On Bounding the Number of Mobiles Sharing a Slot in a Point-to-Multipoint Network

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Outline

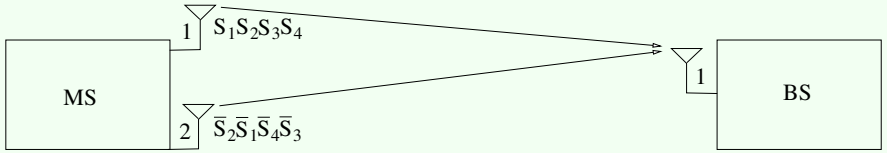
MIMO Techniques

- Spatial Multiplexing
- Spatial Diversity
- Hybrid techniques
- Collaborative Spatial Multiplexing

Necessary Condition

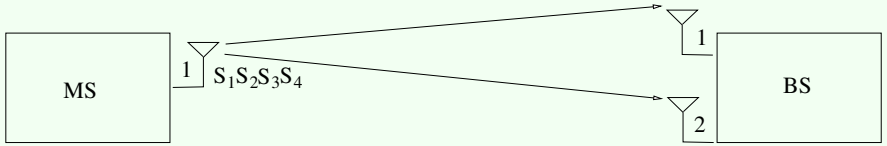
Antennas are separated by a minimum of $\frac{\lambda}{4}$ distance, where λ is wavelength of transmitted signal

Transmit Diversity



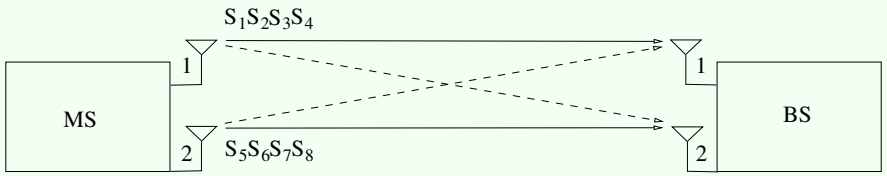
- Several antennas transmit variants of same signal
- Overlapping signals maximize SNR

Receiver Diversity



- One signal is received at several antennas
- Receiver combines signals to maximize SNR

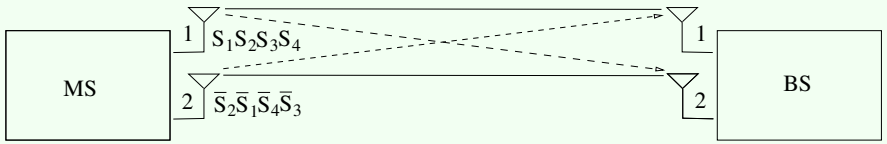
Spatial Multiplexing



- Different signals at different antennas
- Exploits multi-path propagation

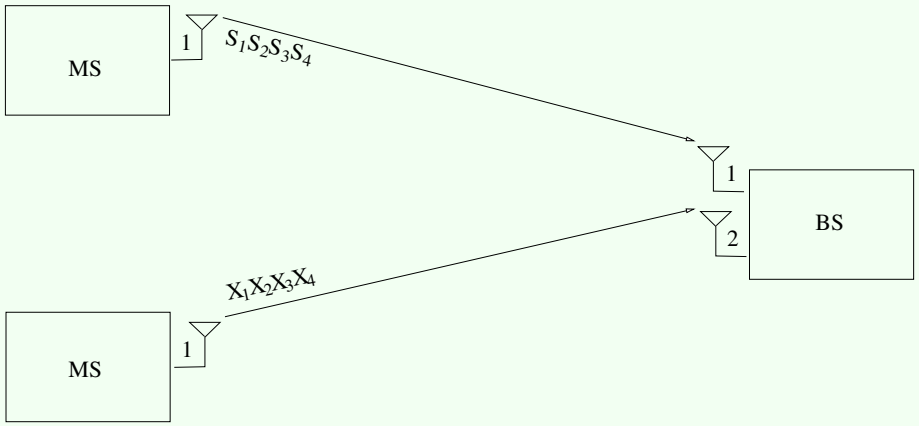
Hybrid Techniques

Alamouti Technique



- Variant of diversity techniques
- Simple receiver combining technique

Collaborative Spatial Multiplexing



- Two Mobile Stations (MSs) transmit at same time
- MSs are scheduled such that interference is negligible
- Improves throughput of the network
- Each MS is equipped with only one antenna
- Typically known as Virtual MIMO (V-MIMO)

Interference Minimizing Techniques

Beamforming

- Data is transmitted along a vector
- Received along another vector
- Choosing vectors is dependent on channel quality between transmitter and receiver

Interference Nulling

- Transmitter 2 nulls its signal at receiver 1
- Choosing vectors is dependent on channel quality between transmitter 2 and receiver 1

Interference Alignment (IA)

- Each transmitter nulls its signals at **every** receiver except one receiver
- Choosing vectors is dependent on channel quality between **every** transmitter and receiver in the network

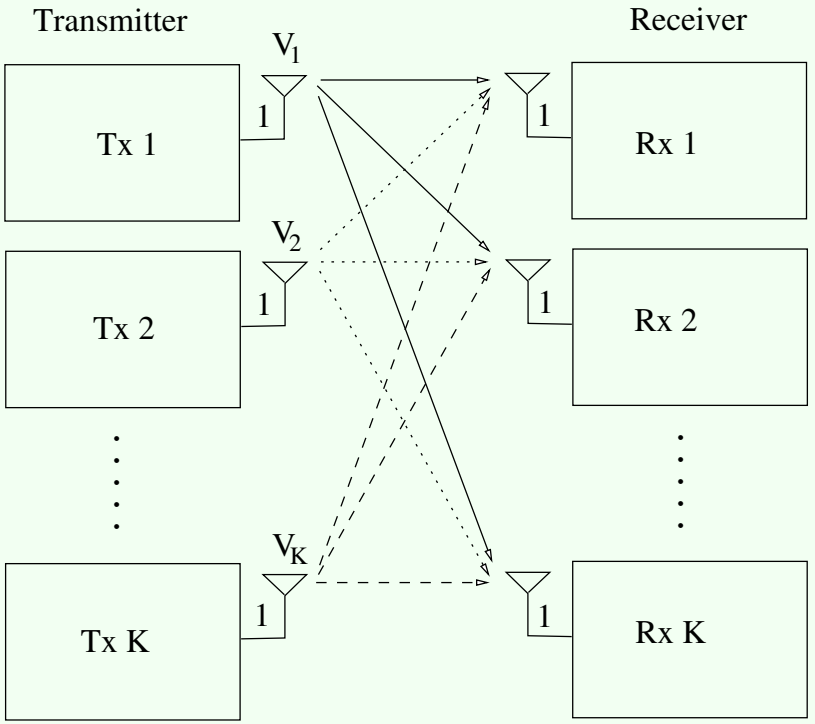


Figure: Interference Alignment

Motivation

In a distributed network

- Each user pair (with one antenna) can transmit data successfully for half the time
- Each user pair with antennas greater than the on-going number of streams can transmit data in same slot

- Similar Studies are unavailable in a centralized network
- C-SM proposes only **two** MSs to share slot

Problem Statement

Find the maximum number of MSs that can share a slot in a centralized network

- Each MS is equipped with multiple antennas
- Each MS has a constant rate requirement
- Each MS moves with a velocity of $0 - 120$ Kmph

Finding Maximum Number of Mobiles that can Share a Slot

System Model

- K MSs, each with two antennas share a slot for transmission
- Each MS utilizes different MIMO technique for transmission
- Inter Carrier Interference (ICI) occurs in the network

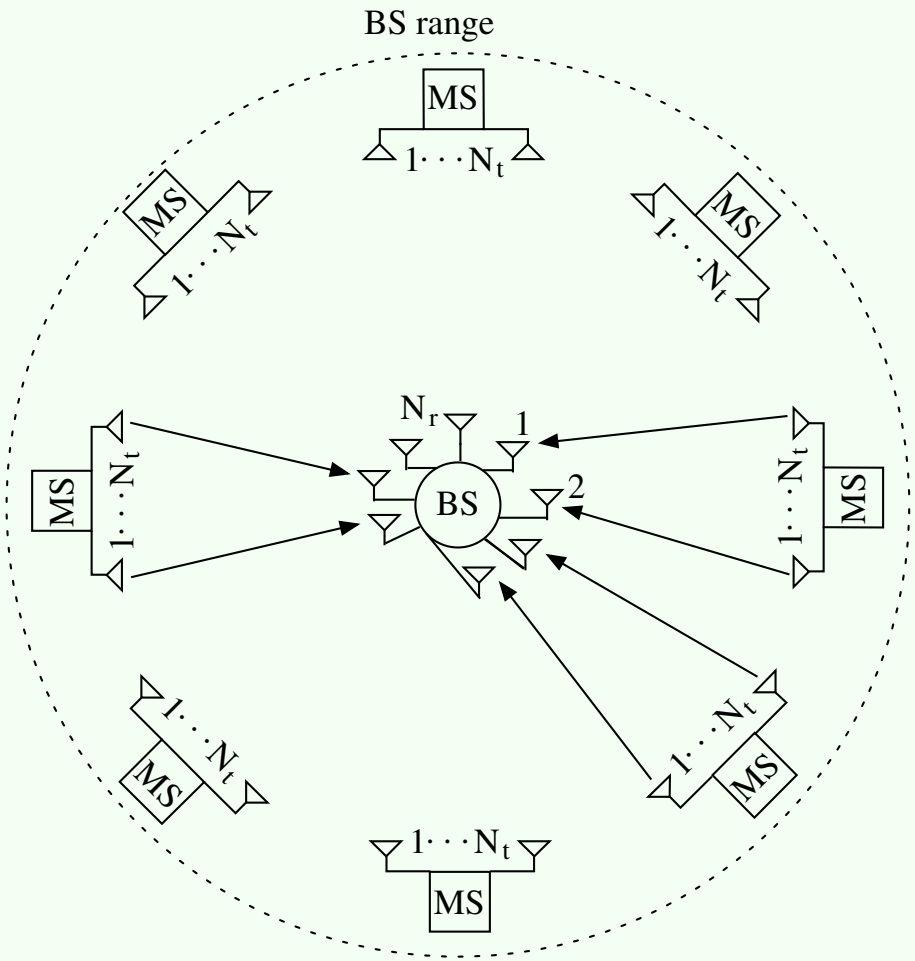


Figure: System Model using IA at each MS

Numerical Results

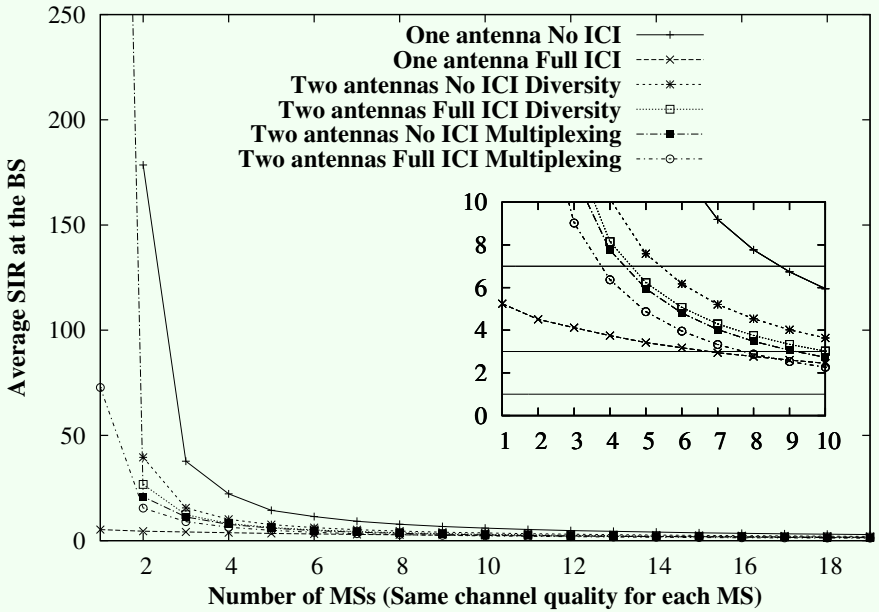


Figure: Same SNR Values at Each MS

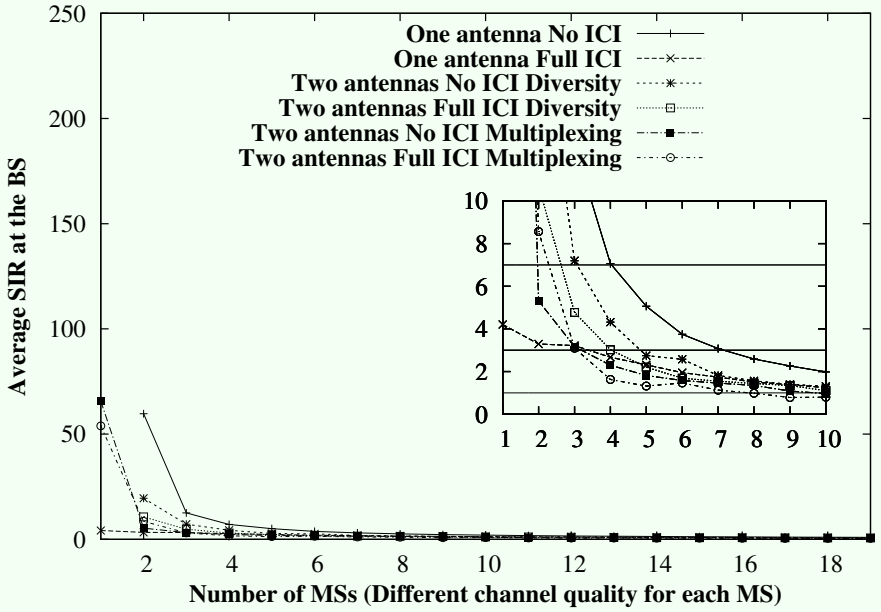


Figure: Different SNR Values at Each MS

Numerical Results

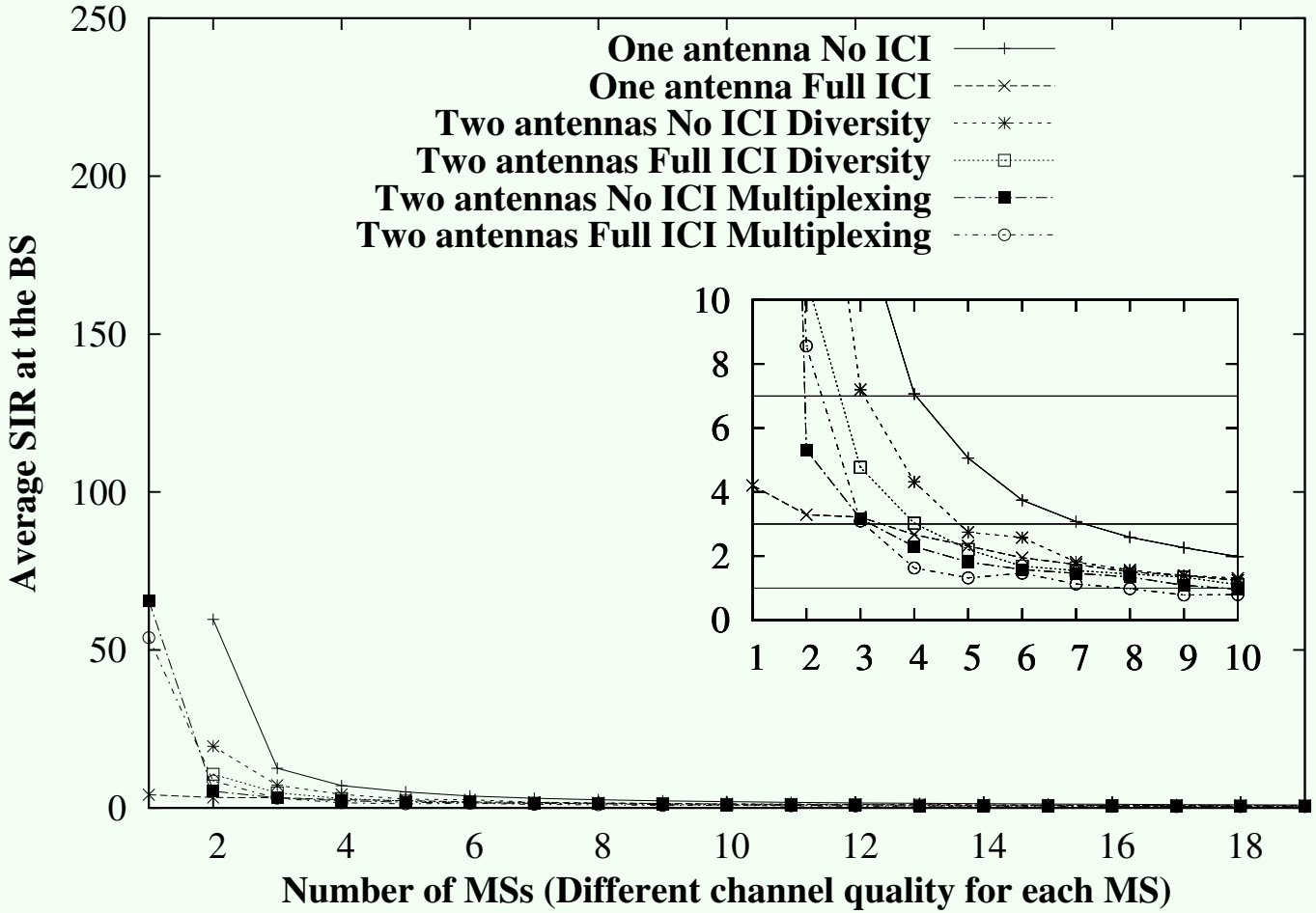


Figure: Different SNR Values at Each MS

Conclusion

Number of MSs that can share a slot depends on

1. Probability of occurrence of ICI in the network
2. MIMO technique used at each antenna
3. Number of antennas at each MS
4. Rate requirement at each MS

Future Work

- Study the system for varying rate requirements at each MS
- Study the system for varying number of antennas at each MS

Questions?

- Please visit *hpcn.cse.iitm.ac.in/phani/home.html* for a detailed project Report