

Load-Based Handover

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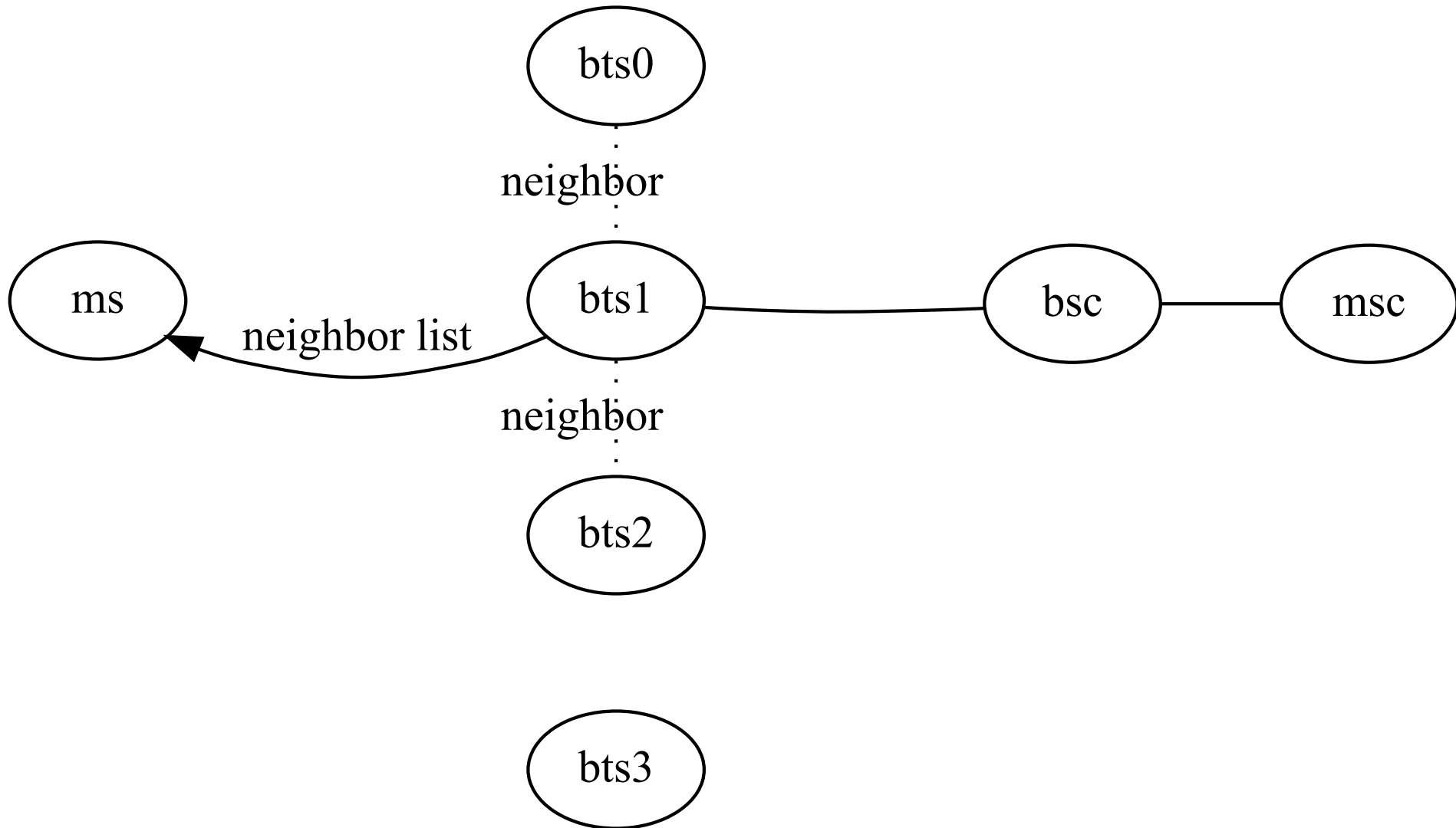
slides

<http://people.osmocom.org/neels/2018>

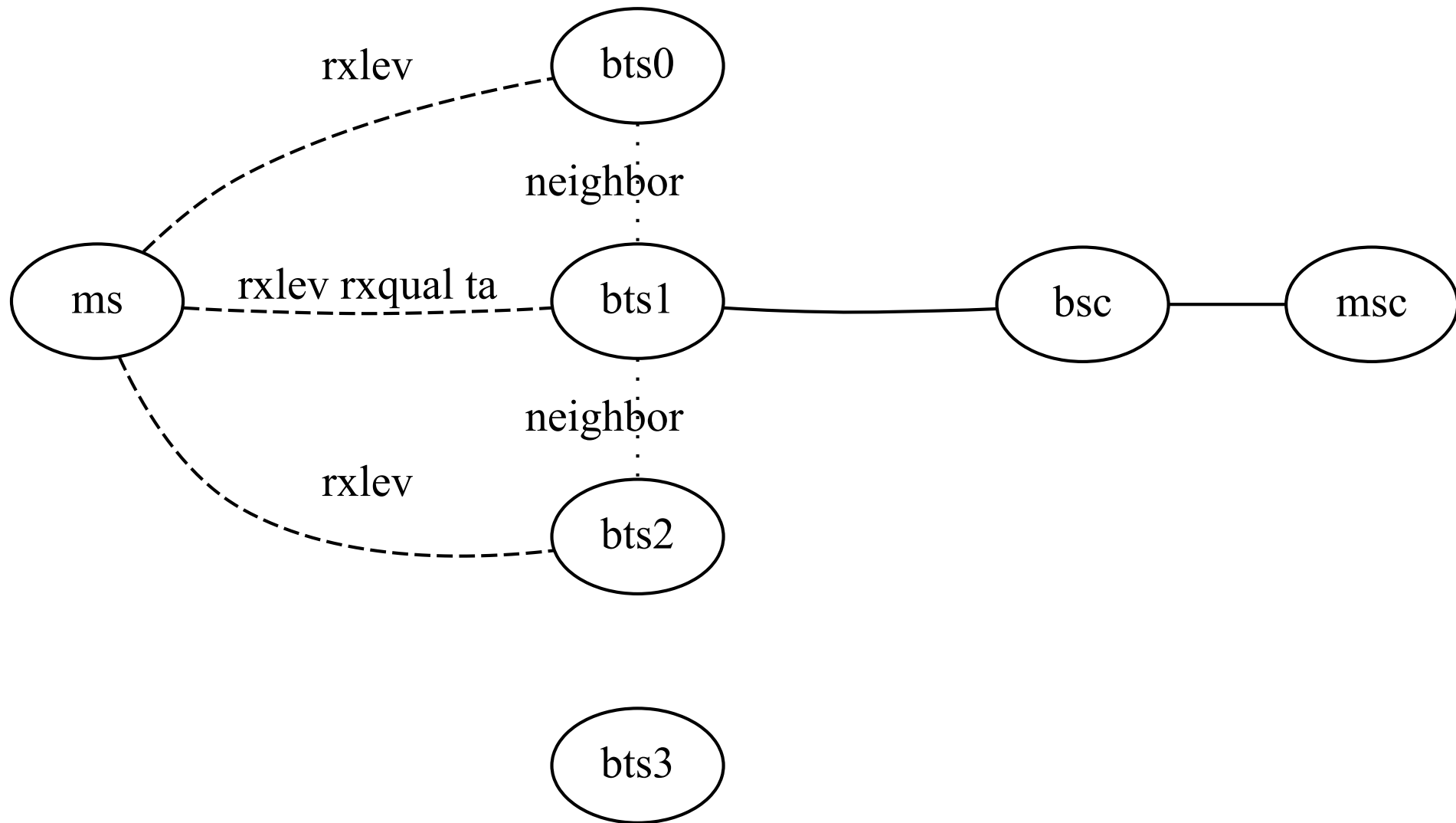
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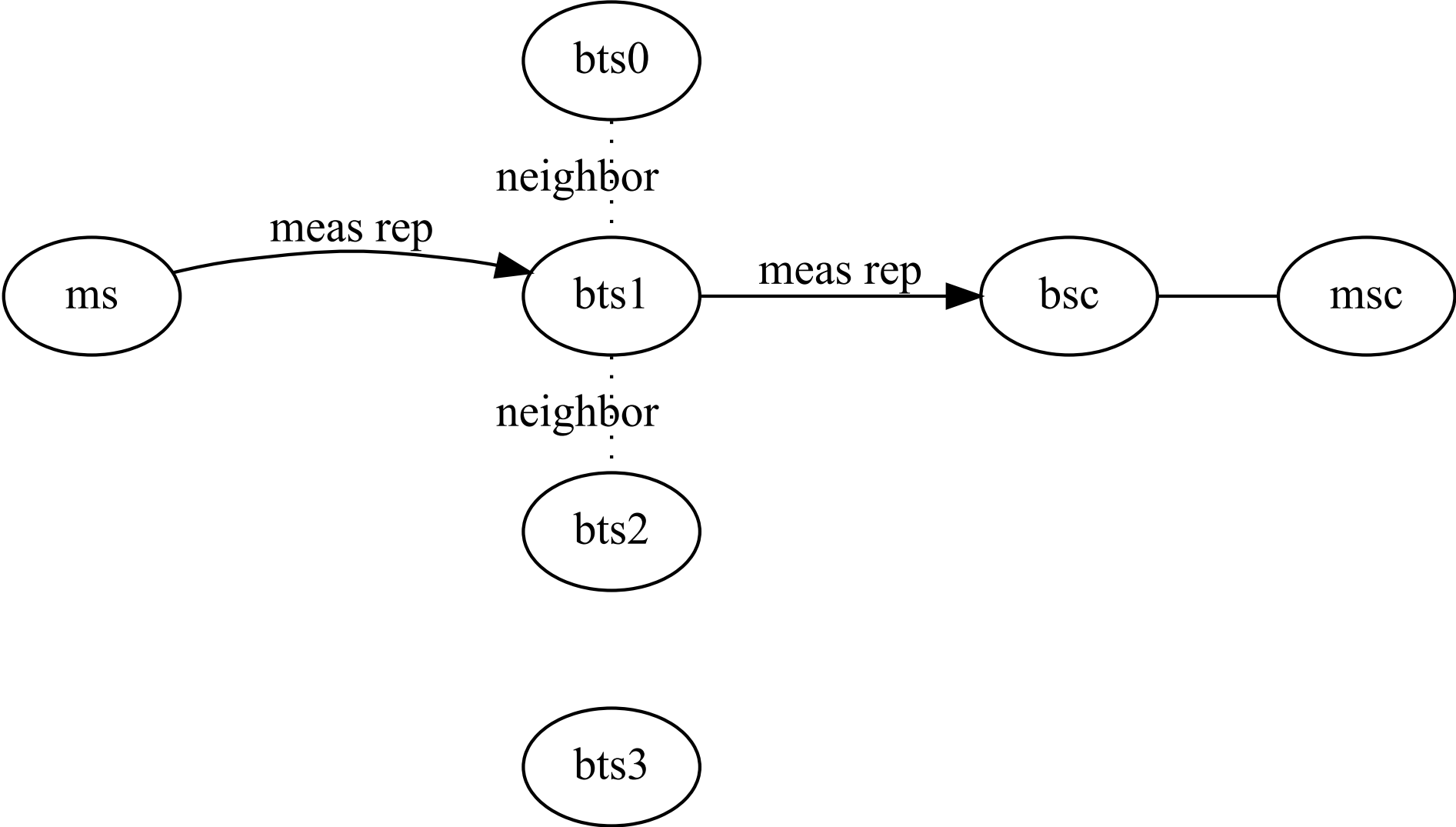
handover, simplified



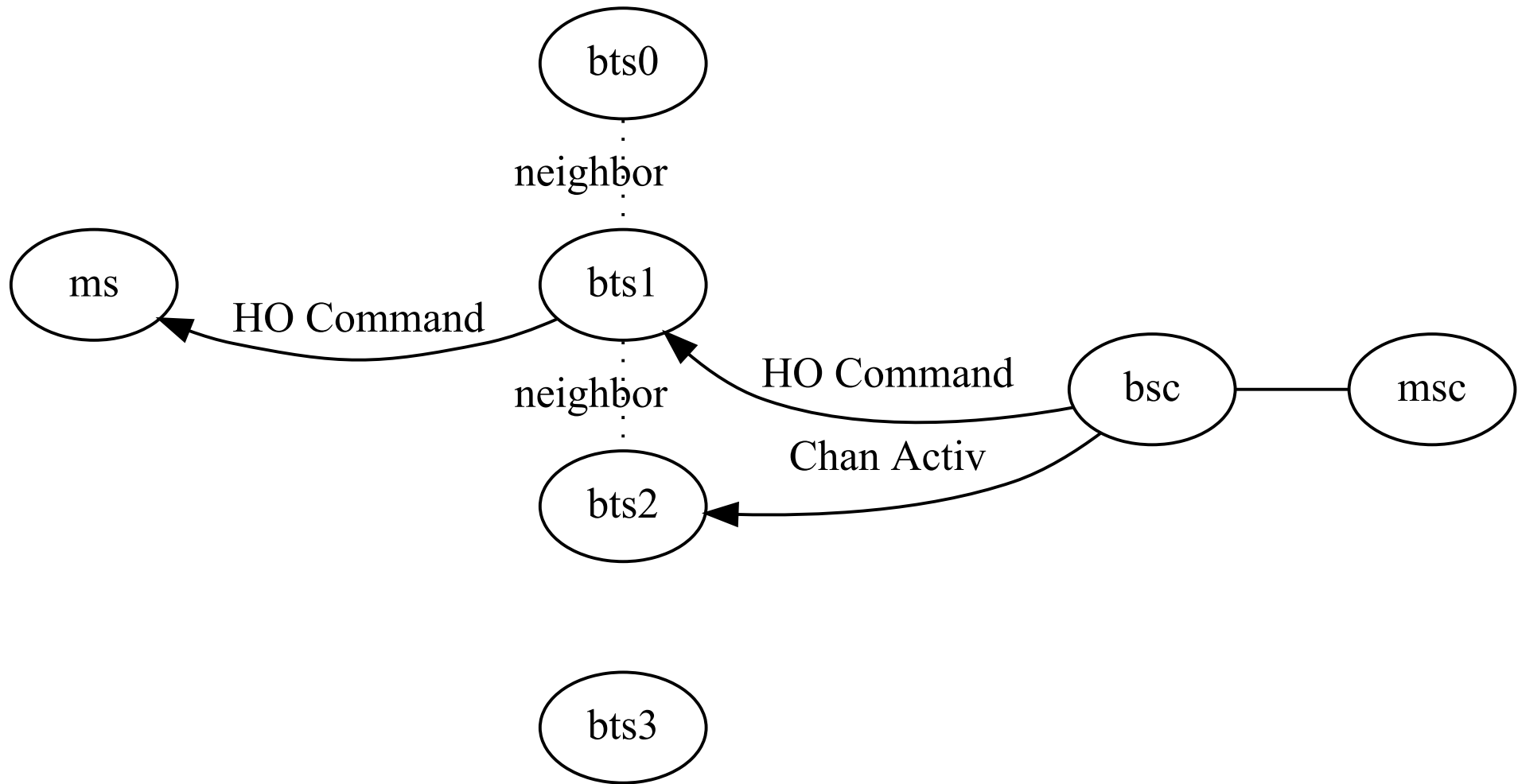
handover, simplified



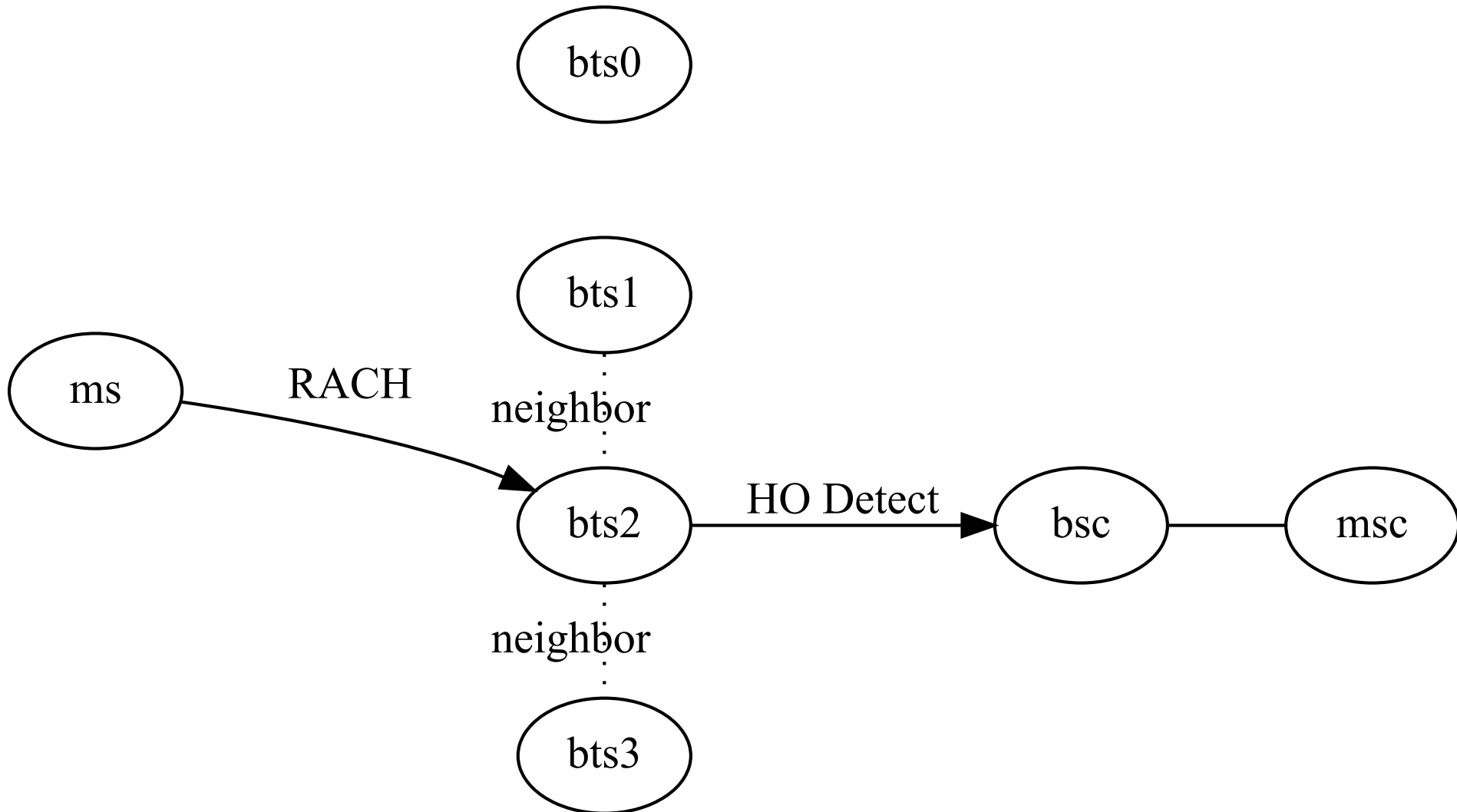
handover, simplified



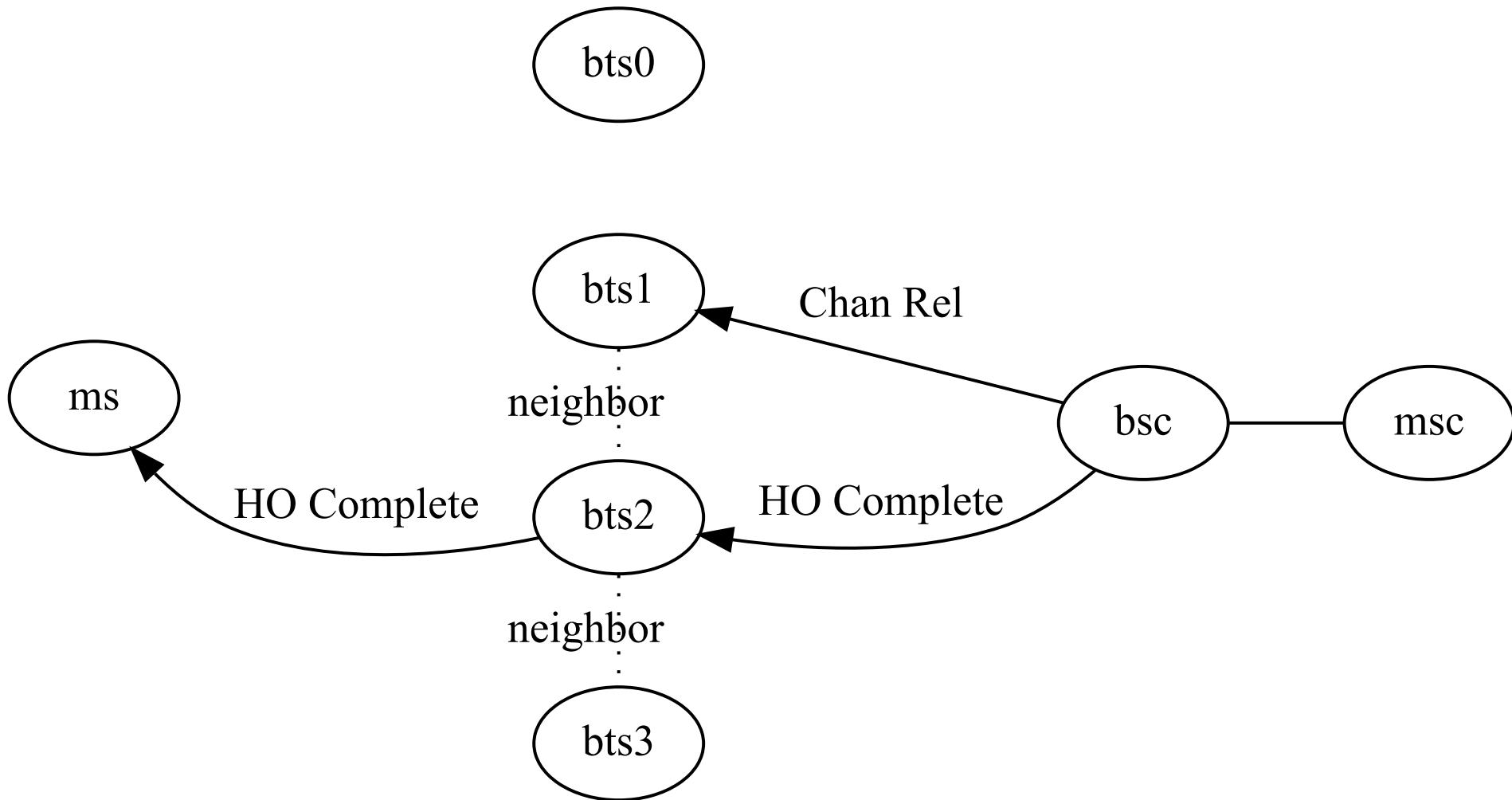
handover, simplified



handover, simplified



handover, simplified



handover, simplified

- config: each BTS has a list of neighbors
 - auto: all other BTS are neighbors
- BSC gathers:
 - RXLEV, RXQUAL, TA on current cell
 - RXLEV on neighbors
 - ...
 - Prepares new lchan, instructs MS to Handover

handover decision algorithm

- handover_decision.c
 - RXLEV, RXQUAL, TA (distance)
 - interference (good RXLEV, bad RXQUAL)
- handover_decision_2.c
 - RXLEV, RXQUAL, TA
 - interference
 - congestion (nr of free lchans)
 - penalty time
 - voice rate / codec

handover_decision_2.c

- based on `openbsc.git jolly/new_handover`
- forward-ported to osmo-bsc in winter 2017

handover config

```
OsmoBSC(config-net)# list
...
handover (0|1|default)
handover algorithm (1|2|default)
```

handover config

```
OsmoBSC(config-net)# list
...
handover (0|1|default)
handover algorithm (1|2|default)
```

Each item can be set globally and per-BTS

```
OsmoBSC(config-net)# bts 0
OsmoBSC(config-net-bts)# list
...
handover (0|1|default)
handover algorithm (1|2|default)
```

handover1 config

```
OsmoBSC(config-net)# list
```

```
...
```

```
handover1 window rxlev averaging (<1-10>|default)
```

```
handover1 window rxqual averaging (<1-10>|default)
```

```
handover1 window rxlev neighbor averaging (<1-10>|default)
```

```
handover1 power budget interval (<1-99>|default)
```

```
handover1 power budget hysteresis (<0-999>|default)
```

```
handover1 maximum distance (<0-9999>|default)
```

handover2 config

s/handover1/handover2/ plus

```
handover2 assignment (0|1|default)
handover2 tdma-measurement (full|subset|default)
handover2 min rxlev (<-110--50>|default)
handover2 min rxqual (<0-7>|default)
handover2 afs-bias rxlev (<0-20>|default)
handover2 afs-bias rxqual (<0-7>|default)
handover2 min-free-slots tch/f (<0-9999>|default)
handover2 min-free-slots tch/h (<0-9999>|default)
handover2 max-handovers (<1-9999>|default)
handover2 penalty-time max-distance (<0-99999>|default)
handover2 penalty-time failed-ho (<0-99999>|default)
handover2 penalty-time failed-assignment (<0-99999>|default)
handover2 retries (<0-9>|default)
handover2 congestion-check (disabled|<1-999>|now)
```

handover2 config

(in case of questions I can't answer, a listing of the online docs...)

```
OsmoBSC(config-net)# handover algorithm ?  
 1      Algorithm 1: trigger handover based on comparing current  
cell and neighbor RxLev and RxQual, only.  
 2      Algorithm 2: trigger handover on RxLev/RxQual, and also to  
balance the load across several cells. Consider available codecs.  
Prevent repeated handover by penalty timers.  
  default Use default (1), remove explicit setting on this node
```

```
OsmoBSC(config-net)# handover1 window ?  
 rxlev   Received-Level averaging  
 rxqual  Received-Quality averaging
```

```
OsmoBSC(config-net)# handover1 window rxlev ?  
 averaging How many RxLev measurements are used for averaging  
 neighbor  How many Neighbor RxLev measurements are used for  
 averaging
```



```
OsmoBSC(config-net)# handover1 window rxlev averaging ?  
<1-10> RxLev averaging: Number of values to average over  
default Use default (10), remove explicit setting on this node
```

```
OsmoBSC(config-net)# handover1 window rxlev neighbor ?  
averaging How many Neighbor RxLev measurements are used for  
averaging
```

```
OsmoBSC(config-net)# handover1 window rxlev neighbor averaging ?  
<1-10> Neighbor RxLev averaging: Number of values to average over  
default Use default (10), remove explicit setting on this node
```

```
OsmoBSC(config-net)# handover1 window rxqual ?  
averaging How many RxQual measurements are used for averaging
```

```
OsmoBSC(config-net)# handover1 window rxqual averaging ?  
<1-10> RxQual averaging: Number of values to average over  
default Use default (1), remove explicit setting on this node
```

```
OsmoBSC(config-net)# handover1 power ?  
budget Neighbor cell power triggering
```

```
OsmoBSC(config-net)# handover1 power budget ?  
  interval      How often to check for a better cell (SACCH frames)  
  hysteresis    How many dBm stronger must a neighbor be to become a HO  
candidate
```

```
OsmoBSC(config-net)# handover1 power budget interval ?  
<1-99>      Check for stronger neighbor every N number of SACCH frames  
default     Use default (6), remove explicit setting on this node
```

```
OsmoBSC(config-net)# handover1 power budget hysteresis ?  
<0-999>    Neighbor's strength difference in dBm  
default     Use default (3), remove explicit setting on this node
```

```
OsmoBSC(config-net)# handover1 maximum ?  
  distance      Maximum Timing-Advance value (i.e. MS distance) before  
triggering HO
```

```
OsmoBSC(config-net)# handover1 maximum distance ?  
<0-9999>    Maximum Timing-Advance value (i.e. MS distance) before
```

```
triggering HO
  default    Use default (9999), remove explicit setting on this node
```

same again for handover2, plus:

```
OsmoBSC(config-net)# handover2 assignment ?
  0          Disable in-call assignment
  1          Enable in-call assignment
  default    Use default (0), remove explicit setting on this node
```

```
OsmoBSC(config-net)# handover2 tdma-measurement ?
  full       Full set of 102/104 TDMA frames
  subset     Sub set of 4 TDMA frames (SACCH)
  default    Use default (subset), remove explicit setting on this node
```

```
OsmoBSC(config-net)# handover2 min ?
  rxlev      How weak may RxLev of an MS become before triggering HO
  rxqual     How bad may RxQual of an MS become before triggering HO
```

```
OsmoBSC(config-net)# handover2 min rxlev ?
  <-110--50> minimum RxLev (dBm)
  default    Use default (-100), remove explicit setting on this node
```

```
OsmoBSC(config-net)# handover2 min rxqual ?
<0-7>      minimum RxQual (dBm)
default    Use default (5), remove explicit setting on this node
```

```
OsmoBSC(config-net)# handover2 afs-bias ?
rxlev      RxLev improvement bias for AFS over other codecs
rxqual     RxQual improvement bias for AFS over other codecs
```

```
OsmoBSC(config-net)# handover2 afs-bias rxlev ?
<0-20>     Virtual RxLev improvement (dBm)
default    Use default (0), remove explicit setting on this node
```

```
OsmoBSC(config-net)# handover2 afs-bias rxqual ?
<0-7>      Virtual RxQual improvement (dBm)
default    Use default (0), remove explicit setting on this node
```

```
OsmoBSC(config-net)# handover2 min-free-slots ?
tch/f      Minimum free TCH/F timeslots before cell is considered
congested
tch/h      Minimum free TCH/H timeslots before cell is considered
congested
```

```
OsmoBSC(config-net)# handover2 min-free-slots tch/f ?
<0-9999>  Number of TCH/F slots
default   Use default (0), remove explicit setting on this node
```

```
OsmoBSC(config-net)# handover2 min-free-slots TCH/F ?
% There is no matched command.
```

```
OsmoBSC(config-net)# handover2 min-free-slots tch/h ?
<0-9999>  Number of TCH/H slots
default   Use default (0), remove explicit setting on this node
```

```
OsmoBSC(config-net)# handover2 max-handovers ?
<1-9999>  Number
default   Use default (9999), remove explicit setting on this node
```

```
OsmoBSC(config-net)# handover2 penalty-time ?
max-distance      Time to suspend handovers after leaving this cell
due to exceeding max distance
failed-ho         Time to suspend handovers after handover failure
to this cell
failed-assignment Time to suspend handovers after assignment
failure in this cell
```

```
OsmoBSC(config-net)# handover2 penalty-time max-distance ?  
<0-99999> Seconds  
default Use default (300), remove explicit setting on this node
```

```
OsmoBSC(config-net)# handover2 penalty-time failed-ho ?  
<0-99999> Seconds  
default Use default (60), remove explicit setting on this node
```

```
OsmoBSC(config-net)# handover2 penalty-time failed-assignment ?  
<0-99999> Seconds  
default Use default (60), remove explicit setting on this node
```

```
OsmoBSC(config-net)# handover2 retries ?  
<0-9> Number of retries  
default Use default (0), remove explicit setting on this node
```

```
OsmoBSC(config-net)# handover2 congestion-check ?  
disabled Disable congestion checking, do not handover based on cell  
overload
```

```
<1-999> Congestion check interval in seconds (default 10)
now      Manually trigger a congestion check to run right now
```

handover_decision_2.c narrative

handover_test.c test_case_23:

```
/* meas-rep <lchan-nr> <rxlev> <rxqual> <nr-of-neighbors> [<cell-idx>  
<rxlev> [...]] */
```

```
"Story: 'A neighbor is your friend'\n",  
"create-bts", "3",
```

```
"print",  
"Andreas is driving along the coast, on a sunny june afternoon.\n"  
"Suddenly he is getting a call from his friend and neighbor Axel.\n"  
"\n"  
"What happens: Two MS are created, #0 for Axel, #1 for Andreas.",  
/* Axel */  
"create-ms", "2", "TCH/F", "AMR",  
/* andreas */  
"create-ms", "0", "TCH/F", "AMR",  
"meas-rep", "1", "40", "0", "1", "0", "30",  
"expect-no-chan",
```



```
"print",
"Axel asks Andreas if he would like to join them for a barbecue.\n"
"Axel's house is right in the neighborhood and the weather is fine.\n"
"Andreas agrees, so he drives to a close store to buy some barbecue\n"
"skewers.\n"
"\n"
"What happens: While driving, a different cell (mounted atop the\n"
"store) becomes better.",
/* drive to bts 1 */
"meas-rep", "1", "20", "0", "1", "0", "35",
"expect-chan", "1", "1",
"ack-chan",
"expect-ho", "0", "1",
"ho-complete",
```

```
"print",
"While Andreas is walking into the store, Axel asks, if he could  
also\n"
"bring some beer. Andreas has problems understanding him: \"I have  
a\n"
"bad reception here. The cell tower is right atop the store, but  
poor\n"
"coverage inside. Can you repeat please?\"\n"
"\n"
"What happens: Inside the store the close cell is so bad, that\n"
```

```
"handover back to the previous cell is required.",
/* bts 1 becomes bad, so bts 0 helps out */
"meas-rep", "1", "5", "0", "1", "0", "20",
"expect-chan", "0", "1",
"ack-chan",
"expect-ho", "1", "1",
"ho-complete",
```

```
"print",
"After Andreas bought skewers and beer, he leaves the store.\n"
"\n"
"What happens: Outside the store the close cell is better again, so\n"
"handover back to the that cell is performed.",
/* bts 1 becomes better again */
"meas-rep", "1", "20", "0", "1", "0", "35",
"expect-chan", "1", "1",
"ack-chan",
"expect-ho", "0", "1",
"ho-complete",
```

```
"print",
/* bts 2 becomes better */
"Andreas drives down to the lake where Axel's house is.\n"
"\n"
"What happens: There is a small cell at Axel's house, which becomes\n"
```

```
"better, because the current cell has no good coverage at the lake.",  
"meas-rep", "1", "14", "0", "2", "0", "2", "1", "63",  
"expect-chan", "2", "2",  
"ack-chan",  
"expect-ho", "1", "1",  
"ho-complete",
```

```
"print",  
"Andreas wonders why he still has good radio coverage: \"Last time  
it\n"  
"was so bad\". Axel says: \"I installed a pico cell in my house,\n"  
"now we can use our mobile phones down here at the lake.\",
```

handover_decision_2.c narrative

test_case_5:

```
"TCH/F keeping with FR codec\n\n"  
"The MS is using full rate V1 codec, but the better cell is  
congested\n"  
"at TCH/F slots. As the congestion is removed, the handover takes\n"  
"place.\n",
```

```
"create-bts", "2",  
"set-min-free", "1", "TCH/F", "4",  
"create-ms", "0", "TCH/F", "FR",  
"meas-rep", "0", "20", "0", "1", "0", "30",  
"expect-no-chan",  
"set-min-free", "1", "TCH/F", "3",  
"meas-rep", "0", "20", "0", "1", "0", "30",  
"expect-chan", "1", "1",  
"ack-chan",  
"expect-ho", "0", "1",  
"ho-complete",
```

handover_decision_2.c narrative

test_case_7:

```
"TCH/F to TCH/H changing with AMR codec\n\n"  
"The MS is using AMR V3 codec, the better cell is congested at  
TCH/F\n"  
"slots. The handover is performed to non-congested TCH/H slots.\n",
```

```
"create-bts", "2",  
"set-min-free", "1", "TCH/F", "4",  
"create-ms", "0", "TCH/F", "AMR",  
"meas-rep", "0", "20", "0", "1", "0", "30",  
"expect-chan", "1", "5",  
"ack-chan",  
"expect-ho", "0", "1",  
"ho-complete",
```

todo

- `handover_decision_2.c` and dynamic timeslots [OS#3002](#)
- tests!
 - `ttcn3`
 - `osmo-gsm-tester`

Currently also implementing:

- inter-BSC handover in `osmo-bsc` [OS#2283](#)

Measurement Report?

- Handover Command
- Handover Detected
- Handover Complete