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August 12, 2026

Draft Standard for
Local and Metropolitan Area Networks—

Backward Notification

Unapproved draft, prepared by the
Time Sensitive Networking Task Group of IEEE 802.1

Developed by the
LAN/MAN Standards Committee
of the
IEEE Computer Society

DRAFT STATUS:

Individual contribution draft, issued for TG discussion.

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PAR (Project Authorization Request) and CSD

Extracts from the PAR~~, as approved by IEEE NesCom 26th September 2026~~:
https://www.ieee802.org/1/files/public/docs2026/ej-PAR-0726-v01.pdf
<< Editor's Note: This link needs to be updated once the PAR is approved by IEEE NesCom. >>

and the CSD (Criteria for Standards Development):
https://www.ieee802.org/1/files/public/docs2026/ej-CSD-0726-v01.pdf

PAR Scope:
This standard specifies procedures, protocols, and managed objects for Backward Notification (BN) to signal data center network conditions toward the source end station. This standard supports Medium Access Control (MAC) bridges, Customer Virtual Local Area Network (C-VLAN) bridges and Service Virtual Local Area Network (S-VLAN) bridges and end stations in data center networks. The BN mechanism conveys information for congestion management, path rebalancing, and failure recovery. This standard specifies how BNs are triggered and constructed, and a service interface for exposing the information to entities above the data link layer. This standard supports managed objects and a YANG data model for backward notification.

PAR Need for the Project:
Backward notification enables timely and informed decisions for congestion management, path re-balancing, and failure recovery, and is particularly valuable for links with long round trip time or when the forward path is unavailable. Backward notification complements existing congestion management techniques and improves the overall robustness and efficiency of data center networks. While Priority-based Flow Control provides hop-by-hop flow control, there remains a need for a standardized multihop backward notification mechanism by which network elements can signal network conditions toward source end stations and expose this information to entities above the data link layer.

CSD Broad market potential:
The data center market continues to grow rapidly, driven by the scaling of the network for Artificial Intelligence (AI), Machine Learning (ML), and High-Performance Computing (HPC) workloads. As these networks scale in size they often include links with long round trip time. The workloads and many new applications place high transient loads on data center networks which demand fast responding congestion management techniques to prevent packet loss. Beyond congestion, data center networks also benefit from timely multi-hop backward signaling of other network conditions to enable faster recovery and more efficient resource utilization (e.g., path load balancing). Priority-based Flow Control (PFC) as well as higher-layer end-to-end congestion control mechanisms are currently used in data center environments. Backward Notification (BN) improves efficiency by enabling bridges at the point of network events, such as congestion, to generate rapid, structured signals and transmit them toward the source end station. These signals convey congestion indications, network state information, and packet-related information to enable timely source-side responses including sender rate adaptation, load balancing decisions, and fast retransmission needed by higher layer entities because of packet loss.

Most data center providers are using Remote Direct Memory Access (RDMA) over Converged Ethernet version2 (RoCEv2) and other proprietary Ethernet-based solutions in addition to new high-performance applications. These environments require lossless or very low loss operation. RoCEv2 and other high-performance applications are used by large enterprises and financial institutions, in addition to high-performance computing and AI environments. Further there is strong interest in accessing new high-speed solid-state data storage technologies over Ethernet networks using Non-Volatile Memory express (NVMe) over Fabrics (NVMe-oF). The rapid scaling of AI training and inference infrastructure has further amplified these requirements. Multiple networking vendors have developed proprietary implementations of backward notification mechanisms in data center networks, demonstrating broad industry recognition of the need for a solution. Data center operators have expressed strong interest in a standardized solution to facilitate interoperability and avoid fragmentation across proprietary implementations. Ongoing standardization efforts in Ultra Ethernet Consortium (UEC) are specifying a programmable congestion management (PCM) framework that is an applicable consumer of backward notifications.

CSD Distinct Identity:

There are no other IEEE 802 standards or projects that specify a mechanism for conveying backward notifications of one or more network conditions (e.g., congestion status, packet loss, link failure) and exposing those notifications to entities above the data link layer. There are clauses in IEEE Std 802.1Q with similar scopes but are substantially different from BN.

IEEE Std 802.1Q Clause 36 specifies PFC, a hop-by-hop, on-off pause mechanism. By contrast, BN operates multi-hop, carries extensible information content, and specifies a service interface to deliver backward notifications to higher layer entities.

IEEE Std 802.1Q Clause 30, 31, 32, and 33 specify a congestion notification mechanism (Quantized Congestion Notification, QCN) in which the response action at the sender is prescribed as a rate limiter, and the notification message is limited to the data link layer and a single bridge domain. By contrast, BN delivers notifications to higher layer entities that can react according to their needs. BN is not limited to a single bridge domain.

CSD Technical Feasibility:
Techniques, similar to the proposed project have been implemented in a proprietary fashion by multiple vendors. Additionally, the mechanisms for generating a specific type of backward notification have been demonstrated by QCN implementations. The proposed project applies to networks of limited bandwidth-delay product and where both bridges and end stations are under the control of a single administration. This ensures that control loops remain short and that end-stations can be trusted to respond appropriately to backward notifications. Backward Notification provides information that is used by higher-layer congestion control mechanisms. PFC and higher-layer congestion control algorithms are broadly implemented in hardware at acceptable cost.

The proposed project specifies backward congestion signaling which has extensive simulation and analysis over the course of 30 years. Recent publications have also shown feasibility via modeling and simulations specifically oriented toward AI and HPC data center environments. Furthermore, multiple networking vendors have independently implemented proprietary backward signaling mechanisms in production data center networks, demonstrating the practical viability of the approach.

CSD Economic Feasibility:

The proposed standard retains existing cost characteristics of bridges including simplicity of queue structures and will not require maintenance of additional queues beyond the existing per traffic class (priority) queues. Standard and proprietary techniques (e.g., PFC and higher-layer congestion control algorithms) are broadly implemented in hardware and have similar cost factors.

The proposed project does not change the cost characteristics of bridges and end stations.

Installation costs of bridges and end stations within the data center are not expected to be significantly affected; any increase in network costs is expected to be more than offset by a reduction in the number of separate networks required. There are no incremental installation costs relative to existing mechanisms that may be used by the proposed standard.

There are no incremental operational costs relative to existing mechanisms that may be used by the proposed standard.

Introduction to the current draft

This introduction is not part of the draft, and will be revised for SA ballot. A set of cover pages will be retained for use during SA ballot.

D0.0
D0.0 is an individual draft contribution.

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<<Some statements>>

Abstract: This standard specifies procedures, protocols, and managed objects for Backward Notification (BN) to signal data center network conditions toward the source end station.

Keywords: Bridged Local Area Networks, local area networks (LANs), MAC Bridges, data center networks, Virtual Bridged Local Area Networks (virtual LANs), Data Center Bridging (DCB), Backward Notification (BN).

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1. Overview

1.1 Scope

This standard specifies procedures, protocols, and managed objects for Backward Notification (BN) to signal data center network conditions toward the source end station. This standard supports Medium Access Control (MAC) bridges, Customer Virtual Local Area Network (C-VLAN) bridges and Service Virtual Local Area Network (S-VLAN) bridges and end stations in data center networks. The BN mechanism conveys information for congestion management, path rebalancing, and failure recovery. This standard specifies how BNs are triggered and constructed, and a service interface for exposing the information to entities above the data link layer. This standard supports managed objects and a YANG data model for backward notification.

1.2 Introduction

Backward notification enables timely and informed decisions for congestion management, path re-balancing, and failure recovery, and is particularly valuable for links with long round trip time or when the forward path is unavailable. Backward notification complements existing congestion management techniques and improves the overall robustness and efficiency of data center networks. While Priority-based Flow Control provides hop-by-hop flow control, there remains a need for a standardized multi-hop backward notification mechanism by which network elements can signal network conditions toward source end stations and expose this information to entities above the data link layer.

1.3 Reference conventions

<<Editor's Note – TBD. >>

2. Normative references

The following referenced documents are indispensable for the application of this document (i.e., they must be understood and used, so each referenced document is cited in the text and its relationship to this document is explained). For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments or corrigenda) applies.

<<Editor's Note – More normative references are TBD. >>

3. Definitions

<<Editor's Note – More definitions are TBD. >>

For the purposes of this document, the following terms and definitions apply. The IEEE Standards Dictionary Online should be consulted for terms not defined in this clause.

This standard makes use of the following term defined in IEEE Std 802:

- end station
- frame
- station

This standard makes use of the following terms defined in IEEE Std 802.1Q:

- Bridge
- Bridge Port
- Bridged Network

The following terms are specific to this standard:

Backward Notification: A mechanism that signals data center network conditions toward the source end station.

4. Abbreviations and acronyms

The following abbreviations and acronyms are used in this standard:

BN	Backward Notification
BNM	Backward Notification Message

<<Editor's Note – More abbreviations and acronyms are TBD. >>

5. Conformance

This clause specifies mandatory and optional capabilities provided by conformant implementations of this standard.

<< Editor's Note – More text for this normative section. >>

5.1 Requirements terminology

For consistency with existing IEEE and IEEE 802.1 standards, requirements are expressed using the following terminology:

a) **Shall** is used for mandatory requirements.
b) **May** is used to describe implementation or administrative choices ("may" means "is permitted to," and hence, "may" and "may not" mean precisely the same thing).
c) **Should** is used for recommended choices (the behaviors described by "should" and "should not" are both permissible but not equally desirable choices).

Protocol Implementation Conformance Statements (PICS) reflect the occurrences of the words "shall," "may," and "should" within the standard.

The standard avoids needless repetition and apparent duplication of its formal requirements by using **is**, **is not**, **are**, and **are not** for definitions and the logical consequences of conformant behavior. Behavior that is permitted but is neither always required nor directly controlled by an implementer or administrator, or whose conformance requirement is detailed elsewhere, is described by **can**. Behavior that never occurs in a conformant implementation or system of conformant implementations is described by **cannot**. The word **allow** is used as a replacement for the phrase "Support the ability for," and the word **capability** means "can be configured to."

5.2 Protocol Conformance Statement (PCS)

A claim of conformance to this standard attests to the implementation of a system or system component specified in this and referenced standards.

The supplier of an implementation that is claimed to conform to this standard shall provide the information necessary to identify both the supplier and the implementation, and shall complete a copy of the relevant PCS proforma provided in this standard together with the Protocol Implementation Conformance Statements (PICS) for the referenced standards, as identified in the PCS.

5.3 Conformant systems, components, and functionality

<< Editor's Note – TBD >>

5.4 XXX requirements

<< Editor's Note – TBD >>

6. Architecture and Principles

<< Editor's Note: This section includes the following introduction material:

- BN objectives and architecture

>>

Figure 6-1 – Backward Notification Model

Table 6-1 – XX

6.1 Condition identification

<< Editor's Note: This section includes the following introduction material:

- Conditions include, but are not limited to, congestion status, packet loss, and link failure. However, this standard does not intend to specifically define condition identification, but rather recommends reusing existing methods.

>>

6.2 Backward Notification triggering

<< Editor's Note: This section includes the following introduction material:

- Determine whether the current condition meets the BN triggering requirements. For instance, this includes how to handle multiple co-occurring conditions, and how to control an appropriate transmission frequency (throttling).

>>

6.3 Backward Notification signaling

<< Editor's Note: This section includes the following introduction material:

- Principles for constructing BN Message (BNM).

>>

6.4 End station BNM processing

<< Editor's Note: This section includes the following introduction material:

- Processing upon receipt of a BNM, including information extraction and exposing to entities above the data link layer via a service interface.

>>

6.5 Bridge BNM processing

<< Editor's Note: This section includes the following introduction material:

- Forwarding and/or processing upon receipt of a BNM. A BN-capable bridge may optionally act as a proxy, e.g., processing upon receipt of a BNM, including information extraction and exposing to entities above the data link layer via a service interface.

>>

7. Service Interface

<< Editor's Note – This section needs to include service interface specifications for exposing the BN information to entities above the data link layer. >>

8. Backward Notification

<< Editor's Note –More text for this normative section. >>

8.1 Bridge component BN aware process

<< Editor's Note – This section needs to include:
- Bridge component BN reference diagram.
- Descriptions of functional entities and related procedures.

>>

8.2 End station component BN aware process

<< Editor's Note – This section needs to include:
- End station component BN reference diagram.
- Descriptions of functional entities and related procedures.

>>

8.3 Variables controlling operation

<< Editor's Note – Variables may be listed by levels:
- Per BN entity.
- Per BN point (bridge or end station).
- Per port.
- Per port per traffic class.
- *Per flow.

>>

8.4 BN procedures

<< Editor's Note – This section needs to include:
- Procedures, and associated state machines and variables that control the BN.
- The procedures:
  - Generating BNMs, and state machines.
  - Creating and Deleting entries in the BN Table.
  - Processing received BNMs.

>>

8.5 Encoding of the BNM PDU

<< Editor's Note – This section needs to include:
- Layered encapsulation of BNM PDU.
- BNM PDU format.

>>

9. Backward Notification (BN) Management

This subclause defines the following managed objects that allows administrative configuration of BN:

<< Editor's Note –More text for this normative section. >>

10. YANG data model for BN

YANG (IETF RFC 7950) is a data modeling language used to model configuration data and state data for remote network management protocols. YANG-based remote network management protocols include the Network Configuration Protocol (NETCONF) (IETF RFC 6241) and RESTCONF (IETF RFC 8040). Each remote network management protocol uses a specific encoding on the wire, such as XML or JSON. A YANG module specifies the organization and rules for the management data, and a mapping from YANG to the specific encoding enables the data to be understood correctly by both client and server.

This clause specifies the YANG data model for BN.

This clause:

<< Editor's Note –More text for this normative section. >>

Annex A (normative) PICS proforma—BN implementations

<< Editor's Note –More text for this normative section. >>

A.1 Introduction

The supplier of a protocol implementation that is claimed to conform to this standard shall complete the following Protocol Implementation Conformance Statement (PICS) proforma.

A completed PICS proforma is the PICS for the implementation in question. The PICS is a statement of which capabilities and options of the protocol have been implemented. The PICS can have a number of uses, including use

a) By the protocol implementer, as a checklist to reduce the risk of failure to conform to the standard through oversight.
b) By the supplier and acquirer—or potential acquirer—of the implementation, as a detailed indication of the capabilities of the implementation, stated relative to the common basis for understanding provided by the standard PICS proforma.
c) By the user—or potential user—of the implementation, as a basis for initially checking the possibility of interworking with another implementation (note that, while interworking can never be guaranteed, failure to interwork can often be predicted from incompatible PICSs).
d) By a protocol tester, as the basis for selecting appropriate tests against which to assess the claim for conformance of the implementation.

A.2 Abbreviations and special symbols

A.2.1 Status symbols

M	mandatory
O	optional
O.n	optional, but support of at least one of the group of options labeled by the same numeral n is required
X	prohibited
pred:	conditional-item symbol, including predicate identification: see A.3.4
¬	logical negation, applied to a conditional item's predicate

A.2.2 General abbreviations

N/A	not applicable
PICS	Protocol Implementation Conformance Statement

A.3 Instructions for completing the PICS proforma

A.3.1 General structure of the PICS proforma

The first part of the PICS proforma, implementation identification and protocol summary, is to be completed as indicated with the information necessary to identify fully both the supplier and the implementation.

The main part of the PICS proforma is a fixed-format questionnaire, divided into several subclauses, each containing a number of individual items. Answers to the questionnaire items are to be provided in the rightmost column, either by simply marking an answer to indicate a restricted choice (usually Yes or No) or by entering a value or a set or range of values. (Note that there are some items where two or more choices from a set of possible answers can apply; all relevant choices are to be marked.)

Each item is identified by an item reference in the first column. The second column contains the question to be answered; the third column records the status of the item—whether support is mandatory, optional, or conditional: see also A.3.4. The fourth column contains the reference or references to the material that specifies the item in the main body of this standard, and the fifth column provides the space for the answers.

A supplier may also provide (or be required to provide) further information, categorized as either Additional Information or Exception Information. When present, each kind of further information is to be provided in a further subclause of items labeled Ai or Xi, respectively, for cross-referencing purposes, where i is any unambiguous identification for the item (e.g., simply a numeral). There are no other restrictions on its format and presentation.

A completed PICS proforma, including any Additional Information and Exception Information, is the Protocol Implementation Conformation Statement for the implementation in question.

NOTE—Where an implementation is capable of being configured in more than one way, a single PICS may be able to describe all such configurations. However, the supplier has the choice of providing more than one PICS, each covering some subset of the implementation's configuration capabilities, in case that makes for easier and clearer presentation of the information.

A.3.2 Additional information

Items of Additional Information allow a supplier to provide further information intended to assist the interpretation of the PICS. It is not intended or expected that a large quantity will be supplied, and a PICS can be considered complete without any such information. Examples might be an outline of the ways in which a (single) implementation can be set up to operate in a variety of environments and configurations, or information about aspects of the implementation that are outside the scope of this standard but that have a bearing on the answers to some items.

References to items of Additional Information may be entered next to any answer in the questionnaire and may be included in items of Exception Information.

A.3.3 Exception information

It may occasionally happen that a supplier will wish to answer an item with mandatory status (after any conditions have been applied) in a way that conflicts with the indicated requirement. No preprinted answer will be found in the Support column for this item. Instead, the supplier shall write the missing answer into the Support column, together with an Xi reference to an item of Exception Information, and shall provide the appropriate rationale in the Exception item itself.

An implementation for which an Exception item is required in this way does not conform to this standard.

NOTE—A possible reason for the situation described previously is that a defect in this standard has been reported, a correction for which is expected to change the requirement not met by the implementation.

A.3.4 Conditional status

A.3.4.1 Conditional items

The PICS proforma contains a number of conditional items. These are items for which both the applicability of the item itself, and its status if it does apply—mandatory or optional—are dependent on whether certain other items are supported.

Where a group of items is subject to the same condition for applicability, a separate preliminary question about the condition appears at the head of the group, with an instruction to skip to a later point in the questionnaire if the "Not Applicable" answer is selected. Otherwise, individual conditional items are indicated by a conditional symbol in the Status column.

A conditional symbol is of the form "**pred**: S" where **pred** is a predicate as described in A.3.4.2 below, and S is a status symbol, M or O.

If the value of the predicate is true (see A.3.4.2), the conditional item is applicable, and its status is indicated by the status symbol following the predicate: The answer column is to be marked in the usual way. If the value of the predicate is false, the "Not Applicable" (N/A) answer is to be marked.

A.3.4.2 Predicates

A predicate is one of the following:

a) An item-reference for an item in the PICS proforma: The value of the predicate is true if the item is marked as supported and is false otherwise.
b) A predicate-name, for a predicate defined as a boolean expression constructed by combining item-references using the boolean operator OR: The value of the predicate is true if one or more of the items is marked as supported.
c) The logical negation symbol "¬" prefixed to an item-reference or predicate-name: The value of the predicate is true if the value of the predicate formed by omitting the "¬" symbol is false, and vice versa.

Each item whose reference is used in a predicate or predicate definition, or in a preliminary question for grouped conditional items, is indicated by an asterisk in the Item column.

A.4 PICS proforma—<BN implementations>

<< Editor's Note – TBD >>

Annex B (informative) BN usage guidelines and comparison with other mechanisms

<< Editor's Note – TBD >>

Annex C (informative) Bibliography

Bibliographical references are resources that provide additional or helpful material but do not need to be understood or used to implement this standard. Reference to these resources is made for informational use only.

<< Editor's Note – TBD >>

Annex Z (informative) Outstanding issues

<<Editor's Note: This annex documents issues that have yet to be resolved during the balloting process, along with their resolution status where appropriate. It will be removed prior to Sponsor ballot.>>