

सत्यमेव जयते

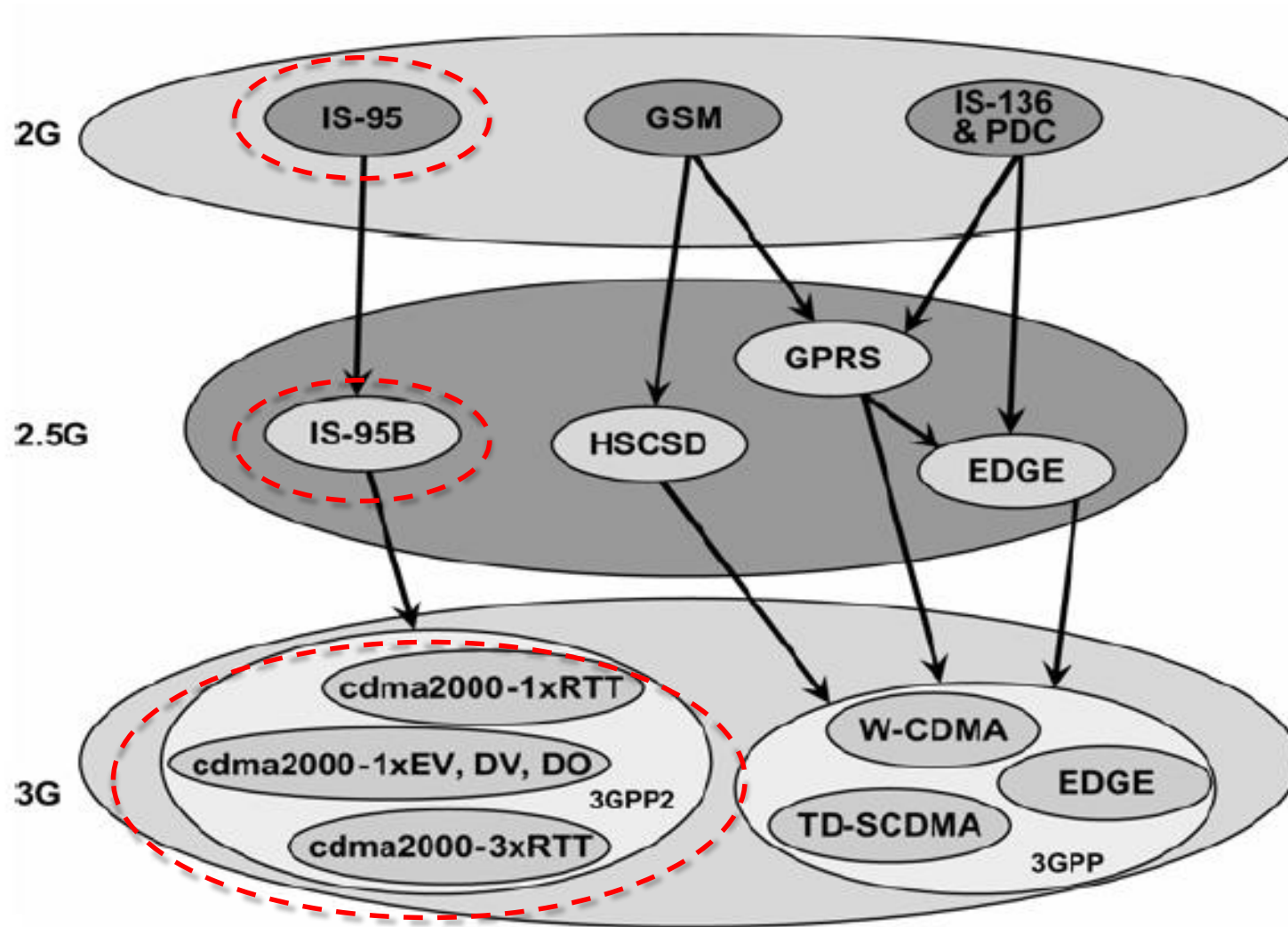
NTIPRIT

CDMA Architecture its Evolution

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Evolution - 2G to 3G



Interim Standard 95 (IS-95)

- Also known as cdmaOne
- 64 users in a 1.25 MHz channel.
- Can be used in 800 MHz and 1900 MHz bands.
- Sprint and Verizon in the U.S.

Interim Standard 95 (IS-95)

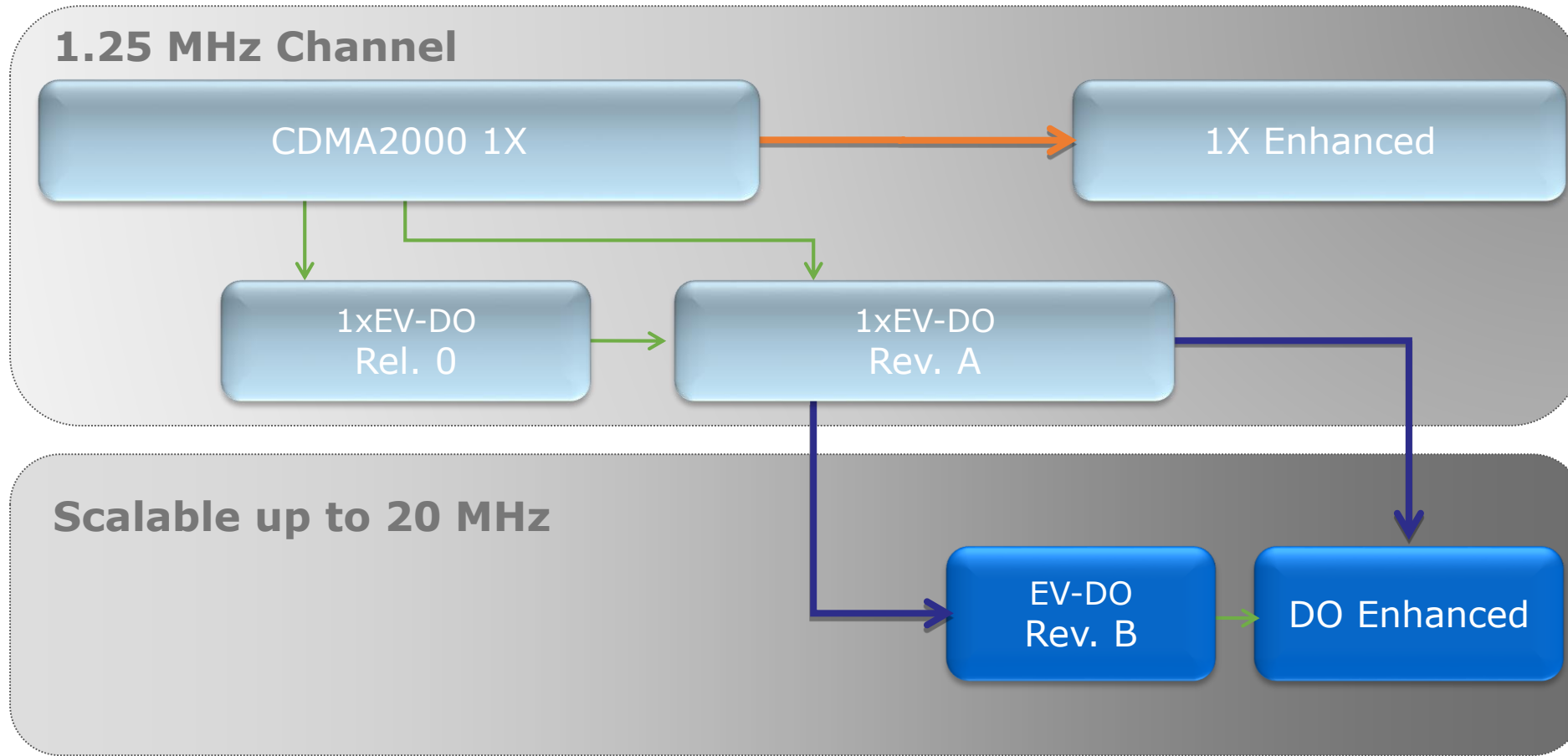
- Spectrum bandwidth:
 - 1850 to 1910 MHz Mobile to Base
 - 1930 to 1990 MHz Base to Mobile
- Channels are 1.25 MHz
 - 3.75 MHz in CDMA 2000, 5 MHz in UMTS
 - Results in approximately only 48 forward/reverse channel pairs in IS-95.
- Adjacent cell phone towers use the exact same channels as all other towers.
 - This is a major difference.
 - Allows for much better frequency reuse and makes setting up a cellular network much easier.

Upgrade path from IS-95A to IS-95B for 2.5G CDMA

- Only one upgrade path for IS-95
- Users can use up to 8 CDMA codes simultaneously.
- $14.4 \text{ kbps} * 8 = 115.2 \text{ kbps}$
- Practical throughput is 64 kbps that can actually be achieved.
- Also changes the method of handoff between base stations.

CDMA2000: Flexible Migration Path

CDMA2000 allows operators the flexibility to design an evolution path that meets their unique needs



2000 | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** | **2009** | **2010** | **2011+**

cdma2000

- From IS-95/IS-95B
- Works within original 2G CDMA channel bandwidth of 1.25 MHz.
- Allows wireless carriers to introduce 3G in a gradual manner.
 - Can introduce 3G capabilities at each cell
 - Do not have to change out entire base stations
 - Do not have to use different spectrum.

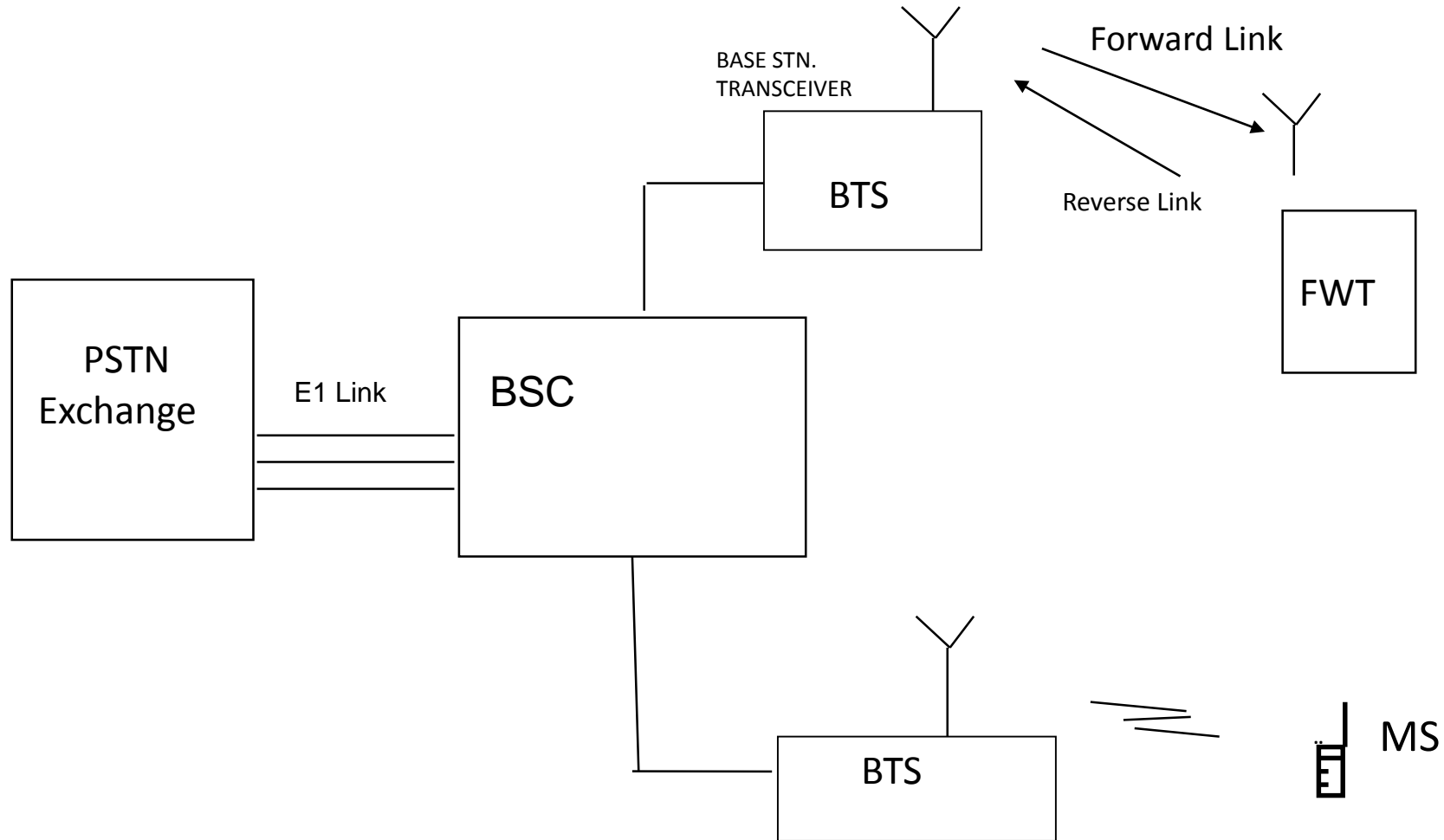
cdma2000 1xRTT

- 1X = one times the original IS-95 (cdmaOne) channel bandwidth.
- RTT = Radio Transmission Technology
- Commonly just referred to as cdma2000 1X.
- Instantaneous data rate of 307 kbps.
 - Typical rates up to 144 kbps
- Uses rapidly adjusting rates.
- No additional RF equipment is needed.
 - All changes made in software or with additional hardware.

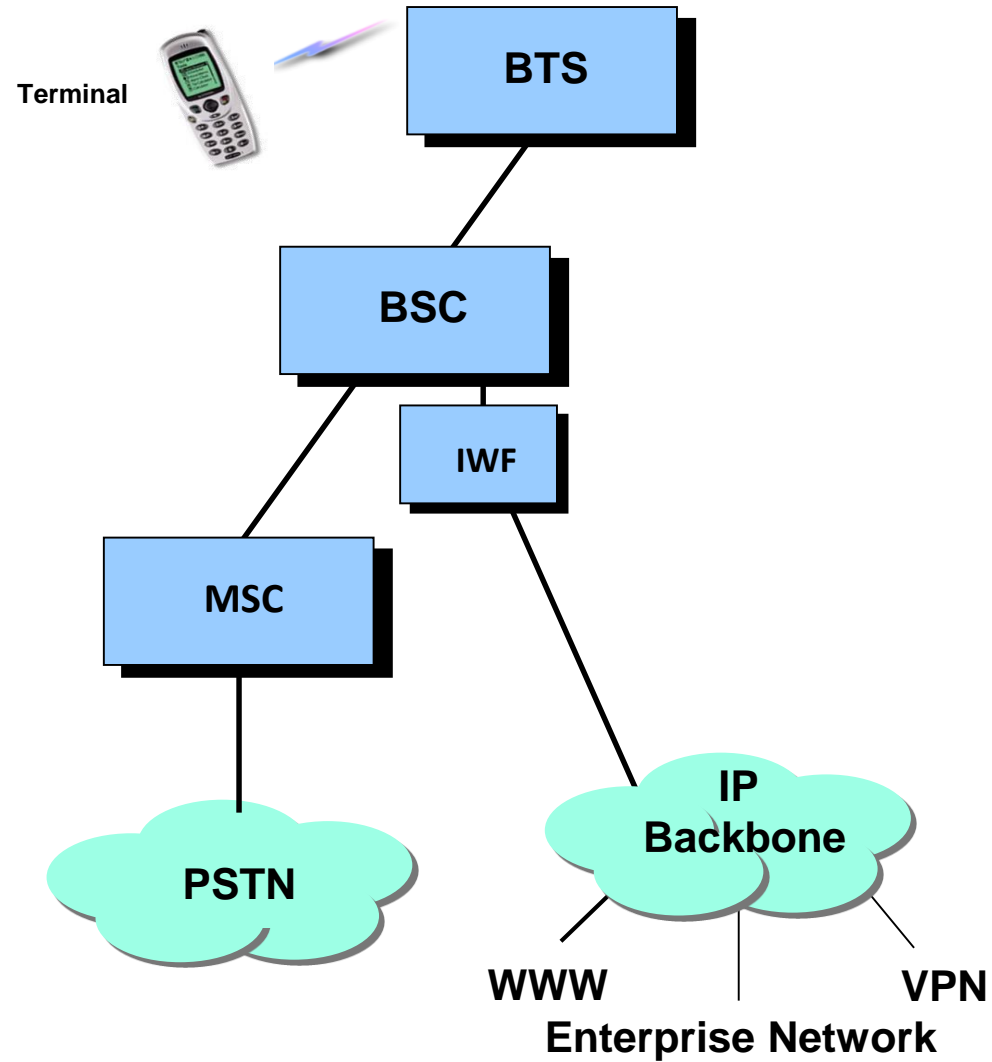
cdma2000 1xEV

- EV = Evolutionary enhancement
- High data rate packet standard overlaid on existing IS-95, IS-95B, and cdma2000 networks.
- 1xEV-DO
 - Data only channel
 - Restricts a shared 1.25 MHz channel strictly to data users.
 - Supports greater than 2.4 Mbps throughput per user.
 - Actual data rates usually much lower.
 - Typical: Several hundred kbps.
 - Highly dependent on number of users, propagation conditions, and velocity of mobile.

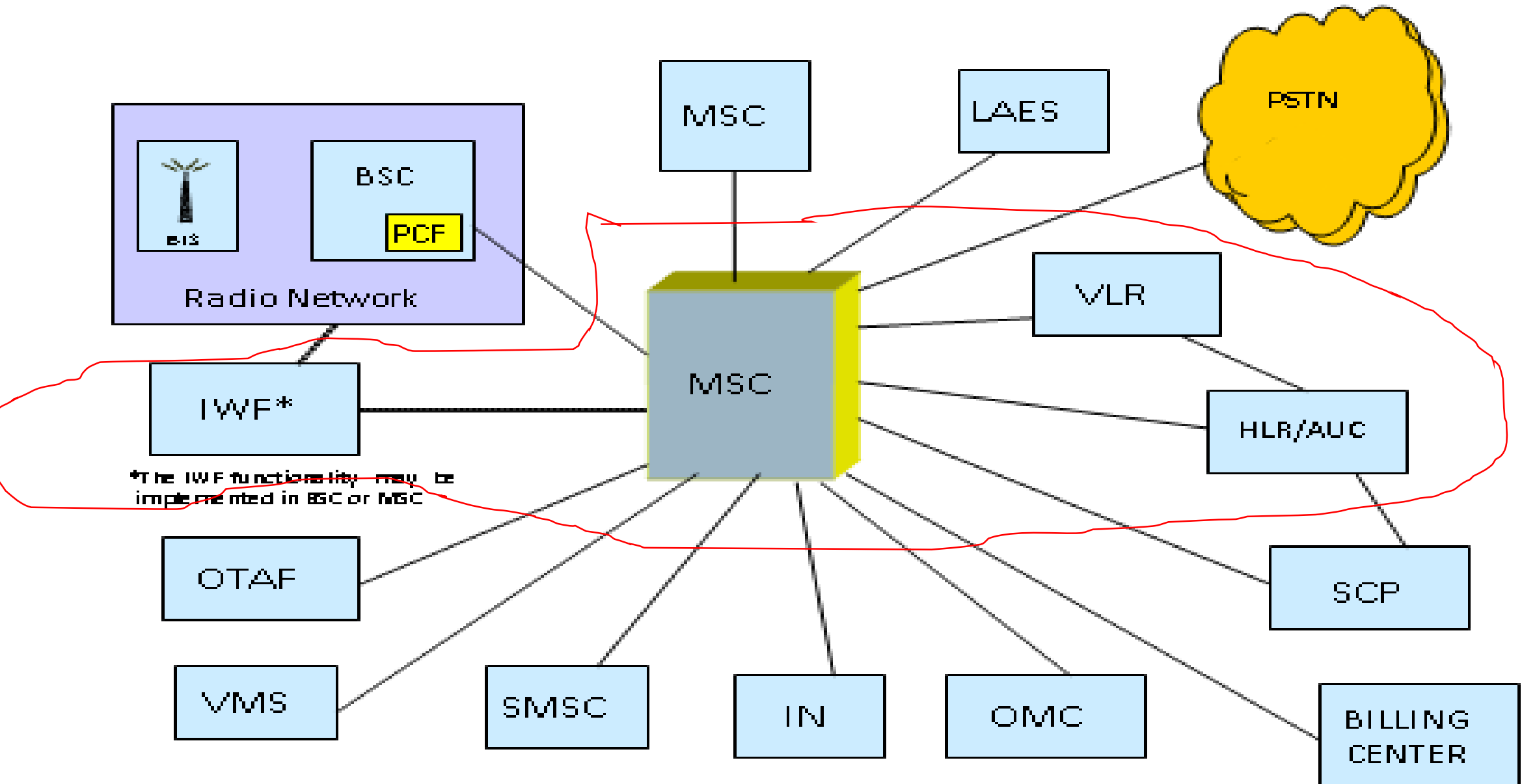
Network Architecture of BSC based IS-95 Systems



Cdma One Network



MSC BASED CORE NETWORK FOR CDMA 2000 1x SYSTEM



MSC/VLR

MSC (Mobile Switching Center) is responsible for **call establishment**, **route selection**, **call control**, **radio resource allocation**, **mobility management**, **location registration** and **channel handoff** in switching areas. In addition, it generates bill information, coordinates services between it and the PSTN.

VLR (Visitor Location Register) acts as a dynamic database and stores the temporary information (all data necessary to set up call connections) about the users roaming to the local MSC area.

HLR/AUC

- **HLR (Home Location Register)** serves as the primary database repository for subscriber information (telecom service subscription information and user status), RS location information, MDN, IMSI (MIN), etc.
- Mobile subscriber profiles, locations and activities, and information about supplementary subscriber services are all seamlessly managed for the Mobile operator by the HLR.
- One HLR can serve one or more MSC.

HLR/AUC

- **AUC (Authentication Center)** is a functional unit of the HLR, specially dedicated to the security management of the CDMA system.
- It is physically combined with the HLR.
- It stores the authentication information and ciphering key and prevents unauthorized users from accessing the system and prevents the unauthorized radio interception.
- Functional entity of HLR/AUC may be physically integrated with logical separation or it can be stand alone HLR/AUC.

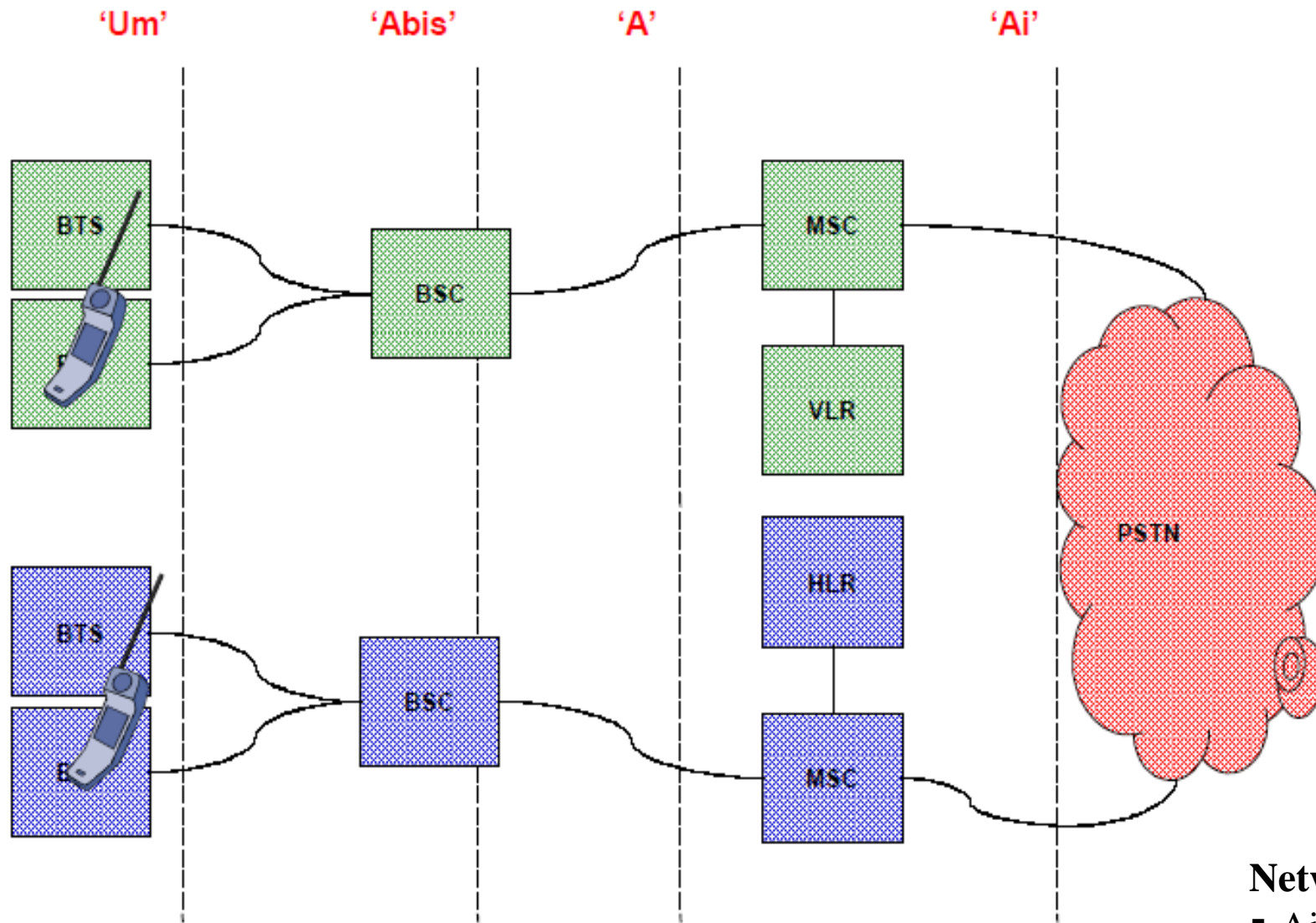
Interworking Function(IWF)

- IWF acts as a **gateway** between the wireless CDMA networks and the wireline Public Switched Telephone Network (PSTN/packet data networks).
- IWF provides the interworking and protocol conversion required for offering data services to cdma One Mobile subscribers.
- The IWF functionality may be implemented in BSC or MSC.

Operations and Maintenance Centre (OMC)

- OMC allows the centralized operation of the various units in the system and the functions needed to maintain the sub systems.
- The OMC provides the dynamic monitoring and controlling of the network management functions for operation and maintenance.

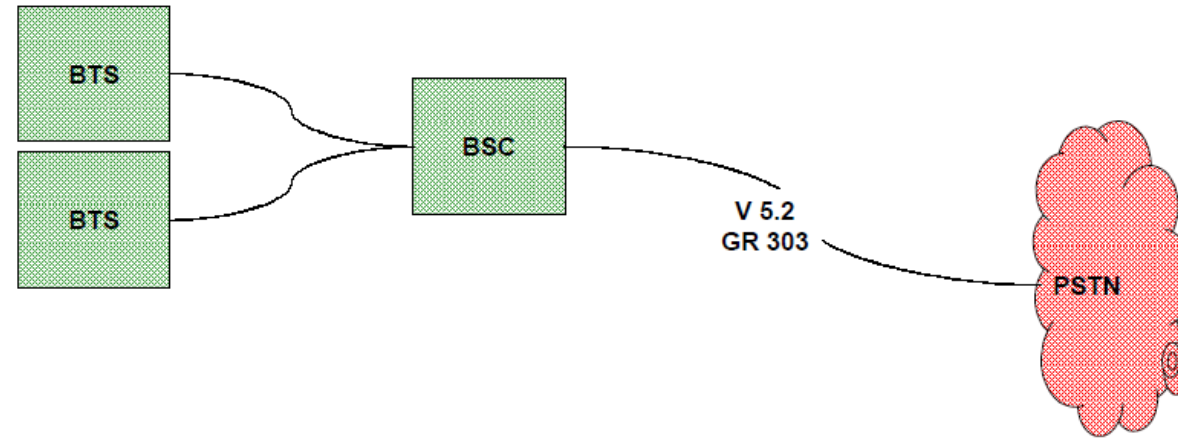
Network Interconnects and Standards



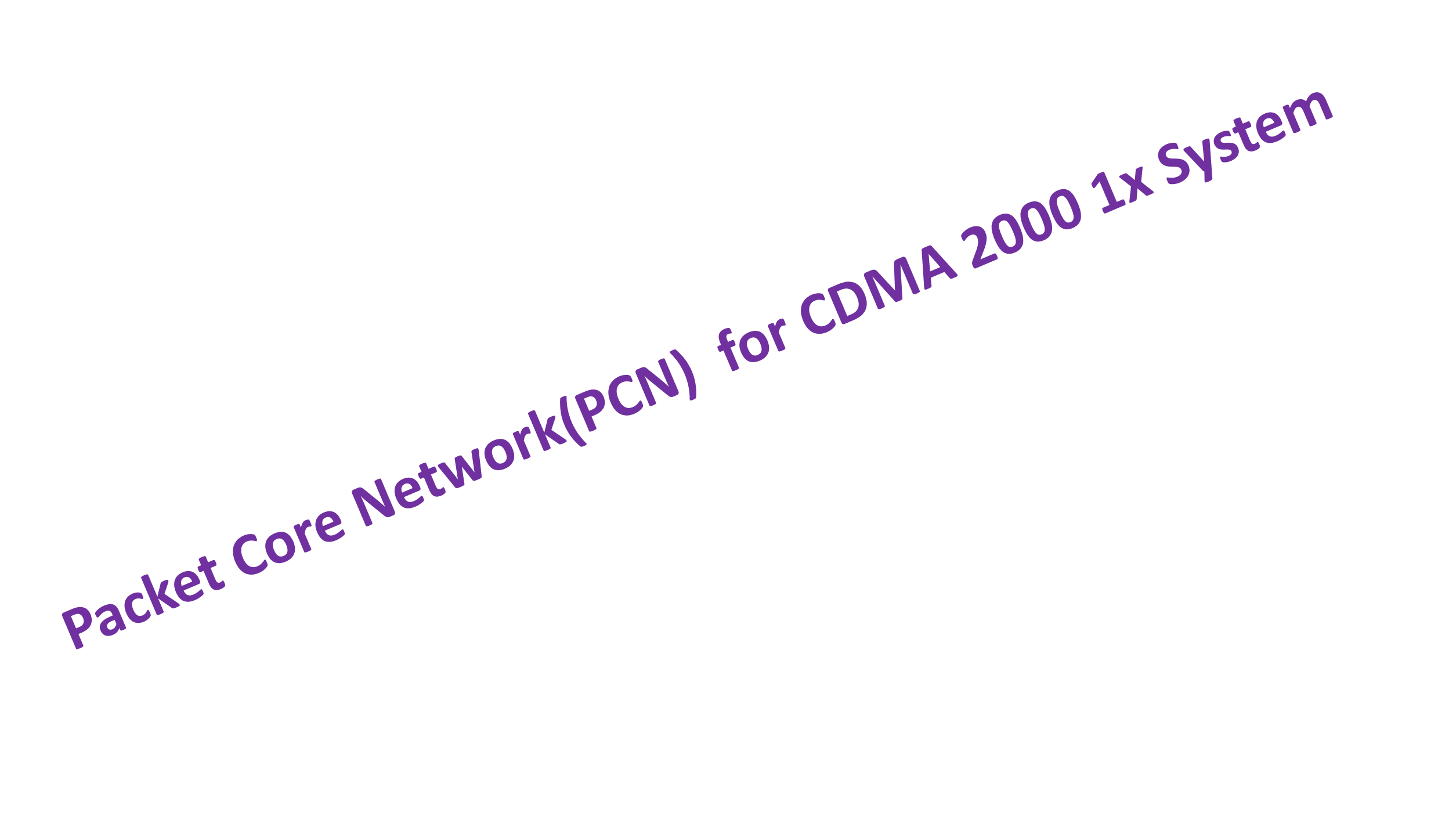
Network Interconnects

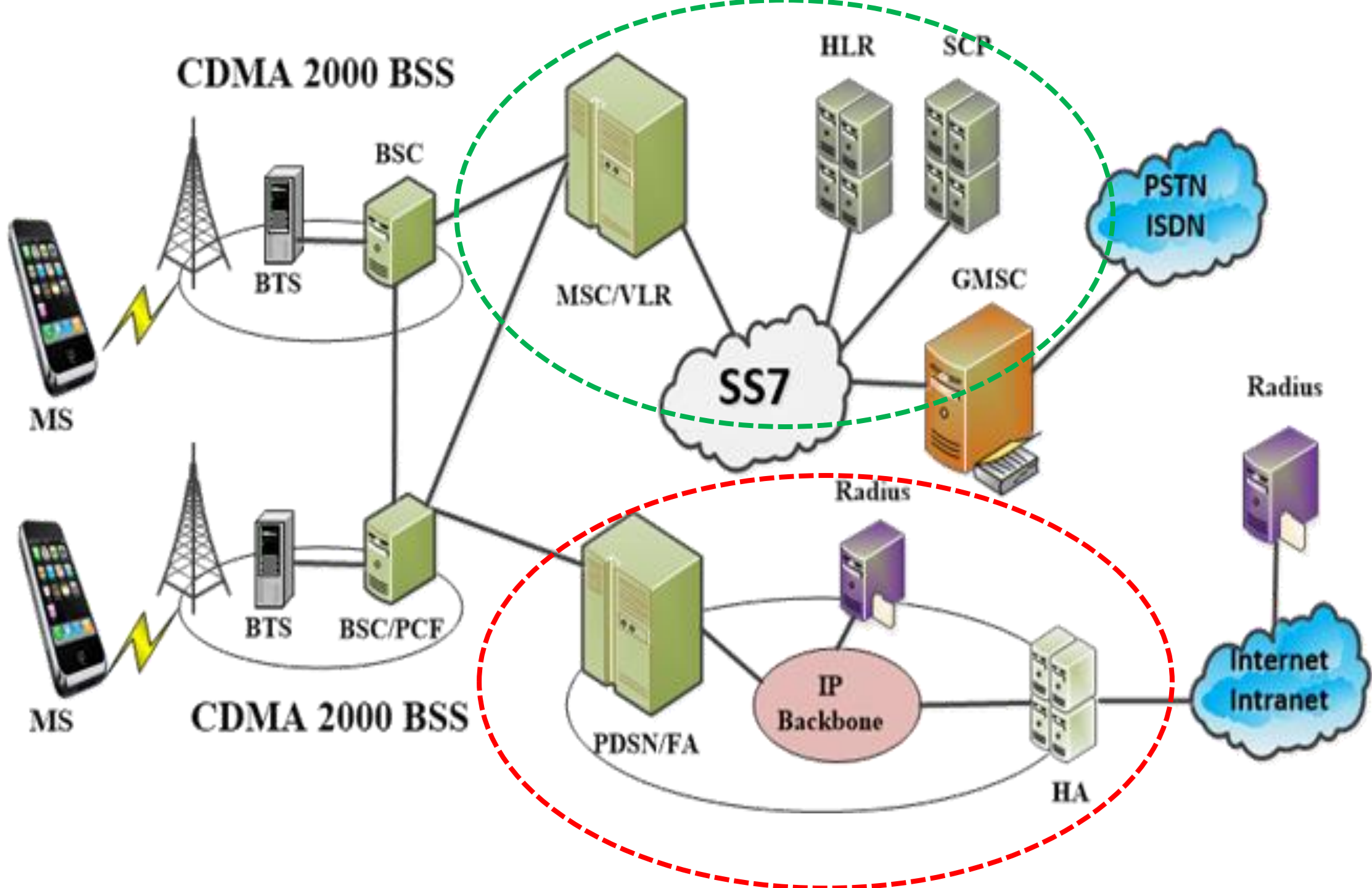
- Airlink: "Um" Interface
- BTS-to-BSC: "A" Base Station Interface (bis)
- BSC-to-MSC: "A" Interface
- MSC-to-MSC: "Ai" Interface

BSC-to-PSTN

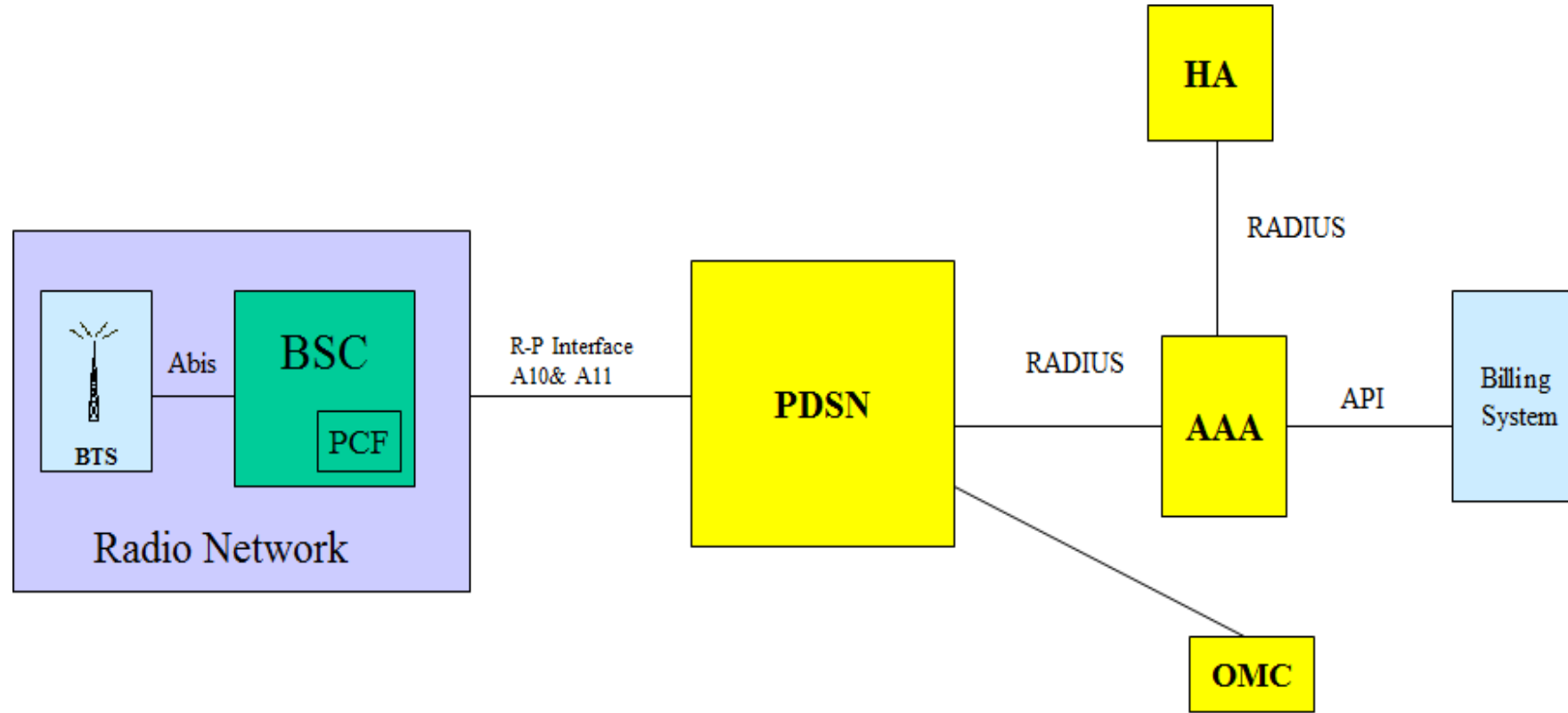


- For WLL applications which have limited or no mobility, therefore allowing the PSTN to perform the functions necessary.
- *V5.2* – interface standard was defined by the ETSI
- *GR-303* –interface defined by Bellcore





Packet Core Network(PCN) for CDMA 2000 1x System



Packet Data Serving Node (PDSN)

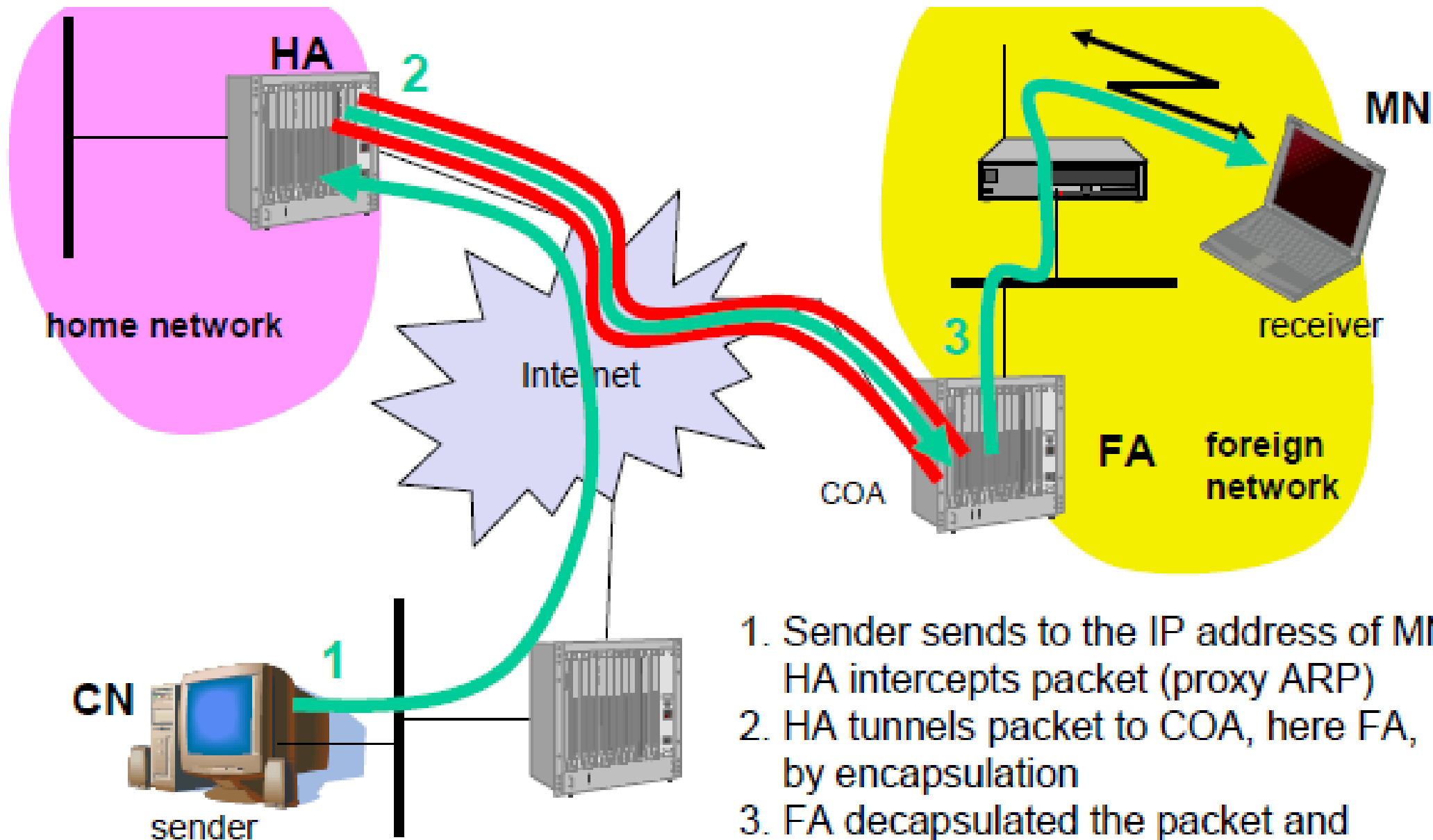
- PDSN provides the gateway between the cellular systems and the wire-line Internet Protocol(IP) Packet Data network.
- It interfaces between transmission of the packet data in the fixed network and its transmission over the air interface.
- One PDSN can be connected to multiple BSCs (PCF) and one BSC (PCF) can connect to multiple PDSNs.
- It also acts as a client for AAA servers.

Authentication, Authorization and Accounting (AAA) Server

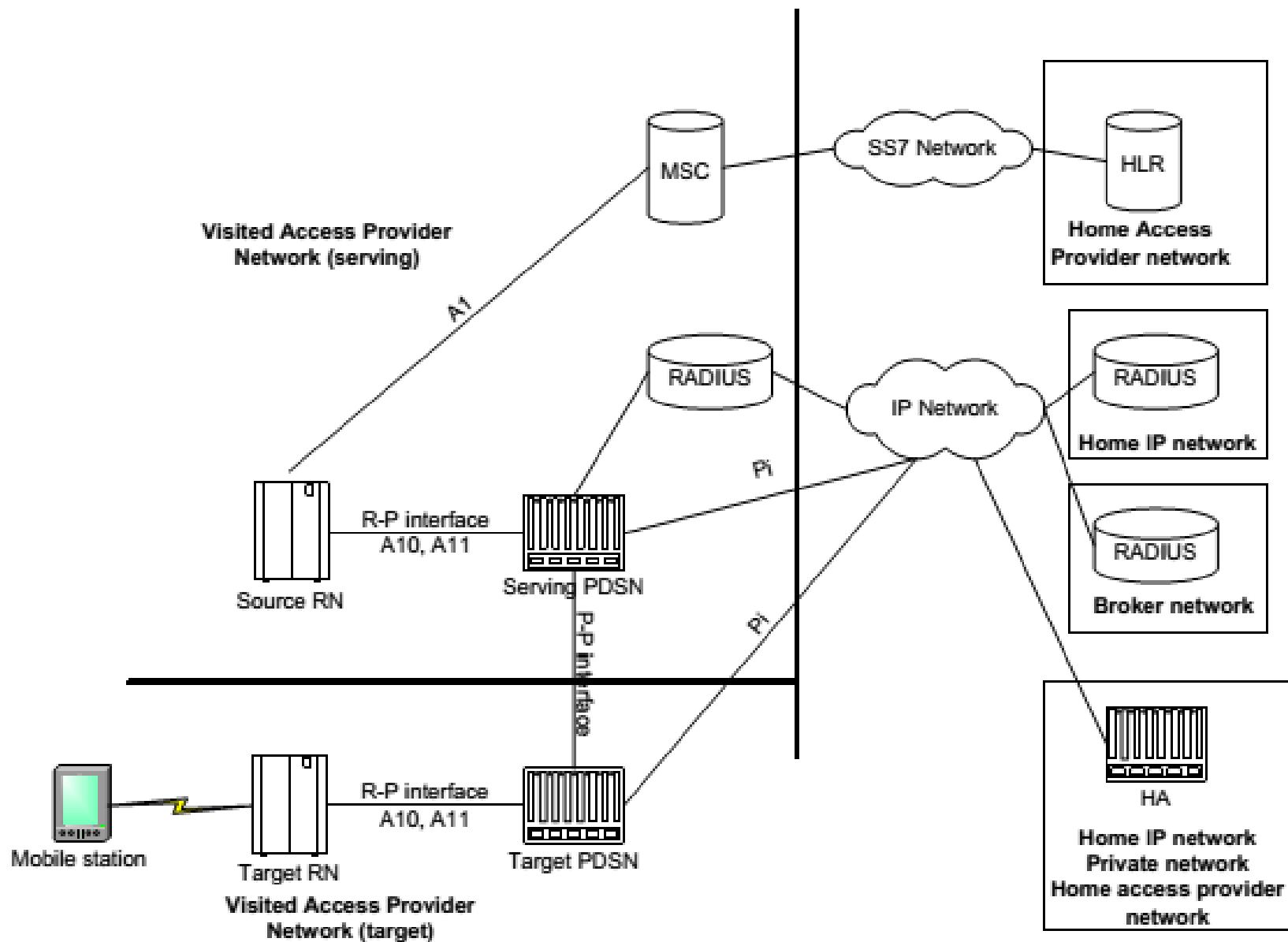
- The AAA server provides the functions of
 - Authentication
 - Authorization
 - Accounting
- It interacts with the PDSN to perform AAA functions in support of the PDSN for requesting Remote Stations.
- It also generates the Usage Data Records (UDRs) for IP services.

Home Agent (HA)

- HA is required to support Mobile IP. HA enables mobility management for Mobile IP subscribers.
- Home Agent authenticates Mobile IP registrations from the Mobile station, maintains current location information for RS and redirects packets to the Foreign Agent.
- The HA is responsible for attracting traffic destined for the mobile node and for tunneling it to the CoA (care of address) associated with a given mobile node for further delivery to mobile node.
- CoA is an indirect pointer to the mobile node and represents the topologically correct and reachable IP address that corresponds to the mobile node's current network attachment, so that the home agent can tunnel packets to mobile node (Mobile IP device).



1. Sender sends to the IP address of MN, HA intercepts packet (proxy ARP)
2. HA tunnels packet to COA, here FA, by encapsulation
3. FA decapsulated the packet and forwards it to the MN



Reference Model for Mobile IP Access

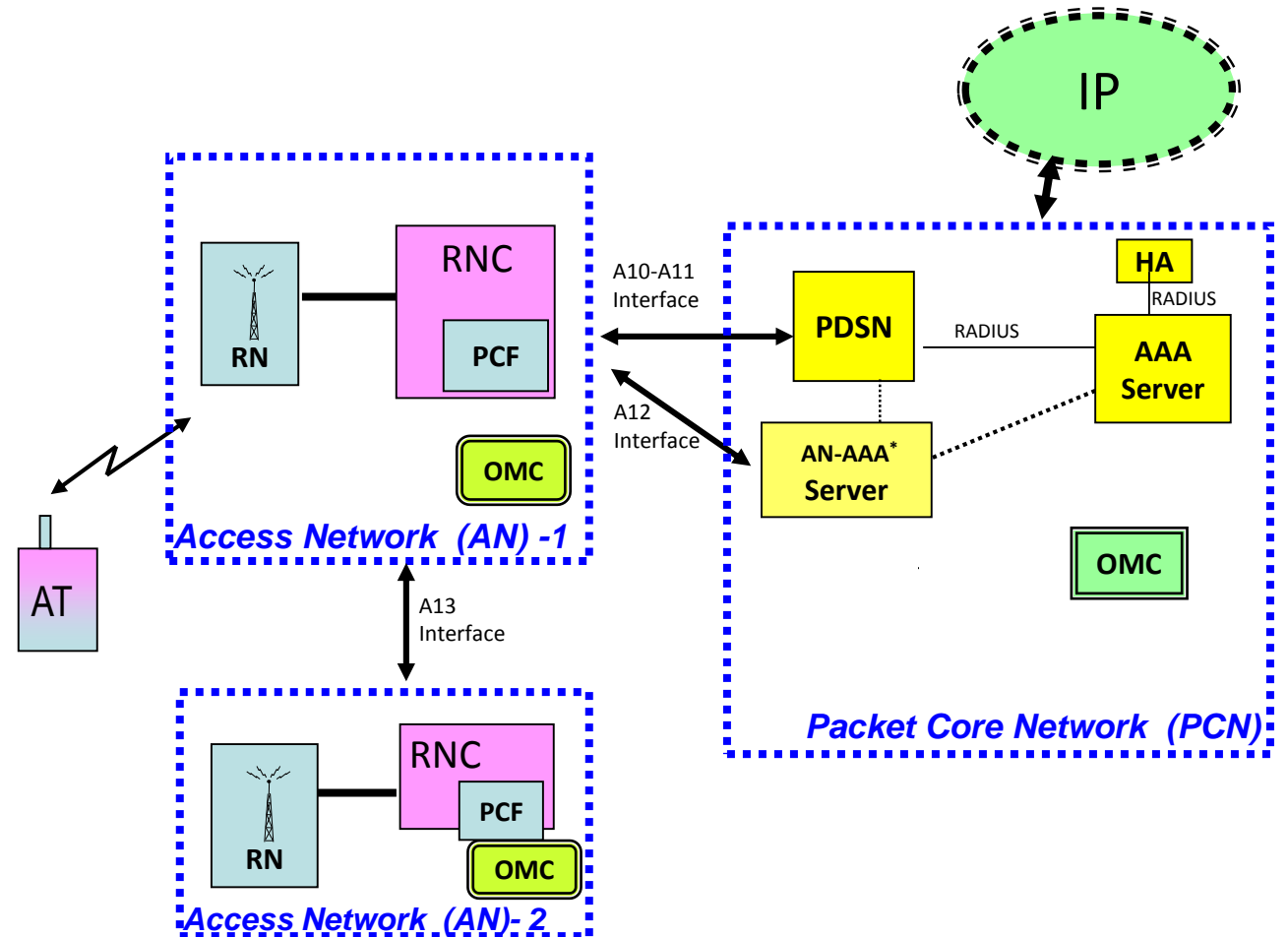
CDMA2000 1x EV-DO System

CDMA2000 1x EV-DO System

CDMA 2000 EV-DO System typically consists

of:

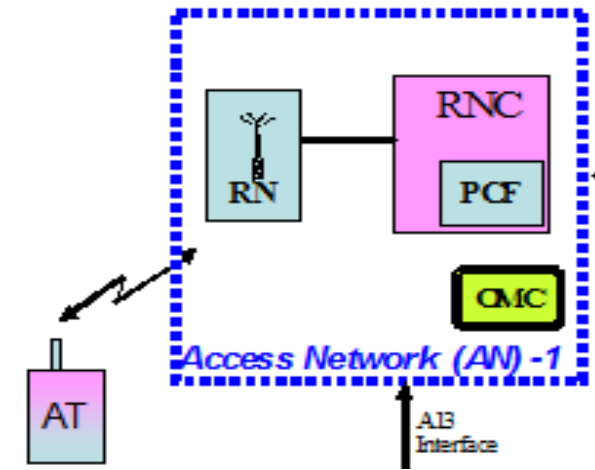
- a) Access Network (AN) consisting of Radio Node (RN) & Radio Network Controller (RNC)
- b) Packet Core Network (PCN)
- c) Operations and Maintenance Centre (OMCs) of AN and PCN



Access Network (AN)

a) Radio Node (RN):

- Multiple circuit transceiver which radiates to cover a cell/sector.
- Consists of radio modules, base band signal processor, network interface, antenna, feeder etc.
- Performs functions related to channel coding/decoding, interleaving, encryption, frame building, modulation /demodulation, RF transceiver, antenna diversity, low noise amplification etc.
- AN obtains timing reference and positioning reference from the GPS system and hence the GPS receiver form an integral part of the RN.
- Can be co-located with RNC or remotely located.

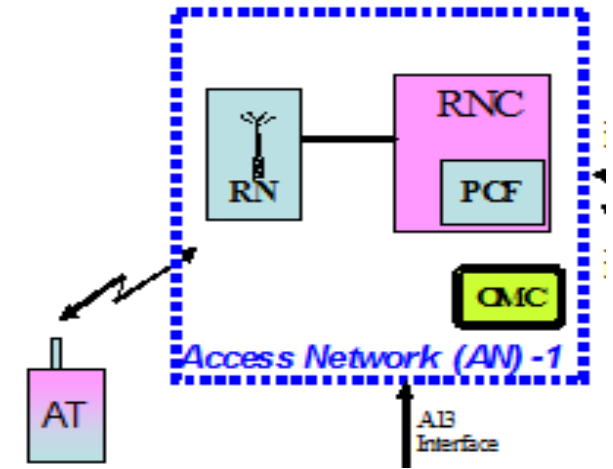


Access Network (AN)

contd..

b) Radio Network Controller (RNC)

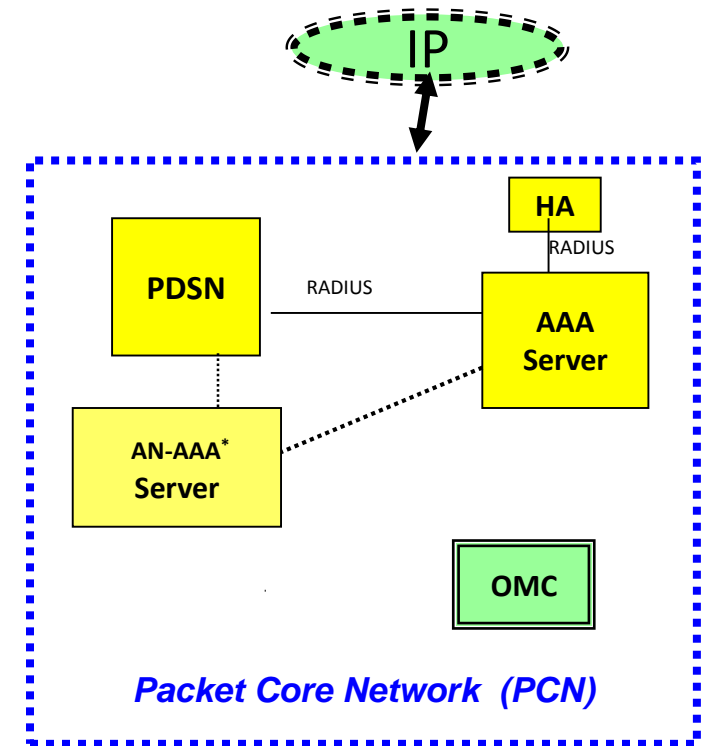
- Responsible for inter - connection between the RN and the PCN
- Provides control and management for one or more RNs.
- RNC performs the radio processing functions such as management of the radio resources, radio channel management, local connection management, decision on handover of calls from one RN to another.
- Packet Control Function (PCF) shall form an integral part of RNC. RNC, through the PCF provides support for packet accounting/charging function for the radio specific parameters.



Packet Core Network (PCN)- EvDO

- **Packet Core Network (PCN)** consists of :
 - Packet Data Serving Node (**PDSN**)
 - Authentication, Authorization & Accounting (**AAA**) Server
 - Home Agent (**HA**)
 - Access Network- AAA (**AN-AAA**) Server.

The functional entities AAA and AN-AAA may be a single physical entity or two separate physical entities.



Ev-DO Network

PDSN, AAA & HA

- The requirements for PDSN, AAA & HA of Ev-DO Packet Core Network are same as that of for Packet Core Network (PCN) of CDMA 2000 1x System.
- In addition, the PCN support A10, A11&A12 interfaces as per IS-878 (3GPP2 A.S0008) / IS-1878(3GPP2 A.S0007).
- The PCN may have to be upgraded to support these interfaces in case existing PCN (being used for CDMA 2000 1x services), is to be used for 1x Ev-DO services.

Ev-DO Network

Access Network - AAA (AN-AAA) Server

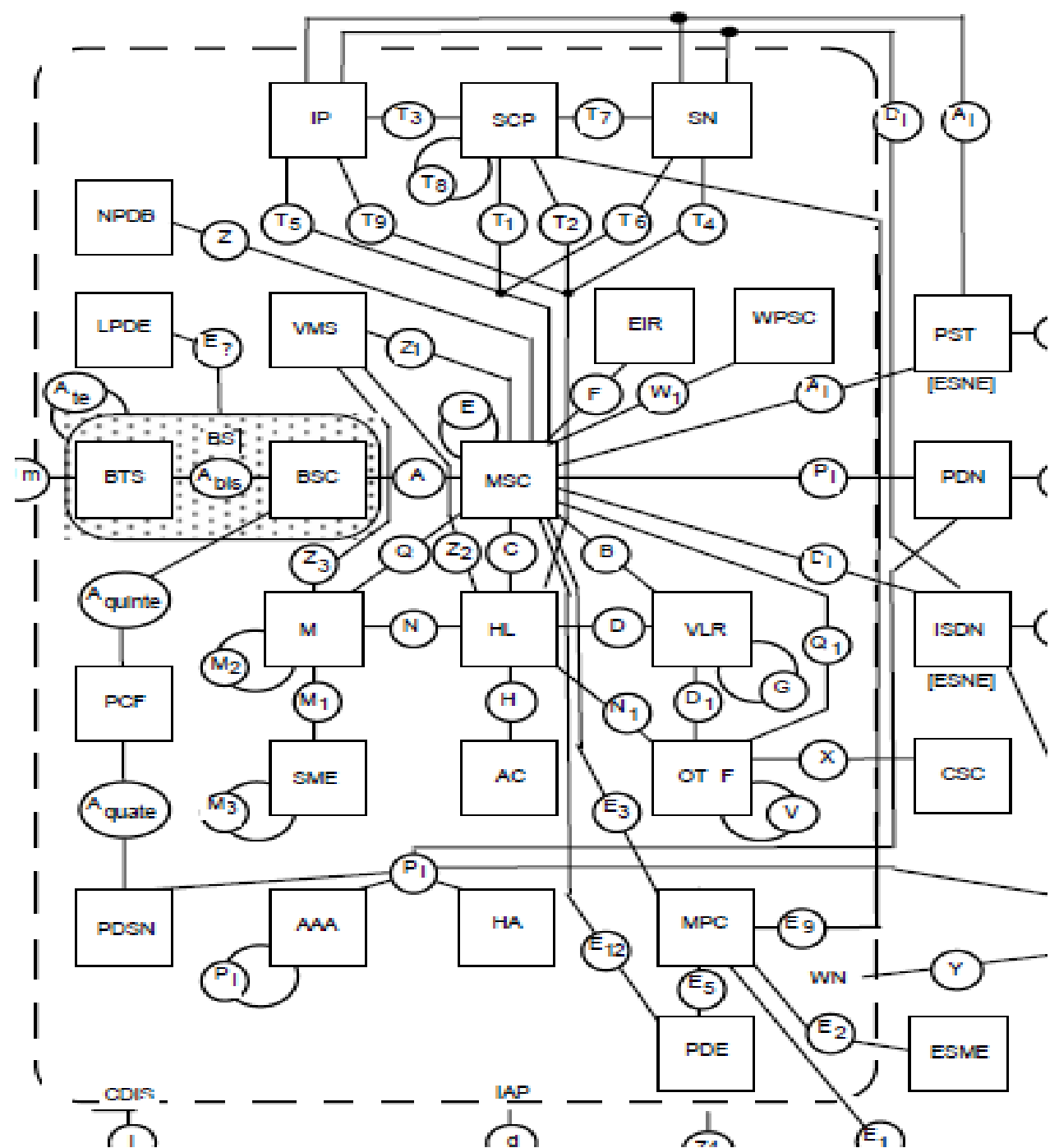
- Entity that performs access authentication functions for the RAN.
- New subsystem required for 1x EV-DO system in addition to the subsystems specified in Packet Core Network (PCN) of CDMA 2000 1x System
- It provides first level of authentication of Ev-DO subscribers.
- The AN-AAA is used for CHAP-based authentication of an access terminal (AT).
- The AN-AAA communicates with the RNC over the A12 interface as defined in 3GPP2 IS-878 / IS-1878(3GPP2 A.S0007) standard. If the AT is authentic, the AN-AAA provides an IMSI for the AT's data connection, which is then associated with the AT's PPP session at the PDSN.

Network supporting both 1x and 1x Ev-DO

In case of CDMA system supporting both CDMA 2000 1x and 1x EV-DO the functionalities (of AN) reside in equivalent equipment as given below :

- ***Access Network (AN)*** : ***Radio Network (RN)***
- ***Radio Node (RN)*** : ***Base Transceivers Stations (BTS)***
- ***Radio Node Controller (RNC)*** : ***Base Station Controllers (BSC)***

3GPP2 S.R0005-B :
Network Reference Model for CDMA2000
Spread Spectrum Systems



AAA	Authentication, Authorization and Accounting	MC	Message Center
AC	Authentication Center	ME	Mobile Equipment
BS	Base Station	MPC	Mobile Position Center
BSC	Base Station Controller	MS	Mobile Station
BTS	Base Transceiver System	MSC	Mobile Switching Center
CDCP	Call Data Collection Point	MT	Mobile Terminal
CDGP	Call Data Generation Point	MWNE	Managed Wireless Network Entity
CDIS	Call Data Information Source	NPDB	Number Portability DataBase
CDRP	Call Data Rating Point	OSF	Operations System Function
CF	Collection Function	OTAF	Over-The-Air Service Provisioning Function
CRDB	Coordinate Routing Data Base	PCF	Packet Control Function
CSC	Customer Service Center	PDE	Position Determining Entity
DCE	Data Circuit Equipment	PDN	Packet Data Network
DF	Delivery Function	PDSN	Packet Data Serving Node
EIR	Equipment Identity Register	PSTN	Public Switched Telephone Network
ESME	Emergency Services Message Entity	SCP	Service Control Point
ESNE	Emergency Services Network Entity	SN	Service Node
HA	Home Agent	SME	Short Message Entity
HLR	Home Location Register	TA	Terminal Adapter
IAP	Intercept Access Point	TE	Terminal Equipment
IIF	Interworking and Interoperability Function	UIM	User Identity Module
IP	Intelligent Peripheral	VLR	Visitor Location Register
ISDN	Integrated Services Digital Network	VMS	Voice Message System
IWF	Interworking Function	WNE	Wireless Network Entity
LPDE	Local Position Determining Entity	WPSC	Wireless Priority Service Center
LNS	L2TP Network Server		

OTA System

- OTA (Over-the-Air) System allows a potential wireless service subscriber to activate (i.e. become authorized for) new wireless services, and allows an existing wireless subscriber to make changes in existing services without the intervention of a third party.
- OTA System permits Service Provisioning (OTASP) and Parameter Administration (OTAPA) in OTA capable Remote Station (RS) / Access Terminal (AT)

□ OTA System consists of two functional entities :

- Over- the- Air Service Provisioning Function (OTAF)
- Customer Service Centre (CSC)

OTAF Server

The OTAF is the entity that interfaces proprietarily with CSCs to support service provisioning activities. The OTAF server has two main applications, *OTASP (Over-the-Air Service Provisioning)* and *OTAPA (Over-the-Air Parameter Administration)*.

OTASP : Allows a **subscriber** to activate new wireless service, and to make changes in existing services without the intervention of a third party.

OTAPA : Allows an **operator** to update the NAM, MDN, PRL, Authentication Key, SSD Service Programming Lock Code etc in a subscriber's already activated OTAPA capable RS/AT over-the-air. OTAPA sessions are *initiated autonomously* by the network, and proceed *without any subscriber involvement* or knowledge and with no limitation on the subscriber's ability to receive telecommunications services.

Thank you