Interference Mitigation to Support Femto ABS in IEEE 802.16m

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Venue: **IEEE Session #64**
Base Contributions:

Re: Contribution in support of a comment on LB30a
Purpose: **Discussion and Approval**

IM for macro and femto

- Femto and overlay macro at different FA
  - No IM issue
  - But, spectrum is expensive.
  - It may not be acceptable to buy an additional carrier frequency to support femto.
- Femto and overlay macro at same FA
  - For CSG-open and Open femto
    - HO is a solution for IM
    - Resource reservation can be done
  - For CSG-closed femto
    - Valid use case
    - But, possible coverage hole for non-member MSs
    - Most difficult

Macro and overlaid CSG-closed femto at same FA (1/2)

- If non-member MS is still connected to macro or any ABS, but sees strong interference from CSG-closed
- Use coordinated IM
  - MS measures the DL from CSG femto, report interference to the serving BS
  - If IM is needed, serving BS and interfering CSG femto will negotiate via backhaul, to mitigate the interference.
    - Reserve resource time/frequency
    - Power control
  - MS measures the DL from CSG femto, report interference, and terminate IM and release resource when interference is not needed.

Macro and overlaid CSG-closed femto at same FA (2/2)

- If non-member MS is not connected to macro or any other ABS, and AMS can only see a CSG-closed femto
- Since MS can only see a CSG-closed femto, the remedy can be
  - **Step 1: MS signals CSG-closed femto, to request IM**
  - **Step 2:** FBS may notify the IM request to the macro and backhaul, to have **coordinated IM**, based on the operator or service rules.
- In such scenario, we need solution for IM on both control and data channel
- Staggered SFH makes MS scanning complicated. It is removed from AWD. We lose one degree of freedom.
- At Step 2, the remaining degrees of freedom can be
  - **Frequency:** FA change, if available
  - **Power:** power control
  - **Service agreement:** CSG-closed FBS exceptionally serve non-member with low priority [CSG-closed temporarily becomes a CSG-open virtually, without changing cell ID]
- The above can be used as femto and femto at same FA.

Step 1: non-member signals CSG-closed femto

- If non-member MS is not connected to macro or any other ABS, and AMS can only see a CSG-closed femto
- MS can only see a CSG-closed femto, so the remedy can be (details in contribution #2596 or its latest version)
  - Trigger: a disconnected AMS who is a non-member of a CSG-closed femto measures that the CSG-closed femto ABS is the only ABS with a RSSI or CINR higher than the minimum acceptable RSSI or CINR for MS to access a BS, for a period of time T greater than a threshold TH1
  - Action: the AMS may request the femto ABS to mitigate the interference by sending an AAI_RNG-REQ message with Ranging Purpose Indication Bit #7 set as '1'.

Step 2: Policy 1- FA change

- Femto changes FA, if available
  - need smooth reconfiguration on changing FA
- Pros: Avoid interference
- Cons: spectrum is expensive. Not sure whether an additional FA will be available

Step 2: Policy 2- power control

- Femto and macro have coordinated IM
  - Femto will reduce its transmission power for DL control channels.
- If femto power is reduced to an extent that all the MSs being served are handed out, femto can enter LDM.
- Pros: CSG-closed does not really serve non-member along data traffic.
- Cons: Member MS of CSG-closed may be hurt/affected (e.g., may be handed out)

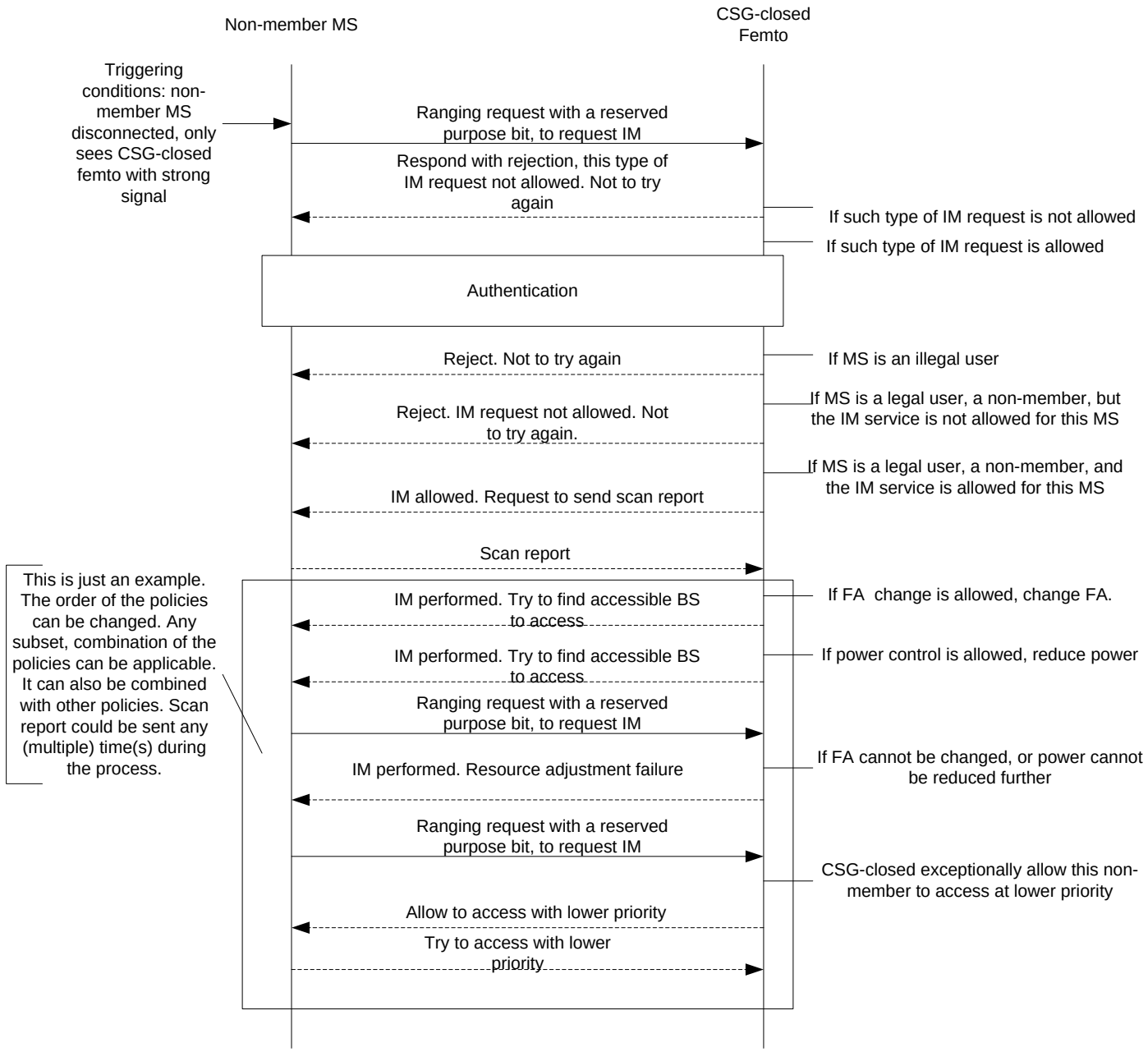
Step 2: Policy 3- Temporary CSG-closed to a virtual CSG-open

- Femto CSG-closed may be temporarily a virtual CSG-open, and this is triggered by the event. CSG-closed may not need to change the cell type by changing cell ID (pick a cell ID from the partition for CSG-open).
  - If such IM request occurs not frequently, dynamic temporary virtual change (no cell ID change) can be a good fit. Such virtual change should not cause the NBR-ADV update.
  - Optionally, of course, it could change the type from CSG-closed to CSG-open, starting from changing cell ID.
- The non-member could get the service in a low priority if there is resource available.
- The cell is still a CSG-closed in regular mode. It will be open only when such IM request occurs. It is different from CSG-open which is open all the time.
- Pros: Member MS of CSG-closed is not hurt/affected.
- Cons: CSG-closed now serves non-member.

Step 2: Policy 4- Rejection

- Possible rejections
  - Femto detects #7 purpose bit in RNG-REQ for IM request, and femto reject such ranging, without going further to authentication. [Should provide a response to MS, tell MS it is not allowed by the policy and not to try again]
  - Femto detects #7 purpose bit in RNG-REQ for IM request, and femto goes further to authentication.
    - If the authentication result is that MS is an illegal user, reject.
    - If MS is a legal user and non-member, and if the policy does not allow IM for this particular user (there could be a policy that only some users or partners who can enjoy the IM). [Should provide response to MS, IM not allowed]
    - If MS is a legal user and non-member, and if the policy allows power control to do IM, but power control fails, reject. If the policy allows CSG-closed temporarily to be a CSG-open, but there is no resource remaining, reject. [Should provide a response to MS: IM allowed but failed]

Illustration



Low duty mode

- It does not solve the problem of IM for overlaid femto and other BSs at same FA, because in AI, it still interferes other BSs.
- However, it can help downlink control interference mitigation.
- For example, with LDM, the scenario that a non-member MS could not hear macro BS will occur with much smaller probability.
- Once non-member could communicate with macro BS, non-member could report interference from CSG-closed femto in LDM, even during NE stage, and macro could ask femto in LDM to perform power control to reduce the interference of DL control.
- Hence, it is beneficial to support LDM.

Proposed text (1/6)

On page 551, line 19, insert the following text as separate paragraphs.

If an AMS who is a non-member of a CSG-closed femto measures that the downlink signal with a RSSI or CINR difference between its serving ABS and the CSG-closed femto ABS is smaller than a threshold TH_IM for a period of time T1 greater than a threshold TH1, the AMS may report it to the serving ABS to trigger DL/UL interference mitigation.

If an AMS who is a non-member of a CSG-closed femto measures that the downlink signal with a RSSI or CINR difference between its serving ABS and the CSG-closed femto ABS is larger than a threshold TH_IM_Release for a period of time T2 greater than a threshold TH2, the AMS may report it to the serving ABS to trigger the release of the reserved resource on DL/UL in the femto.

Proposed text (2/6)

On page 551, line 23, insert the following text as separate paragraphs.

If the operator policy does not allow IM for an AMS which is authorized as a non-member, the femto ABS responds with an AAI_RNG-RSP message with IM Indication ‘00’, which means IM not allowed and not to try again. If the policy allows IM for this AMS, the femto ABS may further request AMS to send scan report via AAI_SCN-REP. AMS can send scan report via AAI_SCN-REP. If the policy allows CSG-closed femto to choose a new FA, and it succeeds, the femto ABS responds with an AAI_RNG-RSP message with IM Indication ‘01’, which means IM performed and AMS to find other BS to access. If the policy allows CSG-closed femto to perform power control, and CSG-closed femto reduces the power on downlink control channel, the femto ABS responds with an AAI_RNG-RSP message with IM Indication ‘01’, which means IM performed and AMS to find other BS to access. Upon receiving the response, AMS may try to find other BS to access. If the CSG-closed femto is still the only ABS with a RSSI or CINR higher than the minimum acceptable RSSI or CINR, the AMS can retry IM request by sending an AAI_RNG-REQ message with Ranging Purpose Indication Bit#7 set as ‘1’. The AMS may retry until it receives AAI_RNG-RSP message with IM Indication ‘10’, which means IM allowed but failed.

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Proposed text (3/6)

If the policy allows CSG-closed femto to choose a new FA, but there is no new FA available, and if the policy allows power control, but the femto does not reduce its power on downlink control channel, the CSG-closed femto ABS responds with an AAI_RNG-RSP message with IM Indication ‘10’, which means IM allowed but failed. Upon receiving the response, AMS may at most retry one more time the IM request by sending an AAI_RNG-REQ message with Ranging Purpose Indication Bit#7 set as ‘1’.

If the policy allows CSG-closed temporarily to allow AMS to access with lower priority than member AMSs, the femto ABS responds with an AAI_RNG-RSP message with IM Indication ‘11’, which means AMS is allowed to access CSG-closed femto ABS with lower priority. The AMS may need to perform a location update and the femto should forward paging to the AMS.

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Proposed text (4/6)

If the policy allows CSG-closed femto to perform downlink power control for downlink control channel, the CSG-closed femto ABS request member AMSs in its coverage to measure and report the received power, via AAI_SCN-REP. The CSG-closed femto may send via message the minimum required power to its member AMSs, and the AMSs send back to femto the power difference of the received power and the minimum required power if the miminum required power is decided at femto ABS, or the AMSs may send both the minimum required power, and the difference of the received power and minimum required power to the femto if the miminum required power is decided at AMS. The femto may reduce its downlink control channel power so that its member AMSs received power is no less than the minimum required power. If the non-member AMS measures that the CSG-closed femto signal strength is lower than the accessible BS by an amount greater than a threshold TH_power for a time T3 greater than a threshold TH3, the CSG-closed femto may increase its downlink transmission power.

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Proposed text (5/6)

A non-member AMS can scan for the accessible BS (e.g., macro, open femto,etc) in UAI of the LDM of CSG-femto and try to access and associate with the accessible BS, if it is not connected. If a non-member AMS scans the AI of CSG-closed femto in LDM and measures that the signal strength is higher than certain threshold, it should report to the accessible BS or the serving ABS about the interference from the AI of the LDM of CSG femto. The accessible BS can negotiate transmission power on DL control channel with the CSG-closed femto, e.g., ask the CSG femto in LDM to reduce power on its DL control channel. The femto may reduce its downlink control channel power so that its member AMSs received power is no less than the minimum required power. If the CSG-closed femto does not want to hand out any of its members in idle mode or sleep mode, so it does not want to further reduce downlink power, but the non-member still gets interference higher than threshold TH_IM in the AI of LDM of the CSG-closed femto, then the femto may allow this non-member to access as an exceptional case if policy permits and it may wake up the CSG-closed femto when this non-member becomes an active MS.

Proposed text (6/6)

On page 38, **15.2.3.2 AAI_RNG-RSP**

In Table 675, add

Name	Value	Usage
……		
IM request response	'00'= IM not allowed and not to try again '01'= IM performed and AMS to find other BS to access '10' =IM allowed but failed '11' = AMS allowed to access CSG-closed femto ABS with lower priority	For CSG-femto to respond AAI_RNG-REQ with Ranging Purpose Indication Bit#7 set as '1'