

Network Working Group  
Internet-Draft  
Intended status: Informational  
Expires: August 5, 2013

Y. Chen  
D. Liu  
H. Deng  
China Mobile  
Lei. Zhu  
Huawei  
Feb 2013

CAPWAP Extension for 802.11n and Power/channel Reconfiguration  
draft-chen-opsawg-capwap-extension-00

## Abstract

CAPWAP binding for 802.11 is specified by [RFC5416](#) and it was based on IEEE 802-11.2007 standard. After [RFC5416](#) was published in 2009, there was several new amendent of 802.11 has been published. 802.11n is one of those amendent and it has been widely used in real deployment. This document extends the CAPWAP binding for 802.11 to support 802.11n.

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## 1. Introduction

IEEE 802.11n standard was published in 2009 and it is an amendment to the IEEE 802.11-2007 standard to improve network throughput. The maximum data rate increases to 600Mbit/s physical throughput rate. In the physical layer, 802.11n use OFDM and MIMO to achieve the high throughput. 802.11n use multiple antennas to form antenna array which can be dynamically adjusted to improve the signal strength and extend the coverage.

There are couple of capabilities of 802.11n need to be supported by CAPWAP control message such as radio capability, radio configuration and station information.

## 2. Conventions used in this document

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [[RFC2119](#)].

## 3. CAPWAP 802.11n support

IEEE 802.11n standard was published in 2009 and it is an amendment to the IEEE 802.11-2007 standard to improve network throughput. The maximum data rate increases to 600Mbit/s physical throughput rate. In the physical layer, 802.11n use OFDM and MIMO to achieve the high throughput. 802.11n use multiple antennas to form antenna array which can be dynamically adjusted to improve the signal strength and extend the coverage.

802.11n support three modes of channel usage: 20MHz mode, 40Mhz mode and mixed mode.802.11n has a new feature called channel binding. It can bind two adjacent 20MHz channel to one 40MHz channel to improve the throughput.If using 40Mhz channel configuration there will be

only one non-overlapping channel in 2.4GHz. In the large scale deployment scenario, operator need to use 20MHz channel configuration in 2.4GHz to allow more non-overlapping channels.

In MAC layer, a new feature of 802.11n is Short Guard Interval(GI). 802.11a/g use 800ns guard interval between the adjacent information symbols. In 802.11n, the GI can be configured to 400nm under good wireless condition.

Another feature in 802.11 MAC layer is Block ACK. 802.11n can use one ACK frame to acknowledge several MPDU receiving event.

CAPWAP need to be extended to support the above new 802.11n features. For example, CAPWAP should allow the access controller to know the supported 802.11n features and the access controller should be able to configure the differe channel binding modes. One possible solution is to extend the CAPWAP information element for 802.11n.

#### [4.](#) CAPWAP extension for 802.11n support

There are couple of capabilities of 802.11n need to be supported by CAPWAP control message such as radio capability, radio configuration and station information. This section defines the extension of current CAPWAP 802.11 information element to support 802.11n.

1. 802.11n Radio Capability Information Element. The information element need to be extended to include 802.11n radio capability. Below is an example of the 802.11n radio capability information element.

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0										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	2	3	4	5	6	7	8	9
Element ID										Length																													
Radio ID					SupChanl width					Power Save					ShortGi20					ShortGi40					HtDelyBlkack					Max Amsdu					Max RxFactor				
Min StaSpacing					HiSuppDataRate					AMPDUBufSize					HtcSupp																								
20MHZ 11gMCS																																							
20MHZ 11gMCS																																							
20MHZ 11gMCS																																							
20MHZ 11gMCS																																							
20MHZ 11aMCS																																							
20MHZ 11aMCS																																							

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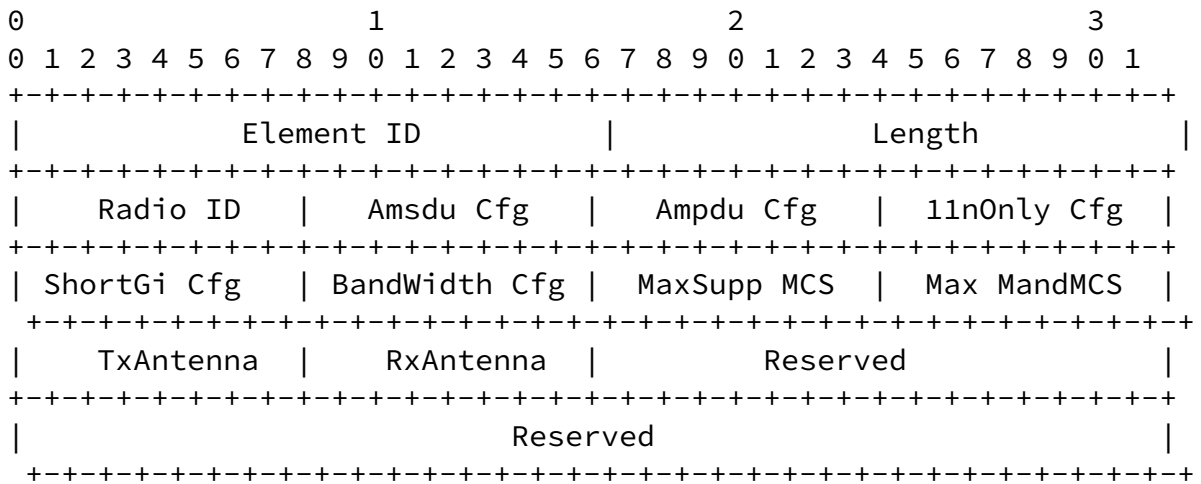
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
|                20MHZ 11aMCS                |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
|                20MHZ 11aMCS                |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
|                40MHZ 11gMCS                |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
|                40MHZ 11gMCS                |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
|                40MHZ 11gMCS                |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
|                40MHZ 11gMCS                |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
|                40MHZ 11aMCS                |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
|                40MHZ 11aMCS                |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
|                40MHZ 11aMCS                |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+

```

1. SupChanl width: The supported bandwith mode. 0x01: 20MHz bandwidth binding mode. 0x02: 40MHz bandwidth binding mode.

2. Power Save: 0x00: Static power saving mode. 0x01: Dynamic power saving mode. 0x03: Do not support power saving mode.
3. ShortGi20: Whether support short GI. 0x00: Do not support short GI. 0x01: Support short GI.
4. HtDelyBlkack: Whether block Ack support delay mode. 0x00: Do not support delay mode. 0x01: Support delay mode.
5. Max Amsdu: The maximal AMSDU length. 0: 3839 bytes. 1: 7935 bytes.
6. Max RxFactor: The maximal receiving AMPDU factor. Default value: 3.
7. Min StaSpacing: Minimum MPDU Start Spacing.
8. HiSuppDataRate: Maximal transmission speed.
9. AMPDUBufSize: AMPDU buffer size.
10. HtcSupp: Whether the packet have HT header.
11. 20MHZ 11gMCS: 128 bitmap.If support should be all zero,

- otherwise all one.
12. 20MHZ 11aMCS: 128 bitmap.If support should be all zero, otherwise all one.
  13. 40MHZ 11gMCS: 128 bitmap.If support should be all zero, otherwise all one.
  14. 40MHZ 11aMCS: 128 bitmap.If support should be all zero, otherwise all one.
  15. 2. 802.11n Raiddo Configuration TLV. Following figure is an example of 802.11n radio configuration TLV.



1. A-MSDU CFG: 0x00: Disable 0x01: Enalbe
2. A-MPDU CFG: 0x00: Disable 0x01: Enalbe
3. 11N Only CFG: Whether allow only 11n user access. 0x00: Allow non-802.11n user access. 0x01: Do not allow non-802.11n user access.
4. Short GI CFG: 0x00: Disable 0x01: Enable
5. Bandwidth CFG: Bandwidth binding mode. 0x00: 40MHz 0x01: 20MHz

6. Max Support MCS: Maximal MCS.
7. Max Mandantory MCS: Maximal mandantory MCS.
8. TxAntenna: Transmitting antenna configuration.
9. RxAntenna: Receiving antenna configuration.
10. Each TxAntenna and RxAntenna bit represent one antenna, 1 means enable, 0 means disable.

3. 802.11n Station Information. Following figure is an example of

802.11n station information information element.

0										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	2	3	4	5	6	7	8	9
Element ID										Length										MAC Address										SupChanl width   Power Save									
ShortGi20					ShortGi40					HtDelyBlkack					Max Amsdu					Max RxFactor					Min StaSpacing					HiSuppDataRate									
AMPDUBufSize										HtcSupp					MCS Set					MCS Set					MCS Set														
MCS Set										MCS Set										MCS Set																			

1. SupChanl width: Supporting bandwidth mode. 0x01: 20MHz bandwidth mode. 0x02: 40MHz bandwidth binding mode.
2. Power Save: 0x00: Static power saving mode. 0x01: Dynamic power saving mode. 0x03: Do not support power saving mode.
3. ShortGi20: Whether support short GI in 20MHz bandwidth mode. 0x00: Do not support short GI. 0x01: Support short GI.
4. ShortGi40: Whether support short GI in 40MHz bandwidth mode. 0x00: Do not support short GI. 0x01: Support short GI.
5. HtDelyBlkack: Whether block Ack support delay mode. 0x00: Do not support delay mode. 0x01: Support delay mode.
6. Max Amsdu: The maximal AMSDU length. 0x00: 3839 bytes. 0x01: 7935 bytes.
7. Max RxFactor: The maximal receiving AMPDU factor.
8. Min StaSpacing: Minimum MPDU Start Spacing.

9. HiSuppDataRate: Maximal transmission speed.



10. AMPDUBufSize: AMPDU buffer size.
11. HtcSupp: Whether the packet have HT header.
12. MCS Set: The MCS bitmap that the station supports.

## 5. Power and Channel auto reconfiguration

Power and channel auto reconfiguration could avoid potential radio interference and improve the Wi-Fi performance. In general, the auto-configuration of radio power and channel could occur at two stages: when the AP power on or during the AP running time.

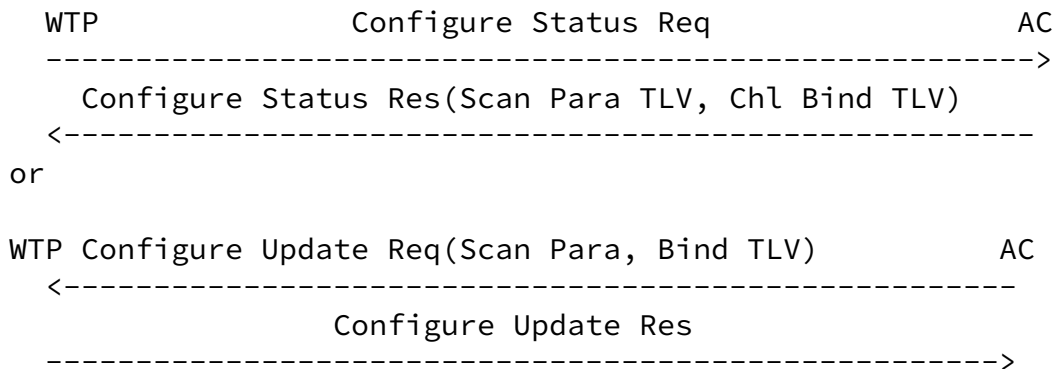
When the AP is power-on, it is of necessity to configure a proper channel to the AP in order to achieve best status of radio links. IEEE 802.11 Direct Sequence Control elements or IEEE 802.11 OFDM Control element defined in [RFC5416](#) should be carried to offer AP a channel at this stage. Those element should be carried in the Configure Status Response message. If those information element is zero, the AP will determine its channel by itself, otherwise the AP should be configured according to the provided information element.

When the AP determines its own channel configuration, it should first scan the channel information, then determine which channel it will work on and form a channel quality scan report. The channel quality report will be sent to the AC using WTP Event Request message by the AP. The AC can use IEEE 802.11 Direct Sequence Control or IEEE 802.11 OFDM Control information element carried by the configure Update Request message to configure a new channel for the AP.

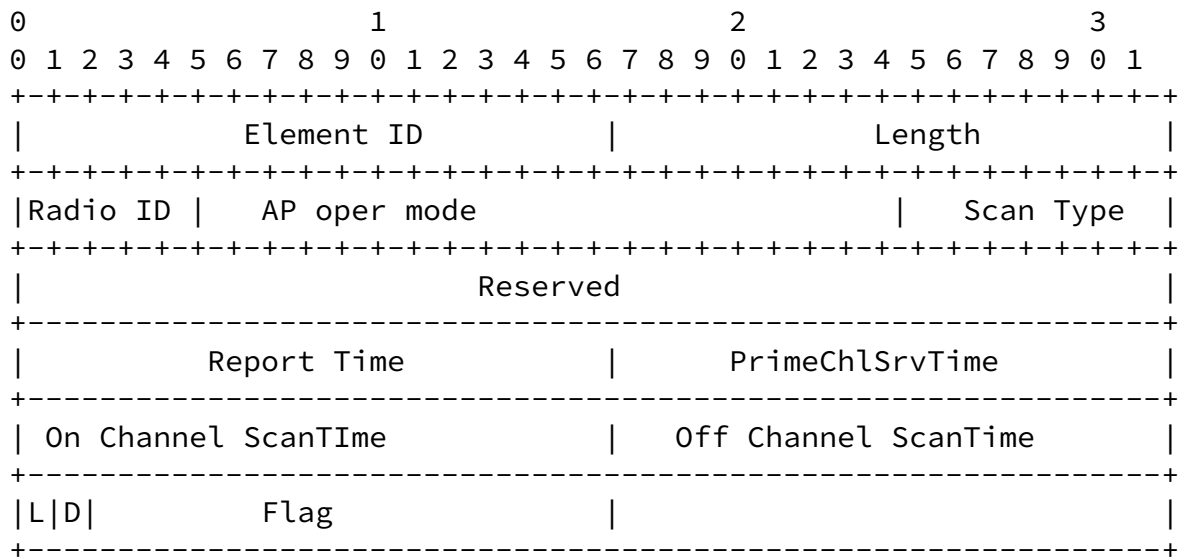
IEEE 802.11 Tx Power information element is used by the AC to control the transmission power of the AP. The 802.11 Tx Power information element is carried in the Configure Status Response message during the power on phase or in the Configure Update Request message during the running phase.

Channel Scan Procedure.

The Channel Scan Procedure is illustrated by the following figure.



The definition of the Scan Para TLV is as follows:



Element ID: TBD; Length:18

AP oper mode: the work mode of the AP. 0x01:normal mode. 0x02: monitor only mode.

Scan Type: 0x01: active scan; 0x02: passive scan.

Report Time: Channel quality report time.

PrimeChlSrvTime: Service time on the working scan channel. This

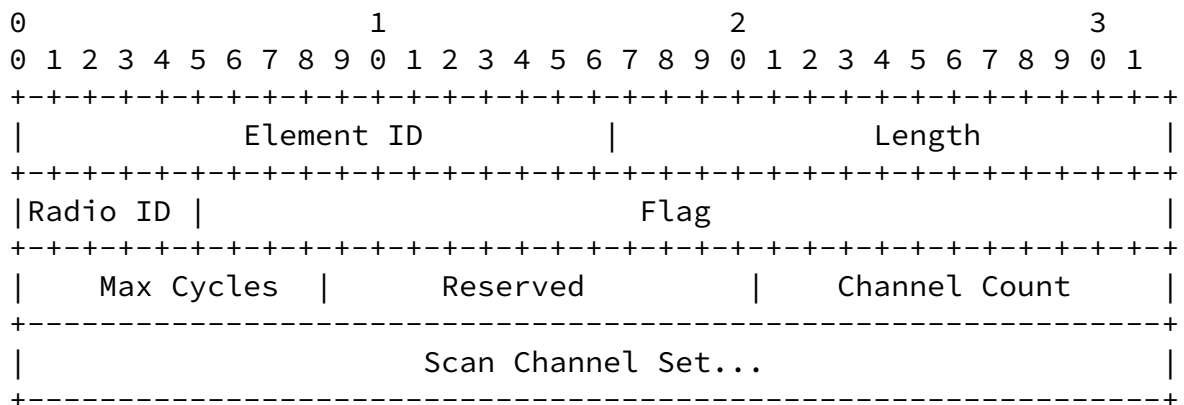
segment is invalid(set to 0) when AP oper mode is set to 2. The maximum value of this segment is 10000, the minimum value of this

segment is 5000, the default value is 5000.

On Channle ScanTime: The scan time of the working channel. When the AP oper mode is set to 2, this segment is invalid(set to 0). The maximum value of thi segment is 120, the minimum value of this segment is 60, the default value is 60.

L=1: Open Load Balance Scan. D=1: Open Rogue AP detection scan.  
Flag: Bitmap, resered for furture use.

The definition of the Channel Bind TLV is as follows:



Element ID: TBD. Length>=12

Flag: bitmap, reserved.

Scan Src: the trigger of the scan event. not defined in this version of the document. set to 0.

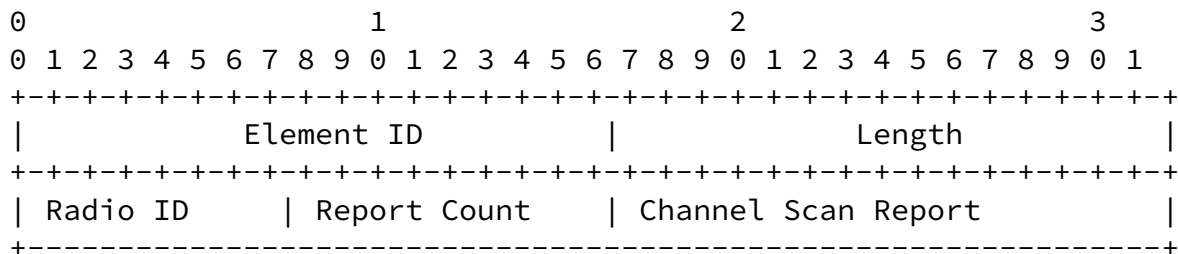
Device Type: the scope of the scan. not defined is this version of the document. set to 0.

Max Cycles: Scan repeat times. 255 means continuous scan.

Scan Channel Set: the channle information. the format is as follows:



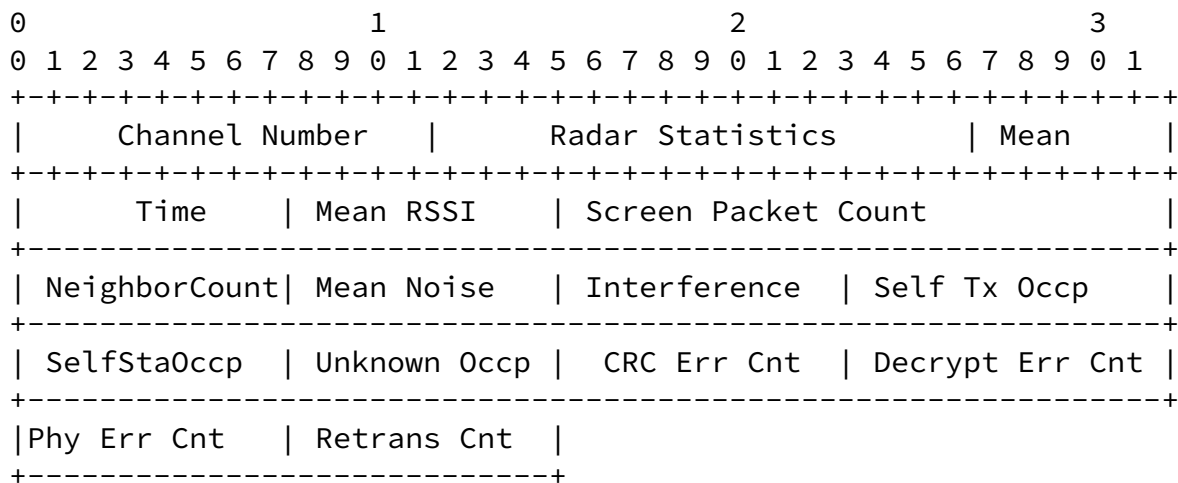
report is Channel Scan Report TLV and Neighbor AP Report TLV. The definition of the Channel Scan Report TLV is as follows:



Element ID: 133; Length: >= 20.

Report Count: the channle number will be reported. The definition of

the channel scan report is as follows:



Channel Number: The channel number.

Radar Statistics: Whether detect radar signal in this channel. 0x00: detect radar signal. 0x01: no radar signal is detected.

Mean Time: Channel measurement duration.

Mean RSSI: The signal strength of the scanned channel.

Screen Packet Count: Received packet number.

Neighbor Count: The neighbor number of this channel.

Mean Noise: the average noise on this channel.

Interference: The interference of the channel.

Self Tx Occp: The time duration for transmission.

Unknown Occp: TBD.

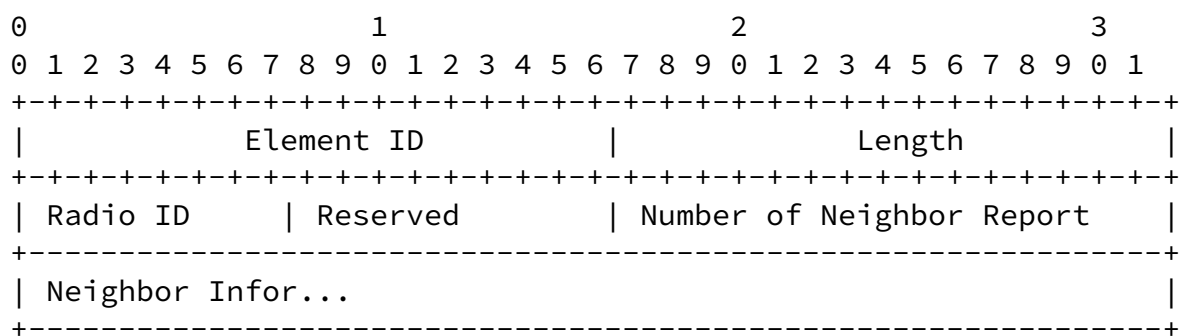
CRC Err Cnt: CRC err packet number.

Decrypt Err Cnt: Decryption err packet number.

Phy Err Cnt: Physical err packet number.

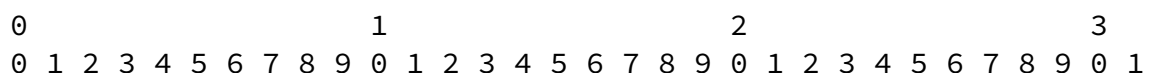
Retrans Cnt: Retransmission packet number.

The definition of neighbor AP report TLV is as follows:



Element ID: 134; Length: >=16

The definition of Neighbor info is as follows:



BSSID			
BSSID		Channel Number	
2rd Offset	Mean RSSI	Sta Intf	AP Intf

BSSID: The BSSID of this neighbor channel.

Channel Number: The channel number of this neighbor channel.

2rd channel offset: TBD.

Mean RSSI: The average signal strength of the channel.

Sta Intf: TBD.

AP Intf: TBD.

## 6. Security Considerations

TBD

## 7. IANA Considerations

None

## 8. Contributors

This draft is a joint effort from the following contributors:

Gang Chen: China Mobile chengang@chinamobile.com

Naibao Zhou: China Mobile zhounaibao@chinamobile.com

Chunju Shao: China Mobile shaochunju@chinamobile.com

Hao Wang: Huawei3Come hwang@h3c.com

Yakun Liu: AUTELAN liuyk@autelan.com

Xiaobo Zhang: GBCOM

Xiaolong Yu: Ruijie Networks

Song zhao: ZhiDaKang Communications

Yiwen Mo: ZhongTai Networks

## 9. Acknowledgements

The authors would like to thanks Ronald Bonica and Benoit Claise for their usefull suggestions.

## 10. Normative References

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### Authors' Addresses

Yifan Chen  
China Mobile



No.32 Xuanwumen West Street  
Beijing 100053  
China

Email: cheniyifan@chinamobile.com

Dapeng Liu  
China Mobile  
No.32 Xuanwumen West Street  
Beijing 100053  
China

Email: liudapeng@chinamobile.com

Hui Deng  
China Mobile  
No.32 Xuanwumen West Street  
Beijing 100053  
China

Email: denghui@chinamobile.com

Lei Zhu  
Huawei  
No. 156, Shi-Chuang-Ke-Ji-Shi-Fan-Yuan Beiqing Road, Haidian District  
Beijing 100095  
China

Email: lei.zhu@huawei.com