

# Performance Analysis of Aruba™ Wireless Local Area Network Lampung University

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**Abstract**— Information Technology has become the catalyst for growth at Lampung University, there were over 25,000 students, 1,300 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 Clear Pass 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 2,647 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 25,000 students, 1,300 lecturer and 645 academic staff that used the internet daily [1]. 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 activit , 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 Air Wave 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 WORKS

Aaron et al on their works on paper [2], they made a deep packet trace analysis of two wireless network environment that is place separately and still parts of a campus, with total observation time was for 3 days to gathering the traffic data for total 32,278 unique device. They get the trends of handhelds device usage including UDP data transactions, and also HTTP protocol with high traffic volume transactions, and video traffics. Yan-Qun Xiao on works [3] 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 [4] [5] [6] [7] [8] [9] [10] [11] [12]. Especially on works [10] Sahin Albayrak et al, They already formulate and compare between the centralization of network resource allocation and user based network convergence on several telecom operators and adopted the concept of game theory, the concept of bargaining games was used for resource sharing network centric and other was multi attribute auctions concept to be implemented for user-centric interface selection, they made comparison of the contributed solutions for each other to measuring the performance in terms of resource allocation efficiency, probability of call blocking and also for users satisfaction.

Security performance in wireless LAN already shown on works [13] [14] [15] [16] [17] [18] [19], Poonam Jindal et al on works [13] They presented their experiments result that have been carried out comprehensively about the performance evaluation of network security in the 802.11 WLAN protocol. Several depth experimental analyses they have done is aimed to study the various impact on several security layer at the performance network in terms for throughput value, responses time value, overhead encryption, frame loss and jitter capturing the packet loss in different scheme network scenarios. Ye Wen on works [20] 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 [21], it has large network with 1,000 access points and 100 units of controllers that separate located around world, the inventory system management proved that Air Wave application was very helpful and useful monitoring program. Air Wave based monitoring system capable to identify the addition of new devices such as new installed access points, other wireless devices, new installed controllers can also monitor [22]. Paper on work [23] shown that California State University (CSU) IT Units determined aruba networks infrastructure provide the better solutions that comply with CSU campus wireless technology infrastructure need. Mostly of engineers said that Aruba provided simplicity operational, easy to manage, future-proofing, and easy for scale-up. Paper on [24] describe that Southampton University (SU) already used 2 Aruba controller within the series was MMC 6,000 this type is multi service controllers, already installed and manage access point for total 500 units of AP 61 series, equipped with aruba operating system firewall and wireless prevention and intrusion detection to serve all students and faculty member.

### III. UNILA'S ARUBA WIRELESS LAN NETWORK TOPOLOGY

Fig. 1 shown Unila's WLAN topology, on data centre (DC) already installed 2 Aruba Controller 7210 series act as master active-active. Clear Pass installed on dedicated server also placed at data center. Aruba clear pass policy system work to manage the role of platform provides and device based network control access for wireless user and VPN services, with capability communicate with RADIUS built in system, external TACACS+, device profiling and also posture assessment, on boarding profile, guest access profile, and a comprehensive context-based system policy engine [25]. Clear Pass use database user from existing radius server on Unila private cloud, radius act as SSO user database backend for many academic application.

Beside Clear Pass, Air Wave Wireless management suite from Aruba networks also installed on data center, Air Wave developed under virtualization technology (cloud computing technology) and run on Unila's private cloud. This makes the operational cost more efficient and made intelligent plan for the IT team to improving the better network, it can automate

tasks by its self, delegating responsibility for solving the problem, rogue AP detection, and provide a time series historical data that can be used for scaling up planning action on the future. There were total 100 indoor series Aruba AP 135 access points, and 30 outdoor series Aruba AP 175 access points, which spread out over 95 buildings, both indoor and outdoor operate on frequency 2.4 Ghz, and 5 Ghz. Each AP connected with distribution switch Cisco WS C2960 S that support PoE+.

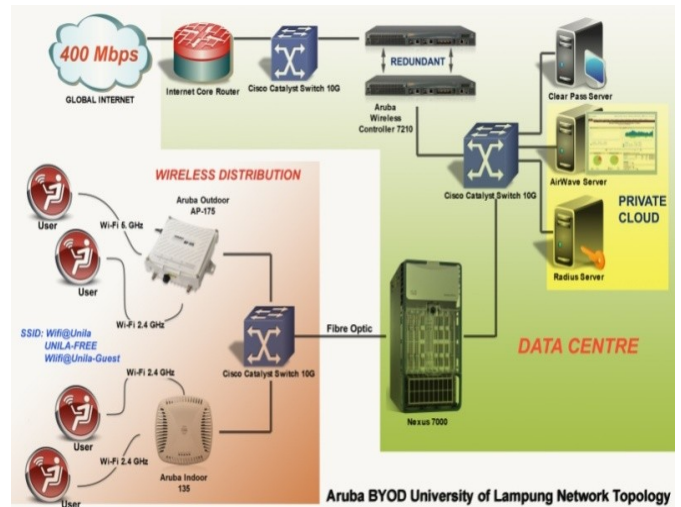


Fig 1. Unila's WLAN topology.

### IV. ARUBA WIRELESS PERFORMANCE ANALYSIS

Several Access Point (AP) usage report was generated by air wave reporting system, there were 3 AP with highest load that were FT Kimia Lt 1, FKIP G Outdoor, GSG A.

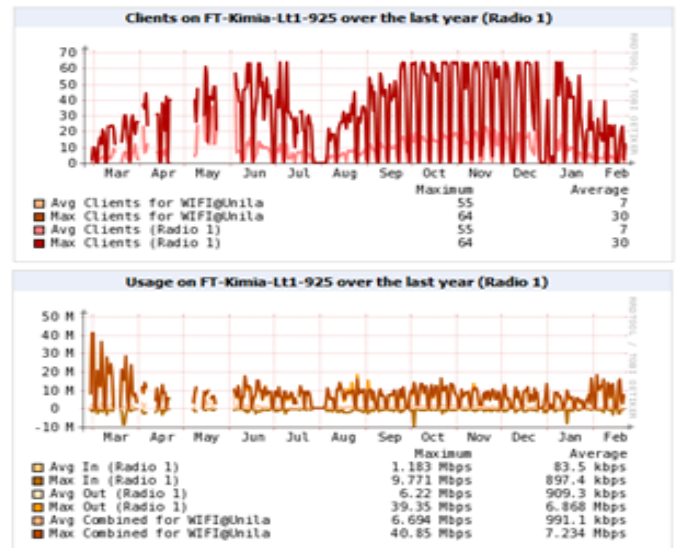


Fig 2. Clients and usage on AP FT Kimia Lt 1 925.

Fig. 2 shown clients and usage report on AP FT Kimia Lt 1 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 are 41 and maximum client connected are 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.

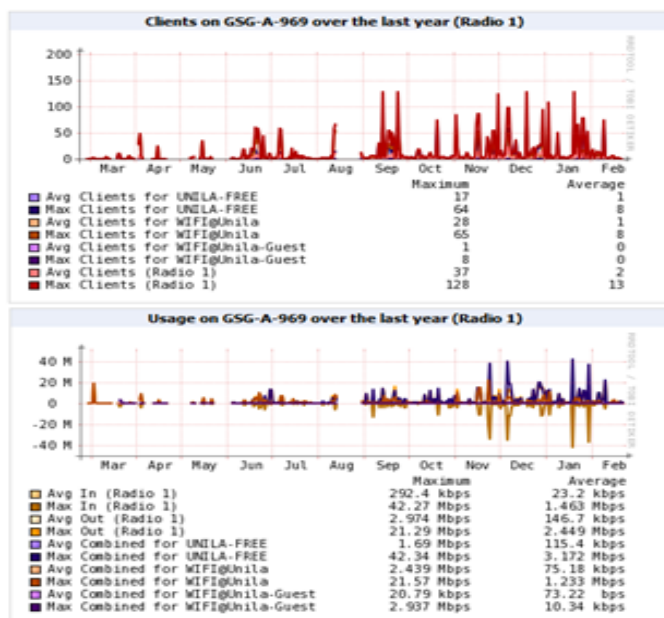


Fig. 4. Clients and usage on AP GSG A 969.

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).

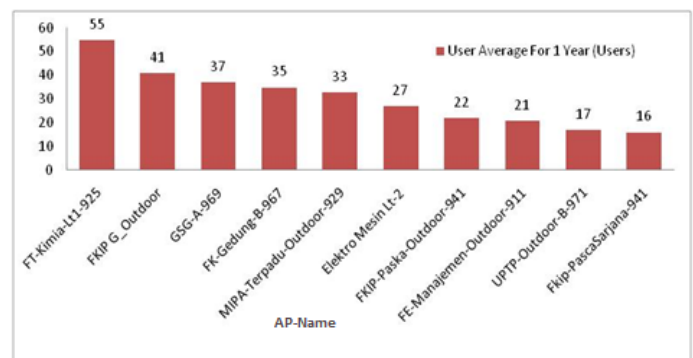


Fig. 5 Top 10 AP by average user for 1 Year.

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.

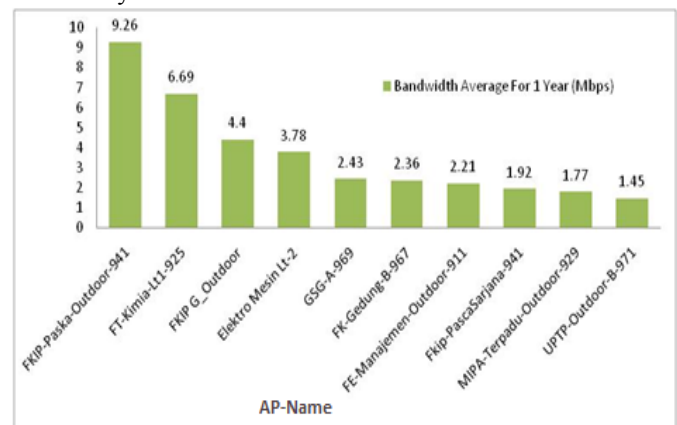


Fig. 6. Top 10 AP by bandwidth average usage for 1 year.

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

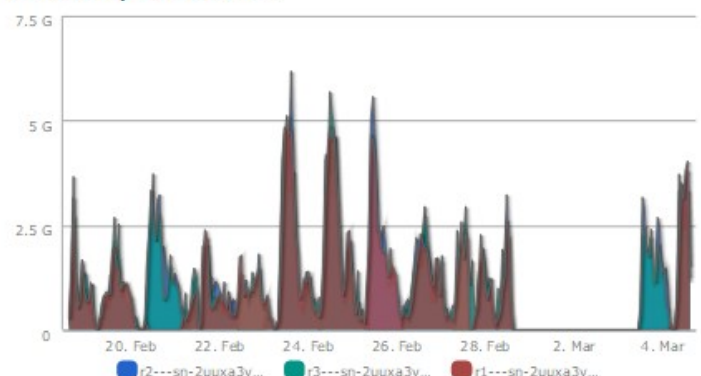


Fig. 7. Top 3 destinations (2 weeks investigation).



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

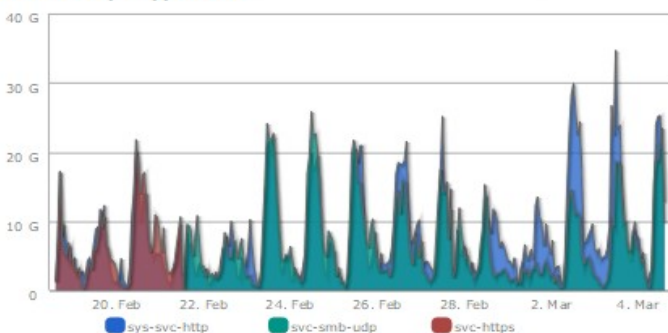


Fig. 9. Trend for top 3 application (2 weeks monitored).

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

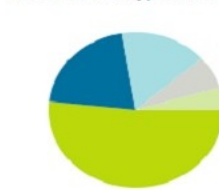
Application	Bytes
sys-svc-http	2.31 TB
svc-smb-udp	1.59 TB
svc-https	390 GB
audit	184 GB
facebook	172 GB
https	59.7 GB
google drive	42.8 GB
youtube	25.6 GB
svc-cfgm-tcp	22.5 GB
Port 6881	19.2 GB

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



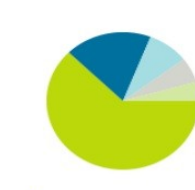
Android	51.7%
Win 7	20.6%
Other	16.1%
Unknown	6.9%
iPhone	4.7%

AOS Device Type	Count	% of Total
Android	17919	51.74%
Win 7	7152	20.65%
Unknown	2385	6.89%
iPhone	1614	4.66%
BlackBerry	1562	4.51%
Win 8	1246	3.60%
Win XP	1047	3.02%
Windows	508	1.47%
Win Vista	312	0.90%
iPad	286	0.83%
Linux	224	0.65%
Symbian	95	0.27%
Windows Mobile	94	0.27%
iPod	79	0.23%
OS X	46	0.13%
Win Server	25	0.07%
Windows Phone 7	21	0.06%
Win CE	16	0.05%
Win 2000	2	0.01%
PSP	2	0.01%
PS Vita	1	0.00%
21 AOS Device Types	34636	100.00%

Fig. 11. Client inventory report.

Fig. 11 shown clients inventory report of all users for 1 year data, there were total **34,636** 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



Unknown	62.5%
Samsung	18.4%
Other	8.7%
Apple	5.8%
RIM	4.5%

Device Manufacturer	Count	% of Total
Unknown	21639	62.48%
Samsung	6384	18.43%
Apple	2022	5.84%
RIM	1562	4.51%
ASUS	1145	3.31%
Lenovo	837	2.42%
Advan	395	1.14%
Nokia	191	0.55%
Sony	117	0.34%
LG	112	0.32%
HTC	78	0.23%
Google	72	0.21%
Motorola	43	0.12%
Huawei	15	0.04%
Hisense	11	0.03%
ZTE	6	0.02%
Polytron	3	0.01%
Nexian	1	0.00%
Cyrus	1	0.00%
Xiaomi	1	0.00%
Dell	1	0.00%
21 Device Manufacturers	34636	100.00%

Fig. 12. Client device manufacturer report.

Fig. 12 shown client device manufacturer report of all users for 1 year data, there were total **34,636** connected devices, **18.43 %** of was Samsung, and **5.84 %** Apple, **4.51 %** RIM, **3.31 %** ASUS.

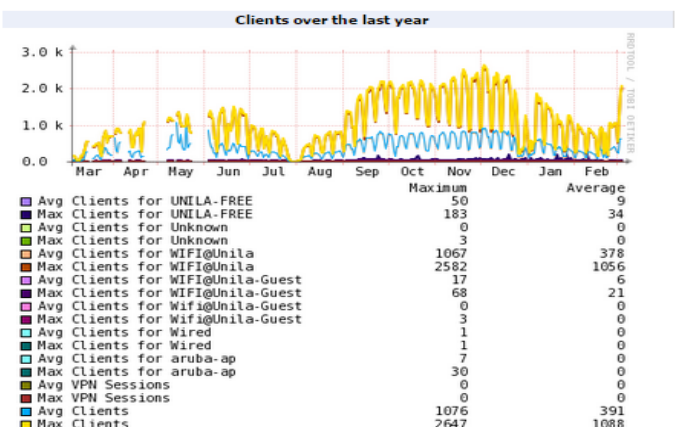


Fig. 13. Clients summary for 1 year.

Fig. 13 shown average client for 1 year was **1,076** and max client **2,647** (November 2015), the most utilize SSID was WIFI@Unila with average clients **1,076** users.

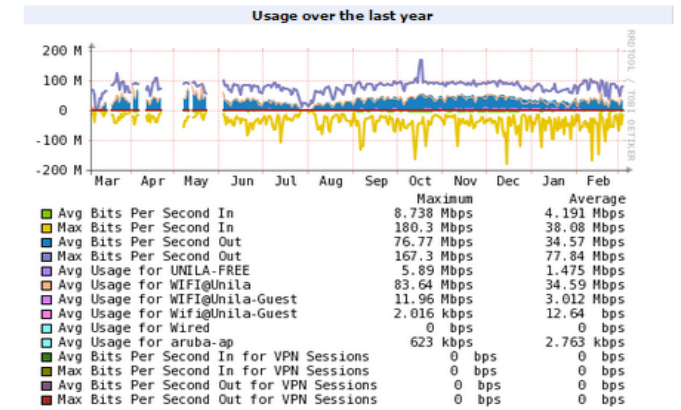


Fig. 14. Bandwidth usage report for 1 year.

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.

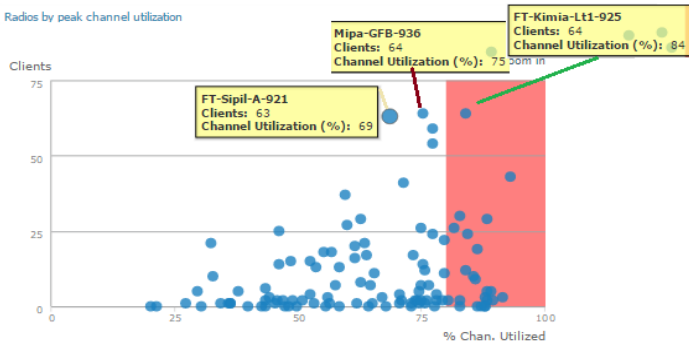


Fig. 15. 2.4 GHz RF performance report.

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.

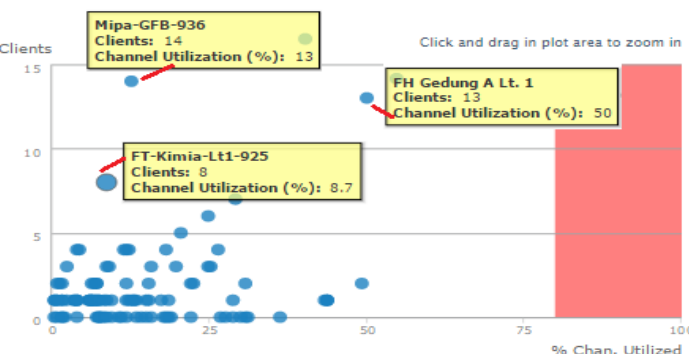


Fig. 16. 5 GHz RF performance report.

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.

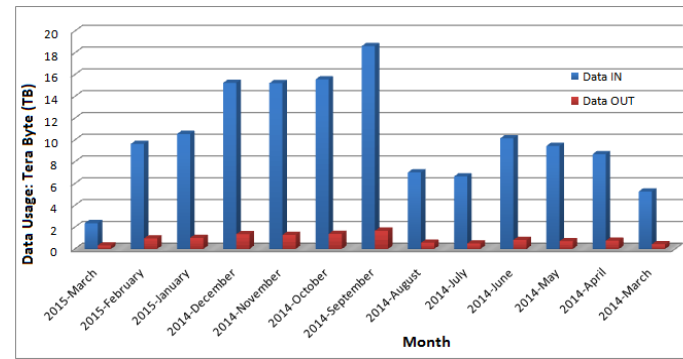


Fig. 17. Data Usage Summary.

Fig. 17 shown WLAN usage summary since 13 March 2014 until 6 March 2015, total Data IN was **134.453** Tera Byte and total Data OUT was **11.790** Tera Byte. 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. Air Wave 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 6.694 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 1,076 average clients for 1 year and max client 2,647 (November 2014). Top application and its data consumed was 1). sys-svc-http: 2.31 TB, 2) svc-smb-udp: 1.59 TB, 3) svc-https: 390 GB, 4) 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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