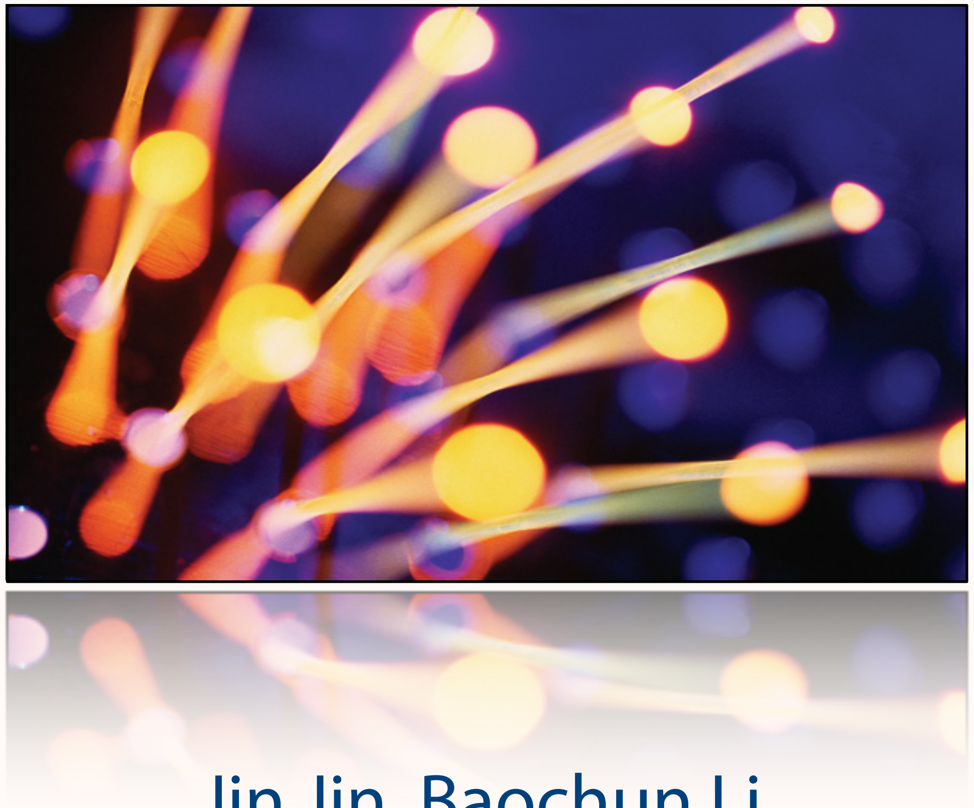
Cooperative Multicast Scheduling with Random Network Coding in WiMAX



Jin Jin, Baochun Li,
Department of Electrical Computer Engineering
University of Toronto

WiMAX MBS

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next generation infrastructure to broadcast data

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- IEEE 802.11j/802.11m

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single channel, single path

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How to properly select a multicast rate?

Observation

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Users can help each other (cooperation)

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- cooperative communication is not well studies in MBS

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Adoption of OFDMA in WiMAX

- concurrent transmissions without interference
- channel diversity gain
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Adoption of OFDMA in WiMAX

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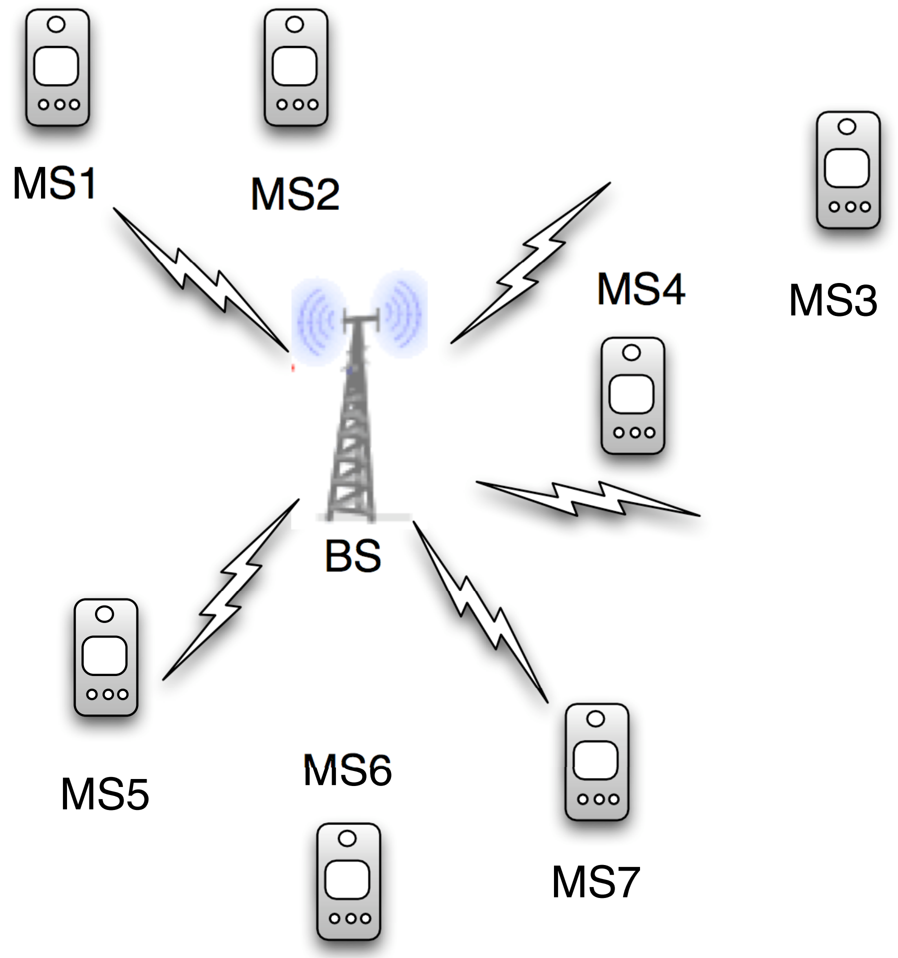
Can we take advantage of all potential benefits and design a multicast scheduling protocol to tightly integate to WiMAX MBS?

Multicast Scheduling

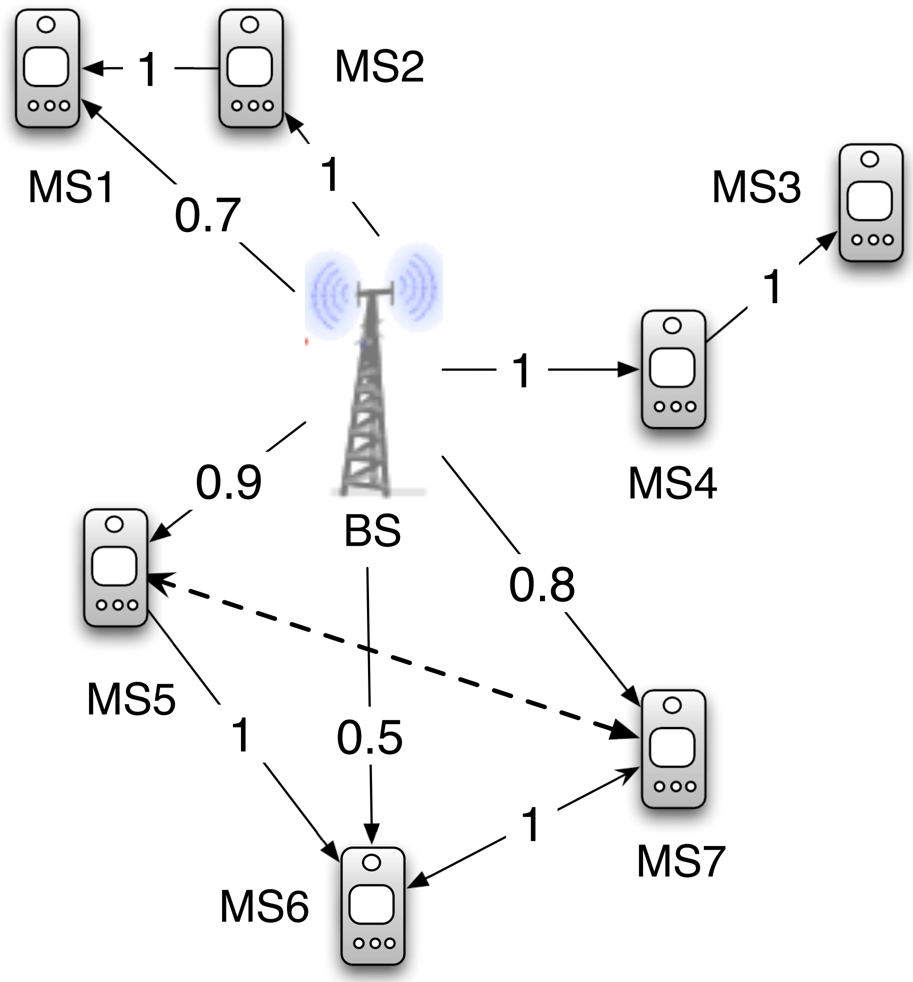
Study from a new perspective

Multiple hops, multiple paths, multiple channels

Network Coding to mitigate the overhead



Conventional Multicast Scheme



Cooperative Multicast Scheme

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How to tightly integrate with WiMAX protocol?

Our Contribution :

Cooperative Multicast Scheduling with Random Network Coding

Optimization

Greedy Optimization Frame Work

time-slotted WiMAX MBS

optimal multicast rate

efficient cooperative communication schedule

proportional fairness criteria

$$\max_{R(t)} \quad \sum_{i \in \zeta} \frac{U_i(t)}{\overline{r}_i(t)}$$

Subject to:

$$U_i(t) = S_{m,i}(t) R_m(t) + \sum_{g \in \zeta} R_{gi}(t)$$

$$0 \leq R_{gi}(t) \leq C_{gi}(t)$$

$$R_{gi}(t) \leq \max\{0, \frac{B_g(t) - B_i(t)}{T}\}$$

$$\sum_{g \in \zeta} R_{gi}(t) \leq \sum_{h=1}^{t-1} R(h) - \frac{B_i(t)}{T} + (1 - S_{m,i}(t)) R_m(t)$$

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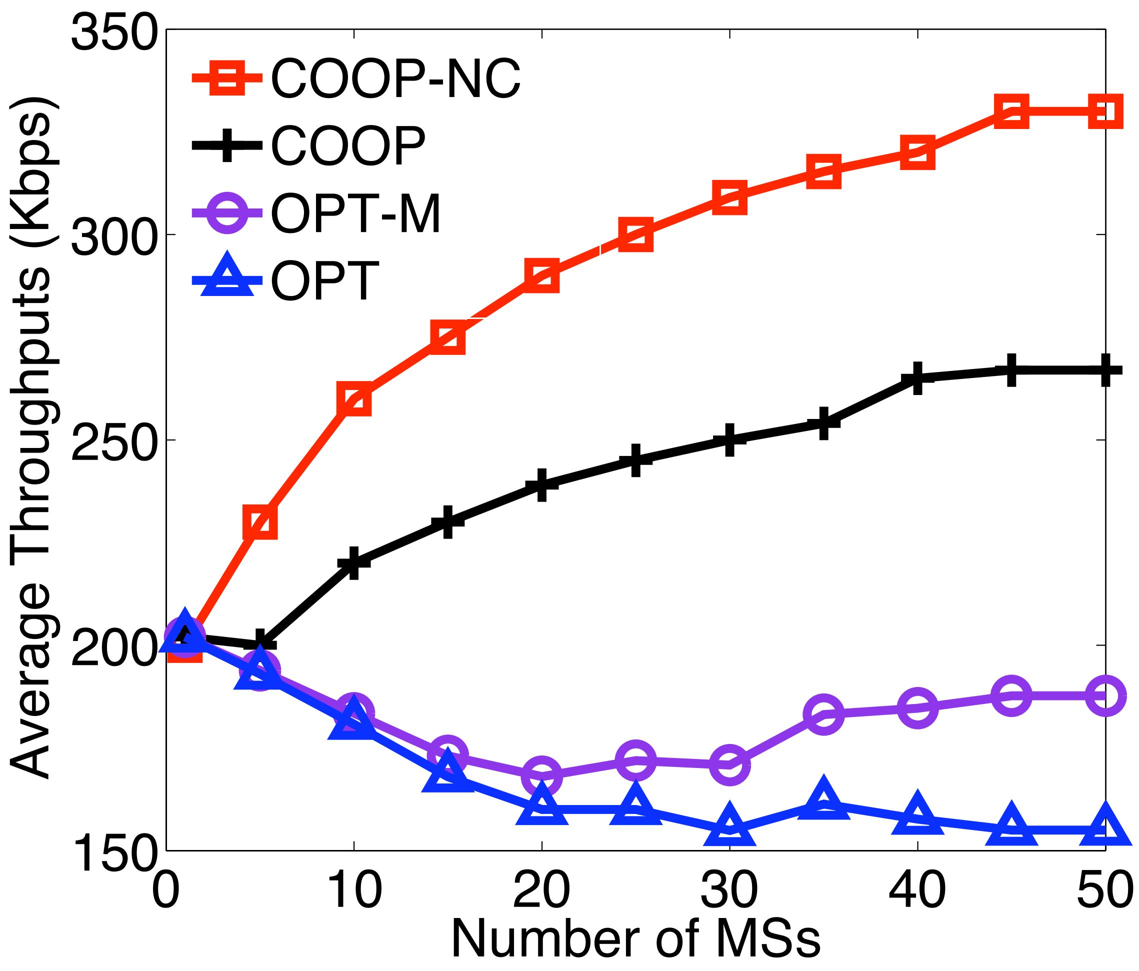

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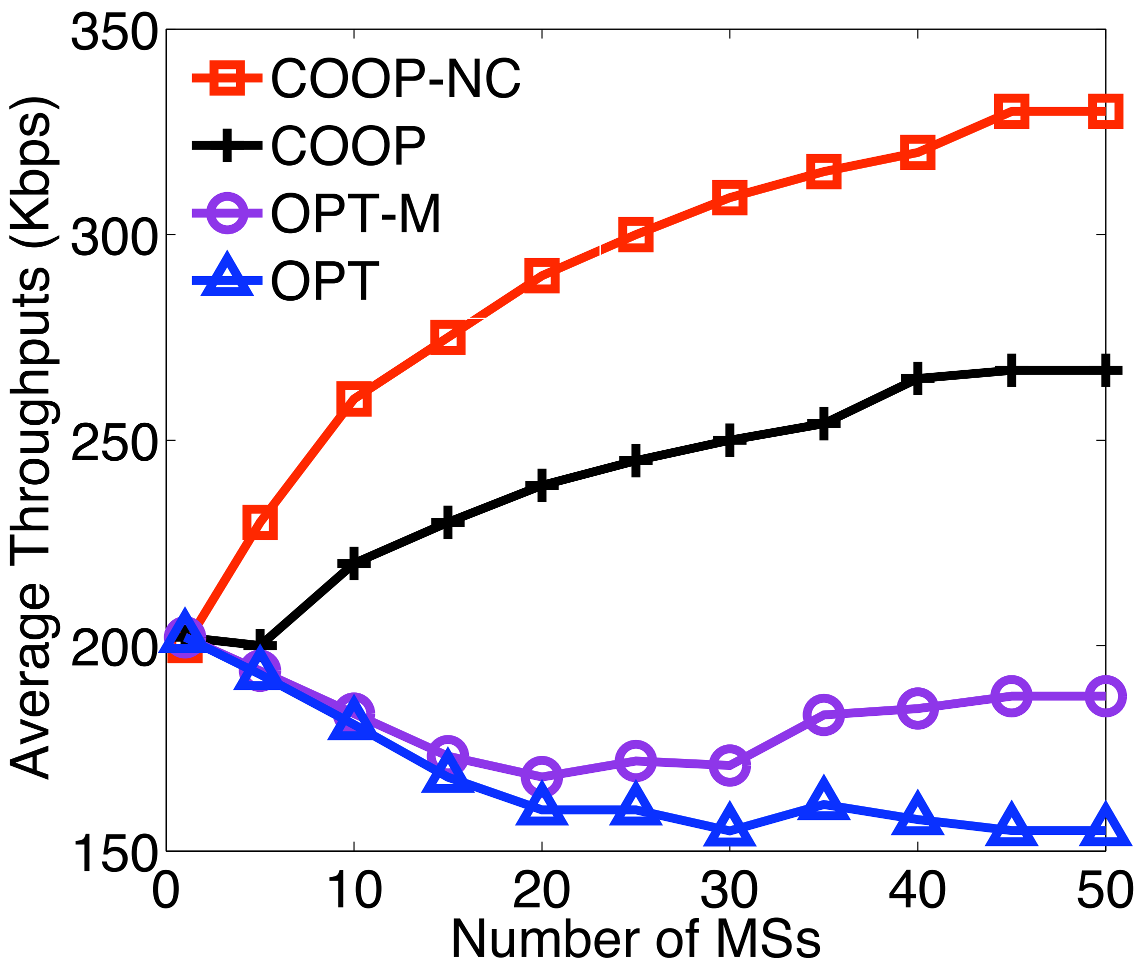

Throughput vs. Number of MSs

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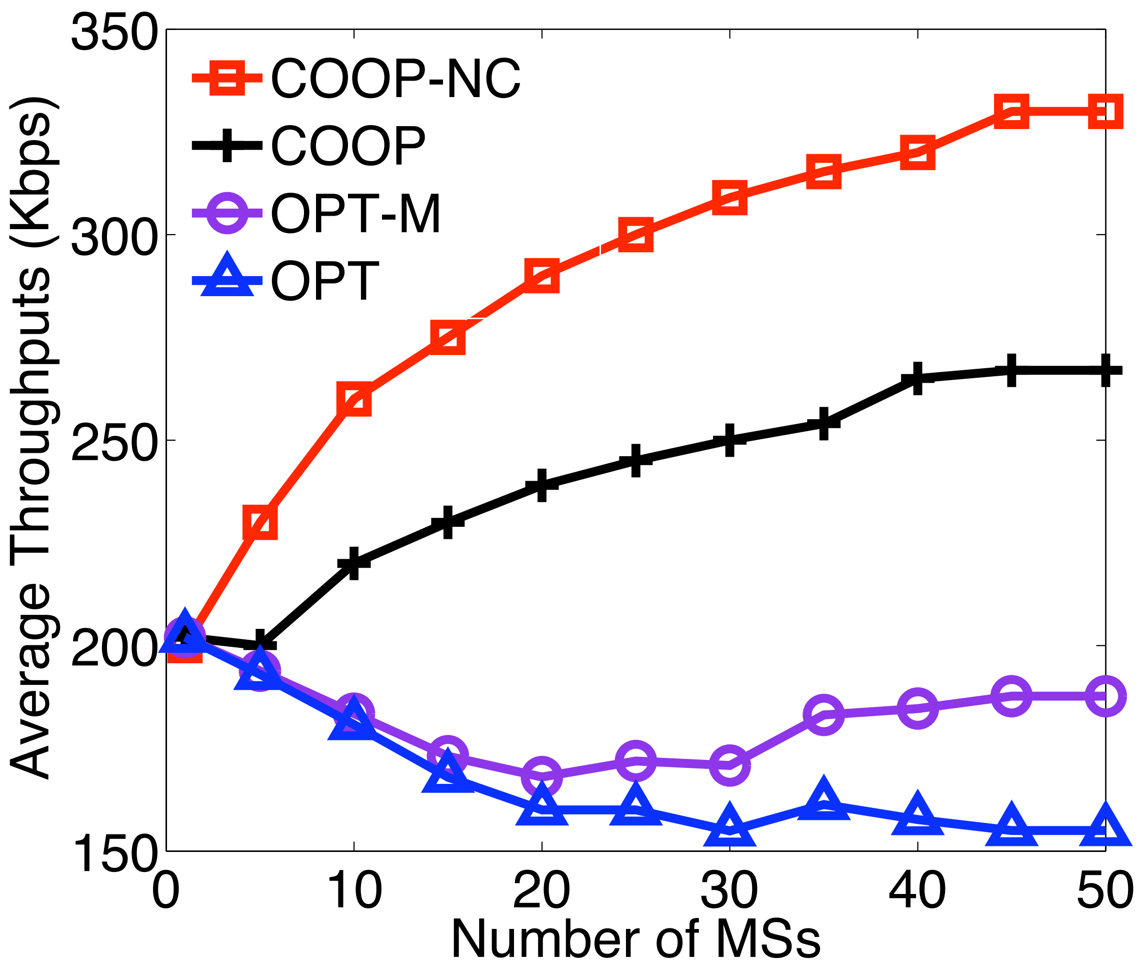

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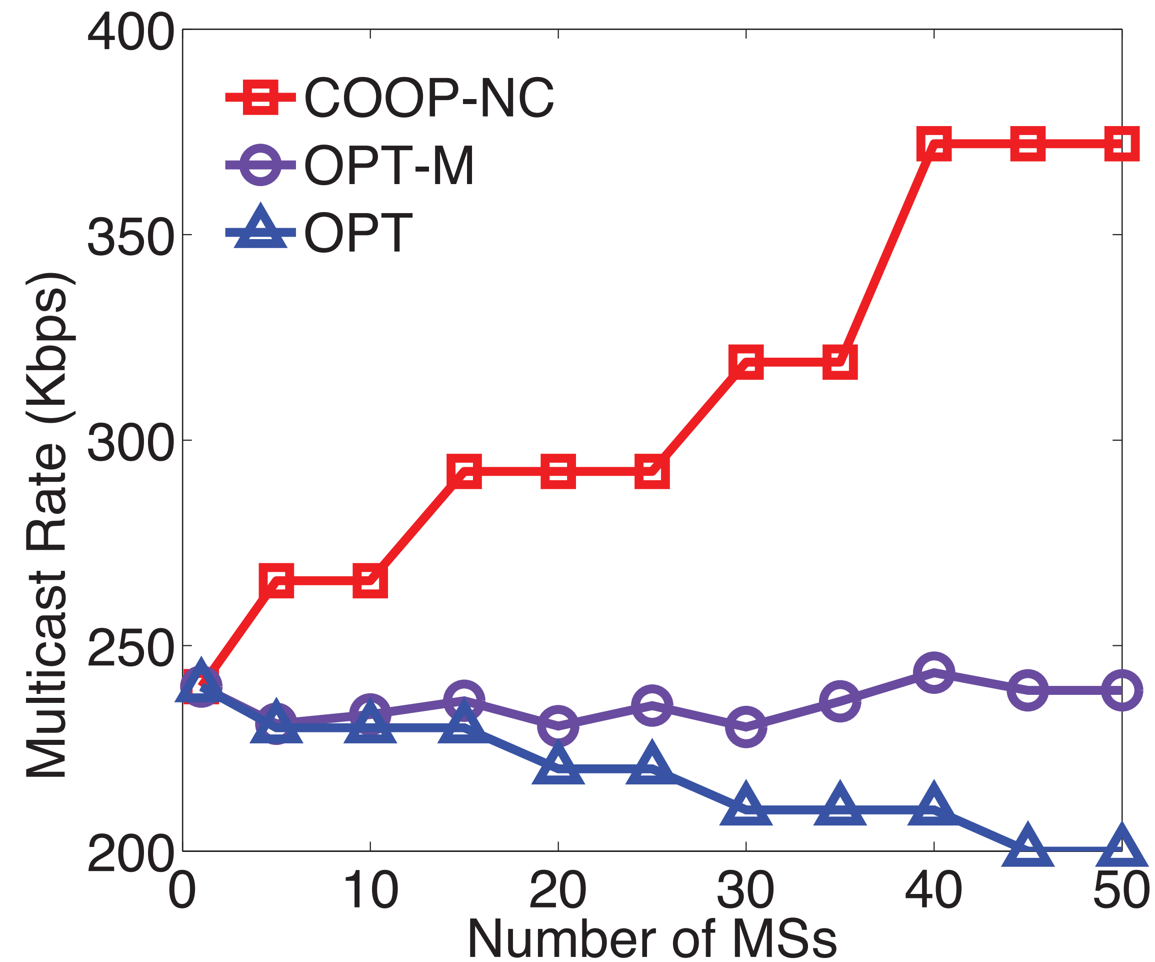

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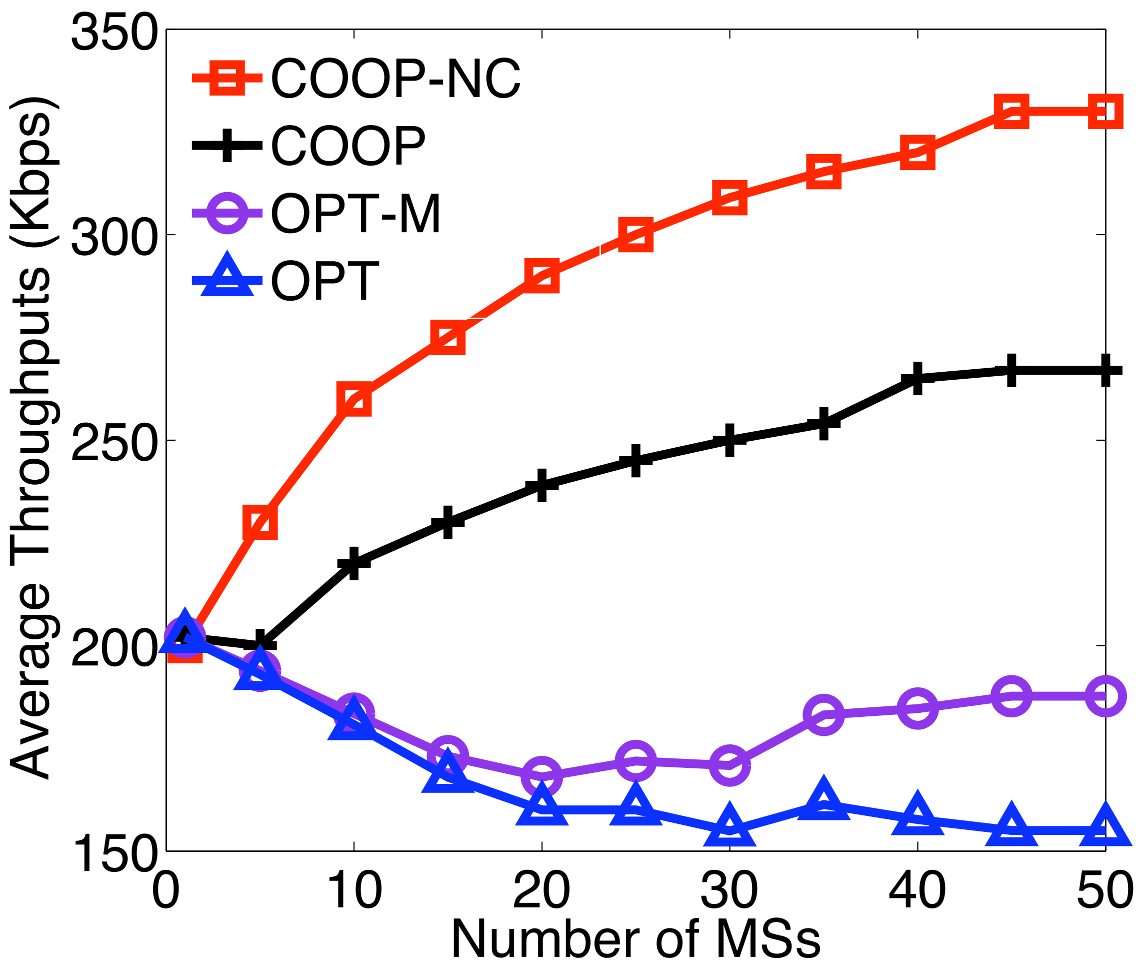

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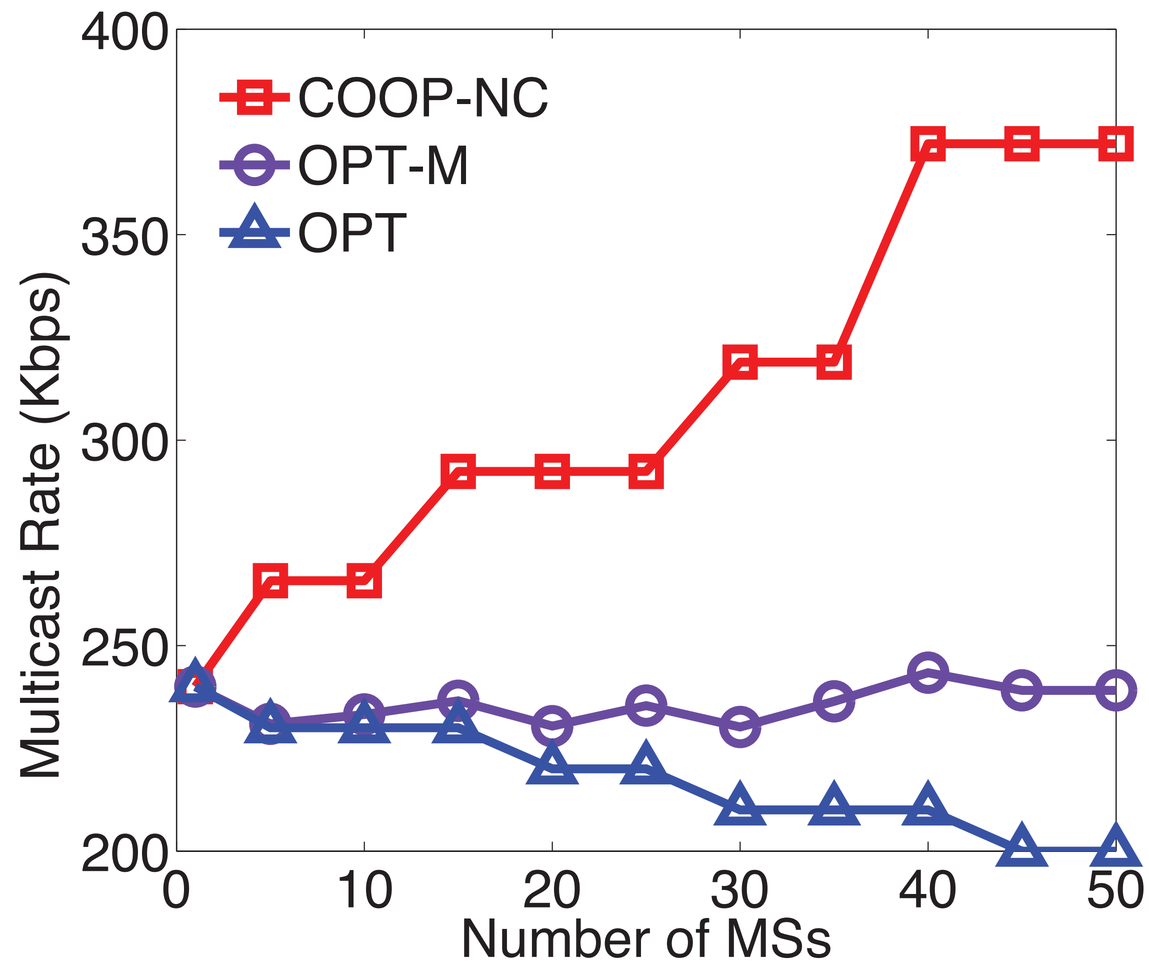

Multicast Rate vs. Number of MSs

Limited Bandwidth Resources

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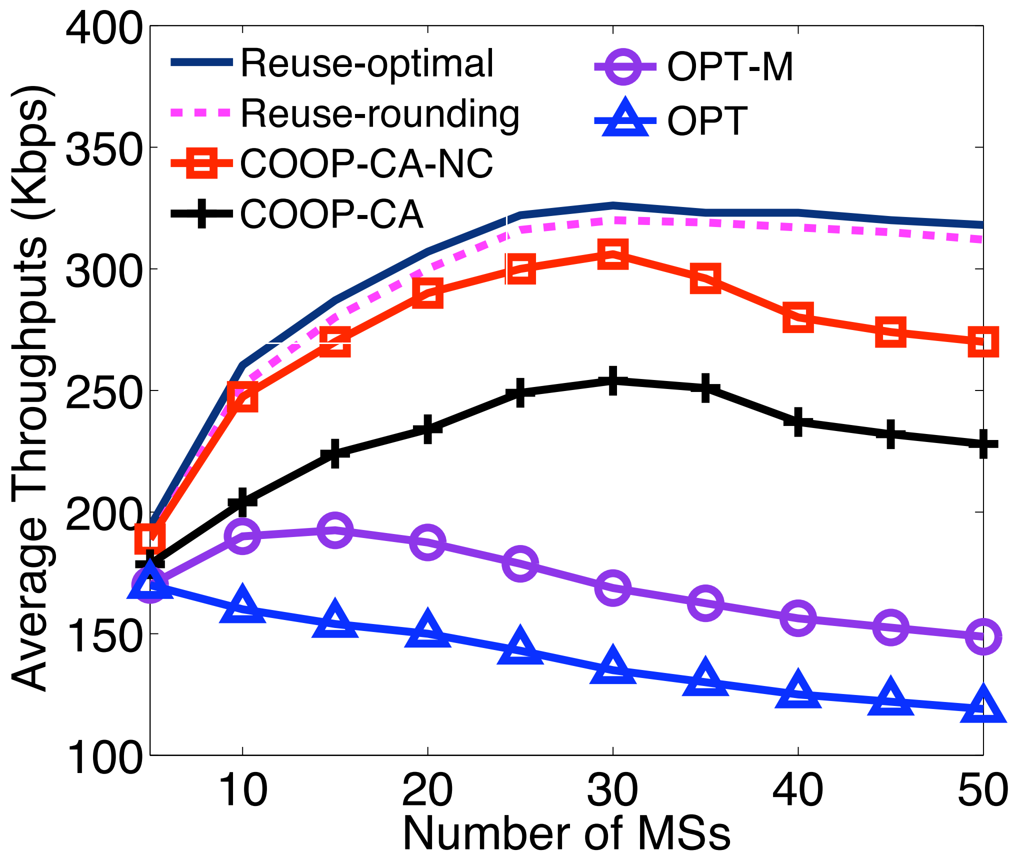
How Efficient are the channel allocated?



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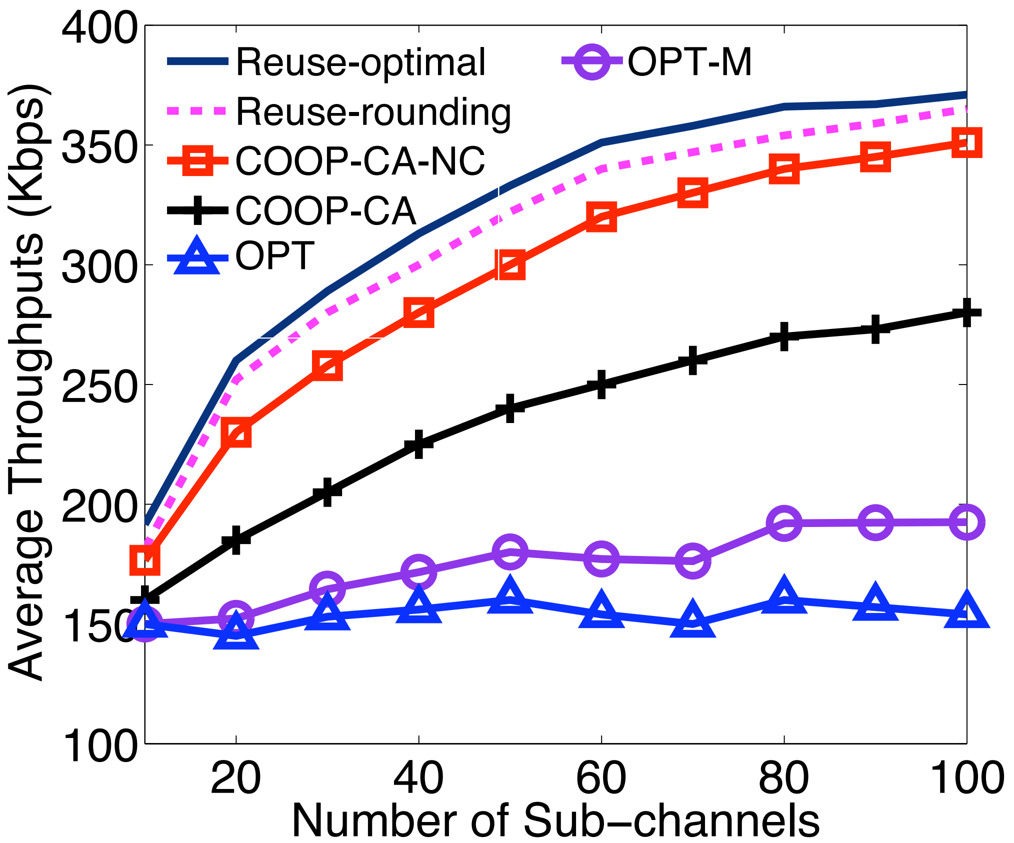


Throughput vs. Number of Sub-channels

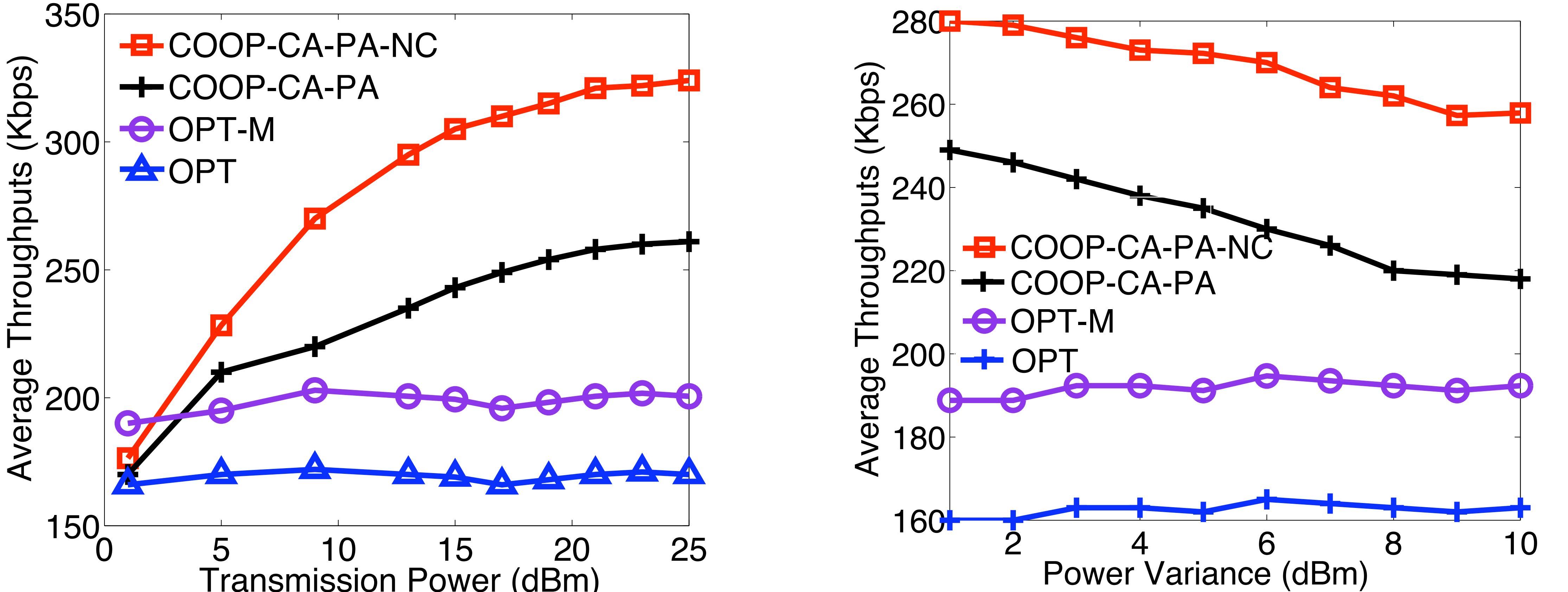
Power Allocation

When power on relays are high constrained

$$\sum_{n\in\chi}\sum_{i\in\zeta} S_{gi}^{(n)} \le P_g \quad \forall g \in \zeta$$

$$0 \le \omega_{gi}^{(n)} \le C_{gi}^{(n)} = \frac{BW}{\overline{r}_i}\cdot \log_2\left(1+\frac{S_{gi}^{(n)}}{\sigma_{gi}^{(n)}}\right)$$

Solve the problem by solving the dual problem



Throughput vs. Power

Throughput vs. Number of Sub-channels

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Lead to the future design in WiMAX

Thank you!

more information:

http://iqua.ece.toronto.edu/~jinjin