### Description
We currently use a fn-advance default of 20 frames, and a rts-advance of 5, resulting in a total of 25 frames (equalling 115ms) of downlink frame number advance.

This will cause

- significantly increased RTT for GPRS user plane data
- increase latency of RLC/MAC signaling, specifically
  - tbf establishment
  - potentially cause window stalls if we don't poll for ACK/NACK a lot sooner than our window filling up.
- probably mess with LAPDm timing

I would guess that on modern hardware, particularly with SCHED_RR on TRX + BTS, we can reduce the fn_advance drastically. The rts_advance likely needs to remain in place without too many changes, as this is the amount of time the PCU has to prepare downlink data (i.e. schedule DL).

As a second step, we could possibly even think of something like a dynamically sized fn-advance, similar to dynamic jitter buffers work in RTP.

### Related issues:
- Related to libosmocore - Bug #4074: LAPD timers completely broken
  - New
  - 06/21/2019

### Associated revisions

**Revision b0c5368 - 07/10/2020 03:32 PM - pespin**

Transceiver: Fix race condition obtaining Dl burst from Upper layer

The queue was being accessed sequentially obtaining and releasing the mutual exclusion zone twice. First in getStaleBurst() dropping all FN=currTime, then in getCurrentBurst() trying to obtain FN=currTime.

However, since in between the mutex is released, it could happen that for instance upper layer would introduce currTime-1 in the queue, which would make then getCurrentBurst() detect that one instead of potential currTime in the queue and return NULL.

By holding the mutex during the call to both functions we make sure the state is kept during the whole transaction.

Related: OS#4487 (comment #7)
Change-Id: lf1fd8d7cf5f21ee2894192ef1ac2a3cdda6bbb98

**Revision 1d0c6fe7 - 07/10/2020 03:32 PM - pespin**

Add rate counter for missing Txbursts when scheduled towards the radioInterface

Related: OS#4487
Change-Id: llb2c492b3c67cbbab11fbb936a3a09b85756aa8

**Revision 624b5cdc - 08/17/2020 05:11 PM - daniel**

osmo-bts-trx: Use much lower clock advance values towards PCU and TRX

osmotrnx fn-advance (which is the clock_advance variable here) and osmotrnx rts-advance together make up the minimum delay the BTS can react
to a channel request, etc.

The default of 20 are around 92ms which is clearly too much. With modern hardware and using SCHED_RR a lower value should not be an issue.

See OS#4487 for some related measurements on more CPU-limited devices like a LimeNet-micro3.

Fixes: OS#4487
Fixes: SYS#4885
Related: SYS#4881
Change-Id: I7da3d0948f38e12342fb714b29f8edc5e9d0933d

History

#1 - 04/08/2020 04:47 PM - daniel
- File Screenshot_20200408-183109.png added
- File Screenshot_20200408-183218.png added
- Status changed from New to In Progress

So far on my laptop I reduced fn-advance to 3 and pings look a lot better.

#2 - 04/09/2020 06:21 PM - daniel

https://gerrit.osmocom.org/c/osmo-bts/+/17766

Please test with those or even lower values and report back what still works.

#3 - 05/12/2020 12:01 PM - laforge
- Assignee changed from daniel to pespin

pespin, please take over

#4 - 06/16/2020 05:11 PM - pespin
- Status changed from In Progress to Feedback
- % Done changed from 0 to 80

I updated the gerrit patch and put some updated comments in there.
So in summary:

- I tested with B200 + osmo-trx-uhd + multi-arfcn with 2 TRX
- I tested with LimeSDR-USB + osmo-trx-ims + 1 TRX
- I had to run osmo-pcu also with SCHED_RR (-r 1) to avoid having issues with PDTCH DI blocks not enqueued quickly enough in BTS (related to rts-advance value)
- I also noticed that using a more conservative logging levels (I was using a quite verbose and compute intensive one for RLCMAC category) also helps in getting more stable.
- "fn-advance" can be decreased to 2 by default, it worked fine. "rts-advance is on the edge already, so I wouldn't touch that one.

I also submitted patches improving some related scheduler code to provide more information. I also added rate counters in order to display issues related to fn-advance and rts-advance ("show rate-counters" in osmo-bts).

#5 - 06/29/2020 03:14 PM - pespin

I did some testing with a LimeNET-micro and so far it looks good from osmo-bts-trx side, but it's not working properly on osmo-trx-ims side due to Tx downlink bursts arriving too late when using fn-advance 2 or 3, I get lots of messages like this from time to time:

DTTRDDL <0003> Transceiver.cpp:430 [tid=140424023869184][chan=0] dumping STALE burst in TRX->SDR interface (0: 2005343 vs 1:2005343), retrans=0

I'm running all through systemd services and they have realtime scheduling set in the service files.

I added some rate counters to monitor that kind of issue in osmo-trx, and provide also some VTY command to establish a threshold at which osmo-trx will exit to flag the BTS that something's wrong, like we do for other counters (overruns, underruns, dropped packets, etc.):
remote: https://gerrit.osmocom.org/c/osmo-trx/+/19050 Rename device specific rate counter multi-thread helpers
remote: https://gerrit.osmocom.org/c/osmo-trx/+/19051 Introduce rate counter tx_stale_bursts

05/10/2021
While at it, I also fixed some bug in the rate counter thresholds I observed.

#6 - 07/08/2020 04:55 PM - pespin

Using current default fn values (20 and so), I have been running osmo-bts-trx-osmo-trx-lms in LimeNet-Micro3 for a few hours with 1 phone attached and pinging some IP addr. Then check over time the related rate counters:

in osmo-bts-trx:

```
trx_clk:sched_dl_miss_fn: 0 (0/s 0/m 0/h 0/d) Downlink frames scheduled later than expected due to missed timerfd event (due to high system load)
```

This one didn't change over time, which is good.

But then in osmo-trx-lms:

```
trx:tx_stale_bursts: 232 (0/s 22/m 232/h 0/d) Number of Tx bursts dropped by TRX due to arriving too late
trx:tx_stale_bursts: 1849 (0/s 0/m 1849/h 1793/d) Number of Tx bursts dropped by TRX due to arriving too late
trx:tx_stale_bursts: 5067 (0/s 0/m 1890/h 5031/d) Number of Tx bursts dropped by TRX due to arriving too late
trx:tx_stale_bursts: 5201 (0/s 0/m 2024/h 5031/d) Number of Tx bursts dropped by TRX due to arriving too late
trx:tx_stale_bursts: 6156 (0/s 0/m 1125/h 5998/d) Number of Tx bursts dropped by TRX due to arriving too late
```

So we are dropping around 2k bursts per hour aprox, with current settings. I still need to figure out what fn param relates to that.

#7 - 07/08/2020 09:38 PM - pespin

After a few more hours with the test running with same environment, I continue to have trx_clk:sched_dl_miss_fn at 0 and trx:tx_stale_bursts at around 2425/h

Regarding that counter, I just found out that there may be a race condition between getStaleBurst() and getCurrentBurst(), where a burst is fed in the queue in between and then getCurrentBurst() fails because the required one may be not the first one even if it was queued and getStaleBurst() will later drop it. So we potentially need to refactor that code to avoid those issues, and repeat the test (adding an extra counter for the case where getCurrentBurst fails, because then by comparing with the other one it can be known if bursts arrived late or never arrived).

If that's not introducing an issue, then we need to investigate whether lowering fn_advance further degrades the current situation or not.

#8 - 07/09/2020 04:28 PM - pespin

I submitted a bunch of more patches fixing the potential race condition as well as adding more counters useful to gasp timing issues:

remote: https://gerrit.osmocom.org/c/osmo-trx/+/19206 Transceiver: Fix race condition obtaining DL burst from Upper layer
remote: https://gerrit.osmocom.org/c/osmo-trx/+/19207 Add rate counter for missing Tx bursts when scheduled towards the radioInterface
remote: https://gerrit.osmocom.org/c/osmo-trx/+/19205 Introduce rate counters to detect issues in received DL bursts from TRXD

#9 - 07/12/2020 09:27 PM - fixeria

A few days ago I implemented the transmit queue in fake_trx.py, so now it behaves just like a normal transceiver and reflects the negative impact of high fn-advance values, see https://osmocom.org/issues/4658#note-8. TL;DR several test cases from ttcn3-bts-test started to fail with queuing enabled. I also believe, that high fn-advance value could most likely be the reason of permanent BTS_Tests.TC_rsl_modify_encr failures. The test case expects a new encryption key to be applied immediately, while on practice it's applied 20 TDMA frames later (5 xCCH frames).

#10 - 07/22/2020 03:37 PM - pespin

After a few hours running same test I did a few days ago (limenet-micro, 1 MS pinging for a few hours, default fn-advance 20):

```
OsmoTRX# show rate-counters
osmo-trx statistics 0:
   device:rx_overruns: 0 (0/s 0/m 0/h 0/d) Number of Rx overruns in FIFO queue
   device:tx_underruns: 0 (0/s 0/m 0/h 0/d) Number of Tx underruns in FIFO queue
   device:rx_drop_events: 0 (0/s 0/m 0/h 0/d) Number of times Rx samples were dropped by HW
   device:rx_drop_samples: 0 (0/s 0/m 0/h 0/d) Number of Rx samples dropped by HW
   device:tx_drop_events: 3 (0/s 0/m 0/h 3/d) Number of times Tx samples were dropped by HW
```
device:tx_drop_samples: 3 (0/s 0/m 0/h 3/d) Number of Tx samples dropped by HW

trx:tx_stale_bursts: 13274 (0/s 0/m 7556/h 10075/d) Number of Tx bursts dropped by TRX due to arriving too late

trx:tx_unavailable_bursts: 13599 (0/s 0/m 7660/h 10377/d) Number of Tx bursts unavailable (not enqueued) at the time they should be transmitted

trx:tx_trxd_fn_repeated: 0 (0/s 0/m 0/h 0/d) Number of Tx bursts received from TRXD with repeated FN

trx:tx_trxd_fn_outoforder: 0 (0/s 0/m 0/h 0/d) Number of Tx bursts received from TRXD with a past FN

trx:tx_trxd_fn_skipped: 141 (0/s 0/m 104/h 118/d) Number of Tx bursts potentially skipped due to FN jumps

For reference, after few startup seconds, all were 0 and trx:tx_unavailable_bursts=184 (expected during startup to have some until it stabilizes).

And osmo-bts-trx:

OsmoBTS# show rate-counters
L1 scheduler timeslot 17:
l1sched_ts:dl_late: 3 (0/s 0/m 0/h 3/d) Downlink frames arrived too late to submit to lower layers
l1sched_ts:dl_not_found: 4 (0/s 0/m 0/h 4/d) Downlink frames not found while scheduling

L1 scheduler timeslot 16:
l1sched_ts:dl_late: 3 (0/s 0/m 0/h 3/d) Downlink frames arrived too late to submit to lower layers
l1sched_ts:dl_not_found: 4 (0/s 0/m 0/h 4/d) Downlink frames not found while scheduling

L1 scheduler timeslot 15:
l1sched_ts:dl_late: 0 (0/s 0/m 0/h 0/d) Downlink frames arrived too late to submit to lower layers
l1sched_ts:dl_not_found: 0 (0/s 0/m 0/h 0/d) Downlink frames not found while scheduling

L1 scheduler timeslot 14:
l1sched_ts:dl_late: 0 (0/s 0/m 0/h 0/d) Downlink frames arrived too late to submit to lower layers
l1sched_ts:dl_not_found: 0 (0/s 0/m 0/h 0/d) Downlink frames not found while scheduling

E1 Input subsystem 0:
hdlc:abort: 0 (0/s 0/m 0/h 0/d) HDLC abort
hdlc:bad_fcs: 0 (0/s 0/m 0/h 0/d) HDLC Bad FCS
hdlc:overrun: 0 (0/s 0/m 0/h 0/d) HDLC Overrun
alarm: 0 (0/s 0/m 0/h 0/d) Alarm
removed: 0 (0/s 0/m 0/h 0/d) Line removed

cell broadcast channel 1:
cbch:rcvd_queued: 0 (0/s 0/m 0/h 0/d) Received + queued CBCH messages (Abis)
cbch:rcvd_dropped: 0 (0/s 0/m 0/h 0/d) Received + dropped CBCH messages (Abis)
cbch:sent_single: 0 (0/s 0/m 0/h 0/d) Sent single CBCH messages (Um)
cbch:sent_default: 0 (0/s 0/m 0/h 0/d) Sent default CBCH messages (Um)
cbch:sent_null: 0 (0/s 0/m 0/h 0/d) Sent NULL CBCH messages (Um)

cell broadcast channel 0:
cbch:rcvd_queued: 0 (0/s 0/m 0/h 0/d) Received + queued CBCH messages (Abis)
cbch:rcvd_dropped: 0 (0/s 0/m 0/h 0/d) Received + dropped CBCH messages (Abis)
cbch:sent_single: 0 (0/s 0/m 0/h 0/d) Sent single CBCH messages (Um)
cbch:sent_default: 0 (0/s 0/m 0/h 0/d) Sent default CBCH messages (Um)
cbch:sent_null: 0 (0/s 0/m 0/h 0/d) Sent NULL CBCH messages (Um)

osmo-bts-trx specific counters 0:
trx_clk:sched_dl_miss_fn: 0 (0/s 0/m 0/h 0/d) Downlink frames scheduled later than expected due to missed timerfd event (due to high system load)
base transceiver station 0:
paging:rcvd: 0 (0/s 0/m 0/h 0/d) Received paging requests (Abis)
paging:drop: 0 (0/s 0/m 0/h 0/d) Dropped paging requests (Abis)
paging:sent: 0 (0/s 0/m 0/h 0/d) Sent paging requests (Um)
rach:rcvd: 33 (0/s 0/m 20/h 30/d) Received RACH requests (Um)
rach:drop: 3 (0/s 0/m 1/h 3/d) Dropped RACH requests (Um)
So from those numbers, my opinion is that on the BTS side, everything looks quite good. I think those 3-4 bursts lost during around 4 hours on TS0 and TS1 we can ignore.

On the TRX side, it looks much worse. More or less tx_unavailable_bursts - 184 (startup drop) - tx_trxd_fn_skipped = tx_stale_bursts. So 99% of the issues are basically bursts arriving too late to the Lower Layer TX thread pushing stuff into the SDR. My observation is that these usually happen in big bursts of hundreds of thousands of FNs at the same time (the counter increments a lot in a few seconds).

Finally, we get 144 skipped FN, which cross-checking against BTS, means either

1. The Kernel dropped UDP packets between BTS->TRX
2. There is some bug in BTS sometimes not sending DL packets and not being counted in the counter.

I also created ticket #4679 to get rid of some bursty log line about rach clipping which may also help getting rid of some unstabilities.

So my opinion right now on the ticket's topic is: I need to do more testing, but looks like we'll be able to decrease fn-advance since the situation is not worse than with a higher value.

BTW, I forgot to say that while running the long test, I see from time to time this from the kernel on journalctl, which may also cause unstabilities:

I did some more tests with LimeNet-micro this time applying ultra-low values proposed by Daniel in [https://gerrit.osmocom.org/c/osmo-bts/+/17766](https://gerrit.osmocom.org/c/osmo-bts/+/17766), and I get similar results to those with current values (high timing ones), so to me it's a green light towards going ahead setting the new lower default values. It also confirms that the issue with dropped DL bursts is within osmo-trx threads themselves, and should be investigated separately.
### OsmoTRX show rate-counters

```
osmo-trx statistics 0:
  device:rx_overruns: 0 (0/s 0/m 0/h 0/d) Number of Rx overruns in FIFO queue
  device:tx_underruns: 0 (0/s 0/m 0/h 0/d) Number of Tx underruns in FIFO queue
  device:rx_drop_events: 0 (0/s 0/m 0/h 0/d) Number of Rx samples dropped by HW
  device:rx_drop_samples: 0 (0/s 0/m 0/h 0/d) Number of Rx samples dropped by HW
  device:tx_drop_events: 3 (0/s 0/m 3/h 3/d) Number of Tx samples were dropped by HW
  device:tx_drop_samples: 3 (0/s 0/m 3/h 3/d) Number of Tx samples dropped by HW
  trx:tx_stale_bursts: 10054 (0/s 0/m 10054/h 8489/d) Number of Tx burts dropped by TRX due to arriving too late
  trx:tx_unavailable_bursts: 10094 (0/s 0/m 10094/h 8529/d) Number of Tx burts unavailable (not enqueued) at the time they should be transmitted
  trx:tx_trxd_fn_repeated: 0 (0/s 0/m 0/h 0/d) Number of Tx burts received from TRXD with repeated FN
  trx:tx_trxd_fn_outoforder: 0 (0/s 0/m 0/h 0/d) Number of Tx burts received from TRXD with a past FN
  trx:tx_trxd_fn_skipped: 0 (0/s 0/m 0/h 0/d) Number of Tx burts potentially skipped due to FN jumps
  trx:rx_empty_burst: 0 (0/s 0/m 0/h 0/d) Number of Rx bursts empty
  trx:rx_clipping: 40086 (0/s 3944/m 39599/h 13817/d) Number of Rx bursts discarded due to clipping
  trx:rx_no_burst_detected: 0 (0/s 0/m 0/h 0/d) Number of Rx burts discarded due to burst detection error
```

(the high clipping here is unrelated and happens because I have the MS at 30cm from the LimeNetMicro pinging some internet host).

### #14 - 08/18/2020 08:26 AM - pespin
- Status changed from Feedback to Resolved
- % Done changed from 80 to 100

https://gerrit.osmocom.org/c/osmo-bts/+/17766 was merged, closing.

### #15 - 09/17/2020 03:50 PM - laforge
- Related to Bug #4074: LAPD timers completely broken added

### Files

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