Survey on Security Threats and Protection Mechanisms in Embedded Automotive Networks

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1. The Automotive Network
2. Threats
3. Protection mechanisms
4. Conclusion

Embedded networks

Modern cars embed

- An internal network...
  - Between 30 and 70 ECUs
  - Several communication protocols: CAN, LIN, MOST, FlexRay...

Source: [Checkoway et al., 2011]

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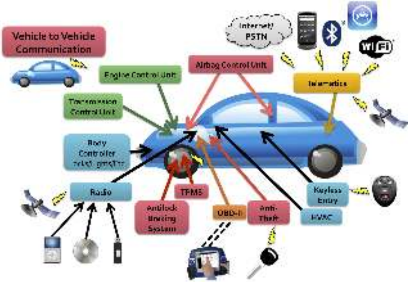
- An internal network. . .
  - Between 30 and 70 ECUs
  - Several communication protocols: CAN, LIN, MOST, FlexRay. . .
- . . . with external connections
  - On Board Diagnostic (OBD) port
  - USB port
  - Bluetooth
  - WiFi
  - GSM
  - 3G/4G
  - Car2Car



Source: [Checkoway et al., 2011]

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CAN & Security

SOF	Identifier	Control	Data	CRC	ACK	EOF
1 bit	12/30 bits	6 bits	0 - 64 bits	16 bits	2 bits	7 bits

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- ~~Confidentiality ?~~ → Broadcast only
- ~~Availability ?~~ → Easy DOS
- ~~Authenticity ?~~ → No authentication

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- Privacy breach

Local attacks

Direct access to the bus

- Additional device plugged in
- Through the OBD port

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Results

- Many documented attacks
- Impersonation, reflashing, "virus"...
- Up to complete takeover

Source: [Koscher et al., 2010]

Remote attacks

[Rouf et al., 2010]

Target: Tire Pressure Monitoring System

- Eavesdropping from up to 40m
- Spoofed messages sent to monitoring ECU

[Francillon et al., 2010]

Target: Passive Keyless Entry and Start

- Relay attack
- Car unlocked and started 50m away from the owner

Remote/Indirect takeover

[Checkoway et al., 2011]

Vulnerabilities found in

- Physical indirect range: CD player, OBD plug-in device, infected smartphone. . .
- Short wireless range: Bluetooth
- Long range: GSM/3G unit

One communication device compromised → Complete takeover of the car

A major concern

Constraints

- Hardware limitations

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- Physical constraints

Protections (1/2)

Cryptography

- Authentication, integrity checks, encryption
- Dedicated hardware for cryptography [Wolf and Gendrullis, 2012]

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Software integrity

- Secure boot
- Virtualization [Groll et al., 2009]

Protections (2/2)

Intrusion detection

- Anomaly-based
  - Tainting tool [Schweppe and Roudier, 2012]
  - Restricted headers & self-checking [Matsumoto et al., 2012]
  - Entropy variations [Muter and Asaj, 2011]
- Signature-based IDS [Muter et al., 2010]

Protections (2/2)

Intrusion detection

- Anomaly-based
  - Detects unknown attacks
  - Requires a very thorough model
- Signature-based
  - Very few false positives
  - Regular updates required

Conclusion

Threats

- Lack of security mechanisms in current automotive networks
- More exposure with wireless communication capacities
- Several documented attacks

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Trends

- A key issue for manufacturers
- Security enforcement
  - Cryptography
  - Software integrity
  - Anomaly detection

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