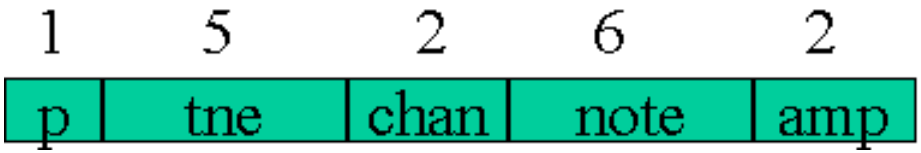
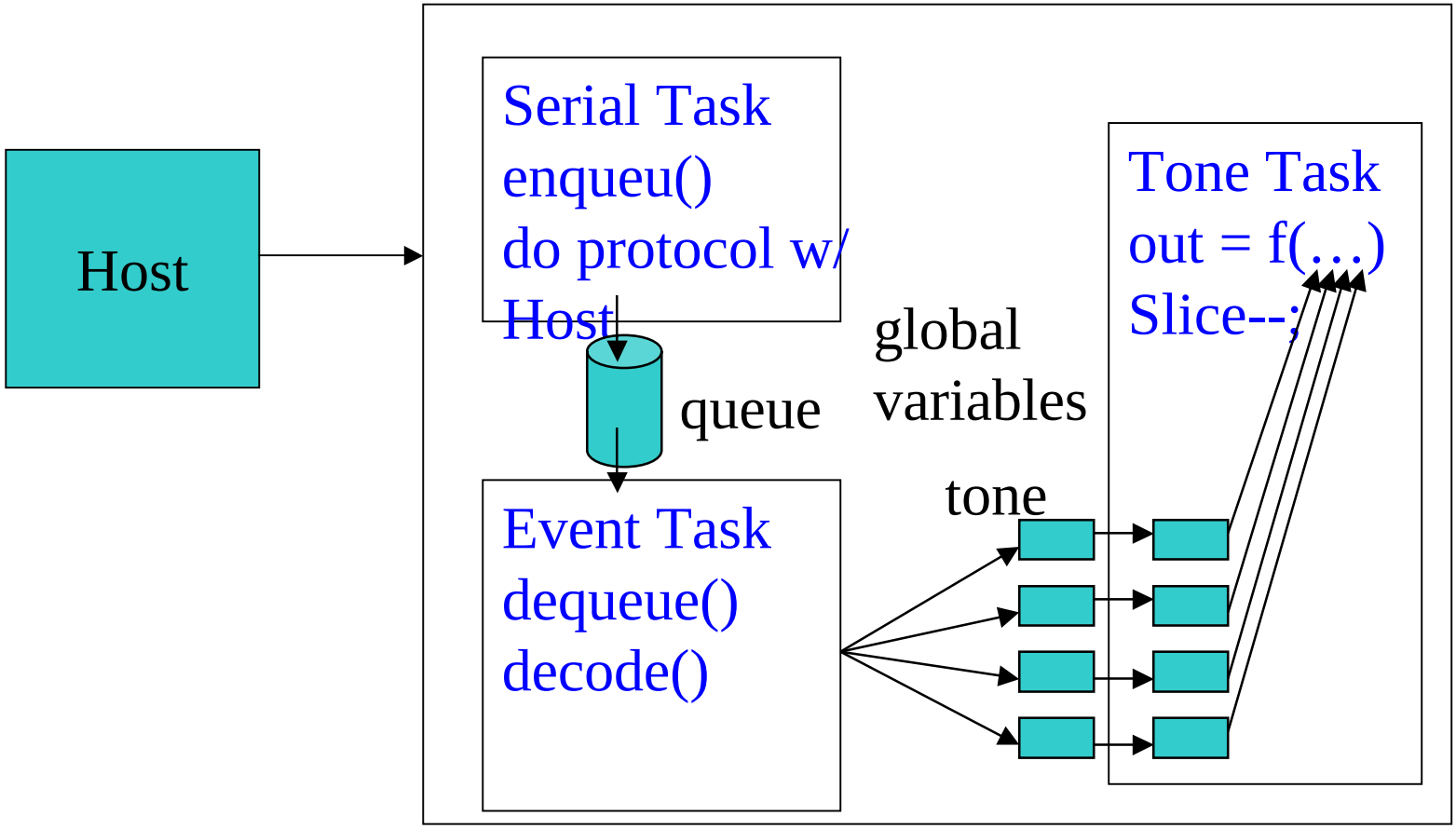
Music Format



if amp = 0, note is a command
switch(note)
0: turn off specified channel
1: continue for specified tne w/ no change
else
set specified channel to specified
note at specified amplitude (1-3)

Data Rate



Worst Case Data Rate: 4 simultaneous packets/event = 8 bytes/event
at 200events/sec * 8bytes/event = 1600bytes/sec = 12.8Kbps
can we run at 19.2?

Serial Communication: RS-232 (IEEE Standard)

- Serial protocol for point-to-point low-cost, low speed applications
- Commonly used to connect PCs to I/O devices
- RS-232 wires

TxD -- transmit data
TxC -- transmit clock
RTS – request to send
CTS – clear to send

RxD – receive data
RxC – receive clock
DSR – data set ready :
DTR – data terminal ready

SG -- Signal Ground

CSE477 –Autumn 99

Transfer modes

- Synchronous
  - Clock signal wire is used by both receiver and sender to sample data
- (Psuedo) Asynchronous
  - No clock signal in common
  - Data must be over sampled to “synchronize”
  - Needs only three wires (one data for each direction, and ground)
- Flow control
  - Handshaking signals to control byte rate, not bit rate. Signals like RTS, CTS, DSR, DTR
  - optional

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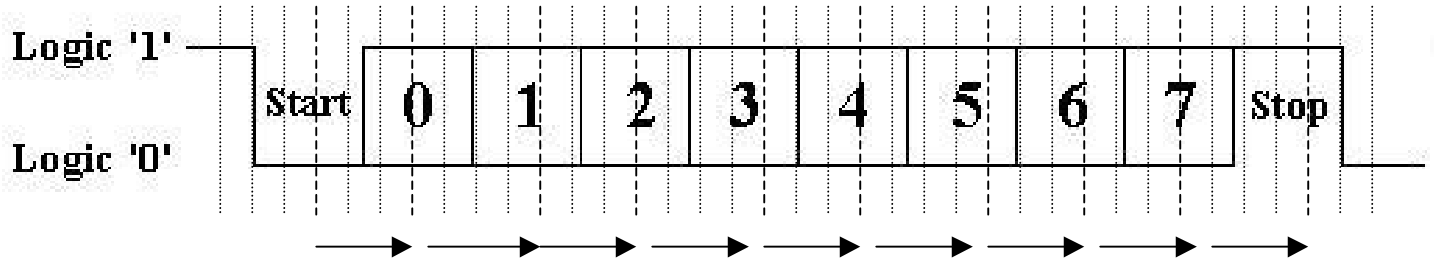
Data Format

Start Bit, Stop bit , Data bits, Parity Bit (odd, even, none)

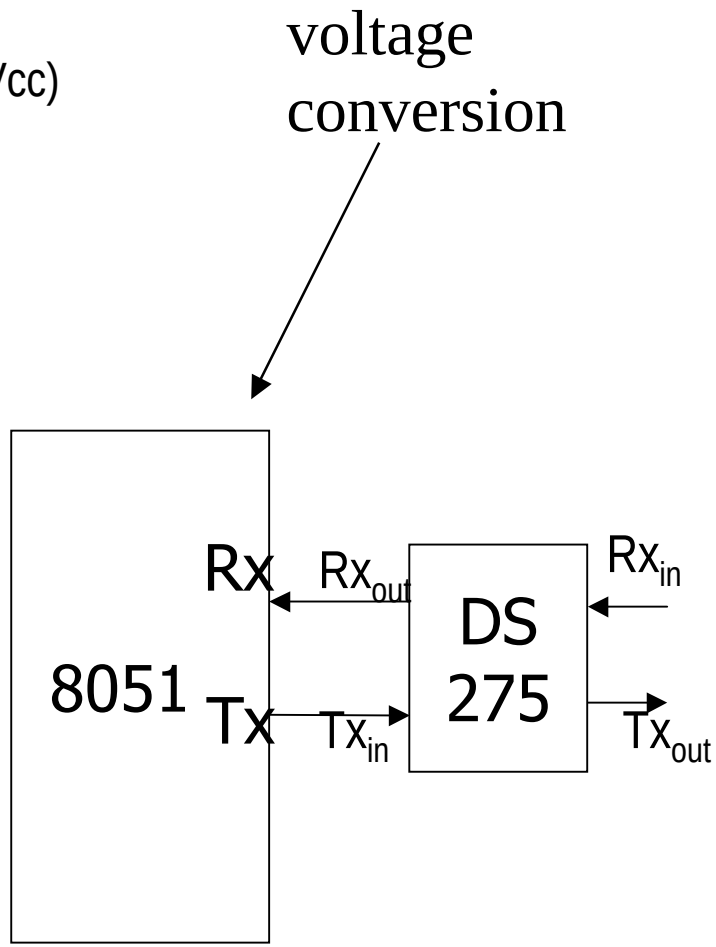


- Logic 0 (space): between +3 and +25 Volts.
- Logic 1 (mark): between -3 and -25 Volts.
- Undefined between +3 and -3 volts.

Level Converter: DS 275

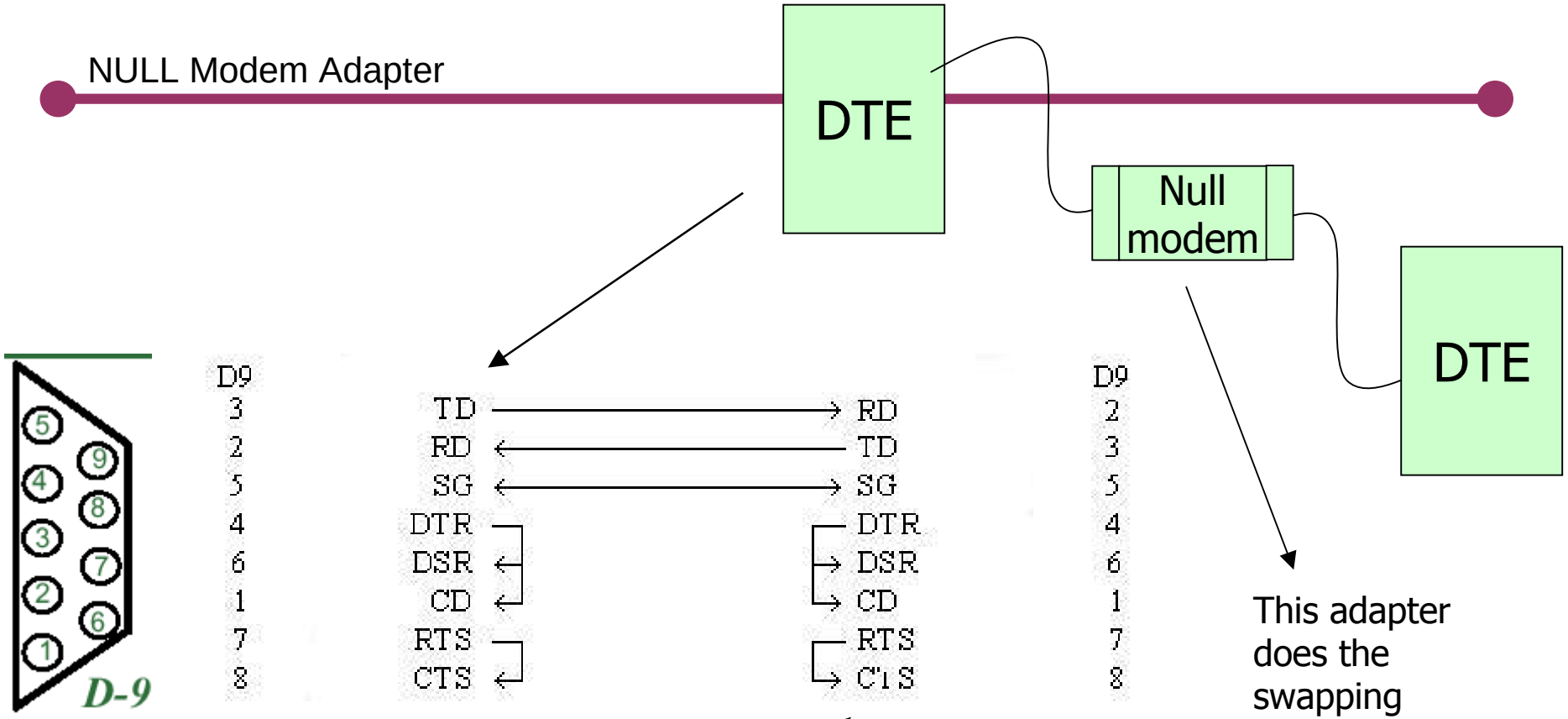
- Pin Description

RXout	- RS- 232 Receiver Output (-0.3V to Vcc)
Vdrv	**- Transmit driver +V (hook to Vcc)**
TXin	- RS-232 Driver Output (-0.3V to Vcc)
GND	- System ground
TXout	- RS-232 Driver Output (+/- 15 V)
RXin	- RS-232 Receive Input (+/- 15 V)
Vcc	- System Logic Supply (+5V)

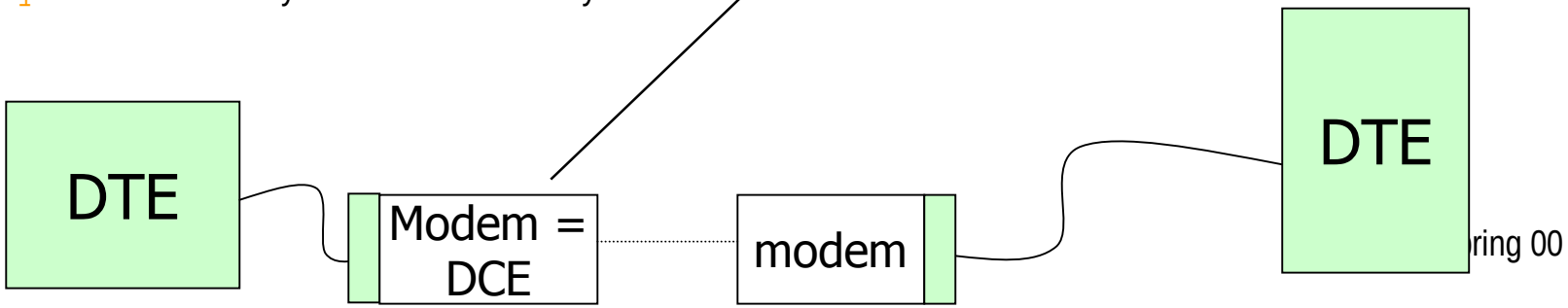


CSE477 –Autumn 99

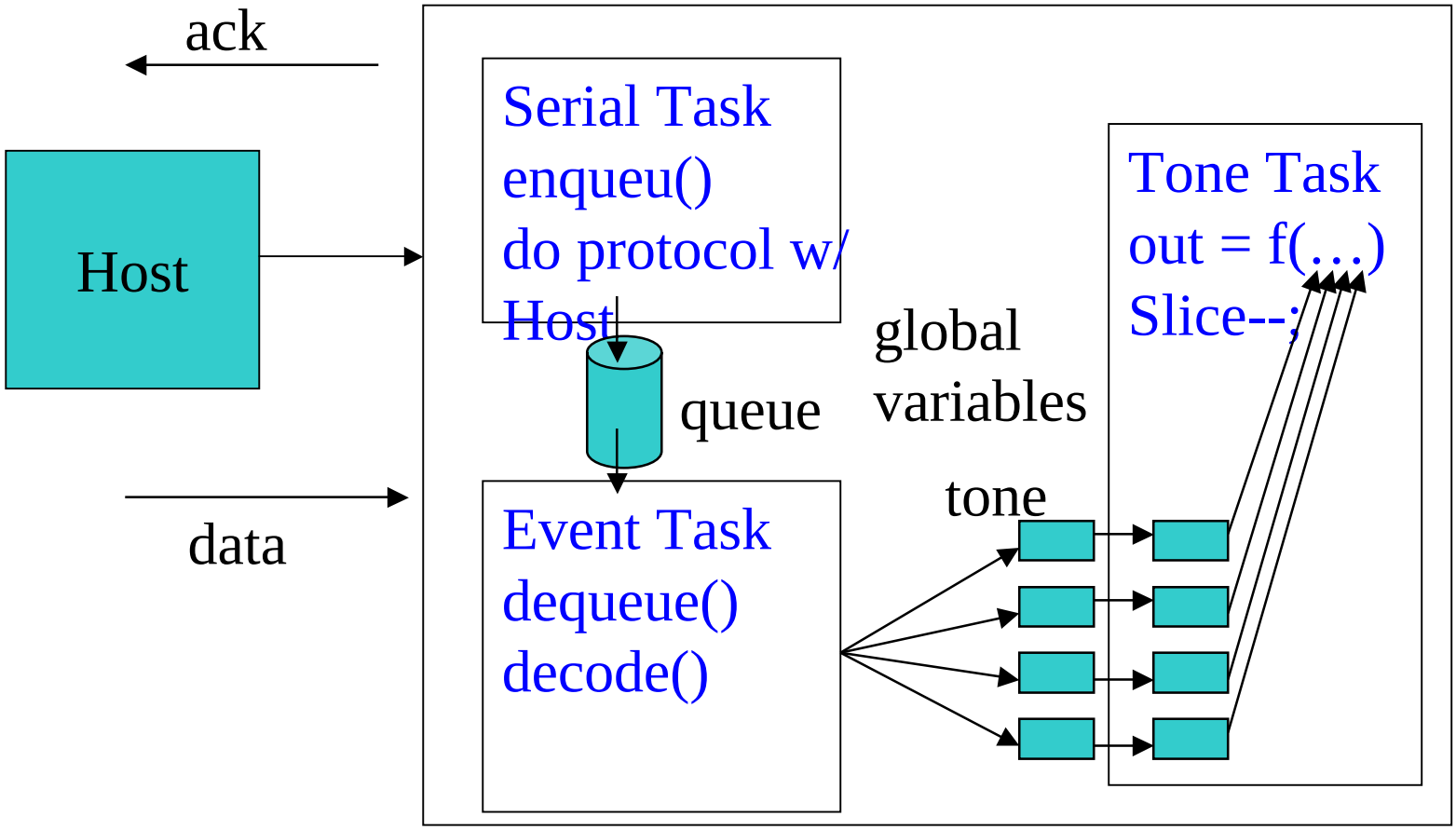
NULL Modem Adapter



- Using only TD, RD, and SG
- No need for flow control (May miss characters if sent too fast)
- Both ends ready to send/receive at any time



SW Flow Control Protocol



Worst Case Data Rate: 4 simultaneous packets/event = 8 bytes/event at 200events/sec * 8bytes/event = 1600bytes/sec = 12.8Kbps

What determines our true bit rate for keeping the buffer full?

Review Questions?

Comparison Non OS Architectures

- See Chapter 5, table 5.1 Simon

Real Time Operating Systems

- What is the basic thing we want the OS to do to help us improve worst case latency? Enable multithreading
- How? Define an OS time-slice (tick) at which highest priority 'runnable' task is continued. Priority function determines response behavior.
- Simplest Scheduling algorithm: each task gets at most 1 tick at a time to run. Round Robin Scheduling. Worst case task latency = #tasks*tick. Worst case run time = ticks/task * #tasks
- Some properties of such system: liveness, safety, fairness, latency, overhead.
- Other niceties: Device Drivers, Synchronization, Message passing, Memory Management

Programmers View

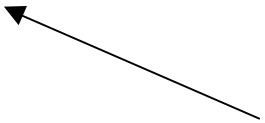
```
void tone_isr(void) interrupt … {
        process_tones();
        if (!--sliceCount) {
                updateToneParameters();
                sliceCount = SliceSize
                isr_send_signal(MUSIC);
        }
}
void serial_isr(void) interrupt …{
        timeCritical();
        os_send_signal(SERIAL);
}
void play(void)  _task_ MUSIC {
        os_create(SERIAL);
        while (1) {os_wait();
                  process_next_event();}
}
void serial(void) _task_ SERIAL {
        while (1) {os_wait();
                    process_serial_data();} // os_create(MUSIC)?
}
```

Advantages:

- Deterministic response time even w/ non deterministic tasks lengths.
- Incremental development

Resources:

- Task switching overhead
- Memory overhead
- Use of system timer
- Degrades best case response time.



Tasks are threads

Another Solution

- Multiprocessor: Dedicate one processor to each (or a few) tasks.
- Still need **synchronization** and **communication**.
- A network of M-BOXes could be an example of a multiprocessor system

Basic Architecture of an RT OS

- Task Table
  - Process state, signal flag, time_out counter, context
- System Interrupt Service Routine (timer)
- System Calls (Code, time)

Embedded Software

- Software States v. Finite State Machines
- Hierarchical State
- Thread/Process Communication
  - Critical Sections
  - Synchronization
  - Messaging and Signaling