Current trends for hardware and software developers

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12 Billion
ARM based chips shipped in 2014 by leading semiconductor companies
Everything Connected

4 Billion
ARM Cortex-M chips shipped in 2014 by leading semiconductor companies

MCUs
radios
sensors
Wide innovation today on Cortex-M
Richer experiences on Cortex-A
Democratizing technology

- Raspberry Pi based “Astro Pi” project
- School children’s experiments to run in space
- Astronaut Tim Peake & UK space organizations
- Joins international Space Station (ISS) in 2016
Choice
“Internet of Things”
IoT Evolution in your business

1. **Monitoring**
   - Sensors and external data sources enable the comprehensive monitoring of:
     - the product’s condition
     - the external environment
     - the product’s operation and usage
   - Monitoring also enables alerts and notifications of changes

2. **Control**
   - Software embedded in the product or in the product cloud enables:
     - Control of product functions
     - Personalization of the user experience

3. **Optimization**
   - Monitoring and control capabilities enable algorithms that optimize product operation and use in order to:
     - Enhance product performance
     - Allow predictive diagnostics, service, and repair

4. **Autonomy**
   - Combining monitoring, control, and optimization allows:
     - Autonomous product operation
     - Self-coordination of operation with other products and systems
     - Autonomous product enhancement and personalization
     - Self-diagnosis and service

[Source: HBR]
Hardware trends
Expanding the Connected Experience
Doing More With Your Smartphone

- SIM
- Sensor hub
- Touch controller
- Bluetooth, WiFi and FM
- Power management
- Memory module
- Camera ISP
- Modem
- GPS
- Audio hub
- Application processor
- NFC
- SIM
Expanding the Connected Experience

Improving Your Lifestyle Through Smart “Appcessories”

Wireless connectivity
Camera ISP
Digital motion processor
Multiple sensors
Application processor
Video transmitter
Autopilot
GPS with compass
Multiple sensors
Application processor
Bluetooth
Sensor hub
Memory module
NFC
Audio hub
Power management
Sensor hub
Touch Controller
Application processor
Audio hub
Touch Controller
NFC
Audio hub
Power management
Sensor hub
Application processor
Bluetooth
Sensor hub
Memory module
NFC
Audio hub
Power management
Sensor hub
Touch Controller
Application processor
Bluetooth
Sensor hub
Memory module
NFC
Audio hub
Power management
Sensor hub
Touch Controller
Application processor
Bluetooth
Sensor hub
Memory module
NFC
Audio hub
Power management
Sensor hub
Touch Controller
Wearable Market

Wearables

Deeply Embedded
- Embedded OS

Tethered Embedded
- Always Aware, Lowest Power

Companion Devices
- High-efficiency Performance, constrained power budget

Standalone Devices
- Rich OS

Peripheral

Autonomous Compute
Expanding the Connected Experience
Enhancing Life With a Smarter Home

Communications
- Broadband modem
- Wireless router
- Home data gateway
- VOIP gateway
- VOIP phone

Home entertainment
- Smart TV
- Set top box
- Wireless speakers
- Blu-Ray/DVD player
- Streaming media player
- Digital cameras
- Digital picture frames

Appliances
- Refrigerator
- Clothes washer
- Clothes dryer
- Cooktop/oven
- Dishwasher
- HVAC
- Water heater
- Vacuum cleaners

Safety and security
- Security system
- Camera surveillance
- Smoke detectors
- CO detectors
- Motion detectors
- Door and window sensors

Convenience
- Door locks
- Windows and blinds
- Lighting
- Smart energy meter
- Thermostat
- Power outlets
- Vacuum cleaner
- Irrigation sensing and control
Smart, Connected Hardware Driving Innovation in Home

Expanding possibilities of hardware accelerating the smart home

50 ARM-based chips in average smart home in 2020*

*ARM estimates
Expanding the Connected Experience
Making Your Car Do More For You

Vehicle systems
- Engine control
- Throttle control
- Transmission control
- Adaptive suspension
- Active steering
- Anti-lock braking
- Battery management
- Passenger airbags
- Tire pressure monitoring
- Immobilizer and alarms
- Telematics
- Communication gateway

Driver cockpit
- Instrument cluster
- Heads-up display
- Infotainment
- Drowsy driver detection
- Audio control
- Climate control

Advanced driver assistance
- Back up camera
- Blind spot detection
- 360 surround view
- Automatic parking
- Automatic braking
- Lane keeping
- Pedestrian and sign recognition

Convenience features
- Keyless entry and remote start
- Mirror control
- Power windows
- Seat comfort and adjustment
- Motorized trunks lift gates
- Interior lighting
- Rear seat entertainment
- Wipers
Automotive Architectures

- NHTSA mandates rear camera for 2018 and is considering mandate for V2V and V2I by 2017
- Nissan CEO, Carlos Ghosn vows to have fully driverless car on sale by 2020
- Self driving technology is a priority for automakers
- This disruption is creating demand for complex SoC

Disruption: Complexity explosion for ADAS & IVI

- Current Architectures
- Centralization
- Integration
- Modular

- Vehicle Cloud Computing
  - Cloud computing supplements embedded computing
  - Fusion of all DCUs in one centralized vehicle computer
  - Melted of domains, fusion of DCUs
  - Centralized Domain Control Units (DCUs)
  - Standardization of basic controller
  - Merging of ECUs, integration of HW & SW into existing ECUs
  - Each function has his own ECU (“One function – one Box”)

Source: Bosch
ARM Ecosystem is Driving Automotive Technology Leadership

- **Vehicle Sensor Fusion** (vehicle context to environment)
  - Analyzing the multitudes of sensor data: Camera, Radar, Ultrasonic, GPS, V2V, and V2I.
  - Similar to sensor hubs in mobile devices creating “contextual awareness”
  - Key building block to robust, fail-functional, autonomous driving

- **Passenger Contextual Awareness** (occupant context to vehicle)
  - Vehicle that anticipates your needs by listening and seeing
  - Microphones = “the ears of the car”
    - always-on voice-recognition
  - Interior camera = “the eyes of the car”
    - Facial / occupant recognition to optimize the vehicle to your likes.

- **Advanced Gateway** “heart of the car”
  - Gateway is at the “heart” of the vehicles enabling distribution of information.
  - “Data” like “life blood” moves from module to module enabling both embedded and cloud computing.
  - Gateway is central to providing FOTA software updates that will allow carmakers to upgrade software in the field just as smartphones get OS updates.
Retail - Smart displays/tags

1. Dynamic Central Software lets you create and update your ESLs across your entire retail estate in seconds.

2. A Dynamic Communicator sits discreetly in store delivering optimised and secure two-way communication between the ESLs and HQ.

3. With extensive design options and a wide range of ESLs to choose from, displaying accurate and impactful price, product and marketing messages on your shelf edge has never been easier.

4. With Bluetooth beacons built-in to the ESLs, deliver personalised, relevant messages straight to your customer in store.

Our ESLs

BLE Beacons
Location - Beacons

Great radio performance

Great APIs for developers

Deep user understanding
Hospitality & Entertainment

**AC/Heating:**
Can turn on/off when an individual is on their way to the office/hotel room etc. Knows personal preferences, user’s location and even weather forecast.

**Security:**
Keyless door locks that send a text message when activated. Choose who has access and record entry/exit logs.

**Lighting:**
Lights that smartly switch on/off when there’s movement in a room. They could predict the average time a bulb will last, and sense when bulbs have blown, thus ordering replacements online.

**Cars:**
Individual gets into car, searches for hotel on GPS navigation, books hotel through navigation and car key provides room key access.

**Fridges:**
Can detect what kinds of products are being stored inside, and keep a track of stock through barcode or RFID scanning. They can determine when foods need to be replenished and order more online.

**Coffee Machines:**
They can track the preferences of customers, digitally update recipes, and help baristas remotely monitor the performance of the machine.
Airbus has incorporated innovative digital tracking and monitoring RFID technology to help streamline and increase the efficiency of its industrial operations. Airbus can track and visualize its production processes in real-time. RFID component tracking and machine vision systems using National Instruments / Cortex-A based SBCs

Source: Airbus / National Instruments
Software algorithms in hardware – eg. Teradeep

We use the latest machine-learning algorithms with efficient implementation in software and hardware. Our main scientific tool are multi-layered neural networks.

These network are composed of multiple layers of processing. Each layer performs: feature extraction with filter templates, reduction of input resolution, non-linear operations.
Long tail of “IoT” devices
Hardware platforms – the new gold rush
Software trends
Security hacks are having corporate wide impact & is discussed all the way in board meetings. While enterprises try to secure their current assets, they’re vary about adding “new threats.” IoT solutions need to address these concerns about network security as well as customer privacy.
The era of the platforms…

1990s
- Devices

2000s
- Architectures

2010s
- Platforms
Software

- MCU/MPUs
- radios
- sensors

C / C++
mbed
yocto

Android
JS
node
Java
ARM
Celebrating 5 years of Open Source Engineering on ARM

**24TB**
data from June 2014 - May 2015
615,000 downloads from >100 countries

**16 Connects**
14 Cities on 3 continents

**1,141,014**
minutes of videos showing demos, talks and training sessions watched

**220 Engineers**
from seed of twenty

**11,589**
patches upstream since 2011

**50,217**
Wiki pages

**>50**
Monthly Software Releases

**>1 Million**
website users

**4,410**
gallons consumed at Linaro Connects

**#3**
company contributor for
Linux Kernels 3.11 - 3.18

www.linaro.org
www.96boards.org

"The ARM situation has just improved tremendously over the last several years. It used to be a major pain to me, it has gone to almost being entirely painless."

- Linus Torvalds
May 2015

Note:
Linus Torvalds image from Linus Foundation. Icons made by theeplk. Logos & trademarks remain the property of their respective owners and represent a range of products and services supported by Linaro.
Getting “things” online…

End-to-End Security, Web, Data Objects & Management

Little Data

ARM mbed™
IoT Device Platform

BIG DATA
mbed Ecosystem

- Partners
- Developers
- Enabled Services
- Enabled Products

mbed Device Server

Free and commercial versions
Application data and device management
Growth market access for cloud platforms and operators

mbed OS

Free & open source for ARM
Leading connectivity standards
Productivity, minimized costs
Built-in device management
Security
135,000+ developers

100+ mbed Enabled products
Anything that could be connected, will be…

- **Right-size processing for new markets**
- **Delivering more performance with less power**
- **Delivering the time and innovation advantage**

Environmental | Energy Grid | Home Automation | Identity & Tracking | Logistics & Shipping | Building Management | Connected Car | Social & Local | Healthcare
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Farming | Energy Grid | Home Automation | Identity & Tracking | Logistics & Shipping | Building Management | Connected Car | Social & Local | Healthcare

Thank you! @vrajeshio