



**FTF 2016**  
TECHNOLOGY FORUM

# SECURE CAN NETWORKS

**FTF-AUT-N1783**

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PUBLIC USE



# AGENDA

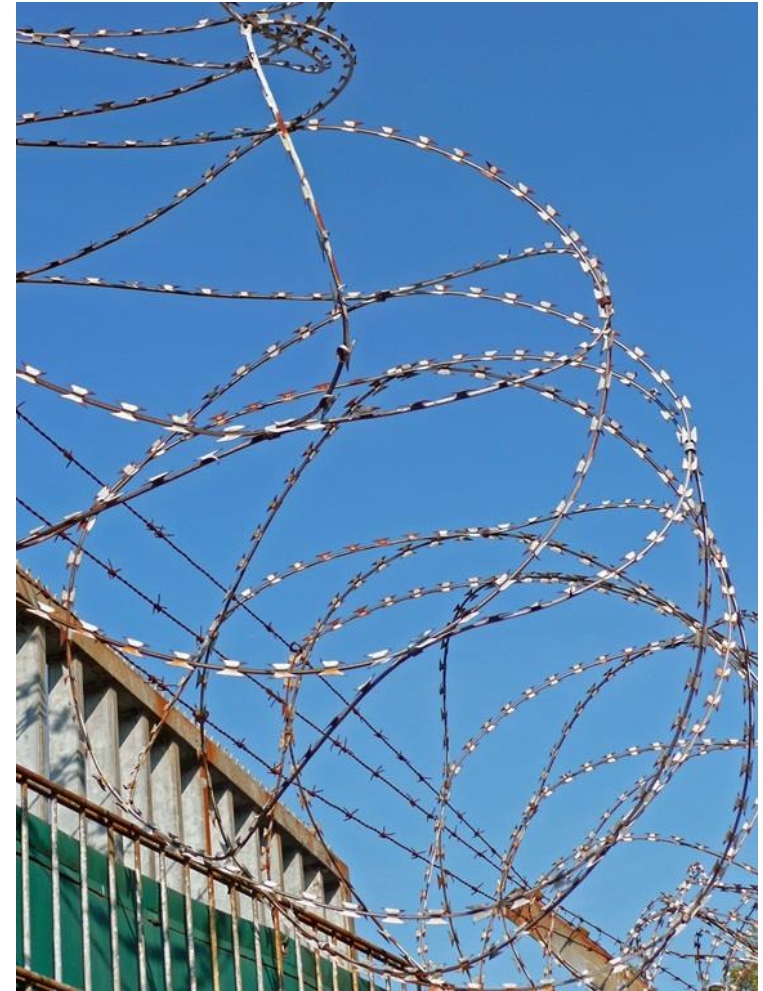
- Introduction: Why Do We Need Security in the Vehicle?
- Functional Security Design Goals Definition
- Automotive Communication Security Concerns
  - Power Up Time
  - Secure Boot
  - Secure Key Storage and Revocation
  - Cryptography
- Conclusions



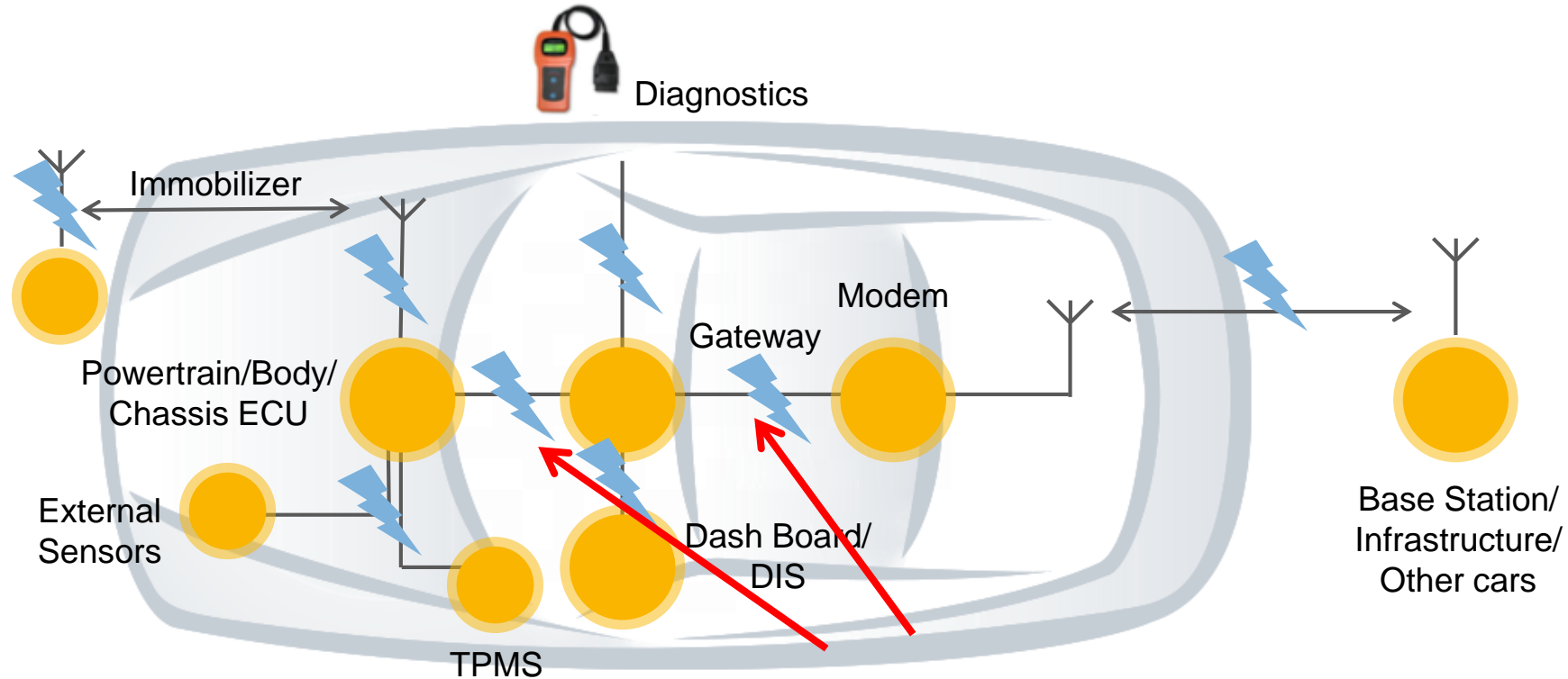


# Introduction: Security – Necessity or Feature?

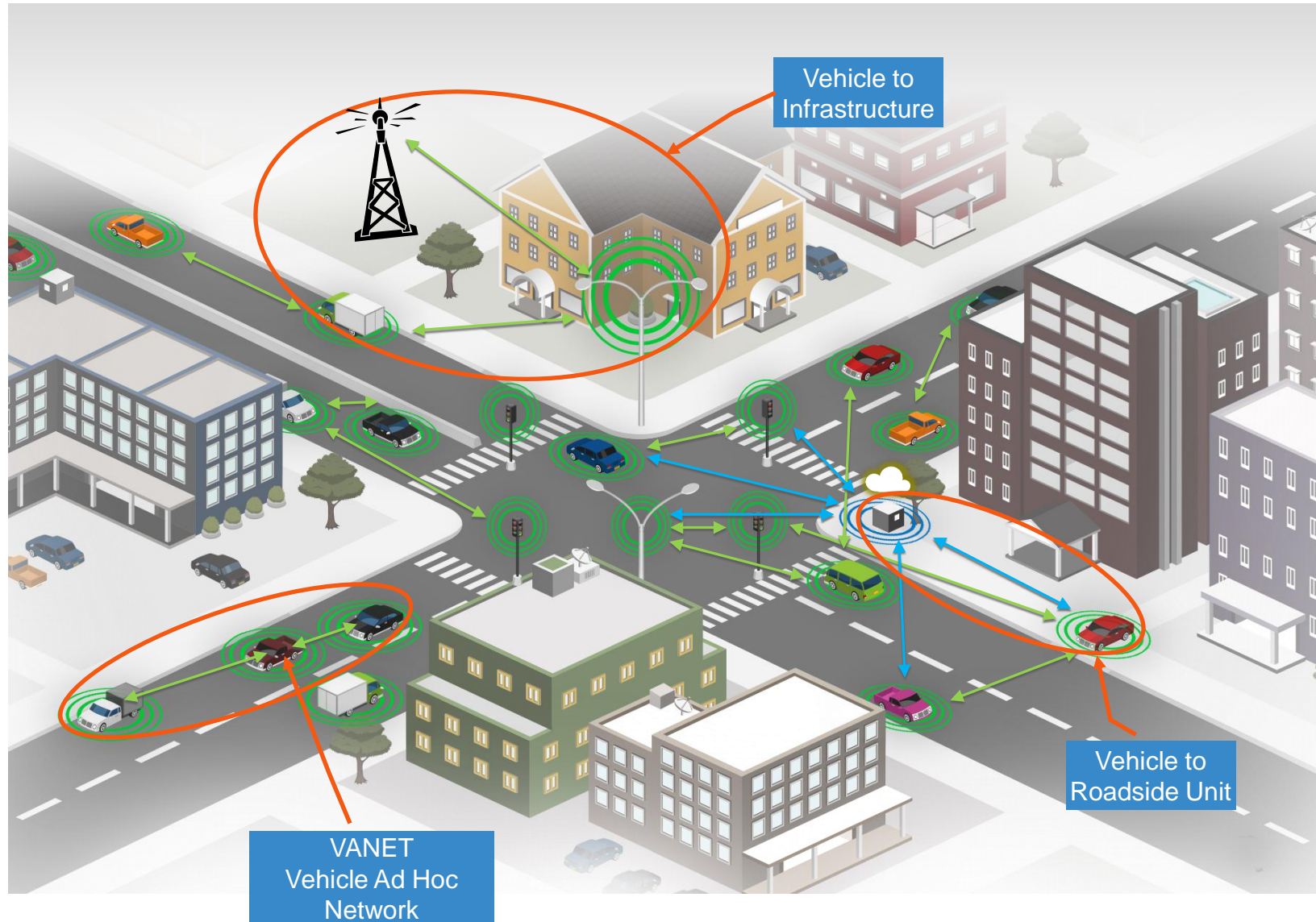
- What needs to be protected?
- What types of attack can be expected?
- What are the attack motivations and methods?
- How much security do we really want?
- How much are we willing to pay for it?
- What is the impact on system complexity?
- How can the security system be maintained and upgraded over time?



# Introduction: Automotive Security Attack Surfaces



# V2V & V2I Communications



# Functional Security Design Goals Definition

## Trustworthy System definition:

- A Trustworthy system is a system which does what its stakeholders expect it to do, resisting attackers with both remote and physical access, else it fails safe.

## Security Enabled SoCs will provide OEM controlled silicon features which simplify the development of trustworthy systems.

- Security features are an opt in scheme
- OEM controlled trade-offs in cryptographic strength
- Debug visibility
- Sensitivity of tamper detection
- Anti-cloning mitigation

# Functional Security Design Goals Definition

## Secure Architecture Objectives

- **Objectives**

- 100% Optional
- Prevent unvalidated code from executing
- Protect persistent and ephemeral device secrets against extraction or exposure
- Protect persistent and ephemeral device secrets against mis-use
- Support strong partitioning

- **Non objectives**

- Preventing advanced physical attacks
- Providing absolute partitioning
- Operating as a single edged sword

# Automotive Communication Security Concerns

## Secure communications require secure ECUs

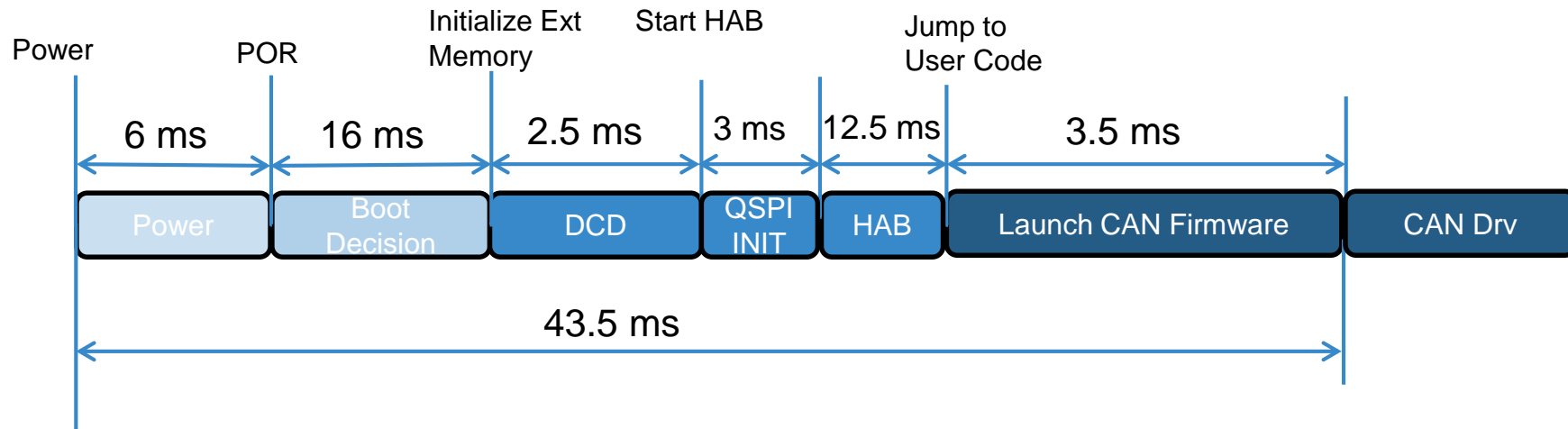
- Power up time
  - ECU is ready, communication is ready
- Secure boot
  - Prevents unauthorized SW execution at reset
- Run time integrity check
  - Prevents unauthorized SW execution during runtime
- Secure key storage and revocation
  - Protects data confidentiality and integrity over time
- Latency
  - SW vs HW Cryptography
- Behavioral model
  - Focuses on identifying abnormal behavior vs preventing attacks.

→ **There is no safety without security**



# Power Up and Secure Boot: Case Study

- i.MX 6SLX – DDR QSPI XIP
- Using 80 Mbytes/s DDR QSPI data rate

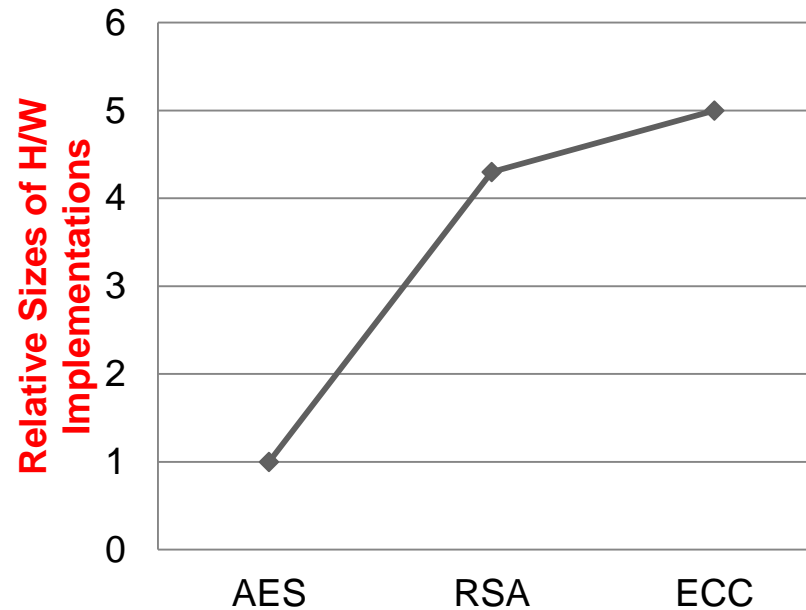
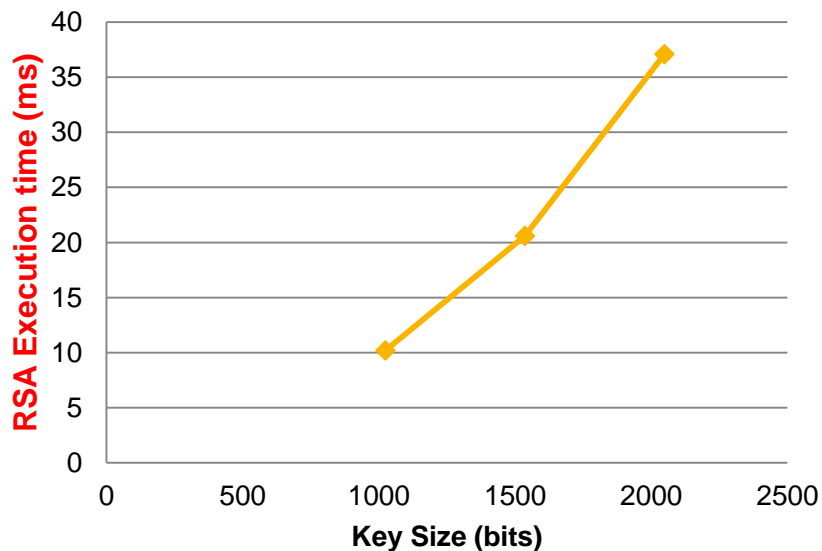


# Secure Key Storage

- Required for Passwords, Cryptography Keys
- On-chip or in-package storage offers significant advantages
  - OTP flash memory is ideal from a security perspective
    - easy to provision
    - difficult to extract values
    - memory bus architecture requires careful design (firewalling)
    - can provide a degree of flexibility (revocation)
  - e-fuses are also used
    - might be more susceptible to attack (i.e. easier to read)
    - limited flexibility – not re-programmable
    - large structures, so limited number can be implemented cost effectively
  - Should not require encryption
- Off-chip storage can be subject to snooping attacks
  - requires keys to be encrypted/decrypted

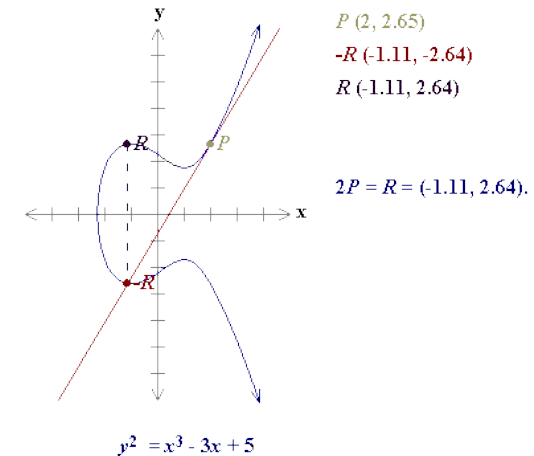
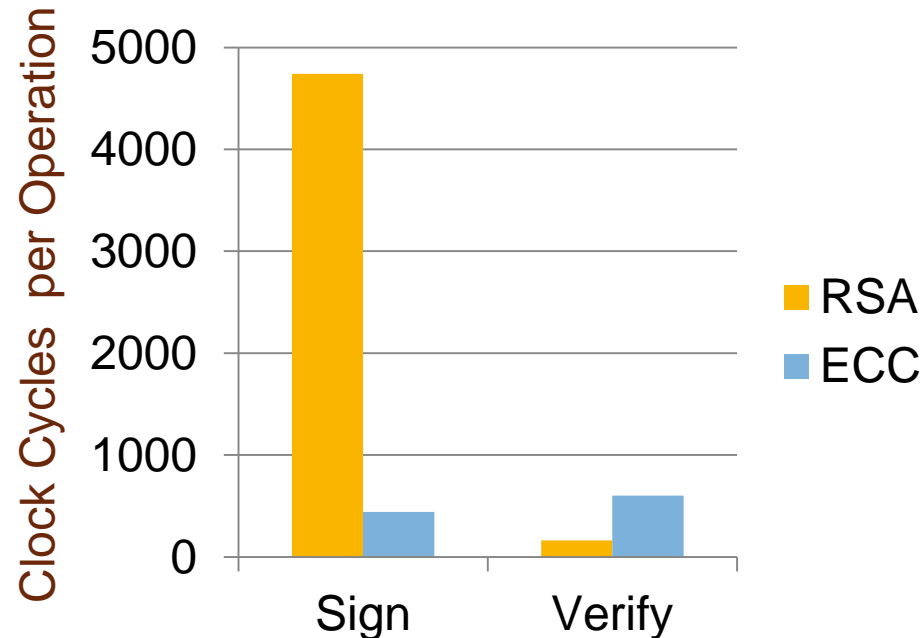
# Cryptography: Crypto Algorithm Metrics

- AES-128, RSA2048, ECC224/256 are commonly used cryptographic algorithms
- Each of these can be accelerated by one to two orders of magnitude (depending on the complexity of the accelerator)
- Cost, performance, and key handling complexity tradeoffs need to be considered











# Cryptography: Relative Performance of Hardware RSA and ECC

- Compares equivalent security strength algorithms
  - RSA-2048 vs. ECC-224
- Example is for hardware implementations with 32 bit multipliers
  - Larger multipliers give higher performance, but at a cost
- Both performance and implementation size get closer between RSA and ECC as key sizes increase





# Cryptography: Cipher Summary

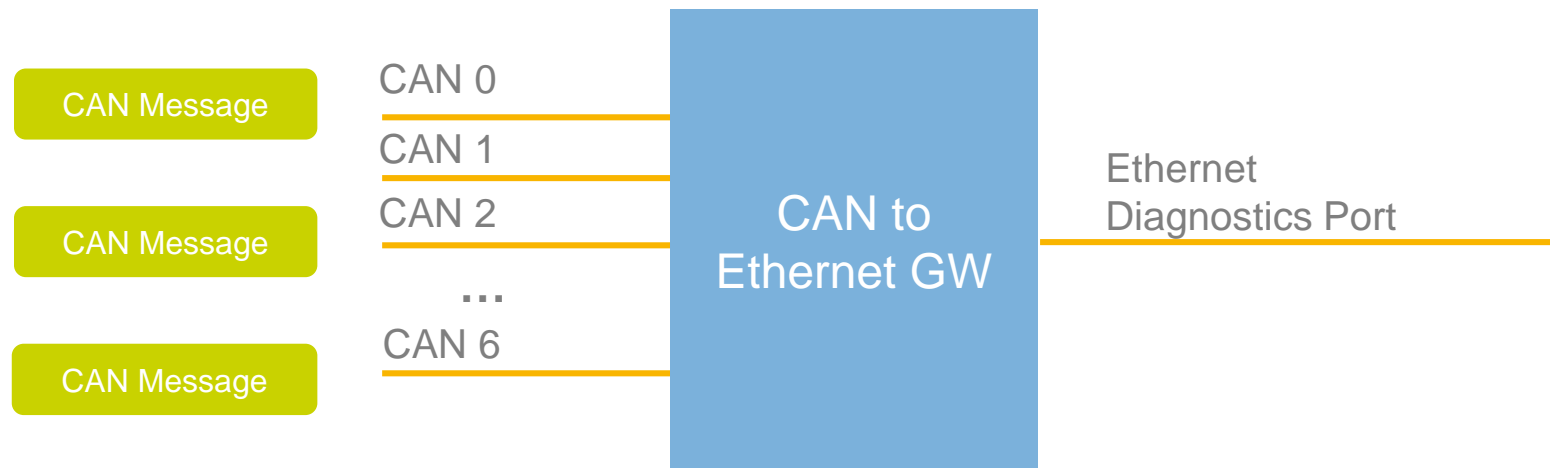
	AES	RSA	ECC
Secure for the next few years		 Key size > 2048	
Type	symmetric	asymmetric	asymmetric
Typical key size [bits]	128, 192, 256	1024, 2048, 3072	180, 224, 256, 320, 512
Execution time	short	long	long
Authentication / verification			
Implementation	HW / SW - good	Could combine into one module, req. big number math functions	
Key Management			

# Encryption vs. Authentication

- Data Content
  - Should the data transmitted be obscured?
- Privacy
  - Is it important to keep the source anonymous?
- Verification of Source
  - Is this message from an authentic source?
- Latency
  - Is the protection of the data delaying its use outside of the requirement?

# Bare Minimum: Diagnostics CAN to Ethernet Gateway

- MPC5748G: Power Architecture® z4 core @160 MHz
- Ethernet low level UDP packet builder: 1.3 us per packet
  - Payload 16 bytes = CAN ID: + DLC + Timestamp + 8 data bytes
  - 100% Traffic → One 8 byte CAN frame every 234 us, 7 CAN buses
    - $7 * 1.3 \text{ us} / 234 \text{ us} = 4\%$



# Bare Minimum CAN to Ethernet Gateway with HW Sign/Verify

- Verify AES CMAC algorithm is used to calculate a 128-bit MAC
  - Latency 30 us, for one message (128 bit, padded if needed)
  - Worst case scenario in this study, 7 CAN buses with Signature verification:
    - $30\text{ us} * 7 = 210\text{ us}$
- Generate AES CMAC algorithm is used to calculate a 128-bit MAC
  - Latency 30 us, for one 128 bit message



# Security to the Vehicle

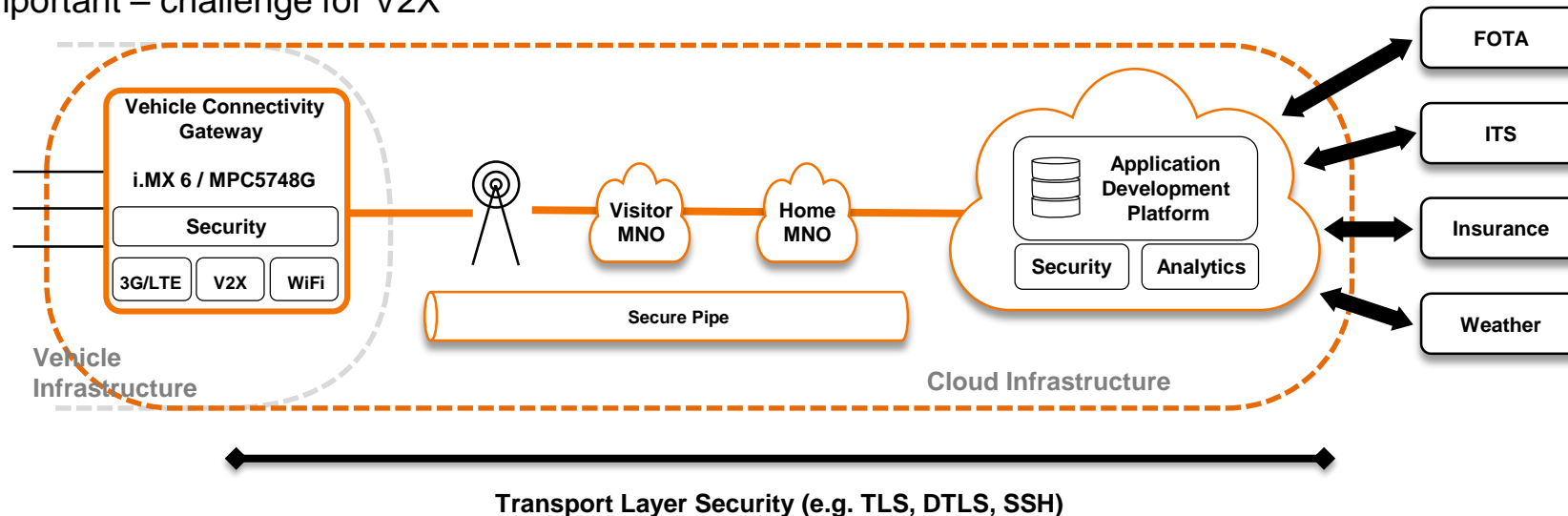
- Do not re-invent the wheel
  - Use industry standards
- Authentication Mandatory
  - Public Key based: ECC, RSA
- Encryption likely
  - Symmetric keys
- Strong Key Management advised
  - Key revocation important – challenge for V2X

## Transport Layer Security Protocols

**TLS** (Transport Layer Security, i.e. SSL)  
- HTTPS, MQTT

**DTLS** (Datagram TLS, i.e. TLS over UDP)  
- IoT Protocols: MQTT-SN, CoAP

**SSH** (Secure Shell)  
- Beyond just transport layer



# Last Thoughts on Security

Implementing in the real world:

**RISK vs COST**

(of successful attack)

(of compromised data)

(of implementation)



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