DNV·GL

FUNCTIONAL IEC 61850 ETHERNET SWITCH TESTING

This document describes the configuration and test procedures to perform a functional IEC 61850 test of an Ethernet Switch. The functional test includes:

- VLAN handling
- Priority tagging
- Enhanced rapid spanning tree protocol (RSTP) performance.

Test environment

The physical test environment consists of the following components:

- 4 Ethernet switches in a ring
- IEC 61850 GOOSE Publisher with 100MB UTP port
- IEC 61850 GOOSE Subscriber with 100MB UTP port
- IEC 61850 Analyser with one or more 100MB UTP ports
- Background traffic generator with 100MB UTP port.



VLAN handling

The goal of the functional VLAN handling tests is to verify the multicasting of VLAN tagged IEC 61850 GOOSE messages.

Id	Test procedure	Verdict
VLAN1	Check if the VLAN tag in the GOOSE message is correct	
	after passing at least two switches	
VLAN2	Check if a VLAN tagged message only appears on the	
	corresponding port.	
VLAN3	Check if a VLAN tagged message with VID 0 is rewritten to	
	the default VID of the corresponding port.	

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Priority tagging

The goal of the functional priority tagging tests is to verify that higher priority messages will prevail lower priority messages. We expect on a network with mixed priority packages that no high priority packages will be dropped.

Id	Test procedure	Verdict
Prio1	GOOSE simulator sends 1000 messages within 1 second with priority=LOW, with no or less than 5% network traffic	
Prio2	GOOSE simulator sends 1000 messages within 1 second with priority=MEDIUM, with no or less than 5% network traffic	
Prio3	GOOSE simulator sends 1000 messages within 1 second with priority=HIGH, with no or less than 5% network traffic	
Prio4	GOOSE simulator sends 1000 messages within 1 second with the priority lower than the 98 % background traffic on a separate VLAN	
Prio5	GOOSE simulator sends 1000 messages within 1 second with the priority the same as the 98 % background traffic on a separate VLAN	
Prio6	GOOSE simulator sends 1000 messages within 1 second with the priority higher than the 98 % background traffic on a separate VLAN	
Prio7	GOOSE simulator sends 1000 messages within 1 second with the priority lower than the 98 % background traffic on the same VLAN	
Prio8	GOOSE simulator sends 1000 messages within 1 second with the priority the same as the 98 % background traffic on the same VLAN	
Prio9	GOOSE simulator sends 1000 messages within 1 second with the priority higher than the 98 % background traffic on the same VLAN	

Rapid Spanning Tree performance

The goal of the Rapid Spanning Tree tests is to verify the recovery of a single communication failure and to measure the recovery time and the number of packet drops. This may depend on:

- Packet size
- Network load
- Connecting / disconnecting the backbone ring.

During the test GOOSE messages are send on a 1 millisecond period. The measured recovery time is the difference between the timestamp of the last received message before the failure and the timestamp of the first received message after the failure. The packet drop is the difference in sequence number of the last and first received GOOSE message. To meet the performance requirements specified in IEC 61850-5 we expect the recovery time to be about 5-10msec per switch. Such performance is possible with enhanced RSTP.

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Id	Test procedure	Verdict	Measurements (min/max)
Rsp1	Check if Spanning Tree Protocol recovery mechanism works on a backbone disconnect when sending 1000 large GOOSE messages per second in a network with about 98% network traffic on the backbone.		
Rsp2	Check if Spanning Tree Protocol recovery mechanism works on a backbone disconnect when sending 1000 small GOOSE messages per second in a network with about 98% network traffic on the backbone.		
Rsp3	Check if Spanning Tree Protocol recovery mechanism works on a backbone disconnect when sending 1000 large GOOSE messages per second in a network with no traffic		
Rsp4	Check if Spanning Tree Protocol recovery mechanism works on a backbone disconnect when sending 1000 small GOOSE messages per second in a network with no traffic		
Rsp5	Check if Spanning Tree Protocol recovery mechanism works on a backbone connect when sending 1000 large GOOSE messages per second in a network with about 98% network traffic on the backbone.		
Rsp6	Check if Spanning Tree Protocol recovery mechanism works on a backbone connect when sending 1000 small GOOSE messages per second in a network with about 98% network traffic on the backbone.		
Rsp7	Check if Spanning Tree Protocol recovery mechanism works on a backbone connect when sending 1000 large GOOSE messages per second in a network with no traffic		
Rsp8	Check if Spanning Tree Protocol recovery mechanism works on a backbone connect when sending 1000 small GOOSE messages per second in a network with no traffic		

Switch configuration

Before shipping the switches to DNV GL, the manufacturer needs to make sure the following equipment is available and configured:

4 identical configured Ethernet switches

Correct amount of Power Supply Units with the required voltage output

Correct amount of glassfiber cables to connect the backbone ring and equipment.

If the Ethernet switch only contains glassfiber ports provide media convertors to unshielded twisted pair as well.

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Port # Description VID <port> **Background Traffic** 200 Background Traffic 200 <port> <port> GOOSE (edge) 100 100 <port> GOOSE (edge) optional 100 <port> GOOSE (trunk) <port> GOOSE (trunk) optional 100 <port> Management 1 <port> Backbone Ring Up Backbone Ring Down <port>

Every switch needs to be configured as follows:

CoS ValueQuality of Service0, 1LOW PRIORITY2, 3Normal priority (when applicable)4, 5Medium priority (when applicable)6, 7High priority

Testing process and test result

For this functional IEC 61850 Switch test, a DNV GL test engineer performs the tests in approximately 5 days. This time estimate is based on the assumption that all switches are configured as specified, support resources are available during the test and that the test can continue without delay after a failure has been identified. The test is performed at DNV GL. As a result DNV GL will provide the test report in pdf format. The test report includes a one page summary that may be used to inform your customers.

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