

Performance Analysis of Aruba™ Wireless Local Area Network Lampung University

By Gigih Nama

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Abstract— Information Technology has become the catalyst for growth at Lampung University, there were over 25000 students, 1300 lecturer, and 645 academic staff should be provided with adequate network capacity in order for enhancing learning, research activity, and other academic use. IT units already developed wireless infrastructure using Aruba Technology since March 2014 to served them. 100 units Aruba series AP-135 and 30 AP-175 already installed on 95 buildings. Wireless Network Controller, Airwave, and ClearPass as a part of Aruba Mobility-Defined Networks Architecture technology also developed. This paper introduce a wireless performance analysis based on airwave reporting application, with 1 year of data report we investigated network activity on each Aruba AP such; usage average, clients average, top applications and destinations, client device inventory. The result of this study shown 3 busiest and high load AP; 1) FT Kimia Lt1 with 55 average clients and 6.694 Mbps average usage, 2) FKIP G Outdoor with 41 average clients and 4.4 Mbps average usage, 3) GSG A 969 with 37 average clients and 2.439 Mbps average usage. Maximum concurrent client connected to Aruba AP was 2647 was held on November 2014. Top application and its data consumed during 2 weeks investigation was; 1) sys-svc-http with 2.31 TB, 2) svc-smb-udp with 1,59 TB, 3) svc-https with 390 GB, 4) facebook with: 172 GB. Top 5 Operating System used by users device was; Android, Win 7, Iphone, Blackberry, Win 8.

Keywords— *Wireless LAN Performance Analysis, Aruba Mobility-Defined Networks Architecture, Wireless monitoring, Aruba Wireless*

I. INTRODUCTION

Nowadays, internet become basic needs for human being. A lot of services are available to fulfill the users need. Internet availability is increasingly recognized as a serious, worldwide public concern. Unila as an academic institution should provide the internet service for thousands of users. Unila has 25000 students, 1300 lecturer and 645 academic staff that used the internet daily [18]. Since March 2014 Unila already developed a comprehensive deployment for wireless infrastructure using Aruba Technology. Total 130 units AP spread for over 95 buildings to support academic activity, installed with 3 type of SSID; 1) Wifi@Unila, 2) Wifi@Unila-guest, 3) UNILA-FREE.

Wireless performance and usage data studies are valuable for Unila's management to improve WLAN infrastructure

services. Very important to understanding how and where clients use the network, type of applications used by users, which AP with highly utilized, which operating system on user device, to make better network provisioning.

This paper presents a performance analysis of wireless local area network Unila. Analysis is based on Airwave reporting system, several report consist of average clients, top applications and destinations, device type/operating system, top AP activity, RF performance, bandwidth and data usage. We collect the wireless activity data since March 2014 until March 2015 for all 130 APs that spread out on all administrative buildings, laboratory, library, convention hall, students dormitory, swimming pool, canteens, etc.

II. RELATED WORK

Aaron et al on works [1], analyzed packet traces from two separate campus wireless networks, with 3 days of traffic for 32,278 unique devices. Trends for handhelds include low UDP usage, high volumes of HTTP traffic, and video traffic. Yan-Qun Xiao on works [2] described design plan of campus wireless network, and studies the learning mode, system structure and platform building of m-learning system based on WLAN.

Some papers presented investigation of wireless networks performance published on works [3][4][5][6][7][9][11][20][21]. Especially on works [2][1] Sahin Albayrak et al, formulated and compared the network-centric resource allocation and user-centric network selection problems in a multi-operator scenario using two different flavors of game theory, namely bargaining games (for network-centric resource sharing) and multi-attribute auctions (for user-centric interface selection), they compared the contributed solutions to one another to investigate their performance in terms of efficient resource allocation, call blocking probability, and user satisfaction.

Security Performance in Wireless LANs already shown on works [8][1][19][22][23][24][25], Poonam Jindal et al on works [8] presented the comprehensive experimental results on the security performance of 802.11 standards of WLAN. An in-depth analysis has been performed to study the impact of various security layers on the network performance in terms of throughput, response time, encryption overheads, packet

loss, frame loss and jitter in different network scenarios. Quantitative measurements are provided to demonstrate the effect of loaded and unloaded network. Ye Wen on works [17] describe that monitoring wireless channel utilization is an important indicator for network capacity and wireless resource usage, they evaluate the wireless channel utilization of the GSM networks of Guangdong Mobile in Guangdong Province.

Related publication on Aruba technology implementation was white paper case study at Henkel [15], it has large network with 1000 access points and 100 controllers located around the world, their inventory management has proven AirWave to be a very useful tool. It allows new devices such as access points, controllers and other wireless can be monitor [16]. Paper on work [12] shown that California State University IT Units determined Aruba Networks provided the best value for fulfilling the needs of the CSU wireless technology infrastructure. The engineers determined that Aruba provided simplicity operational, easy to manage, future-proofing, and easy for scale-up. Paper on [3] describe that Southampton University already used 2 Aruba MMC-6000 Multi-service Mobility Controllers, Approximately 500 Aruba AP-61 Access Points, ArubaOS Policy Enforcement Firewall and Wireless Intrusion Protection to serve all students and faculty member.

III. UNILA'S ARUBA WIRELESS LAN NETWORK TOPOLOGY

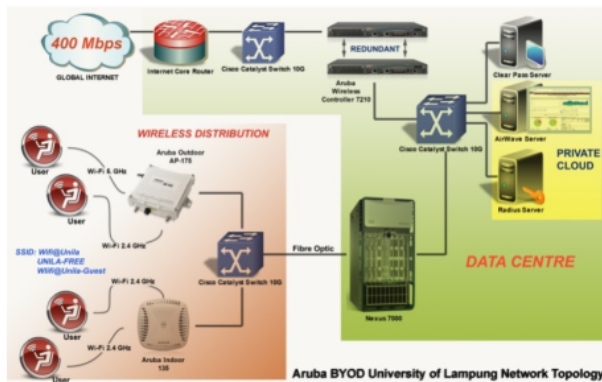


Fig 1. Unila's WLAN topology.

Fig. 1 shown Unila's WLAN topology, on data centre (DC) already installed 2 Aruba Controller 7210 series act as master active-active. ClearPass installed on dedicated server also placed at DC. The Aruba ClearPass Policy Manage platform provides role and device-based network access control for wireless users and VPN infrastructure, with built-in RADIUS, TACACS+, device profiling and posture assessment, on boarding, guest access, and a comprehensive context-based policy engine [14]. ClearPass use database user from existing radius server on Unila Private Cloud, radius act as SSO user database backend for many academic application.

Beside ClearPass, AirWave Wireless Management Suit from Aruba Networks also installed on DC, Airwave developed under Visualization Technology and run on Unila's Private Cloud. It drives operational efficiency and intelligent

planning for teams to managing the networks, can automate tasks, delegate troubleshooting responsibilities, detect rogue APs, and deliver historical data for operational planning or compliance purposes [16]. There were total 100 indoor AP-135 access points, and 30 outdoor AP-175 access points and over 95 buildings, both indoor and outdoor operate on 2.4 Ghz and 5 Ghz. Each AP connected to distribution switch Cisco WS-C2960S that support PoE+.

IV. ARUBA WIRELESS PERFORMANCE ANALYSIS

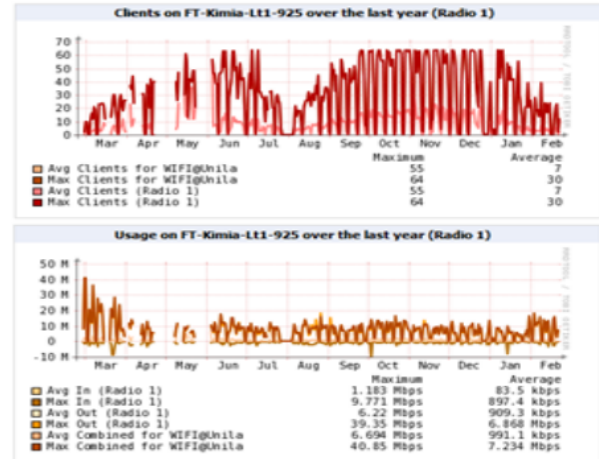


Fig 2. Clients and usage on AP FT Kimia Lt1 925.

Fig. 2 shown Clients and Usage report on AP FT-Kimia-Lt1-929 for 1 year, from this report shown average Client for SSID Wifi@Unila was 55 and maximum client connected 64 on June 2014, bandwidth usage for this AP shown average In: 1.183 Mbps and average Out: 6.22 Mbps, max In: 9.771 Mbps and max Out: 36.35 Mbps.



Fig. 3. Clients and usage on AP FKIP G outdoor.

Fig. 3 shown Clients and Usage report on AP FKIP G_Outdoor for 1 year, from this report shown average Client for SSID Wifi@Unila 41 and maximum client connected 64 on May 2014, bandwidth usage for this AP shown average In: 1.715 Mbps and average Out: 4.114 Mbps , max In: 28.89 Mbps and max Out: 18.25 Mbps.

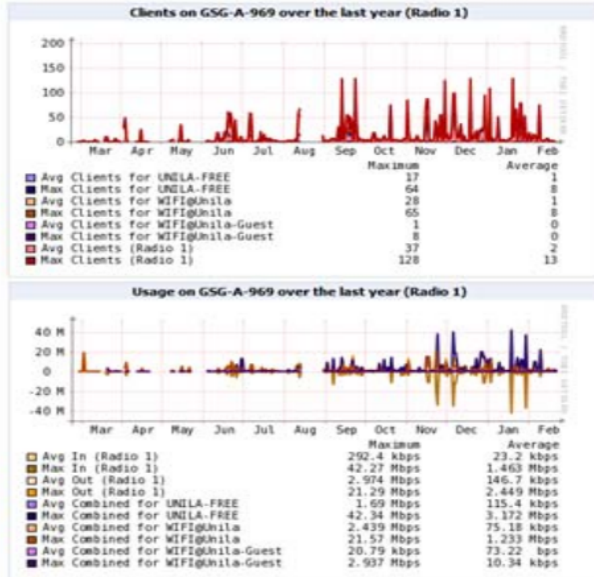


Fig. 4. Clients and usage on AP GSG A 969.

Fig. 4 shown clients and usage report on AP GSG-A-969 for 1 year, from this report shown average client for all SSID 37 maximum client connected 128 on September 2014, bandwidth usage for this AP shown average 20.79 Mbps and Max 21.57 Mbps. GSG is multipurpose building which is often used for graduation ceremony, especially on graduation day there were so many students with their parent attending the event. Fig. 4 shown only on June, September, November, December the Access Point load with high traffic (graduation period).

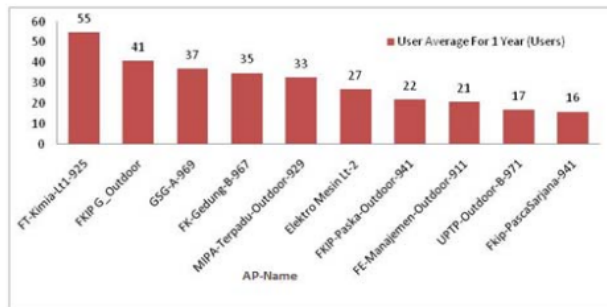


Fig 5. Top 10 AP by average user for 1 Year.

Fig. 5 shown top 10 AP's sort by average user, most utilized user was AP FT-Kimia-Lt1-925 recorded 55 average user, number 10 was AP Fkip Pasca Sarjana with 16 average user on 1 year.

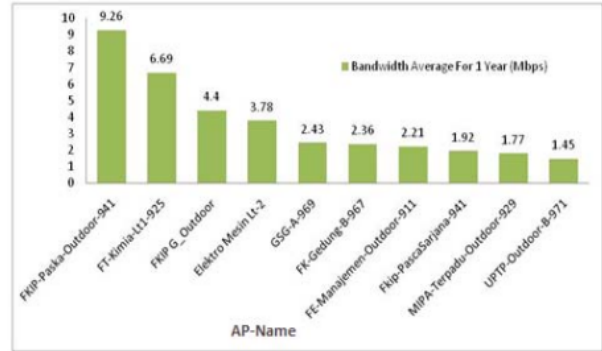


Fig. 6. Top 10 AP by bandwidth average usage for 1 year.

Fig. 6 shown Top 10 AP's sort by bandwidth average usage, most utilize usage was AP FKIP-Paska-Outdoor-941 recorded average 9.26 Mbps, number 10 was AP UPTP-Outdoor-B-971 with 1.45 Mbps.

Trend for Top 3 Destinations

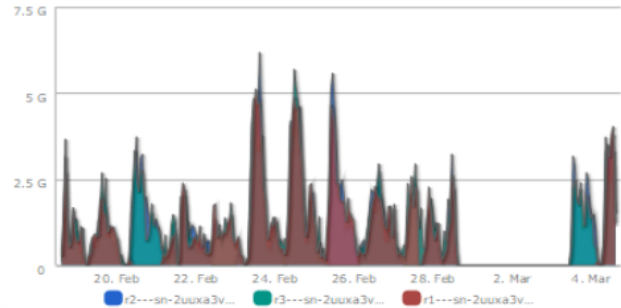


Fig. 7. Top 3 destinations (2 weeks investigation).

Fig. 7. shown Top 3 Destination for 2 weeks (19 Feb-5 March 2015) there was; r2---sn-2uuxa3vhug5, r3---sn-2uuxa3vhug5onpu, r1---sn-googlevideo.com.

Top 10 Destinations

Destination	Bytes
r2---sn-2uuxa3vhug5onpu-cuie.googlevideo.com	296 GB
r3---sn-2uuxa3vhug5onpu-cuie.googlevideo.com	285 GB
r1---sn-2uuxa3vhug5onpu-cuie.googlevideo.com	261 GB
facebook	197 GB
fileshare	143 GB
serv1.idup.in	114 GB
r1---sn-2uuxa3vhug5onpu-cuie.c-pack-google.c...	56.6 GB
google drive	44 GB
abc	35.2 GB
r2---sn-2uuxa3vhug5onpu-cuie.gvt1.com	34.3 GB

Fig. 8. Top 10 destinations (2 weeks report).

Fig. 8 shown top 10 destination during 2 weeks monitoring (19 Feb - 5 March 2015). The Top destination was r2---sn-2uuxa3vhug5onpu-cuie.googlevideo.com with IP address record is 118.98.26.13, This IP were belong to Google Global

Cache (GGC) server owned by PT Telekomunikasi Indonesia (Unila's internet service provider).

Trend for Top 3 Applications

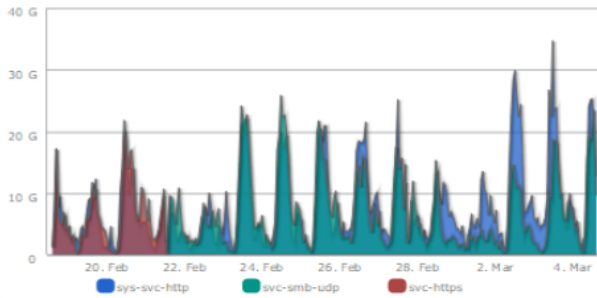


Fig. 9. Trend for top 3 application (2 weeks monitored).

Fig. 9. shown top 3 application for 2 weeks (19 Feb-5 March 2015) there was; **sys-svc-http**, **svc-smb-udp**, **svc-https**

Top 10 Applications

Application	Bytes
sys-svc-http	2.31 TB
svc-smb-udp	1.59 TB
svc-https	390 GB
audit	184 GB
facebook	172 GB
https	59.7 GB
google drive	42.8 GB
youtube	25.6 GB
svc-dgm-tcp	22.5 GB
Port 6881	19.2 GB

Fig. 10. Top 10 applications (2 weeks).

Fig. 10 shown Top 10 Applications during 2 weeks monitoring (19 Feb-5 March 2015). The Top applications was **sys-svc-http** consume **2.31 TB** data, number 10 was **Port 6881** consume around **19.2 GB** data.

AOS Device Type Summary

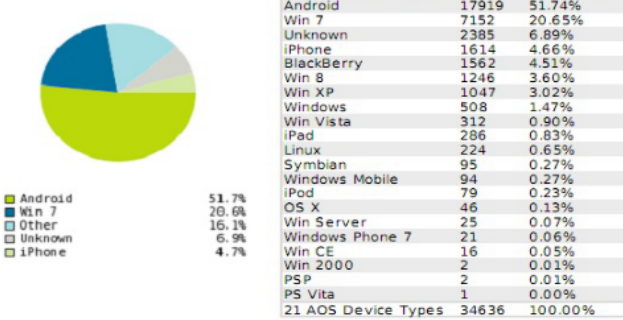


Fig. 11. Client inventory report.

Fig. 11 shown clients inventory report of all users for 1 year data, there were total **34636** connected devices, **51.74 %** of those devices used Android Operating System, and **20.65 %** Win 7, **4.66% iPhone**, **4.51% BlackBerry**, **3.6 % Win 8**.

Device Manufacturer Summary

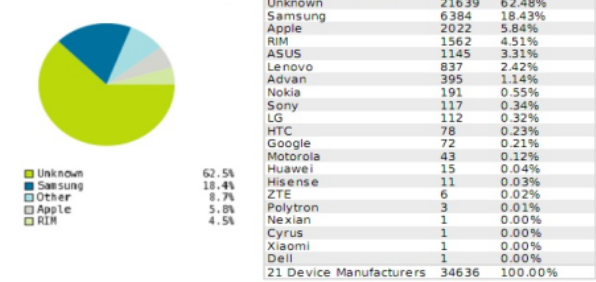


Fig. 12. Client device manufacturer report.

Fig. 12 shown client device manufacturer report of all users for 1 year data, there were total **34636** connected devices, **18.43 %** of was Samsung, and **5.84 %** Apple, **4.51 %** RIM, **3.31** ASUS.

Clients over the last year

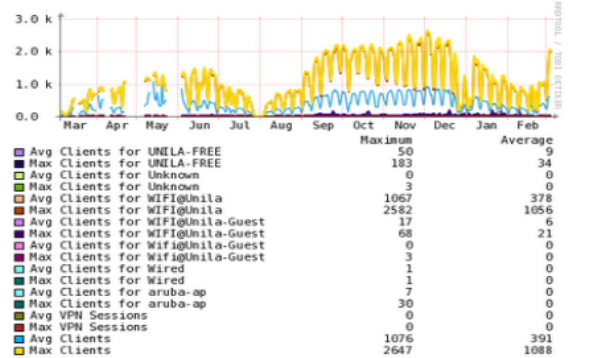


Fig. 13. Clients summary for 1 year.

Fig. 13 shown average client for 1 year was **1076** and max Client **2647** (November 2015), the most utilize SSID was **WIFI@Unila** with average clients **1076** users.

Usage over the last year

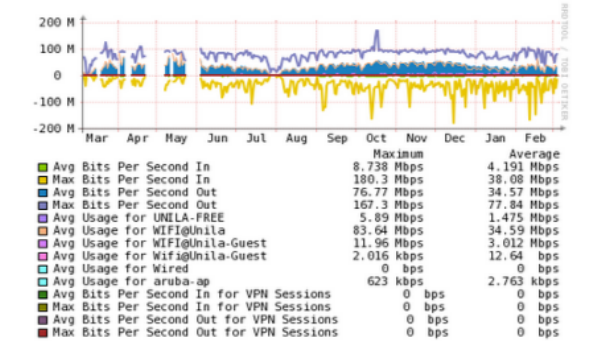


Fig. 14. Bandwidth usage report for 1 year.

Fig. 14 shown average bandwidth usage for SSID **Wifi@Unila** was **83.64 Mbps**, and max Out was **167.3 Mbps** held on October 2014.

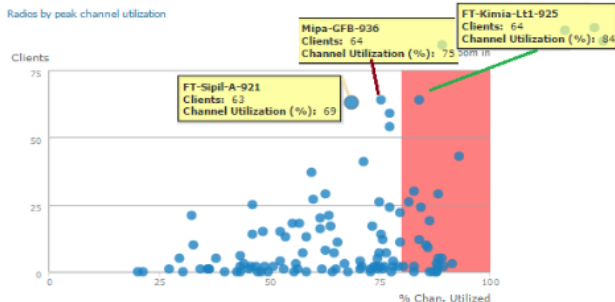


Fig. 15. 2.4 GHz RF performance report.

Fig. 15 shown 2.4 GHz RF Performance report, this report was generated on 4 March 2015 at 1:30 PM, the report shown that AP FT-Kimia-Lt1-925 was connected with 64 users (Channel Utilization: 84 %), Mipa-GFB with 64 users and 75 % Channel Utilization, FT-Sipil-A-921 with 63 users and 69 % Channel Utilization.

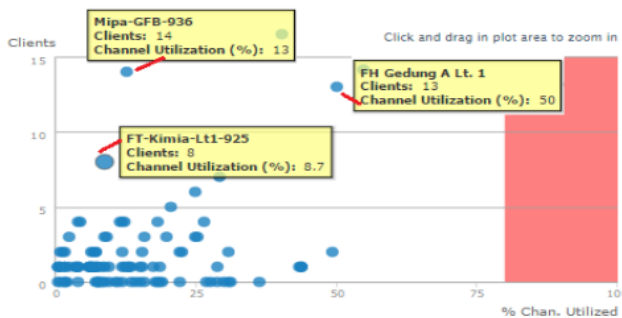


Fig. 16. 5 GHz RF performance report.

Fig. 16 shown 5 GHz report, was captured on 4 March 2015 at 1:30 PM, the report shown that AP MIPA-GFB was connected with 14 users (Channel Utilization: 13 %), FH Lt1 with 13 users and 50 % Channel Utilization, FT-Kimia with 8 users and 8.7 % Channel Utilization.

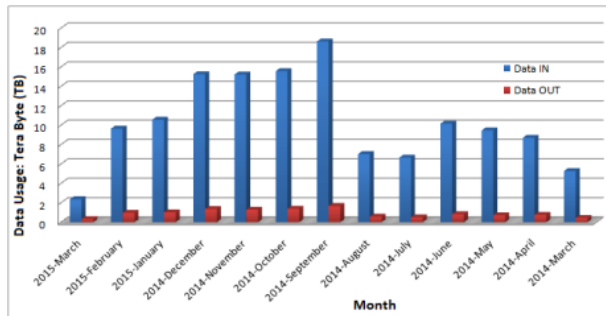


Fig. 17. Data Usage Summary.

Fig. 17 shown WLAN usage summary since 13 March 2014 until 6 March 2015, total Data IN was 134.453 TeraByte and total Data OUT was 11.790 TeraByte. Maximum Data IN and OUT established on September 2014 (IN= 18.615 TB, OUT= 1.667 TB), Minimum Data IN and OUT was March 2014 (IN=2.364 TB, OUT= 0.323 TB).

V. CONCLUSION

We Conducted an performance analysis of Unila's WLAN network for 1 year activity, in an effort to understand patterns of users activity on WLAN network. Airwave reporting system data was analyzed (March 2014-March 2015). The result of this study shown that there were 3 Top AP with high utilized: 1). FT-Kimia Lt1: 55 average clients and 6694 Mbps average usage. 2). FKIP G Outdoor: 41 average clients and 4.4 Mbps average usage. 3). GSG A: 37 average clients and 2.439 Mbps average usage. There were total 1076 average clients for 1 year and max client 2647 (November 2014). Top application and its data consumed was 1). sys-svc-http: 2.31 TB, svc-smb-udp: 1,59 TB, svc-https: 390 GB, facebook: 172 GB (during 2 weeks data captured). Top 5 Operating System of users device was; Android, Win 7, Iphone, Blackberry, Win 8. The result of this study was already presented to Lampung University top level management, we made a recommendation to extend Access Point devices at congested and high density area, especially for 10 area near those several AP; FT Kimia Lt, FKIP G Outdoor, GSG A, FK Gedung B, MIPA Terpadu Outdoor, Elektro Mesin LT.2, FKIP Paska Outdoor FE Manajemen Outdoor, UPTP Outdoor B, Fkip PascaSarjana, to provide more reliable WLAN services.

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