

Impact of Multi-connectivity on Channel Capacity and Outage Probability in Wireless Networks

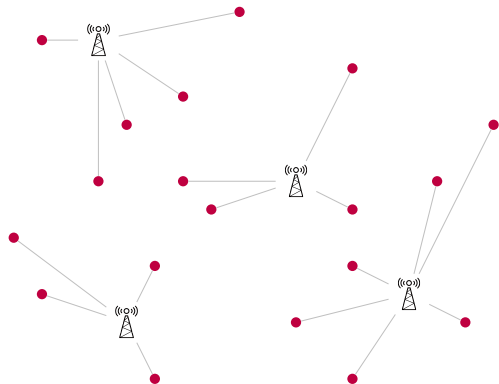
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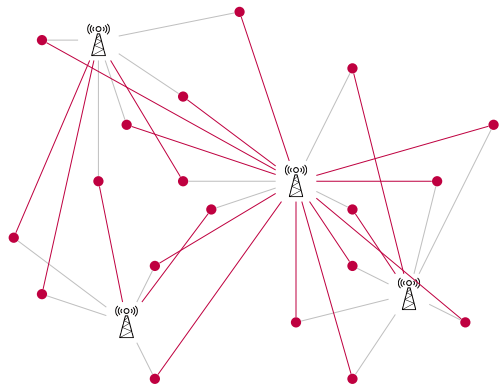
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Outline

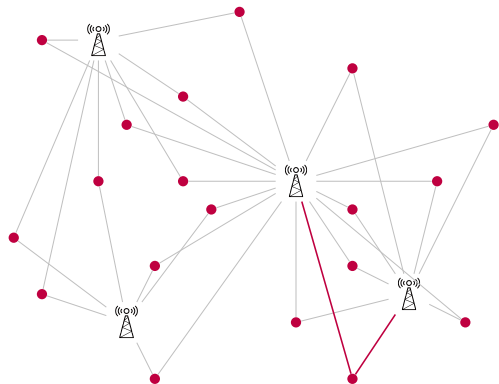


Outline



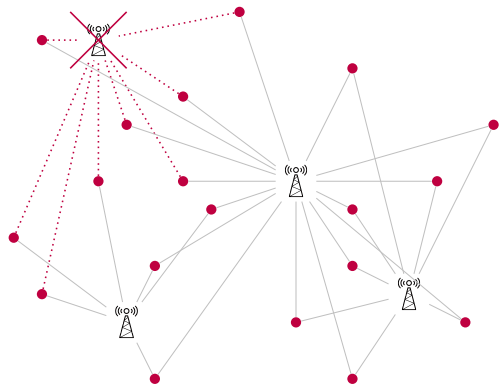
1. Multi-connectivity

Outline



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 - * Channel capacity

Outline

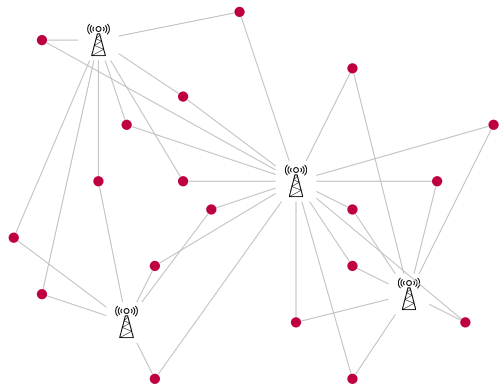


1. Multi-connectivity

* Channel capacity

* **Outage probability**

Outline

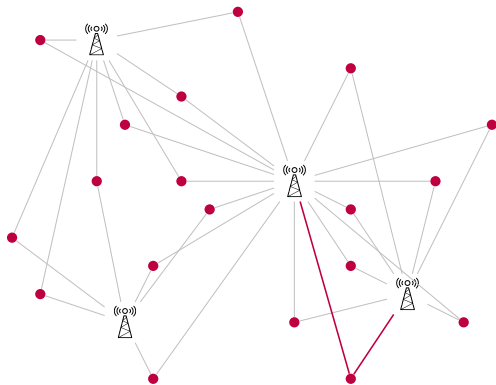


1. Multi-connectivity
 - * Channel capacity
 - * Outage probability

What is the benefit of multi-connectivity?

Model

- Users and base stations are distributed by a Poisson Point Process with densities λ_U and λ_{BS} .
- In the multi-connectivity regime, users connect to the k nearest base stations.



Measures

- **Shannon channel capacity (Shannon, 2001):**

$$C_j = W_j \log_2 (1 + SNR_j)$$

- **Outage probability:** $\mathbb{P}(D_U = 0)$ - a user gets disconnected

Expected channel capacity (approximation)

$$\mathbb{E}(C_{sum}^k) = \frac{\overline{W_{tot}}}{\lambda_U} \frac{\alpha}{2 \ln(2)} \left(\ln(\phi) + \gamma + 1 - \left(H_k + \frac{\lambda_{BS}\pi}{k} \right) \right). \quad (1)$$

Theorem

In the high SNR regime, the sum of the channel capacities, $\mathbb{E}(C_{sum}^k)$, as defined in (1), is decreasing in k .

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Failure models

- **Random failure:** Every BS-U link fails with a probability p .
- **Distance failure:** Links fail when the distance between the user and the BS is higher than a certain threshold.
- **Line-of-sight failure:** Links fail because they are blocked by an object.

Failure models

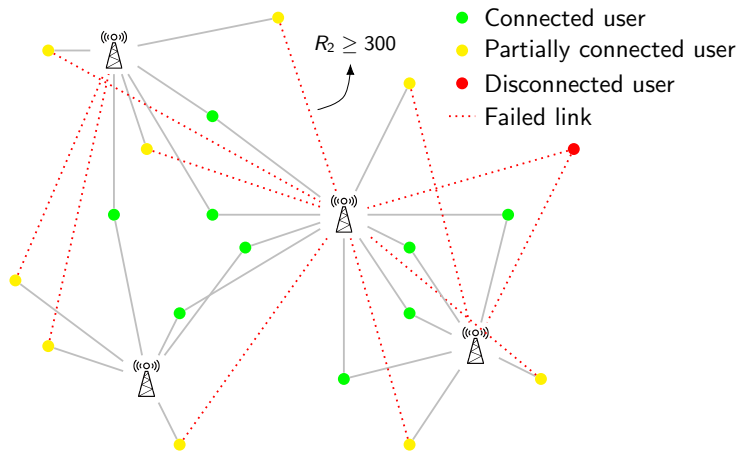
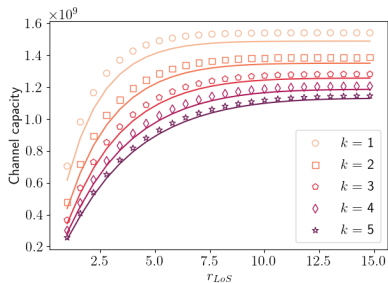
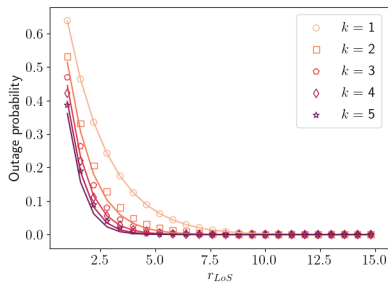


Figure: Distance failure, $r_{max} = 300m$

Simulation results - LoS failure



(a) $\mathbb{E}(C_{sum}^k)$



(b) Outage probability

Figure: Simulated (markers) and calculated (line) expected channel capacities and outage probabilities.

Cumulative distribution

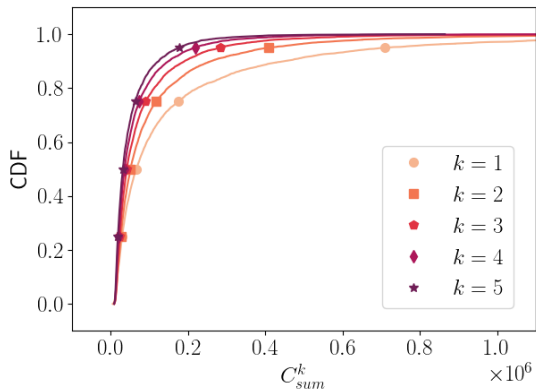


Figure: Cumulative distribution of C_{sum}^k .

Conclusion

In this setting:

Multi-connectivity does not result in more channel capacity,
but the network becomes more *reliable*,
and it results in more *fairness* among users.