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OT Cybersecurity

Fundamentals

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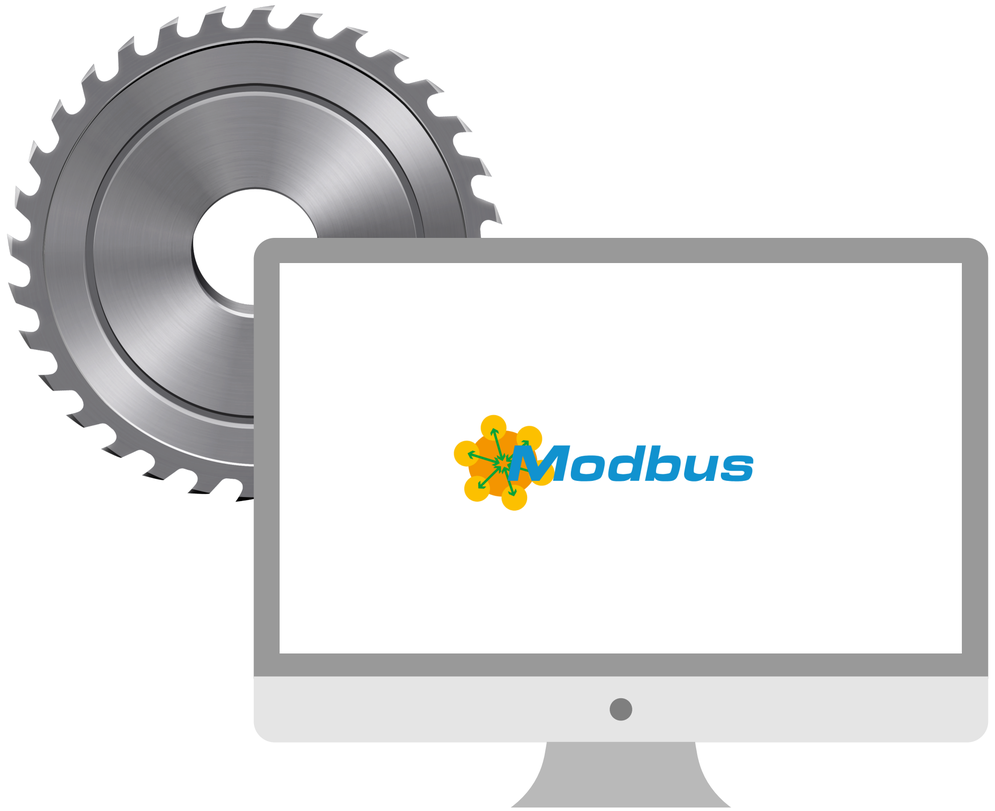
Introduction to OT

OT Cybersecurity Fundamentals

OT Communications & Protocols

What are OT protocols?
Modbus Protocol Technical Analysis
IETF RFC
Exercise 1: Modsim - Modscan
Exercise 2: Wireshark Analysis
Exercise 3: HMI using Winlog lite



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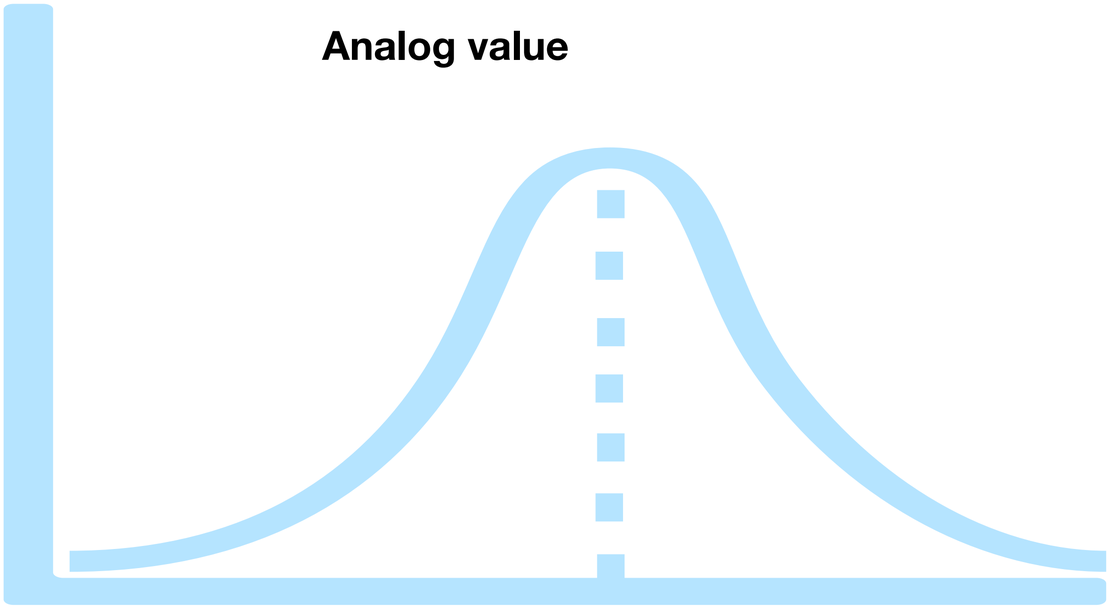
Recap on Sensors

To understand the OT communications protocols we need to understand what types of signals it carries.

Digital value

Binary output signal in the form of a logic “1” or a logic “0”, (“ON” or “OFF”)

Analog value



Produces a continuous output signal or voltage .

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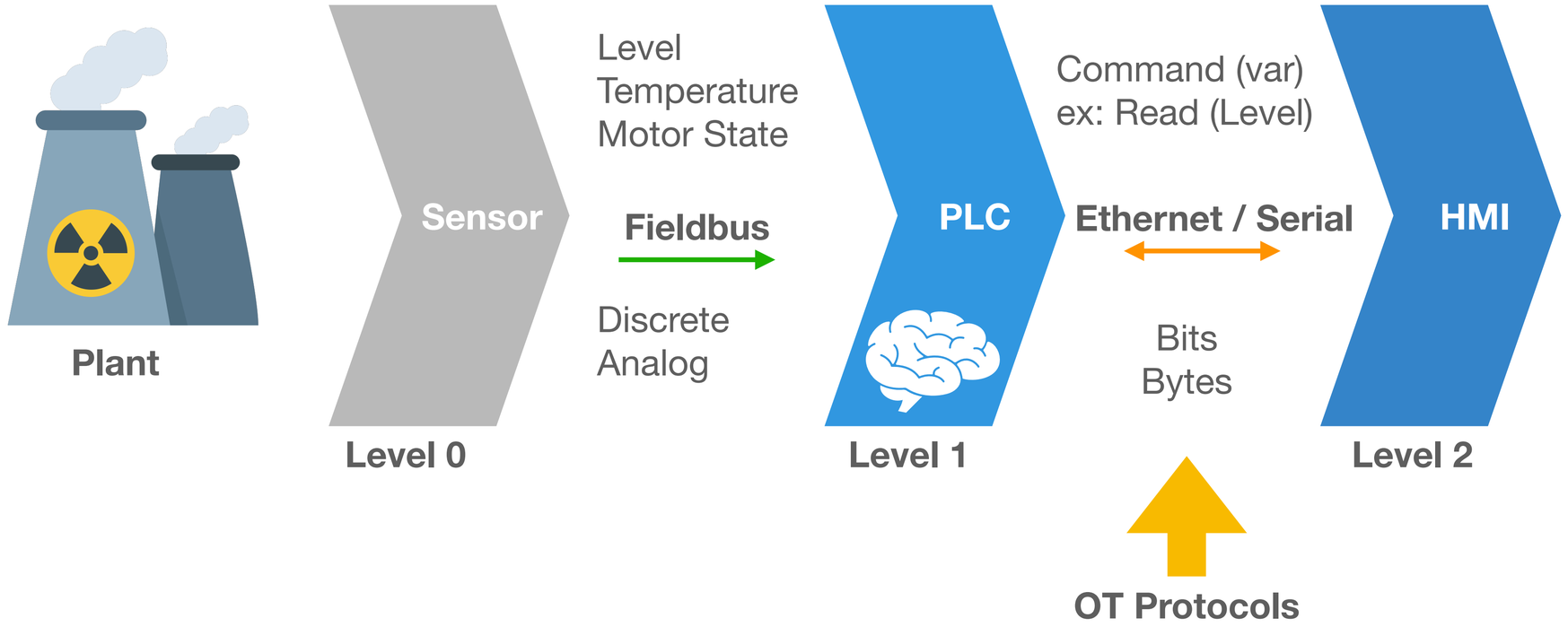
Recap on Supervise and Control

Supervise: Read Values coming from Input devices either discrete or analog (tags)
Control: Setpoints / control commands.



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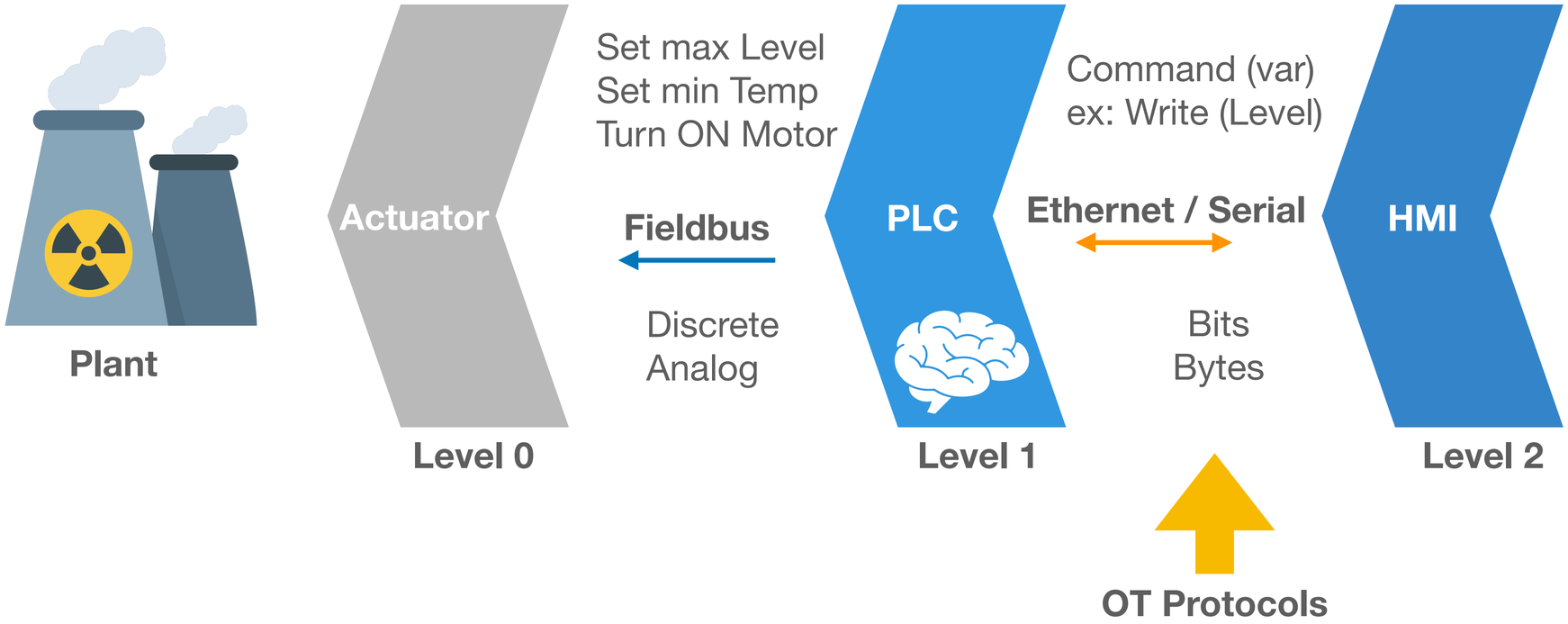

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Operational Technology Protocols

Insecure by design!

Process Automation	Industrial Control Systems	Building Management Systems	Power System Automation	Automatic Meter Reading	Automobile/ Vehicle
CIP	**OPC**	BACnet	**DNP3**	IEC-61107	CAN
Modbus	OPC UA	LonTalk	IEC-60870-5	ZigBee	FlexRay
DNP3	OMG DDS	**Modbus**	**IEC-61850**	**Modbus**	LIN
EtherNet/IP	MTConnect	ZigBee	ICCP	…	…
HART	**Modbus**	…			
PROFINET					
GE SRTP					
…					

Internet Engineering Task Force (IETF) **www.ietf.org**

Responsible of the design and technical specifications of the protocols in the form of RFC (Request For Comments)

Insecure by design, lack authentication, authorization, and encryption.

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Modbus

About?	Designed in 1979 by Modicon (part of Schneider Electric) that invented the first PLC. It's an open standard, freely distributed and is widely supported by Modbus Organization.
What?	It communicates raw messages without restrictions of authentication or excessive overhead. It allows for efficient communications between assets based on request/reply methodology.
Protocol	An application layer messaging protocol (Layer 7 of OSI model). Request / Response protocol using three distinct Protocol Data Units (PDUs): (1) Modbus Request (2) Modbus Response (3) Modbus Exception Response

Schneider Electric MODICON

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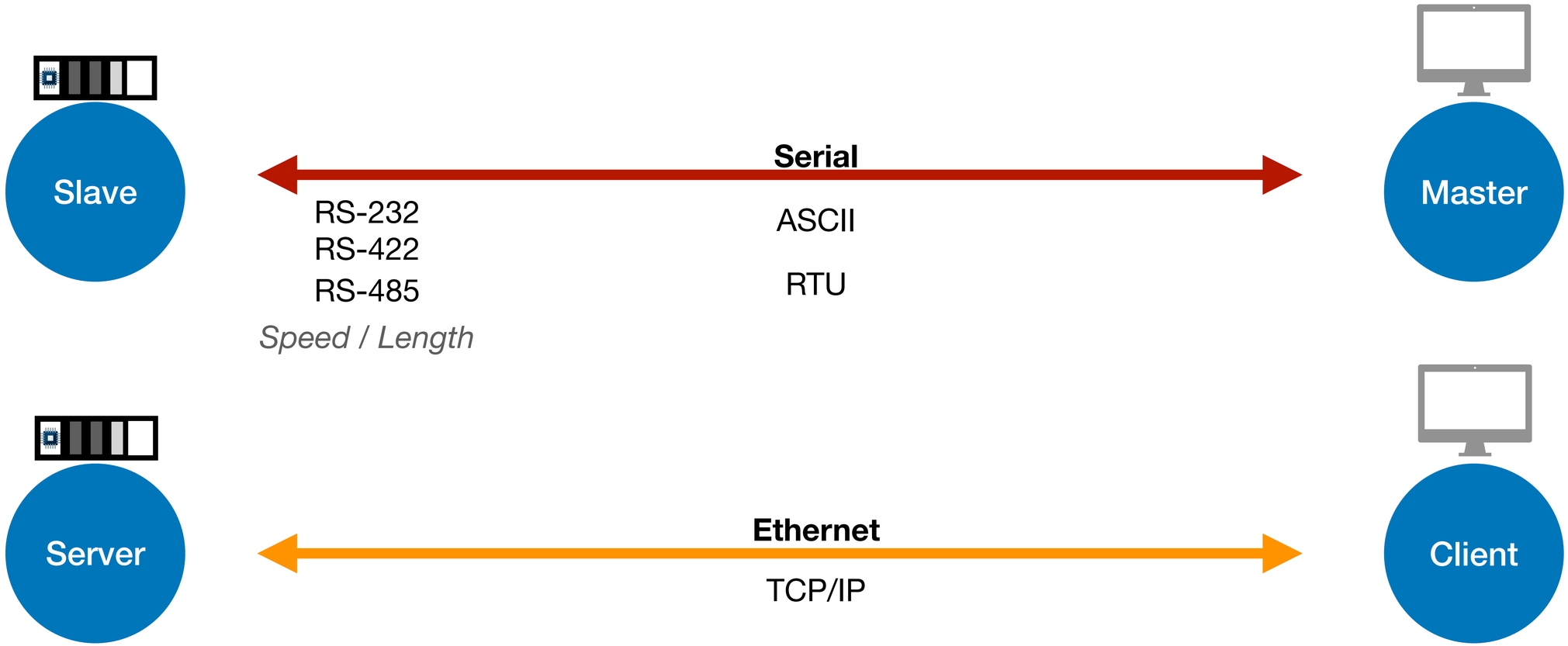
Modbus Communications



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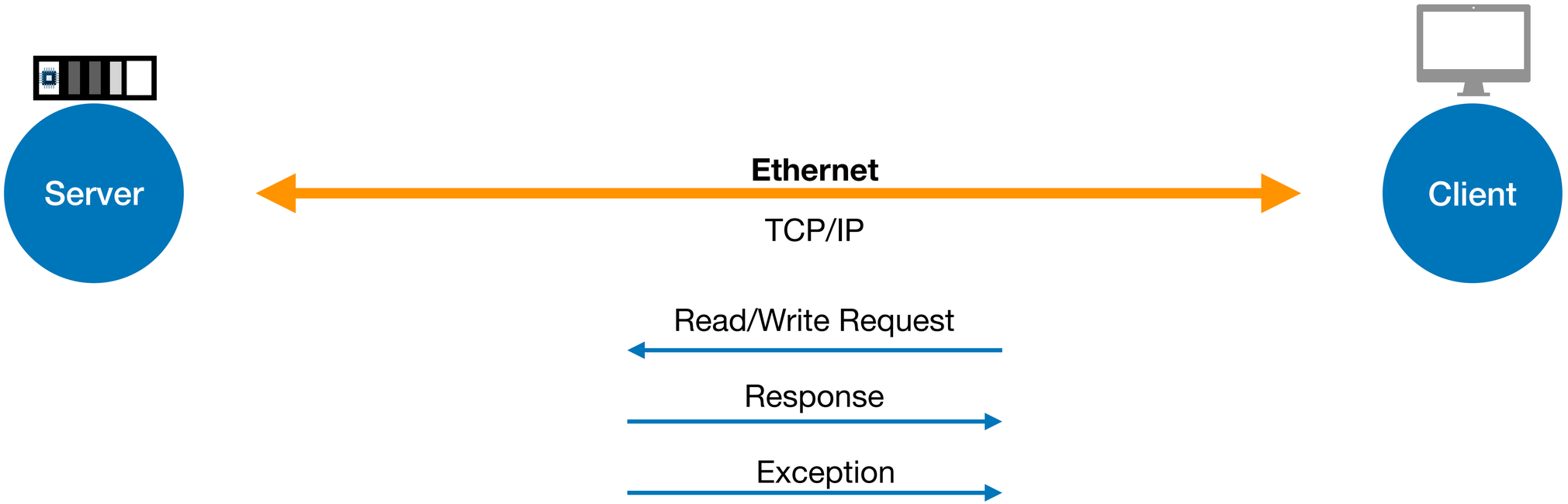
Modbus TCP Communications



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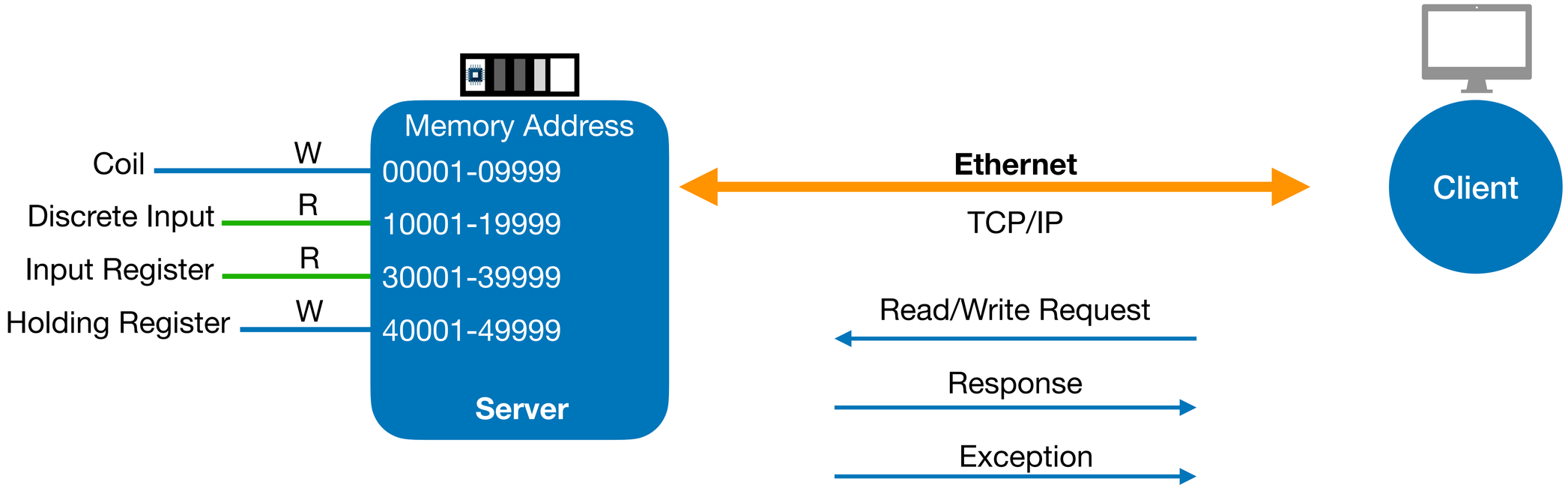

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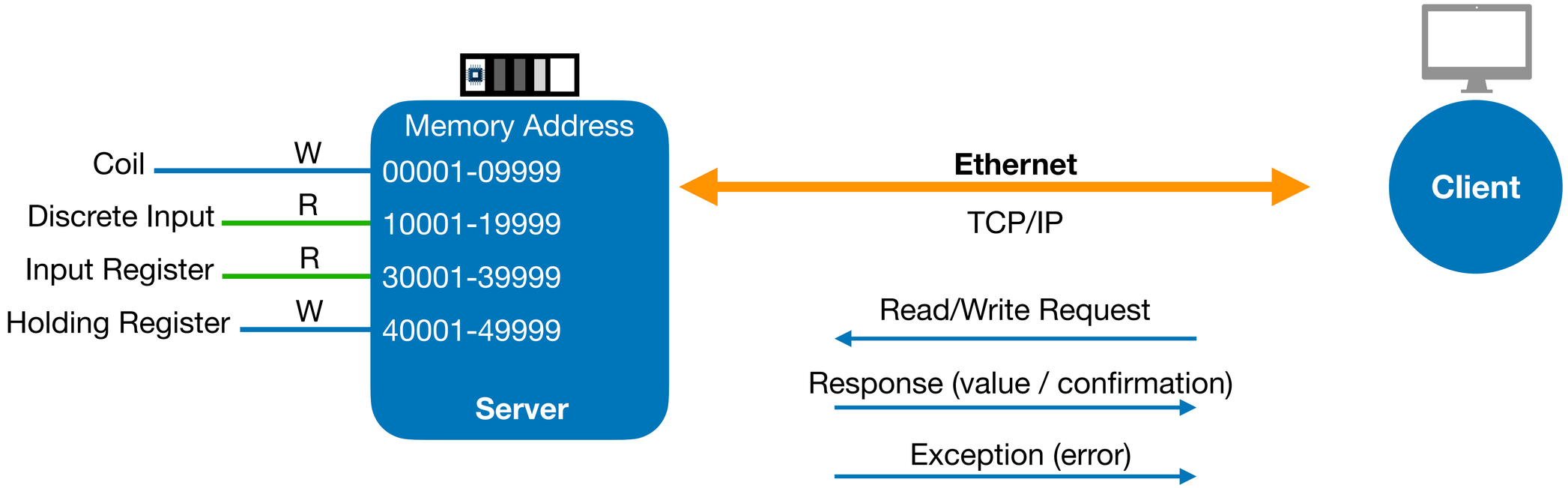
Modbus TCP Communications



Discrete value (0 or 1)

Coil (Read / Write)

Discrete Input (Read only)

Registers (Numeric 16 bits)

Input Register (Read only)

Holding Register (Read / Write)

9999 values for each type

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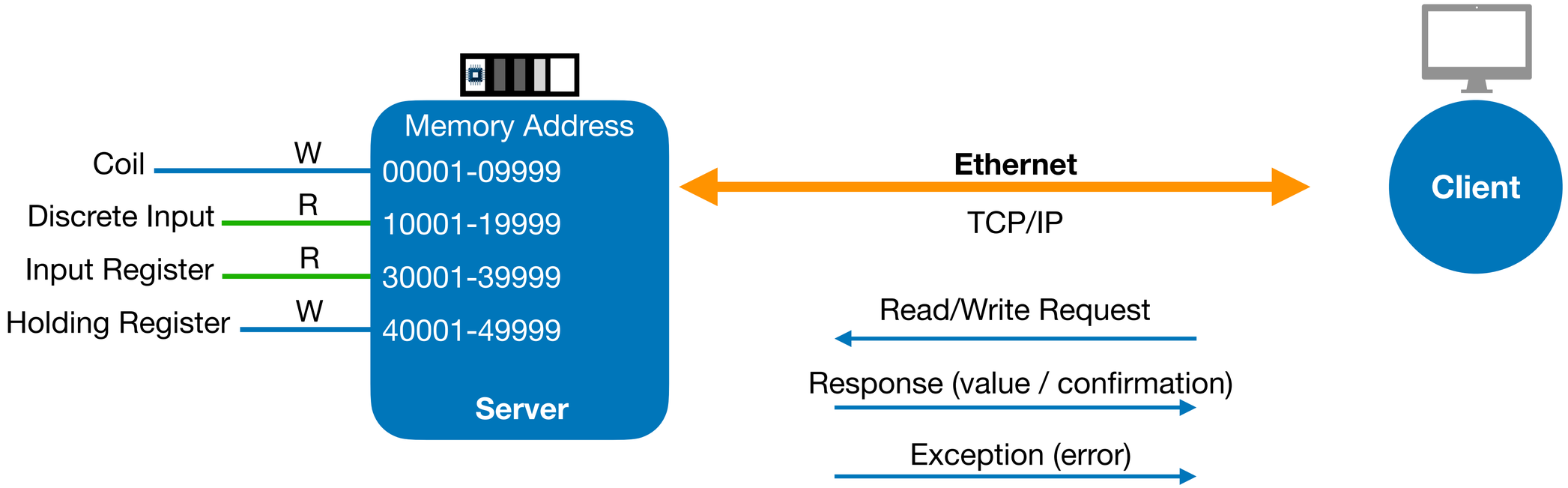
Modbus TCP Communications



Unit Identifier: Each Server has unique ID
Function Code: Each operation represented by specific code
Memory Address: Code (read / write) to which address?

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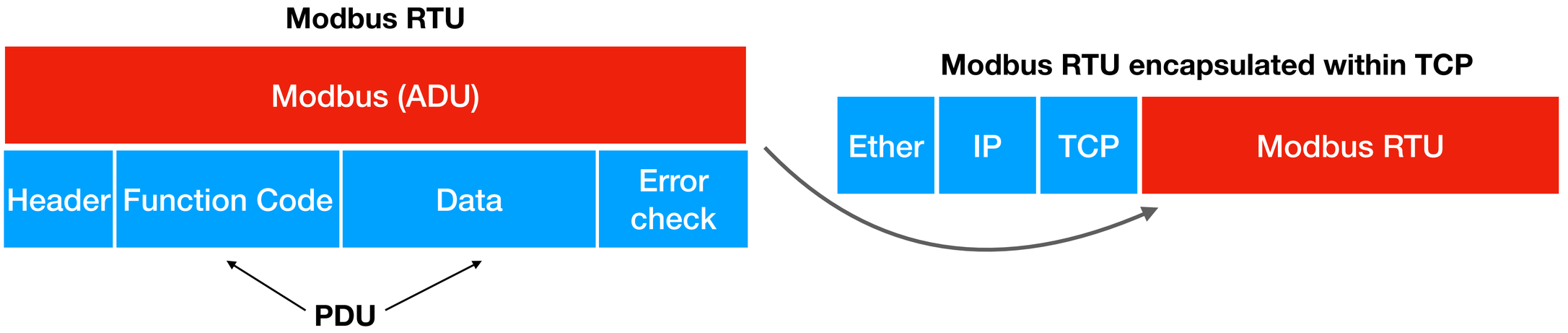
Modbus TCP Communications



ADU: Application Data Unit
PDU: Protocol Data Unit

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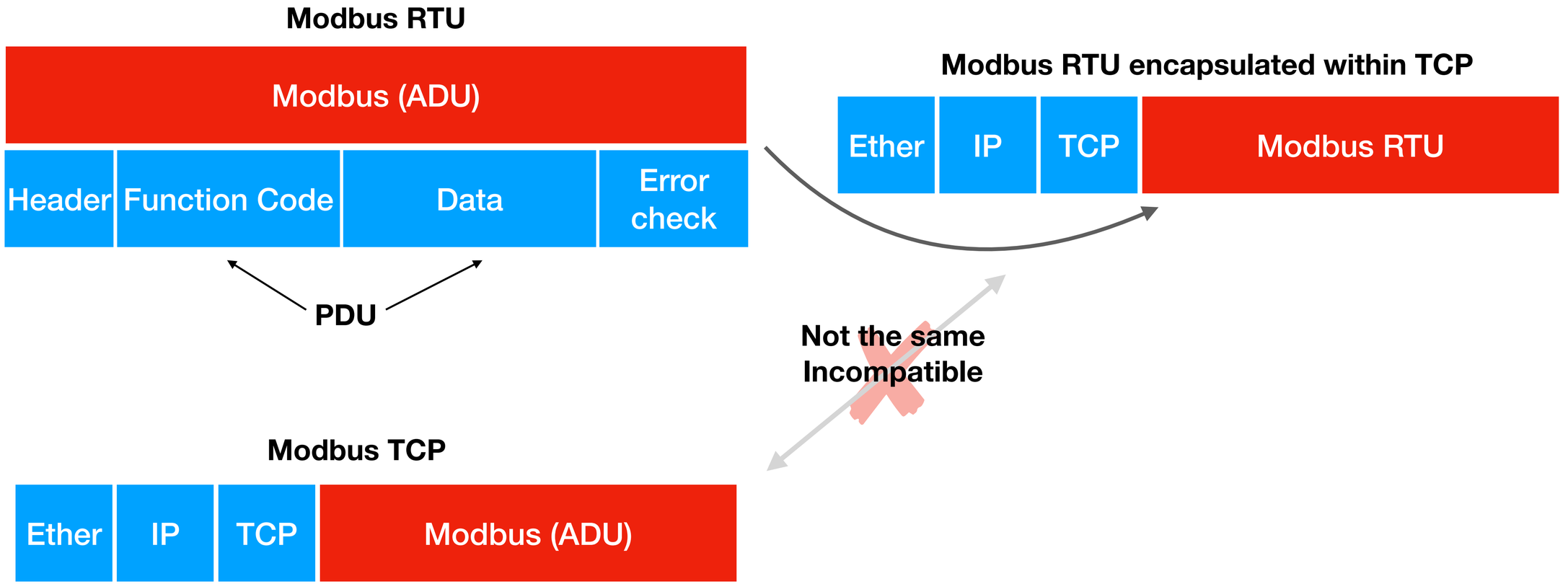
Modbus TCP Communications



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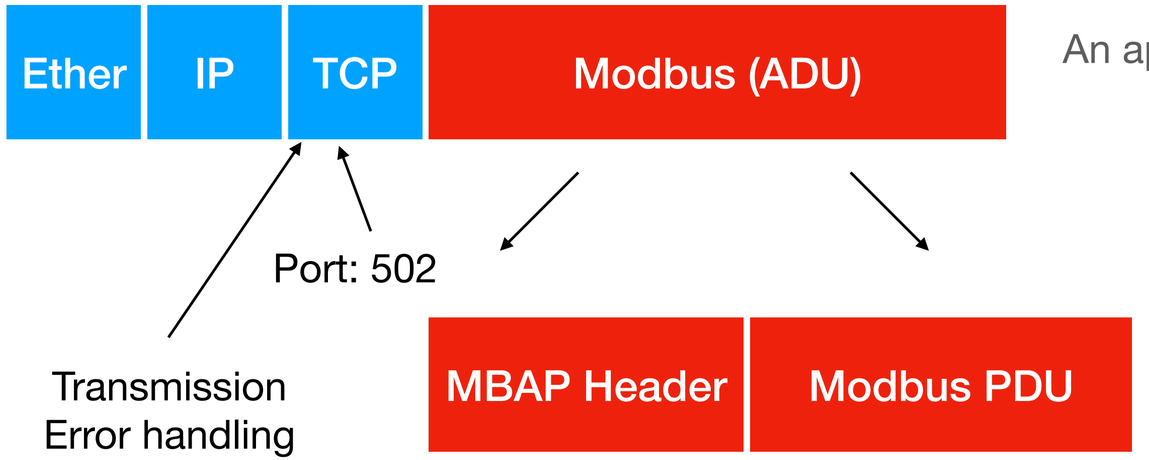

An application layer messaging protocol (Layer 7 of OSI model).

ADU: Application Data Unit
MBAP: Modbus Application Protocol
PDU: Protocol Data Unit

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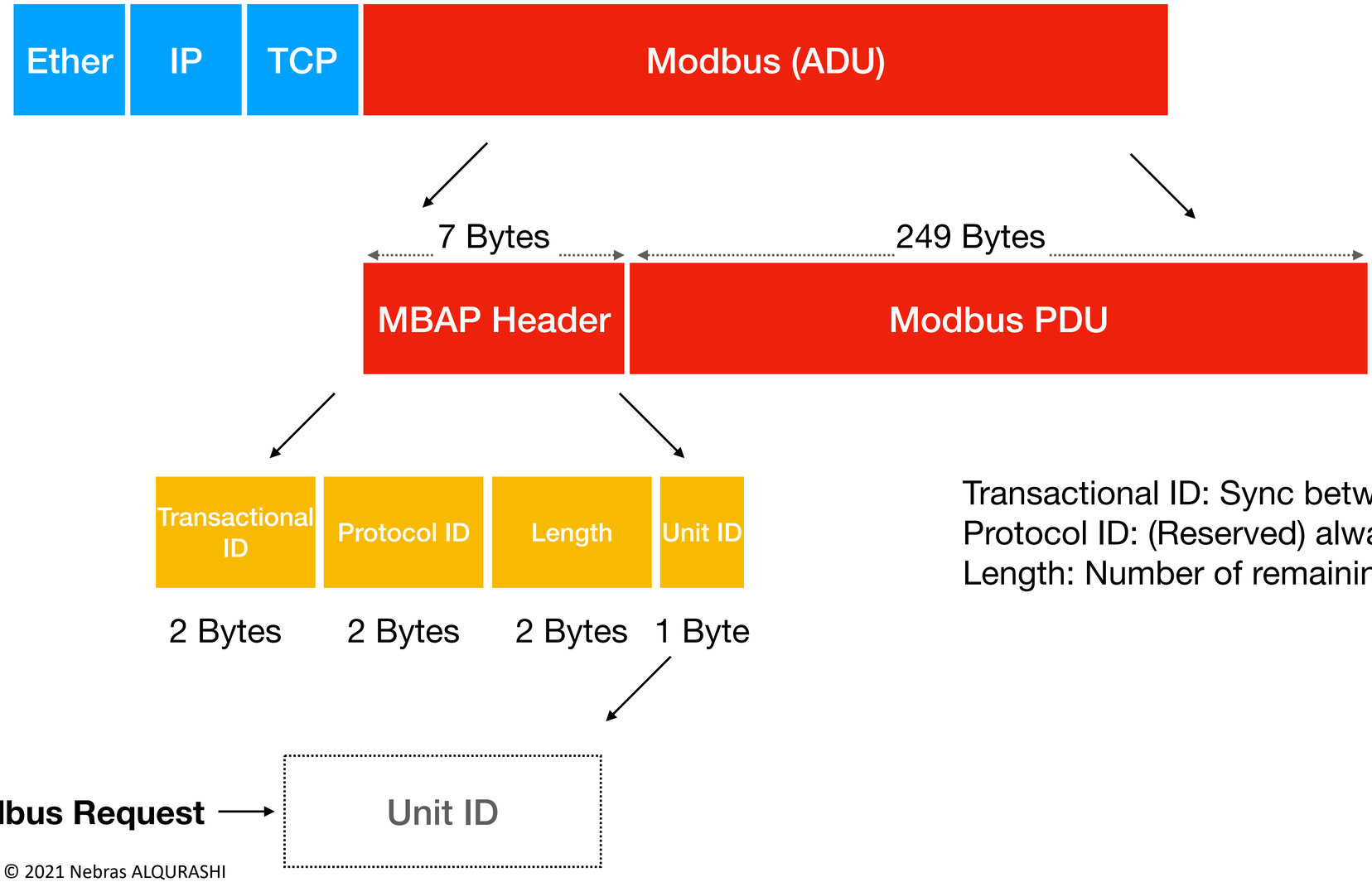
Modbus TCP Communications

Modbus TCP Request



Transactional ID: Sync between messages (request/response)
Protocol ID: (Reserved) always 00 00 for Modbus
Length: Number of remaining Bytes in this frame

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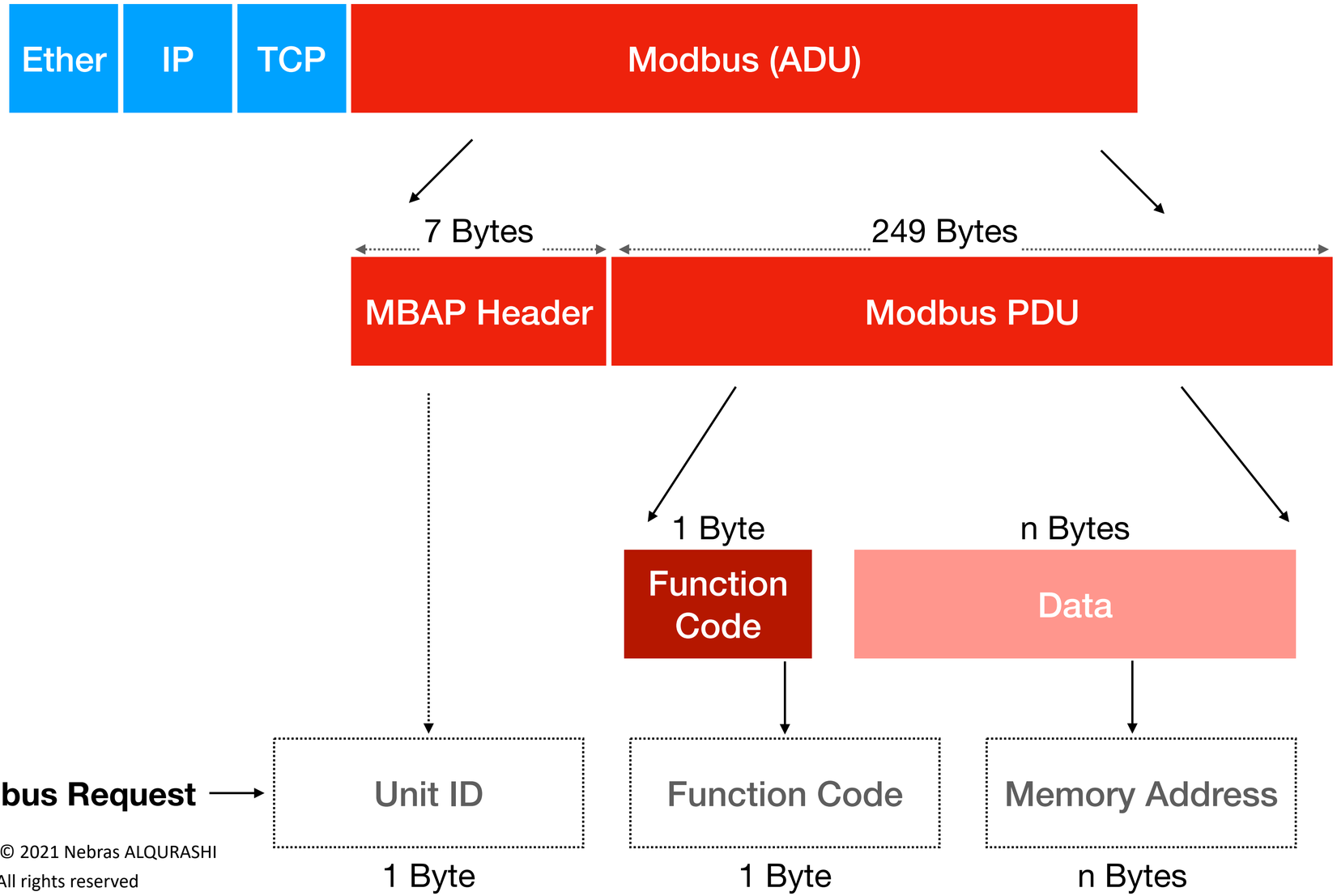
Modbus TCP Communications

Modbus TCP Request



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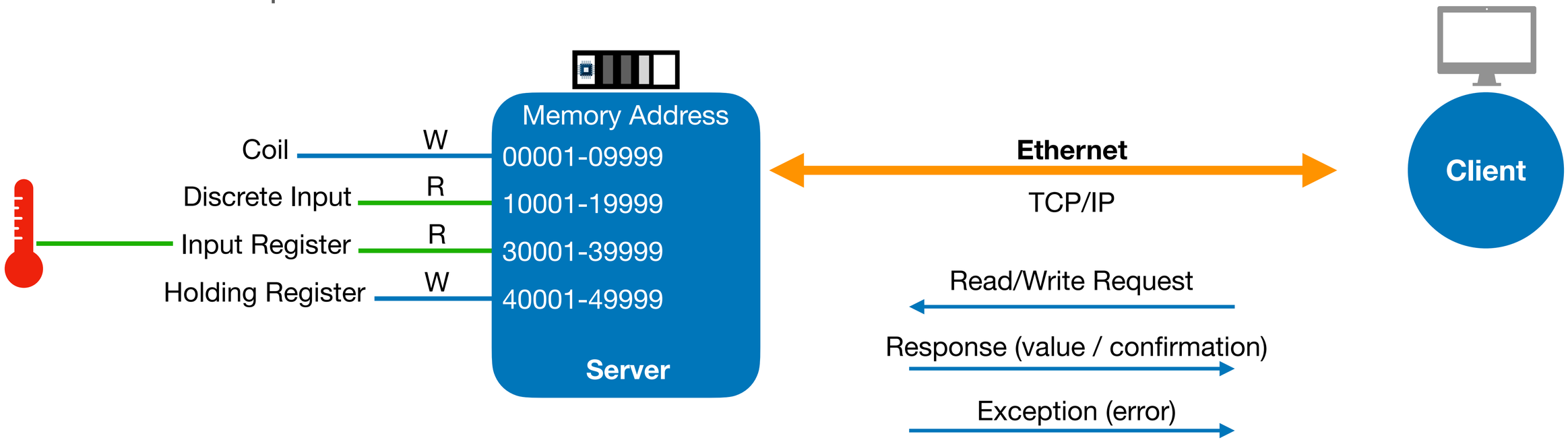
Modbus TCP Communications

Modbus TCP Request



Example: Read Temperature at address 100 from PLC 10

Unit ID: (10) - Function Code: (Read Input Register) - Address (30100)*

In Zero based addressing: (30099)*

** We will see that address can be:*
Start Address and length

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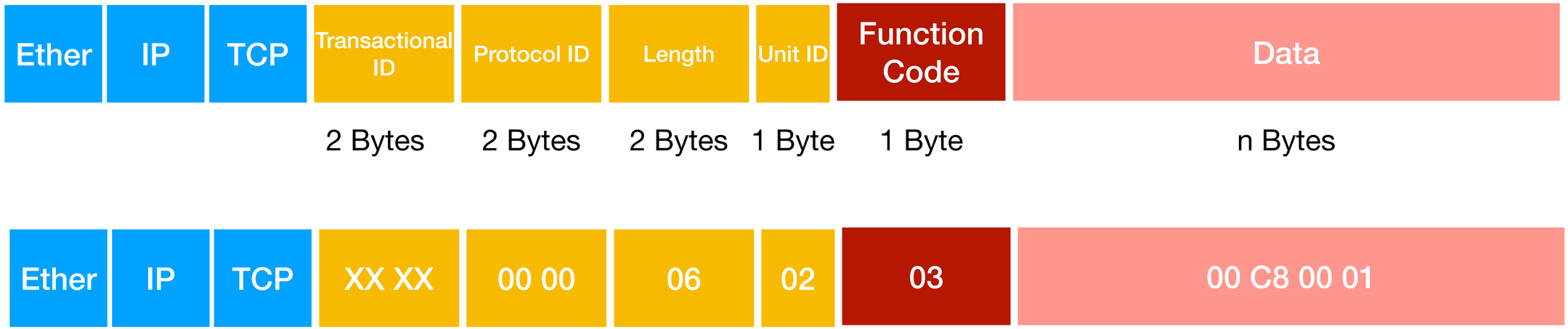
Modbus TCP Communications

Modbus TCP Request



Transactional ID	XX XX (Hex Reference)
Protocol ID	For Modbus always 00 00
Length	Remaining bytes after the length 0x6
Unit ID	To PLC of Unit ID 0x02
Function Code	0x03 (Read Holding Registers)
Memory Address	Start at: Hex (00C8) = 200 for a length of 0x1

Read Holding Register single value from the memory address 200 from PLC ID: 02

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Modbus TCP Communications

Common Modbus Function Codes

Value Type	Function Name	Function Code	Hex
Bits (0 / 1)	Read Discrete Inputs	2	0x02
Bits (0 / 1)	Read Coils	1	0x01
Bits (0 / 1)	Write Single Coil	5	0x05
Bits (0 / 1)	Write Multiple Coils	15	0x0F
Words (16 bit)	Read Input Register	4	0x04
Words (16 bit)	Read Holding Registers	3	0x03
Words (16 bit)	Write Single Register	6	0x06
Words (16 bit)	Write Multiple Registers	16	0x10

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Quick Summary

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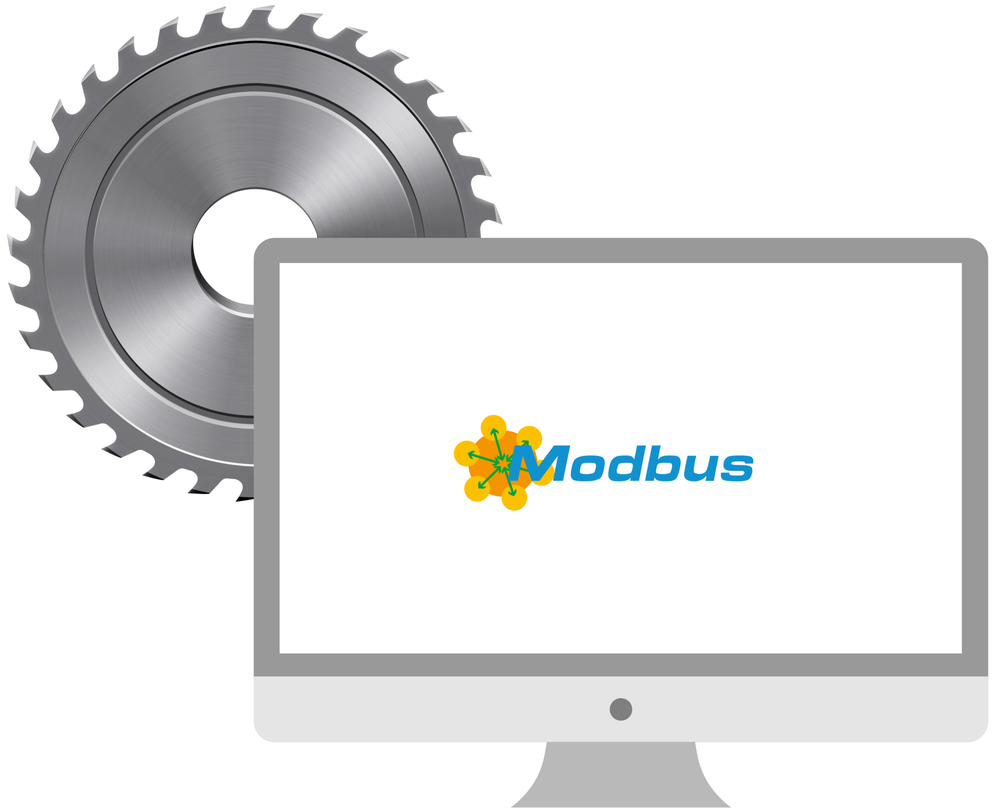

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