

Service Level Guarantee for Mobile Application Offloading in Presence of Wireless Channel Errors

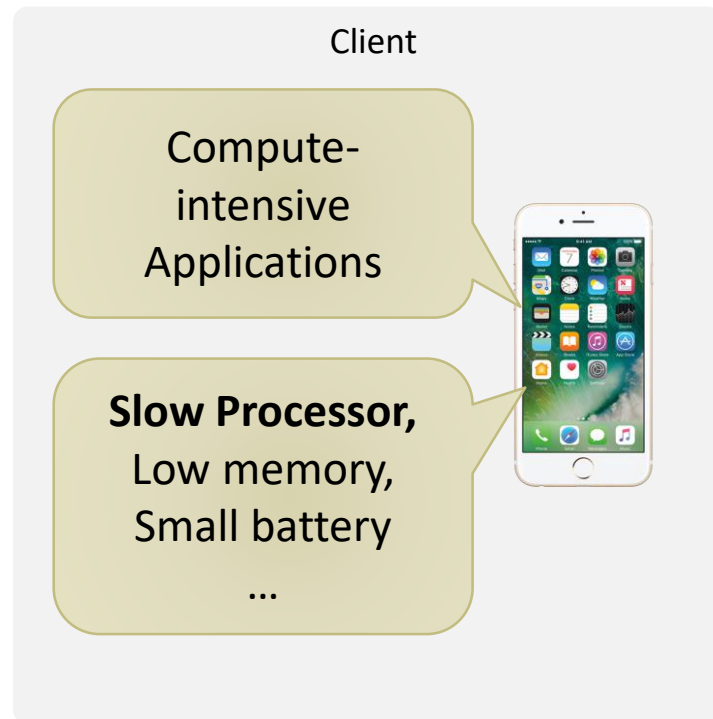
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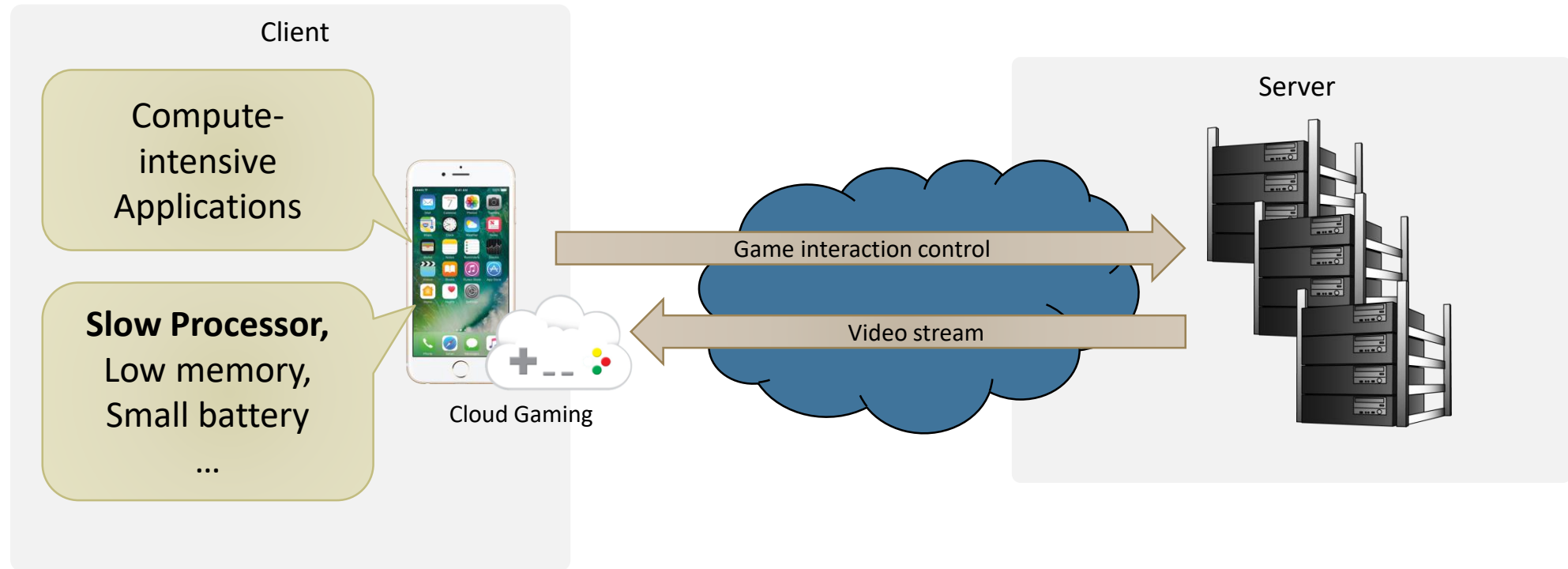
Why Computation Offloading?

- It can provide **fast response time** to user!

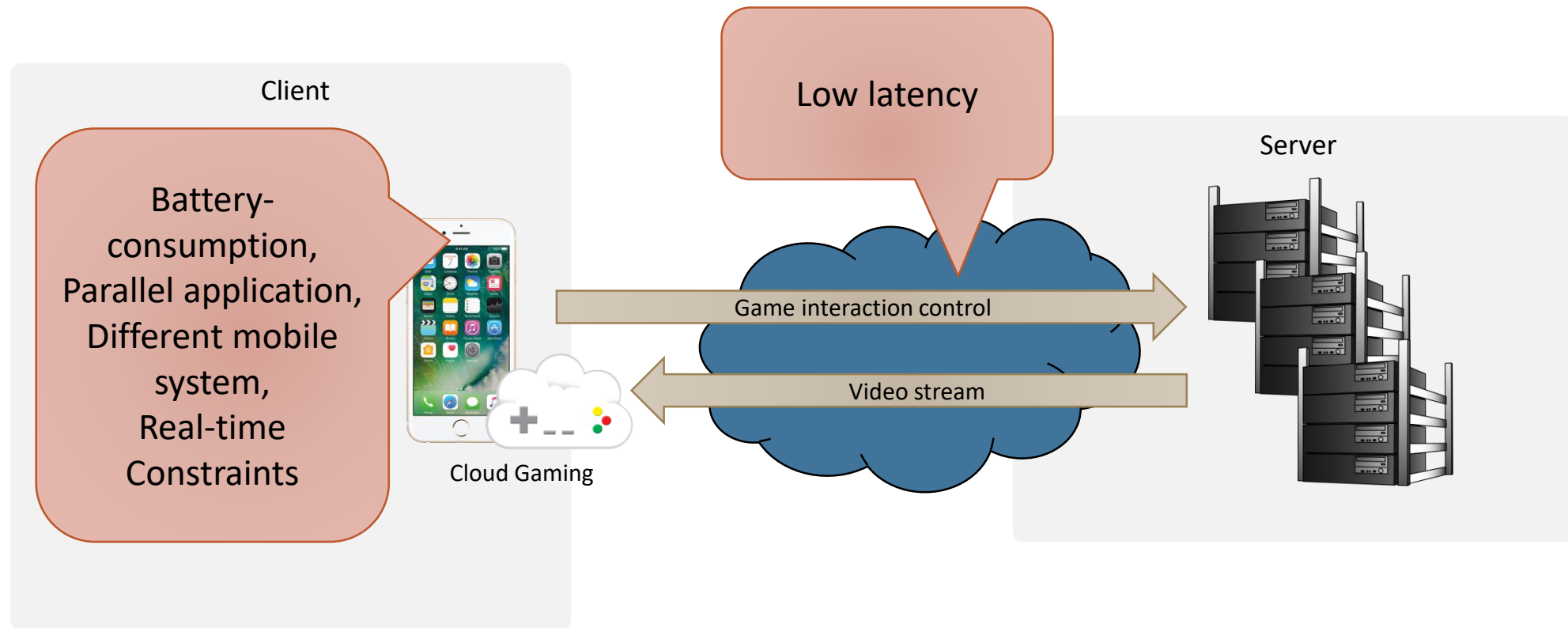


How Offloading Works?

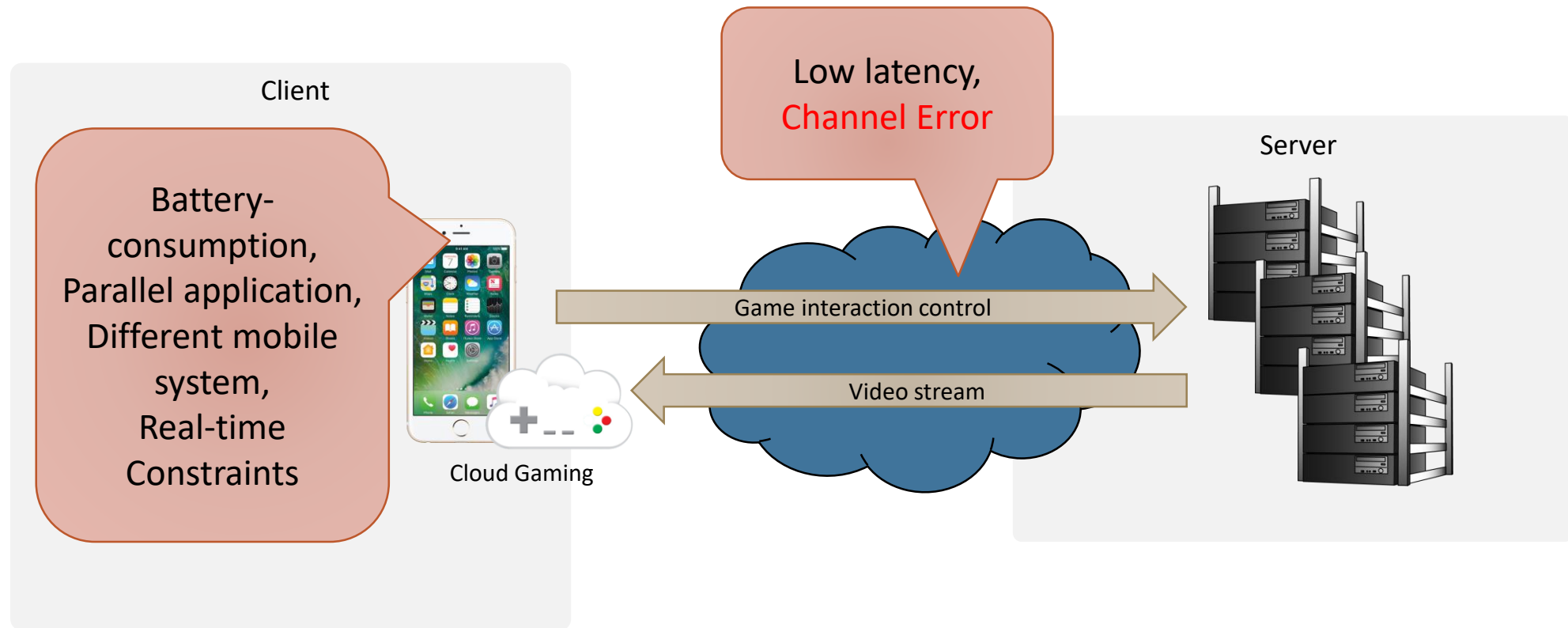
- Mobiles use wireless network to communicate with cloud



Some concerns?

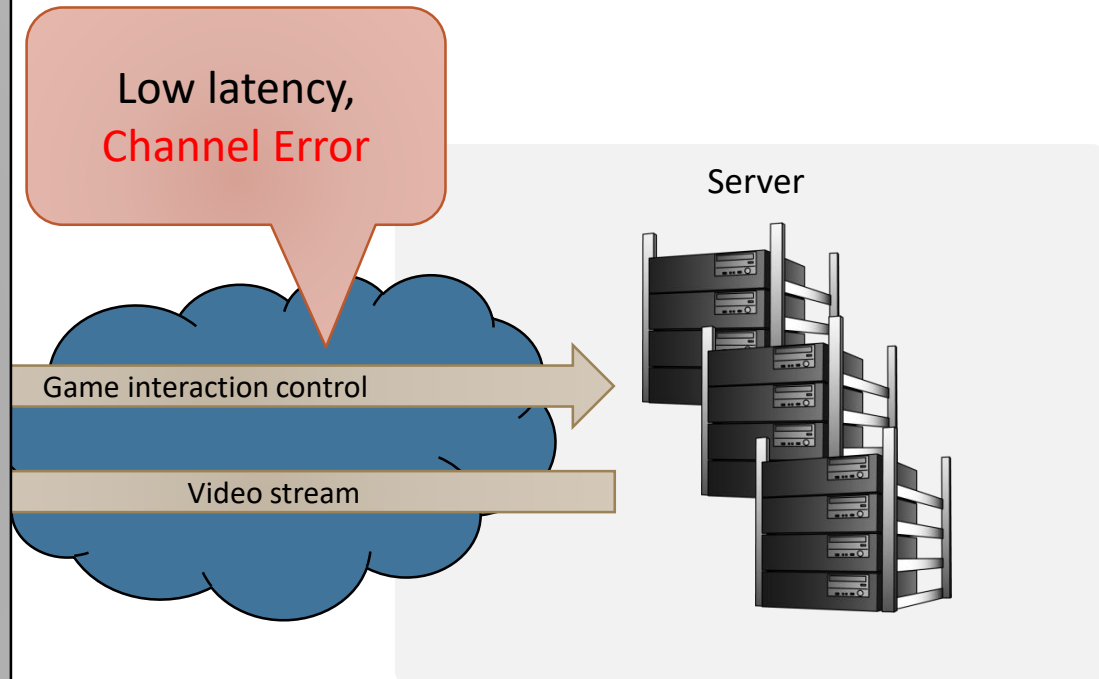
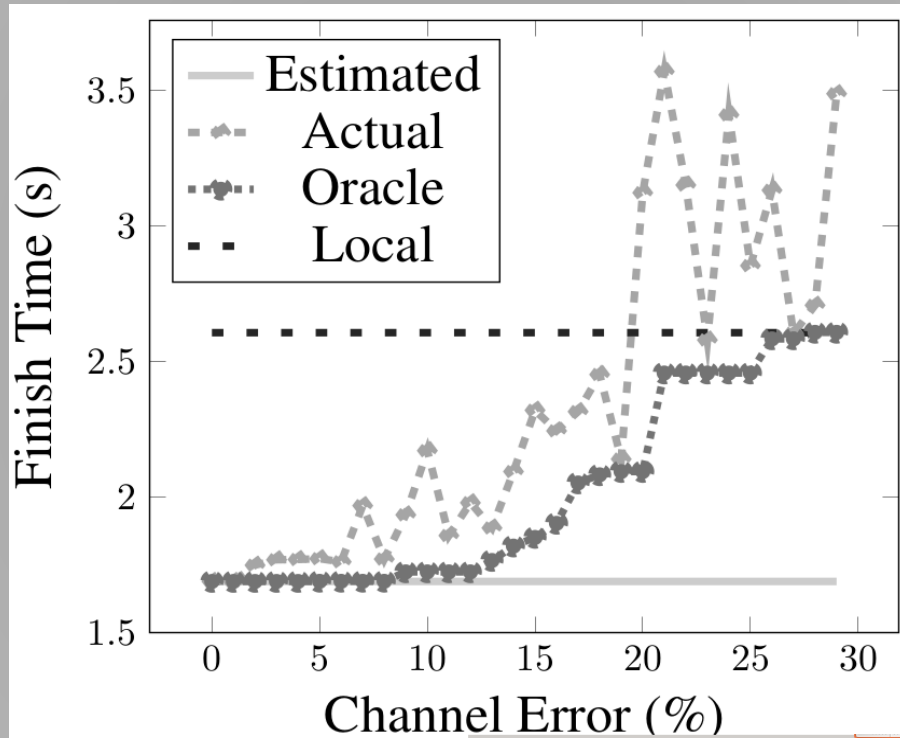


Some concerns?



Some concerns?

- Offloading Gain



Our contribution

- Design an algorithm

- Ensuring service level guarantee (low failure rate)
- Executing faster than local execution
- Dealing with unpredictable channel errors properly

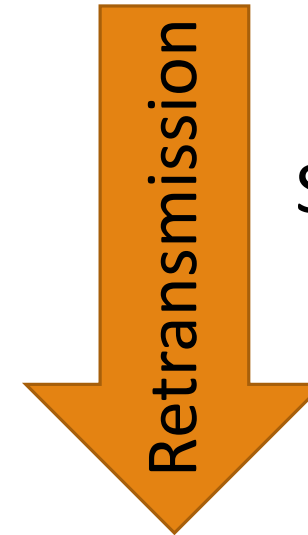
Our Simple Example

- Offload one frame of data; channel error = 0; failure rate = 0.01.

1 attempt -> 0.2 (not satisfy)

2 attempts -> 0.04 (not satisfy)

3 attempts -> 0.008 (**satisfies**)

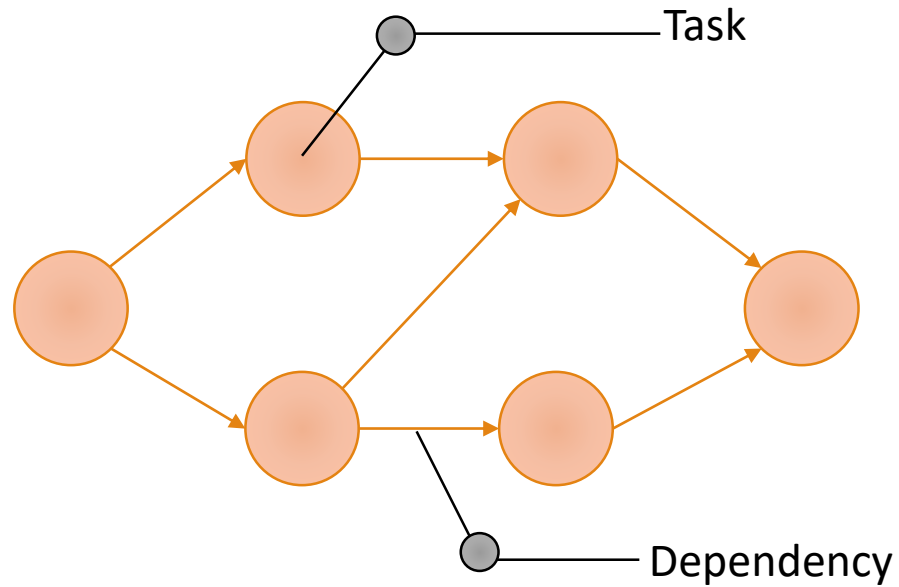


Slower average
execution

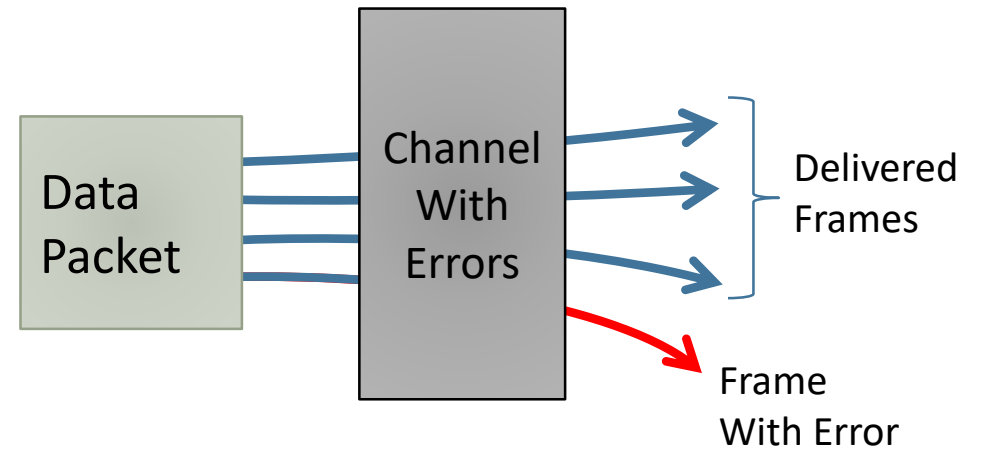
Better
Service Guarantee

Problem Model

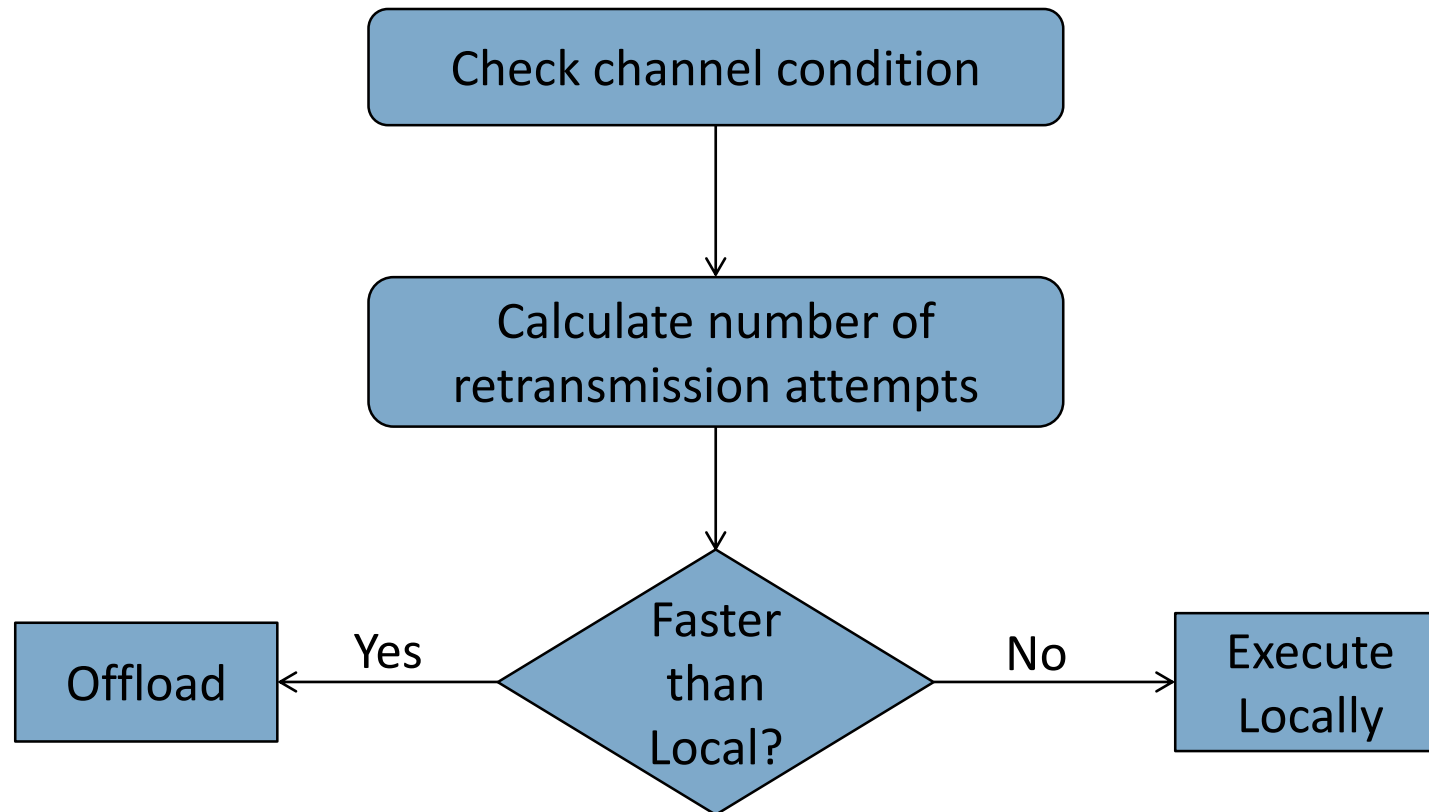
Application



Network



Our Algorithm



Formulation: Objective

Minimize Expected Finish time

$$\text{Min } E[T_m]$$

Formulation Constraint

Service Guarantee Constraint

$$P(T_m > U_m) \leq \epsilon$$

Execution Finish Time

Local Execution Time

Failure rate

Formulation: Summary

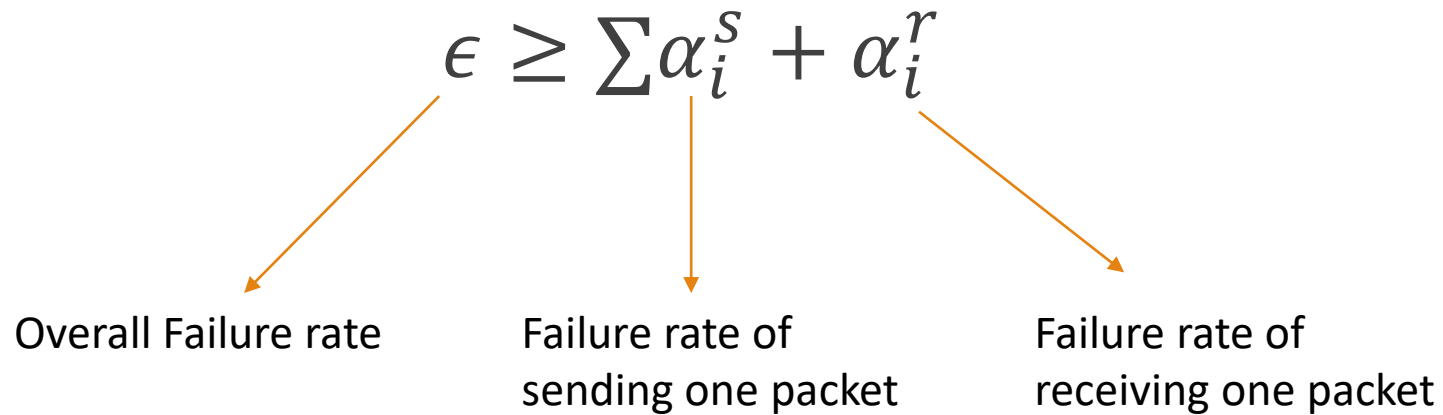
Min $E[T_m]$,

Subject to:

$$P(T_m > U_m) \leq \epsilon$$

Reduction of Service Guarantee

Overall Failure = $\cup P(\text{Individual Migration Failure})$



We choose $\alpha_i^S + \alpha_i^R = \frac{\epsilon}{2^i}$

Single Migration Constraint

$$P(T_m > U_m) \leq \alpha^s$$

Assumptions:

1. Each frame takes equal time
2. One packet fragments into w frames

Single Migration Constraint

How many retransmission attempts satisfy constraint?

$$\text{Migration: } Q \sim \text{Binomial}(z, p) \geq w$$

Random variable
Denoting Number
of transmissions

Number of maximum
Transmission attempts

Probability of
successful transmission

Number of frames

How to calculate z given p and w ?

Calculating transmission attempts

No direct formula to get exact value

Our solution: Use Hoeffding's inequality to approximate z :

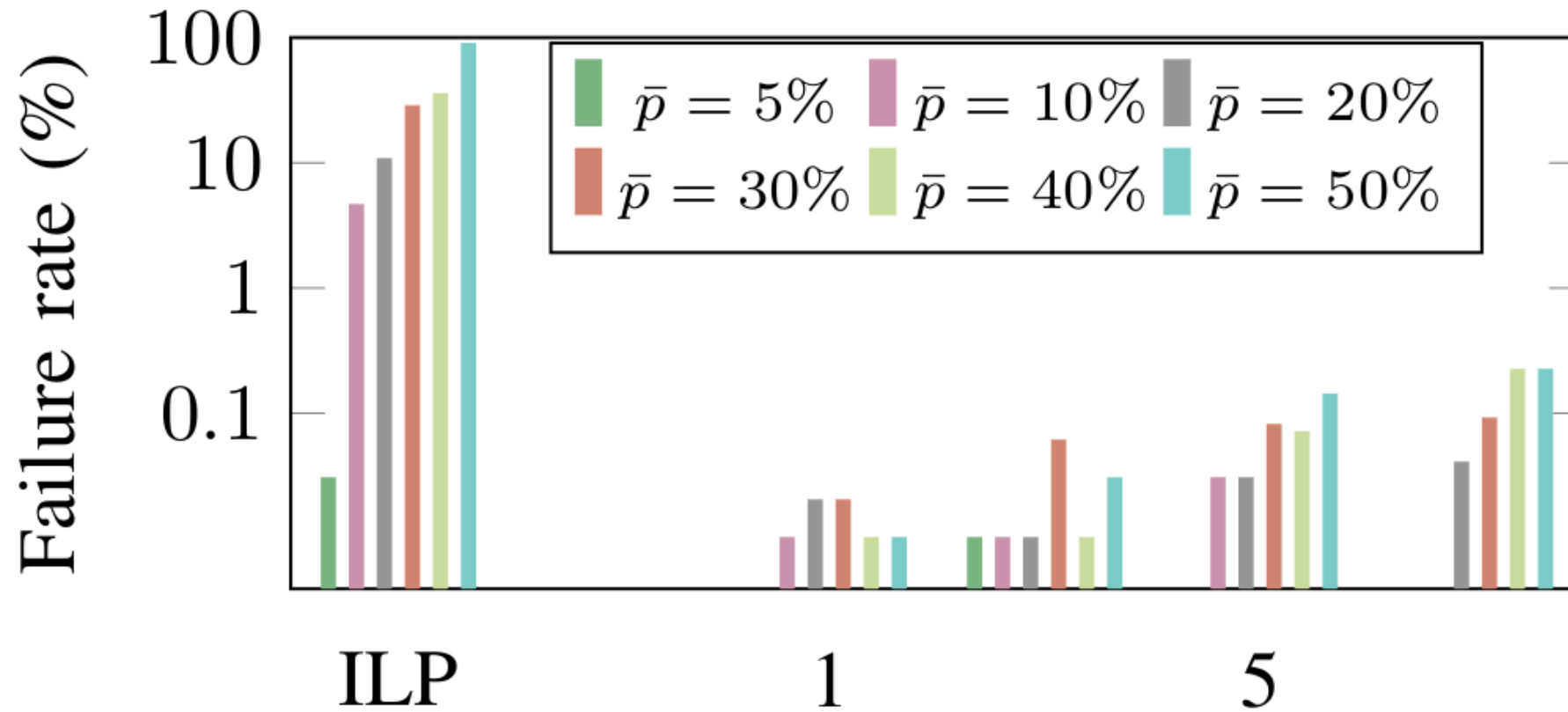
$$z \geq \frac{p(w-1)(4+\sqrt{2})-\ln(\alpha^S)}{2p^2}$$

Similarly, for receiving packet from cloud to mobile,

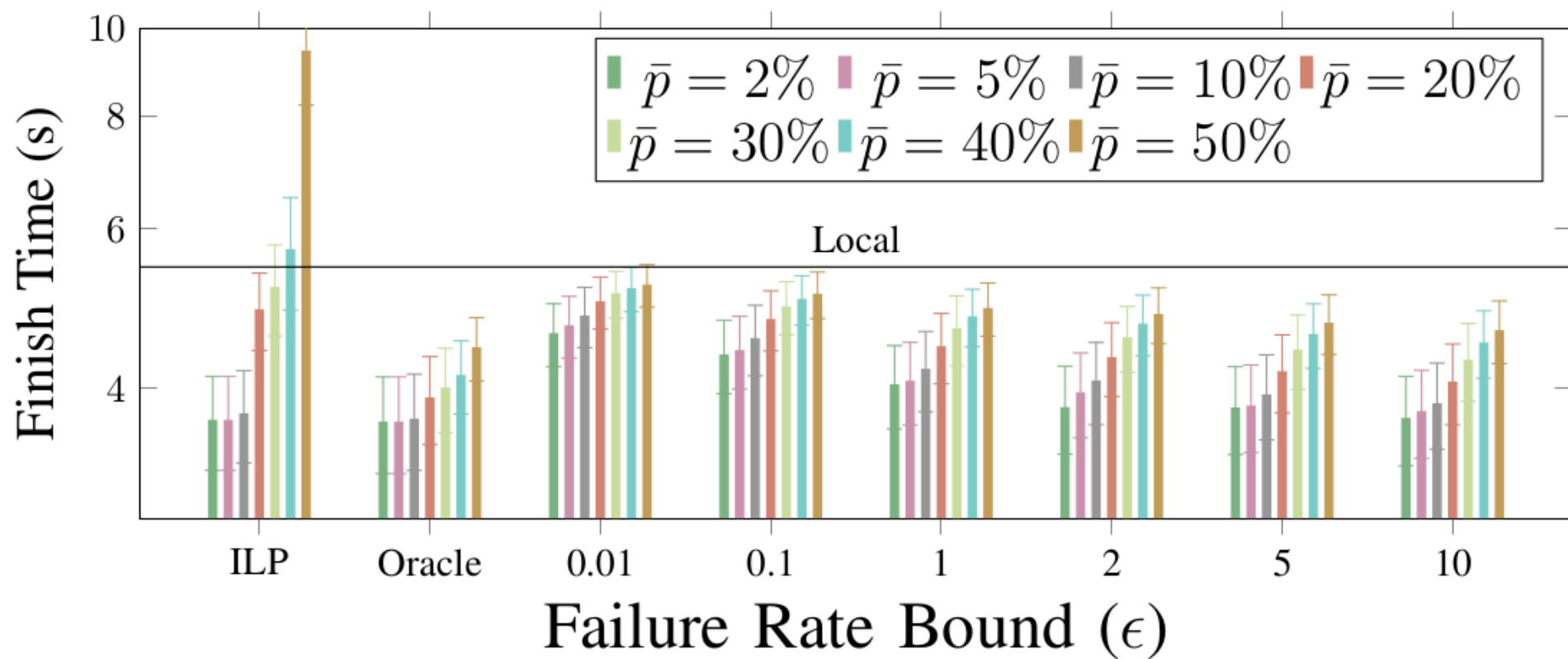
$$z \geq \frac{p(w-1)(4+\sqrt{2})-\ln(\alpha^r)}{2p^2}$$

Expected time maximized when $\alpha^S = \alpha^r$

Evaluation



Finish Times



Summary

- Providing guarantee of service useful in offloading over uncertain network
- Single transfer of data is modeled as a Binomial process
 - Number of transmission attempts obtained using Hoeffding's inequality
- Our algorithm developed can provide stochastic guarantees

Questions?