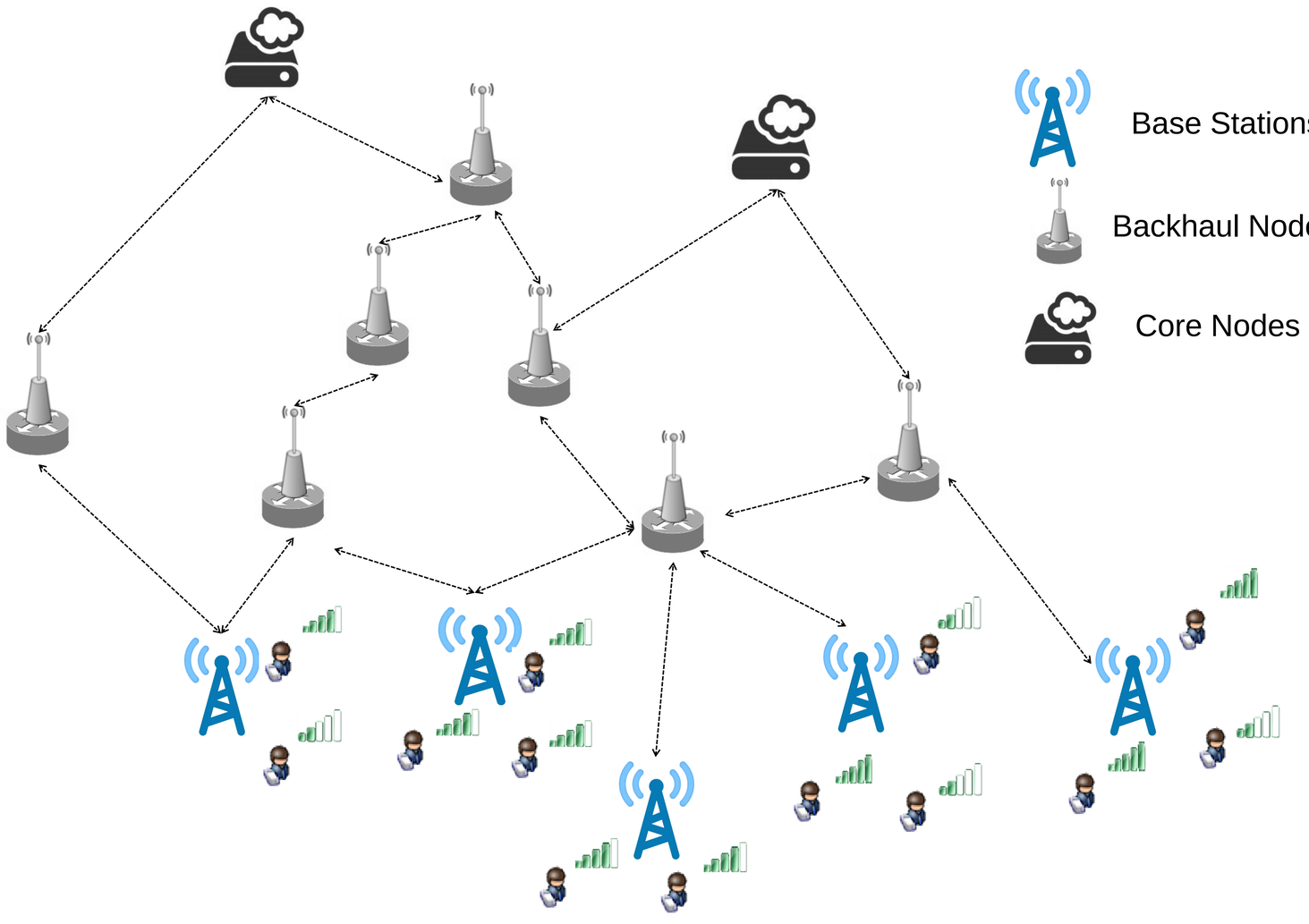
Reducing the Total Energy Consumption of Small Cell Networks

Nikolaos Sapountzis[1], Thrasyvoulos Spyropoulos[1], Navid Nikaein[1] and Umer Salim[2]
[1] Mobile Communications Department, EURECOM, 06410, Biot France firstname.lastname@eurecom.fr
[2] Intel Mobile Communications, Sophia Antipolis, 06560, France umer.salim@intel.com



Motivation

- Increased concerns about energy crisis and environmental protection
- Cellular network RAN consumption a major expense for operators
- Key question: Reduce power consumption while considering: (a) complete network, (b) user QoE.

Approach

Energy-reduction algorithm operating in two phases:
A) switching-off Base Stations (BSs)
B) switching-off Backhaul Nodes (BNs)

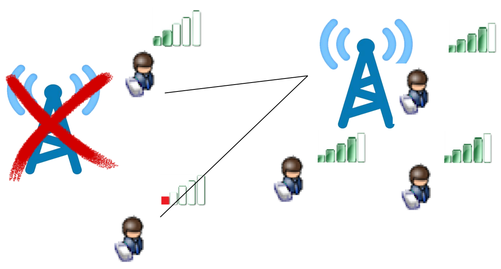
Considerations

- Traffic-differentiation (more realistic in LTE, LTE-A systems),
- Interaction between access-backhaul network
- Exploit spatio-temporal load variability (short time scales)
- Heterogeneity in the backhaul technologies (e.g. copper, fiber, microwave)

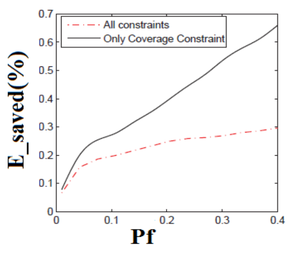
Part A: 3 user-related QoS constraints when switching-off BSs

Decide if we can **safely** switch-off a candidate BSs (e.g. currently lightly loaded) without violating the 3 QoE constraints for (a) users handed over to neighboring BS, (b) users at BSs incurring additional load (due to handovers)

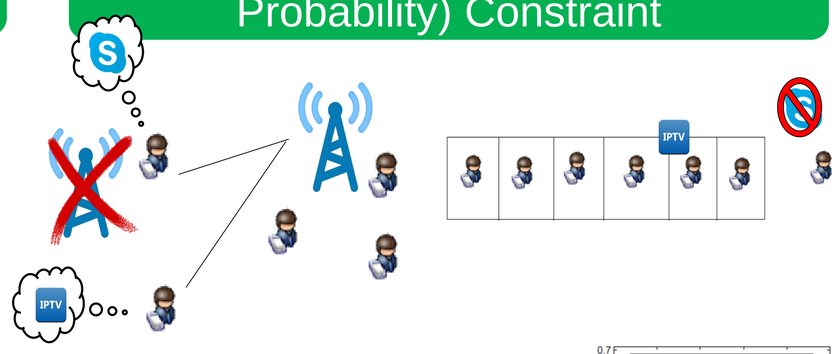
1. Coverage Constraint



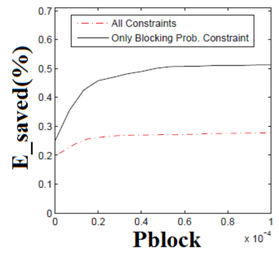
✓ Consider the chance that a UE has poor signal quality when he needs the network



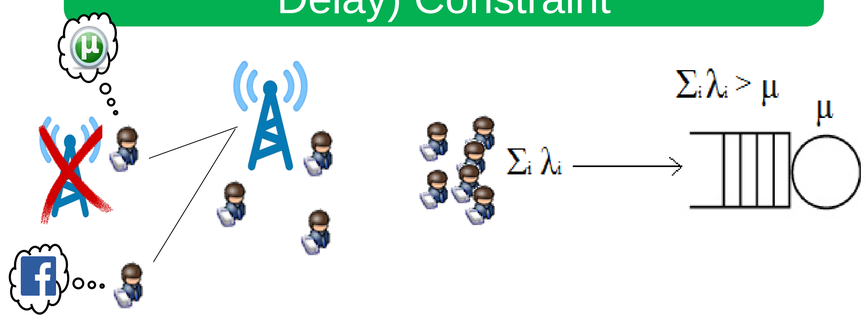
2. Admission Control (Block. Probability) Constraint



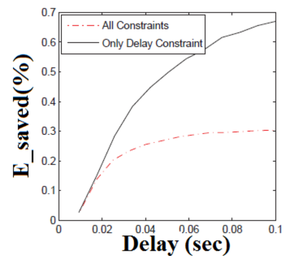
✓ Consider the chance that a flow that requires a certain amount of bandwidth is *blocked* due to lack of resources



3. Admission Control (Service Delay) Constraint

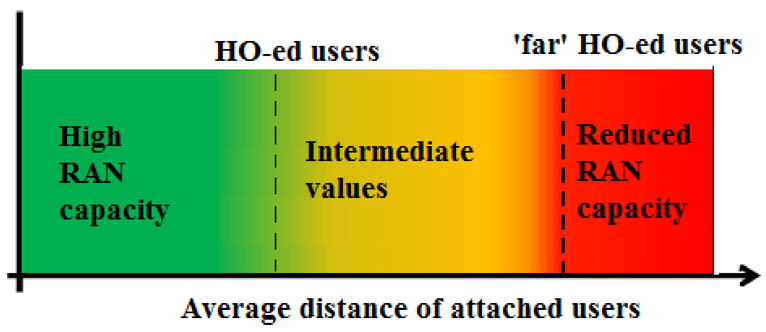


✓ Consider the *service delay* for regular best-effort flows that are multiplexed and have to compete for resources



Need for Backhaul Constraint? No.

✓ The remote BSs will have to deal with *reduced* maximum peak rates => no need for capacity constraint in the backhaul



Part B: A backhaul-related constraint when switching-off BNs

The Network Controller (NC), i.e. the central node of the network (likely SDN-enabled), tries to **safely** switch-off BNs, without affecting the flow conservation on the backhaul network

GIVEN

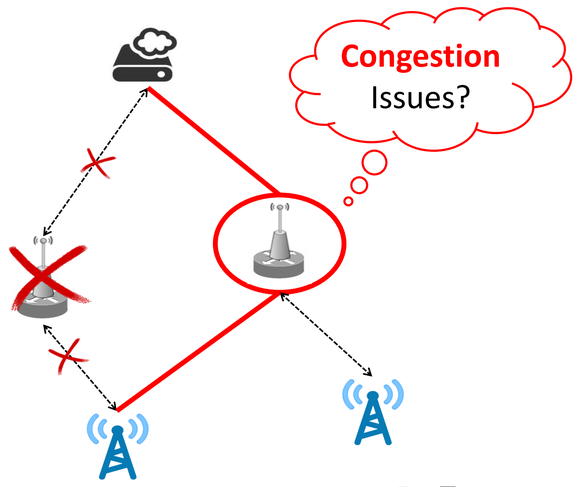
The NC knowledge about:

1. The network topology/link capacities
2. The average peak rates for each cell
3. The max.(supportable) link utilization
4. The links/nodes power consumptions

SUBJECT TO
flow conservation and maximum link utilization constraints

FIND

the powered-on BNs so that the total power consumption is minimized



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