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# Time Synchronization Security using IPsec and MACsec

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# Time Synchronization Security

- Time synchronization is used for various applications.
- Securing the time protocol is a must for securing the applications that use it.
- IEEE 1588 standard: Precision Time Protocol (PTP).
- IEEE 1588 is challenging to secure:
  - A large number of nodes involved in the protocol.
  - Hop-by-hop data modification.
- IEEE 1588 - Annex K: experimental security appendix.



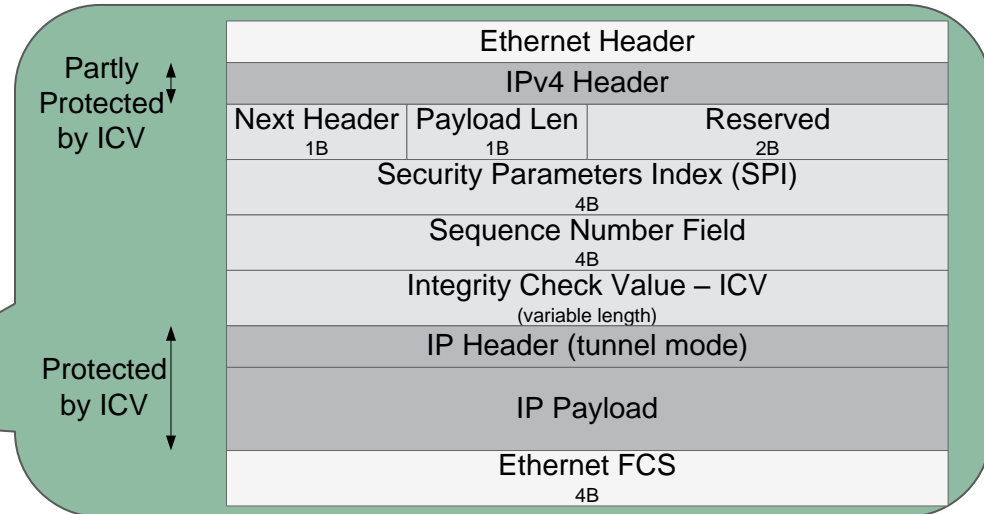
# Agenda

- Brief overview of IPsec, MACsec, and Annex K.
- The IPsec and MACsec scenarios.
- Attacker types.
- Effectiveness of each attacker in the IPsec and MACsec scenarios, Annex K.
- Summary and comparison.
- Conclusion.



# IPsec

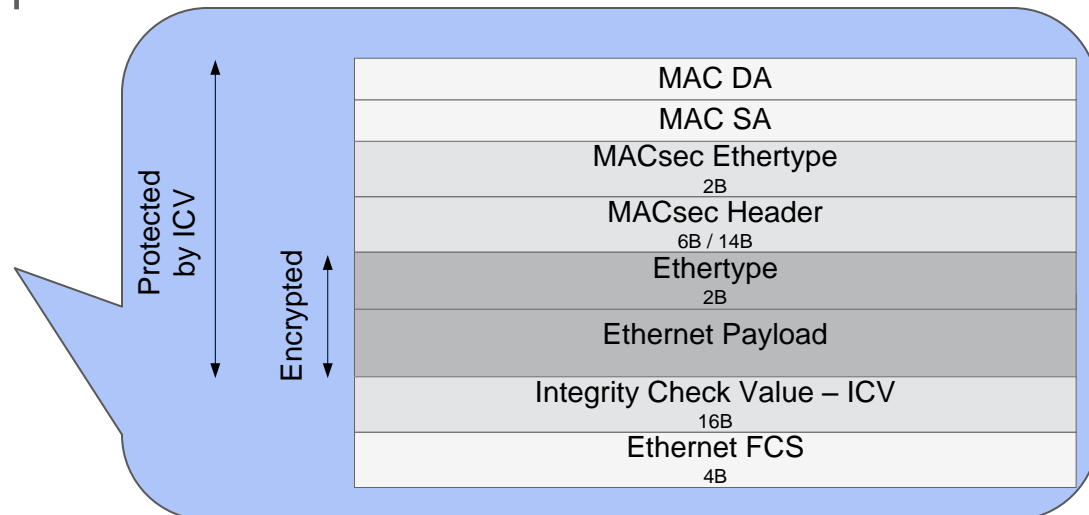
- A suite of security protocols defined by the IETF (RFC 4301 – architecture).
- Two main functions:
  - Integrity protection using Authentication Header (AH).
  - Confidentiality using Encapsulating Security Payload (ESP).
- Both functions support:
  - Integrity protection using Integrity Check Value (ICV).
  - Replay protection using Sequence Number.
- Both functions support:
  - Tunnel mode.
  - Transport mode.
- IPsec AH encapsulation.



# MACsec

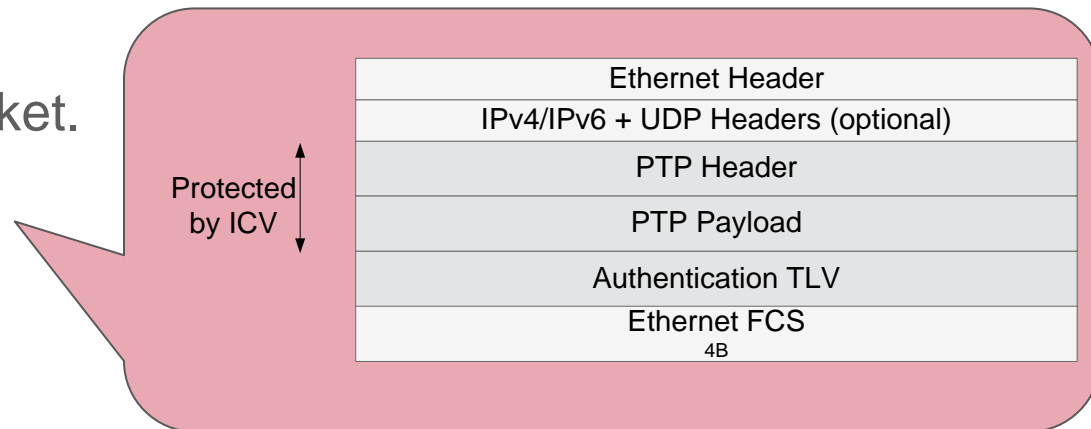
- IEEE 802.1AE – MAC security protocol.
- IEEE 802.1X – authentication, key exchange.
- Supports both encrypted and non-encrypted mode.
- Integrity protection using Integrity Check Value (ICV).
  - L2 header protected by ICV.
- Replay protection using Sequence Number.

- MACsec encrypted packet.



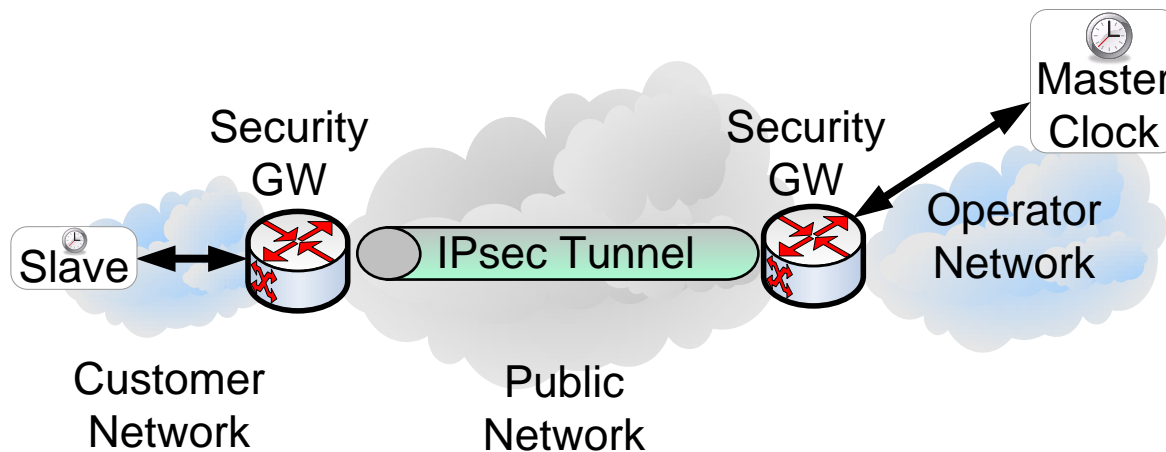
# IEEE 1588 Annex K

- Experimental annex in IEEE 1588-2008 (v2).
- Provides data integrity using symmetric key scheme.
- Authentication TLV includes:
  - Integrity Check Value (ICV).
  - Replay protection using replayCounter.
- Annex K authenticated packet.



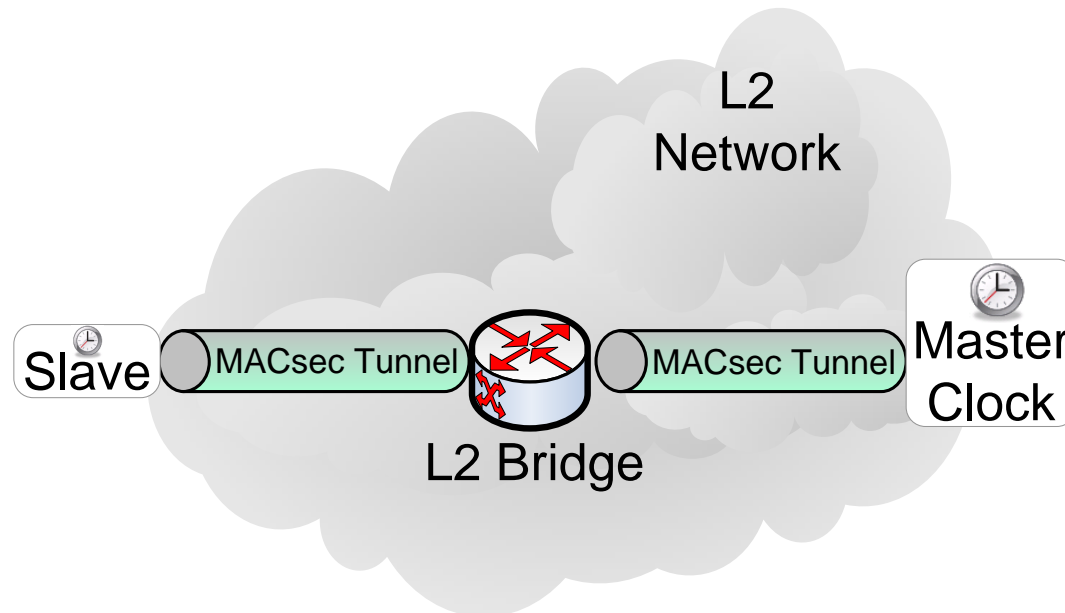
# PTP Security – the IPsec Scenario

- Can be used when PTP is transported over an IP network.
- Network-to-network configuration.
- IPsec can be used in encrypted (ESP) or authenticated (AH) mode.
- Either dedicated tunnel for time sync, or single tunnel for all traffic.
- Typical example: Femtocells in 3GPP.



# PTP Security – the MACsec Scenario

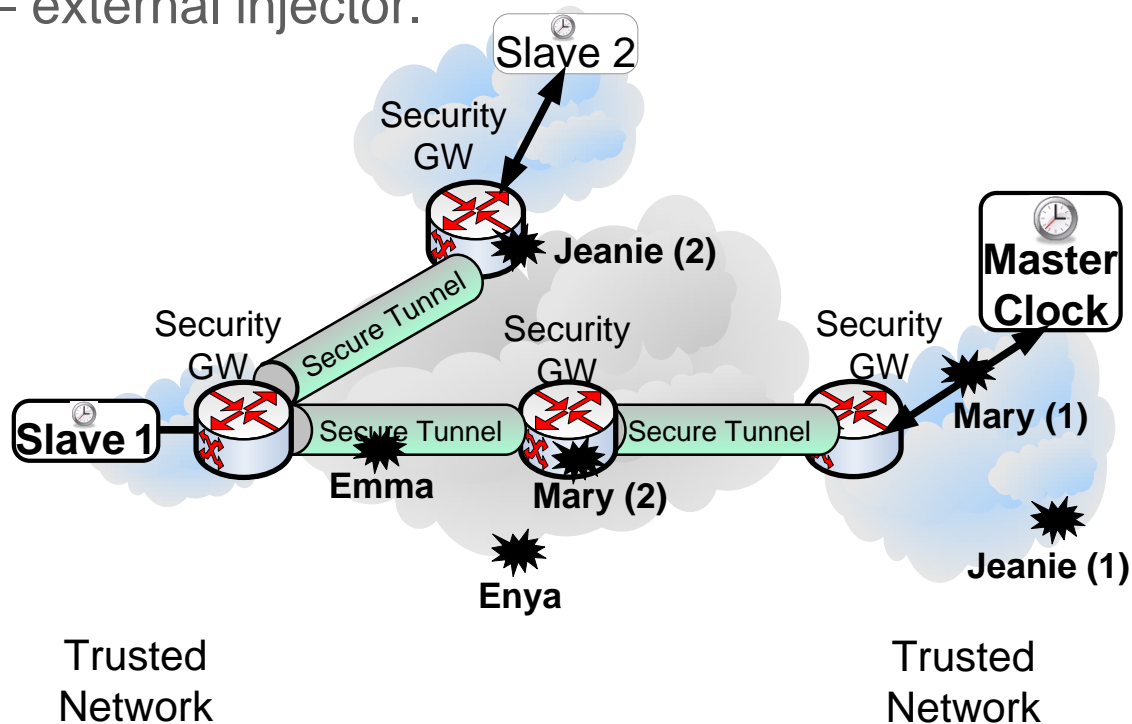
- Can be used in L2 networks.
- Either with/without encryption.
- All data is secured on a hop-by-hop basis.
- Typical example: Audio and Video Bridging (AVB).



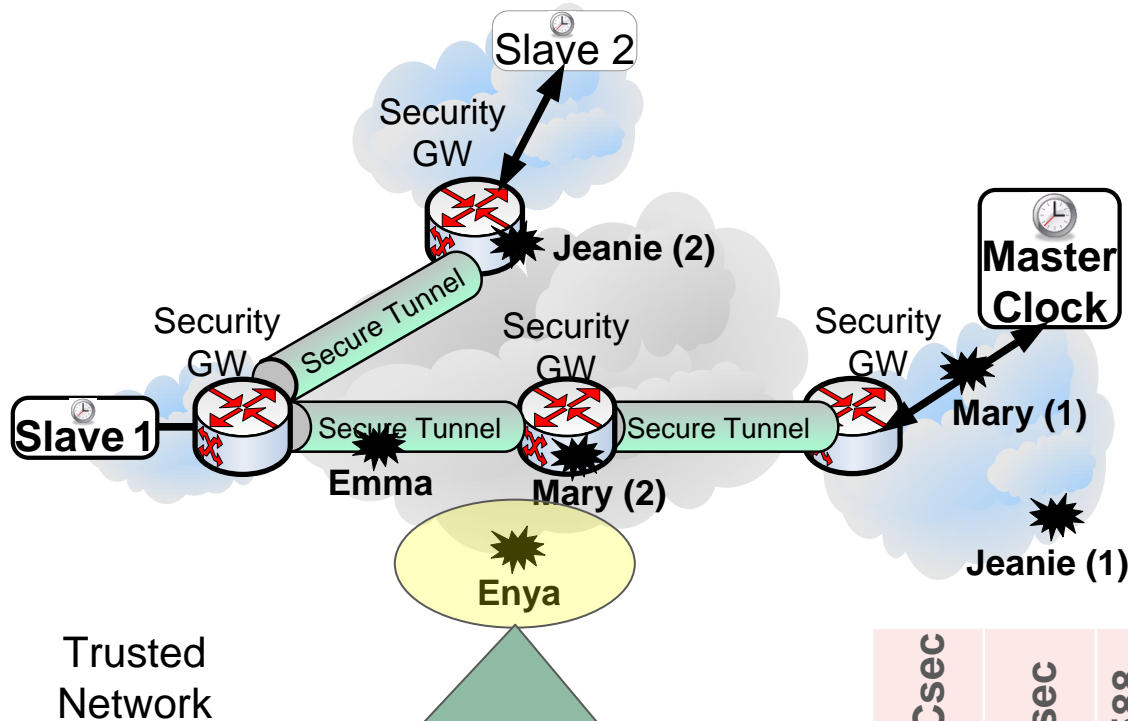


# Typical Attackers

- Mary – internal man-in-the-middle (MITM).
- Jeanie – internal injector.
- Emma – external MITM.
- Enya – external injector.



# Enya – WHAT can Enya do?

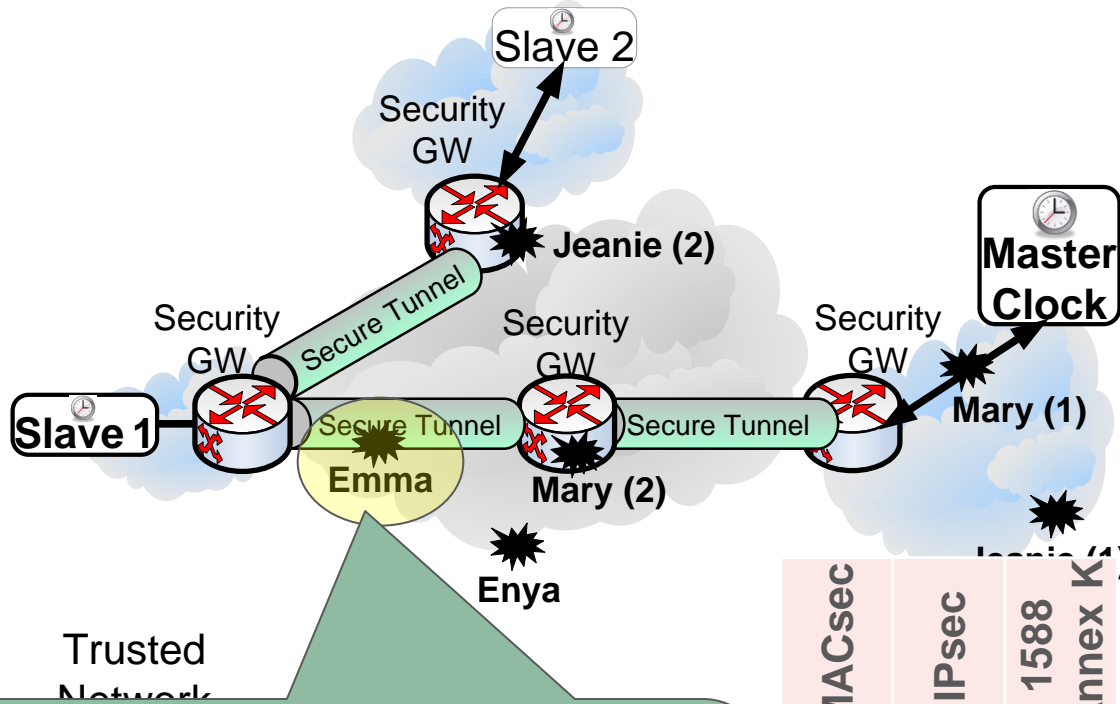


Trusted  
Network

- Cryptographic Performance Attack.
- L2/L3 DoS attacks.

MACsec	IPsec	1588 Annex K
•	•	•
	•	•

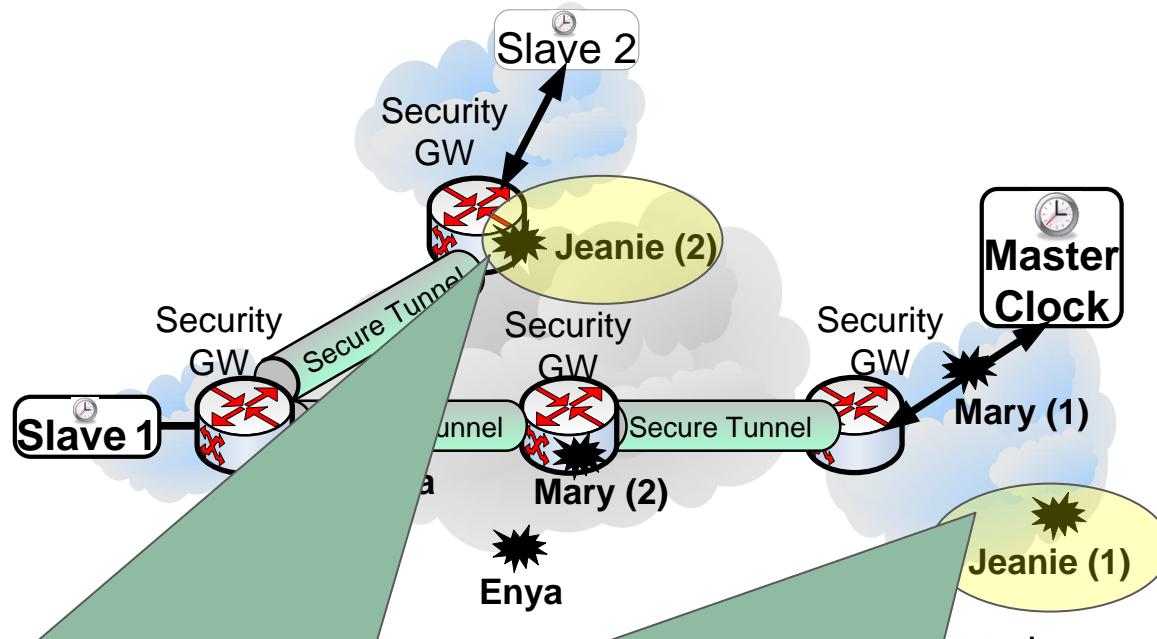
# Emma – WHAT can Emma do?



- Packet Interception and Removal.
- Packet Delay Manipulation.
- Cryptographic Performance Attack.
- L2/L3 DoS attacks.

MACsec	IPsec	1588 Annex K <sup>(1)</sup>
•	•	•
•	•	•
•	•	•
	•	•

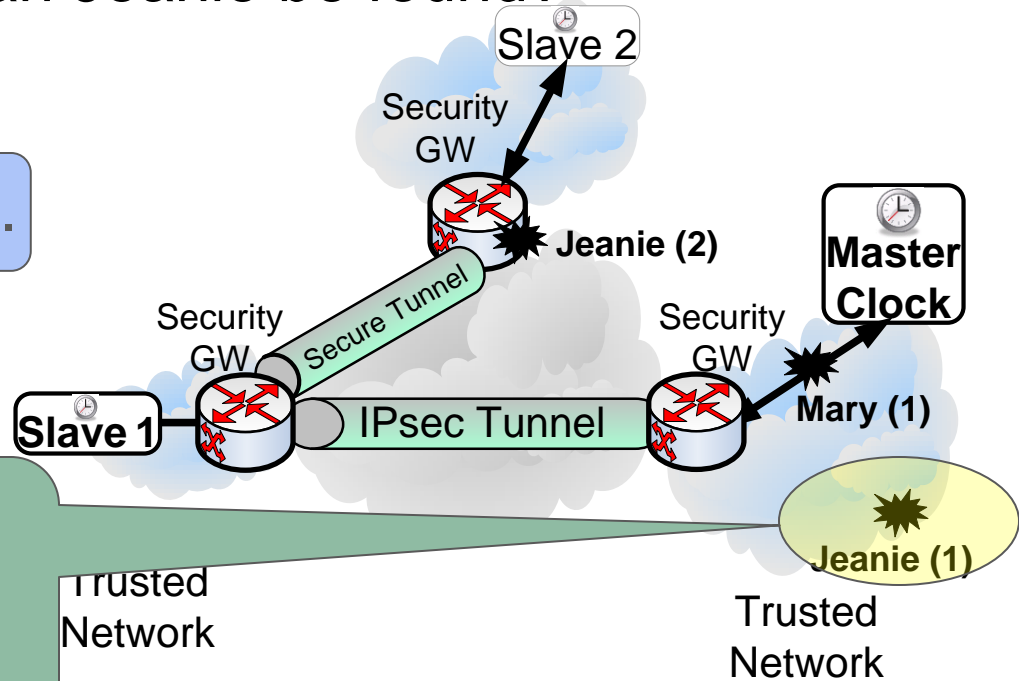
# Jeanie – WHAT can Jeanie do?



- Spoofing.
- Replay.
- Rogue Master Attack.
- L2/L3 DoS attacks.

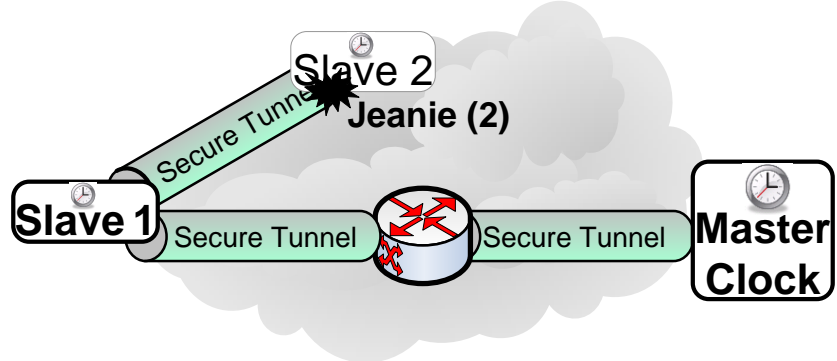
# Jeanie (1) – WHERE can Jeanie be found?

IPsec scenario.

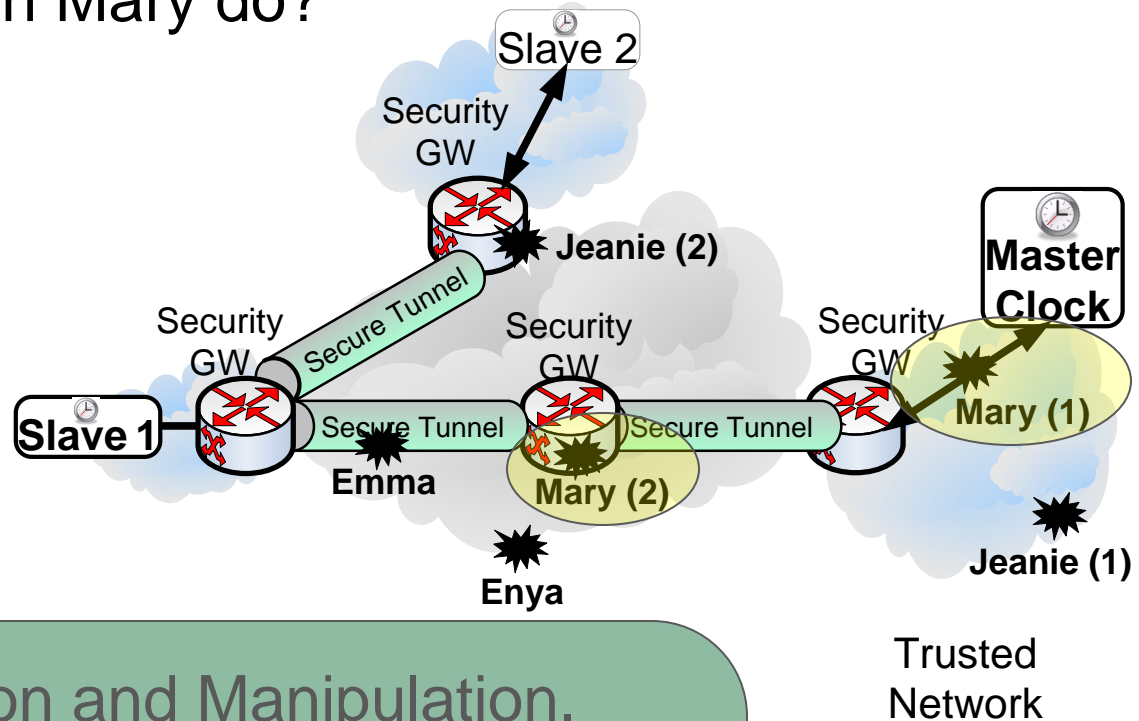


- Jeanie 1 is relevant specifically in the IPsec scenario.
- Network-to-network scheme.

MACsec scenario / Annex K



# Mary – WHAT can Mary do?

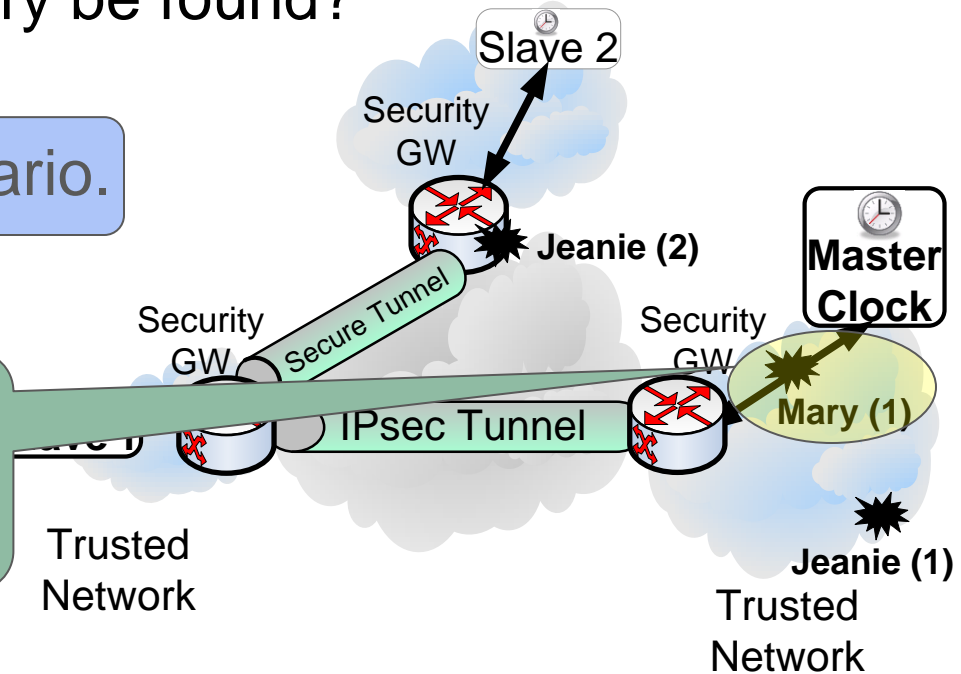


- Packet Interception and Manipulation.
- Packet Delay Manipulation.
- Packet Interception and Removal.
- Spoofing.
- Replay.
- Rogue Master Attack.
- L2/L3 DoS attacks.

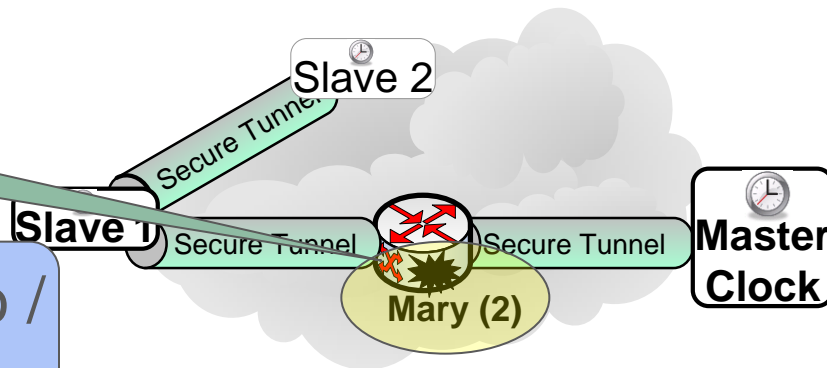
# Mary – WHERE can Mary be found?

## IPsec scenario.

- Mary 1 is relevant specifically in the **IPsec** scenario.
- Network-to-network scheme.



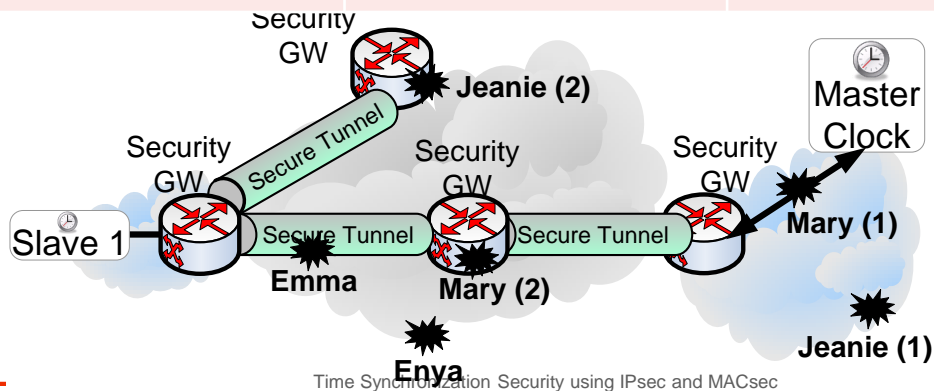
- Mary 2 is relevant specifically in the **MACsec** scenario.
- Hop-by-hop scheme.



## MACsec scenario / Annex K

# Analysis Summary

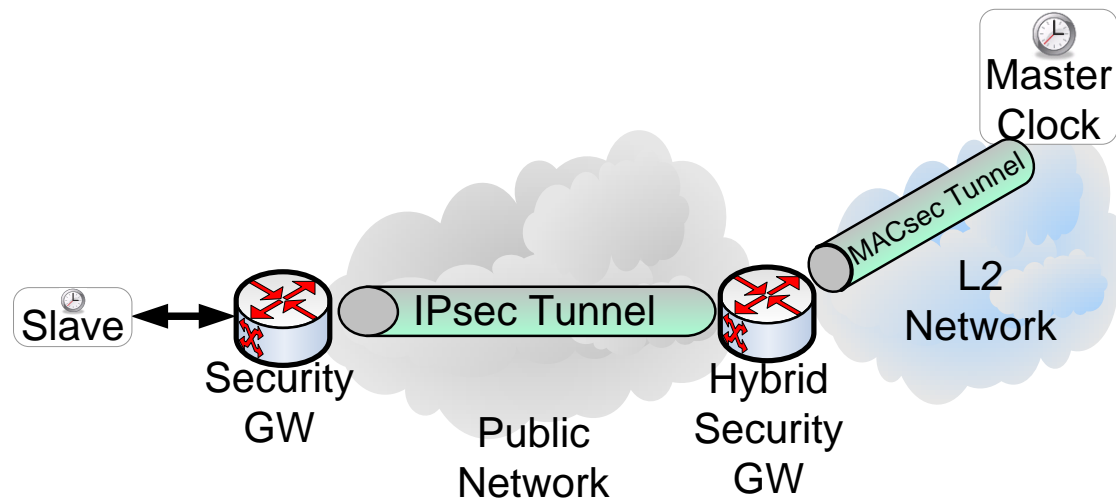
		MACsec Scenario	IPsec Scenario	IEEE 1588 Annex K
Characteristics	Network	L2 typically LAN	L3 typically public network	Any
	Security approach	Hop-by-hop	Network-to-network	Hop-by-hop
	Accuracy	+ (TCs/BCs)	~ (no TCs/BCs)	+ (TCs/BCs)
Threats	L2/L3 DoS Attack Prevention	+	-	-
	Internal attackers in the “trusted network” (Jeanie 1, Mary 1)	+	-	+
	Internal MITM attacks in intermediate nodes (Mary 2)	-	+	-





# Conclusion

- IPsec and MACsec are used in different topologies and scenarios.
- Two **complementary** building blocks for securing time synchronization.
- **Intermediate** solutions in the absence of a standard security solution for PTP.
- **Hybrid** solutions can be used in certain topologies.



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Thanks!