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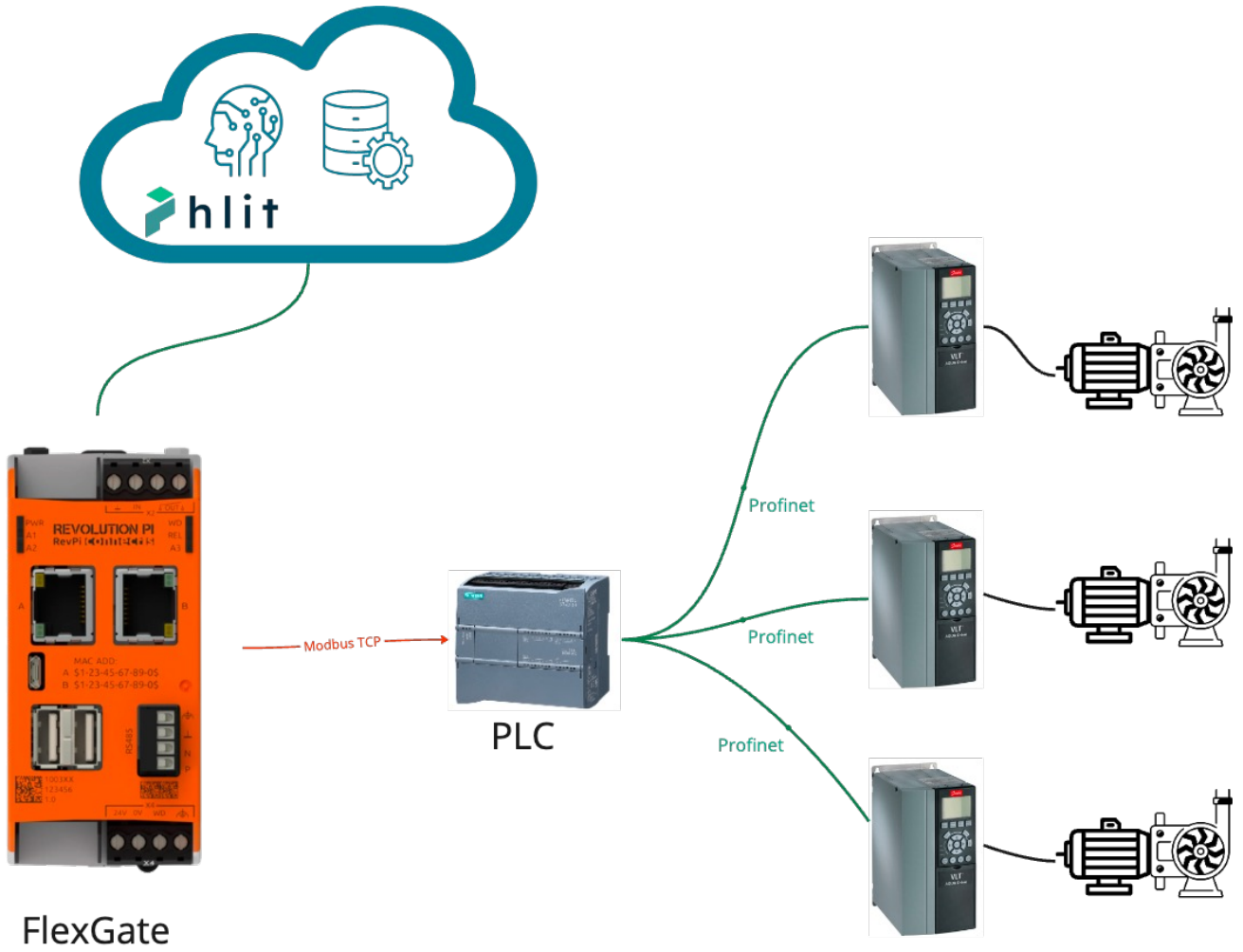
Industrial IoT Communication Protocols

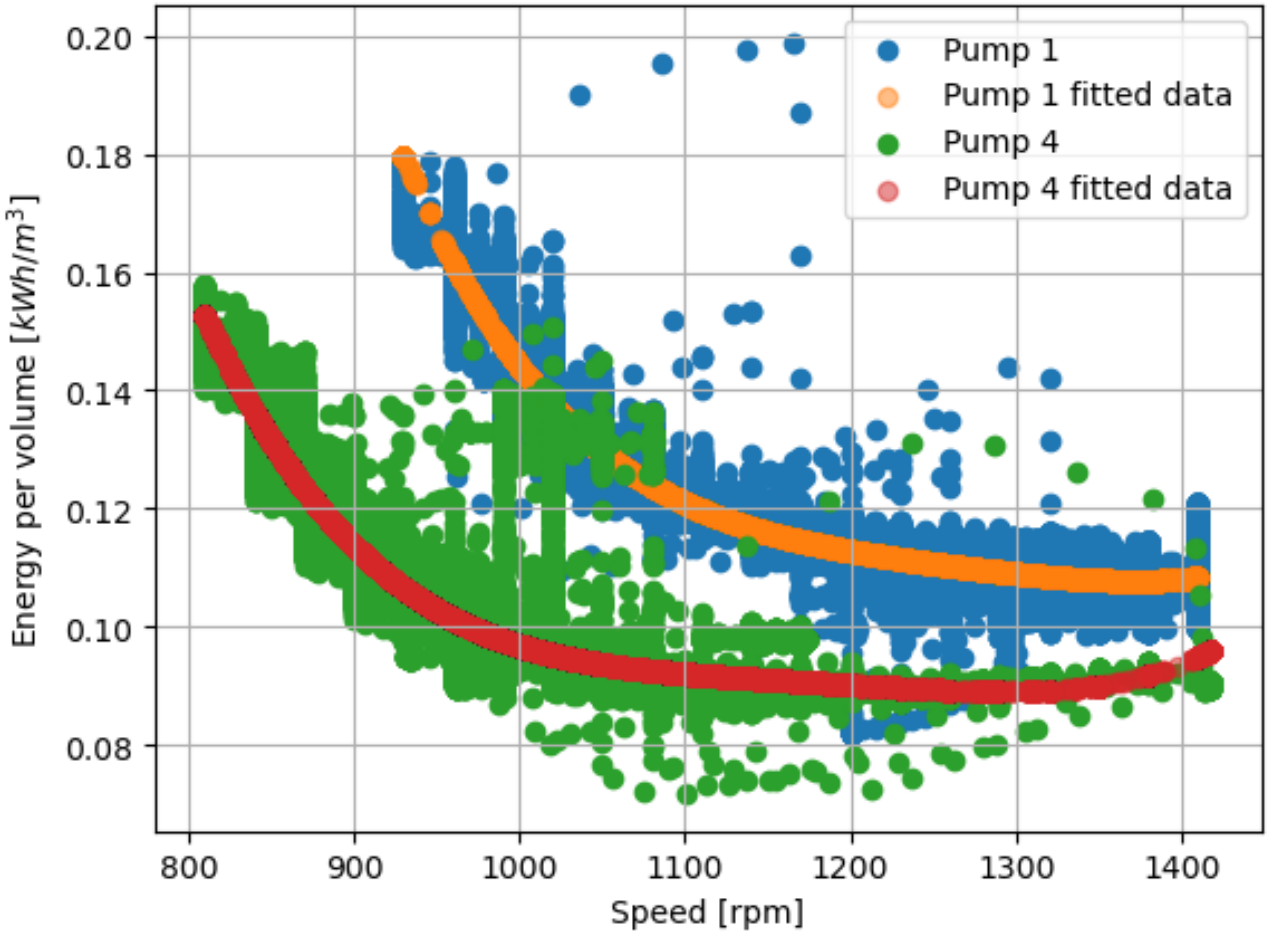
Danmarks Tekniske Universitet
January 3rd, 2024

PHLIT ApS
www.phlit.dk

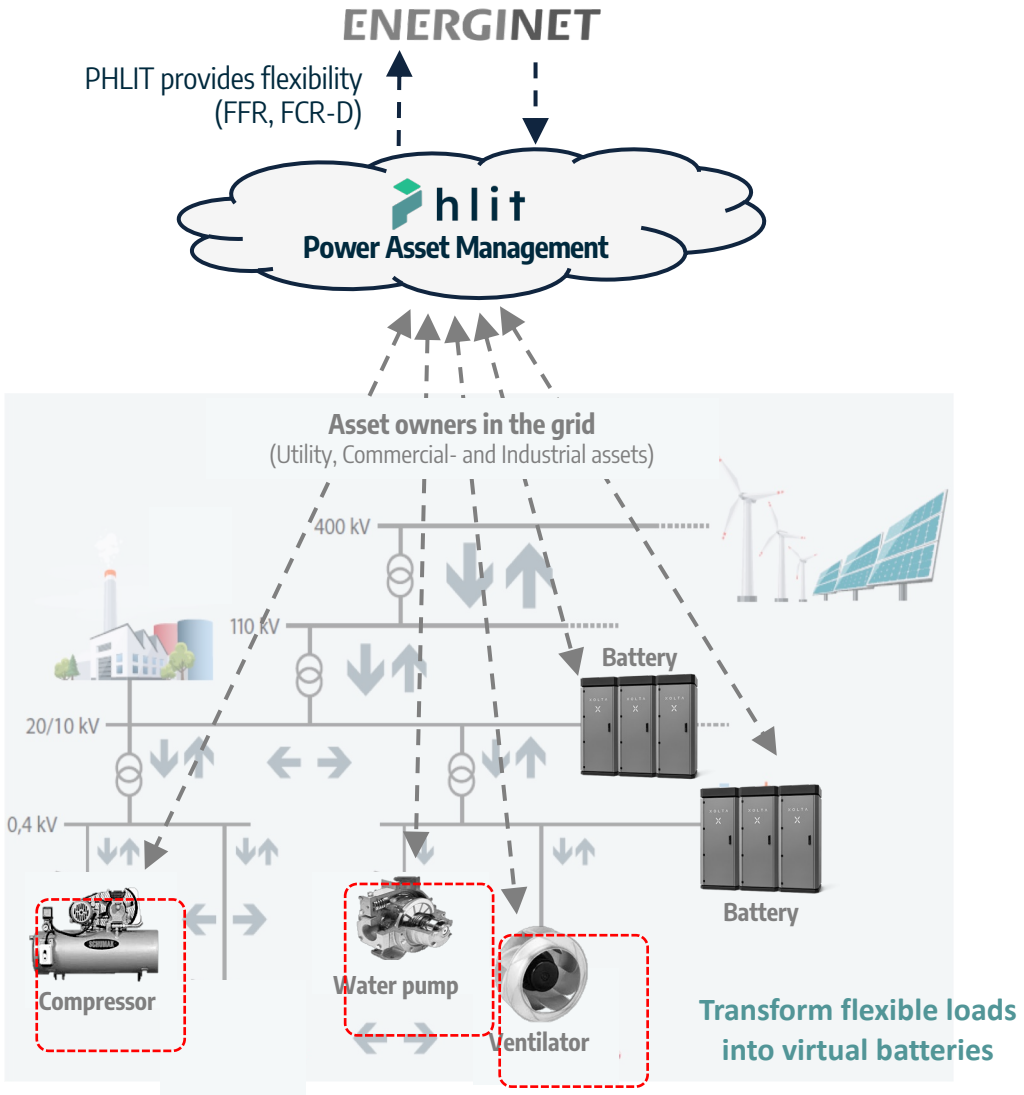
PHLIT Connecting IoT



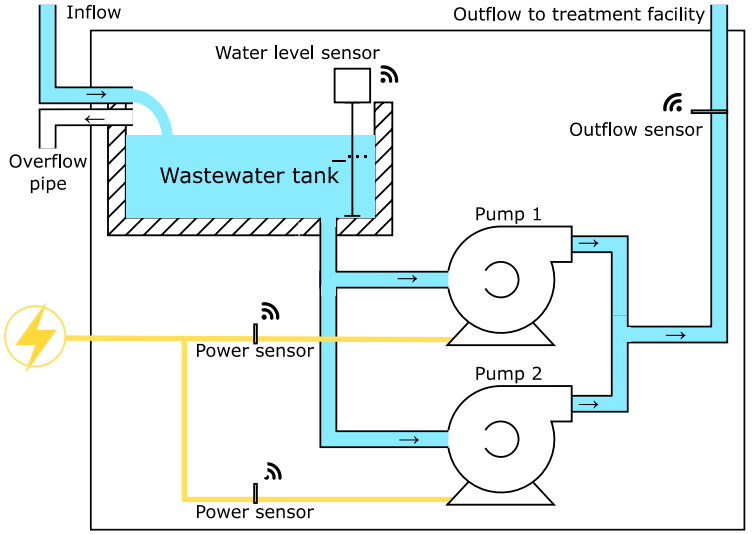
PHLIT Optimise Control



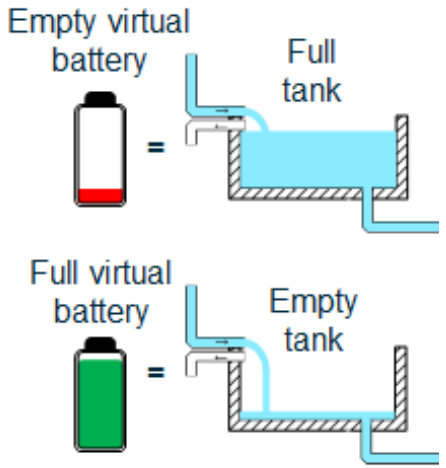
Balance Service Providers: Aggregation Concept



Transform flexible loads into virtual batteries



Wastewater inflow, wastewater tank, and pumps evacuating the wastewater



Usage of wastewater tank capacity used as energy storage medium (i.e. virtual battery)

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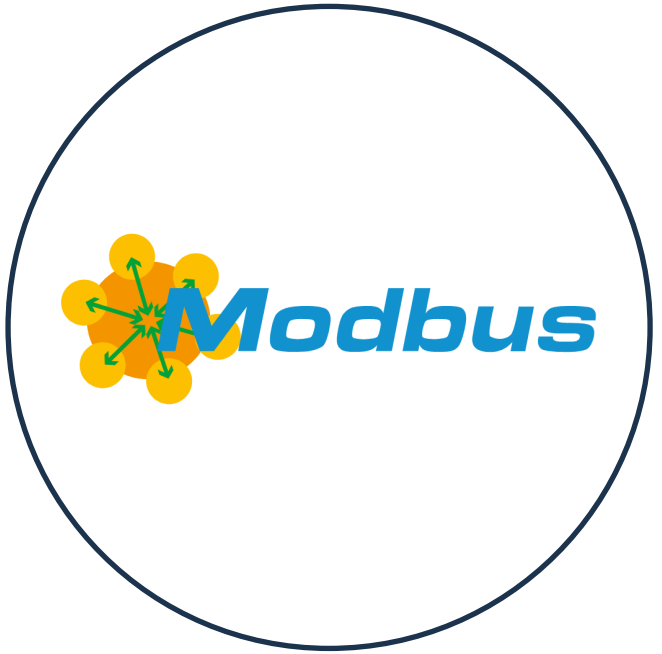
MODBUS

MODBUS



Balance Service Providers: Core Technology

Industrial Communication Protocol

Electrical drives and sensor data are streamed by PLC through e.g. Mobus

Initial proprietary protocol that only Modicon can use

When it was first introduced, it was a proprietary protocol that only Modicon could use

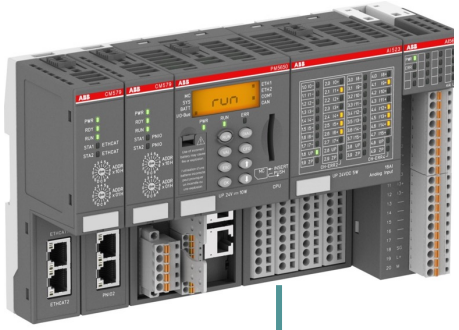
Later Modicon made it an open protocol

However, it was later published royalti-free so that anyone could use it. Finally, Modicon made it an open protocol

Most common used Industrial Protocol

When it was published, a number of companies started creating different interpretations and modifications from the original. As a result, there are now quite a few variations in the field

MODBUS



Modbus

Modbus protocol helps different vendors to communicate with each other

MODBUS RTU

Device requesting information

Master

Only Master can initiate command

RS 485/RS 232

Slave

Unit ID 1

Slave

Unit ID 2

Slave

Unit ID 3

Slave

Unit ID 4

Slave

Unit ID 5

Slave

Unit ID 6

Device supplying information

Slaves will respond command

MODBUS TCP/IP

Modbus RTU protocol with a TCP interface that runs on Ethernet

Server

Not limited to distance

Any device can send command, all can act as Master

Ethernet

Client

IP 1

Client

IP 2

Client

IP 3

Client

IP 4

Client

IP 5

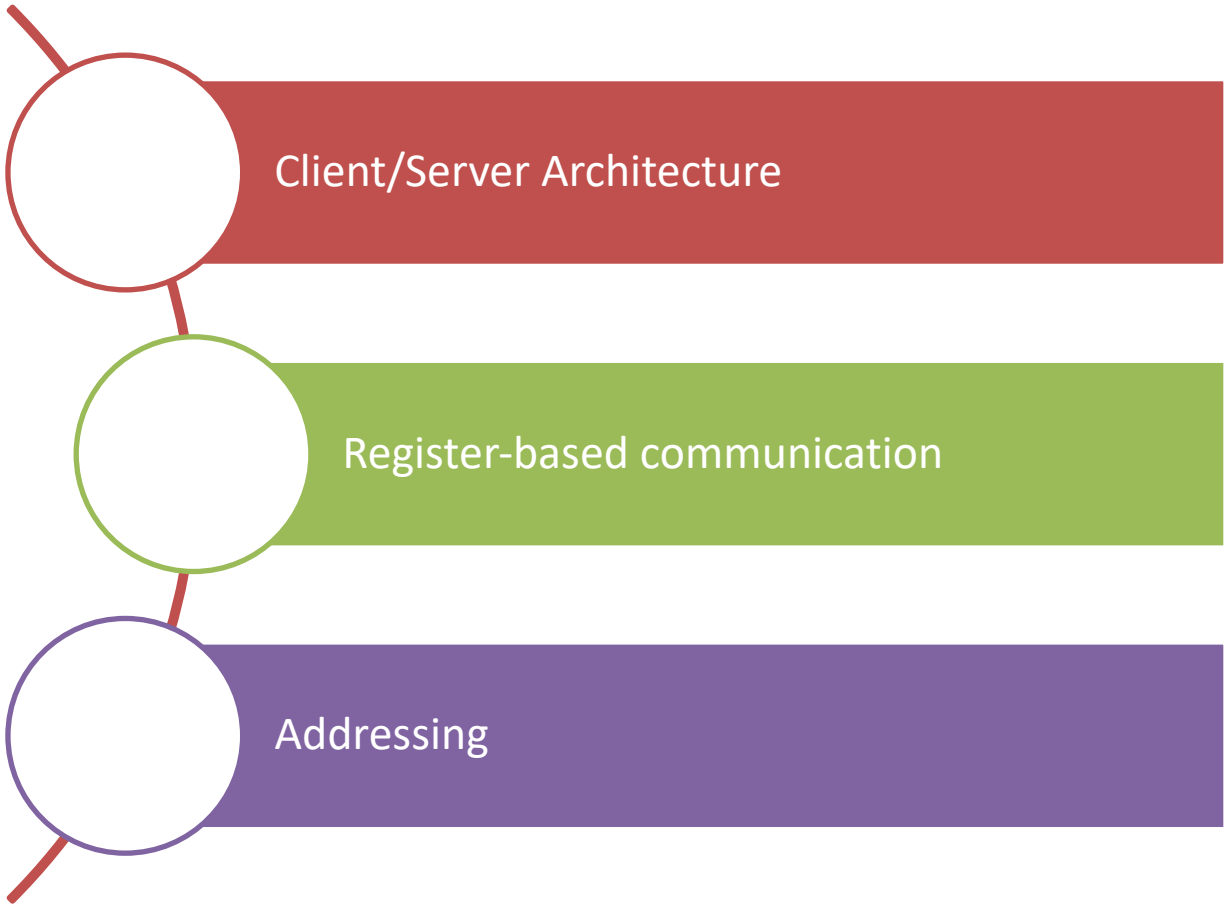
Client

IP 6

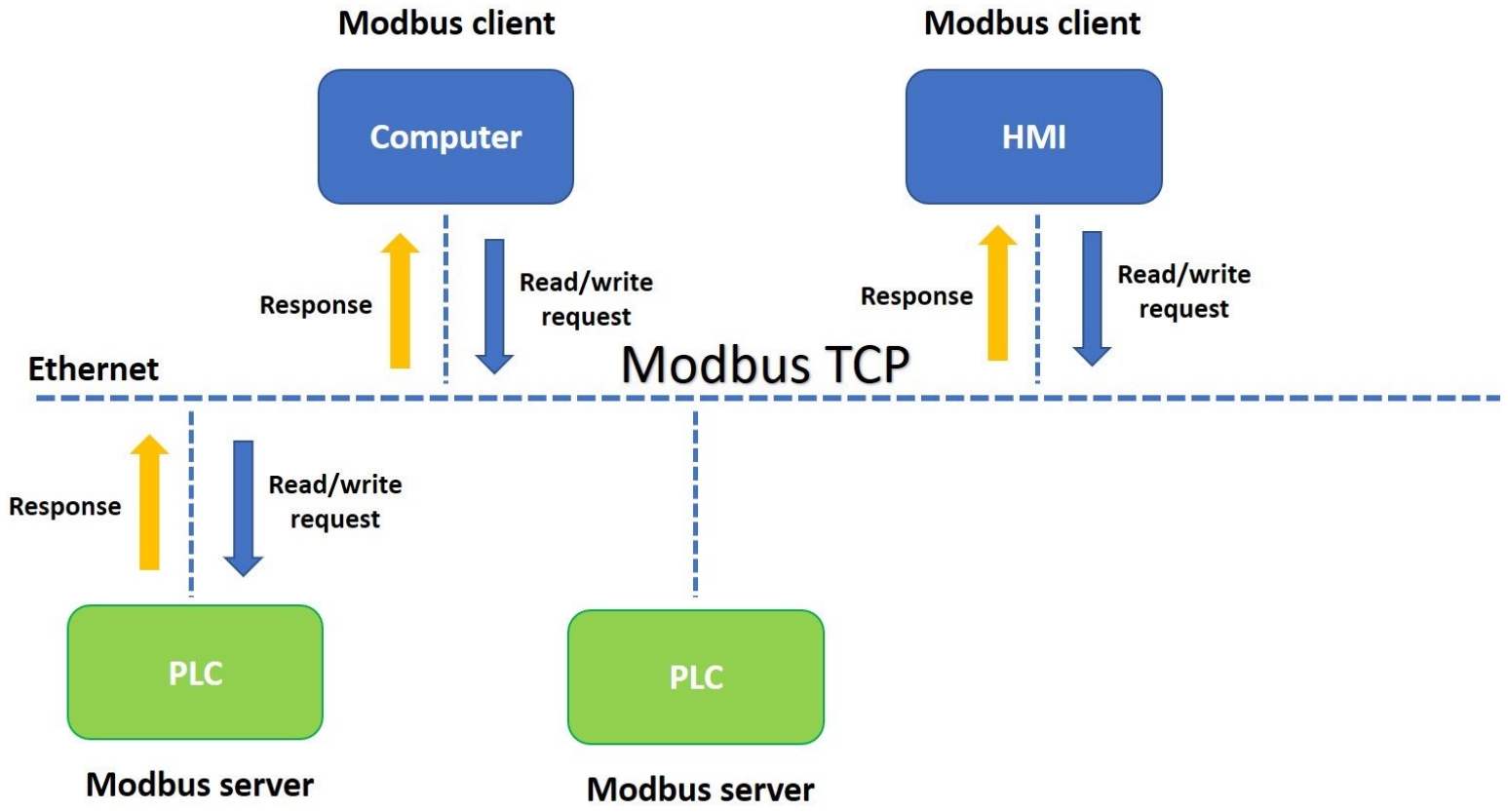
Differences Modbus RTU/TCP

#	Modbus RTU	Modbus TCP
Physical	Serial RS485	Ethernet
Multiple Clients	Only One	Multiple-Client Support
Speed	Max 19200 bps	10Mbps
Distance	Typically not more than 1000m	Unlimited

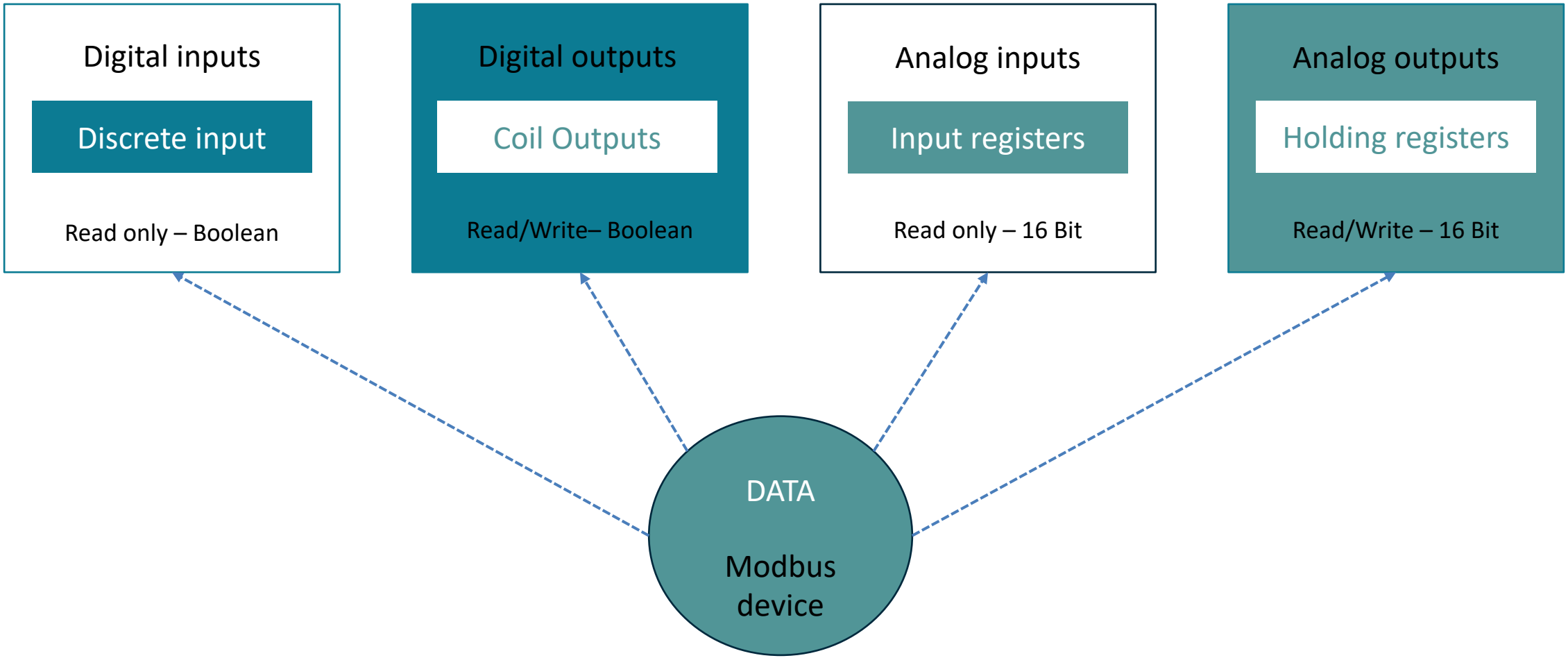
BASIC PRINCIPLES OF MODBUS TCP/IP



Client Server Architecture



Register-based Communication

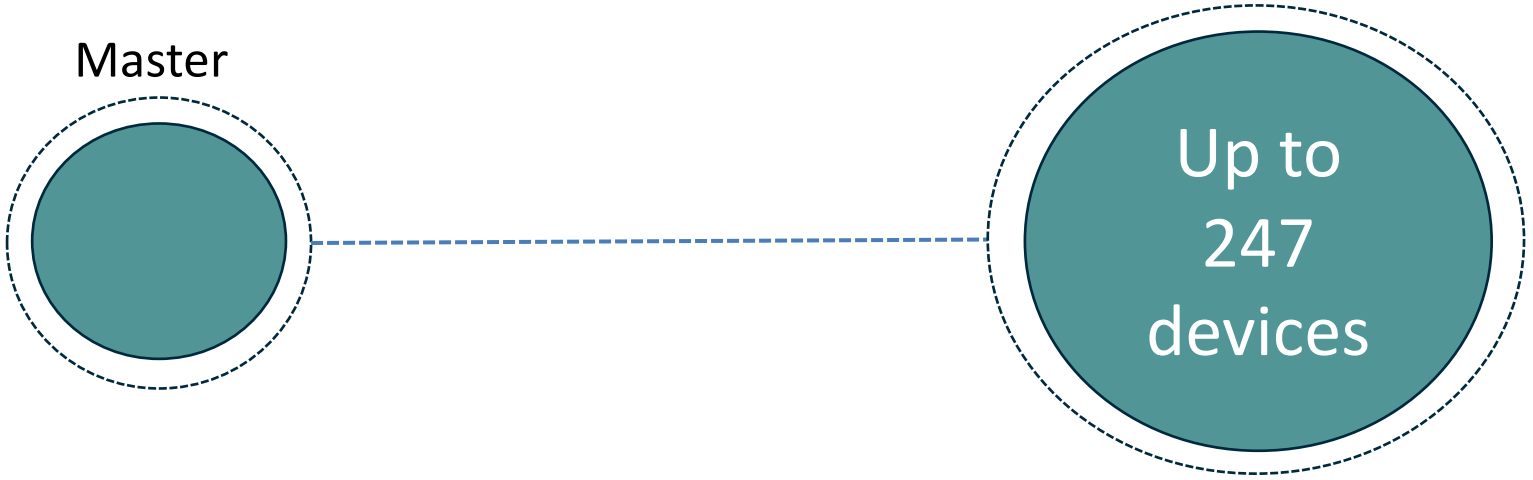


Adressing

Each modbus function has a data table with 9999 values

Coil/Register Numbers	Data Addresses	Type	Table Name
1-9999	0000 to 270E	Read-Write	Discrete Output Coils
10001-19999	0000 to 270E	Read-Only	Discrete Input Contacts
30001-39999	0000 to 270E	Read-Only	Analog Input Registers
40001-49999	0000 to 270E	Read-Write	Analog Output Holding Registers

MODBUS In a Network



A modbus network relies on IDs of individual devices. Message could be sent all over the network however, the data is tagged from 1 to 247. (Modbus Basics restricts to addressing only 247 devices to a master

Data conversion

How to convert data to a 16-bit address?

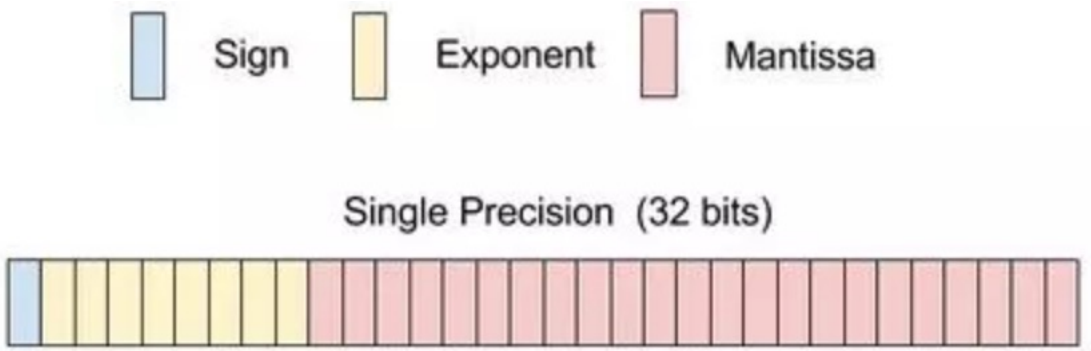
Data Conversion Bit<>Decimal

Problems

- **Max value 65 536**
- **No decimals**
- **No negatives**

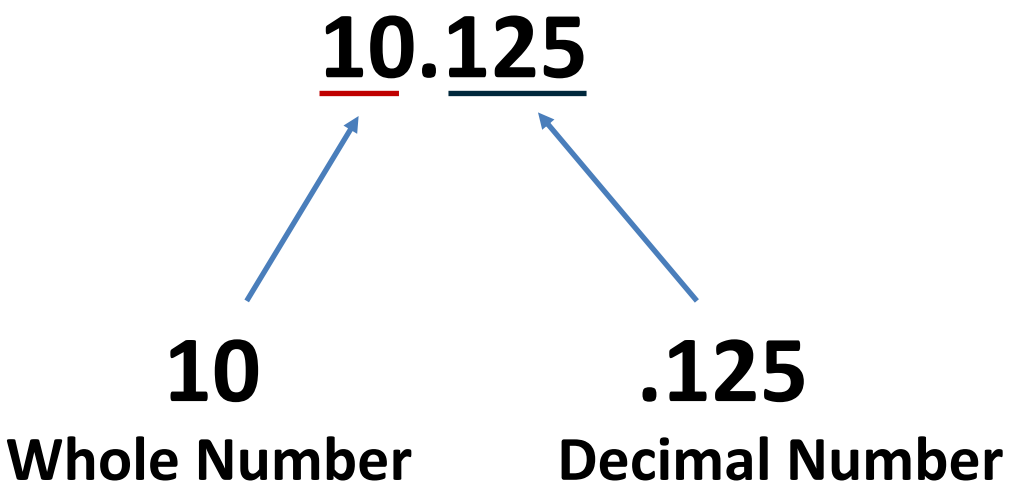
Data Conversion Bit<>Decimal

We can do better: IEE 754 Floatig Pointer Conversion



Data Conversion Bit<>Decimal

Split the whole number and the decimal



Data Conversion Bit<>Decimal

Start with the whole number

Whole Number Division	Result	Remainder
10 / 2	5	0
5 / 2	2	1
2 / 2	1	0
1 / 2	0	1

Result: 1010

Data Conversion Bit<>Decimal

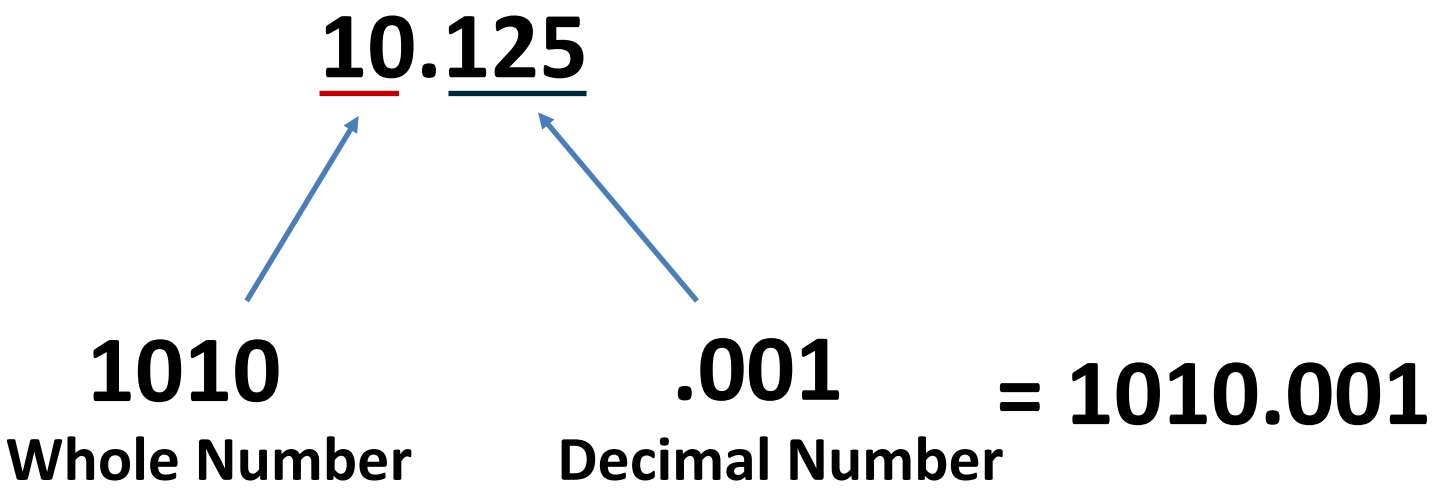
Then convert the decimal

Decimal Number Multiplication	Result	Number in front of decimal
0.125 * 2	0.25	0
0.25 * 2	0.5	0
0.5 * 2	1	1
0 * 2	0	0

Result: 001

Data Conversion Bit<>Decimal

Combine the two binary numbers



Data Conversion Bit<>Decimal

Base 2 normalisation

$$1010.001 = 1.010001 * 2^3$$

Data Conversion Bit<>Decimal

Calculate the exponent

For 32-bit precision use: 127
For 65-bit precision use: 1023

127 + 3 = 130

Data Conversion Bit<>Decimal

Calculate the exponent

Whole Number Division	Result	Remainder
130 / 2	65	0
65 / 2	32	1
32 / 2	16	0
16 / 2	8	0
8 / 2	4	0
4 / 2	2	0
2 / 2	1	0
1 / 2	0	1
0.5 / 2	0	0

Result: 10000010

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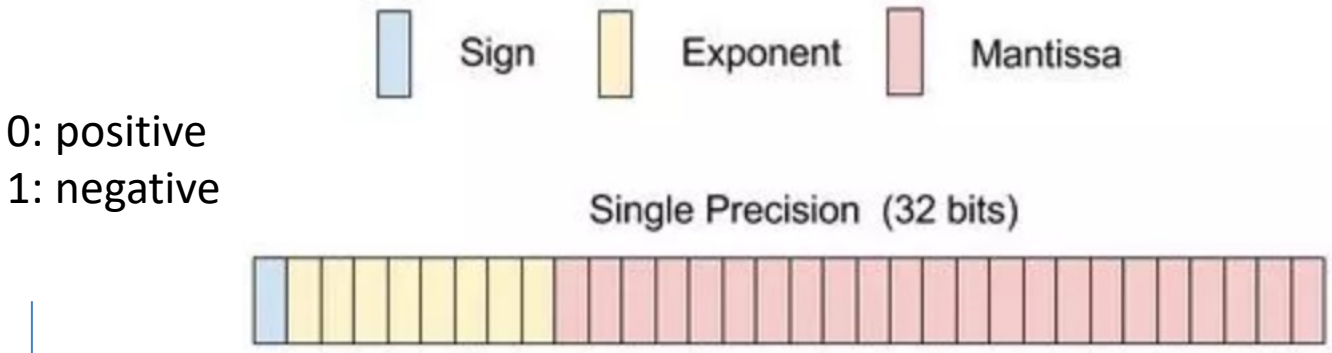
Data Conversion Bit<>Decimal

Determine the Sign

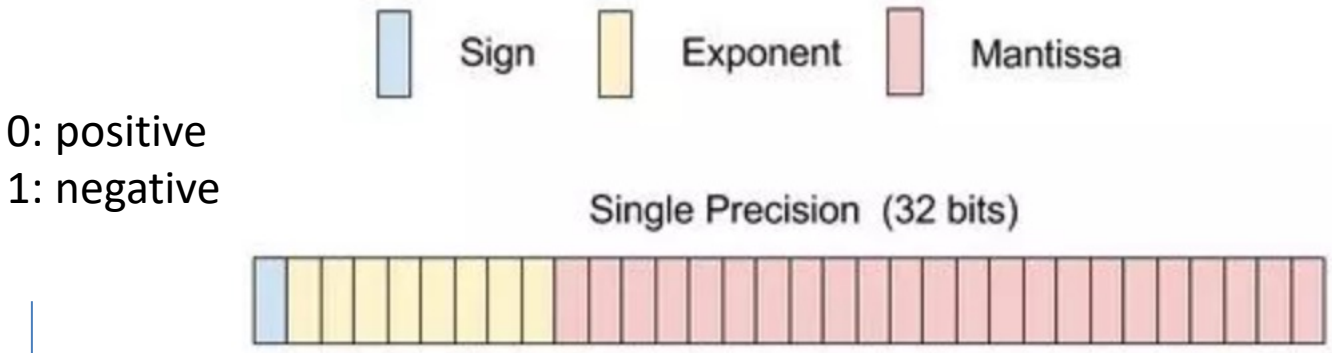


Result: 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

16 bit **16 bit**

Data Conversion Bit<>Decimal

Fill the exponent

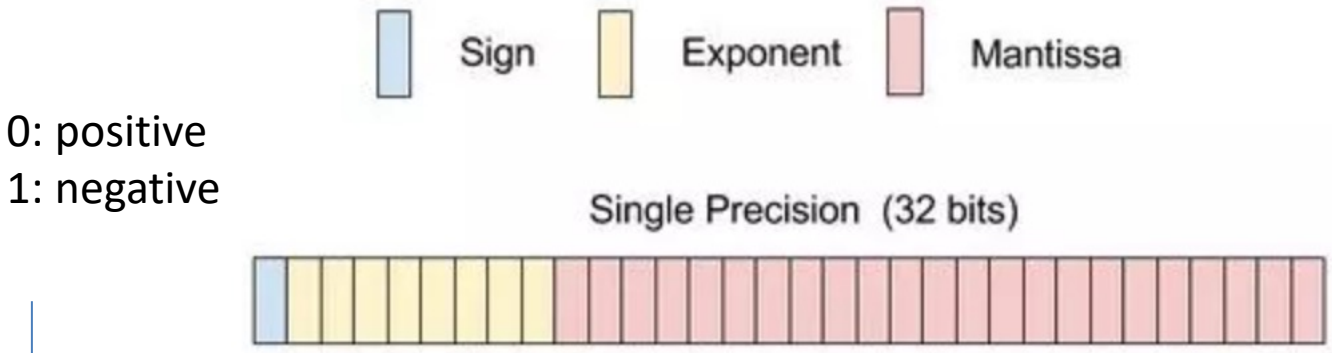


Result: 0 1 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

16 bit **16 bit**

Data Conversion Bit<>Decimal

Fill the Mantissa

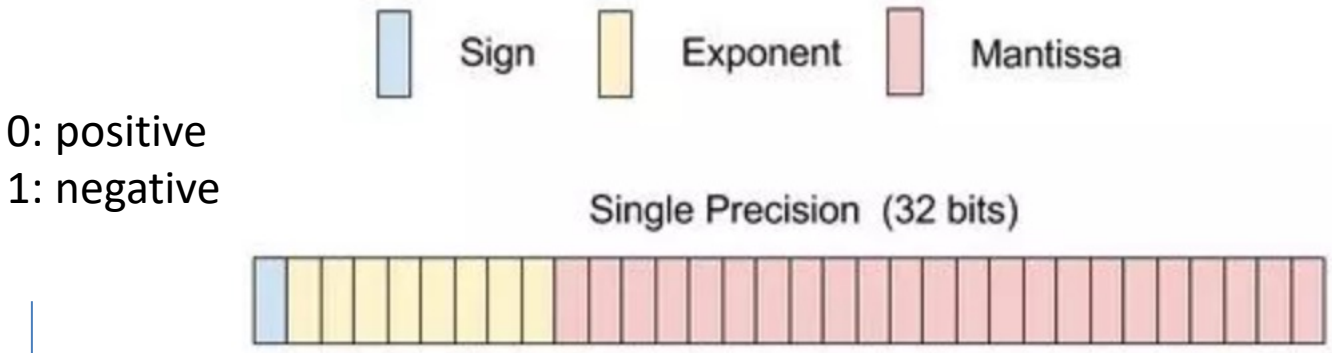


Result: 0 1 0 0 0 0 0 1 0 0 1 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

16 bit **16 bit**

Data Conversion Bit<>Decimal

Fill the Mantissa



Result: 0 1 0 0 0 0 0 1 0 0 1 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

16 bit **16 bit**

Data Conversion Bit<>Decimal

Play time!

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Join the energy transition