

# Multimedia Applications (CS403)

## Multimedia Data Representations (Digital Audio)

Lecture # 7

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# **(Musical Instrument Digital Interface)**

# MIDI

- Midi provides a very low bandwidth alternative on the Web:
  - transmit musical and
  - certain sound effects data

# MIDI on the Web

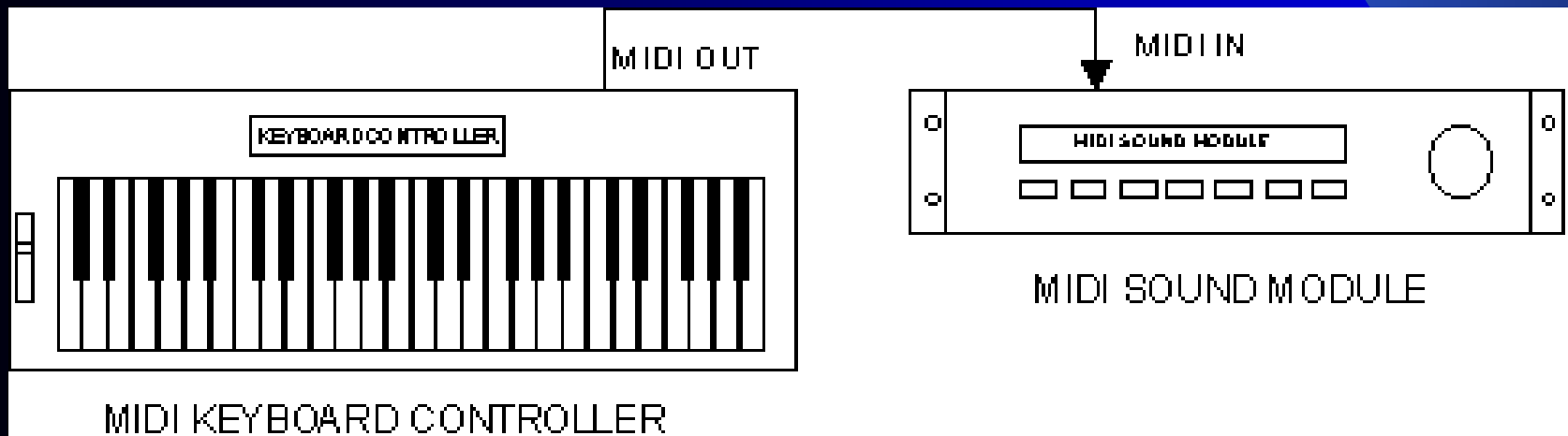
## **Very Low Bandwidth (few 100K bytes)**

- The responsibility of producing sound is moved to the client:
  - Synthesiser Module
  - Sample
  - Soundcard
  - Software Generated

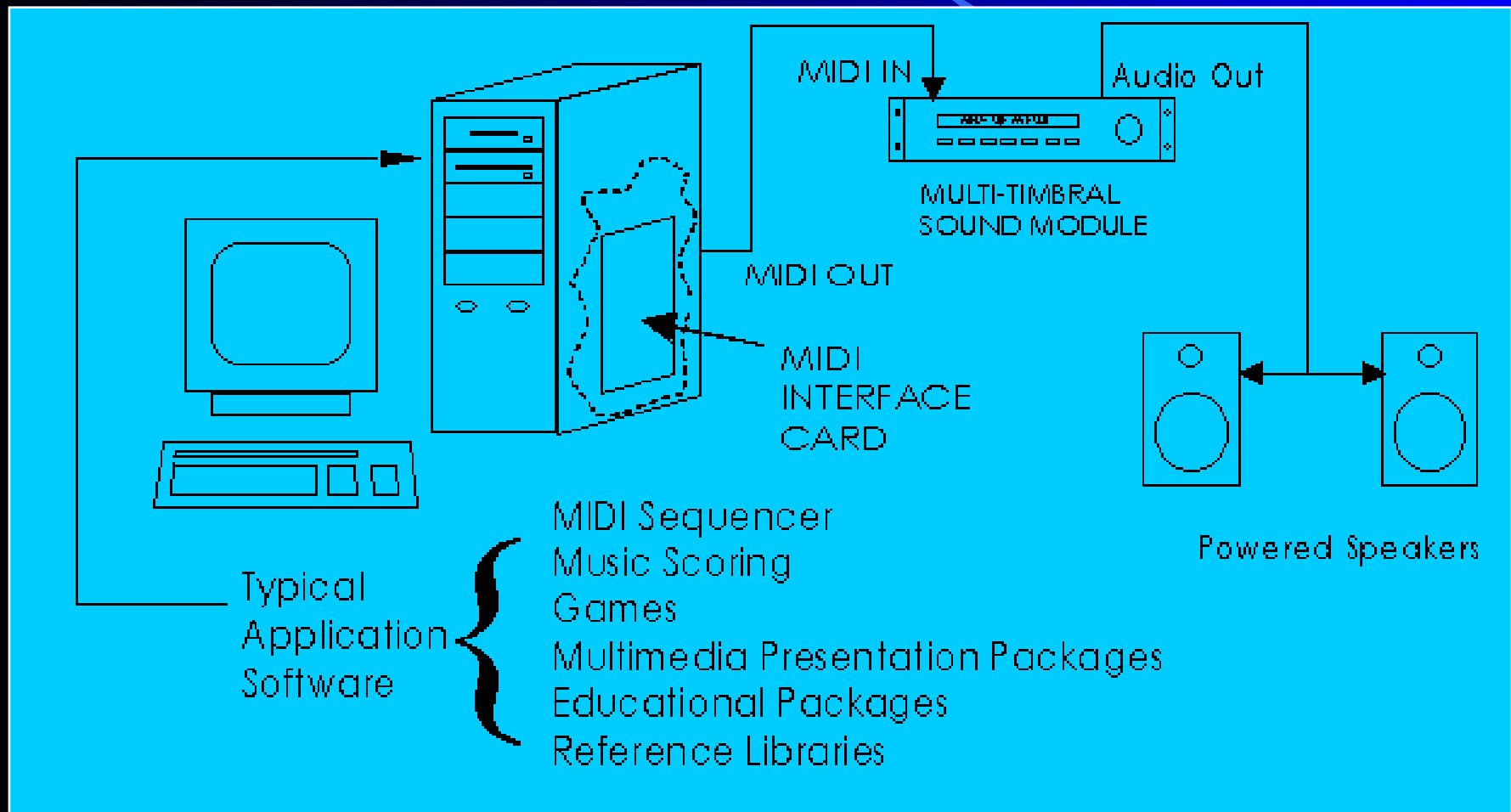
# Introduction to MIDI

- **Definition of MIDI:**

MIDI is a protocol that enables computer, synthesizers, keyboards, and other musical device to communicate with each other.



# A PC-Based MIDI System



# *Components of a MIDI System*

- Synthesizer:
  - It is a sound generator (various pitch, loudness, tone ).
  - A good (musician's) synthesizer often has a microprocessor, keyboard, control panels, memory, etc.

# ***Components of a MIDI System (Cont.)***

- **Sequencer:**

- It can be a stand-alone unit or a software program for a personal computer. (It used to be a storage server for MIDI data. Nowadays it is more a software *music editor* on the computer.
- It has one or more MIDI INs and MIDI OUTs.

- **Track:**

- Track in sequencer is used to organize the recordings.
- Tracks can be turned on or off on recording or playing back.



# Components of a MIDI System (Cont.)

- **Channel:**

- MIDI channels are used to separate information in a MIDI system.
- There are 16 MIDI channels in one cable.
- Channel numbers are coded into each MIDI message.

- **Timbre:**

- The quality of the sound, e.g., flute sound, cello sound, etc.
- Multitimbral - capable of playing many different sounds at the same time (e.g., piano, brass, drums, etc.)

# ***Components of a MIDI System (Cont.)***

- **Pitch:**

- Musical note that the instrument plays

- **Voice:**

- Voice is the portion of the synthesizer that produces sound.
- Synthesizers can have many (12, 20, 24, 36, etc.) voices.
- Each voice works independently and simultaneously to produce sounds of different timbre and pitch.

- **Patch:**

- The control settings that define a particular timbre

# ***Hardware Aspects of MIDI***

- **MIDI connectors:**

Three 5-pin ports found on the back of every MIDI unit

- **MIDI IN:**

the connector via which the device receives all MIDI data.

- **MIDI OUT:**

the connector through which the device transmits all the MIDI data it generates itself.

- **MIDI THROUGH:**

the connector by which the device echoes the data receives from MIDI IN.

# MIDI Messages

MIDI messages are used by MIDI devices to communicate with each other.

MIDI messages are very low bandwidth:

- Note On Command
  - Which Key is pressed
  - Which MIDI Channel (what sound to play)
  - 3 Hexadecimal Numbers
- Note Off Command
- Other command (program change) configure sounds to be played.

# *Structure of MIDI messages:*

- MIDI message includes a status byte and up to two data bytes.
- Status byte
  - The most significant bit of status byte is set to 1.
  - The 4 low-order bits identify which channel it belongs to (four bits produce 16 possible channels).
  - The 3 remaining bits identify the message.
- The most significant bit of data byte is set to 0.

# *Classification of MIDI messages:*

```
MIDI messages ----|
                   |
                   |  --- channel messages ---|
                   |                          |
                   |                          |  -- voice messages
                   |                          |
                   |                          |  -- mode messages
                   |
                   |  --- system messages ---|
                   |                          |
                   |                          |  -- common messages
                   |                          |  -- real-time messages
                   |                          |  -- exclusive messages
```

# *Midi Channel messages:*

Messages that are transmitted on individual channels rather than globally to all devices in the MIDI network.

## *Channel voice messages:*

- Channel Voice Messages are used to send musical performance information. The messages in this category are the Note On, Note Off, Polyphonic Key Pressure, Channel Pressure, Pitch Bend Change, Program Change, and the Control Change messages.
- *Note On / Note Off / Velocity*

# Midi Channel mode messages:

Channel mode messages are a special case of the Control Change message (Bx (Hex) or 1011nnnn (Binary)).

- The difference between a Control message and a Channel Mode message, is in the first data byte.
  - Data byte values 121 through 127 have been reserved in the Control Change message for the channel mode messages.
  - Channel mode messages determine how an instrument will process MIDI voice messages.



# *System Messages:*

- System messages carry information that are not channel specific, Examples:
  - Timing signal for synchronization,
  - Positioning information in pre-recorded MIDI sequences, and
  - Detailed setup information for the destination device
  - Setting up sounds, Patch Names etc.

# *Midi System Real-time Messages*

- These messages are related to synchronization/timing etc.
- The MIDI System Real Time messages are used to synchronize all of the MIDI clock-based equipment within a system, such as sequencers and drum machines.

# System Exclusive Messages

System Exclusive messages may be used to send data such as patch parameters or sample data between MIDI devices. Manufacturers of MIDI equipment may define their own formats for System Exclusive data

# ***Digital Audio and MIDI***

There are many applications of Digital Audio and Midi being used together:

- Modern Recording Studio -- Hard Disk Recording and MIDI
  - Analog Sounds (Live Vocals, Guitar, etc) -- DISK
  - Keyboards, Drums, Samples, Loops Effects -- MIDI
- Sound Generators: use a mix of
  - Synthesis
  - Samples
- Samplers -- Digitise (Sample) Sound then
  - Playback
  - Loop (beats)
  - Simulate Musical Instruments

# ***Digital Audio, Synthesis, Midi and Compression -- MPEG 4 Structured Audio***

- Basic Ideas of compression used as integral part of audio format -- MP3, real audio *etc.*
- Mpeg-4 audio -- actually combines compression synthesis and midi to have a massive impact on compression.
- Midi, Synthesis encode what note to play and how to play it with a small number of parameters -- Much greater reduction than simply having some encoded bits of audio.

Questions ?

# Summary

- The MIDI protocol provides an efficient format for conveying musical performance data, and the Standard MIDI Files specification ensures that different applications can share time-stamped MIDI data. While this alone is largely sufficient for the working MIDI musician, the storage efficiency and on-the-fly editing capability of MIDI data also makes MIDI an attractive vehicle for generation of sounds in multimedia applications, computer games, or high-end karaoke equipment.