3GPP LTE Home (e)NB

(2010. 10.20)

SungHoon Jung: sunghoon.jung@lge.com

LG Electronics RAN2 Team

lgeran2.tistory.com
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
H(e)NB Hierachy

MME / S-GW

MME / S-GW

S1

S1

X2

E-UTRAN

HeNB

HeNB

HeNB

HeNB

HeNB GW

S1

S1

S1

S1

S1

S1

S1

E-UTRAN
Closed Subscriber Group (CSG)

Anyone will be welcome

Only CSG member is allowed

Normal Cell

CSG Cell
How to identify CSG cell?

How to prioritize CSG cell in cell reselection?

How to know whether member or not?
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)

<table>
<thead>
<tr>
<th></th>
<th>H(e)NB Access Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Open Mode</td>
</tr>
<tr>
<td>CSG member UE</td>
<td>Access</td>
</tr>
<tr>
<td>CSG non-member UE</td>
<td>Access</td>
</tr>
</tbody>
</table>

### Diagram:

- **Normal cell**
  - Member UE
  - Non-member UE

- **CSG Cell**
  - Non-member

---

*LG Electronics RAN2 Team*
System Information related to 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

Macro also broadcasts CSG indicator
CSG capable UE

Rel-8
Idle mode
CSG features

CSG Cell

Rel-9
Connected mode
CSG features

UE CSG white-list
Rel-8 CSG capable UE

- Manual Selection (of CSG cell)
- Autonomous search (of CSG cell)
- Priority handling with CSG cell
- Proximity Indication
- E-CGI reporting
- Membership Indication

Rel-8 CSG-related features

CSG cell detection

CSG cell reselection
Cell Type Determination

<table>
<thead>
<tr>
<th></th>
<th>Normal Cell</th>
<th>CSG cell</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSG Indicator</td>
<td>FALSE</td>
<td>TRUE</td>
</tr>
<tr>
<td>CSG identity</td>
<td>Absent</td>
<td>Present</td>
</tr>
</tbody>
</table>
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

<table>
<thead>
<tr>
<th>0 1 2 3 4 5 6 7 8 9 10 ...</th>
<th>n  n+1 n+2... n+K</th>
<th>... 500 501 502 503</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCI range for normal cell</td>
<td>PCI range for CSG cell</td>
<td>PCI range for normal cell</td>
</tr>
</tbody>
</table>

![Diagram showing the allocation of PCI ranges for normal and CSG cells](image-url)
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

- **Re-visit**
  - Autonomous search of the CSG cell
First Visit to Member CSG cell

- **Manual Selection of CSG cell**

  I need to manually select this CSG cell

  And storing:

  - **Freq=3, PCI=500**
  - Location = ...

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

Macro A

MyHome CSG cell

Freq=3, PCI=500

Macro B
Re-visit to Member CSG cell

Autonomous Search

Freq=3, PCI=500

MyHome CSG cell
Freq=3, PCI=500

Location = ...

By looking up:

Freq=3
PCI=500
Location = ...

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

Macro A

This is the cell I know!

Macro B
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)**
  - 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

- Manual Selection of CSG/Hybrid cell
- Autonomous search of CSG/Hybrid cell
- Priority handling with CSG/Hybrid cell
- Proximity Indication
- E-CGI reporting
- Membership Indication

Rel-9 CSG-related features

LG Electronics RAN2 Team
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

Oh, you are approaching CSG cell. I will let you measure CSG cell!

Freq=1

Freq=3
PCI=500

Measurement configuration for Freq.3

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

Oh, target HeNB is the one having E-CGI=blabla. I will prepare it for handover!

SysInfoBlock1
...
E-CGI=blabla

freq1
Freq=3
PCI=500
E-CGI=blabla

FHO preparation

E-CGI reporting
[blabla for the cell of PCI=500]

Freq=3
PCI=500
E-CGI=yyyy

LG Electronics RAN2 Team
Issue: Exclusive Access for members

How to prevent access from non-member UE?
Sol: CSG ID/Membership indication

- CSG ID and Membership are reported

SysInfoBlock1
... CSG identity=xxxx

Oh you are CSG member. Let me hand you over.
Cell type determination

- **New Access Mode**

<table>
<thead>
<tr>
<th></th>
<th>H(e)NB Access Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Open mode</td>
</tr>
<tr>
<td>CSG member</td>
<td>Access</td>
</tr>
<tr>
<td>CSG non-member</td>
<td>Access</td>
</tr>
</tbody>
</table>

- **Normal Cell**
- **Hybrid Cell**
- **CSG Cell**

<table>
<thead>
<tr>
<th></th>
<th>Normal Cell</th>
<th>Hybrid Cell</th>
<th>CSG cell</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSG Indicator</td>
<td>FALSE</td>
<td>FALSE</td>
<td>TRUE</td>
</tr>
<tr>
<td>CSG identity</td>
<td>Absent</td>
<td>Present</td>
<td>Present</td>
</tr>
</tbody>
</table>

LG Electronics RAN2 Team
PCI of Hybrid Cell

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

<table>
<thead>
<tr>
<th>PCI range for normal cell</th>
<th>PCI range for CSG cell</th>
<th>PCI range for normal cell</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 1 2 3 4 5 6 7 8 9 10...</td>
<td>n n+1 n+2... n+K</td>
<td>... 500 501 502 503</td>
</tr>
</tbody>
</table>

N Nonmember
H member

LG Electronics RAN2 Team
**Handover to Normal cell**

1. **UE** → **Source eNB**
   - Measurement configuration
   - Measurement report

2. **Source eNB** → **MME**
   - HO required

3. **MME** → **Target HeNB**
   - HO request

4. **Target HeNB** → **UE**
   - Handover command
Handover to CSG cell

- **UE**
  - Reconfiguration (Report Proximity config)
  - Proximity indication

- **Source eNB**
  - Reconfiguration (Measurement config)
  - Measurement report (PCI, quality)
  - Reconfiguration (SI request)

- **MME**
  - BCCH (E-CGI, CSG ID, SI request)

- **HNB GW**
  - HO required

- **Target HeNB**
  - Access control based on CSG ID
  - HO request

- **Handover command**
Handover to Hybrid cell

- UE
  - Reconfiguration (Report Proximity config)
  - Proximity indication
  - Reconfiguration (Measurement config)
  - Measurement report (PCI, quality)
  - Reconfiguration (SI request)
  - Measurement report (E-CGI, Membership, CSG ID)

- Source eNB
  - BCCH (E-CGI, CSG ID, SI request)

- MME
  - HO required (access mode, CSG ID)
  - Access control based on CSG ID
  - HO request (Membership, CSG ID)

- HNB GW
  - Validate CSG ID

- Target HeNB
  - HO request (Membership, CSG ID)
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**
  - 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)