Explicit Routing Protocol (ERP)

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March 29, 1995

Basic Facts About ERP

What is ERP ?

- An essential component of the Unified Routing Architecture (see RFC1322)

Basic Facts About ERP (cont.)

Superficially ERP looks like a "source-route", but there are **substantial** differences:

- Either the packet originator or **any router** along a path can alter the path by adding ERP header to the packet
- The path may be altered **more than once** – multiple ERP headers
- Path can be expressed in terms of **network aggregates**
- Allows **intermix** of "strict" and "loose" segments
- Additional **error handling** capabilities
- ERP **header compression** via setup – bandwidth vs memory tradeoff

Basic Facts About ERP (cont.)

- Forwarding mechanism, routing information for the mechanism can be acquired from a variety of sources (e.g. statically configured, BGP/IDRP, etc...)

ERP Header Format

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| Next Header   |Routing Type=1 |    FwdDirLen  |   NextHopPtr  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|  Flags  |NestL|            Strict/Loose Bit Mask              |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|        Forwarding Directions, a list of IPv6 addresses        |
|        (integral multiple of 16 octets)                       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

IPv6 Format with ERP Header(s)

```
+--------+------------+---------+------------+-------------------
| Fixed  | Current    |  .....  | Level 1    | TCP header + data
| Header | ERP Header |         | ERP Header |
+--------+------------+---------+------------+-------------------

+--------+--------------+------------+-------+------------+-----------
| Fixed  | Hop-by-hop   | Current    | ..... | Level 1    | TCP header
| Header |Option Header | ERP Header |       | ERP Header | + data
+--------+--------------+------------+-------+------------+-----------
```

Flags

- Must Report Error (MRE) – controls ICMP when a router is unable to follow the Forwarding Directions

- Behavior on Failure of Forwarding Directions (FFD) – controls what to do with a packet (drop vs forward based on destination) when a router is unable to follow the Forwarding Directions

- Source Address Swap (SAS) – used to save source address, when the Level 1 ERP Header is inserted by a router

- Flow Setup Request (FSR) – used to establish state on intermediate routers

- Flow ID Saved (FLS) – used to save Flow-ID when an ERP header is added to a packet that already carries non-zero Flow ID.

Handling Destination Address

- Saved at the last element in the Forwarding Directions by the entity that attaches the first (Level 1) ERP Header

- Restored when the explicit route specified by the Level 1 ERP Header is completed

- Updated (overwritten) by routers that process ERP header

- No address swapping – in contrast with traditional "source-routing"

Incrementing Next Hop Pointer
(“loose hop”)

If the next element in the Forwarding Directions is a “loose” hop, then:

- place the next element from Forwarding Directions into the Destination Address (in the fixed header)
- increment Next Hop Pointer by 1
- submit for normal forwarding procedures

Incrementing Next Hop Pointer ("strict hop")

If the next element in the Forwarding Directions is a "strict" hop, then:

- perform FIB lookup using the address specified in the next element from Forwarding Directions
- if no match found then error, else
- if the next hop (from local FIB) specifies an entity on a common subnet with the local system then increment the Next Hop Pointer by 1
- place address from the FIB entry into the Destination Address (in the fixed header)
- submit for normal forwarding procedures

TO DO items

- Handling Path MTU discovery – similar to handling path MTU discovery in presence of encapsulation
- Defining format of ICMP Error Messages
- MIB

Documentation

- draft-ietf-sdr-erp-01.txt
- draft-ietf-sdr-route-construction-01.{txt,ps}
- draft-ietf-sdr-IPv6-pack-00.txt
- draft-ietf-idr-rifs-00.txt