TSVWG
Internet Draft
Updates: 4727
Intended status: Standards Track
Expires: March 2026

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September 15, 2025

User Ports and Port Identifiers for Experiments
draft-ietf-tsvwg-usr-exp-14.txt

Abstract

This document defines user ports for experiments using transport protocols and the use of experiment identifiers to enable shared use of these ports. It updates RFC 4727 to recommend the use of these experimental identifiers for the system ports for experiments in the same manner.

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1. Introduction

Various network codepoints have been allocated for experimental use, including those for IPv4 [RFC791], IPv6 [RFC8200], ICMPv4 [RFC792], ICMPv6 [RFC4443], UDP [RFC768], and TCP [RFC9293]. These include transport protocol port numbers 1021 and 1022, using the service names "EXP1" and "EXP2", respectively [RFC4727]. Service names are case-insensitive but are shown in upper-case throughout this document to improve their visibility.

There has always been an expectation that experiments needing privileged (system) ports use these assignments and unprivileged ports use those from the dynamic range [RFC6335][RFC7605]. However, dynamic ports can be difficult to reserve in some systems or blocked from traversing some firewalls. As a consequence, there is a need for non-privileged, non-dynamic ports - i.e., user ports - for experiments. The mechanism described in this document is intended for such cases, notably where dynamic ports are insufficient and

where multiple uses of the experiment ports could interfere. This mechanism is not intended for production use, nor is it intended for experiments that can use dynamic ports or where concurrent use of experiment ports is not needed.

This document reserves user ports for experimentation and describes the use of 32-bit unsigned protocol experiment identifiers (PExIDs) to differentiate shared use of these ports for concurrent experiments, by prepending these PExIDs to the experimental protocol's transport data, typically in front of each separate message payload or byte stream.

This document also creates a PExID registry, in addition to the IANA service names and ports registry [SP-reg], to reduce the potential that uses of PExIDs on either user or system experiment ports interfere with each other if they are tested in the same environment or in the public Internet.

This document updates RFC 4727 by adding the following text to section 1:

> "[IANA-THIS-RFC] defines PExIDs, which are recommended for services that might not qualify for a port assignment per current requirements in [RFC6335] and [RFC7605] because they are either short-term or need more than one port number during development (see Sec. 7.1 of [RFC7605])."

2. Conventions used in this document

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in BCP 14 [RFC2119] [RFC8174] when, and only when, they appear in all capitals, as shown here.

3. User Ports for Experiments

The system, user, and dynamic port ranges vary in their properties [RFC7605]. System ports often include privileged access, sometimes known as 'root'. Dynamic ports are used as client ports when establishing associations with services on registered ports. User ports have neither privilege nor the risk of use by other connections. User ports are also more likely be allowed in firewall configurations, where system and dynamic ports can be difficult to 'un-block'.

This document registers USR-EXP1 and USR-EXP2 for user port experiments, using port numbers #UPORT1 and #UPORT2, with the details provided in Section 8. These ports are assigned from the user range, allowing non-privileged experiments without the need to use ports from the dynamic range. They are intended to complement the system ports already assigned for experimental use [RFC4727].

4. Protocol Experiment Identifiers (PExIDs)

This document also creates a registry for port experiment identifiers (PExIDs), in the same manner as the registry created for shared TCP option experiments [RFC6994][TCP-reg]. These PExIDs are intended for services that typically do not qualify for a port assignment per current requirements in [RFC6335] and [RFC7605] because they are either short-term or need more than one port number during development (see Sec. 7.1 of [RFC7605]). Such is the case for student projects that operate over the public Internet and/or across firewalls. Additionally, although protocol designers could select an arbitrary PExID and hope no other concurrent experiment uses it too, PExIDs are obtained as first-come, first-served with no additional requirements, so registration is both easy and encouraged.

The PExID approach is inspired by the ExID method for sharing experimental option codepoints, originally developed for TCP [RFC6994] and later applied to UDP [TH25]. Unlike ExIDs, PExIDs are used in the data path and can be used by applications with no OS modification.

Experimenters SHOULD register PExIDs with IANA and include them at the beginning of their transport data, i.e., at the front of each separate message payload or byte stream, as a 32-bit unsigned integer in network-standard byte order. The use of PExIDs helps differentiate experiments without the immediate need for additional port assignments.

The use of these PExIDs for experiments using existing experiment ports, i.e., system ports EXP1 (#1021) and EXP2 (#1022) is RECOMMENDED.

PExIDs differentiate experiments but are not intended to be specific to a given experiment port, whether system or user, so a single registration is used for all experiment ports. It is the responsibility of the experimenter to determine which port(s) each experiment uses.

If an experiment using PExIDs is intended to be more widely deployed, its designers SHOULD apply for an assigned port, notably

before distribution as a product for public use. The expectations for such services are described in Section 7 of [RFC7605]. If an assigned port is granted to a formerly experimental service with a registered PExID, that service MUST NOT continue to use the experiment ports (even using that PExID) in a deployed system available to the public (i.e., a 'shipped product'), per Section 1.1 of [RFC3692].

If a service transitions from using experiment ports with PExIDs to receiving an assigned port, the service SHOULD NOT continue to use PExIDs in the service when operating on an assigned port. Such use is unnecessarily inefficient and could be misinterpreted as providing benefit. PExIDs are registered for use on the system and user experiment ports only; there is no registration that governs the first bytes used on other assigned ports.

PExIDs SHOULD NOT be used for classroom assignments or training-related experiments; in those cases, dynamic ports are more appropriate. PExIDs SHOULD NOT be used on devices with limited resources, such as Internet of Things (IoT), low-power, or other constrained systems, due to the additional protocol and processing overhead they require. PExIDs are not needed in experiments whose use of experiment ports is contained and would not potentially interfere with other experiments using those ports.

The remainder of this document focuses on the issues associated with using PExIDs.

5. Using PExIDs in Transport Protocols

PExIDs differentiate use of the experiment transport ports, both for UDP and TCP as previously assigned [RFC4727] and for other transports as defined in this document.

The remainder of this section describes PExID use in transport protocols in general, the detailed issues associated with SCTP and DCCP use, and PExID coordination during state negotiation.

5.1. PExID Use in General

PExIDs are intended to be placed in network-standard byte order at the beginning of each independent transport data payload or byte stream.

For connection-oriented transport protocols, such as TCP [RFC9293], SCTP [RFC9260], and DCCP [RFC4340], the PExID is typically sent once for each connection at the beginning of the user transfer and echoed

upon receipt, enabling both ends to confirm the experiment for the connection’s socket pair. That socket pair is then associated with the experiment identified by that PExID for the duration of the connection.

For connectionless transport protocols, such as UDP [RFC768], the PExID is typically included at the beginning of every message in both directions.

In most cases, the PExID is sent as user data. SCTP is one exception, because of its Payload Protocol Identifier (PPID), as discussed further in Section 5.2. Alternately, PExID can be confirmed during the connection or security handshake, as discussed in Section 5.3.

Two endpoints can engage in multiple experiments using the same experimental port number and transport protocol. In such cases, users are expected to support demultiplexing of those different experiments using the PExID. However, PExIDs SHOULD NOT be used to differentiate versions of a protocol or service, because such a service would be more difficult to transition to use of an assigned port for all future versions, as indicated by Section 7.5 of [RFC7605].

5.2. SCTP and DCCP PExID Use

SCTP and DCCP connections already have a mechanism to indicate experimental-use using a self-assigned Private Use DCCP Service Code [RFC4340][RFC5595] or a registered SCTP Payload Protocol Identifier (PPID) [RFC9260]. There is thus no need to use PExIDs to differentiate experiments on the same port number. PExIDs can be used in addition to those codes if desired, notably in developing a single application-layer solution for multiple transport protocols.

SCTP also includes a Payload Protocol Identifier (PPID), which identifies the information within each user message. PPIDs are assigned on a first-come, first-served (FCFS) basis and are abundant (2^32 codepoints), so there is no need for a separate experimental-use PPID. The PExID differentiate shared use of the user experimental port number and thus serves a different purpose than the PPID; both can be used together or separately for SCTP.

Because SCTP supports multiple concurrent streams, it is useful for experiments using PExIDs to be identified in a particular stream before proceeding with other streams, to avoid excessive buffering. For SCTP using only PExIDs for that purpose, users SHOULD send the PExID ordered and reliably as the first user message using PPID of

#PPID1 in stream 0 (the default stream). Until the PExID user message is echoed back on stream 0, user messages on stream 0 SHOULD be sent ordered and the user SHOULD avoid transmitting user messages on other streams. The echoed user message SHOULD use the PPID of #PPID1 assigned for this purpose. That PExID user message MUST contain only the PExID as a 32-bit unsigned integer in network-standard byte order.

5.3. TLS and DTLS Use

Both TLS and DTLS provide extensions to negotiate additional security association parameters [RFC8446][RFC9147]. In both cases, the PExID could be sent in ClientHello requests and echoed in ServerHello responses, although for these protocols the extension requires two fields (because such fields carry only 16 bits of content and two are needed for the 32-bit PExID).

6. PExID Interactions with Other Protocols and Mechanisms

PExIDs help differentiate different uses of the same experimental transport port number using data that augments the port number of the transport header, and thus are not be supported by existing NATs, firewalls, deep-packet inspectors (DPIs), or service function chaining [RFC7665]. To differentiate between shared uses of experiment ports, these devices would need to be modified to detect the PExID, either at the beginning of the connection (for connection-oriented uses) or within each data payload (for connectionless uses).

Some methods to traverse tunnels are also affected by the use of PExIDs. STUN uses a method similar to PExIDs in its in-band message identifier [RFC8489]. These identifiers begin with a 32-bit field first two bits are "00", followed by a type and length, followed by a 32-bit ’magic number’ of 0x2112A442, followed by a 96-bit transaction identifier. PExIDs are similar to the transaction identifier, but they occur earlier in the data stream. The STUN mechanism can be used concurrent with PExIDs if the PExIDs are selected where the two highest bits are something other than "00" (as required in STUN messages). Because not all service or protocols are intended to be used concurrent with STUN, this restricting should not be a concern.

The TURN mechanism for NAT traversal does not interact with use of PExIDs [RFC8656].

Some protocols use "magic bytes" to identify streams and/or messages. PExIDs are a specific interpretation of the first four

magic bytes of each stream or message to demultiplex shared use of the experimental transport ports, thus they are typically not compatible with other concurrent use of magic bytes.

The use of PExIDs may interfere with some aspects of ICMP, because all applications sharing the experiment ports would be treated the same. In such cases, the experimenter is advised to use other means in place of ICMP, e.g., direct measurement of the path MTU.

7. Security Considerations

The creation of new ports for experiment purposes does not create any new security considerations. At best, it potentially reduces the use of privileged system ports for such experiments, which avoids the associated risk of unnecessary privileged access.

Like conventional transport protocol port numbers, PExIDs can be used by deep-packet inspection (DPI) to identify services and protocols (see Sec. 5.2.1 of [RFC6973]). When such information is intended to be protected or private, it can be sent as user data inside an encrypted stream or message, e.g., as user data in TCP/TLS or UDP/DTLS.

PExIDs are not supported by existing firewalls, DPI devices, IPsec traffic selectors or other systems that demultiplex or identify traffic using transport port numbers. Different services using the same port number cannot currently rely on PExIDs for selective filtering.

Experimenters are expected to support security capabilities in any new experiment, regardless of whether an experimental or assigned port is being used (per Section 7.4 of [RFC7605]).

8. IANA Considerations

This document hereby requests the assignment of two user ports for experimental purposes below. IANA is asked to replace instances of #UPORT1 and #UPORT2 throughout this document based on the actual allocation. This paragraph is intended to be removed prior to final publication.

This document also hereby requests the assignment of the SCTP PPID "PEXID" for use in association with these port numbers. IANA is asked to replace instances of #PPID1 throughout this document based on the actual allocation. This paragraph is intended to be removed prior to final publication.

IANA has assigned the following user ports for experiments:

Service Name	USR-EXP1
Transport Protocol(s)	TCP, UDP, DCCP, and SCTP
Assignee	IESG
Contact	IETF Chair
Description	RFC[TBD-rfc]-style Experiment
Reference	RFC [TBD-rfc]
Port Number	#UPORT1 (requesting 1031)
Service Code	none - use private use service codes
Known Unauthorized Uses	none
Assignment Notes	Intended for use with PExIDs only

And:

Service Name	USR-EXP2
Transport Protocol(s)	TCP, UDP, DCCP, and SCTP
Assignee	IESG
Contact	IETF Chair
Description	RFC[TBD-rfc]-style Experiment
Reference	RFC [TBD-rfc]
Port Number	#UPORT2 (requesting 1032)
Service Code	none - use private use service codes
Known Unauthorized Uses	none
Assignment Notes	Intended for use with PExIDs only

IANA has assigned the following SCTP Payload Protocol Identifier (PPID) for experiments associated with these port numbers:

SCTP PPID #PPID1

This document directs IANA to create a "Port Experimental Option Experiment Identifiers (PExIDs)" registry linked under the IANA ports registry [SP-reg], using a the same format and structure as the TCP Experimental Option Experiment ID registry [TCP-reg]. The registry records PExIDs as 32-bit unsigned integers, including a brief description, document pointer (if available), assignee name, and e-mail contact for each entry. It also includes the transport protocol indicated at the time of assignment; additional entries can be added for other transport protocols with different references if needed. Once registered, PExIDs can be used with either the system (EXP1 #1021, EXP2 #1022) or user (USR-EXP1 #UPORT1, USR-EXP2 #UPORT2) ports and with any transport protocol, regardless of whether a separate registration is provided for each transport protocol. This registry has no initial entries.

Entries are assigned on a First Come, First Served (FCFS) basis [RFC8126]. IANA will also record known duplicate uses to assist the community in both debugging assigned uses as well as correcting unauthorized duplicate uses.

IANA should impose no requirements on making a registration request other than indicating the desired codepoint and providing a point of contact. A short description or acronym for the use is desired but not required.

9. References

9.1. Normative References

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10. Acknowledgments

This document was prepared using 2-Word-v2.0.template.dot.

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