Semantic Ad hoc Networking

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Motivations

- Scenario
  - A user visiting a shopping mall wants to obtain information about shops.
- Issues
  - Mutually exclusive double discovery
    - Producers of such information should be found.
    - Routes to reach such producers should be built.

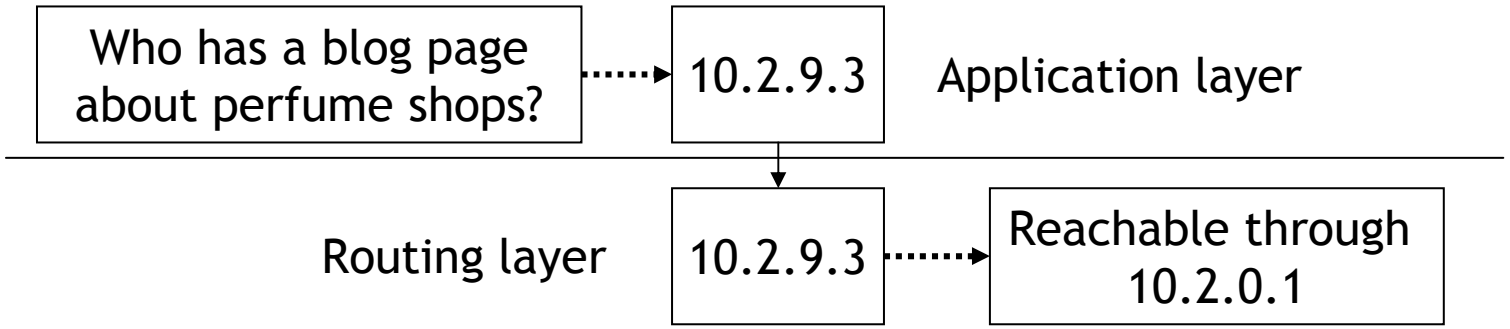
Problems of double discovery

- Increased control overhead
- Degraded responsiveness
  - Changes in application layer (e.g. context change) are not immediately reflected to the routing layer.
  - Changes in routing layer (e.g. broken route) are hidden.
- Context unaware networking
  - “Best” peers are found at application layer while “best” routes are defined by routing layer metrics.

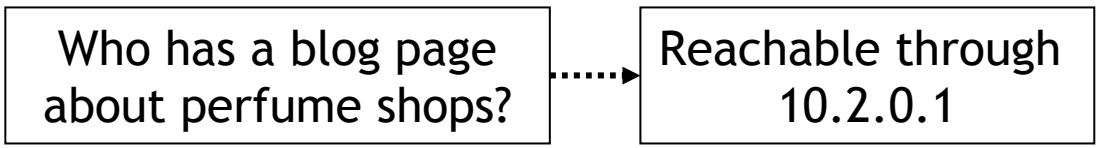
How to tackle?

- What if we combine “finding producers (or consumers)” and “building routes to connect them”.

Existing way



New way



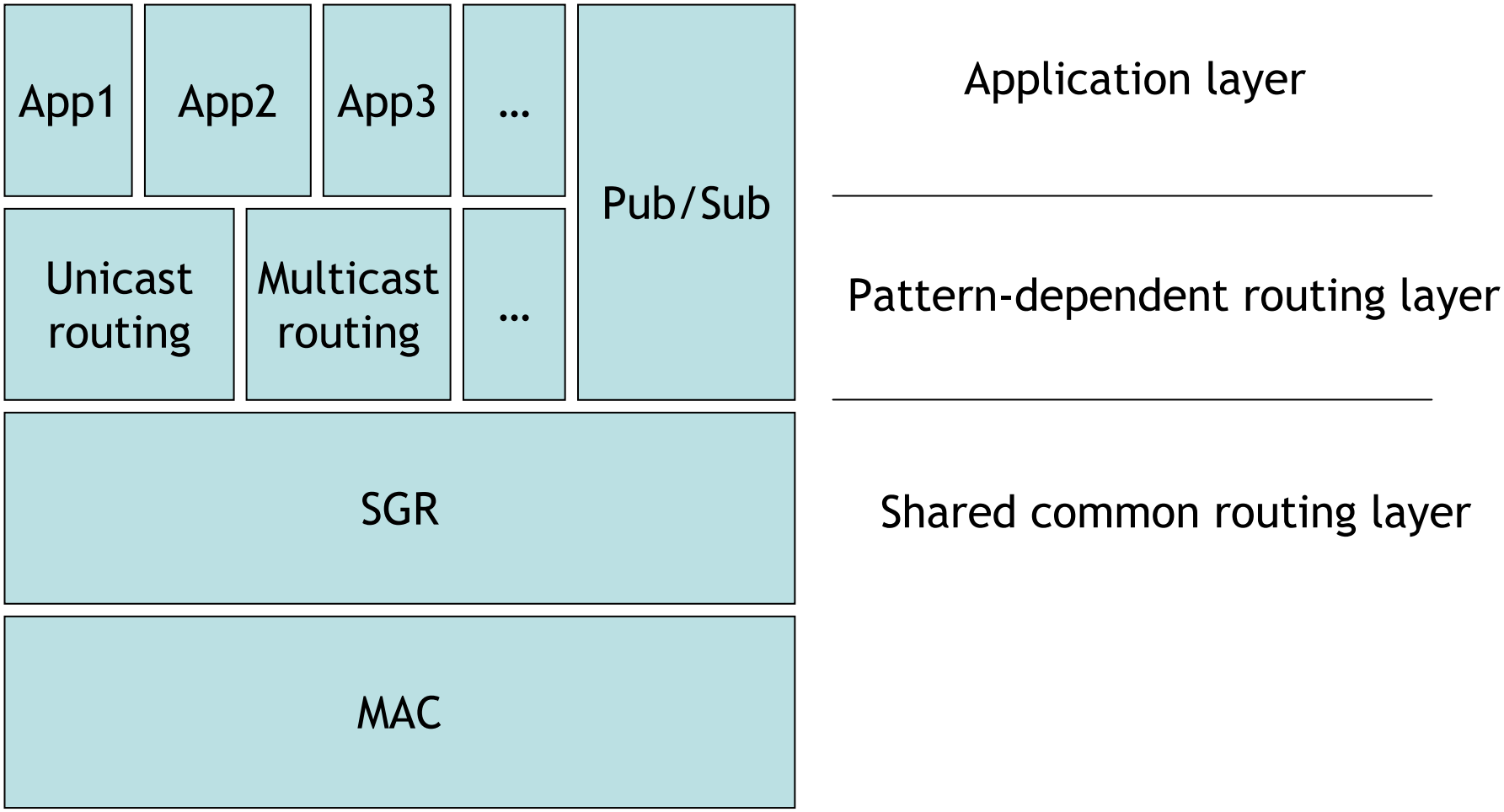
SGR: Shared Generic Routing

- An example of semantic routing
- Combining service/publisher discovery process with that of network routes
- Reduces overhead of double discovery

SGR - Related work

- [M-ZRP]
  - How it works
    - A hello message for route discovery piggybacks service UUIDs.
    - Eventually each node learns which node provides what service.
  - Advantages
    - Service discovery and route discovery are done simultaneously.
    - Smooth service adaptation: If there is a service provided by a node, a route to reach the node is also known.
  - Issues
    - Each node has a unique service and a unique ID.
      - A UUID is just an alias of an address of the node.
      - A service should be provided by only one node.

SGR - Architecture



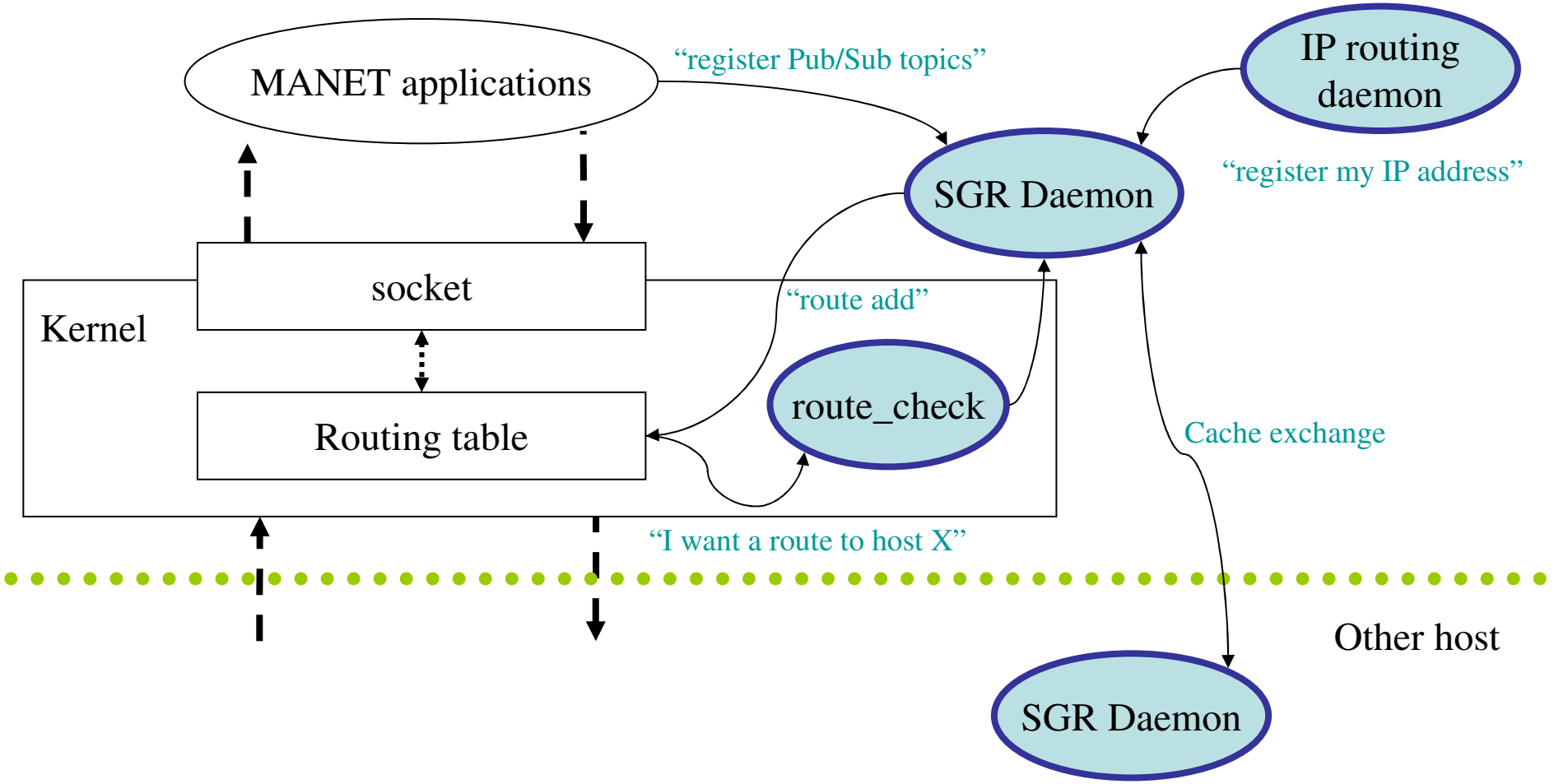
SGR – Target description

- Type
  - Each communication pattern is represented as a type.
  - Used to find a pattern dependent routing component
  - Currently defined types: UNICAST, MULTICAST, PUBSUB
- Tag
  - An identifier used for routing between nodes
  - E.g. An IP address for unicast/multicast routing
  - E.g. A topic in a topic based pub/sub system
- Internal tag
  - An additional identifier that is used, together with a tag, for routing inside of a node
  - E.g. Port number for unicast/multicast routing
  - Note: Originally, internal tag was introduced to deal with cases where there co-exist multiple unicast routing layers.

SGR – How it works

- Periodically, SGR does;
  - Share its cache with neighbors by sending cache advertisement (or CA)
  - Remove stale entries in forward list
  - Send JOIN for all entries in forward & reception list
    - Except entries targeted for itself
  - SOLICIT CA if there is no recent CA from neighbors
- When receiving a packet, SGR does;
  - (CA): Update its cache with entries contained
  - (JOIN): Update its forward list and forward the packet if the tag is not destined for itself.
  - (SOLICIT): Send its cache
  - (DATA): Forward to neighbor nodes and/or deliver to routing layer

SGR – An Linux based implementation

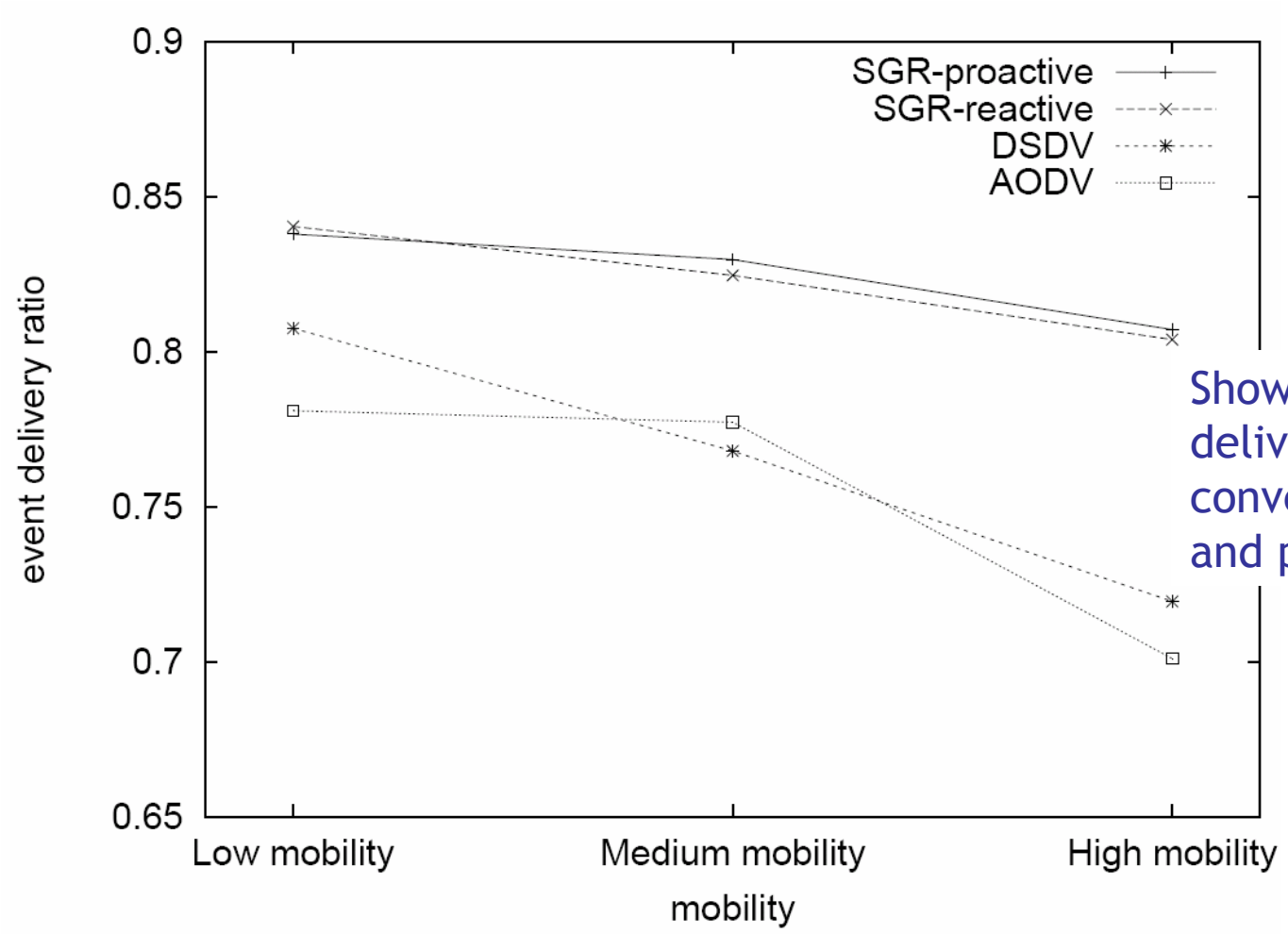


SGR – Simulation based evaluations

- Simulator: ns-2
- Sessions
  - 3 unicast sessions + 2 pub/sub sessions
  - Each pub/sub session has one publisher and two subscribers.
- Space: 1000x1000m
- Number of nodes: 50
- Mobility
  - Low: Maximum speed of 1m/sec with 60 second pause
  - Medium: Maximum speed of 2m/sec with 30 second pause
  - High: Maximum speed of 3m/sec without pause

SGR – Evaluations

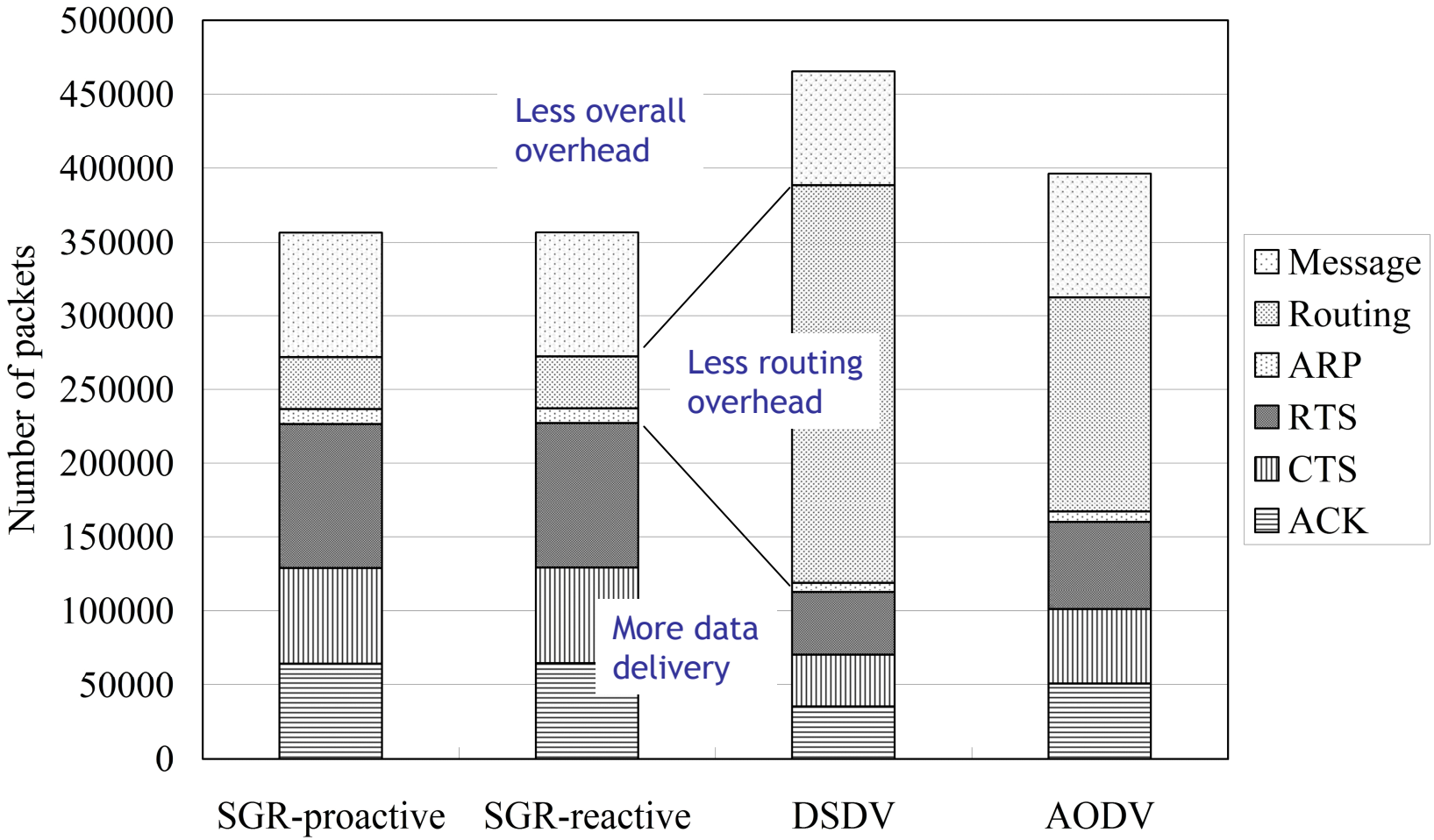
Event delivery ratio of pub/sub sessions



Shows 5~10% higher delivery ratio due to convergence of unicast and pub/sub routing

SGR – Evaluations

Control overhead of all sessions



Conclusion

- By incorporating application layer routing target (e.g. topics in pub/sub) as a routing target of a simple routing protocol, we can reduce control overhead significantly while obtaining higher delivery ratio.

Future work

- Systematic and efficient transformation of various applications' needs to routing targets
- Incorporating advanced MANET routing protocols with ideas of SGR
- Extended utilization of applications' needs beyond routing
  - Network formation
  - Multi-radio interfaces

References

- [M-ZRP] C. N. Ververidis and G. C. Polyzos. “Routing layer support for service discovery in mobile ad hoc networks,” In Proceedings of the Third IEEE International Conference on Pervasive Computing and Communications Workshops