Industry:

Aerospace & Defense

Description:

Established in 1953, Naval Electronics & Surveillance Systems-Surface Systems (NE&SS-Surface Systems) is Lockheed Martin's Center for Excellence in combat system engineering development, production, integration, test, and lifetime support for naval surface ships. NE&SS-Surface Systems has successfully molded its rich radar and surface ship heritage to meet the mission requirements of tomorrow's global surface combatants.

Business Problem:

Lockheed Martin NE&SS-Surface Systems division needed the tools, process and support to successfully model, develop and maintain the system software for the next generation of Navy destroyer.

Rational Solution:

Rational ClearCase, Rational ClearQuest, Rational Rose, Rational SoDA, Rational Unified Process

Key Benefits:

Increased speed and productivity by up to 90 percent in early software development iterations and architectural development

Used the UML to improved communication and promote a common understanding across multiple companies and locations

Effectively managed change in all software artifacts, including visual models, source code and test data

Increased team efficiency through a common and consistent implementation of a proven development methodology

Rational® software

General Dynamics/Lockheed Martin DD 21 Blue Team Leverages Rational Software to Develop Next Generation Navy Destroyer

The DD 21 Blue Team, led by Lockheed Martin Naval Electronics & Surveillance Systems (NE&SS) and General Dynamics Bath Iron Works (BIW), is developing the next generation of Navy Destroyer. The Blue Team, including over 1,000 engineers, developers, analysts and testers, is working together with Rational® consultants, using Rational tools, and employing Rational's approach to software development across the entire project.

Gary Feldman is the Blue Team software director responsible for software development on DD 21. Feldman has been with Lockheed Martin for 10 years and has worked on the DD 21 program since its start over two years ago. Feldman firmly believes that Rational, combined with the Blue Team's Architecture Based Design approach, object-oriented methodology and iterative development process is providing his team with the edge that they need to succeed. He explains, "We are very confident that we have the right team, the right architecture, the right process, the right tools, and the right approach. Rational has given us the ability to assure success, improve speed and quality, and deliver value to the government in software/system development. In the early architectural work and early software iterations, we are seeing increased speed and productivity by up to 90 percent. Rational is helping us give the Navy the best value and the most capability for their dollar."

What makes him particularly excited is Rational's level of involvement from the start of the DD 21 program. This strategic partnership spans the entire development effort and penetrates into every aspect of it. On one end of the spectrum, Rational engineers and consultants worked on site with Lockheed Martin's product teams, collaborating and working side-by-side with Lockheed Martin's system and software engineers. Additionally, Rational CEO Mike Devlin and Chief Scientist Grady Booch participated directly in the Blue Team's Software Requirements Review (SWRR). The SWRR was a review and evaluation of the software architecture and software requirements. Both Booch and Devlin presented at the review and participated in both the preparation and in the conduct of the review. The Blue Team has an agreement with Rational to continue with this level of involvement as the project progresses. Down the road, Booch or a member of his staff will be leading an independent architectural review for DD 21. Rational is on the Team and is participating in the design and the architecture.

DD 21 and the Blue Team

Booch recognizes the difficult challenges faced by the Blue Team, but is confident in their ability to succeed. "Building a system as complex as DD 21 is no easy task. In all such projects, extra effort is required to apply the best engineering practices to take on the complexity and mitigate the risks that would otherwise lead to failure. In my involvement with the Blue Team's requirements, development and architectural design, I've been impressed by their vigorous application of sound systems and software engineering practices: a focus upon architecture, iterative development, and end-to-end modeling using the Unified Modeling Language (UML). Given the geographically distributed nature of the project, I'm glad to see the team focused on providing the tools and processes that will enable those disparate groups to act as one, thus putting the full weight of some amazing development talent upon this project," Booch notes.

Bath Iron Works (prime contractor and shipbuilder) and Lockheed Martin NE&SS-Surface Systems (systems integrator) are leading the DD 21 Blue Team, which is competing to

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develop and deliver the DD 21 System. The Blue Team includes other defense industry leaders such as Northrop Grumman and SAIC. The Blue Team also includes commercial information technology leaders such as Rational, Microsoft and Cisco, as well as Navy laboratories and organizations. Software development will be performed by 16 Blue Team member companies that are domain experts in each of the mission areas. Greater than 80 percent of the software is being developed by Blue Team members currently assessed at Software Engineering Institute/Capability Maturity Model (SEI/CMM) level 4 or 5 and 100 percent of the software is being developed using the Team's defined, managed and optimized process. Another key aspect of this project is that all of the members of the Blue Team are using Rational tools and methods, allowing everyone on the team to share ideas and communicate more effectively. "The entire team recognized the benefits and the whole team adopted this common approach. We're all operating over a distributed, integrated data environment and a collaborative engineering and test environment known as our Virtual Integrated Software Environment (VISE). We are working from the same set of configuration controlled models; we are all sharing data and it is all Web-based," Feldman says.

General Dynamics Bath Iron Works is the lead designer and builder of the Arleigh Burke-class Aegis guided missile destroyer, the most technologically advanced surface combatant in the world. BIW also provides a full array of life cycle services aimed at helping the Navy increase fleet operational readiness and reduce total ownership cost.

Lockheed Martin NE&SS-Surface Systems is the leader in naval combat system design, phased array radar systems, vertical launching systems, and total ship systems integration for military and civil naval requirements. Today, NE&SS-Surface Systems is building on decades of experience in developing advanced next-generation systems to meet future threats. A successful history in large-scale systems integration, radar technology, software development, microelectronics, lifetime support, vertical launching systems, and fire control systems is a sure foundation for creation of future innovative solutions.

Project Startup and Preliminary Results

Phase I of the DD 21 program began in early 1998. One of the first jobs that the Blue Team had to tackle was finding a system and software development solution, including tools, processes and services that would meet their needs immediately, and throughout the life of the project, which has a projected development completion date in 2010. "The Blue Team surveyed the industry leaders in software process and tools and selected Rational because they provided the most comprehensive solution. We quickly brought in Rational during phase I of the program. They began mentoring, integrating the tools into our process, integrating the tools with our internal tools, and modifying the Rational Unified Process® or RUP® to meet the needs of the program and to leverage best commercial practices across the Blue Team. Of course the work will continue into the next phases; Rational will continue to be an integral member of the team in terms of process and architecture and will continue to mentor on tools and participate in architectural reviews. Plans are in place for Rational to continue to be an integral player on our team," adds Feldman.

Modeling with Rational Rose

With over 1000 engineers working on DD 21 at Bath Iron Works, NE&SS and other Blue Team member sites, clear communication and a solid understanding of the project by all team members is crucial to the success of the project. The Blue Team relies on Rational Rose®, the world's leading visual modeling tool, to model all aspects of the ship from the systems level down. Rational Rose uses the UML to improve team communication, while helping individual team members understand complex systems. The UML, which Rational pioneered, is the standard notation of software architecture used to specify, visualize, and document object-oriented systems.

Feldman describes the Blue Team's experience with Rational Rose, "From what we see in the industry, when you go from a structured analysis and design approach to an object-oriented software approach, there are often a lot of translation and communication problems. By using Rational Rose® and UML as a common modeling language across the entire

system, our team has dramatically improved communication and our ability to accurately define requirements from day one. I believe we have done something revolutionary. The shipbuilder, hardware developers and software developers are using the same tools and the same modeling language. We use Rose to model entire systems, software, hardware, people, and databases. We're using UML from the ship system down. We have an entire team across multiple companies in over 20 different geographical locations that are using Rational tools and UML as a common modeling language – and we are seeing impressive results already."

For some of the ship's real-time and embedded systems, such as armament and sensors, the Blue Team is leveraging the real-time capabilities of Rational Rose® RealTime. A member of the Rational Rose family, Rational Rose RealTime is a comprehensive visual development environment that delivers a powerful combination of notation, processes, and tools to meet the challenges of real-time development. Like Rational Rose, Rational Rose RealTime is based in the industry standard UML, but it is optimized for building complex, real-time systems. The Blue Team is developing in a multi-platform environment, primarily in C++ and Java, and reports that the developers have been able to save time by using Rational Rose and Rational Rose RealTime to automatically generate source code directly from their visual models.

The Blue Team is using Rational® SoDA® (Software Documentation Automation) to generate consistent, up-to-date documentation. By extracting data from various tool databases – such as Rational Rose models – SoDA easily creates project documentation based on the latest developments. "SoDA enables us to produce documentation which facilitates supportability. It lets us automatically generate traditional documentation while the data is available to the team. And, by providing automatic documentation and specifications, SoDA enables us to increase the supportability of legacy and non-developmental software. Over 70 percent of our software system will be comprised of existing software components. This high level of reuse has been facilitated by an architecture that is open and scalable. And tools like Rational Rose and Rational SoDA enable us to assure that the reusable components meet the stringent quality and maintainability requirements of the Blue Team," Feldman says.

Managing Change

In any project with the size and scope of the DD 21 program, managing change effectively is essential to the project's success. The NE&SS-Surface Systems team turned to

Rational® ClearCase® and Rational® ClearQuest® for this critically important part of the overall effort. Rational ClearCase is the market-leading software configuration management solution that helps accelerate release cycles by supporting unlimited parallel development and maintains complete, annotated version histories of source code, binaries, executables, documentation, test suites, libraries and Web artifacts as they evolve over the software develop- ment lifecycle. Feldman notes, "We use Rational ClearCase to manage change for all the software products – everything from the Rose models, to the source code to the test data."

Rational ClearQuest is a highly flexible defect and change tracking system that captures and tracks all types of change, on any platform, including Windows, UNIX and the Web. In the Blue Team's multi-platform, distributed development environment, the Web interface on Rational ClearCase and Rational ClearQuest has ensured that everyone has access to the configuration management and defect and change tracking information they need. "We're using Rational ClearQuest for problem reporting and for tracking continuous process improvements. We use it to track not just software problems, but all action items found during verification and validation," reports Feldman.

Feldman continues, "We've been using Rational products at this site for over seven years. The consistent usage across all of the subsystems – and the vertical usage from system requirements down – has grown considerably over that time. The key is that Rational is working with us to assure seamless integration with internally developed and other commercial tools."

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A Strategic Partnership

Even the best engineers, working with the best tools, can be inefficient at times if they do not know how to use the tools in the context of a comprehensive, time-tested development process. Feldman clearly understands this. When he talks about Rational's involvement in the DD 21, he is most enthusiastic about the Rational consulting services – the person-to-person interaction between Rational experts and his own team.

"This is really a strategic partnership. Mike Devlin, Grady Booch and many others at Rational are part of the Blue Team. Blue Team engineers participated in object oriented analysis and design training and training on Rational tools, and Rational mentored the individual project teams to speed the transition from classroom training to practical application. They ensured that everyone was consistently and efficiently using object-oriented design principles, with the right tools as part of our process. It was a training and mentoring effort, but what is different about it is that the Rational engineers and scientists are part of our team. They are working hand-in-hand with the Blue Team software developers, analysts, systems engineers and the Navy to develop a common understanding, a common methodology and to develop, verify and validate requirements and architecture."

While it is relatively early in the DD 21 program, the Blue Team has already noticed improvements. "Without a doubt, we have increased our team's efficiency and productivity. It is not just the common methodology – it is a common and consistent implementation of that methodology that really produces results. By bringing in industry experts we have minimized the learning curve, and we have been enjoying the benefits from day one. Our Team has defined a flexible, scalable total ship computing environment (TSCE) architecture that is based on open, commercial standards. Established architecture teams, supported by experienced mentors in object-oriented development have employed an object-oriented approach to the analysis and design of the ship architecture."

A Proven Process

The expected lifetime of a Navy destroyer is approximately 40 years. As a result, the software and systems that the Blue Team develops must be architecturally sound and highly maintainable. Likewise the software development process must be based on proven best-practices, and object-oriented methodology and iterative development life cycle. RUP is a software engineering process that provides a disciplined approach to assigning tasks and responsibilities within a development organization enabling the Object-Oriented Methodology and the iterative development life cycle. Its goal is to ensure the production of high-quality software that meets the needs of its end users within a predictable schedule and budget. Feldman explains, "One of the overriding goals of the Team during our early software iterations was to define the TSCE to support the life cycle of the program. We needed to define an architecture, a process, and a methodology that allowed us to support not just the first release but the full 40-year life cycle of the ship. It needed to be an open-architecture – robust, flexible and scalable. We worked with Rational to tailor RUP to our specific needs. We integrated RUP with the best practices across our team and across industry and came up with what we call the DD 21 Integrated Software Process or 'DISP.' DISP uses RUP principles and the Rational tool set, but more importantly it incorporates RUP's architectural approach and object-oriented methodology. The DISP is in place and will continue to improve over time. Leveraging the RUP has helped us ensure a flexible and robust architecture and helps drive reuse in our iterative development process."

Early Results

Over two and a half years ago, the Blue Team needed an integrated set of tools and processes that could be deployed across widely distributed teams. They needed those tools and processes to improve communications, improve understanding of requirements, and improve quality. And they wanted a strategic partner that would help them implement those tools and processes most effectively. With the first two phases of the project complete, Feldman has had an opportunity to evaluate the Blue Team's relationship with Rational.

"I'm sure there are many examples of software developers and software development

companies using Rational products successfully. But here we have a large, complex ship, and we're using Rational for everything from the system level down," Feldman notes. "We have completed iterations zero and one of our software and the results are very high productivity, very high quality and a very solid and strong common understanding of user needs and requirements team-wide. Those are the kinds of things that we wanted to see from our Rational tools, process, and relationship – and we have."

The Blue Team has noticed other benefits as well. "Across the team the Rose models and the architectural approach have enabled our software developers to estimate the overall software job with more accuracy than in the past – and that is important. Because of the Unified Modeling Language and the common views across the team, there is a much better understanding of the low-level details and a higher fidelity in the software estimates. Using the Architecture Based Design approach facilitated by the Rational tools set we modeled the system design down to the configuration item level. Rational has also helped us understand the parameters of the software from a standpoint of reliability, availability and scalability and those will drive quality. We have been able to verify that we do indeed have a better understanding and a better ability to shake out requirements earlier. And the early iterations have validated the improvements that we had projected," Feldman explains.

Rational's unique combination of tools, processes and services has helped many organizations shorten their development time and improve productivity. According to Feldman, the early results on the Blue Team are outstanding. "We believe we have a better design. We believe we have a better architecture. And Rational has provided us with the tools, process and expert services that give us the edge we need to continue to be successful throughout the life cycle. With Rational, we fully expect to drive improvements and increase the value to the Navy for years to come."

About Rational

Rational provides a software development platform that improves the speed, quality, and predictability of software projects. This integrated, full life-cycle solution combines software engineering best practices, market-leading tools, and professional services. Ninety-six of the Fortune 100 rely on Rational tools and services to build better software, faster. This open platform is extended by partners who provide more than 500 complementary products and services.

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CS050-B; Rev. 11/03. Subject to change without notice.