International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

Series Y
Supplement 9
(01/2010)

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

ITU-T Y.2000-series – Supplement on multi-connection scenarios

ITU-T Y-series Recommendations – Supplement 9

ITU-T

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
Numbering, naming and addressing	Y.2300–Y.2399
Network management	Y.2400–Y.2499
Network control architectures and protocols	Y.2500–Y.2599
Future networks	Y.2600–Y.2699
Security	Y.2700–Y.2799
Generalized mobility	Y.2800–Y.2899
Carrier grade open environment	Y.2900–Y.2999

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

Supplement 9 to ITU-T Y-series Recommendations

ITU-T Y.2000-series – Supplement on multi-connection scenarios

Summary

Supplement 9 to ITU-T Y-series Recommendations describes the scenarios, use cases and benefits of multi-connection, in which a user equipment keeps more than one network connection simultaneously. Multi-connection brings a number of benefits compared to the single connections currently available. This supplement provides the basis for development of requirements and development of an architecture that supports multi-connection.

History

Edition	Recommendation	Approval	Study Group
1.0	ITU-T Y Suppl. 9	2010-01-29	13

Keywords

Multi-connection, NGN, scenario, use case.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications, information and communication technologies (ICTs). The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

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

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this publication, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Compliance with this publication is voluntary. However, the publication may contain certain mandatory provisions (to ensure e.g., interoperability or applicability) and compliance with the publication is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the publication is required of any party.

INTELLECTUAL PROPERTY RIGHTS

ITU draws attention to the possibility that the practice or implementation of this publication may involve the use of a claimed Intellectual Property Right. ITU takes no position concerning the evidence, validity or applicability of claimed Intellectual Property Rights, whether asserted by ITU members or others outside of the publication development process.

As of the date of approval of this publication, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this publication. 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/.

CONTENTS

Supplement 9 to ITU-T Y-series Recommendations

ITU-T Y.2000-series – Supplement on multi-connection scenarios

1 Scope

This supplement describes the scenarios, use cases and benefits of multi-connection technology, in which user equipment (UE) can maintain more than one network connection simultaneously and dynamically distribute traffic flows over more than one network connection simultaneously, either by real-time choice of the user or automatically, based on policies previously agreed to by the subscriber and operator. Multi-connection capabilities permit UEs to take advantage of the flexibility offered by bandwidth aggregation and service transfer to increase reliability and provide robust service.

The goals of this supplement are first to describe the generic multi-connection scenarios and use cases to illustrate the variability of roles played by the subscriber and operator, and second to summarize the benefits realized by both users and providers of multi-connection service. The requirements and potential solutions to technically achieve the scenarios of multi-connection are out of scope of this supplement.

2 References

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

[ITU-T Y.2011] Recommendation ITU-T Y.2011 (2004), *General principles and general reference model for Next Generation Networks*.

[ITU-T Y.2012] Recommendation ITU-T Y.2012 (2006), *Functional requirements and architecture of the NGN release 1*.

[ITU-T Y.2051] Recommendation ITU-T Y.2051 (2008), *General overview of IPv6-based NGN*.

[ITU-T Y.2052] Recommendation ITU-T Y.2052 (2008), *Framework of multi-homing in IPv6-based NGN*.

[ITU-T Y.2091] Recommendation ITU-T Y.2091 (2007), *Terms and definitions for Next Generation Networks*.

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

3 Definitions

3.1 Terms defined elsewhere

This supplement uses the following terms defined elsewhere:

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

3.2 Terms defined in this supplement

This supplement defines the following terms:

3.2.1 multi-connection: Multi-connection is the collection of several simultaneous connections between two or more peer-(N)-entities. At least one of the connections is required to be associated with a physical layer connection different from the rest of the connections. All connections are dynamically coordinated with each other by the subscriber or the network to provide service to higher layer entities.

3.2.2 service transfer: In multi-connection, one service or more than one service belonging to a single user equipment (UE) are moved from one connection to other connection(s).

4 Abbreviations and acronyms

This supplement uses the following abbreviations and acronyms:

2G	Second Generation
3G	Third Generation
ADSL	Asymmetric Digital Subscriber Line
AP	Access Point
BSS	Base Station Subsystem
FTP	File Transfer Protocol
IP	Internet Protocol
IPTV	Internet Protocol Television
HO	Handover
LTE	Long Term Evolution
NGN	Next Generation Network
P2P	Peer-to-Peer
PC	Personal Computer
QoS	Quality of Service
UE	User Equipment
VoIP	Voice over Internet Protocol
VPN	Virtual Private Network
WLAN	Wireless Local Area Network

5 Conventions

None.

6 Generic scenarios of multi-connection

Multi-connection scenarios are shown but not limited to the ones depicted in Figure 6-1. The general principles of all multi-connection scenarios are summarized as follows:

1) All multi-connection scenarios are based on UEs having multiple physical interfaces, which means scenarios with single physical interfaces are not in the scope of multi-connection.

2) The following cases are not considered as multi-connection scenarios:

   a) Dual mode cell phones which must disable one radio module in order to use the second.

   b) Handover (HO).

3) In multi-connection scenarios, the multiple network entities belonging to different connections may interwork.

4) The layers in the multi-connection scenarios are the logic layers, but not the physical layers.

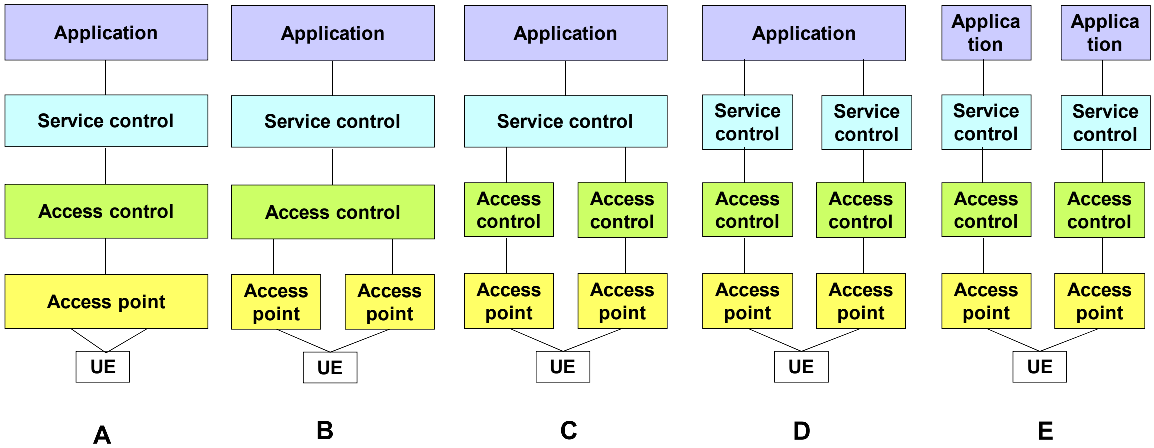

Figure 6-1 – Generic multi-connection scenarios

Scenario A

In scenario A, one UE accesses one access point (e.g., base station subsystem (BSS), NodeB, eNodeB) via multiple frequency bands simultaneously. By accessing one access point (AP) via multiple frequencies, a higher peak data rate can be provided to the UE. This is useful to provide a higher data rate service and optimized user experience, and also trunking efficiency can be increased, which helps to improve resource utilization.

Scenario B

In scenario B, the UE can access multiple access points simultaneously using the same access technology. This scenario provides performance improvements to the user, especially to the user in the cell edge, where the interference can be eliminated based on the coordination of different APs. This scenario will be available in the future when multiple-antenna technology is deployed broadly.

Scenario C

In scenario C, the UE connects to heterogeneous access networks which are controlled by different access control functions but the same service control function. The access control management and the QoS policies are enforced in each access control function and established by the service control point. In this scenario, data flows can be transmitted over different access networks to obtain different QoS assurance.

For example, in the video conference, the voice is transmitted by 2G, 3G or long term evolution (LTE) to assure real-time service, and the video is transmitted by wireless local area network (WLAN), which has higher bandwidth and may be cost efficient for a large number of network flows; both of these two access networks use the same core network. Data flows can also be conveyed by different access networks to increase bandwidth.

For example, the user is downloading a multimedia file with a large volume of data. To improve the downloading rate and to balance the data downloading, the user accesses additional access networks to increase the bit rate.

Scenario D

Scenario D shows a UE connecting to multiple heterogeneous access networks controlled by separate access control and service control functions. The UE can combine the different network capabilities to serve a unified application.

For example, the UE has both 2G and WLAN connections; when the video telephone application is launched, the voice will use the 2G connection to ensure a stable and real-time voice service, and the video will use the WLAN connection to get larger bandwidth. However, the UE may connect to a 2G base station and a WLAN AP simultaneously, and the video telephone application running in the UE thus may have multiple sessions controlled by different networks.

Scenario E

In scenario E, a UE connects to multiple heterogeneous access networks through multiple access points, which are controlled by separate access control and service control functions for different applications. In this scenario, a specific application is bound to use a specific network connection. A UE can be treated as a set of single-interface UEs which support different access technologies and utilize various applications, respectively, but service transfer between different connections should be considered in this scenario.

For example, if the UE connects to the company intranet through a virtual private network (VPN) connection over WLAN, and the user wants to monitor the stock market as well, which is not allowed on the intranet, it is necessary to use the 2G connection to access the stock application at the same time.

7 Use cases of multi-connection

7.1 Use case 1: Multimedia division

This use case shows that a UE can access multimedia services through multiple connections (i.e., multimedia services can be divided and delivered through different data paths).

Alice has to attend a video conference with business partners via her mobile phone when she is walking to her office. On the way to her office, some WLAN hot-spots are available, so Alice decides to initiate the video flow through the WLAN link in order to benefit from higher bandwidth and cheaper cost, whereas she sends and receives the audio flow through the 2G/3G link in order to guarantee the audio flow to be uninterrupted.

7.2 Use case 2: Load balance

This use case shows that a UE can separate a flow between multiple connections simultaneously.

Alice switches the video conference from her mobile phone to her personal computer (PC) after she arrives at her office. The PC can access the Internet via asymmetric digital subscriber line (ADSL) and via a public WLAN in the building. Alice would like to use the WLAN link because it is free, but a colleague tells her that the WLAN link is too unstable to keep video conference continuity today. So Alice decides to use the ADSL link in order to mitigate the load on the WLAN link, but still keeps the WLAN link active.

7.3 Use case 3: Reliability

This use case shows that multi-connection may improve service reliability upon a network or UE failure by using multi-connection.

Alice holds a video conference with her business partners on the PC via ADSL link and WLAN link simultaneously. After a while, the WLAN connection abruptly breaks down due to an unstable situation. Fortunately, the active ADSL connection avoids the interruption of the video conference and Alice continues to hold the conference entirely via the ADSL connection. The use case is shown as Figure 7-1.

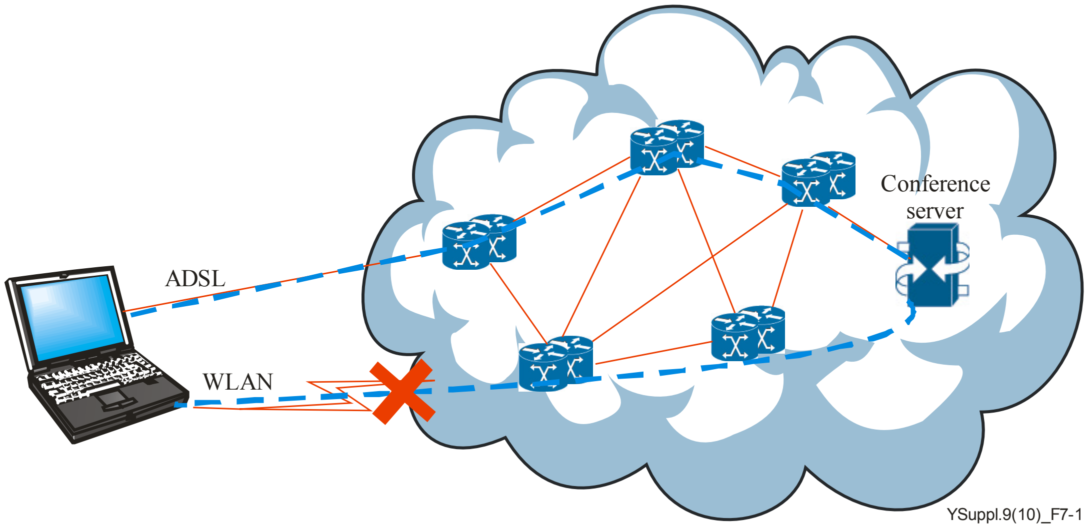

Figure 7-1 – Reliability

7.4 Use case 4: Automatic network selection

The automatic network selection encompasses two cases: the UE-initiated network selection and the network-initiated network selection.

7.4.1 UE-initiated network selection

This use case shows that a UE automatically selects the currently best connections according to configured policy, and activates them.

After the video conference, Alice decides to eat lunch in a nearby restaurant which provides a WLAN link to customers (hot-spot). While waiting, Alice enjoys the MP3 from her favourite on-line music channel through the WLAN link. Suddenly, Alice realizes that she had not checked her corporate email box earlier that morning. Based upon the configured policy (e.g., security class), the UE will automatically choose the 3G link to download her email through her corporate VPN, even though the WLAN is free. The use case is shown as Figure 7-2.

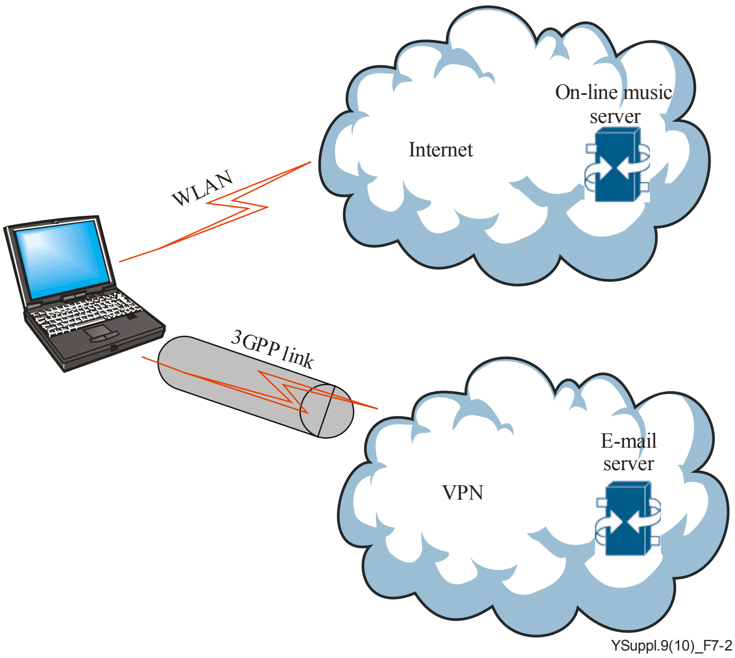

Figure 7-2 – UE-initiated network selection

7.4.2 Network-initiated network selection

This use case shows that UE is provided the best available connection selected by network.

After finishing lunch, Alice enjoys a cup of coffee and the on-line MP3 in the restaurant over the restaurant's WLAN hot-spot link. At that time, her boss initiates a VoIP call to Alice to discuss a business emergency. The network immediately recognizes that the VoIP call needs stricter QoS assurance than it can provide and then chooses a 3G connection rather than the WLAN link to establish a VoIP connection with Alice.

7.5 Use case 5: Service continuity

This use case shows that, in multi-connection, if one of the connections is lost, then the service can use another connection to maintain the service without any interruption.

Alice has both a 3G connection and WLAN connection in her home. She uses the video call service through 3G, and the peer-to-peer (P2P) downloading through WLAN so that the download does not affect her voice service. After a while, she leaves home with a video call active. When the WLAN connection is lost, the network senses the change and automatically starts delivering the P2P data over the 3G connection without restarting the P2P downloading service, and Alice is informed by the network of the change.

7.6 Use case 6: Bandwidth aggregation

This use case shows that the UE can use multiple connections simultaneously to serve a single application in order to get an aggregated bandwidth.

Alice uses a WLAN connection to download a film in the airport. Then she finds there is not enough time to finish downloading before the flight, so she must accelerate the download to save time. So she sets up the 3G connection, and lets the downloading service use both the WLAN and 3G simultaneously to achieve a wider aggregated bandwidth in order to speed up the download.

7.7 Use case 7: Service transfer

This use case shows that the service can move among multiple connections according to policy.

Alice launches a voice call through a WLAN connection, and browses web pages through the 3G connection at the same time. Then she starts a file transfer protocol (FTP) session to download software through the WLAN connection. She feels the WLAN connection becomes congested due to the large number of file transfers, therefore, she chooses to move the voice call to the 3G connection, and this transfer is transparent to her voice call. The use case is shown as Figure 7-3.

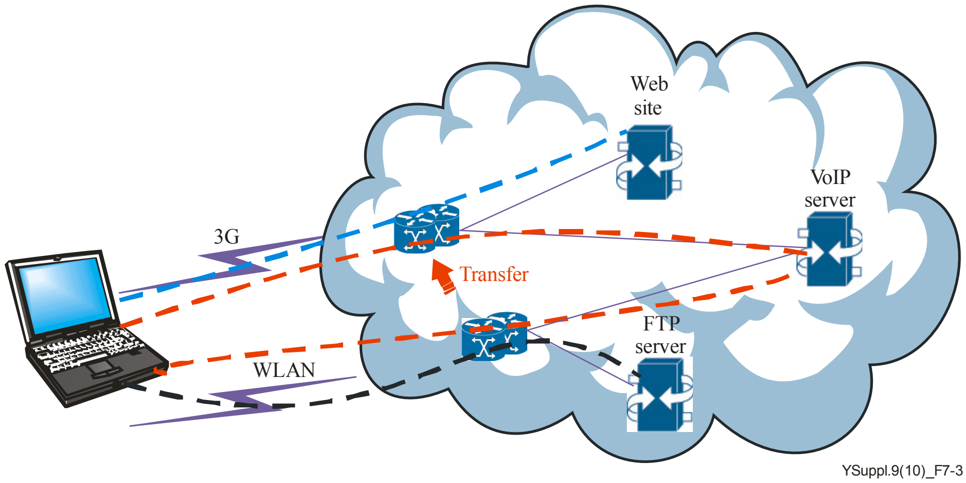

Figure 7-3 – Service transfer

7.8 Use case 8: Service flow duplication

This use case shows the service flow duplication to avoid disruptions created by handover. In other words, a subscriber requires the involvement of another UE in the on-going session; i.e., the duplication of the current session. The multi-connection network and involved UEs have the advantage compared to the "single-connection" network to allocate the required number of simultaneous connections in the UE, thus providing ahead of time a smooth set-up of the duplicated session.

Alice watches a music concert with her family via her multi-connection UE_1 (for instance, a large screen) connected at her home via WLAN or fixed access. Subsequently, she decides to duplicate the on-going session to her multi-connection UE_2 with WLAN and 3G connections, using her UE_1. Instead of using UE_1 to request a classical service transfer to UE_2, she invokes the network operator's service "service flow duplication"; she will avoid interruptions and/or glitches, for instance, delayed video and audio frames or IP packets created by a classical service transfer or HO. Once the multi-connection network performs the service flow duplication and the session run simultaneously in UE_2, Alice has the option to either:

1) Release the 3G connection in UE_2, and only maintain the WLAN connection.
2) Preserve both connections in UE_2 simultaneously. When she moves out of WLAN coverage leaving home, the network automatically shall maintain the service using the 3G connection, without service disruption.

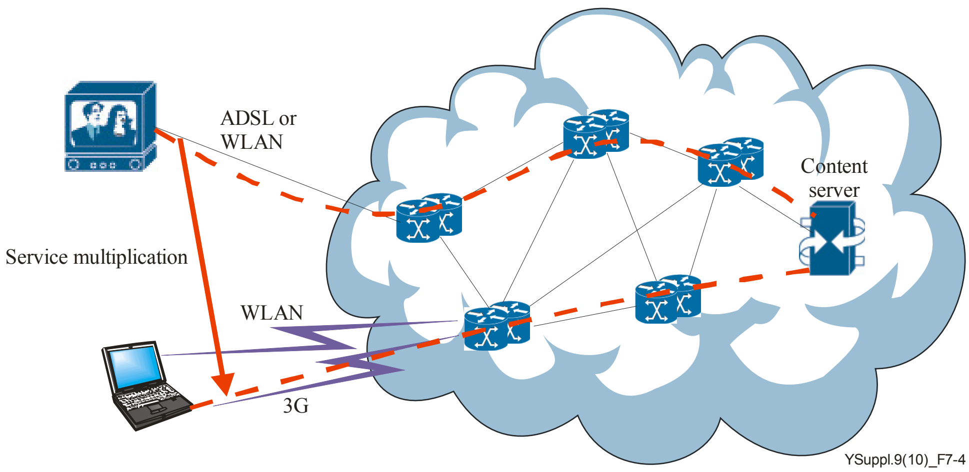

Figure 7-4 – Service flow duplication

7.9 Use case 9: Data transmission rate adjustment

In this use case, when the UE uses bandwidth aggregation, the service flow can be transmitted through different connections by adjusting their bit rate according to the access network's price, speed, etc.

For example, Alice is enjoying Internet Protocol Television (IPTV) via her mobile phone when she is walking to her office. As she moves, she finds that there are some WLAN hot-spots available. So Alice decides to initiate the WLAN link in order to efficiently deliver over two interfaces. Then the server divides and delivers a single stream through the different data paths, adjusting the bit rate for each connection. As shown in Figure 7-5, if a UE has two connections (e.g., one has three times the bit rate availability than the other), then the server adjusts the bit rate of one or both streams.

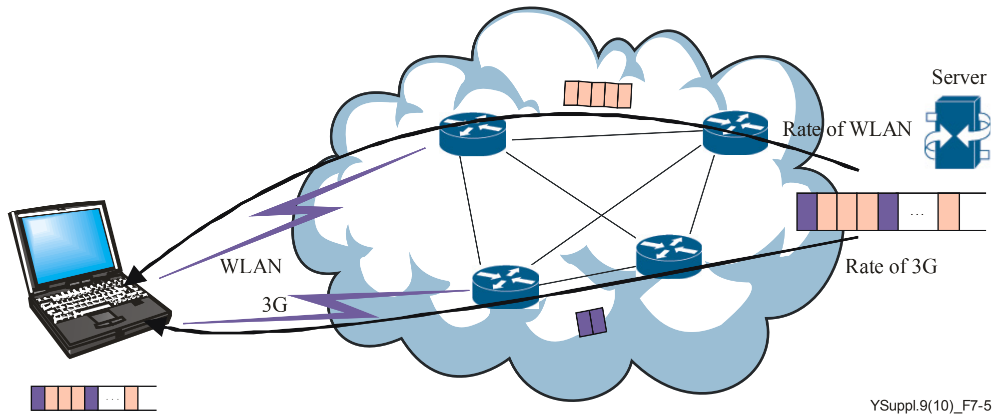

Figure 7-5 – Data transmission rate adjustment

8 Benefits of multi-connection

This clause summarizes the generic benefits of multi-connection from the various use cases described in clause 7. These generic benefits are illustrated in Table 8-1.

In the multi-connection environment, both subscriber and network operator can benefit from multi-connection. The subscriber takes advantage of increased flexibility and the network operator can benefit when deploying multi-connection technologies.

Table 8-1 – Generic benefits of multi-connection

Benefit	Relevant use cases
Service continuity	1, 2, 3, 5, 7, 8
Increased access options	3, 4, 5, 7, 8
Aggregated bandwidth	2, 6, 9
Load sharing	1, 2, 9
Load balancing	2, 7, 9
Flexibility in network selection	4, 5, 7, 8, 9
Reliability	3, 5, 9

8.1 Service continuity

By utilizing multi-connection, UEs and networks are able to redirect or duplicate flow(s) from one connection to another, without interrupting the on-going service, based on the UEs' preferences or upon changes driven by network.

8.2 Increased access options

Multi-connection permits networks to more closely achieve anywhere/anytime multimedia access by providing more access and connection options.

8.3 Aggregated bandwidth

Multiple connections may be maintained simultaneously in order to increase the total aggregated bandwidth available to the UE. It is often desirable to aggregate bandwidth over multiple connections when bandwidth for the UE is limited by the underlying specific technology of a single connection or by some policies. Multi-connection can increase the total bandwidth available to the UE.

8.4 Load sharing

Load sharing is used to spread network traffic load among several connections. This is achieved when the traffic load is distributed among different connections between the UE and the network. It is often desirable that, when there is more than one equivalent connection, the UE distributes its outgoing or incoming traffic among these connections. The load sharing among multiple connections provides better performance for the UE's traffic handling.

8.5 Load balancing

By utilizing multi-connection, it is possible to separate an individual flow between multiple connections related to the single UE. It is also used to mitigate the traffic load on a heavily loaded connection by transferring some of the traffic to a less loaded one without breaking the flow. Therefore, several connections can be used to spread the traffic loads.

8.6 Flexibility in network selection

Multi-connection provides the UE, the application or the network the ability to choose the preferred transmission technology or access network based on cost, efficiency, policies, bandwidth requirement, delay requirement, etc.

8.7 Reliability

Multi-connection provides service robustness when failure occurs in one connection, i.e., the functions of a system component (e.g., interface, access network) are assumed by a secondary system component when the primary component becomes unavailable (e.g., failure). Connectivity is guaranteed as long as one connection is maintained to the network.

Bibliography

[b-IETF RFC 5648] IETF RFC 5648 (2009), *Multiple Care-of Addresses Registration*.
<http://tools.ietf.org/html/rfc5648>

[b-IETF analysis-05] IETF Internet Draft (2008), *Analysis of Multihoming in Mobile IPv6*.
<http://tools.ietf.org/html/draft-ietf-monami6-mipv6-analysis-05>

[b-IETF practices-00] IETF Internet Draft (2009), *Current Practices for Multiple Interface Hosts*.
<http://tools.ietf.org/html/draft-ietf-mif-current-practices-00>

[b-IETF scenario-03] IETF Internet Draft (2008), *Motivations and Scenarios for Using Multiple Interfaces and Global Addresses*.
<http://tools.ietf.org/html/draft-ietf-monami6-multihoming-motivation-scenario-03>

[b-IETF statement-01] IETF Internet Draft (2009), *Multiple Interfaces Problem Statement*.
<http://tools.ietf.org/html/draft-ietf-mif-problem-statement-01>

SERIES OF ITU-T RECOMMENDATIONS

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
Series G	Transmission systems and media, digital systems and networks
Series H	Audiovisual and multimedia systems
Series I	Integrated services digital network
Series J	Cable networks and transmission of television, sound programme and other multimedia signals
Series K	Protection against interference
Series L	Construction, installation and protection of cables and other elements of outside plant
Series M	Telecommunication management, including TMN and network maintenance
Series N	Maintenance: international sound programme and television transmission circuits
Series O	Specifications of measuring equipment
Series P	Terminals and subjective and objective assessment methods
Series Q	Switching and signalling
Series R	Telegraph transmission
Series S	Telegraph services terminal equipment
Series T	Terminals for telematic services
Series U	Telegraph switching
Series V	Data communication over the telephone network
Series X	Data networks, open system communications and security
Series Y	**Global information infrastructure, Internet protocol aspects and next-generation networks**
Series Z	Languages and general software aspects for telecommunication systems

Printed in Switzerland
Geneva, 2010