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Deterministic Networks Gap Analysis
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Abstract

This document introduces and describes several conditions and use cases where the use of an IP-based layer-3 and up is required to provide a complete networking solution to deterministic networks. The contents of this work is a gap analysis to contribute to the design and development of a number of complimentary modules to provide IP-enabled networking for deterministic networks.

Table of Contents

1. Introduction

The first step to become detnet networks was taken at the stub networks such as 6TiSCH-based ones [I-D.ietf-6tisch-tsch], meaning those simple networks that connect the endpoints to one or several gateways, thus enabling both a predictable delay and a very high reliability. These two characteristics must be preserved along the the multi-hop path between source and destination, thus requiring a fully-fledged deterministic end-to-end network including management services to achieve this goal. This is achieved by installing tracks with all the deterministic capabilities.

The evolution towards these kinds of intermediate and backbone deterministic networks has been taken up to the MAC layer by the IEEE by defining several standards to provide building blocks to guarantee a predictable delay, such as buffers, queues and schedulers. The configuration, use, coordination, resources management and control of these blocks must be achieved at a higher layer, tightly linked to the routing scheme. Many applications are currently lacking this kind of solution, forcing bandwidth overprovisioning to reduce packet loss and delay uncertainty.

2. Assumptions

Current packet loss and delay jitter provided by IP networks are not enough for industrial applications

Realtime audio and video for reliable content distribution in local networks is cannot be achieved without time-scheduled IP networks

End-to-end delay and packet loss guarantees cannot be provided without a managed deterministic network

3. Gap Analysis

3.1. 6TiSCH Track management

6TiSCH requires the installation of tracks along a path with deterministic capabilities, including scheduled transmissions, intermediate queue management, synchronization and path and packet redundnacy among others. The mechanism to achieve such a path is achieved by using PCE/SDN operations as defined on RFC 7149 [RFC7149].

On 6TiSCH, IPv6 packets are carried on installed tracks; to reduce resource usage, there is also the need to forward IPv6 packets by opportunistic reuse of track slots and also reuse link bundle slots to forward schedule packets that missed their track. Both mechanisms require the use of Deterministic Networking managament capabilities.

3.2. Deterministic Payload on MPLS

There are certain Non-IP protocols such as Profibus and Modbus which can be carried as IPv6 payload as long as this traffic is treated as Deterministic; this can be achieved by the use of MPLS and and a specific mangement module for layer-2 path redundancy, such as Parallel Redundancy Protocol.

3.3. Traffic Specification implementation for PCE

There are several issues on the implementation of Traffic Specification for the PCE [I-D.ietf-teas-interconnected-te-info-exchange]:

A TEAS adaptation to carry the topology (neighbors, link quality, interference test, etc.) and capabilities (buffers, queues and timers) from the point of view of the individual devices.

A CCAMP/RSVP-TE adaptation to program the individual tracks

An adaptation of PCEP to push an individual device schedule

3.4. Packet-track ID

Track ID on packets is not defined yet; the use of Diffserv/DSCP and MPLS (and G-MPLS for 6TiSCH) are possible alternatives

3.5. Packet Redundancy Protocol

There is a need to define a Packet Redundancy Protocol (PRP) for deterministic networks, including the PRP sequence number which can be defined by the ASN.

4. Acknowledgments

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