Internet Multicast Video Delivery

from Proceedings of the IEEE, Jan 2005

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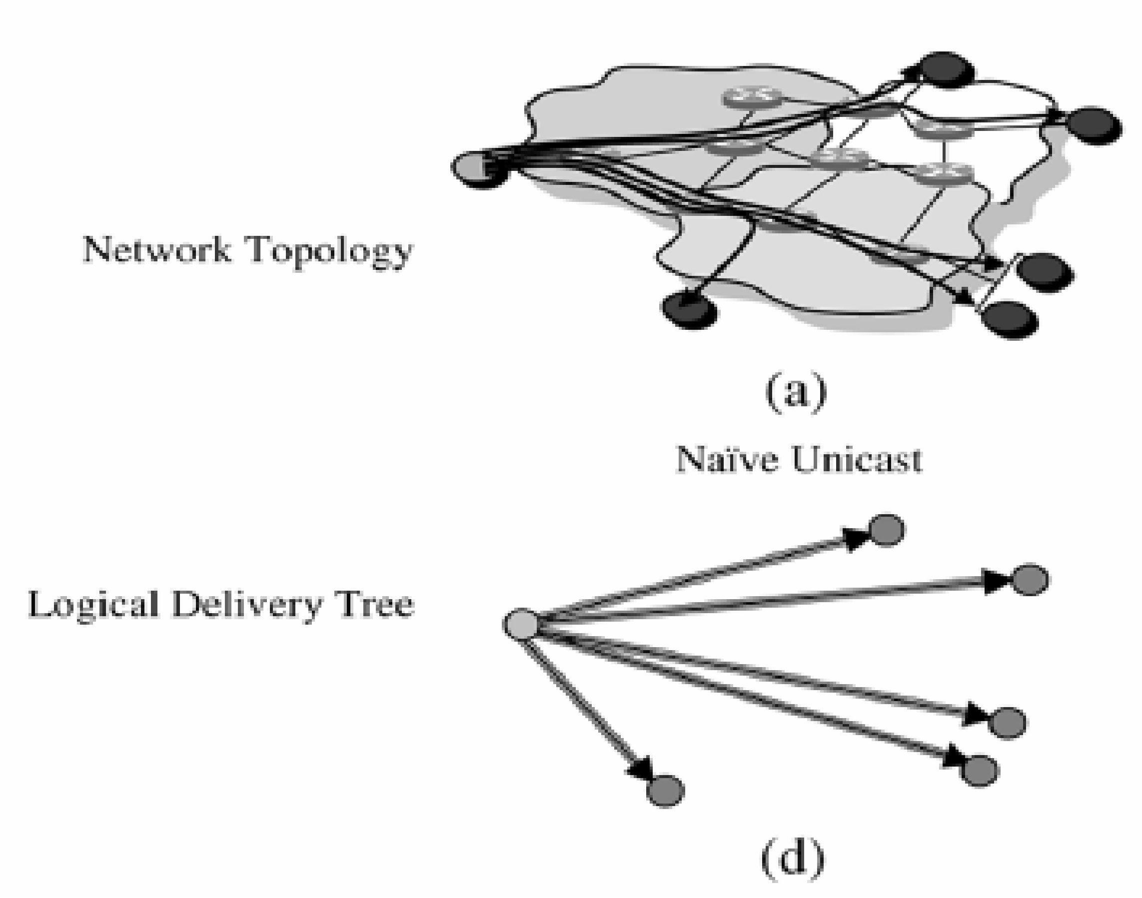
Outline

- Introduction
- IP Multicast
- Overlay Multicast
- Conclusions and Discussions
- References

Introduction

- The Internet's *unicast* service model lacks both [1]efficient multicast routing and [2]QoS guarantees needed for video delivery.
- The simplest multicast delivery architecture over the Internet: *naïve unicast*.

Introduction (Cont.)



Introduction (Cont.)

- The middle ground between broadcast and point-to-point delivery is covered by multicast delivery.
- Multicast delivery is very *flexible* and can enable *a large number of senders* to deliver content to *any number of receivers*.

Introduction (Cont.)

- In multicast video delivery, the architecture *places* receivers who desire the same stream *into one multicast group* and *sends* the stream *only to* that group.
- Basic multicast functionality:
  - Group membership management
  - Data delivery path maintenance
  - Replication and forwarding

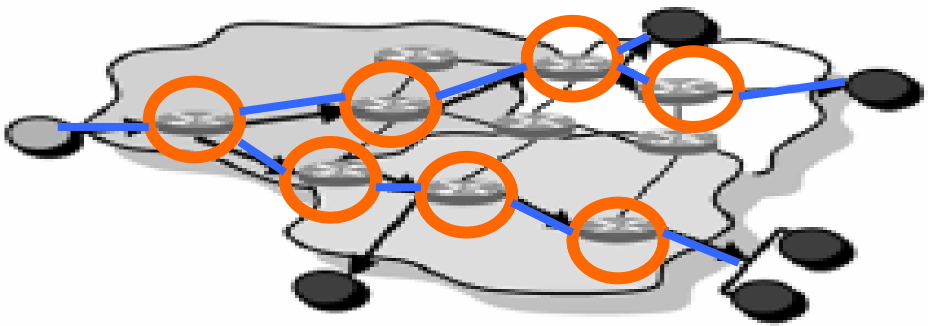
Introduction (Cont.)

- Multicast delivery challenges
  - Delivery Path Construction
  - Dynamics
  - Scalability
  - Supply Bandwidth
  - Restricted Connectivity
  - Deployment

IP Multicast

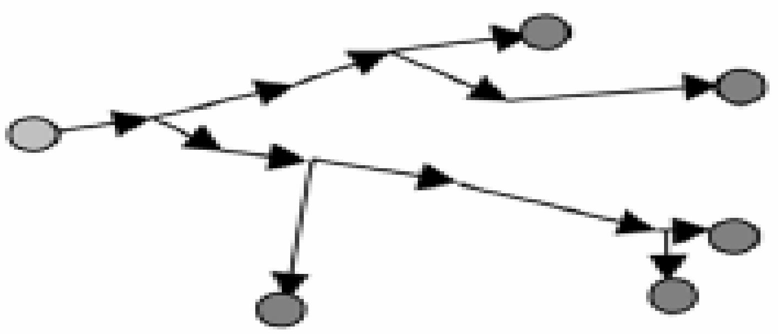
- IP Multicast is proposed in 1988. [1]
- Data originates from a sender, is *replicated at routers* as required, and is forwarded until it reaches a destination.
- *Only one copy* of the video stream traverses each link between the routers, sources, and destinations.

IP Multicast (Cont.)



(b)

IP Multicast



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IP Multicast (Cont.)

Unicast Forwarding Table

128.2/16	→ interface 4
206.15.16/24	→ interface 5

Unicast Router

Unicast Forwarding Table

128.2/16	→ interface 4
206.15.16/24	→ interface 5

Multicast Forwarding Table

224.2.3.4	→ interface 1,4,5
224.5.7.1	→ interface 1,2,3

Multicast Router

Key difference between the two tables:

1) it is *difficult to aggregate* the multicast forwarding table.

2) An entry in the multicast forwarding table change when hosts join or leave any group, where as an entry in the unicast forwarding table may change only when routes in the network change.

IP Multicast (Cont.)

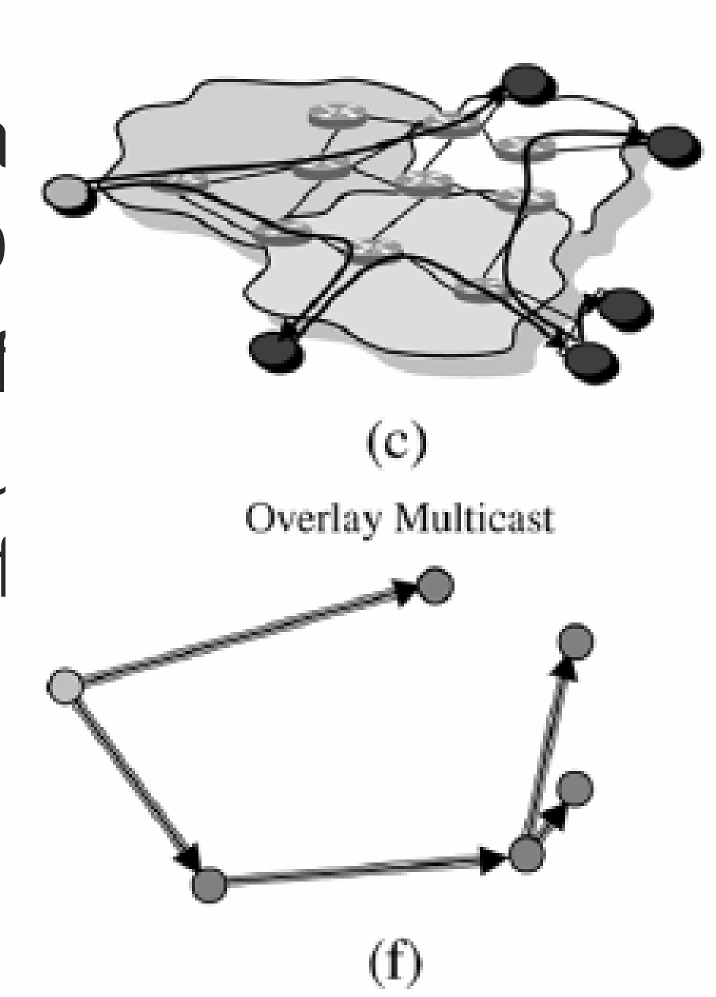
- Protocols for multicast
  - Multicast Routing
    - RPM (Reverse-path multicasting)
    - CBT (Core-based tree)
  - Reliability / Congestion Control
    - RLM [2]

IP Multicast (Cont.)

- Remaining Issues
  - Implementation of the service model turns out to be extremely complex.
  - It is difficult to implement access control, both for receivers of a group and for source sending to a group.

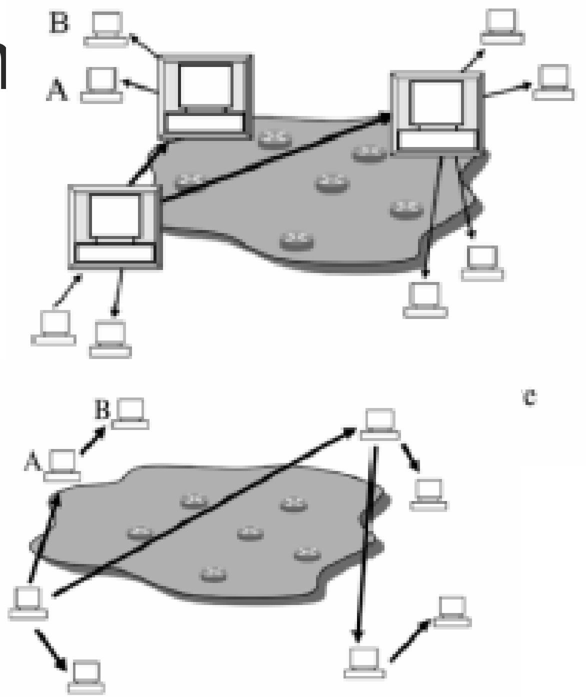
Overlay Multicast

- In overlay multica   ıll
  interior and leaf p
- The architecture f
  decouples the mu   ;ic
  unicast routing inf

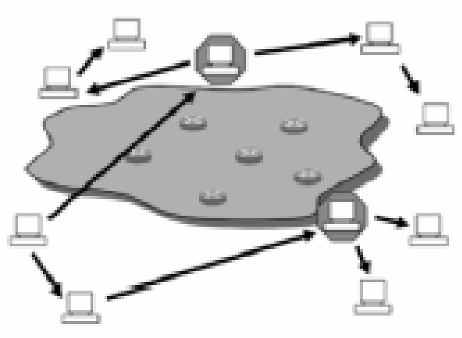


Overlay Multicast (Cont.)

- Three types of overlay m
  models:
  - Dedicated-infrastructure
  - Application-Endpoint
  - Waypoint



Application-Endpoint
(b)



Waypoint
(c)

Overlay Multicast (Cont.)

Table 1 Challenges for Multicast Support [Critical (C), Relevant (R), and Not Applicable (N)]

	Group Dynamics	Scalability		Network Dynamics	Supply Bandwidth	Heterogeneity		NAT	Deployment
		Receiver	Publisher			Receiver	Forwarder		
IP Multicast	C	C	C	C	N	C	N	R	C
Dedicated-Inf	R	C	C	C	R	C	R	R	C
App-Endpoint	C	C	N	C	C	C	C	C	R
Waypoint	C	C	?	C	C	C	C	C	R

Overlay Multicast (Cont.)

- Overlay Multicast Design
  - Tree Construction
    - Static precomputation
    - Centralized construction
    - Self-organization
  - Performance-aware adaptation
  - Hierarchical clustering
    - NICE [3]、 ZIGZAG [4]

Overlay Multicast (Cont.)

- Overlay Multicast Design (Cont.)
  - DHT
    - SplitStream [5]
  - Multiple trees/mesh
    - MDC
  - Rate adaptation
    - MDC
  - NAT/firewall-aware protocol

Conclusions and Discussions

- The key disadvantages of IP multicast is the need to maintain per flow state in all routers leading to scalability issues.
- Overlay network need to handle constant group dynamics, bandwidth constraints, and connectivity restrictions.
- Find the effect of altruism and incentive mechanism for hosts to contribute upstream bandwidth.
- Build a model about how waypoints are managed, which and when waypoint are invoked into a multicast group and when they leave the group.

References

- [1] S. Deering, “Multicast routing in internetworks and extended LANs”, in Proc. ACM SIGCOMM, Aug 1988.
- [2] S. McCanne, V. Jacobson, and V. Metterli, “Receiver-driven layered multicast,” in Proc. ACM SIGCOMM, Aug, 1996.
- [3] S. Banerjee, B. Bhattacharjee, and C. Kommareddy, “Scalability application layer multicast,” in Proc. ACM SIGCOMM, Aug 2002.
- [4] D. Tran, K. Hua, and T. Do, “ZIGZAG: An efficient peer-to-peer scheme for media streaming,” in Proc. INFOCOM, Mar 2003
- [5] M. Castro, P. Druschel, A. Kermarrec, A. Nandi, A. Rowstron, and A. Singh, “SplitStream: High-bandwidth content distribution in cooperative environments,” in Proc. SOSP, 2003.