UWB Channel Soundings and Models — Literature Overview

Abstract

The following is the reproduction of an exhaustive UWB literature list compiled by Jürgen Kunisch and Jörg Pamp, IMST GmbH, presented at the International Workshop on Ultra-Wideband Systems 2003 in Oulu, Finland [1], slightly updated by Ulrich Schuster, ETH Zürich.

I. Channel Measurements

TABLE I
VECTOR NETWORK ANALYZER MEASUREMENTS

Source	Frequency Range in GHz	Bandwidth in GHz	Environment	Distance in m	Antennas
AT&T Labs [2]	4.375–5.625	1.25	residential	1–15	conical monopole dual receive
Ultrawaves [3]	2–8	6	indoor	1.5–13	conical
Whyless [4]	1–11	10	office	3–10	biconical
France Telecom R&D [5], [6]	4–6	2	office	2.6–16.6	dipole
U.C.A.N. [7], [8]	1–9	8 (2 $\times$ 4)	lab/office/corridor	1–18	biconical
U.C.A.N [7]–[10]	2–6	4	lab/office/flat	1–20	conical monopole
Stanford U. [11]	0.001–1.8	1.799	lab	0.6–10	?
Intel R&D [12]–[14]	2–8	6	residential	1–20	biconical dual receive
Intel R&D [15]	2–8 same measurements as [12]–[14] ?	6	residential	?	?
Pacwoman [16]	1.5–6	4.5	seminar room	2 & 5	various low-cost antennas focus on antenna influence
Time-Domain Corporation [17]	1–3	2	remote-to-body LOS	5	diamond dipole
IKT, ETH Zurich [18]	2–6	4	human body measured in office and anech. chamber	0–1	meander-line antenna
Tokyo Denki University [19]	3.1–10.6	7.5	metal desk	0.1–0.7	volcano-smoke monopole
NJIT [20]	2–6	4	classroom / lab LOS directional and omni antennas	1–10	conical monopole log-periodic

TABLE II
DIGITAL SAMPLING OSCILLOSCOPE MEASUREMENTS

Source	Frequency Range in GHz	Bandwidth in GHz	Environment	Distance in m	Antennas
Time-Domain Corp [21]	3–5 (-3dB BW)	2	residential/office	0–10	omnidirectional
Time-Domain Corp/USC [22], [23]		1.3	lab/office	3–13.5	diamond dipole
Intel R&D [13], [14]	2–8 (digital BPF on pulse spectrum)	6	residential	1–20 dual receive	biconical
Stanford U. [11]	?	?	lab	0.6–10	?
Time-Domain Corp. (pulse-scanning receiver) [24]–[26]	?	?	indoor	?	?
Virginia Polytech [27]	0.1–12 (?)	11.9	office / classroom / hallway directional / omni	1–60	biconical TEM horn

II. CHANNEL MODELS

TABLE III
PATH LOSS MODELS

Source	Features	Environment	Measurements
AT&T Labs Research [2], [28], [29]	• one-slope • log-normal shadow fading • path loss coefficient and standard deviation of shadow fading are normally distributed from one home to another	residential	own [2]
Intel R&D [30], [31]	• one-slope • log-normal shadow fading	residential	own [14], [13]
Ultrawaves [32]	• dual-slope	corridor / hall	own [3]
U. of Rome “Tor Vergata” [33]	• dual-slope • log-normal shadow fading	lab/office	Time-Domain / USC [23]
U.C.A.N. [34]	• one-slope • “sub-PL-coefficients” for certain sub-bands	lab/office/flat	own [7], [8]
Time-Domain Corp. [35]	• theoretical multi-slope • connection between measured RMS delay spread and power law		own [26]
U. London / U. Pisa [36]	• deterministic model • frequency dependent • multi-slope, short-distance break-point		no

TABLE IV
MULTIPATH MODELS

Source	Type	Features	Environment	Measurements
Intel R& D [30], [31]	stat.	• Saleh-Valenzuela • log-normal amplitude fading • bandpass model	residential	own [13], [14]
Intel R&D [15]	stat	• exponential power decay and arival delay pdf • models angle of arrival (Laplacian distributed) according to [37] • parameters show frequency dependence	residential	own [15] [12]–[14]?
AT&T Labs [38]	stat.	• single cluster • exponential decay • normal distribution (???)	residential	own [2]
AT&T Labs [39]	stat.	• second order autoregressive • frequency domain • 2 poles per cluster	residential	own [2]
Mitsubishi [33], [40]–[42]	stat.	• tapped delay line • single exponential decay • log-normal decay constant • Nakagami amplitude fading	lab/office	Time-Domain / USC [23]
TRW [43], [44]	stat.	• Angle of Arrival enhanced • Saleh-Valenzuela	lab/office	Time-Domain / USC [23]
U.C.A.N. [7], [8], [45]	stat.	• complex passband • diffuse multipath clusters with exponential decay • multipath power Weibull distributed • strong paths added coherently with a Poisson arrival process	lab/office/flat	own [7], [8]
U.C.A.N. [7], [46]	stat.	• Saleh-Valenzuela • log-normal fading	lab/office/corridor	own [7], [9]
RAWCom Lab [47]	stat.	• two-state Markov • separate modified Poisson arrivals (Δ-K model) • multipath power Gamma distributed exponential decay	indoor	no
TAO [48]	stat.	• small-scale multipath amplitude POCA-NAZU distributed	indoor	no
Telia Research [49]	stat.	• tapped delay line • coherence by birth-death process of echoes • exponential decay	indoor	no
IEEE 802.15 [50]	stat.	• Saleh-Valenzuela • log-normal amplitude fading • bandpassmodel	residential	multiple
CWC U. of Oulu [51], [52]	hybrid	• tapped delay line • Rice/Rayleigh fading • deterministic ray-tracing for most significant reflections	indoor	own [3]
WHYLESS [53]–[55]	hybrid	• Saleh-Valenzuela • amplitudes Rayleigh distributed • spatial correlation by virtual sources	office	own [4]
UWB Wireless Corp. [56]	det.	• multiple frequency-dependent scattering centers • multiple diffraction (GTD)		no
LCST / IETR INSA [57], [58]	det.	• ray-tracing • UTD		no

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