Peer-to-Peer Media Streaming

Focus On:

- How Media is Delivered ?
- NOT on locating content or the bootstrapping process

P2P media streaming architecture

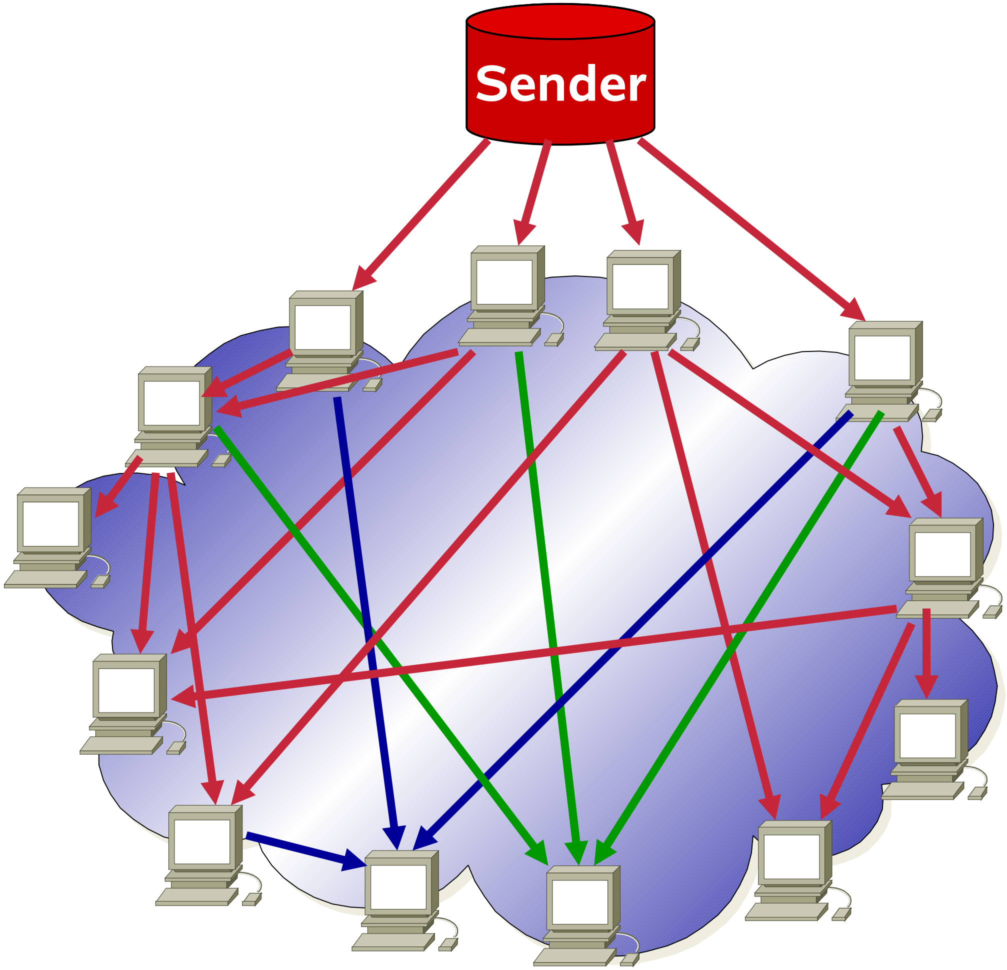
- Mesh-Pull
- Tree-Push
  - No infrastructure support
  - With partial support from infrastructure nodes
- CDNs: (not classified under P2P)
  - Full support from infrastructure nodes

Mesh-Pull Architecture

- Strong similarity to BitTorrent
  - Exchange “buffer maps” and retrieve missing chunks
- Significant difference w.r.t BitTorrent
  - Every chunk has a playback deadline
    - Video chunk scheduling algorithm indispensable
  - Peer selection algorithms:
    - Uses gossip based peer search algorithms
- Many deployed P2P IPTV services use this architecture

  Examples: PPLive, SopCast, CoolStreaming, TVAnts etc

Mesh-Pull: Overview



Mesh

Mesh-Pull Architecture contd..

- Pros
  - Robustness: suitable for high churn in p2p environment
  - Simple: a important selling point
- Cons
  - High initial start-up time
  - Video switching delays
  - Is the stress to the underlying network higher than Tree-Push architecture ???

Peer-to-Peer Streaming Systems

	Push/ pull	Tree/ Mesh	Buffer	Playout Delay	Startup Delay	Quality
PPLive	Pull	Mesh	2 min	1 min	20 s-2 min	Rate: 300 – 350 kbit/s Res. 320 x 240 pixel
Coolstreaming	Pull	Mesh	2 min	1 min	1 min	
Anysee	Push	Hybrid	40 s	20-30 s	20 s	
SopCast	Pull	Mesh	1 min	1 min	1-5 min	

- More
  - CoopNet
  - PALS
  - PROMISE
  - SPLIT Stream
  - Bullet

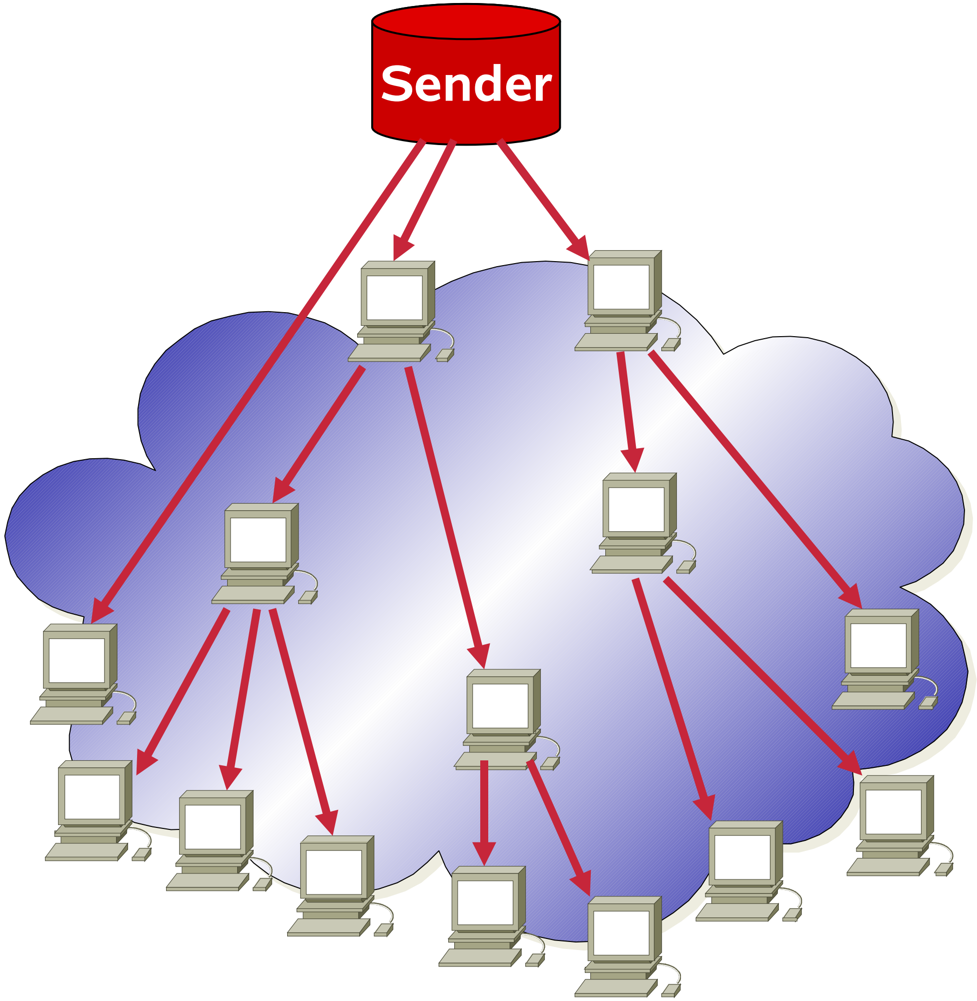
Tree-Pull Architecture

- Important components
  - Distribution tree construction (ex: based on RTT)
  - Distribution tree maintenance
    - Pro-Active node re-positioning
  - Distribution tree repair (in case of churn)
- Operations related to distribution tree can be
  - Centralized (single entity performs the task) OR
  - Distributed
    - At any instant, more than on entity is trying to make decisions that optimize the distribution

Tree-Pull Architecture contd..

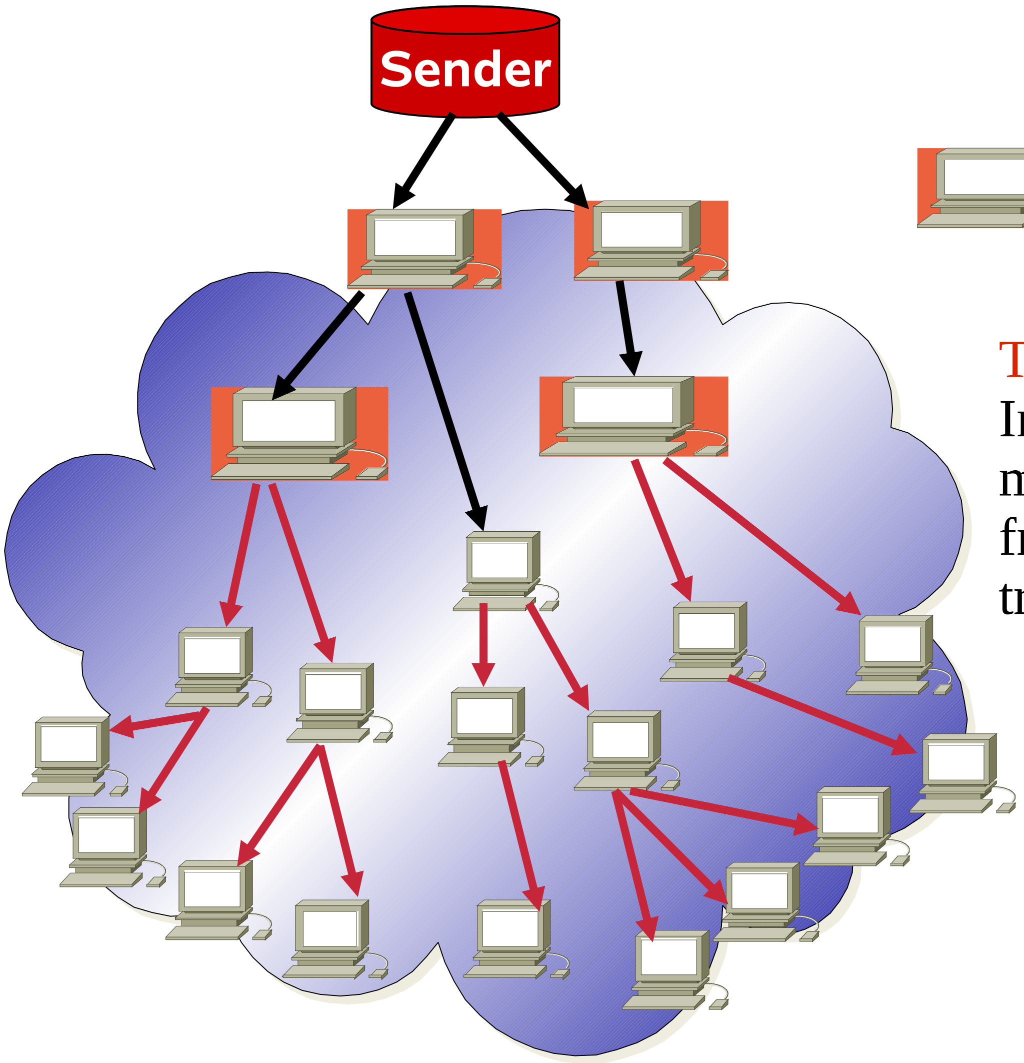
- P2P media distribution solutions based on Tree-Pull
  - (A) No infrastructure nodes
    - purely based on end users
  - (B) With partial support from infrastructure nodes

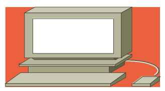
(A) No Infrastructure nodes



Any Deployment Experience:
ESM (End System Multicast)
http://esm.cs.cmu.edu/

(B) Partial support from Infrastructure nodes




→ Infrastructure Node

Tree operations:
Interconnecting infrastructure node might use different tree algorithms from the algorithms used for build tree within normal users

Tree-Push Architecture contd..

- Pros
  - Start-up time is small
  - Playback time lag among peers is less
  - Tree construction mechanism, can optimize the tree so as to reduce stress on the underlying network
- Cons
  - Stability
    - Loss of a node affects all other nodes below its hierarchy.

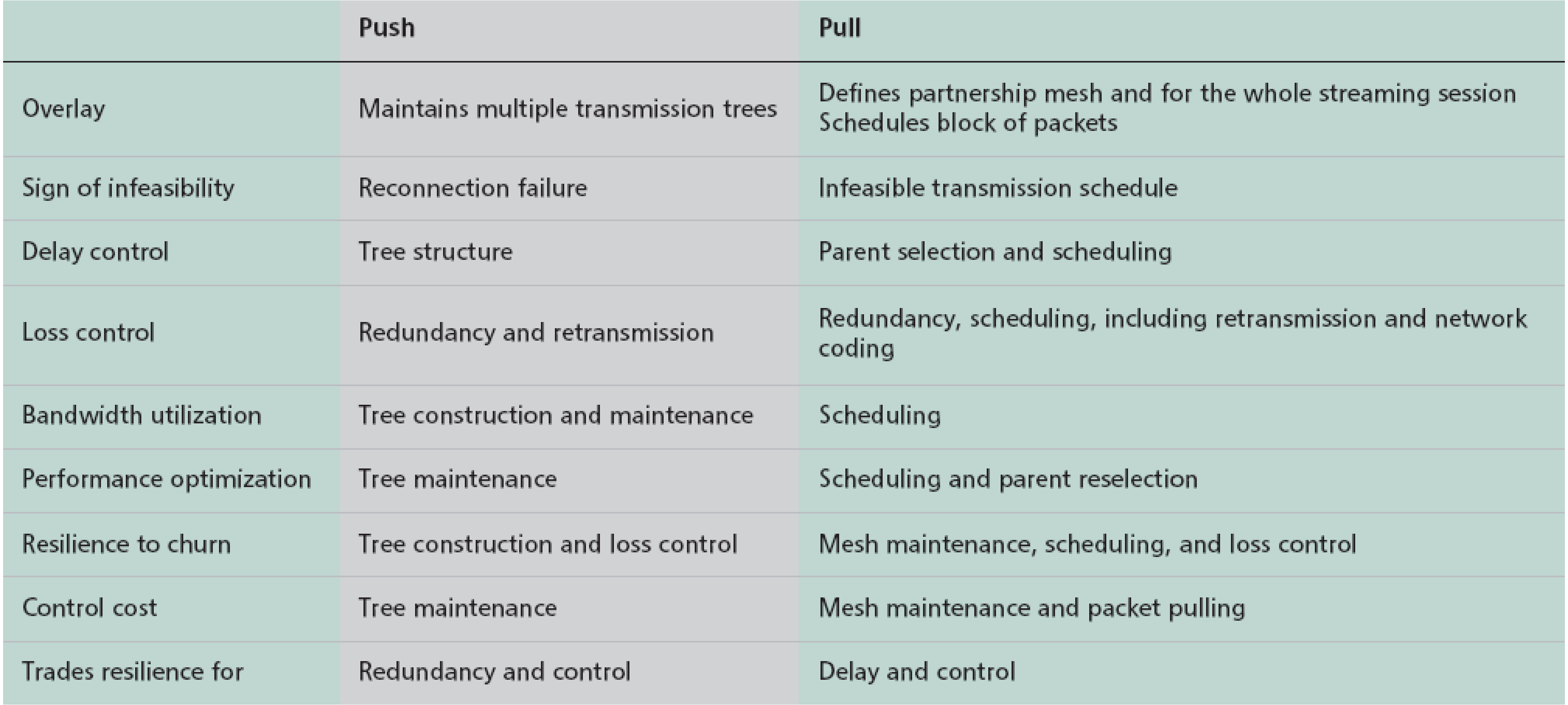
Tree Push Contd..

Stability Issue in Tree-Push

- One proposed Solution: Using multiple trees
  - Media stream is split into 'n' independent streams
  - Each stream is independently decodable
  - Construct distribution tree for every stream

So, instability due to churn can be minimized

Comparison: Tree vs. Mesh



	Push	Pull
Overlay	Maintains multiple transmission trees	Defines partnership mesh and for the whole streaming session Schedules block of packets
Sign of infeasibility	Reconnection failure	Infeasible transmission schedule
Delay control	Tree structure	Parent selection and scheduling
Loss control	Redundancy and retransmission	Redundancy, scheduling, including retransmission and network coding
Bandwidth utilization	Tree construction and maintenance	Scheduling
Performance optimization	Tree maintenance	Scheduling and parent reselection
Resilience to churn	Tree construction and loss control	Mesh maintenance, scheduling, and loss control
Control cost	Tree maintenance	Mesh maintenance and packet pulling
Trades resilience for	Redundancy and control	Delay and control

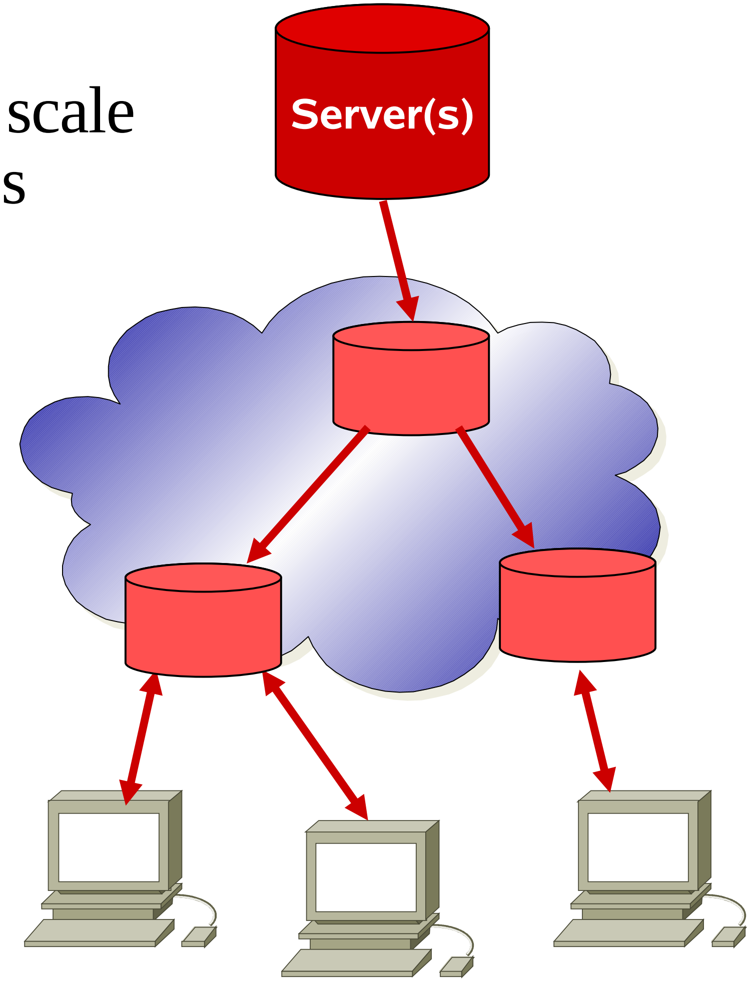
Summary..

- Many real world P2P streaming solutions use Mesh-Pull
- Tree-Pull architecture have largely been in research stage
- For large scale P2P streaming: Many open questions
  - Improving efficiency of the distribution mechanisms
    - Both in network and application perspectives
      - Avoid carrying duplicate traffic in the link
    - Scalability to large number of users
    - Self-Organizing to adapt changing node dynamics (churn)
    - Heterogeneity in user's contributing bandwidth
      - Asymmetric DSL lines
    - Copyrights: DRM issues
    - Firewalls, NAT

CDN based approach

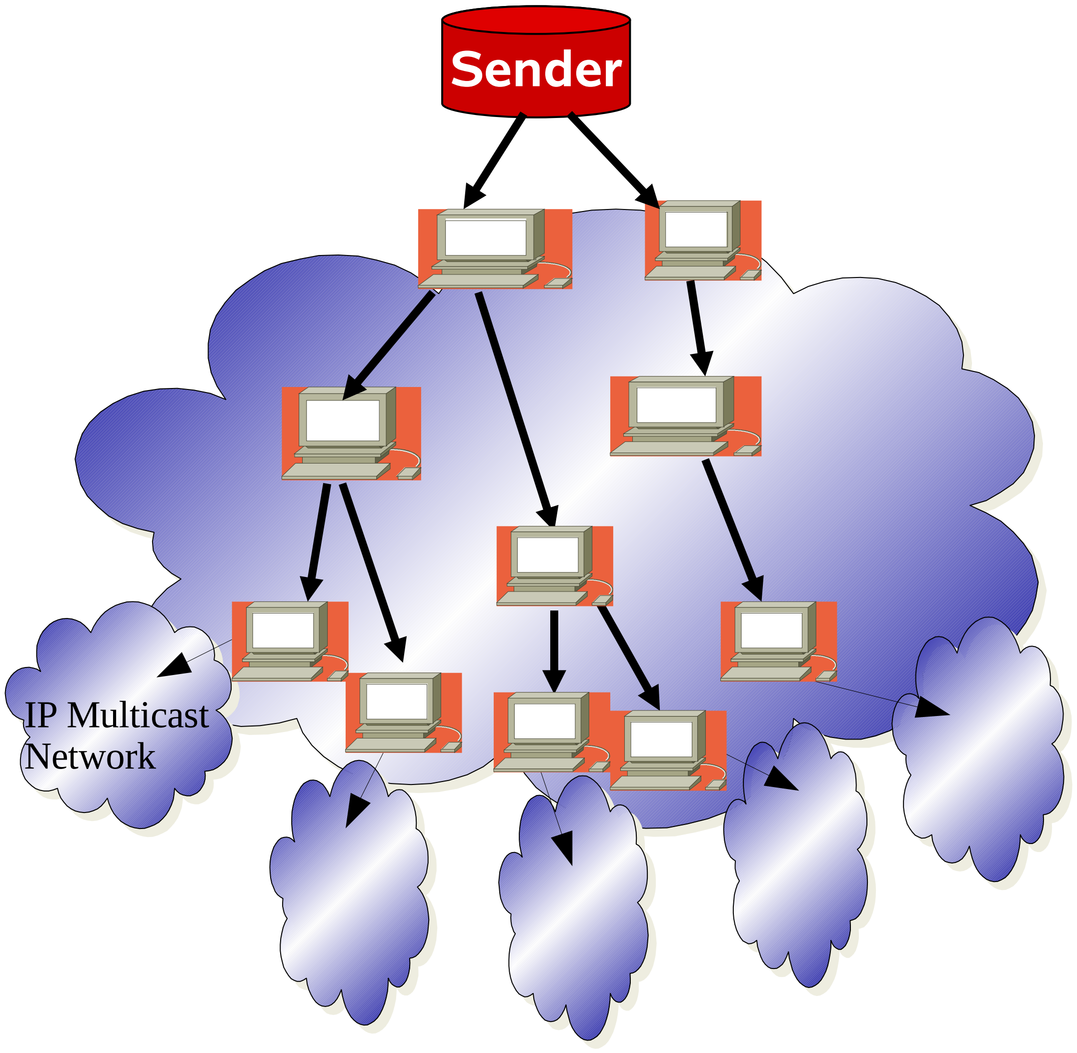
- Not classified under P2P
- Use replication of data by large scale deployment of infrastructure nodes
- Real World Example:

  Akamai Content Distribution Network (CDN)



Active Replication:
Content Distribution Network (CDN)

CDN based approach contd ..
Using CDNs to connect IP Multicast clouds



References & Further reading

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