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## **New Terminology and Clarifications for Diffserv**

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### Abstract

This memo captures Diffserv working group agreements concerning new and improved terminology, and also provides minor technical clarifications. It is intended to update [RFC 2474](#), [RFC 2475](#) and [RFC 2597](#). When RFCs 2474 and 2597 advance on the standards track, and [RFC 2475](#) is updated, it is intended that the revisions in this memo will be incorporated, and that this memo will be obsoleted by the new RFCs.

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## **1. Introduction**

As the Diffserv work has evolved, there have been several cases where terminology has needed to be created or the definitions in Diffserv standards track RFCs have needed to be refined. Some minor technical

clarifications were also found to be needed. This memo was created to capture group agreements, rather than attempting to revise the base RFCs and recycle them at proposed standard. It updates in part [RFC 2474](#), [RFC 2475](#) and [RFC 2597](#). [RFC 2598](#) has been updated by RFC XXXX ([draft-ietf-diffserv-rfc2598bis](#)), and clarifications agreed by the group were incorporated in that update.

## **2. Terminology Related to Service Level Agreements (SLAs)**

The Diffserv Architecture [2] uses the term "Service Level Agreement" (SLA) to describe the "service contract... that specifies the forwarding service a customer should receive". The SLA may include traffic conditioning rules which (at least in part) constitute a Traffic Conditioning Agreement (TCA). A TCA is "an agreement specifying classifier rules and any corresponding traffic profiles and metering, marking, discarding and/or shaping rules which are to apply...."

As work progressed in Diffserv (as well as in the Policy WG [6]), it came to be believed that the notion of an "agreement" implied considerations that were of a pricing, contractual or other business nature, as well as those that were strictly technical. There also could be other technical considerations in such an agreement (e.g., service availability) which are not addressed by Diffserv. It was therefore agreed that the notions of SLAs and TCAs would be taken to represent the broader context, and that new terminology would be used to describe those elements of service and traffic conditioning that are addressed by Diffserv.

- A Service Level Specification (SLS) is a set of parameters and their values which together define the service offered to a traffic stream by a DS domain.
- A Traffic Conditioning Specification (TCS) is a set of parameters and their values which together specify a set of classifier rules and a traffic profile. A TCS is an integral element of an SLS.

Note that the definition of "Traffic stream" is unchanged from [RFC 2475](#). A traffic stream can be an individual microflow or a group of microflows (i.e., in a source or destination DS domain) or it can be a BA. Thus, an SLS may apply in the source or destination DS domain to a single microflow or group of microflows, as well as to a BA in any DS domain.

Also note that the definition of a "Service Provisioning Policy" is unchanged from [RFC 2475](#). [RFC 2475](#) defines a "Service Provisioning Policy" as "a policy which defines how traffic conditioners are configured on DS boundary nodes and how traffic streams are mapped to DS behavior aggregates to achieve a range of services." According to one definition given in [RFC 3198](#) [6], a policy is "...a set of rules to administer, manage, and control access to network resources".

Therefore, the relationship between an SLS and a service provisioning policy is that the latter is, in part, the set of rules that express the parameters and range of values that may be in the former.

Further note that this definition is more restrictive than that in [RFC 3198](#).

### 3. Usage of PHB Group

[RFC 2475](#) defines a Per-hop behavior (PHB) group to be:

"a set of one or more PHBs that can only be meaningfully specified and implemented simultaneously, due to a common constraint applying to all PHBs in the set such as a queue servicing or queue management policy. A PHB group provides a service building block that allows a set of related forwarding behaviors to be specified together (e.g., four dropping priorities). A single PHB is a special case of a PHB group."

One standards track PHB Group is defined in [RFC 2597](#) [3], "Assured Forwarding PHB Group". Assured Forwarding (AF) is a type of forwarding behavior with some assigned level of queuing resources and three drop precedences. An AF PHB Group consists of three PHBs, and uses three Diffserv Codepoints (DSCPs).

[RFC 2597](#) defines twelve DSCPs, corresponding to four independent AF classes. The AF classes are referred to as AF1x, AF2x, AF3x, and AF4x (where 'x' is 1, 2, or 3 to represent drop precedence). Each AF class is one instance of an AF PHB Group.

There has been confusion expressed that [RFC 2597](#) refers to all four AF classes with their three drop precedences as being part of a single PHB Group. However, since each AF class operates entirely independently of the others, (and thus there is no common constraint among AF classes as there is among drop precedences within an AF class) this usage is inconsistent with [RFC 2475](#). The inconsistency exists for historical reasons and will be removed in future revisions of the AF specification. It should now be understood that AF is a type of PHB group, and each AF class is an instance of the AF type.

Authors of new PHB specifications should be careful to adhere to the [RFC 2475 definition of PHB Group](#). [RFC 2475](#) does not prohibit new PHB specifications from assigning enough DSCPs to represent multiple independent instances of their PHB Group. However, such a set of DSCPs must not be referred to as a single PHB Group.

### 4. Definition of the DS Field

Diffserv uses six bits of the IPV4 or IPV6 header to convey the Diffserv Codepoint (DSCP), which selects a PHB. [RFC 2474](#) attempts to rename the TOS octet of the IPV4 header, and Traffic Class octet of the IPV6 header, respectively, to the DS field. The DS Field has a six bit

Diffserv Codepoint and two "currently unused bits".

It has been pointed out that this leads to inconsistencies and ambiguities. In particular, the "Currently Unused" (CU) bits of the DS Field have not been assigned to Diffserv, and have been assigned an experimental use for an explicit congestion notification scheme [4]. In the current text, a DSCP is, depending on context, either an encoding which selects a PHB or a sub-field in the DS field which contains that encoding.

The present text is also inconsistent with [BCP0037](#), IANA Allocation Guidelines for Values in the Internet Protocol and Related Headers [5]. The IPV4 Type-of-Service (TOS) field and the IPV6 traffic class field are superseded by the 6 bit DS field and a 2 bit CU field. The IANA allocates values in the DS field following the IANA considerations section in [RFC 2474](#). Experimental uses of the CU field are assigned after IESG approval processes. Permanent values in the CU field are allocated following a Standards Action process.

The consensus of the DiffServ working group is that [5] correctly restates the structure of the former TOS and traffic class fields.

Therefore, for use in future drafts, including the next update to RFC 2474, the following definitions should apply:

- the Differentiated Services Field (DSField) is the six most significant bits of the (former) IPV4 TOS octet or the (former) IPV6 Traffic Class octet.
- the Differentiated Services Codepoint (DSCP) is a value which is encoded in the DS field, and which each DS Node MUST use to select the PHB which is to be experienced by each packet it forwards.

The two least significant bits of the IPV4 TOS octet and the IPV6 Traffic Class octet are not presently used by Diffserv.

The update should also reference [BCP0037](#).

## **5. Ordered Aggregates and PHB Scheduling Classes**

Work on Diffserv support by MPLS Label Switched Routers (LSRs) led to the realization that a concept was needed in Diffserv to capture the notion of a set of BAs with a common ordering constraint. This presently applies to AF behavior aggregates, since a DS node may not reorder packets of the same microflow if they belong to the same AF class. This would, for example, prevent an MPLS LSR which was also a DS node from discriminating between packets of an AF Behavior Aggregate (BA) based on drop precedence and forwarding packets of the same AF class but different drop precedence over different LSPs. The following new terms are defined.

PHB Scheduling Class: A PHB group for which a common constraint is that ordering of at least those packets belonging to the same

microflow must be preserved.

Ordered Aggregate (OA): A set of Behavior Aggregates that share an ordering constraint. The set of PHBs that are applied to this set of Behavior Aggregates constitutes a PHB scheduling class.

## 6. Unknown/Improperly Mapped DSCPs

Several implementors have pointed out ambiguities or conflicts in the Diffserv RFCs concerning behavior when a DS-node receives a packet with a DSCP which it does not understand.

[RFC 2475](#) states:

"Ingress nodes must condition all other inbound traffic to ensure that the DS codepoints are acceptable; packets found to have unacceptable codepoints must either be discarded or must have their DS codepoints modified to acceptable values before being forwarded. For example, an ingress node receiving traffic from a domain with which no enhanced service agreement exists may reset the DS codepoint to the Default PHB codepoint [DSFIELD]."

On the other hand, [RFC 2474](#) states:

"Packets received with an unrecognized codepoint SHOULD be forwarded as if they were marked for the Default behavior (see Sec. 4), and their codepoints should not be changed."

The intent in [RFC 2474](#) principally concerned DS-interior nodes. However, this behavior could also be performed in DS-ingress nodes AFTER the traffic conditioning required by [RFC 2475](#) (in which case, an unrecognized DSCP would occur only in the case of misconfiguration). If a packet arrives with a DSCP that hadn't been explicitly mapped to a particular PHB, it should be treated the same way as a packet marked for Default. The alternatives were to assign it another PHB, which could result in misallocation of provisioned resources, or to drop it. Those are the only alternatives within the framework of 2474. Neither alternative was considered desirable. There has been discussion of a PHB which receives worse service than the default; this might be a better alternative. Hence the imperative was "SHOULD" rather than "SHALL".

The intent in [RFC 2475](#) clearly concerns DS-ingress nodes, or to be more precise, the ingress traffic conditioning function. This is another context where the "SHOULD" in [RFC 2474](#) gives the flexibility to do what the group intended. Such tortured readings are not desirable.

Therefore, the statement in [RFC 2474](#) will be clarified to indicate that it is not intended to apply at the ingress traffic conditioning function at a DS-ingress node, and cross reference [RFC 2475](#) for that case.

There was a similar issue, which manifested itself with the first incarnation of Expedited Forwarding (EF). [RFC 2598](#) states:

To protect itself against denial of service attacks, the edge of a DS domain MUST strictly police all EF marked packets to a rate negotiated with the adjacent upstream domain. (This rate must be  $\leq$  the EF PHB configured rate.) Packets in excess of the negotiated rate MUST be dropped. If two adjacent domains have not negotiated an EF rate, the downstream domain MUST use 0 as the rate (i.e., drop all EF marked packets).

The problem arose in the case of misconfiguration or routing problems. An egress DS-node at the edge of one DS-domain forwards packets to an ingress DS-node at the edge of another DS domain. These packets are marked with a DSCP that the egress node understands to map to EF, but which the ingress node does not recognize. The statement in [RFC 2475](#) would appear to apply to this case. RFC XXXX [7] ([draft-ietf-diffserv-rfc2598bis](#)) clarifies this point.

## **7. No Backward Compatibility With [RFC 1349](#)**

At least one implementor has expressed confusion about the relationship of the DSField, as defined in [RFC 2474](#), to the use of the TOS bits, as described in [RFC 1349](#). The [RFC 1349](#) usage was intended to interact with OSPF extensions in [RFC 1247](#), which were never widely deployed. The processing of the TOS bits is described as a requirement in [RFC 1812](#) [8], [RFC 1122](#) [9] and [RFC 1123](#) [10]. [RFC 2474](#) states:

"No attempt is made to maintain backwards compatibility with the "DTR" or TOS bits of the IPv4 TOS octet, as defined in [[RFC791](#)].",

In addition, [RFC 2474](#) obsoletes [RFC 1349](#) by IESG action. For completeness, when [RFC 2474](#) is updated, the sentence should read:

"No attempt is made to maintain backwards compatibility with the "DTR/MBZ" or TOS bits of the IPv4 TOS octet, as defined in [[RFC791](#)] and [[RFC1349](#)]. This implies that TOS bit processing as described in [[RFC1812](#)], [[RFC1122](#)] and [[RFC1123](#)] is also obsoleted by this memo. Also see [[RFC2780](#)]."

## **8. IANA Considerations**

IANA has requested clarification of a point in [RFC 2474](#), concerning registration of experimental/local use DSCPs. When [RFC 2474](#) is revised, the following should be added to [Section 6](#):

IANA is requested to maintain a registry of RECOMMENDED DSCP values assigned by standards action. EXP/LU values are not to be registered.

## **9. Summary of Pending Changes**

The following standards track and informational RFCs are expected to be updated to reflect the agreements captured in this memo. It is intended that these updates occur when each standards track RFC progresses to Draft (or if some issue arises that forces recycling at Proposed). [RFC 2475](#) is expected to be updated at about the same time as [RFC 2474](#). Those updates will also obsolete this memo.

[RFC 2474](#): revise definition of DS field. Clarify that the suggested default forwarding in the event of an unrecognized DSCP is not intended to apply to ingress conditioning in DS-ingress nodes. Clarify effects on [RFC1349](#) and [RFC1812](#). Clarify that only RECOMMENDED DSCPs assigned by standards action are to be registered by IANA.

[RFC 2475](#): revise definition of DS field. Add SLS and TCS definitions. Update body of document to use SLS and TCS appropriately. Add definitions of PHB scheduling class and ordered aggregate.

[RFC 2497](#): revise to reflect understanding that AF classes are instances of the AF PHB group, and are not collectively a PHB group.

In addition, RFCXXXX [7] ([draft-ietf-diffserv-rfc2598bis](#)) put a reference to [RFC 2475](#) in the security considerations section to cover the case of a DS egress node receiving an unrecognized DSCP which maps to EF in the DS ingress node.

## **[10. Security Considerations](#)**

Security considerations are addressed in [RFC 2475](#).

## **Acknowledgements**

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## **Normative References**

- [1] Nichols, Blake, Baker, Black, "Defintion of the Differentiated Services Field (DS Field) in the IPv4 and IPv6 Headers" [RFC 2474](#), December 1998.

- [2] Blake, Black, Carlson, Davies, Wang and Weiss "An Architecture for Differentiated Services", [RFC 2475](#), December 1998.
- [3] Heinanen, Baker, Weiss, Wrocklawski, "Assured Forwarding PHB Group", [RFC 2597](#)
- [4] Ramakrishnan and Floyd, "A proposal to add Explicit Congestion Notification (ECN)" to IP, [RFC 2481](#), January 1999
- [5] Bradner and Paxson, "IANA Allocation Guidelines for Values in the Internet Protocol and Related Headers", [BCP0037](#)/RFC2780, March 2000
- [6] Westerinen et al, "Terminology for Policy Based Management", [RFC 3198](#)
- [7] Davie et al, "An Expedited Forwarding PHB", RFC XXXX (ex-draft-ietf-rfc2598bis-02.txt)
- [8] Baker, "Requirements for IP Version 4 Routers", [RFC 1812](#)
- [9] Braden, "Requirements for Internet Hosts -- Communications Layers", [RFC1122](#)/STD003
- [10] Braden, "Requirements for Internet Hosts -- Application and Support", [RFC1123](#)/STD003

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