# Interworkability: The Key Ingredients

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**Abstract**

Interworkability, the ability of two or more devices to interoperate on deeper levels, will take significant cooperative efforts to achieve. In addition to formal standards, user based technical agreements and a merging of management infrastructures is also required. This paper covers a few of the major ingredients that will be necessary to fulfill the vision of fully integrated systems. Critical among these ingredients is the right mix of cooperation and integration across a number of standards and consortia working the problem.

## 1. INTRODUCTION

The fully integrated future intelligent power system complete with dynamic and automated customer systems will be challenging to develop on the envisioned scales. Interworkability goes beyond interoperability in that it includes the ability of the equipment to do most of its own management as well as correctly execute applications for the everyday users. As systems become more complex and scale up to tens of thousands if not millions of intelligent devices, the key elements for interoperable and interworkable systems become increasingly important for both capital cost and life-cycle cost management.

### 1.1. Realizing the need for infrastructure

Too often the perception of building an automation system is taken as just a matter of going to the nearest automation conference and specifying systems with a shopping cart. Blindly buying systems offered with the hopes of taking them back and integrating them at any level is wishful thinking at this time. Yes, it is a future vision that we will be able to someday integrate systems by just plugging them into a communications network. However, the so called "plug and play" promise is yet a good distance off for many systems and components offered in the utility automation and customer communications marketplace. This vision has been put forward so much over the last 20 years that people think it will happen by magic. It will not. The industry needs to realize the need for and then work toward the development of not one but several infrastructures. Moreover, these systems need to be specified, developed, tested, deployed and managed as well as possible at the start.

## 2. INTEROPERABILITY AND INTERWORKABILITY

Interoperability requires agreement. Agreement between equipment as integrated over a network requires not just agreement at all the implemented layers of the OSI Basic Reference Model but also within the Layers above layer seven. This includes how the applications carry out instructions as well as how they assist with initial configuration and ongoing system administration. Another dimension to interoperability is the more involved term interworkability that includes the exchange of meta data and the ability of equipment to support more "plug and play" type set up and integration. Interworkability includes not only the ability to accurately send and receive messages over the network but also be able to correctly interpret and execute the messages in a distributed computing environment where the application could be executed on multiple devices across a network. Equipment that interworks carries a higher standard of execution requirement particularly in a "real-time" control environment where the application must execute within a defined window of time. The term Interworkability is associated with the Manufacturing Message Specification (MMS) Standard also known as ISO 9506. Understanding the execution environment is important to the development of interworkable equipment and applications.

## 3. STANDARDS DEVELOPMENT

### 3.1. Standards Development

The development of well thought out standards that are based on a body of industry knowledge is a starting point for developing interoperable systems. The power industry will need to orchestrate a variety of standards for implementing intelligent systems on the scales now envisioned. Standards are of two types: defacto and dejure.

Defacto standards emerge from sheer strength of presence in the marketplace while dejure standards are developed typically through contributions to Standards Development Organizations (SDO's). SDO's are typically accredited through an organization overseeing the processes to ensure open participation and systematic addressing of issues as the standards develop. Standards from recognized SDO's provide a measure of stability within technical standards so that vendors can build products and have a reasonable expectation of product life-cycle.

### 3.1.1. Standards Participation

Participation in the standards process must go beyond attending meetings. It is the work between meetings that results in modifications or suggested improvements to the standards that provides the raw material for the maturity of standards. In particular extensions of existing standard specifications in response to new applications are one of the key sources of enhancements. In addition, many improvements also come from efforts to apply the standards for new applications and equipment. Many useful contributions to standards have come directly from projects developing applications. Key research and development projects can play a critical role in doing this type of work that not only develops the equipment but also contributes to improvements to the standard.

### 3.1.2. User Groups and Consortia

User Groups and Consortia that are associated with an SDO based standard have the complementary roles of resolving technical issues. These are sometimes called "Tissues" by insiders. In addition user groups will take on the task of standards conformance testing. Conformance testing is not a job performed by formal SDO's, though they may become involved with assisting in the specifications for conformance testing. For the power industry the UCA International User Group has a subcommittee on testing and supports development of quality assurance procedures for use of the IEC 61850 Standard. Similarly the ASHRAE BACnet Standard for Commercial Building Automation has several user groups world wide and includes a manufacturers group.

An active user group is an important ingredient in developing equipment that not only conforms to a standard but also interoperates across the vendor equipment offerings. User groups often get involved with the development of technical implementation agreements that further define how the standard should be applied for truly interoperable/interworkable equipment and applications. These agreements are necessary when the standard contains allowable vendor specific options. These options are in part due to the standards consensus processes but may inhibit interoperability. These agreements in turn may be contributed up to the supporting SDO for adoption as a companion standard or may remain a less formal user community agreement.

## 4. SYSTEMS ENGINEERING

For robust systems development, systems engineering methods should be applied to any project. Systems engineering provides a systematic approach to the development of requirements, documentation and ultimately the management of advanced automation systems. Any system will require rigor to first adequately specify both the function as well as the non-functional requirements necessary to specify systems. Interoperability and interworkability must be built into system specifications from the start. Systems engineering must be applied with other technical disciplines within the application domains such as electrical engineering, telecommunications engineering and software engineering. Systems engineering is particularly important to help specify robust systems that can last for many years in the field. This is another important ingredient in the development of interoperable and interworkable systems.

## 5. RESEARCH AND DEVELOPMENT

R&D is another necessary ingredient in the development of interworkable equipment and applications. There are a number of remaining unresolved issues in the development of robust advanced utility automation systems. Some of the areas still remaining include the following:

### 5.1. Network Research

Several issues in next generation network management infrastructure need to be yet worked out. Large scale addressing, multihoming and integration of management functions over a variety of physical media are remaining issues. The sheer scale of millions of managed networked components poses significant network and systems management issues that remain to be fully addressed.

### 5.2. Cyber Security Research

Developing robustness into massively scaled networks remains an issue as well as developing new technologies such as real time intrusion detection, and robust security management

### 5.3. Development of Tools and Methods

Tools and methods for specifying and documenting future systems is also an area that needs further R&D. Methods are needed to adequately describe architectures. Refining and adopting a model of industry operations is the subject of ongoing work. New areas of complex systems engineering are just beginning to emerge.

### 5.4. Data and Device Models for Advanced Equipment

Uniform and standardized application level communications are still in development and are necessary for the development of interoperable equipment. This need is especially acute for residential in-building appliance and equipment integration.

### 5.5. Designs and Initial Implementations

R&D is also important for initial equipment designs and "bench top" implementations of applications and equipment built to emerging standards. A critical element of standards development for interoperable equipment is the development of real equipment. This work is the refinery for standards maturity since it brings out areas in the standard that are ambiguous or where standards need to be extended for specific functions.

### 5.6. Initial Field Trials

R&D also has a role in the execution of initial field trials. This is also an area of key importance to the development of standards since it places them in real world situations and user experiences. These trials will also reveal issues that once resolved can assist the development of the standard, interoperability agreements and the achievement of interoperable equipment.

## 6. ARCHITECTURE DEVELOPMENT

Architecture development is yet another critical area of development for interoperable equipment. Architectures by definition view the issues from a higher plane than standards development. Architectures are concerned with the following ingredients that are necessary for interworkable equipment on an industry scale.

### 6.1. Integration of Standards

Another dimension of interworkability is the scope and extent of integration achieved across the enterprise or even an industry. Architecture development includes the necessary integration of standards for applications that must integrate systems across the enterprise as well as integrating with other entities. For utilities, operations will integrate with customer systems as well as with Independent System Operators. The integration of standards at the level of industry architectures are another key ingredient for future interworkable systems.

### 6.2. Model Development

An industry model of operations in conjunction with the development of requirements and key standards represents another key ingredient to bring the vision of integrated systems. Models have provided an indispensable tool for the telecommunications, aerospace and other key industries. It is a tool that will contribute to the development of interworkable systems and equipment

### 6.3. Architecture Development

Architecture development is still maturing as a discipline and will likewise contribute as a key set of ingredients for the power industry as it moves forward. Presently, the tools and formal descriptions of architecture are still under development. This area promises to contribute to the larger scale issues of interworkable equipment over the long term

## 7. TECHNICAL TRANSFER

Transfer of the "technology of integration" needs to take place within the following audiences:

### 7.1. Transfer of Technology to Utilities and System Integrators

Utilities and energy service providers will be the integrators of the envisioned future systems. Transfer of the technology of integration is important for correctly specifying, procuring, accepting and managing the next generation of advanced equipment over its life-cycle.

### 7.2. Transfer of Technology to Vendors and Equipment Developers

Technology of integration also needs to transfer to the vendor communities as they design and build the equipment for the next generation of utility automation. Transfer is through the formal standards as well as the user groups and paying attention to emerging industry requirements trends.

### 7.3. Open Source

Open source computer code that represents a consistent approach to implement a given standard may play an increasing role in future systems development. This is an emerging area of technical transfer but one that shows promise for open standards based automation equipment.

## 8. CONCLUSION

Interworkable applications and equipment will take a blend of key ingredients to enable the future visions for the industry. The encouraging part of these scenarios is that significant work has already been completed and much that can be built upon. In addition the numbers of communities that are starting to support the concepts of open systems and standards based equipment are growing. Significant work remains but through cooperation in standards user groups and research efforts the visions of interoperable systems can be manifest.

## Biography

Joseph Hughes is a research project manager for the Electric Power Research Institute in Palo Alto, California. Mr. Hughes has over 25 years in R&D in the power industry Mr. Hughes is a member IEEE and active in IEC and other industry standards and consortia.