Energy Optimization Through Traffic Aggregation in Wireless Networks

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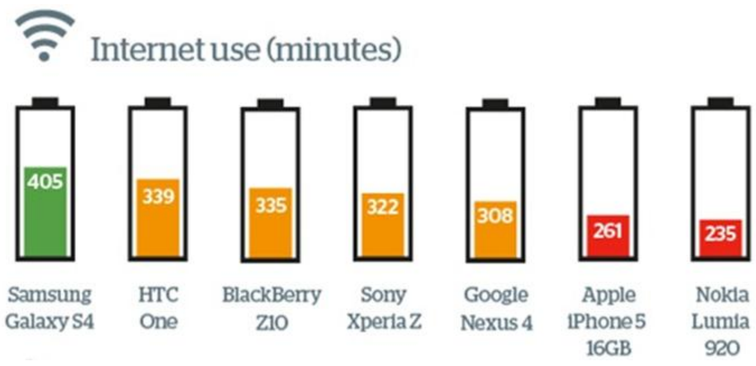
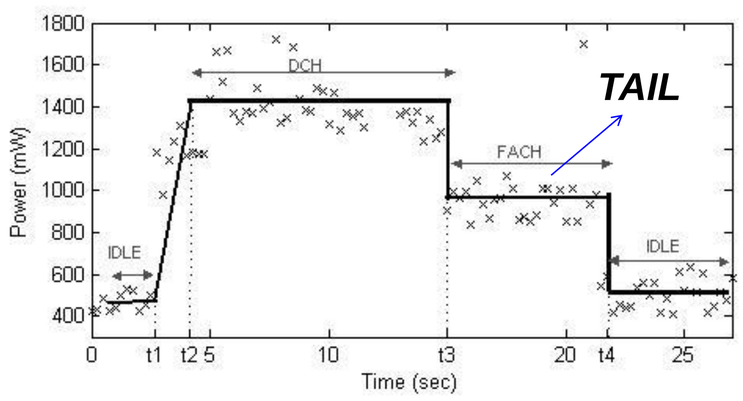
Battery is the bottleneck of smartphones

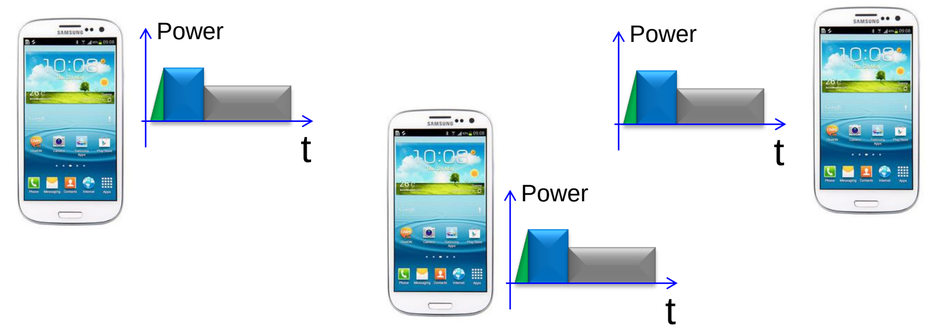


In UMTS 3G and 4G networks, lots of energy is wasted in *TAIL* state

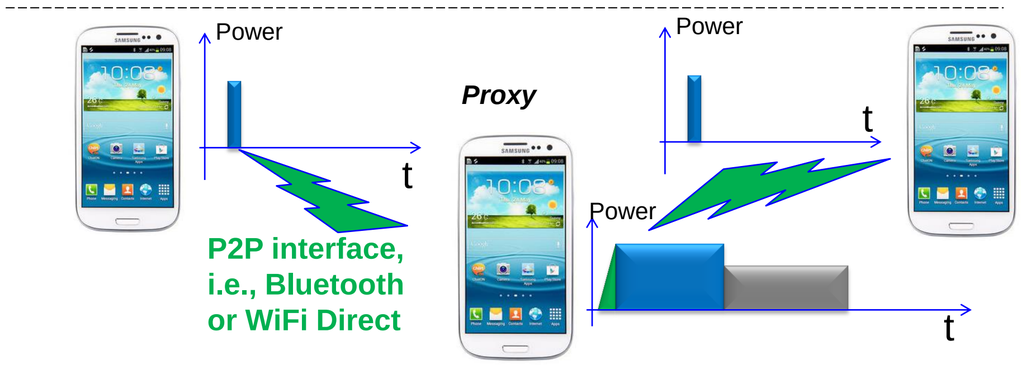


Motivation: Save energy and reduce delay by aggregate traffic on one node (proxy)

Original approach



Our approach

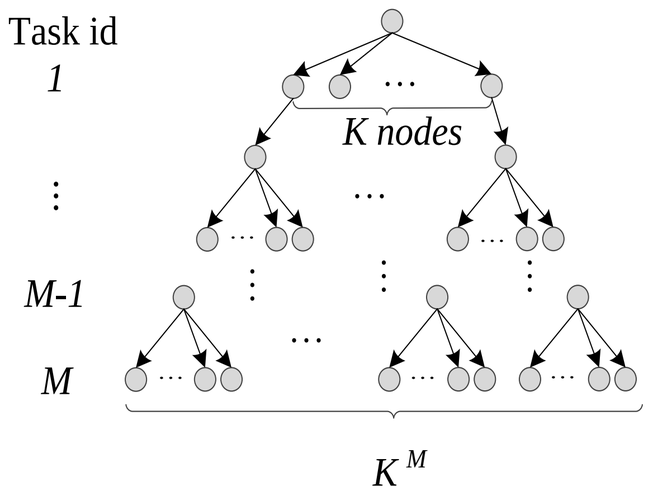


Problem Formulation

Assumptions: Given a group of *K* nodes and *M* tasks, and any task can be scheduled on any nodes when it is generated

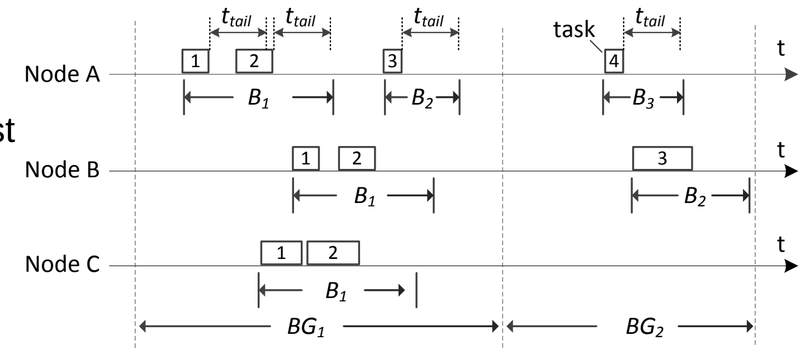
Problem: What is the optimal schedule sequence to get the minimum energy?

Challenge: Solution space is $O(K^M)$, which is hard to solve using traditional algorithms

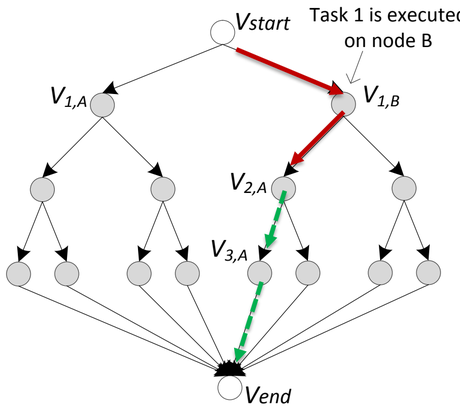


Optimal Traffic Aggregation

Step 1: reduce the problem to sub-problems using burst group (BG)



2 nodes, 3 tasks (K=2, M=3)



Step 2: use A* algorithm to find optimal solution for each sub-problem

Sum of energy before task i

$$F(V_{i,k}) = G(V_{i,k}) + H(V_{i,k})$$

Heuristic estimation of the min energy from task i to the last task

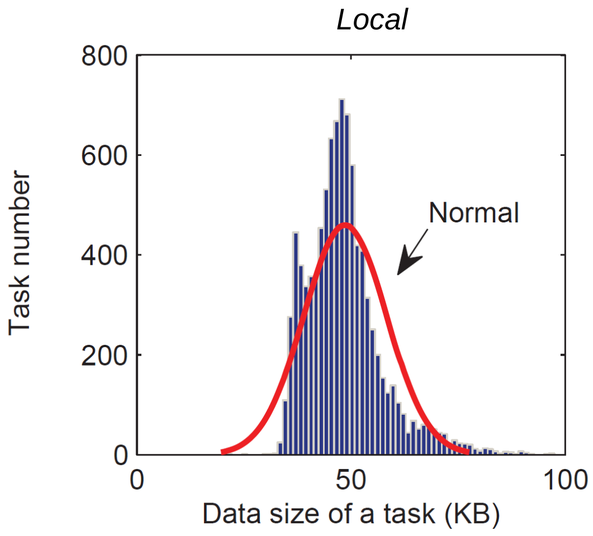
Online Traffic Aggregation

New problems: unaware of future task size and task interval

Predicting data size of task

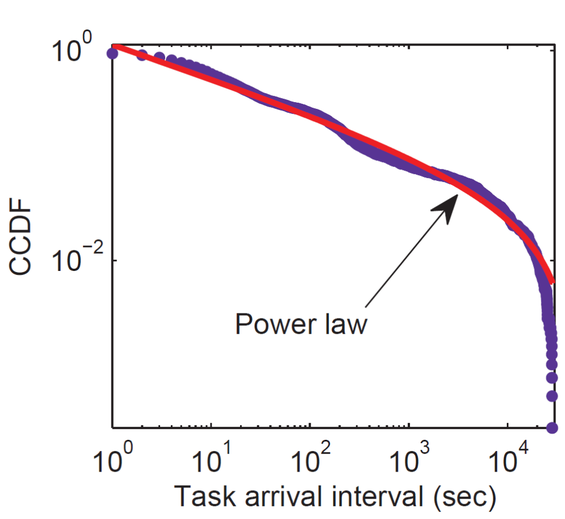
- *Follows normal distribution*
- $\overline{s_i} = (1-\alpha) \times \frac{1}{Q}\sum_{j=i-Q}^{i-1} s_j + \alpha \times s_g$ (Global)

Local



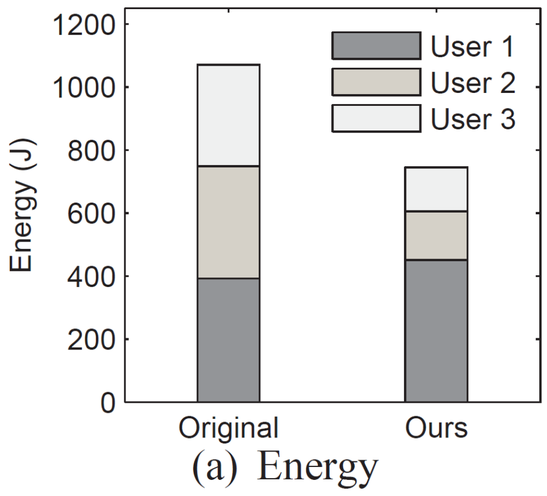
Predicting task interval

- *Follows power law distribution*
- $P(t) \sim at^b + c$



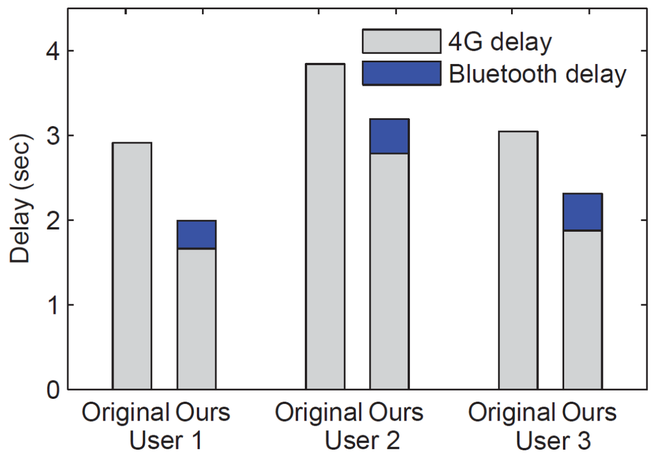
Performance

Testbed: Samsung Galaxy S3 with 4G (HSPA+) data plan, offload traffic using Bluetooth



(a) Energy

Save energy: **30.4%**



(b) Delay

Reduce delay: **31%**

Publication

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