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

Next Generation Networks – Frameworks and functional architecture models

Flow-based service continuity in multi-connection

Recommendation ITU-T Y.2040

International Telecommunication Union

ITU-T Y-SERIES RECOMMENDATIONS

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

GLOBAL INFORMATION INFRASTRUCTURE	
General	Y.100–Y.199
Services, applications and middleware	Y.200–Y.299
Network aspects	Y.300–Y.399
Interfaces and protocols	Y.400–Y.499
Numbering, addressing and naming	Y.500–Y.599
Operation, administration and maintenance	Y.600–Y.699
Security	Y.700–Y.799
Performances	Y.800–Y.899
INTERNET PROTOCOL ASPECTS	
General	Y.1000–Y.1099
Services and applications	Y.1100–Y.1199
Architecture, access, network capabilities and resource management	Y.1200–Y.1299
Transport	Y.1300–Y.1399
Interworking	Y.1400–Y.1499
Quality of service and network performance	Y.1500–Y.1599
Signalling	Y.1600–Y.1699
Operation, administration and maintenance	Y.1700–Y.1799
Charging	Y.1800–Y.1899
IPTV over NGN	Y.1900–Y.1999
NEXT GENERATION NETWORKS	
Frameworks and functional architecture models	**Y.2000–Y.2099**
Quality of Service and performance	Y.2100–Y.2199
Service aspects: Service capabilities and service architecture	Y.2200–Y.2249
Service aspects: Interoperability of services and networks in NGN	Y.2250–Y.2299
Enhancements to NGN	Y.2300–Y.2399
Network management	Y.2400–Y.2499
Network control architectures and protocols	Y.2500–Y.2599
Packet-based Networks	Y.2600–Y.2699
Security	Y.2700–Y.2799
Generalized mobility	Y.2800–Y.2899
Carrier grade open environment	Y.2900–Y.2999
FUTURE NETWORKS	Y.3000–Y.3499
CLOUD COMPUTING	Y.3500–Y.3999
INTERNET OF THINGS AND SMART CITIES AND COMMUNITIES	
General	Y.4000–Y.4049
Definitions and terminologies	Y.4050–Y.4099
Requirements and use cases	Y.4100–Y.4249
Infrastructure, connectivity and networks	Y.4250–Y.4399
Frameworks, architectures and protocols	Y.4400–Y.4549
Services, applications, computation and data processing	Y.4550–Y.4699
Management, control and performance	Y.4700–Y.4799
Identification and security	Y.4800–Y.4899

For further details, please refer to the list of ITU-T Recommendations.

Recommendation ITU-T Y.2040

Flow-based service continuity in multi-connection

Summary

Recommendation ITU-T Y.2040 describes the flow-based service continuity mechanism in a multi-connection environment. This Recommendation also covers scenarios, requirements, solutions, information flows and security. In the multi-connection environment, flow-based service continuity is the mechanism that allows the moving of IP flows from one access to another (target) access, thus minimising service disruption in the case of access loss, or when the access is no longer usable. Flow-based service continuity (FSC) includes two modes, the multi-connection user equipment (MUE) initiated flow-based service continuity mode and the network-initiated flow-based service continuity mode.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T Y.2040	2016-02-13	13	11.1002/1000/12704

Keywords

Flow-based, multi-connection, service continuity.

* 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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As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at http://www.itu.int/ITU-T/ipr/.

Table of Contents

Recommendation ITU-T Y.2040

Flow-based service continuity in multi-connection

1 Scope

This Recommendation describes the flow-based service continuity mechanism in a multi-connection environment. This Recommendation also describes scenarios, requirements, information flow mechanisms and security of flow-based service continuity in a multi-connection environment. For information on other aspects outside of the scope of this Recommendation, such as security and charging for flow-based service continuity in a multi-connection environment, see [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.2028] Recommendation ITU-T Y.2028 (2015), *Intelligent access selection in multi-connection.*

[ITU-T Y.2029] Recommendation ITU-T Y.2029 (2015), *A multi-path transmission control in 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 multi-connection [b-ITU-T Y.2252]: The collection of several connections between two or more peer-(N)-entities simultaneously. At least one of the connections is associated with a physical layer connectivity different from the rest of the connections. All connections are coordinated with each other to provide service to higher layer entities.

3.1.3 multi-connection user equipment (MUE) [ITU-T Y.2027]: A user equipment which can support two or more network connections simultaneously under the control of a network enhanced for multi-connection capability.

3.1.4 service continuity [b-ITU-T Q.1706]: The ability for a moving object to maintain ongoing service including over current states, such as user's network environment and session for a service.

3.1.5 service transfer [ITU-T Y.2251]: Act of moving, one or more services or service components belonging to a single multi-connection UE, from one access network associated with one interface of the multi-connection UE to another access network(s) associated with other interface(s) of the multi-connection UE.

3.1.6 IP flow [b-RFC 3917]: A flow is defined as a set of IP packets passing an observation point in the network during a certain time interval. All packets belonging to a particular flow have a set of common properties. Each property is defined as the result of applying a function to the values of:

1) One or more packet header field (e.g., destination IP address), transport header field (e.g., destination port number), or application header field (e.g., RTP header fields [b-RFC 3550]);
2) One or more characteristics of the packet itself (e.g., number of MPLS labels, etc.);
3) One or more of fields derived from packet treatment (e.g., next hop IP address, the output interface, etc.).

3.2 Terms defined in this Recommendation

None.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

2G Second Generation

3G Third Generation

3GPP 3rd Generation Partnership Project

AC-FE Access Control FE

FE Functional Entity

FSC Flow-based Service Continuity

IAS Intelligent Access Selection

IP Internet Protocol

MC-FE Multi-connection Coordination FE

MAS-F Multi-connection Application Support Function

MMF Multi-connection Media Function

MPC-FE Multi-connection Policy Control FE

MR-FE Multi-connection Registration FE

MTC-FE Multi-connection Terminal Control FE

MUE Multi-connection User Equipment

MUP-FE Multi-connection User Profile FE

QOS Quality of Service

SC Service Continuity

SCF Service Control Function

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

In the multi-connection environment, the multi-connection user equipment (MUE) has more than one active connection simultaneously, it can send and receive different IP flows of the same application through different accesses. In the case where one of the accesses is lost or is no longer usable, a mechanism is provided to move the IP flows to another (target) access in order to minimise service disruption. When an access is recovered, a mechanism is provided to move the IP flow over to the recovered access. Precedence is given to those accesses associated with policies. The covered scenarios include an MUE-initiated flow-based service continuity (FSC) scenario and a network-initiated FSC scenario.

6.1.1 MUE-initiated FSC scenario

In the MUE-initiated FSC mode only the MUE controls the traffic routing for the associated multi-connections and applying policies for FSC rules.

The MUE can request to move selected IP flows from an old access to a new access by sending one or more routing rules to the network. The routing rules specify the selected IP flows and the new access. The MUE determines the routing rules and provides them to the network. The network may either accept or reject the routing rules requested by the MUE, but it does not provide routing rules by itself.

6.1.2 Network-initiated FSC scenario

In the network-initiated FSC mode, the network controls the traffic routing within the multi-connections. The network determines the routing rules and provides them to the MUE. The MUE may either accept or reject the network's request for routing rules (e.g., based on the suitability of the access link conditions), but the MUE does not provide routing rules by itself.

6.2 Requirements

6.2.1 General requirements

In the multi-connection environment, the MUE may transfer one or multiple IP sub-flows seamlessly when the MUE moves out of coverage and the connection is lost, or when there is network congestion. This clause identifies requirements in order to provide service continuity to the user and the application during service transfer:

1) Data forwarding mechanism: A data forwarding mechanism is required to keep data integrity.
2) Mobility control mechanism: A mobility control mechanism is required to minimize the time during the flow transfer and maintain flow service continuity.
3) Flow sequence numbers: sub-flow sequence numbers need to be added to each sub-flow. A flow sequence number is used for transmission control and data recovery at the receiving end.
4) The multi-connection policy control functional entity (MPC-FE) should support specific policy decision algorithms to provide adaptive decision making, such as decomposed service transmission adjustment and service separation decisions.

6.2.1 FSC capability discovery/negotiation requirement

A mechanism is defined for the MUE and the network to discover whether the network and the MUE respectively support FSC and to decide whether FSC is applied for multi-connection. The MUE and the access control functional entity (AC-FE) shall always be aware of which access Internet protocol (IP) flows are used in multi-connection.

During initial multi-connection establishment over the first connection, the MUE triggers a FSC request. The intermediate network nodes indicate to the AC-FE whether they support FSC for the corresponding request. If an MPC-FE is deployed, the AC-FE communicates to the MPC-FE indicating whether or not the MUE and the network support FSC. The MPC-FE then takes the decision of whether or not FSC may apply to the multi-connection and communicates this decision to the AC-FE.

If the network supports FSC and is willing to accept FSC for the multi-connection, the AC-FE confirms the FSC support in an "FSC accepted" indication sent back to the MUE in the multi-connection establishment accept message.

6.2.2 Routing rules

It is recommended that a routing rule contains the following parameters:

– Routing filter
– Routing access information
– Routing rule priority
– Routing rule identifier

A routing filter consists of IP header parameter values and/or ranges used to identify one or more IP flows.

The routing access information identifies the access type where the IP flow shall be routed.

For the purpose of matching user traffic against routing rules, filters are applied in the order designated by the routing rule priority.

The routing rule identifier uniquely identifies a routing rule for one connection. The routing rule identifier is allocated by the entity creating the routing rule; i.e., by the MUE in MUE-initiated FSC mode and by the AC-FE in network-initiated FSC mode.

6.2.3 Delivery of routing rules

Routing rules are exchanged between the MUE and the AC-FE via control plane signalling.

For the MUE-initiated FSC procedure, the routing rules are provided by the MUE to the network. The MUE does not apply new routing rules until the AC-FE has acknowledged them.

For the network-initiated FSC procedure, the MPC-FE makes the decision on when and which flows should be moved to which connections. The MPC-FE learns about the multiple accesses supporting a multi-connection via event triggers from the AC-FE.

7 Flow-based service continuity mechanisms

7.1 Overview

Both, the MUE-initiated FSC mode and the network-initiated mode are supported. The FSC mode applicable to multi-connection is determined during connection establishment. Routing rule installation is possible at any time during the lifetime of the multi-connection sessions. The routing rules can even be installed if there is no IP flow currently matching the routing filter in the routing rule.

The AC-FE performs IP flow routing for downlink traffic. The MUE performs IP flow routing for uplink traffic.

During the multi-connection sessions and when the policies determine that the IP flows should be moved and the target access is available for the MUE, it is possible to move individual IP flows from one access network to another.

When an MPC-FE is deployed and supports FSC, the MPC-FE provides the AC-FE with access information as part of the policy control rules. The access information is used to control the accesses over which the matching traffic is sent.

When an MPC-FE is not deployed or it is inactive for a multi-connection session, the AC-FE may apply static FSC related policies. The AC-FE static policy and control functionality is not based on subscription or user quota information.

For FSC, the MUE and the AC-FE exchange routing rules. Routing rules describe the mapping between a set of IP flows (identified by a routing filter) and a routing access type (e.g., 3GPP or WLAN types) over which to route the IP flows. Routing rules are exchanged over the control plane.

The AC-FE translates access information received in policy control rules into routing rules to be used between the MUE and the AC-FE. In cases where the MUE-initiated FSC is applied (and the policy control entity is deployed for the multi-connection) the AC-FE provides, upon subscription of the MPC-FE, the MPC-FE with notifications of the MUE requests for IP flow mapping to an access type. The MPC-FE analyses the received information (requested IP flow mapping to an access type), makes a policy decision and provides policy control rules to the AC-FE with corresponding access type values.

The FSC-enhanced related functional entities are shown in Figure 7-1.

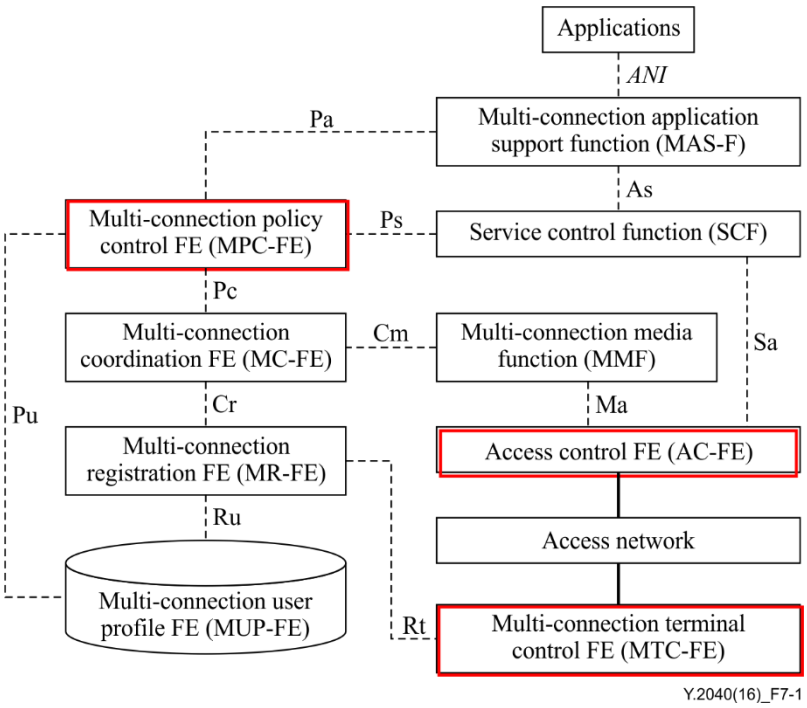

Figure 7-1 – Multi-connection flow-based service continuity related functional entities

7.2 Description of the mechanisms

7.2.1 Description of the FSC mechanisms

Following the above-mentioned requirements, two multi-connection FSC modes are supported, the MUE-initiated FSC mode and the network-initiated mode. The following clauses specify the functional characteristics of each mode and how they are selected.

7.2.2 MUE-initiated FSC mode

In the MUE-initiated FSC mode, the MUE controls the traffic routing among the multi-connections by applying its intelligent access selection (IAS) for FSC rules and/or the user-configured routing rules. When the IAS for FSC rules is used, the MUE can also control traffic routing outside the multi-connection access control functional entity.

The MUE can request to move selected IP flows from one access to another access by sending routing rules to the network. These routing rules specify the selected IP flows and the new (target) access.

The network cannot request FSC. The network may reject FSC requests from MUE due to subscription (or quota) limitations. When the network rejects an IP flow mobility request, the network shall provide to the MUE a specific cause value indicating why the request was rejected. This cause value may be used by the MUE to determine when and if this FSC operation can be requested again.

7.2.3 Network-initiated FSC mode

In the network-initiated FSC mode, the network controls the traffic routing within the multi-connection access control function entity.

The network can request to move selected IP flows from one multi-connection access to another multi-connection access by sending routing rules to the MUE. The routing rules specify the selected IP flows and the new (target) connection.

The MUE may reject (e.g., due to the local operating environment information) a FSC request from the network. When the MUE rejects a FSC request from the network, the MUE shall provide a cause value indicating the reason of the rejection. The cause value may be used by the network to determine when/if this FSC operation can be requested again.

The MUE cannot request IP flow mobility. However, the MUE can indicate to the network when an access for multi-connection purposes can or cannot be used for traffic routing. For instance, in the case where the MUE wants to request a mapping of IP flows to a specific access type, the MUE provides the requested mapping to the network. However, this is not considered a routing rule provision, since the network is considered as the decision point for routing rules in the network-initiated FSC mode. The network then provides new or updated routing rules to the MUE, based on the request received from the MUE, unless the request is contrary to what is allowed by the subscription.

7.2.4 Mode selection

Multi-connection FSC can operate in one of the following modes:

– MUE-initiated mode;

– Network-initiated mode.

The multi-connection FSC mode is selected with the following procedure:

– When an FSC-capable MUE supports multi-connection IAS and it has a routing policy rule valid in the operators' network, then:
  - If the routing policy rule includes at least one "routing policy for FSC" rule (irrespective of its validity), the MUE requests MUE-initiated mode and the network selects MUE-initiated mode;
  - Otherwise, the MUE requests network-initiated mode and the network selects network-initiated mode.

– When an FSC-capable MUE does not support multi-connection IAS or supports multi-connection IAS but it does not have a routing policy rule valid in the network, then:
  - The MUE requests network-initiated mode and the network selects network-initiated mode.

7.3 Capability requirements

7.3.1 FSC-enhanced MUE requirements

To support FSC, the following capabilities of the FSC-enhanced MUE are required:

– Indicate support and request FSC for MUE multi-connection;

– Request FSC mode to the network;

– Send default accesses for FSC to the network (in MUE-initiated FSC mode);

– Receive decisions from the network on whether FSC applies to a connection, on the FSC mode and on the default access;

– Provide handover indication and FSC indication if an access is added for a multi-connection;

– Exchange routing rules with the network;

– Route IP flow(s) by using routing access information;

– Notify to the network that a connection becomes "usable" or "Not usable" (in network-initiated FSC mode).

7.3.2 FSC-enhanced AC-FE requirements

To support FSC, the following capabilities of the FSC-enhanced AC-FE are required:

– Negotiate the capability to support FSC and the FSC mode if the MUE is connected to the network. This negotiation includes receiving the MUE request for FSC, as well as receiving the corresponding support indications from other entities in the network;

– Receive MUE request on a default connection for FSC (in MUE-initiated FSC mode);

– Route IP flow(s) by using the routing access information;

– Exchange routing rules between network and MUE over control plane (protocols);

– Receive UE notification that a connection has become "usable" or "Not usable" (in network-initiated FSC mode).

7.3.3 FSC-enhanced MPC-FE requirements

To support FSC, the following capabilities of the FSC-enhanced MPC-FE are required:

– The MPC-FE controls whether FSC may apply to a multi-connection;

– The MPC-FE may request to be notified by the AC-FE when a connection is added or removed for the multi-connection;

– The MPC-FE may request to be notified by the AC-FE when a connection becomes not "Usable" or "Usable" again;

– The MPC-FE can send policy control rules including access type routing information per policy control rule to the AC-FE;

– The MPC-FE may subscribe to notifications from AC-FE about the routing rules received from the MUE. If the routing rules received from the MUE comply with the user subscription, the MPC-FE installs or modifies policy control rules based on these notifications, only in MUE-initiated FSC mode;

– The MPC-FE determines the desired access type routing information for a policy control rule and accordingly installs or modifies policy control rules to the AC-FE. The MPC-FE request may be rejected by the MUE due to local access conditions. In such cases, the MPC-FE is notified that the policy control rule cannot be fulfilled, only for network-initiated FSC mode.

7.4 Procedures

7.4.1 MUE initiated FSC

Multi-connection FSC operates in the MUE-initiated mode in the following manner. When a MUE is connected simultaneously to multiple access networks, the MUE can use multiple connections to send and receive IP flows. Because of the changes in the access network, sometimes the MUE needs to move one IP flow from one access to another. In that case, the MUE moves one or more IP flow(s) by providing a routing rule to the network, thus updating the routing rules. MUE initiated FSC is shown in Figure 7-2.

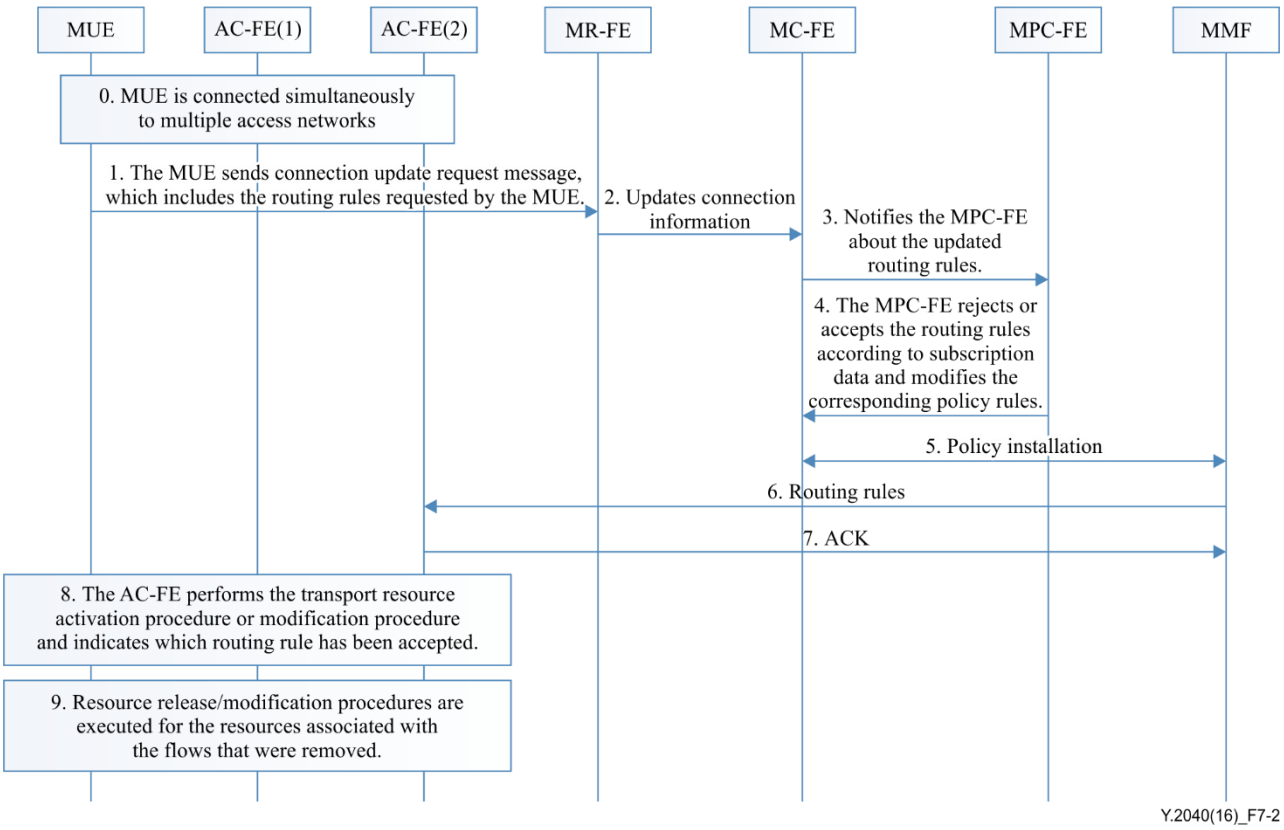

Figure 7-2 – MUE initiated FSC

0. The MUE is connected simultaneously to multiple access networks and it is using multiple connections to send and receive IP flows.
1. The MUE sends a connection update request message to the multi-connection registration functional entity (MR-FE). The message contains the routing rules requested by the MUE.
2. The MR-FE updates the information of the connection by using the connection update request message. Afterwards the MR-FE sends a connection information message to the multi-connection coordination functional entity (MC-FE).
3. The MC-FE sends a transport resource modification request message to the MPC-FE. This message contains the updated routing rules for the MPC-FE.
4. The MPC-FE rejects or accepts the routing rules according to subscription data and modifies the corresponding policy rules.
5. The MC-FE makes and assigns related rules for access network for the multi-connection media function (MMF). In this way, the MMF installs the suitable rules.
6. The MMF sends the new routing rules to the AC-FE(2).
7. The AC-FE(2) updates the routing rules of the connection. Afterwards, it returns an ACK message to the MMF.
8. The AC-FE(2) performs the transport resource activation procedure or modification procedure indicating which routing rule has been accepted.
9. Resource release or modification procedures are finally executed, so the associated resources to the flows can be removed.

7.4.2 Network initiated FSC

The multi-connection FSC operates in network-initiated mode in the following manner. Based on the current status of an access network, one of the existing IP flows is moved from one access network to another automatically. Thus, the network is required to initiate the FSC and move one or more IP flows by providing a routing rule to the MUE updating the routing rules. Network initiated FSC is shown in Figure 7-3.

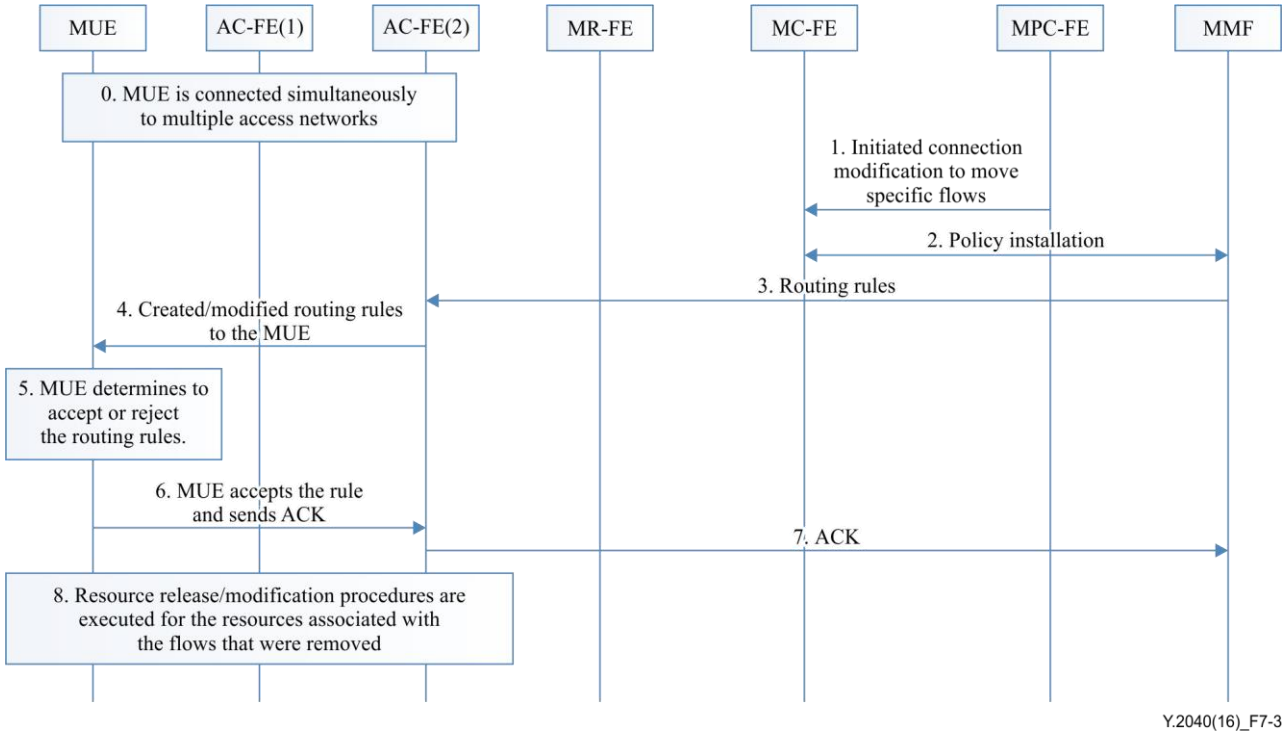

Figure 7-3 – Network initiated FSC

0. The MUE is connected to multiple access networks simultaneously and uses multiple connections to send and receive IP flows.
1. The MPC-FE determines based on policy information and current MUE state that connection modification should be initiated to move specific flows. The MPC-FE provides policy control rules with access type information.
2. The MC-FE makes and assigns related rules for the access network to the MMF. The MMF installs the rules.
3. The MMF sends the new routing rules to AC-FE(2).
4. The AC-FE(2) determines if the new routing rules or the modified routing rules need to be sent to the MUE, based on the received policy control rules. The AC-FE sends the created or modified routing rules to the MUE.
5. The MUE may accept or reject the routing rules. If the MUE rejects the routing rules, the MUE provides a cause value indicating why the request was rejected. This cause value may be used by the network to determine if the FSC operation can be requested again.
6. The MUE applies the accepted routing rules and acknowledges the applied rules in the ACK message sent to the AC-FE(2).
7. The AC-FE(2) indicates to the MMF whether or not the routing rule can be enforced.
8. Resource release or modification procedures are executed for the resources associated with the removed flows.

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Series A	Organization of the work of ITU-T
Series D	General tariff principles
Series E	Overall network operation, telephone service, service operation and human factors
Series F	Non-telephone telecommunication services
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