IPv6 over MS/TP Networks

draft-lynn-6man-6lobac

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Problem Statement

Develop a low-cost **wired** IPv6 solution for commercial building control applications
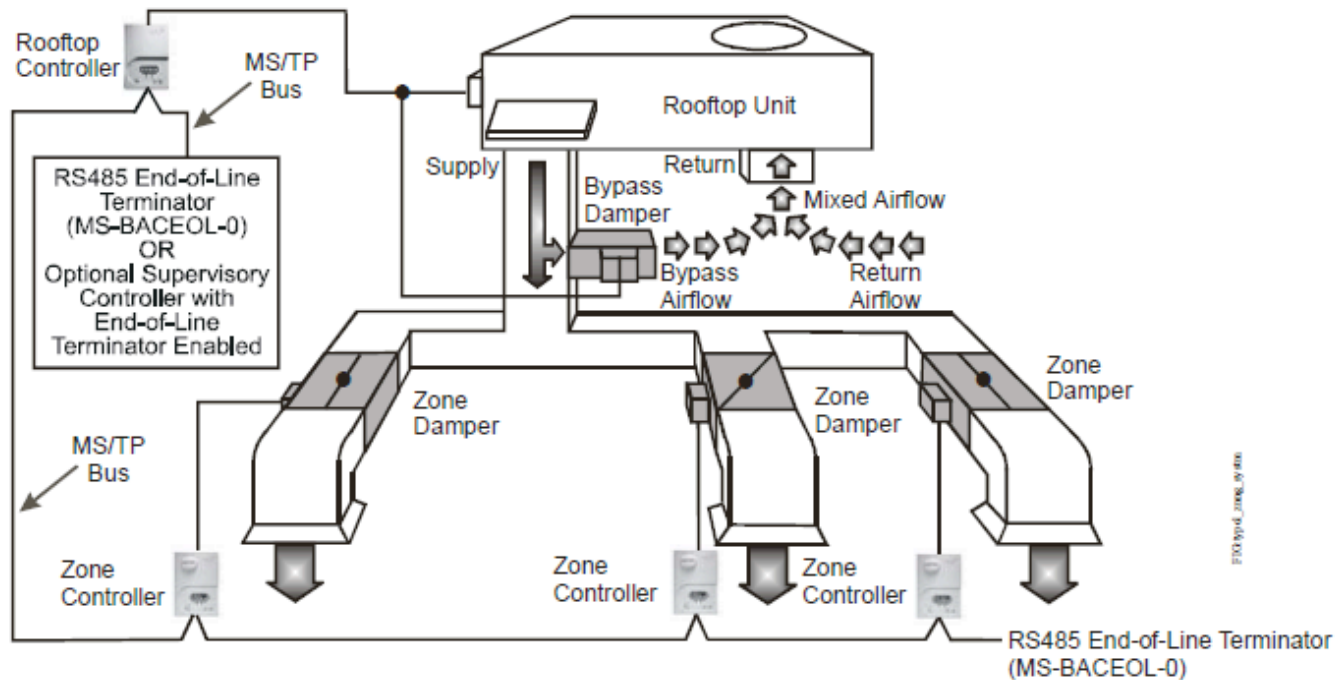

Figure 1: Typical Zoning Control System Installed on a Single MS/TP Bus

Background

- **BACnet** is the ISO/ANSI/ASHRAE [Standard 135-2010] data communication protocol for Building Automation and Control networks

- Dates from the 90's; mature object model plus network layer to "normalize" BAC data links

- The BACnet-IT WG has been established to investigate a) convergence of IT and BAC infrastructure and b) migration to IP standard transport and security protocols

Background (cont.)

- **MS/TP** (Master-Slave/Token-Passing) is a widely used data link defined in BACnet
- Support for IPv6 over MS/TP is seen as an enabler for BACnet-IT
- Based on RS-485 single twisted pair PHY; supports data rates up to 115.2 kpbs over 1 km distance without a repeater
- Contentionless MAC (token passing bus)
- Wired alternative to IEEE 802.15.4

Datalink Comparison

IEEE 802.15.4	MS/TP
CSMA/CA	Token passing
Battery powered	Line powered
Mesh (hidden nodes, interior routers)	Bus (all nodes are link-local)
MSDU is approx. 80 octets	MSDU is 1500 octets
Data rate < 250 kbps	Data rate ≤ 115.2 kpbs
16- or 64-bit (EUI-64) MAC address	8-bit MAC address

Technical Approach

- Minimize changes to existing MS/TP specification [BACnet Clause 9]
- Target co-existence with legacy MS/TP nodes
  - No changes to frame header format or MS/TP Master Node state machine
- Proposed extensions to MS/TP include:
  - Larger payload (1500 octets)
  - 32-bit FCS (CRC-32K)
  - New frame type for IPv6 (LoBAC) Encapsulation
- Leverage elements of 6LoWPAN [RFC 4944]

MS/TP Control Frame Format

0   31

0x55	0xFF	FrameType	DestAddr
SrcAddr	Length = 0		HeaderCRC
Optional 0xFF			
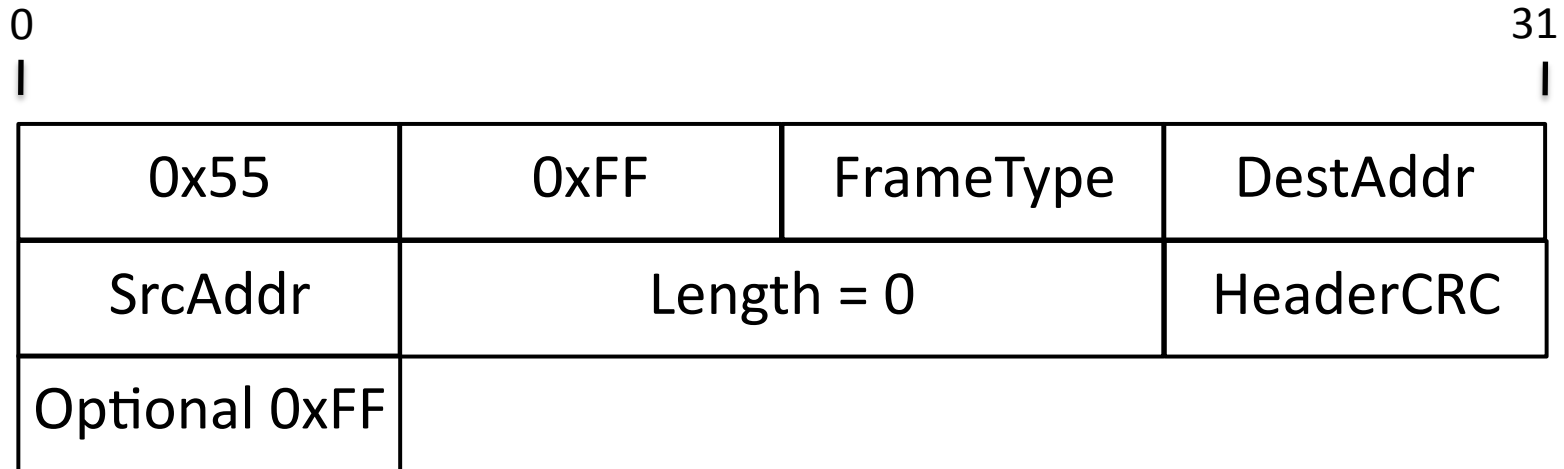
Destination Address: 1 – 127
Source Address: 1 – 127
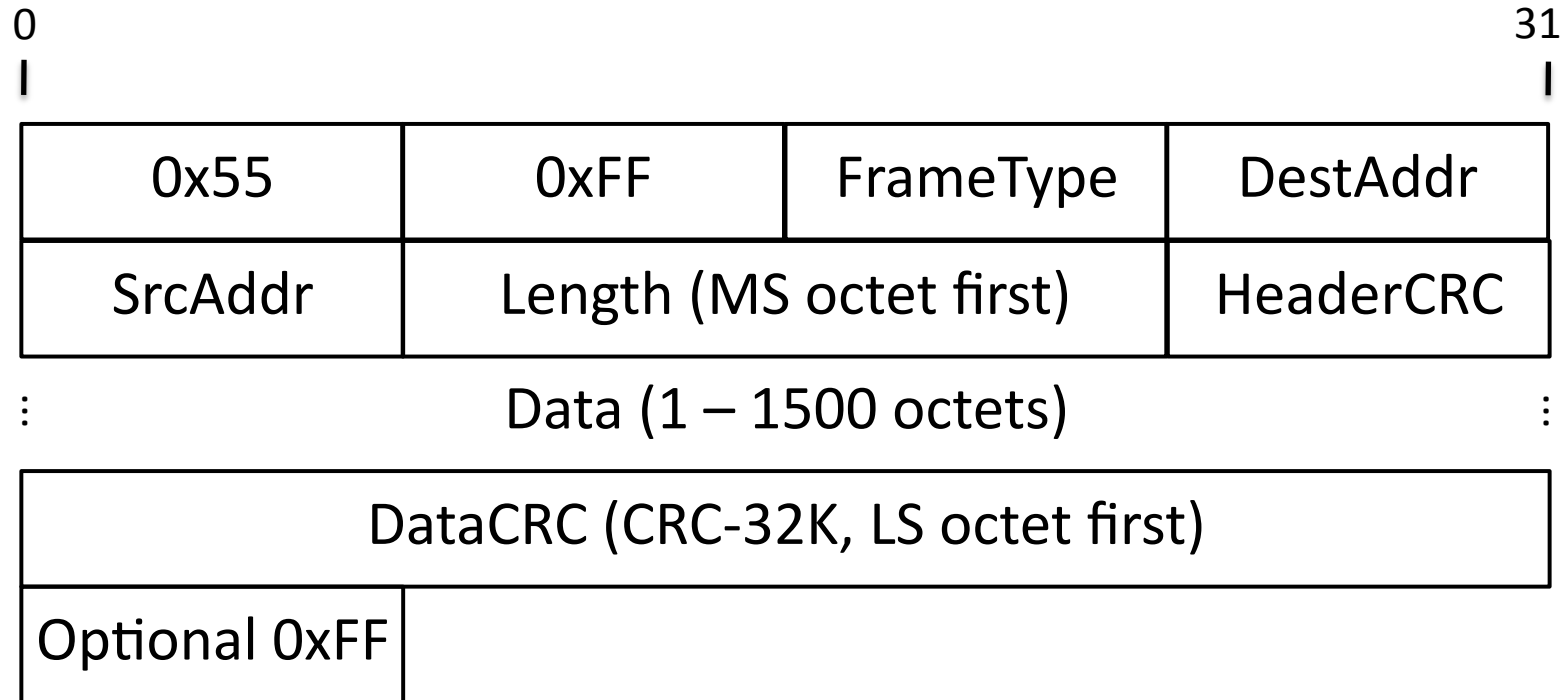Frame Type: 0 = Token
                        1 = Poll for Master
                        2 = Reply to Poll for Master

Node **must** implement these Frame Types in addition to
MS/TP Master Node and Receive Frame state machines

MS/TP Extended Data Frame Format

0   31

0x55	0xFF	FrameType	DestAddr
SrcAddr	Length (MS octet first)		HeaderCRC

⋮ Data (1 – 1500 octets) ⋮

DataCRC (CRC-32K, LS octet first)

Optional 0xFF

Destination Address: 1 – 127, 255 (broadcast)
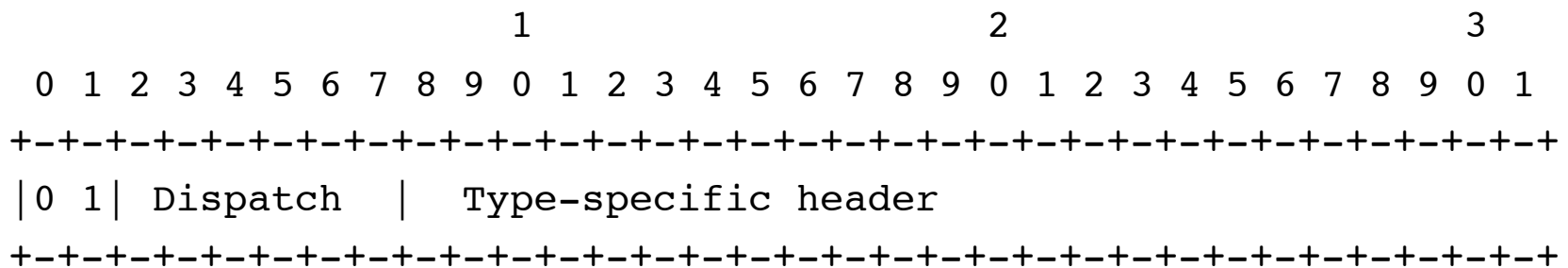Source Address: 1 – 127
Frame Type: 10 = IPv6 (LoBAC) Encapsulation

LoBAC Encapsulation

- Use 6LoWPAN Dispatch Header [RFC 4944]:

```
                     1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|0 1| Dispatch  |  Type-specific header
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Pattern	Header Type
00 XXXXXX	NALP – Not a LoWPAN (LoBAC) frame
01 000000	ESC – Additional Dispatch octet follows
01 000001	IPv6 – Uncompressed IPv6 header
...	Reserved – Reserved for future use
01 1XXXXX	LOWPAN_IPHC – Compressed IPv6 header

LoBAC Encapsulation (cont.)

- No mesh, broadcast, or fragmentation headers
  - Two options remain:

IPv6 Dispatch	IPv6 Header	Payload
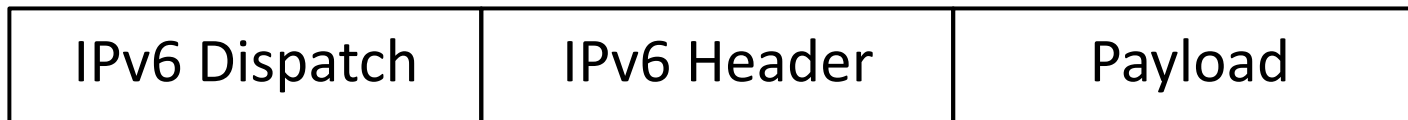
A LoBAC encapsulated IPv6 datagram

IPHC Dispatch	IPHC Header	Payload
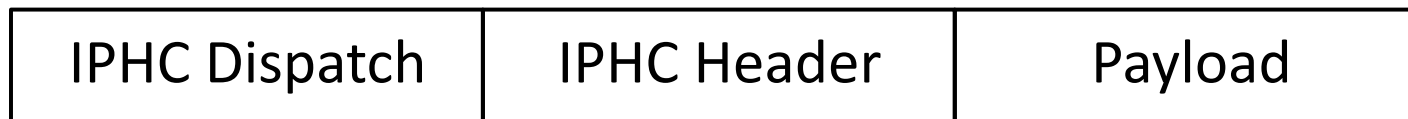
A LoBAC encapsulated LOWPAN_IPHC
compressed datagram

IPHC Compression (RFC-to-be 6282)

- Assumes some 6LBR-like behavior, e.g. context distribution

- Uses 6LoWPAN short address format, but appends 8-bit MS/TP to the octet 0x00

  - For example, an MS/TP node with a MAC address of 0x4F results in the following IPHC short address:

```
|0                1|
|0                5|
+----------------+
|0000000001001111|
+----------------+
```
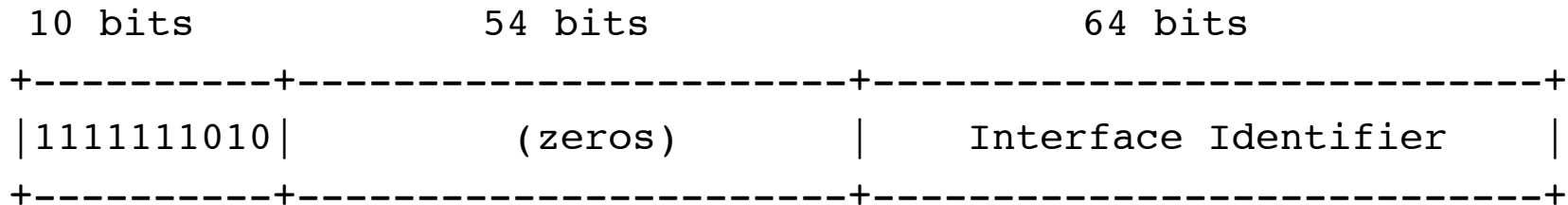
Stateless Address Autoconfiguration

- Typically, 8-bit MAC address is appended to the seven octets 0x00, 0x00, 0x00, 0xFF, 0xFE, 0x00
  - For example, an MS/TP node with a MAC address of 0x4F results in the following Interface ID:

```
|0                1|1                3|3                4|4                6|
|0                5|6                1|2                7|8                3|
+-----------------+-----------------+-----------------+-----------------+
|0000000000000000|0000000011111111|1111111000000000|0000000001001111|
+-----------------+-----------------+-----------------+-----------------+
```

- An EUI-64 **may** be used for the Interface Identifier
  - In this case there **must** be a way to map the IID to an 8-bit MAC address (e.g. registration or DAD)
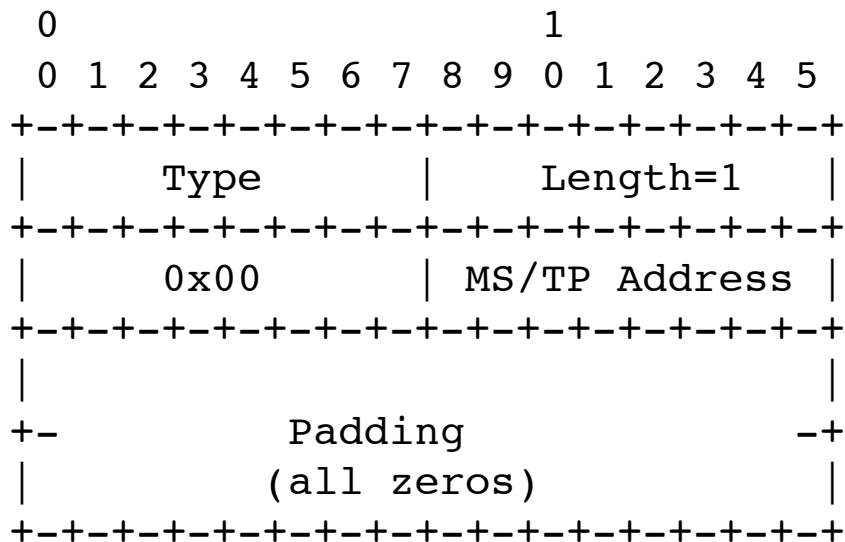
IPv6 Link Local Address

- The IPv6 link-local address [RFC 4291] for an MS/TP interface is formed by appending the Interface Identifier (defined in previous slide) to the prefix FE80::/64:

```
 10 bits              54 bits                       64 bits
+----------+---------------------+---------------------------+
|1111111010|       (zeros)       |    Interface Identifier   |
+----------+---------------------+---------------------------+
```

Unicast Address Mapping

- The Source/Target Link-Layer Address option has the following form when the link layer is MS/TP and the addresses are 8-bit MS/TP MAC addresses:

```
 0                   1
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     Type      |   Length=1    |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     0x00      | MS/TP Address |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                               |
+-          Padding           -+
|         (all zeros)          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

```
Option fields:

Type:
  1 = Source Link-layer address
  2 = Target Link-layer address

Length:
  The value of this field is
  1 for 8-bit MS/TP addresses

MS/TP Address:
  The 8-bit MAC address in
  canonical bit order
```

Thank You

- Please review draft-lynn-6man-6lobac and comment
- Questions?