Influence of moving people on the 60 GHz channel –a literature study

Date: 2009-07-15

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Abstract

This contribution presents results from a literature study on the influence on of moving humans on the 60 GHz channel mainly based on measurements. A couple of parameters describing the shadowing process are presented including some measured numbers for these parameters.

Human induced shadowing events

- **TG3c channel model does not take into account human movement**
- **Statistics about human induced shadowing effects should be included into channel modeling, containing**
  - Amplitude
  - Duration
  - Rising Time
  - Occurence Rate
- **The influence of different parameters should be investigated**
  - Type of antenna
  - Distance
  - …

Overview

- **In [1], the propagation path visibility is investigated by a geometric model for distances up to 10 meters. The authors conclude, that diversity switching between two base stations leads to a 95 % visibility for distances less than 8 meters**

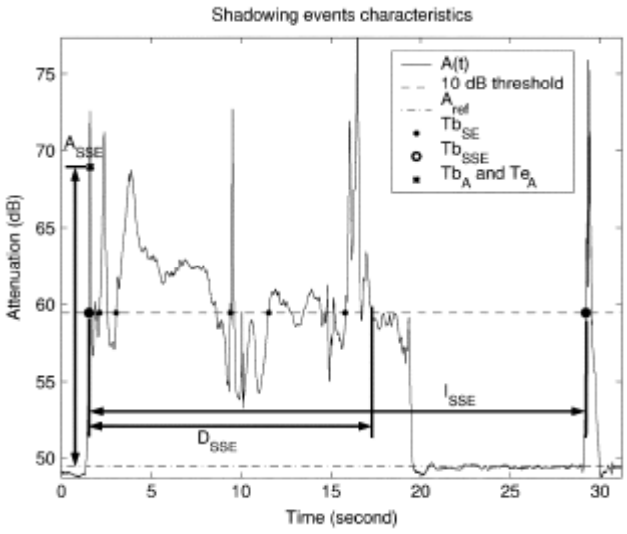
- **In [2], ray tracing in combination randomly walking human obstacles (9 dB attenuation) is used to investigate the effect of human activity on 60 GHz OFDM transmission. Here, also spatial diversity is proposed to overcome the shadowing problem.**

- **In [3-5], amplitude, duration, rising Time and occurence rate are investigated experimentally and a full parameter set for the modeling of these parameters is given. The results are presented on the following slides.**

Human body blockage - Measurements

- **Channel Sounder Measurements (500 MHz bandwidth)**
- **Antennas**
  - 22.4 dBi horn (H)
  - 3 dBi patch antenna (P)
  - HH, PH and PP configuration
- **Room Dimensions: 10 x 13 meters**
- **Three different Tx-Rx combinations**
- **Human activity 0 – 15 persons**
- **20 h total measurement duration**

Parameter Definitions



Taken from [3], © 2004 IEEE

Human body blockage - Amplitude

- **Generally more than 20 dB attenuation due to humans**
- **More pronounced for narrow beamwidth antennas, where the LOS component is more pronounced.**
  - Mean value >15 dB for directive antennas (horn, 22.4 dBi)
  - Mean value <15 dB for 3 dBi patch antennas
- **Amplitude does not depend on number of persons**
- **Amplitude decreases with antenna height**

TABLE V
STATISTICS OF A_{SSE} FOR THE 5 dB THRESHOLD[a]

	Mean value (dB)	Median value (dB)	90^{th} percentile (dB)
HH1	15.5	16.6	22.9
PH1	19.8	21.3	25.1
PP1	12.2	11.9	18.6
PH2	18.1	18.9	23.6
PP2	9.0	8.7	12.1
HH3	12.0	9.9	22.8
PH3	11.6	12.4	15.6

[a] All activity ranges are joined

Taken from [3], © 2004 IEEE

Human body blockage - Dynamics

- **Duration**
  - No clear dependence on antenna configuration
  - Wide spread
  - „Key figures“
    - 300 to 450 ms for 10 dB threshold
    - 100 to 300 ms for 20 dB threshold
    - Dependent on number of persons
  - Good fitting by lognormal or Weibull distribution
  - Higher for NLOS

- **Rising Time**
  - Can be short („worst case“: <30ms)
  - Longer for NLOS than for LOS

TABLE IV
STATISTICS OF D_{SSE} FOR THE 10 dB THRESHOLD[a]

	N_{SSE}	Median value (s)	P90 (s)	P95 (s)
HH1	373	0.301	2.405	5.407
PH1	200	0.266	2.186	5.968
PP1	256	0.282	2.513	5.294
PH2	156	0.430	3.709	15.665
PP2	136	0.163	2.088	12.256
HH3	140	0.432	5.502	9.612
PH3	172	0.398	2.400	4.936

[a] All activity ranges are joined

TABLE VI
SSE RISING TIMES FOR EACH ANTENNA CONFIGURATION

	median (ms)	P10 (ms)	P5 (ms)
HH1	93	42	34
PH1	62	33	27
PP1	136	60	43
PH2	96	38	25
PP2	197	59	34
HH3	111	33	24
PH3	154	37	33

Taken from [3], © 2004 IEEE

Human body blockage – Occurrence Rate

- **Pseudoperiod I_{SSE}**
  - Describes the inter-arrival time between two successive shadowing events (see also Fig. 3 of [3] *Parameter Definitions*)
  - Spreads from 2 s up to 20 minutes depending on human activity

- **Unavailability Rate**
  - Correction: Long Shadowing events not taken into account
  - Values can vary between 1.7 and 5.2 %
  - Configurations with patch antennas benefit from angular diversity

TABLE VII
UNAVAILABILITY RATES OF THE CHANNEL FOR ALL CONFIGURATIONS (THRESHOLD: 10 dB)

	unprocessed UR	corrected UR
HH1	5.7%	4.0%
PH1	1.9%	1.6%
PP1	1.9%	1.7%
PH2	6.8%	5.2%
PP2	1.8%	1.8%
HH3	4.7%	3.1%
PH3	3.0%	3.0%

Taken from [3], © 2004 IEEE

Modeling Results from [5]

- **Amplitude**
  - Normal distribution
  - Dependent on antenna configuration
- **Duration**
  - Lognormal distribution
  - Dependent on antenna configuration, Tx-Rx configuration and number of persons
- **Pseudoperiod (Occurence rate)**
  - Lognormal distribution
  - Dependent on antenna configuration, Tx-Rx configuration and number of persons
- **Rising time**
  - Lognormal distribution
  - Dependent on antenna configuration

Ref. [5] contains a full parameter set for the modeling of the parameters listed above

References

- **[1] K. Sato and T. Manabe. Estimation of propagation-path visibility for indoor wireless LAN systems under shadowing condition by human bodies. *Vehicular Technology Conference, 1998. VTC 98. 48th IEEE*, 3, 1998.**
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- **[3] S. Collonge, G. Zaharia, and GE Zein. Influence of the human activity on wide-band characteristics of the 60 GHz indoor radio channel. *Wireless Communications, IEEE Transactions on,* 3(6):2396–2406, 2004.**
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- **[5] S. Collonge, Caractérisation et modélisation de la propagation des ondes électromagnétiques à 60 GHz à l'intérieur des bâtiments. *PhD thesis*. Rennes. 2003.**