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

draft-ietf-6lo-owc-04

by

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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**

Updates of I.D.-04 (from the I.D.-03)

- Table of Contents

draft-ietf-6lo-owc-03.txt	draft-ietf-6lo-owc-04.txt
6lo Y. Choi, Ed.	6lo Y. Choi, Ed.
Internet-Draft ETRI	Internet-Draft ETRI
Intended status: Standards Track C-M. Kim	Intended status: Standards Track C-M. Kim
Expires: 2 September 2025 KETI	Expires: 8 January 2026 KETI
C. Gomez	C. Gomez
Universitat Politecnica de Catalunya	Universitat Politecnica de Catalunya
1 March 2025	7 July 2025
Transmission of IPv6 Packets over Short-Range Optical Wireless Communications	Transmission of IPv6 Packets over Short-Range Optical Wireless Communications
draft-ietf-6lo-owc-03	draft-ietf-6lo-owc-04
skipping to change at *page 2, line 47*	skipping to change at *page 2, line 47*

⇒ : updated

Motivation:
Why Combine 6LoWPAN HC and SCHC?

- **IPv6 over OWC networks serve**
  - diverse communication patterns
- **6LoWPAN HC:**
  - Lightweight, quasi-stateless
  - Suitable for devices with strict memory/processing limits
- **SCHC:**
  - Stateful, high compression ratio
  - Useful when header fields are predictable

👉 **Enable flexible adaptation**

across Heterogeneity and Traffic patterns

6LoWPAN vs. SCHC at a Glance

Feature	6LoWPAN HC	SCHC
Compression Type	Quasi-stateless	Stateful
Processing Cost (Memory + CPU)	Low	Higher
Efficiency	Moderate	High (when header values are predictable)
Protocol Support	IPv6/UDP	IPv6/UDP/CoAP/ICMPv6/QUIC (etc.)
Coexistence Mechanism	Natively supported	Indicated by "S" bit in 6LoWPAN Capability

Compression Selection Strategy

- **Header Field Predictability**
  - SCHC is efficient
    when header values remain stable
  - 6LoWPAN HC preferred
    if fields are highly dynamic

- **Service Requirements**
  - Delay-sensitive apps
    may benefit from SCHC
  - SCHC reduces transmission time
    over low-rate OWC links

- **Implementation Constraints**
  - SCHC might require
    more resources
  - 6LoWPAN HC suits
    limited hardware

Signaling & Compatibility

- **SCHC Discovery and Negotiation**
  - Use of 6CIO (6LoWPAN Capability Indication Option)
  - "S" bit (47th bit in Capability Bits registry)

- **Multi-hop Considerations:**
  - SCHC requires all nodes to:
    - Use the same route-over mode (SRO, TRO, PRO)
    - Support SCHC consistently across the path

Example Scenarios

1. **Mixed Generation Deployment**
   - Legacy 6LoWPAN-only nodes operate alongside SCHC-capable devices
   - Smooth transition strategy

2. **Multi-Protocol Compression**
   - SCHC used for CoAP, ICMPv6, and even QUIC
   - Enables finer-grained optimization

👉 **Flexible use of both schemes** allows

Performance Tuning based on deployment

Summary

- Annex A: **a hybrid compression approach: Optional, not mandatory in the specification**

- Addresses: **Device heterogeneity, Mixed network deployments**

- Enables: **Efficient use of bandwidth, Low-power operations, Future extensibility with SCHC**

👉 **Supports Flexible Compression Selection based on context**

Further Updates

```
7.  Security Considerations

   [TBD]
```

- **For § 7 (Security Considerations)**, a new contributor, Munhwan Choi (ETRI) has been invited.
- In IETF 124, **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
```

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※ A New I.D., draft-choi-6lo-owc-security : Recently updated into I.D.-02
(https://datatracker.ietf.org/doc/draft-choi-6lo-owc-security/)

Please read the draft
and
welcome any feedback !!

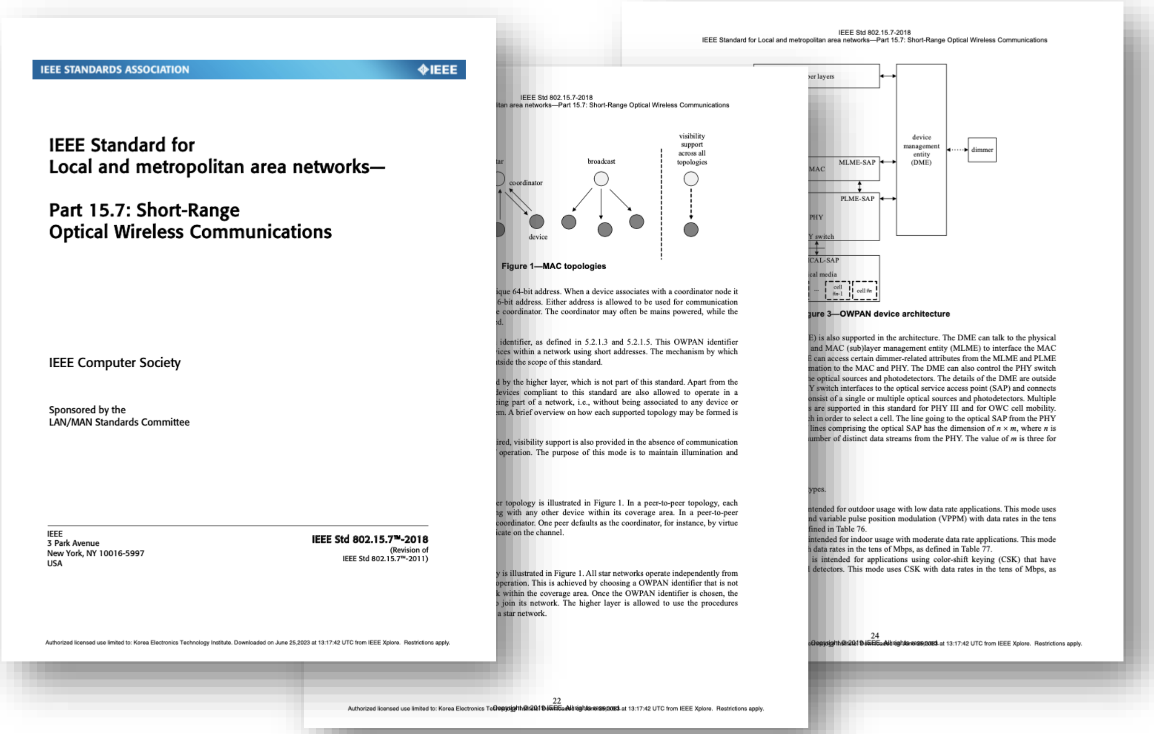
Thank you.

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


IEEE STANDARDS ASSOCIATION

IEEE Standard for
Local and metropolitan area networks—

Part 15.7: Short-Range
Optical Wireless Communications

IEEE Computer Society

Sponsored by the
LAN/MAN Standards Committee

IEEE
3 Park Avenue
New York, NY 10016-5997
USA

IEEE Std 802.15.7™-2018
(Revision of
IEEE Std 802.15.7™-2011)

Figure 1—MAC topologies

Figure 3—OWPAN device architecture

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

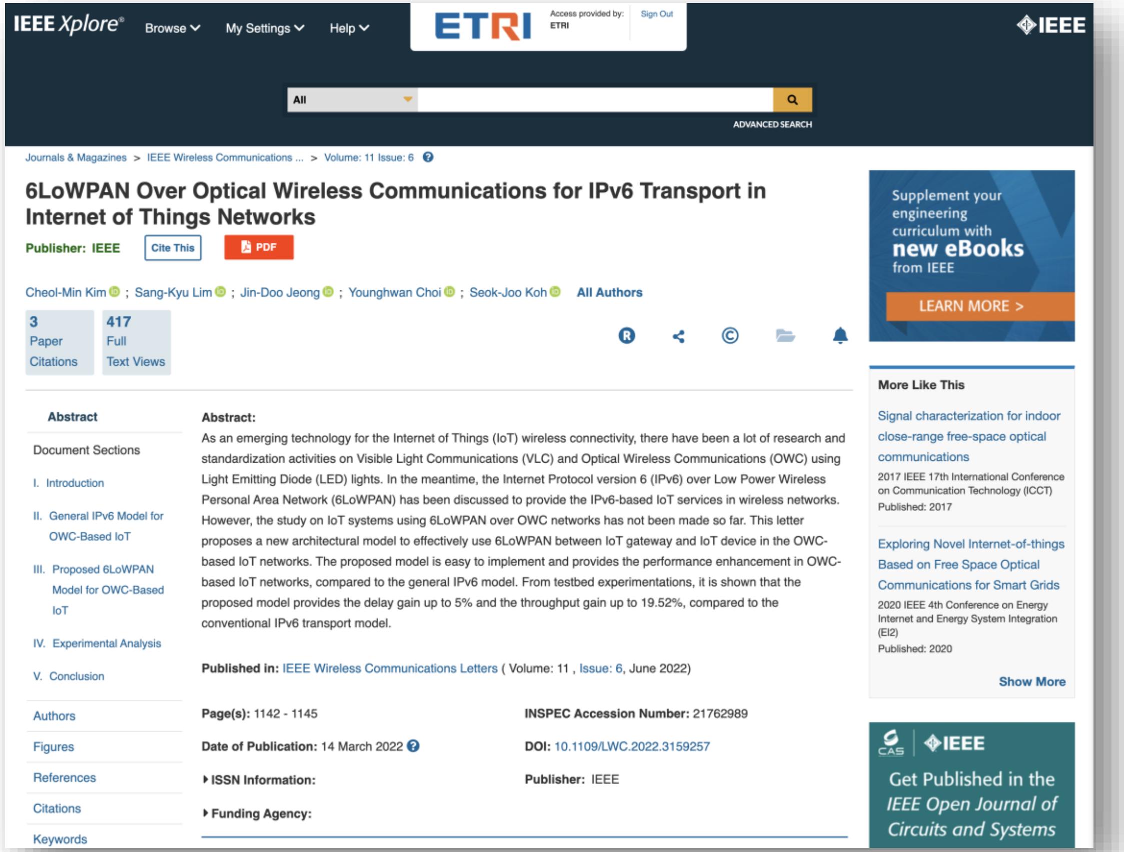
```
PING 2001:db8:aaaa::1cfd:08ff:fe73:8567(2001:db8:aaaa:0:1cfd:8ff:fe73:8567) 100 data bytes
108 bytes from 2001:db8:aaaa:0:1cfd:8ff:fe73:8567: icmp_seq=1 ttl=63 time=1.65 ms
108 bytes from 2001:db8:aaaa:0:1cfd:8ff:fe73:8567: icmp_seq=2 ttl=63 time=1.68 ms
108 bytes from 2001:db8:aaaa:0:1cfd:8ff:fe73:8567: 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

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	::e0:4cff:fe5a:dd06	::1cfd:8ff:fe73:8567	UDP	134	51991 → 1234 Len=100
2	0.000000505	::e0:4cff:fe5a:dd06	::1cfd:8ff:fe73:8567	UDP	134	51991 → 1234 Len=100
3	0.000000599	::e0:4cff:fe5a:dd06	::1cfd:8ff:fe73:8567	UDP	134	51991 → 1234 Len=100

```
> Frame 1: 134 bytes on wire (1072 bits), 134 bytes captured (1072 bits) on interface enx988389fde577, id 0
> Ethernet II, Src: RealtekS_5a:dd:06 (00:e0:4c:5a:dd:06), Dst: SamsungE_fd:e5:77 (98:83:89:fd:e5:77)
v 6LoWPAN, Src: ::e0:4cff:fe5a:dd06, Dest: ::1cfd:8ff:fe73:8567
  v IPHC Header
      011. .... = Pattern: IP header compression (0x03)
      ...0 1... .... .... = Traffic class and flow label: ECN and flow label inline (0x1)
      .... .1.. .... .... = Next header: Compressed
      .... ..10 .... .... = Hop limit: 64 (0x2)
      .... .... 0... .... = Context identifier extension: False
      .... .... .1.. .... = Source address compression: Stateful
      .... .... ..11 .... = Source address mode: Compressed (0x0003)
      .... .... .... 0... = Multicast address compression: False
      .... .... .... .1.. = Destination address compression: Stateful
      .... .... .... ..01 = Destination address mode: 64-bits inline (0x0001)
    00.. .... = ECN: 0
    ..00 .... = Padding: 0x00
    .... 1100  1011 0001  1001 0000 = Flow label: 0x0cb190
    [Source: ::e0:4cff:fe5a:dd06]
    Destination: ::1cfd:8ff:fe73:8567
  v UDP header compression
      1111 0... = Pattern: UDP compression header (0x1e)
      .... .0.. = Checksum: Inline
      .... ..00 = Ports: Inline (0)
    Source port: 51991
    Destination port: 1234
    UDP checksum: 0xc4fa
> Internet Protocol Version 6, Src: ::e0:4cff:fe5a:dd06, Dst: ::1cfd:8ff:fe73:8567
> User Datagram Protocol, Src Port: 51991, Dst Port: 1234
> Data (100 bytes)
```

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.