# IoT Security and Interoperability

Dr Priyanka Bagade, IITK

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# Tools for Achieving Security – 1 [1]

- Virtual Private Networks (VPN)
    - Enables traditional M2M systems working in intranet to transport messages over internet
    - Devices in traditional M2M work similar to when they connect in local network. However the communication happens through internet
    - Disadvantage:
        - Can’t connect to other devices over internet
        - Introduces lack of interoperability which one of the important requirements of IoT technology

# Tools for Achieving Security – 2 [1]

- X.509 certificates and encryption
  - Validates the identities of the devices/users on the internet
  - Supports a Public Key Infrastructure (PKI) architecture.
  - Has Public and Private keys
    - Public key is used for encryption which is publicly available
    - Message can only be decrypted using the private key which is with the trusted user
  - Challenges of using certificates
    - Needs to be installed in the device
    - Limited life span – needs to be updated  when it is still valid
    - Needs a scalable infrastructure for validation
    - Needs to be administer continuously
    - All these challenges make it difficult to be applicable for sensor nodes where close administration is cumbersome

# Tools for Achieving Security – 3 [1]

- Authentication of identities
    - Validates the identities of the device
    - Server authentication – uses certificates
        - Check if the certificate has not be revoked
        - Check if corresponds to the domain name used to connect to the server
    - Client authentication – uses credentials
        - Requires system architects to understand available authentication methods
        - Application later communication protocols such as HTTP and XMPP, use the standardized Simple Authentication and Security Layer (SASL) to publish authentication methods to choose from.
            - Weakness – can trick clients using less secure authentication method to reveal secret to the imposter
            - Suggestions
                - Not to use use unsecured or obsolete methods, such as PLAIN, BASIC, MD5-CRAM, MD5-DIGEST etc
                - use secure methods such as SCRAM-SHA-1 or SCRAM-SHA-1-PLUS
                - If unsecure method is the only option, add it as a warning to event log or inform the operator for the choice of unsecure authentication
        - MQTT sends user credentials in clear text (PLAIN authentication method) enforces clients to use encryption
        - CoAP does not provide inbuilt authentication method. It is built on top of the protocol
        - Lack of authentication methods affects interoperability negatively

# Tools for Achieving Security – 4 [1]

- Usernames and passwords
    - Common method for user authentication
    - Machines use pre-shared key (PSK) for authentication
    - Create passwords randomly to make it similar to PSK methods for machines
    - Challenge:
        - Administration of the credentials
        - Client and server needs to be aware of the identity information
        - Needs to be distributed with the all the devices communicating with the server
    - For XMPP protocol,
        - the device creates its own random identity
        - creates the corresponding account in the XMPP server in a secure manner
        - no need for a common factory default setting
        - reports its identity to a Thing Registry or provisioning server where the owner can claim it and learn the newly created identity
        - never compromises the credentials and does not affect the cost of production negatively
    - Never store password in original format – always store their hashes

# Tools for Achieving Security – 5 [1]

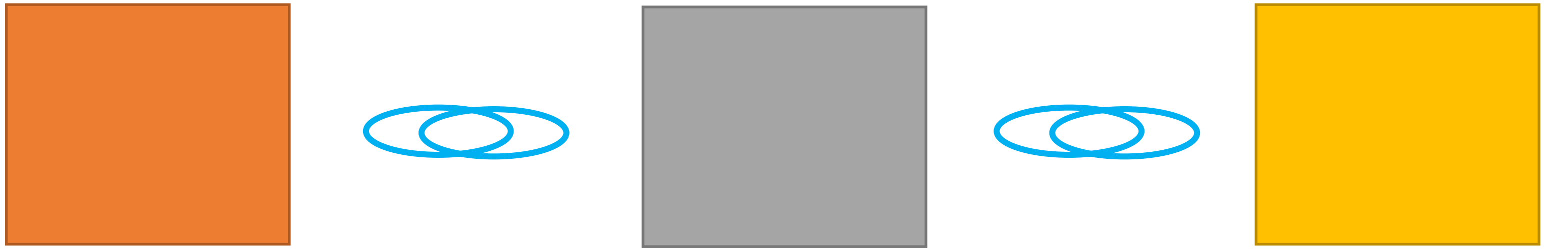
- Using message brokers and provisioning servers
  - Enhances the security
  - Lowers the complexity of the implementation for authentication
  - XMPP servers authenticate clients connected to them also the servers themselves when they intercommunicate to transport messages between domains
    - relieves clients to authenticate each entity trying to connecting to it
  - MQTT does not provide client authentication as a default service

# Tools for Achieving Security – 6 [1]

- Centralization versus decentralization
  - Decentralization provides better security
  - IoT architecture design considerations
    - Avoid storing data in a central position if possible. Only store the data centrally that is actually needed to bind things together.
    - Distribute logic, data, and workload to make solution more scalable
    - Use linked data to spread data across the Internet
    - Use a federated set of small local brokers instead of trying to get all the devices on the same broker
      - XMPP supports federated brokers, MQTT does not.
    - Let devices talk directly to each other instead of having a centralized proprietary API to store data or interpret communication between the two
    - Use small and energy-efficient microcomputers such as the Raspberry Pi in local installations as an alternative to centralized operation and management from a datacenter

# Blockchain Technology

- Distributed database technology with hard to tamper ledger records
- Stores transactions into immutable records
- All records are distributed across multiple participants



- Data
- Hash
- Hash of previous block

# Blockchain for IoT

- Need to use decentralized security for IoT
    - A centralized security model is expensive to scale, maintain and manage.
    - A centralized security infrastructure leads to a single point of failure
        - Easy target for DOS attacks
    - Centralized infrastructure is not suitable for widespread IoT devices
- Mainly used for cloud computing in IoT
- IoT devices are connected via the Blockchain through the cloud
- Hybrid approach
    - Use traditional security methods for data transmission between IoT devices
    - Use blockchain for data communication through cloud
- Challenges of using blockchain in IoT
    - Data replication introduces latency
    - Not suitable for storing real time data due to strong cryptographic process

# Interoperability in IoT Devices [1]

- Heterogeneity in IoT devices
- Solves complexity
  - Communicate with each other with commonly understood language
  - Simplifies installation and device management
- Reduces cost
  - Increases competition in device manufacturers which leads to cost reduction and improvement in functionality and quality
- Allows new kinds of services and reuse of devices
  - Leads to the need of a secure communication infrastructure and an interoperable one
- Combining security and interoperability

# Reading Material

1. Waher, Peter. *Learning internet of things*. Vol. 3. Birmingham: Packt publishing, 2015.

# Questions?