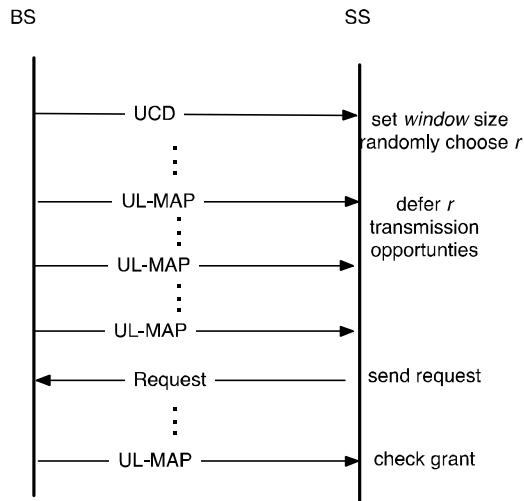




DoS Attacks Exploiting WiMAX System Parameters

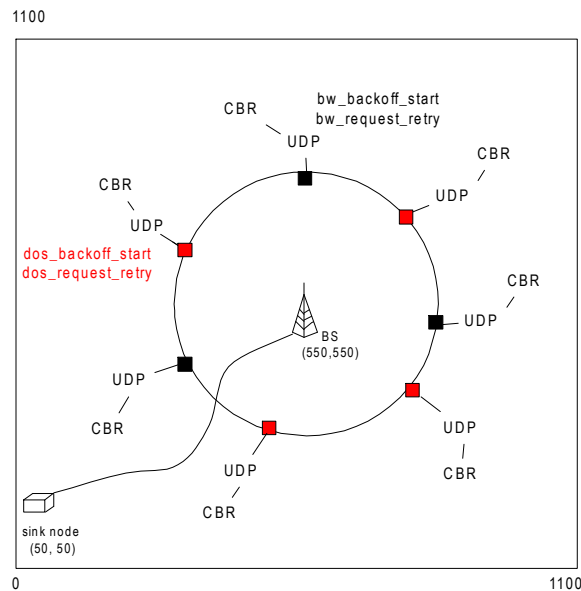
Lu Yu
07/27/2011

Sensitivity of WiMAX Parameters to MAC-level DoS Attacks

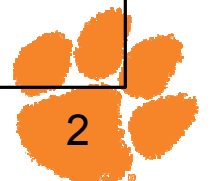


- We consider a new type of DoS attacks on WiMAX networks exploiting WiMAX system parameter.
- We focus on Bandwidth Contention Resolution (BCR) aspects of the WiMAX MAC protocol.
- **Purpose of our work:** To find out which BCR parameter combinations are crucial for configuring WiMAX to be less vulnerable to DoS attacks.

Parameters	Values		
	Low	Medium	High
<i>frame_duration (X1)</i>	0.004	0.01	0.02
<i>number_of_attacker/user (X2)</i>	20/80	50/50	80/20
<i>dos_backoff_start (X3)</i>	1	3	5
<i>dos_request_retry (X4)</i>	2	4	6
<i>bw_backoff_start (X5)</i>	1	3	5
<i>bw_request_retry (X6)</i>	2	4	6



- Attackers ■ and Users ■ contend for bandwidth
- Constant Bit Rate (CBR) traffic generator
- Total numbers of attackers and user: 100
- Network utilization = $2.5/15 < 16\%$



ANOVA Results

Source	SS	DF	MS	F_0	F_α	Prob> F_0	R SQUARE
X1	1.143e10	2	5.713e9	11048.57	2.998	0	0.2169
X2	1.452e7	2	7.258e6	14.04	2.998	0	0.0003
X3	1.291e8	2	6.454e7	124.82	2.998	0	0.0025
X4	1.774e8	2	8.872e7	171.59	2.998	0	0.0034
X5	2.822e9	2	1.411e9	2728.55	2.998	0	0.0536
X6	1.650e10	2	8.250e9	15956.79	2.998	0	0.3133
X1 * X2	7.108e6	4	1.777e6	3.44	2.374	0.008	0.0001
X1 * X3	3.875e8	4	9.688e7	187.37	2.374	0	0.0074
X1 * X4	1.720e8	4	4.301e7	83.18	2.374	0	0.0033
X1 * X5	1.725e9	4	4.312e8	833.89	2.374	0	0.0328
X1 * X6	9.545e9	4	2.386e9	4614.98	2.374	0	0.1812
X2 * X3	3.016e7	4	7.541e6	14.58	2.374	0	0.0006
X2 * X4	3.695e7	4	9.237e6	17.86	2.374	0	0.0007
X2 * X5	6.092e7	4	1.523e7	29.45	2.374	0	0.0012
X2 * X6	8.926e6	4	2.231e6	4.32	2.374	0.002	0.0002
X3 * X4	1.168e8	4	2.920e7	56.48	2.374	0	0.0022
X3 * X5	1.527e8	4	3.818e7	73.85	2.374	0	0.0029
X3 * X6	5.286e8	4	1.321e8	255.57	2.374	0	0.0100
X4 * X5	7.456e6	4	1.864e6	3.61	2.374	0.006	0.0001
X4 * X6	1.066e8	4	2.665e7	51.54	2.374	0	0.0020
X5 * X6	3.870e9	4	9.675e8	1871.14	2.374	0	0.0735
X1 * X2 * X3	1.031e8	8	1.289e7	24.94	1.940	0	0.0020
X1 * X2 * X4	4.540e7	8	5.675e6	10.98	1.940	0	0.0009
X1 * X2 * X5	9.147e7	8	1.143e7	22.11	1.940	0	0.0017
X1 * X2 * X6	3.623e7	8	4.528e6	8.76	1.940	0	0.0007
X1 * X3 * X4	9.952e7	8	1.244e7	24.06	1.940	0	0.0019
X1 * X3 * X5	4.797e7	8	5.997e6	11.6	1.940	0	0.0091
X1 * X3 * X6	1.982e8	8	2.478e7	47.92	1.940	0	0.0038
X1 * X4 * X5	8.019e6	8	1.002e6	1.94	1.940	0.050	0.0002
X1 * X4 * X6	7.409e7	8	9.262e6	17.91	1.940	0	0.0001
X1 * X5 * X6	9.344e8	8	1.168e8	225.9	1.940	0	0.0177
X2 * X3 * X4	3.879e7	8	4.849e6	9.38	1.940	0	0.0007
X2 * X3 * X5	4.518e7	8	5.647e6	10.92	1.940	0	0.0009
X2 * X3 * X6	1.395e8	8	1.744e7	33.73	1.940	0	0.0027
X2 * X4 * X5	4.854e6	8	6.068e5	1.17	1.940	0.311	0.0001
X2 * X4 * X6	2.430e7	8	3.038e6	5.88	1.940	0	0.0005
X2 * X5 * X6	6.429e7	8	8.036e6	15.54	1.940	0	0.0012
X3 * X4 * X5	1.009e7	8	1.261e6	2.44	1.940	0.013	0.0002
X3 * X4 * X6	5.806e7	8	7.257e6	14.04	1.940	0	0.0011
X3 * X5 * X6	2.901e8	8	3.626e7	70.13	1.940	0	0.0055
X4 * X5 * X6	1.107e7	8	1.384e6	2.68	1.940	0.006	0.0002
Error	2.518e9	4870	5.170e5				
Total	5.267e10	5102					

Simulation using ns-2

- For each of the 729 parameter combinations, we run 7 replication. (729x7=5103)
- 7 replications give type II error of less than 0.01 and computation power of larger than 0.99.
- We measure the DoS vulnerability by the average traffic throughput of the users

ANOVA Results

- R-Square:** percentage of variance explained by each source of variation (parameter or parameter combination).
- First Order Effects:
 - X1 explains **21.29%** of DoS vulnerability
 - X6 explains an additional **31.33%**
 - X5 explains no more than **6%**
 - Others show small effects
- Second Order Effects
 - X1*X6 explains **18.12%**
 - X5*X6 explains **no more than 8%**
 - Others show small effects
- Third Order or Higher Order Effects are very small.
- In total, X1 and X6 account for **72%** DoS vulnerability. Adding another parameter X5 account for **86%**.



WiMAX Experiment on GENI ORBIT

Goal of implementing the experiments on GENI

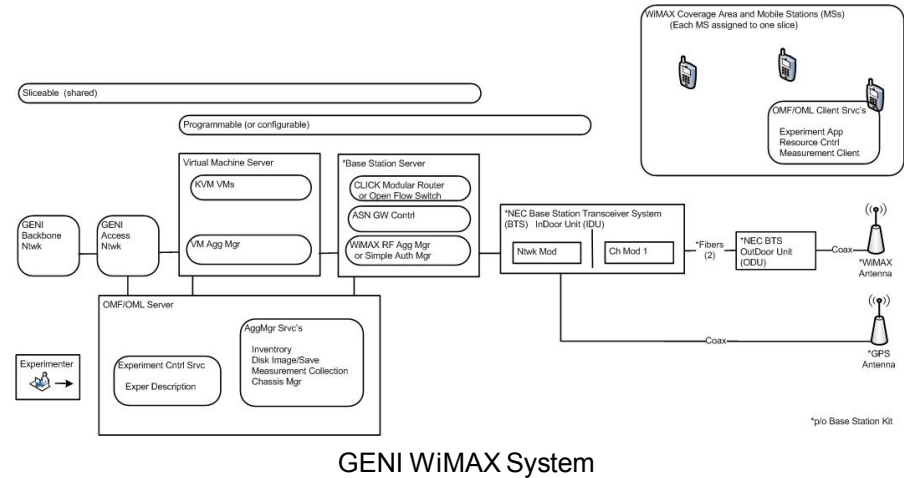
- Migrate the experiment to GENI WiMAX testbed
- Verify the results using a hardware-in-the-loop test environment.

Progress of the WiMAX experiment on ORBIT

- Set up WiMAX network with 4~6 subscriber stations.
- Data collection under different parameter settings without DoS attacks.
- Code for the attackers.
- Data collection on ORBIT should be finished within the year.

Factors that vary from network simulators

- Placement of SSs;
- Number of subscribers;
- Network status, such as signal propagation, etc.



dcdinterv (frames)	Reqbackoffstart	Reqbackoffend	Total Throughput (byts/sec)
0X00C8(200)	3	15	708.304
0X03e8(1000)	0	3	1134.39
0X07d0(2000)	5	10	563.75
0X0064(100)	1	15	1121.771
0X0032(50)	5	15	1121.278
0X0bb8	3	10	1118.820

Number of subscribers: 4
 CBR: 4096 Kbps
 Packet size: 512 bytes



Questions



Thanks!

