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

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
Lightweight Cryptographic Algorithm: ASCON

• Publicly available algorithm that provides both confidentiality and message integrity (Authenticated encryption with associated data (AEAD) and hashing)


• 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

<table>
<thead>
<tr>
<th>Message length (bytes)</th>
<th>No encryption</th>
<th>ASCON</th>
<th>AES</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>2.67E-06</td>
<td>1.85E-04</td>
<td>6.96E-06</td>
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<tr>
<td>100</td>
<td>2.89E-06</td>
<td>3.61E-04</td>
<td>6.63E-06</td>
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<tr>
<td>500</td>
<td>2.42E-06</td>
<td>7.76E-04</td>
<td>5.30E-06</td>
</tr>
</tbody>
</table>

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.
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

Special thanks to the NIST LWC Project Team!

Samuel Dick, Bryson Fraelich, William Duran, Andrew Lee, Agustin Sullivan, Zane Maechalke, Maj. Bobby Birrer
Dr. Steve Fulton, Eric Payne, James Cantrell
Northrop Grumman Corporation
United States Air Force Academy