TSG-RAN WG1 #85 R1-165352
Nanjing, China, May 23 – 27, 2016

Source: Ericsson, AT&T, ETRI, Huawei, HiSilicon, Intel, KT Corporation, Nokia, NTT DOCOMO, Qualcomm, Samsung
Agenda Item: 7.2.2
Document for: Discussion, Decision

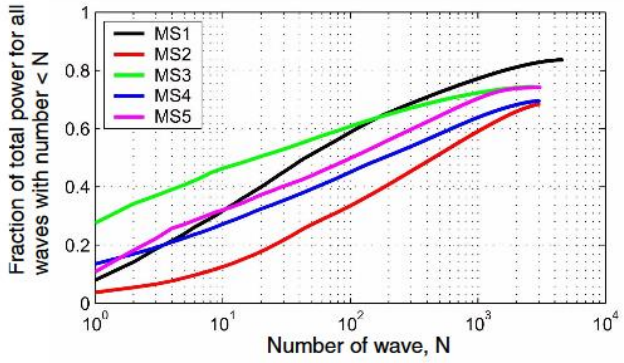
On number of clusters and paths within clusters

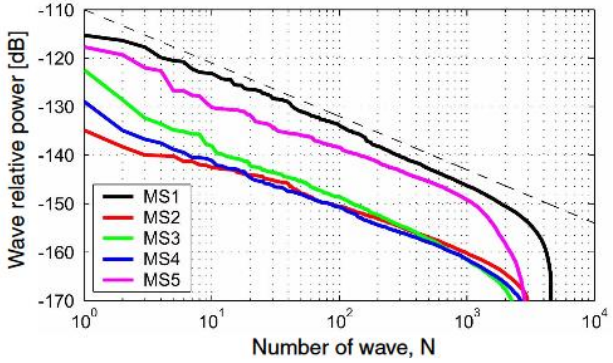
Background

- As agreed in R1-161742, the design target of the new channel is to support large bandwidths and large antenna arrays
- Also agreed in R1-161679 the following:
  - *"Proposal: The possibility to modify the cluster distributions in delay and the sub-path distributions within clusters should be studied in order to support simulations with large bandwidth"*

- The current agreements and working assumptions have 4-20 clusters and 20 equal power MPCs per cluster
- This contribution looks into some experimental evidence regarding the number of MPCs and their power distribution

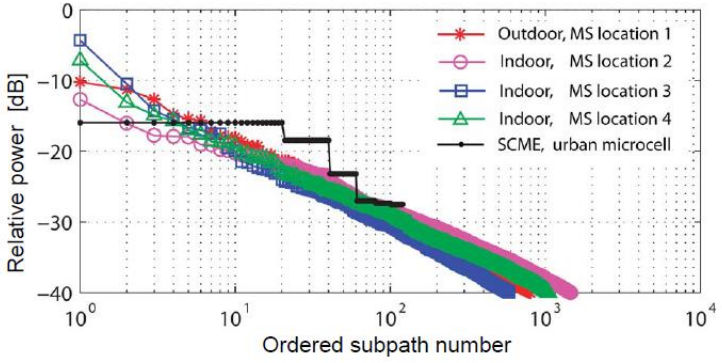
Number of MPCs
Macrocell





- Figure shows ordered power distribution of number of MPCs from small macrocell measurements at 5 GHz [1],[2]
  - Bandwidth 200 MHz, delay resolution 5 ns
  - MIMO array sizes 16x256 (BSxMS), superresolution applied

- Observation 1: Around 400 MPCs capture 50-70% of the total channel power in a small macrocell
  - For 5 ns delay resolution and high angular resolution
- Observation 2: MPC power distribution is continuous, unlike 3D SCM model



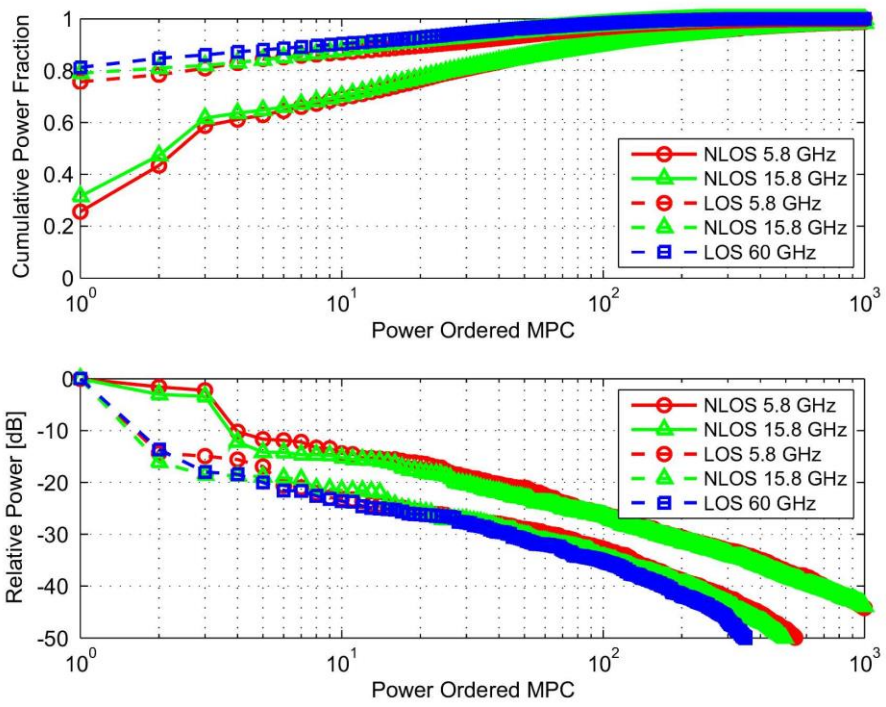
[1] J. Medbo, M. Riback, H. Asplund, J-E. Berg, “MIMO Channel Characteristics in a Small Macrocell”, in *Proc. of IEEE VTC’05, Dallas, September 2005.*

[2] J. Medbo, M. Riback and J.-E. Berg, “Validation of 3GPP Spatial Channel Model including WINNER Wideband Extension using Measurements”, in Proc of VTC 2006 fall, Montreal.

Number of MPCs
Indoor

- Figure shows ordered power distribution of number of MPCs from indoor measurements [3]
  - Bandwidth 150 MHz, delay resolution ~7 ns
  - Array size 25x25x25, angle resolution ~5°x5°

- Observation 3: The number of MPCs is very similar over the 6-60 GHz frequency range
- Observation 4: Around 400 MPCs required to capture 95% of the channel power in an indoor cell
  - For 7 ns delay resolution and 5°x5° degree angular resolution



[3] R1-163254 “On the frequency dependence of LSPs”, Ericsson, Busan, South Korea, April 11 – 15, 2016

Distribution of angles within cluster

- Figure from [4] shows measured macrocell AOA path distribution from [5] compared with WINNER model

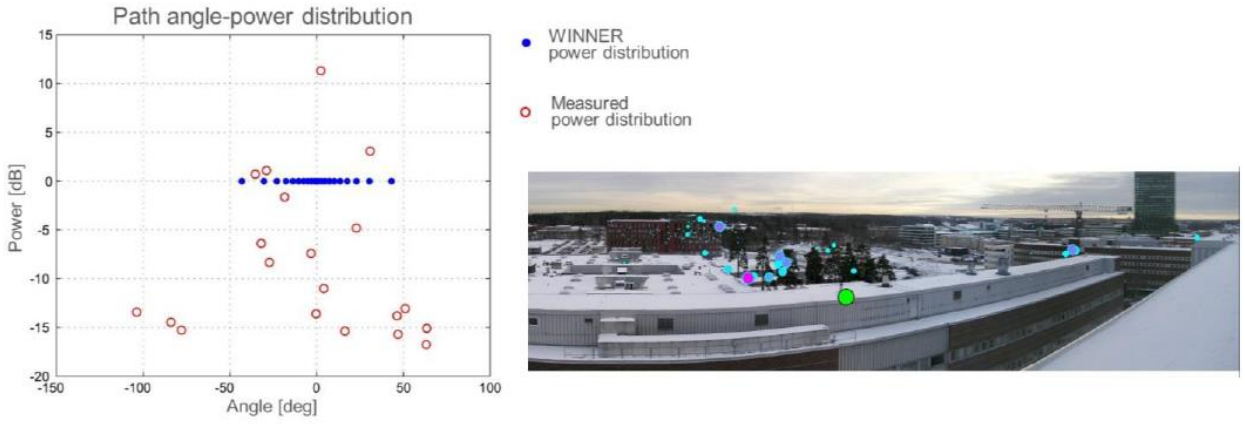


Figure 5-15: Real measured [MAB+12] path directional distribution compared with WINNER type (left) of distribution. The photograph (right) shows the measured paths (circles) as seen from the base station location.

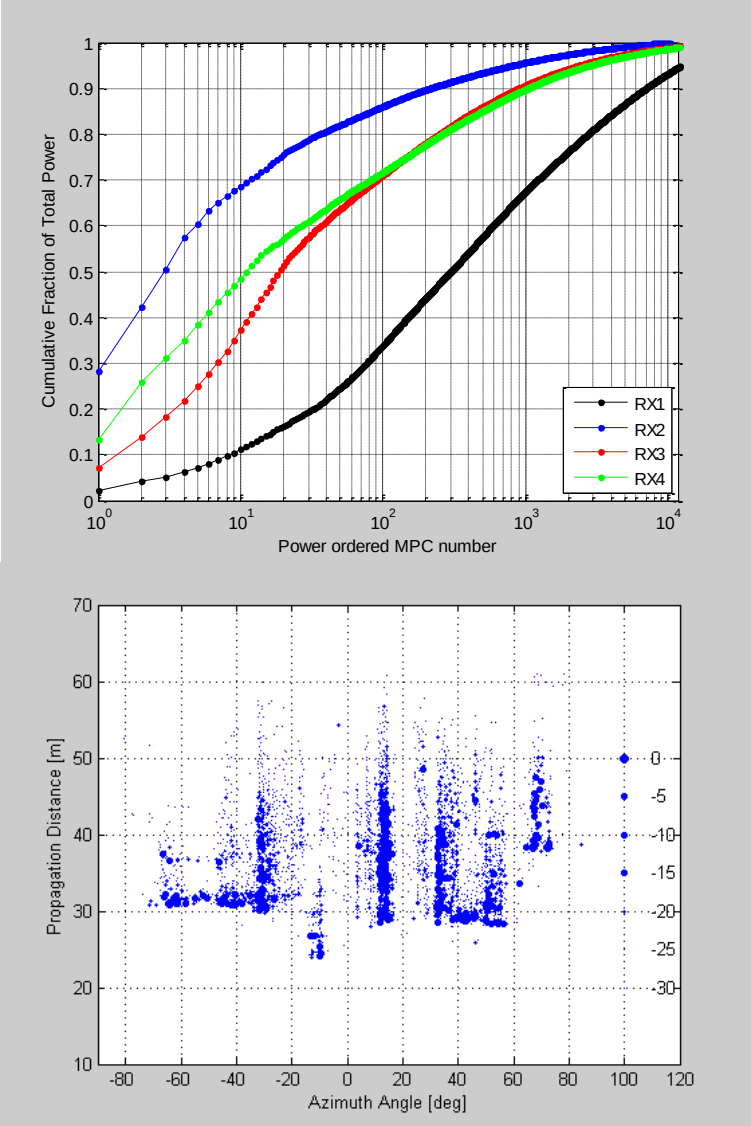
- Observation 5: The path powers fall off with increasing angle offset unlike in the 3D SCM model

[4] METIS Channel Models, Deliverable D1.4, ICT-317669-METIS/D1.4, https://www.metis2020.com/wp-content/uploads/METIS_D1.4_v3.pdf

[5] J. Medbo, H. Asplund, J.-E. Berg and N. Jalden, “Directional channel characteristics in elevation and azimuth at an urban macrocell base station”, in Proc. 6th EuCAP, Prague, Czech Republic, March 2012

Number of MPCs

- Indoor 60 GHz measurements [6]
  - Bandwidth 2 GHz, delay resolution ~0.5 ns
  - Array size 64x256, angle resolution ~1°x1° in boresight
- Observation 6: 1000-10000 MPCs needed to account for 95% of power in an indoor cell
  - For 7 ns delay resolution and 5°x5° degree angular resolution
- Observation 7: 100 strongest MPCs account for 10-70% of power in an indoor cell
  - For 7 ns delay resolution and 5°x5° degree angular resolution
- Observation 8: Number of observed clusters are at the order of 10-20 in an indoor cell
- Observation 9: More clusters and MPCs needed in NLOS than in LOS



[6] R1-165353 "Indoor Highly Resolved Channel Measurements at 60 GHz", Ericsson, **Nanjing, China, May 23 – 27, 2016**

Summary of observations

- Observation 1: Around 400 MPCs capture 50-70% of the total channel power in a small macrocell
  - For 5 ns delay resolution and high angular resolution
- Observation 2: MPC power distribution is continuous, unlike 3D SCM model
- Observation 3: The number of MPCs is very similar over the 6-60 GHz frequency range
- Observation 4: Around 400 MPCs required to capture 95% of the channel power in an indoor cell
  - For 7 ns delay resolution and 5°x5° degree angular resolution
- Observation 5: The path powers fall off with increasing angle offset unlike in the 3D SCM model
- Observation 6: 1000-10000 MPCs needed to account for 95% of power in an indoor cell
  - For 7 ns delay resolution and 5°x5° degree angular resolution
- Observation 7: 100 strongest MPCs account for 10-70% of power in an indoor cell
  - For 7 ns delay resolution and 5°x5° degree angular resolution
- Observation 8: Number of observed clusters are at the order of 10-20 in an indoor cell
- Observation 9: More clusters and MPCs needed in NLOS than in LOS

Proposal

- Proposal: The observations in this contribution should be taken into account when deciding on the number of clusters and paths within clusters