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**

![Network Topology Diagram]

**Approach**

- **What is happening for Transmission Round?**
  - Two channels \( C_A \) and \( C_C \)
  - \( C_A \) is used for transmitting the Data Packets
  - \( C_C \) is used for the Air Cache

- **Transmission Round**

  - **ACTR**: Air Cache Transmission Round
  - **TTTR**: Transmission Group Transmission Round

- **What is the Air Cache content?**
  - Can be Data Packets
  - Can be Parity Packets (FEC)
  - Air Cache Reliable Multicast Protocols

- **How do we update the content of Air Cache?**
  - If Air Cache contains Data Packets we can update the cache by using the retransmission requests.
  - If the Air Cache contains Parity Packets to be updated, any Parity Packet can correct any Data Packet

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

**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) Packed Size of the Air Cache

- **ASPAC**: Adaptive Size of Parity Air Cache (parity packets in AC)

**PPAC-EB (Results & Conclusions)**

- **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

**ASPAC (Results & Conclusions)**

- **Transmission Rounds vs. Air Cache Size vs. Group Size**

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- **Transmission Rounds vs. Air Cache Size vs. Group Size**

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

- **Robustness Test (ASPAC-aircachsize=100000)**
  - (Transmission rps vs Air Cache 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.**