A Protocol for Link Blockage Mitigation in mm-Wave Networks

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Introduction

The expansion of wireless enabled devices along with data hungry applications and services have made the emergence of new high performance wireless technologies inevitable. The current frequency spectrum used (sub 3 GHz) is very populated and has shortage of frequency band to accommodate new traffic demand. millimeter wave (mmW) technology works in an enormous frequency band between 30 GHz-300 GHz.

Cons:

- High penetration loss (compared to sub 3 GHz band)
- Non-omnidirectional due to high attenuation (directional beams)
- Can be easily blocked by objects like human body

Problem and Solution

Problem statement:

- How to decrease the effect of human body blockage on dynamic outdoor mmW links?

The proposed solution:

- Previous blockage incidents (history)
  - Used to make informed decisions on associating UEs to BSs

System Model

Nodes settings

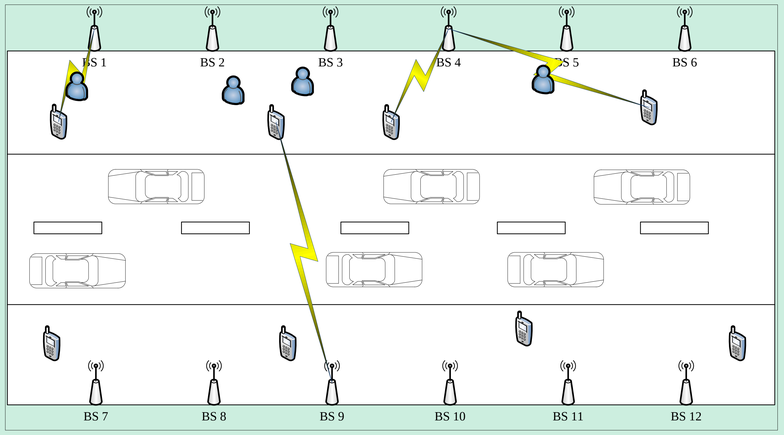
- Constant number of UEs, BSs and blocking objects (BO)
- Constant radius of communication of UEs and BSs

Rate and signal to interference and noise ratio (SINR)

- Computed based on models developed for mmW links

C-RAN primer

- A centralized control entity to provide wireless networks with integrated control
- C-RAN is used to collect and integrate blockage history information



Proposed Method Components

Three components of the proposed method

- Blockage detector component (BD)
- Blockage point collector component (BPC)
- Device association component (DA)

Blockage detector component (BD)

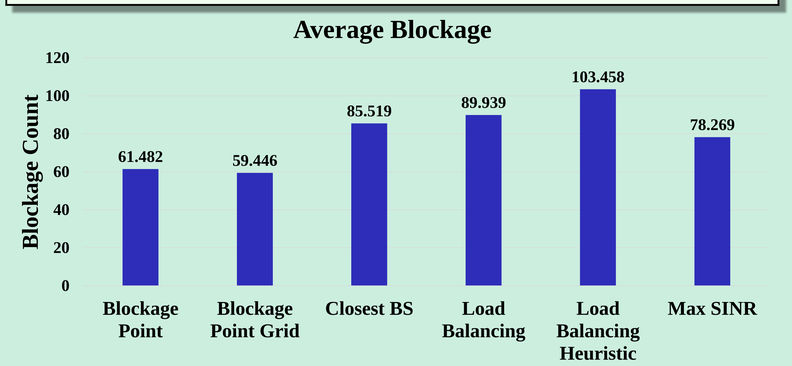
- Detects blockage
  - By measuring RSSI values
- Sends information in blockage information packet (BIP) to associated BS
- BS forwards BIP to C-RAN

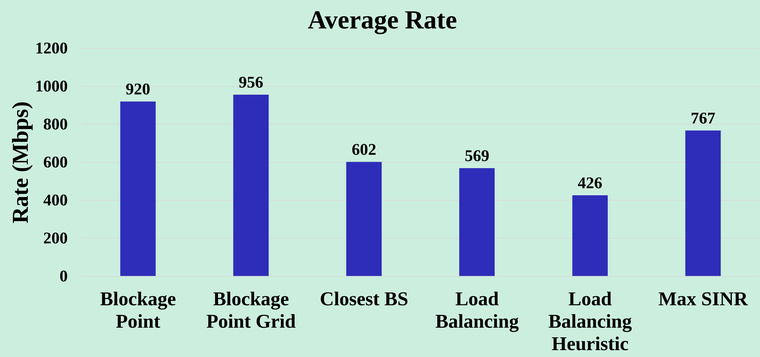
Blockage point collector component (BPC)

- Resides in C-RAN
- Collecting BIPs from all UEs in network and storing them
- Information used to compute blockage score
- Blockage score
  - Quantity computed to determine the blockage likelihood of a UE in a certain location trying to connect to a specific BS
  - Computed as sum of delta functions of blockage points at current location of UE
  - Blockage points happened in neighborhood of UE on links from some UEs and current BS
- Delta function
  - Decreasing function of distance between blockage point and UE
    - Defines the effectiveness of a blockage point on a link
  - Two types
    - Inverted distance
    - Inverted exponential distance

Device association component (DA)

- Uses blockage scores computed by BPC to select the best BS
- Blockage scores of current UE to all BSs in its range are computed by BPC
- BS associated to minimum blockage score is selected for association
- Selected BS does not have capacity for new UE
  - Second best is selected





Conclusion

- Proposed method improves blockage count and rate
- Embedding proposed heuristic in load balancing algorithm has negative effect
- Possible future research
  - Embedding or joint optimization of proposed blockage score with other UA metrics
- Moving nodes assumed to move with slow pace with predictable direction
- More dynamic situation incurs more overhead

M. Zarifneshat, C. J. Liu and L. Xiao, "A Protocol for Link Blockage Mitigation in mm-Wave Networks," 2017 IEEE 14th International Conference on Mobile Ad Hoc and Sensor Systems (MASS), Orlando, FL, 2017, pp. 215-223.