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SERIES Y: GLOBAL INFORMATION INFRASTRUCTURE, INTERNET PROTOCOL ASPECTS AND NEXT-GENERATION NETWORKS

Next Generation Networks – Frameworks and functional architecture models

Intelligent access selection in multi-connection

Recommendation ITU-T Y.2028

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Recommendation ITU-T Y.2028

Intelligent access selection in multi-connection

Summary

The objective of Recommendation ITU-T Y.2028 is to describe intelligent access selection mechanisms in multi-connection. Scenarios, requirements, considerations and solutions on security, as well as pricing aspects are also covered.

In a multi-connection environment, intelligent access selection is a mechanism for the network and/or mobile device to select the preferred network access based on a set of selection criteria (e.g., service type, bandwidth).

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T Y.2028	2015-06-29	13	11.1002/1000/12509

Keywords

Access selection, multi-connection, network discovery.

* To access the Recommendation, type the URL http://handle.itu.int/ in the address field of your web browser, followed by the Recommendation's unique ID. For example, http://handle.itu.int/11.1002/1000/11830-en.

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Intelligent access selection in multi-connection

1 Scope

As smartphone devices have proliferated, the capability of these terminals has also improved far more than before. Moreover, big data may improve the performance of huge-volume data collection and analysis on access/network profiles. Since access discovery and selection require both terminal and network parts to be involved, there are two distinct methods to exchange the details of access and user preferences.

The principle to estimate a solution has two aspects:

1) cost: Is it less expensive?

2) experience: Is it better?

As cost is a key attribute for users to choose access, network selection depends on information such as location and subscriber policy, as well as price policy of the access. For example, when a person enters a coffee shop, they may prefer free access. However, this kind of selection refers to user location where the access is deployed separately; only users can acquire the complete access list dynamically. On the other hand, access providers can set the price policy and confirm the authorization status of a subscribers' access to the service.

The experience issue also needs to consider two parts:

1) personal requirements, such as high speeds for gaming or high bandwidth for video;

2) network status, such as whether there is congestion, or whether it requires complex authentication methods like extensible authentication protocol – subscriber identity module (EAP-SIM).

Before starting the access selection process, there are some information asymmetries between a user and an unknown network. Multiple accesses provide various choices for access selection. The intelligent solution would meet several requirements, such as: less user intervention, less user training, less service interruption, less access congestion and lower cost.

This Recommendation describes scenarios, requirements, unified registration solutions, and other aspects such as security and pricing for intelligent access selection in multi-connection. See also [ITU- T.Y.2251].

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T Y.2027] Recommendation ITU-T Y.2027 (2012), *Functional architecture of multi-connection*.

[ITU-T Y.2251] Recommendation ITU-T Y.2251 (2011), *Multi-connection requirements*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 connection [b-ITU-T X.200]: A connection is an association established for the transfer of data between two or more peer-(N)-entities. This association binds the peer-(N)-entities together with the (N-1)-entities in the next lower layer.

3.1.2 mobility [b-ITU-T Q.1706]: The ability for the user or other mobile entities to communicate and access services irrespective of changes of the location or technical environment.

3.1.3 multi-connection [ITU-T Y.2251]: The functionality which provides capability to the user equipment (UE) and network to maintain more than one access network connection simultaneously.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 mobile device: A device capable of connecting to a mobile access network (e.g., 2G, 3G, 4G, Wi-Fi) including the feature phone, smart phone, tablet, laptop, camera, vehicle, etc.

3.2.2 network discovery: In a multi-connection environment, network discovery is a mechanism for mobile devices to discover all available network accesses and optionally display their names on the mobile devices.

3.2.3 network selection: In a multi-connection environment, network selection is a mechanism for the network and/or mobile device to select the preferred network access based on a set of selection criteria (e.g., service type, bandwidth).

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AAA	Authentication, Authorization, Accounting
AN	Access Network
ANR	Automatic Neighbour Relations
AP	Access Point
EAP-SIM	Extensible Authentication Protocol – Subscriber Identity Module
LTE	Long Term Evolution
MCF	Multi-Connection Functional entity
MUE	Multi-connection User Equipment
QoE	Quality of Experience
QoS	Quality of Service
SSID	Service Set Identifier
UE	User Equipment
W-CDMA	Wideband Code Division Multiple Access
WiMAX	Worldwide Interoperability for Microwave Access
Wi-Fi	Wireless Fidelity
WLAN	Wireless Local Area Network

5 Conventions

In this Recommendation:

The keywords "is required to" indicate a requirement which must be strictly followed and from which no deviation is permitted if conformance to this document is to be claimed.

The keywords "is prohibited from" indicate a requirement which must be strictly followed and from which no deviation is permitted if conformance to this document is to be claimed.

The keywords "is recommended" indicate a requirement which is recommended but which is not absolutely required. Thus this requirement need not be present to claim conformance.

The keywords "is not recommended" indicate a requirement which is not recommended but which is not specifically prohibited. Thus, conformance with this specification can still be claimed even if this requirement is present.

The keywords "can optionally" indicate an optional requirement which is permissible, without implying any sense of being recommended. This term is not intended to imply that the vendor's implementation must provide the option and the feature can be optionally enabled by the network operator/service provider. Rather, it means the vendor may optionally provide the feature and still claim conformance with the specification.

6 Scenarios and requirements

6.1 Scenarios

6.1.1 Access discovery scenario

When coverage of multiple access technologies is available, it is important for terminals to have the capability to discover and select the available and/or desired network(s).

Use case 1: heterogeneous access discovery

Alice arrived at a foreign airport that has ubiquitous wideband code division multiple access (W-CDMA) network coverage everywhere and Wi-Fi only at certain places. Whether she was using the W-CDMA service or not, Alice is able to discover the Wi-Fi network when she moves into the range covered by an access point (AP). The W-CDMA Node B to which Alice has attached might also discover the presence of the Wi-Fi AP.

Use case 2: independent owner discovery

Alice leaves the airport and arrives at her hotel. When she checks in, she finds there are three different service set identifiers (SSIDs) (i.e., names of the Wi-Fi networks): the first is provided by a local operator, the second is owned by the hotel and the third comes from a personal device (such as an Android AP). Alice's mobile device would identify the owners for each access by private/enterprise/home operator/visit operator, etc. The network might also recognize Alice's role, e.g., whether she is a roaming subscriber, a customer of the hotel or only a guest.

Use case 3: different access status discovery

Alice purchases a rate card and accesses Wi-Fi provided by a visited operator. She then enters a café. The café allows its customers to enjoy free Wi-Fi from the same operator but using a different SSID. Therefore, Alice's terminal is informed that there is an additional Wi-Fi access that is different from hers in price or current traffic load, quality of service (QoS), security, available internet/IPv4/IPv6, etc. The network is also able to assess whether she needs to reselect her current access.

6.1.2 Access selection scenario

Since multi-connection may benefit users to obtain better quality of experience (QoE) and benefit operators to balance traffic loads and increase network performance and reliability, mobile devices or the network may initiate access selection to cover certain requirements. The access selection scenario is detailed below:

Use Case 1: Valid access selection

Alice's handset discovered an SSID launched by a high-power AP. However, Alice was too far from the AP to allow her handset's reply to return to the AP. Thus, the AP was unavailable to Alice. Subsequently, her handset deleted the SSID of the AP from her handset's SSID list.

Use Case 2: Dynamic access reselection

Alice is on a moving bus. She is listening to music online via Wi-Fi. Her device is using SSID1 to access AP1. After a while, the bus, travelling to another place, forces Alice's device to disconnect from AP1. Two minutes later, the bus enters the coverage area of the same SSID1, but under AP2. Her device accesses AP2 automatically, without any intervention. Her music service might not maintain the session during the two-minute break.

Use Case 3: Traffic load dispersion access selection

Alice is at the airport and there are two APs serving the same SSID. At this time, AP1 was carrying 80 per cent of the Wi-Fi traffic load, while AP2 was carrying only 20 per cent of the Wi-Fi traffic load. When Alice wants to access the network, she is directed to AP2 through the network traffic load balancing capability.

Use Case 4: Battery-saving access selection

Alice is downloading an e-mail via Wi-Fi access. Suddenly, she receives a voice call from her boss via 3G access. During her call, the e-mail download finishes. In order to save battery power, the Wi-Fi access is automatically turned off.

6.2 Requirements

6.2.1 Access discovery requirement

As the mobile Internet increases in popularity, it is common to discover many different types of access networks available at the same place, and it is important to solve the question of how to select the most appropriate access for users. The following information types are required for access discovery:

1) connection capability of user equipment (UE) (multi-connection or single);
2) location of the UE;
3) current active access connections and services of the UE;
4) access network type (2G, 3G, long term evolution (LTE), Wi-Fi, worldwide interoperability for microwave access (WiMAX));
5) traffic load and active connection state of the access network;
6) IP address type (IPv4, IPv6, dual-stack, private, public) the access network can provide;
7) charging (pricing) type of the access network;
8) signal strength of the access network;
9) authentication type of the access network;
10) QoS capability of the access network;
11) friendly partner list (for roaming);
12) Internet capability (personal, local, public).

6.2.2 Intelligent access selection requirement

Intelligent access selection is the ability to determine which access technologies, among multiple options, to use based on the following considerations:

1) identify and/or update unavailable access connections and filter them out before displaying the access list;
2) minimize user intervention when selecting accesses;
3) optimize network load and bandwidth efficiency;
4) encourage energy efficiency through power management;
5) satisfy certain policies after comparing parameters mentioned in access discovery requirement.

7 Solutions

7.1 Overview

According to the requirements in clause 6.2, there are several solutions. Some solutions would help the network to discover its neighbours, while others would enhance the terminal's capability to do so. The access-select policy can also be made by either the network or the terminal.

7.2 Access discovery solution

7.2.1 Network-based access discovery solution

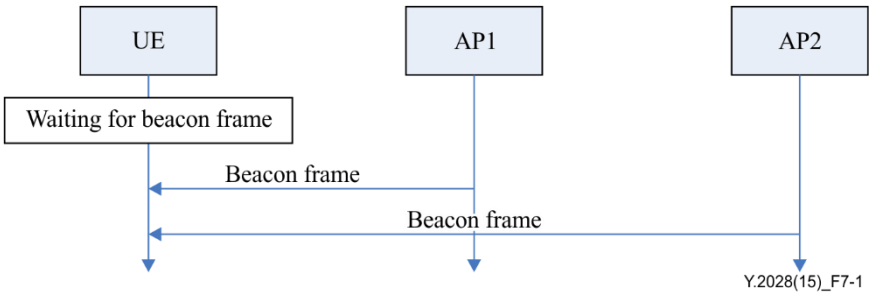


Figure 7-1 – Homogeneous accesses discovery

In a homogeneous network, as shown in Figure 7-1, the UE would continually refresh its channel list, waiting for beacon frames from different APs. All of the frames received would be temporarily saved in order to extract related information or parameters about different access networks.

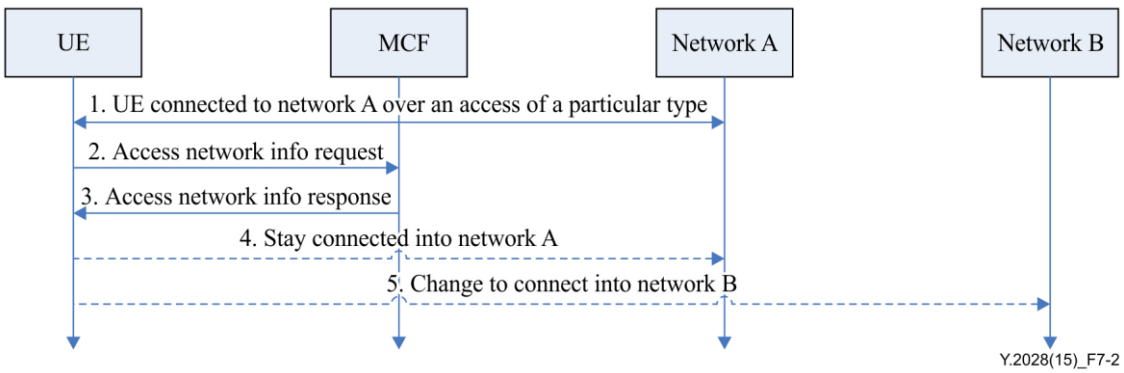


Figure 7-2 – Heterogeneous accesses discovery

In a heterogeneous network as shown in Figure 7-2, once the UE connects to a particular network (e.g., 3GPP) over its access connection, it is required to build a data link to a kind of multi-connection

control functional entity (MCF). There are two main modes of communications between the UE and the MCF:

– push mode: the UE shall establish a secure data connection using the information received in a notification short message service (SMS), which is sent from MCF;

– pull mode: the UE sends a query to the MCF, to retrieve or update inter-system mobility policy or information about available access networks in its vicinity.

As the data link is established, the UE may be required to provide related information to the MCF for policy retrieval, such as:

– location information (e.g., GPS info.)

– discovered radio access network information (e.g., cell ID).

Based on the operator's strategy, the MCF assists the UE in discovering available access networks by providing the following information to the requesting UE.

Inter-system mobility policies (ISMP):

1) access priority: e.g., if a specific radio access technology (RAT) and/or access network identifier is preferable;

2) restriction: e.g., if the inter-system mobility is restricted;

3) validity conditions: e.g., conditions indicating when the provided access network discovery information is valid.

7.2.2 Terminal-based access discovery solution

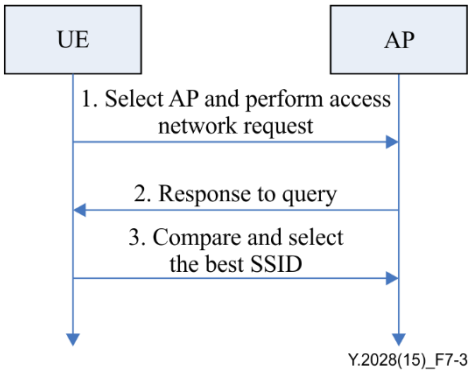


Figure 7-3 – Terminal-based access discovery

In the scenario of terminal-based access discovery, as shown in Figure 7-3, when selecting an AP, a terminal is required to perform an access network request, which includes supported providers, capabilities of the AP, etc. The AP would respond to the terminal with a list of items that specifically describe the available services, which include the capabilities of the networks being accessed, authentication types required by or available with the AP, etc.

After receiving the related information, the terminal would compare provisioned profile information against the data from the AP, confirm the accessible list of roaming providers, and finally associate itself with the best SSID to authenticate identity. All processes are completed in an automatic way.

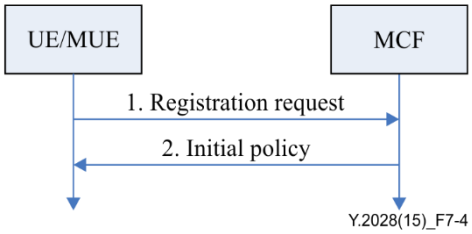
7.3 Access selection solution

7.3.1 Network-based access selection solution

Many operators deploy Wi-Fi to offload cellular network traffic. Hence, access discovery selection is a crucial function to be supported. The policy for selection should make optimal use of the available access technologies. The solution should consider how terminals discover and select access

technologies using policies from their home operator. As to the network aspect, it is easier to acknowledge the coverage of each access, to collect access status dynamically and to schedule the radio resources by time and user class.

1) provisioning: Once the UE is connected to the network by any access, the network policy would be pushed to the UE by the MCF as the reply to the UE's registration request. See Figure 7-4 below.



NOTE – Multi-connection user equipment (MUE)

Figure 7-4 – Network policy provision flow

The policy would refer to the following information:

- access type;
- access name preference;
- authentication type;
- access status;
- relative access;
- friendly roaming list;
- price (optional).

7.3.2 Terminal-based access selection solution

Smartphones supporting multiple access methods soared in 2012, and the capability of these terminals has also improved far more than before. Due to different access authentication requirements, users' calls or sessions may be sporadically interrupted. In practice, some access networks are provided by operators while others may be built by individuals or enterprises; therefore, the handover and roaming issues have gradually become important because the profile for each access network is set separately by its owner. Providing access profiles may help users' preferences in the selection of adequate accesses to properly support their UEs, APPs, specific Operating System functionality and chipset performance.

Before a terminal selects an available connection, each network would provide a necessary access profile with the following information:

- operator ID;
- access type;
- authentication type;
- Internet connectivity;
- pricing
- friendly operator list;
- network status.

The terminal would collect each access profile for users and then make a decision by user/terminal policy. The terminal policy would include the extra information below:

- preferred access type;
- preferred operator type;
- preferred service type;
- preferred network access.

Bibliography

[b-ITU-T Q.1706] Recommendation ITU-T Q.1706/Y.2801 (2006), *Mobility management requirements for NGN*.

[b-ITU-T X.200] Recommendation ITU-T X.200 (1994) | ISO/IEC 7498-1:1994, *Information technology – Open Systems Interconnection – Basic Reference Model: The basic model*.

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