Implementation for Intra-AC Differentiated Services

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Abstract

One of the goals of 802.11aa is to enable link layer adaptation on differentiated frames in a video stream according to channel conditions. This requires an intra-AC differentiated service, which is not supported in 802.11e QoS amendments. This proposal discusses the implementation on link layer intra-AC DiffServ.

Outlines

- ✓ Why we need intra-flow/intra-AC DiffServ?
- ✓ Our solution
- ✓ Modify QoS control field for non-802.11n data frame
- ✓ Modify HT control field for 802.11n data frame
- ✓ Compatibility to (non-)802.11n

Why we need intra-AC DiffServ?

- **VTS PAR scope proposed the following MAC enhancement**
  - Graceful degradation of audio video streams when there is insufficient channel capacity, by *enabling packet discarding without any requirement for deep packet inspection*.
  - *Intra-Access Category prioritization of transport streams* by modifying EDCA timing and parameter selection without any requirement for deep packet inspection.
  - *Improved link reliability* and low jitter characteristics for multicast/broadcast audio video streams
- **Differentiated frames have different importance in a video transport stream, e.g.,**
  - Video content dependent MAC frames, e.g.
    - SVC base layer or enhance layer;
    - I,P,B frames in MPEG-2 or H.264
    - Region of interest based encoding
  - Frames carrying application layer FEC

Our solution

- **Definitions**
  - Intra-AC differentiated service (IACDS): A service which allows link layer Intra-AC prioritization of transport streams and packet discarding without any requirement for deep packet inspection. It enables modifying the EDCA timing and parameter selection for frames belonging to the same AC for intra-AC prioritization and also enables frame discarding for graceful degradation of audio video streams when there is insufficient channel capacity.
- **Abbreviations and acronyms**
  - IACDS Intra-AC Differentiated Service
  - IACDSF IACDS Flag

Our solution (Contd.)

- **Modify existing fields**

Non-QoS Data		*No support*	
QoS Data		Intra-AC Differentiated Service (IACDSF)	Intra-AC DiffServ Information
	Non-802.11n	*Bit 7 (reserved) in **QoS control field** shall be set to 1 for Intra-AC differentiated service support in 802.11aa frame indication;* *0 otherwise*	*Bit 8-15 (overridden) in **QoS control field** shall be used for Intra-AC DiffServ information*
	802.11n	*Bit 20 (reserved) in **HT field** shall be set to 1 for Intra-AC differentiated service support 802.11aa frame indication;* *0 otherwise*	*Bit 25-29 (reserved) in **HT field** shall be used for Intra-AC DiffServ information*

Modify QoS control field
--for non-802.11n data frame

Table 4-Qos Control Field

Applicable frame (sub) types	**Bits 0–3**	**Bit 4**	**Bits 5-6**	**Bit 7**	**Bits 8–15**
QoS (+)CF-Poll frames sent by HC	TID	EOSP	Ack Policy	Reserved	TXOP Limit
QoS Data, QoS Null, and QoS Data+CF-Ack frames sent by HC	TID	EOSP	Ack Policy	*Reserved*	QAP PS Buffer State
	TID	EOSP	Ack Policy	*IACDSF=0*	QAP PS Buffer State
	TID	EOSP	Ack Policy	*IACDSF=1*	*IACDS information*
QoS data frames sent by non-AP QSTAs	TID	0	Ack Policy	Reserved	TXOP Duration Requested
	TID	0	Ack Policy	*IADSF=0*	TXOP Duration Requested
	TID	0	Ack Policy	*IADSF=1*	*IACDS information*
	TID	1	Ack Policy	Reserved	Queue Size
	TID	1	Ack Policy	*IACDSF=0*	Queue Size
	TID	1	Ack Policy	*IACDSF=1*	*IACDS information*

- The lines in blue shall be changed to the lines in red. Note only bits in Italy are changed.
- The IACDSF subfield is 1 bit in length and is set to 1 to indicate IACDS information present in Bit 8-15, and is set to 0 otherwise.

IACDS information subfield

--for non-802.11n data frame

- The IACDS information subfield is an 8-bit field that contains the information used for Intra-AC Differentiated Service. The format of IACDS information subfield is defined in Figure 7-4a.

	B8 B10	B11 B12	B13 B15
	Reserved	Drop Precedence	Priority
Bits:	2	2	3

Figure 7-4a—IACDS information subfield

- Drop Precedence subfield is 2 bits in length and identifies frame dropping policy.
  The interpretation of these 2 bits is given in Table 7-6a. Frames with “drop randomly” flag set may be dropped randomly based on predetermined criteria or on-line determination when necessary. Frames with “drop all” flag set may be dropped in burst in a time period during which there is insufficient channel capacity.

- Priority subfield indicates the priority of the frame in the access category.

Table 7-6a—Drop Precedence subfield

B11 B12	Description
00	No special action
01	Drop randomly if necessary
10	Drop all if necessary
11	Reserved

Modify HT control field
--for 802.11n data frame

	B0 B15	B16 B17	B18 B19	B20	B21	B22 B23	B24	B25 B29	B30	B31
	Link Adaptation Control	Calibration Position	Calibration Sequence	IACDSF	Reserved	CSI / Steering	NDP Announcement	IACDS Information	AC Constraint	RDG / More PPDU
Bits:	16	2	2	1	1	2	1	5	1	1

Figure 7-4a—HT Control field

- The IACDSF subfield is 1 bit in length and indicates an IACDS information subfield is present in the HT control filed if it is set to 1, otherwise it is set to 0.

IACDS information subfield
--for 802.11n data frame

- IACDS information subfield is a 5-bit field that contains the information used for Intra-AC Differentiated Service. The format of IACDS information subfield is defined in Figure 7-4e.

	B25 B26	B27 B29
	Drop Precedence	Priority
Bits:	2	3

Figure 7-4e—IACDS information subfield

- Drop Precedence subfield is 2 bits in length and identifies frame dropping policy.
  The interpretation of these 2 bits is given in Table 7-6da. Frames with “drop randomly” flag set may be dropped randomly based on predetermined criteria or on-line determination when necessary. Frames with “drop all” flag set may be dropped in burst in a time period during which there is insufficient channel capacity.

- Priority subfield indicates the priority of the frame in the access category.

Table 7-6a—Drop Precedence subfield

B11 B12	Description
00	No special action
01	Drop randomly if necessary
10	Drop all if necessary
11	Reserved

Compatibility to (non-)802.11n

- **No impact on non-QoS data frames**
- **For non-802.11n QoS data**
  - Backward compatibility to EDCA
    - 802.11aa devices can process EDCA frames produced by legacy devices.
  - Forward compatibility to EDCA
    - Legacy 802.11e device can process 802.11aa frames as normal EDCA frames.
    - However, a frame generated by 802.11aa device may not contain information of QAP PS buffer status, a possible optional function for EDCA
- **For 802.11n QoS data**
  - Our solution is fully backward & forward compatible, i.e., legacy 802.11n device can process 802.11aa frames as normal QoS frames, and 802.11aa devices can process QoS data frames produced by legacy devices as well.