Hands on Relay School
Dialup Communications

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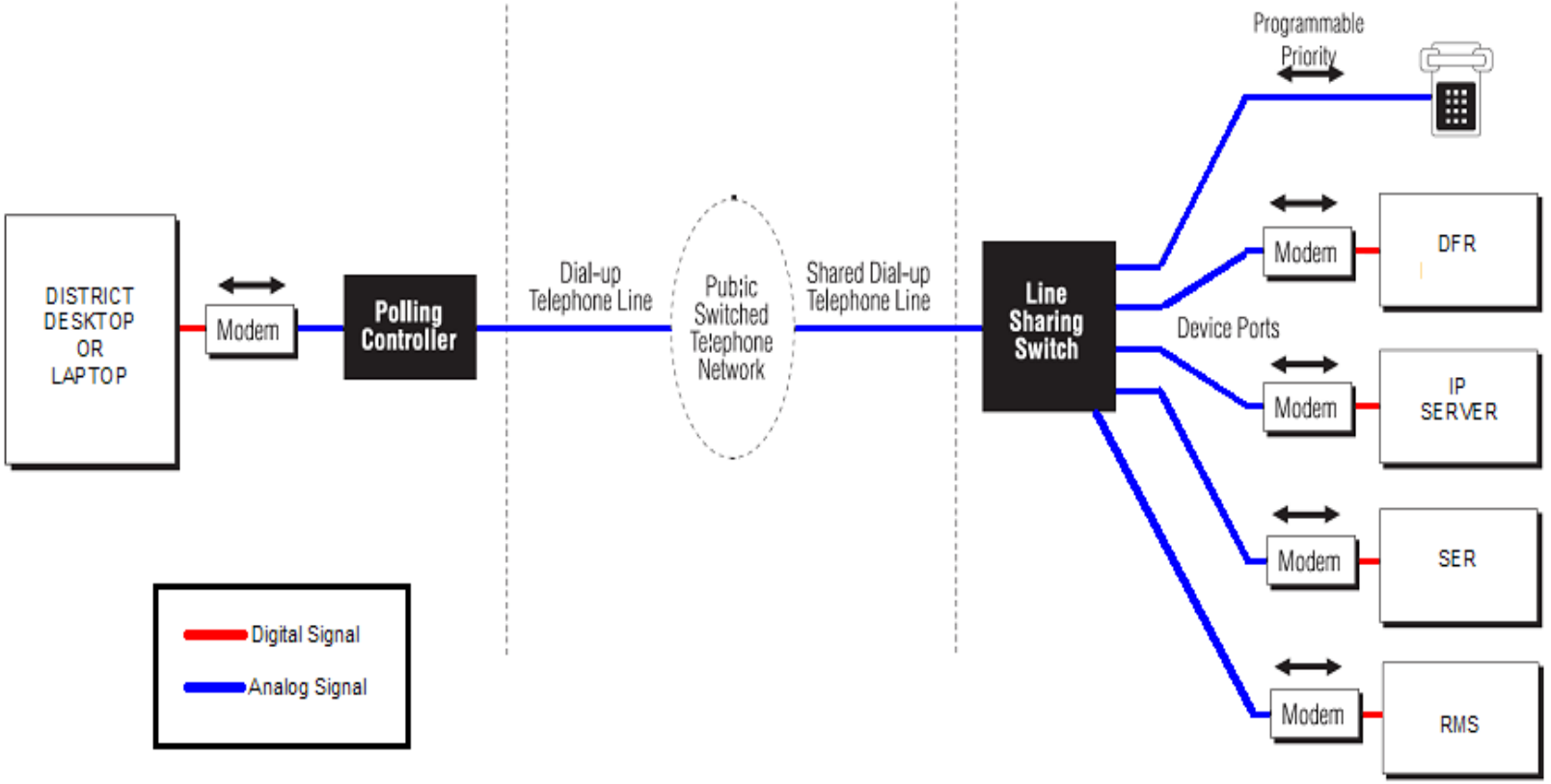
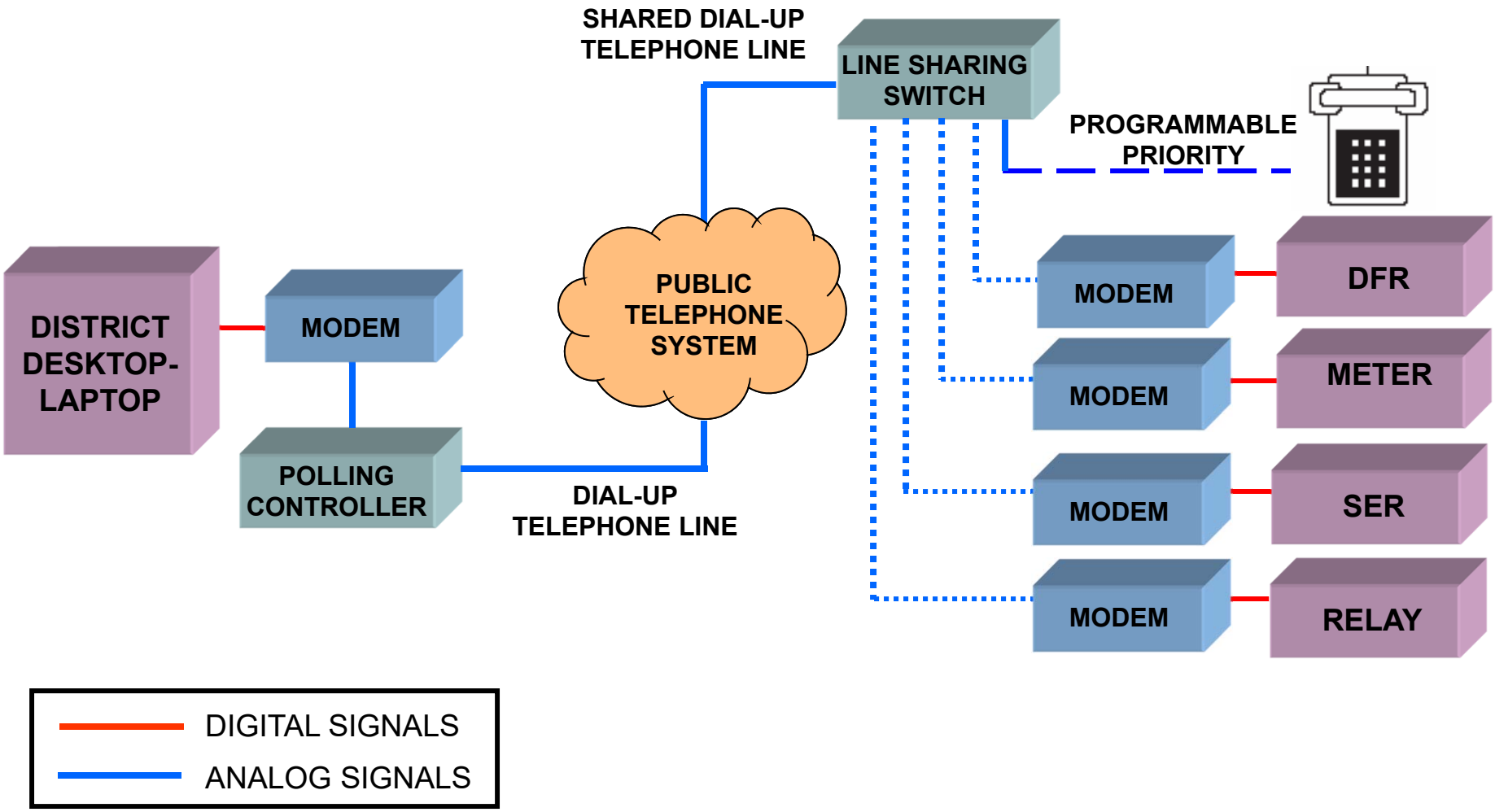
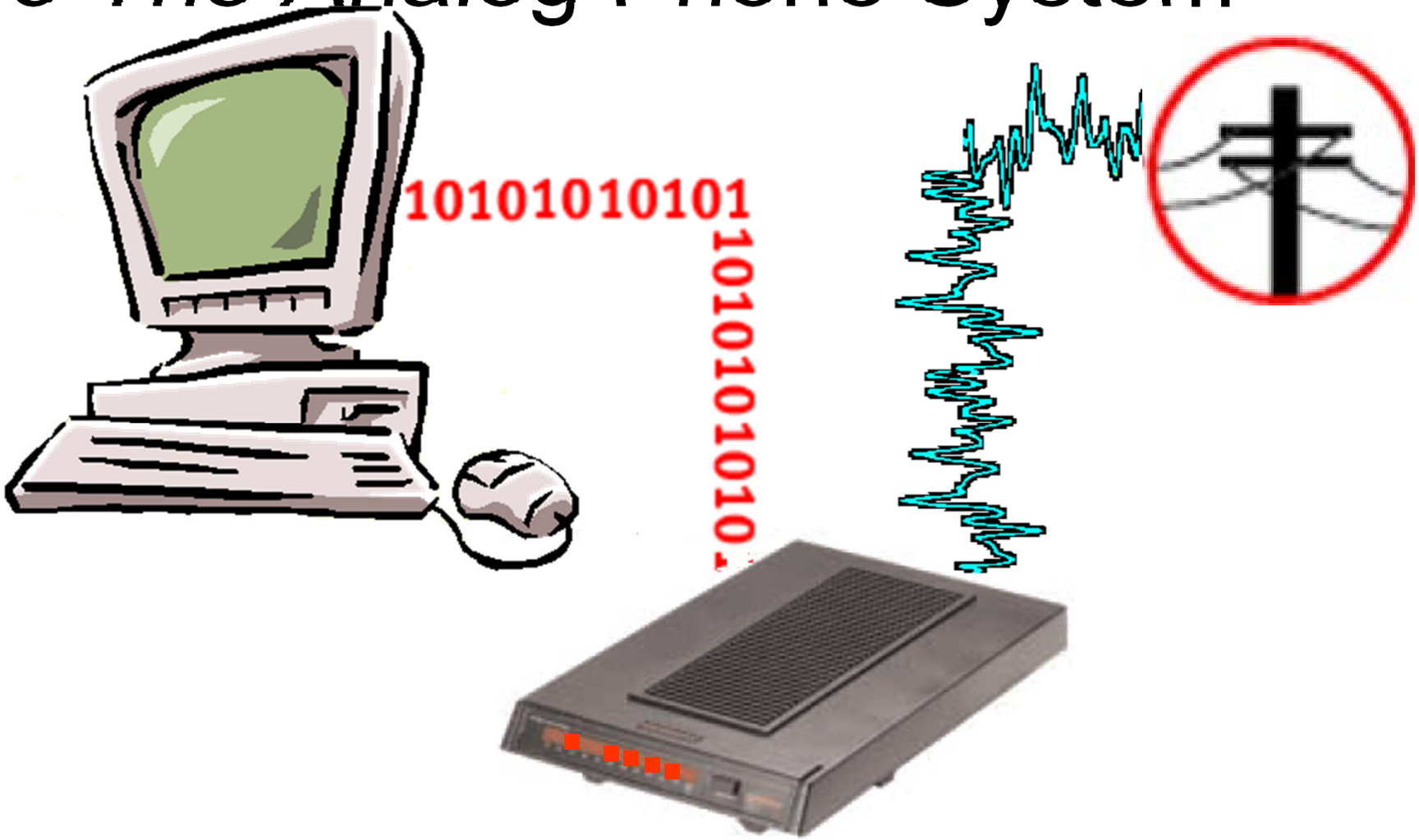
Dial-Up System Example



Typical Dial-Up System



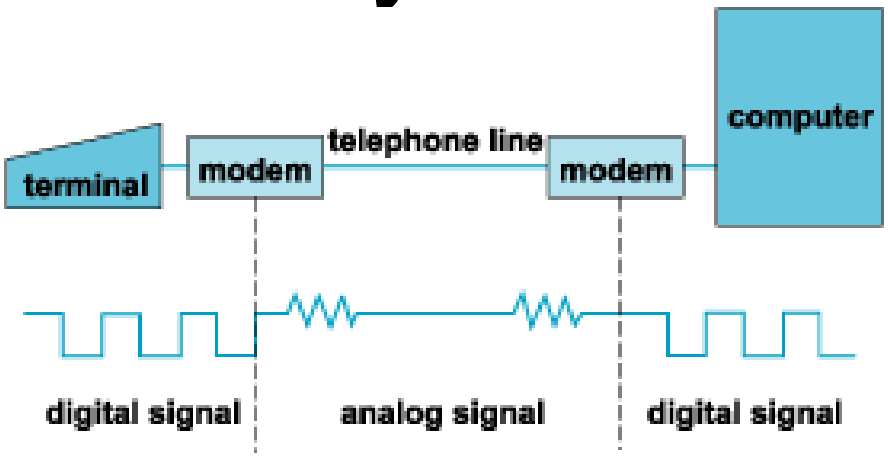
A Modem Connects Your Computer To The Analog Phone System



Modem History

- In the beginning…
  - Computers brought about a need to interconnect
  - Digital data exchange was expensive
  - Computers transmit data using digital signaling
  - Telephone circuits transmit analog signals
  - Therefore, a device is needed to convert these signals
- Led to the creation of a modulator/demodulator
  - Bell 202 modem ~ 300 baud

Modem History



- Modem modulates an analog carrier signal to encode digital information
- Modem demodulates the carrier signal to decode transmitted data

Modem History – Hayes Smartmodem

- Standard 300 bit/s modem
- Programmable by computer
- Could operate phone line using settings
  - pick up
  - hang up
  - dial
  - answer

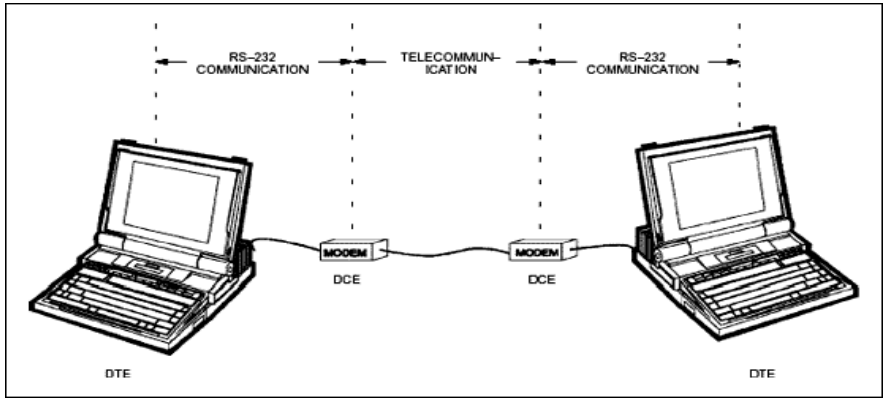
Modem History – Hayes Smartmodem

- Pre-Smartmodem
  - To connect required 2 step process: user manually dialed number, then plugged handset into acoustic coupler
  - Modems were either call-only or answer-only
- Smartmodem
  - Computer dialed by sending command, modem plugged directly into phone line
  - Modems operated in either call or answer mode – depending on commands from computer

Modem History - Hayes Smartmodem

- Hayes Smartmodem features still in use today:
  - 1. Command Mode and Data Mode
  - 2. Command Syntax
  - 3. Hayes Command Set

1. Command Mode & Data Mode



- Command Mode – modem is programmed
- Data Mode – data is sent to and from computers

2. Command Syntax

- **AT** begins each modem command
- Basic – character followed by a digit, ex. **F1**
- Extended – An & (ampersand) and a character followed by a digit, ex. **&F1**
- Register – Ex. **Sr=n**, where r is the number of the register to be changed and n is the value, ex. **S0=1** (auto answer setting)

3. Hayes Command Set

- Hayes Command Set = Command language
- “Hayes compatible” modem does not mean the modem follows the entire, original Hayes Command Set

Initialization String

- A command that is entered into the modem that will instruct the modem to perform in a certain way
- Ex. **AT&F0&N6V0&W**
- Specific to each modem type
- Note: **ATF0** = **ATF**

Modem variations

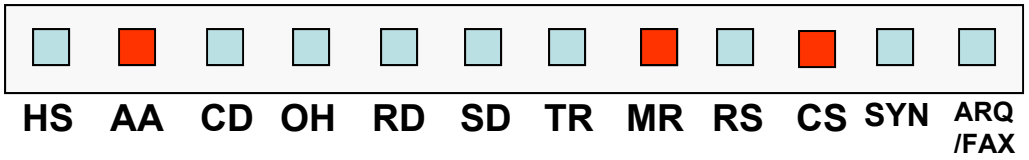
- US Robotics/Courier for labs today
- External or Internal

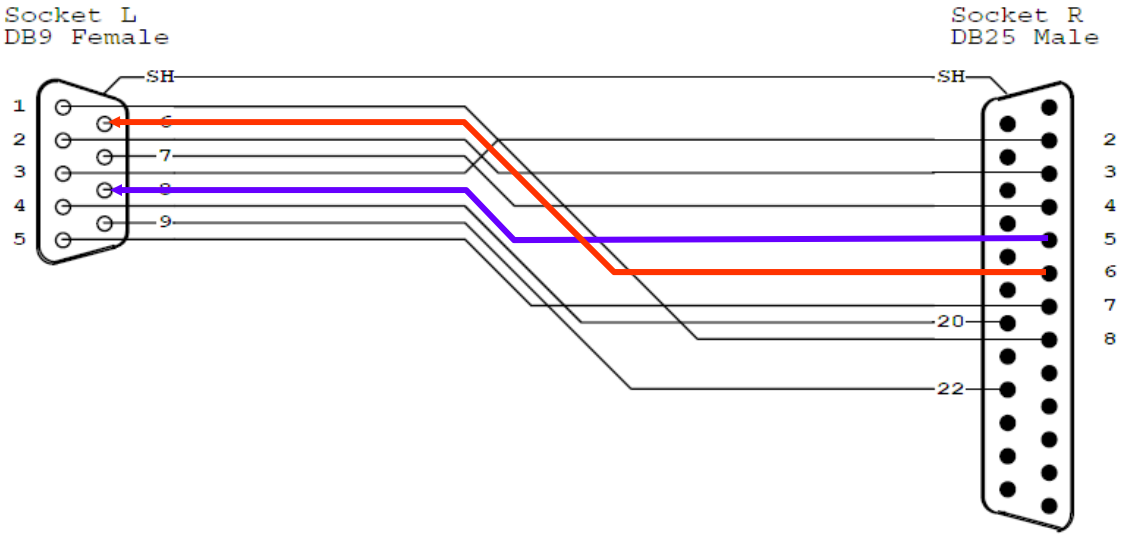
US Robotics – LED explanations

- HS – High Speed
- AA – Auto Answer
- CD – Carrier Detect
- OH – Off Hook
- RD – Received Data
- SD – Send Data
- TR (DTR) – Terminal Ready
- MR – Modem Ready
- RS (RTS) – Request to Send
- CS (CTS) – Clear to Send
- SYN – Synchronous Mode
- ARQ/FAX – Error Control

LED indications with no communications software active and accessing Com 1 and the modem configured for Auto Answer

A Modem Ready (Data Set Ready-DSR) (MR) signal is sent from the modem's Pin 6 to the PC's Pin 6.
A Clear to Send (CS) signal is sent from the modem's Pin 5 to the PC's Pin 8.

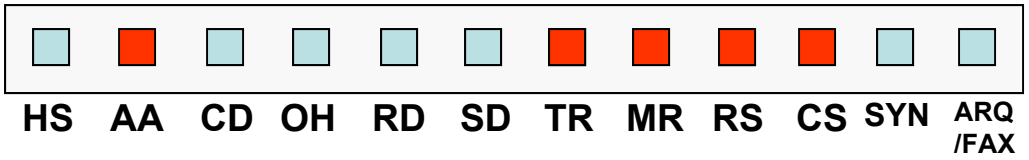


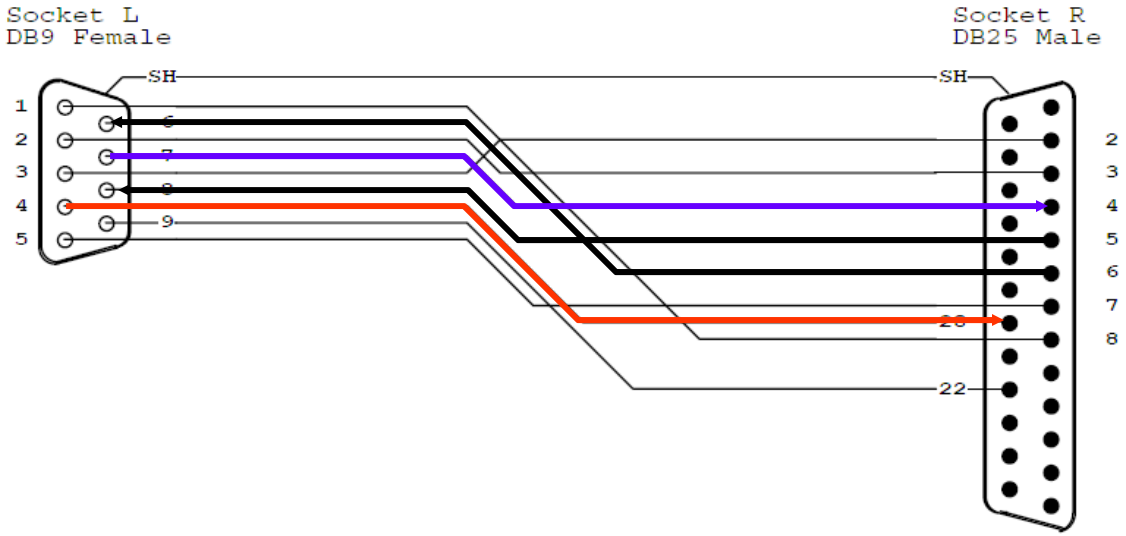


Once the communications software has made a connection to Com 1, the PC informs the modem that it is available (Data Terminal Ready – TR) and Ready to Send (RS) data when a connection to the remote device is made.

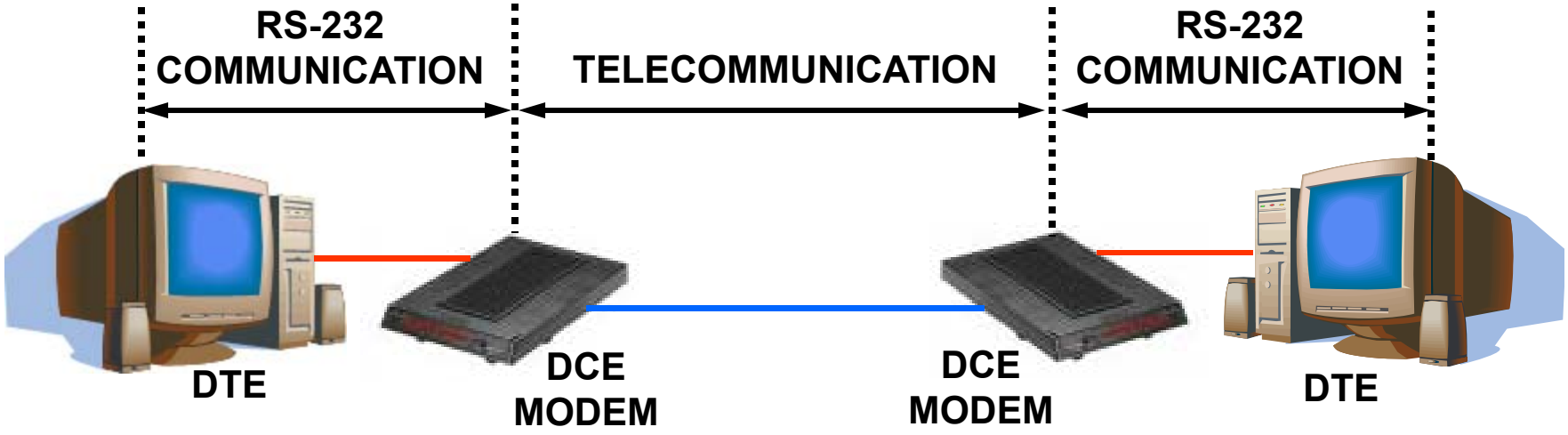
DTR (TR) PC Pin 4 – Modem Pin 20

RTS (RS) PC Pin 7 – Modem Pin 4



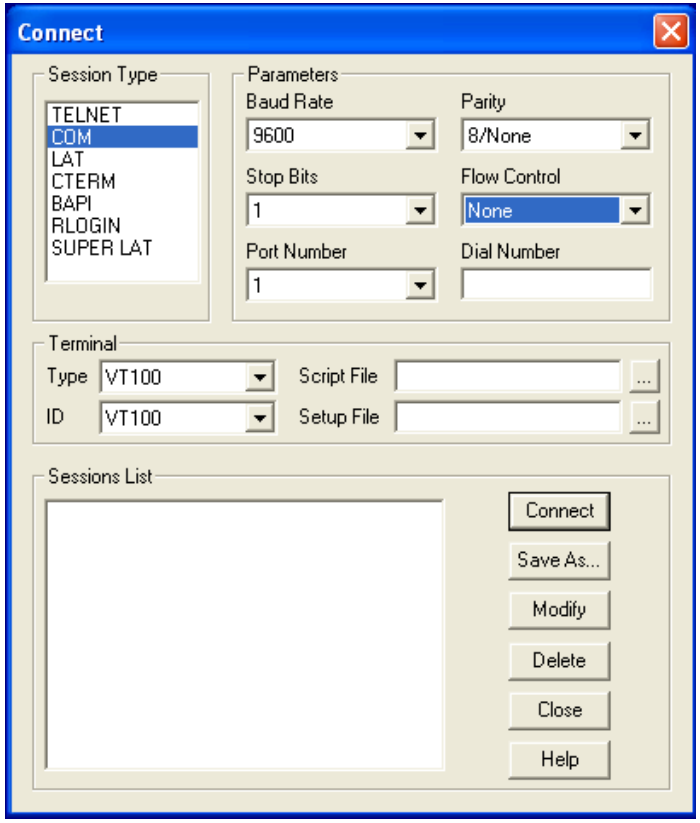


Labs



- Command Mode – Connect to modem
  - Lab A, B, C – Change and view settings
- Data Mode – Communicate with neighbor
  - Lab D – Set up communication with neighbor
  - Lab E – Baud rate mismatch
  - Lab F – Enable Flow Control
  - Lab G – Noisy line simulation

Lab A - Communicate with modem



- Type **`AT`** <Enter> to verify communications
- Notice modem's LED indications
- **`AT&K0`** and **`ATI4`**

Modem memory – US Robotics

Memory type	Applies to	Loss of power will	Command
RAM	The current settings.	Cancel any changes you make. To save settings before resetting the modem, use &W. See Working with RAM in this section for more detailed information.	**ATI4**
NVRAM	Saved settings (any configurations you can store, retrieve, and change).	NOT affect your settings.	**ATI5**
Flash	Three templates of permanent settings (the Courier 56K Business Modem's operating software).	NOT affect your settings. You can retrieve the permanent settings, and save them to NVRAM, but you cannot alter them.	Not applicable.

Modem memory - NVRAM

- Save settings in NVRAM
  - US Robotics – **`&W`** command saves current settings to NVRAM
  - **`ATI5`** – shows settings saved in NVRAM
- Load NVRAM settings on power-up (Switch setting)

Lab B – save setting change to NVRAM

- Lab B
  - Enter **`AT&K2&W`**
    - Changes data compression to “enabled”
    - Saves setting in NVRAM
  - Then, use **`ATI5`** to verify setting change

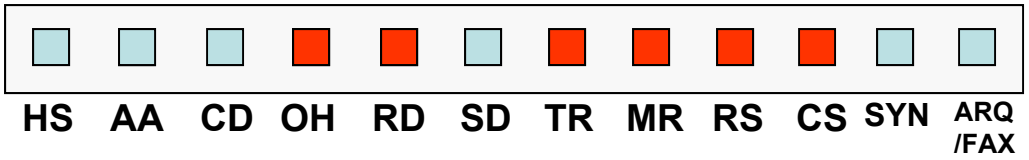
Modem memory

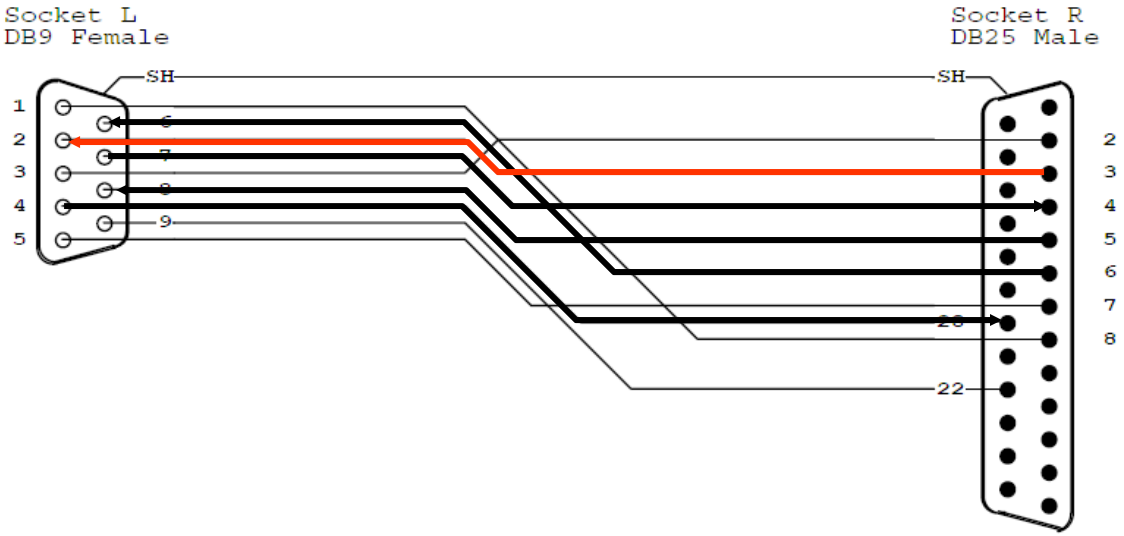
- RAM – **`ATI4`**
- NVRAM – **`ATI5`**
- ROM – stores flow control templates
  - **`AT&F0`** – No Flow Control
  - **`AT&F1`** – Hardware Flow Control
  - **`AT&F2`** – Software Flow Control

Lab C – Load flow control template

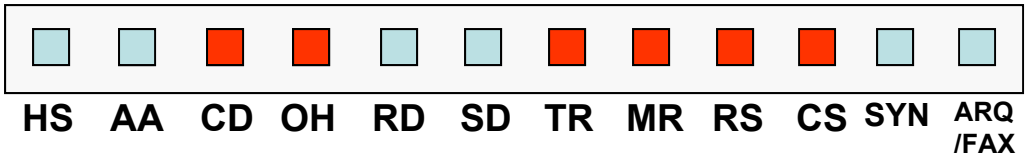
- Lab C
  - Load No Flow Control template
  - Save to NVRAM
  - View the settings

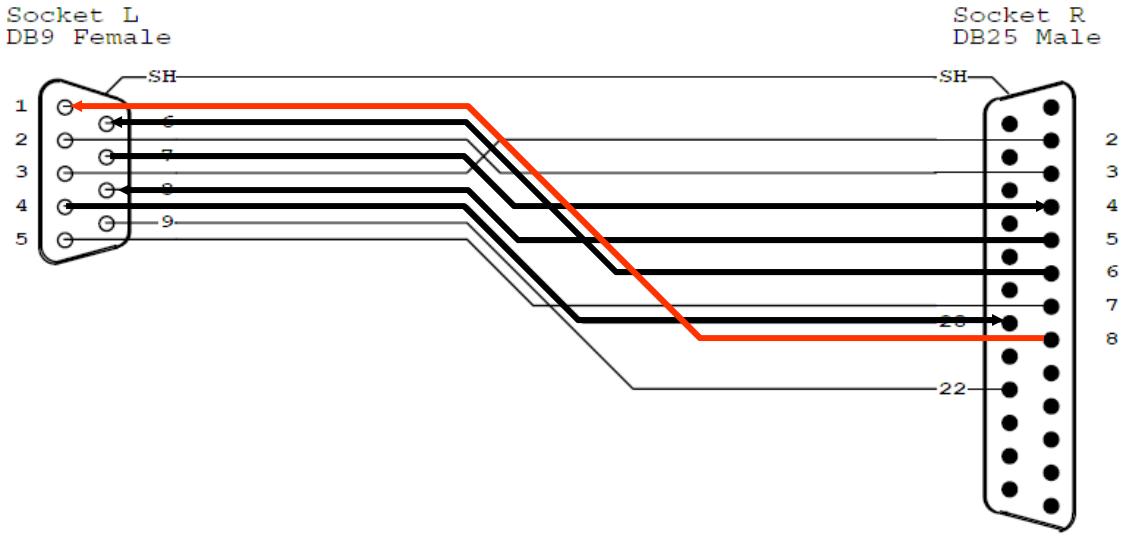
When you initiate a call to the remote device, your communication's software transmits an ATDT command, with the number to be called. The modem will go off-hook and dial the number. AA indication will go out and OH will illuminate. Each time a ring is detected, the modem will transmit that information from its Pin 3 to the PC's Pin 2 on the Receive Data (RD) line. The modem's RD indication will light briefly.





Once the remote modem answers, the local modem will send a low frequency hailing tone. The remote will respond with a higher frequency tone. Both tones can be heard on the modems speaker. Each modem will send its connected DTE a Carrier Detect (CD) signal, from the modem's Pin 8 to the DTE's Pin 1 and the "Handshake" process will begin. If handshaking is successful, data transfer may commence.

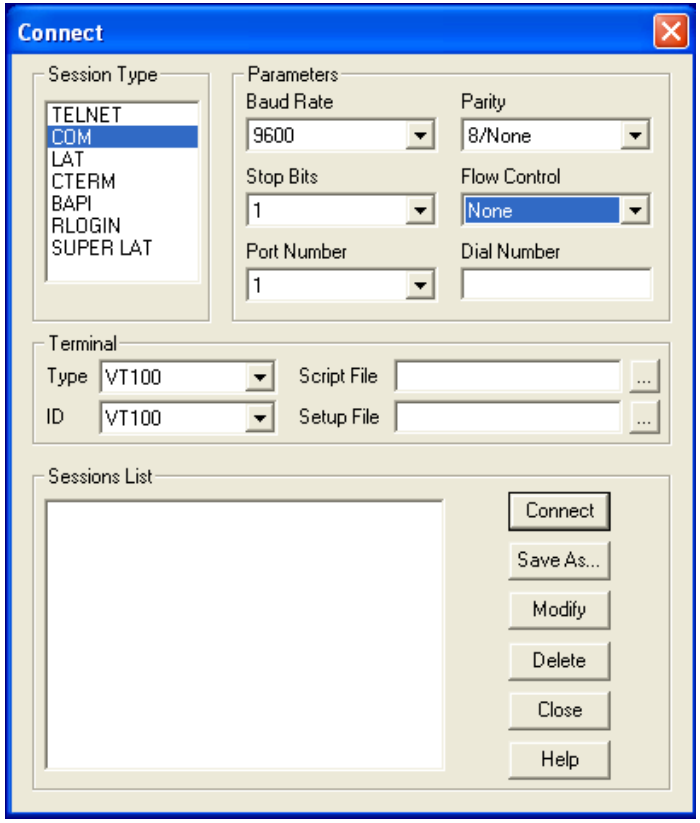




Modem Handshaking

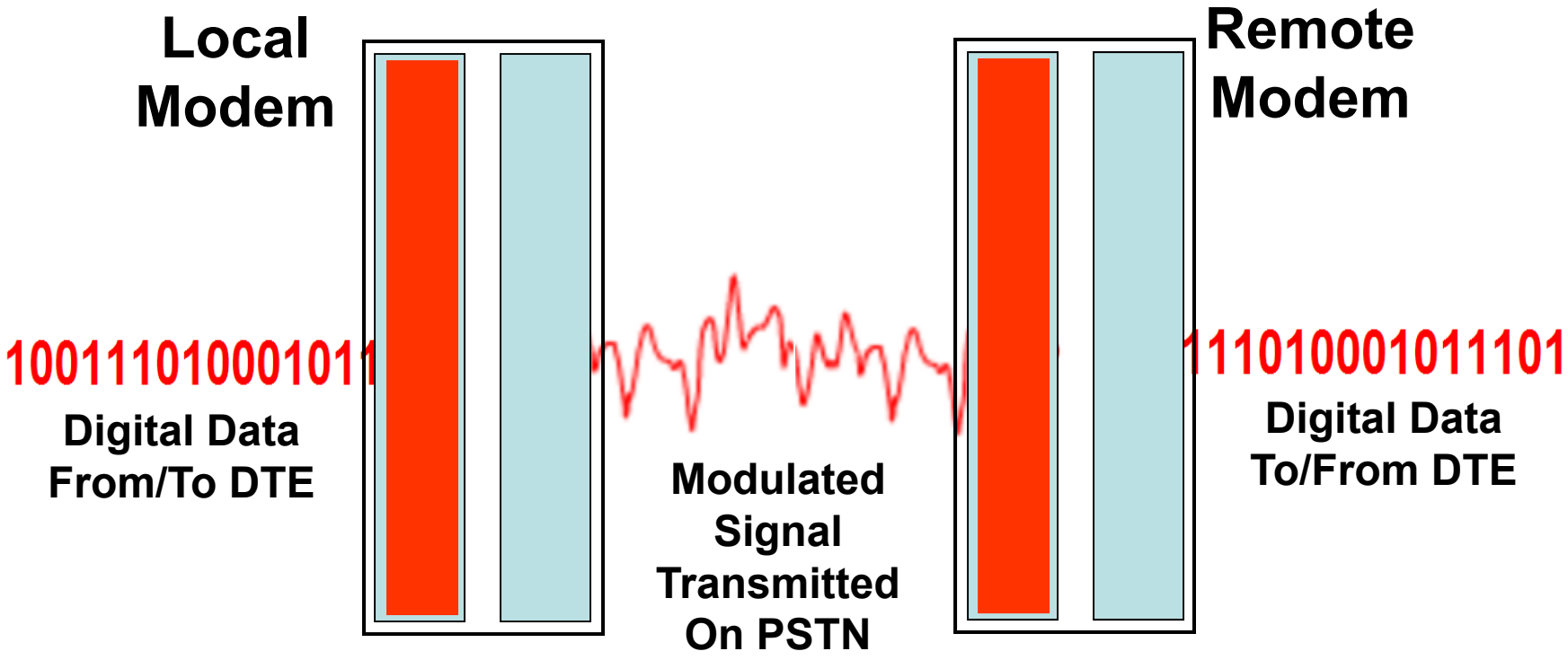
- The sequence between two modems during the connection process that determines the parameters of the conversation.
  - Modulation protocol
  - Connection speed
  - Data Compression
  - Error Control
- Audible tones and LED indications – good clues
- Result Code
  - Ex. Connect 19200/ARQ/LAPM/V.34bis
  - Result Code – can be verbal or numeric

LAB D – Communicate with neighbor

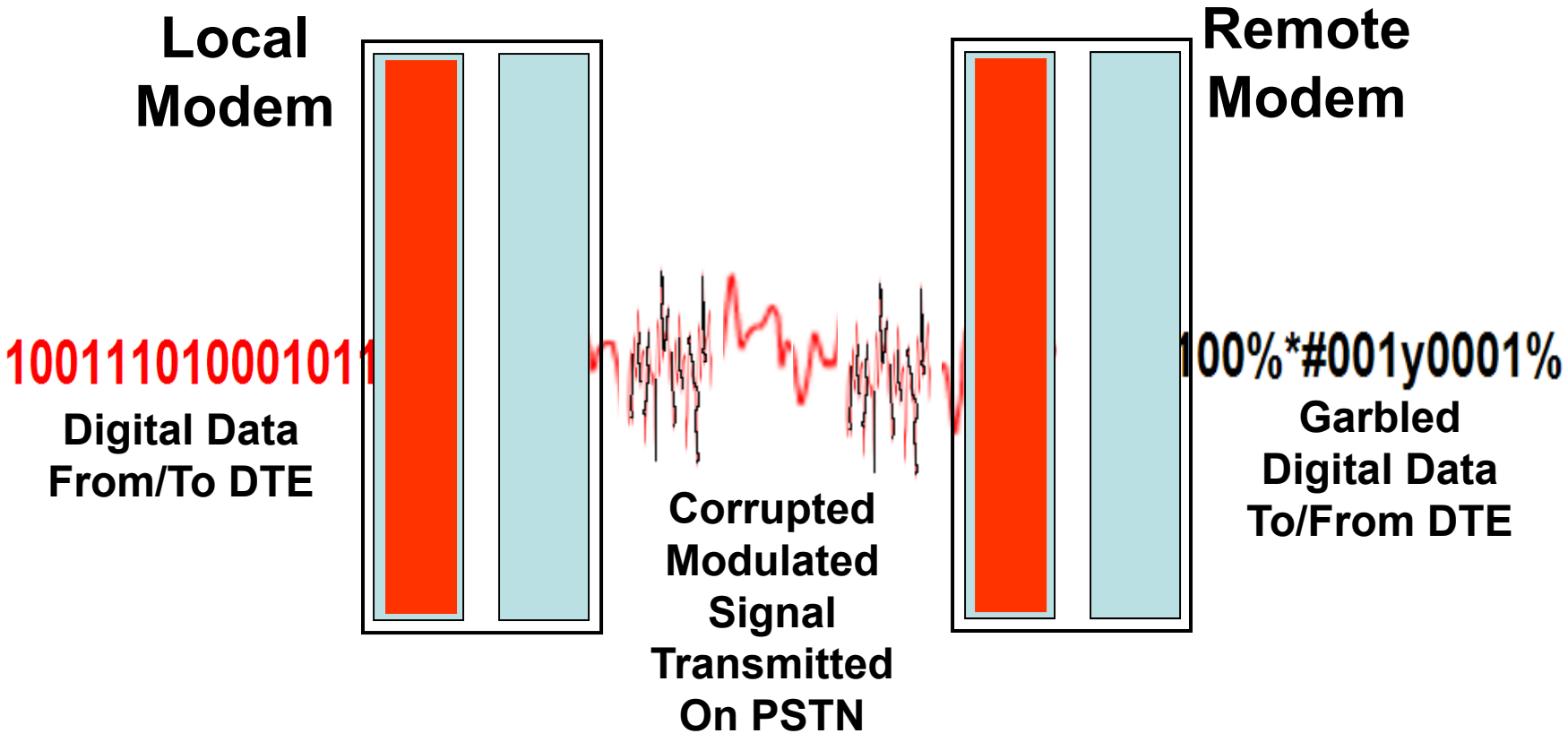


- Designate caller and receiver
- Connect at 9600 baud
- Load No Flow Control template (AT&F setting)
- Receiver enable auto answer (**`ATS0=1`**)
- Caller dial receiver (**`ATDT ___`**)
- Notice Result Code

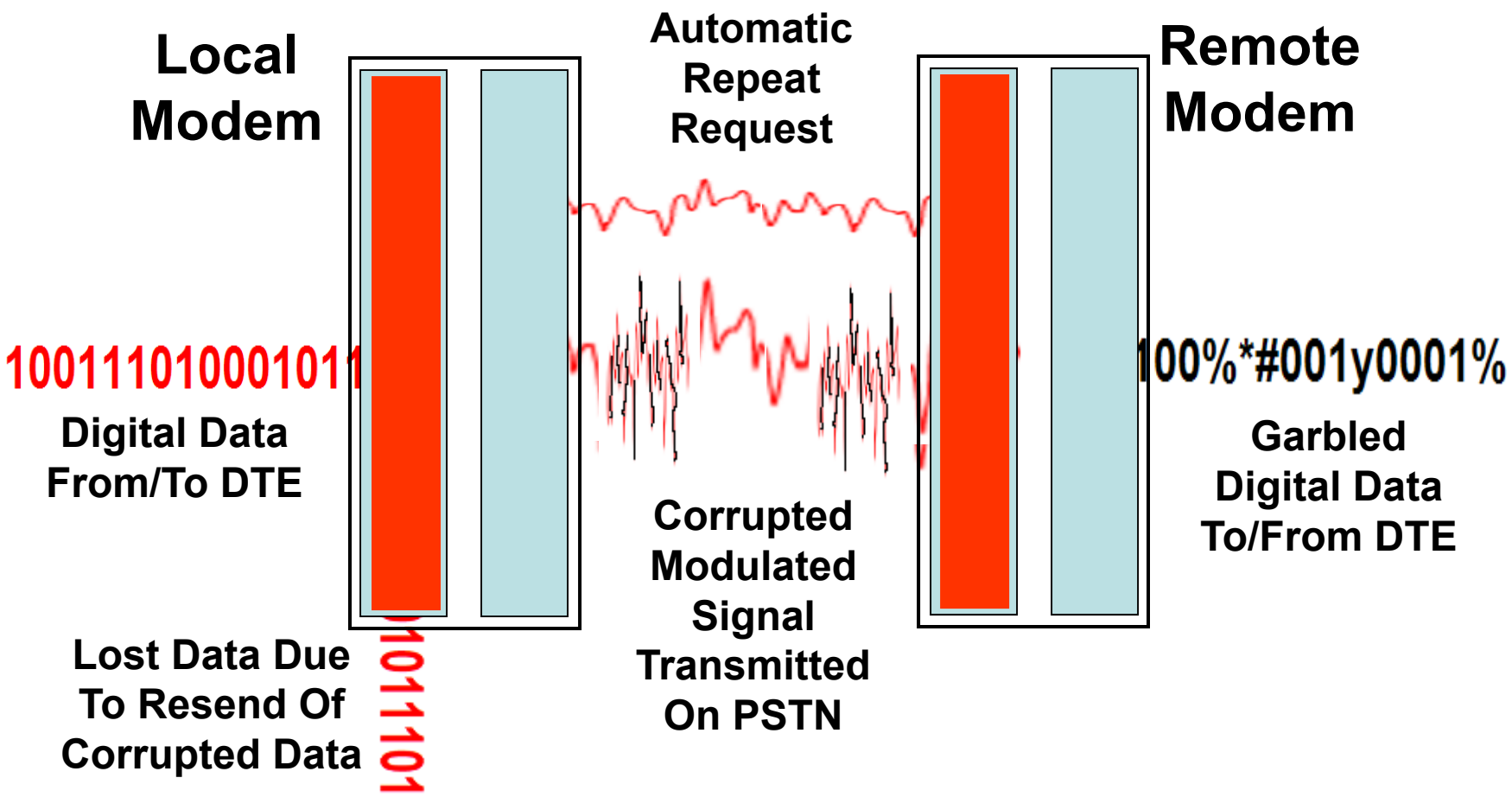
Simple Transmission Of Data In A Perfect World



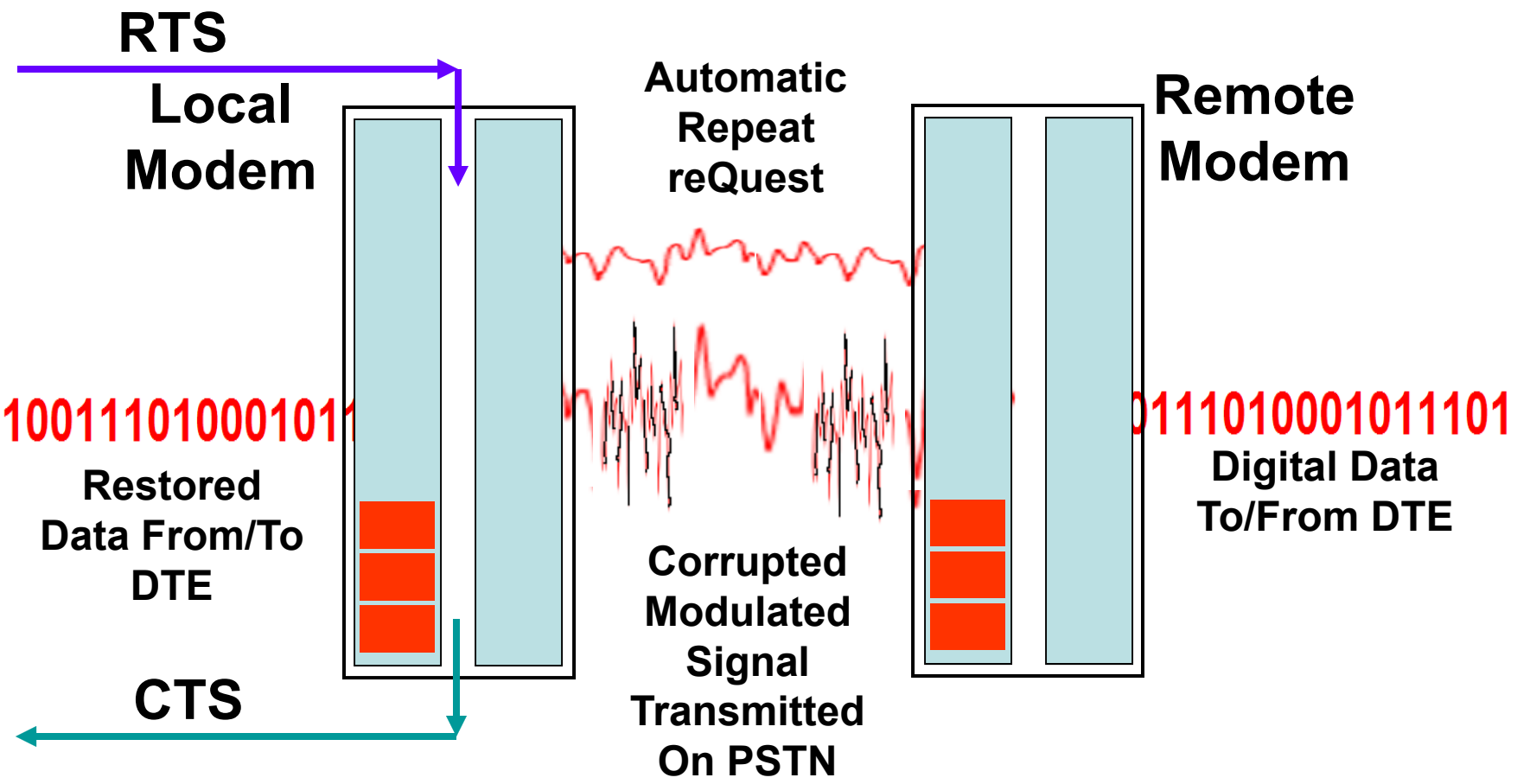
Simple Transmission Of Data In An Imperfect World



Simple Transmission Of Data In An Imperfect World Using Error Control



Real World Data Transmission Using Buffers, Data Compression, Error And Flow Control

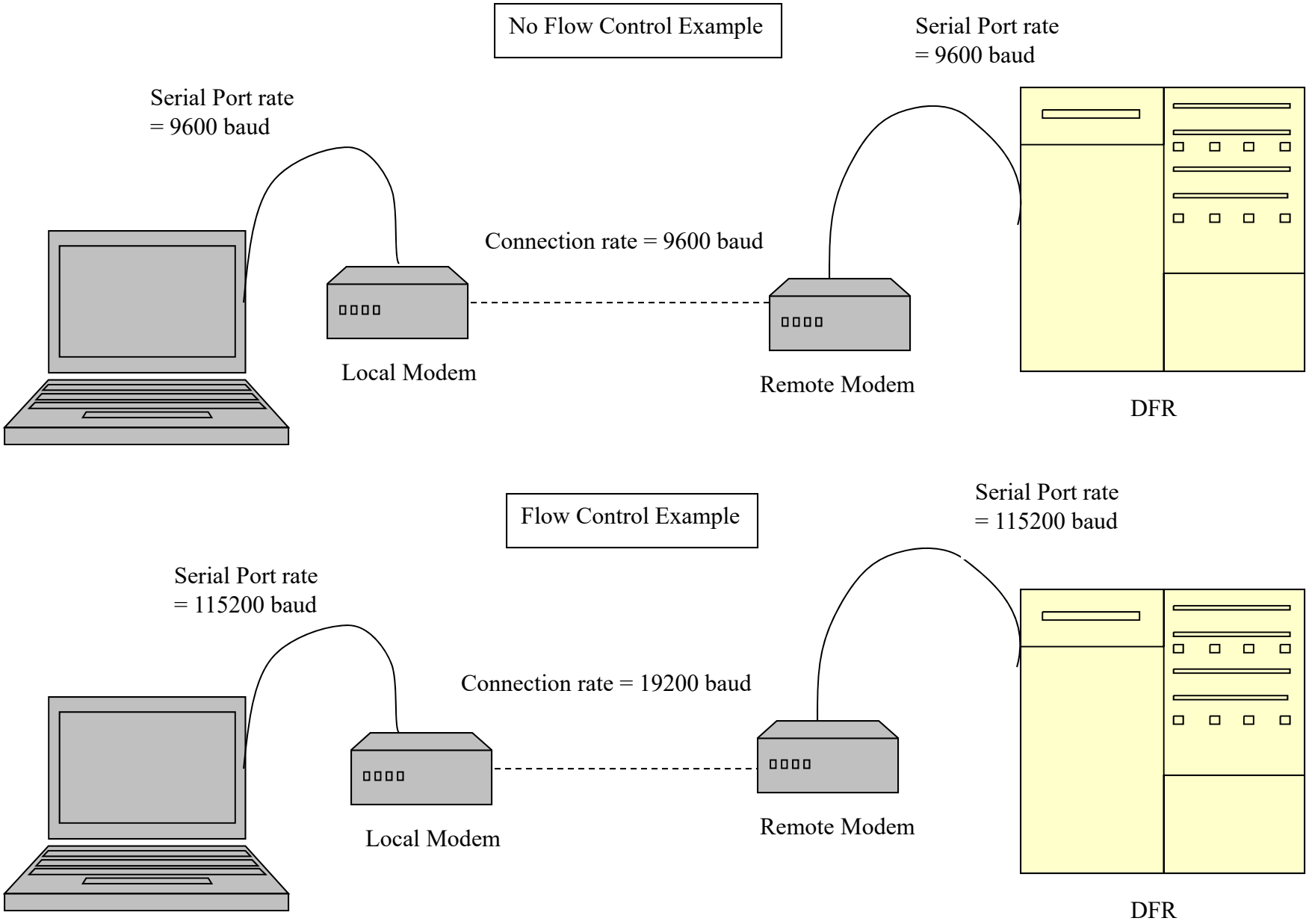


Flow Control

- No Flow Control
  - Baud rates have to match up
  - Use setting to control connection rate
- Hardware – RTS/CTS
  - Modem drops CTS when the buffer reaches 90% capacity
  - Sometimes able to watch with LED indications
- Software – XON/XOFF
  - Modem sends terminal OFF character <Ctrl>-S when the buffer reaches 90% capacity
  - Can be riskier than Hardware – mixes flow control characters with the data
- Flow control type determined by end device

Serial Port Rate & Connection Rate

- 3 components of the modem connection are between:
  - PC and “local” modem – Serial Port Rate
  - Modem and modem – Connection Rate (slowest)
  - “Remote” modem and end device – Serial Port Rate
- Maximal throughput
  - Serial Port Rate > Connection Rate


No Flow Control Example
Serial Port rate
= 9600 baud
Serial Port rate
= 9600 baud
Connection rate = 9600 baud
Local Modem
Remote Modem
DFR
Flow Control Example
Serial Port rate
= 115200 baud
Serial Port rate
= 115200 baud
Connection rate = 19200 baud
Local Modem
Remote Modem
DFR

LAB E– Baud Rate Mismatch

- Lab
  - Caller connect at 115,200 and receiver connect at 9,600
  - Load No Flow Control Template **(&F0**)

LAB F – Baud Rate Mismatch with Flow Control enabled

- Lab
  - Caller connect at 115,200 and receiver connect at 9,600
  - Load Hardware Flow Control Template (**`&F1`**)

Substation Line Sharing Switch (SLSS)

- Allows a single phone line to be shared by multiple devices
- Can be used with Polling Controller
- How to Program

Polling Controller

- Polling Controller's are used with SLSS's
- Dialing string without Polling Controller
  - **ATDT 9,13604182693,,,22,,,22,,,22**
- Dialing string with Polling Controller
  - **ATDT 9,13604182693*02**
- How to Program

Other ATI commands

- **`ATI6`**
  - Characters sent and resent
  - Number of retrains requested
- **`ATI11`**
  - Signal to Noise ratio of last successful connection

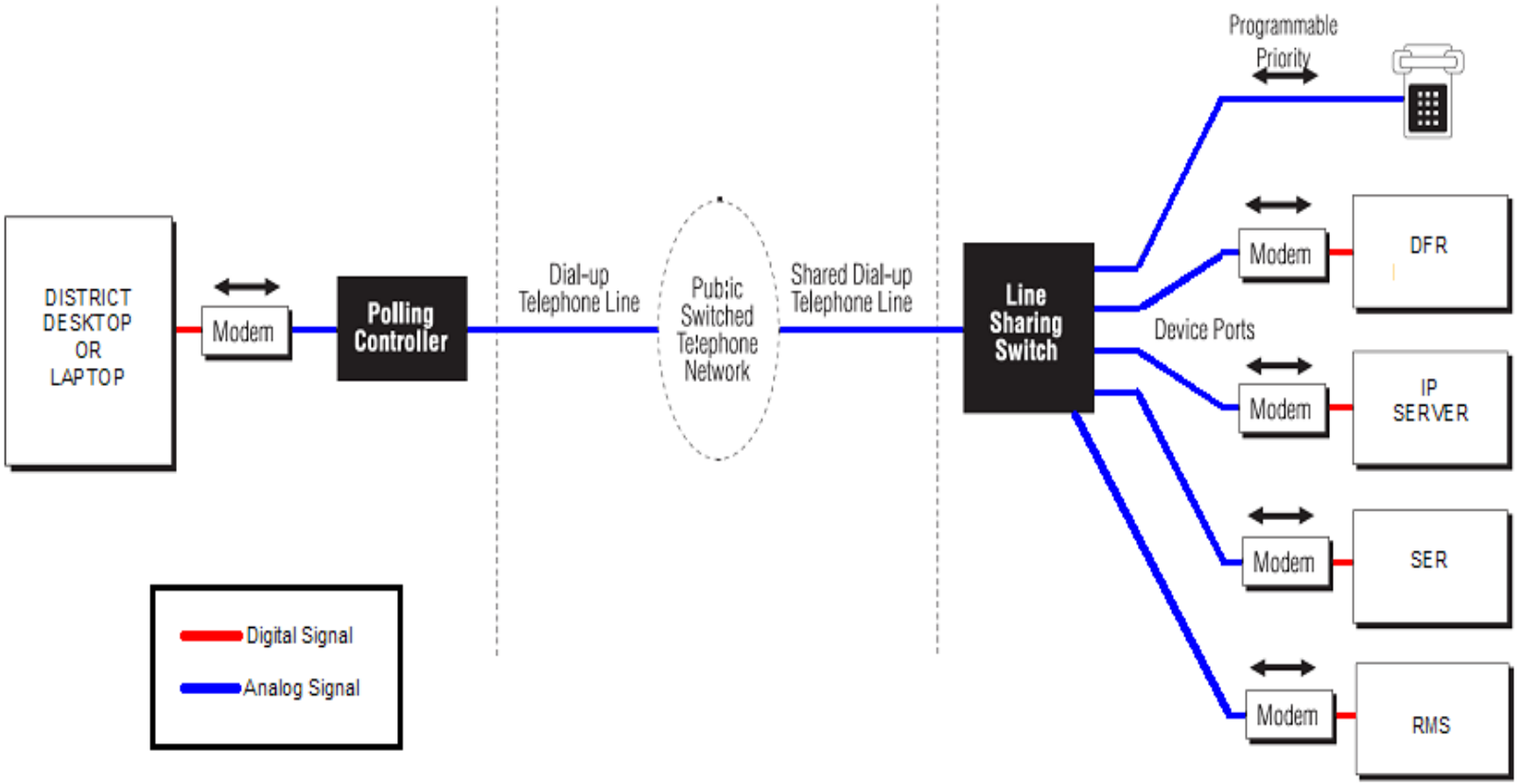
Lab G – Noisy line simulation

- Lab
  - Caller and Receiver connect at 115,200
  - Load Hardware Flow Control template (**`&F1`**)
  - **`ATI6`** and **`ATI11`** commands – show details about quality of last connection
  - Introduce “noise” into telephone line with pot, compare **`ATI6`** and **`ATI11`** results

Signal to Noise Ratio/Stable bps

40+	33,600 - 56,000
37-40	33,600-56,000 (a little unstable at high speeds)
34-37	31,200-33,600
31-34	28,800-31,200
29-31	26,400-28,800
28-29	24,000-26,400
25-28	16,800-24,000
23-25	14,400-16,800 (NOTE: If your SNR is around this level or lower the FCC may step in if your telco won't fix it, this level is not required to be supported, but often is by local teclos and must be upheld if in their charter.)
21-23	12,000-14,400
18-21	9600-12,000 (NOTE: If your SNR is around this level or lower the FCC will step in if your telco won't fix it, this level is REQUIRED, BARE MINIMUM support.)
14-18	7200-9600
13-14	4800-7200
6-13	2400-4800
1-6	300-2400 if you are lucky enough to connect.

Questions?


DISTRICT DESKTOP OR LAPTOP
Modem
Polling Controller
Dial-up Telephone Line
Public Switched Telephone Network
Shared Dial-up Telephone Line
Line Sharing Switch
Programmable Priority
Device Ports
Modem
DFR
Modem
IP SERVER
Modem
SER
Modem
RMS
Digital Signal
Analog Signal