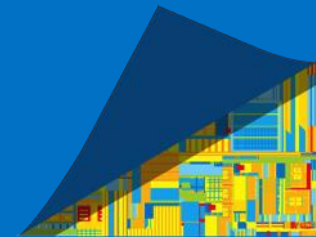
Future of Mobility – Visioning the Future

Mobile Communications Group



Mobile Devices – the last Decade

Smartphones and tablets became ubiquitous

Enabled Everyday, Always-On, Always-Connected usages we could not fathom in the 90s:

- HD multimedia capture and playback
- Personal navigation
- Rich gaming experiences
- Social media and multimedia messaging
- mCommerce

We are on the cusp of the next epoch in mobility innovations …

Picture Credits: LetsGoDigital, DigitalTrends, dougdivetre.com, Gadgetreview

Drivers for the Next Epoch: Perceptual Computing

Our devices understand our intentions in a more natural way than more traditional forms of input such as keyboard and mouse

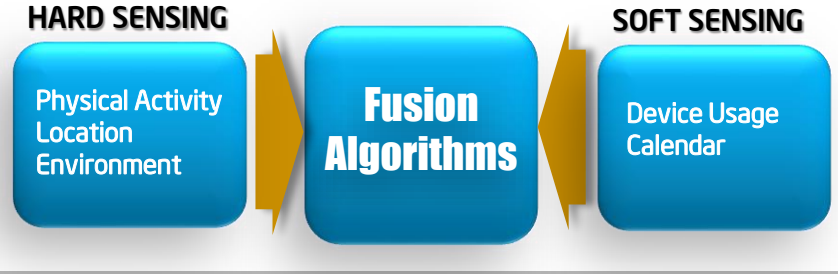
- distance and movement
- face/object recognition
- Gesture recognition
- Audio
- Augmented Reality

Enablers:

- Multiple HD cameras
- Digital audio processing
- Sensors
- Low-power wireless
- Platform SW for real-time A/V processing

http://www.intel.com/content/www/us/en/architecture-and-technology/perceptual-overview.html

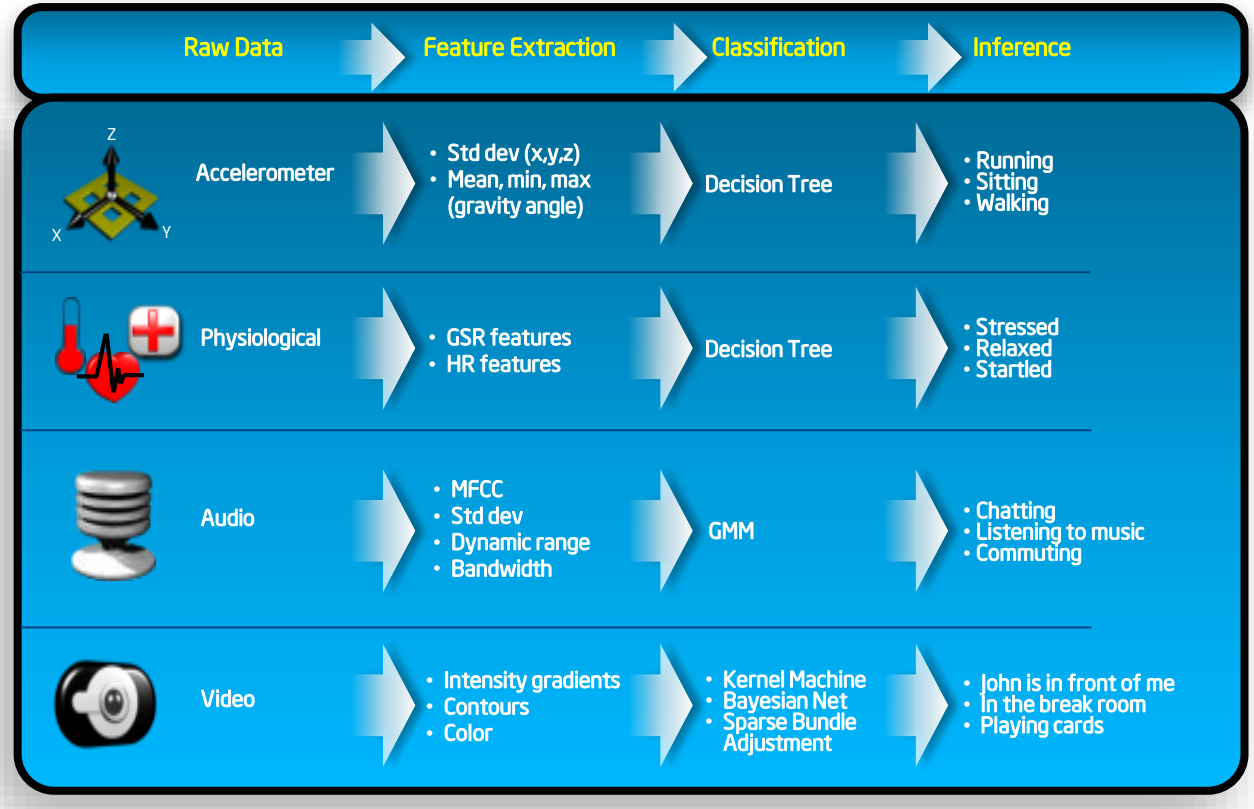
Drivers for the Next Epoch: Contextual Sensing



Enablers:

- Always-on, ultra low power sensing and I/O
- Effective workload partitioning
- Context primitives

From Sensors to Inferred Context



Drivers for the Next Epoch: Device Ensembles

Wearables: watches, glasses, bracelets, woven in fabrics, in shoes and helmets …

Ingestible and In-Body Devices(IBD)

Device Ensembles: Phones and tablets as hubs for multi-point proximity networks with wearables and IBDs

Enables new usages that go beyond inertial and basic contextual sensing.

Picture Credits: Google, Jawbone, Fitbit, Nike, Proteus DH, InformationWeek

An Example Usage Domain: Quantified Self

- Quantify and visualize a person's behavioral and biological state via wearable/portable sensing and analytics technologies
- Enable an end-user to manage everyday wellness by measuring physiological state anywhere
- Enable an end-user to manage wellness and disease via simple bio-chemical sensing

Enablers:

- Wearable bio-substrates & device ensembles
- Advanced Bio-Sensors
- Analytics

Quantified Self (QS) Usages

Themes: Awareness - Wellness - Disease Management - Sports

Infants/kids

Continuous body temperature, urination (when to change diaper), milk intake (by weight) and sleep and crying cycles, dehydration, sneezing/coughing, developmental milestones. **Special Care:** Seizures, Autistic kids

Adults

Wellness: Vital Signs + health indicators (BG, Cholesterol, urine analysis) + physical attributes (body stiffness, muscular strength, lung capacity), Fitness level, Pain, severity of cold, coughs/sneezes
Lifestyle: Sleep Quality, Stress, Physical Activity, Hygiene (freshness of breath), Allergens
Disease Management: Cardiovascular, Diabetes, Respiratory Diseases, Sleep Apnea, Arthritis
Women's Health: Ovulation/fertility cycle, Hot Flushes, menopausal symptoms, bone density (indirect indicators), skin quality / fairness

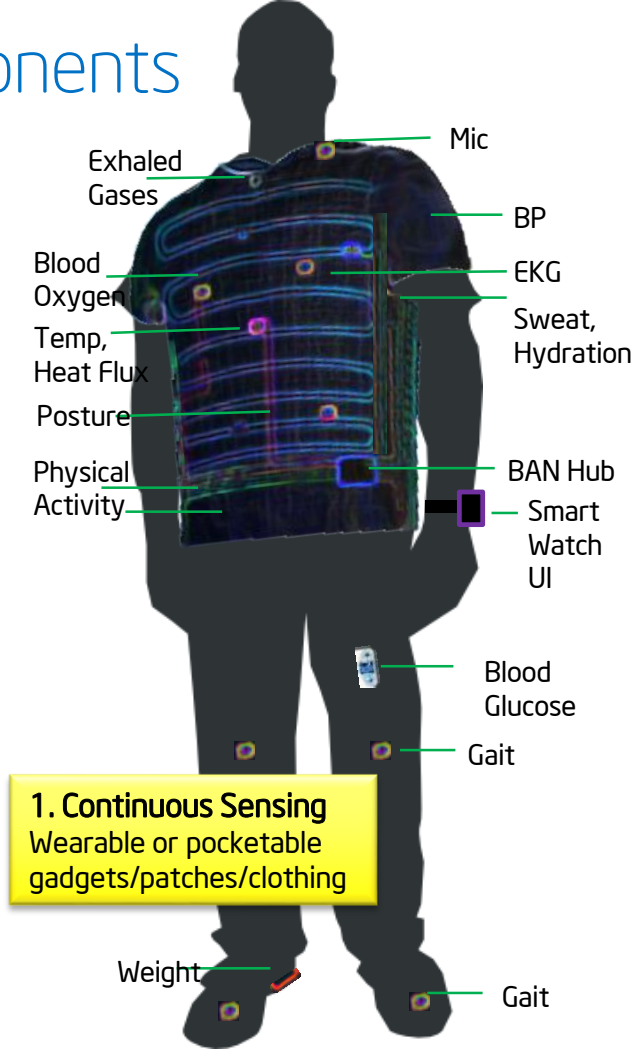
Elderly

Vital signs + health parameters, urination & frequency, medication alerts, limb tremors, gait, fall detection, hydration level, food intake, sleep quality, vision, hearing

Sports

Vital signs, Fitness level, hydration/sweating, respiratory capacity, muscular strength, stamina, temperature, fatigue

QS Components



1. Continuous Sensing
Wearable or pocketable gadgets/patches/clothing

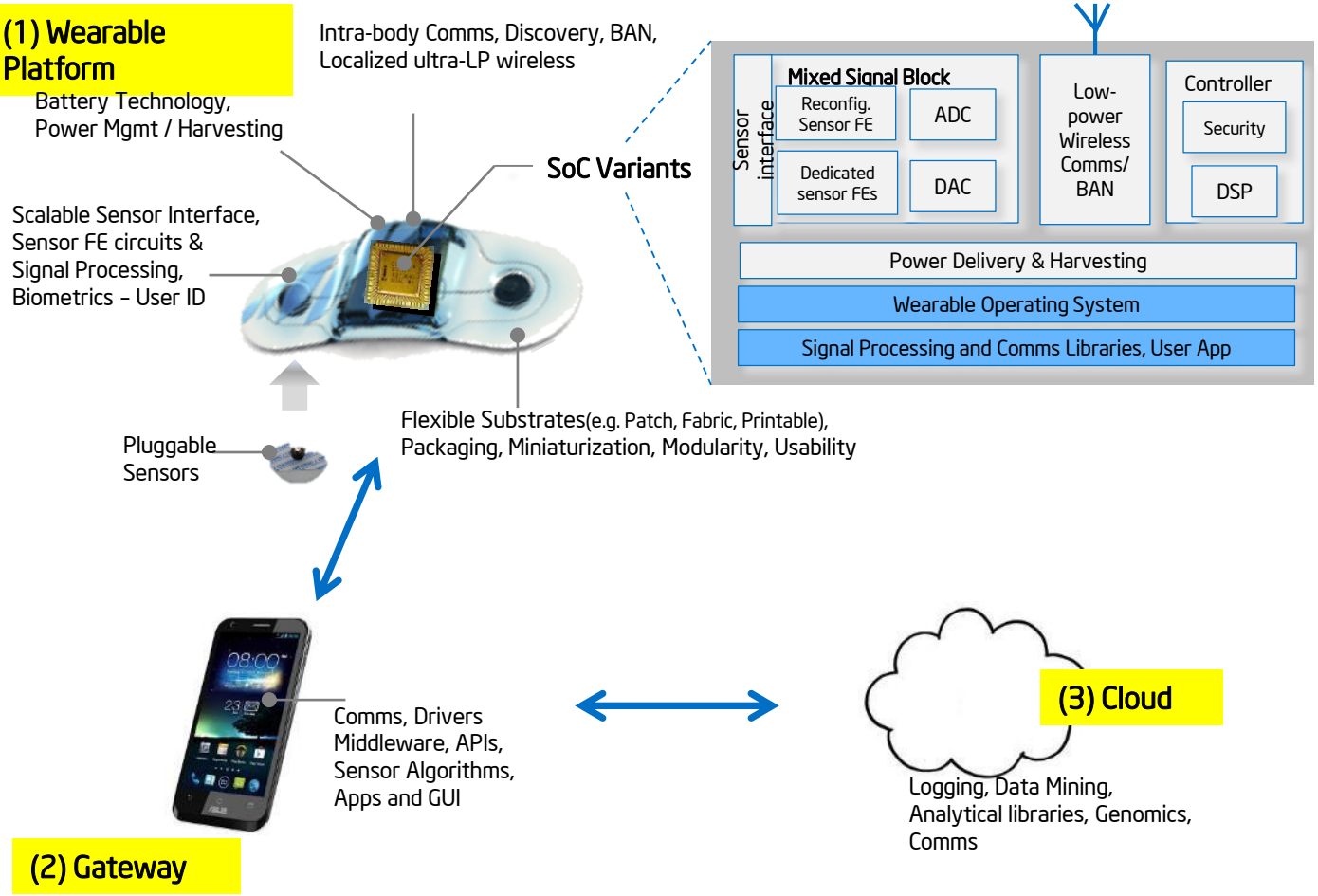
2. Spot Check
Home Self-tests
- *Blood Pressure, Weight, Fat%*
- *Glucose, Cholesterol, Lipids, Urine Tests*
- *Skin tone, Images*
- *Specialty Biosensors, MEMS, Microfluidics*

Gateway + Local Analytics

Advanced Analytics
- *Interesting patterns and correlations*
- *Historical review*
- *Peer-group comparison*
- *Insights and recommendation*

3. Manual Log
- *Lab reports*
- *Food Intake*
- *Emotional states*
- *Symptoms*
- *Pain*

Example E2E Embodiment



This is just the beginning … Significant research and enabling challenges/opportunities lie ahead …

Research Challenges

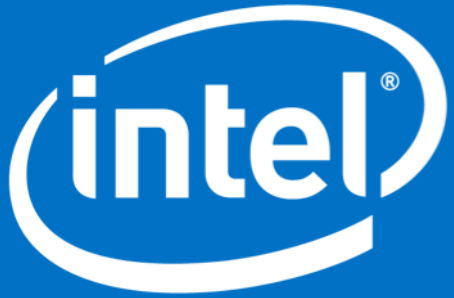
- Device ensembles
  - Ultra-low power, short range radios
  - Interoperable, reconfigurable, proximity-based M2M communication protocols
  - Security framework: discovery, pairing, multi-factor authentication, ultra-low power continuous encryption, access control that works across IBDs, wearables and phones/tablets
  - IO and compute sharing among devices
- Sensing and Analytics
  - Machine learning, data fusion, classification and inference algorithms
  - Fusing local real-time analytics with cloud based analytics

Enabling Challenges

- Device ensembles
  - User Experience – intuitive to manage policies discover and interact with
  - Integrating bio-sensors
  - Energy harvesting for wearables and IBDs
  - Integrate silo'ed devices with new standards-based M2M frameworks – radio, protocols
- Sensing and analytics
  - Interoperable cloud-based backend analytics and fusion with local hub-based analytics
- Debug
- Device form-factors and packaging

Call to Action

- Rally around key life-changing usages enabled by perceptual computing, contextual sensing and proximity-based device ensembles
- Collaborate on standards where interoperability is required
- Build partnerships to deploy services
- Innovate in core new technologies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