



PACIFIC CONTROLS DRIVES INTERNET OF THINGS INNOVATION

New machine communication protocol and intelligent data gateway drives new values



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The convergence of smart connected devices and cloud computing is unleashing an age of anytime, anywhere connectivity that is fostering entirely new modes of customer interaction and service delivery. However, to realize the full potential of the Internet of Things opportunity, customers will need new tools and technologies. Pacific Controls G2021 services gateway and embedded integration tools simplify device connectivity, management and data services by providing an innovative platform that integrates distributed devices with business enterprise applications providing users and developers a path for building open, scalable applications and smart services.

Many diverse businesses are now discovering the concept of connectivity and smart services. The opportunities driven by this trend are enormous and everywhere. However, the existing tools that support the development of smart systems are not providing the full measure of value they could. The next chapter in the smart sensors, machines and systems arena will be driven by new tools and platforms that will help product OEMs, service providers and enterprise users realize more value by providing a unified solution framework that strips out unnecessary complexity and costs and, ultimately, leverages intelligence in devices, networks and cloud-based services.

THE CONVERGENCE OF NETWORKED COMPUTING WITH REAL TIME MACHINE INTELLIGENCE IS DRIVING THE NEED FOR NEW CAPABILITIES

Evolving Internet of Things Technologies

Machine communications or the Internet of Things and cloud computing are combining to create new modes of asset intelligence, collaboration and decision making. This convergence is informing significant new capabilities in which inputs from machines, people, sensors, video streams, maps, news feeds, and more are digitized and placed onto networks. These inputs are integrated into systems that connect people, processes, and knowledge to enable collective awareness, efficiencies and better decision making.

This story is about the intersection of embedded software tools, intelligent device networking and cloud computing services which together have the potential to create a new “superset” of value in the marketplace.

Each of these technologies inherently have standalone value: embedded tools enable smarter more feature-rich products, device connectivity fosters information sharing and awareness and cloud computing offers significantly easier to use and lower cost data management.

What is important about this next wave of M2M, IoT and Smart Systems is the combined impact of these technologies. While there is standalone value in each of the innovations, it is the combination of all three technologies that will allow computing technologies to inform real-world physical systems.

This white paper is about a new Internet of Things (IoT) gateway and software tools offering from Pacific Controls which we believe has the potential to significantly change how solutions for smart connected devices are designed, deployed and managed.





About Pacific Controls

Pacific Controls (PC) is a global provider of end-to-end managed application services and solutions for machine-to-machine (M2M) and Internet of Things applications.

PC innovation lies at the intersection of three core capabilities:

- machine and device data platforms
- end-to-end managed service delivery, and
- IT infrastructure integration

Pacific Controls is at the forefront of platform, data infrastructure and service delivery innovation for enterprise and publicly managed solutions partnering with leading product OEMs, carriers, service providers, governments and diversified enterprises to help fully leverage smart connected devices, machines and the Internet of Things and People.

For more information visit www.pacificcontrols.net

Convergence Drives New Internet of Things Value

The business and technology development history of the critical elements that comprise smart connected systems embedded software, device connectivity and now cloud computing have all evolved in separate cultures and silos. That's not a good thing when

defining and deploying real-world technology to deliver smart connected systems innovation. M2M is a story of "piece-meal" technologies cobbled together from disparate supply-side vendor segments that have, for the most part, never really spoken, communicated or learned from each other.

Because all of these technologies have evolved in relative isolation from real-time, real-world devices and systems, developers working on machine-based applications and smart systems are waking up to new possibilities, including:

- The need to integrate sensors and devices across extremely diverse domains, utilizing varied networks and many protocols.
- The rapidly rising requirement for sensor and machine data to be interoperable with a growing array of applications and systems over open networks.
- The requirement for a unified family of software and tools to develop smart connected device data management today's diverse software offerings and fragmented supplier community will not meet market needs.
- The maturation of cloud computing technologies and the related lower cost of integrating IT capabilities with real-time devices and systems.

This is where the new values of Pacific Control's Multi-Services IoT Gateway and Embedded Device Communication Protocol as well as the company's Galaxy 2021 Platform really come into focus.

PC has recognized that the intersection of these technologies creates a differentiated business model by cleverly combining their potential. All three technologies need to be interwoven and mutually supportive, and increasingly, we believe success only goes to the player that effectively utilizes the combined potential.

PC HAS RECOGNIZED IOT TECHNOLOGY CONVERGENCE CREATES NEW USER AND CUSTOMER VALUE

Sensors and Machines Systems Require New Development and Integration Tools

Our society is at the cusp of a "perfect storm" of network connectivity. This phenomenon is not just about the dichotomy between people communicating with people or machines communicating with machines: it also includes people communicating with machines (e.g. a networked ATM), and machines communicating with people (e.g. automated stock ticker alerts on your smartphone).

The concept of network effects states that the value of a network grows exponentially with the number of nodes connected to it. Along with the value, however, so too grows the complexity of the software integrated into devices and the reliance on people and organizations developing and supporting these systems to effectively manage the. With the rapid growth of wireless networks from cellular to Wi-Fi to sensor networks connecting devices to the Internet has never been easier. Many new classes of devices are becoming network enabled. The fact that a rapidly expanding range of devices have the capability to automatically transmit information about status, performance and usage and can interact with people and other devices anywhere in real time points to the increasing complexity of these devices. For example,

software for the average mobile phone contains over 10 million lines of code. Over the last five years, software in automobiles has grown from an average of 35 million lines of code to over 100 million. The astronomical growth of features and functions within and among connected devices pushes the bounds of what designers of software for products ever had in mind.

Some basic design principles must be put in place to guide the development of smart connected devices and systems. It demands that we design not only devices and networks but also data and information management systems in ways not well addressed by current technologies.

The growing scale of interactions between feature-rich devices and the antiquated tools available today to develop them fall far short of what's really needed.

The tools we are working with today to make products "smart" were not designed to handle the scope of new capabilities, the diversity of devices

and the massive volume of data-points generated from sensor, device and machine interactions. These challenges are diluting the ability of engineering organizations to efficiently and effectively manage development. The fragmented nature of software offerings available today and the growing complexity of IoT and M2M applications make it extremely difficult to build effective systems.

TODAY'S ANTIQUATED TOOLS CANNOT ADDRESS THE GROWING SCALE OF INTERACTIONS BETWEEN FEATURE-RICH NETWORKED DEVICES

Pacific Controls Internet of Things Innovation

What Pacific Controls has recognized is the need for a development approach and an integration platform that can leverage embedded development tools, connectivity and device data management in a unified manner a unified approach with an architecture that's not too complex for product OEMs, developers or users to utilize.

Customers expect evolving software tools to be functional, ubiquitous, and easy-to-use. Within this construct, however, the first two expectations run counter to the third. In order to achieve all three, a new approach is required a unified development, integration and management platform for smart connected devices.

Next Gen IoT Gateways

Pacific Controls recently introduced a Multi Service IoT gateway which is an integrated, headless wireless gateway that enables communication with on board systems, machines and sensors.

The gateway enables real time communications with diverse machines and devices by providing a rich range of RF technologies including cellular, WiFi, BlueTooth, and GPS to maximize the availability of communication links at minimal cost.

The gateway's flexible architecture addresses critical requirements including:

- device connectivity and management;
- device discovery and configuration management;
- bi-directional communications;
- data aggregation, normalization and management; and
- cloud and enterprise IT systems integration

THE TOOLS WE ARE WORKING WITH TO MANAGE "SMART" MACHINES WERE NOT DESIGNED FOR TODAY'S DATA VOLUME AND COMPLEXITY

PC's Multi-Services Gateway and Embedded Device Communication Protocol offering is a device connectivity, management and data integration platform that quickly connects devices in order to build and manage end to end M2M and IoT applications.

Their development represents a true shift in thinking about how devices and systems will be integrated and how they will interact.

Key elements they have addressed include:

- **Optimized for Diverse Domain Communications Protocols:** Providing a rich array of field device and machine communications protocols, including industrial, building/facility and mobile/automotive protocol support and integration;
- **Software Defined Device and Machine Integration:** PC's architecture decouples the relationship between "data producers" and "data consumers" allowing developers to freely design and build multiple parallel relations between any device and any application with no dependencies and no limitations;
- **Real-Time Data Aggregation, Normalization and Management:** The platform is designed for real time data aggregation, management and actions. It filters and aggregates sensor and device data locally as well as aggregates and integrates data with Web services and higher level systems enabling the continuous comparison of device data to various parameters in real-time no matter what type of device data transactional, unstructured or time series;
- **Automated Systems Trouble Shooting and Support:** Sophisticated control logic and rules management can be applied to streaming device data to trigger business decisions in real-time as well as deploy software agents (or Gbots) to analyze and trouble shoot systems and devices.
- **Security at the Device and at the Network Levels:** Security is addressed throughout the device and IoT solution lifecycle, from the initial design to the operational environment.

We are reaching a critical juncture in market development where developers will soon be crying out for a completely new approach one where the invested effort in developing capabilities and applications can be utilized again and again across an ever broader spectrum of devices and connectivity and integration schemes.



Edge Device Communication Protocol (EDCP)

Pacific Controls' EDCP is based on years of machine-based software development and integration.

EDCP is a software framework for creating smart gateway devices and IoT solutions. It enables machine communication, filters and aggregates sensor and device data locally as well as integrates data with Web services and higher level systems.

Its primary features include:

- Data Acquisition and Logging;
- Data Normalization;
- Data Analysis;
- Data Transmission;
- Control;
- Web Services; and,
- Remote Management.

EDCP runs on a variety of hardware platforms and is flexible, extensible, lightweight and secure as an IT framework for adding intelligent networked devices to create Internet of Things solutions.



CUSTOMERS EXPECT EVOLVING SOFTWARE TOOLS TO BE FUNCTIONAL, UBIQUITOUS, AND EASY-TO-USE

When telephones first came into existence, all calls were routed through switchboards and had to be connected by a live operator. It was long ago forecast that if telephone traffic continued to grow in this way, soon everybody in the world would have to be a switchboard operator. Of course that has not happened, because automation was built into the systems to handle common tasks like connecting calls.

We are quickly approaching analogous circumstances with the proliferation of smart connected devices. Each new device requires too much customization and maintenance just to perform basic tasks. We must develop software and methods to automate development, facilitate re-use, and easily connect and integrate device data or risk constraining the growth of this market.

PC has designed a software platform and development tools that work together seamlessly, securely and safely across diverse devices and supports interoperability over long application deployment cycles.

Optimizing Diverse Communications Schemes

The Internet of Things, in many ways, presupposes the existence of a zero infrastructure, adhoc network that

makes seamless peer-to-peer physical connections possible. Obviously, billions of devices of wildly varying types cannot each receive individual attention and configuration by humans, or conform to elaborate prior specifications. If it literally takes a trained network engineer to install a smart light bulb, the Internet of Things is never going to work users must be able to do this without even realizing there is a network there at all.

Many schemes and 'standards' for device connectivity already exist. But of course, all those 'solutions' add up to one big problem. Users don't want many standards; they want one solution. In the end, they just want it all to work seamlessly and therein lies the challenge networks of this scale and this application diversity have never been successfully assembled before.

PC realizes that device communications technology has evolved to the point where a rich array of field device and machine communications protocols, enabling device integration across diverse domains, such as industrial, commercial and consumer focused applications.

PC's multi-services IoT gateway enables integration of a wide range of protocols from automotive, home automation and industrial automation protocols, to protocols supporting device in smart city and telematics applications.

THE NEXT BIG STEP IN MACHINE-BASED SYSTEMS WILL BE THE MOVE TO SOFTWARE-DEFINED MACHINES

Distributed Software Defined Machine Data Management

Capturing the real value of smart connected devices goes much further than providing simple connectivity and databasing. For example, real pervasive managed services will allow networked, embedded devices to execute remote applications as if those applications were part of the internal operating system. Devices will need to host intelligent software components that communicate to other devices directly (peer-to-peer) or to logical collections of devices (peer-to-group) in any programming language, over any network and do so autonomously. This is a big leap from where we are today.

The bit, the byte, and later the packet made possible the entire enterprise of digital computing and global networking. Until the world agreed upon these basic concepts, it was not possible to move forward. The next great step in Information and communications technologies completely fluid information and fully interoperating machines and devices requires an equally simple, flexible, and universal abstraction schema that will make information itself truly portable in both physical and virtual space, and among any conceivable information devices and systems. For the

Internet of Things to really take off, radical new thinking about information technology must begin at the most basic levels, with new conceptions about how devices, information, people and systems will interact.

The next big step in machine based systems will be the move to software defined machines. Pacific Control's Embedded Device Communication Protocol (EDCP) provides just such an extensible and universal abstraction layer for integrating sensor, device and machine data. EDCP enables device data normalization and filtering, whether its structured, unstructured or time series. This obviates the notion that somehow all of these IoT systems will push all of the streaming device data back to a cloud based system for aggregation and processing. The "physics" of these systems will not allow for that scale of data to be effectively managed in the cloud.

This view represents the big difference in how the "IT culture" views real time and operational systems. If you left the architecting of these systems to the IT professionals, they would all be direct descendents of the corporate main frame, and work on the same "batched computing" model an archival model, yielding a historian's perspective where information about events is collected, stored, queried, analyzed, and reported upon. But all after the fact.

GIVEN THE IMMATURE STATE OF TODAY'S REAL-WORLD SYSTEMS, MOST PEOPLE HAVE TROUBLE GRASPING THE POWER DATA MANAGEMENT CAPABILITIES ENABLE

Reliability And Certifications

Given the diverse and often harsh environments such a platform product must perform in, ruggedness and reliability are critical. Pacific Controls IoT gateway adheres to the following:

Environment

- Operation temperature: -20 C ... +70 C
- Storage temperature: -40 C ... +80 C
- Relative humidity: 95 % (non-condensing)

Enclosures/Housings

- NEMA 2 (IP40) Housing
- Dimensions: (W)140 x (D) 90 x (H) 32 mm

Certifications:

- CE
- EN 61000-6-2:2005 EMI/EMC Certification Compliance
- IEC 60068-2 Mechanical Vibration, Bump and Shock test compliance
- UL/EN 61010-1 Electrical safety compliance
- FCC Part 15: Subpart B Section 15.107 and 15.109

That's a very different thing from feeding the real-time inputs of billions of tiny "state machines" into systems that continually compare machine state to sets of rules and then do something on that basis. IoT and machine-based systems will need to be based on highly distributed architectures.

The Real Value Is In The Management of Data

Machine builders, service providers and users need new tools to liberate the intelligence in the world of connected device data. Tools need to be able to conduct a search or query that acts on unstructured, transactional and real time data simultaneously. This would allow users to determine where deeper analytics or the creation of an ad hoc business process can add value.

The actual sensing of physical parameters is done by different sensor endpoints which typically provide raw measurements, or its accomplished sometimes by a machine controller which provides information over various communication protocols. In either case, the value inherent in the system is really in the ability to filter and normalize the data into information that can be acted upon. PC's gateway enables these capabilities at the edge no matter what type of data or communication protocol is involved.

Given the immature state of today's real-world systems, most people have trouble grasping the power and importance these capabilities enable. The ability to normalize and utilize data near the point where its created and be able to detect patterns in data is the holy grail of Smart Systems and IoT because it allows not only patterns but a whole higher order of intelligence to emerge from large collections of ordinary data. The implications are obviously immense.

Automating Systems Trouble Shooting and Support

Of all the new capabilities that Pacific Controls' IoT Gateway technology enables is the ability of systems to automatically learn from history; learning to detect hard-to-discern patterns from installed equipment data that supports the development of algorithms that automate various response and support scenarios.

Galaxy Gbots are a family of system management and customer support software tools autonomous software agents which observe and act upon device, equipment and systems behavior. Gbots are enabled by "self-learning" software agents installed in devices and equipment and implemented as a managed service.

PC HAS DESIGNED AN IOT GATEWAY AND SOFTWARE TOOLS THAT WORK TOGETHER SEAMLESSLY, SECURELY AND SAFELY

These agents or "bots" are able to sense conditions (e.g. electrical system overload protection), understand customer/user preferences (e.g. is the temperature too high) and ultimately identify issues within a system to repair or initiate actions to optimize its performance.

Galaxy Gbots are not about technological drama or "futurism." It's about matching feasible technology to real customer needs and delivering it in a manner that aligns with the industry's behavior and needs. Gbots are a significant step function change in the way systems will be designed, deployed, managed and supported in the future.

Securing Devices and Networks Is Critical

With the disjointed, patchwork security solutions presently in place and the lack of general market understanding of the critical role security will play, particularly among larger established software players, of what is needed for device security, the field is wide-open for any almost any viable solution.

Nevertheless, today's IoT systems and solutions must not be based on stopgap security measures. IoT

systems today must be able to effectively manage the security requirements of disparate devices and have two main qualities: automation and homogeneity. It must handle common tasks without human intervention, and it must provide a single platform and interface for interaction with a wide range of devices. What is needed is new infrastructure software plus centralized business processes for dealing with security within and across a diverse range of device manufacturers and service providers.

Pacific Controls Embedded Device Communication Protocol and multi service gateway addresses security throughout the device and IoT solution lifecycle, from the initial design to the operational environment.

In this new IoT gateway platform and embedded software framework, PC has deployed a multi-layered approach to security that starts at the beginning when power is applied, establishes and retains a trusted communication link that can't be tampered with and enables devices to perform their individual tasks as well as, in a network context, recognize and counteract various threat scenarios.

Security at both the device and network levels is critical to the operation of IoT systems.



PACIFIC CONTROLS IS PROVIDING A TRUE END-TO-END SOLUTION

A New Generation of IoT Managed Services and Systems

Technology advancements need to engender new system elements and new services. Correctly balanced, technology and new service delivery modes can help customers reach their goals of increased operating efficiency, reduced costs, automated system upgrades, and more efficient operations. Achieving this critical balance is the challenge that Pacific Controls' Galaxy managed services and enterprise delivery platform is aimed squarely at solving.

Galaxy is an end to end platform for managed services that proactively monitors assets, providing transparency into how critical "real world" systems are performing (buildings, smart grid assets, etc.), where critical faults lie, and where opportunities exist to significantly reduce operational expenses.

Galaxy is also a "Platform of Platforms." It is intended to reduce a significant percentage of the complexities of application development, management and delivery. The challenges of networking smart devices, developing M2M applications, integrating complex

IT systems and unifying services delivery in a coherent and cost-effective manner have been big hurdles to adoption that Pacific Controls and its Galaxy platform are finally addressing.

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About Harbor Research

Founded in 1984, Harbor Research Inc. has more than twenty five years of experience in providing strategic consulting and research services that enable our clients to understand and capitalize on emergent and disruptive opportunities driven by information and communications technology. The firm has established a unique competence in developing business models and strategy for Smart Systems and the Internet of Things.

