

# Non-3GPP Access Networks



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This page is about ways of connecting to a 5G core that are not specified by 3GPP. We start by nailing down the meaning of the term access network.

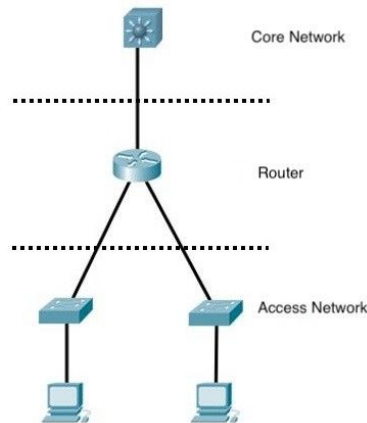
**Definition:** An access point of a network is a device that users can connect to gain access to the network.

For examples,

- a gNB is an access point of a 5G core network that 5G NR enabled devices can use to gain access to that core.
- a WiFi router is an access point of the internet that WiFi enabled devices can use to gain access to the internet.

**Definition:** An access network of a network is a system of access points to that network, together with the backhaul to connect access points to that network.

Note that an access network is a distinct network from the network that it provides access to. To make the distinction clear, consider the role of a router. In general, a router is a device that enables connection between two separate networks. Access points are connected to routers as a midpoint between the access network to its network. To make the language clearer, the latter is often called the core network.



For example,

- the set of all of DISH's gNBs together with the backhaul to connect those gNBs to AMFs and UPFs at data centers constitutes an access network of DISH's core network.
- the set of all of DISH Riverfront's WiFi access points together with all the cables running from them (backhaul) constitutes an access network of the internet, with the internet being the core network in this case.

## 3GPP ANs

**Definition:** An access point to a telecommunications core network is a 3GPP access point if the access point is specified by 3GPP technical specifications.

For examples,

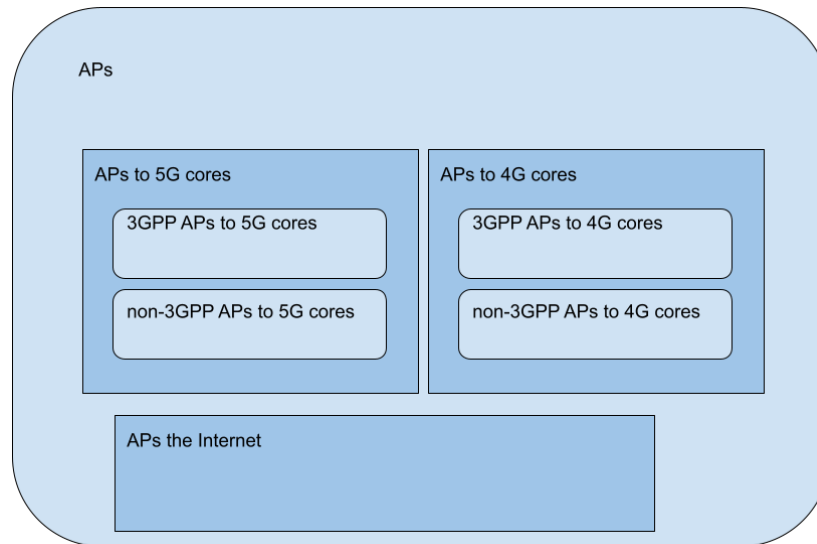
- gNBs are access points to a 5G core that are specified by 3GPP and so are referred to as 3GPP access points, and an access network of gNBs is a 3GPP access network.
- 4G base stations, called eNBs, are access points to 4G core networks that are specified by 3GPP and so are called 3GPP access points, and an access network of eNBs is a 3GPP access network.

## Non-3GPP ANs

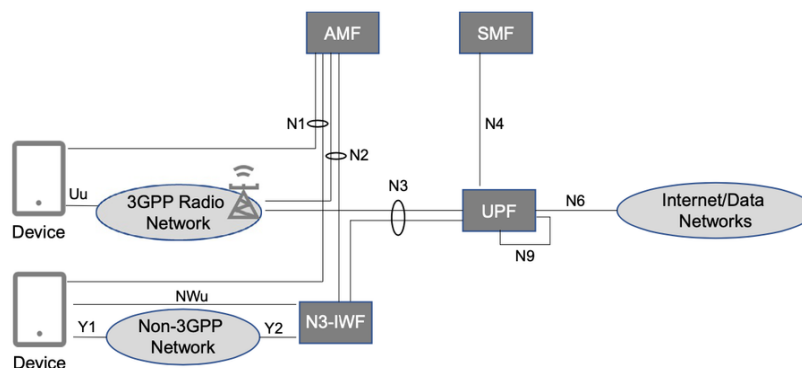
For a contrasting example, WiFi access points are not specified by 3GPP standards. So, if a UE connects to a 5G core through a WiFi access point, then that access point is called a non-3GPP AP.

**Definition:** An access point to a telecommunications core network is a non-3GPP access point if the access point is not specified by 3GPP technical specifications.

Note that this definition is more subtle than “not 3GPP specified”; non-3GPP access points are not the complement of the set of 3GPP access points in the set of all access points to all core networks. For example, if a WiFi access point connects to the internet (and not a telecom core) then it is neither a 3GPP access point nor a non-3GPP access point.



The diagram below shows one of the examples of a non-3GPP AN that this page will cover; in the example shown, a network function called the non-3GPP inter-working function (N3IWF) allows the access point (at the bottom) to mimic the behavior of a gNB (at the top) for establishment of N1, N2, and N3 connections.



This page will cover three types of non-3GPP access points: untrusted WiFi, trusted WiFi, and wireline.

## Untrusted WiFi

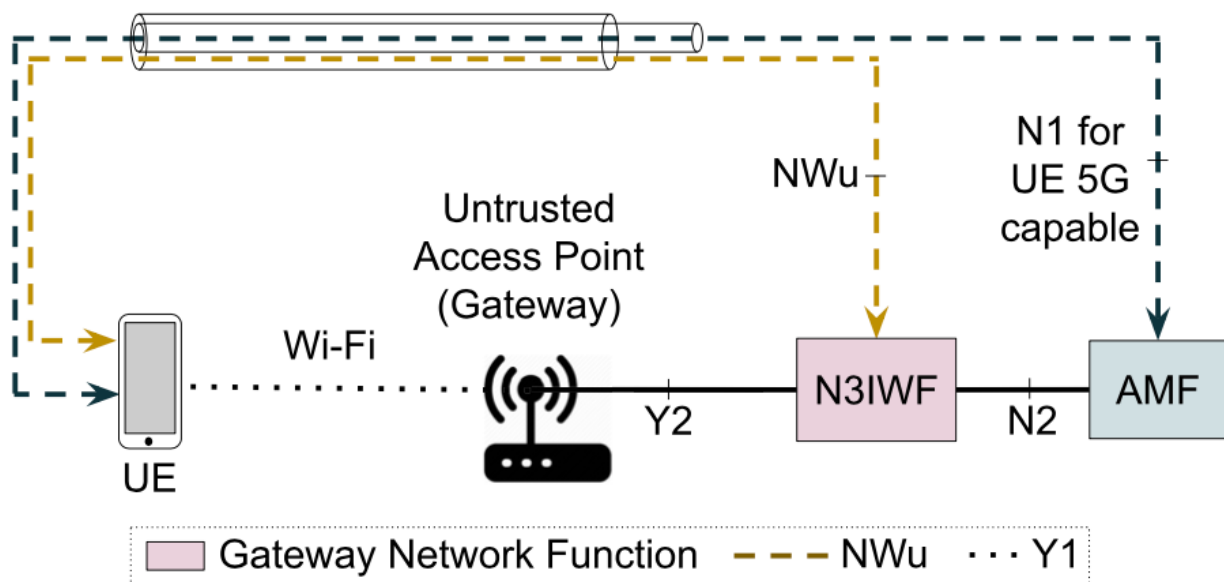
The term “untrusted access network” means that the 5G network operator does not trust the security offered by the access network. As an example, consider the WiFi connection offered at a coffee shop. A user might connect to a network operator’s 5G core through this Wi-Fi access point. The network operator does not have control over access to the coffee shop Wi-Fi access points. So, if that access point is to provide connectivity to the 5G core, then the 5G core must provide a second layer of access control (including authentication.)

To do this, the control plane connection is not simply from the UE, to the WiFi access point, to the AMF; the N3IWF network function is inserted so that the combination of the AP and N3IWF play the role of a base station.

In the diagram below

- the N1 connection is between the UE and AMF, but passes through the AP and N3IWF transparently; it is analogous to the connection between the UE and AMF that passes transparently through the gNB in NG-RAN. This connection uses an IPsec tunnel called NWu, the analogy of the Wu tunnel for NG-RAN.
- the N2 connection is between the UE and N3IWF, but passes through the AP transparently; it is analogous to the connection between the UE and gNB in NG-RAN. This connection also uses an IPsec tunnel.

Shown in the diagram above, but not below, once the UE is authenticated with the PLMN it can request PDU sessions through an N3 connection to a UPF. User plane traffic is transported inside a IPsec security association.



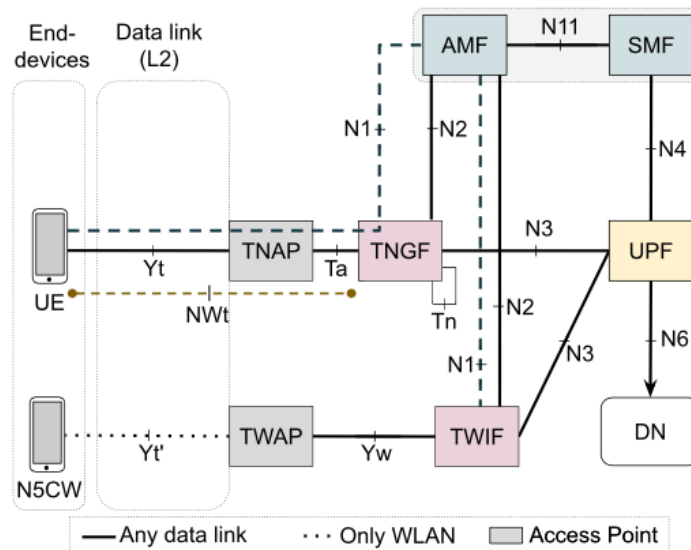
A 5G enabled UE can have an access network discovery and selection policy (ANDSP) that allows it to identify relevant non-3GPP access points. In particular for WiFi, a WLAN selection policy allows discovery of usable WiFi and N3IWF instances for the UE's PLMN. Thus, the order of events is discovery of the AP, authentication and authorization with the AP, UE discovers a N3IWF, UE and N3IWF establish N1 connection, UE and N3IWF establish a N2 connection to a AMF, then authentication with the 5G network, then establishment of a PDU session. The second to last step there uses a vendor specific version of extensible authentication protocol for 5G (EAP-5G).

## Trusted WiFi

If a PLMN controls the access to a Wi-Fi network then authentication on a Wi-Fi access point can be considered sufficient for authentication onto the core.

- In general, such an access point is called a trusted non-3GPP access point (TNAP), the connection to the core is provided by a network function called trusted non-3gpp gateway function (TNGF), and the pair act together like a gNB in NG-RAN.
- In particular, for Wi-Fi such an access point is called a trusted WLAN access point (TWAP), the connection to the core is provided by a network function called a trusted WLAN interworking function (TWIF), and the pair act together like a gNB in NG-RAN.

Both the general and particular case are shown in the diagram below.



The diagram also shows a pair of possibilities; the UE may or may not be equipped to communicate with the control plane of a 5G core.

- In the TNAP case above, the UE is shown to have this ability, and thus has a connection analogous to the Wu, the NWt, with the N1 connection running through it to the AMF.
- In the TWAP case above, the UE is shown to be non-5G capable (N5GC) over wireless (N5CW), meaning that it can not send control plane information. Instead, the TWIF coordinates with the AMF for control plane information, and the UE has no control plane connection.

That is, the diagram is meant to show 4 possibilities at once

1. 5G capable UE over any trusted access network
2. 5G capable UE over a WiFi trusted access network
3. not-5G capable UE over any trusted access network
4. not-5G capable UE over WiFi trusted access network.

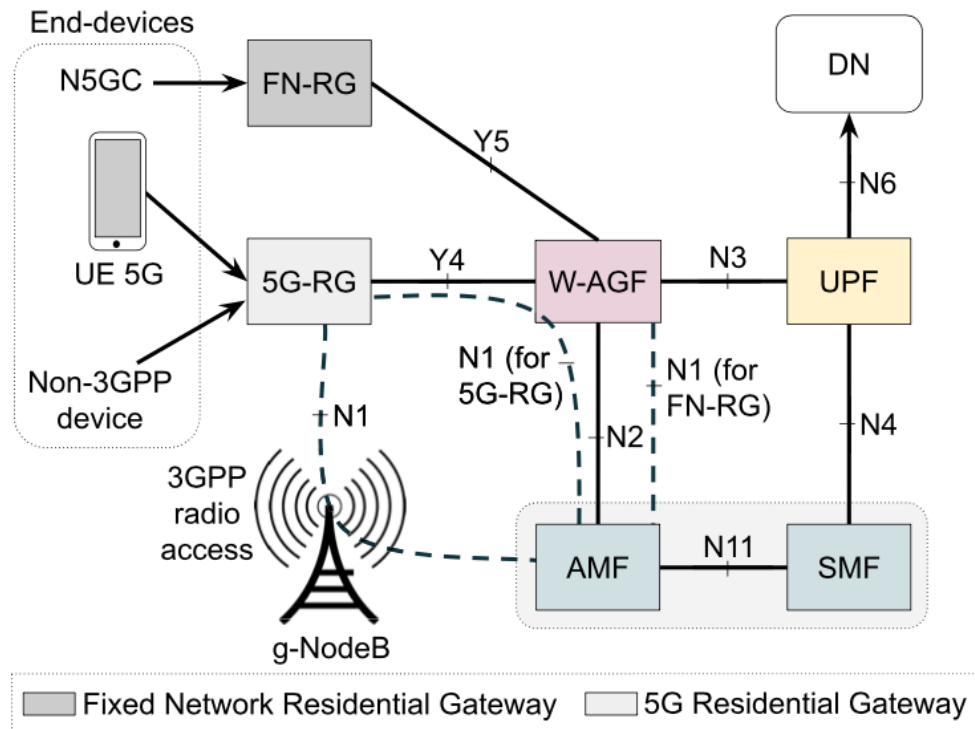
3GPP describes an optional discovery method; the UE and access network can be equipped with access network query protocol (ANQP) which allows the UE to discover that an access point has a trusted relationship with a PLMN.

## Wireline

A wireline access point interfaces with UE via a cable running between the UE and the access point. This allows devices that are not equipped for 5G NR or maybe not equipped with Wi-Fi to connect to the 5G core. Devices without 5G NR abilities might not be equipped to send 5G control plane signaling.

For UE capable of control plane signaling, a wireline connection from the UE connects to a device called a 5G regional gateway (5G-RG), which in turn connects to a core network function called a wireline access gateway function (W-AGF), and the pair together act like a gNB in NR-RAN; the N1 runs from the UE passing through the 5G-RG to the W-AGF to the AMF, while and the N2 runs from the W-AGF to the AMF.

For devices not capable of control plane signaling, non-5G capable UE (N5GC UE), a wireline connection from the UE connects to a device called a fixed network residential gateway (FN-RG), which in turn connects to a W-AGF. In this case, the control plane functionality that usually resides in the 5G capable UE resides instead in the W-AGF. Thus, the N1 does not involve the UE or the FN-RG.



Release 16 describes two kinds of wireline connections that apply to both 5G capable and N5GC UE;

1. wireline 5G broadband access network (W-5GBAN),
2. wireline 5G cable access network (W-5GCAN).

## 5G Includes All Access Networks

As seen above, 3GPP has created specifications for connectivity through 5G cores for any kind of access network. This ability to connect through different access points facilitates service continuity when UE move e.g. out of range of NG-RAN and into range of a Wi-Fi access network, or service optimization when multiple access networks are available by choosing to use the network with the strongest connection. Further, 3GPP has specified ways for UE to be simultaneously connected to a 5G core through multiple access networks.

## Multi-Connection

Release 16 covered multi-connectivity options to support a single PDU session that is simultaneously active over both NG-RAN and non-3GPP connections; for this the UE, AMF, UPF, and N3IWF must all be compliant. The options for multi-connection will be presented in a separate section under Access Networks in this Introduction to 5G.