

DAU AND GROUND STATION SET UP – CONCEPT OF OPERATIONS

**Lee H. Eccles
Jessica D. Moore
Richard D. Stiers
Boeing Test & Evaluation
P. O. Box 3707, M/C 1J-95
Seattle, WA 98124-2207**

Abstract

Many systems in use today to generate the set up information for Data Acquisition Units (DAUs) and for Telemetry Ground Stations are tailored around the requirements for a particular set of supplier's hardware. This makes adding support for a new supplier a costly operation. An attempt is under way to enable development of a system that could be used to set up a DAU and a Telemetry Ground Station with equipment from the currently existing suppliers as well as future suppliers. The goal is to reduce the impact of adding a different supplier's hardware into a system. As the first step in this process it was necessary to agree upon a Concept of Operations that could meet the needs of multiple companies. Once the Concept of Operations was developed then the standards necessary to enable the development of this type of a system could be considered. This paper discusses the Concept of Operations that was developed and the rationale behind the decisions that were made.

Introduction

Each supplier of Data Acquisition Units (DAUs) provides software to program their hardware and each set of hardware requires that a different set of registers be programmed with different bit patterns. The situation is somewhat analogous to software concepts of assembly language and high level languages. In addition the set up software that is used to set up a DAU probably cannot be used to set up the data processing system. This is the result of the suppliers for the DAUs and the data processing system typically being different. There have been efforts made to create the equivalent of high level languages to address the set up of the DAUs and the Telemetry Attributes Transfer Standard (TMATS) has existed for several years to create a standard way to pass the set up information from the Data Acquisition system to the ground station. What has not existed is a single "high level language" that is capable of supporting all

aspects of the system. However, before such a language and its supporting compilers can be successfully developed one or more Concepts of Operations needs to be agreed to so that the language can provide the necessary features. The Concept of Operations helps define the requirements for the language.

The Situation

Over the last few years there have been efforts to develop a high level language to set up a DAU but little has been done to address a replacement for TMATS. The authors are aware of three independent attempts to develop a high level language to be used to set up a DAU. The first of these was developed by ACRA Controls (now Curtiss-Wright). It is called the eXtensible Instrumentation Definition Markup Language (XidML). ACRA intended XidML to be an open standard so it was posted on a website where other suppliers and users had access to it. The reports that we have seen from users of XidML indicate that they are very much satisfied with it. They can use it with hardware supplied by Curtiss-Wright as well as legacy equipment or hardware purchased from other suppliers. XidML is currently limited to setting up a DAU and TMATS is still required to set up the data processing system. What most people see as a major drawback to XidML is that only Curtiss-Wright has adopted it so that it can only be used with others supplier's hardware if the user does its own development.

Another language that has been developed to address this issue is the Instrumentation Hardware Abstraction Language (IHAL). IHAL was developed by Knowledge Based Systems (KBSI) under contract from Edwards Air Force Base. The development of IHAL was supported by a working group made up of Test Range operators and manufacturers. The Range Commanders Council – Telemetry Group (RCC-TG) has adopted IHAL as a standard but as far as we can tell no user has implemented it and is using it. There have been multi-vendor demonstrations of IHAL at ITC in past years. IHAL is designed to be part of an interactive system where the user made a change and received immediate feedback if there was a problem with the proposed change.

The third attempt to address this issue is the integrated Network Based Telemetry (iNET) program's Metadata Description Language (MDL) standard. The MDL is the most ambitious of these efforts. It makes an attempt to describe everything from the measurement requirements, to the set up of the DAU and the Data Processing. In addition it provides a document describing the test as well as the set up of the hardware and software. The iNET standards have yet to be released so all that exists is a draft of the standard. In an effort to mature the standard the iNET program has contracts with multiple companies to develop systems around the draft standards. They are examining the results of these efforts as well as the feedback from the vendors to help mature the standards.

The MDL Users Group

The MDL Users Group was formed to address the issues that people were finding with the iNET MDL Standard. It consists of representatives from four potential users including Airbus, Airbus Helicopters,

Boeing Test & Evaluation and Embraer, as well as ten suppliers of DAUs and/or support hardware and software. Also included are representatives of the iNET program, Southwest Research Institute who is responsible for writing the iNET Standards, and the RCC-TG who will be responsible for maintaining the standards once they are released. This group first made an effort to come up with a Concept of Operations that the MDL would need to support to meet our needs.

The “System” Model

The model to be used to implement the system is similar to the IHAL model and is shown in Figure 1. The operator will be working at the Configuration Manager. Previously set up files, either partial or complete, can be loaded into the Configuration Manager from the Users Database Management System or a new file can be created. We expect that a set of Graphical User Interfaces (GUIs) will be available as part of the Configuration Manager to enable operation. It is also assumed that each supplier of hardware in the system will provide the software necessary to design and configure their hardware. A standard interface between the Configuration Manager and the Supplier Configuration Software is also necessary and has yet to be addressed. The Supplier Configuration Software can exist on a server in the users system, on the same hardware as the Configuration Manager or on the DAU itself. There is also another place where the Supplier Configuration Software could reside and, although people express horror at the thought of depending upon that location, it could reside on a system at the supplier’s site. This last option would probably be most useful when trying to decide what hardware to purchase. It would allow the user to try to configure a system before buying it. The other block in the diagram is the User Constraints and Policies. These put limits on how a DAU can be configured but are items that the supplier’s software will not know about. The DB API is the Application Programming Interface between the users database system and the Configuration Manager.

Note that the Users Group is not trying to standardize on the system model. It is just a tool to help us describe what needs to be in the language.

The Concept of Operations

There are two areas of concern when trying to configure and set up a DAU. The first we will call the “Design” process which is involved with the hardware that will be assembled to create a DAU. This can involve installing cards into a chassis or assembling a stack of modules. Regardless of whether a chassis or stack is used, the steps necessary to select and arrange them into an assembly is the same, so we will use the term “modules” when describing the elements in either case. The modules may include power supplies, core or overhead modules, signal conditioners and possibly a chassis. The other process is the “Configuration.” This process is concerned with defining the set up for the channels on the signal conditioning modules although the set up for the overhead modules may also be part of this process.

In general the Concept of Operations expects the processes to be both interactive and iterative. By interactive we mean that the user can get immediate feedback for each selection that is made if that selection is unacceptable or if it requires a change to a previous selection. By iterative we mean that the user can do part of a process and save the partial result. At a later time the partial information can be reloaded and the process continued. The other general concept is that when the design and configuration processes are complete, the final MDL file can be submitted to the supplier configuration software which will return a list of warnings and errors.

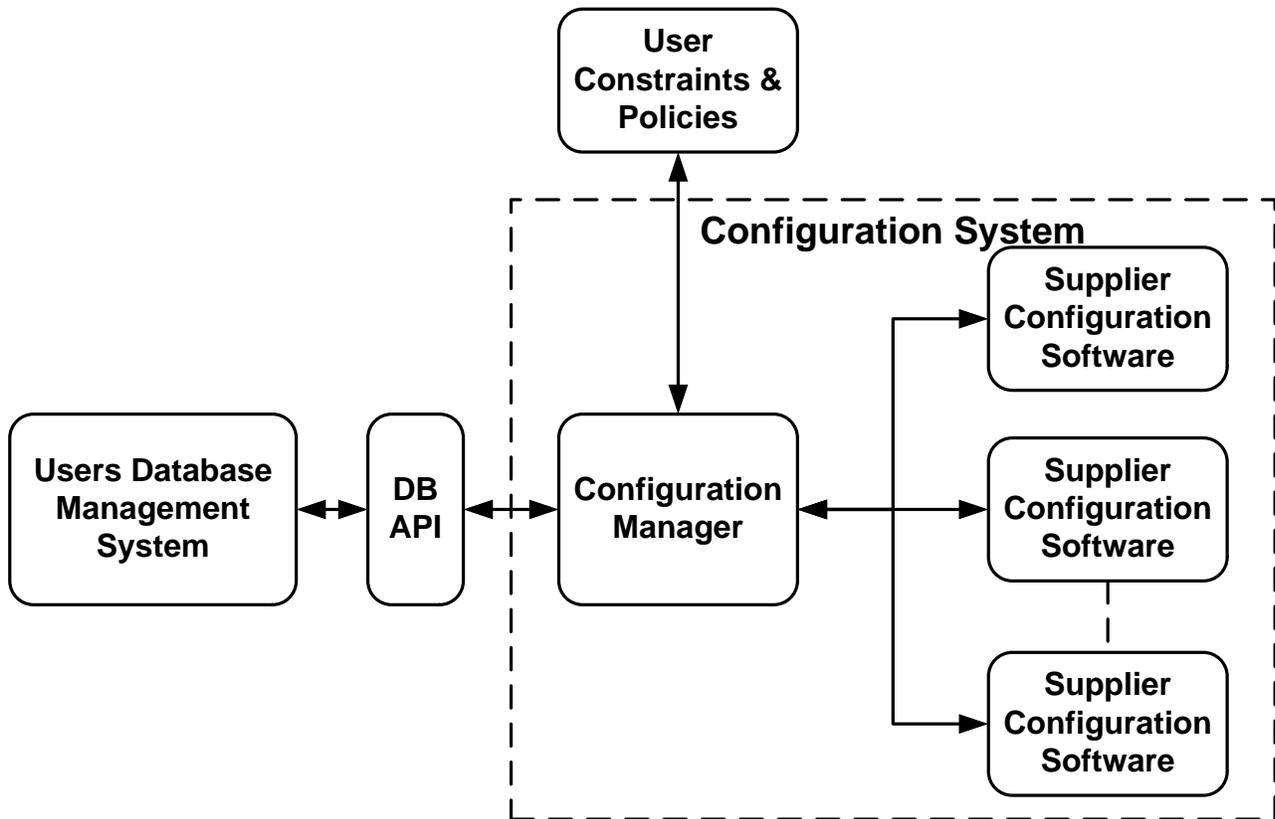


Figure 1 System Model

The Design Process

During the design process the user will select the modules and possibly a chassis that will be assembled to create the DAU. A high level flowchart of one possible implementation is shown in Figure 2. To accomplish this, a library of the available functions will be requested from the supplier’s software package. In IHAL this is called the Instrument Pool. In MDL it may be something that needs to be added.

It is expected that the user at the Configuration Manager will select the modules that are required for the DAU. As each module is selected and its location in the stack or chassis is defined, the system will keep track of the size of the stack or the available slots in the chassis. It should be able to report the possible range of power required by the assembly. This will change as transducers are added and become more completely defined but at this point in the process it will inform the operator about potential problems. The weight of the unit can also be defined.

There are two schools of thought about when the validation of the selections should be made. In the case of a new user the interactive mode may be preferable so that any problems are reported as the selections are made. However, the experienced user may well want to turn the automatic validation feature off and complete all selections before allowing the supplier's software to confirm the selections or point out that mistakes may have been made. However, this is a design problem for the Configuration Manager and not an issue with the MDL.

The Configuration Process

A very high level flow diagram of the expected Concept of Operations for the configuration process is shown in Figure 3. During the Configuration process the user will need to determine the capabilities of the module that is being configured from the supplier configuration software. The exact programmable characteristics of a given module are expected to be identified as tag/data pairs. The tags may either be included in the schema, as was done by the IHAL; or they may be selected from a dictionary as is done in XidML. The current plan for MDL is to define the tags in the schema.

As much as possible, the system should only allow the user to select options that are valid. For example, if the gain of a particular channel on a module can only be set to 1, 2, 4 or 8, the user would see a drop down list and only be allowed to pick from that list. This implies that the language must include enumerations that can be used to specify acceptable values. For lists of values for which enumerations are not appropriate a range of values and a step size can be used to define the acceptable values. Each parameter that has an impact on the transfer function (calibration) of the measurement must be reported even if it is not programmable. For example, suppose that a bridge signal conditioning card has a fixed gain of 100 volts per volt. The gain value is not programmable but it is important when calculating the end-to-end transfer function of the measurement.

The Modification or Editing Process

A very high level flow diagram of the expected Concept of Operations for this Process is shown in Figure 4. This Process is very similar to the previous two Processes. However in this Process an existing design or configuration or both will be recovered from the Users Data Base and loaded into both the Configuration Manager and the supplier's software. From this point there are several possible things that

can be done. If what was loaded is a partially completed design or configuration the user can proceed to complete the DAU design or set up. If the user is trying to troubleshoot a problem with a DAU then the settings can be displayed and a decision made about the changes required to fix the problem.

Summary

The Concept of Operations is a tool that was developed to help define the requirements for the Meta Description Language (MDL). Within itself it is not part of the language but it helps define what the language needs to support. This is just the beginning of the process of defining what needs to be added to the MDL to be able to meet the user's needs. The plan is to first define the MDL that is needed to set up a DAU and then proceed with what is required to set up a Ground Station. The set up for a ground station has yet to be addressed.

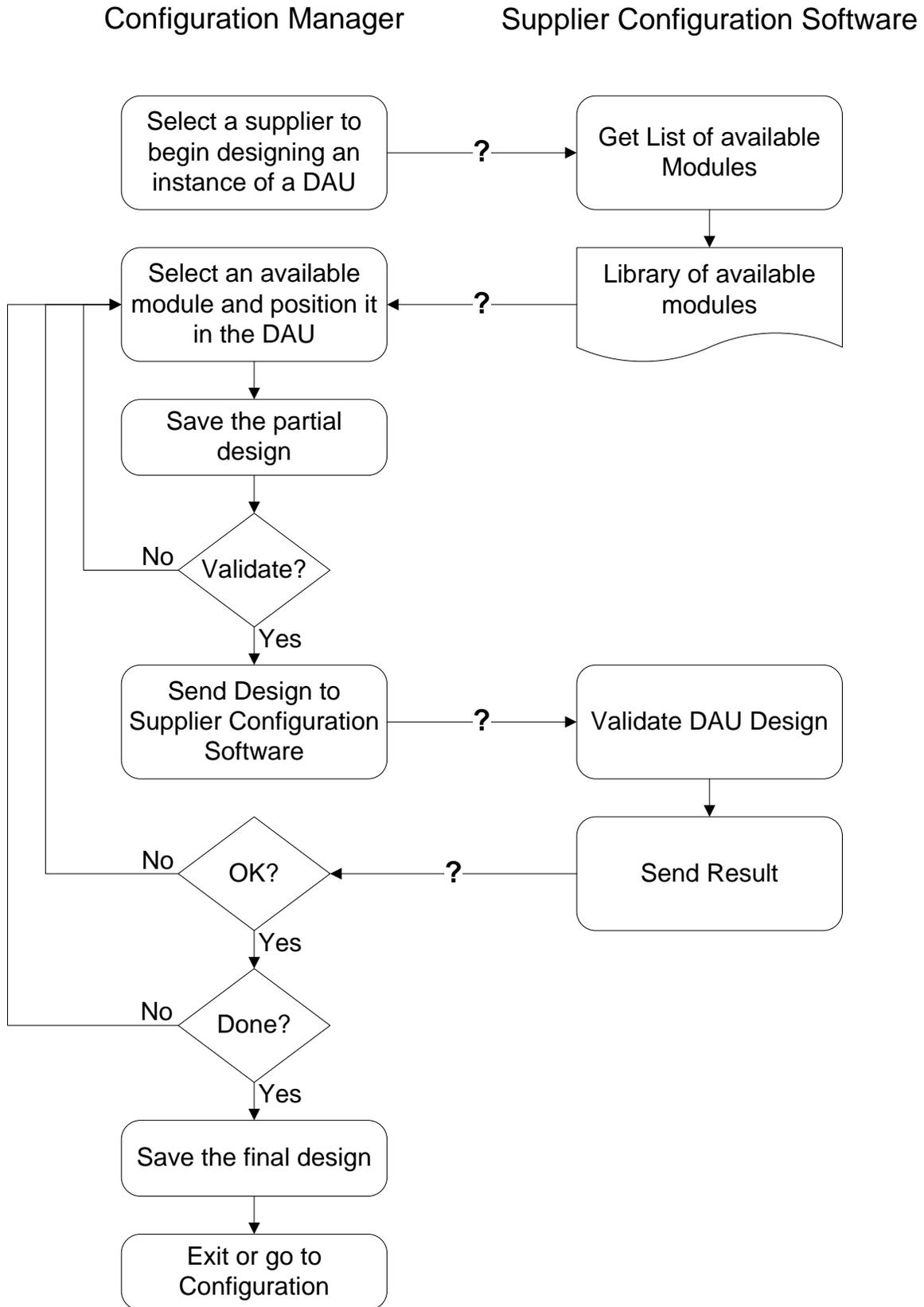


Figure 2 Design Process High Level Concept of Operations

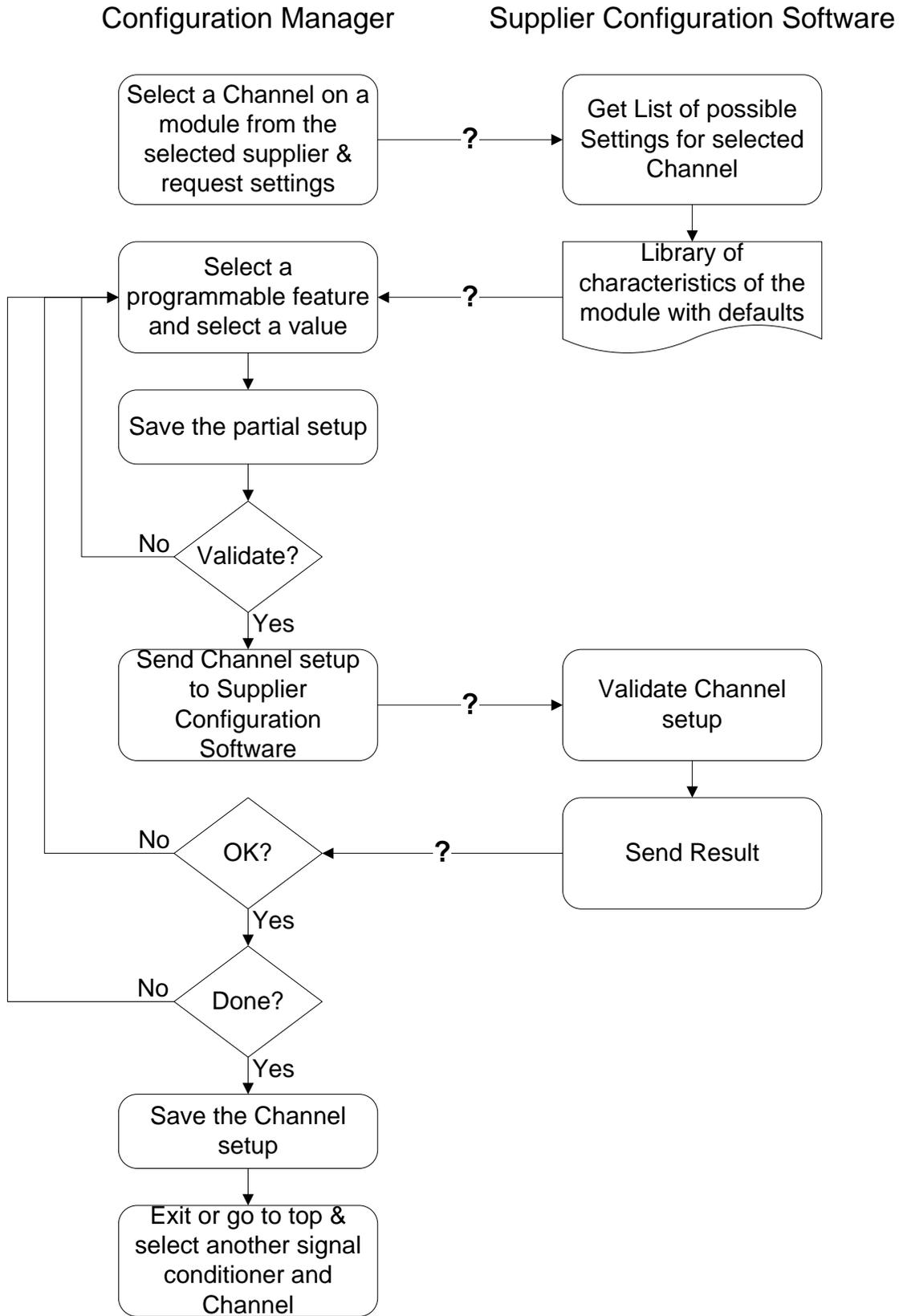


Figure 3 Configuration Process High Level Concept of Operations

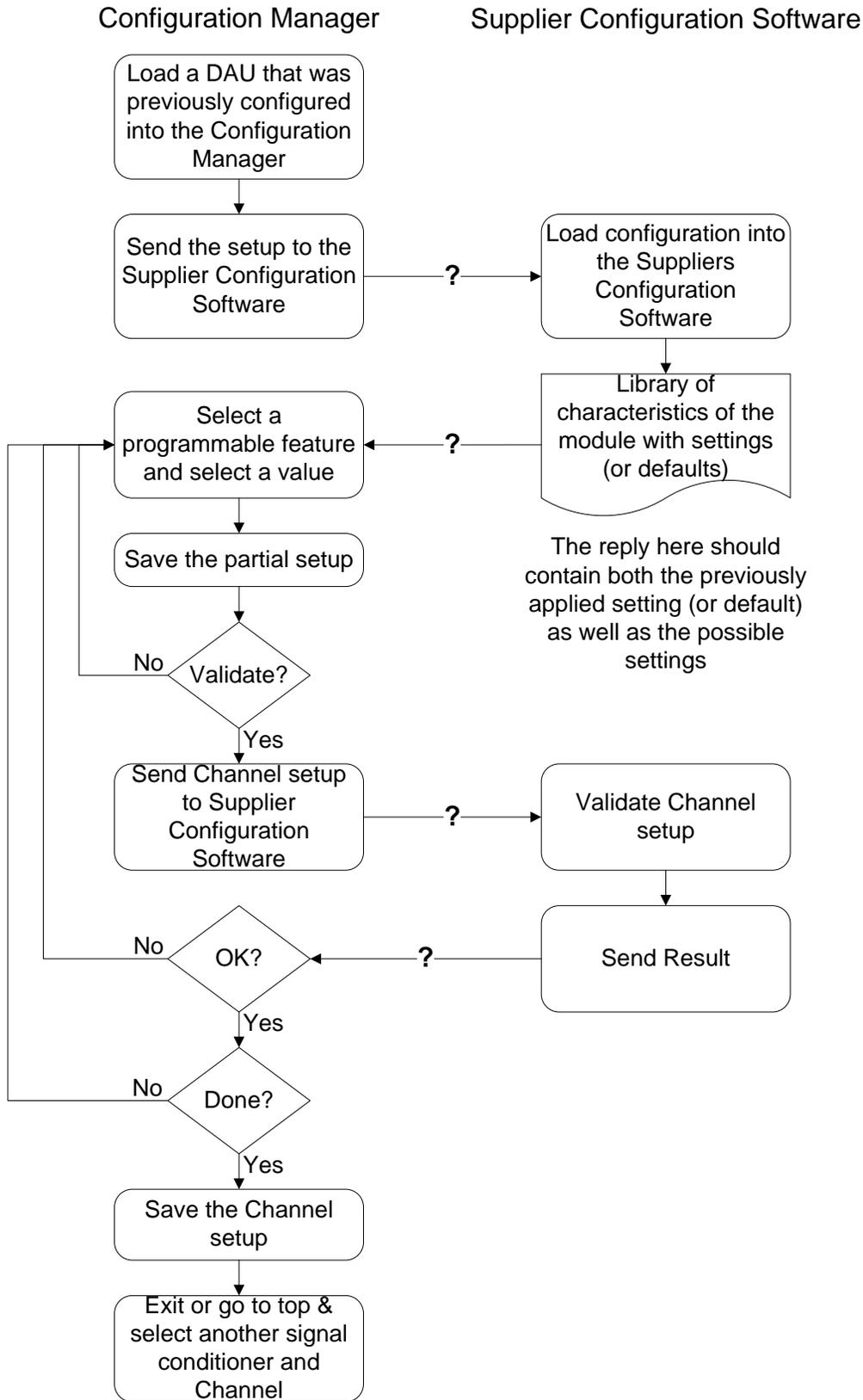


Figure 4 Modification or Completion of an Existing Configuration