

Application Note

Jumbo Frames and MTU Settings Guide for Digital Substations

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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

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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

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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:

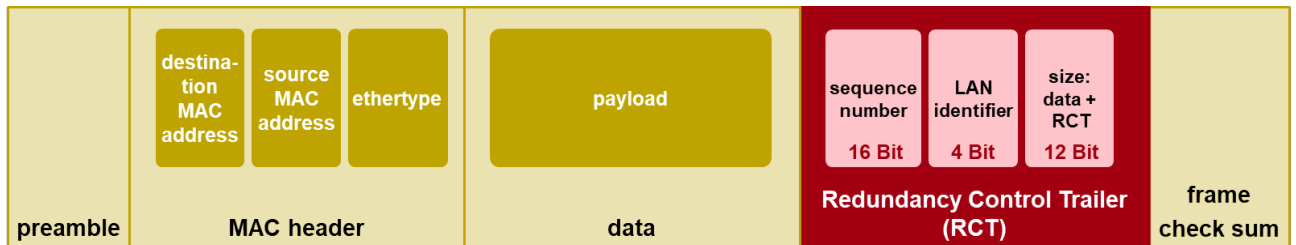


Figure 1 - PRP RCT

HSR Protocol add a Header (HSR Tag):

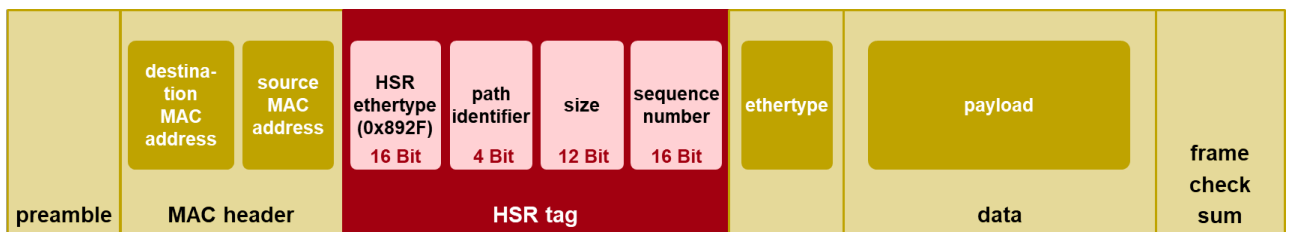


Figure 2 - HSR Header

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

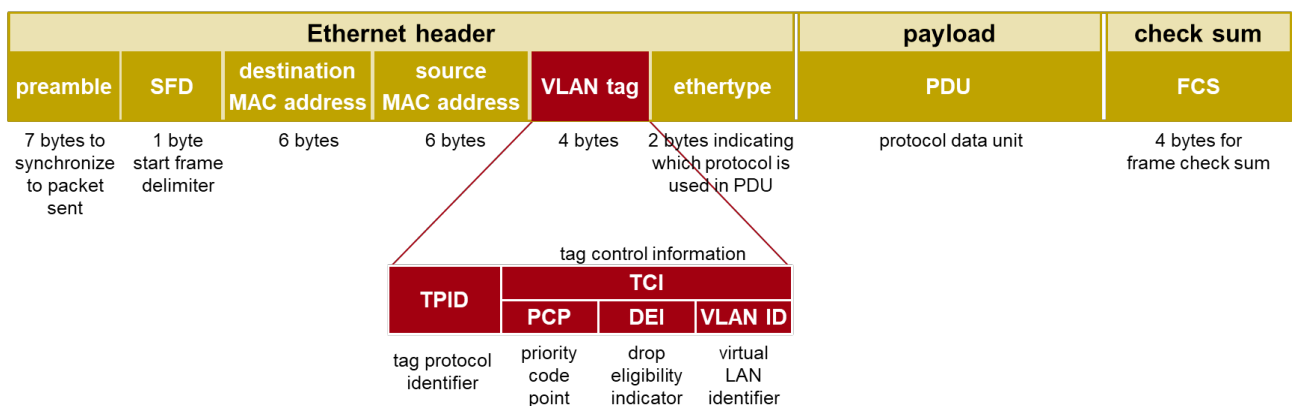


Figure 3 - VLAN tag

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:

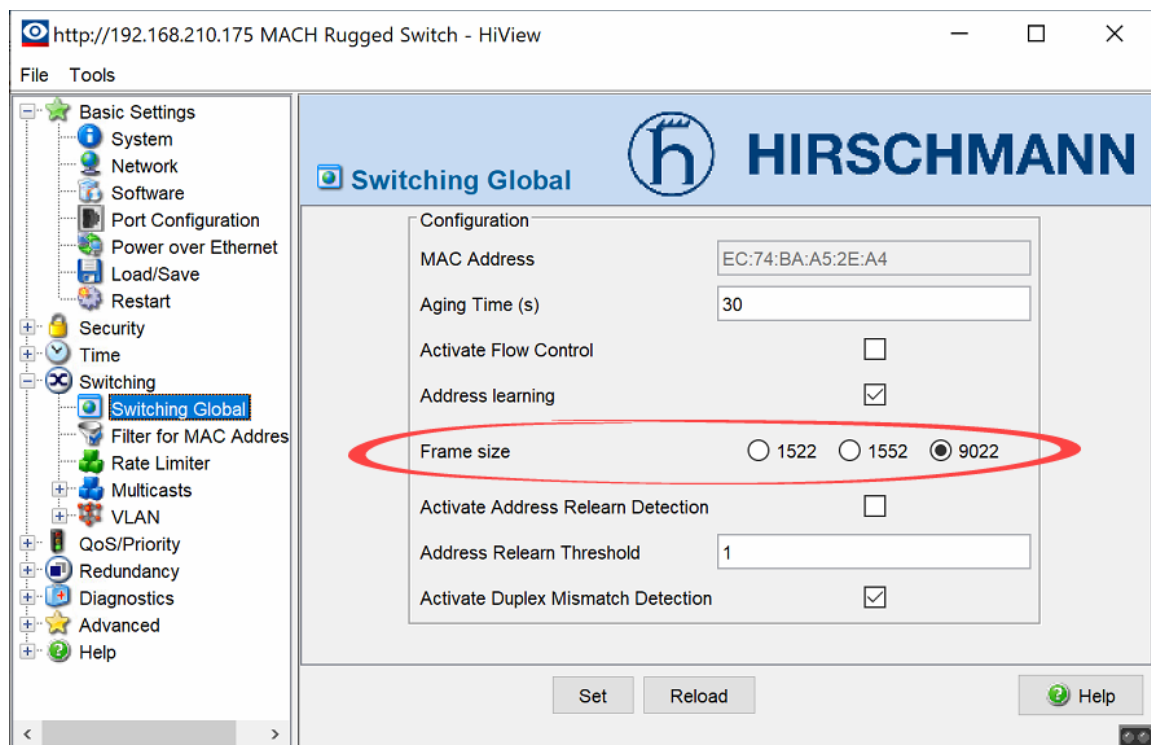
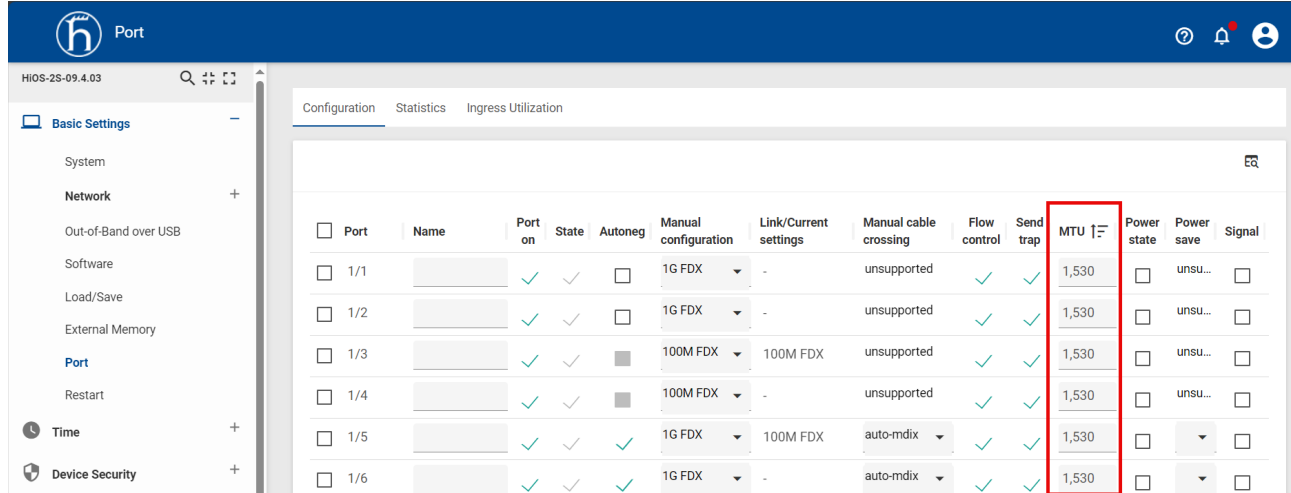


Figure 4 - MTU Global Setting

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:

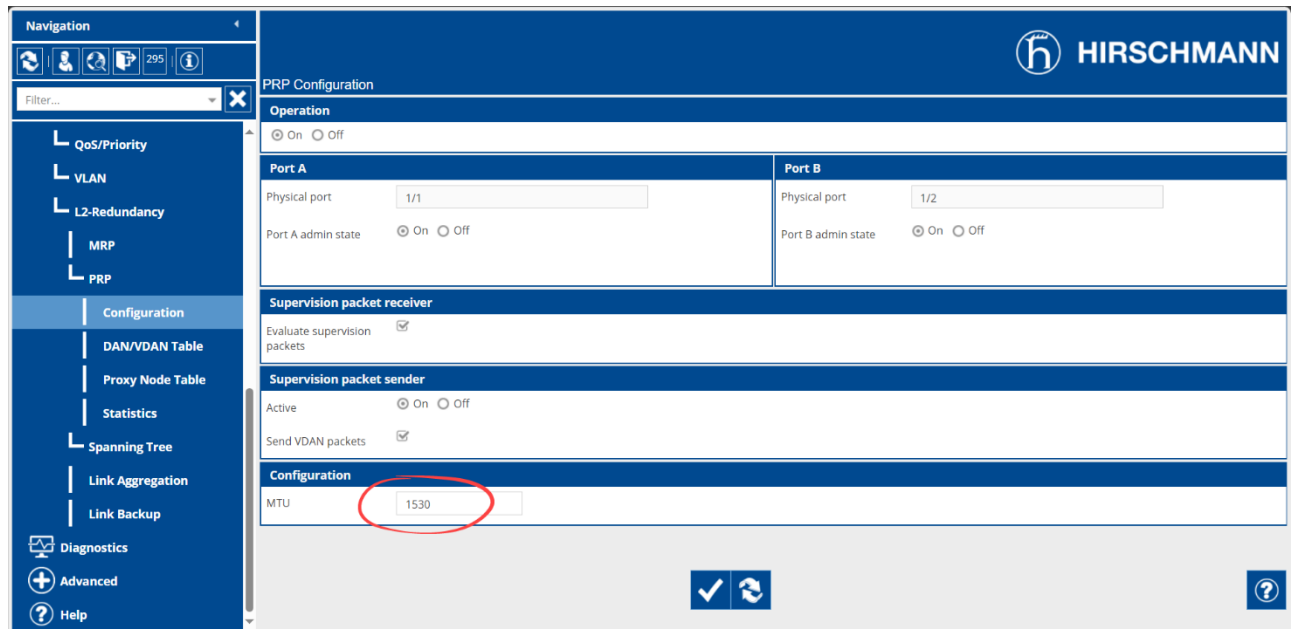


Port	Name	Port on	State	Autoneg	Manual configuration	Link/Current settings	Manual cable crossing	Flow control	Send trap	MTU	Power state	Power save	Signal
1/1		✓	✓	<input type="checkbox"/>	1G FDX	-	unsupported	✓	✓	1,530	<input type="checkbox"/>	unsu...	<input type="checkbox"/>
1/2		✓	✓	<input type="checkbox"/>	1G FDX	-	unsupported	✓	✓	1,530	<input type="checkbox"/>	unsu...	<input type="checkbox"/>
1/3		✓	✓	<input checked="" type="checkbox"/>	100M FDX	100M FDX	unsupported	✓	✓	1,530	<input type="checkbox"/>	unsu...	<input type="checkbox"/>
1/4		✓	✓	<input checked="" type="checkbox"/>	100M FDX	-	unsupported	✓	✓	1,530	<input type="checkbox"/>	unsu...	<input type="checkbox"/>
1/5		✓	✓	<input checked="" type="checkbox"/>	1G FDX	100M FDX	auto-mdix	✓	✓	1,530	<input type="checkbox"/>	▼	<input type="checkbox"/>
1/6		✓	✓	<input checked="" type="checkbox"/>	1G FDX	-	auto-mdix	✓	✓	1,530	<input type="checkbox"/>	▼	<input type="checkbox"/>

Figure 5 - MTU Configuration 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

- QoS/Priority
- VLAN
- L2-Redundancy
 - MRP
 - PRP
- Configuration**
 - DAN/VDAN Table
 - Proxy Node Table
 - Statistics
 - Spanning Tree
 - Link Aggregation
 - Link Backup
- Diagnostics
- Advanced
- Help

PRP Configuration

Operation: ☒ On ☐ Off

Port A

Physical port: 1/1

Port A admin state: ☒ On ☐ Off

Port B

Physical port: 1/2

Port B admin state: ☒ On ☐ Off

Supervision packet receiver

Evaluate supervision packets: ☒

Supervision packet sender

Active: ☒ On ☐ Off

Send VDAN packets: ☒

Configuration

MTU: 1530

✓ ↺ ?

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.

Example:

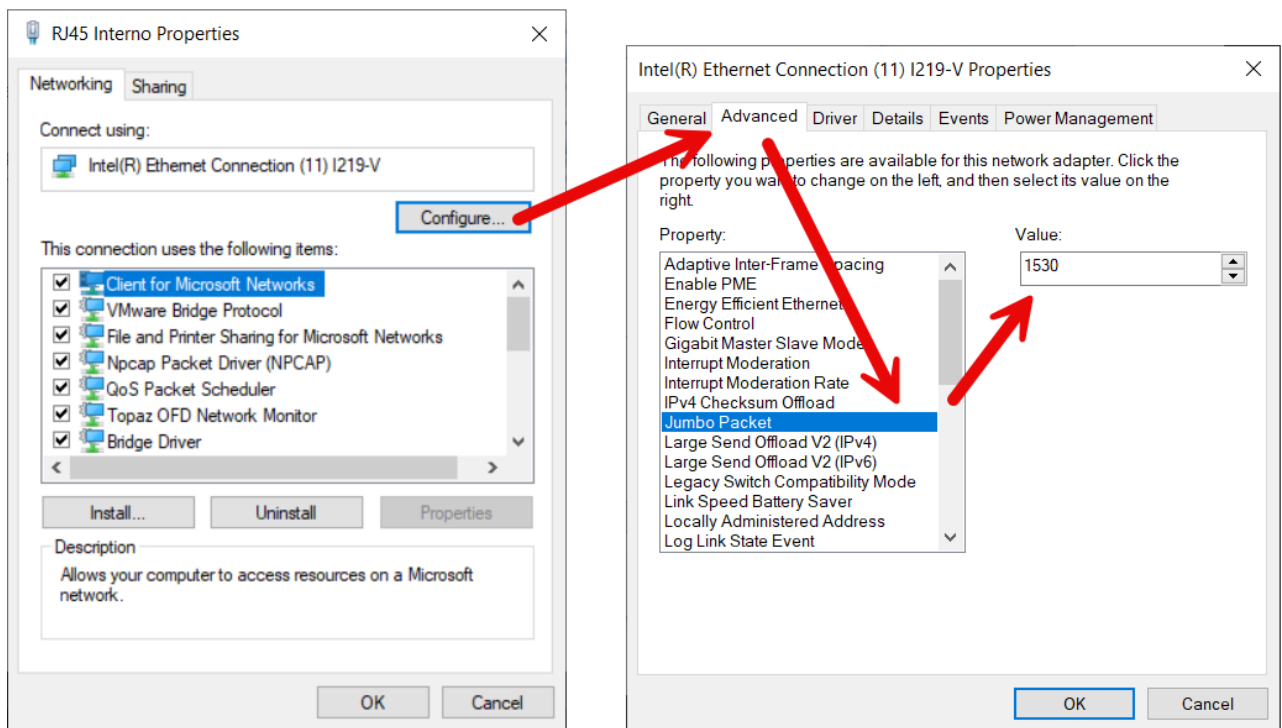


Figure 7 - Step by Step enabling Jumbo Frame

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>

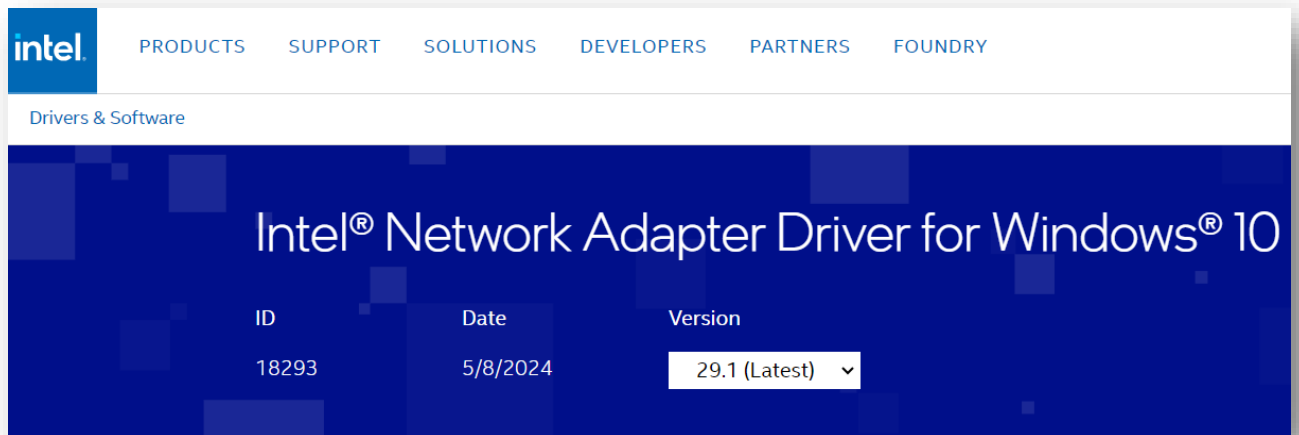


Figure 8 - Intel Ethernet driver update

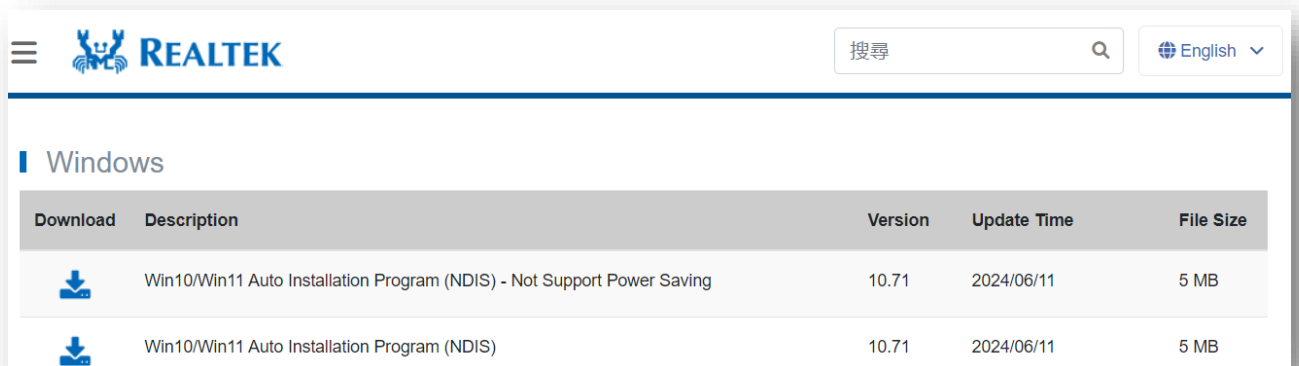


Figure 9 - Realtek Ethernet driver update

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:

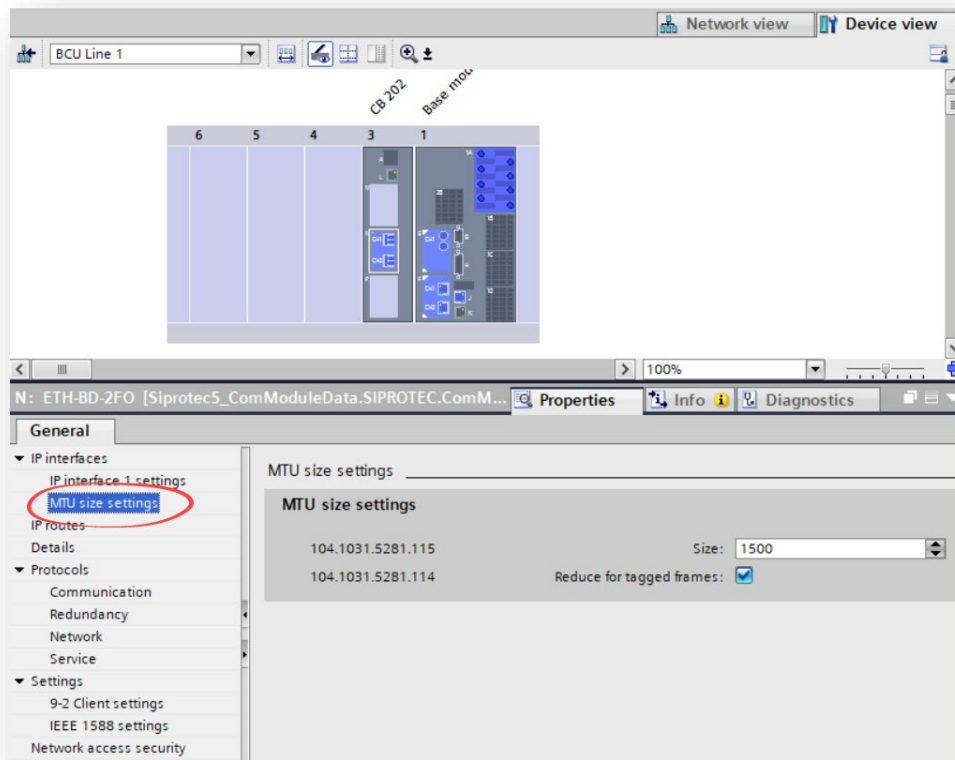


Figure 10 - MTU setting for protection relay

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.



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

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