

Constrained-Cast: Source-Routed Multicast for RPL

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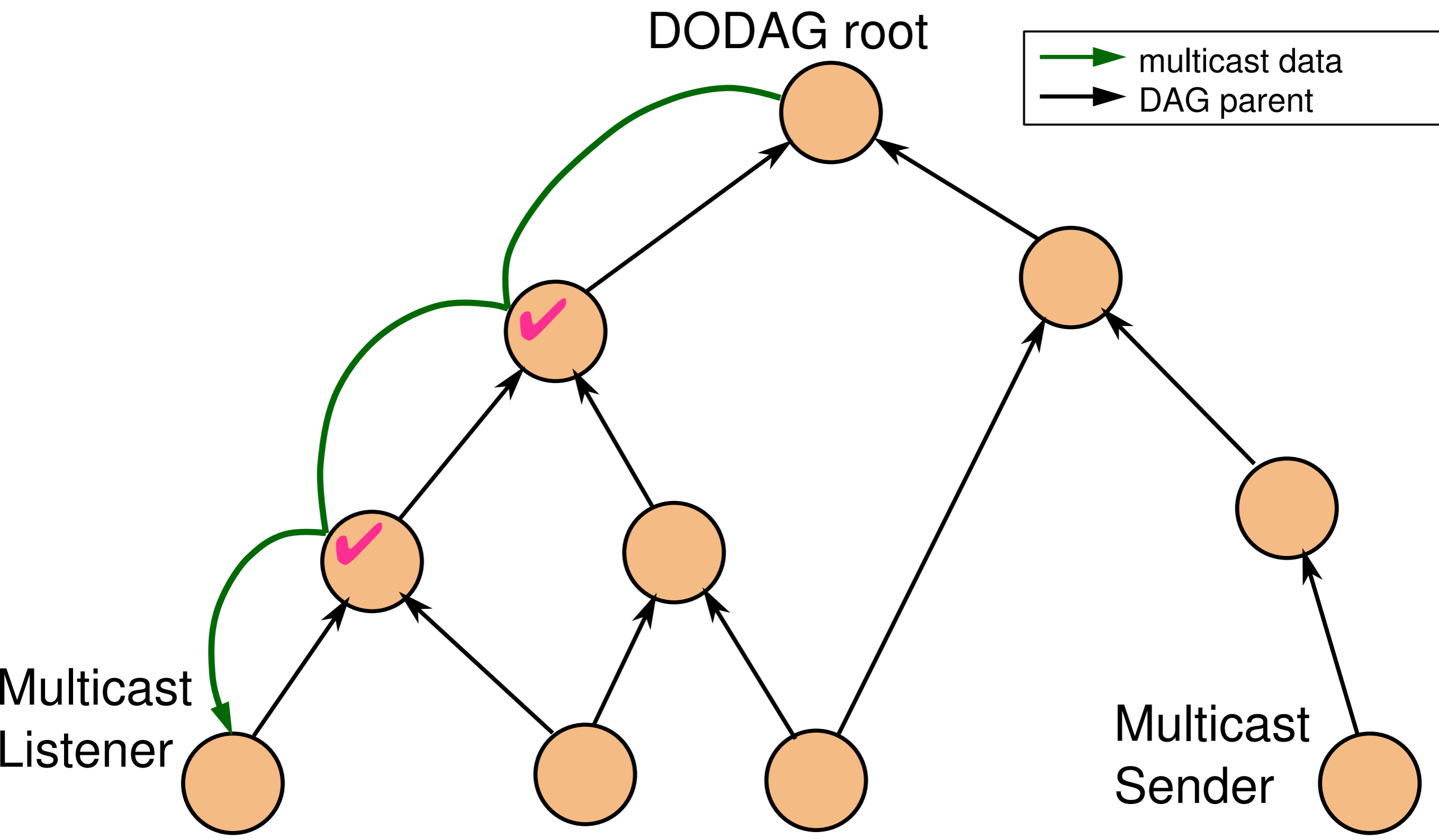
Supported by Siemens Corporate Technology

RPL Multicast

- Assumes **Storing Mode**
- Multicast DAOs indicate subscription to multicast address
 - percolate up and create bread-crumbs
- Specification in RFC 6550:
 - incomplete, untested

How to do this for Non-Storing Mode?

- Non-Storing is based on source-routing by root
- How to source-route multicast packets?
 - List all outgoing interfaces?



Embed an Outgoing Interface List?

- Non-starters:
 - List of 16-byte IPv6 Addresses
 - Even with RFC 6554 style compression

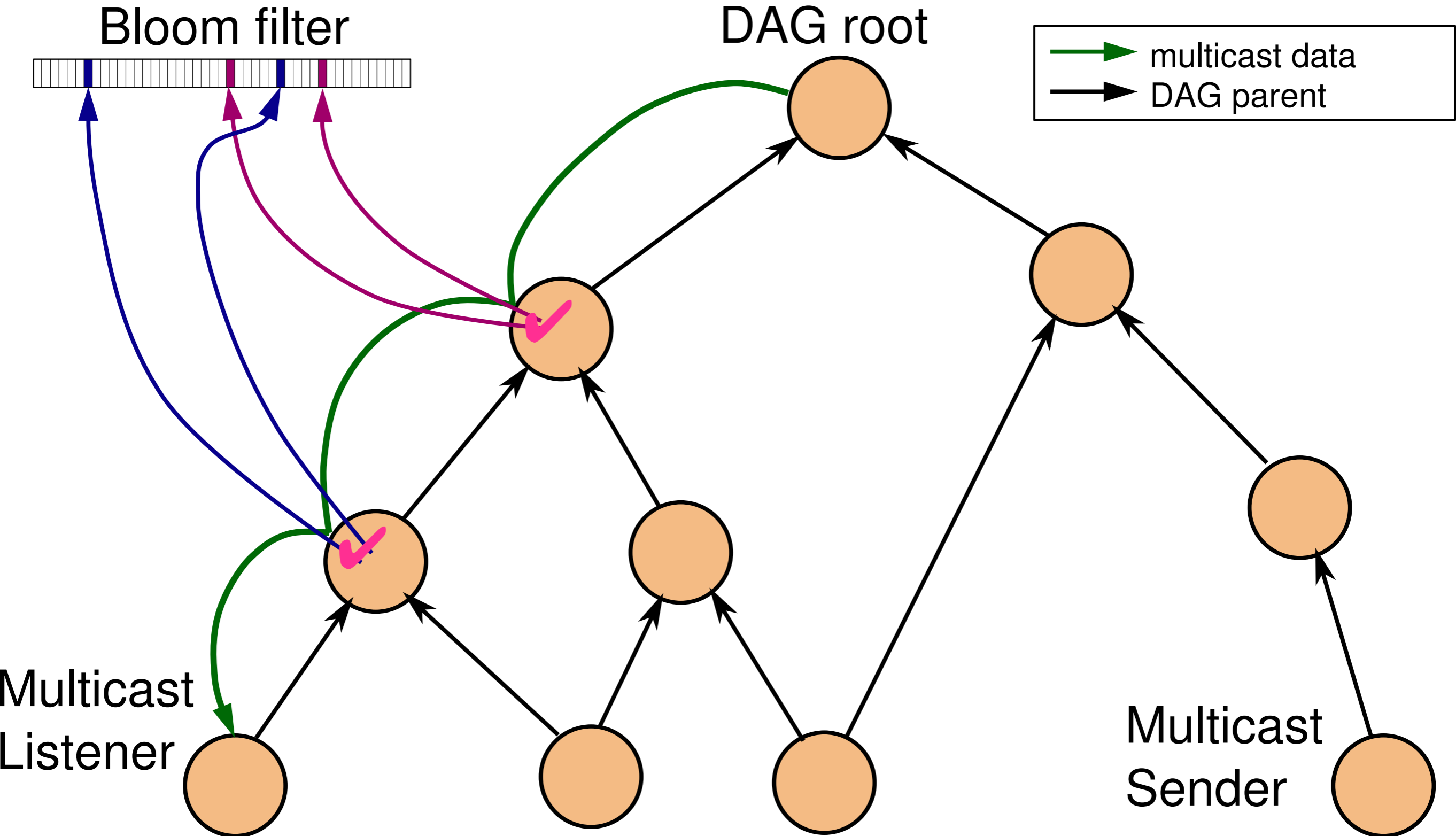
BIER

- Bit-Indexed Explicit Replication (BOF@IETF91)
- lists all egress routers in a bitmap
 - requires **numbering** all egress routers
 - requires network **map** in forwarders
- So use the bitmap for something different

Bloom Filters

- Compact representation of a match/non-match for elements in a large set
- Hash the element with multiple hash functions, result → index bitmap
- If **all** corresponding bits are set: match
- [B. H. Bloom, CACM July 1970]

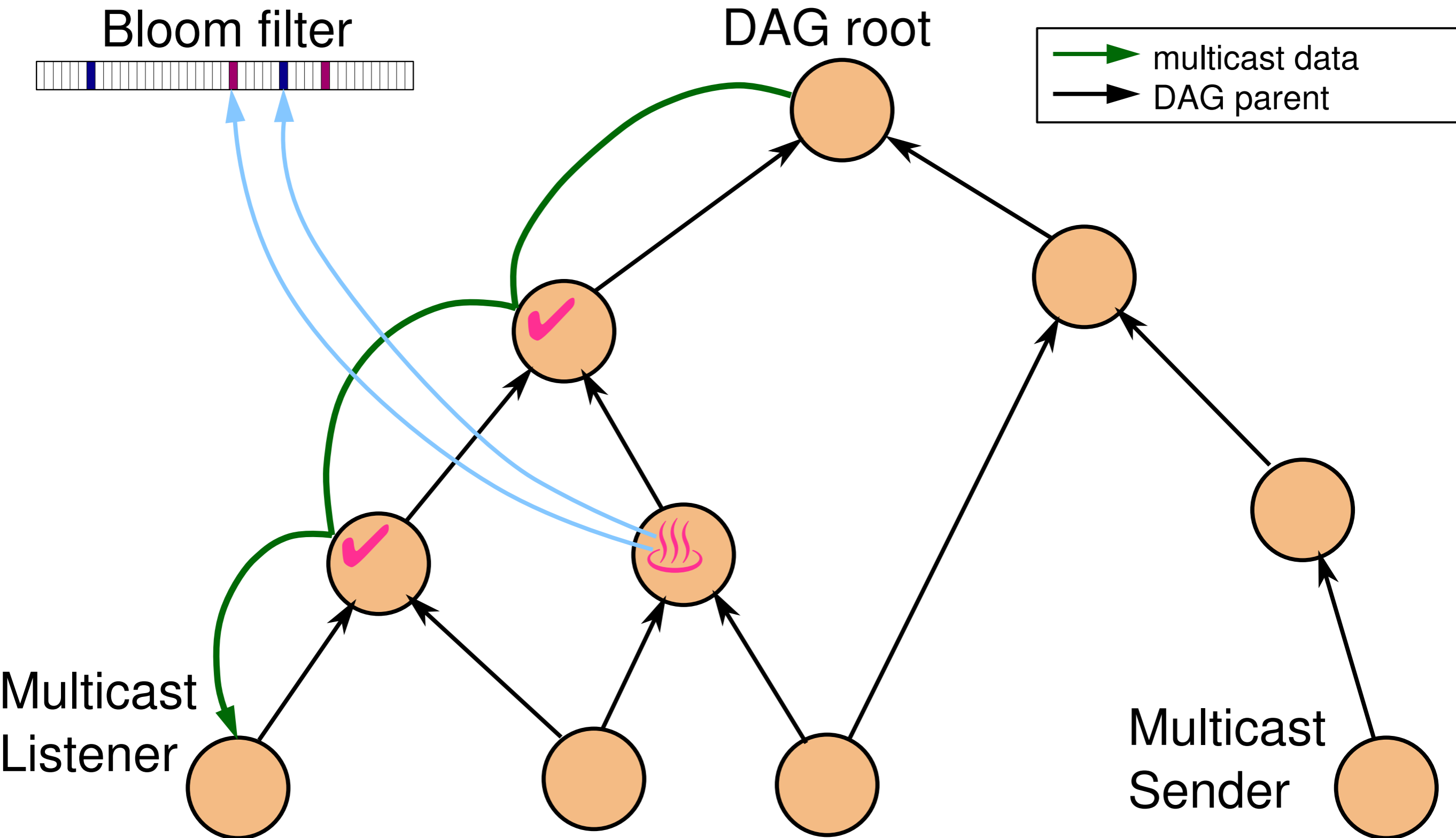
Send Bloom Filter with packet, match OIF



False positives?

- Bloom filters are **probabilistic**
- False positive: match indicated by aliasing of hash values
- Cause spurious transmission

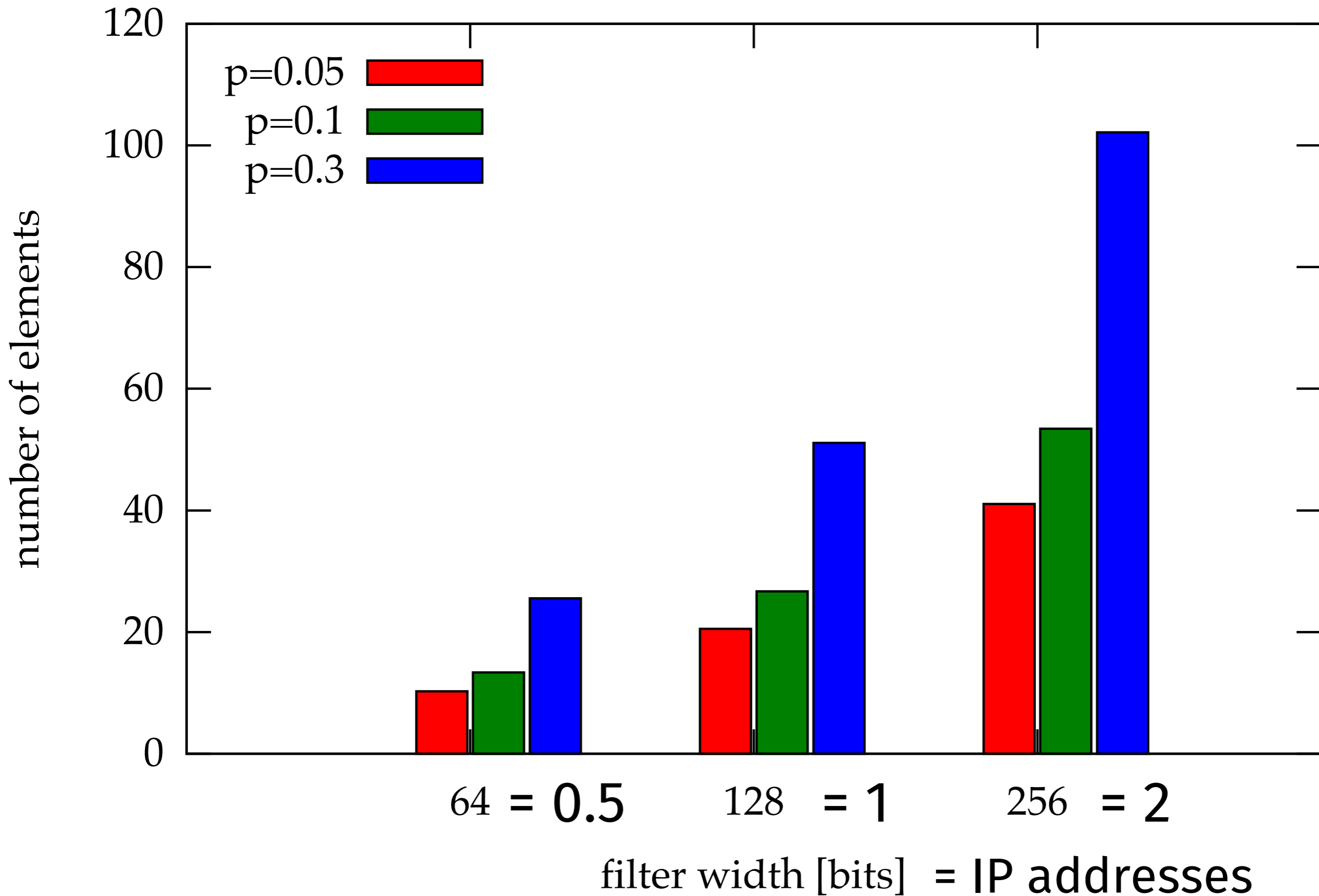
False positive causes spurious transmission



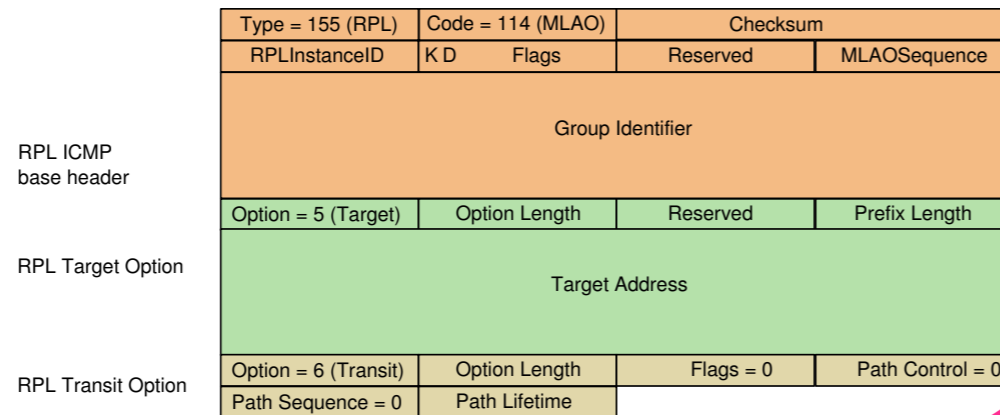
How bad are false positives?

- False positives cause spurious transmission
- No semantic damage (hosts still filter out)
- Waste in energy and spectrum:
 - \sim false-positive-rate \times density
- Can easily live with significant percentage

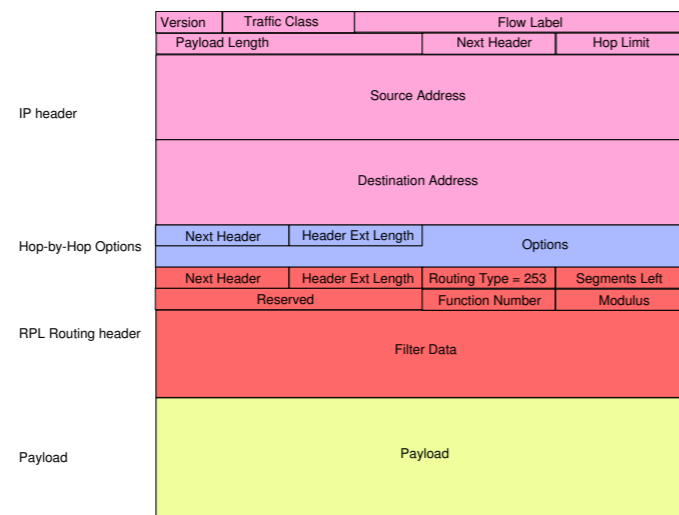
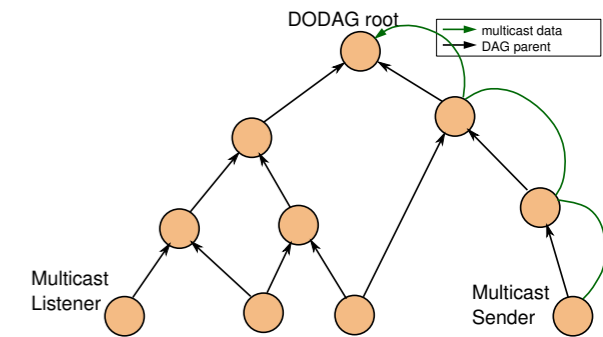
Number of **forwarders**, filter size, f.p.r.:



Protocol



- Membership: MLAOs (go right up to root)
- Submit: tunnel up to root
- Deliver: root inserts bloom filter



Implementation

- Implemented 2013 in Contiki
- Forwarders compute the hash functions **once** and then simply bit-match their OLF hash bits against bloom filter
- Root:
 - easy insertion of path for new member
 - recompute bloom filter on leave