M-MPAC'09

Count on me
Lightweight Ad-Hoc Broadcasting in Heterogeneous Topologies

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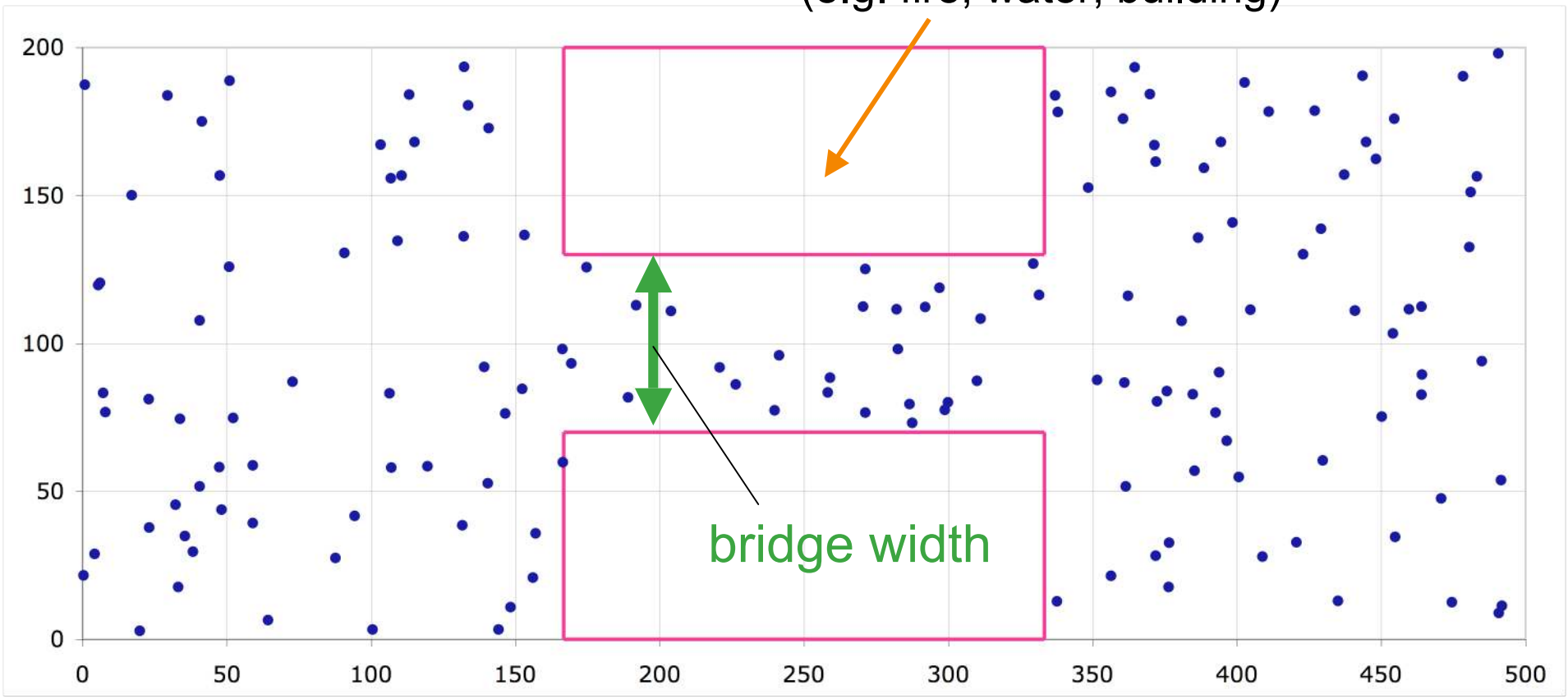
Why broadcast?

- **Fundamental** mechanism for wireless and MANETs
  - ➔ look-up (routes, data, services, participants)
  - ➔ propagation (signalling, data)

- **Lightweight**, **resilient**, and **efficient** approaches needed
  - ➔ better understanding of bcast can help shape higher levels

The problem:
Heterogeneous topologies



Outline

- Which broadcast to use? Background
- PAMPA in heterogeneous topologies
- 3 hardening mechanisms - many combinations
- Evaluation

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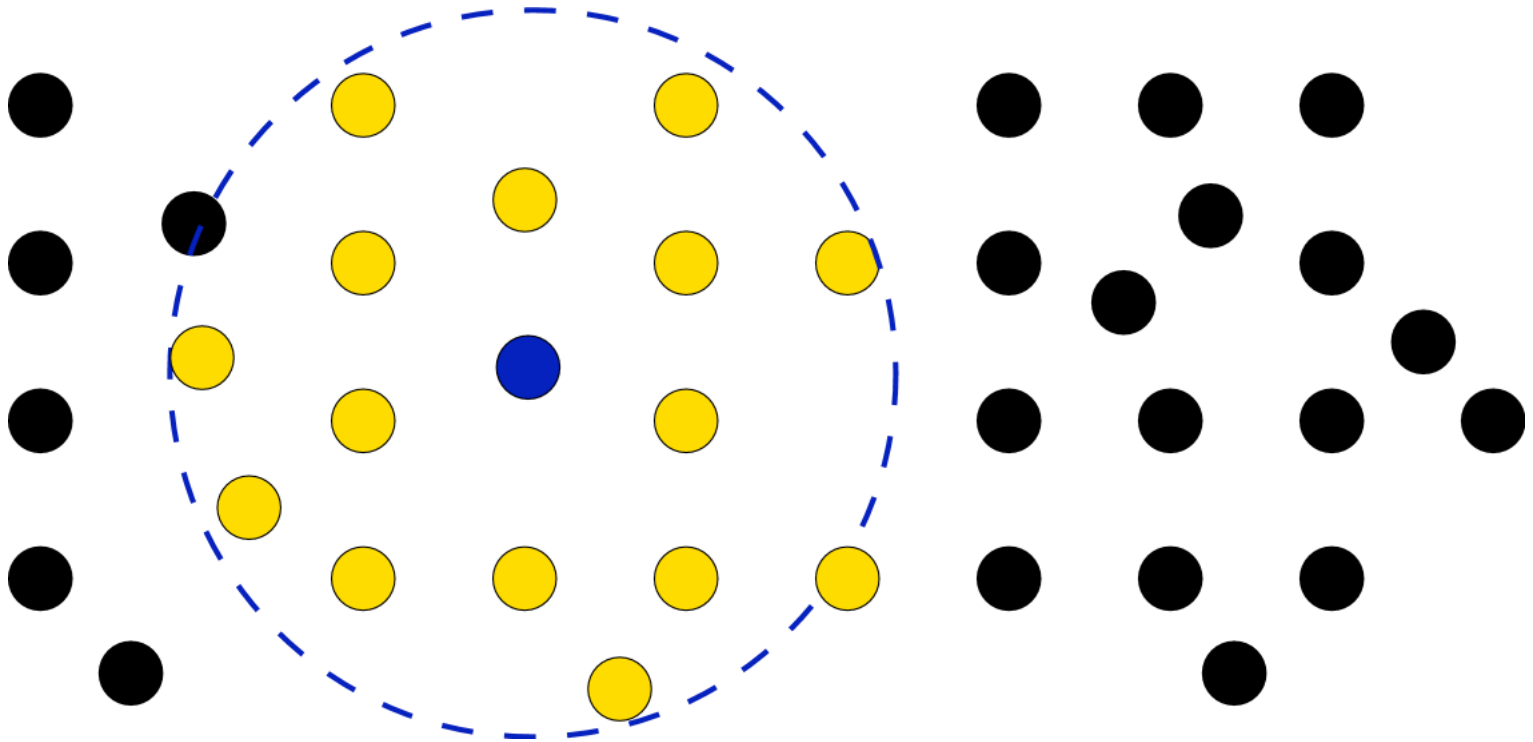
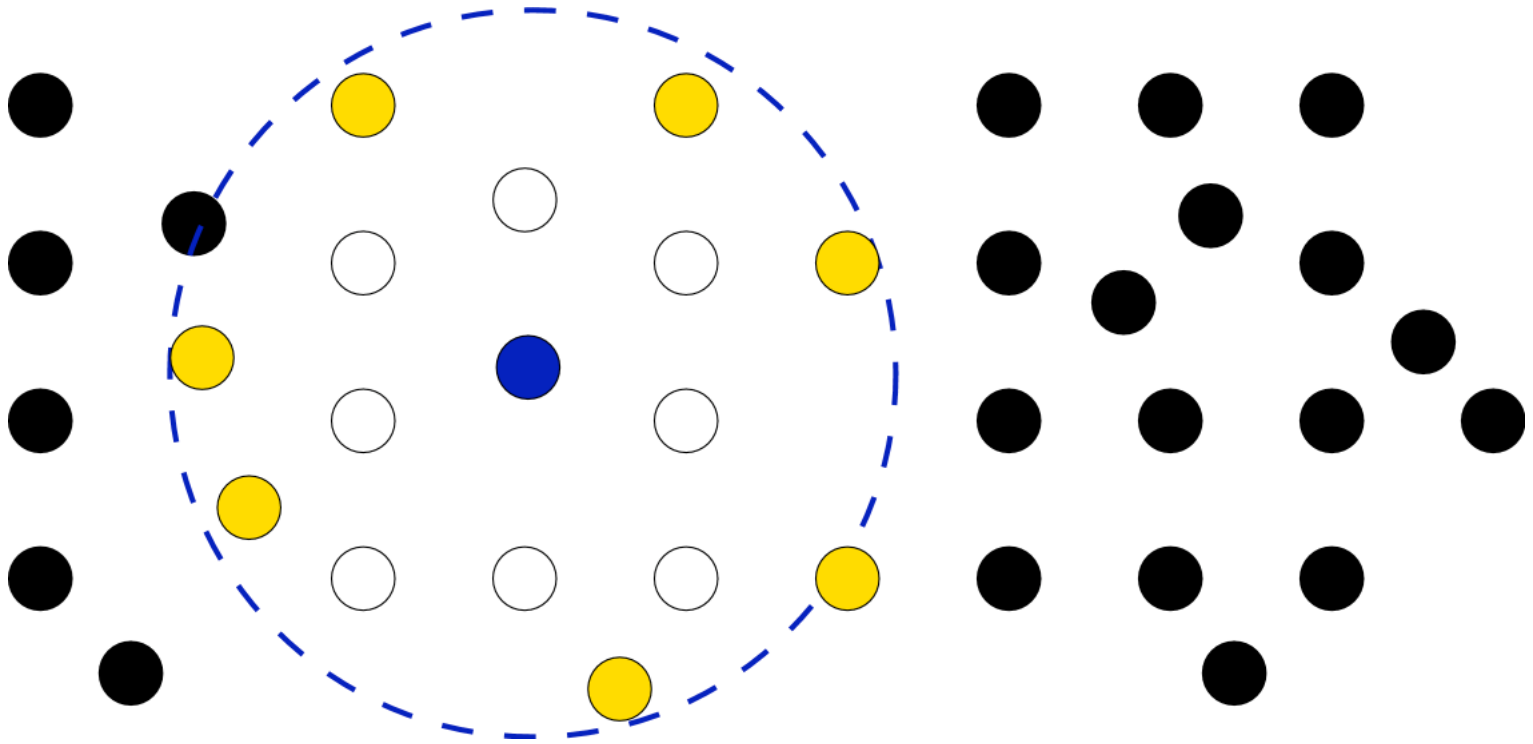
Which broadcast to use?

- Flooding: Powerful but costly



Improved broadcast

- Silence is (sometimes) gold – but when to refrain?



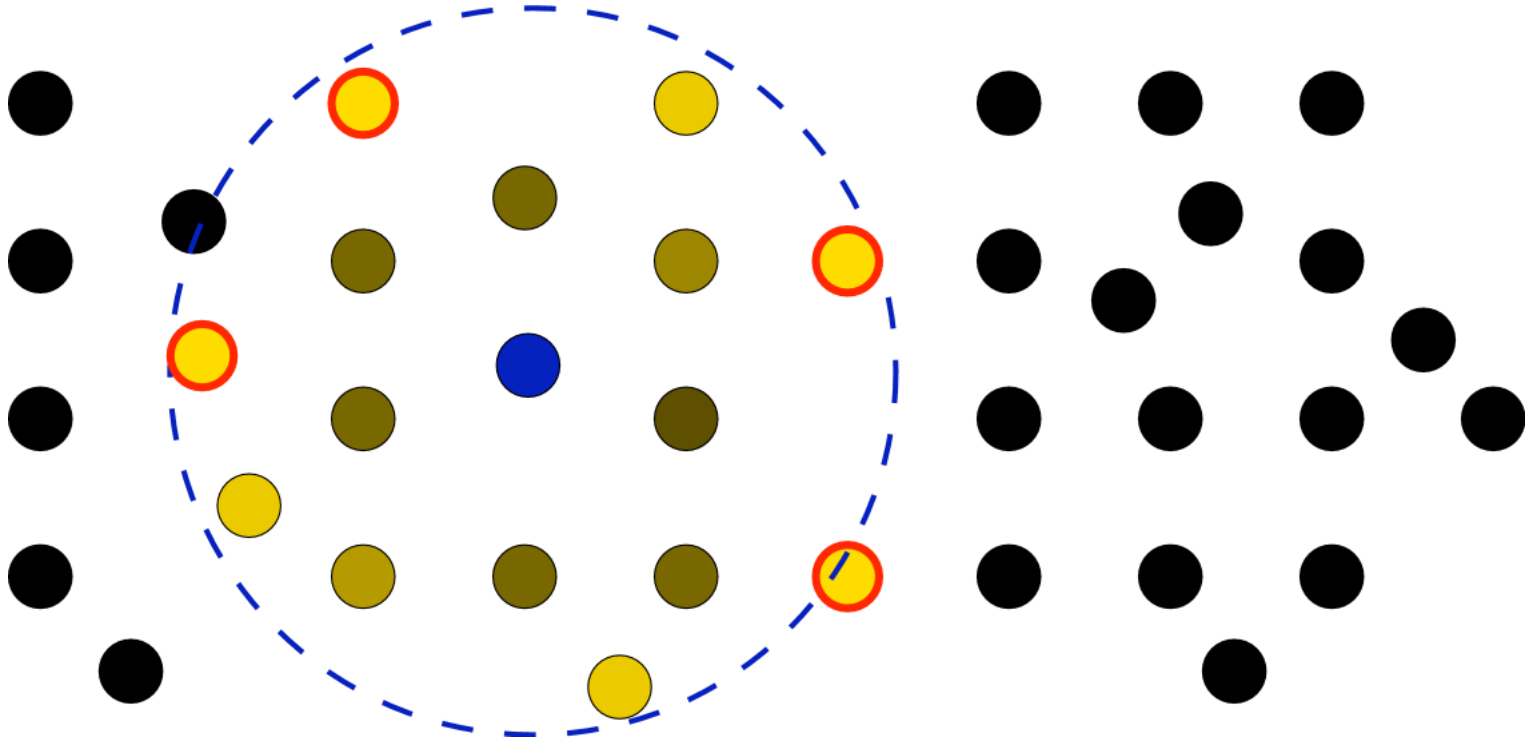
Improved broadcast – Approaches

When to refrain? When to retransmit?

- **Random** decision → Gossip
  - ➔ but best probability depends on density → Smart Gossip
- **Counting** during random delay (counting schemes)
  - ➔ retransmit if heard count < threshold (e.g. 2)
  - ➔ random delay means sometimes suboptimal
- **Max signal strength** (RSSI) over random delay
  - ➔ retransmit if max heard strength < threshold
  - ➔ here too randomness can be suboptimal
- Pick **best positioned** node (e.g. six shot shot bcast)
  - ➔ but require position information (GPS or other)

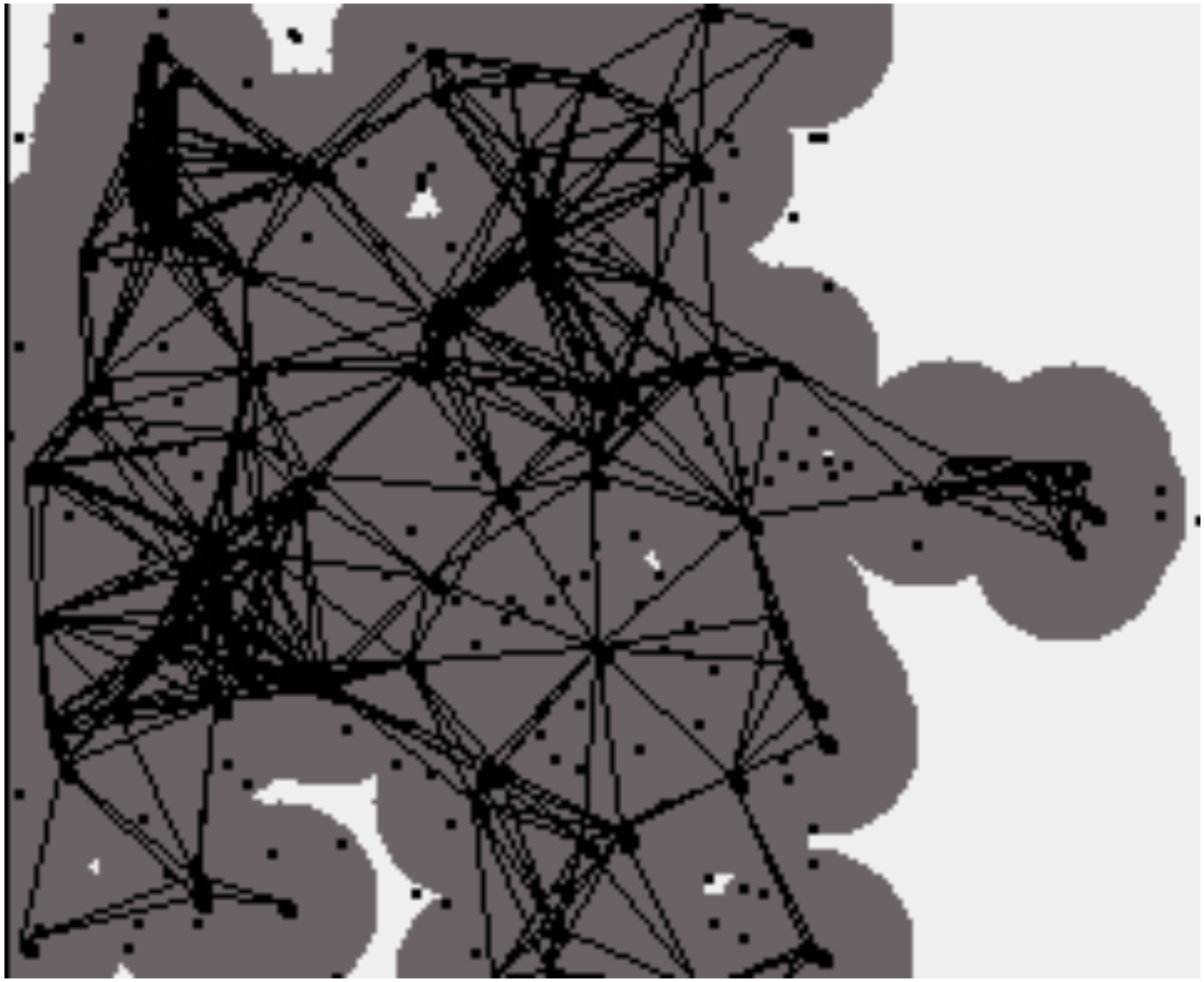
Our pick: PAMPA

- No randomness / no learning / no location required



- ➔ signal strength → listening delay
- ➔ # of heard retransmissions < threshold → retransmit

PAMPA in Action



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Metrics

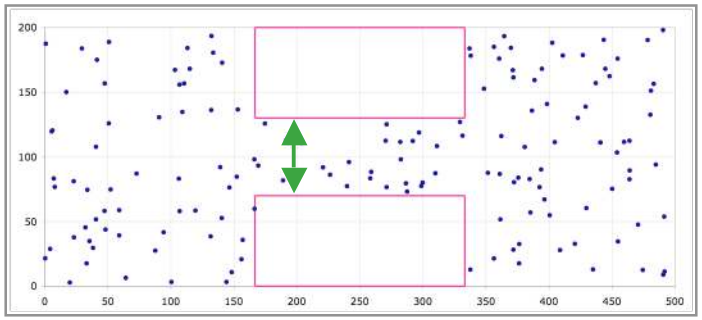
- **Delivery ratio**
  - ➔ Proportion of nodes that get a broadcast
  - ➔ The higher the better
- **Retransmission ratio**
  - ➔ Proportion of receiving nodes that retransmit
  - ➔ The lower the better
- **90%-QoS**
  - ➔ % of node topologies where avg. delivery ratio > 90%
- **E.g. Flooding**
  - ➔ Delivery ~ 100% if connected network (and no collision)
  - ➔ Retransmission ratio = 1

Experimental set-up

- ns2: 200x500m, 200 nodes positioned, 40m radio range

for each width (0m to 160m)

random topology



× 40

for each protocol (flooding, PAMPA, …)

for each random topology (1..40)

each node broadcasts once in turn

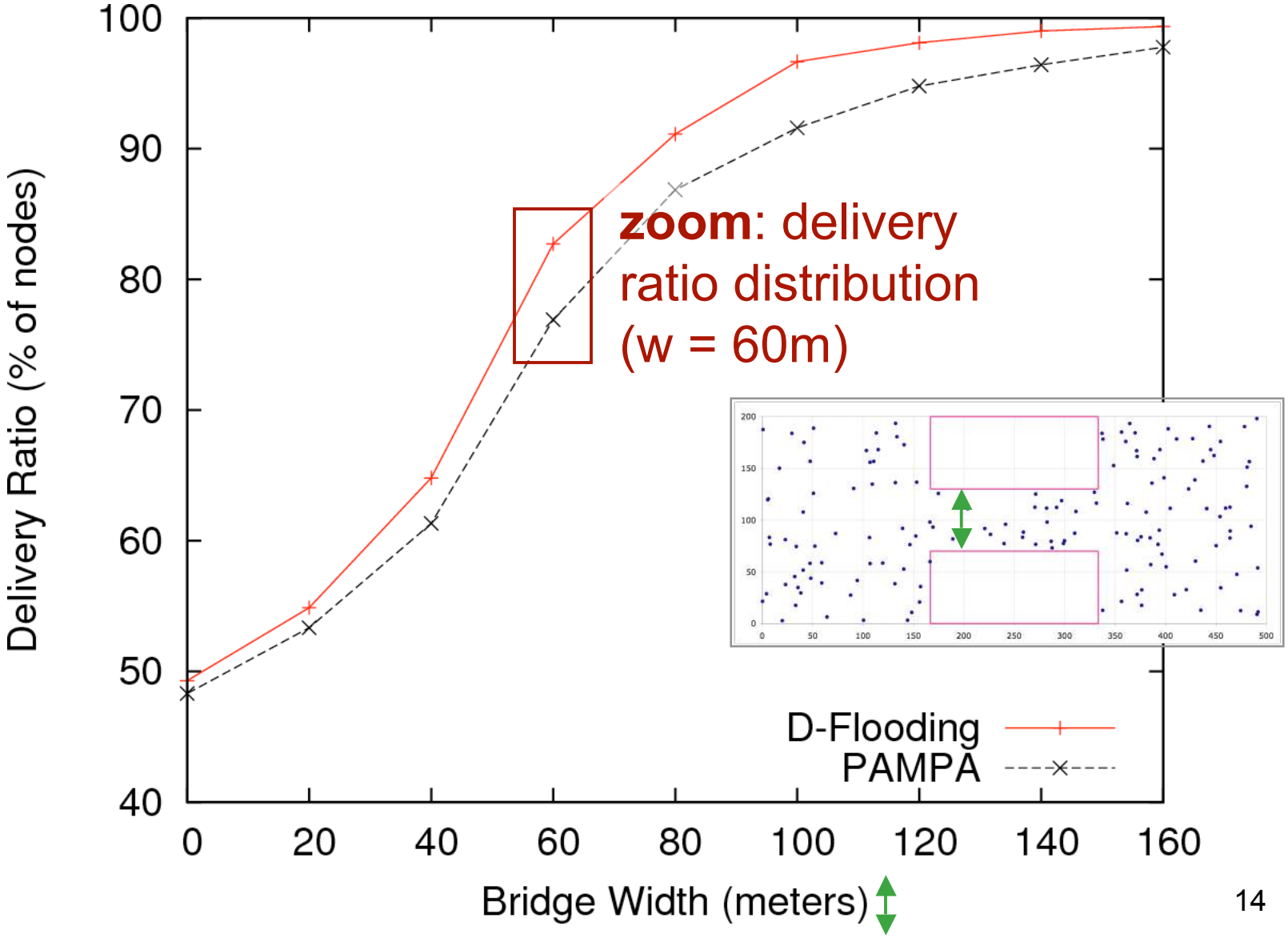
average of protocol

× 40

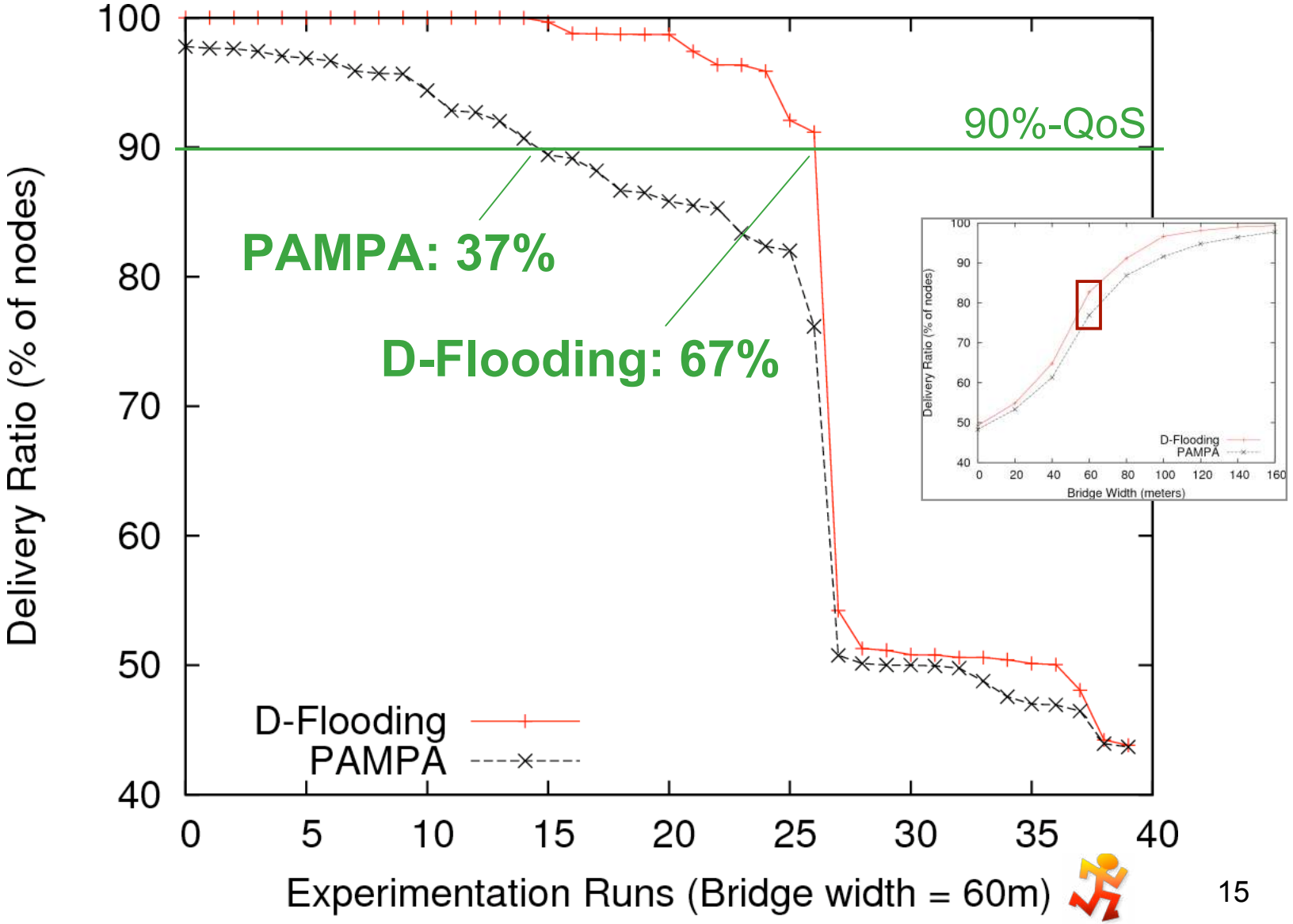
average of run

× #nodes

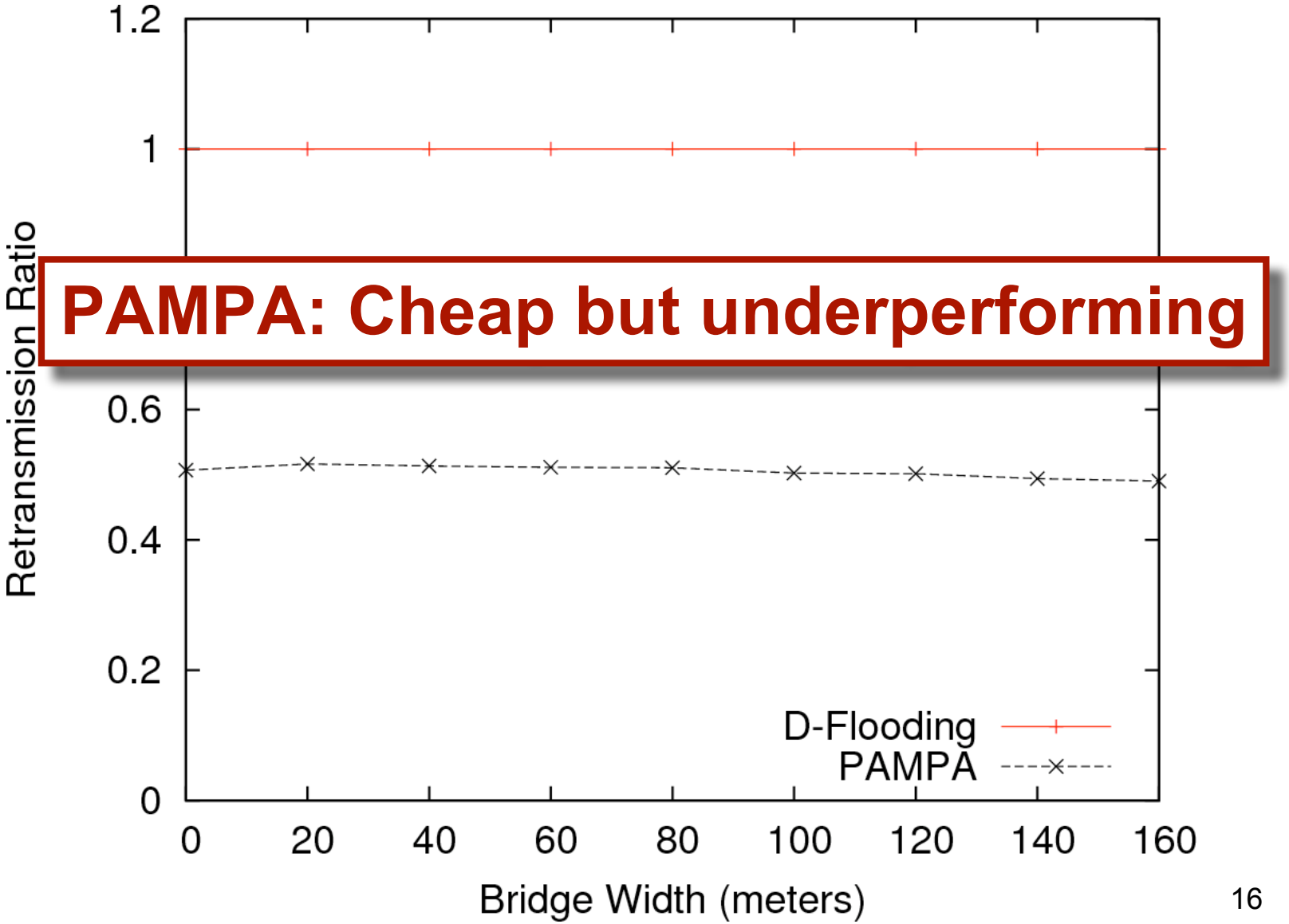
Average Delivery Ratio



Delivery ratio distribution

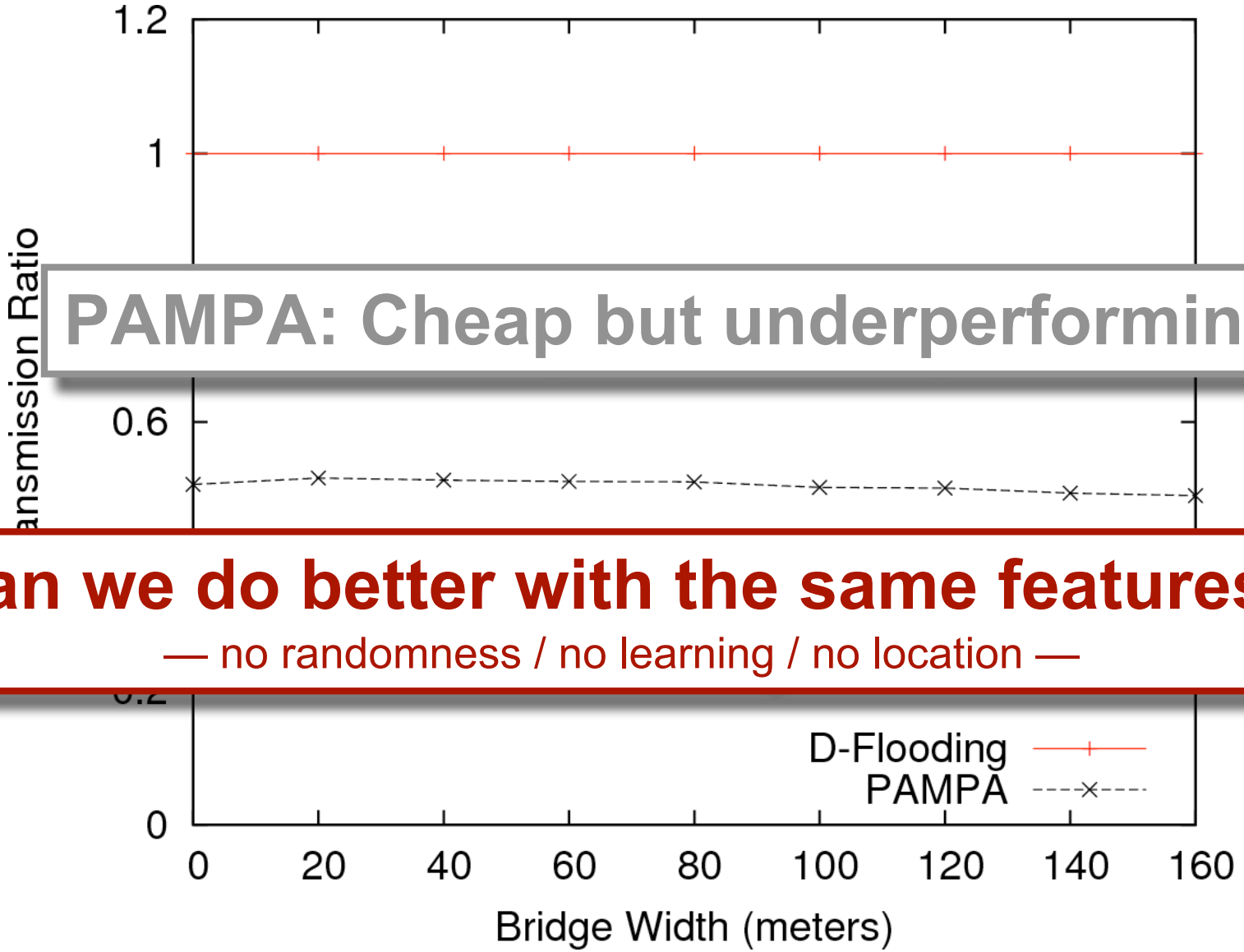


Retransmission ratio



PAMPA: Cheap but underperforming

Retransmission ratio



PAMPA: Cheap but underperforming

Can we do better with the same features?

— no randomness / no learning / no location —

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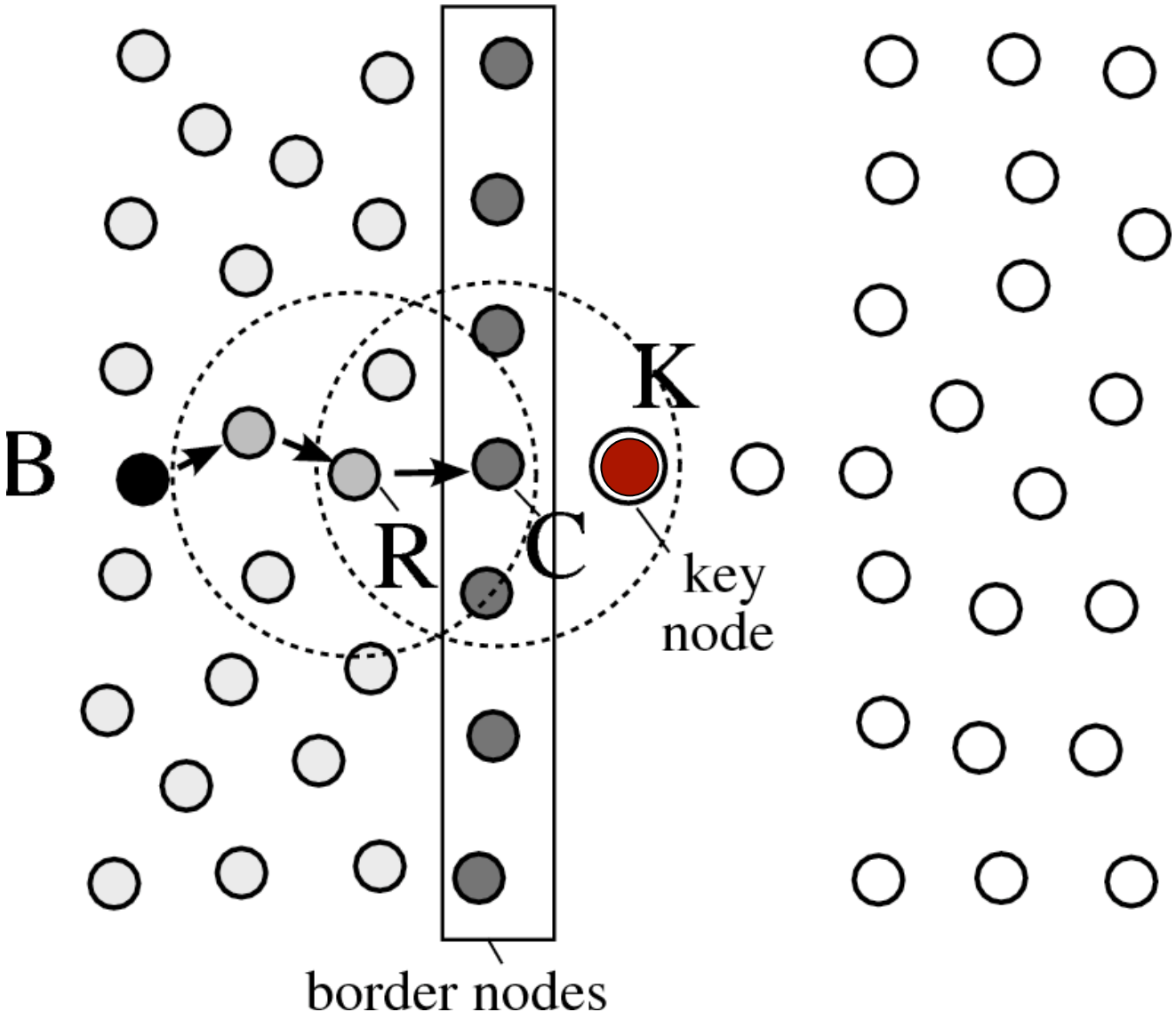
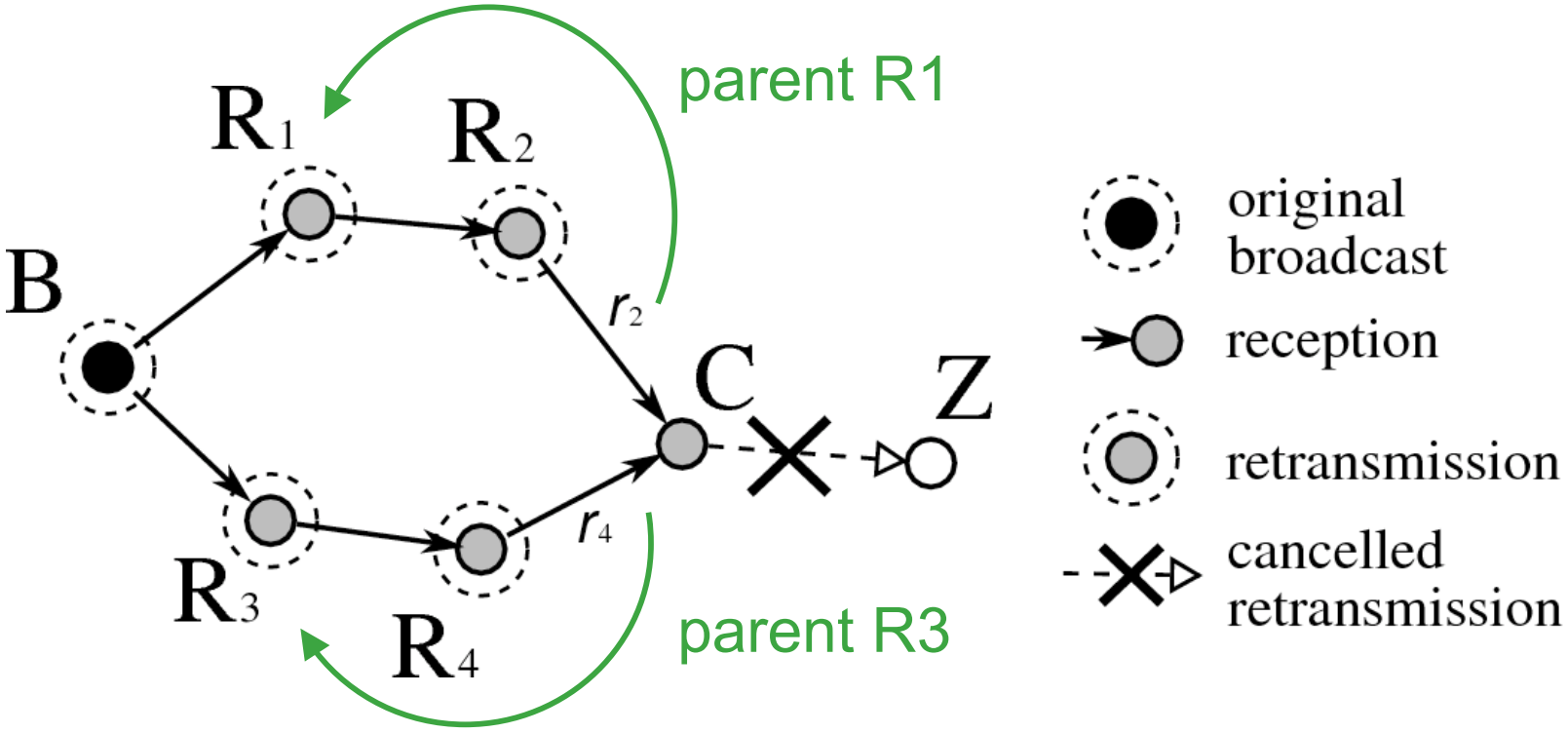
Key nodes



Mechanism 1: Common parent (CP)

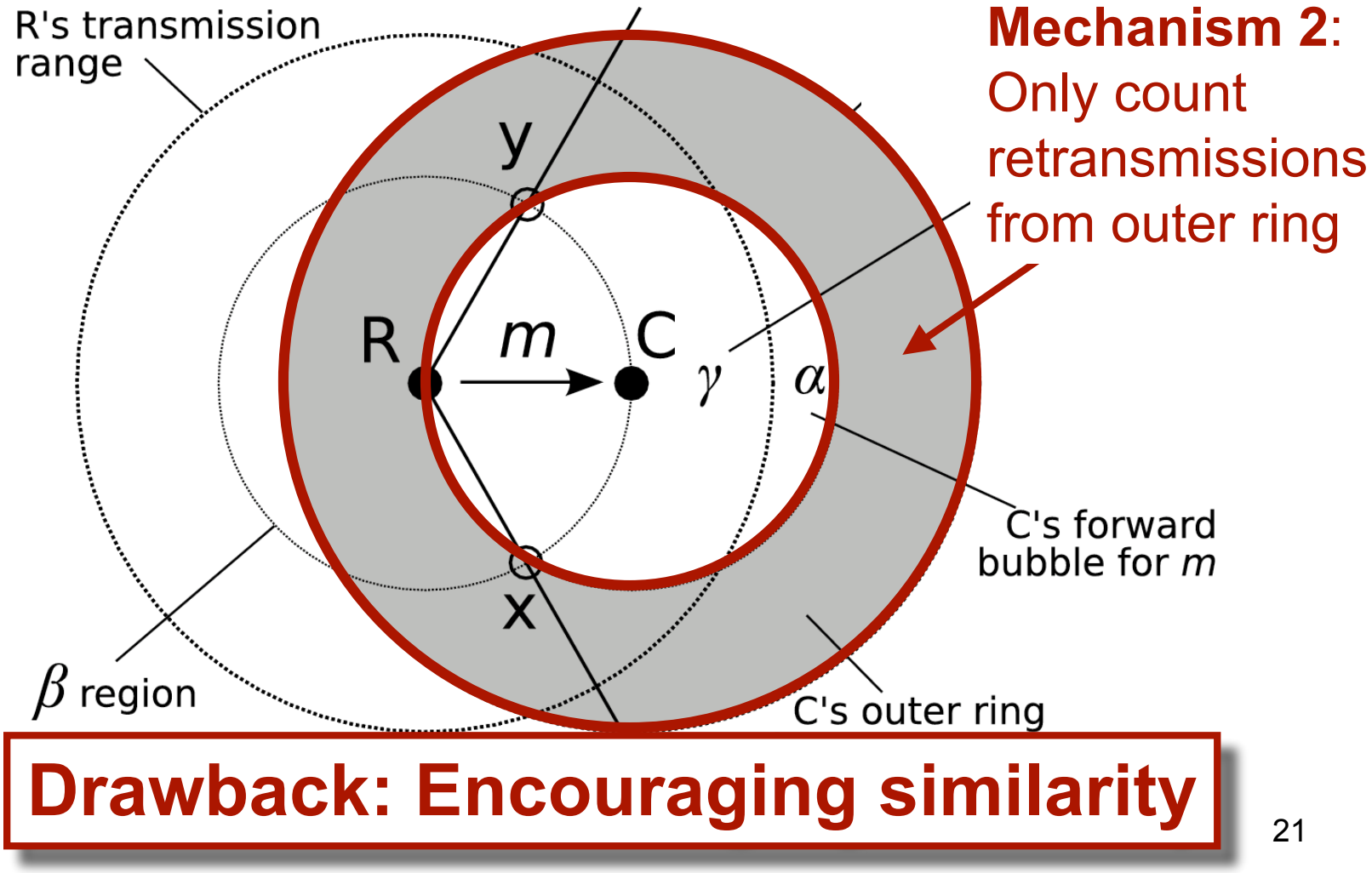
- **Goal**: avoid over cancellation



- **Mechanism 1**: If different parents ($R_1 \neq R_3$) do not count

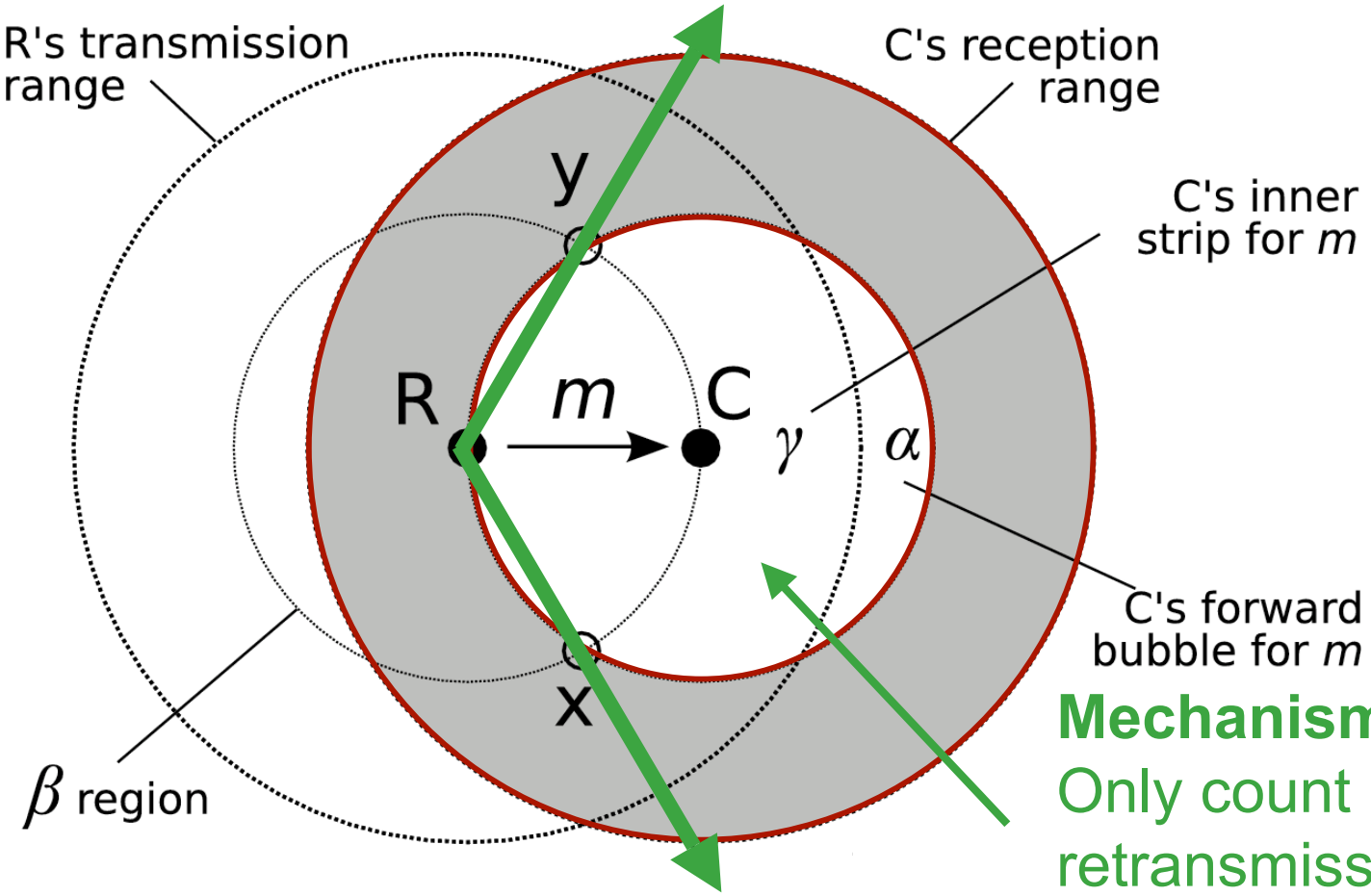
Mechanism 2: Look-ahead (TH)

- Goal: detect what is going on on the other side



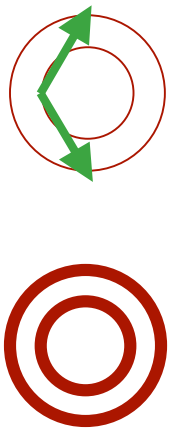
Mechanism 3: Angular L-ahead (ATH)

- Goal: detect what is going on on the other side



Mechanism 3: Only count retransmissions from inner ring

Protocol nutshell: counting matrix

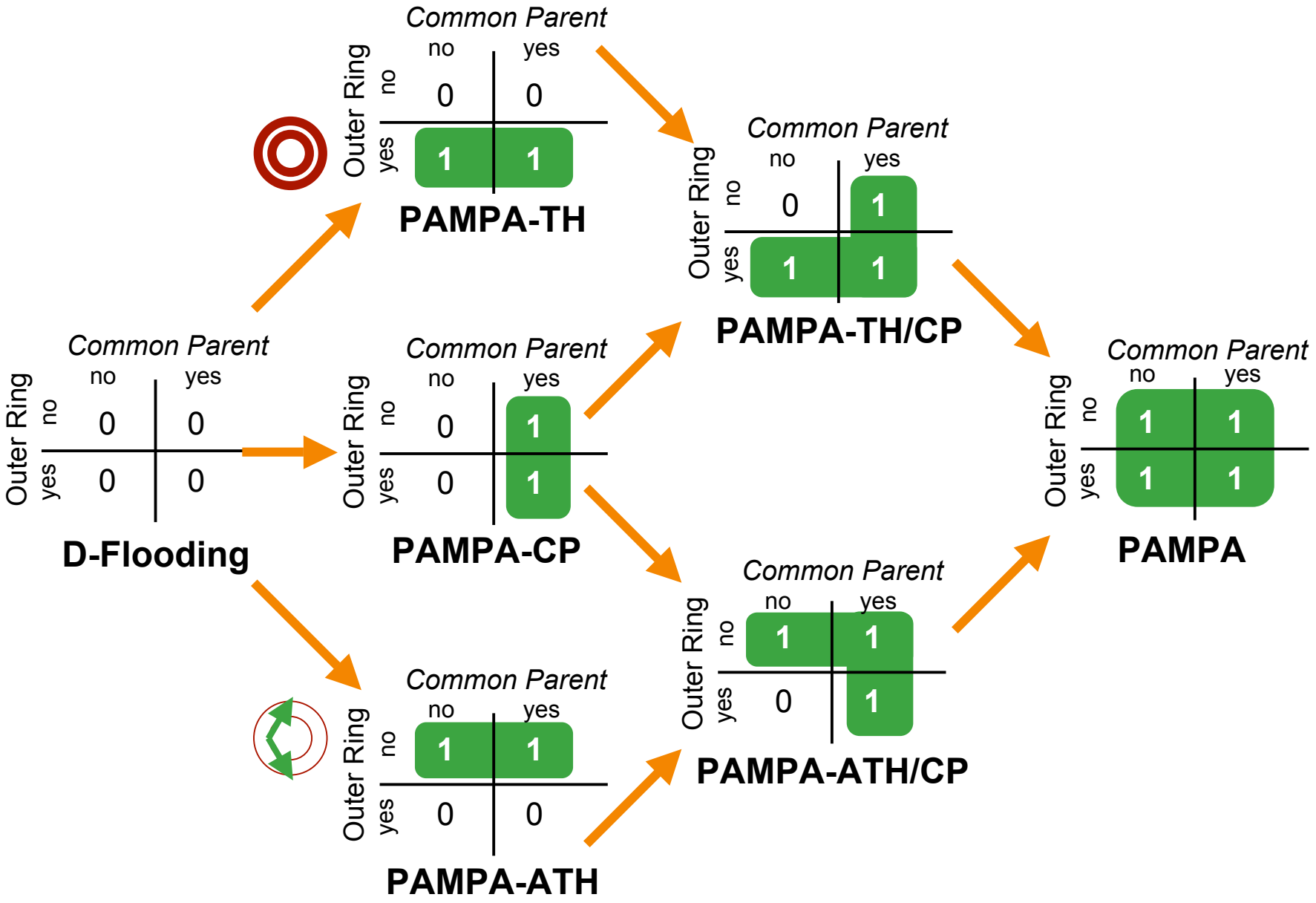


Common Parent

Outer Ring

	no	yes
no	0	0
yes	0	0

D-Flooding


Common Parent
Outer Ring
no
yes
0
0
1
1
PAMPA-TH
Common Parent
Outer Ring
no
yes
0
1
1
1
PAMPA-TH/CP
Common Parent
Outer Ring
no
yes
0
0
0
0
D-Flooding
Common Parent
Outer Ring
no
yes
0
1
0
1
PAMPA-CP
Common Parent
Outer Ring
no
yes
1
1
1
1
PAMPA
Common Parent
Outer Ring
no
yes
1
1
0
1
PAMPA-ATH/CP
Common Parent
Outer Ring
no
yes
1
1
0
0
PAMPA-ATH
Less retransmissions

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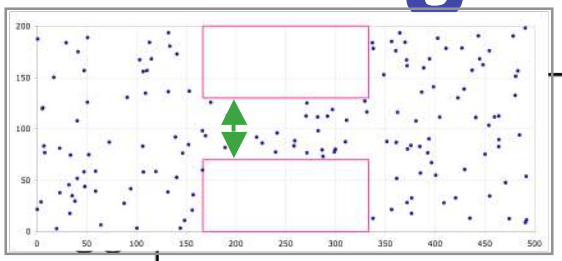
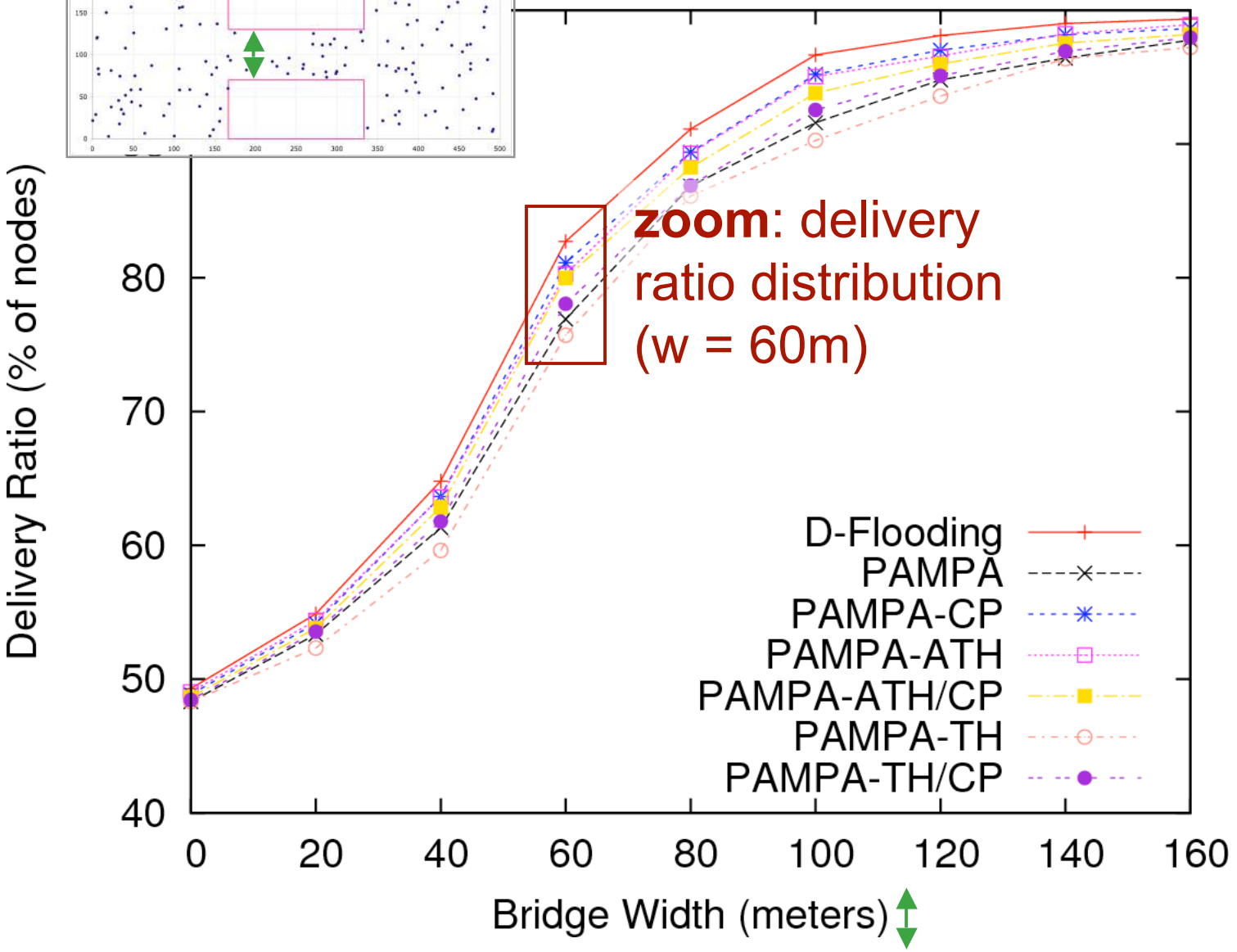
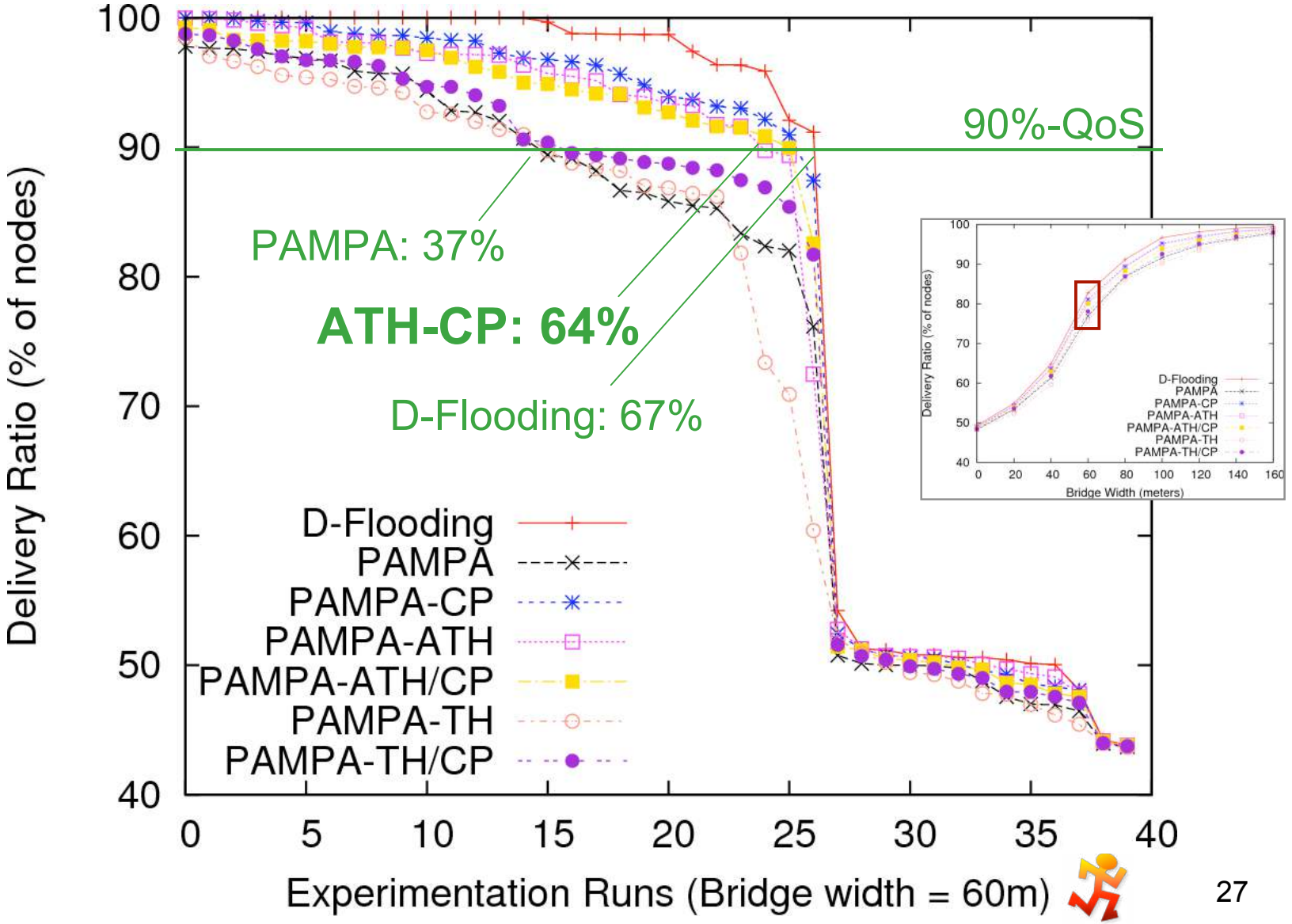
Average delivery ratio



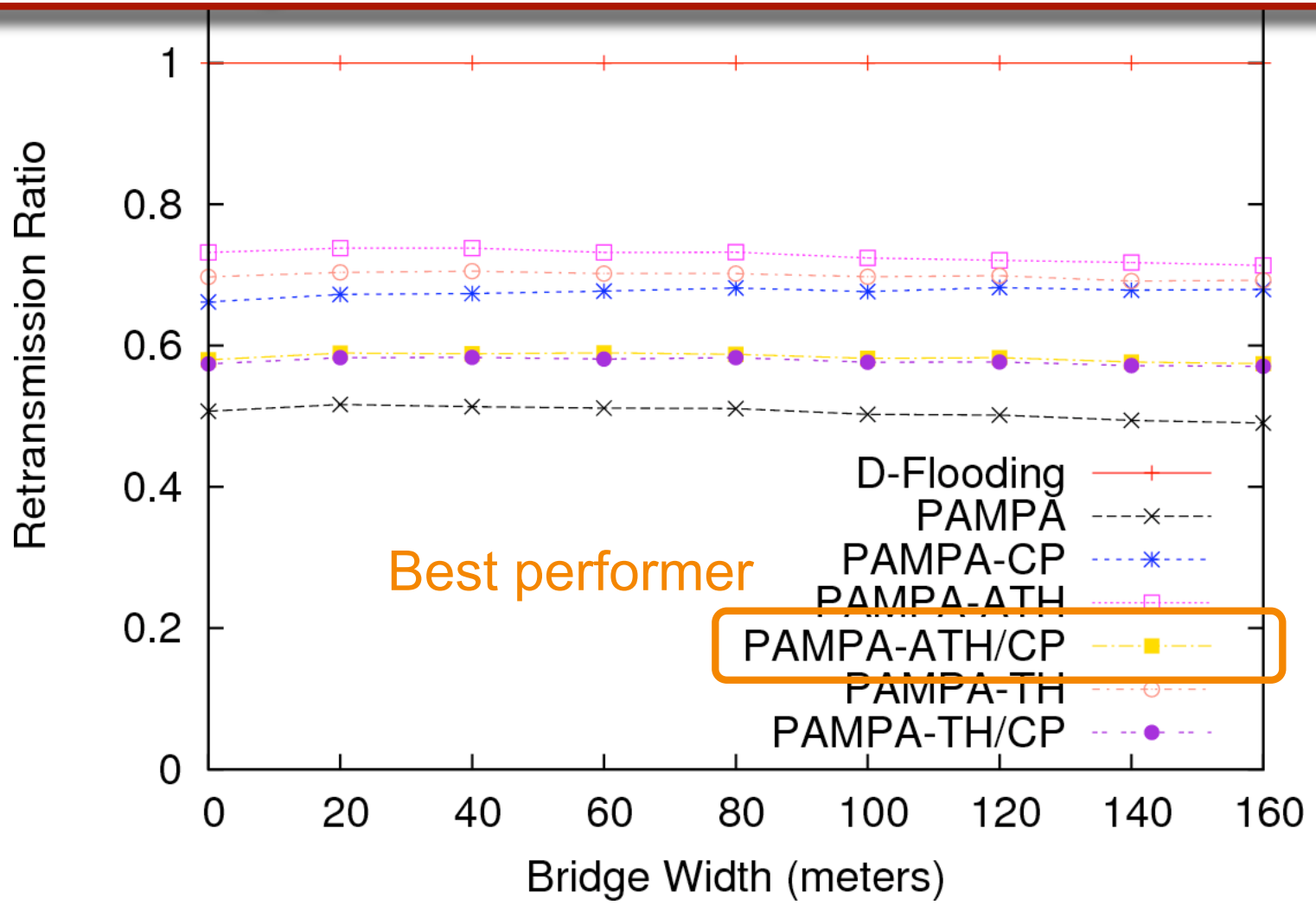


Delivery ratio distribution



Retransmission ratio

Hardening has a cost – but a moderate one



Conclusion

- A family of **hardened** lightweight broadcasts
  - ➔ entirely context-based (no probabilities)
  - ➔ “lightweight” context (no location, no directional antenna)

- One **combination** (ATH-CP) particularly promissing
  - ➔ limited overhead (0.58 vs. 0.5 for PAMPA)
  - ➔ far improved 90%-QoS (e.g. 64% vs. 37% for w=60m)

Limitations & Future work

- Limitation 1: **Baseline**
  - ➔ more retransmissions expected to deliver better service (although not always true: TH variant)
  - ➔ Does ATH/CP really do better than a random approach?

- Limitation 2: Experimental **validity**
  - ➔ so far: all results = ns2 simulations w/ ideal model
  - ➔ in practice: radio propagations not isotropic
  - ➔ in practice: RSSI value not always distance indicator

Future work

- Add **mobility**
  - ➔ key challenge: which mobility model?
- Comparison against **randomised** variants (incl. gossip)
  - ➔ in particular when varying density / adding failure rates
- **Log-normal shadowing** radio in ns2
  - ➔ to better reflect imperfect radio propagation and RSSI
- **Real-life** deployment
  - ➔ on-going within FP7 Wisebed project