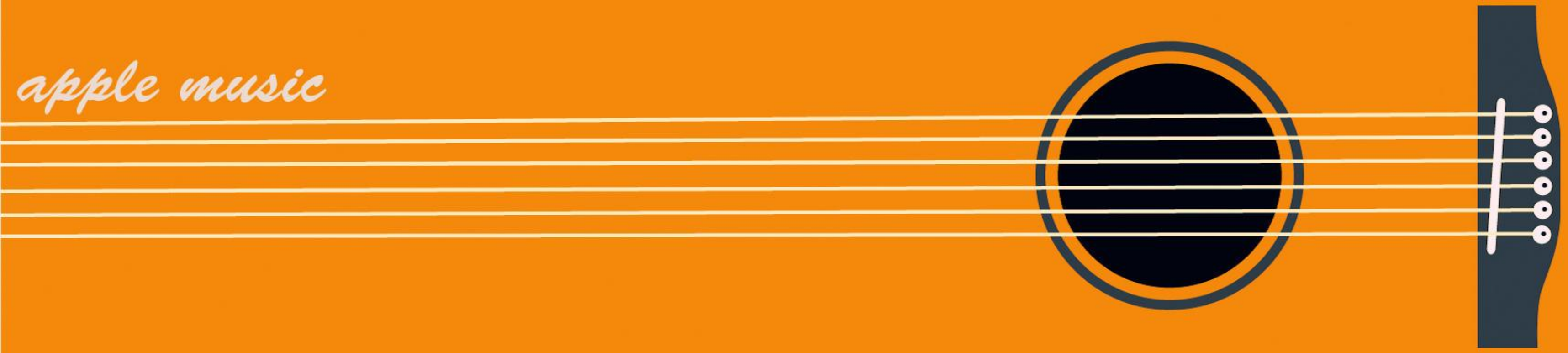
MUSIC IN THE AIR



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OUTLINE:

- MOTIVATION.
- APPLICATIONS.
- ABOUT THE TECHNOLOGY MUSIC IN THE AIR: HISTORY TO CURIE.
- ABOUT INTEL CURIE.
- INTEL CURIE FEATURES.
- ACCELEROMETER/GYROSCOPE.
- PATTERN MACHINE.
- DATA SYNC and PROCESSING.
- VARIOUS GESTURES and DAW
- DATA SET.
- CURIE WORKING.
- CHALLENGES AND FUTURE.
- EXTRA MIDI IF REQUIRED.

MOTIVATION:

- To Study the application of Technology in Music Industry.
- To explore the area of ARTIFICIAL INTELLIGENCE(AI) in the field of Music.
- To understand how Musical Instruments are capable of interacting with various technology.

APPLICATIONS:

VARIOUS APPLICATIONS OF INTEL CURIE PROCESSOR are listed below:

1. To impose the concept of AI in Music industry (MUSIC IN THE AIR).
2. Fitness devices (Bands).
3. Sports industry: Bringing IOT to sports analytics, develop solutions to track a ball's 3D trajectory.
4. Health-care application development.
5. Any software applications that can be used for analytics.

“MUSIC IN THE AIR”

ABOUT THE TECHNOLOGY:

- Technology in Music has often worked to complement raw notes, masking its flaws and bringing about physical transformation in the instruments we play.
- First there were ‘MIDI Controllers’ (digital recording Technology ‘MIDI TECHNOLOGY’ was launched in 1983 by 3 Major companies of music industry: ROLAND, KORG,YAMAHA.).
- AUTOTUNE PROGRAMMES: software which interacts with MIDI technology.
- Now there seem to be none or rarely it may seem, as we move towards “virtual instruments”.
- Using this WEARBLE TECHNOLOGY In MUSIC, instrument less stage shows are become possible.

VARIOUS FEATURES OF WEARABLE TECHNOLOGY IN MUSIC INDUSTRY

(INTEL's CURIE PROCESSOR)

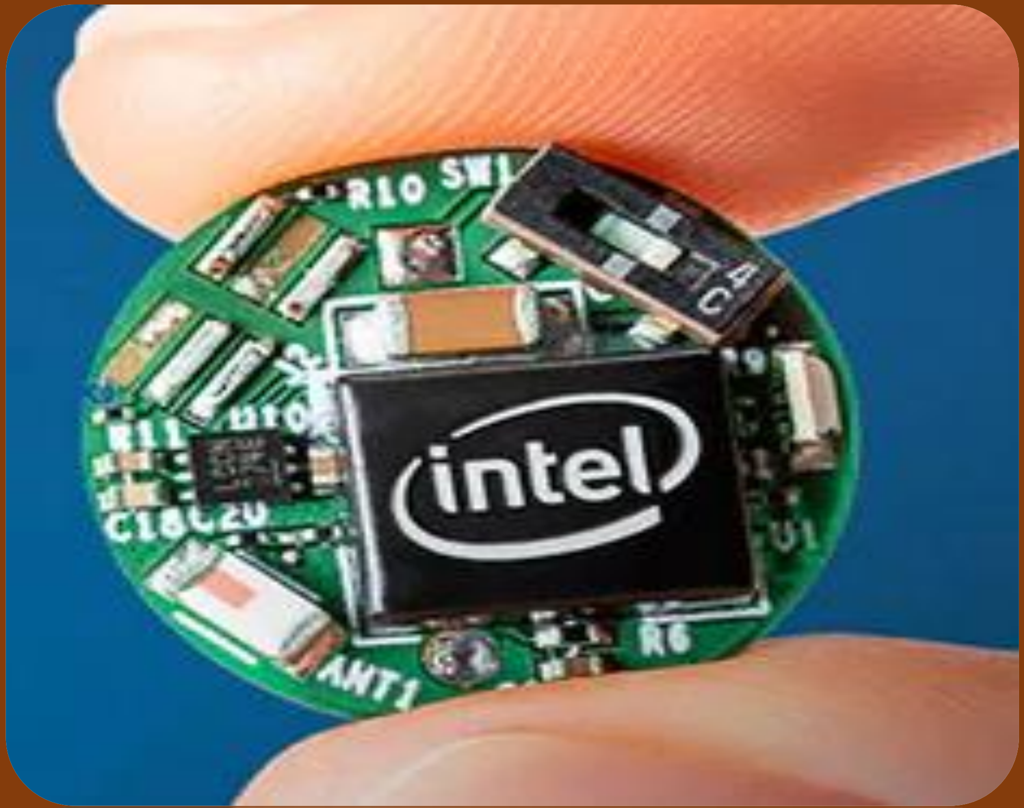
- This Technology includes intel's CURIE PROCESSOR.
- Enables musician to perform without any instruments.
- Digital Sound(Output Sound).
- Supports various type of Tones.
- Support to Various Instruments (Mostly Electronic Instruments).

Intel Curie Band

Wearable Technology

This Band Includes

Intel Curie Processor



INTEL CURIE PROCESSOR

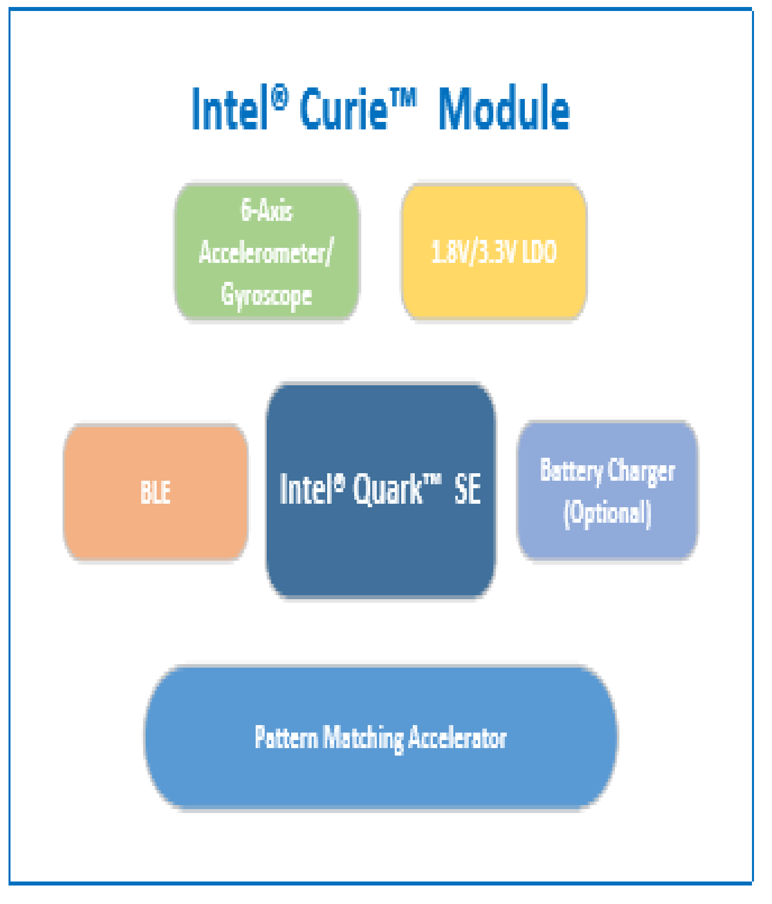
- Intel's Curie module is a tiny system-on a-chip (SoC) based on the Intel Quark SE.
- The SoC is the size of a shirt button but includes everything required to provide compute power for wearable devices.
- The Curie module is designed to enable even inexperienced makers of wearable tech to make smart products.

INTEL QUARK(SE) PROCESSOR: AN ABSTRACT OVERVIEW

- It is an low-power-consumption system-on-chip (SoC) that provides edge analytics with a sensor subsystem and pattern-matching capability.
- MAJOR FEATURES:
  - Pattern matching.
  - Internal sensor subsystem: 6-axis compass/accelerometer with temperature sensor.
  - Intelligence at the edge: Edge Analytics.

INTEL CURIE PROCESSOR: FEATURES

- SIZE: Tiny, circular in shape like shirt button.
- Equipped with 32-bit INTEL QUARK SoC.
- 384 kB Flash Memory.
- 80kB SRAM.
- Comes in an Easy to integrate package.
- 6- axis combo(GYROSCOPE AND ACCELEROMETER) sensor.
- Gesture recognition.
- Pattern matching.
- Bluetooth low energy for communication: are handled by Bluetooth low energy stack in the device.
- Battery charging capabilities.

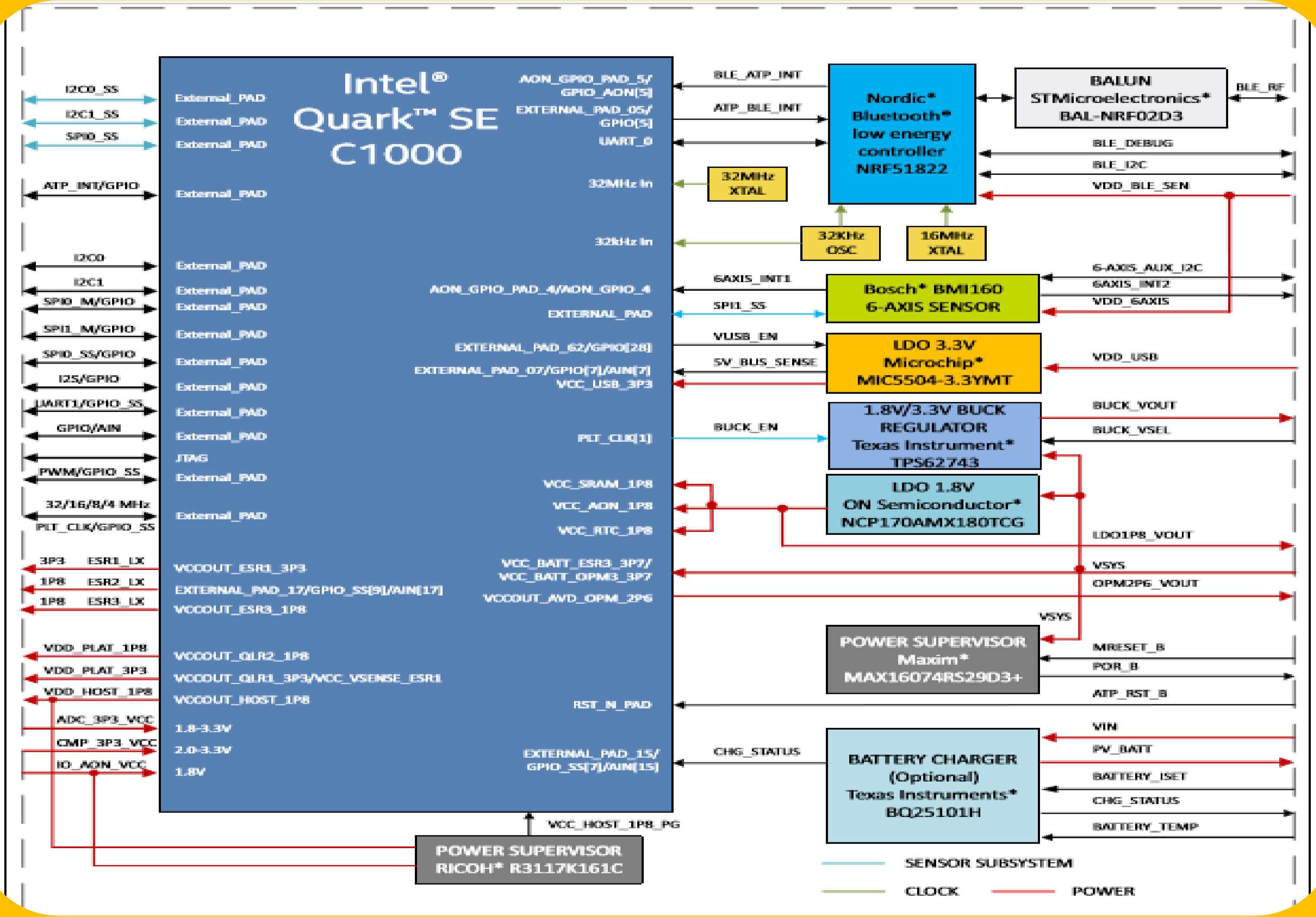


INTEL S/W KIT FOR CURIE PROCESSOR

Software Kit Includes:

- RTOS (Real Time OS).
- Middleware Services.
- Middleware drivers.
- Basic devices management.
- Analytic Features.

INTEL CURIE: ABSTRACT VIEW TO BLOCK DIAGRAM

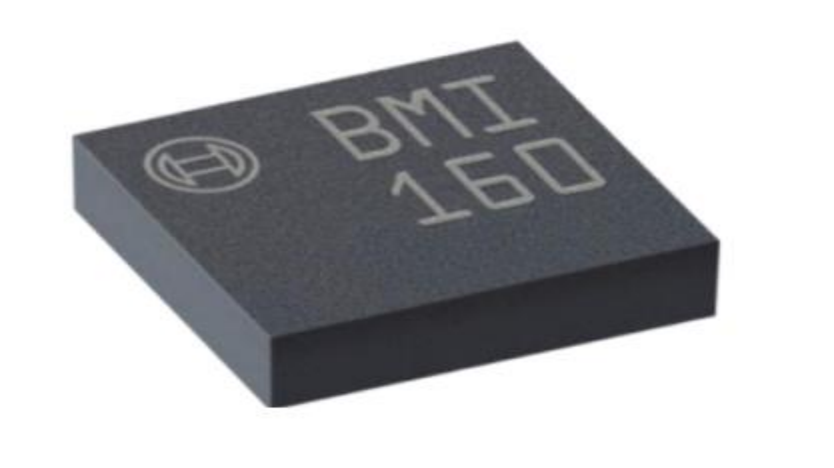


INTEL CURIE: SIX AXIS ACCELEROMETER/GYROSCOPE SENSOR

- Intel Curie Includes a Bosch BMI160 6-axis sensing device.
- Connected to SPI1_SS interface, only ARC core can communicate with this block.
- Sleep or stand by mode to support low power applications.
- Separate power supply to sensor block.

Bosch-BMI160 integrated device Features:

- Provides SPI interface from the ARC processor core to the 6-axis sensor to configure and read sensor data.
- Hardware synchronization of inertial sensor data.
- Precise acceleration measurement.
- Precise Angular rate (gyroscopic) measurement.

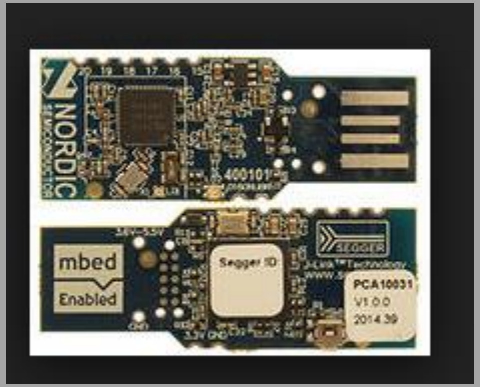


INTEL CURIE : COMMUNICATION TECHNIQUE (BLUETOOH COMMUNICATION)

- Intel Curie Module includes a Nordic nRF51822 (used to create BLUETOOTH LOW ENERGY APPLICATIONS, It integrates a low energy controller and host, and provides a full and flexible API for building Bluetooth low energy System on Chip (SoC) solutions.) that is interfaced to the Intel Quark microcontroller via UARTO.
- All the Bluetooth Low energy operations (wireless personal area network technology) operations are handled by the Bluetooth Low Energy stack in the device.

Advantages of Bluetooth Low Energy as compared to Classical Bluetooth:

- Bluetooth Low Energy is intended to provide considerably Reduced Power Consumption.
- Bluetooth Low Energy is intended to provide Reduced cost.
- Maintains a similar communication range.

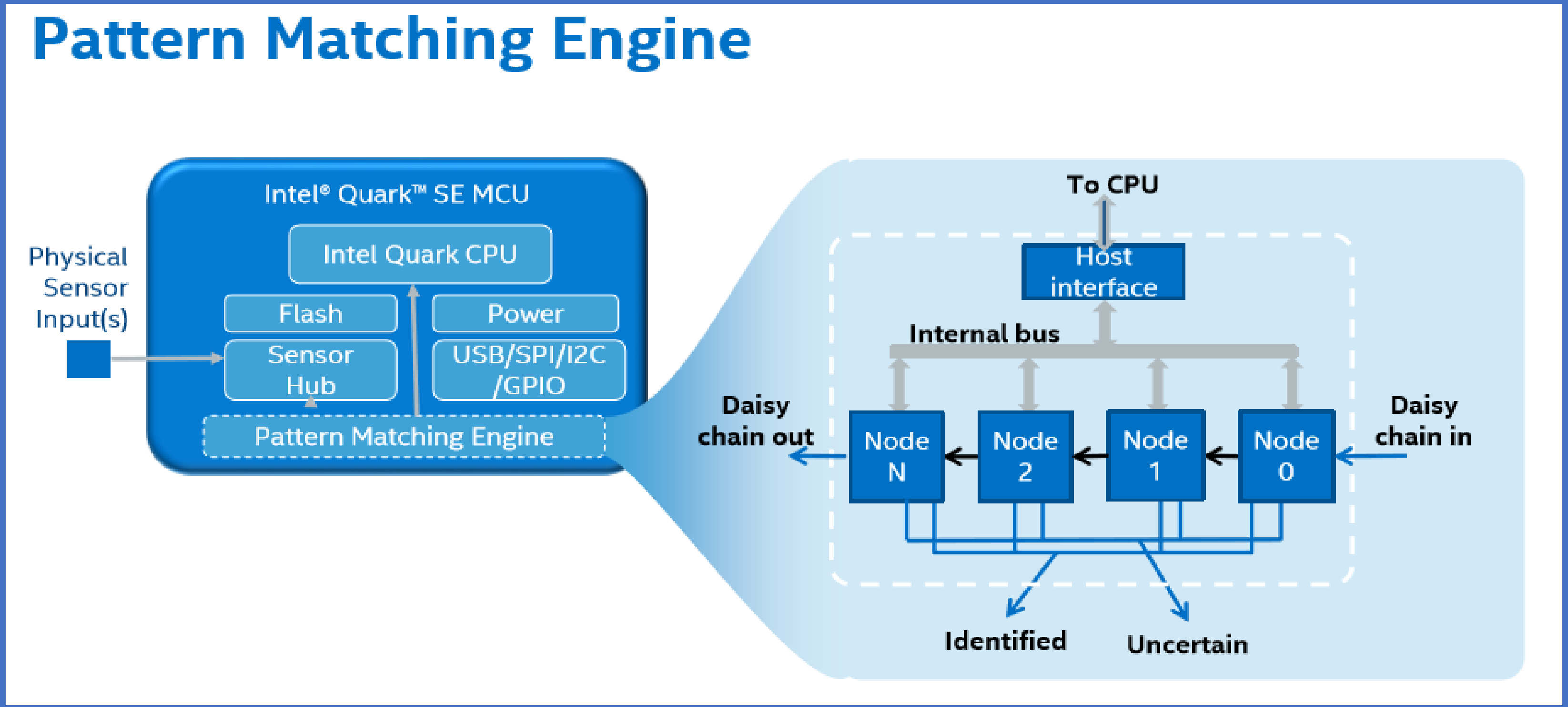


INTEL CURIE: PATTERN MATCHING

The Pattern Matching Engine :

- Learns various patterns.
- Recognizes patterns in arbitrary sets of data.
- Parallel data recognition engine.
- 128 parallel arithmetic units.
- Constant recognition time.
- Vector Data : upto 128 bytes.
- Pattern Classification States:
- ID: identified, unique match.
- UNC: uncertainty, more than one category matches.
- UNK: unknown, no match
- 2 Pattern matching algorithms:
- K nearest neighbour.
- Radial basis function.

INTEL CURIE: PATTERN MATCHING



- Support for up to 32,768 categories.
- Supervised Learning.
- Operations:
  - Recognize a vector.
  - Save the knowledge base from the network.
  - Load the knowledge base to the network.

INTEL CURIE: DATA SYNCHRONIZATION

- Sensor time is sync with update of DATA register.
- Synchronization is digital statement.
- Data from Accelerometer and Gyroscope are strictly synced on H/W level.
- Bosch BMI160 supports various levels of Data Synchronization.

INTEL CURIE: DATA PROCESSING

- The Data from sensors are sampled with data rate of 6400Hz for gyroscope and 1600Hz for accelerometer.
- The Data Processing implements a low pass filter configured in the register:
  - ACC_CONF: for Accelerometer.
  - GYR_CONF: for gyroscope.

GESTURES IN MUSIC PRODUCTION

Free hand Gesture controlled expressions are based on:

- Tracking of Hand held devices like drumsticks, guitar etc.

- In order to avoid necessity of holding a device, sensors can be on hands (CURIE BAND, includes GYROSCOPE and ACCELEROMETER).

- Various different musical contexts of gestural control in music :

  - INSTRUMENT MANIPULATION: takes place at the level of real-time sound synthesis control of digital musical instruments.

  - SCORE LEVEL CONTROL (SCORES ARE WRITTEN MANUSCRIPTS OR DOCUMENTS): conducting, manipulates the expression of a performance, not the material performed.

  - POST PRODUCTION ACTIVITIES: address the control of digital audio effects, sound spatialization, and mixing.

SURVEY ON GESTURES

SURVEYED GESTURES TO CONTROL VARIOUS PARAMETERS OF MUSIC:

- TEMPO: was controlled with the depth position of the hand. Moving the hand forward increases the musical tempo, putting the hand back slows the tempo down.
- DYNAMICS, derived from the vertical hand position. Moving the hand up and down causes the volume level to increase and decrease.
- ARTICULATION , was controlled by the grab strength. The flat hand produced a legato and the fist a staccato articulation. For poses in-between the note lengths were interpolated.
- TIMBRE, manipulation was done by hand tilting between the horizontal (soft sound) and vertical(shrill sound)pose. The timbres were achieved by oscillator hard syncing.

SUGGESTED GESTURES FOR MUSICAL TEMPO CONTROL

Accelerando (increase tempo, 100% = 29 suggestions)

$T1$	fast fanning away with the back of one (open) hand, also described as wiping away (9 suggestions, 31%)
$T2$	fast circular movement of one (open) hand, away from the body, back of the hand heading forward (5 suggestions, 17.2%)
$T3$	one hand moves to the right, also described as fast-forwarding on a video recorder (4 suggestions, 13.8%)

Ritardando (decrease tempo, 100% = 34 suggestions)

$t1$	one (open) hand, palm downward, moves downward, also described as "calm-down gesture" (11 suggestions, 32.4%)
$t2$	opposite of gesture $T3$, one hand moves to the left, also described as rewinding on a video recorder (4 suggestions, 11.8%)

SUGGESTED GESTURES FOR MUSICAL TEMPO CONTROL

Crescendo (increase volume level, 100% = 45 suggestions)

$D1$	one (open) hand, palm downward, moves upward (17 suggestions, 37.8%)
$D2$	both hands open, palms facing each other, spreading arms. In some cases the movement triggers the crescendo irrespective of the distance of both hands. Other participants expressed a specific loudness value through the distance between both hands. (5 suggestions, 11.1%)
$D3$	similar to $D1$ but with palm heading upward (4 suggestions, 8.9%)
$D4$	similar to $D1$ but with two hands (4 suggestions, 8.9%)
$D5$	similar to $D1$ but with two hands and palm heading upward (4 suggestions, 8.9%)
$D6$	one (open) hand, held vertical, moves to the right (3 suggestions, 6.7%)

Decrescendo (decrease volume level, 100% = 48 suggestions)

$d1$	opposite of gesture $D1$, one (open) hand, palm downward, moves downward (18 suggestions, 37.5%)
$d2$	opposite of gesture $D4$, similar to $d1$ but with both hands (16 suggestions, 33.3%)
$d3$	opposite of gesture $D2$, both hands open, palms facing each other, bringing arms together (3 suggestions, 6.3%)
$d4$	opposite of gesture $D6$, one (open) hand, held vertical, moves to the left (3 suggestions, 6.3%)

SUGGESTED GESTURES FOR MUSICAL TEMPO CONTROL

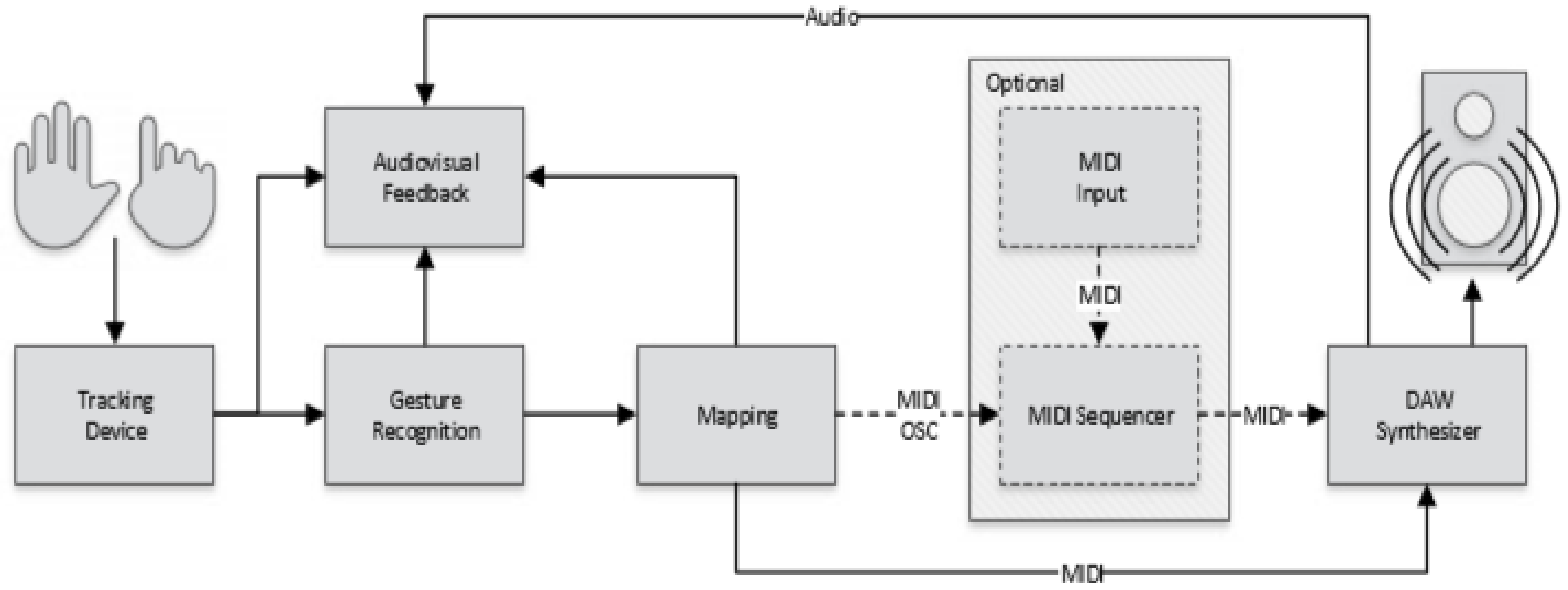
Legato (broad articulation, 100% = 24 suggestions)

$A1$	smooth horizontal wave movement of one open hand, palm heading downward (6 suggestions, 25%)
$A2$	both hands open and arms wide open, also described as indicating a long tone length (5 suggestions, 20.8%)
$A3$	one hand, open/flat (4 suggestions, 16.7%)

Staccato (short articulation, 100% = 42 suggestions)

$a1$	rhythmic dabbing movement with fist, beak pose or thumb and index finger with one hand (11 suggestions, 26.2%)
$a2$	similar to $a1$ but with both hands moving symmetrical (11 suggestions, 26.2%)
$a3$	opposite of $A2$, both hands open, held close to each other, also described as indicating a short tone (4 suggestions, 9.5%)
$a4$	opposite of $A3$, fist (4 suggestions, 9.5%)
$a5$	opposite of $A1$, one (open) hand, vertically held, makes choppy up and down movements, also described as hacking with the side of the hand (4 suggestions, 9.5%)

EXAMPLE OF FREE-HAND INTERACTION WITH DAW(DIGITAL AUDIO WORK STATION)



DATA SETS FOR EXPRESSIVE MUSICAL GESTURES

After understanding how Various Gestures can be recorded from various Musical Instruments, now the next step is to understand how various data sets are recorded with respect to different musical instruments.

Here for understanding 2 Acoustic instruments:

PIANO and VIOLIN are taken as example

VIOLIN

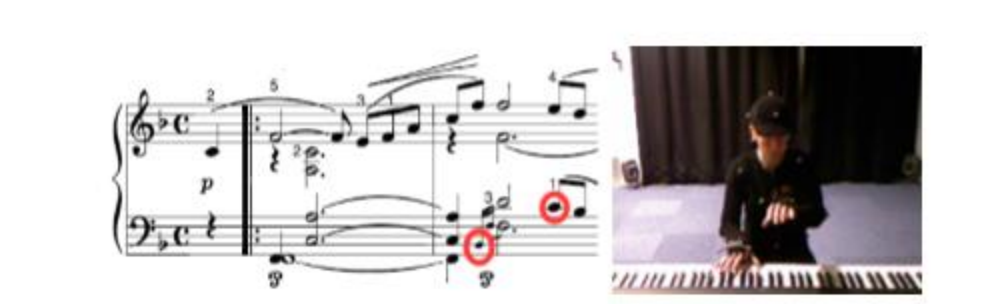
Here for demo five violinists performing standard pedagogical phrases with variation in dynamics and tempo.

- Various Gestures and Motions are captured by GYROSCOPE,ACCELROMTER).
- 50 trials performed for various dynamics, tempo, slow-fast data-sets.
- Observing and storing STAFF NOTATIONS of particular gestures.
- Data sets are stored in the form of STAFF NOTATION in MIDI software.

VIOLIN

For demo two pianists performing a repertoire piece with variations in tempo, dynamics and articulation.

- Various Gestures and Motions are captured by GYROSCOPE,ACCELROMTER).
- In each of the conditions for metronome and speed, they played with 5 expressive intentions:
  - normal, still (trying to move as little as possible), exaggerated, finger legato (melodic consecutive notes smoothly connected) and staccato (detached consecutive notes)
  - 3 takes were recorded in each of the conditions, making a total of 105 takes per pianist.
- The piano dataset includes position/orientation of multiple joints, as well as aligned audio, video and MIDI.



INTEL CURIE TECHNOLOGY : WORKING

- This module unlocks various possibilities for a wearable device.
- It's a low-power solution designed for wearable devices, consumer and industrial edge products.
- This could be a new tool for digital music production.

How does this technology work?

To answer this question, we must study the basics of electronic music production. Musical Instrument Digital Interface (MIDI) is a protocol used by digital music instruments to communicate. MIDI protocol enables (digital) musical instruments to exchange data parameters like note, duration, octave, expression, pressure, velocity, glide and many more. Using MIDI, synthesizers, drum machines, and recording devices can interact like network devices. Even Analog instruments can be fitted with MIDI modules.

REFER MIDI PPT FOR MORE DETAILS

Title and Content Layout with SmartArt

- Wear Intel Curie Band (hands/legs).
- Track Gestures.

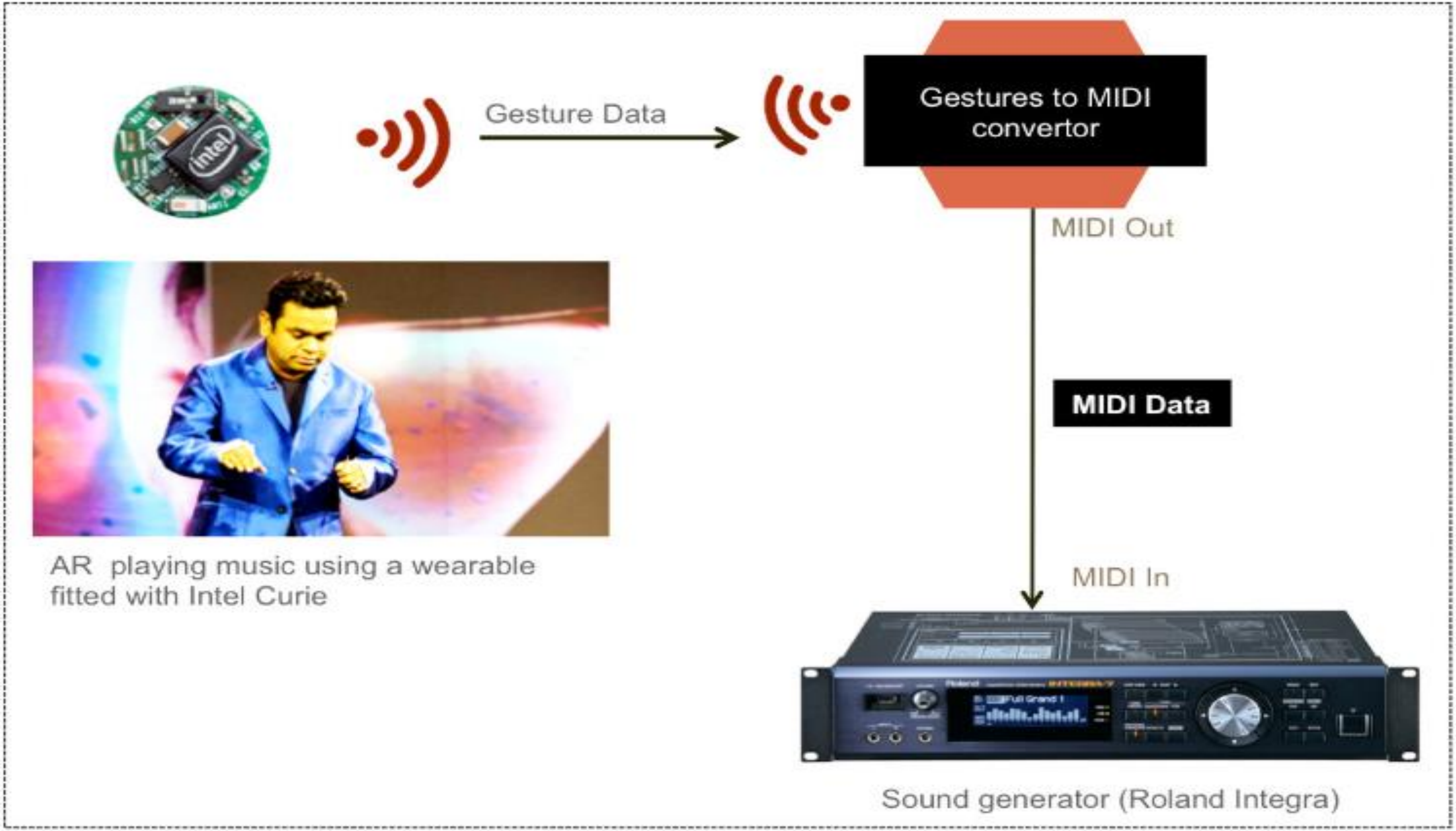
INITIAL LAYER

MIDDLE LAYER

- Gesture to MIDI data.
- Sending MIDI data to MIDI H/W or S/W.

- Receiving MIDI data by MIDI H/W or S/W.
- Triggering of Sound by MIDI to OUTPUT sound devices.

FINAL LAYER



AR playing music using a wearable fitted with Intel Curie

CHALLENGES

GENERAL CHALLENGES :(Throwing light on all the areas where INTEL CURIE can be used.)

- Since this module uses BLUETOOTH LOW ENERGY for Communications hence, Low Energy – Low Privacy.
- Motion or Gesture capturing is not 100% accurate.
- Costly (Overall Set up).
- Data Sharing up to short distances (due to BLE).

CHALLENGES IN MUSIC INDUSTRIES:

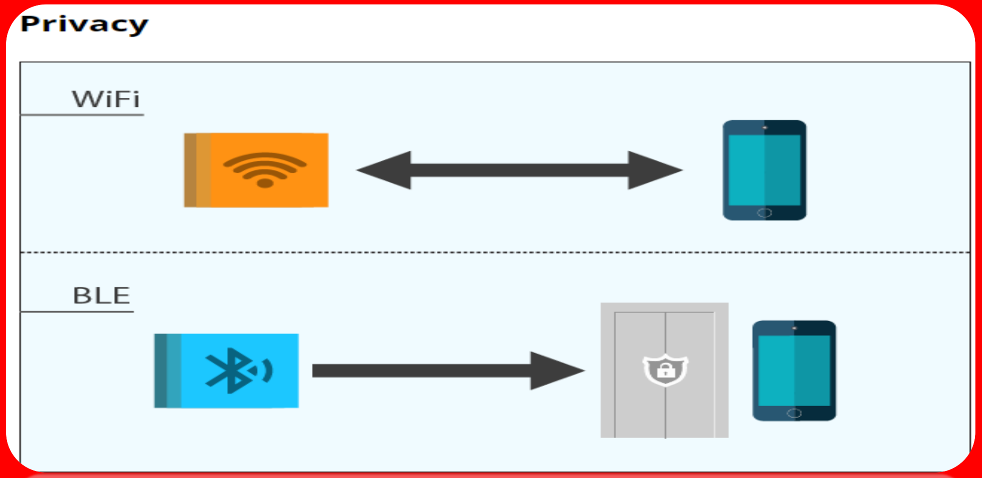
- Flavor of various ACOUSTIC MUSICAL INSTRUMENTS is missing.
- Synchronization is major issue.
- The most problematic issue of gestural music interaction in the mapping of gesture data to musical data.
- Speed, latency, hardware-specific problems, and stability problems.

FUTURE ENHANCEMENTS

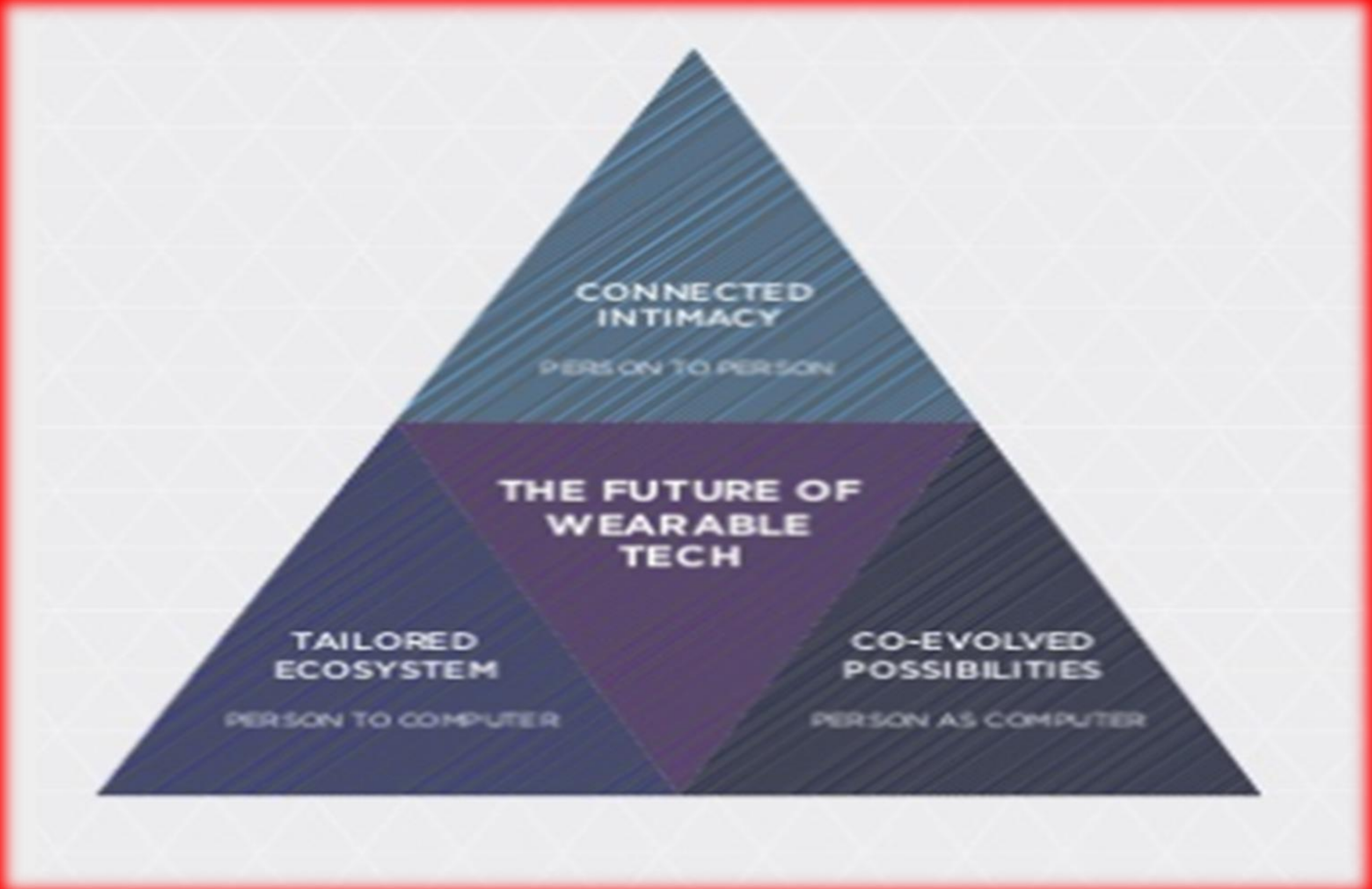
1.Communication technology (use of WIFI over BLE):

- Increases Speed.
- Data sharing over long distances and accurate Data detection.

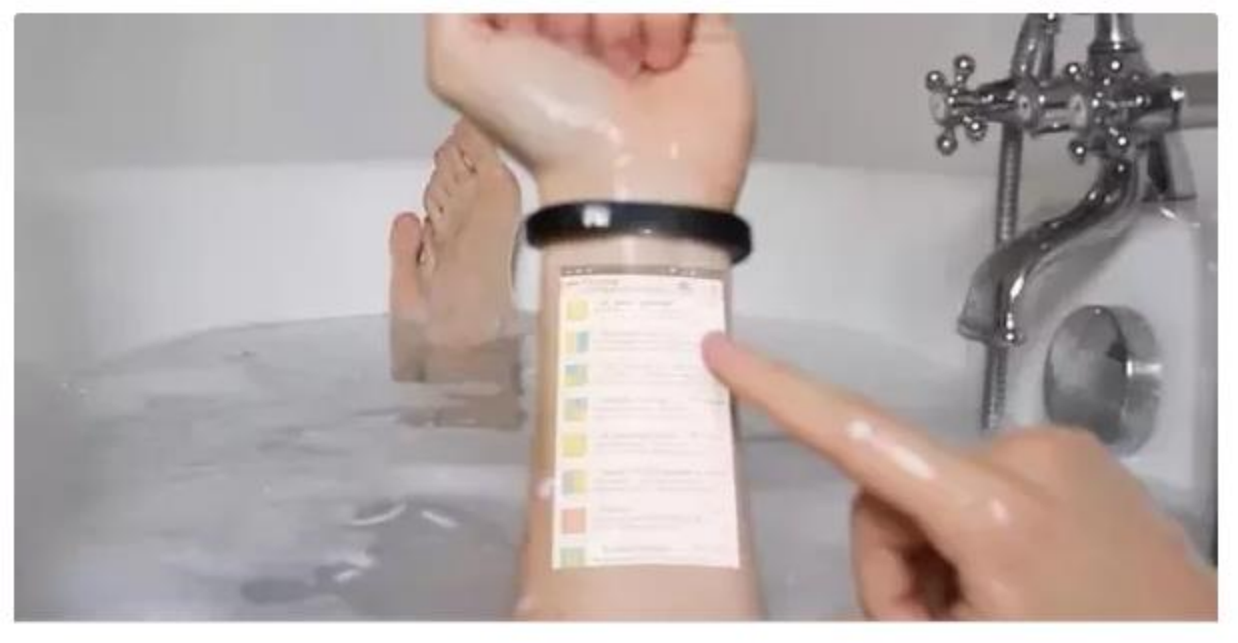
2. In context to music industry , more data sets should be prepared to provide originality (original flavour) of sound for various ACOUSTIC INSTRUMENTS like harmonium, flute etc.



FUTURE ENHANCEMENTS IN WEARABLE TECHNOLOGY



Implantable smartphones



What's up with Millenials' purchases in the next year?

Percentage of Millenials likely to purchase:

What will the wearable future look like?

52% of adults agree that automated facial recognition will replace the need to remember names

56% say life expectancy will increase on average by 10 years

42% agree that the average person's athletic ability will improve dramatically

52% say that half of all TV watching will happen on wearable screens

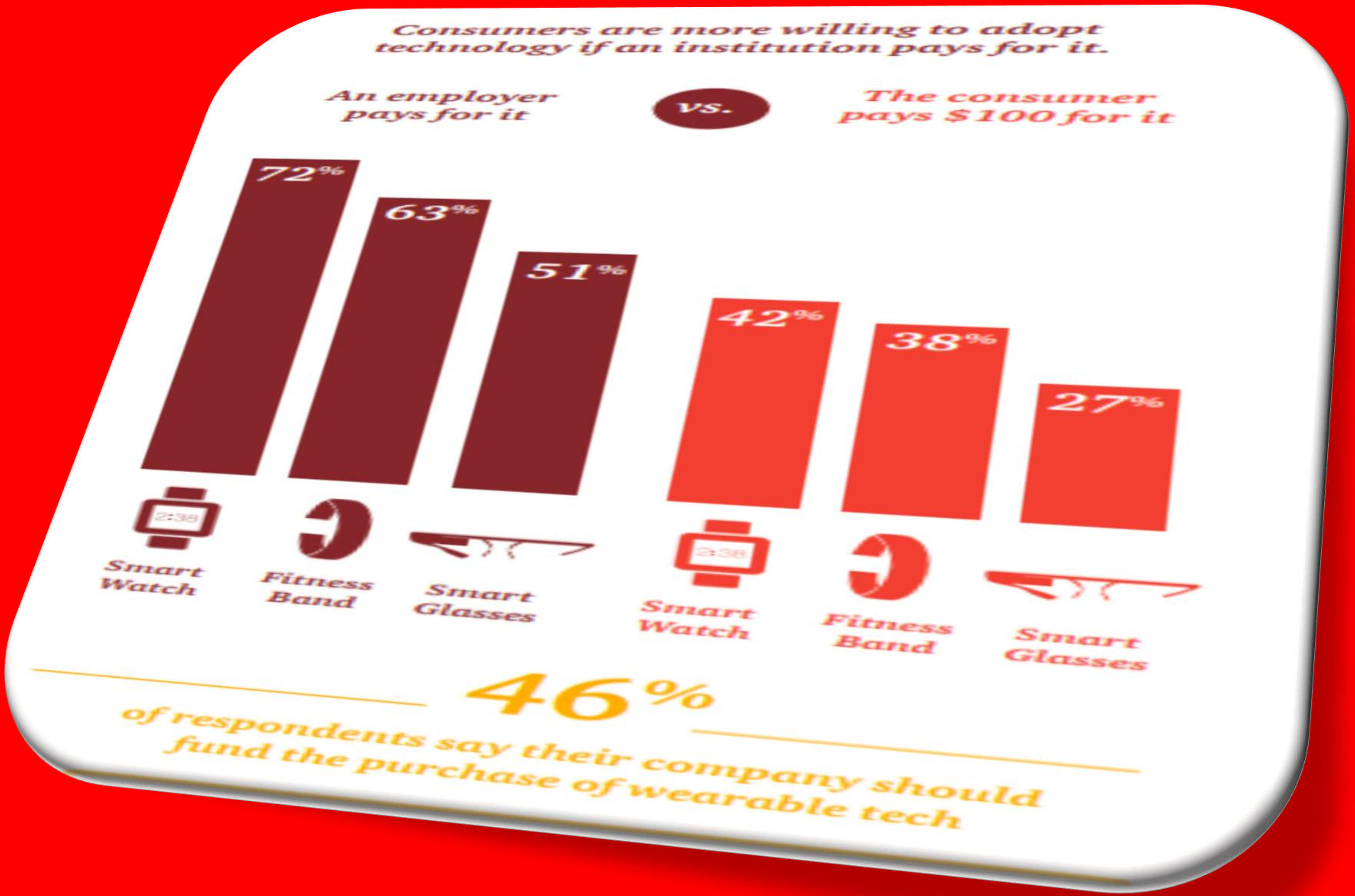
46% say obesity rates will decrease

52% agree that people will rarely have face to face conversations

57% agree that people will rely more on their wearable devices for support than they do their friends & family

55% agree that everyone will work from home/remotely at least part of the time

63% agree that work and life will become inseparable


Consumers are more willing to adopt technology if an institution pays for it.
An employer pays for it
vs.
The consumer pays $100 for it
72%
63%
51%
42%
38%
27%
Smart Watch
Fitness Band
Smart Glasses
Smart Watch
Fitness Band
Smart Glasses
46%
of respondents say their company should fund the purchase of wearable tech

Among all adults:

76% believe it's important for wearable tech to help us get more out of our time

77% believe it's important for wearable tech to make us more efficient/productive both at home and at work


Wearable tech will strengthen my connection to family and friends
Percent who agreed this is important:
General Population 72%
Millenials 83%
Early Adopters 80%

THANKS A LOT ☺