COMMUNICATION PROTOCOLS

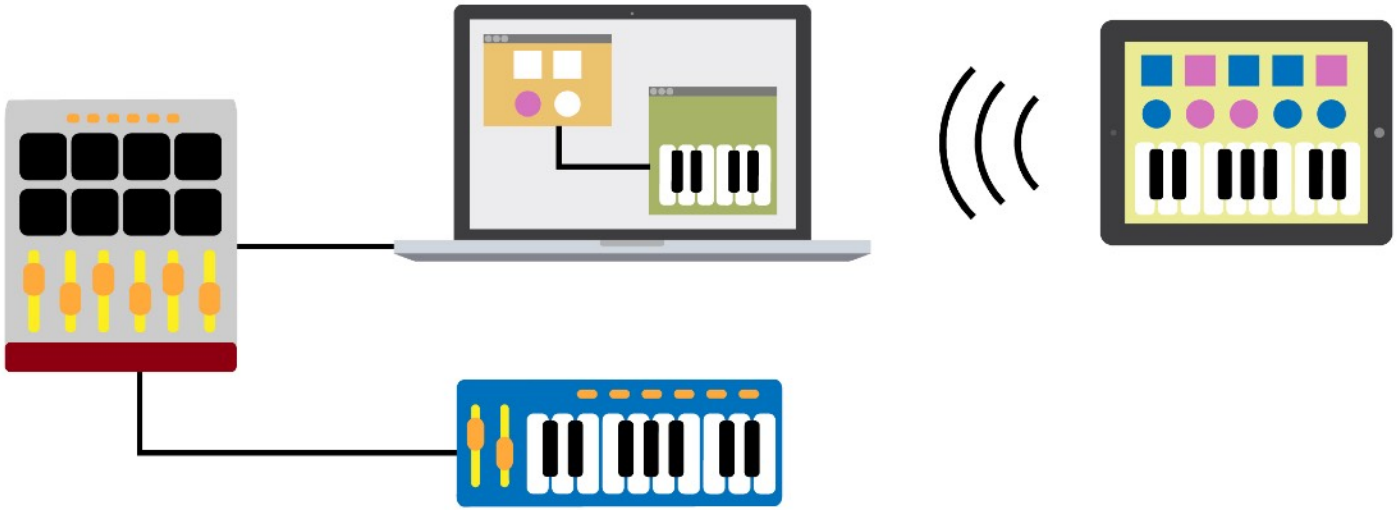
MIDI
OSC

TOMMASO ROSATI
SOUND ART

MIDI

Musical Instrument Digital Interface

MIDI, is a standardized protocol consisting of messages and rules for communication between musical instruments and other digital interfaces.



MIDI

Musical Instrument Digital Interface

The first instrument to use the MIDI protocol is the **Sequential Circuits Prophet 600** from 1983.

Despite updates like MIDI 2.0 in 2023, MIDI's structure remains conceptually the same, proving its value as an easy-to-program language that doesn't need complex technology.

MIDI

Musical Instrument Digital Interface

Cables

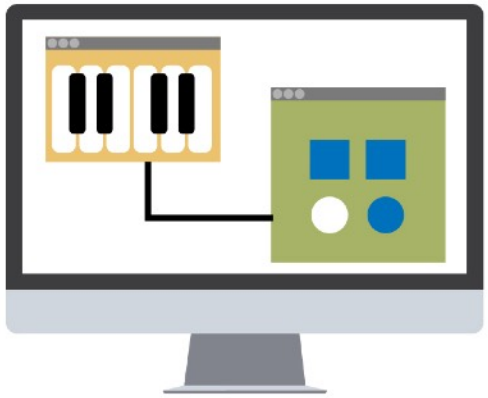
- standard 5-pin MIDI connector

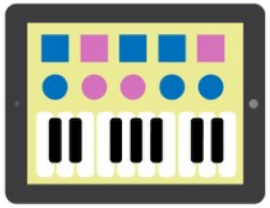
- USB cables

MIDI
Musical Instrument Digital Interface

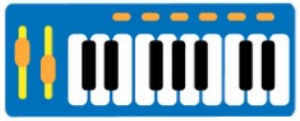
Can be also transmitted

Virtual software connections
Bridge software like
MIDI Yoke (PC)
or using Driver IAC (Mac)





WIFI or Bluetooth LE
on PC, Mac, Linux, iOS, Android…



MIDI

Musical Instrument Digital Interface

Types of messages

Channel Voice Message

can be routed to one of the **16 channels** available in MIDI

System Message

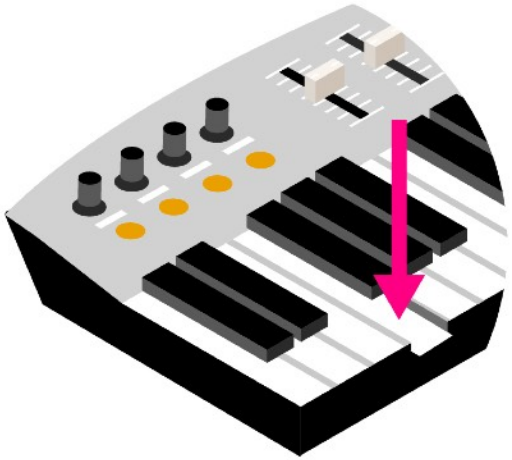
apply globally within the system and not to a specific device

Types of messages
Channel Voice Message

MIDI
Musical Instrument Digital Interface

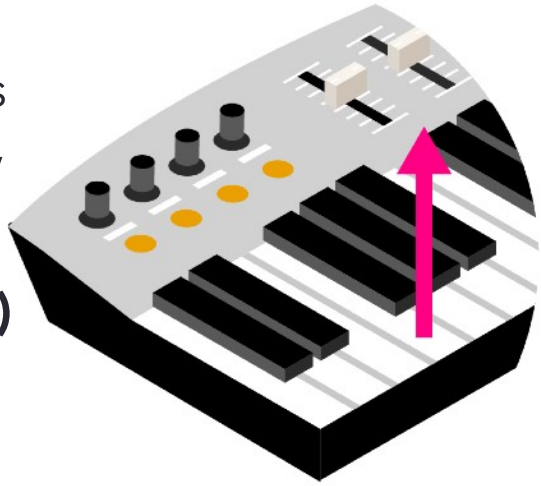
status: NOTE ON
1° data byte: NOTE
2° data byte: VELOCITY

NOTE ON – When a key is pressed on the keyboard, a Note ON (note pressed) message is sent, consisting of two numbers: **pitch (0-127)** and **velocity (0-127)**.



status: NOTE OFF
1° data byte: NOTE
2° data byte: VELOCITY

NOTE OFF – When the key that was previously pressed is now released, a Note OFF message is generated that also consists of two numbers: **pitch (0-127)** and **velocity (0-127)** the key is released.

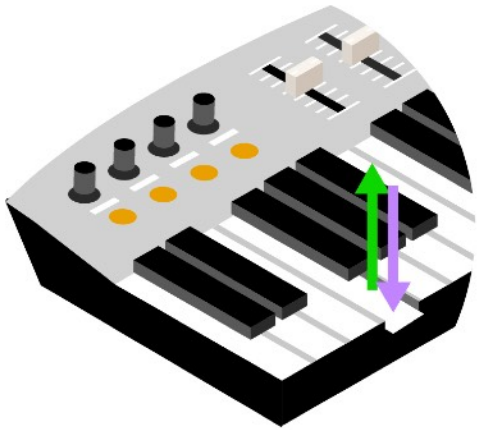


Types of messages
Channel Voice Message

MIDI
Musical Instrument Digital Interface

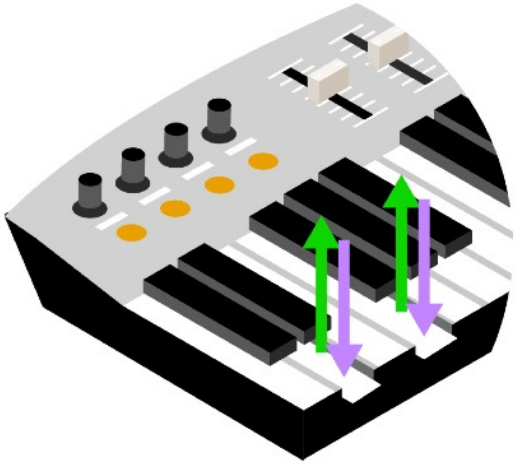
AFTERTOUCH or CHANNEL PRESSURE – This parameter takes the value of a sensor and transmits any changes in the pressure exerted on a previously pressed note in real time. This pressure is applied to the entire keyboard.

status: AFTERTOUCH
1° data byte: AFTERTOUCH VALUE



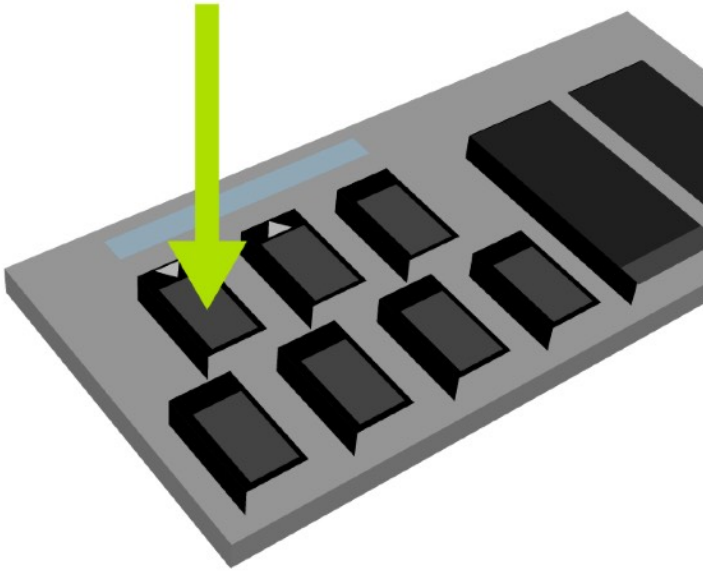
POLYPHONIC AFTERTOUCH or POLYPHONIC KEY PRESSURE – It is similar to the Aftertouch but refers to independent pressure sensors for each note.

status: AFTERTOUCH
1° data byte: NOTE
2° data byte: AFTERTOUCH VALUE



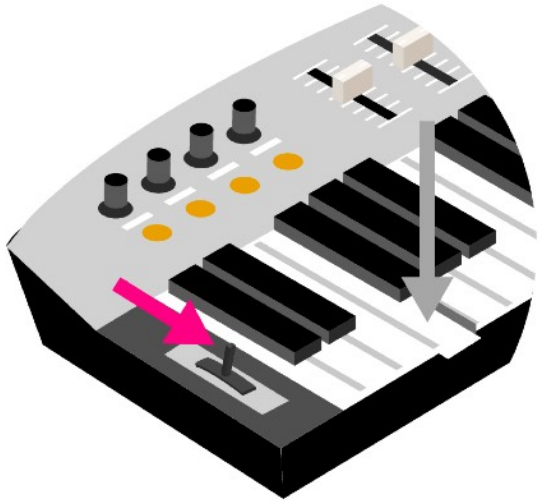
Types of messages
Channel Voice Message

MIDI
Musical Instrument Digital Interface



status: PROGRAM CHANGE
1° data byte: PRESET NUMBER

PROGRAM CHANGE - We use it to change a preset, or program.



status: PITCH BENDER
1° data byte: VALUE A (MSB)
2° data byte: VALUE B (LSB)

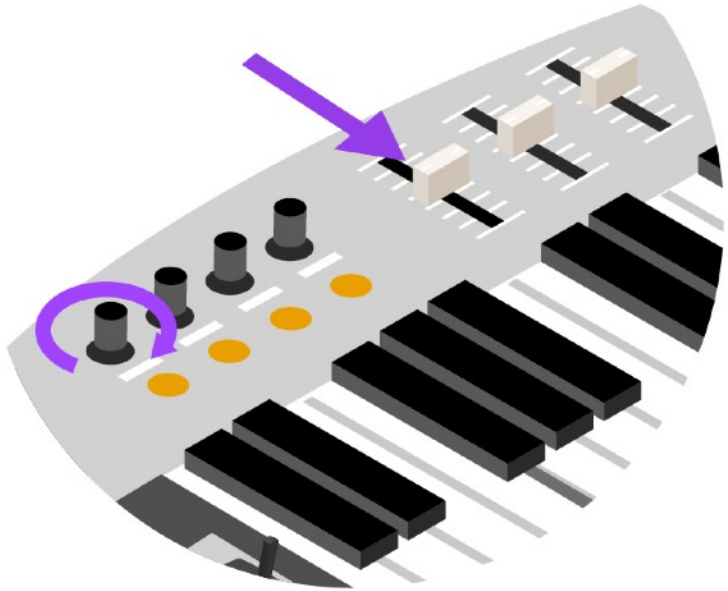
PITCH BEND – MIDI keyboards have sliders, wheels, or joysticks which can be moved to vary the pitch during the sustain of a note.

Types of messages
Channel Voice Message

MIDI
Musical Instrument Digital Interface

status: CONTROL CHANGE
1° data byte: CC NUMBER
2° data byte: VALUE

CONTROL CHANGE – consisting of two numbers (**CC 0-127** and **VALUE 0-127**), allows control values (up to 128 controllers for each channel) to be transmitted.

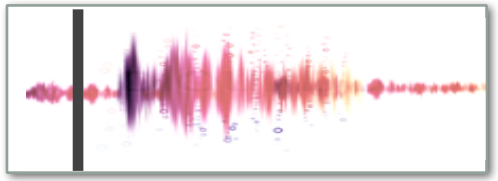


Types of messages
System Message

MIDI
Musical Instrument Digital Interface

COMMON MESSAGE

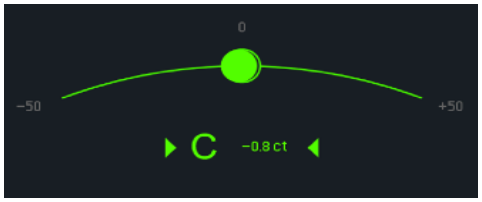
MIDI Time Code Quarter Frame **synchronizes** multiple streams of audio and video in the format hours:minutes:seconds:frames.



Song Position Pointer, indicates the **playback** or cursor's position when playing a MIDI file.

1223050	Grace Flows Down	David E. Bell,Louie Giglio,Rod Padgett
31113/6	Amazing Grace	John Newton,Nathan Pellingham
4737522	Amazing	John Newton,John P. Rees,Mark Roach
64533	All Because Of God's Amazing Grace	Stephen R. Adams
3270152	Amazing Grace	John Newton,John P. Rees,Ken Barker,Word Music G...
4985666	Amazing Grace	John Newton,John P. Rees,Shannon Anderson
4639462	Amazing Grace	John Newton,Jon Bauer
666072	Amazing Grace	Edwin Othello Excell,John Newton,John P. Rees,O. D.,...

Song Select, allows you to **select a song** within a sequencer.



Tune Request, is used to send the **tuning value** of an instrument.

Types of messages
System Message

MIDI
Musical Instrument Digital Interface

REAL TIME

MIDI Clock, The clock is used to **synchronize** the BPM (beats per minute) of multiple connected MIDI instruments.

Start, is used to bring all instruments to the same **starting position** of the song

Stop, stops the recording or playback of instruments connected to the sequencer.

Active Sensing, is sent every 300 milliseconds to **keep the connection** between main and secondary devices active.

System Reset, resets the secondary devices to the default conditions.

Types of messages
System Message

MIDI
Musical Instrument Digital Interface

EXCLUSIVE MESSAGE

System Exclusive (SysEx), controls each instrument's global functionality and are used according to the manufacturer's requirements. Since they are specific to a particular device, they can only be interpreted by compatible devices.

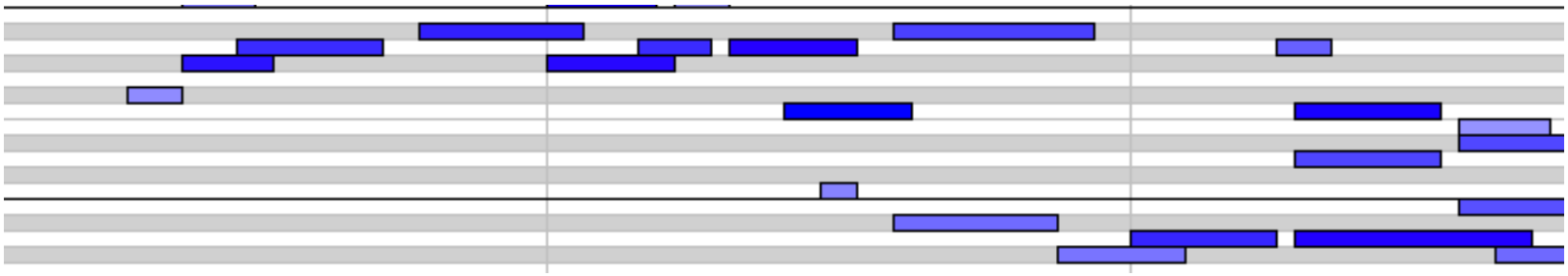
MIDI file

MIDI
Musical Instrument Digital Interface

nomefile.mid

A MIDI file, .mid, is a file format that contains a sequence of MIDI data, consisting of several messages distributed in various channels, capable of being interpreted by any MIDI compatible hardware device or software instrument.

It's NOT an audio file!



Standard MIDI
General MIDI

MIDI
Musical Instrument Digital Interface

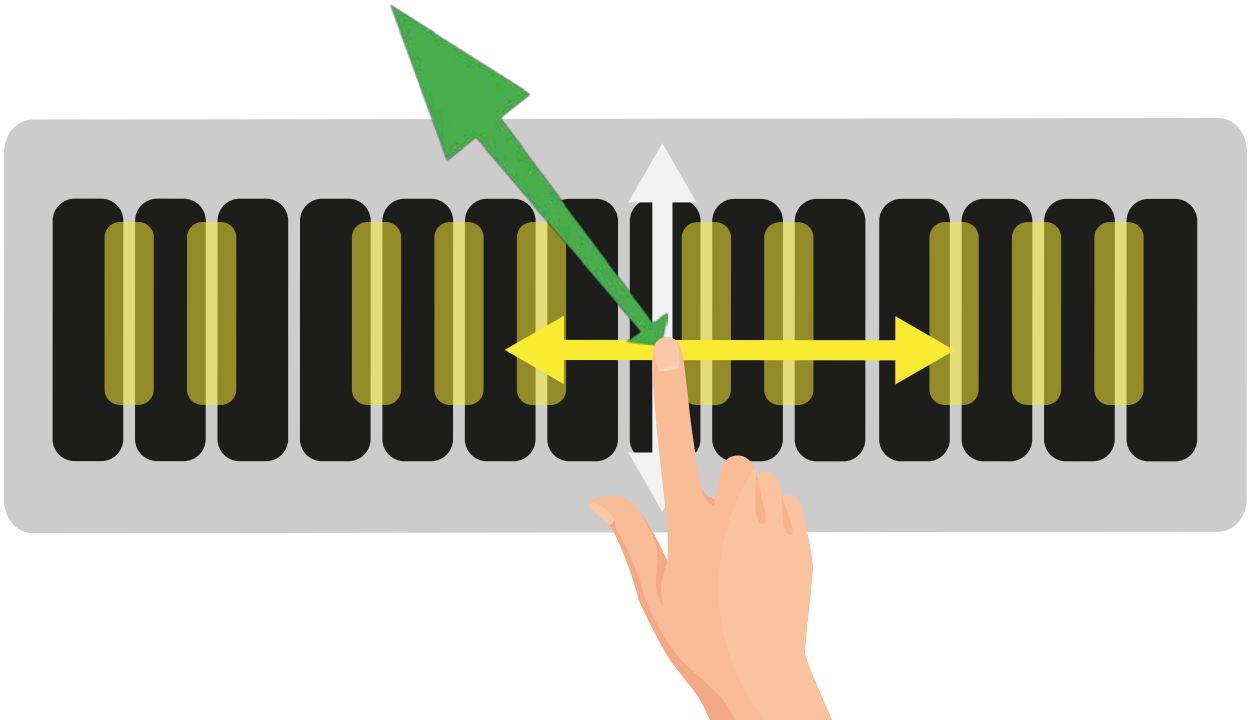
Some standards, like **General MIDI**, handle the way instruments are identified, allowing us to quickly assign tracks to various instruments of our choice.

MPE

MIDI
Musical Instrument Digital Interface

MPE merges multiple MIDI channels to give each note more gestural possibilities, like controlling horizontal and vertical finger position and pressure.

This allows one finger to control note, intensity, timbre, and reverb. Software is needed to interpret these controller signals into sound.



Connections

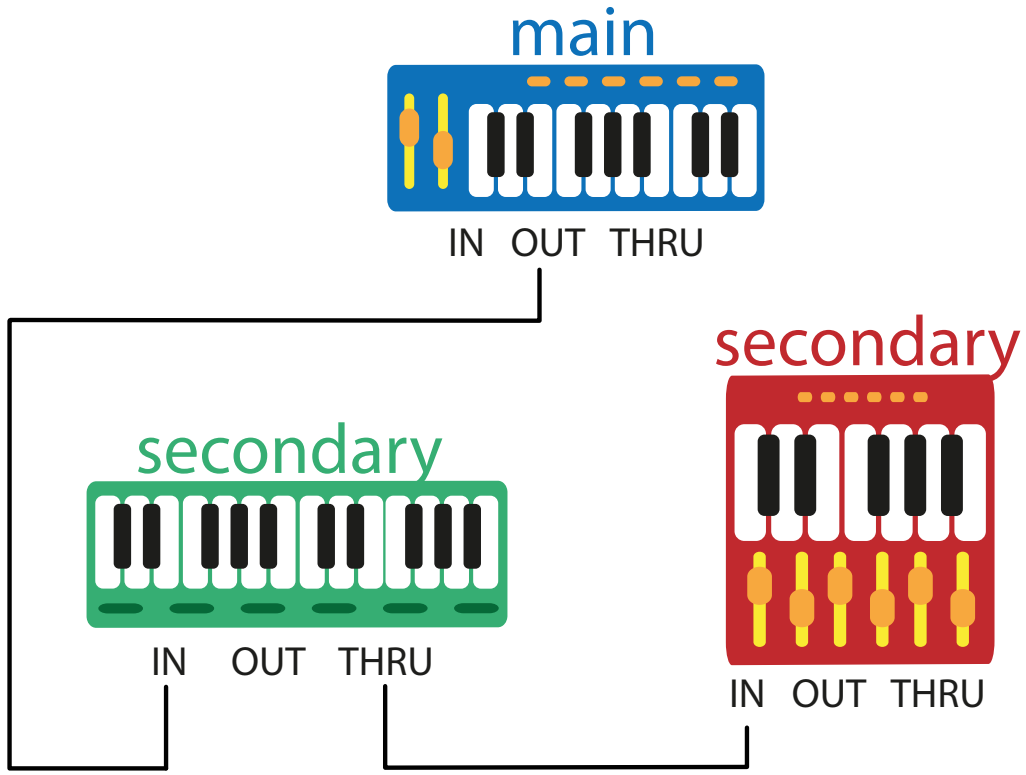
MIDI
Musical Instrument Digital Interface

In MIDI connections with standard 5-pin MIDI cables we can have three type of ports:

MIDI IN, receives MIDI messages from other external devices

MIDI OUT, sends MIDI messages out of the main device

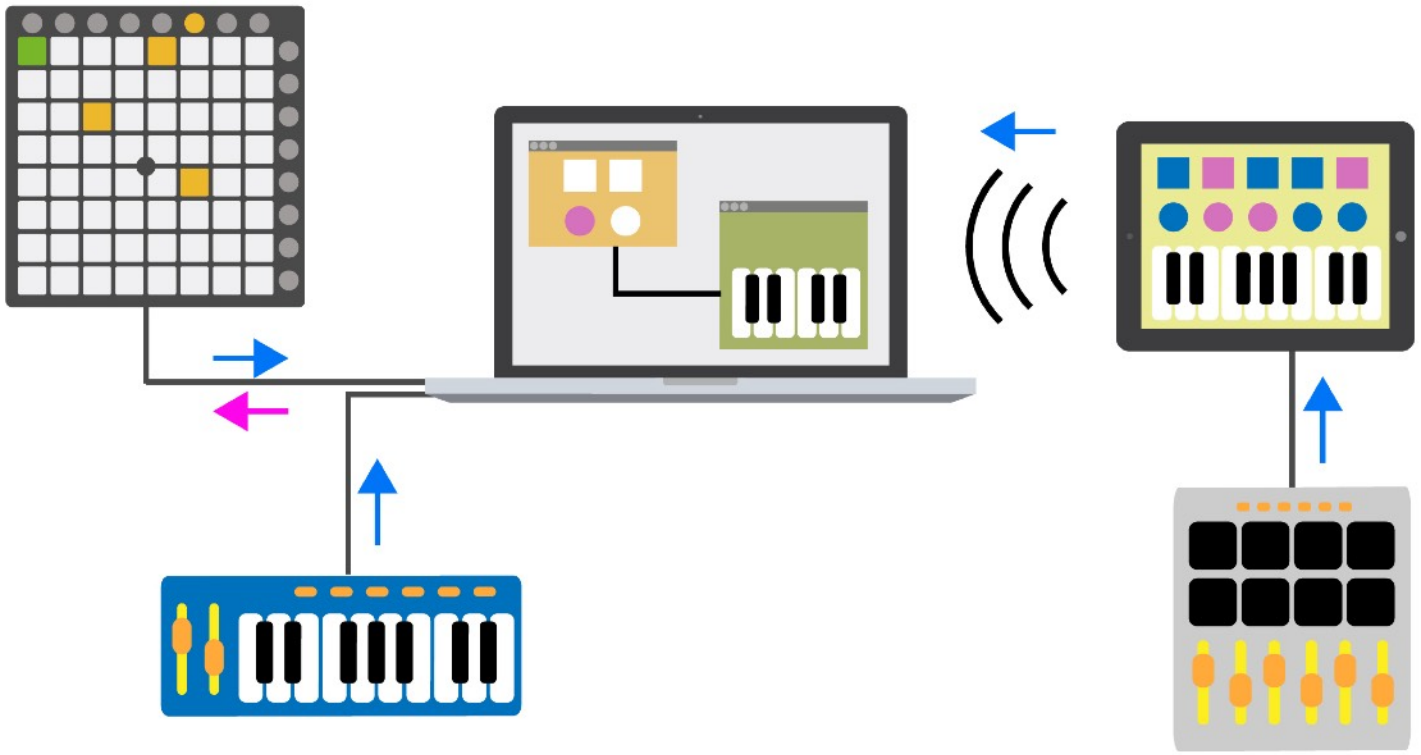
MIDI THRU, passes the MIDI signal from the IN port to the OUT port without applying variations.



Connections

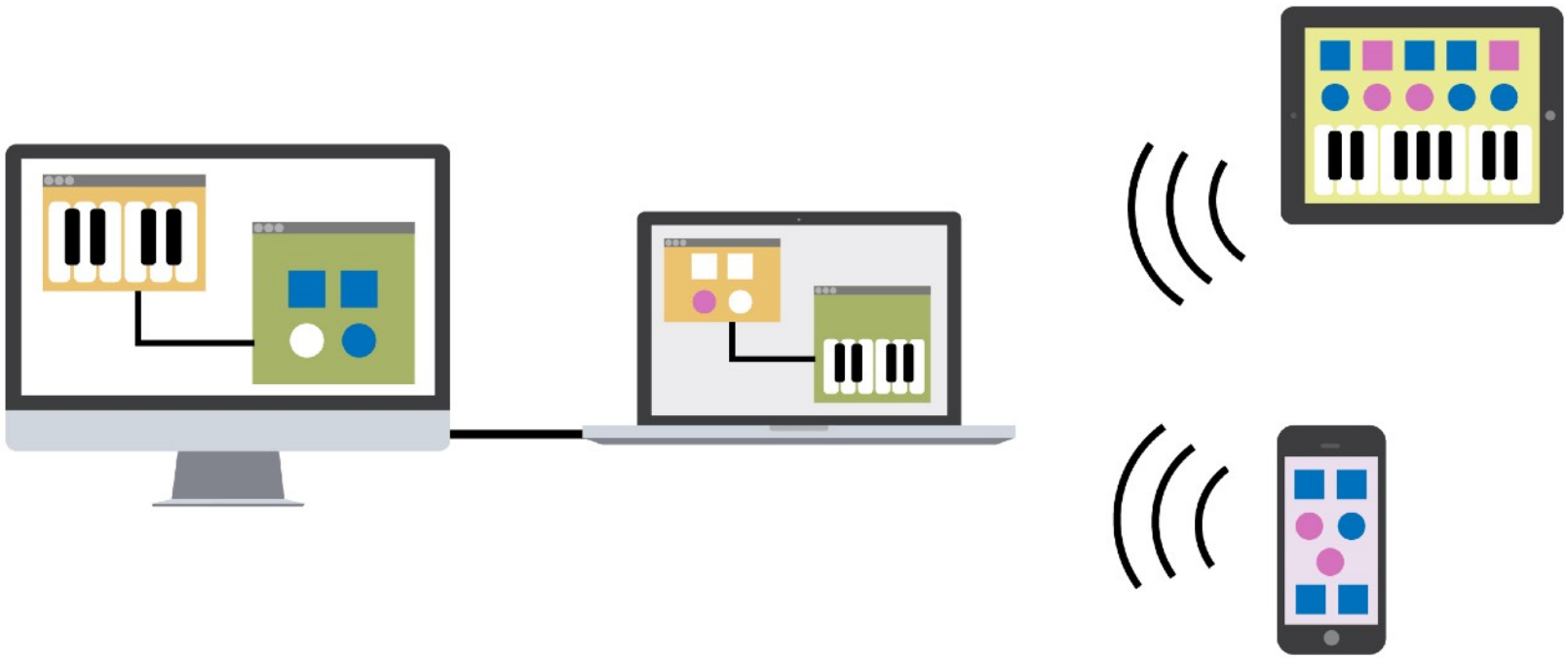
MIDI
Musical Instrument Digital Interface

In systems that are comprised of entirely digital devices, the concept of main and secondary loses some relevance due to the flexibility offered by digital systems.



OSC
Open Sound Control

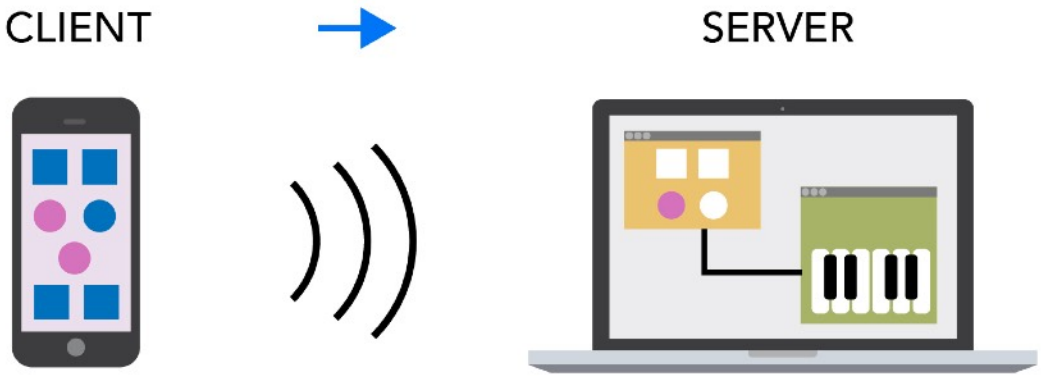
OpenSound Control (OSC) created by CNMAT in 1997, is an open-source protocol for communication between computers, audio synthesizers, and other multimedia devices over a network.



OSC
Open Sound Control

OSC-type messages can be passed back and forth using the classic network architecture type: **client/server**.

Typically clients send messages to the server and servers receive and execute OSC messages.



OSC messages

OSC
Open Sound Control

OSC messages are composed of three parts:

address pattern is a string that specifies the address relative to the data that is transmitted
example: **/squarewave/parzial/one**

type tag string specify the data type of each argument
example: **float**

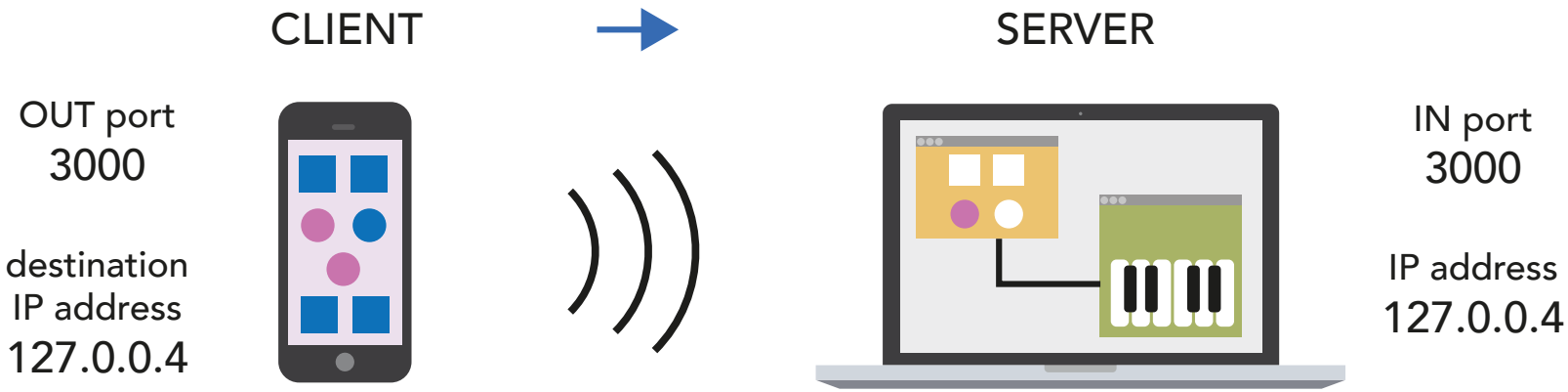
arguments are the parameter values contained in the message
example: **440.5**

OSC messages

OSC
Open Sound Control

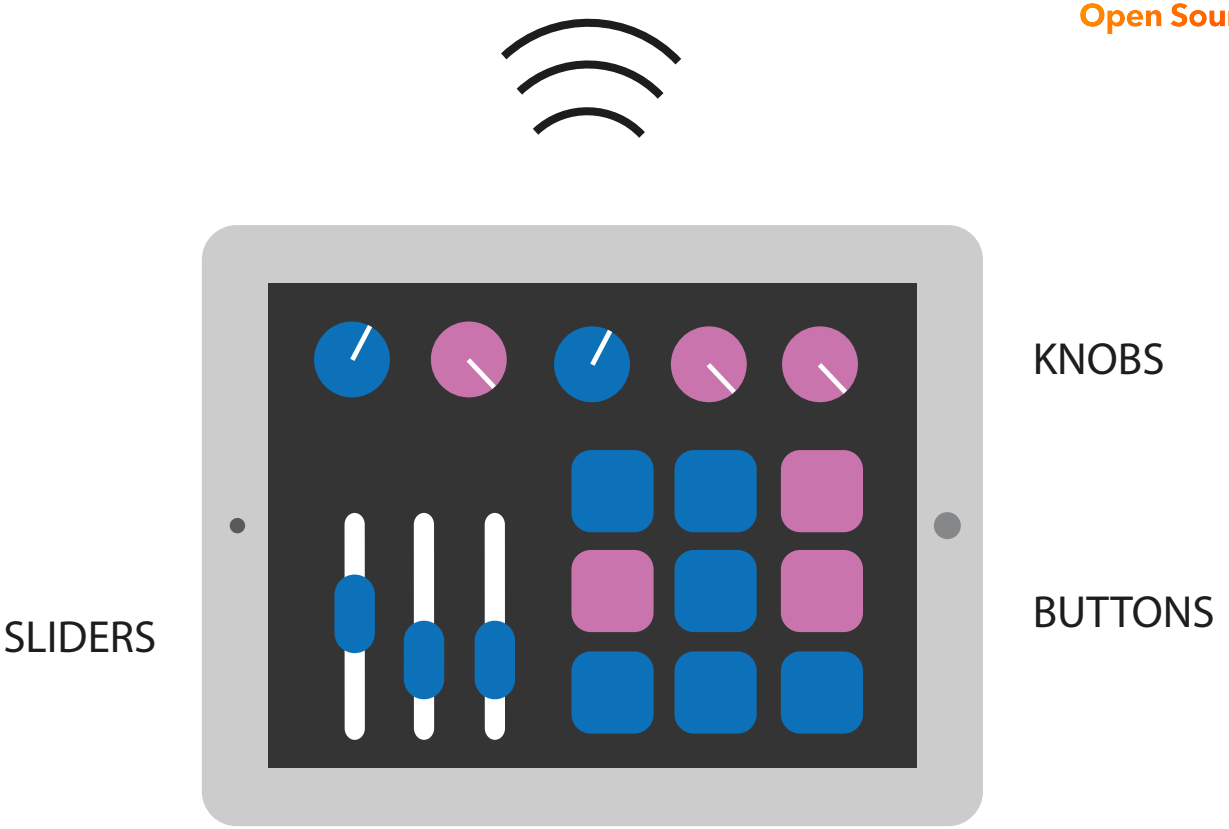
For clients to send OSC messages, they need to set the destination/server **IP addresses**.

Both clients and servers should also be configured with a send and a receive **port**.



OSC messages

OSC
Open Sound Control



OSC is popular on smartphones and tablets, transmitting data via Wi-Fi. OSC-compatible apps let users create custom control interfaces with sliders, knobs, and buttons, and can also use acceleration and rotation sensors for live performance control.

OSC messages

OSC
Open Sound Control

OSC communicates data quickly over networks and has higher resolution than MIDI, using 32-bit processing for more flexibility. However, it is less ubiquitous than MIDI and requires specifying the address and port for device connections.

www.tommasorosati.it