

Application Note

Jumbo Frames and MTU Settings Guide for Digital Substations

Author João Jorge | joao.jorge@omicronenergy.com

Date June 27th, 2024

Related OMICRON Product

Every OMICRON's IEC 61850 solution running on Redundant and/or VLAN tagged networks or dealing with communication protocols using Authentication.

Application Area IEC 61850, IEC 62439, Power Utility Communication

Keywords

Jumbo Frame, MTU, PRP, HSR, VLAN

Version v1.0

Document ID ANS_24003_ENU



Abstract

This Guide describes how to adapt your network infrastructure to proper work with redundant networks with PRP or HSR protocols and VLAN tagging or Protocols with Authentication without connection issues due to increased Bytes added for such features.



General information

OMICRON electronics GmbH, including all international branch offices, is henceforth referred to as OMICRON.

The product information, specifications, and technical data embodied in this Application Note represent the technical status at the time of writing and are subject to change without prior notice.

We have done our best to ensure that the information given in this Application Note is useful, accurate and entirely reliable. However, OMICRON does not assume responsibility for any inaccuracies which may be present.

OMICRON translates this Application Note from the source language English into a number of other languages. Any translation of this document is undertaken for local requirements, and in the event of a dispute between the English and a non-English version, the English version of this note shall govern.

All rights, including translation, reserved. Reproduction of any kind, for example, photocopying, microfilming, optical character recognition, and/or storage in electronic data processing systems, requires the explicit consent of OMICRON. Reprinting, wholly or partly, is not permitted.

© OMICRON 2024. All rights reserved. This Application Note is a publication of OMICRON.



Table of contents

1	Safe	ety instructions	4
2	Prob	plematic and Solutions	5
	2.1	Problematic when working in a Digital Substation Environment	5
	2.2	Solution for Ethernet Switches	6
	2.3	Solution for Workstations or Laptops	8



1 Safety instructions

This Application Note may only be used in conjunction with the relevant product manuals which contain all safety instructions. The user is fully responsible for any application that makes use of OMICRON products.

Instructions are always characterized by a > symbol, even if they are included in a safety instruction.

NOTICE

Severe injury, equipment damage or loss of data possible.

- Carefully read and understand the content of this Application Note as well as the manuals of the systems involved before taking them into operation.
- Please contact OMICRON support if you have any questions or doubts regarding the safety or operating instructions.
- Follow each instruction listed in the manuals, especially the safety instructions, since this is the only way to avoid the danger that can occur when working on high voltage or high current systems.
- Only use the equipment involved according to its intended purpose to guarantee safe operation.
- Existing national safety standards for accident prevention and environmental protection may supplement the equipment's manual.
- Before starting a test always check that the test signals are suitable for your system under test.
- It is important to understand test modes and simulation flags as defined by IEC 61850 and how to operate these for IEDs under test, before starting to test in a real-life substation. This topic is out of scope of this application note.

DANGER

Death or severe injury caused by high voltage or current.

 Before wiring up or rewiring the equipment always turn off each system involved to the test process.

Only experienced and competent professionals that are trained for working in high voltage or high current environments may implement this Application Note. Additionally, the following qualifications are required:

- Authorized to work in environments of energy generation, transmission, or distribution, and familiar with the approved operating practices in such environments.
- Familiar with the five safety rules.
- Good knowledge/proficient in working with the OMICRON CMC test sets and IEC 61850 testing procedures.



2 Problematic and Solutions

2.1 Problematic when working in a Digital Substation Environment

The redundant protocols from IEC 62439 add extra size to the transmitted messages over redundant networks.

PRP Protocol add a Trailer:

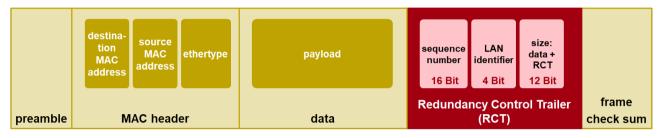


Figure 1 - PRP RCT

HSR Protocol add a Header (HSR Tag):

	destina- tion MAC address	source MAC address	HSR ethertype (0x892F) 16 Bit	path identifier 4 Bit	size 12 Bit	sequence number 16 Bit	ethertype	payload	frame
preambl	e MAC h	leader		HSR	tag			data	check sum

Figure 2 - HSR Header

Also, when working with VLANs we also add extra size to the packets:

		Ether	net header			payload	check sum
preamble	SFD	destination MAC address	source MAC address	VLAN tag	ethertype	PDU	FCS
7 bytes to synchronize to packet sent	1 byte start frame delimiter	6 bytes	6 bytes	4 bytes tag contr	2 bytes indicating which protocol is used in PDU ol information	protocol data unit	4 bytes for frame check sum
			TPID -	l.	TCI DEI VLAN ID		
			tag protocol identifier	code eli	drop virtual gibility LAN licator identifier		

Figure 3 - VLAN tag



Maximum Transmission Unit (MTU) is a measurement in bytes of the largest data packets that an Ethernet connected device can accept.

Some Ethernet Switches have by default a small port MTU setting (like 1518 Bytes) that do not cover these extra bytes added by VLANs or redundancy protocols and may cause communication issues or either no communication. Some Ethernet Adapters of computers may also have small MTU settings that would cause an issue when working for instance with IEDScout or Wireshark.

For example, with the default MTU setting 1518 Bytes, the port transmits the Ethernet packets up to the following size:

- 1518 bytes without VLAN tag (1514 bytes + 4 bytes CRC)
- 1522 bytes with VLAN tag (1518 bytes + 4 bytes CRC)

If you use a PRP redundancy protocol, you may require an MTU that is larger by 6 bytes (depends on specific hardware or switch model/brand). If you use the device in the transfer network with double VLAN tagging, you may require an MTU that is larger by 4 bytes.

Connection issues may also happen if you add extra features to the communication, for example if you add Authentication to the protocols used inside the Substation that increases the size of the packet.

Even issues writing the configuration to relays could be experienced in such situations.

2.2 Solution for Ethernet Switches

Just in case you are suffering connection issues:

Increasing the general MTU Setting

Some switches have a single MTU setting that applies for all their ports, it is recommend increasing it to at least 1530 Bytes to cover most of the cases. Example with Hirshmann MAR1040:

💁 http://192.168.210.175 MACH Rugged Switch - HiView 🦳 🗌	×
File Tools	
Basic Settings System Network Software Port Configuration Power over Ethernet Load/Save Restart Security Filter for MAC Address Filter for MAC Address Frame size O 1522 O 1552 O 9022 Activate Address Relearn Detection Address Relearn Threshold Address Relearn Threshold Address Relearn Threshold Address Relearn Threshold Activate Duplex Mismatch Detection	IN
Help	
Set Reload 🔮	Help

Figure 4 - MTU Global Setting



Increasing the MTU setting per Ethernet port

Some switches have a dedicated MTU setting separated for every specific port, it is recommend increasing it to at least 1530 Bytes to cover most of the cases. Be careful cause using huge MTU setting may decrease the network performance. Example with Hirshmann Bobcat BRS50:

h Port															Ø.	¢ ° e
Hi0S-2S-09.4.03 Q :	* 🗅 🔒															
Basic Settings	-	Configu	iration	Statistics Ing	ress Utilizati	on										
System	- 1															EQ
Network	+															
Out-of-Band over USB	- 1		Port	Name	Port on	State	Autoneg	Manual configuration	Link/Current settings	Manual cable crossing	Flow control	Send trap	мти↑₽	Power state	Power save	Signal
Software	- 1		1/1		\checkmark	\checkmark		1G FDX 🗸		unsupported	\checkmark	\checkmark	1,530		unsu	
Load/Save External Memory	- 1		1/2		_ ~	\checkmark		1G FDX 🚽	-	unsupported	\checkmark	\checkmark	1,530		unsu	
Port	- 1		1/3		_ ~	\checkmark		100M FDX 🗸	100M FDX	unsupported	\checkmark	\checkmark	1,530		unsu	
Restart	- 1		1/4		_ ~	\checkmark		100M FDX 🗸	-	unsupported	\checkmark	\checkmark	1,530		unsu	
C Time	+		1/5		~	\checkmark	\checkmark	1G FDX 🗸	100M FDX	auto-mdix 👻	\checkmark	\checkmark	1,530		•	
Device Security	+		1/6		_ ~	\checkmark	\checkmark	1G FDX 🗸	-	auto-mdix 👻	~	\checkmark	1,530		•	
	_			F	igure 5	- M1	U Cor	figuratior	per Port							

Increasing the MTU setting on the DAN ports of a Redbox

Some Redboxes have a dedicated MTU setting that applies for their redundant DAN ports (Double Attached Node ports), it is recommend increasing it to at least 1530 Bytes to cover most of the cases, please also increase the MTU settings of the SAN (single attached node) ports of the Redbox to the same Bytes value. Example with Hirshmann RSP35:

Navigation 4						
295						IANN
Filter 👻 🗙	PRP Configuration					
L QoS/Priority	Operation On Off					
	Port A			Port B		
L _{L2-Redundancy}	Physical port	1/1		Physical port	1/2	
MRP	Port A admin state	⊙ On ◯ Off		Port B admin state	⊙ On ◯ Off	
Configuration	Supervision packet					
DAN/VDAN Table	Evaluate supervision packets	ζ.				
Proxy Node Table	Supervision packet	sender				
Statistics	Active	⊙ On ○ Off				
L Spanning Tree	Send VDAN packets	Y				
Link Aggregation	Configuration					
Link Backup	мти	1530				
Diagnostics						
Advanced			1 2			?
🕐 Help						

Figure 6 - MTU Configuration for DAN Ports



2.3 Solution for Workstations or Laptops

When configuring larger MTU settings on an Ethernet switch you may need to increase the frame size over the computer Ethernet adapter's setting in order to avoid communication issues for applications that use your laptop's network adapter like IEDScout. It can be done enabling the Jumbo Frame feature of the Ethernet adapter driver.

In computer networking, Jumbo Frames are Ethernet frames with more than 1500 bytes of payload, the limit set by the IEEE 802.3 standard. The payload limit for Jumbo Frames is variable: while 9000 bytes is the most used limit, smaller and larger limits exist. Many Gigabit Ethernet switches and Gigabit Ethernet network interface controllers and some Fast Ethernet switches and Fast Ethernet network interface cards can support jumbo frames. For our case with Digital Substations, we can also use a setting like 1530 Bytes.

RJ45 Interno Properties × Intel(R) Ethernet Connection (11) I219-V Properties \times Networking Sharing General Advanced Driver Details Events Power Management Connect using ny following p perties are available for this network adapter. Click the Intel(R) Ethernet Connection (11) I219-V property you wa o change on the left, and then select its value on the right Configure .. Value Property: This connection uses the following items: Adaptive Inter-Frame pacing 1530 + ~ Enable PME Client for Microsoft Networks ~ Energy Efficient Ethern ~ VMware Bridge Protocol Flow Control 🗹 🏪 File and Printer Sharing for Microsoft Networks Gigabit Master Slave Mod ~ Npcap Packet Driver (NPCAP) Interrupt Moderation Interrupt Moderation Rate ✓ QoS Packet Scheduler IPv4 Checksum Offload ~ Topaz OFD Network Monitor 🗹 🐙 Bridge Driver Large Send Offload V2 (IPv4) Large Send Offload V2 (IPv6) e Legacy Switch Compatibility Mode Link Speed Battery Saver Install. Uninstall Locally Administered Address Log Link State Event Description Allows your computer to access resources on a Microsoft network OK Cancel OK Cancel

Figure 7 - Step by Step enabling Jumbo Frame

Sometimes the "Advanced" tab of the Ethernet driver may not be available, or the Jumbo Packet setting may not be available, this may happen if you have outdated Ethernet driver, so please upgrade your driver in this case.

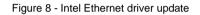
Main Ethernet Adapter manufacturers allow you to directly download their driver updates:

https://www.intel.com/content/www/us/en/download-center/home.html

Example:



ntel.	PRODUCTS	SUPPORT	SOLUTIONS	DEVELOPERS	PARTNERS	FOUNDRY		
Drivers & S	oftware							
		Intel [®] N	Vetwork	< Adapt	er Driv	er for W	/indows ^a	® 10
		ID	Date	Versio	n			
		18293	5/8/2024	29.	1 (Latest) 🗸 🗸			



	REALTEK	搜尋	Q	🏶 English 🗸
Windo	WS			
Download	Description	Version	Update Time	File Size
*	Win10/Win11 Auto Installation Program (NDIS) - Not Support Power Saving	10.71	2024/06/11	5 MB
*	Win10/Win11 Auto Installation Program (NDIS)	10.71	2024/06/11	5 MB

Figure 9 - Realtek Ethernet driver update

Note: In case you are suffering connection issues and had to change the MTU or Jumbo Frame settings in the Laptops and Switches, please try to use the same MTU settings in Bytes for all network devices.



2.4 Solution for Relays

Some specific relays have a setting for the MTU of their communication interfaces that may also be changed:

							h Netwo			evice vi	ew
BCU Line 1		▶ 🖽	6	•	🔍 ±						
				(8202	Base mou						< ■
	6	5	4	3	1						
					_		100%		-		~
¢ IIII		_					100%	1			
K IIII N: ETH-BD-2FO [Sip	rotec5_(ComMod	uleData	.SIPRO	TEC.ComM		100%	况 Diag			
	rotec5_(ComMod	uleData	.SIPRO	TEC.ComM			🛿 Diag			_
N: ETH-BD-2FO [Sip	rotec5_(Π			TEC.ComM			🛚 Diag			_
N: ETH-BD-2FO [Sip General IP interfaces		Π	uleData I size set		TEC.ComM			C Diag			_
N: ETH-BD-2FO [Sip General		мти		ttings _				Diag			_
Seneral General IP interfaces IP interface 1 settin MTU size settings		мти	l size set TU size	ttings _	s		i Info i				
A: ETH-BD-2FO [Sip General IP interfaces IP interfaces 1 setting IMU size settings IP Toutes Details		мти	l size set TU size : 104.10	ttings setting: 31.5281.	s 115	Properties	Linfo Li	1500			_
A: ETH-BD-2FO [Sip General IP interfaces IP interfaces 1 setting IMU size settings IP Toutes Details		мти	l size set TU size : 104.10	ttings _	s 115		Linfo Li	1500			
N: ETH-BD-2FO [Sip General IP interfaces IP interface 1 setting IP routes Details Protocols Communication		мти	l size set TU size : 104.10	ttings setting: 31.5281.	s 115	Properties	Linfo Li	1500			
A: ETH-BD-2FO [Sip General IP interfaces IP interface 1 setting IP routes Details Protocols		мти	l size set TU size : 104.10	ttings setting: 31.5281.	s 115	Properties	Linfo Li	1500			
I: ETH-BD-2FO [Sip General IP interfaces IP interface 1 settin MTU size settings IP routes Details Protocols Communication Redundancy		мти	l size set TU size : 104.10	ttings setting: 31.5281.	s 115	Properties	Linfo Li	1500			-
A: ETH-BD-2FO [Sip General IP interfaces IP interfaces 1 settin MTU Size settings IP Pottes Details Protocols Communication Redundancy Network Service		мти	l size set TU size : 104.10	ttings setting: 31.5281.	s 115	Properties	Linfo Li	1500			
N: ETH-BD-2FO [Sip General IP interfaces IP interfaces 1 settin MTU Size settings IP Pottes Details Protocols Communication Redundancy Network Service		мти	l size set TU size : 104.10	ttings setting: 31.5281.	s 115	Properties	Linfo Li	1500			-
N: ETH-BD-2FO [Sip General IP interfaces IP interface 1 settings IP routes Details Protocols Communication Redundancy Network Service Settings		мти	l size set TU size : 104.10	ttings setting: 31.5281.	s 115	Properties	Linfo Li	1500			

Figure 10 - MTU setting for protection relay



Support

When you are working with our products, we want to provide you with the greatest possible benefits. If you need any support, we are here to assist you.



OMICRON Support – get in touch

omicronenergy.com/support

At our support hotline, you can reach well-educated technicians for all of your questions.

Make use of our 24/7 hotlines:

Americas: +1 713 830-4660 or +1 800-OMICRON Asia-Pacific: +852 3767 5500

Europe / Middle East / Africa: +43 59495 4444

Additionally, you can find the service center or sales partner closest to you at omicronenergy.com.



OMICRON Customer Portal – stay informed

my.omicronenergy.com

Browse through the knowledge library and find manuals, application notes, conference papers, and much more.

Download the latest software updates and learn about upcoming events.



OMICRON Academy – learn more

omicronenergy.com/academy

Learn more about your product in one of the training courses offered by the OMICRON Academy.

For more information, additional literature, and detailed contact information of our offices worldwide please visit our website.