OAI eNB Real-Time on Limited-CPU Machine
CPU burns electricity

All modern CPU are limited by thermal dissipation

• C-states
• Core state from C0 (active) to C7 (deep sleep)
• Maximum transition: less than 200µs

P-states = core frequency

• Harms because the frequency choice is based on sliding average

Thermal protection

• Intel Power clamp should not activate itself

Hyperthreading

• A commercial trick, not twice the cores
Linux scheduling

Premption

• Low latency Linux
  • 1000 Hz scheduler: 1 millisecond
  • Is not what we need

No premption

• Most real-time OS doesn’t use preemption
• Openair has a embedded scheduler: LTE frame

How to

• Reserve cores for eNB critical part (frame processing)
• Keep at least one core for other tasks
• Be aware of shared HW: RAM with video processor, various resources with cards like WiFi
USB dialog

USB messages

- Big messages save CPU but increase latency
- UHD involves memory to memory transformations
  - Each memory copy costs
OpenAir realtime issues

No core isolation
- Linux can keep up to 1ms (low latency kernel) core before next preemption
- Shared hardware not monitored

Useless recommendations
- Block C-state to C0 saves 2µs maximum latency (from C1)
- Hyper-threading harms only if Linux grabs the uniq core
- Low latency kernel is far too slow

Over complex operations
- Each call to the kernel, to pthread_mutex() has a cost
OpenAir realtime issues

Total CPU is the limit

- Operations can be done with less CPU
- OpenAir already uses SIMD
  - The corner stone of last ten years CPU improvements
  - No LTE realtime SDR is possible without SIMD instructions
- Faster blocks can be made
  - Turbo codec
  - Modulation, scrambling
  - ...
  - PHY processing is the actual limit of SDR
Open cells on going code

Run on stock Linux

• Core isolation helps to make more stable execution

Improvements done on « old develop » branch

• Simplified build, less files
• ITTI recoded, and many « utilities »: log, mem allocation, ...
• Much less threads
• CPU saves in several critical places
• Reworked sub frame numbering and processing to use the LTE 3ms jitter
Open cells on going code

Merge in near future

• Since new develop is available, we can merge
  • Some is already in
  • Some will be merged, nevertheless we did similar things
  • Some will remain separate
    • Not common like build, logs
    • Commercial offer from Open Cells company
Demonstrated system

**I5-4300M CPU, single memory channel**

- 2013 laptop CPU, comparable to i7-xxxxU recent series
- USRP B210
- Commercial UE
- All in one configuration: eNB + EPC

Show

- Full rate traffic 5MHz
- Runs 10MHz, nevertheless a bug prevent to traffic
- Runs 20MHz, but not enough CPU for payload processing