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| --- | --- |
| Project | **IEEE 802.21.1 Media Independent Services** **<**[**http://www.ieee802.org/21/**](http://www.ieee802.org/21/)**>** |
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| Abstract | Based on the discussion of the contribution “Proposed Update for “D2D Communications Service” Section of IEEE 802.21.1 Draft Standard” (DCN 21-15-0021-00-SAUC) in IEEE 802.21 Session #67, this document proposes revised text of “D2D Communication Service” Section for IEEE 802.21.1 Draft Standard. |
| Purpose | To be part of 802.21.1 draft standard document. |
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	5. D2D communications service
		1. Introduction

Device-to-device (D2D) communication is direct data communication between mobile nodes (MNs) and attracts attentions in perspective of network resource management and communication service based on proximity. Applications of D2D communications can be social networking, advertisement, public safety, data sharing, and data offload.

For D2D communication, media independent service (MIS) framework of IEEE 802.21 standard is able to help an MN to search for and connect to its peer. MIS framework of IEEE 802.21 standard is common platform to support interworking between networks using IEEE802 and non-IEEE802 technologies, so that MIS framework can be easily extended to a platform for D2D communications such as Wi-Fi Direct, 3GPP proximity service (ProSe), and IEEE 802.15.8 peer aware communication (PAC).

The MIS framework can apply to D2D communication with or without assistance of network entities such as a base station or an access point. For D2D communication with network assistance, network entities with MIS framework provide configuration information for an MN to discover its peer and control D2D connections of MNs. For D2D communication without network assistance, MNs with MIS framework can find and select the most appropriate D2D technology that can offer the best quality of service (QoS) or quality of experience (QoE).

This section introduces discovery and connection for D2D communication based on MIS, and includes methods and signaling for supporting discovery and connection for D2D communication based on MIS.

* + 1. Service scenarios and call flows
			1. D2D communication with network assistance

Communication service providers and network operators have interest in D2D communication because D2D communication can provide communication between MNs in close proximity with a small amount of network resource. By using D2D communication, MNs in close proximity can share data such as video clips or local information. Service providers of D2D communication can distribute local advertisement information or emergency information such as location of emergency shelters. Network operators can save network resources by offloading data to D2D communication. For making a connection for D2D communication, it is difficult for an MN to discover its peer that is able to offer communication services (e.g., data sharing, local advertisement and emergency information) that the MN wants to receive.

Communication service providers and network operators will help an MN to search for and connect to its peer by assistance of network infrastructures. The D2D communication with network assistance can be called as network-assisted D2D communication (NADC).

MIS framework, which is control plane of infrastructure network, can be the control plane for NADC. MIS framework provides network configuration information for MN and controls MN’s connection to access network by using point of service (PoS) and Information Server, which are defined in IEEE 802.21 standard as network-side instance of MIS framework and server that provides network configuration information, respectively. Thus, with minor modification of Information Server and PoS, MIS framework can provide configuration information of MN’s peer for MN and controls MN’s D2D connection.

* + - * 1. Service flows

For NADC, both MN and NADC provider is able to initiate D2D communication. Therefore, service flows for NADC needs to be classified into MN-initiated D2D communication and NADC provider-initiated D2D communication.

1. Service flows of MN-initiated D2D communication
	1. MN requests information to connect with its peer to Information Server.
	2. Information Server responds to the MN with configuration information to connect with a candidate peer of the MN. The configuration information may be technology of D2D communication such as Wi-Fi Direct and PAC, identifier (e.g., MAC address and IP address) of the candidate peer, and frequency information that its candidate peer can use.
	3. Based on configuration information from Information Server, the MN searches for and connects to its peer node.
2. Service flows of NADC PoS-initiated D2D communication
	1. NADC PoS that controls and manages D2D communications of MNs requests information for a peer node of MN to Information Server.
	2. Information Server responds to NADC PoS with configuration information to connect with a candidate peer of the MN. The configuration information may be technology of D2D communication such as Wi-Fi Direct and PAC, identifier (e.g., MAC address and IP address) of the candidate peer, and frequency information that its candidate peer can use.
	3. The NADC PoS sends the configuration information of a candidate peer to the MN.
	4. The MN decides whether to use D2D communication. If the MN decides to use D2D communication, the MN tries to search for and connect to its peer node by using the configuration information from NADC PoS.
		* + 1. High level illustration

Figure 1 shows control signaling for NADC by using media independent service messages. Information Server provides configuration information for an MN’s peer. The configuration information of Information Server can be requested by MNs and PoS. PoS controls MNs’ connection of D2D communication by requesting MN to select D2D communication and assigning radio resource for D2D communication. NADC provider can operate its own PoS, and NADC PoS can communicate with other PoSes. MN and its peer, NADC PoS, and Information Server are equipped with MIS function (MISF) and the following assumptions apply to Fig. 1.

1. MN’s peer can provide communication service that the MN wants to receive.
2. MN and its peer should communicate by using the same D2D communication technology.
3. Information Server should know proximity between mobile nodes.
4. Information Server may derive proximity between MNs by using MNs’ location information (e.g., GPS information).
5. Information Server should know communication services (e.g., local information service, file transmission, and voice call) that MNs can provide.
6. Information Server should know D2D communication technologies that MNs can use.
7. NADC PoS controls MNs’ D2D connection and control MNs’ radio resource for D2D communication.

**

Figure 1—Control signaling of NADC.

* + - * 1. Stages for NADC based on MIS Framework

NADC based on MIS framework comprises three stages as in Figure 2.

1. In the first stage, D2D devices register to Information Server with their configuration information for D2D communications. The configuration information can be types of D2D technologies such as Wi-Fi Direct and 3GPP ProSe.
2. In the second stage, NADC PoS discovers pairs for D2D communications.
3. In the third stage, NADC PoS orders D2D devices to make D2D communications.



Figure 2—Stages for NADC based on MIS framework.

* + - * 1. Signal flows and primitives/messages

Stage 1: registration of D2D devices

Information Server collects configuration information, which includes list of D2D communication technologies used by MN, for MNs’ registrations to Information Server. Signal flows shown in Figure 3 are as follows.

1. MN requests registration to Information Server by sending MIS\_D2D\_Registration request message with its configuration information including its available D2D communication technologies (i.e., D2D\_Techlist). (Step 1)
2. Information Server responds with MIS\_D2D\_Registration response message. (Step 2)



Figure 3—Registration of D2D devices with list of D2D technologies.

* New primitive/message
1. —MIS\_SAP primitives

|  |  |  |  |
| --- | --- | --- | --- |
| **Primitives/Messages** | **Servicecategory** | **Description** | **Definedin** |
| MIS\_D2D\_Registration | Command | This primitive/message is used for MN to register D2D devices | 5.5.2.1.4IEEE802.21.1 |

* New parameter

|  |  |
| --- | --- |
| **Parameter** | **Description** |
| D2D\_Techlist | List of D2D communication technologies used by an MN |
| Config\_Info | Information that includes location information and network connection information (e.g., radio frequency and network identification) of communication devices |

Stage 2: discovery of pairs for D2D communications

Information Server provides configuration information that can help MN discover its peer. Signal flows shown in Figure 4 are as follows.

a) MN-initiated D2D communication

1. MN informs Information Server of its location (QUERIER\_LOC), communication service (QUERIER\_D2D\_SERVICE), and available D2D service communication (QUERIE\_D2D\_TECHLIST) and requests information of candidate peer for D2D communication. (Step 1)
2. Information Server responds with the peer’s identity (IE\_D2D\_PEERID) and configuration information (IE\_D2D\_CONFIG) to discover the peer. (Step 2)

b) NADC PoS-initiated D2D communication

1. NADC PoS informs Information Server of MN’s location (QUERIER\_LOC), communication service (QUERIER\_D2D\_SERVICE), and available D2D communication (QUERIE\_D2D\_TECHLIST) and requests information of candidate peer for D2D communication. (Step 1)
2. Information server responds with the peer’s identity (IE\_D2D\_PEERID) and configuration information (IE\_D2D\_CONFIG) to discover devices that is available to make D2D communication. (Step 2)

****

1. **MN-initiated D2D communication**

****

1. **NADC PoS-initated D2D communication**

Figure 4—Discovery of D2D devices with list of D2D technologies.

1. —MIS\_SAP primitives

|  |  |  |  |
| --- | --- | --- | --- |
| **Primitives/Messages** | **Servicecategory** | **Description** | **Definedin** |
| MIS\_Get\_Information | Information | Request to get information from repository | 7.4.25IEEE802.21 Revision |

* New parameters

MIH\_Get\_Information primitive/message and QUERIER\_LOC parameter have been defined in IEEE 802.21 standard, and new parameters are defined as follows.

|  |  |
| --- | --- |
| Name | Description |
| QUERIER\_D2D\_SERVICE | Communication services (e.g., local information service, file transmission, and voice call) that MN wants to be served |
| QUERIER\_D2D\_TECHLIST | Available D2D communication list (e.g., LTE D2D, Wi-Fi Direct, and PAC) of the MN that wants proximity service |

* New information elements

|  |  |
| --- | --- |
| Name | Description |
| IE\_D2D\_PEERID | Peer’s identity(e.g., MAC address, IP address, and IMSI(International Mobile Subscriber Identity)) |
| IE\_D2D\_CONFIG | Configuration information(e.g., frequency band) to help the MN configure its peer |

Stage 3: connection for D2D communications

MN or PoS can initiate to change communication technology of MN’s D2D connection. For example, MN or PoS initiate to change Wi-Fi Direct of MN’s D2D connection into IEEE 802.15.8 PAC. Signal flows shown in Figure 5 are as follows.

a) MN-initiated D2D communication

1. MN requests its peer to change its D2D communication into other D2D communication technology (e.g., PAC) by sending MIS\_D2D\_Connection request message. (Step 1)
2. Changing D2D connection between MN and its peer by using other D2D communication (e.g., PAC): Out of Scope (Step 2)
3. MN’s peer responds to MN with connection result (success or fail) by sending MIS\_D2D\_Connection response message. (Step 3)

b) NADC PoS-initiated D2D communication

1. NADC PoS requests MN to change its D2D communication technology into other D2D communication technology (e.g., PAC) by sending MIS\_D2D\_Connection request message. (Step 1)
2. MN requests its peer to change its D2D communication into other D2D communication technology (e.g., PAC) by sending MIS\_D2D\_Connection request message. (Step 2)
3. Changing D2D connection between MN and its peer by using other D2D communication (e.g., PAC): Out of Scope (Step 3)
4. MN’s peer responds to MN with connection result (success or fail) by sending MIS\_D2D\_Connection response message. (Step 4)
5. MN responds to PoS with connection result (success or fail) by sending MIS\_D2D\_Connection response message. (Step 5)

**

1. **MN- initiated D2D communication**

**

**(b) NADC PoS-initiated D2D communication**

Figure 5—Connection for D2D communications.

* New primitive/message
1. —MIS\_SAP primitives

|  |  |  |  |
| --- | --- | --- | --- |
| **Primitives/Messages** | **Servicecategory** | **Description** | **Definedin** |
| MIS\_D2D\_Connection | command | This primitive/message is used for an MN and its peer to make a connection of D2D communication technology. | 5.5.2.1.4IEEE802.21.1 |

* New parameters

|  |  |
| --- | --- |
| Parameter | Description |
| D2D\_Tech | Information of D2D communication technologies that MN or its peer can use |
| D2D\_Config | Configuration information(e.g., frequency band) to help the MN configure its peer |
| D2D\_PeerID | Peer’s identity(e.g., MAC address, IP address, and IMSI) |

* + - 1. D2D communication without network assistance

Various technologies for D2D communication have been developed recently. Smart devices such as smartphones and tablet PCs already implement Wi-Fi Direct. Future smart devices may implement developing technologies of D2D communication technologies such as 3GPP ProSe and PAC. For future smart devices, it is important for the smart devices to select the most appropriate technology of D2D communication that can support the best QoS or QoE.

By using D2D communication, smart MNs in close proximity can directly share data such as video clips or local information without network assistance. D2D communication can serve local advertisement information or emergency information such as location of emergency shelters.

MIS framework will support MNs to select appropriate technology of D2D communication without any network assistance. Existing MIS framework can enable MNs to monitor link status, which is status (e.g., signal strength and data rate) of physical layer and data link layer by using media independent event service (MIES) and can select the most appropriate access network by using media independent control service (MICS) even without network assistance. Therefore, if MIES and MICS are extended for supporting D2D communication, it will be possible for MNs to monitor link status of D2D communications and select the most appropriate technology of D2D communication without network assistance.

* + - * 1. Service Flows

Jane is user of an MN that supports D2D communication. Smith is user of a peer node of Jane’s MN

1. Jane’s MN and Smith’s MN transfer data through D2D communication “P” (e.g., Wi-Fi Direct).
2. Jane’s MN detects that link status (e.g., signal strength and data rate) of D2D communication “P” is getting worse due to some reason such as radio interference.
3. Jane’s MN discovers the most appropriate D2D communication “Q” (e.g., PAC) that is different from D2D communication “P” by monitoring link status of “Q.”
4. Jane’s MN requests Smith’s MN to change D2D communication “P” into D2D communication “Q.”
5. Jane’s MN and Smith’s MN make a connection by using D2D communication “Q.”
6. Jane’s MN and Smith’s MN can transfer data through D2D communication “Q.”
	* + - 1. High level illustration

Figure 6 shows control signaling for D2D communication without network assistance. The service flows are explained specifically in “5.5.2.2.1 Service flows.” The following assumptions apply to Fig. 6.

1. MN’s peer can provide communication service that the MN wants to be served.
2. MN and its peer should communicate by using the same D2D service communication technology.
3. MN can monitors link status of D2D communication.
4. MN and its peer can change their D2D communication technology without any network assistance.



Figure 6—Control signaling of D2D communication without network assistance.

* + - * 1. Stages for D2D communication without network assistance
1. In the first stage, MN discovers pairs for D2D communications.
2. In the second stage, MN orders D2D devices to make D2D communications.



Figure 7— Stages for D2D communication without network assistance.

* + - * 1. Signal flows and primitives/messages

Changing connection of D2D communication

MN changes communication technology of its D2D connection depending on its link status. For example, MN changes Wi-Fi Direct of MN’s D2D connection into IEEE 802.15.8 PAC depending on its link status. Signal flows shown in Figure 7 are as follows.

1. Connection between MN and its peer by using D2D communication (e.g., Wi-Fi Direct): Out of Scope (Step 0)
2. MN monitors its link status of current D2D communication technology and determines to change D2D communication technology into other D2D communication technology. (Step 1)
3. MN requests its peer to change its D2D communication into different D2D communication technology (e.g., PAC) by sending MIS\_D2D\_Connection request message. (Step 2)
4. Changing connection between MN and its peer by using other proximity service communication (e.g., PAC): Out of Scope (Step 3)
5. MN’s peer responds to MN with connection result (success or fail) by sending MIS\_D2D\_Connection response message. (Step 4)



Figure 8—Changing connection of D2D communication.

* New primitive/message

MIS\_D2D\_Connection primitive/message is explained in “5.5.2.1.4.3 Stage 3: connection for D2D communications.”

* New parameters

D2D\_Tech, D2D\_Config, and D2D\_PeerID are explained in “5.5.2.1.4.3 Stage 3: connection for D2D communications.”

* + 1. Service specific primitives
			1. MIS\_SAP primitives
				1. MIS\_D2D\_Registration

MIS\_ D2D\_Registration.request

Function

MIS\_D2D\_Registration is used for MN to request registration to Information Server by sending MIS\_D2D\_Registration request message with its configuration information including its available D2D communication technologies.

Semantics of service primitive

MIS\_D2D\_Registration.request (

 DestinationIdentifier,

 D2D\_Techlist,

 Config\_Info

 )

Parameters:

|  |  |  |
| --- | --- | --- |
| Name | Data type | Description |
| DestinationIdentifier | MISF\_ID | This identifies a remote MISF that will be the destination of this request. |
| D2D\_Techlist |  | List of available D2D technologies |
| Config\_Info |  | Configuration information for making a D2D connection |

When generated

This primitive is invoked by MIS user when it needs to register an MN to Information Server before making a D2D connection.

Effect on receipt

On receipt, the local MISF sends an MIS\_D2D\_Registration request message to the destination MISF.

MIS\_ D2D\_Registration.indication

Function

This primitive is used by an MISF to notify an MIS user that an MIS\_D2D\_Registration request message has been received.

Semantics of service primitive

MIS\_D2D\_Registration.indication (

 SourceIdentifier,

 D2D\_Techlist,

 Config\_Info

 )

Parameters:

|  |  |  |
| --- | --- | --- |
| Name | Data type | Description |
| SourceIdentifier  | MISF\_ID | This identifies the invoker of this primitive, which is a remote MISF. |
| D2D\_Techlist |  | List of available D2D technologies |
| Config\_Info  |  | Configuration information for making a D2D connection |

When generated

 This primitive is generated by the local MISF when an MIS\_D2D\_Registration request message is received

Effect on receipt

The local MIS user will perform necessary actions to process the registration request and respond with an MIS\_D2D\_Registration.response.

MIS\_D2D\_Registration.response

Function

This primitive is used by an MIS user to send the processing status of a received registration request.

Semantics of service primitive

MIS\_D2D\_Registration.response (

 DestinationIdentifier,

 Status

 )

Parameters:

|  |  |  |
| --- | --- | --- |
| Name | Data type | Description |
| DestinationIdentifier | MISF\_ID | This identifies a remote MISF, which will be the destination of this response. |
| Status | STATUS | Status of operation |

When generated

This primitive is invoked by the MIS user to report back the result after completing the processing of a registration request.

Effect on receipt

Upon receipt, the local MISF sends an MIS\_D2D\_Registration response message to the destination MISF.

MIS\_ D2D\_Registration.confirm

Function

This primitive is used by the local MISF to convey the result of a registration request to an MIS user.

Semantics of service primitive

MIS\_D2D\_Registration.confirm (

 SourceIdentifier,

 Status

 )

Parameters:

|  |  |  |
| --- | --- | --- |
| Name | Data type | Description |
| SourceIdentifier | MISF\_ID | This identifies the invoker of this primitive, which is a remote MISF.. |
| Status | STATUS | Status of operation |

When generated

This primitive is used by an MISF to notify an MIS user the result of an MIS\_D2D\_registration request.

Effect on receipt

Upon receipt, the MIS user can determine the result of the registration request.

* + - * 1. MIS\_D2D\_Connection

MIS\_ D2D\_Connection.request

Function

MIS\_D2D\_Connection is used for an MIS user to request an MISF to make a D2D connection with its configuration information including its available D2D communication technologies.

Semantics of service primitive

MIS\_D2D\_Connection.request (

 D2D\_PeerID,

 D2D\_Tech,

 D2D\_Config

 )

Parameters:

|  |  |  |
| --- | --- | --- |
| Name | Data type | Description |
| D2D\_PeerID | MISF\_ID | This identifies a peer for D2D communication.  |
| D2D\_Tech |  | Technology for D2D communication |
| D2D\_Config |  | Configuration information for making a D2D connection |

When generated

This primitive is invoked by MIS user when it needs to connect to its peer before making a D2D connection.

Effect on receipt

On receipt, the local MISF sends an MIS\_D2D\_Connection request message to the destination MISF.

MIS\_ D2D\_Connection.indication

Function

This primitive is used by an MISF to notify an MIS user that an MIS\_D2D\_Connection request message has been received.

Semantics of service primitive

MIS\_D2D\_Connection.indication (

 SourceIdentifier,

 D2D\_Tech,

 D2D\_Config

 )

Parameters:

|  |  |  |
| --- | --- | --- |
| Name | Data type | Description |
| SourceIdentifier  | MISF\_ID | This identifies the invoker of this primitive, which is a remote MISF. |
| D2D\_Tech |  | Technology for D2D communication |
| D2D\_Config |  | Configuration information for making a D2D connection |

When generated

 This primitive is generated by the remote MISF when an MIS\_D2D\_Connection request message is received

Effect on receipt

The remote MIH user will perform necessary actions to process the connection request and respond with an MIS\_D2D\_Connection.response.

MIS\_ D2D\_Connection.response

Function

This primitive is used by an MIS user to send the processing status of a received connection request.

Semantics of service primitive

MIS\_D2D\_Connection.response (

 DestinationIdentifier,

 Status

 )

Parameters:

|  |  |  |
| --- | --- | --- |
| Name | Data type | Description |
| DestinationIdentifier | MISF\_ID | This identifies a remote MISF, which will be the destination of this response. |
| Status | STATUS | Status of operation |

When generated

This primitive is invoked by the MIS user to report back the result after completing the processing of a connection request.

Effect on receipt

Upon receipt, the local MISF sends an MIS\_D2D\_Connection response message to the destination MISF.

MIS\_ D2D\_Connection.confirm

Function

This primitive is used by the local MISF to convey the result of a connection request to an MIS user.

Semantics of service primitive

MIS\_D2D\_Registration.confirm (

 SourceIdentifier

 Status

 )

Parameters:

|  |  |  |
| --- | --- | --- |
| Name | Data type | Description |
| SourceIdentifier | MISF\_ID | This identifies the invoker of this primitive, which is a remote MISF. |
| Status | STATUS | Status of operation |

When generated

This primitive is used by an MISF to notify an MIS user the result of an MIS\_D2D\_connection request.

Effect on receipt

Upon receipt, the MIS user can determine the result of the connection request.

* + - 1. MIS\_Get\_Information

\* Parameters and information elements will be added for D2D communication service.

* + - 1. MIS\_LINK\_SAP primitives
				1. Link\_D2D\_Registration

Link\_D2D\_Registration.request

Link\_D2D\_Registration.confirm

Link\_ D2D\_Registration.indication

Link\_ D2D\_Registration.response

* + - 1. Link\_D2D\_Connection

Link\_D2D\_Connection.request

Link\_D2D\_Connection.confirm

Link\_D2D\_Connection.indication

Link\_D2D\_Connection.response

* + 1. Service specific protocol features
			1. MIS protocol messages for command service
				1. MIS\_D2D\_Registration

MIS\_ D2D\_Registration request

MIS\_ D2D\_Registration indication

MIS\_ D2D\_Registration response

* + - 1. MIS\_D2D\_Connection

MIS\_D2D\_Connection request

MIS\_D2D\_Connection indication

MIS\_D2D\_Connection response

* + - 1. MIS protocol messages for information service
				1. MIS\_Get\_Information

\* Parameters and information elements will be added for D2D communication service.

Table E.2- **MIH\_LINK\_SAP/IEEE 802.11/IEEE 802.3/IEEE 802.1ag primitives mapping**

|  |  |  |  |
| --- | --- | --- | --- |
| **Primitives** | **IEEE Std 802.11** | **IEEE Std 802.3** | **IEEE Std 802.1ag[B19]** |
| Link\_D2D\_Connection | MLME-CHANNELSWITCH request,MLME-TPCADAPT request | N/A | N/A |