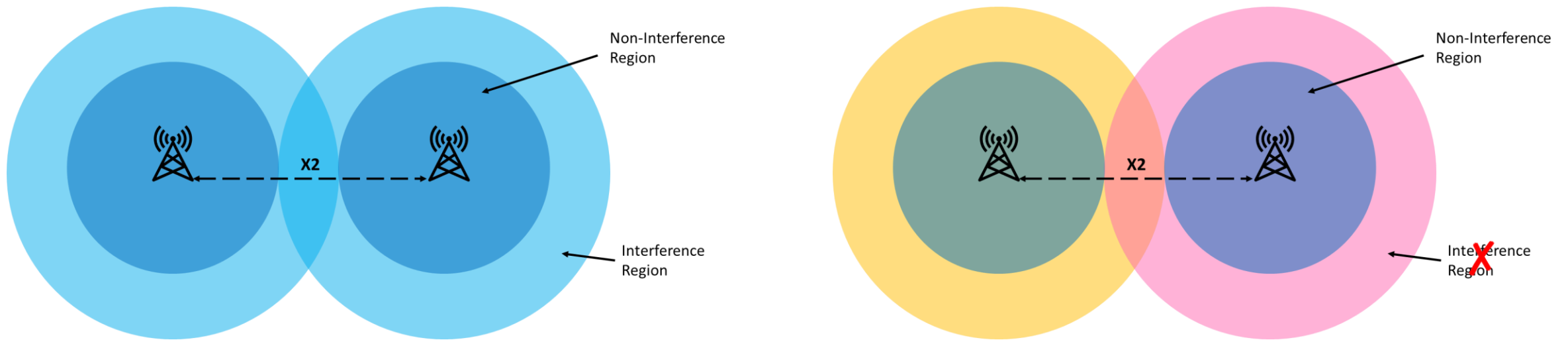


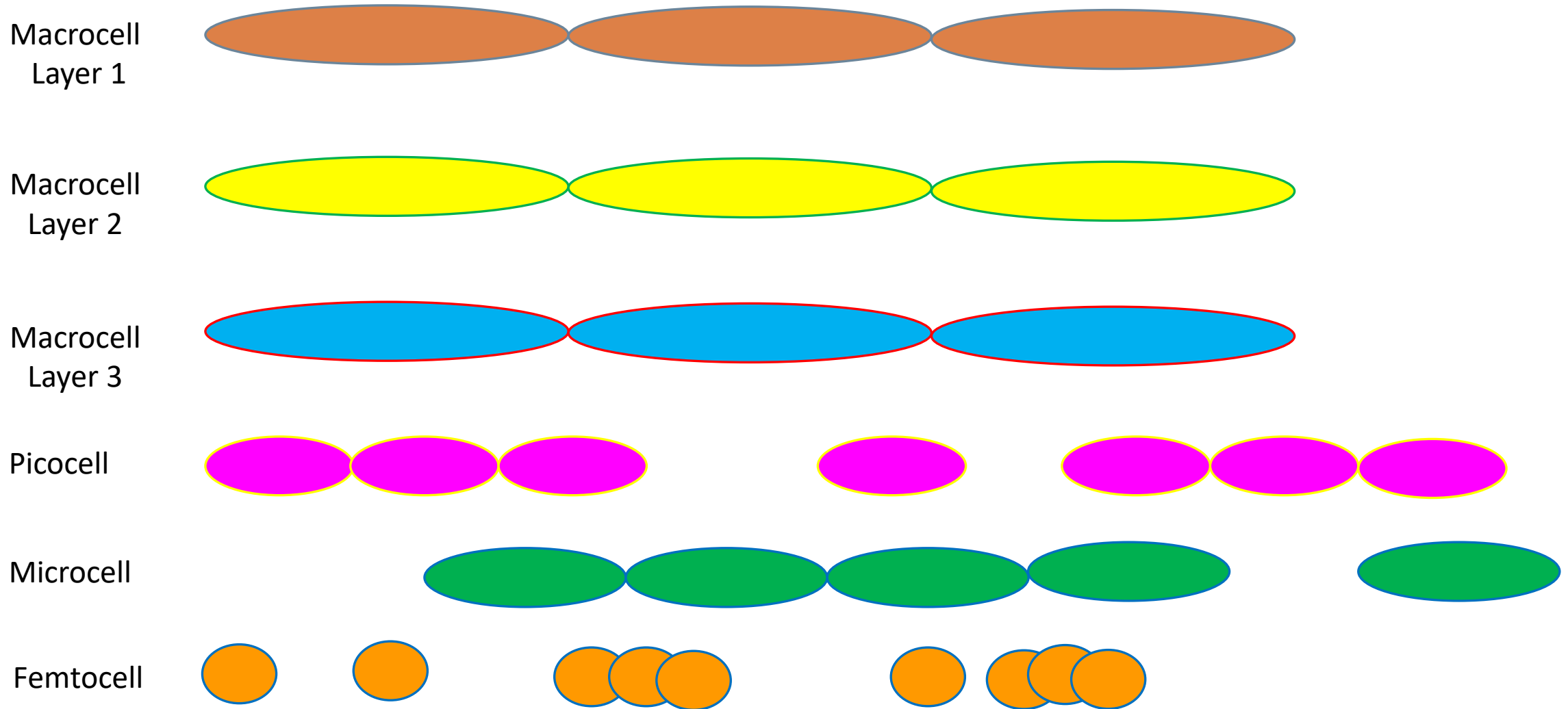
3GPP SON Series: SON Management in HetNets and Enhanced ICIC (*eICIC*)

Inter-Cell Interference Coordination (ICIC) Recap

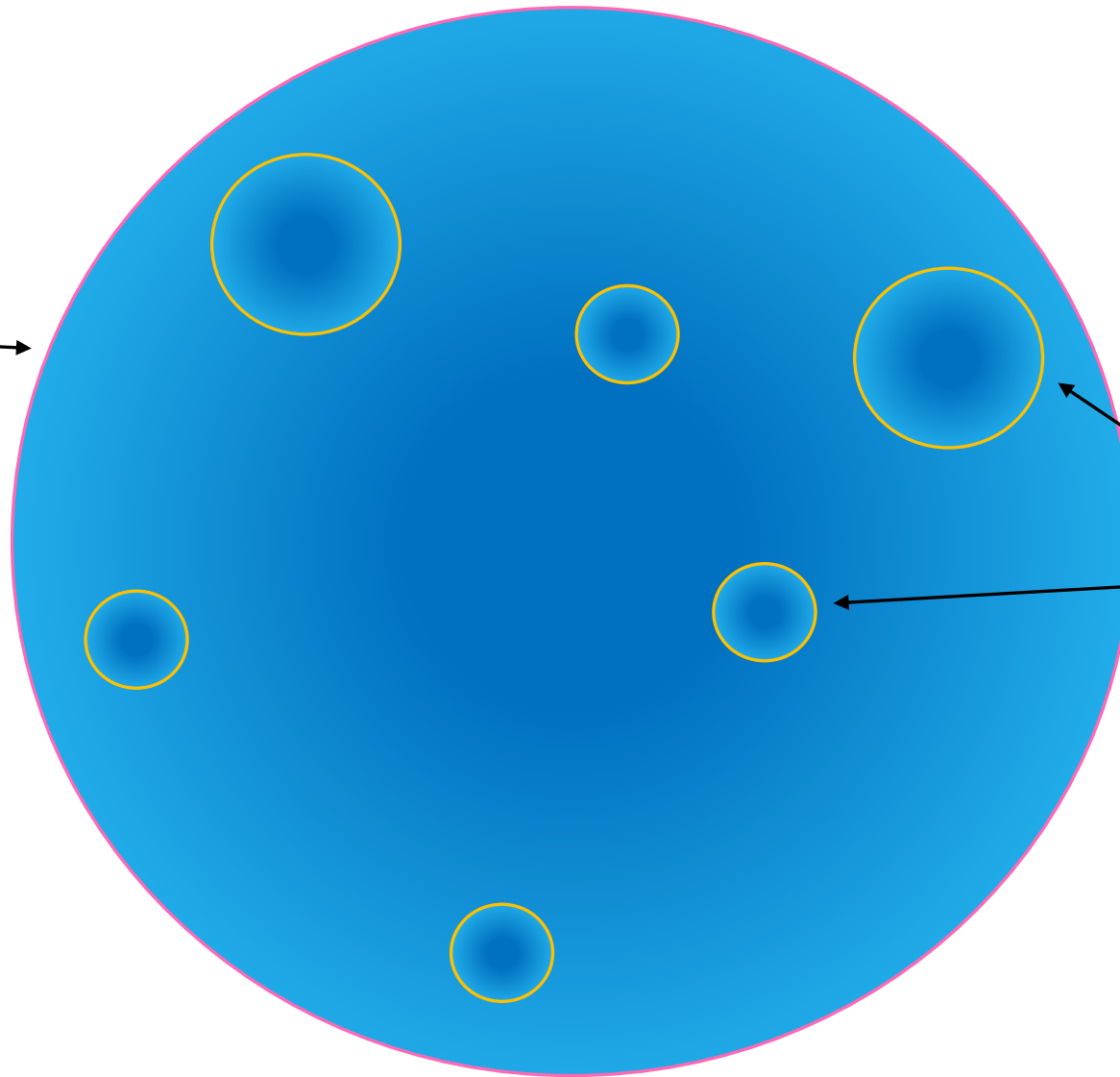


The goal of Inter-Cell Interference Coordination (ICIC) is to ensure there is no interference in overlapping areas between cells

Heterogeneous Network (HetNet) Recap

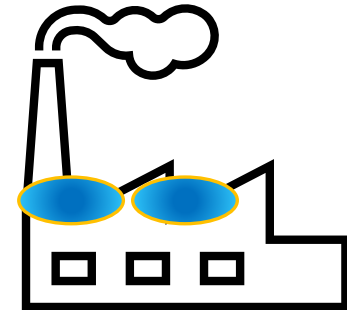
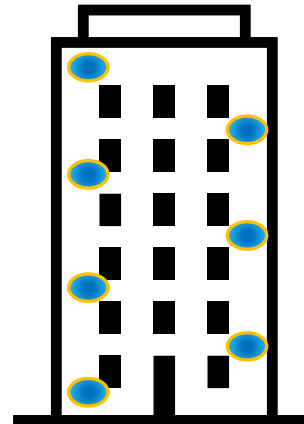
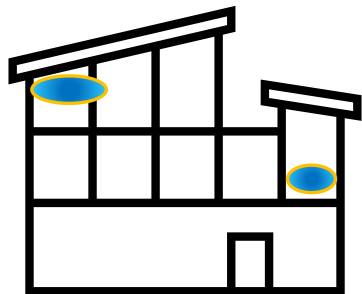


Macro cell
(pink border)

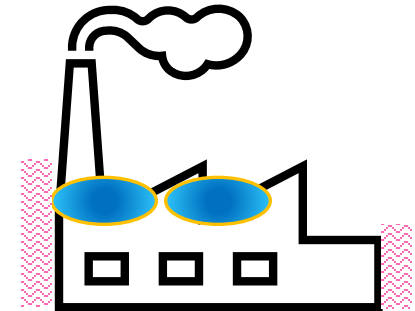
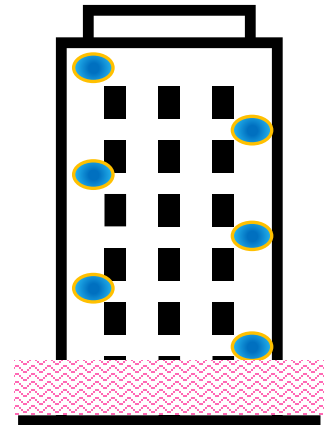
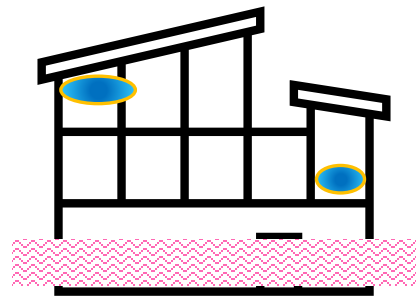


Small cells
(yellow border)

HetNet with Macrocell and Small Cells



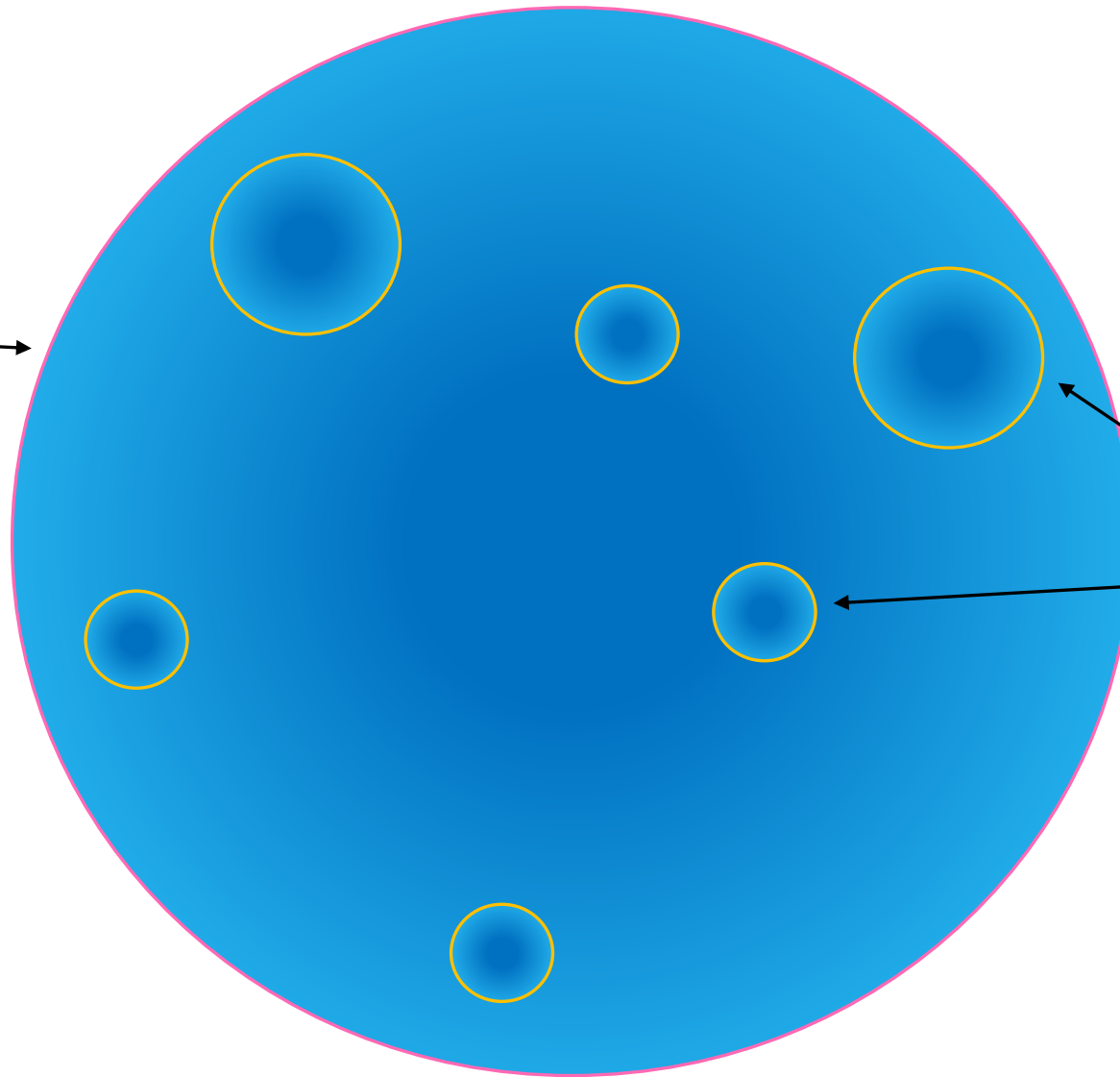
HetNet with Macrocell and Small Cells



 Interference zone

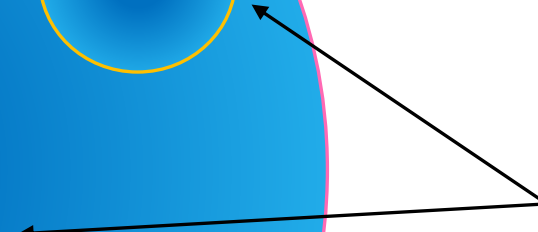
Aggressor Cell

Macro cell
(pink border)

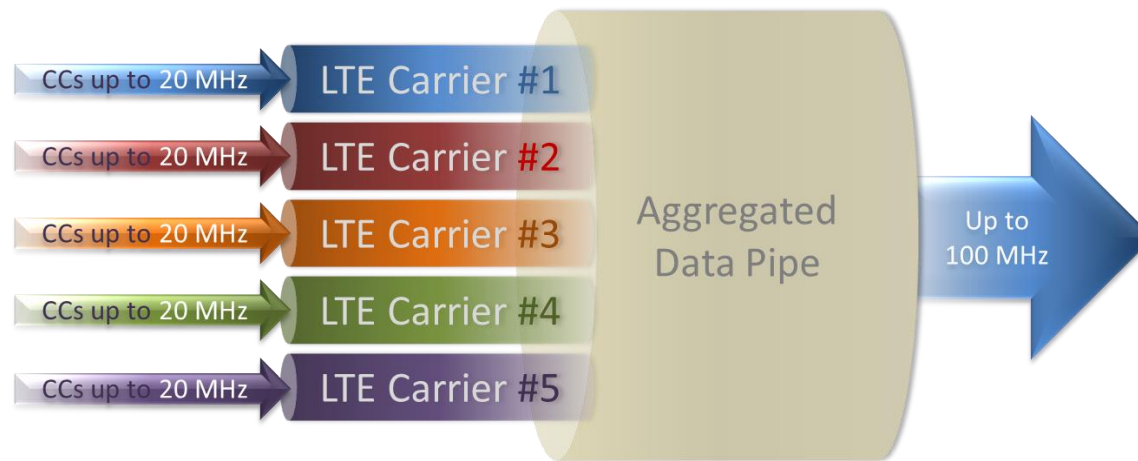
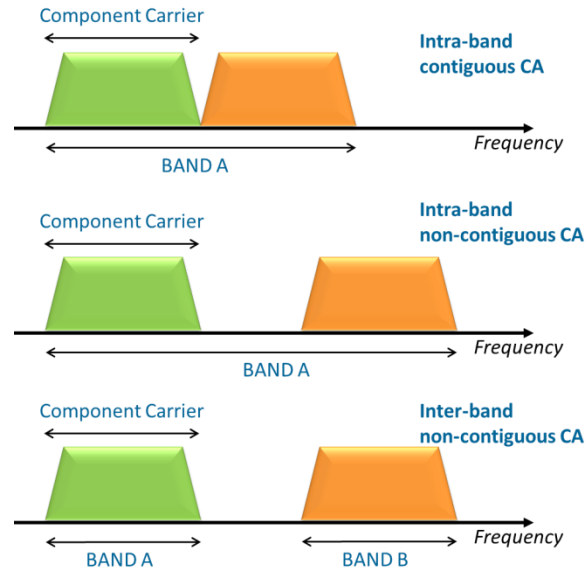


Victim Cell

Small cells
(yellow border)

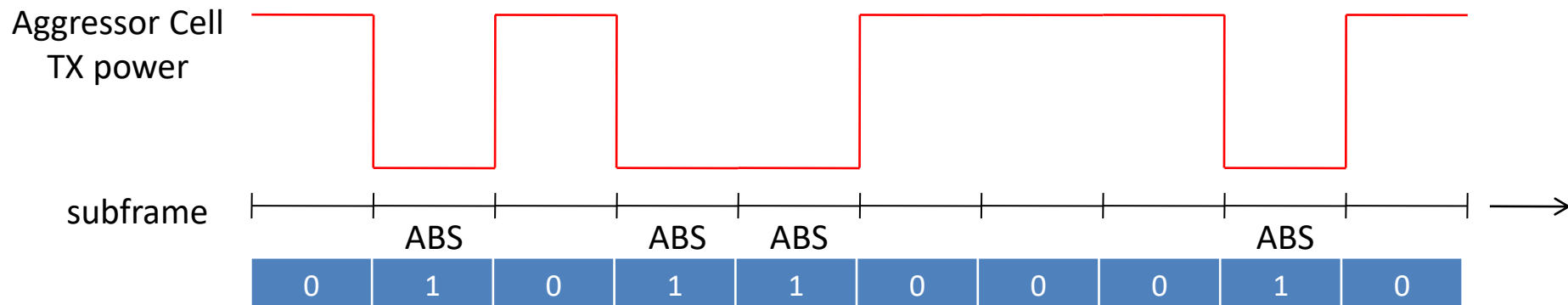


Carrier Aggregation (CA)

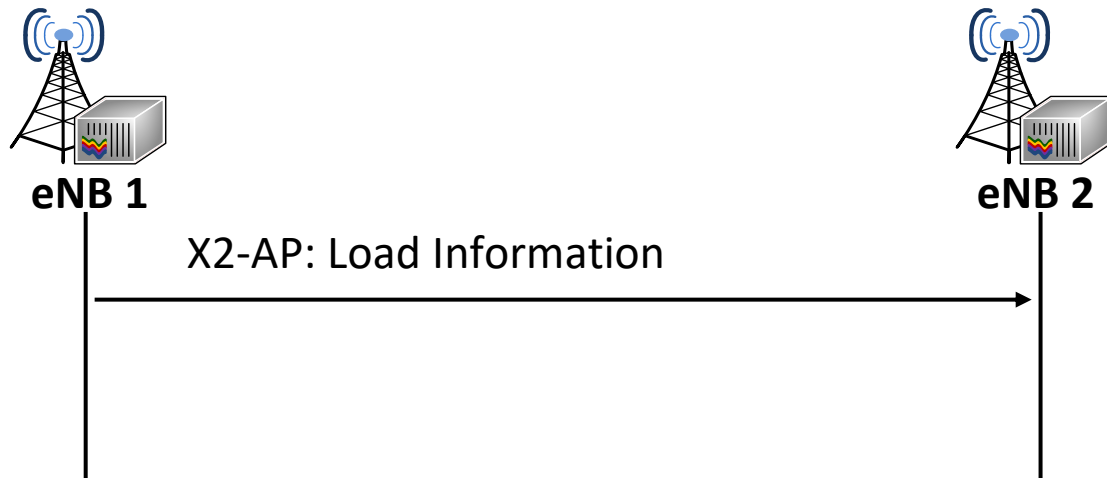


Almost Blank Subframe (ABS)

- Aggressor cell silences for some time
 - To provide protected resources to victim cell
 - Still PSS, SSS, PRS, CSI-RS, SIB1, Paging transmitted for backward compatibility, so called it “Almost”
- Victim cell makes use of the silence time
 - For eNB of victim cell to schedule UEs in victim cell
 - For UE in victim cell to check its’ serving cell radio condition
 - For UE in victim cell to measure its serving cell
 - For UE in another cell to measure victim cell



X2-AP Load Indication



9.1.2.1 LOAD INFORMATION

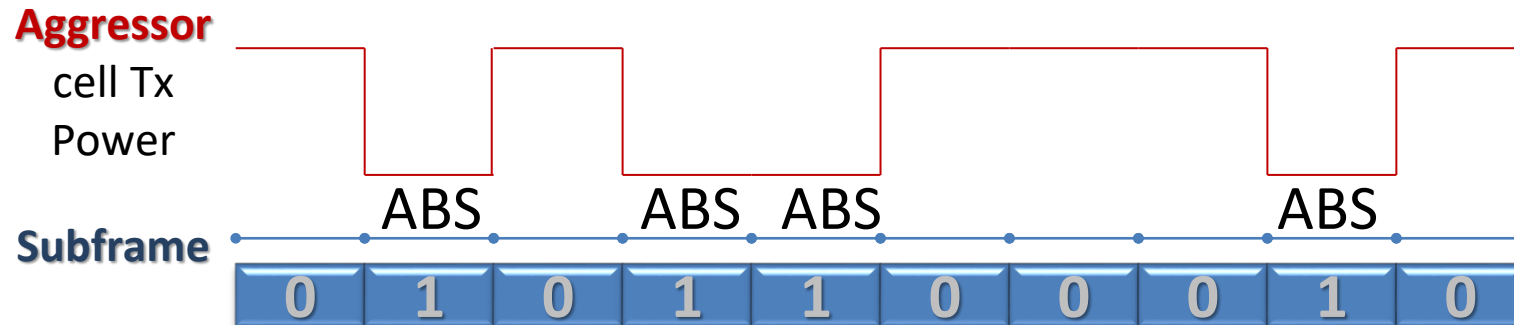
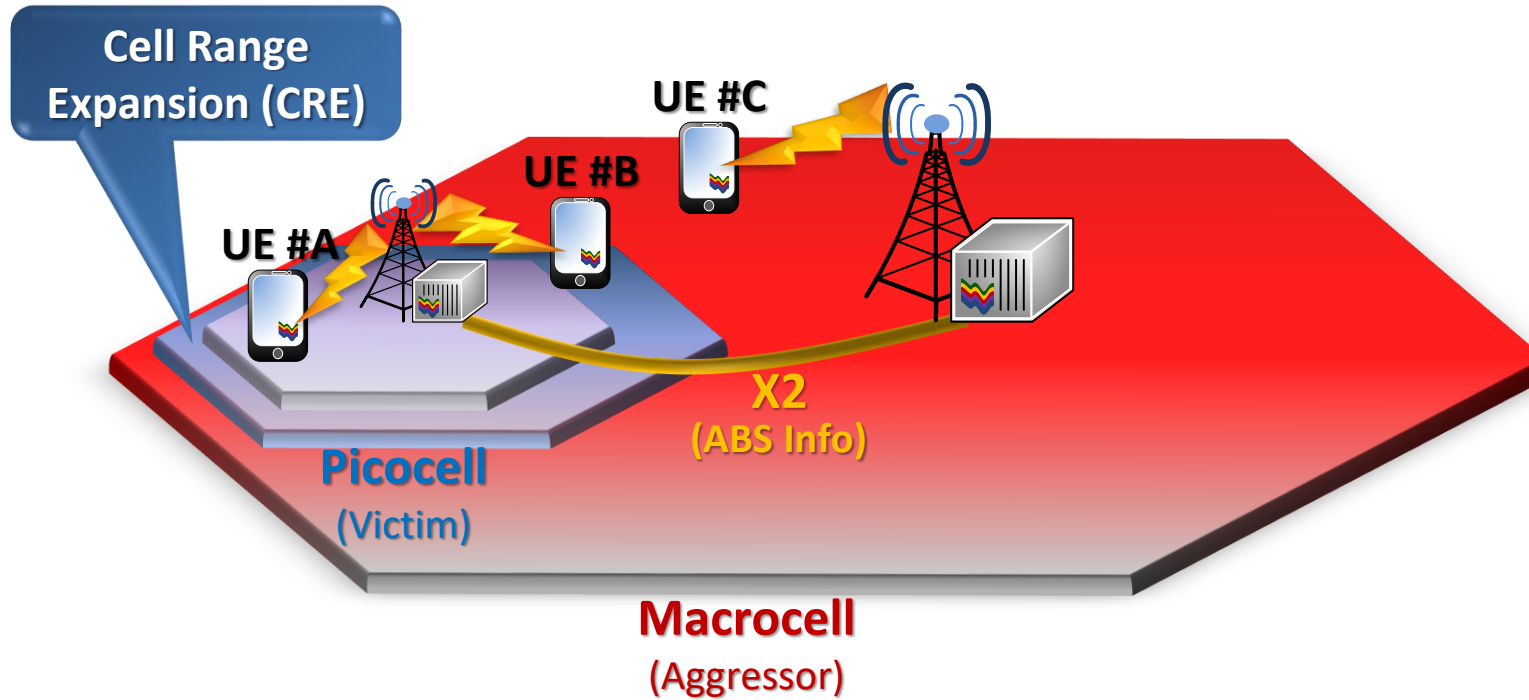
This message is sent by an eNB to neighbouring eNBs to transfer load and interference co-ordination information.

Direction: eNB₁ → eNB₂.

| IE/Group Name | Presence | Range | IE type and reference | Semantics description | Criticality | Assigned Criticality |
|---------------------------------------|----------|------------------------|-----------------------|---|-------------|----------------------|
| Message Type | M | | 9.2.13 | | YES | ignore |
| Cell Information | M | | | | YES | ignore |
| >Cell Information Item | | 1... <maxCellineNB> | | | EACH | ignore |
| >>Cell ID | M | | ECGI 9.2.14 | Id of the source cell | - | - |
| >>UL Interference Overload Indication | O | | 9.2.17 | | - | - |
| >>UL High Interference Information | | 0... <maxCellineNB> | | | - | - |
| >>>Target Cell ID | M | | ECGI 9.2.14 | Id of the cell for which the HII is meant | - | - |
| >>>UL High Interference Indication | M | | 9.2.18 | | - | - |
| >>Relative Narrowband Tx Power (RNTP) | O | | 9.2.19 | | - | - |
| >>ABS Information | O | | 9.2.54 | | YES | ignore |
| >>Invoke Indication | O | | 9.2.55 | | YES | ignore |

| Range bound | Explanation |
|--------------|---|
| maxCellineNB | Maximum no. cells that can be served by an eNB. Value is 256. |

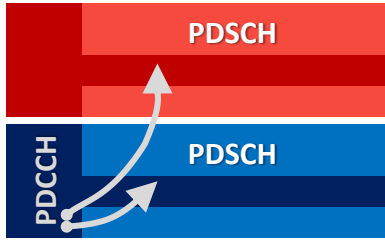
Non-CA based Enhanced ICIC (eICIC)



Source: eXplanoTech

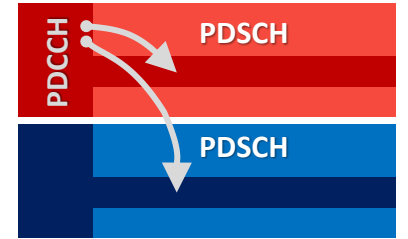
CA based Enhanced ICIC (eICIC)

UE #A

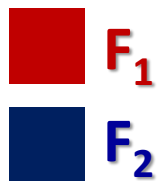
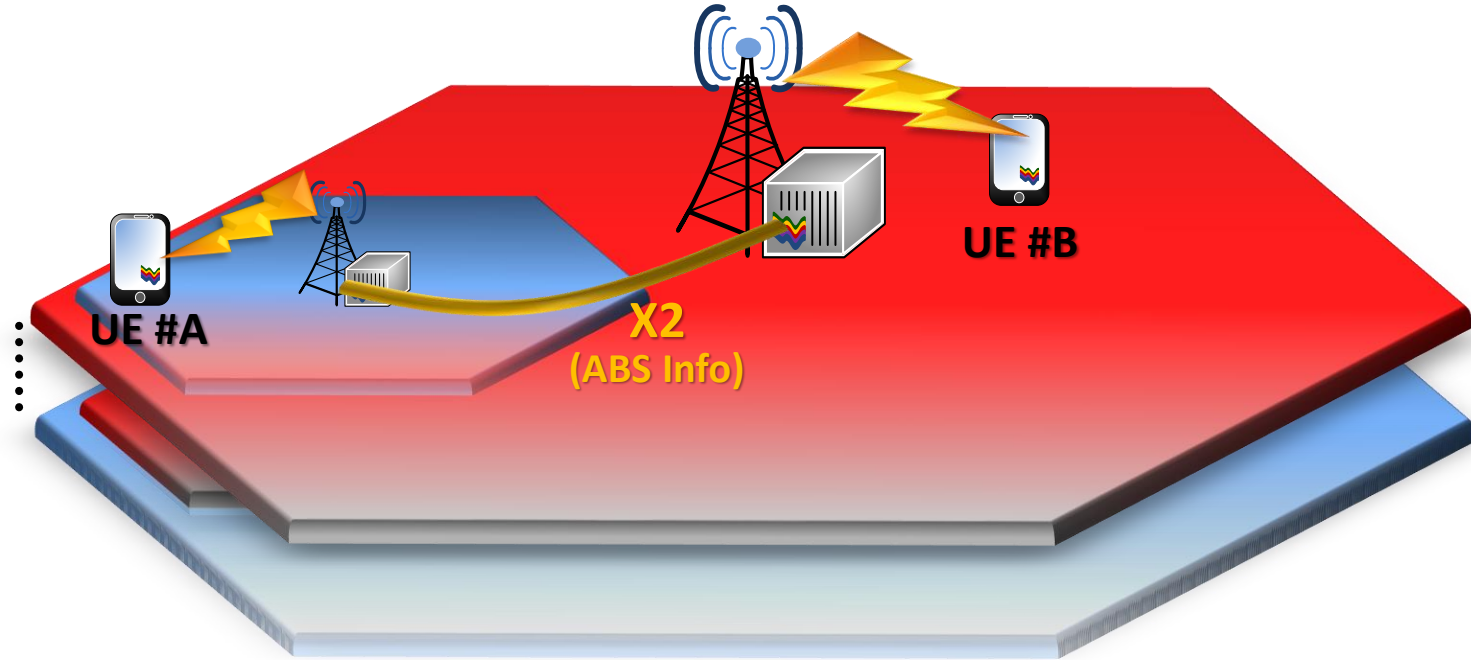


Control signal on F₂
Data signal on both

UE #B



Control signal on F₁
Data signal on both

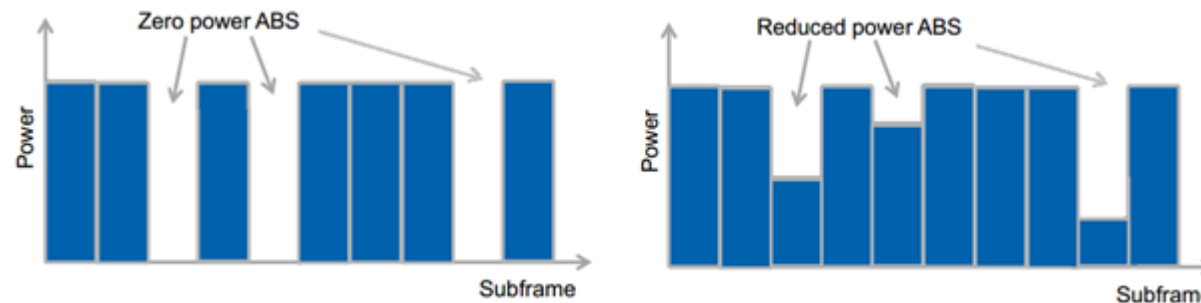


UE#A and UE#B are Cross-Carrier Scheduled (CCS)

Source: eXplanoTech

Non-CA based Further enhanced ICIC (FeICIC)

- At the transmitter side in DL
 - Combination of ABS + power reduction (RP-ABS)
- At the receiver side in DL
 - Use of advanced UE receiver (cancellation/discard of known signals such as CRS...)



Source: Frank Rayal, See Reference [2]

References and Further Reading

- Netmanias: Interference Coordination in LTE/LTE-A (2): eICIC (enhanced ICIC) ([link](#))
- Frank Rayal: Further Enhanced ICIC (FeICIC) by Faris Alfarhan ([link](#))
- All about Wired and Wireless Technology: ICIC and eICIC by Adnan Basir ([link](#))
- From 4G to 5G: Self-organized Network Management meets Machine Learning by Jessica Moysen and Lorenza Giupponi ([link](#))
- 3G4G: Self-Organizing Networks / Self-Optimizing Networks ([link](#))
- The 3G4G Blog: SON ([link](#))

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