Large Scale Multicast over UDL

Asian Institute of Technology

Satellite network & IP

- Wide Area Coverage
- Broadcast & High Bandwidth
- One-way communication channel
- Strengthen the broadcasting property
- Minimum bandwidth consumption

Multicast Loss on Satellite UDL Study

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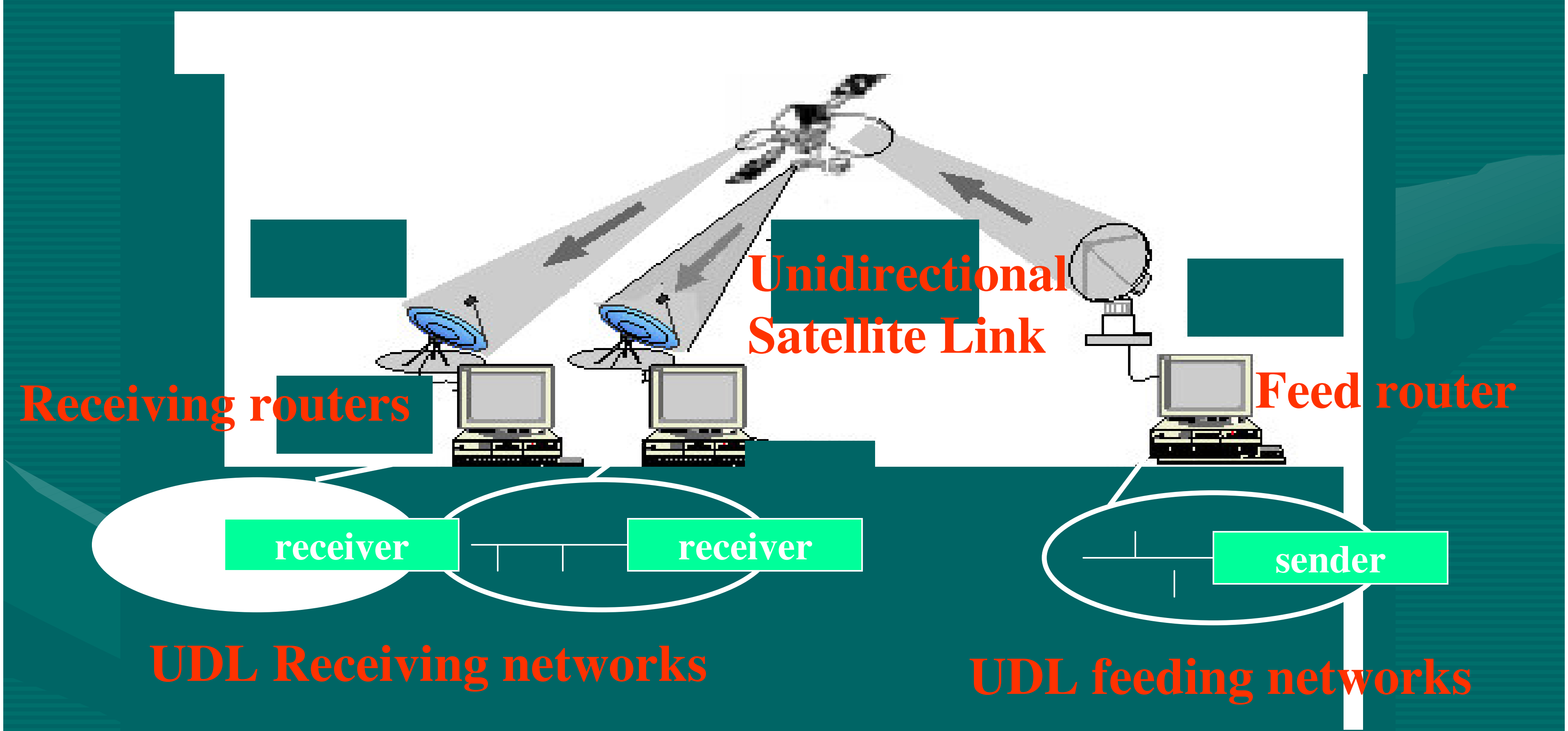
Objectives

- Study loss pattern of receivers which shares same UDL link
  - Does they share same loss? How much percentage?
  - Where loss happen? Satellite link or end systems?

AI3 UDL Testbed

- Asian Internet Interconnection Initiatives project (www.ai3.net), WIDE project
- 9.6 Mbps C band satellite link
- FEC ¾ at link layer
- Feeder at Japan
- Receivers at Thailand, Indonesia, Myanmar, Vietnam, Philippine, Malaysia, Lao

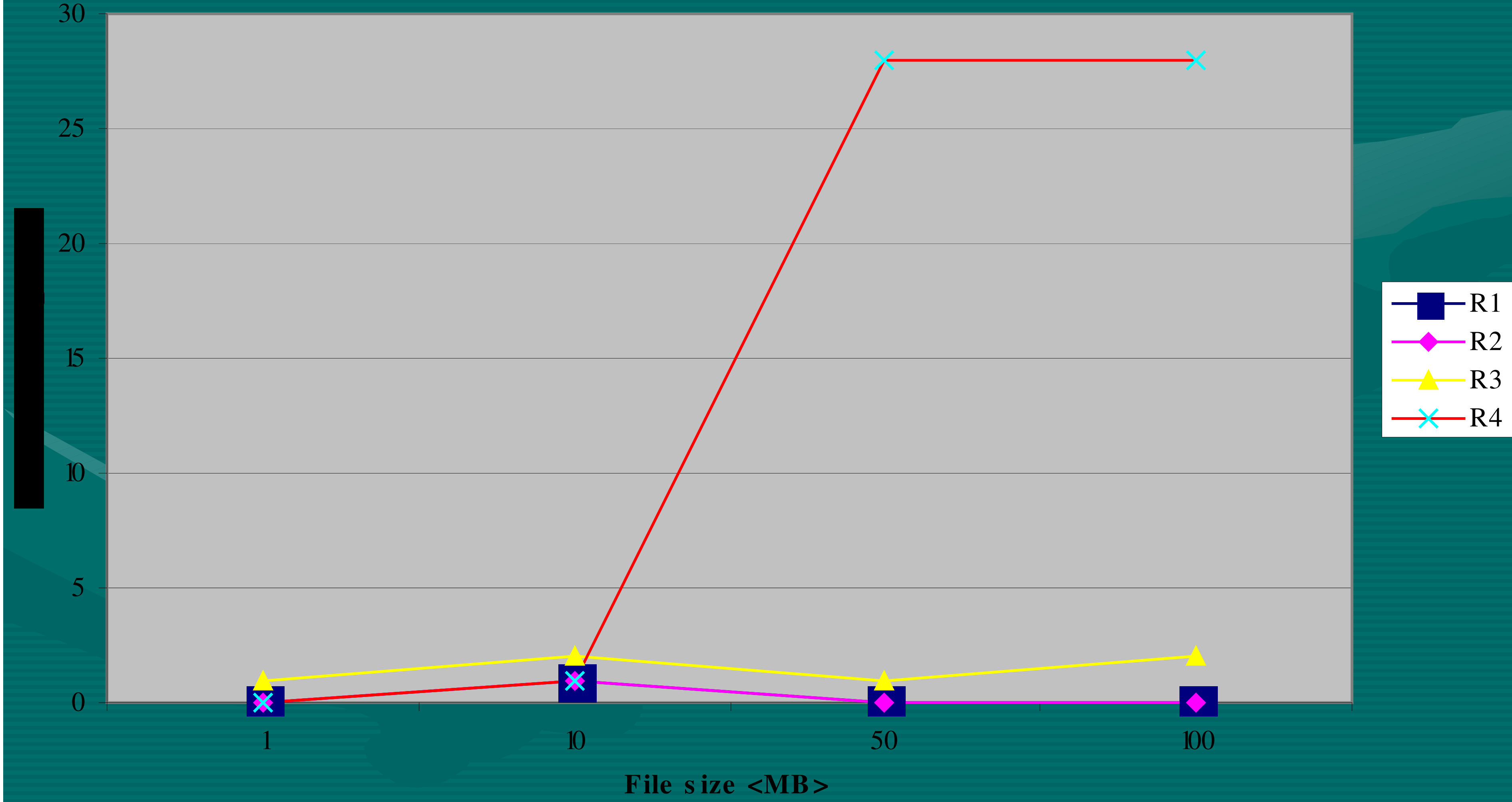
Experiment Network



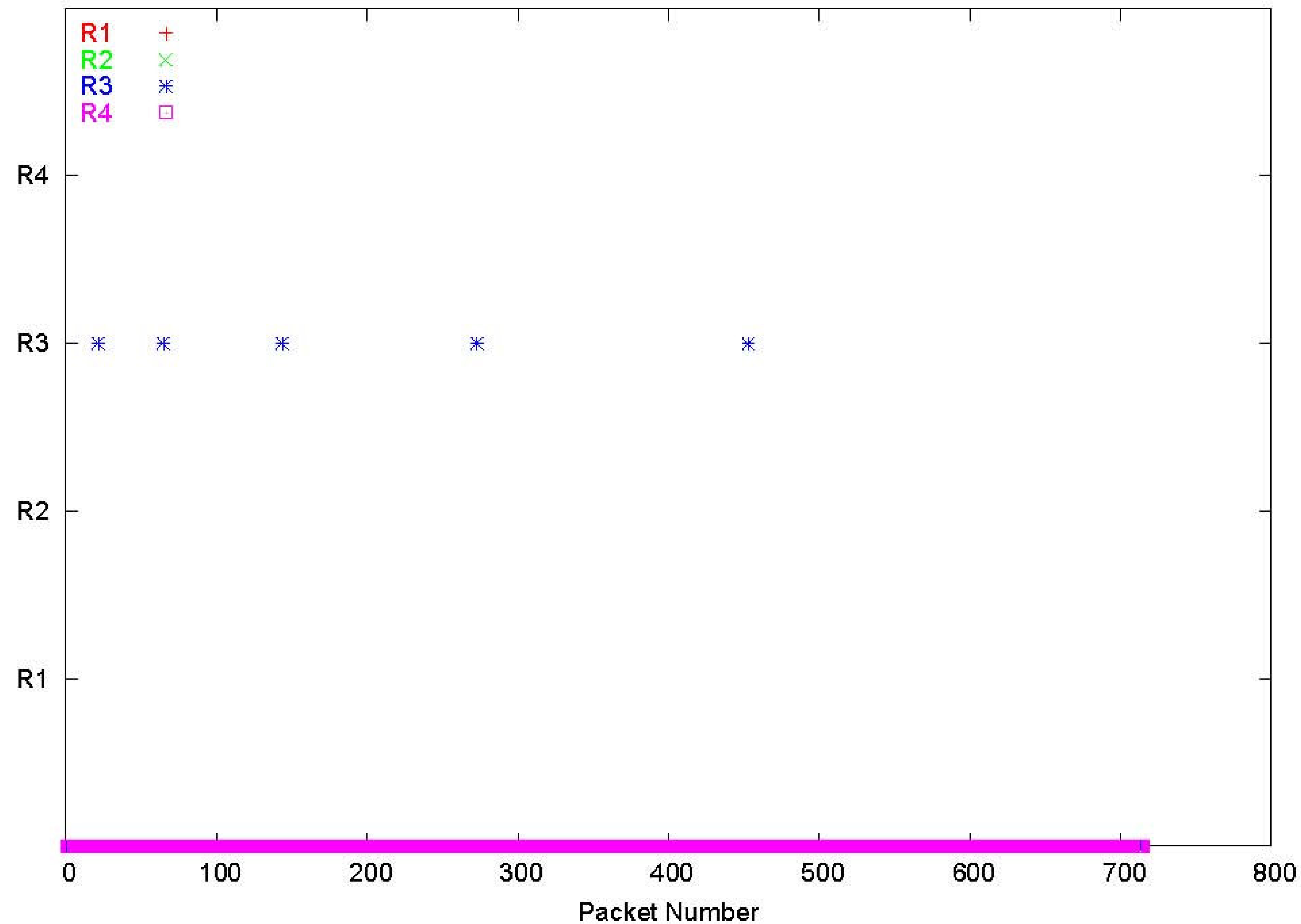
Experiment Environment

- One Multicast sender at Japan
- 4 receivers <R1, R2, R3, R4> are in different UDL sites<1 in Thailand, 2 in Indonesia, 1 in Malaysia >.
- Link Usage ~ 7Mbps
- 1 Mbps steady Sending Rate
- 4 file sizes <1,10,50,100 MB>

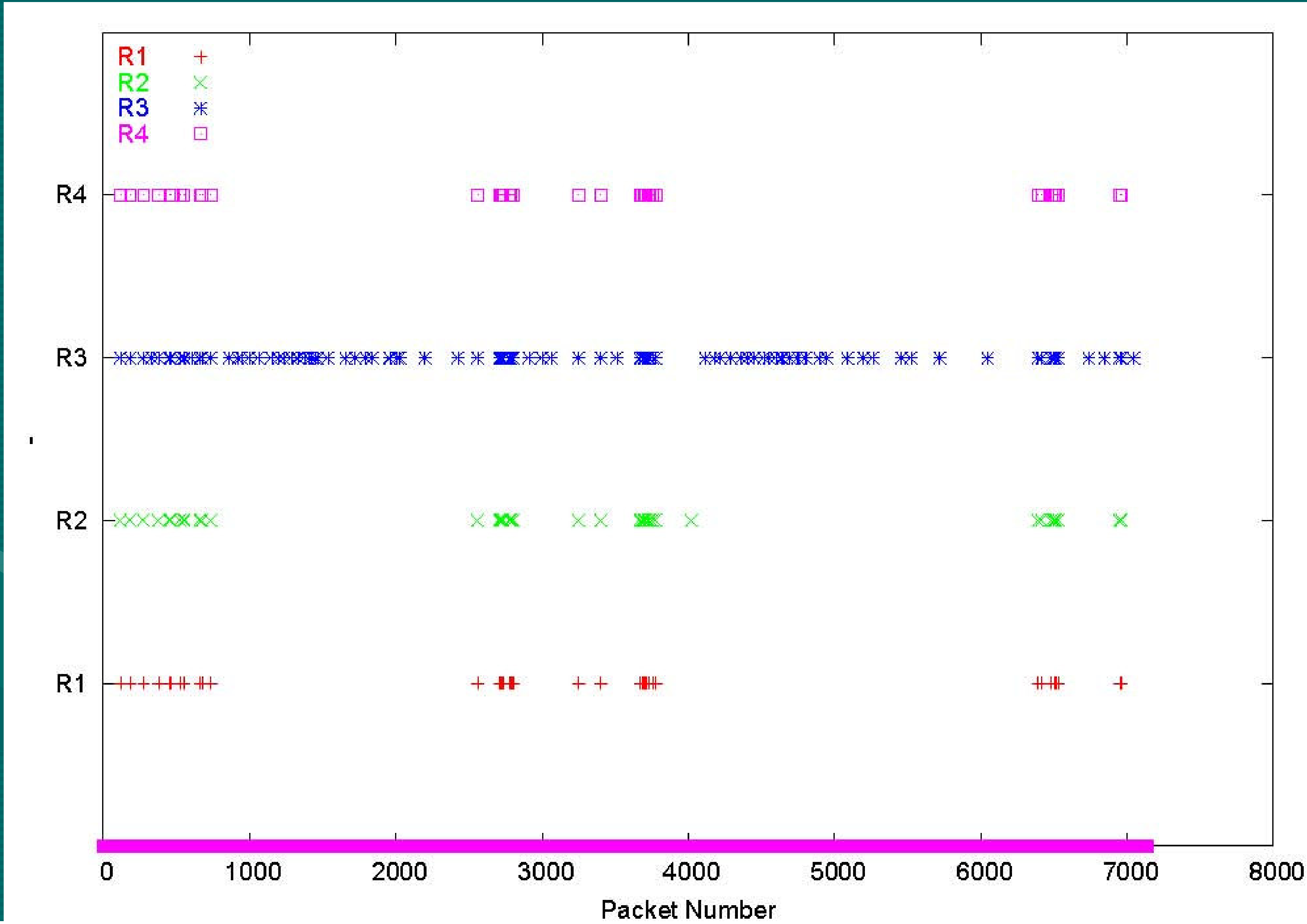
Loss Percentage



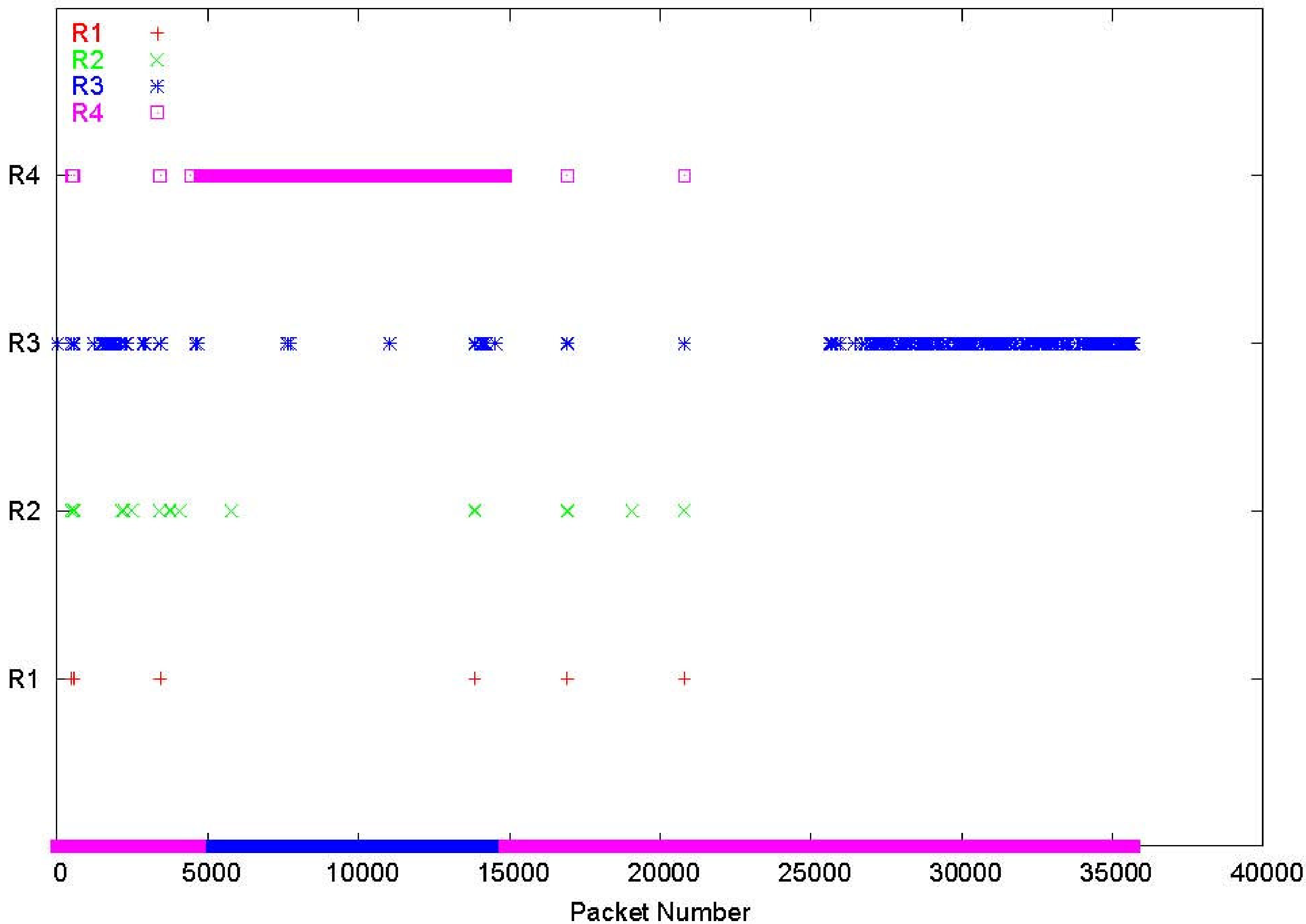
Loss pattern <file size = 1 M>



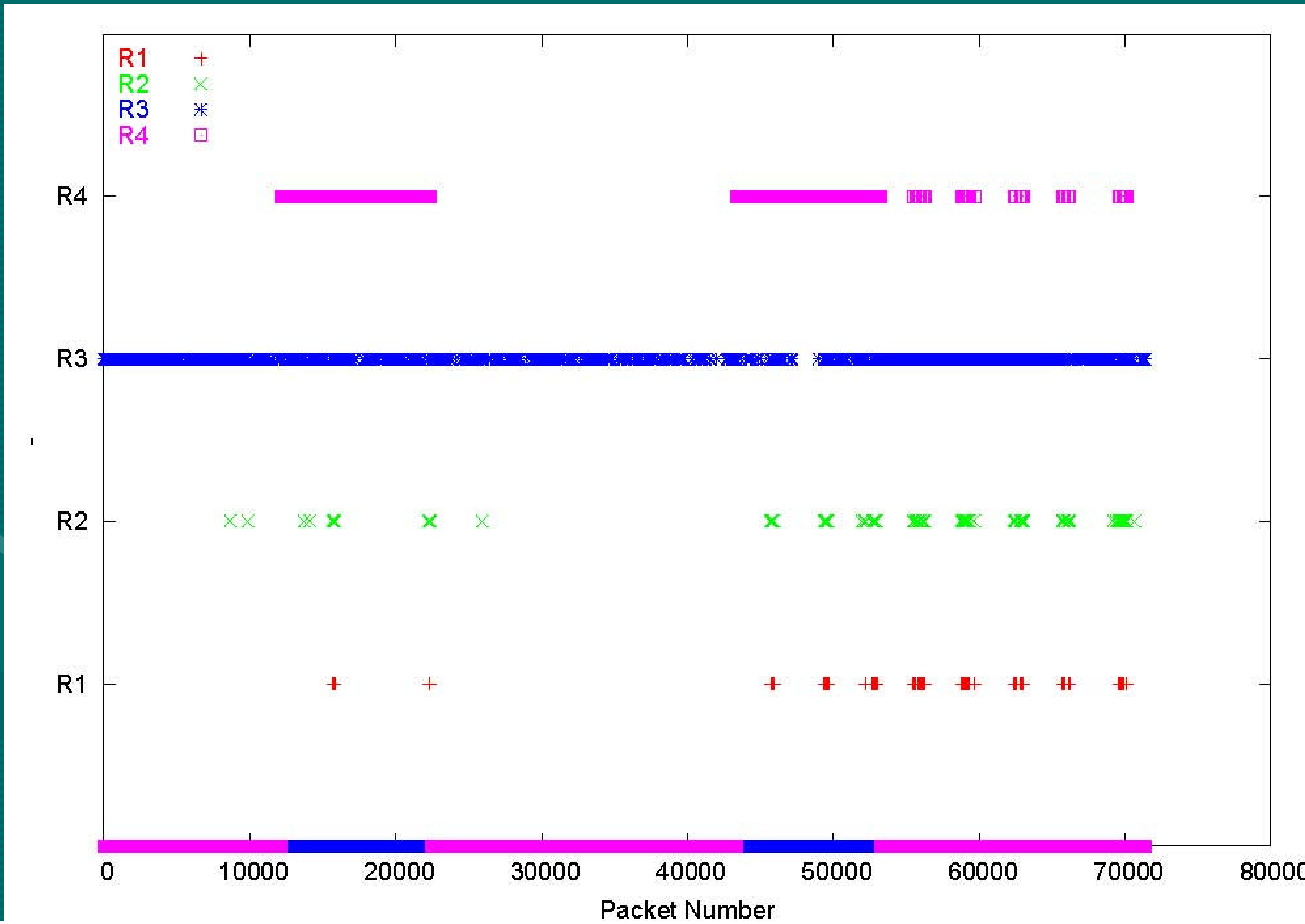
Loss pattern <file size = 10 M>



Loss pattern <file size = 50 M>



Loss pattern <file size = 100 M>



Loss sharing

Number of receivers shared loss	1 M	10 M	50 M	100 M
1 <not shared>	100%	56.6%	99.8%	98%
2	0%	0%	0.1%	1%
3	0%	0%	0%	0%
4	0%	43.3%	0.1%	1%

Conclusion

- Receivers do not have same loss pattern
- Low percentage of shared loss
- Most losses happen on end-systems
  - Low signal
  - Bad network equipments
  - Power outage
- Reliable multicast which works to correct losses on end system is needed.

Loss burstiness study

- Burstiness of satellite link
  - Physical layer, link layer
  - FEC at link layer
- Burstiness at network layer
  - Error correction at lower layer
  - Router’s queue management <droptail, RED>

Testbed – 3 channels

Experiment Environment

- 3 satellite links
  - 2 KU links(1.5Mbps. 0.5 Mbps)
  - 1 C links (6 Mbps)
- Send/receive between routers
- 10,000 packets each hour, sending rate of 10 packets per second.
- 60 hours

Burstiness Frequency

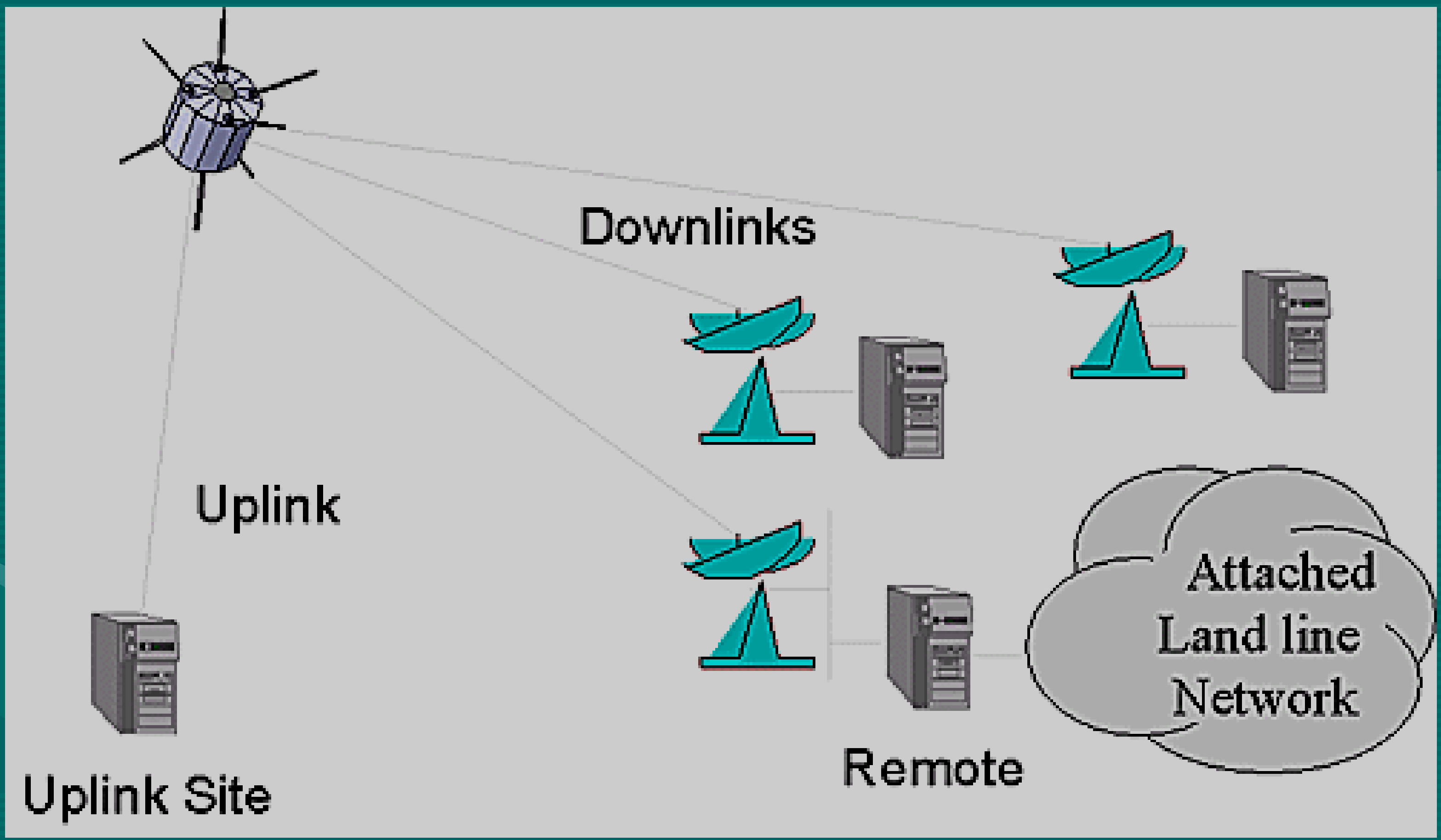
Bursty – Loss length >=2 consecutive packets

	by frequency
C	14.29%
KU#1	28.09%
KU#2	18.90%

Conclusion

- Most losses are not bursty
  - Implies congestion loss
- Congestion control is needed

Unidirectional Link (UDL)



UDL Characteristics

- Available for remote geographical area
- No return path
  - sender can not get any acknowledgement from the receivers.
- Communication signal may be dropped due to the atmospheric condition

Data Dissemination Techniques

Data Dissemination Techniques

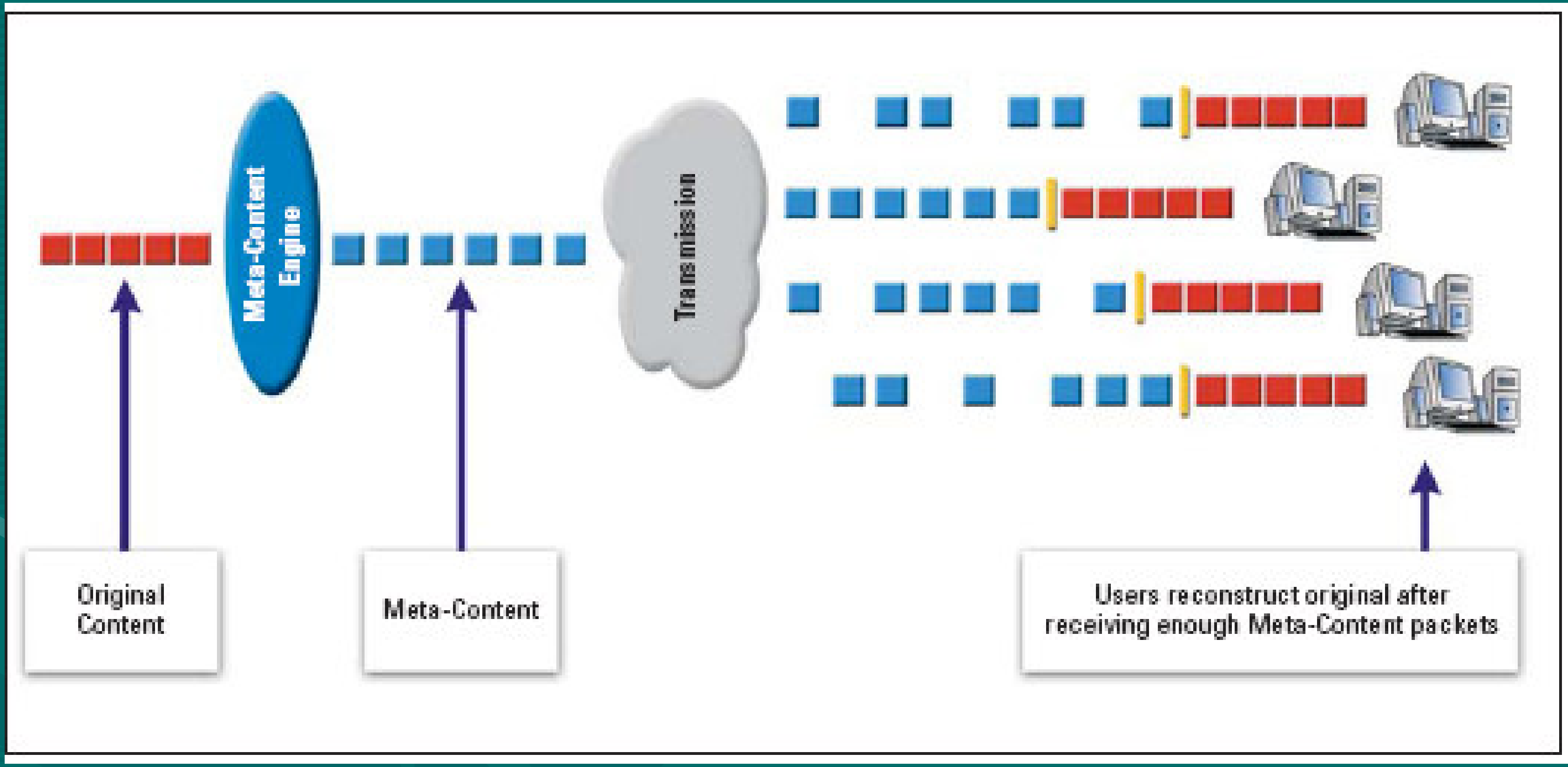
- Digital Fountain
  - J. Byers, M. Luby, M. Mitzenmacher, A. Rege. A Digital Fountain Approach to Reliable Distribution of Bulk Data, *Computer Communication Review*, *a publication of ACM SIGCOMM*, February 1998.
- Broadcast Disk
  - S. Acharya, R. Alonso, M. Franklin, S. Zdonik. Broadcast Disks: Data Management for Asymmetric Communication Environments. *Proceedings of the ACM SIGMOD Conference, San Jose, CA*, 1994.

Digital Fountain

Digital Fountain

- Derived from idea of FEC
- Using concept of Meta-Content
- Different from FEC in term of “No redundant data”
- Any meta-content that equal to original data can be reconstructed

Digital Fountain



Meta-Content

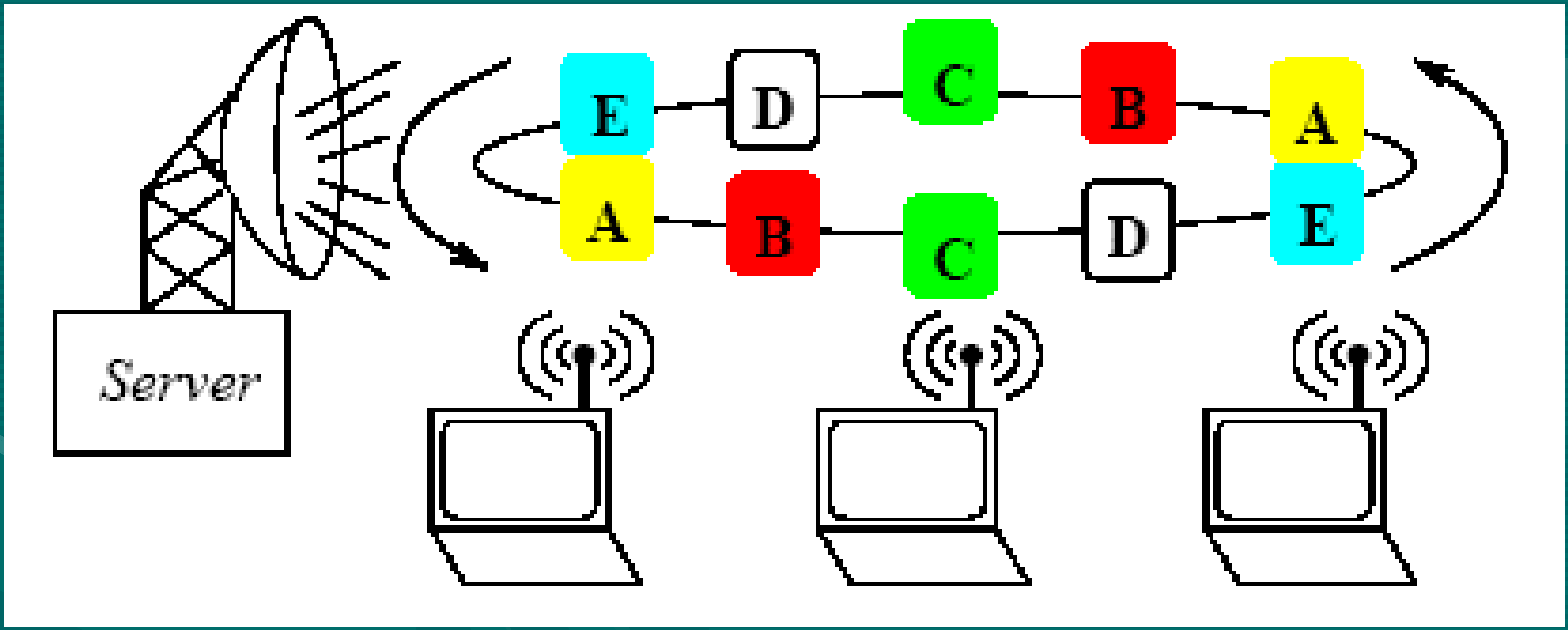
- Packets are independently generated from content at any specified rate.
- A bit-for-bit accurate copy of the original content is quickly recovered from any number of Meta-Content packets that in aggregate is equal to the length of the original content

Broadcast Disk

Broadcast Disk

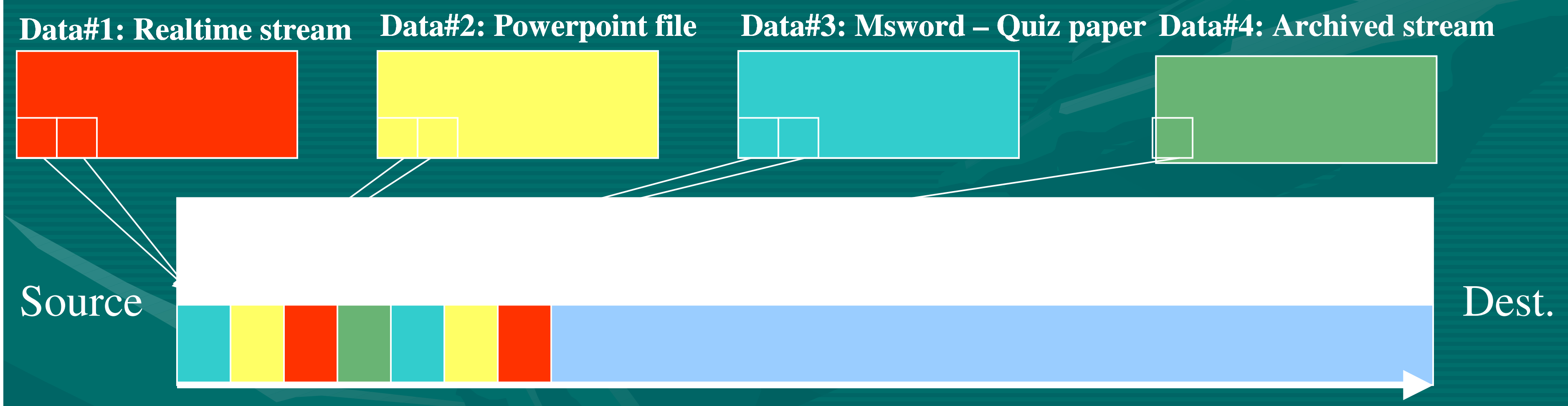
- Proposed in 1994
- Represented each data as “Disk”
- Multiplexed all data into the same link
- Periodic data broadcasting with priority
- Higher priority data get the higher bandwidth

Broadcast Disk



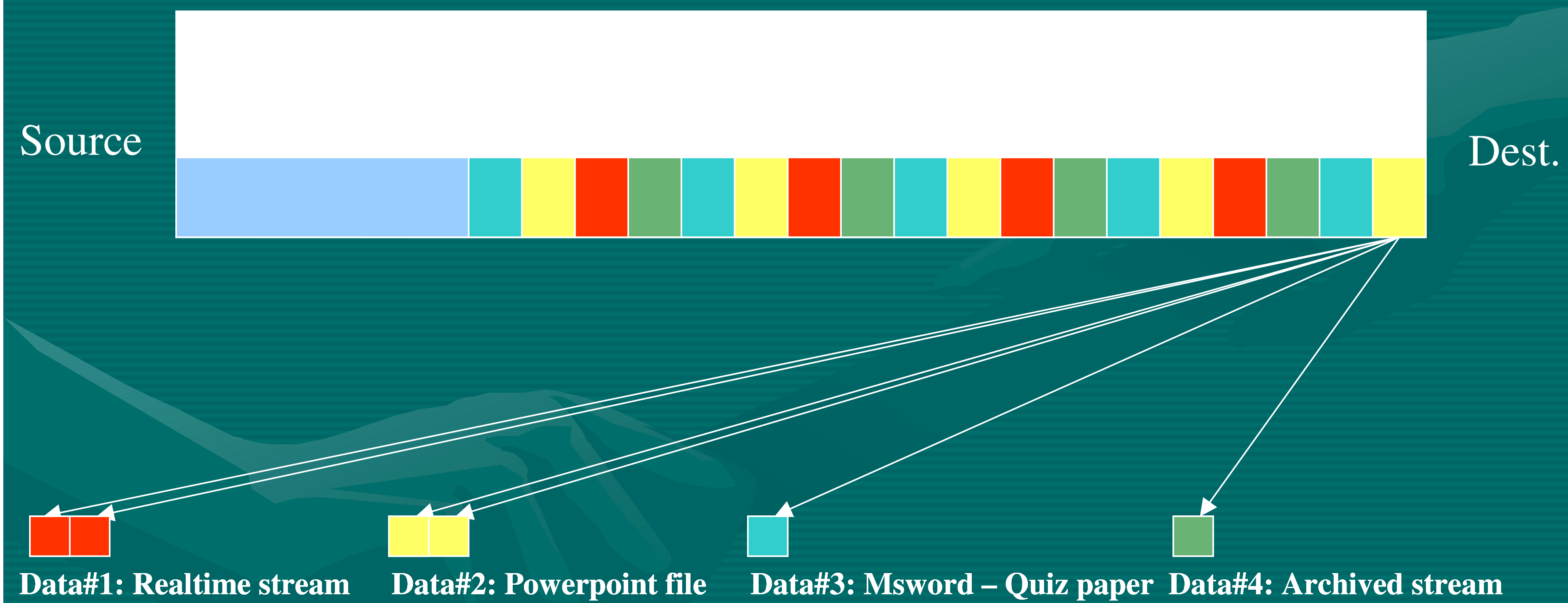
Broadcast Disk

Multiplex



Broadcast Disk

Demultiplex



Discussion

- Broadcast Disk need only a simple implement of sender and receiver
- No need of any computational part (encode-decode)
- Digital Fountain suffer from the overhead in implementing of Meta-content encoder & decoder
- Meta-content is a proprietary mechanism

Discussion

Transmission time comparison between Broadcast Disk and Digital Fountain

Original Data Size (MB)	**1**	**2**	**4**	**8**
Broadcast Disk				
Experimental Result [second (round)]	10.55 (2)	16.04 (2)	23.24 (2)	62.02 (2)
Simulated Result (10% loss) [second (round)]	15.825 (3)	24.06 (3)	34.86 (3)	124.04 (4)
Digital Fountain				
Propagation delay (10% loss) (second)	13.2	26.4	52.8	105.6
Encoding Time (second)	0.26	0.53	1.06	2.13
Decoding Time (second)	0.14	0.19	0.4	0.87
Total time (second)	**13.6**	**27.12**	**54.26**	**108.6**

Simulation and Experiment

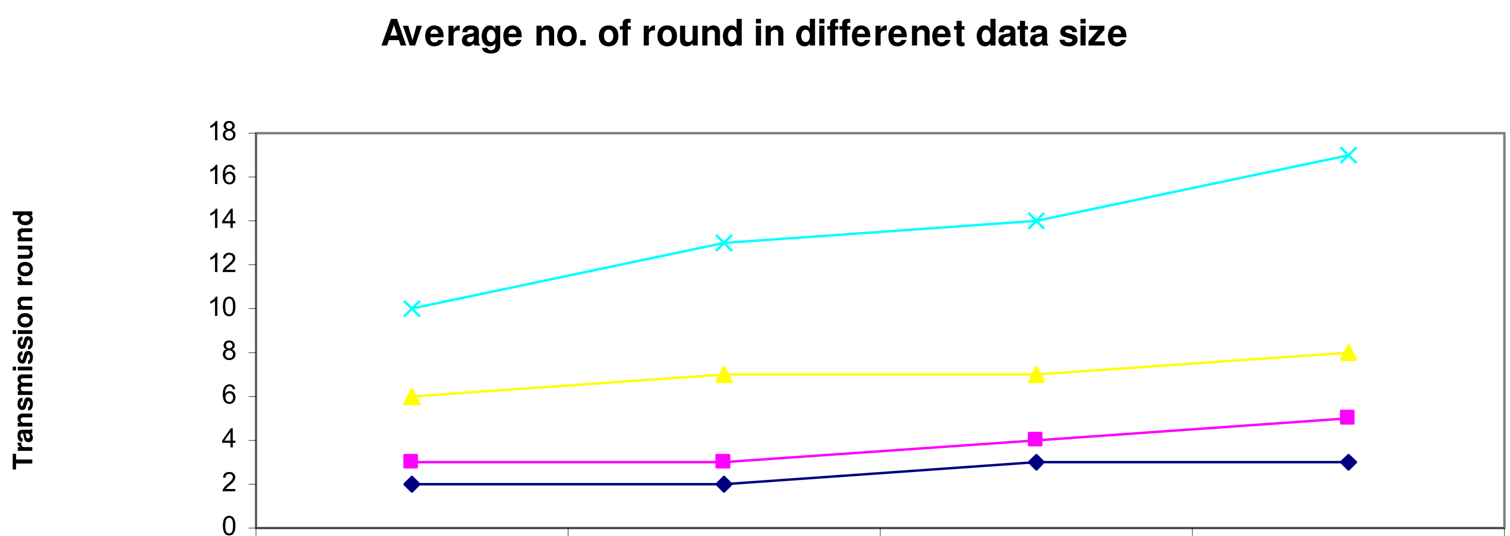
Simulation & Experiment with Broadcast Disk

- Setup 3 queue with different priority
- Transmission pattern
  - 1 1 1 1 2 2 3
  - Transmit data in queue 1 – 4 times
  - Transmit data in queue 2 – 2 times
  - Transmit data in queue 3 – 1 time
- Fix the environment in queue 2 and 3, and change data size in queue 1 in each experiment
- Transmission Bandwidth limited to 1.5 Mbps

Simulation

- Using NS
- Simulation at random data loss rate 1%, 10%, 25% and 50%

Simulation Results



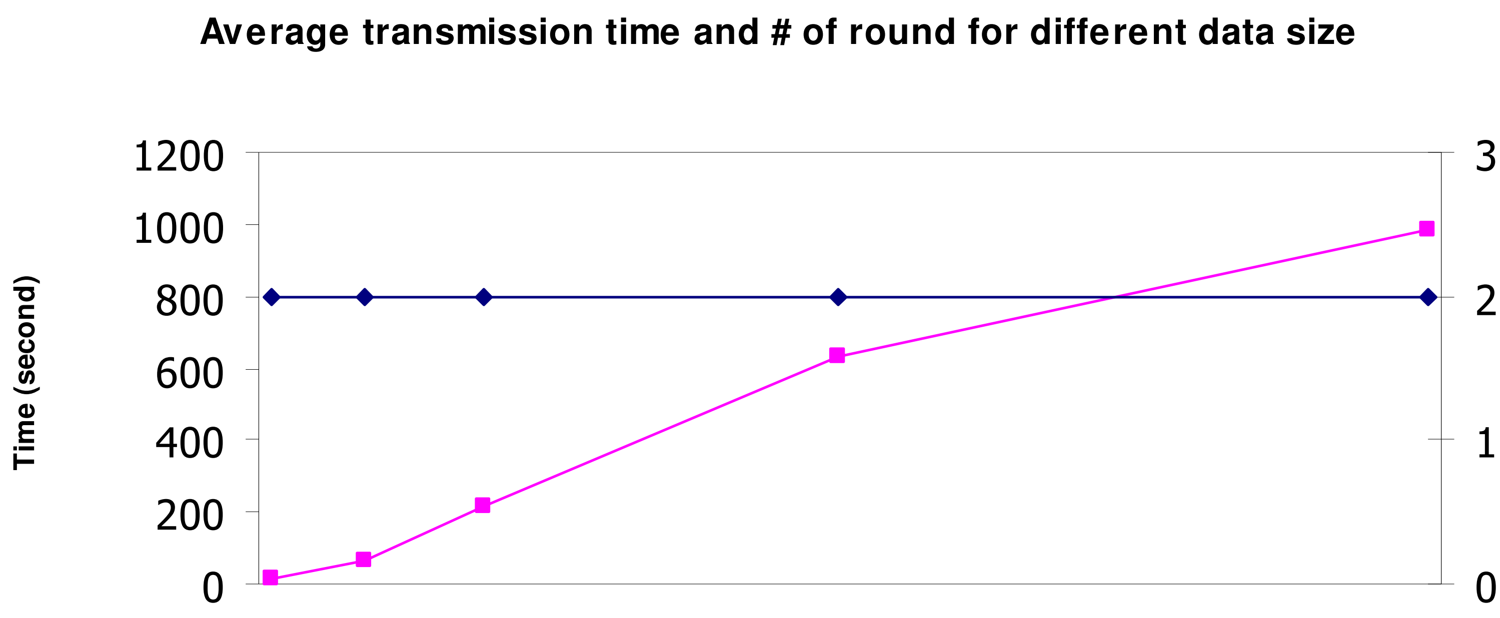
	1	5	10	50
loss 1%	2	2	3	3
loss 10%	3	3	4	5
loss 25%	6	7	7	8
loss 50%	10	13	14	17

Data size (MB)

Experiment with Broadcast Disk

- Use the same parameter as in simulation
- Sending data from sfc-cpu.ai3.net (Japan)
- Receiving data at 202.249.24.89 (AIT)

Experimental Results



	1	5	10	25	50
Tx Time	12	65	212	630	988
# Round	2	2	2	2	2

Data Size (MB)

Simulation & Experiment Summary

- In real testing environment Broadcast Disk use smaller number of round in transmission than in simulation. This may be caused by the randomness of data loss pattern.
- The result of the experiment over satellite link is close to the simulation result at loss rate 1%

Streaming and Reliable data distribution

- Due to the cost of satellite channel is too high
  - We have to optimize link utilization by sending multiple data simultaneously
  - Example: Sending real time video + Archived Data
  - For example: Broadcast real time class while sending E-learning materials

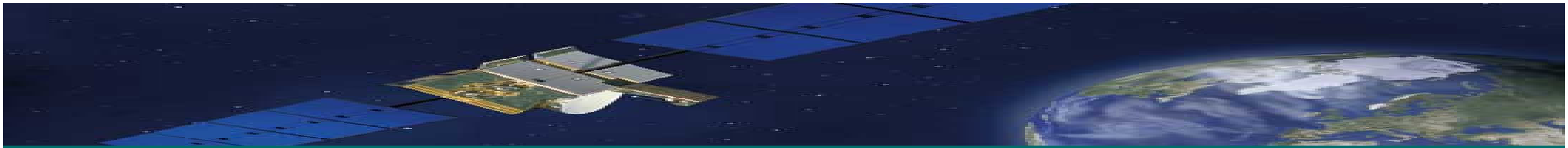
Plan

- Scheduling
- Optimized disks

Bulk Data Transfer over Satellite Link

- One-to-many IP-based content delivery protocol
- Provide reliability without relying on acknowledgement
- Support reliable bulk transfer for any media to co-exist with streaming applications
- Unique satellite characteristics are taken into design consideration
- Scalable to accommodate large number of receivers
- Implemented and tested on real satellite link.
- Windows and Unix version

Satellite Internet for Distributed Education



Satellite Internet

Satellite Internet for distributed education

- Coverage over large geographical area

  Information can be transmitted to wide geographical area under the satellite footprint, to remote places which cannot be reached by terrestrial links.

- Broadcast & High bandwidth

  Large amount of information is broadcasted to many receivers in different places.

Satellite UDL & IP Multicast

- Strengthen the broadcasting property
- Minimum bandwidth consumption
- Used for massive information delivery
  - Video streaming
  - Bulk file transfer

Real Time vs. Reliable Multicast

Real Time

- Cannot allow delays but can tolerate some data loss
- Live Feed/ Conferencing (Audio and Video)

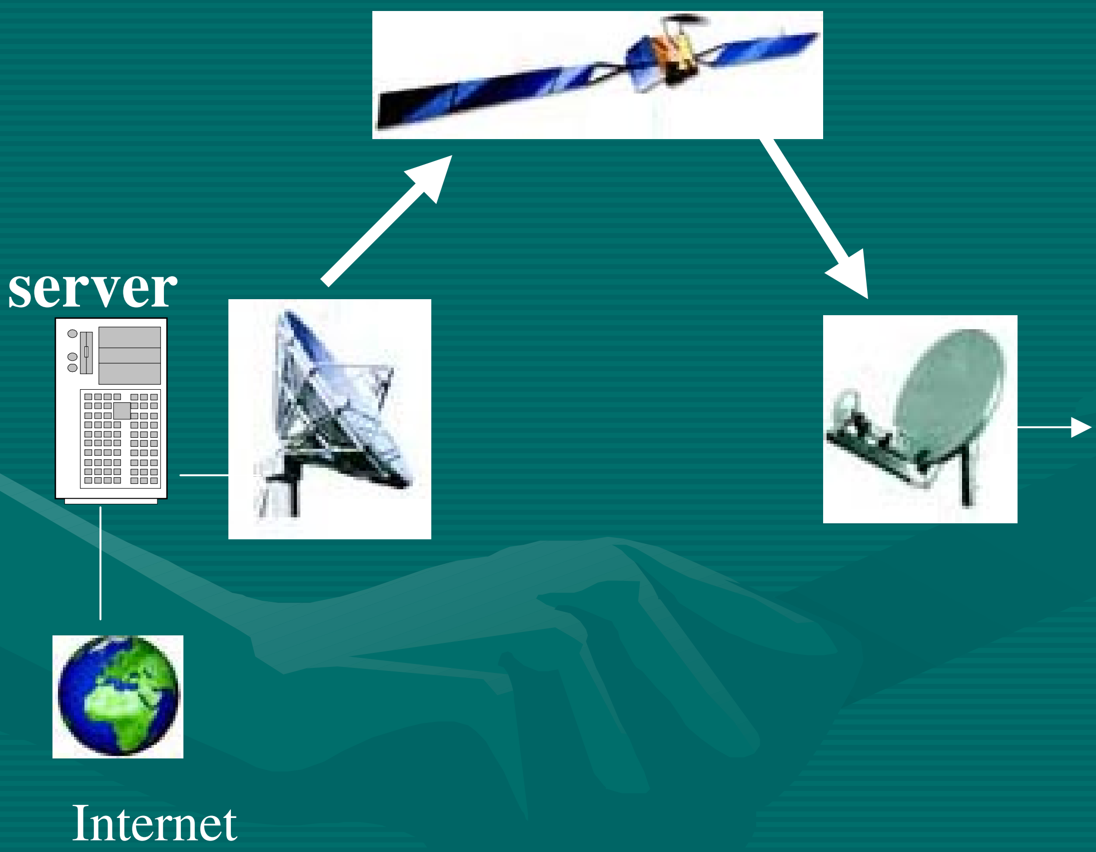
Reliable

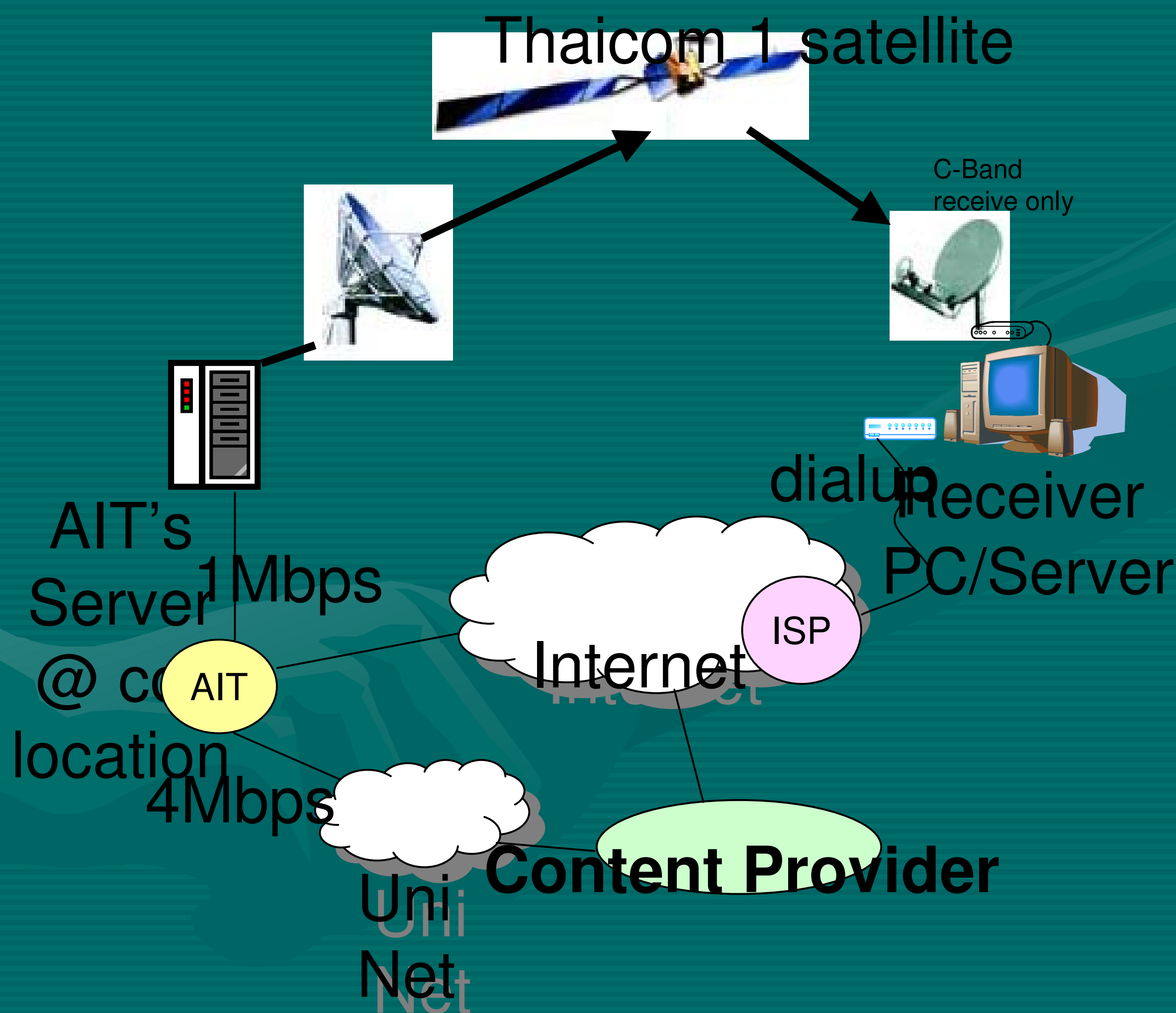
- Requires total reliability with the expense of delay
- Software Upgrade Distribution, White Board Collaboration Applications

Demonstration

QuickTime™ and a
DV - PAL decompressor
are needed to see this picture.

Remote Classroom : A prototype of distributed education over satellite




Thaicom 1 satellite
C-Band
receive only
AIT’s
Server
@ c
location
1Mbps
AIT
4Mbps
Uni
Net
Internet
ISP
dialup
Receiver
PC/Server
Content Provider

Plan

- Mobile and Ad Hoc Network
- Sensor networks
- Streaming audio for mobile users (villagers)

Thank You