IEEE 802.11 Architecture

The IEEE 802.11 standard, commonly known as Wi-Fi, outlines the architecture and defines the MAC and physical layer specifications for wireless LANs (WLANs). Wi-Fi uses high-frequency radio waves instead of cables for connecting the devices in LAN. Given the mobility of WLAN nodes, they can move unrestricted within the network coverage zone. The 802.11 structure is designed to accommodate mobile stations that participate actively in network decisions. Furthermore, it can seamlessly integrate with 2G, 3G, and 4G networks.

The Wi-Fi standard represents a set of wireless LAN standards developed by the Working Group of IEEE LAN/MAN standards committee (IEEE 802). The term 802.11x is also used to denote the set of standards. Various specifications and amendments include 802.11a, 802.11b, 802.11e, 802.11g, 802.11n etc.

Table of Content

Important Terminologies of IEEE 802.11 Architecture

Spotlight

Station: Stations (STA) comprise all devices and equipment that are connected to the wireless LAN. It can be of two types:

- **Wireless Access Point (WAP):** WAPs or simply access points (AP) are wireless routers that bridge connections for base stations.
- **Client:** Examples include computers, laptops, printers, and smartphones.

Access Point: It is a device that can be classified as a station because of its functionalities and acts as a connection between wireless medium and distributed systems.

Distribution System: A system used to interconnect a set of BSSs and integrated LANs to create an ESS.

Frame: It is a MAC protocol data unit.

SSID (Service Set Identifier): It's the network name for a particular WLAN. All-access points and devices on a specific WLAN must use the same SSID to communicate.

SDU: It is a data unit that acts as an input to each layer. These can be fragmented or aggregated to form a PDU.

PDU: It is a data unit projected as an output to communicate with the corresponding layer at the other end. They contain a header specific to the layer.

Network Interface Controller: It is also known as network interface card. It is a hardware component that connects devices to the network.

Portal: Serves as a gateway to other networks

IEEE 802.11 Architecture and Services

In the year 1990, IEEE 802.11 Committee formed a new working group, the IEEE 802.11 standard which defines protocols for Wireless Local Area Networks (WLANs). Just like how Ethernet provides services for wired media, IEEE 802.11 architecture is designed to provide features for wireless networks.

An AP supports both wired and wireless connections. The 802.11 standard calls the upstream wired network the distribution system (DS). The AP bridges the wireless and wired L2 Ethernet frames, allowing traffic to flow from the wired to the wireless network and vice versa. Each wireless network has a unique SSID.

The 802.11 architecture provides some basic services for WLANs whose implementation is supported by MAC layer:

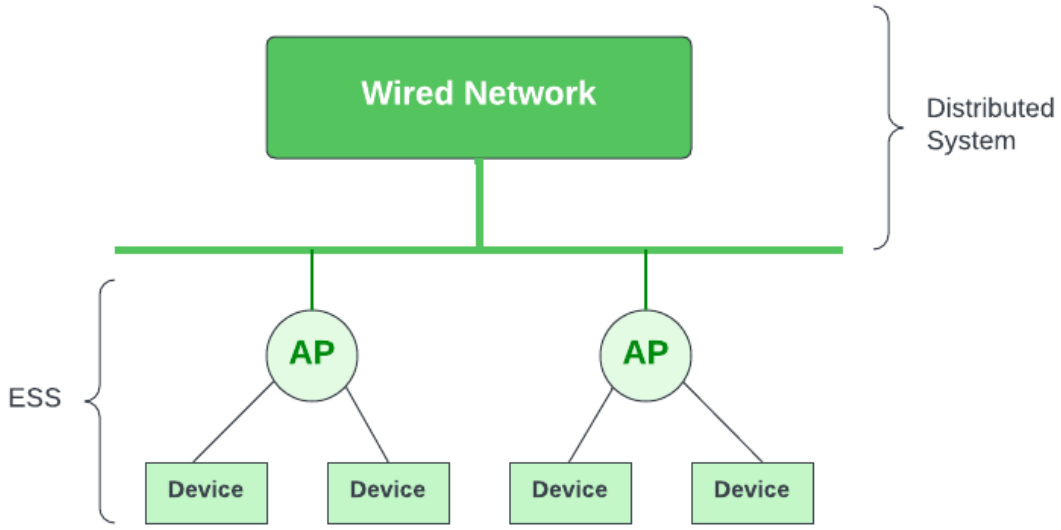
Basic Service Set

The Basic Service Set configuration consists of a group of stations and relies on an Access Point (AP), which serves as a logical hub. Stations from different BSSs interact through the AP, which functions as a bridge, linking multiple WLAN cells or channels.

Operating Modes

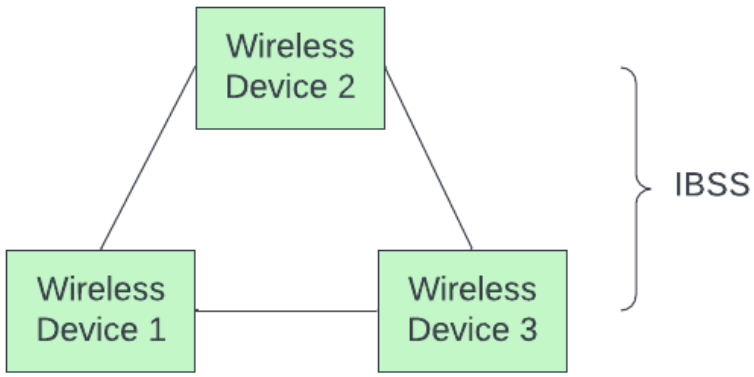
Depending upon the mode of operation, BSS can be categorized into the following types:

- **Infrastructure BSS:** Communication between stations takes place through access points. The AP and its associated wireless clients define the coverage area and form the BSS.



Infrastructure BSS

- **Independent BSS** – Supports mutual communication between wireless clients. An ad-hoc network is spontaneously created and does not support access to wired networks.



Independent BSS

Independent Basic Service Set

In the IBSS configuration, also referred to as independent configuration or ad-hoc network, no single node is required to act as a server. The stations communicate directly with one another in a peer-to-peer basis. Generally, IBSS covers a limited area instead of a large network. Typically covering a specific area, IBSS is used for specific, short-term purposes with a limited number of nodes.

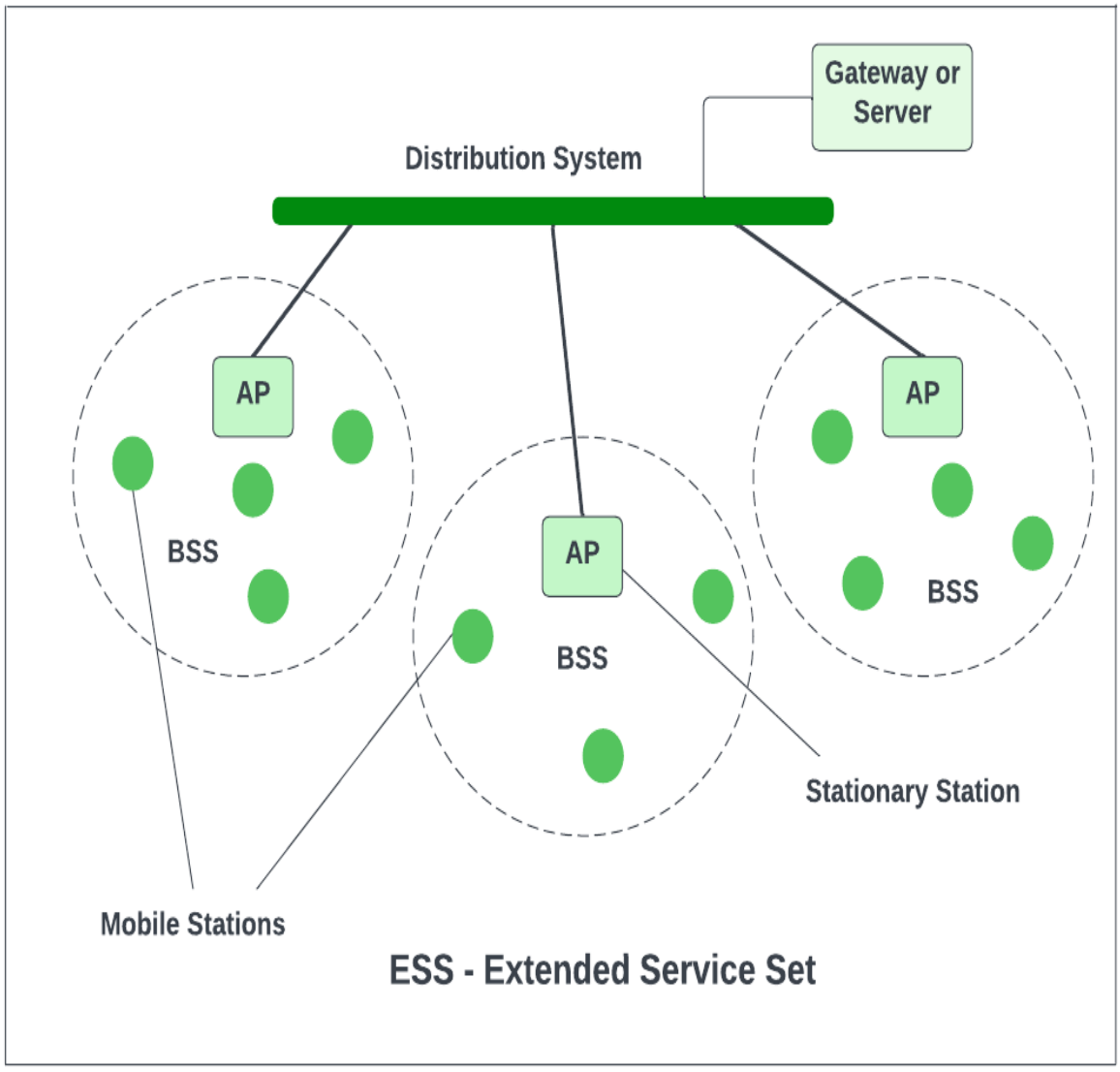
Extended Service Set

ESS connects multiple BSSs and consists of several BSS cells, which can be interlinked through wired or wireless backbones known as a distributed system. Multiple cells use the same channel to boost aggregate throughput to network. The equipment outside of the ESS, the ESS and all of

its mobile stations comprise a single MAC layer network where all stations are virtually stationary. Thus, all stations within the ESS appear stationary from an outsider's perspective.

Other components include:

- **Distribution System (DS):** Links APs within the ESS.
- **Portal:** Serves as a gateway to other networks.



Architecture for IEEE 802.11 Configuration

- **Roaming:** In an environment with multiple access points (like a large office building or campus), a device can move from the range of one AP to another and still maintain its connection. This is possible due to the underlying architecture of the IEEE 802.11 standard which allows for roaming between APs.
- **Authentication and Association:** Before a station can send or receive data frames on a WLAN, it needs to establish its identity with an AP. This process is called authentication. After authentication, the station then establishes a data link-layer connection with the AP through a process called association.

Services provided by the WLAN

Service	Provider	Used to Support
Association	Distribution System	MSDU delivery
Authentication	Station	LAN access and security
De-authentication	Station	LAN access and security
Disassociation	Distribution System	MSDU delivery
Distribution	Distribution System	MSDU delivery
Integration	Distribution System	MSDU delivery
MSDU Delivery	Station	MSDU delivery
Privacy	Station	LAN access and security
Re-associaction	Distribution System	MSDU delivery

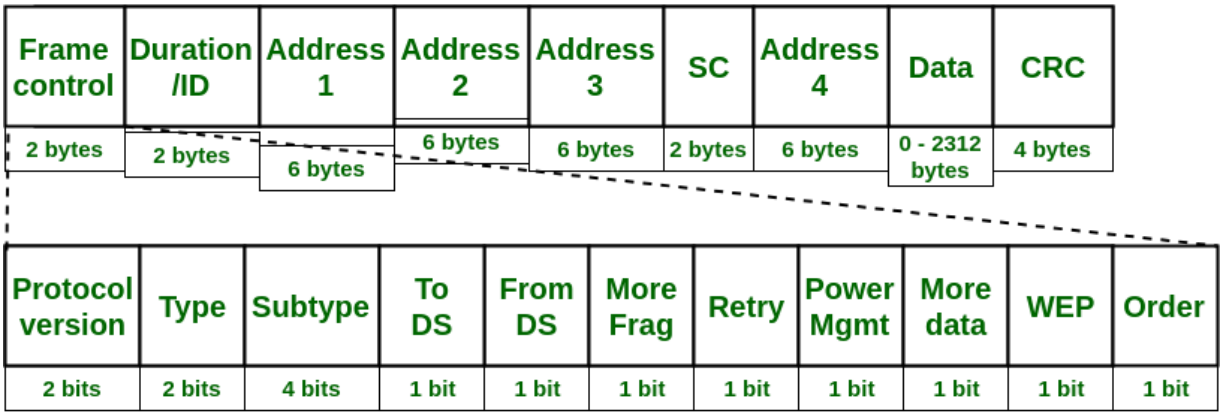
NOTE:

MSDU: *Information that is delivered as a unit between MAC users.*

MPDU: *The unit of data exchanged between two peer MAC entities using the services of the physical layer.*

Frame Format of IEEE 802.11

IEEE 802.11 MAC layer data frame consists of 9 fields:



Frame Control

It is 2 bytes long and defines type of frame and control information. The types of fields present in FC are:

- **Version:** Indicates the current protocol version.
- **Type**: Determines the function of frame i.e. management(00), control(01) or data(10).
- **Subtype**: Indicates subtype of frame like 0000 for association request, 1000 for beacon.
- **To DS**: When set indicates that the destination frame is for DS(distribution system).
- **From DS:** When set indicates frame coming from DS.
- **More frag (More fragments)**: When set to 1 means frame is followed by other fragments.
- **Retry: I**f the current frame is a re-transmission of an earlier frame, this bit is set to 1.
- **Power Mgmt (Power Management):** It indicates the mode of a station after successful transmission of a frame. Set to '1' field indicates that the station goes into power-save mode. If the field is set to 0, the station stays active.
- **More data:** It is used to indicate to the receiver that a sender has more data to send than the current frame.
- **WEP**: It indicates that the standard security mechanism of 802.11 is applied.
- **Order:** If this bit is set to 1 the received frames must be processed in strict order.

Duration / ID

It contains the value indicating the period of time in which the medium is occupied (in μs).

Address 1 to 4

These fields contain standard IEEE 802 MAC addresses (48 bit each). The meaning of each address is defined by DS bits in the frame control field.

SC (Sequence Control)

It consists of 2 sub-fields i.e. sequence number (12 bits) and fragment number (4 bits). Sequence number is used to filter duplicate frames.

Data

It is a variable length field which contains information specific to individual frames which is transferred transparently from a sender to the receiver.

CRC (Cyclic Redundancy Check)

It contains 32 bit CRC error detection sequence to ensure error free frame.

Note: *To know more about the features of IEEE 802.11 MAC frame visit this article.*

Wi-Fi Alliance

Wi-Fi Alliance is a global non-profit organization that performs the task of monitoring products from different manufacturers which are certified on the basis of IEEE 802.11 standard. There is always a concern whether products from different vendors will successfully interoperate. Early 802.11 products suffered from interoperability problems because the Institute of Electrical and Electronics Engineers (IEEE) had no provision for testing equipment for compliance with its standards. Hence, Wi-Fi Alliance's main objective is to establish a single global standard for high-speed wireless LANs and ensure interoperability among 802.11 devices.

Before 1999, Wi-Fi Alliance was known as Wireless Ethernet Compatibility Alliance (WECA). It created a test-suite to certify interoperability for 802.11 products and launched the Wi-Fi CERTIFIED program in March of 2020. This program offers a renowned designation of quality and interoperability, ensuring that certified products provide the best quality and user experience.

Advantages and Disadvantages of IEEE 802.11 Architecture

There are some list of Advantages and Disadvantages of IEEE 802.11 Architecture are given below :

Advantages of IEEE 802.11 Architecture

- **Fault Tolerance:** The centralized architecture minimizes the bottlenecks and introduces resilience in the WLAN equipment.
- **Flexible Architecture**: Supports both temporary smaller networks and larger, more permanent ones.
- **Prolonged Battery Life:** Efficient power-saving protocols extend mobile device battery life without compromising network connections.

Disadvantages of IEEE 802.11 Architecture

- **Noisy Channels:** Due to reliance on radio waves, signals may experience interference from nearby devices.
- **Greater Bandwidth and Complexity:** Due to necessary data encryption and susceptibility to errors, WLANs need more bandwidth than their wired counterparts.
- **Speed:** Generally, WLANs offer slower speeds compared to wired LANs.

Applications of IEEE 802.11 Architecture

- **Home Networking:** Connecting devices, laptops, smart TVs, speakers, gaming consoles etc.
- **Wi-Fi Hotspots:** Free or paid internet access to visitors in coffee shops, hotels, airports, malls and restaurants.
- **Connectivity in Campus:** Provide internet access in university, colleges, schools or corporate campuses.

Conclusion

IEEE 802.11, widely recognized as Wi-Fi, revolutionized wireless communication by establishing protocols for WLANs. With an intricate architecture supporting both localized and expansive

interference and marginally slower speeds than wired networks, Wi-Fi's broad applications, from home setups to public hotspots, underscore its transformative impact on modern connectivity, making it indispensable in today's digital age.

FAQs: IEEE 802.11 Architecture

1. What are the different types of 802.11 frames?

There are three types of frames defined in IEEE 802.11 standard: Data, Management and Control frame.

2. What does 802.11 b stand for?

802.11b, often known as 802.11 High Rate or Wi-Fi, is a standard set by IEEE as an enhancement to the original 802.11. This standard enables wireless LANs to transmit at 11

3. How does 802.11 work?

The 802.11 protocol series uses carrier-sense multiple access with collision avoidance (CSMA/CA). This means that devices first check a channel for other active users, including those not using the 802.11 standard, before sending each frame. While some might refer to these as "packets," the more technically accurate term is "frame."

Last Updated : 02 Nov, 2023

Architecture of linux operating system

What is Information Architecture in UX Design ?

Deploy a Microservices Architecture with AWS

E-commerce Architecture | System Design for E-commerce Website

What is a web server - Working and Architecture

3 Essentials for E-commerce Architecture

Design Patterns Architecture

Event-Driven Architecture Patterns in Cloud Native Applications

Explain the Architecture Overview of Angular ?

Translatotron 2 Speech-to-Speech Translation Architecture

Article Contributed By :

tanyadiit7

tanyadiit7

Follow

Vote for difficulty

Current difficulty : Medium

Easy | Normal | Medium | Hard | Expert

Article Tags : Geeks Premier League 2023 , Geeks Premier League

Improve Article | Report Issue

Company

About Us
Legal
Careers
In Media
Contact Us
Advertise with us
GFG Corporate Solution
Placement Training Program
Apply for Mentor

Explore

Job-A-Thon Hiring Challenge
Hack-A-Thon
GfG Weekly Contest
Offline Classes (Delhi/NCR)
DSA in JAVA/C++
Master System Design
Master CP
GeeksforGeeks Videos

Languages

Python
Java
C++
PHP
GoLang
SQL
R Language
Android Tutorial

DSA

Data Structures
Algorithms
DSA for Beginners
Basic DSA Problems
DSA Roadmap
Top 100 DSA Interview Problems
DSA Roadmap by Sandeep Jain
All Cheat Sheets

Data Science & ML

Data Science With Python
Data Science For Beginner
Machine Learning Tutorial
ML Maths
Data Visualisation Tutorial
Pandas Tutorial
NumPy Tutorial
NLP Tutorial
Deep Learning Tutorial

HTML & CSS

HTML
CSS
Bootstrap
Tailwind CSS
SASS
LESS
Web Design

Python

Python Programming Examples
Django Tutorial
Python Projects
Python Tkinter
Web Scraping
OpenCV Python Tutorial
Python Interview Question

Computer Science

GATE CS Notes
Operating Systems
Computer Network
Database Management System
Software Engineering
Digital Logic Design
Engineering Maths

DevOps

Competitive Programming

AWS

Docker

Kubernetes

Azure

GCP

DevOps Roadmap

System Design

What is System Design

Monolithic and Distributed SD

High Level Design or HLD

Low Level Design or LLD

Crack System Design Round

System Design Interview Questions

Grokking Modern System Design

NCERT Solutions

Class 12

Class 11

Class 10

Class 9

Class 8

Complete Study Material

Commerce

Accountancy

Business Studies

Indian Economics

Macroeconomics

Microeconimics

Statistics for Economics

UPSC Study Material

Polity Notes

Geography Notes

History Notes

Science and Technology Notes

Economy Notes

Ethics Notes

Previous Year Papers

Colleges

Indian Colleges Admission & Campus Experiences

Top Engineering Colleges

Top 50 Tree

Top 50 Graph

Top 50 Array

Top 50 String

Top 50 DP

Top 15 Websites for CP

JavaScript

TypeScript

ReactJS

NextJS

AngularJS

NodeJS

Express.js

Lodash

Web Browser

School Subjects

Mathematics

Physics

Chemistry

Biology

Social Science

English Grammar

Management & Finance

Management

HR Managament

Income Tax

Finance

Economics

SSC/ BANKING

SSC CGL Syllabus

SBI PO Syllabus

SBI Clerk Syllabus

IBPS PO Syllabus

IBPS Clerk Syllabus

SSC CGL Practice Papers

Companies

IT Companies

Software Development Companies

Top MBA Colleges

Top Architecture College

Choose College For Graduation

CyberSecurity Companies

Service Based Companies

Product Based Companies

PSUs for CS Engineers

Preparation Corner

Company Wise Preparation

Preparation for SDE

Experienced Interviews

Internship Interviews

Competitive Programming

Aptitude Preparation

Puzzles

Exams

JEE Mains

JEE Advanced

GATE CS

NEET

UGC NET

More Tutorials

Software Development

Software Testing

Product Management

SAP

SEO

Linux

Excel

Write & Earn

Write an Article

Improve an Article

Pick Topics to Write

Share your Experiences

Internships