

Network Function Insertion for Reliable and Secure Control Messaging Over Commodity Transport

Messaging Resiliency in Industrial Control Systems

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FUNDAMENTAL QUESTIONS/CHALLENGES

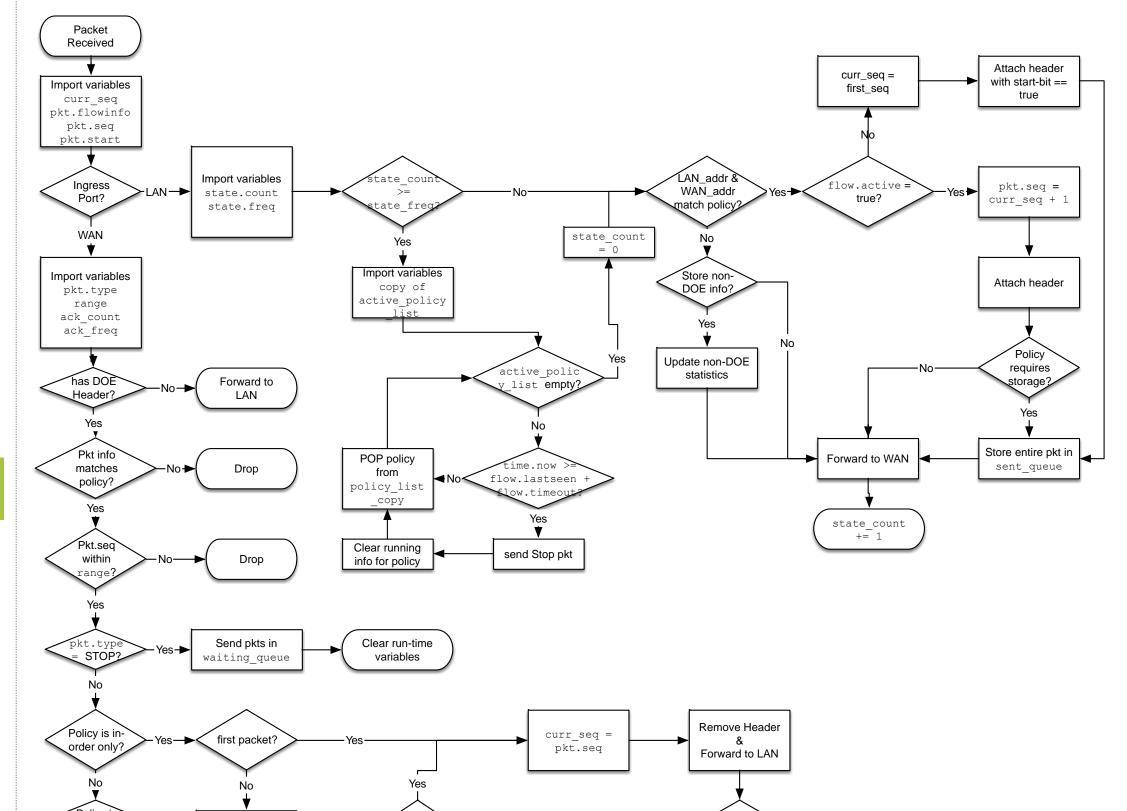
Sensor data and control directives from oil/gas production facilities are • commonly transmitted unencrypted using unreliable transport protocols over lossy network infrastructures.

- Even in cases where encryption or reliable transmission is used, • network threats evolve on a time scale significantly faster than the upgrade schedules of industrial equipment.
- This activity decouples the implementation of secure, reliable transport ulletfrom the actual industrial hardware, providing agility in responding to new threats without downtime of production equipment or waiting for vendor upgrades.

RESEARCH PLAN

- Create emulated topologies with end hosts to create the unreliable • transfer scenarios in oil/gas industrial control systems (ICS)
- Observe and examine loss and other conditions that impact resilience ulletof the network
- Develop and implement algorithms to increase connection resilience ulletto be run on network function nodes

RESEARCH RESULTS



- Develop and create metrics to define and measure topology resilience ulletand connection quality
- Test the connection quality achieved on infrastructure that is created ٠ on the GENI testbed

INTERACTION WITH OTHER PROJECTS

- Operational knowledge has been gained through our meetings with ulletour collaborator, Dr. Art Conklin.
- We collaborate and participate in the NSF GENI project, a nationwide • testbed for network science and engineering research.
- Our research utilizes University of Houston's NSA-funded testbed: ۲
 - Over 1000 1Gb and 10Gb switch ports from Brocade, Cisco, Dell/Force10, HP, Intel and Pica8
 - Over a dozen SDN switches
 - A variety of specialized forwarding devices (NPUs, hybrid serverswitches, etc.) from Caros, Cavium, Freescale, Intel, and Znyx
 - Over 250 general purpose CPU cores and 1.5TB of ram across two dozen servers
 - Over 100TB of raw storage capacity and 24 line-rate taps

Assign incoming Policy requires lossless? pkt.seq > packet sequence Drop acknowledgement curr_se number as pkt.seq Import variables sent queue missing_queu waiting_queue Send ack Stop Pkt in Drop pkt stating packet = RFR? ack_count == 0 Forward buffered copy of pkt to WAN Flush sent_queue = Send ack. pkt sent_queue missing_queue = = ACK? up to ack_seq Remove Heade ack_count += 1 ack count curr_seq ack_freq? true? pkt.seq Forward to LAN _seq Remove Heade Update t.sec in Flow is End curr_seq active? waiting_queu Forward to LAN to pkt.see pkt **in** remove from pkt.seq Send RFR curr_se sing qu issing_queu ssinq ue have Drop outstandin Append values

Append to

waiting_queue

issing_q

empty?

BROADER IMPACT

Network function insertion for reliable and secure control messaging over commodity transport

• No need to replace existing equipment to gain functionality • Single point of testing and certification

 Guarantee in-order delivery of individual messages • Per-device/flow or per-site ordering

between pkt.seq

and curr_seq **to**

missing queue

• Single point of configuration for an entire site

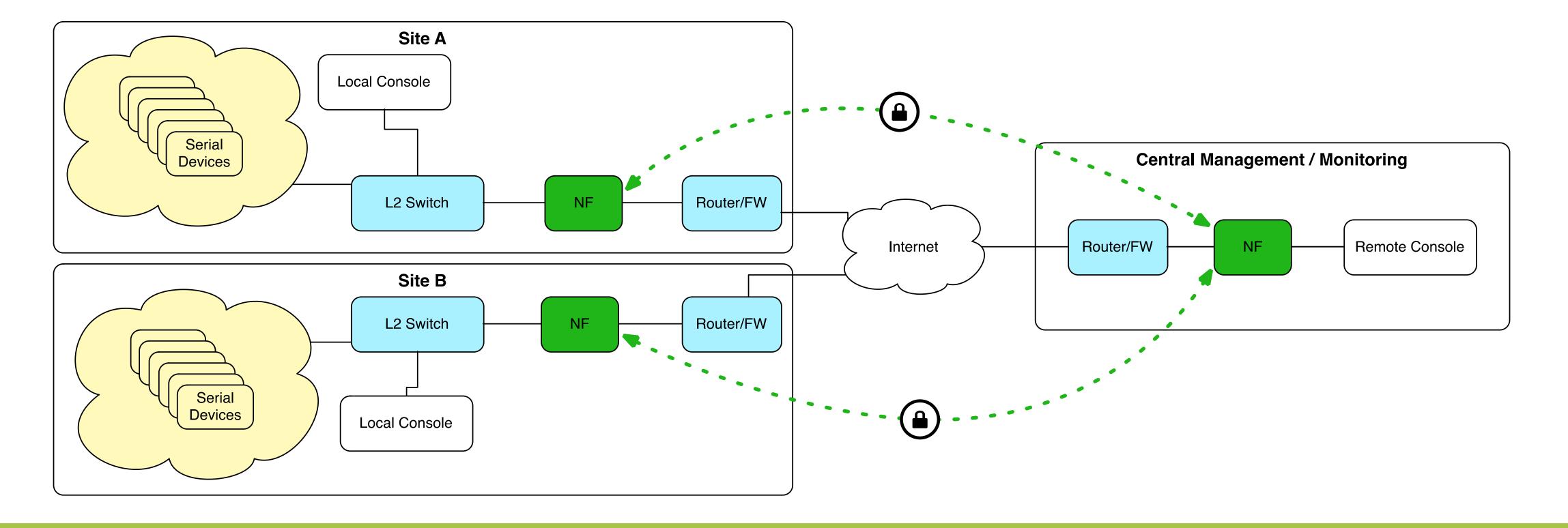
• No need for power-hungry CPU or added cost to individual devices

pkt.seq >

curr_seq + 1

• Wide options for site-to-site encryption

• Possible transparent (port-mirroring) operation



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