Extending Range and Mobility of 60 GHz Networks

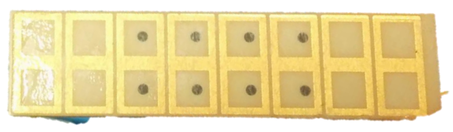
Guillermo Bielsa [1,2], Adrian Loch [1], Joerg Widmer [1]
[1]IMDEA Networks Institute, [2]University Carlos III of Madrid

Motivation

- **Millimeter-wave communications are being considered for 5G networks:**
  - Understanding the performance of 60GHz COTS is important: both static and mobile
- **Short range communication links:**
  - Experimentally check if frequency selectivity can be exploited to extend range

60GHz COTS Static & Mobility study [1]

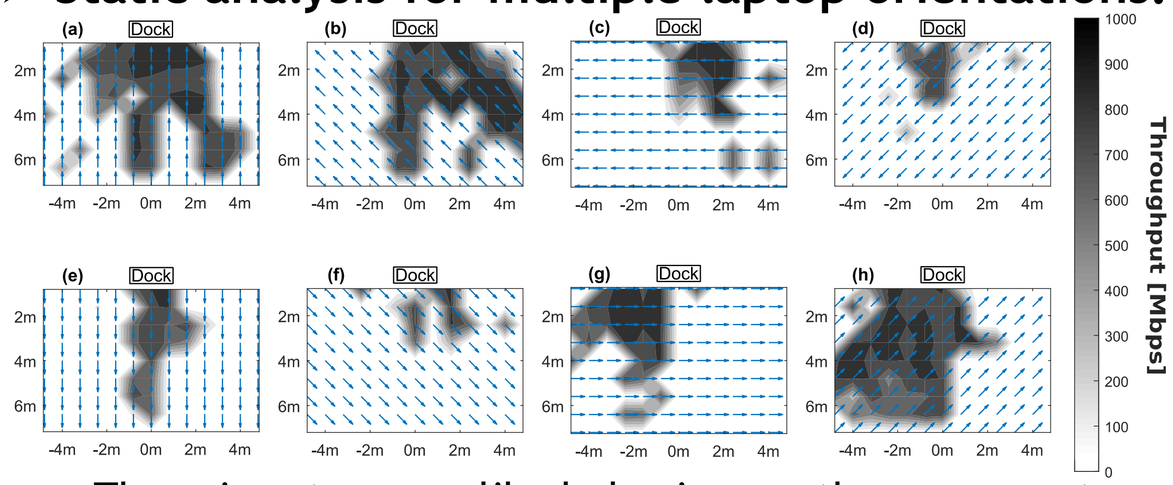
Dell D5000 docking station with phased antenna array



Comparison between:

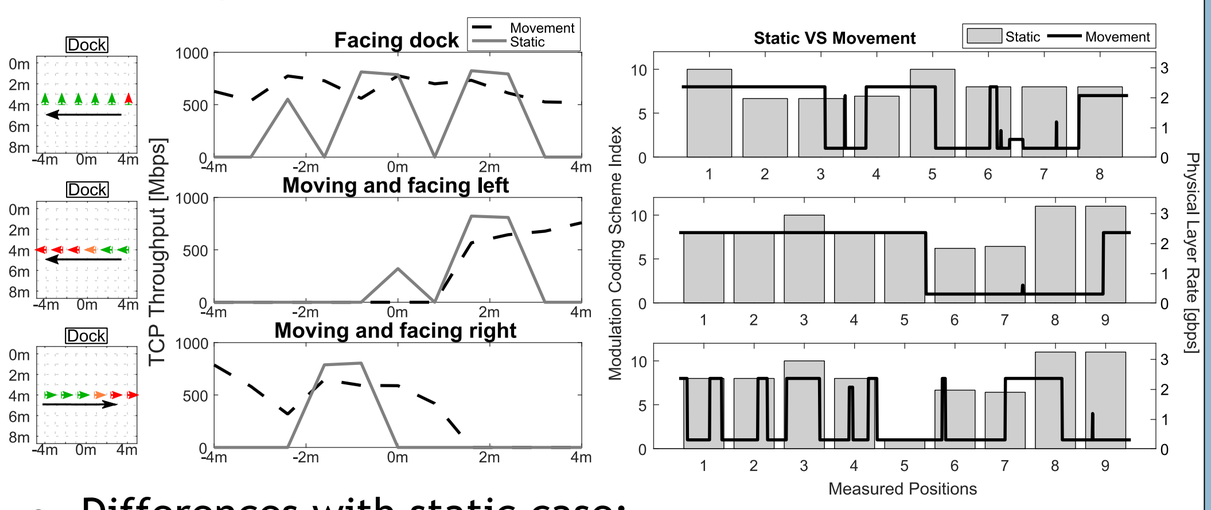
- Static and mobile measurements
- For different trajectories

Static analysis for multiple laptop orientations:



- There is not a cone-like behaviour as theory suggest:
  - Irregular beam patterns
  - Impact of antenna placement

Mobility evaluation:



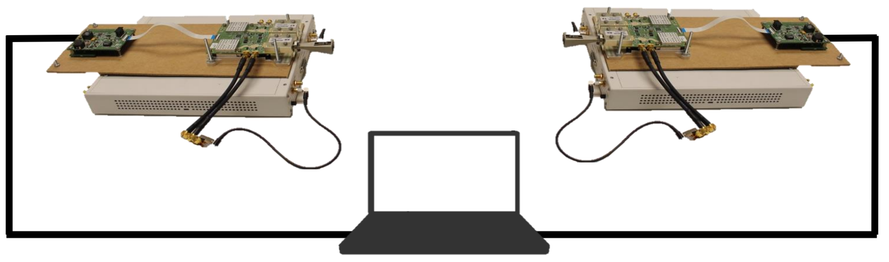
- Differences with static case:
  - Throughput decrease on ~30% on average
  - Data & Control packets increase with movement
  - High link robustness in dynamic scenarios

	Static	Mobile	Difference
Throughput	790.7Mbps	606.8Mbps	-30.29%
Num. Control Pkts	603.3pkts/s	883.6pkts/s	31.71%
Num. Data Pkts	24310pkts/s	26780pkts/s	9.22%
Ratio Control/Total	2.42%	3.19%	31.81%
Control Pkt Error Rate	0.02%	0.36%	94.11%
Data Pkt Error Rate	0.0004%	0.45%	99.92%

Further research on better beam-training mechanisms for mobility is required

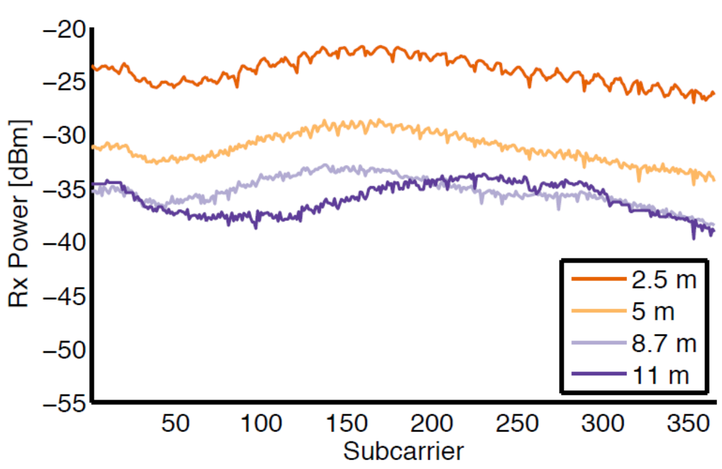
Exploiting Frequency Selectivity [2]

- **Equipment:**
  - SDR: USRP X310
  - 60 GHz Converter: Sivers IMA FC1005V/00
  - 20º horn antenna

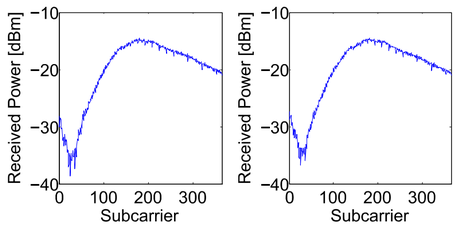


- **We can exploit frequency selectivity**
  - Channel measurements show frequency selectivity
  - Constant channels and carriers in static scenarios

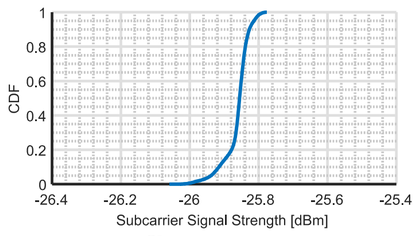
Channel measurements



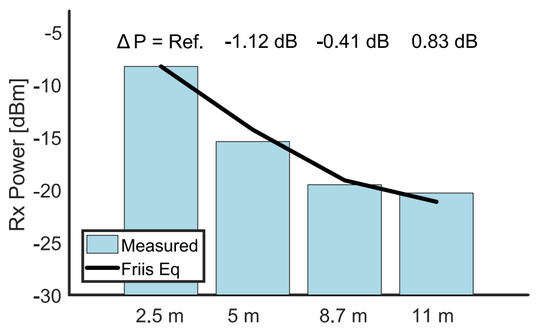
Consecutive measurements

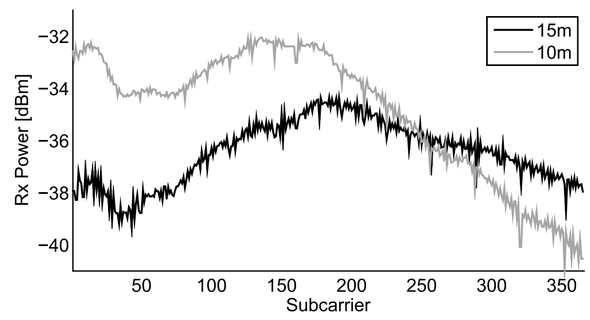


CDF one carrier, one hour

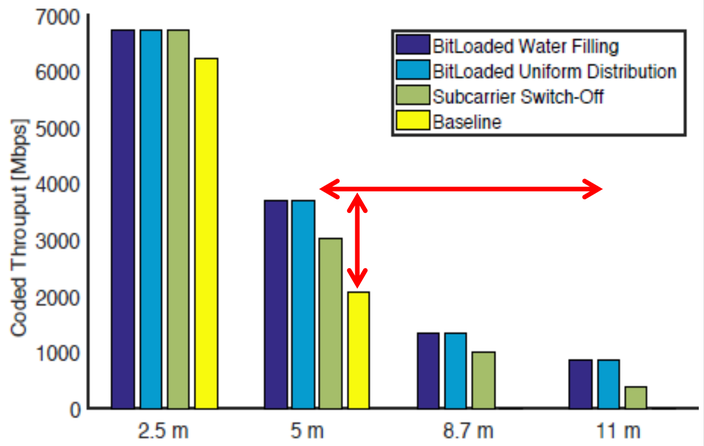


- There are constructive and destructive reflections





- **Results for Lab scenario**
  - 100% link distance increase
  - Up to 80% link rate increase at distance 5m
  - Simple mechanisms as Subcarrier Switch-off achieve a significant gain



Reference

[1] 60GHz Networking: Mobility, Beamforming, and Frame Level Operation From Theory to Practice. Guillermo Bielsa, Adrian Loch, Irene Tejado, Thomas Nitsche, Joerg Widmer. (Under submission)

[2] 60 GHz Range Boost: Exploiting Frequency Selectivity in Millimeter-Wave Networks. Guillermo Bielsa, Adrian Loch, Joerg Widmer.
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