

# Limiting Mutual Interference Between NGSO Satellite Constellations via Probabilistic Look Aside

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## BACKGROUND

### Research question

- Large NGSO satellite constellations will share radio spectrum
- Can they co-exist without causing harmful interference to each other?
- Managing In-line events is the main challenge

### Two types of in-line events

- **Physical** in-line events: determined by
  - Ephemeris data (**readily available**)
- **Interfering** in-line events: determined by
  - Ephemeris data **AND**
  - Beam direction, radio channels, and antenna polarization (**uncommon to share**)
- Operators can only infer physical in-line events if ephemeris is the only shared information

## METHODOLOGY

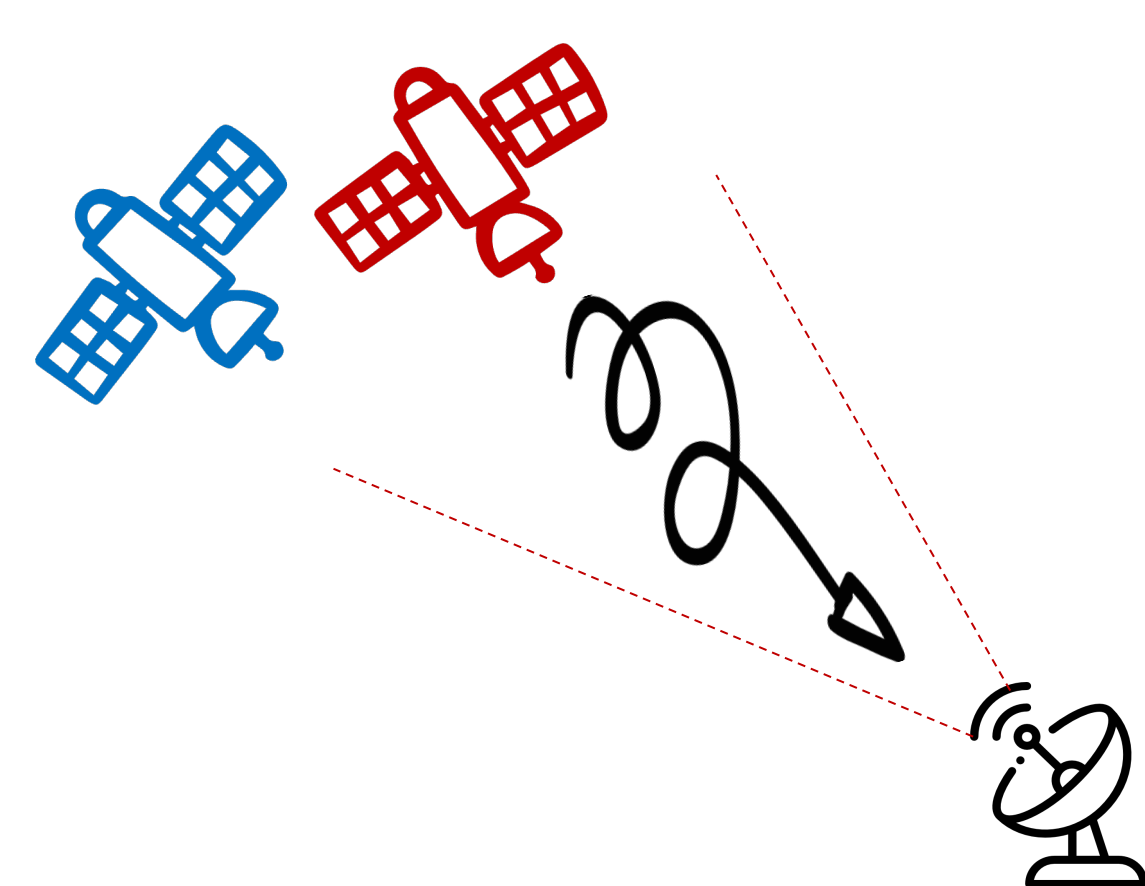
### Conventional methods

(assuming ephemeris is the only info shared)

- **Accept interference:** risk of high interference
- **Band splitting (FCC default):** reduce bandwidth
- **Look aside:** always choose a sub-optimal satellite

### Proposed: Probabilistic look aside

- Balance interference mitigation and assignment quality
- Each operator can choose one probability; what probability should they choose?

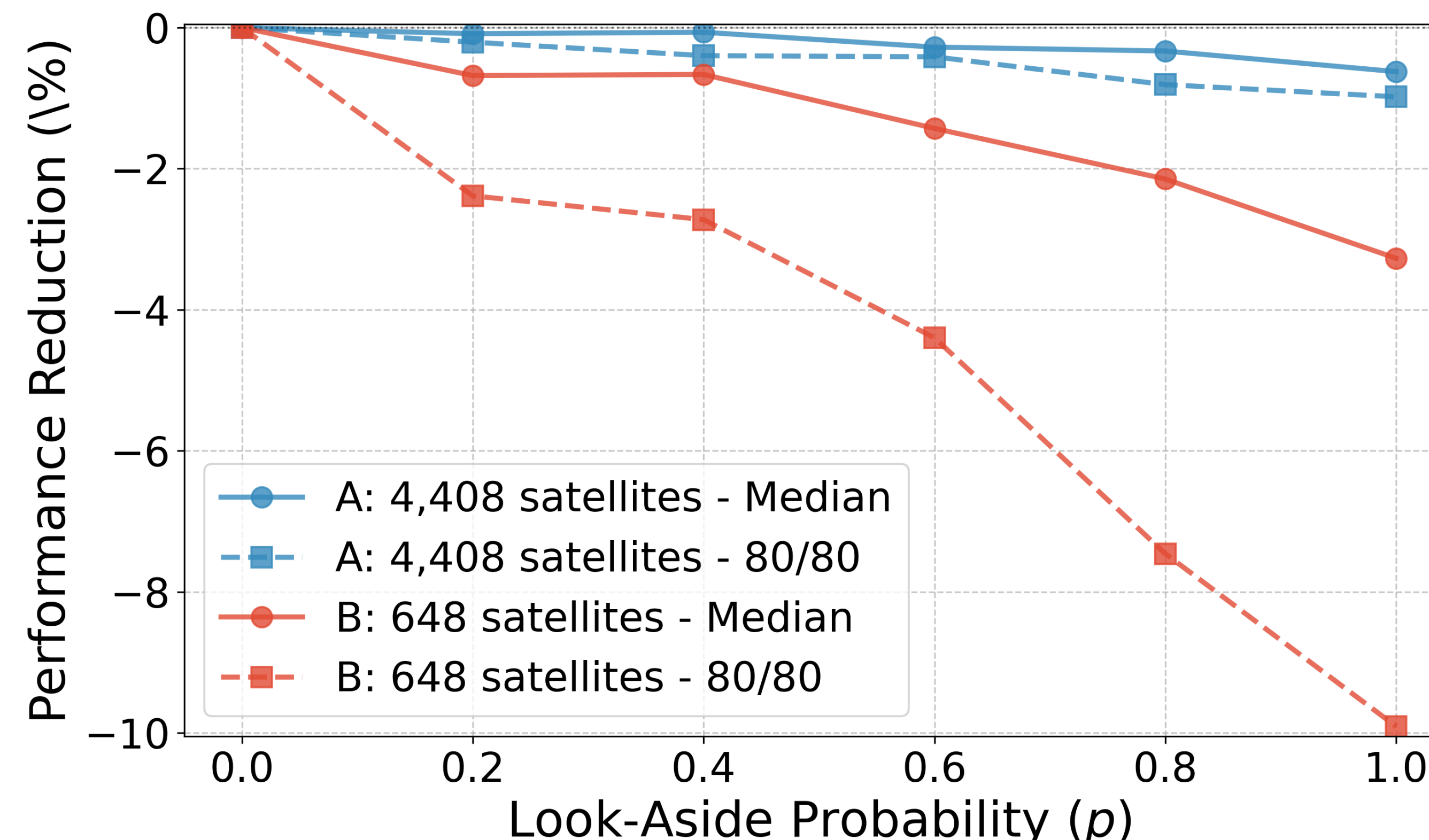
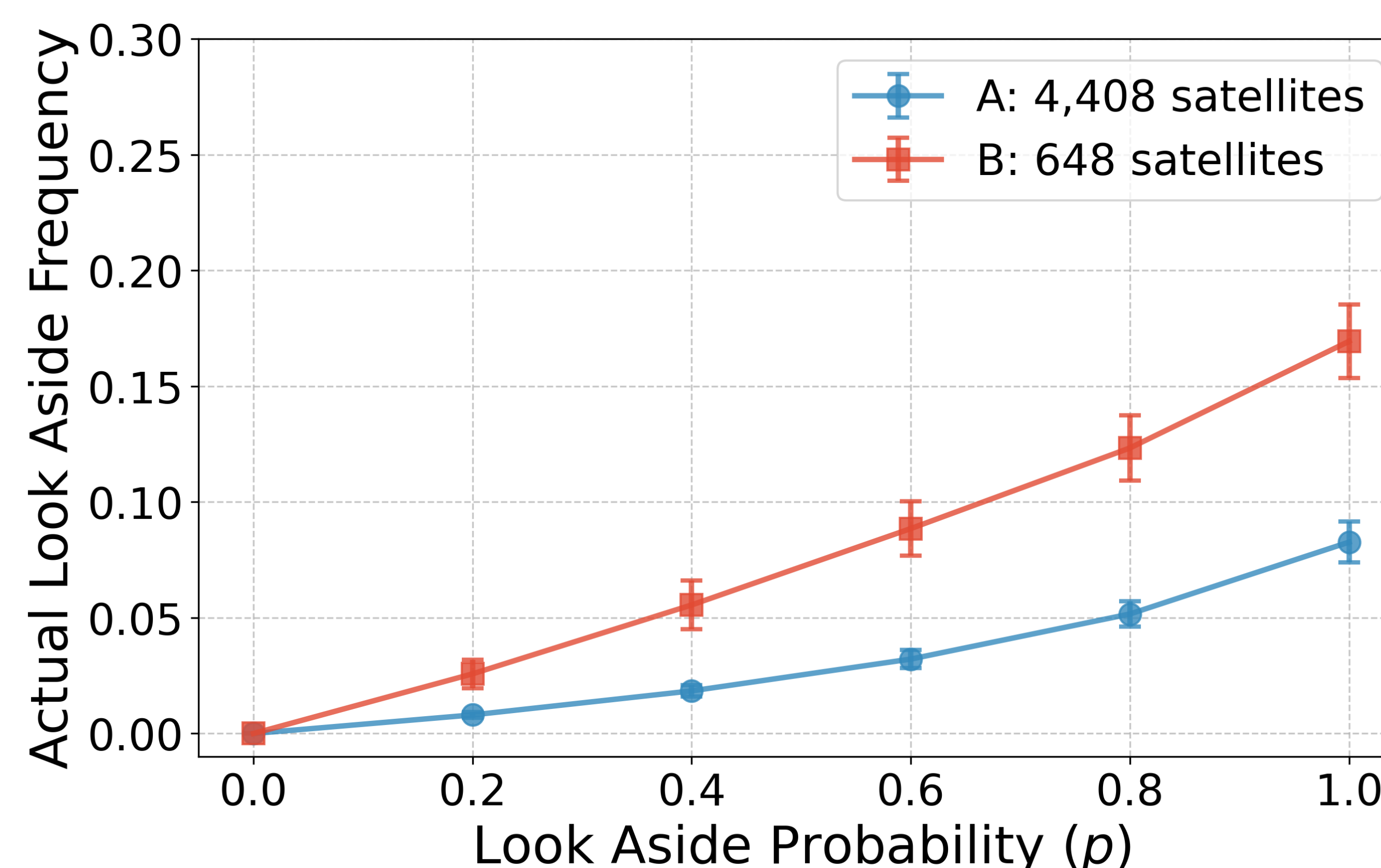


> I see an inline satellite  
 > Flip a coin ~ Bernoulli(p)  
 > Heads  
 > I'm switching satellite

## RESULTS

### Small constellations might need protection from large constellations

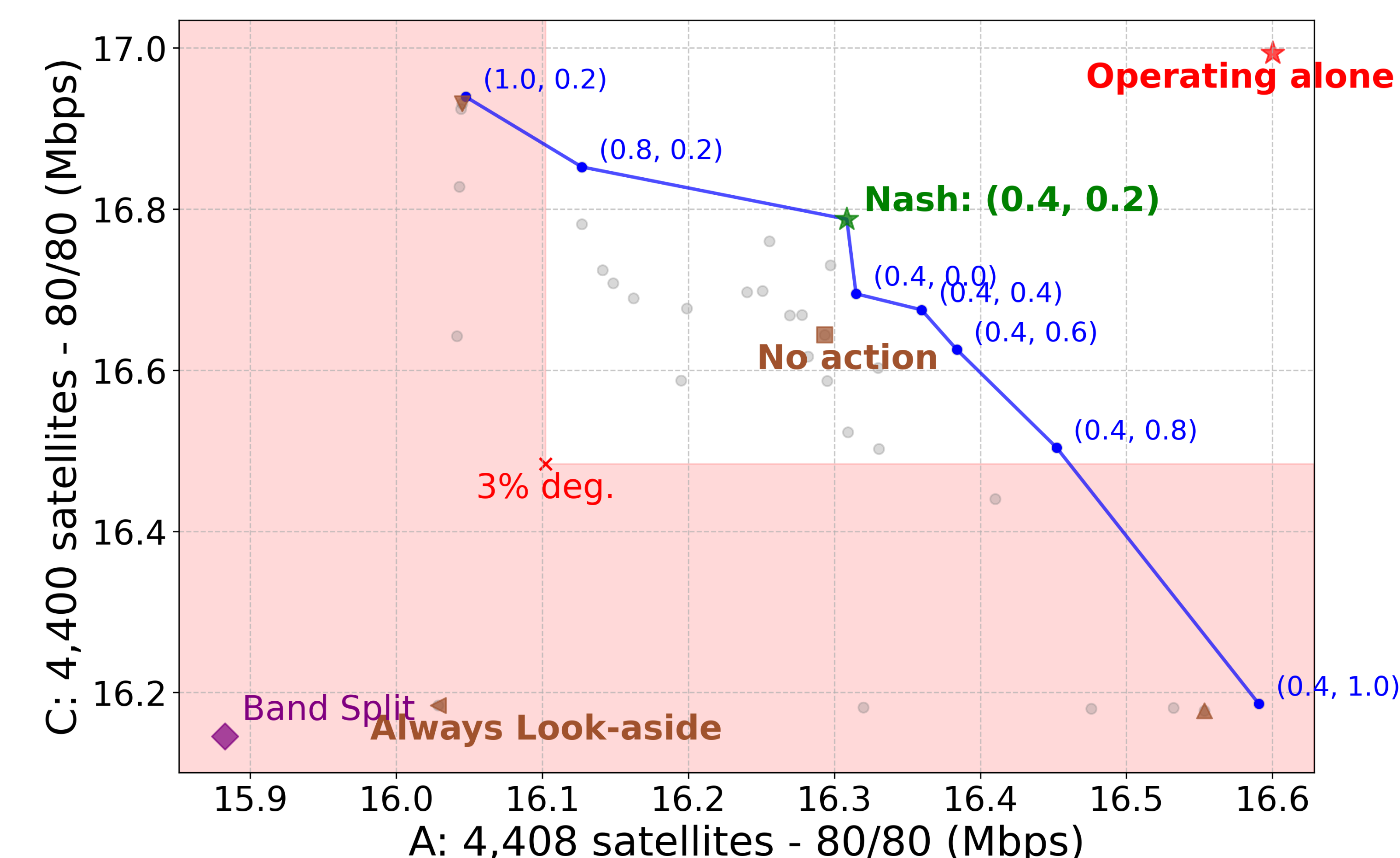
- Large constellations create more in-line events
- Small constellations lose more performance to look aside
- Thus, small constellations have a disadvantage
- **Neither the ITU nor the FCC policy regarding NGSO-NGSO considers constellation size**



## RESULTS (CONT.)

### Comparing mitigation strategies for two equally-sized constellations

- 80/80 metric: rate achieved by 80% of users 80% of the time
- **Band splitting** gives the worst performance: **incentivize coordination**
- No action can be better than always look-aside
- Probabilistic look-aside gives better performance
  - **Nash equilibria:** outcome of operators choosing probabilities independently
  - **Pareto frontier:** outcome of operators negotiating look-aside probabilities
  - Outcomes achieve both strategic stability and Pareto-efficiency



## FUTURE DIRECTIONS

- How much performance improvement can operators achieve by sharing more information?
- Does the benefit of sharing more information outweigh the cost to share?