Reliable Multicast over Satellite

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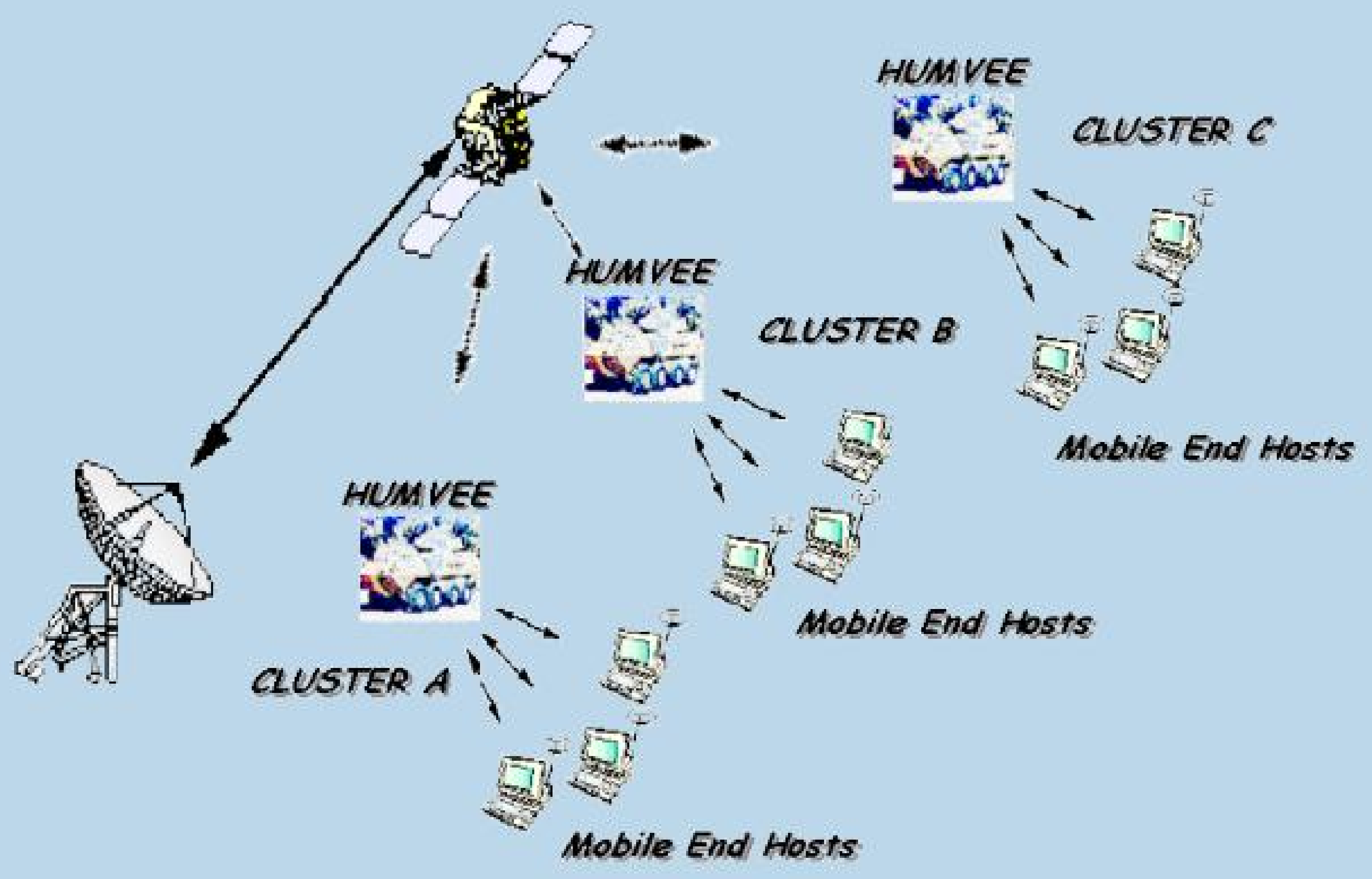
Problem Statement

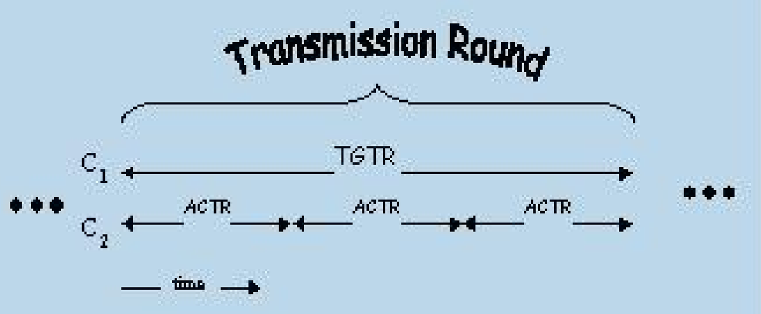
The emergence of satellite networks and the demand for reliability in transferring large files over such networks has created the need for efficient reliable multicast protocols, customized for networks with FLAT (one-hop) hierarchy. The challenging problem is that of reliability (e.g., delivery of data to the receivers w/o loss) in multicasting protocols.
In our work we use the technique of Air Caching to construct innovative reliable protocols. The combination of Air Caching with forward error correction (FEC) can boost substantially the performance of reliable protocols in terms of transmission rounds, by paying a small overhead in bandwidth usage.

Network Topology



Approach

- What is happening Per Transmission Round ?
  - Two channels C_1 and C_2
  - C_1 is used for transmitting the Data Packets
  - C_2 is used for the Air Cache



ACTR : Air Cache Transmission Round
TGTR : Transmission Group Transmission Round

- Transmission on C_1 and on C_2 happens in parallel

- What is the Air Cache content?
  - Can be Data Packets
    Data Air Cache Reliable Multicasting Protocols
  - Can be Parity Packets (FEC)
    Parity Air Cache Reliable Multicasting Protocols
- How we update the content of Air Cache?
  - If Air Cache contains Data Packets we can update the cache by using the retransmission requests. In the Cache the most requested Data Packets.
  - If Air Cache contains Parity Packets no need for update. Any Parity Packet can correct any Data Packet
- How often we update the content of Air Cache?
  - Per ACTR
  - PER TGTR

NOTE: For the Parity Air Cache there is no need for update because each parity packet can correct each data packet

Proposed Protocols

Taxonomy

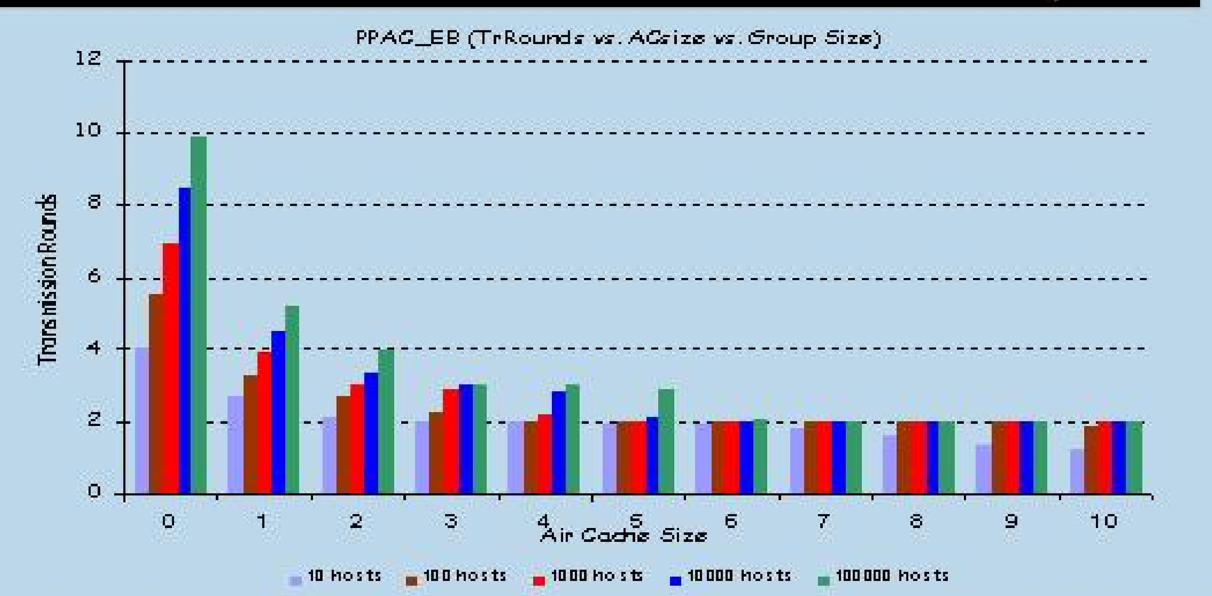
1. Non-adaptive Air Cache
2. Adaptive Air-Cache
   - 2.a. Size Adaptation
   - 2.b. Content Adaptation
   - 3.b. Hybrid (Size and Content Adaptation)

Description of some worth-looking protocols

- **PPAC-EB** : Parity Packets in Air Cache - Extended Buffering (parity packets in AC)
  Parity Packets in Air Cache
  Constant size of the Air Cache
- **ASPAC** : Adaptive Size of Parity Air Cache (parity packets in AC)
  Improved version of PPAC-EB (less extra bandwidth overhead)
  Size of AC is decided based on feedback

PPAC-EB (Results & Conclusions)

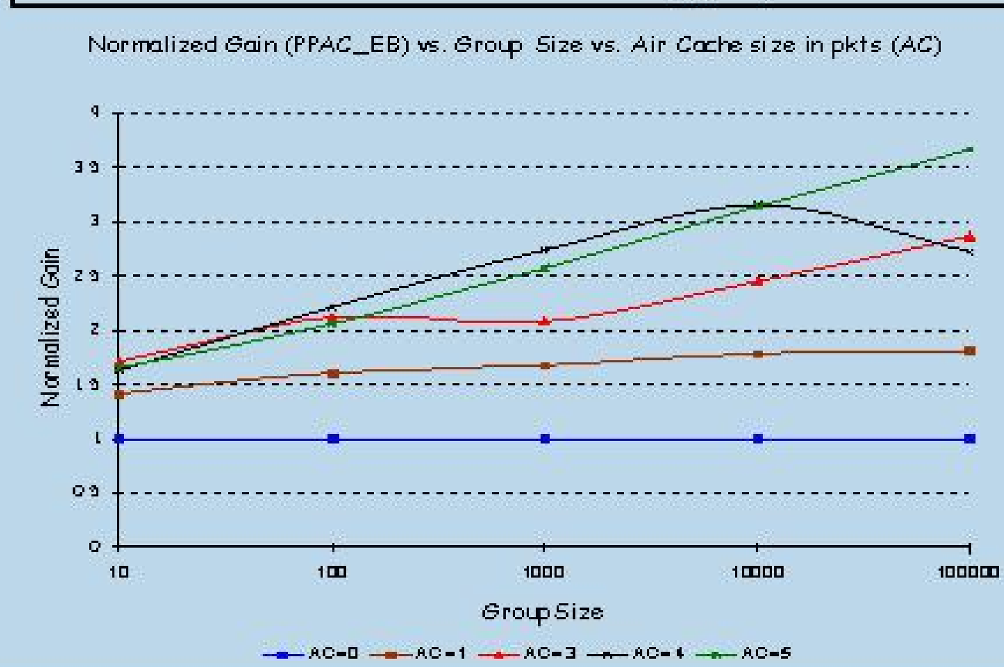
I. Transmission Rounds vs. Air Cache Size vs. Group Size



PPAC-EB very scalable; performance not affected by group size; 10 to 100000.
Disadvantages: constant size of Air Cache even when not really needed

II. Transmission Rounds vs. Group Size vs. Air Cache Size

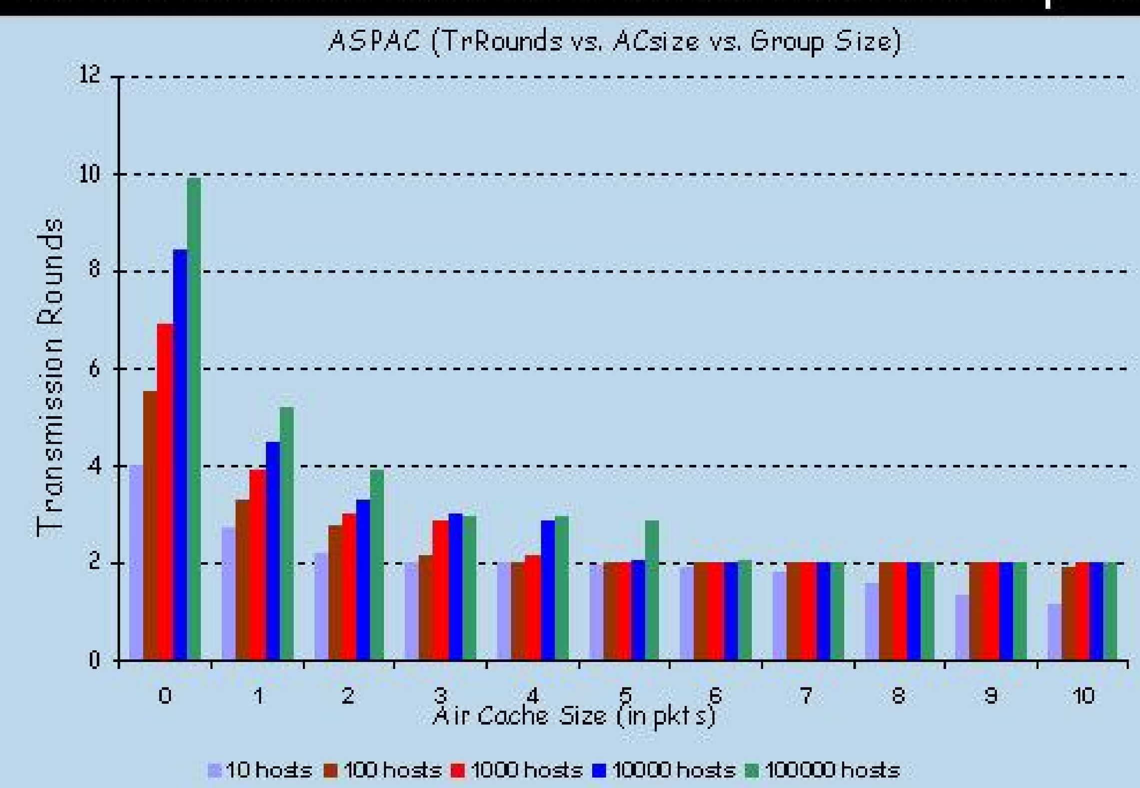
$$NormalizedGain = \frac{TransmissionRounds_{PPAC} * TGsize}{TransmissionRounds_{FEC} * (TGsize + ACsize)}$$



Normalized Gain: a metric for relative performance of PPAC-EB vs FEC. Combines transmission rounds and bandwidth usage. NG >1 for ACsize > 0 (PPAC_EB outperforms FEC). NG for FEC: flat line through 1.

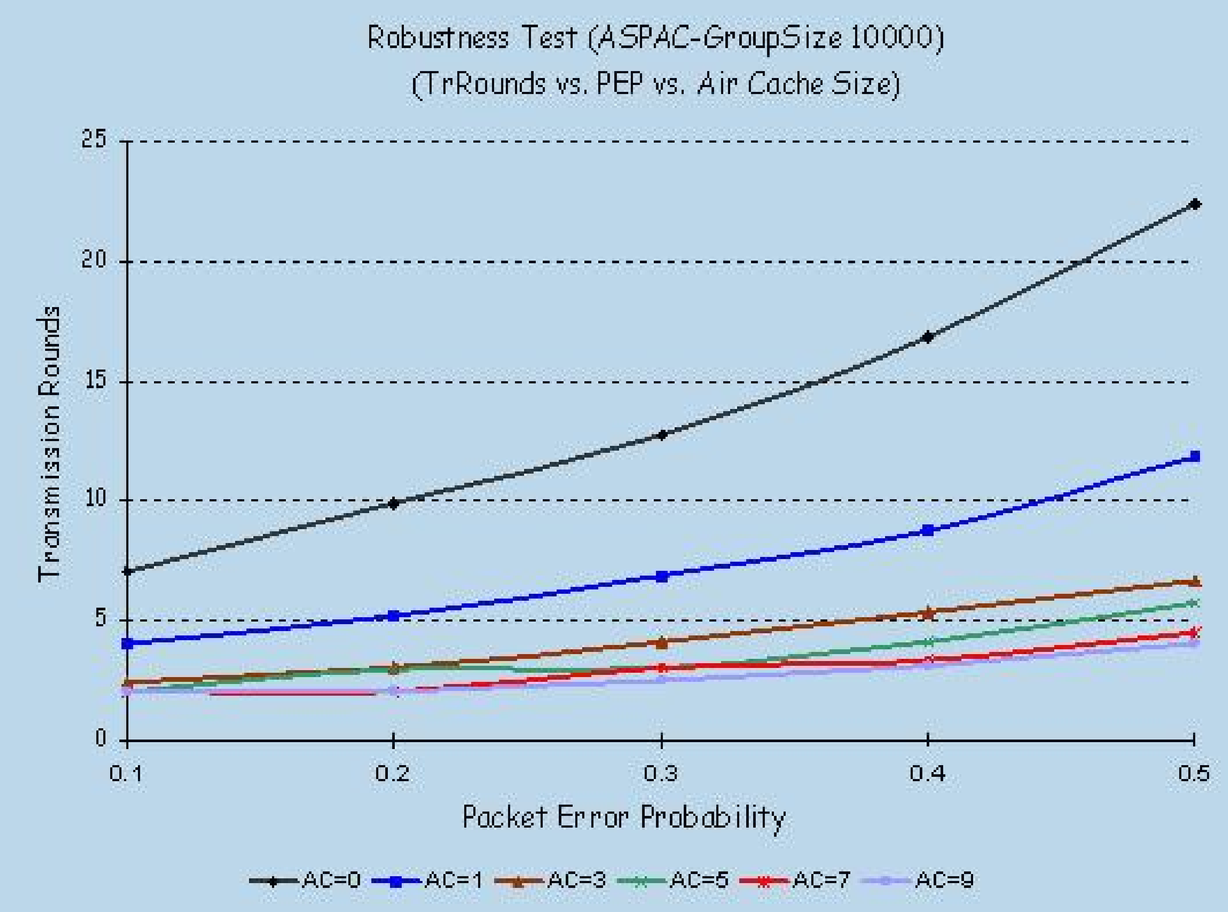
ASPAC (Results & Conclusions)

I. Transmission Rounds vs. Air Cache Size vs. Group Size



This protocol's performance is as good as PPAC-EB's with the difference that we do not use redundant Air Cache size. The latter improvement in the protocol's functionality makes ASPAC more efficient in terms of BW requirements compared to PPAC-EB.

II. Transmission Rounds vs. Packet Error Probability vs. Group Size



The Protocol seems Robust even in cases of high Packet Error Probability (PEP). This result is mainly based on the combination of the Air Caching Technique and FEC which give proactive correction capabilities to the protocol