anima
Internet-Draft
Intended status: Standards Track
Expires: 25 October 2026

M. Han, Ed.
J. Zhao, Ed.
Z. Ruan
S. Zhang
China Unicom

23 April 2026

Automatic Network Congestion Relief in GeneRic Autonomic Signaling Protocol (GRASP)

draft-han-anima-grasp-congestion-relief-01

Abstract

This draft defines new autonomic technical objectives for automatic congestion relief using the Grasp protocol acording to the [RFC 9222]. In operator networks, network devices can automatically respond and achieve real-time self-healing for network failures such as fiber optic cable faults and optical module malfunctions

Status of This Memo

Copyright Notice

Table of Contents

1. Introduction

1.1. Overview

GeneRic Autonomic Signaling Protocol (GRASP) [RFC8990] is intended to be used for Service Announcement, Discovery and Selection especially in network or for network services intended to be deployable without dependencies against centralized "server" entities, such as fully autonomous networks or Autonomous Service Agents (ASA).

To support these goals, GRASP provides a hop-by-hop network wide flooding of announcement or discover messages reliably and secured and without looping messages. This flooding is achieved with a per-hop GRASP agent responsible for per-hop flooding of GRASP messages.

Automatic Network Congestion Relief is introduced by [I-D.zhao-anima-automatic-congestion-relief]. The ntwork congestion caused by fiber or optoelectronics devices failures becoming a common issue for operators, which caused by the disaster and construction work. It requires dedicated staff to perform daily traffic inspections and manually adjust configurations on an hourly basis, which significantly increases the difficulty of network maintenance.

This draft introduces an automatic congestion relief mechanism based on traffic analysis and auto-regulation. In the event of failures congestion, it can respond to congestion and initiate real-time self-healing processes, solving the network congestion and maintenance challenges faced by operators fiber or optoelectronics devices failures, and ensuring the stable operation of the network.

The mechanism in this document enables the Automatic Network Congestion Relief through GRASP.

2. Conventions and Definitions

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. Problem Statement

When a failure occurs in a carrier network, such as a power outage of core equipment caused by a fire, it may affect tens of millions of mobile users’ voice and short message services, as well as multiple dedicated lines for government or enterprise customers. Traditional troubleshooting and reconfiguration performed manually consume a significant amount of time.

Meanwhile, centralized control solutions like Software-Defined Networking (SDN), while offering a global view, face bottlenecks in scalability and real-time performance due to their core reliance on a central controller and periodic link-state polling mechanisms. This makes them ill-suited to handle sudden failures and severe fluctuations that may occur in large-scale carrier networks. Particularly when physical-layer failures such as fiber cuts trigger abrupt congestion, existing mechanisms often fail to achieve rapid and accurate congestion detection and traffic scheduling.

This problem statement focuses on the operational challenge within carrier network edge environments (specifically at the convergence points of metropolitan area networks and backbone networks) under such scenarios. That is, while maintaining basic routing reachability, how to effectively detect sudden congestion caused by underlying failures and achieve fast, adaptive traffic redirection. We propose to explore a solution based on a distributed negotiation mechanism (such as the GRASP protocol). By establishing real-time information exchange and collaborative decision-making capabilities among routers, this approach aims to overcome the respective shortcomings of traditional end-to-end control and centralized SDN architectures. The ultimate goal is to enable autonomous discovery, determination, and mitigation of network congestion, thereby enhancing the overall resilience and service performance of the network.

3.1. Intended User and Administrator Experience

For network administrators, the anticipated experience is as follows: In large-scale carrier networks, administrators will no longer need to frequently conduct traffic inspections and manually adjust configurations on an hourly basis. Ideally, the proposed automatic congestion mitigation mechanism will autonomously address sudden network congestion events. Administrators would only need to periodically review logs to track potential network failures and carry out corresponding troubleshooting, without having to manually configure traffic adjustments.

4. Approach of Automatic Network Congestion Relief

This section introduces the building blocks for an autonomic network congestion relief solution. It uses the generic discovery and negotiation protocol defined by [RFC8990]. The relevant GRASP objectives are defined in Section 5.

The procedures described below are carried out by an ASA in each device that participates in the solution. We will refer to this as the Traffic ASA.

An edge device monitors link conditions (such as link bandwidth, bandwidth utilization, and link priority) to detect congestion or link degradation. When the traffic on a link exceeds a predefined bandwidth threshold, the edge device lowers the priority of the excess traffic and notifies the backbone router. The backbone router then updates the Link Priority Table and selects alternative paths based on the priorities, bypassing the current link.

5. Automatic Network Congestion Relief Objectives

This section defines the GRASP Objective used to support autonomic network congestion relief. In accordance with RFC 8990, an Objective is a named data structure used for negotiation or synchronization, while its encoding within GRASP messages is referred to as an Objective option. This document defines the Objective semantics and data content, while the encoding follows the standard GRASP specification.

5.1. LinkStatus Objective

The LinkStatus Objective option is a GRASP Objective option conforming to the GRASP specification [RFC8990] which is designed for synchronization. It carries the link state information as its value: the bandwidth and the utilization rate of bandwidth. This Objective is used for sharing locally observed link quality data between edge devices.

5.2. LinkPriorityAdjust Objective

The LinkPriorityAdjust Objective carries a routing adjustment policy that indicates which traffic flows should have their priority adjusted under current network conditions. This Objective enables an edge device to proactively send an adjustment request to a backbone router to modify the routing preference of its upstream traffic.

6. Example of an Application Scenario

Measurement and Advertisement: Gateway1 and Gateway2 measure in real time the link utilized bandwidth and traffic to Router1 and Router2.

Edge State Synchronization: Gateway1 requests Gateway2’s LinkStatus via M_REQ_SYN, or proactively publishes its own LinkStatus.

Congestion Detection and Intelligent Decision: Based on aggregated link states (bandwidth, utilization) and algorithms on ASA, Gateway1 determines that the link to Router1 is congested and and decides to lower the priority of traffic that exceeds the threshold.

Policy Delivery to the Backbone: Gateway1 constructs a LinkPriorityAdjust Objective and sends it directly to the backbone Router1 via M_REQ_SYN or M_SYNCH.

Backbone Application and Flooding: After receiving and applying the new priority table, Router1 notifies upstream routers to adjust paths via route flooding, so that more traffic is eventually directed to Router2.

```
 --------------------------------------------------------------
 | --------------------          --------------------  |
 | | Backbone Router2 |    Network2     | Backbone Router1 |  |
 | --------------------          --------------------  |
 -----------|-------------------------------------|------------
            |                                     |
            |                                     x
            | 100GB x 9                           x 100GB x 3(9)
            |                                     |
 -----------|-------------------------------------|-----------
 | --------------------          -------------------- |
 | |  Edge Gateway2   |    Network1     |  Edge Gateway1   | |
 | --------------------          -------------------- |
 |                                                          |
 -------------------------------------------------------------
```

Figure 1: Application Case

7. Security Considerations

TBD.

8. IANA Considerations

TBD.

9. References

9.1. Normative References

[RFC5305] Li, T. and H. Smit, "IS-IS Extensions for Traffic Engineering", RFC 5305, DOI 10.17487/RFC5305, October 2008, <https://www.rfc-editor.org/info/rfc5305>.

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, DOI 10.17487/RFC2119, March 1997, <https://www.rfc-editor.org/info/rfc2119>.

[RFC8174] Leiba, B., "Ambiguity of Uppercase vs Lowercase in RFC 2119 Key Words", BCP 14, RFC 8174, DOI 10.17487/RFC8174, May 2017, <https://www.rfc-editor.org/info/rfc8174>.

[RFC9222] Carpenter, B., Ciavaglia, L., Jiang, S., and P. Peloso, "Guidelines for Autonomic Service Agents", RFC 9222, DOI 10.17487/RFC9222, March 2022, <https://www.rfc-editor.org/info/rfc9222>.

9.2. Informative References

[RFC8990] Bormann, C., Carpenter, B., Ed., and B. Liu, Ed., "GeneRic Autonomic Signaling Protocol (GRASP)", RFC 8990, DOI 10.17487/RFC8990, May 2021, <https://www.rfc-editor.org/info/rfc8990>.

[I-D.zhao-anima-automatic-congestion-relief] Zhao, J. and S. Zhang, "Automatic Network Congestion Relief", Work in Progress, Internet-Draft, draft-zhao-anima-automatic-congestion-relief-00, 3 March 2025, <https://datatracker.ietf.org/doc/html/draft-zhao-anima-automatic-congestion-relief-00>.

Authors' Addresses

Mengyao Han (editor)
China Unicom
Beijing
China
Email: hanmy12@chinaunicom.cn

Jing Zhao (editor)
China Unicom
Beijing
China
Email: zhaoj501@chinaunicom.cn

Zheng Ruan
China Unicom
Beijing
China
Email: ruanz6@chinaunicom.cn

Shuai Zhang
China Unicom
Beijing
China
Email: zhangs633@chinaunicom.cn