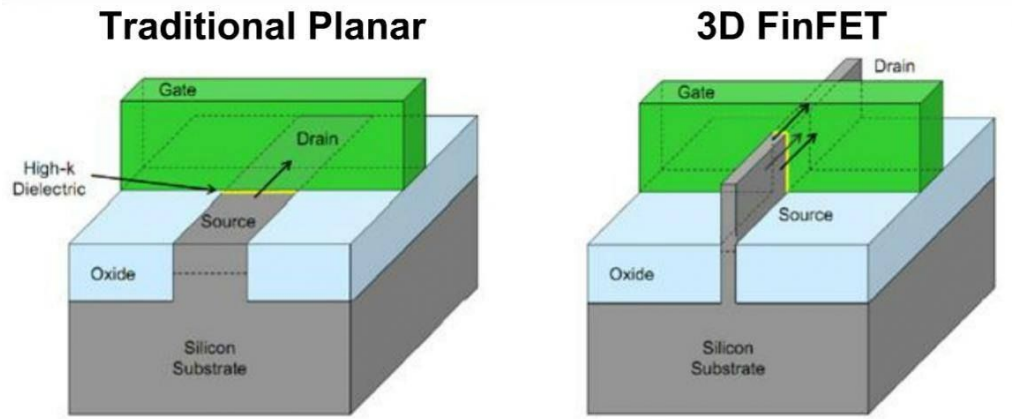
FINFET

A FinFET is a MOSFET with the channel elevated so the gate can surround it on three sides.

FinFET technology provides numerous advantages over bulk CMOS, such as higher drive current for a given transistor footprint, hence higher speed, I-V curves get flatter, meaning lower dynamic power consumption, **lower leakage**, hence lower power consumption, no random dopant fluctuation, hence better mobility and scaling of the transistor beyond 28nm.



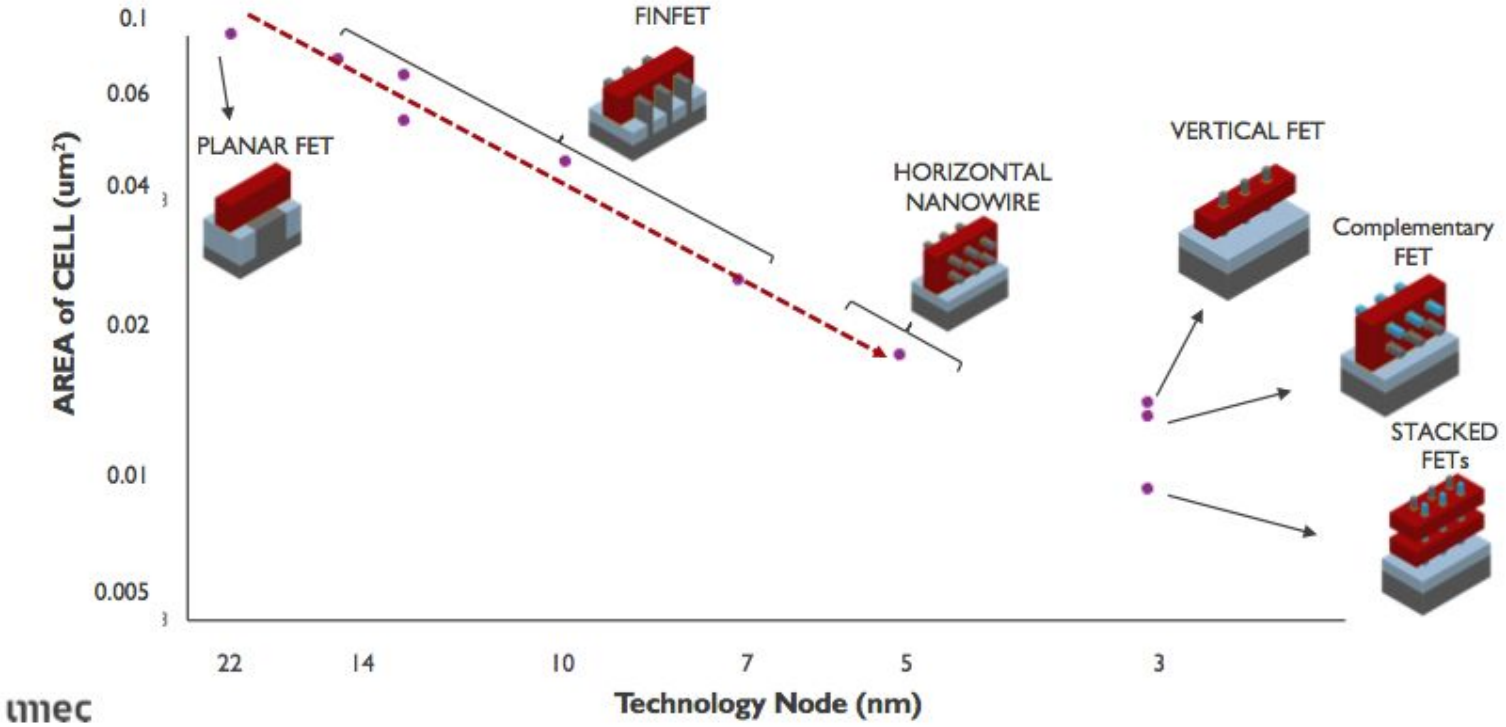
Traditional 2-D planar transistor form a conducting channel in the silicon region under the gate electrode when in the “on” state

3-D Tri-Gate transistor form conducting channels on three sides of a vertical fin structure, providing “fully depleted” operation

Advantages of FINFET

1. A large number of transistors can be incorporated into a single chip. FinFET technology is suitable for IC fabrication, as it has higher scalability for the given footprint area than MOSFETs.
2. As chips are downsized, transistors also shrink. This compactness brings the drain and source closer and reduces the gate control over the channel carriers. This type of short-channel effect can cause serious issues in MOSFETs. The presence of fins gives FinFETs better short-channel behavior.
3. To improve short-channel behavior, channel doping is common in planar MOSFETs. The wrap-around gate over the thin body makes channel doping optional in FinFETs. Therefore, no dopant-induced fluctuations are present in FinFETs.
4. The length of the gate is significant in reducing leakage current, and thereby leakage power. As the gate is wrapped around the drain-source channel, there is sufficient gate length in FinFETs and there is no leakage current when the gate is not energized. However, in MOSFETs, as the gate is scaled down, leakage current exists.
5. Leakage current and leakage voltage are responsible for leakage power in switching devices. Since FinFETs are devices with low leakage current, their power consumption is less than that of MOSFETs.
6. In planar MOSFETs, the device drive strength is dependent on the channel width, whereas a FinFET transistor's drive strength can be increased by incorporating multiple or longer fins.
7. A higher drive current can be reflected as fast switching times in FinFETs. Otherwise, it can be said that three-dimensional FinFETs are high-speed devices compared to planar MOSFETs.
8. It is easy to fabricate multi-gate devices using FinFET technology. Planar construction makes multi-gate construction tedious in MOSFETs.
9. FinFETs offer an excellent subthreshold slope and higher voltage gain than planar MOSFETs.

What's after FINFET

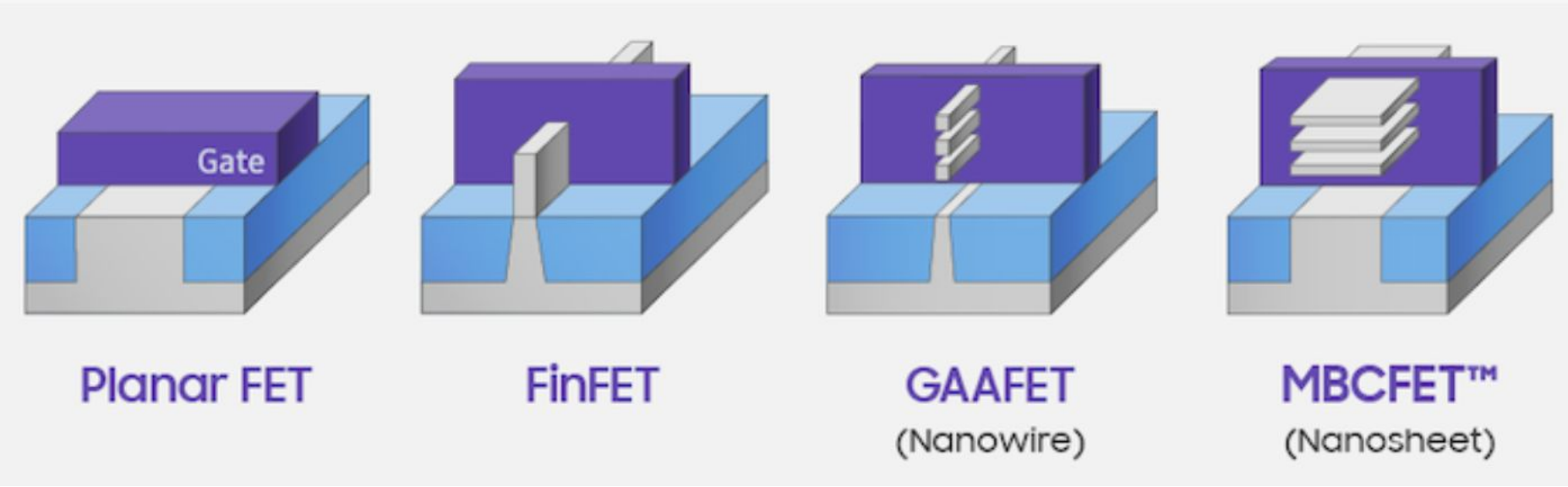


TSMC stays with FINFET for 3nm, Samsung might use MBCFET

https://semiengineering.com/whats-after-finfets/

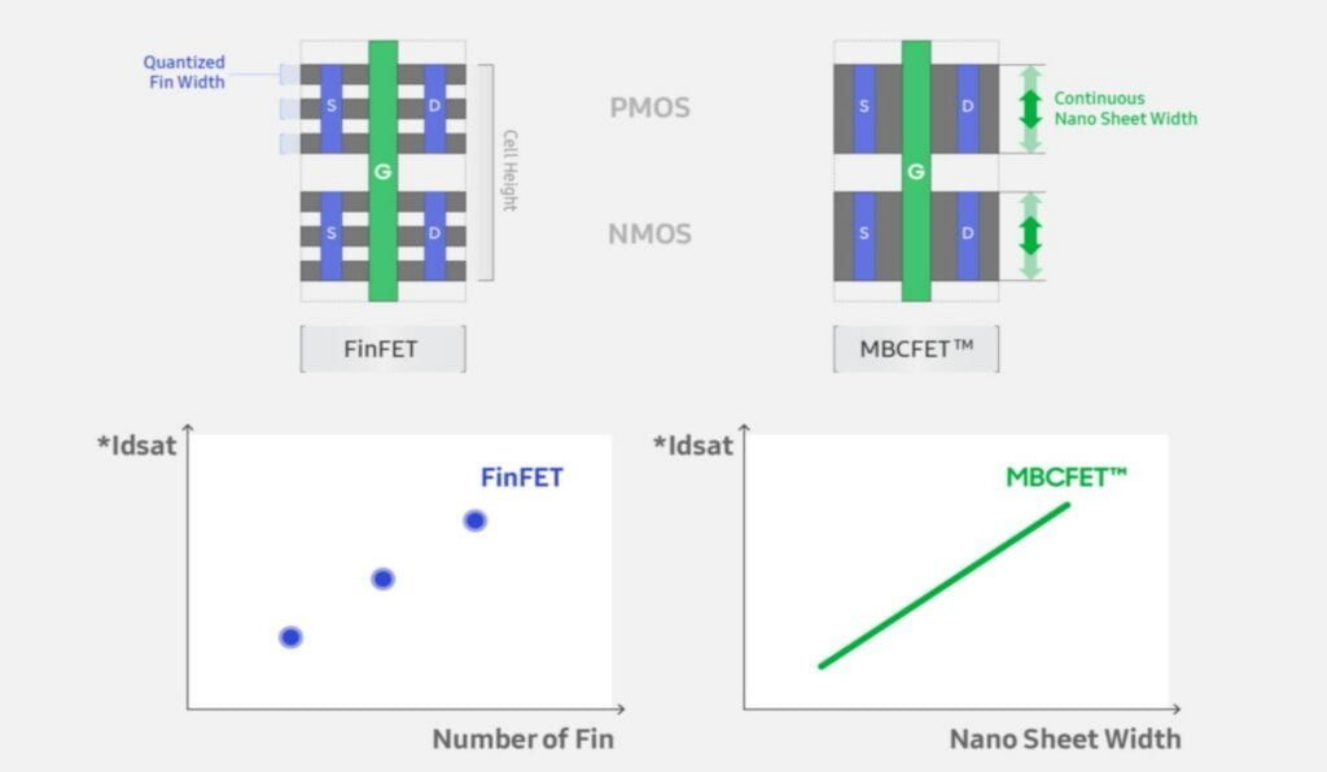
New FETs

A **gate-all-around** (GAA) FET, abbreviated GAAFET, and also known as a surrounding-gate transistor (SGT), is similar in concept to a FinFET except that the gate material surrounds the channel region on all sides. Depending on design, gate-all-around FETs can have two or four effective gates.



https://hardwaresfera.com/en/noticias/hardware/intel-finfet-gaafet-litografia/

MBCFET (Samsung)



https://news.samsung.com/global/infographic-reduced-size-increased-performance-samsungs-gaa-transistor-mbcfettm

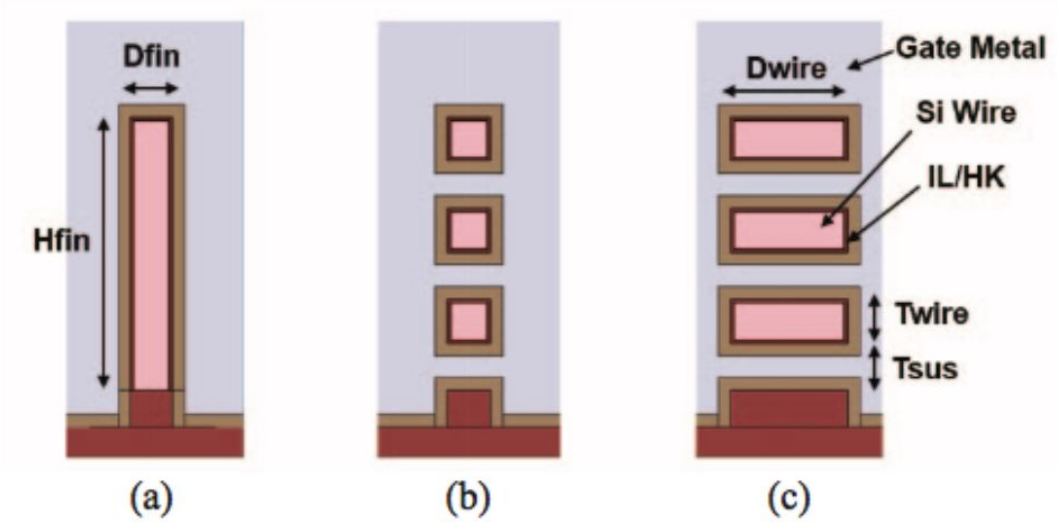
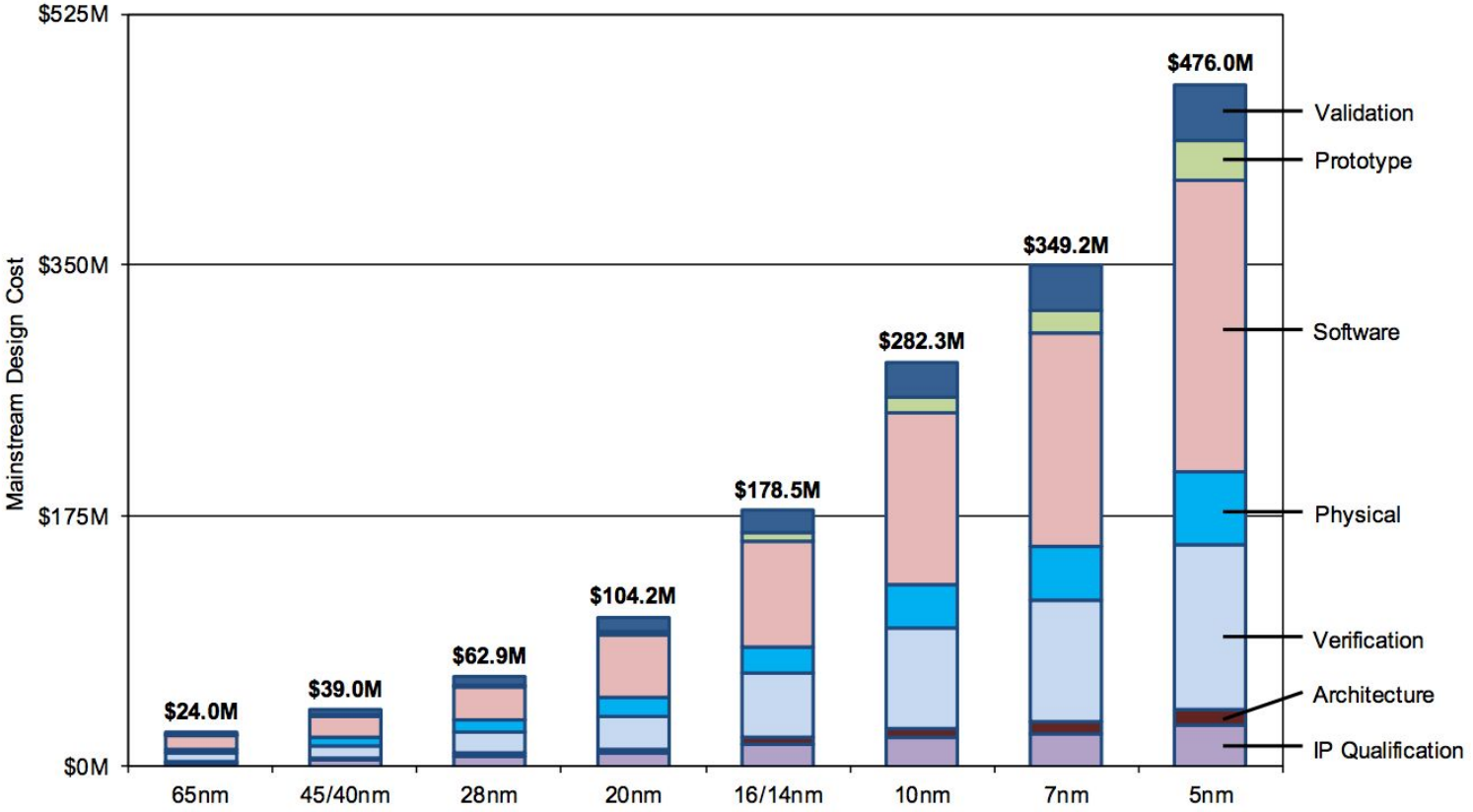


Fig. 5: Cross-section simulation of (a) finFET, (b) nanowire, and (c) nanosheet. Source: IBM.

Design Cost


$525M
$350M
$175M
$0M
Mainstream Design Cost
$24.0M
$39.0M
$62.9M
$104.2M
$178.5M
$282.3M
$349.2M
$476.0M
65nm
45/40nm
28nm
20nm
16/14nm
10nm
7nm
5nm
Validation
Prototype
Software
Physical
Verification
Architecture
IP Qualification