

R-Pi

Team Emertxe



IoT Protocols

6LoWPAN



6LoWPAN

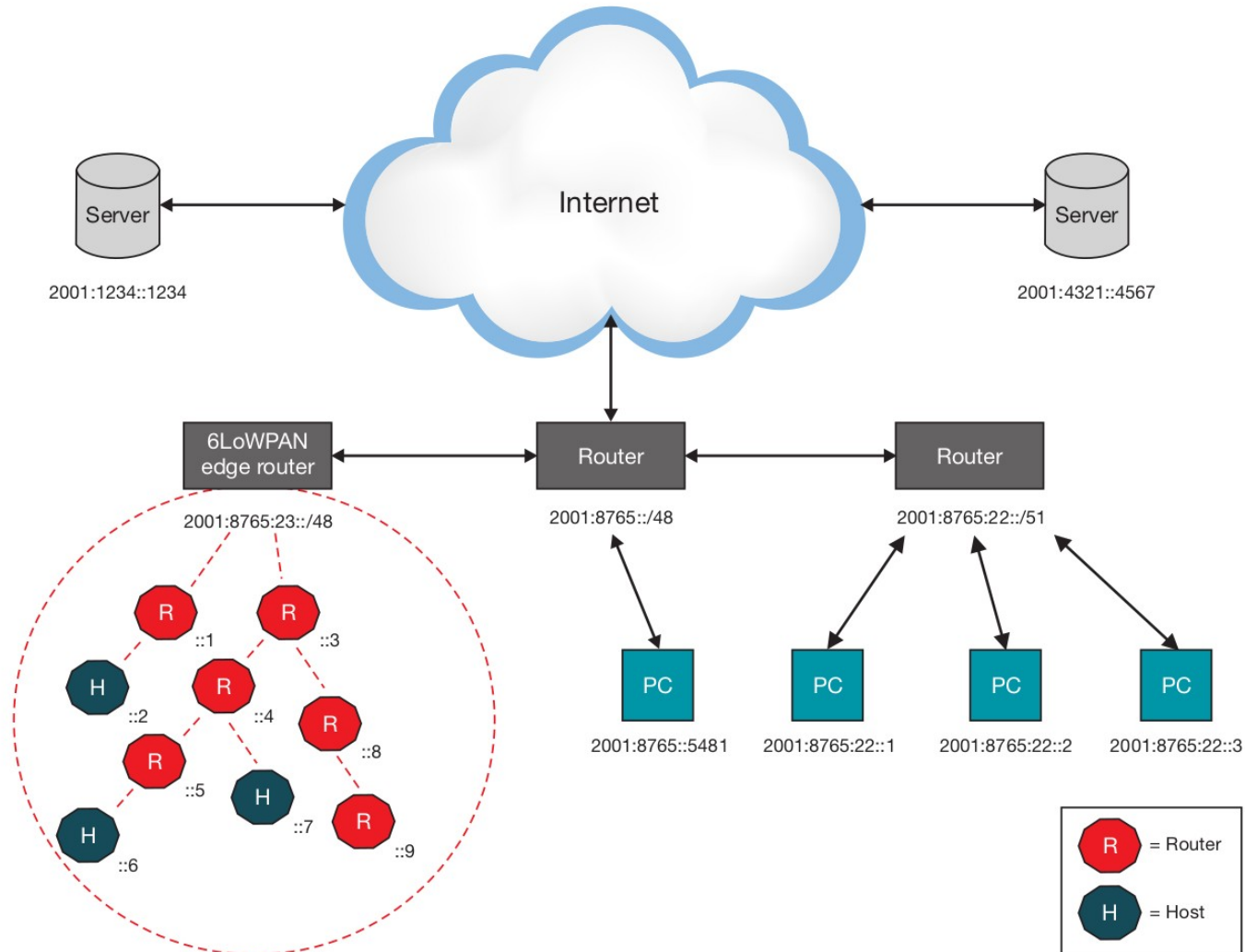
Introduction



- 6LoWPAN: IPv6 over Low-Power Wireless Personal Area Networks.
- Networking technology or adaptation layer that allows, IPv6 packets to be carried efficiently within small link layer frames, such as those defined by IEEE 802.15.4.
- Open standard defined in RFC 6282 by the Internet Engineering Task Force (IETF).
- A powerful feature of 6LoWPAN is that while originally conceived to support IEEE 802.15.4 low-power wireless networks in the 2.4-GHz band, it is now being adapted and used over a variety of other networking media including Sub-1 GHz low-power RF, Bluetooth Smart, power line control (PLC) and low-power Wi-Fi.

Open Standards: The standards body that defines many of the open standards used on the Internet such as UDP, TCP and HTTP.

6LoWPAN Architecture



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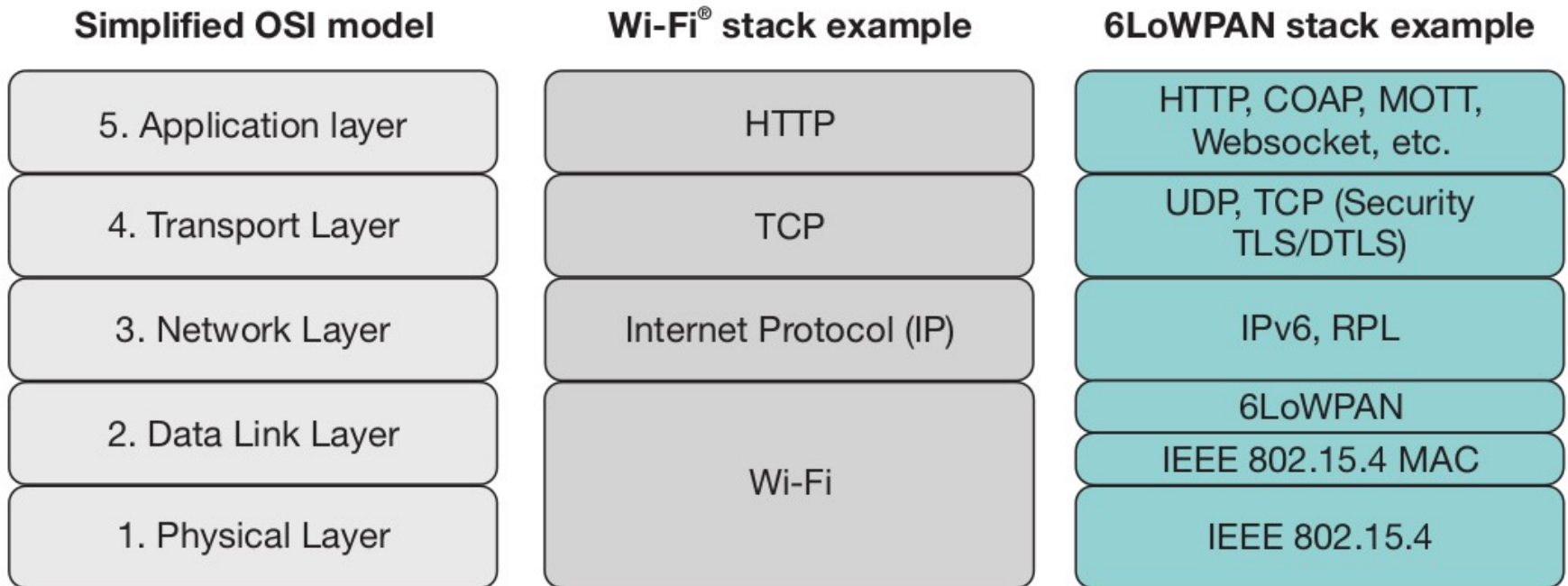
Architecture



- Edge router handles three actions,
 1. The data exchange between 6LoWPAN devices and Ipv6 network
 2. Local data exchange between the devices present within the 6LoWPAN mesh.
 3. The Maintenance of the 6LoWPAN network(Radio Subnet).

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System stack overview



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Ipv6 over IEEE 802.15.4: Challenges

1. IPv6 datagrams are not a natural fit for IEEE 802.15.4 networks.

- Low throughput, limited buffering and datagrams that are one-tenth of IPv6 minimum MTU make header compression and data fragmentation a necessity.
- Example:
 - IEEE 802.15.4 link headers can limit the effective possible payload to 81 bytes. This makes IPv6 (40 bytes), TCP (20 bytes) and UDP (8 bytes) headers seem way too large.

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Ipv6 over IEEE 802.15.4



1.2.

- Since IEEE 802.15.4 is both low power and low throughput, in addition to the use of RF as media, it is more prone to spurious interference, link failures and asymmetric links (A can hear B, but B cannot hear A).
- Those characteristics require the network layer to be adaptive and responsive at the same time as low power and efficient.

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Ipv6 over IEEE 802.15.4



1.3.

- The most common network topology for 6LoWPAN is a low-power mesh network.
 - negates the assumption that a link is a single broadcast domain, something that is very important since the very foundation of IPv6 such as neighbor discovery relies on it.

Challenges 1 - 3 are addressed by 6LoWPAN

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Adaptation layer



- When sending data over MAC and PHY layers, an adaptation layer is always used.
- The main focus, was to optimize the transmission of IPv6 packets over low-power and lossy networks such as IEEE 802.15.4
 - Header compression
 - Fragmentation and reassembly
 - Stateless auto configuration

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Header compression

IPv6 header

| | | | | | | | | |
|-----|---------------|------------|----------------|-------------|-----------|--|---|----------|
| Ver | Traffic class | Flow label | Payload length | Next header | Hop limit | Source address 64-bit prefix, 64-bit HD | Destination address 64-bit prefix, 64-bit HD | 40 bytes |
|-----|---------------|------------|----------------|-------------|-----------|--|---|----------|

1. Compressed header, FE80::CAFE:00FF:FE00:0100 → FE80::CAFE:00FF:FE00:0200

| | | |
|----------|---------------|---------|
| Dispatch | Compr. header | 2 bytes |
|----------|---------------|---------|

2. Compressed header, 2001::DEC4:E3A1:FE24:9600 → 2001::4455:84C6:39BB:A2DD

| | | | | | |
|----------|---------------|-----|-----------|----------------------------------|----------|
| Dispatch | Compr. header | CID | Hop limit | Destination address 64-bit HD | 12 bytes |
|----------|---------------|-----|-----------|----------------------------------|----------|

3. Compressed header, 2001::DEC4:E3A1:FE24:9600 → 2001::4455:84C6:39BB:A2DD

| | | | | | | |
|----------|---------------|-----|-----------|---------------------------------|---|----------|
| Dispatch | Compr. header | CID | Hop limit | Source address 64-bit prefix | Destination address 64-bit prefix, 64-bit HD | 20 bytes |
|----------|---------------|-----|-----------|---------------------------------|---|----------|

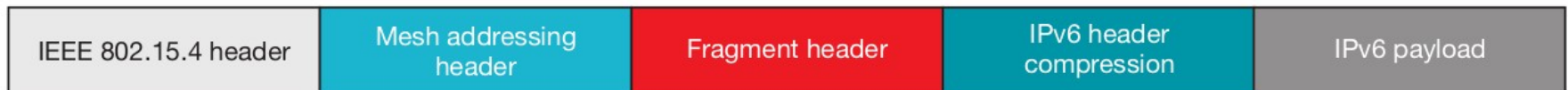
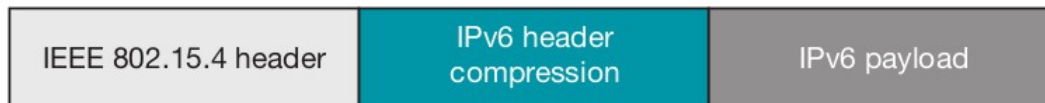
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Fragmentation and reassembly

- In order to enable the transmission of IPv6 frames over IEEE 802.15.4 radio links, the IPv6 frames need to be divided into several smaller segments.
- For this purpose, additional data in the headers are generated to reassemble the packets in the correct sequence at the end.
- When data packets are re-assembled, the additional information added is removed and the packets are restored to their initial IPv6 format.

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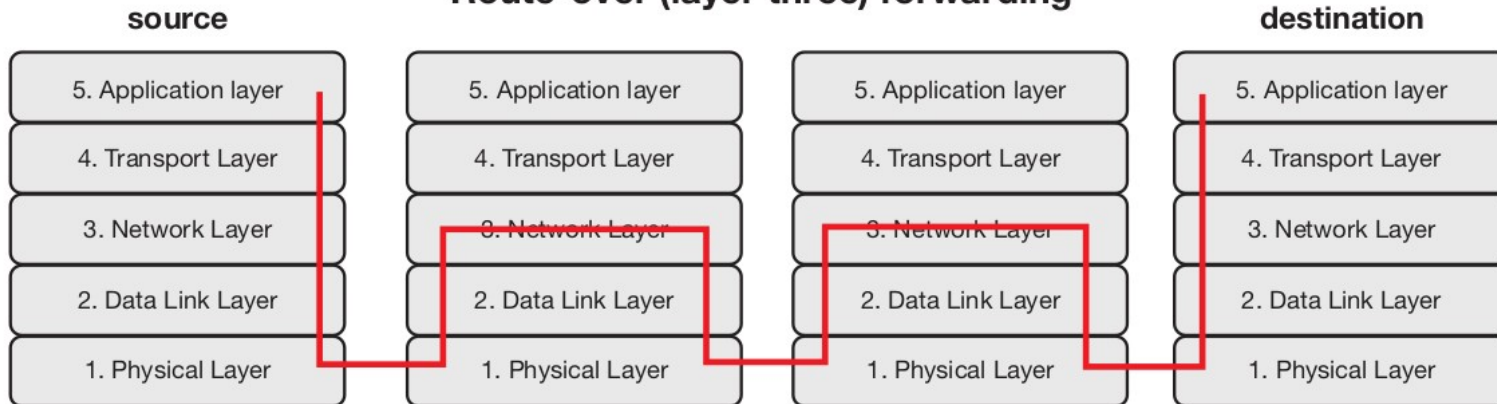
Header formats



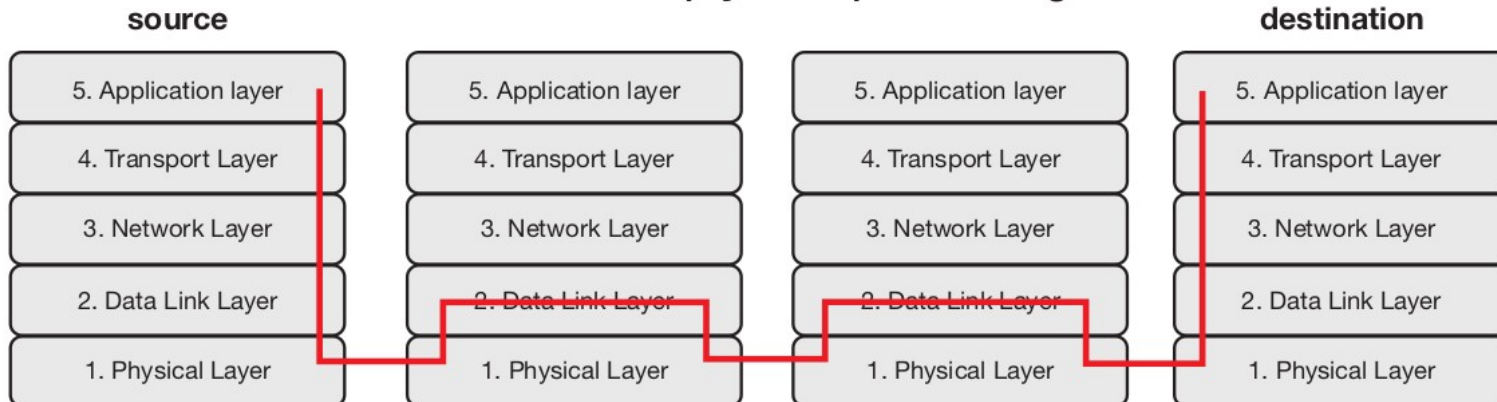
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Routing

Route-over (layer three) forwarding



Mesh-under (layer two) forwarding



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Security



- 6LoWPAN takes advantage of the strong AES-128 link layer security defined in IEEE 802.15.4.
- The link layer security provides link authentication and encryption.
- In addition to link layer security, transport layer security (TLS) mechanisms have been shown to work great in 6LoWPAN systems.
- Implementing TLS/DTLS requires the device to have necessary resources, such as a hardware encryption engine to enable the use of advanced cipher suites, etc.
 - TI's CC2538 wireless MCU, does the job

THANK YOU