

3GPP LTE Home (e)NB

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H(e)NB Definition

- ▶ **H(e)NB = Home (e)NodeB**
 - A HeNB is a **Customer-Premises Equipment** that connects a 3GPP UE over (E)UTRAN wireless air interface to a mobile operator's network using a broadband IP backhaul.

From TS 22.220

Use Cases



Home Cell



Café/restaurant cells



Lower price

Preferential service

High data rate

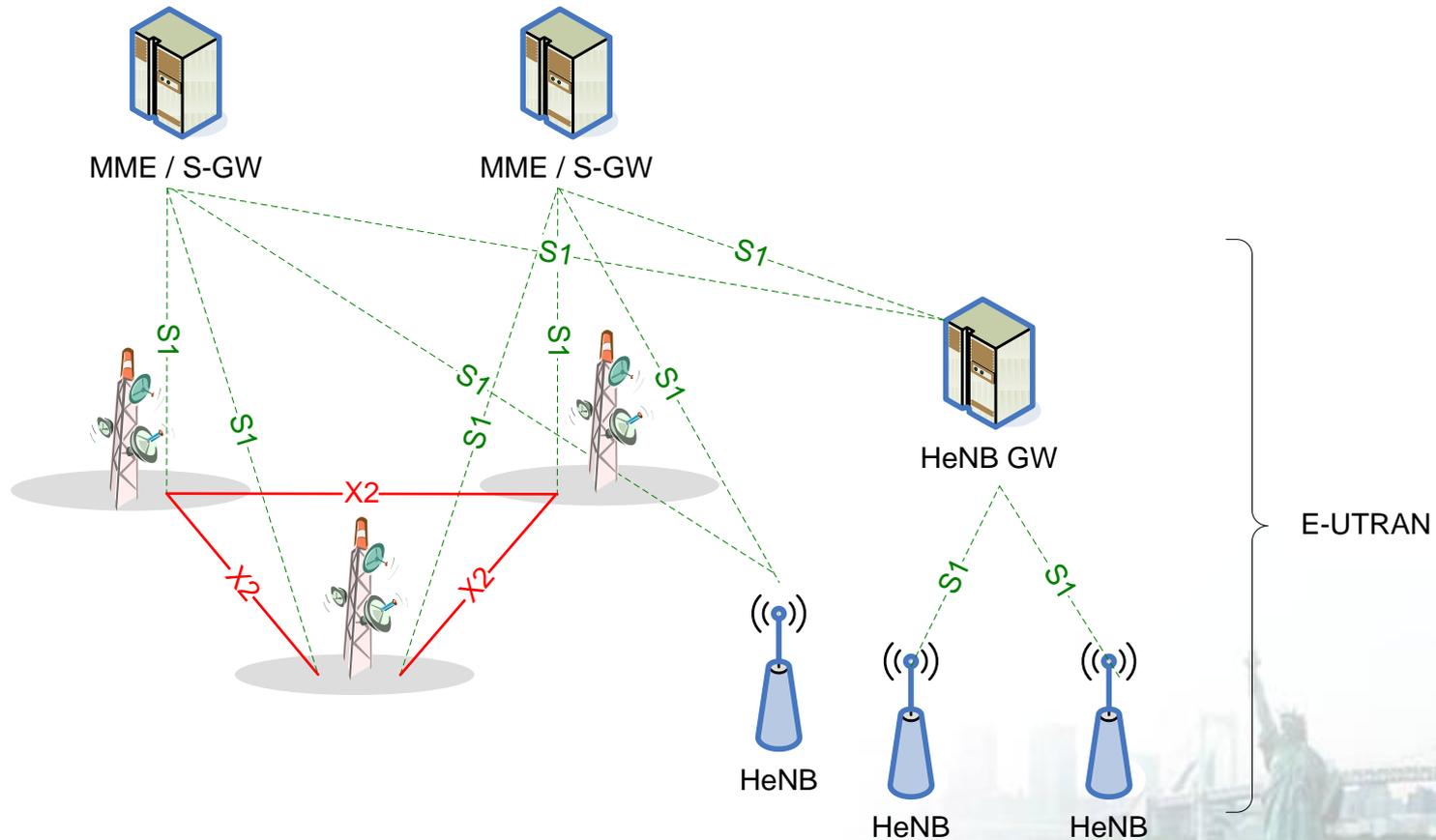
Exclusive access



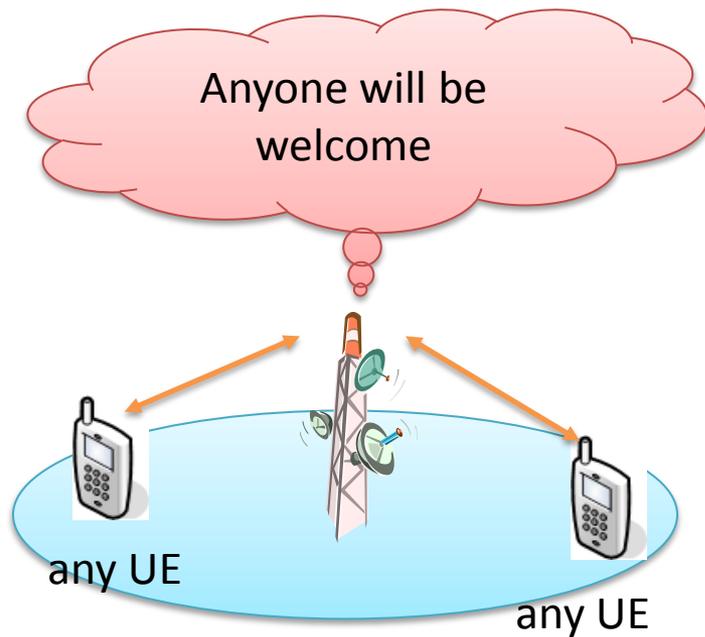
Enterprise Cells

See TS 22.220
for detailed scenarios

H(e)NB Hierachy



Closed Subscriber Group (CSG)



Normal Cell



CSG Cell

H(e)NB issues for RRC_IDLE

- ▶ How to identify CSG cell?
- ▶ How to prioritize CSG cell in cell reselection?
- ▶ How to know whether member or not?

Cell Reselection

H(e)NB Issues for RRC_CONNECTED

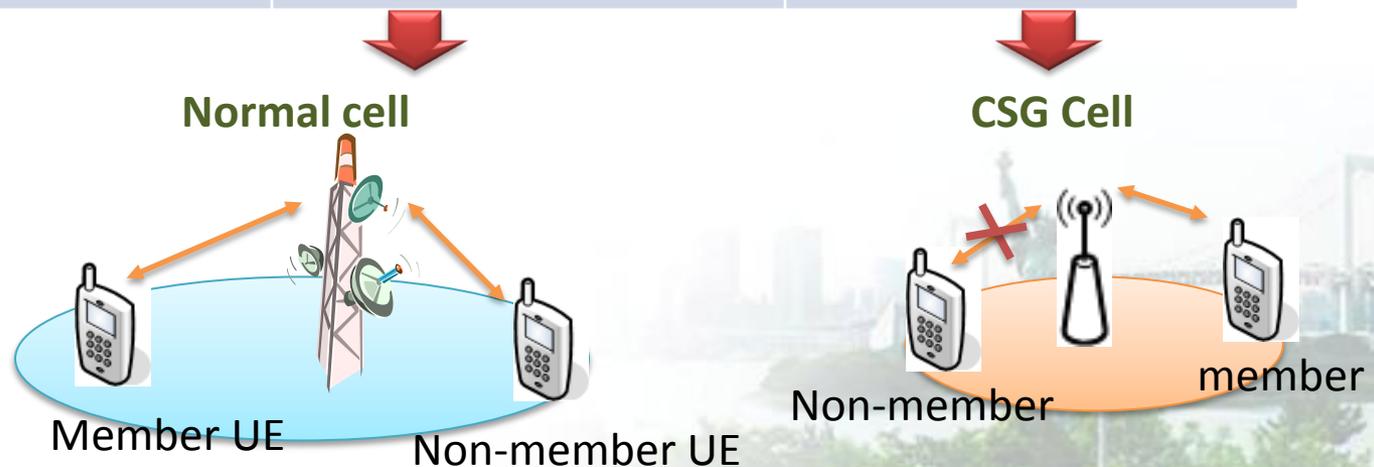
- ▶ How to identify CSG cell?
- ▶ How to be configured for measurement of CSG cells
- ▶ How to know whether member or not?
- ▶ How to resolve possible PCI confusion?

Handover

H(e)NB Access Mode

▶ Two Access Modes (Rel-8)

	H(e)NB Access Mode	
	<u>Open Mode</u>	<u>Closed Mode</u>
CSG member UE	Access	Preferential Access
CSG non-member UE	Access	No Access



System Information related to CSG cell

Macro also broadcasts CSG indicator



CSG Cell

CSG indicator

- 'I am a CSG cell or not'

CSG identity

- '*this* CSG is supported'

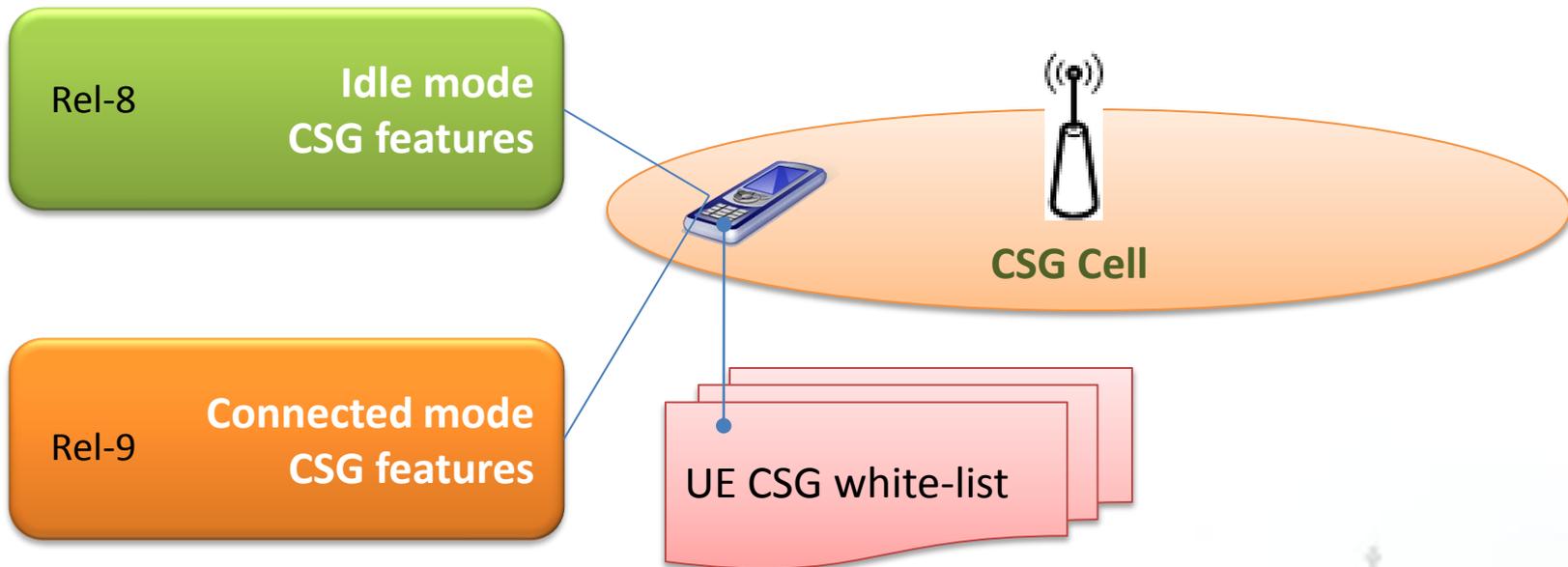
HNB name

- 'My name is THIS' : Human readable characters

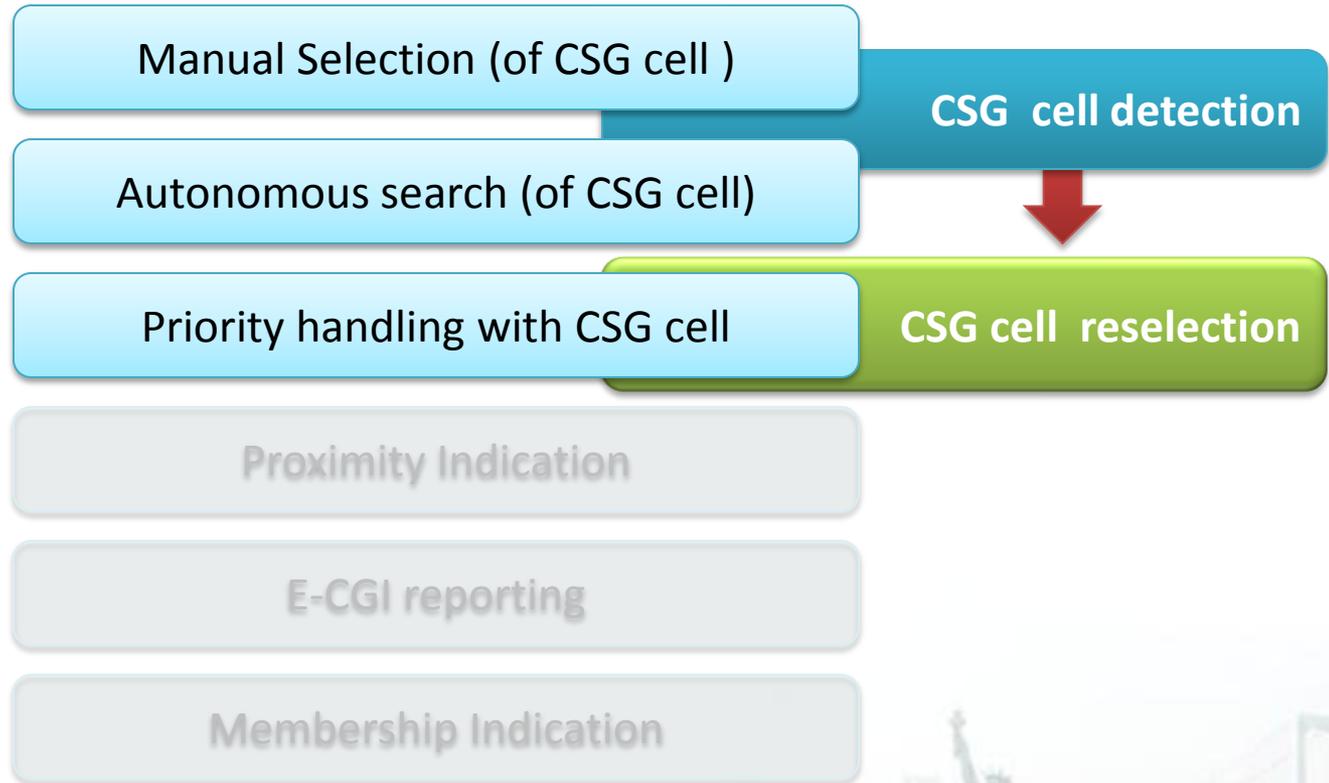
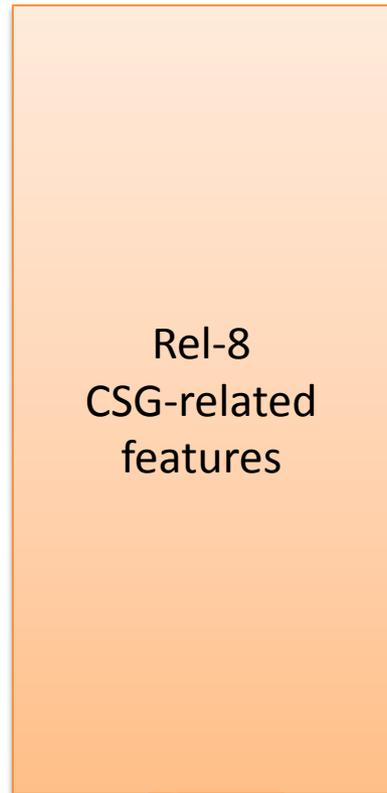
PCI range for CSC cells

- PCI range reserved for CSG cells

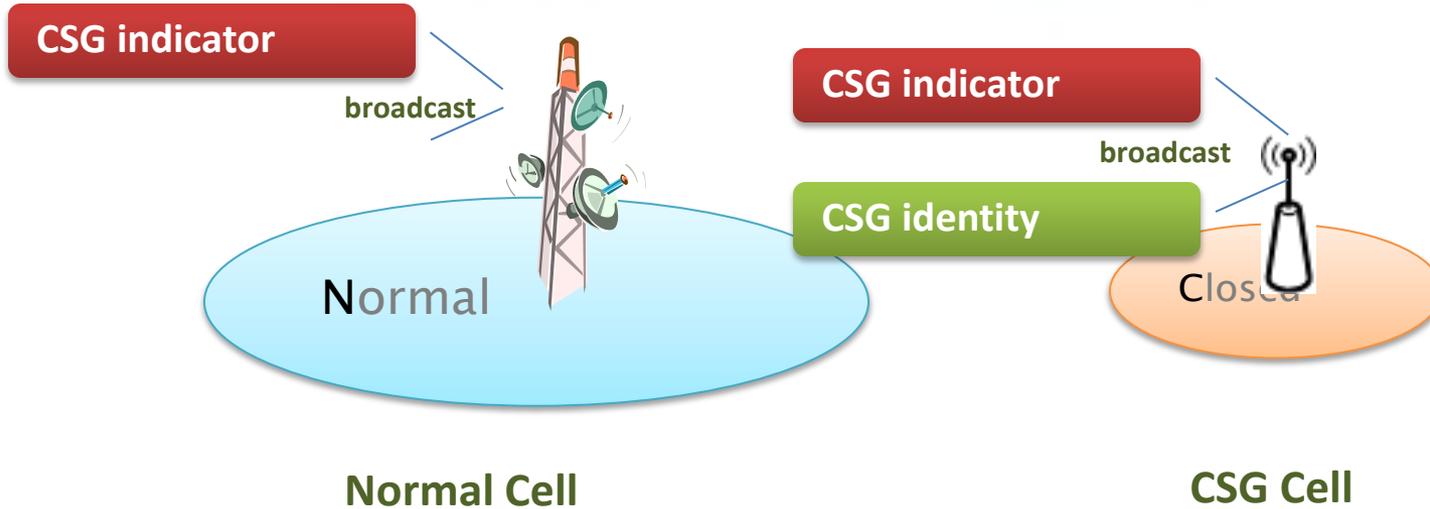
CSG capable UE



Rel-8 CSG capable UE



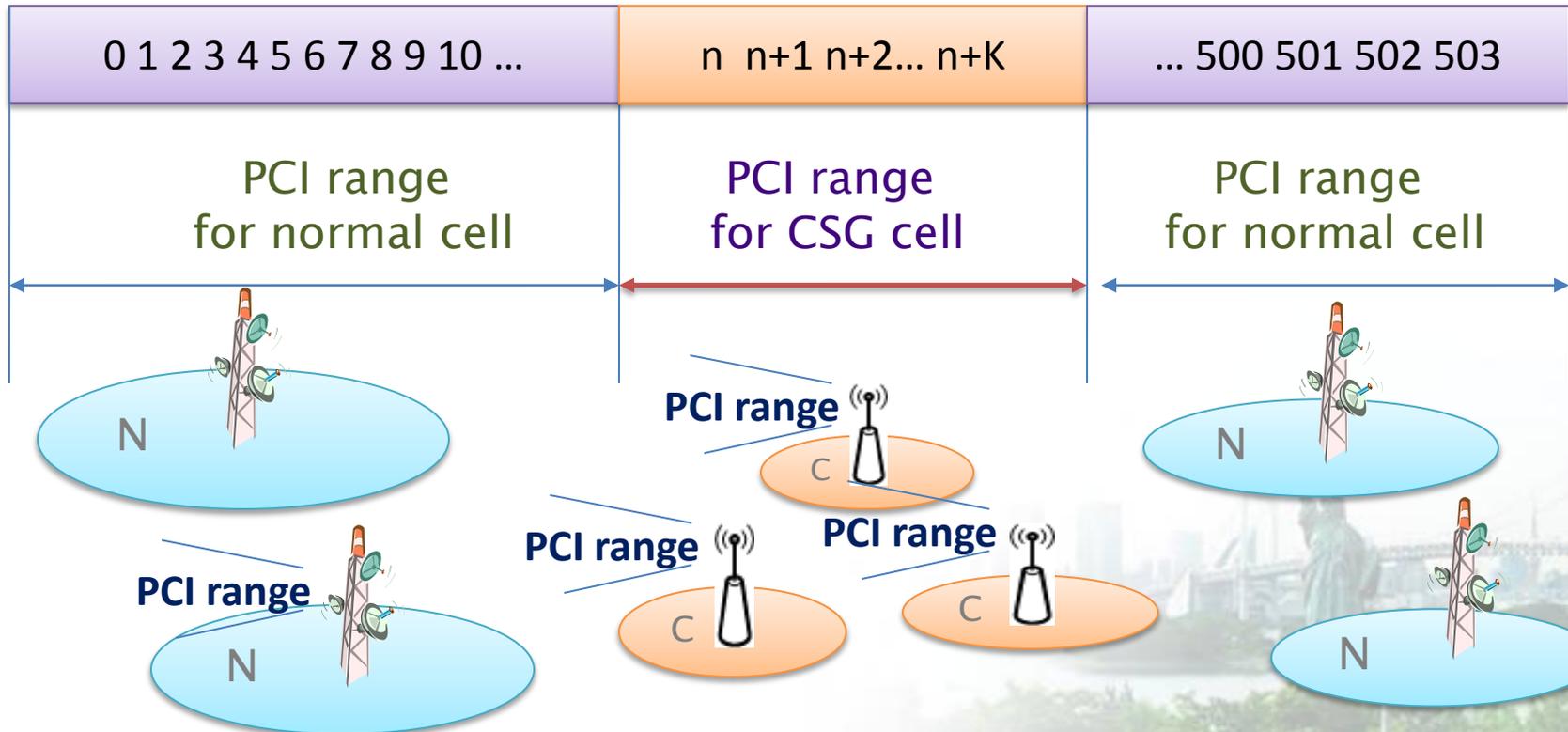
Cell Type Determination



	Normal Cell	CSG cell
CSG Indicator	FALSE	TRUE
CSG identity	Absent	Present

NW assumption on **PCIs** for CSG cells

- ▶ **Physical Cell Identity** for CSG cells are **reserved** by operators
- ▶ Reserved PCI range info for CSG cells is broadcast

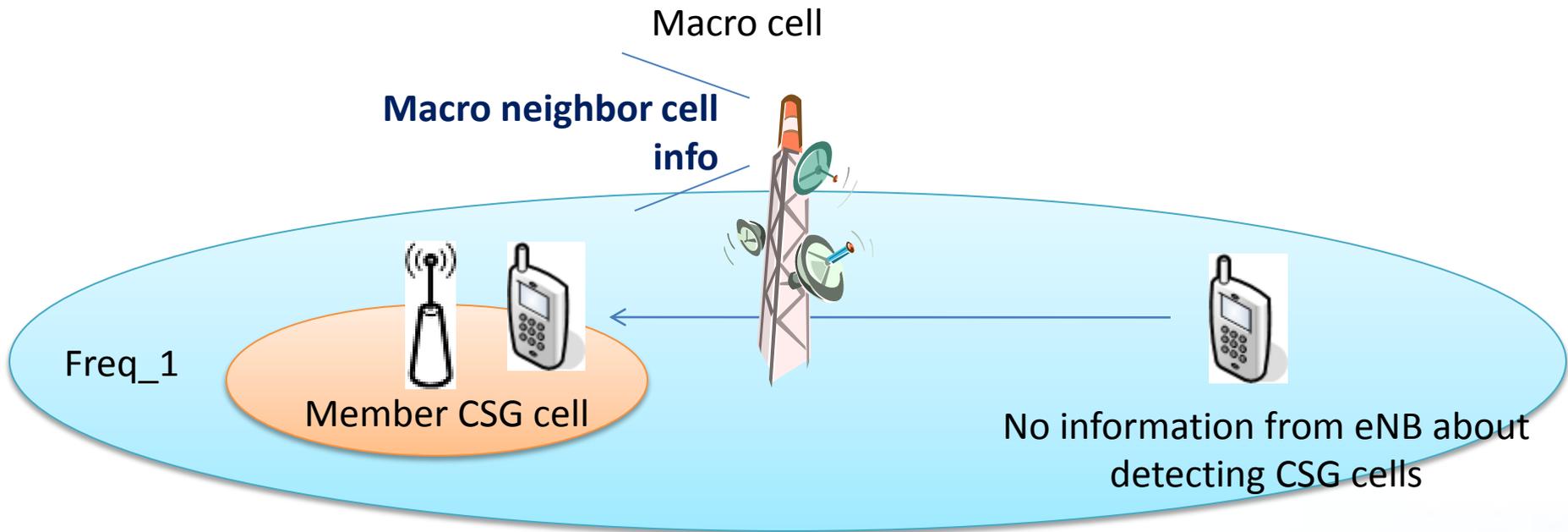


Benefit of Reserving PCIs for CSG cells?

- ▶ **Quick identification of CSG cell**
 - PCI of a cell can be rapidly identified
- ▶ **Measurement-related efficiency for non-CSG capable UE**
 - Unnecessary measurement/evaluation of CSG cells for reselection can be avoided
 - Unnecessary attempt to camp on CSG cell is avoided

Issue: CSG cell Detection

- ▶ No CSG cell information in Neighbor Cell List



How to detect member CSG cell?

Sol: Manual Selection+Autonomous Search

▶ Initial Visit

- Manual Selection of CSG cell

New



▶ Re-visit

- Autonomous search of the CSG cell

Re-visit



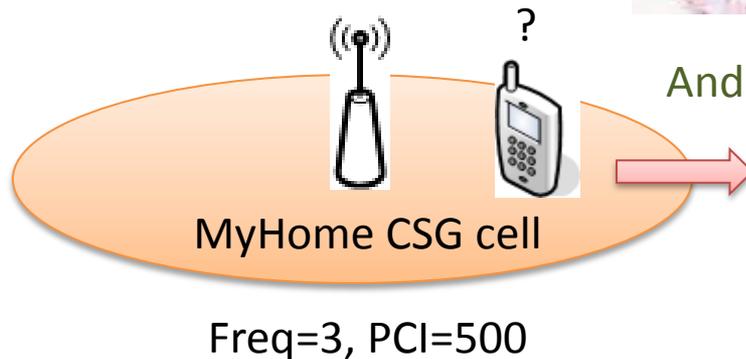
First Visit to Member CSG cell

▶ Manual Selection of CSG cell

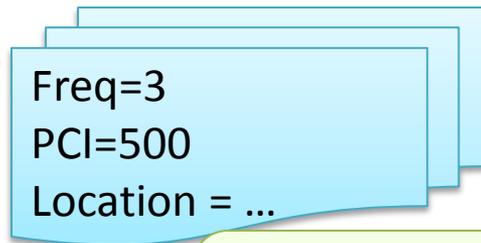


Macro A

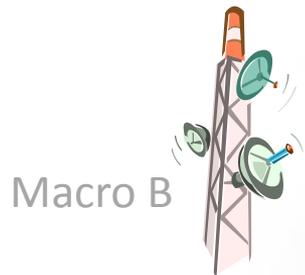
I need to manually select this CSG cell



And storing :



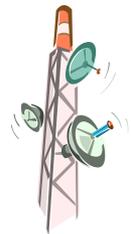
- Location
- Fingerprint of Neighbor Macro Cells; or
 - GNSS position; or



Macro B

Re-visit to Member CSG cell

▶ Autonomous Search



Macro A



MyHome CSG cell

Freq=3, PCI=500



By looking up:

Freq=3
PCI=500
Location = ...

Location

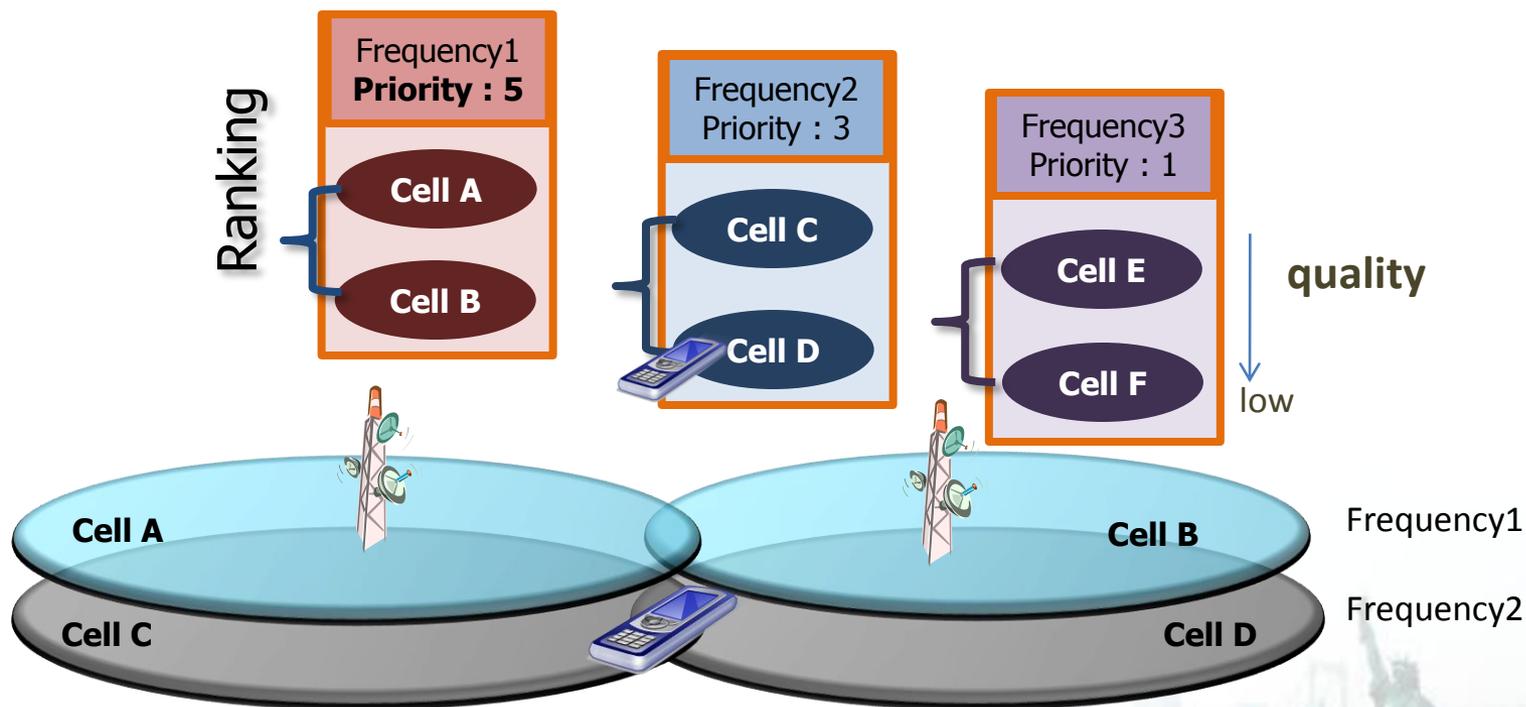
- Fingerprint of Neighbor Macro Cells; or
- GNSS position



Macro B

Issue: Priority vs CSG cell in Reselection

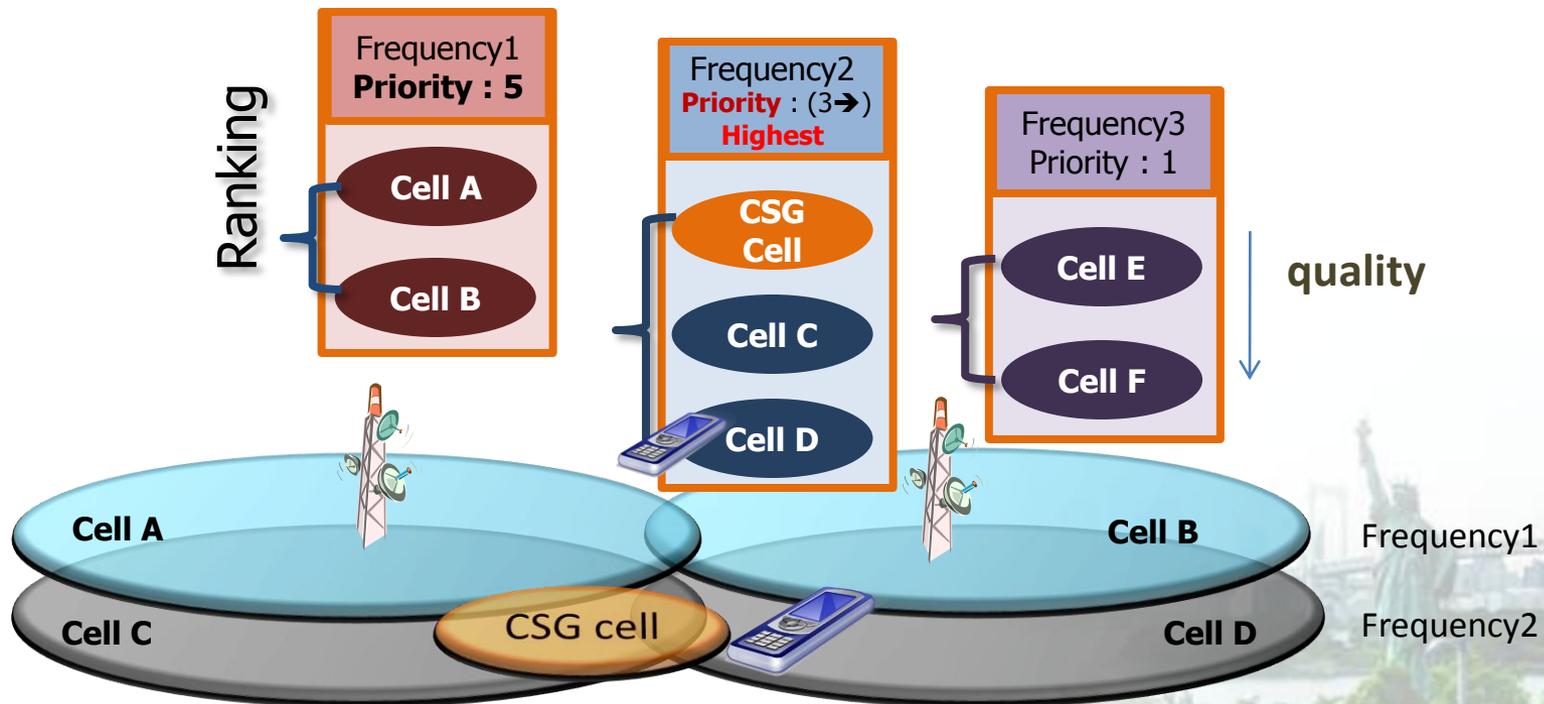
- ▶ In normal cell reselection, UE should reselect highest frequency priority cell



- ▶ **CSG cell may not be highest frequency priority cell**
 - UE will not reselect CSG cell having non-highest frequency priority

Sol: Highest Priority Assumption for CSG cell

- ▶ Highest frequency priority assumption for best ranked CSG cell
 - If CSG cell is best ranked on its frequency, its frequency priority should be assumed to be highest value by UE.



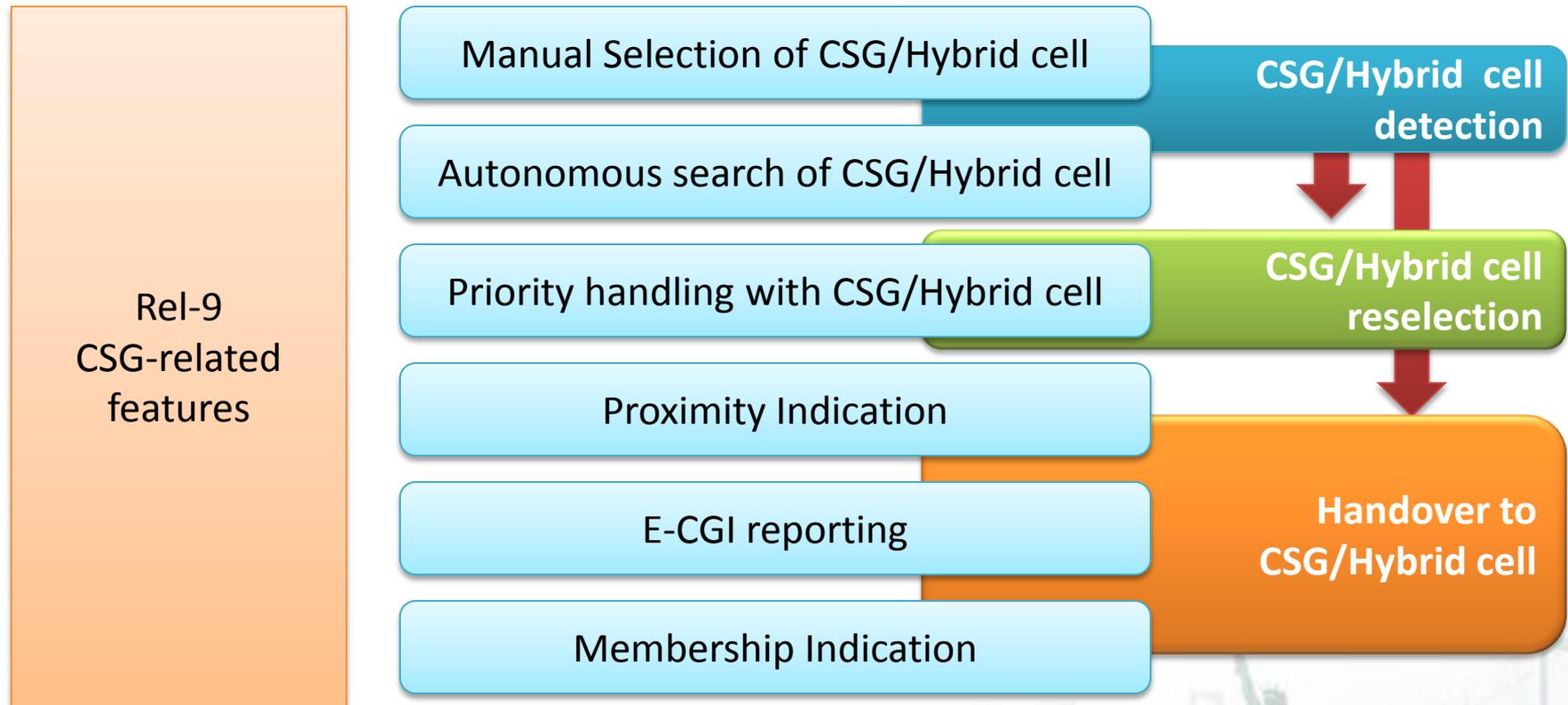
Intra frequency reselection with non-member CSG cell

- ▶ **Intra Frequency Reselection Indicator (IFRI)** Placed in SIB2
 - When camping on a cell is not allowed, reselection to other cell on the SAME frequency is allowed if IFRI is set to TRUE
 - To avoid inter-cell interference between cells on the same frequency

- ▶ **Normal Cell**
 - Normal behavior with IFRI

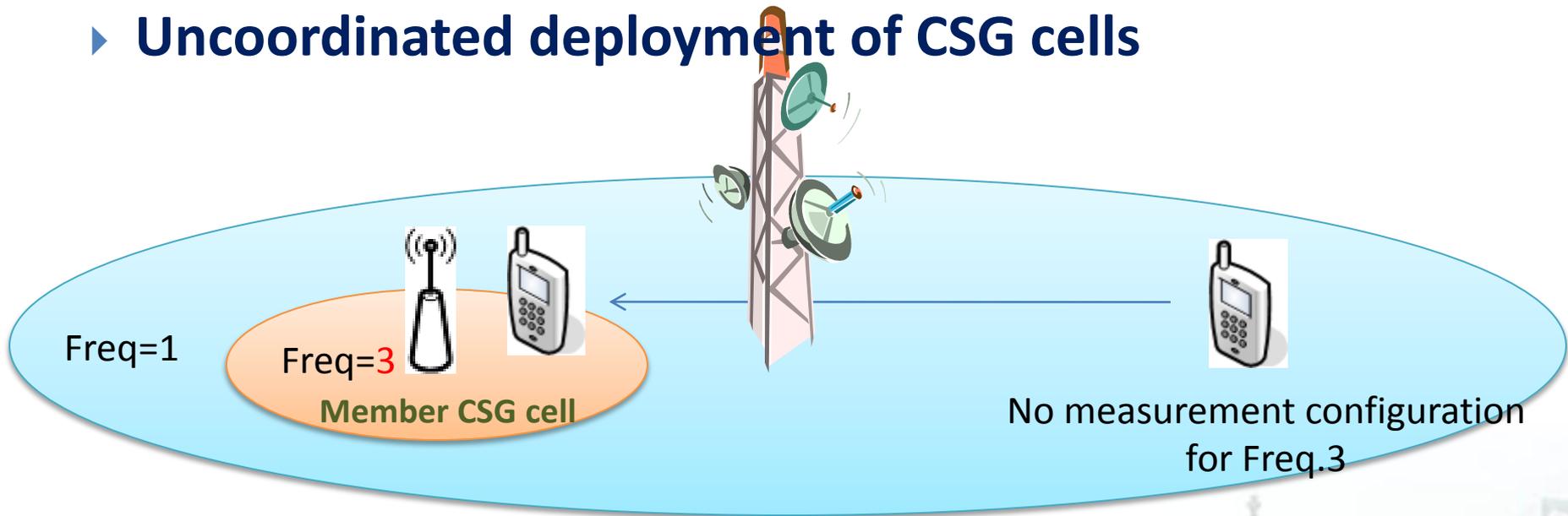
- ▶ **CSG cell**
 - UE can attempt intra-frequency reselection regardless of IFRI.
(Ignoring IFRI)

Rel-9 CSG capable UE



Issue: CSG cell Measurements

- ▶ Connected mode measurements are under eNB control
- ▶ Uncoordinated deployment of CSG cells

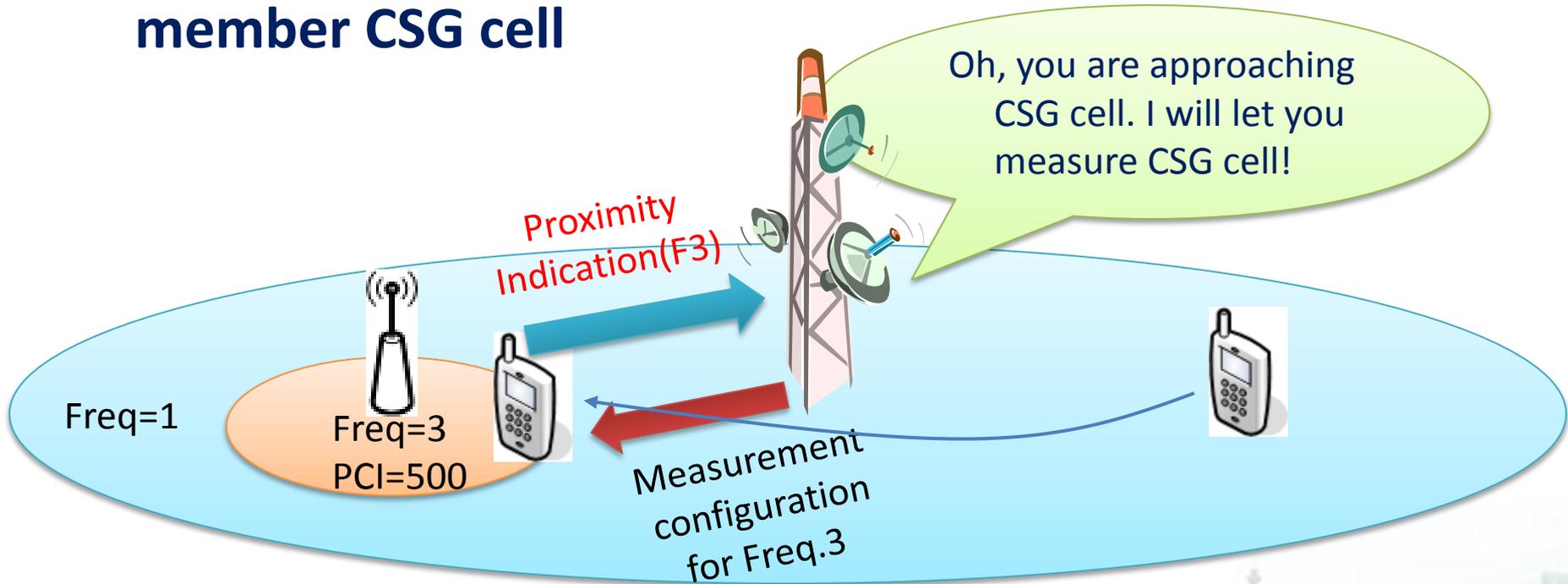


- ▶ No inter-frequency measurements on CSG layer(s)

How to detect member CSG cell?

Sol: Proximity Indication

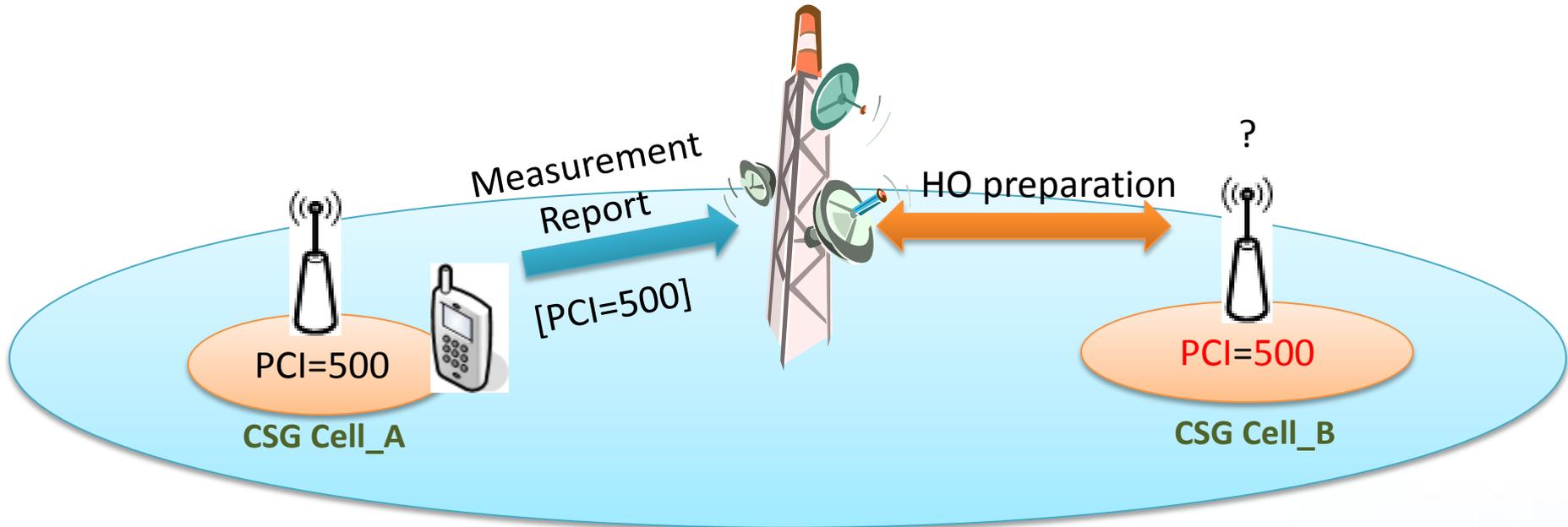
- ▶ UE sends Proximity indication in the vicinity of member CSG cell



Proximity trigger: Autonomous search!

Issue: Possible PCI confusion

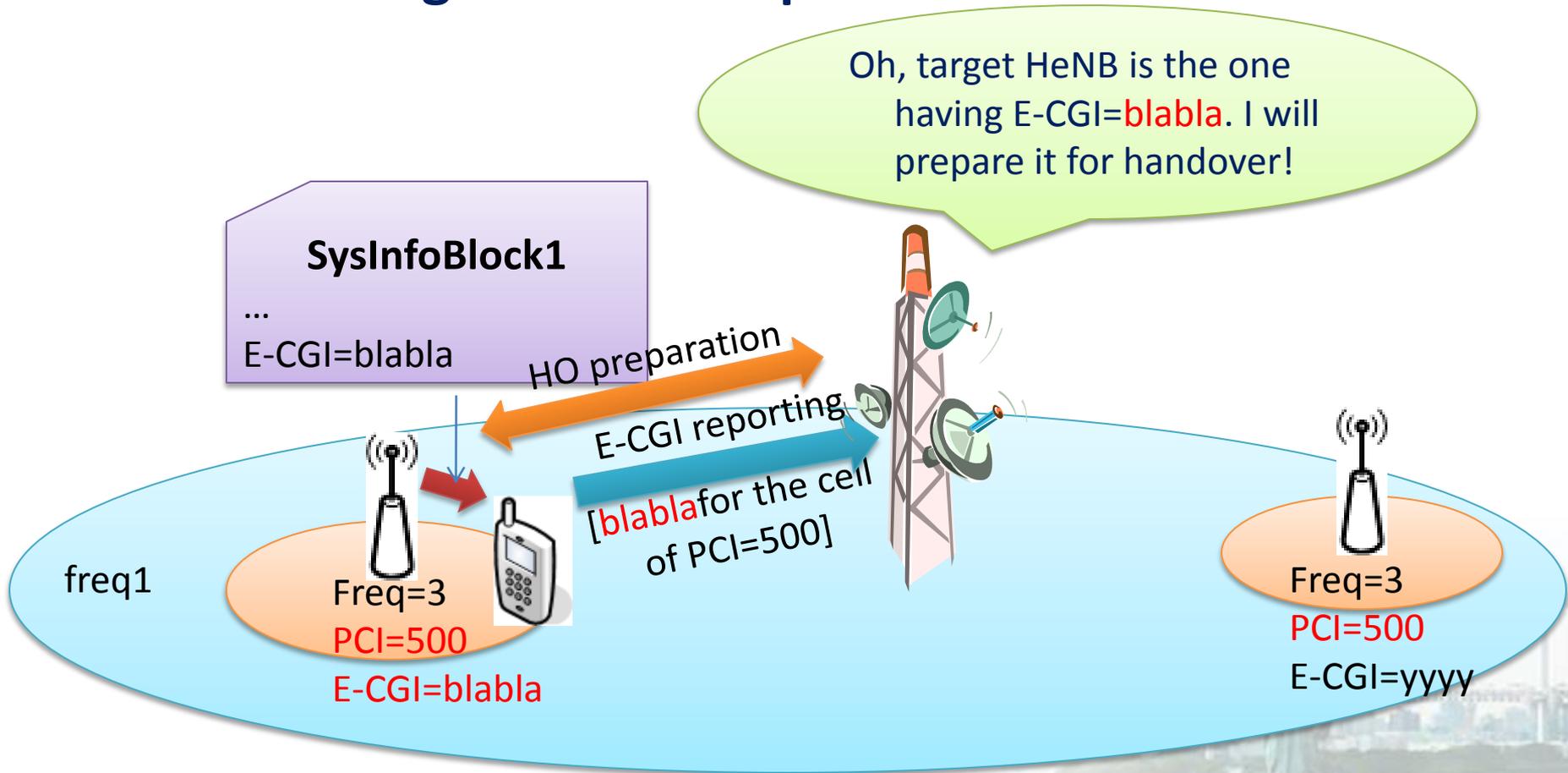
► Uncoordinated deployment of HeNBs



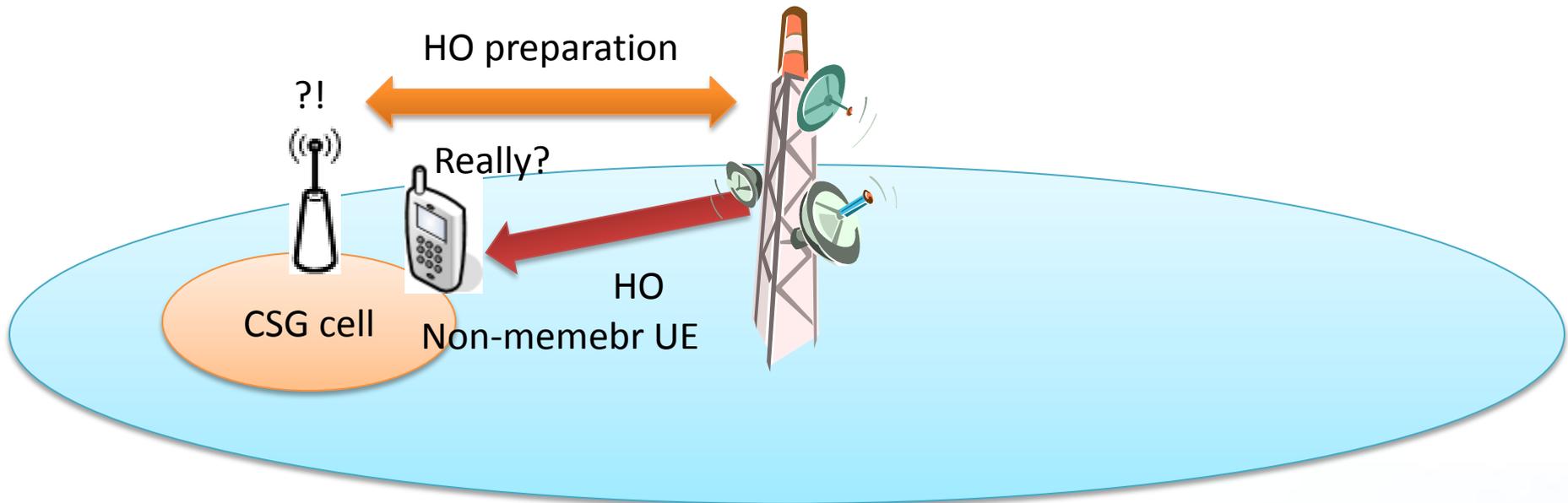
How can source eNB uniquely identify correct target HeNB?

Sol: E-CGI reporting

- ▶ E-CGI of target HeNB is reported



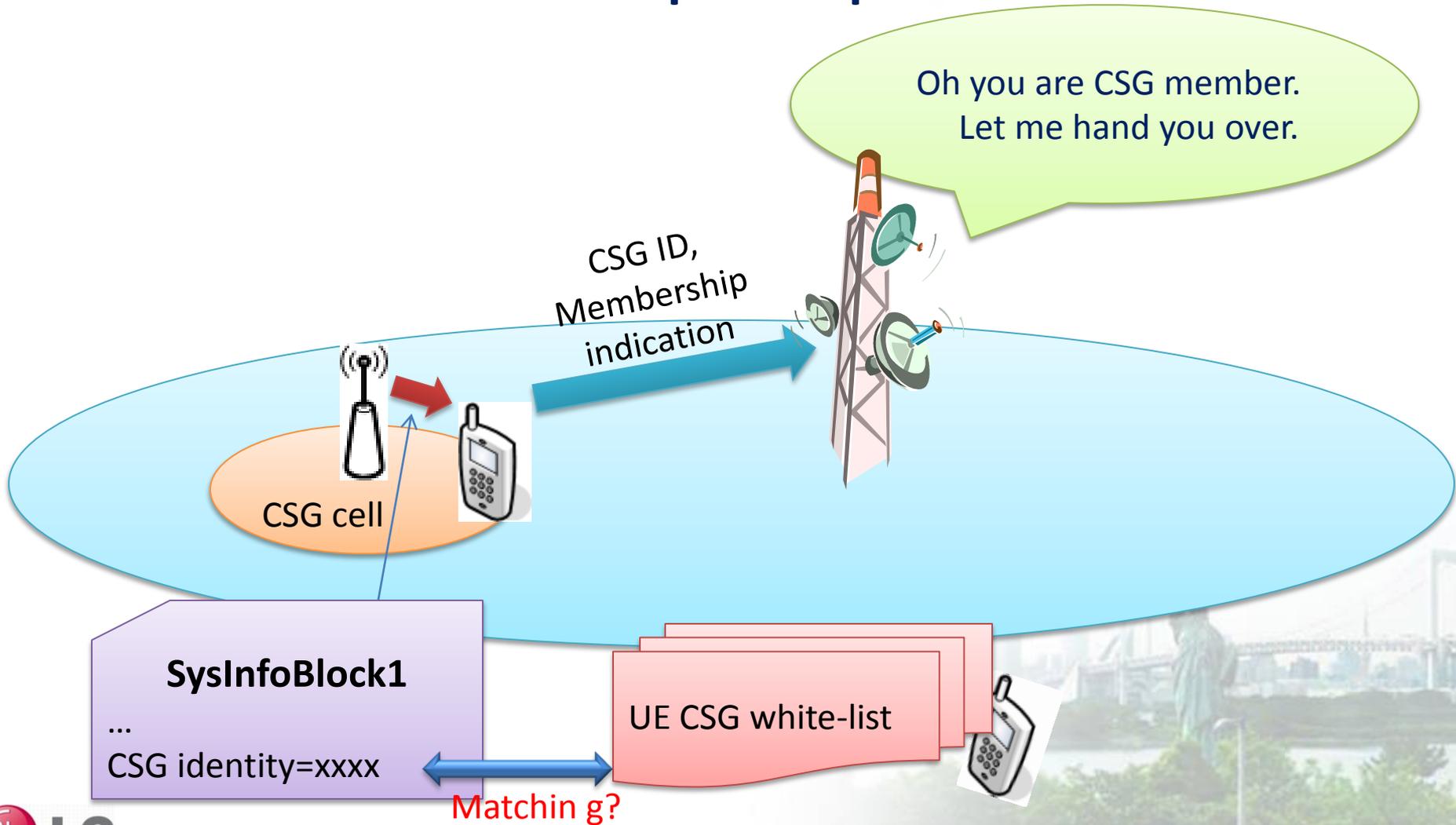
Issue: Exclusive Access for members



How to prevent access from non-member UE?

Sol: CSG ID/Membership indication

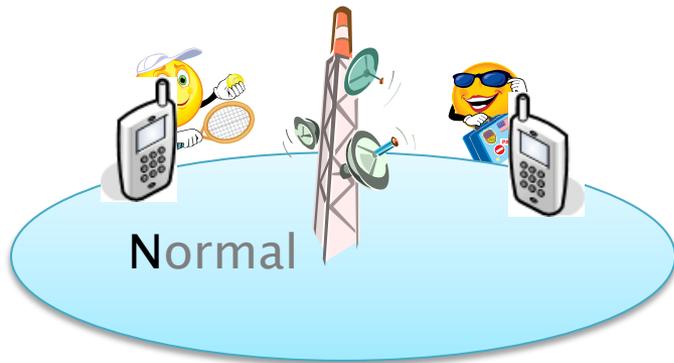
- ▶ CSG ID and Membership are reported



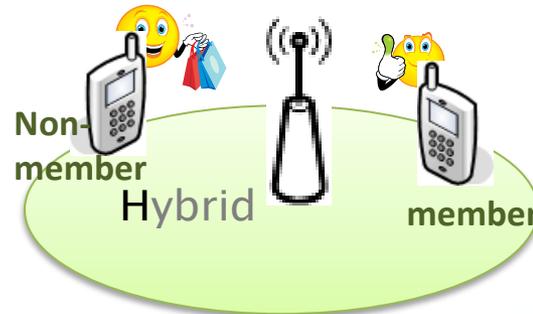
Cell type determination

▶ New Access Mode

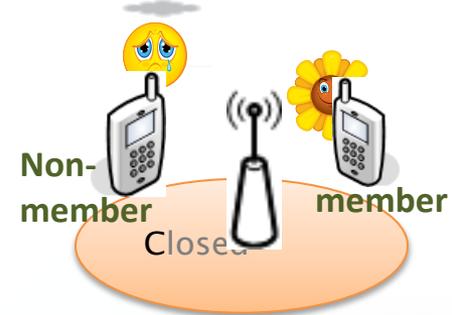
	H(e)NB Access Mode		
	Open mode	Hybrid mode	Closed mode
CSG member	Access	Preferential Access	Preferential Access
CSG non-member	Access	Access	No Access



Normal Cell



Hybrid Cell

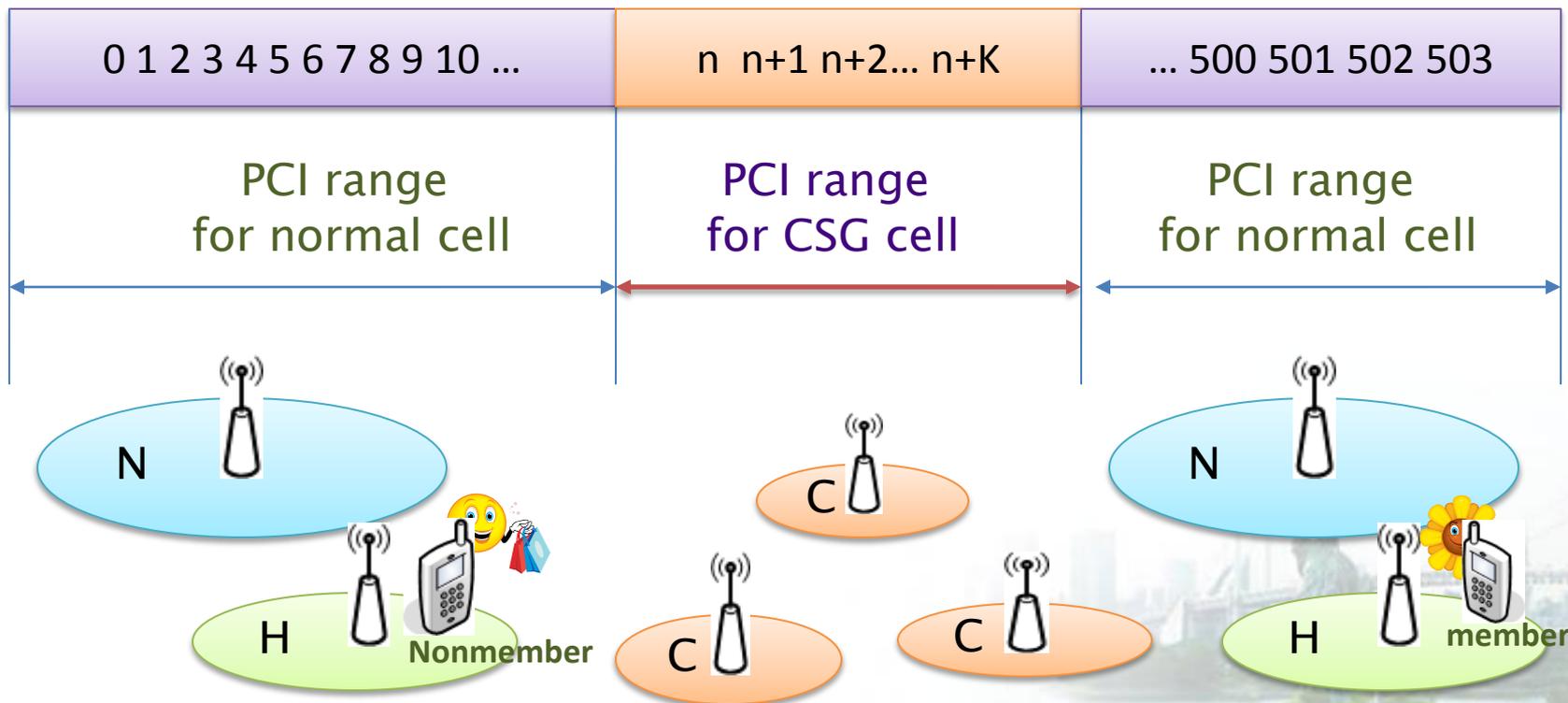


CSG Cell

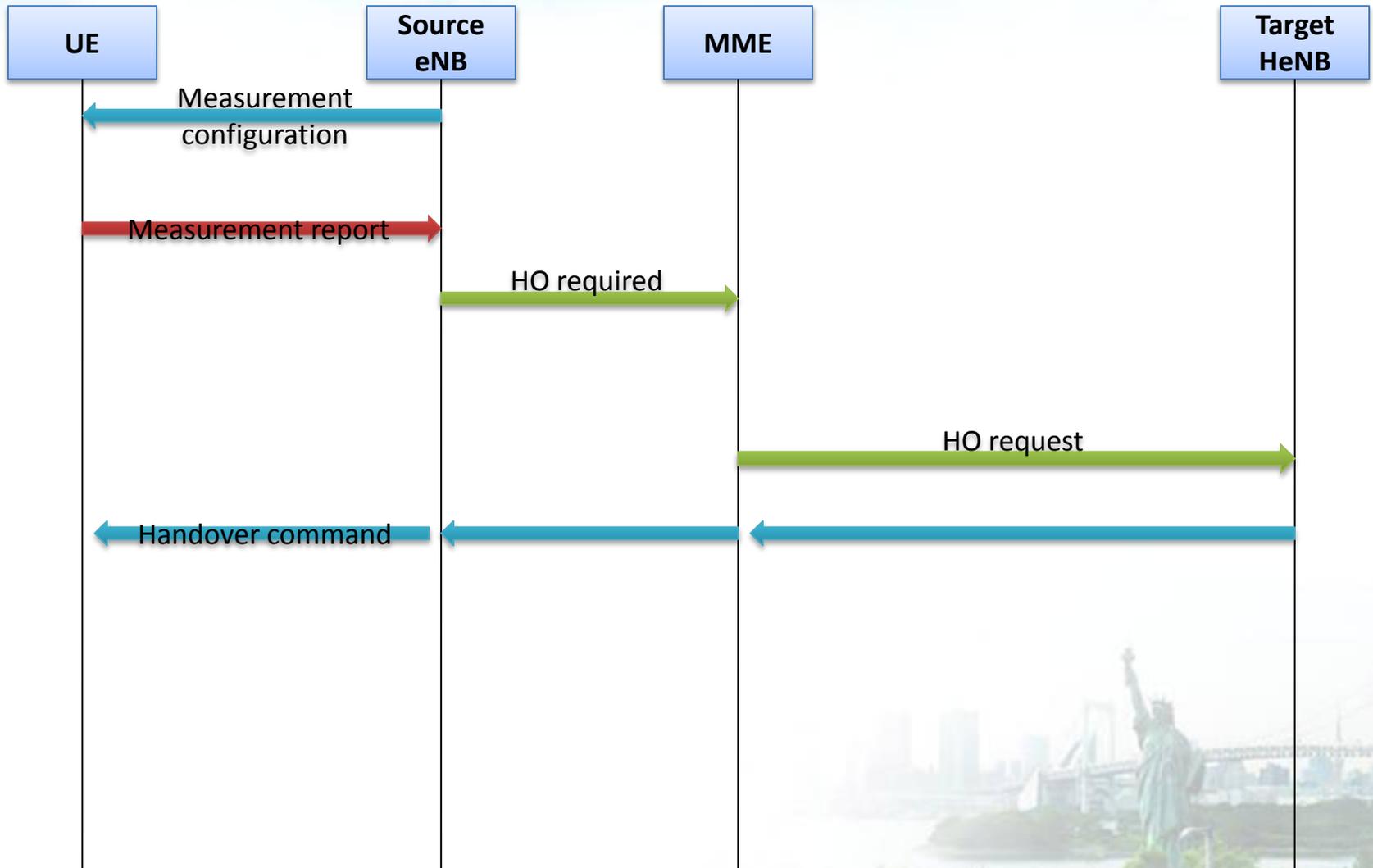
	Normal Cell	Hybrid Cell	CSG cell
CSG Indicator	FALSE	FALSE	TRUE
CSG identity	Absent	Present	Present

PCI of Hybrid Cell

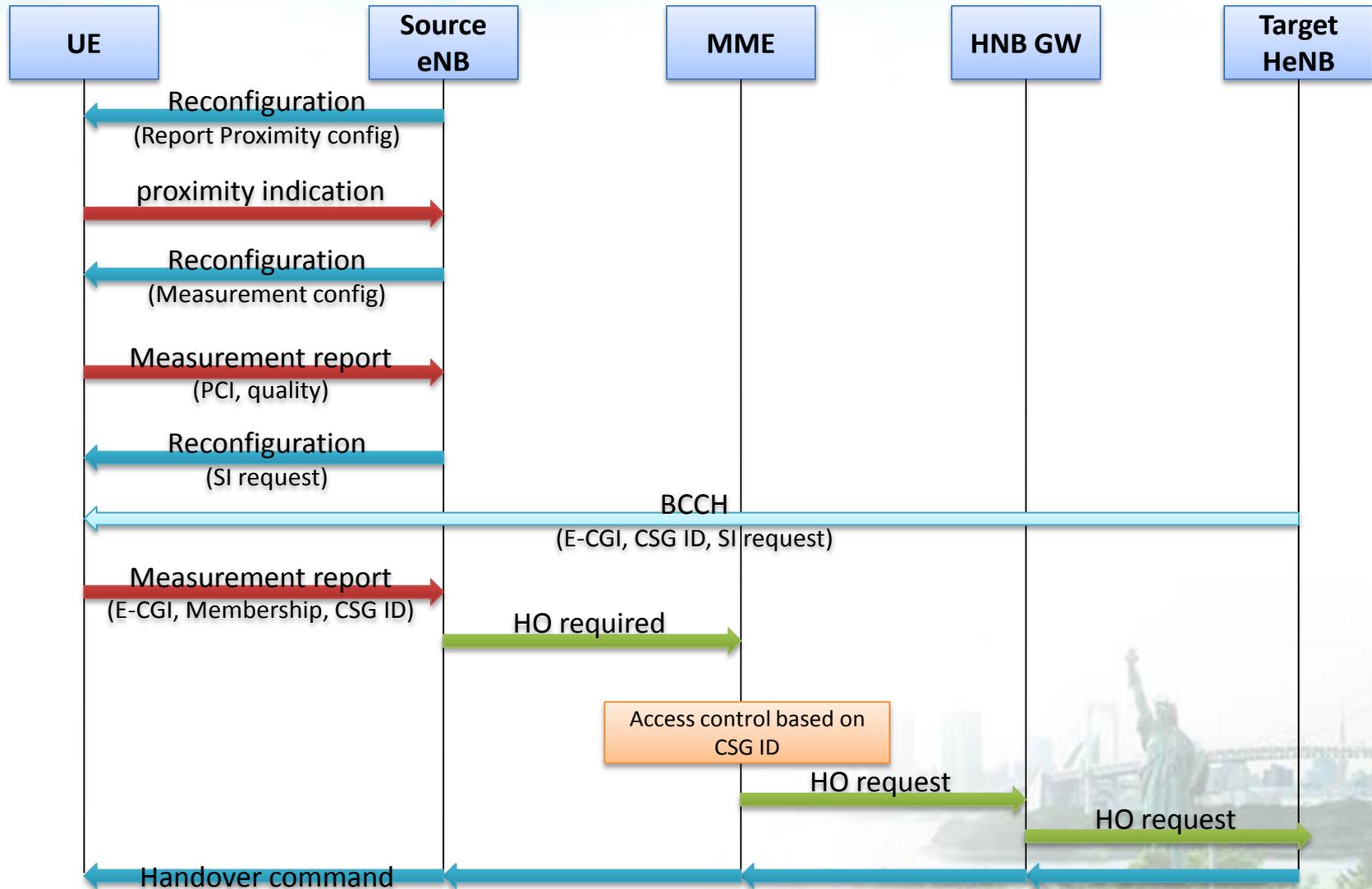
- ▶ PCI of Hybrid cell is outside the PCI range for CSG cells



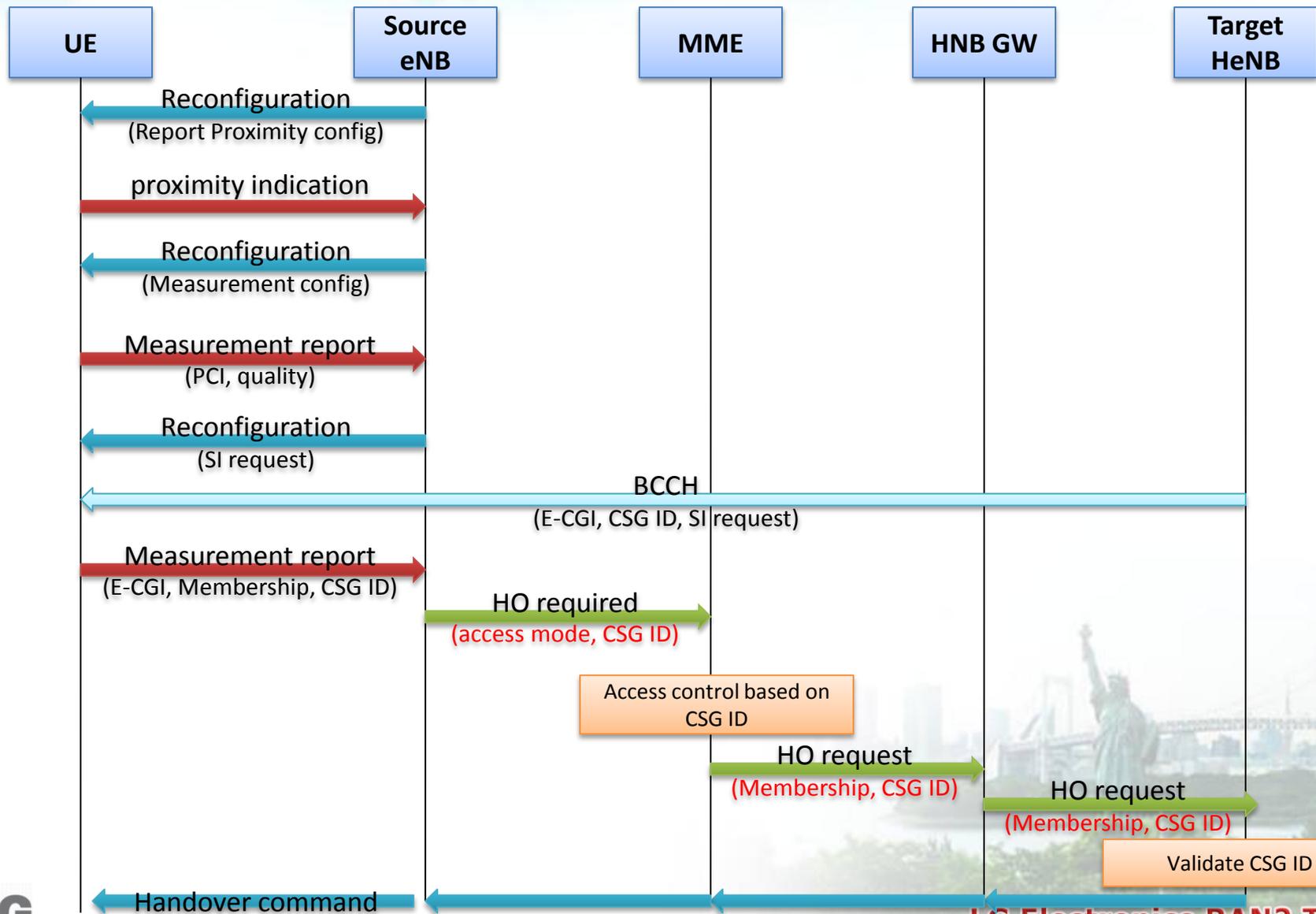
Handover to Normal cell



Handover to CSG cell



Handover to Hybrid cell



Annex

▶ CSG support

- CSG support for RRC_IDLE
- CSG support for RRC_CONNECTED

CSG support for RRC_IDLE

▶ **Mandatory**

- Identifying whether a cell is CSG or not
- Ignoring CSG cells in cell selection/reselection

▶ **Non-mandatory** ← May not implemented in early Rel-8 UEs

- Manual CSG selection
- Autonomous CSG search
- Implicit priority handling for cell reselection with CSG cells

Capability support for non-mandatory features are not signalled by “feature group indicator” since this is idle mode operation

CSG support for RRC_CONNECTED

▶ Proximity Indication

- Intra-frequency
- Inter-frequency

▶ SI acquisition

- Intra-frequency
- Inter-frequency

Decision on capability support of these is pending.

(either mandatory with capability bit used as IOT bit signaling or optional)