Project: IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs)

Submission Title: [Handover Strategy for High-speed Rail Communications]
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Abstract: []

Purpose: [For discussion]

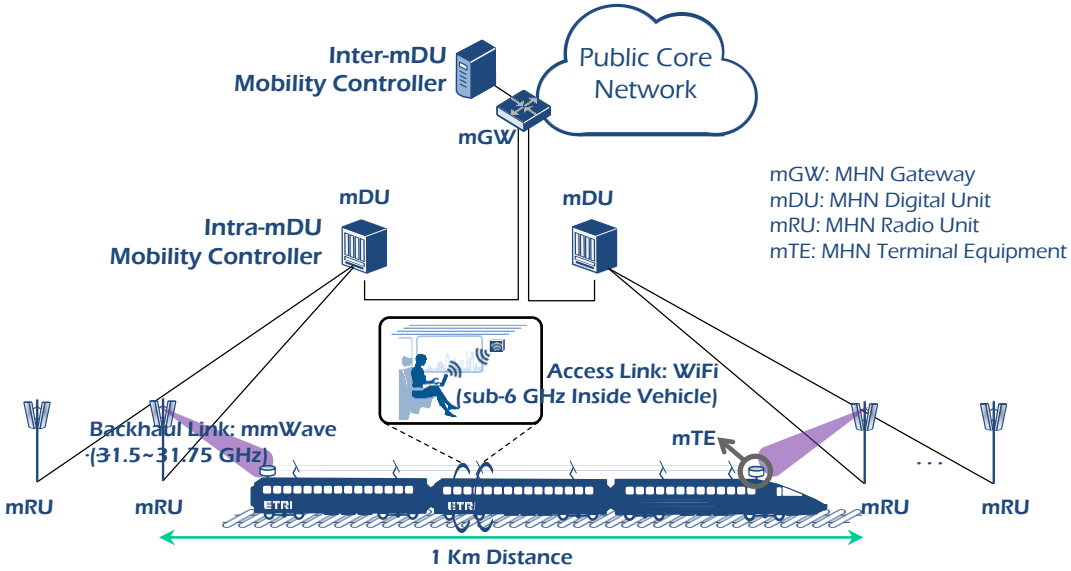
Handover Strategy for High-speed Rail Communications

Outline

- Background
- Network Deployment for Dual-antenna HSR Communications
- Antenna Pattern and Channel Gain
- Handover Strategy for HSR Communications
- Discussions

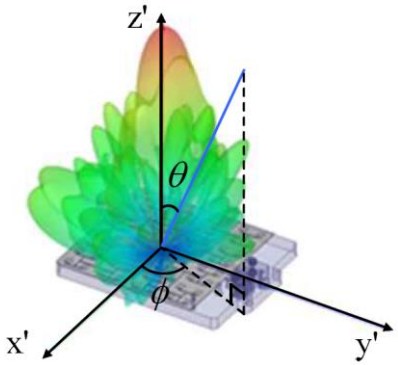
Background

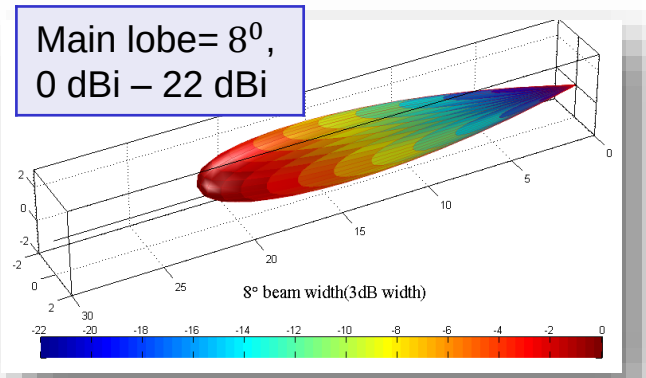
- Mobile wireless backhaul supporting very high traffic volume on new frontier bands (mmWave)
  - Backhaul link : use mmWave
  - Access link inside vehicle : use sub 6GHz (Wi-Fi or Small cell)



Network Deployment

- Directional Antennas
  - Yagi antenna
  - Horn antenna
  - Helical antenna
  - Panel antenna

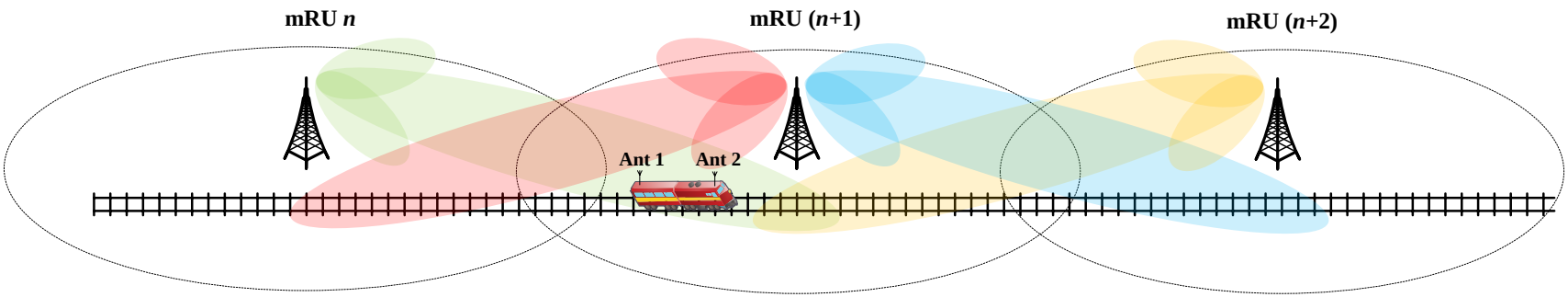




Carrier frequency	32 GHz	mmWave
MIMO Conf.	1 x 2 [DL] 2 x 1 [UL]	Directional antennas
Distance between mRUs	1 Km	
Antenna height	10 m for mRU 3 m for mTE	Can be varied
Mobility	Up to 500 Km/h	

Network Deployment

- Assumptions
  - Free space channel model without the consideration of shadowing
    - The railway are deployed in the suburban environment (80% wide suburban & 20% tunnel), where the shadowing and reflections are rarely existed.
  - mRUs are deployed dedicated for the rail communications
    - LoS path
  - Antenna radiation
    - Same type of antennas for mRU and mTE

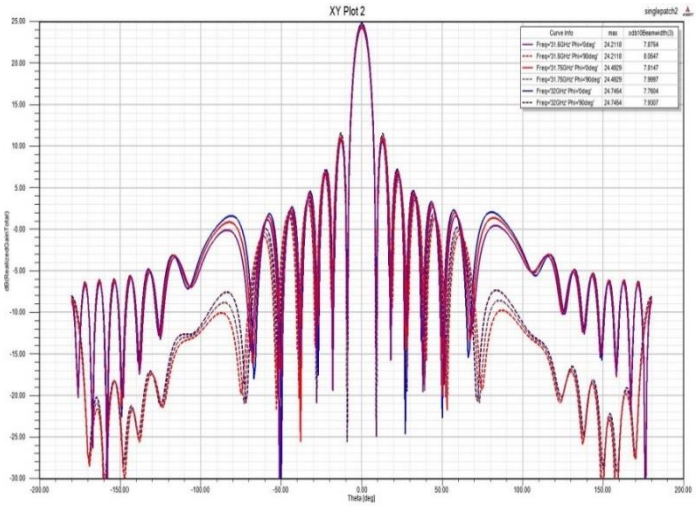


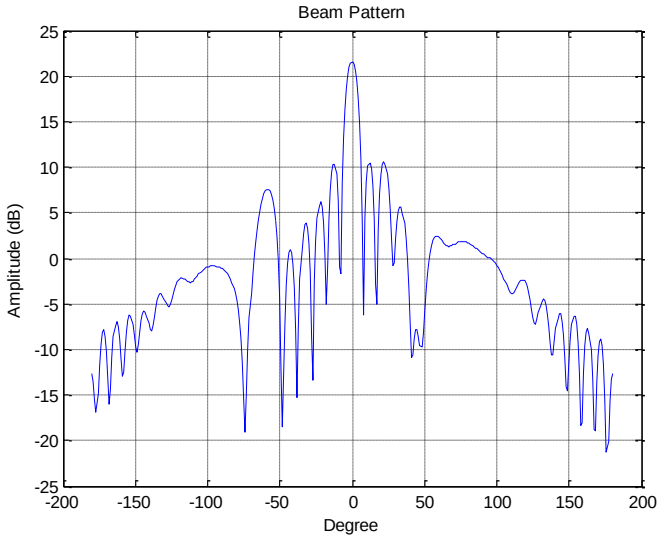
Antenna Pattern and Channel Gain

- PL Model & Radiation Pattern
  - PL model
    - Free space PL model [ITU-R]

$$L_s = 20\log\left(\frac{4\pi d}{\lambda}\right) = 92.45 + 20\log f_{GHz} + 20\log d_{km}[dB]$$

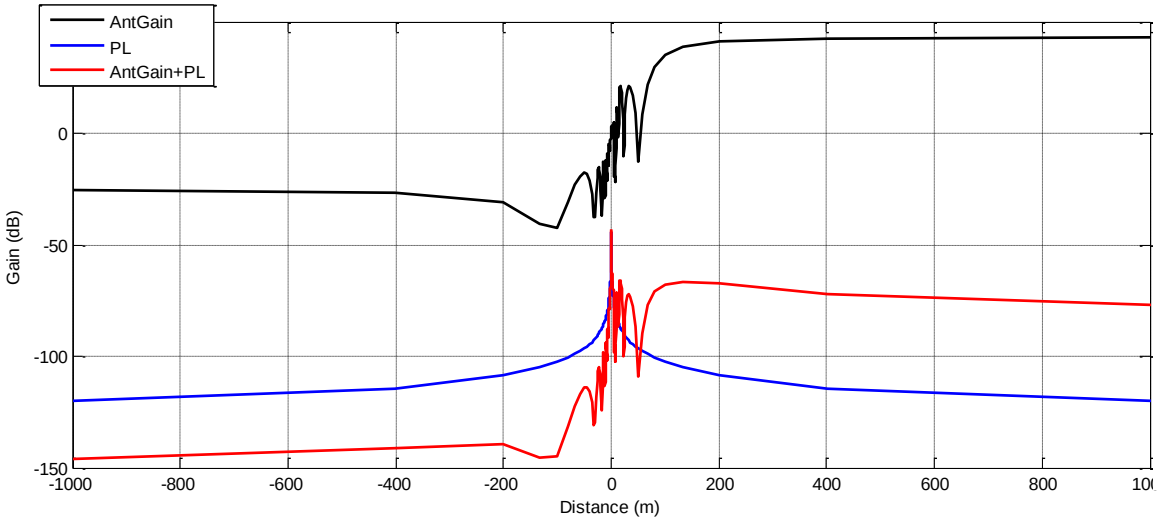
  - Antenna radiation pattern

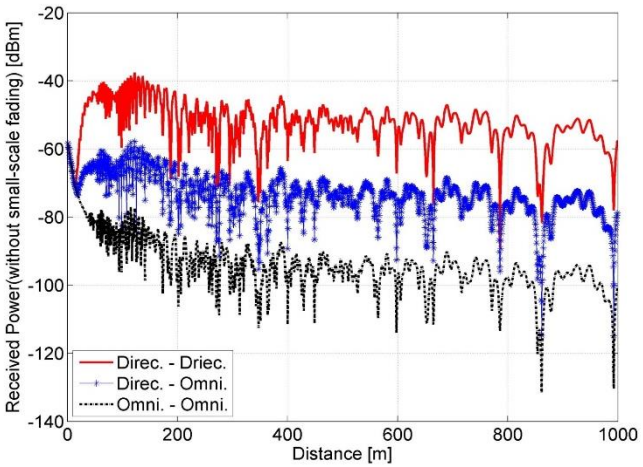




Antenna Pattern and Channel Gain

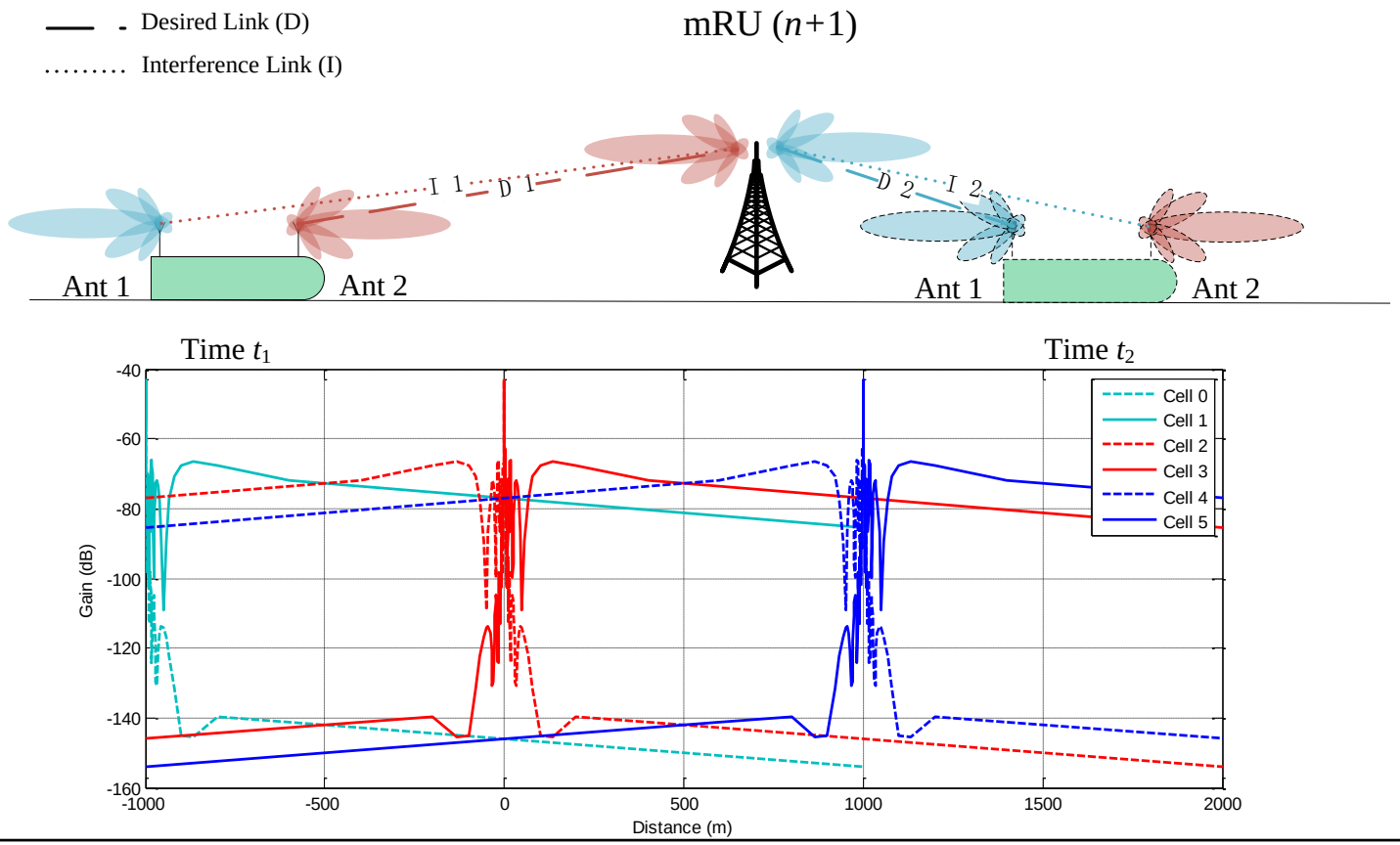
- Assumptions for Analysis
  - Assume the antenna radiation pattern for both Tx antenna and Rx antenna are identical.
  - Assume the radiation pattern is launched in horizontal direction, and both of patterns are parallel to each other.
  - The antenna gain is calculated by adjusting the angular.





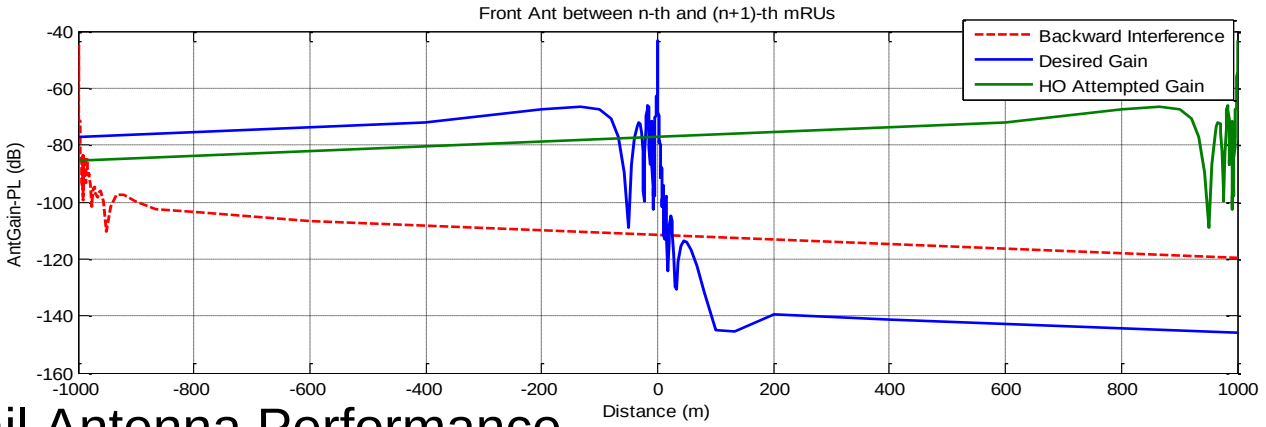
Antenna Pattern and Channel Gain

- Multicell Scenario

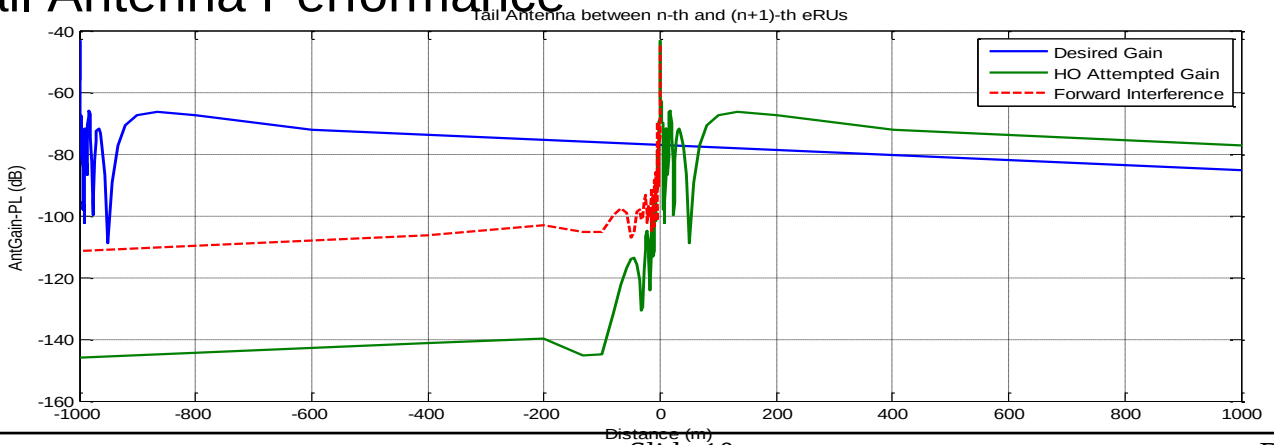


Antenna Pattern and Channel Gain

- Head Antenna Performance



- Tail Antenna Performance

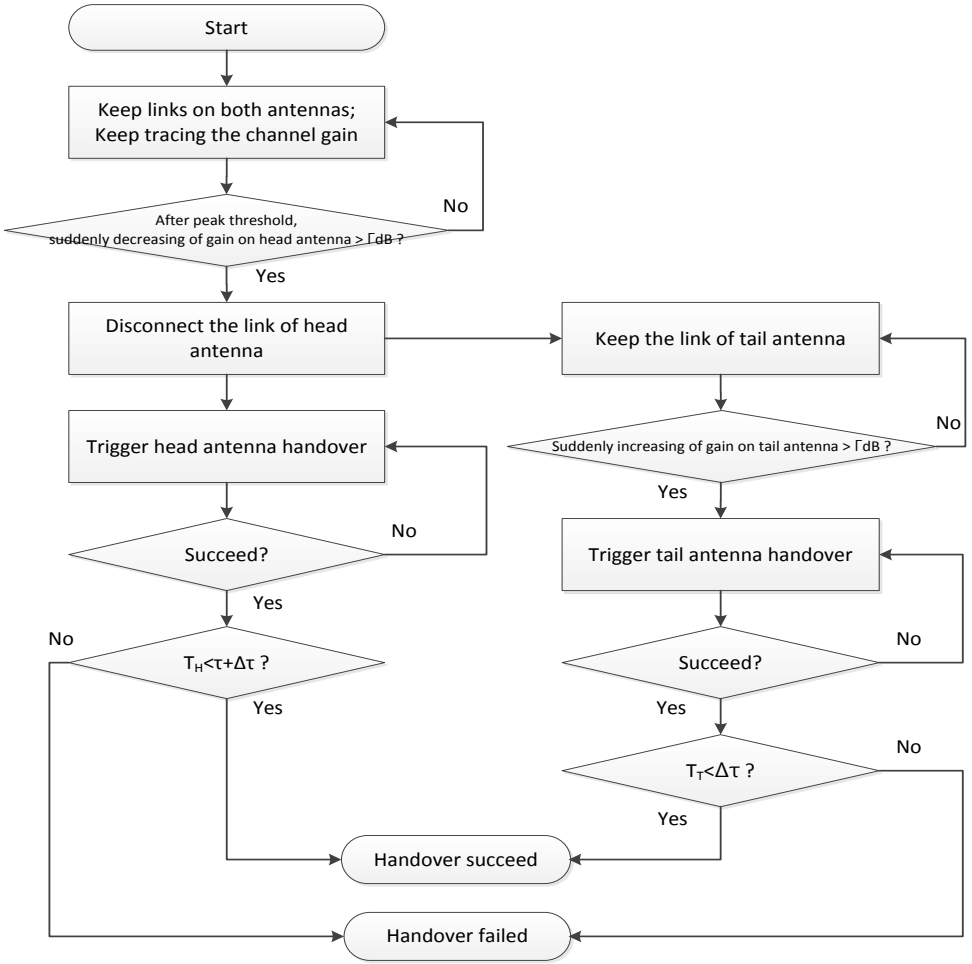


Antenna Pattern and Channel Gain

- Discussion
  - Mostly, the backward interference level is below 25dB
    - Due to the adoption of directional antenna
  - Due to the radiation pattern, a through of wave exists before arriving at the serving mRU.
    - Can be considered as the preparation point for HO
    - For the head antenna, the HO is triggered in advance.

Handover Strategy for HSR Communications

- HO Trigger



Discussions

- No soft HO
  - Due to high complexity & work burden for redesign the full system including the HW
  - Make it compatible to existing cellular systems (LTE)
- Assumptions
  - Pilot and control information are always available for measurement report [trigger condition]
- Conclusions
  - Different HO procedures for head antenna & tail antenna are necessary.
    - For head antenna, the HO preparation should be done before the 1st deep through, then HO is triggered at the 1st deep through even it is a little earlier.
      - How can we know when to trigger?
      - To avoid ping-pong effect due to early trigger HO
      - DL power control should be forbidden since the wrong time of HO triggering will lead to failure.
      - HO when meeting