Simplified CF-Async Service

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CF-Async Fundamentals

- CF-Async is a delivery modality, not a service class.
- Both contention-based Async and CF-Async deliver frames for the "asynchronous data" service class.
- Time-Bounded Services involve one or more, service classes.
- CF-Async differs from contention-based async in media access and control communication:
  - Access to the medium for CF-Async transmission is controlled by the PCF. Stations receive permission to transmit when "poll"ed" by the PCF.
  - CF-Async frames are delivered without contention delays and backoffs, but only during the CF-Period of each superframe.
  - CF-Async acknowledgments and polls are (generally) piggybacked on the headers of CF-Async data frames.

Things to Change About CF-Async

1. Unify asynchronous data handling:
   - Eliminate the separate CF frame type.
   - Adopt consistent acknowledgment timing.
   - Define rules under which all active stations can receive asynchronous data frames during the contention period and the contention free period.
2. Correct some problems:
   - Fix a mechanism broken in 20b3.
   - Fix a latent flaw present in 20bX.
   - Clarify the rules for usage of the CF-period.

Eliminating the CF Frame Type

CF-Async does not need a separate frame type:

- By defining some new subtypes, all asynchronous data frames can use the "Asynchronous data" type.
- This simplifies the use of either contention-based async or CF-Async for data frame transmission at stations that support both delivery modalities.
- This creates a reserved frame type, which may be useful for other service classes. (Time-Bounded Service may be able to benefit from using the spare frame type.)
- Using a single frame type simplifies asynchronous data delivery and allows simpler control state machines, especially for IFS and Ack generation.

NOTE: The terms "CF-up" and "CF-down" that still appear in the draft are strictly descriptives (meaning to and from the PCF, respectively). The adoption of 94/236 eliminated the CF-up and CF-down frame types (which are unnecessary).

What is Optional About CF-Async?

- The ability for a station to operate as the PCF is optional.
- The options concerning contention-free "service" pertain to transmission during the CF-Period.
  - All stations can receive data frames sent as CF-Async.
  - Stations may optionally transmit data frames when polled by the PCF.
  - Stations that are not "CF-Aware" acknowledge CF-Data frame reception identically to contention-based data frames (by sending an ACR control frame).
- The elimination of the separate CF frame type simplifies the reception of asynchronous data frames by non-CF-Aware stations.

Fixing a Broken Mechanism

Draft changes from 94/236 broke a PCF mechanism:

- The CF-Poll frame control bit was eliminated, using the receipt of a CF frame from the PCF as an implicit CF-Poll.
- Without an explicit CF-Poll function, the PCF has no way to acknowledge a received CF frame without granting access to the medium. This means that, under certain conditions, THE CF-PERIOD MIGHT NEVER END!

The best way to correct this is to use one of the Subtype bits to encode the "CF-Poll" function. This is detailed in a subsequent slide.
Fixing a Latent Flaw

The PCF description in 93/20bX contains a flawed mechanism:

- The communication of CF-Poll and CF-Ack indications, when there is no CF-Data frame to transfer, is specified to occur using a CF-Data frame with a zero-length payload.

This is a bad approach:

- The receipt of a data frame generates an indication to the receiver's LLC, even for zero-length payloads.
- There is no mechanism to distinguish zero-length MSDUs provided by the upper LLC and zero-length CF-Data frames generated by the MAC.

The best way to correct this is to use one of the Subtype bits to encode a "no payload" function. This is detailed in a subsequent slide.

The Async Data Subtype Field

<table>
<thead>
<tr>
<th>Async Subtype</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>0000</td>
<td>any STA Data (same as 20b3)</td>
</tr>
<tr>
<td>0001</td>
<td>any CF-STA Data CF-Ack (same as 20b3)</td>
</tr>
<tr>
<td>0010</td>
<td>PCF Data CF-Poll</td>
</tr>
<tr>
<td>0011</td>
<td>PCF Data CF-Ack CF-Poll</td>
</tr>
<tr>
<td>1000</td>
<td>null function</td>
</tr>
<tr>
<td>1001</td>
<td>any CF-STA CF-Ack (no data)</td>
</tr>
<tr>
<td>1010</td>
<td>PCF CF-Poll (no data)</td>
</tr>
<tr>
<td>1011</td>
<td>PCF CF-Ack CF-Poll (no data)</td>
</tr>
</tbody>
</table>

- Non-CF-aware stations only need to test for "No-Data = 0" in the Subtype field of Async frames.
- Each CF-related combination already needs to be handled by the PCF and/or CF-aware stations (see 94/207A).

CF-Period Usage Rules

1. Only Data frames (and resulting Ack frames, if any) shall be sent during the CF-period. All management frames shall be sent during the contention period.
2. A PCF may send Async Data frames to any active station (not to stations in PSP or PSNP mode).
   - CF-aware stations shall acknowledge receipt of each Async Data frame (from the PCF) that has CF-Poll=1 using CF-Ack=1 in a Data frame (possibly with No-Data=1), sent after an SIFS-interval; and shall acknowledge the receipt of all other Async Data frames using ACK Control frames sent after an SIFS-Interval.
   - Non-CF-aware stations shall acknowledge receipt of (all) Async Data frames using ACK Control frames sent after an SIFS-interval. (This is the same as these stations already do for contention-based async.)
3. When polled by the PCF (CF-Poll=1 in the header of a directed Data frame), a CF-aware station may send one Data frame to any destination.
   - Such a frame directed to or through the PCF station shall be acknowledged by the PCF, using CF-Ack=1 in a Data frame (possibly with No-Data=1), sent after an SIFS-interval.
   - Such a frame directed to non-PCF stations shall be acknowledged using an ACK Control frame sent after an SIFS-Interval. (This is the same as these stations already do.)
   - A polled CF-aware station with neither a Data frame nor acknowledgement to send shall not respond, permitting the PCF to resume transmission after a PIFS-interval.
4. The PCF shall not send Data frames with CF-Poll=1 if insufficient time remains in the current CF-Period to permit the polled station to transmit a Data frame containing a maximum-length MPDU.
MOTION #1
1. To restore the explicit CF-Poll capability lost in 93/203b3, using a bit in the Frame Subtype, as defined in document 94/252.
(motion not made due to approval of Motion #4)

MOTION #2
2. To eliminate the use of zero-length CF-Async frames for polling and acknowledgement when there is no CF-Async data, using instead a "no data" bit in the Frame Subtype, as defined in document 94/252.
(motion not made due to approval of Motion #4)

MOTION #3
3. To adopt the changes to contention free asynchronous operation, including frame types/subtypes, usage rules, IFS durations, etc. as defined in document 94/252.
(motion not made due to approval of Motion #4)

MOTION #4
4. To adopt the changes to contention free asynchronous operation, including frame types/subtypes, usage rules, IFS durations, etc. as defined in document 94/252; and to modify the updates to section 4.1.2.1.2 to designate the "reserved" frame type (type code =11) as "time bounded" frame type.
(this motion was approved in MAC group 18-2-12)