ISDN

I ntegrated

S ervices

D igital

N etwork

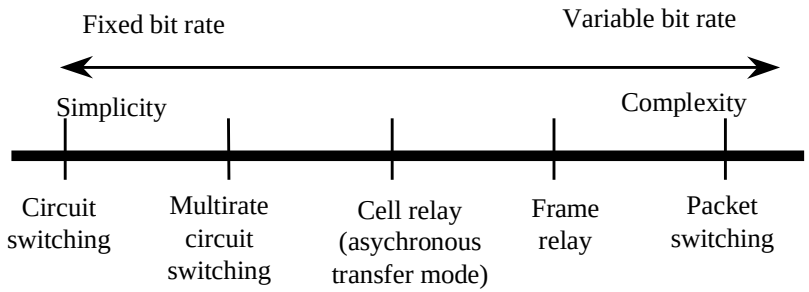
- Principles and Basics
- Reference Points, Interfaces, Services
- Protocol Architecture
- Applications
  - LAN LAN Connections
  - PPP, Dial In (Remote Access)
  - Videoconferencing

ISDN Principles

Defined by ITU-TS (I.120, 1994)

- Voice and non voice applications using a limited set of standardized facilities, interfaces and standards
- Support for switched and non switched applications
  - Circuit switching
  - Packet switching
  - Leased lines
- Fundamental building block (today) is a 64 kbps connection
- Layered protocol architecture

Circuit vs. Packet Switching



Circuit Switching

- Connection means a physical communications channel
- Exclusivly used by the two subscribers for call-duration
- Example PSTN
- Fixed data rate
- "Bit pipe", no error- or flow control
- Connection setup time
  - Analog, Digital

Packet switching

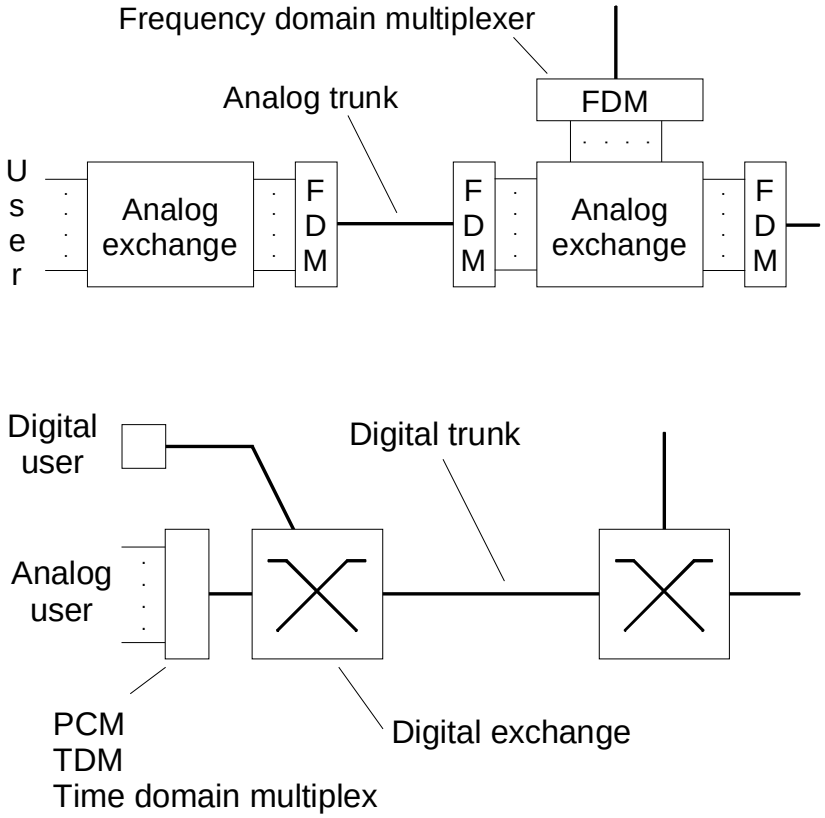
- All data is segmented into packets
- Packet store and foreward
- End Systems may operate at different data rates
- Sophisticated error and flow control procedures applied on each link.

Evolution, not Revolution

- POT (Plain Old Telephone) network
  - Concept: Network for voice transport
  - Structure: Strict hierarchy
  - Several specialized networks (i.e. X.25), separated from telephone network
- ISDN
  - involves digitization of the telephone network (-> not a pure telephony network any more)
  - Evolution from the POT because of advantages for carriers
  - Transition of one (or more) decades
  - Use of existing networks (i.e. "the last mile")
  - Connections at other rates than 64kbps

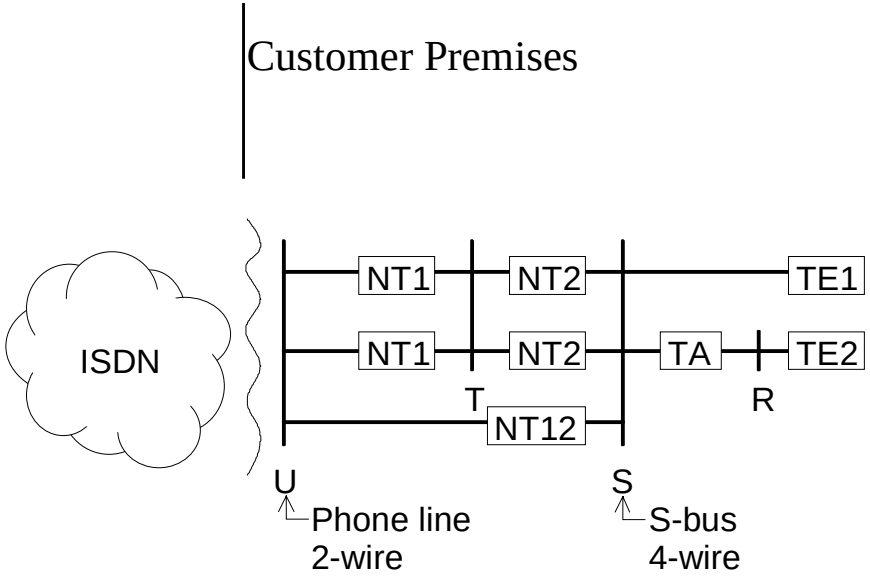
ISDN for the Carrier

- Analog transmission of voice
  - More noise
  - More expensive equipment
- First step: Introducing digital transmission (starting in the 60ties)
- Second: Introducing digital exchanges (starting late 70ties)
- Integration of transmission and exchange



Reference Points / User Access

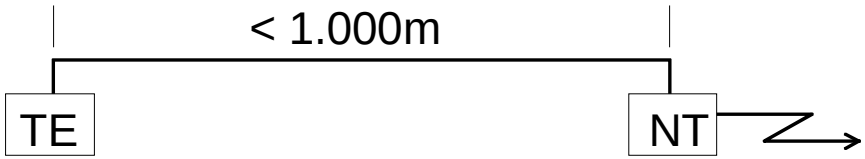
- Interface Standards
  - Group functions on user premises
  - Define Reference points
- TE1: Equipment with standard ISDN-Interface (ISDN-Telephone, Computer with ISDN Interface)
- TE2: Non-ISDN equipment (i.e. Modem with V.24 interface at R)
- TA: Terminal adapter
- S0
  - 4 wire bus, up to 8 devices, up to 2 active at the same time.



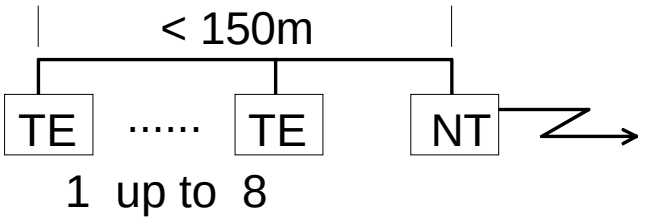
S-Interface

- The standard ISDN-interface is the S-interface

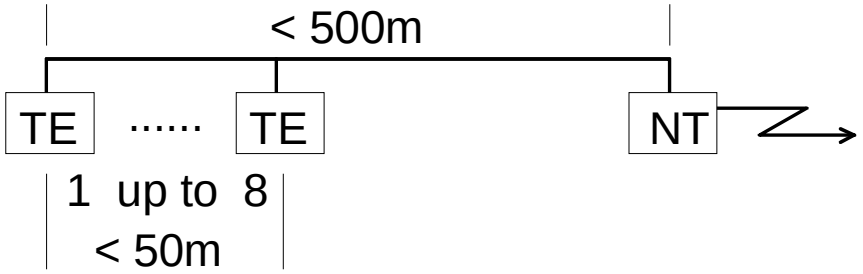
- Configuration
  - Point to point



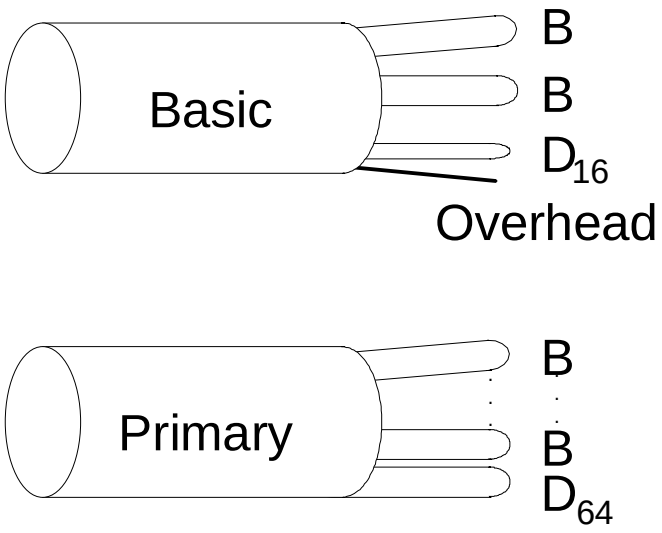
  - Point to multipoint (passive bus)



  - Point to multipoint (extended bus)



User Interface



- Basic rate Interface S0
  - 2*B (64kbps) + D (16kbps) + synchronizing and framing = 192kbps
- Primary Rate Interface S2M
  - 2.048 (1.544) Mbps

    30 (23) *B (64kbps)

    1 (1) *D (64kbps)
- Channel functions

  B: - Digital voice (PCM)

  - User Data ("transparent pipe“)

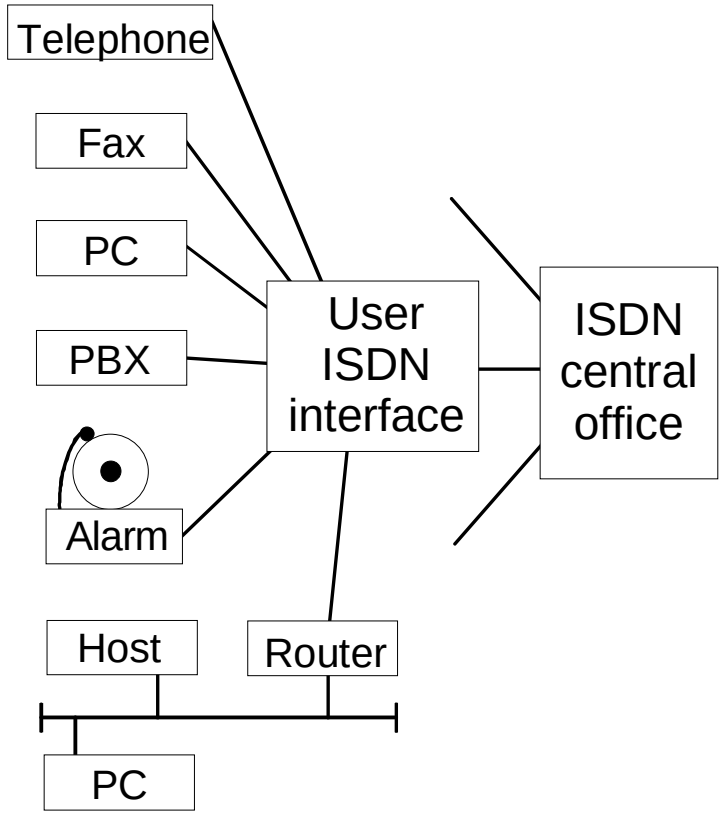
  D: - Signalling (EDSS1, propri.)

  - Low speed data (packet sw.)

  - Telemetry

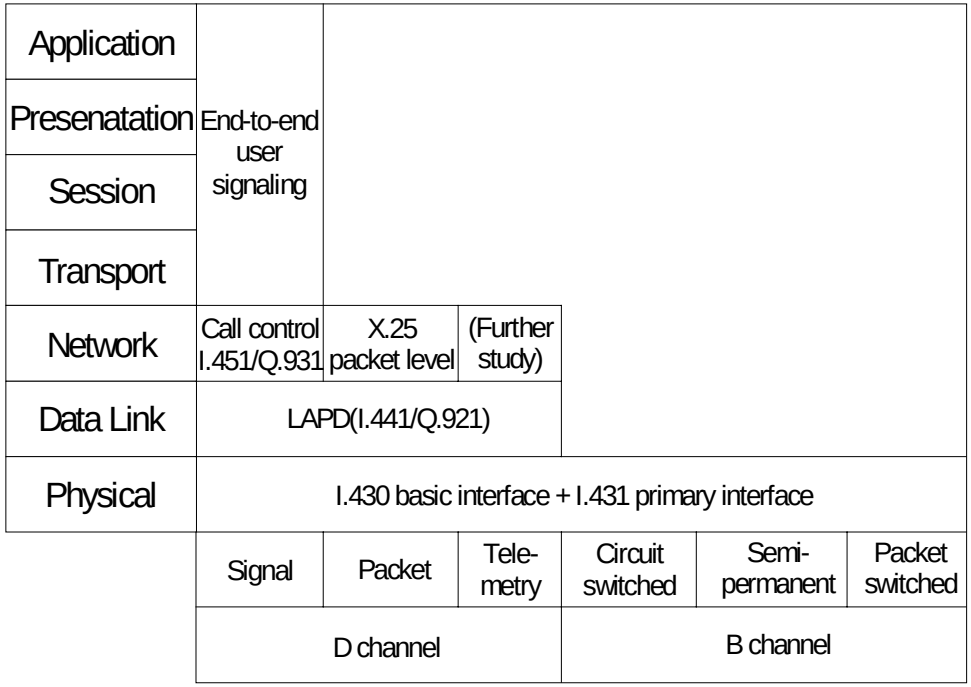
Integrated Services

- Services
  - Voice transmission
  - Transparent data transmission
  - Facsimile Group 4 (not compatible to Group 3)
  - Teletex
  - Packet switched services
- No "upper layer" services like mail, databases or fax Group 3/4 gateways
- Provided at a standardized user-network interface



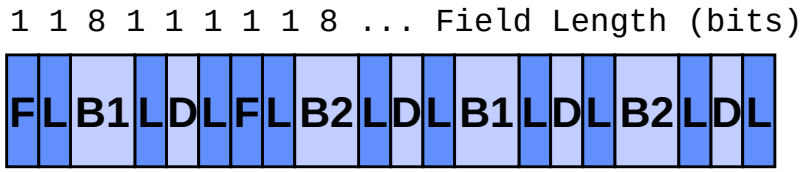
Protocol Architecture

- B- and D-channels are multiplexed over the same physical interface
- D-channel,
  - signalling (call control)
  - LAPD, based on HDLC
- B-channel
  - Circuit switched, setup on demand
  - Transparent data pipe, layer 2-7 not spec. Compatibility?
  - Most important for Data communication: IP over PPP over ISDN

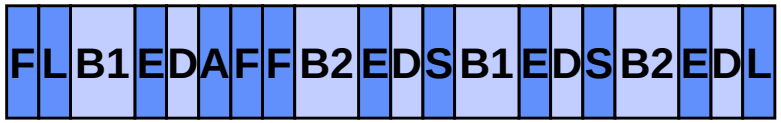


Physical Layer Frame Format

- Format differs depending on direction (outbound (terminal to network) inbound (net to terminal))
- Frame length 48 bits (with 36 bits of data)
- Mechanism to avoid collisions
- Multiplexing of B1, B2 and D-channel data



TE frame (terminal to network)

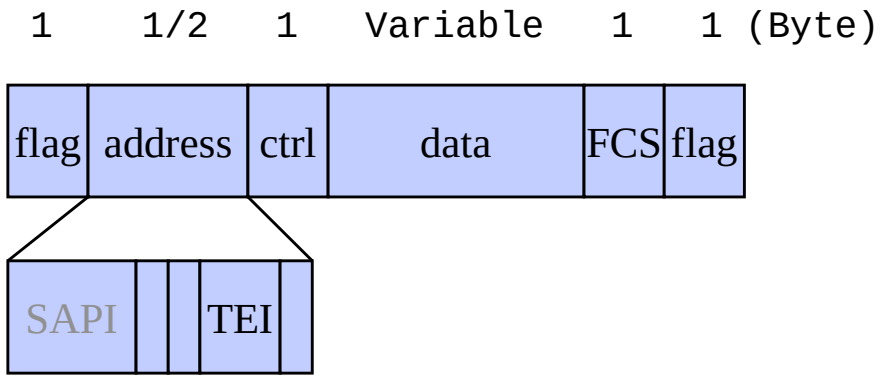


NT frame (network to terminal)

F	framing bit (provides sync.)
B1:	B1 channel bits (user data)
B2:	B2 channel bits (user data)
D:	D channel bits (signalling)
L:	Load balancing
E:	Echo of previous D-bit
A:	Activation bit
S:	Spare bit

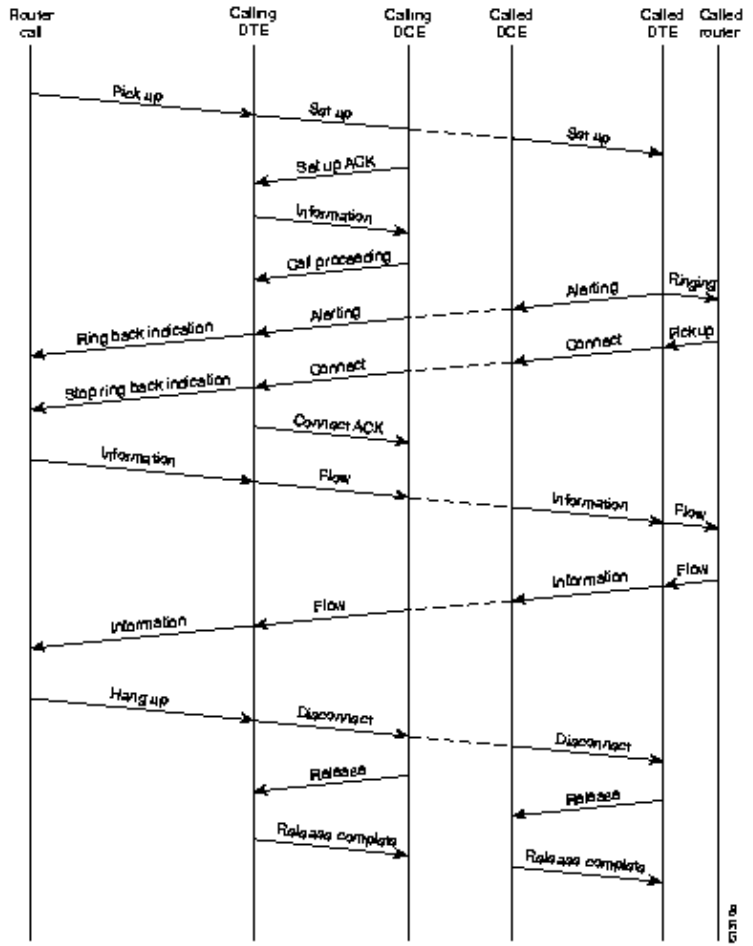
Data Link Layer (for ISDN Signalling)

- LAPD: Link Acces Procedure, D-Channel
- similar to HDLC (High Level Data Link Control)
- TEI: Terminal Endpoint Identifier - layer 2 address of a single Terminal (all ones: broadcast)

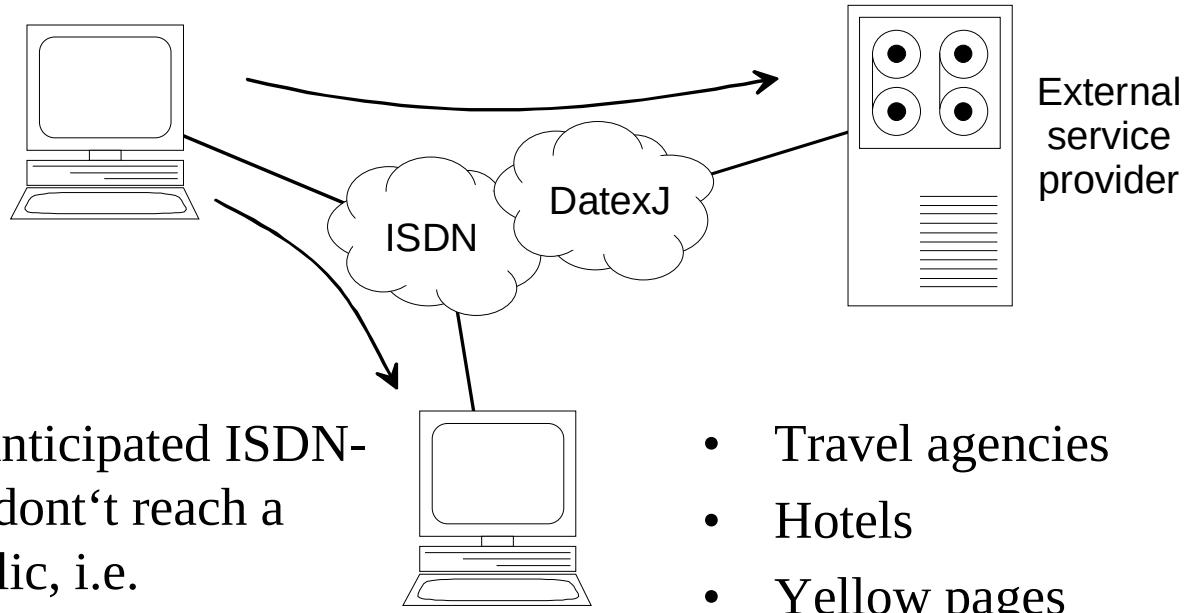


Network Layer (for Signalling)

- ITU-T Q.930 and ITU-T Q.931
- in Europe: EDSS1
- Protocol to control connections:
  - call establishment
  - call termination
  - information
    (i.e. numbers, charging)
- Proprietary variants by vendors
  (i.e. Cornet, Siemens)



ISDN based Applications



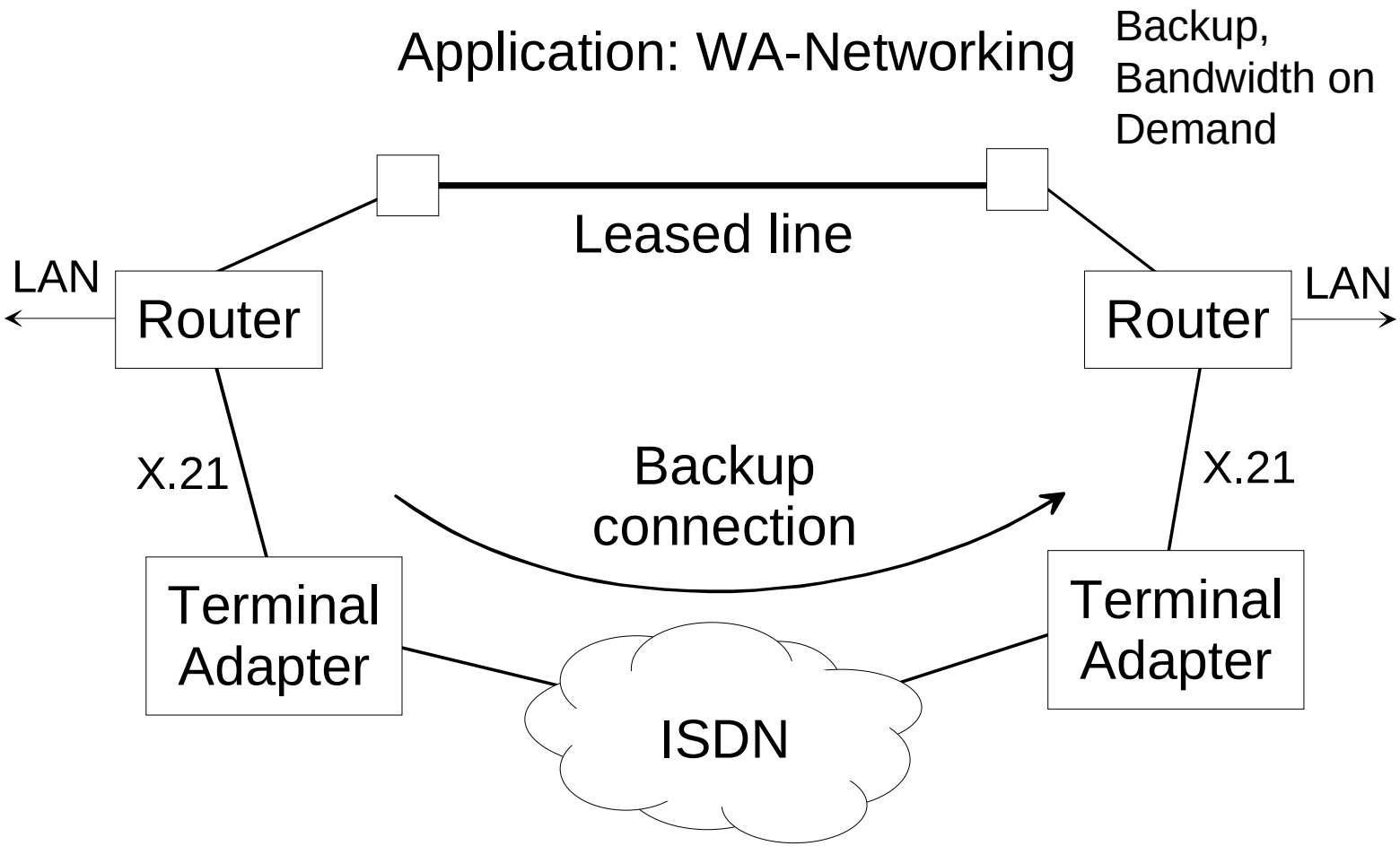
- Most of anticipated ISDN-Services dont‘t reach a wide public, i.e.
  - FAX group 4
  - (Euro) Filetransfer

- Travel agencies
- Hotels
- Yellow pages
- Shops
- **IP Transport**
- **Electronic banking**
- **Videoconferencing**

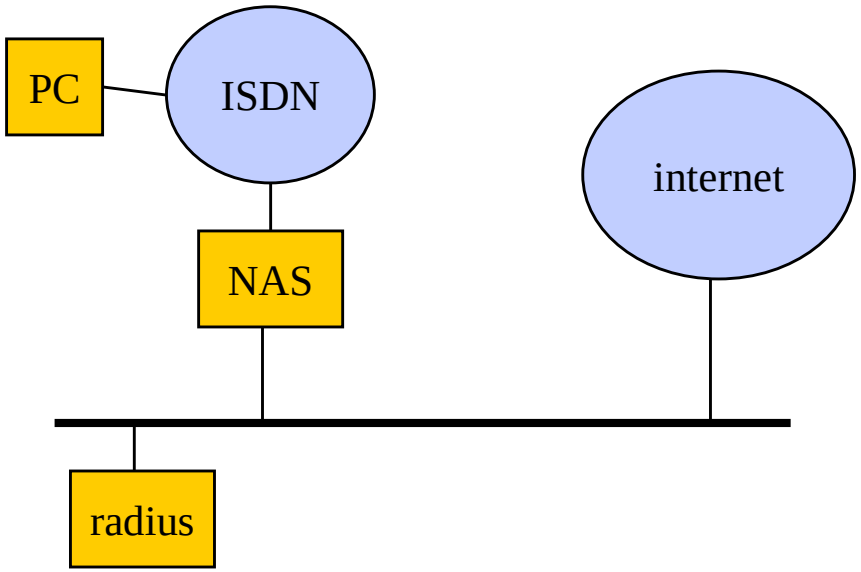
ISDN and Data Communication: PPP

- Question: How to transport IP-Packets over ISDN ?
  - Remember: user data: B-channel, transparent pipe, just layer 1 defined
- Protocol Stack for B-Channel needed !
- Most common solution: IP over PPP over ISDN
- Point to Point Protocol
  - standard internet encapsulation protocol for serial links
  - LCP (Link Control Protocol): establish, configure, test data link connection
  - PAP (Password Authentication Protocol)
  - NCP (Network Control Protocol), supporting IP, IPX, Decnet

LAN-LAN Connection



ISDN / Remote Access

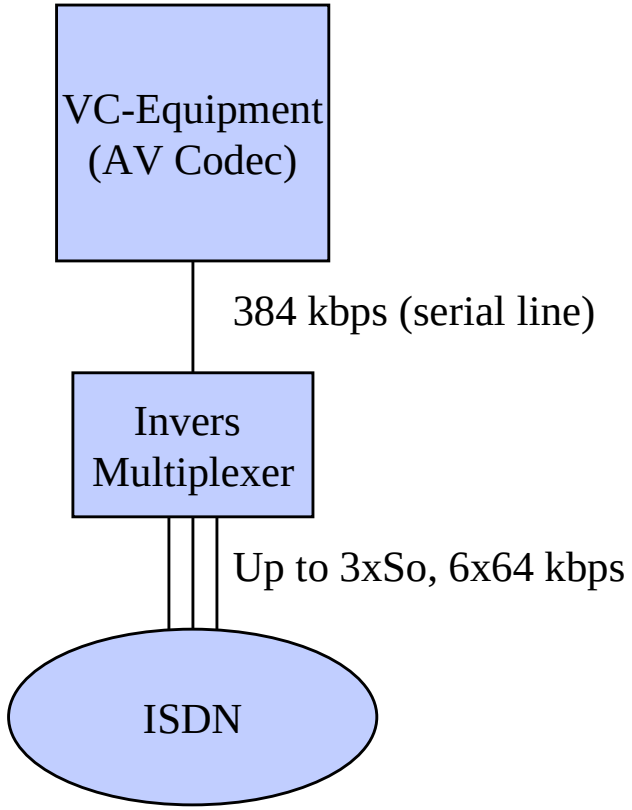


remote access dial in user server
(authentication)

- user- administration
  - RADIUS -Server
- security
  - PAP, CLI (calling line identification by ISDN network), Callback
- dynamic assignment of IP-address
- performance
  - 64 kbps
  - + channel bundling
  - + compression
- standard internet application software

ISDN Videoconferencing

- H.320 Standard
  - general Standard, ensuring compatibility
  - contains other standards for special tasks
  - i.e. H.261 Video Compression
- Bandwidth
  - 64 kbps possible
  - 128 kbps quite good
  - 384 kbps business grade quality



References

William Stallings: Data and Computer Communications (Macmillan Publishing)

Tutorial: Internetworking Technology Overview
www.cisco.com/univercd/cc/td/doc/cisintwk/ito_doc/index.htm

Requests for Comments:

- RFC 1661: The Point to Point Protocol (PPP)
  updated by RFC 2153
- RFC 1662: PPP in HDLC Framing
- RFC 1618: PPP over ISDN

Source for RFCs: http://andrew2.andrew.cmu.edu/rfc/rfc-front.html