



# Requirements for Fail-Safe Automotive Solutions with NOR Flash Memory

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# Automotive Megatrends

## Electrification

*Electrified  
Transportation*



## Connectivity

*Totally Connected,  
Digitized*



## Autonomy

*Levels 1 - 5*



## *Implications*

**All sub-systems grow in connectivity and intelligence**

**User interface transitions from mechanical to electronic**

**Sensors proliferate → ever-increasing need for bandwidth**

**Safety and security requirements increase**

**In-car experience = home/office experience on wheels**

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## *Implications*

Need more compute **performance** to support digitization of the vehicle

Increasing functionality implies growing software **complexity**

**Low power** to support electrification of the vehicle

Rising **functional safety** requirement to meet ISO 26262 standard

Cannot compromise on **security**

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“Connected Car” transforms transportation and drives semiconductor growth in vehicles



\$300 ~ \$1,000  
Semiconductor Content  
2017

Auto Semi CAGR = 6%  
2017 – 2022








\$400 ~ \$2,000+  
Semiconductor Content  
2022

# Cyber Attacks and Electronic System Safety are Growing Concerns

## U.S. TRAFFIC DEATHS REPORTEDLY TOPPED 40,000 AGAIN IN 2018

Per National Safety Council estimates

NEWS | SHARE: |  |  |  |  | 

by Words: Collin Woodard • February 13, 2019

*Reuters* reports that based on estimates provided by the National Safety Council, traffic deaths in the U.S. topped 40,000 last year. That would make 2018 the third year in a row with traffic deaths above that mark, according to the nonprofit organization. And while the good news is that the NSC estimates there were 231 fewer deaths than in 2017, a decrease of about 1 percent, those figures are 14 percent higher than they were back in 2014. An additional 4.5 million people were seriously injured in wrecks in 2018, which represents a 1-percent decline, as well.

Source: <https://www.motortrend.com/news/u-s-traffic-deaths-2018-how-many/>

## Hackers crack Tesla Model 3 in competition, Tesla gives them the car

Fred Lambert - Mar. 23rd 2019 4:32 pm ET  @FredericLambert

Source: <https://electrek.co/2019/03/23/tesla-model-3-hacker-competition-crack/>

## Lawmakers Propose Bills to Secure Connected Planes, Trains and Automobiles

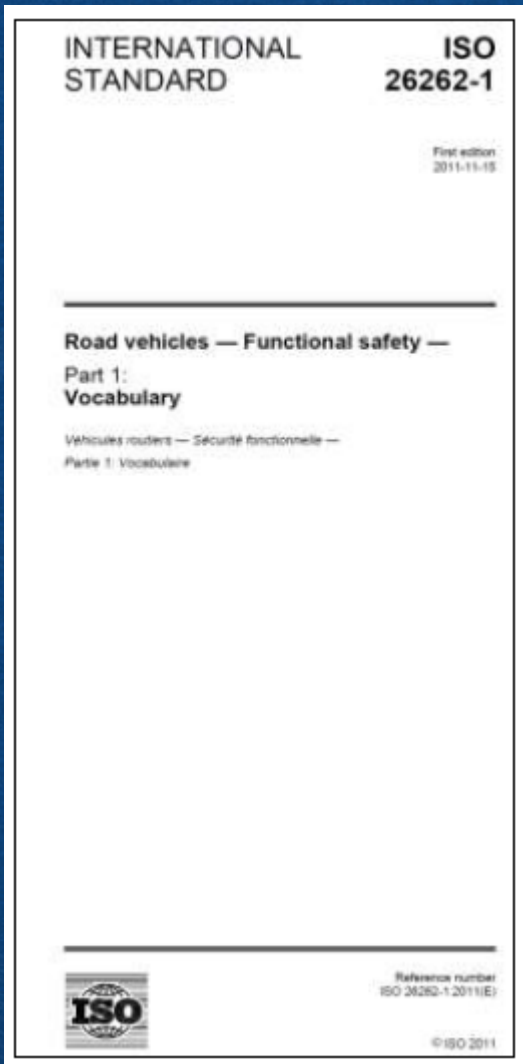
JULY 22, 2019

The legislation would set “reasonable” security measures for the numerous IT systems that power our increasingly connected vehicles.

Source: <https://www.nextgov.com/cybersecurity/2019/07/lawmakers-propose-bills-secure-connected-planes-trains-and-automobiles/158599/>

Our Responsibility: Assure highest degrees of **functional safety** and **security**

# What is Functional Safety?

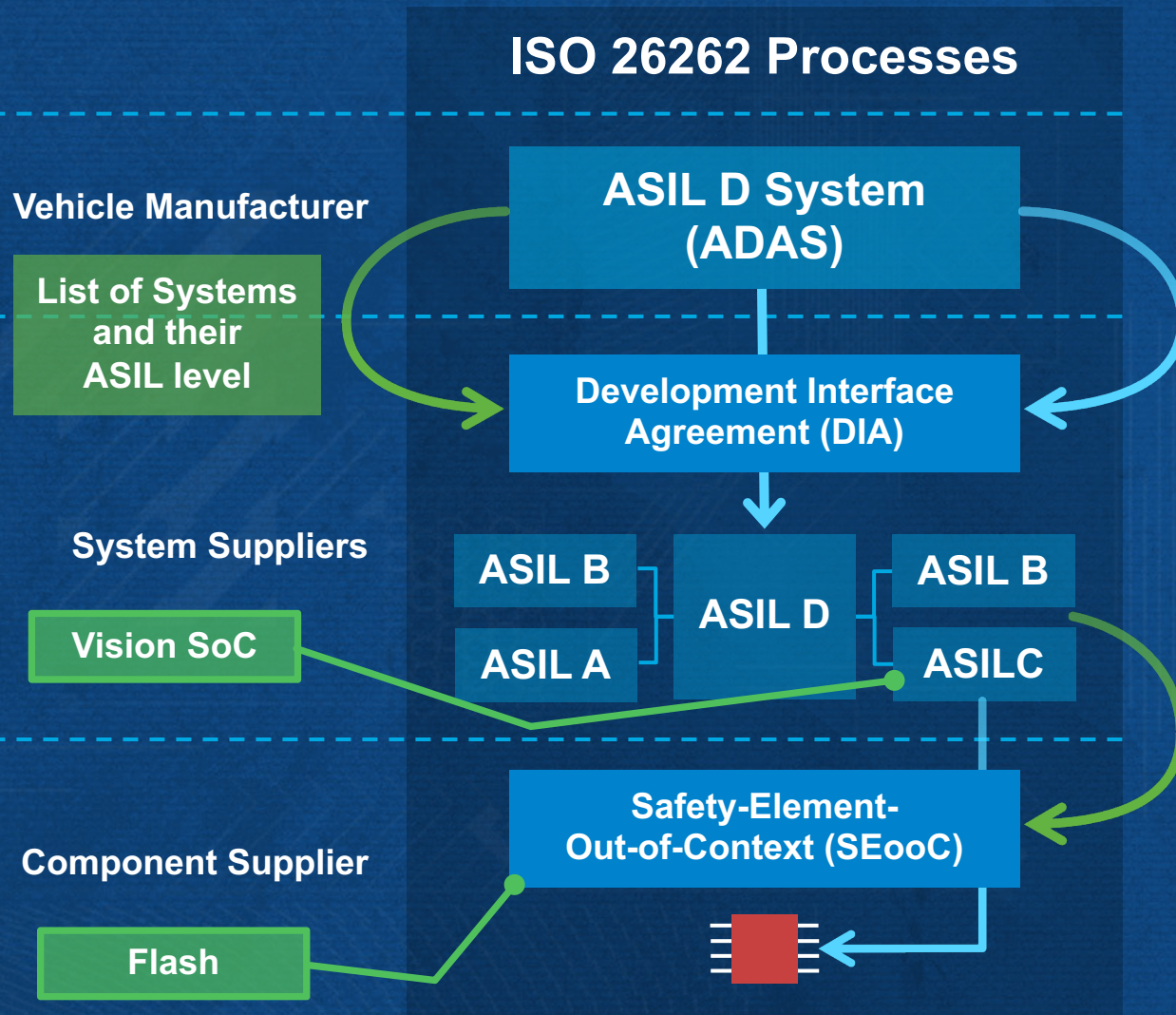


“Absence of **unreasonable risk** due to **hazards** caused by **malfunctioning behavior** of electronic systems.”

- Risk = function of probability and extent of damage/harm
- Functional safety = detecting and managing failures
- Architected and designed-in safety features to the product
- Measures to identify random failures during operation

ASIL Level	Failure Rate	SPFM	LFM	Application (example)
A	<1000 FIT	Not relevant	Not relevant	Rear Lights
B	<100 FIT	≥ 90%	≥ 60%	Cluster
C	<100 FIT	≥ 97%	≥ 80%	Adaptive Cruise Control
D	<10 FIT	≥ 99%	≥ 90%	Powertrain

# How Safety is Implemented in Automotive Today



## Implication to Flash Memory Supplier?

- Upgrade to ISO 26262 compliant development process
- Invest in Functional Safety Organization
- Add safety mechanisms to the architecture to achieve required safety level
- Lots of functional safety documentation
- Safety analysis and compliance process

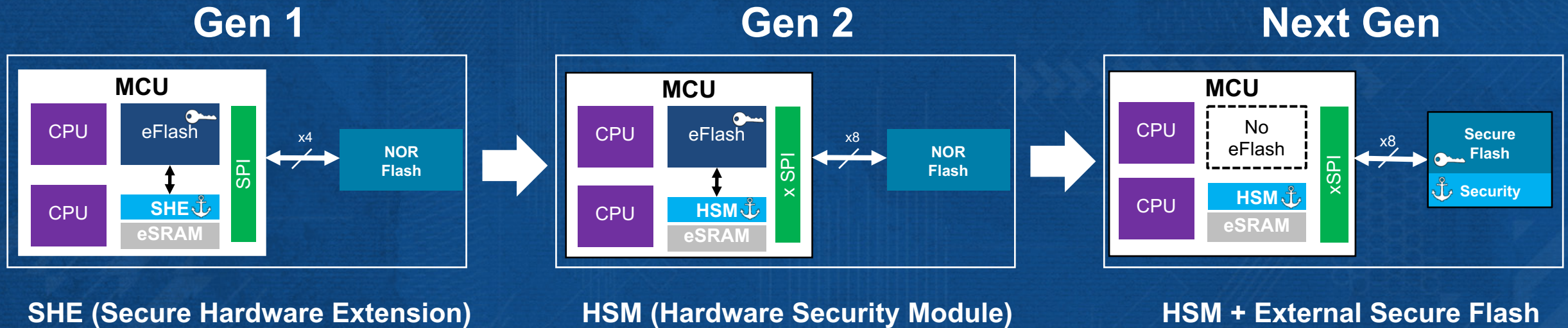
# Addressing Failures in Flash Memory Device

Early Detection of Potential Errors to Achieve Functional Safety Requirements

Failure Mode	Failure Description	Safety Mechanism
Flash Cell Failures	Charge loss and layer defects can lead to read/write errors	ECC (SECDED) Data Integrity Check
Reliability Latent Failures	Number of program/erase cycles vs. data retention can lead to margin loss and read/write errors	Program Failure Detection Erase Failure Detection
Noise Failures	Device interface and internal power supply spikes can cause incorrect operations	ECC (SECDED) Interface CRC
System and Component Power Fault	Faulty boot and power loss during erase/program can lead to wrong configuration, wrong data write	SafeBoot Safe RESET






# Evolution of Security in Embedded Systems



⚓ Root-of-Trust  
🔑 Shared secret and keys

- Next generation automotive MCU's migrate to 28nm and below technology nodes
  - Challenging to offer viable automotive-qualified eNVM technology
  - Growing code size and complexity requires more eFlash and eSRAM with limited scalability
  - Secure MCU need external secure Flash to protect code, data and system secrets

# Automotive Evita Standard is a Good Benchmark

Cryptographic Architecture/Implementation	 light	 medium	 full	Secure Flash Light	Secure Flash Full
Typical Use Case	Sensor/Actuator ECU	Gateway ECU	V2X Comm. ECU	ASIL-A/B Safety Systems	ASIL-C/D Safety Systems
<b>Cryptographic Algorithms</b>					
Asymmetric encryption/decryption		✓	✓		✓
Symmetric encryption/decryption	✓	✓	✓	AES	AES
Hashing		✓	✓	SHA	SHA
<b>Hardware Acceleration</b>					
Asymmetric encryption/decryption			✓		ECC, RSA
Symmetric encryption/decryption	✓	✓	✓	AES	AES, DES
Hashing			✓	SHA	SHA
<b>Security Features</b>					
Secure / authenticated boot	✓/✓	✓/✓	✓/✓	✓	✓
Key control per use / bootstrap	✓/✓	✓/✓	✓/✓		✓
PRNG with TRNG seed	✓	✓	✓	✓	✓
Monotonic counters 32 / 64 bit	✓/✓	✓/✓	✓/✓		✓
Tick/UTC-synced internal clock	✓/✓	✓/✓	✓/✓		✓
<b>Internal processing</b>					
User extendable feature set		✓	✓		✓
Internal V/NV (Key) memory	✓	✓	✓	✓	✓

# Secure NOR Flash Use Cases



Cryptographically secure storage of code, data, and system secrets (keys, certificates)



Firmware over the air (FOTA) updates between host, secure storage, and cloud

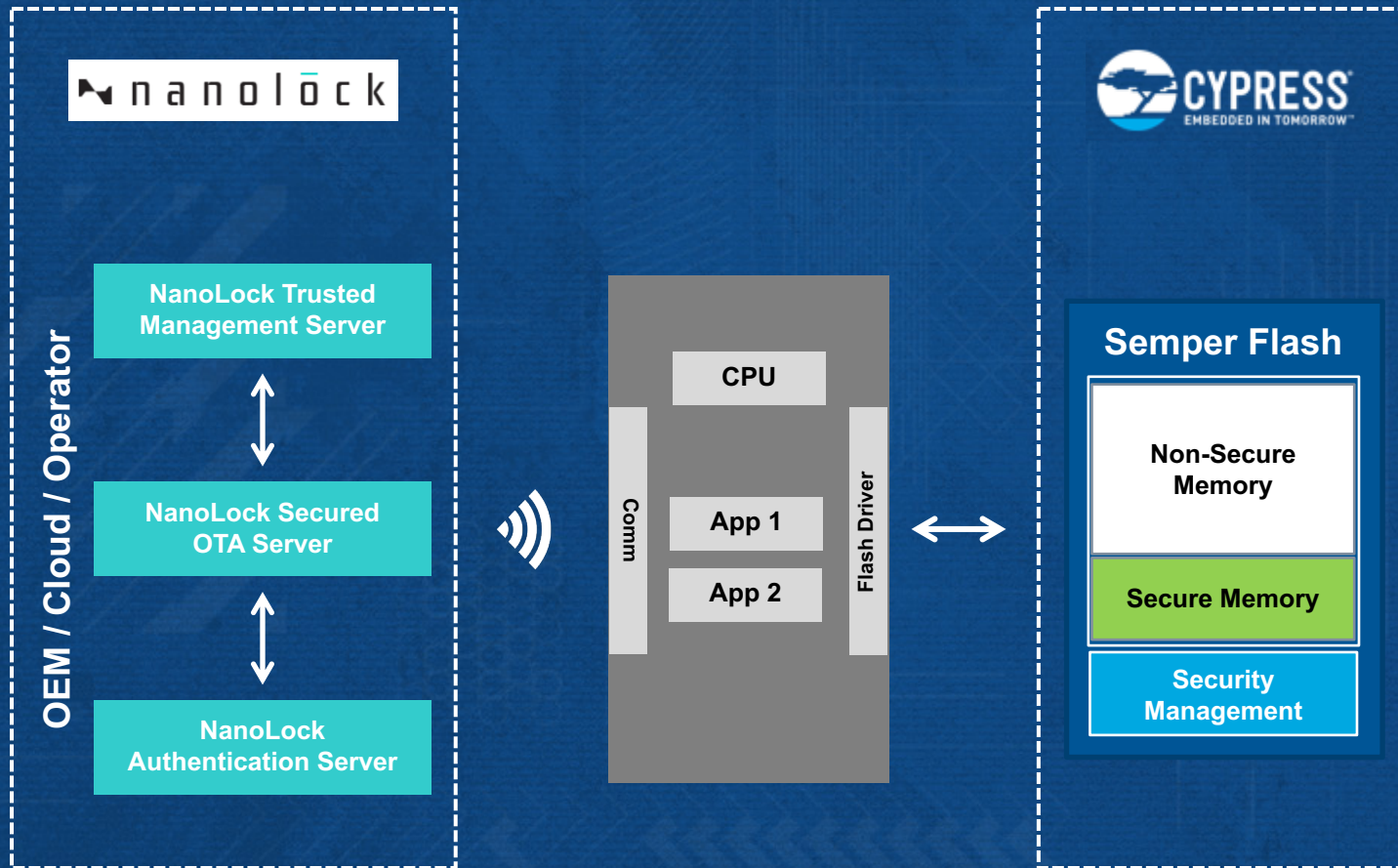


Fast secure boot for firmware authentication, version attestation, and rollback protection



Secure provisioning in unsecure manufacturing facilities and unsecure service centers

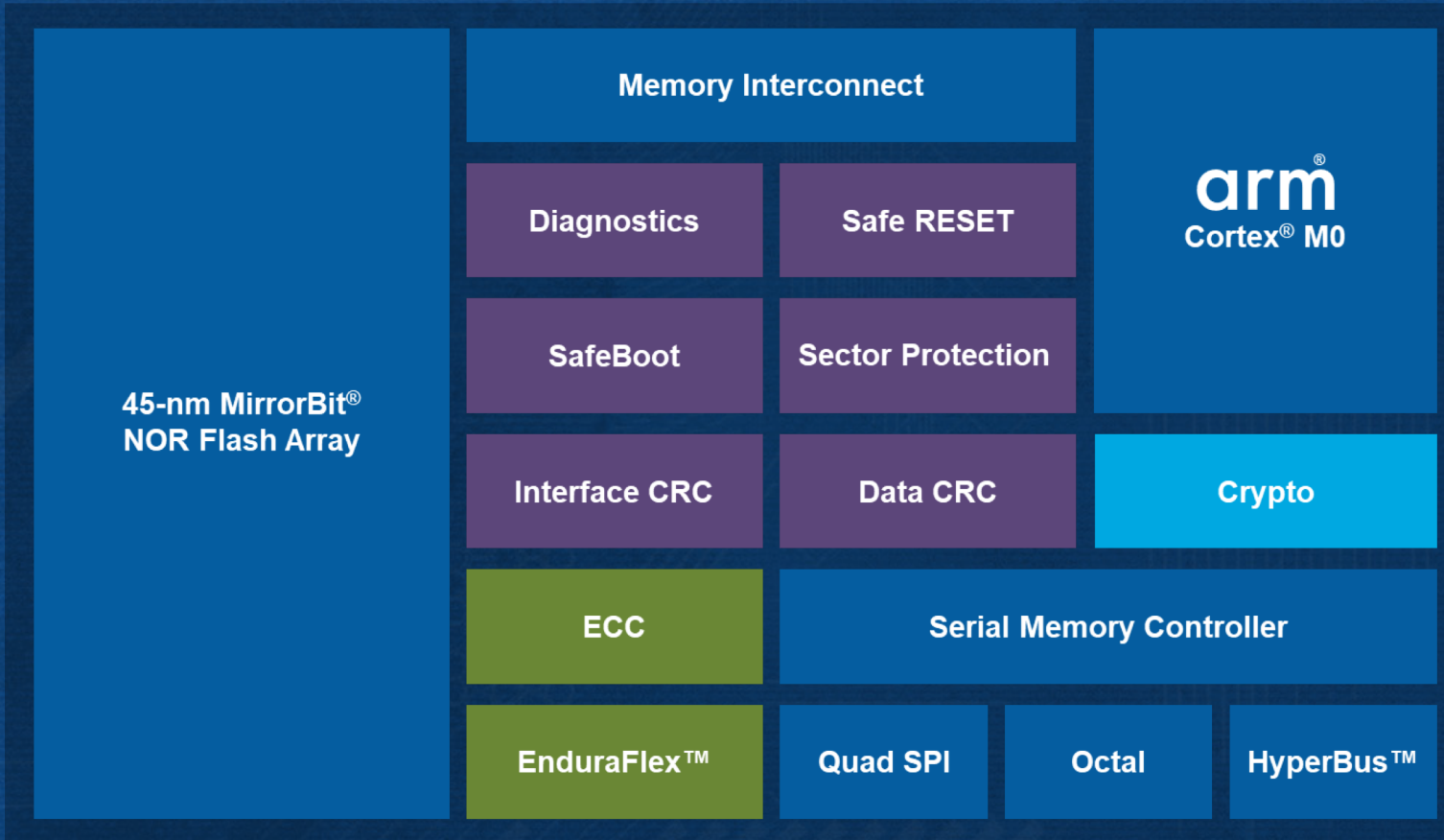
# Protecting, Managing, and Updating Connected Edge Devices



- **Real-time attack prevention** of firmware manipulation & reliable status and alerts
- **Prevent** outsiders, insiders and supply-chain attacks
- **Reliable OTA updates** and status through a root-of-trust
- **Big data analysis** - Unique and trusted device analytics to identify critical patterns and anomalies.

Security risks for connected systems is growing and customers need an end-to-end solution

# Semper NOR Flash Family Architecture



- **Functional Safety**

- Architected and designed to automotive safety standards
- ASIL-B compliant and ASIL-D ready

- **Security**

- Root of Trust and secure storage

- **Best Reliability and Endurance**

- EnduraFlex™ architecture enables >1M endurance cycles and 25 years data retention
- Grade-1 (125°C) automotive qualified

- **Highest Density**

- MirrorBit® technology delivers up to 4Gb with 400 MB/s bandwidth

## LEGEND

Functional Safety

Security

Reliability

Performance



**CYPRESS**<sup>®</sup>  
EMBEDDED IN TOMORROW<sup>™</sup>