

Successful validation of consistent and reliable IP/MPLS communications for line differential protection

Investigation rationale

- As TDM equipment and services are being discontinued, operators are migrating applications to packet technologies
- Protection application communications have stringent quality of service (QoS) requirement
- Verification that IP/MPLS communications can meet critical requirements for line differential protection

IP/MPLS benefits

- TDM services functionality along with the additional benefits of a packet-switched network
- Deterministic quality of service (QoS) and inherent security based on label-switched paths (LSP) and VPN
- Improved bandwidth efficiency and service flexibility
- Application convergence over one network: teleprotection, SCADA, LMR, telephony, video surveillance, wireless broadband, IEC 61850 and IT applications

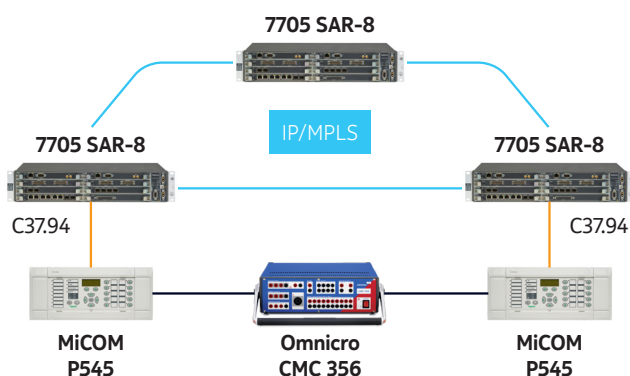
Investigation objective

- Assess the impact of IP/MPLS communications to protection applications performance (channel delay, current measurement accuracy and tripping time)

Validation equipment

- Schneider Electric MiCOM P545 relay, Nokia 7705 Service Aggregation Router (SAR), Omicron CMC 356 relay test set

Test configuration



Conclusion

IP/MPLS network, with proper network configurations, can consistently meet stringent communications requirement and reliably transport safety-critical grid applications.

Results

Test case	Test scenario		Test results	Conclusion
Average channel delay*	1		2.860 ms	PASS
	2		4.218 ms	PASS
	3		4.365 ms	PASS
	4		4.356 ms	PASS
Average differential current measurement accuracy**	1		< 0.67%	PASS
	3		< 0.64%	PASS
	4		< 0.62%	PASS
Average tripping time***	1	1 Amp	26.994 ms	PASS
		2 Amp	25.776 ms	PASS
		5 Amp	24.645 ms	PASS
		10 Amp	24.194 ms	PASS
	2	1 Amp	28.024 ms	PASS
		2 Amp	27.021 ms	PASS
		5 Amp	26.354 ms	PASS
		10 Amp	25.699 ms	PASS
	3	1 Amp	28.616 ms	PASS
		2 Amp	27.670 ms	PASS
		5 Amp	26.711 ms	PASS
		10 Amp	26.223 ms	PASS
	4	1 Amp	28.584 ms	PASS
		2 Amp	27.707 ms	PASS
		5 Amp	26.571 ms	PASS
		10 Amp	26.223 ms	PASS
Channel communications recovery	Failed primary path		Error messages detected; no alarm message	PASS
	Restore primary path		No error or alarm message	

Test scenario 1: Connected directly the two relays

Test scenario 2: Connected the two relays through the IP/MPLS network

Test scenario 3: Injected 160 Mb/s of 128 bytes long background traffic; 7705 SAR-8 network port rate-limited to 100 Mb/s; QoS and ADC enabled

Test scenario 4: Injected 400 Mb/s of 1024 bytes long background traffic; 7705 SAR-8 network port rate-limited to 100 Mb/s; QoS and ADC enabled

* Test results were the average of 500 measurements

** Test results were the average of 500 measurements at rated current input of 1A

*** Test results were the average of 50 measurements