# Deploying Engenius Series in Distributed AccessPoint Peering Approach to Scale Ad-Hoc WlanConfiguration

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**Abstract:**
Unbelievable rapid advancement in computer technologies has brought about multitude of devices. Enterprises and campus networks operating in single broadcast domain results to large amount of traffic being flooded to all network nodes in local area networking (LAN) modes. But the advent of wireless local area networks (WLAN) model setup eliminates bottlenecks associated with LAN. In this paper, a review of WLAN potential is carried out and procedures for deploying access points (APs) as technology driver in WLAN is reported. With singular aim of scaling campus wireless network in Rufus Giwa Polytechnic Owo, Nigeria, APs were configured and integrated with existing network management infrastructure (NMI). Full series of EnGenius APs were acquired, configured and deployed into portable and semi-permanent buildings (Mass Communication, Lecture Theatres, Workshops etc.) and connected to function asAP node in the deployed WLAN architecture. Each full series AP, configured in point-to-point (P2P) enable *peering*mode and the whole system represented distributed access point (DAP) paradigm, which provided reliable connectivity through a flexibly-designed fine-grain service management and traffic-blocking control policy. Distributed AP (DAP) technique enable addition and movement of stations to areas with cable-laying difficulties, thus making installation expenses significantly lowered. DAP and peering mode provided an easier management and efficient service delivery. Distributed paradigm scales the system while peering offer balanced-load, making each dual-band AP deliver stable links and higher capacity to extend served users.

*Keyword* - **AP, EnGenius, Ethernet, IEEE802.11, MikroTik, Peering**

## I. INTRODUCTION

Unbelievably rapid advancement of computer technologies has brought about a multitude of devices, appliances and gadgets. Local area networks (LANs) are set up simply by deploying a router and connecting one or several devices. Though, modern routers allow users to connect devices via Ethernet cables or Wi-Fi, Access Points (APs) act as portal for devices to connect to LAN and achieve WLAN architecture [1].Therefore, APs feature in WLAN to connect computational devices in corporate offices, homes, public places to include campuses (ICT-complex), enterprises (airport, restaurant/hotels etc) using IEEE 802.11 standards and APs to communicate over wider coverages of 10 kilometers or more.

Wireless LAN is high frequency LAN based on IEEE 802.11 standards. IEEE 802.11 is a set of IEEE standards governing wireless network transmissions, collectively called Wi-Fi. Various standards of WLAN includes IEEE 802.11a, 802.11b, 802.11ac, 802.11af, 802.11bg and 802.11n among others. WLAN support high-speed internet using radio-frequency (RF) technique, guided by Wi-Fi trademark and IEEE standards. WLAN operates above 10Mbps, connecting telephones, computers and routers using Wi-Fi Alliance provisions [2]. The 802.11 specification [3] is a standard for wireless LAN. Ratified by the Institute of Electrical and Electronic Engineers (IEEE) in the year 1997, 802.11 governs wireless network transmissions [4].

Modern LANs employ wireless access point infrastructures (including wireless routers, antennae, APs) to improve service and coverage without expenses on cabling [5]. Prepared APs and devices integrated within ad-hoc WLAN enable portability of network services to users. Improved connectivity as users move around is guaranteed, and WLAN is flexibly characterized with *ad-hoc* or *infrastructure* configuration modes.Ad-hoc wireless networks enables two or more portable devices communicate in wireless equivalence of peer-to-peer (P2P) networks discussed in [6].Therefore, connection to existing wired network (or wireless AP) in ad-hoc mode or direct connection to client devices or terminal station characterize WLAN structures and models. This enables centralized or distributed technologies.

Distributed AP configuration in point-to-point enables collaborative *spread-spectrum* or OFDM signaling techniques [7]and each AP implement 'comp' technology to provide connection to broadband Internet WLANs [8].

Associated IEEE 802.11 standards and protocols enable WLAN link devices and operate P2P. Thus, P2P distributed access point (DAP) approach offer distributed processingviamultiple peering nodes to offer easy deployment and efficient implementation of WLAN, which provided the dynamism specifically presented in [9].

## II.REVIEW ON WIRELESS TECHNOLOGIES

Wireless refers to the medium and mode of transmitting electromagnetic or infrared (IR) waves across networks. Wireless devices have visible or built-in antennae and sensors, including cellular phones, sensors, remote, satellite disc receiver and laptops enabled to work with IEEE 802.11 family of standards [3]. As observed in [9], wireless systems have become highly inefficient due to increasing number of users and requests for most applications over the Internet remain congested grossly because of limited spectrum (bandwidth) resource [10]. Outdoor cellular technologies (including GSM, CDMA, WIMAX, LTE, Satellite etc.) and indoor technologies (including WLAN, Wi-Fi, Bluetooth, IrDA, Zigbee etc.) are defined to enable WLAN technology implementations in [11].

With wireless systems characterized with various technologies and methodologies, approach for deployment on campuses or larger enterprises are either centralized or distributed architectures [12]. WLAN architectural approaches are based on legacy IEEE 802.11 standard and various deployment techniques or technologies are defined in [13] to include IEEE 802.11 (Bluetooth), wireless local Area Networking (WLAN), wireless personal Area Networking (WPAN), wireless sensor networking (WSN), broadband WLANs, Wireless Wide Area Networking (WWAN), Worldwide Interoperability for Microwave Access (WiMAX) and Cognitive Radio Networking (CRN). WLAN is a therefore a model deployment and also a wireless technology.

A LAN is setup by simply deploying a router to distribute and deliver data to devices within the network; and connecting multiple computers, phones, tablets and other devices [14]. The Institute of Electrical and Electronics Engineers (IEEE) gave 802.11 specifications as the family of standards for Wireless Fidelity (Wi-Fi), including the WLAN. Ratified by IEEE in the year 1997 as reported in [15], the standardization version 802.11 provides for 1-7mbps data rates and set of fundamental signaling methods plus other services [16]. Among the IEEE 802 standards, 802.11 (Wi-Fi) focus on the bottom (physical and link) layers of ISO model [17]. Therefore, LAN applications, network operating system, protocol and even TCP/IP or Novell runs on 802.11-compliant WLAN architectures easily as they would run over Ethernet [18].

Basically, different approaches used to deploy APs have philosophical differences that impacted deployment costs, system security and network components' manageability. For performance, management tools of APs by existing Network Management Infrastructure (NMI) enable direct connected to trusted wired infrastructure for wireless connections to clients. Clients with access mechanisms such as IEEE 802.11ac Wi-Fi alliance standard connects to thewireless medium and APs transmit and communicate using WLAN model setups described in [6].

Centralized WLAN architecture has one or more serving points as special purpose switches deployed via wireless APs to distribute wireless traffics. Specialized WLAN switch (connectors)is also discussed in [6] but on the contrary, distributed WLAN architecture adheres strictly to IEEE 802.11 standardization and built-in WLAN security principles to access/control wireless services. In-built capabilities of APs enable layer-2 bridging and coordinated management, enabling wireless traffic load to be literarily distributed across all connected APs. This technique eliminate centralized problem of single-point-of-failure [19].

AN unstructured P2P system does not have a fixed topology for routing and this administration enables each AP node to self-organize and achieve load balancing. Elaborately discussed and proved in [19], further analysis in [20]confirmed P2P nodes'efficiency in peering andcollaboration. The technique make aggregate resources grow with utilization and entire WLAN model scales with much reliability in communication. Any of the deployed AP node initiates connectionand DAP processingparadigm for collaborative computing and distributed processing discussed in [19] became evident.

## III. SYSTEM APPROACH - P2P MODELING

Appearance of EnGenius AP, shown in Fig.1a revealed a compact, light-weight (0.43kg) and 25mm x 120mm x 170mm for height x width x length dimensions, suitable for easy installation and deployment. Using existing infrastructure of Mikrotik router deployed for connecting portable (mobile or terminal) devices to Internet via Ethernet cables and/or wireless access using IEEE 802 standards.

### *A. Locating APs to deploy WLAN*

Using the satellite view produced on Google map and Geographical Information System (GIS) agent, Rufus Giwa Polytechnic, Owo (RUGIPO), located along Akure-Benin expressway campus was analyzed and locations proposed for APs mapped out as shown in Fig. 2. ICT complex and other mapped locations were traced and indicated.

For this research, $AP_1$ located (mounted) on a 10metre pole in Computer Science Department and $AP_2$in Mass Communication building were configured to operate in point-to-point (P2P) mode within BSS serviced by network management centre (NMC) configured at main ICT. P2P approach of configuration to implement peering technique was designed to enable the AP nodes collaborate and deliver higher capacity through the dual-band capability of each Engenius AP with rating 2.4/5GHz. Proposed locations for other APs is shown in Fig. 3.

### *B. Configuringmultiple APs - peering technique*

One EWS 333 EnGenius AP, 2.4/5GHz rating was configured and installed to operate indoor while another ENS 202 EXT 2.4/5GHz rating was configured to operate outdoor in the service centre. Both configurationswere made to comply with IEEE 802.11ac Wave2, facilitating two multi-user multiple input multiple output (2MU-MIMO) capability required for peering.

Multiple units of APs (tagged $AP_1$, $AP_2$,…,$AP_n$) were configured and installed in ICT complex, Library, Mass Communication building, 800-seaterLT etc. in point-to-point (P2P) *peering* mode. APs form peers and all peers are integrated within WLAN architecture as shown in fig.1b.

Peer mode offer configuration mechanism whereby an AP configured, deployed and managed at NMI center is enabled to communicate with other configured APs (installed at designated locations) within the 10Km distance coverage of the deployed WLAN. P2P structure enable frame exchange within its basic service set (BSS) and frames from BSS enabled the system to forward and follow any station's BSS therefore implementing an infrastructural BSS modelof WLAN system.

With the BSS infrastructure included in the transmission, architecture deployed as infrastructural WLAN enable the deployment of multiple APs to feature distributed access point (DAP) technique. Other network infrastructures (router, cloud switch etc.) within the system enable each 2.4/5GHz Engenius AP location to deliver dual-links (2.4GHz and 5GHz) while the deployed APs in P2P mode deliver a load balance distribution offer via line of sight (LOS) transmission technique.

Terminal devices (TD) are portable or mobile devices (MD) equipped with Wi-Fi access mechanisms to wireless medium and radio contact with APs. Communication between two terminal devices ($TD_1$ and $TD_2$) or mobile devices are enabled by sending from first terminal device to AP and then from the AP to second terminal device. APs perform communication via created abstract medium of distribution.

### *C. DAP approach- collaboration andload balance*

Distributed Access Point (DAP) approach connects multiple APs as integrated infrastructure to distribute frames and feature balanced-load communication paradigm. Each APs performintelligent function within BSSstations to offer performance and also to others in extended service set (ESS). ESS of infrastructure BSSenable exchange of frames with wired network[21]and distributed communication among APs. BSS aspect of ad-hoc networking has sets of APs, devices/stations communicating with each other [6]. Multiple APs within BSS in WLAN implement distributed computing and co-operative communication over Internet. This characteristic featureis achieved in cognitive networking to aid intelligent communications[9].

The physical structure of the full series EnGenius AP configurationparameters and accessories with built-in and external antenna depicted the simple format with easy-to-connect features as shown in fig. 1ai (built-in) and 1aii (external) respectively.


Fig. 1ai EnGeniusEWS333 AP with built-in antenna


Fig. 1aii EnGeniusENS 202 EXT AP with external antenna

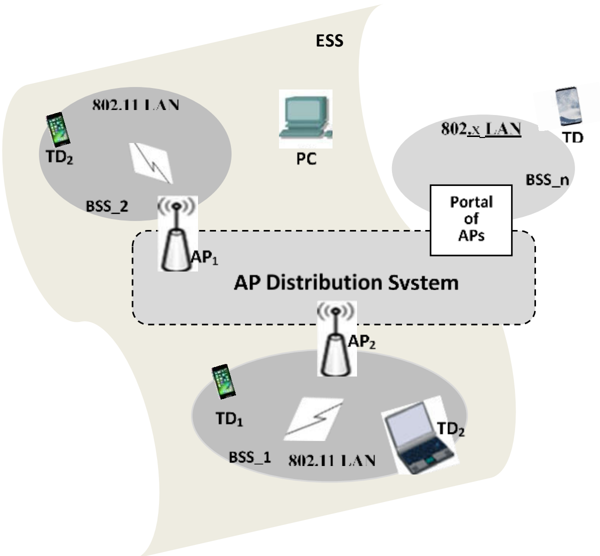


Fig. 1b. DAP nodes in WLAN service architecture

Fig. 2 Google-earth view showing AP locations (pin points)

Each AP is connected directly to the trusted (sector antennae) infrastructure at the NMC to provide wireless connection to configuredstation (terminal, mobile and portable devices). Distributed processing technique has an advantage of collaboration using an extension approach to distribute traffic load across participating APs. DAP technique does not depend on centralized element in the processing of wireless traffic and it has characteristic of no single point of failure. APs communicate among themselves to forward traffic from one BSS to another while facilitating movement of stations from one BSS to another.

More portable stations(laptops, phones, tablets etc.) were deployed within the BSS design to offer service to the various units and semi-permanent buildings includingComSci, Lecture Theatre, Library etcandstations moved from one BSS to another have access to reliable Internet service continuously. Stations within the ESS implement single MAC-layer network function common to infrastructure BSS model discussed in [22]. Maintaining the outdoor AP was easy because Power over Ethernet (PoE) ports provided protection capability in common mode to secure internal circuits and other components.

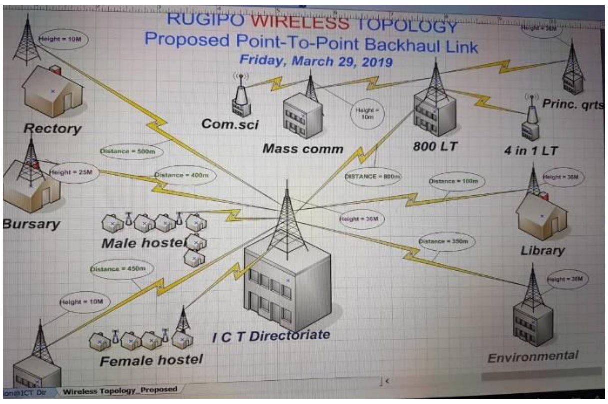


Fig. 3 Peering APscollaborate toscaleexistingnetwork

Internet services enjoyed by users within entire system ESS was confirmed to be created and managed by the peering APs in ICT and other locations. This is a pointer to the peering approach and DAP techniques. This implementation offered system scaling and other numerous benefits in addition to easy-to-deploy and easy-to-manage advantages.

## IV. MEASURING THE PERFORMANCE OF DAP PEERING NODES

AP as wireless infrastructure acts as a portal for stations to connect LAN. Deployed APs (ENS 202 Ext and EWS 330) supports dual-bands in the WLAN to incorporate BSS delivery of two spatial-streams of data transmission at 2.4GHz and 5GHz ratings. Internet speed transmission rates was measured using**SpeedTest()**function parameter run on the address bar of any browser interface.

Performance measure gave uplink and downlink rates of approximated values of 2.4GHz (16.72Mbps) and 5GHz (19.58Mbps) respectively in peak periods. This translates to increased efficiency as no station experienced significant delay within BSS. With the multiple APs deployed over the entire WLAN model, wireless coverage to all sectors depicts AP collaboration efficiency. This is network scaling offer as number of stations representing the served users connected to the wireless system also increased.

This remarkable benefit accrue to DAP technique and peering model used in deployed WLAN. Major benefit is connectivity and easy deployment techniques. Another is simplicity and maintainability because all accessories supplied with EnGenius AP are units that are easily deployable as plug and plays add-ons, including wall mounting kits, PoE and switch components.

On service mobility, P2P approach and DAPmodel make it easier to add and or move stations. P2P paradigm deliver efficient and reliable use of resources. Deployed APs offer concurrent user (mobile or workstation) access capability to offer higher per-user bandwidth of approximately 20Mbps across the system.

Next is performance. In terms of latency, the responsiveness of the network remain stable at every BSS of each APs while throughput measure remain unaffected. With the 20 megabits per second (20Mbps) network capacity deployed, dual-uplink Ethernet ports and dual-band (dual 5GHz) support in P2P mode provided required capacity at all ends.

Also, DAP technique and peering mode APs deploy built-in Bluetooth modules to expand service while providing access to concurrent users as discussed in [23]. Characteristic feature of dual-uplink Gig-Ethernet ports, which supports large-traffic volume of data transmission is evident in EnGenius AP. Equally, built-in WLAN security, layer-2 bridging and access control capabilities of APs provided link stability. The built-in surge protectors provided dual-link backups and communication reliability.

## V. CONCLUSION

Access points is a wireless network device that acts as a portal for devices to connect to a local area network (LAN). AP deliver long-distance wireless coverage through DAP and wireless distribution system (WDS) to improve link stability. Elimination of cabling difficulty reduced costs as the easy deployment, supported by dual-bands P2P mode, provided higher network capacity. P2P distributed access point (DAP) modes offered technical benefits of dual-stack mode, which enable flexible switching between P2P and PMP. Easy deployment technique makes DAP faster to add and move users, devices and workstations.

In agreement with [6], P2P approach and DAP implementation offer efficient scaling for wireless networks. Large enterprises and organizations certainly require a network of APs and switches and wireless campus construction via WLAN is therefore, a roadmap to digital transformation. With APs, the basic adaptation necessary to meet requirements of current computational techniques and technologies is obtained.

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**ACKNOWLEDGEMENT**

Special thanks to the Tertiary Education Fund (TETFund) of Federal Republic of Nigeria for providing support for this research and the Polytechnic community for providing an enabling environment to carry out research in diverse fields of study.

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| (i) EnGenius EWS330 AP | (ii) EnGenius I |