



Smart Technology Choices and Leadership **i.MX Applications Processors**

Shanghai FD SOI Forum

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Business and Advanced Technology Adoption

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Smart World

SECURE, CONNECTED, LOW-POWER, SCALABLE

Internet of Things



Software

- Ease-of-use
- Open-source
- Security
- Device Management
- Professional Services

Solutions

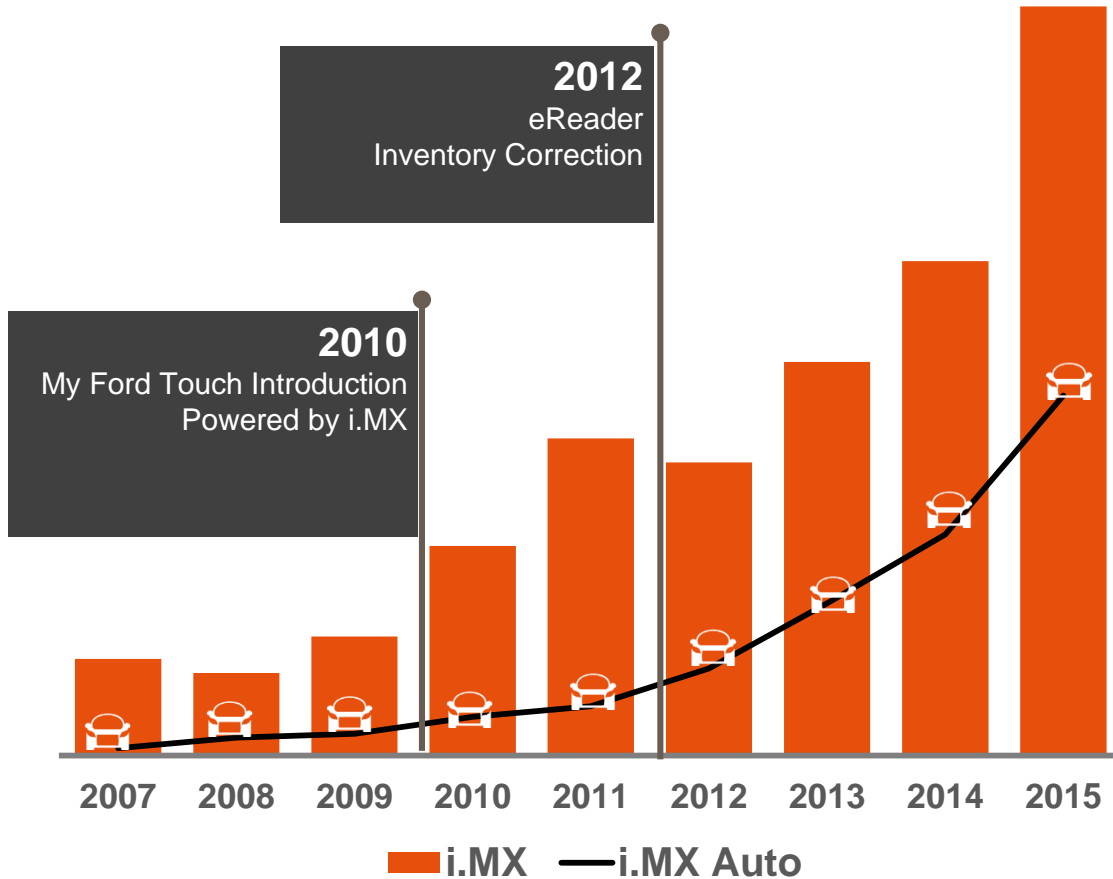
- Embedded Processing
- Connectivity Protocols
- Multi-Sensing Applications
- Video | Image | Graphics | Voice

Technology Innovations

- Advanced NVM, RF, Mixed Signal Analog, and Sensors integration
- Powerful, Secure, Low-Power MCUs & Applications Processors
- System Miniaturization & Advanced Packaging



i.MX Driving Explosive Growth in Smart Vehicles & Smart Devices



Over **200M i.MX** SOCs shipped to date

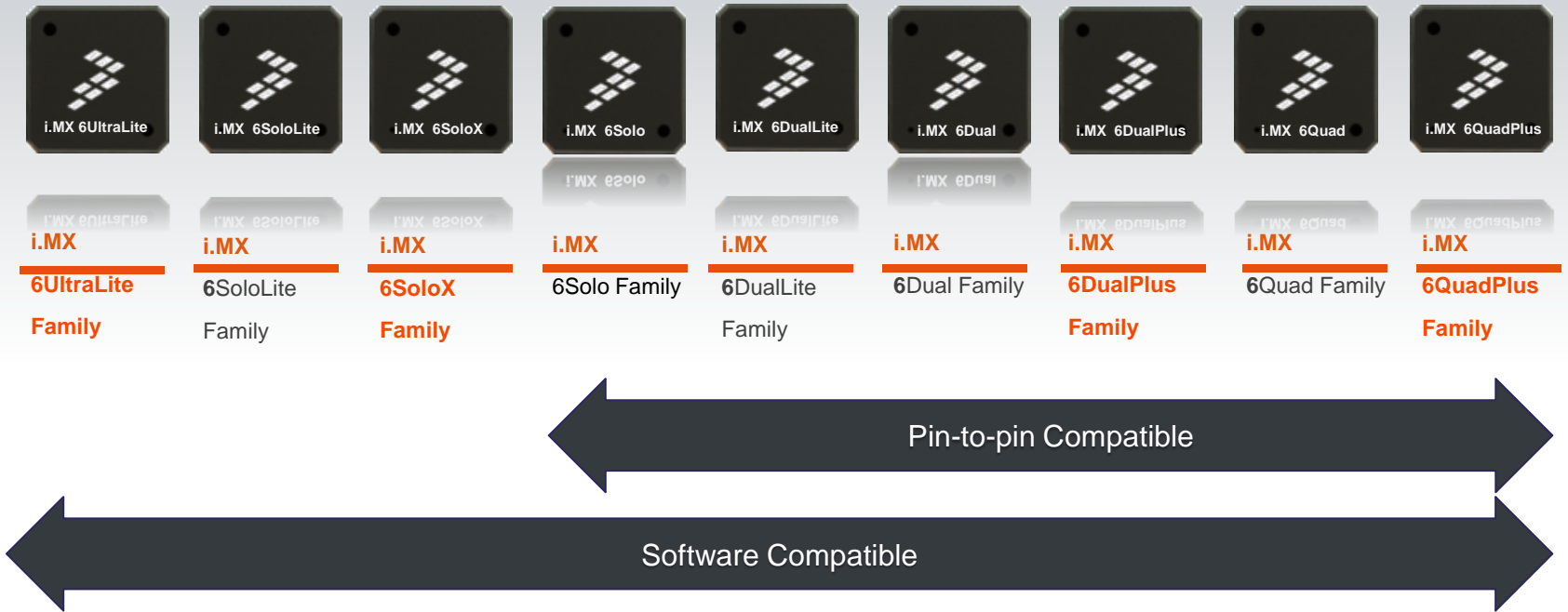
Over **35M vehicles** enabled with i.MX since 2007

Leader in eReaders and Auto Infotainment MPU

i.MX 6 Series: Supreme Scalability and Flexibility

Leverage One Design Into Diverse Product Portfolio

Scalable series of **NINE** ARM-based SoC Families

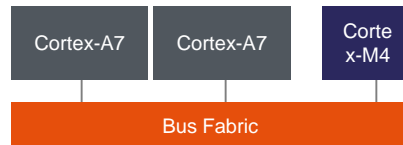


Expanded series for performance, power efficiency and lower BOM

Recently Announced i.MX 7D & 7S Advantages

Advanced Heterogeneous Architecture

- Single and Dual Cortex-A7 Core up to 1GHz
- Cortex-M4 up to 266MHz
 - Offload Tasks
 - Optimize Power
 - Increase Security



Unmatched Power Efficiency

- 3x improvement in Power Efficiency vs i.MX 6
- 100 uW/MHz for Cortex-A7
- 70 uW/MHz for Cortex-M4
- One third the power consumed in the Low Power suspend mode (250uW) vs i.MX 6



Enabling Flexible High Speed Connectivity

- PCI-e v2.1
- Dual Gbit Ethernet with AVB
- DDR QuadSPI support
- eMMC 5.0

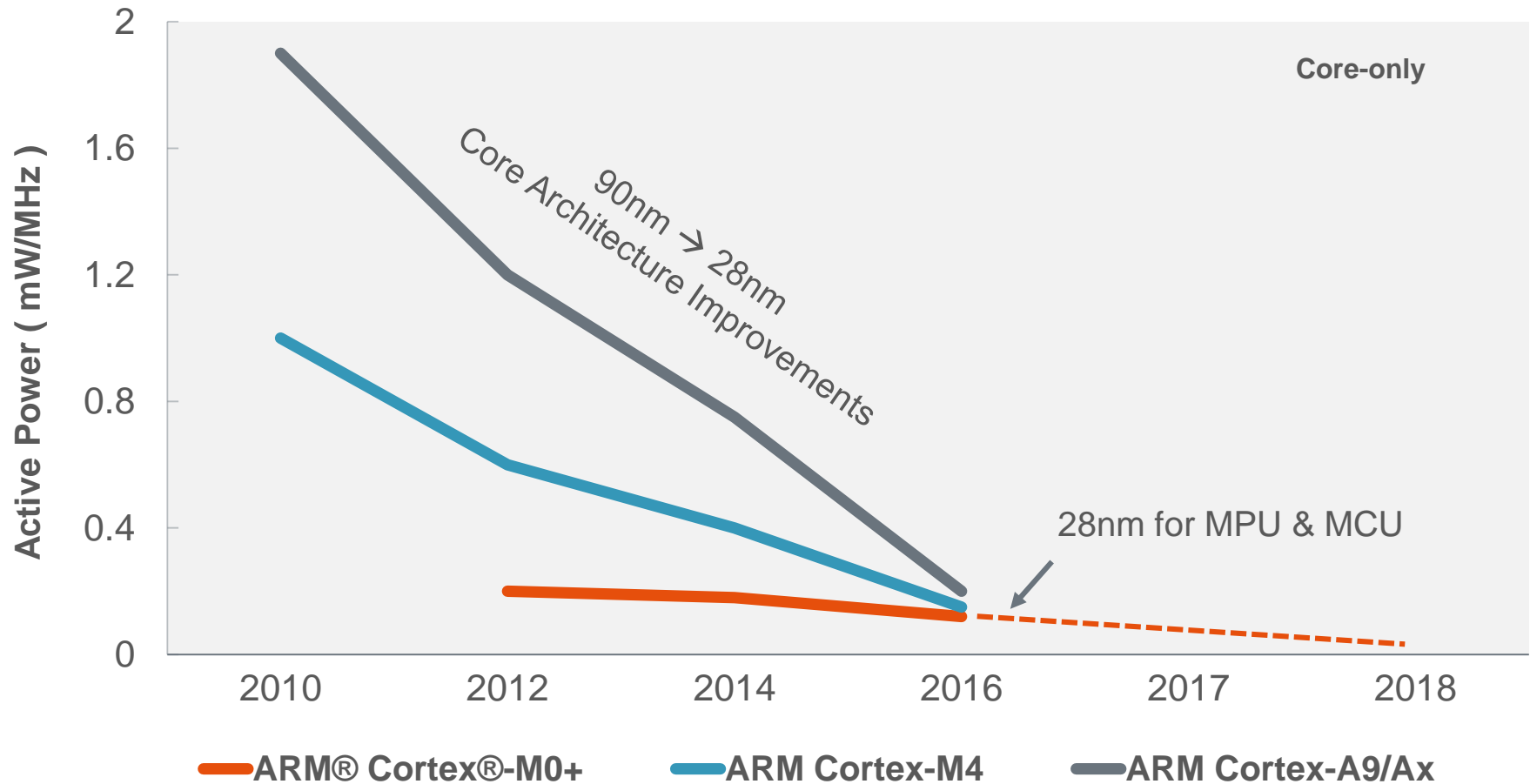


Complete Security Infrastructure

- Secure Boot
- Crypto H/W Acceleration
- Internal and External Tamper Detection
- Secure RAM
- DPA attack Resistance
- Secure JTAG



Processing Power Efficiency



i.MX Processor Roadmap

Two New i.MX Platforms Based on 28nm FD SOI Technology

i.MX 6QuadPlus



i.MX 6Quad



i.MX 6DualPlus



i.MX 6Dual



i.MX 6DualLite



i.MX 6Solo



i.MX 6SoloX



i.MX 6SoloLite



i.MX 6UltraLite

ARM® v7-A



i.MX 8 series

Advanced Graphics & Performance

ARM® v8-A

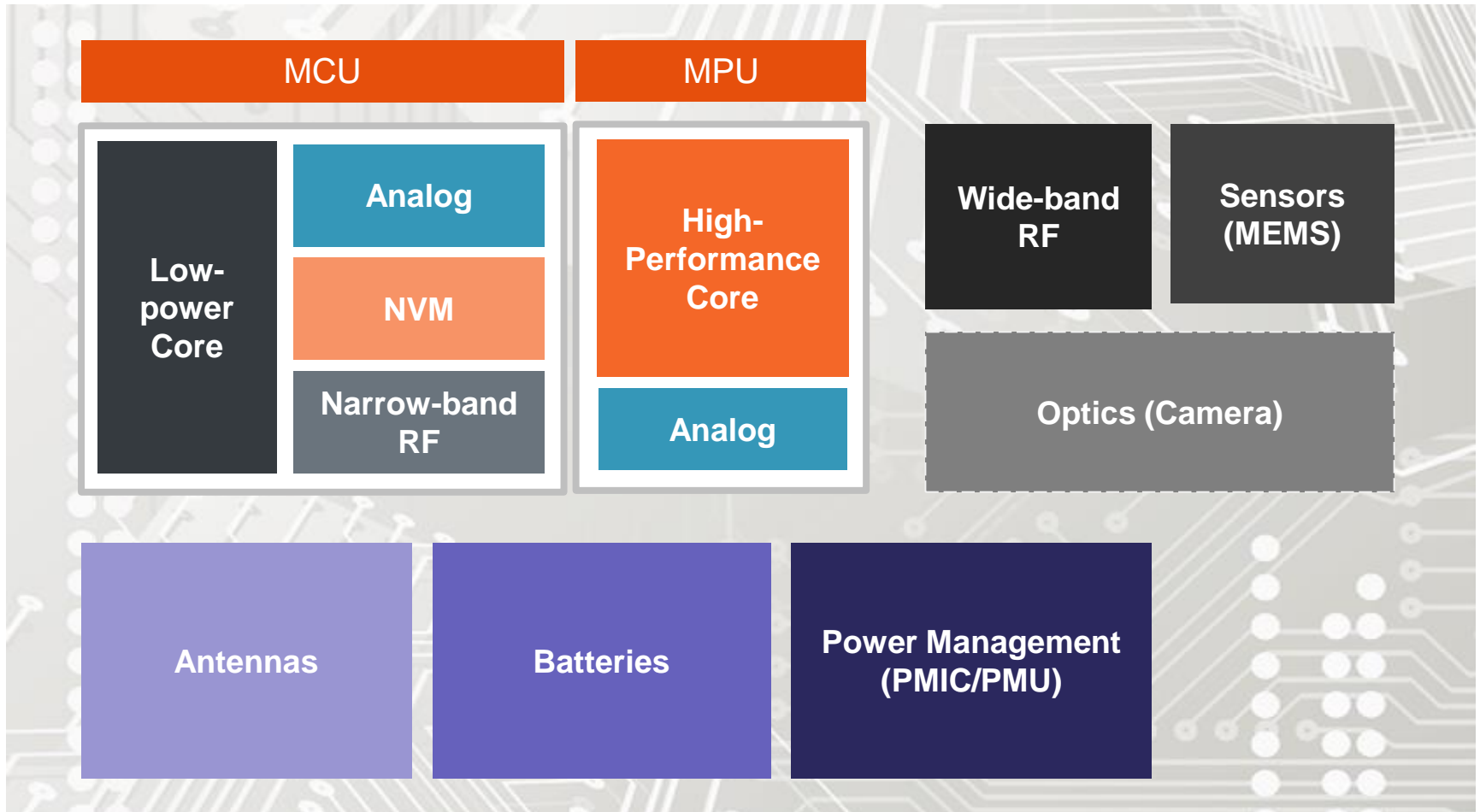
i.MX 7 series

Power Efficiency

ARM® v7-A

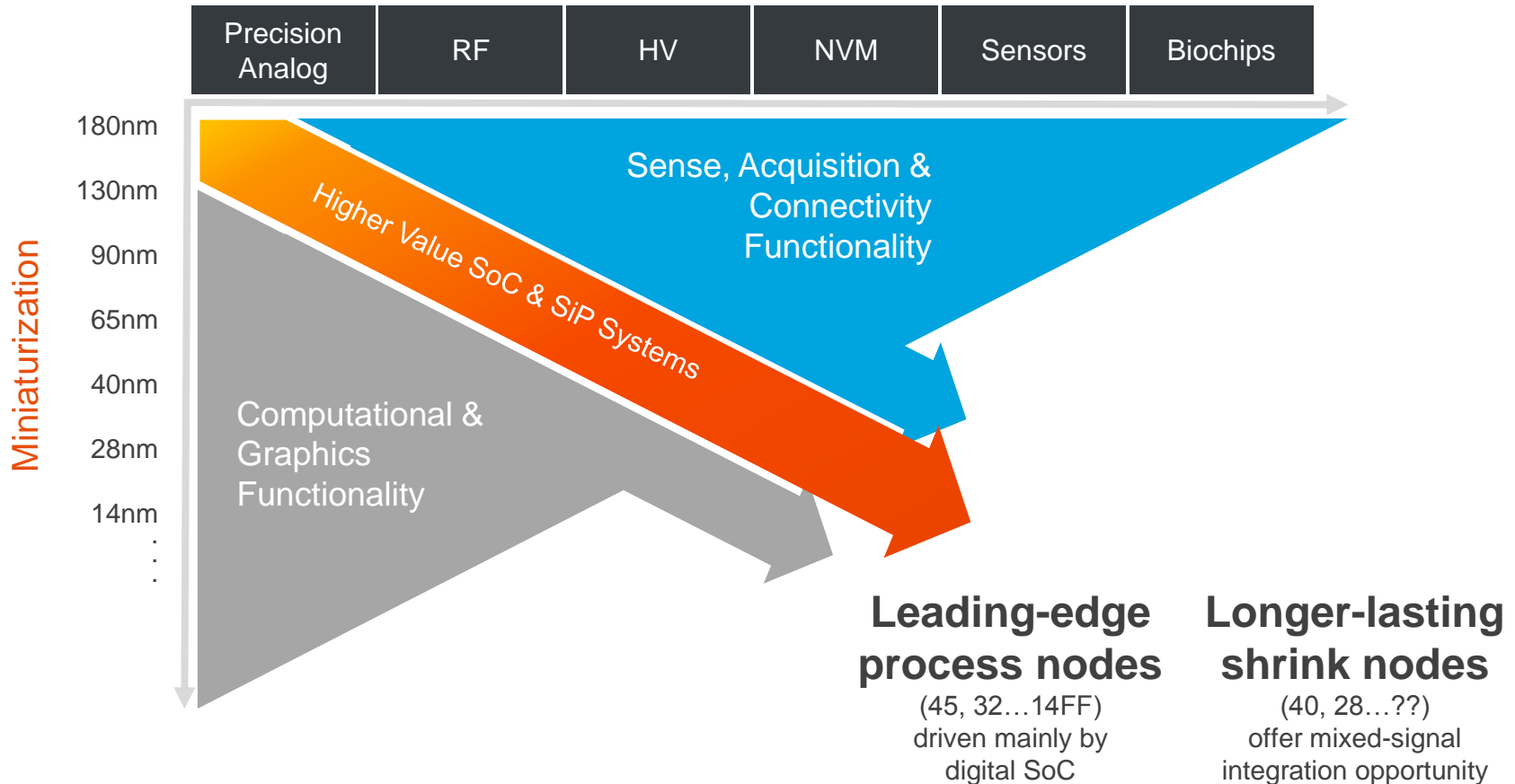


End Nodes **TODAY**

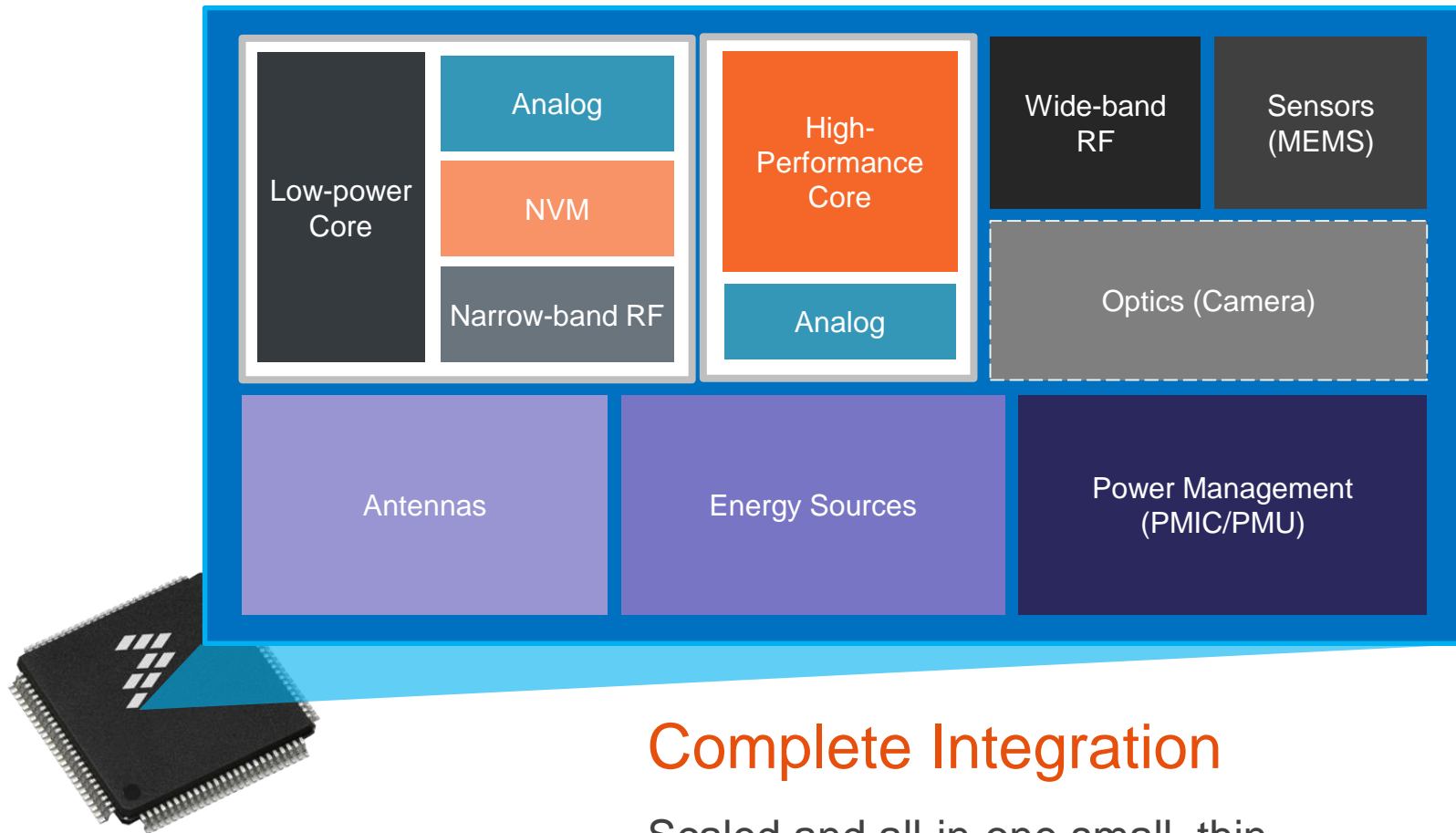


Increasing Integration of Diverse Components

Diversification



End Nodes of **TOMORROW**

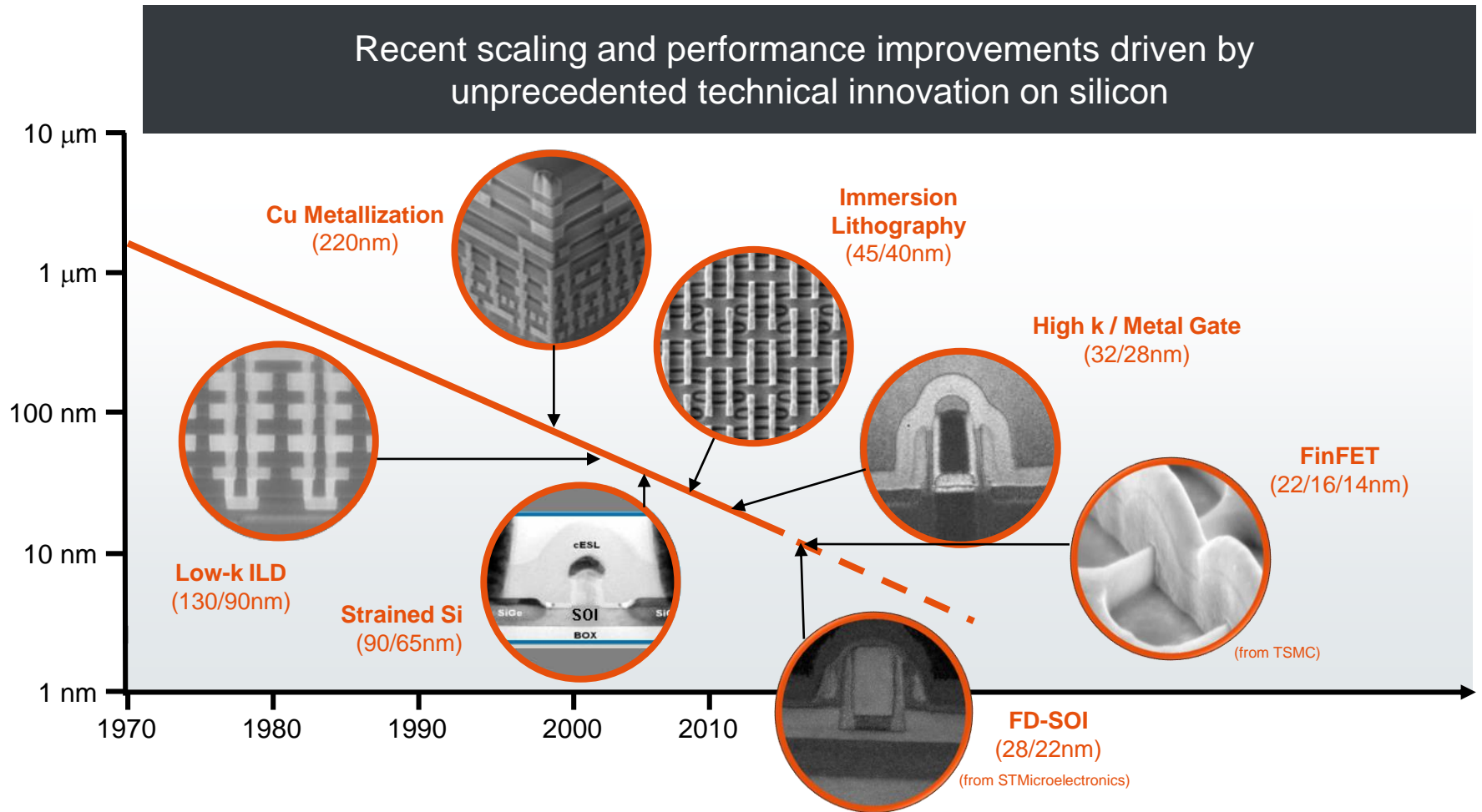


Complete Integration

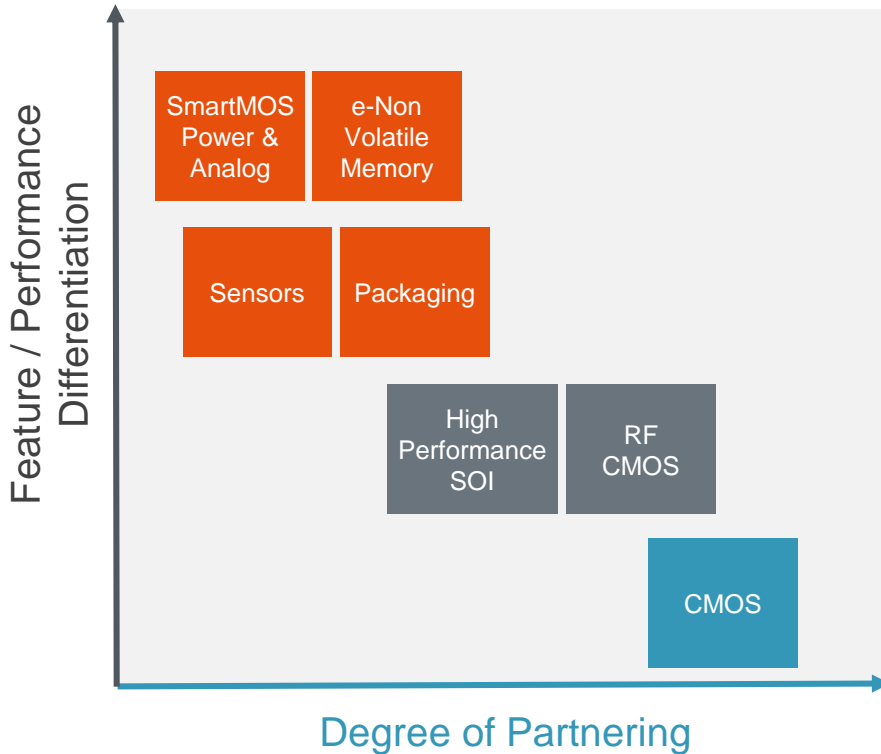
Scaled and all-in-one small, thin form factor package

Moore's Law

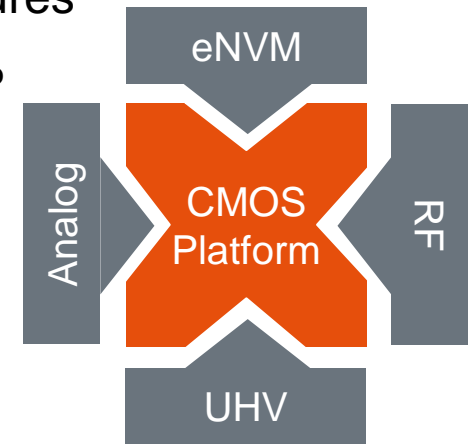
“No Exponential is Forever...but Forever can be Delayed”



Freescale Process Development Strategy



- **CMOS Platform-Based Technologies:**
 - Leverage foundry standard technology
 - Adapt for targeted applications
- **Differentiating Technologies:**
 - Focus on performance/features
 - High re-use >80% of the technology platform
 - Wholly-owned intellectual property



Smart Technology Choices

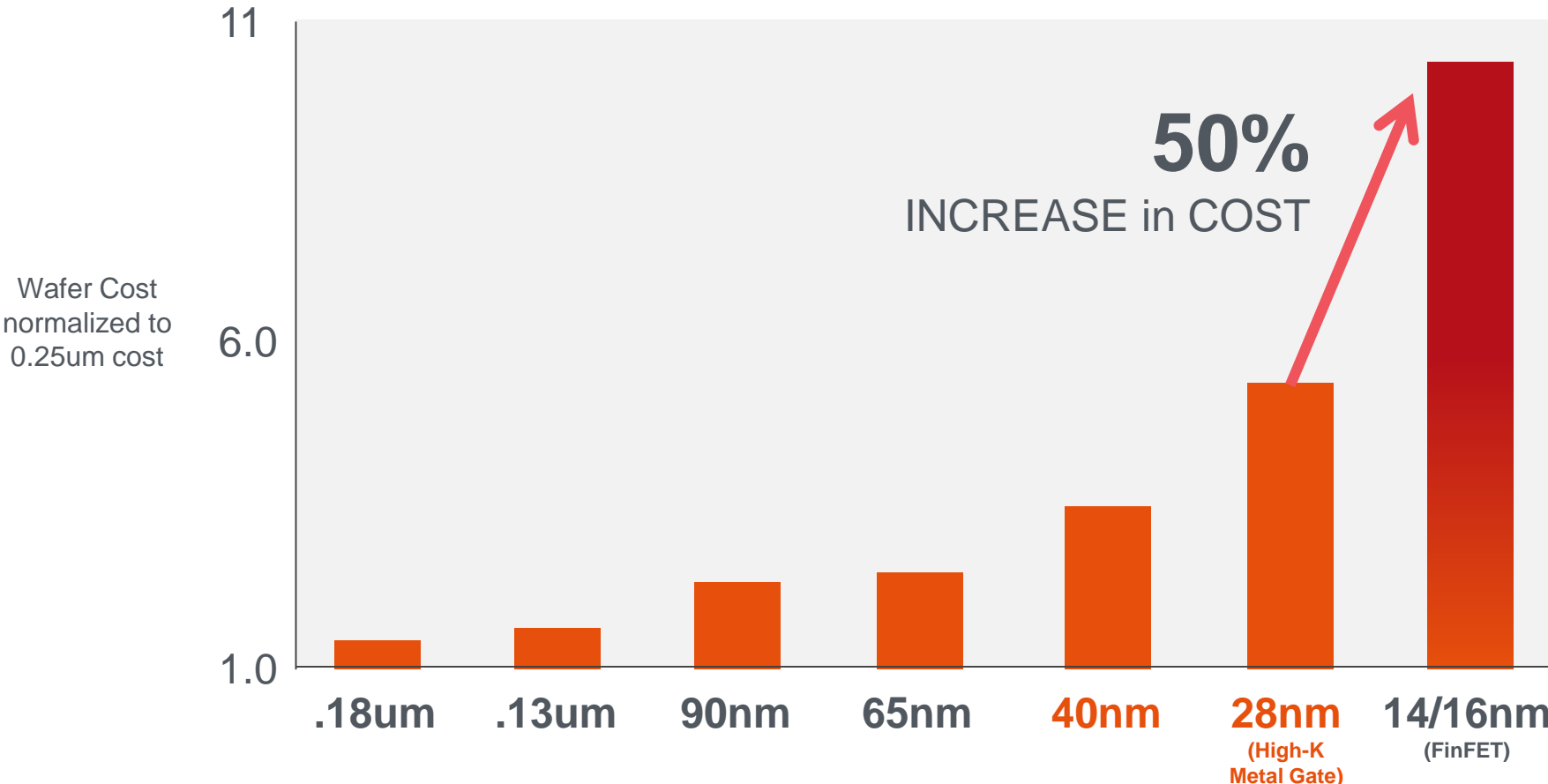


Which node?



Which process architecture?

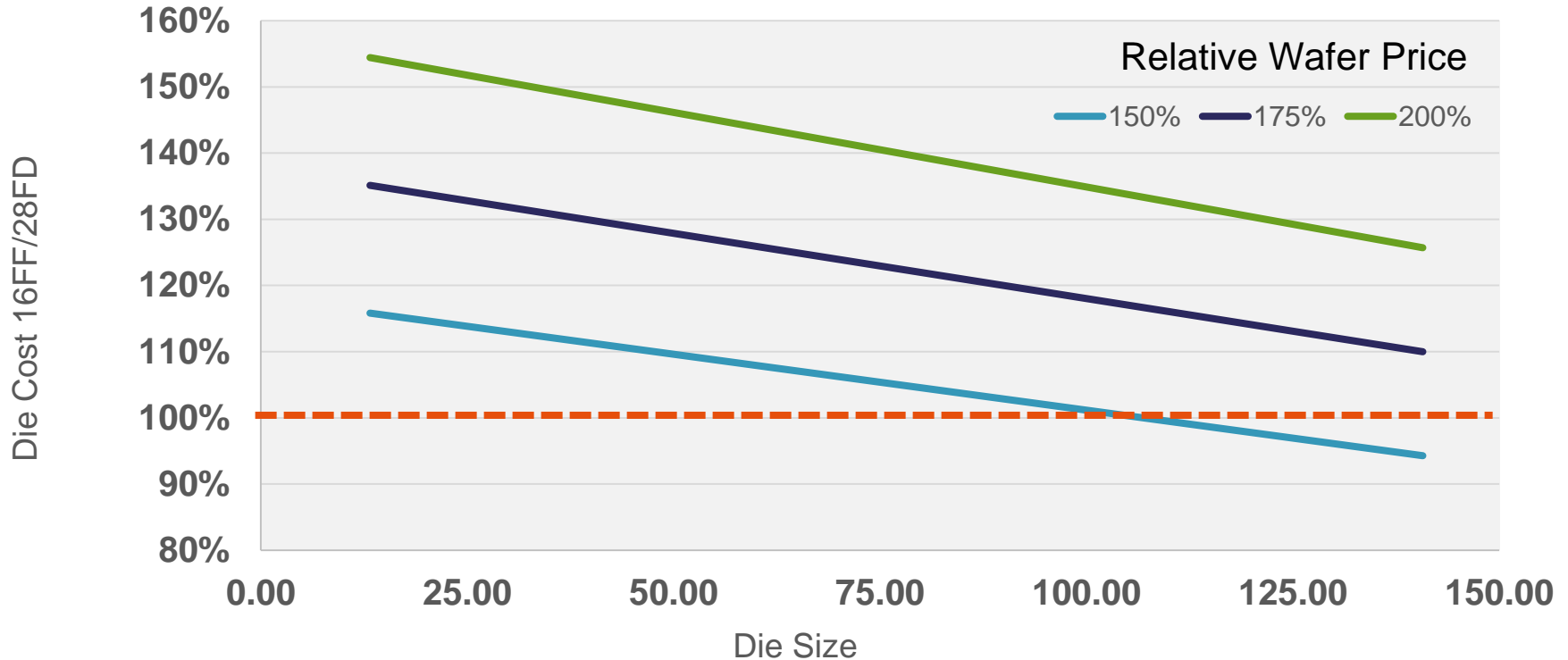
28nm – ‘Last Simple Node?’



40nm to 28nm will be significant % of worldwide capacity in 2020

Cost Vs. Performance

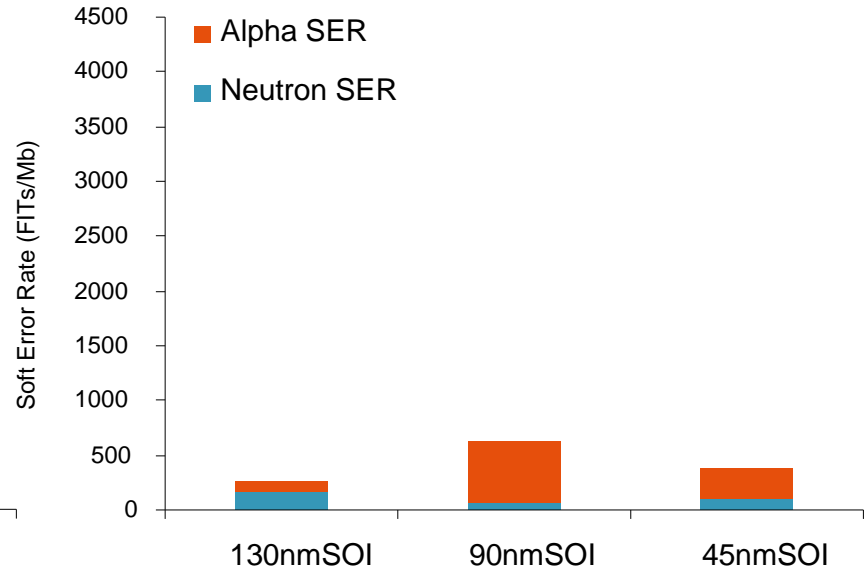
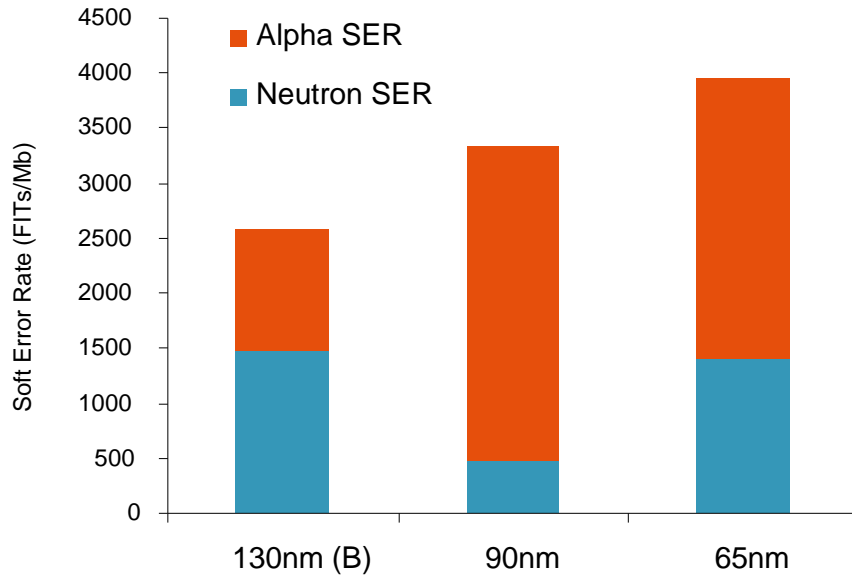
i.MX Die Cost Comparison: 16FF vs 28FD



i.MX Processors

- Large range of die size
- Larger amount of analog
- Pads and overhead not scaling
- Future RF integration

Freescale History Leveraging SOI

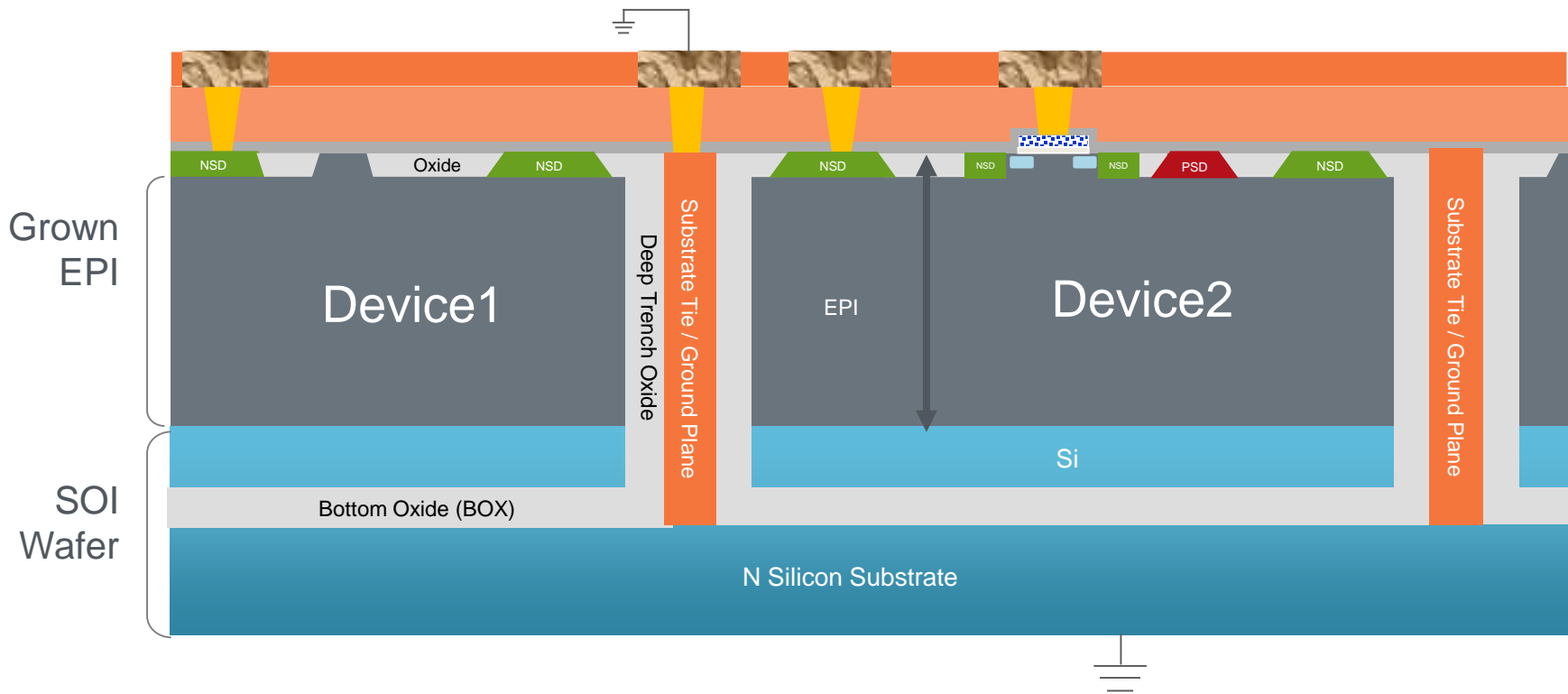


- Freescale has developed 20+ processors over 3 generations of SOI technology
- Soft Error Rate (SER) is becoming an increasingly significant factor as SoC memory arrays continue to increase in size & density
- Bulk technology performs successively worse with each technology node
- SOI provides 5 ~ 10x better SER reliability and the gap is widening as geometries shrink
- 28 FD SOI benefits extend to 10-100X better immunity

SER Comparison

Technology	Intrinsic (Technology) SER	Product-Level SER
28nm Bulk Si	Moderate	Design techniques / protection
28nm FD-SOI	Low	Protection techniques depend on amount of memory and logic content
14/16nm FinFET	Low	Protection techniques depend on amount of memory and logic content

Freescale Leveraging SOI for **Power Management ICs**



- Each component is surrounded on all sides by hard ground plane
- Each component or group of components is surrounded by oxide isolation
- No parasitic components to substrate.
- System-level voltage-expansion and physical area shrink by eliminating substrate injection and device cross-talk concerns in design.

FD SOI Advantages



1

Power-Performance Benefits

Low Vdd with Performance
Improved Electrostatics
Scalable Platform

2

Analog & RF Characteristics

Better Gain, Matching, Noise
Gate 1st Integration

3

Lower Risk Manufacturing

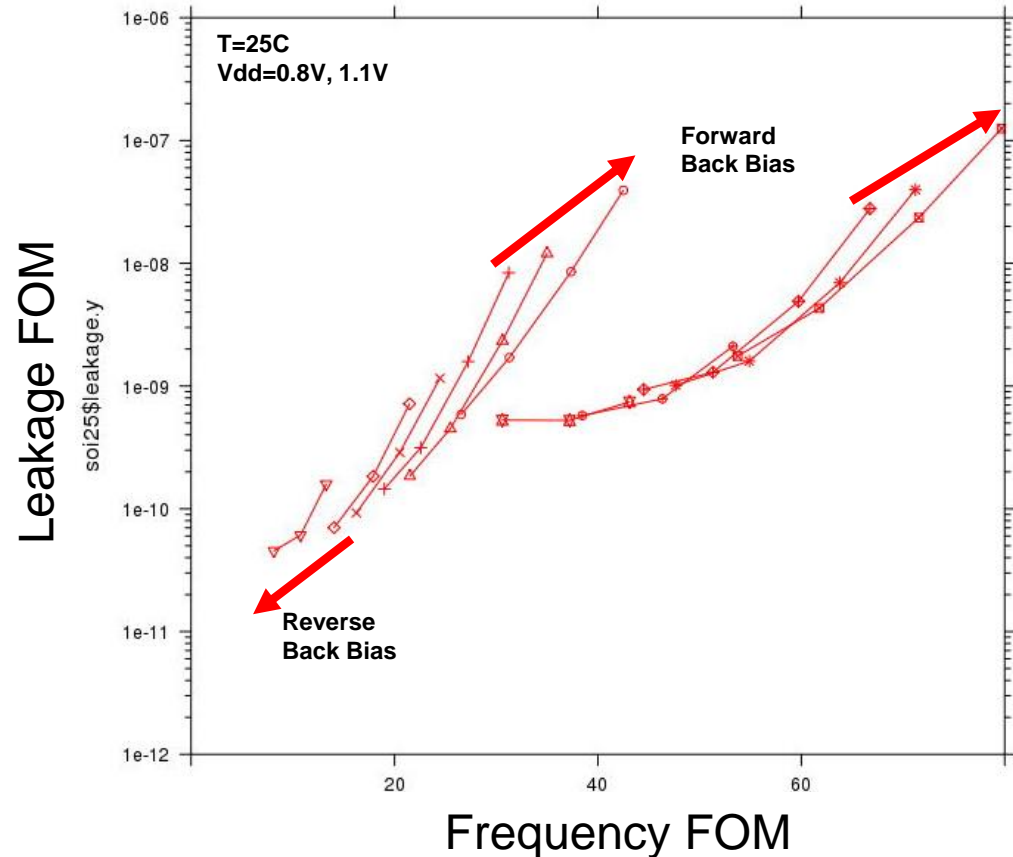
Simple Integration / Fast TAT
Extends 28nm install base
Low complexity planar device

28nm FD-SOI Platform

Back-bias enables large dynamic operating range

Good power-performance at low voltages, temperatures (IOT standby mode)

Logic Gate Leakage/Performance Metric



Each point represents simulated average over three X1 library cells from a unique V_t -L combination. Ignores interconnect impact, which is highly implementation dependent

Process Technology Implications

28nm & Beyond	High-K Metal Gate	FD-SOI	FinFET
Energy Efficiency	●	●	●
Cost Competitiveness	●	●	●
Ease of Design	●	●	●
Ease of Diversification	●	●	●

Multi-Cores

- Power Management
- Performance
- Security / ARM® TrustZone

Memory

- Secure Java / OS support
- Connectivity S/W stack

Non-volatile Memory

- Program Complexity
- Data Collection

RF Connectivity

- Wireless Everywhere

FD SOI Gaps Addressed by Freescale



1

Utilizing Full Range of Back-Gate Biasing

Extended Bias Range
BEOL TDDDB Rules
Enhanced Voltage Management

2

Expanding Richness of Design Collateral

DDK Enhancements
RAM Compiler Enhancements
IO Enhancements

3

Enabling Auto Quality and Analog IP

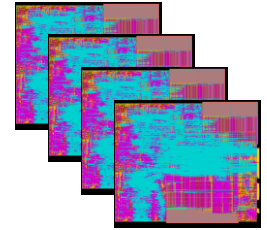
Unique Design Rules & Verification
Supporting Multiple IP Vendors
Auto Aging Use Case



Single A53 @ >1.2 GHz

Lower Power & Smaller Area

- Leveraging Bias Range
- Scalable Performance

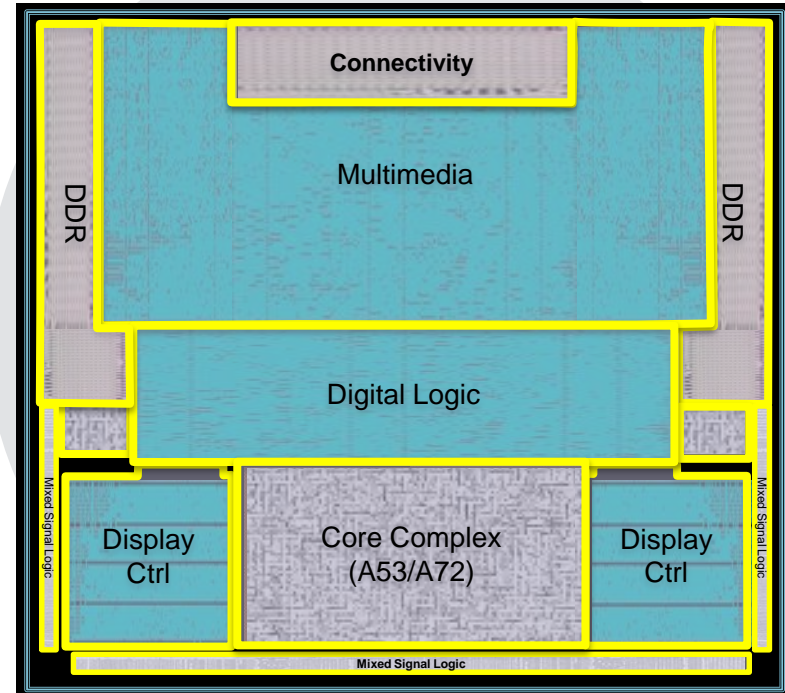


Subsystem Attributes	28 FD SOI	Alternative 28nm
Instances	550K	1250K
Leakage (Typical / WC)	70 / 175mA	125 / 315mA
Normalized dynamic power	0.75	1.0
Area	1.3 sqmm	1.7 sqmm

i.MX 8 Coming Soon...

Leveraging superset design...

- ARM® V8-A 64 bit architecture
- 10+ core complex
 - Cortex-A72, Cortex-A53...
- Enhanced graphics
- Leadership 4k video
- Integrated vision
- Low power 4k multi-display
- Mixed signal
- Rich connectivity
- Compelling auto features



28nm Technology

Positioning FD SOI for leadership in broad market applications processors

Summary

- The evolving smart world requires a broad range of applications processors
- I/O counts, integrated PHYs and interface speeds are increasing
- Integration of functions in a cost effective technology is required for success
- 28 FD SOI offers advantages that allows scaling from small power efficient processors to high performance safety critical processors
- Freescale's broad i.MX product portfolio and technology adoption strategy enables cost-effective ground-breaking solutions
- Future roadmap for i.MX will leverage 14nm class devices in order to scale power-performance when market demand justifies higher cost and expense of development





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