Transmission of IPv6 Packets over Short-Range Optical Wireless Communications (IPv6 over OWC)

draft-ietf-6lo-owc-05

by

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Cheol-min Kim (KETI), Carles Gomez (UPC)

Status of “IPv6 over OWC”

- draft-choi-6lo-owc-00 (IETF 117, San Francisco, July 2023)
  - The Introduction to the new I.D. IPv6 over OWC
- draft-choi-6lo-owc-01 (IETF 118, Prague, November 2023)
  - Revision addressing technical issues related to IPv6 over OWC
- draft-choi-6lo-owc-02 (IETF 119, Brisbane, March 2024)
  - Revision incorporating comments from IETF118
  - Addition of SCHC in IPv6 over OWC
- draft-ietf-6lo-owc-00 & 01 (IETF 120, Vancouver, July 2024)
  - I.D.-00 (an initial draft of draft-choi-6lo-owc-02 with typos fixed)
  - Addition of SCHC in IPv6 over OWC (new texts and figures in § 4.5.2 & § 6.)
- draft-ietf-6lo-owc-02 (IETF 121, Dublin, November 2024)
  - Revision for Fig.5, Fig.7 and Fig.8
  - IANA comment about the I.D.-01 & References
- draft-ietf-6lo-owc-03 (IETF 122, Bangkok, March 2025)
  - Comments and feedback from IEEE802.15 members and the 6lo meeting in IETF 121
  - IANA comment about the I.D.-02
- draft-ietf-6lo-owc-04 (IETF 123, Madrid, July 2025)
  - Feedback from the 6lo meeting in IETF 121
  - A New Section Added (Annex A): Hybrid compression strategy using 6LoWPAN HC + SCHC
- **draft-ietf-6lo-owc-05 (IETF 124, Montreal, Nov. 2025)**
  - **IETF editorial conventions**
  - **Improved logical flow**

Summary of Revised I.D.-05

draft-ietf-6lo-owc-04.txt

```
6lo                                                          Y. Choi, Ed.
Internet-Draft                                                       ETRI
Intended status: Standards Track                             C-M. Kim
Expires: 8 January 2026                                              KETI
                                                             C. Gomez
                                  Universitat Politecnica de Catalunya
                                                          7 July 2025

    Transmission of IPv6 Packets over Short-Range Optical Wireless
                                Communications
                          draft-ietf-6lo-owc-04
```

draft-ietf-6lo-owc-05.txt

```
6lo                                                          Y. Choi, Ed.
Internet-Draft                                                       ETRI
Intended status: Standards Track                             C-M. Kim
Expires: 24 April 2026                                               KETI
                                                             C. Gomez
                                  Universitat Politecnica de Catalunya
                                                        21 October 2025

    Transmission of IPv6 Packets over Short-Range Optical Wireless
                                Communications
                          draft-ietf-6lo-owc-05
```

- **Why Revision Needed (I.D.-04 issues)?**
  - **Inconsistent** section structures (numbering & cross-references)
  - **Repetitive** or **informal** expressions
- **Revision Goal**
  → **Unify** and **clarify** **wording** in RFC style

- **Main Focus**
  - Applied IETF **editorial conventions**
  - Improved **logical flow** : **§1 & §4**
  - Ensured **normative consistency**

→ **No technical changes** introduced

Key Editorial Updates (1/2)

- §1. Revised and added for clear motivation and context

draft-ietf-6lo-owc-04.txt	draft-ietf-6lo-owc-05.txt
1. Introduction	1. Introduction
The rapid growth of the Internet of Things (IoT) has led to a significant increase in the number of wireless communication technologies utilized for real-time data collection and monitoring in various industrial domains, such as manufacturing, agriculture, healthcare, transportation, and so on. This trend highlights the importance of wireless communication in facilitating real-time data exchange and analysis, ultimately contributing to enhanced operational efficiency and decision-making processes across different industrial sectors.	The rapid growth of the Internet of Things (IoT) has led to a significant increase in the number of wireless communication technologies utilized for real-time data collection and monitoring in various industrial domains, such as manufacturing, agriculture, healthcare, transportation, and so on. This trend highlights the importance of wireless communication in facilitating real-time data exchange and analysis, ultimately contributing to efficiency and decision-making processes across different industrial sectors.
⋮	⋮
	While IEEE 802.15.7 and its related amendments define the physical and MAC layers for Optical Wireless Communication (OWC), the documents do not specify how IPv6 packets are transmitted over such links. Therefore, this document defines the adaptation of IPv6 over OWC to enable IP-based interoperability across OWC and other low-power wireless technologies.
OWC is immune to Radio Frequency (RF) interference, making it highly suitable for environments such as hospitals, airplanes, and industrial facilities, where RF interference is a concern. Additionally, OWC can leverage existing visible light infrastructure,	OWC is immune to Radio Frequency (RF) interference, making it highly suitable for environments such as hospitals, airplanes, and industrial facilities, where RF interference is a concern. Additionally, OWC can leverage existing visible light infrastructure,

The Introduction now provides a clearer motivation for using IPv6 over OWC — highlighting advantages such as immunity to RF interference and integration with lighting infrastructure."

Key Editorial Updates (2/2)

- §4. Revised for clear context and for better readability

draft-ietf-6lo-owc-04.txt	draft-ietf-6lo-owc-05.txt
4.2. Stateless Address Autoconfiguration	4.2. Stateless Address Autoconfiguration
The RID is an output created by the F() algorithm with input parameters. One of the parameters is Net_Iface, and the OWC 16-bit Link-Layer Address MUST be a source of the Net_Iface parameter. The 16-bit address can easily be targeted by attacks from a third party (e.g., address scanning). The F() algorithm with SHA-256 can provide secured and stable IIDs for OWC devices. In addition, an optional parameter, Network_ID, is used to increase the randomness of the generated IID with the OWC Link-Layer Address. The secret key SHOULD be at least 128 bits. It MUST be initialized to a pseudorandom number [RFC4086].	The Random Identifier (RID) is derived using the F() algorithm defined in [RFC7217]. One of the input parameters to F() is Net_Iface, which MAY be derived from the 16-bit or 64-bit OWC Link-Layer Address. However, because short (16-bit) addresses are easily predictable and can be subject to address-scanning attacks, implementations SHOULD apply the randomized identifier generation scheme of [RFC7217] to ensure IID stability and privacy. The F() algorithm SHALL use SHA-256 as the hash function. An optional Network_ID parameter MAY be included to increase randomness in IID generation. The secret key MUST be at least 128 bits long and SHOULD be initialized with a cryptographically strong pseudorandom value as recommended in [RFC4086].
4.4. Neighbor Discovery	4.4. Neighbor Discovery
* When an OWC 6LN is directly connected to a 6LBR, the 6LN MUST register its address with the 6LBR by sending Neighbor Solicitation (NS) with the Extended Address Registration Option (EARO) [RFC8505]. When the 6LN and 6LBR are linked to each other, 6LBR assigns an address to the 6LN. In this process, Duplicate Address Detection (DAD) [RFC6775]. is not required.	* When an OWC 6LN is directly connected to a 6LBR, the 6LN registers its address with the 6LBR by sending a Neighbor Solicitation (NS) message including the Extended Address Registration Option (EARO) [RFC8505]. In this single-hop case, Duplicate Address Detection (DAD)[RFC6775] is not required, since the 6LBR manages address registrations for its attached nodes.
* When two or more multi-hop topology by OWC 6LNs are connected to the 6LBR, the 6LBR performs DAD for the acquired link-local address of the 6LNs. In this topology, 6LNs that have two or more links with neighbor nodes may act as routers.	* For multi-hop topologies, the 6LBR MUST perform DAD on registered addresses to ensure address uniqueness across the entire OWC network. In such networks, intermediate 6LNs that connect to multiple neighbors MAY act as 6LoWPAN Routers (6LRs) to forward Neighbor Discovery messages as specified in [RFC6775].
* For receiving RSs and RAs, the OWC 6LNs MUST follow Sections 5.3 and 5.4 of [RFC6775].	* When receiving RSs and RAs, the OWC 6LNs MUST follow Sections 5.3 and 5.4 of [RFC6775].

Key Editorial Updates (2/2) – cont'd

- §4. Revised for clear context and for better readability

draft-ietf-6lo-owc-04.txt	draft-ietf-6lo-owc-05.txt
4.5.2. SCHC header compression	4.5.2. SCHC header compression
In addition, Static Context Header Compression and fragmentation (SCHC)[RFC8724] is optionally used in OWC networks to reduce overhead. A signaling mechanism SHOULD be implemented to indicate whether a node supports SCHC compression. For instance, SCHC MAY be used to compress IPv6 headers, IPv6/UDP headers, IPv6/UDP/CoAP (if CoAP is used), etc. [RFC8724].	The 6LoWPAN Capability Indication Option (6CIO) is defined in [RFC6775]. This document introduces a new capability flag, the 'S' bit, indicating support for SCHC header compression. In addition, Static Context Header Compression and fragmentation (SCHC)[RFC8724] is optionally used in OWC networks to reduce overhead. A signaling mechanism SHOULD be implemented to indicate whether a node supports SCHC compression. For instance, SCHC MAY be used to compress IPv6 headers, IPv6/UDP headers, IPv6/UDP/CoAP (if CoAP is used), etc. [RFC8724].
In the star topology, in order to signal that a node supports SCHC for header compression, the node uses the 6LoWPAN Capability Indication Option (6CIO), with a new 6LoWPAN Capability Bit called the "S" bit. This 'S' bit is intended to indicate generic SCHC functionality, making it applicable beyond OWC networks. Future standardization efforts may define a generic specification for the 'S' bit that extends to other link-layer technologies. The "S" bit is the last bit (47th bit) of the "6LoWPAN Capability Bits" registry (see Figure 5).	In the star topology, in order to signal that a node supports SCHC for header compression, the node uses the 6LoWPAN Capability Indication Option (6CIO), with a new 6LoWPAN Capability Bit called the "S" bit. This 'S' bit is intended to indicate generic SCHC functionality, so that it is applicableit emulates beyond OWC networks. Future standardization efforts MAY define a generic specification for the 'S' bit that extends to other link-layer technologies. The "S" bit is the last bit (47th bit) of the "6LoWPAN Capability Bits" registry (see Figure 5).

Key Editorial Updates (2/2) – cont'd

- §4. Revised for clear context and for better readability

draft-ietf-6lo-owc-04.txt

4.7. Unicast and Multicast Address Mapping

The OWC Link Layer does not support multicast. Therefore, packets are always transmitted unicast between two OWC devices. Even in the case where a 6LBR is attached to multiple 6LNs, the 6LBR cannot multicast to all the connected 6LNs. If the 6LBR needs to send a multicast packet to all its 6LNs, it has to replicate the packet and unicast it on each link. However, this is not energy-efficient; the central node, which is battery-powered, must take particular care of power consumption. To further conserve power, the 6LBR MUST keep track of multicast listeners at OWC link-level granularity (not at subnet granularity), and it MUST NOT forward multicast packets to 6LNs that have not registered as listeners for multicast groups the packets belong to. In the opposite direction, a 6LN always has to send packets to or through the 6LBR. Hence, when a 6LN needs to transmit an IPv6 multicast packet, the 6LN will unicast the corresponding OWC packet to the 6LBR.

draft-ietf-6lo-owc-05.txt

4.7. Unicast and Multicast Address Mapping

IEEE 802.15.7 does not natively support link-layer multicast transmission. Therefore, IPv6 packets over OWC are normally delivered as unicasts between two OWC devices. When a 6LBR is connected to multiple 6LNs, it MAY emulate multicast delivery by performing link-layer broadcast or by replicating packets as multiple unicasts, while considering the resulting energy impact on constrained nodes.

To reduce unnecessary transmissions, the 6LBR SHOULD maintains a record of multicast listeners at the OWC link-layer granularity (rather than the subnet level) and MUST NOT forward multicast packets to 6LNs that have not registered as listeners for the relevant groups.

In the reverse direction, a 6LN MUST send IPv6 multicast packets as unicasts to the 6LBR, which then distributes them according to its multicast listener table.

Consistency Enhancements

- **Improved document-wide consistency**
  - **Unified terminology** ('OWC device', '6LBR', '6LR') in §5 (Internet Connectivity Scenarios)
  - Refined **figure captions** and **table titles**

Further Updates

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7.  Security Considerations

   [TBD]
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- **For § 7 (Security Considerations)**, a new contributor, Munhwan Choi (ETRI) has been invited.
- In IETF 125, **some of his stable contents will be incorporated** in the next updates with quick presentation.

draft-choi-6lo-owc-security-00

6lo — M. Choi, Ed.
Internet-Draft — Y. Choi
Intended status: Informational — ETRI
Expires: 13 April 2025 — 10 October 2024

Security considerations for IPv6 Packets over Short-Range Optical Wireless Communications
draft-choi-6lo-owc-security-00

Table of Contents

※ A New I.D., draft-choi-6lo-owc-security : Recently updated into I.D.-03
(https://datatracker.ietf.org/doc/draft-choi-6lo-owc-security/)

Please read the draft
and
welcome any feedback !!

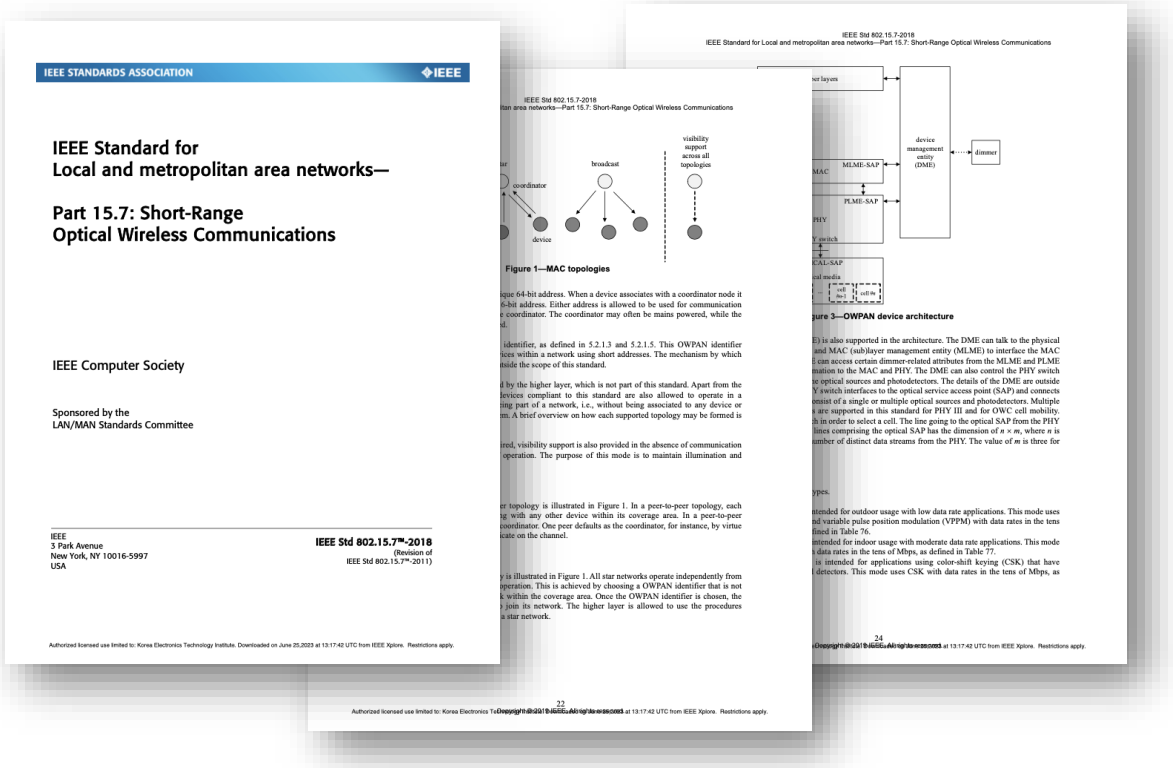
Thank you.

Ref.#1: Short-Range Optical Wireless Communications (OWC) ?

- **OWC** uses **intensity modulation of optical sources**, such as **Light Emitting Diodes (LEDs)**.
- **OWC** combines lighting and **bidirectional data communications**.
- **OWC** can be applied to various domains including area **lighting, signboards, streetlights, vehicles, traffic signals, displays, LED panels, and digital signage, smart phones** …
- **OWC** devices can be powered by **limited energy sources (e.g., battery or energy harvesting)** for energy-efficient services.

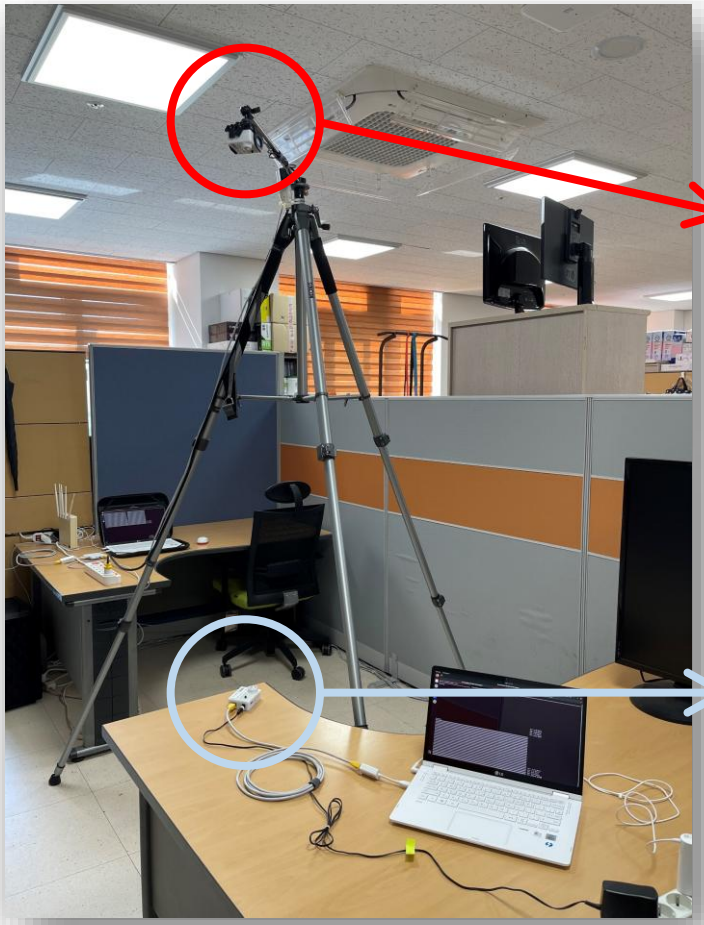
Ref.#2: OWC v.s. IEEE 802.15.7

- OWC is defined by **IEEE 802.15.7 standard**
  providing six key characteristics, including



Visible Light Communication (VLC),
Short-Range Bidirectional Communication,
Line-of-Sight (LOS) &
Non-Line-of-Sight (NLOS) Support,
High and Low Data Rates,
Energy Efficiency,
and Secure Communication.

Ref.#3: Test-bed for “IPv6 over OWC”

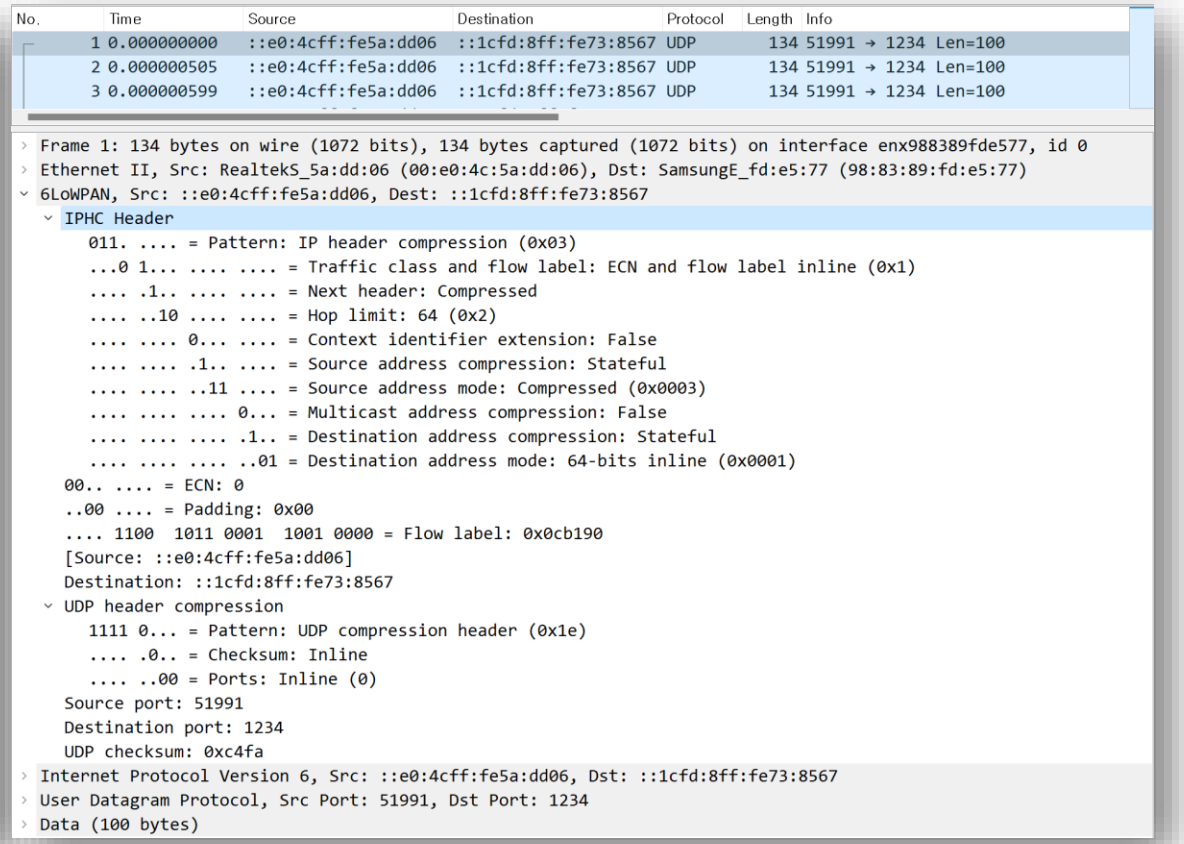


Ref.#4: Test Results of “IPv6 over OWC”

- Ping responses

```
PING 2001:db8:aaaa::1cfd:08ff:fe73:8567(2001:db8:aaaa:0:1cfd:8ff:fe73:8567) 100 data bytes
108 bytes from 2001:db8:aaaa:0:1cfd:8ff:fe73:8567: icmp_seq=1 ttl=63 time=1.65 ms
108 bytes from 2001:db8:aaaa:0:1cfd:8ff:fe73:8567: icmp_seq=2 ttl=63 time=1.68 ms
108 bytes from 2001:db8:aaaa:0:1cfd:8ff:fe73:8567: icmp_seq=3 ttl=63 time=1.68 ms
108 bytes from 2001:db8:aaaa:0:1cfd:8ff:fe73:8567: icmp_seq=4 ttl=63 time=1.65 ms
108 bytes from 2001:db8:aaaa:0:1cfd:8ff:fe73:8567: icmp_seq=5 ttl=63 time=1.67 ms
108 bytes from 2001:db8:aaaa:0:1cfd:8ff:fe73:8567: icmp_seq=6 ttl=63 time=1.65 ms
108 bytes from 2001:db8:aaaa:0:1cfd:8ff:fe73:8567: icmp_seq=7 ttl=63 time=1.65 ms
108 bytes from 2001:db8:aaaa:0:1cfd:8ff:fe73:8567: icmp_seq=8 ttl=63 time=1.67 ms
108 bytes from 2001:db8:aaaa:0:1cfd:8ff:fe73:8567: icmp_seq=9 ttl=63 time=1.65 ms
108 bytes from 2001:db8:aaaa:0:1cfd:8ff:fe73:8567: icmp_seq=10 ttl=63 time=1.65 ms
108 bytes from 2001:db8:aaaa:0:1cfd:8ff:fe73:8567: icmp_seq=11 ttl=63 time=1.65 ms
108 bytes from 2001:db8:aaaa:0:1cfd:8ff:fe73:8567: icmp_seq=12 ttl=63 time=1.65 ms
108 bytes from 2001:db8:aaaa:0:1cfd:8ff:fe73:8567: icmp_seq=13 ttl=63 time=1.65 ms
108 bytes from 2001:db8:aaaa:0:1cfd:8ff:fe73:8567: icmp_seq=14 ttl=63 time=1.63 ms
108 bytes from 2001:db8:aaaa:0:1cfd:8ff:fe73:8567: icmp_seq=15 ttl=63 time=1.65 ms
108 bytes from 2001:db8:aaaa:0:1cfd:8ff:fe73:8567: icmp_seq=16 ttl=63 time=1.62 ms
108 bytes from 2001:db8:aaaa:0:1cfd:8ff:fe73:8567: icmp_seq=17 ttl=63 time=1.67 ms
108 bytes from 2001:db8:aaaa:0:1cfd:8ff:fe73:8567: icmp_seq=18 ttl=63 time=1.65 ms
108 bytes from 2001:db8:aaaa:0:1cfd:8ff:fe73:8567: icmp_seq=19 ttl=63 time=1.62 ms
108 bytes from 2001:db8:aaaa:0:1cfd:8ff:fe73:8567: icmp_seq=20 ttl=63 time=1.62 ms
108 bytes from 2001:db8:aaaa:0:1cfd:8ff:fe73:8567: icmp_seq=21 ttl=63 time=1.68 ms
108 bytes from 2001:db8:aaaa:0:1cfd:8ff:fe73:8567: icmp_seq=22 ttl=63 time=1.62 ms
108 bytes from 2001:db8:aaaa:0:1cfd:8ff:fe73:8567: icmp_seq=23 ttl=63 time=1.64 ms
108 bytes from 2001:db8:aaaa:0:1cfd:8ff:fe73:8567: icmp_seq=24 ttl=63 time=1.65 ms
108 bytes from 2001:db8:aaaa:0:1cfd:8ff:fe73:8567: icmp_seq=25 ttl=63 time=1.67 ms
108 bytes from 2001:db8:aaaa:0:1cfd:8ff:fe73:8567: icmp_seq=26 ttl=63 time=1.62 ms
108 bytes from 2001:db8:aaaa:0:1cfd:8ff:fe73:8567: icmp_seq=27 ttl=63 time=1.66 ms
108 bytes from 2001:db8:aaaa:0:1cfd:8ff:fe73:8567: icmp_seq=28 ttl=63 time=1.64 ms
```

- Wireshark captured



Ref.#5: IEEE WCL about “IPv6 over OWC”

Cheol-min Kim, Sang-Kyu Lim, Jin-Doo Jeong, Younghwan Choi, Seok-Joo Koh, "**6LoWPAN Over Optical Wireless Communications for IPv6 Transport in Internet of Things Networks**” **IEEE Wireless Communications Letters**, Vol. 11, Issue 6, June 2022.