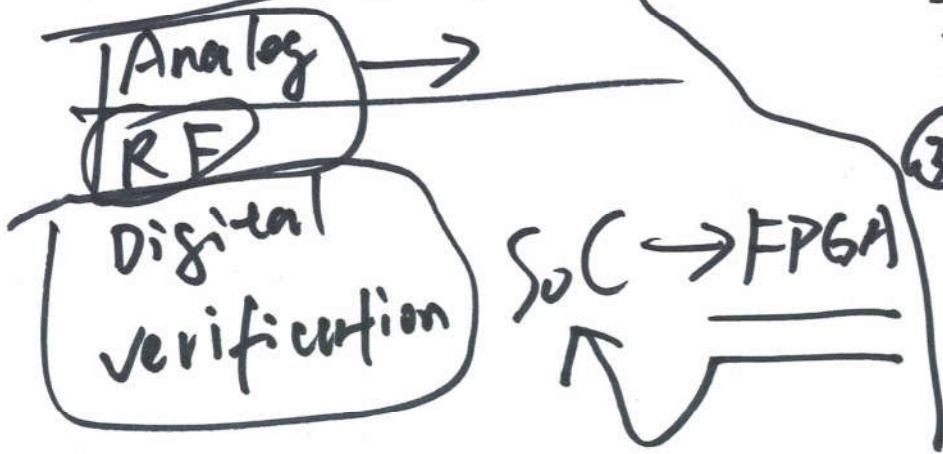


① fabless: Qualcomm, Nvidia, AMD, Broadcom

Mixed-signal IC  
② IDM: Integrated Devices Manufacturer  
Intel, Samsung, TI, Micron



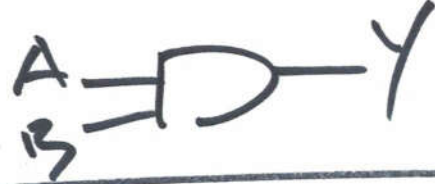
③ Pure-play foundry: TSMC  
Global Foundry  
UMC  
⋮

0.03-23nm ④

180nm	90nm	65nm	22nm	10nm	5nm	2nm
↑	→	↑	↑	↑	↑	↑
1999	2003	2005	<del>2011</del> 2012	2016	2020	2023

⑤ Moore's Law

$$Y = A \& B$$



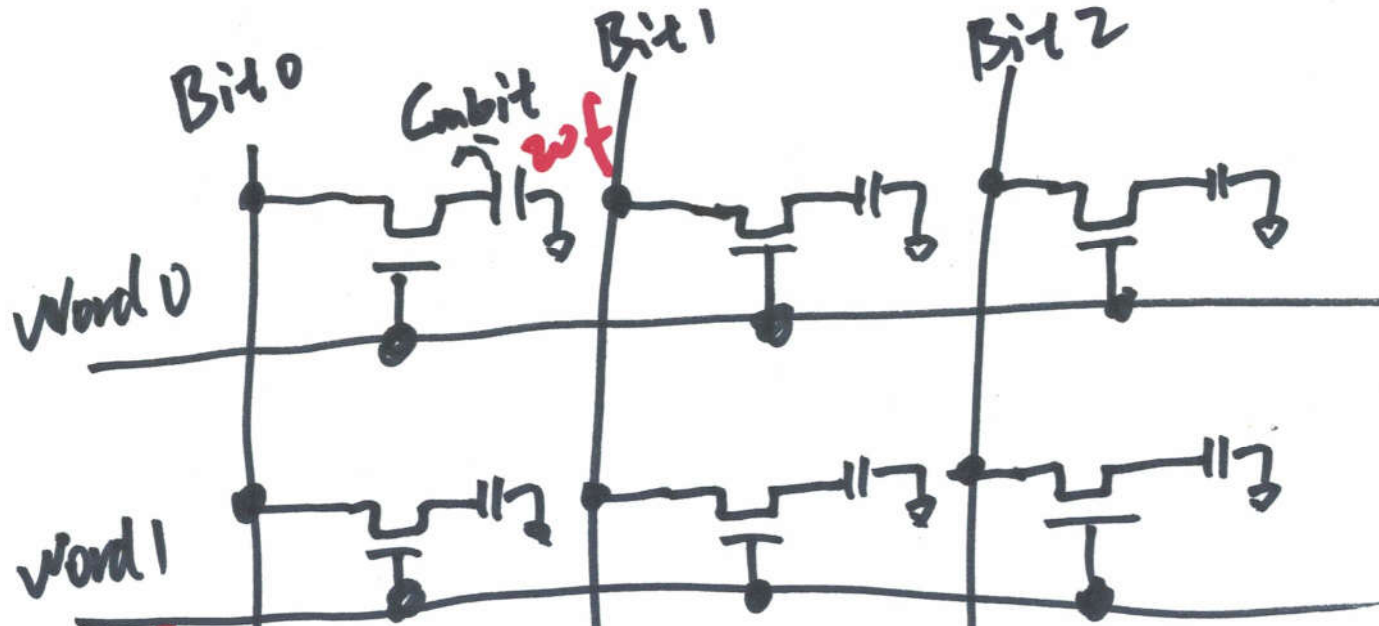
RTL

SRAM  
DRAM  
SDRAM

DRAM

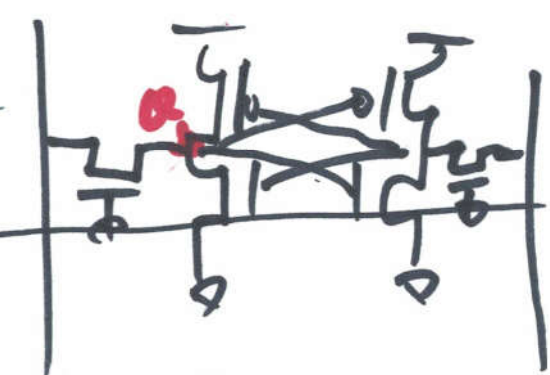
Dynamic: 1mbit

Caps are leaking charge through the NMOS

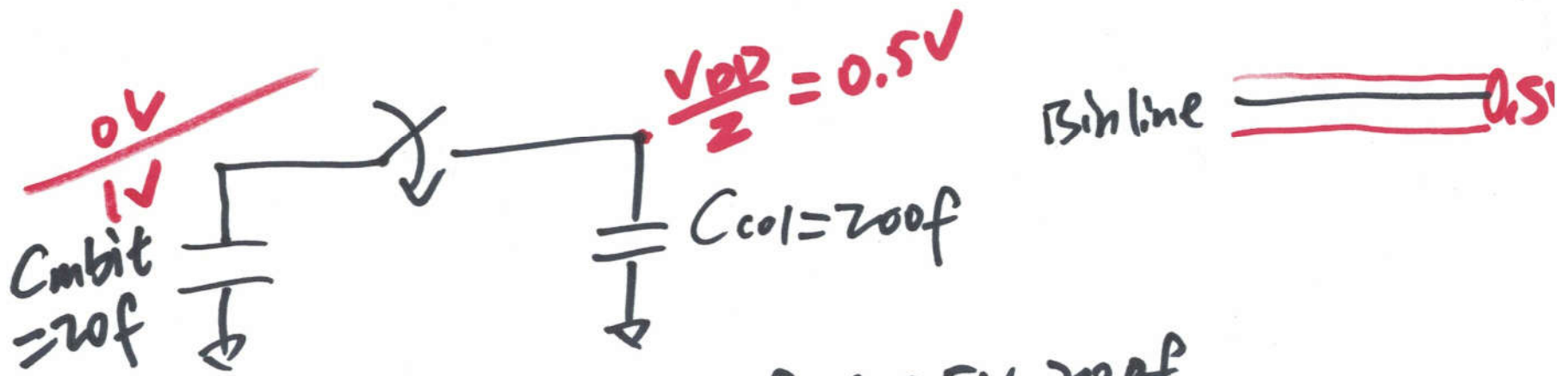


$C_{col} = 200f$   
(parasitic)

NSA: NMOS Sense Amplifier  
PSA: PMOS Sense Amplifier



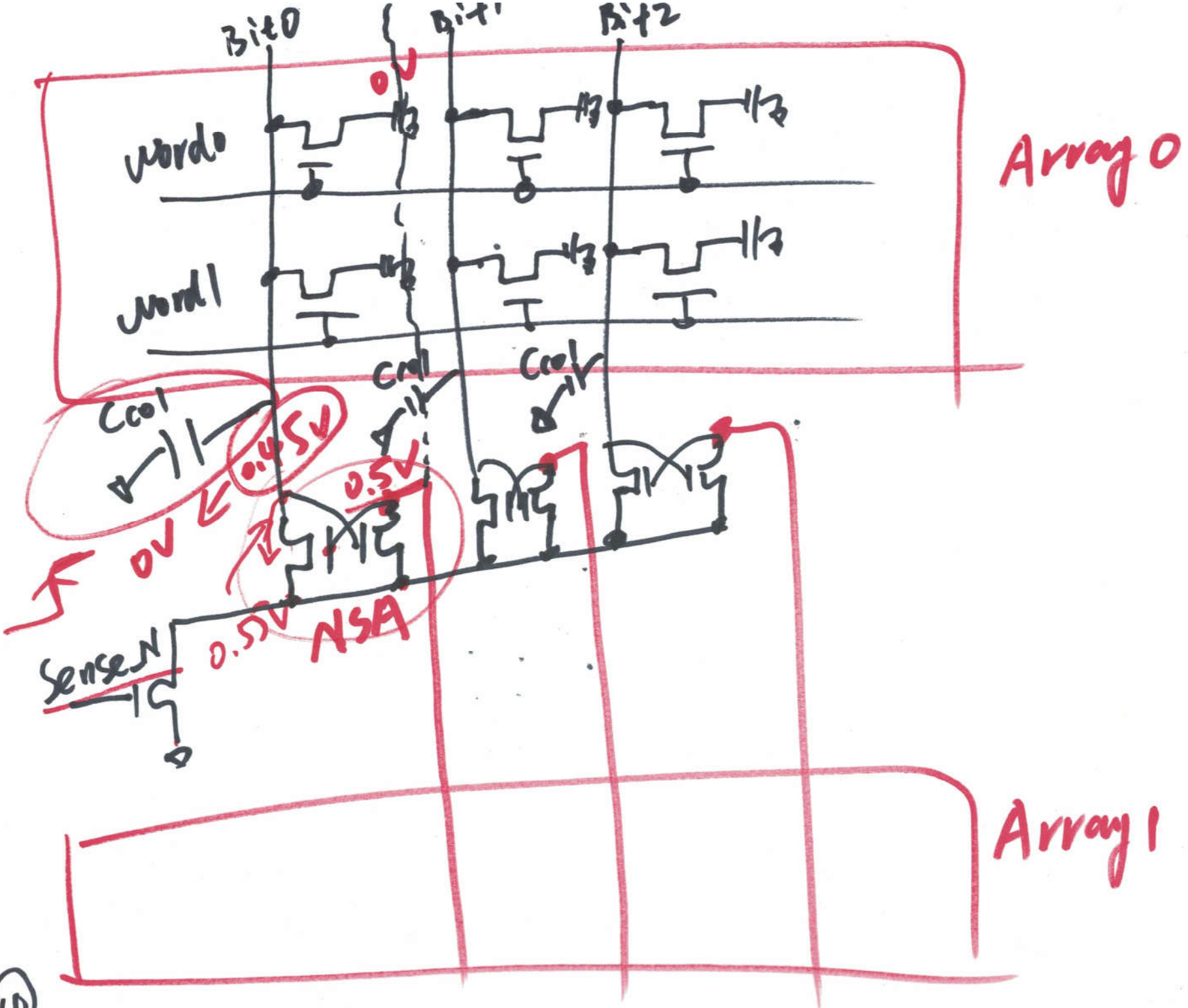
(2)

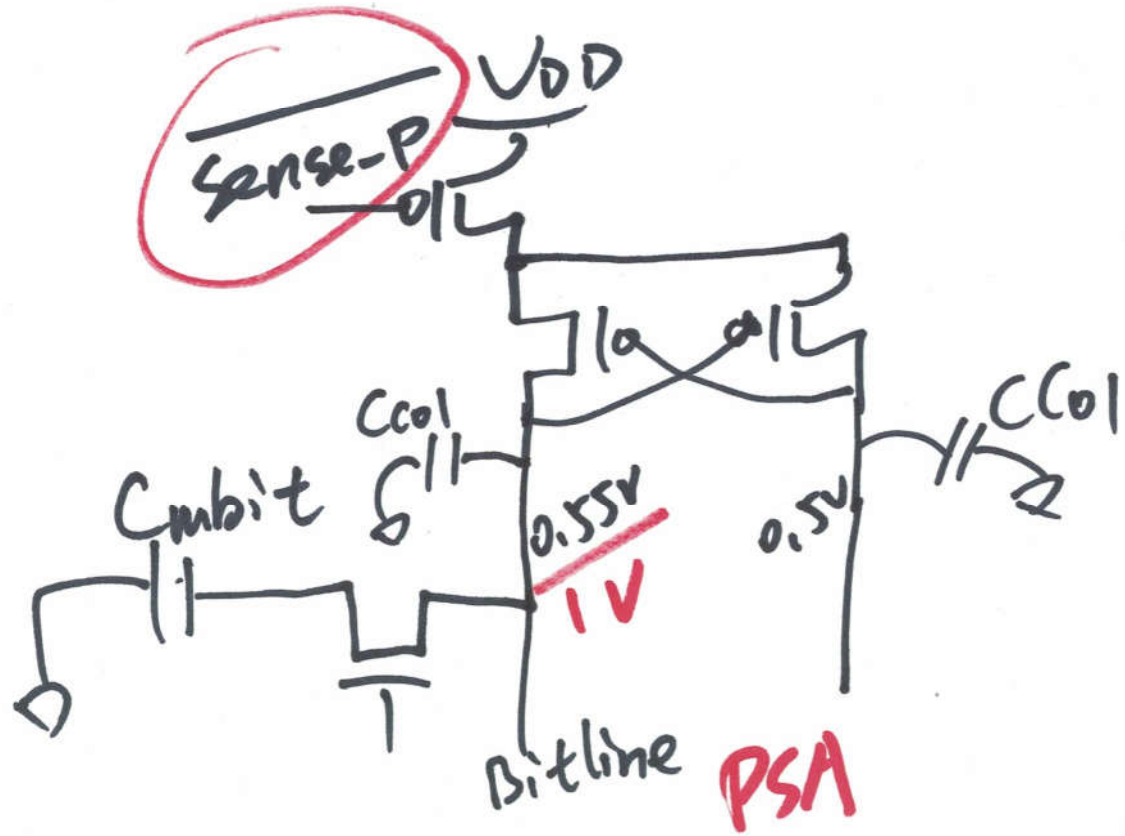


$$\begin{aligned}
 V_{\text{final}} &= \frac{Q_{\text{final}}}{C_{\text{final}}} = \frac{0V \cdot 20f + 0.5V \cdot 200f}{20f + 200f} \\
 &= \frac{100f}{220f} = \underline{0.45V}
 \end{aligned}$$

$$\begin{aligned}
 V_{\text{final}} &= \frac{Q_{\text{final}}}{C_{\text{final}}} = \frac{1V \cdot 20f + 0.5V \cdot 200f}{20f + 200f} \\
 &= \frac{120f}{220f} = \underline{0.55V}
 \end{aligned}$$

(3)





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