

Project	IEEE 802.20 Working Group on Mobile Broadband Wireless Access < http://ieee802.org/20/ >	
Title	MBFDD Performance Report 2 Presentation	
Date Submitted	2006-01-06	
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Re:	MBWA Call for Proposals	
Abstract	This contribution (part of the MBFDD proposal package for 802.20), contains the MBFDD Performance Report 2 Presentation slide set.	
Purpose	For consideration of 802.20 in its efforts to adopt an FDD proposal for MBWA.	
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MBFDD Performance Evaluation Report II

Jim Tomcik

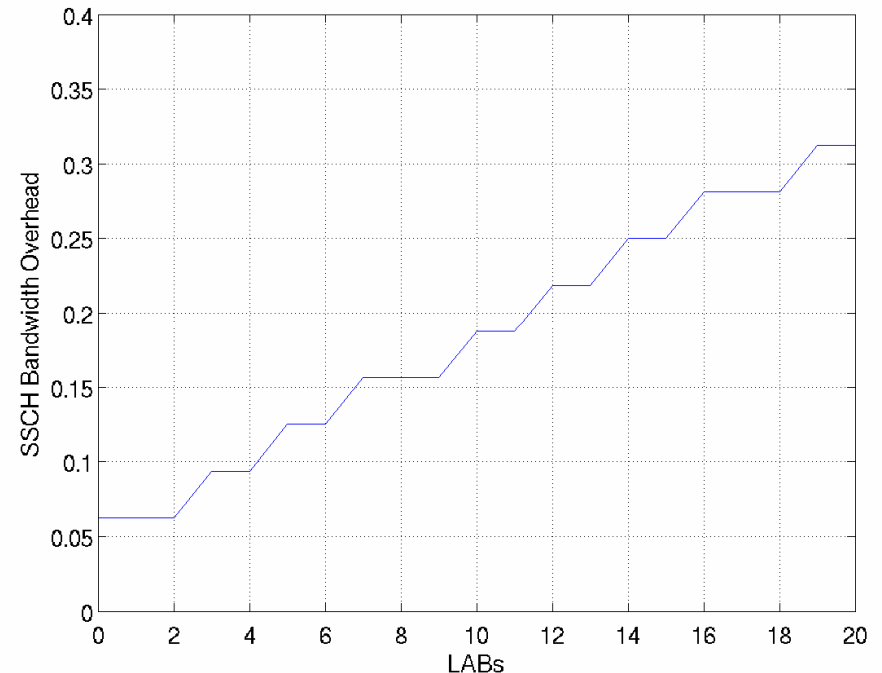
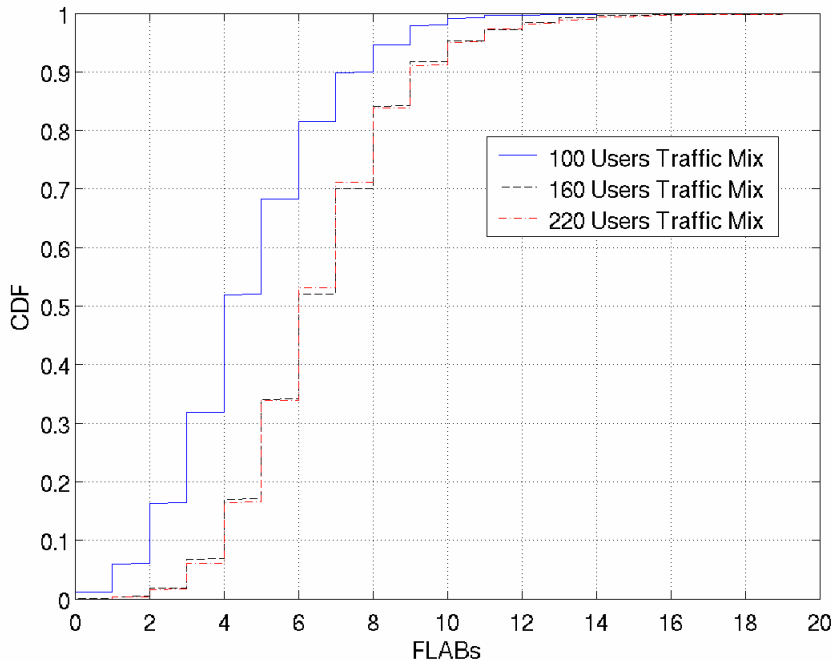
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Outline

- Report II Requirements:
 - Traffic mix simulations.
 - Overhead channel modeling.
 - QoS arbitration.
 - Performance of each individual QoS class.
 - Mobility and handoff
- Performance of Salient Features:
 - Antenna techniques.
 - MIMO Multiple Code Word with Successive Interference Cancellation.
 - Precoding.
 - System enhancements.
 - Quasi-Orthogonal Reverse Link (QORL).
 - Fractional Frequency Reuse (FFR).
 - Spatial Division Multiple Access (SDMA).

Overhead Channel Dimensioning

- Simulated a packet-by-packet scheduler to generate assignment statistics.
- SSCH dimension: 12 total assignments, power control bits for 200 users, and ACK/NACK for 30 RL channels → 22% FL overhead.
- Resource utilization is shown not to be affected by 8 FLAB constraints.
- Typical scheduling load is much less than the maximum dimension.

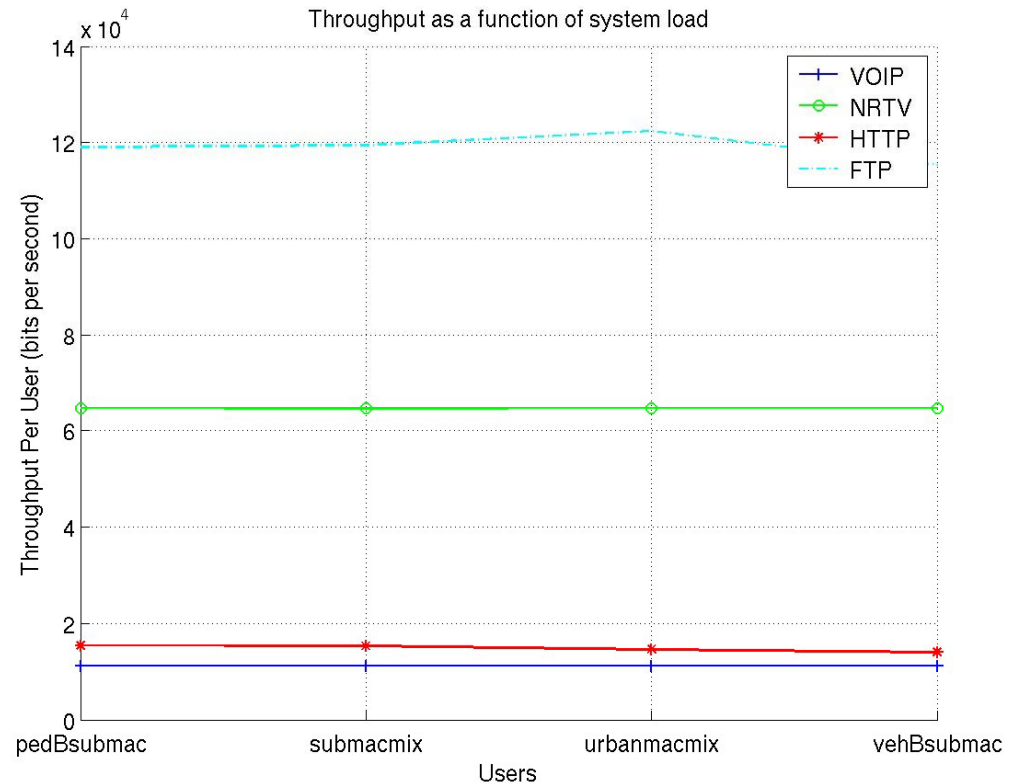


Traffic Mix Assumptions

	FL Evaluation	RL Evaluation
QoS Admission Control	30-30-30-10% Per-sector FTP-HTTP-NRTV-VOIP	VOIP
TCP Packet Size	1500 bytes	N/A
Maximum RLP Transmissions	1(VOIP), 2(Others)	1
Simulation Time	5:00 minutes	5:00 minutes

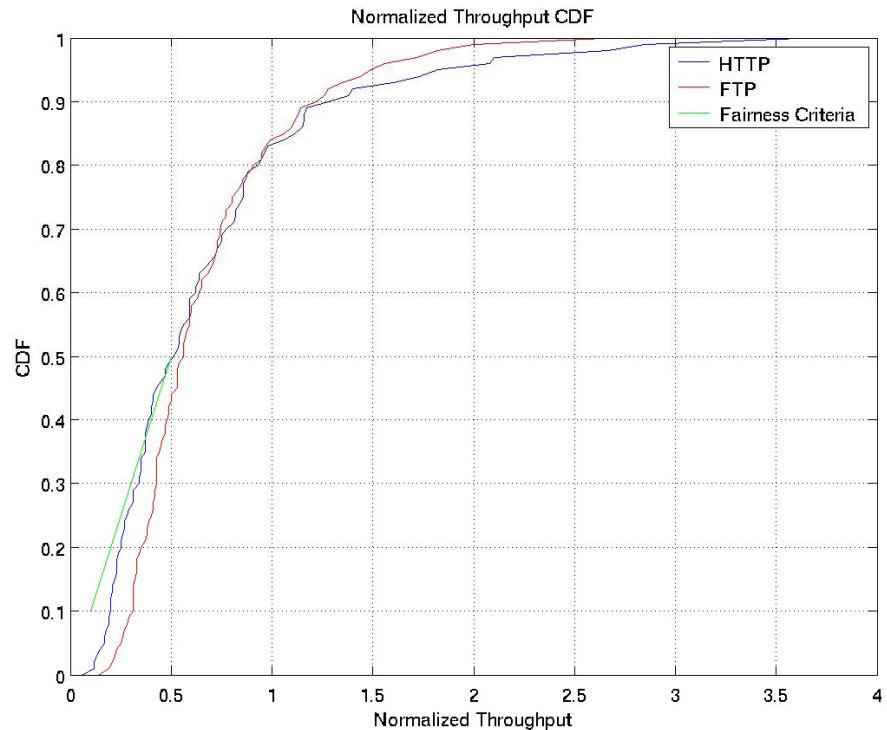
Channel Mix Test

- Channel models:
 - Suburban macro pedB
3 Km/h
 - Suburban macro vehB
120 Km/h
 - Suburban macro mix.
 - Urban micro mix.
- 19 cell wrap-around layout.
- Traffic mix:
 - 30-30-30-10
 - 10 users per sector.
- Conclusions:
 - Served data rate matches the offered data rate.
 - Different channel models have similar performances.



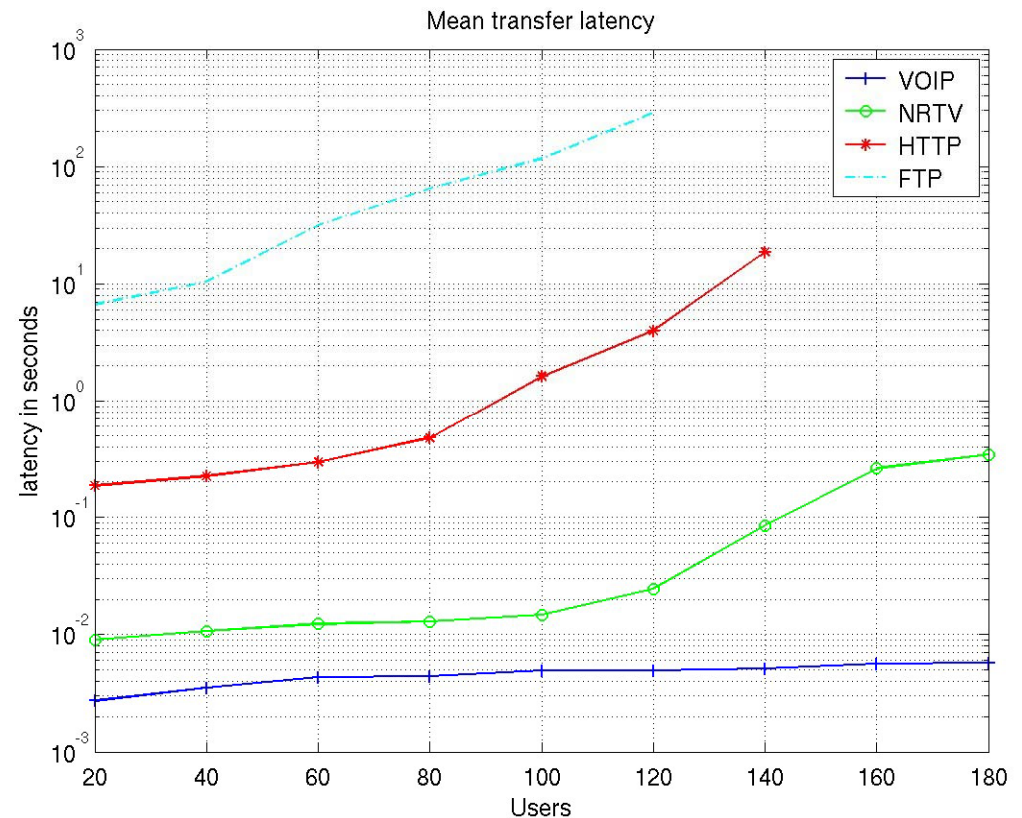
Fairness Among BE Flows

- Simulation setup:
 - Suburban macro mix.
 - Loading level: 80 users/sector
 - EF and AF flows is scheduled with higher priority than the BE flows.
 - Proportional fairness is enforced among BE flows.
- Conclusion:
 - BE flows meet the 802.20 fairness.



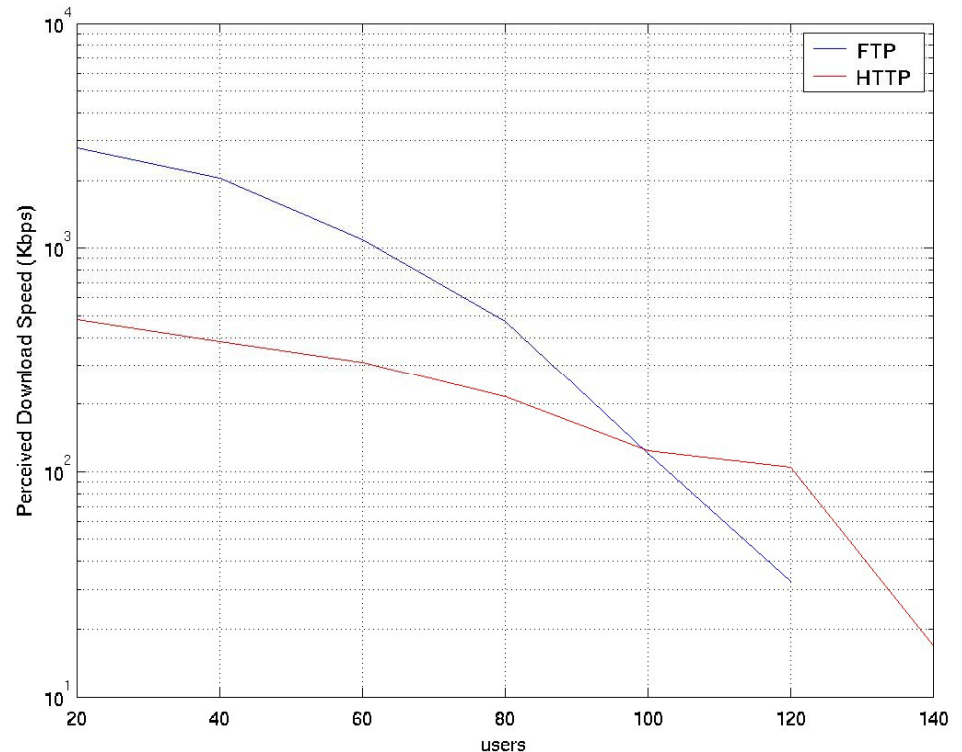
Latency vs. Load

- Flows with QoS reservation:
 - Mean latency of VOIP and NRTV satisfy QoS for all loading level.
- Best effort flows:
 - HTTP and FTP latency increases as load increases.



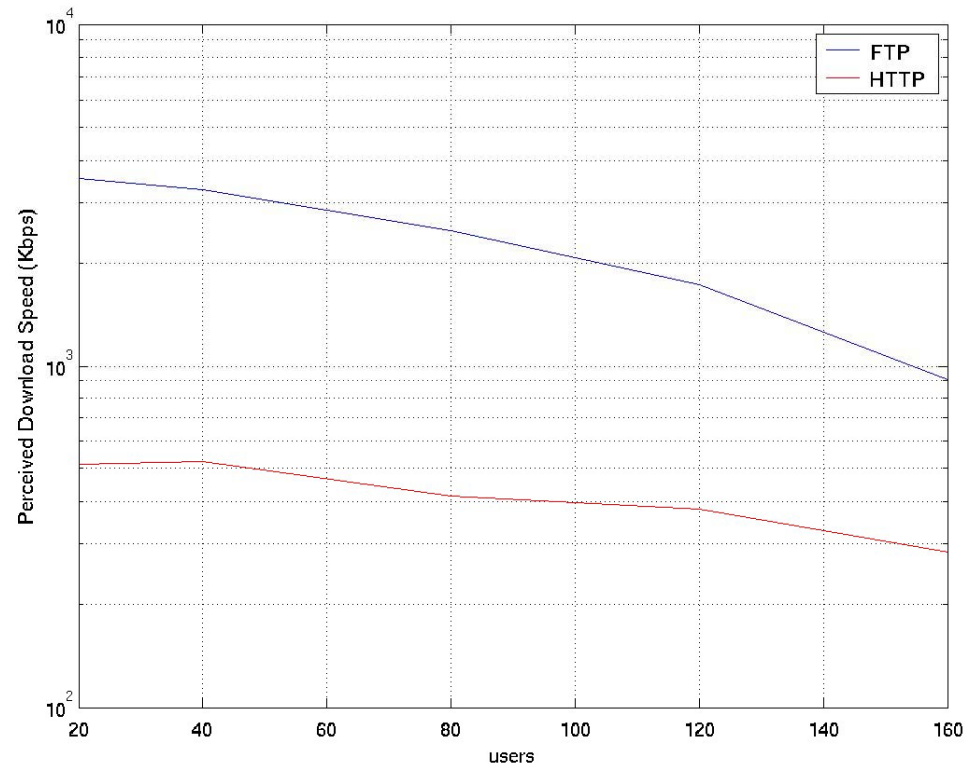
Download Speed vs. Load

- Simulation setup:
 - SIMO 1x2
- Light loading at 20 users per sector
 - FTP: 3 Mbps.
 - HTTP: 500 Kbps.
- Heavy loading
 - FTP and HTTP rate reduces significantly for more than 100 users per sector.



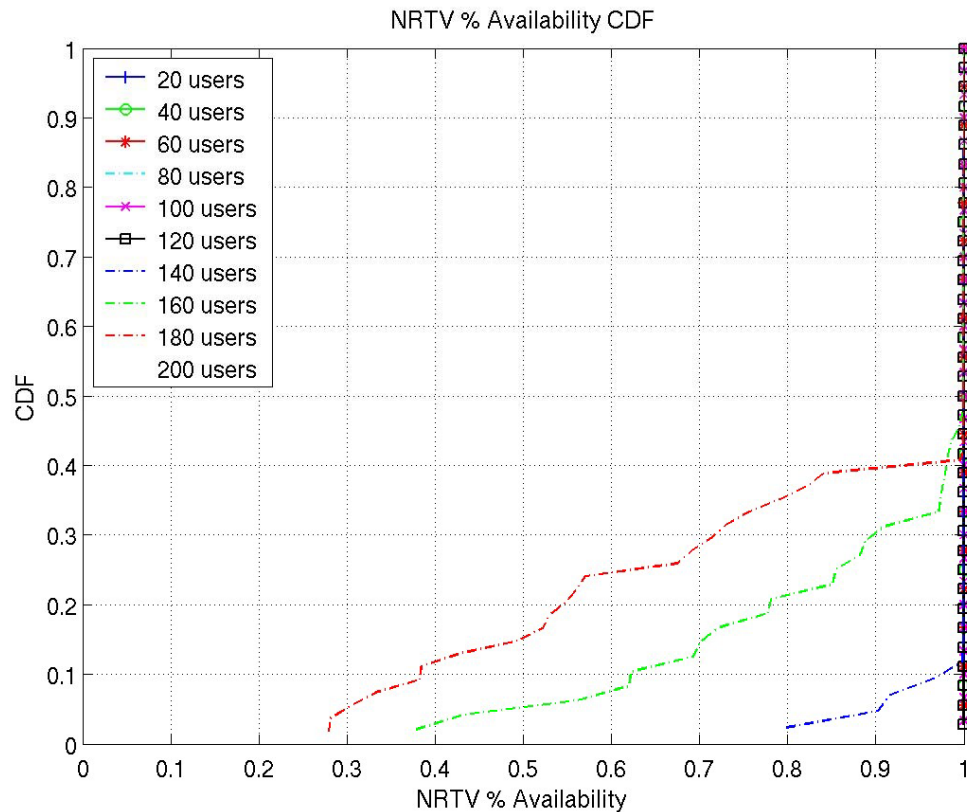
MIMO Download Speed

- Simulation setup:
 - MIMO 4x4 with single codeword decoding and linear MMSE receiver.
- MIMO 4x4 @160 users/sector has better FTP/HTTP download speed than SIMO 1x2 system @ 60 users/sector.



NRTV Availability

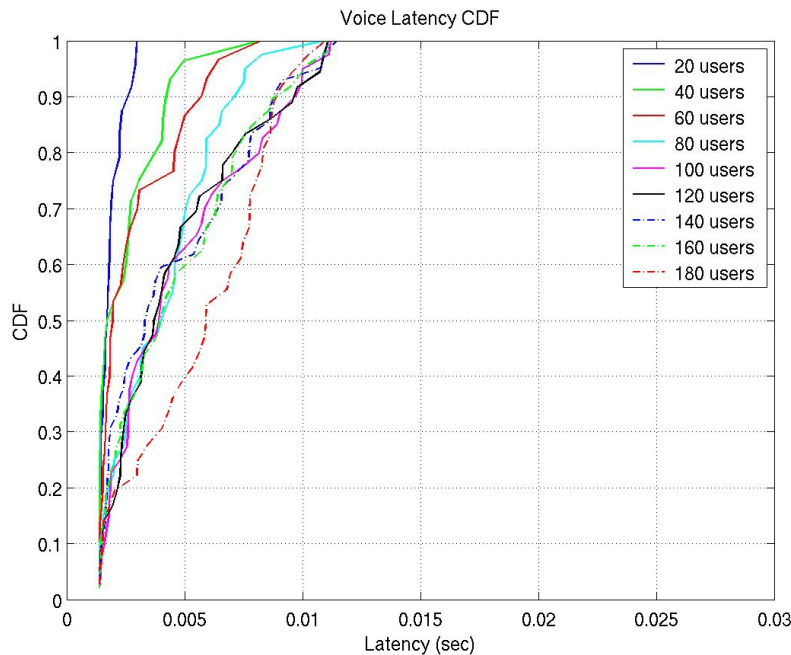
- NRTV availability is defined as the percentage of NRTV packets of a user that are not in outage condition (> 5 sec delay).



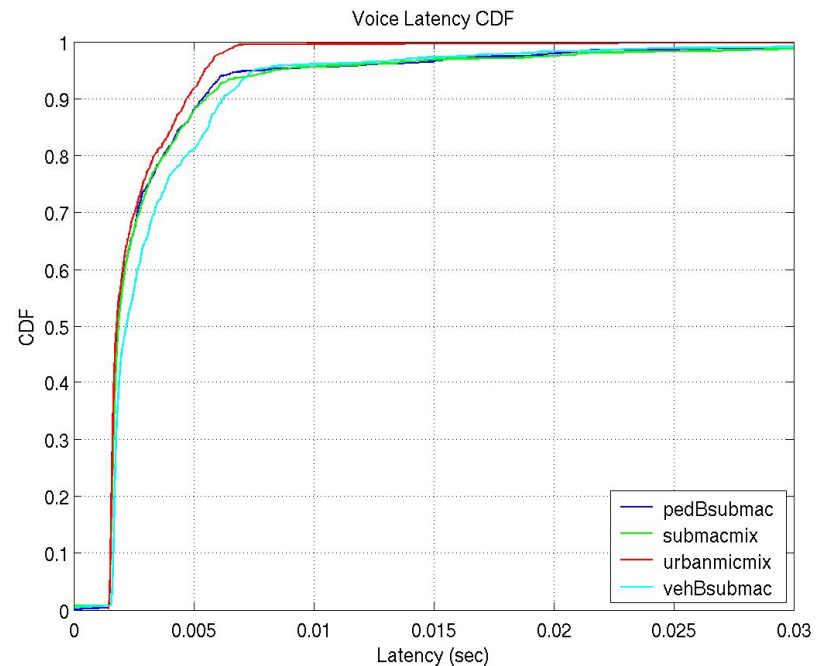
Voice Latency vs. Load

- RL voice traffic is simulated with 20 voice users/sector to approximate the RL traffic of a 200 users/sector with the specified traffic mix.
- Maximum FL mean user latency is less than 12 ms @ 180 users/sector.

Forward Link

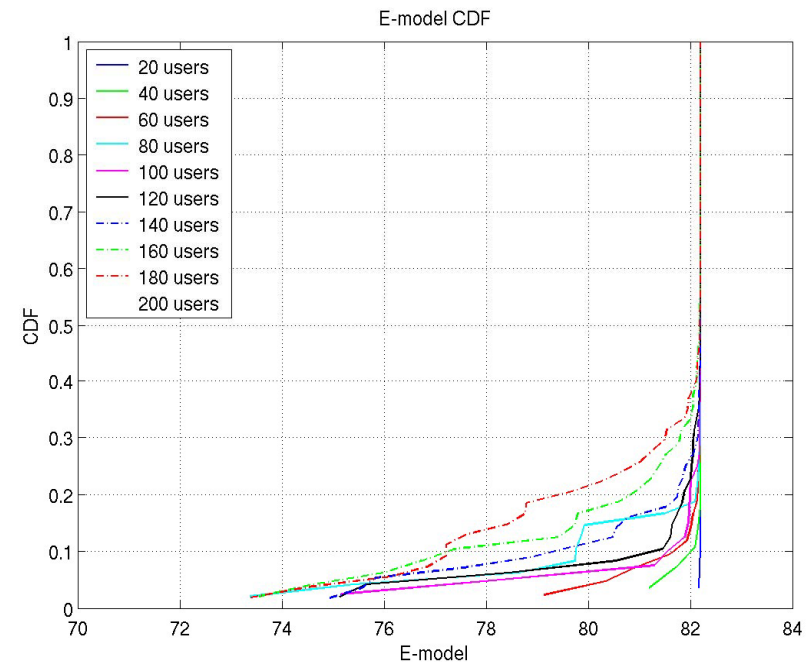
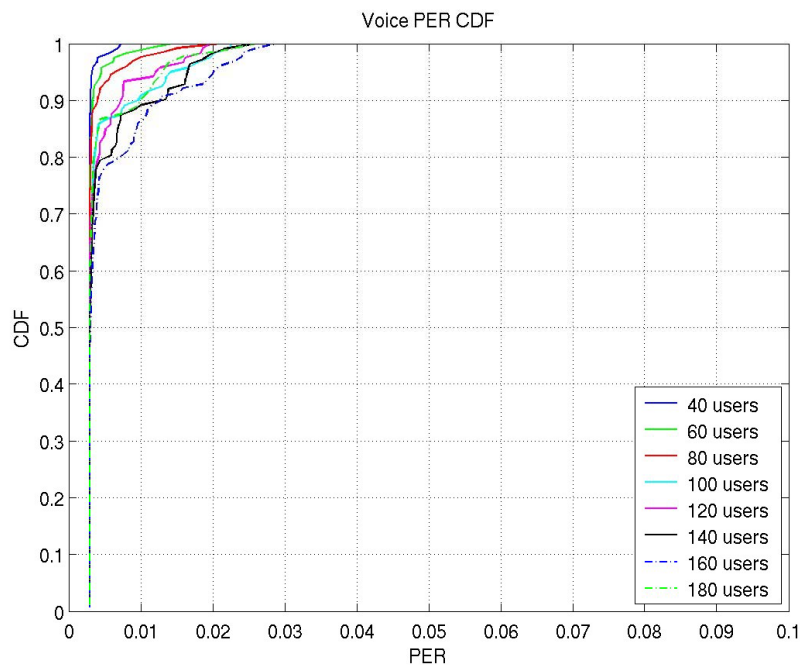


Reverse Link



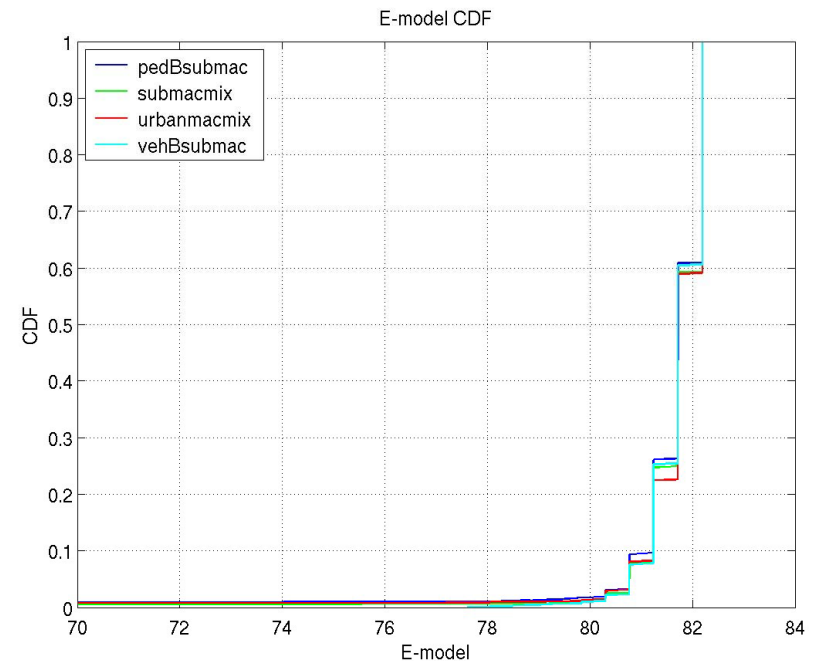
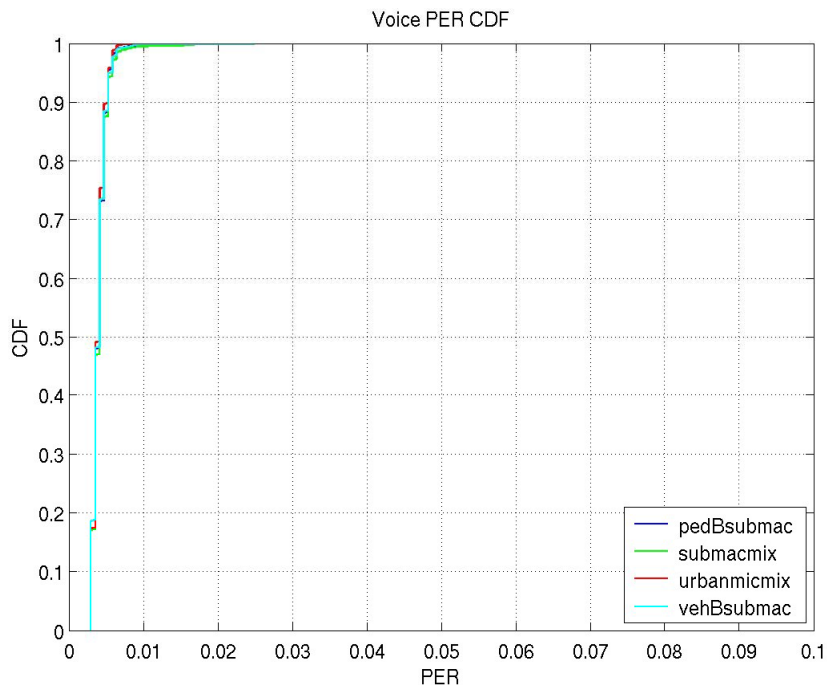
FL Voice E-Model Score

- User mean PER tail increases as load increases.
- E-Model score reflects the packet errors experienced by users in poor channel condition.



RL Voice E-Model Score

- User PER distributions are similar for different channel models.
- E-Model score reflects the packet errors experienced by users in poor channel condition.



Outline

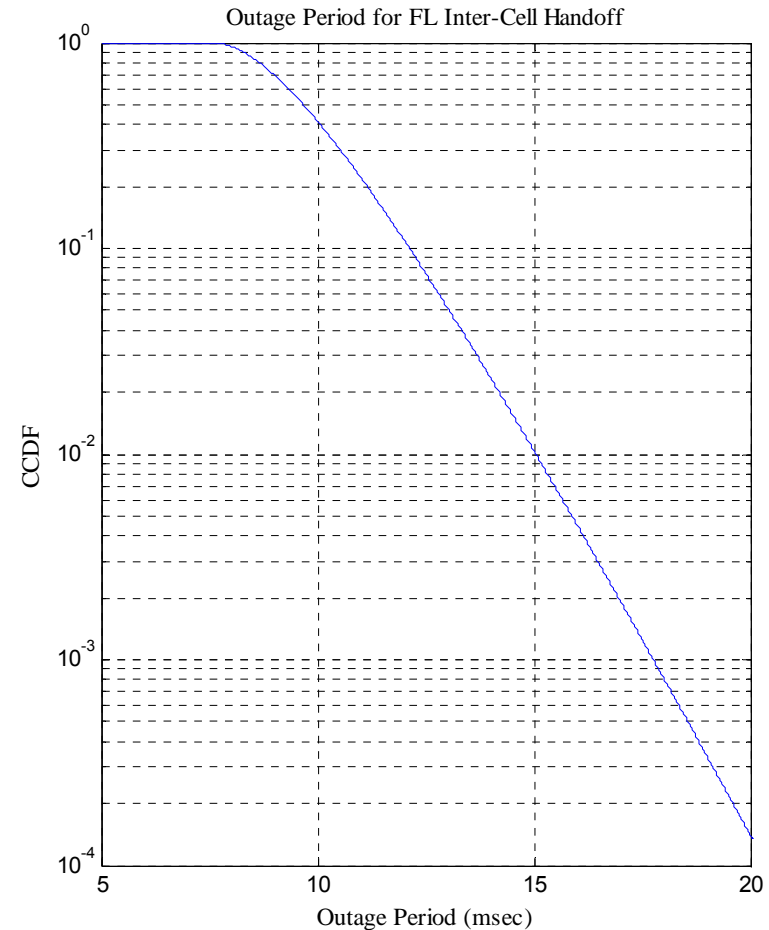
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Mobility and Handoff

- Handoff decision
 - FL: based on FL pilot measurements
 - RL: based on R-CQICH erasure indicators
- Handoff indication to the desired sector
 - FL: using R-CQICH
 - RL: using R-REQCH
- Handoff completion
 - When AT receives assignment from the new sector

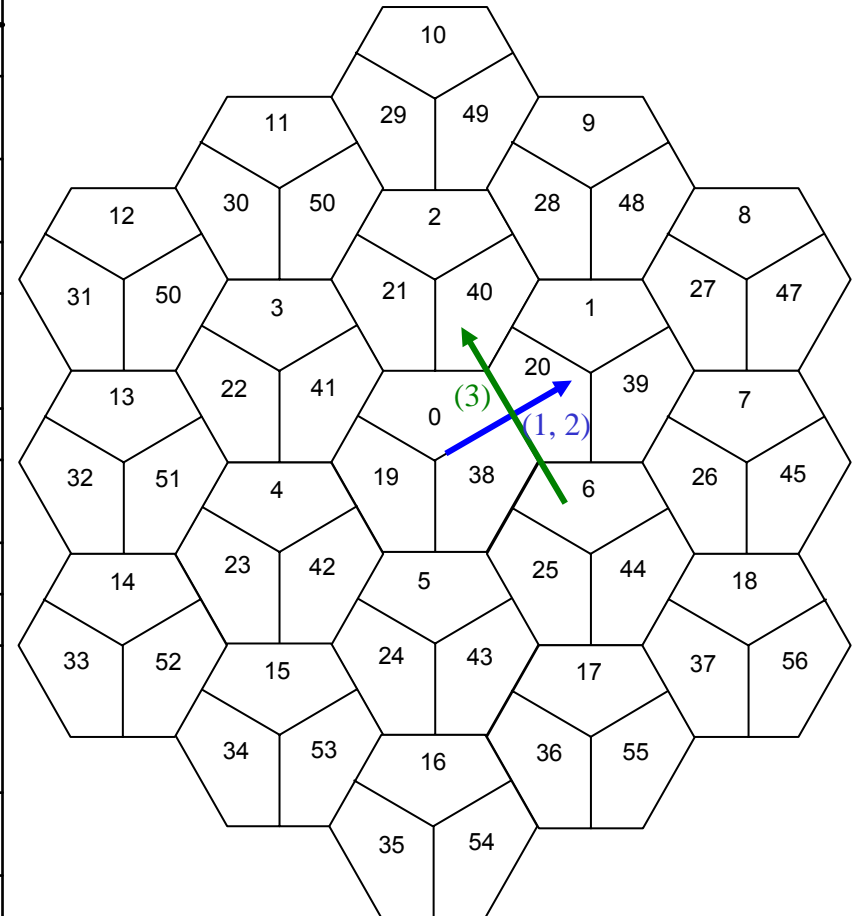
Outage and Connection Drop

- Current serving sector continues to serve the terminal during L1 handoff signaling (and even part of L2 handoff negotiation).
- Outage may happen only during FL handoff (inter-cell)
- Outage period is equal to one-way backhaul delay.
- Connection drop probability is practically zero.

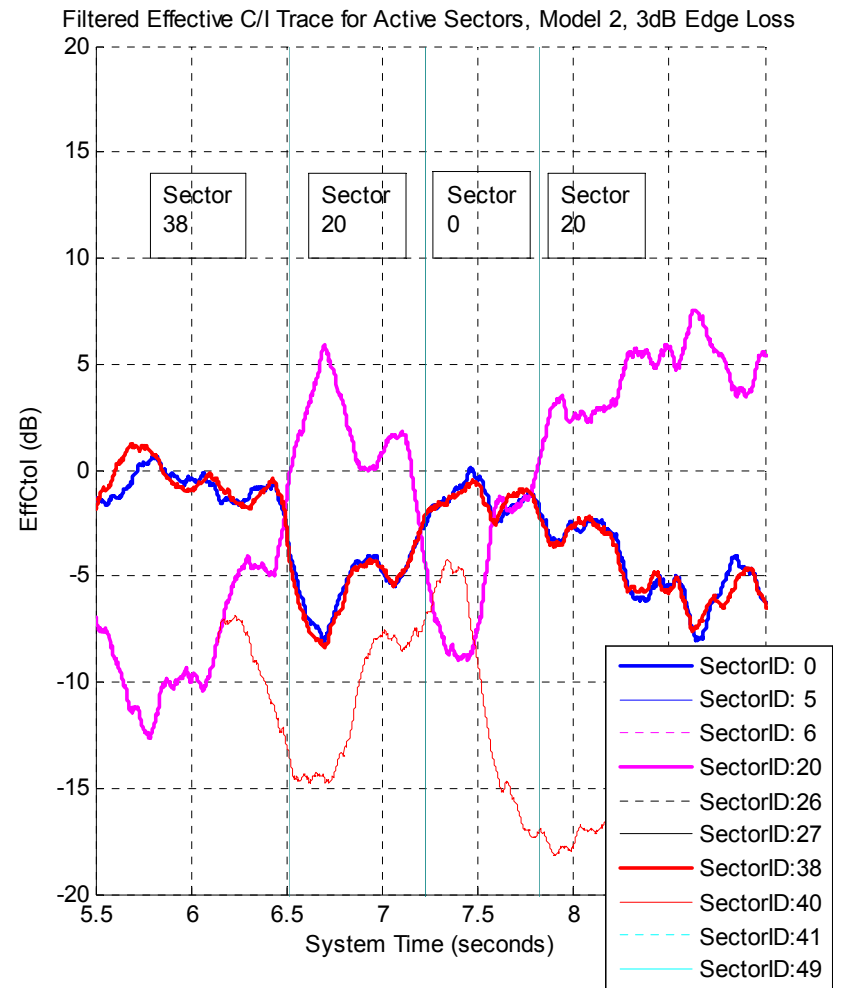
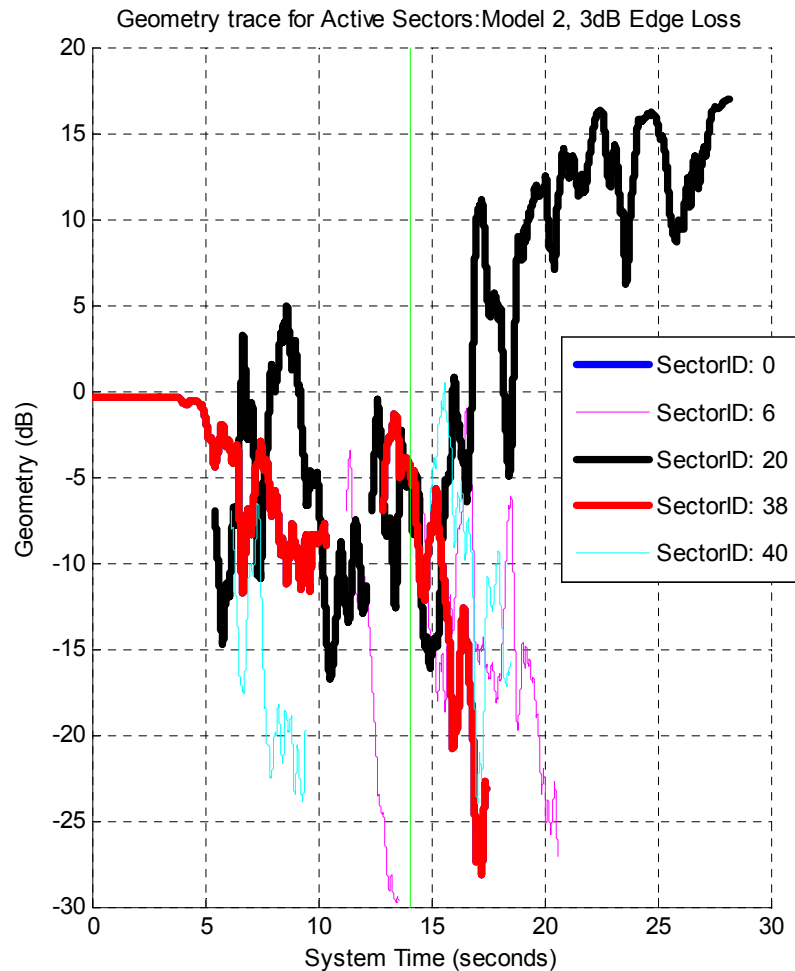


Mobility Simulation Models

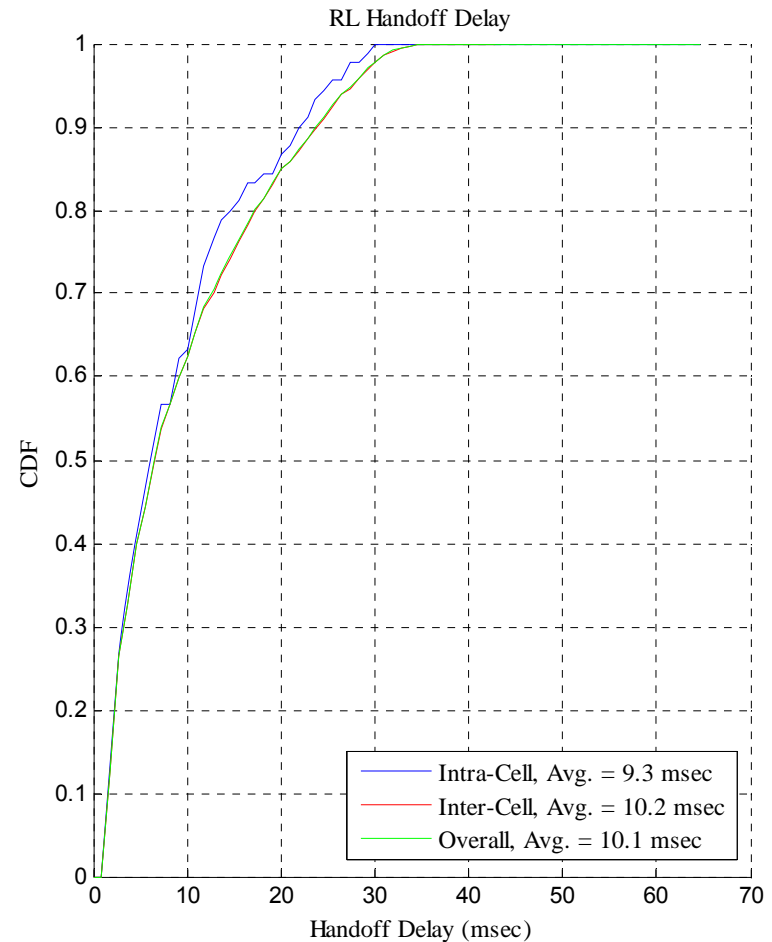
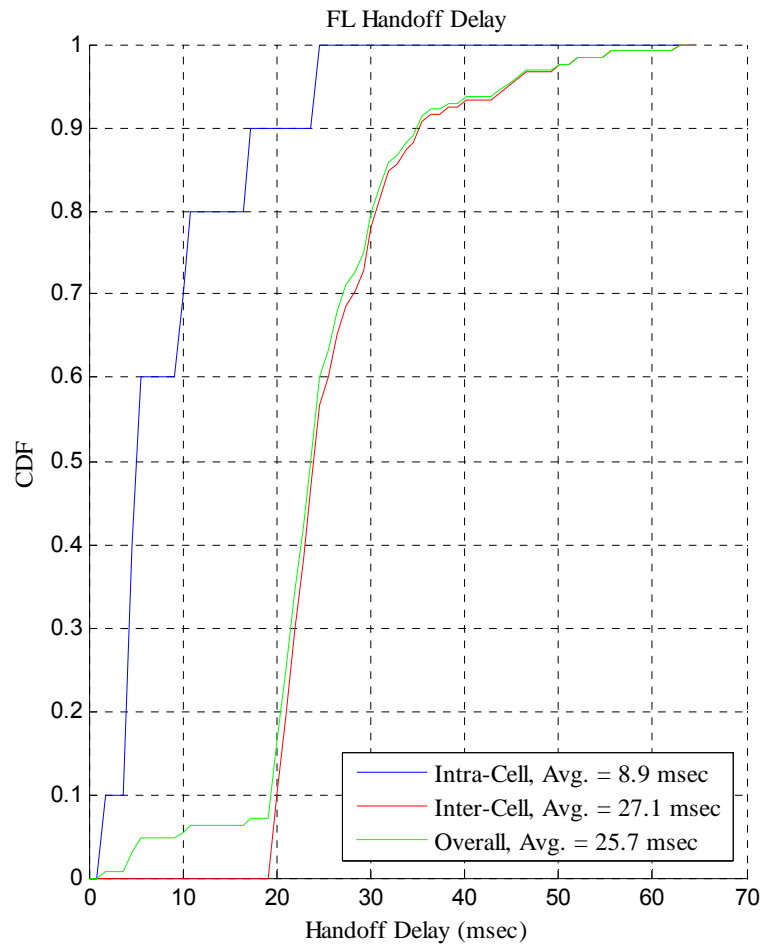
Parameter Name	Interpretation	Value
R	Site-to-site distance	1000 m
EdgeLoss	Sudden propagation loss at cell edge for model 2	3, 6, 9 dB
V	Mobile Speed	3, 30, 120 Km/h
D_{corr}	Shadow Fading Corr. Distance	30 m
D_0	Distance of starting point from A in paths 1 and 2 (same as distance of ending point from B)	30 m
D_3	Total distance covered by terminal in path 3	1000 m
FilterTimeConstant	SINR and C/I filter time constant for active set management and handoff decision	100 msec
AddThreshold	Active set add threshold (on filtered SINR)	-7 dB
DropThreshold	Active set drop threshold (on filtered SINR)	-9 dB
DropTimer	Active set drop timer (if the SINR of an active set sector remains below DropThreshold for this period, it is dropped from the active set.)	2 sec
FLHandoffHysteresis	Forward link handoff hysteresis (on filtered effective C/I)	2 dB
RLHandoffHysteresis	Reverse link handoff hysteresis (on CQI erasure indicator rate)	0.1



Mobility Simulations, Model 2



Handoff Delay Distributions



Idle State Performance

- Duty cycle in idle state
 - Required to read 8 OFDM symbols every page period

Paging period in superframes	Paging period in seconds	Duty Cycle (%)
2	0.04588	2.3
16	0.367	0.29
64	1.468	0.072.
128	2.94	0.036

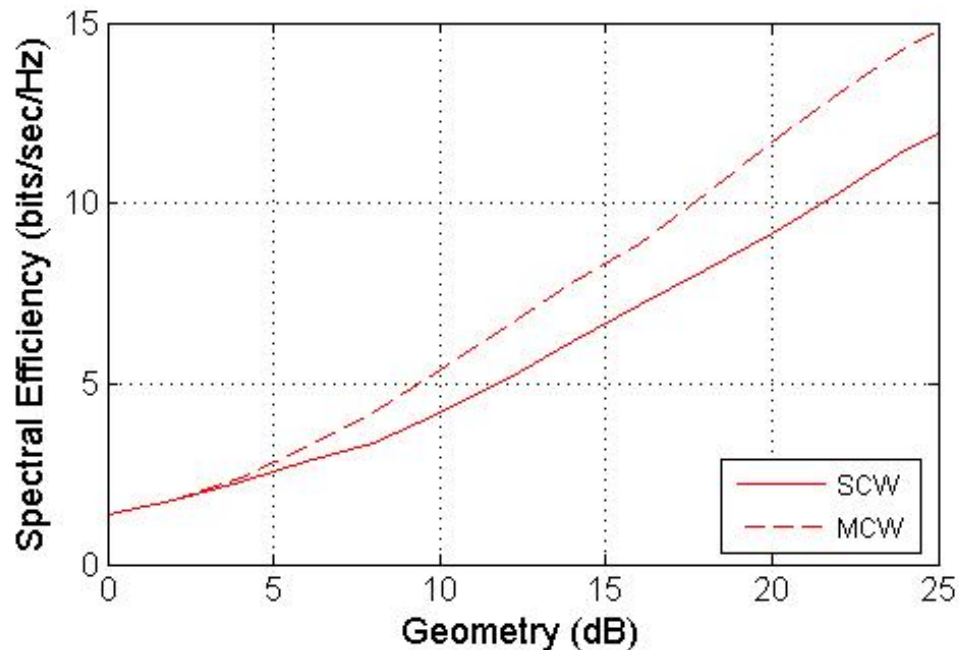
- Access delay
 - Access opportunity occurs every six frames (5.5msec)
- Paging overhead: 1.55%
 - Assuming 20 pages/second/sector, 5 MHz system
 - QuickPage: 1.25% and Paging on traffic channel: 0.3%

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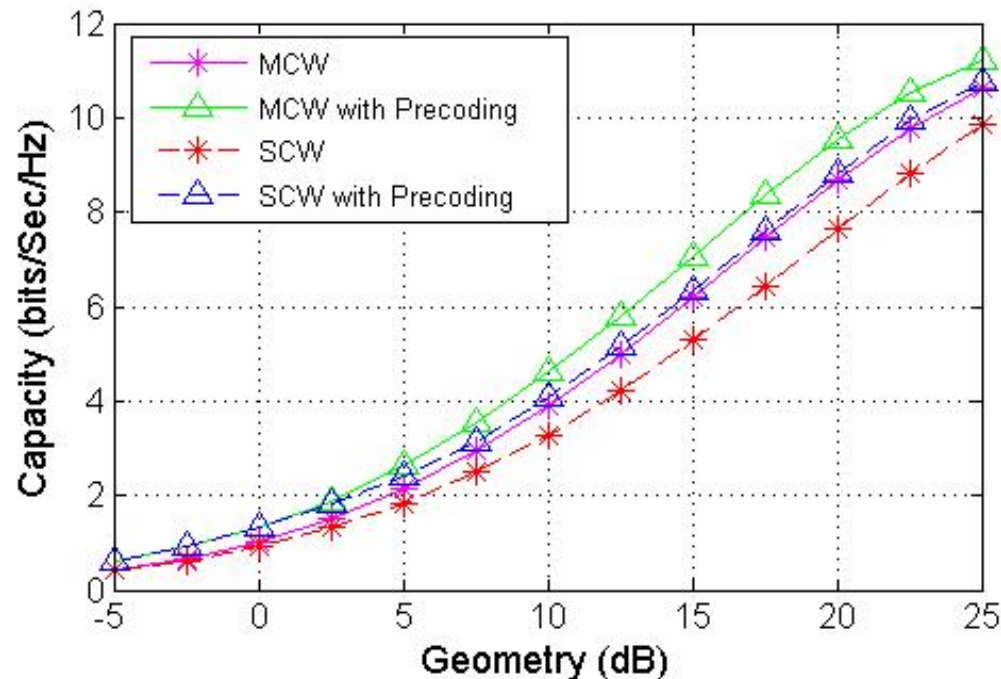
MCW vs. SCW

- Performance captures rate prediction, HARQ, coding and channel estimation performance.
- Channel model: pedB@3km/hr,
- Spatial correlation:
 - Suburban macro, AoD: 50 degree; AS: 2 degree,
 - Antenna configuration: 4x4 with 10λ spacing at AP and 0.5λ spacing at AT.



FDD MIMO Precoding Capacity Study

- Gap to capacity 3 dB to model coding and channel estimation loss.
- Precoding codebook size: 64
- Feedback over 5 MHz channel.
- Channel model: pedB@3km/hr;
- No spatial correlation, antenna configuration: 4x2



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Simulation Numerology

Parameters	Values
Bandwidth of Operation	5MHz
FFT Size	512
Chip rate	4.9152Mcps
Subcarrier spacing	9.6kHz
Guard carriers	32 subcarriers
Cyclic Prefix	6.51 μ s
Windowing Duration	3.26 μ s
OFDM Symbol Duration (For 6.51 μ s CP)	113.93 μ s

Quasi-Orthogonal Reverse Link

- Antenna configuration: 1x4 (diversity antennas)
- Channel model: pedB@3km/h, vehA@30km/h.
- Spatial correlation: urban micro (500m site-to-site distance).
- MMSE
 - Estimate spatial structure of all intra-sector users.
 - Additional estimation loss due to QORL is modeled.
 - Other sector interference is modeled as spatially uncorrelated.
- Results are conservative
 - Same multiplexing order for all users.
 - No user clustering has been implemented in simulations.

Sector Throughput (Kbps)	Q = 1	Q = 2	QORL Gain
PedB at 3 Km/h	5716	7251	27%
VehA at 30 Km/h	5646	6990	24%

Fractional Frequency Reuse

- 300 meters site-to-site distance, urban micro propagation loss.

	FFR Results for FDD			
	Throughput (kbps)	%-change Throughput	5%-Spectral Eff (bps/Hz)	%-change 5%-Spec Eff
1x1, EGOS, baseline	2985		0.30	
1x1, EGOS, PL 10%	3090	3.52	0.31	3.33
1x1, EGOS, PL 20%	3197	7.10	0.39	30.00
1x1, EGOS, PL 27%	3210	7.54	0.44	46.67
1x1, EGOS, PL 50%	3180	6.53	0.69	130.00
1x1, PF, baseline	5087		0.35	
1x1, PF, PL 10%	5520	8.51	0.48	37.14
1x1, PF, PL 20%	5343	5.03	0.56	60.00
1x1, PF, PL 27%	5387	5.90	0.61	74.29
1x1, PF, PL 50%	4821	-5.23	0.90	157.14
1x2, EGOS, baseline	4779		0.60	
1x2, EGOS, PL 10%	5122	7.18	0.68	13.33
1x2, EGOS, PL 20%	5075	6.19	0.80	33.33
1x2, EGOS, PL 27%	5045	5.57	0.83	38.33
1x2, EGOS, PL 50%	4707	-1.51	1.27	111.67
1x2, PF, baseline	6853		0.60	
1x2, PF, PL 10%	7350	7.25	0.77	28.33
1x2, PF, PL 20%	7155	4.41	0.85	41.67
1x2, PF, PL 27%	7086	3.40	0.94	56.67
1x2, PF, PL 50%	6028	-12.04	1.47	145.00

FL SDMA

- Channel model: pedB@ 3km/h.
- Spatial correlation: suburban macro.
- Codebook size: 2
- Users select one beam at the beginning of each simulation run.
- MRC: no estimation of spatial structure of intra-sector and inter-sector interference.
- MMSE: spatial processing based on estimate of spatial structure of intra-sector and inter-sector interference.

Sector Throughput (Kbps) and Gain over Baseline System	SDMA				Baseline FDD	
	4x2		4x4		1x2	1x4
	0.5 λ		0.5 λ			
	MRC	MMSE	MRC	MMSE	MRC	MRC
1km BS to BS Suburban Macro PedB 3km/h	8709 (47%)	10431 (76%)	11571 (49%)	15155 (96%)	5912	7740