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Automotive Cybersecurity - Challenges and Practical Guidance

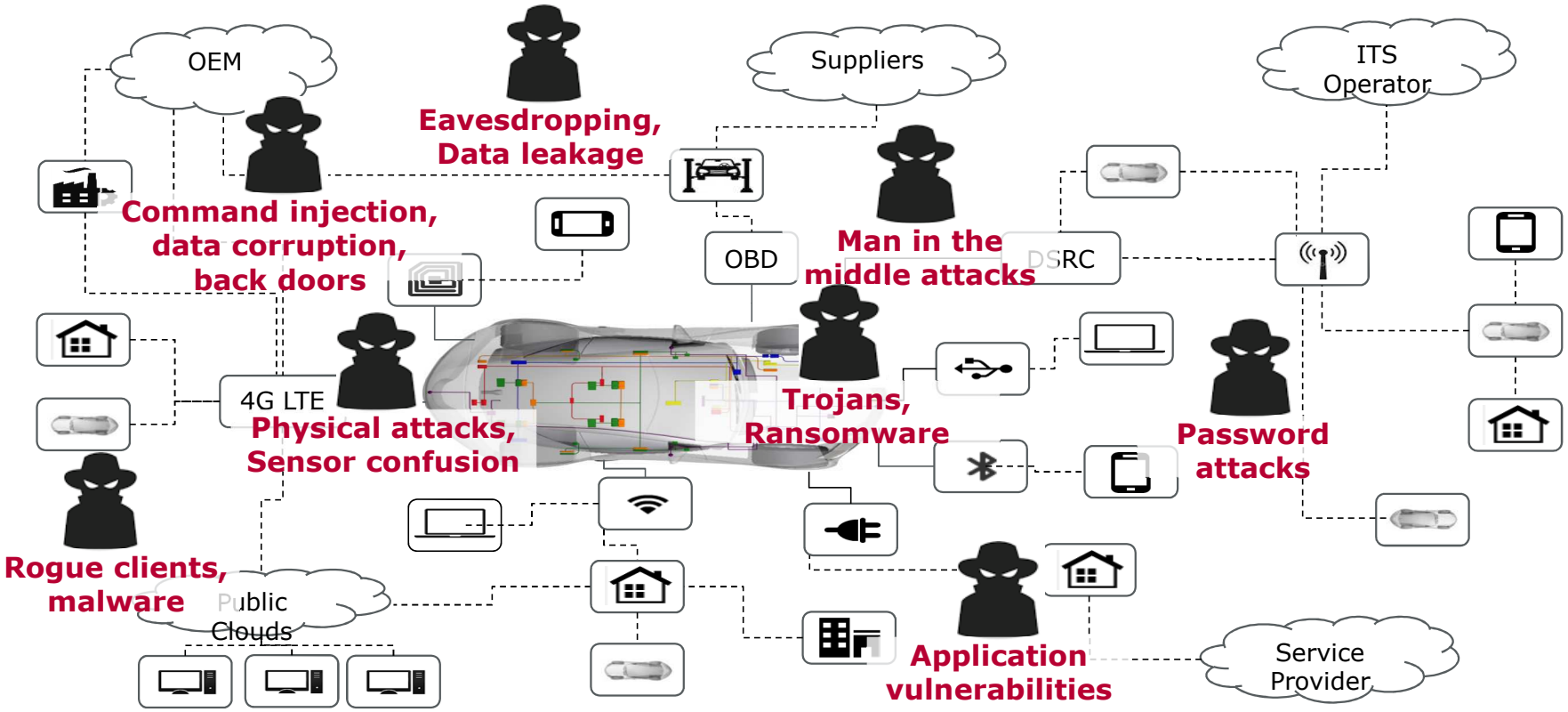
Vector Technology Days 2019 - 2019-10-23, Böblingen, Germany

V1.0 | 2019-10-23

Agenda

1. Introduction
2. Threat Analysis and Risk Assessment
3. Design for Security
4. Security Testing
5. Summary

ACES (Autonomy, Connectivity, Efficiency, Services) ▶ Cyberattacks



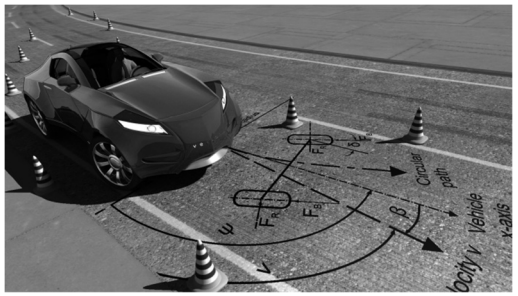
Security will be the major liability risk in the future.
Average security breach is detected in 70% of all cases by third party – after 8 months.

Automotive Trends Impact Safety and Security

1. Powertrain

Energy efficiency

Unintended speed change



2. Driver Assistance

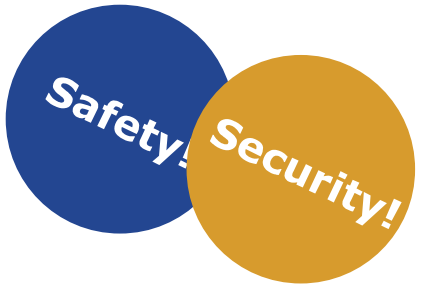
Autonomous driving

Signal confusion

3. Connectivity

Always connected

Sudden Driver distraction



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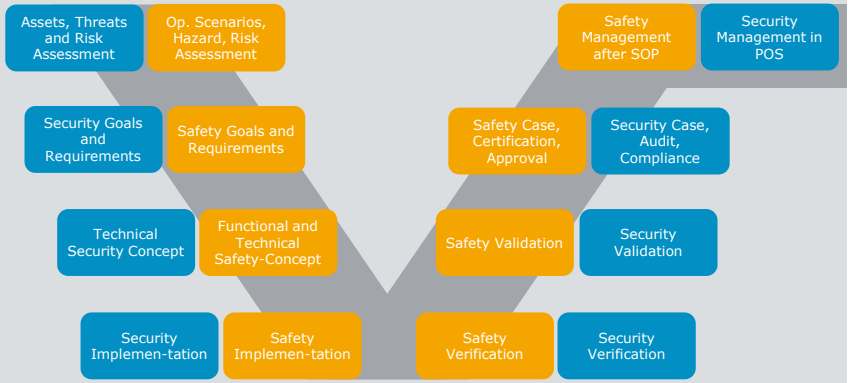
Security and Safety Standards Evolve in Parallel

Functional Safety
(IEC 61508, ISO 26262, ISO/PAS 21448)

- Hazard and risk analysis
- Functions and risk mitigation
- Safety engineering

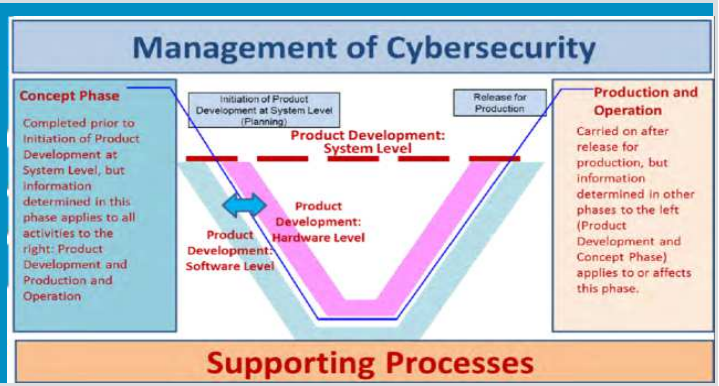
ISO 26262:2018 does not address security, but requires trade-offs without impact on functional safety.



+ Security
(ISO 27001, ISO 15408, ISO 21434, SAE J3061)

- Threat analysis and risk assessment
- Abuse, misuse, confuse cases
- Security engineering

Security and Safety are inter-related and demand holistic systems engineering



For (re) liable and trusted operation **security is a enabler for safety**

Upcoming ISO/SAE 21434 Standard for Automotive Cybersecurity

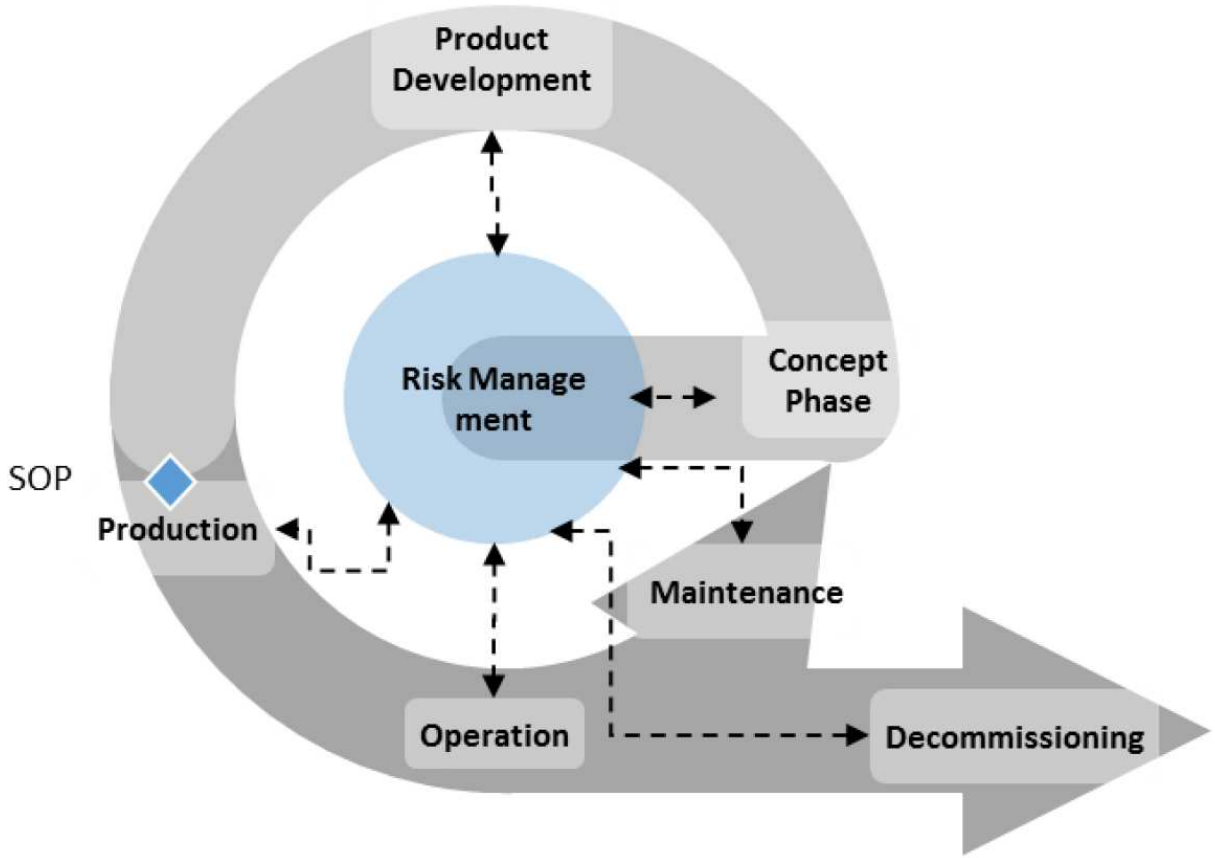
Planning

- Kickoff - 17.10.2016
- Currently: Committee Draft
- Release: 2020 (Planned)

Approach

Risk-oriented approach following the Vector method for the whole lifecycle:

- Concept/design phase
- Product development
- Production (roll out)
- Operation
- Decommissioning (roll over)



Focus on governance - ISO 21434 does NOT mandate technologies or solutions

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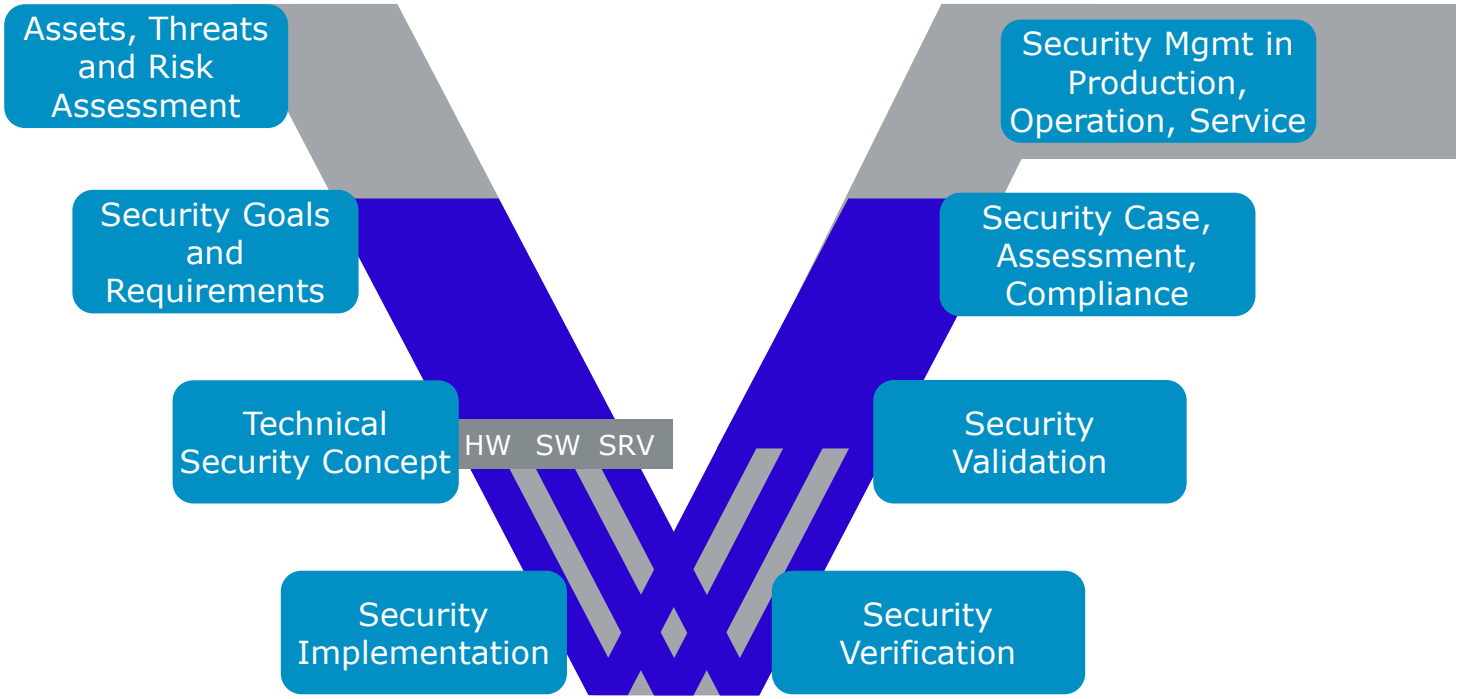
Security Engineering



Most security attacks are process and implementation related.
They rarely lie within the cryptographic protocols and algorithms.

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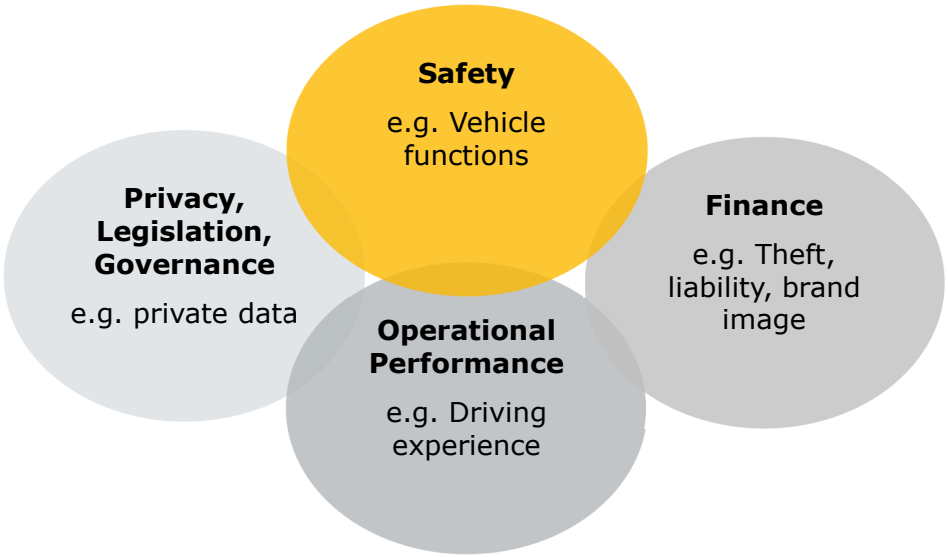
TARA - Identify and Agree on Assets

Specific automotive asset categories

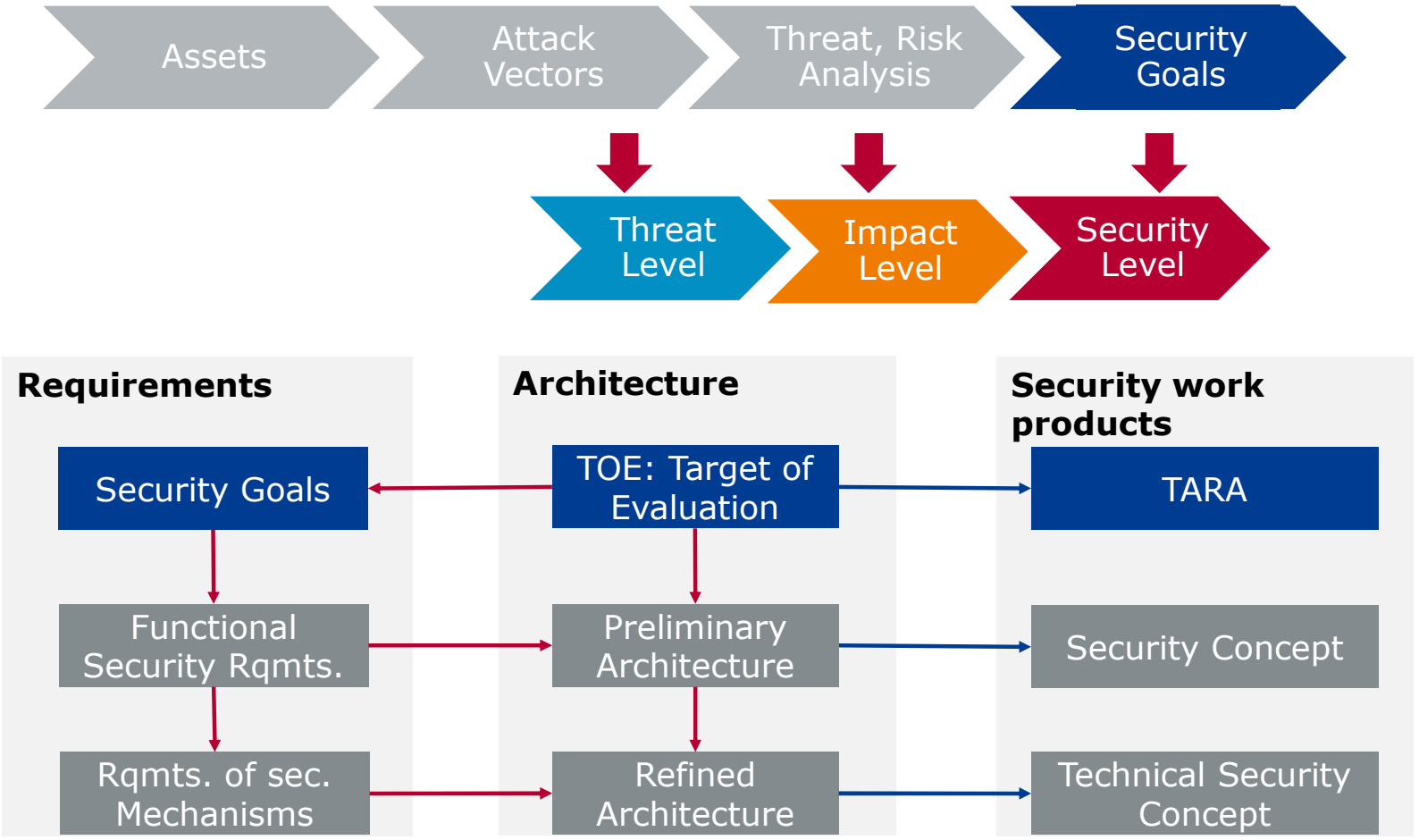


Checklist to identify assets

- Which information, algorithm or intellectual property shall **remain confidential?**
- Which data (e.g. configuration parameters) shall **remain unchanged?**
- Which functions or procedures shall be **exclusively applied** by e.g. the OEM?
- Which functions or data shall be always **available?**
- Which company **guidelines** or **legal requirements** on data or procedures must be fulfilled?

Automotive Cybersecurity focuses on Confidentiality, Integrity, Authenticity, Availability, Governance (CIAAG)

Identification of Security Goals by Threat Analysis and Risk Assessment (TARA)



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Determine Necessary Security Level with TARA Results

Asset ID	Asset / Vehicle Function	CIAAG	Attack vector	Potential effect of attack	Threat ID	Threat	Expertise	Expertise numerical	Window of Opportunity	WoO numerical	Equipment / Effort	Effort numerical	Threat numerical	Threat level (high=4; low=1)	Safety	Financial	Operational	Privacy	Impact Level	SGID
Ast 01	Safety-Mechanisms	Avail	Availability: Attacker floods CAN-Bus and thereby tries to disable vehicle primary functions.	Attacker disables engine control during an overtaking maneuver if system can impact safety-critical functions.	Tht-1	Not further considered on advice of client because the HU is rated QM with respect to ISO 26262.	Layman	0	Critical	0	Standard	0	0	4	No injury	No impact	No impact	No effect	No impact	n/a

Security Level (SL)	Impact Level (IL)					
Threat Level (TL)		0	1	2	3	4
	0	QM	QM	QM	QM	Low
	1	QM	Low	Low	Low	Medium
	2	QM	Low	Medium	Medium	High
	3	QM	Low	Medium	High	High
	4	Low	Medium	High	High	Critical

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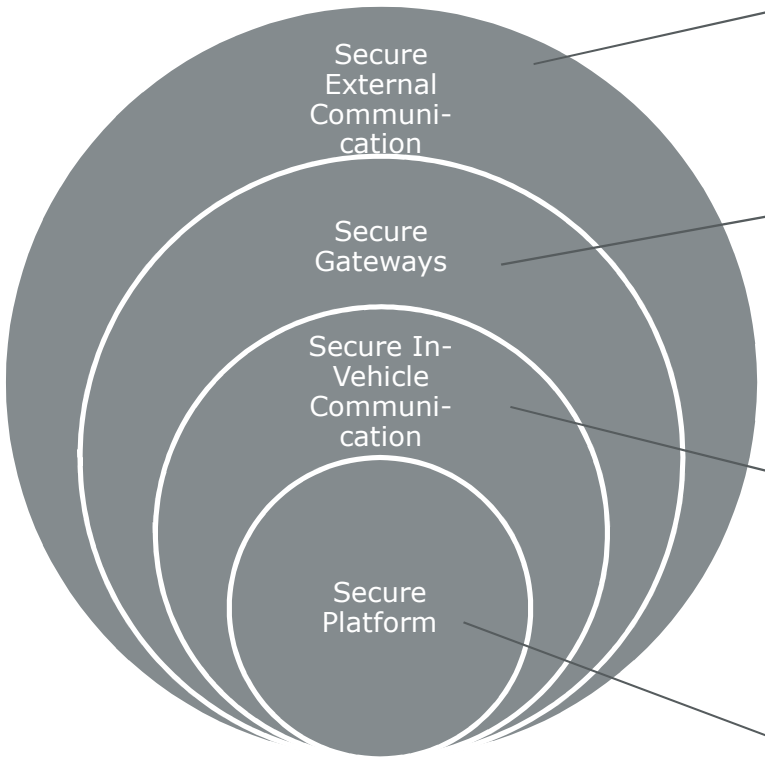
Layered Security Concept

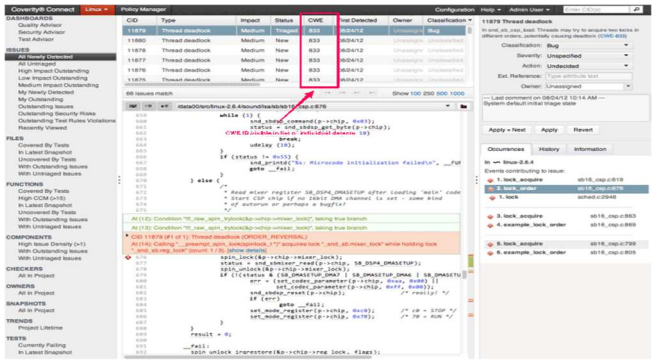
Legacy: Outside in



New development: Inside out

- Secure communication to services outside the vehicle
- Intrusion detection mechanisms
- Firewalls
- Key Infrastructure / Vehicle PKI
- Synchronized secure time
- Authenticity of messages
- Integrity and freshness of messages
- Confidentiality of messages
- Key storage
- Secure boot and secure update
- Crypto library
- HW trust anchor (HTA)

Security by Design: Secure Coding



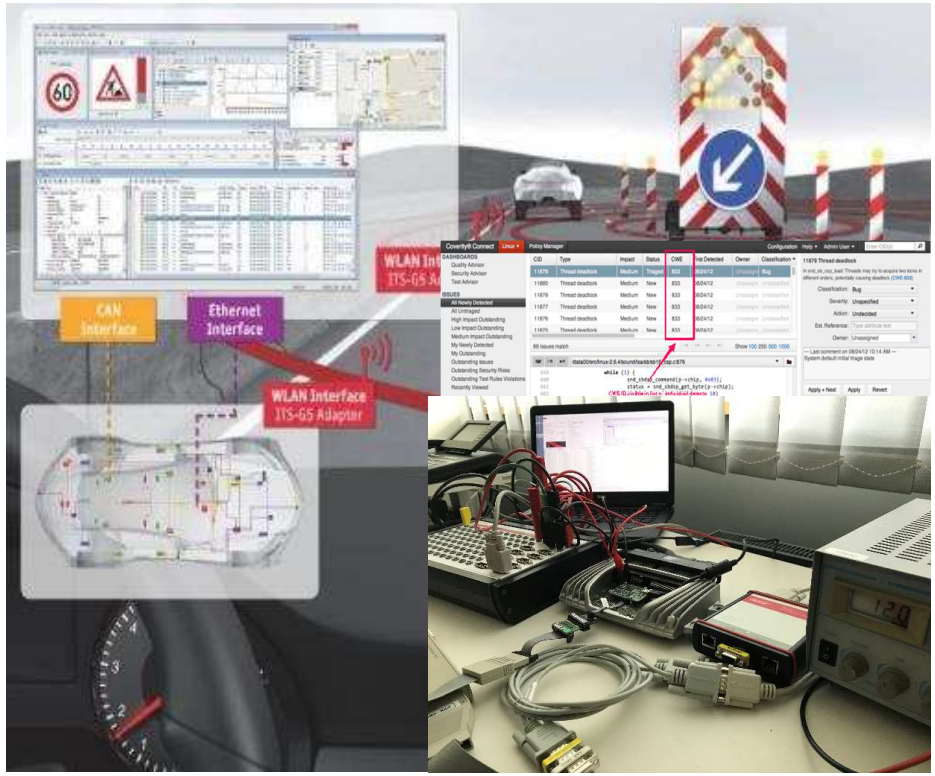
- **Goal**
  - **Avoid design and code errors which can lead to security exploits**

- Approach
  - **Use a hardened OS with secure partitioning**
    Avoid embedded Linux due to its complexity and rapid change and thus many security gaps, (e.g. NULL function pointer dereferences, which allow hackers to inject executable code).
  - **Deploy secure boot strategy**
    Starting with first-stage ROM loader with a pre-burned cryptographic key, the next levels are verified before executing to ensure authenticity of each component of the boot
  - **Apply rigorous static code analysis**
    Tools like Coverity, Klocwork or Bauhaus allow security checks, such as NULL pointer dereferences, memory access beyond allocated area, reads of uninitialized objects, buffer and array underflows, resource leaks etc.
  - **Use modified condition/decision coverage (MC/DC)**
    Detect backdoors

Security Implementation, Verification and Validation

- **Design**
  - Defensive coding, e.g. memory allocation, avoid injectable code, least privileges
  - Programming rules such as MISRA-C, SEI CERT
  - Trusted cryptographic algorithms
  - Key management and HW-based vaults for secrets
  - Awareness and governance towards social engineering

- **V&V Methods and Tools**
  - Static / dynamic code analyzer
  - Unit test with focused coverage, e.g. MC/DC
  - Interface scanner, layered fuzzing tester, encryption cracker, vulnerability scanner
  - Risk-based penetration testing



Classic structural coverage test is not sufficient. Test for the known – and for the unknown.

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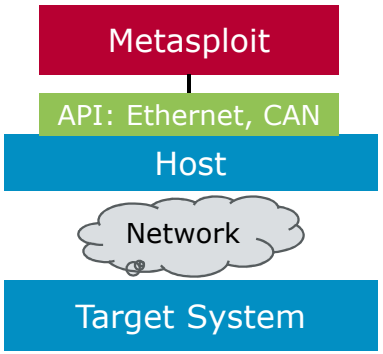
Security Validation: Penetration Testing Approach

1. Overview:
   - **Penetration Testing** is an offensive approach for security
   - Highly automated tools because a **high and growing** number of potential threads has to be systematically validated.
   - **Example: Metasploit** (*Open Source Framework*)



2. Basic Approach:
   - Scan the target system concerning vulnerabilities.
   - Select one of the proposed exploits, which make the weakness applicable.
   - Select and apply a payload (e.g. *meterpreter backdoor*) to get access to target ressources.

Permission of the target owner makes the difference between *penetration testing* and *hacking*.

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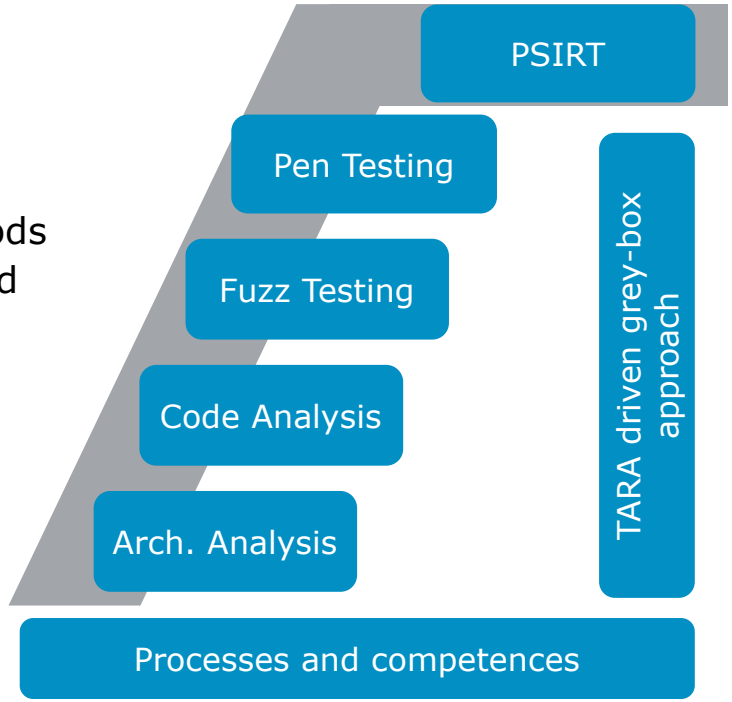
Security by Lifecycle: Verification, Validation and Life-Cycle Management

- **PSIRT Collaboration (Product Security Incident Response Team)**
  - Handover, task assignments and distribution
- **OTA Updates: Ensure that each deployment satisfies security requirements**
  - Data encryption: Protection of intellectual property by encryption
  - Authorization: Protection against unauthorized ECU access
  - Validation: Safeguarding of data integrity e.g. in the flash memory
  - Authentication: Verification of authenticity through signature methods
  - Governance: Safety/security documentation is continuously updated
- **Pen Testing**
  - Connect with misuse, abuse and confuse cases
  - Vector Grey-Box PenTest based on TARA and risks
  - DoS, Replay, Mutant/Generated Messages
- **Fuzz Testing**
  - Brute-force CAN Fuzzer for fuzzing the Application SW
- **Analyses**
  - Code level: CQA, Coverage (e.g., VectorCAST)
  - Architecture level: Attack analysis, vulnerability analysis



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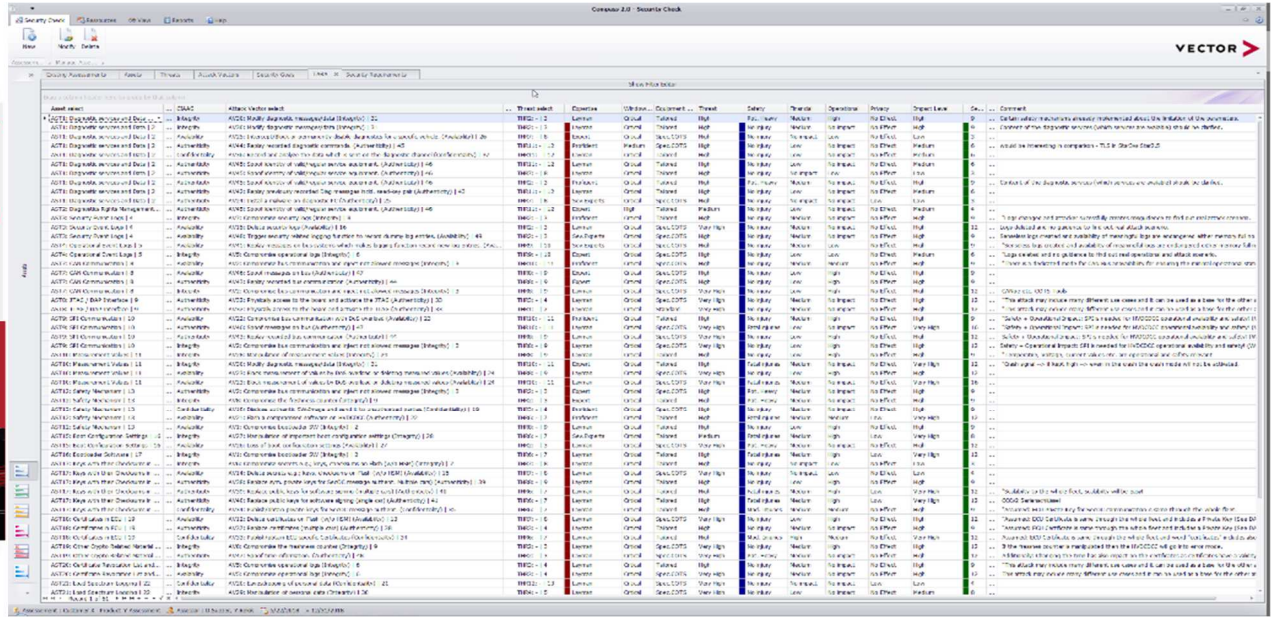
Summary

- **Security Context**
  - **ACES** (Autonomy, Connectivity, Efficiency, Services) depend of **effective cybersecurity**
  - **Standardization** of ISO/SAE 21434 is **in process**
  - Cybersecurity has to be implemented in **co-existence with functional safety**
- **Security Engineering**
  - **Cyber security goals** are derived by the Threat Analysis and Risk Assessment (**TARA**)
  - Cyber security embodies **layered scopes** from the secrets of the HTA to the public infrastructure
  - The security concepts implements **security mechanisms** to ascertain cybersecurity
- **Assurance of Security**
  - Architecture level **attack analysis**, stringent **coding guidelines** and gapless **code analysis**
  - Complementary set of test methods including **fuzz testing** and **penetration testing**
  - Comprehensive **security management** according governance regulations

Automotive cybersecurity remains is an evolving challenge

COMPASS: Vector Product for Security Check, TARA and Continuous Documentation

COMPASS information: www.vector.com/compass



Vector SecurityCheck facilitates

- **Systematic risk assessment and mitigation**
- **Traceability and Governance** with auditable risk and measure list
- **Heuristic checklists** with continuously updated threats and mitigation

Thank you for your attention.
For more information please contact us.

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