Overlay Multicast Protocol for Delivering Layered Data Structure

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Introduction

- Internet as a place to present self-produced creations
  - Blog, MySpace, YouTube etc.
- Increasing demand for real-time group communication
  - Rich environment at end use on both creating and distributing high-quality multimedia contents

Supporting creative activity of users
distributing real-time streaming contents
to large group of peoples

LOLCAST:
an adaptive Overlay Multicast protocol for real-time group communication in a heterogeneous environment

Target Environment

- Target user
  - Ordinary Internet User
  - 1. Limitation in computation and network resource
  - 2. Has heterogeneous resource environment for receiving the contents
  - 3. No special equipment or financial support for distributing the contents

  - Both sender and receiver is an ordinary Internet user

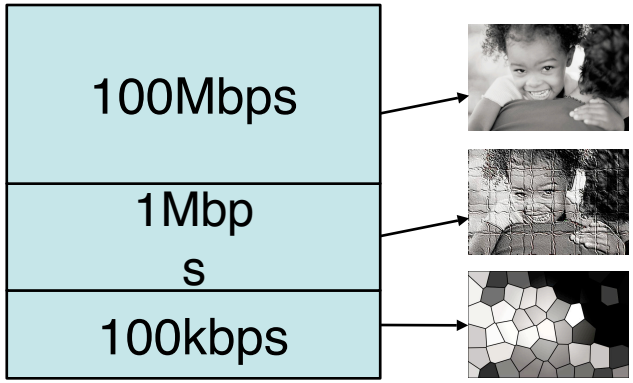
- Target group size
  - Several hundreds

Major Issues in Overlay Multicast Research

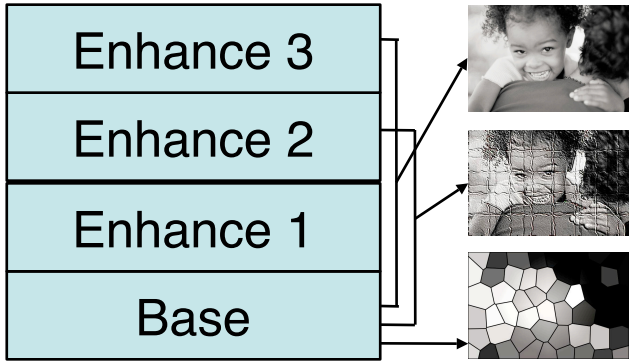
- Recent group communication methods could not support ordinary users
  - Server-client model->high load in first hop link for sender
  - IP Multicast -> issues left for deployment
  - Overlay Multicast (OLM)
- Adapting to end node heterogeneity
  - Resource environment for each node is various
  - Every path condition between each node is different
- Adapting to end node instability
  - OLM relies on network constructed by end nodes
  - Fundamental issue for OLM

Recent approaches to adapt end node heterogeneity

- Multi-version approach (Ottawa Univ. Peng He)
  - Source sends multiple data with different rate containing same information
    - Receiver acquires most suitable data
    - Ex. End System Multicast (CMU)
  - Bandwidth Efficiency ↘
- Multi-layer approach
  - Source sends layered coded data which consists from multiple non-overlapped data
    - Quality increases by number of layer
    - Receiver acquire suited number of layers
    - Ex. Okada's work (Waseda Univ), Koguchi's work (Waseda Univ), LION, PALS, etc.
  - CPU Resource Efficiency ↘
  - Protocol will be format dependent
- Both Approaches only supports video data



Multi-version data structure



Multi-layer data structure

Recent approaches to adapt end node instability

- Two approaches taken (Univ. of Kentucky)
- Reactive Approach
  - Starts recovery process after the node detects node failure
  - Basically runs join procedure again which requires long time
- Proactive Approach
  - Deal with node failure before it happens
  - Pre-calculate new parent node (Yang's work)
  - Redundant path in control topology (HostCast)
  - Randomized data forwarding (PRM)

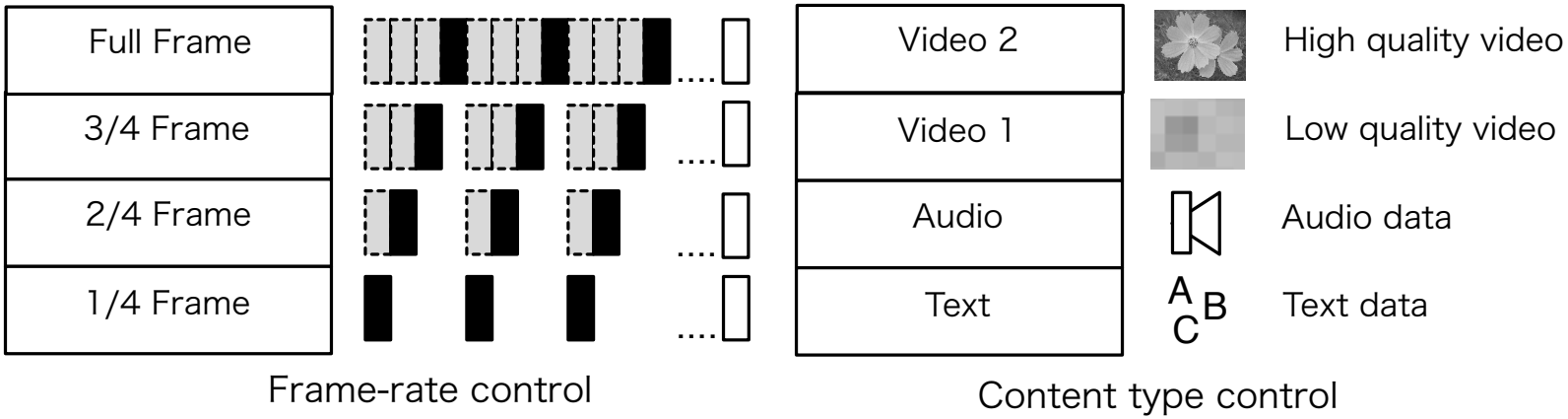
- However there is fundamental recovery time
  - Convergence time in control topology
  - Time for requesting to start sending the data to parent
- In addition no support for avoiding congestion

Approach

- LOLCAST: Abstract Layered Overlay Multicast
  - Adaptive OLM protocol in a heterogeneous environment for group communication such as real-time video streaming
- Adapting to end node heterogeneity
  - Abstract data structure
    - Simple layered data structure for various type of contents
- Adapting to end node instability
  - Multi-path layer distribution
    - multiple data sending path for sending base layer redundantly
    - using the characteristics of layered data
  - Congestion Avoidance
    - decreasing the number of layer receiving in case of network congestion
    - using the characteristics of layered data

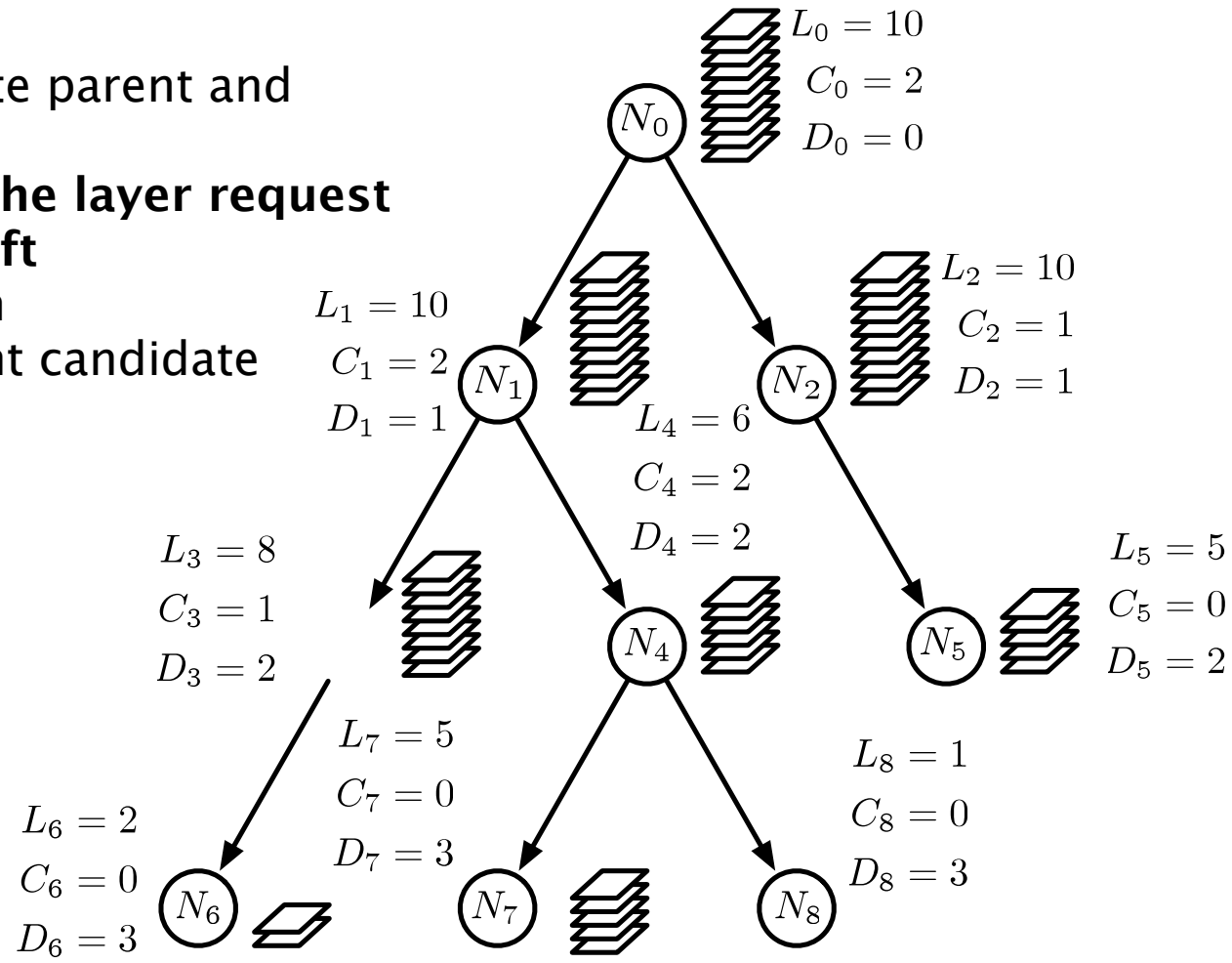
Abstract Layered Data

- **Combining various type of data abstractly**
- Data consist of multiple layer with three parameters
  - type, bandwidth and dependency
- Supported data types
  - Multi-version data
  - Layered coded data
    - MDC (Multiple description coding)
  - Data with combined data type (Text, Audio, Video)
  - Frame-rate controlling data
  - or combining each above

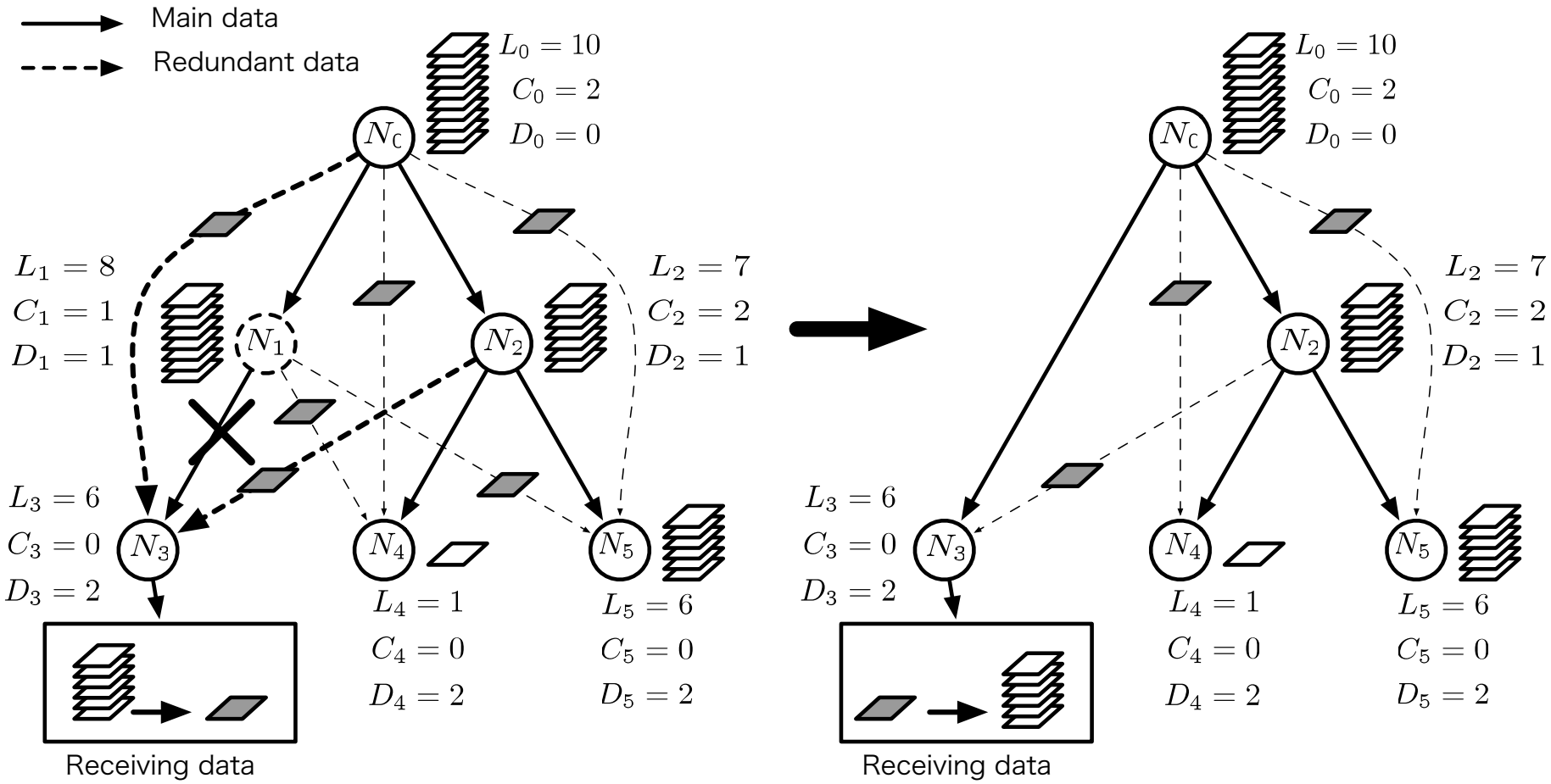


Tree Construction

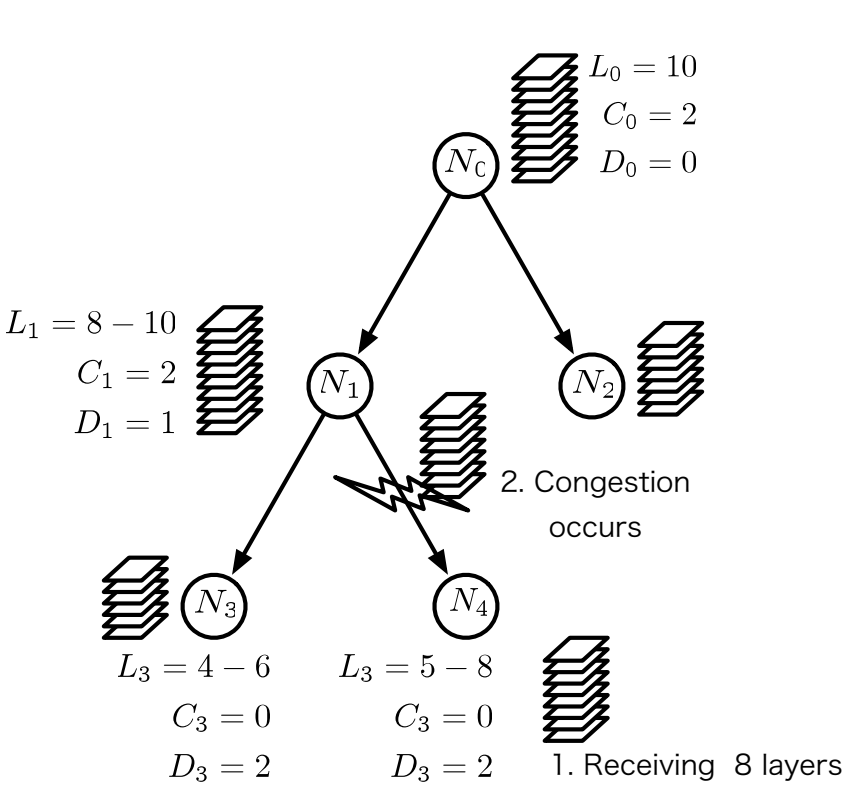
Source node maintains the tree structure
1. Node asks source for parent
2. Source search for appropriate parent and returns parent candidate list
   - **Has equals to or near to the layer request**
   - **Has enough bandwidth left**
   - **Above all sorted by depth**
3. Node try to join to the parent candidate

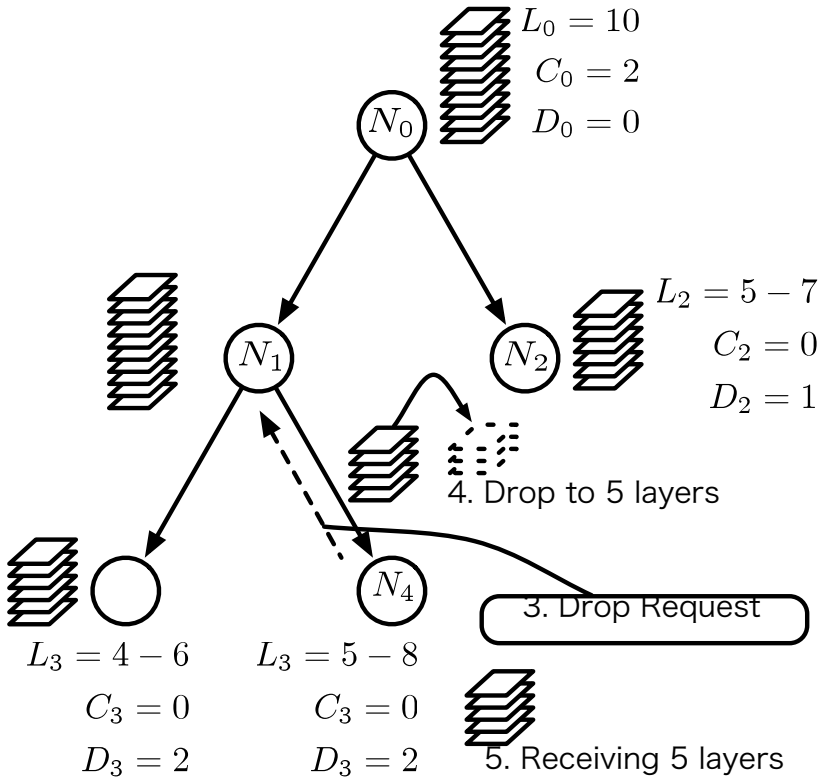


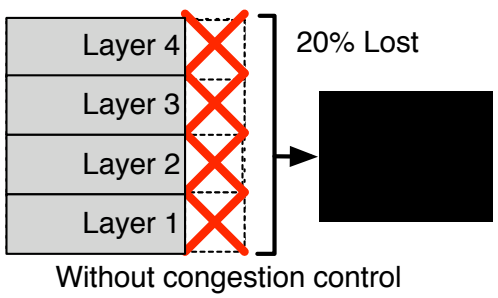
Multi-path layer distribution method

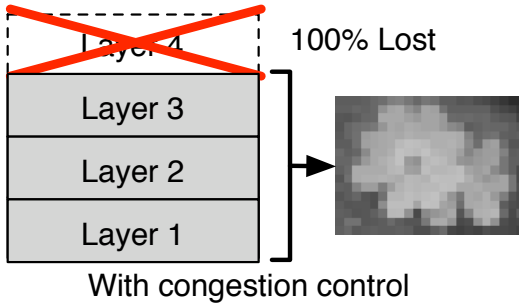


Congestion avoidance method









Functional Comparison

	Node Heterogeneity	Tree and Node Instability
LOLCAST	Abstract Layered Data	Congestion control Multi-path layer distribution
Narada (CMU)	Multi-version approach	Reactive Approach
Okada's work (Waseda Univ.)	Multi-layer approach	Proactive Approach (Backup parent candidates)
Koguchi's work (Waseda Univ.)	Multi-layer approach	Reactive Approach
HostCast (Univ. of Calfornia)	None	Proactive Approach (Redundant data sending path)
PRM (Univ. of Maryland)	None	Proactive Approach (Randomized data forwarding)
Yang's work (Univ. of Kentucky)	None	Proactive Approach (Pre-calculate backup node)

Conclusion

- Proposed LOLCAST to solve two issues in Overlay Multicast research
- LOLCAST proposed with three major functions
  - 1. OLM Protocol for sending Abstract Layered Data
  - 2. Multi-path layer distribution method to adapt instability
  - 3. Congestion avoidance method to adapt instability
- Future work
  - Evaluating the effectiveness of our protocol
    - Backup node selection in multi-pat layer distribution
    - Amount of data saved by using congestion avoidance