A Conceptual Model of ICT Interoperability

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Abstract

This document proposes a formulation for an index of interoperability and recommends extensive academic research focus on the nature, requirements, methods, and confirmation of interoperability. Dependence on interoperable ICT (Information and Communications Technology) solutions is rapidly growing. This reliance has resulted primarily from improvements in the capabilities of computing systems and from the many important and ongoing social, economic and technological changes happening in the world today . Despite these improvements and changes, interoperable solutions have relatively languished. In part, this is because there is no generally agreed definition of interoperability. This has led to confusion in the marketplace and a dulling effect on growth.

Problem Description

1.0 Problem Description

Development and implementation of ICT (Information and Communications Technology) solutions today often consume more time and money than would be the case in a more ideal situation. Among the causes of that are the absence of a generally accepted definition of 'interoperability', and the diversity of its goals. The disparities in both seemingly lead to provider/buyer disputes over products and services. Meanwhile, the beneficiary of the solution in question receives suboptimal value.

1.1 Inadequate Definition

The concept of interoperability is just that ... a concept. Unfortunately, there is no generally accepted definition. As a direct consequence of this, different pseudo definitions have arisen. Most seem dominated by marketing hype (the reader is

free to verify this), and bear little resemblance to anything more than a marketing promotion (hype).

There are some exceptions to this somewhat dismal observation. Here are two of the more notable ones:

- Interoperability refers to the ability of two or more systems (computers, communication devices, networks, software, and other information technology components) to interact with one another and exchange data according to a prescribed method in order to achieve predictable results.[1]
- Interoperability is the ability to exchange information .. and to use it.[2]

One implication from these well-respected definitions is that 'interoperability' is a Boolean-valued, system attribute. The creators of these pseudo definitions seem to believe that interoperability is a property of ICT systems have, or do not have, with no shadings of gray in between. This is inadequate. I interoperability is a real-valued attribute (i.e., according to some scale) that applies to a wide range of relationships among ICT processing entities.

1.2 Disparate Goals

The problem, today, with interoperability is perhaps best stated in paraphrasing Strother Martin's role in the movie “Cool Hand Luke”, “What we have here is, failure to interoperate.” The wide diversity of solutions providers, user environments, processor environments, and their respective dynamics lead to complex challenges. The viewpoints of each differ, resulting in disparity among the goals.

What worked well from one provider may not operate seamlessly with another provider's offering (or with their own offerings, for that matter). Cultural and operational differences in user environments may be incompatible. Technical capabilities of processing components may not work well together. Taken together with the rapid changes taking place in each of these areas, interoperability is an exceedingly complex matter.

As a result of all this inconsistency and uncertainty, it is not unexpected that different views of the goals of interoperability would arise. Here are a few representative examples. All contribute to the goals of interoperability.

- Quality of service
- Breadth of interface
- Limited user intervention

1http://www.telehealthlab.com
2http://www.opengroup.org

- Ease of implementation, operation
- Ease of adaptation, portation due to changes in
  - technology
  - solution requirements
  - organization
- Long life (throughout the life cycle)

1.3 Difficulties Due to Non-interoperable Solutions

It is difficult to conceive of a current problem, one worthy of an ICT solution, that does not require a significant degree of interoperability. What is more interesting to understand are the characteristics of problems that give rise to the greatest reliance on interoperability. Consider these examples:

- Cross cultural – Cultures the world over differ in ways that are important to ICT. Character sets, numbering methods, calendars, and currency are just a few. Interoperability difficulties show themselves in flawed financial exchanges and list ordering, among many, many others.
- Public and product safety – All aspects of entities involving safety require seamless interoperation with all others in order to assure that unsafe situations, of the types the precautions were intended to address, do not arise.
- Privacy, security, etc. - Elements of security and privacy rely extensively on one another.

Providing Interoperability

2.0 Providing Interoperability

Two aspects of interoperability require understanding by the reader. These are the ways by which interoperability functionality is provided (i.e., approaches), and the need for adequate evaluation.

2.1 Approaches

At one level of abstraction, there are two ways to providing interoperability: embedded and interfaced. Let us examine each.

The embedded approach consists of associating two entities so closely that it is exceedingly difficult to distinguish them, or for other entities to gain access to them. Use of the embedded approach to providing interoperability often leads to what has been termed fully integrated solutions. In order to understand completely the functions of interoperability, one must thoroughly understand all

of each of the tightly coupled entities.

Properties typical of the embedded approach

- technology limited
- single vendor solutions,
- custom specification
- proprietary products

The interfaced approach is entirely different. It uses an interface definition to specify the means by which entities relate to one another. By understanding the specification, one can completely understand the functions of interoperability the interface supports. Industry trends seem to favor interfaced solutions [3] For additional information concerning interfaced approaches, refer to Appendix A.

Properties typical of the interfaced approach

- technology agnostic
- multiple vendors solutions, specified
- industry-wide standards

2.2 Evaluation of Interoperability

The inadequacy of using a Boolean valued variable to represent the value of the interoperability variable cannot be denied. There is a measurable scale for it, not simply a toggle switch. Interoperability is an attribute that is measured using a real variable, and not a Boolean variable.

Assessment of interoperability is a non-trivial activity because so many factors contribute to it. First is collection of the requirements. Then determination of whether the requirements are satisfied. Because some requirements may be more important than others, and because some may be provided while others are not provided, some algorithm must be applied to assure consistency of the metric for interoperability.[4]

3www.it.northropgrumman.com: Interoperability is best achieved initially through data sharing over standard data links and evolves toward shared understanding where coalition partners operate as an integrated unit.

4http://www.itsi.disa.mil: Assessments <of interoperability>will focus on the thorough examination of system requirements, documentation, and technical capabilities...

Conceptual Model

$$V = \frac{\sum_{i=1}^{n} (E_i * M_i)}{\sum_{i=1}^{n} M_i}$$

Where:
V = the value of the index of interoperability
i = the interoperability function number
n = the number of interoperability functions
E = the extent to which an interoperability function is provided ($0 \leq E \leq 1$)
M = the importance of the interoperability function

Summary

The current state of the understanding of interoperability is lacking and requires improvement. This conceptual model provides a point of departure, a framework for future research to address some important questions:

- How does one go about reducing the claims of interoperability from hollow, provider declarations to some more uniform and credible statement?
- How dies one go about incorporating the absence of interoperability into evaluation of procurements?
- What is the value of non-required interoperability features?
- Is there a role for engineering practices such as formal definition methods?
- What part of IT budgets is being spent addressing interoperability issues?

Appendix A- Interfaces

Interfaces that are bully-exposed and reliable lead to high quality interoperability. If ICT entities do not work well together, then the functionality that passes across

them will be corrupt . It is useful to understand how people, devices and programs relate to one another. Several relationships, often called interfaces, among these entities have arisen to provide the functionality necessary to support interoperability.

- Between human beings and hardware entities – Humans interact with hardware constantly. Humans type on keyboards (which convert keystrokes into electrical impulses), move pointer devices, and read monitors as a matter of course.
- Between software entities – Perhaps the single operation with which the typical user is most familiar is 'cut and paste' from a text to a spreadsheet document. In this operation the text program makes available to the spreadsheet program, the data in question. It does so by placing the data into memory that is available for reading by the spreadsheet program. An adequate description of the data exists in order that the spreadsheet acquire the data and use it as intended.
- Between software and hardware entities – The capabilities of both the device and the program must be matched in order to interoperate effectively. An example is that the program must have the capability of producing dialogue that the device can hear, understand, and operate upon.
- Between hardware entities – In general, mechanical and electrical properties of the two entities must be compatible. The well-known laws of geometry and physics dictate the overall quality of this type of interoperability. Connector-to-connector, and connector-to-wire interfaces are examples.

Complex relationships among interfacing entities typically result from even the simplest of operations. A failure along any of the chain of events represents a failure of interoperability. That is, the requisite task goes undone, or done incorrectly, with potentially damaging results.

References

Worldwide web:

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5. The Open Group - http://www.opengroup.org
6. Telehealth Interoperability Laboratory of Alberta, Canada - http://www.telehealthlab.com