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Optimizing Mobile Computational Offloading with Delay Constraints

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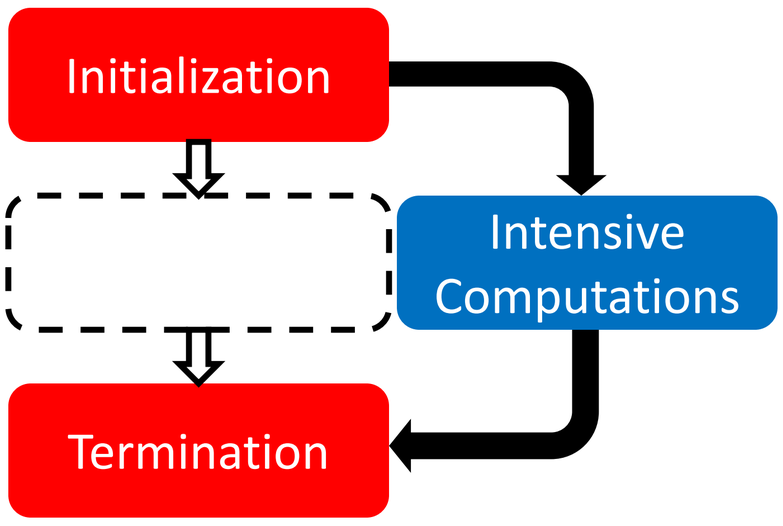
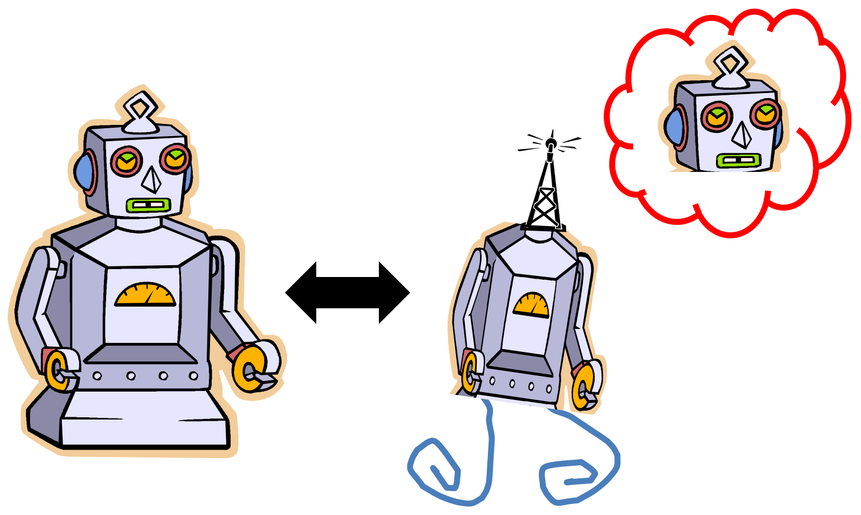
What is Computational Offloading?



Computational Offloading:
Sending Resource-hungry Computations to Remote Server

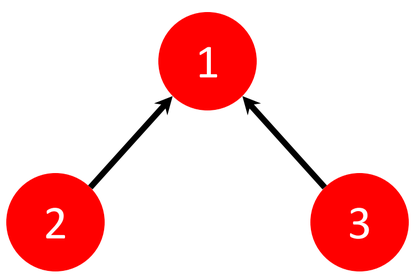
- Save: Energy Consumption, etc.
- Cost: Data Communication, etc.



Problem Formulation

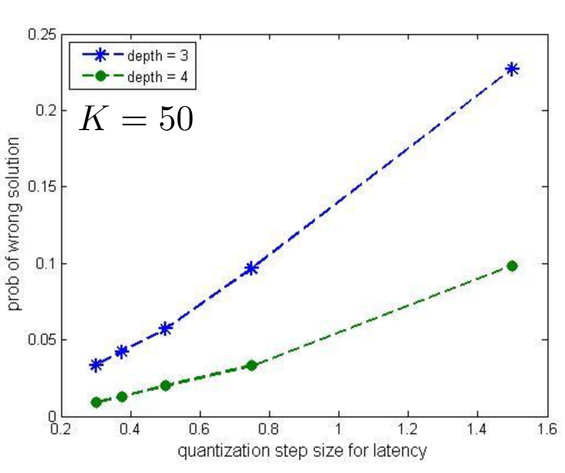
Min *Cost Function*
s.t. *Maximum Delay*

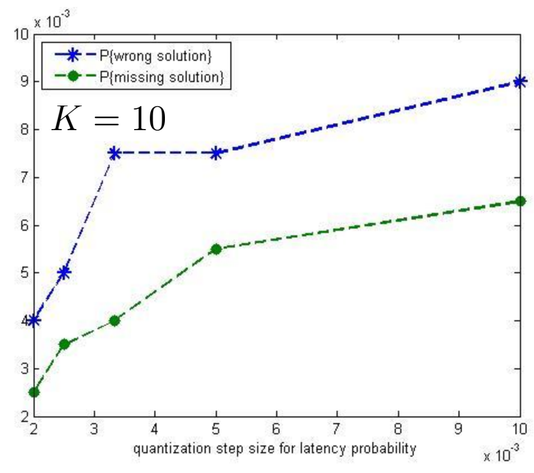
$$T_{total} = T_1 + \max\{T_2, T_3\}$$



Algorithms	Graph	Delay	Complexity
Graph Partitioning	General	NA	Polynomial Time
Binary Linear Integer Programming	Chain	Linear	Not Poly-time Guaranteed
Our Algorithm	Tree	Non-linear	$O(NK)$

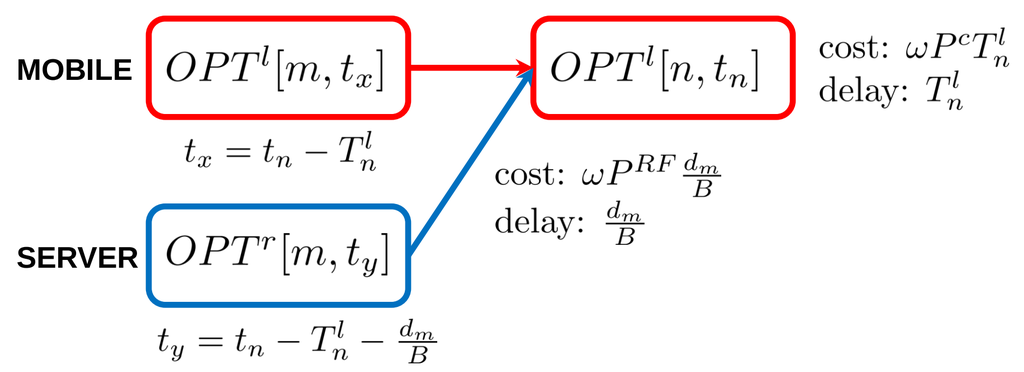
Simulation Results





Algorithm

- A Simple Case



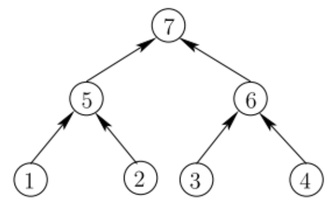
$$OPT^l[n, t_n] = \omega P^c T_n^l + \min\left\{OPT^l\left[m, t_n - T_n^l\right], OPT^r\left[m, t_n - T_n^l - \frac{d_m}{B}\right] + \omega P^{RF}\frac{d_m}{B}\right\}$$

- General Case

Quantization: $q_{up}(t) = t_k, k \in \{1, \cdots, K\}$

$$OPT^l[n, t_k] = \omega P^c T_n^l + \sum_{m \in \mathcal{C}(n)} \min\left\{OPT^l\left[m, t_k - q_{up}\left(T_n^l\right)\right], OPT^r\left[m, t_k - q_{up}\left(T_n^l + \frac{d_m}{B}\right)\right] + \omega P^{RF}\frac{d_m}{B}\right\}$$

- Complexity Analysis
  - BFS: *O(N)*
  - OPT Values: *O(NK)*



Discussion & Future Work

- We also perform stochastic analysis that is applicable to probabilistic delay constraints: $\mathbf{P}\{T_{total} \leq t_{max}\} \geq p_{obj}$.
- Simulation Results show that K~10 provides good performance.

Future Work:
- Generalize our algorithm to acyclic graphs.
- Identify potential applications on mobile networks ,cloud robotics, sensor networks, etc.

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