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

ITU-T Y.2000-series – Supplement on scenarios for the evolution of NGN network capabilities to include information storage, processing and delivery

ITU-T Y-series Recommendations – Supplement 13

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Supplement 13 to ITU-T Y-series Recommendations

ITU-T Y.2000-series – Supplement on scenarios for the evolution of NGN network capabilities to include information storage, processing and delivery

Summary

Supplement 13 to ITU-T Y-series Recommendations describes various scenarios for the evolution of NGNs to enhance network capabilities by introducing new technologies and new business models.

The following enhanced capabilities of NGNs are considered: information delivery, information storage and information processing. These enhanced capabilities can bring new services for the end-user and better performance for the NGN itself.

Some key use cases of the enhanced network capabilities are introduced from different perspectives: enhanced capability itself, provisioning of the enhanced capability and consumption of the enhanced capability.

History

Edition	Recommendation	Approval	Study Group
1.0	ITU-T Y Suppl. 13	2011-01-28	13

FOREWORD

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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.

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1 Scope

This Supplement describes various scenarios for the evolution of NGNs to enhance network capabilities by introducing new technologies and new business models.

The following enhanced capabilities of NGNs are considered: information delivery, information storage and information processing. These enhanced capabilities can bring new services for the end-user and better performance for the NGN network itself.

Some key use cases of the enhanced network capabilities are introduced from different perspectives: enhanced capability itself, provisioning of the enhanced capability and consumption of the enhanced capability.

2 References

[ITU-T Y.101] Recommendation ITU-T Y.101 (2000), *Global Information Infrastructure terminology: Terms and definitions*.

[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 (2010), *Functional requirements and architecture of the NGN*.

[ITU-T Y.2091] Recommendation ITU-T Y.2091 (2011), *Terms and definitions for next generation networks*.

3 Definitions

3.1 Terms defined elsewhere

None.

3.2 Terms defined in this Supplement

This Supplement defines the following terms:

3.2.1 information delivery capability: This is the capability of the network to deliver information for end users or applications.

NOTE – Considering that more and more applications demand large transport bandwidth, the information delivery capability can be enhanced through different ways, such as multi-path delivery, usage of massive media servers supporting large scale content distribution, etc.

3.2.2 information processing capability: This describes the capability of the network to process information for end-users or applications.

NOTE – The information processing capability can provide dynamic resource allocation and the end-user can apply for designated quota of information processing resources, such as CPU time slot and memory, and release them dynamically. The information processing capability can also be integrated with the information storage capability so that data stored in the network can be visited and handled by authorized applications (e.g., analysis applications for data mining).

3.2.3 information storage capability: This is the capability of the network to store information for end-users or applications.

NOTE – This information from end-users or applications can be stored in the network in a secure way. The information can be also retrieved by the owner or shared with other authorized end users or applications. End-users or applications could be charged upon the storage space and storage time.

4 Abbreviations and acronyms

This Supplement uses the following abbreviations and acronyms:

ANI Application Network Interface

NNI Network Network Interface

UE User Equipment

UNI User Network Interface

5 Conventions

None.

6 Use cases for capability aspect

This clause describes use cases for the three enhanced network capabilities under consideration, including:

- Information delivery capability.
- Information storage capability.
- Information processing capability.

New applications can be supported by NGN with these enhanced capabilities. Each of these capability enhancements also brings new requirements for NGN.

6.1 Use cases of information delivery

These cases of information delivery deal with delivering service-related information for end-users or service provider, including signalling, voice, short message, video, streaming, files, etc. Basically, information delivery concerns carrying service-related information to the right people, in the right format, and at the right time.

Compared with current NGN capabilities, the proposed enhancements of the information delivery capability concern NGNs in two different ways, i.e., enhancements for multi-path delivery and large scale content distribution.

6.1.1 Use cases for multi-path delivery

The "multi-path delivery" feature enables the NGN to manage and utilize multiple available paths for the transmission of streams generated by one or more applications.

Multiple alternative paths are constructed through the NGN, yielding a variety of benefits such as fault tolerance, increased bandwidth and transmission performance, as well as improved security. Increased robustness and throughput, and higher link utilization of the NGN help to reduce the NGN provider's operational costs and to increase the services offered to customers.

Increased transmission performance and fault tolerance can be provided via:

- Simultaneous, parallel transport paths.
- Load balancing over available assets.

- Avoidance of path discovery when re-allocating a previously broken stream.

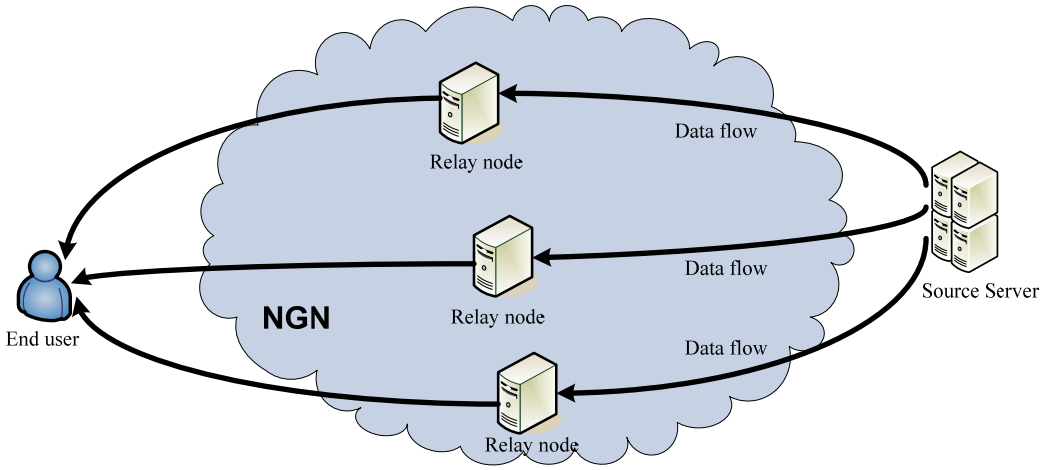

Figure 6-1 – Multi-path delivery

Figure 6-1 shows a use case of multi-path delivery. The following is a description of the related operational flows:

1) Multiple transport paths are established through different relay nodes between the source server and the end-user;
2) The quality of these transport paths is measured and monitored;
3) Depending on the requirements,
   a) The fastest path is selected to transport the data to the End user; or
   b) Multiple paths are selected to transport the data to the End user.

6.1.2 Use cases for large scale content distribution

The enhanced NGN can support large scale content distribution by using massive media servers.

Massive media servers deployed in the edge of network and adjacent to users can help to store and share media content. Media servers can act as aggregators of content (video, audio, photos, books, etc.), allowing the end users to access the media from remote locations via Internet.

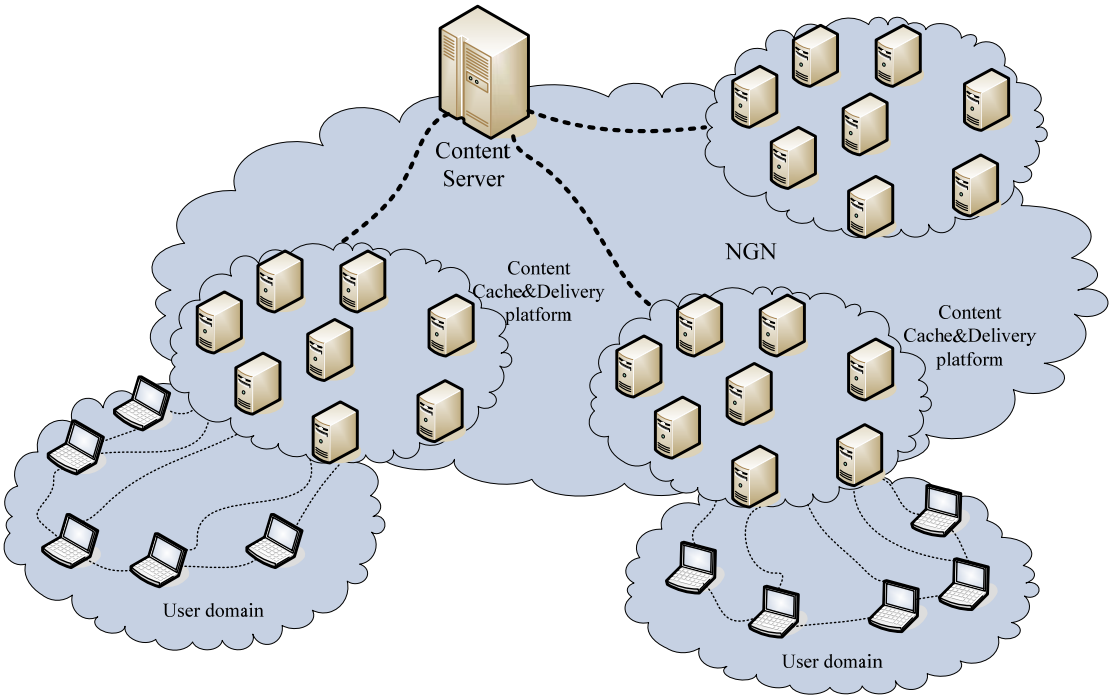

Figure 6-2 – Use case for large scale content distribution

Figure 6-2 shows a use case for large scale content distribution. The following is a description of the related operational flows:

1) The content is delivered from the content source server to content cache and delivery platforms which are located at the edge of the network, close to the user domains. The content cache and delivery platforms can be composed by many media servers and can cache the content in a distributed manner. Being near to the local users, the content cache and delivery platforms help to reduce the backbone traffic and improve the user's quality of experience of the service;

2) Users get the content from the content cache and delivery platforms;

3) Users can also exchange content among themselves (in peer-to-peer manner), decreasing the load of the content cache and delivery platforms.

6.2 Use cases of information storage

As shown in Figure 6-3, these use cases concern the enhanced NGN's information storage capability involving interactions among the user domain, service domain and network domain. Accordingly, three roles are identified in these use cases: users, NGN network operator, service providers. Users may include personal users and enterprise users. The NGN network operator is usually also a service provider at the same time. Other service providers are third-party service providers.

Compared with current NGN's capabilities, the proposed enhancements of the information storage delivery capability concern NGN in two ways:

- the enhanced NGN can store much more types of information than the current NGN. Many types of information from user equipment (UE) and service providers' devices are actually carried by the NGN;
- the enhanced NGN's information storage capability is open to users and service providers. Users and service providers can use the enhanced NGN's information storage service to store their information. The user information stored in NGN can be shared with other users and service providers with the owner's permission.

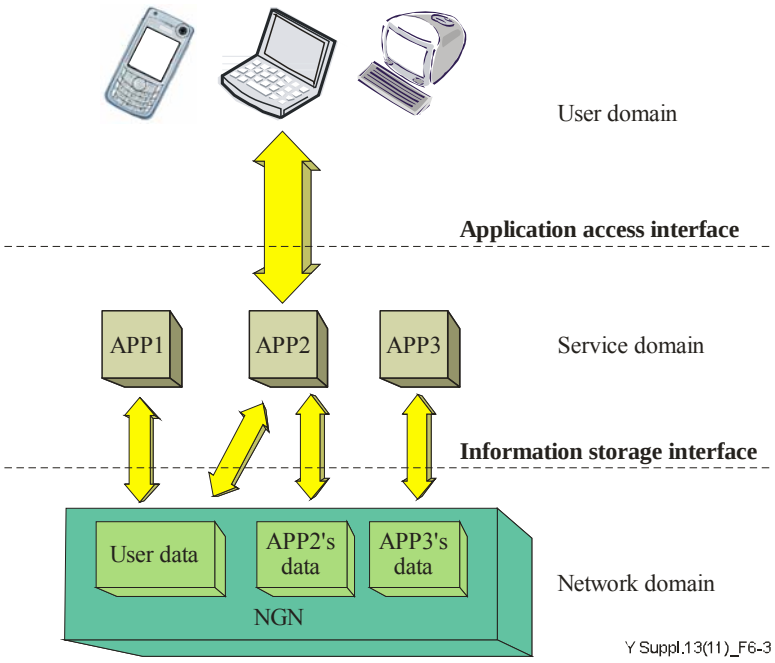

Figure 6-3 – Information storage capability and interaction among domains

Three use cases are described in the following three clauses.

6.2.1 Storage service for end-users

The NGN stores user information that was traditionally stored in user equipment or other user devices. The information from end-users can be stored in the network in a secure mode. This information may include user profile, user presence information, phonebook, user activity log, diary, photo, etc. The information can also be retrieved by the owner or be shared with other authorized users. The storage service is provided to users through applications like online phonebook, online diary, online album, network disk, etc.

There are three advantages of storing user information in the NGN:

1) Firstly, the NGN can provide massive space to store large amount of information. On the contrary, some user equipment, especially mobile terminals, does not have enough space to store long-term information and big content files.

2) Secondly, the NGN can provide secure and reliable storage service. Lost or broken user equipment can cause information loss, and the loss of user equipment may also cause the leak of private information.

3) Thirdly, the people can access and share their information from any user equipment. If a person uses multiple terminals or just uses a new terminal, they can still access and share the information stored in NGN.

   This use case can bring new applications to end-users. Some applications are replacements of some terminal-side applications, and some others could not be implemented in network-side or terminal-side deployments. End-users can be charged for the time of application usage and the storage space.

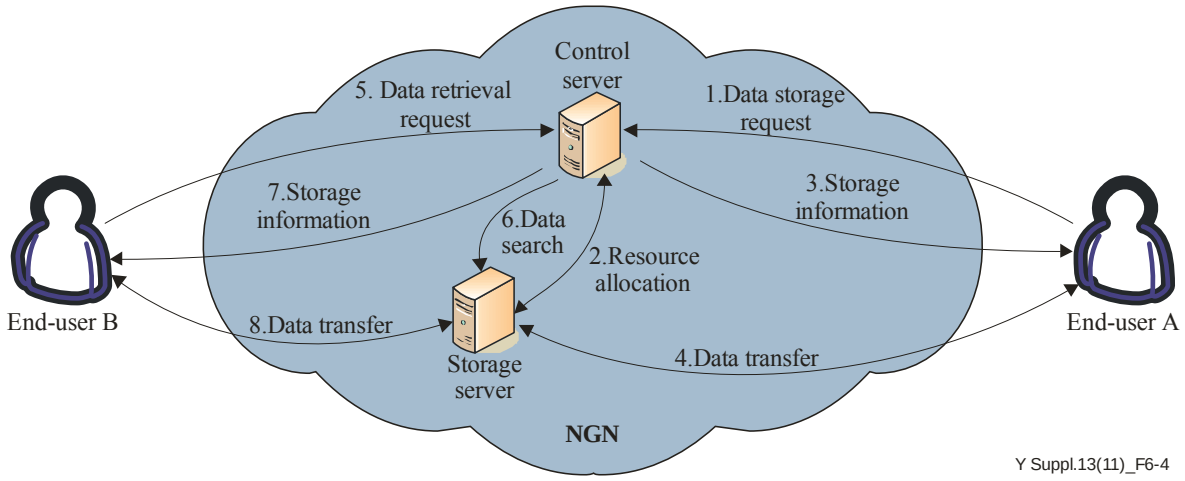

Figure 6-4 – Storage resources used by end-users

Figure 6-4 shows a use case for storage resources used by end-users. The following is a description of the related operational flows:

1) End-user A wishes to share some of his or her photos, he or she sends a data storage request to the control server in the NGN. The request may indicate the description of the data, the required storage size, the required number of copies, the data expiration date, the data access control information, etc.

2) The control server verifies the request of end-user A and requests the storage server to allocate storage resources for the photos.

3) The control server returns the storage information to end-user A.

4) End-user A directly contacts the storage server to transmit the photos.

5) End-user B, a friend of user A, wishes to retrieve the photos stored by user A. He or she sends a data retrieval request to the control server.

6) The control server verifies that the end-user B can download the photos, and then looks up the position of the stored photos on the storage server.

7) The control server returns the photos position to the end-user B.

8) End-user B directly downloads photos from the storage server.

6.2.2 Providing user information to applications

The NGN can store user information and provide it to multiple applications with the permission of the user. This information may include user profile, buddy list, user presence information, user activity log, interests, etc. With this user information, many new applications can be deployed. For example, using the buddy list, social network services can be deployed. Similarly, using user location data, location-based services can also be deployed.

This type of use case allows application or service providers to provide many new applications to users. The NGN operator and application or service provider may share the earnings from users. The application or service provider can be charged according to the type and the amount of the used information.

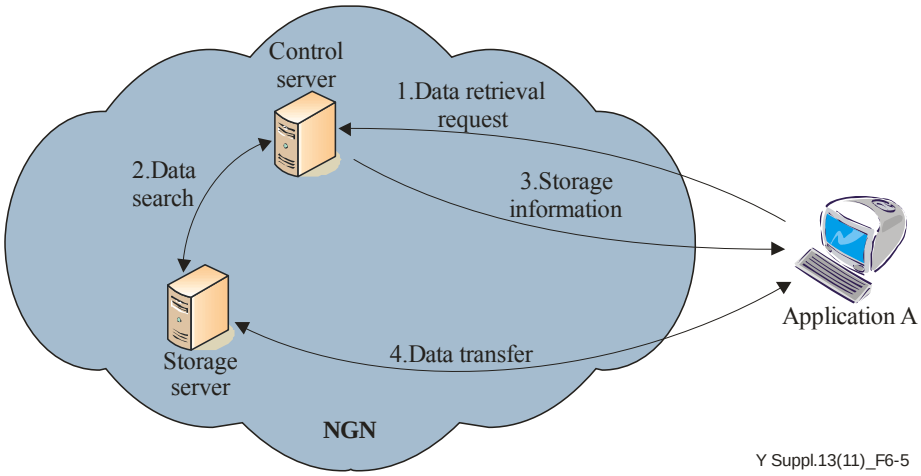

Figure 6-5 – providing user information to applications

Figure 6-5 shows a use case for providing user information to applications. The following is a description of the related operational flows:

1) Application A needs end-user A's buddy list to infer the relationship between end-user A and end-user B. Application A sends data retrieval request to control server.

2) The control server verifies that Application A can access the profile of end-user A. The control server looks up the position of end-user A's profile on the storage server.

3) The control server returns the storage information to Application A.

4) Application A directly contacts the storage server for data transmission.

6.2.3 Storing application-specific information

Applications may utilize the NGN's storage service to store application-specific information. This information is not provided by users or the NGN uniformly. An application can store any information it wants. Using this storage service, new applications can be easily deployed without deploying and maintaining extra storage devices. In addition, the information is stored in a reliable and secure way. This storage service is very useful for the rapid deployment of new applications, and is also very suitable for small third-party application providers, which cannot afford the cost of deploying and maintaining storage devices.

The NGN operator and application or service providers can share the earning from users. This type of use case encourages more application providers to provide more applications. Application providers can be charged according to the storage space and storage time.

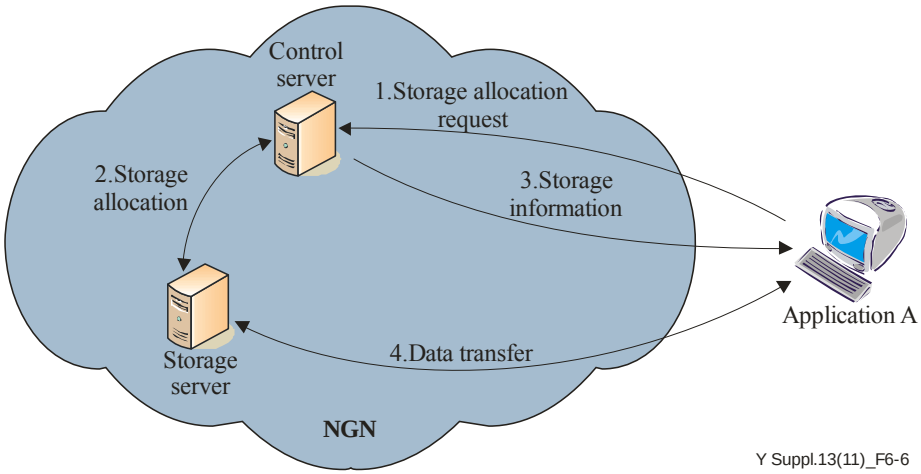

Figure 6-6 – Storing application-specific information

Figure 6-6 shows a use case for storing application-specific information. The following is a description of the related operational flows:

1) Application A requires storage for its operation. Application A sends a data resource request to the control server.

2) The control server verifies the request and checks the quota of Application A. The control server contacts the storage server to allocate storage resources for Application A.

3) The control server returns the storage information to Application A.

4) Application A directly contacts the storage server for data storage and retrieval.

6.3 Use cases of information processing

With the rapid increase of information and computing scale, individual end-users or small enterprise are more likely not satisfied by their own processing capability. End-users can instead purchase computing resources supplied by the network and be charged depending on their computing quota and service time. Accordingly, NGN can provide flexible charging capabilities, and the end user can be charged for the amount of consumed resources.

6.3.1 Information processing capability provided by NGN

The information processing capability is provided by NGN. NGN can achieve economies of scale to reduce hardware cost, power cost, and management cost. Computing resources of single physical equipment can also be shared by different users and applications to achieve higher efficiency.

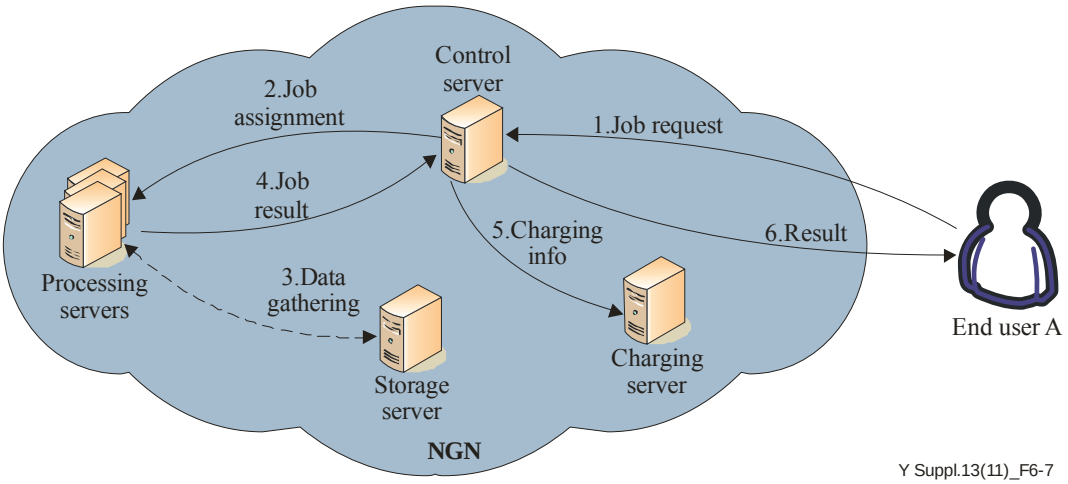

Figure 6-7 – Information processing capability provided by NGN

Figure 6-7 shows a use case for information processing resources provided by the network. The following is a description of the related operational flows:

1) End-user A wants to execute a computationally intensive job, such as speech recognition, on their user equipment. As the user equipment does not have enough computing resources or battery energy to support this job, the user equipment sends the job request to the control server in the NGN.

2) The control server dispatches the job to processing servers which have computing resources for the request job.

3) The processing servers may collect additional data for the assigned job from storage servers.

4) After the job has been completed, processing servers return the result.

5) The NGN charges end-user A based on the amount of computing resources used by this job.

6) The job result is returned to the end-user A.

6.3.2 Information processing resources contributed by end users

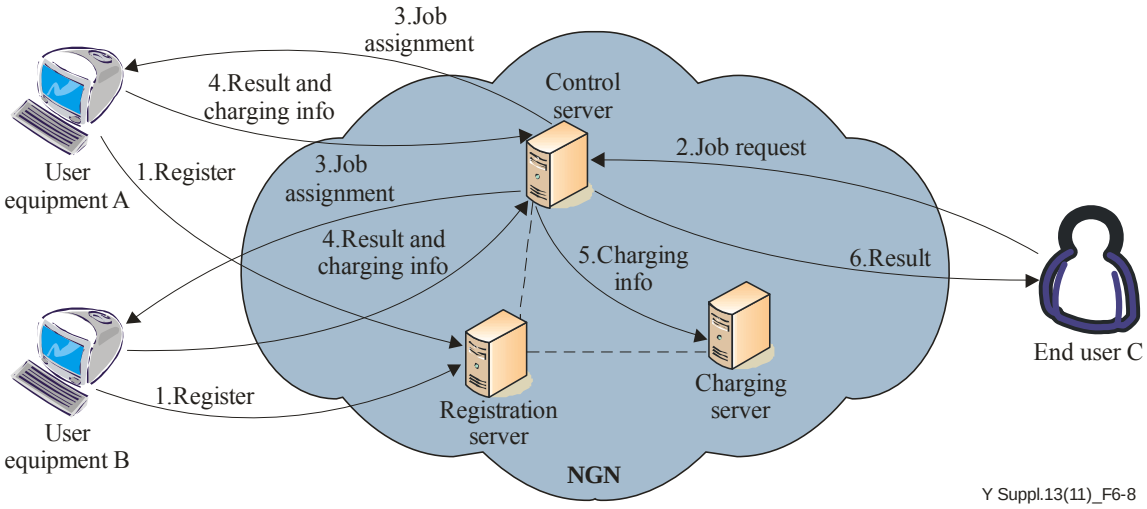

Figure 6-8 – Information processing resources contributed by end users

End-users may contribute their computing resources through the NGN to other end-users, e.g., individuals or small enterprises. The NGN acts as a computing resource broker in this case. The computing resources are contributed by the end-users who are willing to let other end-users use their spare processing resources. The NGN is required to coordinate the computing resource sharing process and to provide resource registration, security, QoS management and charging capabilities. Resource contributing end-users may be able to earn credits from the network. End-users are not aware of whether resources consumed by them are contributed by other end-users or directly provided by the NGN.

Figure 6-8 shows a use case for information processing resources contributed by end-users. The following is a description of the related operational flows:

1) User equipment includes computers owned by end-users of the NGN. The owners of user equipment A and B are willing to contribute their computing resources. User equipment A and B register to the registration server and indicate the amount of computing resources that they can contribute.

2) End-user C submits an information processing job to the control server in the NGN.

3) The control server divides the job submitted by end-user C to several small tasks and assigns them to user equipment A and B. While user equipment A and B are executing the job, the network may keep monitoring the execution progress.

4) User equipment A and B return the job result to the control server after finishing the job. User equipment A and B also returns the resource consumption information to the control server. The resource consumption information includes computing time used for the job or the amount of computing resources consumed by the job.

5) The charging information, including the resource consumption information, is forwarded to the charging server. The charging process includes charging the end-user C and giving credits to user equipment A and B.

6) The NGN returns the job result to end-user C.

6.3.3 Information processing resources provided through virtual desktop interface

Some user equipment functions (e.g., decoding, data mining, office operation or even voice service) are migrated to the NGN. The NGN can dispatch virtual machines for the user's task execution, in which virtual desktop serves for the final result displaying and delivering the displaying result to the end-user. The end-user can get displaying results and inter-act with virtual machines just by connecting to the Virtual Desktop system inside NGN through virtual desktop access protocol.

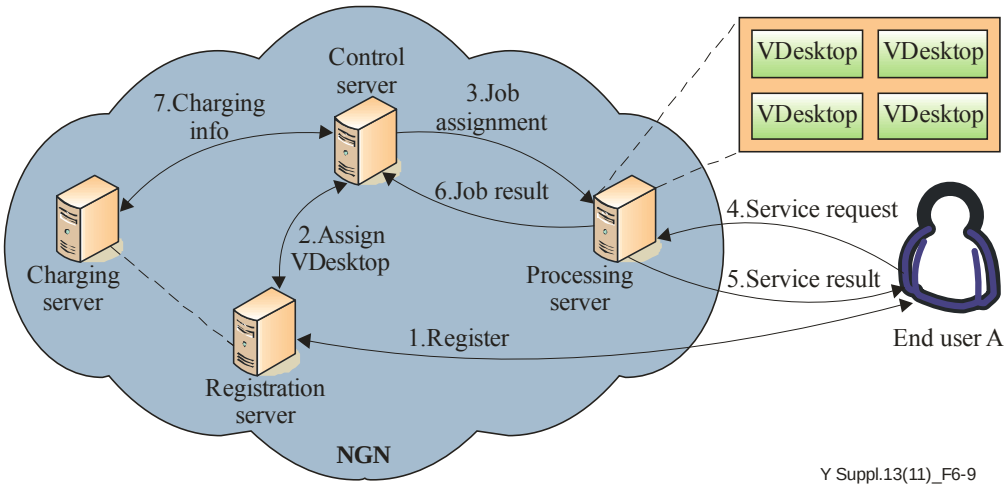

Figure 6-9 – Information processing resources for virtual desktop

Figure 6-9 shows a use case for information processing resources provided for virtual desktop. The following is a description of the related operational flows:

1) When end-user A attaches the NGN, they register to the registration server and indicate that some of the user terminal's tasks shall be implemented by the virtual desktop approach.

2) The registration server communicates with the control server to assign the virtual desktop. In the form of a virtual machine, the virtual desktop resides in a processing server.

3) The control server dispatches the job to processing servers which have computing and memory resources for the requested job, and sends back the information of assigned virtual desktop to the end-user A.

4) When user A wants to execute a computationally intensive job, such as speech recognition, on their user equipment, they send a service request message to the assigned virtual machine.

5) The processing servers process the assigned job and return the result displaying to user A through virtual desktop system.

   Through the virtual desktop, the user can send commands to the virtual machine and get result displaying screen from the virtual machine.

6) The job executing information such as resources consumption is returned to the control server.

7) NGN charges user A based on the amount of resources consumed by this job.

7 Use cases for the capability provisioning and consumption perspectives

This clause describes capability provisioning and consumption perspectives for the enhanced NGN capabilities. It includes:

- Capability provisioning by different roles
- Capability consumption by different roles

Network operators can choose one or multiple deployment options as described in the following clauses.

These deployment options can be in the form of a data centre or a storage network, etc.

7.1 Capability provisioning

As shown in Figure 7-1, three approaches for capability provisioning can be used in deployment:

- Capability provisioning by application servers (AS)

  Information storage or processing capabilities can be deployed in application servers which are provided by third party service providers through ANI.

- Capability provisioning by end-user equipment

  Information storage or processing capability can be provided by end users. When end-users are willing to contribute their spare resources, NGN can cooperate with end-user equipment to utilize their information storage or processing capabilities through UNI. In this case, end-users may earn credits from the network via resource contribution, while the network operators can reduce its capital expenditure or operational expenditure.

- Capability provisioning by service stratum/transport stratum components

  The NGN operator can deploy information delivery, storage and processing capabilities as components in the service stratum or transport stratum of its NGN. In this case, capabilities are used through internal interfaces where the network operator may further optimize the resource utilization or management process.

NOTE – Capabilities provided by other networks through the NNI are treated in the same way as those provided by application servers (ASs).

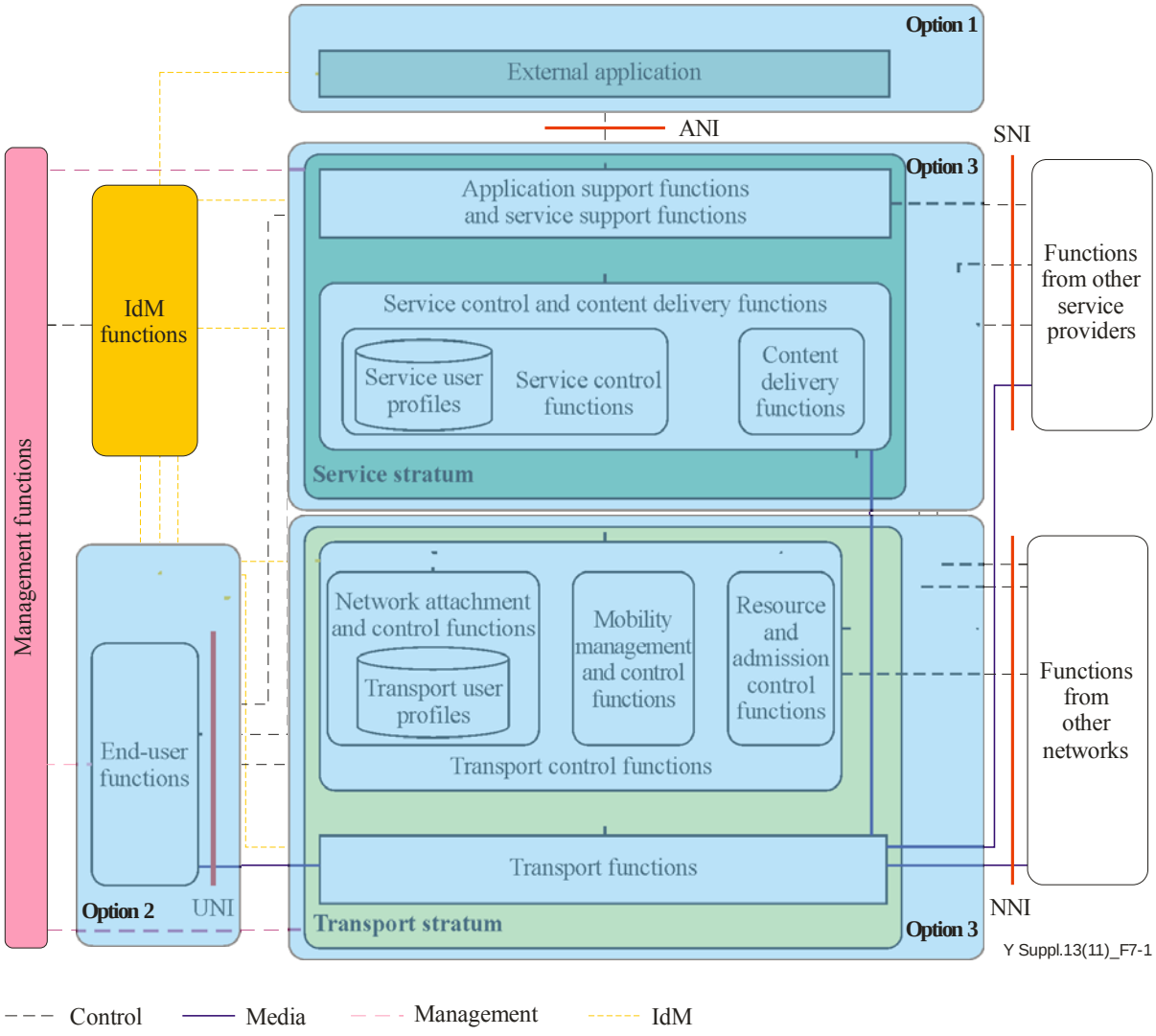

Figure 7-1 – Capability provisioning

7.2 Capability consumption

The information delivery, storage and processing capabilities can be consumed by different parties through different service interfaces:

a) Capabilities consumed by applications

Applications can use the enhanced capabilities provided by NGN to serve end-users in NGN, or end-users outside of NGN (e.g., PSTN user, Internet user). The enhanced capabilities can be provided to applications via APIs or other methods (e.g., virtual machine services).

b) Capabilities consumed by end-users

End-users may directly use the network provided information storage or processing capabilities through UNI. End-users can use the NGN capabilities to compensate their user equipment's storage and processing capability shortage; and such enhancement can be transparent to the applications running on user equipment.

c) Capabilities consumed by NGN

The NGN operator can use the enhanced information storage and processing capability to reduce its capital expenditure or operational expenditure. Furthermore, the enhanced capabilities can also be used for increasing service quality, reliability and flexibility of the NGN. In the NGN architecture, components that can utilize the enhanced capabilities include, but are not limited to, user profile functions, application support functions, service support functions and service control functions. When the enhanced capabilities are used by components inside the NGN, the capabilities can be invoked through internal interfaces, where the NGN network operator can further optimize the resource utilization or management process.

Annex A

Functions required to support the enhanced capabilities

To support the enhanced capabilities, the network is required to provide the following functions:

- User authentication and resource access control:

  Only authenticated users or applications can use the enhanced capabilities. Furthermore, the NGN provides access control to prevent unauthorized data or resource access.

- Service invoking interface:

  The NGN provides functions that support applications, users or NGN components to invoke the enhanced capabilities.

- Job scheduling and monitoring for information processing capability:

  For information processing capability, a single job could be divided to multiple tasks and executed in parallel. Furthermore, the NGN provides ways to schedule jobs based on resource availability and job priority. The NGN also monitors the job progress and restart or reschedule jobs in case of failures.

- Data replication and data synchronization for information storage capability:

  The NGN provides basic data replications and data synchronization services, so that data can be reliably stored by the NGN without user intervention.

- Data access control, privacy and Copyright protection for information storage capability:

  The NGN provides data access control for the stored information. Furthermore, private data access patterns (including the time, location, frequency and the user identity which accesses certain data) should not be leaked to unauthorized parties. The NGN also provides integrated copyright protection capabilities for data stored by NGN.

- Storage and processing resource management and load balancing:

  The NGN can manage the storage and processing resources provided by different parties. It redirects processing tasks or move data in order to balance the load of each resource provider.

- Coordination for joint information storage and processing tasks:

  The NGN uses multiple capabilities to perform a single job. It coordinates the processing and information gathering procedures while performing such tasks.

- QoS management and charging capability:

  The NGN provides QoS measurement and enforcement for the enhanced capabilities. It also provides accounting and charging capability for resource provision and consumption.

These functions can be matched to the capability enhancement use cases as follows:

Table A.1 – Relationship between supporting functions and use cases

	User authentication and resource access control	**Service invoking interface**	**Job scheduling and monitoring**	**Data replication and data synchronization**	**Data access control, privacy and copyright protection**	**Storage and processing resource management and load balancing**	**Coordination for joint information storage and processing tasks**	**QoS management and charging capability**
Storage used by user	√	√		√	√	√		√
Providing user information to applications	√	√		√	√	√		√
Storing application-specific information	√	√		√	√	√		√
Information processing capability provided by NGN	√	√	√			√	√	√
Information processing resources contributed by users	√	√	√			√	√	√
Capability provisioning by application servers	√		√	√	√	√	√	√
Capability provisioning by end-user equipment	√		√	√	√	√	√	√
Capability provisioning by service stratum or transport stratum components	√		√	√	√	√	√	√
Capability consumed by applications	√	√	√	√	√	√	√	√
Capability consumed by end-users	√	√	√	√	√	√	√	√
Capability consumed by NGN			√	√		√	√	√

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