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H. Song  
X. Jiang  
R. Even  
Huawei  
D. Bryan  
Ethernod.org  
Y. Sun  
ICT-CAS  
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**P2P Overlay Diagnostics**  
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**Abstract**

This document describes mechanisms for P2P overlay diagnostics. It defines extensions to the RELOAD P2PSIP base protocol to collect diagnostic information, and details the protocol specifications for these extensions. Useful diagnostic information for connection and node status monitoring is also defined. The document also describes the usage scenarios and provides examples of how these methods are used to perform diagnostics in P2P overlay networks.

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## Table of Contents

<a href="#">1.</a>	<a href="#">Introduction</a>	<a href="#">3</a>
<a href="#">2.</a>	<a href="#">Terminology</a>	<a href="#">4</a>
<a href="#">3.</a>	<a href="#">Diagnostic Scenarios</a>	<a href="#">4</a>
<a href="#">4.</a>	<a href="#">Overview of operations</a>	<a href="#">5</a>
<a href="#">4.1.</a>	<a href="#">"Ping-like" Behavior: Extending Ping</a>	<a href="#">7</a>
<a href="#">4.2.</a>	<a href="#">"Traceroute-like" Behavior: The Path_Track Method</a>	<a href="#">7</a>
<a href="#">5.</a>	<a href="#">RELOAD diagnostic extensions</a>	<a href="#">8</a>
<a href="#">5.1.</a>	<a href="#">Diagnostic Data Structures</a>	<a href="#">8</a>
<a href="#">5.1.1.</a>	<a href="#">DiagnosticsRequest Data Structure</a>	<a href="#">9</a>
<a href="#">5.1.2.</a>	<a href="#">DiagnosticsResponse Data Structure</a>	<a href="#">10</a>
<a href="#">5.1.3.</a>	<a href="#">dMFlags and Diagnostic Kind ID Types</a>	<a href="#">11</a>
<a href="#">5.1.4.</a>	<a href="#">Extending Diagnostic Information</a>	<a href="#">14</a>
<a href="#">5.2.</a>	<a href="#">Request Extension: Ping</a>	<a href="#">14</a>
<a href="#">5.3.</a>	<a href="#">New Request: PathTrack</a>	<a href="#">14</a>
<a href="#">5.3.1.</a>	<a href="#">PathTrack Request</a>	<a href="#">15</a>
<a href="#">5.3.2.</a>	<a href="#">PathTrack Response</a>	<a href="#">15</a>
<a href="#">5.4.</a>	<a href="#">Error Codes</a>	<a href="#">16</a>
<a href="#">5.5.</a>	<a href="#">Message Processing</a>	<a href="#">16</a>
<a href="#">5.5.1.</a>	<a href="#">Message Creation and Transmission</a>	<a href="#">16</a>
<a href="#">5.5.2.</a>	<a href="#">Message Processing: Intermediate Peers</a>	<a href="#">17</a>
<a href="#">5.5.3.</a>	<a href="#">Message Response Creation</a>	<a href="#">18</a>
<a href="#">5.5.4.</a>	<a href="#">Interpreting Results</a>	<a href="#">19</a>
<a href="#">6.</a>	<a href="#">Authorization through Overlay Configuration</a>	<a href="#">19</a>
<a href="#">7.</a>	<a href="#">Security Considerations</a>	<a href="#">20</a>
<a href="#">8.</a>	<a href="#">IANA Considerations</a>	<a href="#">20</a>
<a href="#">8.1.</a>	<a href="#">Diagnostic Kind ID Types</a>	<a href="#">20</a>



<a href="#">8.2.</a>	Message Codes . . . . .	<a href="#">21</a>
<a href="#">8.3.</a>	Error Code . . . . .	<a href="#">22</a>
<a href="#">8.4.</a>	Message Extension . . . . .	<a href="#">22</a>
<a href="#">8.5.</a>	Diagnostics Flag . . . . .	<a href="#">22</a>
<a href="#">8.6.</a>	XML Name Space Registration . . . . .	<a href="#">23</a>
<a href="#">9.</a>	Acknowledgments . . . . .	<a href="#">23</a>
<a href="#">10.</a>	References . . . . .	<a href="#">24</a>
<a href="#">10.1.</a>	Normative References . . . . .	<a href="#">24</a>
<a href="#">10.2.</a>	Informative References . . . . .	<a href="#">24</a>
<a href="#">Appendix A.</a>	Examples . . . . .	<a href="#">25</a>
<a href="#">A.1.</a>	Example 1 . . . . .	<a href="#">25</a>
<a href="#">A.2.</a>	Example 2 . . . . .	<a href="#">25</a>
<a href="#">A.3.</a>	Example 3 . . . . .	<a href="#">25</a>
<a href="#">Appendix B.</a>	Problems with Generating Multiple Responses on Path	26
<a href="#">Appendix C.</a>	Changes to the Draft . . . . .	<a href="#">26</a>
<a href="#">C.1.</a>	Changes since -00 version . . . . .	<a href="#">26</a>
<a href="#">C.2.</a>	Changes since -01 version . . . . .	<a href="#">26</a>
<a href="#">C.3.</a>	Changes since -02 version . . . . .	<a href="#">27</a>
<a href="#">C.4.</a>	Changes since -03 version . . . . .	<a href="#">27</a>
<a href="#">C.5.</a>	Changes since -04 version . . . . .	<a href="#">27</a>
<a href="#">C.6.</a>	Changes since -05 version . . . . .	<a href="#">27</a>
<a href="#">C.7.</a>	Changes in version -10 . . . . .	<a href="#">27</a>
	Authors' Addresses . . . . .	<a href="#">27</a>

## [1.](#) Introduction

In the last few years, overlay networks have rapidly evolved and emerged as a promising platform for deployment of new applications and services in the Internet. One of the reasons overlay networks are seen as an excellent platform for large scale distributed systems is their resilience in the presence of failures. This resilience has three aspects: data replication, routing recovery, and static resilience. Routing recovery algorithms are used to repopulate the routing table with live nodes when failures are detected. Static resilience measures the extent to which an overlay can route around failures even before the recovery algorithm repairs the routing table. Both routing recovery and static resilience rely on accurate and timely detection of failures.

There are a number of situations in which some nodes in a P2P overlay may malfunction or behave badly. For example, these nodes may be disabled, congested, or may be misrouting messages. The impact of these malfunctions on the overlay network may be a degradation of quality of service provided collectively by the peers in the overlay network or an interruption of the overlay services. It is desirable to identify malfunctioning or badly behaving peers through diagnostic tools, and exclude or reject them from the P2P system. Node failures may be also caused by underlying failures, for example the recovery



from an incorrect overlay topology may be slow when the IP layer routing failover speed after link failures is very slow. Moreover, if a backbone link fails and the failover is slow, the network may be partitioned, leading to partitions of overlay topologies and inconsistent routing results between different partitioned components.

Some keep-alive algorithms based on periodic probe and acknowledge mechanisms enable accurate and timely detection of failures of one node's neighbors [[Overlay-Failure-Detection](#)], but these algorithms by themselves can only detect the disabled neighbors using the periodic method. This may not be enough for service providers operating the overlay network.

A single, general P2PSIP overlay diagnostic framework supporting periodic and on-demand methods for detecting node failures and network failures is desirable. This document describes a general P2PSIP overlay diagnostic extension to the P2PSIP base protocol RELOAD [[I-D.ietf-p2psip-base](#)] and is intended as a complement to keep-alive algorithms in the P2PSIP overlay itself.

## **2. Terminology**

This document uses the concepts defined in RELOAD [[I-D.ietf-p2psip-base](#)].

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [[RFC2119](#)].

## **3. Diagnostic Scenarios**

P2P systems are self-organizing and ideally require no network management in the traditional sense to set up and to configure individual P2P nodes. However, users of an overlay, as well as P2P service providers may contemplate usage scenarios where some monitoring and diagnostics are required. We present a simple connectivity test and some useful diagnostic information that may be used in such diagnostics.

The common usage scenarios for P2P diagnostics can be broadly categorized in three classes:

- a. Automatic diagnostics built into the P2P overlay routing protocol. Nodes perform periodic checks of known neighbors and remove those nodes from the routing tables that fail to respond to connectivity checks [[Handling Churn in a DHT](#)]. However, the unresponsive nodes may only be temporarily disabled, for example



due to some local cryptographic processing overload, disk processing overload or link overload. It is therefore useful to repeat the connectivity checks to see if such nodes have recovered and can be again placed in the routing tables. This process is known as 'failed node recovery' and can be optimized as described in the paper "Handling Churn in a DHT" [[Handling Churn in a DHT](#)].

- b. Diagnostics for a particular node to follow up an individual user complaint or failure. For example, in this case a technical support person may use a desktop sharing application with the permission of the user to determine remotely the health and possible problems with the malfunctioning node. Part of the remote diagnostics may consist of simple connectivity tests with other nodes in the P2PSIP overlay and retrieval statistics of nodes from the overlay. The simple connectivity tests are not dependent on the type of P2PSIP overlay. Note that other tests may be required as well, such as checking the health and performance of the user's computer or mobile device and also checking the bandwidth of the link connecting the user to the Internet.
- c. P2P system diagnostics to check the overall health of the P2P overlay network, the consumption of network bandwidth, for the presence of problem links and also to check for abusive or malicious nodes. This is not a trivial problem and has been studied in detail for content and streaming P2P overlays [[Diagnostic Framework](#)] as well as in earlier P2PSIP documents [[Diagnostics and NAT traversal in P2PP](#)]. While this is a difficult problem, a great deal of information can be obtained in helping these diagnostics by sending messages to diagnose the network. This document provides a framework for obtaining this information.

#### **4. Overview of operations**

The diagnostic mechanisms described in this document are mainly intended to detect and locate failures or monitor performance in P2PSIP overlay networks. It provides mechanisms to detect and locate malfunctioning or badly behaving nodes including disabled nodes, congested nodes and misrouting peers. It provides a mechanism to detect direct connectivity or connectivity to a specified node, a mechanism to detect the availability of specified resource records and a mechanism to discover P2PSIP overlay topology and the underlay topology failures.

The P2PSIP diagnostics extensions define two mechanisms to collect data. The first is an extension to the RELOAD Ping mechanism,





allowing diagnostic data to be queried from a node, as well as to diagnose the path to that node. The second is a new method and response, PathTrack, for collecting diagnostic information iteratively. Payloads for these mechanisms allowing diagnostic data to be collected and represented are presented, and additional error codes are introduced. Essentially, this document reuses RELOAD [[I-D.ietf-p2psip-base](#)] specification and extends them to introduce the new diagnostics methods. The extensions strictly follow RELOAD specification on the messages routing, transport, NAT traversal etc. The diagnostic methods are however P2PSIP protocol independent.

This document primarily describes how to detect and locate failures including disabled nodes, congested nodes, misrouting behaviors and underlying network faults in P2PSIP overlay networks through a simple and efficient mechanism. This mechanism is modeled after the ping/traceroute paradigm: ping [[RFC0792](#)] is used for connectivity checks, and traceroute is used for hop-by-hop fault localization as well as path tracing. This document specifies a "ping-like" mode (by extending the RELOAD Ping method to gather diagnostics) and a "traceroute-like" mode (by defining the new PathTrack method) for diagnosing P2PSIP overlay networks.

One way these tools can be used is to detect the connectivity to the specified node or the availability of the specified resource-record through the extended P2PSIP Ping operation. Once the overlay network receives some alarms about overlay service degradation or interruption, a Ping is sent. If the Ping fails, one can then send a PathTrack to determine where the fault lies.

The diagnostic information can only be provided to authorized nodes. Some diagnostic information can be provided to all the participants in the P2PSIP overlay, and some other diagnostic information can only be provided to the nodes authorized by the local or overlay policy. The authorization depends on the type of the diagnostic information and the administrative considerations, and is application specific.

This document considers the general administrative scenario based on diagnostic kind type, where a whole overlay can authorize a certain type of diagnostic information to a small list of particular nodes (e.g. administrative nodes). That means, if a node gets the authorization to access a diagnostic kind type, it can access that information from all nodes in the overlay network. It leaves the scenario where a particular node authorizes its diagnostic information to a particular list of nodes out of scope. This could be achieved by extension of this document if there is requirement in the near future. The default policy or access rule for a type of diagnostic information is "permit" unless specified in the diagnostics extension document. As the RELOAD protocol already



requires that each message carries the message signature of the sender, the receiver of the diagnostics requests can use the signature to identify the sender. It can then use the overlay configuration file with this signature to determine which types of diagnostic information that node is authorized for.

#### **4.1. "Ping-like" Behavior: Extending Ping**

To provide "ping-like" behavior, the RELOAD Ping method has been extended to collect diagnostic data along the path. The request message is forwarded by the intermediate peers along the path and then terminated by the responsible peer. After optional local diagnostics, the responsible peer returns a response message. If an error is found when routing, an Error response is sent to the initiator node by the intermediate peer.

The message flow of a Ping message (with diagnostic extensions) is as follows:

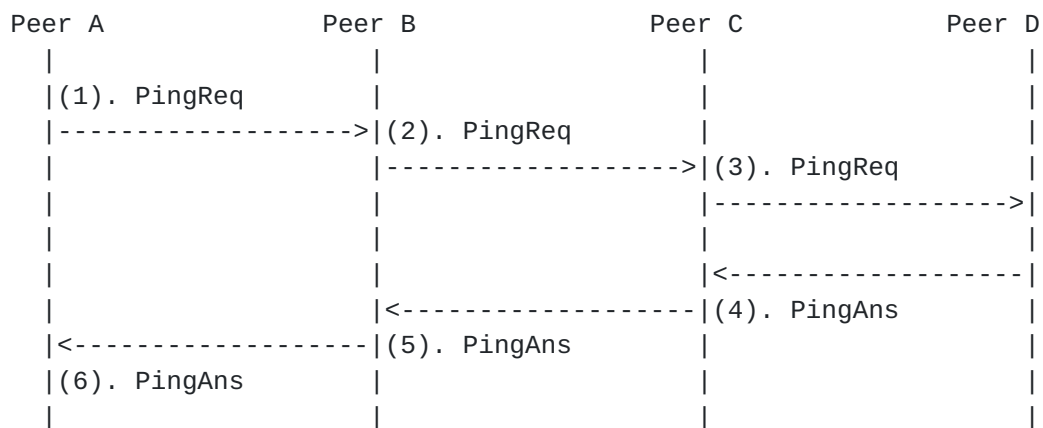


Figure 1: Ping Diagnostic Message Flow

#### **4.2. "Traceroute-like" Behavior: The Path\_Track Method**

We define a simple PathTrack method for retrieving diagnostic information iteratively. For example, in Figure 2, the initiator node A asks its neighbor B which is the next hop peer to the destination ID, and then retrieves the next hop peer C information, along with optional diagnostic information of B, to the initiator node. Then the initiator node A asks the next hop peer C (directly or via symmetric routing) to get the further next hop peer D information and diagnostic information of C. Unless a failure prevents the message from being forwarded, this step can be iteratively repeated until the request reaches responsible peer D for the destination ID, and retrieves diagnostic information of peer D.



The message flow of a PathTrack message (with diagnostic extensions) is as follows:

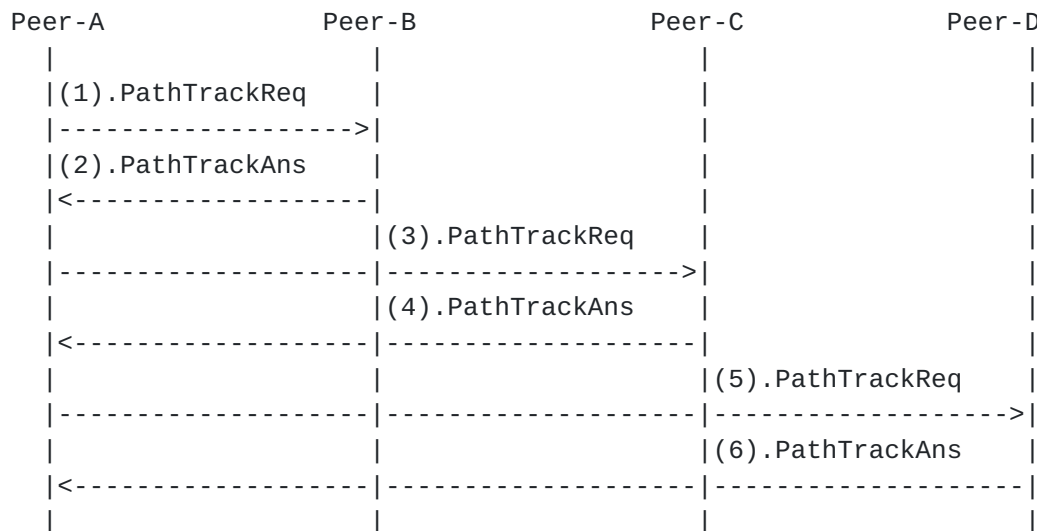


Figure 2: PathTrack Diagnostic Message Flow

There have been proposals that RouteQuery and a series of Fetch requests can be used to replace the PathTrack mechanism, but in the presence of churn such an operation would not, strictly speaking, provide identical results, as the path may change between RouteQuery and Fetch operations. (although obviously the path could change between steps of PathTrack as well).

## 5. RELOAD diagnostic extensions

This document extends RELOAD to carry diagnostic information. Considering the special usage of diagnostics, this document defines extensions for a payload to Ping, as well as the new method PathTrack and its response. Additionally, new Error codes, message bodies for conveying diagnostics, and some suggested common diagnostic values are defined. Processing of the PathTrack message and the diagnostic bodies is discussed.

The mechanism defined in this document follows the RELOAD specification, the new request and response message use the message format specified in RELOAD messages. Please refer to the RELOAD [\[I-D.ietf-p2psip-base\]](#) for details of the protocol.

### 5.1. Diagnostic Data Structures

The diagnostics use the following common diagnostics data structures. Two common structures are defined, DiagnosticsRequest for requesting data, and DiagnosticsResponse for returning information.



### **5.1.1. DiagnosticsRequest Data Structure**

The DiagnosticsRequest data structure is sent to request diagnostic information and has the following form:

```
enum{ (2^16-1) } DiagnosticKindId;

struct{
    DiagnosticKindId kind;
    opaque diagnostic_extension_contents<0..2^32-1>;
}DiagnosticExtension;

struct{
    uint64 expiration;
    uint64 timestamp_initiated;
    uint64 dMFlags;
    uint32 length;
    DiagnosticExtension diagnostic_extensions[length];
}DiagnosticsRequest;
```

The fields in the DiagnosticsRequest are as follows:

expiration : The time when the request will expire represented as the number of milliseconds elapsed since midnight Jan 1, 1970 UTC not counting leap seconds. This will have the same values for seconds as standard UNIX time or POSIX time. More information can be found at UnixTime [[UnixTime](#)]

timestamp\_initiated : The time when the P2PSIP diagnostics request was initiated represented as the number of milliseconds elapsed since midnight Jan 1, 1970 UTC not counting leap seconds. This will have the same values for seconds as standard UNIX time or POSIX time.

length : the length of the extended diagnostic request information in bytes. If the value is greater than or equal to 1, then some extended diagnostic information is requested. The value of length MUST NOT be negative.

dMFlags : A mandatory field which is an unsigned 64-bit integer indicating which base diagnostic information the request initiator node is interested in. The initiator sets different bits to retrieve different kinds of diagnostic information. If dMFlags is set to zero, then no base diagnostic information is conveyed in the PathTrack response. If dMFlag is set to all '1's, then all base diagnostic information values are requested. A request may set any number of the flags to request the corresponding diagnostic information.





Note this memo specifies the initial set of flags, the flags can be extended. The dmflags indicate general diagnostic information. The mapping between the bits in the dmFlags and the diagnostic information kind presented is as described in [Section 8.5](#).

diagnostic\_extensions : consists of one or more DiagnosticExtension structures (see below) documenting additional diagnostic information being requested.

Each DiagnosticExtension has the following fields:

kind : a numerical code indicating the extension kind of diagnostic information(see [Section 8.1](#)). Note that kind 0xFFFFE is reserved for overlay specific diagnostics and may be used without IANA registration for local diagnostic information. And the kind from 0x0000 to 0x003F MUST NOT be indicated in the diagnostic\_extensions in the message request because they can be represented in the dmFlags in a much simpler way.

diagnostic\_extension\_contents : the opaque data containing the request for this particular extension. This data is extension dependent.

#### **[5.1.2](#). DiagnosticsResponse Data Structure**

```
enum { (2^16-1) } DiagnosticKindId;
struct{
    DiagnosticKindId kind;
    opaque diagnostic_info_contents<0..2^16-1>;
}DiagnosticInfo;

struct{
    uint64 expiration;
    uint64 timestamp_received;
    uint8 hop_counter;
    DiagnosticInfo diagnostic_info_list<0..2^32-1>;
}DiagnosticsResponse;
```

The fields in the DiagnosticsResponse are as follows:

expiration : The time when the response will expire represented as the number of milliseconds elapsed since midnight Jan 1, 1970 UTC not counting leap seconds. This will have the same values for seconds as standard UNIX time or POSIX time.

timestamp\_received : The time when P2PSIP Overlay diagnostic request was received represented as the number of milliseconds elapsed since midnight Jan 1, 1970 UTC not counting leap seconds.



This will have the same values for seconds as standard UNIX time or POSIX time.

`hop_counter` : This field only appears in diagnostic responses. It MUST be exactly copied from the TTL field of the forwarding header in the received request. This information is sent back to the request initiator, allowing it to compute the hops that the message traversed in the overlay.

`diagnostic_info_list` : consists of one or more `DiagnosticInfo` values containing the requested diagnostic information.

The fields in the `DiagnosticInfo` structure are as follows:

`kind` : A numeric code indicating the type of information being returned. For base data requested using the `dmFlags`, this code corresponds to the `dmFlag` set, and is described in [Section 5.1.1](#). For diagnostic extensions, this code will be identical to the value of the `DiagnosticKindId` set in the "kind" field of the `DiagnosticExtension` of the request. See [Section 8.1](#).

`diagnostic_information` : Data containing the value for the diagnostic information being reported. Various kinds of diagnostic information can be retrieved, Please refer to [Section 5.1.3](#) for details of the diagnostic kind ID for the base diagnostic information that may be reported.

#### **[5.1.3](#). `dmFlags` and Diagnostic Kind ID Types**

The `dmFlags` field described above is a 64 bit field that allows initiator nodes to identify up to 62 items of base information to request (the first and last flags being reserved) when sending a request. When the requested base information is returned in the response, the value of the diagnostic kind ID will correspond to the numeric field marked in the `dmFlags` in the request. The values for the `dmFlags` are defined in [Section 8.5](#) and the diagnostic kind IDs are defined in [Section 8.1](#). The information contained for each value is described in this section.

`STATUS_INFO` (8 bits): A single value element containing an unsigned byte representing whether or not the node is in congestion status. An example usage of `STATUS_INFO` is for congestion-aware routing. In this scenario, each peer has to update its congestion status periodically, an intermediate peer in the distributed hash table (DHT) network will choose its next hop according to both the DHT routing algorithm and the status information, and then forward requests to the chosen next hop, so as to avoid increasing load on congested peers. The rightmost 4



bits are used and other bits MUST be cleared to "0"s for future use. There are 16 levels of congestion status, with "0x00" represent zero load and "0x0F" represent congested. This document is not going to provide a measurement method for congestion, although a node can contemplate its CPU/memory/bandwidth usage percentage in the past seconds and normalize the highest value to the range [0x00, 0x0F]. This document reserves these bits and leave it for this purpose. A future draft may define it.

ROUTING\_TABLE\_SIZE (32 bits): A single value element containing an unsigned 32-bit integer representing the number of peers in the peer's routing table. The administrator of the overlay may be interested in statistics of this value for reasons such as routing efficiency. Access to this kind of diagnostic information MUST NOT be allowed unless compliant to the rules defined in [Section 6](#).

PROCESS\_POWER (32 bits): A single value element containing an unsigned 32-bit integer specifying the processing power of the node in unit of MIPS.

BANDWIDTH (32 bits): A single value element containing an unsigned 32-bit integer specifying the bandwidth of the node in unit of Kbps.

SOFTWARE\_VERSION: A single value element containing a US-ASCII string that identifies the manufacture, model, operating system information and the version of the software. The format is as follows: ApplicationProductToken (Platform; OS-or-CPU) \* VendorProductToken (VendorComment). One example is: MyReloadApp/1.0 (Unix; Linux x86\_64) libreload-java/0.7.0 (Stonyfish Inc.). Access to this kind of diagnostic information MUST NOT be allowed unless compliant to the rules defined in [Section 6](#).

MACHINE\_UPTIME (64 bits): A single value element containing an unsigned 64-bit integer specifying the time the node has been up in seconds.

APP\_UPTIME (64 bits): A single value element containing an unsigned 64-bit integer specifying the time the P2P application has been up in seconds.

MEMORY\_FOOTPRINT (32 bits): A single value element containing an unsigned 32-bit integer representing the memory footprint of the peer program in kibibytes (1024 bytes). Access to this kind of diagnostic information MUST NOT be allowed unless compliant to the rules defined in [Section 6](#).



**DATASIZE\_STORED** (64 bits): An unsigned 64-bit integer representing the number of bytes of data being stored by this node. Access to this kind of diagnostic information **MUST NOT** be allowed unless compliant to the rules defined in [Section 6](#).

**INSTANCES\_STORED**: An array element containing the number of instances of each kind stored. The array is indexed by Kind-ID. Each entry is an unsigned 64-bit integer. Access to this kind of diagnostic information **MUST NOT** be allowed unless compliant to the rules defined in [Section 6](#).

**MESSAGES\_SENT\_RCVD**: An array element containing the number of messages sent and received. The array is indexed by method code. Each entry in the array is a pair of unsigned 64-bit integers (packed end to end) representing sent and received. Access to this kind of diagnostic information **MUST NOT** be allowed unless compliant to the rules defined in [Section 6](#).

**EWMA\_BYTES\_SENT** (32 bits): A single value element containing an unsigned 32-bit integer representing an exponential weighted average of bytes sent per second by this peer.  $\text{sent} = \alpha \times \text{sent\_present} + (1 - \alpha) \times \text{sent}$  where  $\text{sent\_present}$  represents the bytes sent per second since the last calculation and  $\text{sent}$  represents the last calculation of bytes sent per second. A suitable value for  $\alpha$  is 0.8. This value is calculated every five seconds. Access to this kind of diagnostic information **MUST NOT** be allowed unless compliant to the rules defined in [Section 6](#).

**EWMA\_BYTES\_RCVD** (32 bits): A single value element containing an unsigned 32-bit integer representing an exponential weighted average of bytes received per second by this peer.  $\text{rcvd} = \alpha \times \text{rcvd\_present} + (1 - \alpha) \times \text{rcvd}$  where  $\text{rcvd\_present}$  represents the bytes received per second since the last calculation and  $\text{rcvd}$  represents the last calculation of bytes received per second. A suitable value for  $\alpha$  is 0.8. This value is calculated every five seconds. Access to this kind of diagnostic information **MUST NOT** be allowed unless compliant to the rules defined in [Section 6](#).

**UNDERLAY\_HOP** (8 bits): Indicates the IP layer hops from the intermediate peer which receives the diagnostics message to the next hop peer for this message. (Note: RELOAD does not require the intermediate peers to look into the message body. So here we use PathTrack to gather underlay hops for diagnostics purpose).

**BATTERY\_STATUS** (8 bits): The left-most bit is used to indicate whether this peer is using battery or not. If this bit is clear as '0', then the peer is using a battery power. The other 7 bits are to be determined by specific applications.





#### **5.1.4. Extending Diagnostic Information**

The `DiagnosticsExtension` structure may be used to extend the diagnostic information collected.

#### **5.2. Request Extension: Ping**

To extend the ping request for use in diagnostics, a new extension of RELOAD is defined. The structure for a `MessageExtension` in RELOAD is defined as:

```
struct {  
    MessageExtensionType  type;  
    Boolean               critical;  
    opaque                extension_contents<0..2^32-1>;  
} MessageExtension;
```

For the Ping request extension, we define a new `MessageExtensionType`, extension `0x0002` named `Diagnostic_Ping`, as specified in Table 4 and specified in the RELOAD. The extension contents consists of a `DiagnosticsRequest` structure as defined in [Section 5.1.1](#). This extension MAY be used for new requests of the the Ping method and MUST NOT be included in requests using any other method.

This extension is not critical. If a peer does not support the extension, they will simply ignore the diagnostic portion of the message, and will treat the message if it was a normal ping. Senders MUST accept a response that lacks diagnostic information and SHOULD NOT resend the message expecting a reply. Receivers who receive a method other than Ping including this extension MUST ignore the extension.

#### **5.3. New Request: PathTrack**

This document defines a simple PathTrack method to retrieve the diagnostic information from the intermediate peers along the routing path. At each step of the PathTrack request, the responsible peer responds to the initiator node with requested status information such as congestion state, its processing power, its available bandwidth, the number of entries in its neighbor table, its uptime, its identity and network address information, and the next hop peer information.

A PathTrack request specifies which diagnostic information is requested using a `DiagnosticsRequest` Data structure. Base information is requested by setting the appropriate flags in the `dmFlags` field of the `DiagnosticsRequest`. If the flag is clear (no bits are set), then the PathTrack request is only used for requesting the next hop information. In this case the iterative mode of



PathTrack is degraded to a RouteQuery method which is only used for checking the liveness of the peers along the routing path. The PathTrack request can be routed directly or through the overlay based on the routing mode chosen by the initiator node.

A response to a successful PathTrackReq is a PathTrackAns message. There is a general diagnostic information portion of the payload, the contents of which are based on the flags in the request. Please refer to [Section 5.1.3](#) for the definitions of the base diagnostic information, and [Section 8.2](#) for the numeric message code for the new request.

#### **[5.3.1.](#) PathTrack Request**

The structure of the PathTrack request is as follows:

```
struct{
    Destination destination;
    DiagnosticsRequest request;
}PathTrackReq;
```

The fields of the PathTrackReq are as follows:

destination : The destination which the initiator node is interested in. This may be any valid destination object, including a NodeID, opaque ids, or ResourceID.

request : A DiagnosticsRequest, as discussed in [Section 5.1](#).

#### **[5.3.2.](#) PathTrack Response**

The structure of the PathTrack Response is as follows:

```
struct{
    Destination next_hop;
    DiagnosticsResponse response;
}PathTrackAns;
```

The fields of the PathTrackAns are as follows:

next\_hop : The information of the next hop node from the responding intermediate peer to the destination node. If the responding peer is the responsible peer for the destination ID, then the next\_hop node ID equals the responding node ID, and after that the initiator MUST stop the iterative process.

response : A DiagnosticsResponse, as discussed in [Section 5.1](#).



#### **5.4. Error Codes**

This document extends the Error response method defined in the RELOAD specification to describe the result of diagnostics. When an error is encountered in RELOAD, the Message Code 0xFFFF is returned. The ErrorResponse structure includes an error code, and we define new error codes to report on possible error conditions detected while performing diagnostics:

Code Value	Error Code Name
101	Underlay Destination Unreachable
102	Underlay Time exceeded
103	Message Expired
104	Upstream Misrouting
105	Loop detected
106	TTL hops exceeded

The final error codes will be assigned by IANA as specified in RELOAD protocol [[I-D.ietf-p2psip-base](#)].

This document introduces several types of error information in the error\_info field in the case of Code 101. These are represented as an opaque UTF-8 text string. Here are some examples for the error info.

error\_info:

net unreachable  
host unreachable  
protocol unreachable  
port unreachable  
fragmentation needed  
source route failed

The error\_info field of the Code 102 to 106 are to be specified by the specific overlay.

#### **5.5. Message Processing**

##### **5.5.1. Message Creation and Transmission**

When constructing either a Ping message with diagnostic extensions or a PathTrack message, the sender MUST create a DiagnosticsRequest data structure. The sender MUST set the expiration field of this structure in Unix time timestamp format. The value MUST be at least 10 seconds in the future, and MUST NOT be more than 600 seconds in the future. The timestamp\_initiated field MUST be set to the current time in Unix time timestamp format. The sender includes the dMFlags



field in the structure, and MAY send any number (or all) of the flags to request the desired diagnostic information. The sender MAY leave all the bits unset, requesting no diagnostic information. The sender MAY also include diagnostic extensions for additional information. If the sender includes any extensions, it MUST calculate the length of these extensions and set the length field to the correct length. If no extensions are included, the sender MUST set length to zero.

When constructing a diagnostic Ping message, the sender MUST create an MessageExtension structure as defined in RELOAD. The value of type MUST be 0x0002. The value of critical MUST be FALSE. The value of extension\_contents MUST be the DiagnosticsRequest structure defined above. The sender MUST place the MessageExtension structure in the extensions field of the MessageContents structure. The message MAY be directed to a particular NodeId or ResourceID, but SHOULD NOT be sent to the broadcast NodeID.

When constructing a PathTrack message, the sender MUST set the message\_code for the RELOAD MessageContents structure for PathTrack. The request field of the PathTrackReq MUST be set to the DiagnosticsRequest data structure defined above. The destination field MUST be set to the desired destination, which MAY be either a NodeId or ResourceID but SHOULD NOT be the broadcast NodeID.

#### **5.5.2. Message Processing: Intermediate Peers**

When a request arrives at a peer, if the peer's responsible ID space does not cover the destination ID of the request, then the peer MUST continue processing this request according to the overlay specified routing mode from RELOAD protocol.

In P2PSIP overlay, the error response can be generated by the intermediate peer or responsible peer, either to a diagnostic message or other messages. When a request is received at a peer, the peer may find some connectivity failures or malfunction peers through the pre-defined rules of the overlay network, e.g. by analyzing via list or underlay error messages. The peer SHOULD report the error responses to the initiator node. The malfunction node information SHOULD also be reported to the initiator node in the error message payload. All error responses contain the Error code followed by descriptions if they exist.

Each intermediate peer receiving a Ping message with extensions (and which understands the extension) or receiving a PathTrack request/response SHOULD check the expiration value (Unix time format) to determine if the message is expired. If the message expired, the intermediate peer SHOULD generate a message with Error Code 103





"Message Expired" and return it to the initiator node, and discard the message.

The peer SHOULD return an Error response with the Error Code 101 "Underlay Destination Unreachable" when it receives an ICMP message with "Destination Unreachable" information after forwarding the received request to the destination peer.

The peer SHOULD return an Error response with the Error Code 102 "Underlay Time Exceeded" when it receives an ICMP message with "Time Exceeded" information after forwarding the received request.

The peer SHOULD return an Error response with Error Code 104 "Upstream Misrouting" when it finds its upstream peer disobeys the routing rules defined in the overlay. The immediate upstream peer information SHOULD also be conveyed to the initiator node.

The peer SHOULD return an Error response with Error Code 105 "Loop detected" when it finds a loop through the analysis of via list.

The peer SHOULD return an Error response with Error Code 106 "TTL hops exceeded" when it finds that the TTL field value is no more than 0 when forwarding.

### **5.5.3. Message Response Creation**

When a diagnostic request message arrives at a peer, it understands the extension (in the case of Ping) or the new request type PathTrack, and it is responsible for the destination ID specified in the forwarding header, it MUST follow the specifications defined in 5.1.3 of RELOAD protocol to form the response header, and perform the following operations:

The receiver MUST check the expiration value (Unix time format) in the DiagnosticsRequest to determine if the message is expired. If the message is expired, the peer MUST generate a message with the Error Code 103 "Message Expired" and return it to the initiator node, and discard the message.

If the message is not expired, the receiver MUST construct a DiagnosticsResponse structure. The destination peer MUST copy the TTL value from the forwarding header to the hop\_counter field of the DiagnosticsResponse structure. Note that the default value for TTL at the beginning represents 100-hops unless overlay configuration has overridden the value. The receiver MUST generate an Unix time format timestamp for the current time of day and place it in the timestamp\_received field. The receiver MUST construct a new expiration time and place it in the expiration field of the



DiagnosticsResponse. This expiration **MUST** be at least 10 seconds in the future and **MUST NOT** be more than 600 seconds in the future.

The destination peer **MUST** check if the initiator node has the authority to request that type of diagnostic information, and if appropriate, appends the diagnostic information requested in the `dMFlags` and `diagnostic_extensions` (if any) in the `diagnostic_info_list` field of the `DiagnosticsResponse` structure. If there is any information returned, the receiver **MUST** calculate the length of the response and set length appropriately. If there is no diagnostic information returned, length **MUST** be set to zero.

In the event of an error, an error response containing the error code followed by the description (if they exist) **MUST** be created and sent to the sender. If the initiator node asks for diagnostic information that they are not authorized to query, the receiving peer **MUST** return an Error response with the Error Code 2 "Error\_Forbidden".

#### **5.5.4. Interpreting Results**

The initiator node, as well as the responding peer, **MAY** compute the overlay One-Way-Delay time through the value in `timestamp_received` and the `timestamp_initiated` field. However, for a single hop measurement, the traditional measurement methods **MUST** be used instead of the overlay layer diagnostics methods.

The P2P overlay network that uses the diagnostics methods specified in this document **MUST** enforce time synchronization with a central time server. Network Time Protocol [[RFC5905](#)] can usually maintain time to within tens of milliseconds over the public Internet, and can achieve better than one millisecond accuracy in local area networks under ideal conditions. However, this document does not specify the choice for time synchronization. It depends on the implementation.

The initiator node receiving the Ping response **MAY** check the `hop_counter` field and compute the overlay hops to the destination peer for the statistics of connectivity quality from the perspective of overlay hops.

### **6. Authorization through Overlay Configuration**

The overlay configuration file **MUST** contain the following XML elements for authorizing a node to access the relative diagnostic kinds.

diagnostic-kind: This has the attribute "kind" with the hexadecimal number indicating the diagnostic Kind Type, this attribute has the



same value with [Section 8.1](#), and at least one sub element "access-node".

access-node: This element contains one hexadecimal number indicating a NodeID, and the node with this NodeID is allowed to access the diagnostic "kind" under the same diagnostic-kind element.

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

The authorization for diagnostic information must be designed with care to prevent it becoming a method to retrieve information for bot attacks. It should also be noted that attackers can use diagnostics to analyze overlay information to attack certain key peers. As this document is a RELOAD extension, it follows RELOAD message header and routing specifications, the common security considerations described in the base document [[I-D.ietf-p2psip-base](#)] are also applicable to this document. Overlays may define their own requirements on who can collect/share diagnostic information.

## **[8.](#) IANA Considerations**

### **[8.1.](#) Diagnostic Kind ID Types**

IANA SHALL create a "RELOAD Diagnostic Kind ID Types" Registry. Entries in this registry are 16-bit integers denoting diagnostics extension data kind types carried in the diagnostic request and response message, as described in [Section 5.1.2](#). Code points from 0x0000 to 0x003F SHALL be assigned together with flags within "RELOAD Diagnostics Flag" registry via [RFC 5226](#) [[RFC5226](#)] standards action. Code points in the range 0x0040 to 0xFFFFD SHALL be registered via [RFC 5226](#) standards action.



Diagnostic Kind Type	Code	Specification
reserved	0x0000	RFC-XXXX
STATUS_INFO	0x0001	RFC-XXXX
ROUTING_TABLE_SIZE	0x0002	RFC-XXXX
PROCESS_POWER	0x0003	RFC-XXXX
BANDWIDTH	0x0004	RFC-XXXX
SOFTWARE_VERSION	0x0005	RFC-XXXX
MACHINE_UPTIME	0x0006	RFC-XXXX
APP_UPTIME	0x0007	RFC-XXXX
MEMORY_FOOTPRINT	0x0008	RFC-XXXX
DATASIZE_STORED	0x0009	RFC-XXXX
INSTANCES_STORED	0x000A	RFC-XXXX
MESSAGES_SENT_RCVD	0x000B	RFC-XXXX
EWMA_BYTES_SENT	0x000C	RFC-XXXX
EWMA_BYTES_RCVD	0x000D	RFC-XXXX
UNDERLAY_HOP	0x000E	RFC-XXXX
BATTERY_STATUS	0x000F	RFC-XXXX
reserved	0x003F	RFC-XXXX
local use (reserved)	0xFFFE	RFC-XXXX
reserved	0xFFFF	RFC-XXXX

Table 1: Diagnostic Kind Types

## 8.2. Message Codes

This document introduces two new types of messages and their responses, requiring the following additions to the "RELOAD Message Code" Registry defined in RELOAD [[I-D.ietf-p2psip-base](#)]. These additions are:

Message Code Name	Code Value	RFC
path_track_req	101	RFC-AAAA
path_track_ans	102	RFC-AAAA

Table 2: Extensions to RELOAD Message Codes

[To RFC editor: Values starting at 101 were used to prevent collisions with RELOAD base values. Once RELOAD moves to RFC, these values may start at the next higher value after the RELOAD base values. The final message code will be assigned by IANA. And all RFC-AAAA should be replaced with the RFC number of RELOAD when publication.]





### 8.3. Error Code

This document introduces the following new error codes, extending the "RELOAD Message Code" registry as described below:

Message Code Name	Code Value	RFC
Error_Underlay_Destination_Unreachable	101	RFC-AAAA
Error_Underlay_Time_Exceeded	102	RFC-AAAA
Error_Message_Expired	103	RFC-AAAA
Error_Upstream_Misrouting	104	RFC-AAAA
Error_Loop_Detected	105	RFC-AAAA
Error_TTL_Hops_Exceeded	106	RFC-AAAA

Table 3: Extensions to RELOAD Error Codes

### 8.4. Message Extension

This document introduces the following new RELOAD extension code:

Extension Name	Code Value	RFC
Diagnostic_Ping	0x0002	RFC-AAAA

Table 4: New RELOAD Extension Code

### 8.5. Diagnostics Flag

IANA SHALL create a "RELOAD Diagnostics Flag" Registry. Entries in this registry are 1-bit flags contained in a 64-bits long integer dMFlags denoting diagnostic information to be retrieved as described in [Section 5.3](#). New entries SHALL be defined via [\[RFC5226\]](#) Standards Action. The initial contents of this registry are:



diagnostic information	diagnostic flag in dMFlags	RFC
Reserved	0x 0000 0000 0000 0000	RFC-XXXX
STATUS_INFO	0x 0000 0000 0000 0001	RFC-XXXX
ROUTING_TABLE_SIZE	0x 0000 0000 0000 0002	RFC-XXXX
PROCESS_POWER	0x 0000 0000 0000 0004	RFC-XXXX
BANDWIDTH	0x 0000 0000 0000 0008	RFC-XXXX
SOFTWARE_VERSION	0x 0000 0000 0000 0010	RFC-XXXX
MACHINE_UPTIME	0x 0000 0000 0000 0020	RFC-XXXX
APP_UPTIME	0x 0000 0000 0000 0040	RFC-XXXX
MEMORY_FOOTPRINT	0x 0000 0000 0000 0080	RFC-XXXX
DATASIZE_STORED	0x 0000 0000 0000 0100	RFC-XXXX
INSTANCES_STORED	0x 0000 0000 0000 0200	RFC-XXXX
MESSAGES_SENT_RCVD	0x 0000 0000 0000 0400	RFC-XXXX
EWMA_BYTES_SENT	0x 0000 0000 0000 0800	RFC-XXXX
EWMA_BYTES_RCVD	0x 0000 0000 0000 1000	RFC-XXXX
UNDERLAY_HOP	0x 0000 0000 0000 2000	RFC-XXXX
BATTERY_STATUS	0x 0000 0000 0000 4000	RFC-XXXX
Reserved	0x FFFF FFFF FFFF FFFF	RFC-XXXX

[To RFC editor: Please replace all RFC-XXXX in this document with the RFC number of this document.]

## 8.6. XML Name Space Registration

This document registers a URI for the config-diagnostics XML namespaces in the IETF XML registry defined in [[RFC3688](#)]. All the elements defined in this document belong to this namespace.

URI: urn:ietf:params:xml:ns:p2p:config-diagnostics

Registrant Contact: The IESG.

XML: N/A, the requested URIs are XML namespaces

And the overlay configuration file MUST contain the following xml language declaring P2PSIP diagnostics as a mandatory extension to RELOAD.

```
<mandatory-extension>
    urn:ietf:params:xml:ns:p2p:config-diagnostics
</mandatory-extension>
```

## 9. Acknowledgments

We would like to thank Zheng Hewen for the contribution of the initial version of this document. We would also like to thank Bruce Lowekamp, Salman Baset, Henning Schulzrinne, Jiang Haifeng and Marc



Petit-Huguenin for the email discussion and their valued comments, and special thanks to Henry Sinnreich for contributing to the usage scenarios text. We would like to thank the authors of the RELOAD protocol for transferring text about diagnostics to this document.

## **10. References**

### **10.1. Normative References**

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- [RFC3688] Mealling, M., "The IETF XML Registry", [BCP 81](#), [RFC 3688](#), January 2004.
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### **10.2. Informative References**

- [UnixTime]  
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**[Overlay-Failure-Detection]**

Zhuang, S., "On failure detection algorithms in overlay networks", Proc. IEEE Infocomm, Mar 2005.

**[Handling\_Churn\_in\_a\_DHT]**

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**[Diagnostics\_and\_NAT\_traversal\_in\_P2PP]**

Gupta, G., "Diagnostics and NAT Traversal in P2PP - Design and Implementation", Columbia University Report , June 2008.

[RFC5226] Narten, T. and H. Alvestrand, "Guidelines for Writing an IANA Considerations Section in RFCs", [BCP 26](#), [RFC 5226](#), May 2008.

**[Appendix A](#). Examples**

Below, we sketch how these metrics can be used.

**[A.1](#). Example 1**

A peer may set EWMA\_BYTES\_SENT and EWMA\_BYTES\_RCVD flags in the PathTrackReq to its direct neighbors. A peer can use EWMA\_BYTES\_SENT and EWMA\_BYTES\_RCVD of another peer to infer whether it is acting as a media relay. It may then choose not to forward any requests for media relay to this peer. Similarly, among the various candidates for filling up routing table, a peer may prefer a peer with a large UPTIME value, small RTT, and small LAST\_CONTACT value.

**[A.2](#). Example 2**

A peer may set the STATUS\_INFO Flag in the PathTrackReq to a remote destination peer. The overlay has its own threshold definition for congestion. The peer can obtain knowledge of all the status information of the intermediate peers along the path. Then it can choose other paths to that node for the subsequent requests.

**[A.3](#). Example 3**

A peer may use Ping to evaluate the average overlay hops to other peers by sending PingReq to a set of random resource or node IDs in





the overlay. A peer may adjust its timeout value according to the change of average overlay hops.

## **Appendix B. Problems with Generating Multiple Responses on Path**

An earlier version of this document considered an approach where a response was generated by each intermediate peer as the message traversed the overlay. This approach was discarded. One reason this approach was discarded was that it could provide a DoS mechanism, whereby an attacker could send an arbitrary message claiming to be from a spoofed "sender" the real sender wished to attack. As a result of sending this one message, many messages would be generated and sent back to the spoofed "sender" - one from each intermediate peer on the message path. While authentication mechanisms could reduce some risk of this attack, it still resulted in a fundamental break from the request-response nature of the RELOAD protocol, as multiple responses are generated to a single request. Although one request with responses from all the peers in the route will be more efficient, it was determined to be too great a security risk and deviation from the RELOAD architecture.

## **Appendix C. Changes to the Draft**

To RFC editor: This section is to track the changes. Please remove this section before publication.

### **C.1. Changes since -00 version**

1. Changed title from "Diagnose P2PSIP Overlay Network" to "P2PSIP Overlay Diagnostics".
2. Changed the table of contents. Add a section about message processing and a section of examples.
3. Merge diagnostics text from the p2psip base draft -01.
4. Removed ECHO method for security reasons.

### **C.2. Changes since -01 version**

Added BATTERY\_STATUS as diagnostic information.

Removed UnderlayTTL test from the Ping method, instead adding an UNDERLAY\_HOP diagnostic information for PathTrack method.

Give some examples for diagnostic information, and give some editor's notes for further work.



**C.3. Changes since -02 version**

Provided further explanation as to why the base draft Ping in the current form cannot be used to replace Ping, and why some combination of methods cannot replace PathTrack.

**C.4. Changes since -03 version**

Modified structure used to share information collected. Both mechanisms now use a common data structure to convey information.

**C.5. Changes since -04 version**

Updated the authors' addresses and modified the last sentence in . ([Section 5.3.2](#))

**C.6. Changes since -05 version**

Resolve Marc's comments from the mailing list. And define the details of STATUS\_INO.

**C.7. Changes in version -10**

Resolve the authorization issue and other comments (e.g. define diagnostics as a mandatory extension) from WGLC. And check for the languages.

**Authors' Addresses**

Haibin Song  
Huawei

Email: [haibin.song@huawei.com](mailto:haibin.song@huawei.com)

Jiang Xingfeng  
Huawei

Email: [jiang.x.f@huawei.com](mailto:jiang.x.f@huawei.com)

Roni Even  
Huawei  
14 David Hamelech  
Tel Aviv 64953  
Israel

Email: [roni.even@mail01.huawei.com](mailto:roni.even@mail01.huawei.com)



David A. Bryan  
Ethernod.org  
Williamsburg, Virginia  
United States of America

Email: [dbryan@ethernod.org](mailto:dbryan@ethernod.org)

Yi Sun  
ICT-CAS

Email: [sunyi@ict.ac.cn](mailto:sunyi@ict.ac.cn)