6LoWPAN
Technical Overview

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6LoWPAN - Introduction

- With more and more successful real environment WSN deployments on one hand, and the success and ubiquitous of IP Networks on the other, experts having been working towards an approach to bring the two together. 6LowPAN is an approach in this direction.

- 6LowPAN is an acronym for IPV6 over Low Power Personal Area Networks (such as the IEEE 802.15.4 radio).

- It is the working group name in the IETF (Internet Engineering Task Force).

- The IETF 6LoWPAN working group was formed in 2004 to address the challenge of enabling wireless IPv6 communication over the newly standardized IEEE 802.15.4 low-power radio for devices with limited space, power and memory, such as sensor nodes.

- 6LoWPAN provides a WSN node with IP communication capabilities. Simply speaking, it puts an adaptation layer above the 802.15.4 link layer and provides the ability of TCP/IP communication above the adaptation layer. The adaptation layer is necessary because stacking IP and above layers "as is" may not fit within one 802.15.4 frame.

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Acronyms

Acronym	Description
IETF	Internet Engineering Task Force
IEEE	Institute of Electrical and Electronics Engineers
NAT	Network Address Translation
AODV	Ad hoc On Demand Distance Vector
DYMO	Dynamic MANET On-demand
WSN	Wireless Sensor Network
IPV6	Internet Protocol Version6
MTU	Maximum Transmission Unit
PAN	Personal Area Network
RFC	Request For Comment
TCP	Transmission Control Protocol
UDP	User Datagram Protocol

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6LoWPAN Stack Architecture

ISO/OSI Layer Model

Application Layer
Presentation Layer
Session Layer
Transport layer
Network Layer
Data link Layer
Physical Layer

6LoWPAN Stack

6 LoWPAN Specific Applications (Using Socket Interface)
Not Explicitly used
Not Explicitly used
TCP/UDP
IPV6 and Adaptation Layer for routing, fragmentation/reassembling
IEEE 802.15.4 (unslotted CSMA/CA)
IEEE 802.15.4 PHY

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6LoWPAN : Physical Layer

- The PHY layer provides the basic communication capabilities of the physical radio.

- It is based on IEEE 802.15.4 with a data rate of 250 Kbps and operating frequency of 2400 – 2483.5 MHz.

- The Physical layer PDU is IEEE 802.15.4 compliant with a maximum payload of 127 bytes.

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6LoWPAN : Data Link Layer

- The Data Link layer provides services to enable reliable, single-hop communication links between devices.

- The MAC PDU is IEEE 802.15.4 compliant.

- IEEE 802.15.4 networks does not require to run in beacon-enabled mode. In nonbeacon - enabled networks, data frames (including those carrying IPv6 packets) are sent via the contention-based channel access method of unslotted CSMA/CA.

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6LoWPAN : Adaptation Layer

- The adaptation layer is the main component of 6LoWPAN.

- The first major function of this layer is the TCP/IP header compression. TCP/IP headers are too large for 802.15.4, which has a maximum packet size of 128 bytes; instead IPv6 header size is 40 bytes, UDP and ICMP header sizes are both 4 bytes, TCP header size is 20. Without compression, 802.15.4 is not possible to transmit any payload effectively.

- A second major function of the adaptation layer is to handle packet fragmentation and reassembling. IEEE 802.15.4 has a maximum frame size of 128 bytes, while IPv6 requires a maximum transmission unit (MTU) of 1280 bytes. This mismatch has to be handled in the adaptation layer.

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6LoWPAN : Adaptation Layer continued...

- The third major function of the adaptation layer is routing. The border nodes of the WSN should be able to route IPv6 packets into the WSN nodes from outside and route inside packets to outside IP network.

  - Different routing protocols of adaptation layer are shown in table.

- There are other functions of the adaptation layer on networking related things like neighbor discovery and multicast support.

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6LoWPAN : Adaptation Layer continued...

- Routing per se is a two phased problem that is being considered for 6LoWPAN.

  1)**Mesh Routing** in the PAN Space

  2)Routability of packets **to/from the IPV6 domain from/to the PAN domain**

  Some of the routing protocols currently being developed by 6LoWPAN Community, those are **LOAD,DYMO-LOW, Hi-Low**.

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6LoWPAN : Adaptation Layer continued...

Routing Protocol	Description
LOAD	6LoWPAN Ad hoc Routing Protocol (LOAD) is a simplified On-demand routing protocol based on AODV[RFC3561] for 6LoWPAN . The Ad hoc On Demand Distance Vector (AODV) routing algorithm is a routing protocol designed for ad hoc mobile networks. AODV is capable of both unicast and multicast routing. It is an on demand algorithm, meaning that it builds routes between nodes only as desired by source nodes. It maintains these routes as long as they are needed by the sources.
DYMO Low	The Dynamic MANET On-demand (DYMO) for 6LoWPAN routing protocol is intended for use by mobile nodes in wireless multihop networks. It offers adaptation to changing network topology and determines unicast routes between nodes within the network
Hi-Low	Hierarchical routing protocol is based on 16-bit short address of a 6LoWPAN

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6LoWPAN : Network Layer

- It provides the Internetworking capability to sensor nodes.

- Addresses IPv6 node requirements.

- Appropriate security services.

- Routing considerations.

- Network management with SNMP (Simple Network Management Protocol).

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6LoWPAN : Transport Layer

- The Transport Layer is responsible for delivering data to the appropriate application process on the host computers.

- Some Transport layer protocols are UDP and TCP.

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6LoWPAN : Application Layer

- 6LoWPAN specific applications using socket interface
- Applications
  - Equipment health monitoring
  - Environment monitoring
  - Security
  - Home
  - Building automation

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IETF documents on 6LoWPAN

Title		Reference
Problem Statement		RFC4919("Problems Statement, Assumptions and Goals for IPv6 for LoWPANs", Define the problem statement and goals of 6lowpan networks)
6LoWPAN Format		RFC4944 (Defines basic packet formats and sub-IP adaptation layer for transmission over 6LoWPAN.Includes framing, adaptation, header compression, address generation, and packet delivery in mesh topology)
Routing Requirements		Problem Statement and Requirements for 6LoWPAN Routing draft-ietf-6lowpan-routing-requirements-00
Routing Protocols	Load Routing Protocol	draft-daniel-6lowpan-load-adhoc-routing-02.txt
	Dymo Routing Protocol	draft-montenegro-6lowpan-dymo-low-routing-02
	HiLow Routing Protocol	draft-daniel-6lowpan-hilow-hierarchical-routing-00.txt
Header Compression		Compression Format for IPv6 Datagrams in 6LoWPAN Networks draft-ietf-6lowpan-hc-04
Neighbor Discovery		Neighbor Discovery for 6LoWPAN draft-ietf-6lowpan-nd-00
Use Cases		Design and Application Spaces for 6LoWPANs draft-ietf-6lowpan-usecases-01

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References

- http://www.ietf.org/rfc/rfc4944.txt?number=4944

- http://www.ietf.org/proceedings/06mar/IDs/draft-ietf-6lowpan-problem-02.txt

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Thank You

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