Service Provider Wi-Fi: Architectures, Use cases and Deployments

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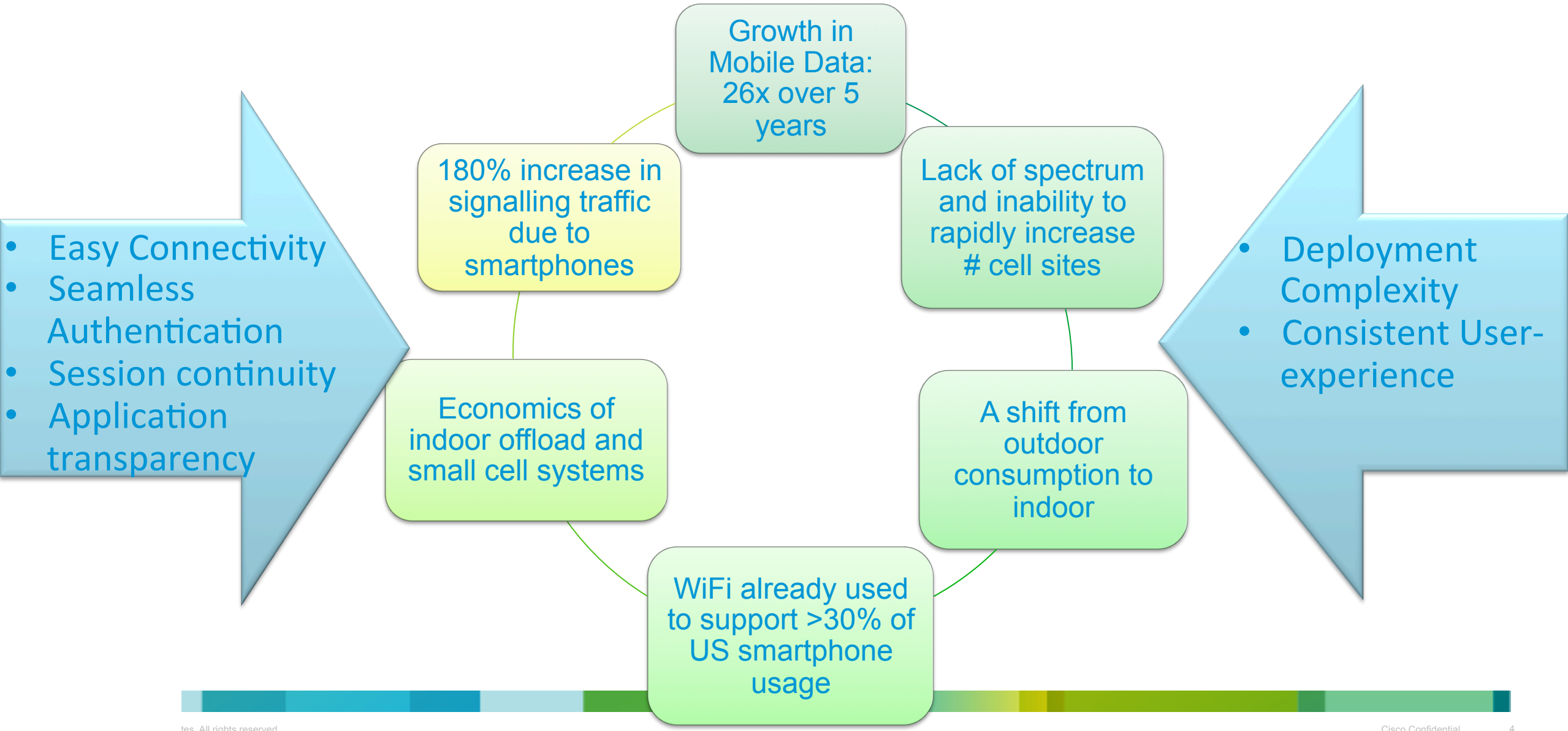
Session Agenda

Outline and Key Takeaways

- SP Wi-Fi: Drivers/Motivators ??
- Carrier-grade Wi-Fi Requirements
- Integration with existing Mobile Networks
- Solution e2e System/Functional Components
- Use cases and Call flows
- Case Studies
- Summary

Why SP Wi-Fi ???

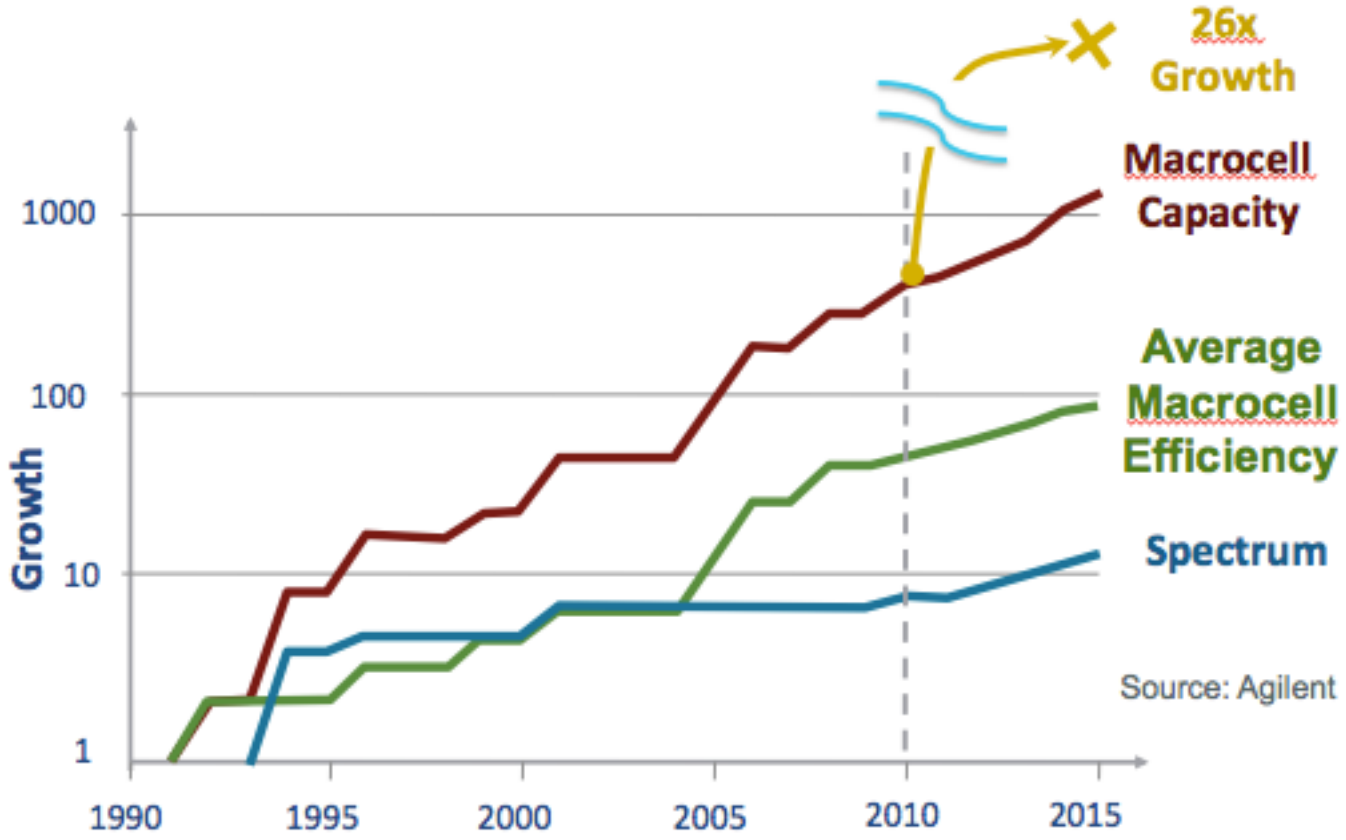
SP WiFi: Solving Providers' challenges



Drivers For Change: Scaling Supply

Delivering 26x increase in Supply

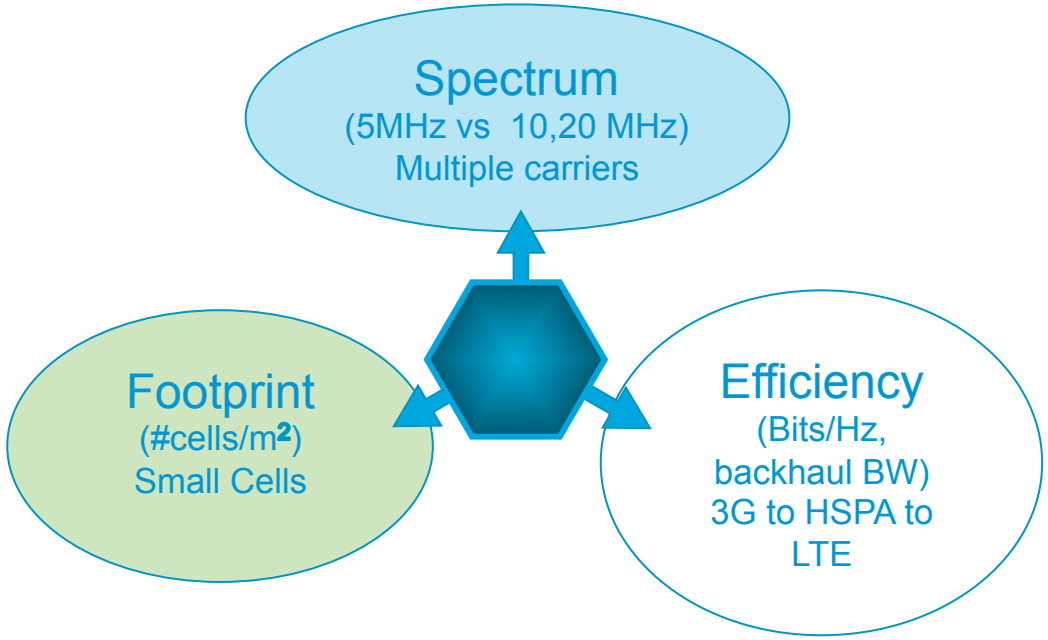
- Service usage growing unchecked
- Macrocell capacity growth cannot keep up with demand
- Licensed spectrum availability not growing to meet demand
- Smaller Cells are needed to scale supply efficiently & economically
- Licensed and Unlicensed Spectrum will need to be exploited

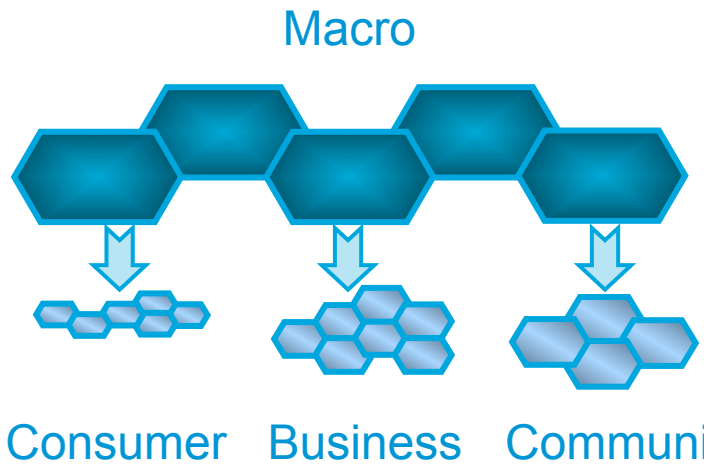


Why Small Cells?

Drivers for change

- Meet Subscriber Demand
  - Increased coverage and service ubiquity
  - Higher Speed enabling richer applications
- High Volume Low Cost Technology
  - SP WiFi is to Mobile (3G/4G) as Carrier Ethernet is to Wired (SDH/PDH)
- Licensed Spectrum Availability
  - Not growing to meet demand
- Hierarchical Network Approach
  - Macro cells & small cells





Service Provider Wi-Fi Deployment: Motivators ???

Retention & Loyalty

- Why operators use free public Wi-Fi to increase loyalty?
- How much free public Wi-Fi was able to improve churn?
- What are the key issues operators consider to be successful?
- How major service providers execute this part of the strategy?

Indirect ARPU Increase

- What are most common ways to increase ARPU using public Wi-Fi?
- How operators use Wi-Fi to move customers up the value chain?
- How open consumers are to accept advertising and personalized marketing

New Revenues

- Are customers willing to pay fixed fees to get access to the public Wi-Fi network everywhere?
- How operators offer their Wi-Fi service to non-customers as well as to customers not eligible for free access?
- Are there new services to be provided, which can generate new revenues?

Mobile Data Offload

- What opportunity cable operators see offering offload service to mobile carriers?
- Which locations are considered most likely to need mobile offload?
- How to increase probability of mobile operators buying the service from the cable operator (vs. making their own Wi-Fi network)?

SP Wi-Fi Requirements ???

SP WiFi Vision: End user perspective

Cellular Mobility Experience on WiFi

Cellular

Example: GSM Phone

Turn on phone and get secure cellular connectivity

WiFi

Example: iPhone

Turn on phone and get secure WiFi connectivity

- Roaming anywhere – no logins or passwords
- Automatic Network Selection
- Access anywhere with my profile & services

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Connected Mobile Experiences
Three Stages to Engagement

Mobile device detection, registration

Seamless, secure Wi-Fi onboarding

Location-based content and services

Connected Mobile Experiences

RETAIL

Connected Consumers

- Context rich promotions
- Better informed purchase decisions
- Better in-store experiences

HOSPITALITY

Connected Guests

- Indoor maps with featured attractions
- Personalized 3rd party advertising
- Special promotions

TRANSPORTATION

Connected Travelers

- Better planning for high traffic areas
- Transportation updates and indoor directions
- Dwell times-based promotions

SP WiFi Vision: Holistic Perspective

WiFi Service Requirements

Ubiquitous Access

- Automatic service advertisement
- Automatic network selection
- Roaming
- Inter-access mobility

Common Authentication

- SIM credentials
- Non-SIM credentials
- Single AAA infrastructure

Seamless Services

- Monetization opportunities
- Consistent services
- Session persistence
- Wholesale/Roaming

Unified Control

- Traffic path selection
- Billing
- QoS
- Quota management
- “One Subscriber”

Carrier Class Solution for MNOs, MSOs and Hotspot Providers

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SP WiFi

One Access Technology, Many Deployment Models

Uncontrolled	No SP involvement. User driven offload via unmanaged device.
Home/Soho Dual SSID (Community)	SP provides dual SSID home device. Private and public (community) SSID
Hot Spot / Hot Zone	SP installed and managed hot spots in Malls, restaurants, Hotels,…
High Density Wireless	SP installed and managed hot spots in high density user areas (stadiums,..)
Metro / Mesh	SP install and manages outdoor WiFi for large dense urban areas coverage
Enterprise Guest Access	Enterprise Guest Access managed by SP

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SP WiFi

Key Requirements

Carrier Grade	Manageability, Network Reliability and Availability 100s of thousands of APs ; Millions (residential); Millions of Clients
Radio Performance	Radio differentiation, Link Budgets, Beamforming, MIMO Interference Management, Radio Resource Management
Mobility	Seamless authentication and Fast Roaming/Handoff WiFi to WiFi (inter and intra-vendor), 3G/4G to WiFi
Roaming	Seamless roaming (with little or no user intervention) Support home and “visited” network scenarios
Standards Compliant	Critical to support Multi-vendor solution 3GPP compliance important to MNOs
Integration	Common Billing, Policy and Subscriber Management Leverage MPC/EPC for WiFi network Parental Control / Lawful Intercept / Local Breakout

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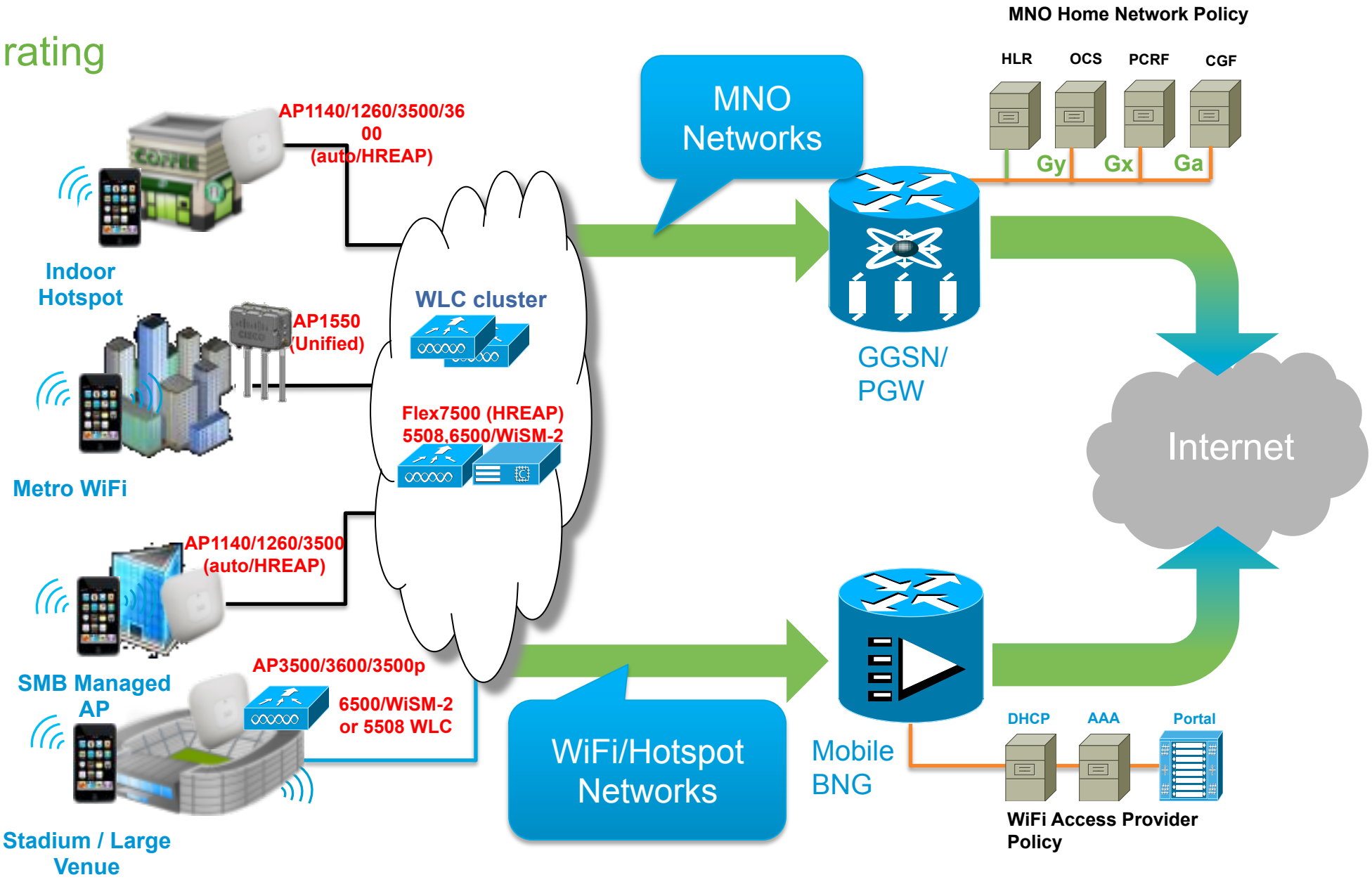
Mobile Packet Core Integration

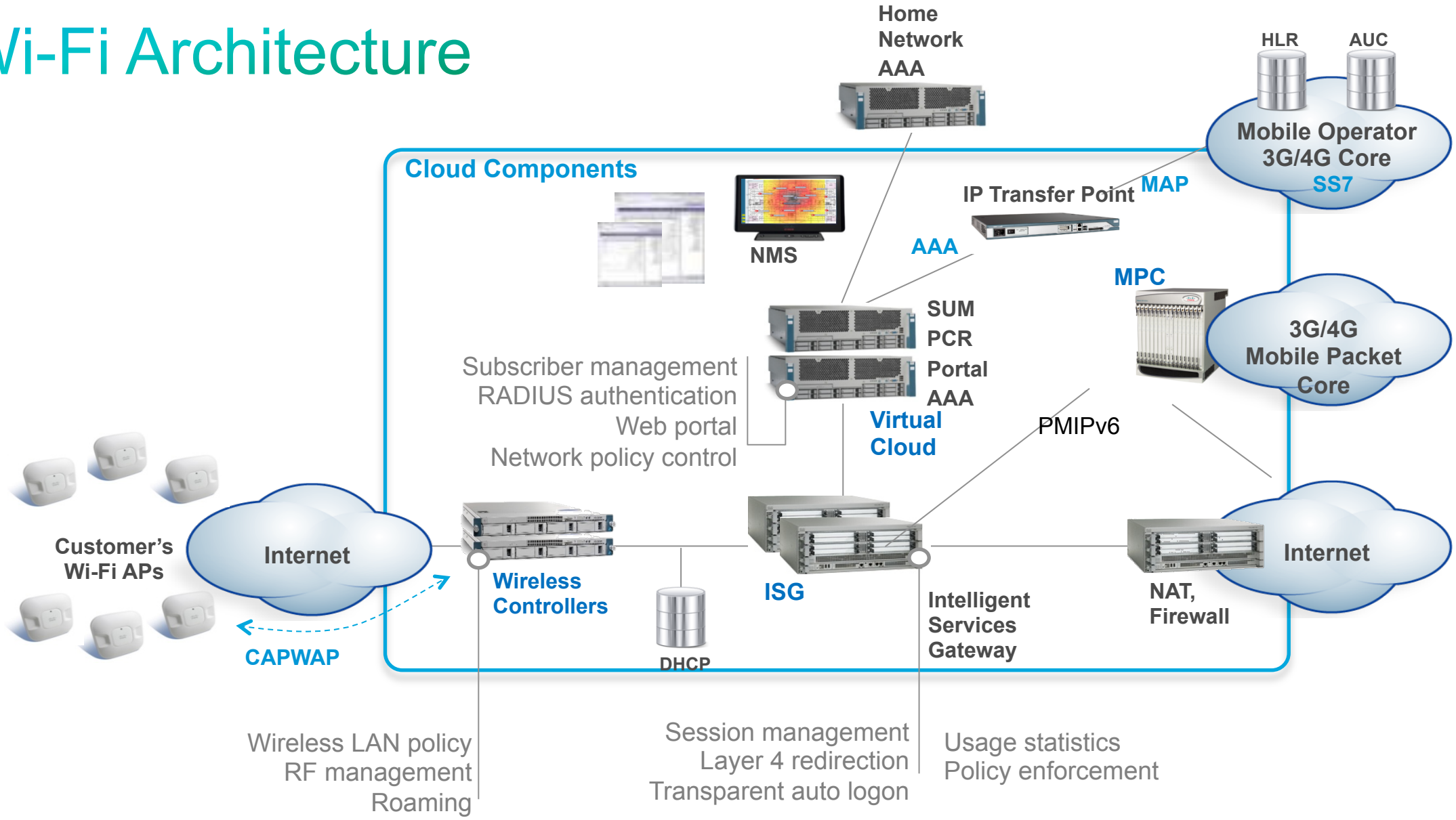
SP WiFi Architectures Today

Two Solitudes integrating

- Separate Cores
- Hotspot Core vs. MPC
- EAP-SIM Authentication
- Diameter vs. Radius Policy
- IP in the access will persist: control and data planes

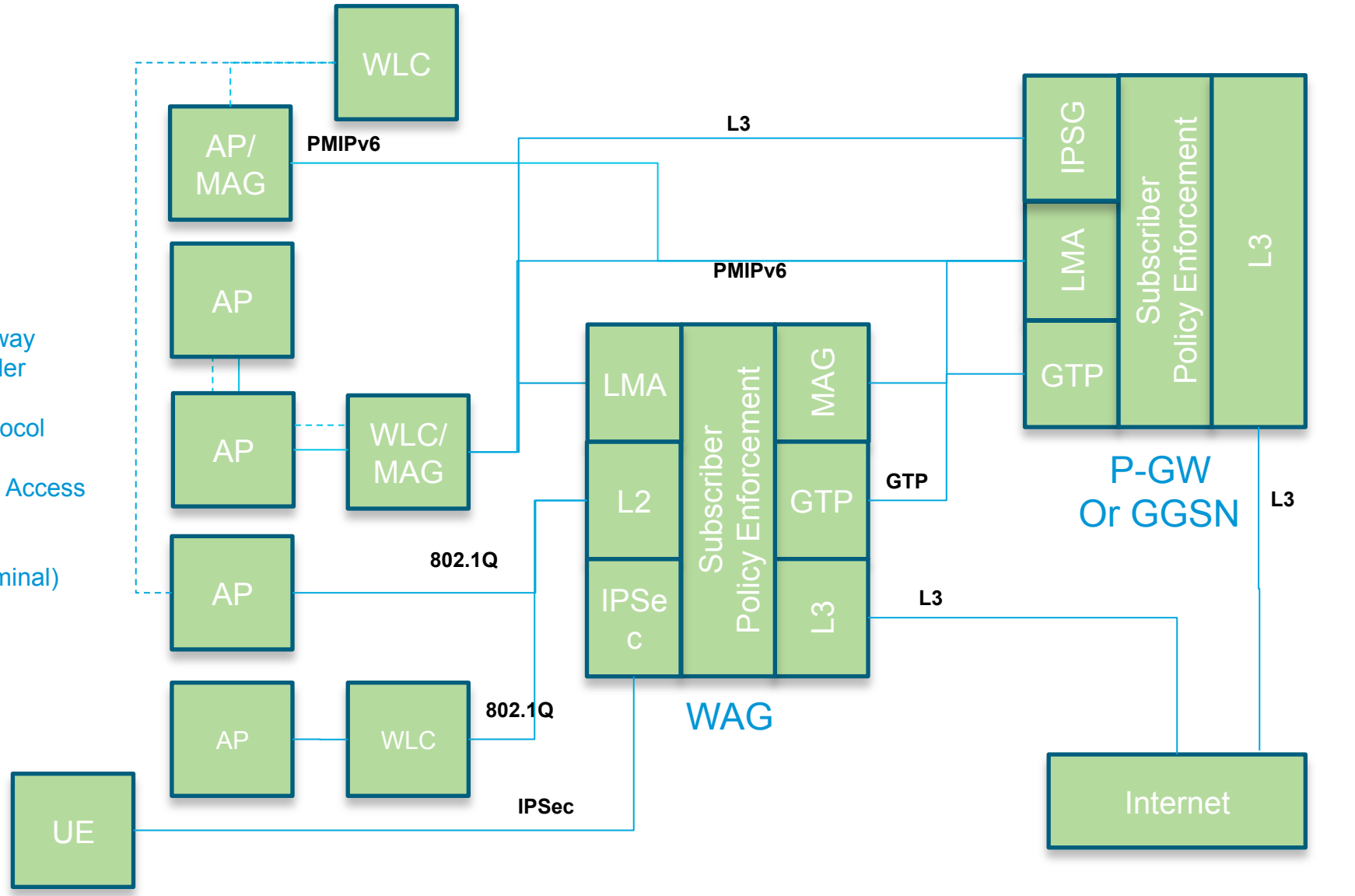


SP Wi-Fi Architecture



SP WiFi Functional Architecture

AP= Access Point
MAG=Mobility Access Gateway
WLC= Wireless LAN controller
LMA= Local Mobility Anchor
GTP= GPRS Tunneling Protocol
IPSG= IP Services Gateway
EWAG= Enhanced Wireless Access Gateway
PMIP= Proxy Mobile IP (v6)
UE= User Entity (mobile terminal)



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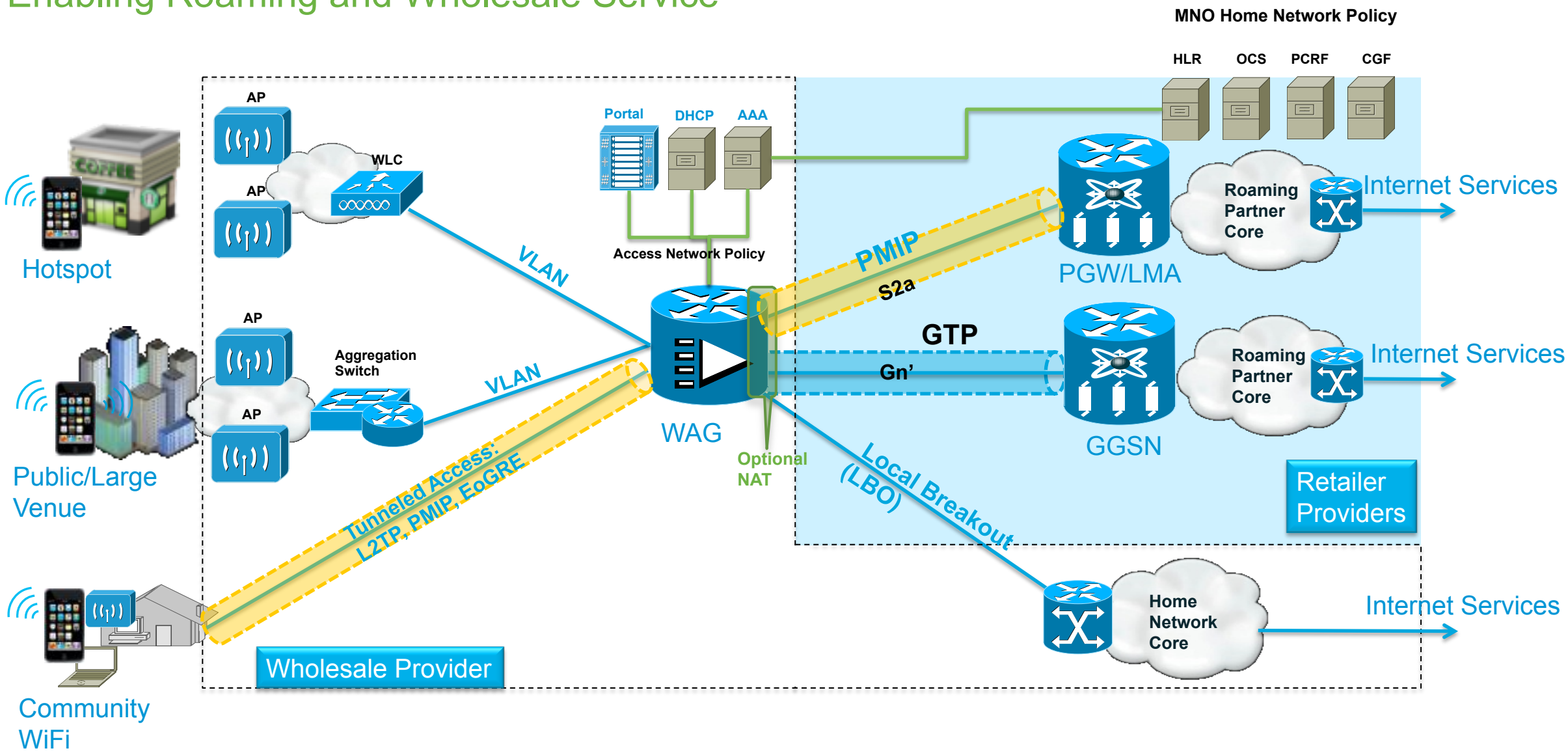
SP WiFi Roaming Architecture

Enabling Roaming and Wholesale Service



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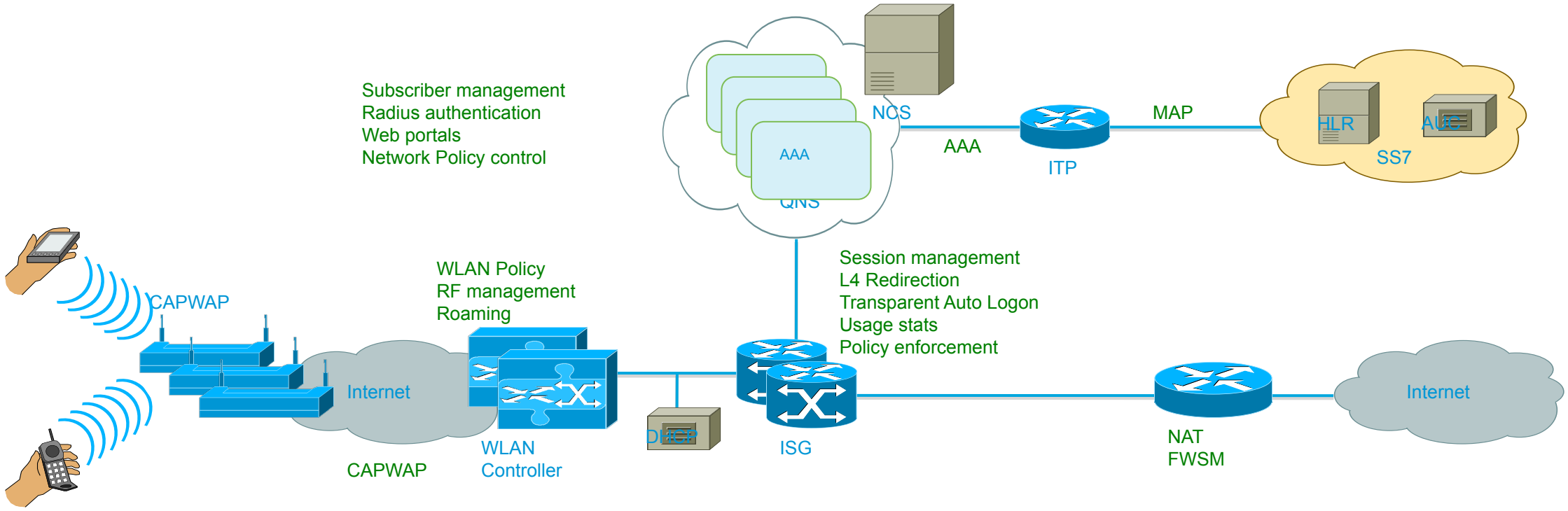
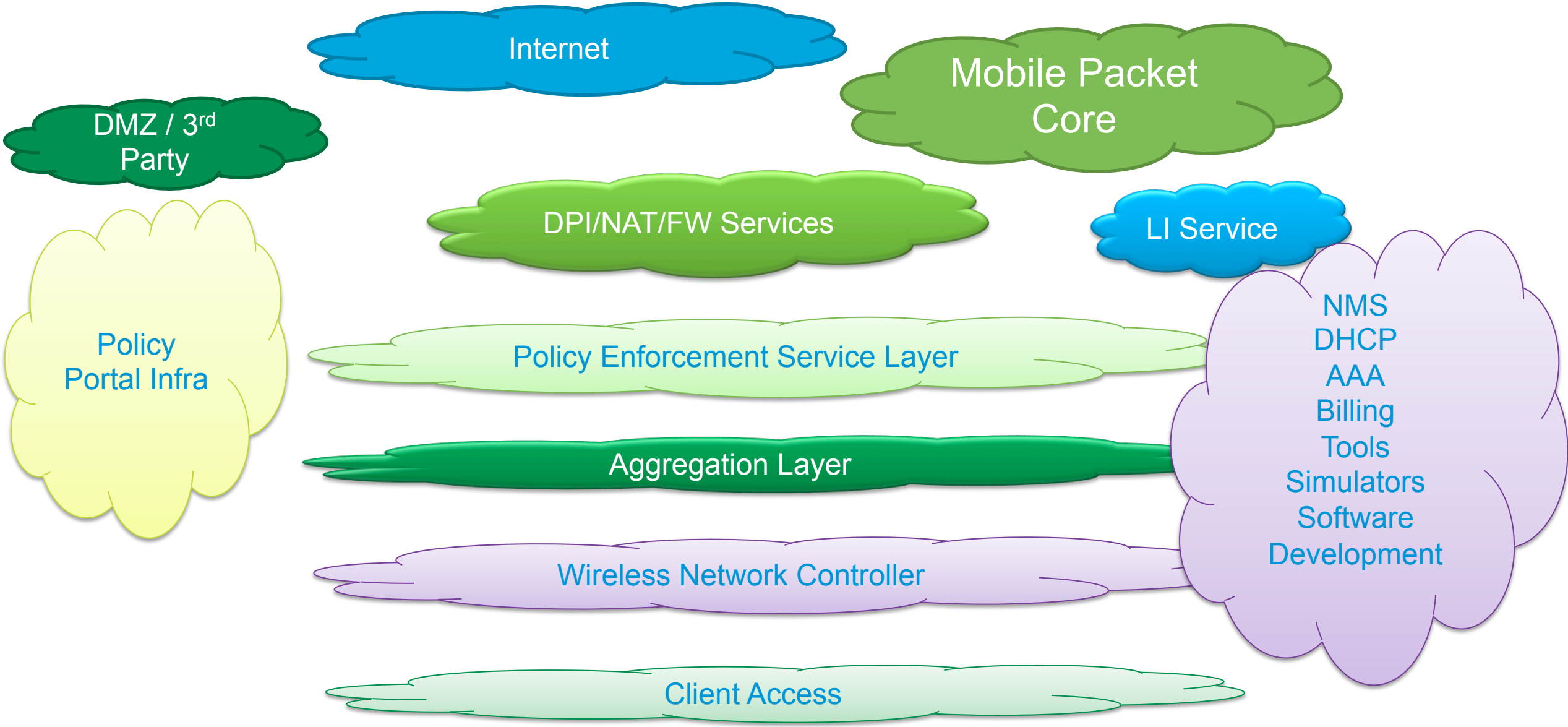
SP Wi-Fi: End-to-end System Components

SP Wi-Fi: Solution Overview

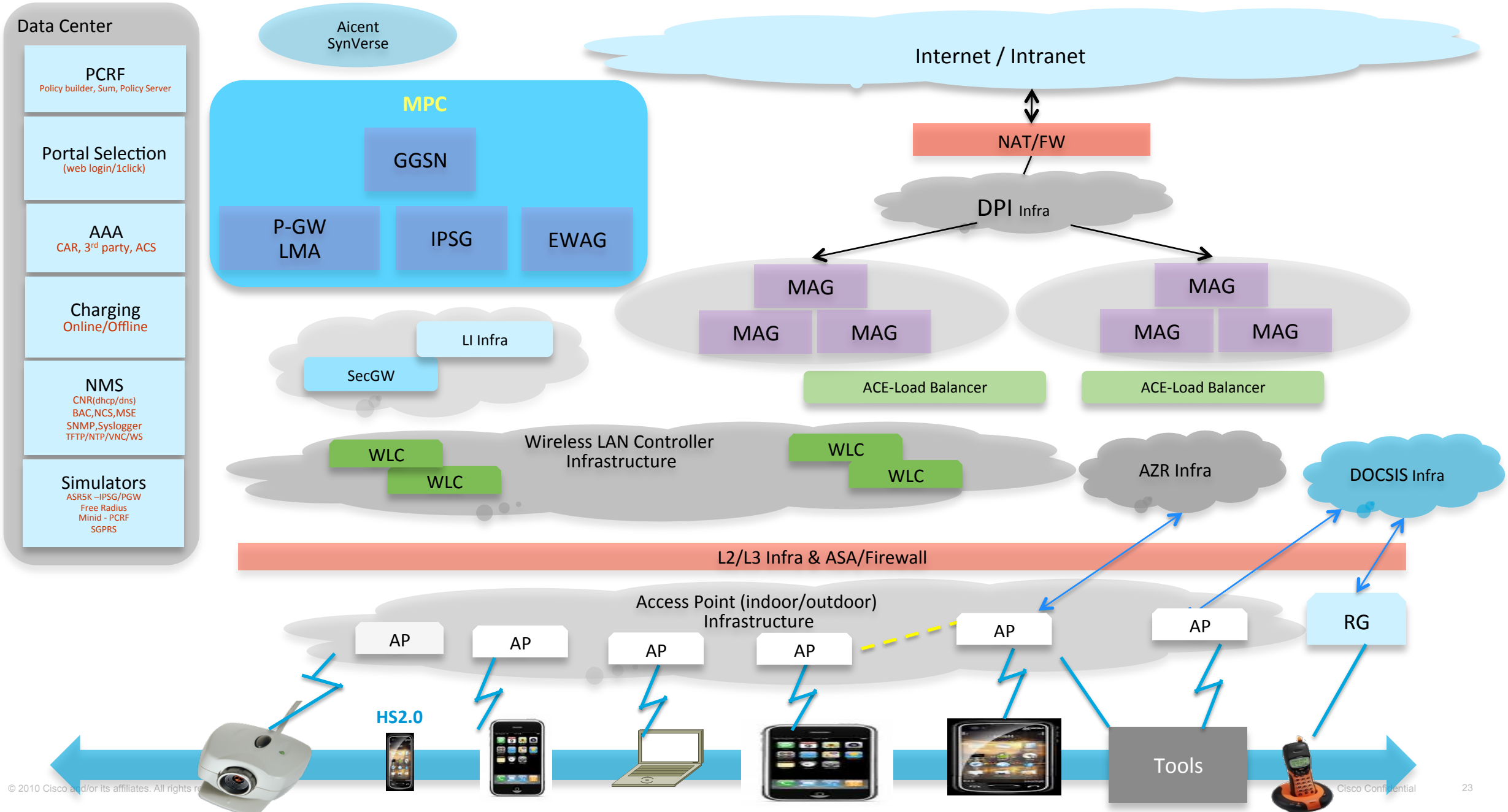


CAPWAP	Control And Provisioning of Wireless Access Point
ITP	IP Transfer Point
FWSM	FireWall Service Module
WLAN	Wireless LAN
QNS	Quantum Networking Suite (Broadhop)
SUM	Subscriber Manager
NCS	Network Control System

SP Wi-Fi: Solution Framework



Solution Framework – Summary View



Core SP WiFi Functional components

Key Considerations in SP WiFi Network Design

Authentication Authorization

AAA / RADIUS
DIAMETER
HLR / HSS
Integration / Roaming
Authentication point
EAP / Web Auth

Address Allocation

Before / After ISG
At LMA
External DHCP
IPv4 / IPv6
Pool depletion
Location based

Session Management

Keep alive
Idle Timeout
Quota enforcement
Policy enforcement
Session differentiation
Session Initiation

Transport Backhaul

CAPWAP
Fragmentation
PMIPv6 (MAG/ LMA)
L2TP (AZR) / GTP
Autonomous AP
MPC integration

Redundancy Load balancing

HSRP/ GLBP
1:1 Redundancy
N:1 Redundancy
ACE based
Single SSID
Multiple SSID

Accounting Billing & Policy

Start and Stop Records (CDR)
Who sends them
Integration with Existing billing
Gx / Gy / Gz
Policy definitions

Web Portals

When to redirect
L4 / HTTP 302
Who redirects
Redirection Portals
Web Authentication
Self service Portals
Whitelisting
Location based

Mobility

WiFi only mobility
Hierarchical mobility
WiFi / Macro
Max mobility coverage
Roaming agreements
Mobility events
Anchors / tracking

Network Management

Security
Zero touch rollout
Legal Intercept
Parental Control
Analytics / planning
Asset tracking
Rogue AP's

Subscriber Management

Provisioning
Pre-paid / Quotas
WiFi only users
Transparent logon
Service profiles
Self service portals

Address Allocation & Management

Considerations

- When to assign?
  - Before authentication for Web-auth users
  - Post authentication for EAP / 802.1x
- Where in the network?
  - In the access network (eg. EWAG) or in the core (eg. ISG / IPSG Subscriber Service Managers)
- What to assign?
  - Location based address assignment with option 82
- Subnet size?
  - Oversubscription ratio
  - Lease time
  - Broadcast domain size
- Overlapping IP address from different administrative domains

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Subscriber Session Initiation & Termination

Deployment considerations

- Session creation (First Sign of Life - FSOL)
  - DHCP initiated (L2 connected)
  - Unclassified MAC (L2 Connected)
  - Unclassified IP (L3 routed)
  - Radius proxy (L3 routed)
  - RADIUS accounting start (L3 Routed)
- Session termination options
  - Idle timeouts? Keep alives? How are you billing ?
  - DHCP lease expiry
  - Authentication timeout

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Session Management

Service considerations

- Service Differentiation
  - Gold / Silver / Bronze / policy enforcement
  - Parental control / DPI
- Quota enforcement
  - Usage based / Time based
- Location based services
- Free services
  - Open garden
  - Whitelisting
- Dynamic service updates
  - Policy push
- Service Control and Policy
  - DPI
- Targeted Push Advertising
  - Intelligent, Location-aware
- Branding

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Authentication Options

Two main authentication models

- EAP/802.1x – WLC Authentication / ISG - Authorization
  - AAA is the authentication server
  - Seamless authorization but requires client configuration (certificates, username/pwd, etc)
  - EAP-SIM/AKA helps if proper supplicant available on terminal device

- Weblogin – Portal-based Authentication and Authorization
  - Open SSID
  - Requires no client configuration, completely Web-based
  - Subsequent Logons are transparent using device MAC address
  - Vulnerable to MAC Spoofing

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Mobility Management

Essentials for Mobility

- Common anchor point for all access technologies
- A common subscriber identifier across all access technologies
  Eg. MAC address, MSISDN…. key for inter-access mobility
- Address allocated from a common DHCP pool
- A common authentication scheme
- Common session identifier
  For common billing and subscriber service across WiFi/3G/4G
- Ability to track subscriber

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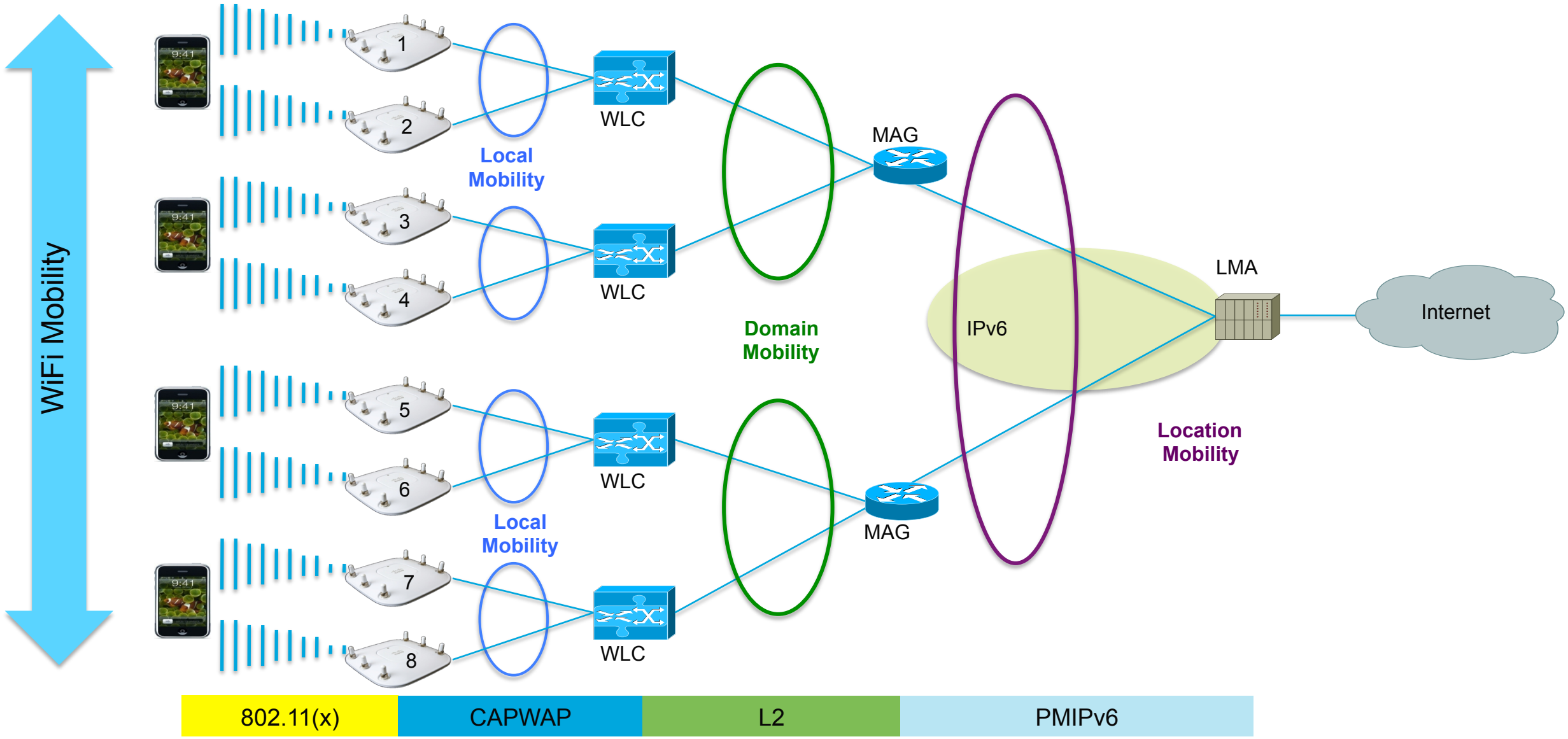
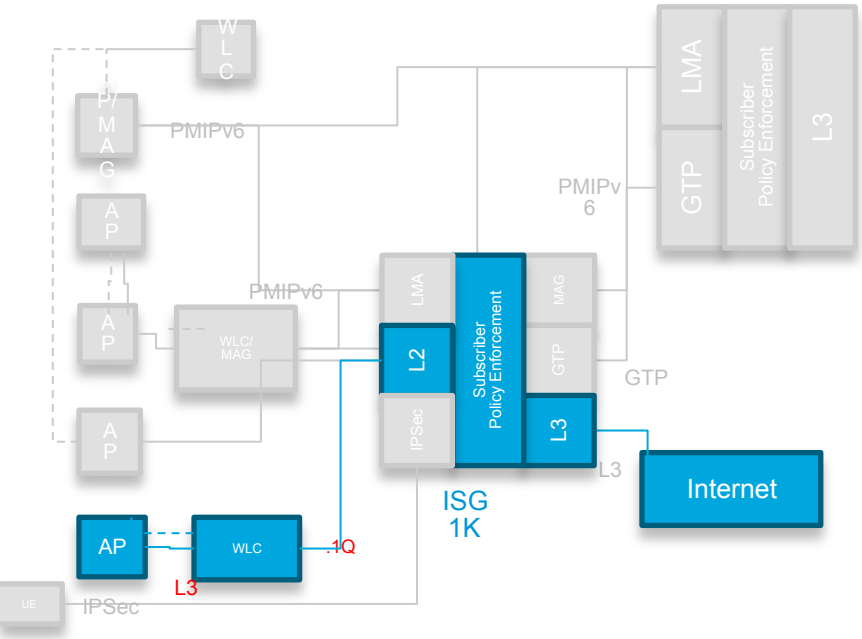
PMIPv6 – Hierarchical mobility



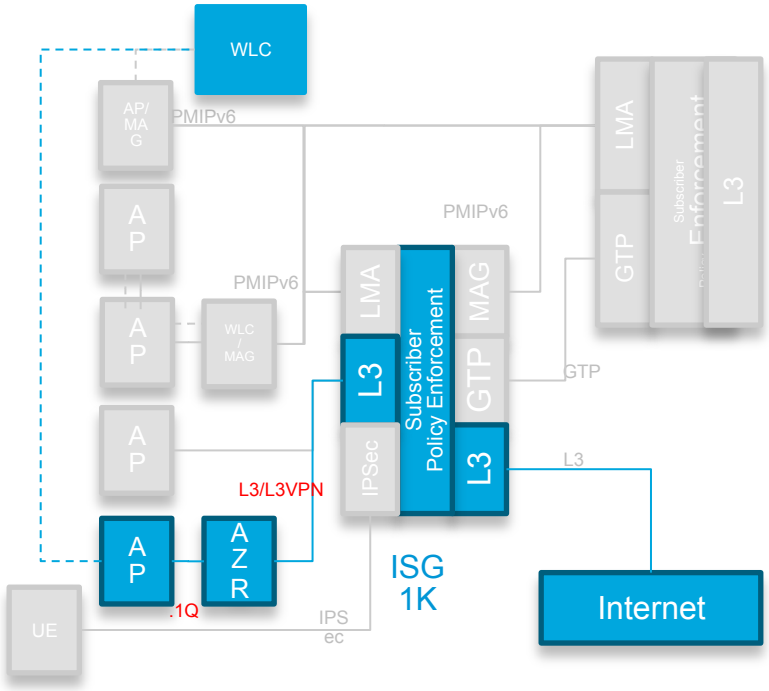
Use cases / Call Flows

Architecture Use Cases

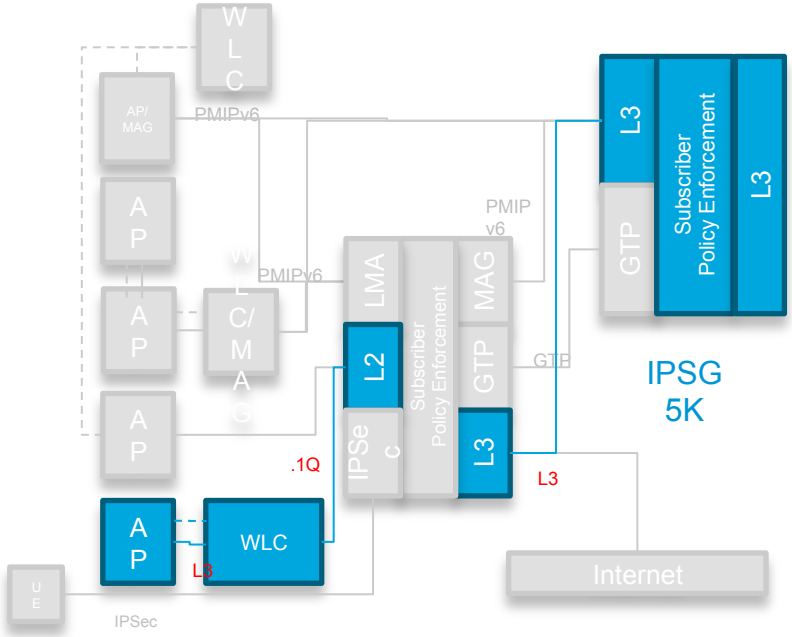
Layer 2 connected



L3 Routed



MPC Integration



Metro-WiFi Deployment

Hotspot Deployment

MPC Integration

Regression of SP Wi-Fi 1.0 – Validated Use Cases

Market Segments	Use Case Scenarios
Metro-WiFi Deployment (Layer2)	• Open Authentication • Web Authentication (Web-Login) • Web Authentication (One-Click) • Voucher-based Authentication • Pre-paid (Time/Quota) • EAP-PEAP • EAP-SIM • Hotspot 2.0 • Open Transparent Auto Logon (TAL) (MAC-based)
HotSpot Deployment (Layer3)	• All the above PLUS (except HS2.0) • WISPr 1.0 • TAL (MAC-based with DHCP Lease Query) • IP-TAL
MPC Integration Deployment	• Web-Authentication (using WLC LWA & WLC re-direct to External Portal) • EAP-PEAP • EAP-SIM

Web Authorization for SP WiFi Access

Why is it needed?

- Web portal based access continues to be demanded by MNOs and WiFi Access providers
- Many mobile devices do not have SIM cards or SIM-based clients apps
  - WiFi iPAD and iPod touch are two major examples
  - Will every WiFi connected device get a SIM? When?
- BYOD will be a major use case for WiFi access going forward
- Exploit visiting “non-subscribers” – a good “churn” opportunity for you
  - Need a portal login and splash page to offer your service

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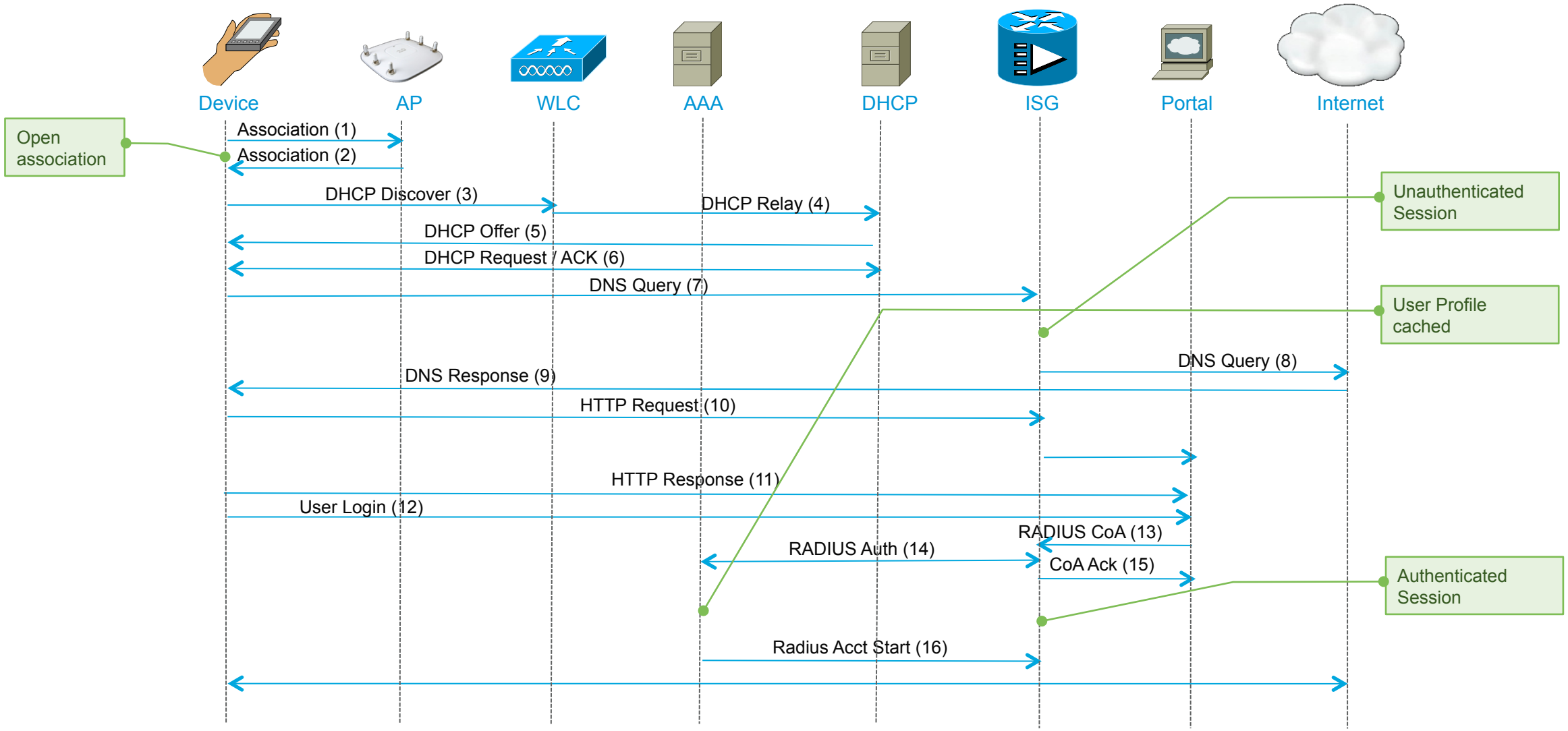
Web authentication

L4 redirection at the ISG



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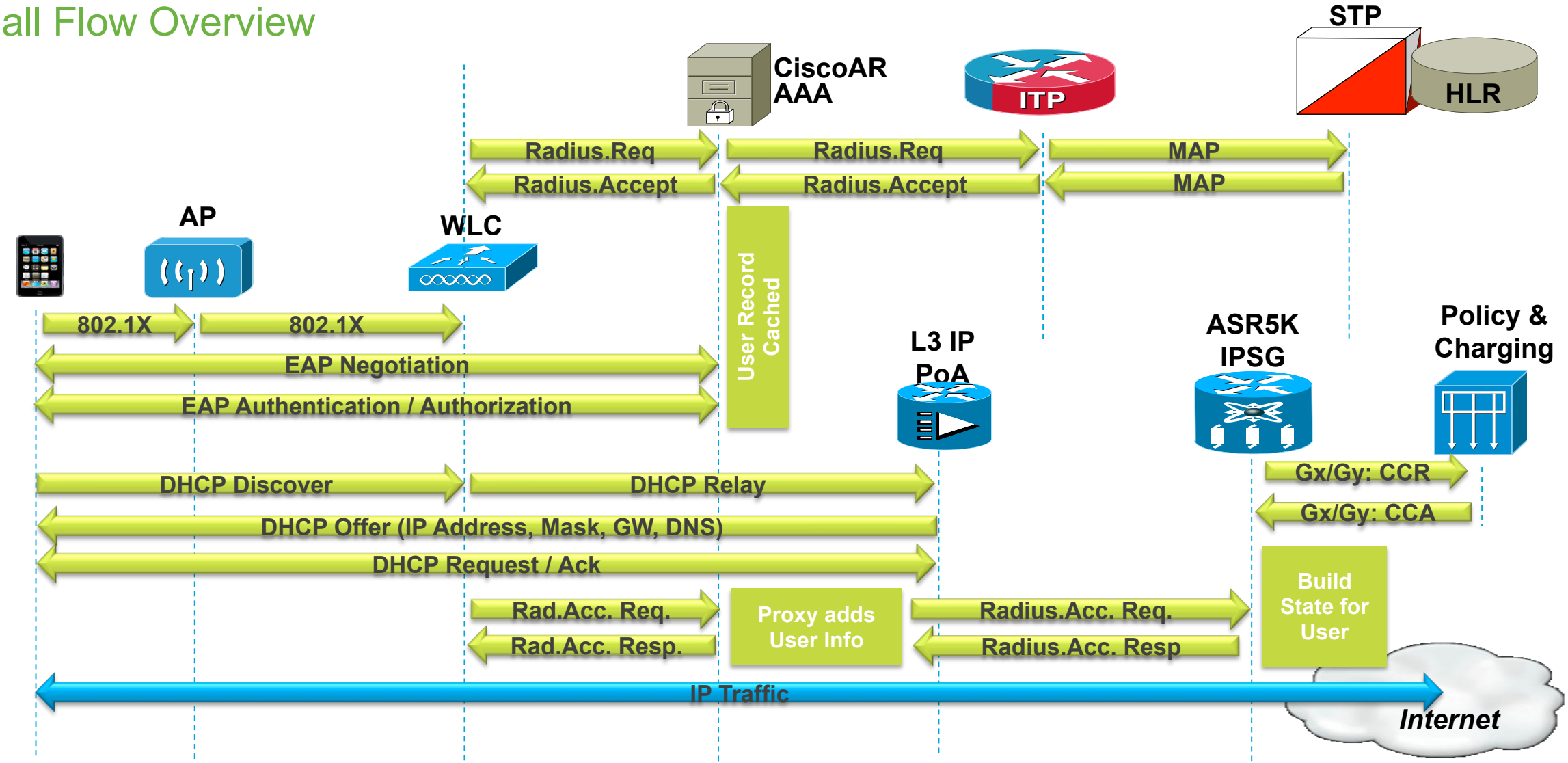
MPC: EAP-based Authentication

Call Flow Overview



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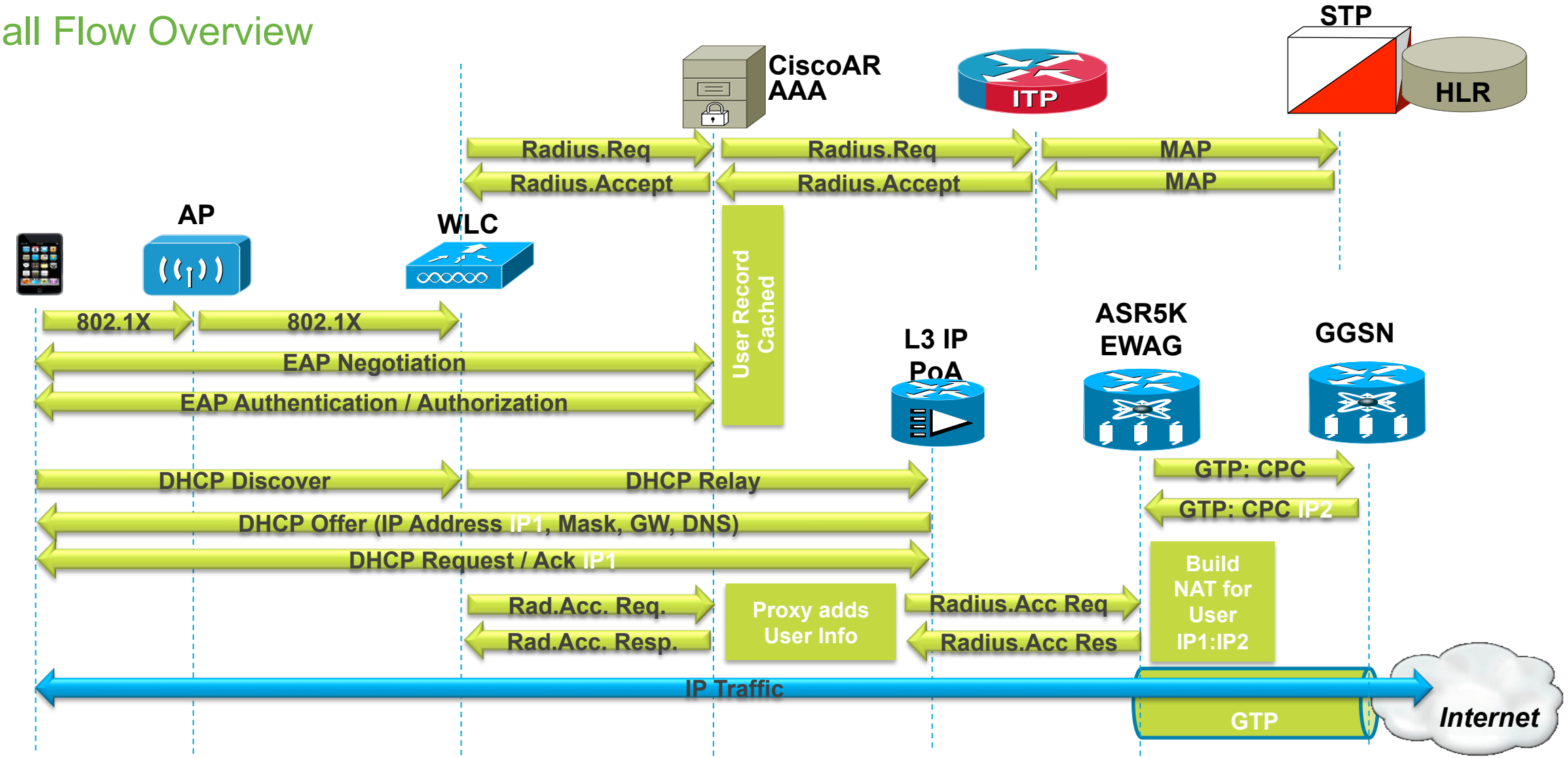
MPC: 3G/GTP Integration into GGSN

Call Flow Overview



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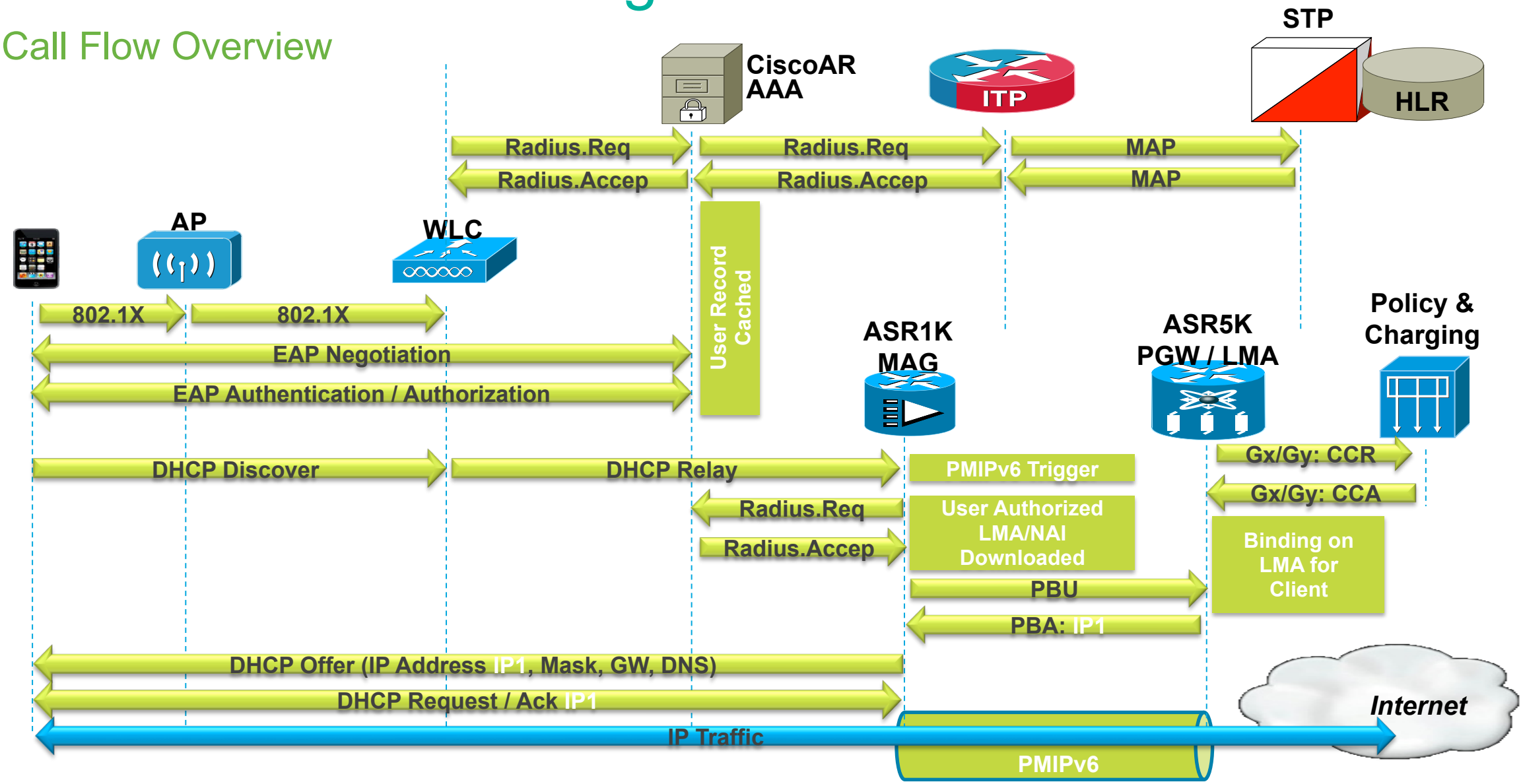
MPC: 4G/PMIPv6 Integration into PGW

Call Flow Overview



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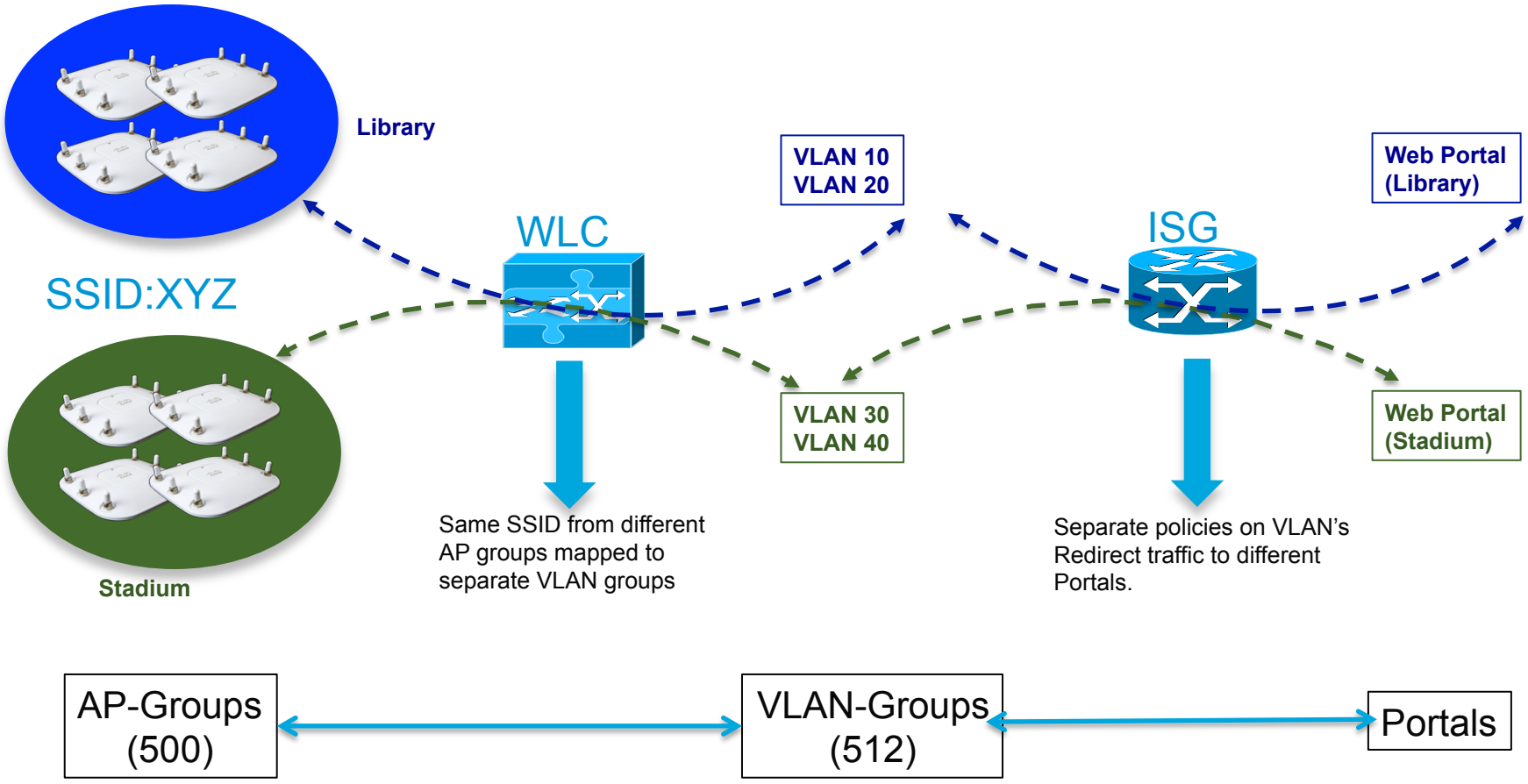
Location based services

VLAN based



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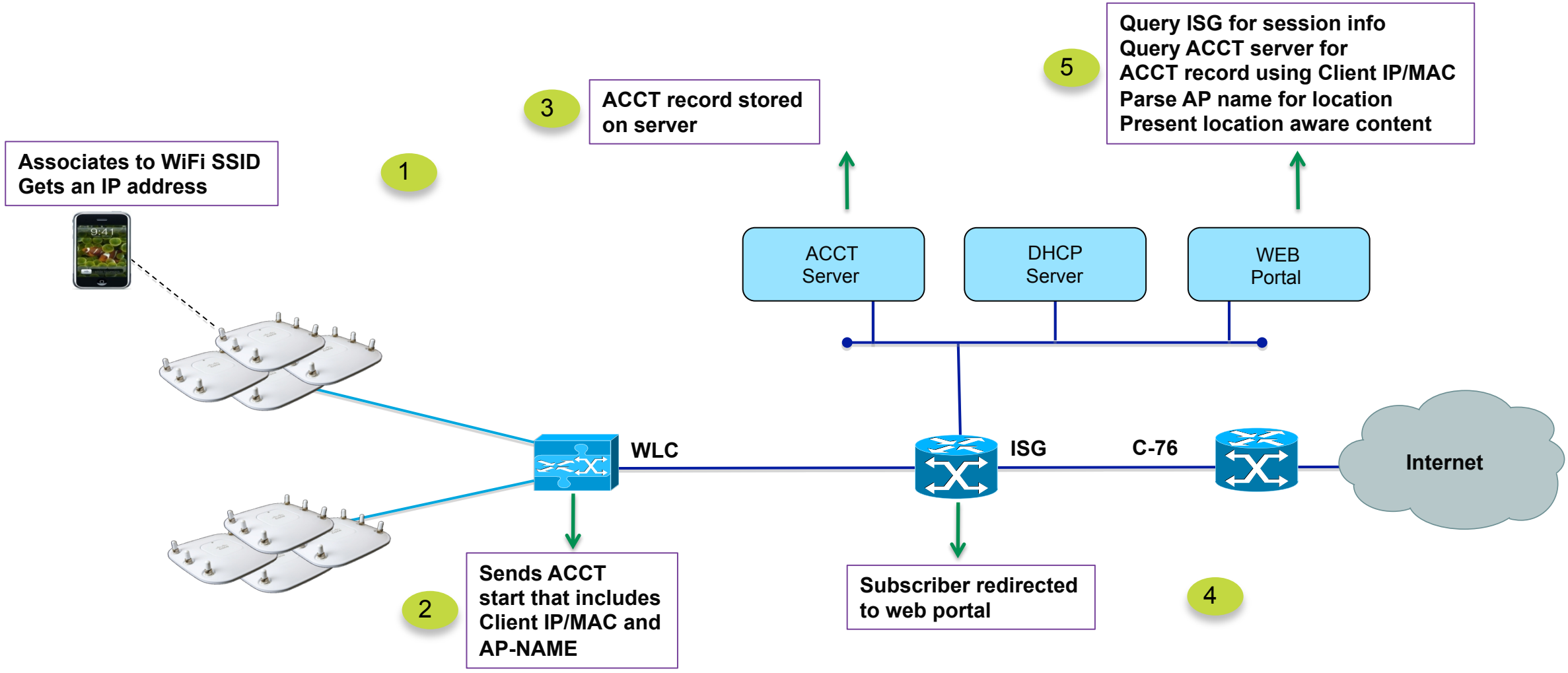
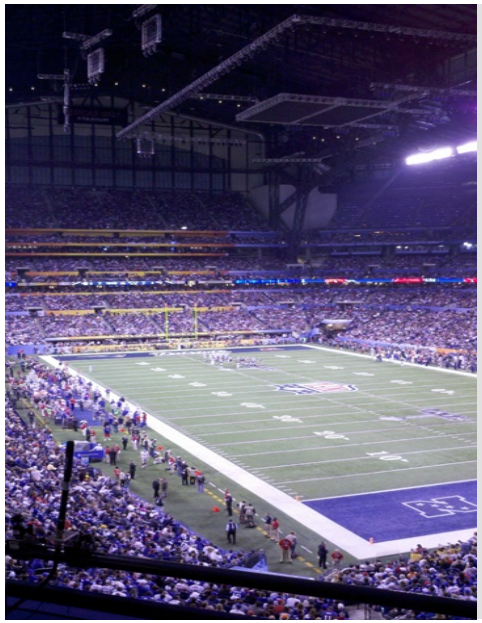
RADIUS-based Location awareness

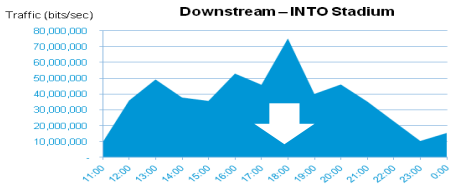


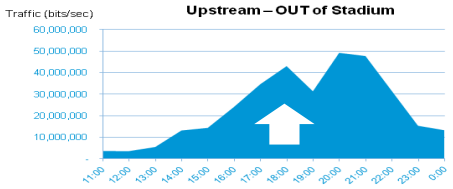
Case Studies / Customer Deployments

Connected Stadium – Super Bowl XLVI



- *Fan facing Wi-Fi access for Super Bowl activities*
- *Carrier-neutral Wi-Fi access – free to all fans*
- *Provided by Verizon wireless*
- *Objective: increased fan experience and 3G offload*
- *High speed data as well as Voice & SMS worked well*
- *604 in-stadium Access Points*





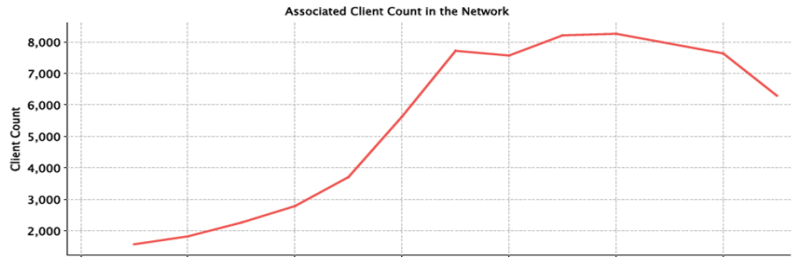
Downstream
Peak: 75 Mbps
Total: 225.3 GB

Upstream
Peak: 42 Mbps
Total: 144.6 GB

Total attendance:
68,658

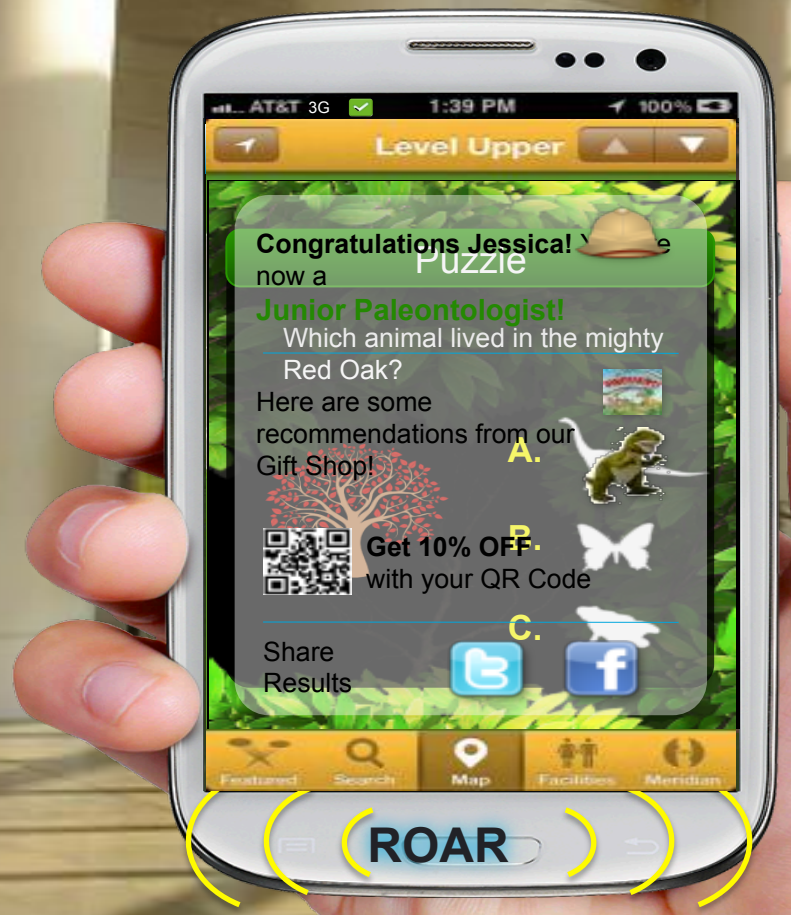
Unique Associations:
12,946 (19%)

Simultaneous access:
8,260 (12%)



Venue: Fernbank Museum with AT&T

Transforming Visitor Experience with Personalized, Managed Wi-Fi



- Business Intelligence
- Promotions
- Analytics
- Social Networking

Fernbank Museum with AT&T

Real-Time and Historical Location Analytics

- Path Analysis
- Time of Day
- Dwell Times

Copenhagen Airport

Aid Travelers through Wi-Fi Services

What's New

- **Location Analytics with ThinkSmart**

- Security Personnel
- Check-In Personnel
- Customs Personnel
- Traffic Flow
- Advertising Placement

Hospitality – Case Study

Away from MGM Property

Inside or Near MGM Property

Cellular Network

Cable/MSO: Cablevision

224,000 Brand Impressions per day
1,000,500 devices detected, 596,000 are iOS

Separate use cases for device categories:
Laptop, Tablet, Phone

Use cases Deployed: TOS Update, Branding, App Promo

- Cablevision Setup
- Serve at beginning of session, every 5 min.
- iOS devices get App promo as first imp
- Average serve rate of 1-3 impressions per day per surfing device.
- Workdays are 30-40% more active than holidays, snow days or weekends.

Enabling GOGO
In-Flight Wi-Fi Access Services

Project Details

- Worlds largest leading in-flight Service Operating on United, American, Delta, US Air, Air Tran and Virgin (over 1,081 planes)
- Air to ground uses CDMA backaul , in-plane WIFI AP s
- Ubiquitous WIFI access – Iphone , laptop
- Full e2e solution
  - multi-device portal with custom airline branding
  - subscriber profile management
  - service plan selection, prepaid access
  - credit card billing
  - dynamic content delivery

DELTA
Alaska Airlines
UNITED
AmericanAirlines
U·S AIRWAYS
AIR CANADA
AirTran
Virgin america

Summary & Takeaways

Summary

- SP WiFi access is a business reality today for MNOs and Hotspot providers alike
- Mobile Packet Core integration is a multifaceted problem
  - attention needed to multiple factors
- WiFi access and aggregation uses IP control plane mechanisms.
  - WiFi Access Gateways need proper interworking support
- Wholesale access and roaming is a key consideration
  - WiFi Access Gateway need to support multiple roaming partners; 3G, 4G core interfaces
- Rich service management needed for subscriber differentiation and monetization
- There is no single solution for all access types, but all types of access should be supported at the service layer
- The results of a good deployment will deliver outstanding user experience!

Thank you.