Performance Analysis of Stealth Distributed Hash Table with Mobile Nodes

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Outline

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Problems with DHTs and Mobility?

- Assumes homogeneity
  - All nodes are treated equally (routing, storing etc.)
  - Similar bandwidth, processing power, uptime
  - Mobile environments are very heterogenous!
- Security (or lack thereof)
  - Sniffing, Man in the Middle, Routing Table Poisoning
  - Difficulties in supporting user authentication
  - Very easy to join/sniff wifi networks, need for increase security
- Churn
  - Wait for next slide...

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Problems with DHTs and Mobility?

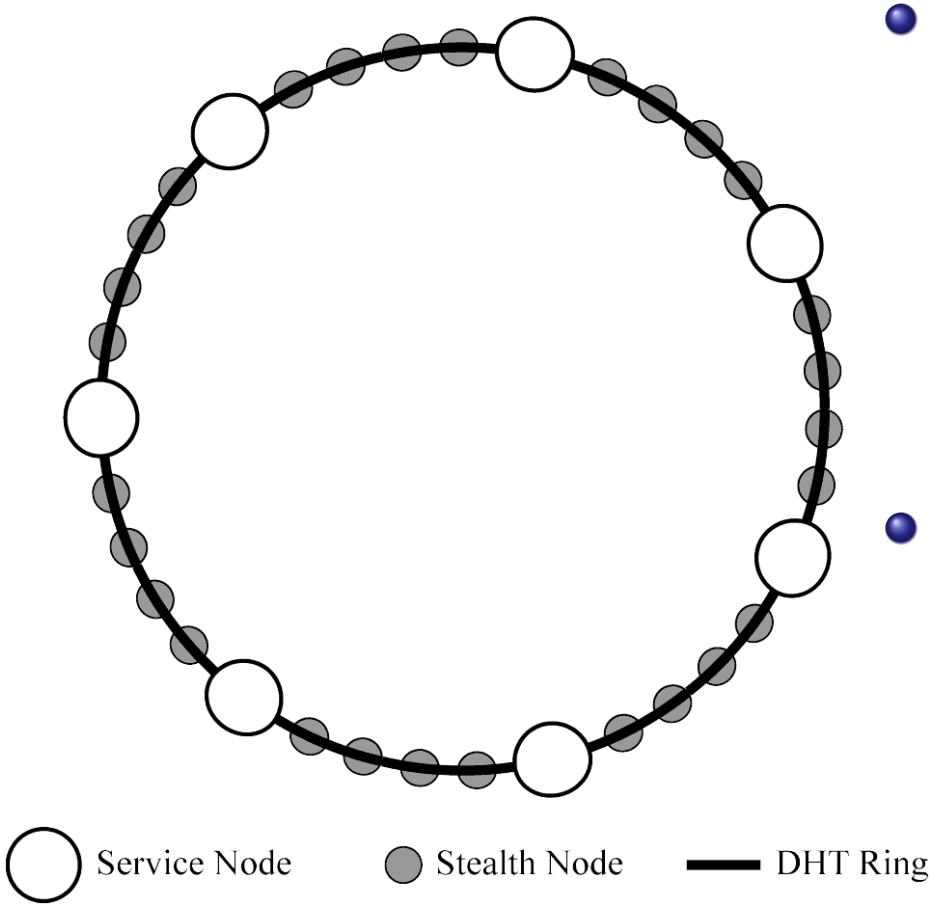
Mobility Churn

- Join forces routing updates
- Leaves make the routing tables stale

When does this happen?

- Loses connectivity when out of range
- Batteries prone to running dry
- When changing Access Point
  - Hand-over time
  - May retain IP address (No need to rejoin, but data may be stale)
  - May change IP address (May need to rejoin, or re-announce)

What are Stealth DHTs?

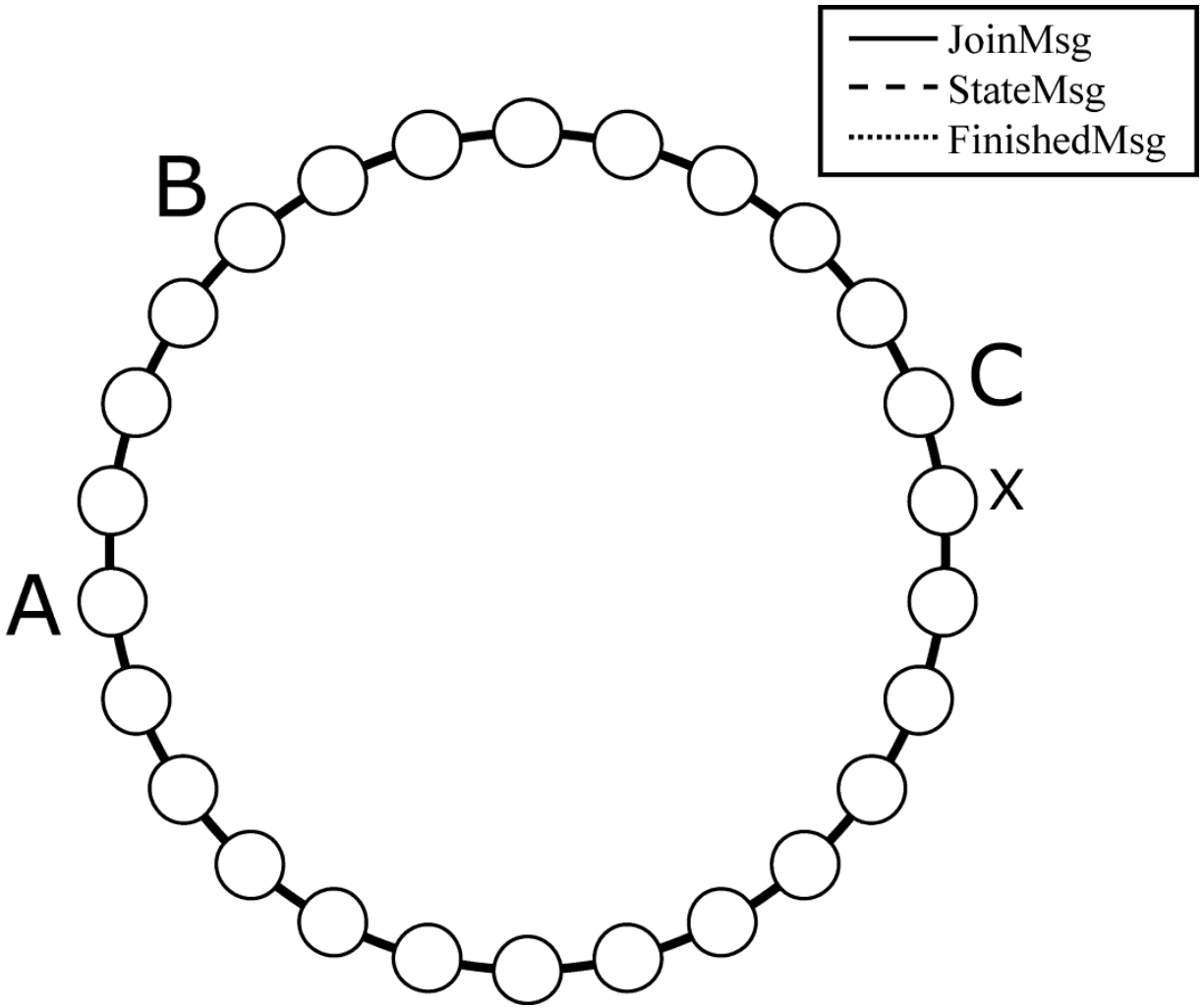


- Service Nodes
  - Assumed to be the more capable nodes
  - Responsible for forwarding and storing data
  - e.g. Wired Node
- Stealth Nodes
  - Assumed to be the less capable nodes
  - Have no responsibilities
  - Invisible to all nodes, including Service nodes
  - e.g. Wireless Node

How does it help?

- Does not assume homogeneity
  - Nodes can now be divided based on their capabilities
  - More powerful nodes, take more responsibility
- Churn (joins and leaves) generates little to no overhead
  - Stealth join requires less overhead
  - Joining of Stealth nodes does not require routing updates
  - Stealth nodes leaving does not make routing tables stale
- Security ~~(or lack thereof)~~
  - Authentication for the Service nodes ensure that only authorised nodes route and store message
  - Stealth nodes cannot commit sniffing, corruption attacks

Pastry's Join - State Gathering



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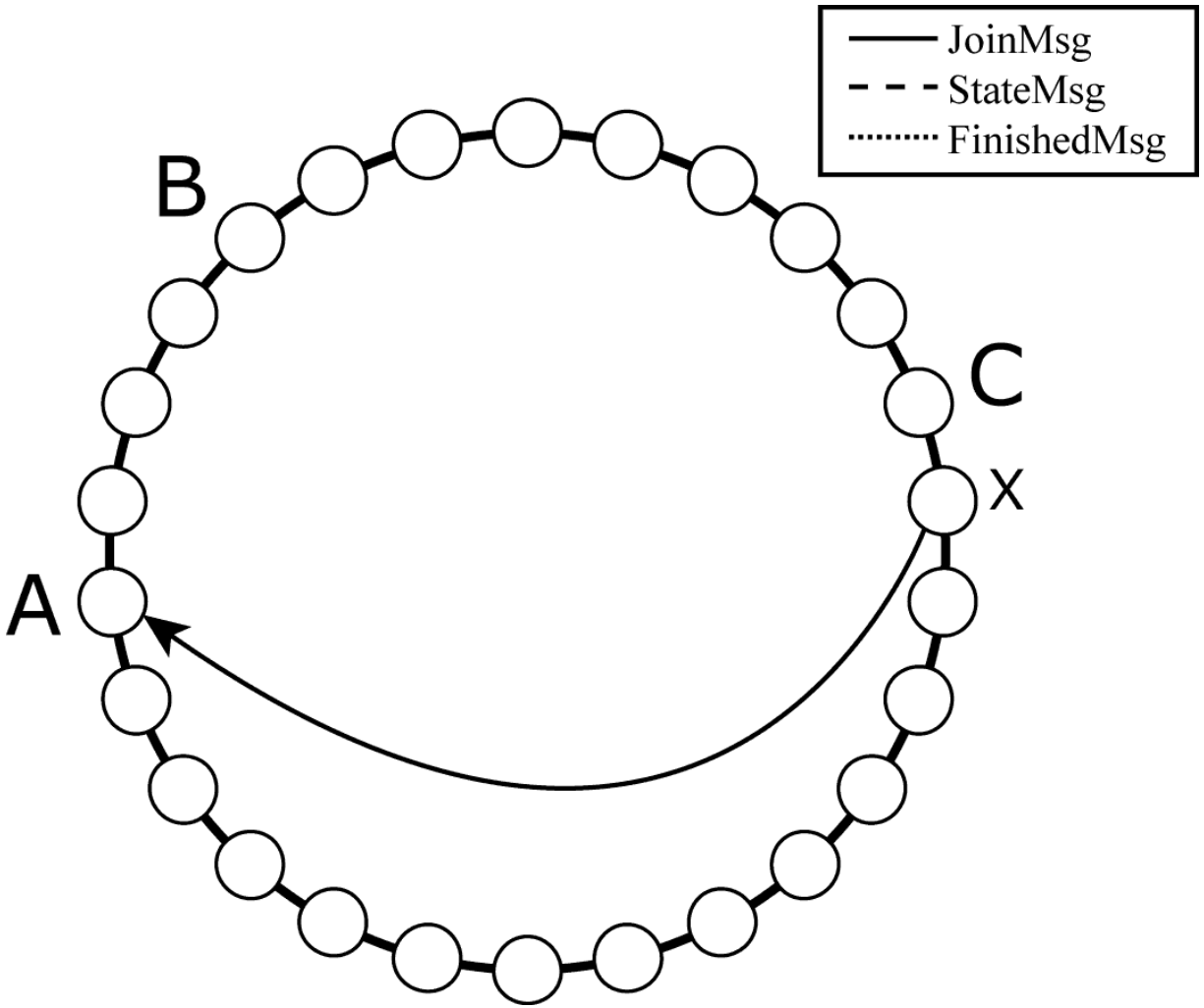

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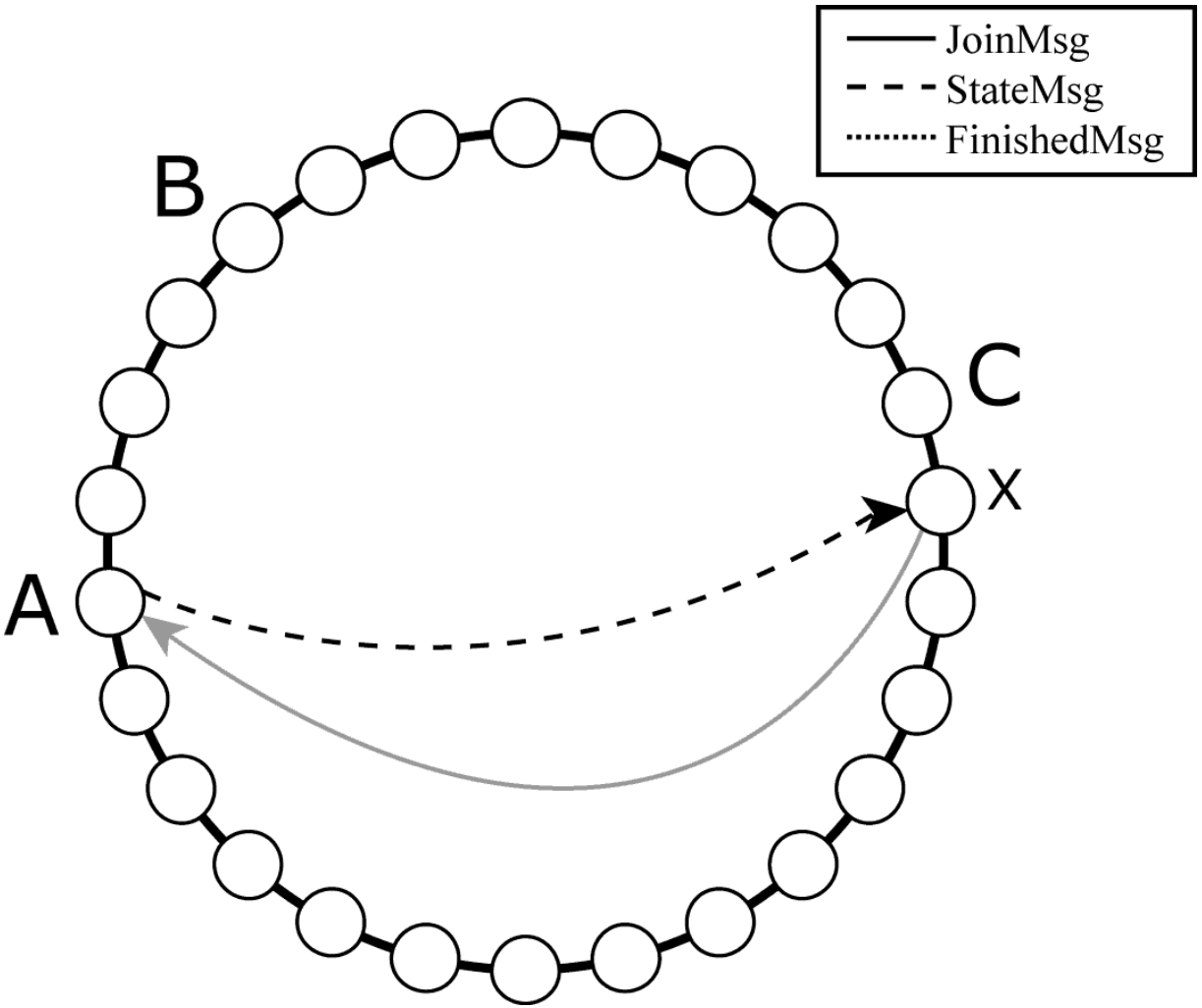

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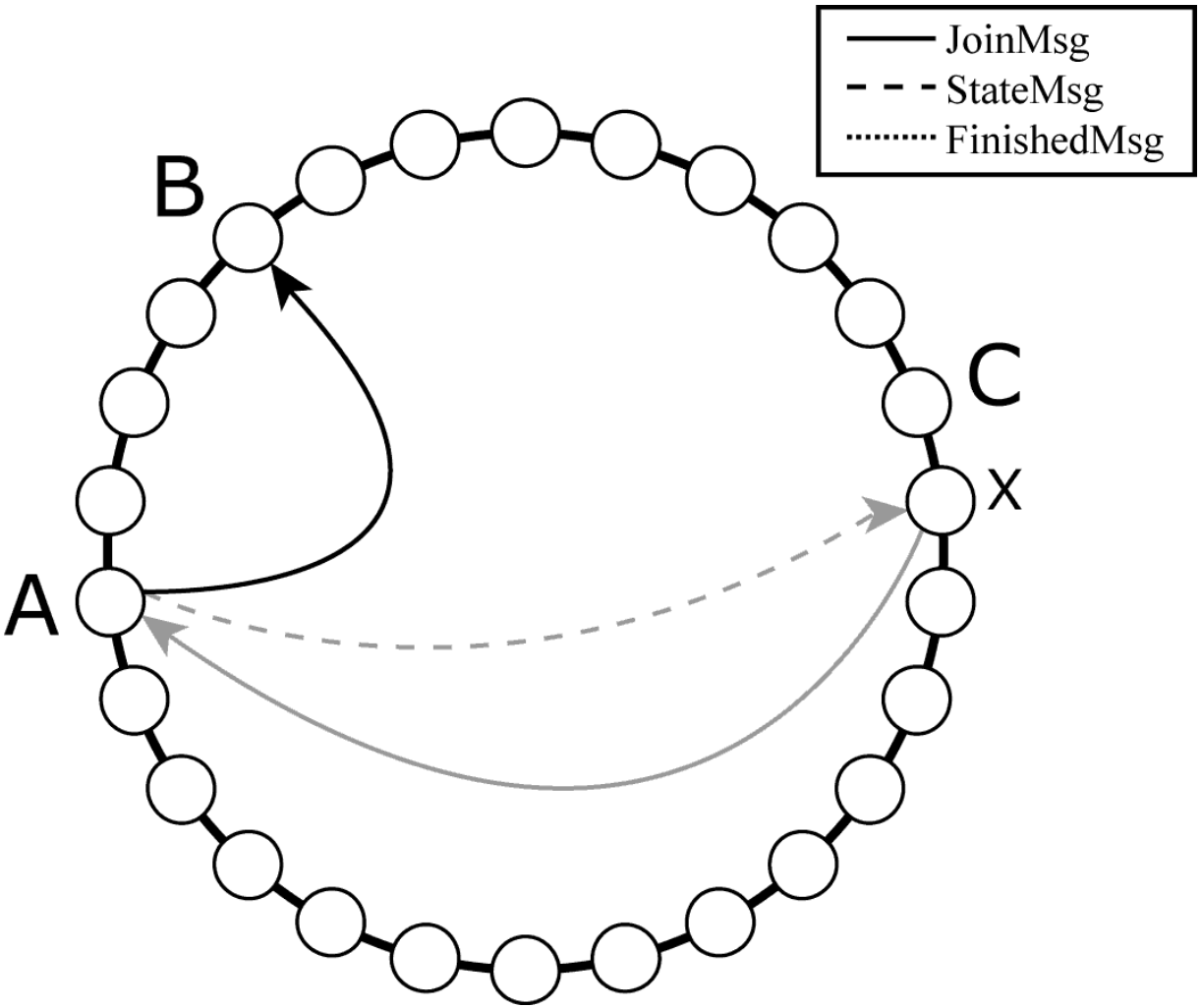

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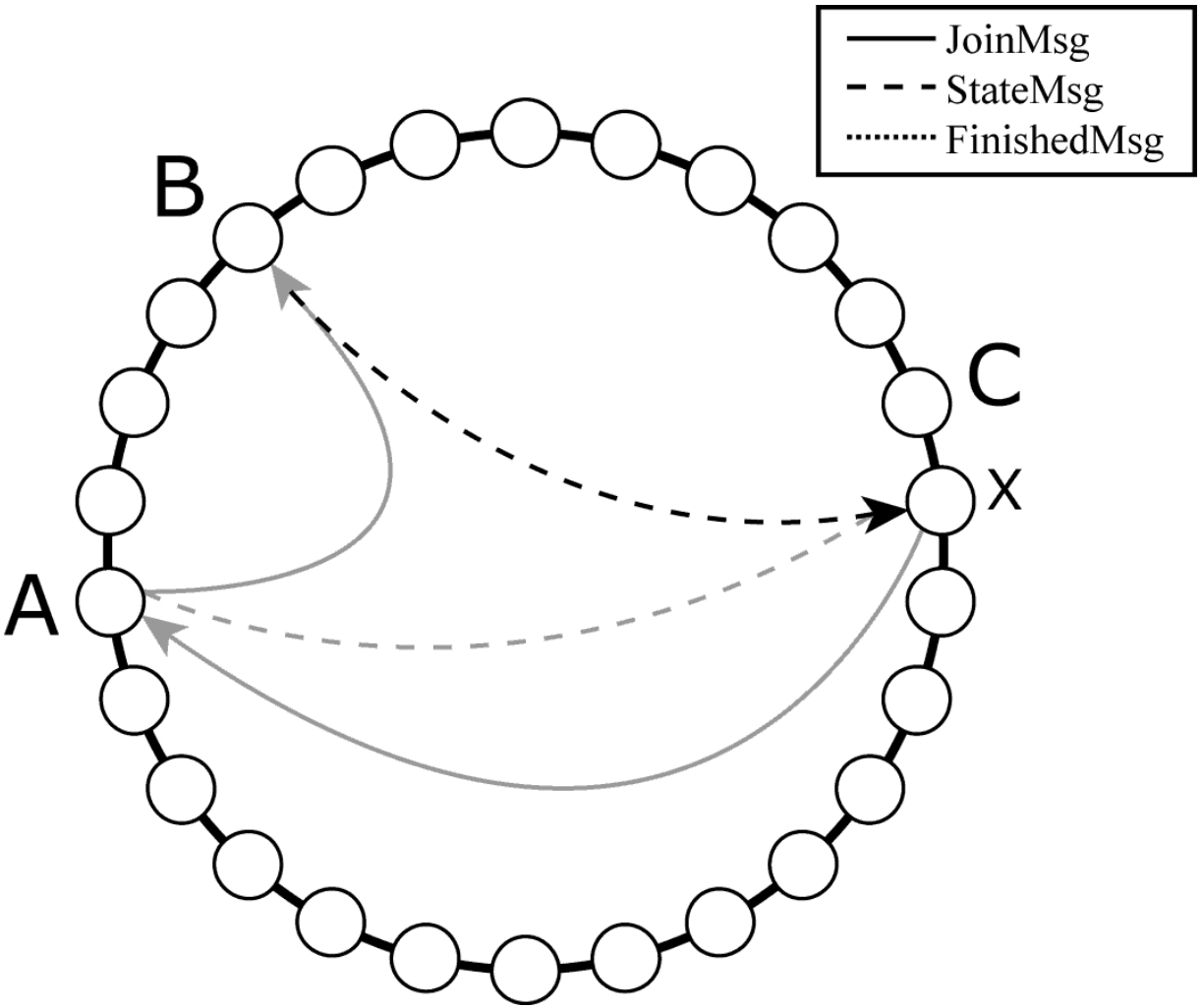

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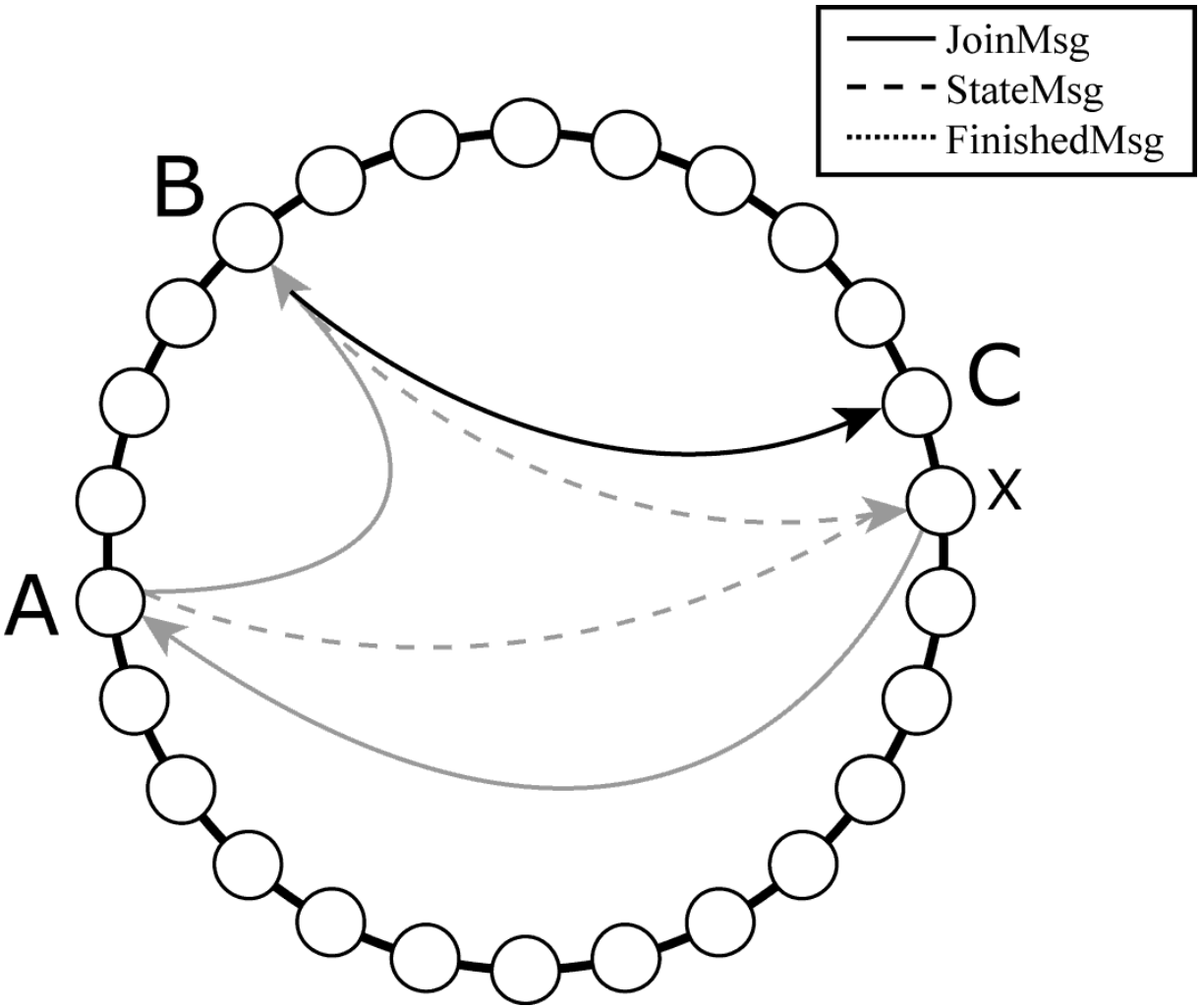

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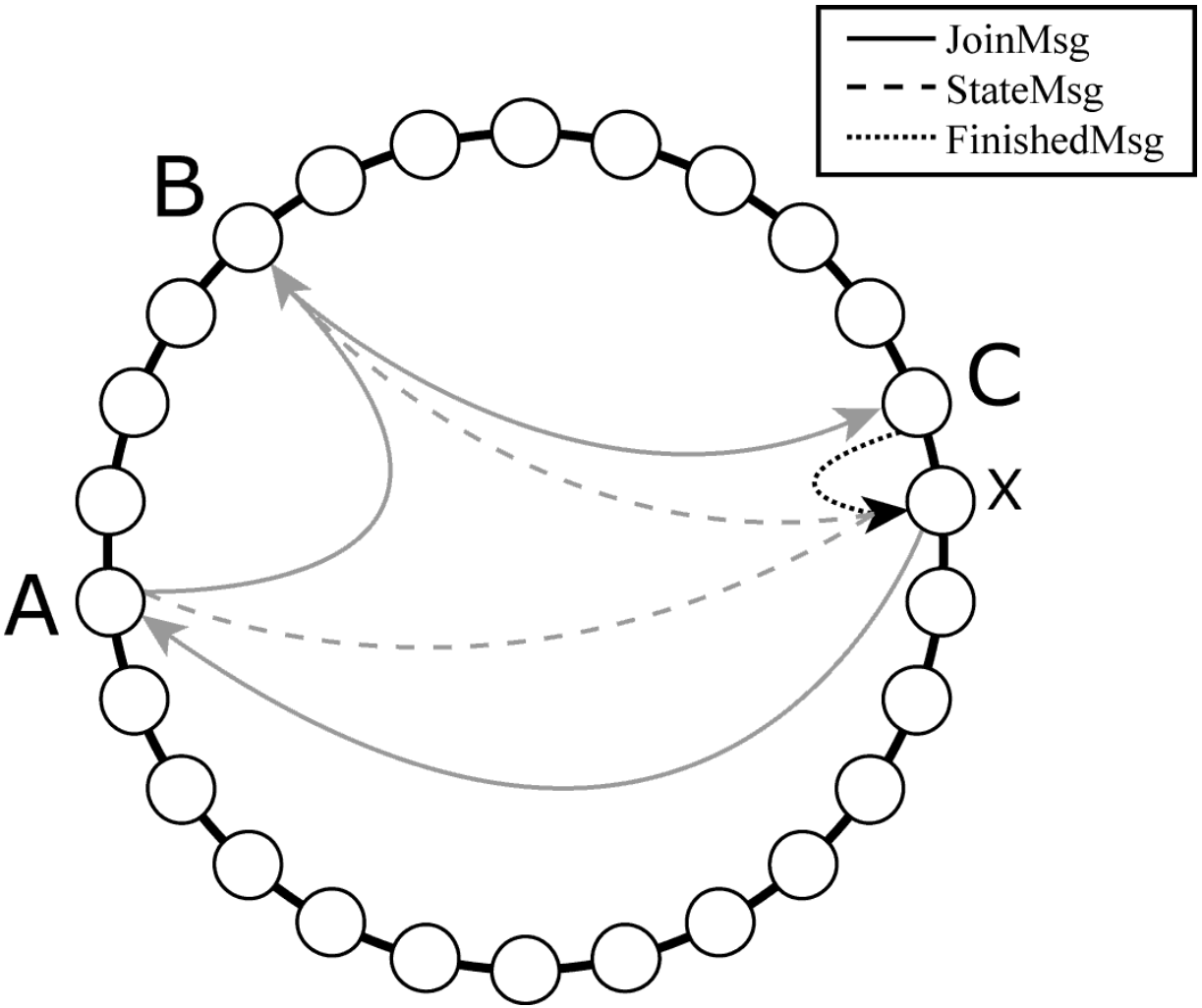
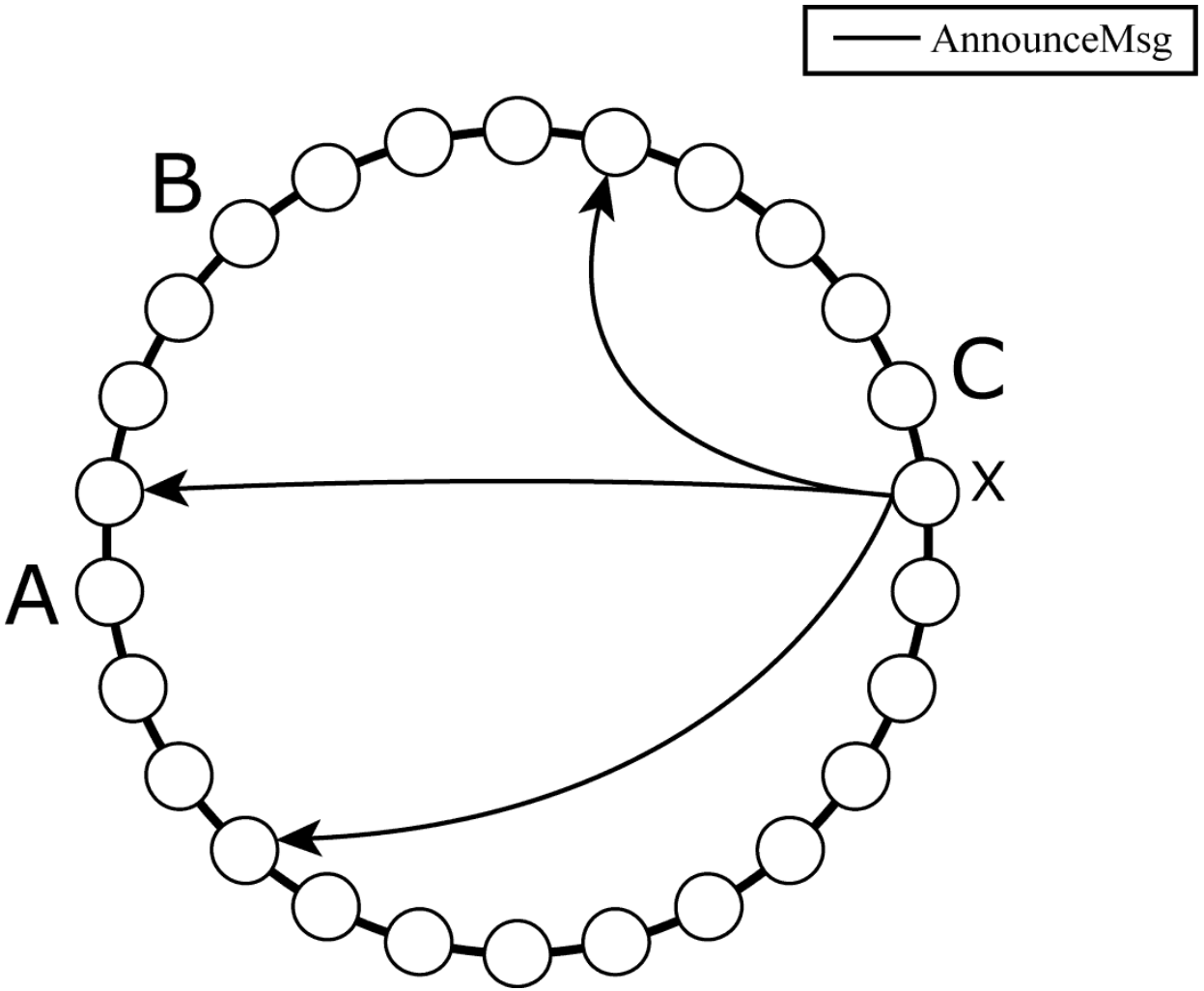
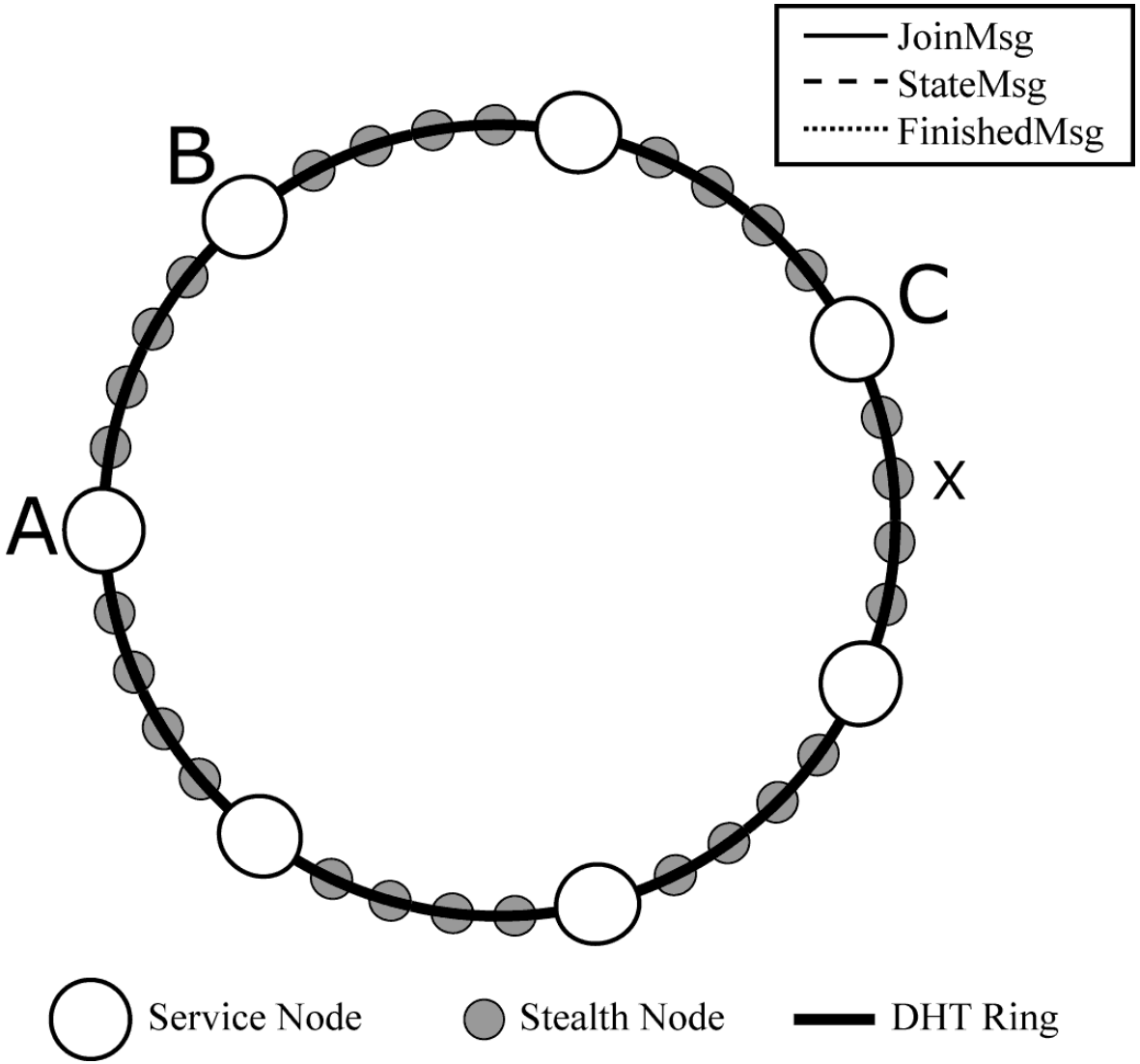


Pastry's Join - Announcement



Stealth Node's Join - State Gathering



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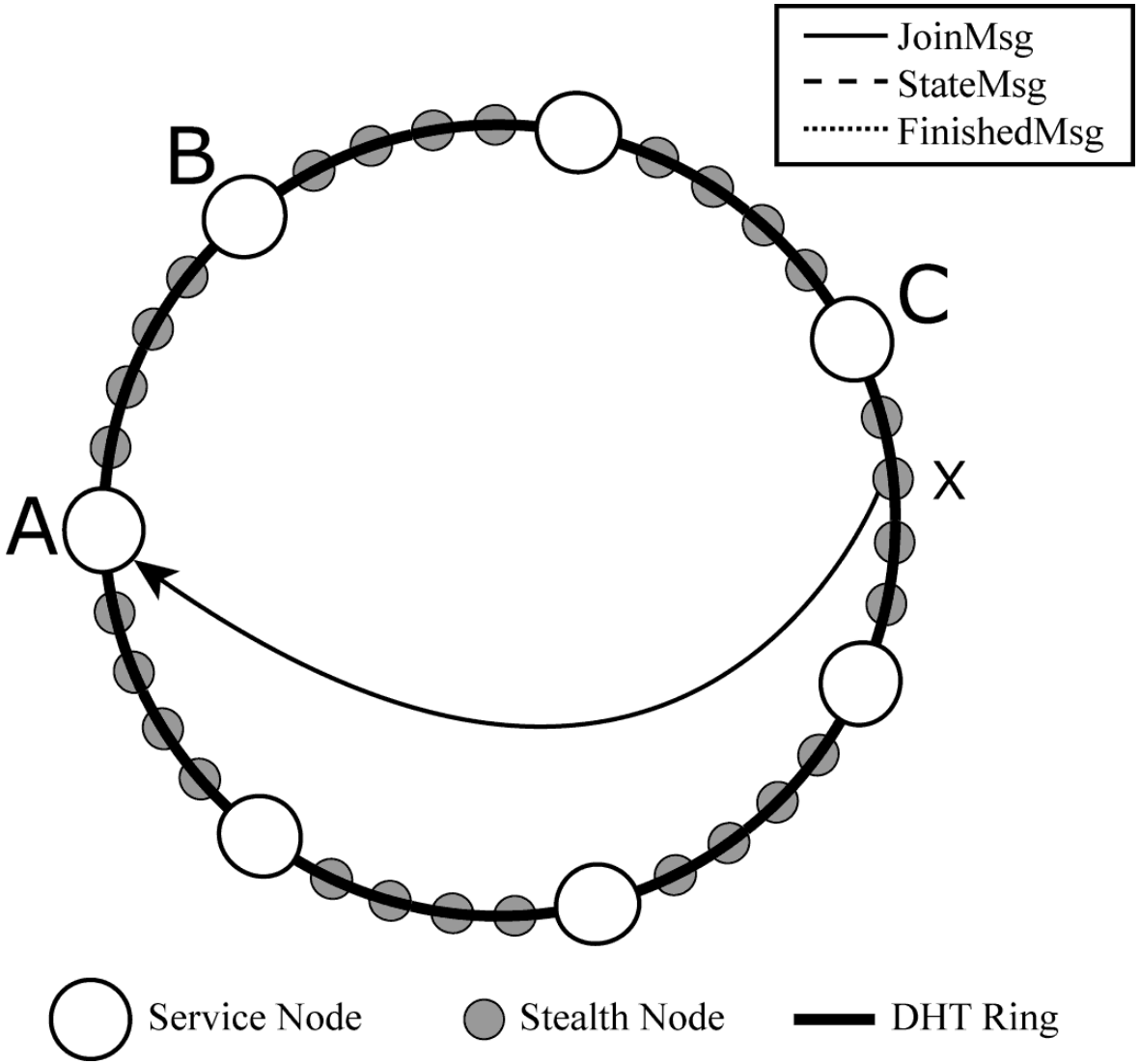

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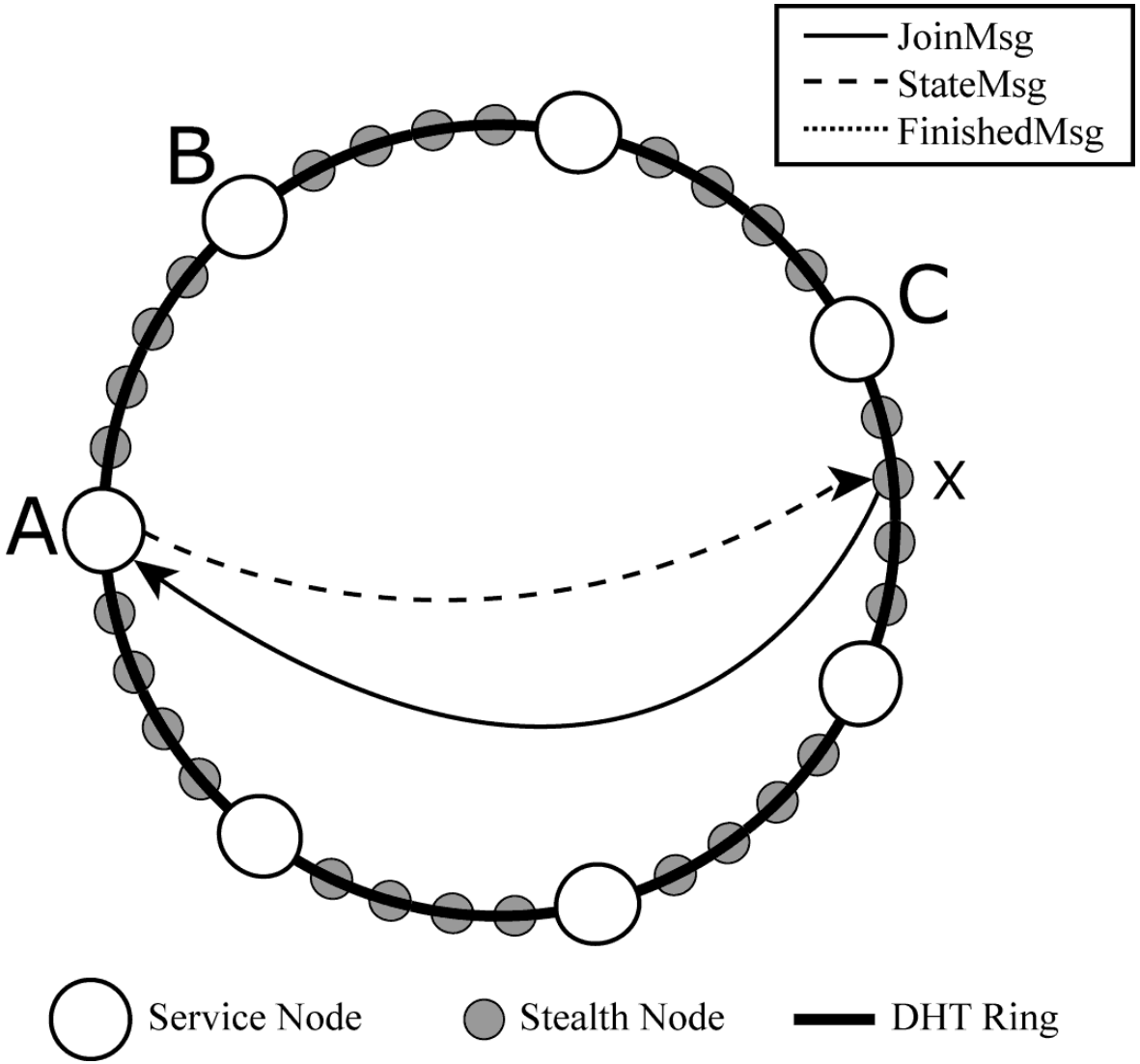

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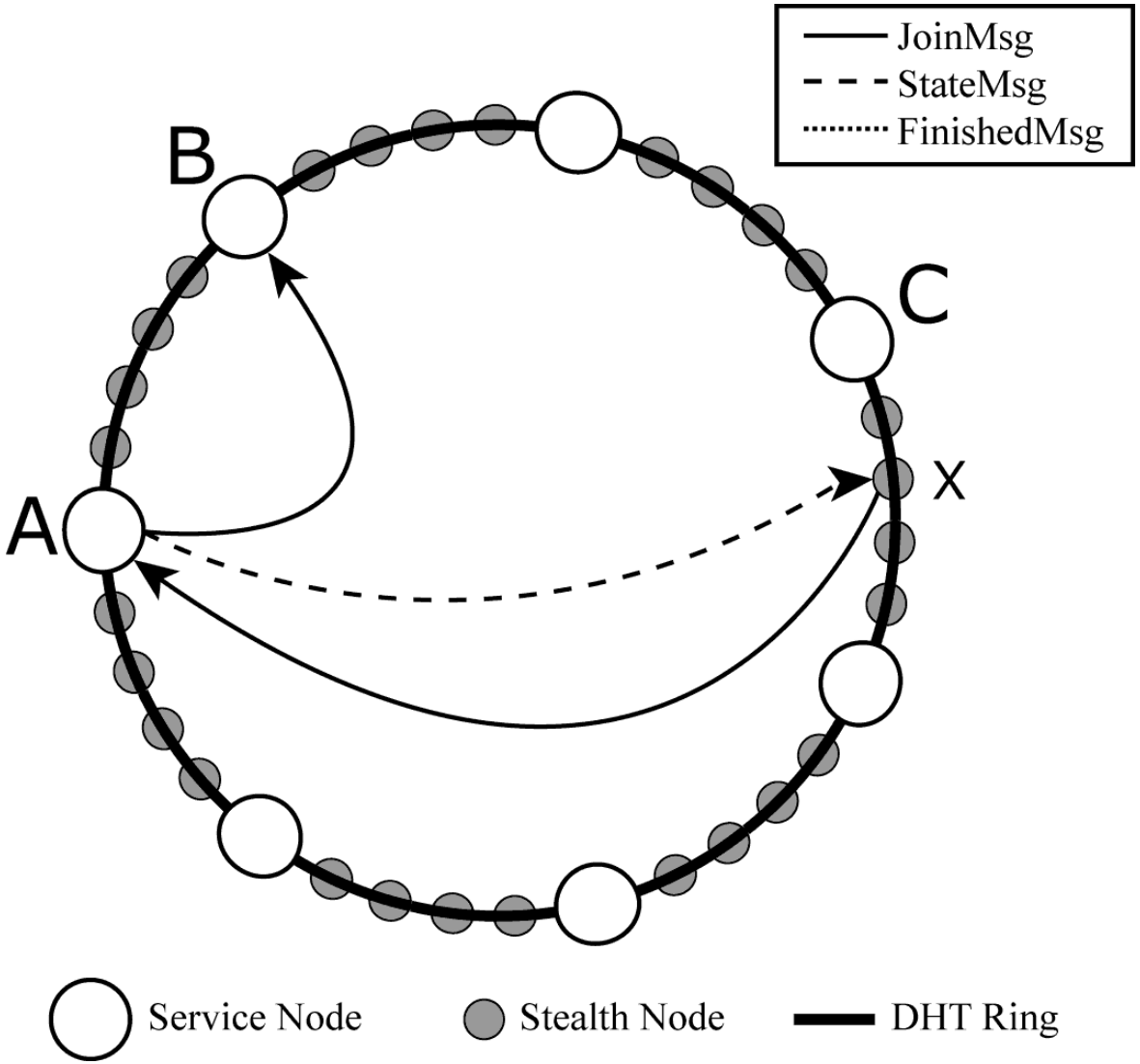

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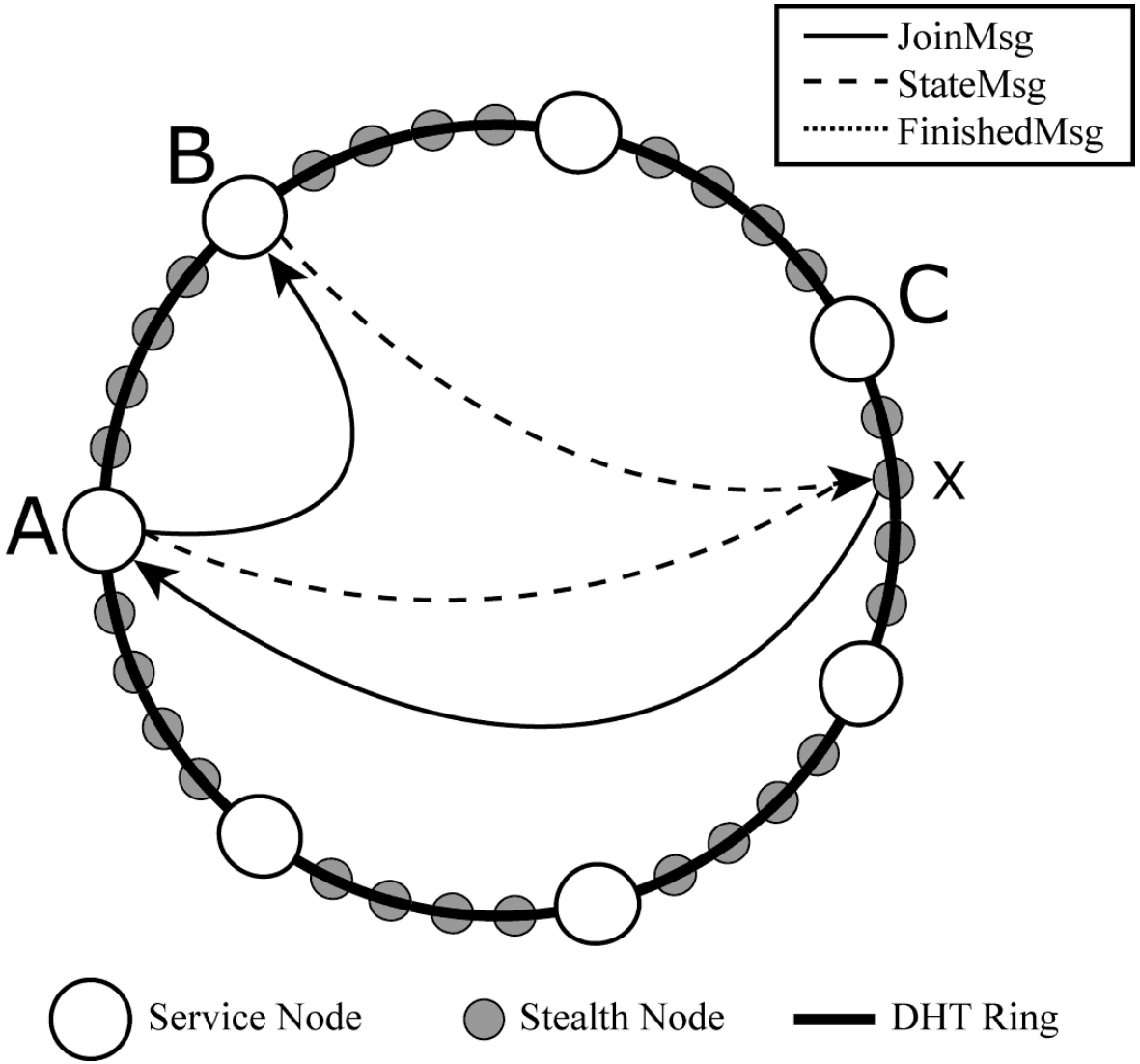

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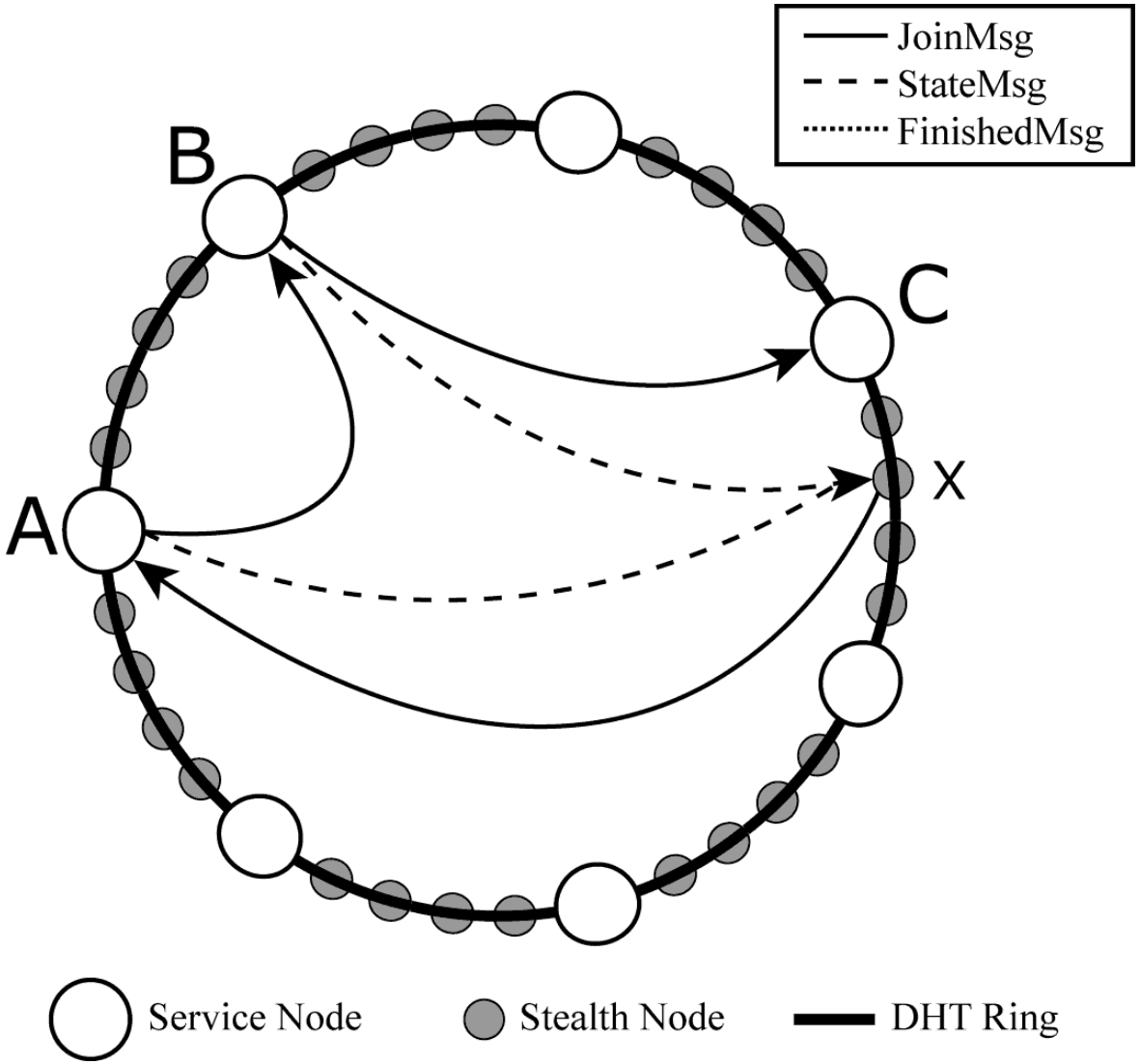

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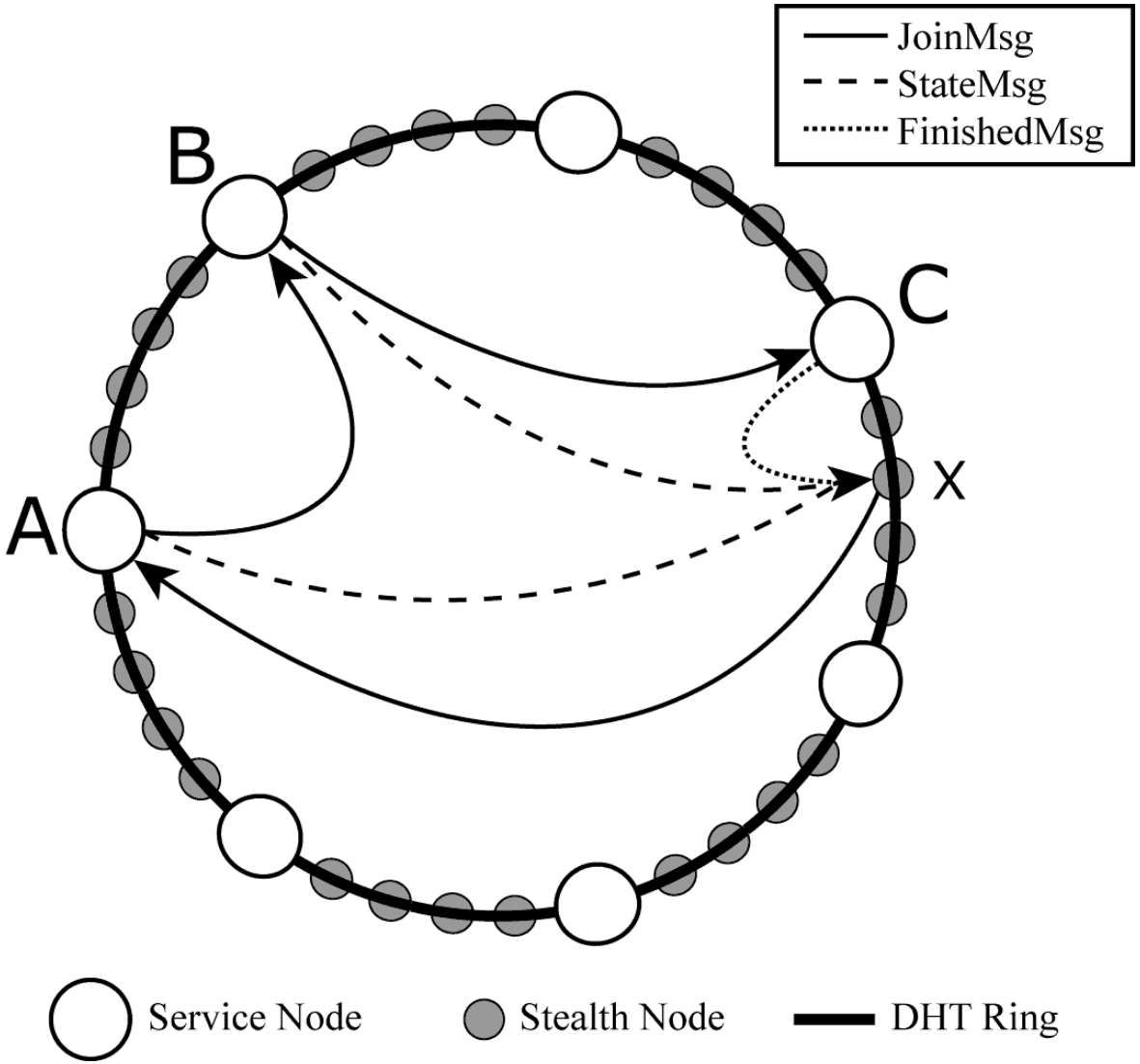

Stealth Node's Join - Announcement

and NO announcement!

How does it work? - Summary

- Service nodes join normally
- Stealth nodes join but do not announce

- Therefore
  - Stealth nodes never appear in any node's routing tables
  - Stealth nodes still have complete routing tables, thus resistance and optimal routing (of their own messages)
  - Stealth nodes are not responsible for routing, or storing keys, etc
  - Stealth node's churn affects no one
  - Stealth nodes are effectively invisible
- However
  - Stealth nodes won't receiving routing updates

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How does it work? - Summary

However Stealth nodes don't receiving routing updates. (ie knowledge that new service nodes have joined)
Therefore they have an increasingly stale routing table

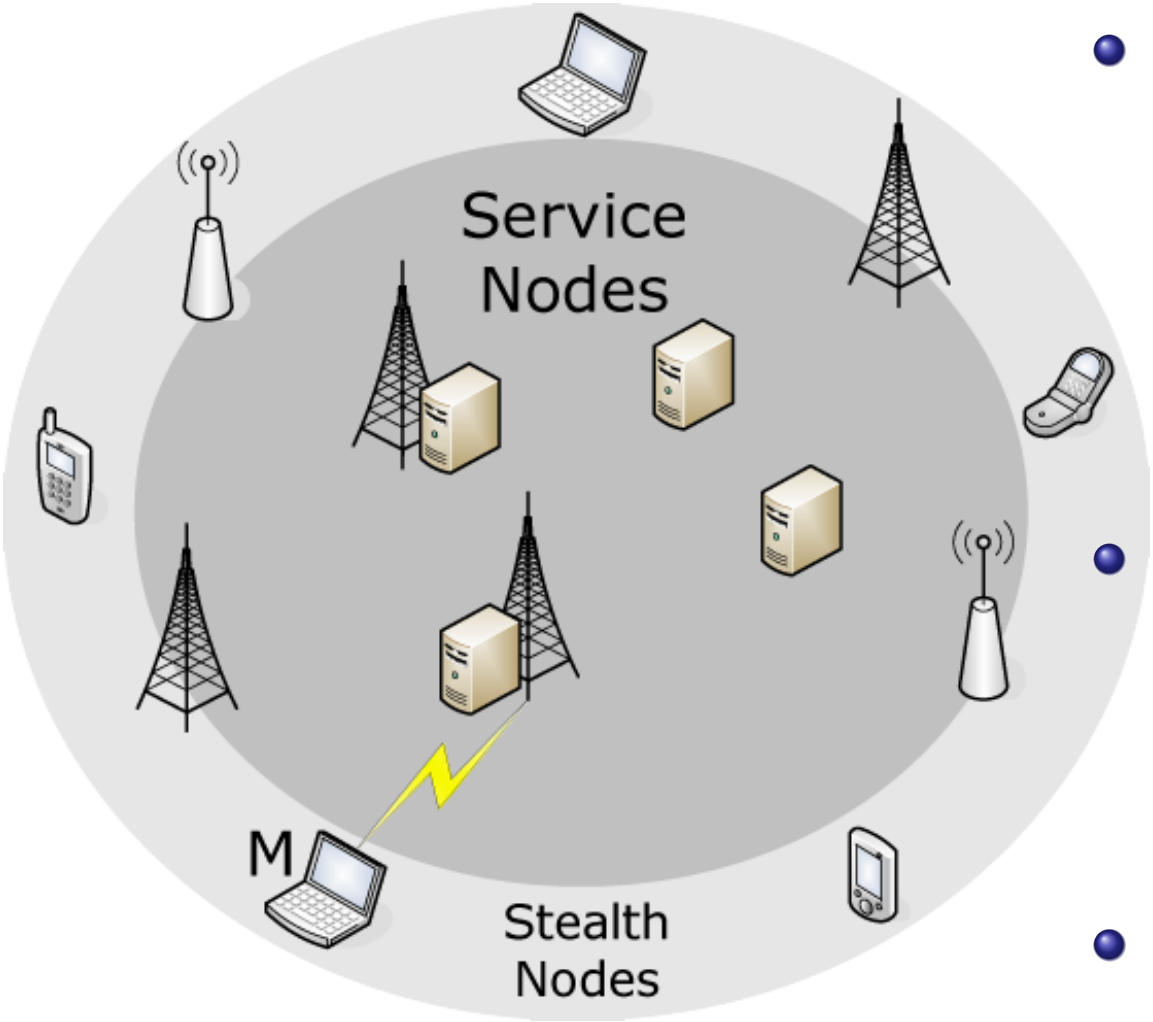
Three solutions to this:

- Polling for updates
- Piggy backing updates
- Periodically rejoining the network

Methodology

- Implementation
  - Wrote a Peer-to-Peer simulator in java
  - Implemented both Pastry and Stealth DHT (based on Pastry)
- Constructed networks of 1-1000 peers
  - 1000 Router transit-stub GT-ITM network (4% transit nodes)
  - Each stub/edge router was a wifi access point
  - Connected Stealth nodes in a random fashion to the APs
  - Connected Service nodes in a random fashion via wired links to the APs
- Simulations (Realistic Scenario)
  - Place 1 million keys in the network
  - Requested keys due to a Zipf distribution $\alpha = 1.2$
  - With and Without Mobility Churn
    - Random Waypoint Model with mean 60min "thinking" times

Methodology

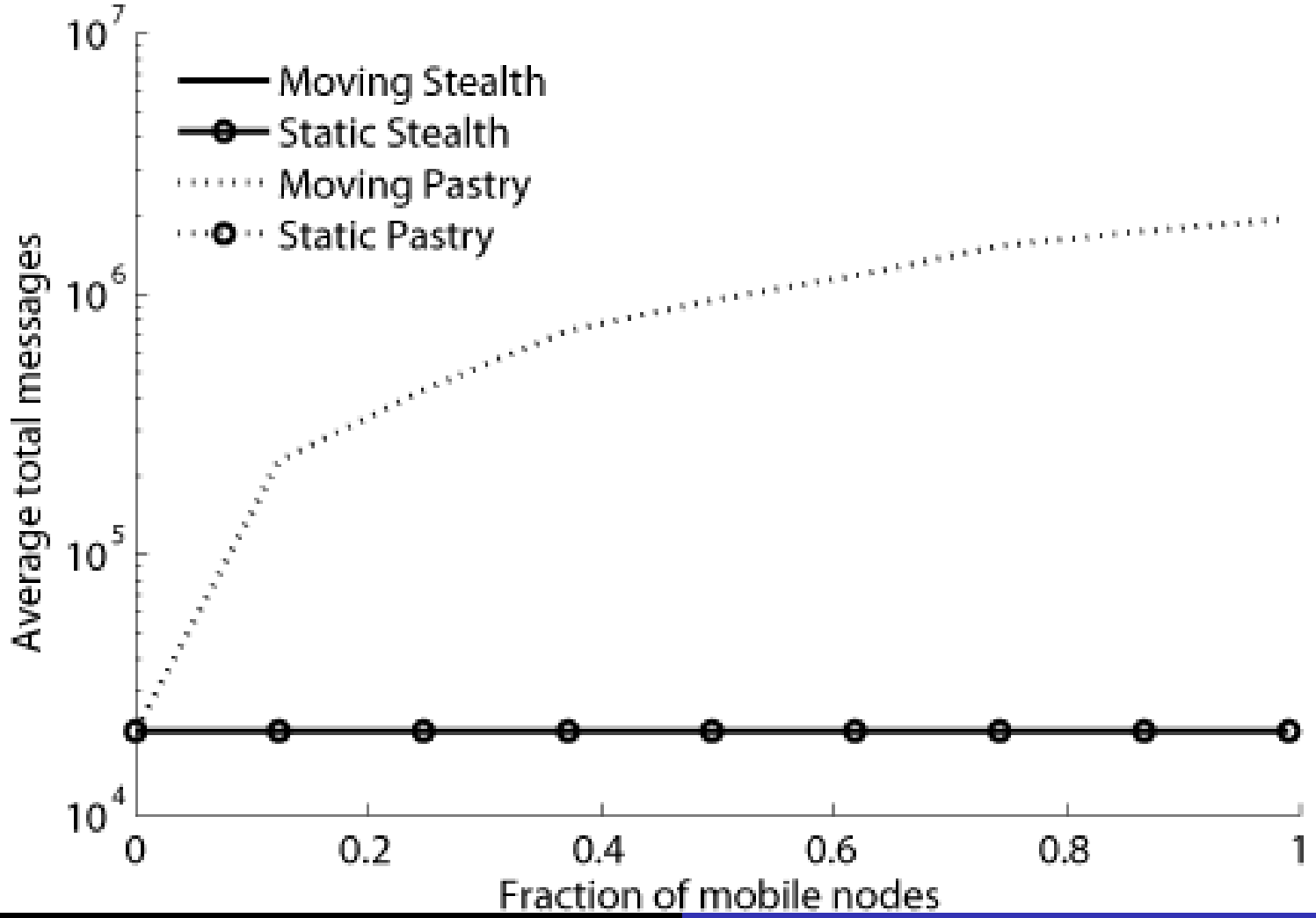


- Service Nodes
  - PCs (workstation/servers etc)
  - Connected via a wired Network
- Stealth Nodes
  - Mobile devices
  - Connected via the wifi Access Points
- Service/Stealth all in the same DHT

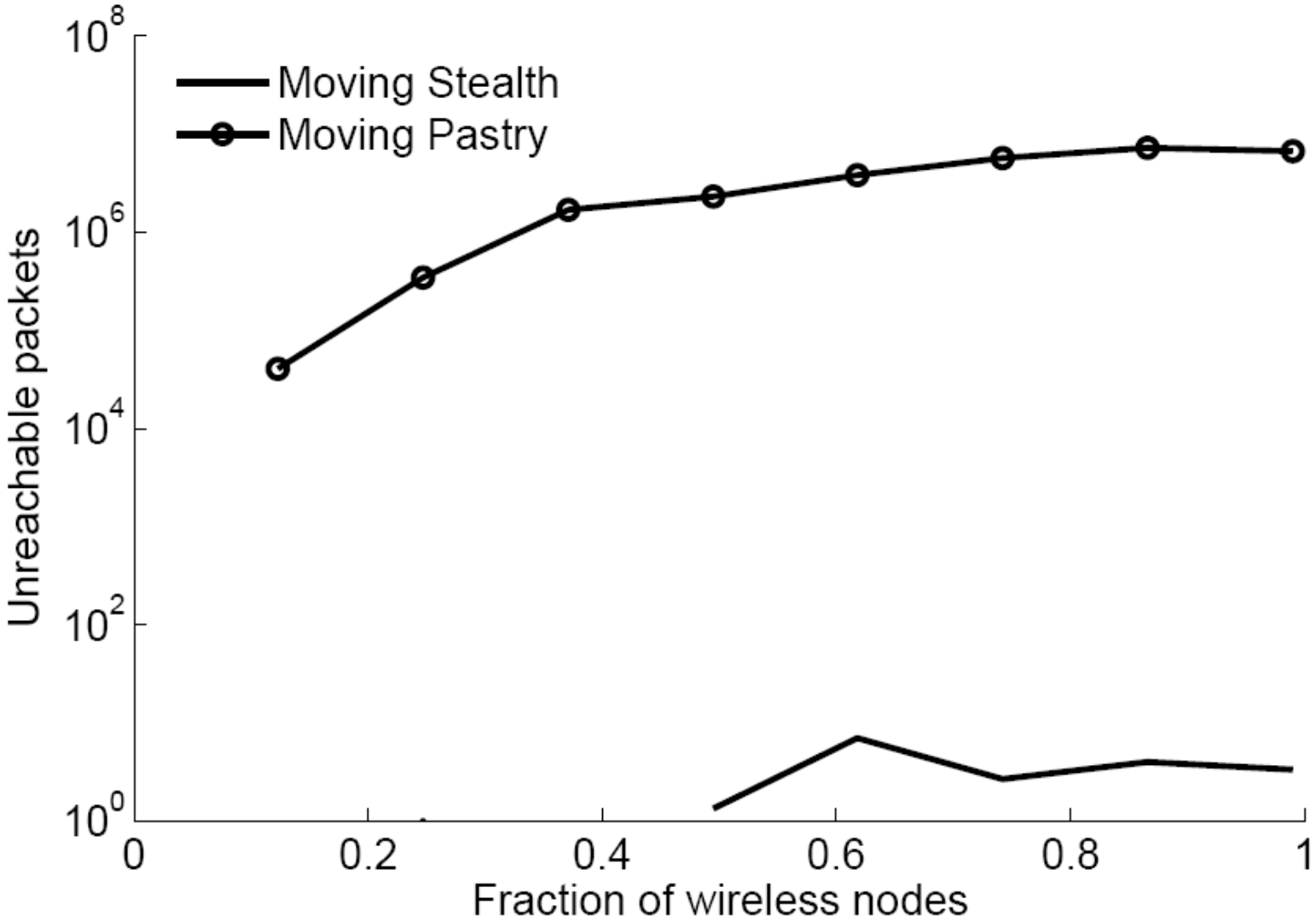
Results - Introduction

- All plots show 1000 Peer networks
  - 1% Service nodes
  - 99% Stealth nodes
- Plots on the x-axis show fractions of Stealth nodes who were wireless vs wired
- Moving {Stealth, Pastry} refers to simulations where wireless nodes moved from AP point to AP. (A new IP is obtained)
- Static {Stealth, Pastry} refer to simulations where nodes did not move

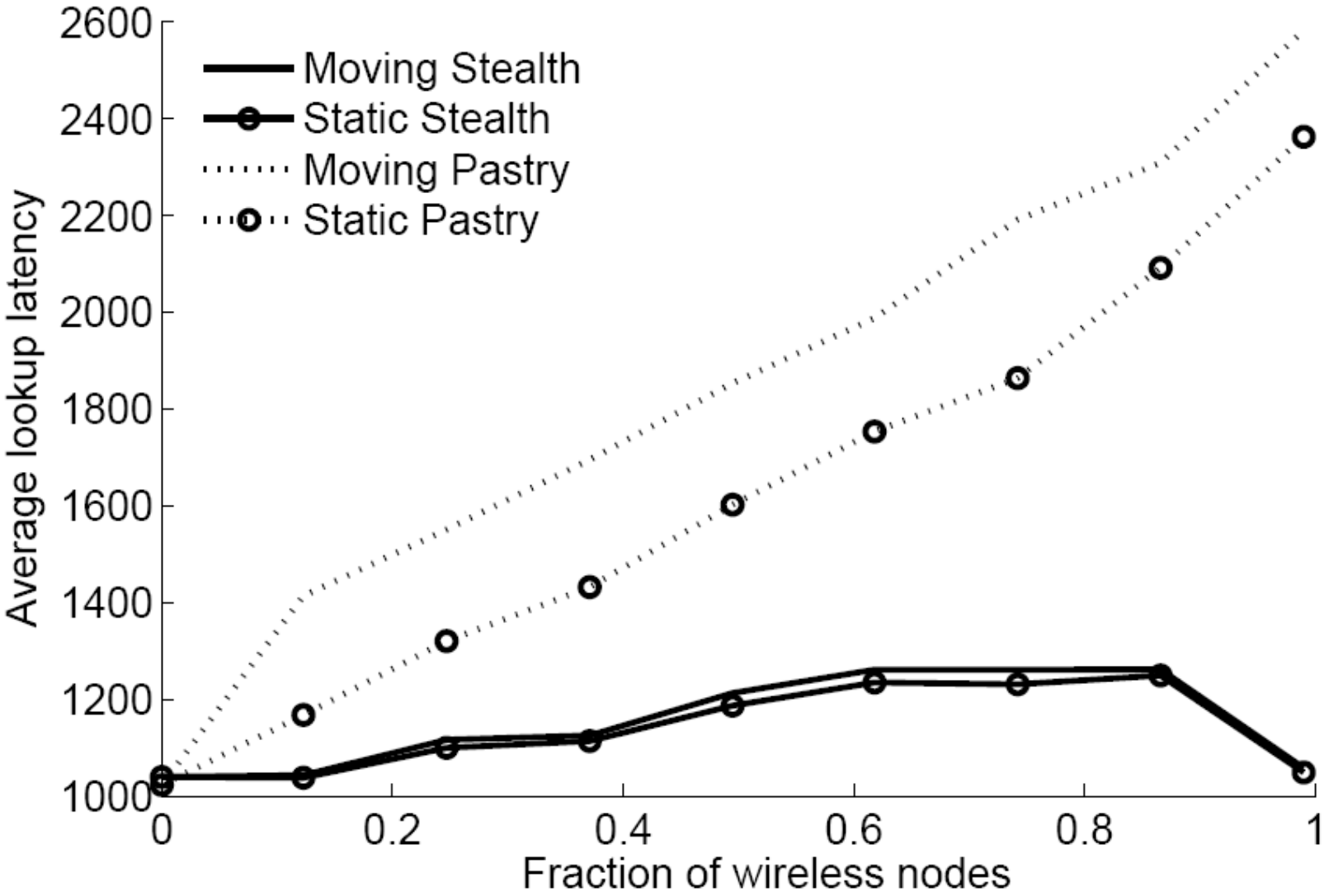
Total number of messages



Failed packets due to nodes being unreachable



Average lookup latency



Summary

Stealth DHT

- Partitions the network into two groups
- Increases DHT performance in most areas
- Returns control to the service operator

Outlook

- Investigate possible applications to run on top of a Stealth DHT
  - Content Distribution Networks
  - Novel Peer-to-Peer Applications
- Automatically decide who is Stealth/Service node, and change them on the fly
- Look in detail how this can be applied to MANETs

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Thank you for listening

Questions?

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