

# QoS Enabled Multicast for Structured P2P Networks

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# Agenda

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- > Introduction
- > Overview of Pastry
- > Pastry routing
- > Scribe overview
- > Scribe group member management
- > Considerations about QoS with Scribe / Pastry
- > Building QoS-aware multicast trees with Scribe / Pastry
- > Evaluation with Freepastry
- > Conclusion
- > Outlook

# Introduction

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- > IP Multicast not widely deployed in the Internet
- > Application Level Multicast (ALM) as a possible solution
- > Quality of Service concepts required for ALM
  
- > Concept to enable QoS with structured P2P networks
- > Application with Scribe / Pastry
  - Replace Pastry random ID assignment with QoS-aware method
  - One Pastry P2P network per multicast group
  - Root of multicast tree gets greatest Pastry ID
  
- > Concept is used in the European EuQoS project to enable IP Multicast (with QoS support) on end-systems

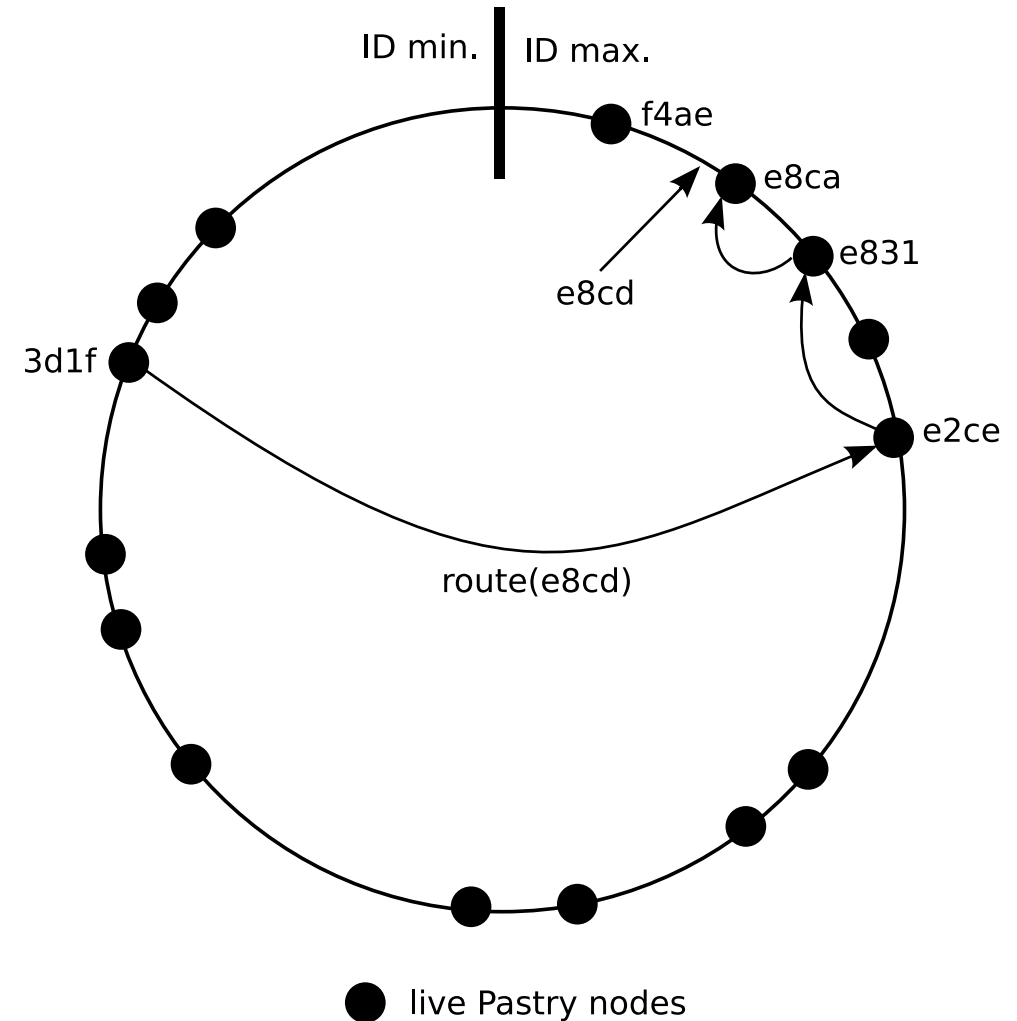
# Pastry Overview

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- > P2P routing substrate
- > Ring structure
- > Each peer has an unique ID (128 Bit)
- > IDs are randomly chosen when joining the P2P network
- > Choice is uniformly distributed
- > ID assignment is neither locality nor QoS aware
- > Routing overhead:  $O(\log n)$
- > Routing mechanism is network proximity aware
- > Open-source implementation available (Freepastry)

# Pastry Routing

- > Simplified example of Pastry routing
- > destination: e8cd
- > source: 3d1f
- > prefix routing
- > routing hops:
  - e2ce
  - e831
  - e8ca
- > e8ca is numerically closest to e8cd



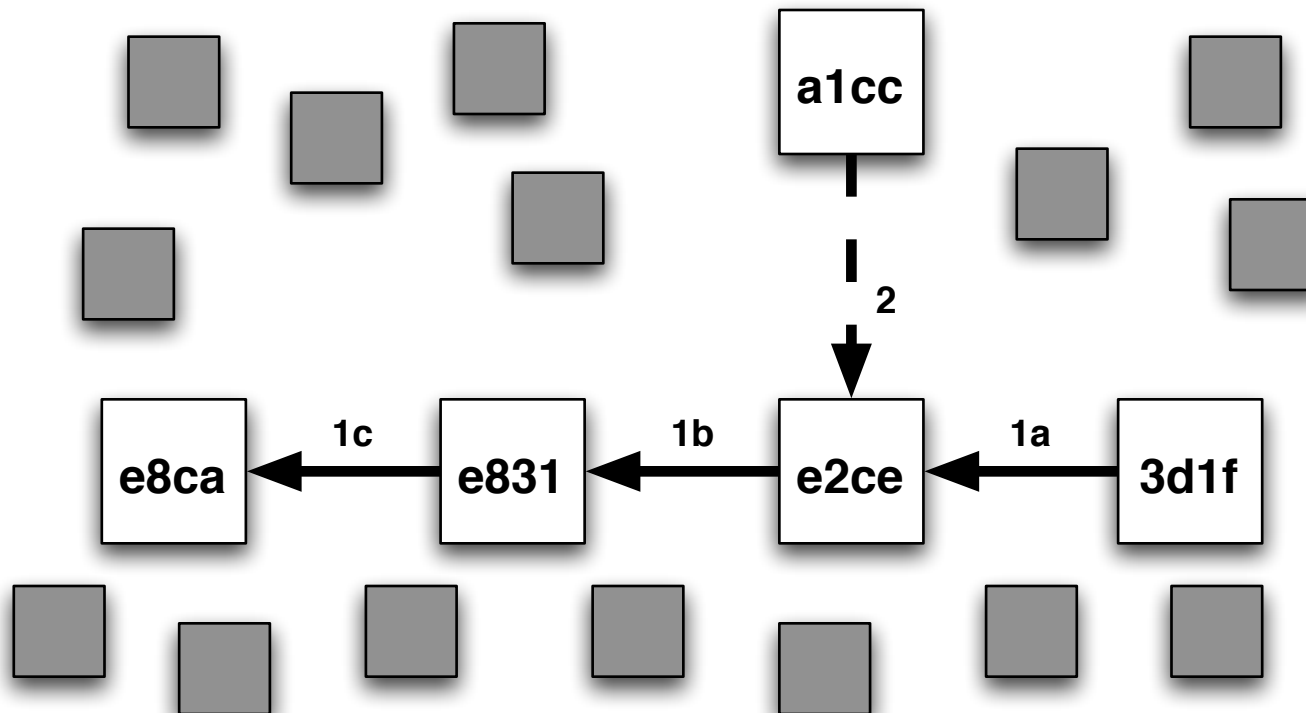
# Scribe Overview

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- > Core based Application Level Multicast (ALM)
- > Uses Pastry to construct an overlay structure (forwarding tree)
- > Each multicast group (topic) has an unique multicast group (topic) ID (# of bits  $\geq$  # of bits in an Pastry ID)
- > Each multicast group has a core (root) node, which is the root of the distribution tree
  - Root is the node with the ID numerically closest to the topic ID
  - All outgoing traffic is forwarded to the root node, which forwards the traffic to it's direct child nodes
- > Open-source implementation available (Freepastry)

# Scribe Group Member Management

- > TopicID = e8cd  $\rightarrow$  root = e8ca (numerically closest to topicID)
- > 1a- c: join of 3d1f via e2ce (makes e2ce and also e831 join)
- > 2: join of a1cc via e2ce (e2ce already in group, no extra joins)



# Considerations about QoS with Scribe / Pastry

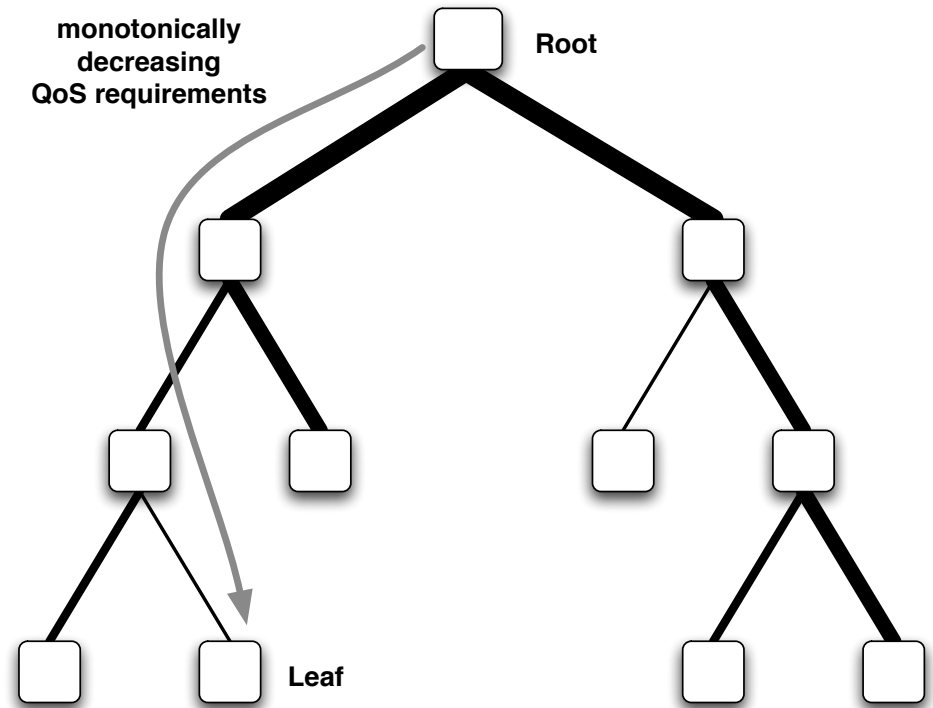
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- > QoS requires limited resources of the end-system
- > Network QoS is not necessarily “free of charge”
  
- > All Pastry/Scribe nodes (independent on their topic membership) can be/are used to forward multicast traffic
  - one Pastry ring per multicast group (topic) needed
- > For joining the Pastry ring associated with a multicast group (topic), the IP-address of at least one node must be known
  - one DHT-like service is needed, which stores the endpoint-addresses of at least few ring-members



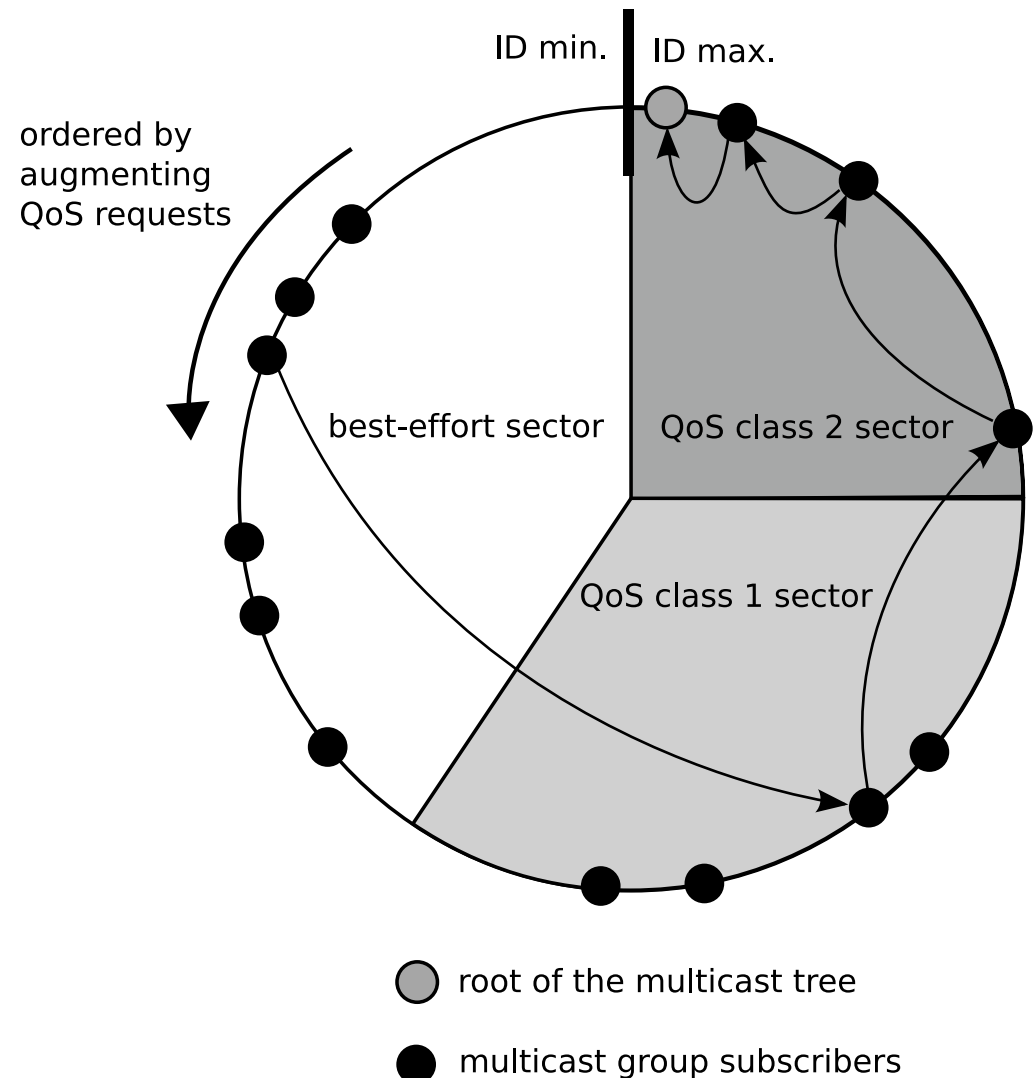
# Building QoS aware Multicast Trees with Scribe / Pastry

- > Structure of multicast tree for providing QoS (bandwidth/jitter)
- > Root node has highest QoS requirements / capabilities
- > Child QoS req.  $\leq$  parent QoS req.
- > all e2e paths root  $\rightarrow$  leafs: monotonically decreasing QoS requirements / capabilities



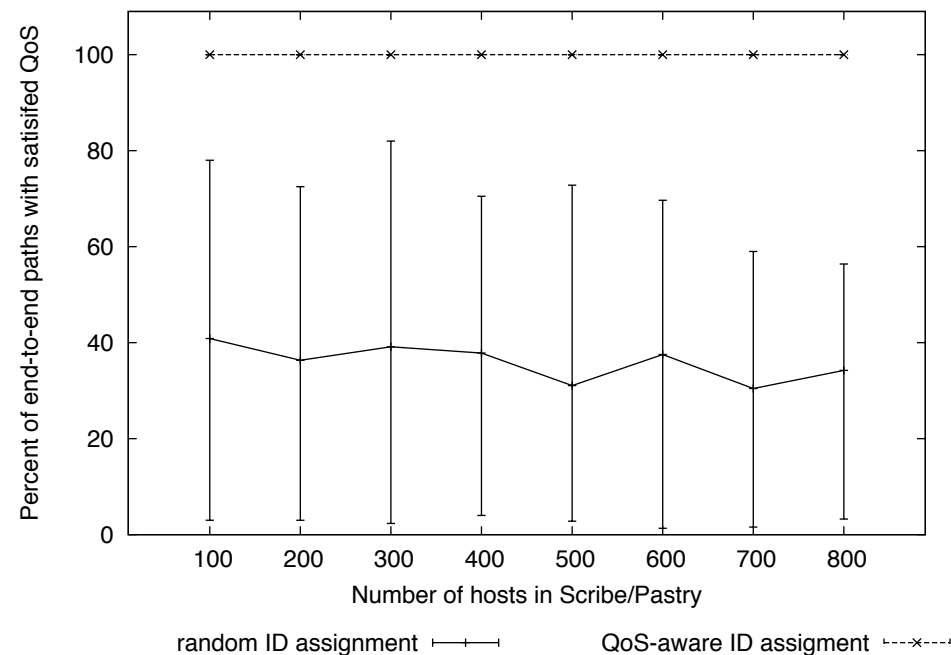
# Building QoS aware Multicast Trees with Scribe / Pastry cont.

- > Root gets highest possible Pastry ID
- > Assignment of IDs to joining nodes depends on QoS req.:  
higher QoS → higher ID
- > This enforces Scribe to construct multicast trees with required structure for QoS support



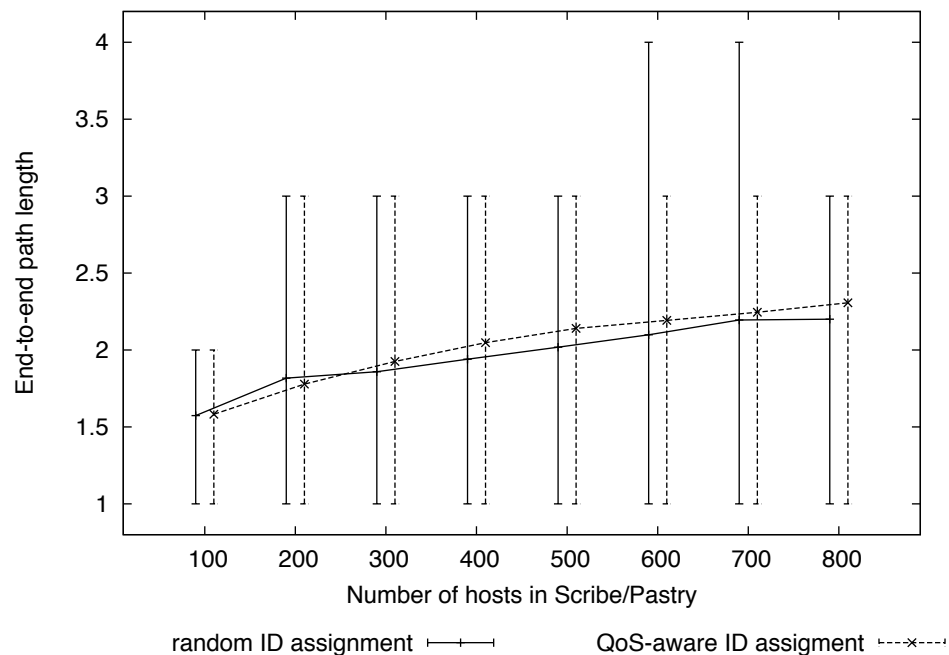
# Evaluation with Freepastry

- > Topologies with 100, ..., 800 hosts (each 40x), QoS: 1 - 255
- > End-to-end paths with QoS requirements satisfied
  - random ID assignment: avg. 35% - 40%, high deviations
  - QoS aware ID assignment: 100%



## Evaluation with Freepastry cont.

- > QoS-aware ID assignment results in same average end-to-end path lengths as with default (random) Scribe / Pastry
- > QoS-aware ID assignment in Pastry assures QoS-aware tree building with Scribe



## Conclusion / Outlook

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- > Default Scribe / Pastry ID assignment does not guarantee building QoS-aware multicast tree
- > Presented modifications to Scribe / Pastry to enable QoS-aware multicast tree building
  - QoS-related Pastry ID assignment
  - One Pastry P2P network per active multicast group (topic)
  - Root node has greatest possible Pastry ID
- > Outlook:
  - Compare end-to-end delays for random and QoS-aware ID assignment in Scribe / Pastry
  - Work presented is part of OM-QoS, a general concept to enable QoS in structured P2P networks (Chord, CAN, ...)
    - adapt mechanisms to other structured P2P networks