Interference mitigation to support overlaid CSG-closed femto ABS

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Re: Contribution in support of a comment on LB30a

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Problem definition

- Large interference from an inaccessible Femtocell may saturate or block the MS radio receiver, such that it will not able to maintain the communication with the serving BS.

- When a non-member AMS is seriously interfered by a neighbor CSG-closed Femtocell ABS and cannot get any service from the network, what should be done for such MS?

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.

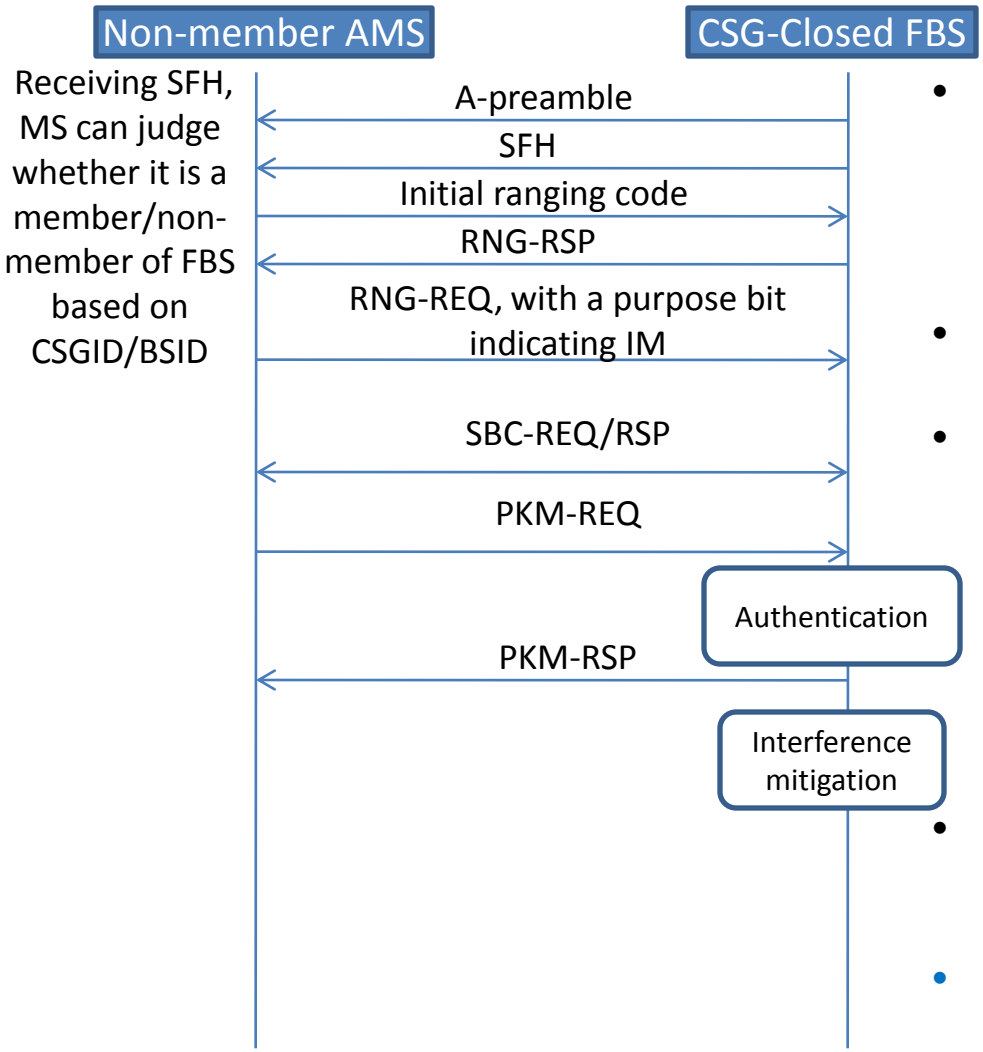
Macro and overlaid CSG-closed femto at same FA (2/2)

- 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

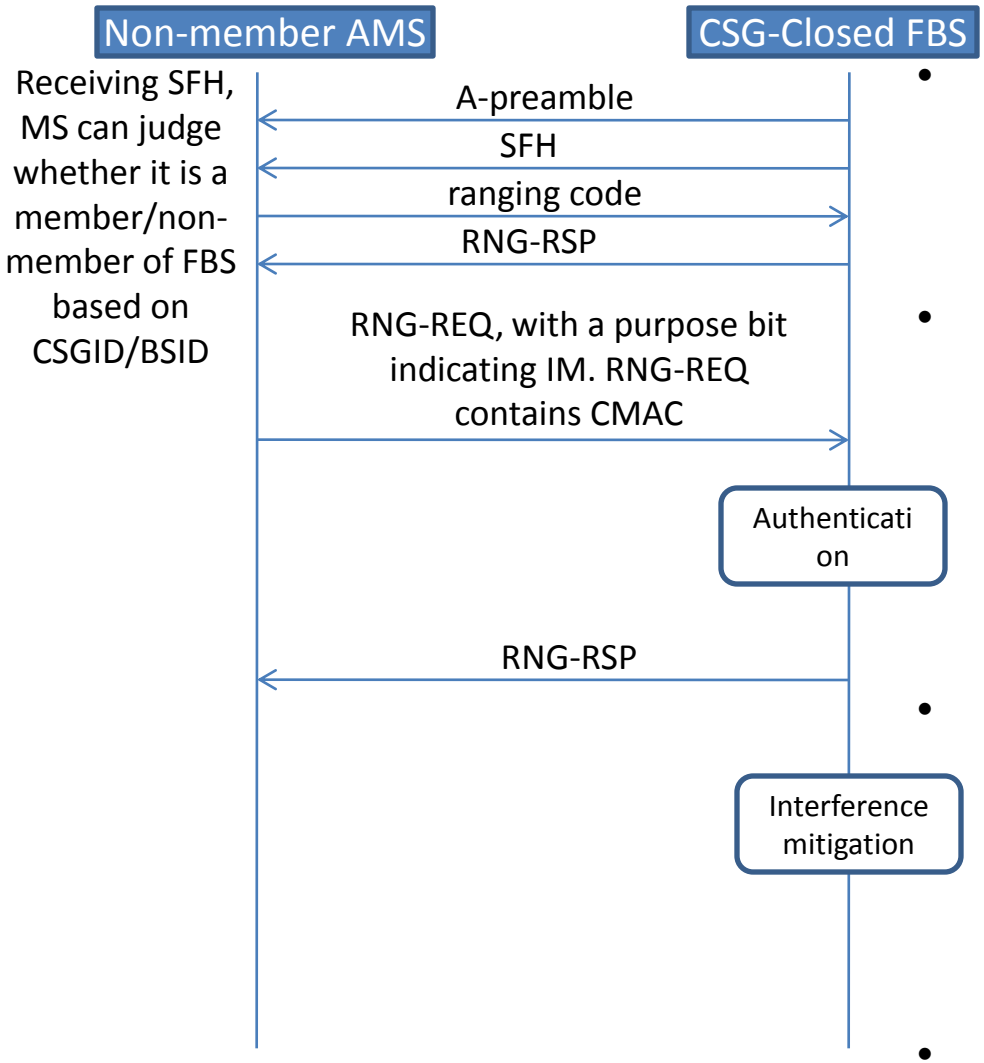
- If non-member MS is not connected to macro or any other ABS, and AMS can only see a CSG-closed femto
- MS can only see a CSG-closed femto, so the remedy can be (details in contribution #2596 or its latest version)
  - Trigger: a disconnected AMS who is a non-member of a CSG-closed femto measures that 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 1 - Solution (1/2)



- This case is for that an AMS has no valid AK context.
- If an AMS is seriously interfered by a neighbor CSG-closed femto ABS and cannot get any service from the network, the MS may request the femto ABS to mitigate the interference .
- MS can send an AAI_RNG-REQ message with Ranging Purpose Indication Bit#5 set as '1'.
- Having received this IM indication, the CSG-closed Femto ABS may further allow MS to enter the EAP stage for authentication.
- If the FBS recognize the AMS is illegal, it rejects any request from MS. If the FBS recognize that the AMS is a legal user but a non-member, the FBS may either accept the IM request, or reject.
- Whether to accept the request of IM or reject, depends on the FBS service provider or operator rule.
- Advantage:
  - Prevent the CSG femto generating coverage hole to non-member MS

Step 1: Solution (2/2)



- This case is for that an the case that an AMS has a valid AK context
- This can happen, for example, AMS was in idle state served by a macro BS, but now it cannot hear macro, but only a strong interference from inaccessible CSG-closed FBS.
- If an AMS is seriously interfered by a neighbor CSG-closed Femtocell ABS and cannot get any service from the network, the MS may request the femto ABS to mitigate the interference.

MS can send an AAI_RNG-REQ message with Ranging Purpose Indication Bit#5 set as '1', and the CMAC is contained.

- The Femto ABS may authenticate the request.

If the FBS recognize the AMS is illegal, it rejects any request from MS. If the FBS recognize that the AMS is a legal user but a non-member, the FBS may either accept the IM request, or reject.

- Whether to accept the request of IM or reject, depends on the FBS service provider or operator rule.

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)

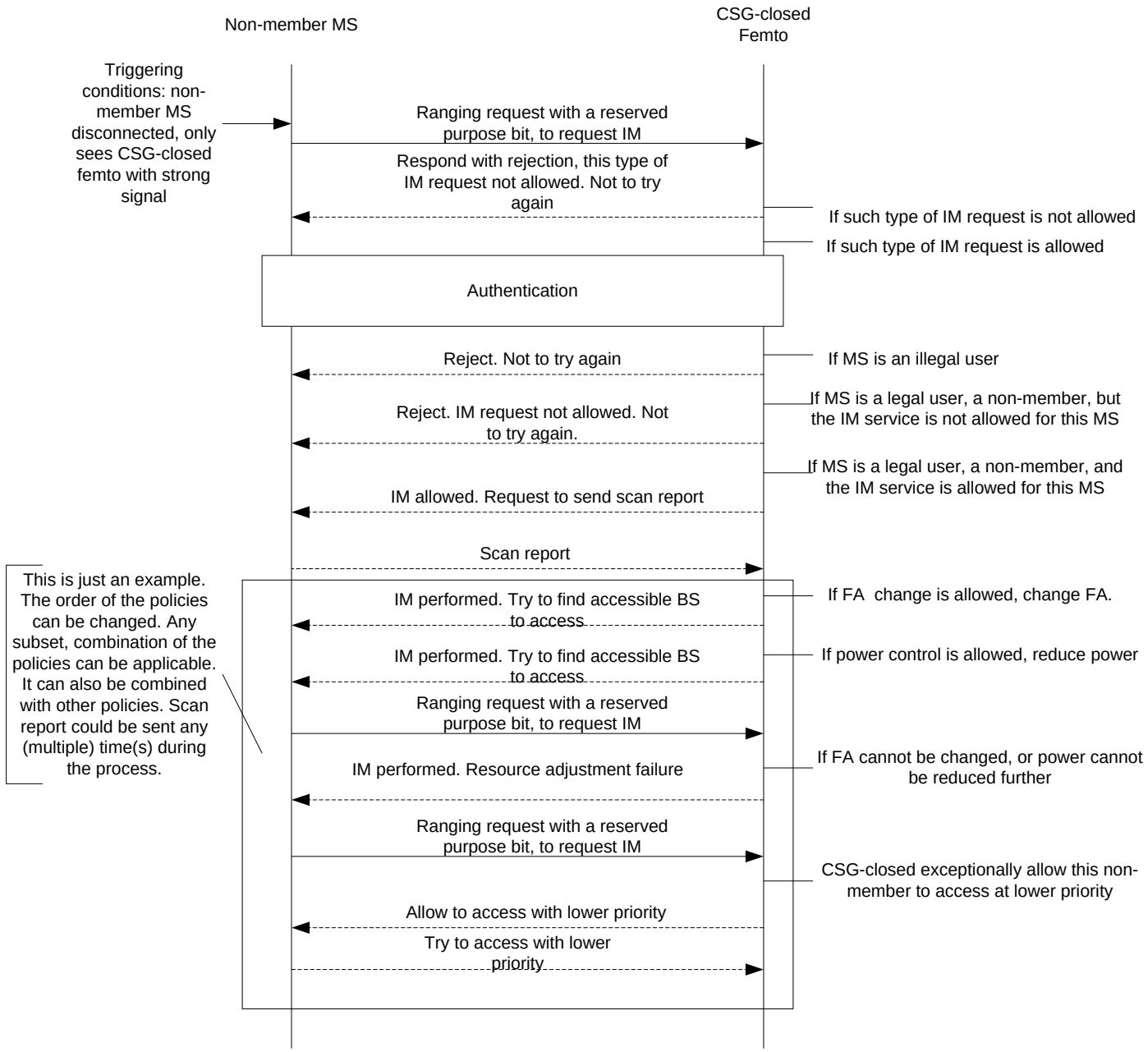
Step 2: Policy 3- Temporary CSG-closed to a virtual CSG-open (only as an example of one of the possibilities)

- 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 (1/2)

Insert the following text to page 551, line 22

If an AMS is severely interfered by a neighbor CSG-closed femto ABS and cannot get any service from the network, the MS may request the femto ABS to mitigate the interference by sending an AAI_RNG-REQ message with Ranging Purpose Indication Bit#3 set to '1', to indicate the interference mitigation request. If the AMS has a valid AK context, the AAI_RNG-REQ message shall contain CMAC tuple.

Upon receiving ranging purpose indication bit #3 being '1', if the femto ABS does not accept this type of ranging request, it rejects this request. If the femto ABS accepts this type of ranging request, the femto ABS and the network may further authenticate the AMS. Only if the non-member AMS is authenticated, the femto ABS should accept the request.

Proposed text (2/2)

On page 36, **15.2.3.1 AAI_RNG-RSP**

In Table 674, revise

Name	Value	Usage
	…… If Bit#2 is set to 1, ranging request for emergency call setup. When this bit is set to 1, it indicates AMS action of Emergency Call process.	
Ranging Purpose Indication	If bit #3 is set to '1', it indicates that an non-member AMS requests interference mitigation to a CSG-closed femto ABS, to compensate for the coverage hole generated by the CSG-closed femto If bit #5 is set to 1, it indicates that the AMS is initiating location update for transmission to DCR mode from idle mode. …….	It shall be included when the AMS is attempting to perform reentry, HO or location update