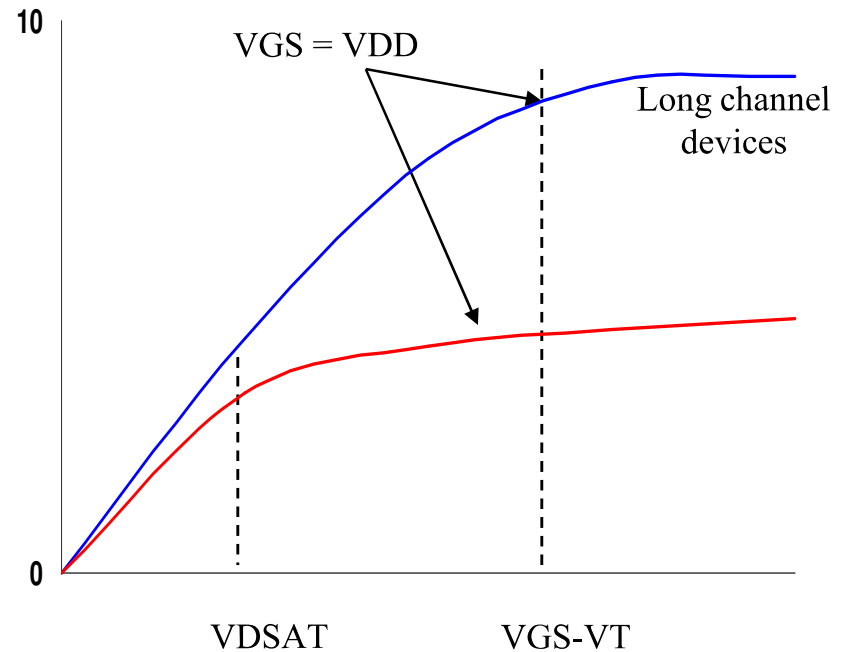
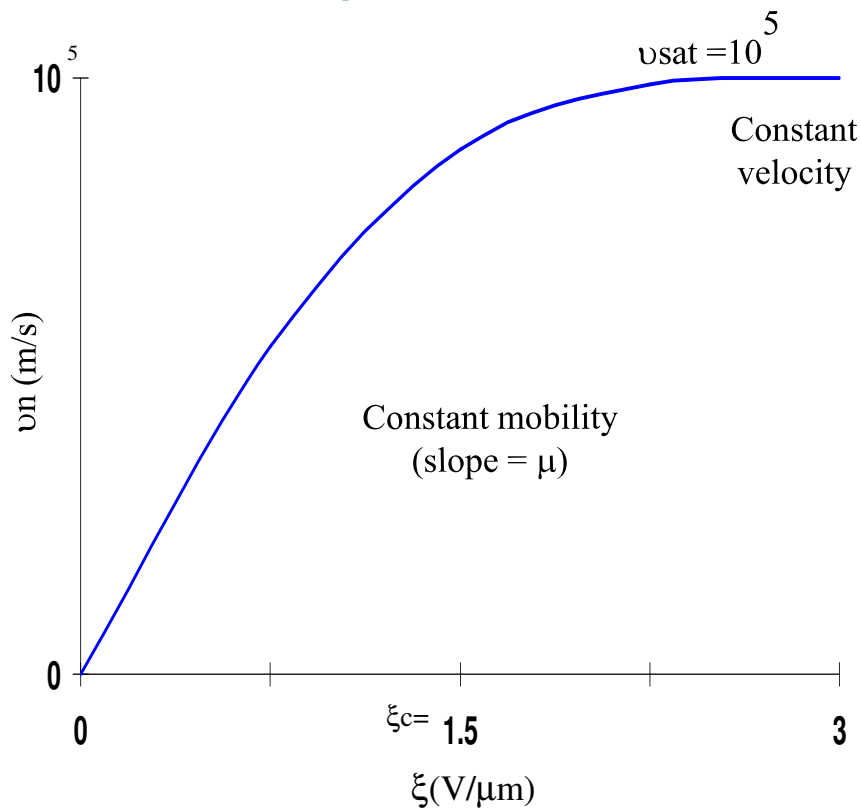


IV Curve

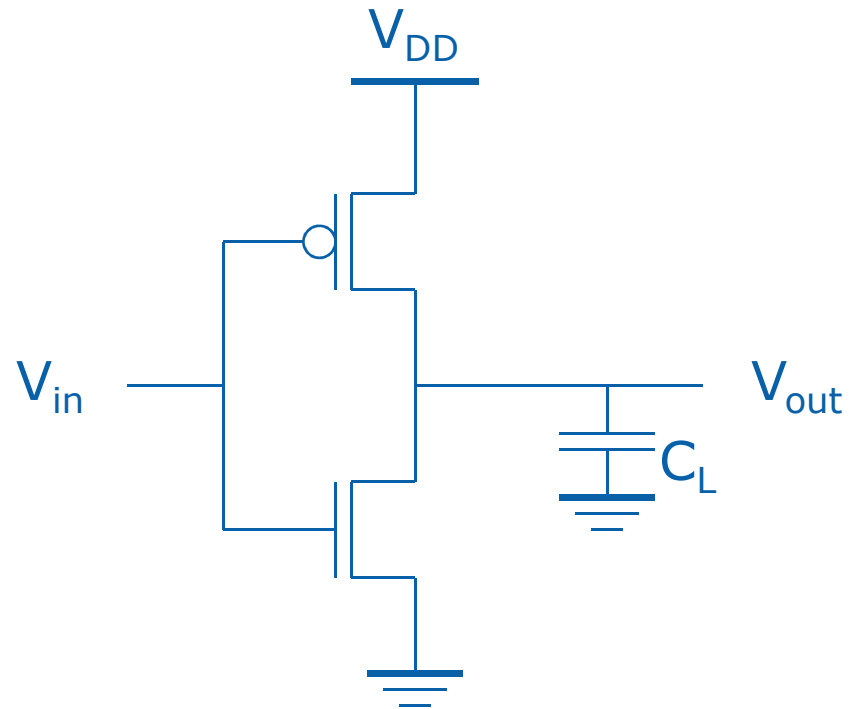


Short Channel Effects

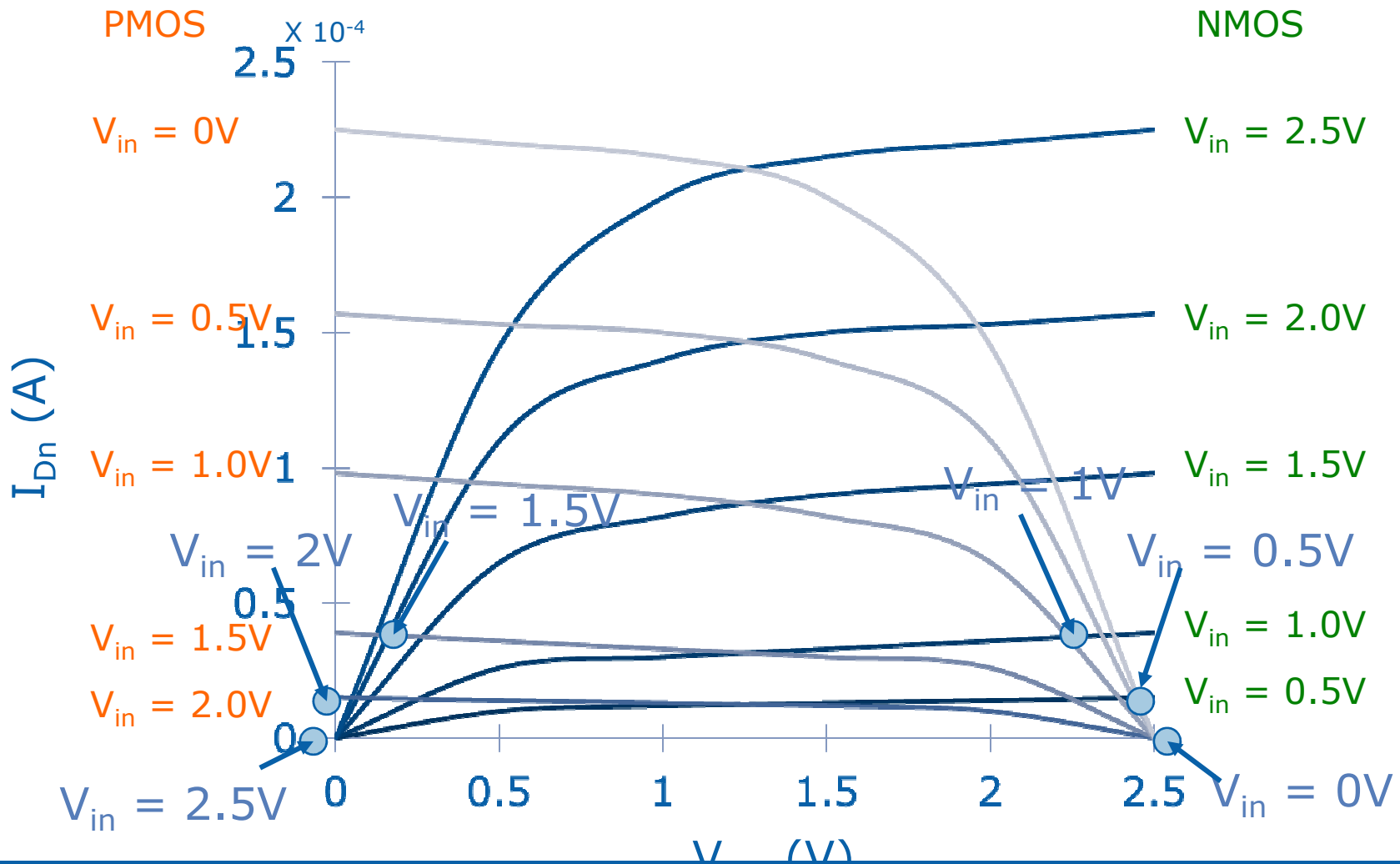
- Short channel device behavior is mainly due to velocity saturation



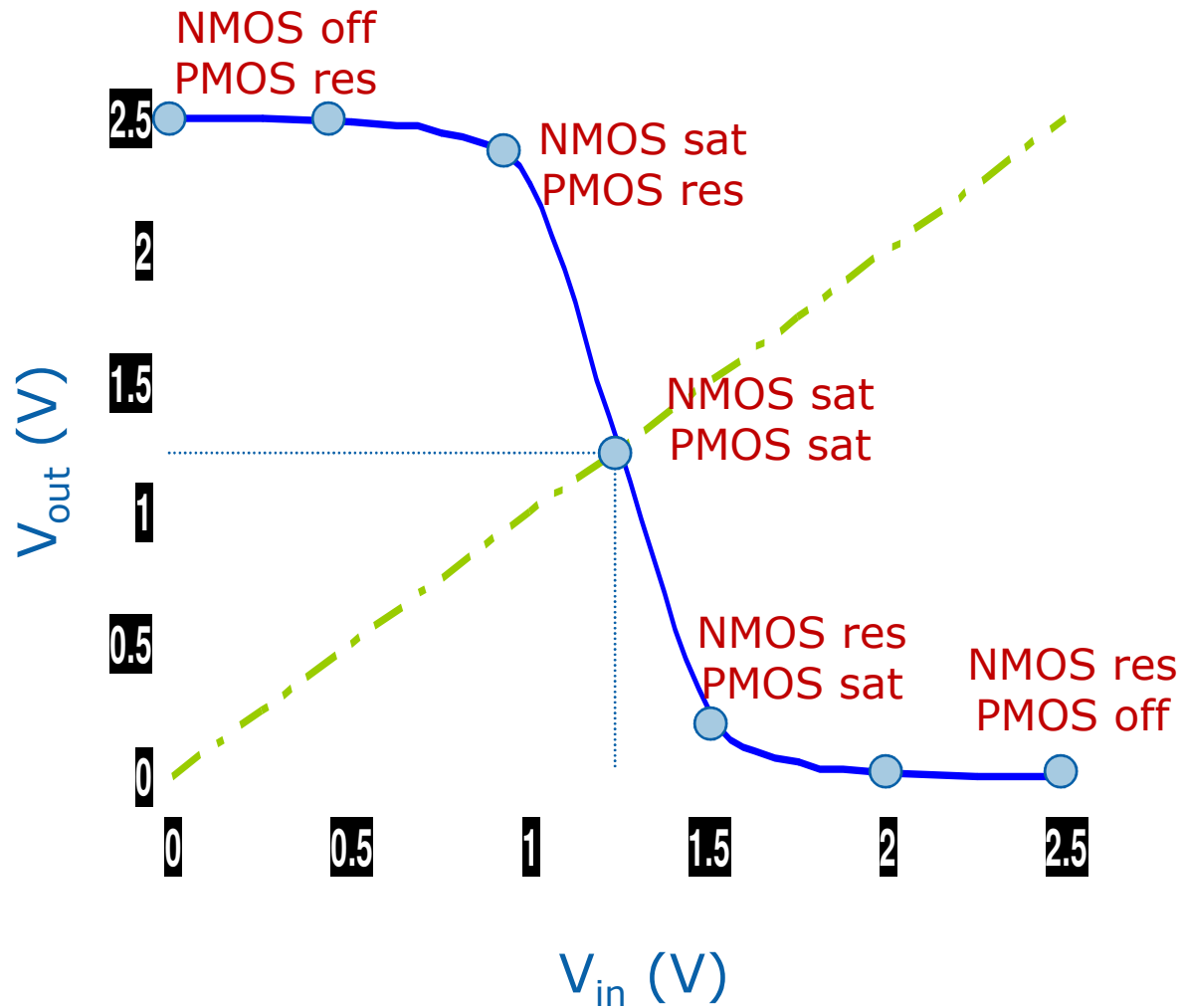
CMOS Inverter



CMOS Inverter Load Lines



CMOS Inverter VTC



Introduction to CMOS

What **did** we learn?

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