Basic Terminology

Data Terminal Equipment (DTE)

Refers to machines ranging from computers to printers, and terminals.

Data Communication Equipment (DCE)

- Refers to specialized switching equipment, modems, routers, hubs, switches, etc.

RS-232: Connectors and Cabling

- Serial ports follow a standard called the ***RS-232*** specification.

- The standard defines the meaning of the different serial signals and their respective pin assignments on a standard 25-pin (DB-25) serial connector.

Table 1
DB-25 pin assignments

Pin	Name	Signal	Pin	Name	Signal
1	FG	Frame ground	14	STD	Secondary TD
2	TD	Transmitted data	15	TC	Transmit clock
3	RD	Received data	16	SRD	Secondary RD
4	RTS	Request to send	17	RC	Receive clock
5	CTS	Clear to send	18	-	Unassigned
6	DSR	Data set ready	19	SRTS	Secondary RTS
7	SG	Signal ground	20	DTR	Data terminal ready
8	DCD	Data carrier signal	21	SQ	Signal quality detector
9	-	Positive voltage	22	RI	Ring indicator
10	-	Negative voltage	23	DRS	Data rate selector
11	-	Unassigned	24	SCTE	Clock transmit external
12	SDCD	Secondary DCD	25	BUSY	Busy
13	SCTS	Secondary CTS			

- DB-25 connectors are either male, with the pins sticking out, or female, with matching sockets.

- In order to reduce design complexity, network software is organized as a series of layers or levels, each one built on its predecessor.

- The RS-232 specification defines the maximum length of serial cable to be 75 feet at 9,600 bps.

- This is a conservative figure and has been extended as far as 1,000 feet. These limits depend on the type of equipment in use and the environment under which they operate.

- The complete RS-232 specification defines signals that go largely unused in standard types of communication, especially for smaller equipment like laptops. Many alternate serial connectors have come into widespread use.

- These connectors provide the same necessary pins as a DB-25, but are smaller, more manageable connectors. Because they provide access to the same signals, devices that use different connectors are compatible as long as the proper converters are used.

DIN-8

- DIN-8 serial connectors are small, and almost circular. They are used on Macs, and often on laptops because they are so compact. DIN-8s provide the seven most common serial signals whose pin assignments are shown in the table below.

DIN-8 Pin	Corresponding DB-25 Pin	Signal	Function
3	2	TD	Transmitted data
5	3	RD	Received data
6	4	RTS	Request to send
2	5	CTS	Clear to send
4,8	7	SG	Signal ground
7	8	DCD	Data carrier detect
1	20	DTR	Data terminal

DB-9

- DB-9s are most commonly found on PCs. They look like smaller versions of the DB-25 connector.

- DB-9s provide the eight most common serial signals whose pin assignments are shown in the table below.

DB-9 Pin	Corresponding DB-25 Pin	Signal	Function
2	3	RD	Received data
3	2	TD	Transmitted data
8	5	CTS	Clear to send
7	4	RTS	Request to send
6	6	DSR	Data set ready
5	7	SG	Signal ground
4	20	DTR	Data terminal ready
1	8	DCD	Data carrier detect

RJ-45

- RJ-45 connectors look a lot like standard telephone connectors. They house eight wires instead of the four wires in a telephone connector.

- RJ-45s are not typically found on computers or normal serial equipment, but, because they are so small, they are often used on devices that have a lot of ports spaced very close together.

- Terminal servers are good examples of devices that use RJ-45.

Establishing a connection

- (1). The phone number is dialed.
- (2). Ring Indicator (pin 22) is on at the distant end.
- (3). If the terminal or computer (DTE) is on, DTR is on, allowing the call to be answered. This is called auto-answer. When DTR is on and ring indicator is detected, the call will automatically be answered.
- (4). Once answered, each modem will raise its data set ready lead as an indication that a line is present for that station.
- (5). The originating station is on; its DTR lead is on (high), so that the connection can be maintained.
- (6). The connection is now established.
- (7). Data may now be exchanged between the two devices.

Terminating the connection

- The connection is broken when either end drops DTR. The DTE may drop DTR generally in one of several ways.
- Place the terminal into a mode known as "local mode". This is contrasted with being "on-line". while in on-line mode, DTR is on.
- By placing the terminal off-line or in local mode, DTR is lowered, automatically causing the modem to drop the connection.
- Unplugging or turning off the terminal or computer. Lack of power lowers DTR, causing a disconnect by the modem.
- The program executing on the DTE can generally control the DTR signal and bring it down at will.

Half-Duplex DTE-DCE Interaction

- (1). RTS (pin 4) is raised by DTE
- (2). DCD (pin 8) is checked by the modem to see if the far-end DTE has its RTS high.
- (3). If the far end's RTS is high (DCD is on), the modem does not give CTS, and the DTE drops RTS and goes back to step 1. If DCD is off, it proceeds to step 4.
- (4). If DCD is off, the local modem (DCE), after a slight delay, gives a CTS (pin 5) signal to the DTE.
- (5). DTE then presents data on the transmitted data lead (pin 2), and the modem transmits this to the far end.
- (6). The receiving modem puts the received data on pin 3 for presentation to the destination DTE.
- (7). The originating DTE continues with RTS held high until all the data is transmitted. Then it drops its RTS, which drops DCD at the far end and CTS locally, causing the line to be idle once again.
- (8). Either DTE can now raise RTS to obtain control of the line.

Full-Duplex DTE-DCE interaction

- Both DTEs have RTS held high, both modems give CTS constantly, and both modems have DCD high because the far end's RTS lead is on constantly.
- Data can now flow in both direction simultaneously at any time.

The NULL Modem

- A null modem cable allows us to connect one host to another nearby host or serial device directly using RS-232 signaling. A null modem cable is limited to 30 feet in length.
- This special type of cable will allow two computers to communicate via their serial ports. It's called a "null-modem" or “crossover” cable because it eliminates using modems and phone lines.
- The purpose of a null-modem cable is to permit two RS-232 "DTE" devices to communicate with each other without modems or other communication devices (i.e., "DCE's) between them.

- To achieve this, the most obvious connection is that the TD signal of one device must be connected to the RD input of the other device (and vice versa).

- Most DTE devices use other RS-232 pins for hardware flow control. One of the most common schemes is for the DTE to assert the RTS signal if it is ready to receive data and for the DCE to assert CTS when it is able to accept data.

- By connecting the RTS pin of one DTE to the CTS pin of the other DTE, we can simulate this handshake.

- Also, it is common convention for many DTE devices to assert the DTR signal when they are powered on, and for many DCE devices to assert the DSR signal when they are powered on, and to assert the CD signal when they are connected.

- By connecting the DTR signal of one DTE to both the CD and DSR inputs of the other DTE (and vice versa), we are able to trick each DTE into thinking that it is connected to a DCE that is powered up and online.