PNM APPROACHES FOR IN-PREMISE WIFI NETWORKS – APPLYING LESSONS LEARNED FROM DOCSIS PROACTIVE MAINTENANCE PRACTICES

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Abstract

By leveraging the existing capabilities in wireless equipment, providers can develop processes to determine an optimal channel layout for Wi-Fi devices and help elevate the home Wi-Fi connection. The results can mitigate many of the problems associated with management of a Wi-Fi network and provide a better experience for subscribers.

This paper provides insight into Wi-Fi diagnostics for proactively detecting concerns as well as rectifying them. Proactive diagnostics for both Carrier Wi-Fi and standard in home service are covered. In addition, measuring and improving install quality for preventative management will be covered in this paper.

OVERVIEW

The adoption of PNM (Proactive Network Maintenance) for DOCSIS systems has increased over the last several years with many operators reporting success at getting ahead of plant problems. This has been done by mitigating and then correcting problems before the customer can detect them. This increases customer satisfaction and reduces churn. The success of PNM we see in DOCSIS cable plants leads us to examine the other parts of the service offering that could benefit from similar approaches.

WiFi networks, especially the in premise networks, are an area that needs attention and is growing very rapidly. There are estimated to be more than 7 billion **new** WiFi devices between now and the end of 2017 according to Sys-Con. (Afshar) Privately we've been told by operators that anywhere from 20-40% of all inbound tech support calls directly relate to the in home LAN and the vast majority of those are WiFi network issues. The expansion of CableWiFI as part of the strategy for large MSOs is also driving the expansion of WiFi as part of the core service offering and adding new challenges for delivering good performance. As clients with low RSSI connect to an access point the service degrades somewhat for the other clients, even if their RSSI is high. CableWifi clients often place that kind of strain on in home gateways as customers access those access points from outside the customer premise.

PNM precepts:

1. Collect data from network elements. In this case we can only collect information from the gateways and not usually the normal WiFi clients.

2. Automatically discern problems and where possible apply measures to mitigate the problem.

3. Provide reporting so that operational staff can prioritize and response to issues. In some cases the mitigation already applied will be sufficient.

4. Work with a wide range of currently deployed and new equipment.

COLLECTION OF DATA AND PROBLEM DETECTION

There are several methods of collecting data from gateways and these will vary by manufacturer and sometimes model.

1. TR-069 via TR-181
2. SNMP via CLAB-WIFI-MIB
3. SNMP via vendor specific MIB
4. Syslog parsing

For our field testing the devices selected only supported a vendor specific MIB for WiFi diagnostics. Our current testing is ongoing and currently covers a few hundred customers. We are currently gathering data every 15 minutes and storing the information in a database for offline analysis. We focused purely on the 2.4 GHz band for WiFi because we only had a few devices using 5 GHz bands and none showed any errors or contention.

We focused on gathering:

1. SSID name and current state of operations
2. Firmware version on the gateway
3. Currently used WiFi Channel
4. Which modes of 802.11 were being used
5. The output power of the AP (percentage and in DBM)
6. How often the gateway scanned to see if it should change to another channel.
7. The number of times the wireless AP itself had reset
8. Retransmit counters
9. Interference detection
10. Transmit Error Counters:

- no association error count
- RTS and CTS failures
- non data frames detected and FCS (CRC) errors

For the client focused stats:

1. Count, MAC, and status of all clients
2. Current time each client has stayed connected (Authenticated and Associated)
3. Received and transmitted packets per client
4. AP to client transmission failure counts
5. Up and down data rates from the AP to each client
6. The RSSI for each client

We have found many of the problems we expected to. For example, low RSSI clients have poor performance and nearly half of the clients we examined had periods of very poor RSSI and transmission rates. (See Figure 1, 2)

Errors were detected on at least one of the 2.4 GHz WiFi channels by 57% of the gateways and some of the most commonly used channels were the most problematic. Channel 11 for example showed interference on 42.86% of the devices tracked. (See Figure 3)

We also discovered some things that surprised us. About 12% of the gateways in our test group found interference on the channel they were using, but did not change that channel automatically as they had been configured to do. This occurred even though the devices could see other channels that were not impinged. This could have been because the device was actively sending or receiving data when it looked at its interference state, the user had hard coded the channel in the web interface, or for some other reason.

We saw tremendous swings in RSSI and data rates that were apparently unrelated to interference on the channel. These appeared to be the result of customers moving around their home and hitting spots of no or greatly reduced signal.

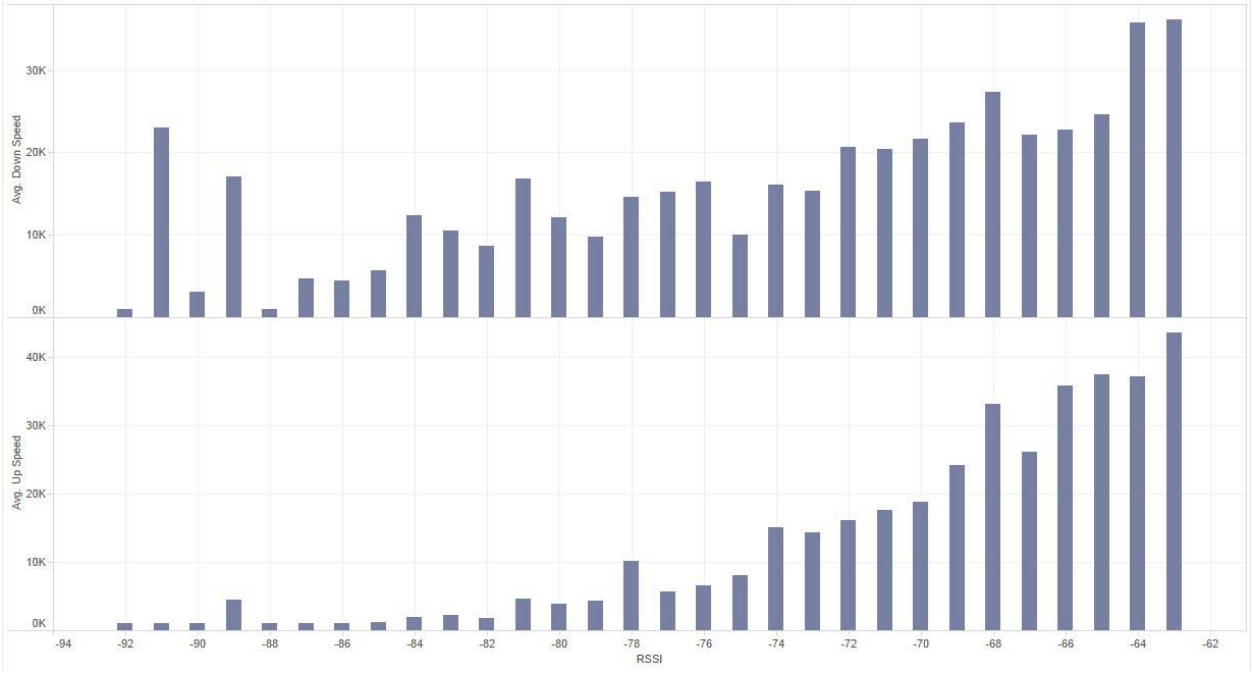

Figure 1 Graph of Low RSSI

Avg RSSI	Min RSS	Max RSSI	Std Dev
-61.94	-92	-1	14.9596

Figure 2 RSSI

Channel	1	2	3	4	5	6	7	8	9	10	11
% of AP's Inteference	17.05%	17.05%	23.04%	13.82%	17.51%	25.81%	31.34%	29.03%	27.65%	34.56%	42.86%

Figure 3 Common channel with Interference

AUTOMATED PROBLEM MITIGATION OR RESOLUTION

The next step was to proactively correct or mitigate the issues detected. Finding the devices that see errors on specific channels and then instructing those devices to move to new channels is straightforward and in most cases this resolved the problems we saw. We have a few cases where it did not and those are still under investigation.

Automatically correcting for poor RSSI clients by changing channels was effective in a few (~8%) cases, but will generally require moving the gateway to a more central location in the home or installing an additional WiFi AP. One additional item that we were able to detect and correct was a version firmware version that correlated to higher error counts.

REPORTING OF ISSUES FOR CORRECTION

Reporting on these problems is relatively straightforward, but the most impactful reports we found were looking for the top 10% of gateways with high error counts and/or retransmit counters. (See Figure 4)

The graph in Figure 5 displays tracking of individual client RSSI to determine if additional access points need to be installed. Tracking each client RSSI should be done both for troubleshooting and to see if we need to reposition the access point or consider installing a new secondary access point to ensure good service. It's critical to track RSSI both at the time of install, based on the installer's test client, and over time.

MAC	Time	WiFi TX Retransmit	No Association Errors	BAD FCS Count	RX Bad PLCP Count
xxxxxxxxxxxx	2014-07-19 17:02:07	26025	905	449583	526385
xxxxxxxxxxxx	2014-07-19 17:02:16	52	110	421393	1260174
xxxxxxxxxxxx	2014-07-19 17:02:17	0	60	18887576	67110359
xxxxxxxxxxxx	2014-07-19 17:02:19	0	50	74168	191856
xxxxxxxxxxxx	2014-07-19 17:02:23	1964	49	582823	2432109
xxxxxxxxxxxx	2014-07-19 17:02:23	1398	141	478979	652086
xxxxxxxxxxxx	2014-07-19 17:02:24	176570	940	357194	237959
xxxxxxxxxxxx	2014-07-19 17:02:24	0	1	0	0
xxxxxxxxxxxx	2014-07-19 17:05:54	78373	1855	2701035	1287425
xxxxxxxxxxxx	2014-07-19 17:05:54	0	0	0	0
xxxxxxxxxxxx	2014-07-19 17:05:56	41890	191	41479	47262
xxxxxxxxxxxx	2014-07-19 17:05:56	20809	349	883291	1012911
xxxxxxxxxxxx	2014-07-19 17:05:57	37813	900	5113959	1571170
xxxxxxxxxxxx	2014-07-19 17:05:57	364	858	10877	390711
xxxxxxxxxxxx	2014-07-19 17:05:59	148109	2619	346791	136623
xxxxxxxxxxxx	2014-07-19 17:06:00	0	31	179	923
xxxxxxxxxxxx	2014-07-19 17:06:01	0	90	5624	44563
xxxxxxxxxxxx	2014-07-19 17:06:02	72216	657	167477	48416
xxxxxxxxxxxx	2014-07-19 17:06:03	4575	517	283392	346111
xxxxxxxxxxxx	2014-07-19 17:06:04	0	30	122672	1315494
xxxxxxxxxxxx	2014-07-19 17:06:04	0	120	162792	2245441
xxxxxxxxxxxx	2014-07-19 17:06:04	0	90	2393908	5041171
xxxxxxxxxxxx	2014-07-19 17:06:05	0	90	621575	1473963
xxxxxxxxxxxx	2014-07-19 17:06:05	118327	2577	1348379	3063571

Figure 4 Error Report for Top 10% of Gateways

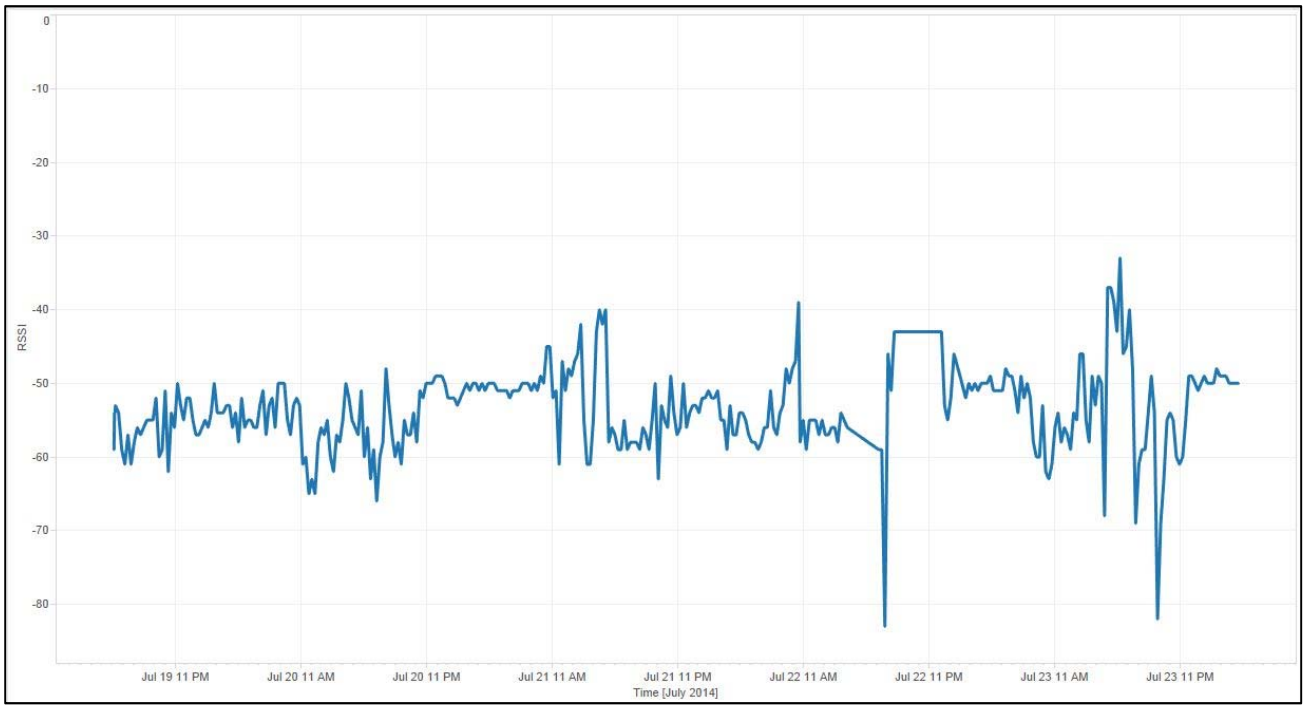

Figure 5 Graph of Single Client RSSI

BIBLIOGRAPHY

Afshar, Vala. "The BLOG." 12 February 2014. A. Huff Post TECH. 2 July 2014. <http://www.huffingtonpost.com/vala-afshar/50-incredible-wifi-tech-s_b_4775837.html>