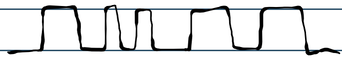
Notes

Radio Theory – Scheduler Simulation



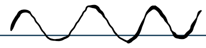
In wired networks:

1) a cable has fixed capacity.

2) data arrives almost perfectly.

but in wirless:

1) the medium is shared

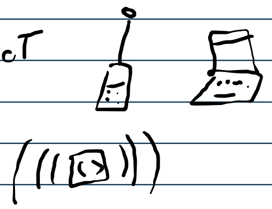
2) signal quality changes over time 

3) errors happen often

4) resources must be scheduled smartly

So the goal is to efficiently and fairly share a limited wireless channel among many users whose channel quality constantly changes.

UE means user equipment. phone, laptop or IoT

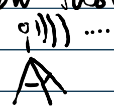


in the simulation a UE will have:

- Data waiting to be sent (buffer)
- Radio link to base station (ignored for now)
- A channel quality
- State transmissions (HARQ)

* The base station decides who transmits, when and how fast.

It is like traffic controller for radio resources.



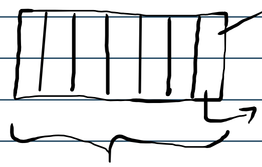
Time structure = TTI (Transmission Time Interval)

LTE= 1ms   NR ≤ 1ms

In each TTI:

1) Channel quality is picked up
2) Scheduler runs
3) Radio resources is allocated
4) Data is transmitted
5) ACK/NACK feedback is generated

* Resource Block

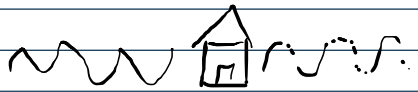


who gets what?

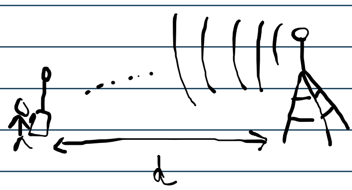
UE ← Rb

* CQ, the channel quality is base off distance + obstacles

ignored here



High data rate near BS



* Pathloss = $PL_0 + 10n \log_{10}(d)$

PL_0 → loss at 10 meters

$10n \log_{10}(d)$ → enviorment facter $n \in [2,4]$

+ smooth + deterministic

* SINR (signal to interference and noise ratio)

it measures link quality, how strong is the desired signal compared to noise?

given in dB: $SINR = P_{rx} - Noise$

High SINR → clean signal

Sim:
SINR comes from pathloss + transmit power + noise floor

High SINR → clean signal

Low SINR → unreliable transmission

pathloss + transmit power + noise floor

* CQI, Channel quality indicator is compressed representation of SINR that is discrete in 0–15. Higher CQI means better channel.

* MCS, CQI → MCS → bits per Rb

Modulation and Coding Scheme says: how many bits can be sent per Rb.

Low MCS → fewer bits → very reliable
High MCS → many bits → fragile

Schedulers do link adaptation:

better channel → higher MCS → more bits

* Throughput vs capacity

Throughput → How many bits were successfully delivered

capacity → How many bits could be sent

thus erros make thr < cap

* BLER block rate

Simply a probability that a transport fails

High CQI → low BLER

low CQI → high BLER

* Hybrid Automatic Repeat Request

1. Scheduler sends a transport block

2. Reciver tries to decode

3. if successful → ACK / otherwise NACK

4. failed blocks are retransmitted

Data only leaves the buffer after ACK.

* Schedulers

Round Robin → equal Rb to all UEs

MAX CQI → Rb to UE with best channel
(Max Thrput)

Proportional Fair → $PF = \frac{\text{intant rate}}{\text{average rate}}$ for UE

* Jain's Fairness index $J = \frac{(\sum x_i)^2}{N \sum x_i^2}$ → UE Thrput

$J = 1$ → perfect fair