Validated: IP/MPLS QoS for teleprotection

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In recent testing, a new IP/MPLS QoS mechanism called Asymmetrical Delay Control (ADC) was found to prevent teleprotection false trips. This is good news for utility operators who had been wary about the capability of packet networks to meet their stringent teleprotection requirements.

The tests were performed at the Technology and Innovation Centre at the University of Strathclyde, UK.

Why is this important? Teleprotection systems, such as current differential protection, play a critical role in preventing instability in the grid and damage to expensive assets such as transformers, to ensure continuous electricity supply which is a keystone of modern society.

Teleprotection relays typically exchange real time grid information in TDM format. They require a highly reliable communications network that can meet QoS and availability requirements consistently.

In the past, TDM/SDH/SONET transport networks have proven well-suited to carry the TDM traffic for the protection application.

However, as TDM equipment and services start to be discontinued, electric grid operators need to evaluate migration of teleprotection traffic to a packet network such as IP/MPLS (Fig. 1).

Utilities are understandably cautious about moving, though. For example, current differential protection demands not just low network delay and jitter but also low delay asymmetry — the difference in delay between forward path (go path) and reverse path (return path) delays.

Excessive asymmetry causes the protective relay to falsely trip, resulting in unnecessary grid disturbance.

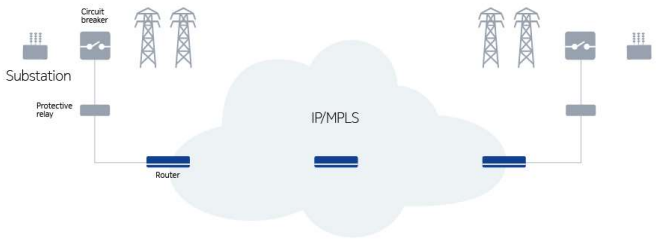

Figure 1. IP/MPLS utility grid

With proper QoS in place, an IP/MPLS network can already tightly control delay and jitter. However, attaining low delay asymmetry is not as straightforward as you'd think. It does not just require sending packets in both directions on the same physical path with QoS control.

The challenge is to equalize the playout buffer wait time in both edge routers connected to the two protection relays. In an ideal network with no network jitter, wait times on both sides are always equal. But when affected by network jitter, due to its random nature, the playout buffer wait times could become unequal, causing delay asymmetry and false trip in protection relays.

ADC was invented by Nokia to remove the random wait time impact and restore delay symmetry.

After a period of rigorous testing in its own lab, the company enlisted the expertise of the University of Strathclyde to validate ADC's effectiveness. Thorough testing was performed in the university's lab (Fig. 2):

- Two Alstom P545 protection relays connected to a Nokia IP/MPLS lab network
- A Calnex Paragon-X was used to simulate random jitter added to packet flows

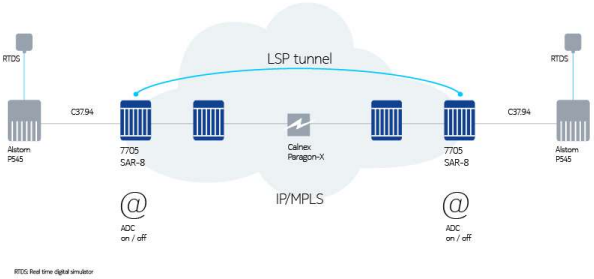

Figure 2: Test configuration

The results were stellar. Without ADC, false trips were observed frequently. When ADC was turned on, no false trips occurred! ADC can indeed empower IP/MPLS to reliably carry current differential protection traffic under all conditions.

Strathclyde and Nokia published a technical paper that detailed the findings of the tests. Strathclyde was invited to present the paper in the recent 13th Developments in Power System Protection (DPSP) conference in Edinburgh, UK.

For a quick read, a one-page summary is also available.

To learn more about carrying teleprotection traffic over IP/MPLS in general and ADC in particular, download the whitepaper Enabling reliable transport for teleprotection.

Our authors look forward to your questions and comments.