

IPv6 over MS/TP Networks

draft-ietf-6lo-6lobac-05

Kerry Lynn, Editor <kerlyn@ieee.org>

Jerry Martocci <jerald.p.martocci@jci.com>

Carl Neilson <cneilson@deltacontrols.com>

Stuart Donaldson <stuart.donaldson@honeywell.com>

6lo WG, IETF 96, Berlin, 18 Jul 2016

Motivation

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

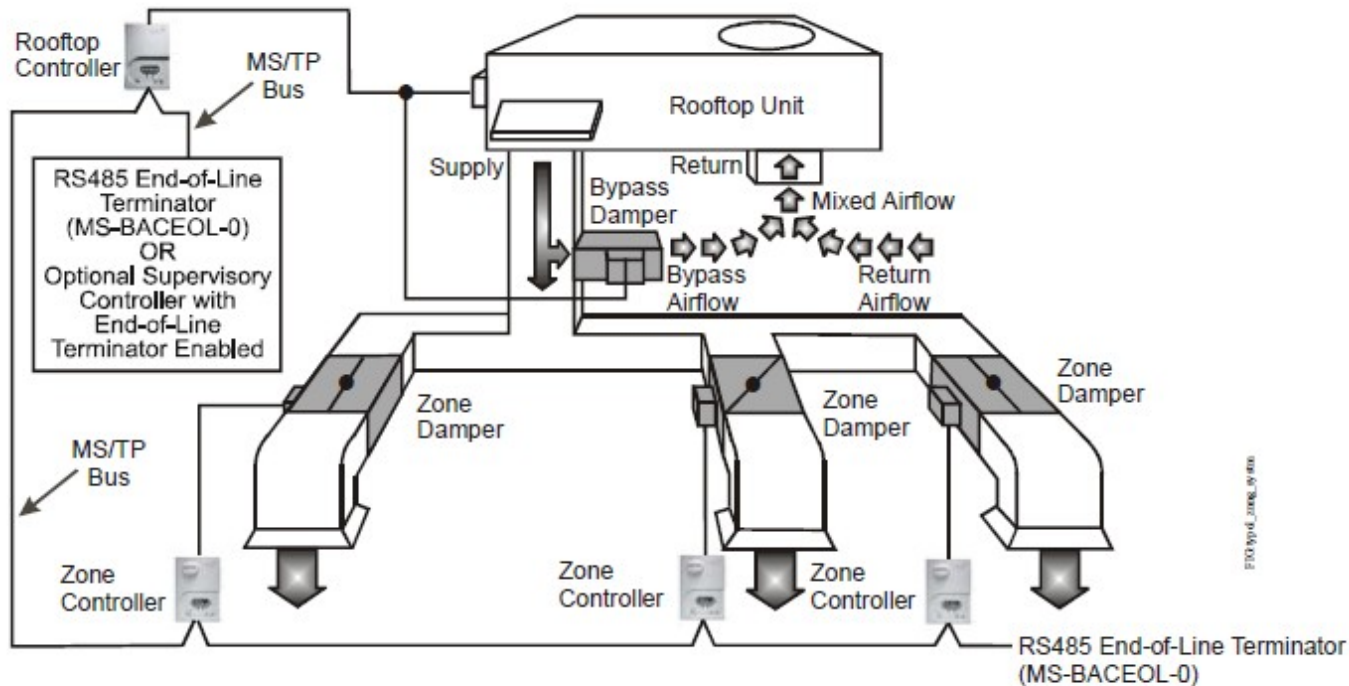


Figure 1: Typical Zoning Control System Installed on a Single MS/TP Bus

Background

- **BACnet** is the ISO/ANSI/ASHRAE [Standard 135-2012] data communication protocol for Building Automation and Control networks
- **MS/TP** (Master-Slave/Token-Passing) is a widely used data link defined in BACnet
 - Based on RS-485 single twisted pair PHY; supports data rates up to 115.2 kbps over 1 km distance
 - Contention-less MAC (token passing bus)
 - Consider it a wired alternative to IEEE 802.15.4

Technical Approach

- Leverage 6Lo specs [RFCs 4944, 6282, 6775]
- Minimize changes to existing MS/TP specification [BACnet Clause 9]
- Goal: co-existence with legacy MS/TP nodes
 - No changes to frame header format, control frames, or MS/TP Master Node state machine
- MS/TP Extended Frames proposal includes:
 - New frame type for IPv6 (LoBAC) Encapsulation
 - Larger MSDU (1500+ octets)
 - 32-bit FCS (CRC-32K)
 - COBS (Consistent Overhead Byte Stuffing) encoding

Status

- Proposal has passed WGLC
 - First presented to 6man in July '11
 - Two interoperable implementations, Contiki and RIOT (tested at ETSI 6lo PlugTest in Yokohama)
 - No external dependencies; BACnet has assigned a FrameType and draft of new Clause 9 is available for reviewers
 - Three detailed reviews

Thank you Peter, James, and Carsten

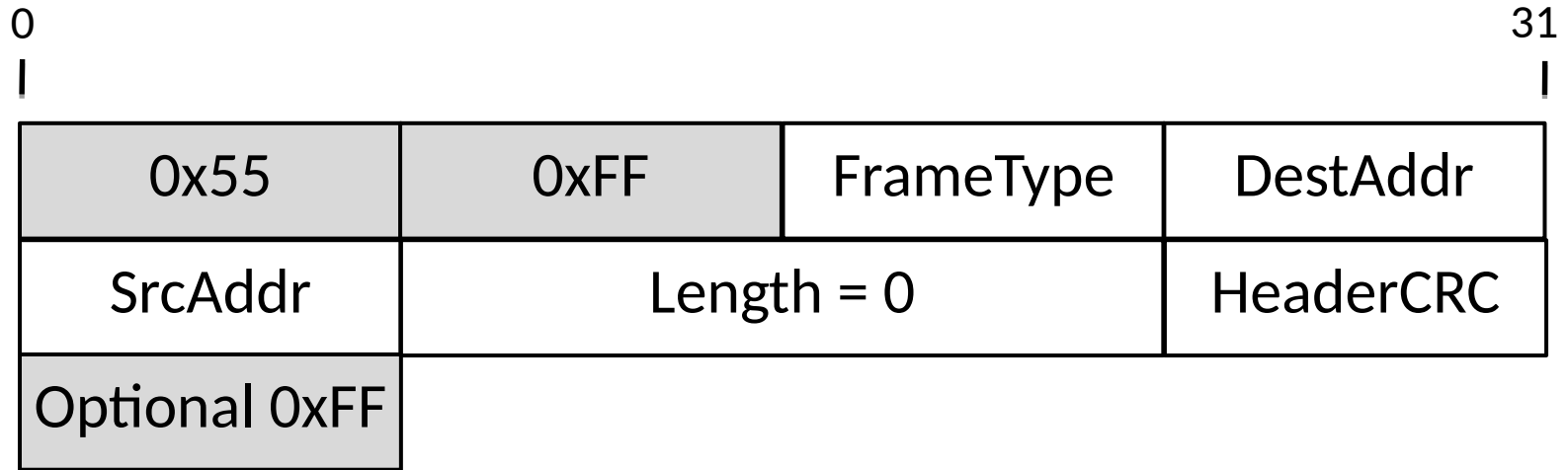
Changes since -05

- Primarily editorial, following Carsten's review

A MAC-derived IID is recommended for on-link and 64-bit privacy IID for off-link traffic

Backup Slides

MS/TP Control Frame Format

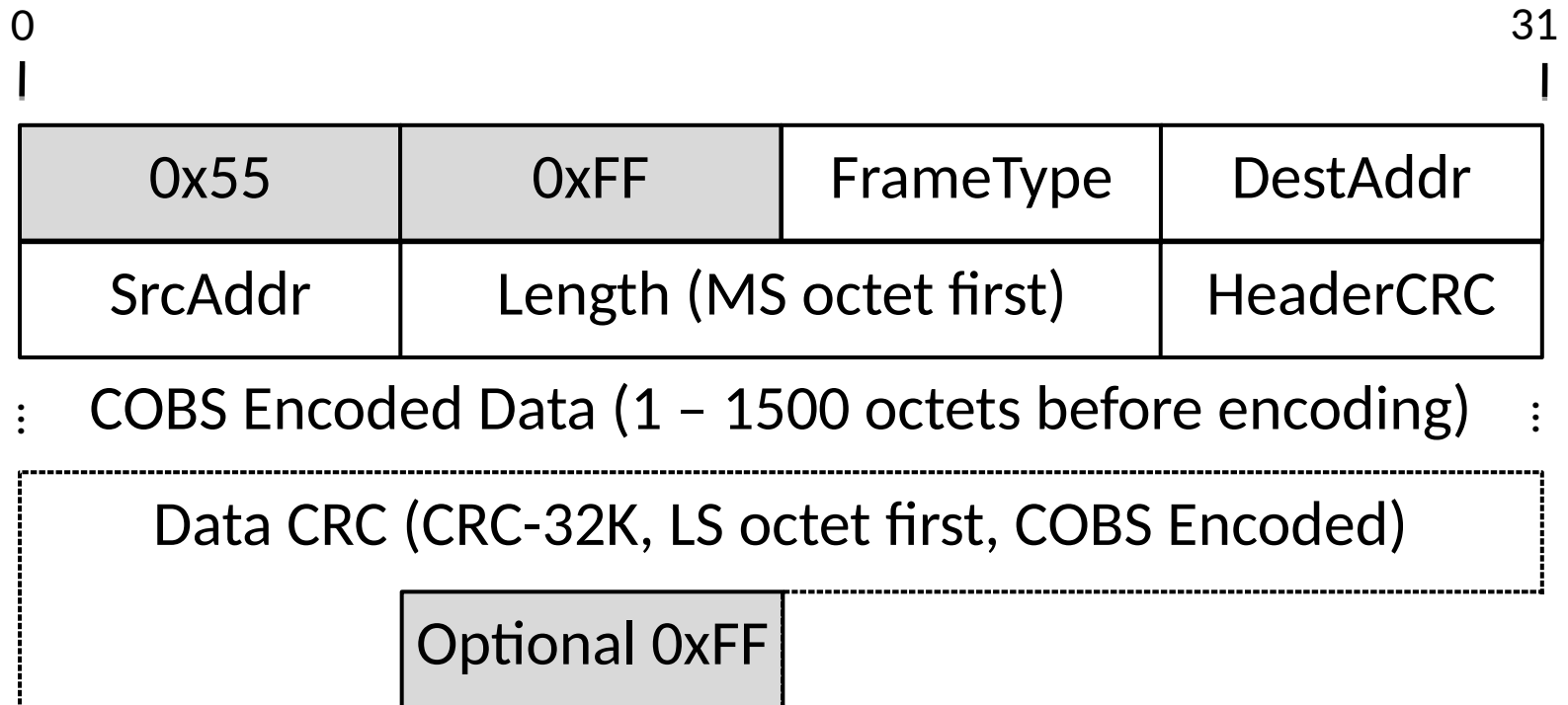


Frame Type: 0 = Token
 1 = Poll for Master
 2 = Reply to Poll for Master

Destination Address: 0 – 127

Source Address: 0 – 127

MS/TP Encoded Data Frame Format



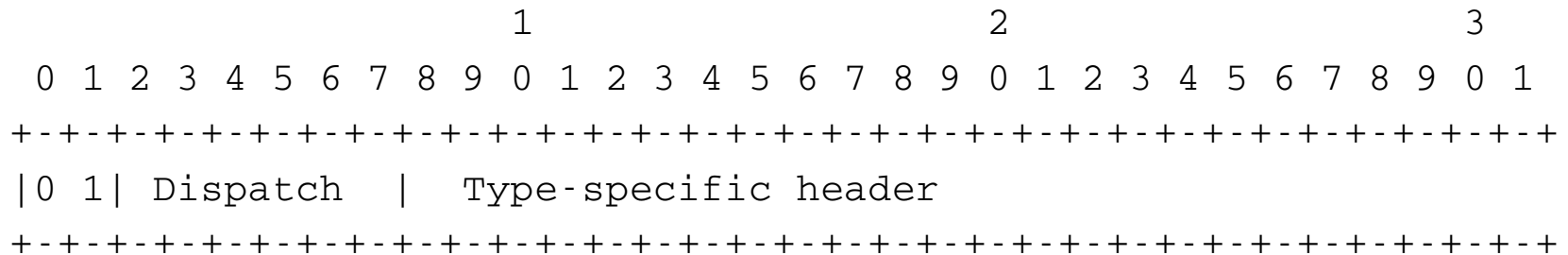
Frame Type: 34 = IPv6 (LoBAC) Encapsulation

Destination Address: 0 – 127 or 255 (all nodes)

Source Address: 0 – 127

LoBAC Encapsulation

- Uses 6LoWPAN Dispatch Header [RFC 4944]:



Pattern	Header Type
01 1XXXXX	LOWPAN_IPHC – Compressed IPv6 header

LoBAC Encapsulation (cont.)

- No mesh, broadcast, or fragmentation headers
 - One option remains:



A LoBAC encapsulated LOWPAN_IPHC
[RFC 6282] compressed datagram

IPHC Compression [RFC 6282]

- Assumes some 6LBR-like behavior, e.g. 6LoWPAN Context Option (6CO, [RFC 6775])
- Uses 6LoWPAN short address format, formed by appending 8-bit MS/TP address 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 |
+-----+
| 00000000001001111 |
+-----+
```

Stateless Address Auto-Configuration

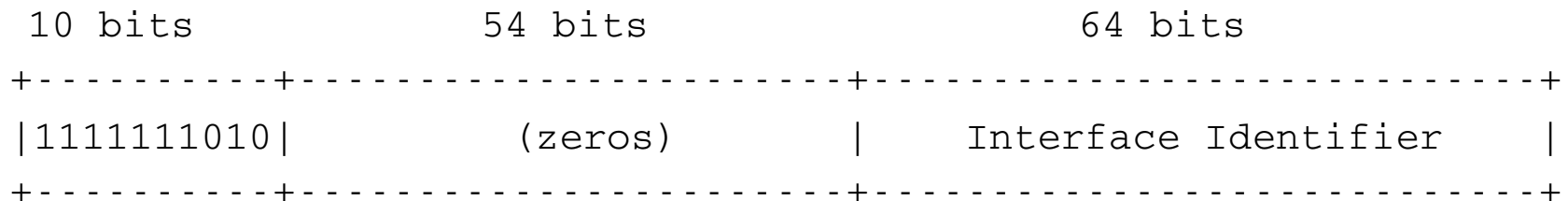
- Typically, 8-bit MAC address is appended to the seven octets 0x00, 0x00, 0x00, 0xFF, 0xFE, 0x00
 - For example, an MS/TP node with a MAC address of 0x4F results in the following Interface ID:

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

- A privacy address **may** be used for the Interface Identifier (SHOULD be for ULA/Global addresses)
 - In this case there **must** be a way to map the address to an 8-bit MAC address (e.g. ARO in NS [RFC 6775])

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:



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

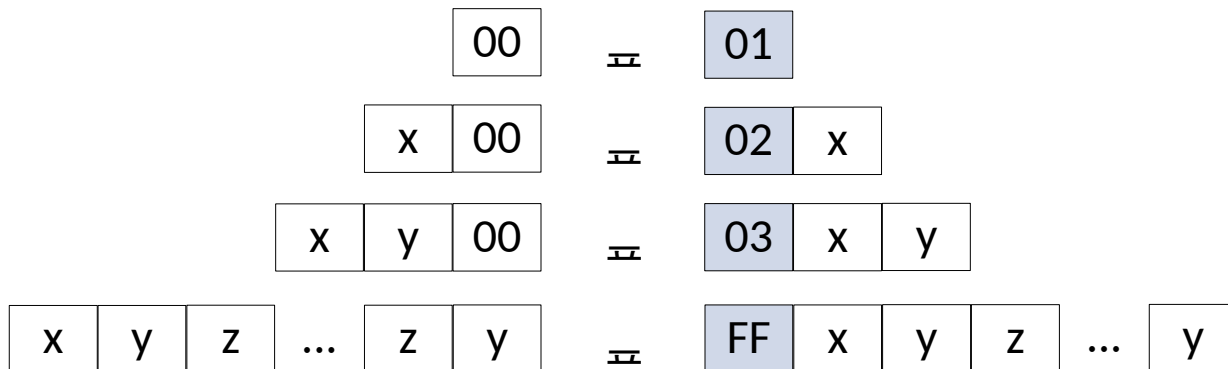
Multicast Address Mapping

- MS/TP only supports link-local broadcast
- Uses 6LoWPAN short address format, formed by appending 0xFF to the octet 0x00
 - All IPv6 multicasts on the MS/TP link map to the following IPhc short destination address:

```
| 0                               1 |  
| 0                               5 |  
+-----+  
| 0000000011111111 |  
+-----+
```

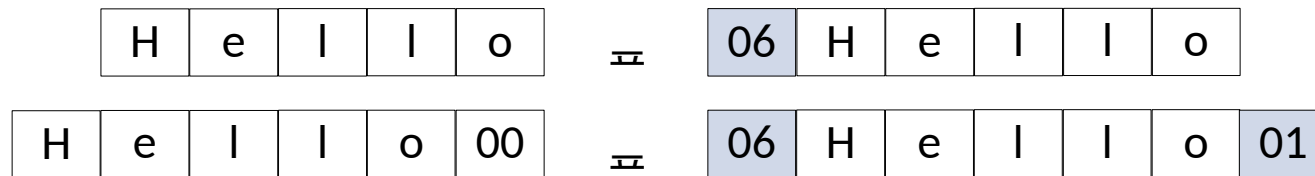
COBS Encoding Basics

Code	Followed By	Meaning
0x00	(not applicable)	(not allowed)
0x01	nothing	A single zero byte
0x02	one data byte	The single data byte, followed by a zero byte
n	$(n - 1)$ data bytes	The $(n - 1)$ data bytes, followed by a zero byte
0xFE	253 data bytes	The 253 data bytes, followed by a zero byte
0xFF	254 data bytes	The 254 data bytes, not followed by a zero byte



COBS Encoding in Detail

- "Phantom zero" is appended to input to resolve ambiguity in final code block:



- An arbitrary octet (e.g. 0x55) may be removed by XOR-ing it over the COBS encoder **output** stream
- COBS overhead:
 - At least one octet per encoded field
 - At most one octet in 255 (6 octets in 1501; $\approx 0.4\%$)