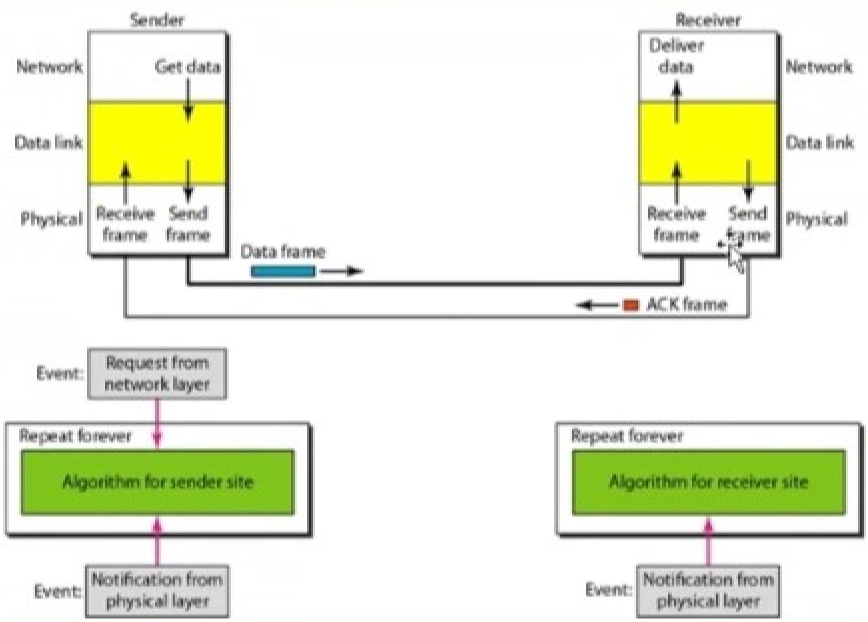
## Figure 11.8 *Design of Stop-and-Wait Protocol*



## Algorithm 11.3 *Sender-site algorithm for Stop-and-Wait Protocol*

```
while(true)                              //Repeat forever
canSend = true                           //Allow the first frame to go
{
 WaitForEvent();                         // Sleep until an event occurs
 if(Event(RequestToSend) AND canSend)
 {
    GetData();
    MakeFrame();
    SendFrame();                         //Send the data frame
    canSend = false;                     //Cannot send until ACK arrives
 }
 WaitForEvent();                         // Sleep until an event occurs
 if(Event(ArrivalNotification)           // An ACK has arrived
  {
    ReceiveFrame();                      //Receive the ACK frame
    canSend = true;
  }
}
```

**Figure 11.5** *Taxonomy of protocols discussed in this chapter*

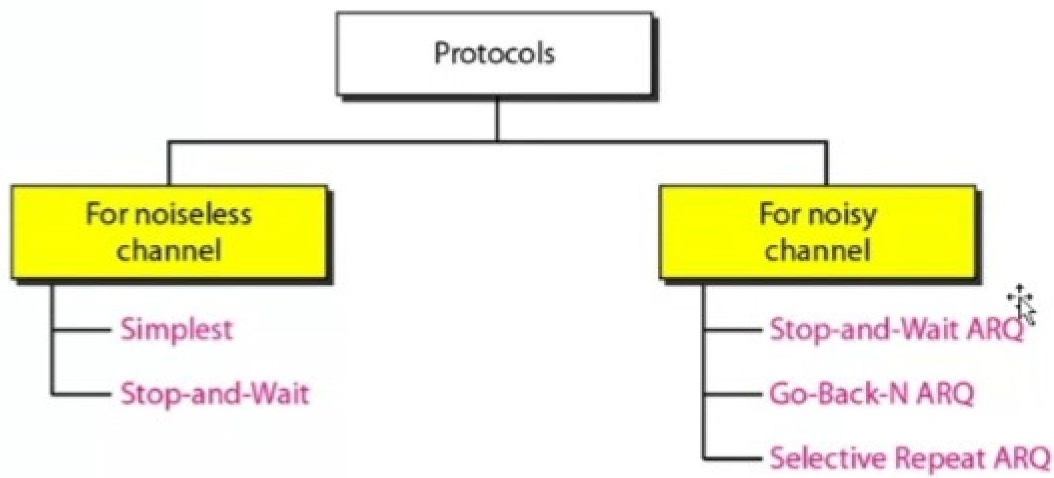
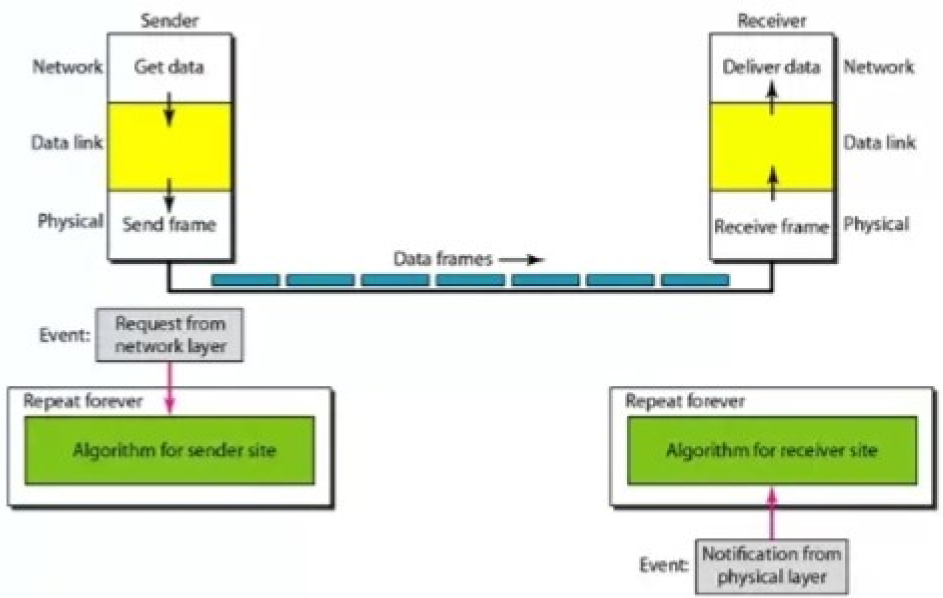


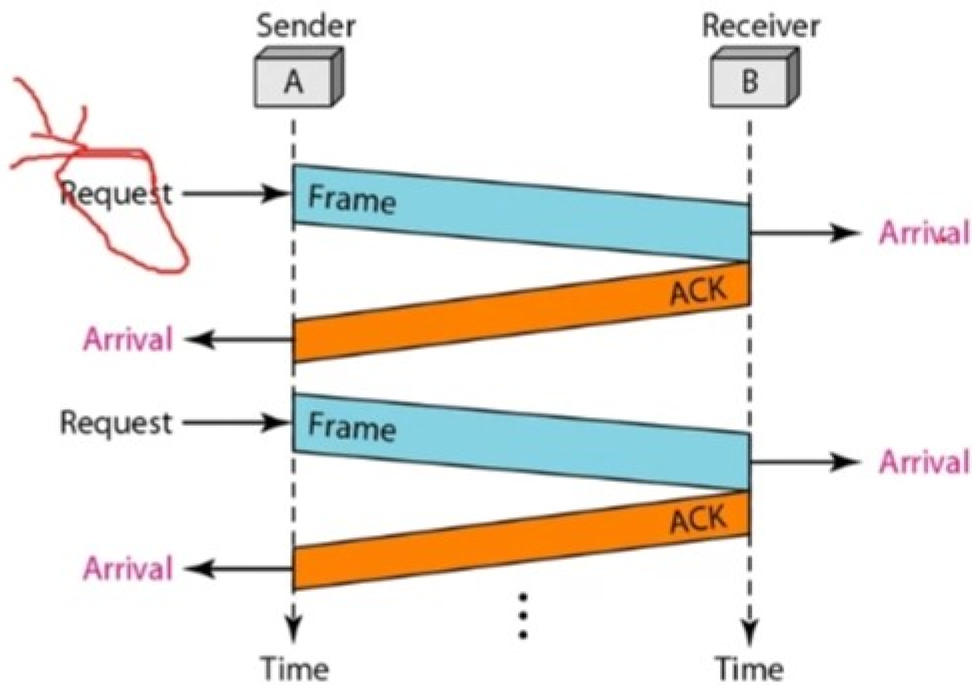
**Figure 11.6** *The design of the simplest protocol with no flow or error control*



**Algorithm 11.2** ***Receiver-site algorithm for the simplest protocol***

```
while(true)                             // Repeat forever
{
  WaitForEvent();                       // Sleep until an event occurs
  if(Event(ArrivalNotification))        //Data frame arrived
  {
     ReceiveFrame();
     ExtractData();
     DeliverData();                     //Deliver data to network layer
  }
}
```

## Figure 11.9 *Flow diagram for Example 11.2*



# 11-5 NOISY CHANNELS

***Although the Stop-and-Wait Protocol gives us an idea of how to add flow control to its predecessor, noiseless channels are nonexistent. We discuss three protocols in this section that use error control.***

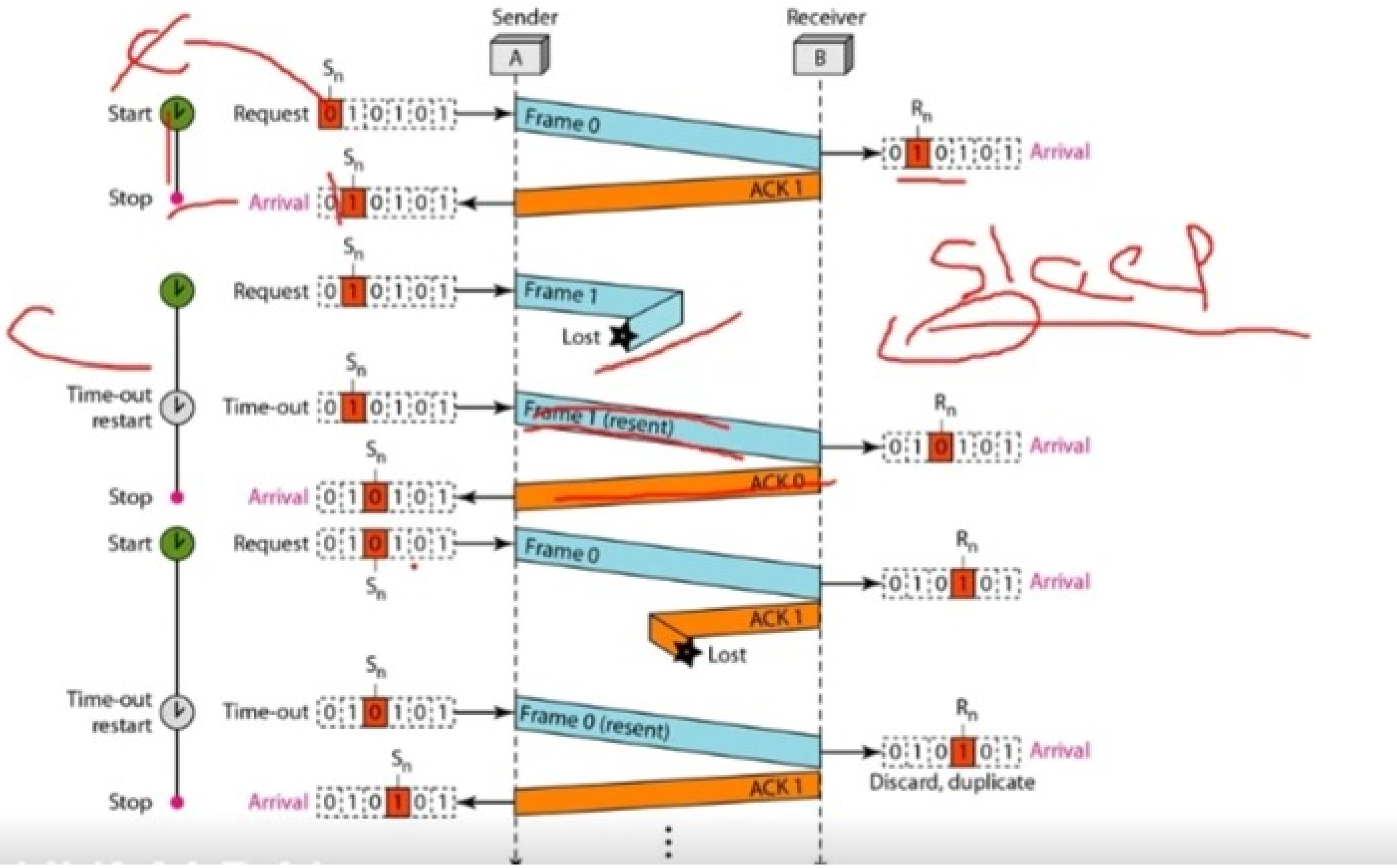
***Topics discussed in this section:***

**Stop-and-Wait Automatic Repeat Request**
**Go-Back-N Automatic Repeat Request**
**Selective Repeat Automatic Repeat Request**

***Note***

**Error correction in Stop-and-Wait ARQ is done by keeping a copy of the sent frame and retransmitting of the frame when the timer expires.**

## Figure 11.11 *Flow diagram for Example 11.3*



## *Example 11.4*

***Assume that, in a Stop-and-Wait ARQ system, the bandwidth of the line is 1 Mbps, and 1 bit takes 20 ms to make a round trip. What is the bandwidth-delay product? If the system data frames are 1000 bits in length, what is the utilization percentage of the link?***

### Solution

**The bandwidth-delay product is**

$$\boxed{(1 \times 10^6) \times (20 \times 10^{-3}) = 20{,}000 \text{ bits}}$$

$$\frac{1000}{20000} =$$

Set Up Monitors

## *Example 11.4 (continued)*

***The system can send 20,000 bits during the time it takes for the data to go from the sender to the receiver and then back again. However, the system sends only 1000 bits. We can say that the link utilization is only 1000/20,000, or 5 percent. For this reason, for a link with a high bandwidth or long delay, the use of Stop-and-Wait ARQ wastes the capacity of the link.***