A Real-World Analysis of Lightweight Cryptographic Algorithm ASCON

NIST Lightweight Cryptography Workshop 2022

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Agenda

- Background and Introduction
- Motivation and Problem Statement
- Experimental approach
- Results
- Discussion
- Summary, Next Steps, Conclusion

Introduction and Background

- Cyber-physical systems are growing exponentially
- Data sharing introduces new threat landscape
- Low SWaP-C devices cannot implement common cryptographic algorithms
  - This influenced lightweight cryptographic algorithms
- Literature lacks metrics on real world applications of lightweight crypto algorithms

https://news.usni.org/2022/04/06/panel-pentagon-needs-to-be-clearer-on-goals-for-jadc2Panel: Pentagon Needs to be Clearer On Goals for JADC2 - USNI News

Early implementation and analysis leads to future preparedness and better adoption.

Motivation

- Low SWaP-C/embedded device communication
  - IP/Internet backbone
  - Message Brokers
- Efficient data sharing is key, but data protection is paramount
  - IoT and Ransomware
  - IoT as a pivot point

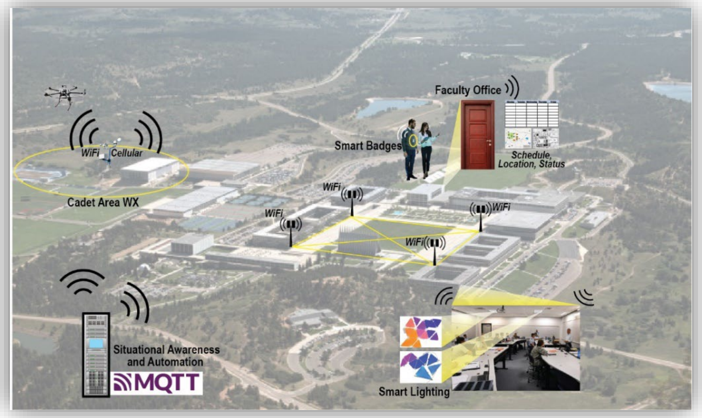
JADC2 and IoT require changes to cryptographic algorithms to support domain.

Lightweight Cryptographic Algorithm: ASCON

- Publicly available algorithm that provides both confidentiality and message integrity (Authenticated encryption with associated data (AEAD) and hashing)
- Finalist in the Competition for Authenticated Encryption: Security, Applicability and Robustness (2014 – 2019)
- Finalist in NIST Lightweight Cryptography Competition
- Post quantum capabilities and consistently a top performing algorithm across various benchmarks

Experimental Approach

- United States Air Force Academy Internet of things Development environment
  - Raspberry Pi devices
    - Raspberry Pi Zero with 1GHz, single core SoC, 512 MB RAM
    - Raspberry Pi 3 with 1.2 GHz, quad core SoC, 1 GB RAM
    - Raspberry Pi 4 with 1.5 GHz, quad core SoC, 1GB RAM
  - Weather data messaging system
  - Personnel location tracking system



- Long running experiments performed over 30 min – 12 hours
  - RAM
  - CPU
- Roundtrip time experiments evaluate time for message sharing, encryption and decryption for different size messages

Experimental Results

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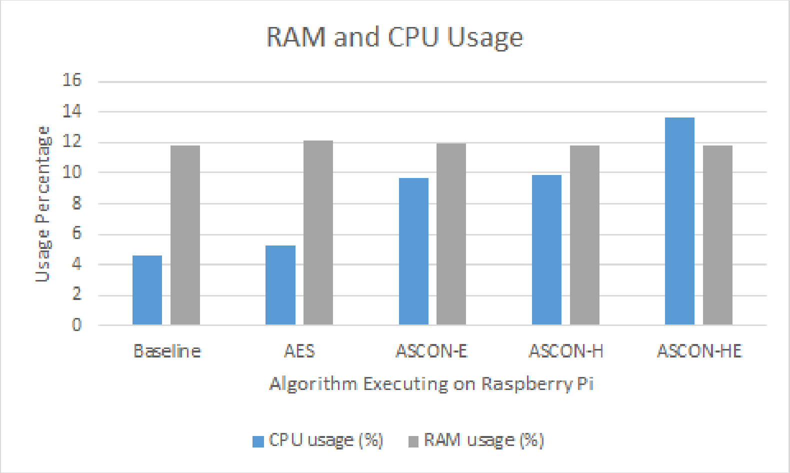
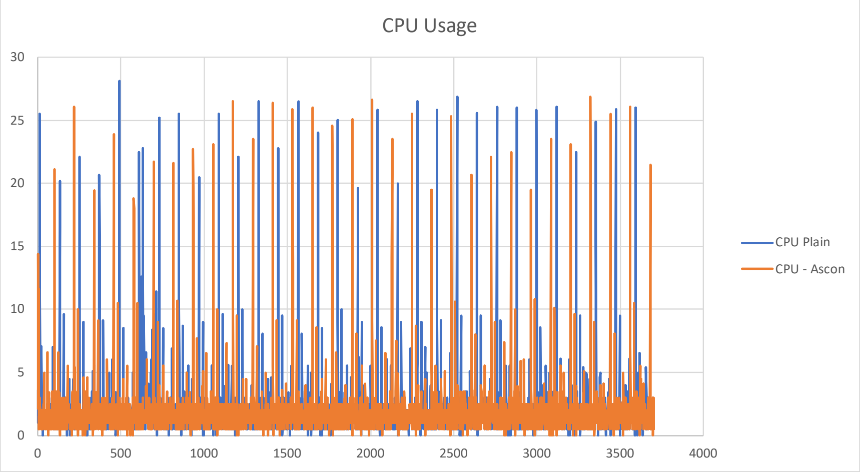
	Average time per trial		
Message length (bytes)	No encryption	ASCON	AES
10	2.67E-06	1.85E-04	6.96E-06
100	2.89E-06	3.61E-04	6.63E-06
500	2.42E-06	7.76E-04	5.30E-06

Experiment 1: Message length evaluation



Experiment 2: AES & ASCON Comparison



Experiment 3: 30 min ASCON CPU Usage

Discussion

- Performance was as expected for ASCON compared to AES
  - High degree of software design in AES and relative infancy of ASCON
  - Additional resource constrained devices will not be able to run AES without additional modifications
- Lightweight cryptographic standards provide necessary antispoofing capabilities
  - MQTT does not natively include this as a capability

Additional analysis and application of LWC algorithms will provide necessary confidentiality and availability to realize a secure JADC2 comms infrastructure.

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Next Steps

- Perform additional security evaluations
  - Currently, cadets are evaluating spoofing capabilities and hardening their environment using ASCON to drive both confidentiality and integrity
- Implement additional lightweight cryptographic algorithms in the environment
  - This will provide additional measures of performance and flexibility to choose algorithms for different scenarios
- Key management
  - Additional experimentation to evaluate key management approaches and their impact on low SWaP-C devices

Summary and Thanks

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