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Amendment 1

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SERIES Y: GLOBAL INFORMATION INFRASTRUCTURE, INTERNET PROTOCOL ASPECTS, NEXT-GENERATION NETWORKS, INTERNET OF THINGS AND SMART CITIES

Internet protocol aspects – Quality of service and network performance

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Hand-over performance among multiple access networks

Amendment 1

Recommendation ITU-T Y.1546 (2014) – Amendment 1

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Recommendation ITU-T Y.1546

Hand-over performance among multiple access networks

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Summary

Ubiquitous wireless access to IP-based networks in many areas raises the scenario of multiple communications opportunities, possibly among both free and subscription network services. Recommendation ITU-T Y.1546 provides common reference events and parameters for attachment and hand-over performance. The mapping between the set of common events and technology-specific protocol events are provided in Annex A and Annex B, and these will be expanded as needed.

Amendment 1 introduces new Annex C on the IP-based service availability function.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T Y.1546	2014-10-29	12	11.1002/1000/12328
1.1	ITU-T Y.1546 (2014) Amd. 1	2018-06-13	12	11.1002/1000/13628

Keywords

Availability; hand-over performance; IP networking.

* 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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The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

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Hand-over performance among multiple access networks

Amendment 1

Editorial note: This is a complete-text publication. Modifications introduced by this amendment are shown in revision marks relative to Recommendation ITU-T Y.1546 (2014).

1 Scope

This Recommendation defines IP-layer and sub-IP-layer performance parameters for communication scenarios where one or more network technologies provide the access path between a user's communication device and an IP-based network (the Internet is the most common example), where the number of access paths to the IP-based network is changing (possibly due to mobility or to other factors such as failure or overload).

The performance parameters defined here build on the foundation of point-to-point parameters defined in [ITU-T Y.1540] and point-to-multipoint parameters defined in [ITU-T Y.1544].

One way to view the coverage of this Recommendation in comparison with [ITU-T Y.1540] is to view them both in the context of the 3-by-3 matrix of communication phases and performance categories of speed, accuracy and dependability.

Table 1 – Coverage of ITU-T Y.1540

Function/Criteria	Speed	Accuracy	Dependability
Activation			
Information transfer	ITU-T Y.1540 packet transfer performance parameters		
Deactivation			

Whereas [ITU-T Y.1540] covers the important phase of communication when the user device has activated a network interface and performed sub-IP layer and IP layer configurations, this Recommendation recognizes the importance of metrics for access network activation and deactivation corresponding to a user device's mobility into and beyond coverage areas, and the policy of a user device to use access networks it deems suitable.

Furthermore, this Recommendation recognizes that when more than one access network is accessible to the user device, the device policy may be to:

- hand-over communications to one network and deactivate others;
- prefer one access network but keep the other networks active or in back-up/standby;
- use the information transfer capabilities of all networks simultaneously.

New performance parameters are needed to accommodate all the policies above. At the core of hand-over performance is the simple activation speed and accuracy of the newly accessible network, followed by the implementation of policy, or policy action followed by deactivation.

Policy implemented before activation, based on *a priori* knowledge or field strength measurements is beyond the scope of this Recommendation. This phase of operation is often referred to as access network "discovery".

Thus, this Recommendation recognizes policy as an element of activation, prior to hand-over or possibly precluding hand-over when all information transfer capabilities will be used simultaneously.

Table 2 – Coverage of this Recommendation

Function/Criteria	Speed	Accuracy	Dependability
Activation	This Recommendation		
Policy decision	(User device or network or negotiation by both)		
Hand-over	This Recommendation		
Information transfer	ITU-T Y.1540 packet transfer performance parameters		
Deactivation	This Recommendation		

Table 3 – Topics for further study

Function/Criteria	Speed	Accuracy	Dependability
Activation (for >1 individual access networks)	Simultaneous activation		
Information transfer	Multipath/multi-access packet transfer performance parameters		
Deactivation	Simultaneous deactivation		

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 I.350] Recommendation ITU-T I.350 (1993), *General aspects of quality of service and network performance in digital networks, including ISDNs*.

[ITU-T Y.1241] Recommendation ITU-T Y.1241 (2001), *Support of IP-based services using IP transfer capabilities.*

[ITU-T Y.1540] Recommendation ITU-T Y.1540 (2016~~1~~), *Internet protocol data communication service – IP packet transfer and availability performance parameters.*

[ITU-T Y.1544] Recommendation ITU-T Y.1544 (2008), *Multicast IP performance parameters.*

[ITU-T Y.1545.1] Recommendation ITU-T Y.1545.1 (2017), *Framework for monitoring the quality of service of IP network services.*

~~[3GPP TS 23.401] 3GPP TS 23.401 (2014-06), *General Packet Radio Service (GPRS) enhancements for Evolved Universal Terrestrial Radio Access Network (E-UTRAN) access*, ver. 12.5.0.~~

[ETSI TS 123 401] ETSI TS 123 401 V12.11.0, LTE; *General Packet Radio Service (GPRS) enhancements for Evolved Universal Terrestrial Radio Access Network (E-UTRAN) access.*

[IEEE 802.11] IEEE Std 802.11- 2012, *IEEE Standard for Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications*.

3 Definitions

3.1 Terms defined elsewhere

None.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 accessible network: An access network which, either recognizes the user device as participating in a subscription, has permission or which requires terms and conditions that the user has or will accept.

3.2.2 coverage – definitions of overlaps and gaps

Wireless networks provide variable coverage areas due to many factors including transmission power restrictions, radio antenna location and transmission obstacles in the line-of-sight between antennae.

3.2.2.1 coverage gap: When a user device is unable to receive signals from (or send signals to) an accessible network, then this device is located in a coverage gap and all means of IP packet transfer are unavailable (according to the ITU-T Y.1540 definition of service availability).

3.2.2.2 overlapping coverage area: When a user device is able to receive signals from and send signals to more than one accessible network, then this device is located in an overlapping coverage area and IP packet transfer service may be available (according to the ITU-T Y.1540 definition of service availability) from more than one type of network or more than one network operator.

3.2.2.3 single coverage area: When a user device is only able to receive signals from and send signals to a single accessible network, then this device is located in a single coverage area and IP packet transfer service may be available (according to the ITU-T Y.1540 definition of service availability).

3.2.3 subscriber: An entity (associated with one or more users) that is engaged in a subscription with a service provider. The subscriber is allowed to subscribe and unsubscribe to services, to register a user or a list of users authorized to enjoy these services, and also to set the limits relative to the use that associated users make of these services. There may be data transfer limits on a subscription. There may be multiple devices used as part of the subscription.

NOTE – This Recommendation focuses on a single device.

3.2.4 user device: A generic version of names for "mobile station" (MS) and "user equipment" (UE) used in other standards bodies.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

DNS Domain Name Service

DHCP Dynamic Host Configuration Protocol

HA Host Activation

HC Host Connect

HR Host Release

HT Host Termination

LA Link Attach

LC Link Connect

LR Link Release

LT Link Termination

MP Measurement Point

MS Mobile Station

UE User Equipment

5 Conventions

None.

6 Reference events

This clause defines the critical reference events for network activation and deactivation.

- network discovery (sub-IP layer event) and activation start;
- IP network configuration complete;
- network rejection;
- network activation attempt time-out.

6.1 Reference events at the user device (or other key location)

This clause proposes two sets of reference events at unified measurement points (MPs) for IP and sub-IP layer events. Ingress and egress measurement points allow observation of both directions of transmission for IP and sub-IP layer packets.

6.1.1 Ingress MP at sub-IP layer (L=> link)

Sub-IP connect reference event (LC): Occurs when a sub-IP packet ingress event occurs, and the packet is a request to attach to a particular access network.

Sub-IP release reference event (LR): Occurs when a sub-IP packet ingress event occurs, and the packet is a request to release resources on a particular access network.

6.1.2 Egress MP at sub-IP layer

Sub-IP attach reference event (LA): Occurs when a sub-IP packet egress event occurs, and the packet confirms attachment to a particular access network.

Sub-IP termination reference event (LT): Occurs when a sub-IP packet egress event occurs, and the packet acknowledges a request to release resources on a particular access network.

6.1.3 Ingress MP at IP layer (H=host, associated with a sub-IP layer)

Host Config reference event (HC): Occurs when an IP packet ingress event occurs, and the packet's function is to request access to the Internet using a globally routable address (possibly thru NAT).

Host release reference event (HR): Occurs when an IP packet ingress event occurs, and the packet's function is to release a globally routable address.

6.1.4 Egress MP at IP layer (associated with a sub-IP layer)

Host activation reference event (HA): Occurs when an IP packet egress event occurs and the packet's function is to provide the necessary addresses (e.g., host IP, domain name service (DNS) IP) to access to the Internet using a globally routable address.

Host termination reference event (HT): Occurs when an IP packet egress event occurs, and the packet's function is to confirm the release of a globally routable address, and no packets with destination of the released host ID are observed for T_{Lmax} (the waiting time to confirm that a stream has terminated).

7 Performance parameters

This clause defines the performance parameters for network activation and deactivation, as well as for hand-over and other policies.

- activation time (for successful activations);
- activation failure ratio;
- deactivation time (for successful deactivations);
- deactivation failure ratio;
- hand-over time (for overlapping coverage, single network access);
- hand-over time (for overlapping coverage, multiple network access – for further study);
- outage time (for coverage gaps or non-overlapping coverage).

Table 4 – Parameters defined in this Recommendation

Criterion / Function	Speed	Accuracy	Dependability
Access	Successful sub-IP attach time Successful IP activate time	Incorrect sub-IP attach ratio Incorrect IP activate ratio	Failed sub-IP attach ratio Failed IP activate ratio
Hand-over	Successful hand-over time		Failed hand-over
User information transfer			Outage time
Disengagement	Successful sub-IP detach time Successful IP deactivation time	Incorrect sub-IP detach ratio Incorrect IP deactivation ratio	Failed sub-IP detach ratio Failed IP deactivation ratio

The definitions for these parameters follow:

7.1 Communication access parameters

7.1.1 Speed – successful (sub-IP/IP) attach/activate time

An attach attempt succeeds when a properly formatted attach request message enters the ingress MP, and a corresponding confirmation message exits the egress MP within a maximum waiting time, T_{AXmax} (where X is either L or H, corresponding to the sub-IP or IP layer process). The provisional value of T_{AXmax} is three seconds. Activate attempts are observed similarly.

Attach time is defined as the interval starting when the first bit of a properly formatted attach request message enters the ingress MP, until the last bit of a properly attach confirmation message exits the egress MP.

In terms of reference events, the sub-IP attach is the time interval from LC to LA.

In terms of reference events, the IP activate is the time interval from HC to HA.

Note that these times essentially measures the time needed to complete a successful attach/activate attempt.

The attach/activate time is expressed in seconds, with sufficient resolution to distinguish variability in successive attempts, when present. Multiple measurements may be summarized using statistics such as the minimum, maximum, median, mean, variance, percentiles, etc.

7.1.2 Accuracy – incorrect (sub-IP/IP) attach/activate ratio

An incorrect attach/activate outcome occurs when an attempt results in incorrect or unexpected confirmation message at the egress MP within a maximum waiting time, T_{AXmax}.

An incorrect attach/activate outcome is a logical parameter, where attempts that result in an incorrect response are indicated with "1", and other responses are indicated with "0". As an example, consider attachment to a specific Wi-Fi network, but a different network replies and results in the wrong service set identification (SSID) being displayed in status information. This would be an incorrect attach outcome.

The incorrect attach/activate ratio parameter is defined as the ratio of the incorrect attach/activate outcomes to total attempts collected over time at a single host, over many destination hosts, or both.

7.1.3 Dependability – failed (sub-IP/IP) attach/activate outcome and failed ratio

[ITU-T I.350] states that the term dependability "is the performance criterion that describes the degree of certainty (or surety) with which the function is performed regardless of speed or accuracy, but within a given observation interval."

An attach/activate attempt fails when an attach/activate message packet enters the ingress MP, and a corresponding confirmation message does not exit the egress MP within a maximum waiting time, T_{AXmax}.

The failed attach/activate outcome is a logical parameter, where failed attempts are indicated with "1" and successful attempts are indicated with "0".

The failed attach/activate ratio parameter is defined as the ratio of the failed attach/activate attempts to total attach/activate attempts collected over time at a single host, over many destination hosts, or both. These failed join ratios are distinguished by an adjective, such as host failed attach/activate ratio, or group failed attach/activate ratio.

7.2 Communication hand-over parameters

7.2.1 Speed – successful hand-over time

A simple hand-over causes a user device to take on the identity assigned by a newly attached network by using the IP address of that network in its packet transfer attempts (on that network). A simple hand-over is possible when:

- the user device is successfully attached to an access network and activated its IP packet transfer capability;
- the user device enters an overlapping coverage area;
- the user device has successfully attached to another access network that is preferred by its policy or other means, and activated its IP packet transfer capability on that network.

A simple successful hand-over occurs when packet transfer using the identity assigned by a newly attached network (i.e., the IP address) is successful.

The time interval from cessation of packet transfer on the original access network (referring to [ITU-T Y.1540], the last packet ingress reference event is the exact time reference) to the first successful packet transfer on the new access network (referring to [ITU-T Y.1540], the first packet ingress reference event is the exact time reference) is the hand-over time.

7.2.2 Accuracy – (for further study)

7.2.3 Dependability – failed hand-over

Under the conditions required for simple hand-over, a failed hand-over occurs when packet transfer using the identity assigned by a newly attached network (i.e., the IP address) fails to traverse the path to its intended egress point.

For practical reasons, observations at the user device may infer failures from the lack of response from a reliable Internet host, ideally a host which was reachable on the original network prior to hand-over.

7.3 User information transfer parameters

7.3.1 Speed – (for further study)

7.3.2 Accuracy – (for further study)

7.3.3 Dependability – outage time

Outage time is the interval beginning with the observation of a coverage gap, and ending with a successful (sub-IP/IP) attachment and activation.

7.4 Communication disengagement parameters

7.4.1 Speed – successful (sub-IP/IP) detach/deactivate time

A detach attempt succeeds when a properly formatted detach request message enters the ingress MP, and a corresponding confirmation message exits the egress MP within a maximum waiting time, T_{DXmax} (where X is either L or H, corresponding to the sub-IP or IP layer process). The provisional value of T_{DXmax} is three seconds. Deactivate attempts are observed similarly.

Detach time is defined as the interval starting when the first bit of a properly formatted detach request message enters the ingress MP, until the last bit of a properly detach confirmation message exits the egress MP.

In terms of reference events, the sub-IP detach is the time interval from LR to LT.

In terms of reference events, the IP deactivate is the time interval from HR to HT.

Note that these times essentially measures the time needed to complete a successful detach/deactivate attempt.

Detach/deactivate time is expressed in seconds, with sufficient resolution to distinguish variability in successive attempts, when present. Multiple measurements may be summarized using statistics such as the minimum, maximum, median, mean, variance, percentiles, etc.

7.4.2 Accuracy – incorrect (sub-IP/IP) detach/deactivate ratio

An incorrect detach/deactivate outcome occurs when an attempt results in incorrect or unexpected confirmation message at the egress MP within a maximum waiting time, T_{DXmax}.

An incorrect detach/deactivate outcome is a logical parameter, where attempts that result in an incorrect response are indicated with "1", and other responses are indicated with "0". As an example, consider detachment to a specific Wi-Fi network, but a different network replies and results in the wrong network/SSID being detached. This would be an incorrect detach outcome.

The incorrect detach/deactivate ratio parameter is defined as the ratio of the incorrect detach/deactivate outcomes to total attempts collected over time at a single host, over many destination hosts, or both.

7.4.3 Dependability – failed (sub-IP/IP) detach/deactivate outcome and failed ratio

A detach/deactivate attempt fails when a detach/deactivate message packet enters the ingress MP, and a corresponding confirmation message does not exit the egress MP within a maximum waiting time, T_{DXmax}.

The failed detach/deactivate outcome is a logical parameter, where failed attempts are indicated with "1" and successful attempts are indicated with "0".

The failed detach/deactivate ratio parameter is defined as the ratio of the failed detach/deactivate attempts to total detach/deactivate attempts collected over time at a single host, over many destination hosts, or both. These failed join ratios are distinguished by an adjective, such as host failed detach/deactivate ratio, or group failed detach/deactivate ratio.

Annex A

Mapping of reference events to IEEE 802.11 wireless LAN

(This annex forms an integral part of this Recommendation.)

Figure A.1 provides a mapping for attachment (user device on left side).

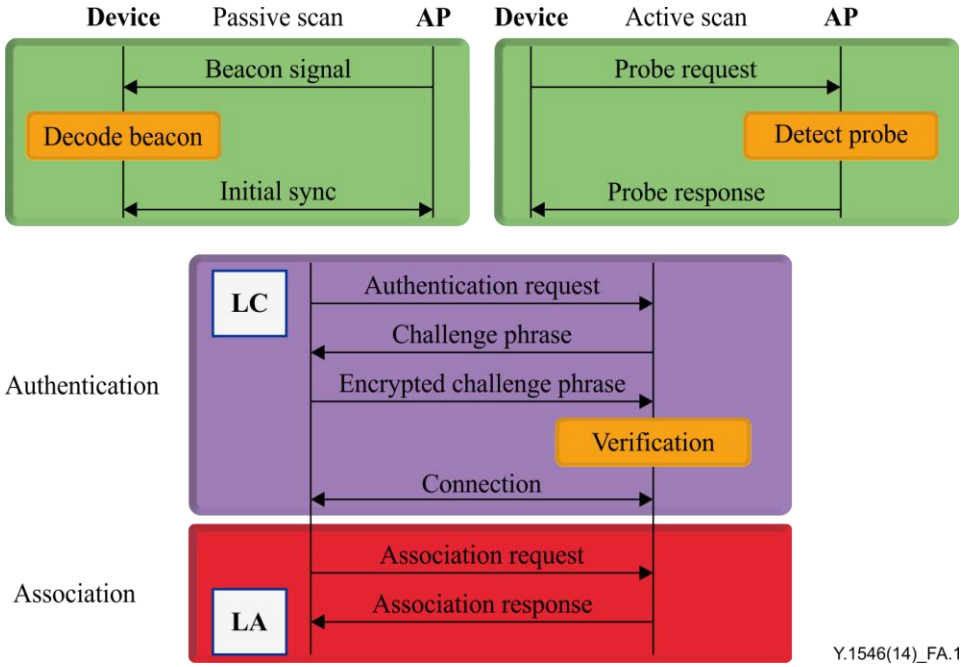

Figure A.1 – Wireless LAN attachment

Figure A.2 provides a mapping for activation using dynamic host configuration protocol (DHCP) (user device is designated Client).

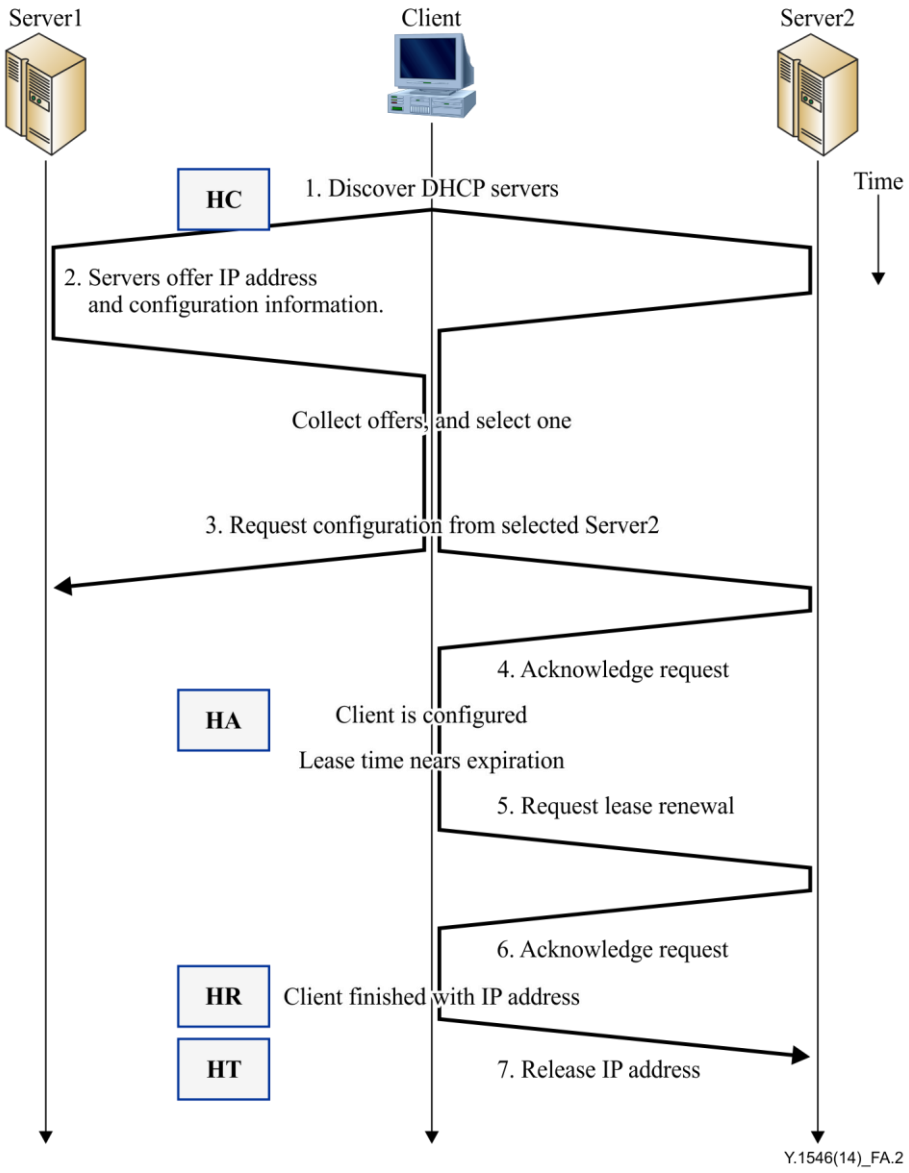

Figure A.2 – DHCP IP attachment and detachment

Annex B

Mapping of reference events to ETSI TS 123 401 (3GPP TS 23.401)

(This annex forms an integral part of this Recommendation.)

Figure B.1 provides a mapping for attachment and activation (user device is designated UE).

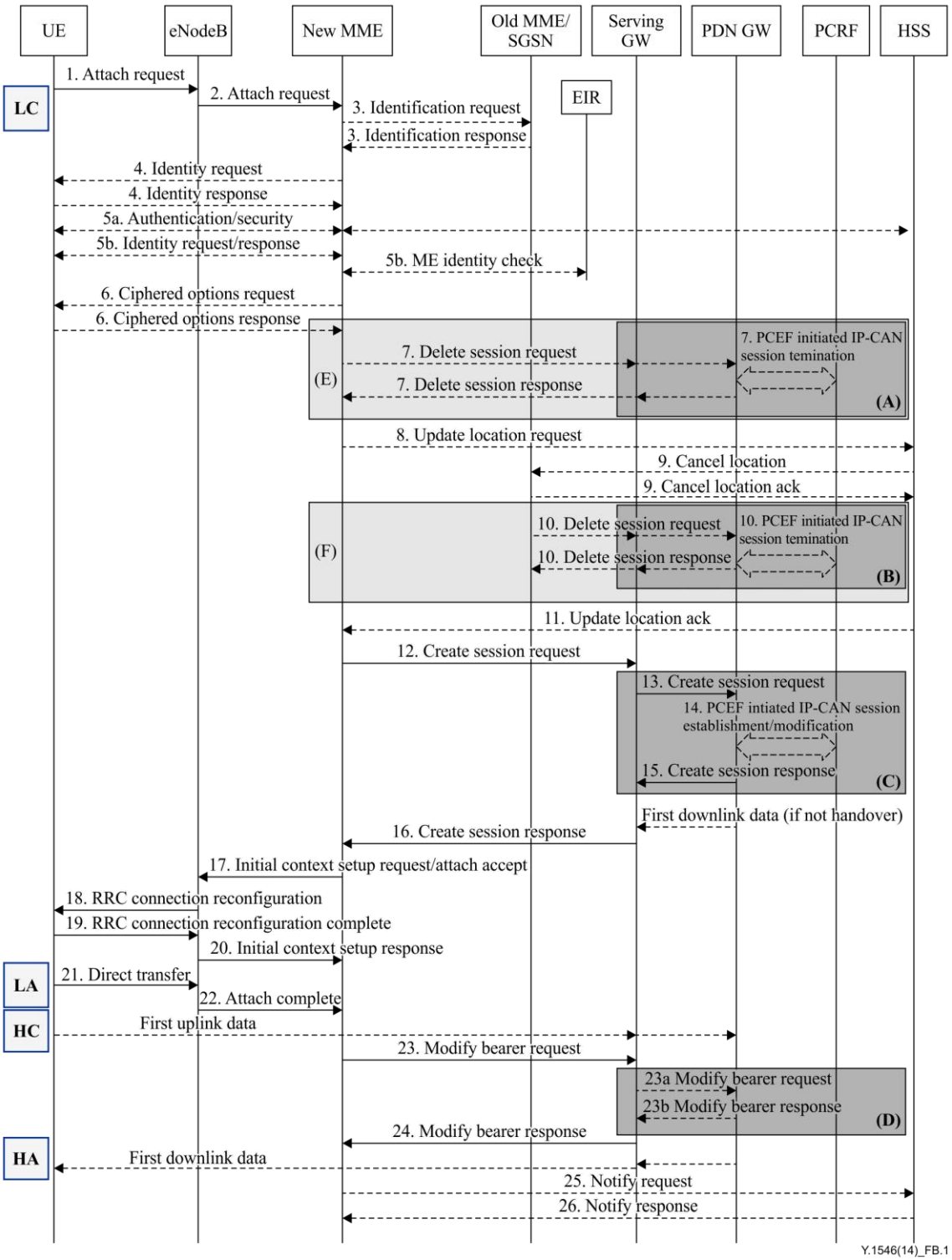

Figure B.1 – LTE activation and attachment

Annex C

IP-based service availability function

(This annex forms an integral part of this Recommendation.)

Introduction

The 2016 version of [ITU-T Y.1540] adopts new parameters for IP service availability, with a reduced evaluation interval at 1 minute, and packet loss ratio threshold of 0.20.

In the context of [ITU-T Y.1545.1], two definitions of IP service have been included. The first is a simple definition of an IP packet transfer service:

> IP network service [ITU-T Y.1241]: "defined as a data transmission service in which the data passed across the interface between the user and provider is transferred in the form of Internet Protocol (IP) packets (sometimes called datagrams). IP network service includes the service provided by using the IP transfer capabilities."

The IP network service and the ITU-T Y.1540 IP service availability function are well-aligned. There are no control or management aspects in the IP network service definition and none are evaluated with the ITU-T Y.1540 IP service availability function, since it was designed to measure the information transfer phase of communications and not the activation phase. The broader service definition adds control and management functions to IP packet transfer:

> IP-based service [ITU-T Y.1241]: "defined as a service provided by the service plane to an end user (e.g., a host (end system) or a network element) and which utilizes the IP transfer capabilities and associated control and management functions, for delivery of the user information specified by the service level agreements."

Clearly, the single-dimension of packet loss is not sufficient to evaluate IP based service. The ITU-T Y.1540 IP service availability function is sufficient for "always-on" services without frequent activation operations typical with mobile devices that attach to different local area networks and perform a new IP-layer activation each time.

This Recommendation addresses the many performance parameters associated with communications access and disengagement, as shown below, but does not attempt to assess availability when the access and disengagement functions are needed. Table C.1 (the same as Table 4) lists the parameters defined in this Recommendation.

Table 1 – Parameters defined in this Recommendation

Criterion / Function	Speed	Accuracy	Dependability
Access	Successful sub-IP attach time Successful IP activate time	Incorrect sub-IP attach ratio Incorrect IP activate ratio	Failed sub-IP attach ratio Failed IP activate ratio
Hand-over	Successful hand-over time		Failed hand-over
User information transfer			Outage time
Disengagement	Successful sub-IP detach time Successful IP deactivation time	Incorrect sub-IP detach ratio Incorrect IP deactivation ratio	Failed sub-IP detach ratio Failed IP deactivation ratio

Within the context of a single local area network and technology, the availability function needs to cover the access and information transfer functions and cover other control and management functions, such as domain name server (DNS) access.

Dimensions of IP based service availability

In the access phase of communication, successful sub-IP network attachment for a user host is an essential first step. We are primarily concerned with IP network activation using either of the available address families (IPv4 or IPv6) when evaluating IP based service availability.

Private IP network: In many network configurations, both mobile and fixed access technologies, the user host must first obtain a combination of private network and service provider network configuration items, including private network IP address and service provider DNS server list.

Globally-routable IP network: The success of private IP network activation is dependent on a prior service provider network activation in the case of a fixed access technology (e.g., cable modem, DSL), or a subsequent IP network attachment (e.g., mobile network PDP attachment in the service provider network). In either fixed or mobile access, this form of attachment makes one or more globally-routable IP address(es), possibly available to the user host through network address translation (NAT).

DNS: Another key aspect of service is the availability of at least one DNS server from the provisioned list of servers.

Carrier-grade NAT: Some networks apply a further stage of NAT before user packets are assigned a globally routable address, but this is an on-going process accounted for in the information transfer phase of communication. We include address family translation in this category.

Each of these dimensions must be available with a minimal level of performance.

The success of each of the access functions above is dependent on the correct operation of the user's host, which is one of a set of hosts authorized by the service subscriber. Where the private IP network is owned and managed by the subscriber, then correct operation of the private network is also a dependency.

Last, the ITU-T Y.1540 IP service availability function is applied between the destination user host (or its service demarcation point) on the service provider's network and a valid gateway on the service provider's network.

State diagram of IP based service availability (incorporating access)

The current diagram corresponding to the ITU-T Y.1540 IP service availability function is quite simple, identifying the Available and Unavailable state with the evaluation function for packet loss indicated on both state transition paths (because the outcome of one function controls the transition in either direction). See clause 7 of [ITU-T Y.1540] for thresholds applying to the IPLR-based evaluation to determine occupation of the Activated and Available state, or the Unavailable state (as illustrated in Figure C.1), and supporting background material.

Figure C.1 takes the IP based service access phase and functions into account.

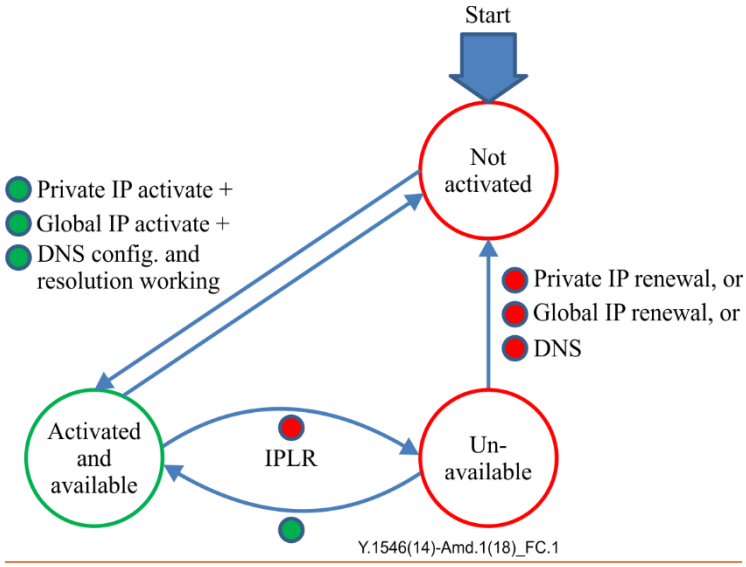

Figure C.1 – State diagram of IP-based service availability evaluation

Additional considerations:

1. DNS resolution success does not imply all possible names can be resolved.
2. Use of non-SP-configured DNS is assumed to be usage beyond the service agreement.
3. There may be authentication required to receive an IP address and this process is out of scope, but this detail can also be judged in combination with successful IP activation or sub-IP attachment.
4. By focusing on the IP-layer, we retain a manageable scope and allow sub-IP layer service providers to extend the definitions here in their unique environments.

Figure C.1 illustrates successful testing with green ellipses and failures with red. The provisional thresholds for these success or fail evaluations are tabulated in Tables C.2 and C.3, governing occupation of the Not Activated state in case of failure.

Table C.2 – Provisional performance objectives for service activation

Performance parameter	Provisional objective for minimum performance
Successful IP activate time, IPv4 and IPv6, private address space	< 10 seconds
Service authentication time	Unbounded
Successful IP activate time, IPv4 and IPv6, global address space	< 1 second
DNS address resolution time, AA and AAAA records	< 1 second
NOTE 1 – The values in Table C.2 are provisional. They need not be met by networks at this time and are subject to revision (up or down) following further study and operational experience. NOTE 2 – Since the objectives above are minimum performance thresholds, typical user experience should be much better than the thresholds under normal circumstances. NOTE 3 – Usually, activation using one of the IP address families will be essential for global communications. The measurement should specify which family and whether private, global, or both address types are essential. NOTE 4 – See the IETF Performance Metrics Registry for a definition of DNS Response Time and DNS Response Loss (https://tools.ietf.org/html/draft-ietf-ippm-initial-registry-04#section-6).	

Table C.3 – Provisional performance objectives for service renewal

Performance parameter	Provisional objective for renewal failure
Successful IP renewal time, IPv4 and IPv6, private address space	> 10 seconds
Successful IP renewal time, IPv4 and IPv6, global address space	> 1 second
NOTE 1 – The values in Table C.3 are provisional. They need not be met by networks at this time and are subject to revision (up or down) following further study and operational experience. NOTE 2 – Since the objectives above are Failure thresholds, typical user experience should be much lower than the thresholds under normal circumstances. NOTE 3 – IP Renewal time is measured using the IP Activation time metric. NOTE 4 – Usually, activation using one of the IP address families will be essential for global communications. The measurement should specify which family and whether private, global, or both address types are essential. NOTE 5 – Failure of service renewal causes transition to the not activated service state. This is indicated in Figure C.1 with lines illustrating the transition from activated and available state to not activated, and the transition from Unavailable to Not Activated.	

More comprehensive tests of DNS support of a service agreement, beyond connectivity and (any) address resolution, are for further study.

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