Bandwidth Fair Application Layer Multicast for Multi-party Video Conference Application

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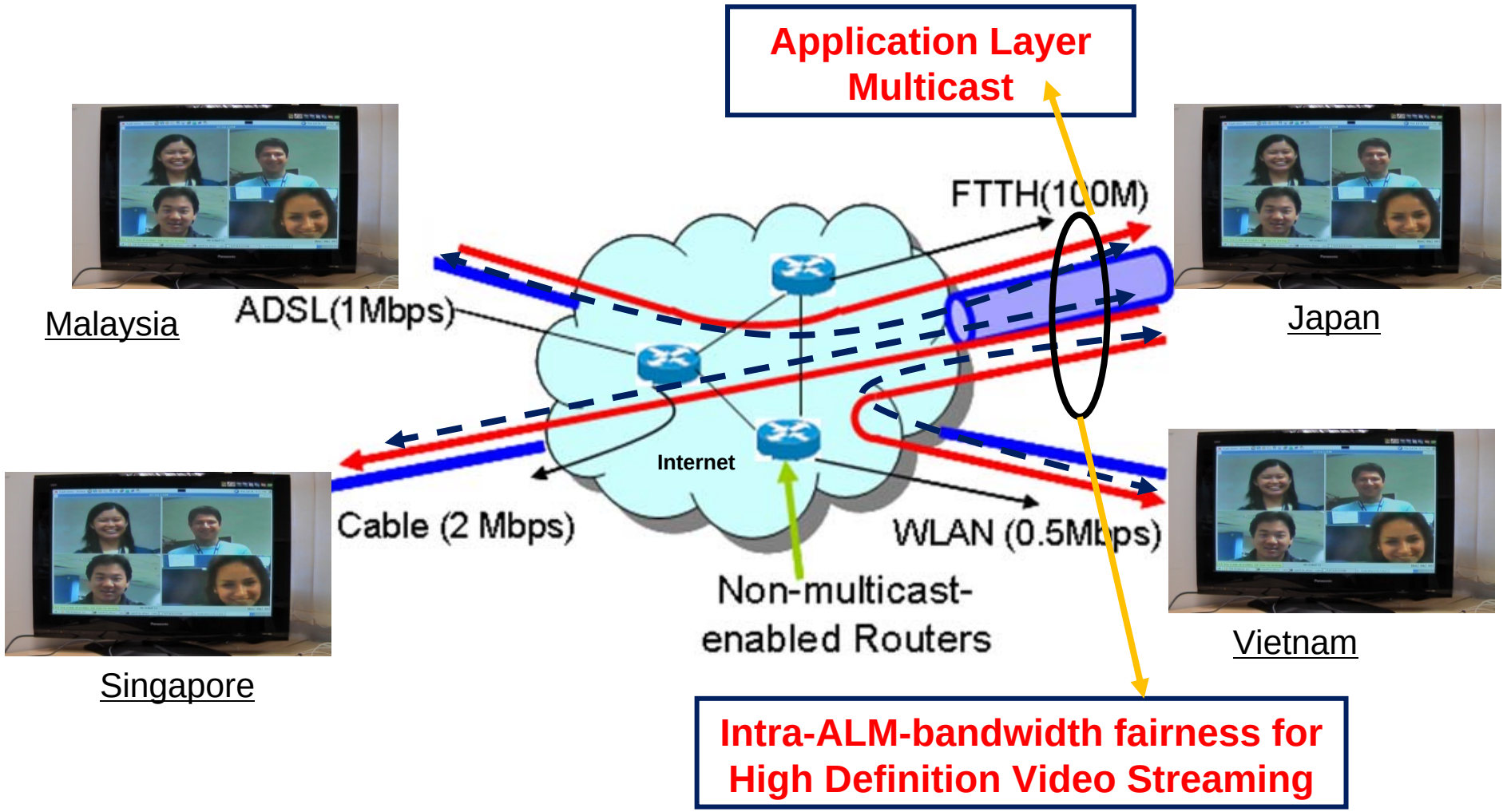
Outline

- Bandwidth Fair Application Layer Multicast
  - Comparison between MST vs. N-Tree
- ALMCast
  - Design & Implementation
- Related Work
- Conclusion
- Future Work

Vision & Target

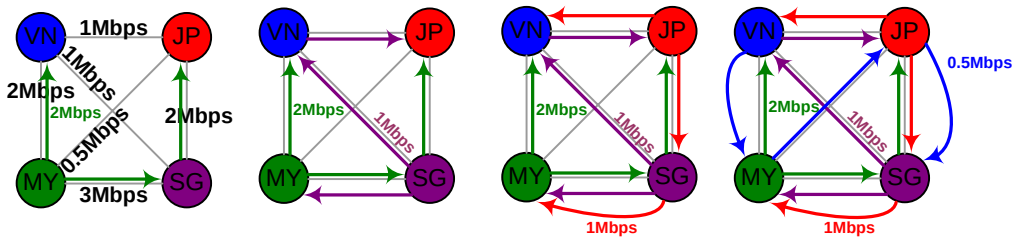
Multipoint small group communication over the internet

eg. SOHO business, remote office communication



Prim-MST vs. N-Tree Construction

Prim-MST based tree construction



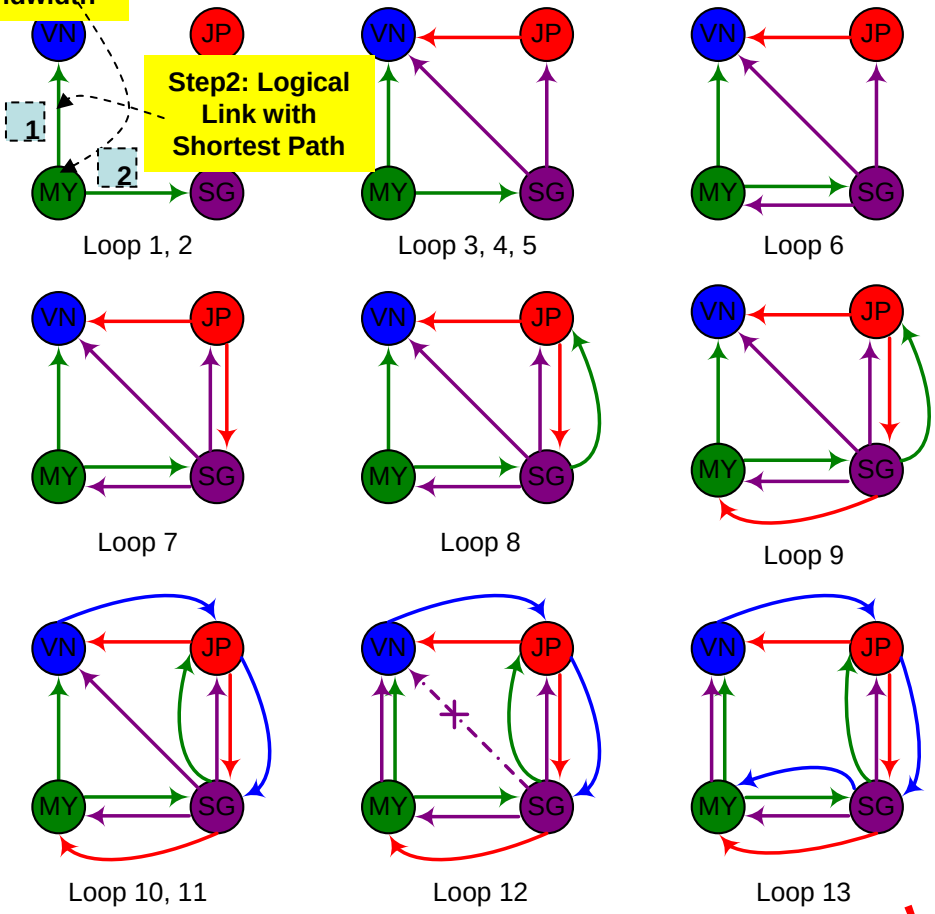
MY Stream – 2 Mbps
SG & JP Stream – 1 Mbps
VN Stream – 512 Kbps

Non-Bandwidth Fair!

Bandwidth Fair N-tree construction

Step1: Node with Largest upload bandwidth

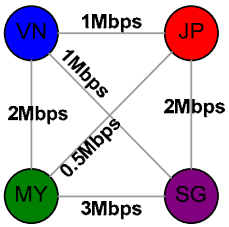
Step2: Logical Link with Shortest Path



MY Stream – 1 Mbps
SG & JP Stream – 1 Mbps
VN Stream – 1 Mbps

Bandwidth Fair!

Link:



Upload:

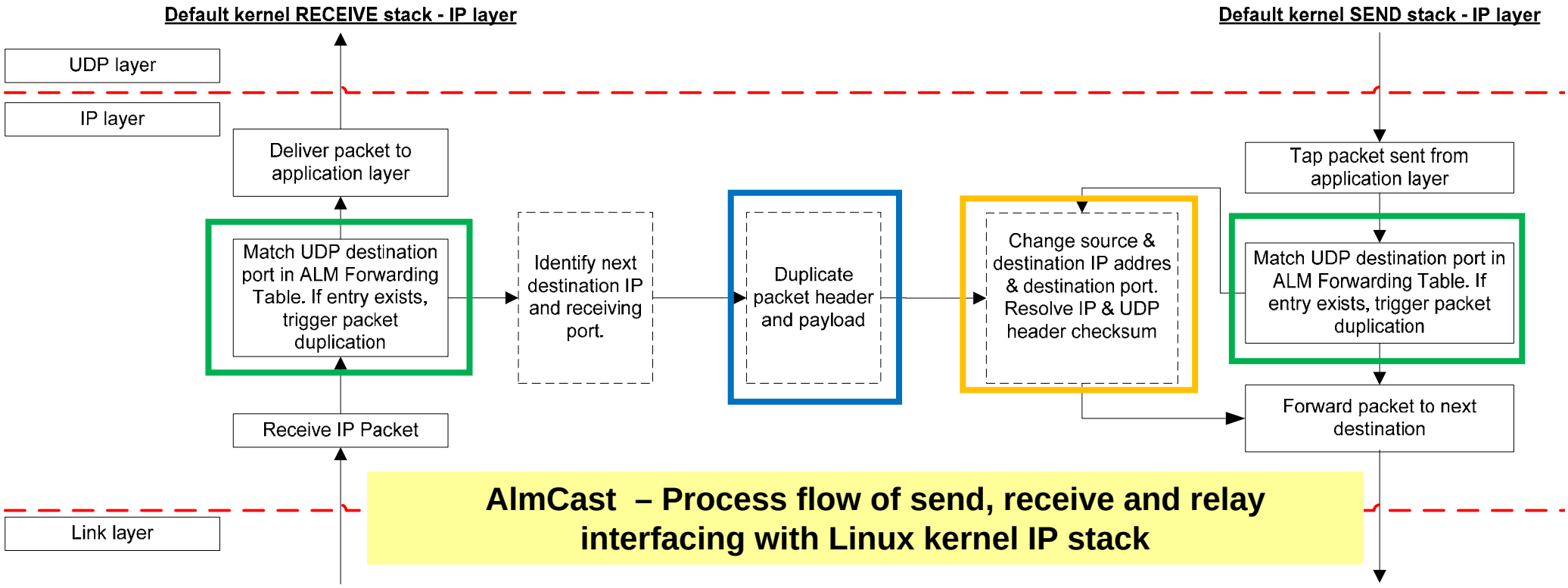
B(VN) = 2Mbps
B(JP) = 4Mbps
B(SG) = 5Mbps
B(MY) = 9Mbps

Delay:

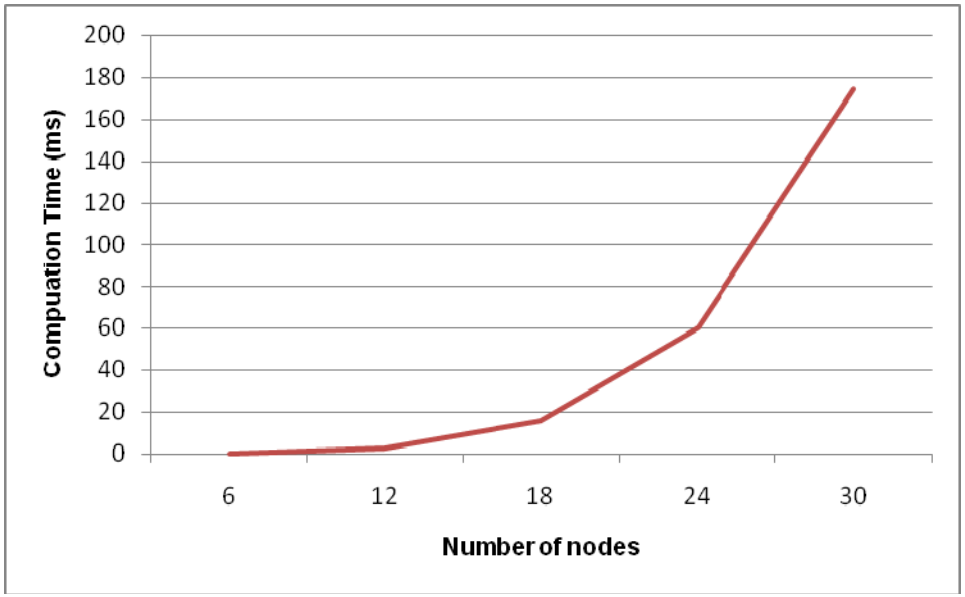
MAX_LATENCY: D = 250ms
D(VN,JP) = D(VN, SG) = D(VN,MY) = 50ms
D(JP,SG) = 70ms
D(SG,MY) = 100ms
D(MY,JP) = 300ms

ALMCast

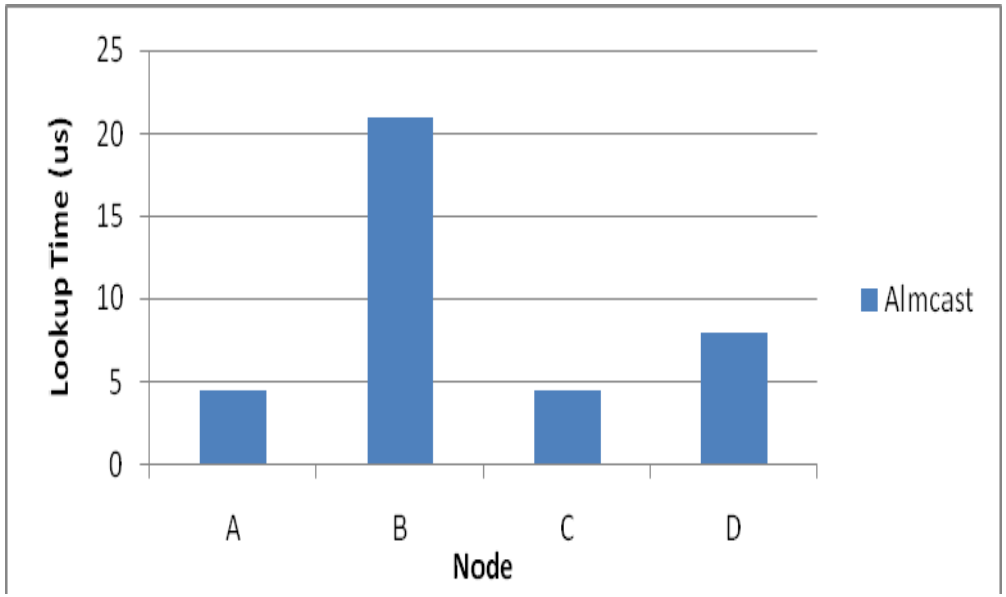
- Kernel-based data replication & forwarding.



Experimental Result



N-Tree computation time



Route lookup delay for Almcast packet delivery

- N-Tree is targeted for small group video conferencing application with number of participants less than 12 nodes,
- 0.27ms for 6 nodes* and 2.5ms for 12 nodes* shall provide on time tree re-computation for fast route convergence.
- Average lookup and forwarding time for Almcast are around 20-21us at node B and less than 7us for node A, C and D*.

***PCs of Pentium IV 1.8GHz with 512MB memory**

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Ideas for life

Feature of Bandwidth Fair N-Tree

This proposal achieves

- *N* source trees building concurrently in an *N* participant session.
- acceptable perceived AV quality with equal bandwidth slot allocation to all sources, a crucial feature for high-definition video streaming
- Kernel-based high speed data replication and forwarding for ALM

Related Work

- Most current art DO NOT ensures optimum bandwidth allocation and utilization in multiple source based trees scenario.
- Prim-MST
  - bias towards shortest delay path
  - builds source-based tree in sequence
- ALMI
  - a single N source tree based on minimal delay incurring high link stress on shared path

Conclusion

- We have designed and implemented N-Tree algorithm & Almcast with modified IP stack in Linux Kernel 2.6.11.12 to
  - demonstrate the basic principles of N-Tree algorithm
  - proved kernel-based packet replication and delivery for small group AV communication is possible.

- Bandwidth Fair N-Tree algorithm is suitable for AV conferencing applications where
  - small group of participants exchange AV stream
  - high degree of interactivity exist
  - better AV quality throughout the session over the internet.

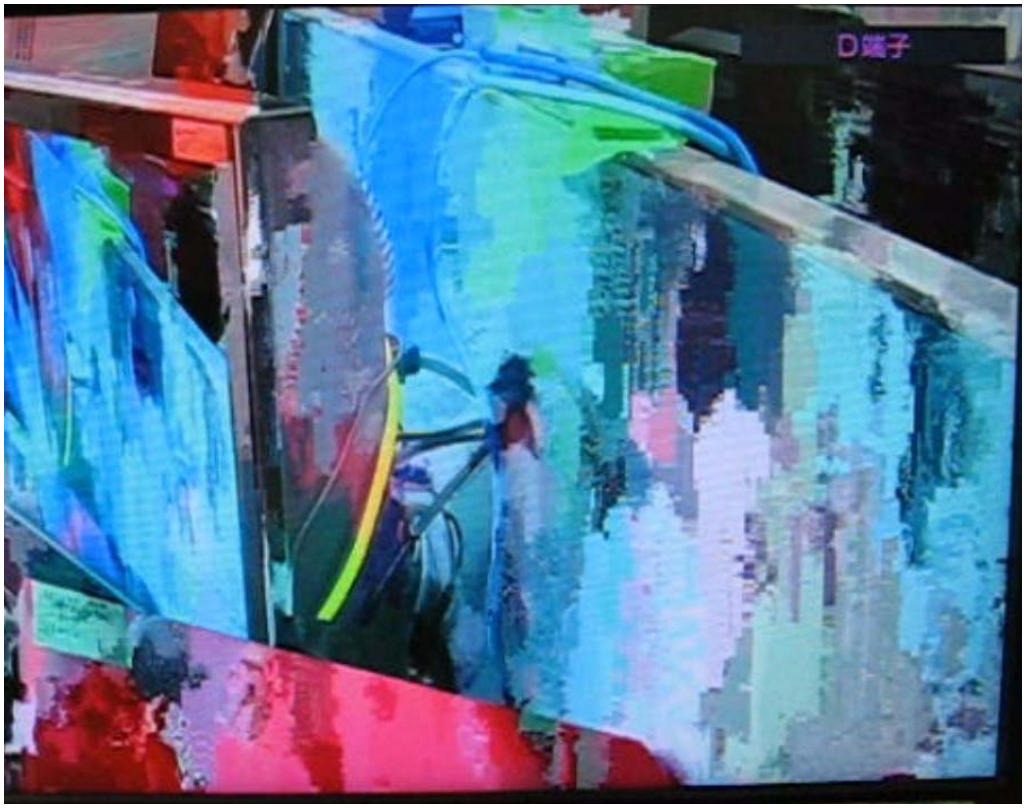
Future Work

- Large-scale distributed deployment
  - Dynamic member join/leave with distributed tree construction in 100-1000 nodes clusters.
  - Test bed with participants spanning across different regions (Japan/Malaysia/Singapore/Vietnam etc) for ALM-based video conferencing.

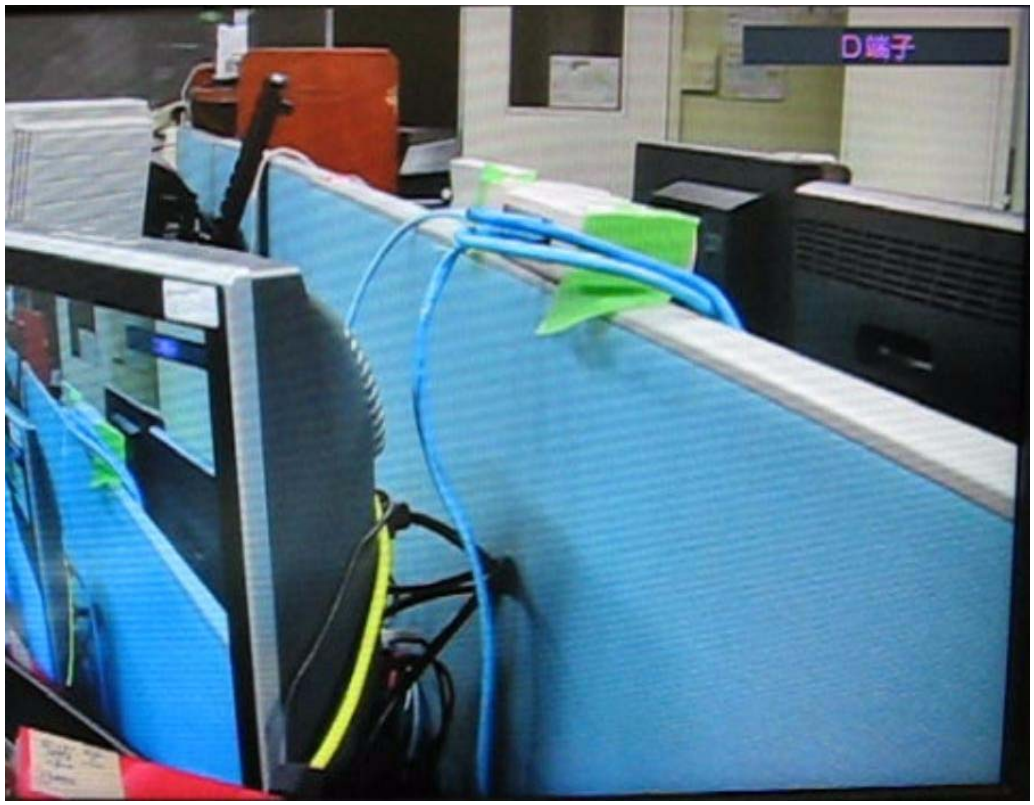
- Near-Zero loss rate, fast route convergence
  - Ensure short tree calculation time upon membership change and network condition change
  - Ensure video quality with near-zero loss rate upon route convergence.

Thank You

Why Bandwidth is important for HD Video Quality?



Shortest Delay Prim-MST based approach – Sending high bitrate video resulting in High Video Loss Rate



Bandwidth Fair N-tree approach – Best perceived video quality 3Mbps

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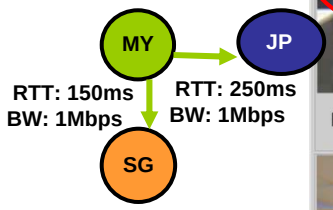
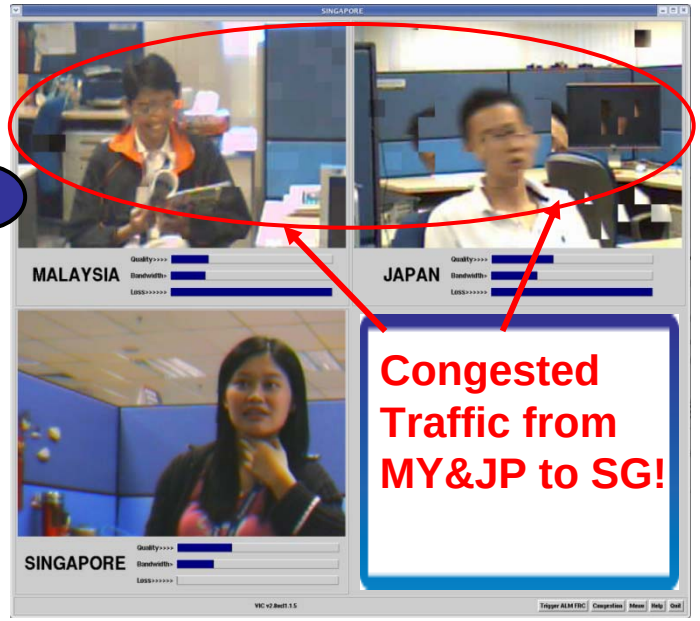
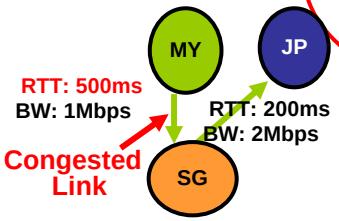
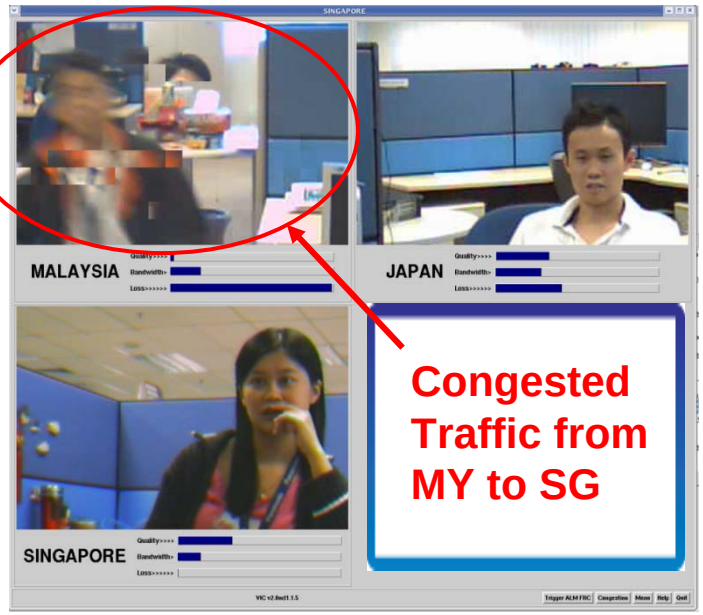
Congestion Avoidance



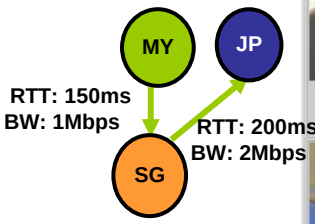


(1) Without ALM
<Legacy System>

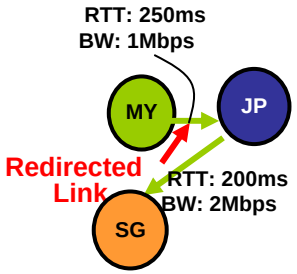


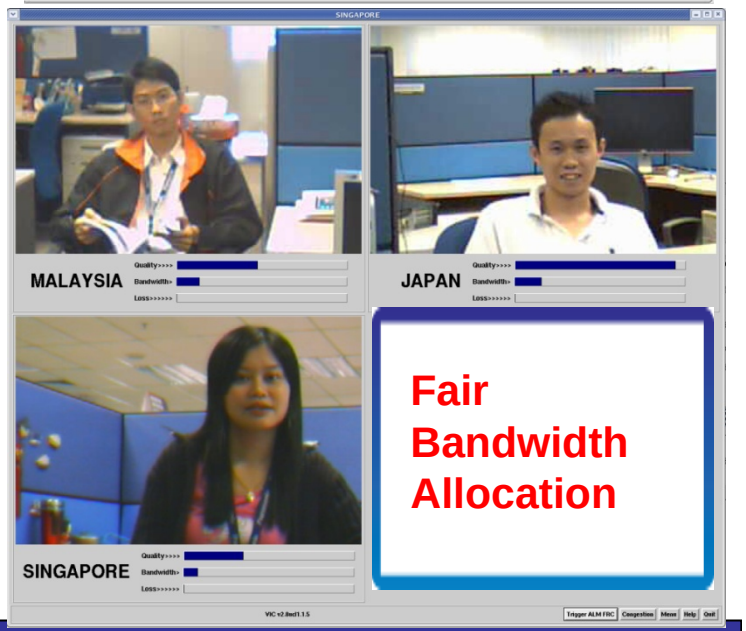


(3) Network Congestion



(2) With ALM





(4) Congestion Avoidance