How fast?
How furious?

Real people
Real optimizations

"Measuring QoE of Interactive Workloads and Characterising Frequency Governors on Mobile Devices."

IISWC 2014

Volker Seeker, Pavlos Petoumenos,
Hugh Leather and Bjorn Franke

"Measuring QoE of Interactive Workloads and Characterising Frequency Governors on Mobile Devices."

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"Refreshingly low on quantitative data"

"Measuring QoE of Interactive Workloads and Characterising Frequency Governors on Mobile Devices."

IISWC 2014

Volker Seeker, Pavlos Petoumenos, Hugh Leather and Bjorn Franke

"Refreshingly low on quantitative data"

Testing
Evaluating
Tuning

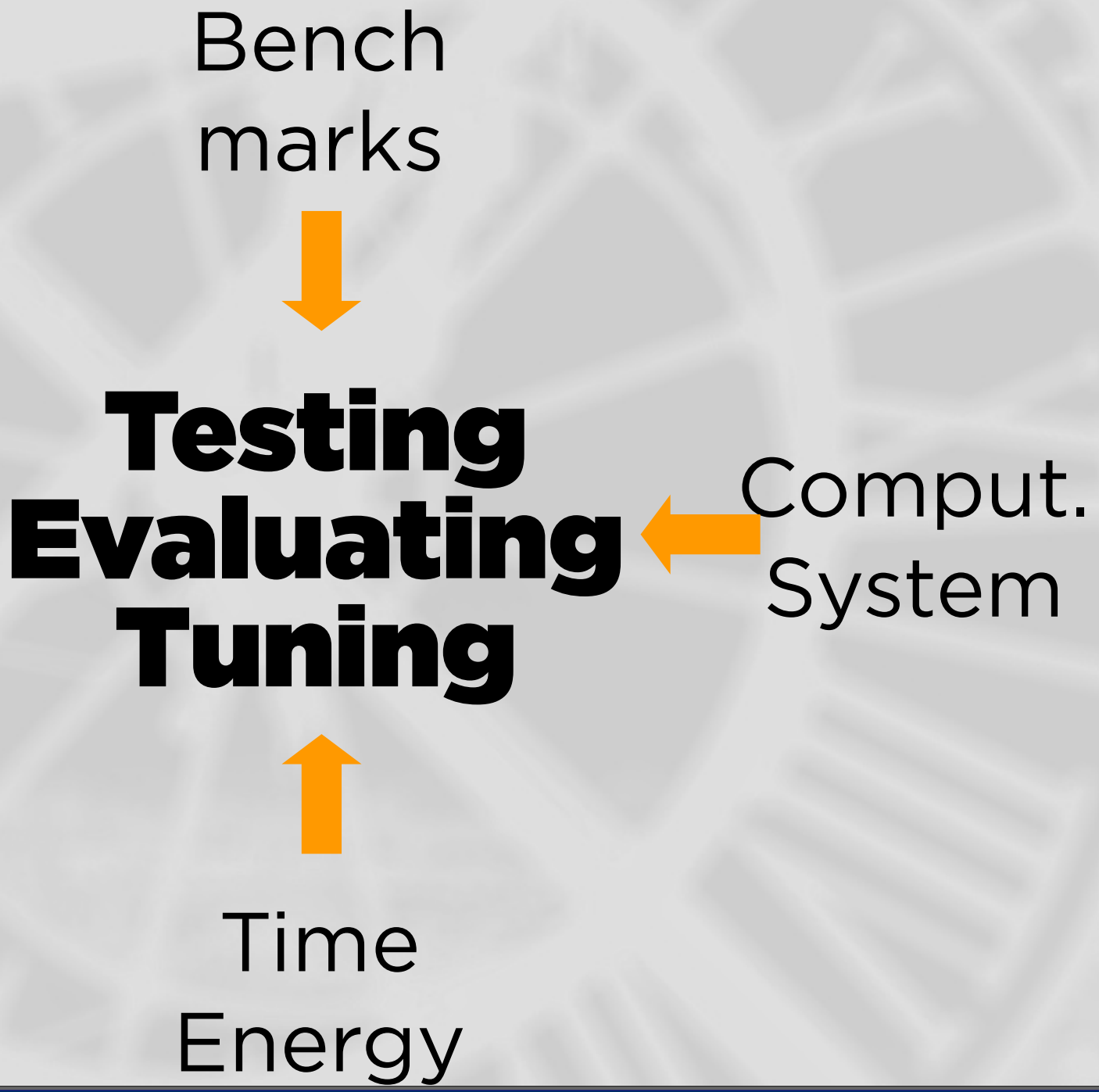
Bench marks

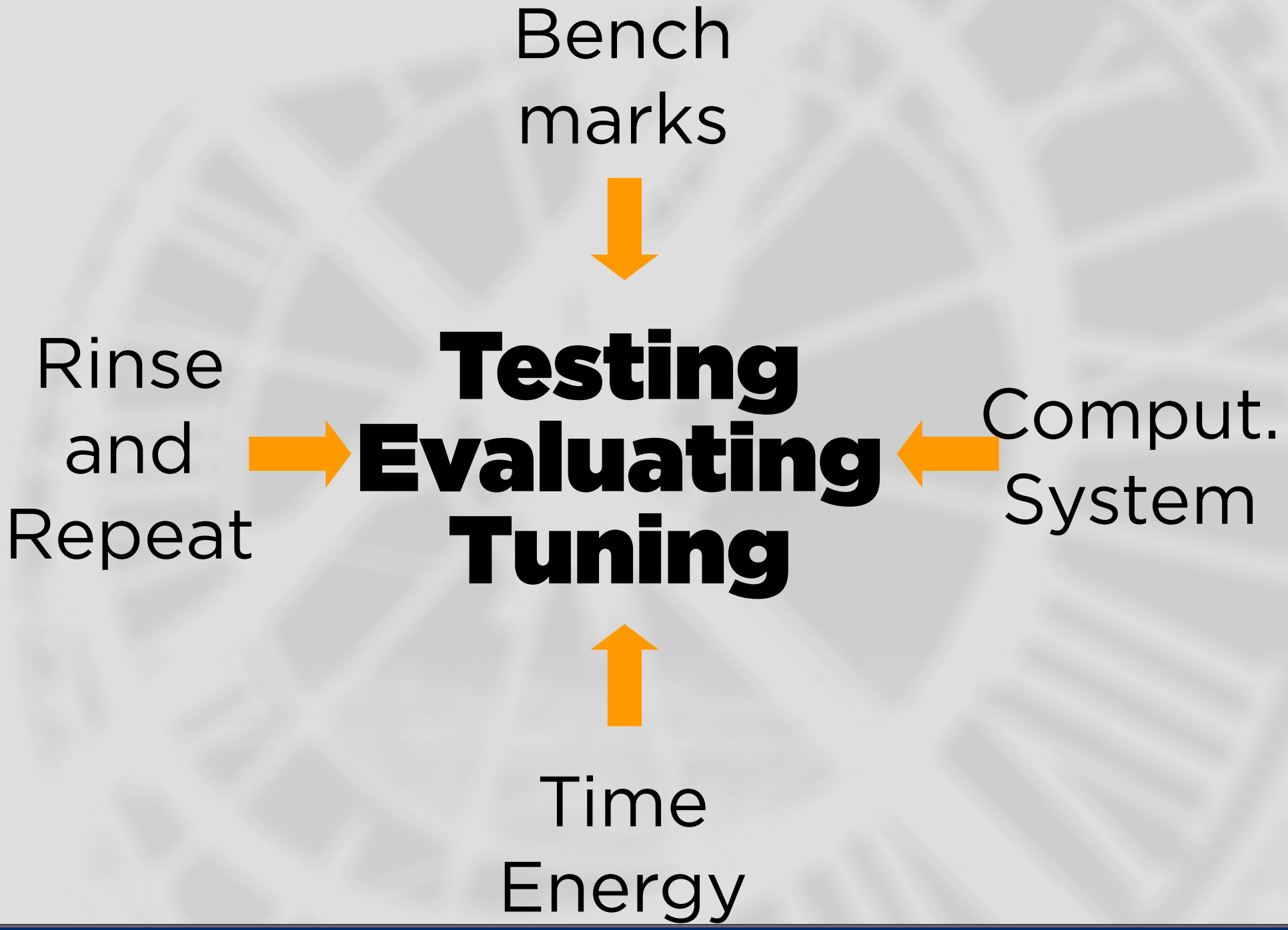
Testing
Evaluating
Tuning

Bench marks

Testing
Evaluating
Tuning

Comput. System


Bench marks
Testing
Evaluating
Tuning
Comput. System
Time
Energy


Bench marks
Rinse and Repeat
Testing
Evaluating
Tuning
Comput. System
Time
Energy

One size fits all?

Servers ✓

One size fits all?

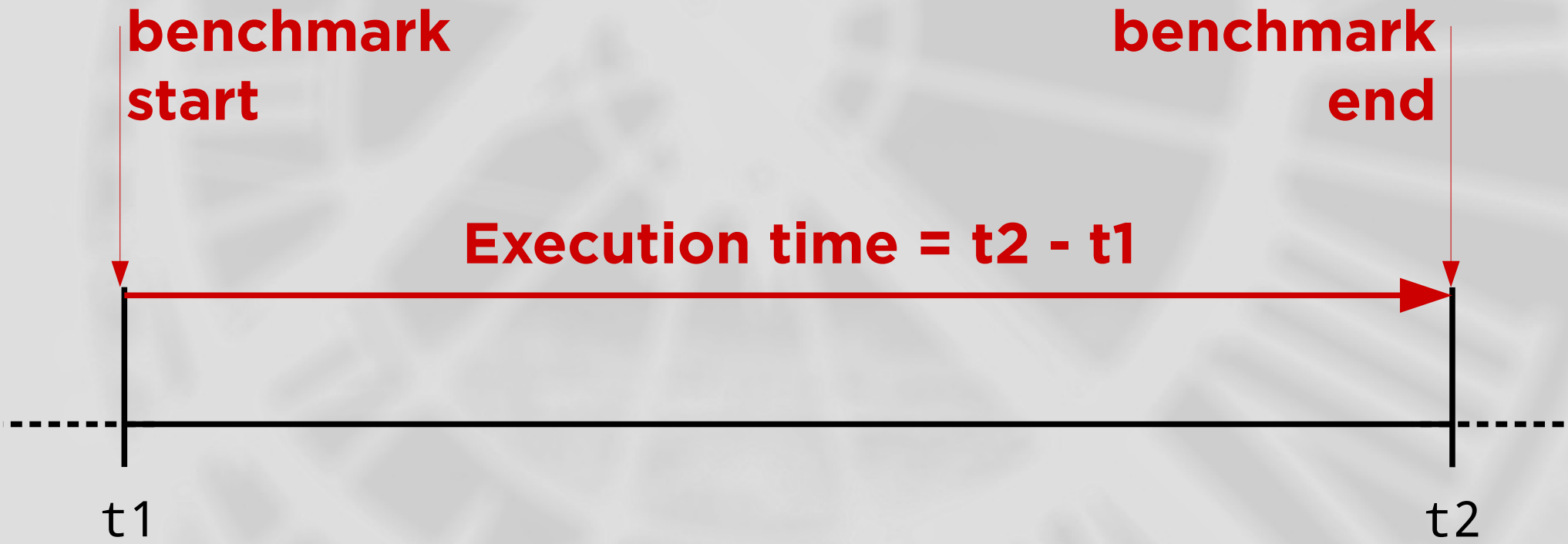
Desktops 

One size fits all?

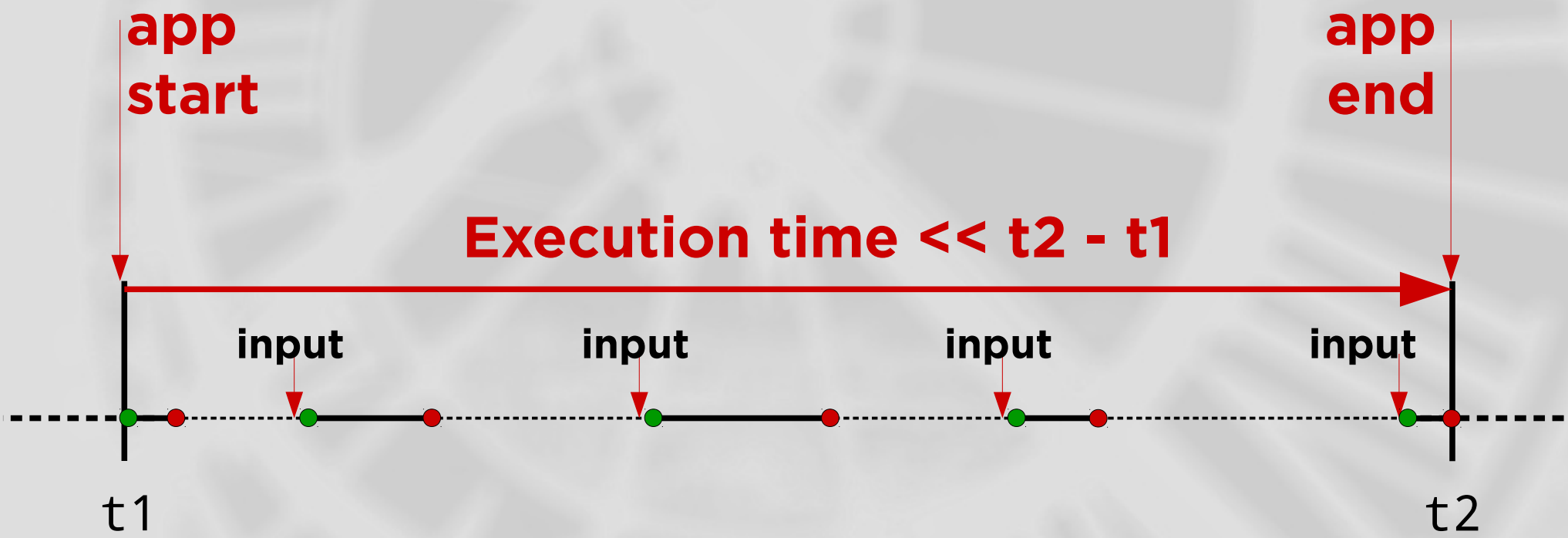
Smartphones 

What does the user really care about?

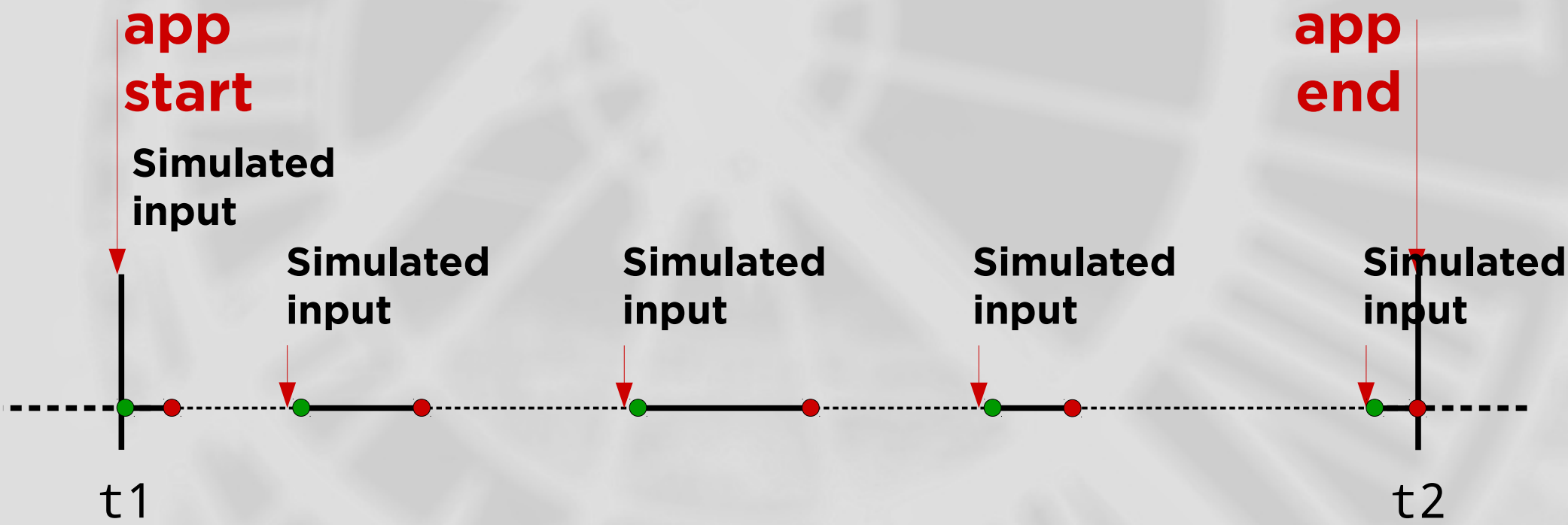
Standard Benchmarks



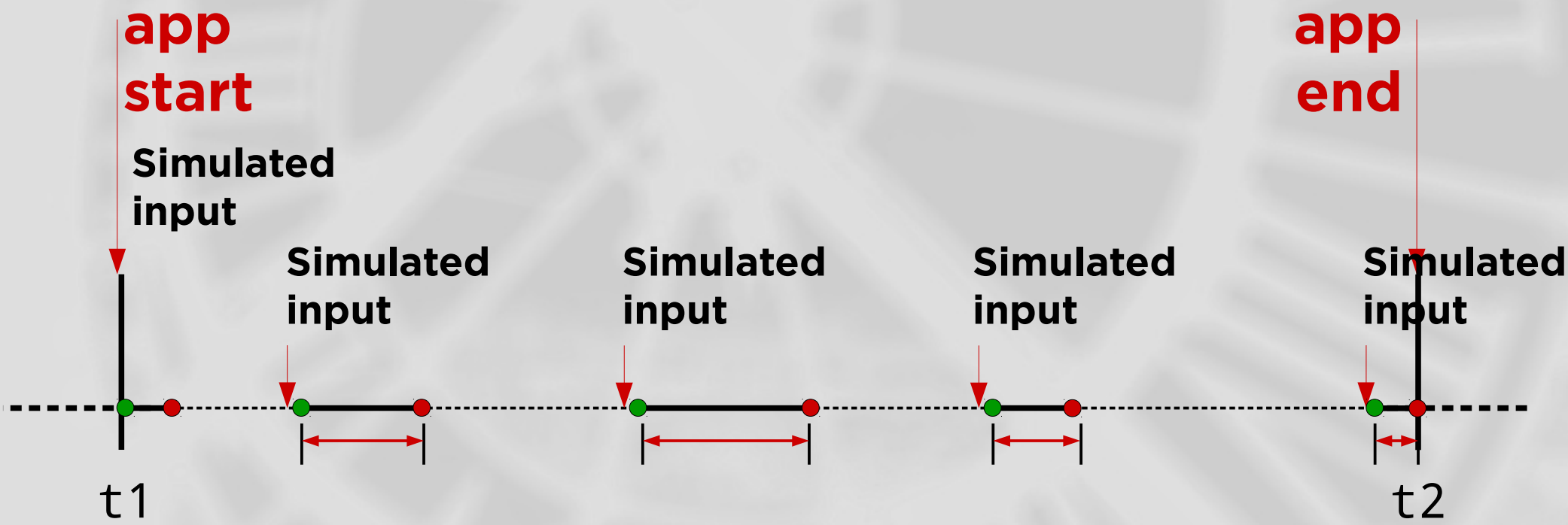
Mobile apps


app start
app end
Execution time << t2 - t1
input
input
input
input
t1
t2

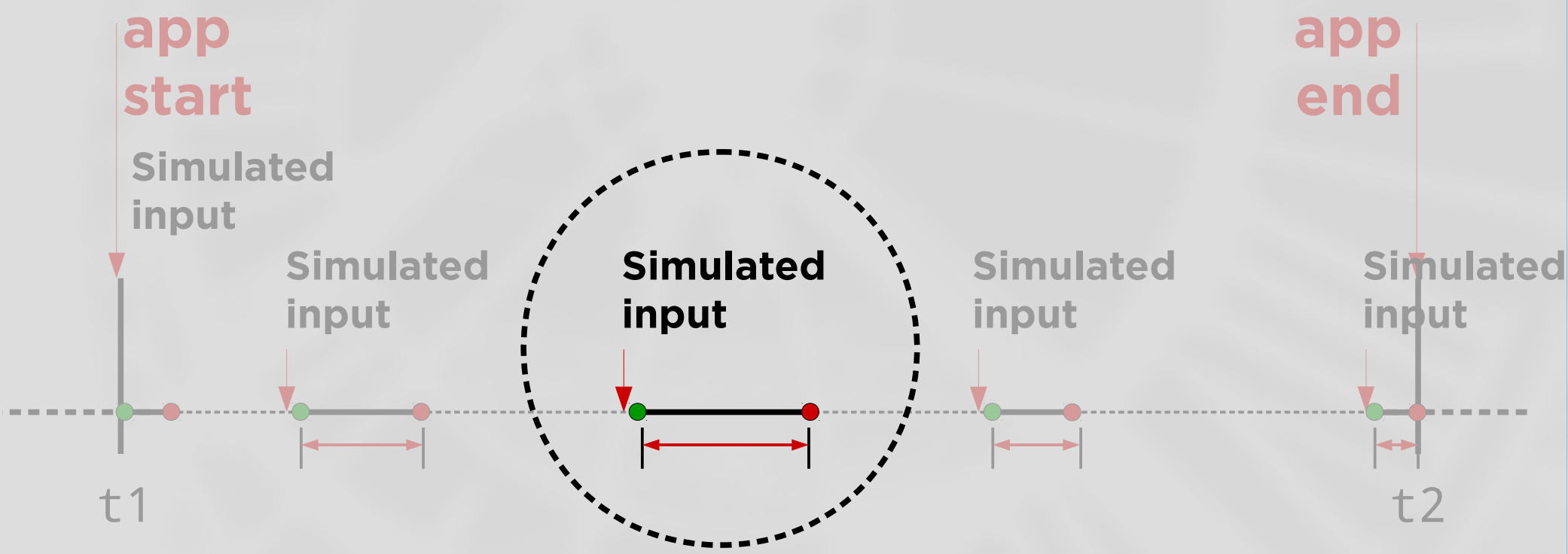
Input Replay



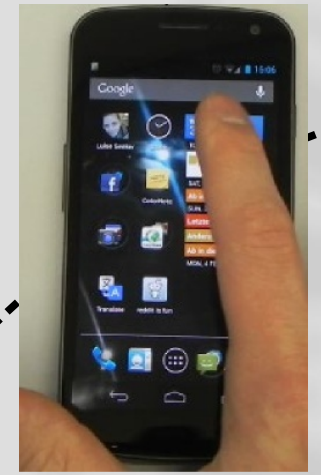
Input Replay



Input Replay

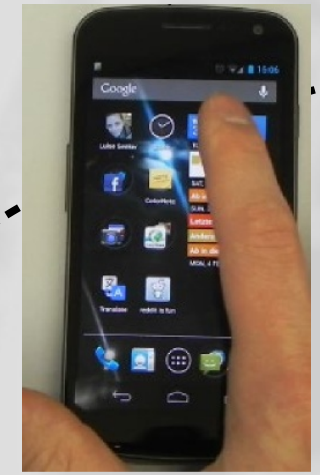


What does the user care about?



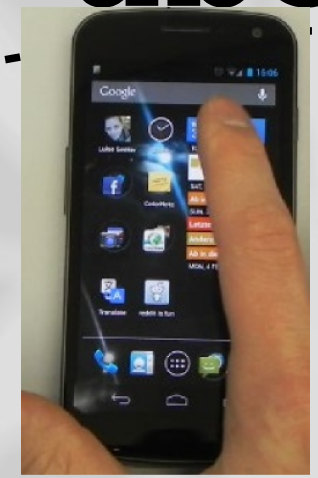
input

What does the user care about?



I/O

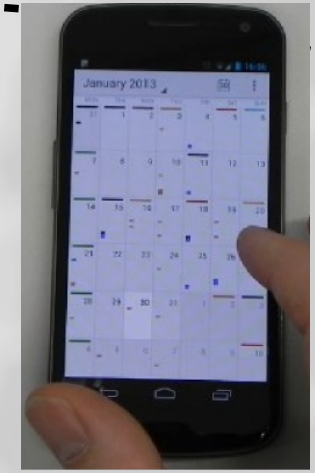
What does the user care about?



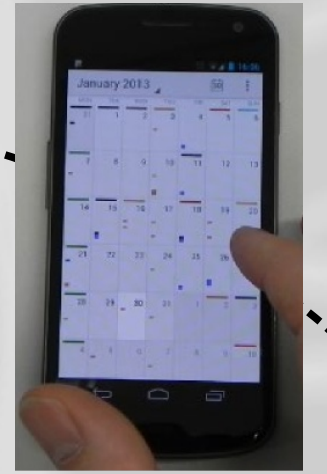
I/O

Processing

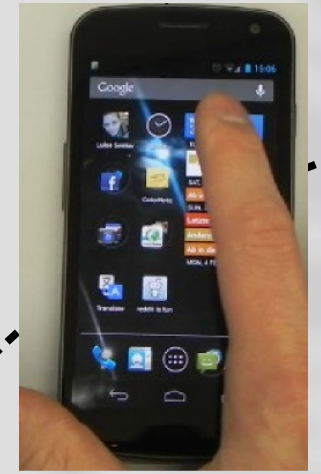
What does the user care about?

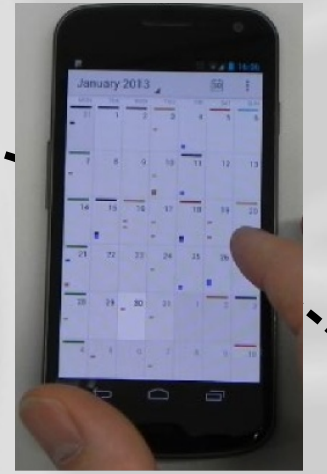


What does the user care about?



What does the user care about?

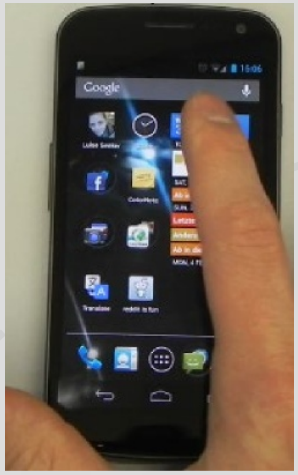


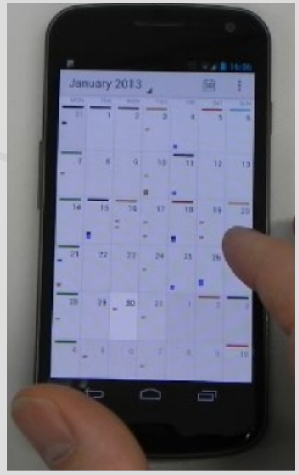


System's perception of latency

User's perception of latency

What does the user care about?





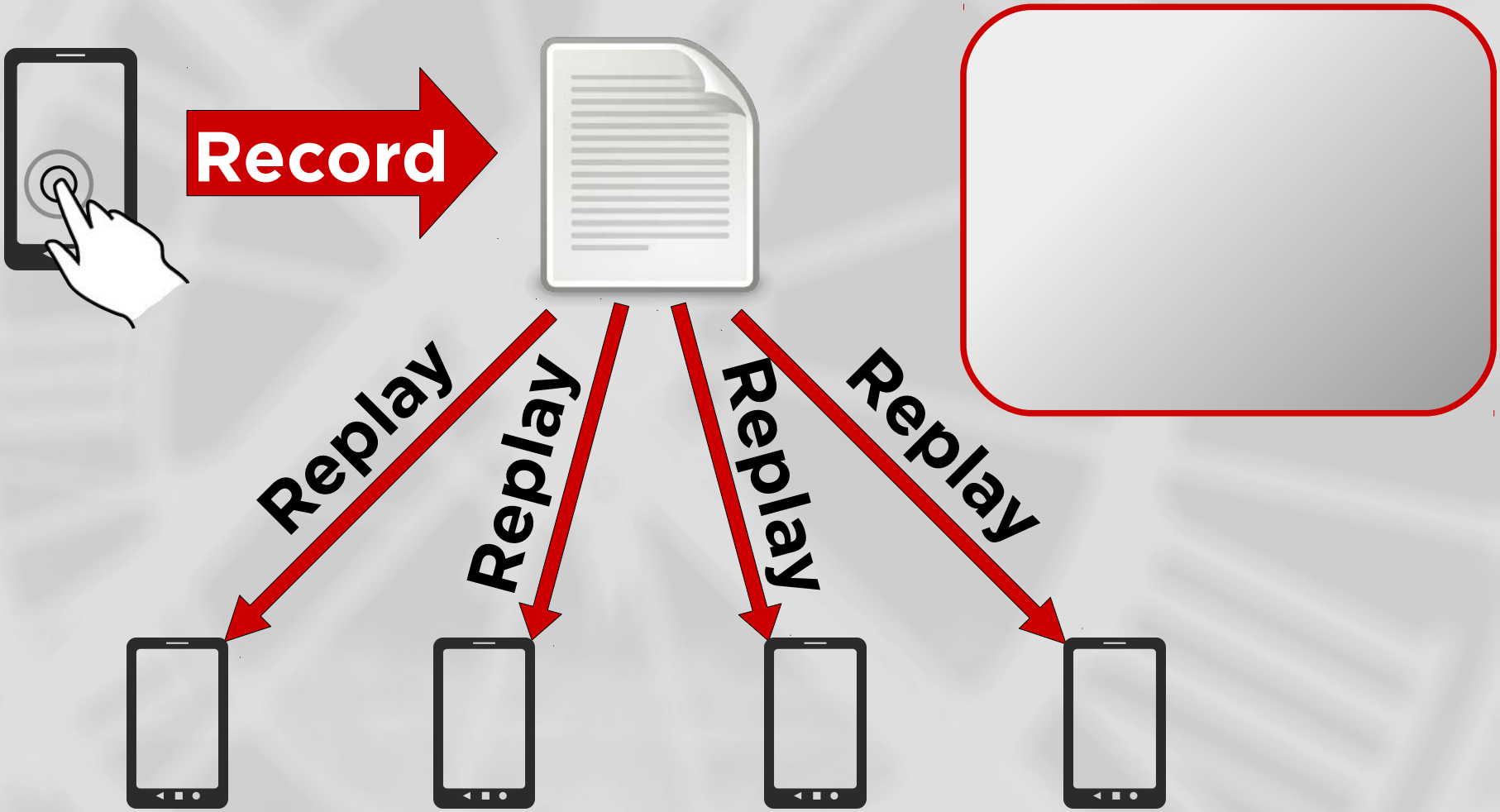
Interaction Lag

Quantifying interaction lags

Record/Replay

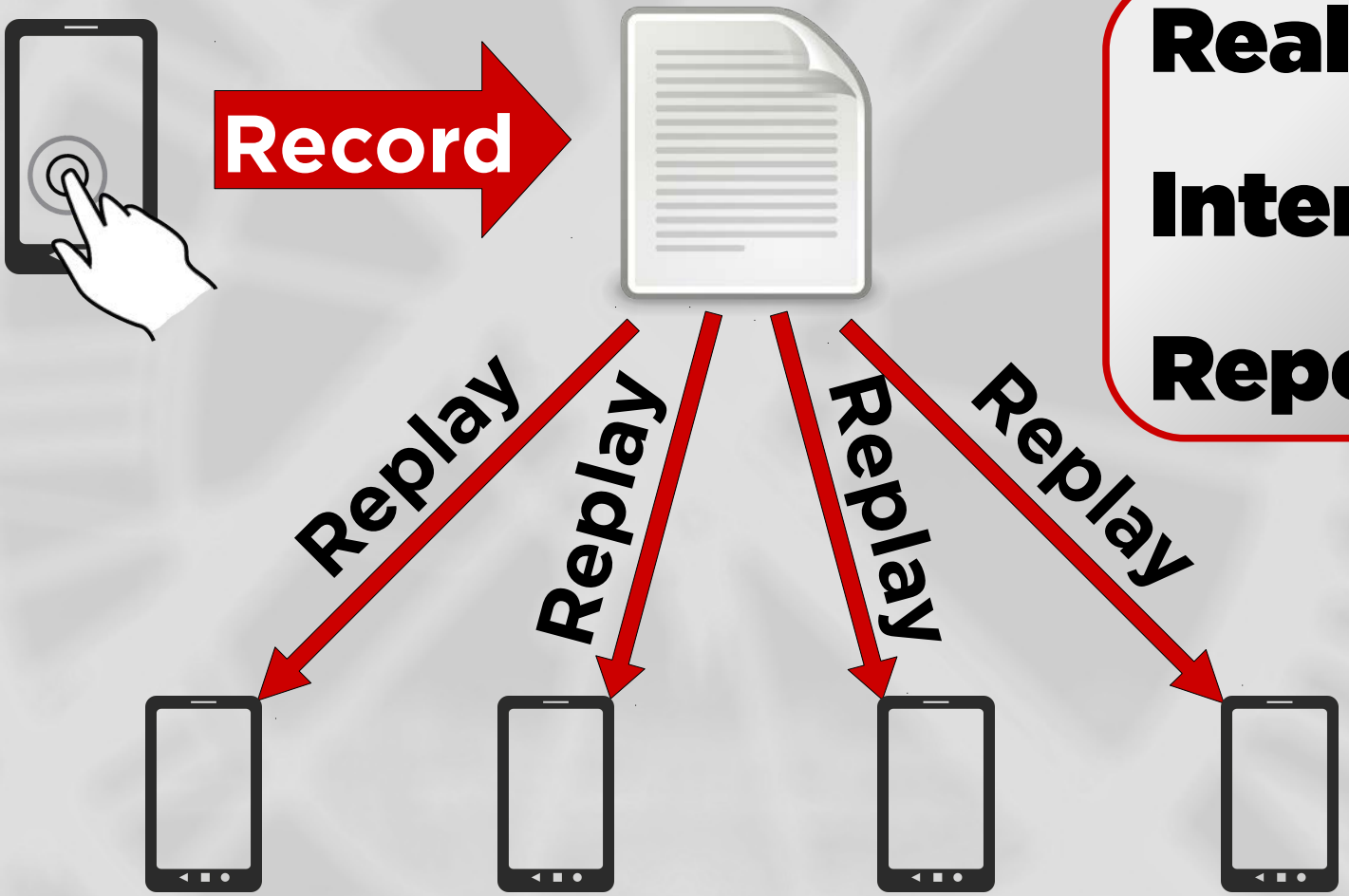
Sample

Record/Replay



Sample

Record/Replay

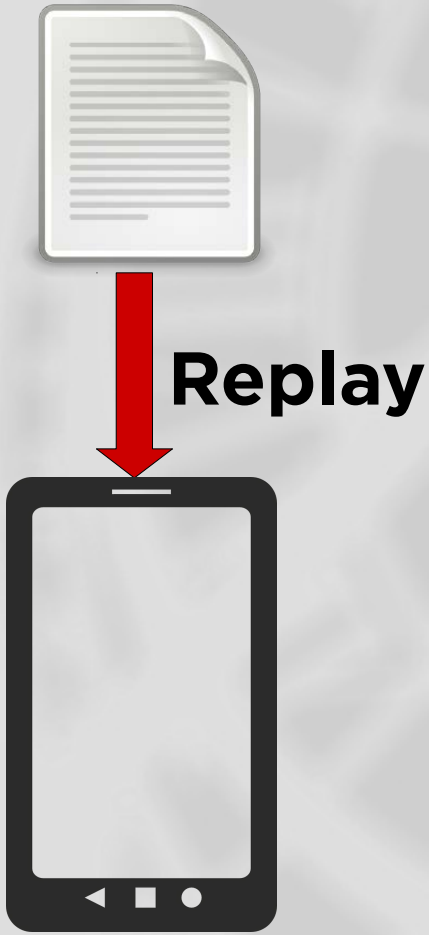


Realistic

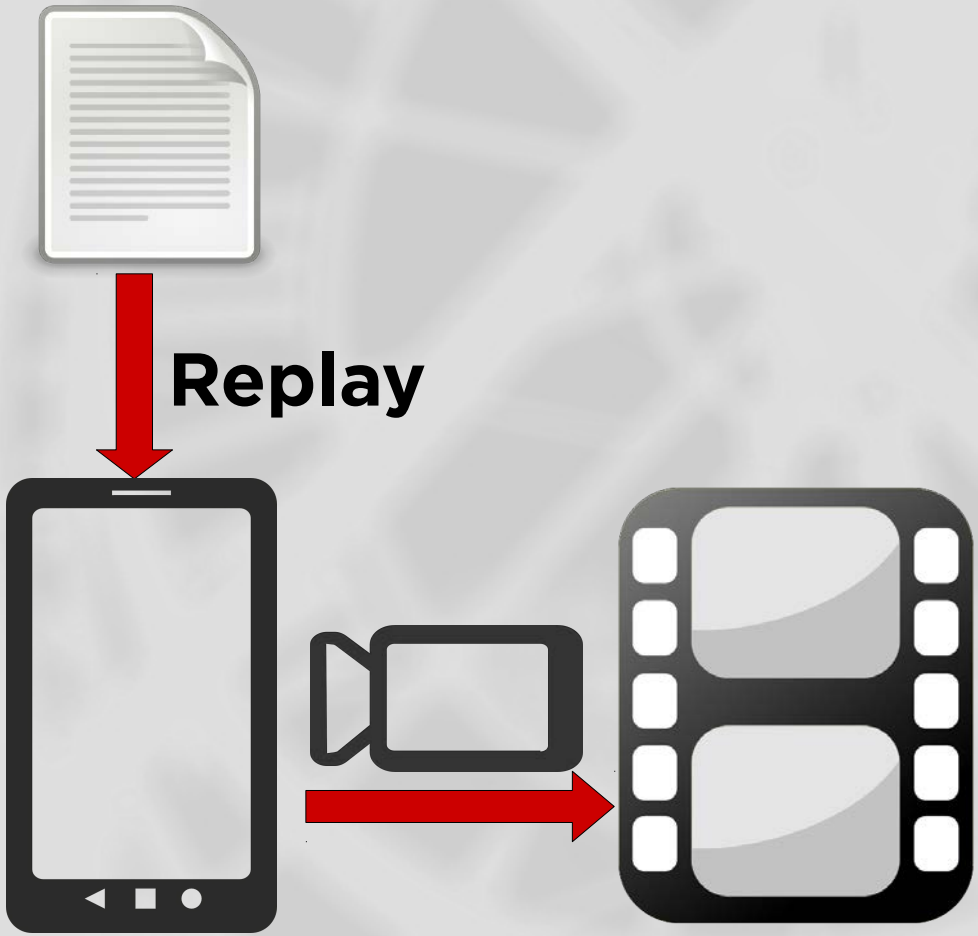
Interactive

Repeatable

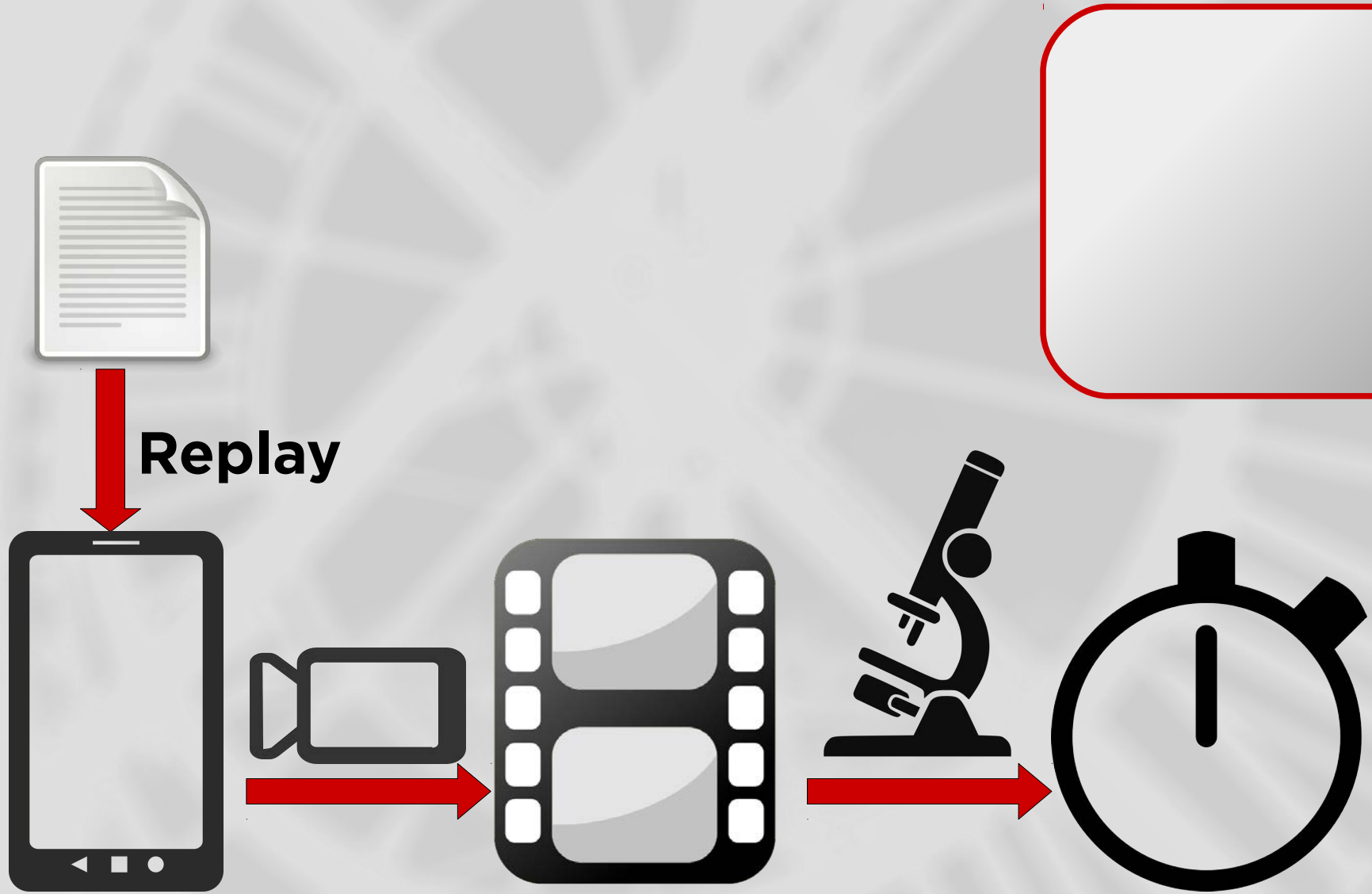
Markup



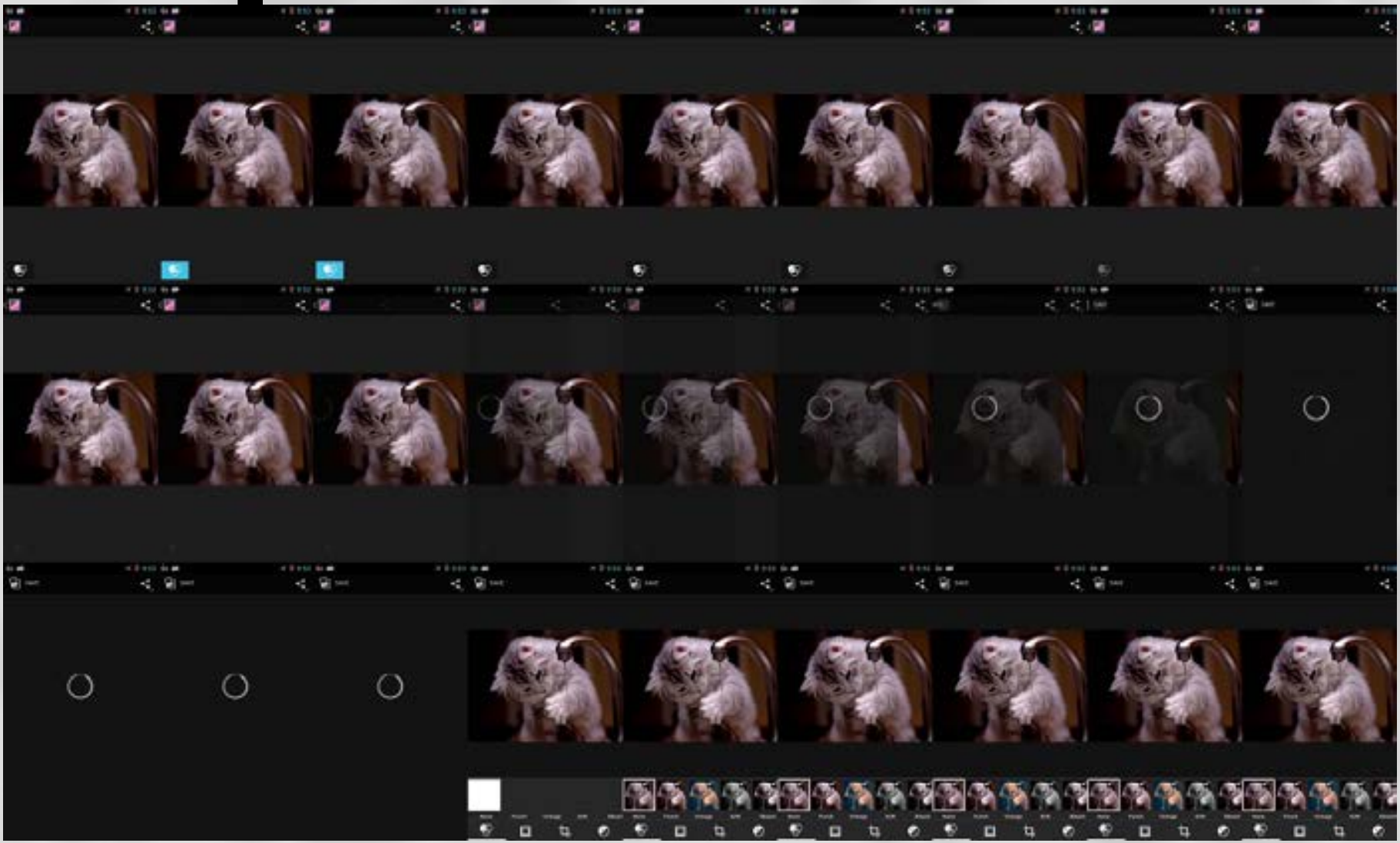
Markup



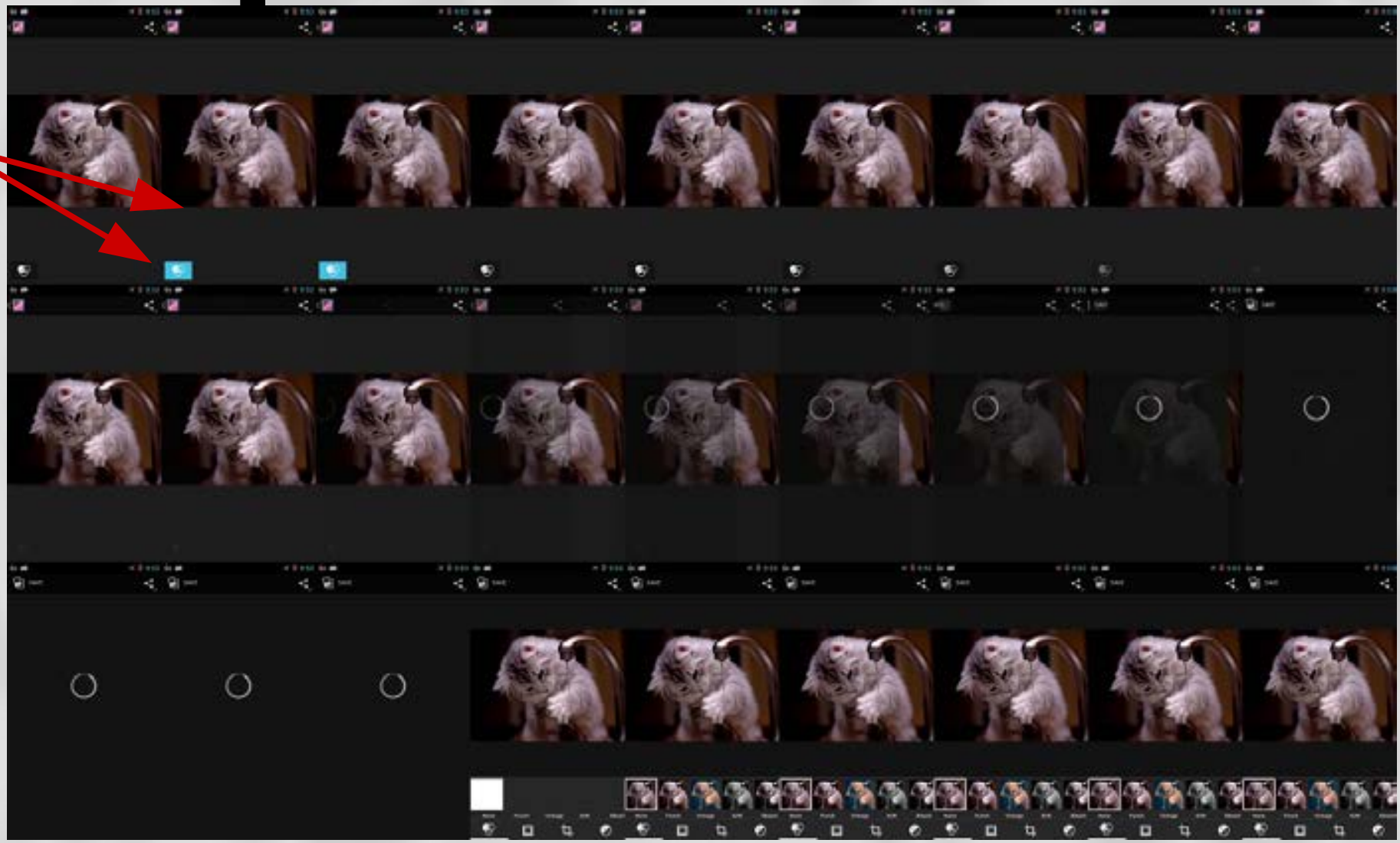
Markup



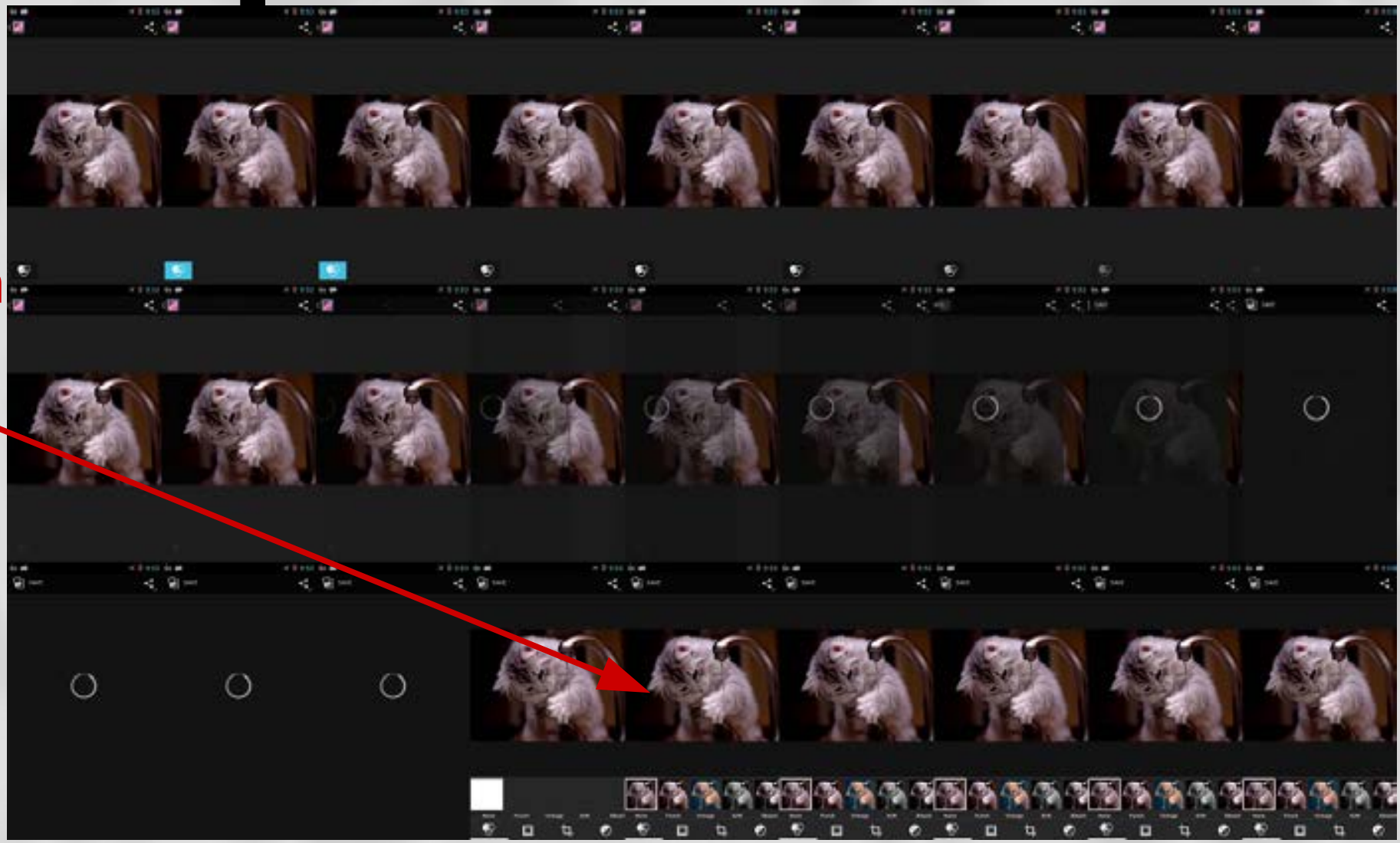
Markup



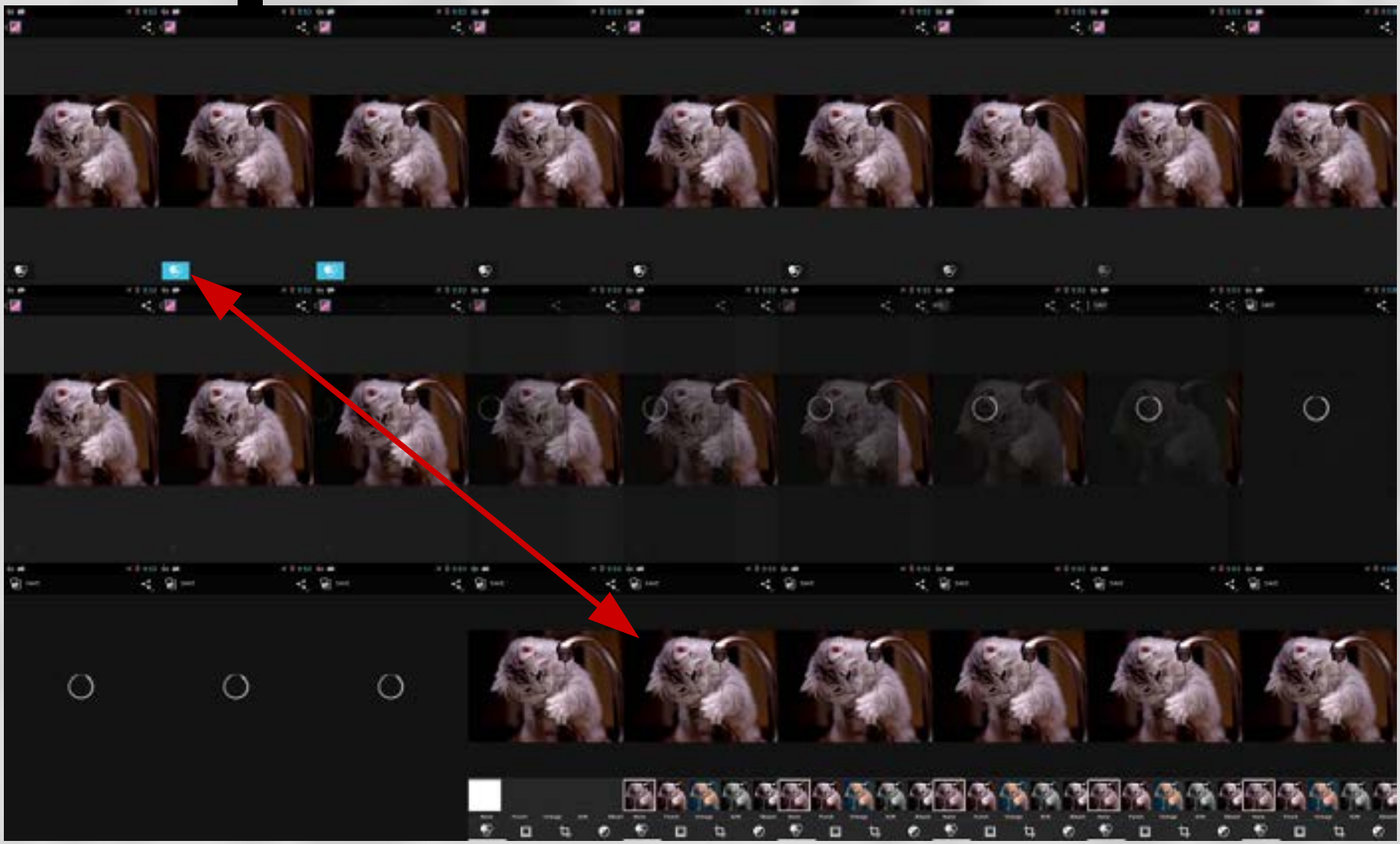
Markup



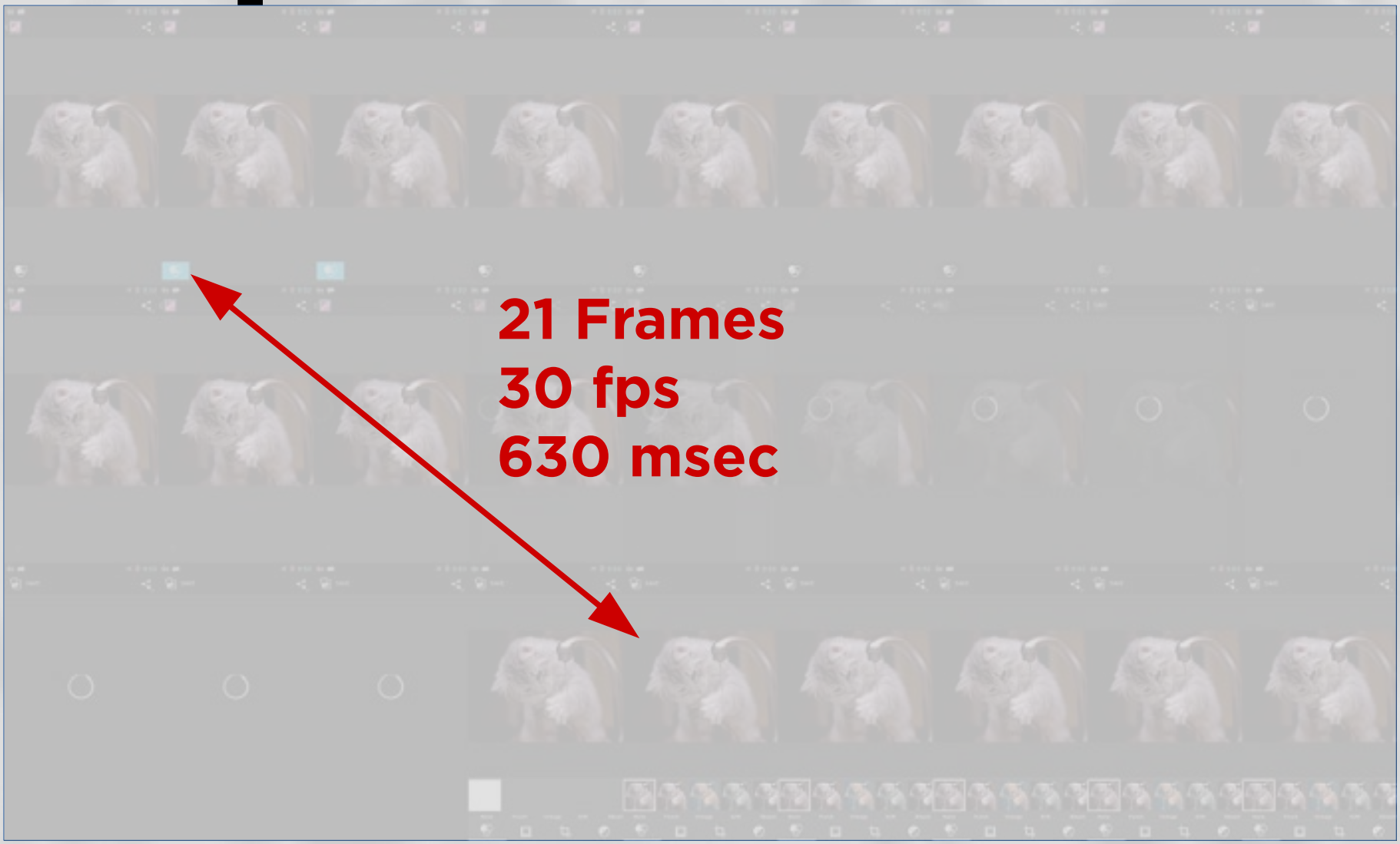
Markup



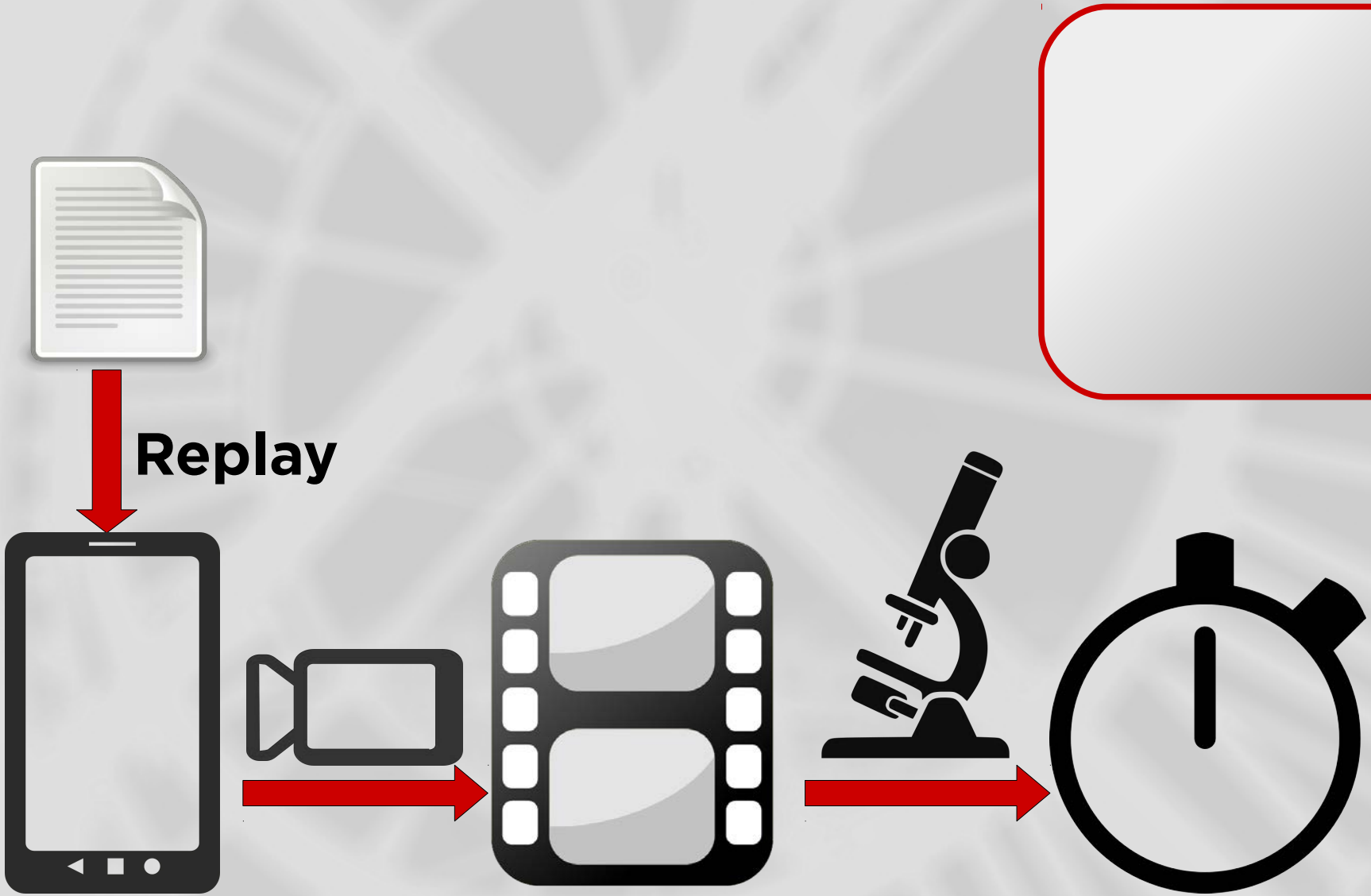
Markup



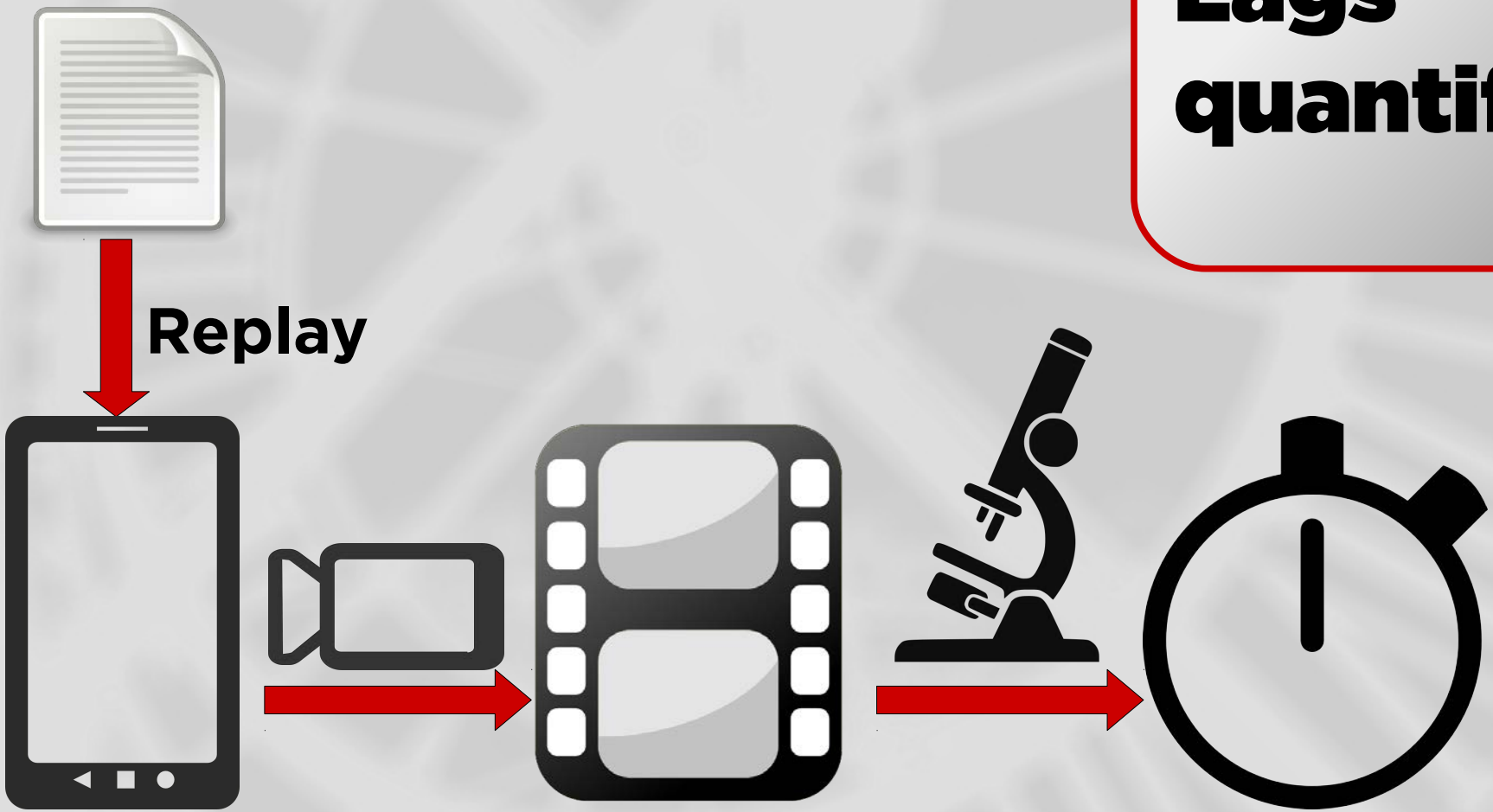
Markup



Markup



Markup

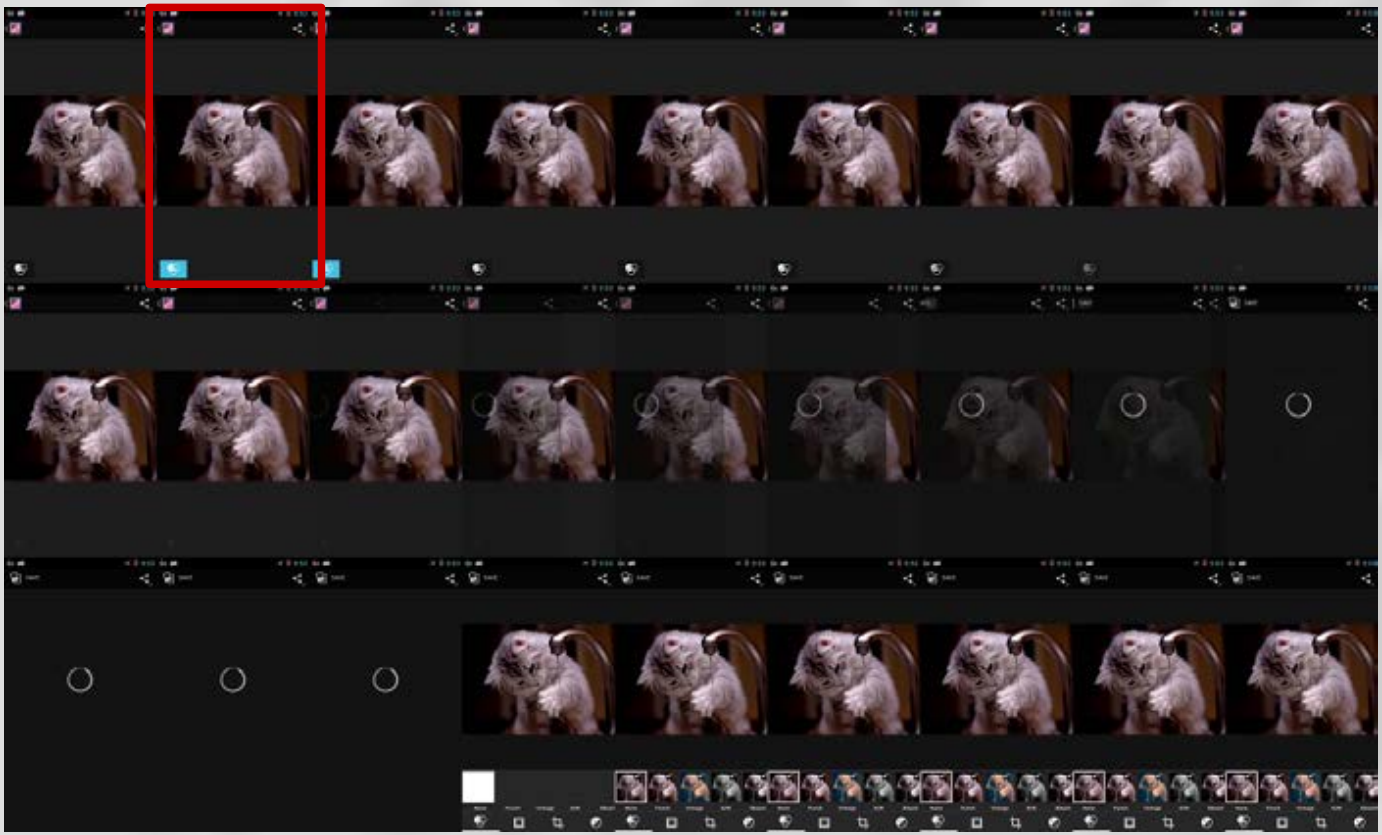


Lags quantified

Markup

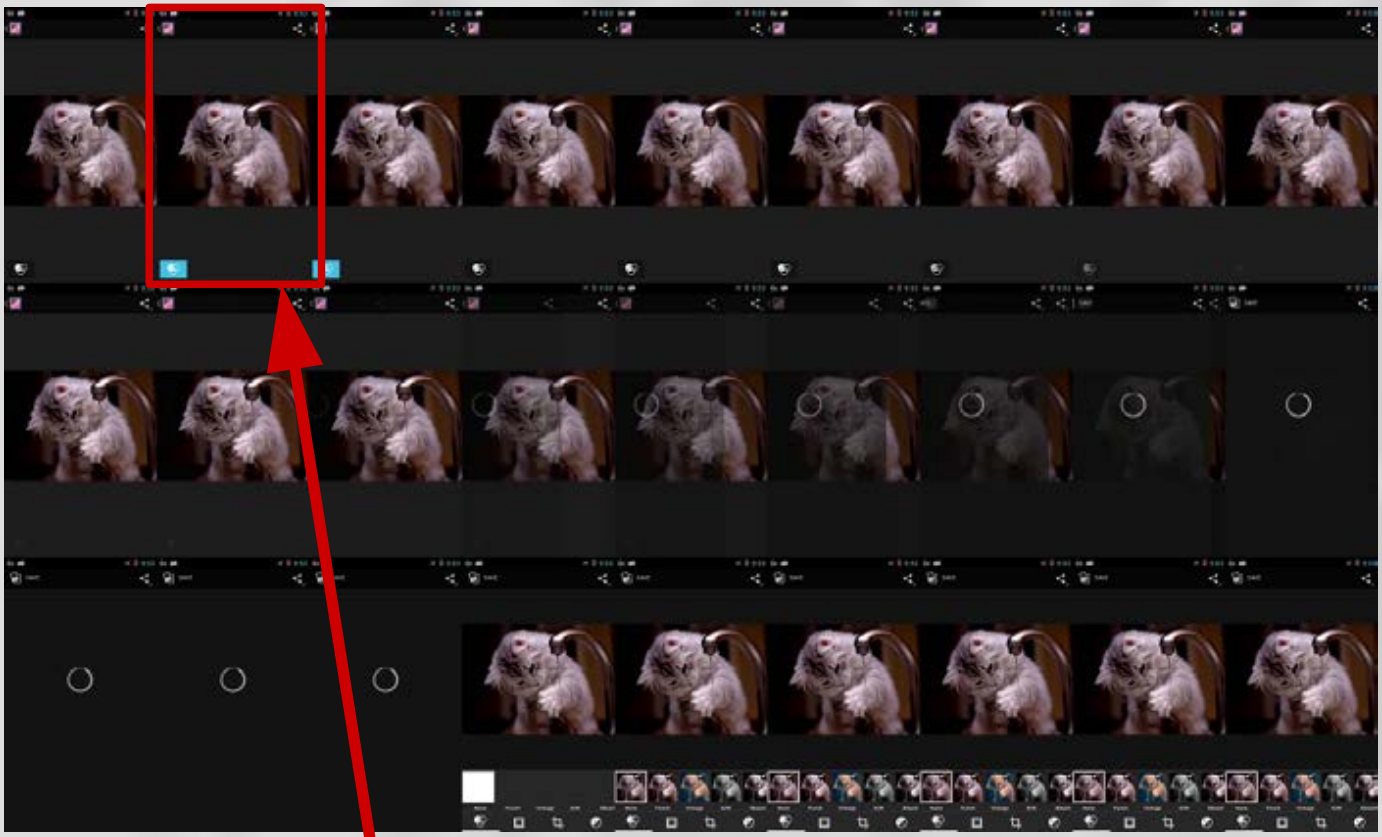
45 sec per lag

Semi-automatic markup



45 sec per lag

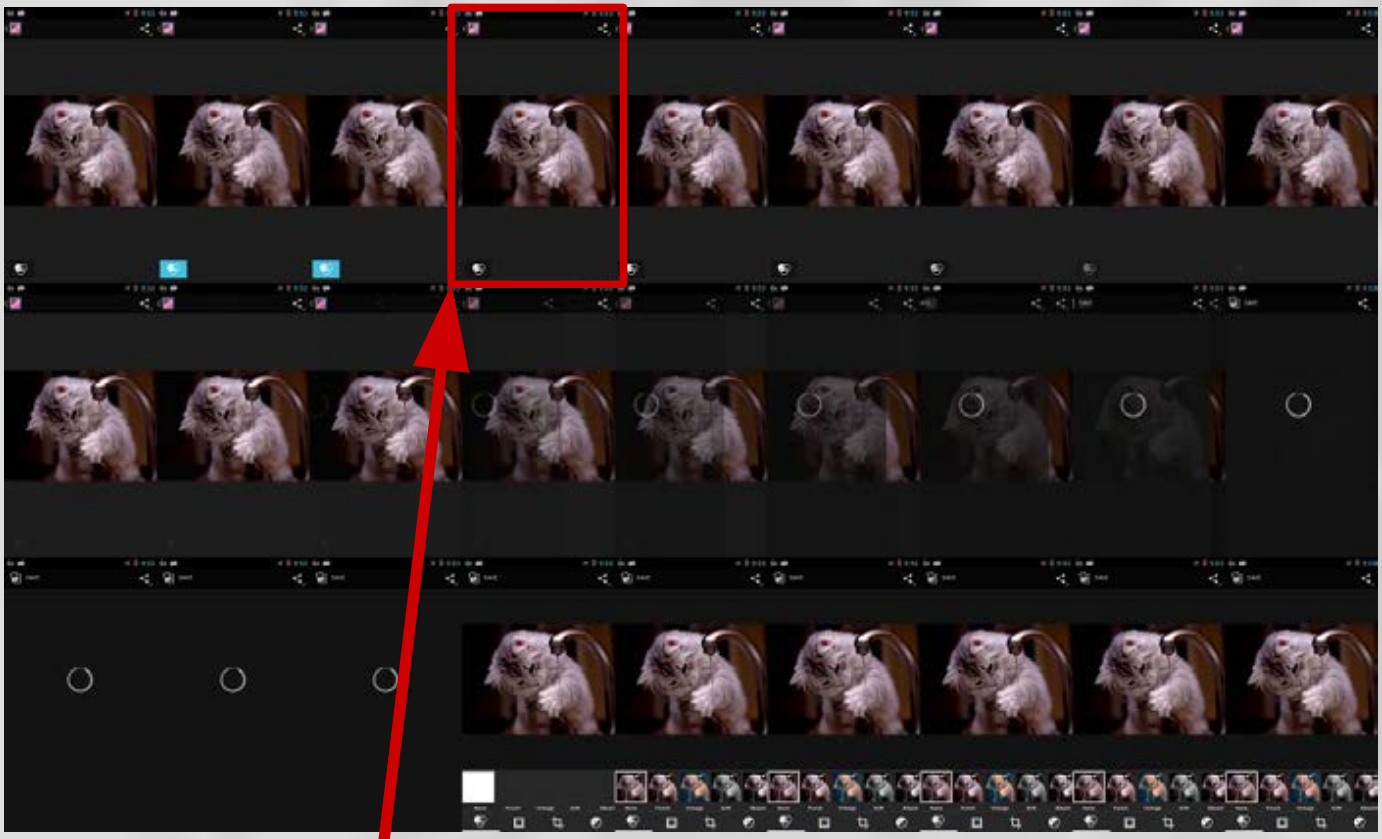
Semi-automatic markup



45 sec per lag

Interaction ends after first frame

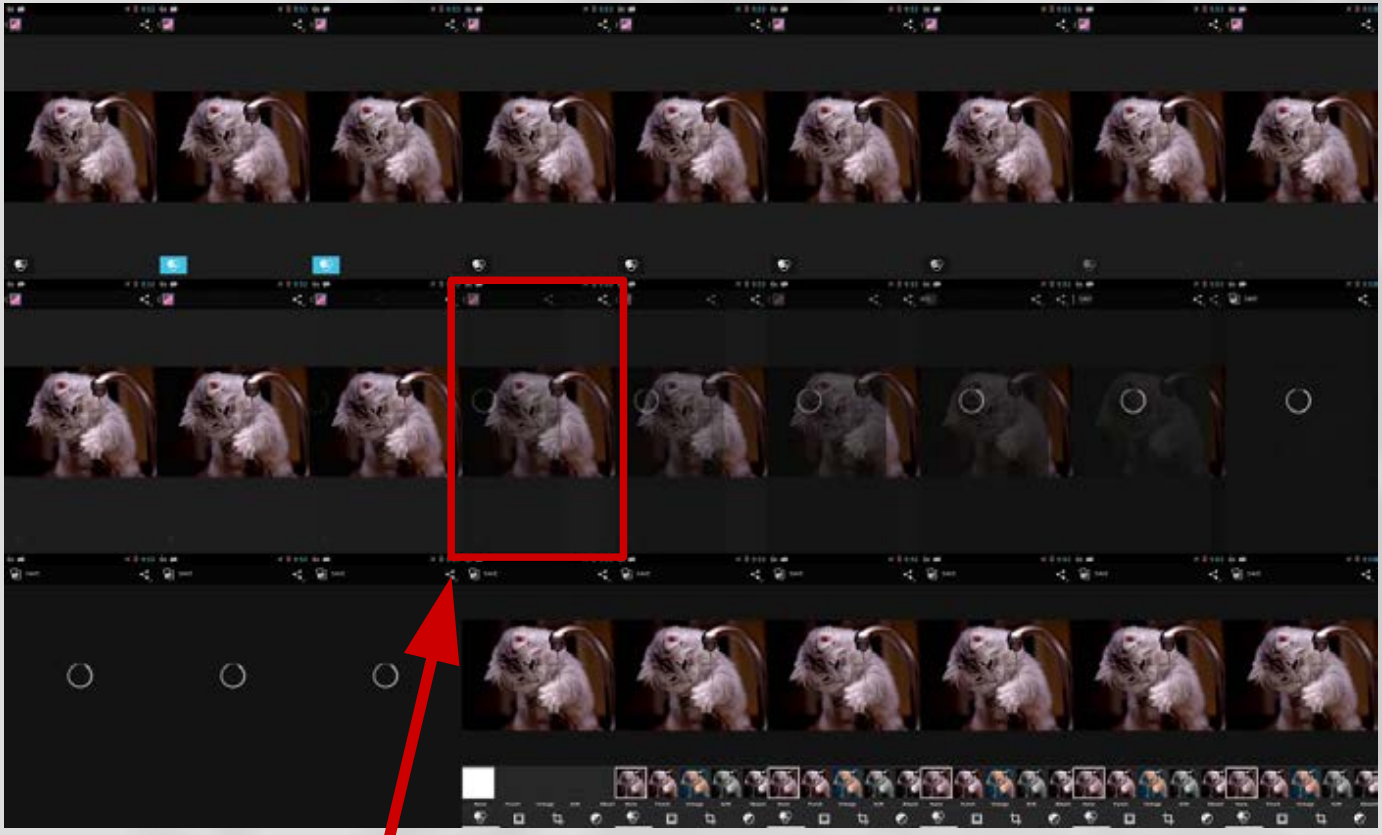
Semi-automatic markup



First Screen Change

45 sec per lag

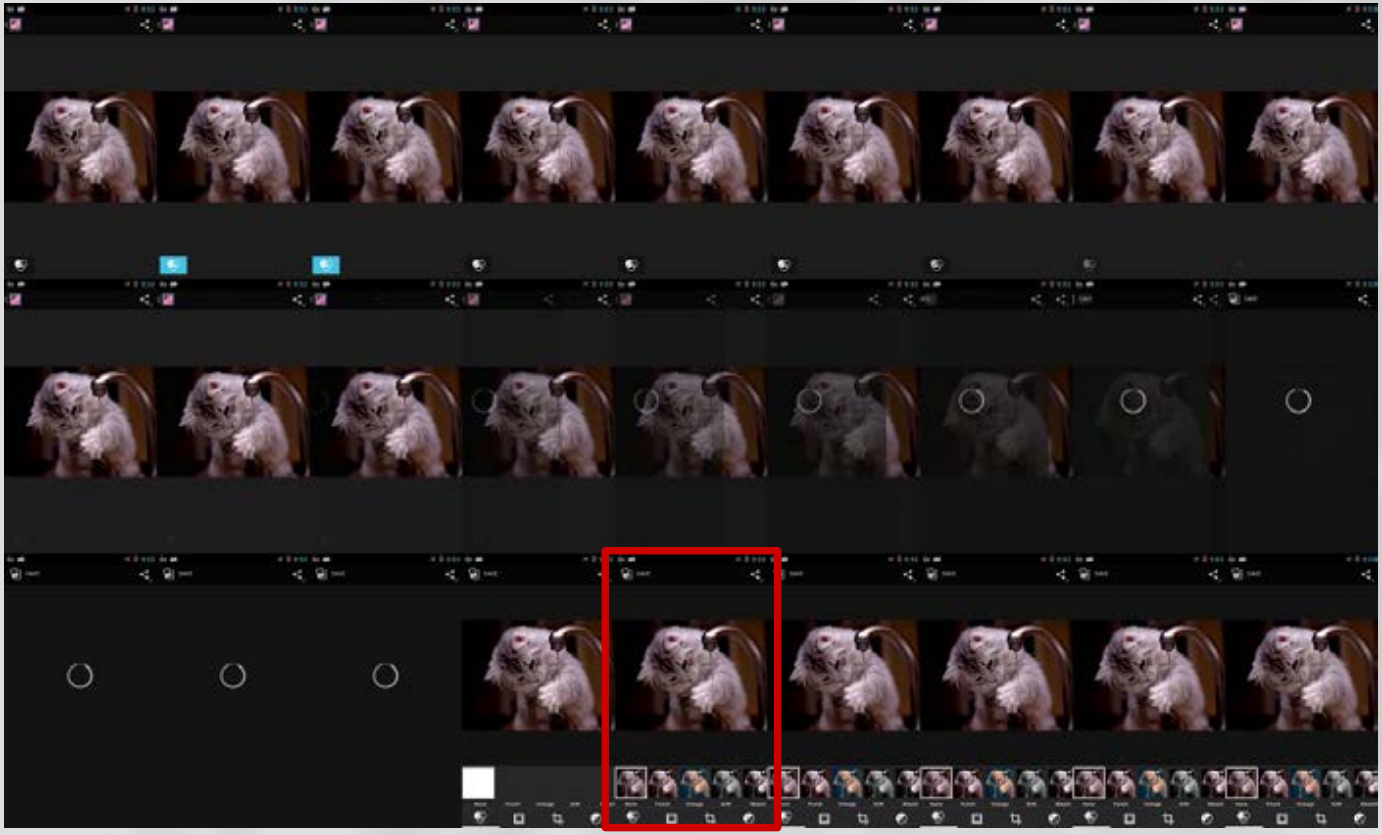
Semi-automatic markup



45 sec per lag

Screen Changes after frames of no change

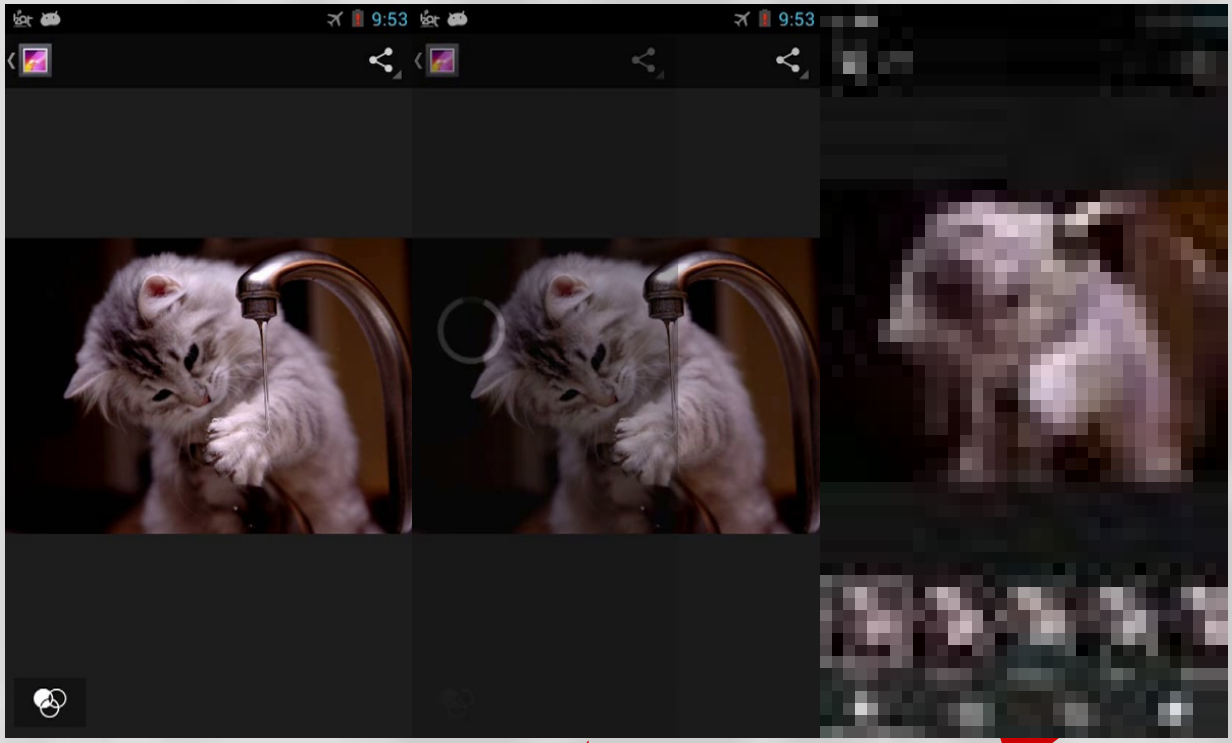
Semi-automatic markup



45 sec per lag

Screen stops changing

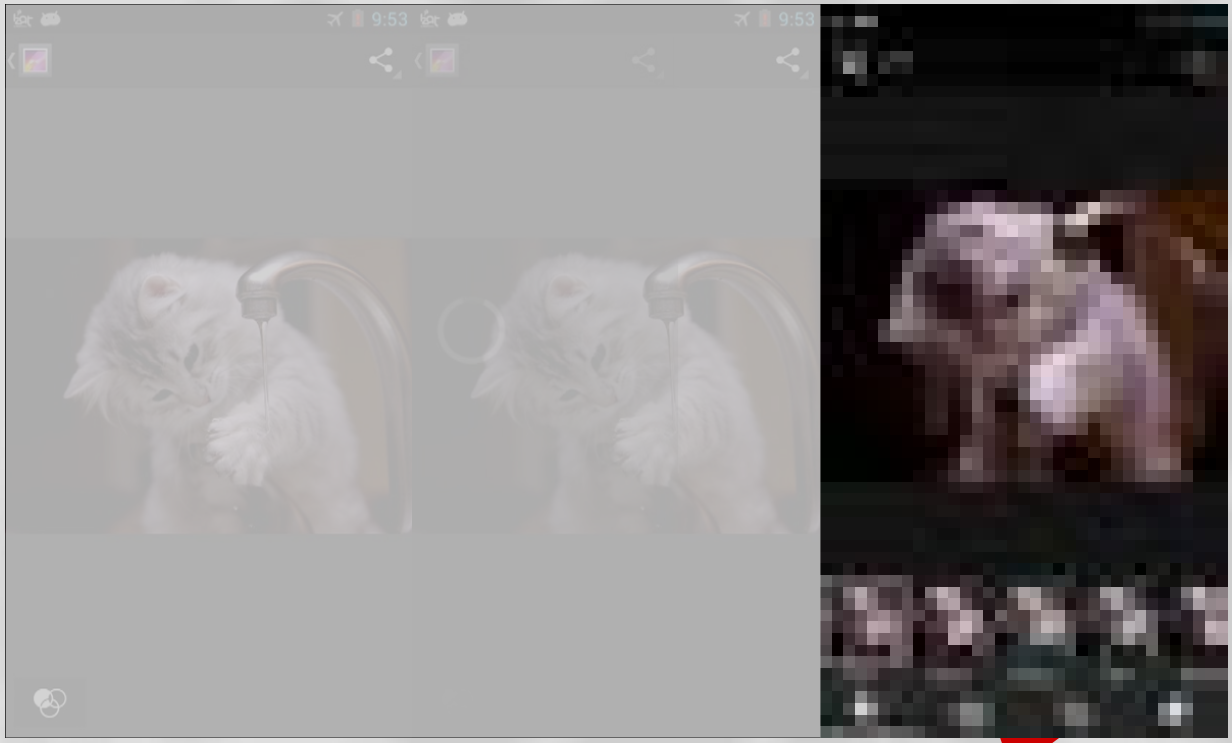
Semi-automatic markup



3 frames to choose from

45 sec per lag

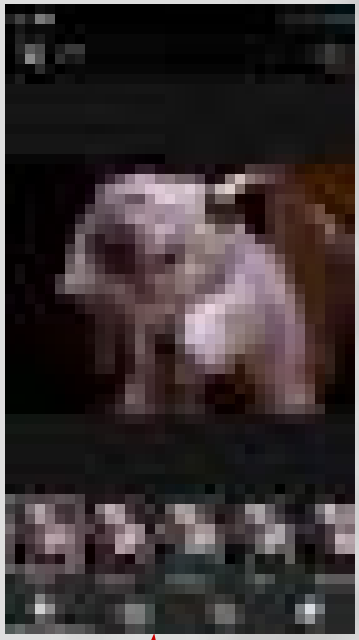
Semi-automatic markup



2-5 sec per lag

Interaction End

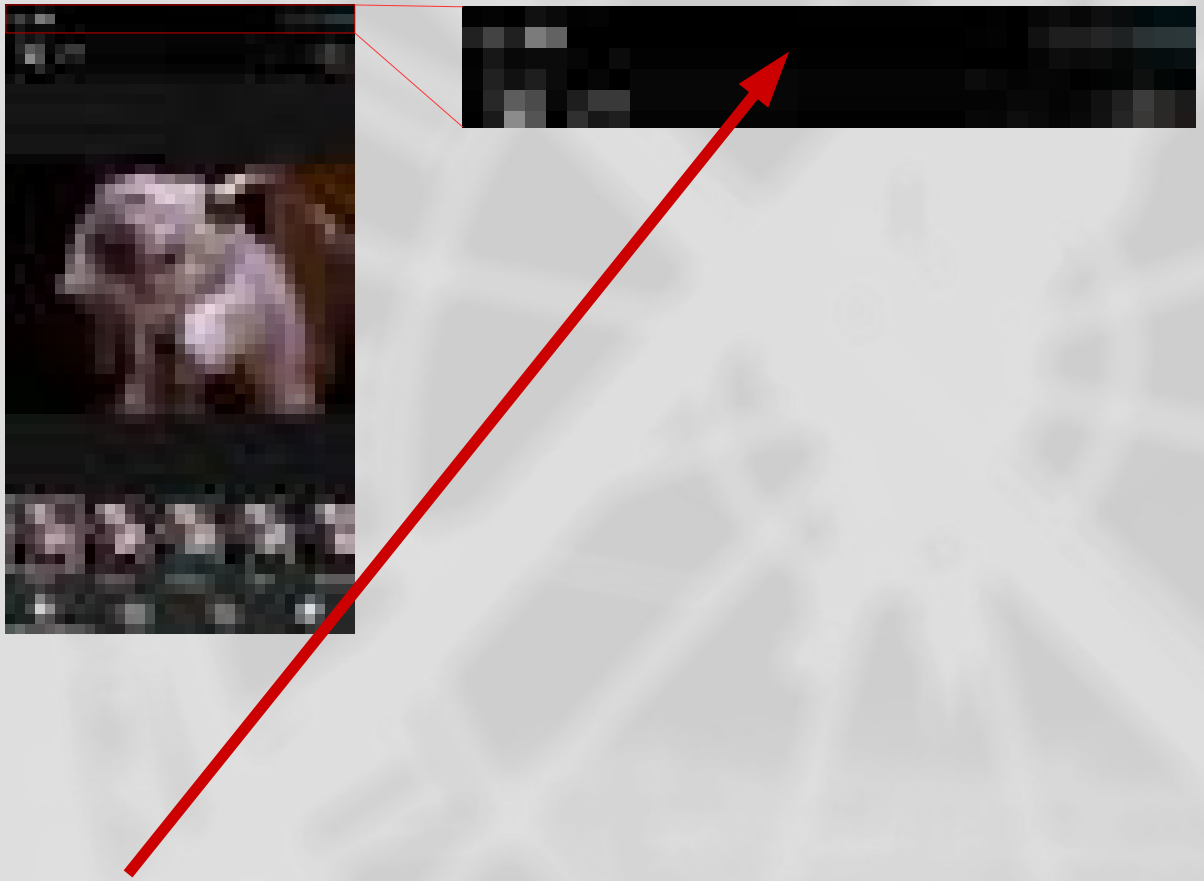
Semi-automatic markup



Save frame

2-5 sec per lag

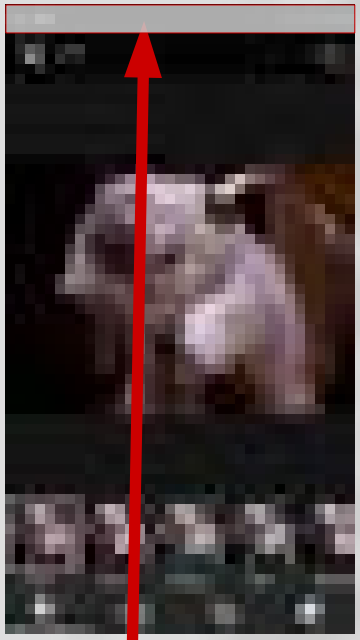
Semi-automatic markup



Variable area

2-5 sec per lag

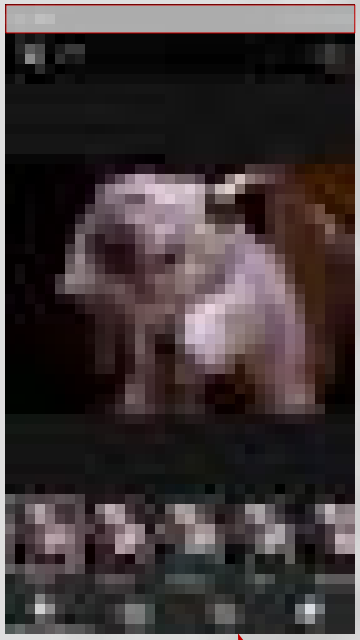
Semi-automatic markup

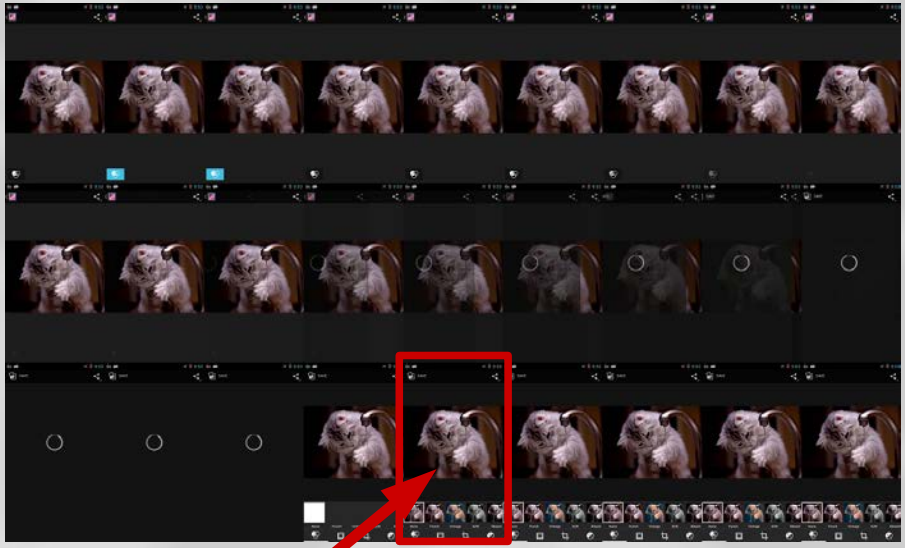


masked area

2-5 sec per lag

Semi-automatic markup





Human input needed only once

Interaction End

Representative

Representative

Real Mobile Applications

Real Inputs

Real Metrics

Repeatable

Repeatable

Same behaviour every time

Automatic

Automatic

No code analysis

No instrumentation

No humans needed*

*after initial video markup

After the fact

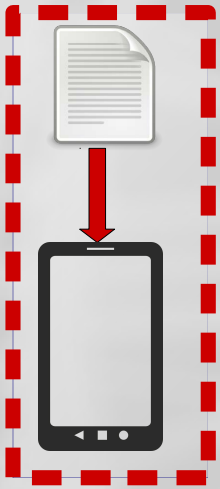
Lag End Estimation

Can only identify lags offline

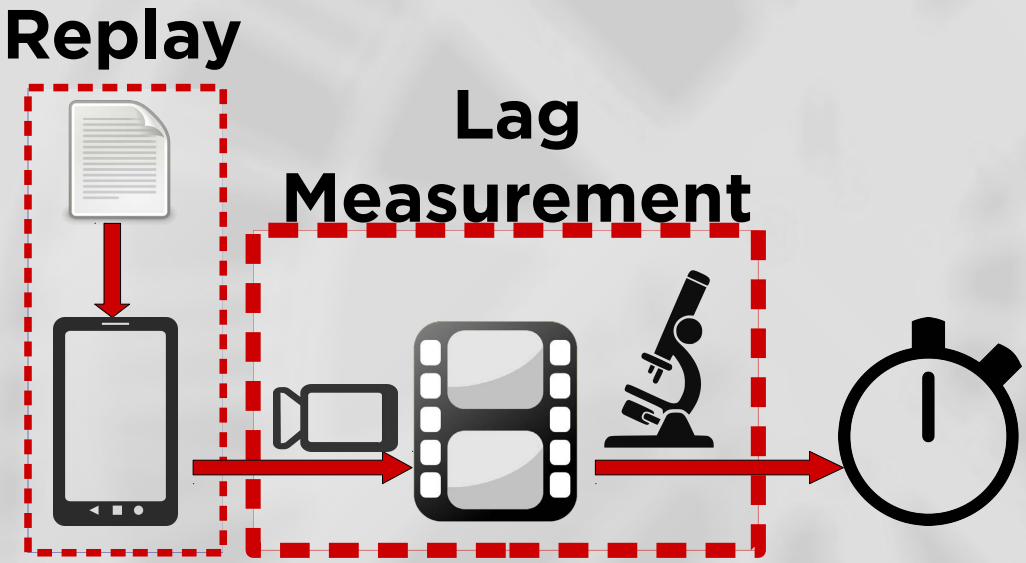
Want to identify lags online

Training

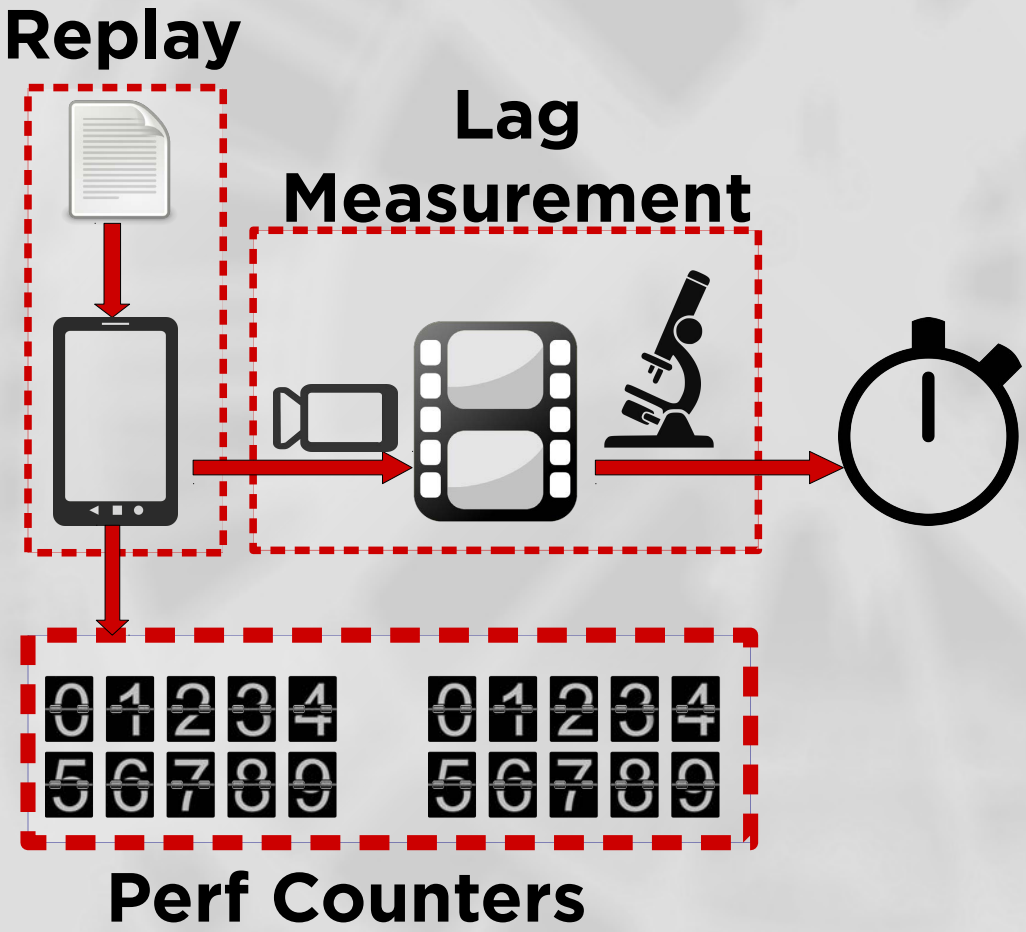
Replay



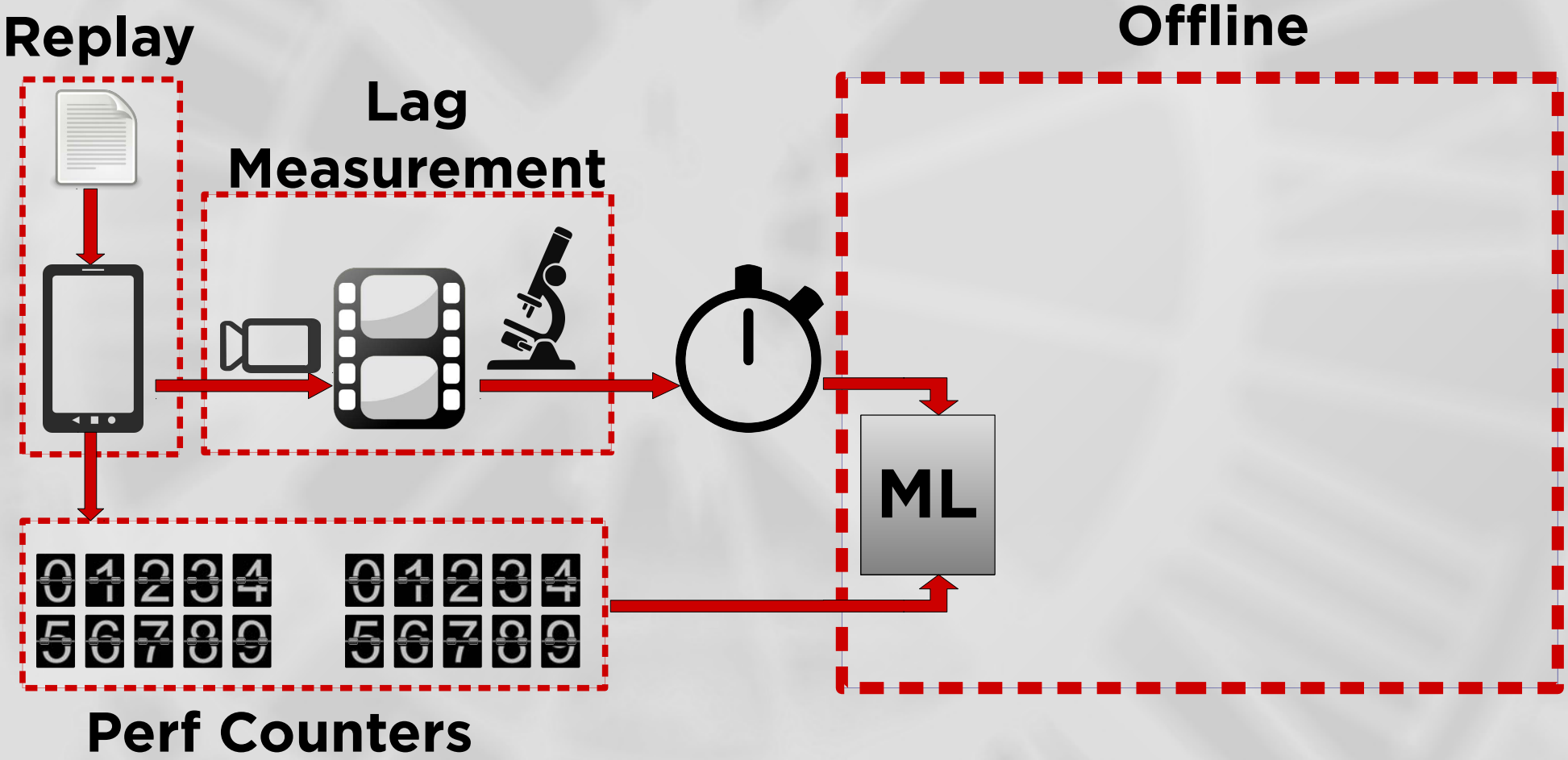
Training



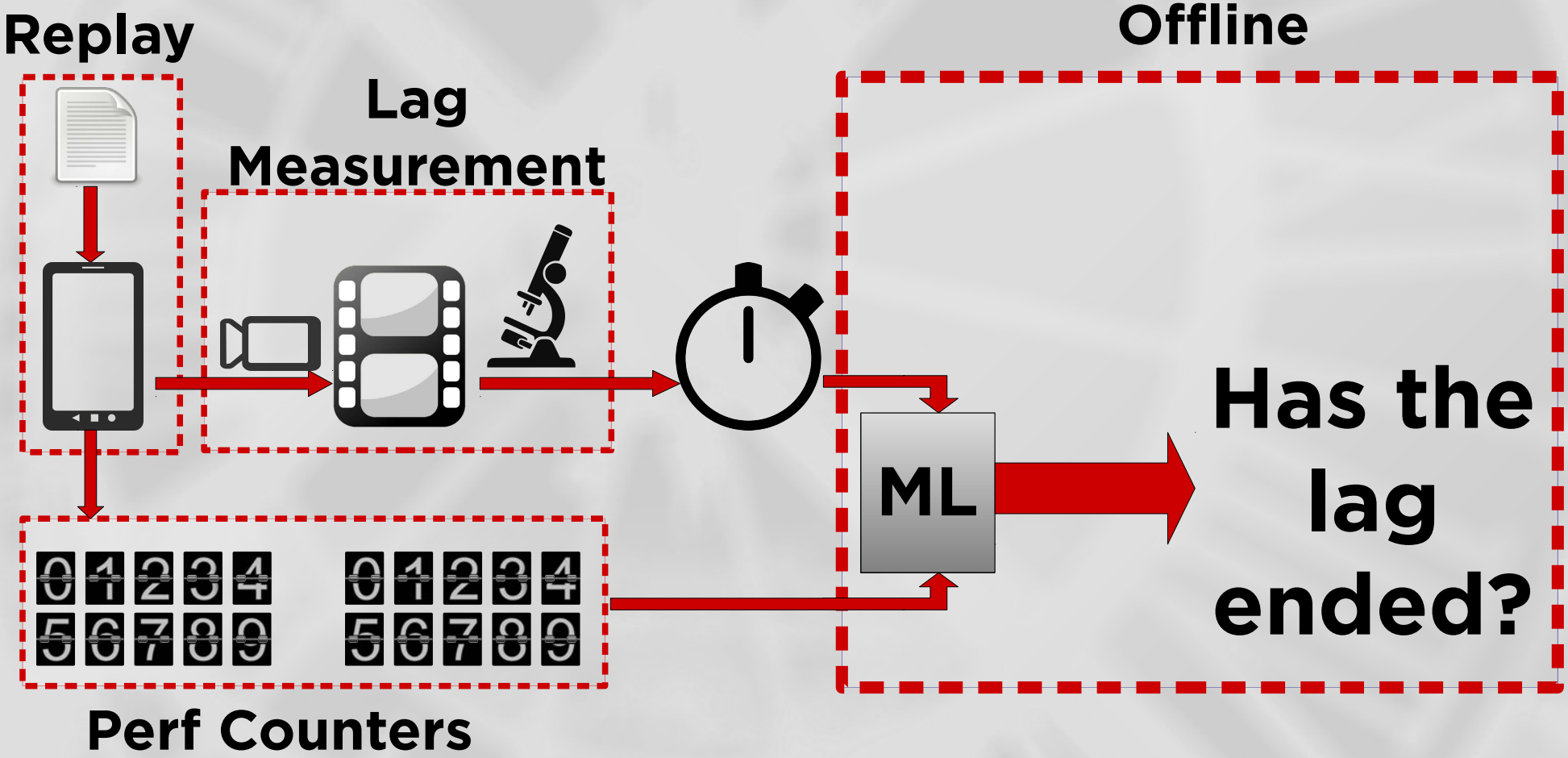
Training



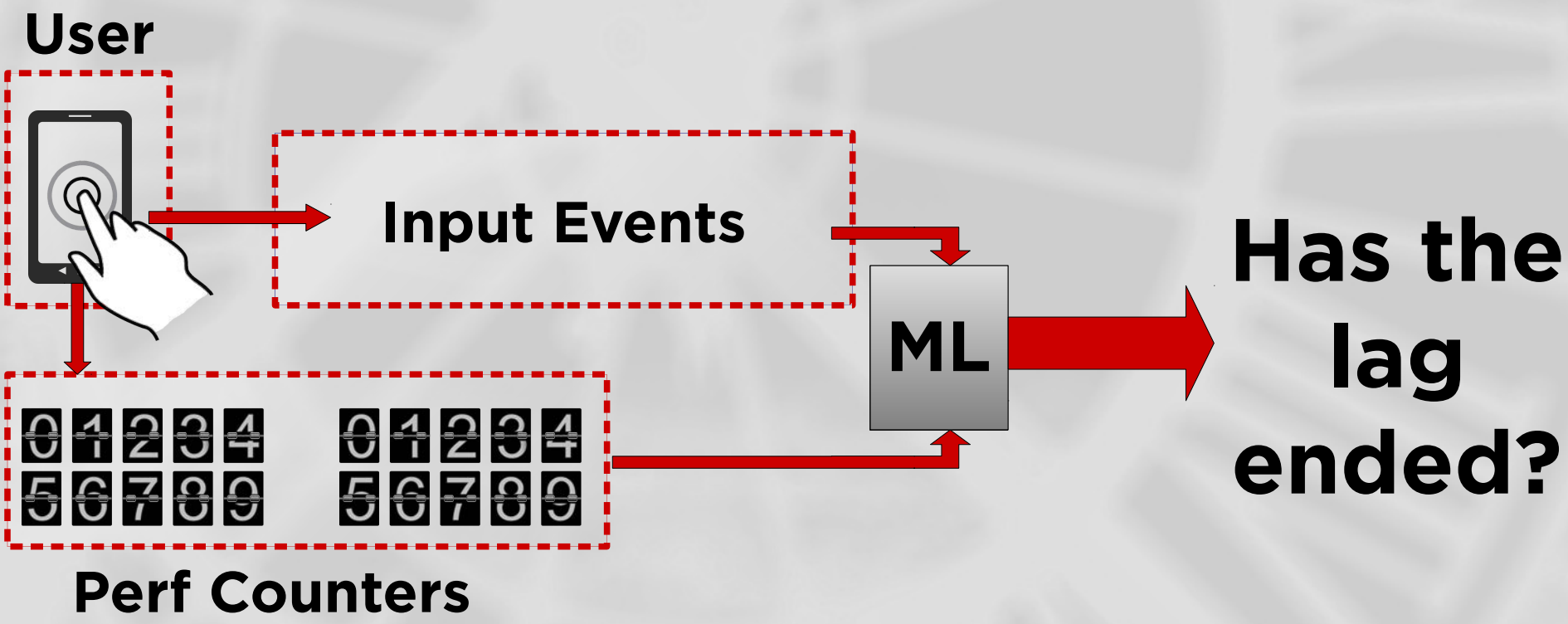
Training



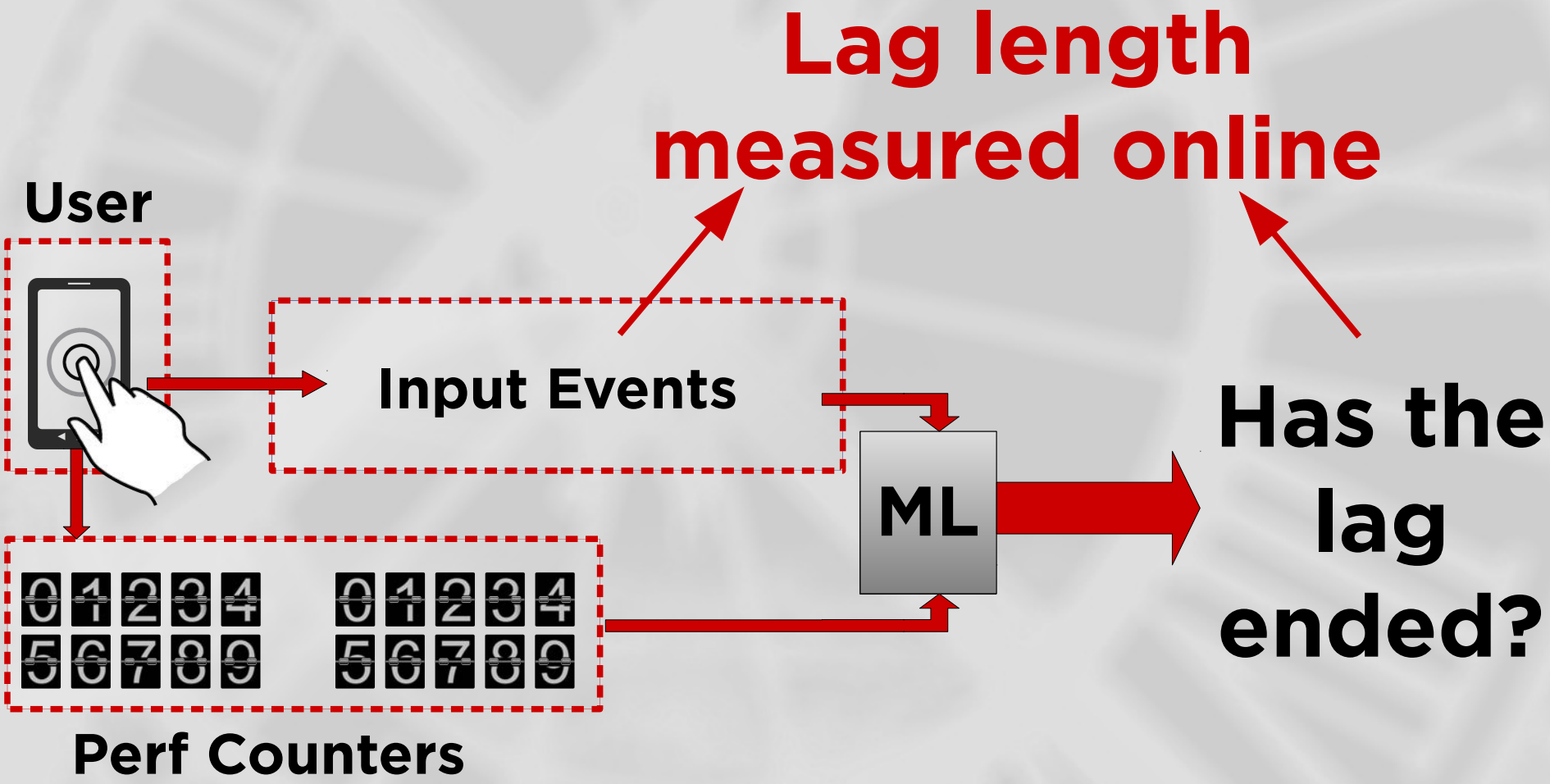
Training


Replay
Lag Measurement
Offline
ML
Has the lag ended?
Perf Counters

Online prediction



Online prediction



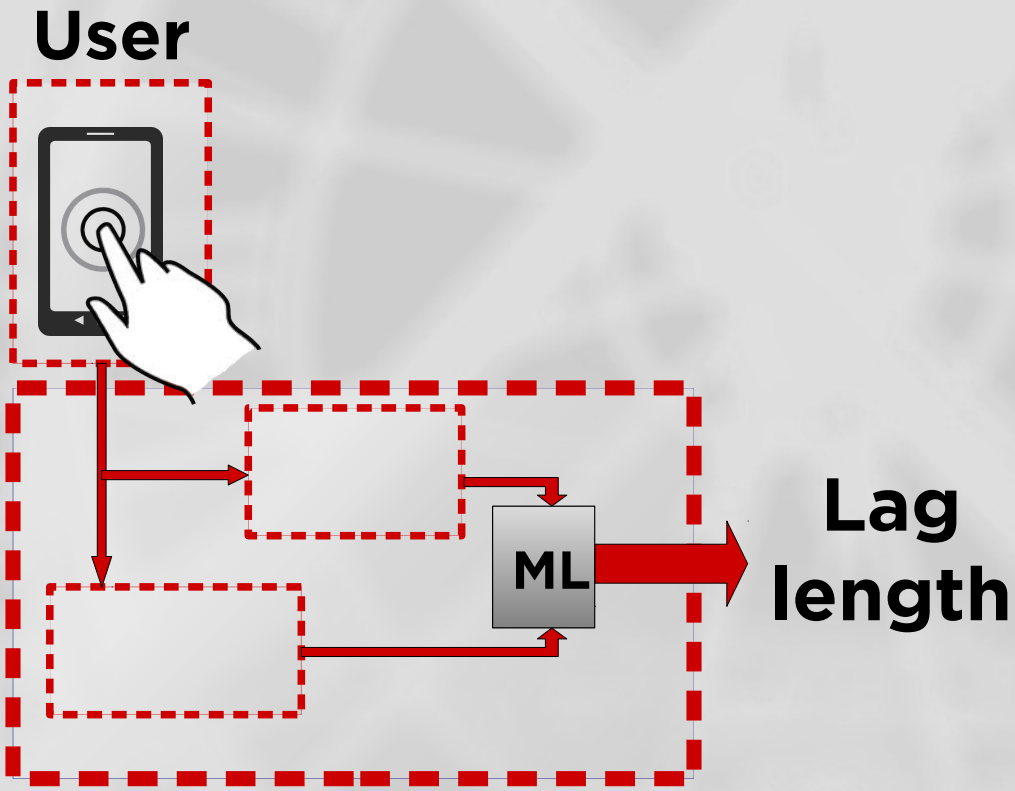
Before the fact

Lag End Predictor

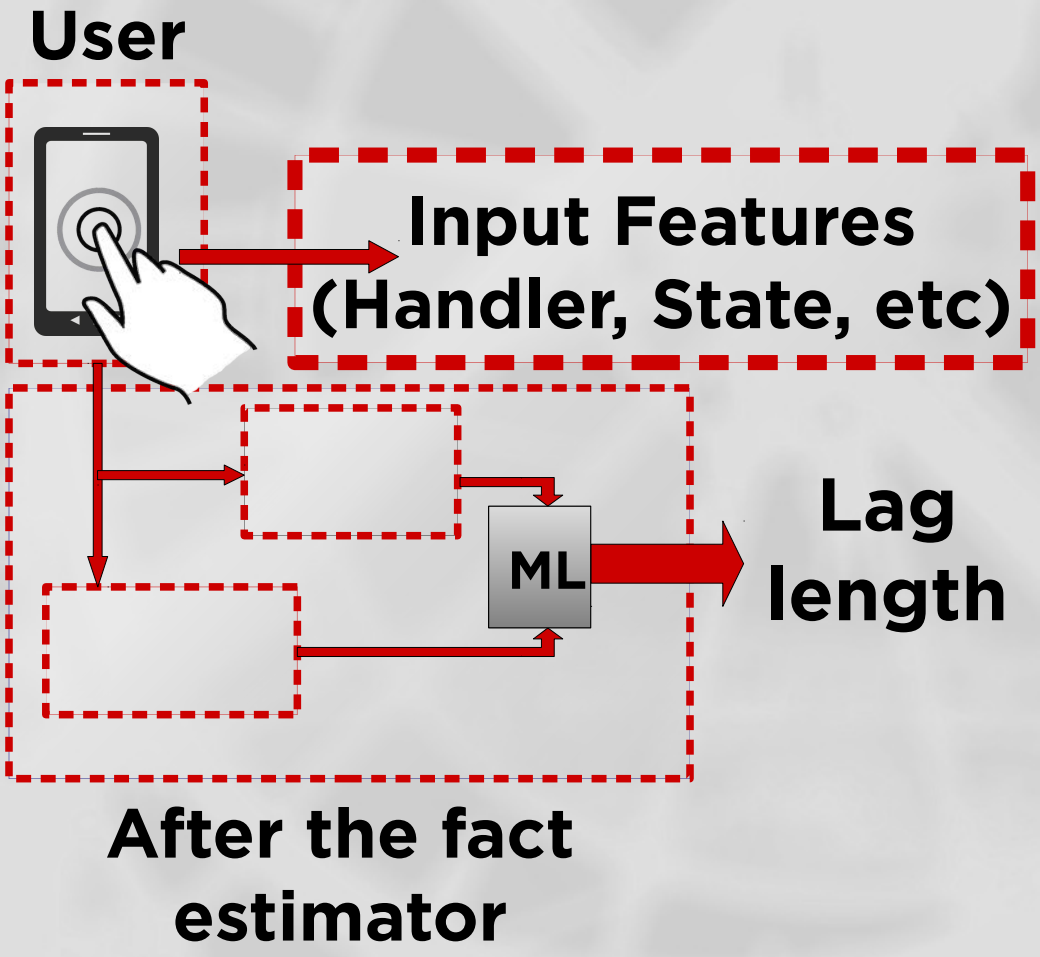
Can tell whether the interaction has ended

Want to tell when the interaction will end

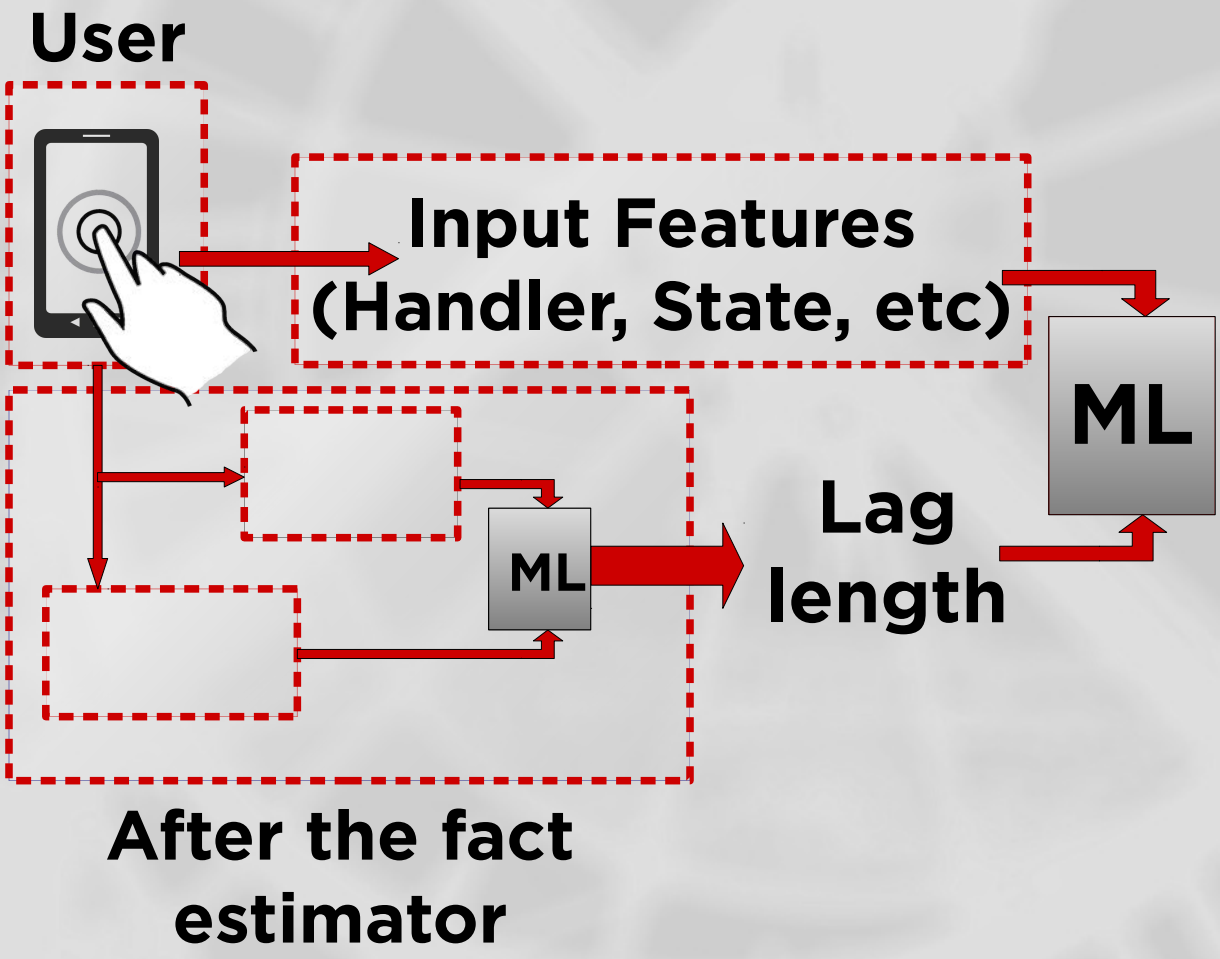
Lag end prediction



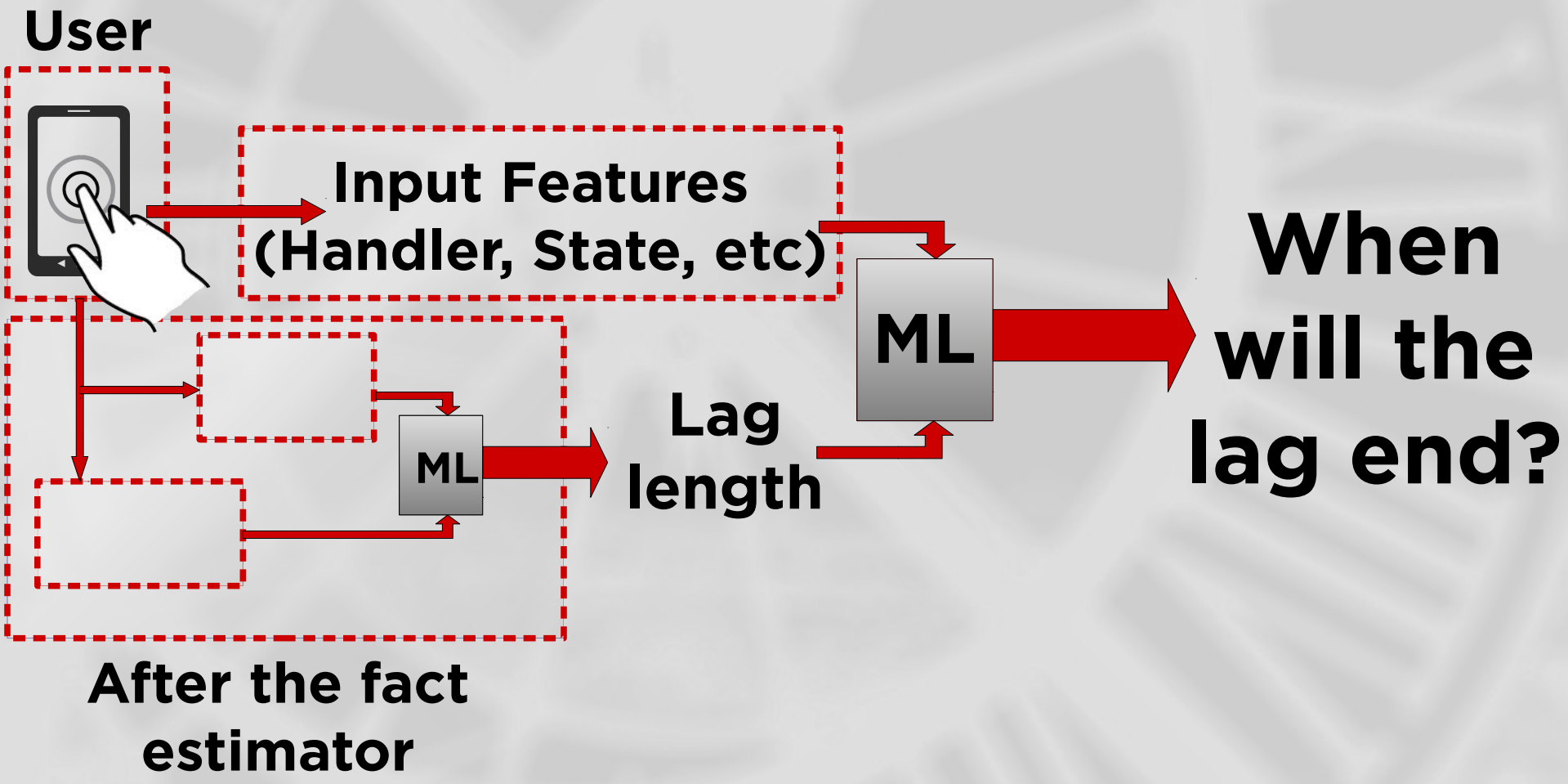
Lag end prediction



Lag end prediction



Lag end prediction



Summary

Summary

Can test/fine-tune heuristics offline

Summary

Can test/fine-tune heuristics offline

Will evaluate them online

Summary

Can test/fine-tune heuristics offline

Will evaluate them online

Will adapt them online

Summary

Can test/fine-tune heuristics offline

Will evaluate them online

Will adapt them online

For what users care about

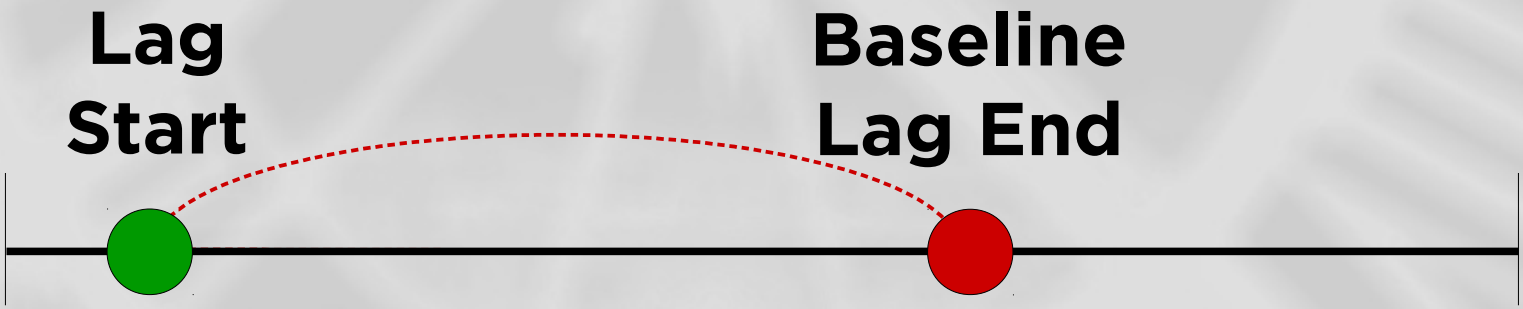
Android Frequency Governors

Android Frequency Governors

Energy VS QoE

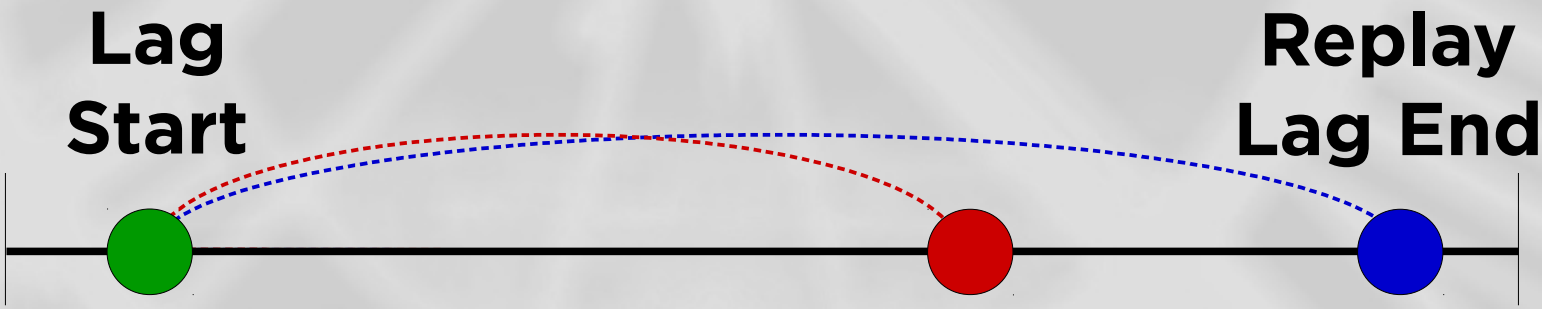
Android Frequency Governors

Energy VS QoE



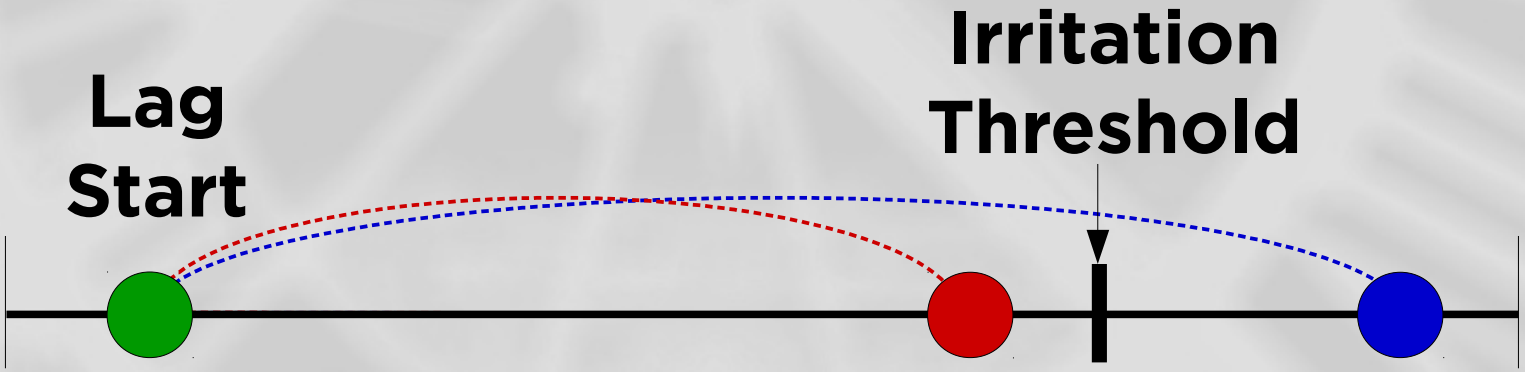
Android Frequency Governors

Energy VS QoE



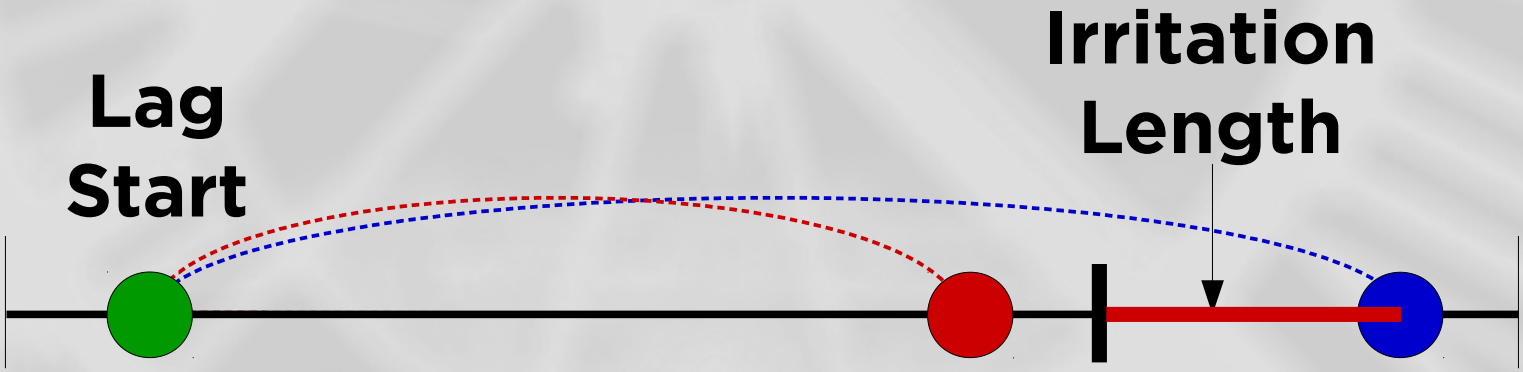
Android Frequency Governors

Energy VS QoE

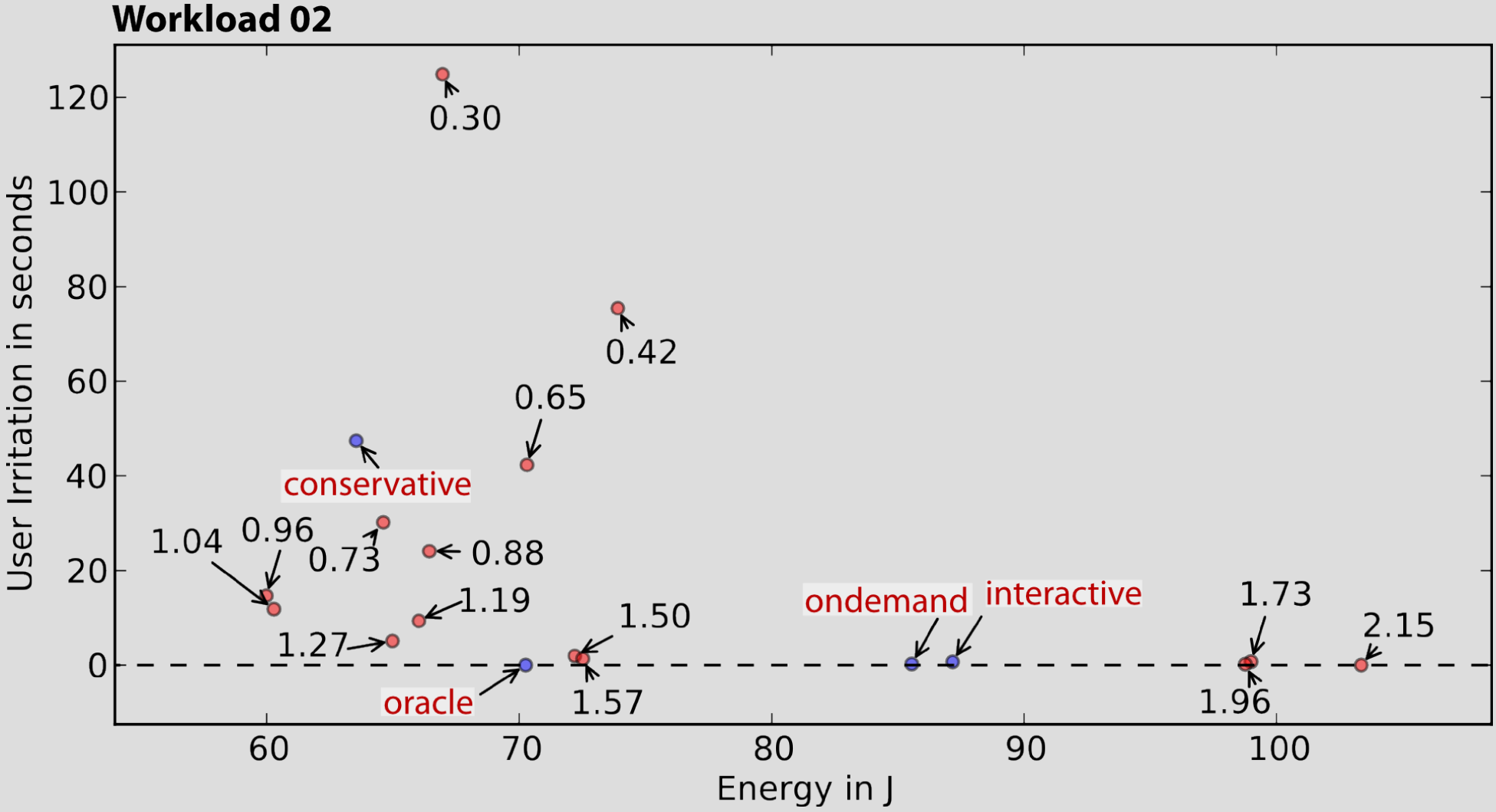


Android Frequency Governors

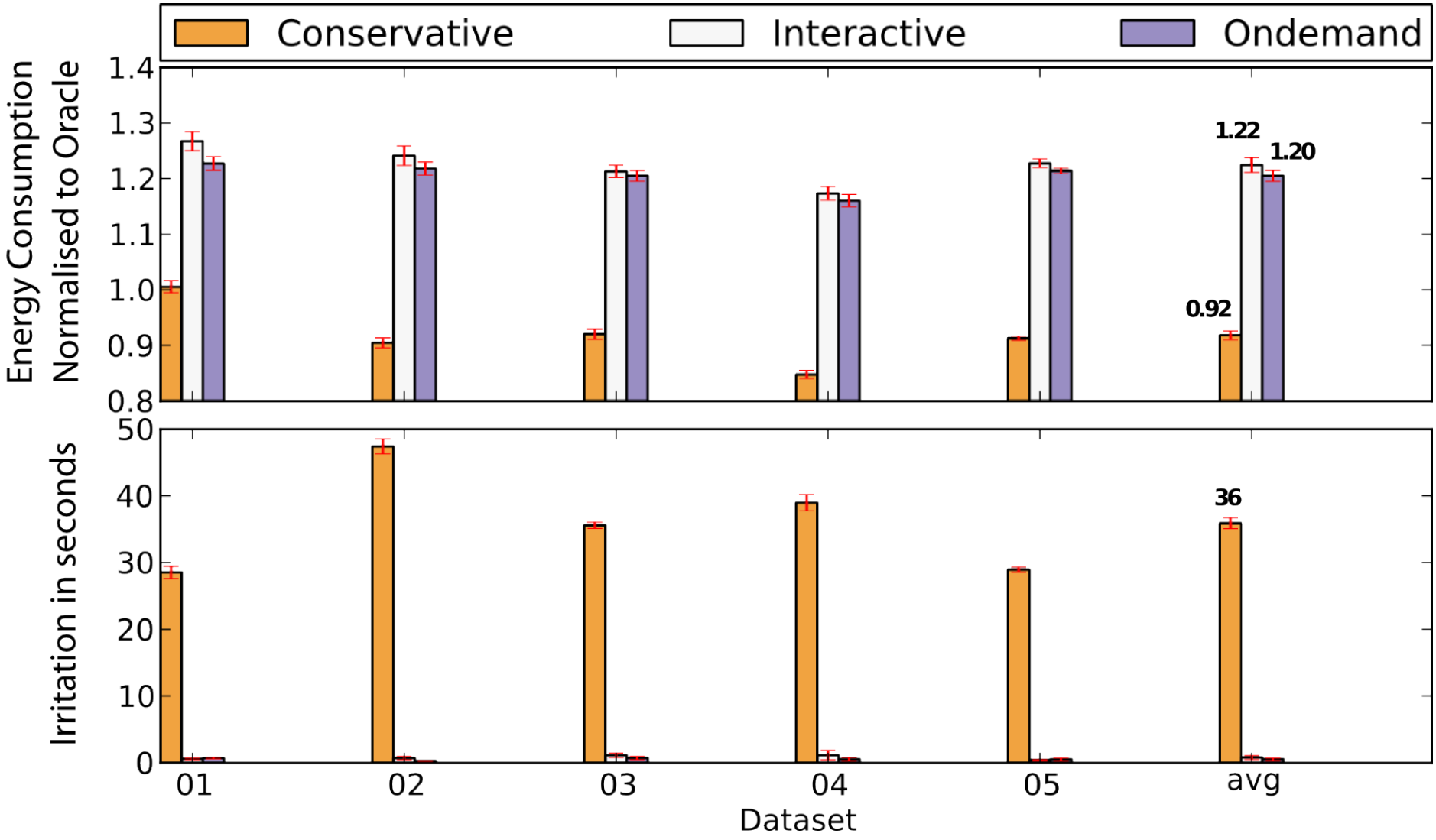
Energy VS QoE



Energy vs QoE

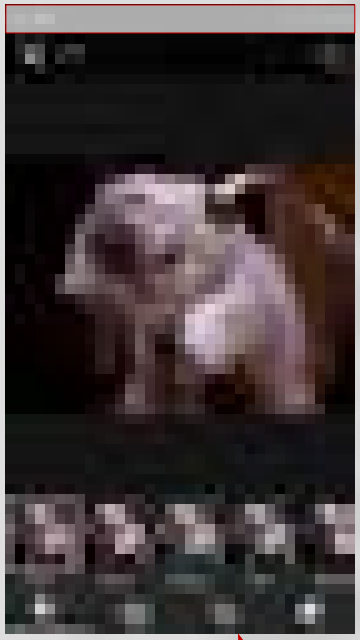


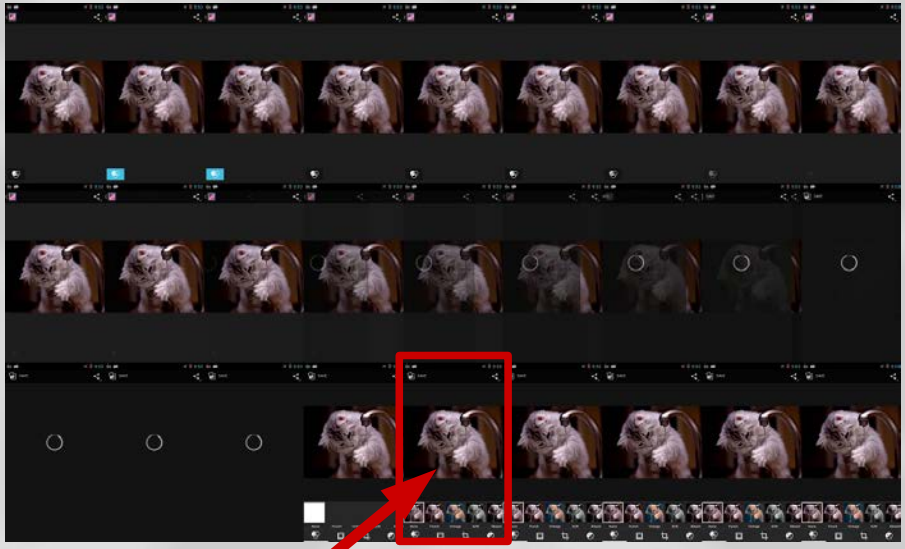
Energy vs QoE



Fully Automatic Markup

Fully automatic markup

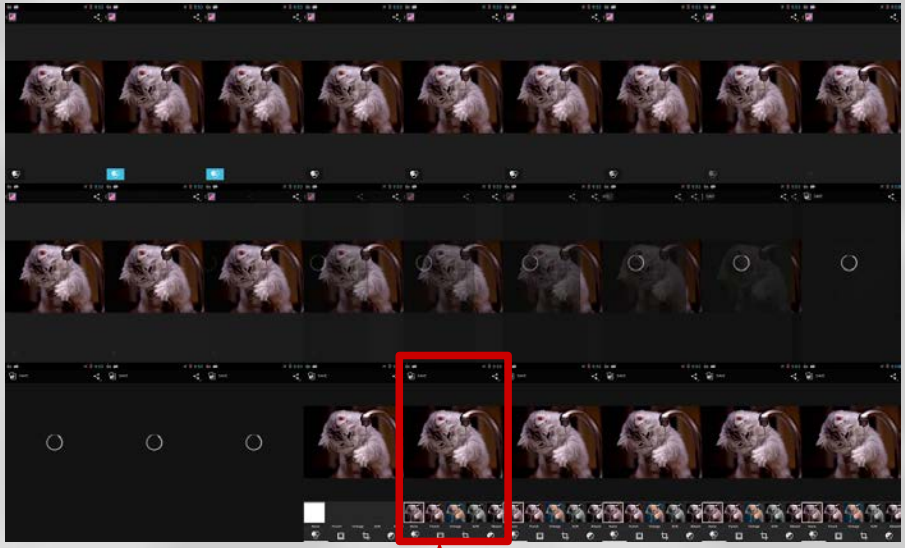




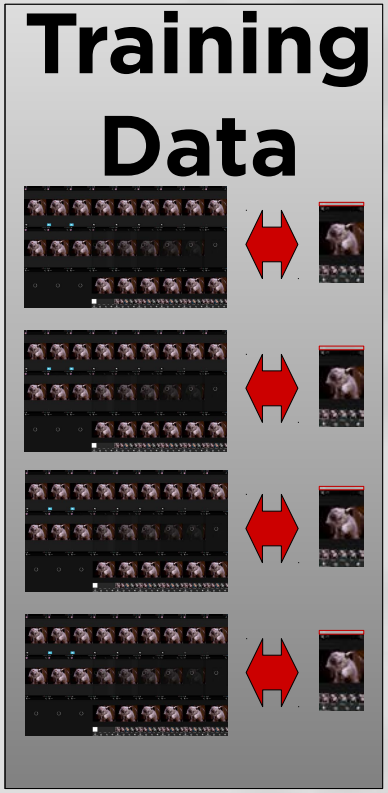
Human input needed only once

Interaction End

Fully automatic markup



Training Data



ML

Human input needed only for training