

Koala

Ultra-Low Power Data
Retrieval in Wireless
Sensor Networks

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Low Power Probing (LPP)

Flexible Control Protocol (FCP)

Koala

Story



Life Under Your Feet



Dozer

Nicolas Burri, Pascal von Rickenbach, Roger Wattenhofer
ETH Zurich, Switzerland





Repeated Research



Goals

Per mille
Duty-cycle

No clock
Synchronization

Medium
Size
Networks

Simplicity

Sleeping



Wake up

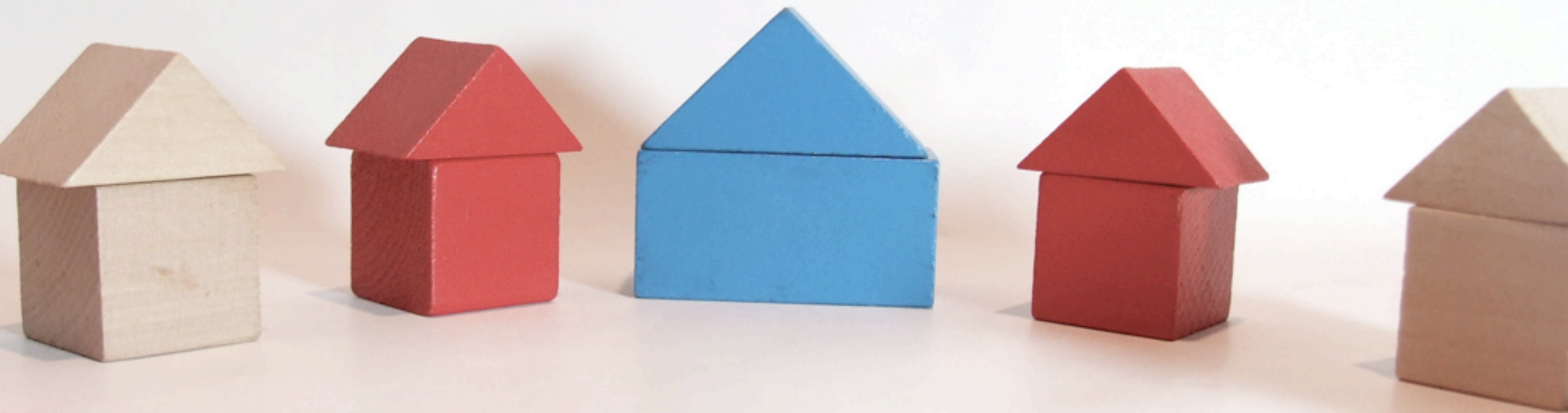


Wake up
an entire
network



Stay up





Neighborhood Discovery

Download





Recap



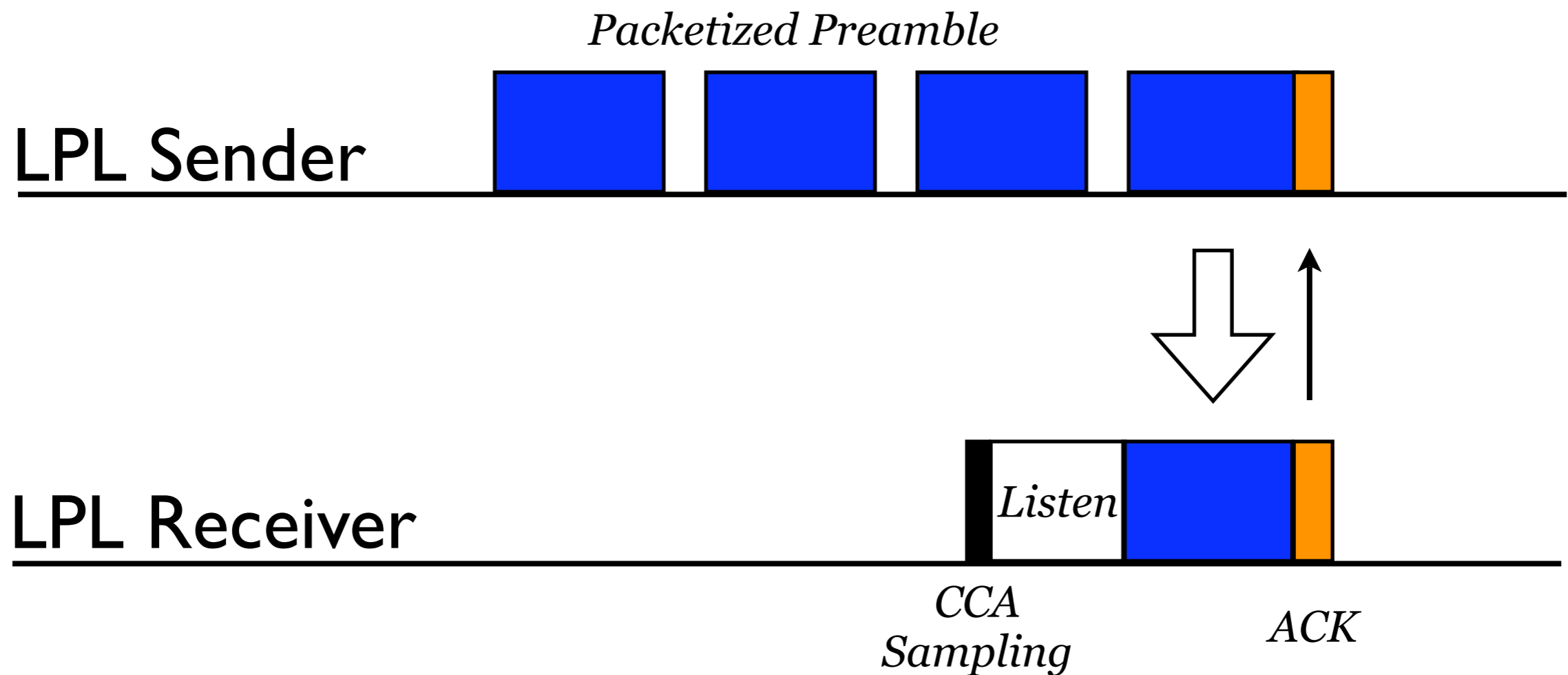
Koala

1	Wake up	Low Power Probing
2	Stay up	Drip
3	Neighborhood Discovery	Flexible Control Protocol
4	Data Download	

I . Wake up

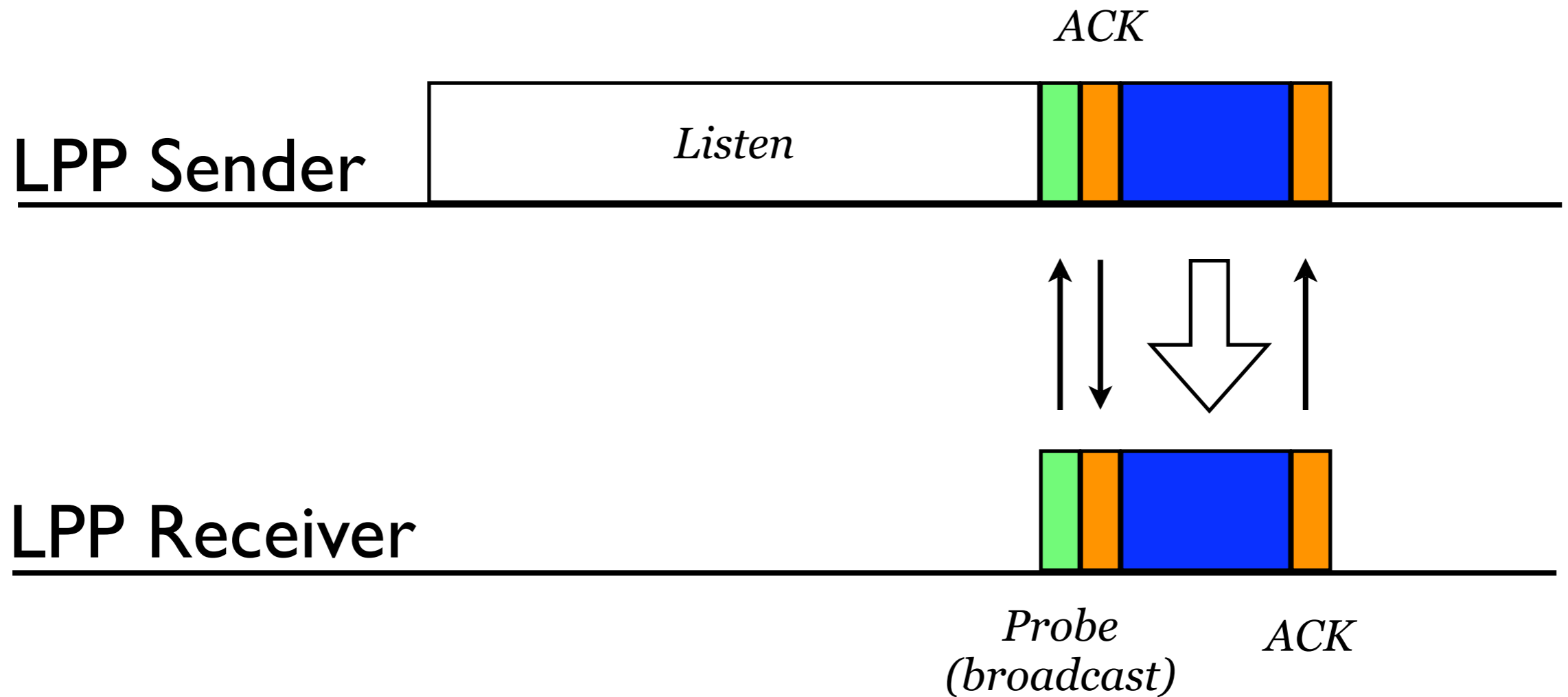
Low Power Probing

Low Power Listening

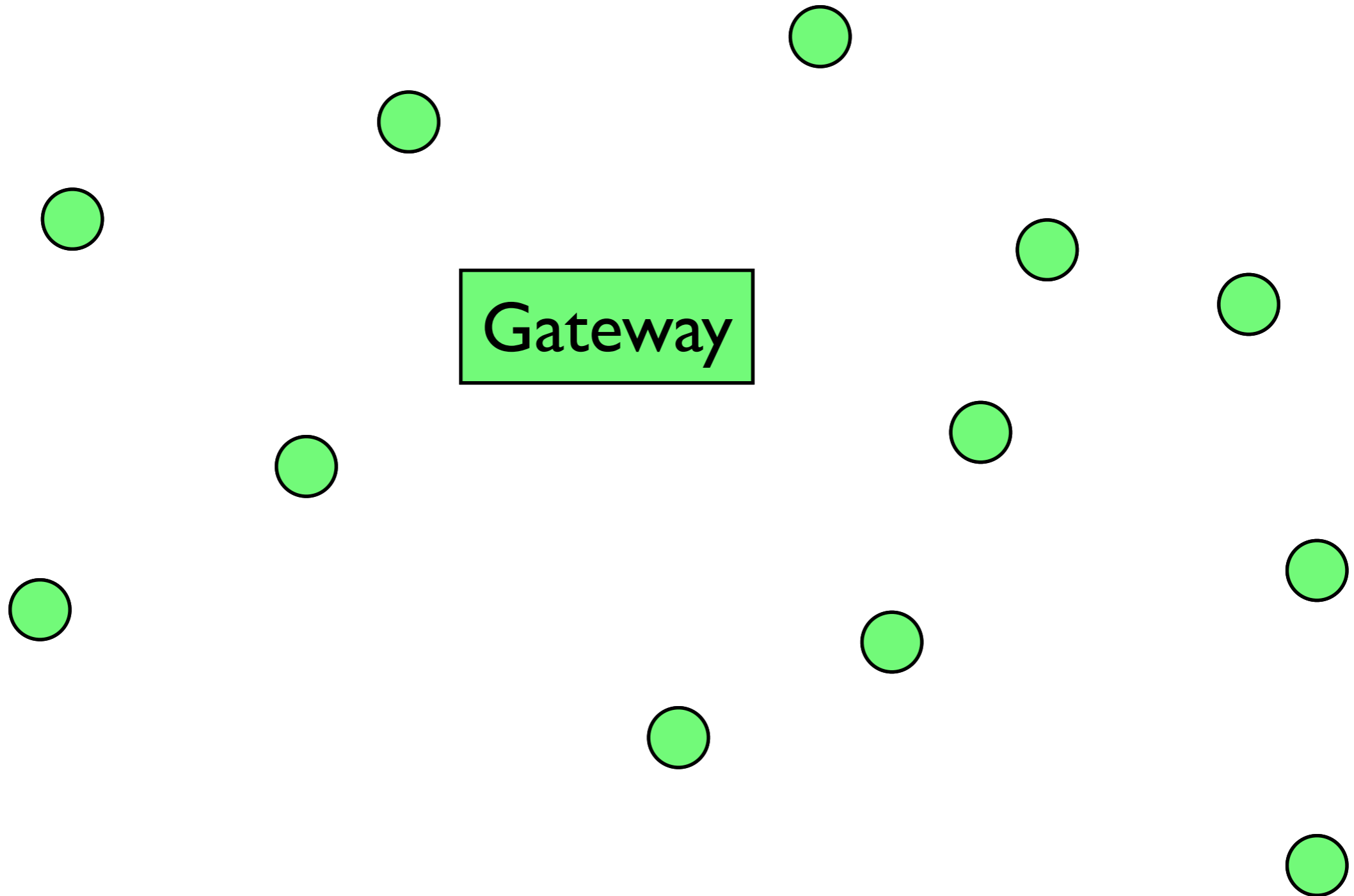




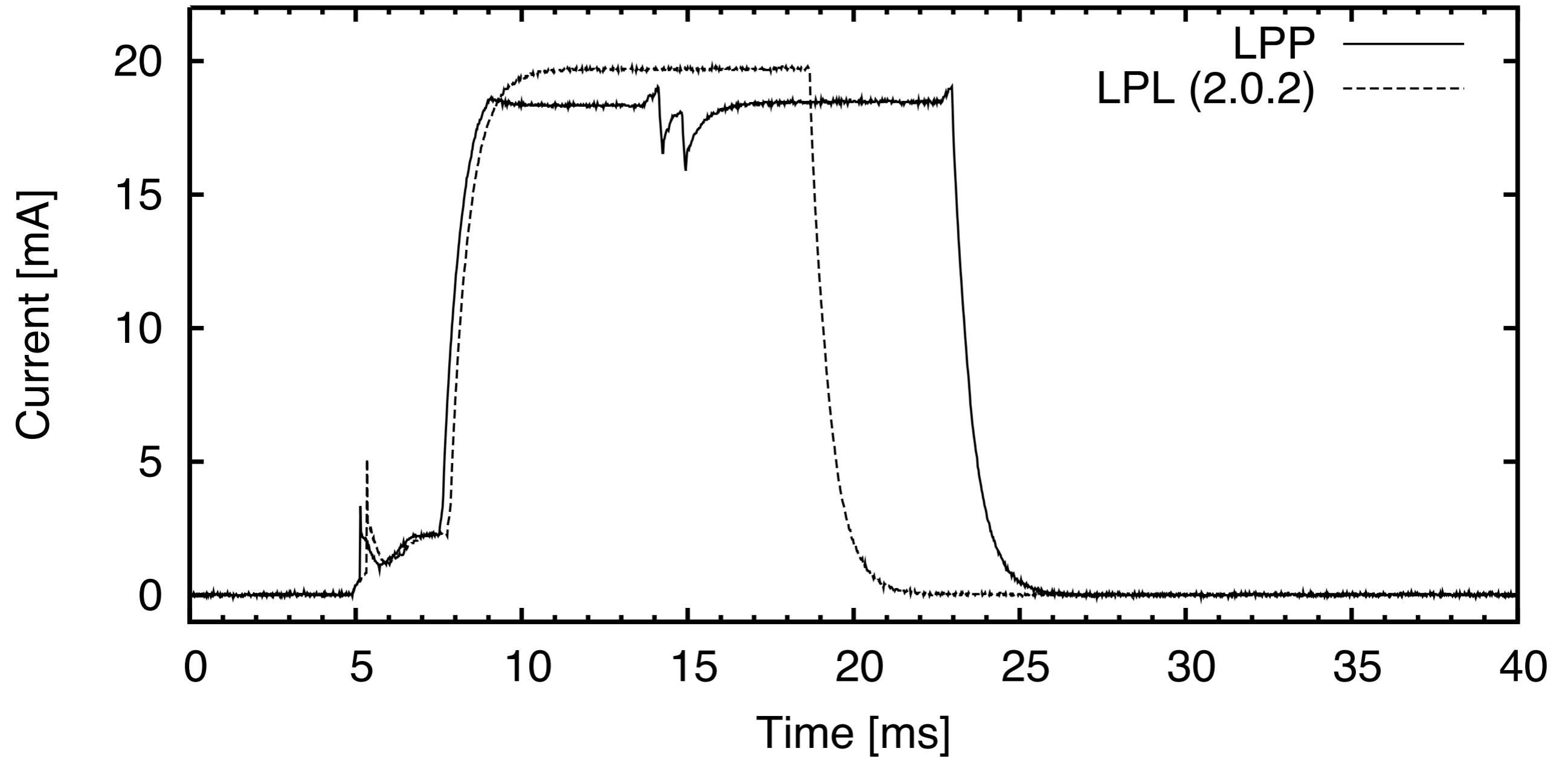
Low Power Probing

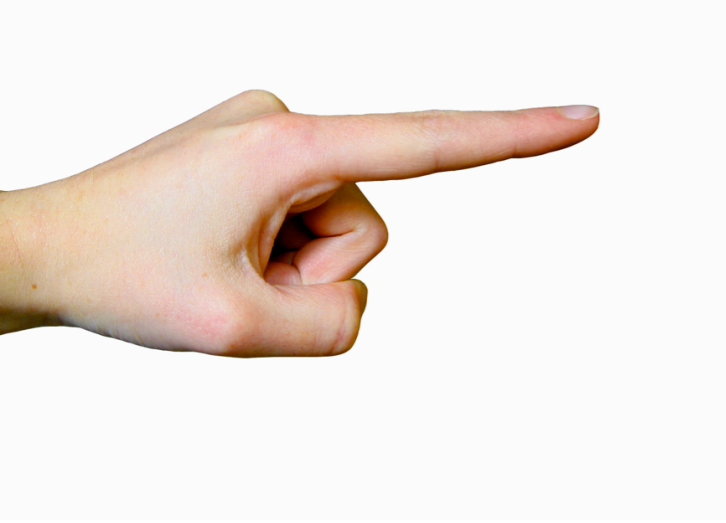


How does it work?



Performance of LPP





LPP vs LPL



- Probing in LPP is takes in average 26% longer that LPL

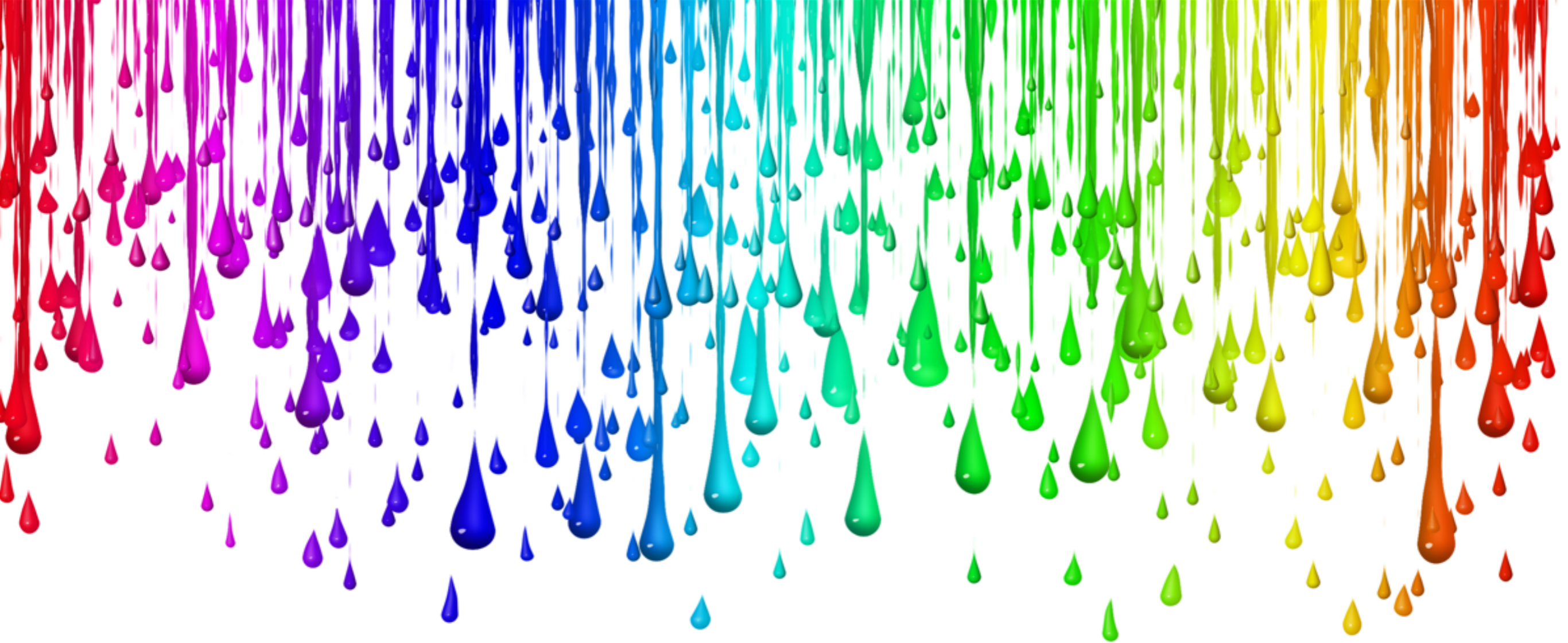
but

- LPP is resilient against RF interference

and

- LPP generates less noise during wake-up.

2. Stay up



Drip

3. Neighborhood Discovery

Two steps

1. Each mote discover its neighbors.
2. The gateway retrieves the neighbor list from each mote using Flexible Control Protocol.





ALPINE



ON

SIREN



OFF

SPEECH



VOLUME

Requirements

Trickle Timer

- Bounded amount of traffic
- Independent of node density
- Fairness



Solution

- Send beacons using an exponential distribution
and
- Suppress the transmission if you receive another beacon before your timer expires.

Problem

- Generating an exponential distribution requires computing the logarithm
- ... which can be approximated using the first term from the Taylor expansion:

$$\log(x) = (x - 1) - \frac{(x - 1)^2}{2} + \frac{(x - 1)^3}{3} - \frac{(x - 1)^4}{4} \dots$$

Flexible Control Protocol



Mote Herding for Tiered Wireless Sensor Networks

Thanos Stathopoulos, Lewis Girod, John Heidemann, Deborah Estrin
UCLA



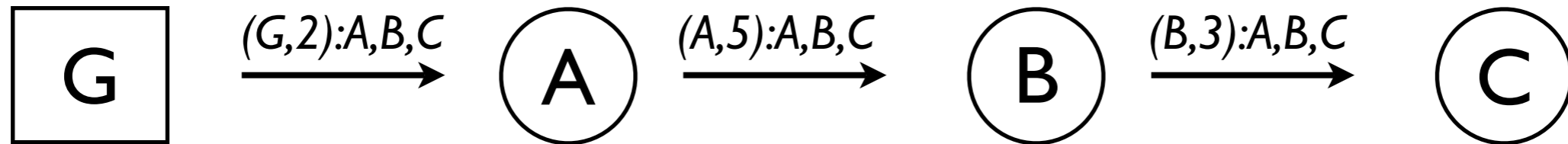
Centroute



FCP Characteristics

- Fixed header of 3 bytes.
- Source routing for establishing a path.
- Everything is soft-state.
- It's easy to reply (mote) but more complicated to initiate a connection (usually the gateway).

Path establishment

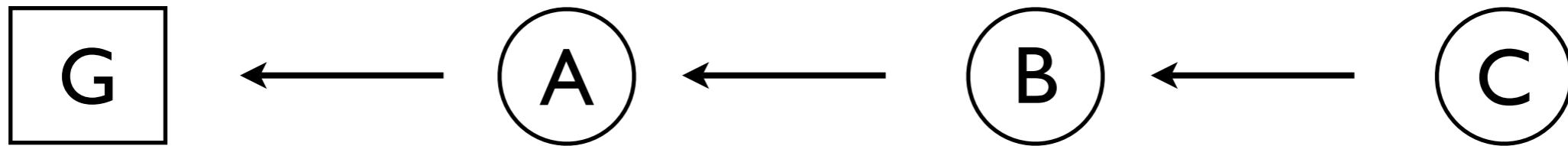


Prev Hop	In ID	Next Hop	Out ID
G	2	B	5

Prev Hop	In ID	Next Hop	Out ID
B	3	C	

Prev Hop	In ID	Next Hop	Out ID
A	5	C	3

Path establishment

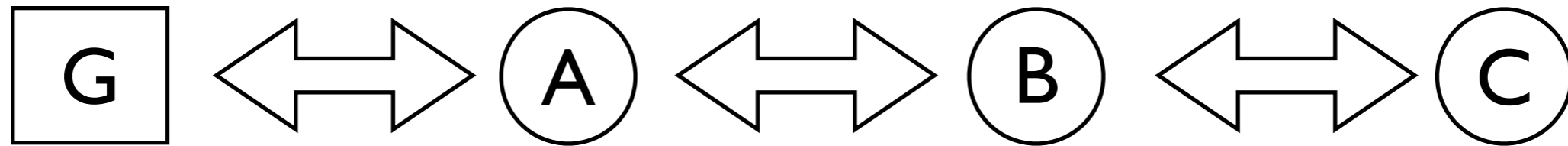


Prev Hop	In ID	Next Hop	Out ID
G	2	B	5

Prev Hop	In ID	Next Hop	Out ID
B	3	C	

Prev Hop	In ID	Next Hop	Out ID
A	5	C	3

Data transfer

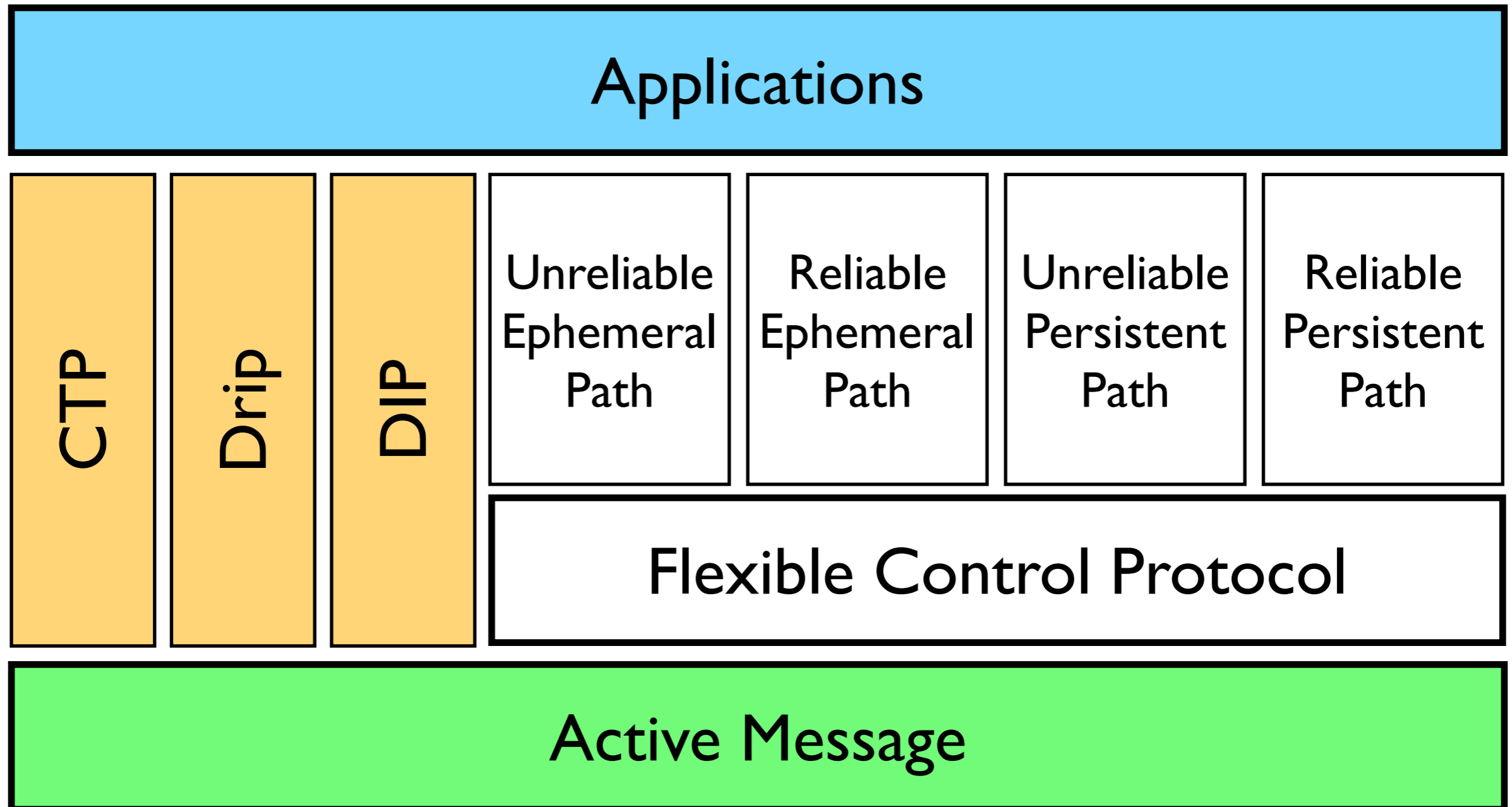


Prev Hop	In ID	Next Hop	Out ID
G	2	B	5

Prev Hop	In ID	Next Hop	Out ID
B	3	C	

Prev Hop	In ID	Next Hop	Out ID
A	5	C	3

Flexible Control Protocol



4. Download

Download

Unreliable Persistent Path

or

Reliable Persistent Path



Unreliable Persistent Path

1. Pick a path.
2. Establish the connection.
3. Request for chunks of data until the desired interval of data is retrieved.

One more thing



Channel Switching

Flexible Control Protocol



Evaluation

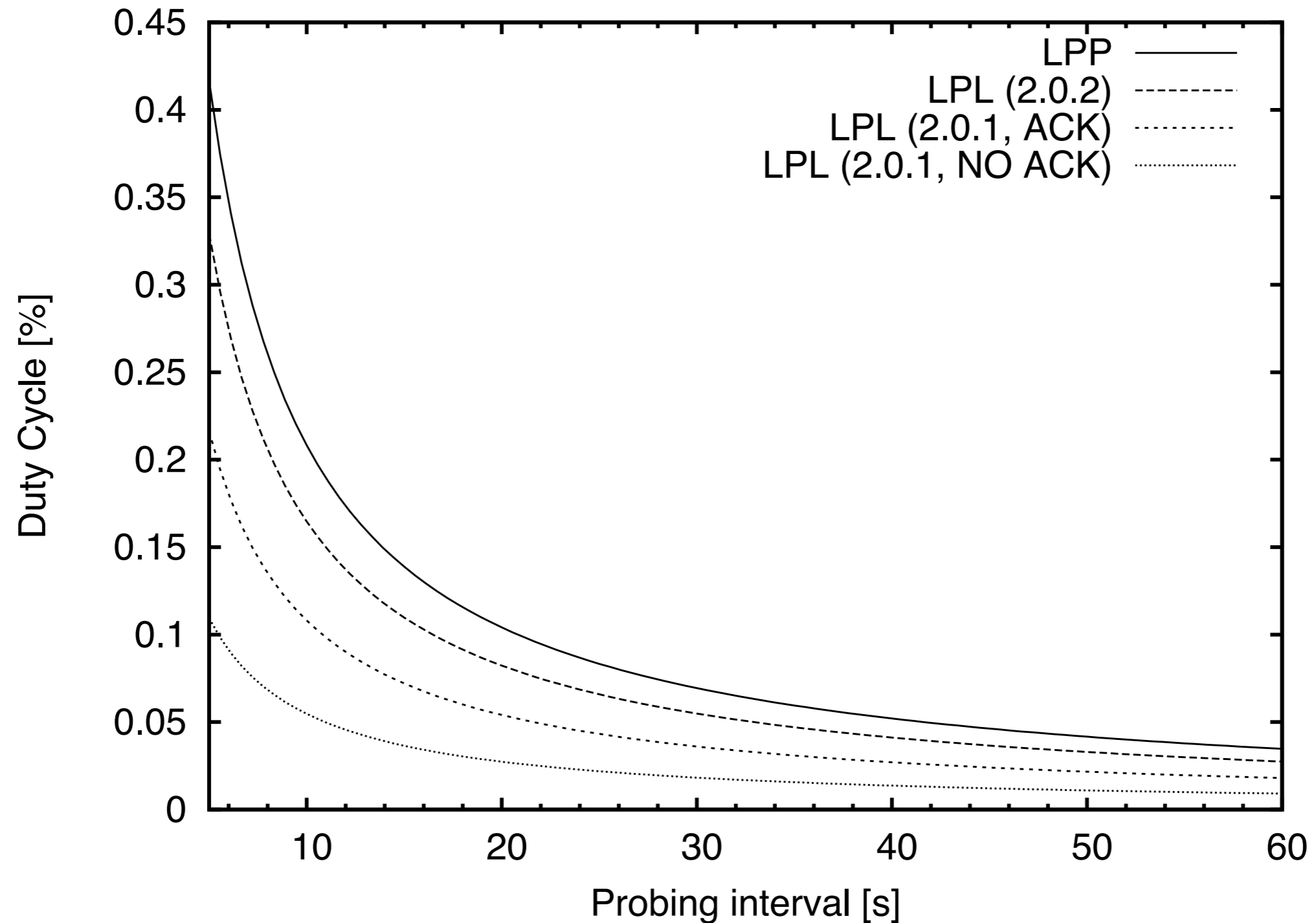


What do we want to measure?

- Cost of LPP.
- Performance of the wake up procedure.
- Performance of the download.
- Impact of the channel switching.

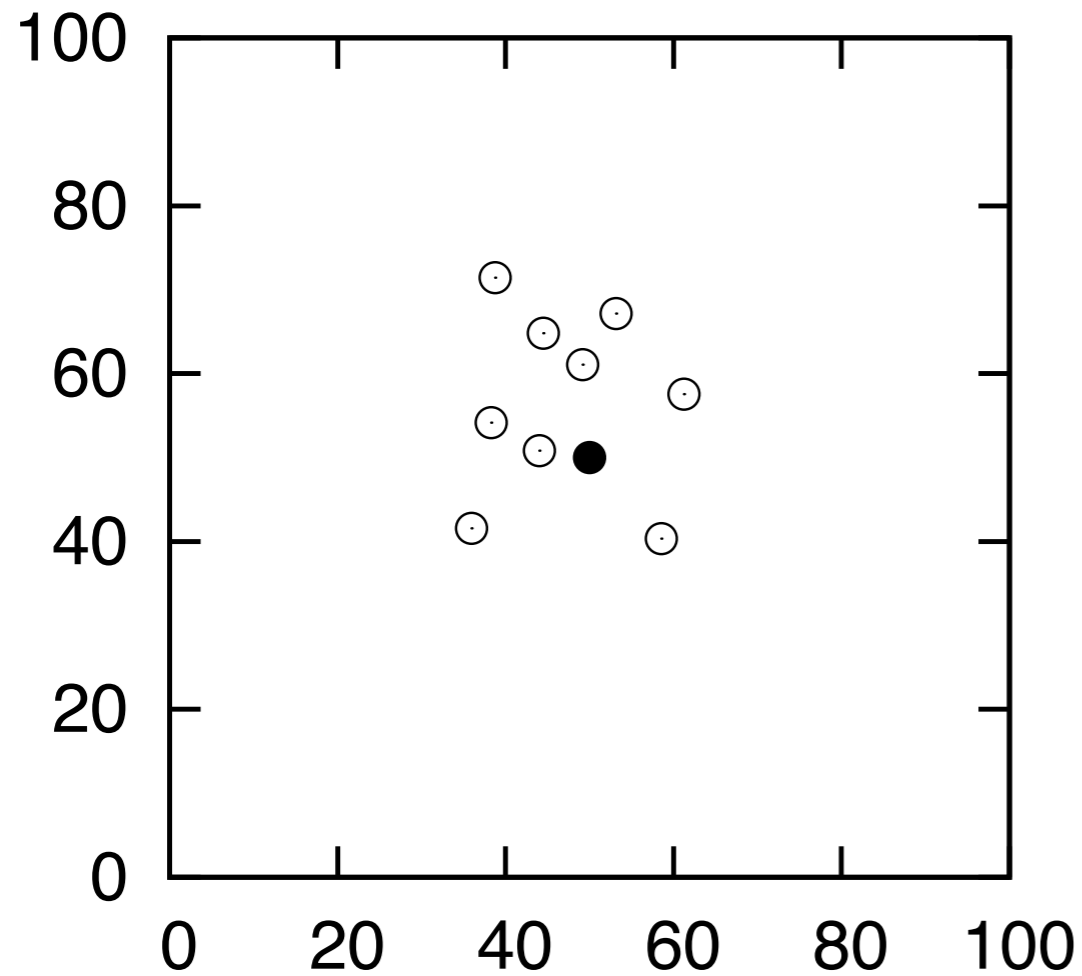


Performance of the LPP

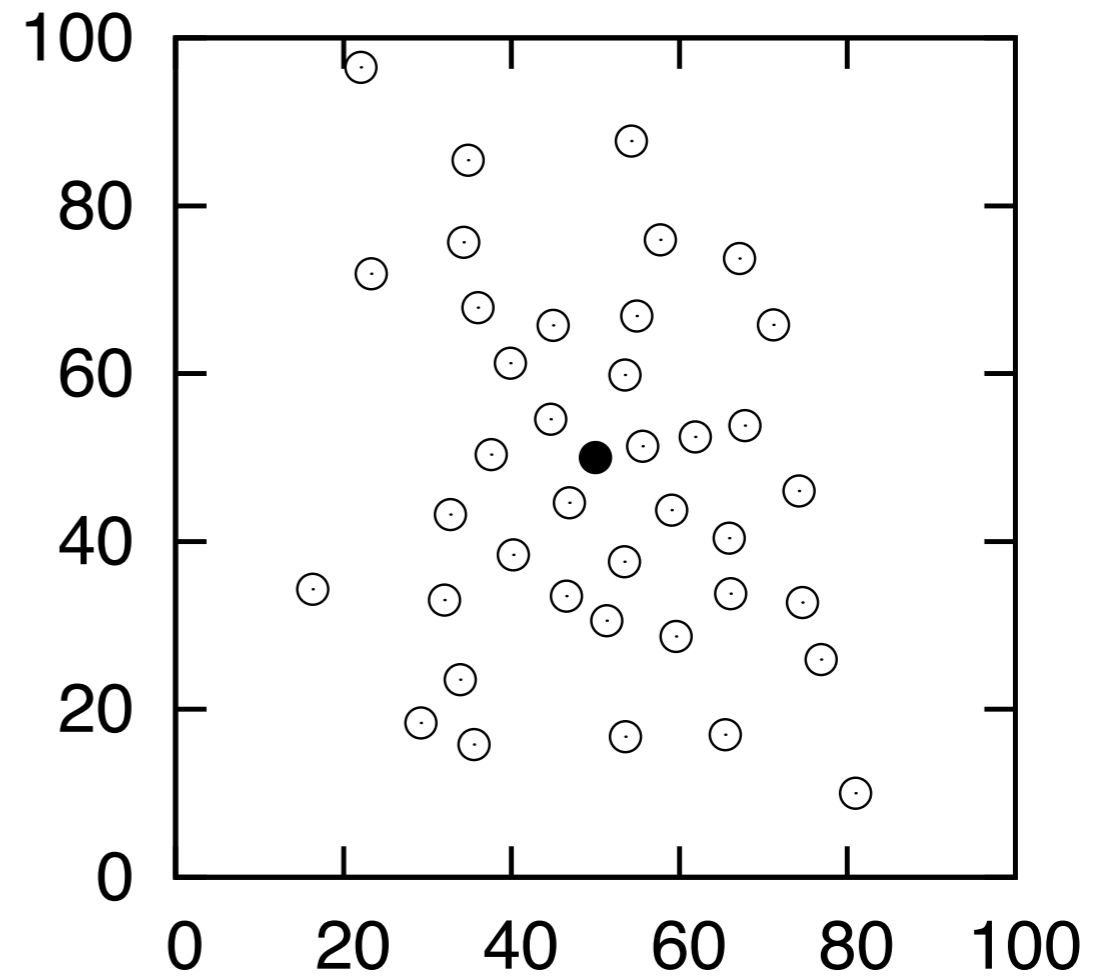


TOSSIM

10 nodes

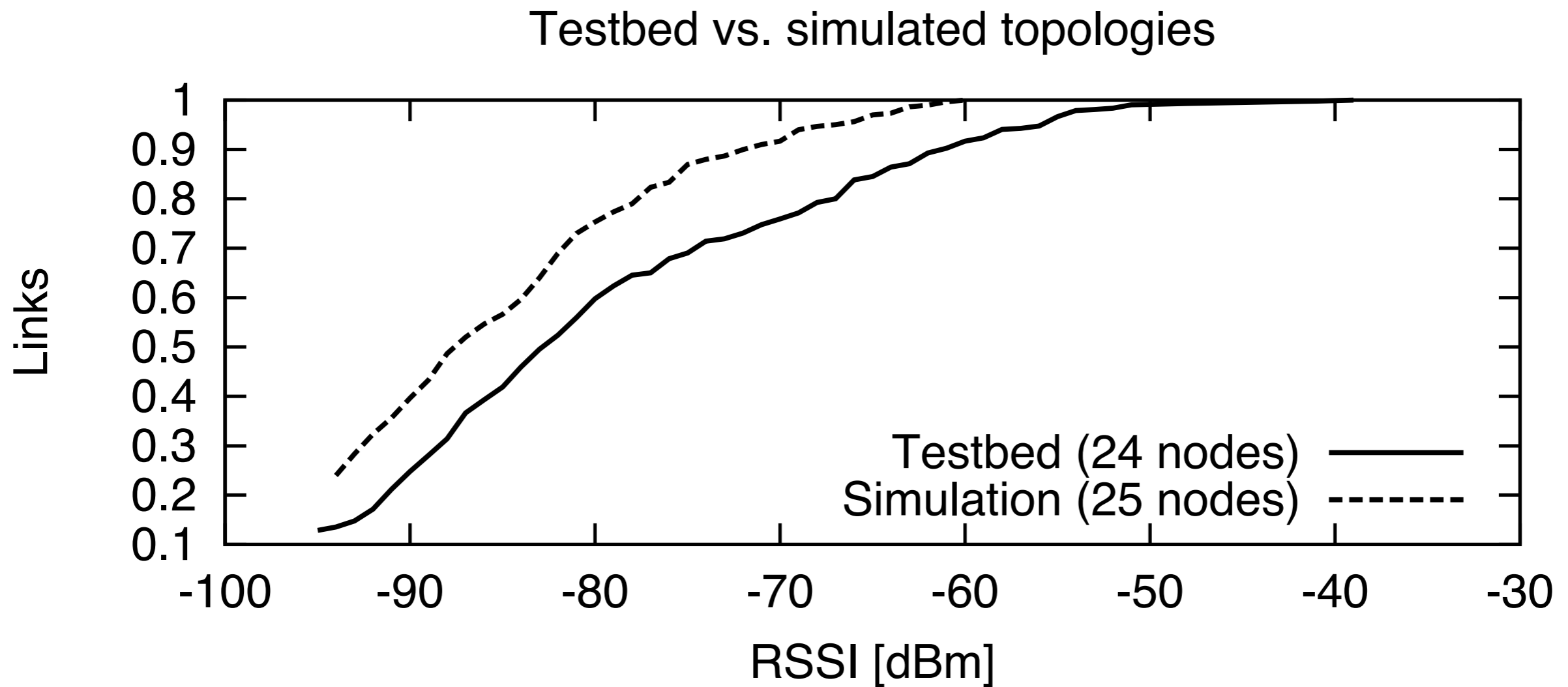


40 nodes



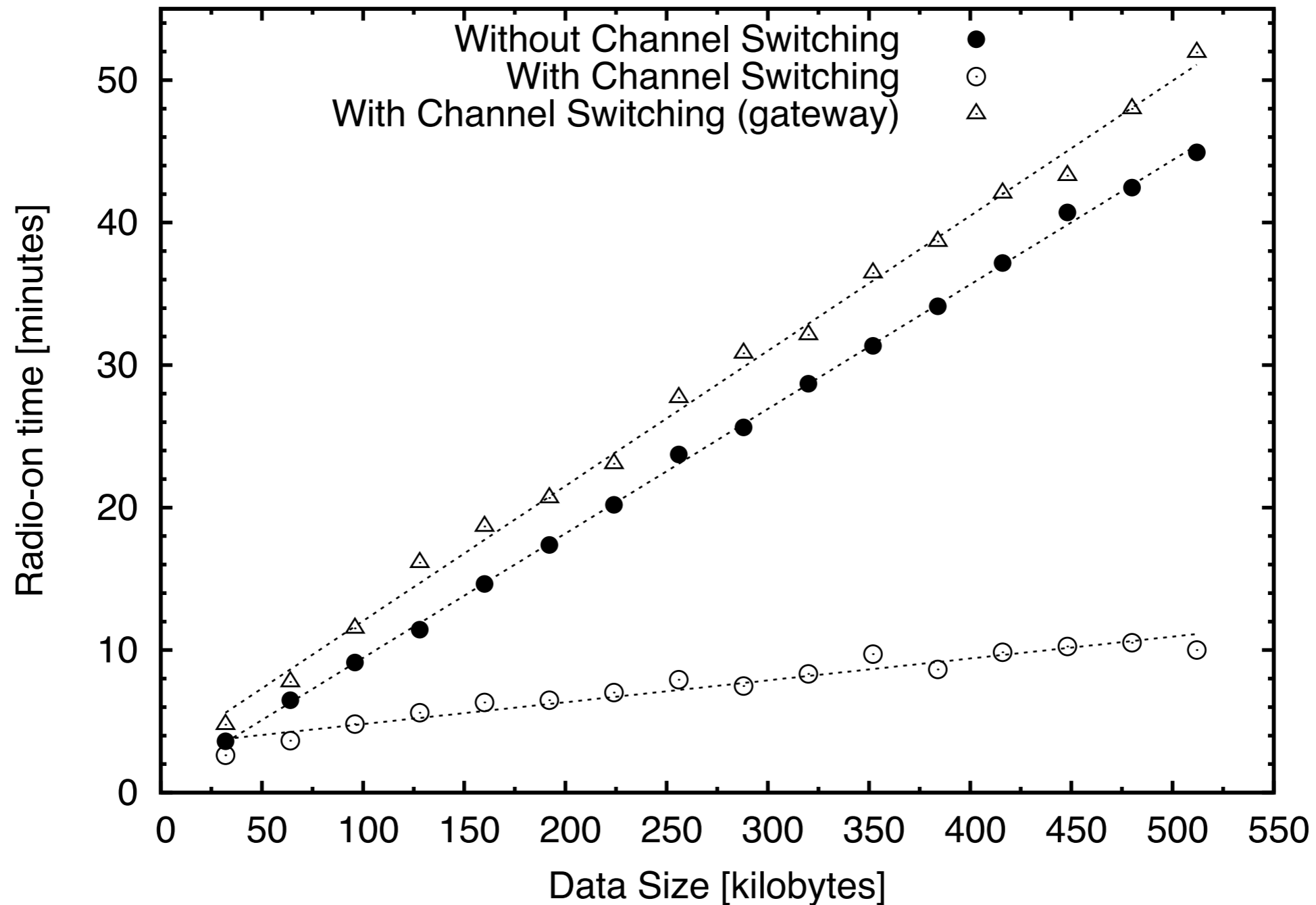
Gains are computed using the Log Distance Path Loss model.
Noise is simulated by CPM using meyer-heavy.txt noise trace.

Testbed vs TOSSIM



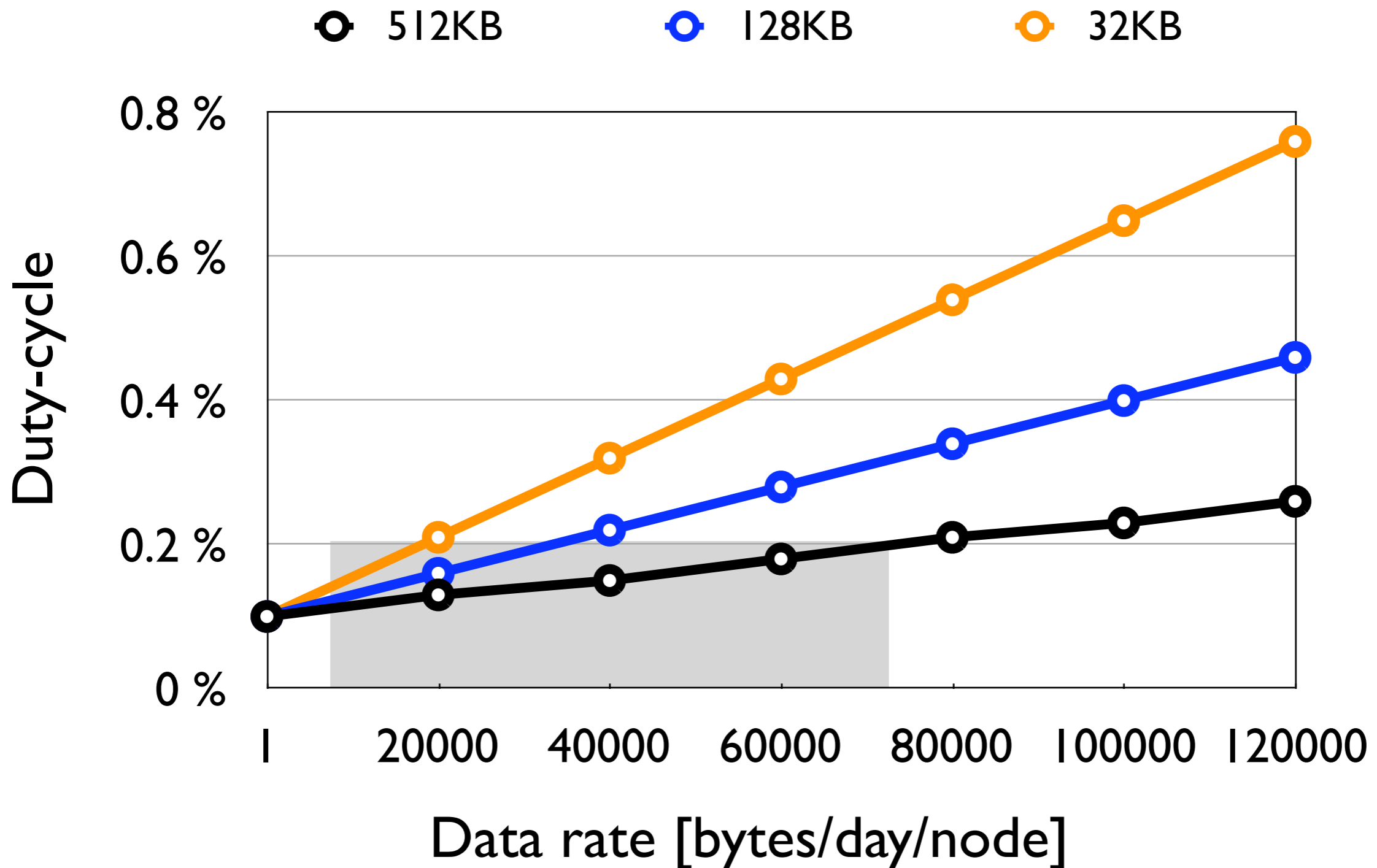
Impact of channel switching

25-node network, LPP interval of 20 seconds



Performance of Koala

25-node random network, LPP interval of 20 seconds, with channel switching

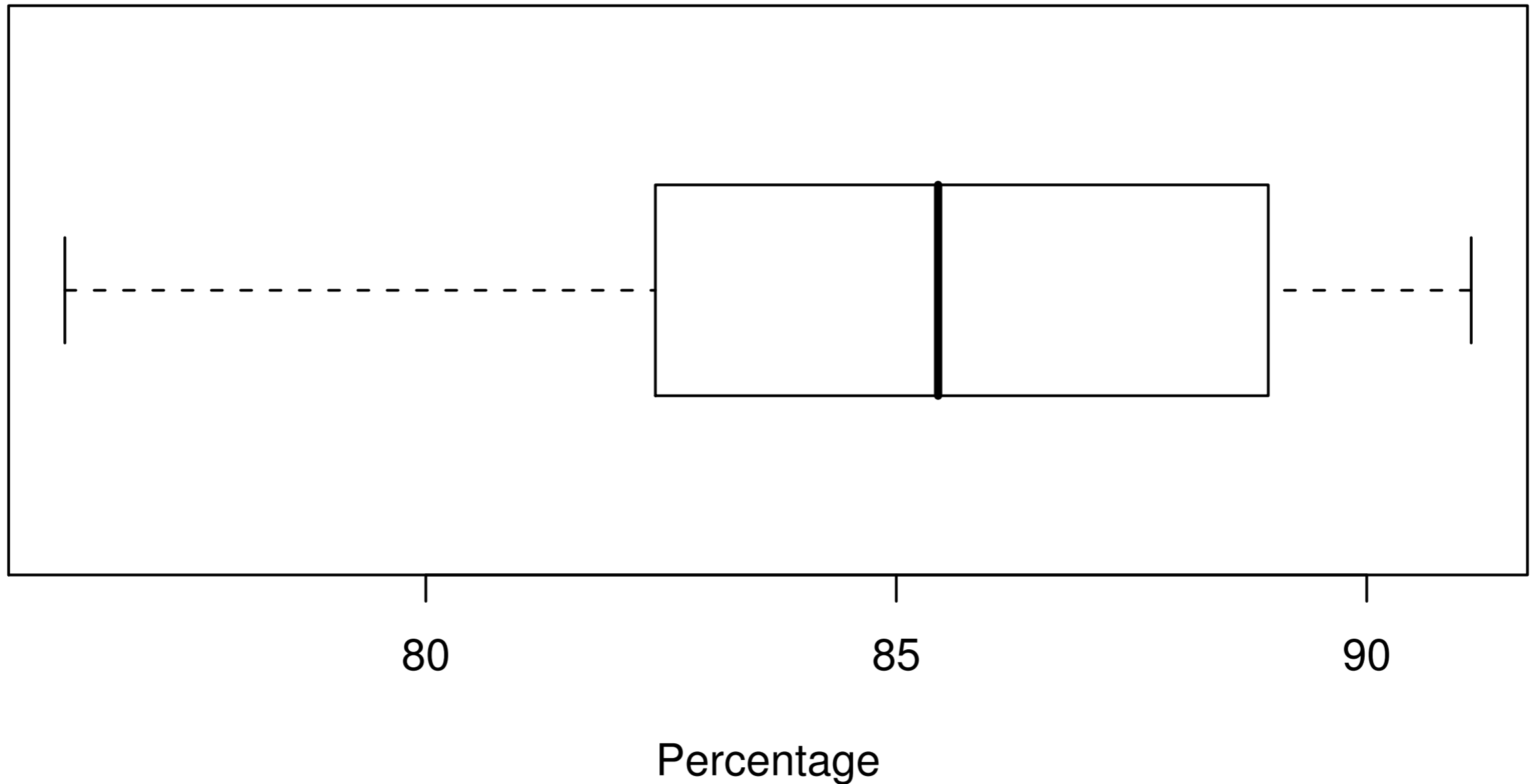


Can we do
better?



Overhead

Percentage of time in idle listening.

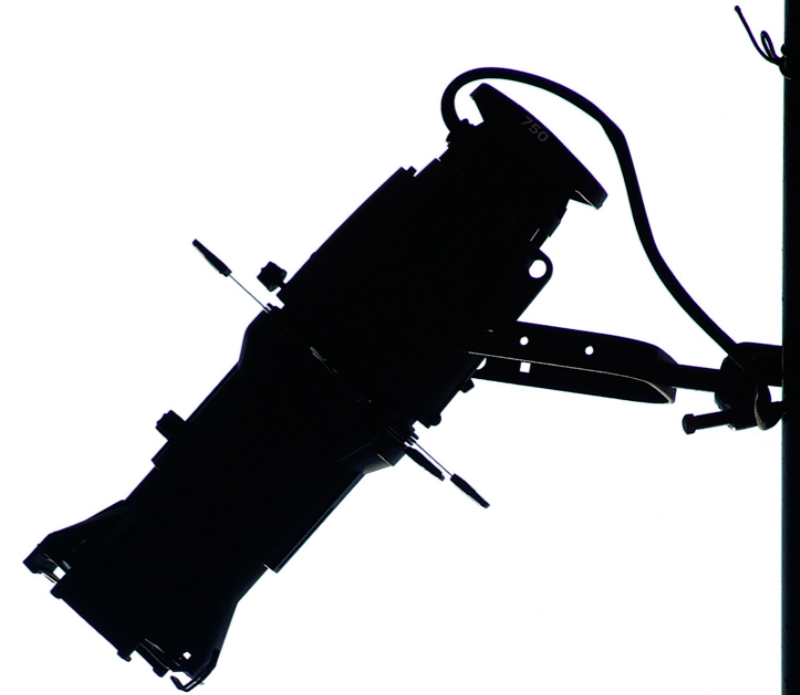


Future work

- Integration with Flush/RCRT.
- Full LPP compatibility with LPL.
- Improvements in path selection.



Status



- LPP is already in `tinycos-2.x-contrib`.
- FCP and Koala will follow soon.
- Testing in the field is in progress.

Thanks!

Thanks!

Questions?

