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

Future networks

Technical requirements for supporting application addressing in edge computing for future networks including IMT-2020

Recommendation ITU-T Y.3137

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Recommendation ITU-T Y.3137

Technical requirements for supporting application addressing in edge computing for future networks including IMT-2020

Summary

Application addressing is the process to discover the Internet protocol (IP) address of the server on which the application is running when user equipment (UE) intends to access the application. Recommendation ITU-T Y.3137 specifies the technical requirements for supporting application addressing in edge computing for future networks including IMT-2020, and also proposes new requirements towards fixed mobile convergence (FMC) architecture for future networks including IMT-2020.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
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Application addressing, IMT-2020, technical requirements, use cases.

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Technical requirements for supporting application addressing in edge computing for future networks including IMT-2020

1 Scope

This Recommendation presents the technical requirements of application addressing in edge computing for future networks including IMT-2020. Application addressing is the process to discover the Internet protocol (IP) address of the server which the application running on when user equipment (UE) intends to access the application. This Recommendation specifies the following aspects of application addressing in edge computing in the context of future networks including IMT-2020:

- Technical requirements of application addressing in edge computing.
- Fixed mobile convergence (FMC) architecture enhancement requirements.

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.3101] Recommendation ITU-T Y.3101 (2018), *Requirements of the IMT-2020 network.*

[ITU-T Y.3108] Recommendation ITU-T Y.3108 (2019), *Capability exposure function in IMT-2020 networks.*

[ITU-T Y.3130] Recommendation ITU-T Y.3130 (2018), *Requirements of IMT-2020 fixed mobile convergence.*

[ITU-T Y.3131] Recommendation ITU-T Y.3131 (2019), *Functional architecture for supporting fixed mobile convergence in IMT-2020 networks.*

[ITU-T Y.3133] Recommendation ITU-T Y.3133 (2019), *Capability exposure enhancement for supporting fixed mobile convergence in IMT-2020 networks.*

[ITU-R M.1645] Recommendation ITU-R M.1645 (2003), *Framework and overall objectives of the future development of IMT-2000 and systems beyond IMT-2000.*

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 control plane [b-ITU-T Y.2011]: The set of functions that controls the operation of entities in the stratum or layer under consideration, plus the functions required to support this control.

3.1.2 fixed mobile convergence [b-ITU-T Y.3100]: In the context of IMT-2020, the capabilities that provide services and application to end users regardless of the fixed or mobile access technologies being used and independently of the users' location.

3.1.3 fixed network [b-ITU-T Q.1762]: A network that provides wire-based (e.g., copper, fibre) or wireless access to its services. The fixed network may support nomadism, but does not support mobility.

3.1.4 IMT-2020 [b-ITU-T Y.3100]: Systems, system components, and related aspects that [support to] provide far more enhanced capabilities than those described in [ITU-R M.1645].

3.1.5 mobile network [b-ITU-T Q.1762]: A network that provides wireless access to its services and supports mobility.

3.1.6 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.

3.1.7 mobility management [b-ITU-T Q.1706]: The set of functions used to provide mobility. These functions include authentication, authorization, location updating, paging, download of user information and more.

3.1.8 service continuity [b-ITU-T Q.1743]: The uninterrupted user experience of a service that is using an active communication (e.g., an ongoing voice call) when a [user equipment] undergoes a radio access technology change or a CS/PS domain change without, as far as possible, the user noticing the change.

NOTE – In particular service continuity encompasses the possibility that after a [radio access technologies] / domain change the user experience is maintained by a different telecommunication service (e.g., tele- or bearer service) than before the RAT/domain change.

3.2 Terms defined in this Recommendation

This Recommendation defines the following term:

3.2.1 application addressing: The process to discover the IP address of the server on which the application is running when UE intends to access the application.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AR Augmented Reality

API Application Programming Interface

BRAS Broadband Remote Access Server

DNS Domain Name System

EAS Edge Application Server

EDC Edge Dispatch Centre

FMC Fixed Mobile Convergence

ID Identifier

IP Internet Protocol

IPv4 Internet Protocol version 4

IPv6 Internet Protocol version 6

LDNS Local Domain Name System

NAT Network Address Translation

QoE Quality of Experience

QoS Quality of Service

UE User Equipment

UPF User Plane Function

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 Recommendation is to be claimed.

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

6 Overview

With edge computing, operators are able to host their own or third party applications and contents closer to the user. The user can access the application/content via a locally deployed user plane function (UPF) to fulfil the low latency requirement of diverse services, with the heavy traffic offloading from the backbone network to the edge. However, currently in the industry, there is still a lack of common understanding of how to support application addressing in edge computing for future networks including IMT-2020. It is important to study application addressing in edge computing, which is the process to discover the Internet protocol (IP) address of the optimal edge application server (EAS) based on the user's real-time location and the load conditions of EAS, thus fulfilling the service requirements.

According to [ITU-T Y.3130], through FMC provided by IMT-2020, the end user can enjoy a seamless service experience and ubiquitous service availability, and service providers can provide seamless service realization for fixed and mobile access networks. Application addressing in edge computing is necessary in the context of FMC, which aims to provide seamless edge applications experience and ubiquitous edge application availability.

Considering the typical use cases of application addressing in edge computing (including but not limited to discovery of IP address of EAS via the domain name system (DNS); relocation of EAS owing to mobility via DNS; relocation of EAS via DNS when EAS performance degraded; network information exposure via DNS related application addressing; and FMC supported application addressing), some capabilities are required to be introduced in application addressing in edge computing. The technical requirements of application addressing in edge computing are described in clause 7.

7 Technical requirements of application addressing in edge computing

7.1 Requirements of discovery of IP address of EAS via DNS

UE needs to discover the IP address of the suitable EAS via DNS and edge dispatch centre (EDC), which is a unified dispatch centre and could be built, deployed or operated by network operators or third party providers. The traffic can be locally routed to the EAS to optimize user service experience.

[REQ 7.1-1] It is required to carry service information in the DNS request including service identification including but not limited to domain name and service requirements such as high computing requirements.

[REQ 7.1-2] It is required to ensure the packet is a DNS request and to send the DNS request to the local DNS, alternatively by reading the destination IP address and port number in DNS request.

[REQ 7.1-3] It is required to carry the public IPv4/v6 address of the UPF / broadband remote access server (BRAS) in the DNS request.

[REQ 7.1-4] It is required to acquire the comprehensive status of EASs, including but not limited to the location and real-time status.

[REQ 7.1-5] It is required to assign optimal EASs based on key factors including but not limited to UE's location, the EAS's location, the EAS's load status, network link information and service requirements including but not limited to latency.

[REQ 7.1-6] It is required to send the information of the assigned EAS and related UPF to the IMT-2020 core network, to assist the configuration of traffic steering rule.

7.2 Requirements of relocation of the EAS owing to mobility via DNS

When UE is subject to mobility, the relocation of the UPF may be triggered to ensure service continuity. In addition to that, the relocation of the EAS may be required, because the quality of experience (QoE) may be degraded since the distance between EAS and UE becomes greater when UE still accesses the same EAS, so the seamless relocation of the EAS may be required in application addressing.

[REQ 7.2-1] It is required to generate the notification information to indicate that EAS relocation may be required, including but not limited to the notification information of the UPF change.

[REQ 7.2-2] It is required to trigger a new DNS request when the notification information is received.

NOTE 1 – When the EDC assigns a new EAS to UE, the traffic steering rule needs to be configured.

[REQ 7.2-3] It is required to notify the new EAS information and UE information to the IMT-2020 core network and to assist the configuration of the traffic steering rule.

[REQ 7.2-4] It is recommended to indicate the service continuity need in the DNS request.

NOTE 2 – For services with a service continuity need, the EDC is recommended to assist with the related information delivery.

[REQ 7.2-5] It is recommended to store UE information and related application information, including but not limited to the UE identifier (ID) and session ID, which are used to assist the context transfer.

[REQ 7.2-6] It is recommended to send a context synchronization notification to the new EAS and previous EAS for services with continuity requirements.

7.3 Requirements of relocation of EAS via DNS when the performance of EAS degrades

The application client and the application server could know the real-time status of the service quality, so the relocation could be triggered by the application client or the application server. When the initially assigned EAS becomes non-optimized since its own condition degraded, a new EAS is required to guarantee the service quality. The EDC chooses a new EAS for UE according to factors including but not limited to the location and status of the EAS and UE location, and then the IMT-2020 core network configures the traffic steering rule to the new EAS.

[REQ 7.3-1] It is required to set conditions to trigger EAS relocation including but not limited to conditions when the status of service connection has degraded to the condition that EAS cannot meet service requirements.

[REQ 7.3-2] It is required to monitor the status of the service connection to assist in taking the decision of whether EAS relocation is needed.

[REQ 7.3-3] It is required to initiate a new DNS request to the EDC when the conditions are met.

[REQ 7.3-4] It is required to send a notification to the IMT-2020 core network to indicate that a new EAS has been assigned to UE, and IMT-2020 core network will then add a traffic rule on the given UPF.

NOTE – For a service with a continuity need, the EDC is recommended to assist with the related information delivery.

[REQ 7.3-5] It is recommended to indicate the service continuity need during EAS relocation.

[REQ 7.3-6] It is recommended to recognize that the relocation request is from the same UE to assist information delivery; alternatively, this can be done according to a UE's IP address.

7.4 Requirements of network capability exposure related application addressing

According to [ITU-T Y.3108] and [ITU-T Y.3133], the IMT-2020 FMC network is required to provide an access network information application programming interface (API) to edge applications, which should expose up-to-date information regarding specific access network technology. Application addressing needs to consider the status of network information exposure when the application requires timely network information exposure, in conditions including but not limited to network congestion and path latency.

Since the IMT-2020 core network functions have different latencies, the latency of network information exposure is different for the same services deployed in different locations.

[REQ 7.4-1] It is required to consider network capability exposure requirements of edge applications.

[REQ 7.4-2] It is required to consider the status of network capability exposure, including but not limited to the latency between EAS and IMT-2020 core network functions.

7.5 Requirements of FMC supported edge application addressing

According to [ITU-T Y.3130] and [ITU-T Y.3131], through FMC provided by an IMT-2020 the end user can enjoy a seamless service experience and ubiquitous service availability, and service providers can provide seamless service for fixed and mobile access networks. FMC supported edge application addressing is necessary, to make sure the service continuity of application addressing in edge computing with guaranteed Quality of Service (QoS)including the handover between different access networks and migration from a single access network to multiple access networks.

When UE changes the access network, the UE's IP address may change, and a new DNS request may be triggered. There are two scenarios in application addressing in FMC. One is that the service requests to be served is on the same EAS, another is that service requests may be assigned to different EASs.

[REQ 7.5-1] It is required to receive the change of network topology from network operators, to ensure the accuracy of application addressing.

[REQ 7.5-2] It is recommended to read the service continuity requirements carried in the DNS request. Alternatively, the requirements may be served on the same EAS.

[REQ 7.5-3] It is recommended to have a unique and unchanged UE ID to identify the same UE with a different access network for EDC.

[REQ 7.5-4] It is recommended to carry the unique and unchanged UE ID in the DNS request to assist EDC for services with continuity needs.

NOTE 1 – An EAS may be divided into a fixed network EAS and a mobile network EAS by operators to achieve traffic steering. Another case is that the assigned EAS may change when the access network changes.

[REQ 7.5-5] It is required to consider the type of EAS and access network, to schedule the request to the proper EAS.

NOTE 2 – For a service with continuity need, the EDC is recommended to assist with the related information delivery.

[REQ 7.5-6] It is recommended to notify the two EASs to perform the application context transfer when there is a continuity need.

[REQ 7.5-7] It is recommended to know the UE information and related application connection information, including but not limited to the UE ID and session ID.

NOTE 3 – The session is maintained by the application.

7.6 Requirements of application addressing across multiple edge computing platform operators

In edge computing, there will be various EASs deploying the same services belonging to different edge computing platform operators; among different edge computing platforms, the application addressing is also required to improve the efficiency of the EAS in the network.

[REQ 7.6-1] It is required for edge computing platform operators to expose the address information of the edge computing platform and the information of the EAS deployed on the edge computing platform to the EDC. EAS information includes, but is not limited to, location, service ID and status.

[REQ 7.6-2] It is required for edge computing platform operators to support users from different network operators to access services on the edge computing platform.

[REQ 7.6-3] It is required to manage the edge computing platform's status, including, but not limited to, the status of edge applications.

8 FMC architecture enhancement requirements

Based on the requirements of IMT-2020 FMC described in [ITU-T Y.3130], there are several enhancement requirements proposed to FMC architecture as described in clauses 8.1 to 8.3.

8.1 Requirements of session management

Session management for FMC enhancement requirements are aligned with the requirements of authentication in the IMT-2020 FMC network identified in [ITU-T Y.3130], in particular with the following additional requirements:

- The IMT-2020 FMC network is required to support the interaction with the EDC.
- The IMT-2020 FMC network is required to support traffic switching, splitting and steering based on the notification message from the EDC.
- The IMT-2020 FMC network is required to carry the IP address of UPF/BRAS in the DNS request to indicate UE's location.

8.2 Requirements of address allocation

- The IMT-2020 FMC network is required to allocate the IP address of UPF/BRAS according to the location of UPF/BRAS.
- The IMT-2020 FMC network is required to allocate the IP address of the EAS according to the location of the EAS.
- The IMT-2020 FMC network is required to synchronize the address allocation with the EDC to assist with application addressing in edge computing.

8.3 Requirements of authentication and authorization

Authentication and authorization for FMC enhancement requirements are aligned with the requirements of authentication in the IMT-2020 FMC network identified in [ITU-T Y.3130], in particular with the following additional requirements:

- The IMT-2020 FMC network is required to provide a unified storage capability for the authentication and authorization of the EAS, which may be via fixed or mobile access technologies.
- The IMT-2020 FMC network is required to authenticate and authorize the EDC.
- The IMT-2020 FMC network is recommended to store the mapping of user ID and EAS to assist service continuity based on the unified ID of the end user for fixed and mobile access technologies.

9 Security considerations

As specified in clause 7, when the EDC carries out the application addressing user, the network information is required as assist information. The following apply:

- The authentication and authorization of the EDC to obtain the network information is required.
- When authentication and authorization is periodic, authentication and authorization are required when the period expires.
- For the active update mechanism, which will report the update status of the network to the EDC, authentication and authorization is required at each update.

In addition, the security and privacy considerations of application addressing in edge computing should be aligned with the requirements specified in [ITU-T Y.3101] and [b-ITU-T Y.2701].

Appendix I

Use cases of application addressing in edge computing

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

The use cases of application addressing in edge computing are described below.

Use case 1: Discovery of IP address of the EAS via DNS

Figure I.1 shows the process of application addressing in edge computing when UE first accesses the server.

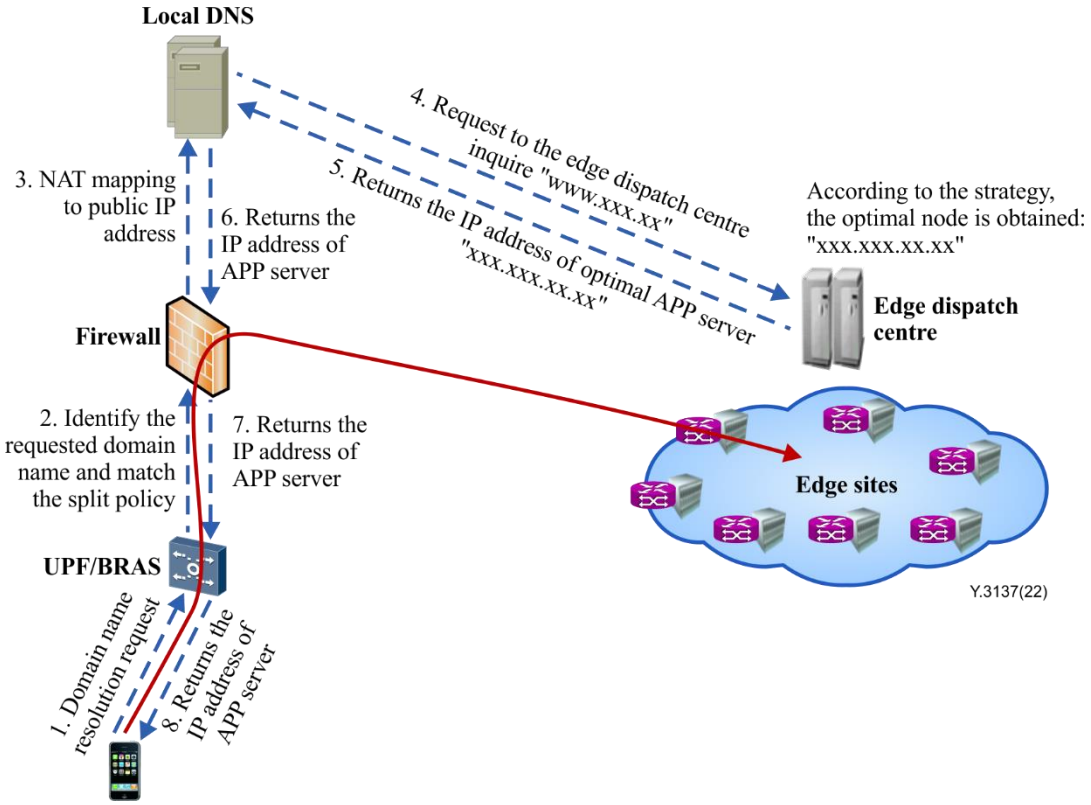

Figure I.1 – Overview of application addressing in edge computing

1. UE sends the DNS request message to UPF/BRAS.
2. UPF/BRAS identify the request message and matches the flow steering rules.
3. With network address translation (NAT), the private source IP address of the DNS request message is transferred to a public IP address.

NOTE – UE has a private IP address, and the DNS request message includes it and the NAT translates it into a public IP address.

4. The local DNS (LDNS) sends the DNS request to the EDC.
5. The EDC determines the optimal EAS and then returns the IP address of the chosen EAS to the LDNS.
6. The LDNS returns the IP address of the EAS to the firewall.
7. The IP address of the EAS is sent to the UPF/BRAS.
8. The UPF/BRAS send the IP address of the EAS to the UE.

Use case 2: Relocation of EAS owing to mobility via DNS

According to [ITU-T Y.3130], service continuity and guaranteed QoS are supported by FMC in IMT-2020.

When UE is mobile, the previous UPF and EAS may cease to be optimized, so UE at its new location initiates a new DNS request to find a suitable EAS and UPF as shown in Figure I.2.

1. The relocation is triggered when the conditions are met, and then edge relocation is performed by the EDC.
2. Then the traffic steering configuration is finished by the IMT-2020 core network.
3. When services have service continuity needs, the context transfer is performed with the cooperation of the EDC and EAS.

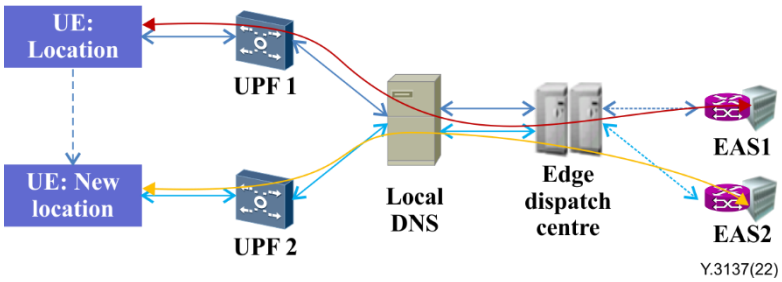

Figure I.2 – Relocation of EAS owing to mobility via DNS

Use case 3: Relocation of EAS owing to mobility via DNS

When the initially assigned EAS becomes non-optimized as its own condition has degraded, a new EAS is required to guarantee the service quality as shown in Figure I.3. The EDC chooses new a EAS for UE according to, but not limited to, the location and status of the EAS and the UE's location, and then the IMT-2020 core network configures the traffic steering rule to the new EAS.

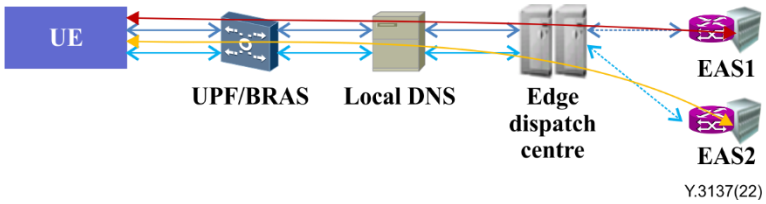

Figure I.3 – Overview of the relocation of EAS when the performance of EAS degrades

Use case 4: Network capability exposure related application addressing

According to [ITU-T Y.3108] and [ITU-T Y.3133], the IMT-2020 FMC network is required to provide access network information APIs to edge applications, which should expose up-to-date information regarding specific access network technology. Application addressing needs to consider the status of network information exposure when the application requires timely network information exposure, including but not limited to conditions of network congestion condition and path latency.

Use case 5: Network capability exposure related to application addressing

When UE changes the access network, the UE's IP address may change and a new DNS request may be triggered. There are two scenarios in application addressing in FMC. One is that the service requests are to be served on same EAS, and another is that service requests may be assigned to different EASs.

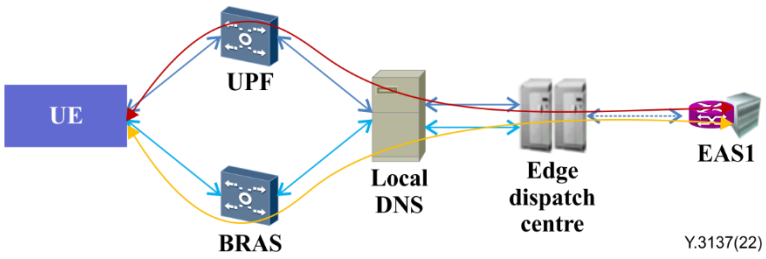

Figure I.4 – FMC supported application addressing with the same EAS

As shown in Figure I.4 and Figure I.5, with the support of FMC, UE can access an EAS with a different access network. When UE changes the access network and requests to be served by the same EAS, it proposes new requirements. It is an enhanced requirement on the basis of [ITU-T Y.3130].

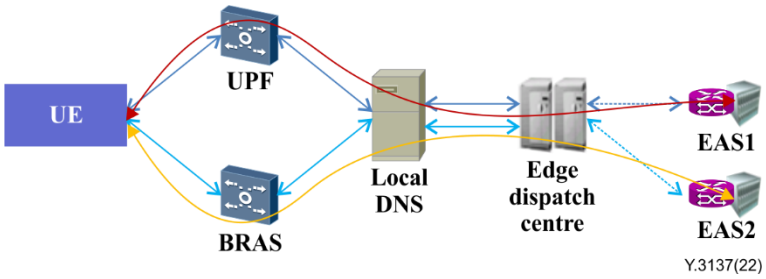

Figure I.5 – FMC supported application addressing when the EAS changes

Use case 6: Application addressing across multiple edge computing platform operators

In edge computing, there will be various EASs deploying the same services belonging to different edge computing platform operators. Among different edge computing platforms, application addressing is also required to improve the efficiency of the EAS in a network.

NOTE – For example, for an augmented reality service deployed on different edge computing platforms, when UE initiate a request, without the coordination between edge computing platforms, the EDC can only schedule services among one edge computing platform in operator A, even if operator B near to UE also deploys the requested service, which causes the low-efficiency of edge services in the network.

Therefore, in application addressing in edge computing, it is required for different edge computing platform operators to have a coordination mechanism to assign an optimal EAS for UE as shown in Figure I.6. The application addressing process includes the following steps:

1. EDC selects the best edge computing platform provider based on the status of edge applications.
2. The edge computing platform performs scheduling based on an internal strategy to assign optimal EAS for users.

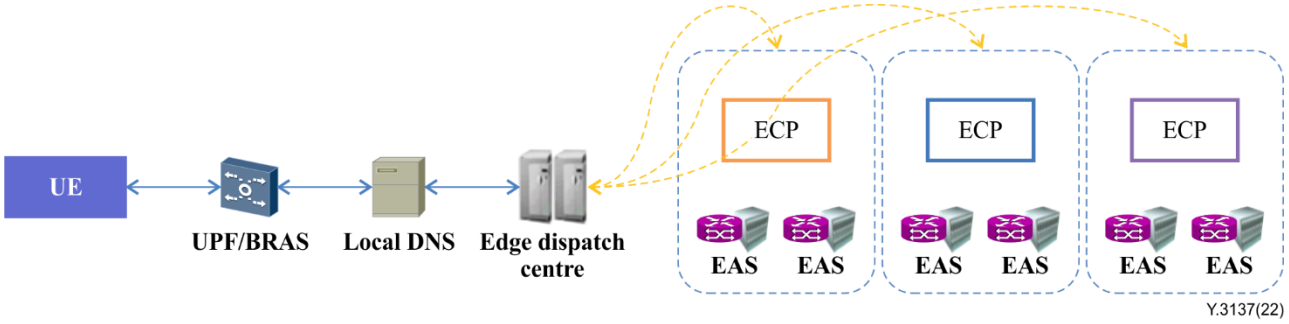

Figure I.6 – Application addressing across multiple edge platform operators

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