

Little things are going to make a big difference

Will Tu
Embedded Segment Marketing Director

Connected Intelligence



Smart energy
Power management
Servers
Industrial appliances

Human interface
Location aware
MEMS sensors



Health
Fitness
Medical devices

Smart homes
Security
Safety
Automotive
Electric vehicles



Sensing, processing, controlling, automating, communicating, connecting

ARM in IoT Spans Sensors to Servers

Infrastructure

Servers, network infrastructure

ARM Cortex®-A processors

Gateways

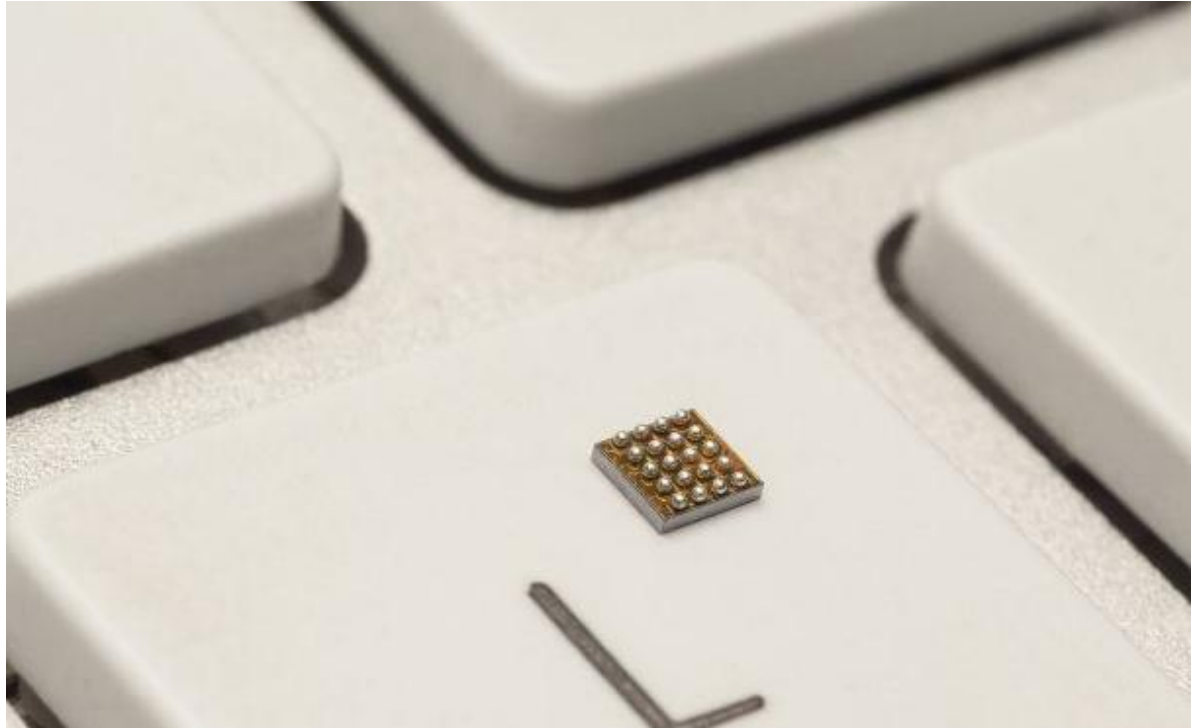
Cell modems & rich edge products

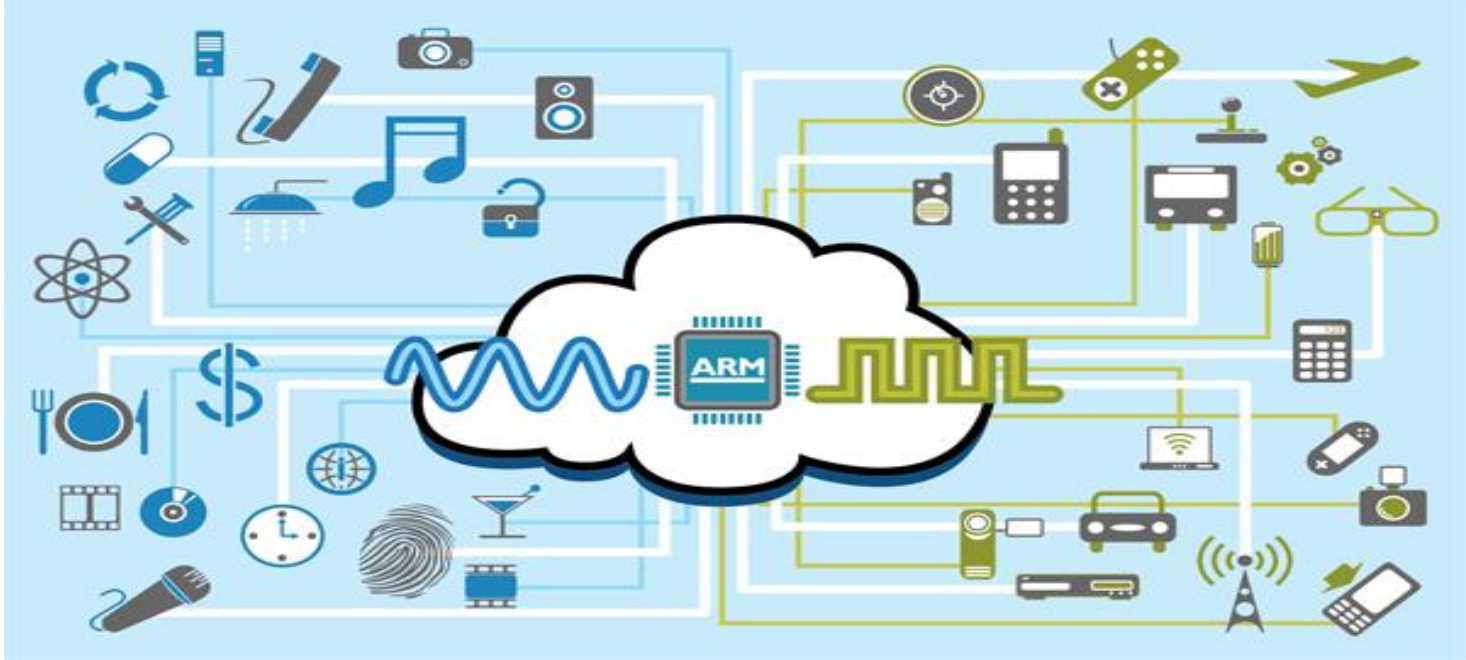
ARM Cortex-R & Cortex-A processors

Smart sensor nodes

microcontroller + sensors + RF

ARM Cortex-M





Are you ready for the Opportunity for Analog in the Internet of Things?

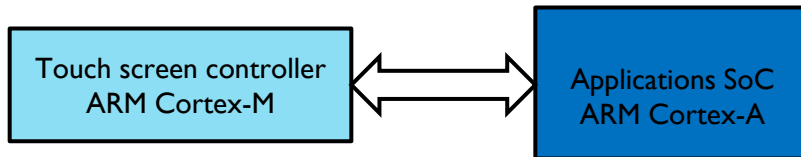
Sensors: Big Data Starts with Little Data

Bringing context awareness to products

- Sensor fusion requires intelligence at the node
- Awareness of user Identity, location, time, activity
- Bringing context to otherwise 'flat' big-data

More efficient systems, more accurate data

- Corroboration of multiple sensor sources
- Digital pre-processing and communication
- Minimize communication activity and bandwidth
- Wake host processor only when necessary



ST LIS331EB smart motion sensor
3-axis sensor-fusion accelerometer
ARM Cortex-M0 Processor



Cypress TrueTouch
Noise immune multi-touch sensor
ARM Cortex-M Processor

Sensor fusion based systems set to grow from 400M units in 2012 to over 2.5 billion units in 2016
– Semico Research

Challenges

Low power
Battery-powered
applications



**Drive for smaller
form factors**
Digital integration on
analog friendly
CMOS nodes 130nm
or greater

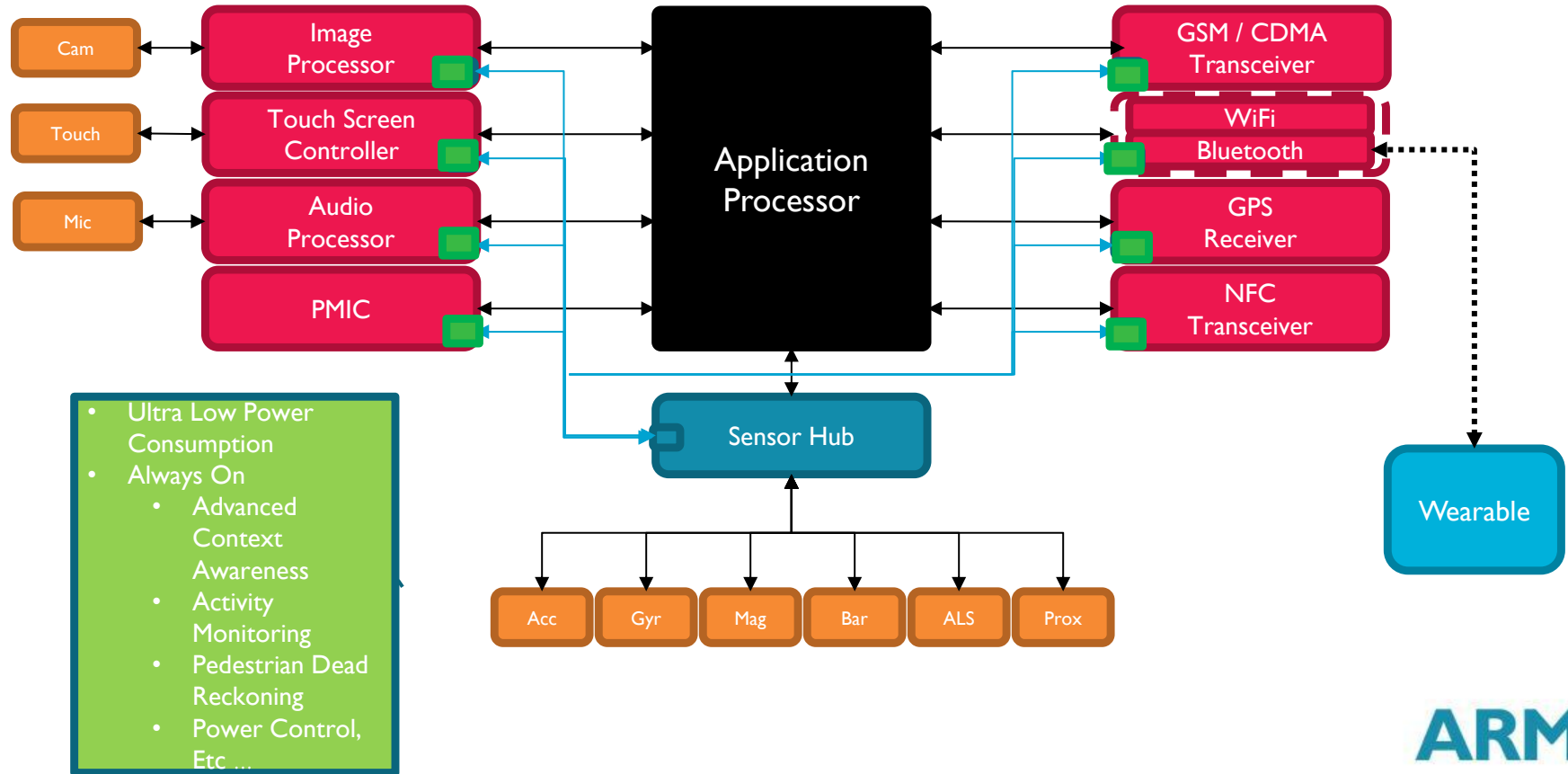
Cost pressures
Die size
Manufacturing
options (fabless,
fab-lite)



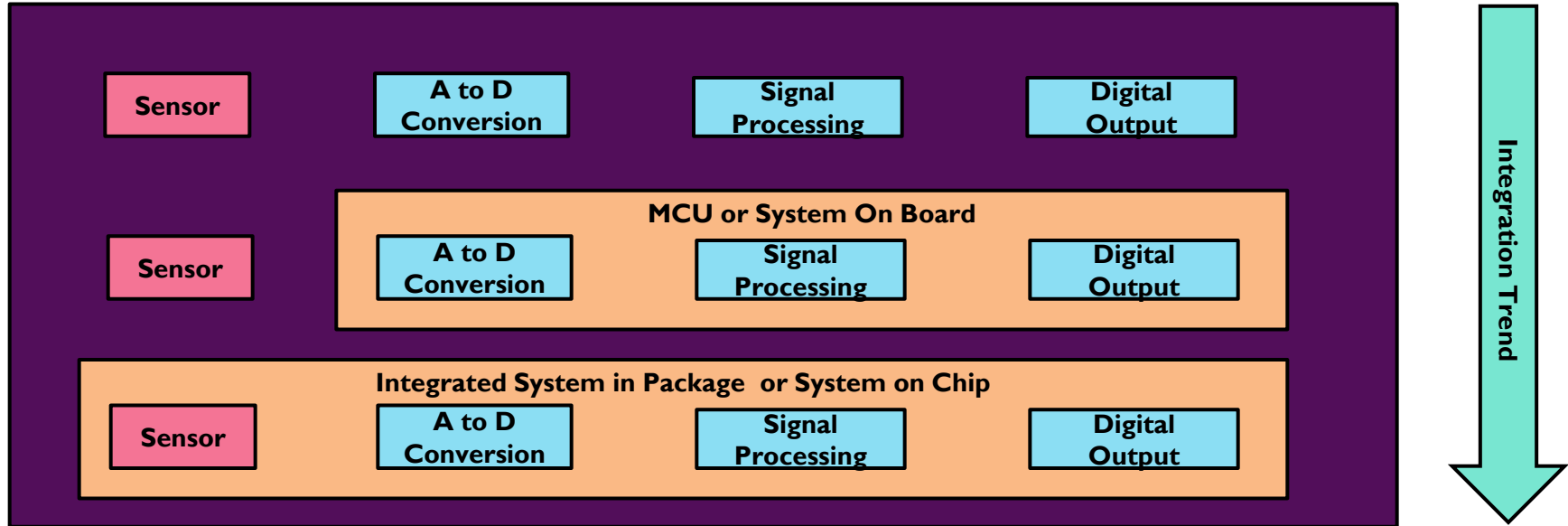
**Time to
Market**
Ecosystems

**CPU
familiarity**
Performance
Libraries
Scalability

Distributed Sensor Hub Block Diagram



MEMS Sensor Evolution



The Right Processor For the Task

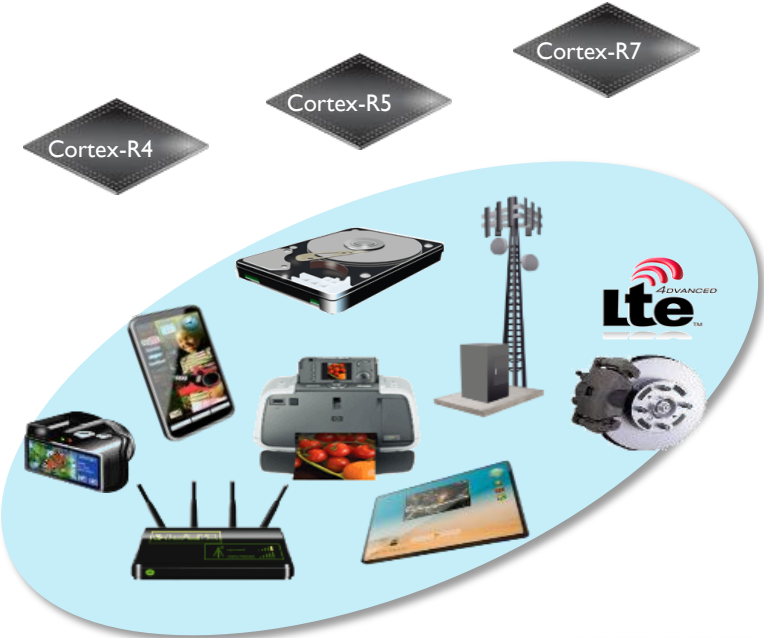


Cortex-M0+

Cortex-M0

Cortex-M3

Cortex-M4



Cortex-R4

Cortex-R5

Cortex-R7

Advanced
Lte

ARM

Affordable Intelligent Control

- Picking the right Cortex-M processor:
 - Sensors, security systems, controllers
 - Heating Ventilation Air Conditioning control
 - Radio communications, health and fitness, medical devices

VABS	VADD	VCHP	VCHPE	VCVT	VCYTR	VDIV	VLDM
VLDK	VHLL	VHLS	VMOV	VMSR	VMSR	VHUL	VNEG
VNHLL	VNHLS	VNHUL	VPOP	VPSH	VSQRT	VSTH	VSTR
VSUB	VFMA	VFMS	VFNMA	VFNMS			

Cortex-M4 FPU

FKH	QADD	QADDH	QADDL	QASX	QDMD	QDSUB	QSAK
QSUB	QSUBH	QSUBL	QADDF	QADDFH	QADDFL	QSUBH	QSUBL
SHADD	SHASH	SHASHH	SHASHL	SHASHH	SHASHL	SHASHH	SHASHL
SHLAD	SHLADH	SHLADL	SHLADH	SHLADL	SHLADH	SHLADL	SHLADH
SHLAWT	SHLAWT	SHLAWT	SHLAWT	SHLAWT	SHLAWT	SHLAWT	SHLAWT

ADC	ADD	ADR	AND	ASR	B
CLZ	RFC	BFI	BIC	CDP	CLREX
CBNZ	CBZ	CPH	CPF	DBG	COF
LDRH	LDRSH	LDRSHL	LDRSH	LDRSH	LDRSH
LDRSBT	LDRSBT	LDRSBT	LDRSBT	LDRSBT	LDRSBT
LSR	MSR	MLS	MLA	MOV	MOVT
MRC	MRR	MUL	MVN	NOP	ORH
ORR	PLD	PLDW	PLI	POP	PSH
RBIT	REV	REVH	RSB	SBC	SBFX
			SDIV	SEV	SHAL
			SHULL	SSAT	STC
			STHA	STHDB	STR
			STRB	STRBT	STRD
			STRBK	STRBK	STRBK
			STRH	STRHT	STRT
			SUB	SXTB	SXTH
			TBB	TBH	TBQ
			TKY	UBFX	UDIV
			UHAL	UHALL	USAT
			UKTR	UKTRH	WEE
			WFI	YIELD	ITD

BART	BLX	ADC	ADD	ADR
BLX	CPS	AND	ASR	B
DHR	BL	BIC		
DSR	CHN	CHP	COF	
HR	LDR	LDRB	LDRH	
HSR	LDRH	LDNRB	LDNRH	
MSR	LSL	LSR	MOV	
NOP	REV	MUL	MVN	ORR
REVH	REVSH	POP	PUSH	ROR
SEV	SXTB	RSE	SBC	STB
SXTBH	UKTR	STR	STRB	STRH
UKTRH	SWD	SUB	SVCE	STR
WFI	YIELD			

Cortex-M0/M0+/M1

Cortex-M3

Cortex-M4

Wi-Fi™
M-Bus wireless
Bluetooth®
RFID
NFC
ZigBee®
 Control your world

Cortex-M0
Cortex-M0+
Cortex-M3
Cortex-M4

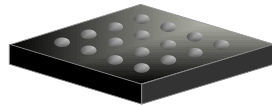
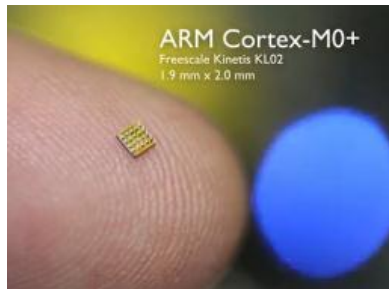
ARM Cortex-M0+: Ease of Use Speeds Time-to-Market

- Write in C, no need for assembly
 - Wide availability of reusable software
- Clean 32-bit architecture
 - Unified linear 4GB address space
 - NVIC manages the interrupts
- Great debug capabilities
 - Breakpoints, watchpoints and even trace
- Broad Tool Support
 - Reuse your preferred IDE, most suppliers support ARM

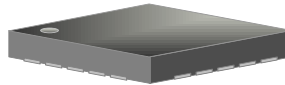


ARM Cortex-M0+: Small is Beautiful

- Cortex-M0+ starts from 12kGates
- Best in class code density, reducing flash size needed

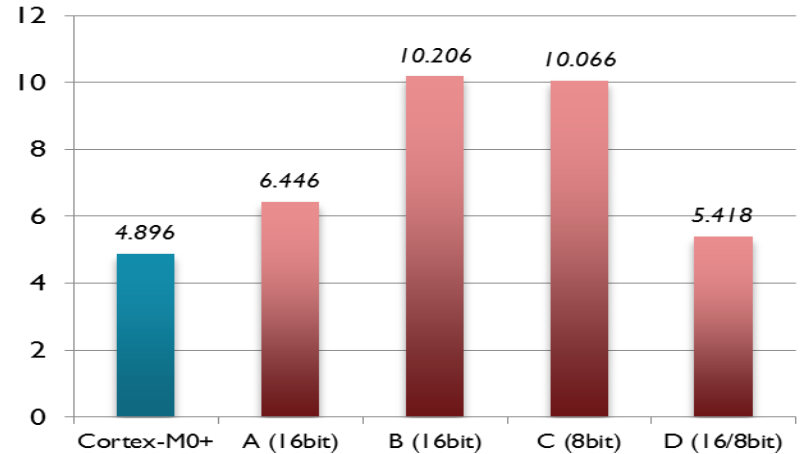


CSP16 (2x2mm)



QFN20 (3x3mm)

CoreMark Code in kB



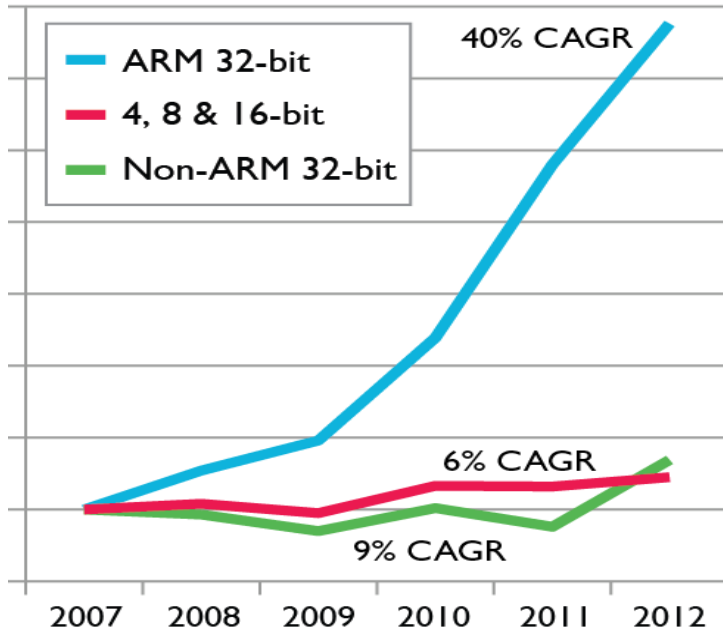
CoreMark code compiled optimized for size
A, B, C & D: same low power MCU as in previous slides

Reach lowest power consumption, smallest form factor and cost



ARM in Embedded

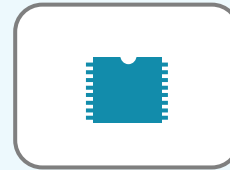
Relative growth in MCU & smartcard



8.7 billion

1.9 billion

ARM Cortex-M-based devices shipped in 2012
by leading semiconductor companies



MCUs



radios



sensors

32-bit intelligence starting at \$0.50



Case Study: 9 - Axis Sensor

Performance

Sensor Fusion algorithms are non-trivial to create features such as tilt compensated compass. Cortex-M0+ 2x more performance than 8/16 bit CPUs (.93DMIP/MHz)

Cost Pressure

Cortex-M0+ only takes 12K gates, efficient + best in class code density reduces the amount of OTP or FLASH memory needed

Packaging

Integrating CPU with sensor in one package allowing smaller form factor for end application, which is critical in applications like Smartphones & Google glasses. ARM CPUs synthesizable on CMOS friendly analog.

Low Power

Consumption to address battery powered applications such as wearable devices. Cortex M0+ consumes 9uA/MHz

Time to Market

ARM CPU ecosystem provides plenty of software tool options. CPU enable product allowing customers to create their own sensor fusion IP. Sensor provider can also provide software examples as reference designs.

Process Nodes for ARM Processors

Company	16/14nm FinFET	20nm	32nm 28nm	45nm 40nm	55nm	65nm	90nm	110nm	130nm	180nm	250nm
TSMC											
GLOBAL-FOUNDRIES											
IBM											
Samsung											
UMC											
SMIC											
Hynix											
SilTerra											
CSMC											
Dongbu											
Tower-Jazz											
Grace											
HeJian											
HHNEC											
MagnaChip											
Vanguard											
XFab											

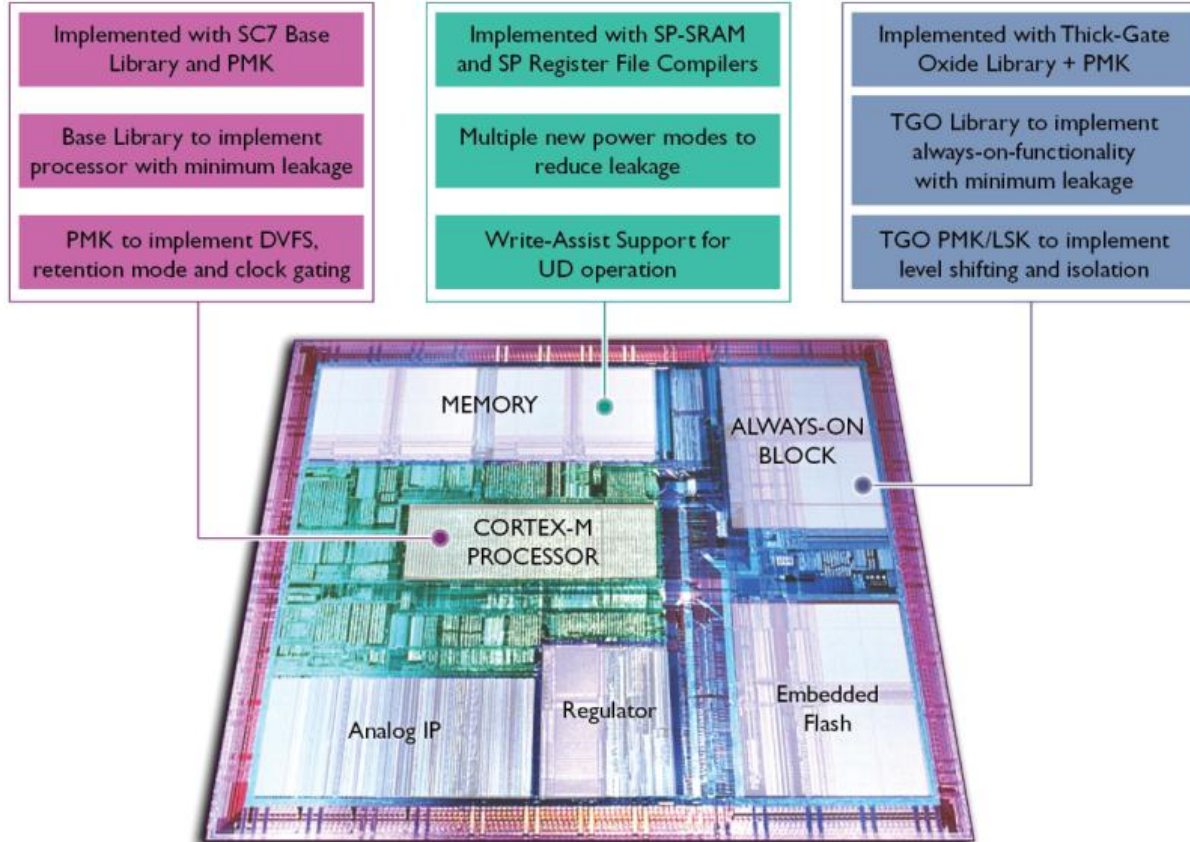
32/64-bit Applications Processors

Embedded MCU + IoT
Real-time + DSP Cores
8/16/32-bit Embedded Cores

ARM provides the most comprehensive implementation solutions for mixed-signal devices



ARM Artisan Implementation Solutions for Embedded & IoT based SoC Design



DesignStart – Starting Point for IP Evaluation

The screenshot shows the ARM DesignStart website. The main navigation bar includes 'Products', 'Support', 'Community', 'Markets', and 'About'. A search bar is located on the right. The left sidebar contains 'Quick Links' and 'Products' sections. The main content area is titled 'DesignStart Online Access to ARM IP' and features tabs for 'Physical IP' and 'Processor IP'. Below the tabs, there is a 'WELCOME' section for 'Joel Rosenberg, ARM' and a 'Limited Release Products' link. The main content is divided into four columns: 'FOUNDRY', 'TECHNOLOGY', 'PROCESS', and 'PRODUCT GROUPS'. The 'FOUNDRY' column lists various foundries with their respective IP counts. The 'TECHNOLOGY' column lists technology nodes. The 'PROCESS' column lists process types. The 'PRODUCT GROUPS' column lists IP types. A 'Recently Added IP' table is located at the bottom of the main content area.

Foundry

Process Geometry

Process Node

IP Type

FOUNDRY	TECHNOLOGY	PROCESS	PRODUCT GROUPS
SMIC (60)	28 nm (44)	28nm-HPP (9)	Embedded Memory IP (378)
Samsung (57)	32 nm (11)	28nm-SLP (11)	Interface IP (74)
Silterra (29)	40 nm (37)	32SOI (2)	Logic IP (216)
TSMC (183)	45 nm (18)	55nm-LPe (9)	
Tower (17)	55 nm (21)	65nm-G (7)	

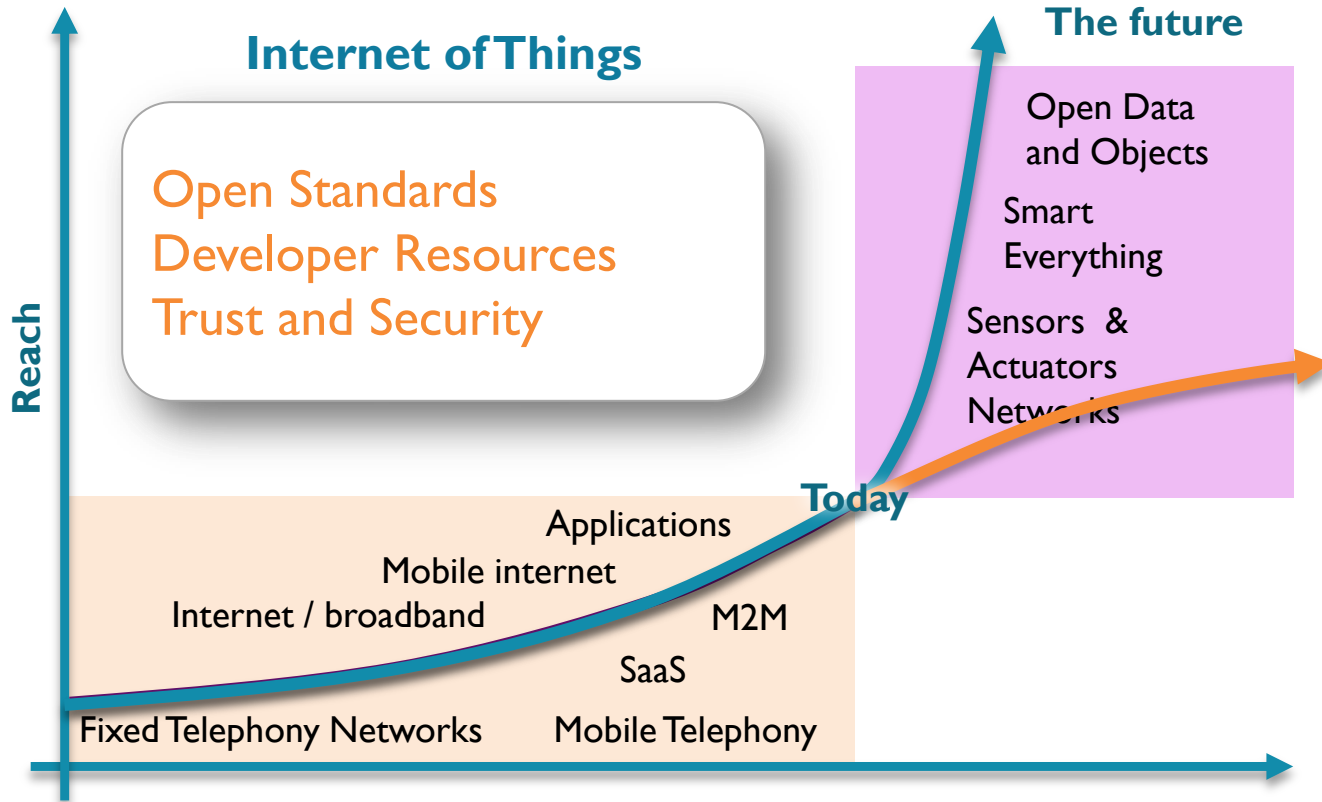
PRODUCT NAME	DATE ADDED
TSMC CLN28LP ARM Routing Technology Kit TS55TF000	01/27/2013
TSMC CLN28LP SC12MC High Perf C35 PMK LVT TS55LP002	01/08/2013

> 130 unique Physical IP Platforms

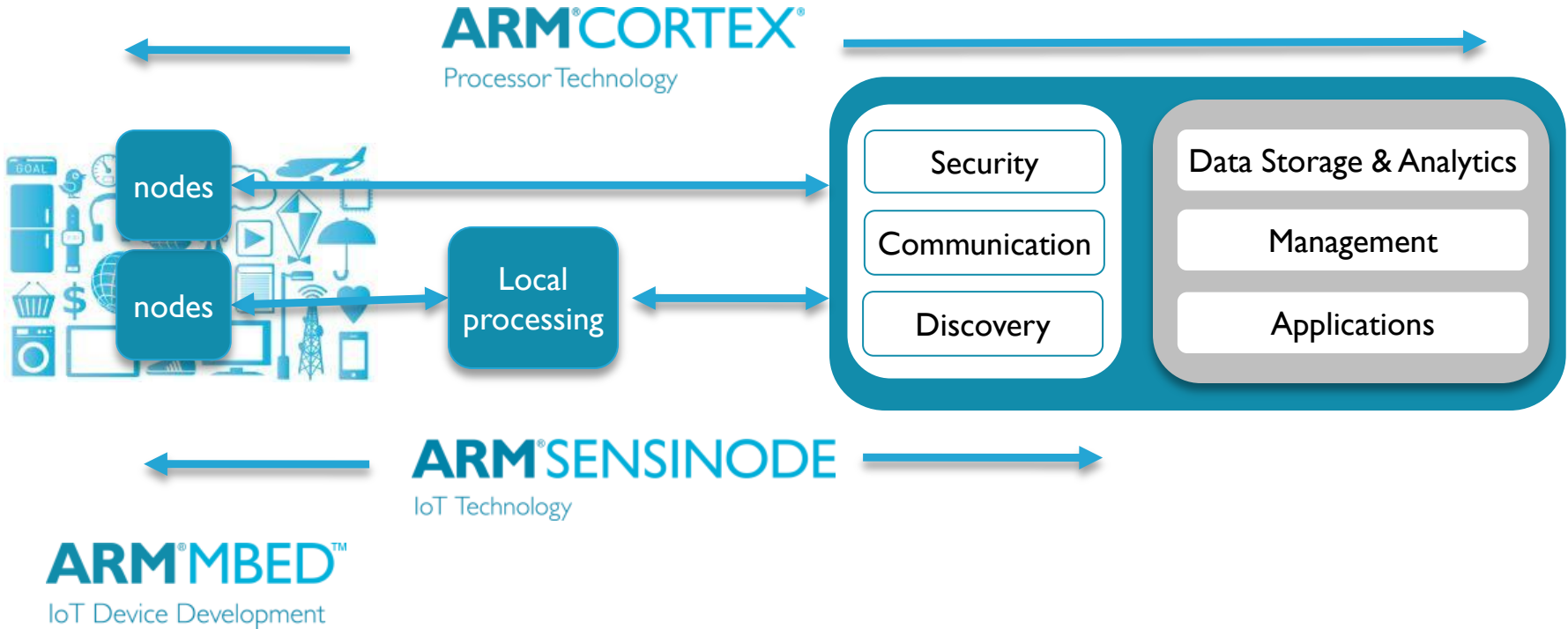
- Free IP evaluation

ARM® DesignStart™
IP Online Access

Big Data Starts with Little Data



IoT Architecture – ARM Offering



Growing the IoT Market

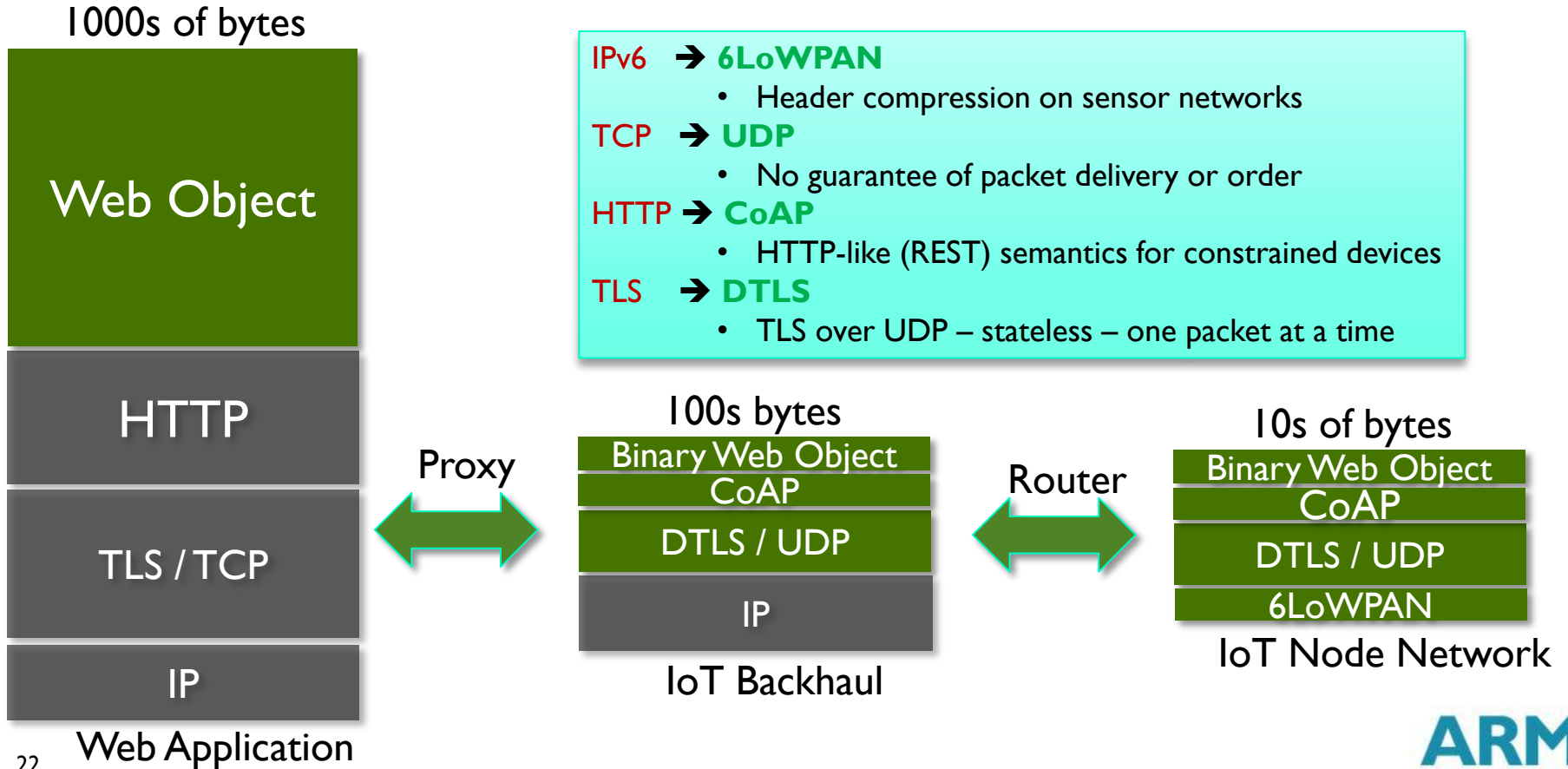
- ARM is dedicated to a standards-based IoT with billions of IP and Web-based devices

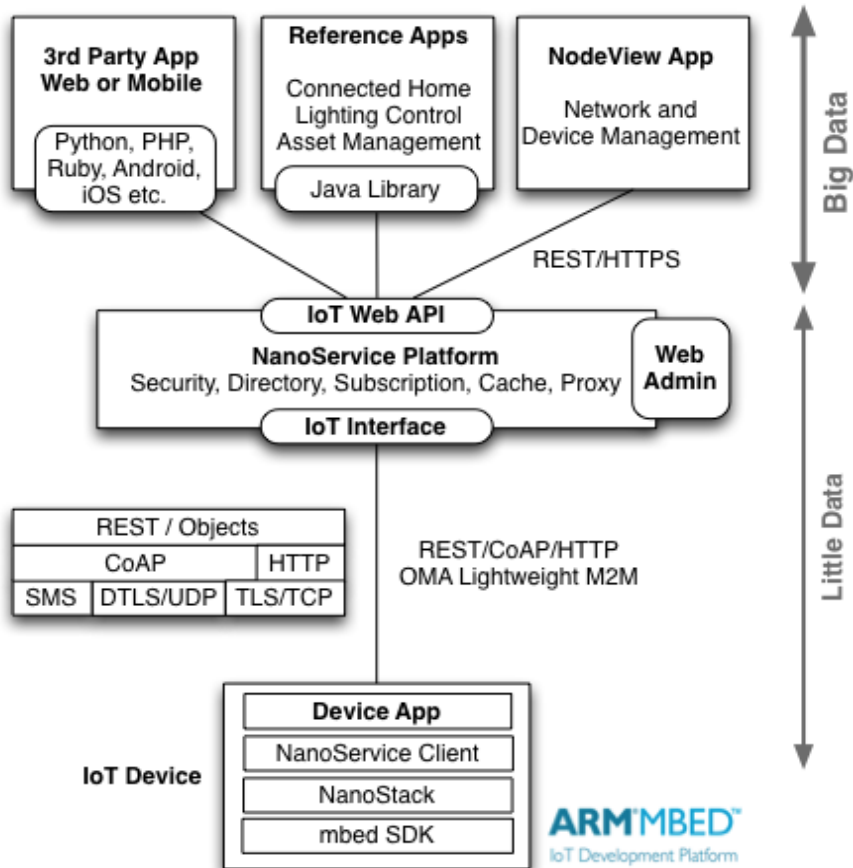


- Sensinode was a pioneer in creating and deploying these key IoT open standards
- Sensinode software enables efficient and secure communication from device to cloud
- 6LoWPAN, ZigBee IP CoAP, TLS, OMA Lightweight etc.



From Web Applications to IoT Nodes





- **Web Application SDK**

Reference Applications for rapid development of customer application that controls/monitors the M2M nodes.

- Lighting, Connected Home, Asset Management
- NodeView Network Management

- **NanoService Platform**

IoT application and data management platform, may be deployed in private or public server infrastructure.

- NanoService Clients (C/C++, Java ME, Java SE)
- NanoService Edge

- **NanoMesh**

Leading 6LoWPAN protocol stack for low-power RF and power line networks.

NanoService – An End-to-End Solution

Illustrative WSN and Cellular Deployments

Web Applications

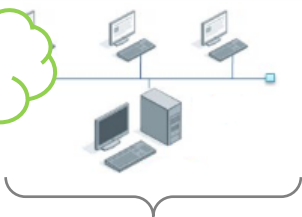


NodeView

Smart City Applications



NanoService Platform



6LoWPAN,
DTLS, CoAP,
Binary

IPv6, DTLS,
CoAP,
Binary

IPv6, TLS,
HTTP,
JSON

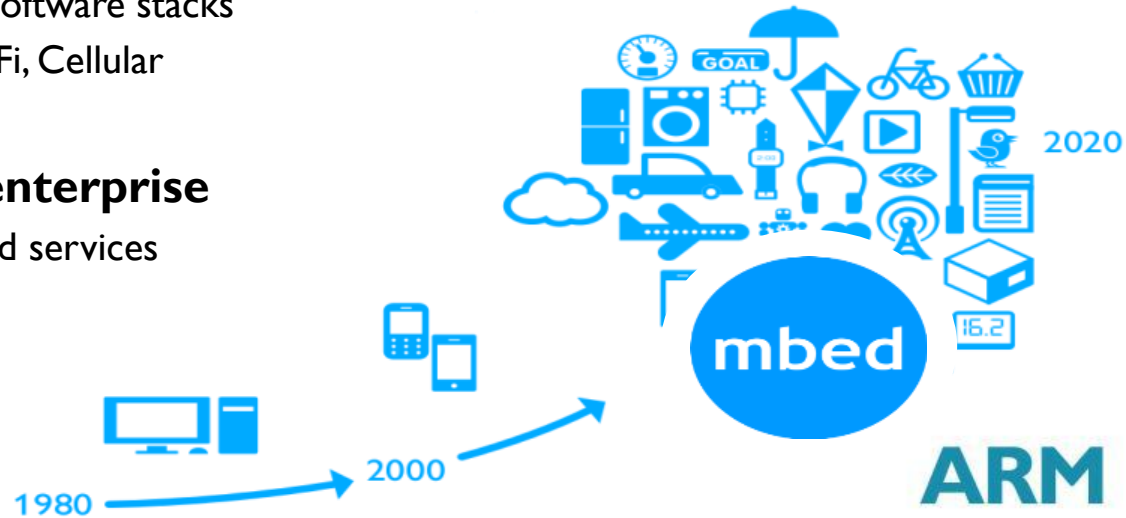


Asset Tracking Applications

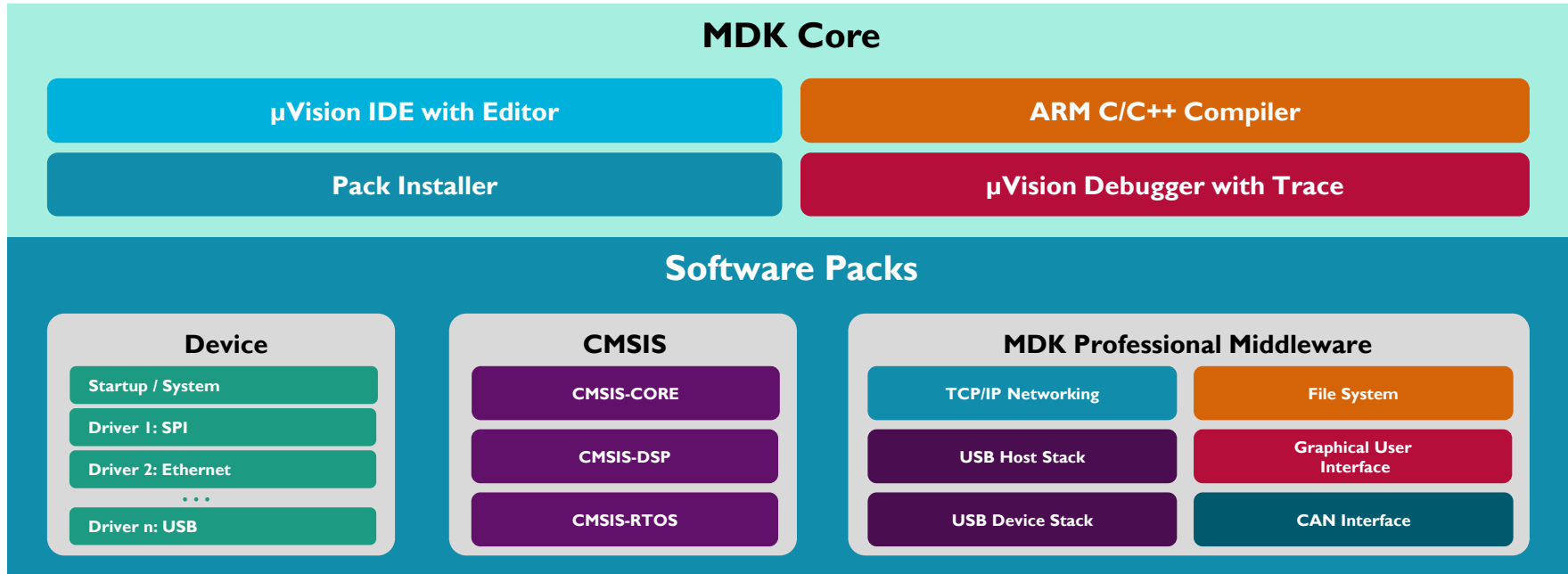


mbed: Connecting Cortex-M to the Cloud

- **mbed will enable IoT device creation on a massive scale**
 - An open source platform and libraries for Cortex-M Microcontrollers
 - Opening up IoT to a vast new audience of professional developers
- **Consolidating fundamental embedded building blocks**
 - Microcontrollers, Radios, Sensors, Software stacks
 - Bluetooth, 802.15.4/6LoWPAN, WiFi, Cellular
- **Simplifying integration with enterprise**
 - Embedded agents and APIs for cloud services



Software Packs in MDK-ARM™ Version 5



Keil™ Microcontroller Development Kit (MDK)

The Opportunity in Front of Us All

Next billion



Trillions of devices



Data

Data



Imagine the possibilities

Summary

- IoT is incredibly important to all of us.
- ARM is about partnerships, enablement, and innovation
- ARM wants to partner with all of you to help accelerate IoT so that little data can become big data