

# EE2020: The MOSFET

## The Device That Powers The Modern World

Anthony Wall  
11 March 2020

### 2-Terminal

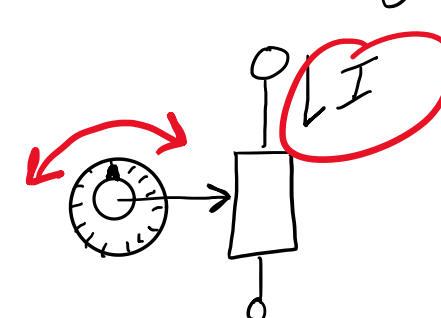


- Performs a fixed function
- Cannot be controlled
- No complex functions by cascading

### 3 Terminal



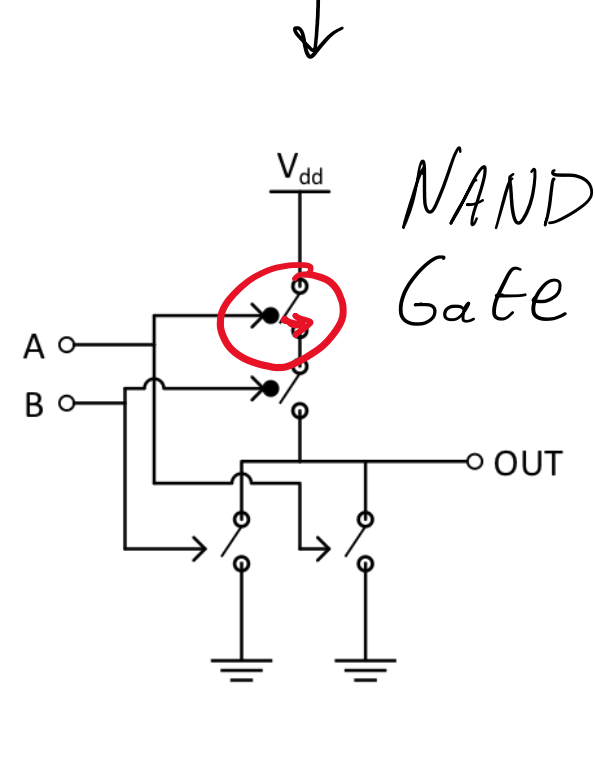
- 3rd terminal controls device properties e.g. Variable R
- Dependant functionality
- Complex functions by cascading



## Electronically Controlled Device

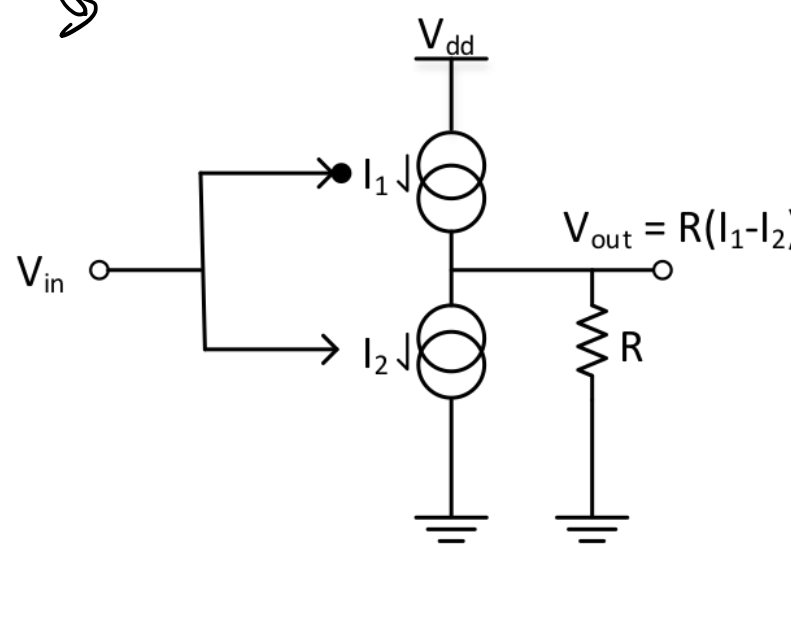
### Digital Logic

- 3 Terminal device as a switch
- Logic functions



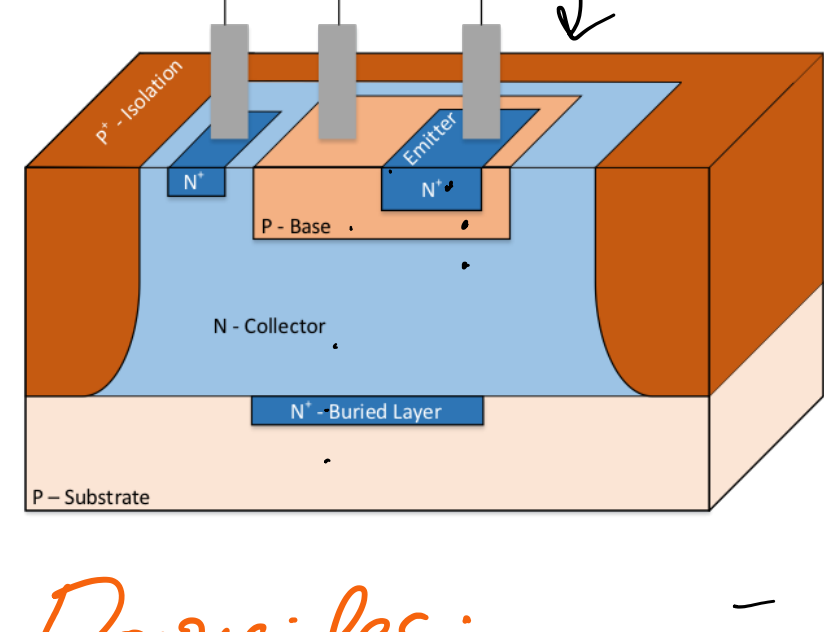
### Analogy Amplifiers

- 3-terminal device as a current source
- Current controlled by 3rd terminal

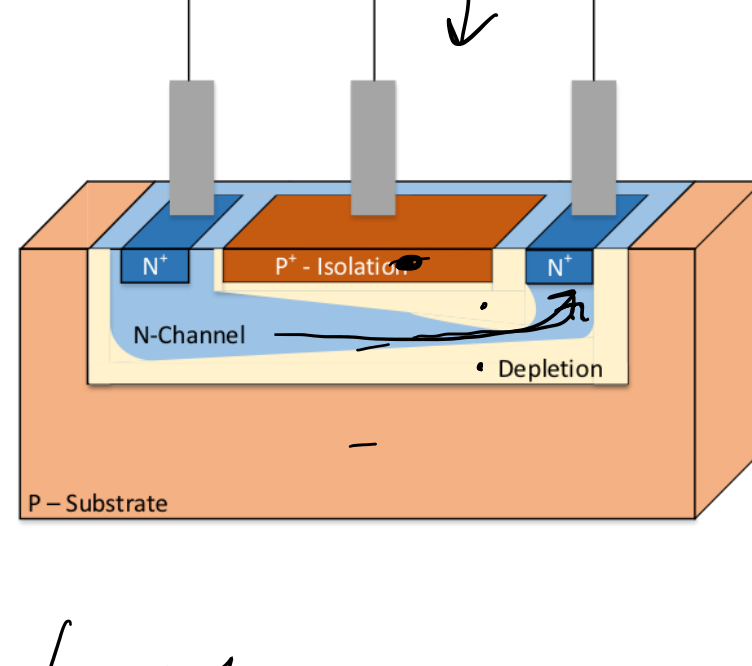


### Other Devices

#### BJT



#### JFETs

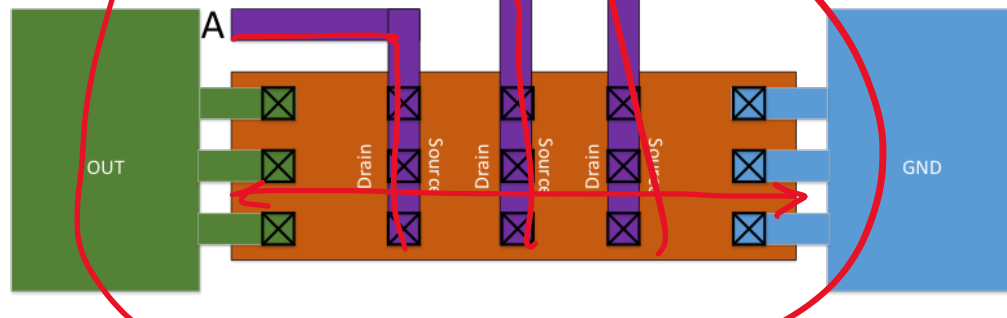
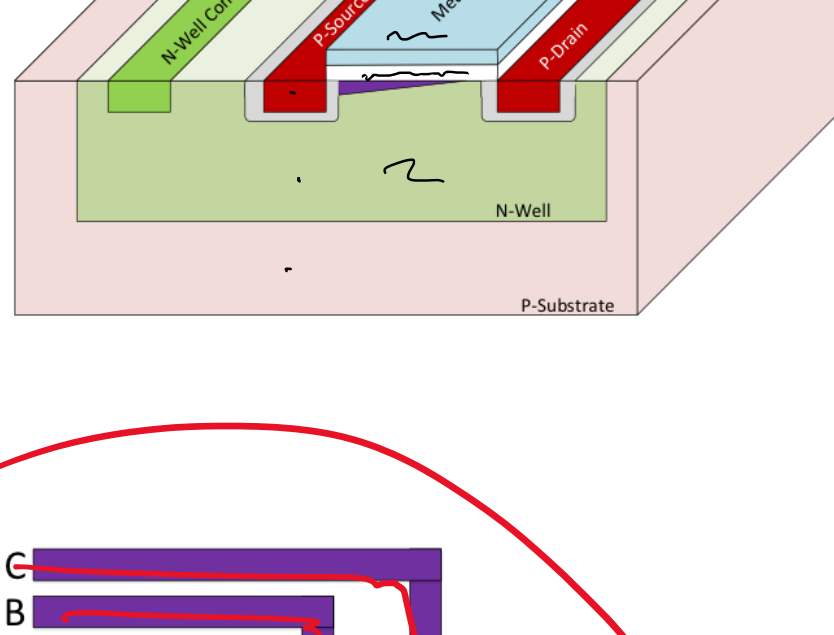


#### Downsides:

- Many Vertical Layers
- Hard to miniaturise
- Sensitive to doping

## MOSFET Advantages

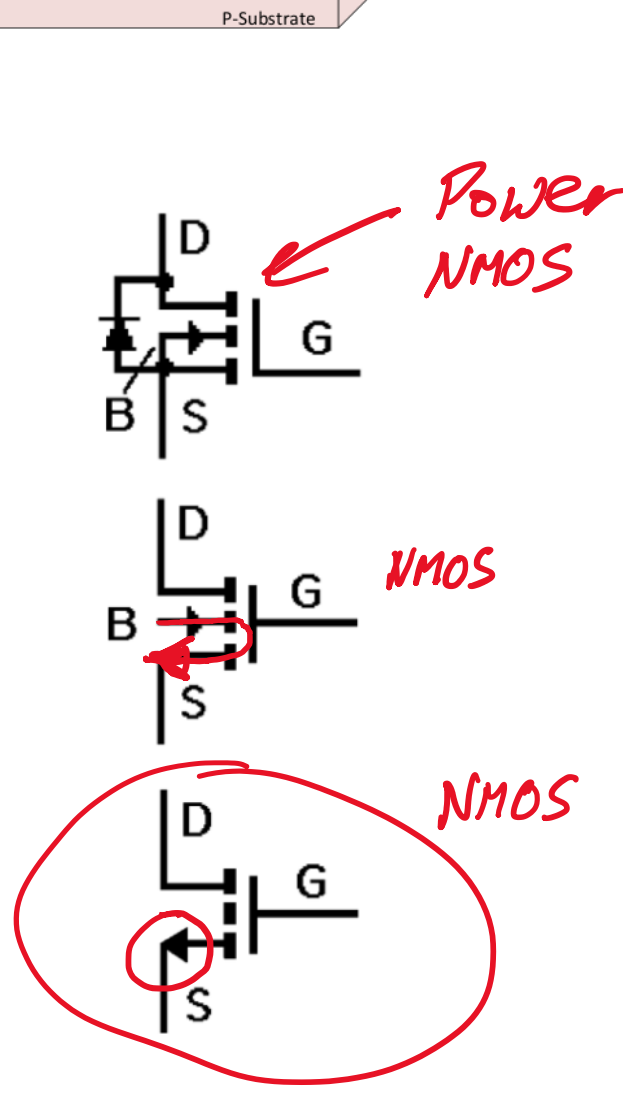
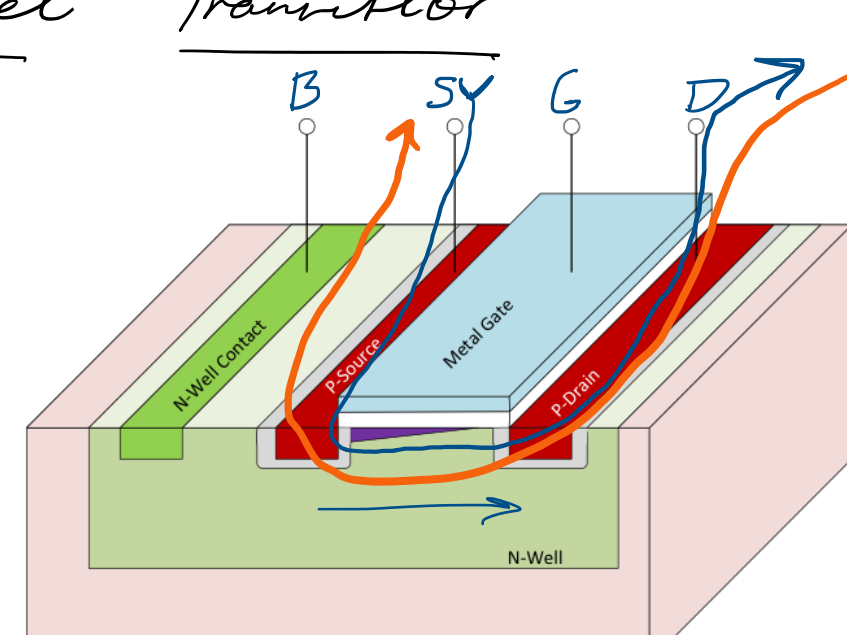
- Simple to make
- Reliable w/ little variation
- Entirely out of Si & Ox
- Zero gate current



## MOSFET: High Level View

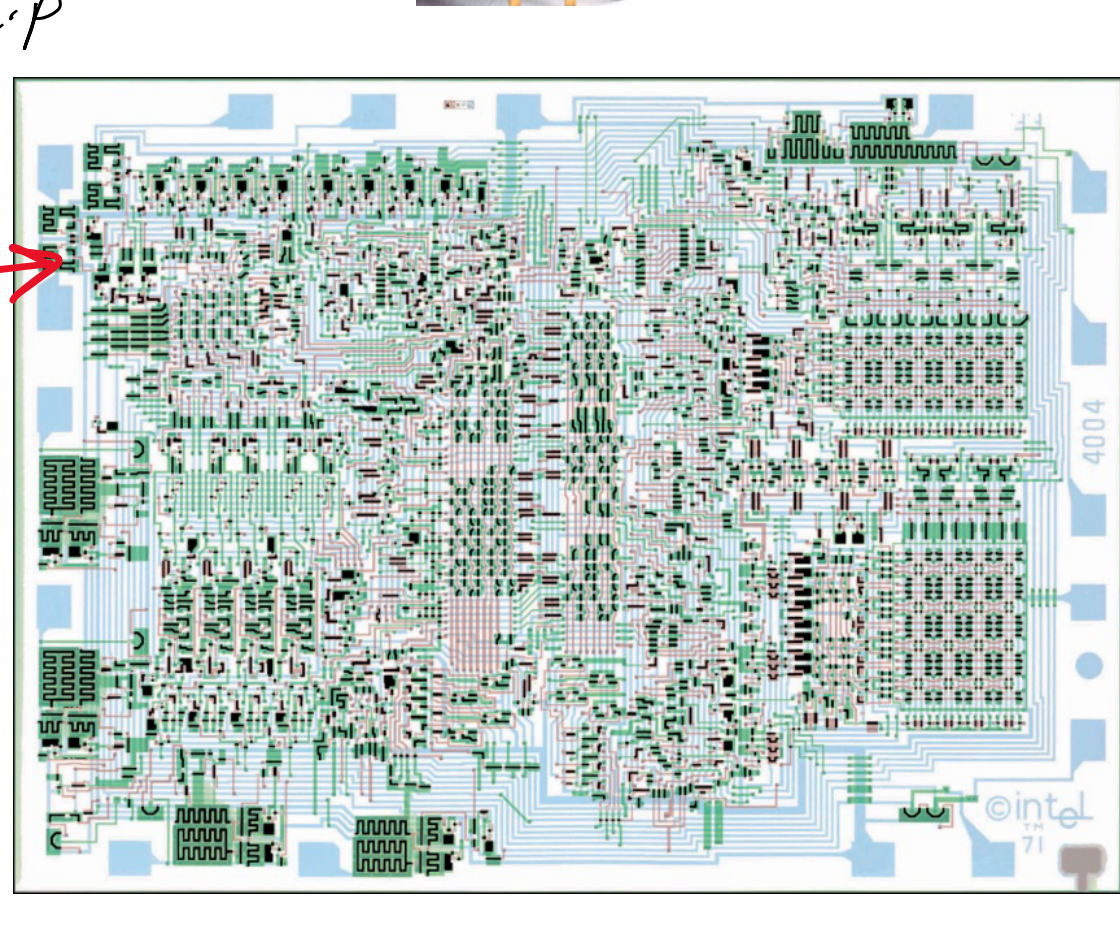
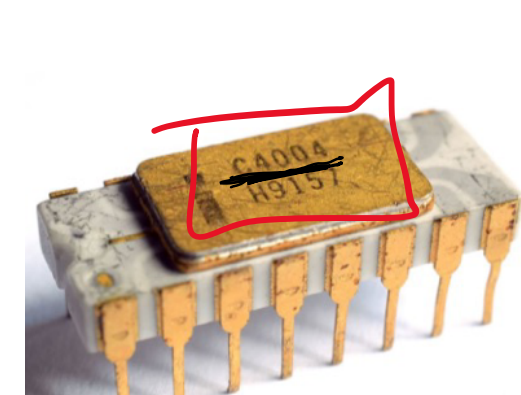
Metel Oxide Semiconductor Field Effect Transistor

- Source - Source of e in device  
↳ Where electron enter
- Drain - Where the e leave
- Gate - Controlling I from D → S  
↳ w/ gate Voltage
- Bulk - Treat: as ground ≡ Source



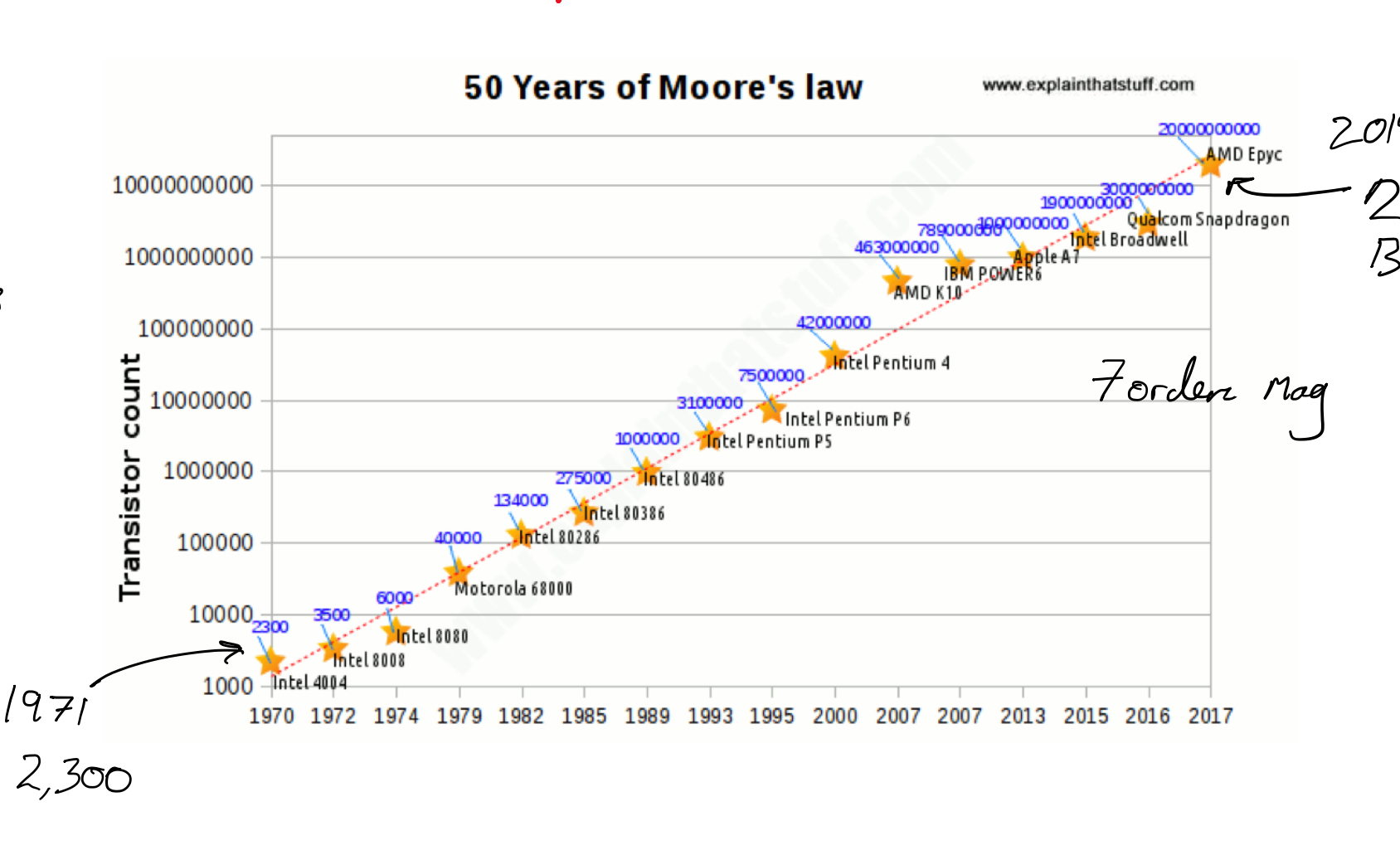
## Driver of the Technological Age

- Libienfeld 1925
- Hard to make : 1959
- 1964 : first CMOS chip
- 1971 : Intel 4004  
2300
- First processor



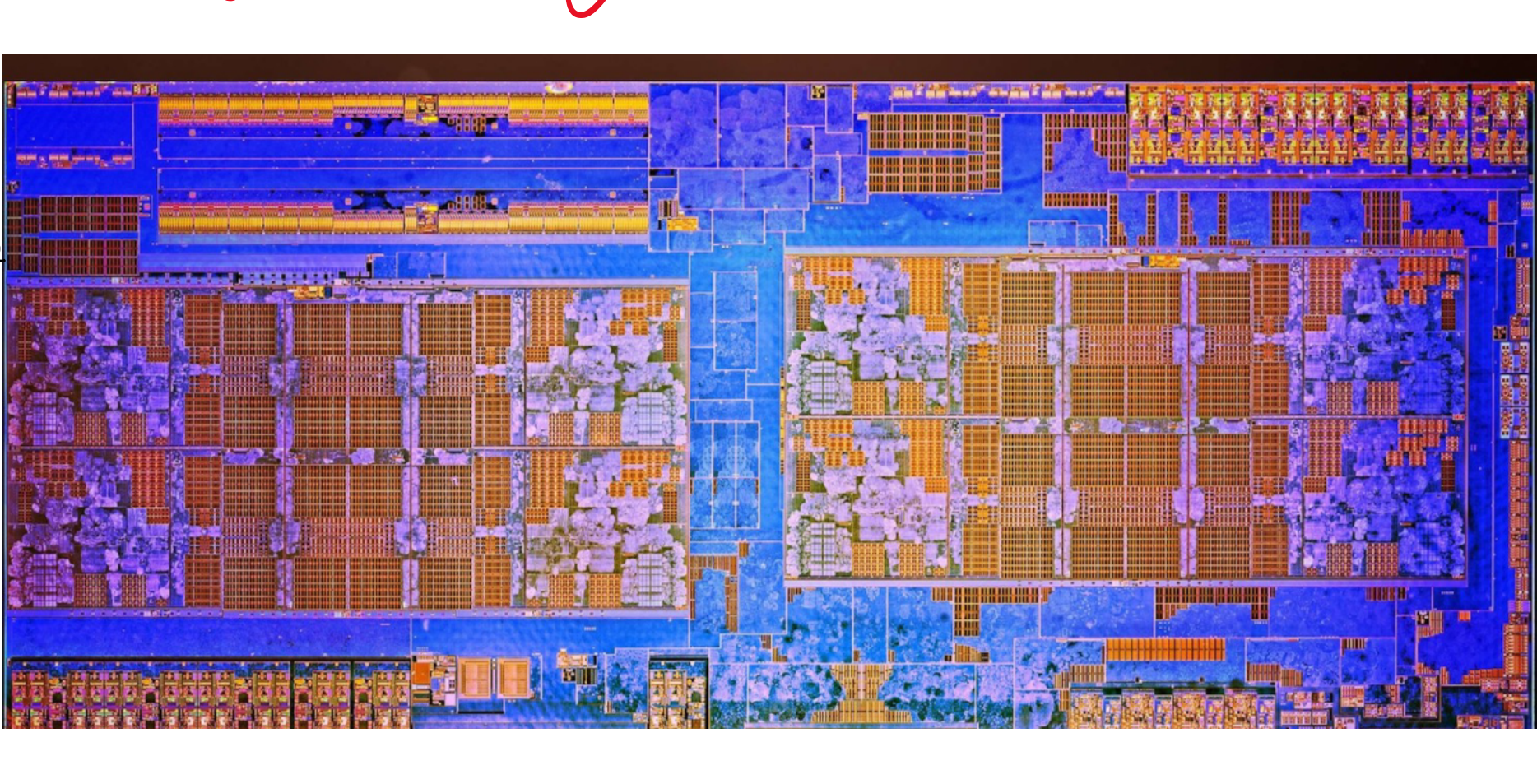
## Moore's Law Explosion

- 1965 :  
No. Transistor / IC  
doubles each 24 months  
↳ 18 months  
Last for 10 years



## Technology Today

2019  
AMD Epyc  
20 Bn transistors



## The Plan ...

- Tools
- MOSCAP
- How D & S added to influence conductivity

- Understand how current flows in channel