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Recommendation

# ITU-T Q.5004 (02/2023)

SERIES Q: Switching and signalling, and associated measurements and tests

Signalling requirements and protocols for IMT-2020 – Signalling requirements and architecture of IMT-2020

# Signalling architecture of lite IMS for IMT-2020 networks and beyond

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# Recommendation ITU-T Q.5004

## Signalling architecture of lite IMS for IMT-2020 networks and beyond


### Summary

Recommendation ITU-T Q.5004 specifies the signalling architecture of lite IMS for IMT-2020 networks and beyond, designed for the Internet protocol multimedia system (IMS) domain with high efficiency, extensibility, intelligence and high value addition characteristics.



### History

| Edition | Recommendation | Approval | Study Group | Unique ID* |
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| 1.0 | ITU-T Q.5004 | 2023-02-13 | 11 | 11.1002/1000/15256 |



### Keywords

IMS, IMT-2020 network and beyond, signalling architecture.


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# Recommendation ITU-T Q.5004

## Signalling architecture of lite IMS for IMT-2020 networks and beyond

### 1 Scope

This Recommendation presents the signalling architecture of lite IMS for IMT-2020 networks and beyond.

Lite IMS is an evolved version of IMS with the characteristics of high efficiency, extensibility, intelligence and high value addition, designed for application in IMT-2020 networks and beyond. This Recommendation specifies the reference model, signalling architecture, function entities, reference points, relationship between lite IMS and IMS, as well as security considerations for lite IMS.

### 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.2012] Recommendation ITU-T Y.2012 (2010), *Functional requirements and architecture of next generation networks*.

[ITU-T Y.2701] Recommendation ITU-T Y.2701 (2007), *Security requirements for NGN release 1*.


### 3 Definitions

#### 3.1 Terms defined elsewhere

None.

#### 3.2 Terms defined in this Recommendation

This Recommendation defines the following term:

**3.2.1 lite IMS**: An evolved version of an Internet protocol multimedia system with the characteristics of high efficiency, extensibility, intelligence and high value addition, designed for application in IMT-2020 networks and beyond.

### 4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

API Application-Programming Interface

DNS Domain Name Server

EF End-user Function

FE Functional Entity

HTTP Hypertext Transfer Protocol

| | |
|---|---|
| IMT-2020 | International Mobile Telecommunications-2020 |
| I-CSCF | Interrogating Call Session Control Function |
| ID | Identifier |
| IMS | Internet Protocol Multimedia System |
| IP | Internet Protocol |
| IT | Information Technology |
| NE | Network Element |
| NFS | Network Function Service |
| NRF | Network Repository Function |
| P-CSCF | Proxy Call Session Control Function |
| SAF | Service and Application Function |
| SBI | Service-based Interface |
| S-CSCF | Serving Call Session Control Function |
| SDP | Session Description Protocol |
| SEF | Service Enabler Function |
| SIP | Session Initiation Protocol |
| SUPF | Service User Profile Function |
| TCF | Transport Control Function |
| UCF | Unified Control Function |
| UE | User Equipment |

## 5 Conventions

None.

## 6 Reference model of lite IMS

Figure 6-1 depicts the reference model of lite IMS.

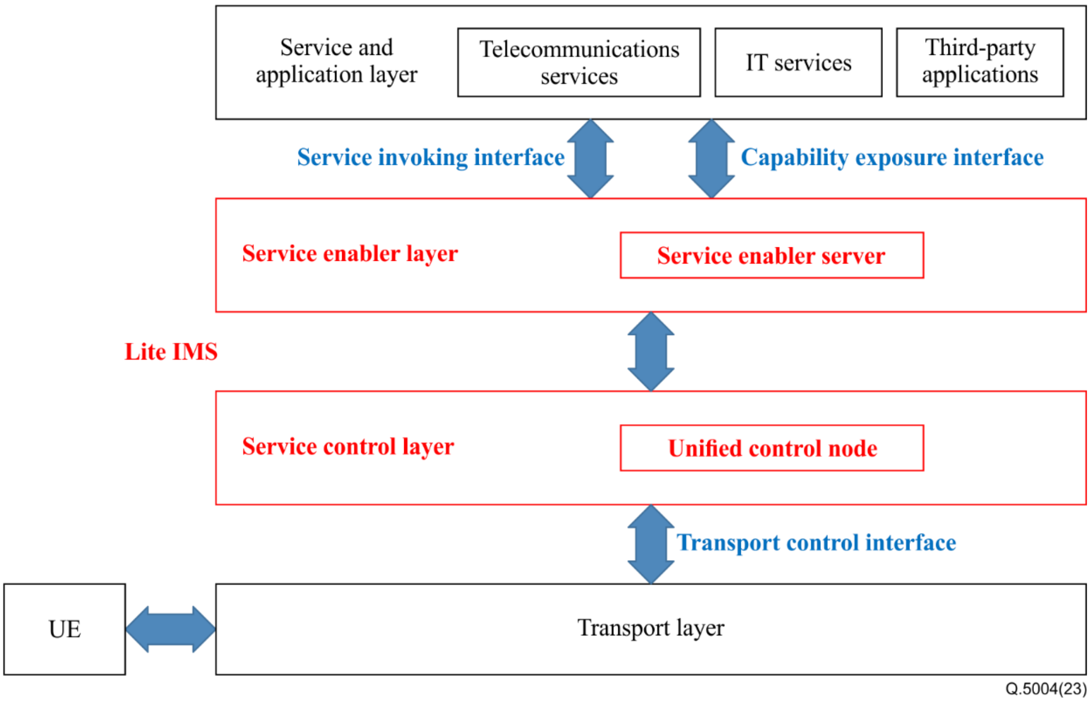


**Figure 6-1 – Reference model of lite IMS**

As illustrated in Figure 6-1, lite IMS mainly includes two layers: service enabler; and service control.

In the service control layer, the unified control node performs functions including registration and authentication, service routing, service triggering and Internet protocol (IP) routing control. It interacts with the transport layer via a control interface to optimize routing selection. Moreover, it provides fundamental capabilities for service control to the service enabler server.

In the service enabler layer, the server deployed provides the service (or capabilities for it) and application provision in two different ways. The service and application can directly invoke service capabilities via the applicable interface or capabilities can be exposed to the service and application layer via a service exposure interface so as to provide more complex service by means of service composition.

Both service-based interface (SBI) and a restful interface can be used for the implementation of the interfaces mentioned in the preceding paragraph.

## 7 Signalling architecture of lite IMS

Figure 7-1 depicts the signalling architecture of lite IMS.

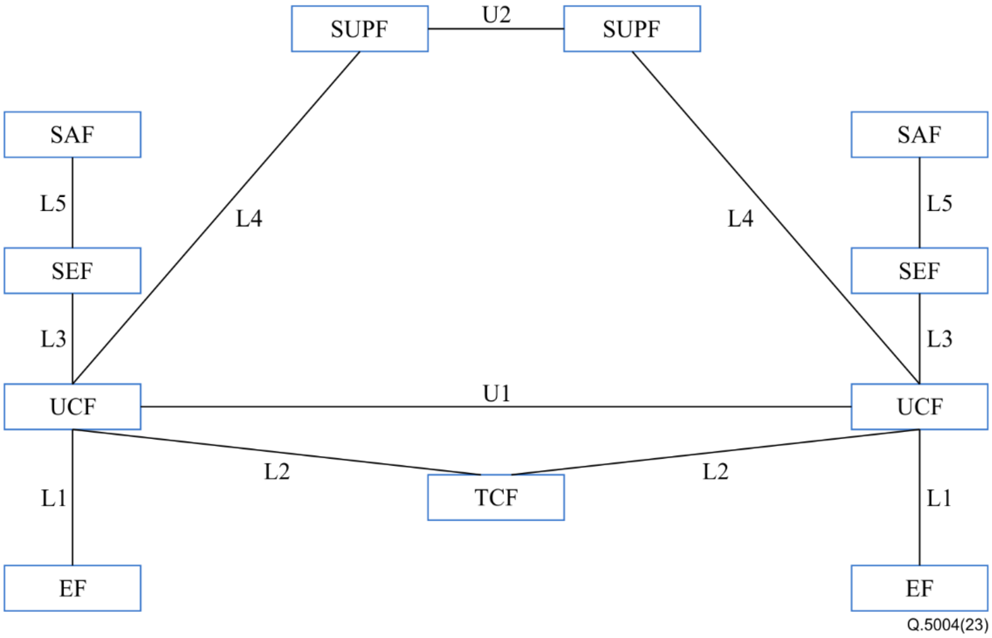


**Figure 7-1 – Signalling architecture of lite IMS**

The signalling architecture of lite IMS consists of several functions that cooperate to provide the service control and service support functions and capabilities. These functions include:

– unified control function (UCF);

– service enabler function (SEF);

– service user profile function (SUPF);

– end-user function (EF);

– transport control function (TCF);

– service and application function (SAF).

### 7.1 Unified control function

A UCF includes those service control functions performed by a session border controller and a serving-, interrogating- or proxy-call session control function (S/I/P-CSCF) in the lite IMS.

A UCF mainly performs the following functions:

- deals with the service registration and performs authentication and authorization functions;
- interacts with the SUPF to store, update, delete and query user profiles;
- processes signalling messages from EFs and determines the corresponding signalling routing based on different policies;
- performs service triggering according to user profiles fetched from SUPF;
- controls traffic optimization of media plane through interaction with the TCF, including the release of optimization policy to TCF, and interacts with TCF for the selection of optimized media routing path;
- cooperates with SEF to guarantee service and application provision;
- supports emergency call and legal interception – detailed implementation is for further study;
- deals with the interworking between different lite IMSs or different IMSs.

## 7.2 Service enabler function

With the introduction of service-based technology, SEF performs functions related to not only service and application support, but also network capability exposure. The service capabilities for calls provided by an SEF focus on a minimal set. Other service capabilities, such as those that are supplementary and intelligent, can also be implemented as plug-in elements in SEF as needed.

A SEF mainly includes the following:

- registration, authentication, authorization and other functions at the application level;
- responsibility for the management of service and application – the interaction between an SEF and SAF may be implemented as a publish-subscribe scheme to realize a two-way flexible mechanism;
- responsibility for the management, classification, encapsulation and provision of network capabilities;
- provision of service capabilities either directly via an invoking interface or via an exposure interface for service composition.

## 7.3 Service user profile function

A SUPF performs user profile maintenance and management functionalities, mainly including storage, update, deletion and query of user subscription information and other related data according to the requests of a UCF. With the interaction between UCF and SUPF, the user profile can be used for the registration, authentication and authorization process. With the interaction between SEF and SUPF, the user profile can be used for the registration, authentication, authorization and other functions at the application level.

In the user profile, a new type of user identifier (ID) may be introduced based on vertical industry requirements. Furthermore, an access control policy may be introduced in an SUPF to handle the privacy or security perspective. For example, it is prohibited to provide a user profile related to call capability in the interaction with a UCF.

## 7.4 End-user function

EFs, as specified in [ITU-T Y.2012], support end-user access to lite IMS.

## 7.5 Transport control function

As a multimedia processing unit, a TCF performs media accessing and interworking, media resources management, policy control, content and context analysis and traffic scheduling functionalities. A TCF receives: network information from the transport layer; and application bandwidth and quality of service assignment requirements from the service control layer. A TCF makes decisions regarding network resource and admission control. For example, it receives the request messages including multimedia flow and transcoding directive from a UCF via an L2 interface, then performs the transcoding action, and finally returns the transcoded multimedia flow to the UCF. It supports a unified policy database and consistent policy specifications, as well as a variety of access and core networks within a general resource control framework. Furthermore, it supports the establishment of traffic-scheduling rules based on relevant information, such as traffic localization, selection of the traffic delivery network node, network status and intelligent routing policy.

## 7.6 Service and application function

An SAF provides services or applications to EFs, and should meet flexible requirements from not only the public network, but also vertical industry. The interaction between an SAF and SEF is based on a loose coupling mechanism.

The detailed functionalities of an SAF and its interface with EFs lie outside the scope of this Recommendation.

## 8 Functional entities of lite IMS

### 8.1 Functional entities in unified control function

As shown in Figure 8-1, the functional entities (FEs) in a UCF mainly include the following.

- Authentication and authorization FE: Performs the authentication and authorization functions through the interaction with an SUPF. Different authorization mechanisms are provided for different trust level or service requirements.
- Registration FE: Performs registration-related functions. For different types of user equipment (UE), the registration process can be customized. For example, taking account of low-power wide-area Internet of things devices, periodic registration may be avoided to save energy.
- Routing control FE: Interacts with a TCF for the selection of optimized routing path media accessing and interworking, media resources management. Among the selection factors, a service level agreement should be included and be one of the most important factors.
- SEF selection FE: Selects a suitable SEF based on service requirements. The selection of SEF(s) is a dynamic procedure decoupled from registration, and flexible selection policies are taken into account, including security, cost and availability. During service provision, the SEF can be re-selected with a mechanism similar to that of re-invite in the session initiation protocol (SIP) process.
- Peer interaction FE: Interacts with other UCF(s) based on a loose-coupling mechanism.

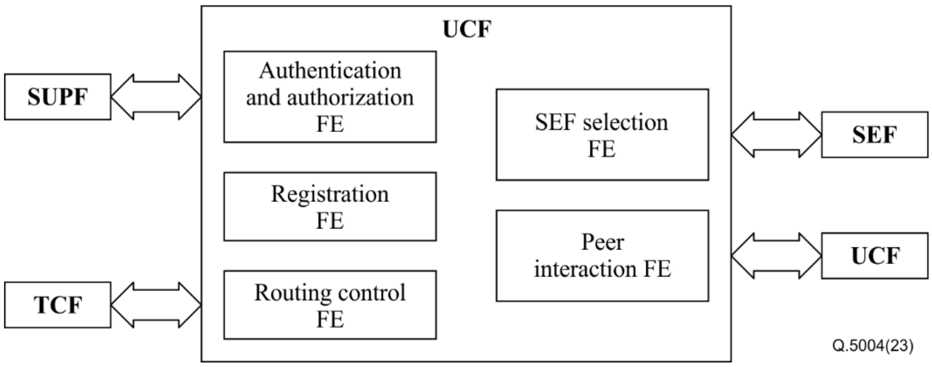


**Figure 8-1 – Functional entities in UCF**

### 8.2 Functional entities in a service user profile function

As shown in Figure 8-2, the FEs in an SUPF mainly include the following.

- Authentication and authorization FE: Performs user profile maintenance and management functionalities, mainly including storage, update, deletion and query of user subscription information plus other related data according to UCF requests. On interaction between a UCF and SUPF, the user profile can be used for the registration, authentication and authorization process.
- Addressing FE: A SUPF receives an addressing request from a calling UCF to the called user, queries the UCF address of the called user based on the independent self-organizing data network, and provides the query result to the calling UCF, so that it can send the call request to the called UCF.

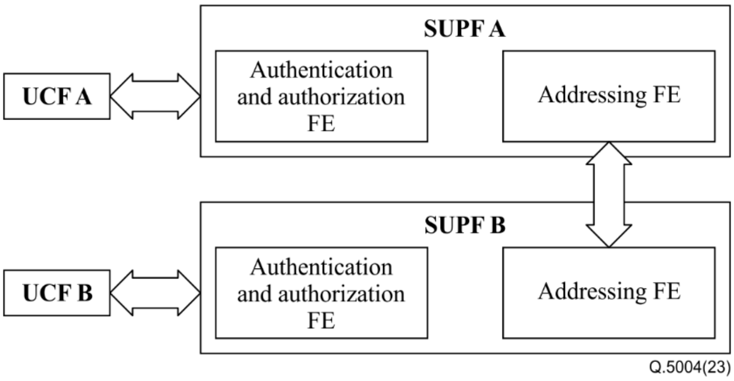


**Figure 8-2 – Functional entities in an SUPF**

### 8.3 Functional entities in a service enabler function

As shown in Figure 8-3, the FEs in an SEF mainly include the following.

- SAF coordination FE: SAF informs its interested users and call events through the subscription mechanism. SEF provides an application-programming interface (API) for an SAF to collect and execute SAF call instructions, and cooperate with SAF to execute various new services.
- SIP signalling processing FE: an SEF receives the SIP signalling sent by the UCF and converts it into the corresponding call event; it also receives call instructions sent by the SAF and converts them into the corresponding SIP signalling.

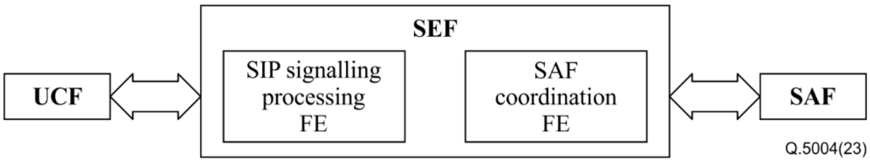


**Figure 8-3 – Functional entities in an SEF**

## 9 Reference points of lite IMS

### 9.1 Reference point U1

Reference point U1, for which SIP or hypertext transfer protocol (HTTP) can be used, exists between UCFs.

As different vertical requirements are involved in service provision, different types of UCF(s) may exist. In order to realize interworking of different types of UCF(s), the following basic information is specified, but the transmission information between UCF(s) is not limited to the following contents:

- information related to call participants: such as caller ID or called party ID, similar to the "from", "to" header fields in SIP;
- information about media intercommunication: such as the address of the called and called media, codec, similar to a session description protocol (SDP);
- call event information: such as call ringing, off-hook, release, similar to 18x, 200 of SIP.

When the calling party and called party register on the same UCF, the call can be terminated within this UCF. In this case, information transmission on the U1 interface is not required.

### 9.2 Reference point U2

Reference point U2 exists between different SUPFs that make up one independent, self-organized data network.

Each SUPF has a unique domain name; and the self-organizing SUPF network is connected through a domain name server (DNS) protocol.

The basic query flow shown in Figure 9-1 is used to interpret this reference point.

Steps 1-8: During call establishment, the calling SUPF carries the called domain name and queries the IP address corresponding to the called SUPF with the DNS.

Steps 9-10: A basic function of U2 is to address the UCF of the called user based on the DNS query results (the IP address corresponding to the called SUPF). The calling SUPF carries the called number and queries the called SUPF for the corresponding UCF address.

For a specific user, the SUPF that accommodates its user data store is unique and does not change. However, the same user can register for different UCFs at different times, and the same SUPF can serve multiple different UCFs. Therefore, the calling SUPF must carry the number of the called user and query the called SUPF for the UCF registered by the called user.

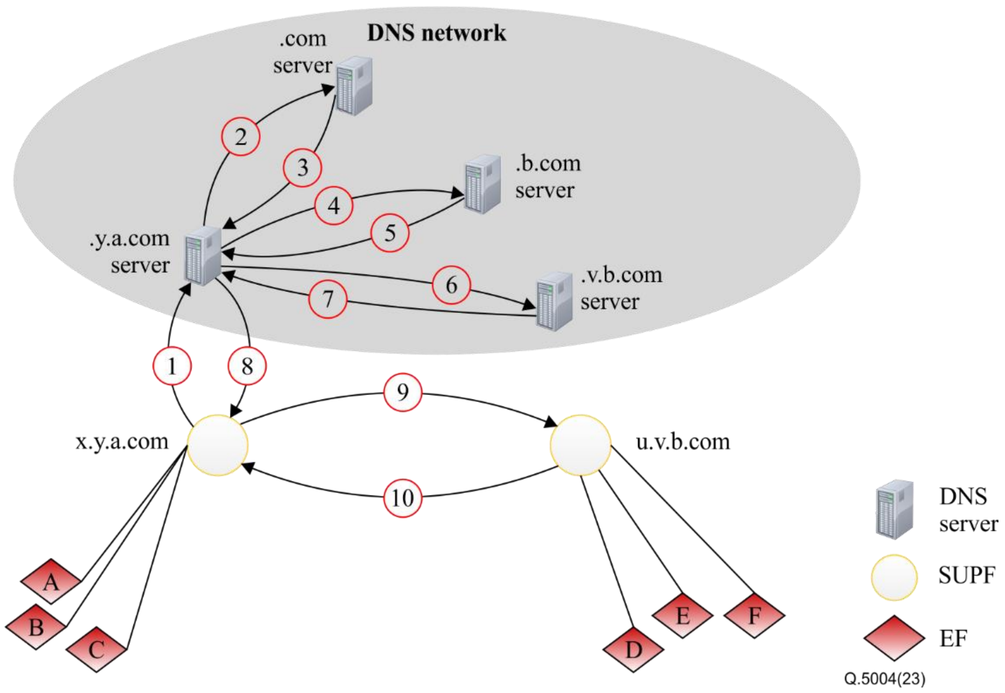


**Figure 9-1 – Basic query flow**

## 9.3 Reference point L1

Reference point L1 exists between a UCF and EF. It is mainly used for EF registration and session control. In order to maintain forward compatibility, use of an SIP is proposed for the L1 interface and related business processes.

## 9.4 Reference point L2

Reference point L2 exists between a UCF and TCF. The UCF requests the TCF to provide media capability through this interface. This interface can be applied as an SBI by using a request-response mechanism: media plane capabilities of TCF are disassembled into different services, referred to as network function services (NFSs). Each NFS has the characteristics of independence and autonomy. For a media plane NFS, the network repository function (NRF) needs to be specified as responsible for the automatic management of all NFSs, including registration, discovery and status detection. After a network function is powered up, it will actively report its own NFS information to the NRF. When a UCF needs to use a certain media capability, it needs to query the NRF to obtain a specific NFS instance.

This interface mainly realizes media access, media interworking, as well as media resource request and processing.

Media accessing: each EF participating in the call has a corresponding media endpoint on the network side. This endpoint is used for the media access of this EF, including audio and video. When an EF initiates or receives a call, the UCF completes the application for a media endpoint to the TCF through the L2 interface. The TCF applies for a new endpoint for this user and returns the relevant information of the endpoint to the UCF. The UCF saves the application results and finally sends the information of this endpoint to the EF to realize the connection between the EF and this media endpoint. When the parameters of media access change, such as IP or port, encoding and decoding or code rate, the UCF updates these parameters through the L2 interface.

Media interworking: Based on an L2 interface, a UCF controls interworking between media endpoints on the network side to realize the interworking with an EF corresponding to each endpoint.

Media resource management: when media resources are needed during the session, such as playing tone, dual tone multi-frequency and voice conference, the UCF indicates the type of media resources, the parameters necessary for using media resources and the corresponding endpoint of using media resources through a L2 interface. After the TCF allocates the required media resources and completes media processing, it indicates the results through the L2 interface.

## 9.5 Reference point L3

Reference point L3 exists between a UCF and SEF, and a SIP is suggested for L3 to ensure smooth evolution from existing IMS architecture including the following.

When an UCF receives any signalling from an EF or other UCFs, it unconditionally forwards the message to a SEF through L3 interface, and the SEF controls the triggering of service. Call-related signalling includes EF registration signalling and various call event signalling, such as initial call event or off-hook event.

Due to their close relationship, an SEF can also be deployed to a UCF as one of its components, which can avoid message transmission via the L3 interface and trigger service more efficiently.

## 9.6 Reference point L4

Reference point L4, for which a diameter protocol or HTTPs are suggested, exists between an UCF and SUPF.

Reference point L4 processes and delivers user profile and user profile management information to the UCF according to the storage, update and query user profile requests from it. With reference point L4, the user profile can be used for the registration, authentication and authorization process. Information related to authentication and authorization is transferred via L4.

The SUPF receives the addressing request from the calling UCF to the called user through the L4 interface, completes the query of the UCF address of the called user based on the independent self-organizing data network, and provides the query result to the UCF through the L4 interface, so that the calling UCF can send the call request to the called UCF.

## 9.7 Reference point L5

Reference point L5, for which HTTP is suggested, exists between an SEF and SAF.

The publish or subscribe mechanism is suggested for L5 implementation and information about service capability invocation is transferred via L5.

Based on L5, solutions to the following problems while triggering new services in the current IMS system are expected.

- Low efficiency of third party development: SIP has high complexity, low awareness of third party developers and low efficiency of development and maintenance.
- Too long connection delay: multiple services in a single session are triggered serially and the connection delay increases significantly.

With the increasing number of new services in the future, the negative impact of the above problems will be more prominent.

An SEF provides an API for a SAF to call, receive and execute SAF call instructions, and cooperates with the SAF to finish various new services.

Before the call starts, the SAF should inform its interested users and call events through the subscription mechanism. For the SAF, initial call event notification is required, and other events (such as ringing or off-hook) are optional, which can greatly reduce unnecessary message delivery and processing.

During the call process, when an event occurs, an SEF sends the corresponding call event of a specific user to the SAF according to the subscription content of the SAF. After the SAF completes its own processing, it sends a call control instruction (not required) to the SEF according to its own business logic. The SEF executes the relevant processing according to the instruction to trigger a service.

APIs are divided into those for call events and call control instructions. For examples, see Appendix I.

When there are multiple SAFs, the calling order is changed from the original sequential mode to the parallel mode, as follows.

1) Parallelization of call events sent by SEF: all call events, including initial call events and intra-session call events, can be sent to each SAF together instead of waiting for a SAF response message to be received before sending it to the next SAF.
2) Parallelization of SAF processing call events: each SAF processes call events in parallel immediately after receiving them, instead of only one SAF running at a certain time.
3) Execution by SEF of parallelization of instructions: after a SEF sends a call event to multiple SAFs in parallel, the SEF receives multiple call control instructions triggered by the call event from multiple SAFs, and then executes these instructions in parallel.

The SEF judges whether the received multiple instructions are mutually exclusive, so as to determine the set of mutually exclusive instructions among the multiple call control instructions. Since multiple instructions in the set of mutually exclusive instructions cannot be executed in parallel, the SEF selects the instruction with the highest priority from the set of mutually exclusive instructions according to a certain priority order.

## 10 Relationship between lite IMS and IMS

Lite IMS simplifies the current IMS architecture and realizes its original basic functions. Some core differences between lite IMS and IMS are summarized in Table 1.

**Table 1 – Core differences between lite IMS and IMS**

| Comparison item | IMS | Lite IMS |
|---|---|---|
| User data node | independent home subscriber server | – self-organizing user data network composed of SUPFs<br>– enables independent operation and opening |
| Service trigger mode | serially | in parallel,<br>has more efficient third party development efficiency and |

**Table 1 – Core differences between lite IMS and IMS**

| Comparison item | IMS | Lite IMS |
|---|---|---|
| | | accelerates the process of call establishment |
| Media management | originating and terminating separation | – originating and terminating unification<br>– lower media delay and more synchronous media experience |
| Call control network element (NE) | multiple NEs: P-CSCF, S-CSCF, I-CSCF | unified NEs,<br>accelerates the call establishment process. |

## 11 Security consideration

The security requirements for signalling architecture of lite IMS for IMT-2020 network and beyond should be aligned with the requirements specified in [ITU-T Y.2701]. No specific consideration of security mechanisms is required in this Recommendation.

# Appendix I

## Application programming interface format

(This appendix does not form an integral part of this Recommendation.)

### I.1 Examples of API format

Table I.1 lists examples of APIs for call events and call control instructions for the interface between an SEF and SAF, with their type, description and typical operation.

**Table I.1 – Examples of APIs for call events and call control instructions**

| Type | Description | Typical operation |
|---|---|---|
| Call event API | SEF informs SAF of various events during an SAF decision-making session | Subscribe: subscribe<br>Unsubscribe: unsubscribe<br>Initcall: initial call notification<br>Ring: ring notification<br>Answer: off-hook notification<br>Release: release notification |
| Call control instruction API | After SAF makes a decision, it sends the instructions for execution by SEF, which acts accordingly | Callnewuser: call a new user<br>Releaseuser: release the user<br>Playvoice: play voice to user<br>SDP action: add, modify, or delete an SDP<br>Para action: add, modify or delete call parameters |

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