
**Information technology — Internet of
media things —**

**Part 2:
Discovery and communication API**

*Technologies de l'information — Internet des objets media —
Partie 2: API pour la découverte et la communication*

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Foreword

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This document was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 29, *Coding of audio, picture, multimedia and hypermedia information*.

A list of all parts in the ISO/IEC 23093 series can be found on the ISO website.

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Introduction

The ISO/IEC 23093 series provides an architecture and specifies APIs and compressed representation of data flowing between media things.

The APIs for the media things facilitate discovering other media things in the network, connecting and efficiently exchanging data between media things. The APIs also provide means for supporting transaction tokens in order to access valuable functionalities, resources, and data from media things.

Media things related information consists of characteristics and discovery data, setup information from a system designer, raw and processed sensed data, and actuation information. The ISO/IEC 23093 series specifies data formats of input and output for media sensors, media actuators, media storages, media analyzers, etc. Sensed data from media sensors can be processed by media analyzers to produce analysed data, and the media analyzers can be cascaded in order to extract semantic information.

This document contains the APIs to discover media things in the network, and communicate between media things along with the APIs to facilitate transactions between media things.

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Information technology — Internet of media things —

Part 2:

Discovery and communication API

1 Scope

This document specifies the abstract class of a media thing (MThing), which is a basic component to construct Internet of media things. The MThing class contains the basic APIs to:

- discover other MThing(s) in the network;
- connect/disconnect MThing(s);
- support transactions (e.g. payments) using media tokens between MThings.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 23093-1¹⁾, *Information technology — Internet of media things — Part 1: Architecture*

ISO/IEC 23093-3:—²⁾, *Information technology — Internet of media things — Part 3: Media data formats and API*

ISO/IEC 21000-7:2007, *Information technology — Multimedia framework (MPEG-21) — Part 7: Digital Item Adaptation*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 23093-1 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

4 APIs

4.1 General

This clause specifies APIs to discover MThings, and connect/disconnect communication between MThings. In addition, APIs and return class types are specified to provide MThing information and hardware descriptions.

An MThing can be discovered by its capabilities and/or supported media token types. The discovered MThing(s) can then relay its (their) information to the requester (i.e. another MThing).

1) Under preparation. Stage at time of publication: ISO/IEC DIS 23093-1:2019.

2) Under preparation. Stage at time of publication: ISO/IEC FDIS 23093-3:2019.

Figure 1 shows the process to discover MThings in the network by a required capability. Each MThing, which supports the required capability, can send back its information. In the figure, an MThing broadcasts a message using `discoverMThingByCapability()` to look for MSensors that are capable of capturing an audio (Figure 1, item 1). Each MSensor (e.g. MMicrophone1, MMicrophone2, MCamera1) sends back its information using `sendBackMThingInfo()`, which returns the data format `MThingInfo` specified in ISO/IEC 23093-3³⁾ (Figure 1, item 2).

Figure 2 shows the process of connecting MThings with a capability. An MThing (i.e. ReqMThing) can ask the availability of the specific capability (e.g. `SENSOR_CAPTURE_AUDIO`) with the function `isCapabilityAvailable()` to another MThing (Figure 2, item 1). If the capability “`SENSOR_CAPTURE_AUDIO`” is currently unavailable, the MThing (i.e. MMicrophone1) notifies “unavailable” (Figure 2, item 2). The ReqMThing can ask the availability of the specific capability again to other MThings (Figure 2, item 3) with the binary representation of “MSensor” and “`SENSOR_CAPTURE_AUDIO`”. Because the MCamera1 notifies the ReqMThing that its “`SENSOR_CAPTURE_AUDIO`” capability is available (Figure 2, item 4), the ReqMThing can connect to the camera and reserve its “`SENSOR_CAPTURE_AUDIO`” capability (Figure 2, item 5). As long as the capability “`SENSOR_CAPTURE_AUDIO`” of the MCamera1 is used by the ReqMThing, other MThings cannot access the corresponding capability.

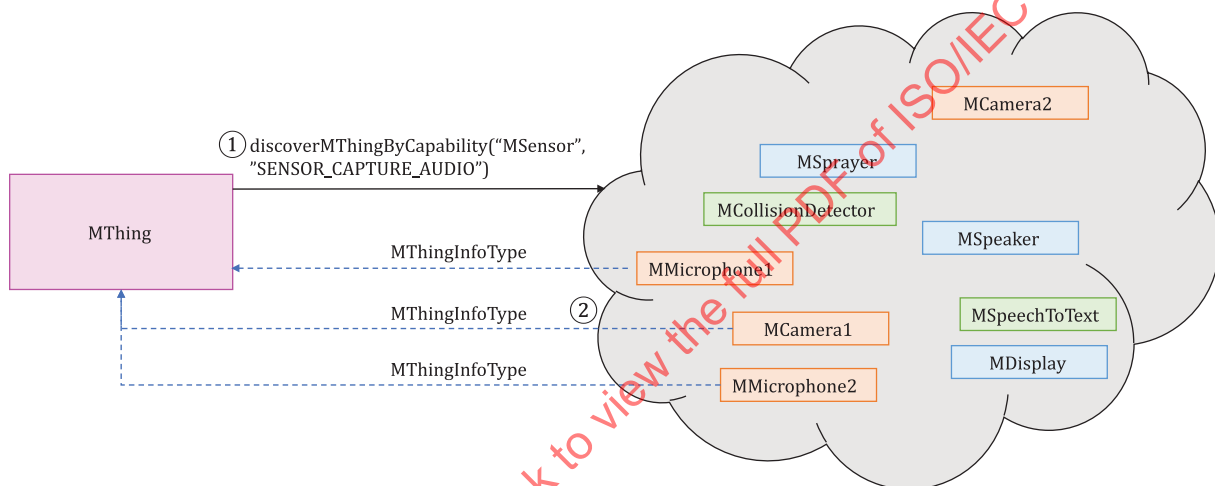


Figure 1 — Discovering MThings by capability

3) Under preparation. Stage at time of publication: ISO/IEC FDIS 23093-3:2019.

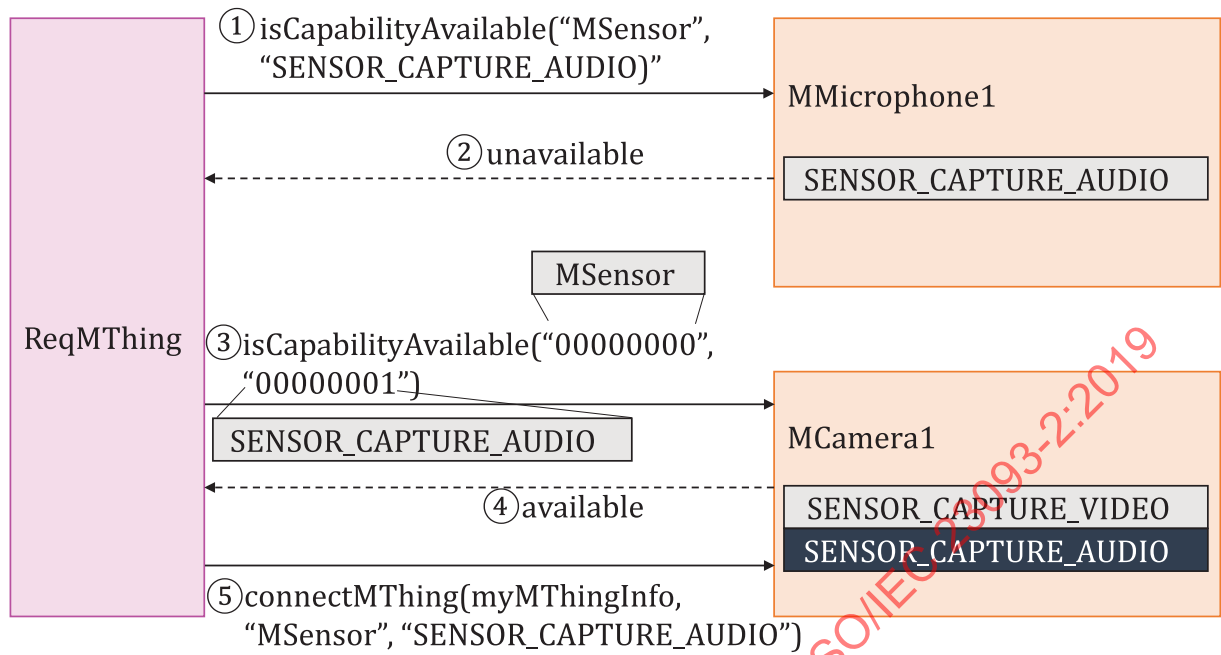


Figure 2 — Connecting MThings based on a capability

Figure 3 shows the process of disconnecting (i.e. releasing capabilities of) an MThing. The ReqMThing can release either all of its reserved capabilities of the MCamera (Figure 3, items 1 and 2) or a designated capability (e.g. SENSOR_CAPTURE_AUDIO) (Figure 3, items 3 and 4) using `disconnectMThing()`.

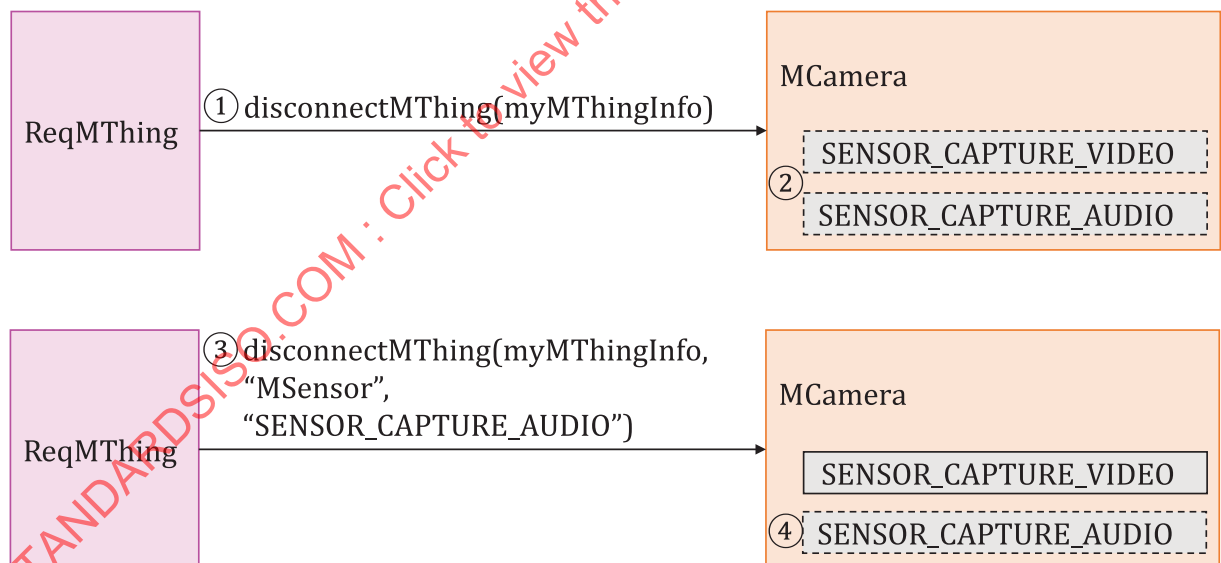


Figure 3 — Disconnecting an MThing

Figure 4 shows the process where an MThing alerts other MThings that all or some of its capabilities are going to be unavailable. The MCamera can alert the MThing_01 that either all of the capabilities reserved by MThing_01 are unavailable (Figure 4, items 1 and 2) or a designated capability (e.g. SENSOR_CAPTURE_AUDIO) is no longer available to MThing_01 (Figure 4, items 3 and 4) using `alertDisconnection()`.

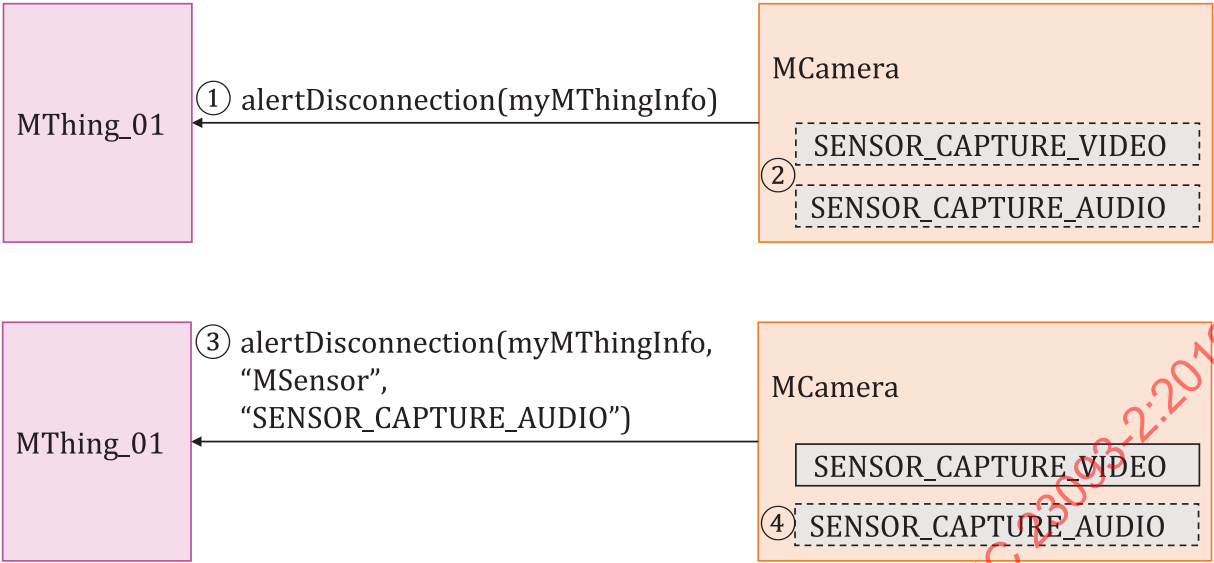


Figure 4 — Alerting disconnection to an MThing

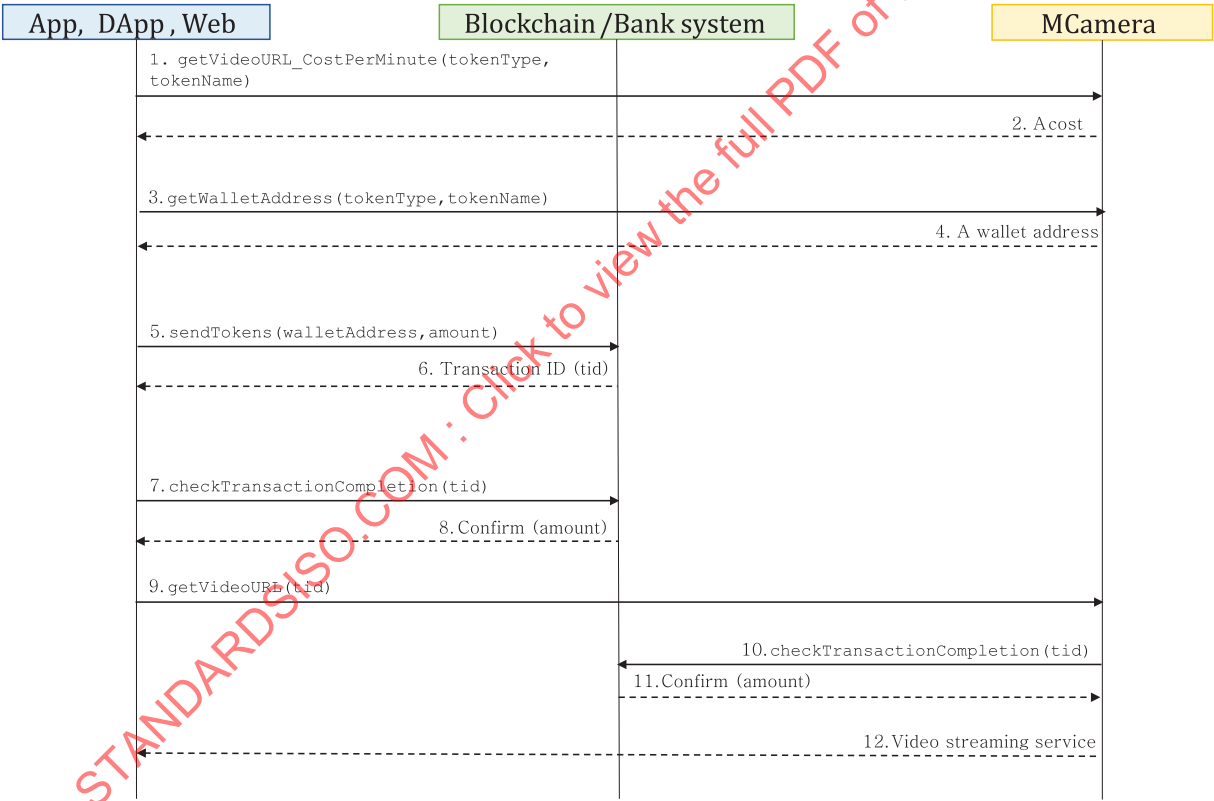


Figure 5 — Transaction process between a user and an MThing

Figure 5 shows a sequence diagram of a transaction process between a user and an MThing. Suppose that a user wants to watch a video captured from a nearby camera (i.e. MCamera). The user asks a cost per minute to watch a video taken by the MCamera using `getVideoURL_CostPerMinute()` through their user interface of Apps, DApps, or Web (Figure 5, item 1) with desired media token defined by `tokenType` (e.g. cryptocurrency or legal tender) and `tokenName` (e.g. Bitcoin or US dollar). The MCamera returns the cost per minute to let the user use the `getVideoURL()` function (Figure 5, item 2). If the user wants to watch the video with the responded price, they ask a wallet address (Figure 5, item 3) of the desired MToken. Again, the MCamera responds with the proper wallet address (Figure 5, item 4). The

user sends some amount of MTokens to the wallet address through a payment system like a blockchain or a banking system (Figure 5, item 5) which returns a transaction ID (Figure 5, item 6). With this transaction ID (i.e. `tid`), the user can confirm (Figure 5, item 8) whether the token transaction was successfully completed to the designated wallet address or not (Figure 5, item 7) using `checkTransactionCompletion(tid)`. Once the transaction is confirmed, the user can ask for the video stream service to the MCamera using `getVideoURL(tid)` (Figure 5, item 9). The MCamera checks for the completion of the token transaction using `checkTransactionCompletion(tid)` (Figure 5, item 10) and the amount of MTokens received (Figure 5, item 11). The MCamera returns a video URL and streams the video as much as the user paid (Figure 5, item 12). The details of APIs, `getVideoURL_CostPerMinute()` and `getVideoURL()` are given in ISO/IEC 23093-3.

Figure 6 shows a sequence diagram of a transaction process between MThings. Suppose that a camera (i.e. MCamera) wants to stream a captured video to a nearby display (i.e. MDisplay) and play it. The MCamera asks a cost per minute to play a video on the MDisplay using `setVideoURL_CostPerMinute()` (Figure 6, item 1) with desired media token defined by `tokenType` (e.g. cryptocurrency or legal tender) and `tokenName` (e.g. Bitcoin or US dollar). The MDisplay returns the cost per minute to use the `setVideoURL()` function (Figure 6, item 2). If the MCamera wants to play the video with the responded price, it asks a wallet address (Figure 6, item 3) of the desired MToken. Again, the MDisplay reponses with the proper wallet address (Figure 6, item 4). The MCamera sends some amount of MTokens to the wallet address through a payment system like a blockchain or a banking system (Figure 6, item 5) which returns a transaction ID (Figure 6, item 6). With this transaction ID (i.e. `tid`), the MCamera can confirm (Figure 6, item 8) whether the token transaction was successfully completed to the designated wallet address or not (Figure 6, item 7) using `checkTransactionCompletion(tid)`. Once the transaction is confirmed, the MCamera can ask for the video play service to the MDisplay using `setVideoURL(tid, url)` (Figure 6, item 9). The MDisplay checks for the completion of the token transaction using `checkTransactionCompletion(tid)` (Figure 6, item 10) and the amount of MTokens received (Figure 6, item 11). The MDisplay plays the video using the received video URL as much as the MCamera paid and notifies the completion of the video playing service (Figure 6, item 12). The details of APIs, `setVideoURL_CostPerMinute()` and `setVideoURL()` are given in ISO/IEC 23093-3.

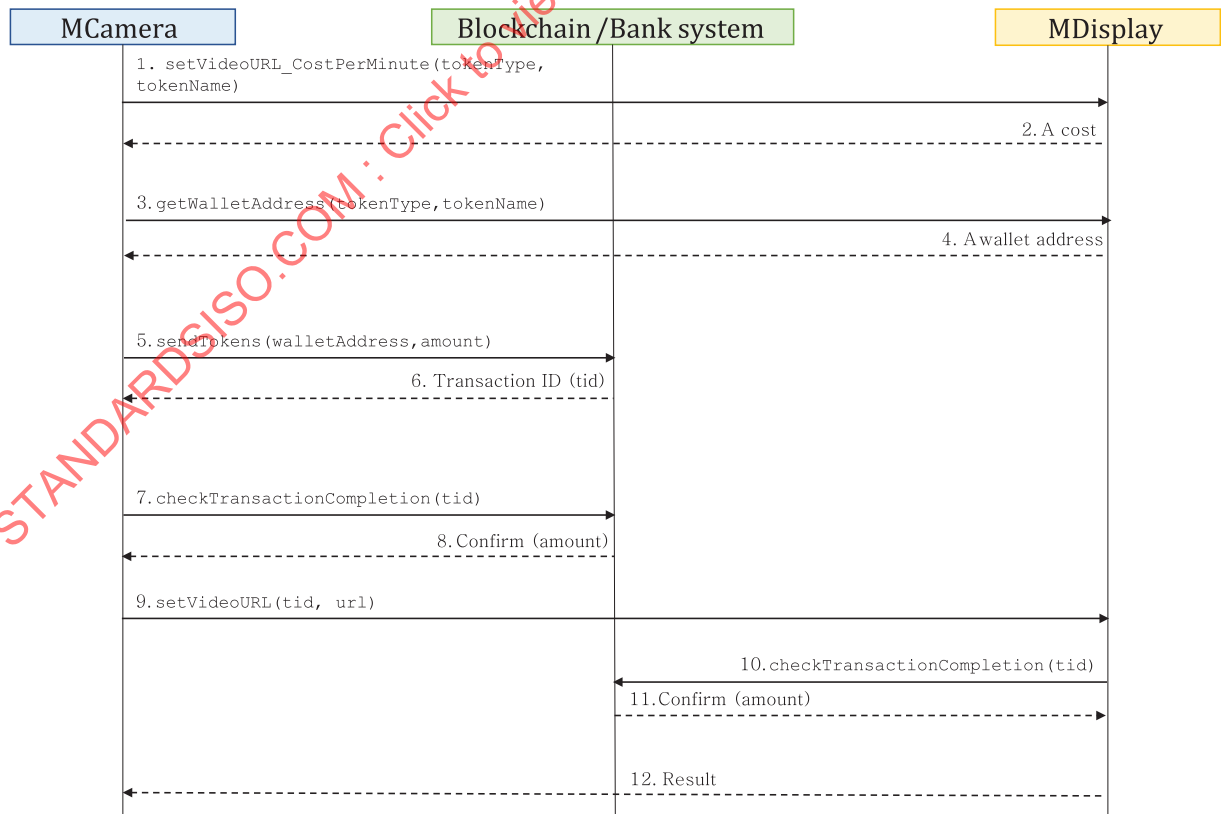


Figure 6 — Transaction process between MThings

4.2 Abstract Class of MThing

4.2.1 General

The class `MThing` is a base class of all kinds of MThings. This class includes essential fields and functions of an MThing.

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4.2.2 MThing APIs

Table 1 presents a class for MThing.

Table 1 — MThing class

Nested Classes	
Modifier and Type	Method and Description
Constructor	
Constructor and Description	
MThing()	
<i>Default constructor.</i>	
MThing(String id)	
MThing(String id, String ipAddress, Integer port)	
Fields	
Modifier and Type	Field and Description
String	id
	<i>Unique identifier.</i>
String	ipAddress
int	port
Methods	
Modifier and Type	Method and Description
Type	get()
void	set(Type)
List< MThingInfoType >	discoverMThingByCapability(String MThingType, String capability)
	<i>This function returns a list of MThings, which support the capability required. The MThingType and capability (i.e. formal parameters) shall be described in string (e.g. term ID or binary representation) from MThingTypeCS and capabilityCS in accordance with ISO/IEC 23093-3:—, A.1 and A.2, respectively.</i>
List< MThingInfoType >	discoverMThingByToken(int tokenType, String tokenName)
	<i>This function returns a list of MThings, which support the token type and name. If tokenType is 0, it denotes "cryptocurrency", if tokenType is 1, it denotes "legal tender". The tokenName shall be described in string (e.g. term ID or binary representation) from TokenTypeCS in accordance with ISO/IEC 23093-3:—, A.5.</i>
	Ex) dicoverMThingByToken(0, "BTC") or dicoverMThingByToken(0, "00000001")
	Ex) dicoverMThingByToken(1, "USD") or dicoverMThingByToken(1, "10010100")

Table 1 (continued)

int	isCapabilityAvailable(String MThingType, String capability) <i>This function asks if the designated capability with MThingType is available. The MThingType and capability (i.e. formal parameters) shall be described in string (e.g. term ID or binary representation) from MThingTypeCS and capabilityCS in accordance with ISO/IEC 23093-3:—, A.1 and A.2, respectively. If the capability is available, returns 1, otherwise, returns 0.</i> Ex) isCapabilityAvailable("MSensor", "SENSOR_CAPTURE_AUDIO"); or isCapabilityAvailable("00000000", "00000001");
String	getWalletAddress(int tokenType, String tokenName) <i>This function returns a wallet address according to the token type and the token name requested. If tokenType is 0, it denotes "cryptocurrency", if tokenType is 1, it denotes "legal tender". The tokenName shall be described in string (e.g. term ID or binary representation) from TokenTypeCS in accordance with ISO/IEC 23093-3:—, A.5. The function returns a wallet address if the task succeeds or null if there is no wallet address for the designated tokenType and tokenName.</i> Ex) getWalletAddress(0, "BTC") or getWalletAddress(0, "00000001") Ex) getWalletAddress(1, "USD") or getWalletAddress(1, "10010100")
String	sendTokens(String walletAddress, float amount) <i>This function transfers tokens to a receiver MThing using its wallet address. The amount of tokens is transferred to the walletAddress. The function returns a transaction ID if the task succeeds or null if fails.</i>
float	checkTransactionCompletion(String tid) <i>This function checks the completion of a transaction with the transaction ID, tid. An MThing (e.g. a token sender) and its corresponding MThing (e.g. a token receiver) are able to check whether the (token) transaction with the transaction ID is completed or not. It returns the amount of tokens if the transaction has completed, returns -1, otherwise.</i>
int	connectMThing(MThingInfoType myMThingInfo) <i>This function reserves all available capabilities of the target MThing by sending the (requester) MThing information, myMThingInfo. If the task succeeds, returns 1, if fails, returns 0, and returns -1 if the targetMThing does not respond.</i>
int	connectMThing(MThingInfoType myMThingInfo, String targetMThingType, String targetCapability) <i>This function reserves the designated capability of the target MThing by sending the (requester) MThing information, myMThingInfo. The targetMThingType and targetCapability shall be described in string (e.g. term ID or binary representation) from MThingTypeCS and capabilityCS in accordance with ISO/IEC 23093-3:—, A.1 and A.2, respectively. If the task succeeds, returns 1, if fails, returns 0, and returns -1 if the targetMThing does not respond.</i> Ex) connectMThing(myMThingInfo, "MSensor", "SENSOR_CAPTURE_AUDIO"); or connectMThing(myMThingInfo, "00000000", "00000001");

Table 1 (continued)

int	disconnectMThing(MThingInfoType myMThingInfo) <i>This function releases all reserved capabilities of the target MThing by sending the (requester) MThing information, myMThingInfo. If the task succeeds, returns 1, if fails, returns 0, and returns -1 if the targetMThing does not respond.</i>
int	disconnectMThing(MThingInfoType myMThingInfo, String targetMThingType, String targetCapability) <i>This function releases the designated capability of the target MThing by sending the (requester) MThing information, myMThingInfo. The targetMThingType and targetCapability shall be described in string (e.g. term ID or binary representation) from MThingTypeCS and capabilityCS in accordance with ISO/IEC 23093-3:—, A.1 and A.2, respectively. If the task succeeds, returns 1, if fails, returns 0, and returns -1 if the targetMThing does not respond.</i> Ex) disconnectMThing(myMThingInfo, "MSensor", "SENSOR_CAPTURE_AUDIO"); or disconnectMThing(myMThingInfo, "00000000", "00000001");
int	alertDisconnection(MThingInfoType myMThingInfo) <i>This function alerts a disconnection of all reserved capabilities of the requester MThing to the target MThing by sending the (requester) MThing information, myMThingInfo. If the task succeeds, returns 1, if fails, returns 0, and returns -1 if the targetMThing does not respond.</i>
int	alertDisconnection(MThingInfoType myMThingInfo, String myMThingType, String myCapability) <i>This function alerts a disconnection of the designated capability of a requester MThing to a target MThing by sending the (requester) MThing information, myMThingInfo. The myMThingType and myCapability shall be described in string (e.g. term ID or binary representation) from MThingTypeCS and capabilityCS in accordance with ISO/IEC 23093-3:—, A.1 and A.2, respectively. If the task succeeds, returns 1, if fails, returns 0, and returns -1 if the targetMThing does not respond.</i> Ex) alertDisconnectCapability(myMThingInfo, "MSensor", "SENSOR_CAPTURE_AUDIO"); or alertDisconnectCapability(myMThingInfo, "00000000", "00000001");
MPEG21TerminalCapabilityType	getMPEG21TerminalCapabilityList() <i>This function produces hardware descriptions that shall be described in accordance with the specifications of ISO/IEC 21000-7 TerminalCapabilityType. The returned type, MPEG21TerminalCapabilityType, is defined in the following section.</i>

4.3 Return type class

4.3.1 MThingInfoType

4.3.1.1 General

This subclause specifies return class types of MThing information. For an easy industrial adoption, the return type classes are provided in JAVA, C++, and C.

4.3.1.2 JAVA class

Table 2 presents return class types of MThing information in JAVA.

Table 2 — Return class types of MThing information in JAVA

Constructor	
Constructor and Description	
MThingInfoType()	
<i>Default constructor.</i>	
MThingInfoType(int type, String MThingInfo)	
Fields	
Modifier and Type	Field and Description
int	type
	<i>A returning type of MThing Information. 0 = None, 1 = XML, 2 = Binary, 3 = JSON</i>
String	MThingInfo
	<i>MThing information shall be described by the data format of MThingInfo in accordance with ISO/IEC 23093-3.</i>
Methods	
Modifier and Type	Method and Description
int	getType()
void	setType(int type)
String	getMThingInfo()
void	setMThingInfo(String MThingInfo)

4.3.1.3 C++ class

Table 3 presents return class types of MThing information in JAVA.

Table 3 — Return class types of MThing information in C++

Constructor and Destructor	
Constructor and Destructor Description	
MThingInfoType()	
<i>Default constructor.</i>	
MThingInfoType(int type, String MThingInfo)	
~ MThingInfoType()	
<i>Default destructor.</i>	
Member Data	
Modifier and Type	Member Data and Description
int	type