IDF16
INTEL DEVELOPER FORUM

Intel® Knowledge Builder for Intel® Curie™ Module and Intel® Quark™ SE Microcontroller

Chris Rogers
Intel® Knowledge Builder Toolkit Venture Lead, Intel Corporation

Tim Appleton
Product Marketing Engineer, Intel Corporation

intel
experience what's inside™

Agenda

- Internet of Things and Wearables
- Intel® Curie™ Module and Intel® Quark™ SE Microcontroller
- Intel® Knowledge Builder Toolkit
- Value Proposition and Business Model
- Next Steps

IDF16
INTEL DEVELOPER FORUM

Agenda

- Internet of Things and Wearables
- Intel® Curie™ Module and Intel® Quark™ SE Microcontroller
- Intel® Knowledge Builder Toolkit
- Value Proposition and Business Model
- Next Steps

IDF16
INTEL DEVELOPER FORUM

INTERNET OF THINGS: TIPPING POINT

† COST OF SENSORS **2X** PAST 10 YEARS

† COST OF BANDWIDTH **40X** PAST 10 YEARS

† COST OF PROCESSING **60X** PAST 10 YEARS

Cost reduction scenarios described are intended as examples of how a given Intel-based product, in the specified circumstances and configurations, may affect future costs and provide cost savings. Circumstances will vary. Intel does not guarantee any costs or cost reduction.

† Source: Gartner

Use Case and Business Model Innovation

Intelligent Connected Devices

Consumer

Sports

Fitness

Fashion

Makers

Education

Industrial

Home/Building Management

Retail Smart Shelving

Industrial Wearables

Smart Appliances

Industrial Automation

IDF16 INTEL DEVELOPER FORUM

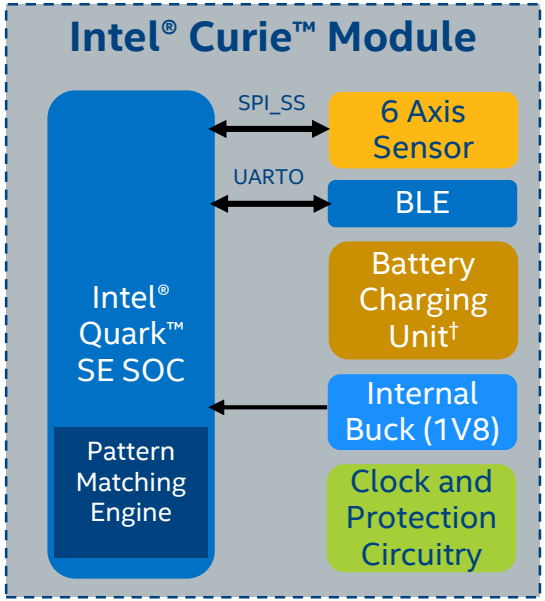
Explosion of Products and Services

Agenda

- Internet of Things and Wearables
- Intel® Curie™ Module and Intel® Quark™ SE Microcontroller
- Intel® Knowledge Builder Toolkit
- Value Proposition and Business Model
- Next Steps

IDF16
INTEL DEVELOPER FORUM

Intel® Curie™ Module and Intel® Quark™ SE Microcontroller



- 32MHz Intel Quark SE SOC
- On-Chip Flash/RAM (384kB/80kB)
- Bluetooth* Low Energy (BLE)
- Battery-Charging†
- 6-axis motion sensors: Accelerometer and Gyro
- Sensor hub processor
- **Pattern matching technology**
- Ideal for "always-on" applications

† Not included in all Intel Curie module versions

IDF16 INTEL DEVELOPER FORUM

Intel® Knowledge Builder Toolkit

Pattern Matching Model Creation

Pattern Matching Model Execution

Intel® Knowledge Builder Toolkit

Developer tool enables algorithm development for Intel® Quark™ SE pattern matching engine

Intel Quark SE Intelligent Edge Device

HW-based pattern matching engine

IDF16 INTEL DEVELOPER FORUM

Augmented Use Cases Using The Pattern Matching Engine

Industrial IOT

Example Use Case	Basic Analytics	With Pattern Matching
Industrial Worker	# of activities completed	Process compliance and repetitive or unsafe motion
Predictive Maintenance	Motor vibration threshold limits	Motor vibration spectral analysis
Motion Detection	Passive Infrared triggered (yes/no)	Motion direction, velocity, and pattern

IDF16 INTEL DEVELOPER FORUM

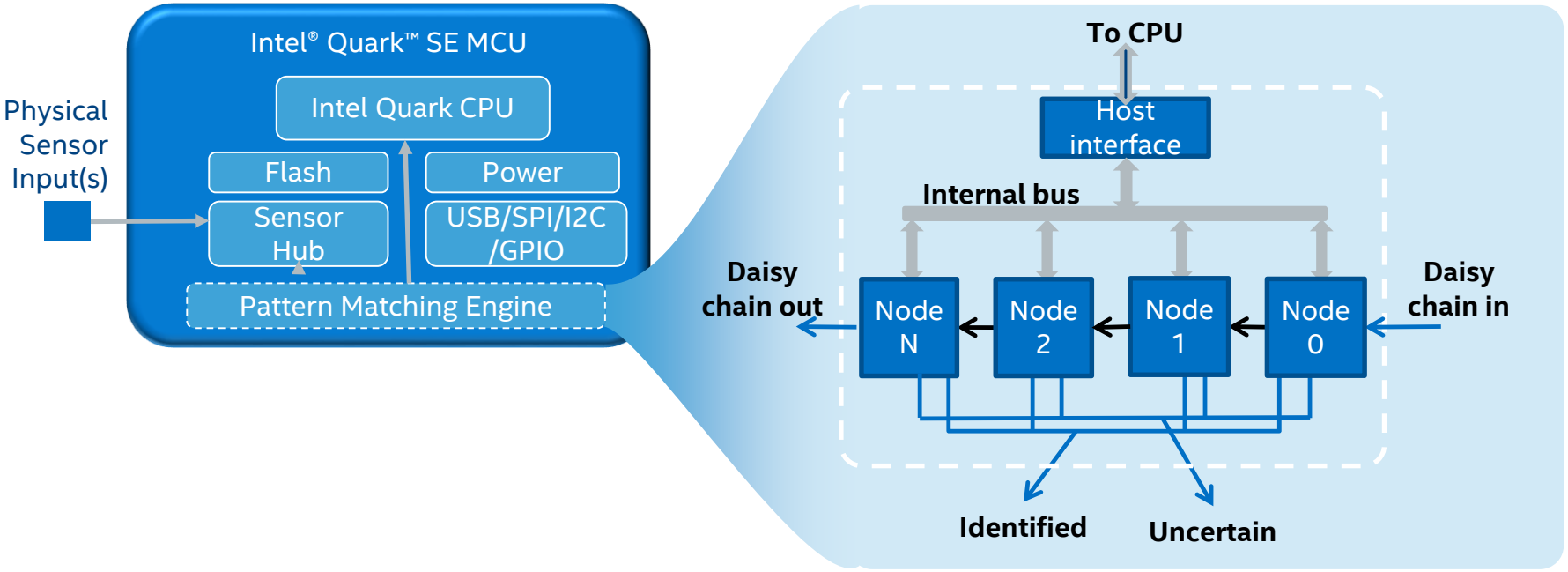
Augmented Use Cases Using The Pattern Matching Engine

Consumer Wearables

Example Use Case	Basic Analytics	With Pattern Matching
Virtual Running Coach	Speed and distance	Running form: foot strike, arm flexion, foot pronation
Action Sports	Rotation, velocity, g-force	Identify tricks in real time (back flip, Front Side 180, etc.)
Ball Sports	# of shots, velocity, etc.	Swing quality, form, shot identification
Strength Training	# of reps	Activity classification and technique analysis
Elder Care	Fall detection	Fall prediction via gate and posture analysis

IDF16 INTEL DEVELOPER FORUM

Pattern Matching Engine



Agenda

- Internet of Things and Wearables
- Intel® Curie™ Module and Intel® Quark™ SE Microcontroller
- Intel® Knowledge Builder Toolkit
- Value Proposition and Business Model
- Next Steps

IDF16
INTEL DEVELOPER FORUM

Code-Based vs Data-Driven Pattern Matching Algorithms

Hypothetical Challenge: Program a Machine to Discern an Apple From an Orange

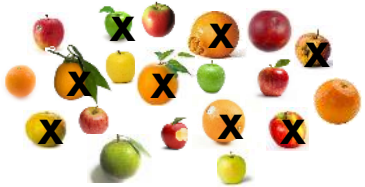
Code-Based Algorithm

Devise Model Hypothesis

Develop Code-Based Algorithm

```
switch object.color{
    case 'red'   :
    if (object.owner == 'teacher')
    { object.type = 'apple'};
    else
    {if (object.texture =='smooth')
    { object.type = 'apple'};
    else
    { object.type = 'unknown'};
    case 'orange':
    if ((object.weight>100) && (object.weight<150))
    { object.type = 'orange'};
}
```

Validate Against Representative Dataset



Data-Driven Algorithm

Collect Representative Dataset

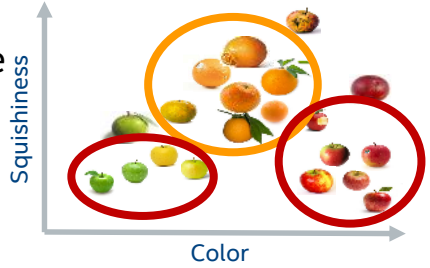
Generate Abstract Feature Candidate List

Weight	Size	Squishiness	Shininess	Fragrance
	Roundness	Color	Texture	Symmetry

Select Best Features

Squishiness | Color

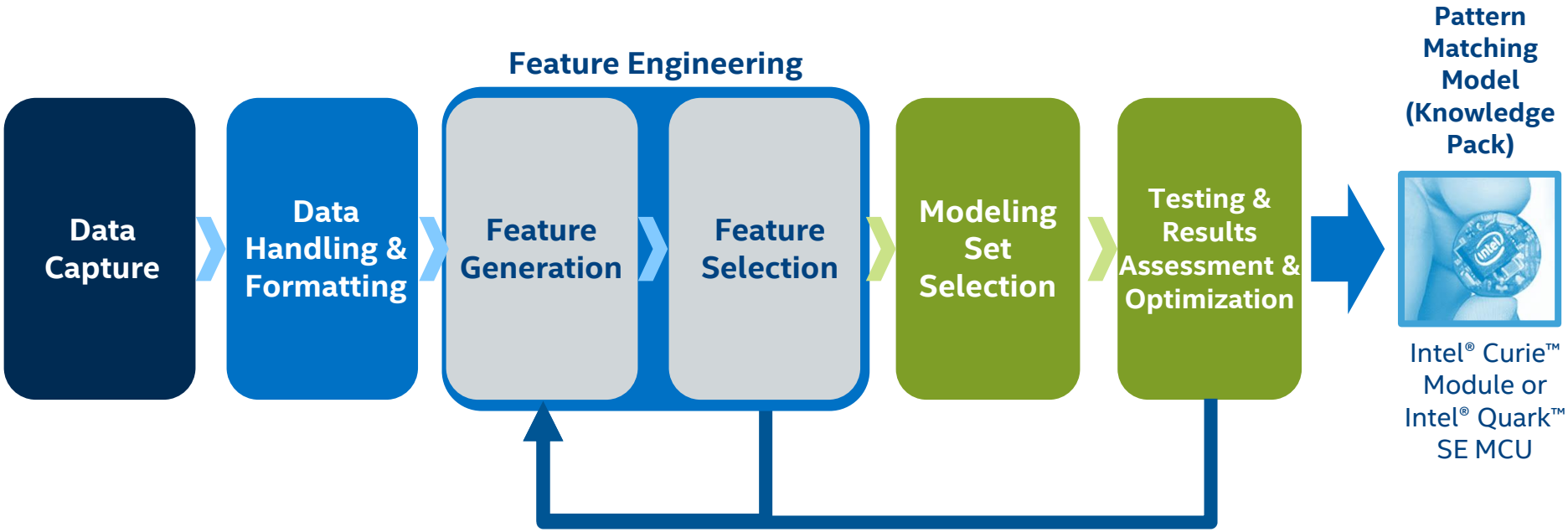
Define Node Mapping to Selected Features



IDF16 INTEL DEVELOPER FORUM

Intel® Knowledge Builder Toolkit

Development Workflow

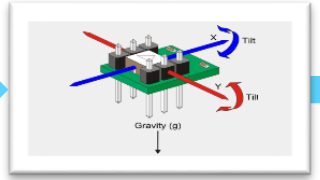


IDF16 INTEL DEVELOPER FORUM

Product Development Flow

1

2



3

4

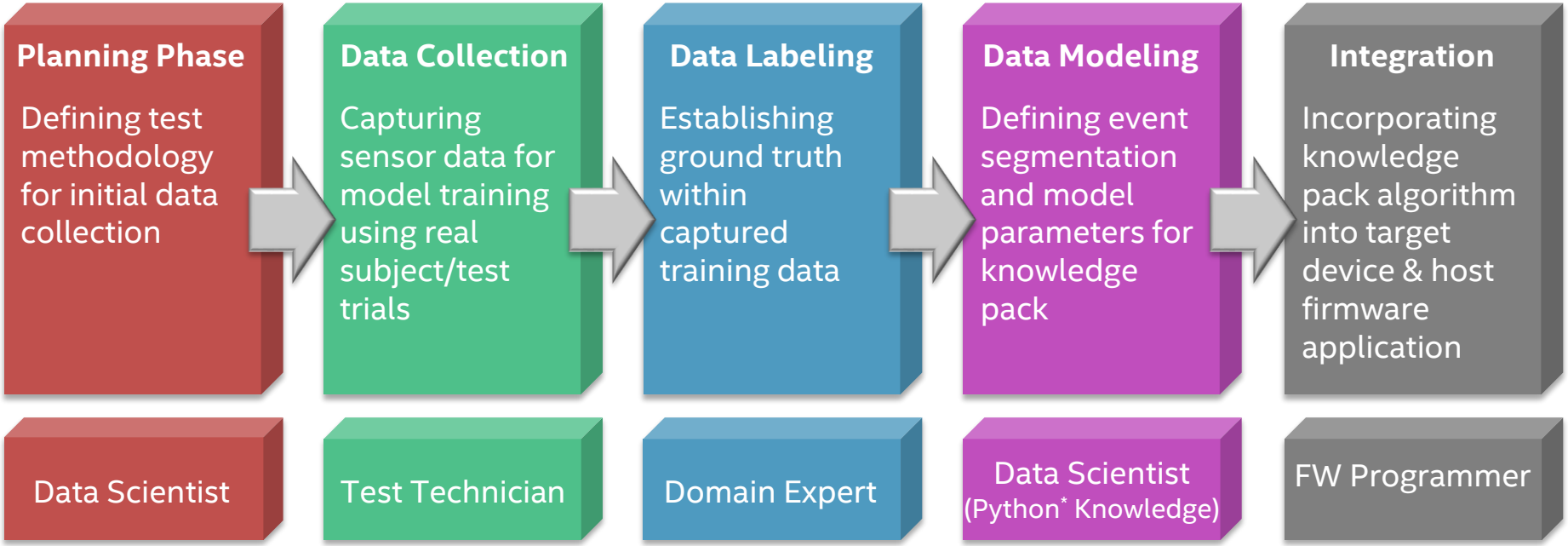
Final Product can now recognize target patterns <u>without</u> need for Cloud

1. Compact data collector placed on target device e.g., shoe → 2. Data from accelerometer or other sensor collected → 3. Intel **Cloud** tool analyses data and looks for target patterns & creates detection models → 4. Target model downloaded to Intel® Curie™ Module in device/product

Data from final product allows continuous model improvement

IDF16 INTEL DEVELOPER FORUM

Development Pipeline and Skills Needed



Agenda

- Internet of Things and Wearables
- Intel® Curie™ Module and Intel® Quark™ SE Microcontroller
- Intel® Knowledge Builder Toolkit
- Value Proposition and Business Model
- Next Steps

IDF16
INTEL DEVELOPER FORUM

Initial Development Savings†

Our Experience: Using Intel® Knowledge Builder Toolkit

Development Savings Of Up To 75%

→ 2-8 months → down to 3-8 weeks

→ 40% smaller teams

→ Automates and simplifies many Data Scientist tasks

Development Savings From Labor Costs: $165K - $550K

IDF16 INTEL DEVELOPER FORUM

† Based on experience from Intel development teams. Results may vary.

What Drives Value?

Automated Model Creation	Model Evolution	Real-time Insights On Device	Hardware-Based Accelerators

Why does that drive value?

Development cost savings ($165-$550K†)	Scalable ongoing customer relationship	Insights Happen Immediately	Speed Efficiencies
Simplified Process and Lower Risk	Product Relevancy With End Users	Insights Occur Even When Not Connected	Power Efficiencies
Time to Market Savings (2-6 months†)	New business Models for Products	Lower Network Load	Seamless Integration Hardware/Software

IDF16 INTEL DEVELOPER FORUM

† Based on experience from Intel development teams. Results may vary.

New Business Models Made Possible

Devices using Intel® Knowledge Builder Toolkit provide more accurate, meaningful, tailored user experience that improves over time.

Step Tracker

Running Coach

Personalized Insights

Multifunctional

Ongoing Impact On Product Value

IDF16 INTEL DEVELOPER FORUM

Intel® Knowledge Builder Business Model

Customer Segment	Customer Development Phase	When Customer Ships Devices	Ongoing Device Learning
Makers / Startups	**Free** Intel® Knowledge Builder Toolkit Cloud Account	**Royalty Free** Intel® Knowledge Packs on Arduino* 101 / Genuino* 101 Boards	
Consumer Wearable	**Free** Intel Knowledge Builder Toolkit Cloud Account	**Per Unit Royalty** for Activated Intel Knowledge Pack (Volume Discounted)	**Per Unit Royalty** for each OTA Updated Intel Knowledge Pack (Volume Discounted)
IoT Device OEMs			

Free access to tools during development

Developers pay only for production devices using pattern matching accelerator algorithms

IDF16 INTEL DEVELOPER FORUM

Agenda

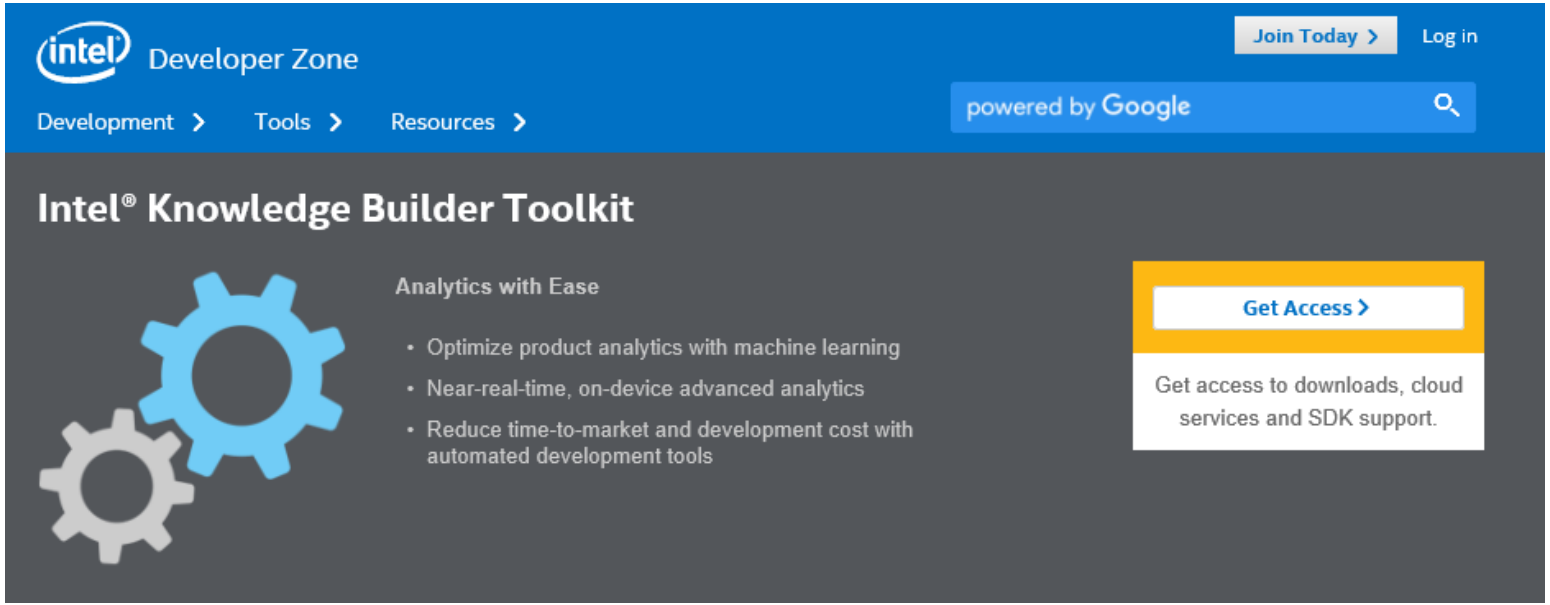
- Internet of Things and Wearables
- Intel® Curie™ Module and Intel® Quark™ SE Microcontroller
- Intel® Knowledge Builder Toolkit
- Value Proposition and Business Model
- Next Steps

IDF16
INTEL DEVELOPER FORUM

Accessing Intel® Knowledge Builder Toolkit

Begin by going to Intel® Developer Zone:

https://software.intel.com/en-us/intel-knowledge-builder-toolkit

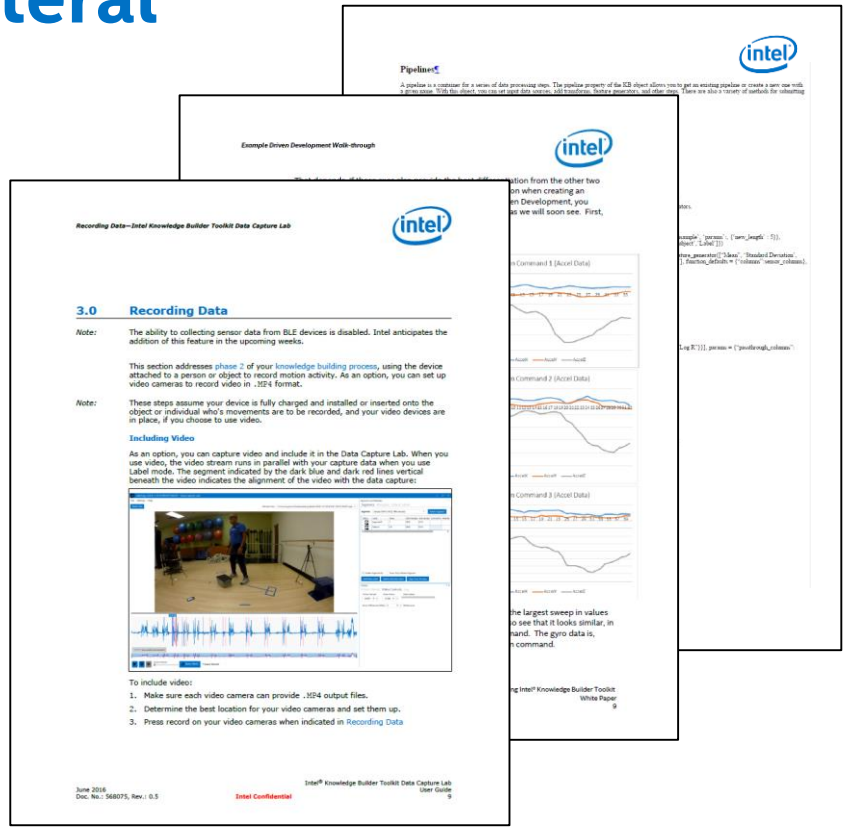


IDF16
INTEL DEVELOPER FORUM

Documentation and Collateral

Download

software.intel.com/en-us/intel-knowledge-builder-toolkit



Recording Data—Intel Knowledge Builder Toolkit Data Capture Lab

3.0 Recording Data

Note: The ability to collecting sensor data from BLE devices is disabled. Intel anticipates the addition of this feature in the upcoming weeks.

This section addresses phase 2 of your knowledge building process, using the device attached to a person or object to record motion activity. As an option, you can set up video cameras to record video in .MP4 format.

Note: These steps assume your device is fully charged and installed or inserted onto the object or individual who's movements are to be recorded, and your video devices are in place, if you choose to use video.

Including Video

As an option, you can capture video and include it in the Data Capture Lab. When you use video, the video stream runs in parallel with your capture data when you use Label mode. The segment indicated by the dark blue and dark red lines vertical beneath the video indicates the alignment of the video with the data capture:

To include video:

1. Make sure each video camera can provide .MP4 output files.
2. Determine the best location for your video cameras and set them up.
3. Press record on your video cameras when indicated in Recording Data

June 2016
Doc. No.: 568075, Rev.: 0.5
Intel Confidential
Intel® Knowledge Builder Toolkit Data Capture Lab
User Guide
9

Example Driven Development Walk-through

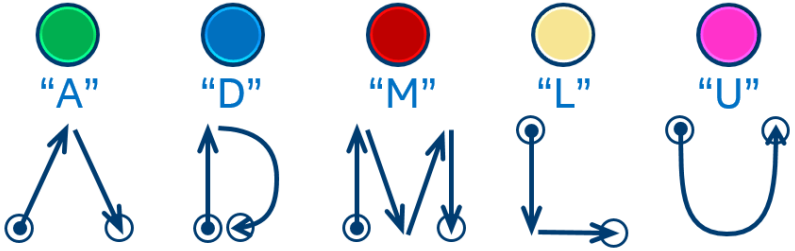
Pipelines

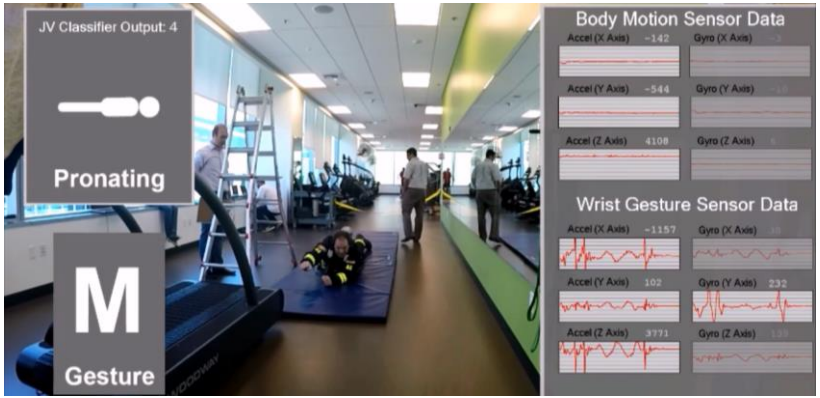
Whitepapers, User Guides, Templates, Sample Code…

IDF16 INTEL DEVELOPER FORUM

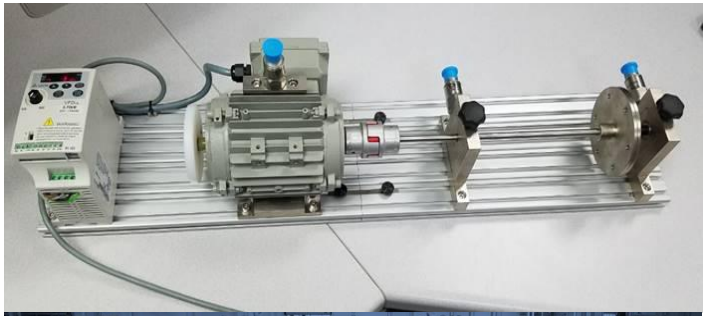
Visit the Demo Showcase

Gesture Recognition: Booth 575





Industrial Equipment Monitoring: Booth 573

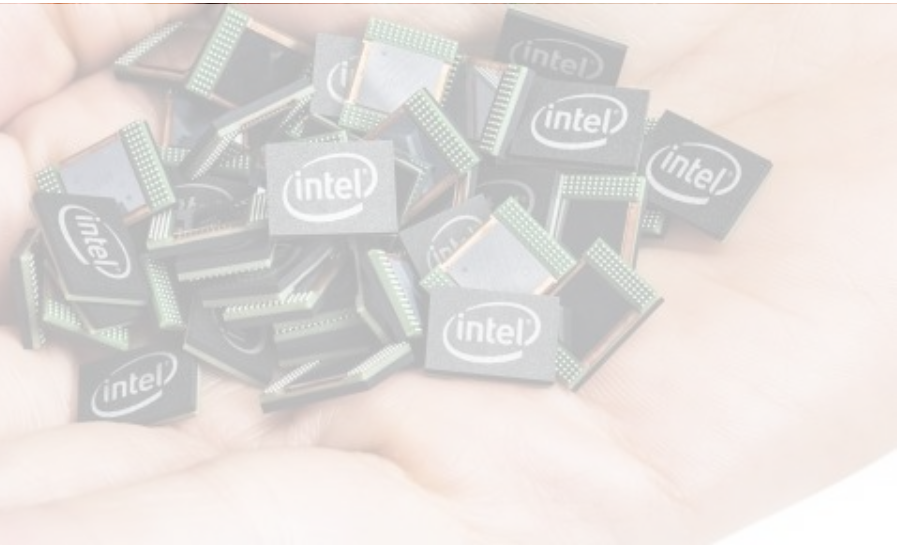


IDF16
INTEL DEVELOPER FORUM

Parting Thoughts

Key questions to ask yourself about your next industrial or consumer IOT product…

- Will my product have basic analytics or advanced analytics?
- Is my analytics development process efficient and affordable?
- Can my product easily adapt to customer demands?



Technical Sessions in New Devices & Services Track

Tuesday, August 16, 2016

11:00 AM – 12:00 PM *NDSBZ01* — Intel® Knowledge Builder for Intel® Curie™ Module and Intel® Quark™ SE Microcontroller ***Level 2 Room 2007***

1:15 PM – 2:15 PM *SOFTS02* — ChromeOS* and coreboot* on Intel® Architecture – An Engineering Primer for Developers, Partners, OEMs and ODMs ***Level 2 Room 2006***

2:30 PM – 3:30 PM *NDSTS01* — Building Intel® Curie™ Products Starting from Arduino 101* Boards ***Level 2 Room 2004***

4:00 PM – 5:00 PM *NDSTS02* — Intel® Curie™ Technology: Transforming Experiences ***Level 2 Room 2004***

4:00 PM – 5:00 PM *VRGTS04* — The Sensification of Virtual Reality Using Intel® RealSense™ Technology ***Level 2 Room 2005***

Wednesday, August 17, 2016

11:00 AM – 12:00 PM *IOTTI01* — Accelerating Innovation with Next-generation Intel® Atom™ Processor-based Platform ***Level 2 Room 2016 Tech & Business Insight***

11:00 AM – 12:00 PM *NDSTS03* — Intel® Robotics Overview ***Level 2 Room 2004***

1:15 PM – 2:15 PM *NDSTI01* — Intel® RealSense™ Technology: Adding Human-like Sensing to Devices ***Level 2 Room 2016 Tech & Business Insight***

2:30 PM – 3:30 PM *NDSTS04* — Deliver Amazing Connected Drone Experiences with the Intel® Aero Platform for UAV ***Level 2 Room 2004***

4:00 PM – 5:00 PM *NDSTS05* — Getting Started with the Intel® RealSense™ Robotic Development Kit ***Level 2 Room 2004***

Thursday, August 18, 2016

9:30 AM – 10:30 AM *IOTTS06* — Portable Particulate Matter Sensor Powered with Intel® Curie™ Module ***Level 2 Room 2008***

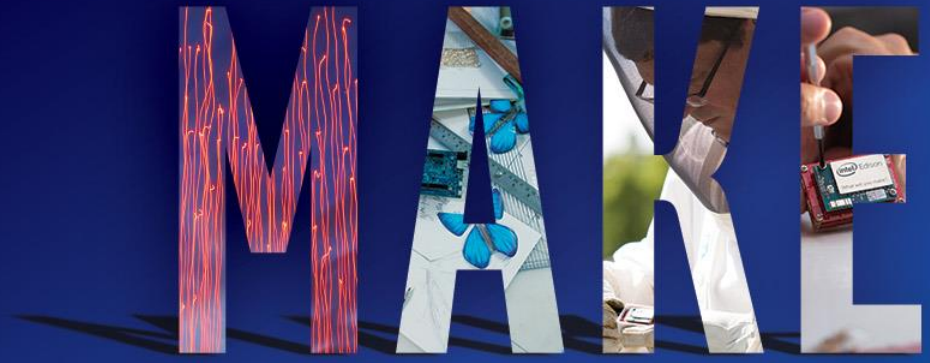
IDF16
INTEL DEVELOPER FORUM

Legal Notices and Disclaimers

- Intel technologies' features and benefits depend on system configuration and may require enabled hardware, software or service activation. Performance varies depending on system configuration. No computer system can be absolutely secure. Check with your system manufacturer or retailer or learn more at intel.com.
- Tests document performance of components on a particular test, in specific systems. Differences in hardware, software, or configuration will affect actual performance. Consult other sources of information to evaluate performance as you consider your purchase. For more complete information about performance and benchmark results, visit http://www.intel.com/performance.
- Software and workloads used in performance tests may have been optimized for performance only on Intel microprocessors. Performance tests, such as SYSmark and MobileMark, are measured using specific computer systems, components, software, operations and functions. Any change to any of those factors may cause the results to vary. You should consult other information and performance tests to assist you in fully evaluating your contemplated purchases, including the performance of that product when combined with other products. For more complete information visit http://www.intel.com/performance.
- Cost reduction scenarios described are intended as examples of how a given Intel-based product, in the specified circumstances and configurations, may affect future costs and provide cost savings. Circumstances will vary. Intel does not guarantee any costs or cost reduction.
- This document contains information on products, services and/or processes in development. All information provided here is subject to change without notice. Contact your Intel representative to obtain the latest forecast, schedule, specifications and roadmaps.
- No license (express or implied, by estoppel or otherwise) to any intellectual property rights is granted by this document.
- Statements in this document that refer to Intel's plans and expectations for the quarter, the year, and the future, are forward-looking statements that involve a number of risks and uncertainties. A detailed discussion of the factors that could affect Intel's results and plans is included in Intel's SEC filings, including the annual report on Form 10-K.
- All products, computer systems, dates and figures specified are preliminary based on current expectations, and are subject to change without notice. The products described may contain design defects or errors known as errata which may cause the product to deviate from published specifications. Current characterized errata are available on request.
- Intel does not control or audit third-party benchmark data or the web sites referenced in this document. You should visit the referenced web site and confirm whether referenced data are accurate.
- © 2016 Intel Corporation. Intel, the Intel logo, Curie, Quark and others are trademarks of Intel Corporation in the U.S. and/or other countries.
- † Development cost savings have been estimated by Intel analytics and embedded device developers based on their personal development experience using standard tools alone compared to having Intel® Knowledge Builder Toolkit. Activities included in the analysis include data collection, algorithm development, C Code programming, and algorithm testing. Estimated savings include costs associated with 11 weeks of reduced development time based on typical embedded developer and analytics developer labor rates in the US.
- *Other names and brands may be claimed as the property of others.

IDF16 INTEL DEVELOPER FORUM

THE FUTURE IS WHAT YOU



IDF16 INTEL DEVELOPER FORUM