BUILD OR MERGE: LOCATIONAL DECISIONS IN MOBILE ACCESS NETWORKS

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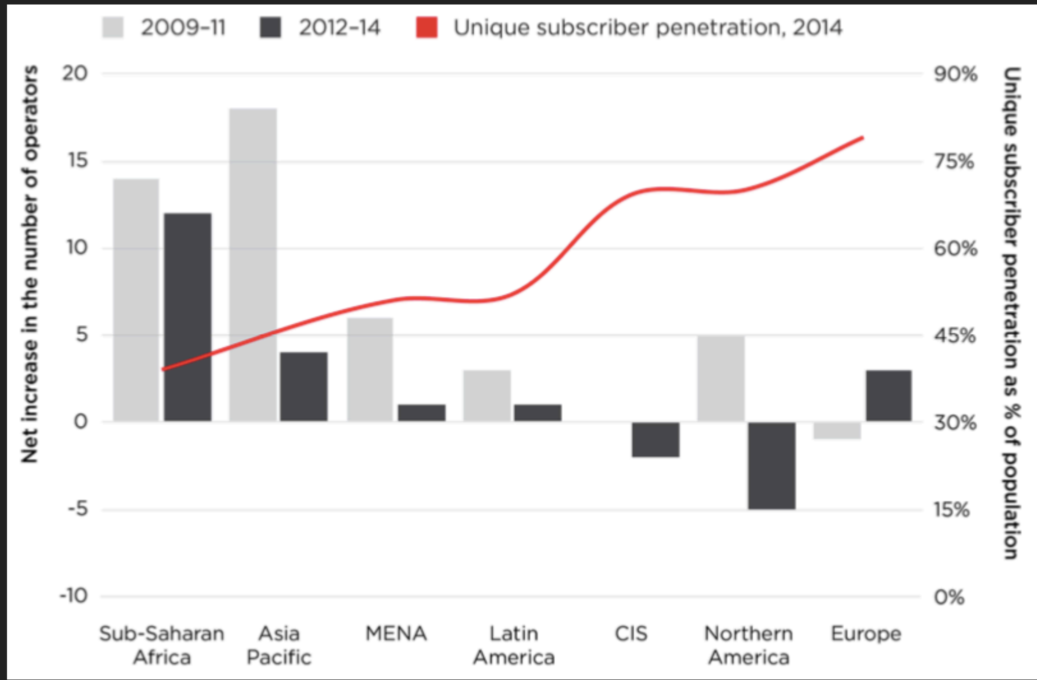
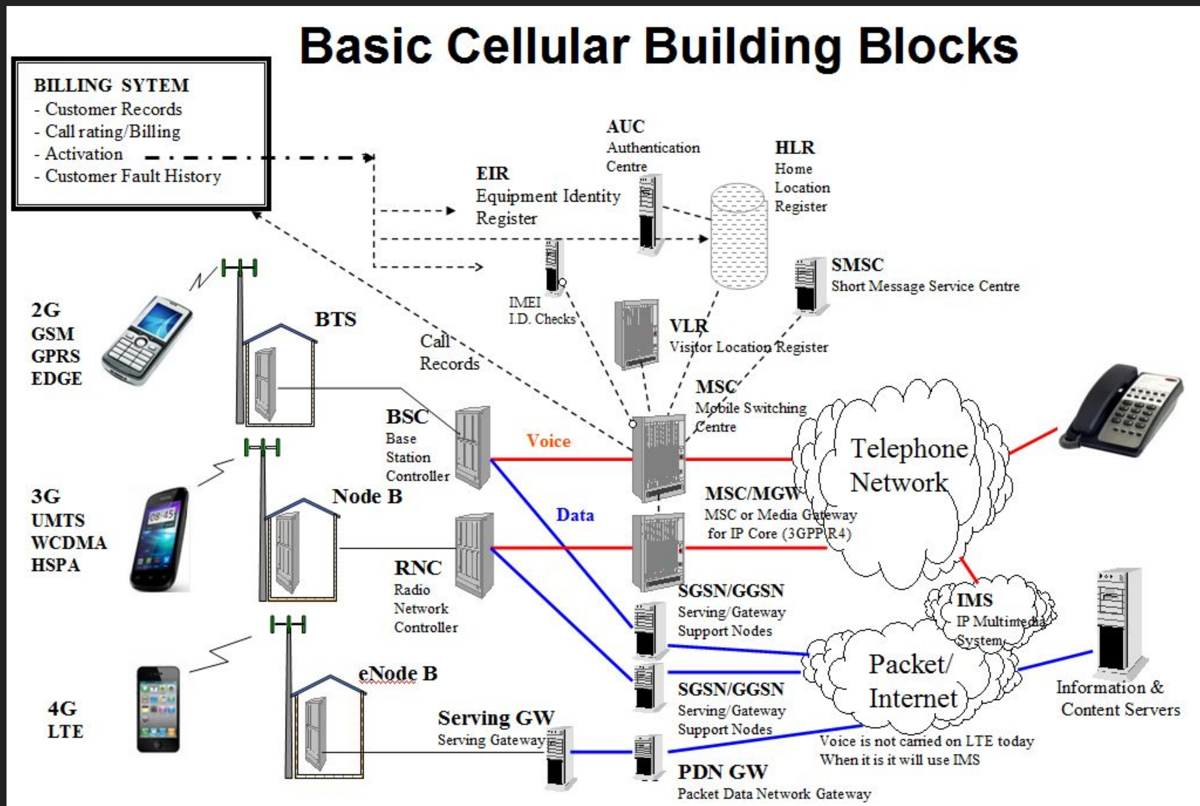
MERGERS IN TELECOMS

- Even in a steady market mergers take place
- The net result is consolidation of the industry
- But the consolidation of the industry should bring along a consolidation of networks



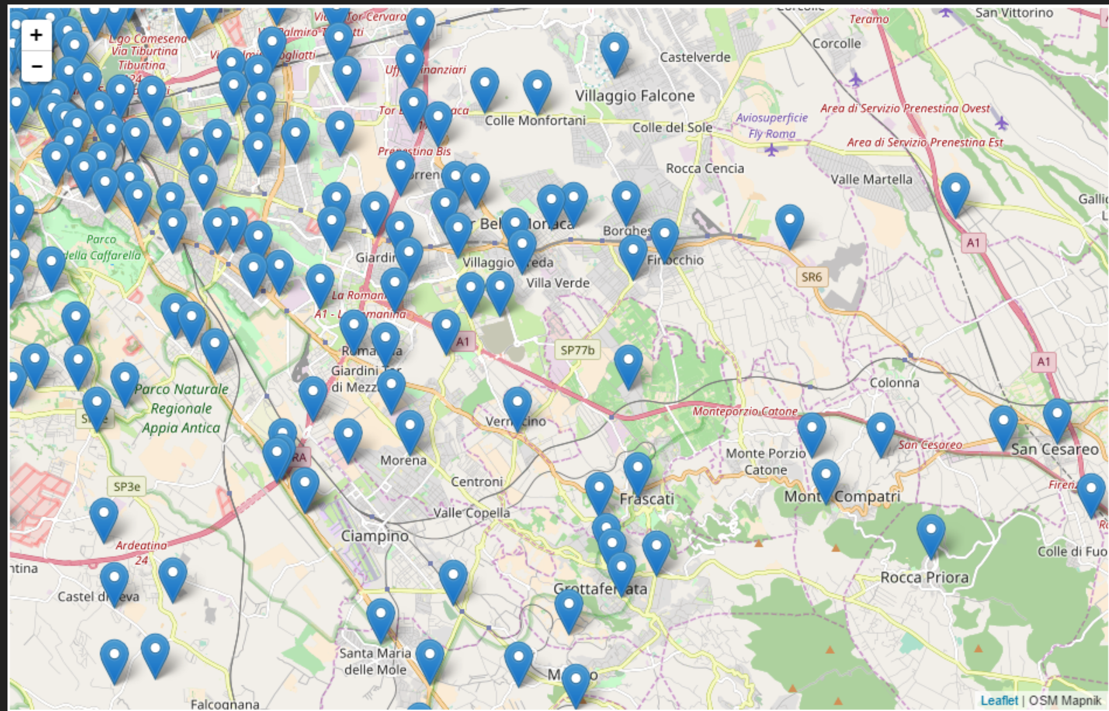
THE ACCESS NETWORK IN MODERN CELLULAR NETWORKS

- The latest 3 generations of mobile networks exhibit a similar access structure
- Though differing for coverage of the access node, the consolidation problem is basically the same



THE SPATIAL DISTRIBUTION OF ACCESS NODES

- Our test-bed comprises a set of real cell tower sites
- The area is around 400 square kilometres, located South-East of the urban area of Rome, Italy.
- The overall number of actual tower sites in the area is 52, which we have divided between two operators
- An additional set of potential locations has been included



THE NETWORK CONSOLIDATION PROBLEM

- The access network of two operators to be merged is largely redundant
- The coverage areas of Operator A and Operator B are typically fully overlapping
- There is room for a significant reduction in the number of cell towers
- But the location and coverage of single cell towers are almost never perfectly coincident
- Our goal: reducing the overall costs by acting on the number and location of cell towers

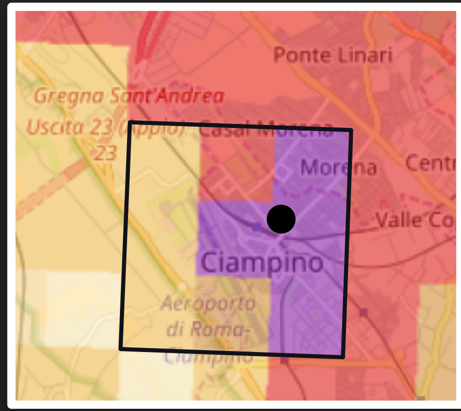
CONSOLIDATION ACTIONS

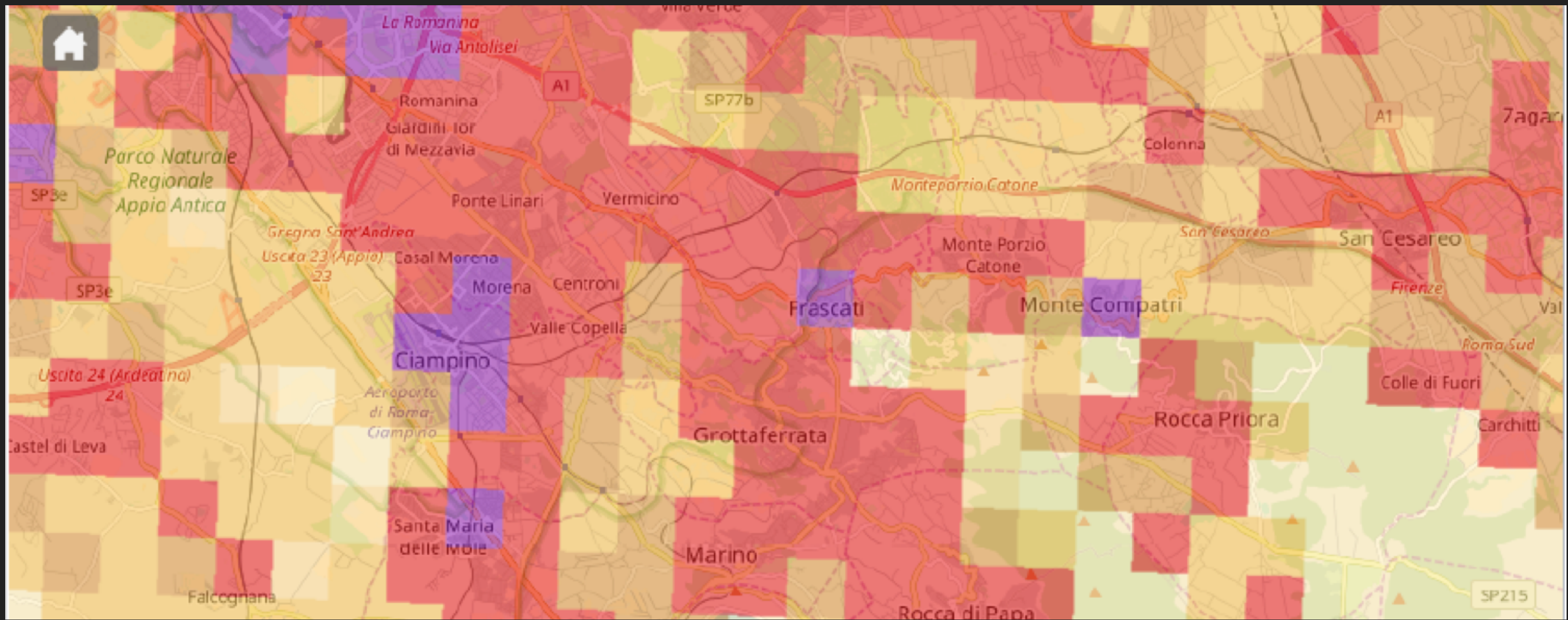
- Switching off access nodes
- Setting up new access nodes
- Adapting the capacity of access nodes (number of TR modules)

- INPUTS
  - Traffic demand (derived from a demographic database through the Geographic Network Traffic Model by Tutschku and Tran-Gia)
  - Costs

THE TRAFFIC MAP

- The expected traffic has been computed for each 1 square km cell
- The traffic has then been aggregated on a set of centroids through clustering
- Traffic centroids are then associated to Access Points on the basis of their coverage





COST ASSUMPTIONS

- We define costs parametrically, taking the set-up cost of a single tower as the baseline
- CAPEX
  - Set-up costs = 100;
  - Switch-off costs = 70.
- OPEX
  - Maintenance costs = 8;
  - Power costs = 2;
  - Site rental = 50.

- Time horizon: 5 years
- Discount rate: 3%

COST OPTIMIZATION APPROACH

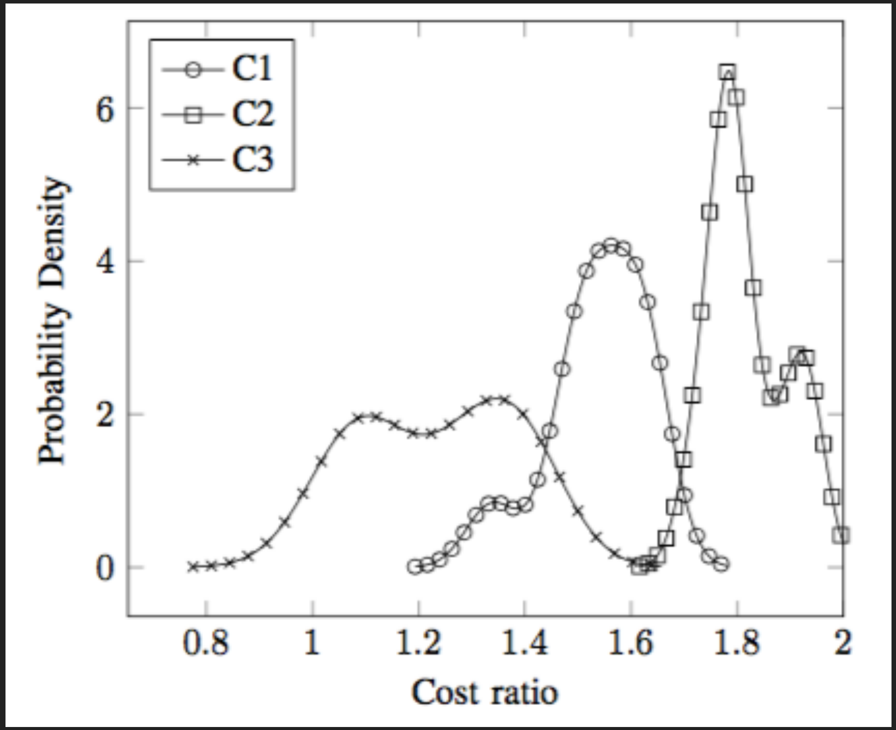
- It's a variant of the Single Source Capacitated Facility Location Problem
  - Set of potential locations for facilities with activation costs
  - Set of clients and allocation costs
  - Find actual location of facilities and client demands allocation to facilities, minimizing total activation+allocation cost
- Our variant: additional capacity and service-range capability decision for the active facilities (AP)
- Modelled as ILPs (Integer Linear Programs) with ~103 variables and ~8*103 constraints.
- ILP written in AMPL with CPLEX 12.5 solver
- Standard PC, Intel i5, 2.7 GHz, 4GB RAM, under Windows 10 OS

THE EXPERIMENTS

- Two operators to be merged: Operator A and Operator B
- A resulting operator after merger: Operator Z
- Comparison: Operator Z vs Operator A/B (after building to cover the same traffic demand)
- Three groups of configurations: C1, C2, C3
- Number of configurations for each group: 30
- Overall number of access points constant in each group
  - C1: 40 APs
  - C2: 60 APs
  - C3: 28 APs
- Number of APs of Operator A (or B) randomly varying over the configurations

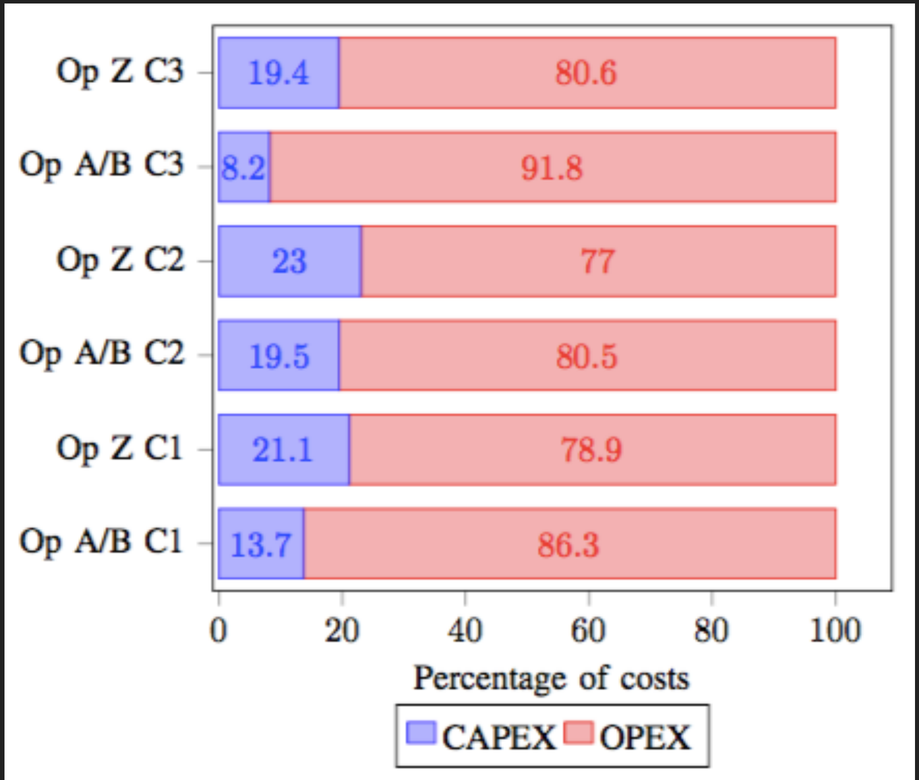
BUILD OR MERGE

- We compare the costs of two scenarios (Op Z/Op A or B):
  - Operator Z resulting from the merge of Operator A and Operator B
  - Operator A (or B) growing its network to meet the same traffic demand as the union of the two operators
- The costs of Operator Z are larger
- Building pays over Merging



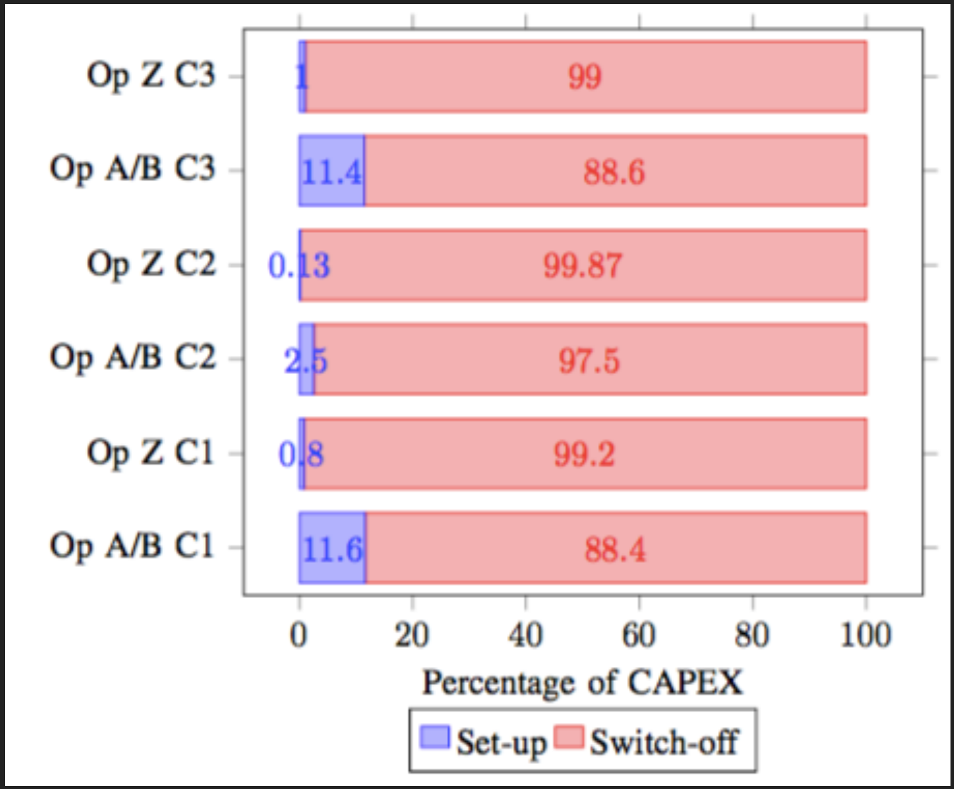
COMPOSITION OF COSTS: CAPEX VS OPEX

- The weight of CAPEX is much larger for the after-merger network
- Merging carries along a reduction of overall network costs over a longer time horizon



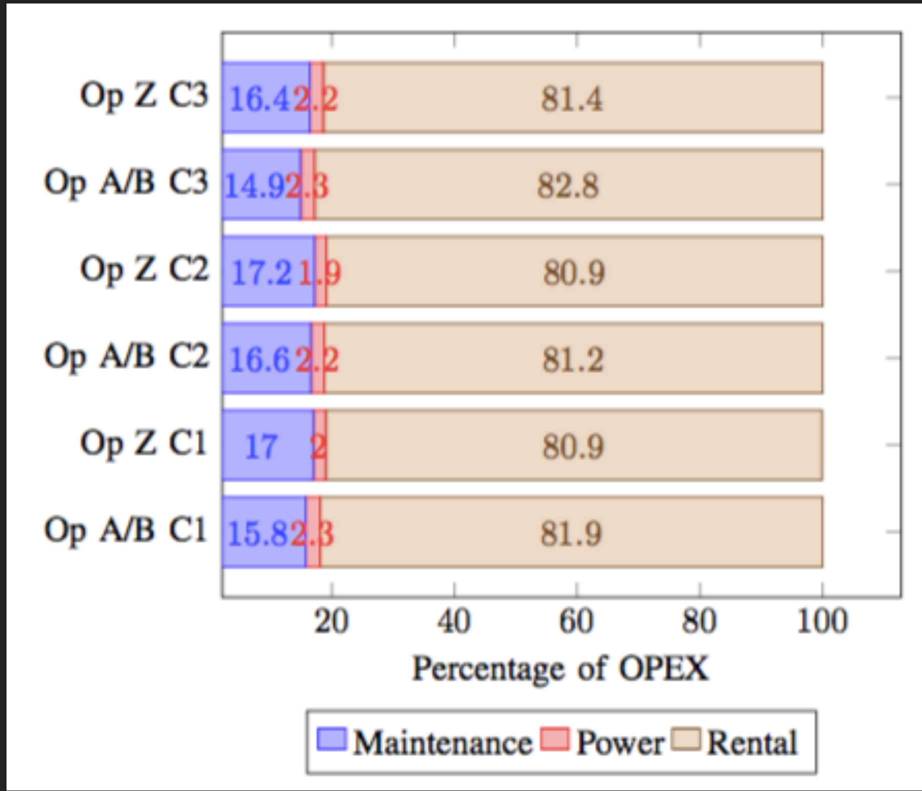
COMPOSITION OF CAPEX: SET-UP VS SWITCH-OFF

- Switch-off costs are by far the dominant component
- The imbalance is larger for the case of merging



COMPOSITION OF OPEX

- Rental costs dominate (over 80%)
- Maintenance costs account for more than 15%
- Power costs are negligible
- No significant differences (in composition) between merge and build cases



CONCLUSIONS

- Merging carries along an increase in access network costs by slightly more than 50%
- OPEX are the dominant portion of costs, accounting for over 85% of total costs for the operators to be merged
- CAPEX costs are represented just by for the
- Switch-off costs are prevalent among CAPEX (in excess of 85%) especially for the after-merger network (over 99%)
- Rental cost is the most significant OPEX item, accounting for about 80%
- Power costs are a negligible fraction of the overall OPEX.