BNG - Control & User Plane Separation Architecture, Requirements & Interfaces

draft-wadhwa-rtgwg-bng-cups-01.txt

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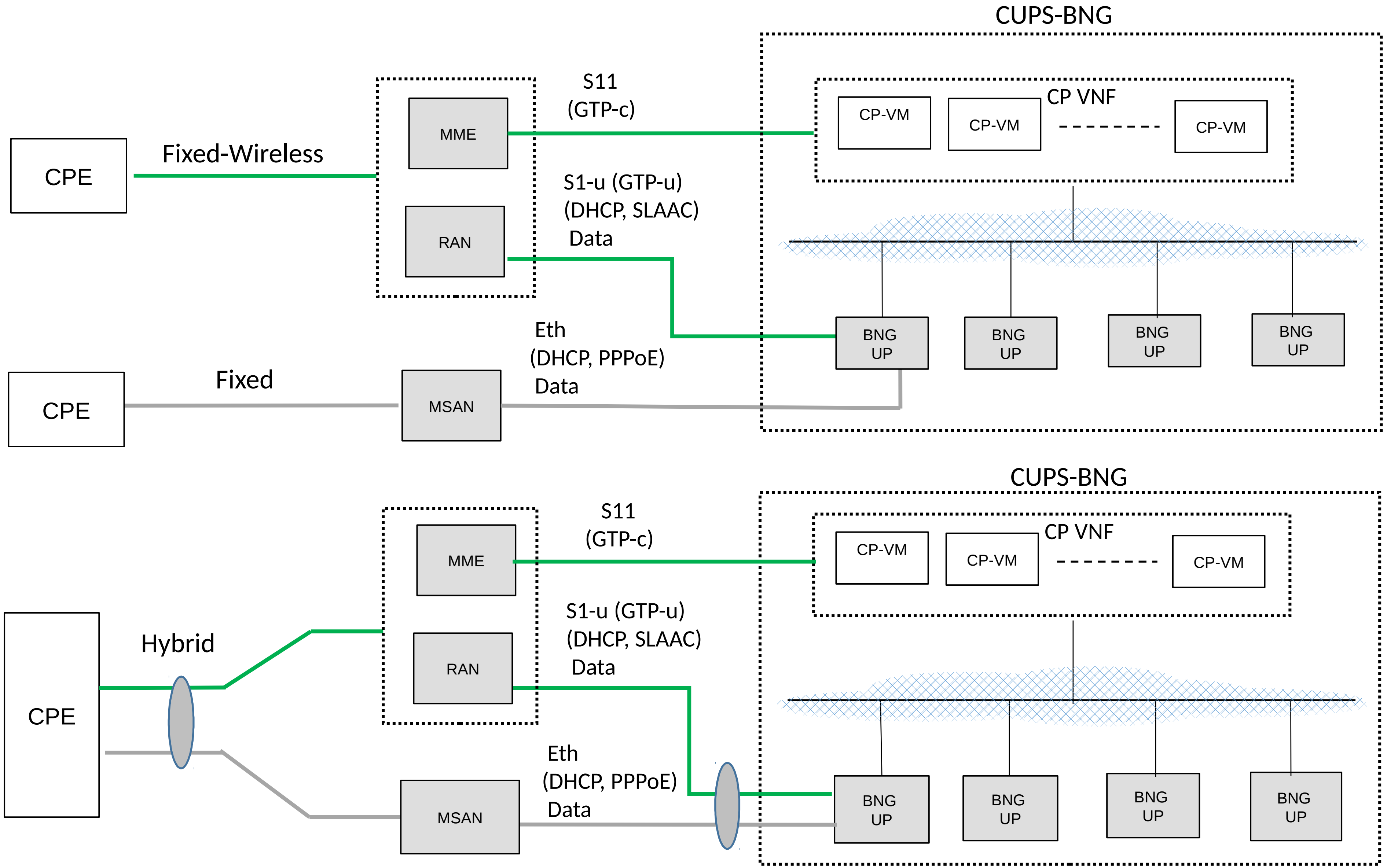
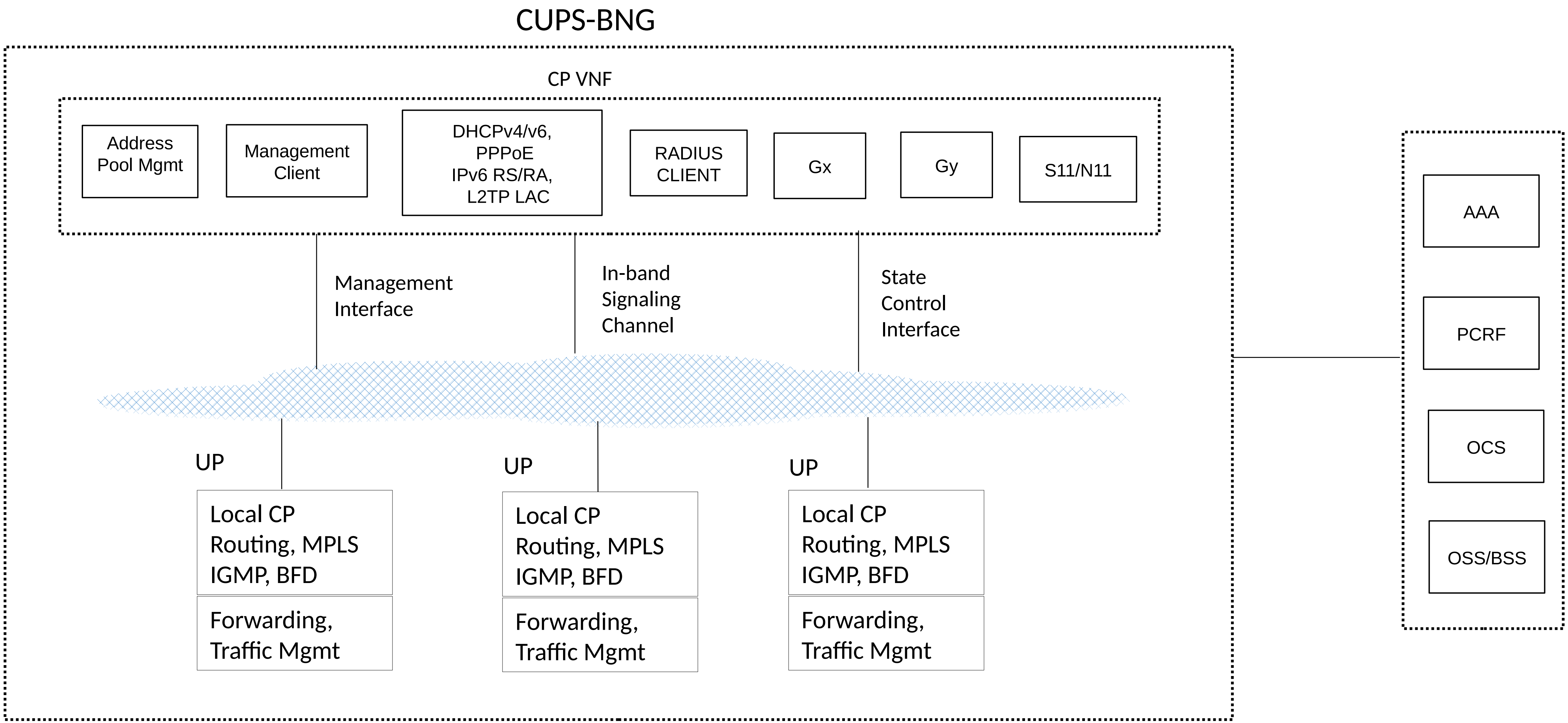
Why CUPS on BNG ?

- **Allows control and data plane to scale independently.**
- **Flexible placement of control plane and data plane elements**
  - Data plane for BNG can be distributed e.g. if CDN caches are distributed.
  - Control plane can be centralized.
  - Control plane as VNF. Data plane can be PNF or VNF.
- **Operational Simplicity**
  - Single point for management and control for cluster of BNGs.
  - Single interface towards external systems (AAA servers, PCRF, OCS, OSS/BSS).
- **Convergence of BNG control plane with session management (control plane) functions in 4G/5G packet core**
  - BNG terminating fixed, fixed-wireless and hybrid access.
  - BBF and 3GPP defining converged architecture for 5G (fixed access integrated or interworked with 5G core).
  - CUPS is de facto in EPC and 5GC

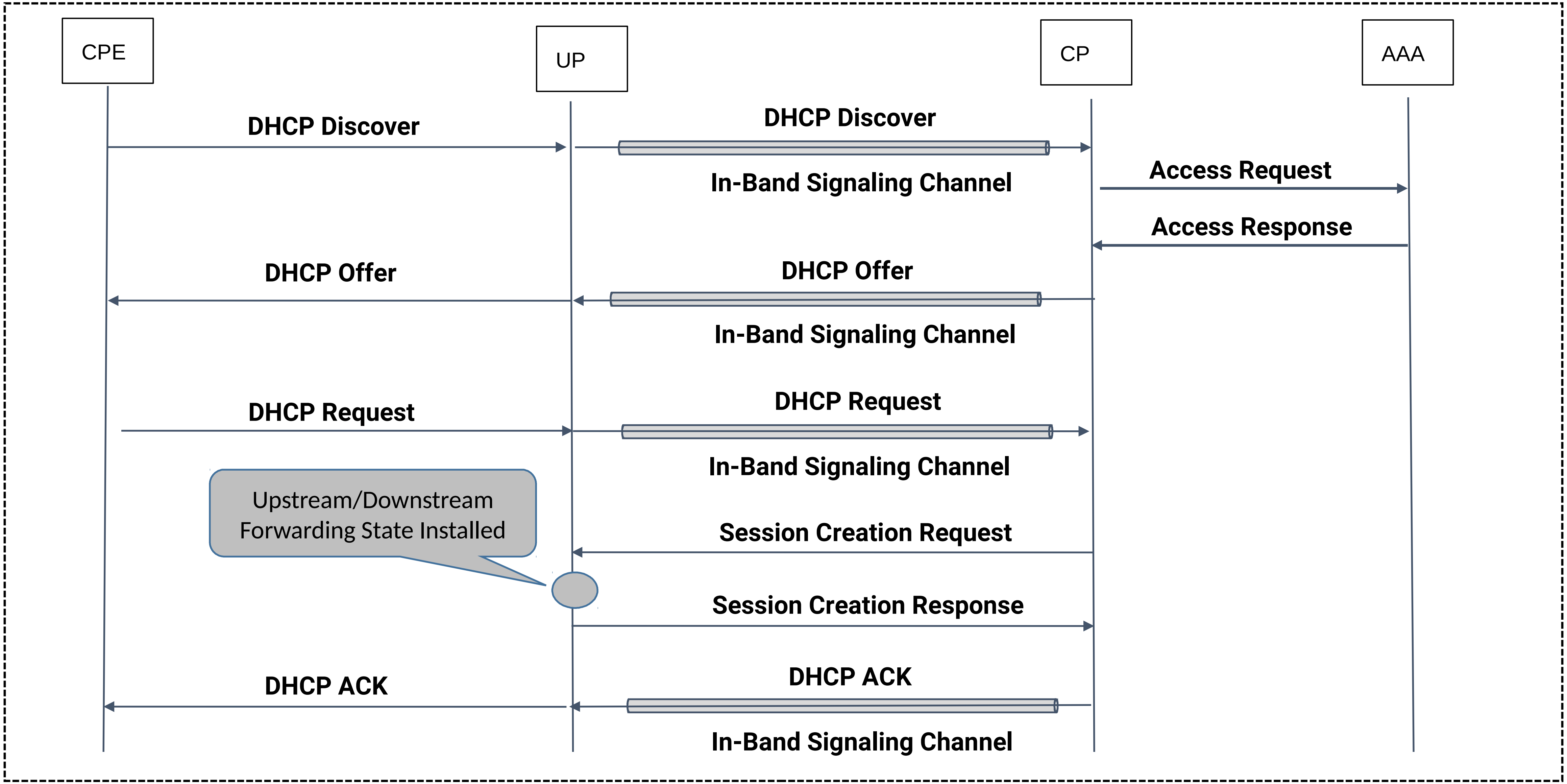
CUPS BNG – Deployment Scenarios (Fixed/Fixed-Wireless/Hybrid Access)



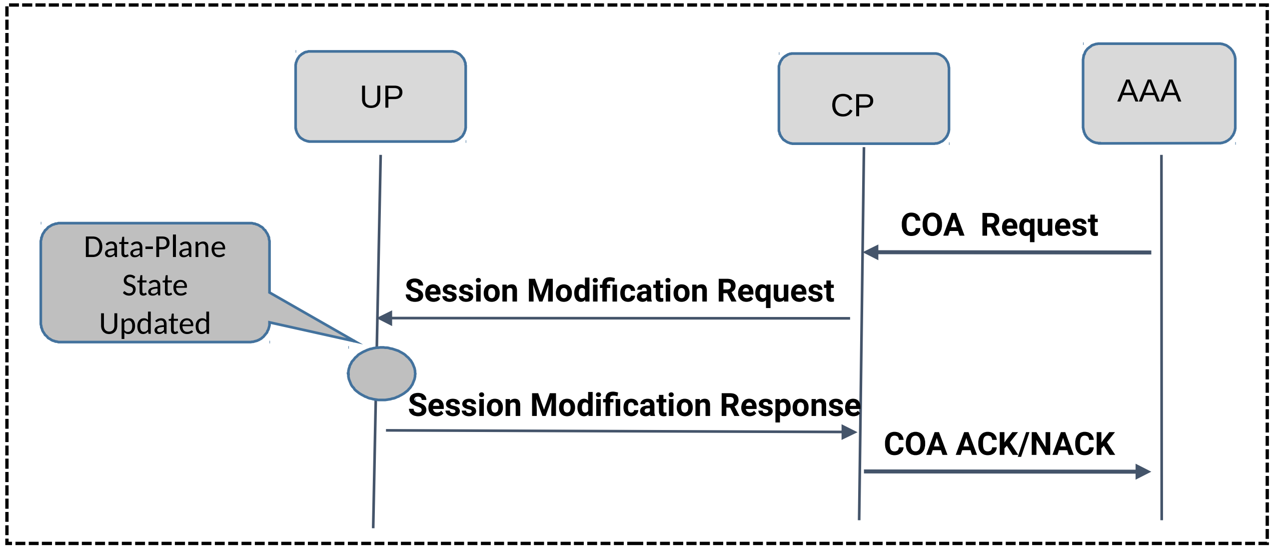
CUPS – Functional Decomposition



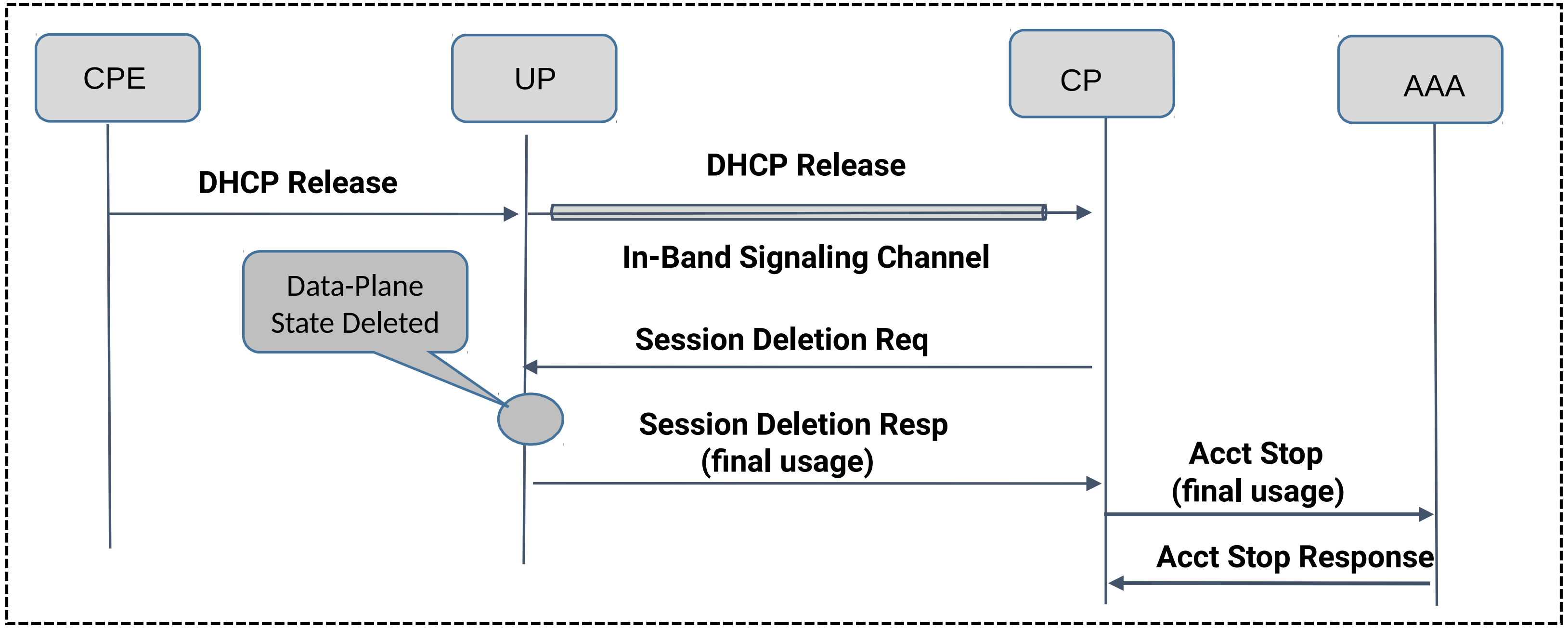
State Control Interface – Session-Level State Management



State Control Interface - Session Level State Management

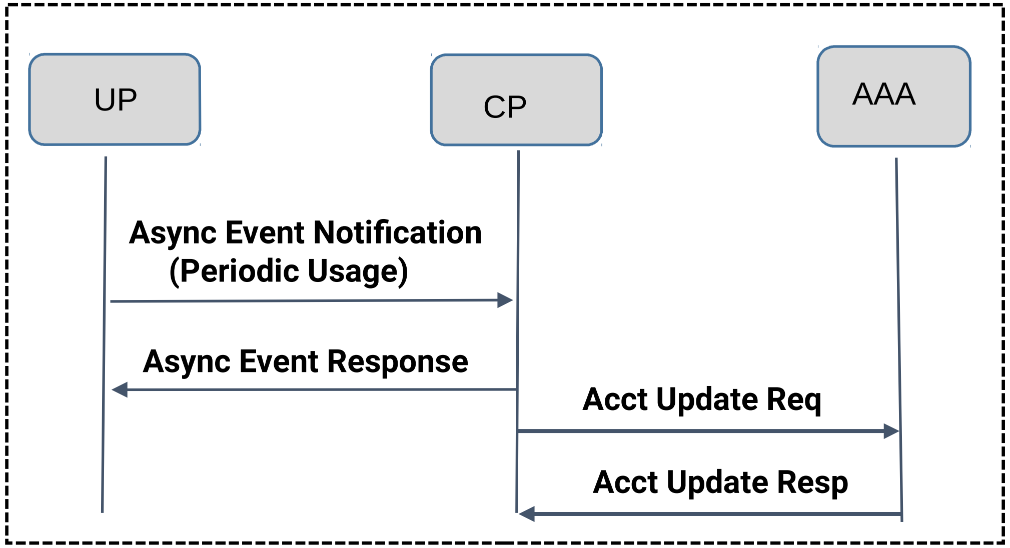


Session Modification - Triggers
- RAIDUS COA
- Gx RAR
- Administrative action
- Credit Control



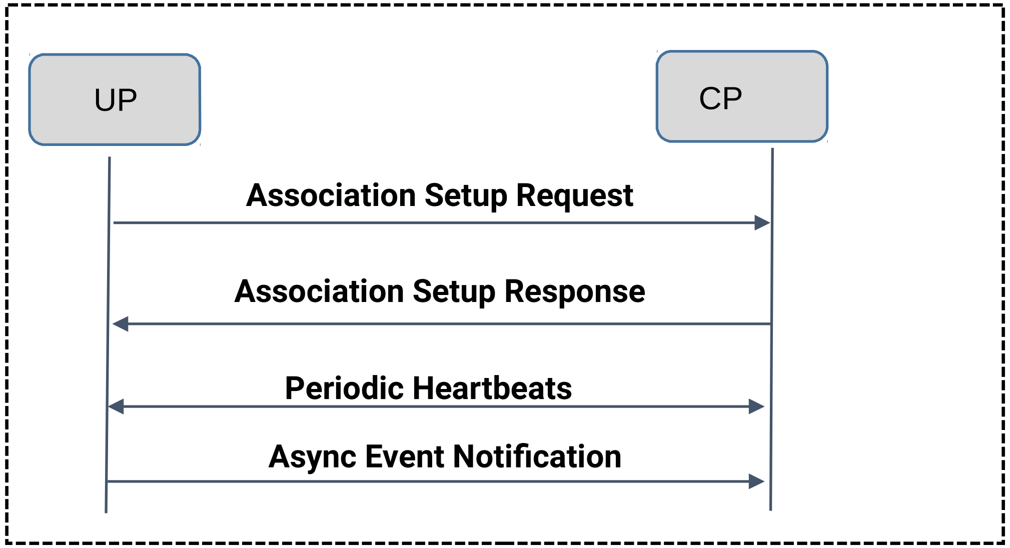
Session Deletion - Triggers
- CPE Initiated (DHCP Release, PPPoE PADT)
- Timeouts (DHCP lease, PPP KA)
- Inactivity Detected
- Subscriber Unreachability Detected
- RAIDUS initiated disconnect
- Administrative action
- End of Credit Action

State Control Interface - Session Level Event Notification



Examples of Session Level Notifications
- Periodic Usage Reporting
- Threshold Based Usage Reporting
- Inactivity Timeout
- Subscriber Unreachability Detected

State Control Interface – Node Level Management



Examples of Node Level Management
- Association Establishment (capabilities, s/w release, load/overload information, resource info etc)
- Periodic Heartbeats (for liveness detection)
- Asynchronous notifications (e.g. to report switchovers)

State Control Interface – Session Level State Management

CP
VNF

Packet Detection Rule (Upstream : Access->Network]

Match Rule

Port/VLAN-Tag(s)

MAC@

[Session-ID]

[IPv4@ / IPv6@/ IPv6 Prefix]

Action : Remove L2 Encaps, IP FIB Lookup, Fwd to network

Packet Detection Rule (Downstream : Network -> Access)

Match Rule

IPv4 @ / IPv6@ /IPv4 prefix / IPv6 prefix

Action : Add Encaps { Port/VLAN-Tag(s), Subscriber MAC, [Session ID] }, Forward to Access

Routing Info

IPv4/v6 Address, Prefix Length

Gateway IP Address

Aggregation Prefix

QoS Info

- Local QoS Profile
- MBR/CBR
- Markings..

Usage Reporting Info

- Reporting Triggers
- Time thresholds, quotas.
- Volume thresholds, quotas

BNG

UP

State Control Interface – Protocol Requirements

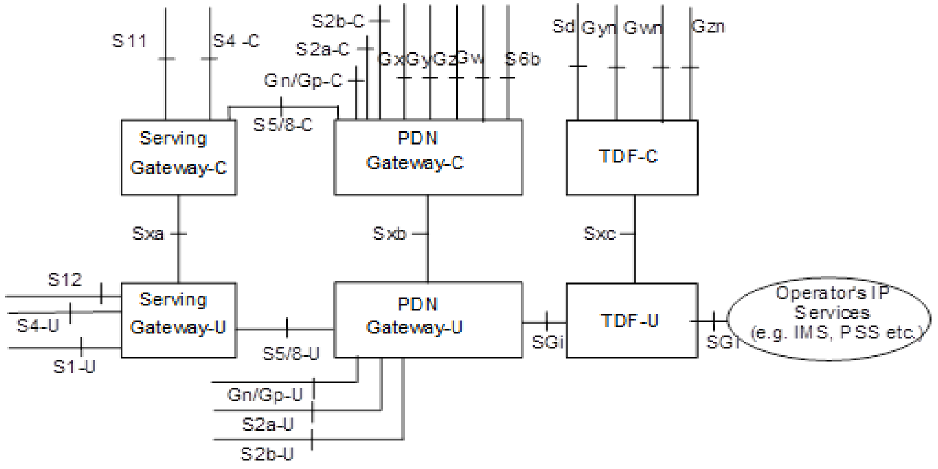
- MUST allow fixed, fixed-wireless (4G/5G) and hybrid access on BNG.
- MUST support tunneled/non-tunneled, L2/L3 access.
- Underlying transport SHOULD not have HOL Blocking.
- MUST support application level reliability (request/response mechanism).
- MUST be extensible (messages MUST support carrying Information Elements as TLVs).
- MUST allow vendor specific extensions.
- SHOULD minimize "chatiness" (e.g. minimize message round-trips to create session state on UP)
- MUST support setting of in-band signaling channel between CP and UP.
- MUST support state management for forwarding state, QOS enforcement, and usage-tracking (both periodic and threshold based).
- MUST support asynchronous notifications from UP to CP.
- MUST support graceful handling under overload (e.g. via temporary message throttling from CP to UP under overload).
- MUST support liveness detection between CP and UP.
- MUST support mechanisms for CP and UP redundancy.
- SHOULD optimize amount of information passed where possible (e.g. if forwarding actions or QOS enforcement is shared for multiple sessions, then this should be passed by reference after initial creation).

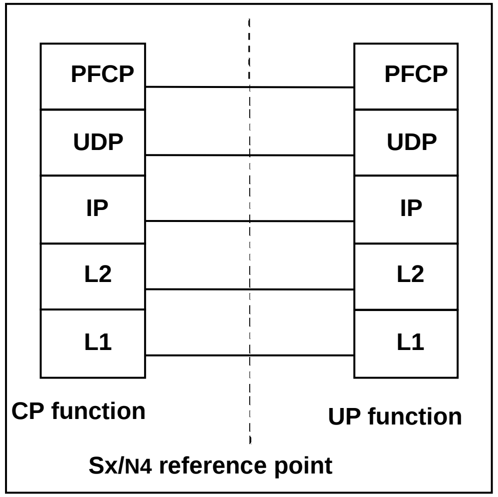
In-Band Signaling Channel - Requirements

- UP MUST pass signaling messages received from CPE unmodified to CP.
- UP MUST pass unmodified the signaling (response) messages from CP to CPE.
- UP MUST signal “access circuit ID” as meta-data with messages passed to CP.
- UP MUST pass received Ethernet frame to CP. UP MUST pass local MAC@ to CP. CP MUST encapsulate response messages and pass the Ethernet frame to UP.
- In-Band Signaling Channel MUST be dynamically setup between CP and UP via signaling.
- CP MUST be able to indicate to UP specific message types that MUST be sent to CP over signaling channel.
- CP MUST be able to dynamically instruct UP to block certain messages over a signaling channel.
- CP MUST be able to control the UP to limit the rate of control messages (on a per message-type basis) sent to the CP.
- CP MUST be able to control the relative priority with which the UP sends certain control messages (e.g. prioritize DHCP Renews over Discovers, or PPP Keepalives over PADI).
- The in-band signaling channel MUST support converged access.
    - It MUST therefore support transporting both Ethernet and IP payloads.

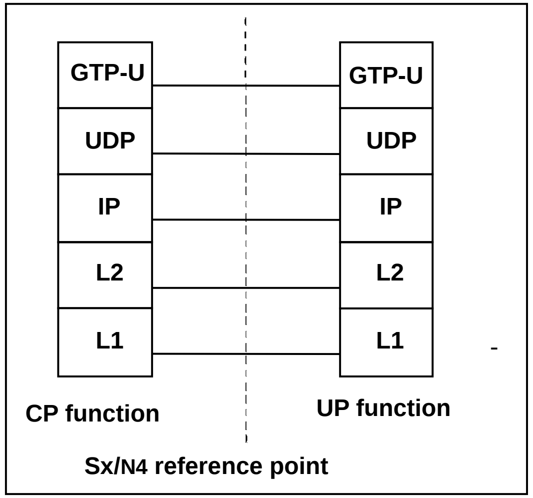
Protocol Selection Input

- 3GPP has already defined a protocol for CUPS between gateways – PFCP (Packet Forwarding Control Protocol) in [TS 29.244].
- The protocol machinery is purpose built for large scale state management between CP and UP.
- The containers used to convey forwarding state, QOS enforcement, usage-reporting are defined generically and can be applied to state relevant to BNG.
- Requires extensions in the form of new IEs or extending a small subset of existing IEs for BNG, mainly for :
    - L2 access that is typical for BNG, and IP/Routing interactions on UP specific to BNG (e.g. prefix aggregation, Gateway IP for CPEs).
- PFCP IEs are extendable and defined as TLVs.
- The 32 bit number space for TLV types is already partitioned into “3GPP specified” and “vendor specified”. BNG specific TLVs can be defined by IETF or IANA.
- Extend PFCP for BNG CUPS:
    - Allows convergence
        - Multiple access types (Fixed, FWA, Hybrid) on BNG upfront.
        - In future will allow fixed broadband integration with 5GC (as defined in BBF SD-407).
        - Provides the possibility of “unified” CP to control different UPs (e.g. BNG on PNF, EPC or 5GC elements on VNF).
    - Provides a scalable and hardened/deployed baseline. No need to reinvent the wheel
- Consider undertaking protocol extensions to PFCP for CUPS BNG in IETF





PFCP Protocol Stack



PFCP User-Plane for In-Band Control Protocol Messages

Thank you