

The Rational Rhapsody family from IBM

Collaborative systems engineering and embedded software development



Break down engineering and development silos

How do systems engineers and software developers, creating embedded and real-time applications in fields such as automotive, electronics, avionics controls, next-generation wireless infrastructures, consumer electronics, medical devices and industrial automation, collaborate across multiple disciplines and meet the complex requirements to deliver safe and robust systems—especially when there is little time to produce, let alone test, the systems and software before they go into production?

To overcome these challenges, IBM provides the IBM® Rational® Rhapsody® family of products, delivering key capabilities for the IBM Rational Solution for Systems & Software Engineering.

The powerful, flexible design and development capabilities of the Rational Rhapsody family of products provide a systems engineering and embedded software development solution that operates across the requirements, specification, design, implementation and testing phases of the development lifecycle. Throughout the development lifecycle, the Rational Rhapsody family assists in managing complexity through visualization, facilitates collaboration by making it easier to communicate design information with stakeholders and helps maintain consistency throughout the design to respond faster to ever-changing requirements.

The Rational Rhapsody product line provides flexible solutions, based on SysML/UML, that focus on the needs of systems engineers and embedded software developers. Tailored solutions are available for AUTOSAR, multicore, Android, MARTE, DDS, DoDAF, MODAF, UPDM and the UML testing profile. You can even create your own custom domain-specific language, using profiles and helpers to automate your development.

Building innovative products requires collaboration from cross-discipline teams, which may include mechanical, electrical, management, quality assurance and many others. Central design-sharing through IBM Rational Rhapsody Design Manager software helps the extended team to share, trace, review and analyze design and lifecycle information earlier to avoid costly integration errors later.

Additionally, support is available for advanced requirements management and analysis, customizable documentation generation, graphical prototyping, automated model-based unit testing, The MathWork Simulink integration and more.

Collaboration for faster, more agile design and development

Defining solid architectures and designs help teams address the growing complexity of today's embedded systems. Getting the design right is critical to helping teams break down the complexity to manageable pieces and reduce costly rework later. However, all too often design teams work in silos that lead to costly errors discovered late in the lifecycle.

With the introduction of IBM Rational Rhapsody Design Manager software, teams can integrate design into the overall systems engineering and software lifecycles to collaborate on designs across organizational boundaries, disciplines, supply chains and domains. Organizations can use design more effectively to manage complexity, mitigate risk and improve the overall quality, time and agility of their design, planning, development and delivery.

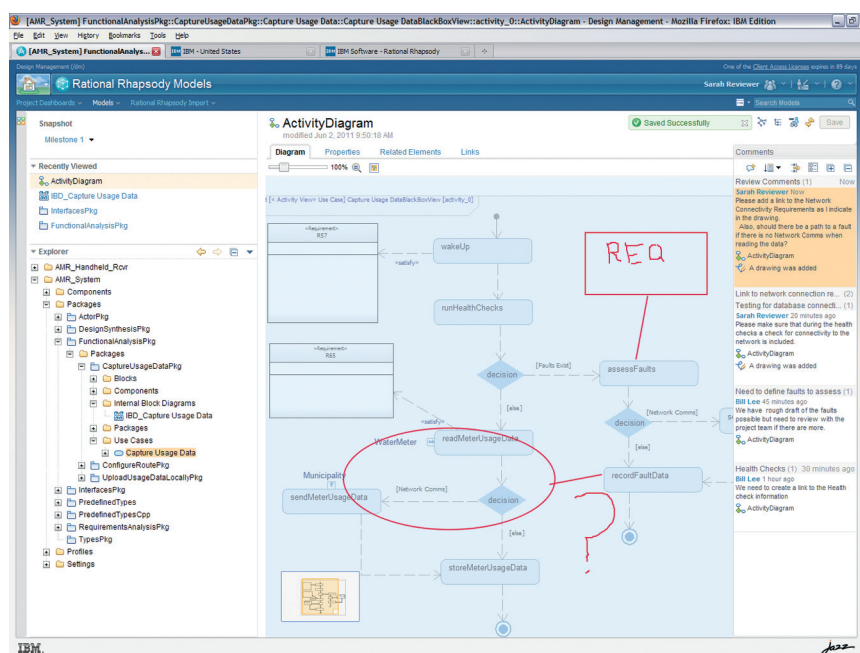


Figure 1. The web client view of Rational Rhapsody Design Manager enables the extended team to collaborate, share, review, search and trace design and lifecycle information.

Based on the IBM Jazz™ platform, IBM Rational Rhapsody Design Manager software provides additional design management capabilities to enable sharing and collaboration on designs by an extended team of stakeholders, inside and outside the organization.

- **Manageable.** Teams can store and manage Rational Rhapsody designs and other types of architectures, designs and models in a central location.
- **Searchable.** Teams can search through multiple designs by keyword. The search can include designs, design elements, attributes, descriptions and metadata information.
- **Accessible.** Teams can easily access design information through a web client to navigate, search and review designs.
- **Agile.** Team members can sketch design ideas and rapidly share them with key stakeholders, before turning them into more complete architectures.
- **Collaborative.** Systems engineers, software architects, software engineers and testers can collaborate with design stakeholders for design correctness, alignment with requirements, feasibility and compliance to organizational standards. Review cycles are automated: stakeholders can provide comments and mark up the actual designs, which can then be updated in Rational Rhapsody.
- **Traceable.** Rational Rhapsody Design Manager supports linking and traceability from design elements to other designs and lifecycle artifacts (architecture management, requirements management, change management and quality management) through Open Services for Lifecycle Collaboration (OSLC).

- **Consistent.** Rational Rhapsody Design Manager provides a single-source-of-truth workflow with requirements also stored on the Jazz platform to avoid synchronization issues.
- **Transparent.** Team members can obtain a real-time view to follow design management and other lifecycle activities through a web dashboard that is integrated with other Jazz-based products.

Leverage model-based systems engineering to manage complexity

The IBM Rational Rhapsody family of products provides systems engineers with the tools to specify a system correctly—and to communicate the design of the system more effectively to all stakeholders in the development process.

Focusing on the needs of systems engineers, IBM Rational Rhapsody Designer for Systems Engineers and IBM Rational Rhapsody Architect for Systems Engineers editions provide a SysML/UML-based environment to capture, analyze, structure and specify complex systems with tight integrations within the overall product lifecycle. Simulation is the key to prove a design is functioning correctly earlier in the development lifecycle to validate requirements when they are least costly to fix. Rational Rhapsody Designer for Systems Engineers software provides simulation for early validation through model execution and model-level debugging of designs.

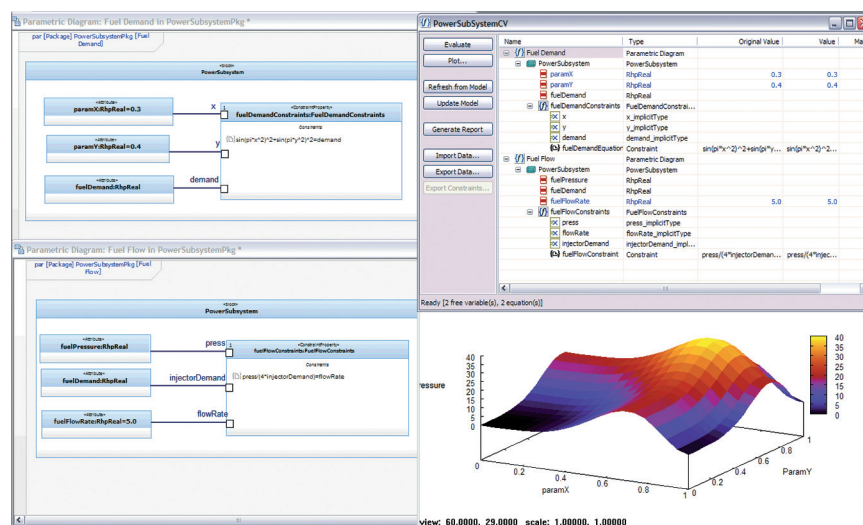


Figure 2. The parametric constraint evaluator helps you make better informed architecture and design decisions by showing the results of different parameters of SysML parametric diagrams.

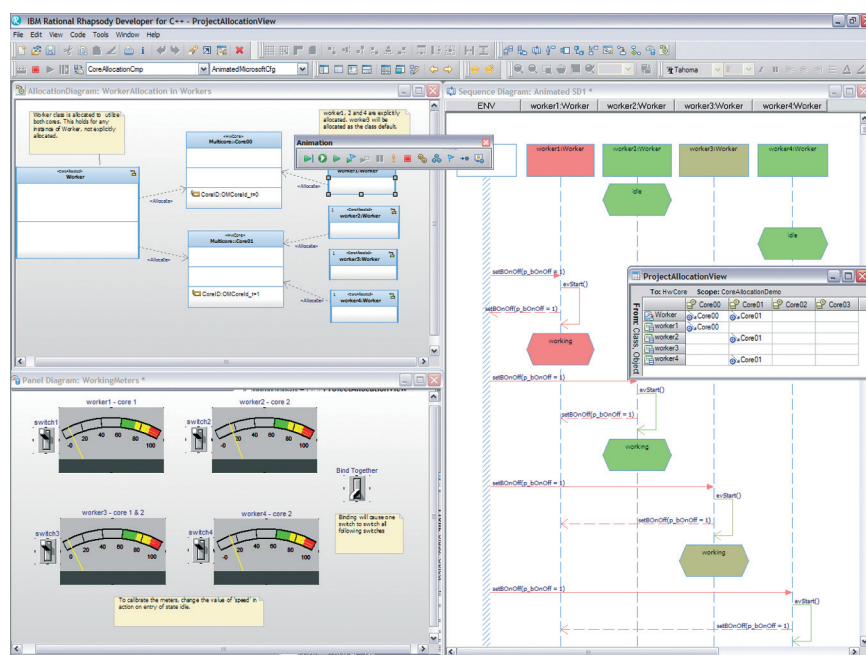


Figure 3. Rational Rhapsody software's advanced simulation capabilities and multicore support combine to assist in structuring multicore applications.

Rational Rhapsody solutions for systems engineering are designed to be:

- **Consistent.** Capturing designs using a SysML/UML-based environment enables systems engineers to clearly and unambiguously capture requirements and design. The check-model capability provided helps ensure that the model and its interfaces are complete and correct.
- **Validated.** Simulation capabilities in the Rational Rhapsody Developer and Rational Rhapsody Designer for Systems Engineers software enable execution of design behavior specified in activity diagrams or statecharts early in the development cycle when problems found are easier and least costly to address.
- **Optimized.** A parametric constraint evaluator assists in optimizing architectures or performing trades study analysis by evaluating SysML parametric diagrams.
- **Managed.** Rational Rhapsody Design Manager enables requirements from IBM Rational DOORS® software or other requirements stored on the Jazz platform to be referenced directly in the design, thus avoiding the need to synchronize requirements. Additionally, the Rational Rhapsody Gateway component of the Rational Rhapsody Tools and Utilities Add On product provides a powerful traceability solution that uses a bidirectional interface between the model and leading requirements management and authoring products, such as Rational DOORS software and IBM Rational RequisitePro® software—helping ensure that the design addresses all requirements.

- **Automated.** Helpers provide automation for systems engineering steps to avoid manual entry and help maintain consistency of design. Customizable report-generation capabilities found in the Rational Rhapsody Tools and Utilities Add On enable generation of documentation at the push of a button.
- **Intuitive.** The Rational Rhapsody Designer for Systems Engineers and Rational Rhapsody Architect for Systems Engineers editions present features and guidance to help new systems engineers become productive quickly.

IBM Rational Rhapsody solutions for software developers

IBM Rational Rhapsody Developer and IBM Rational Architect for Software provide a visual software development environment for C++, C, Java, C# or Ada programming languages. Developers can work in a flexible fashion in code or in the design with changes synchronized between both. Existing code can be visualized for reuse, better understanding and further development. Rational Rhapsody solutions plug into the Eclipse platform, enabling developers to use the code development capabilities of Eclipse and analysis and design benefits of Rational Rhapsody software in a single environment.

The IBM Rational Rhapsody Developer family can help accelerate development by generating full code for an application, including the behavior of state charts, initialization code and many build artifacts for leading real-time operating systems. The provided execution framework enables applications to be built and tested on a host platform before the target hardware is available, thereby enabling software development to start earlier. These applications can then be quickly retargeted to the hardware—empowering developers to prove functionality earlier and companies to leap ahead of their competition.

Rational Rhapsody Developer solutions can generate applications in C, C++, Java, and Ada programming languages that target 8-bit, 16-bit, 32-bit, 64-bit or multicore targets using a real-time framework. A documented reference workflow,

optimized framework with MISRA C/C++ and ARINC 653 support and automated traceability of high- and low-level requirements to design and code are available to help teams working on products with safety concerns, such as automobiles, aircraft or medical devices, comply with safety standards such as ISO 26262, IEC 61508, DO-178B, DO-178C faster.

Rational Rhapsody solutions for software development are designed to be:

- **Concurrent.** Software development can begin on the host to validate functional behavior or perform trade studies for a variety of targets, including multicore, early—even before target hardware is available. After the target is available, the developer can use target resources more efficiently by focusing on debugging target-specific issues.
- **Automated.** Combined with its real-time execution framework, IBM Rational Rhapsody Developer software can generate code from structural and behavioral model views, along with build artifacts, to produce an executable application for C, C++, Java or Ada more quickly than manual editing. It can meet many MISRA-C and C++ coding standards for projects concerned with coding standards.
- **Efficient.** Development projects rarely start from scratch; they're usually based on existing code and leverage third-party libraries. Rational Rhapsody solutions graphically represent existing code and take advantage of external code within the model to build and document applications and improve team communication.
- **Flexible.** Rational Rhapsody solutions enable a code-centric workflow, easing adoption of model-driven development (MDD). Whether changes are made in the model or within the code, they are dynamically updated in both. Developers who prefer a model-based approach can design at a higher level of abstraction, analyze and validate the design at the graphical level and produce code and documentation automatically. A combination of approaches is also possible.
- **Feature-rich.** The Rational Rhapsody family provides a feature-rich solution for designing, developing, testing and implementing robust, high-quality code in an environment that has multiple domain-specific language capabilities.

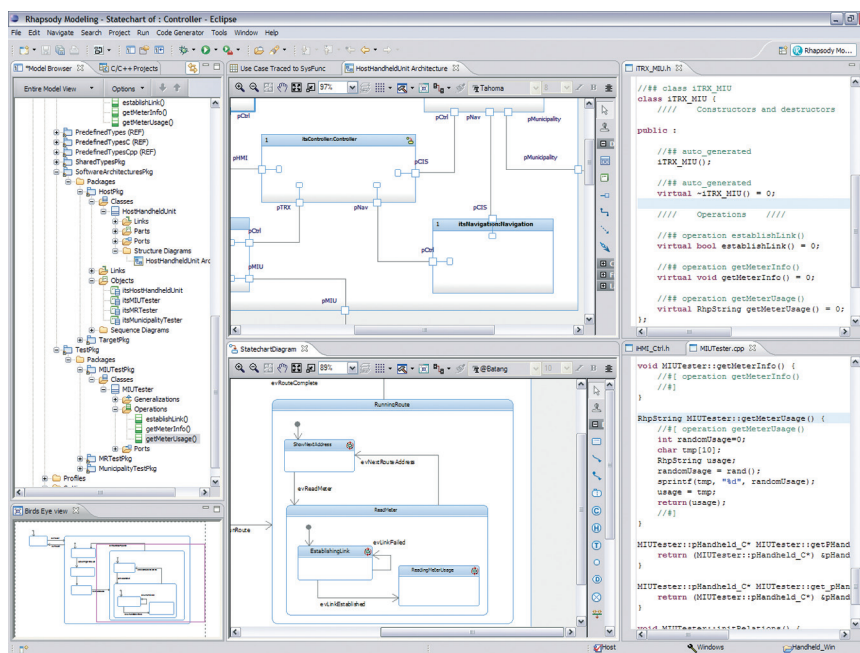


Figure 4. Rational Rhapsody solutions integrate into the Eclipse environment, as provided with Rational Team Concert for example, creating a powerful platform for model and code development and debugging.

Enhance quality and productivity with a world-class solution

The Rational Rhapsody environment for systems engineering, embedded software and testing concentrates on product depth for a truly world-class experience—one that has been hailed by critics as a top development environment for systems engineering, embedded software and testing. By integrating and automating the systems and software engineering process to achieve deployable systems, the open architecture of Rational Rhapsody solutions facilitates new levels of quality and productivity.

A flexible environment is provided that can be tailored to an organization's existing domain and tool chain by extending the language with domain-specific profiles. In addition, customization is available through powerful application programming interfaces (APIs), enabling development automation to increase productivity and enabling integration with other lifecycle and third-party tools, such as configuration management, requirements management and analysis or other modeling capabilities.

“We needed an integrated solution to optimize our process and procedures and provide our developers with the agility they need to respond to changes. This is what IBM Rational provided, from the requirements with DOORS to the code with Rhapsody”

—Project lead at international transportation company

Industry- and domain-focused solutions

The Rational Rhapsody family of products provides solutions focused on the needs of specific industries and technologies based on industry-leading modeling languages—SysML and UML—with extensions for many industry-specific needs, enabling systems and software engineers to work in the language best suited to the project's needs, regardless of industry or embedded device. Support for AUTOSAR is provided for development of automotive systems from concept to production code. Capabilities are included to assist in the development and visualization of applications targeting multicore processors and the Android platform for mobile device development. Further, the Rational Rhapsody product family supports DoDAF

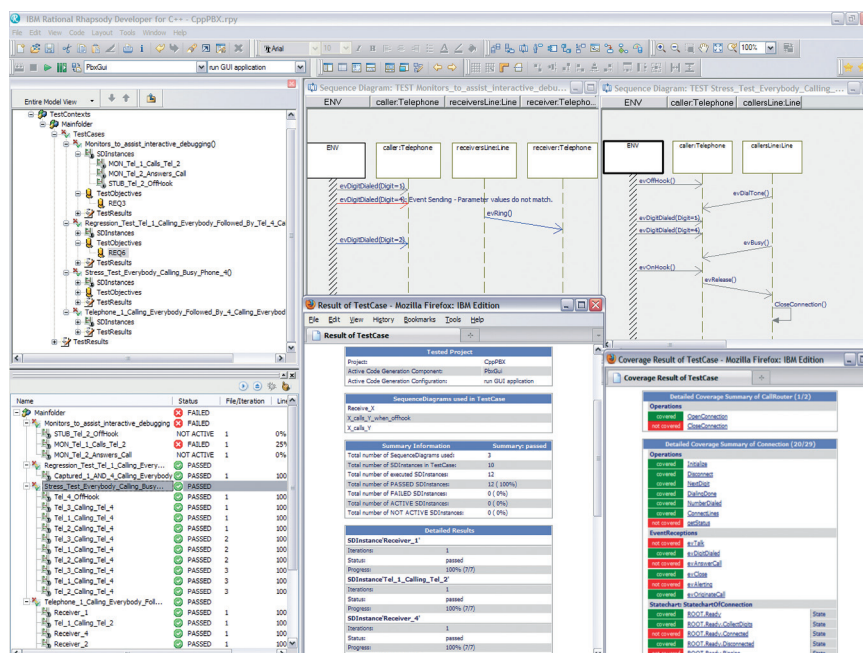


Figure 5. Rational Rhapsody TestConductor Add On can automate design validation, unit and regression testing by driving and monitoring test cases specified with UML diagrams.

(Department of Defense Architecture Framework), MODAF (Ministry of Defense Architecture Framework) and UPDM standards for structuring systems design. The solutions provide Data Distribution for Real-Time Systems (DDS) for developing applications that take advantage of publish-subscribe communications of data.

For industry-specific development, Rhapsody solutions are designed to be:

- **Consistent.** Because the diagrams in a Rational Rhapsody model are interrelated, changes to an element in one diagram are automatically propagated throughout the model, enhancing data consistency across systems.
- **Traceable.** The Rational Rhapsody for DoDAF, MODAF and UPDM Add-On solution uses standard UPDM, DoDAF and MODAF diagrams and notations to support the design, construction and analysis of compliant DoDAF or MODAF architectures. This enables engineers and developers to validate their architecture by simulating the model, automatically generating the derived products and generating comprehensive DoDAF or MODAF documentation while achieving traceability.
- **Reusable.** Rational Rhapsody software offers solutions designed specifically for automotive systems and software applications. Rational Rhapsody software offered one of the first AUTOSAR-specific MDD environments to build on the power of SysML and UML. Now, automotive engineers can define and dynamically analyze requirements in SysML that flow down into the software architecture and behavior designed using UML. From UML production application, C code can be generated for the software component that integrates with the AUTOSAR RTE.

Management and traceability for integrated requirements

The IBM Rational Rhapsody family of products offers integrated requirements management and traceability solutions for even the most complex projects, providing users with the requirements capture, traceability and analysis capabilities they need from requirements, design, test cases and code. Rational Rhapsody Design Manager enables integration to lifecycle artifacts through OSLC. Traceability to requirements, work items, test cases, defects or other design artifacts and impact analysis diagrams provide greater insight into assessing the impact of a change on the design. Rational Rhapsody Gateway software features a bidirectional interface to requirements-management products, including Rational DOORS software, Rational RequisitePro software, Microsoft Word and Microsoft Excel, enabling comprehensive traceability analysis.

Rational Rhapsody solutions can capture project requirements, using requirements diagrams, use-case diagrams, sequence diagrams, activity diagrams and state charts. Users may then create traceability links from the model, including test cases, to the requirements, automatically providing comprehensive traceability, impact analysis and coverage documentation. Rational Rhapsody software can generate requirements information from the model into the code to provide full lifecycle traceability from requirements, design and implementation.

Model-based testing to automate quality

Rational Rhapsody model-based testing (MBT) is a critical paradigm that helps bring the benefits of MDD to the testing process. MBT enables engineers to iteratively simulate a design to locate errors early in the process, automate tedious testing, incorporate requirements-based testing to validate the design against requirements and use the Rational Rhapsody Automatic Test Generation Add On capabilities to automatically create coverage tests from the design. The graphical panel feature provided with Rational Rhapsody Developer and Rational Rhapsody Designer for Systems Engineers helps bring the design to life with a mock-up or prototype that simulates the design with elements such as knobs, meters or buttons, enabling early validation and communication of functional behavior.

Using the Rational Rhapsody TestConductor Add On solution, engineers and developers can create unit test cases graphically, using UML sequence diagrams, state charts, activity diagrams or flowcharts. They can also develop test cases in code. Not only can graphical test cases help customers and project stakeholders better understand code tests, they can also help communicate intended behavior more effectively. The solution creates a unified repository with requirements, implementation and test cases all stored within the same environment, which can be managed as part of the overall product test plan with the IBM Rational Quality Manager software.

The Rational Rhapsody TestConductor Add On tool can automate the testing process by automatically creating a test architecture, driving inputs into the system under test and monitoring outputs to automate the validation of the design against the requirements on host or target. Testing can also be done

on external code not developed in the Rational Rhapsody tool to visualize and automate testing of previously developed or third-party code. Developers can manually create a suite of test cases for unit testing or regression testing, or they can leverage sequence diagrams created during simulation.

Collaborative development with enhanced documentation

Reporting tools available within the Rational Rhapsody Tools and Utilities Add On can help simplify the delivery and maintenance of design documentation over the life of a project. Features include the ability to synchronize design, documentation and code and create documentation in text, HTML, Rich Text Format (RTF), Microsoft PowerPoint or Microsoft Word directly from the design. For formal reports and design reviews, wizard-based document generation tools can help you easily update or regenerate documentation each time the design changes. Also, documentation can be generated using IBM Rational Publishing Engine software to extract information from multiple products.

The Rational Rhapsody family of products promotes concurrent, collaborative engineering by integrating with leading configuration management tools, such as IBM Rational Team Concert™ software, IBM Rational ClearCase® software and IBM Rational Synergy software to manage the model information for parallel development. The Rational Rhapsody solution provides graphical differencing and merging capabilities that integrate within the change management lifecycle to manage branching and merging for parallel development across projects, organizations or globally distributed teams.

“Model-driven development with UML and SysML has become essential for improving productivity and quality of embedded software development. IBM Rational Rhapsody provides features that enable embedded developers to validate their designs early and improve productivity. [Rational] Rhapsody’s unique support for both code-centric and model-centric workflows should help traditional coders more easily adopt model-driven development, and its support for strategic software asset reuse will enable organizations to more effectively leverage their intellectual property.”

—Dr. Jerry Krasner, Embedded Market Forecasters

Why IBM?

The Rational Rhapsody product family offers visual development environments tailored for systems engineers and embedded software developers that integrate into the overall development lifecycle—from requirements capture to implementation and system acceptance testing. Based on industry-standard SysML/UML languages and providing visual development of C, C++, Java, C# and Ada languages from model-based designs, Rational Rhapsody solutions promote early validation of design behavior through simulation and execution to identify design errors when they’re introduced—and less costly to fix.

IBM Rational Rhapsody products address a broad range of system, software and test development challenges, including targeting multicore processors, safety critical development, Android, AUTOSAR, UPDM and DDS. Designed for ease of use, early design validation and increased productivity—including integration within the Eclipse platform—these solutions can help embedded and real-time developers to more quickly and easily build and deliver the complex, robust, high-quality products that today’s marketplace demands.

For more information

To learn more about the IBM Rational Rhapsody family of software products, please contact your IBM marketing representative or IBM Business Partner, or visit:

ibm.com/software/products/us/en/ratirhapfami

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