

# IoT Protocol Stack

as defined in RFC 4944, 6282, 7049, 7252, and 8724!



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# What is the Internet Protocol Suite (or TCP/IP)?

# What is the Internet Protocol Suite (or TCP/IP)?

"a framework for organizing the set of standardized communication protocols used on the Internet and computer networks"

\* Source: "Requirements for Internet Hosts -- Communication Layers", RFC 1122.

TCP/IP\*

**Application** 

**Transport** 

Internet

Link

Here is the original TCP/IP model!

TCP/IP

4 Application

**Transport** 

2 Internet

1 Link

- It consists of Four Layers, Application, Transport, Internet and Link Layer.
- And It is numbered from the bottom up, ...



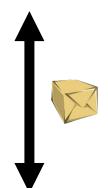
TCP/IP

4 Application

**Transport** 

Internet

Link



• BUT the direction depends on if the device is *Transmitting* or *Receiving* a packet.

TCP/IP

4 Application

**Transport** 

Internet

1 Link

• The Internet Protocol Suite evolved through research and development funded over a period of time.

\* Source: "Data Communications and Networking Book by Behrouz", A. Forouzan, Originally Published: 2001.

TCP/IP\*

5 Application
5 Transport
6 Internet
7 Data Link
1 Physical

- In this process, the *specifics of protocol components and their layering changed*.
- Thus, one of the evolved versions of the Internet Protocol Suite is the TCP/IP Protocol Suite, that comes with 5 Layers.

\* Source: "Data Communications and Networking Book by Behrouz", A. Forouzan, Originally Published: 2001.

TCP/IP\*

Application

5 Application

Transport

4 Transport

Internet

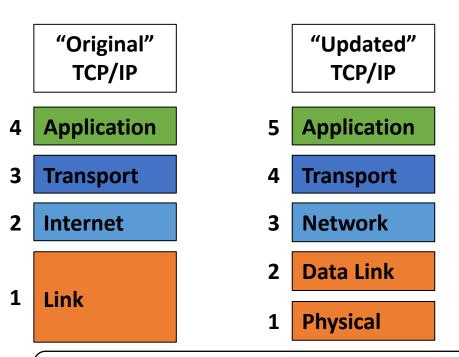
3 Network

Link

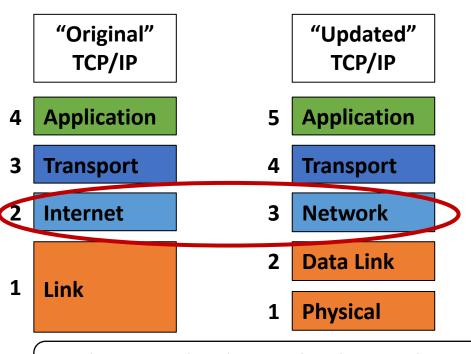
2 Data Link

1 Physical

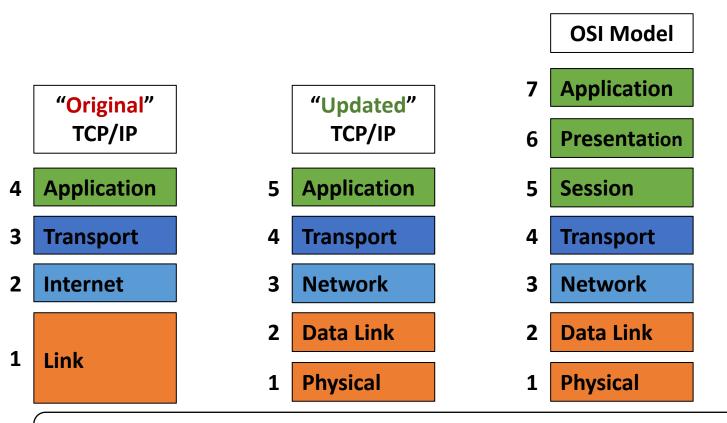
• In this version, there is one Extra Layer, and one Renamed Layer.



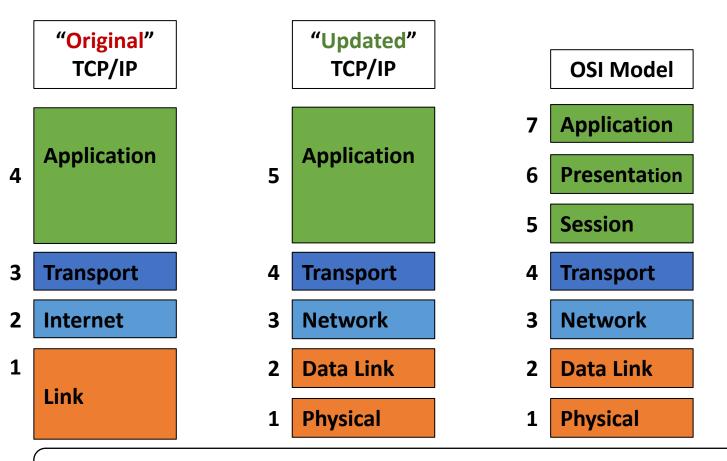
• The original Link Layer has been split into Data Link and Physical Layers.



- The original Link Layer has been split into Data Link and Physical Layers.
- The Internet Layer has been renamed to Network Layer.



Now, if we compare the Five-Layer TCP/IP Protocol Suite to the OSI Model, which consists of 7 layers ...



... the Application, Presentation and Session Layers are illustrated as Application Layer in the TCP/IP Model.

TCP/IP

5 Application

Transport

Network

**Data Link** 

Physical

In the rest of this video, we will focus on the Five-Layer TCPIP Protocol Suite.

TCP/IP

**Protocols** 

5 Application

**HTTP** 

4 Transport

Network

**Data Link** 

1 Physical

TCP/IP

**Protocols** 

5 Application

Transport

Network

**Data Link** 

**Physical** 

**HTTP** 

TCP - UDP

TCP/IP

**Protocols** 

5 Application

**Transport** 

Network

2 Data Link

**Physical** 

**HTTP** 

TCP - UDP

IPv4 - IPv6

TCP/IP

**Protocols** 

5 Application

Transport

Network

Data Link

**Physical** 

**HTTP** 

TCP - UDP

IPv4 - IPv6

**Ethernet / Wi-Fi** 

TCP/IP

**Protocols** 

5 Application

Transport

Network

**Data Link** 

Physical

**HTTP** 

TCP - UDP

IPv4 - IPv6

**Ethernet / Wi-Fi** 

Cables / NIC

TCP/IP Protocols

5 **Application** 

Transport

Network

Data Link

**Physical** 

**HTTP** 

TCP - UDP

IPv4 - IPv6

**Ethernet / Wi-Fi** 

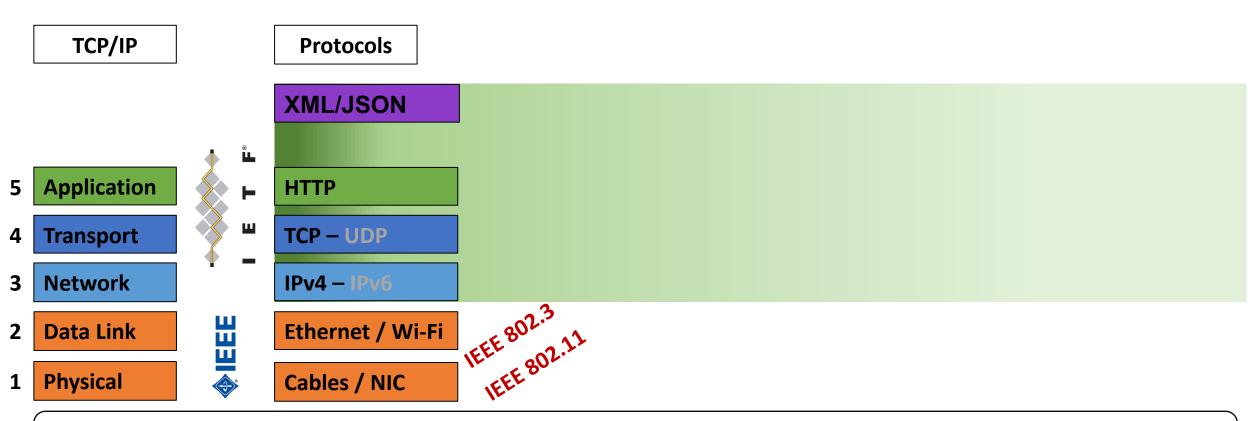
Cables / NIC

IEEE 802.3

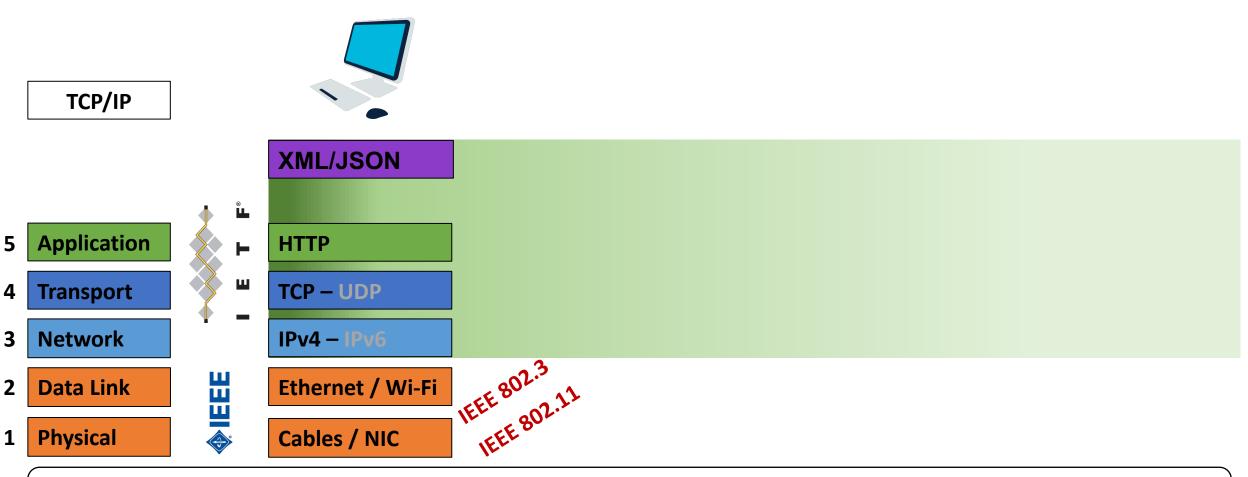
- IEEE 802.3 defines the Physical layer and Data Link layer's Media Access Control (MAC) protocols of wired Ethernet.
- IEEE 802.11 specifies the set of MAC and Physical Layer protocols for Wi-Fi.

TCP/IP **Protocols** XML/JSON **Application HTTP Transport** TCP - UDP Network IPv4 - IPv6 IEEE 802.3 IEEE 802.11 **Ethernet / Wi-Fi Data Link Physical** Cables / NIC

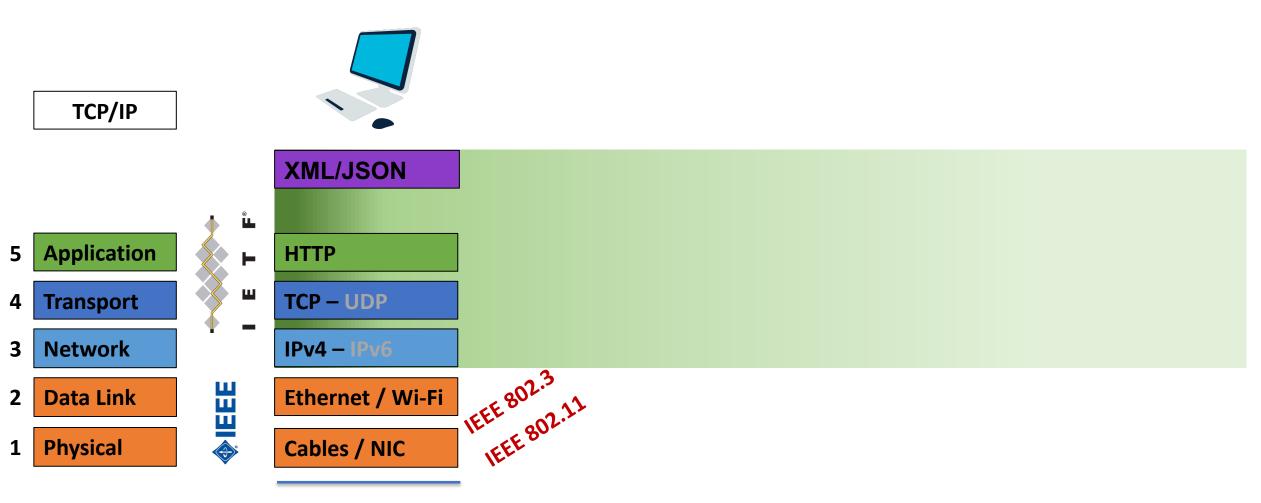
• On top of the HTTP, there is typically very verbose Web Representation Formats such as XML or JSON to structure the information.



- The Protocols at the two bottom Layers are being standardized at the IEEE.
- The protocols from Layer 3 and above are being standardized at the **IETF** standardization organization.

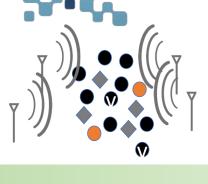


By employing this Five-Layer TCP/IP Protocol Suite, two or more typical computers may communicate to carry data from one to another.



Throughput: Gbit/s MTU: 1000s of bytes





TCP/IP

Application

4 Transport

5

Network

2 Data Link

1 Physical





XML/JSON

**HTTP** 

**®** 

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EEE EEE

TCP - UDP

IPv4 - IPv6

Ethernet / Wi-Fi

Cables / NIC

Fi IEEE 802.3
IEEE 802.11

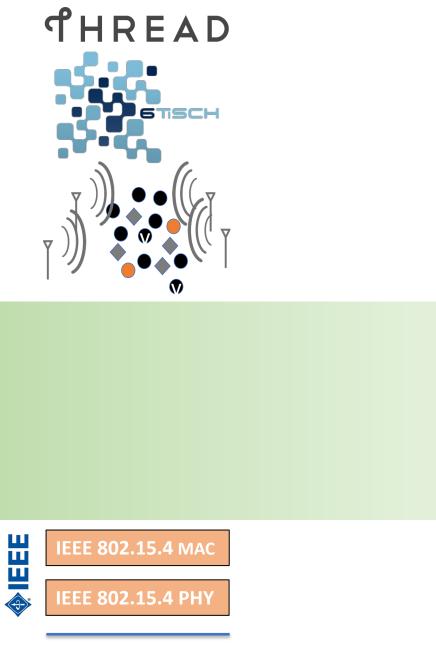


IEEE 802.15.4 MAC

**IEEE 802.15.4 PHY** 

Throughput: Gbit/s MTU: 1000s of bytes

Throughput: ~ 100 Kbit/s MTU: 100s of bytes

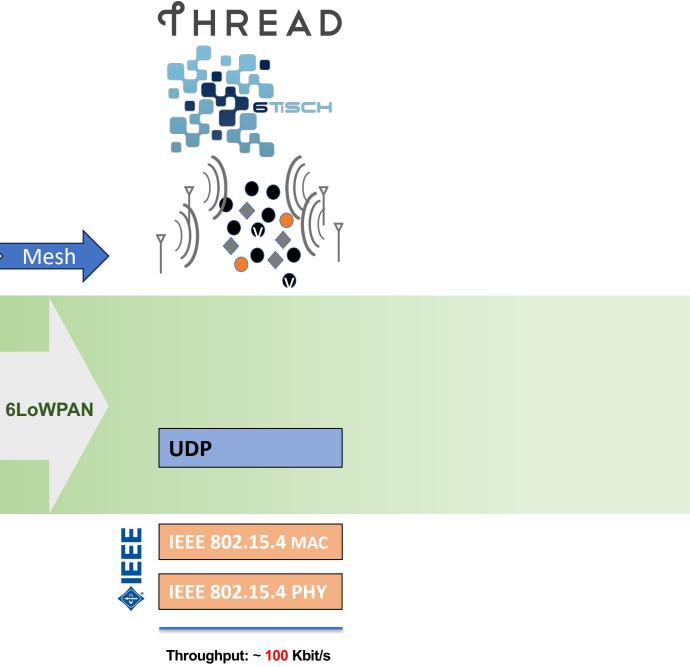


TCP/IP Mesh XML/JSON **® Application HTTP 6LoWPAN** П **Transport** TCP - UDP Network IPv4 - IPv6 EEE EEE **Ethernet / Wi-Fi Data Link** Cables / NIC **Physical** 

> Throughput: Gbit/s MTU: 1000s of bytes

5

Throughput: ~ 100 Kbit/s MTU: 100s of bytes



TCP/IP

**Application** 5

**Transport** 

Network

**Data Link** 

**Physical** 



Mesh



XML/JSON

**HTTP** 

**®** 

П

EEE EEE

TCP - UDP

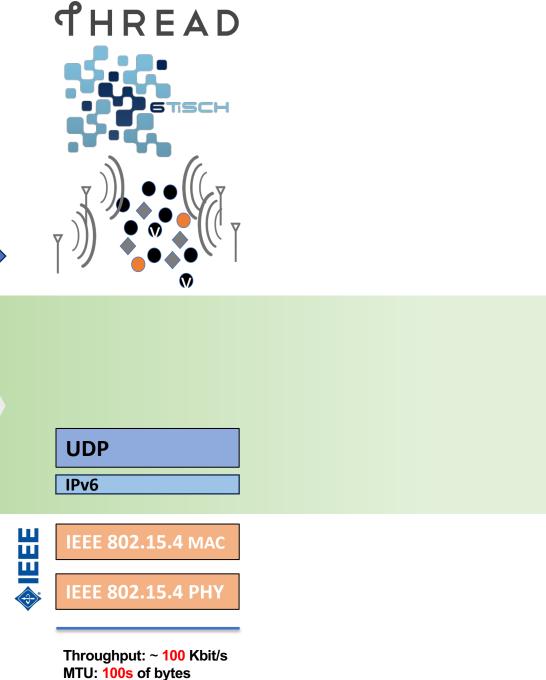
IPv4 - IPv6

**Ethernet / Wi-Fi** 

Cables / NIC

Throughput: Gbit/s MTU: 1000s of bytes

MTU: 100s of bytes



TCP/IP **® Application** 5

**Transport** 

Network

**Data Link** 

**Physical** 

**HTTP 6LoWPAN** TCP - UDP IPv4 - IPv6 **Ethernet / Wi-Fi** Cables / NIC

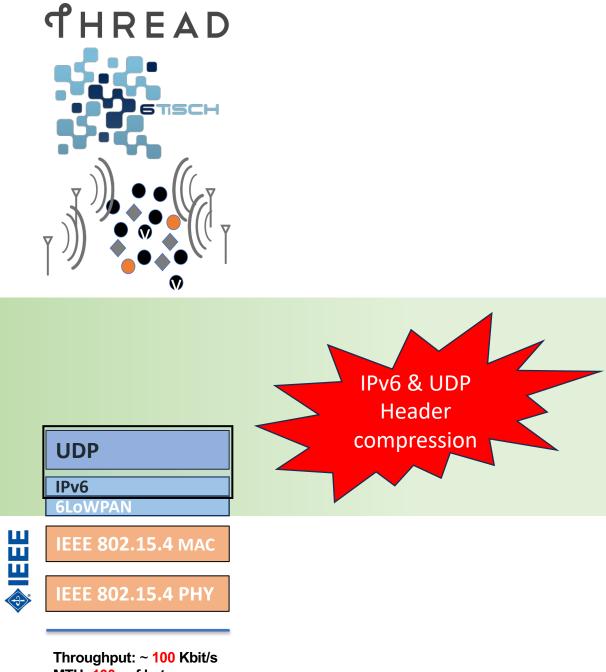
Mesh

Throughput: Gbit/s MTU: 1000s of bytes

XML/JSON

П

EEE EEE



TCP/IP ® LL

**Application** 5

**Transport** 

Network

**Data Link** 

**Physical** 



XML/JSON

TCP - UDP

IPv4 - IPv6

**Ethernet / Wi-Fi** 

**HTTP** 

П

HEEE C



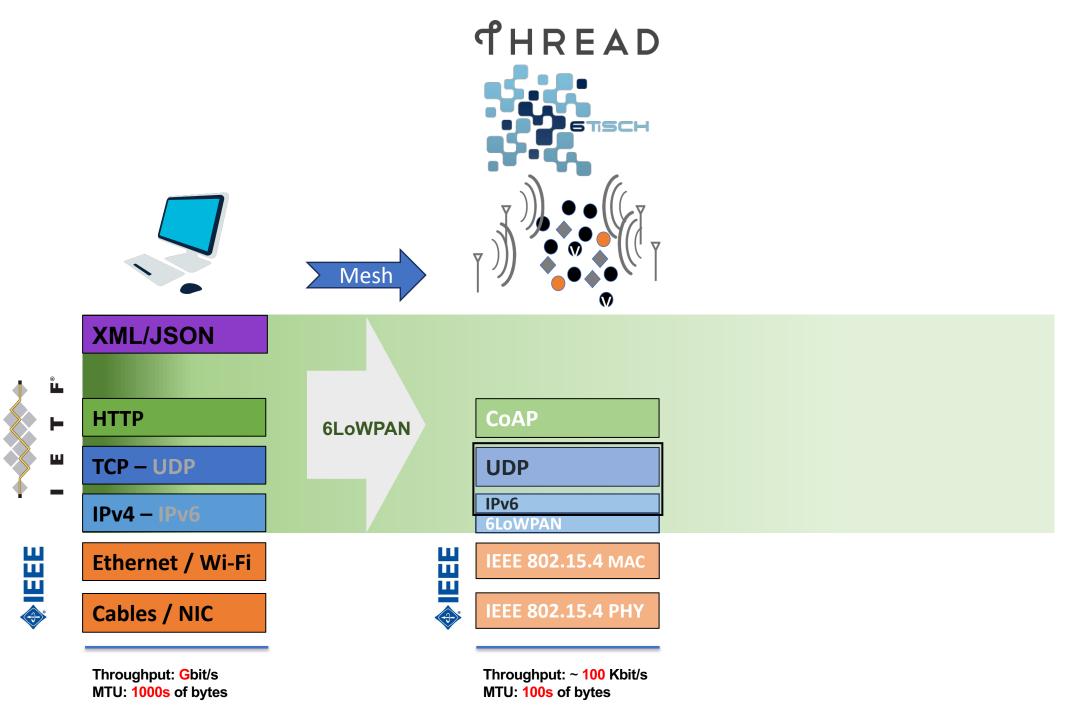




Throughput: Gbit/s MTU: 1000s of bytes

Cables / NIC

MTU: 100s of bytes



TCP/IP

**Application** 

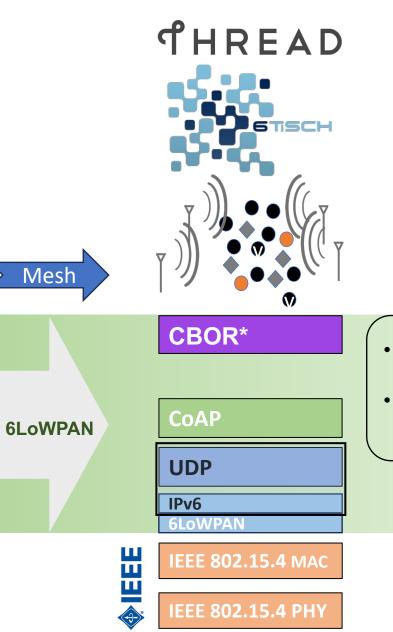
**Transport** 

Network

**Data Link** 

**Physical** 

5



\* CBOR stands for Concise Binary

CBOR is a binary data serialization

format loosely based on JSON.

Object Representation.

Mesh

Throughput: Gbit/s MTU: 1000s of bytes

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XML/JSON

TCP - UDP

IPv4 - IPv6

Cables / NIC

**Ethernet / Wi-Fi** 

**HTTP** 

TCP/IP

**Application** 

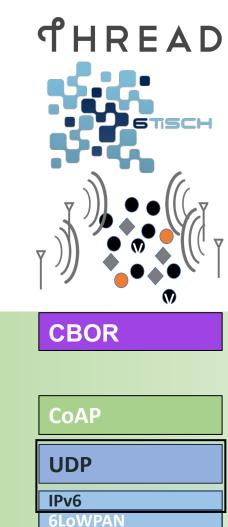
**Transport** 

Network

**Data Link** 

**Physical** 

Throughput: ~ 100 Kbit/s MTU: 100s of bytes



**IEEE 802.15.4 MAC IEEE 802.15.4 PHY** 

> Throughput: ~ 10 Kbit/s MTU: 10s of bytes

Throughput: ~ 100 Kbit/s MTU: 100s of bytes

TCP/IP



**Transport** 

Network

**Data Link** 

**Physical** 



® LL















XML/JSON

**HTTP** 

Cables / NIC

**6LoWPAN** 

TCP - UDP

IPv4 - IPv6

**Ethernet / Wi-Fi** 

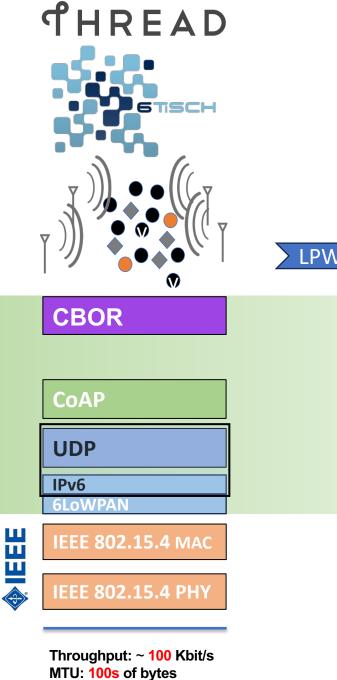
Throughput: Gbit/s MTU: 1000s of bytes H







e.g., LoRa



Mesh

**6LoWPAN** 

XML/JSON

TCP - UDP

IPv4 - IPv6

Cables / NIC

Throughput: Gbit/s

MTU: 1000s of bytes

**Ethernet / Wi-Fi** 

**HTTP** 

® LL

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TCP/IP

**Application** 

**Transport** 

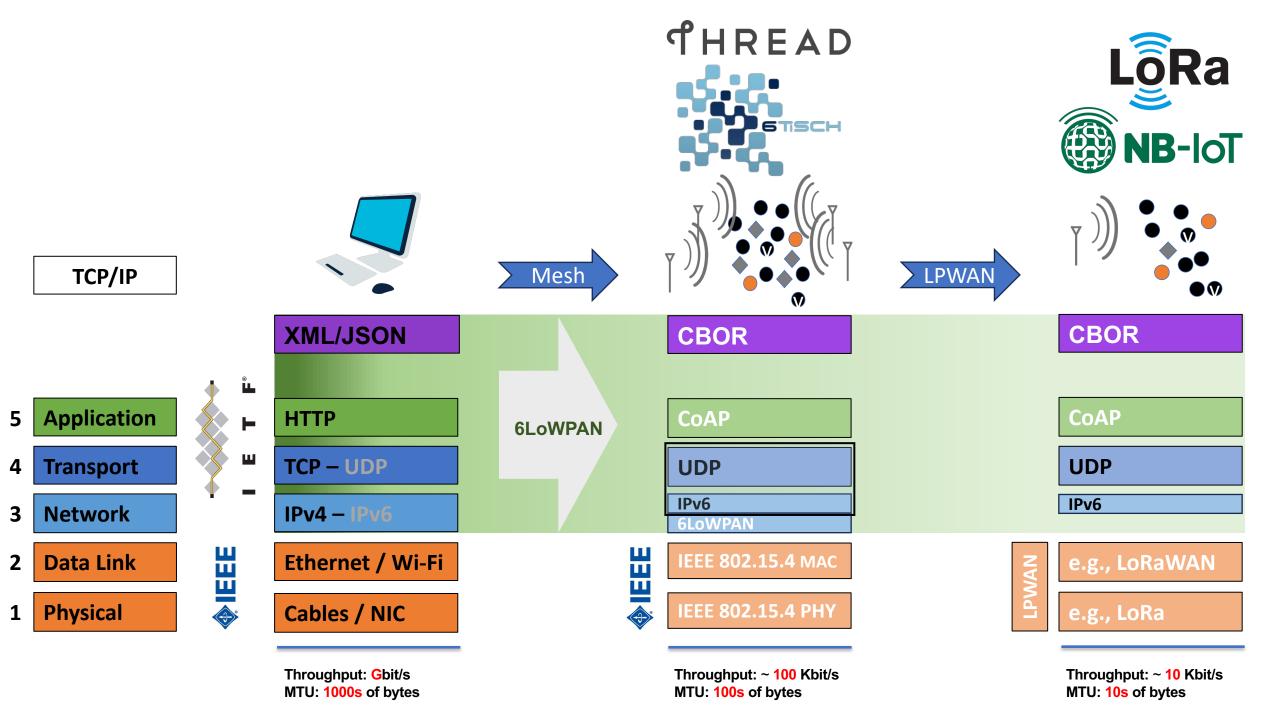
Network

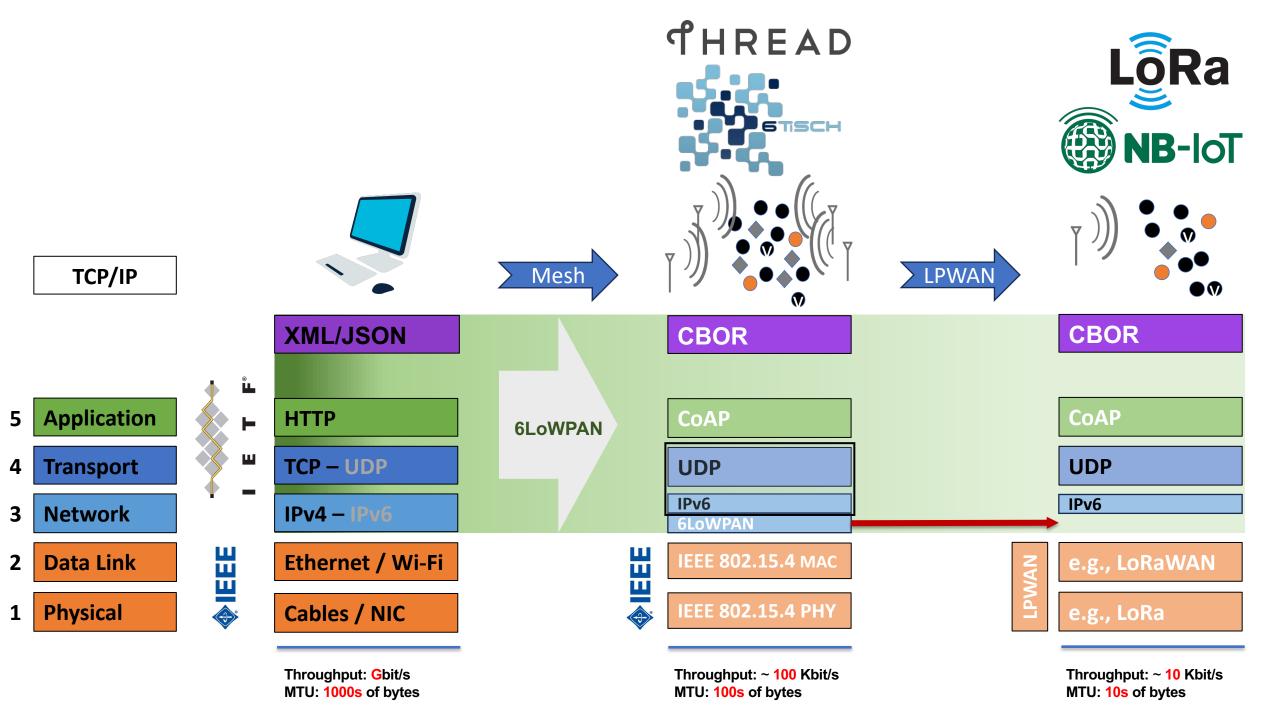
**Data Link** 

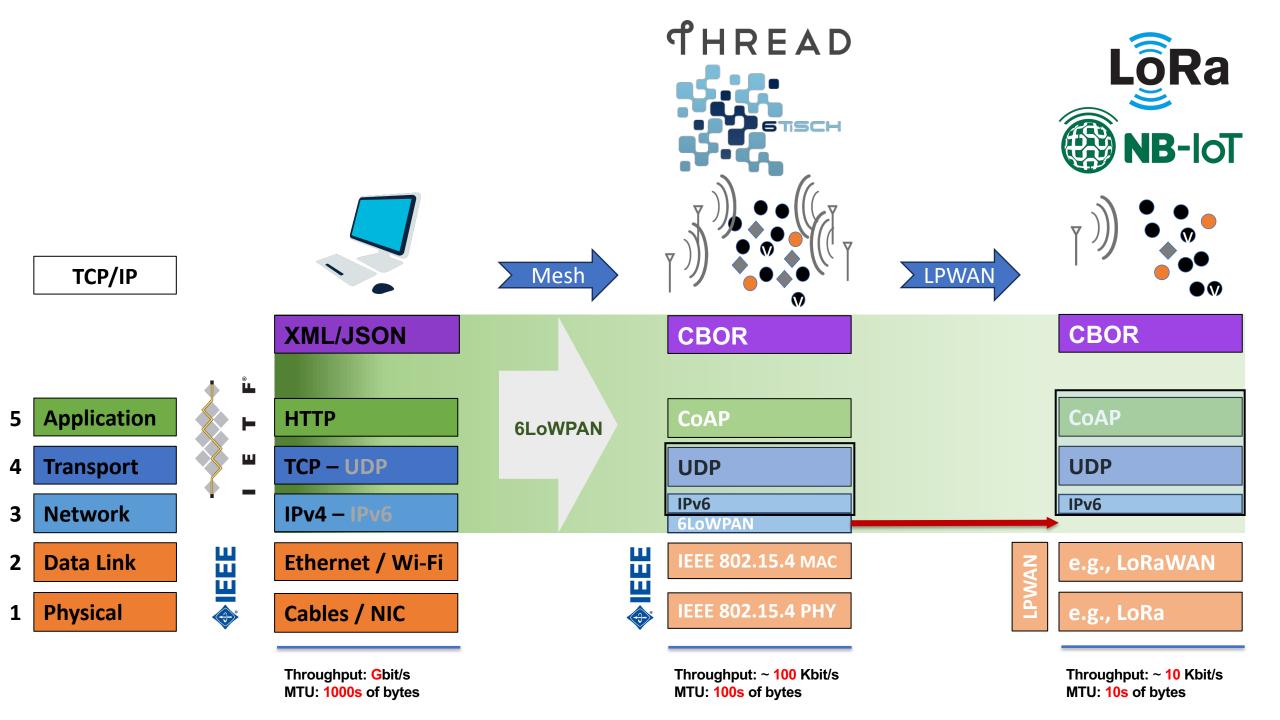
**Physical** 

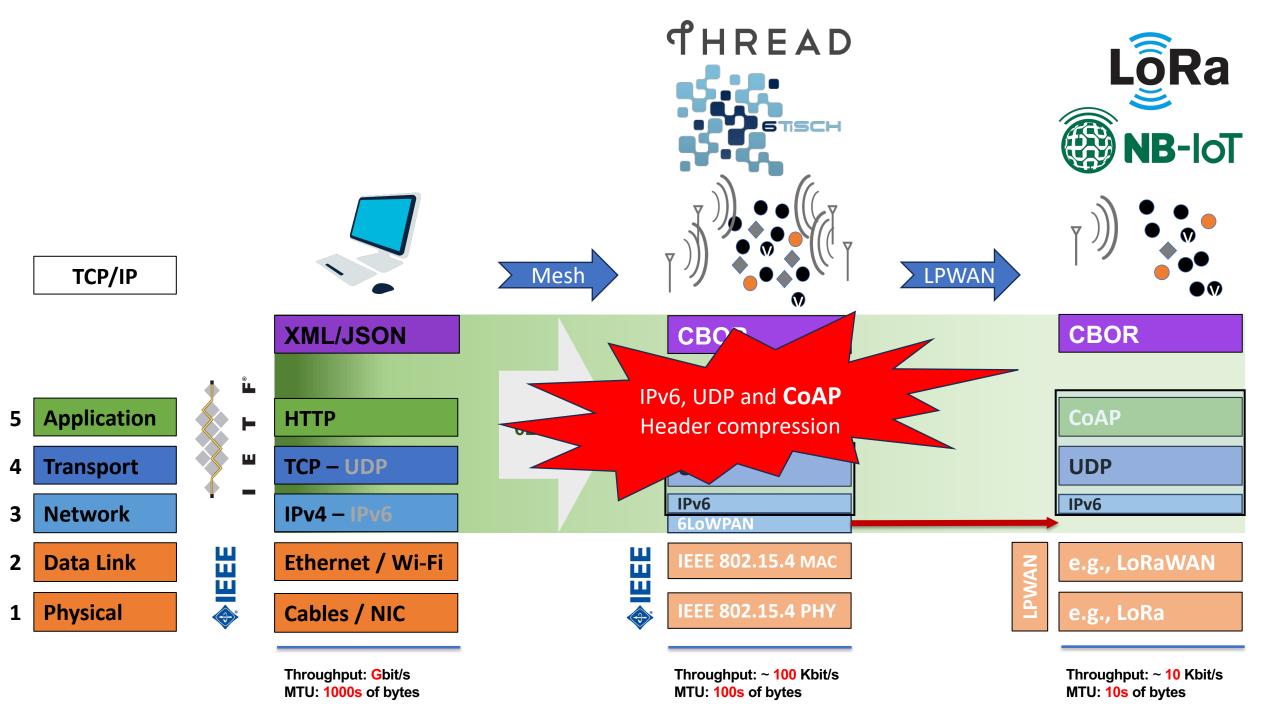
LoRa **NB-IoT** LPWAN e.g., LoRaWAN e.g., LoRa Throughput: ~ 10 Kbit/s

MTU: 10s of bytes



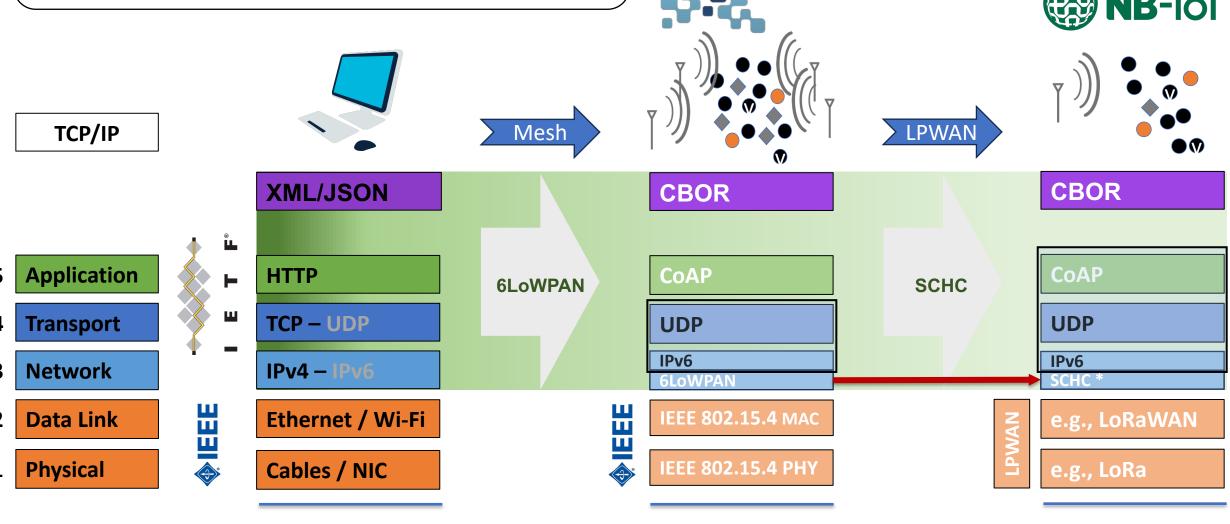






- \* SCHC stands for Static Context Header Compression.
- SCHC is packet-oriented (i.e., flow-independent) and a generic framework, since it can be applied to other protocols in addition to IPv6, UDP, & CoAP.





Throughput: Gbit/s MTU: 1000s of bytes Throughput: ~ 100 Kbit/s MTU: 100s of bytes

Throughput: ~ 10 Kbit/s

MTU: 10s of bytes



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as defined in RFC 4944, 6282, 7049, 7252, and 8724!



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