



Configit Software

“A Powerful Approach to Managing Complex Configurations”

January 2006

A CIMdata Product Review

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CIMdata[®]

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“A Powerful Approach to Managing Complex Configurations”

This CIMdata Product Review describes the difficulties generally associated with traditional approaches to configuration management and how Configit Software’s technology has been designed to overcome many of them. This product review takes a look at the business issues driving companies towards a better way to handle the definition and management of product complexity, and how a number of companies are taking advantage of Configit Software’s approach.

Executive Summary

In today’s highly competitive global market, it is no longer good enough just to reduce cost, shorten cycle time, and improve product quality. A company must also be able to introduce more innovative products with more features utilizing more innovative business processes and techniques. There is no doubt that innovation is recognized as a critical issue if a business is going to maintain its competitiveness in the global marketplace. However, innovation must be achieved while reducing overall product related costs across development, production and service, and maintaining product leadership. This requires leveraging and reusing the product-related intellectual capital created by business partners working together across the extended enterprise value chain, and designing and delivering highly-configurable and feature-rich, and often more complex, products quickly and efficiently.

Dealing with product complexity has never been an easy task. With the increasing demand for more feature-rich products, which have a high degree of configurable options, many companies find themselves constrained by old configuration management methodologies, and supporting technologies and Information Technology (IT) systems. In many cases, much of this increase in product complexity is due to the incorporation of embedded electronics and software found in today’s products that only a few years ago had none. The push for mass customization and the consumers’ desire to have a product that can be tailored to their specific needs have driven much of this complexity—a complexity that must be handled by an efficient configuration management methodology and the appropriate enabling technologies.

A company’s approach to configuration management should not be taken lightly. The approach taken, which some say should drive the entire business, can have a significant impact on the company’s ability to operate efficiently and effectively. Unfortunately, most companies use a somewhat limited and inflexible top-down approach to configuration definition and management. This top-down approach generally requires a company to define its products at a high level and then define all the subsystems and components required (i.e., buildable options) in each of the final assemblies that will be offered to the market. This approach, which has been well supported by software companies in the sales configurator and manufacturing systems domains, is usually complex and burdensome.

CIMdata’s review of Configit Software’s approach in solving the main problems associated with today’s top-down configuration methodology indicates that their technology focuses on streamlining the configuration construct (i.e., how a configuration solution stores and transverses an option tree). Their apparently unique approach seeks to allow sales divisions and manufacturers of complex and highly configurable products to efficiently handle a large number of product options and variants. Their approach can be used to support the full lifecycle of complex products, from sales and production to set-up and maintenance. At the core of their approach is their patented technology called Virtual Tabulation®.

This configuration technology, which was invented by Configit Software—a spin-off of the IT University of Copenhagen, is based on software verification research. Virtual Tabulation makes it possible to compile a description of the parameters making up a product into a very compact lossless format, called a virtual table. This mathematically based virtual table contains all legal combinations of values to the configuration rules. Configit Software has learned how to construct virtual tables that can contain billions of configurations in a few kilobytes. This makes it possible to embed virtual tables virtually anywhere—even on tiny embedded electronic devices.

A key benefit of Virtual Tabulation is that this table is generated once for a specification and can then be used repeatedly. When the virtual table has been generated,

lookup times are extremely short and predictable. Virtual Tabulation solves the difficult part of the configuration problem once. Traditional approaches solve it over and over again. This Virtual Tabulation construct also allows for the configuration to be defined by a user starting anywhere within the configuration. This flexible and user-friendly approach has been proven to enable multiple industrial applications. These applications range from serving as an embedded configurator in an industrial controller, to replacing a company's existing sales configurator, to tightly integrating with a company's existing CAD and PLM solutions to provide a robust configuration driven product development process.

CIMdata's experience indicates that any company that does or wishes to offer complex, highly configurable products to the market should consider Configit Software's solution. CIMdata especially recommends that companies in the high-tech, aerospace, heavy equipment, machine tool, and automotive industries investigate how they can potentially take advantage of Configit Software's technology and approach.

Introduction

Businesses today face three on-going challenges: improving customer intimacy, improving operational excellence, and providing product leadership. Customer intimacy requires understanding and responding quickly to current and potential customers, their needs, establishing effective relationships with them, and providing consistent, long-term customer value. Achieving operational excellence, requires enterprises to focus on operating efficiently, effectively, and flexibly, working with their partners to reduce the cost and time necessary to deliver high-quality products and services that meet their customer's requirements in a timely manner. Being a product leader means providing leading-edge products and solutions tailored to customer needs.

To meet these challenges, businesses must become more innovative. However, being an innovative business doesn't simply mean creating innovative products; it also means improving the processes and enabling systems a company uses to design, manufacture, market, deliver, and service its products. Today, innovation is recognized as a critical issue if a business is going to maintain its competitiveness in the global marketplace. However, innovation must be achieved while reducing overall product-related costs across development, production and service, and maintaining product leadership.

Achieving product leadership focuses on revenue generation from a steady stream of innovative, new products and new product features. Today, enterprises must bring innovative products to market more effectively and more quickly to maximize customer

interest and sales. The pressures to reduce time, improve product quality, and lower costs certainly haven't gone away; they are being reaffirmed and folded into programs that focus on delivering the "right" product to the "right" customer, at the "right" time and cost. To continue to expand, product leadership companies must continue to enter new markets with more innovative products. This requires leveraging and reusing the product-related intellectual capital created by business partners working together across the extended enterprise value chain, and designing and delivering highly-configurable, feature-rich, and often more complex, products quickly and efficiently.

Dealing with product complexity has never been an easy task, but with the increasing demand for more feature-rich products, which have a high degree of configurable options, many companies find themselves constrained by old configuration management methodologies, and supporting technologies and Information Technology (IT) systems.

In many cases, much of this increase in product complexity is due to the incorporation of embedded electronics and software found in today's products that only a few years ago had none. There is no doubt that this is a valid statement. However, the push for mass customization and the consumers' desire to have a product that can be tailored to their specific needs have driven much of this complexity—a complexity that must be handled by an efficient configuration management methodology and the appropriate enabling technologies.

A company's approach to configuration management should not be taken lightly. This methodology, which some say should drive the entire business, can have a significant impact on the company's ability to efficiently and effectively operate in today's global market. To understand it, one must first understand the definition of the term configuration—*The grouping of a component or product as defined by the number, nature, and inter-connections of its constituent parts.*

Many times this is referred to in the Product Lifecycle Management (PLM) and Product Data Management (PDM) software domains as a product structure, but it is actually more. This can also be described as the performance, functional, and physical attributes of an existing or planned product, or a combination of products, or one of a series of sequentially-created variations of a product.

With this definition in mind, configuration management (CM) can be described as follows: *A management process for establishing and maintaining consistency of a product's performance, functional, and physical attributes with its requirements, design, and operational information throughout its lifecycle.*

CM is an integrated part of product definition lifecycle management (i.e., management of a product's definition throughout the lifecycle of that product)—applicable to all elements of a product, including its mechanical, electrical, software, and documentation components. Robust CM methodologies require a number of activities to be performed. These activities generally include:

- establishing and maintaining the definition and status of products and their components, and all associated information and the relationships between each.
- managing all changes to any product, component or defining documentation in an auditable, repeatable, verifiable, controlled manner.
- keeping track of what you design, develop, deliver, sell, and support.

There are many reasons why a good configuration management methodology and proper supporting technologies are required. Probably the most important reason is that when implemented and used properly, they provide a more effective control of product configurations throughout the development, production, and maintenance phases of a product's lifecycle. This is critical in today's organizations that must operate global teams where controlled access to the appropriate product configuration is extremely important to ensure the correctness of shared product information.

First generation solutions, which were first introduced in the 1980s, are primarily rule-based configuration systems. In these systems, relationships among options, parts and variants are typically described as if-then rules that are evaluated only in a forward direction.

Second generation solutions, which were first introduced in the 1990s, were primarily designed as constraint-based configuration systems. In these systems relationships are described as declarative constraints that should always hold. These constraints are usually more expressive than rule-based.

Third generation solutions, which have only recently begun to be introduced to the market, are primarily virtual table-based configuration systems. They tend to be expressive as constraint-based systems but insensitive to constraint formulation. In many cases, this allows non-experts to express and maintain rules and constraints.

In general, first generation configuration management solutions allow the product designer or configuration manager to define some type of generic product structures (e.g., tree structure) with specified variants and associated inclusive/exclusive variant conditions. These variants usually have two or more option definitions that include two or more discrete option values. In addition, these tools provide the ability to define option dependencies through the use of simple/complex logical expressions (e.g., “if-then-else” expressions).

More advanced second generation configuration management tools also allow the configurator (i.e., the person defining the configuration rules) to select option sets with fixed and/or derived defaults, and to define and manage families of options and their decomposition. Those tools that support a product design approach to configuration definition, usually also provide functionality that allows the user to:

- create, modify, and assign architecture breakdown structures.
- assign physical and functional breakdowns to one or more products.
- define, edit, and query option combinations.
- relate option combinations to architecture locations (i.e., nodes).
- develop and assign part and design solutions for the specified option

combinations for each node.

- define parametric interfaces to facilitate modular design and re-use, including the management of product families.
- define technical dependencies and compatibility rules.

The primary weaknesses of these design centric configuration tools and those delivered by traditional manufacturing and sales/marketing-centric configuration management software solution providers center around their inability to quickly and easily validate and traverse the configuration structure (i.e., tree), and their inability to drive (i.e., start) the configuration from any point (i.e., node) of the tree. These weaknesses are primarily a result of the top-down approach to configuration definition that software companies have used for years to attempt to solve this “configuration” problem.

Limitations with Today's Approach

In today's typical design-to-order businesses, competition is pushing the business model from a configuration management methodology that supports a case-by-case engineer-to-order approach into a more cost-efficient configure-to-order manner. In this approach, solutions are built from standard components and combined to fulfill specific customer needs. An efficient mapping of customer needs to possible configurations of available components provides a challenge that must be solved. Unfortunately, many of today's configuration management solutions do a poor job supporting this business model.

The top-down approach, and the technologies that support it, generally require a company to define its products at a high level and then define all the subsystems and components required (i.e., buildable options) in each of the final assemblies that will be offered to the market. This approach, which has been well supported by software companies in the sales configurator and manufacturing systems domains, is usually cumbersome. This is because it always requires a top-down build approach—an approach that requires the interpretation of configuration rules, from the saleable product level down, every time the system and/or a user wants to configure a product. Utilizing such an approach is rather resource-intensive (i.e., time and memory)—a problem that is particularly apparent in situations where the user does not know where he/she is going—not to mention that users of this type of system can only traverse the configuration tree from the top down (i.e., the user must first choose the model, and then choose its valid features). The following example can be used to illustrate this point.

If someone is looking to purchase an automobile, the person first needs to know the make/manufacture (e.g., BMW), then the model (e.g., 3 Series), then look up the valid options (e.g., sport suspension, heated seats, etc.) for that specific make and model. What the buyer cannot do is look for all BMW models and option packages that have a sport suspension and heated seats as valid options. This basically limits the product company's ability to focus on features, and requires them to focus on the model.

The traditional approach described above is even more cumbersome if a company wishes to define configuration rules within its engineering and design environment, only to have to go through a significant re-engineering and/or re-entry of them for their top-down sales configurator (usually found in a Customer Relationship Management (CRM) solution). As a result, many industrial companies still use a Microsoft Excel spread sheet table that lists all the valid options. Here again we have a very limited approach to a complex problem since it usually leads to extremely large, non-automated lookup tables that have little, if any intelligence. It usually leads to an inefficient communication of those rules and downstream errors.

Other problems that often result from the limited approaches described above include:

1. Maintenance of the rules, configuration trees, etc. is often limited to few very experienced and expensive resources.
2. The solutions are stand-alone “islands” with weak or no integration with other business systems or associated configuration logic.
3. The solutions are often limited to a single process (i.e., sales or maintenance) and different configuration solutions serve different business processes and as a result they are disconnected.

Configit's Approach Described

Configit Software's approach in solving the main problems associated with today's top-down configuration approach focuses on streamlining the configuration construct (i.e., how a configuration solution stores and transverses an option tree). Their approach seeks to allow sales divisions and manufacturers of complex and highly-configurable products to efficiently handle a large number of product options and variants. Their approach can be used to support the full lifecycle of complex products, from sales and production to set-up and maintenance. At the

core of their approach is their patented technology called Virtual Tabulation (see Figure 1). This technology, which runs on a Microsoft .NET and JAVA architecture, makes it possible to configure and control complex products of all types relatively easily and efficiently.

This configuration technology, which was invented by Configit Software, is based on software verification research. Virtual Tabulation makes it possible to compile a description of the parameters making up a product into a very compact lossless format, called a virtual table. Configit Software reports that this mathematically based virtual table contains all legal combinations of values to the configuration parameters (i.e., rules). Configit Software has learned how to construct virtual tables that can contain billions of configurations in a few kilobytes. This makes it possible to embed virtual tables virtually anywhere—even on tiny embedded electronic devices (please see the last section for some real world application examples).

Virtual Tabulation® is a patented product configuration technology developed by Configit Software.

Based on a computer science research in the area called “Formal Verification,” Virtual Tabulation makes it possible to compile a description of the parameters making up a product into a very compact lossless format, called a virtual table, containing all legal combinations of values to the parameters. Virtual Tabulation changes the way a company can model its products and deploy and interact with configurators. Virtual Tabulation solves the difficult part of the configuration problem once, where traditional approaches solve it over and over again.

A key benefit of Virtual Tabulation is that this table is generated once for a specification and can then be used repeatedly. When the virtual table has been generated, which can take a few seconds to a minute or so, lookup times are extremely short and predictable, and thus there is no uncertainty about performance. Virtual Tabulation solves the difficult part of the configuration problem once. Traditional approaches solve it over and over again. This Virtual Tabulation construct also allows for the configuration to be defined by a user starting anywhere (i.e., at any node of the configuration tree). For example, a potential personal computer buyer can first select the type of CPU, then the amount of memory, etc. There is no need to start at the top level (i.e., with the computer make and model). If an option is not available because of a selection already made, the virtual table allows the user to select it and then notifies them the one or more options that have to be removed. This flexible and very quick approach is impressive.

Configit Software's suite enables rapid development of intuitive and easy-to-use configurator-powered applications. In many ways, Configit Software's technology enables a third generation approach to CM. According to Configit Software, its CM solution has been designed to set a new standard for:

- Capacity—handling more product variants, more complexity, more parameters, more rules and larger data sets
- Performance—no errors and fast, guaranteed response times
- Flexibility—data and rules are only maintained in one place
- User friendliness—guided configuration without dead-ends
- Compactness—deployment on almost any platform, for example laptop computers, PDAs, controllers, and mobile devices

The above Configit Software differentiators are impressive. Their approach appears to be unique in the market today and companies that choose to take advantage of what it has to offer can have a competitive advantage. It should be noted that Configit Software is pursuing an original equipment manufacturer (OEM) model. This OEM model will allow other software solution providers to embed Configit Software's patented Virtual Tabulation technology into their own software. This OEM business strategy appears to be very

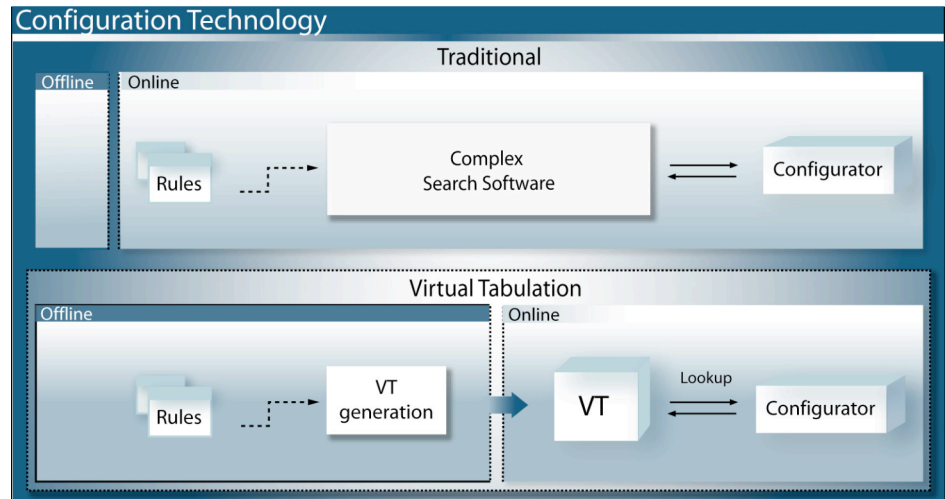


Figure 1—Comparison of Traditional and Virtual Tabulation Technologies

promising. It should help both Configit Software as well as their potential partners in the PLM, Enterprise Resource Planning (ERP), and general sales configurator space. If this strategy works, many of the limitations that exist in today's configurators can be overcome.

One can easily envision the development of configuration rules in a Computer Aided Design (CAD) environment or a PLM solution that has been fully integrated with Configit Software's technology. (It is important to note that Configit Software's solution can already import rules in a number of different formats, e.g., Boolean.) Configit Software's technology can then be used iteratively within the development environment to test, validate, and refine the rules. This task, which is usually left until the end of the development cycle, is critical and costly if not done properly and in a timely manner. A number of Configit Software's clients report that they have found a number of configuration errors (e.g., conflicts) once the rules that they thought were correct had been loaded and validated in Configit Software's solution. Since Configit Software's solution uses a quick compilation route, errors are reported rapidly. This allows the development organization to focus on the complete and valid set of rules. It also ensures that downstream systems (e.g., ERP and sales configurators) only receive valid rules.

Configit Software's solution does not have to start within the CAD or PLM environment. It can start with those people responsible for the definition of valid saleable products. Often companies execute this activity within their sales and marketing organization, or perhaps their manufacturing operations. Since Configit Software's solution supports the import of configuration rules in multiple formats, it can be used with ERP and other sales configurators. In fact, it can replace those tools if desired. The solution's web-based UI can be used to maintain and compile the configuration rules as well as run a user-friendly product configurator (a number of examples can

be found at Configit Software’s web site—www.configit-software.com).

Finally, the main and most important configuration management related issue that a company needs to solve is not really technology related. There is no doubt that Configit Software’s technology provides a new and powerful approach to configuration management, but no matter how powerful it is, it cannot define a company’s product configuration strategy (i.e., how a company wants to model its products) or the rules associated with it. To fully take advantage of Configit Software’s solution, most companies will likely need to define and implement a new way of modeling products, and defining and managing the associated configuration rules. This should not necessarily be seen as an issue, but rather as an opportunity—an opportunity that new technologies and approaches generally offer. It undoubtedly offers a new way to rapidly and efficiently define and introduce new highly-configurable products into the market.

Configit Software

As mentioned previously, Configit Software is a spin-off of the IT University of Copenhagen and the core technology embedded in the software is based on more than ten years of research in formal software verification. The company is headquartered in Copenhagen, Denmark.

Configit Software currently employs a broad spectrum of people, ranging from several PhDs (1/2 of their technical staff have a PhD in Computer Science) with world-class knowledge in the field of the mathematics behind configuration, to business and commercially oriented people with proven track records in the IT-industry experienced in delivering value to their customers.

Since its start in the year 2000, Configit Software has developed from a research and development project to a well-established growth company. The company is currently owned by its employees, as well as CAT Innovation and Slottsbacken—two venture capital firms based out of Scandinavia. For the last several years, Configit Software has sold their solution via its partner channels on a worldwide basis.

Configit Software’s focus is on developing and marketing standard software for creating product configurator based solutions (see Figure 2 for an illustration of Configit Software’s overall technology offering). The software has been proven in a number of different industrial applications and has been often used to develop advanced setup and installation software in electronic devices, such as industrial controllers and telecommunications equipment, and for developing configuration-based sales and production support solutions.

How Configit Software’s Approach can be Applied

Configit Software’s technology has multiple industrial applications, many of which have already been mentioned. These applications range from serving as an embedded configurator in an industrial controller (see Figure 3), to replacing a company’s outdated sales configurator, to tightly integrating with a company’s existing CAD and PLM solutions to provide a robust configuration-driven product development process. The following three examples provide some additional insight on how Configit Software’s technology has already been deployed by a number of leading industrial companies.

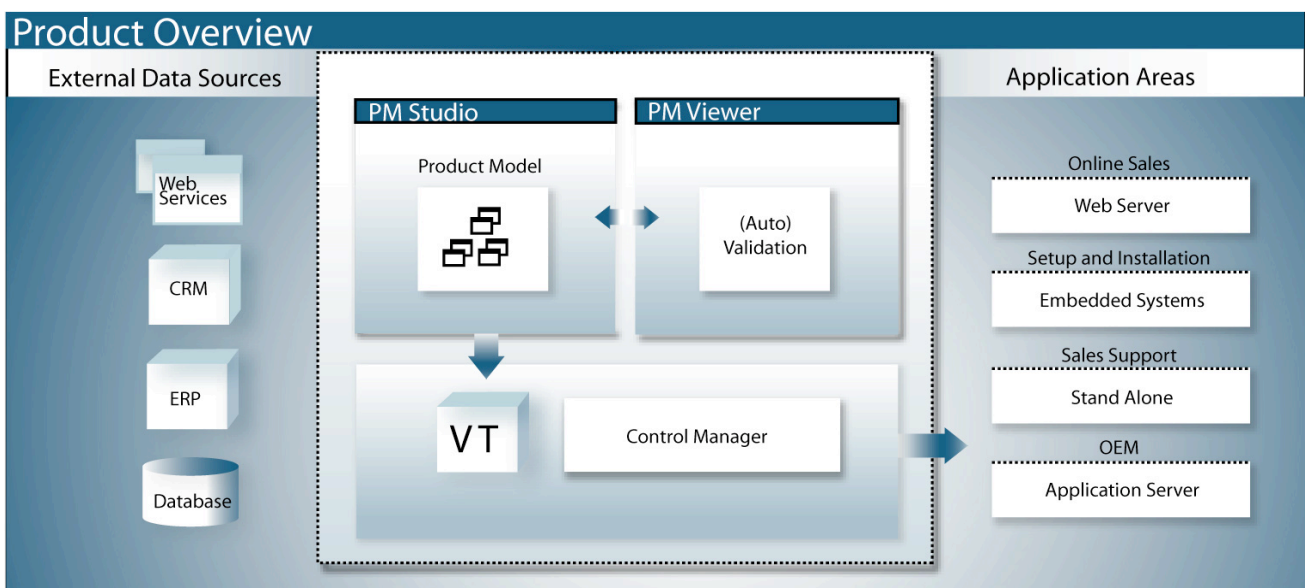


Figure 2—Configit Software’s Technology Components

Embedded Systems

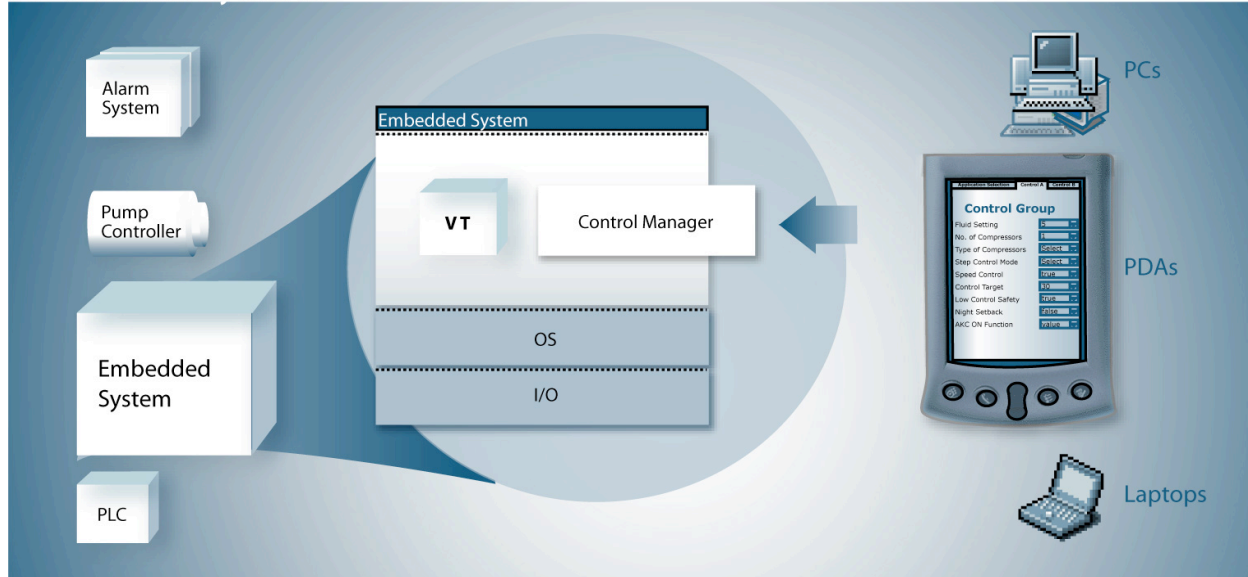


Figure 3—Configit Software's Technology as used in an Embedded System Environment

Danfoss is a leading supplier of automated solutions to the global refrigeration air conditioning industry. They have embedded Configit Software's configuration technology on their newest line of cooling controllers, and developed a generic setup program that prevents the user from selecting incorrect parameter combinations. Danfoss reports that this has greatly decreased the time it takes to properly install and configure a new system. It has also allowed Danfoss to focus on product features without having to dumb their products down to the point where they add less value. In addition, it has become much easier for them to ensure that maintenance service always has the updated configuration embedded in their controllers and that the service technicians require much less training because of the new system's ease of use.

Vestas Wind Systems is a world leader in wind technology and a driving force in the development of the wind power industry. Vestas uses Configit Software's technology to setup the more than 2,000 parameters that control a wind turbine. Vestas reports that in the past, this complex task took a significant amount of time and for inexperienced technicians it removes the possibility that they would go down a dead-end configuration path. In addition, it greatly reduces the chance that a very expensive wind turbine would be either out of service or damaged once it is in operation.

The third and final example is from Psion Teklogix. Psion Teklogix is a leading global provider of solutions for mobile computing and wireless data collection. They selected Configit Software's technology as a configuration-based sales support solution. Psion Teklogix reports that since Configit Software's technology is based on Microsoft .NET, it was quickly

integrated with their Baan ERP system and Selligent CRM system. They stated that this allowed them to quickly and easily implement the solution in their North American and European operations. It should also be noted that the Configit solution provided them with a solution where the sales people were guided through a validated configuration process—according to Psion Teklogix, a functionality that was not supported by their Baan implementation.

Conclusion

The industry examples described above illustrate how a number of companies have successfully taken advantage of what Configit Software has to offer. It should be noted that they are not the only applications for Configit Software's technology. CIMdata's experience indicates that any company that does or wishes to offer complex, highly configurable products to the market should consider Configit Software's solution—either integrated with their current development or manufacturing systems environment or as a replacement to their current sales configurator. Since Configit Software's solution can be internally and/or externally facing there are a number of areas that can benefit. Companies in the high-tech, aerospace, heavy equipment, machine tool, and automotive industries should investigate how they can potentially take advantage of Configit Software's technology and approach. In addition, just about any company that embeds parameterized software in their products should seriously consider what Configit Software has to offer.

About CIMdata

CIMdata, a leading independent worldwide firm, provides strategic consulting to maximize an enterprise's ability to design and deliver innovative products and services through the application of PLM. CIMdata works with both industrial organizations and suppliers of technologies and services seeking competitive advantage in the global economy by providing world-class knowledge, expertise, and best-practice methods on PLM solutions.

CIMdata helps industrial organizations establish effective PLM strategies, identify requirements, and select PLM technologies, optimize their operational structure and processes to implement solutions, and deploy these solutions.

For PLM solution suppliers, CIMdata helps define business and market strategies, delivers worldwide market information and analyses, provides education and support for internal sales and marketing teams, as well as overall support at all stages of business and product programs to make them optimally effective in their markets.

CIMdata provides world-class knowledge, expertise, and best-practice methods on PLM solutions. These solutions incorporate both business processes and a wide-ranging set of PLM enabling technologies.

In addition to consulting, CIMdata conducts research, provides PLM-focused subscription services, and produces several commercial publications. The company also provides industry education through international conferences in North America, Europe, and the Pacific region.

To learn more about CIMdata's services, visit our website at www.CIMdata.com or contact CIMdata at: 3909 Research Park Drive, Ann Arbor, MI 48108, USA. Tel: +1 (734) 668-9922. Fax: +1 (734) 668-1957.