Corporate R&D

FCC Filing: Mobile Broadband Coverage by Technology

19 February 2010

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Overview

- ***Objectives***
  - Present coverage capabilities of mobile broadband technologies in various US frequency bands, at various assumed targeted uplink data rates.
- ***Assumptions***
  - COST-Hata propagation model for coverage
  - AWGN channel with shadow fading margin
  - Technology bandwidths
    - LTE (Rel. 8) – 2 x 10 MHz
    - DOrA – 2 x 1.25 MHz
    - HSPA (Rel. 6) – 2 x 5 MHz
  - Caveat regarding link budget results
    - Link budget results for HSPA and LTE were generated with results from Qualcomm computer simulations. Link budgets for DO Revision A were generated from measurements of existing Qualcomm base station and mobile handset chipsets, which would capture practical implementation impairments.

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Link Budget by Technology – Suburban Morphology

Item	Uplink	Uplink	Uplink	Uplink	Uplink	Uplink	Uplink	Uplink	Uplink	Comments
System configuration	**LTE**	**LTE**	**LTE**	**DOrA**	**DOrA**	**DOrA**	**HSPA**	**HSPA**	**HSPA**	
Carrier frequency (MHz)	700	700	700	850	850	850	850	850	850	
BS effective antenna heights (m)	30	30	30	30	30	30	30	30	30	Range of heights determined by practical availability, affects coverage very significantly.
UE/AT antenna heights (m)	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	
Cell edge reliability (%)	90%	90%	90%	90%	90%	90%	90%	90%	90%	
Transmission bit rate for data channel (bits/s)	328,000	680,000	1,256,000	307,200	614,400	1,228,800	256,000	512,000	1,024,000	
Target packet error rate for the required SNR in item (14)	1%	1%	1%	1%	1%	1%	1%	1%	1%	
Pathloss model	AWGN	AWGN	AWGN	AWGN	AWGN	AWGN	AWGN	AWGN	AWGN	
Transmitter (Mobile)										
(1) Number of transmit antennas	1	1	1	1	1	1	1	1	1	
(2) Maximal transmit power per antenna (dBm)	23	23	23	23	23	23	23	23	23	
(3) Transmitter antenna gain (dBi)	-4	-4	-4	-4	-4	-4	-4	-4	-4	
(4) Body Losses (dB)	5	5	5	5	5	5	5	5	5	
(5) EIRP = (2) + (3) - (4) dBm	14	14	14	14	14	14	14	14	14	
Receiver (Base Station)										
(6) Number of receive antennas	2	2	2	2	2	2	2	2	2	
(7) Receiver antenna gain (dBi)	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	
(8) Cable, connector, and combiner losses (dB)	2.75	2.75	2.75	2.75	2.75	2.75	2.75	2.75	2.75	
(9) Receiver noise figure (dB)	4	4	4	4	4	4	4	4	4	
(10) Thermal noise density (dBm/Hz)	-174	-174	-174	-174	-174	-174	-174	-174	-174	
(11) Total noise density	-170	-170	-170	-170	-170	-170	-170	-170	-170	
(12) Occupied channel bandwidth (for meeting the requirements of the traffic type) (Hz)	1,440,000	1,440,000	1,440,000	1,228,000	1,228,000	1,228,000	3,840,000	3,840,000	3,840,000	
(13) Effective noise power = (11) + 10log((12)) dBm	-108	-108	-108	-109	-109	-109	-104	-104	-104	
(14) Interference Margin (dB)	5	5	5	5	5	5	5	5	5	Range from 3-7 dB, representing 50-80% loading.
Required Eb/No (dB)	-1.2	-1.9	-1.6	0.0	-1.4	-0.4	-0.8	0.4	-1.0	
(15) Required SNR (dB)	-7.6	-5.2	-2.2	-6.0	-4.4	-0.4	-12.6	-8.4	-6.7	
(16) Receiver implementation margin (dB)	0	0	0	0	0	0	0	0	0	
(17) Receiver sensitivity	-116	-114	-111	-115	-114	-110	-117	-113	-111	
(18) Link budget	141	138	135	140	138	134	141	137	135	
Calculation of available pathloss										
(19) Lognormal shadow fading std deviation (dB)	8	8	8	8	8	8	8	8	8	Range from 6-10 dB, 8 dB very typical.
(20) Shadow fading margin (function of the cell area reliability (6) and (19)) (dB)	10.3	10.3	10.3	10.3	10.3	10.3	10.3	10.3	10.3	
(21) BS selection/macro-diversity gain (dB)	4.5	4.5	4.5	5.5	5.5	5.5	5.5	5.5	5.5	
(22) Penetration margin (dB)	14	14	14	14	14	14	14	14	14	Range from 12-15 dB dependent on frequency, morphology, and actual measurement if possible.
(23) Maximum Allowable Path Loss	118.0	115.5	112.6	118.1	116.5	112.5	119.7	115.5	113.8	
Range/coverage efficiency calculation										
(24) Maximum cell radii (km)	1.28	1.09	0.90	1.15	1.03	0.80	1.28	0.97	0.87	
(25) Coverage area = $(2.59*(23)^2)$ (km^2/site)	4.22	3.06	2.08	3.41	2.77	1.64	4.23	2.44	1.95	

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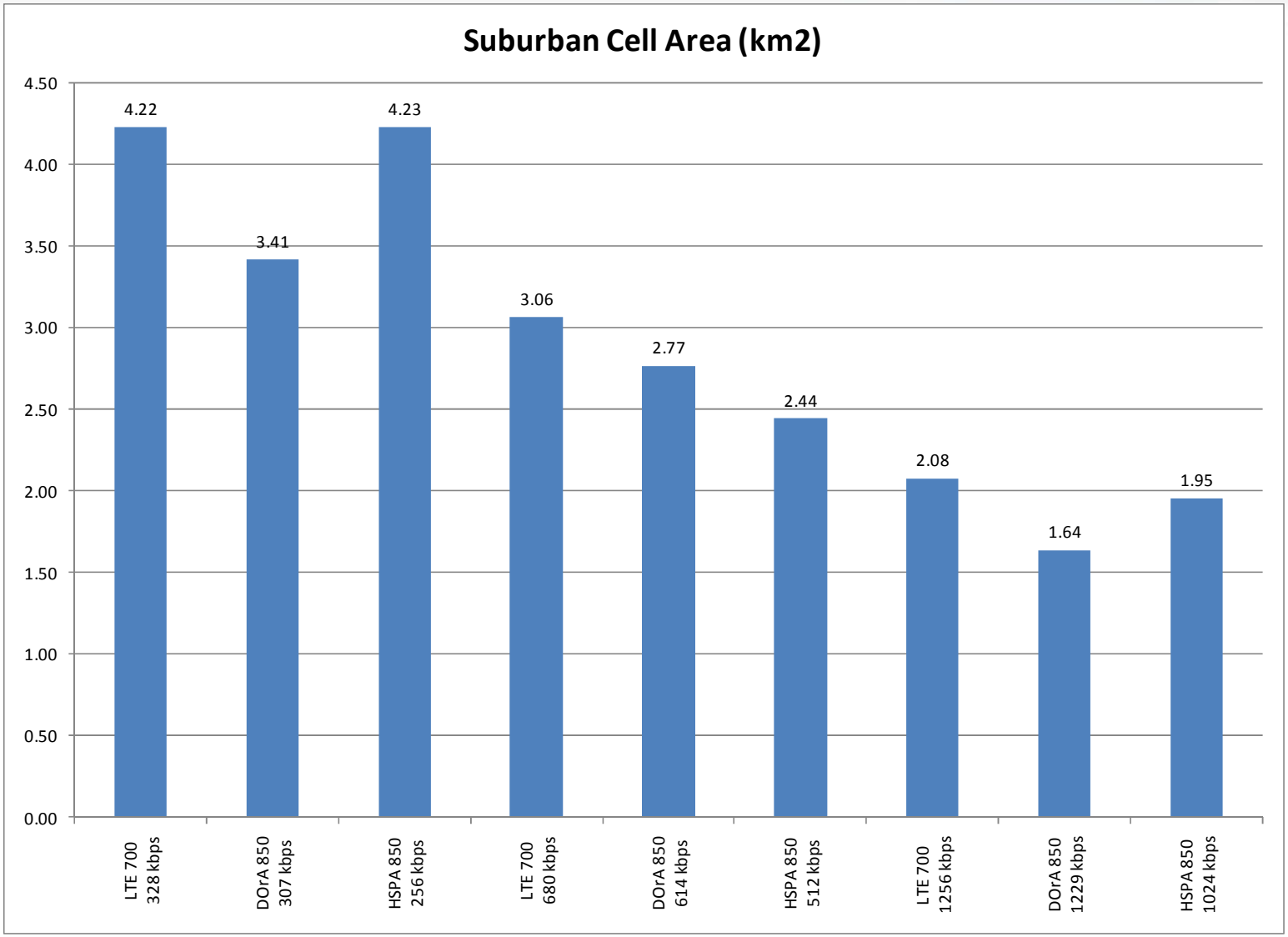
Suburban Coverage by Technology



Link Budget by Technology – Rural Morphology

Item	Uplink	Uplink	Uplink	Uplink	Uplink	Uplink	Uplink	Uplink	Uplink	Comments
System configuration	**LTE**	**LTE**	**LTE**	**DOrA**	**DOrA**	**DOrA**	**HSPA**	**HSPA**	**HSPA**	
Carrier frequency (MHz)	700	700	700	850	850	850	850	850	850	
BS effective antenna heights (m)	50	50	50	50	50	50	50	50	50	Range of heights determined by practical availability, affects coverage very significantly.
UE/AT antenna heights (m)	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	
Cell edge reliability (%)	90%	90%	90%	90%	90%	90%	90%	90%	90%	
Transmission bit rate for data channel (bits/s)	328,000	680,000	1,256,000	307,200	614,400	1,228,800	256,000	512,000	1,024,000	
Target packet error rate for the required SNR in item (14)	1%	1%	1%	1%	1%	1%	1%	1%	1%	
Pathloss model	AWGN	AWGN	AWGN	AWGN	AWGN	AWGN	AWGN	AWGN	AWGN	
Transmitter (Mobile)										
(1) Number of transmit antennas	1	1	1	1	1	1	1	1	1	
(2) Maximal transmit power per antenna (dBm)	23	23	23	23	23	23	23	23	23	
(3) Transmitter antenna gain (dBi)	-4	-4	-4	-4	-4	-4	-4	-4	-4	
(4) Body Losses (dB)	5	5	5	5	5	5	5	5	5	
(5) EIRP = (2) + (3) - (4) dBm	14	14	14	14	14	14	14	14	14	
Receiver (Base Station)										
(6) Number of receive antennas	2	2	2	2	2	2	2	2	2	
(7) Receiver antenna gain (dBi)	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	
(8) Cable, connector, and combiner losses (dB)	2.75	2.75	2.75	2.75	2.75	2.75	2.75	2.75	2.75	
(9) Receiver noise figure (dB)	4	4	4	4	4	4	4	4	4	
(10) Thermal noise density (dBm/Hz)	-174	-174	-174	-174	-174	-174	-174	-174	-174	
(11) Total noise density	-170	-170	-170	-170	-170	-170	-170	-170	-170	
(12) Occupied channel bandwidth (for meeting the requirements of the traffic type) (Hz)	1,440,000	1,440,000	1,440,000	1,228,000	1,228,000	1,228,000	3,840,000	3,840,000	3,840,000	
(13) Effective noise power = (11) + 10log((12)) dBm	-108	-108	-108	-109	-109	-109	-104	-104	-104	
(14) Interference Margin (dB)	5	5	5	5	5	5	5	5	5	Range from 3-7 dB, representing 50-80% loading.
Required Eb/No (dB)	-1.2	-1.9	-1.6	0.0	-1.4	-0.4	-0.8	0.4	-1.0	
(15) Required SNR (dB)	-7.6	-5.2	-2.2	-6.0	-4.4	-0.4	-12.6	-8.4	-6.7	
(16) Receiver implementation margin (dB)	0	0	0	0	0	0	0	0	0	
(17) Receiver sensitivity	-116	-114	-111	-115	-114	-110	-117	-113	-111	
(18) Link budget	141	138	135	140	138	134	141	137	135	
Calculation of available pathloss										
(19) Lognormal shadow fading std deviation (dB)	8	8	8	8	8	8	8	8	8	Range from 6-10 dB, 8 dB very typical.
(20) Shadow fading margin (function of the cell area reliabilityn (6) and (19)) (dB)	10.3	10.3	10.3	10.3	10.3	10.3	10.3	10.3	10.3	
(21) BS selection/macro-diversity gain (dB)	4.5	4.5	4.5	5.5	5.5	5.5	5.5	5.5	5.5	
(22) Penetration margin (dB)	11	11	11	11	11	11	11	11	11	Range from 8-12 dB dependent on frequency, morphology, and actual measurement if possible.
(23) Maximum Allowable Path Loss	121.0	118.5	115.6	121.1	119.5	115.5	122.7	118.5	116.8	
Range/coverage efficiency calculation										
(24) Maximum cell radii (km)	6.74	5.70	4.65	6.15	5.51	4.19	6.88	5.16	4.60	
(25) Coverage area = $(2.59*(23)^2)$ (km^2/site)	117.59	84.00	56.07	98.06	78.73	45.56	122.48	69.08	54.78	

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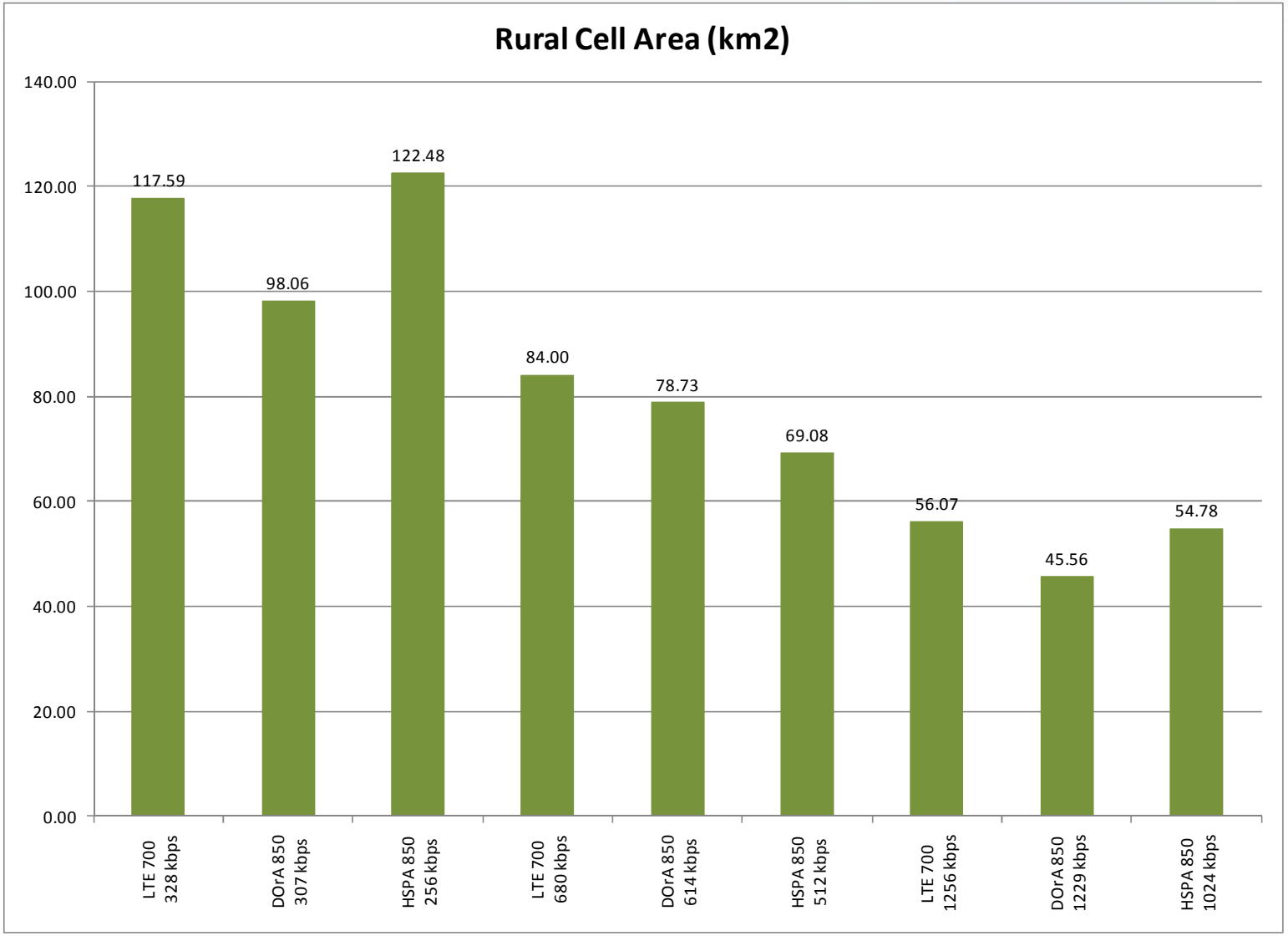
Rural Coverage by Technology