TECHNOLOGY DETAIL

AN INTELLIGENT SYSTEMS SOLUTION FOR THE INTERNET OF THINGS

"It's the combination of highly reliable hardware and software components, processes, and people working together in near-perfect unison that will bring about this level of reliability. Our mission is to support the new PTC [Positive Train Control] communications ecosystem and to assist the railroads with adopting this new technology."

Robert Turnbull, CEO, Meteorcomm

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OVERVIEW

The Internet of Things (IoT) is fundamentally reshaping business and technological requirements within the business landscape. Innovative solutions that intelligently monitor and control remote sensors and devices are revolutionizing enterprise computing. These next-generation intelligent systems are collecting, analyzing, and enabling organizations to act upon massive volumes of raw business data generated by vast numbers of endpoints, to improve business intelligence and automate business processes. Your network and system architects will need to reorganize your IT infrastructure to accommodate and support the Internet of Things. And they will need to enhance IT architectures to efficiently gather, process, and exchange IoT data in a highly scalable, secure, and reliable manner.

This paper highlights key IoT design issues and technical challenges and explains how Red Hat®'s intelligent systems solutions can help you address the stringent scalability, reliability, and security requirements of the Internet of Things. Red Hat's distributed architectural framework and standards-based solutions can help you transform big data generated by the IoT into meaningful and actionable information that increases productivity and delivers business results.

THE INTERNET OF THINGS TRANSFORMS I.T.

The Internet of Things is giving rise to a new era of networked computing where business applications intelligently monitor and control remote sensors, mobile devices, and smart machines and where devices such as actuators, valves and switches are connected and communicating.

The resulting data can automate processes, eliminate inefficiencies, and accelerate business innovation. IoT-driven intelligent systems are actually a "system of systems" deployed in cloud, data center, and field environments. By gathering and analyzing massive amounts of data, this wave of increasingly intelligent systems will help you make more accurate and well-informed decisions. And by intelligently controlling remote devices, next-generation applications will help you improve automation and optimize business processes.

The IoT is transforming virtually every industry: energy, healthcare, transportation, retail, hospitality, manufacturing, and financial services. Applications that will be re-invented through access to IoT data resources include:

- Smart building technology including automated lighting, temperature, energy, and industrial control systems.
- Optimized inventory, logistics, and supply chain management solutions.
- Intelligent manufacturing systems.
- Fleet tracking and delivery optimization solutions.
- Targeted shopping, customer care, and advertising applications.
- Smart transportation, security, environmental, and utility systems.
- Intelligent patient monitoring and management solutions.

THE IOT INTRODUCES MORE STRINGENT REQUIREMENTS

The sheer scale and public nature of the Internet of Things poses a variety of technical challenges for IT planners. Network and system architects must upgrade IT infrastructure to address the increased scalability, reliability, and security demands of the IoT.

SCALABILITY

The IoT introduces unprecedented scalability considerations, with vast numbers of devices generating massive amounts of data. IDC expects the global installed base of IoT endpoints to reach 212 billion connected devices by 2020.[1] An individual intelligent system might gather and analyze billions of data objects from millions of distinct endpoints presenting unparalleled data collection, processing, storage, and networking challenges.

RELIABILITY

IoT-based applications and automated business processes impose stringent system availability demands. Many intelligent systems will be employed for mission-critical applications where system downtime can result in diminished productivity, dissatisfied customers, or lost revenue. Some intelligent systems—emergency services, medical applications, and surveillance solutions—will be used in safety-critical applications where system downtime can lead to loss of life or property or cause significant environmental or health hazards.

SECURITY

The distributed nature of IoT solutions presents a myriad of security challenges. Intelligent systems may rely on the Internet for connectivity or use cloud-based compute or storage resources. Security systems and practices must be extended to protect against data loss, service theft, and increasingly sophisticated denial-of-service attacks in a scalable manner. Intelligent systems must support cohesive authentication, authorization, and auditing capabilities to establish trust, govern access to resources, and ensure compliance with governmental regulations and corporate policies. And they must support strong encryption schemes to safeguard data confidentiality and protect intellectual property.

1 Worldwide Internet of Things (IoT) 2013–2020 Forecast: Billions of Things, Trillions of Dollars, IDC, October 2013

INTELLIGENT SOLUTIONS FOR THE INTERNET OF THINGS

Red Hat's intelligent systems solutions are specifically designed to address the stringent scalability, reliability, and security requirements of IoT-based systems. The solutions are based on a hierarchical model that uses standards-based protocols and components for ultimate flexibility and economics.

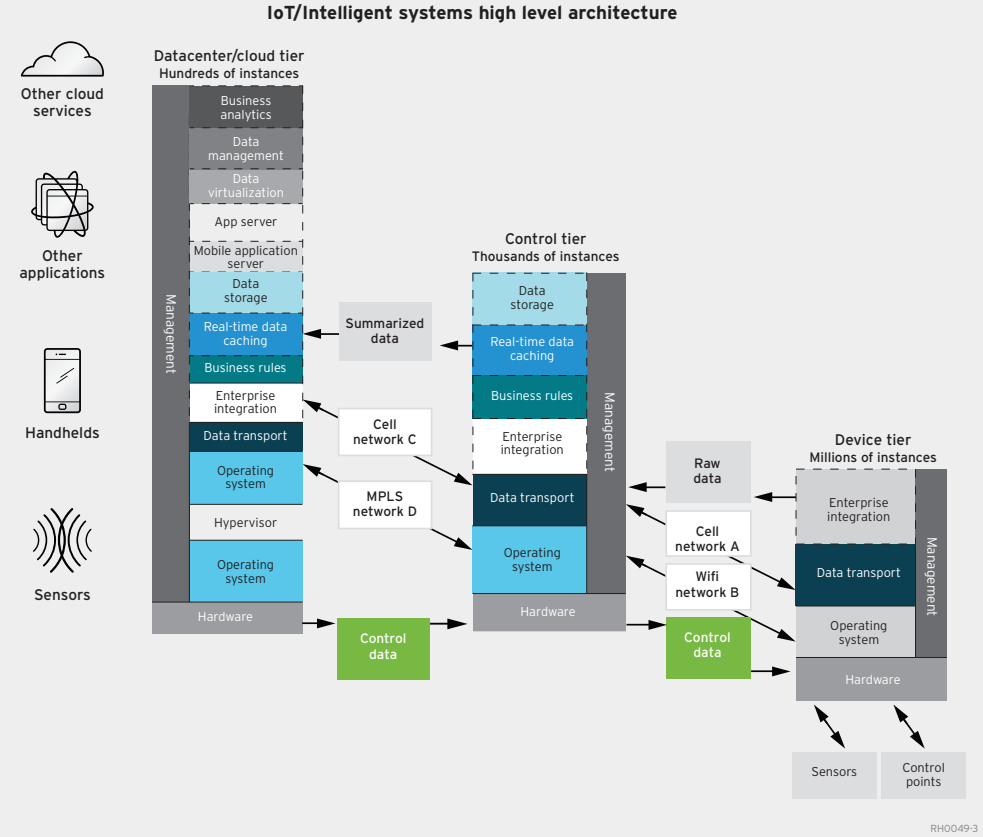

Figure 1. The distributed architecture includes distinct device, control, and datacenter and cloud tiers.

The device tier encompasses a wide variety of intelligent endpoints, including mobile computing devices, wearable technology, remote sensors and controls, and autonomous machines and appliances. Standards-based wired and wireless networking protocols are employed for connectivity, and standards-based data transport and messaging mechanisms are used to forward raw data and exchange control information. The device tier also includes gateways that facilitate interoperability with legacy devices and proprietary endpoints. An intelligent system might include hundreds of thousands or even millions of devices.

Alternative two-tier model

Red Hat also supports a two-tier intelligent systems solution in which devices interface directly with the datacenter and cloud tier. This model is ideal for consumer applications, which typically have longer decision windows and less stringent bandwidth requirements and don't require a control layer to offload processing functions.

CONTROL TIER

The control tier acts as an intermediary that facilitates communications, offloads processing functions, and drives action. It also analyzes tactical data and executes business rules and issues control information downstream. The control tier collects, summarizes, and stores device data and forwards it upstream. An intelligent system might include thousands of IoT controllers. The controllers may include gateway functionality to enable legacy device support.

DATACENTER AND CLOUD TIER

The datacenter and cloud tier performs large-scale data computation and acts as a repository for data storage and strategic analysis. It is also where most of the user and management interfaces are. It provides a virtual environment for instantiating applications, storing data, and executing complex event processing, distributed computing, and business analytics functions. The datacenter and cloud tier analyzes data and intelligently creates and adapts business rules based on historical trends. It collects and examines aggregated data from the control tier and disseminates business rules downstream. An intelligent system might include hundreds of datacenter and cloud tier instances where management and security control takes place.

A HIGHLY SCALABLE, RELIABLE, AND SECURE SOLUTION

Red Hat's tiered model lets your systems take full advantage of the Internet and cloud computing. Our open and standards-based solutions ensure maximum choice and cost savings.

HIGHLY SCALABLE

The distributed model enables ultimate scalability and superior economics. The intermediary control layer offloads raw data processing, business logic execution, and device interactions from the datacenter and cloud tier. It also reduces endpoint storage and processing requirements, enabling simpler and less-costly devices.

The control tier can be expanded in an incremental fashion to support increasing numbers of devices or growing data volumes. Control tier elements can be geographically distributed to optimize performance (balancing compute, network, and storage resources) and economics (containing network bandwidth costs).

HIGHLY RELIABLE

The hierarchical topology is inherently resilient at every level and between levels. Architects can implement redundant elements and domains to eliminate single points of failure and deliver high service levels. A properly engineered system with highly reliable networking, compute, and storage elements can ensure continuous service availability for mission-critical applications.

HIGHLY SECURE

The distributed architectural model allows for multiple levels of security for ultimate protection. Architects can take a "defense in depth" approach to network and system security, implementing distinct security measures and practices (e.g. encryption, secure authentication, authorization, auditing, and patch and configuration management) at different tiers to isolate and contain attacks and to protect against the widest range of threats and vulnerabilities.

HIGHLY FLEXIBLE

By decomposing the system into distinct functional layers with standards-based interfaces, the tiered model gives you a choice in protocols and products. You can avoid vendor lock-in and mix and match components and suppliers to construct the best overall solution that meets your specific functional goals and budget constraints. The modular approach enables vendors to streamline product development and time-to-market, helping you accelerate business innovation.

RED HAT INTELLIGENT SYSTEMS SOLUTIONS

Whether you are designing a complete system or developing individual components of an intelligent system, Red Hat can help you eliminate cost and complexity, streamline development and integration, and accelerate time-to-market and system deployment. Our open standards-based middleware solutions and open operating platforms help you accelerate deployment, optimize performance, and address the stringent scalability, reliability, and security demands of the IoT.

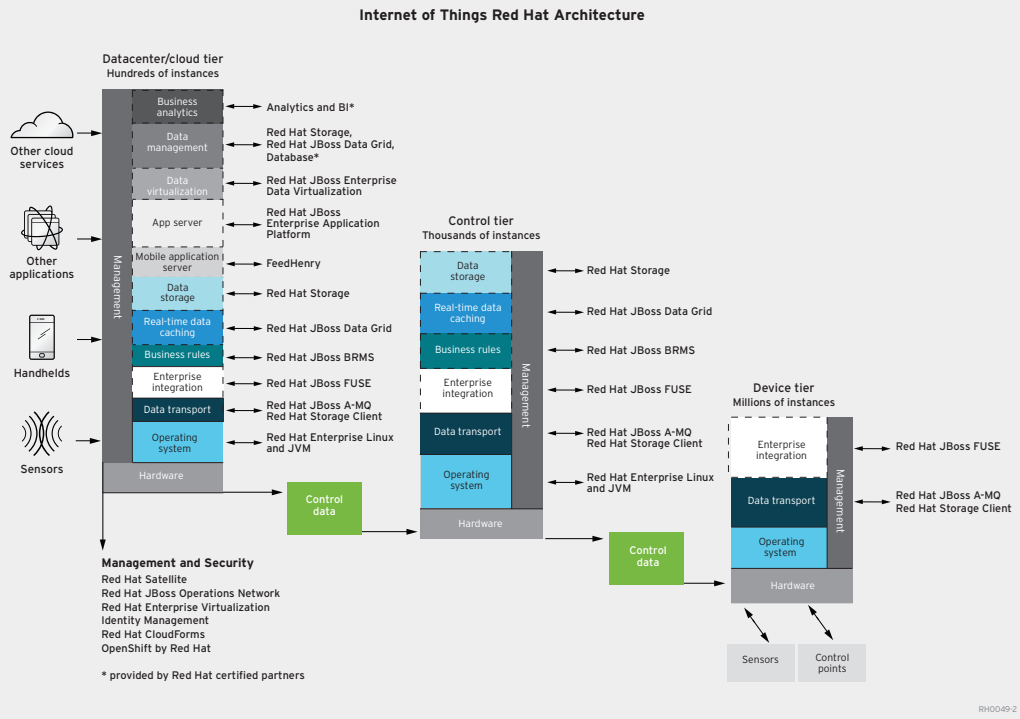

Figure 2. Red Hat offers open source platform, middleware, storage, cloud management, and virtualization technologies that span the entire intelligent systems solutions architecture.

Boxes indicated in white were defined in the previous tier. To prevent repetition, the definition is not repeated once established.

"Red Hat offers the best of both worlds; we have the backing of a leader in the industry and a custom-tailored solution for our product."

STEVE CHRISTIAN,
VICE PRESIDENT OF MARKETING,
VERIMATRIX, INC.

Red Hat's intelligent systems solutions include:

- **Red Hat JBoss® Middleware.** Red Hat's standards-based middleware portfolio helps you:
  - Accelerate IoT application development, deployment, and performance.
  - Efficiently integrate data and applications.
  - Automate business processes across physical, virtual, mobile, and cloud environments.

  The portfolio is based on a modular architecture, so you can pick and choose the individual components that are required for your application.
- **OpenShift by Red Hat.** Red Hat's flexible Platform-as-a-Service (PaaS) solution lets you quickly develop, host, and scale IoT applications in a cloud environment. The flexible platform gives you a choice of offerings, including online, on-premise, and open source project options.
- **Red Hat Enterprise Linux®.** The world's leading enterprise Linux distribution creates a solid foundation for intelligent systems solutions. One platform meets the needs of the datacenter, the controllers, and x86- or Atom-based devices. Red Hat Enterprise Linux reduces the complexity of customization and integration and provides a reliable, stable, and secure operating environment for IoT applications.
- **Red Hat Storage Server.** Red Hat's open, software-defined storage platform is ideal for large-scale IoT applications. Red Hat Storage Server manages unstructured data in physical, virtual, and cloud environments, combining file and object storage with a scale-out architecture to cost-effectively manage petabyte-scale data growth.

RED HAT'S INTELLIGENT SYSTEMS SOLUTIONS

TIER AND LAYER	FUNCTION	RED HAT SOLUTION
Device tier		
Enterprise integration and data transformation layer	Converts data payload from legacy or proprietary formats	Red Hat JBoss Fuse
Data transport layer	Moves data asynchronously between sensors and control points using open standards-based messaging	Red Hat JBoss A-MQ
Operating system layer	Provides the base upon which middleware and applications run; provides the Java™ Development Kit (JDK) for above layers; and provides the foundation for a secure, maintainable and scalable IoT and Intelligent Systems implementation.	Red Hat Enterprise Linux
Control tier		
Real time data-state layer	Stores real time in-memory key/value pair data, which is monitored by a business rules management system (BRMS) for action	Red Hat JBoss Data Grid
Data storage layer	Intermediately stores data that may be needed for tactical analysis, regulatory requirements, or other needs	Red Hat Storage Server
Business rules layer	Matches patterns in data and takes action based on predefined business rules	Red Hat JBoss BRMS
Enterprise integration layer	Automates routine services for applications—e.g. data routing, transformation, splitting/aggregation, and protocol mediation	Red Hat JBoss Fuse

"When we need help, we can escalate issues to Red Hat and get rapid service from their support and engineering teams. That makes us very nimble when resolving issues and allows us to impress customers with our service levels."

DAVE CIABATTONI,
SENIOR DIRECTOR OF GLOBAL RESEARCH AND DEVELOPMENT, LABVANTAGE SOLUTIONS, INC.

TIER AND LAYER	FUNCTION	RED HAT SOLUTION
Data transport layer	Moves data asynchronously between sensors and control points using open standards-based messaging	Red Hat JBoss A-MQ
Datacenter and cloud tier		
Business analytics layer	Analyzes data and intelligently adapts business rules based on historical trends	Red Hat JBoss Data Grid
Data storage layer	Stores data for long-term analysis	Red Hat Storage Server
Data virtualization layer	Abstracts data and decouples business applications from devices	Red Hat JBoss Data Virtualization
Application server layer	Runs applications and services	Red Hat JBoss Enterprise Application Platform

Table 1: Each tier of Red Hat's intelligent systems solutions architecture is broken out into distinct functional layers. The corresponding Red Hat solutions are listed for each layer.

INDUSTRY USE CASES

REQUIREMENTS	RED HAT DIFFERENTIATORS	EXAMPLES
Energy and utilities		
Implement smart grids and distribution systems Proactively manage usage and balance sources to optimize economics and conserve energy Contain carbon emissions	Reliability and security to ensure continuous service availability and protect against sabotage Compliance with industry regulations Support to keep the grid up and running	Meter control and data management Energy management Dynamic demand management Substation automation
Healthcare		
Help healthcare providers improve quality of care and patient outcomes Reduce healthcare costs Improve communications and information sharing across disciplines and systems	Reliability for life-saving applications Performance for measuring and processing massive data volumes in real time Compliance with governmental regulations like HIPAA to protect patient privacy	Medical imaging Healthcare management Patient monitoring Electronic medical and health record management
Transportation		
Implement smart systems for airline, automotive, shipping, rail, and roads Improve efficiency, predictability, and safety Contain costs and conserve energy	Performance and reliability for analyzing and managing real-time transportation data Security to protect against malicious attacks Support to keep transportation systems running around the clock	Fleet and freight optimization Traffic management Terminal operations Baggage management Ticketing and fare systems On-board entertainment and guidance

REQUIREMENTS	RED HAT DIFFERENTIATORS	EXAMPLES
Retail		
Help retailers reach buyers at the right moment with the right offer Provide insight into buying habits Proactively manage inventory levels and supply chain	Performance and reliability for revenue assurance Security and compliance for financial transactions Support to keep retail systems running smoothly	Point-of-sale systems Retail kiosks Card readers Inventory management Workforce management Security and loss prevention

Table 2: Examples of Red Hat intelligent systems applications in sample industries

CONCLUSION

The Internet of Things is reshaping enterprise computing. Next-generation intelligent systems will help you transform raw data into meaningful and actionable information that increases productivity, improves decision making, and boosts business results.

The magnitude of the Internet of Things creates unprecedented architectural challenges for IT planners. Intelligent systems will analyze and act upon massive amounts of data gathered from millions of autonomous devices. Red Hat's intelligent systems solution lets you take full advantage of the IoT without compromising security or service quality. Our standards-based operating platforms, virtualization technologies, storage, open hybrid cloud, management, and middleware solutions address the most stringent scalability, reliability, and security requirements so you can take on the IoT with confidence.

"As the leader in enterprise open source technology, Red Hat provides a unique value proposition in the embedded and intelligent systems market by allowing customers to experience RedHat's proven security, reliability, and scalability outside thedatacenter."

MARK ENZWEILLER
SENIOR VICE PRESIDENT OF GLOBAL CHANNELS AND ALLIANCES, RED HAT

NEXT STEPS

To learn how Red Hat can help you design or develop a comprehensive intelligent systems solution visit www.redhat.com/embedded.

For more information, download the following Red Hat whitepapers:

- "Beyond smart devices: Building an intelligent system with Red Hat"[2]
- "How Red Hat delivers a secure enterprise platform for next-generation datacenters"[3]

2 https://engage.redhat.com/content/beyond-smart-devices-s-201404090208

3 http://www.redhat.com/resourcelibrary/whitepapers/red-hat-secure-enterprise-platform

ABOUT RED HAT

Red Hat is the world's leading provider of open source solutions, using a community-powered approach to provide reliable and high-performing cloud, virtualization, storage, Linux, and middleware technologies. Red Hat also offers award-winning support, training, and consulting services. Red Hat is an S&P company with more than 70 offices spanning the globe, empowering its customers' businesses.

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