The Evolution from PPPoE to IPoE sessions

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Agenda

- From PPP to IP, a natural evolution
- Carrier Ethernet Service Delivery Models
- Intelligent Service Gateway for PPPoE and IPoE
  - Overview
  - ISG IP Session Models
  - IP Sessions Additional Considerations
- Conclusion

PPP to IP, A Natural Evolution For Carrier Ethernet Triple Play Services

- Broadband Access Technology options are evolving and diversifying while having two common technology denominators, **Ethernet** multiplexing/ aggregation and **IP** services
  - WiMAX 802.16D/E gets traction in emerging worldwide markets
  - New DSL flavours (ADSL2+ and VDSL) defined an Ethernet baseline for the Access Nodes at the UNI and NNI level
  - Metro FTTX P2P (802.3ah) and MP (PON) deployments are increasing in relevance for both residential and business services
- Triple/Quad Play services like IPTV and VOD have imposed **IPoEthernet** as service encapsulation baseline
  - PPPoE may still be used for Internet Access
- High market penetration targets requires advanced **subscriber management** functions for PPPoE and IPoE service models to optimize the operational costs
  - And to enable mass customization of the broadband services
- Cisco offers "**Intelligent Services Gateways**" to address the PPPoE to IPoE migration while maintaining all subscriber management functions

Carrier Ethernet Architectures and Service Delivery Models

Carrier Ethernet Architecture Models

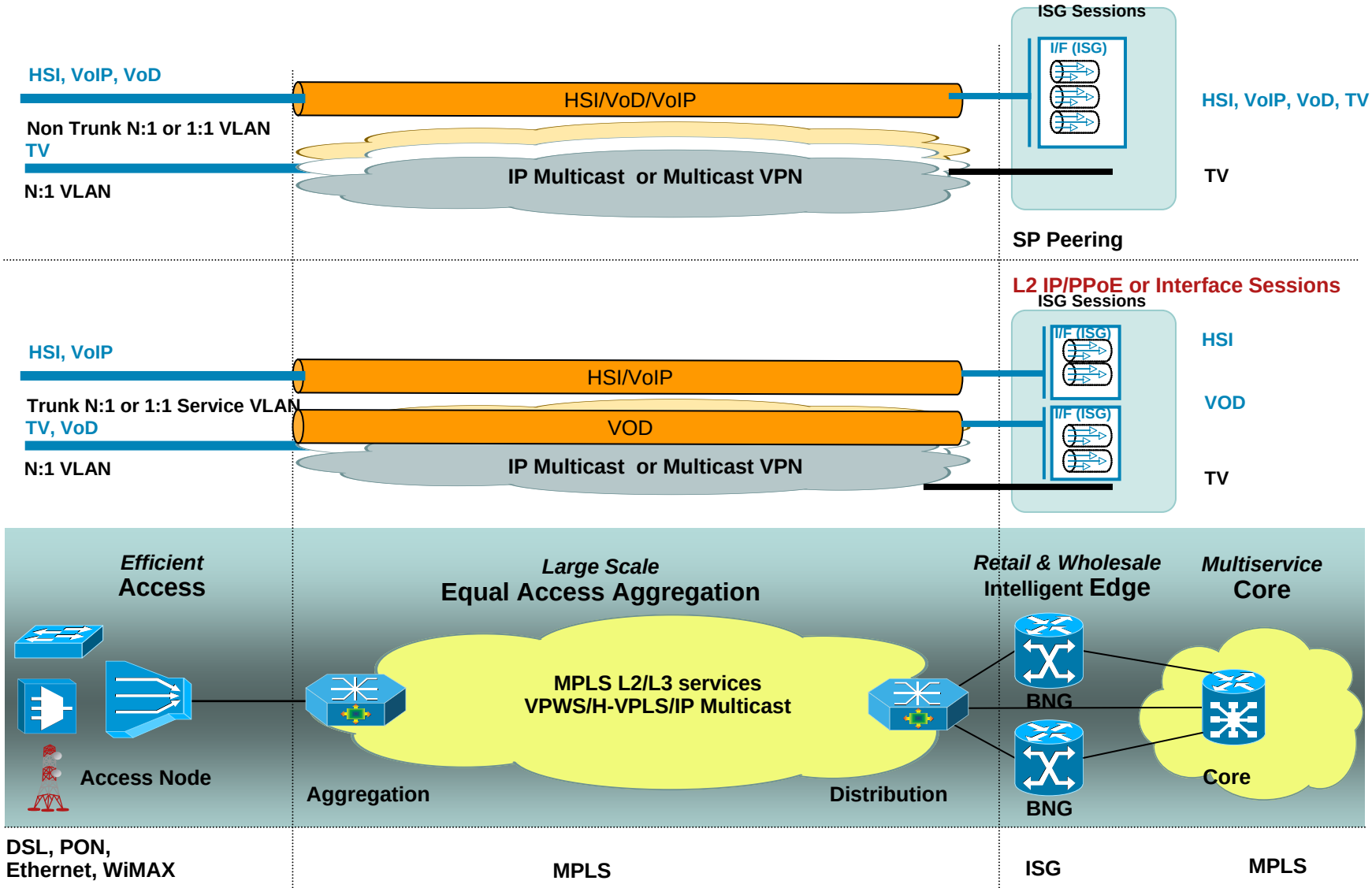
- **Operational & cost considerations drive two architectures models:**
  Distributed and Centralised IP Edge Architectures
- **Drivers for the centralized edge architecture**
  - Align with existing SP organizational and operational structures
  - An order of magnitude fewer subscriber state aware network elements to manage
  - May improve the CAPEX efficiency especially if services planned allow network oversubscription
  - Operational and organizational differentiation into access, aggregation, edge and core network layers
- **Drivers for the distributed edge architecture**
  - Single point of implementing (L2/L3) services edge
  - Consolidation of functions eliminates differentiated infrastructure
  - Simplified operations by removing the overlay circuit based aggregation network transport
  - Increased penetration of 3play services (VOD) drives lower oversubscription on the aggregation network and makes less suitable centralized edge devices
  - Increased flexibility for local content injection, network based admission control for VoD and more optimal handling for peer to peer traffic

Notes:

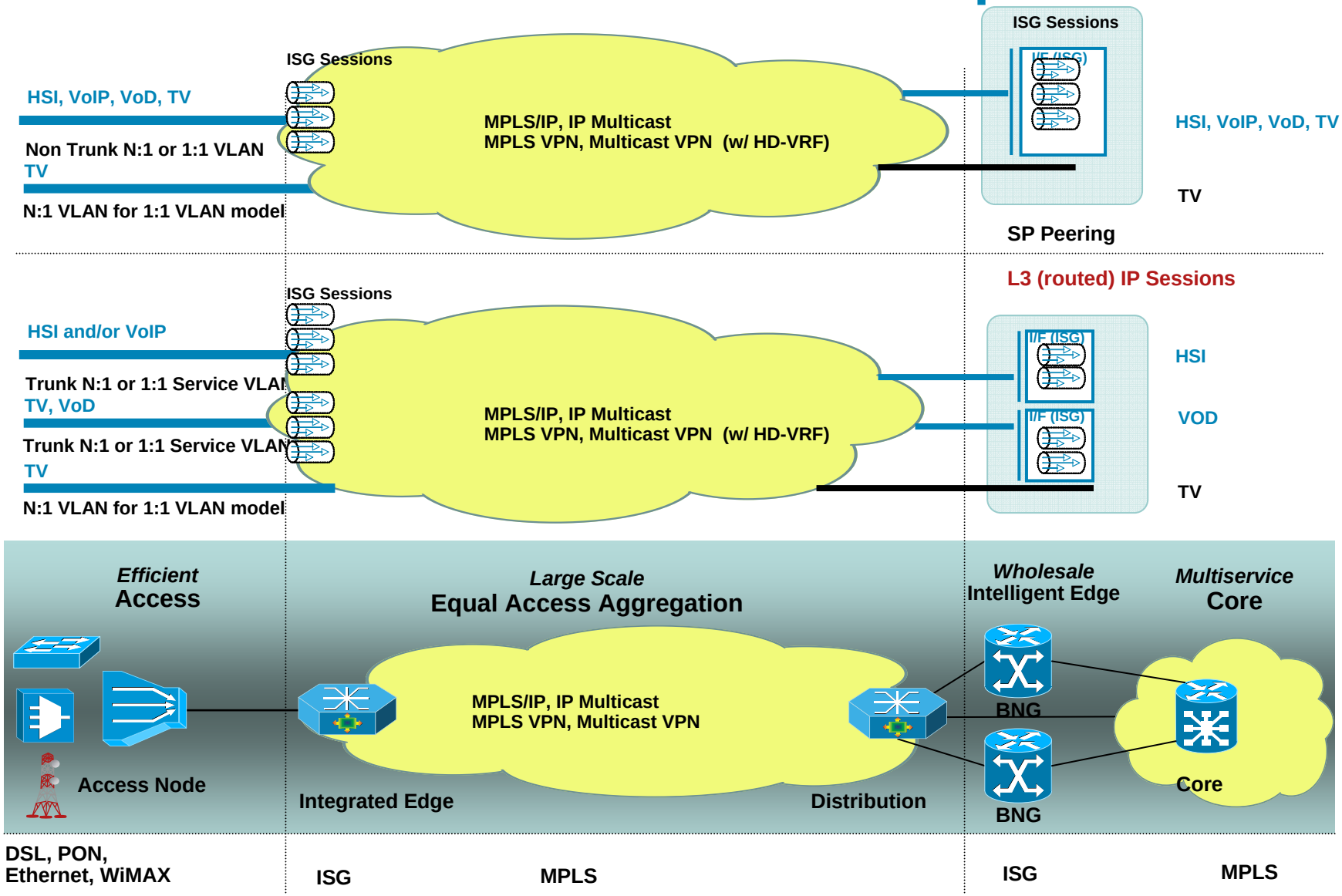
An MPLS/IP transport for the Core & Aggregation layers can accommodate both architecture models

These two architecture models may be combined on a service basis in the scope a network deployment for meeting certain practical considerations (for example centralised edge for Internet Access while it already exists and distributed Video and Voice services edge to optimize the costs)

Centralised Services Architecture Options



Distributed Services Architecture Options

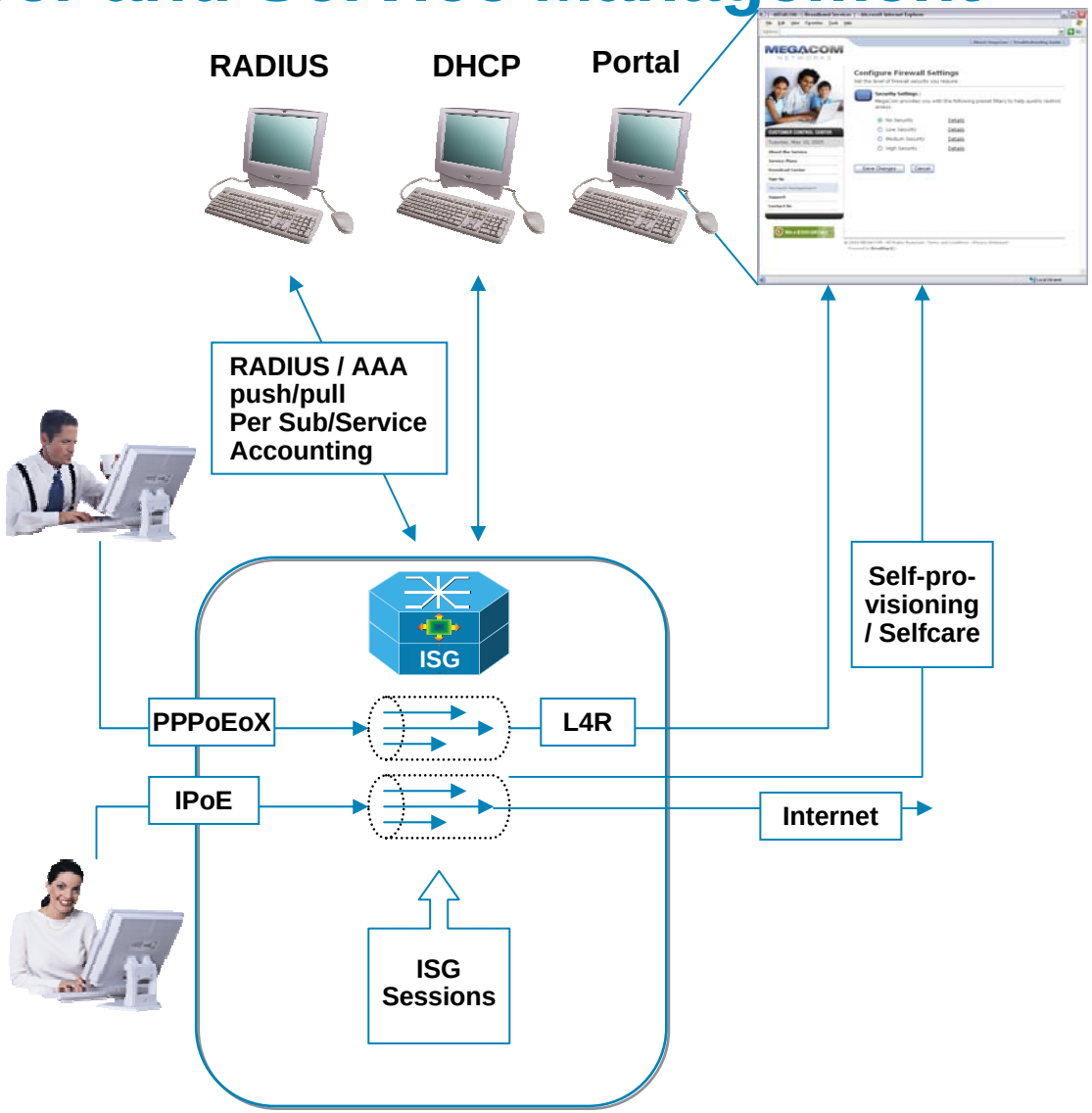


ISG
Intelligent Services Gateway

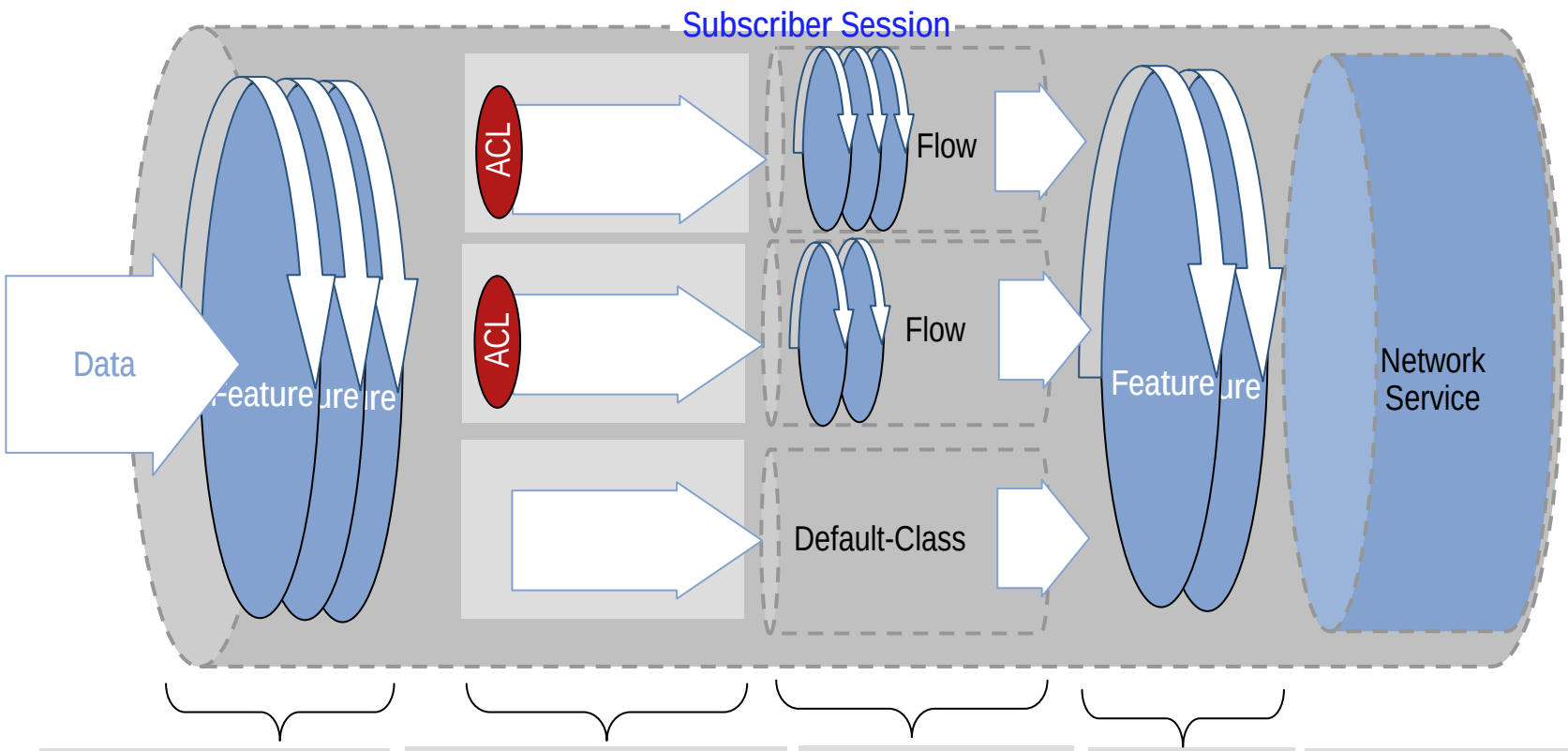
Intelligent Services Gateway
Dynamic Subscriber and Service Management

- **It enables a Cisco network device to be a Policy Enforcement Point (PEP) (and optionally PDP)**

- **It is an IOS functional component that enables:**
  - IP and PPPoE session management and control
    - IP service flow management and control
  - Local and remote Session Control Policies with event and condition based enforcement:
    - AAA, Transparent or Portal based Logon, Logoff, Timeouts, Time Volume Prepaid
  - Local and remote Traffic Control Policies with event and condition based enforcement:
    - QOS, ACLs, L4 redirect
  - Local and remote Network Control Policies with event and condition based enforcement:
    - L2TP selection, VRF selection and transfer



ISG Subscriber Session Data Plane



Session-Features:
Apply to the entire session
e.g. per-session-ACL, Policing, H-QOS, Accounting, L4 redirect

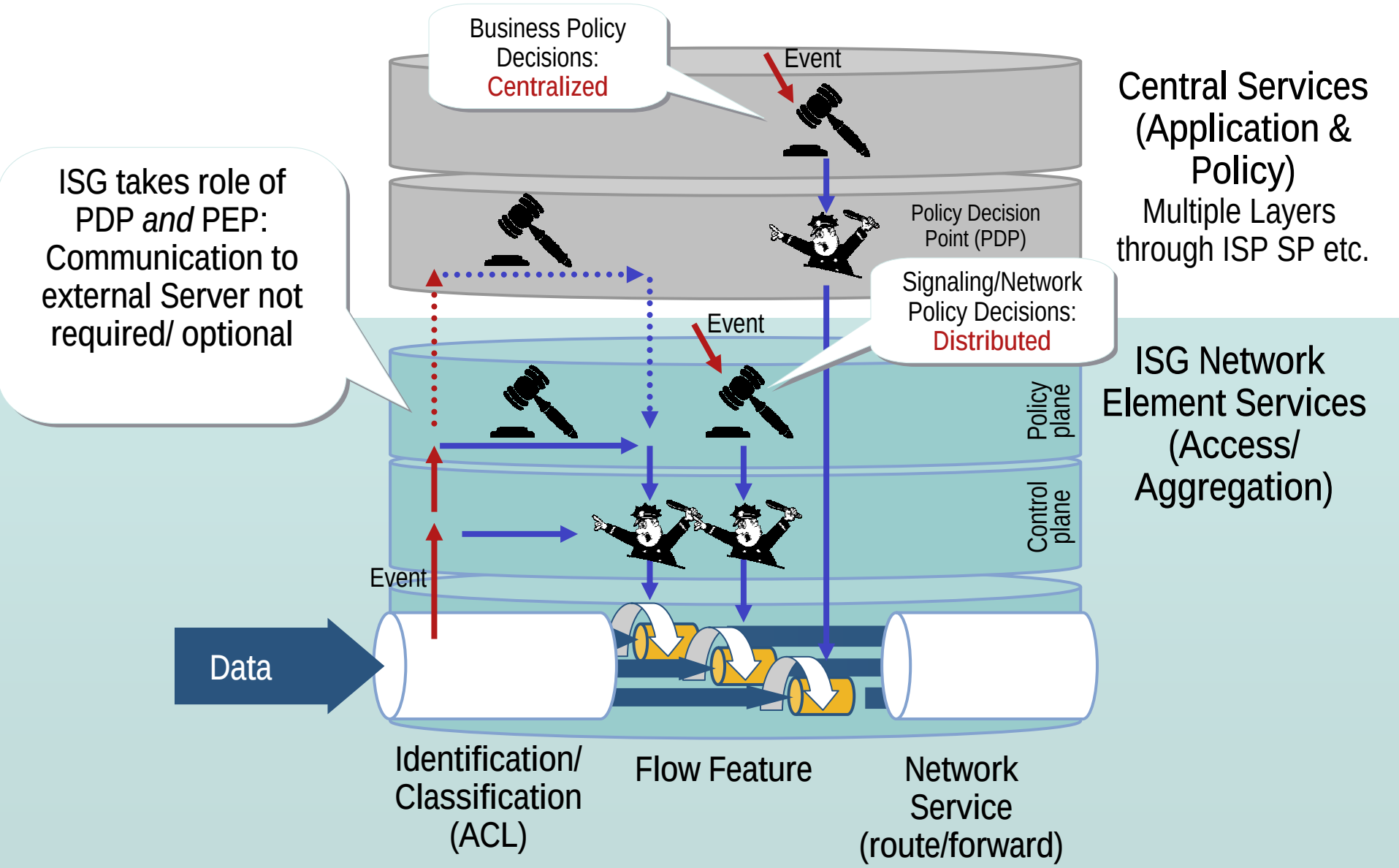
Traffic Classification
(using traffic classes: class-map type traffic)

Flow-Features:
Apply to the classified flow
(a portion of the entire session data)

Session-Features:
Apply to the entire session
e.g. PBHK

Network Service:
Forwarding (at L2, e.g. L2TP) or
Routing (L3, e.g. connection to a VRF)
Mutually exclusive

ISG Internal and External Policy Control



ISG Local Policy Control

Control Policy

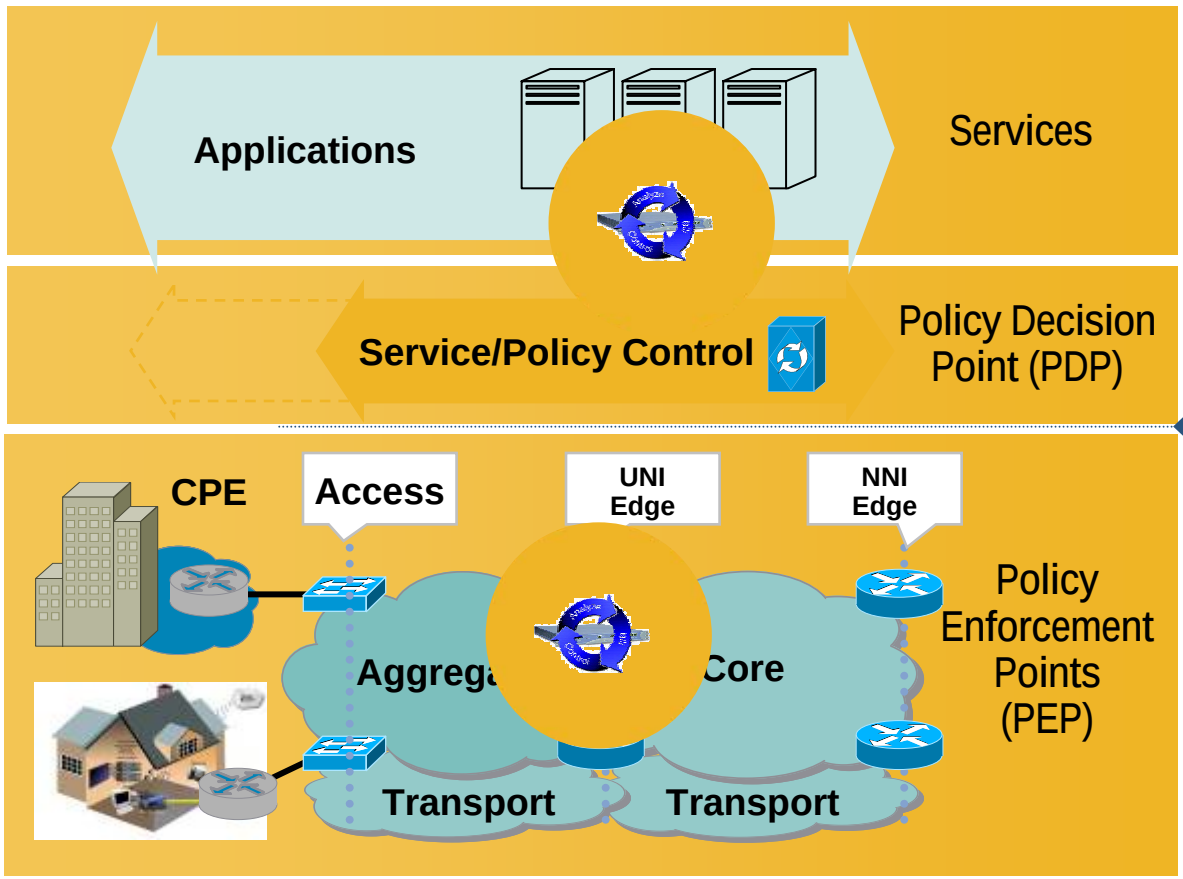
Associate Events and Conditions to an ordered list of Actions

Condition	Event	Condition	Event	Condition	Event
					
Control Class: *List of Actions* 1. Disable Service B 2. Enable Service A		Control Class: *List of Actions* 1. Enable Service X 2. Enable Service Y 3. Take Action R		Control Class: *List of Actions* 1. Enable Service PBHK 2. Take action AAA 3. Enable Service L4R 4. Take action: Set Timer	


```
policy-map type control SUBSCRIBER_RULE
 class type control always event session-start
  10 service-policy type service name PBHK
  20 authorize aaa password lab identifier circuit-id
  30 service-policy type service name L4R
  40 set-timer IP_UNAUTH_TIMER 5
 !
 class type control always event account-logon
  10 authenticate aaa list IP_AUTH_LIST
  20 service-policy type service unapply name L4R
 !
 class type control CND_U event timed-policy-expiry
  10 service disconnect
!
```

ISG Remote Policy Control

ISG Dynamic Interface for Session and Service Control
RADIUS CoA, SGI (SOAP/BEEP)…



Dynamic Session Interface
- Session logon/logoff
- View Service List
- Service logon/logoff
- View Session status
- View System messages
- Feature Change

ISG features controllable by RADIUS

Service polices including traffic policies, L4 redirect, Subscriber ACL, Idle Timer, Session Timer, QoS, Session/Service Accounting, Pre-paid

ISG – Key Functionality

Service Selection / Self-Care	Reduced CAPEX and OPEX for mass customization of broadband services
Flexible Accounting	Per session and per service accounting, QoS Accounting, Pre-paid (volume), Pre-paid (Time-Based), Tariff-Switching (Pre-Paid and Post-paid)
Authentication / Authorization	L4 redirect for Web-Based Authentication, Transparent Auto Logon, PPP Authentication
Dynamic Policy Push	Policies for session bandwidth, security and accounting that can be pushed dynamically in real time while session is still active – using standardized protocols (e.g. RADIUS, RFC3576 CoA)
Flexible Session Type	PPP and IP-Sessions - using different session initiators; access protocol agnostic
Policy based rules – "Control Policy"	Event triggered conditional actions: Association of actions based on events
"Domain Switching" MPLS integration – VRF-Switching	Map user to VRF Dynamic VPN Selection
Multidimensional Identity	Policy determination based on all aspects of subscriber identity
Timeouts	Idle Timeout, Session and Service Timeouts
Conditional debugging	Debugging based on any subscriber, service or any other identifier

ISG IP Session Models

ISG IP Sessions Models

ISG IP Sessions:

- L2 or L3 (routed) connected sessions

ISG IP Session Creation:

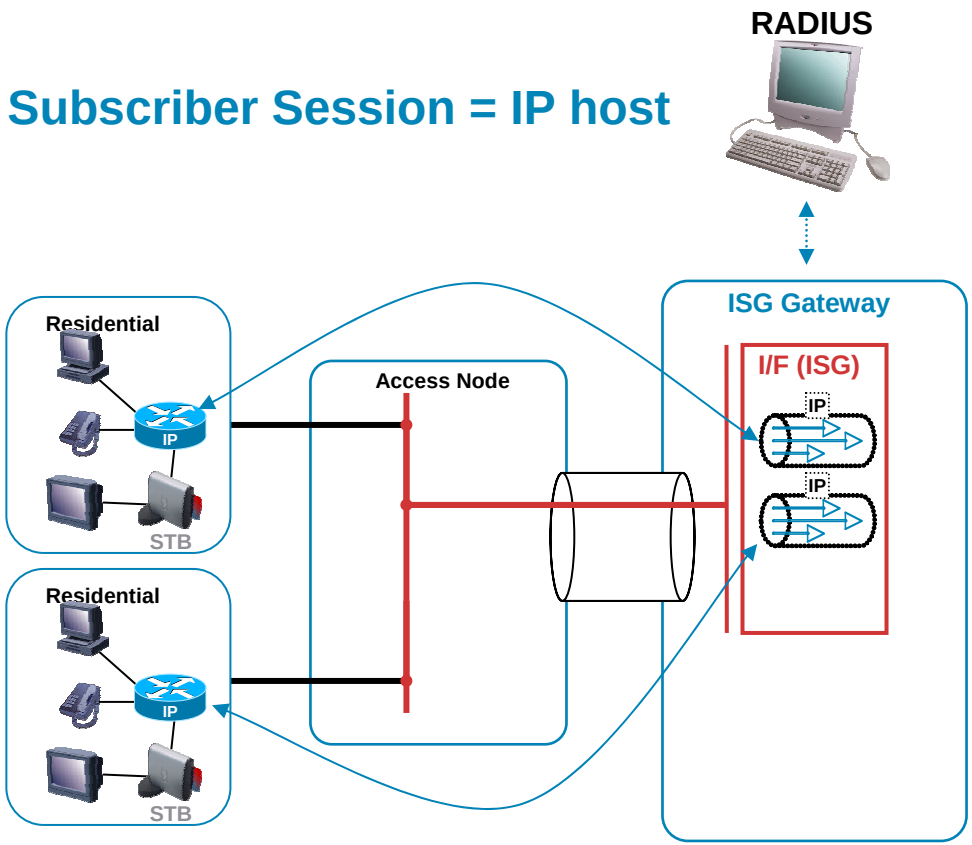
- **RADIUS Access Request:** For routed IP subscribers, a new IP session is triggered by the RADIUS Access Request while ISG acts as RADIUS proxy
- **Unclassified source IP address**: For routed IP subscribers, a new IP session is triggered by the appearance of an IP packet with an unclassified source IP address
- **DHCP DISCOVER:** For Layer 2 connected IP subscribers, a new IP session is created based on DHCP Discover, while ISG acts as a DHCP relay or server
- **Unclassified source MAC address**: For Layer 2 connected IP subscribers, a new IP session is triggered by the appearance of an IP packet with an unclassified source MAC address

ISG IP Sessions Termination:

- **DHCP IP Sessions:** DHCP RELEASE or lease expiry
- **RADIUS IP Sessions:** RADIUS Accounting-Stop (for RADIUS proxy operation)
- **Any IP sessions models**: Session Timeout, Account Logoff, ARP/ICMP/(BFD) keepalives timeout

ISG IP Session

Subscriber Session = IP host



Note: In case of a bridged CPE each IP host creates it's own IP Session on the ISG gateway

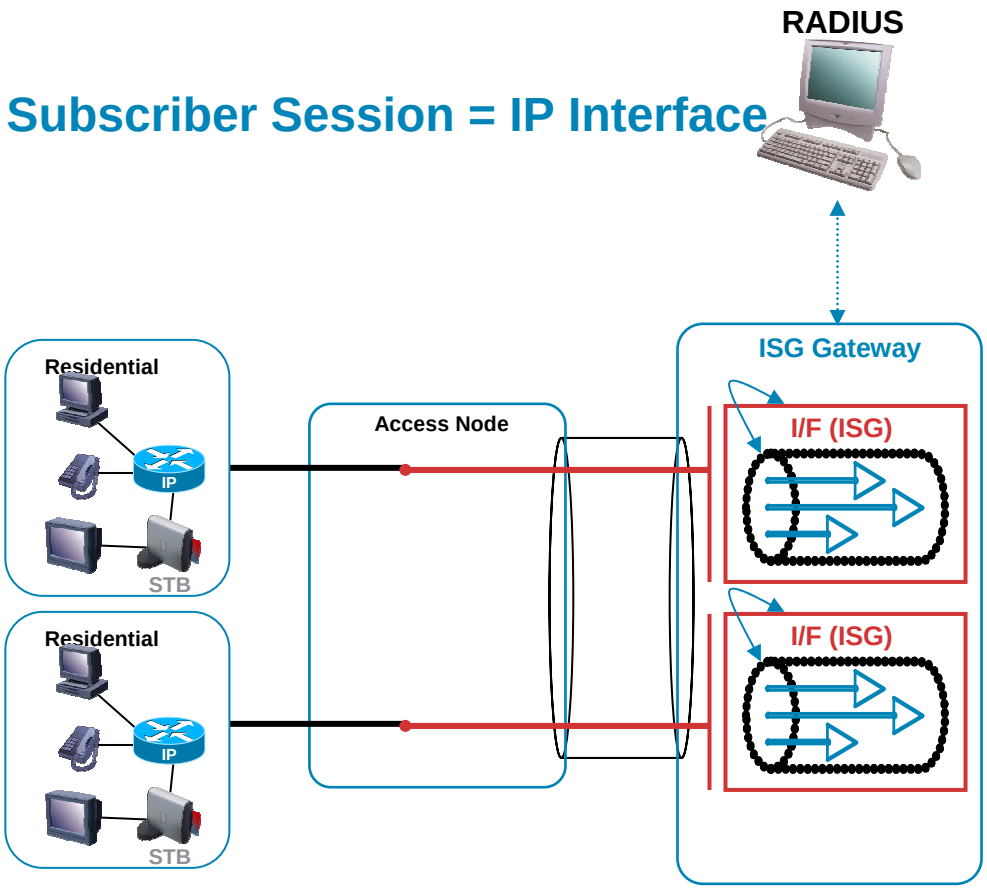
*Fist Sign of Life

IP session

- Defined by a flow of traffic going to and from a subscriber IP address
- Configurable on logical (dot1q or QinQ) interfaces
- Session creation by FSOL* IP Packet, RADIUS proxy or DHCP relay
- Session end defined by DHCP lease, RADIUS Accounting Stop or timeout
- 1:n relationship between Interface and IP Session
- When using ISG/RADIUS for provisioning, features are applied to the session itself, not the interface
- Classification based on MAC, IP
- L2 connected or routed from first Aggregation device

ISG IP Interface Session

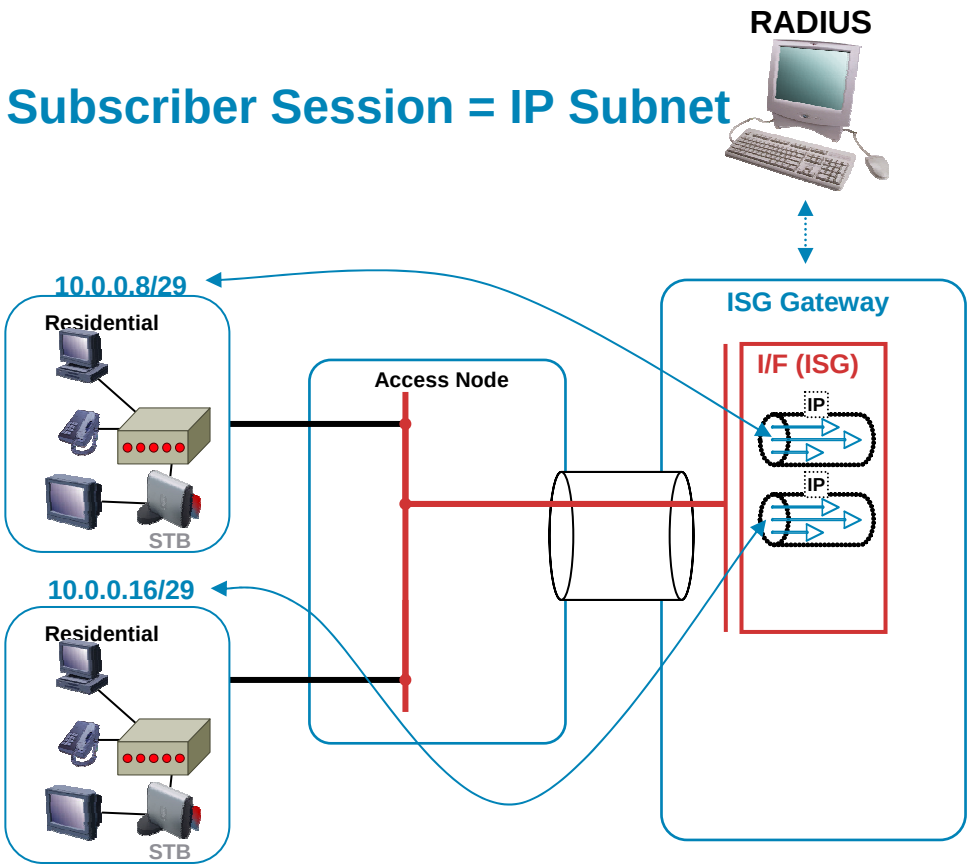
Subscriber Session = IP Interface



IP interface session

- Defined by all traffic to and from a subscriber subinterface
- Configurable on logical Interfaces (dot1q or QinQ)
- 1:1 Mapping between Session and Interface
- Session initiation is at provisioning time (same for acct. start)
- Session end is at de-provisioning time (same for acct. stop)
- Dynamic RADIUS based features provisioning and changes

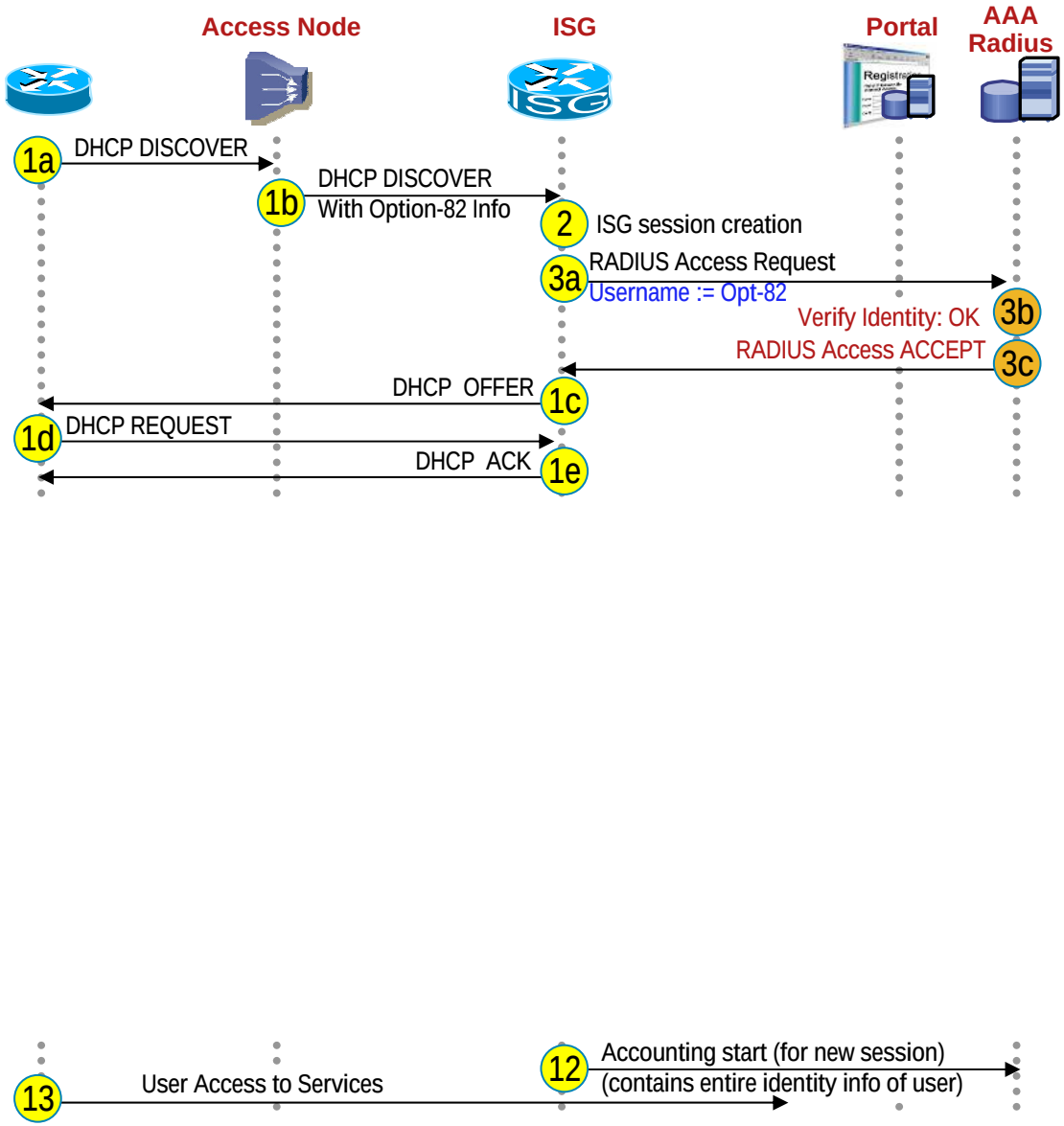
ISG IP Subnet Session



IP subnet session

- Configurable on Physical or Logical (dot1q or QinQ)
- Represents a subscriber IP subnet
- IP subnet sessions are supported as routed IP subscriber sessions only.
- IP subnet sessions are created the same way as IP sessions
- (except that when a subscriber is authorized or authenticated and the Framed-IP-Netmask attribute is present in the user or service profile, ISG converts the source-IP-based session into a subnet session with the subnet value in the Framed-IP-Netmask attribute=

DHCP Initiated IP session
IP Subscriber Transparent Auto Logon



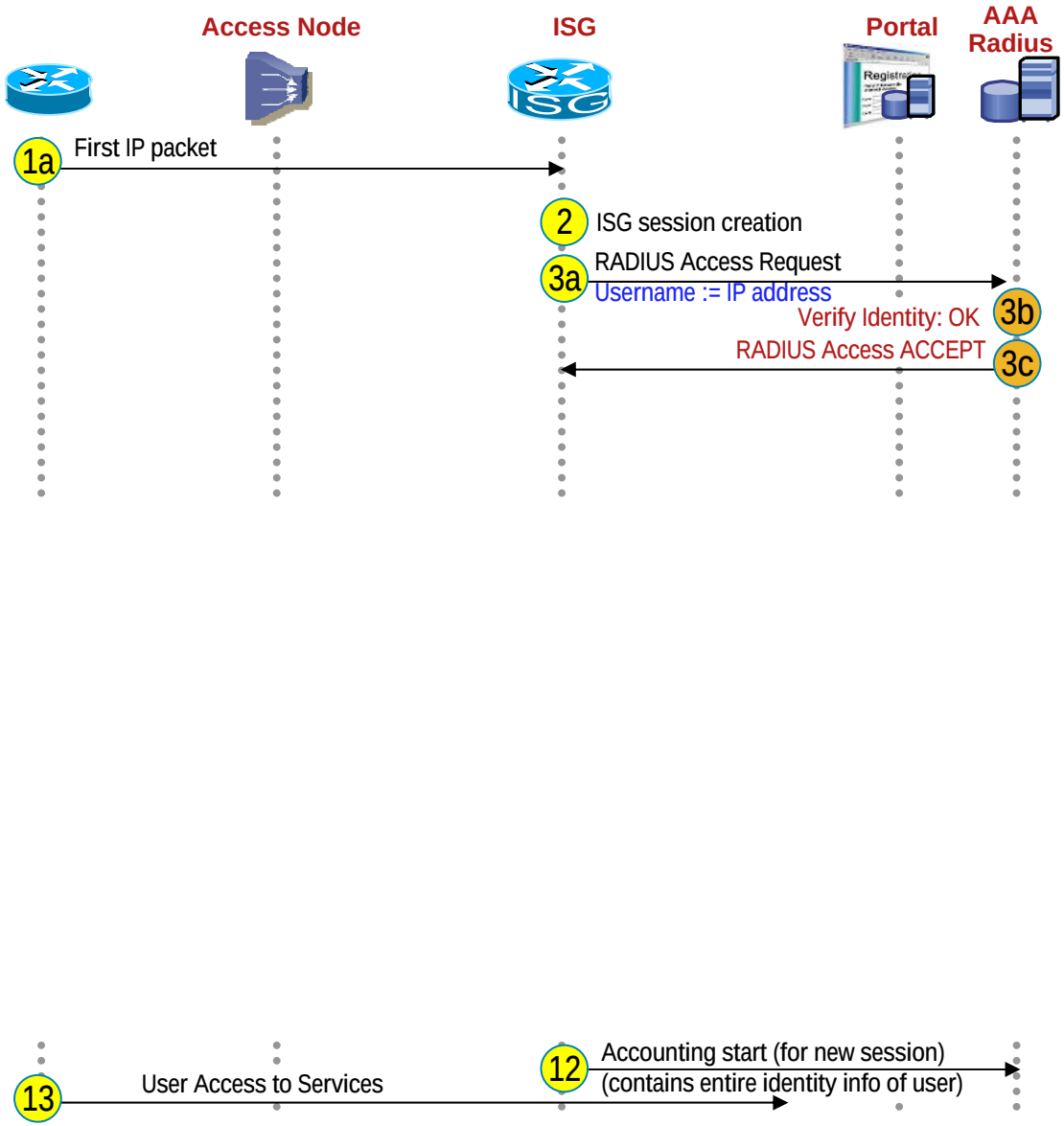
Notes:

1b. Note: We assume DHCP DISCOVER is the first sign of life. Conditions may arise such as a user leaves his previous session with a long lease still outstanding. When he returns, his PC will just send packets using the existing address. The first IP packet will be treated as the session-start event, the system will correlate the MAC address (if available) against cached DHCP information and then continue as shown.

3b. The AAA server knows which port the user is connected to and will use the Opt-82 information to successfully authorize the User.
This results in TAL-like (transparent auto logon) behavior.

PPPoE sessions have a similar model

Routed IP session
IP Subscriber Transparent Auto Logon

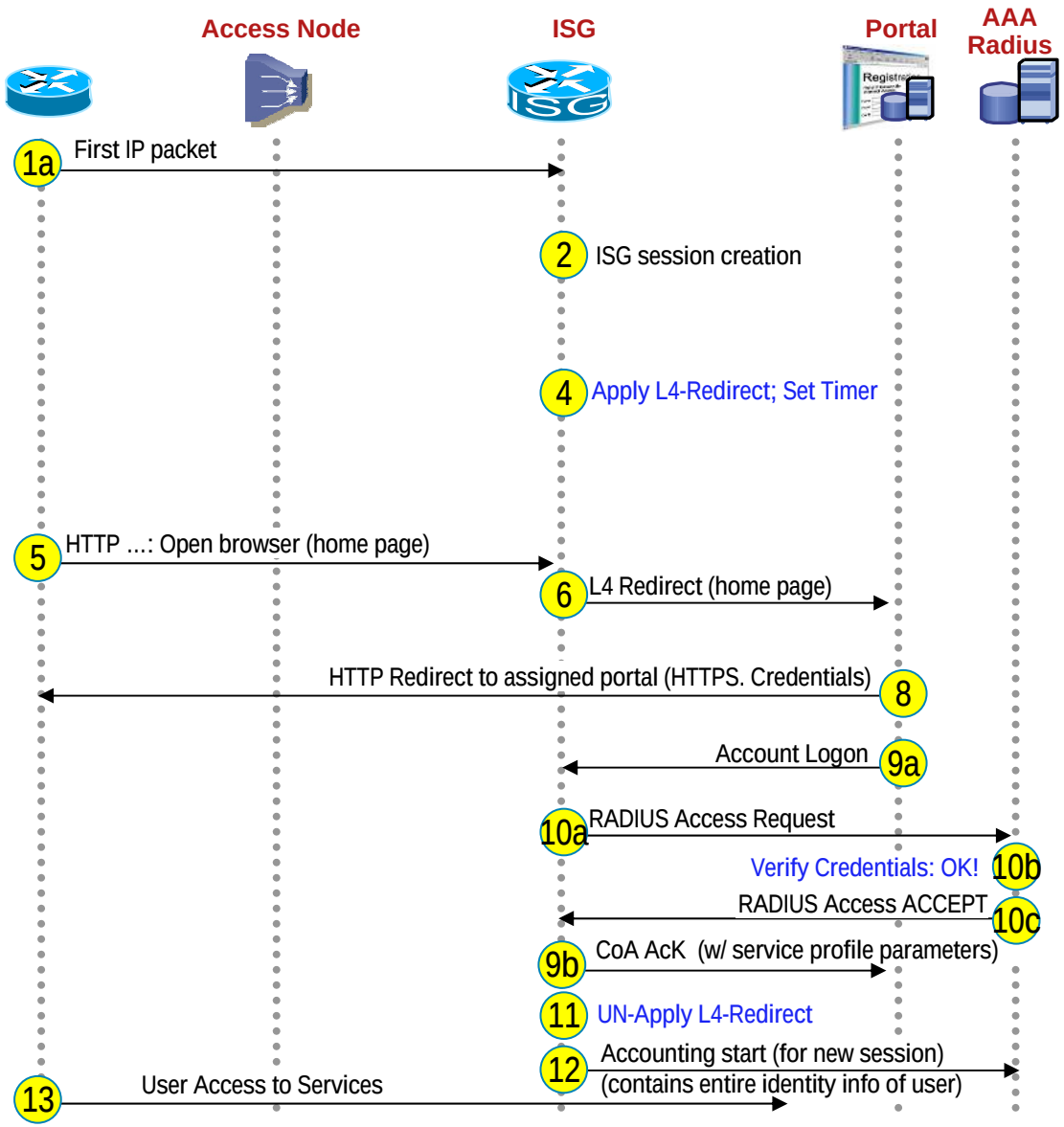


Notes:

1a. Note: We assume the first IP packet is the first sign of like and the ISG gateway is configured for Transparent Auto Logon. The ISG session is created and RADIUS authorization is initiated

3b. The subscriber profile in the RADIUS server is defined based on the static IP address allocated to that subscriber. This results in TAL-like (transparent auto logon) behavior.

Routed IP session
IP Subscriber Web Portal Authentication



Notes:

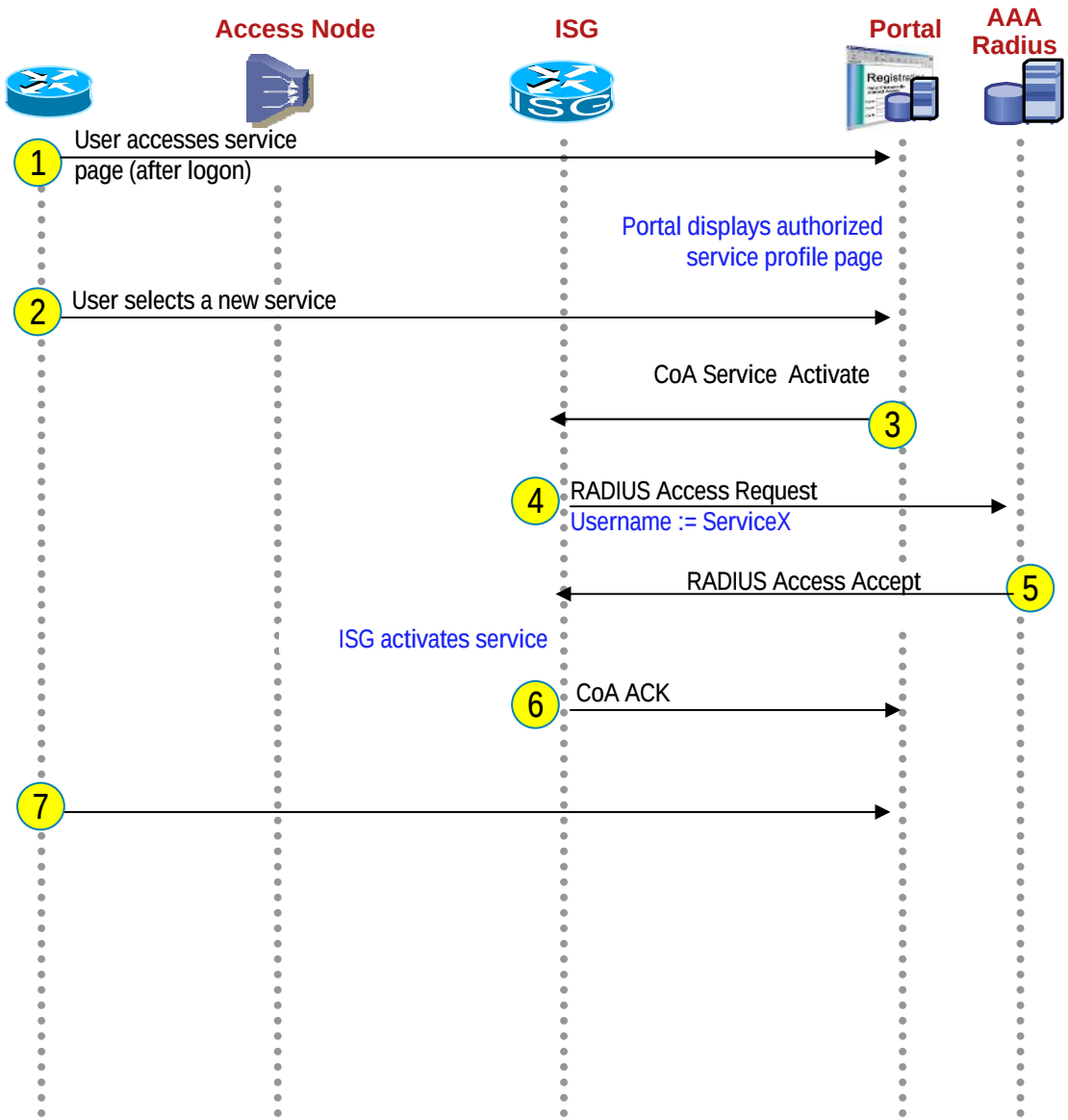
1a. We assume the first IP packet is the first sign of life

2. The IP Session is created with a basic set of policies that are granting access to the authentication portal and L4-redirect to that portal

4. Redirect User to Portal to have him input his credentials and service preference. Set a timer which will remove the session if the authentication is not successful (avoid accumulating state).

12. Accounting record informs AAA server about user's identity (IP address and user name). Note: Accounting messages need to be understood as state/event notifications, not just charging information.

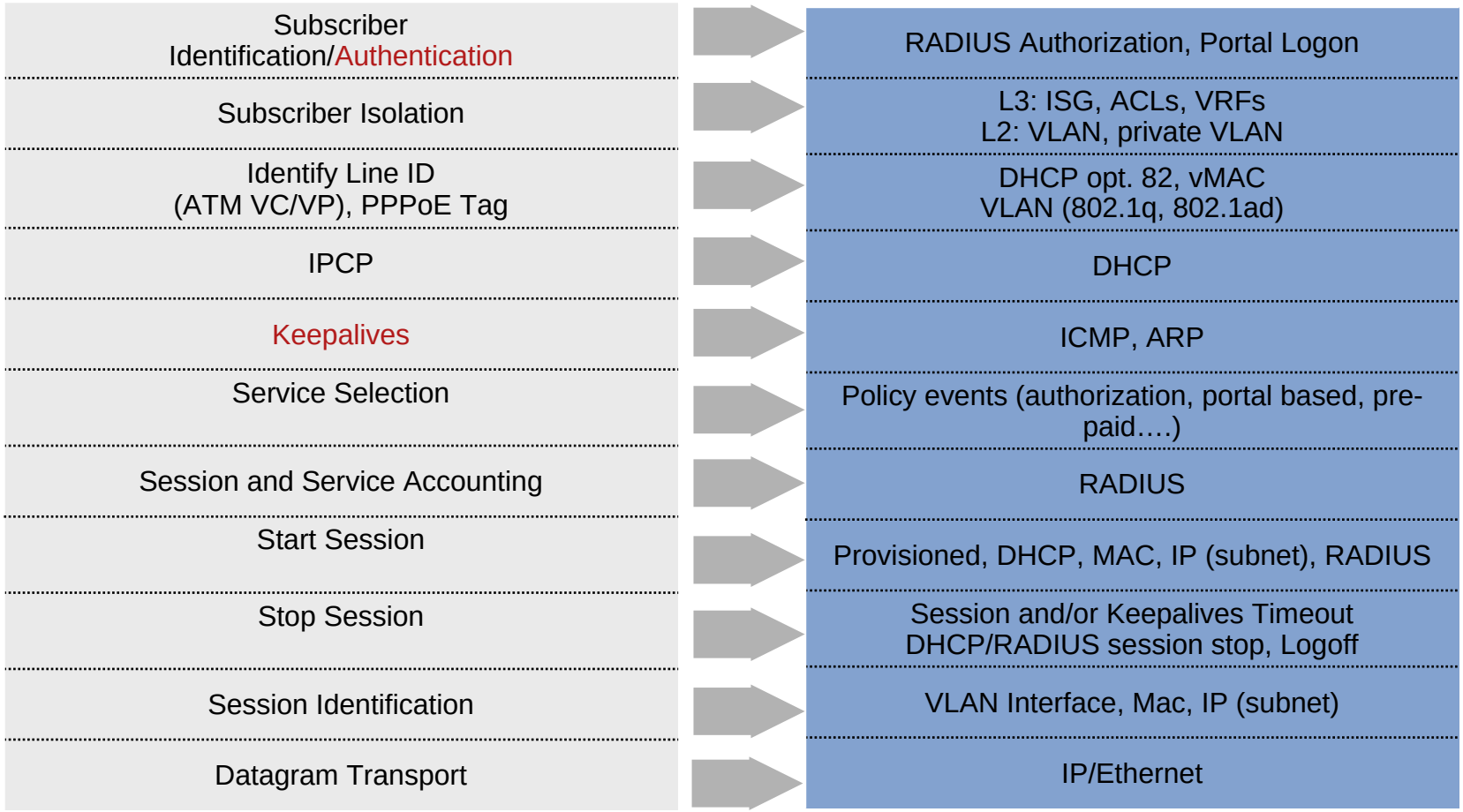
IP Subscriber Dynamic Service Selection



Notes:

0. Subscriber is logged on and portal displays authorized service profile info
1a. User requests addition of a new service (video) to their profile.
1b. Back-end process request/payment/subscription info and updates subscriber profile. Portal displays result
2. User activates new service.
3. Portal sends new service activate CoA to ISG
4. ISG requests service profile from Radius
7. User has access to prioritized service

PPP to IP Sessions Evolution
Experience very similar to former PPP

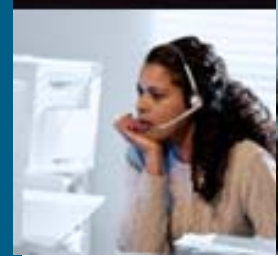


Some open considerations…

Advanced Authentication (CHAP, PAP, EAP based)

Consistent and coordinated session lifecycle on the client and server

Additional Considerations For Transparent PPPoE to IPoE Migration

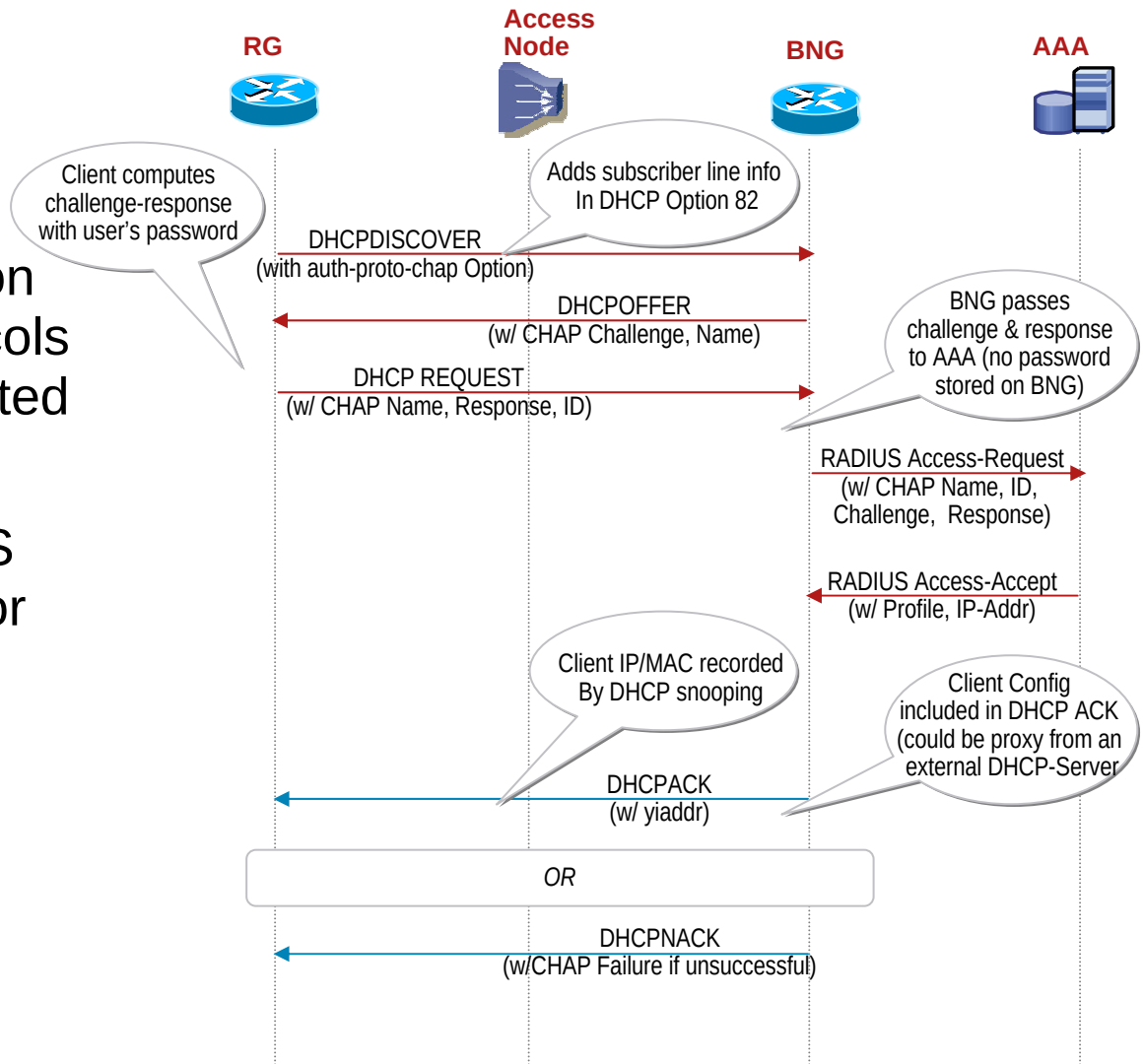


IP sessions Authentication for Transparent Evolution from PPPoE to IPoE

- **Target:**
  - **Use the PPPoE authentication models to avoid operational impact**
- **Requirements:**
  - **The authentication must be secure**
    - Client credentials are sent based on a secure encryption scheme
  - **The authentication must be before IP address allocation**
    - Ensures entitlement to the service
    - Ensures safe and predictable IP address usage
    - Ensures predictable legal intercept for the client traffic
    - Ensures that any attacks are launched by known individuals
  - **The authentication process must accommodate clients that can't perform authentication**
  - **The authentication process must rely on standards protocols and not disrupt or change existing protocols**
- **Standardization Direction:**
  - **Started efforts in IETF for defining the DHCP authentication models**

DHCP-AUTH as “drop-in” for PPPoE
draft-pruss-dhcp-auth-dsl-02.txt (Alternative 1)

- Use existing DHCP message set
- Reverse Authentication and other Auth Protocols (e.g. EAP) not supported
- All Attributes are mapped from RADIUS including IP address or Pool



Enhanced DHCP-Auth – For EAP, CHAP server auth etc.
draft-pruss-dhcp-auth-dsl-02.txt (Alternative 2)

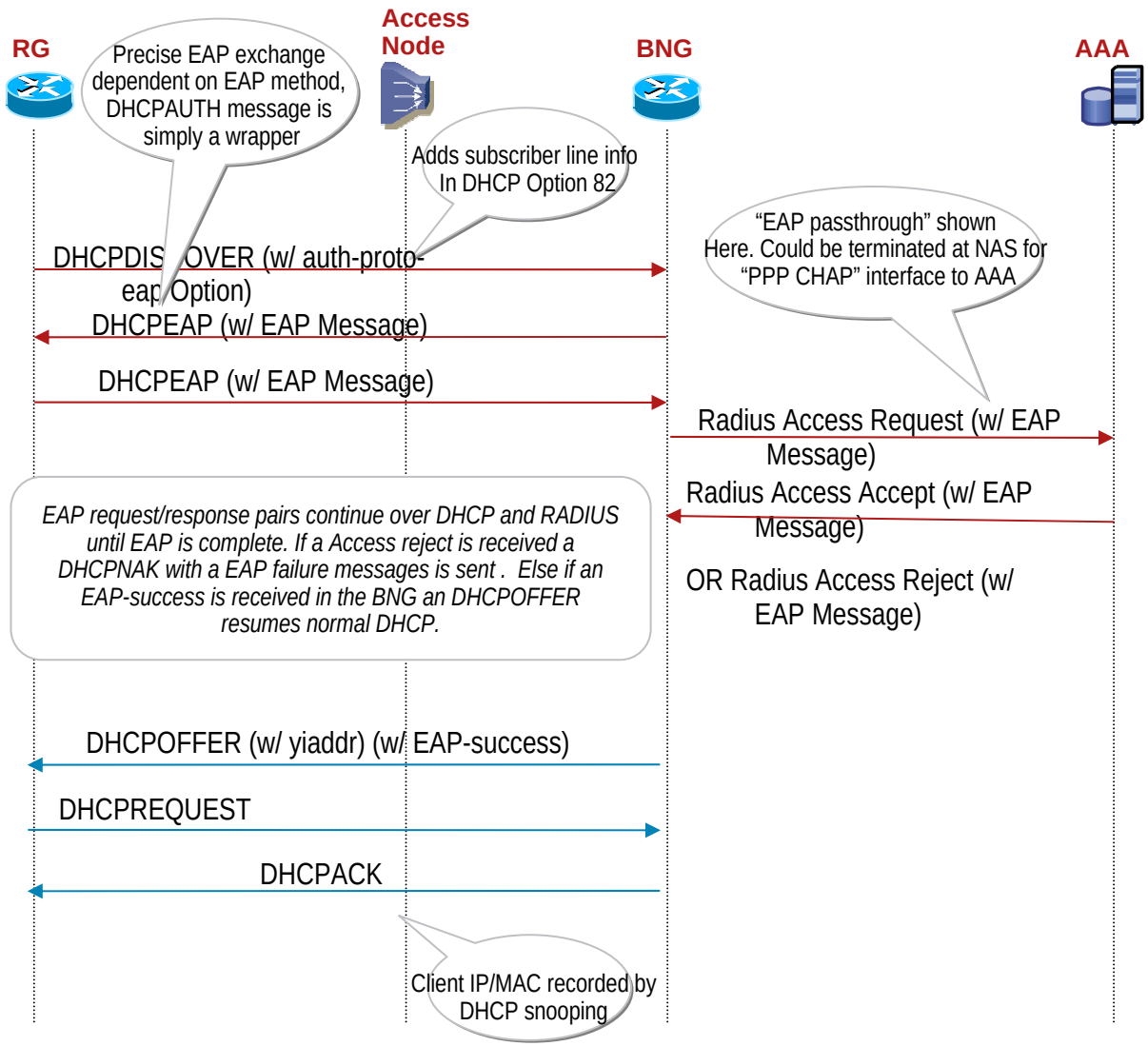
Expands capabilities of "Alternative 1" :

– supports CHAP server authentication

- supports EAP and with that more advanced methods for authentication

Requires:

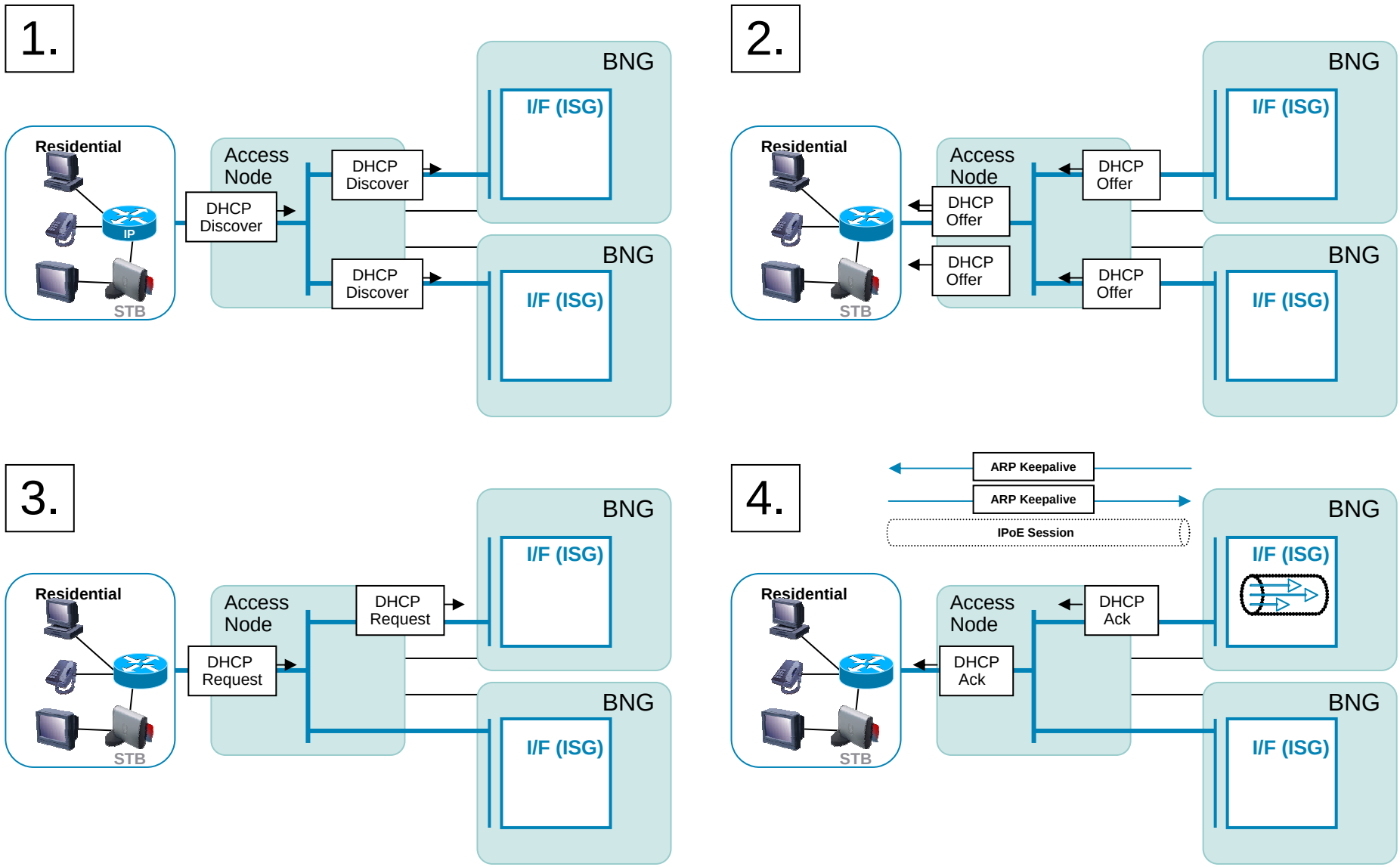
- A new message
- DHCP message size >= 1604 for use with EAP message option (RFC 2132 – max DHCP message size option)



IP sessions Keepalives for Transparent Evolution from PPPoE to IPoE

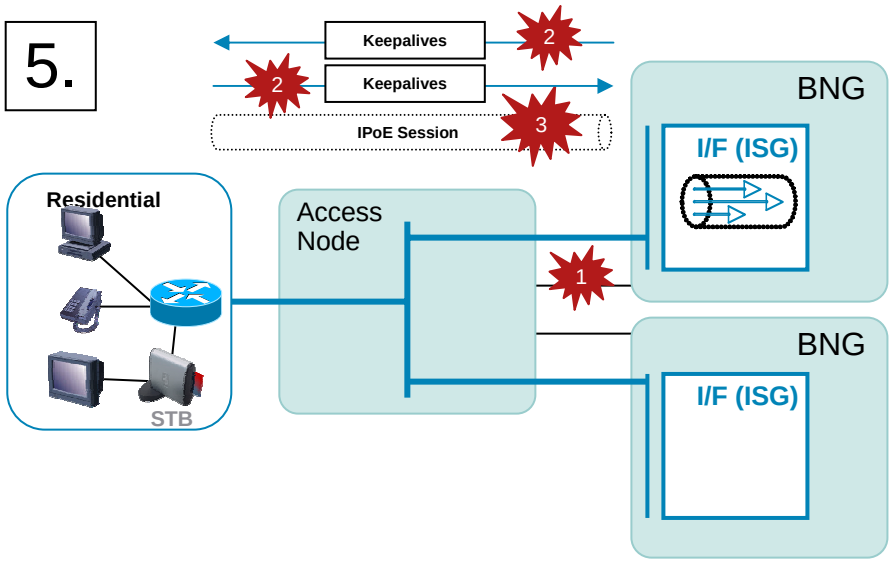
- **IP sessions considerations**
  - IP flows are connection-less
  - Neither Ethernet nor IP have a well-defined, built-in session life cycle
- **IP Sessions need to be defined in respect of a session lifecycle**
  - IPoE session start/stop can be inferred from
    - data-plane: e.g. 1st reception packet/frame from an unclassified source (IP/MAC address) and idle timeout
  - or
    - control-plane: e.g. by performing/witnessing a successful DHCP lease and lease expiration/release (similarly with RADIUS)
- **In addition, there has to be a keepalives mechanism that allows detection of a session failure, resp. failed connectivity**
- **An IP Session keepalives mechanism needs to be implemented on client and server in order to obtain PPP like behavior**
  - By the server: to enable accurate session lifecycle and accounting
  - By the IP client: to enable a similar inter server redundancy model
- **DSLF WT-146 has specified several keepalives mechanisms for IP sessions, in the server and client: ARP, BFD based**

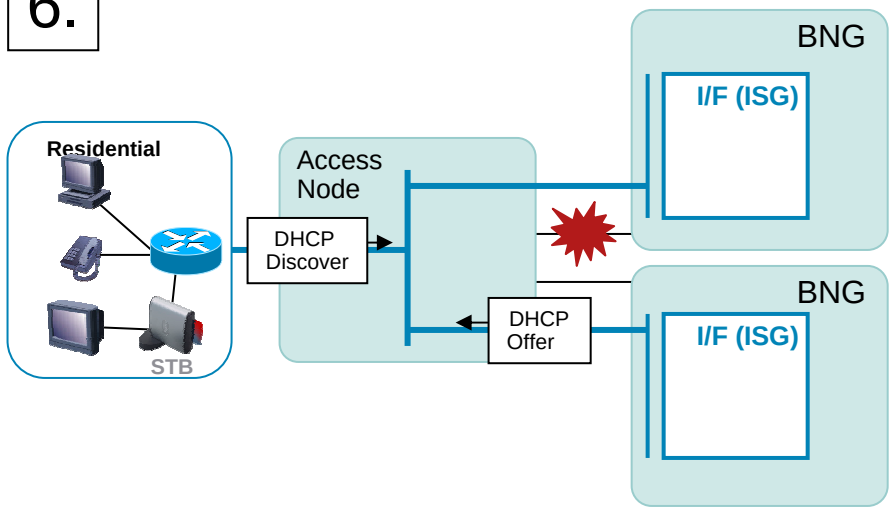
Access Node Dual-homing IPoE Session Re-Initiation

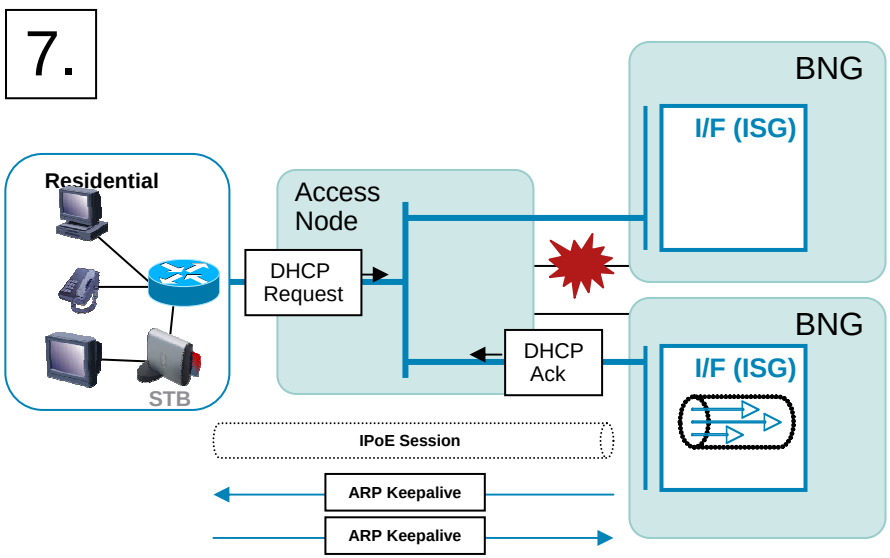


For IP routed sessions, FSOL is an RADIUS AR or new IP flow

Access Node Dual-homing
IPoE Session Re-Initiation (continued)







- IPoE Session with a connection-oriented concept with built-in lifecycle management
- Session failure can be detected by means of session keep-alives (ICMP, ARP, BFD)
- Both, client and server (BNG) will be aware of session failure and terminate the session context
- Client will/may re-initate a new session upon session failure and thereby create a new session with a standby BNG

For IP routed sessions, keepalives are based on BFD or ICMP

Conclusion

PPP to IP Journey....
A Natural But Simple Evolution

- Carrier Ethernet deployments with IPTV services and Ethernet based access options are driving the migration from PPP to IP
- This migration has to be transparent for the service provider from functional and operational aspects
- There are various service delivery models that drive different IP session deployment models

- Cisco Intelligent Services Gateway enables the same services and operational behaviour for PPPoE and the various IP sessions models
- Standardization efforts are in place to fine tune the remaining functional aspects for full operational consistency

- In conclusion the migration from PPP to IP can be considered a natural and simple evolution …