TECHNICAL CODE

INTERNET OF THINGS (IoT) - SECURITY MANAGEMENT

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Development of technical codes

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Foreword

This technical code for Internet of Things (IoT) - Security Management ('this Technical Code') was developed pursuant to section 185 of the Act 588 by the Malaysian Technical Standards Forum Bhd ('MTSFB') via its Information and Network Security Working Group. This technical is an extension to the requirement as stipulated in MCMC/MTSFB TC G009:2016, *Requirements for Information and Network Security*.

This Technical Code shall continue to be valid and effective until reviewed or cancelled.

INTERNET OF THINGS (IoT) - SECURITY MANAGEMENT

0. Introduction

The Internet of things (IoT) can be perceived as a far-reaching vision with technological and societal implications. From the perspective of technical standardisation, the IoT can be viewed as a global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving interoperable information and communication technologies (ICT). Through the exploitation of identification, data capture, processing and communication capabilities, the IoT makes full use of "things" to offer services to all kinds of applications, whilst ensuring that security and privacy requirements are fulfilled.

The IoT is expected to greatly integrate leading technologies, such as technologies related to advanced M2M communication, autonomic networking, data mining and decision-making, security and privacy protection and cloud computing, with technologies for advanced sensing and actuation.

The dependency on IoT is imminent - and so are the challenges and threat it will inevitably bring to security and privacy. A strong commitment to provide a secure and resilient network, protecting sensitive information, is necessary to mitigate the risk.

1. Scope

This Technical Code provides an overview of the Internet of Things (IoT) security management framework with requirements guideline for services provider in the IoT ecosystem. It provides security principles, security objectives and requirement for IoT services provider as an extension to the requirement as stipulated in the document 'MCMC/MTSFB TC G009:2016 - *Requirements for Information and Network Security'*.

2. Normative reference

The following normative references are indispensable for the application of this Technical Code. For dated references, only the edition cited applies. For undated references, the latest edition of the normative references (including any amendments) applies.

ITU-T Y.4000/Y.2060, *Overview of the Internet of Things*

ITU-T Y.4100/Y.2066, *Common requirements of the Internet of Things*

ITU-T Y.4401/Y.2068, *Functional framework and capabilities of the Internet of Things*

3. Abbreviations

IoT	Internet of Things
M2M	Machine-to-Machine

4. IoT security threats

4.1 As mentioned, if the IoT Layers are not properly configured, the IoT devices and system might expose to the security threats. The vulnerabilities appear in all code from time to time and this includes compromise of device, infrastructure, network and interface.

4.2 The current state of IoT security seems to take all the vulnerabilities from existing space, such as network security, application security, mobile security, and Internet connected devices, and combine them into a new (even more insecure) space. Furthermore, based on a study, among the threats are

a) 90 % of IoT devices collected at least contains one personal information;

b) 80 % of devices along with their cloud and mobile application components failed to require password of a sufficient complexity and length;

c) 70 % of IoT devices did not encrypt communications to the Internet and local network;

d) 70 % of IoT devices along with their cloud and mobile application enable an attacker to identify valid user account through account enumeration techniques; and

e) 6 out of 10 IoT devices that provide user interfaces were vulnerable to a range of issues such as persistent Cross Site Scripting (XSS).

4.3 Additionally, Open Web Application Security Project (OWASP) Internet of Things Top Ten Project listed the security issues and impact related to IoT includes:

a) Insecure Web Interface;

b) Insufficient Authentication/Authorisation;

c) Insecure Network Services;

d) Lack of Transport Encryption;

e) Privacy Concerns;

f) Insecure Cloud Interface;

g) Insecure Mobile Interface;

h) Insufficient Security Configurability;

i) Insecure software/firmware; and

j) poor physical security.

5. Principle of IoT security

The principles of IoT Security listed below are among the best practices and also a guideline of implementation of IoT Security.

5.1 Assume a Hostile Device

Devices are likely to fall into the wrong hands. Assume attackers will have physical access to devices and able manipulate and launch malicious attacks.

5.2 Test for Scale

The volume of IoT means that every design and security consideration shall also take into account scale. Simple bootstrapping into an ecosystem can create a self-denial of service condition at IoT scale. Security countermeasures shall perform at volume.

5.3 Internet of lies

Automated systems are extremely capable of presenting misinformation in convincing formats. IoT systems should always verify data from the device in order to prevent autonomous misinformation from tainting a system.

5.4 Exploit autonomy

Automated systems are capable of complex, monotonous, and tedious operations that human users would never tolerate. IoT systems should seek to apply this advantage for security purpose.

5.5 Expect isolation

The advantage of autonomy should also extend to situations where a component is isolated. Security countermeasures shall never degrade in the absence of connectivity.

5.6 Protect uniformly

Data encryption only protects encrypted pathways. Data that is transmitted over an encrypted link is still exposed at any point it is unencrypted, such as prior to encryption, after decryption, and along any communications pathways that do not enforce encryption. Careful consideration shall be given to full data lifecycle to ensure that encryption is applied uniformly and appropriately to guarantee protections. Encryption is not total - be aware that metadata about encrypted data might also provide valuable information to attackers.

5.7 Encryption is tricky

It is very easy for developers to make mistakes when applying encryption. Using encryption but failing to validate certificates, failing to validate intermediate certificates, failing to encrypt traffic with a strong key, using a uniform seed, or exposing private key material are all common pitfalls when deploying encryption. Ensure a thorough review of any encryption capability to avoid these mistakes.

5.8 Device and system hardening

Be sure that IoT components are stripped down to the minimum viable feature set to reduce attack surface. Unused ports and protocols should be disabled, and unnecessary supporting software should be uninstalled or turned off. Be sure to track third party components and update them where possible. Secured element should be embedded in hardware to additional hardware layer security protection.

5.9 Limit what you can

To the extent possible limit access based on acceptable use criteria. Limit access to white lists of rules that make sense.

5.10 Lifecycle support

IoT systems should be able to quickly on-board new components, but should also be capable of re-credentialing existing components, and de-provisioning components for a full device lifecycle. This capability should include all components in the ecosystem from devices to users.

5.11 Data in aggregate is unpredictable

IoT systems are capable of collecting vast quantities of data that shall seem innocuous at first, but complex data analysis shall reveal very sensitive patterns or information hidden in data. IoT systems shall prepare for the data stewardship responsibilities of unexpected information sensitivity that shall only be revealed after an ecosystem is deployed.

5.12 Plan for the worst

IoT systems should have capabilities to respond to compromises, hostile participants, malware, or other adverse events. There should be features in place to re-issue credentials, exclude participants, distribute security patches and updates, and so on, before they are ever necessary.

5.13 The long haul

IoT system designers shall recognise the extended lifespan of devices will require forward compatible security features. IoT ecosystems shall be capable of aging in place and still addressing evolving security concerns. New encryption, advances in protocols, new attack methods and techniques, and changing topology all necessitate that IoT systems be capable of addressing emerging security concerns for years after they are deployed.

5.14 Attackers target weakness

Ensure that security controls are equivalent across interfaces in an ecosystem. Attackers will identify the weakest component and attempt to exploit it. Mobile interfaces, hidden API's, or resource constrained environments shall enforce security in the same way as more robust or feature rich interfaces. Using multi-factor authentication for a web interface is useless if a mobile application allows access to the same API's with a four-digit PIN.

5.15 Transitive ownership and disposal

IoT components are often sold, transferred or disposed. Plan for this eventuality and be sure IoT systems can protect, isolate and sanitise data to enable safe transfer of ownership or disposal to the third party.

5.16 N:N Authentication

Realise that IoT does not follow a traditional 1:1 model of users to applications. Each component shall have more than one user and a user shall interact with multiple components. Several users might access different data or capabilities on a single device, and one user might have varying rights to multiple devices. Multiple devices shall need to broker permissions on behalf of a single user account, and so on. Be sure the IoT system can handle these complex trust and authentication schemes.

5.17 IoT value chain obligation (Software and firmware update hardened with security requirements)

a) The IoT device: The IoT device provider need to ensure that software is always running at the latest version.

b) The IoT system provider: The system provider need to ensure that software is always running at the latest version.

c) The IoT network provider: The network provider need to ensure that software is always running at the latest version.

5.18 Transparency across IoT providers

IoT Service Provider need to know their supply chain**,** namely, whether there are any associated vulnerabilities with the software and hardware components provided by vendors outside their organisation. Increased awareness could help manufacturers and industrial consumers identify where and how to apply security measures or build in redundancies. Depending on the risk profile of the product in question, developers, manufacturers, and service providers will be better equipped to appropriately mitigate threats and vulnerabilities as expeditiously as possible, whether through patching, product recall, or consumer advisory.

6. IoT reference model

The IoT reference model shown in Figure 1. It is composed of four layers as well as management capabilities and security capabilities which are associated with the four layers. The four layers are as follows:

a) application layer;

b) service support and application support layer;

c) network layer; and

d) device layer.

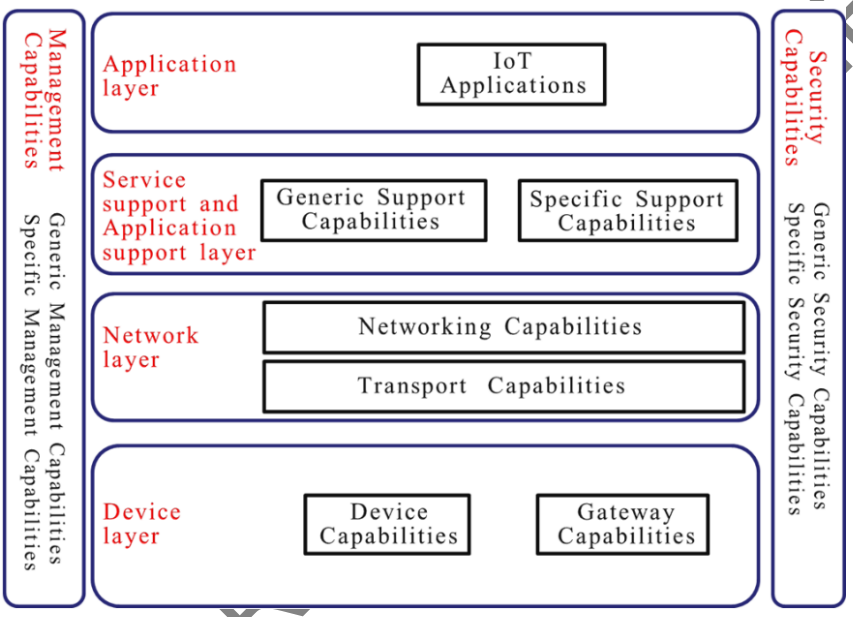

Figure 1. IoT Reference Model

6.1 Application layer

The application layer is the layer that interact with the user and it contains IoT applications. It can be in the form of mobile apps, software application or web.

6.2 Service support and application support layer

The service support and application support layer consist of the following two capability groupings:

a) generic support capabilities: The generic support capabilities are common capabilities which can be used by different IoT applications, such as data processing or data storage. These capabilities shall be also invoked by specific support capabilities, e.g., to build other specific support capabilities.; and

b) specific support capabilities: The specific support capabilities are particular capabilities which cater for the requirements of diversified applications. In fact, they shall consist of various detailed capability groupings, in order to provide different support functions to different IoT applications.

6.3 Network layer

This consists of the following two types of capabilities:

a) networking capabilities: provide relevant control functions of network connectivity, such as access and transport resource control functions, mobility management or authentication, authorisation and accounting (AAA), and

b) transport capabilities: focus on providing connectivity for the transport of IoT service and application specific data information, as well as the transport of IoT-related control and management information.

6.4 Device layer

6.4.1 Device layer capabilities can be logically categorised into two kinds of capabilities:

a) Device capabilities;

The device capabilities include but are not limited to:

i) direct interaction with the communication network;

ii) indirect interaction with the communication network;

iii) ad-hoc networking; and

iv) sleeping and waking-up.

b) Gateway capabilities

The gateway capabilities include but are not limited to:

i) multiple interfaces support; and

ii) protocol conversion.

6.5 Management capabilities

6.5.1 In a similar way to traditional communication networks, IoT management capabilities cover the traditional fault, configuration, accounting, performance and security (FCAPS) classes,

6.5.2 The IoT management capabilities can be categorised into generic management capabilities and specific management capabilities.

6.5.3 Essential generic management capabilities in the IoT include:

a) device management;

b) local network topology management; and

c) traffic and congestion management.

6.5.4 Specific management capabilities are closely coupled with application-specific requirements such as smart grid power transmission line monitoring requirements.

6.6 Security capabilities

6.6.1 There are two types of security capabilities: generic security capabilities and specific security capabilities.

a) Generic security capabilities are independent of applications. They include:

   i) at the application layer: authorisation, authentication, application data confidentiality and integrity protection, privacy protection, security audit and anti-virus;

   ii) at the network layer: authorisation, authentication, use data and signalling data confidentiality, and signalling integrity protection; and

   iii) at the device layer: authentication, authorisation, device integrity validation, access control, data confidentiality and integrity protection.

b) Specific security capabilities are closely coupled with application-specific requirements such as mobile payment, security requirements.

7. IoT functional reference model

7.1 The IoT functional framework in functional view shown in Figure 2 is to describe the IoT capabilities at the functional level in order to guarantee that the IoT capabilities can fulfil all common requirements of the IoT specified in ITU-T Y.2066.

7.2 A practical way is to describe the IoT capabilities in groups corresponding to all categories of common requirements of the IoT as specified in ITU-T Y.2066. The IoT functional framework in functional view consists of groups of the IoT capabilities and their relationships.

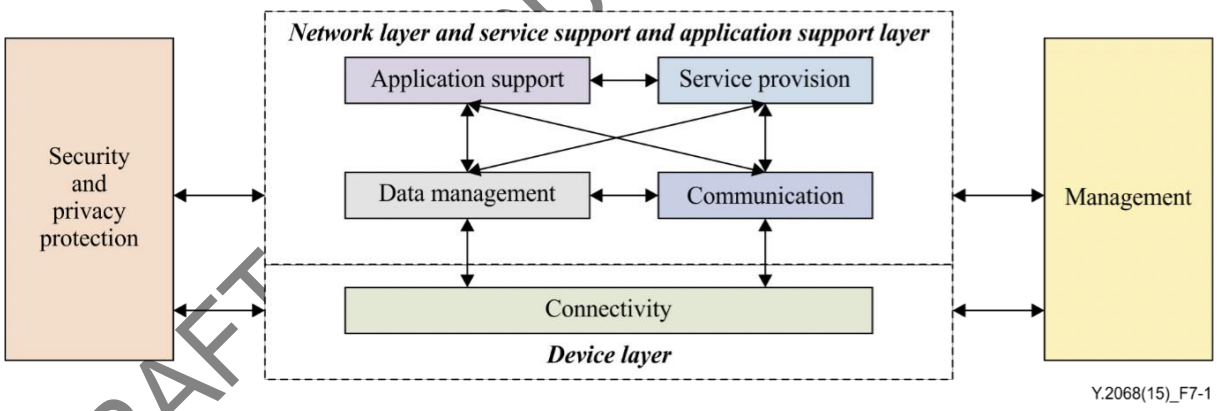

Figure 2. IoT functional framework in functional view

7.3 The connectivity group provides services to the data management group and communication group. It can provide services to the communication group and data management group triggered by requests. The security and privacy protection group configures and manages the security and privacy protection aspects of connectivity capabilities, and the management group configures and manages the other aspects of connectivity capabilities.

7.4 The communication group provides communication services to the other functional group. The other functional groups use the communication services. The management group configures and manages the communication capabilities. The security and privacy protection group configures and manages the security and privacy protection aspects of communication capabilities.

7.5 The data management group provides services to the other functional groups. The other functional groups request and configure the data management services. The management group configures and manages the data management capabilities. The security and privacy protection group configures and manages the security and privacy protection aspects of data management capabilities.

7.6 The application support group requests services from the data management group and communication group, and these two groups can provide services to the application support group. The management group configures and manages the application support capabilities. The security and privacy protection group configures and manages the security and privacy protection aspects of application support capabilities.

7.7 The service provision group requests services from the data management group and communication group, and these two groups can provide services to the service provision group. The management group configures and manages the service provision capabilities. The security and privacy protection group configures and manages the security and privacy protection aspects of the service provision capabilities.

7.8 The security and privacy protection group configures and manages the security and privacy protection aspects of the capabilities in other functional groups.

7.9 The management group configures and manages the capabilities, except the security and privacy protection aspects of these capabilities, in other functional groups.

8. Security and privacy protection requirements

Security and privacy protection requirements refer to the functional requirements during capturing, storing, transferring, aggregating and processing the data of things, as well as to the provision of services which involve things. These requirements are related to all the IoT actors. Matching analysis results between security and privacy protection requirements of the IoT and the supported capabilities of the IoT are shown in Table 1.

No	Security and Privacy Protection	Requirement	Description
1	Communication security	Communication security shall be required	Secure, trusted and privacy protected communication capability shall be required, so that unauthorised access to the content of data can be prohibited, integrity of data can be guaranteed and privacy-related content of data can be protected during data transmission or transfer in IoT.
2	Data management security	Data management security shall be required	Secure, trusted and privacy protected data management capability shall be required, so that unauthorised access to the content of data can be prohibited, integrity of data can be guaranteed and privacy-related content of data can be protected when storing or processing data in IoT.
3	Service provision security	Service provision security shall be required	Secure, trusted and privacy protected service provision capability shall be required, so that unauthorised access to service and fraudulent service provision can be prohibited and privacy information related to IoT users can be protected.

4	Integration of security policies and techniques	Integration of different security policies and techniques shall be required.	The ability to integrate different security policies and techniques shall be required, so as to ensure a consistent security control over the variety of devices and user networks in IoT.
5	Mutual authentication and authorisation	Mutual authentication and authorisation shall be required.	Before a device (or an IoT user) can access the IoT, mutual authentication and authorisation between the device (or the IoT user) and IoT shall be required to be performed according to predefined security policies.
6	Security audit	Security audit shall be required in the IoT.	Security audit shall be required to be supported in IoT. Any data access or attempt to access IoT applications shall be required to be fully transparent, traceable and reproducible according to appropriate regulation and laws. In particular, IoT shall be required to support security audit for data transmission, storage, processing and application access.

Table 1. Snapshot of IoT common requirements related to Security and Privacy Protection

Bibliography

[1] OWASP Internet of Things Project
https://www.owasp.org/index.php/OWASP_Internet_of_Things_Project

[2] Internet of things research study 2015 report - Hewlett Packard Enterprise
http://h20195.www2.hpe.com/V4/getpdf.aspx/4aa5-4759enw

[3] OWASP - https://www.owasp.org/index.php/Top_IoT_Vulnerabilities

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