Kuliah 6
Dasar Multimedia

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Lab. Multimedia Signal Processing and Wireless

Last week

- Crucial ➔ size of sampling and quantization
- How about transfer huge size of data?
- **Trade off between desired fidelity and file size**
- Bandwidth Considerations for Web and other media.

Cont last week, **Streaming Audio**

- Buffered Data:
  - Trick get data to destination before it’s needed
  - Temporarily store in memory (Buffer)
  - Server keeps feeding the buffer
  - Client Application reads buffer
- Needs Reliable Connection, moderately fast too.
- Specialised client, Steaming Audio Protocol (PNM for real audio).

This week
Synthetic Sounds

- To cope the size problem
  - Compression
  - Sound → synthetic
- Synthezise sounds — hardware or software
- Client produces sound — only send parameters to control sound (**MIDI)**

synthesis techniques

- Example
  - FM (Frequency Modulation) Synthesis – used in low-end Sound Blastercards, OPL-4 chip, Yamaha DX Synthesiser range popular in Early 1980's.
  - Wavetable synthesis – wavetable generated from sound waves of real instruments
  - Additive synthesis — make up signal from smaller simpler waveforms
  - Subtractive synthesis — modify a (complex) waveform but taking out elements
- Physical Modelling — model how acoustic sound in generated in software
- Modern Synthesisers use a mixture of sample and synthesis.

MIDI

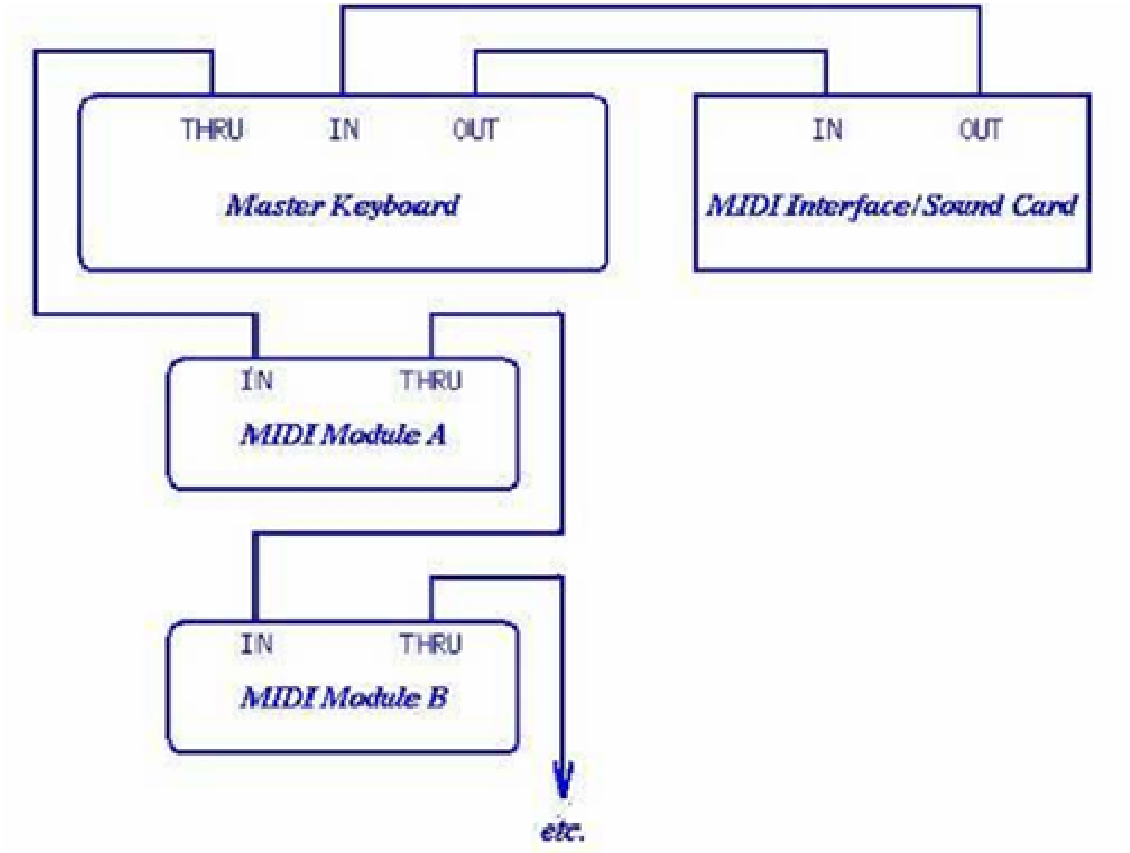
- **What is MIDI?**
- **No Longer** Exclusively the Domain of Musicians.
- Midi provides a very low bandwidth alternative on the Web:
  - transmit musical and
  - certain sound effects data
- also now used as a *compression control language (modified)*
  - MPEG-4

MIDI on the Web

- **Very Low Bandwidth (few 100K bytes)**
- **The responsibility of producing sound is moved to the client:**
  - **Synthesiser Module**
  - **Soundcard**
  - **Software Generated**
- **Most Web browsers can deal with MIDI.**

Definition of MIDI:

- A protocol that enables computer, synthesizers, keyboards, and other musical device to communicate with each other.



Components of a MIDI System

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

Basic MIDI Concepts

- Track:
  - Track in sequencer is used to organize the recordings.
  - Tracks can be turned on or off on recording or playing back.
- Channel
  - MIDI channels are used to separate information in a MIDI system.
  - There are 16 MIDI channels in one cable.
  - Usually a channel is associated with a particular instrument: e.g.,channel 1 is the piano, channel 10 is the drums, etc.
  - 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.)

Basic MIDI Concepts (Cont.)

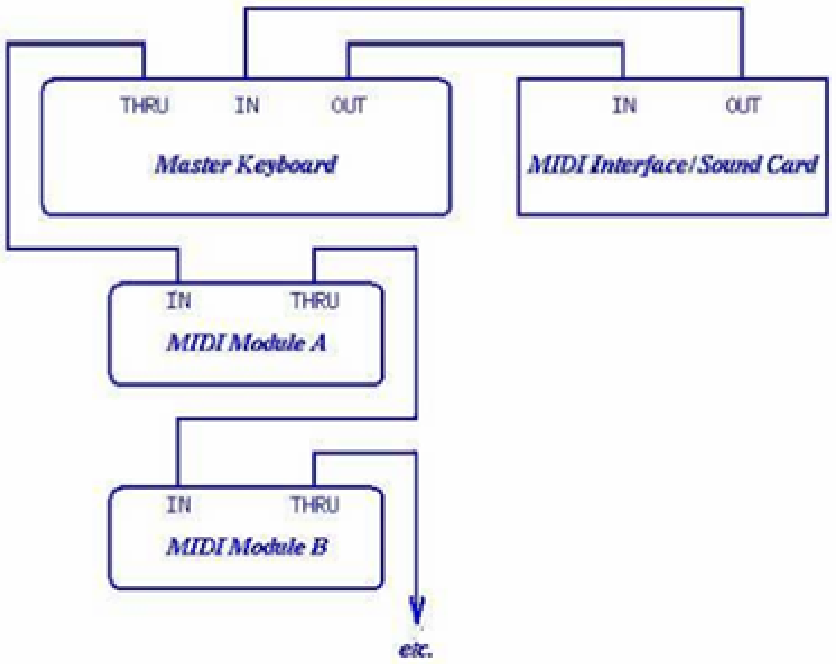
- Pitch
  - The Musical note that the instrument plays
- Voice:
  - Voice is the portion of the synthesizer that produces sound.
  - Synthesizers can have many (12, 20, 24, 36, etc.) voices.
  - Each voice works independently and simultaneously to produce sounds of different timbre and pitch.
- Patch:
  - The control settings that define a particular timbre.

Hardware Aspects of MIDI

MIDI connectors:

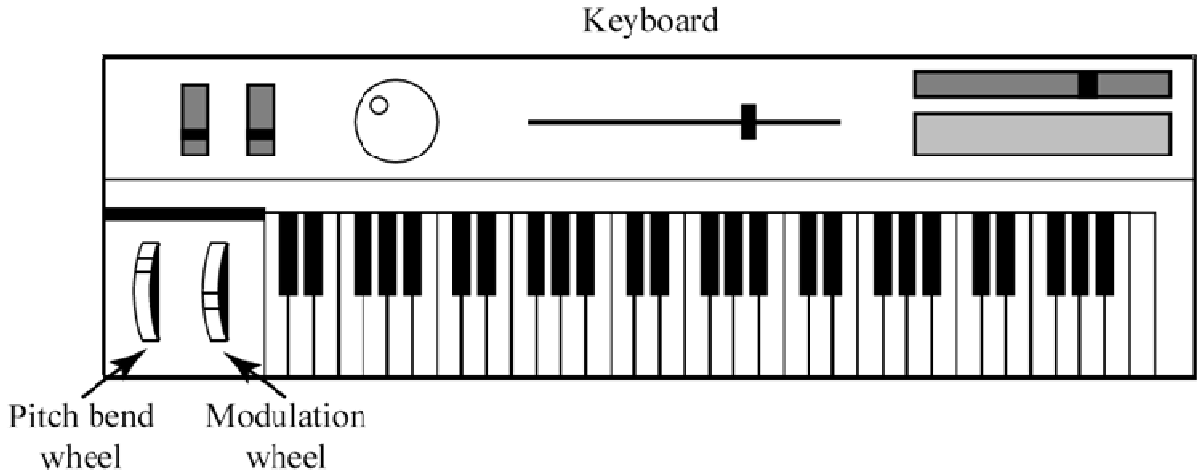
– Three 5-pin ports found on the back of every MIDI unit

- **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.



Hardware cont

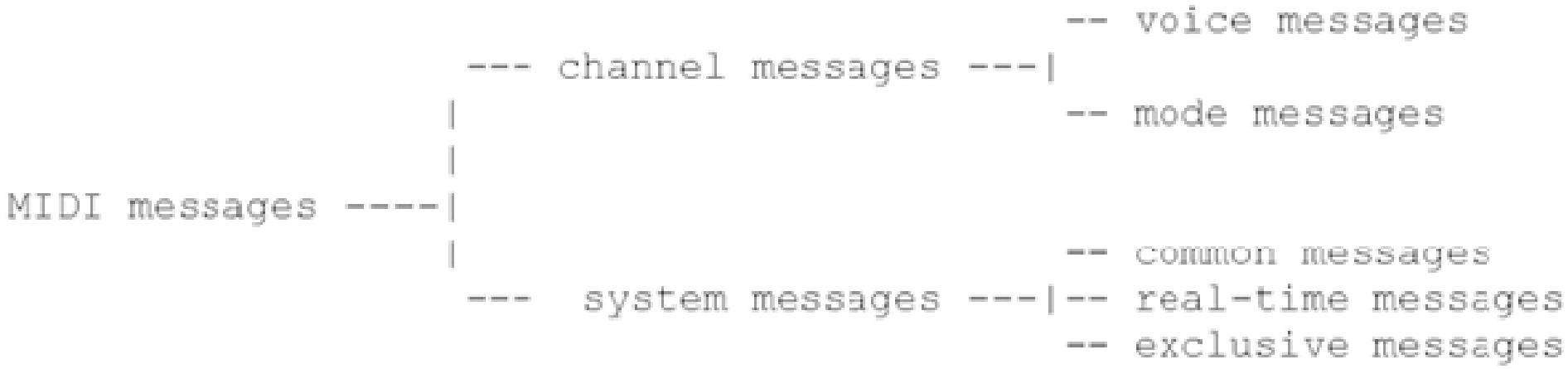
- The MIDI hardware setup consists of a 31.25 kbps serial connection.
- Usually, MIDI-capable units are either Input devices or Output devices, not both.



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 Similar
- Other command (program change) configure sounds to be played.

Classification of MIDI messages



Channel Message

- A. Channel messages: can have up to 3 bytes:
  - The first byte is the status byte (the opcode, as it were); has its most significant bit set to 1.
  - The 4 low-order bits identify which channel this message belongs to (for 16 possible channels).
  - The 3 remaining bits hold the message. For a data byte, the most significant bit is set to 0.

Voice messages:

- This type of channel message controls a voice, i.e., sends information specifying which note to play or to turn off, and encodes key pressure.
- Voice messages are also used to specify controller effects such as sustain, vibrato, tremolo, and the pitch wheel. Look at table.

Table voice message

Voice Message	Status Byte	Data Byte1	Data Byte2
Note Off	&H8n	Key number	Note Off velocity
Note On	&H9n	Key number	Note On velocity
Poly. Key Pressure	&HAn	Key number	Amount
Control Change	&HBn	Controller num.	Controller value
Program Change	&HCn	Program number	None
Channel Pressure	&HDn	Pressure value	None
Pitch Bend	&HEn	MSB	LSB

(** &H indicates hexadecimal, and 'n' in the status byte hex value stands for a channel number. All values are in 0..127 except Controller number, which is in 0..120)

Definition

- *Midi Channel messages:*
  - messages that are transmitted on individual channels rather that globally to all devices in the MIDI network.
- *Channel voice messages*
  - Instruct the receiving instrument to assign particular sounds to its voice
  - Turn notes on and off
  - Alter the sound of the currently active note or notes

Midi Channel Control Messages

- Notes: ‘x’ in status byte hex value stands for a channel number.

Voice Message	Status Byte	Data Byte1	Data Byte2
Note off	8x	Key number	Note Off velocity
Note on	9x	Key number	Note on velocity
Polyphonic Key Pressure	Ax	Key number	Amount of pressure
Control Change	Bx	Controller number	Controller value
Program Change	Cx	Program number	None
Channel Pressure	Dx	Pressure value	None
Pitch Bend	Ex	MSB	LSB

Midi Command Example

- **A Note On message is followed by two bytes, one to identify the note, and on to specify the velocity.**
- **To play:**
  - **Note number 80 (HEX 50)**
  - **With maximum velocity (127 (Hex 7F)**
  - **On channel 13 (Hex C),**
- **The MIDI device would send these three hexadecimal byte values: 9C 50 7F**

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.

System Real-Time Message	Status Byte
Timing Clock	F8
Start Sequence	FA
Continue Sequence	FB
Stop Sequence	FC
Active Sensing	FE
System Reset	FF

System common messages

- These contain the following (unrelated) messages

System Common Message	Status Byte	Number of Data Bytes
MIDI Timing Code	F1	1
Song Position Pointer	F2	2
Song Select	F3	1
Tune Request	F6	None

General MIDI (GM)

- Problem: Midi Music may not sound the same everywhere?
- Basic GM Idea:
  - MIDI + Instrument Patch Map + Percussion Key Map –> a piece of MIDI music sounds (more or less) the same any-where it is played
    - Instrument patch map is a standardised list consisting of 128 instruments (patches).
    - Same instrument type sounds if not identical sound
    - Percussion map specifies 47 percussion sounds. Same Drum type sounds on keyboard map
    - Key-based percussion is always transmitted on MIDI channel 10 (Default)
    - Can be transmitted on other channels as well

Requirements for General MIDI Compatibility

- Supportall 16channels—Defaultstandard Multitimbral MIDI Specification
- Each channel can play a different instrument/program — multitimbral
- Each channel can play many notes — polyphony
- Minimum of 24 (usually much higher 64/128) fully dynamically allocated voices — shared across all channels

General MIDI Instrument Patch Map

Prog No.	Instrument
(1-8	PIANO)
1	Acoustic Grand
2	Bright Acoustic
3	Electric Grand
4	Honky-Tonk
5	Electric Piano 1
6	Electric Piano 2
7	Harpsichord
8	Clav
(17-24	ORGAN)
17	Drawbar Organ
18	Percussive Organ
19	Rock Organ
20	Church Organ
21	Reed Organ
22	Accoridan
23	Harmonica
24	Tango Accordian
(33-40	BASS)
33	Acoustic Bass
34	Electric Bass(finger)
35	Electric Bass(pick)
36	Fretless Bass
37	Slap Bass 1
38	Slap Bass 2
39	Synth Bass 1
40	Synth Bass 2

Prog No.	Instrument
(9-16	CHROM PERCUSSION)
9	Celesta
10	Glockenspiel
11	Music Box
12	Vibraphone
13	Marimba
14	Xylophone
15	Tubular Bells
16	Dulcimer
(25-32	GUITAR)
25	Acoustic Guitar(nylon)
26	Acoustic Guitar(steel)
27	Electric Guitar(jazz)
28	Electric Guitar(clean)
29	Electric Guitar(muted)
30	Overdriven Guitar
31	Distortion Guitar
32	Guitar Harmonics
(41-48	STRINGS)
41	Violin
42	Viola
43	Cello
44	Contrabass
45	Tremolo Strings
46	Pizzicato Strings
47	Orchestral Strings
48	Timpani

(49-56 ENSEMBLE)		(57-64 BRASS)	
49	String Ensemble 1	57	Trumpet
50	String Ensemble 2	58	Trombone
51	SynthStrings 1	59	Tuba
52	SynthStrings 2	60	Muted Trumpet
53	Choir Aahs	61	French Horn
54	Voice Oohs	62	Brass Section
55	Synth Voice	63	SynthBrass 1
56	Orchestra Hit	64	SynthBrass 2
(65-72 REED)		(73-80 PIPE)	
65	Soprano Sax	73	Piccolo
66	Alto Sax	74	Flute
67	Tenor Sax	75	Recorder
68	Baritone Sax	76	Pan Flute
69	Oboe	77	Blown Bottle
70	English Horn	78	Skakuhachi
71	Bassoon	79	Whistle
72	Clarinet	80	Ocarina

(81-88 SYNTHLEAD)		(89-96 SYNTH PAD)	
81	Lead 1 (square)	89	Pad1 (new age)
82	Lead 2 (sawtooth)	90	Pad2 (warm)
83	Lead 3 (calliope)	91	Pad3 (polysynth)
84	Lead 4 (chiff)	92	Pad4 (choir)
85	Lead 5 (charang)	93	Pad5 (bowed)
86	Lead 6 (voice)	94	Pad6 (metallic)
87	Lead 7 (fifths)	95	Pad7 (halo)
88	Lead 8 (bass+lead)	96	Pad8 (sweep)

General MIDI Percussion Key Map

MIDI Key	Drum Sound	MIDI Key	Drum Sound
35	Acoustic Bass Drum	59	Ride Cymbal 2
36	Bass Drum 1	60	Hi Bongo
37	Side Stick	61	Low Bongo
38	Acoustic Snare	62	Mute Hi Conga
39	Hand Clap	63	Open Hi Conga
40	Electric Snare	64	Low Conga
41	Low Floor Tom	65	High Timbale
42	Closed Hi-Hat	66	Low Timbale
43	High Floor Tom	67	High Agogo
44	Pedal Hi-Hat	68	Low Agogo
45	Low Tom	69	Cabasa
46	Open Hi-Hat	70	Maracas
47	Low-Mid Tom	71	Short Whistle
48	Hi-Mid Tom	72	Long Whistle
49	Crash Cymbal 1	73	Short Guiro
50	High Tom	74	Long Guiro
51	Ride Cymbal 1	75	Claves
52	Chinese Cymbal	76	Hi Wood Block
53	Ride Bell	77	Low Wood Block
54	Tambourine	78	Mute Cuica
55	Splash Cymbal	79	Open Cuica
56	Cowbell	80	Mute Triangle
57	Crash Cymbal 2	81	Open Triangle
58	Vibraslap		

Digital Audio and MIDI

- Modern Recording Studio — Hard Disk Recording and MIDI
  - Analog Sounds (Live Vocals, Guitar, Sax 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

End of lectures