EdgeDroid

An Experimental Approach to Benchmarking Human-in-the-Loop Applications

M. Olguín Muñoz[†], J. Wang[‡], M. Satyanarayanan[‡] and J. Gross[†]

[†] KTH Royal Institute of Technology
[‡] Carnegie Mellon University

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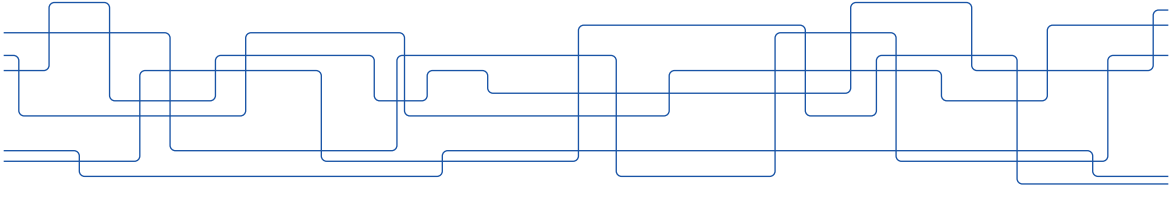


65
126ft
NE
354


SAMSUNG

Sensory Input

Human-parseable
Feedback

Studying Human-in-the-Loop Applications

Need to understand and optimize these applications:

- How do they interact with each other?
- How do they interact with infrastructure?
- How do they scale?

With which methodology can we study these behaviors?

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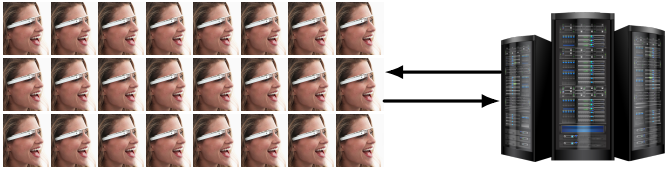

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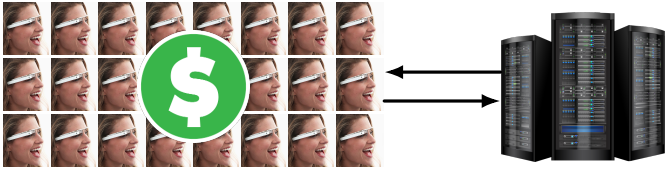

Costly

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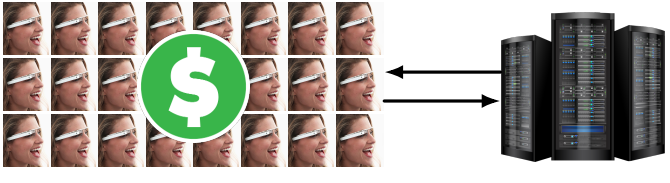
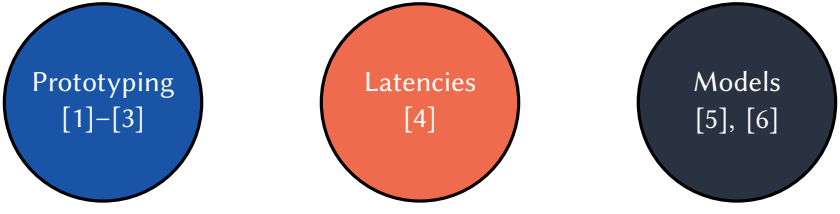
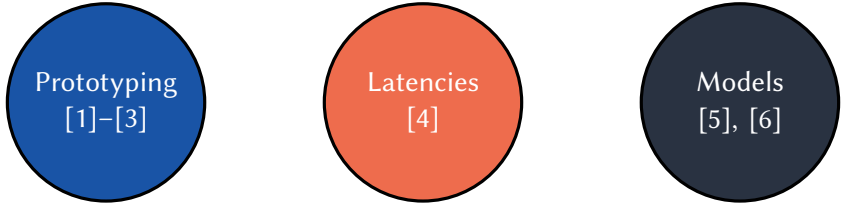


Costly, poor repeatability

Previous & Related Work



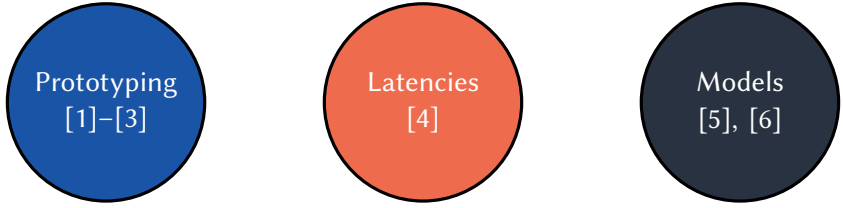
Previous & Related Work



Our Contributions

- A methodology for benchmarking human-in-the-loop applications.

Previous & Related Work



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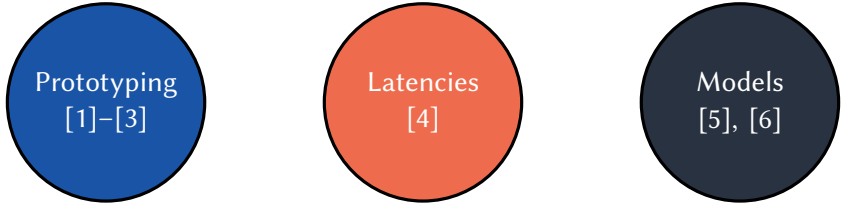
- A methodology for benchmarking human-in-the-loop applications.
- EdgeDroid: A benchmarking tool-suite.

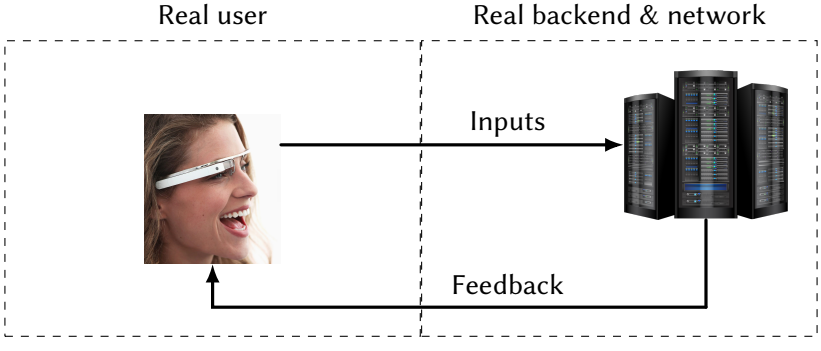
Previous & Related Work



Our Contributions

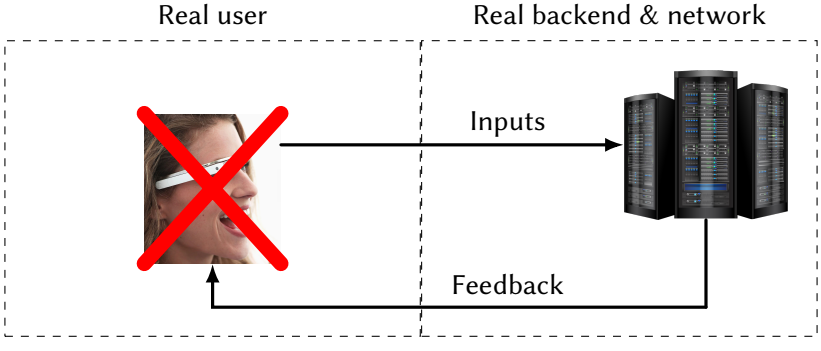
- A methodology for benchmarking human-in-the-loop applications.
- EdgeDroid: A benchmarking tool-suite.
- Experiments and measurements which show the effectiveness of the approach.

Approach



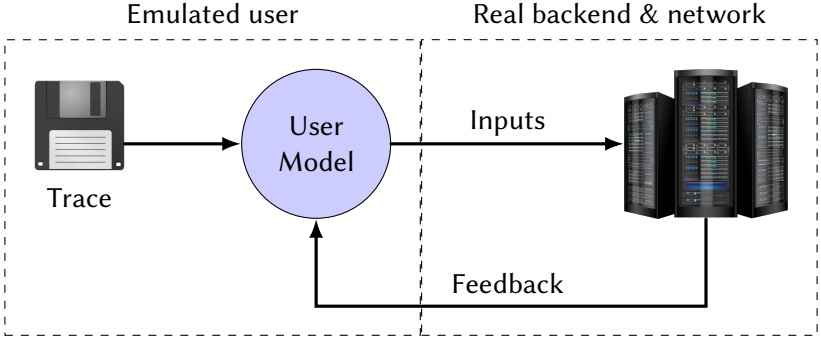
Benchmarking human-in-the-loop applications is HARD

Approach



What if we could do away with the human users?

Approach



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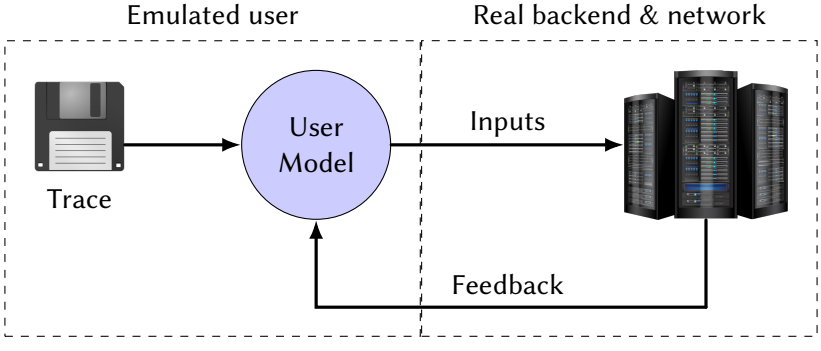
Repeatable, scalable!

Approach

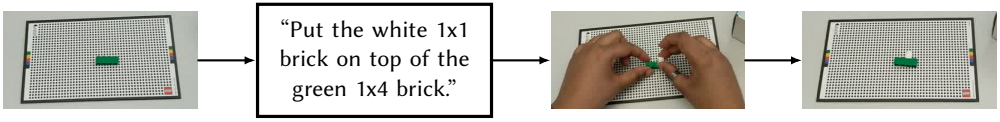


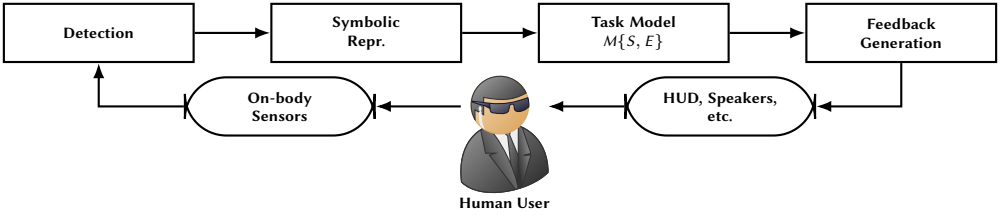
What if we could do away with the human users?

Repeatable, scalable!

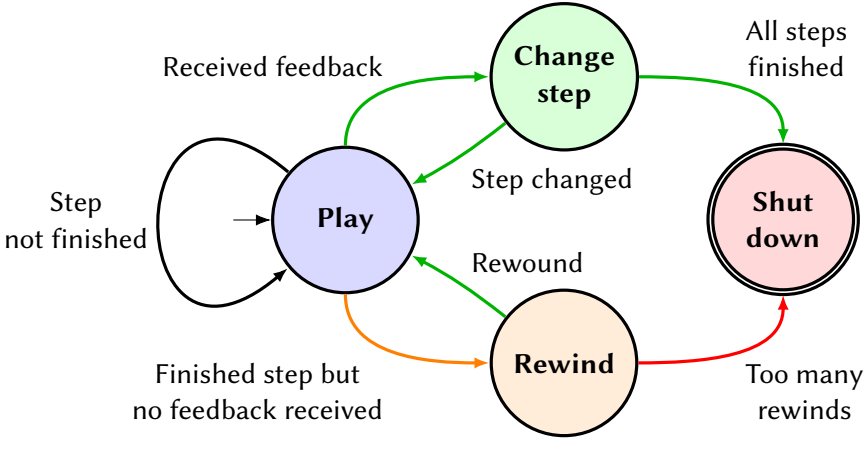
Key question: Credibility.

Task-guidance Wearable Cognitive Assistance [1]

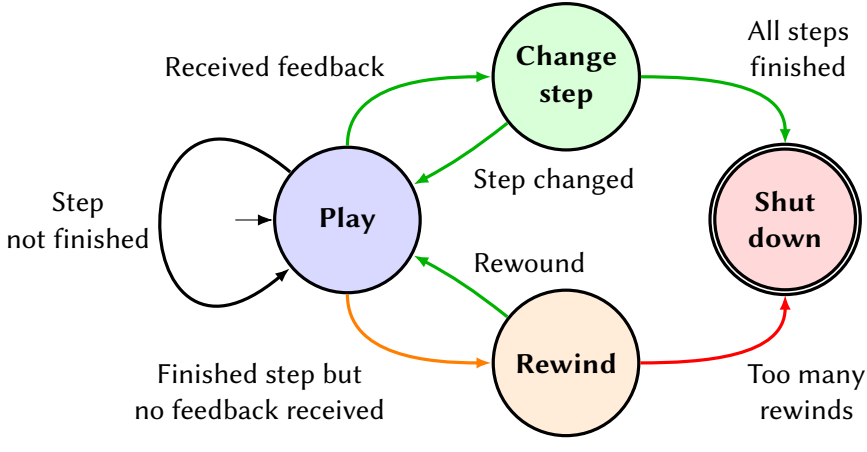




User Model

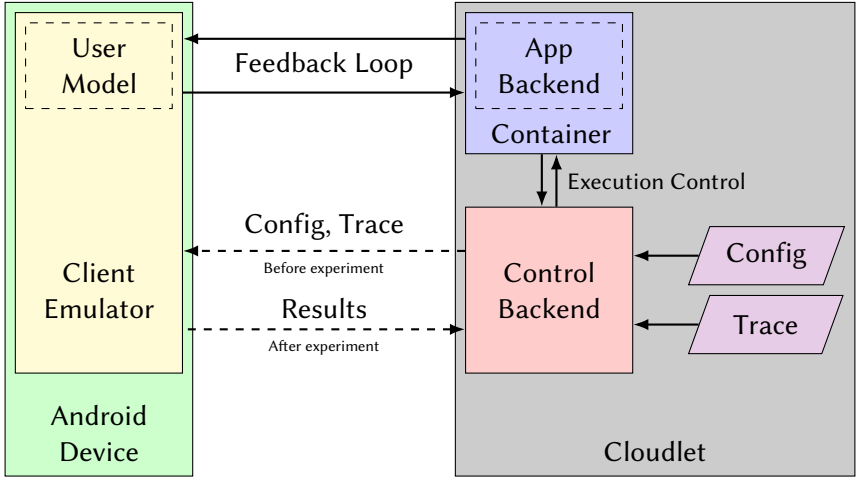

Change step
All steps finished
Received feedback
Step changed
Step not finished
Play
Shut down
Rewound
Rewind
Finished step but no feedback received
Too many rewinds

User Model



Currently working on a more thorough characterization of human behavior.

Implementation



https://github.com/molguin92/EdgeDroid

Evaluation

Key purpose:
Demonstrate utility of EdgeDroid.

Scenarios

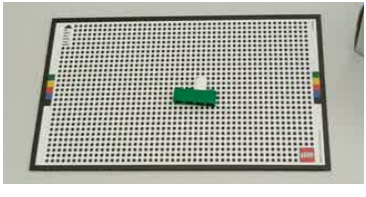
- *Optimal* scenarios with 1, 5 and 10 devices.
- Weakened wireless link with 10 devices.

Table: Latency bounds (Chen *et al.* [4]).

Latency [ms]	Quality
< 600	Excellent
$600 - 2700$	Impaired
> 2700	Unusable

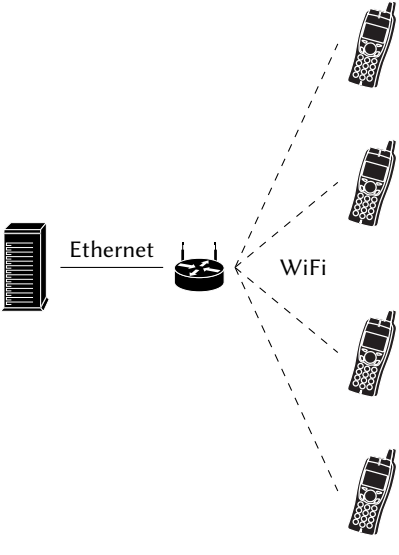
Evaluation Setup

Application



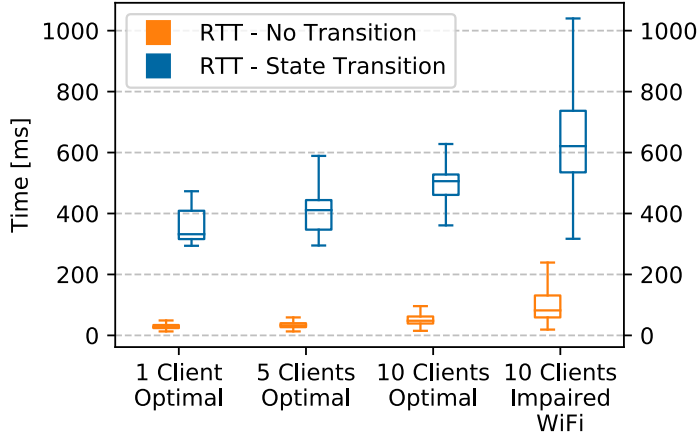
LEGO Assistant

- 7 steps
- 2 min average duration

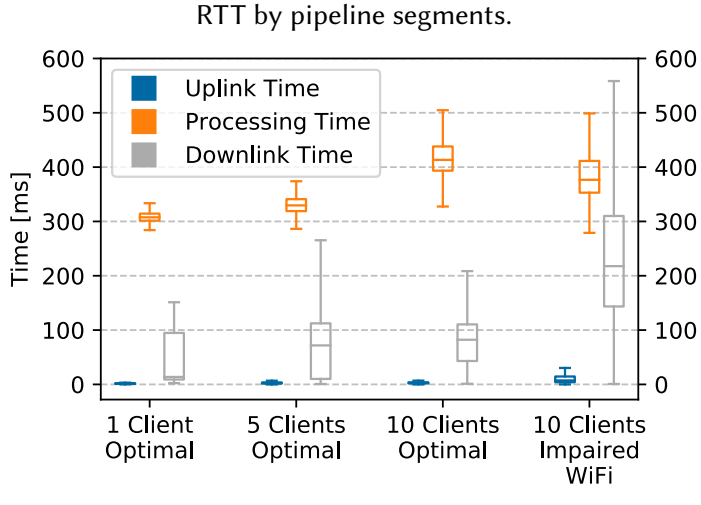


Results

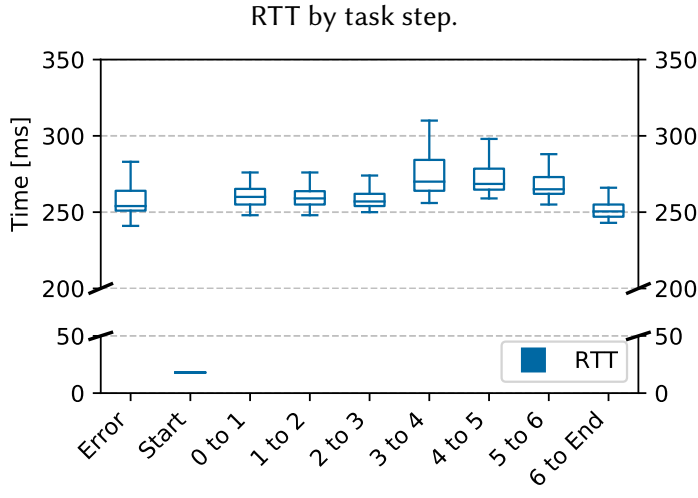
Inputs that triggered a state change vs. inputs that did not.



Results


RTT by pipeline segments.
Uplink Time
Processing Time
Downlink Time
Time [ms]
600
500
400
300
200
100
0
1 Client Optimal
5 Clients Optimal
10 Clients Optimal
10 Clients Impaired WiFi

Results


RTT by task step.
Time [ms]
350
300
250
200
50
0
RTT
Error
Start
0 to 1
1 to 2
2 to 3
3 to 4
4 to 5
5 to 6
6 to End

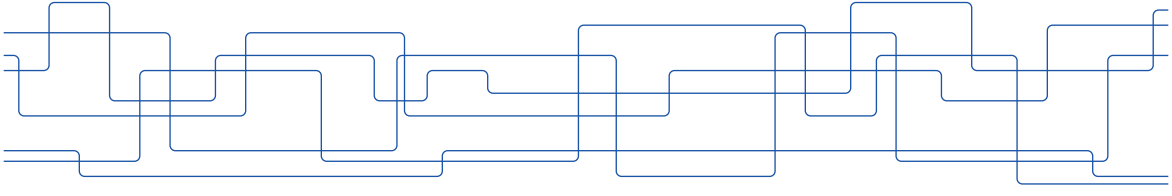
Conclusions

Future Work

- More accurate user model.
- Expand to other types of Applications.

Summary

- There's a need to study the scaling of Human-in-the-Loop applications.
  - This is difficult due to human users.
- We present a methodology + tool suite for benchmarking:
  - **EdgeDroid**
  - Trace based.
  - Model of human behavior.
- We present results which show the utility of EdgeDroid.

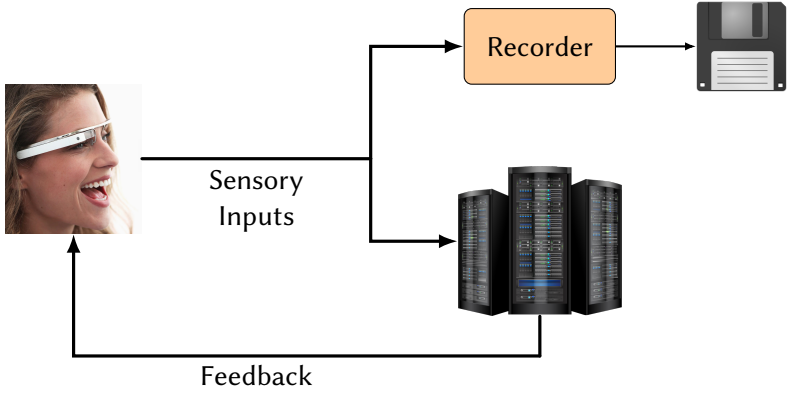


Requirements

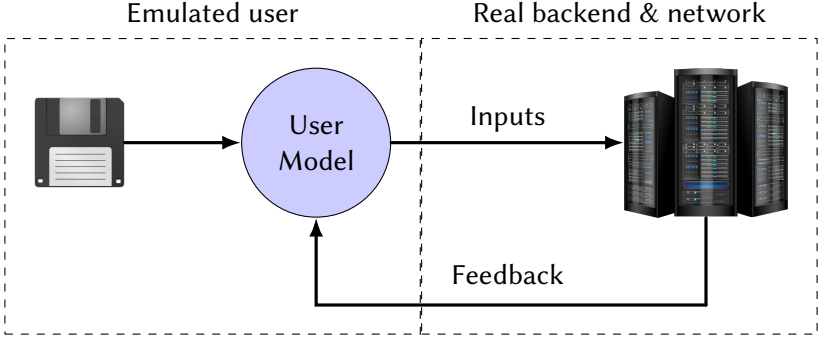
- Generate realistic, high-dimensional, real-time inputs.
- Correctly and realistically react to feedback.
- KPI: Delays.

Trace of pre-recorded inputs & a model of user behavior

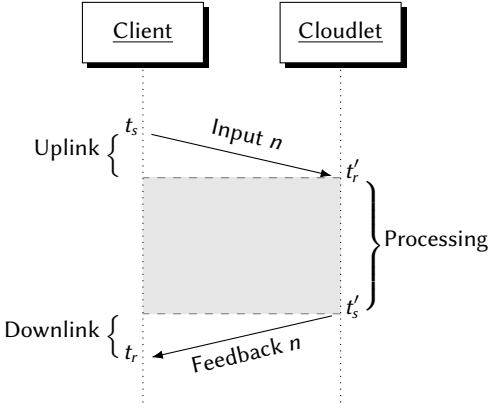
Tracing



Trace Replay



Timestamping



Clocks are synchronized previous to the experiment.

Timestamps at key points to obtain:

$$\Delta T_{\text{up}} = t'_r - t_s \tag{1}$$
$$\Delta T_{\text{proc}} = t'_s - t'_r \tag{2}$$
$$\Delta T_{\text{down}} = t_r - t'_s \tag{3}$$

$$\Delta T_{\text{total}} = \Delta T_{\text{up}} + \Delta T_{\text{proc}} + \Delta T_{\text{down}} = t_r - t_s \tag{4}$$

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