

Real-Time Embedded Systems

CpE-450 Spring 07

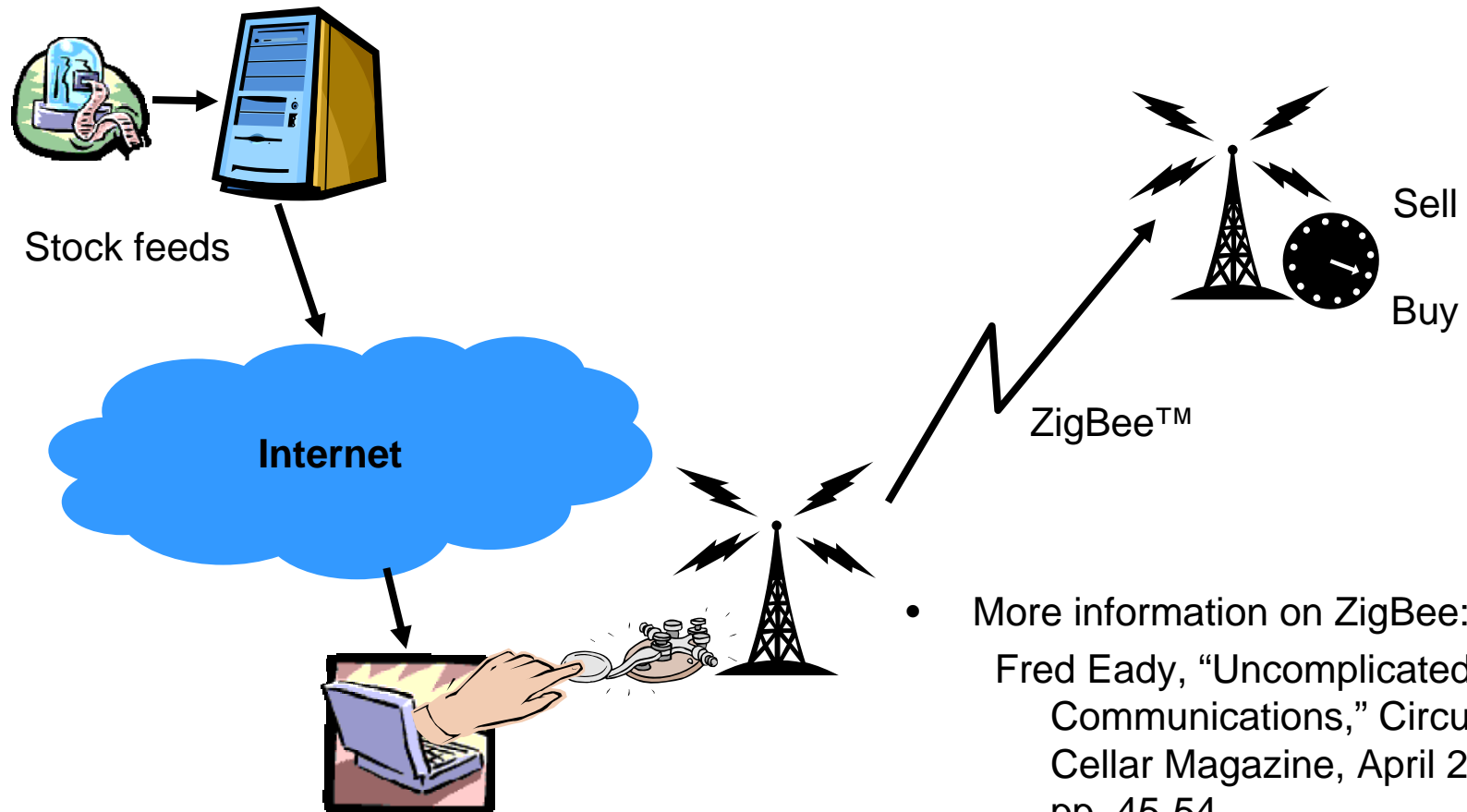
Class 10

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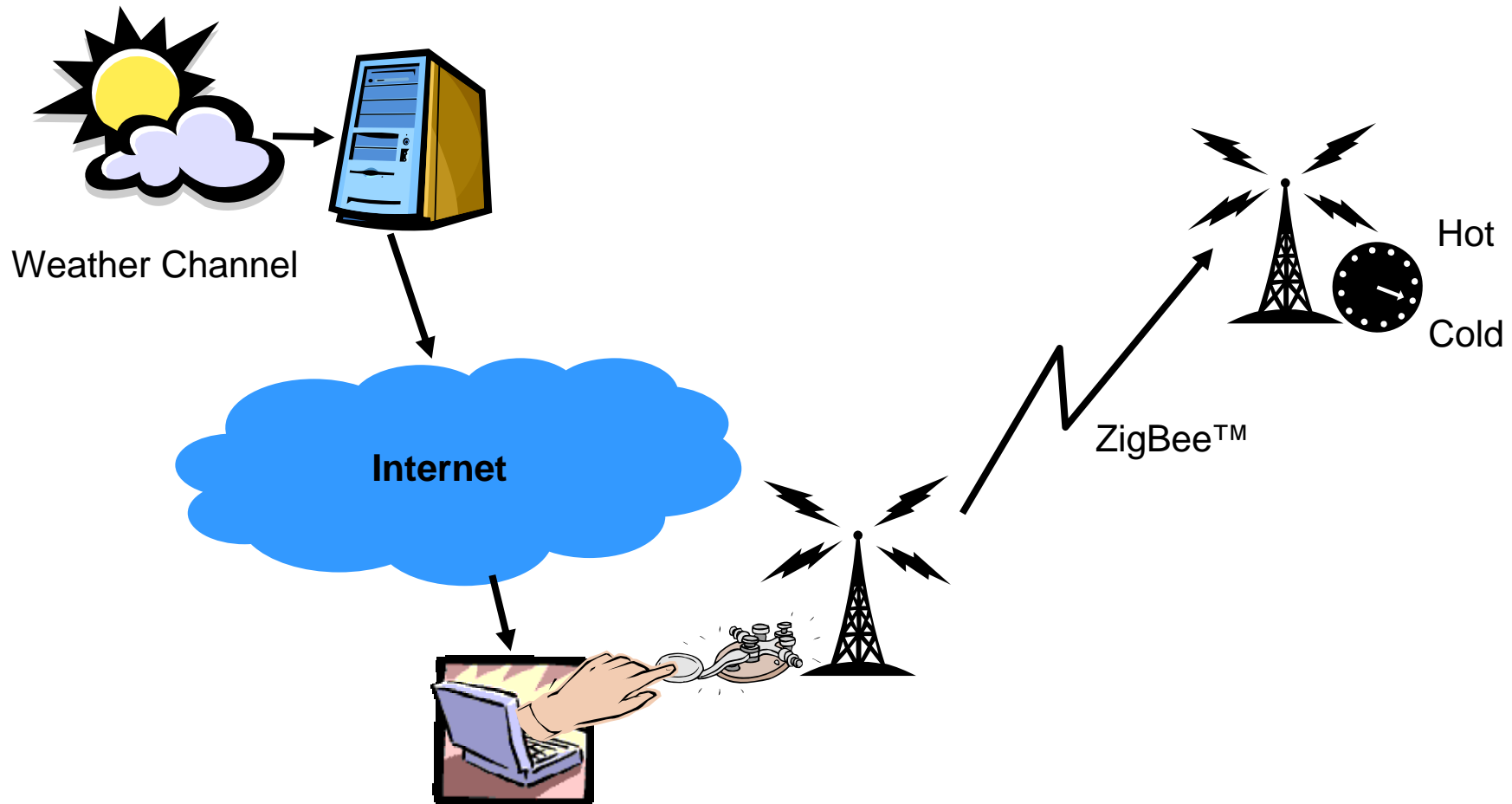
Case Study: Real-Time Stimulus for the Day Trader

- Richard Hoptroff, "Stock Clock," Circuit Cellar Magazine, April 2006, pp. 58-61.
- ftp://ftp.circuitcellar.com/pub/Circuit_Cellar/2006/189/Hoftroff-189.zip

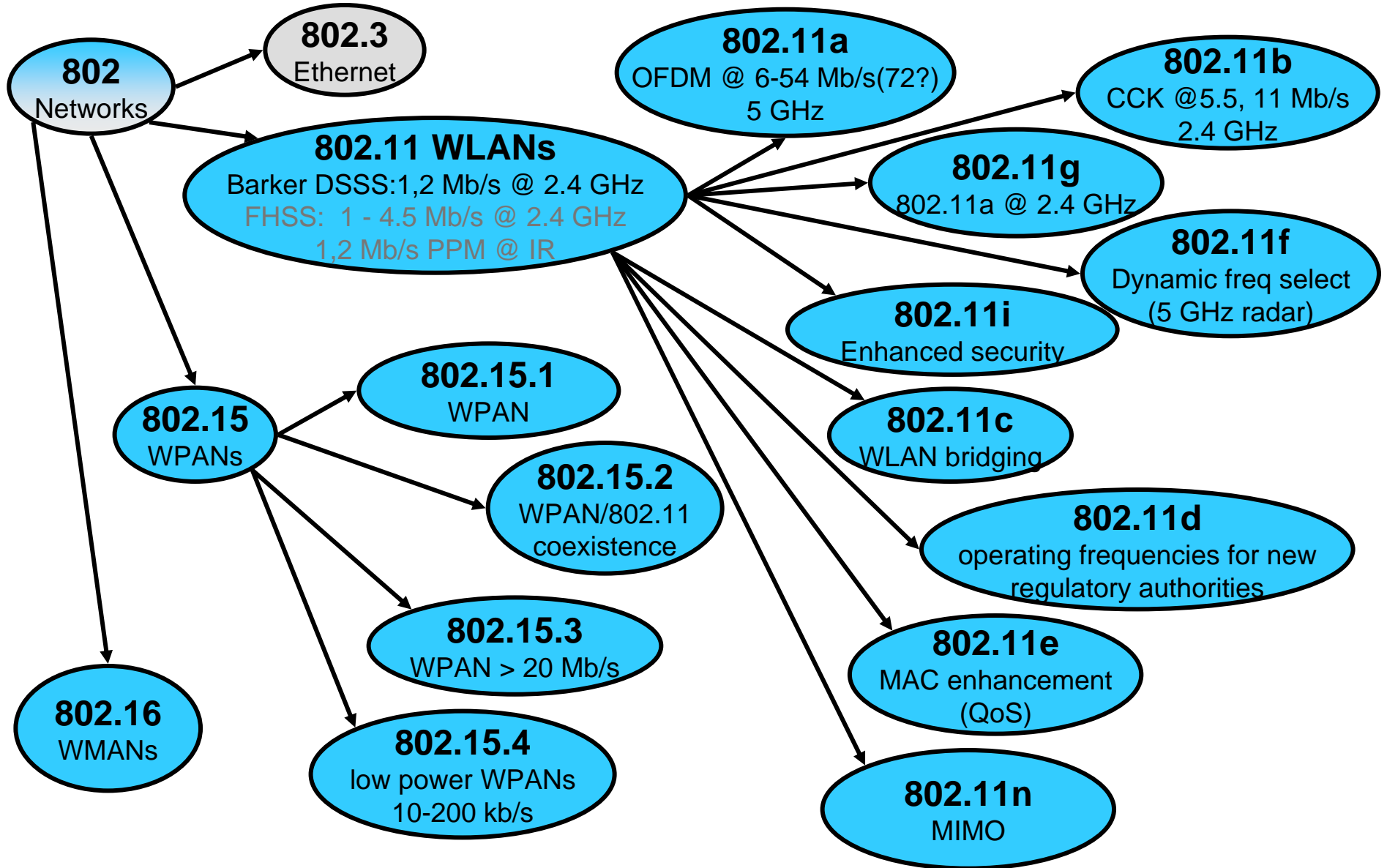


- More information on ZigBee:
Fred Eady, "Uncomplicated RF Communications," Circuit Cellar Magazine, April 2007, pp. 45-54.

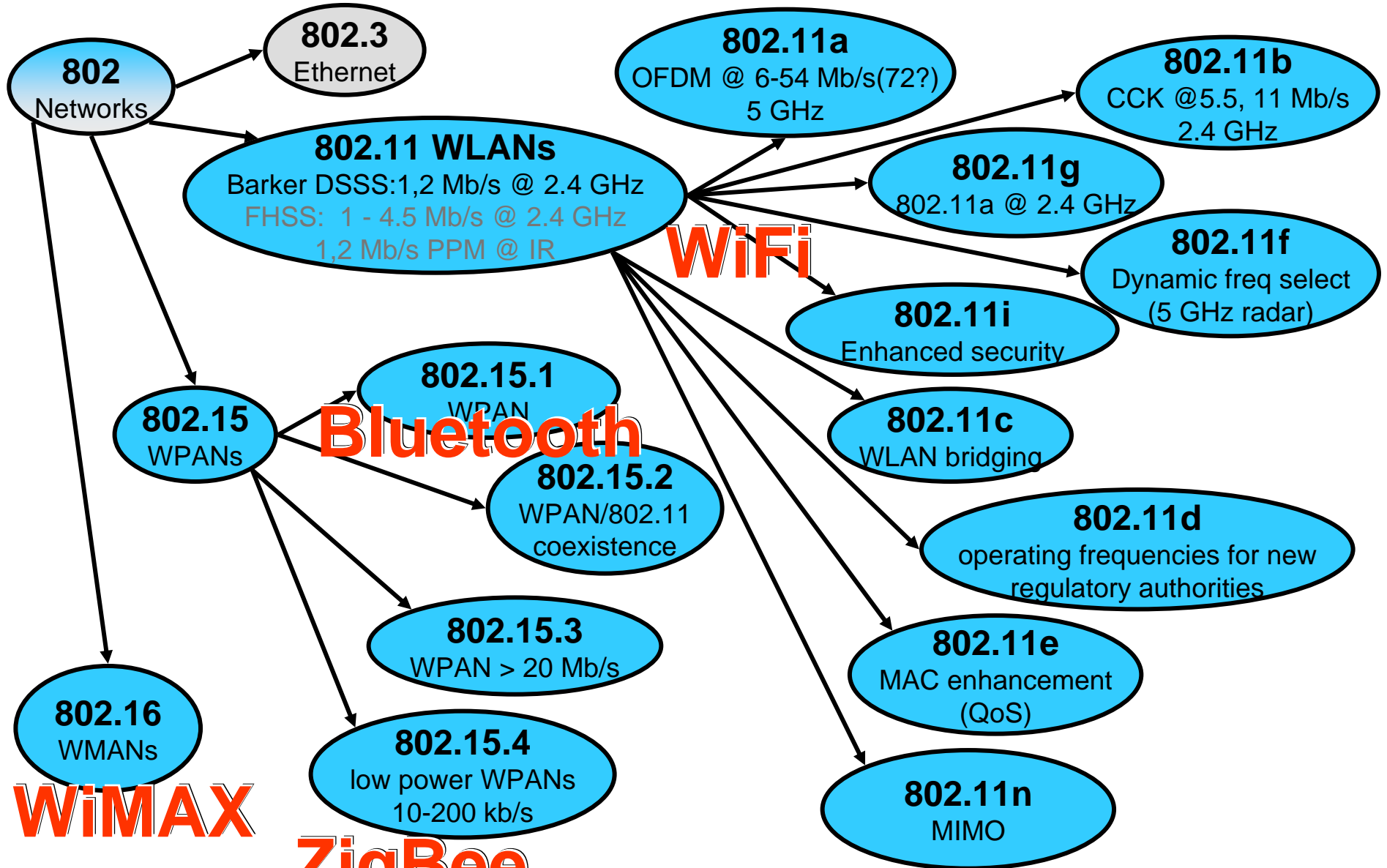
Case Study: Pick your own data source/display



IEEE 802 Standards (Alphabet Soup)

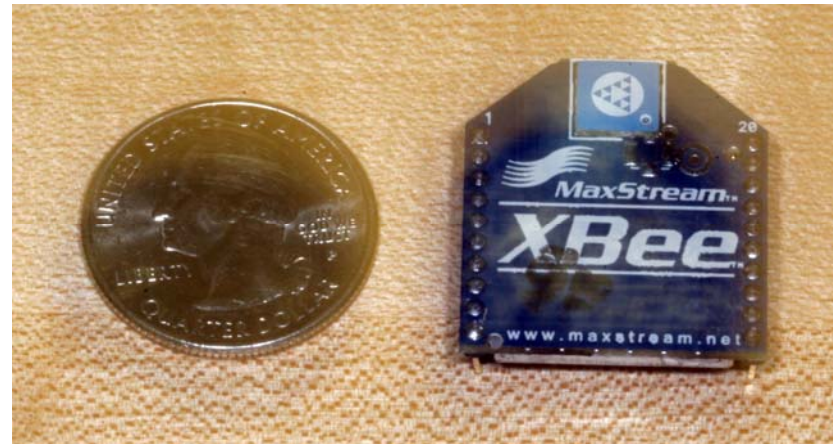


IEEE 802 Standards (Alphabet Soup)

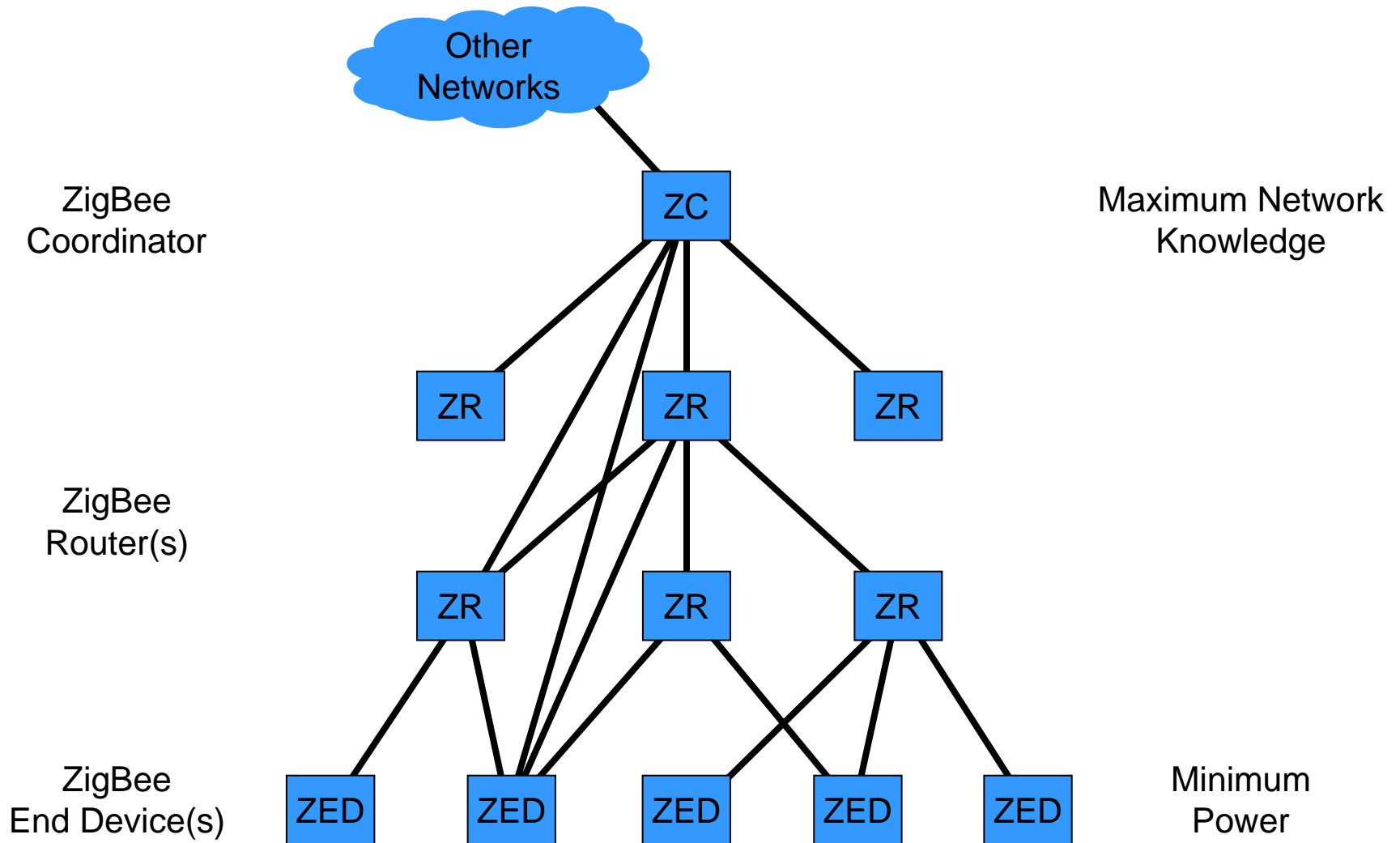


ZigBee Devices

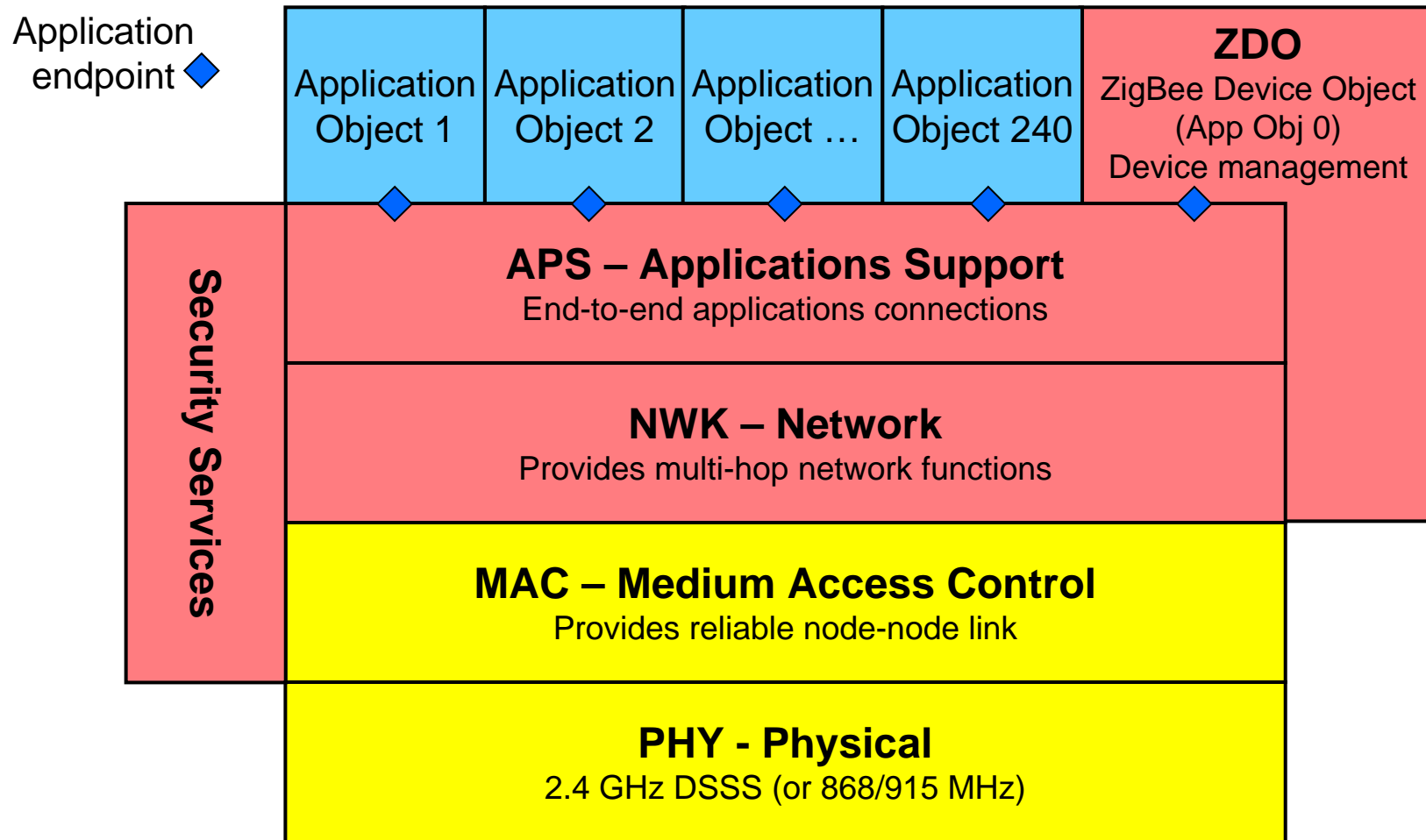
- Transmit power: 1 – 60 mW
- 2.400 – 2.4835 GHz operation
- Channel data rate: 250 kb/s
- End user data rate: 115.2 kb/s
- Direct Sequence Spread Spectrum
- Peer-to-peer, point-to-point, point-to-multipoint and mesh networks
- CSMA-CD
- 12-16 DSSS channels
- 65,000 network addresses per code
- Power-down current $<10 \mu\text{A}$, operating current $\sim 45 \text{ mA}$



ZigBee Networking



ZigBee Protocol Stack



Defined by:

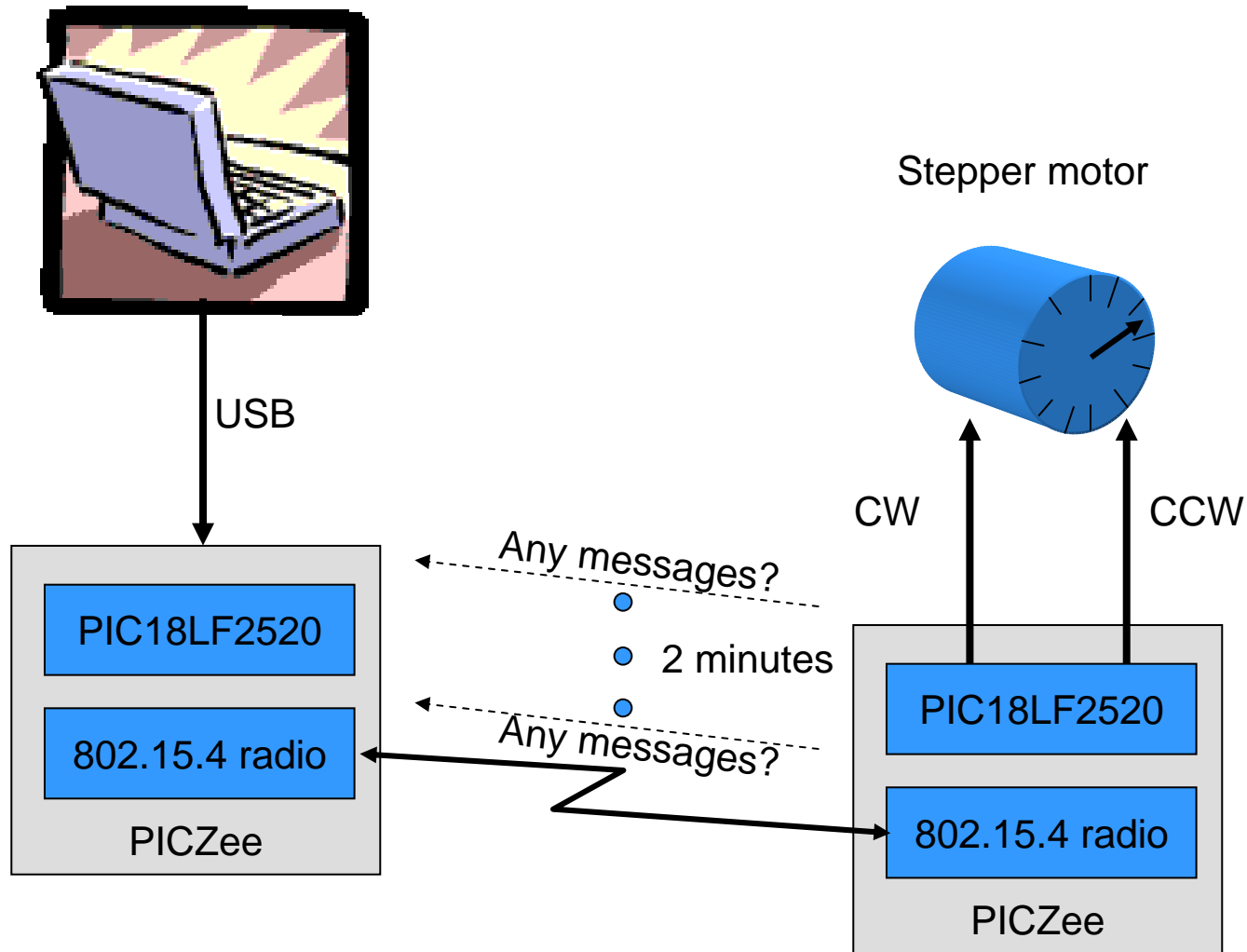
IEEE 802.15.4

ZigBee Alliance

Application developer

Source: Pixie™ brochure

System Components



Coordinator Code Structure

```
void main(void)
{
    currentPrimitive = NO_PRIMITIVE;
    NetworkDescriptor = NULL;
    ZigBeeInit();
    if(!blsBound) myStatusFlags.bBidSwitchToggled = TRUE;
    while(TRUE)
    {
        ZigBeeTasks( &currentPrimitive );
        switch(currentPrimitive)
        {
            case NLME_NETWORK_FORMATION_confirm:
                process_network_formation(); break;
            case NLME_PERMIT_JOINING_confirm:
                process_network_joining(); break;
            case APSDE_DATA_indication:
                process_binding(); break;
            case APDSE_DATA_confirm:
                ack_message(); break;
            case NLME_SYNC_confirm:
                process_update_request(); break;
            case NO_PRIMITIVE:
                if(!ZigBeeStatus.flags.bits.bNetworkFormed)
                    process_network_formation();
                else if (ZigBeeReady() && bIsBound && bSendUpdate)
                {
                    TxBuffer[TxData++] = PointerPositionByte; /* send message */
                    currentPrimitive = APSDE_DATA_request;
                }
                if(myStatusflags.bits.bBindSwitchToggled)
                    bind_process();
        }
    }
}
```

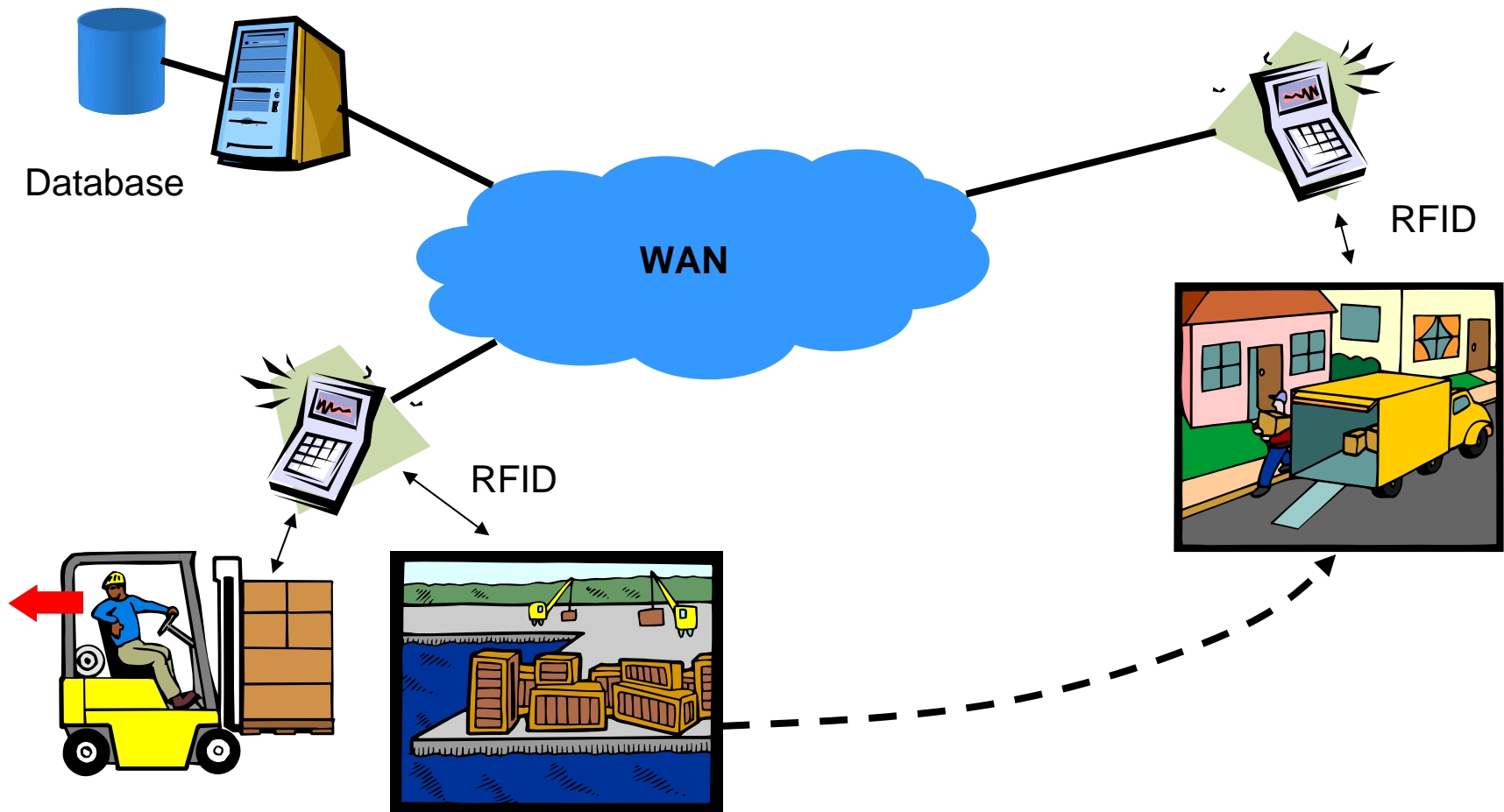
Reference: CC #189, p. 60

Endpoint Code Structure

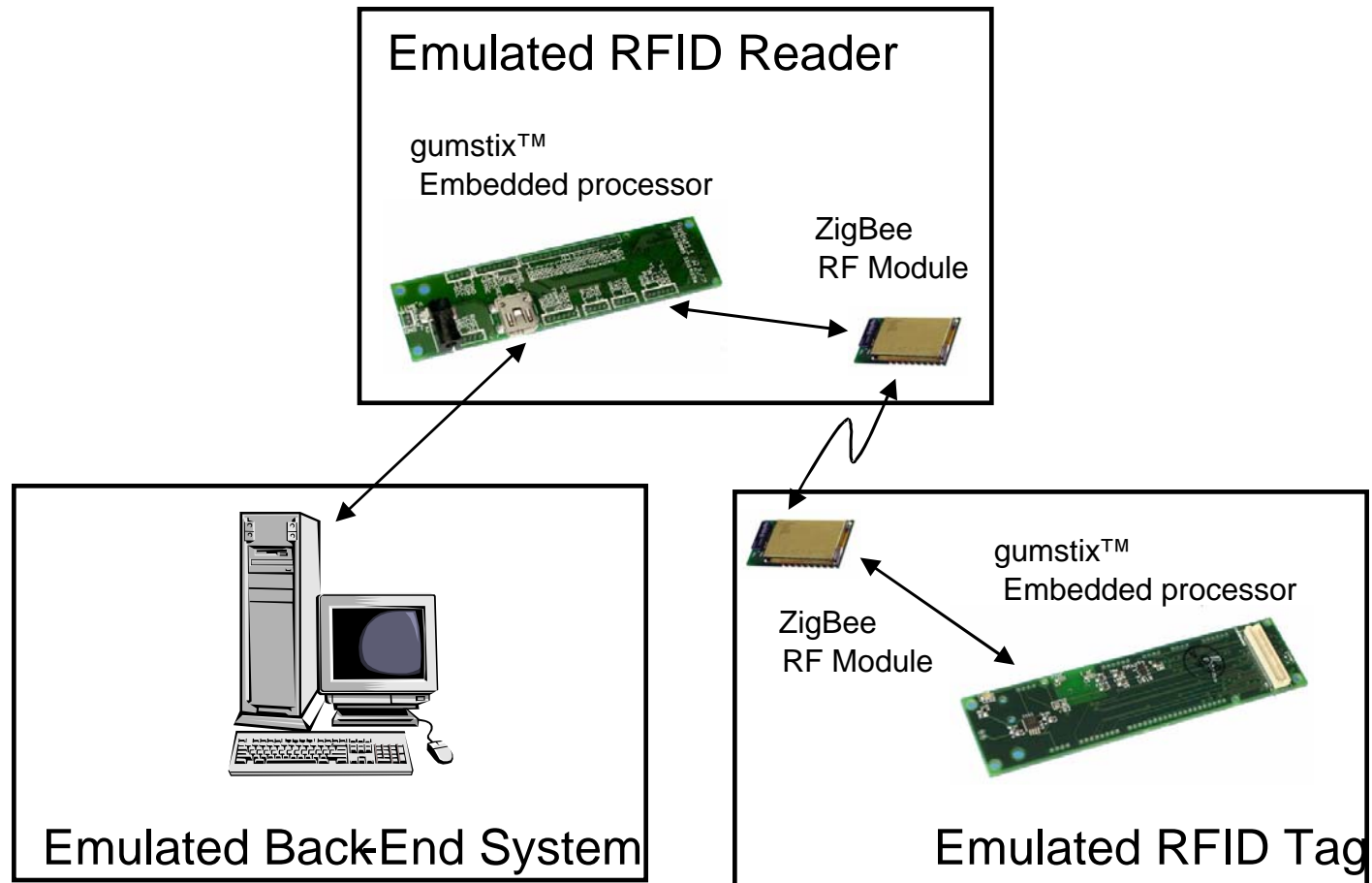
```
void main(void)
{
    currentPrimitive = NO_PRIMITIVE;
    NetworkDescriptor = NULL;
    ZigBeeInit();
    if(!blsBound) myStatusFlags.bBidSwitchToggled = TRUE;
    while(TRUE)
    {
        ZigBeeTasks( &currentPrimitive );
        switch(currentPrimitive)
        {
            case NLME_NETWORK_DISCOVERY_confirm:
                form_network(); break;
            case NLME_JOIN_confirm:
                join_network(); break;
            case APSDE_DATA_indication:
                switch (params.APSDE_DATA_indication.DstEndpoint)
                {
                    case EP_ZDO:    process_binding(); break;
                    case EP_LIGHT:  process_data(); break;
                }
            case APDSE_DATA_confirm:
                ack_message(); break;
            case NLME_SYNC_confirm:
                process_update_request(); break;
            case NO_PRIMITIVE:
                join_bind();
        }
        if ( (currentPrimitive == NO_PRIMITIVE) && myProcessesAreDone() )
        {
            SLEEP();
            currentPrimitive = NMLE_SYNC_request;
        }
    }
}
```

Reference: CC #189, p. 61

Variations on a Theme



Prototype RFID System



Homework

- No homework this week, Quiz 2 due 4/17