



# Network Framework of IMS

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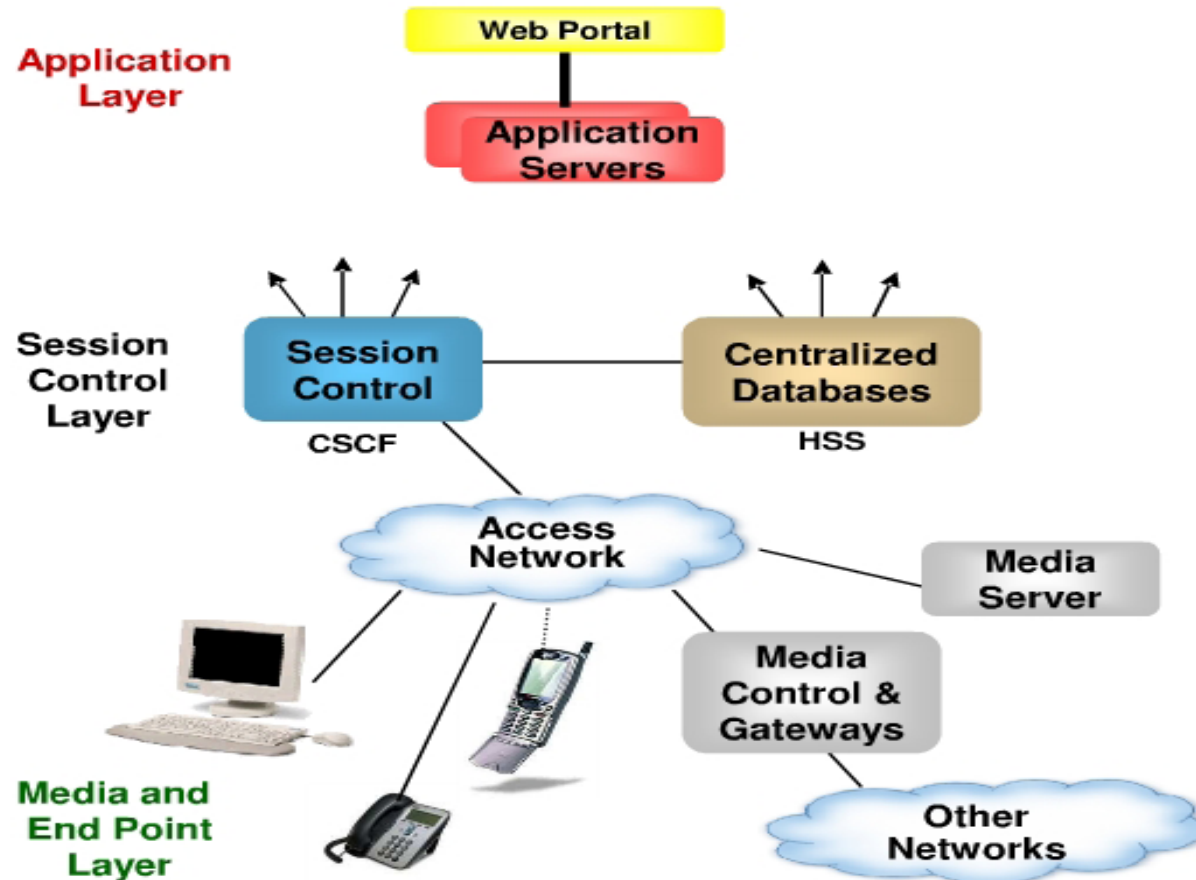
## Course Objectives:

To learn the IMS basic concept and basic technologies, including the service, functional architecture, function entities, interface, protocol and information flows.

# Agenda

- 
- **IMS brief introduction**
  - **IMS functional architecture & function entity**
  - **IMS Interface & Signaling flows**

# What's IMS?



## IMS is:

Home control service infrastructure

A VoIP Telephony and Multimedia Services Architecture

Defined with Open Standard Interfaces -> 3GPP and 3GPP2

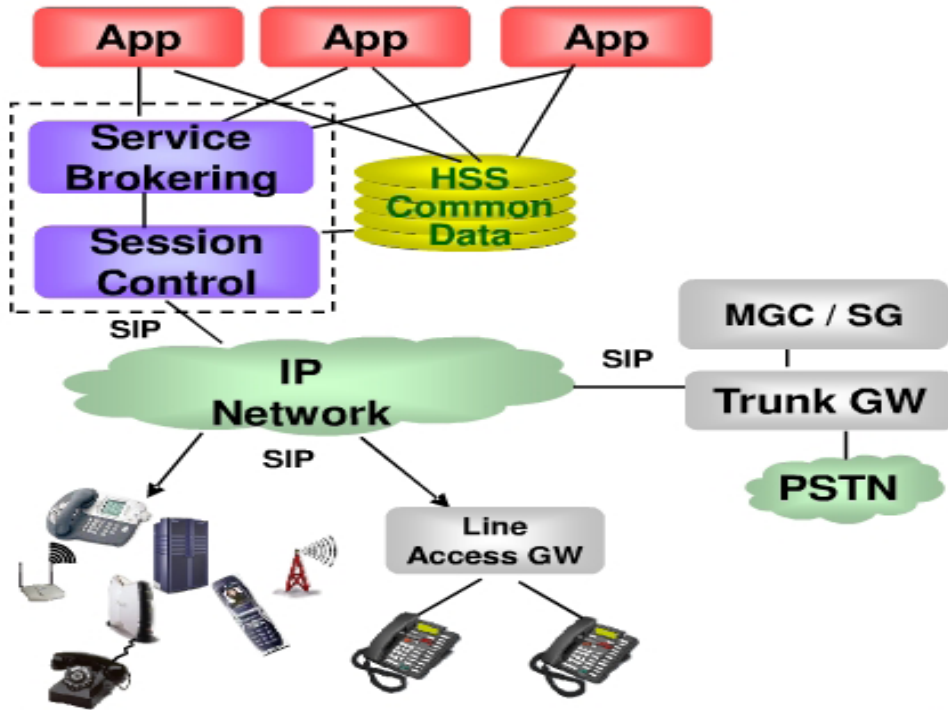
Based on IETF Protocols (SIP, Diameter, RTP..)

Applicable for Both Wireless and Wireline Networks

A Solution for Service Transparency

Capable of Interworking with PSTN and Legacy IN Based Services

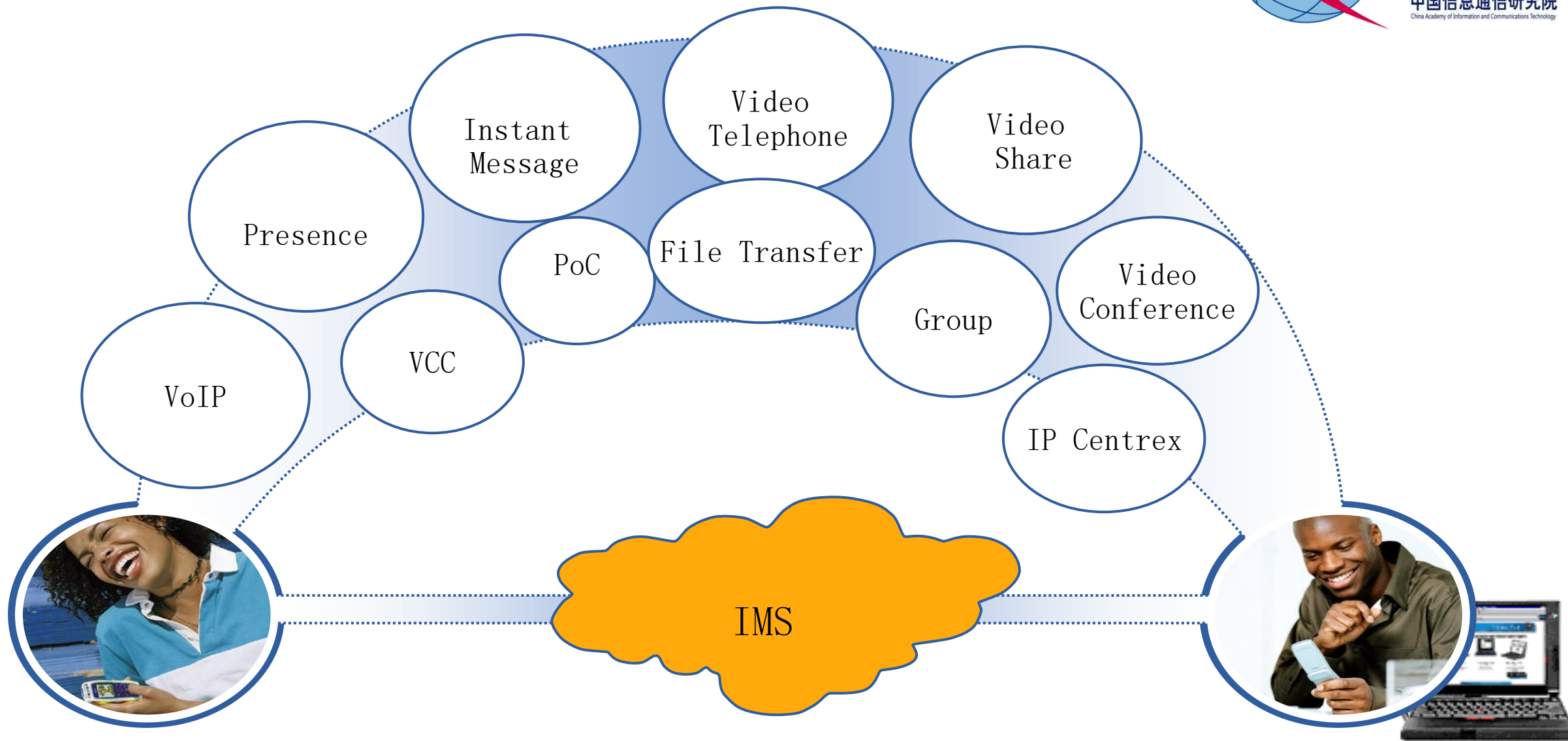
# The IMS Model



**Increasingly, customers are telling Lucent this is the direction of choice in evolving their network**

- Focus is on building a new overlay network with the goal of providing new services and applications to grow revenue
- Infrastructure is designed for voice, data, multimedia and other applications
- Optimized for new endpoints (next generation VoIP clients) and new access technologies (VoDSL, VoBB, 802.11, 802.16, etc)
- Legacy endpoints can be adapted to provide ubiquitous services across all endpoints
- Overlay approach consistent with vendors need to modernize network infrastructure
- Separation of functions is optimized for next generation services: session, data, applications, PSTN interfaces
- Well defined application interfaces makes it easy to deploy third-party services
- Converged architecture is applicable to wireline and wireless

# IMS Service





# Operator's Attention Point On IMS



## Multimedia Service

- Video conference/video telephony
- Multimedia ringing tone/ring back tone



## ICT application

- Use IMS for enterprises ICT application and unified communication



## Network evolution

- SIP IAD、SIP AG access to IMS
- IMS support for PSTN/ISDN Emulation/Simulation service
- AGCF and mAGCF access to IMS



## Service engine open to 3<sup>rd</sup> party and Internet

- IMS service ability open to 3rd party and internet for more flexible service and application

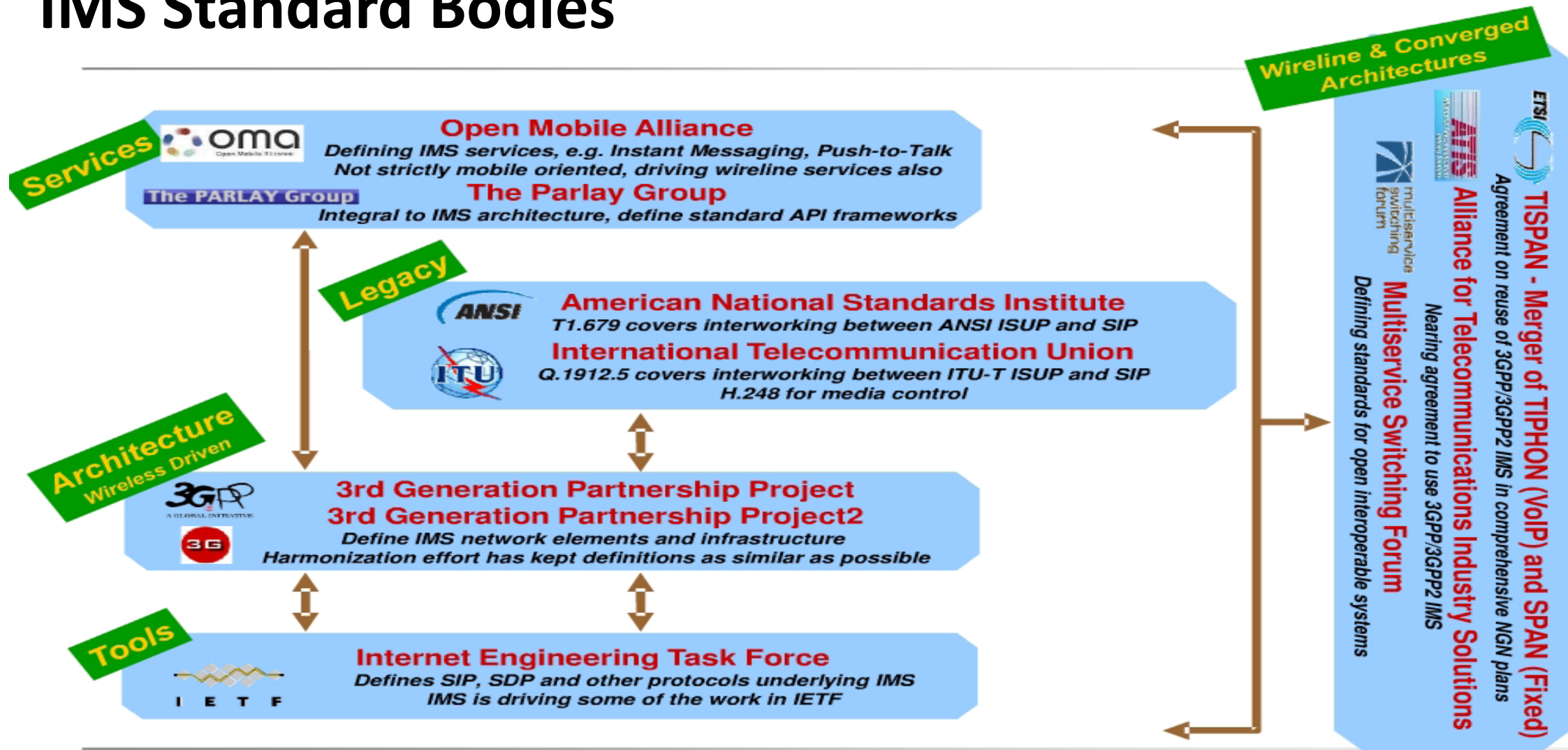
# Agenda

- IMS brief introduction
- ➔ ● IMS functional architecture & function entity
- IMS Interface & Signaling flows

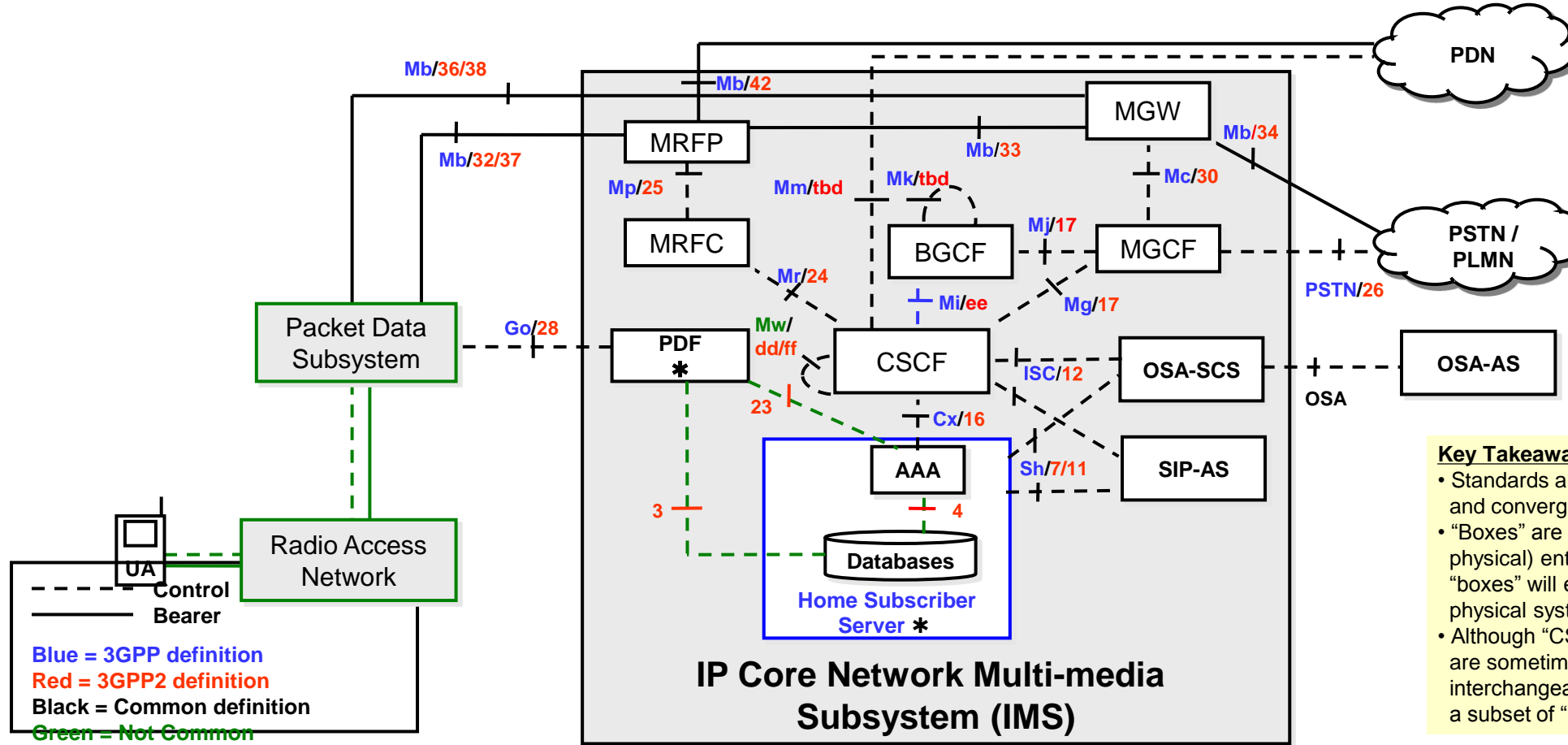




# IMS Standard Bodies



# 3GPP/3GPP2 IMS Network Architecture



**Key Takeaways**

- Standards are well defined and converged
- “Boxes” are logical (not physical) entities. Several “boxes” will exist on same physical system
- Although “CSCF” and “IMS” are sometimes used interchangeably, “CSCF” is a subset of “IMS”

\* For 3GPP, the PDF is within the P-CSCF. For 3GPP2, the PDF is a network entity of it's own.  
 \* For 3GPP the HSS also contains HLR functionality which is not shown here. For 3GPP2 the AAA function shown in the HSS is a stand-alone entity.  
 \* Additional interfaces exist in both the 3GPP and 3GPP2 reference models but are not included in this proposal for harmonization.

# IMS Entity Definitions

## ■ Signaling Entities

- **HSS** - Home Subscriber Server or “HSS Collective”
  - Consists of AAA and Databases
- **CSCF** - Call Session Control Function – 3 flavors
  - S-CSCF – Serving: Session control entity for endpoint devices
  - I-CSCF – Interrogating: Entry point to IMS from other networks
  - P-CSCF – Proxy: Entry point to IMS for devices
- **BGCF** - Breakout Gateway Control Function
  - Selects network to use for PSTN/PLMN interworking
- **MGCF** - Media Gateway Control Function
  - Controls MGW
- **MRFC** - Multimedia Resource Function Controller
  - Controls MRFP
- **PDF** - Policy Decision Function
  - Authorizes QoS requests
- **AS** - Application Servers – provides services and applications
  - Session Initiation Protocol (SIP) AS
  - Open Service Access (OSA) Service Capability Server (SCS) & OSA AS
  - AIN Interworking Server

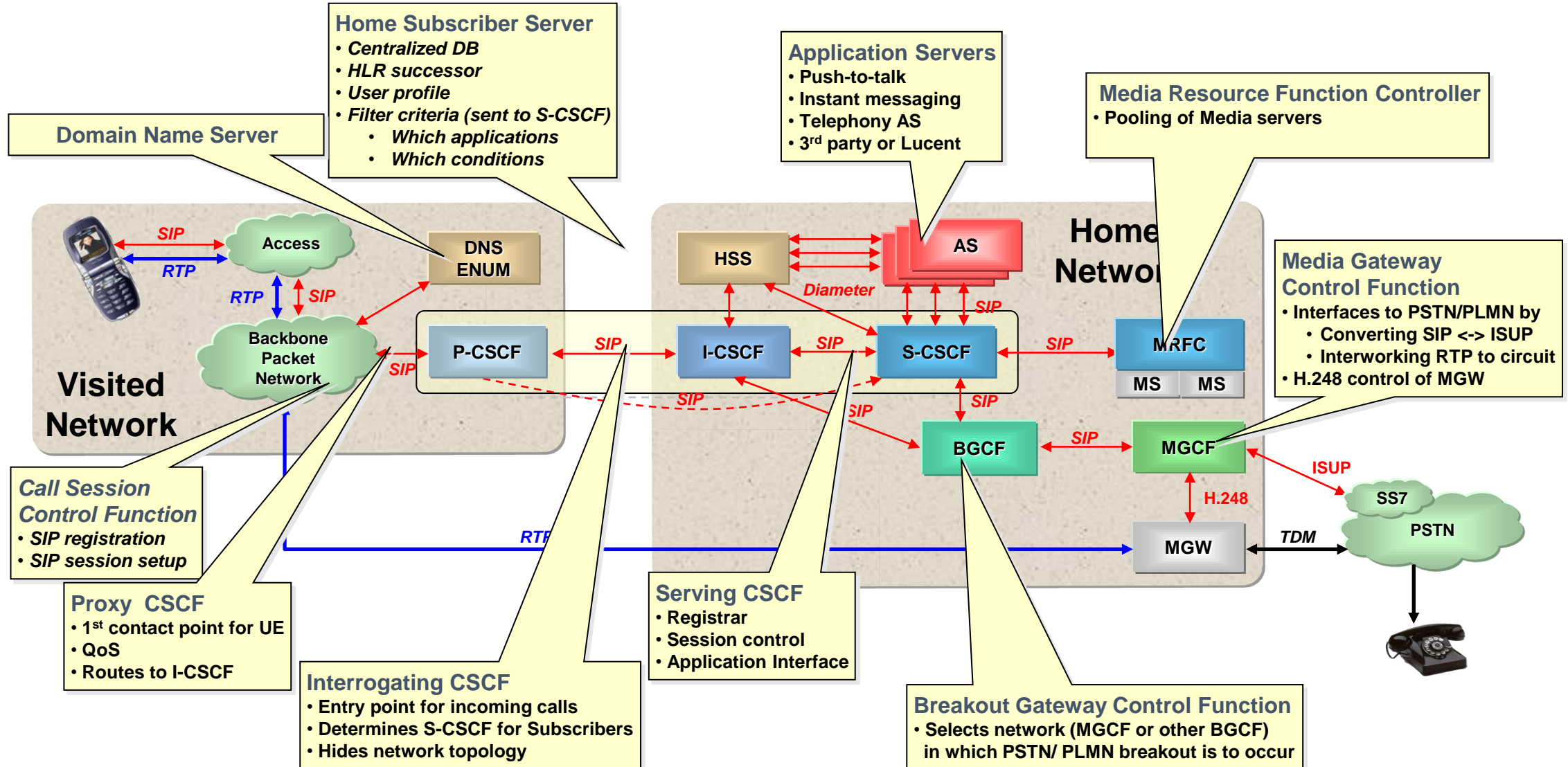
## Bearer Entities

- **MGW** - Media Gateway
  - Inter-works RTP/IP and PCM bearers
- **MRFP** - Multimedia Resource Function Processor
  - Provides conferencing, transcoding and announcements

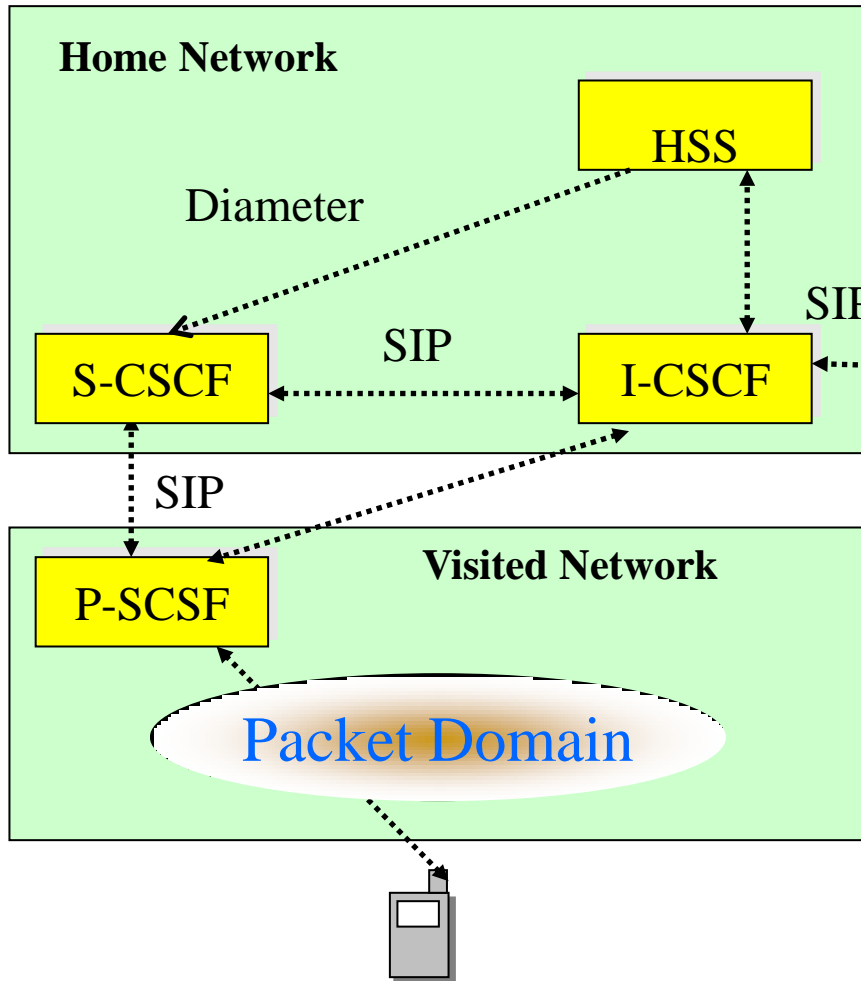
## Support Systems

- **HSS** - Home Subscriber Server or “HSS Collective”
  - Consists of AAA and Databases
- **SLF** – Subscriber Locator Function
  - Provides location of associated HSS
- Charging Entities
  - ECF** – Event Collection Function (On Line)
  - SCF** – Session Collection Function (On line)
  - CCF** – Charging Collection Function (Off-Line)
- **DNS and ENUM**

# 3GPP Network Elements



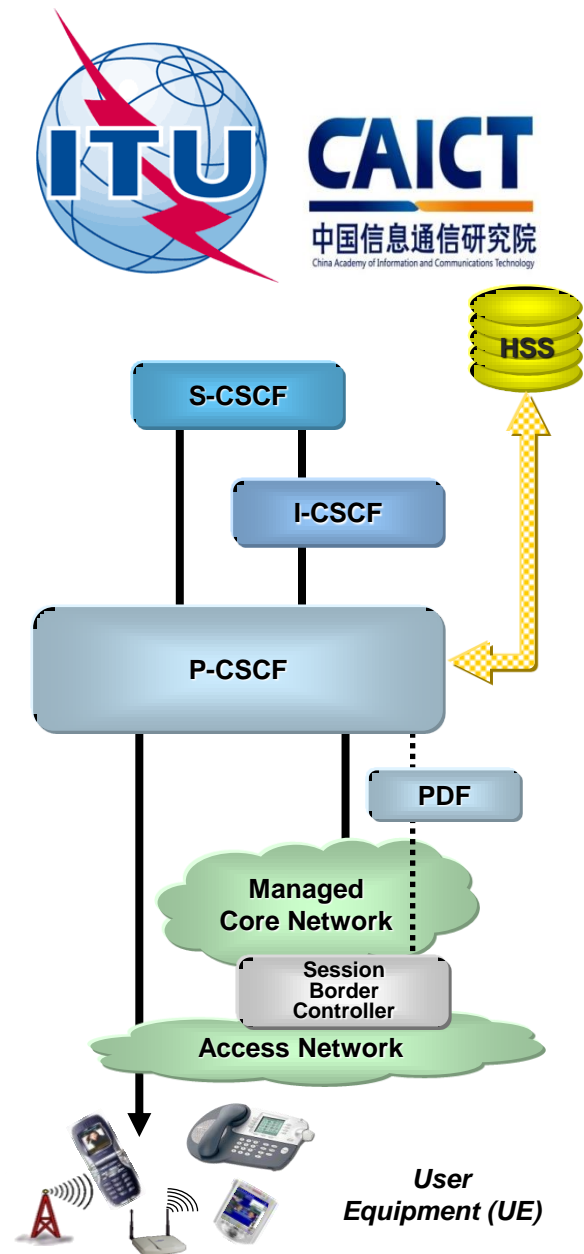
# Call Session Control Function (CSCF)



- **SIP Proxies used to manages SIP sessions**
  - Coordinates with other network elements
  - Session control, feature control, resource allocation, ...
- **Three flavors of CSCFs**
  - Serving CSCF (S-CSCF) - Session control entity for endpoint devices
  - Interrogating CSCF (I-CSCF) - Entry point to IMS from other networks
  - Proxy CSCF (P-CSCF) - Entry point to IMS for devices
- **Functionally CSCFs follows Internet paradigms**
  - P-CSCF → I-CSCF → S-CSCF
  - Stateless entities at network edge, state entities in core
  - Simple processing at edge, complex processing in core
  - Security and authentication requirements increase towards core

# Proxy CSCF (P-CSCF)

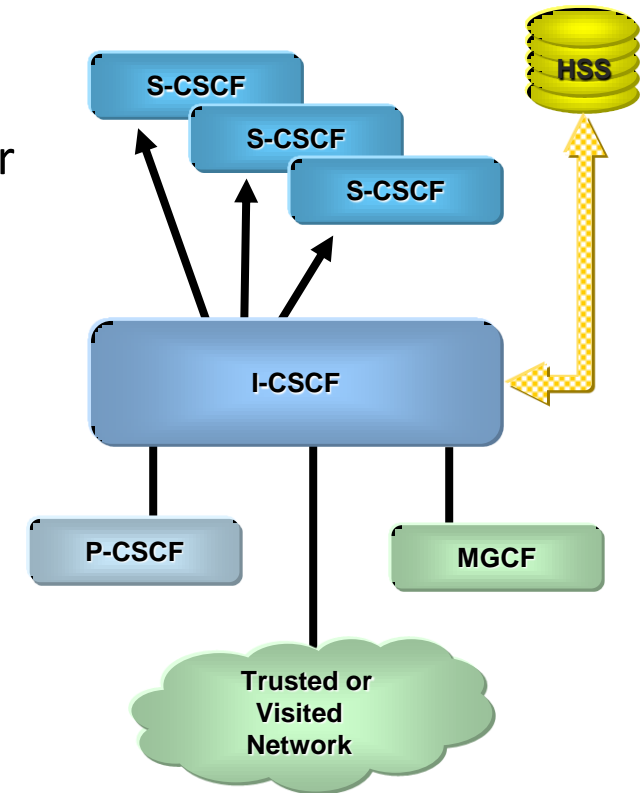
- **First contact point within the IMS for the subscriber**
  - Well known address(es) within network
  - P-CSCF discovery can either be statically configured or via DHCP
- **Authentication and Authorization**
  - Routes incoming requests based on registration status
    - Sends the SIP REGISTER request received from the UE to an I-CSCF determined using the home domain name, as provided by the UE
    - Sends SIP messages received from the UE to the SIP server S-CSCF, whose name the P-CSCF has received as a result of the registration procedure
    - Rejects non-authorized requests
  - Authorize the bearer resources for the appropriate QoS level
    - PDF functionality integrated in release 5, separate entity in release 6
- **SIP compression and decompression**
- **Acts as a B2BUA**
  - Generates CDR events
  - Can act as User Agent and terminate calls in abnormal situations
  - Detects and handles emergency session establishments



**Security element at edge of IMS network  
providing initial entry point for user equipment**

# Interrogating CSCF (I-CSCF)

- **Initial contact point for incoming network connections**
  - Well known address within network
  - Selects S-CSCF for a user performing SIP registration
    - Provides S-CSCF fan-out to support scalability
    - Selection can be static or dynamic based on current conditions and user location
  - Routes request to proper S-CSCF or external network element
    - Query HSS for the address of S-CSCF to handle call
    - If no S-CSCF is currently assigned, (e.g. unregistered termination), then assign S-CSCF to handle the SIP request
- **Acts as a stateless SIP proxy**
  - Generates CDR events
- **Provides Topology Hiding Inter-network Gateway (THIG)**
  - Not required but provides valuable capabilities
  - Hides configuration, capacity, and topology of network from outside



**IMS network routing proxy and S-CSCF scalability support**

# Serving CSCF (S-CSCF)



## Registrar and Notification Server

- Acts like an IETF RFC 3261 compliant Registrar
- IETF RFC 3265 compliant event notifications, e.g., registration
- Generally 1-1 binding between registered endpoint and S-CSCF

## Locally Stores Subscriber Data

- The Serving CSCF retrieves the subscriber data from the HSS
- Includes filter criteria information,

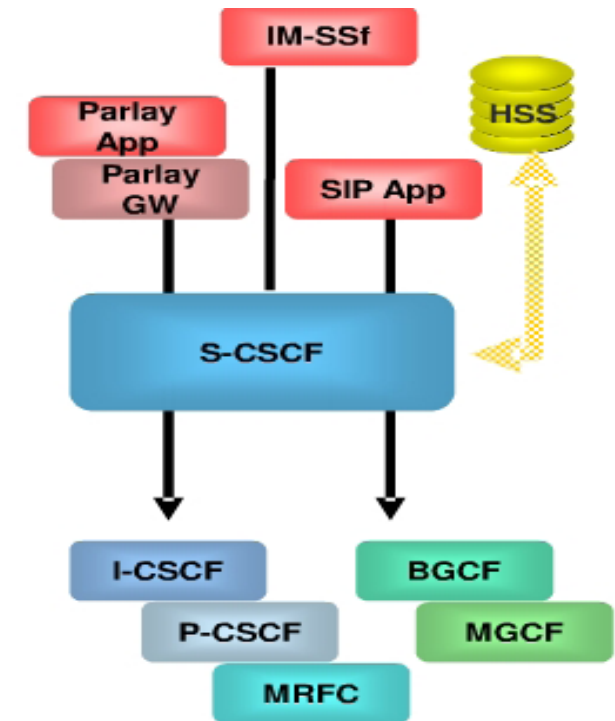
Which Application Servers to contact for specified events

## Session Control and Routing

- Provides session control for the registered endpoint's sessions
- Behaves as both SIP Proxy and User Agent
- Generates session level CDRs

## Bearer Authorization

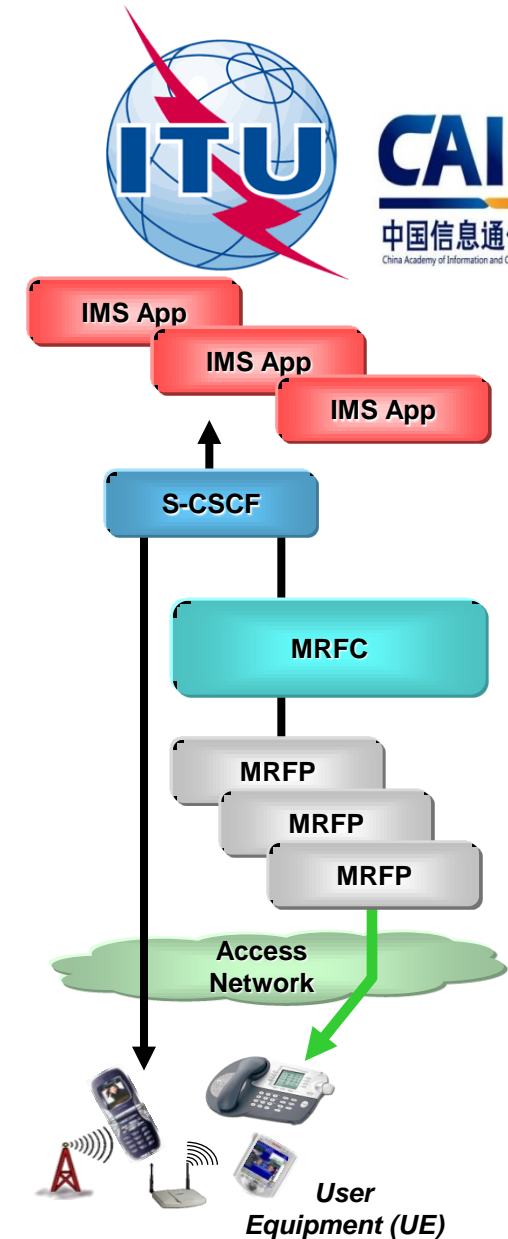
- Ensures that media types and quantities indicated by SDP for a session are within boundaries of subscriber's profile.





# Multimedia Resources (MRFC & MRFP)

- **Multimedia Resource Function Controller (MRFC)**
  - Controls the media streams resources in the MRFP via H.248
  - Requests received from IMS elements
    - Standard ISC SIP requests utilizing SIP RFC 3264 Offer/Answer model
  - Generates CDRs
- **Multimedia Resource Function Processor (MRFP)**
  - Provides resources to be controlled by the MRFC (H.248)
    - Mixes incoming media streams (e.g. for multiple parties)
    - Sources media streams (for multimedia announcements)
    - Processes media streams (e.g. audio transcoding, media analysis)
    - Tones and announcements – Applied on receipt of ACK, self-timed with BYE or stopped on BYE
    - Support DTMF within the bearer path
  - Notify the MRFC when an event has occurred
    - For example: AS/CSCF may have directed it to collect DTMF digits



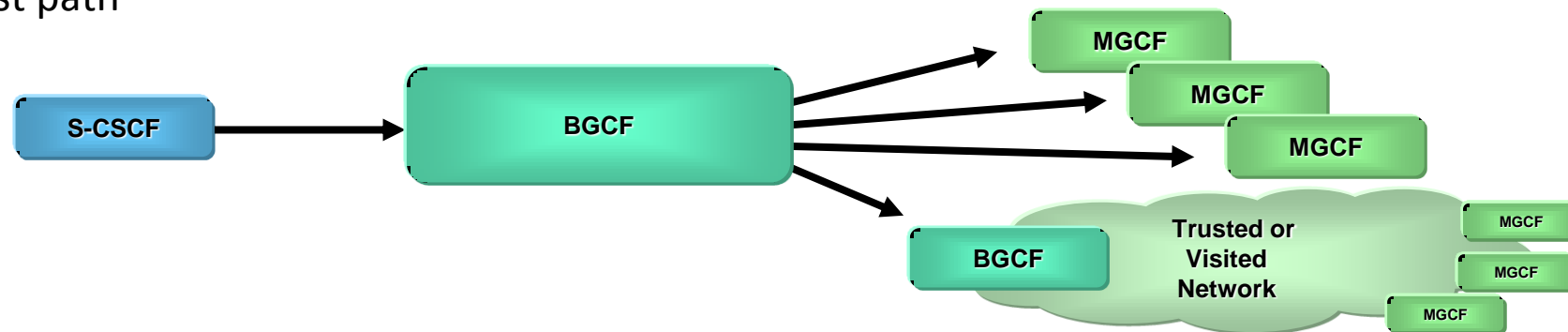
**Central management of a pool of media resource servers**



# Breakout Gateway Control Function (BGCF)

- Selects the network in which PSTN breakout is to occur
  - MGCF selected if breakout is to occur in the same network
  - BGCF of a peer network can be selected to hand-off routing
- No standards for criteria BGCF uses for selection, some possible factors:
  - Current location of the calling UE
  - Location of the PSTN address
  - Local policies and business agreements between the peer network
    - Minimize path distance
    - Least cost path

- Generates CDRs



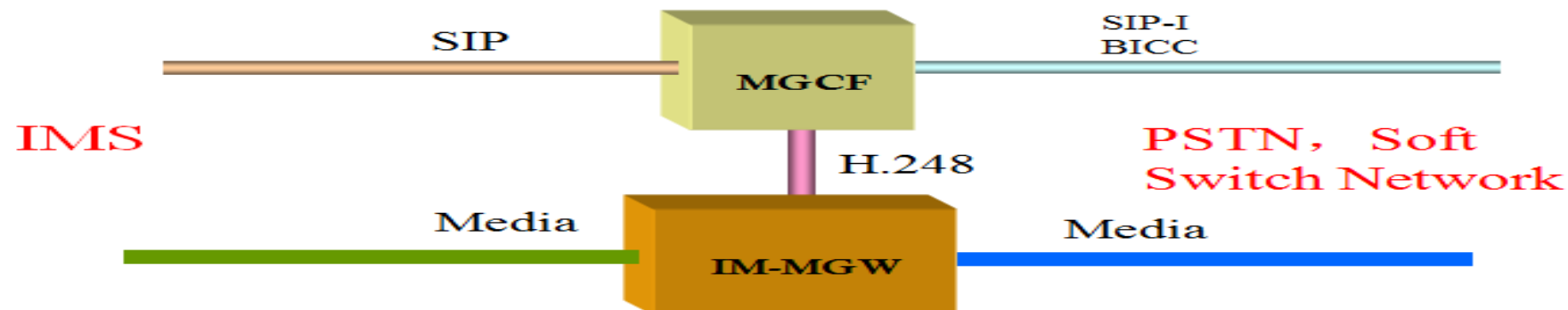
**PSTN Egress Selection**



# Media Gateway Control Function (MGCF)

## Media Gateway Control Function (MGCF)

- Controls the parts of the call state that pertain to connection control for media channels in a MGW
  - May include sophisticated TDM routing capabilities
- Communicates with the I-CSCF using SIP Mg interface
- Communicates with the I-CSCF and BGCF (SIP)
- Performs protocol conversion between ISUP and SIP (accordance with ITU-T Q.1912.5)
- Out of band information assumed to be received in MGCF and may be forwarded to the CSCF/MGW

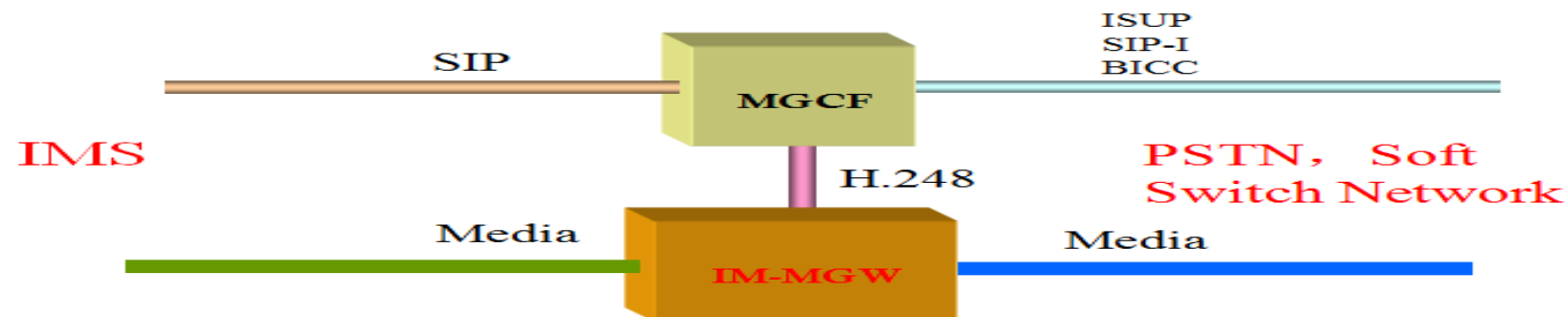


# Media Gateway (MGW)



Media Gateway (MGW) performs the following functions:

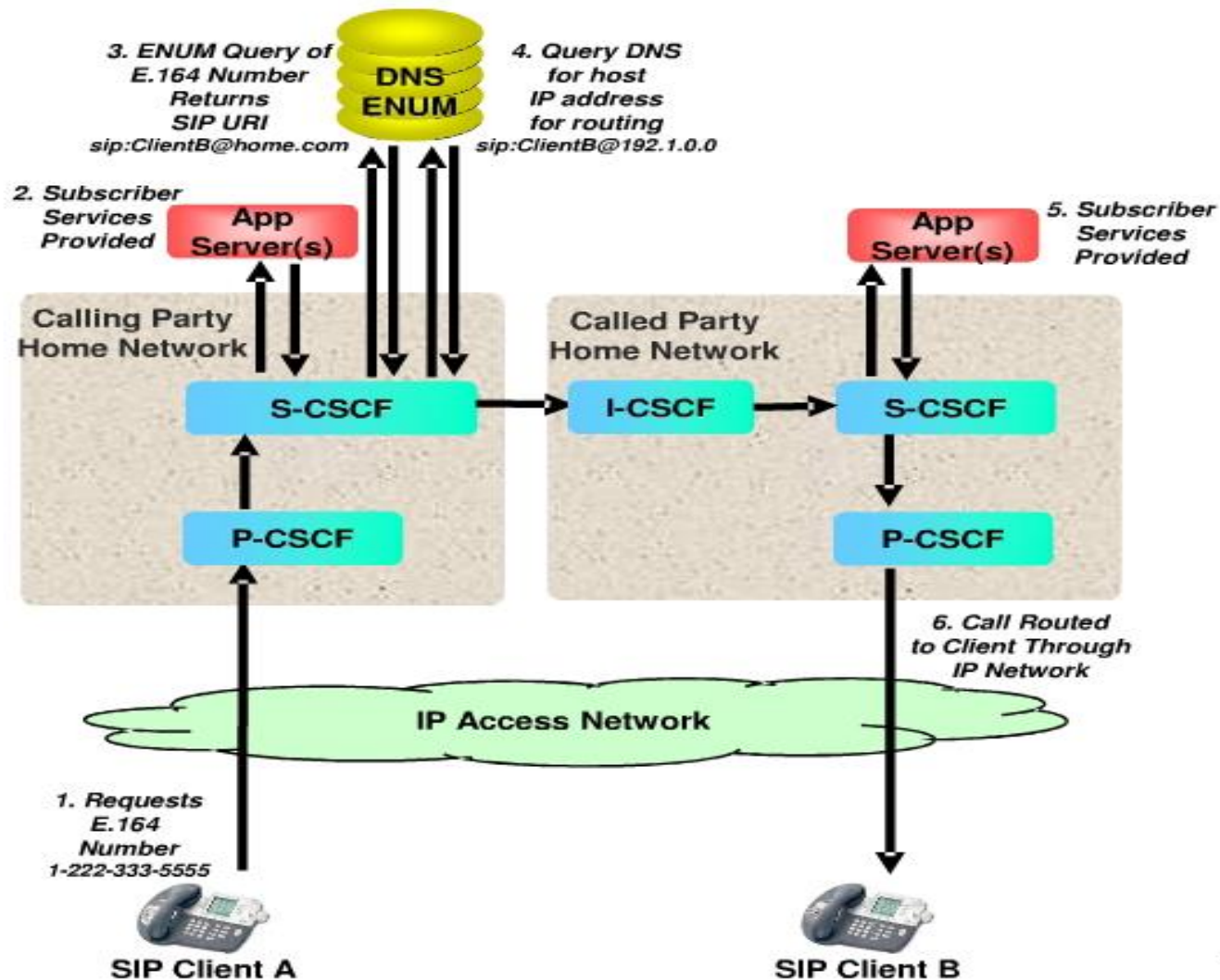
- May support both the multimedia and TDM domains
- Interacts with the MGCF for resource control (H.248 protocol)
- May terminate bearer channels from a switched circuit network and media streams from a packet network (e.g. RTP streams)
- May support media conversion, bearer control, and payload processing (e.g. codec, echo canceller, conference bridge)
  - May support tones and announcements
- Will be able to detect event (i.e. bearer loss, DTMF digits, etc.) and notify the MGCF
- May be connected via the Mb/36/38/34/33 to various network entities, such as MRFP
- Will perform DiffServ Code Point (DSCP) markings on the IP packets
- Will support conversion between RFC 2833 DTMF packets & G.711



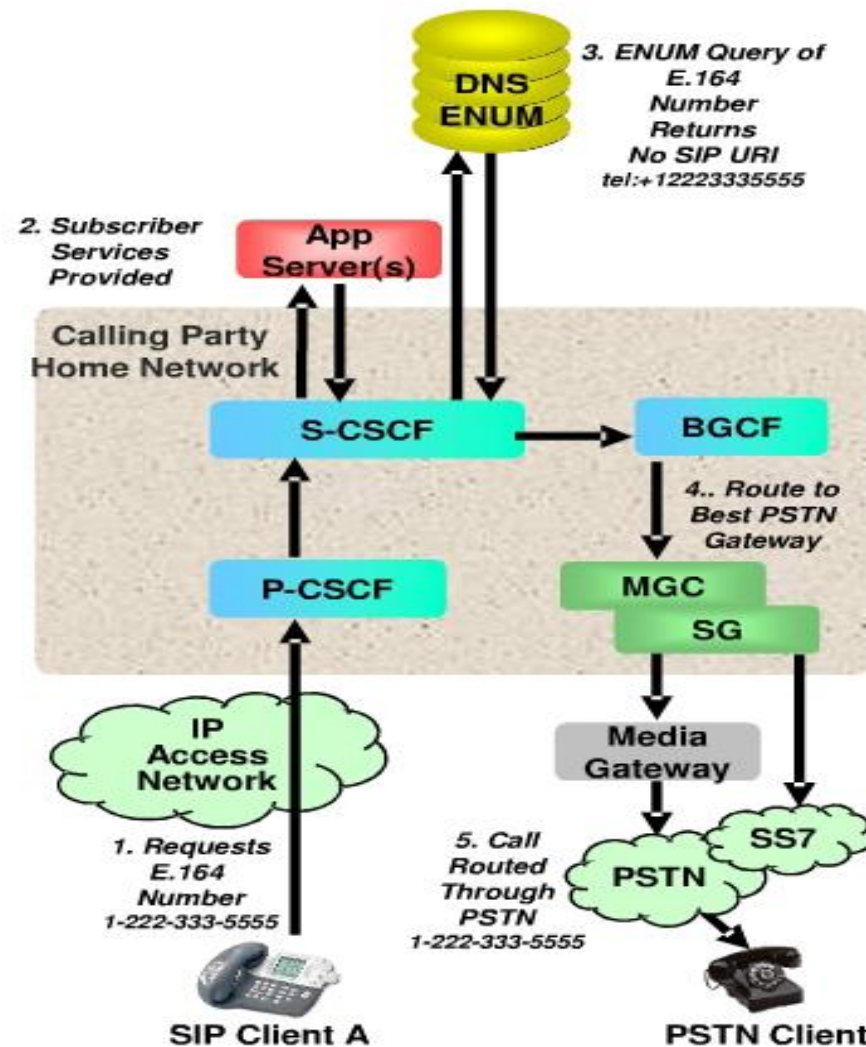


# ENUM Server

## IMS to IMS Call



## IMS to PSTN Call

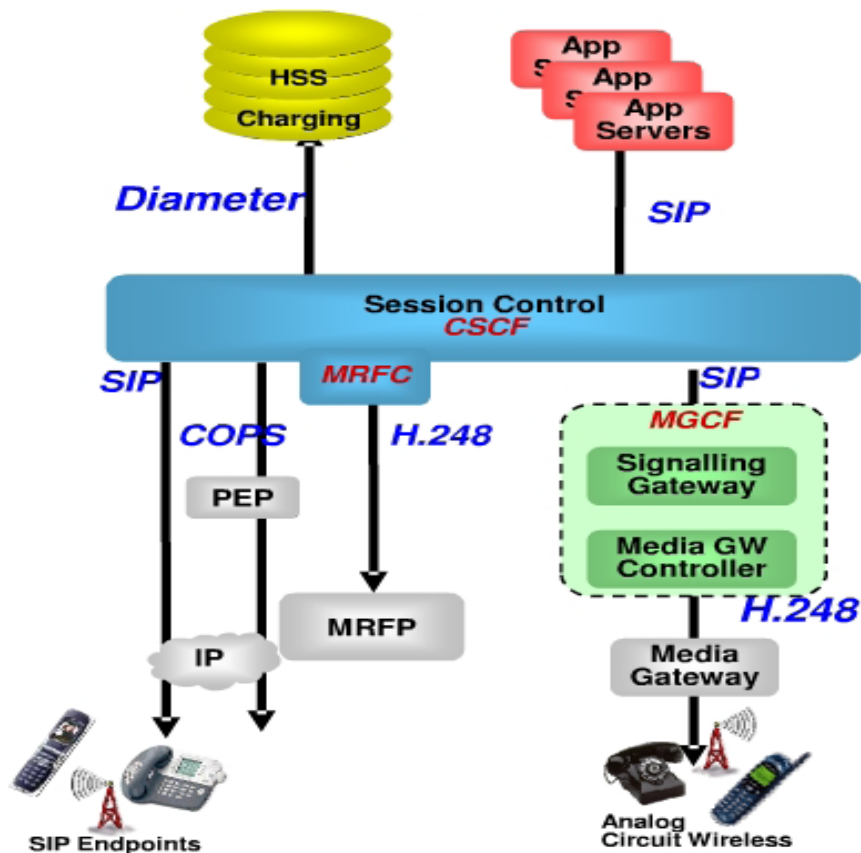


# Agenda

- IMS brief introduction
- IMS functional architecture & function entity
- ➔ ● IMS Interface & Signaling flows



# Protocol used in IMS



1. SIP
  - Dominant call control protocols in IMS
  - Used between UE/AS and session control, or within session control layer elements.
2. Diameter
  - Used to exchange user info between HSS and session control/AS. (Cx, Sh, Si interfaces, etc.)
  - Used to exchange charging information between charging collection function and session control/AS (Ro, Rf interfaces)
  - Used to exchange QoS related info between P-CSCF and PDF (Gq interface)
3. H.248
  - Used by MGC to control MGW
  - Used by MRFC to control MRFP

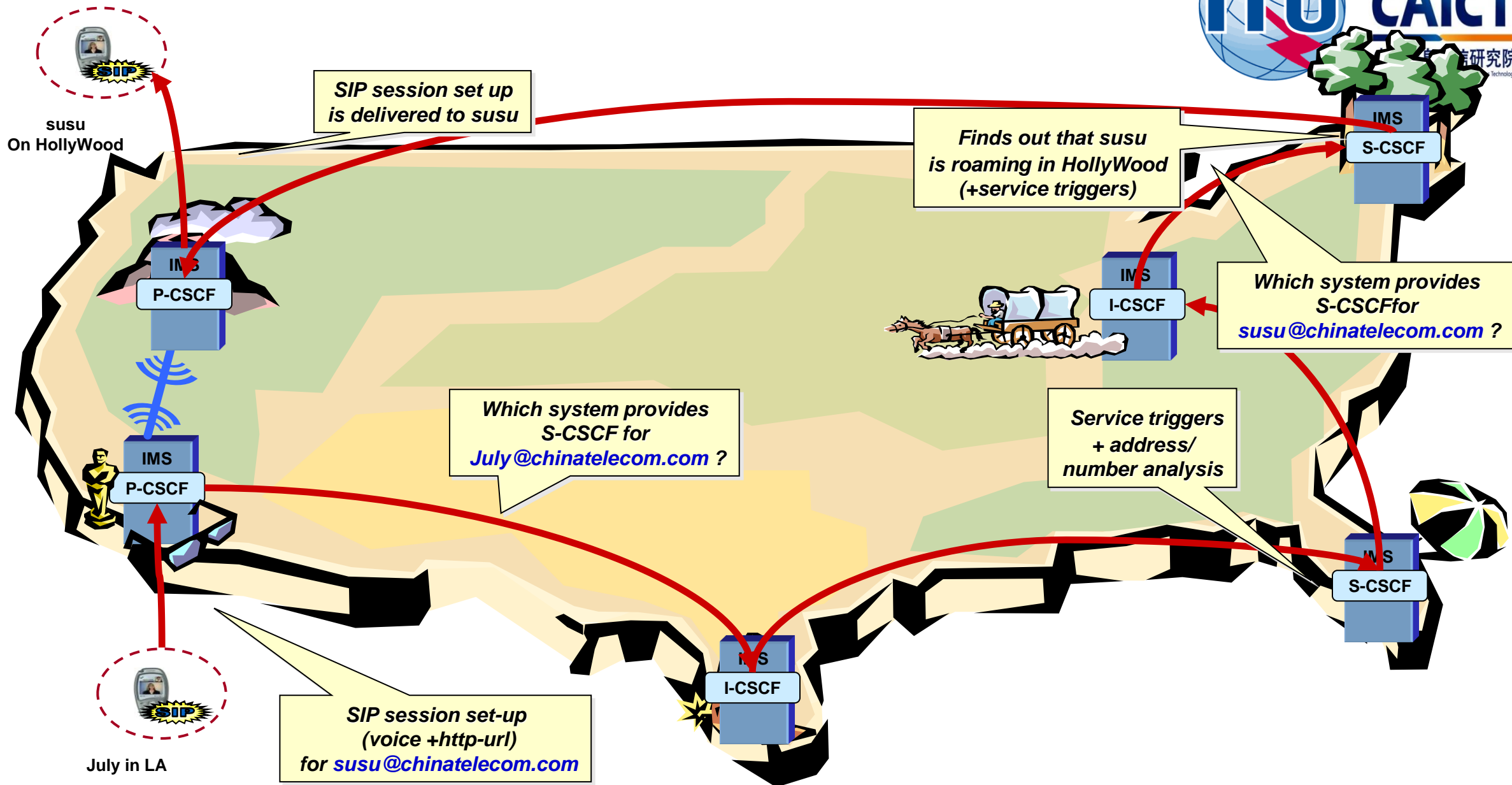
# Major SIP IETF RFC Used In IMS

- ❑ RFC 3261 - (base) SIP protocol
- ❑ RFC 2976 - SIP INFO method
- ❑ RFC 3262 - Reliability of provisional responses in SIP
- ❑ RFC 3265 - SIP specific event notification
- ❑ RFC 3311 - SIP UPDATE method
- ❑ RFC 3312 - Integration of resource management and SIP
- ❑ RFC 3313 - Private SIP extensions for media authorization
- ❑ RFC 3323 - Privacy mechanism for SIP
- ❑ RFC 3325 - Private SIP extensions for network asserted identity
- ❑ RFC 3326 - Reason Header for SIP
- ❑ RFC 3327 – SIP extension header field for registering contacts
- ❑ RFC 3428 – SIP extension for instant messaging
- ❑ RFC 3455 - Private header extensions to SIP for 3GPP
- ❑ RFC 3515 - SIP REFER method
- ❑ RFC 3608 - SIP extension header field for service route discovery
- ❑ RFC 3680 - SIP event package for registrations

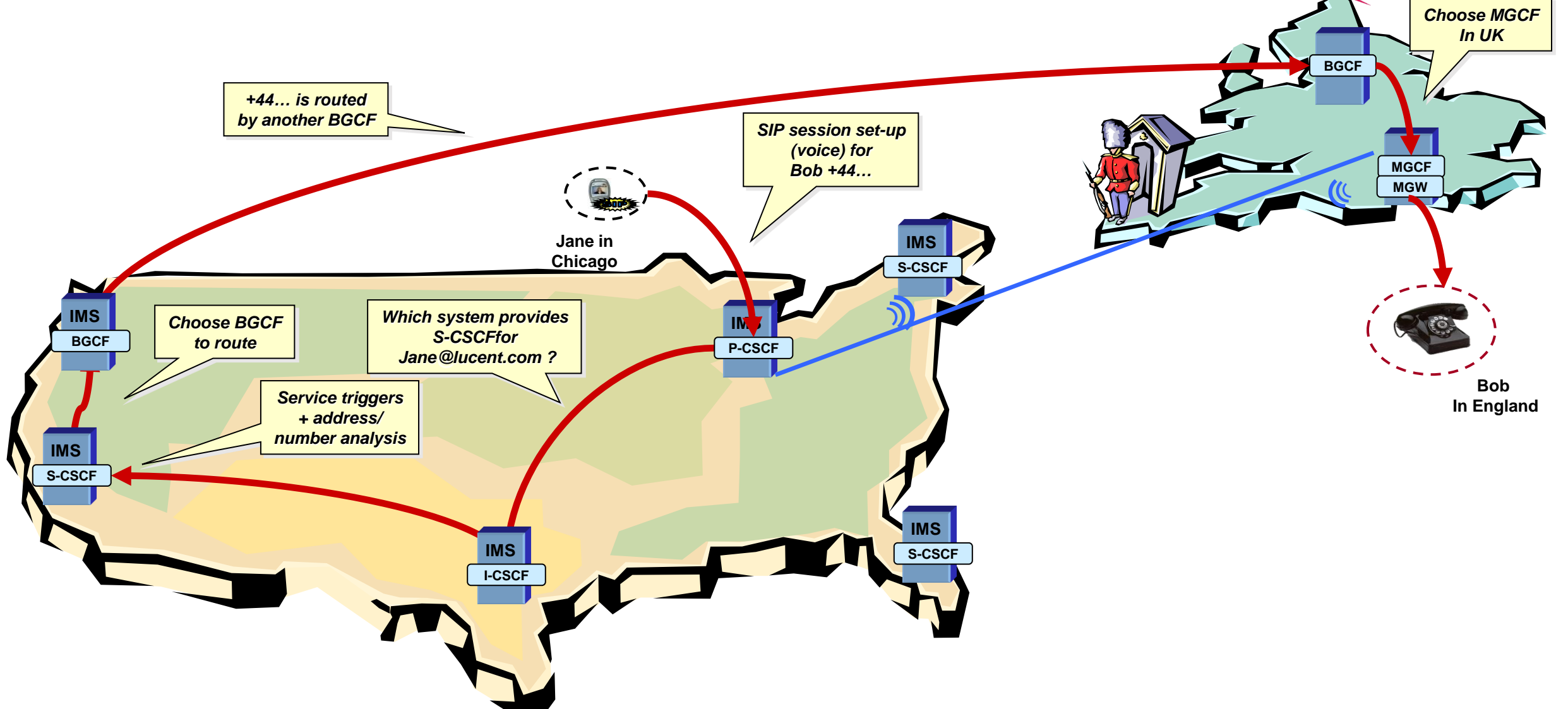




# Geographically Distributed IMS Scenario - 1



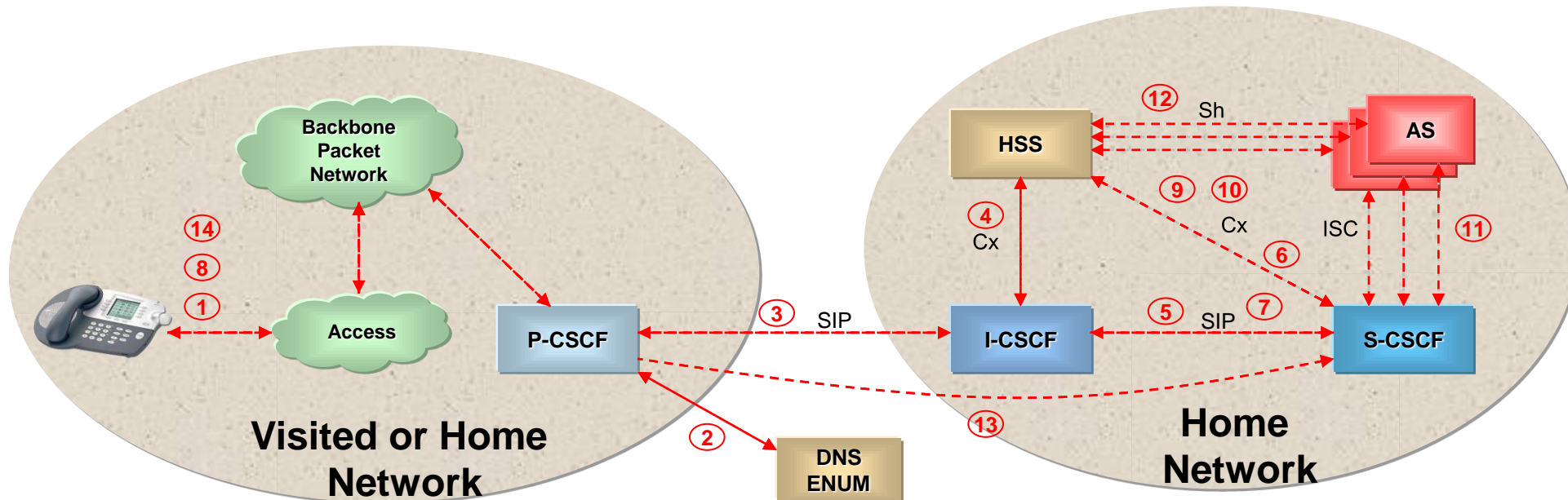
# Geographically Distributed IMS Scenario - 2



# SIP Registration / Re-Registration

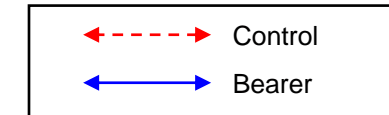
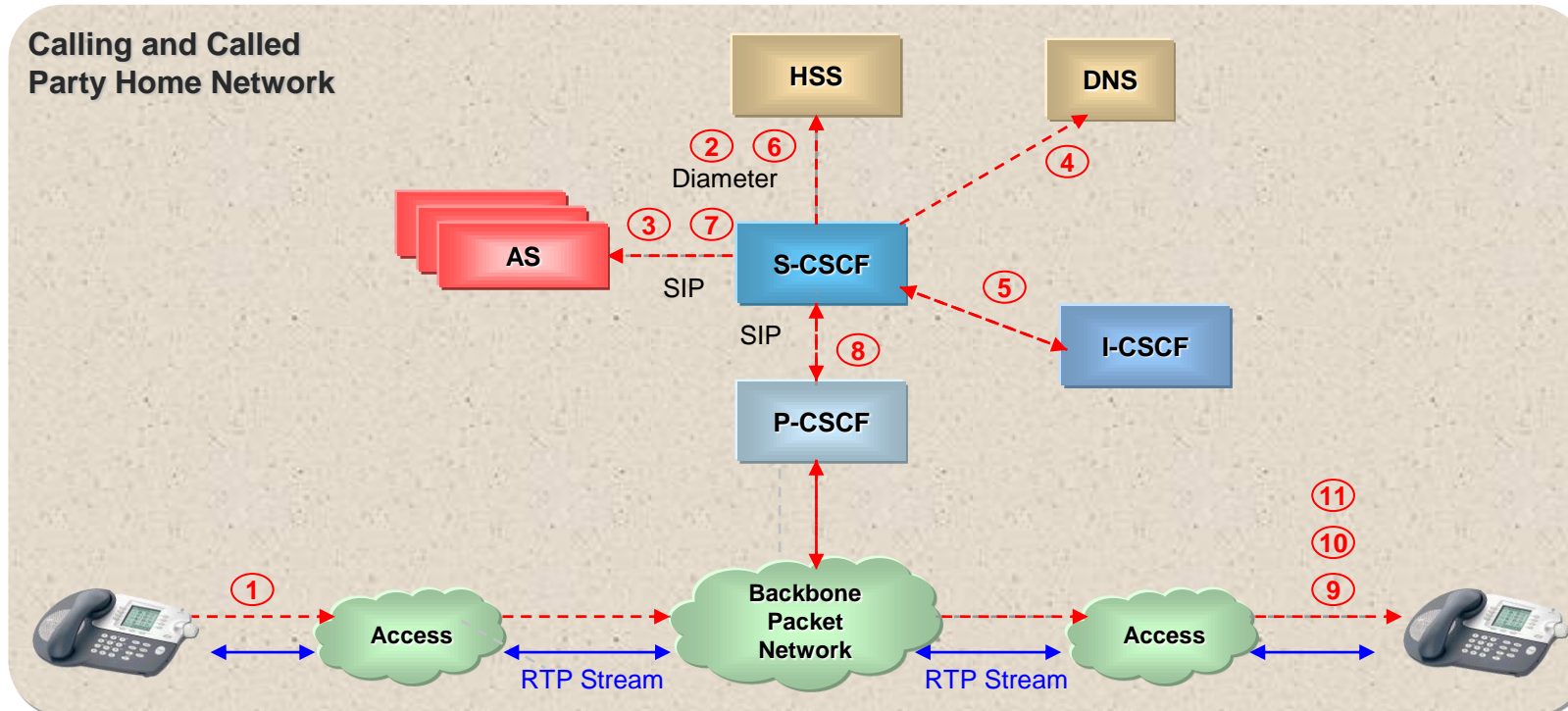


- ① Initiate SIP Registration
- ② Query DNS to obtain routing information for I-CSCF
- ③ Forward SIP REGISTER to Home Network
- ④ Retrieve information needed for S-CSCF Selection
- ⑤ Forward SIP REGISTER to S-CSCF
- ⑥ Retrieve and select Authentication Vector
- ⑦ Reject with Authentication Data
- ⑧ Re-initiate SIP Registration (steps 1 – 5)
- ⑨ Store S-CSCF Name
- ⑩ Retrieve Subscriber Profile and Filter Criteria
- ⑪ Register with AS(s) based on Filter Criteria
- ⑫ AS(s) retrieve Subscriber profile (if needed)
- ⑬ P-CSCF SUBSCRIBE, for de-registration
- ⑭ UE SUBSCRIBE, for de-registration



# IMS Subscriber to IMS Subscriber (Single Network)

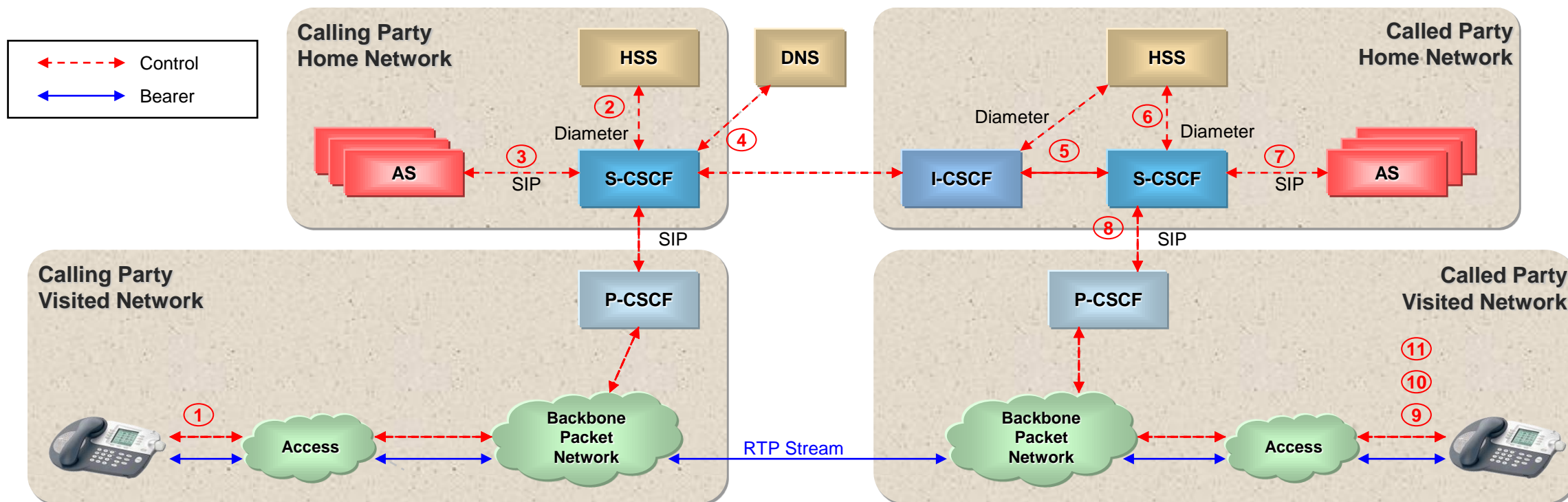
- ① Initiate SIP Invitation
- ② Retrieve Subscriber Profile (if needed)
- ③ Apply Service Logic
- ④ Retrieve Address of CLD Party Home Network and Forward INVITE.
- ⑤ Identify Registrar of CLD Party and Forward INVITE.
- ⑥ Retrieve Subscriber Profile (if needed)
- ⑦ Apply Service Logic
- ⑧ Forward INVITE to CLD Party
- ⑨ SDP Negotiation / Resource Reservation Control
- ⑩ Ringing / Alerting
- ⑪ Answer / Connect



# IMS Subscriber to IMS Subscriber (Multiple Networks)



- ① Initiate SIP Invitation
- ② Retrieve Subscriber Profile (if needed)
- ③ Apply Service Logic
- ④ Retrieve Address of CLD Party Home Network and Forward INVITE.
- ⑤ Identify Registrar of CLD Party and Forward INVITE.
- ⑥ Retrieve Subscriber Profile (if needed)
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- ⑧ Forward INVITE to CLD Party
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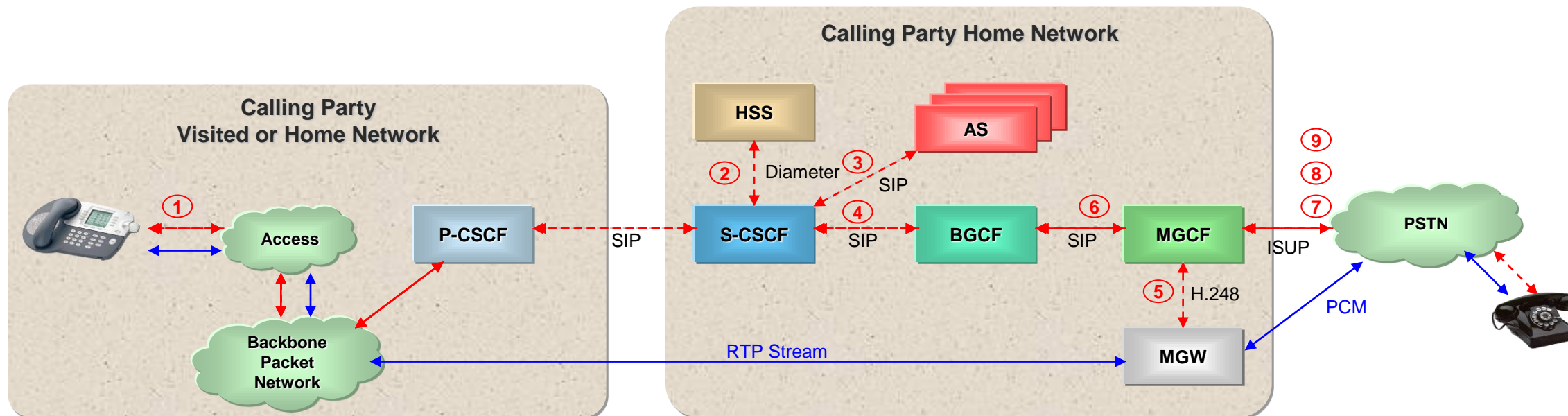
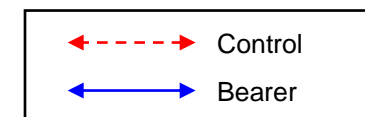




# IMS Subscriber to PSTN(Single BGCF)

- ① Initiate SIP Invitation
- ② Retrieve Subscriber Profile (if needed)
- ③ Apply Service Logic
- ④ Select network to access PSTN, and select MGCF
- ⑤ Seize trunk / determine media capabilities of MGW
- ⑥ SDP Negotiation / Resource Reservation Control

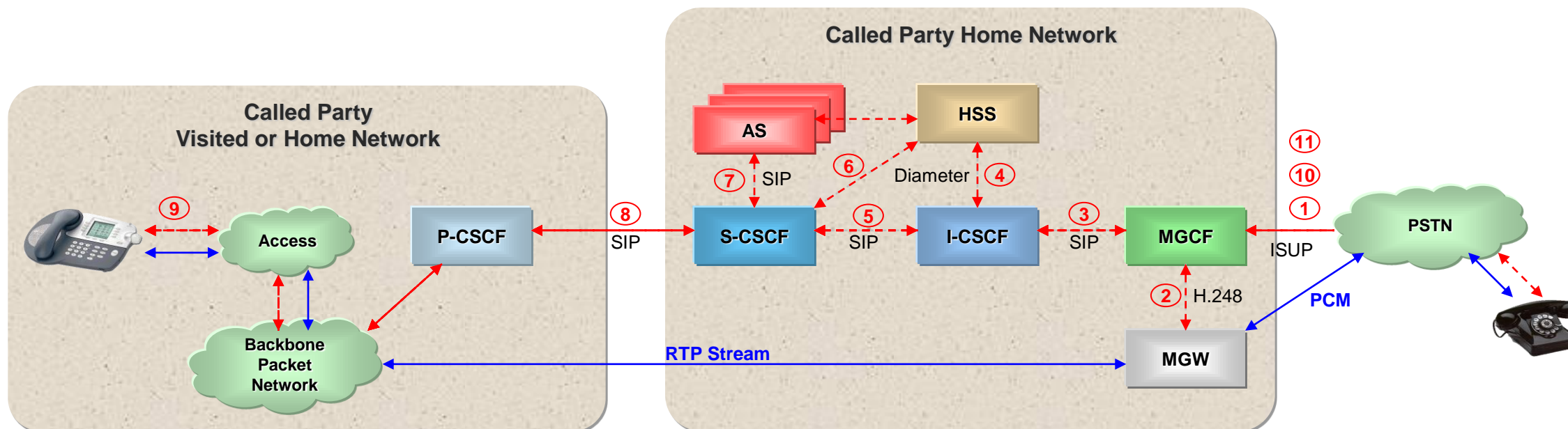
- ⑦ ISUP IAM
- ⑧ Ringing / Alerting
- ⑨ Answer / Connect





# PSTN to IMS Subscriber

- ① Incoming Call (ISUP IAM)
- ② Seize Trunk and IP Port
- ③ Initiate SIP Invitation
- ④ Determine where the Subscriber is Registered
- ⑤ Forward SIP INVITE to S-CSCF
- ⑥ Retrieve Subscriber Profile (optional)
- ⑦ Service Logic (if needed)
- ⑧ Forward SIP INVITE to Called Party UE
- ⑨ SDP Negotiation / Resource Reservation Control
- ⑩ Alerting / Ringing
- ⑪ Connect / Answer





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