CIS 700/002 : Special Topics : Secure MQTT for IoT

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CIS 700/002: Security of EMBS/CPS/IoT

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What is MQTT?

- Message Queue Telemetry Transport (MQTT) is a publish-subscribe-based "lightweight" messaging protocol over TCP/IP protocol

TABLE I: MQTT Header

bit	7	6	5	4	3	2	1	0
byte 1	Message Type				DUP Flag	QoS Level		Ret
byte 2	Remaining Length							
Variable Header								
Payload								

https://en.wikipedia.org/wiki/MQTT

Why MQTT?

- Quite popular
  - Facebook Messenger
  - AWS IoT
- Lightweight
  - Minimize code footprint on devices
  - Reduce network bandwidth usages

The goal of “Secure” MQTT

- Authenticate each IoT device
- Encrypt communication channels btw IoT devices
  - Focus of this paper

“Secure” MQTT Alternatives

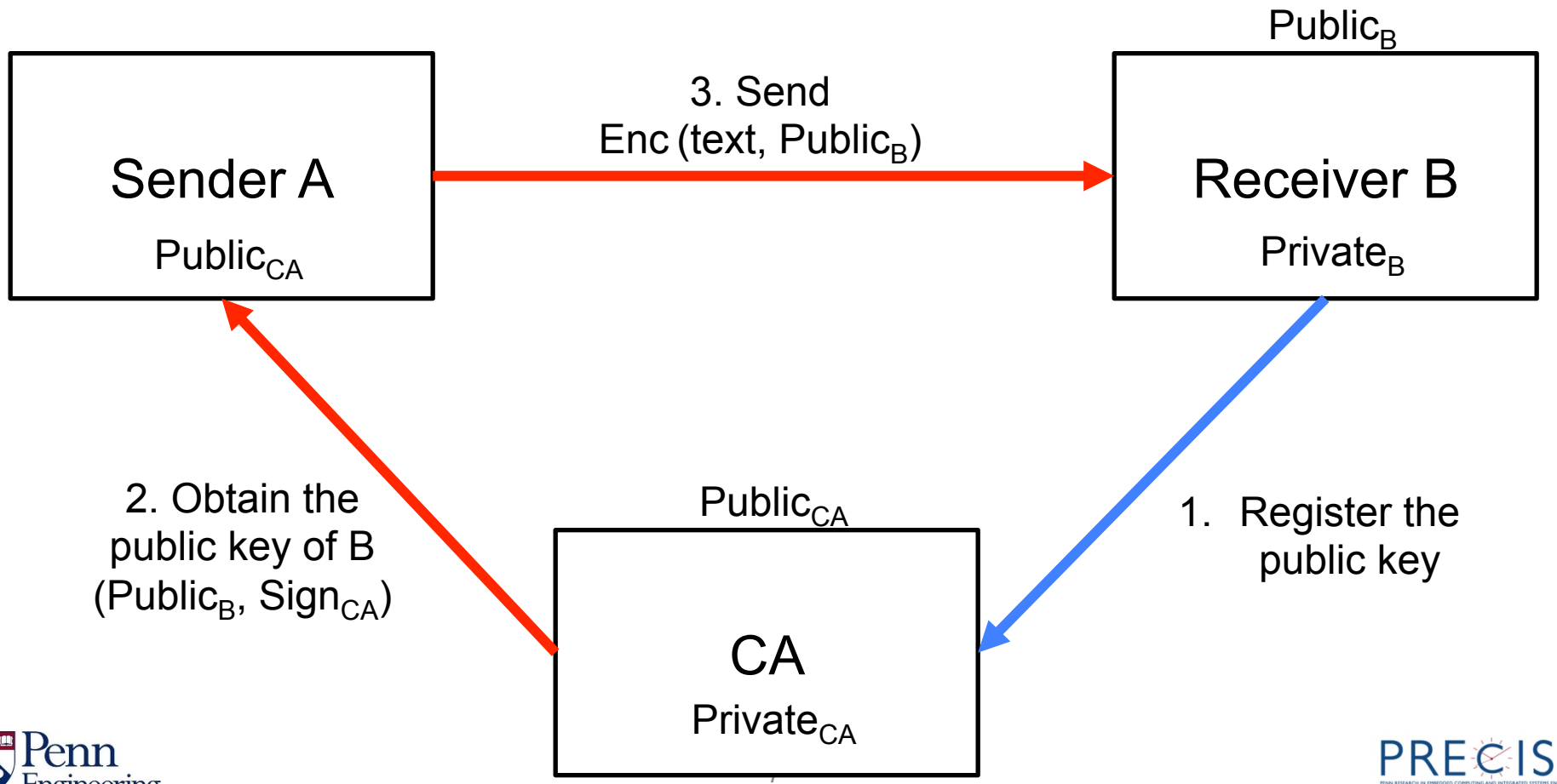
- MQTT + SSL/TLS
  - Storing and managing the certificates are cumbersome
  - SSL/TLS is weak on various attacks (e.g., BEAST, CRIME, RC4, Heartbleed)
  - (we think) key revocation is not simple

Contributions

- Proposes a secure MQTT protocol
  - MQTT + Attribute Based Encryption (ABE)

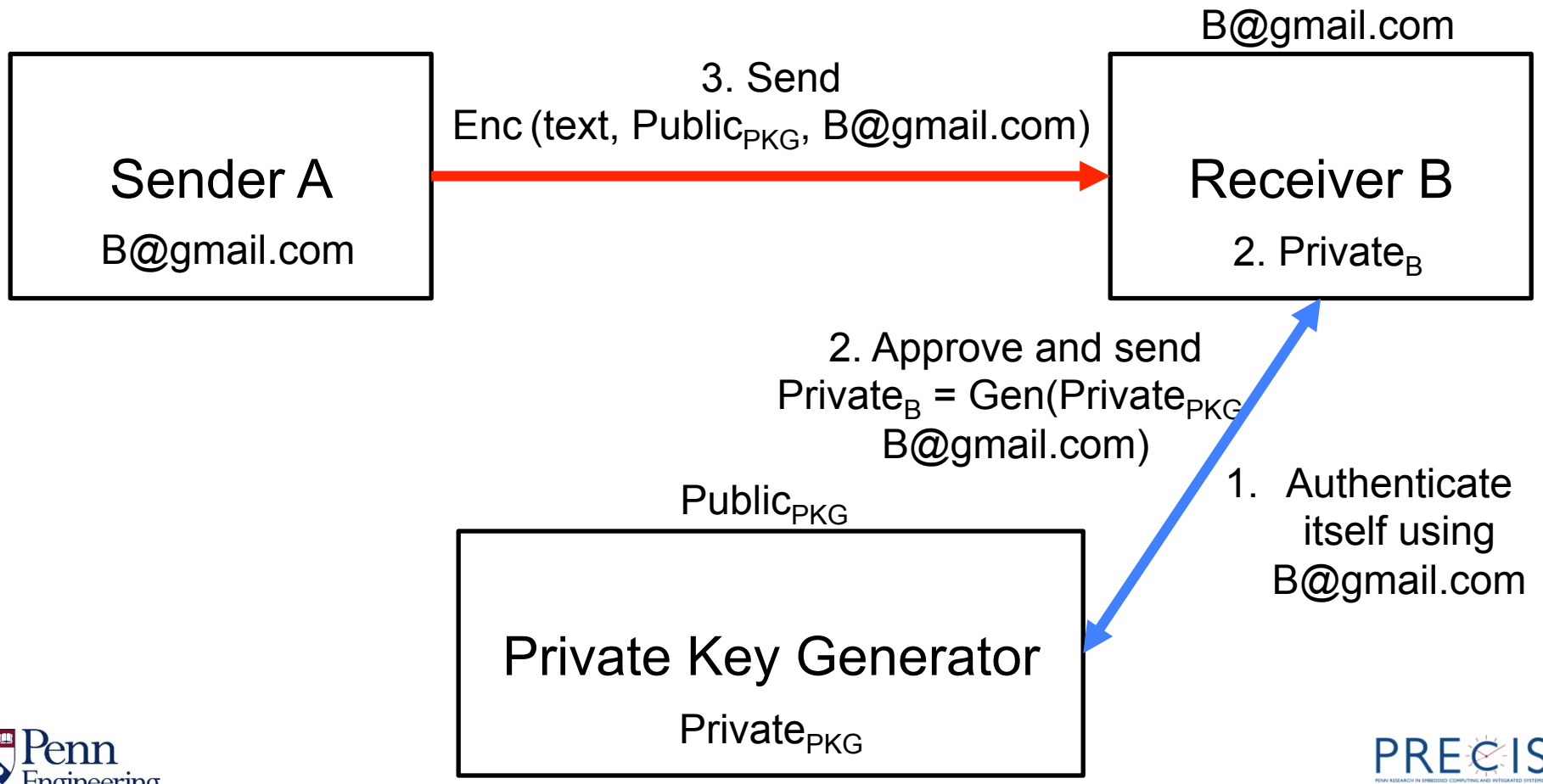
Public-key Encryption

- Identity of a receiver
  - The public key of the receiver



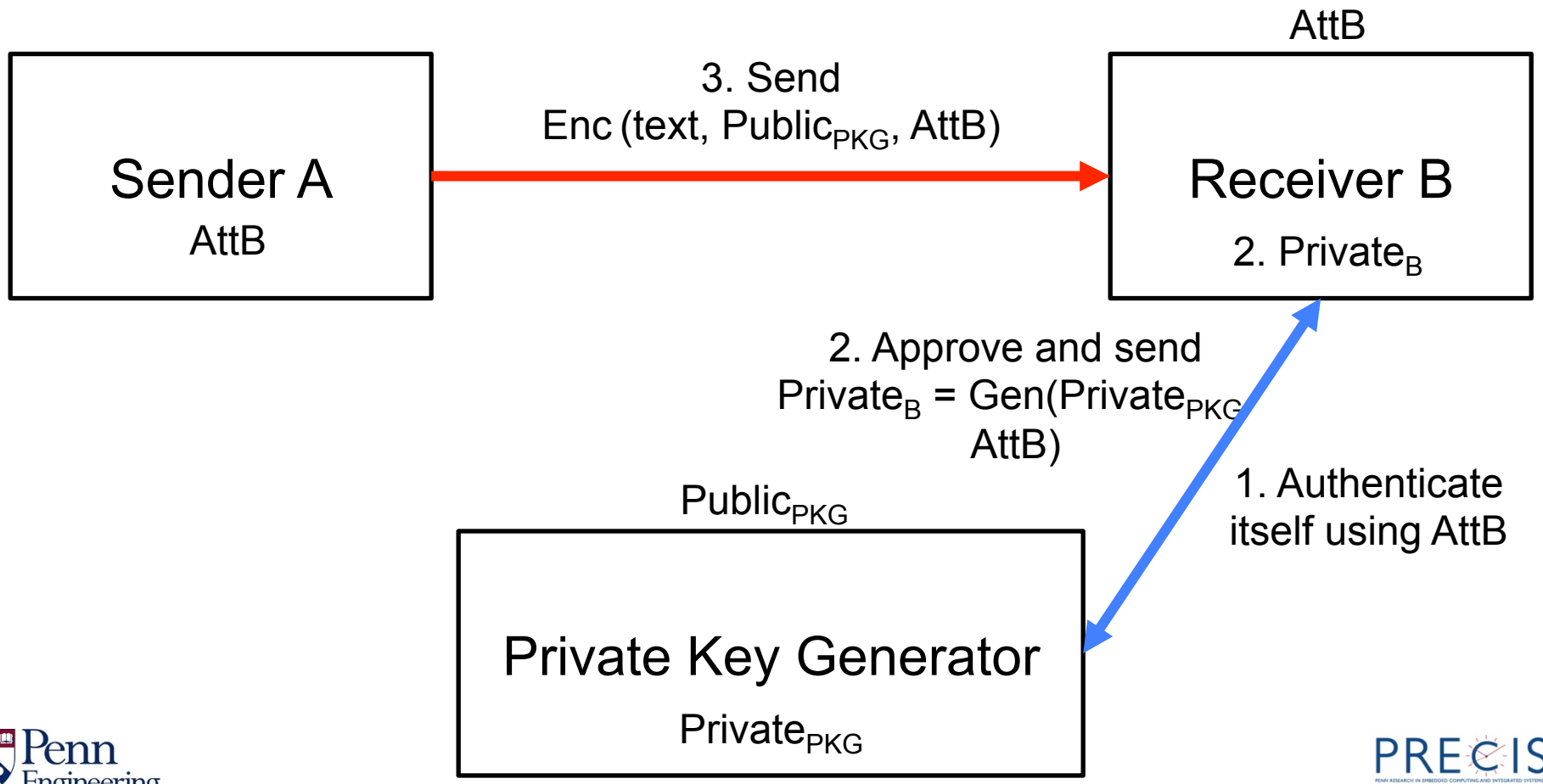
Identity Based Encryption

- Identity of a receiver
  - ID of the receiver



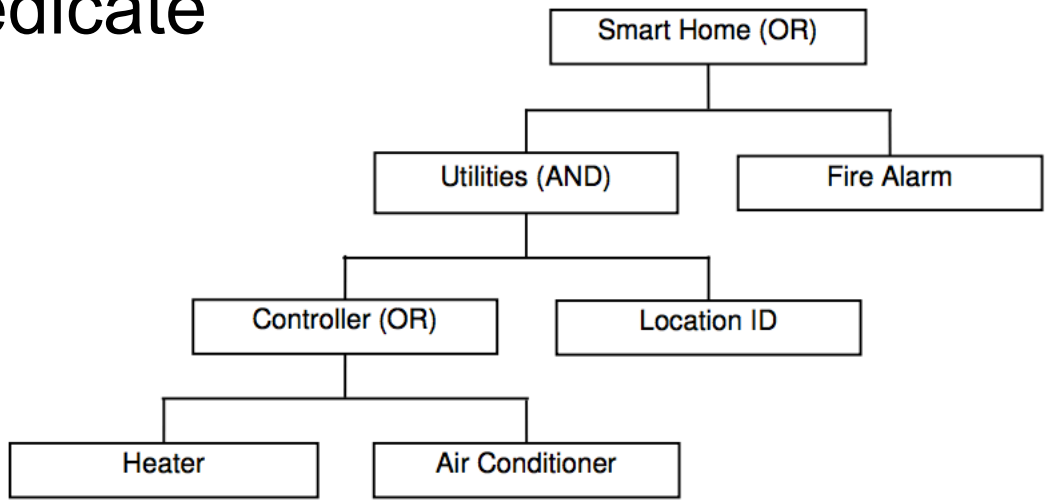
Attribute Based Encryption (ABE)

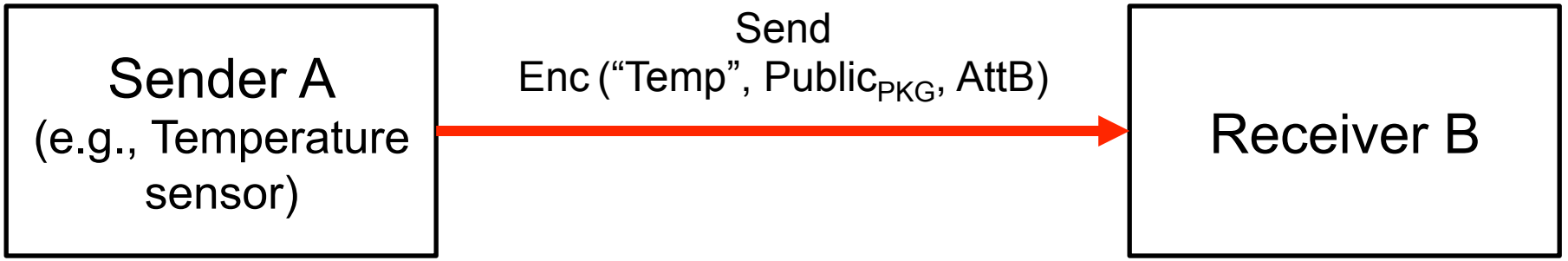
- Identity of a receiver
  - Attributes of the receiver



Attributes

- An attribute of receivers
  - A predicate



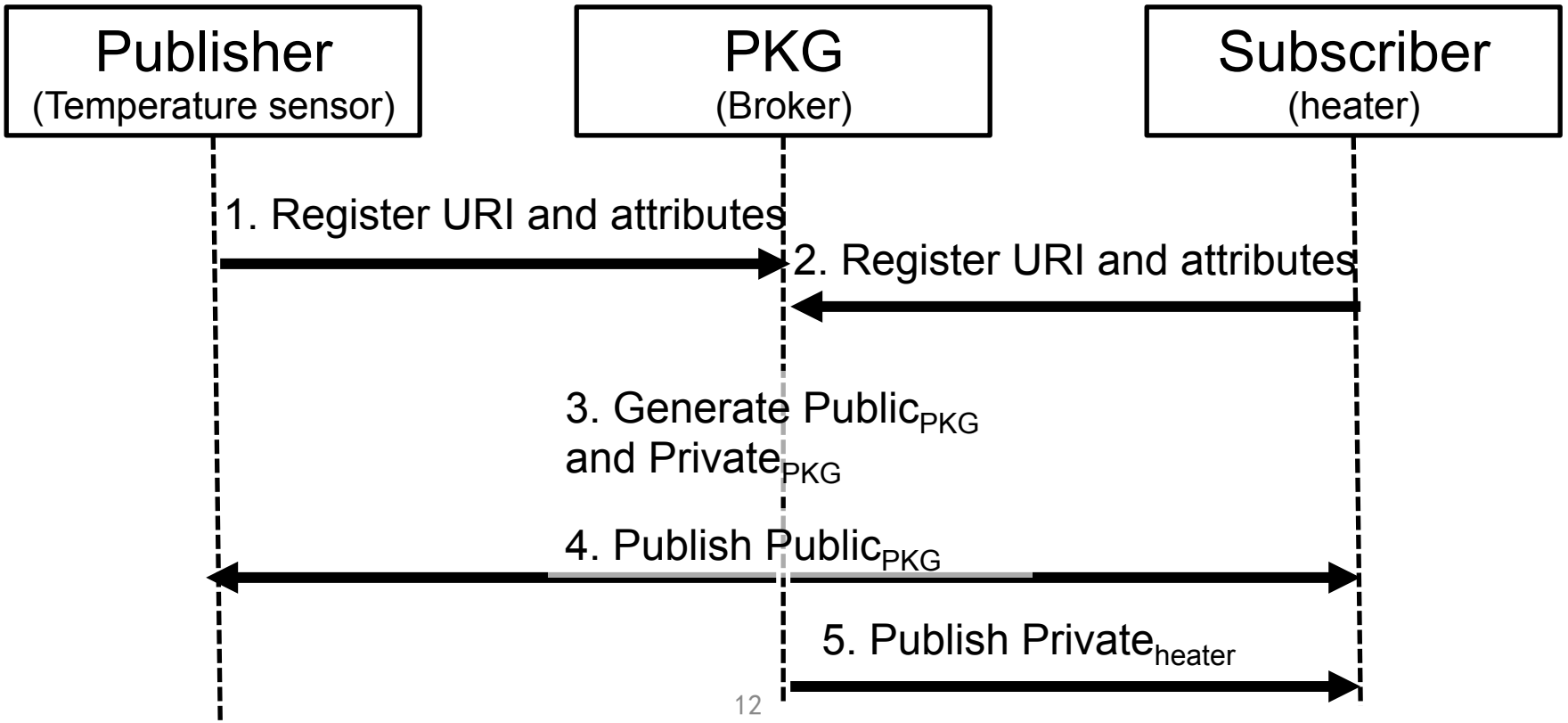


Proposed Secure MQTT (SMQTT)

- SMQTT = MQTT+ABE
  - Update MQTT protocol for ABE
  - Use the ABE scheme based on lightweight Elliptic Curve Cryptography
  - Types of ABE
    - Ciphertext-Policy ABE (CP-ABE)
    - Key-Policy ABE (KP-ABE)

SMQTT Protocol

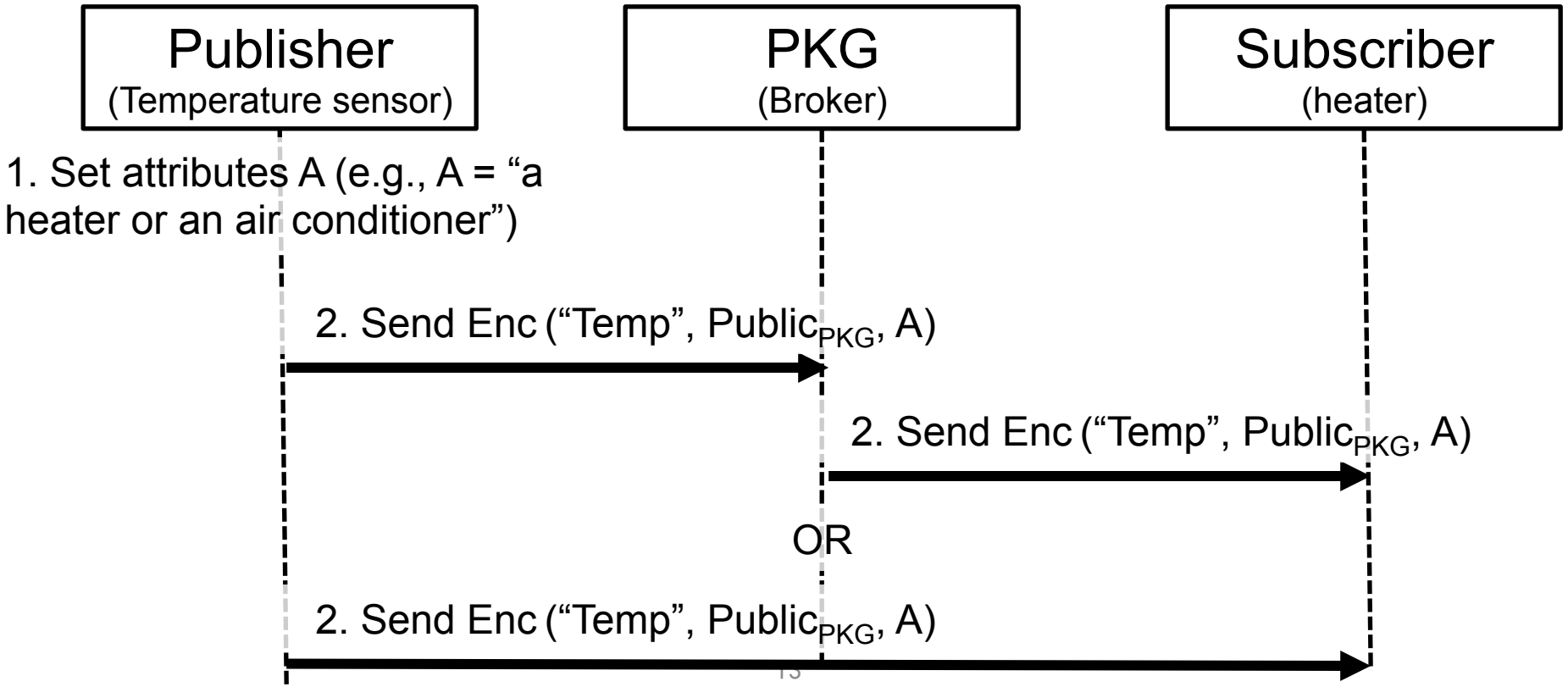
- Setup phase



Note. The universe of all attributes U is known for all entities

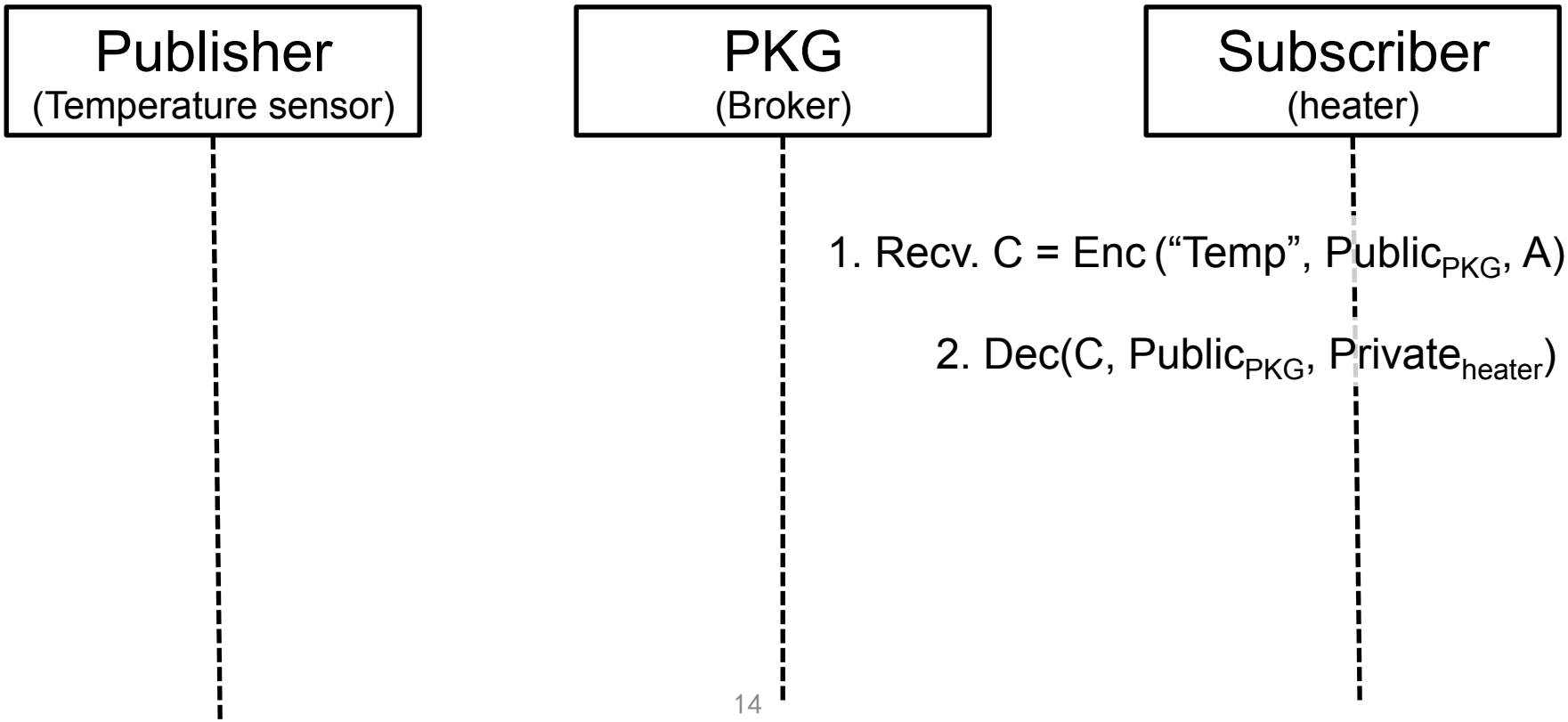
SMQTT Protocol

- Encryption/Publish phase



SMQTT Protocol

- Decryption phase



Performance Analysis

- System details

Hardware	Intel Core DUO CPU@3Ghz
Primary Memory capacity	2 GB
Operating System	Windows 7, 32bit, Linux Mint 13
Java version	1.6
MQTT version	3.1
Broker version	Mosquitto Broker 1.2
Client (Publisher and Subscriber)	Eclipse Paho client 0.9

- Setup phase time of PKG

TABLE VI: Set up Time for KP/CP-ABE

Key Size	KP-ABE (ms)	CP-ABE (ms)
256 bits	187	588
512 bits	4307	19177

Discussion

- Pros/Cons of SMQTT protocol for IoT

- Pros
  - Prior key distribution is not required
  - Broadcast encrypted messages

- Cons
  - How does PKG verify the attribute of a receiver?
    - “PKG verifies attributes and other details given by the device”
    - Any adversary can claim any attributes