Security Considerations in DetNet / TSN

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Background

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- The DetNet evolution:
  - Local area (isolated) networks ➔ wide area networks
- Control of physical devices:
  - Power grids
  - Industrial controls
  - Building controls
- Converged network:
  - Non-DetNet traffic
  - DetNet traffic
  - Control / signaling

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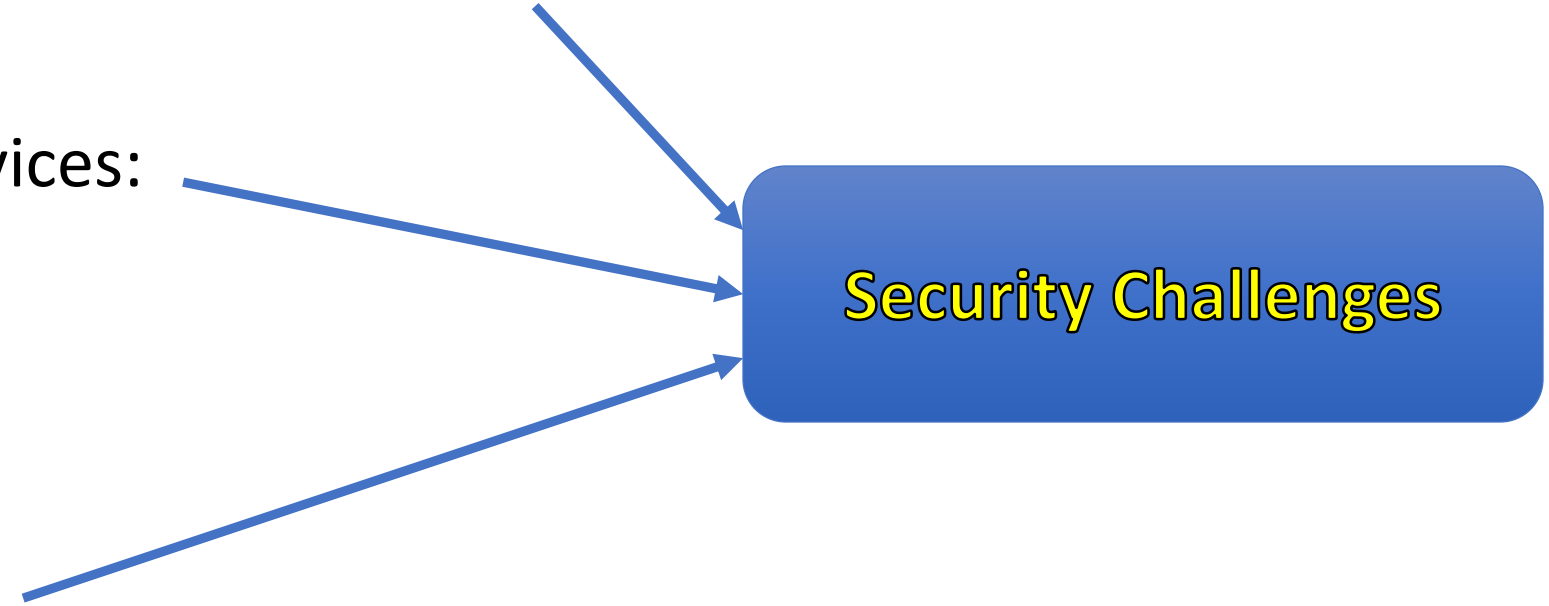


DetNet Security Considerations IETF Draft

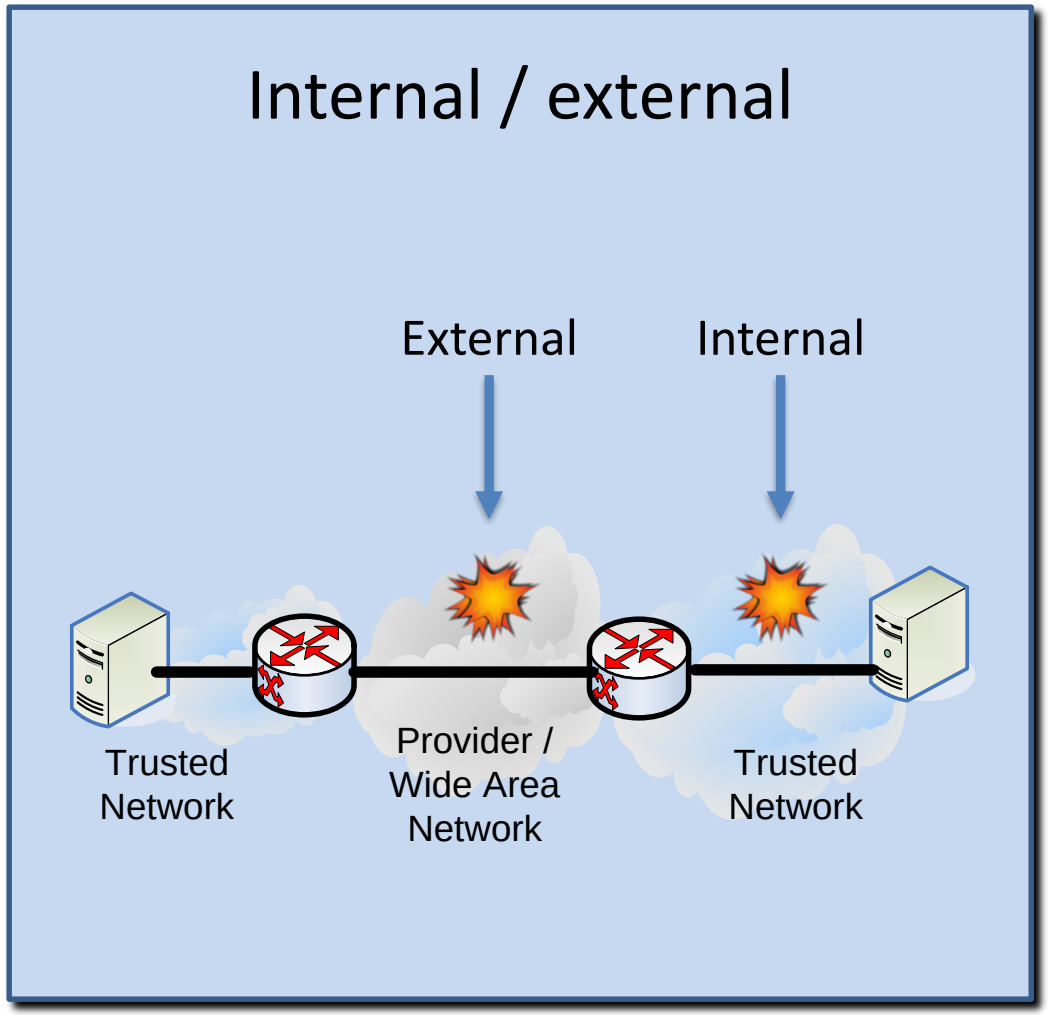
draft-ietf-detnet-security-03

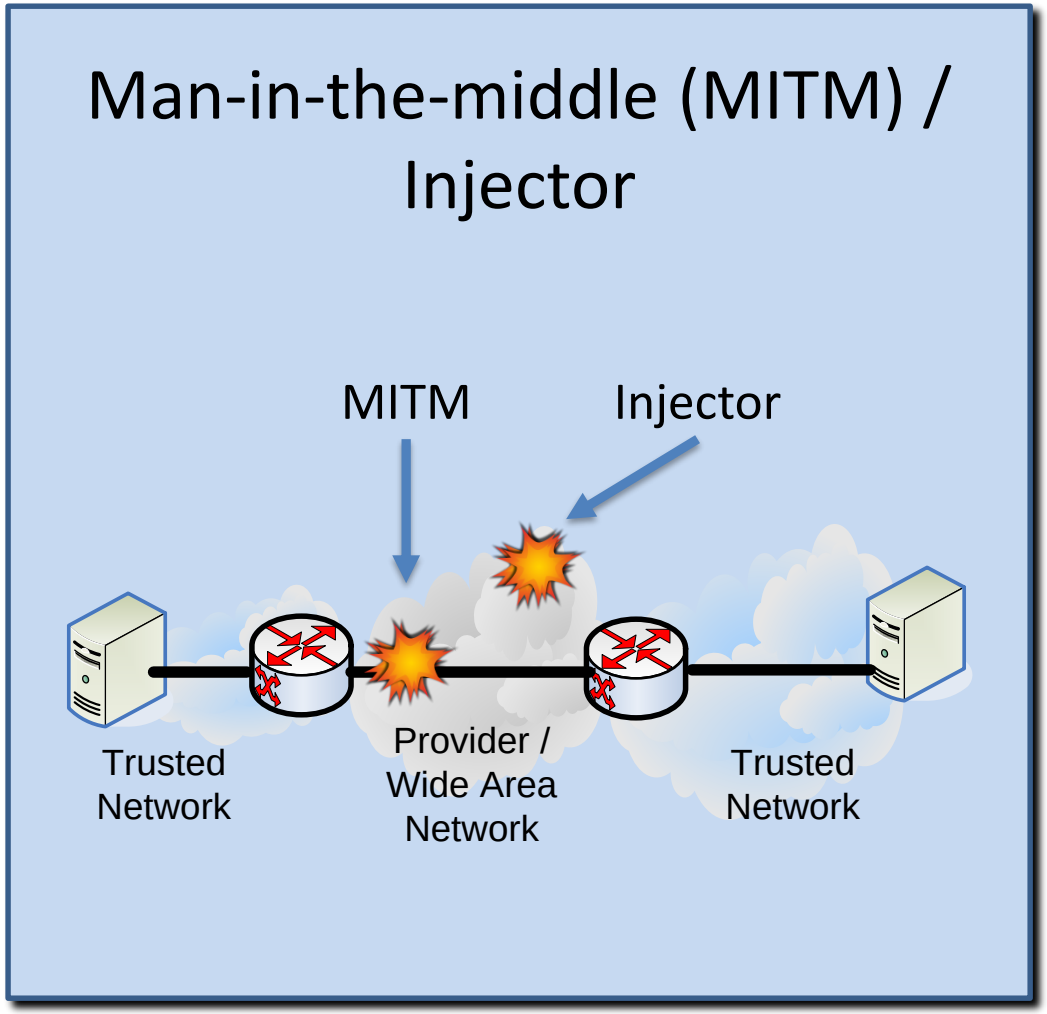
Draft Outline

- Security threats
- Impact of security threats
- Mitigations
- Association of attacks to use cases

Attacker Types

[Based on RFC 7384]





Threats

Threats

- **Delay attack**
  - Attacker maliciously delays DetNet data flow traffic.
- **DetNet flow modification and spoofing**
  - Attacker modifies the headers of en route DetNet packets, or spoofs DetNet packets ➔ manipulating the resource consumption.
- **Inter-segment attack**
  - Attacker injects traffic from one segment, affecting the performance of other segments.

Threats (2)

- **Replication: Increased Attack Surface**
  - Multiple paths ➔ more points in the network that can potentially be attacked.
- **Replication-related Header Manipulation**
  - Attacker modifies replication header ➔ Forward both replicas / eliminate both replicas / flow hijacking.
- **Path Manipulation**
  - Attack control plane ➔ manipulate the paths being used.
- **Path Choice: Increased Attack Surface**
  - Attack control plane ➔ increase number of points that can potentially be attacked.

Threats (3)

- **Control or Signaling Packet Modification**
  - Modify control / signaling packets ➔ manipulate path / resource allocation.
- **Control or Signaling Packet Injection**
  - Inject control / signaling packets ➔ manipulate path / resource allocation.
- **Reconnaissance**
  - Passive eavesdropping ➔ gather information about DetNet flows, bandwidths, schedules.
- **Attacks on Time Sync Mechanisms**
  - Attack time sync mechanism ➔ disrupt DetNet flow forwarding.

Summary of Threats

Attack	Attacker Type			
	Internal MITM	Internal Inj.	External MITM	External Inj.
Delay attack	+		+	
DetNet Flow Modification or Spoofing	+	+		
Inter-segment Attack	+	+		
Replication: Increased Attack Surface	+	+	+	+
Replication-related Header Manipulation	+			
Path Manipulation	+	+		
Path Choice: Increased Attack Surface	+	+	+	+
Control or Signaling Packet Modification	+			
Control or Signaling Packet Injection		+		
Reconnaissance	+		+	
Attacks on Time Sync Mechanisms	+	+	+	+

Impact

Impact

	Control Plane	Data Plane

Impact of Recon and Delay Attacks

	Control Plane	Data Plane
Reconnaissance	• Monitor changes in the network • Monitor flows and their IDs • Identify controllers	• Identify active targets • Determine type of targets based on observed stream parameters. • Find opportune moment to conduct final attack

Impact of Recon and Delay Attacks

	Control Plane	Data Plane
Reconnaissance	• Monitor changes in the network • Monitor flows and their IDs • Identify controllers	• Identify active targets • Determine type of targets based on observed stream parameters. • Find opportune moment to conduct final attack
Delay attacks	• Resource exhaustion (removing old links delayed) • Reduces QoS (creating new links delayed) • Denial of Service (due to exhaustion, not enough to form new link) • Loss of privacy (data sent to old target)	• Increased buffering in bridges • Elimination nodes consume more resources • Skew path metrics • Outage (single path)

Impact of Spoofing and Modification Attacks

	Control Plane	Data Plane
Modification / spoofing	• Create/Remove/Modify streams • Modify network paths	• Skew path metrics • Consume resources • Disrupt links • Affect voting at elimination bridges • Crash application

Mitigations

Mitigations

Mitigation Method	Relevant Attack(s)
• Path redundancy	• Man-in-the-middle attacks

Mitigations

Mitigation Method	Relevant Attack(s)
• Path redundancy • Integrity protection • DetNet node authentication • Encryption	• Man-in-the-middle attacks • Modification/tampering • Spoofing • Recon

Mitigations

Mitigation Method	Relevant Attack(s)
• Path redundancy	• Man-in-the-middle attacks
• Integrity protection	• Modification/tampering
• DetNet node authentication	• Spoofing
• Encryption	• Recon
• Control message protection	• Control plane attacks
• Performance analytics	• Resource exhaustion attacks

Association of Attacks to Use Case Themes

Association of Attacks to Use Cases

- A set of use case themes
- For each theme: a discussion about specific security considerations

  - Network Layer - AVB/TSN Ethernet
  - Central Administration
  - Hot Swap
  - Data Flow Information Models
  - L2 and L3 Integration
  - End-to-End Delivery
  - Proprietary Deterministic Ethernet Networks
  - Replacement for Proprietary Fieldbuses
  - Deterministic vs Best-Effort Traffic
  - Deterministic Flows
  - Unused Reserved Bandwidth
  - Interoperability
  - Cost Reductions
  - Insufficiently Secure Devices
  - DetNet Network Size
  - Multiple Hops
  - Level of Service
  - Bounded Latency
  - Low Latency
  - Symmetrical Path Delays
  - Reliability and Availability
  - Redundant Paths
  - Security Measures

Mapping Attacks to Use Case Themes

Theme	Attack									
	1	2	3	4	5	6	7	8	9	10	11
Network Layer - AVB/TSN Eth.	+	+	+	+	+	+	+	+	+	+	+
Central Administration						+	+	+	+	+	+
Hot Swap		+	+								+
Data Flow Information Models											
L2 and L3 Integration					+	+					

...

Summary

Applicability to IEEE 802.1

- Attacks and mitigation are mostly relevant for IEEE 802.1
- Impacts and use cases are partly relevant to IEEE 802.1
- This document is a useful reference for IEEE 802.1
- This document does not define security solutions

Status of this Work

- Early 2017 – work started
- Early 2018 – taking a timeout until DetNet data plane solutions will be stable
- Solicit review from a wide audience