

Solutions for the Alternative Route of the Teleprotection Communication Channel

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Introduction

Optimal alternative communication paths for the teleprotection signals were considered within the company **JP EMS (Serbian Transmission System and Market Operator)** with the aim of increasing the availability of the communication path. Solution has to:

- Meet the requirements expressed in the relevant (IEC 60834) standards – dependability, security and transmission time.
- Take into account the existing network infrastructure as well as location of the communication and teleprotection equipment in substations.

Interfaces Considered in Redundant Communication Path for Teleprotection Signals

Teleprotection terminal possible location:

- In the telecommunications room or
- In the protection equipment room (far from the multiplexer).

The main communication path for the teleprotection is OPGW.

Two interfaces were considered as optimal solutions:

- E12 (ITU-T G.703-2 Mb/s)
- Ethernet (IEEE 802.3).

E12 fully meets the requirements with regard to the standard. Several dozen devices are running already equipped with interface E12.

It was necessary to test the Ethernet interface.

Testing Ethernet Over SDH

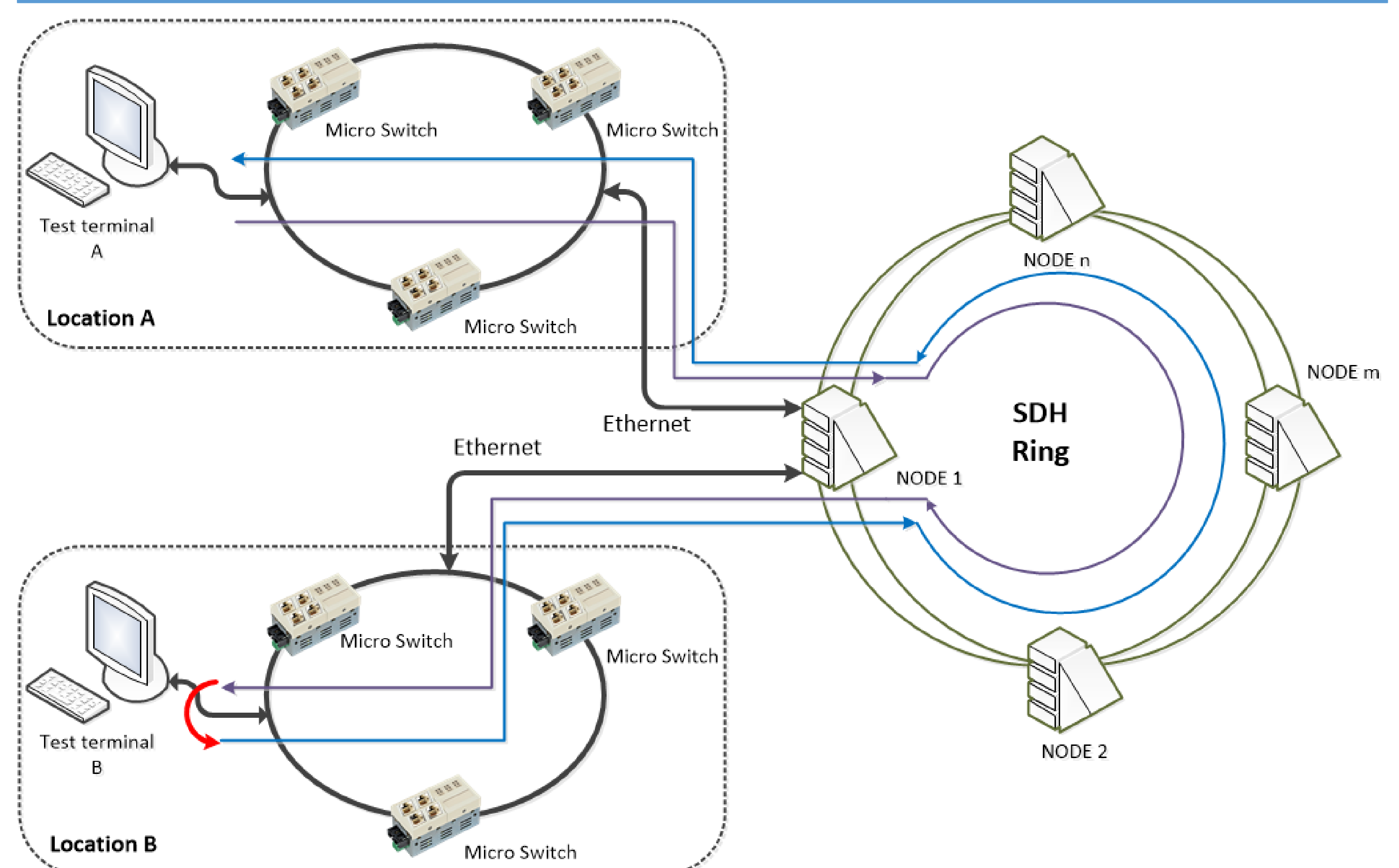
The combination of the Ethernet interface and the SONET/SDH was specially analyzed as the transmission path.

Tests were conducted to determine whether the proposed solution meets the requirements for transmission of the teleprotection signals. During testing, three types of messages were used:

- GOOSE (Generic Object Oriented Substation Message),
- Dedicated and
- Ping (Packet Internet Groper).

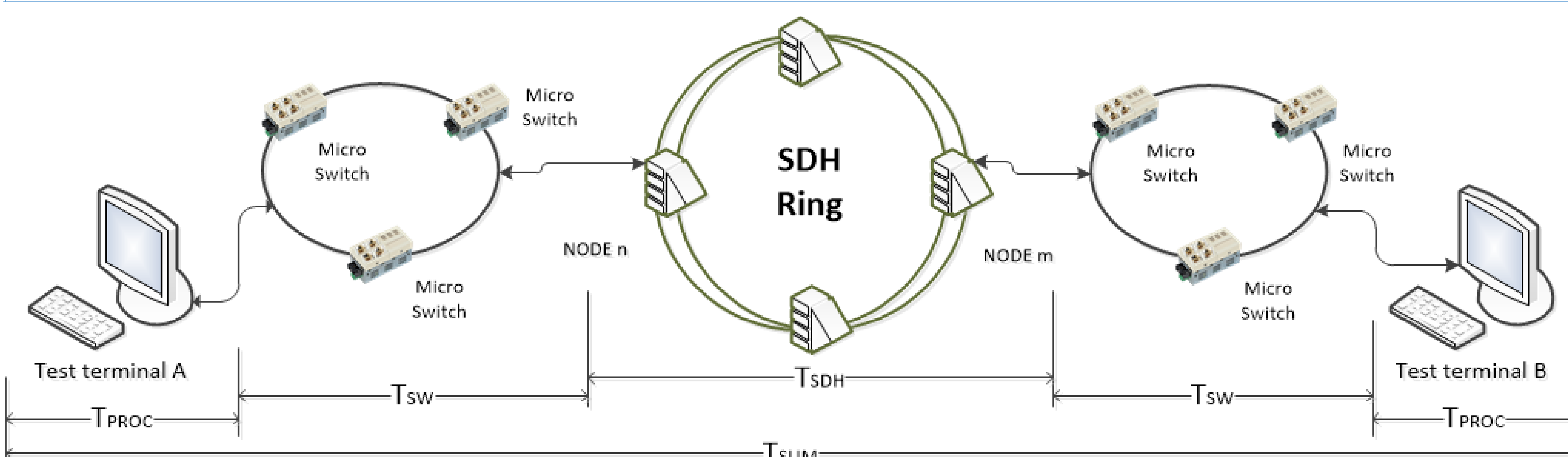
For purposes of testing, the LAN was formed in such a way to simulate almost worst case where the teleprotection terminals could be situated.

Configuration of the VLAN for Testing



Dedicated (unicast) and GOOSE (multicast) messages were generated by the software using protocols from the second and third layer of the OSI model.

Ping messages are the standard tool for testing computer networks, and they are generated using ICMP (Internet Control Message Protocol) Echo function.



The transmission time for all three types of messages was measured for three network configurations:

- With SDH ring and switches – complete configuration ($TSUM = 2 * TPROC + 2 * TSW + TSDH$),
- With SDH ring and without switches ($TSUM = 2 * TPROC + TSDH$),
- Without SDH ring and switches ($TSUM = 2 * TPROC$).

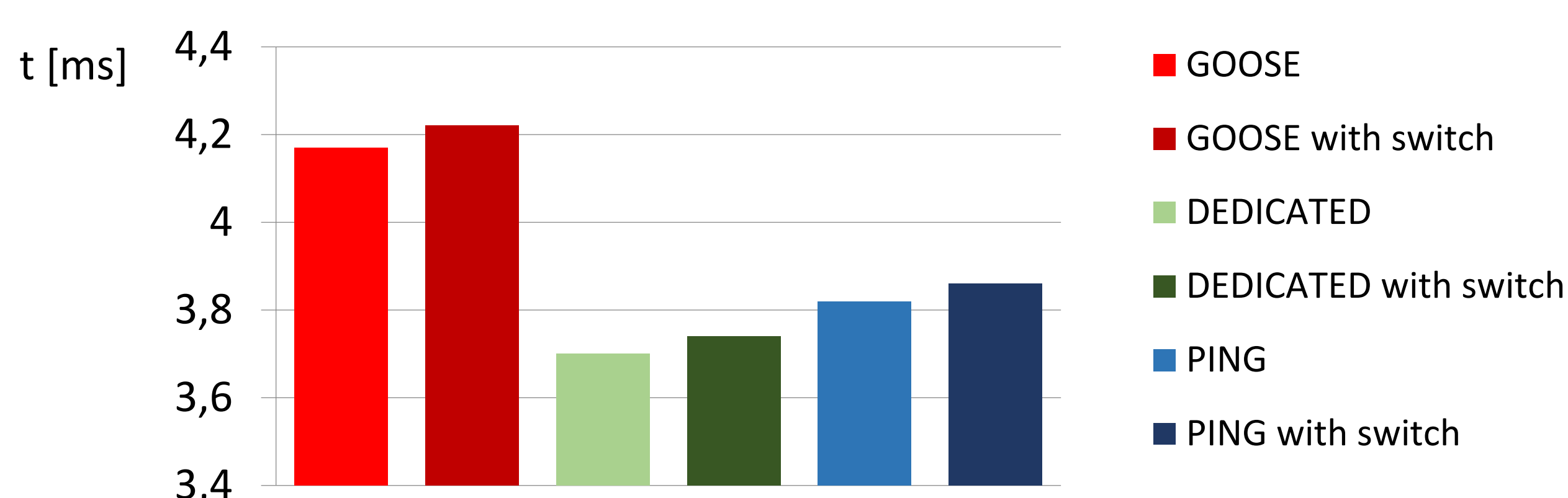
Most of the transmission time is spent in the SDH equipment and is approximately 3 - 3.5 ms.

The Result of Testing and Conclusion

Both interfaces, Ethernet and E12, meet the requirements (dependability, security and transmission time) defined in the relevant standards.

When the teleprotection terminal is situated in the telecommunications room (a rare case in the future) none of the two interfaces has any clear advantage. In other cases in JP EMS telecommunication network Ethernet interface has several advantages in comparison with E12:

- Using Ethernet interface does not require an upgrade of existing telecommunication equipment in the substations.
- The conversion of the interface in order to use packet network is not needed.



Summary Results of the Transmission Time of the Messages

TYPE	SWITCHES	TRANSMISSION TIME [ms]			
		MAX	AVERAGE	MIN	STDEV
GOOSE	no	7.40	4.17	3.96	0.0730
	yes	6.16	4.22	4.02	0.0691
DEDICATED	no	7.59	3.70	3.51	0.0908
	yes	7.29	3.74	3.53	0.0942
PING	no	4.07	3.82	3.65	0.0666
	yes	4.08	3.86	3.67	0.0687

Packet networks are increasingly used in substations, so the coexistence of the packet and the SDH network is utilized in this way. It turned out that the transmission of the teleprotection signals using Ethernet over SDH is an acceptable implementation in the configuration where the teleprotection equipment is connected in the VLAN network.

Test results have shown that the transmission time of the teleprotection commands in the test configuration was significantly below the 10 ms.