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INFRASTRUCTURE, INTERNET PROTOCOL ASPECTS
AND NEXT-GENERATION NETWORKS

Next Generation Networks – Quality of Service and
performance

Flow aggregate information exchange functions in NGN

Recommendation ITU-T Y.2122

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Recommendation ITU-T Y.2122

Flow aggregate information exchange functions in NGN

Summary

Recommendation ITU-T Y.2122 specifies the requirements and architecture for flow aggregate information exchange functions (FIXF). FIXF allows network domains to exchange flow aggregate information that reflects the current network conditions. In order to guarantee end-to-end QoS in NGN, cooperation among networks in an end-to-end path is necessary. Exchange of network configuration information is a key component of cooperation among participating networks. Flow aggregation has been considered a scalable technique for traffic management. Additional information obtained through FIXF can improve the accuracy of performance estimation and effectiveness of resource management.

Source

Recommendation ITU-T Y.2122 was approved on 29 June 2009 by ITU-T Study Group 13 (2009-2012) under Recommendation ITU-T A.8 procedures.

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Introduction

This Recommendation specifies the requirements and architecture for flow aggregate information exchange functions (FIXF). It addresses the flow or flow aggregate (FA) performance prediction by way of exchanging the network operating parameters or unique parameters of flow aggregates. There are a few critical parameters (e.g., number of hops, link capacity, etc.) for the performance of a flow for a given QoS architecture, which are sometimes tuned dynamically (from time-to-time, from flow-to-flow) within a network. By having the other networks' parameters for the flow (or for the flow aggregate to which the flow belongs), one can infer the performance of the flow in these networks and in its own network. The estimation can be complemented by measurement, i.e., the estimation rules can be further adjusted by the measured performances. Consider the following example: A delay bound for an expedited forwarding (EF) flow in a differentiated services (DiffServ) network can be calculated by using parameters given from neighbouring networks. The initial delay estimation rule can be just to adopt the delay bound obtained from the calculation. The bound, however, can be too conservative, compared to the measured delay, especially when the maximum burst sizes of flows in the same class are large. Then one can adjust the estimation rule to reduce the expected delay value under condition that the maximum burst sizes are large.

One obvious benefit of this approach is that upon a flow admission request, network operators can immediately decide whether the requested end-to-end performances can be met, based on the estimation rules that have been adjusted and stabilized. The frequency of the exchange, estimation, comparison, and adjustment can vary according to implementation. The frequency of exchange for a given flow aggregate, for example, depends on the parameter value precision, flow granularity, intended level of accuracy, etc.

The overall process for the performance estimation is depicted in Figure Intro.1.

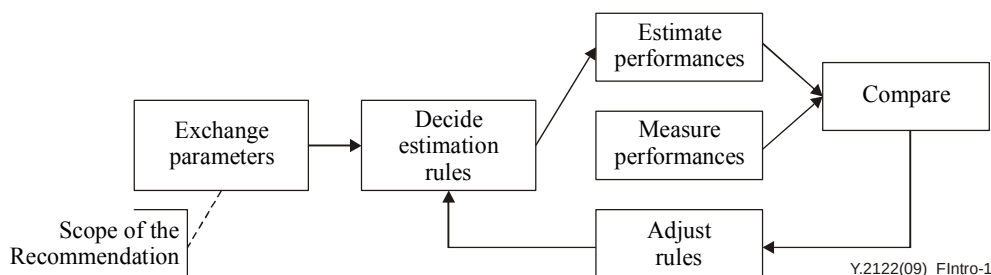


Figure Intro.1 – Estimation process example based on exchanged parameters

The network operating parameters to be exchanged vary according to network QoS architecture. For example, in the DiffServ [b-IETF RFC 2475] architecture (or 802.1Q, 802.11e-type networks) the important parameters include the behaviour aggregate (BA) to which a packet belongs, and the bandwidth utilization of the BA based on the implied admission policy (e.g., not more than 10% for EF BA). In another example, the flow aggregation granularity and the number of hops in an aggregation region, in case of a flow-based network such as flow state aware network [b-ITU-T Y.2121], are the important parameters.

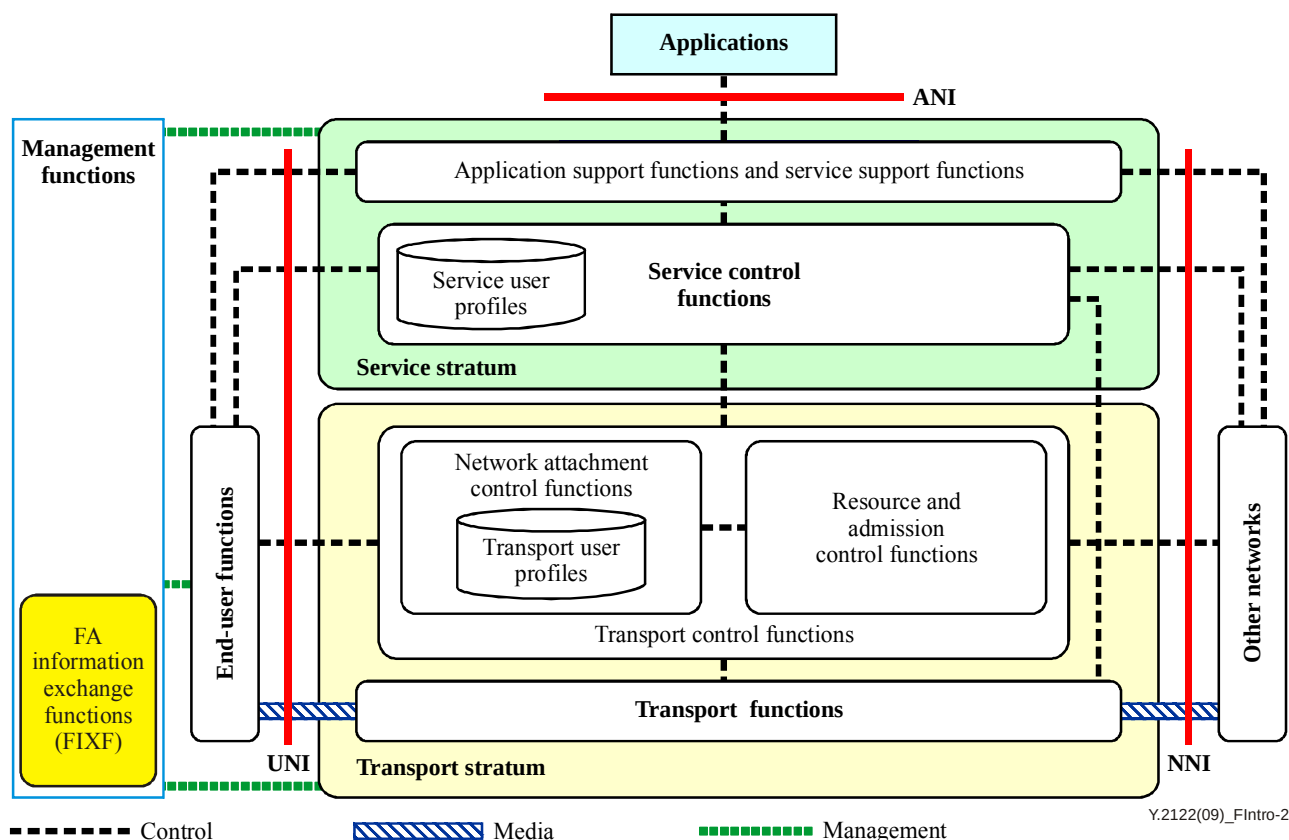


Figure Intro.2 – Position of the FA information exchange functions in the NGN architecture [ITU-T Y.2012]

As depicted in Figure Intro.2, the FA information exchange functions defined in this Recommendation are one of the NGN management functions. The goal of the functions is to provide additional information to improve the accuracy of the admission decision. The FIXF collects the FA configuration information throughout the networks. The collected information can be used for estimating the end-to-end QoS, thus possible applications of this function can be the resource and admission control functions (RACF) or other management functions that handle end-to-end QoS.

Recommendation ITU-T Y.2122

Flow aggregate information exchange functions in NGN

1 Scope

This Recommendation defines the network operating parameters of a flow aggregate (FA) to be exchanged among different network domains for various types of FAs in NGN, and defines the architecture for exchanging these parameters. It also defines, for informational purposes, the mapping of the transport technology specific parameters to the defined network operating parameters. The details of the protocols are for further study and are out of the scope of this Recommendation. Usage examples of the exchanged operating parameters are shown in several appendices.

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 (2006), *Functional requirements and architecture of the NGN release 1*.

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

3 Definitions

This Recommendation defines the following terms:

3.1 aggregation end point: The node where a flow aggregate is de-aggregated. Aggregate start and end points for a flow aggregate can collocate in the same node.

3.2 aggregation region: A set of neighbouring nodes within which every flow maintains its membership of a flow aggregate unaltered. For example, in a DiffServ network, the aggregation region is usually limited to a single node, since at the very next node the membership within a behaviour aggregate is likely to be changed. An aggregation region is defined per flow aggregate. Typically, a node can belong to multiple aggregation regions at the same time.

3.3 aggregation start point: The node where flows are aggregated to form a flow aggregate.

3.4 flow: A set of IP packets that have the same IP 5-tuple in case of IPv4 packets, or have the same flow label in case of IPv6 packets.

3.5 flow aggregate: A set of flows treated in the same way in terms of scheduling.

3.6 flow aggregate membership: The flows within the flow aggregate. The membership can be identified by the set of flow IDs within the flow aggregate. A given flow at a given node cannot be a member of different flow aggregates at the same time.

3.7 flow aggregate table: A set of flow aggregate table entries.

3.8 flow aggregate table entry: A set of information for a flow aggregate including flow aggregate specific configuration parameters. A flow aggregate table entry is the elementary unit to be maintained and exchanged.

3.9 number of hops: The number of nodes in an aggregation region, including both aggregation start point and aggregation end point.

3.10 policy region: A set of neighbouring nodes within which a single policy regarding the flow aggregation is applied. In this Recommendation, it is assumed that an administrative domain is a single policy region. A "network" or a "domain" means a policy region.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AEP	Aggregation End Point
AR	Aggregation Region
ASP	Aggregation Start Point
BC	Bandwidth Constraint
Bs	Sustainable Burst Size
CT	Class Type
DiffServ	Differentiated Services
DSCP	DiffServ Code Point
DS-MPLS	DiffServ over MPLS
ECN	Explicit Congestion Notification
FA	Flow Aggregate
FIE-FE	FA Information Exchange functional entity
FIG-FE	FA Information Gathering functional entity
FIM-FE	FA Information Management functional entity
FIXF	Flow Aggregate Information Exchange Functions
FSA	Flow State Aware
IntServ	Integrated Services
LSB	Least Significant Bit
LSP	Label Switched Path
MAM	Maximum Allocation Model
MSB	Most Significant Bit
PHB	Per Hop Behaviour
R	Representative
RACF	Resource and Admission Control Functions
RDM	Russian Dolls Model
Rs	Sustainable Transfer Rate
TE	Traffic Engineering
WFQ	Weighted Fair Queuing

5 Conventions

None.

6 High level requirements for FA information exchange functions

The FA information exchange functions described in this Recommendation are required to:

- 1) be able to gather information on flow aggregates configuration parameters from networks, which are physically separated and are willing to exchange their information;
- 2) be able to provide gathered information to application entities which can utilize the global FA information to facilitate end-to-end QoS;
- 3) have minimum impact on the performance of the underlying transport layer; and
- 4) be flexible in updating, exchanging, and gathering transaction's frequencies and triggering methods.

7 Information exchange architecture

This clause provides:

- a description of functional entities of the FA information exchange functions; and
- a description of modes of the FA information exchange functions required to establish the management view of a complete end-to-end customer service and the hierarchy of management information flows required to provide and maintain such a service.

It should be noted that the modes of information exchange presented here are lists of reasonable approaches to meet the requirements for orderly provision of end-to-end QoS services which should allow operators to cooperate; or an operator maintaining multiple domains to cooperate among domains, in support of this. More modes of operation can further be defined.

7.1 Overall architecture

Figure 7-1 describes the functional architecture of FA information exchange with the functional entities. (For a detailed description of the functional entities, see clause 7.4). This architecture includes:

- FIM-FE (FA information management functional entity): FIM-FE is responsible for maintaining and updating the information on a per-flow aggregate basis. This information is captured in a form of a flow aggregate table.
- FIE-FE (FA information exchange functional entity): FIE-FE is responsible for providing the FA table to the FIG-FE.
- FIG-FE (FA information gathering functional entity): FIG-FE is the final point of the information gathering and processing. FIG-FE is responsible for handling requests from applications it is associated with.

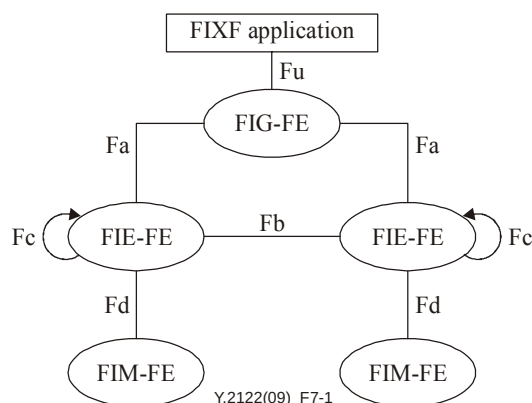


Figure 7-1 – Functional architecture for FA information exchange

7.2 Modes of operation

The management of operations for information exchange, collecting and processing over multiple network domains is a challenging issue. Recently, the exchange procedures for the QoS measurement information over networks have been standardized both in ITU-T [b-ITU-T Y.2173] and IETF [b-IETF RFC 5470]. This clause defines the operation modes for generic flow aggregate information exchange based on the distributed models such as specified in [b-ITU-T Y.2173]. A network participating in flow aggregate information exchange functions is required to support the following modes of operations.

7.2.1 Hub mode

In Hub mode, it is assumed that a central entity exists for cooperation among networks in the end-to-end path. The central entity governs all the transactions (information exchanges) among networks. Note that this does not imply there should only be one central entity over Internet.

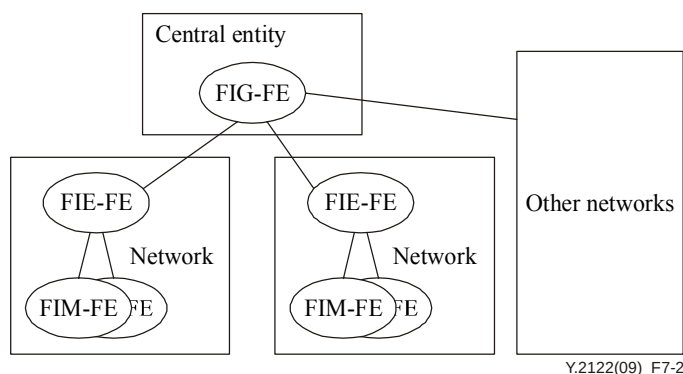


Figure 7-2 – Hub mode operation

7.2.2 Star mode

In Star mode, the central entity described in Hub mode is distributed to edge networks, usually in the ingress edge networks (by an edge network it is meant a network that directly interfaces to an access network or CPN). The central entity communicates with downstream or upstream networks. One of the most obvious advantages of the Star mode over the hub mode is its scalability.