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Next Generation Networks – Security

Performance models and metrics for deep packet inspection

Recommendation ITU-T Y.2773



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Recommendation ITU-T Y.2773

Performance models and metrics for deep packet inspection

Summary

Recommendation ITU-T Y.2773 specifies the performance models and metrics for deep packet inspection in evolving networks. This Recommendation specifies deep packet inspection- (DPI-) specific performance models and measure points of DPI performance metrics, and also specifies categorization methods of DPI performance metrics. Furthermore, a DPI performance description template and DPI specific performance metrics are specified.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
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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.

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Recommendation ITU-T Y.2773

Performance models and metrics for deep packet inspection

1 Scope

This Recommendation specifies performance models and metrics for deep packet inspection (DPI) in evolving networks.

The scope of this Recommendation is limited to:

- DPI-specific performance models
- DPI-specific performance metrics.

The specification of new metrics ensures specification quality as required by performance-related Recommendations.

Implementers and users of this Recommendation shall comply with all applicable national and regional laws, regulations and policies. The mechanism described in this Recommendation may not be applicable to international correspondence in order to ensure the secrecy and sovereign national legal requirements placed upon telecommunications providers, as well as the ITU Constitution and Convention.

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 I.350] Recommendation ITU-T I.350 (1993), *General aspects of quality of service and network performance in digital networks, including ISDNs*.
- [ITU-T Y.2770] Recommendation ITU-T Y.2770 (2012), *Requirements for deep packet inspection in next generation networks*.
- [ITU-T Y.2771] Recommendation ITU-T Y.2771 (2014), *Framework for deep packet inspection*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 application [ITU-T Y.2770]: A designation of one of the following:

- an application protocol type (e.g., IP application protocols ITU-T H.264 video, or session initiation protocol (SIP));
- a served user instance (e.g., VoIP, VoLTE, VoIMS, VoNGN, and VoP2P) of an application type, e.g., "voice-over-Packet application";
- a "provider specific application" for voice-over-Packet, (e.g., 3GPP provider VoIP, Skype VoIP);

- an application embedded in another application (e.g., application content in a body element of a SIP or an HTTP message).

An application is identifiable by a particular identifier (e.g., via a bit field, pattern, signature, or regular expression as "application level conditions", see also clause 3.2.2 of [ITU-T Y.2770]), as a common characteristic of all the above listed levels of applications.

3.1.2 deep packet inspection (DPI) [ITU-T Y.2770]: Analysis, according to the layered protocol architecture OSI-BRM [b-ITU-T X.200], of:

- payload and/or packet properties (see list of potential properties in clause 3.2.11 of [ITU-T Y.2770]) deeper than protocol layer 2, 3 or 4 (L2/L3/L4) header information, and
- other packet properties

in order to identify the application unambiguously.

NOTE – The output of the DPI function, along with some extra information such as the flow information, is typically used in subsequent functions such as reporting or actions on the packet.

3.1.3 DPI engine [ITU-T Y.2770]: A subcomponent and central part of the DPI functional entity which performs all packet path processing functions (e.g., packet identification and other packet processing functions in Figure 6-1 of [ITU-T Y.2770]).

3.1.4 DPI node [ITU-T Y.2771]: A network element or device that realizes the DPI related functions. It is thus a generic term used to designate the realization of a DPI physical entity.

NOTE – Functional perspective: the DPI node function (DPI-NF) comprises the DPI policy enforcement function (DPI-PEF) and the (optional) local policy decision function (L-PDF), hence, the DPI-NF is functionally equal to the DPI functional entity.

3.1.5 DPI policy condition (also known as DPI signature) [ITU-T Y.2770]: A representation of the necessary state and/or prerequisites that identify an application and define whether a policy rule's actions should be performed. The set of DPI policy conditions associated with a policy rule specifies when the policy rule is applicable (see also [b-IETF RFC 3198]).

A DPI policy condition must contain application level conditions and may contain other options such as state conditions and/or flow level conditions:

- 1) State condition (optional):
 - a) network grade of service conditions (e.g., experienced congestion in packet paths); or
 - b) network element status (e.g., local overload condition of the DPI-FE).
- 2) Flow descriptor/Flow level conditions (optional):
 - a) packet content (header fields);
 - b) characteristics of a packet (e.g., number# of MPLS labels);
 - c) packet treatment (e.g., output interface of the DPI-FE).
- 3) Application descriptor/application level conditions:
 - a) packet content (application header fields and application payload).

NOTE – The condition relates to the "simple condition" in the formal descriptions of flow level conditions and application level conditions.

3.1.6 flow descriptor (also known as flow level conditions) [ITU-T Y.2770]: A set of rule conditions that is used to identify a specific type of flow (according to clause 3.1.3 of [ITU-T Y.2770]) from inspected traffic.

NOTE 1 – This definition of flow descriptor extends the definition in [b-ITU-T Y.2121] with additional elements as described in clause 3 of [ITU-T Y.2770].

NOTE 2 – For further normative discussion of the flow descriptor as used in [ITU-T Y.2770], see Annex A of [ITU-T Y.2770].

3.2 Terms defined in this Recommendation

None.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

3GPP	Third Generation Partnership Project
DNNF	Determining Next Node Function
DPI	Deep Packet Inspection
DPI-AcIF	DPI Action Information Function
DPI-AnF	DPI Analyser Function
DPI-FE	DPI Functional Entity
DPI-NF	DPI Node Function
DPI PD-FE	DPI Policy Decision Functional Entity
DPI-PEF	DPI Policy Enforcement Function
DPI-PIB	DPI Policy Information Base
DPI-ScF	DPI Scan Function
FIB	Forwarding Information Base
HTTP	Hypertext Transfer Protocol
IP	Internet Protocol
KPI	Key Performance Indicator
L-PDF	Local Policy Decision Function
MP	Measurement Point
MPLS	Multi-Protocol Label Switching
NMS	Network Management System
OSI-BRM	Open System Interconnection-Basic Reference Model
PIB	Policy Information Base
QoE	Quality of Experience
QoS	Quality of Service
SD-PDF	Session-Dependent Policy Decision Function
SIP	Session Initiation Protocol
SI-PDF	Session-Independent Policy Decision Function
TCP	Transmission Control Protocol
VoIMS	Voice over Integrated Media System
VoIP	Voice over Internet Protocol
VoLTE	Voice over Long Term Evolution
VoNGN	Voice over Next Generation Network
VoP2P	Voice over Peer to Peer

Table 4-1 – Mathematical symbols for DPI metrics

ε_{DPI}	(DPI) error rate	-
$\varepsilon_{\text{f-n}}$	(DPI) false-negative error rate	-
$\varepsilon_{\text{f-p}}$	(DPI) false-positive error rate	-
$\phi_{\text{P,In}}$	(DPI) processing rate of incoming packets	$[\text{s}^{-1}]$
$\phi_{\text{P,Out}}$	(DPI) packet rate in outgoing direction	$[\text{s}^{-1}]$
$\phi_{\text{P,Node,Out}}$	packet node throughput	-
$\phi_{\text{P,Identified}}$	rate of successfully identified packets	-
$P_{\text{Hit,BloomFilter}}$	estimated information certainty of probability	-
N_{db}	the number of DPI policy rules	-
S_{p}	the packet size	-
N_{DPIeng}	the number of DPI engines	-
τ_{TD}	node-internal transfer delay (of DPI node)	$[\text{ns}]$
D_{dpi}	DPI inspection depth	-
$\lambda_{\text{TCP,con,est}}$	TCP successful connection establishment rate	-
$N_{\text{TCP,concur}}$	Number of concurrent TCP connections	-
$\lambda_{\text{TCP,succ}}$	TCP connection establishment success rate	-
$\lambda_{\text{HTTP,trf,rate}}$	HTTP application transaction identification rate	-
N_{Tags}	Number of supported application tags	-
T_{rule}	Rule take effect time	-
T_{failover}	Failover time	-
T_{deploy}	DPI node deployment time	-
T_{syn}	Redundancy data synchronization time	-
T_{NMS}	NMS response time	
N_{NMS}	Concurrent NMS number supported by a DPI entity	-
$N_{\text{rulewrite}}$	NMS DPI rule number written per second	-
$T_{\text{agereport}}$	NMS DPI rule age report time	-
E_{bit}	Energy per bit	-
E_{packet}	Energy per packet	-

5 Conventions

None.

6 DPI performance model and categorizations

6.1 DPI performance model

The DPI performance metrics are specified on the basis of DPI functions and events that may be observed at measurement points (MPs). An example of a DPI performance model is illustrated in Figure 6-1.

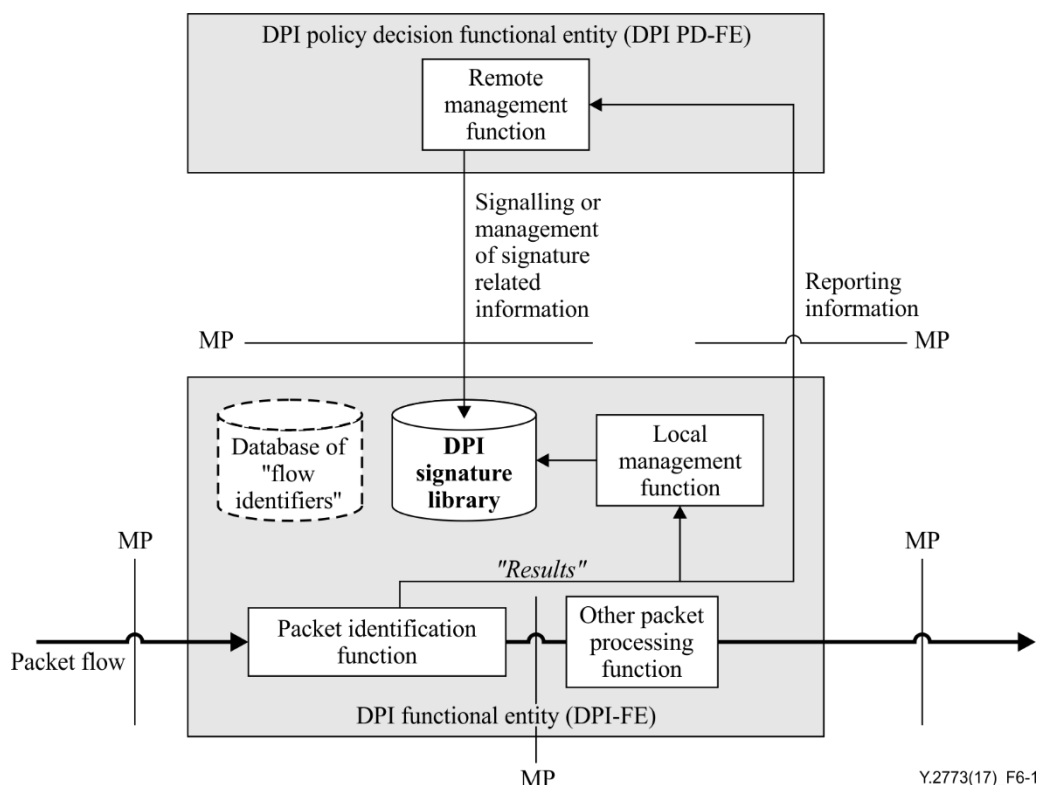


Figure 6-1 – An example of a DPI performance model

6.2 Categorization based on the type of performance metric

For comparability and completeness, DPI performance is considered in the context of the $m \times n$ (m and n are integers greater than 1) performance matrix specified in [ITU-T I.350]. Three DPI functions are identified in the matrix: application identification, policy information base (PIB) maintenance and system status. Each function is considered with respect to four general performance concerns: speed, accuracy, dependability and resources.

Table 6-1 – Categorization of DPI performance metrics

DPI function	Performance concern			
	Speed	Accuracy	Dependability	Resources
Application identification	×	×	×	×
PIB maintenance	×	×	×	×
System status	×	×	×	×

6.3 Categorization based on functional planes and DPI node

A description of performance metrics is logically clear if the metrics are classified based on functional planes and entities. Specifications of functional planes and entities can be seen in Figure 7-6 and Figure 7-7 of [ITU-T Y.2771], which are used as a basis for the specification of the classification method in this Recommendation (see Figure 6-2).