MIDI
Musical Instrument Digital Interface

The MIDI protocol — a “language” that lets synthesizers, computers and other devices talk to each other.
The MIDI Language

Messages use MIDI cables. Audio uses audio cables.
MIDI Messages

- Note on
- Note off
- Program change (patch change)
- Pitch bend
- Controller change
- Polyphonic pressure (aftertouch)
- Monophonic pressure (aftertouch)
MIDI Channels

MIDI cable carries **16 channels**
Multi-port MIDI Interface (2 in/out pairs)

*Thru* switch – connects In to Out, for use without a computer
Leave in ‘out’ position for sequencing!
Multi-port MIDI Interface (8 in/out pairs)

Each MIDI cable can carry 16 channels.
Two Kinds of MIDI Network

Purpose: provide pathways for MIDI messages

**MIDI Daisy-chain Network**

Devices connected in series:

```
interface
```

**MIDI Star Network**

Devices connected in parallel:

```
interface
```
The 3 devices must share 16 channels.

THRU port: transmits copy of messages from IN port.

The 3 devices must share 16 channels.
Each device has **16 channels** all to itself. Any device can act as a **controller**.
Pros and Cons

**MIDI Daisy-chain Network**
- does not require multi-port MIDI interface

**MIDI Star Network**
- more accurate timing
- more channels
- more than one device can act as controller
MIDI Data Transmission

What goes through the MIDI cable?

Timed pulses of electricity – **31250 per second**

![Diagram](chart)

voltage: lo hi lo hi lo hi lo hi lo hi lo hi

bits: 1 1 0 1 0 0 0 1 1 0 1 0 1 0 0 0 1 1 0 0 1
MIDI Data Encoding

The bits encode numbers, in groups of 8 bits.

1101000110100101000011001

= 163 decimal

Byte: an 8-bit binary number
MIDI Message Bytes

Stream of bytes parsed into MIDI messages. Each message contains one or more bytes...

First byte: **Status Byte**
- what type of message [e.g., *note-on*]
- what channel (for some message types)

Then, zero or more **Data Bytes**
- meaning and number of bytes depend on type of message
- each byte has a range from 0 to 127 [128 values]
MIDI Data Rate

• 31250 bits / second = 3125 10-bit bytes / second

• Typical messages have 2 to 3 bytes.

• So MIDI can handle between 1000 and 1500 messages per second.

• Sounds like a lot, but it’s easy to clog the stream with controller and pitch bend messages
Types of MIDI Message

- **Voice**
- **Mode**
- **Real-time**
- **Common**
- **SysEx**
# Channel Voice Messages

<table>
<thead>
<tr>
<th>Type</th>
<th>Data 1</th>
<th>Data 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Note on</td>
<td>Note num</td>
<td>Velocity</td>
</tr>
<tr>
<td>Note off</td>
<td>Note num</td>
<td>Velocity</td>
</tr>
<tr>
<td>Program change</td>
<td>Program num</td>
<td>-</td>
</tr>
<tr>
<td>Pitch bend</td>
<td></td>
<td>Bend amount</td>
</tr>
<tr>
<td>Control change</td>
<td>Controller num</td>
<td>Value</td>
</tr>
<tr>
<td>Mono pressure</td>
<td>Value</td>
<td>-</td>
</tr>
<tr>
<td>Poly pressure</td>
<td>Note num</td>
<td>Value</td>
</tr>
</tbody>
</table>

- All values 0 to 127, except Pitch bend: -8192 to 8191
Channel Voice Oddities

- Program change can select only 128 programs. Bank Select (a type of Control change message) lets you select 128 programs within each bank.

- Pitch bend has much wider range (16384 values). Why? Our ears more sensitive to pitch changes.

- Note off rarely used. Instead, note on with velocity = 0
Different meanings for “control,” “controller”

1. An instrument that controls others
   [guitar controller, wind controller, keyboard controller, etc.]

2. Physical controls on an instrument
   [mod. wheel, joystick, foot pedal, breath controller, etc.]

3. MIDI control change messages
   [volume controller, pan controller, controller #6, etc.]
Control Change Message

- One of the 7 Channel Voice messages
- Data byte 1: controller number
- Data byte 2: value [0-127]
- Lots of controller numbers in common use
- Effect on sound dependent on synthesizer patch
## Common Control Change Messages

<table>
<thead>
<tr>
<th>Controller Name</th>
<th>Controller Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modulation wheel</td>
<td>1</td>
</tr>
<tr>
<td>Breath controller</td>
<td>2</td>
</tr>
<tr>
<td>Foot controller</td>
<td>4</td>
</tr>
<tr>
<td>Data entry</td>
<td>6</td>
</tr>
<tr>
<td>Volume</td>
<td>7</td>
</tr>
<tr>
<td>Pan</td>
<td>10</td>
</tr>
<tr>
<td>Sustain (damper) pedal</td>
<td>64</td>
</tr>
</tbody>
</table>

- Sustain pedal is a *switch controller* – it’s either on or off.