Freescale's View of the **Internet of Tomorrow**

EUF-IND-T1463

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M A Y . 2 0 1 5

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Agenda

- Freescale's definition of the Internet of Things (IoT)

- Architectural view of IoT infrastructure

- Applications of IoT

- i.MX 7 applications processors introduction

- Layerscape architecture introduction

- Q&A

The Promise of the Internet of Things

2.4 billion Internet users
12 billion connected devices in 2013

5 billion Internet users
50 billion connected devices by 2020

Devices talking to each other, all connected to the cloud and servers

All communicating securely

Resulting in savings and value creation
Impact on U.S. GDP ~$1.4 trillion in 2025

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Typical Views of IoT: Generalized

Building Automation

Smart City

Smart Lighting

Smart Grid

Smart Health

Industrial Automation

Or You Get a Lot of Talk About M2M
With the Smart Devices Controlling the Universe

IoT Is More Than M2M

Machine to Machine

Machine to Infrastructure

Machine to Environment

Machine to Human

Cellular-Centric View

Billions of subscribers, **trillions** of objects, All seamlessly connected to the cellular infrastructure
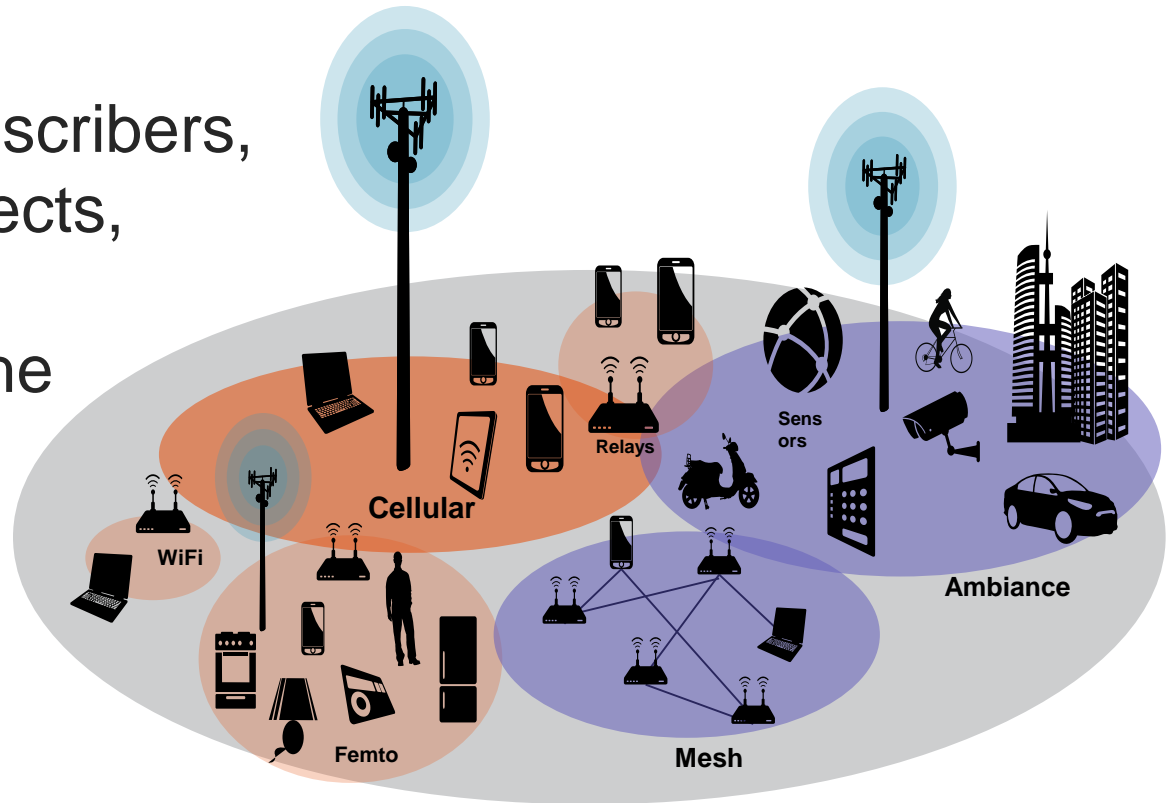
Second View
Pervasive Remote Monitoring and/or Control

New breed of hierarchical gateways connecting tiny sensing nodes to the Cloud using the most efficient way to make the connection

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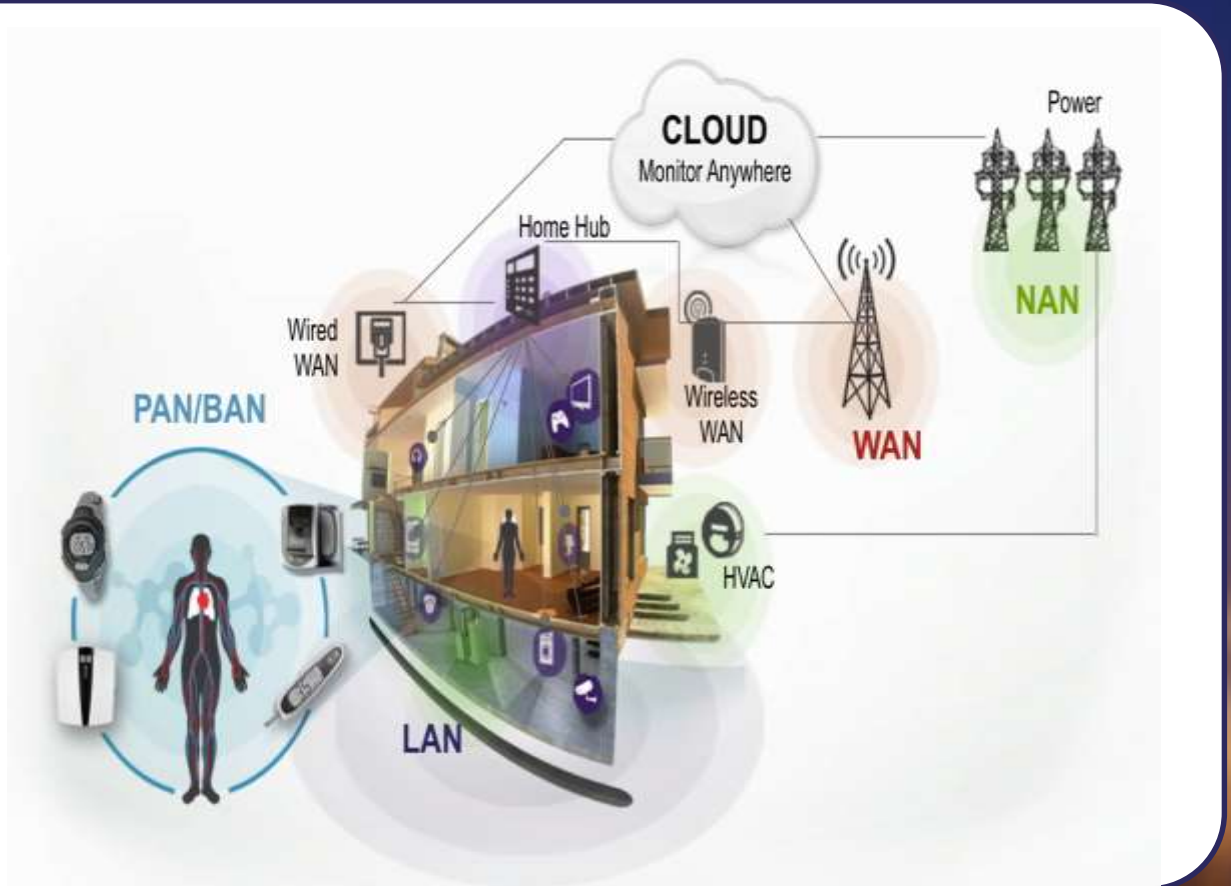
Fundamental Difference
Existing ISP Providers Believe in This Model

Cellular

Cloud
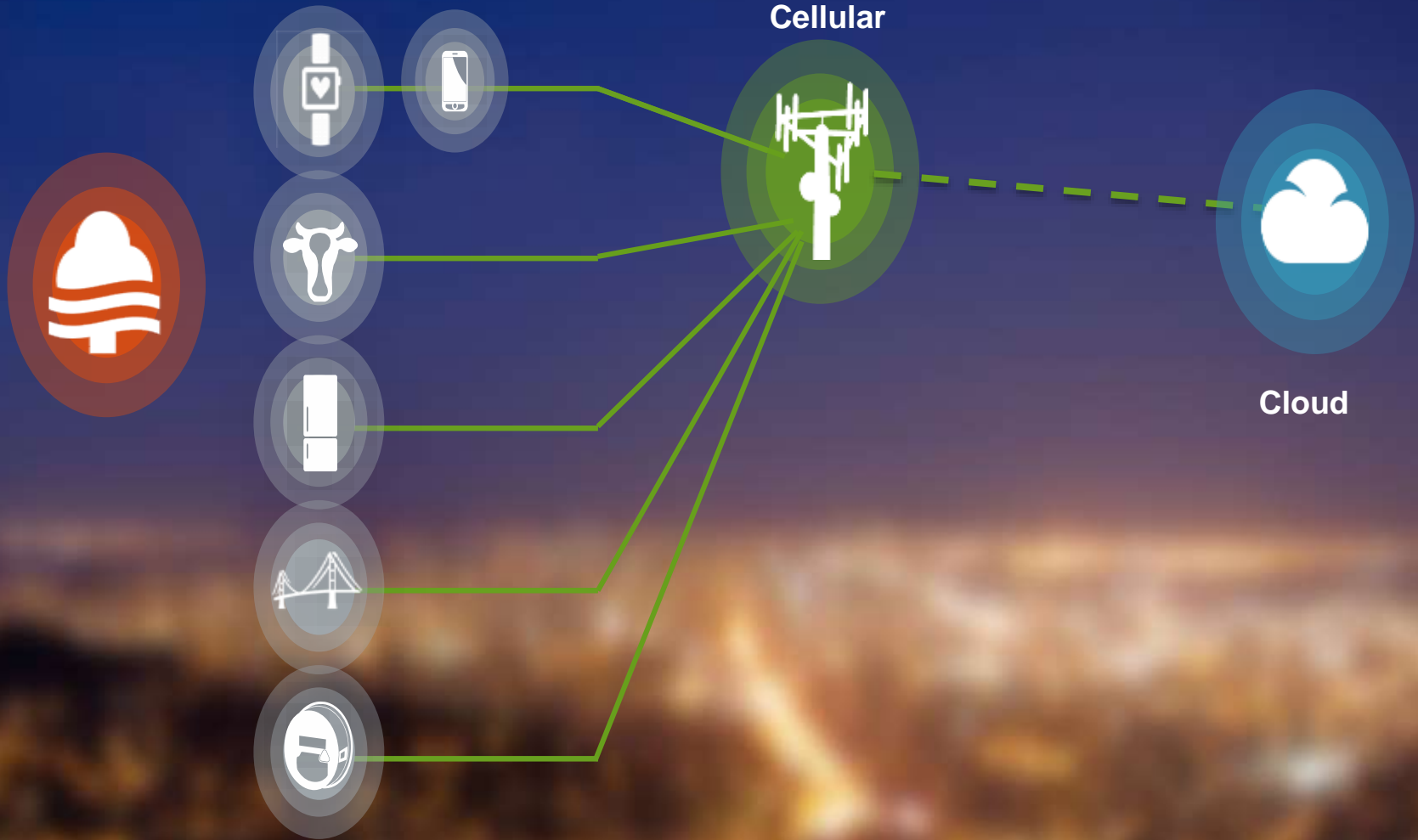
Fundamental Difference

Today We Believe the Model Should Look Like

Satellite

Cellular

Cloud

Fiber

Best Available
Route to Cloud

Gateway
Box

Proprietary

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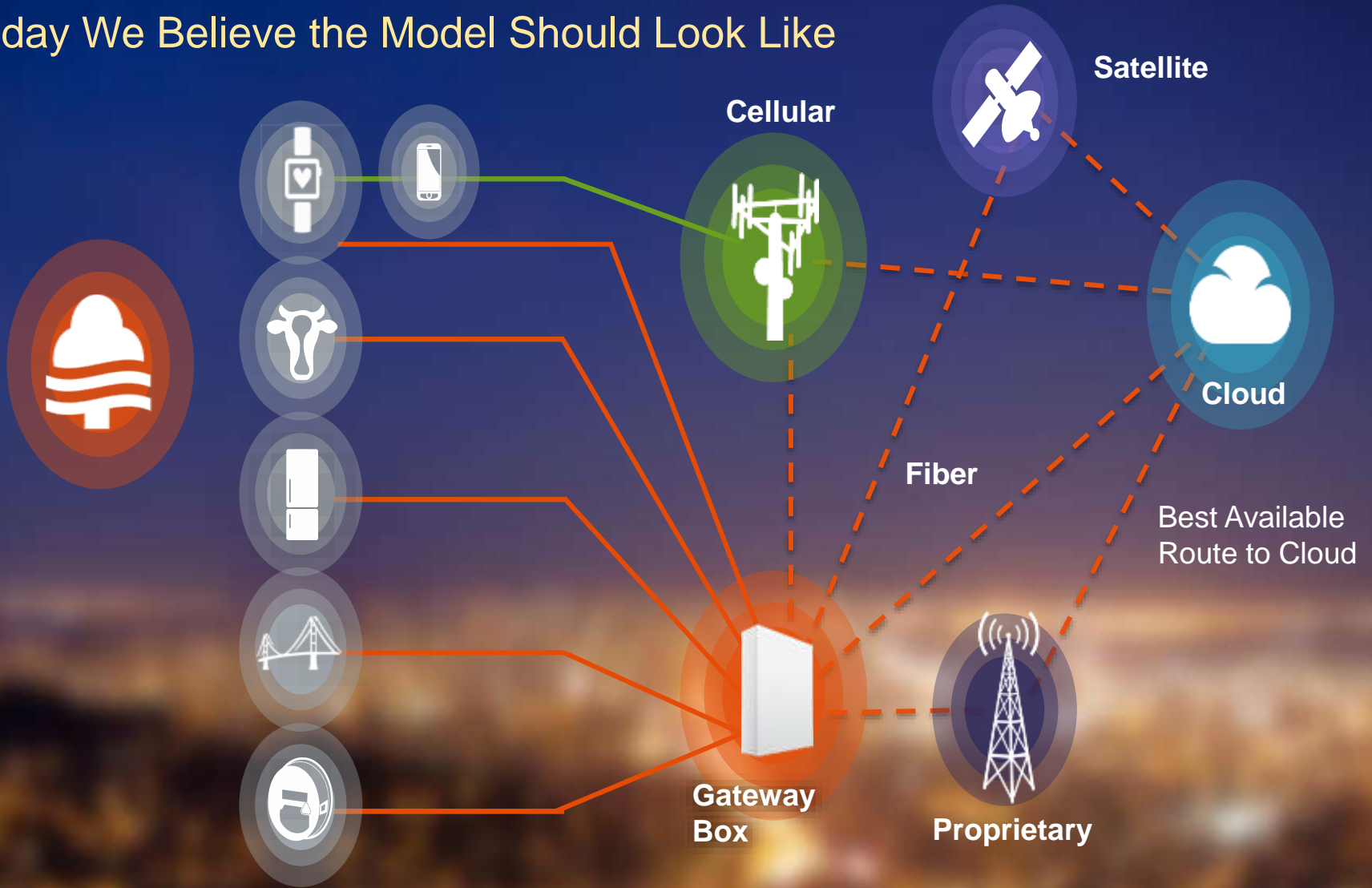
Fundamental Difference

In the Future We Believe the Model Will Look Like

Cellular

Cloud

Fiber

Gateway
Box

TV White Space,
Sub-gig, etc.
Ex: Weightless

Infrastructure of the Internet of Things

Edge Nodes

MCUs | Energy

Sensors | Connectivity

PAN/LAN Connectivity

Gateway

WAN Connectivity

Cloud

Application/ Action

Big Data
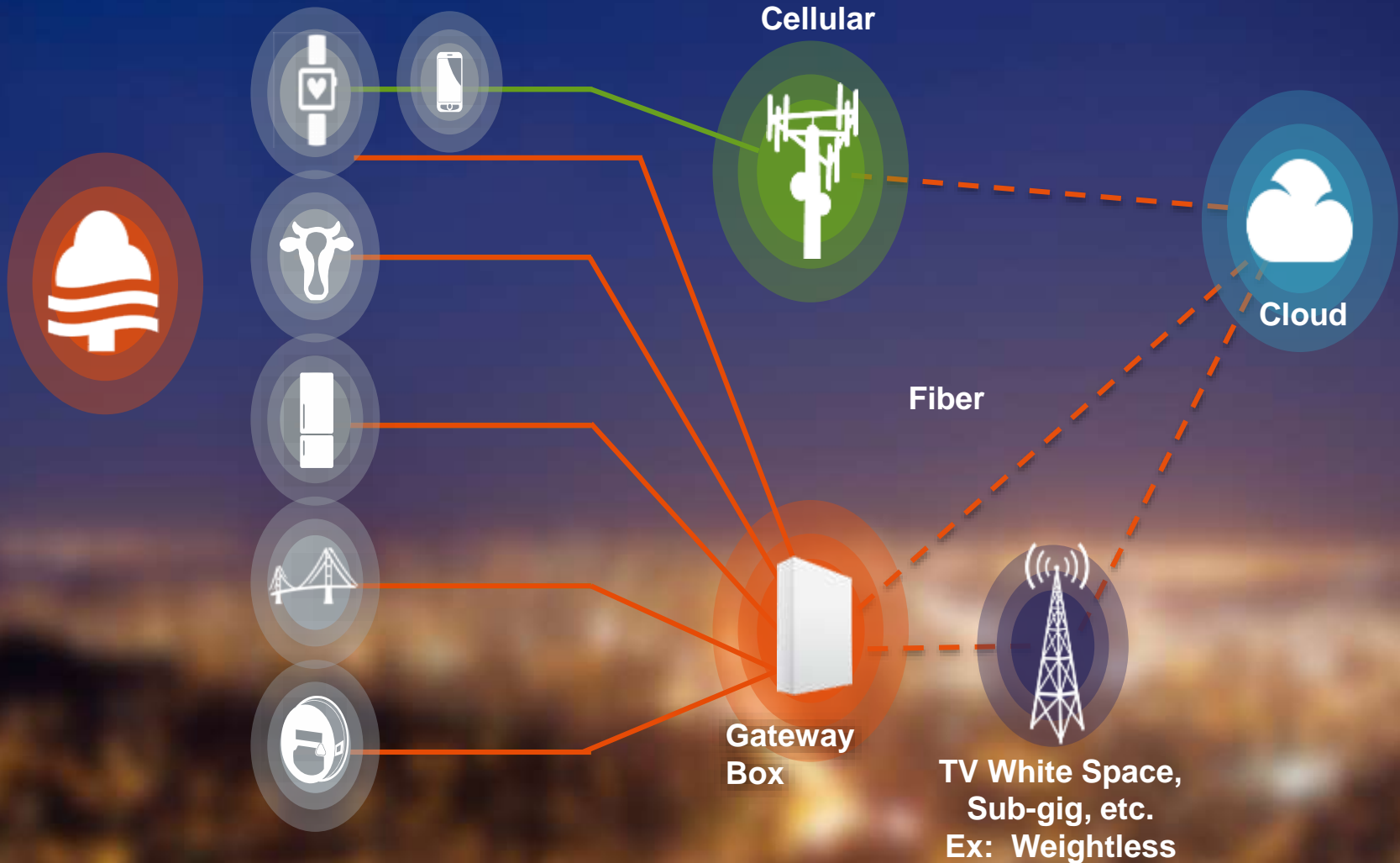
Infrastructure of the Internet of Things
The Challenge

Most parts of this infrastructure and, to the greatest extent, the edge nodes use different technology nodes, different tool sets, different development environments, different levels of security competence and resources, even different programming languages

Edge Nodes	PAN/LAN Connectivity	Gateway	WAN Connectivity	Cloud
MCUs / Energy / Sensors / Connectivity				Application/Action Big Data

Infrastructure of the Internet of Things
The Solution

Java technology to embrace the entire system and unify the Internet of Things, even down to the tiniest and most resource-constrained edge/sensing nodes

MCUs | **Energy**

Sensors | **Connectivity**

Edge Nodes

PAN/LAN Connectivity

Gateway

WAN Connectivity

Cloud

Application/ Action

Big Data

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One Box: Connecting The Cloud to the Tiniest Edge Nodes

MCUs | Energy

Sensors | Connectivity

Edge Nodes

PAN/LAN Connectivity

Gateway

WAN Connectivity

Cloud

Application/ Action

Big Data

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One Box: Connecting The Cloud to the Tiniest of Edge Nodes

Hierarchical gateways act as the *glue* that pulls all of the pieces together and support:

- Modular BAN/PAN/LAN/HAN connectivity topologies

- Modular NAN/WAN communications solutions

- Protocol translation

- Security

- Firewall and VPN

- Switching and routing

- Storage

They perform new functions:

- Offload some/most of service provision from servers

- Intelligence and analytics: **Java Event Processing Embedded**

- Etc.

Example: Smart Energy

Where Real Time Access To Usage Data + Smart Consumers =
Energy cost savings and **reduced carbon footprint**

Smart Energy

Utility Provider

Example: Smart Transportation

Where Smart Transportation + sensors on Infrastructure & trains = Reduced maintenance cost and **no more fatalities**

Smart Transportation
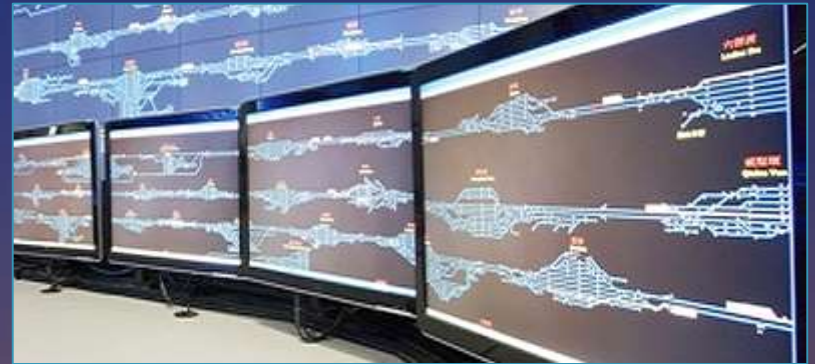
Command/Control Center

Example: Smart Health

Where biometric sensors + Big Data = **Revolution in healthcare**

Smart Health

Health Care Provider

The Need for a Secure Service Delivery Infrastructure

World's first IoT secure service delivery infrastructure based on open platforms
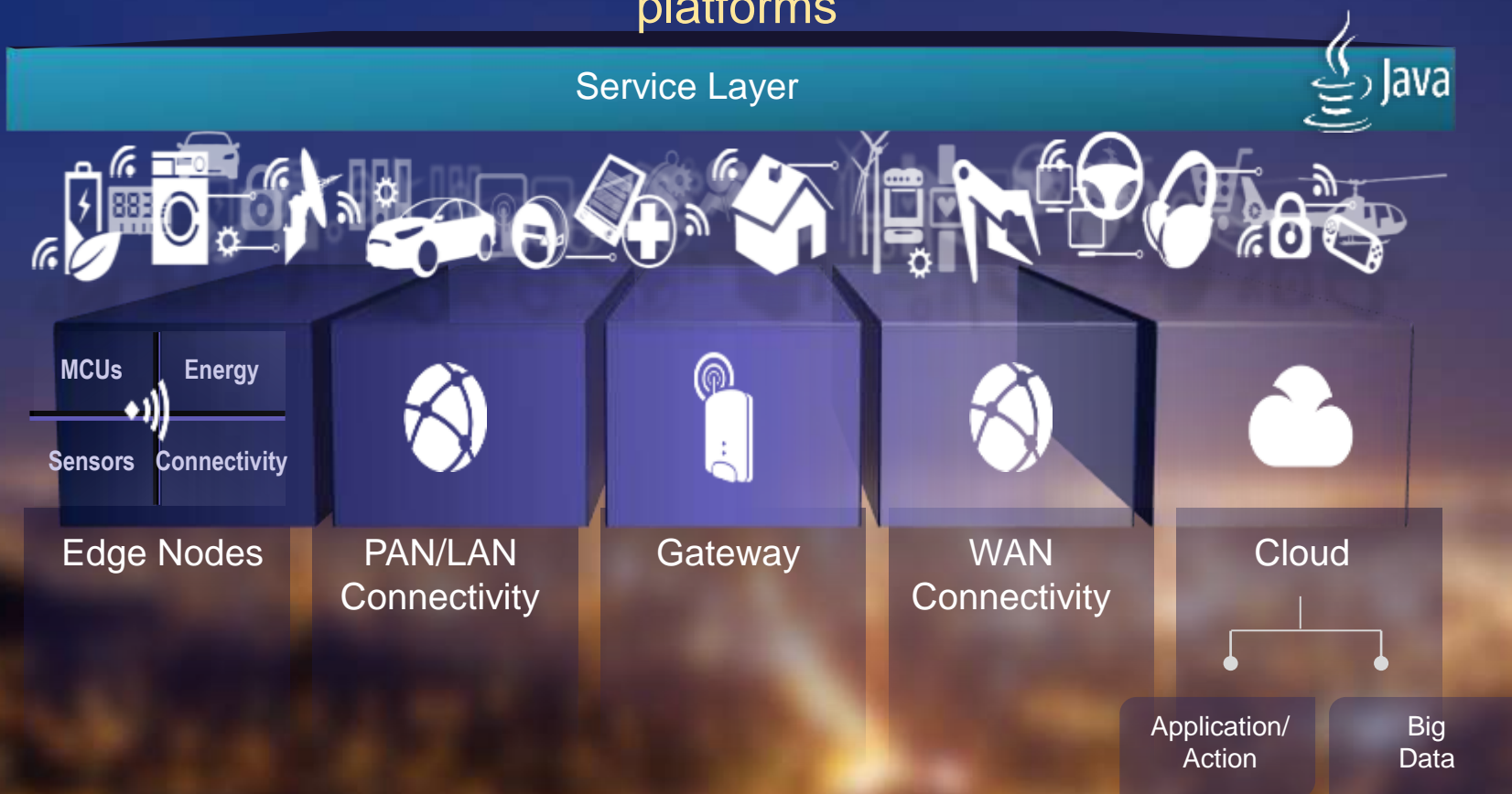
Need for Security, as Stakes Are Very High

Best-in-Class Security

Freescale's extensive portfolio of secure, scalable embedded processing solutions +

Java's industry-leading security +

System-level security optimizations +

Use-case based best practices =

Secure Service Delivery Infrastructure

Freescale IoT Offerings

Edge Product	BAN/PAN/ & Wired/Wireless, Power Line LAN	Layers of Aggregation / Hubs / Gateways	Wired/Wireless, Power Line WAN	Remote Cloud-based Processing

Xtrinsic Sensing
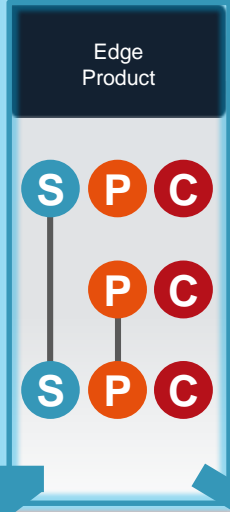*Intelligent Contextual Sensing.*

The right combination of intelligent integration, logic and customizable software on the platform to deliver smarter, more differentiated applications.

For IoT it provides Context: Identity, Activity, Location, & Time

Connectivity
BAN/ PAN/ LAN

Fully integrated Short Range radios with best in class power performance, and Powerline Communications

Edge products:
- Very small
- Low cost
- Low power
- Low complexity
- Industrial grade & robust

S Sensing

P Embedded Processing

C Communications

Kinetis Microcontrollers
Design Potential. Realized

Industry's most scalable ultra-low-power, mixed-signal MCU solutions based on the ARM® Cortex™-M and Cortex™-M0+ architectures.

Vybrid Controller Solutions
Rich Apps in Real Time.

Real-time, highly integrated solutions with best-in-class 2D graphics to enable your system to control, interface, connect, secure and scale.

i.MX Applications Processors
Your Interface to the World.

Industry's most versatile solutions for multimedia and display applications, with multicore scalability and market-leading power, performance & integration.

QorIQ Processors built on Layerscape Architecture
Accelerating the Network's IQ

Industry's first software-aware, core-agnostic networking system architecture for the smarter, more capable networks of tomorrow – end to end.

Scalable Industry Standard Solutions, Software and Development Ecosystem

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Fulfilling the Promise of IoT by establishing

The World's First Secure Service Delivery Infrastructure Based on Open Platforms

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PRESS RELEASE | September 23, 2013, 7:05 a.m. ET

Freescale and Oracle Address Industry Demand for Common IoT Standards

Companies collaborate to establish advanced gateway platform for secure delivery of IoT services

SAN FRANCISCO--(BUSINESS WIRE)--September 23, 2013--

The Internet of Things (IoT) -- which many experts in the fields of IT and engineering believe is the fourth industrial revolution -- holds the promise of delivering dramatic innovations for existing industries, while enabling the creation of entirely new markets. However, one of the biggest barriers to widespread IoT implementation is the lack of a secure, standardized and open infrastructure model for the delivery of IoT services.

To address this challenge, Freescale Semiconductor (NYSE: FSL) and Oracle are working together to rapidly evolve the IoT with a new, secured service platform that will help standardize and consolidate the delivery and management of IoT services for the home automation, industrial and manufacturing automation markets.

The solution combines end-to-end software with a converged gateway design (called the "one box" platform) to establish a common, open framework for secured IoT service delivery and management. A "box" (or service gateway) built on the platform can consolidate boxes from multiple IoT service providers into a single, unified appliance. The one box platform will help simplify and secure the delivery of IoT services to end users in a home, business or other location, supporting the rapid deployment of a vast array of innovative IoT services.

"The one box platform represents a significant milestone in the evolution of the Internet of Things, establishing a standardized and secure platform for service providers to quickly and cost-effectively introduce differentiating IoT services," said Geoff Lees, senior vice president and general manager of Freescale's MCU business. "Freescale's extensive portfolio of secure, scalable embedded processing solutions is ideal for enabling this critical bridge to common standards for IoT infrastructure."

OneBox Means Integrating All "Boxes" Into One:
Connecting the Cloud to the Fog

BAN/PAN/LAN/HAN Side

NAN/WAN Side

Display

Superset of Standards

Superset of Standards

Bluetooth

Zigbee, 802.15.4

WiFi, DASH7, ISA100

Wireless HART, EnOcean

Fog

Wireless MBus

Ethernet, EtherCAT, Profinet, Modbus,

HPGP

Etc.

Wired & Wireless

Wired & Wireless

Switching & Routing

Protocol Conversion

Firewall & VPN

Security

OneBox Gateway

Storage

Ethernet / Fiber

Weightless

802.11ah

Cellular

Sub Gig

Satellite

Cloud

PLM/PLC (G3, Prime, etc.)

Etc.

**UART, SPI, I2C, USB, X10,
RS-485, RS-422, RS-232, etc.**

What devices to monitor/ control

What short-range device access link

Targeting CPE

What Cloud access link
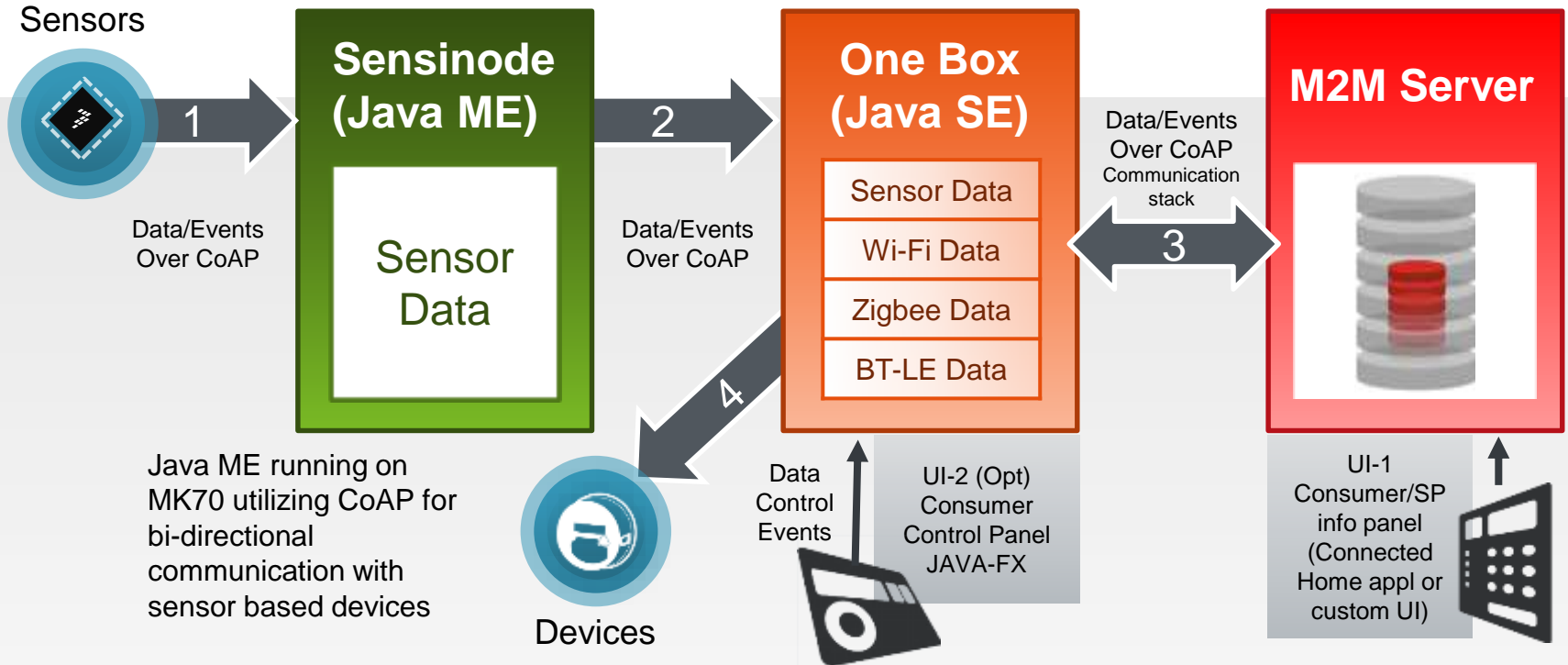
Optimize the communications, processing, and storage requirements of all stakeholders (i.e. teleco providers, security, utility, energy, automation, control, and other future service providers), @Home, @Factory, @Hospital, or other target facilities / environments

Java One Demo: ARM®/Sensinode <> OneBox <> Oracle Database

Sensors

Sensinode (Java ME)

Sensor Data

1 — Data/Events Over CoAP

One Box (Java SE)

Sensor Data
Wi-Fi Data
Zigbee Data
BT-LE Data

2 — Data/Events Over CoAP

M2M Server

Data/Events Over CoAP Communication stack

3

4 — Data Control Events

Devices

Java ME running on MK70 utilizing CoAP for bi-directional communication with sensor based devices

UI-2 (Opt) Consumer Control Panel JAVA-FX

UI-1 Consumer/SP info panel (Connected Home appl or custom UI)

REST APIs

Data Management
- Database
  - Definition of Data structure
- Java FX GUI on Tablet
- REST APIs

Java SE platform provides embedded environments with interoperability for BT, Zigbee etc
Oracle Event Processing for Java Embedded enables analysis of real-world data to enable real-time intelligence via back end server

Demonstration of One-Box at Java One, Sep 2013

- One-Box with Java SE

- Smart Meter

- Allure Thermostat

- Smart Plugs

- Security Camera

- Server (laptop)

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Internet of Things: The Better Light bulb

192.168.1.1

- **Device operation is transparent to the user**

- **Device can sense/learn from its Environment**

- **Device is trusted to transmit *my* data securely to trusted entities**

- **Device is connected (always or on demand)**

- **Some Examples**
    - Light bulbs that change their luminance based on time, number of people in the room
    - Point of Sale Terminals that secure themselves
    - Home Controls that learn their 'user's' needs for heat or cold in the home
    - Beds that mold themselves automatically to the person lying in them
    - Shopping carts that automatically sync your shopping list from home
    - Coffee makers that learn when to start heating up based on your personal sleep patterns
    - Vacuum cleaners that order new cleaning filters when your usage is typically greatest

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New IOT-Based Segments/Devices Require:

- **Processors be inherently communications capable**
  - **To keep fresh:** Ability to update, patch, download and extract information via IP transmission
  - **To be aware:** Control multiple devices via standard wireless (wifi, BT, ZigBee, IR, camera, NFC)
  - **To be secure:** Ensure data is trusted throughout the "usage" path up to the cloud
  - **To be controlled in new ways:** New app installs, service upgrades and personalization

- **Deliver the right performance, integration and power (Tiered Platform)**
  - **Primary use:** Quiescent, low power data acquisition and wireless control(Cortex M4/M0)
  - **Secondary Use:** Full speed, end user responsiveness w/ full featured OS (Cortex Ax)
  - **Why?** Must 'sip' power for background tasks; **Active time: rarely;** Full featured OSs widen code availability
  - **So?:** Not about MIPS; more about tiered computation levels with wide SW support

- **i.MX 7 applications processors developed as a family to offer customer's a scalable choice**
  - **Ability to scale performance as their needs scale** → Cortex® A7+M4+M0
  - **Ability to scale security levels** → Secure boot to full PCIv4 compliance
  - **Ability to scale I/O choice:** Fast IO, dual Ethernet, multiple serial ports
  - **Ability to scale solutions** → Pin and power compatibility

i.MX 7 Series

i.MX 7 Family of Application Processors

Two new i.MX Family Members built on One 28nm Low Power Platform

Add: A7 Core, 32bit DDR, M4 core EPD Display, PCIe

i.MX 7Solo → i.MX 7Dual
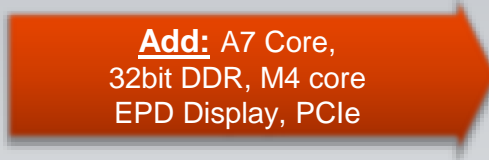
Single Cortex A7, 800 MHz
Cortex M0+; 16-bit DDR3; 2x GigE,
Full Security w/ Tamper resist

Industrial HMI Control
Mainstream Point of Sale/Printing
Home Control
Basic Wearables
General Embedded Control

Dual Cortex A7, 800 MHz
Cortex M4, 2xGigE, 32-bit DDR3
Full Security w/ Tamper resist

eReaders
High End Point of Sale/Printers
Home Automation
Industrial HMI with Security
Wearables

Introducing QorIQ LS1020A, LS1021A and LS1022A
The World's Most Efficient Communications Processors Under 3 W

Leveraging over 20 years of networking expertise, the ARM-based QorIQ LS1 family is optimized to offer unprecedented efficiency and security, together with the broadest array of high-speed interconnects and features ever offered in a sub-3 W networking processor.

LS102x Family - Target Markets and Applications

IoT Gateways
- High-speed interfaces
- Multi-protocol support
- High-bandwidth LAN/WAN support

Industrial Automation and Control
- Industrial interfaces
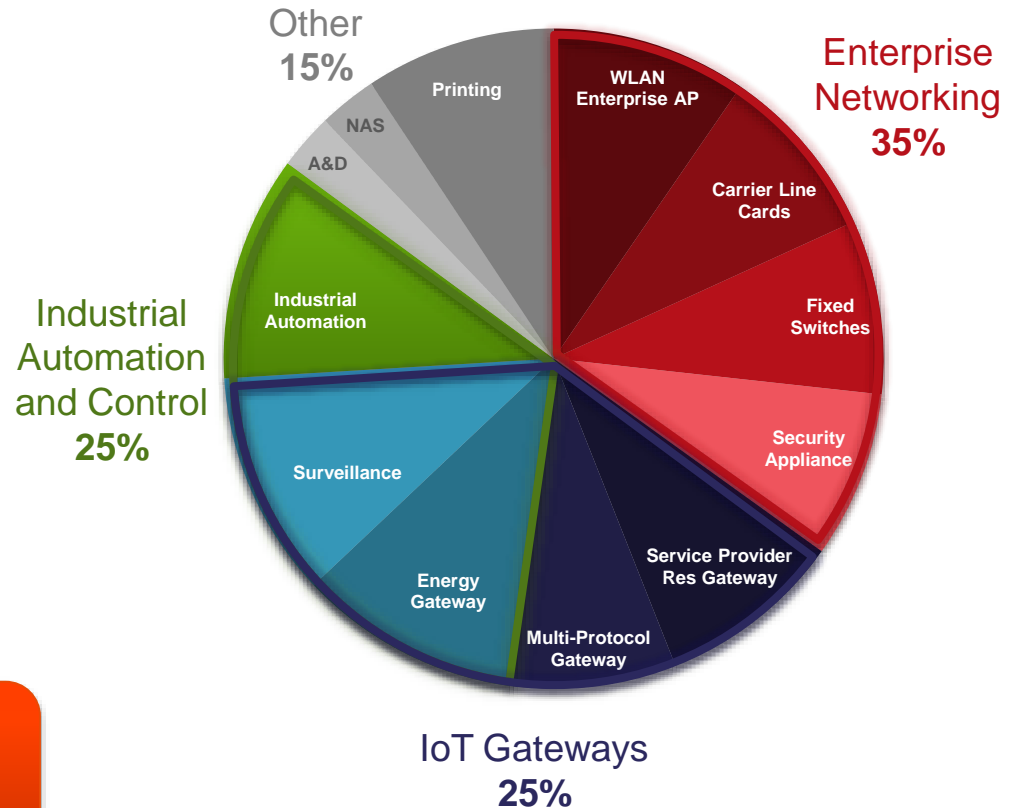- LCD for HMI support
- Industrial protocol support

Enterprise Networking
- High-speed interfaces
- Security engine
- ECC-protected caches
- Virtualization

The LS1 processor family extends Freescale's market leadership

$1.9B SAM in 2015

Other
15%

Industrial Automation and Control
25%

Enterprise Networking
35%

IoT Gateways
25%

Pie chart segments: Printing, WLAN Enterprise AP, NAS, A&D, Carrier Line Cards, Industrial Automation, Fixed Switches, Surveillance, Security Appliance, Energy Gateway, Multi-Protocol Gateway, Service Provider Res Gateway

Source: IDC and IMS Research, World Market for Internet connected Devices, August, 2012

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David Kramer, 10/16/13

LS102x Product Family Snapshot

	LS1021A	LS1020A	LS1022A
Core Type	ARM Cortex™-A7 MPCore™ + NEON		
Cores/Threads	2 / 2		
Frequency	Up to 1GHz		Up to 600MHz
L1 I/D	32kB / 32kB with ECC		
L2 (Unified)	512kB Shared with ECC		
SRAM	128kB with ECC		
DDR	1x(16/32B +ECC) DDR3L/4 up to 1.6GT/s		DDR3L (8/16B) up to 1.0GT/s
SerDes	4x up to 6.0GHz		1x up to 5GHz
Ethernet	3 x 1GE		2 x 1GE
PCIe	2 x Gen 2.0 (up to 5.0GT/s)		1x Gen 2.0
SATA 3.0	1 up to 6.0GHz		No
USB	1 x USB 3.0 and 1 x USB 2.0		1 x USB 2.0
CAN	Up to 4		Up to 4
TDM/HDLC	2		No
UART/I²C/SPI	Up to 8 / 3 / 2		
I²S	Up to 4		
LCD	1 x Controller	No	
Acceleration	SEC,QE		SEC
	Trusted architecture		
	Pin Compatible 19x19mm, 0.8mm pitch		

LS1020 Family:
All feature Dual Cortex A7 Cores ARM

LS1020
Networking
- Up to 1GHz
- 2.1W Typ.

LS1021
Industrial Printing
- Up to 1GHz
- 2.2W Typ.
- Adds LCDC
- Adds CAN

LS1022
Entry Consumer & Industrial
- Up to 600MHz
- 1.6W Typ.

ECC and Trust on Board
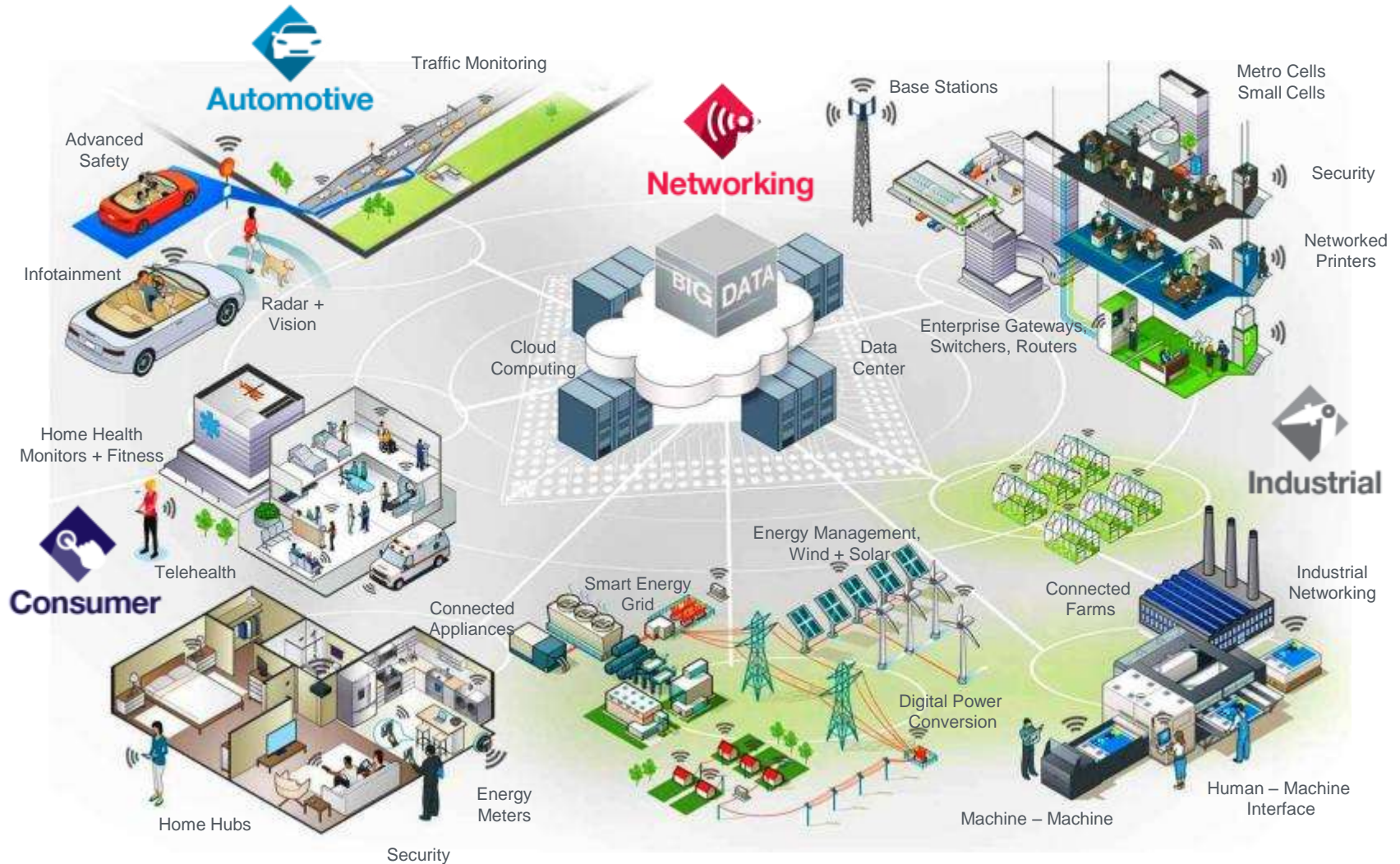**Pin & Software Compatibility**

In Summary

- The Internet of Things (IoT) - the fourth industrial revolution –delivers dramatic innovations for existing industries

- Enables the creation of entirely new markets

- Biggest barriers to widespread IoT implementation is the lack of a secure, standardized and open infrastructure model for the delivery of IoT services

- One-Box: Secured service platform will help standardize and consolidate delivery and management of IoT services for home automation, industrial and manufacturing automation markets

- More connectivity features to be added to increase capability

- Check out freescale.com/iot

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Our Products Power The Internet of Things

Microcontrollers | Digital Networking | Auto MCU | Analog and Sensors | RF

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