AWS-3 Interference Analysis

Summary of Optimi Monte Carlo Simulation Results

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Overview

- T-Mobile has proved in front of FCC and other parties the significant amount of harmful interference to AWS-1 services when AWS-3 transmits following the proposed FNPRM rules
  - The tests show that harmful interference occurs at levels between 20 and 30dB below the maximum allowed transmit power
- The following study incorporates the results from the lab tests into a Monte Carlo simulation tool to analyze the extent of the problem in a realistic network deployment
  - Previous statistical analysis presented by M2Z don't incorporate many of the characteristics of a real network, such as the uneven traffic distribution of the users
- The simulation results show an overall degradation in system capacity of 5.3%, and in particular the home traffic is degraded by 10.6%
  - In terms of sector capacity, around **20% of the sectors will experience a capacity loss higher than 10%**
  - Furthermore, these numbers are diluted since the users experiencing interference in their homes will have a **constant** problem that may not happen every day, but will be very frequent and will ultimately push those users to leave T-Mobile service:
    - For users with a AWS-3 router inside their homes there is **more than 60%** chance that the call fails when there is a simultaneous AWS-3 transmission
    - For users that have an adjacent neighbor with an AWS-3 router, there is **close to 30%** chance to have a failure when the AWS-3 router is transmitting

Simulation assumptions

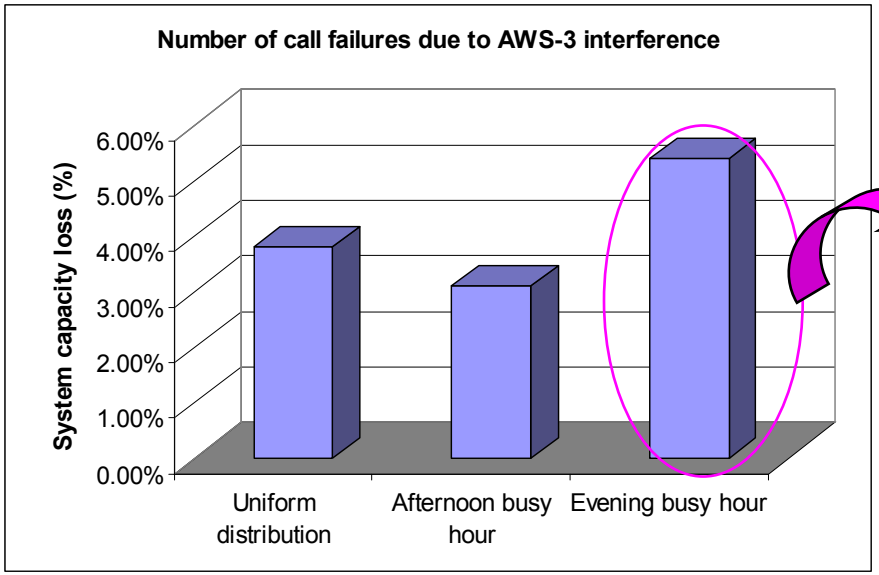
- Traffic distribution
  - 41 sites with 123 sectors total. AWS-1 and AWS-3 sectors are assumed to be colocated
  - Users are statistically distributed in the simulation area following a certain traffic map
  - 5000 erlangs of UMTS traffic, 60% indoor and 40% outdoor
    - This yields an average load of 40 erlangs/sector, which is a conservative setting
  - The AWS-3 network carries 600 Mbps of uplink traffic. The number of AWS-3 devices in the area is calculated based on expected WiMAX capacity (5.4 Mbps/sector in uplink) and average user throughput (125 kbps/user). The effective ratio of AWS-3 devices is 2.88 per each AWS-1 mobile in the F2 block (or 0.32 per each AWS-1 mobile)
    - The effective probability of having interferer and victim in the same home is 7.2%
  - AWS-3 devices don't transmit all the time (there is a 20% UL activity factor)
- Power settings
  - AWS-1 base stations have a maximum transmit power of 61 dBm EIRP. AWS-1 devices receive their signal at a power level that is dependent on the pathloss to their serving BTS
  - AWS-3 devices have a maximum transmit power of 36 dBm (23dBm/MHz for 20MHz, based on FNPRM rules). The actual transmit power level is relative to the pathloss to their serving BTS
  - AWS-3 devices have an OOBE attenuation of 53 dB (60+10logP, based on FNPRM rules)
  - AWS-1 devices have an adjacent channel selectivity ranging from 68 dB to 46 dB (based on results from FCC tests). Furthermore, the simulator incorporate "hard limits" on AWS-3 interference based on lab test results

- Time of the simulations
  - The simulations have been studied at two different times of the day, following typical network behaviour:
    - Afternoon busy hour, where there is an important share of users at work
    - Evening busy hour, where most of the indoor traffic is at home

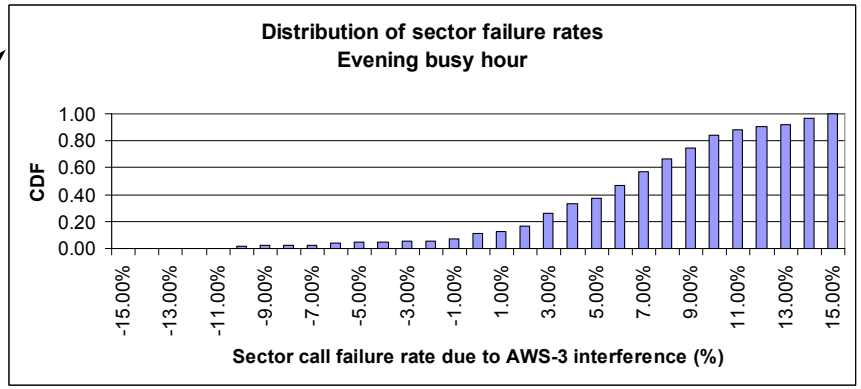
Comparison between M2Z's and Optimi's assumptions

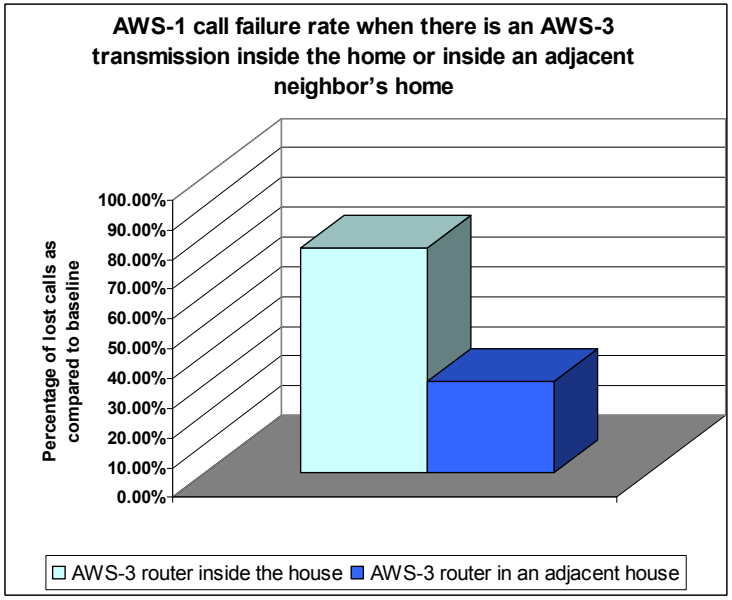
	M2Z	Optimi
AWS-1 channel	F2	F2
Type of simulator	Static Monte Carlo	Static Monte Carlo
Simulator complexity. Functional units	Basic. Single link level curve. RF centric engine (only power control modeled)	Complex. Multiple link level curves. Implementation of Admission Control, Load Control, Soft Handover and Packet Scheduler
Number of cells	1 single cell with traffic	123 cells with traffic
Network topology	Hexagonal (18 interfering cells)	Irregular based on a real network deployment
Environment	Suburban	Suburban
Propagation data	Based on Extended Hata Model for all locations	Based on tuned model from a propagation tool. Different terrains have different propagation characteristics
BTS EIRP (AWS-1)	69, 59, 49 dBm	59 dBm
AWS-1 load	94 users/sector	40 erlangs/sector (≈80 users)
AWS-1 Service	Voice 12.2 kbps, 50% Activity factor	Voice 12.2 kbps, 50% Activity factor
Ratio of interferers to victims (F2 block/total)	≈4 AWS-1 F2 block only 0.44 total AWS-1	2.88 F2 block only 0.32 total AWS-1
AWS-1 Traffic distribution	Uniform across the cell	According to traffic maps for residential, business and outdoor users
AWS-3 Model	UL Transmission with max power?	UL Transmission with power control, signal with 20, 10 and 5 MHz bandwidth, 20% Activity factor
AWS-3 EIRP	33 dBm	30, 33, 36 dBm depending on Bandwidth
Interference thresholds that caused call failures:	AWS-1 ACS: 65 dB (+1.6dB?) AWS-3 ACLR: 55 dB (5 MHz), 67 dB (10 MHz), 75 dB (15 MHz)	Based on lab measurements for RSCP≥ -85 dBm For other values: AWS-1 ACS of 68 to 46 dB (based on lab measurements) AWS-3 ACLR of 53 dB (based on FNPRM)
Degradation metric	Overall capacity loss	Overall capacity loss, sector-specific capacity loss, cluster-specific capacity loss and impact on users with persistent interference at home

Simulation results



Distribution of call failure rate per sector due to AWS-3 interference. Almost 20% of the sectors experience more than 10% failure rate due to AWS-3 interference





In Summary:

- 5.3% overall capacity loss during evening times
- Between 7 and 10% capacity loss in the residential areas
- Users with AWS-3 routers in their homes have 70% chance of experiencing problems during AWS-3 transmissions
- Users with AWS-3 routers in their neighboring homes have 30% chance of experiencing problems during AWS-3 transmissions