Voice And Telephony over ATM: Status

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Overview

- VTOA: Protocol Stack and Services
- AAL: AAL1, AAL5, New AAL2
- Interworking Function
  - Signaling
  - Addressing
  - Timing and Synchronization

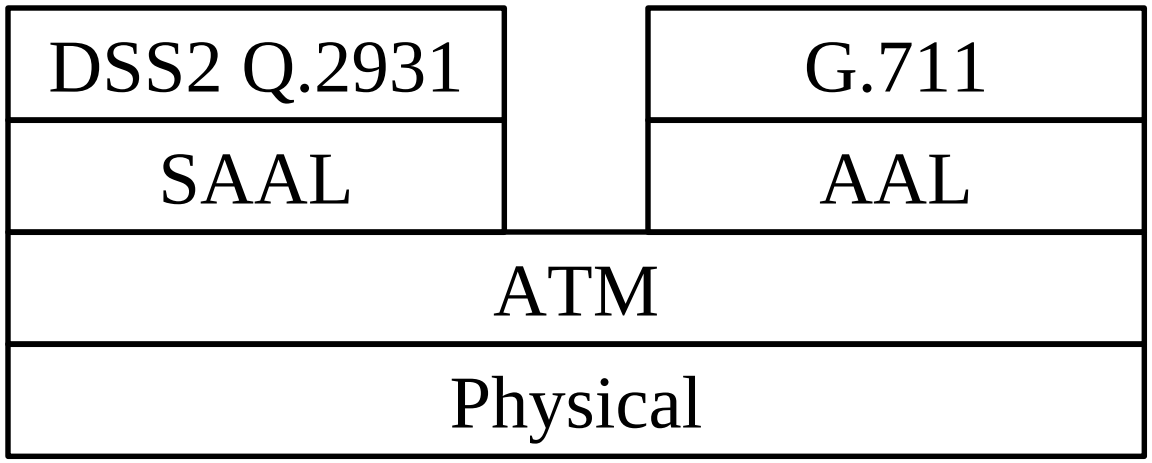
Voice over ATM: Issues

- Connection Setup
- Coding/decoding of voice in to bits
- Packing of digital bit stream into cells (AAL1 or AAL5)
- End-to-end transmission of cells (Trunking)

Why VOA?

- Single physical connection for voice, video, data
- Integrated management, maintenance, signaling
  $\Rightarrow$ Reduced cost

Protocol Reference Model



- AAL1 or AAL5. AAL5 required.
- One packet per cell
- 64 kbps PCM μ-law or A-law (G.711)

VTOA Services

- N-ISDN
  - 64 kbps
  - 2×64 kbps
  - 384 kbps
  - 1536 kbps
  - 1920 kbps
  - Multirate N×64 kbps
- Analog
  - 3.1 kHz Voice
  - 7 kHz tones and announcements

Supplementary Services

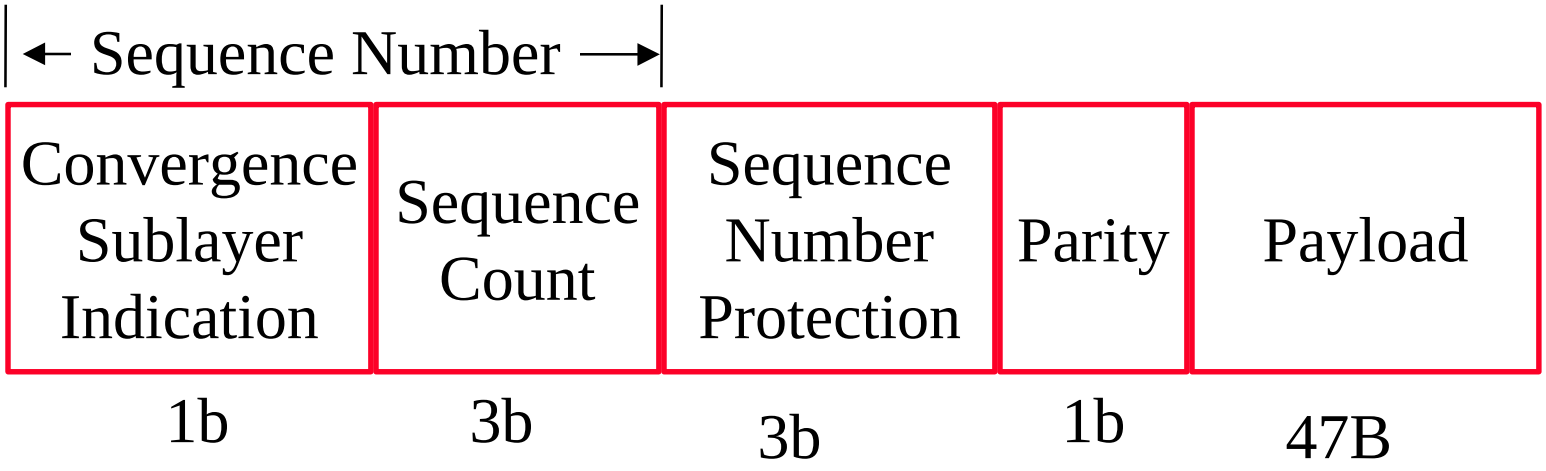
- Direct Dialing In (DDI)
- Multiple Subscriber Number (MSN)
- Caller Id Presentation
- Caller ID Restriction
- Connected Line ID Presentation
- Connected Line ID Restriction
- Subaddressing

Note: All these are available from UNI 4.0

ISO Supplementary Services

- Name Id
- Call Transfer
- Call Diversion/forwarding
- Call Completion
- Call offer
- Call Intrusion
- Do Not Disturb
- Call Interception

AAL1



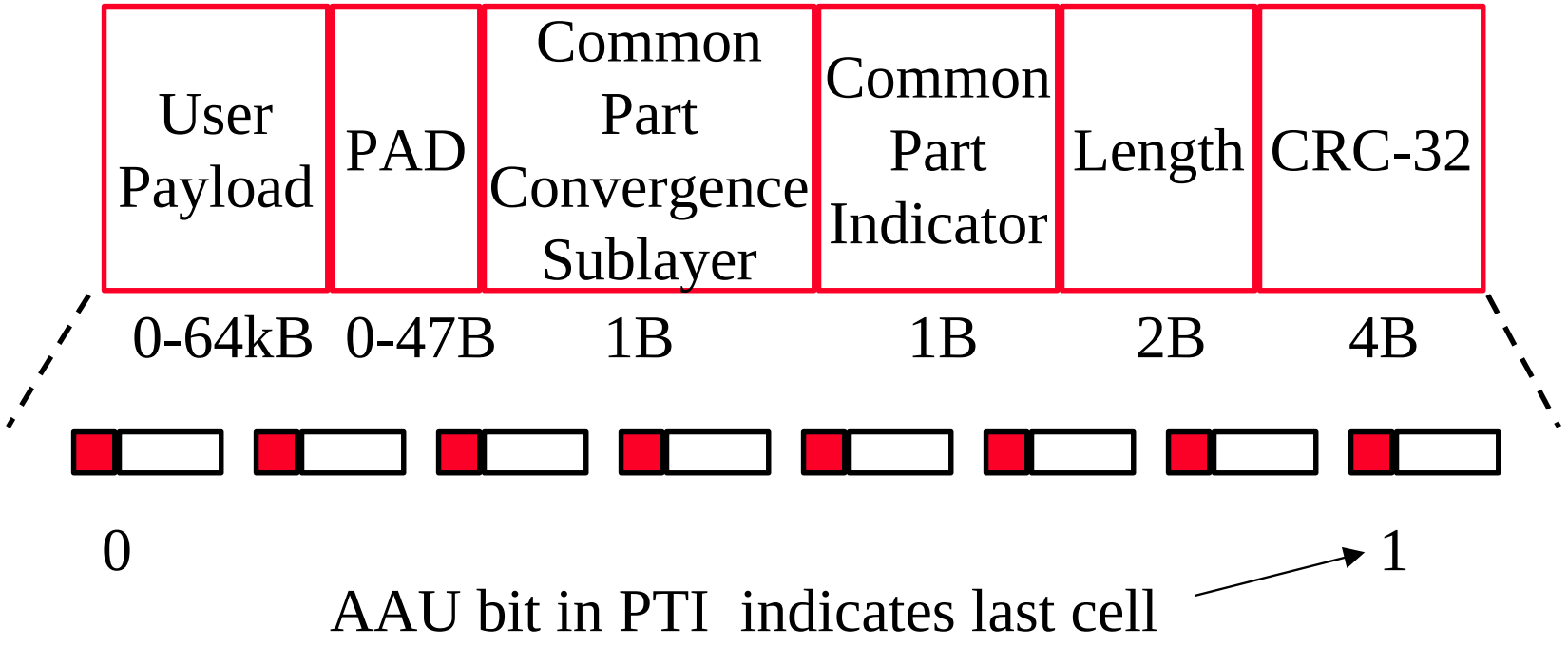
- Misordering bad ⇒ Sequence number
- Convergence Sublayer Indication (CSI)
  Used for clock synchronization
- Constant Bit Rate (CBR)
- Indication of lost or errored cells (Seq #)

AAL 1 Problems

- Fixed size (47B) payload
- Single user per VC
- No partial fill ⇒ Bandwidth
- Only 64k or N×64k
- No support for
  - Forward error correction
  - Compression (VBR),
  - Silence suppression,
  - Idle channel removal
- Not generally available

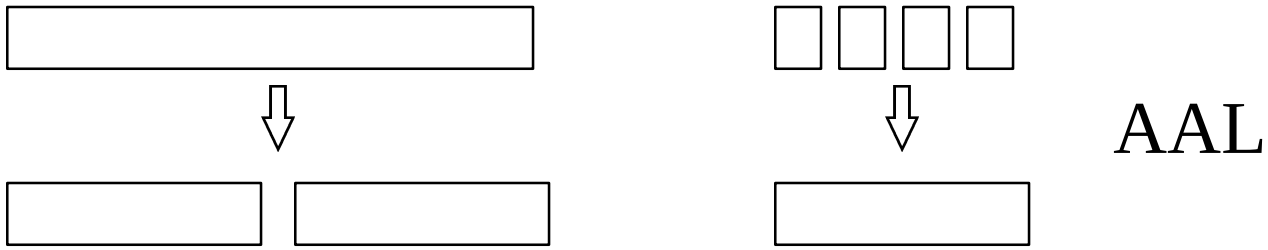
AAL 5

- Designed for data traffic
- No per cell length field, No per cell CRC
- One voice packet/cell ⇒ Payload = 8 to 40 bytes



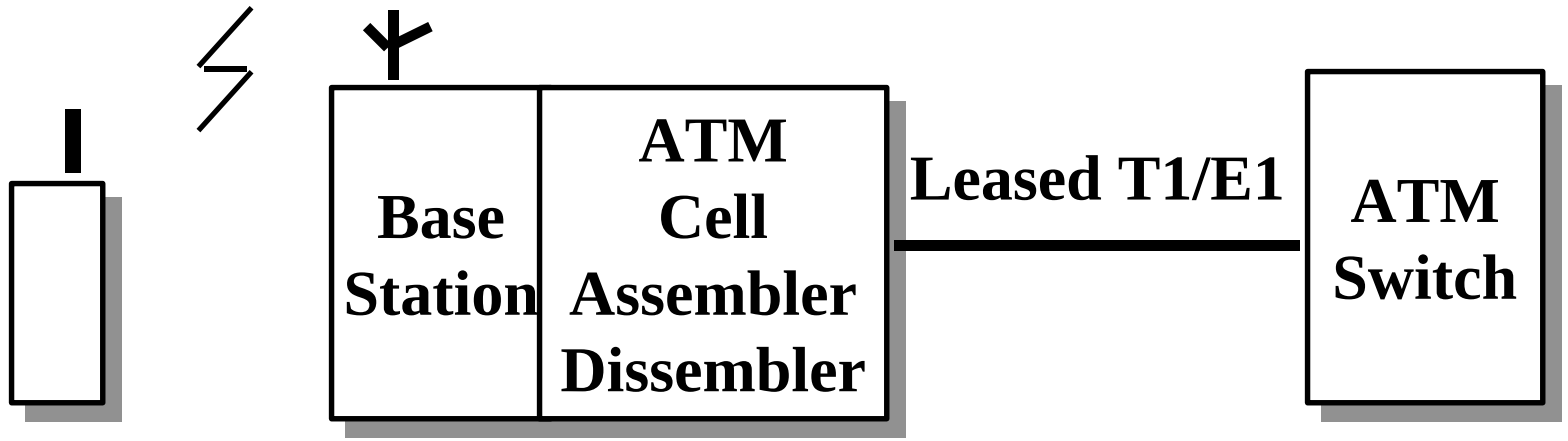
Delay

- 48 bytes at 64 kbps = 6 ms
  ⇒ Need Echo cancellers
- 48 bytes at 16 kbps = 24 ms ⇒ too long
- Can't fill a cell completely
- Current AALs allow segmentation
  (long packets to multiple cells).
- Do not allow blocking (short packets in one cell)



Low-Bit Rate Voice

- Time to fill 48-byte payload @8 kbps = 48 ms

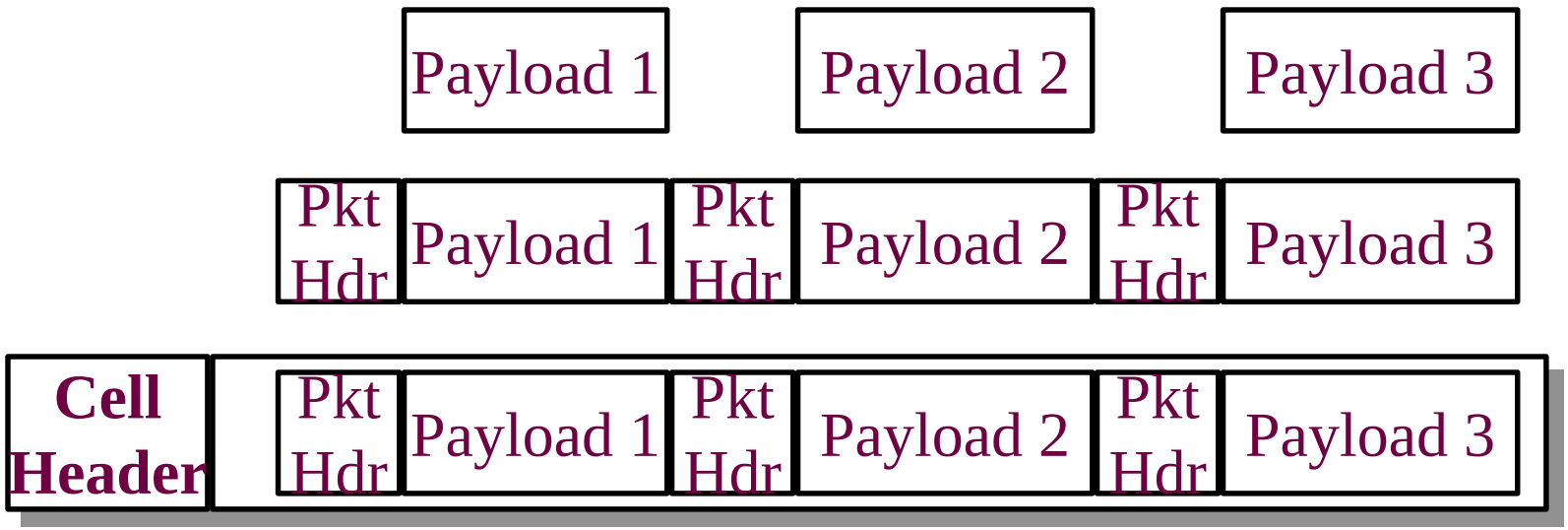


AAL2: History

- Sept 95: T1S1.5 "Short Multiplexed AAL (SMAAL)"
- May 96: ITU-T started AAL-CU
- Feb 97: ITU-T Completed AAL2 (Record: 9 Months)

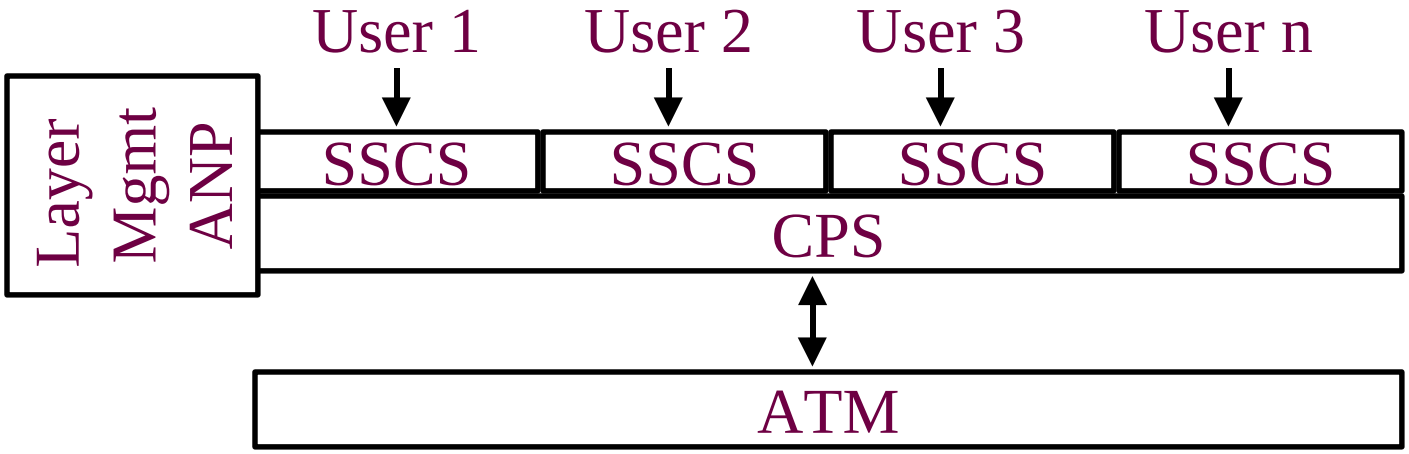
AAL2

- Ideal for low bit rate voice
- Variable/constant rate voice
- Multiple users per VC
- Compression and Silence suppression
- Idle channel suppression



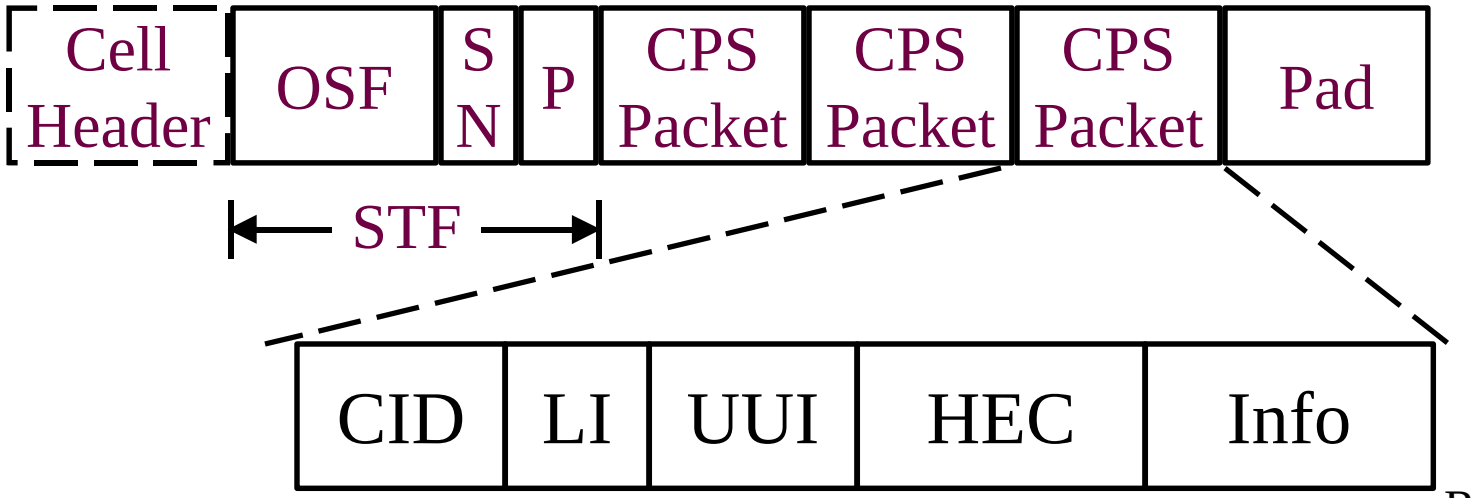
Protocol Structure

- Common Part specification (CPS)
- AAL2 Negotiation procedure (ANP)
- Service Specific Convergence Sublayer (SSCS)
  Null for Mobile Voice. May have SSCS for Trunking

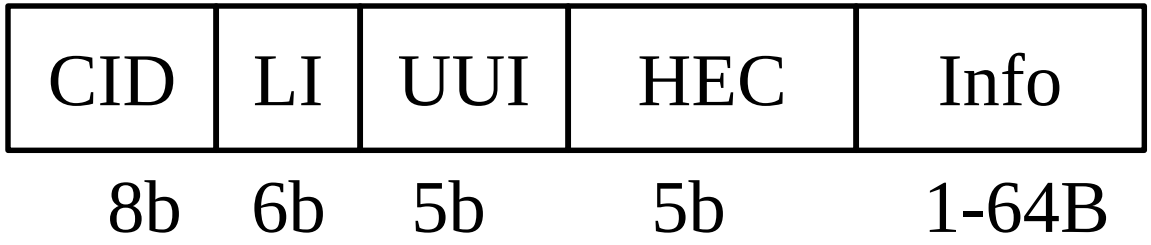


Cell Format

- STF: Start field = CPS PDU header
- OSF: Offset of the first packet
- SN: Sequence number mod 2, 0 or 1
- P: Parity (odd) of start field
- Pad: Padding (0-47 bytes)

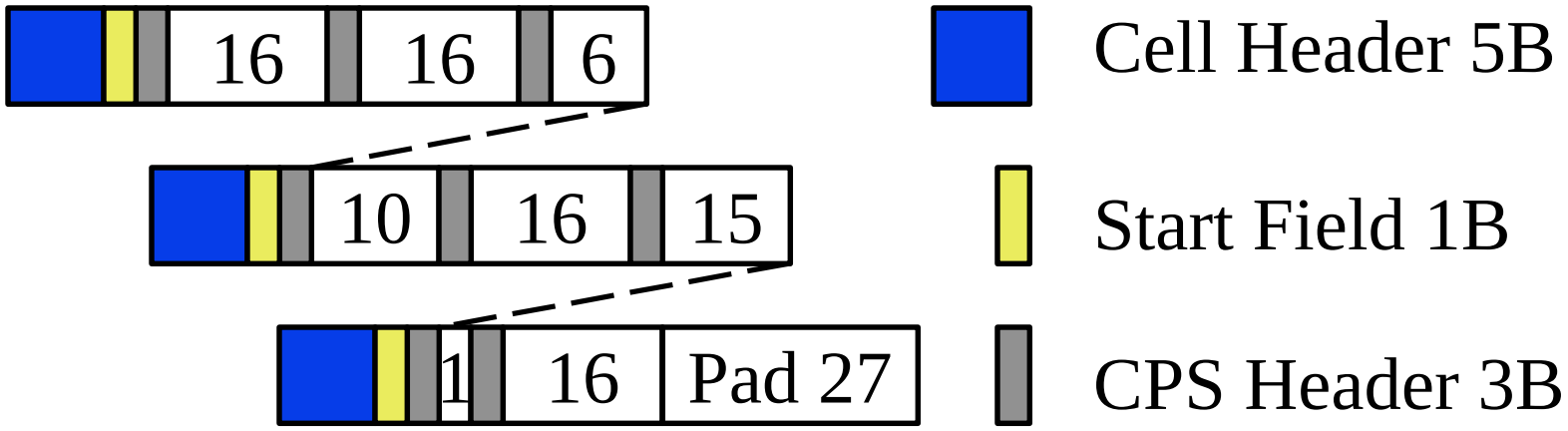


CPS Packet Format



- Channel ID (CID): 0 = Not used,
  1= Mgmt, 2-7=Reserved, 8-255=User ID
- Length (LI): 0-64, Default=45B
- User-to-User Indication (UUI):
  0-27 = ID, 28-29=Resvd 30-31=OAM

Protocol Efficiency

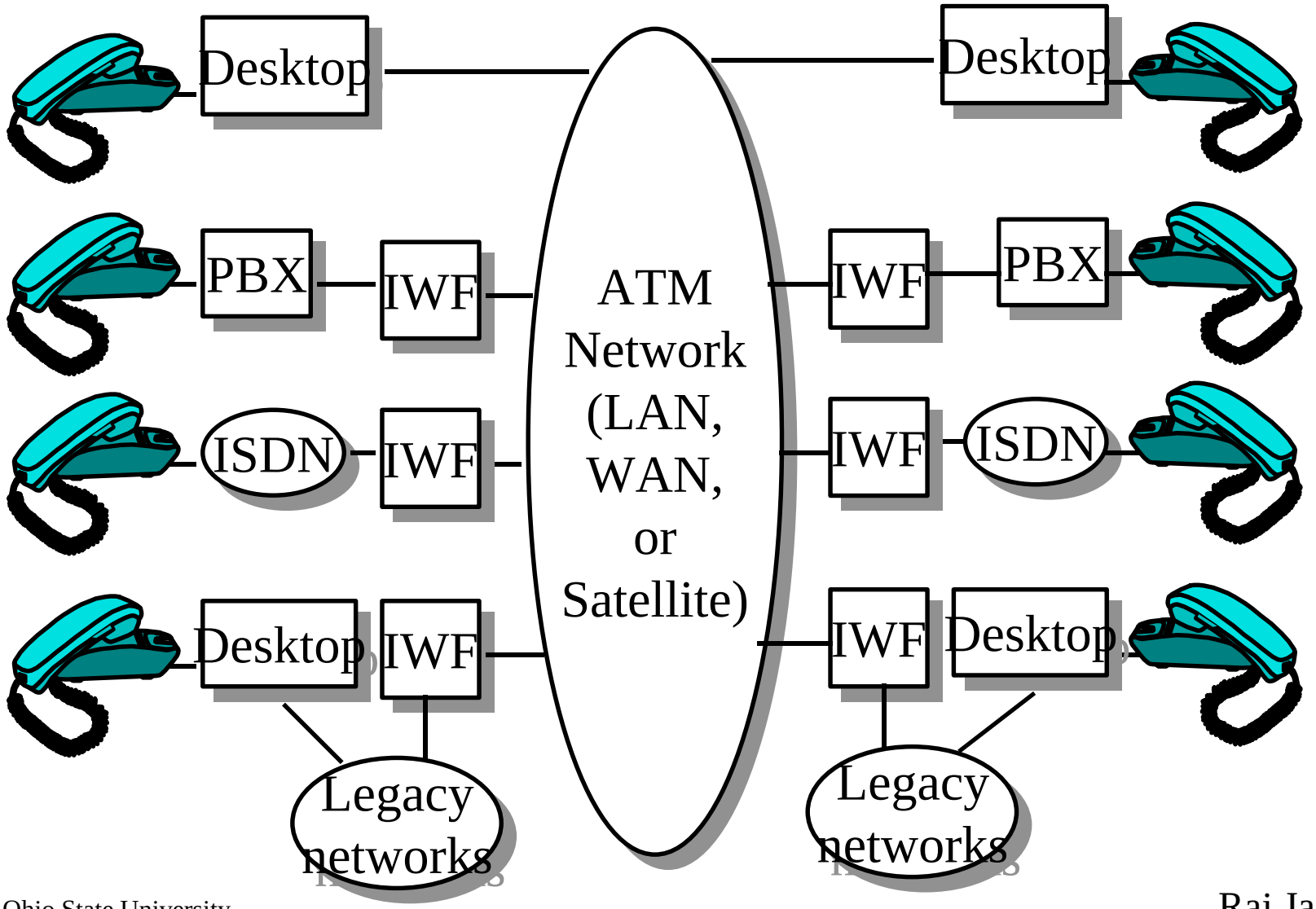


	Fill Delay	Size	Efficiency
32 kbps ADPCM	4 ms	16 B	84%
32 kbps ADPCM	8 ms	32 B	91%
64 kbps PCM	4 ms	32 B	91%
64 kbps PCM	8 ms	64 B	96%
64 kbps PCM	5.6 ms	45 B	94%

AAL2: Status

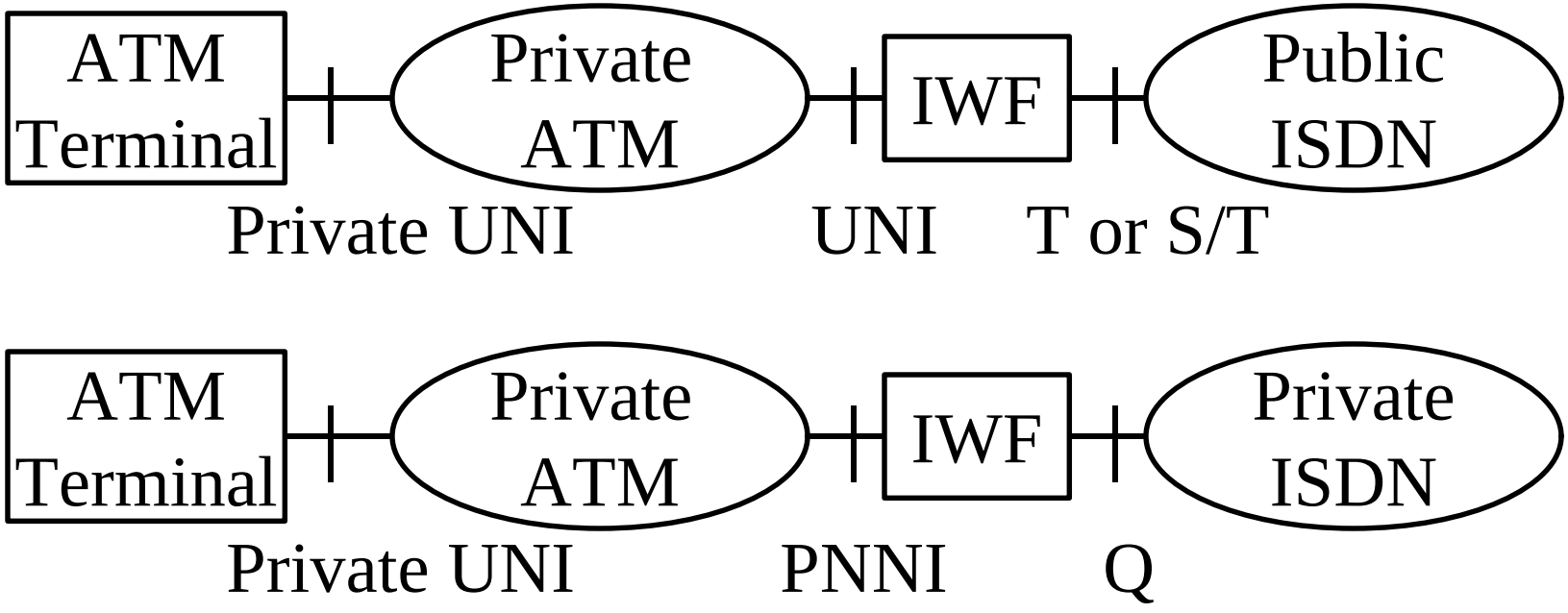
- Sept 97: I.363.2 approved
- Sept 97: Segmentation and reassembly
  I.366.1 frozen
- June 98: I.trunk to be frozen
- On-Going:
  - AAL2 negotiations procedures (ANP)
  - Operations, Administration and Maintenance (OAM)
- Future: Interworking with
  - Voice over IP
  - Voice over Frame Relay

VTOA


Desktop
PBX
IWF
ISDN
IWF
Desktop
IWF
ATM
Network
(LAN,
WAN,
or
Satellite)
Legacy
networks
Desktop
IWF
PBX
IWF
ISDN
IWF
Desktop
Legacy
networks

ATM-ISDN Interworking

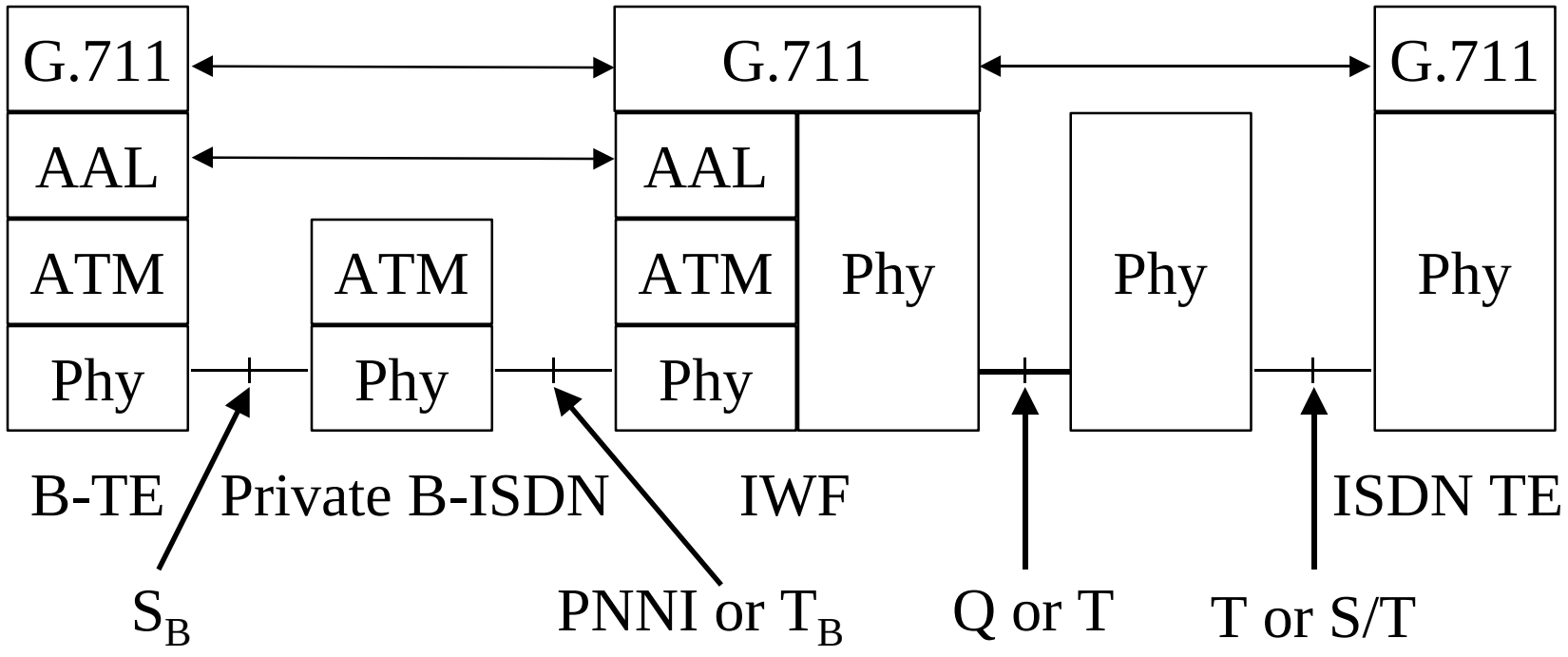
- One ATM connection per N-ISDN channel per call (Current)
- ATM signaling channel (VC=5) mapped to ISDN D channel



IWF Functionality

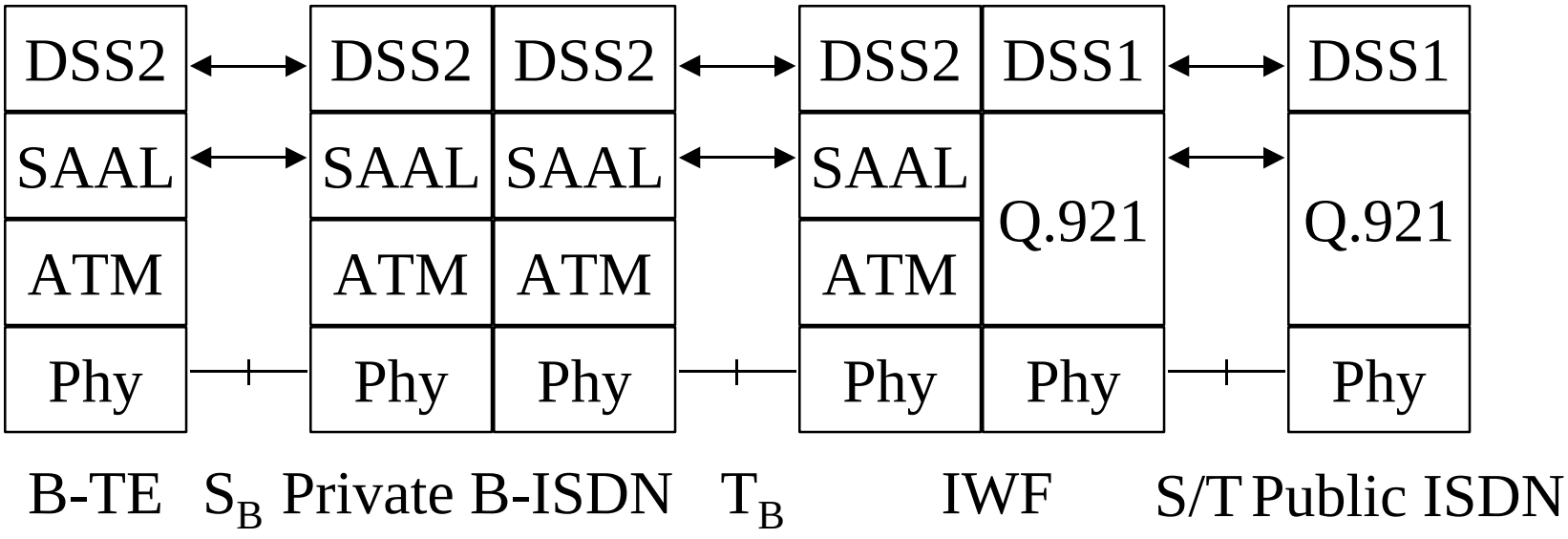
- User Plane Protocols
- Signaling: Control Plane Protocols
- Timing & Synchronization
- Addressing

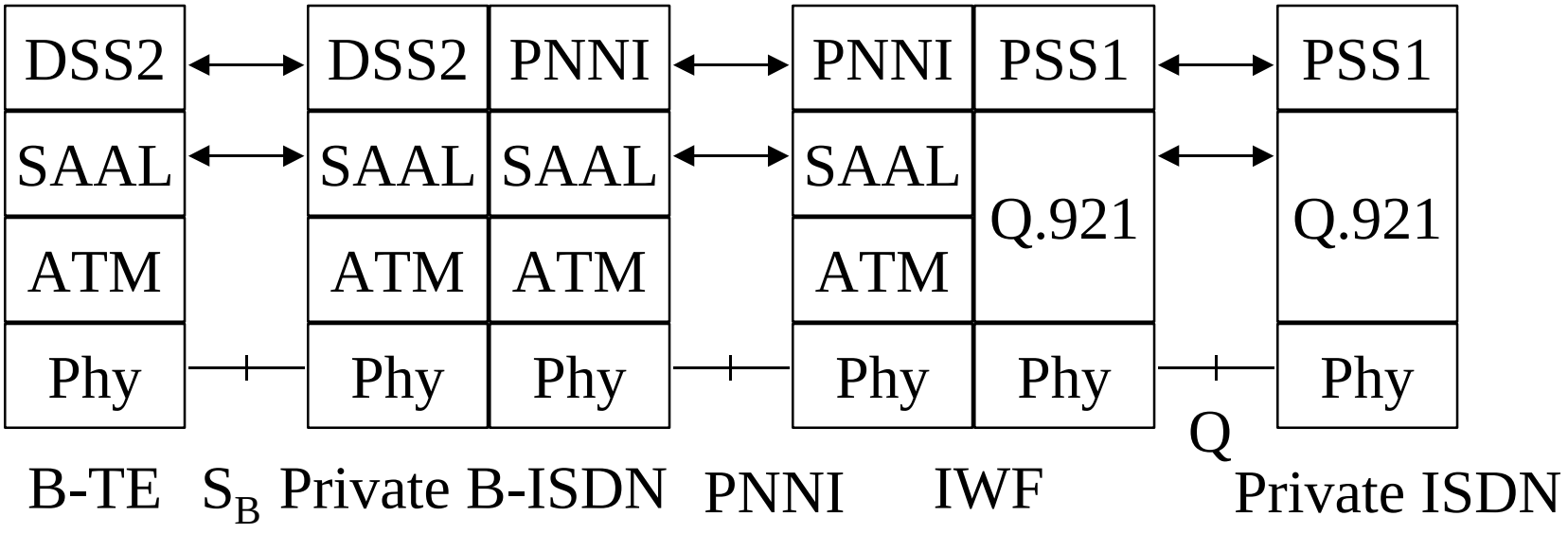
User Plane Protocols

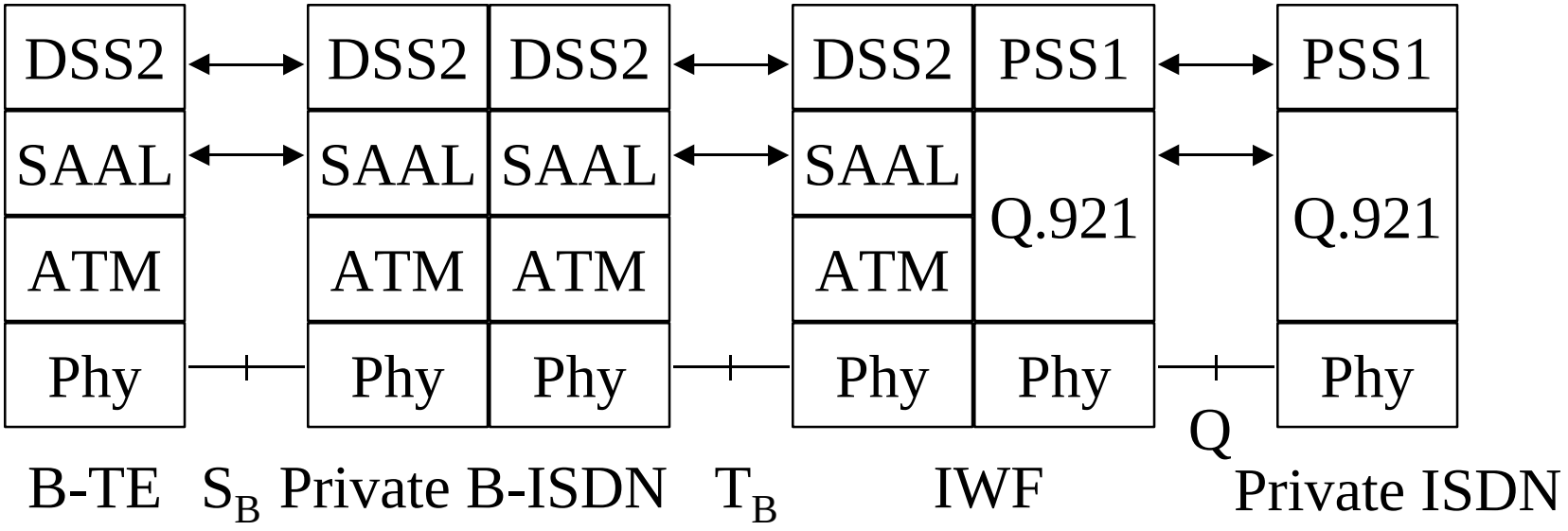


Control Plane Protocols

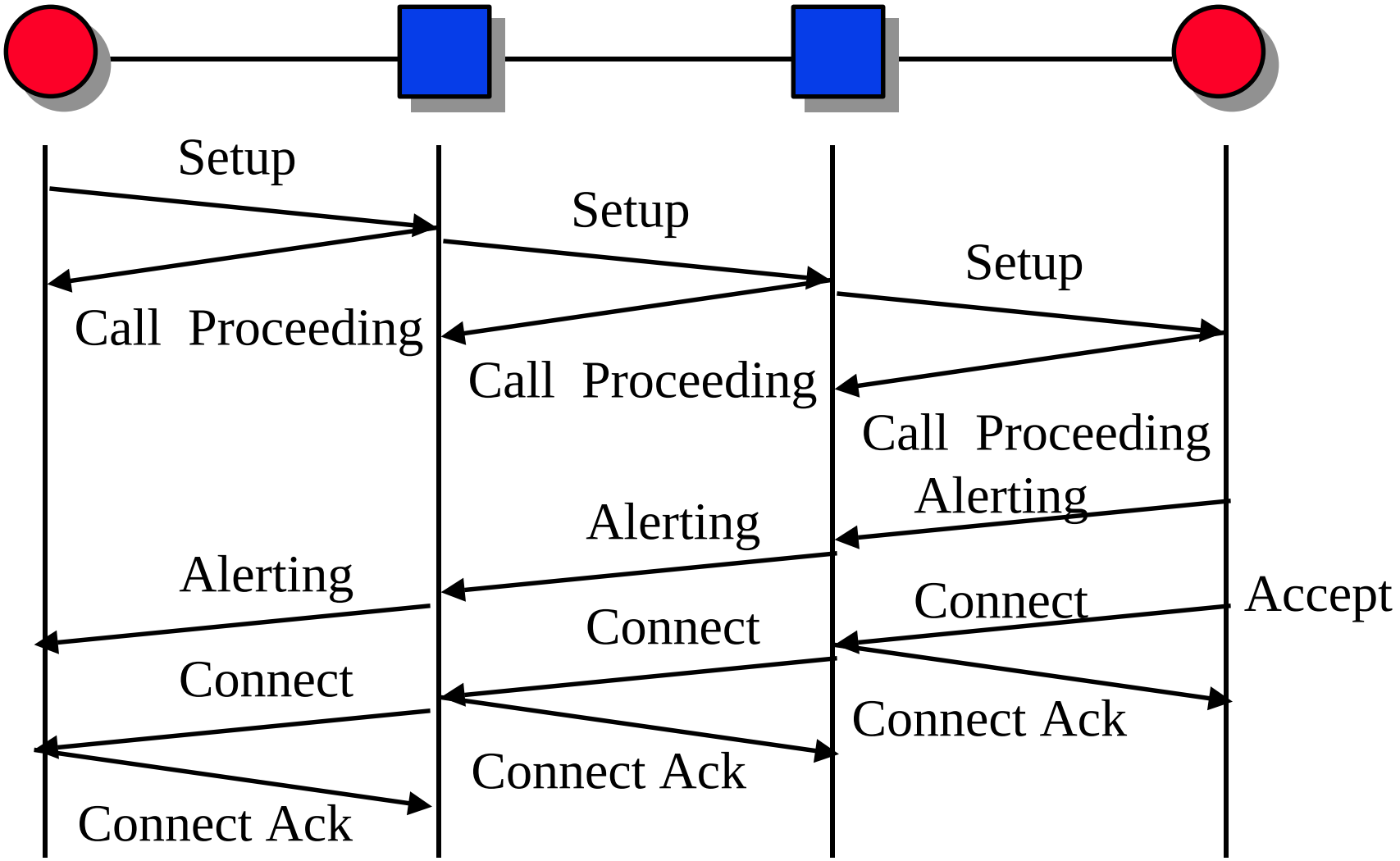
- Q.Sig Private N-ISDN (PSS1)
- Q.921+DSS1 Public N-ISDN
- SAAL+DSS2 Public B-ISDN
- PNNI Signaling Private B-ISDN




DSS2
DSS2
PNNI
PNNI
PSS1
PSS1
SAAL
SAAL
SAAL
SAAL
Q.921
Q.921
ATM
ATM
ATM
ATM
Phy
Phy
Phy
Phy
Phy
Phy
Q
B-TE
S_B
Private B-ISDN
PNNI
IWF
Private ISDN

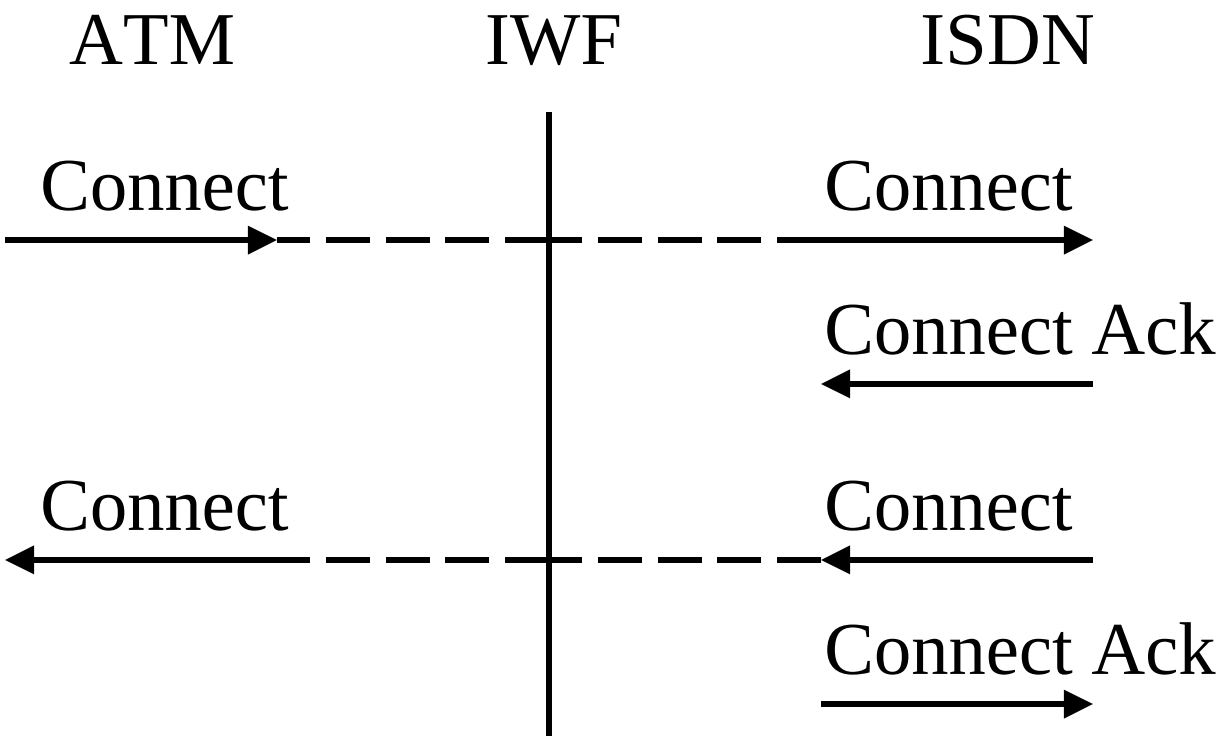

DSS2
DSS2
DSS2
DSS2
PSS1
PSS1
SAAL
SAAL
SAAL
SAAL
Q.921
Q.921
ATM
ATM
ATM
ATM
Phy
Phy
Phy
Phy
Phy
Phy
Q
B-TE
S_B
Private B-ISDN
T_B
IWF
Private ISDN

Q.2931 Signaling

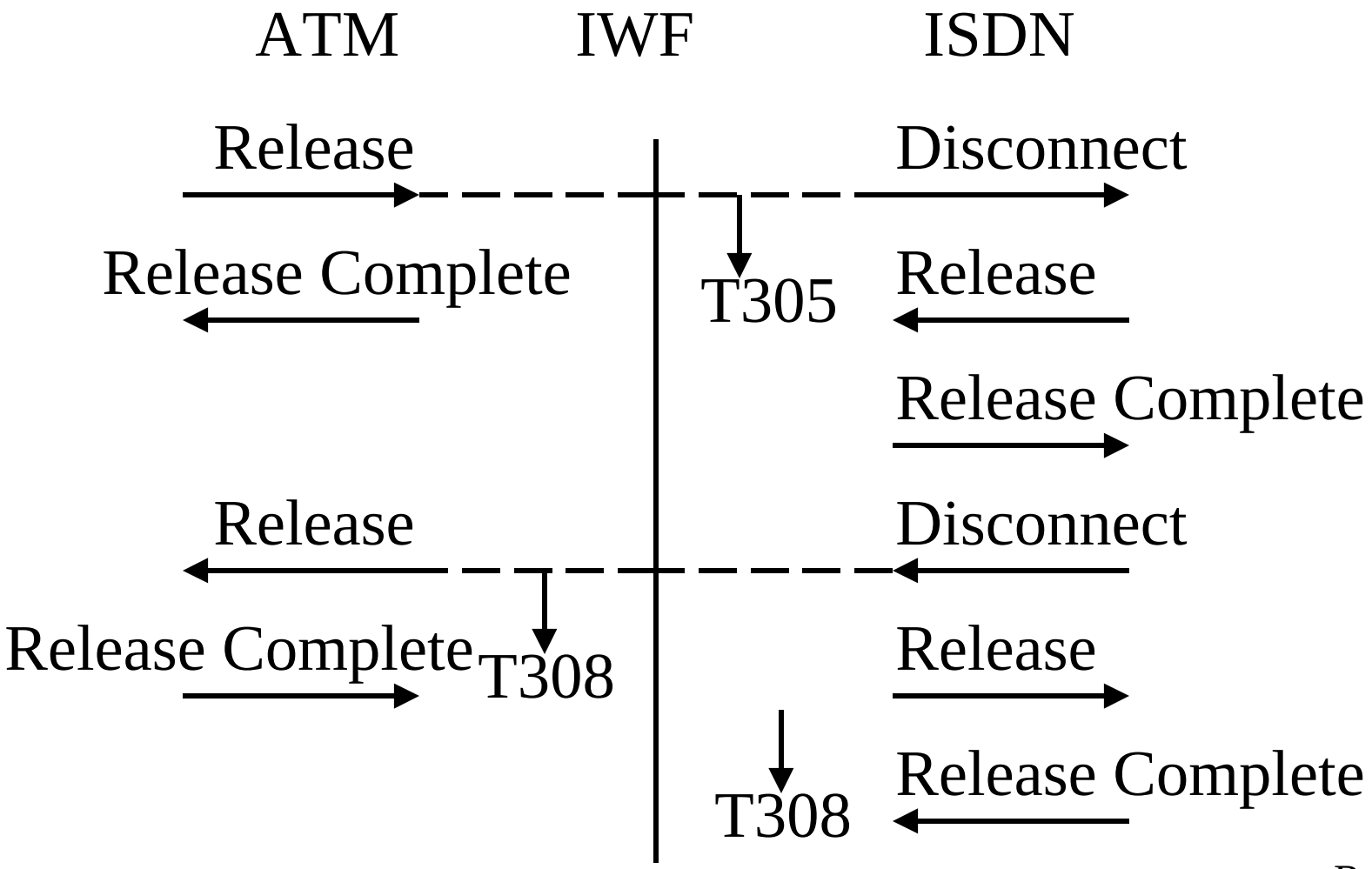


Setup Mapping

- Terminate each protocol, or
  Map each message

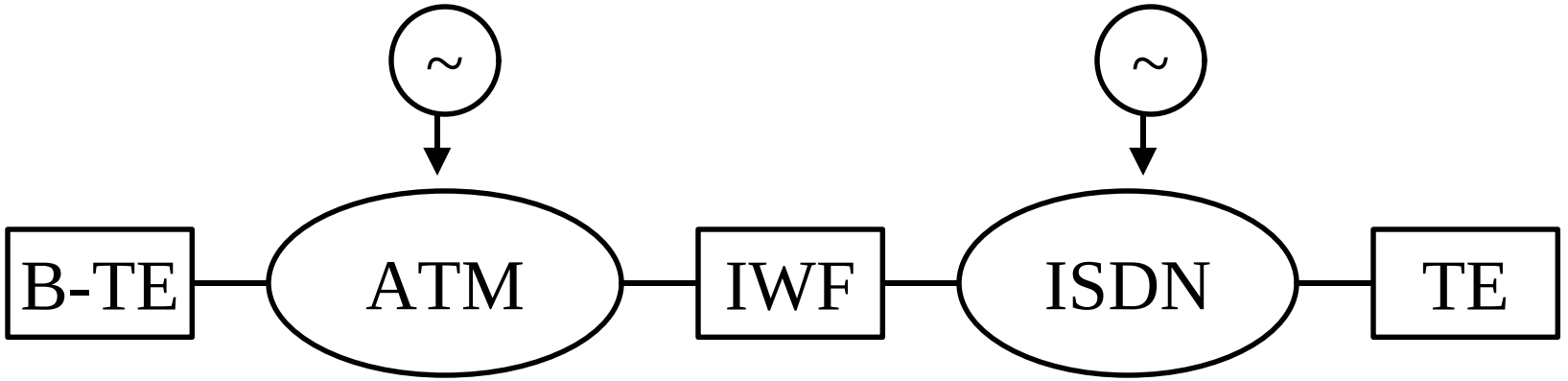


Call Clear Mapping



Timing & Synchronization

- Phy based (Stratum 4)
- Adaptive (buffer fill based)
- Free-running

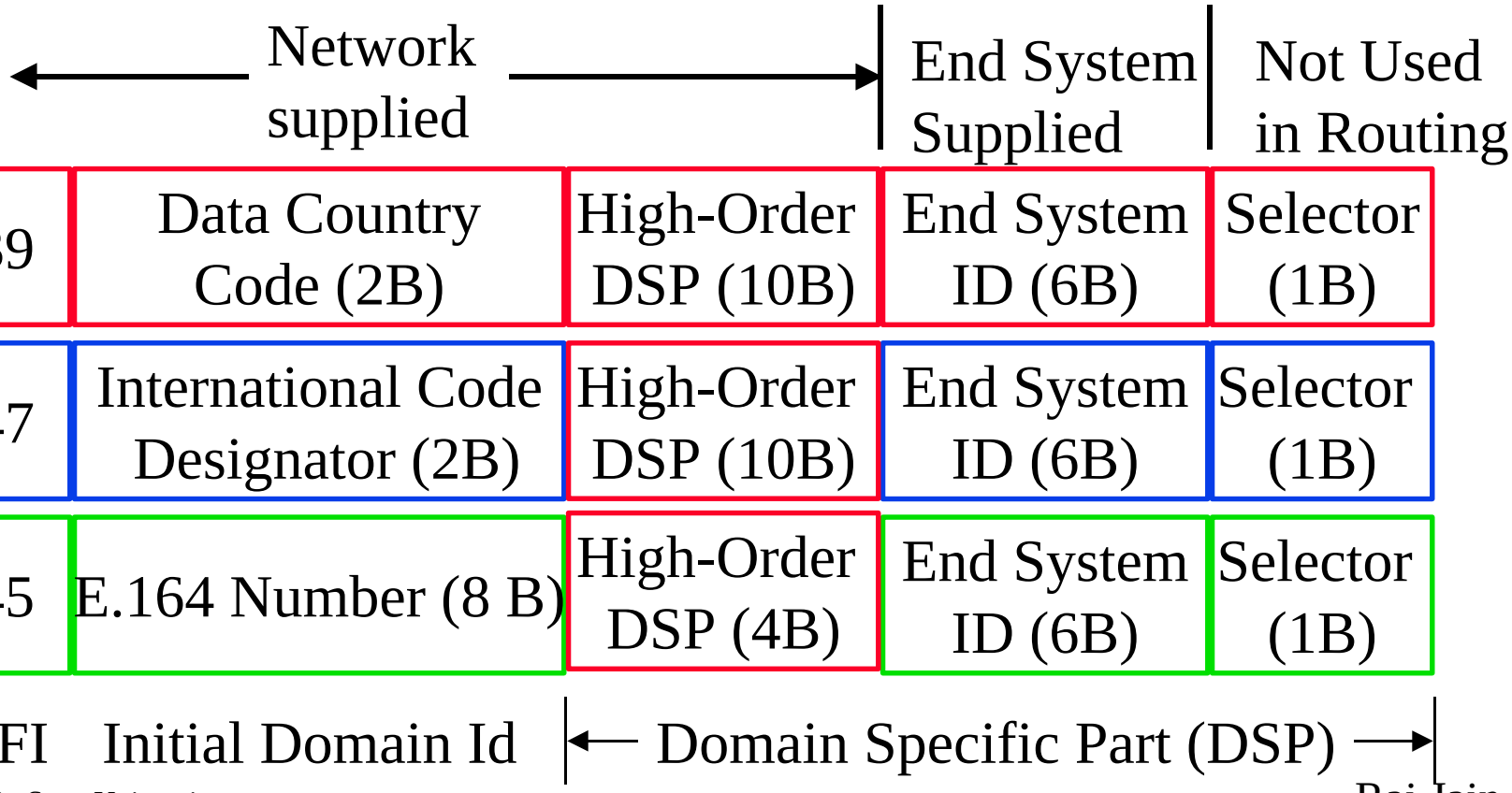


E.164 Numbers

- North American Numbering Plan (NANP): 1(614)-555-1212
- E.163 numbering plan for telephony: 12 digits
- E164 numbering plan for ISDN: 15 digits
- Defined in ITU-T recommendation E.164 for ISDN
- ISDN numbers uniquely identify interfaces to public networks
- Administered by public networks (Therefore, are not easily available for private network use)

ATM Addresses

- ATM Forum specifies three NSAP-like address formats: DCC Format, ICD Format,E.164
- NSAP = Network Service Access Point



Addressing

- Authority and Format Identifier (AFI)
  39 = ISO DCC,
  47 = British Standards Institute ICD,
  45 = ITU ISDN
- Initial Domain Identifier (IDI). Domain Specific Part (DSP)
- ISDN uses E.164 numbers (up to 15 BCD digits)
- ATM forum extended E.164 addresses to NSAP format. E.164 number is filled with leading zeros to make 15 digits.

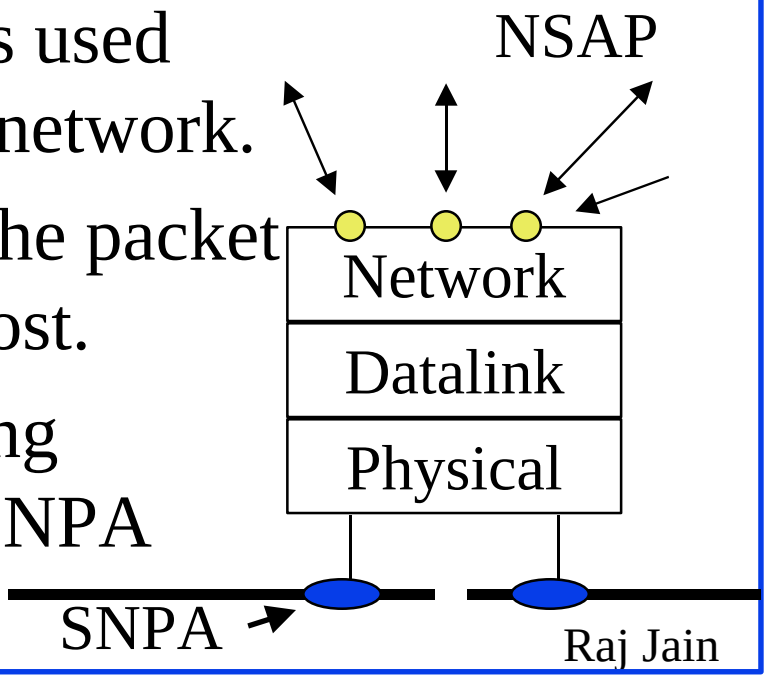
Addressing (Cont)

- End System Identifier (ESI):
  48-bit IEEE MAC address
- Selector is for use inside the host and is not used for routing.
- All ATM addresses are 20 bytes long.
- ATM forum removed the division of DSP into areas, etc.

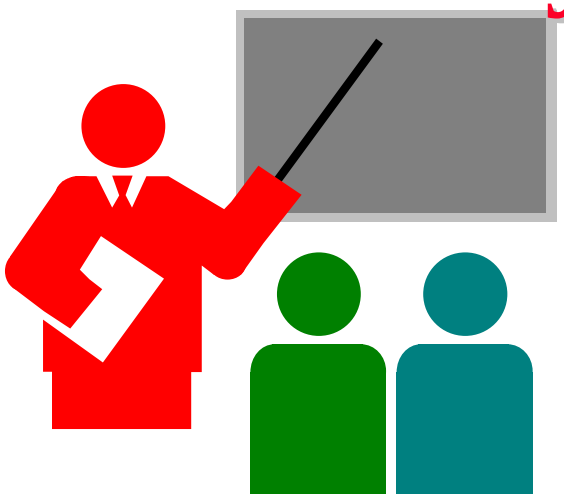
- Private networks must support all three formats
  Type of Number field = Unknown
  Numbering Plan Indication field = ISO NSAP
- Public networks must support native E.164 and may optionally support three NSAP-encoded formats. For E.164:
  Type of Number field = International number
  Numbering Plan Indication field = Recommendation E.164

NSAP is a Misnomer!

- NSAP = Network Service Access Point
  Identifies network layer service entry
- SNPA = Subnetwork point of attachment
  Identifies the interface to subnetwork
- SNPA address (or part of it) is used to carry the packet across the network.
- CLNP uses NSAP to deliver the packet to the right entity inside the host.
- ATM uses NSAP-like encoding but ATM addresses identify SNPA and not NSAP.



Summary



- Circuit emulation services for CBR using AAL1 or AAL5.
- ATM Trunking using AAL2 is being developed. Allows low bit rate VBR, multiple users/cell
- IWF has to deal with data forwarding, signaling, addressing, and clock synchronization.

References

- For a tutorials on VTOA, Signaling, and PNNI see: http://www.cis.ohio-state.edu/~jain/
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- ATM Forum, "Circuit Emulation Service Specification V2.0," af-vtoa-0078.000, January 1997.
- ATM Forum, "Dynamic Bandwidth Utilization in 65 kbps time-slot trunking over ATM- using CES," af-vtoa-0085.000, July 1997

- ATM Forum, "ATM Trunking using AAL1 for Narrowband Services V1.0," af-vtoa-0089.00, July 1997
- ATM Forum, "PNNI V1.0," af-pnni-0055.000, March 1996.
- ATM Forum, "UNI Signaling 4.0," af-sig-0061.000, July 1996.
- ITU-T, "B-ISDN ATM Adaptation Layer Specification: Type 2 AAL," I.363.2
- ITU-T, "B-ISDN ATM Adaptation Layer Specification: Type 1 AAL," I.363.1, Aug 96.

- ITU-T, "B-ISDN ATM Adaptation Layer Specification: Type 5 AAAL," I.363.5, Aug 96.
- ITU-T, "General Arrangements for Interworking Between B-ISDN and 64 kb/s Based ISDN," I.580, March 1993.

VOA Products

- GDC, "APEX Family of ATM Products," http://www.gdc.com/products/prod_atm_vsm.html Implements AAL2.
- Nortel, "Magellan Passport ATM Switch," VBR Voice. Not AAL2.
- CISCO, Stratacom ATM Switches, Not AAL2.

Abbreviation

AAL	ATM Adaptation Layer
AAL-CU	AAL Composit User
ADPCM	Adaptive Differential Pulse Code Modification
ANSI	American National Standards Institute
ATM	Asynchronous Transfer Mode
CBR	Constant Bit Rate
CCS	Common Channel Signaling
CES	Circuit Emulation Service
CID	Channel Identifier
CPS	Common Part Sublayer
ITU-T	International Telecommunications Union - Telecommunications Sector
LI	Length Indicator

PCM	Pulse Code Modulation
PCR	Peak Cell Rate
PDU	Protocol Data Unit
SMAAL	Short Multiplexed AAL
SSCS	Service Specific Convergence Sublayer
UUI	User-to-User Indication
VBR	Variable Bit Rate
VTOA	Voice and Telephony over ATM

Thank You!