Wireless LAN Lifecycle Management

Black Box Network Services WLAN quarterly performance assessment for a 300-bed Acute Care Hospital

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Black Box Network Services' WLAN Stability Assessment service monitors and reports on key operational metrics of the Wi-Fi service delivered with InnerWirelessHD3.

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Introduction

The adoption of all things wireless in US hospitals continues unabated. New Wi-Fi devices from VoIP handsets, to iPads and smart pumps continue to be added to the clinical environment at high rates. To remain effective tools for mobile staff, wireless devices require a very high level quality of service which necessitates ongoing assessment of Wi-Fi performance.

Black Box Network Services enables mission-critical WLAN with InnerWirelessHD3, an advanced deployment methodology that enables independent control over both WLAN coverage and capacity to enable mission-critical Wi-Fi deployments. Leveraging industry standard, enterprise-grade access points (APs), multiple APs are collocated in a cabinetized solution to enable multiple, independent WLANs. These multiple WLAN are enabled across an entire facility with engineered coverage and optimized capacity.

As part of InnerWirelessHD3, Black Box Network Services provides a suite of wireless lifecycle services to its customers to establish and maintain a high level of wireless performance while also economically extending the useful life of the wireless ecosystem.

WLAN data can be utilized to help ensure the integrity of the wireless ecosystem. Using this information, Black Box Network Services generates quarterly WLAN reports for Cisco customers, complete with recommendations necessary to maintain or restore performance levels.

Black Box Network Services receives and reviews weekly reports to monitor overall system health. The review is focused on major metrics that can indicate possible areas of concern, while also providing comprehensive system data that is used to monitor for anomalies or unanticipated increases in system loading.

Automated data extracts are received weekly via electronic mail, and are processed and stored in an Black Box Network Services proprietary database that allows for exception reporting and historical trend analysis. The data is provided by customers, extracting information from their Cisco WLAN Wireless Control System (WCS) software.

The following areas are reviewed weekly for anomalies:
- Inventory of devices
- Network performance (controller port utilization)
- Controller performance (CPU/Memory)
- Wireless radio utilization (RF channel utilization)
- Client counts
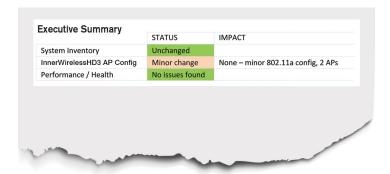- Busiest APs
- Configuration changes

What follows are actual extracts from information reported in the Black Box Network Services Quarterly Stability Assessment Report for a 300-bed Acute Care Hospital (ACH) with Cisco APs deployed with InnerWirelessHD3.

■ Executive Summary

Each quarterly report begins with a simple executive dashboard indicating the overall health of the entire WLAN. Status and trends are reported for WLAN system inventory, AP configurations and overall system performance and health. The Executive Summary is meant as a pointer for the IT department to any area that will require attention and action by the staff.

Executive Summary

	STATUS	IMPACT
System Inventory	Unchanged	
InnerWirelessHD3 AP Config	Minor change	None – minor 802.11a config, 2 APs
Performance / Health	No issues found	

■ System Inventory

While a quarterly review of WLAN system inventory might seem excessive, it is often key to detecting unauthorized changes to network hardware and software.

It is also a convenient reference when systems with multiple generations & models of WLAN components are involved since the availability of specific features may not be uniform across all models.

System inventory reports from Cisco's Wireless Control System (WCS) indicates the customers' system configuration remained unchanged during the last quarter.

A summary of key WLAN equipment is included for reference.

- Controllers
  4 WiSM controllers (All at 4.2.130.0 software code release)
  – Wireless Controller_assigned to Layer 1
  – Wireless Controller_assigned to Layer 2
  – Wireless Controller_assigned to Layer 3
  – Wireless Controller_SPARE
  MSE/WLA-None

- Access Points
  171 Access Points total
  (X # are on InnerWirelessHD3)
  All Access Points at 4.2.130.0 software code release

Cisco Model #s:
  – 96 = AP_MODEL 1
  – 70 = AP_MODEL 2
  – 5 = AP_MODEL 3

Access Point Configurations

By design, WLAN APs support a very wide array of functions and features. This is necessary to support the different performance requirements for data, VoIP and other types of WLAN clients. InnerWirelessHD3, with up to 4 WLANs (and channels) per coverage area, provides a unique capability for optimizing WLAN service levels for

unique capability for optimizing WLAN service levels for each client type. As such, AP configurations for those APs physically connected InnerWirelessHD3 must be documented, since configuration changes (intentional and inadvertent) can be the source for unexplained network performance degradations. AP configurations must be confirmed in order to achieve, and maintain, optimized WLAN performance.

Recommended Remediation: (Priority: LOW)
Correct settings for the two access points shown.

	802.11a Channel (current / Incorrect)	802.11a Channel (**remediate**)
AP 01.00.05S.CH6	157	60
AP 01.01.08S.CH6	56	48

During the initial installation, all on InnerWirelessHD3 Access Points are configured to operate on a fixed channel and at a specific power output level. This specific configuration is unique to the customer's installation, and is designed based on specified design goals of the WLAN implementation. To ensure that the WLAN operates per Black Box Network Services specifications, weekly monitoring of the AP configuration state is compared to required settings for ALL access points. Exceptions would trigger an immediate notification to our team, indicating that a change occurred without consulting Black Box Network Services Support personnel.
    A change was noted for two APs with 802.11a channel assignments. No alert was provided to IT personnel since 802.11a is not in use, and thus the configuration change had no operating impact.

WLAN Performance / Health

The IT staff requires a concise statement of the current performance and any anomalies of their wireless network.

This section introduces five core performance metrics that could impact service levels; WLAN controller utilization, Network utilization, Client Counts, Radio Utilization and the #/type of 802.11 counters.

Overall Performance Summary:

• Controllers: No Concerns
  There are no indications of problems with the wireless LAN controllers based on reported CPU or memory utilization Wired ports % utilization appear to be within normal limits.

• Access Points: No Concerns
  InnerWirelessHD3 Access Points appear to be performing as expected.

• Cisco WCS: Stability Issue
  (Cisco TAC /ACH) An issue was observed whereby the WCS service/system would be periodically unavailable causing interruptions in the management-only portion of the WLAN. WCS is an out-of-band management platform; Controllers are responsible for runtime operation. WCS instability appears to have produced data-spikes in recorded statistics for some data, but it is believed that these are data-only issues, not true indications of runtime performance problems.
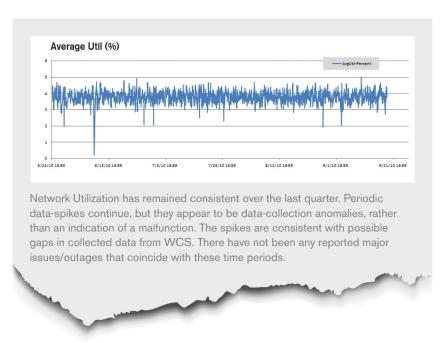
WLAN Controller Utilization

Thin APs are managed by WLAN Controllers and inadequate capacity could limit overall network capacity. This metric could signal the need for major controller upgrades or technology refresh.

Summary, WE 9/19:

Controller		CPU Util.	Mem. Util.	Port 1	Port 2	Port 3	Port 4
Wireless Controler	Average	2.18	44.00	5.60	2.30	3.29	4.98
	MAX	8	44	6.58	3.51	4.42	5.83
	Min	0	44	4.89	1.43	2.42	4.38
Layer 1	Average	2.45	44.00	6.22	4.38	5.47	4.90
	MAX	11	44	7.27	7.23	6.72	7.04
	Min	0	44	3.91	0.64	3.46	1.3
Layer 2	Average	2.64	46.00	4.41	4.29	4.06	4.76
	MAX	7	46	6.13	5.62	5.51	7.02
	Min	0	46	2.17	2.51	2.46	2.29
Layer 3	Average	0.36	46.00	4.93	1.41	4.21	3.61
SPARE	MAX	2	46	5.44	1.74	4.6	3.97
	Min	0	46	4.72	1.32	4.02	3.45

Network Utilization

This metric is a leading indicator for overall network capacity and could signal the need for major upgrades or technology refresh.

Average Util (%)

Network Utilization has remained consistent over the last quarter. Periodic data-spikes continue, but they appear to be data-collection anomalies, rather than an indication of a malfunction. The spikes are consistent with possible gaps in collected data from WCS. There have not been any reported major issues/outages that coincide with these time periods.
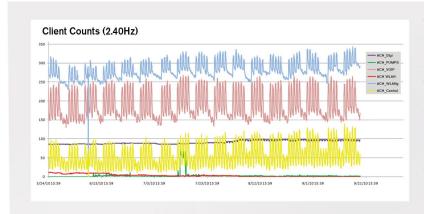
Client Counts

This metric is a 'sanity check' on how the network resources are being utilized. The Client Counts should closely track the facility's occupancy and workflow. The impact of major 'roll outs' of new wireless devices should be easily seen. Any uncorrelated changes should be investigated.
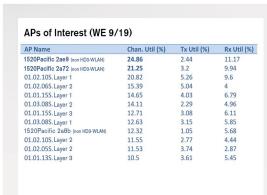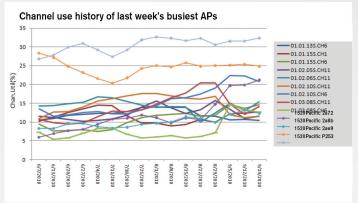

Client Counts (2.40Hz)

To indicate possible issues with wireless usage, historical client counts (authenticated wireless devices) is tracked on a weekly basis. Client counts for the ACH_WLANg, ACH_VOIP, and off-campus show typical Monday-through-Sunday cyclical behavior within a consistent range. ACH_Pumps and ACH_Digi (mobile computers) showed some increase in activity. According to Black Box Network Services Support, these increases occurred during known times of device testing or device additions.

Busiest APs/ Radio Utilization

The preceding metrics are averages across the entire WLAN. This metric gives insight into the non-uniform geographic distribution of clients and their non-uniform usage of the WLAN resource. Because Wi-Fi is a contention based protocol, the protocol becomes unstable above 60% utilization. Thus it is advisable to categorize each AP's utilization into three groupings i.e. <15%, <30%, and >30%. Any AP with a utilization of >30% should be individually investigated to identify the cause of the loading and remediation steps should be implemented.

APs of Interest (WE 9/19)

AP Name	Chan. Util (%)	Tx Util (%)	Rx Util (%)
1520Pacific 2ae9 (non HD3-WLAN)	24.86	2.44	11.17
1520Pacific 2a72 (non HD3-WLAN)	21.25	3.2	9.94
01.02.10S. Layer 1	20.82	5.26	9.6
01.02.06S. Layer 2	15.39	5.04	4
01.01.15S. Layer 1	14.65	4.03	6.79
01.03.08S. Layer 2	14.11	2.29	4.96
01.01.15S. Layer 3	12.71	3.08	6.11
01.03.08S. Layer 1	12.63	3.15	5.85
1520Pacific 2a8b (non HD3-WLAN)	12.32	1.05	5.68
01.02.10S. Layer 2	11.55	2.77	4.44
01.02.05S. Layer 2	11.53	3.74	2.87
01.01.13S. Layer 3	10.5	3.61	5.45

Channel use history of last week's busiest APs

Benchmarks used for baseline analysis:

• *Total Utilization:* 15% or less is norm, 16-30% minor concern, 30% and higher merit a closer look.

• *TX or RX Utilization:* 10% or less is norm, 15% or less minor issue, anything higher requires a closer look.
   Channel utilization percent history for this subset of APs: (non InnerWirelessHD3 APs are shown with dot-maker)
   Recommendation: No action at this time. Monitor InnerWirelessHD3 APs for increases beyond baseline.

■ *802.11 Counters*

The final "counter" metric provides further insight into the non-uniform, geographic distribution of clients and their non-uniform usage of the WLAN resource. All wireless communications is susceptible to interference. Some occurrence of data errors within 'frames' is to be expected along with resulting 'retry' transmissions and changes to how packets are 'fragmented' for over-the-air transmission.

However, excessive errors, retries, and fragments are strong indicators that localized WLAN capacity is unnecessarily being lost and steps should be taken to identify and remediate the root-causes.

- FCS Error Count = the number of MPDU received with Frame Check Sequence (FCS) error per second.
- Retry Count = the number of MSDUs successfully transmitted after one or more retransmissions per second.
- Tx / Rx Fragment Count = this counter is incremented for each unsuccessfully received MPDU of type Data or Management.

Thresholds

Thresholds	Nominal	Observe	Investigate
FCS errors	< 200,000	200,000 to 350,000	> 350,000
Retry Count	< 20,000	20,000 to 50,000	> 50,000
Tx / Rx Fragment	< 200,000	200,000 to 350,000	> 350,000

Remediation

- APs to Monitor: These APs show elevated FCS error counts (currently categorized as Minor concern)
  - 01.01.05S.Layer 1
  - 01.01.06S.Layer 1
  - 01.02.03S.Layer 1
  - 01.02.07S.Layer 1
  - 01.03.04S.Layer 1
  Recommended action: Continue to monitor for trend analysis to determine if there is an issue, or if monitoring thresholds should be adjusted.

- APs of Concern:
  - ACH_off-campus (Non InnerWirelessHD3)
  Concern: This AP shows extremely elevated FCS, Retries, and Tx Fragmentation counts.
  Note: This is an non InnerWirelessHD3 access point.
  Recommended action: investigate wireless coverage, interferers, and wired connectivity.
  - 1520Pacific P253 (Non InnerWirelessHD3)
  Concern: This AP shows elevated Retry counts.
  Note: This is an non InnerWirelessHD3 access point.
  Recommended action: investigate wireless coverage, and interferers.

Summary

Routine WLAN performance assessment and remediation will be critical in meeting the escalating demands of mobile healthcare providers and their patients. As well as provide mission and life critical performance for Wi-Fi enabled medical devices. Smartphones are forecasted to become the #1 device for eHealth with mobile devices of all types exceeding 5.6 billion worldwide by 2015.

Conclusions / Recommended Actions

In general, the ACH WLAN operated with InnerWirelessHD3 appears to be providing the required level of service. Black Box Network Services recommends continued monitoring and trend analysis to provide alerting of possible changes to network health, and to reaffirm normal baseline thresholds for error condition reporting.

The data reviewed to date shows that InnerWirelessHD3 APs are performing at lower channel utilization compared to non InnerWirelessHD3 counterparts, primarily as a result of the multiple layers. Courtesy monitoring of the non InnerWirelessHD3 APs will continue; however 802.11 counters suggest performance remediation might be required in the future.

It is anticipated that the current WLAN on InnerWirelessHD3 configuration will meet the foreseeable needs of ACH, with sufficient overhead to accommodate moderate increases in Wi-Fi traffic and client additions.

Black Box Network Services

Black Box Network Services (BBNS) enables mission-critical, in-building wireless for enterprise organizations in healthcare and hospitality, as well as government and Fortune 500 through InnerWireless4G and InnerWirelessHD3. Mission-critical wireless delivers all key wireless services, including 3G/4G, fire/life/safety, 802.11 and medical telemetry, with engineered coverage and capacity to ensure all wireless devices stay connected with optimal service levels. As a system integrator, our rigorous engineering processes document the wireless characteristics of every installation – enabling 100% first-time acceptance of all wireless deployments. Coupled with a complete range of unmatched professional services, BBNS creates a long-term partnership with our customers that maximizes both total cost of ownership and return on investment. BBNS ensures mission-critical wireless delivers everything, everywhere, everytime.

Black Box (NASDAQ: BBOX) is leading communications systems integrator dedicated to designing, sourcing, implementing and maintaining today's complex communications solutions. Black Box services more than 175,000 clients in approximately 150 countries with approximately 200 offices throughout the world.