A Secure Network Architecture for the Internet of Things Based on Local Authorization Entities

Hokeun Kim, Armin Wasicek, Benjamin Mehne and Edward A. Lee (UC Berkeley)

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http://terraswarm.org/

Motivation

Main Challenges for IoT Security

- Heterogeneity in security requirements & resource availability

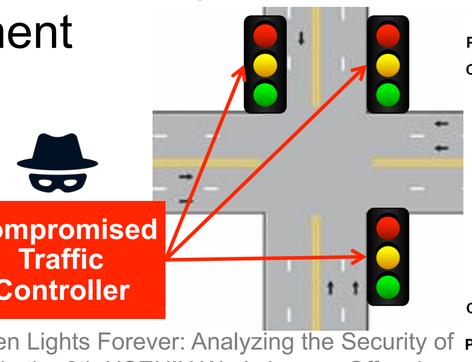
Cardiac monitor and emergency service
- Privacy
- Resource constraints

Drones and ground air traffic control
- Strong and frequent authorization
- Intermittent connectivity

Apple pay
- Confidentiality
- Authentication
- Moderate resource constraints

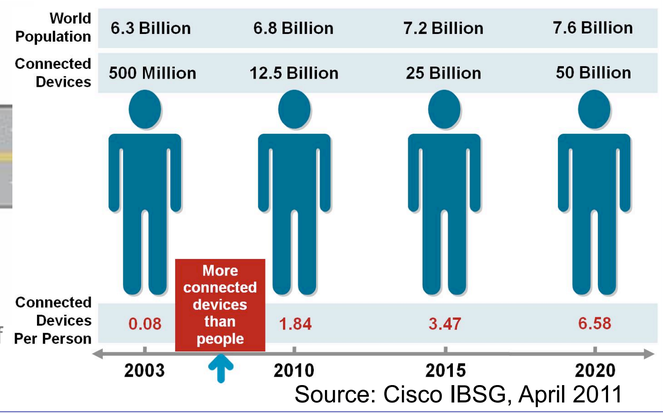
Ambient temperature sensors and receivers
- Data integrity
- Resource constraints

- Operation under open/untrusted environment



B. Ghena, *et al.*, "Green Lights Forever: Analyzing the Security of Traffic Infrastructure," in the 8th USENIX Workshop on Offensive Technologies 2014 (WOOT 14)

- Scalability



Source: Cisco IBSG, April 2011

IoT-related Security Requirements Breakdown

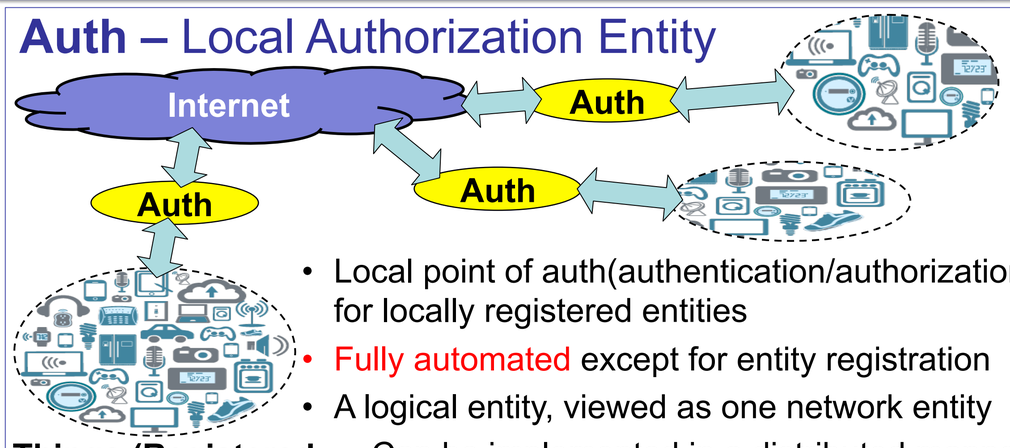
- Strong and frequent authorization & authentication for safety-critical components
- Automated mutual authentication for machine to machine communication
- Dealing with intermittent connectivity
- Support for one-to-many communication (e.g., broadcasting, publish-subscribe) for scalability
- Consideration for resource-constrained devices
- Privacy
- Dynamic entity registration

Goal

- **Organization of existing security measures with emphasis on flexibility and usability**
  - **To address IoT-related security requirements above**

Proposed Approach Overview

Auth – Local Authorization Entity



- Local point of auth(authentication/authorization) for locally registered entities
- Fully automated except for entity registration
- A logical entity, viewed as one network entity
  - Can be implemented in a distributed manner to increase availability

Auth DB – Information for Local Authorization

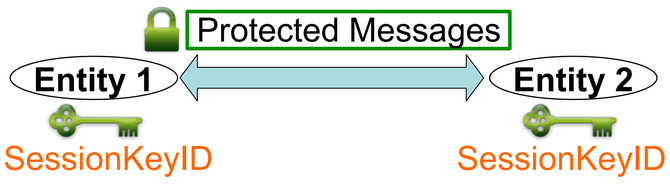
Main Database Tables
- Registered Entity Table
- Communication Policy Table
- Cached Session Key Table

Information for Each Entity
- Unique name, group
- Distribution key, key distribution conditions
- Dynamic entity registration is manageable w/ local Auth

Session Keys Generated by Auth
- Current owner(s)
- Validity periods
- Support for entities with intermittent connectivity (allow caching keys)

Specification of Secure Communication
- Cipher/hash algorithm, crypto key length, validity period
- Different communication policies to support heterogeneous security requirements
- From safety-critical entities under untrusted environment (frequent authorization) to resource-constrained devices

Session Key – For Protecting Communication

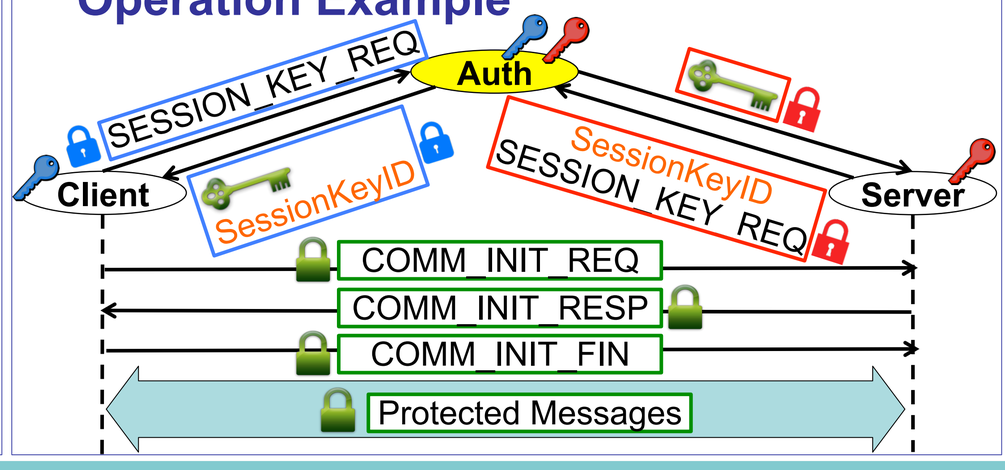


- **Symmetric crypto key for protecting a single session of communication**
  - Generated by Auth, delivered to authorized entities
  - Has a unique session key ID, specified usage conditions (cipher, hash, validity periods)

Distribution Key – For Secure Delivery of Session Keys

- **Pre-shared symmetric key to encrypt session keys**
  - Only known to Auth & entity
  - W/ specified usage conditions (cipher, hash, validity periods)
- **Updating distribution key**
  - W/ public key crypto (keys exchanged during entity registration)
  - If a resource-constrainted entity can't perform public key crypto, it can optionally use permanent distribution key without updates

Operation Example



Experiments and Results

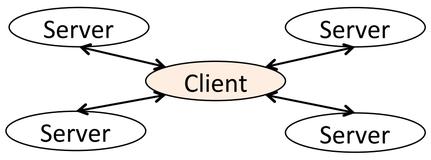
Evaluation of Scalability of Proposed Approach and SSL/TLS for following scenarios

Experimental Setup

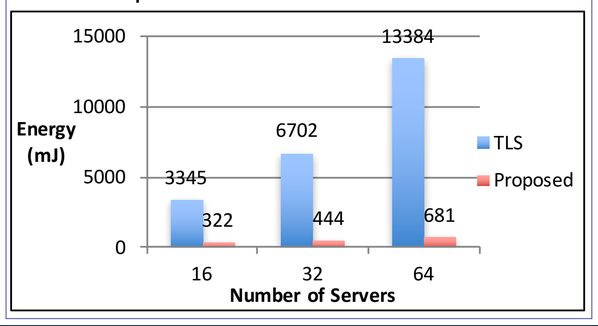
- Assume that there is a resource-constrained client/publisher which communicates with multiple servers/subscribers
- Measure security overhead of the resource-constrained client/publisher
- Convert the security overhead (network packets, cyprto operations) into energy consumption using numbers in [1],[2]

[1] Feeney and Nilsson. "Investigating the energy consumption of a wireless network interface in an ad hoc networking environment", IEEE INFOCOM 2001
[2] Rifa-Pous and Herrera-Joancomarti. "Computational and Energy Costs of Cryptographic Algorithms on Handheld Devices", Future Internet, Feb. 2011.

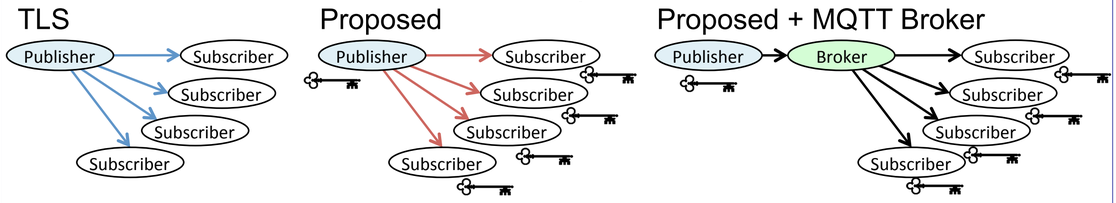
Scenario 1: A resource-constrained client and servers



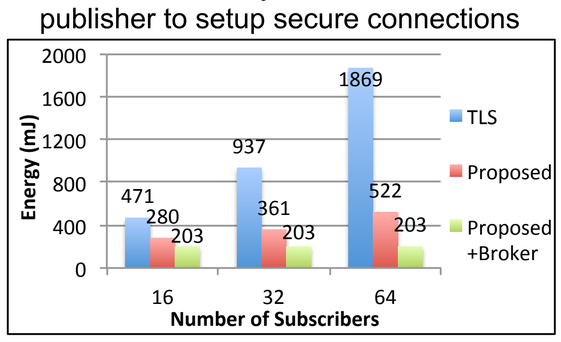
- Estimated security overhead for the client to setup secure connections with servers



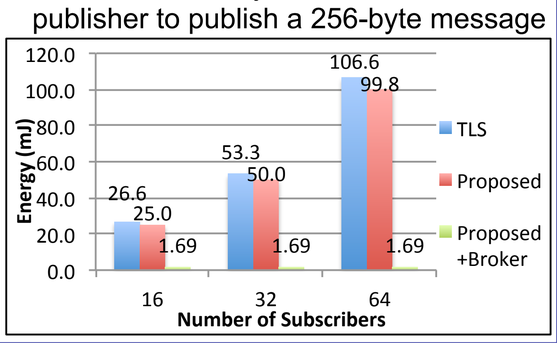
Scenario 2: A resource-constrained publisher and subscribers



- Estimated security overhead for the publisher to setup secure connections



- Estimated security overhead for the publisher to publish a 256-byte message



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