IPv6 Community Wifi

Unique IPv6 Prefix per Host

IPv6 Enhanced Subscriber Access for WLAN Access

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- 19-01-2016

IPv6 timeline

4 waves... as noticed by ALU IP Division

~2000

IPv6 INIT
- IPv6 native routing

~2005

IPv6 infrastructure
- Interconnecting IPv6 clouds (6PE/6VPE)

~2010

IPv6 for services
- Residential (BNG)
- Business VPN

~2015

IPv6 for Mobile access (3GPP)
- **IPv6 for Carrier Wi-Fi**

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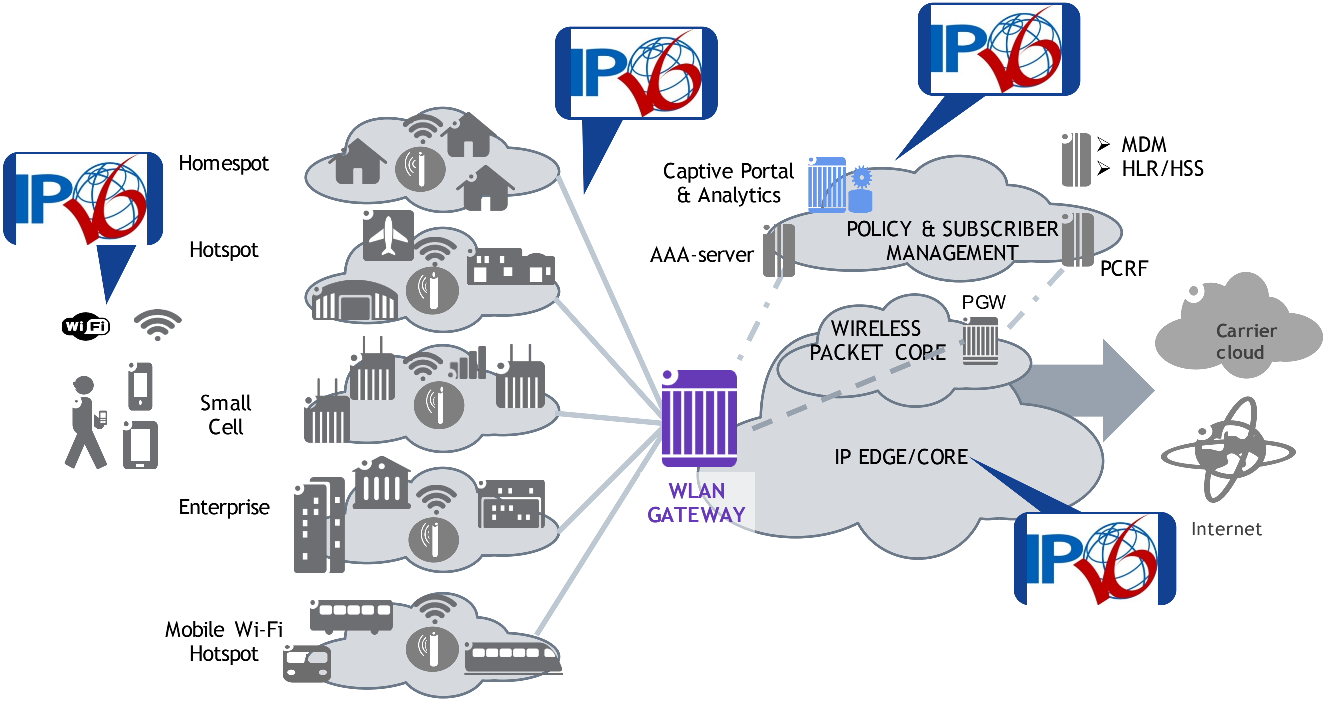
Carrier wi-fi

Who? What? How?

- Who?
- What?
  - Community Wi-Fi (residential Wi-Fi, like Fon/Wifree/…)
  - Hotspot aggregation (venues, stadiums, airports, …)
  - Mobile off-load (connect to mobile network over Wi-Fi)
- How?
  - Offering seamless (and secured) connectivity over Wi-Fi
  - Tunneling traffic from access points towards centralized gateway (next slide)

Wireless LAN gateway

Ecosystem



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WLAN Gateway

Push towards IPv6

- What are the IPv6 enablers for carrier Wi-Fi?
- Dynamic behavior of sessions, consuming more IP-addresses
  - Each session, being redirect, active or passive will consume IP address
  - NAT44 only option for IPv4, with clear disadvantages (next slide)
- Huge variety of IPv6 enabled, host-OS's (IOS, Android, windows…)
  - Note that for Wi-Fi (in opposite to mobile) not only SIM-based devices are present. Regular PC's/laptops/gaming consoles may connect as well.

WLAN gateway

IPv4 addressing challenges

- IPv4 inefficient address usage
  - Open SSID: no detection mechanism when UE disappears
  - Closed SSID (PMK caching): UE will return in Wi-Fi range and will request/re-use the previous IPv4 address
- IPv4 NAT44 characteristics
  - Only few hundred ports per UE required
  - Data retention and lawful intercept (NAT logging)
  - Focus on fragmentation/reassembly over tunnels

Wlan gateway

IPv6 only?

- IPv6 only the best way forward for Wi-Fi?
- Long term… yes
- Today… technically yes
  - But today…
  - Still NAT required: NAT64 (DNS64)
  - Most Wi-Fi devices are dual stack (initial start with IPv4), and still some Wi-Fi devices are IPv4-only
  - In contrast to mobile/cellular, where a UE (Smartphone) is a controlled device, this is not the case for Wi-Fi. IPv4 will remain for a while…

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WLAN gateway

dual stack approach

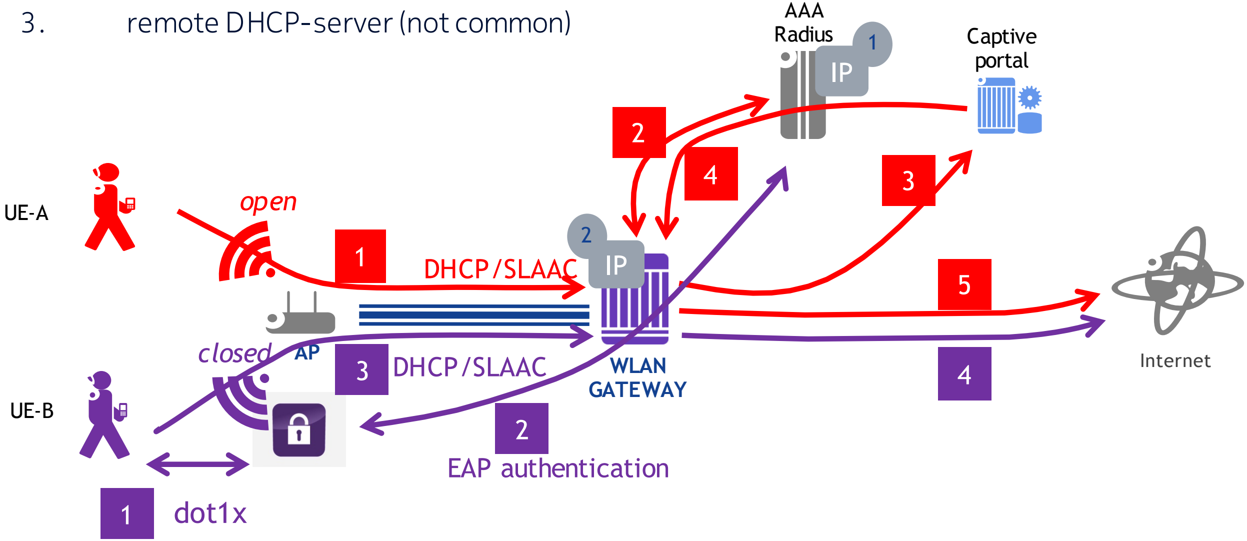
- Why dual stack?
  - Most of the Wi-Fi devices support dual stack
  - Even some “legacy” IPv4-only devices
  - Hitless Introduction
- Three dual-stack IPv4/v6 models are envisaged:
  - DHCPv4 + SLAAC/64
  - DHCPv4 + SLAAC/64 with DHCPv4 linking
  - DHCPv4 + DHCPv6/128 IA_NA

    … most of the devices start with SLAAC and may enable DHCPv6

WLAN gateway

IP address assignment

- Following network elements can assign the IPv4 and/or IPv6 address:
  1. AAA/Radius server
  2. WLANGW/WAG (local DHCP server)
  3. remote DHCP-server (not common)



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IETF DRAFT - Unique IPv6 Prefix Per Host

(draft-ietf-v6ops-unique-ipv6-prefix-per-host-00)

- Draft is currently mainly focused around Comcast's deployment of community Wi-Fi, under leadership of John Brzozowski
- The current draft explains the high level architecture and provides some technological details regarding IPv6 address assignment related aspects for community Wi-Fi access
- The implementation provides each Subscriber with a unique /64 address, allowing flexibility per subscriber on addressing technology used to derive /128 IPv6 addresses
- The architecture allows IPv6 support for UE's with minimal address management capabilities
- The draft provides insight in a real deployment considerations regarding address assignments (other aspects were explained
- The documented use-case deploys a captive portal for subscriber identification

Details

Generalized Community WIFI Topology

```
                            +-----+
                            | AAA |
                            +-----+
                               /
                            Radius
                             /
                        +----+
                        | CP |
            +----+      +---------+
UE--802.11--| AP |---Soft_GRE---| WLAN-GW |----Internet/WAN access
            +----+      +---------+
                            |
                         IP/HTTP
                            |
                  +----------------------+
                  | HTTP Captive Portal  |
                  +----------------------+
```

- UE: User Equipment.
- 802.11: Wireless Network
- AP: Access Point.
- Soft-GRE: Stateless GRE tunnel
- WLAN-GW: Wireless LAN Gateway
- CP: Control Plane component of the WLAN-GW (uses DHCP, ARP, DHCPv6, ICMPv6 (RS/RA/NS/NA), Radius, Diameter, etc.)
- AAA: Accounting, Authorization and Authentication
- HTTP Captive Portal: Captive portal used to redirect traffic towards during subscriber onboarding process

Details

IPv6 Wi-Fi Subscriber Onboarding Procedures (1)

```
UE                 WLAN-GW            AAA          Captive-Portal DNS
|                    |                  |                |         |
|                    |                  |                |         |
|--------RS--------->|                  |                |         |
|                    |---Access-Req---->|                |         |
|                    |<--Access-Acc-----|                |         |
|                    |(=Radius UE info) |                |         |
|<-------RA----------|                  |                |         |
|(/64; M,L=0; O,A=1) |                  |                |         |
|                    |                  |                |         |
|------NS(DAD)------>|                  |                |         |
|                    |                  |                |         |
|-DHCPv6(info Req)-> |                  |                |         |
| (Ask DNS IP addr.) |                  |                |         |
|                    |                  |                |         |
|<---DHCPv6 Reply--- |                  |                |         |
|                    |                  |                |         |
|--------------------------------DNS--------------------------->|
|                    |                  |                |         |
|------HTTP GET----> |                  |                |         |
|<--HTTP Redirect--- |                  |                |         |
|                    |                  |                |         |
|--------------------------------DNS--------------------------->|
|                    |                  |                |         |
|<----------------------HTTP Login------------------->|         |
|                    |                  |                |         |
|                    |                  |<-UE Identified-|         |
|                    |<--Radius CoA-----|                |         |
|                    |(remove HTTP Red.)|                |         |
|                    |                  |                |         |
|<--------UE/Subscriber connected to Internet/WAN------------------->
|                    |                  |                |         |
|                    |                  |                |         |
```

- When UE connects it sends a RS to learn
  - IPv6 Gateway, Prefix information, DNS, remaining info for global routing
  - RS send from UE via the AP-bridge onto the Soft-GRE the WLAN-GW
  - Due to split-horizon for BUM traffic the RS is not seen by other UE's connected to the same AP
- First time UE connects it is not Authorized and WLAN-GW queries AAA server
- AAA server checks policy DB and returns /64 together with http-redirect to Captive portal via Radius-acknowledge message

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Details

IPv6 Wi-Fi Subscriber Onboarding Procedures (2)

```
UE                 WLAN-GW              AAA         Captive-Portal DNS
|                    |                   |                |         |
|--------RS--------->|                   |                |         |
|                    |---Access-Req----->|                |         |
|                    |<--Access-Acc------|                |         |
|                    |(=Radius UE info)  |                |         |
|<-------RA----------|                   |                |         |
|(/64; M,L=0; O,A=1) |                   |                |         |
|                    |                   |                |         |
|------NS(DAD)------>|                   |                |         |
|                    |                   |                |         |
|-DHCPv6(info Req)-> |                   |                |         |
| (Ask DNS IP addr.) |                   |                |         |
|                    |                   |                |         |
|<---DHCPv6 Reply--- |                   |                |         |
|                    |                   |                |         |
|--------------------------------DNS------------------------------->|
|                    |                   |                |         |
|------HTTP GET----->|                   |                |         |
|<--HTTP Redirect--- |                   |                |         |
|                    |                   |                |         |
|--------------------------------DNS------------------------------->|
|                    |                   |                |         |
|<----------------------HTTP Login----------------------->|         |
|                    |                   |                |         |
|                    |                   |<-UE Identified-|         |
|                    |<--Radius CoA------|                |         |
|                    |(remove HTTP Red.) |                |         |
|                    |                   |                |         |
|<--------UE/Subscriber connected to Internet/WAN------------------->
|                    |                   |                |         |
```

- WLAN-GW uses received Radius info to compose the "RA" response to the UE originated "RS" message
- RA contains few important bits of information
  - A IPv6 /64 prefix
  - Some flags
- (1) IPv6 /64 prefix
  - Locally managed pool on WLAN-GW
  - Pool signaled through Radius
- (2) Some flags
  - Indicate to use SLAAC and/or DHCPv6
  - Prefix is on/off-link
  - Is there need to request 'Other' information (e.g DNS)?

Details

IPv6 Wi-Fi Subscriber Onboarding Procedures (3)

```
UE                 WLAN-GW              AAA          Captive-Portal DNS
|                   |                    |                 |         |
|                   |                    |                 |         |
|--------RS-------->|                    |                 |         |
|                   |---Access-Req---->  |                 |         |
|                   |<--Access-Acc-----  |                 |         |
|                   |(=Radius UE info)   |                 |         |
|<-------RA---------|                    |                 |         |
|(/64; M,L=0; O,A=1)|                    |                 |         |
|                   |                    |                 |         |
|------NS(DAD)----->|                    |                 |         |
|                   |                    |                 |         |
|-DHCPv6(info Req)->|                    |                 |         |
| (Ask DNS IP addr.)|                    |                 |         |
|                   |                    |                 |         |
|<---DHCPv6 Reply---|                    |                 |         |
|                   |                    |                 |         |
|--------------------------------DNS---------------------------->|
|                   |                    |                 |         |
|------HTTP GET---->|                    |                 |         |
|<--HTTP Redirect---|                    |                 |         |
|                   |                    |                 |         |
|--------------------------------DNS---------------------------->|
|                   |                    |                 |         |
|<-----------------------HTTP Login------------------->|         |
|                   |                    |                 |         |
|                   |                    |<-UE Identified-|         |
|                   |<--Radius CoA-----  |                 |         |
|                   |(remove HTTP Red.)  |                 |         |
|                   |                    |                 |         |
|<--------UE/Subscriber connected to Internet/WAN------------------>
|                   |                    |                 |         |
|                   |                    |                 |         |
```

- IPv6 RA flags for best common practice
  - **M-flag = 0** (UE/subscriber address is not managed through DHCPv6), this flag may be set to 1 in the future if/when DHCPv6 prefix delegation support over Wi-Fi is desired)
  - **O-flag = 1** (DHCPv6 is used to request configuration information i.e. DNS, NTP information, not for IPv6 addressing)
  - **A-flag = 1** (The UE/subscriber can configure itself using SLAAC)
  - **L-flag = 0** (The UE/subscriber is off-link, which means that the UE/subscriber will send packets ALWAYS to his default gateway, even if the destination is within the range of the /64 prefix)

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Details

IPv6 Wi-Fi Subscriber Onboarding Procedures (4)

```
UE                WLAN-GW             AAA         Captive-Portal DNS
|                   |                  |                |         |
|                   |                  |                |         |
|--------RS-------->|                  |                |         |
|                   |---Access-Req---->|                |         |
|                   |<--Access-Acc-----|                |         |
|                   |(=Radius UE info) |                |         |
|<-------RA---------|                  |                |         |
|(/64; M,L=0; O,A=1)|                  |                |         |
|                   |                  |                |         |
|------NS(DAD)----->|                  |                |         |
|                   |                  |                |         |
|-DHCPv6(info Req)->|                  |                |         |
| (Ask DNS IP addr.)|                  |                |         |
|                   |                  |                |         |
|<---DHCPv6 Reply---|                  |                |         |
|                   |                  |                |         |
|--------------------------------DNS---------------------------->|
|                   |                  |                |         |
|------HTTP GET---->|                  |                |         |
|<--HTTP Redirect---|                  |                |         |
|                   |                  |                |         |
|--------------------------------DNS---------------------------->|
|                   |                  |                |         |
|<-----------------------HTTP Login------------------->|         |
|                   |                  |                |         |
|                   |                  |<-UE Identified-|         |
|                   |<--Radius CoA-----|                |         |
|                   |(remove HTTP Red.)|                |         |
|                   |                  |                |         |
|<--------UE/Subscriber connected to Internet/WAN------------------->
|                   |                  |                |         |
|                   |                  |                |         |
```

- Deploying a unique IPv6 per UE/subscriber
  - Each UE belongs to unique /64 subnet, hence through natural network behavior all traffic will be directed to the default gateway (=WLAN-GW)
  - Due to the flags set hosts can keep using privacy addresses within the /64 prefix
  - Accounting per UE can be done per /64 instead of per /128 IPv6 address
- UE Learning about DNS
  - Most common Stateless DHCPv6 is used by UE/subscribers
  - RA extensions for RNDSS RFC6106 can be used also, albeit less supported on UE devices
  - Both technologies can be used simultaneous and are non-mutual exclusive (however the address must be identical)
- Captive portal used to identify the subscriber (other means could potentially be used also)

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Details

IPv6 Wi-Fi Subscriber Onboarding Procedures (5)

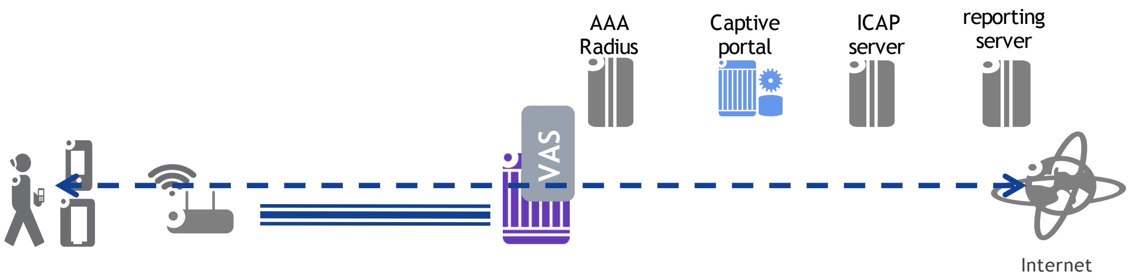
```
UE                 WLAN-GW              AAA         Captive-Portal DNS
|                    |                   |                |         |
|                    |                   |                |         |
|--------RS--------->|                   |                |         |
|                    |---Access-Req----->|                |         |
|                    |<--Access-Acc------|                |         |
|                    |(=Radius UE info)  |                |         |
|<-------RA----------|                   |                |         |
|(/64; M,L=0; O,A=1) |                   |                |         |
|                    |                   |                |         |
|------NS(DAD)------>|                   |                |         |
|                    |                   |                |         |
|-DHCPv6(info Req)-> |                   |                |         |
| (Ask DNS IP addr.) |                   |                |         |
|                    |                   |                |         |
|<---DHCPv6 Reply--- |                   |                |         |
|                    |                   |                |         |
|--------------------------------DNS---------------------------->|
|                    |                   |                |         |
|------HTTP GET----> |                   |                |         |
|<--HTTP Redirect--- |                   |                |         |
|                    |                   |                |         |
|--------------------------------DNS---------------------------->|
|                    |                   |                |         |
|<-----------------------HTTP Login------------------->|         |
|                    |                   |                |         |
|                    |                   |<-UE Identified-|         |
|                    |<--Radius CoA------|                |         |
|                    |(remove HTTP Red.) |                |         |
|                    |                   |                |         |
|<--------UE/Subscriber connected to Internet/WAN------------------>
|                    |                   |                |         |
|                    |                   |                |         |
```

- IPv6 ND Timers
  - IPv6 Router Advertisement Interval = 300s
  - IPv6 Router LifeTime = 3600s
  - Reachable time = 30s
  - IPv6 Valid Lifetime = 3600s
  - IPv6 Preferred Lifetime = 1800s
  - Retransmit timer = 0s
- Geo-localization for UE
  - When DHCPv6 is used AP can insert interface-id in DHCP solicit message
  - When using SLAAC alternate information can be used. E.g. NSoGRE to harvest the AP MAC address

Wi-Fi specific features:

Value-added-services (IPv6 aware)

- Carrier Wi-Fi mandates VAS in order to monetize Wi-Fi as a service. Only offering connectivity (bit-pipe) is not a future-save business case.
- Few examples:
  - HTTP(s) redirects are influencing QoE heavily. Soft-redirect recommended (white listing), with success verification
  - Parental control based on ICAP (blacklist filtering)
  - Usage based billing
  - Inserting pop-ups in http session (in-browser notifications)

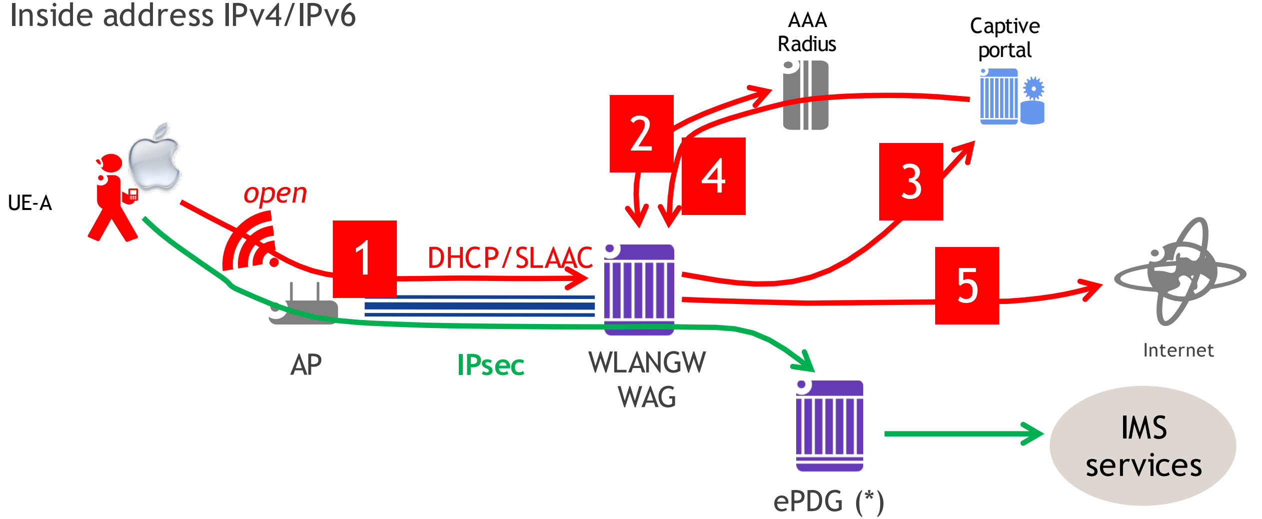


Value-added-services supported over IPv6 !

Wi-Fi specific features:

Voice over wifi (apple wifi calling)

- Delivering Voice over Wi-Fi in a secured way, over an “untrusted” connection
- Encryption/authentication from Smartphone, with dedicated encrypted tunnel
- IPv4 or IPv6 IPsec tunnels towards ePDG
- Inside address IPv4/IPv6



(*) ePDG: evolved packet data gateway

SUMMARY

What does IPv6 bring to carrier Wi-Fi?

- More available IP addresses
- Avoiding NAT44 means:
  - less logging/processing/resources
  - No fragmentation/reassembly issues
- Easy integration
  - Offering IPv6 over IPv4 infrastructure is possible
  - Hitless introduction of IPv6 Wi-Fi devices (single or dual stack)
  - Wi-Fi specific features are operational in IPv6 environment

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