Multicast Packing for Coding across Multiple Unicasts

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What's the Problem?

How to design NC for multiple unicasts to achieve good performance, e.g., common rate & cost?

NP-hard!
State-of-the-Art

- Integer LP approach
  - Scalability problem
- Evolutionary approach
- Pairwise NC
  - Ignores NC beyond two sessions
- Interference Alignment
  - Might be infeasible
Multicast Packing Code (MPC)
Strengths of MPC

- Applicable to any graph.
- Search space = all partitions of unicast sessions, irrelevant to network size.
- Rate region is characterized by a simple linear program.
- Allow NC across more than three unicast sessions.
Characterizing Achievable Rate of MPC

The value of each flow at $s_i = 1$  

Each unicast session achieves unit rate

LP1  LP2  LP3  LP4  LP5

LP for MPC
Finding Good Partitions

\[ \omega_i = (s_i, d_i) \]  
\text{\textit{i}th unicast session}
Evaluation - Simulation Setup

Two Objectives:
- Max. common rate
- Min. cost

# of unicast sessions: 3~7

Metrics:
- Performance gain
- Ratio of scenarios with gains
Evaluation - Simulation Results

**Common rate**

| $|\Omega|$ | $\eta$ | $\gamma$ | Time (sec) |
|------|------|-------|----------|
| 3    | 18   | 94.44 | 3.23     |
| 4    | 20   | 100   | 4.74     |
| 5    | 30   | 96.67 | 6.71     |
| 6    | 46   | 89.13 | 9.75     |
| 7    | 50   | 84    | 15.32    |

**Cost**

| $|\Omega|$ | $\eta$ | $\gamma$ | Time (sec) |
|------|------|-------|----------|
| 3    | 18   | 30.59 | 3.91     |
| 4    | 20   | 29.51 | 7.11     |
| 5    | 30   | 27.22 | 10.8     |
| 6    | 46   | 24.69 | 12.16    |
| 7    | 50   | 23.5  | 17.76    |

- **MPC is more scalable than routing**
- **MPC achieves fairly better performance than routing**
- **The annealing algorithm is efficient in finding good partitions**
Conclusion

• Introducing MPC

• The rate region of MPC is characterized by a linear program

• Simulated annealing algorithm to find good partitions

• Evaluation
Thank you!

Questions?