



## **Embedded and IoT Development with Renesas and SQL Embedded Database**

## Welcome to the Intelligent RZ/A Device Data Management Platform

Intelligent embedded systems and devices that produce and consume information are the basis for innovative new products that make informed decisions to improve our everyday lives. While these products span every market, including medical devices, industrial automation, home automation, appliances, automotive, and many more, their defining characteristic is the capacity to both collect and process data. Robust hardware and software solutions are required to develop these products, starting with the microprocessor and database software that is essential for the IoT device to collect data, analyze information, and make smart decisions.

The RZ/A family of microprocessors combine an ARM Cortex-A9 CPU with large on-chip RAM, graphics processing and standard interfaces necessary to collect, store, and communicate information. The on-chip RAM on RZ/A can eliminate the need to add external memory and the complexity of routing high speed memory signals, making for an extremely compact embedded platform with an MPU. The RZ/ is an ideal platform for ITTIA DB SQL, an embedded database library and development tool that uses simple concepts, such as tables and transactions, to save information safely and efficiently on flash media. Local tasks query tables with SQL to locate vital records instantly, while networked devices securely access and synchronize the same tables with remote database communication.

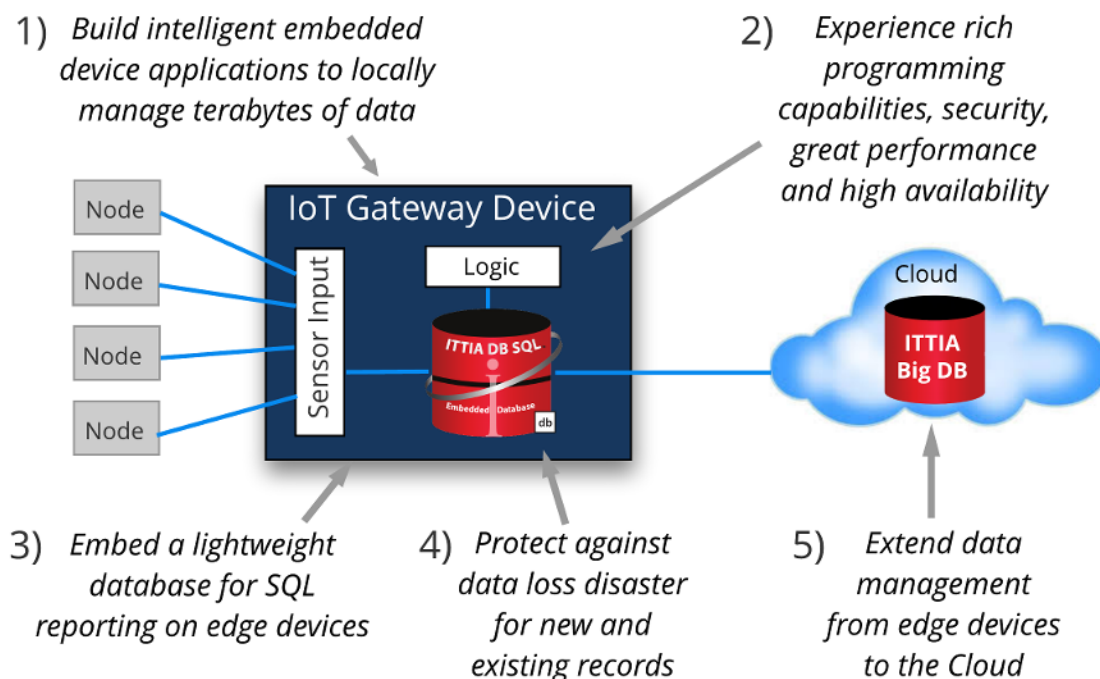


Figure 1: RZ/A and ITTIA DB SQL are ideal components for IoT Gateway Devices

The goal of this white paper is to introduce an important alternative to an in-house data management solution. When manufacturers choose to benefit from ITTIA DB SQL and RZ/A, they experience an out-of-the-box database product that is fully relational, easy to use, and completely integrated.

## **Moving Forward by Minimizing Total Cost of Development and Ownership for Device Data Management**

Saving data in a custom file format is an easy way to collect information as it becomes available on an embedded device. However, when data must be updated in place or organized in any way, every change introduces a risk of data loss or inconsistency if the device should fail unexpectedly. Storing records in ITTIA DB SQL database tables mitigates this risk and enables applications to search over a large volume of data.

When concurrent tasks share access to the storage media, it is important to never overwrite information that other tasks might be actively reading. Developers typically define critical sections to protect shared resources, using mutual exclusion to completely block shared access while a resource is being used. However, critical sections must be applied uniformly and should execute quickly, both difficult conditions to guarantee with flash media. ITTIA DB SQL automatically protects tables with database transactions, which allow concurrent tasks to safely and efficiently share access.

When data is shared continuously with web services or other devices, sending the same records more than once is very inefficient. Tracking the status of each record individually introduces significant overhead, but simply recording the newest record sent does not account for updated or deleted records. ITTIA DB SQL uses replication logging to track changes sequentially, enabling efficient bi-directional synchronization with other relational databases.

## Crossing Data Management Borders with Comprehensive Data Collection Features

The RZ/A1H+RSK Development Board provides rich interfaces for Internet of Things devices:

- I/O protocols such as SPI, UART, I2C on which sensors can be connected.
- Ethernet and WiFi over SPI or SD interface for internet/cloud communication.
- Graphical display with capacitive-touch input for robust HMI solutions.
- NAND flash and USB with ample capacity for persistent storage.

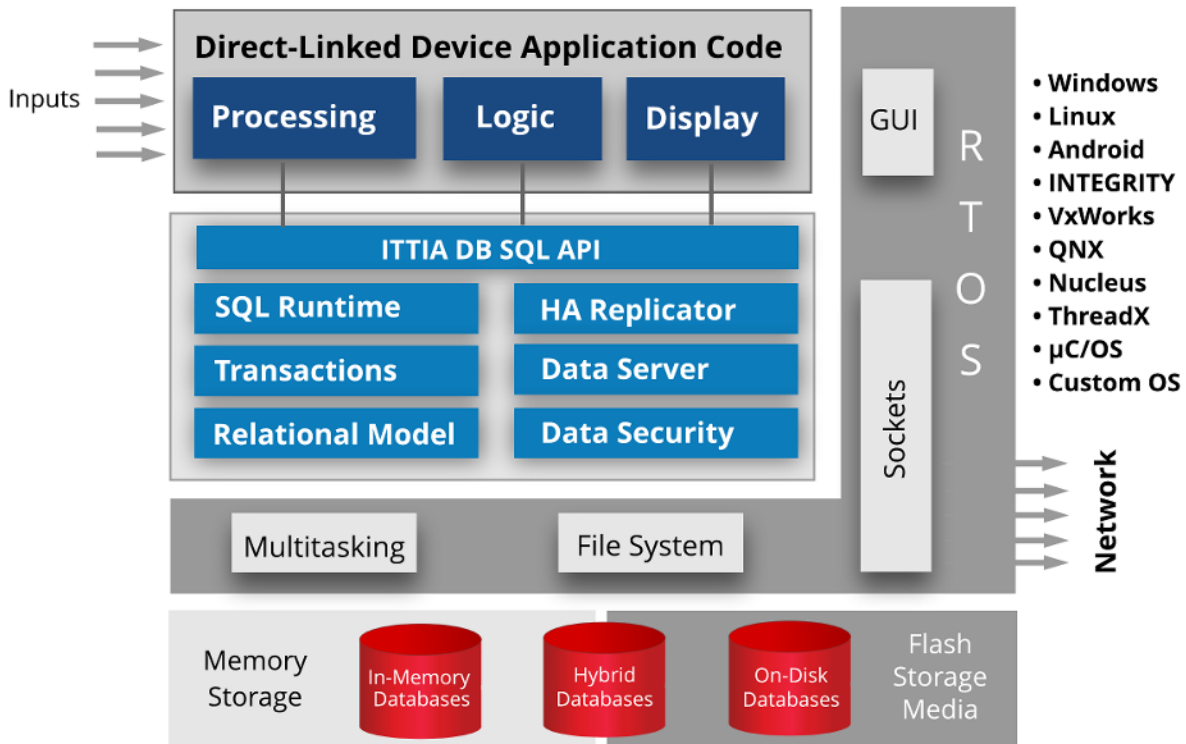


Figure 2: Components of a Device Embedded with ITTIA DB SQL

# Markets

Industrial Automation



Medical Devices



Automotive



Building Automation



Solar/Energy



Consumer Electronics



ITTIA DB SQL stores and retrieves information on the RZ/A with:

- Transactional Storage
- Data Modeling with Relational Tables
- SQL and Table-Direct APIs
- Secure Local and Remote Access
- Concurrent Transactions
- Replication and High Availability
- Rich Data Types Support
- Small Footprint
- On-Disk, In-Memory and Hybrid Data Management
- Connecting Embedded and Mobile Data to the Cloud

Together, the RZ/A and ITTIA DB SQL:

- Deliver a Complete Out-of-the-Box Development Platform
- Empower Developers with Full Relational Data Management
- Offer Excellent Ease-of-Use
- Exceptional Performance
- Much Shorter Development Cycle
- Greatly Reduced Time to Market
- Tremendous Savings on Development and Cost

## Strong Hardware Development Platform with a Focus on Continuous Data Management and Communication

Data collected on the RZ/A in an ITTIA DB SQL database can be communicated to other devices:

- **Tablet computers** can synchronize to review collected information later when the RZ/A devices is inaccessible.
- **Cloud servers** can pool information from many devices and relay information between them. Additional insight from data mining and other activities can be sent back to the RZ/A device.
- **Other embedded systems** can replicate data from the RZ/A to improve redundancy and overall resilience.

Replication and synchronization are an easy way to communicate information when data is already stored in a relational database.

## Stand for Efficiency, High Performance, and Advanced Concurrency

Database transactions and the relational model are simple concepts that allow applications to efficiently query information while it is continuously updated and accumulated.

On the RZ/A, ITTIA DB SQL application developers invoke functions to store data with features such as transaction logging, scalable index algorithms, isolated concurrency, replication, security, and data sharing features. Since ITTIA DB SQL is distributed with the application, no additional installation is required.

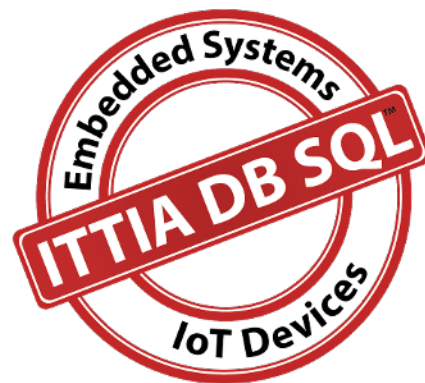
ITTIA DB SQL is well-suited for devices and embedded systems with limited resources and a dedicated user interface. These systems allow devices to gain intelligence by storing, managing and sharing large volume of data.

## Enterprise Freedom on Embedded RZ/A Platform to Manage Data

The Renesas Starter Kit+ for RZ/A has been developed to speed up device evaluation, code development and so reduce time to market. As the name suggests, an Renesas Starter Kit+ is a complete development kit for the Renesas RZ/A device family. ITTIA DB SQL offers robust, full-featured data management technology scaled down to meet the constrained resources of the RZ/A.

ITTIA DB SQL stores data in platform-independent format so that database files can be transferred to or from the RZ/A with no additional conversion steps.

ITTIA DB SQL is easily ported to any operating system capable of supporting the RZ/A, including Linux, Android, INTEGRITY, VxWorks, QNX, Nucleus, and  $\mu$ C/OS. ITTIA DB SQL can even be used without an operating system in single-tasking applications.



## ITTIA DB SQL Demonstration Application on RZ/A1H+RSK

Consider a scenario in the medical sector. A simple, non-invasive electronic patch, resembling a temporary tattoo, produces a continuous stream of information about a patient's health. And because a readout instrument is required to view and record this vital data, the RZ/A1 and ITTIA DB SQL provide an ideal platform for a device to collect and process the information produced by an electronic medical patch.

For example, a diabetic patient can use this information to monitor the level of glucose in their blood and take proactive measures. Should a medical emergency arise, the medical history stored on such an RZ/A1 device could prove invaluable to first responders, especially when combined with measurements from other medical equipment available in an ambulance. However, an urgent situation does not leave enough time to review all available information. The capability to rapidly process and query that information becomes essential.

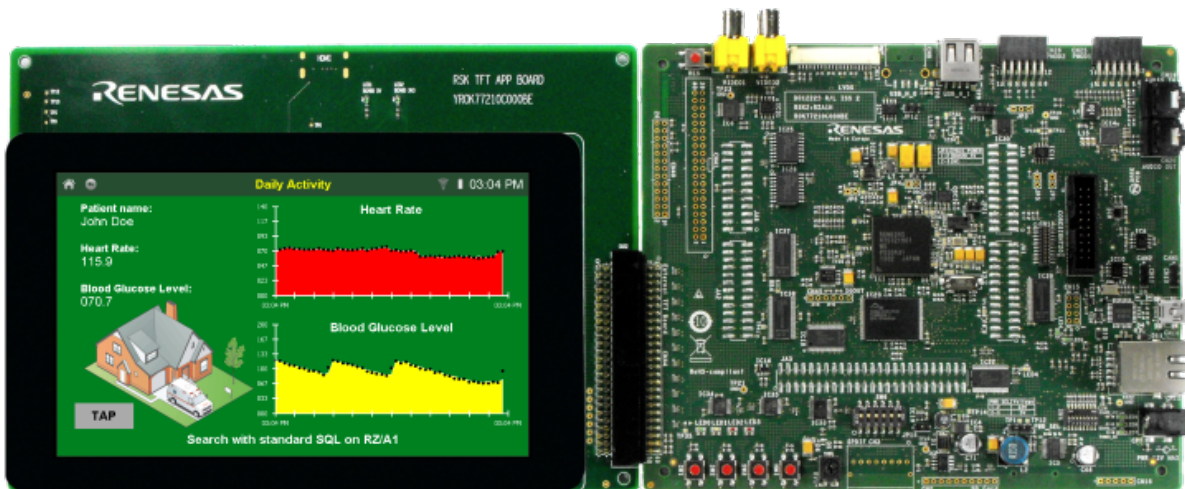


Figure 3: ITTIA Portable Patient Monitor Demonstration

ITTIA and Renesas have developed a sample application to demonstrate this scenario on the Renesas Starter Kit+ for RZ/A. The demo is run directly from QSPI flash, which stores both application code and image data, and uses no external memory. The large 10 megabyte internal memory of the RZ/A supplies the LCD frame buffer that is essential for interactive applications and a database page cache, which can be as small as 32 KiB.

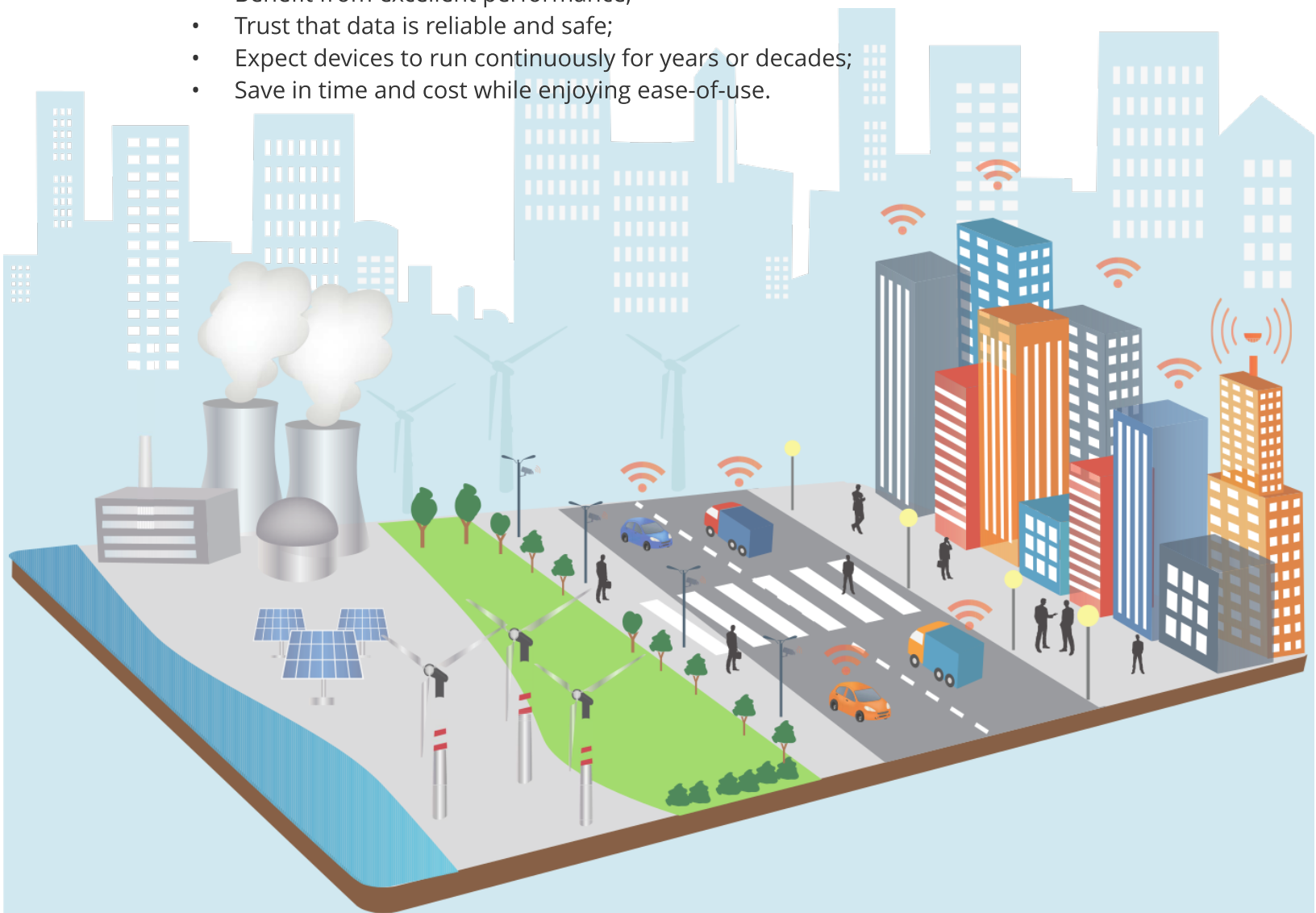
Application source code for this demonstration is available by request at:  
<http://www.ittia.com/platforms/renesas>

## Renesas plus ITTIA is the Right Formula for Innovation

The right development tools, including database and hardware, are required to build competitive products. Applications that produce detailed logs and accept remote configuration data benefit from this combination. By storing information in an ITTIA DB SQL database, it is easy to produce summary reports and exchange settings from any individual device. As secure information becomes stored and available on RZ/A devices, this data must remain secure. An encrypted ITTIA DB SQL database provides a safe and efficient location to store information.

With ITTIA DB SQL and RZ/A, manufacturers of embedded and intelligent IoT devices and gateways:

- Enjoy lower total cost of ownership;
- Experience the freedom to select an ideal operating system;
- Benefit from excellent performance;
- Trust that data is reliable and safe;
- Expect devices to run continuously for years or decades;
- Save in time and cost while enjoying ease-of-use.





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