‘Are we nearing the end of nm-Silicon?!’

Communication Products

DEFENCE AND SPACE

Ralph Green

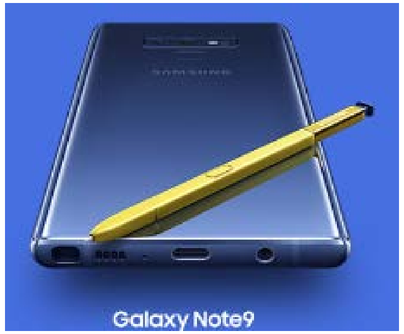
1st October 2018

AIRBUS

What comes after nm-Silicon?

We consider see that nm-silicon is approaching the end of the traditional technology development road –

Silicon Technology development has been driven by Commercial High volume consumer products this has been strongly influenced by mobile devices the latest released handset are shown below, going forward Automotive and IoT will also influence the market



A12 processor on TSMC's 7nm

Qualcomm SnapDragon 845 processor 10nm

Reliability MTTF

Commercial Product life time is typically < 5years

iPhone	Release date	Support ended	Support lifespan	Launch price
iPhone	June 29, 2007	June 20, 2010	2 years, 11 months	$499/$599*
iPhone 3G	July 11, 2008	March 3, 2011	2 years, 7 months	$199/$299*
iPhone 3GS	June 19, 2009	September 18, 2013	4 years, 2 months	$199/$299*
iPhone 4	June 21, 2010	September 17, 2014	4 years, 2 months	$199/$299*
iPhone 4S	October 14, 2011	September 12, 2016	4 years, 10 months	$199/$299/$399*
iPhone 5	September 21, 2012	September 18, 2017	4 years, 11 months	$199/$299/$399*
iPhone 5C	September 20, 2013	September 18, 2017	3 years, 11 months	$99/$199*
iPhone 5S	September 20, 2013	(current)	> 5 years	$199/$299/$399*
iPhone 6 (Plus)	September 19, 2014	(current)	> 4 years	$649/$749/$849 ($749/$849/$949)
iPhone 6S (Plus)	September 25, 2015	(current)	> 3 years	$649/$749/$849 ($749/$849/$949)
iPhone SE	March 31, 2016	(current)	> 2 years, 5 months	$399/$499
iPhone 7 (Plus)	September 16, 2016	(current)	> 2 years	$649/$749/$849 ($769/$869/$969)
iPhone 8 (Plus)	September 22, 2017	(current)	> 1 year	$699/$849 ($799/$949)
iPhone X	November 3, 2017	(current)	> 10 months	$999/$1149
iPhone XS (Max)	September 21, 2018	(current)	> 0 months	$999/$1149/$1349 ($1099/$1249/$1449)
iPhone XR	September 21, 2018	(current)	> 0 months	$749

DSM processes have a MTBF target of ~10 years

Radiation Hardness / Tollerance is a key issue for space use we cannot continue to have many years of testing prior to use

Life time can be extended by reducing voltages and temperature BUT is this compatible with a Satellite 10 - or 20 year mission ?

AIRBUS

Availability of Leading Edge Fabrication Capability

As technology shrinking becomes more complex, it is requiring more capital, expertise, and resources, the number of companies capable of providing leading edge fabrication has been steadily dropping. As of 2018, only three companies are fabricating integrated circuits on the most cutting edge process: Intel, Samsung, and TSMC. (https://en.wikichip.org/wiki/technology_node)

There is currently no European Foundry for sub 14nm?

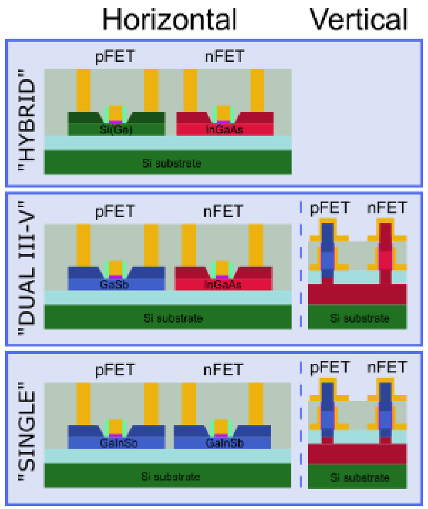
Number of Foundries with a Cutting Edge Logic Fab										
SilTerra										
X-FAB										
Dongbu HiTek										
ADI	ADI									
Atmel	Atmel									
Rohm	Rohm									
Sanyo	Sanyo									
Mitsubishi	Mitsubishi									
ON	ON									
Hitachi	Hitachi									
Cypress	Cypress	Cypress								
Sony	Sony	Sony								
Infineon	Infineon	Infineon								
Sharp	Sharp	Sharp								
Freescale	Freescale	Freescale								
Renesas (NEC)	Renesas	Renesas	Renesas	Renesas						
SMIC	SMIC	SMIC	SMIC	SMIC						
Toshiba	Toshiba	Toshiba	Toshiba	Toshiba						
Fujitsu	Fujitsu	Fujitsu	Fujitsu	Fujitsu						
TI	TI	TI	TI	TI						
Panasonic	Panasonic	Panasonic	Panasonic	Panasonic	Panasonic					
STMicroelectronics	STM	STM	STM	STM	STM					
UMC	UMC	UMC	UMC	UMC	UMC					
IBM	IBM	IBM	IBM	IBM	IBM	IBM				
AMD	AMD	AMD	GlobalFoundries	GF	GF	GF	GF			
Samsung	Samsung	Samsung	Samsung	Samsung	Samsung	Samsung	Samsung	Samsung	Samsung	
TSMC	TSMC	TSMC	TSMC	TSMC	TSMC	TSMC	TSMC	TSMC	TSMC	
Intel	Intel	Intel	Intel	Intel	Intel	Intel	Intel	Intel	Intel	Future
180 nm	130 nm	90 nm	65 nm	45 nm/40 nm	32 nm/28 nm	22 nm/20 nm	16 nm/14 nm	10 nm	7 nm	5 nm

Where do we go next - Foundry roadmap example –TSMC 28nm

	28nm	20nm	16nm	10nm	7nm	5nm	3.5nm
Year	2011	2014	2015	2016	2017	2019	2022
Transistor	Planar	Planar	FinFET	FinFET	FinFET	FinFET	HNW
Channel (NMOS/PMOS)	Si/Si	Si/Si	Si/Si	Si/Si	Si/Si	Si/SiGe	Si/Si
Threshold voltages	4	4	5	5	5	5	3-4
Metal layers	10	10	11	12	13	14	15

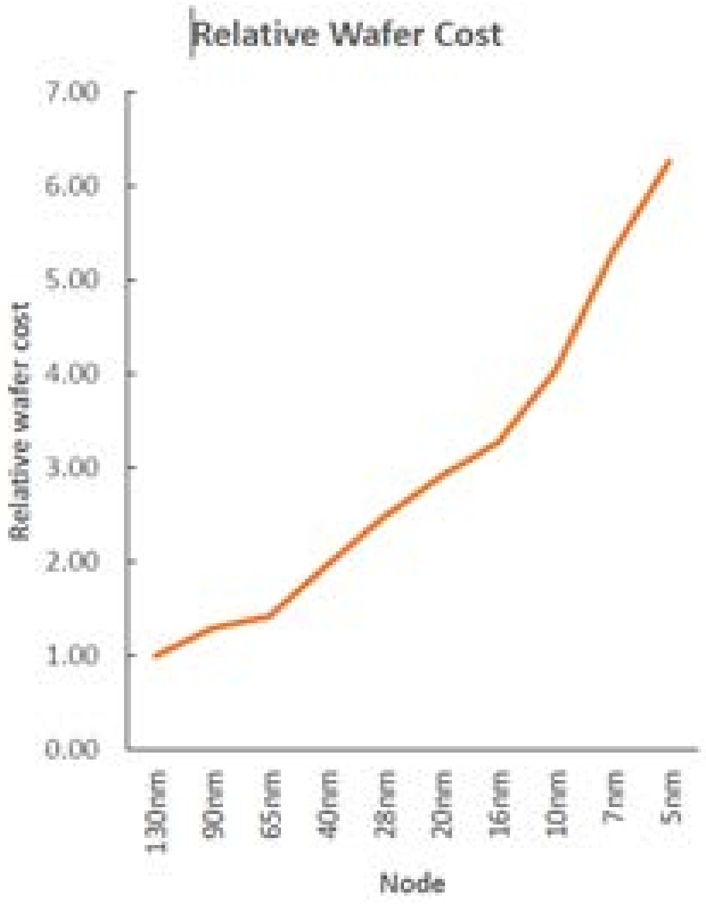
After 3.5nm TSMC expect nanowire technology to provide density scaling

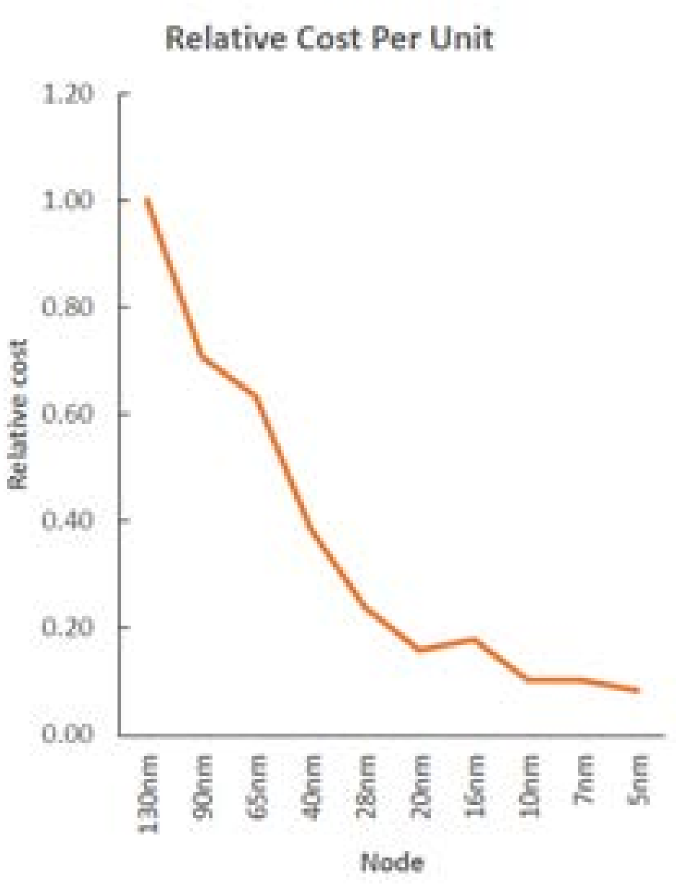
European developments : H2020 (http://insight.eit.lth.se/index.php?gpuid=29&L=1)
Enhance advanced CMOS RF and logic capability through the use of III-V heterostructure nanowires monolithically integrated on a silicon platform.



Cost is a big Concern

For space applications the cost of using custom deep sub micron technology is a significant business concern as we do not have the high volumes which give a reduced unit cost



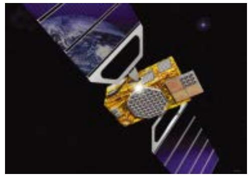


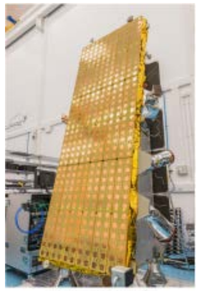
Source: IC Knowledge –Strategic Cost Model

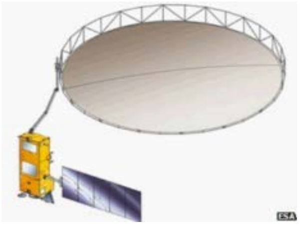
Time to Market for Space use

The time to market depends on the application / mission area

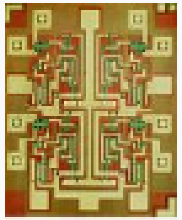
Application	**Time to Flight**
Telecommunication	< 5 years
Navigation	5- 8 Years
Remote Sensing	5 -10 years
Science	10 – 15 years







Semiconductor manufacturing processes



10 µm – 1971
6 µm – 1974
3 µm – 1977
1.5 µm – 1982
1 µm – 1985
800 nm – 1989
600 nm – 1994
350 nm – 1995
250 nm – 1997
180 nm – 1999
130 nm – 2001
90 nm – 2004
65 nm – 2006
45 nm – 2008
32 nm – 2010
22 nm – 2012
14 nm – 2014
10 nm – 2017
7 nm – 2018
5 nm – ~2020

Need to reduce the time from 1st commercial release of a semiconductor technology to use in space currently this can > 6 years

Europe 2018 : 28nm FD-SOI ASIC near to flight this is > 6-8 years since first commercial product was commercially released

USA 2018 : 14nm FinFET ?

https://en.wikipedia.org/wiki/Semiconductor_device_fabrication

Where, What and Why we need to consider using commercial DSM devices

Where:

Telecommunications, Navigation, Earth Observation, Science

Applications:

Frequency Conversion, Signal Processing, Data Compression, Signal/ Data Security/Encryption, Data Storage, Telemetry and Control,

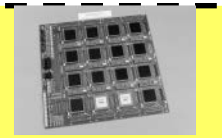
What:

ADC, DAC, SERDES, ASICs, FPGA

Why:

- Benefits: , **Reduced Time to Market,** Performance, Power saving, Speed,
- Challenges: **Cost?,** Reliability, Customisation

Airbus Telecommunications Processors: Roadmap Success Story



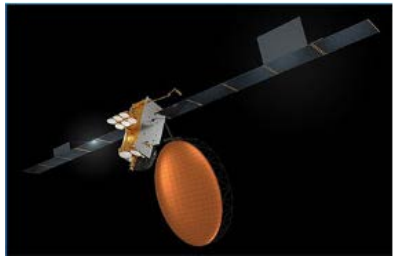
1997
Reconfigurable
Regenerative Digital
Payload Demonstrator
100k-gate FPGAs

1988 Beginning of Digital Signal Processor Developments

2005-2008
Inmarsat 4 F1,2,3

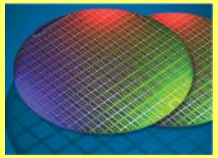
2007- 2012
SkyNet 5 F1,2,3,4

2013
Alphasat I-XL

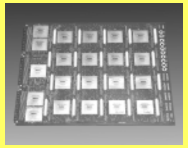


2019
Inmarsat 6 F1, F2

1988 — 2000 — 2005 — 2013 — 2020 — 2025



800 nm
ASIC
Technology



1999
EU ACTS project
WISDOM

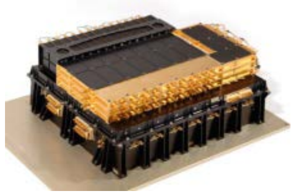
Digital Signal Processor
R&D Activity

2005
Inmarsat 4
Gen 1 Processor

650 nm ASIC
Technology

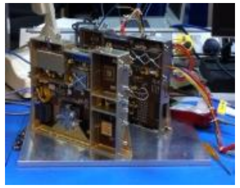
2007
SkyNet 5
Gen 2 Processor

2013
Alphasat
Gen 3 Processor



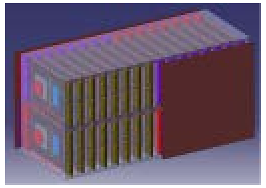
180 nm ASIC
Technology

2016
Gen 4 Processor



90 nm ASIC
Technology

2021
Gen 5 Processor



28 nm ASIC
Technology

?

3.5 nm COTS or
nano wire
Technology

Long heritage, continuous product line development for more modular, more capacitive and lower cost/GHz solutions

AIRBUS

Thank you

AIRBUS