Information Storage Industry Center
University of California San Diego
UCSD

Project Brief **May 15, 2006**

Storage Systems Interoperability and Standards-Based Implementation: What are the Strategy and Economic Impacts?

R. Balachandra (Northeastern University) and J.E. Short (UCSD)

Defining Interoperability: Introduction

Storage systems interoperability, the business of creating easily configurable, high-performance hardware and software storage solutions for businesses, has emerged in the vendor and end user communities as a proposed future direction to reduce storage systems complexity and cost, at a time of sharply increasing storage and storage access demands. At the technical engineering level, this direction has encouraged vendors to collaborate in standards bodies such as ANSI and IETF, and to test their implementation of standards in interoperability test suites.

At the business level, a focus on the business value of interoperability comes at a time of sharply increasing storage and storage access demands, driven by the rapidly declining costs of data acquisition and access, increasingly data-intensive applications, and regulatory changes in records management and data retention that affect what data companies keep, and how and where they keep it, in the future. Storage systems interoperability and its importance in the firm's IT infrastructure generally is a key management factor in regulatory compliance and increased business performance at reduced IT costs in the typical Fortune 1000 firm.

Conceptually, interoperability has been defined as "the ability of a system or product to work with other systems or products without special effort on the part of the customer." In the ideal interoperable system all components are "plug and play." Any component can be easily plugged into the system (as the hardware connections are all standardized) and the component starts functioning immediately (with the installation of the appropriate software drivers). The operating software automatically detects the component and chooses the appropriate driver to make the component work. Interoperability is increasingly important as information technology (IT) solutions become both larger and more complex—and as corporations become more dependent on them. This is particularly true of the data storage industry, where product compatibility and interoperability is facilitated by API (Application Programming Interface) software and marketing partnerships rather than an industry accepted protocol based on open, standards-based architectures.

There are signs, however, that business and technical factors may be forcing the industry to change. With the introduction of the Storage Networking Industry Association's (SNIA's) Storage Management Initiative (SMI), the idea of making storage system components interoperable may have gained some momentum. The open SMI standard, developed with the participation of most of the leading storage system developers, represents a first step towards architecting and engineering interoperable components. There are important business reasons for this collaboration. If past history is to be believed, the prospective benefits of interoperability in this industry could be large - the PC market, for example, exploded when IBM opened its architecture to outside hardware and software developers. Moving the basis of vendor competition away from proprietary systems towards an open, standards based competition could substantially grow the market and open up new revenue streams in storage

services and software. For data storage technology users, the promise of interoperability is lower costs associated with purchasing, implementing and managing storage systems. If such product and the attendant cost savings could be realized, the market for these products could increase exponentially.

Factors Driving and Inhibiting Interoperability

For the vision of storage system interoperability to be realized, both technology users and storage system vendors will have to address the challenges associated with any move towards designing and engineering interoperable products. First and foremost, storage industry competition today is based around proprietary products manufactured by a few, dominant firms with established customer bases and above market-average revenue performance. In short, storage is an example of a concentrated industry, exhibiting relatively high barriers to entry at the enterprise level, and high switching costs for existing customers. This is not the typical market model encouraging collaboration. Still, developer support for the SMI and end user pressures for lower cost storage solutions provide some evidence that greater interoperability and standards-based product development will continue to evolve, albeit with varying degrees of support. Therefore, it is worthwhile to examine the business factors driving and inhibiting interoperability.

From the end user's point of view, greater interoperability is mostly positive. The promise of interoperable systems is significantly reduced costs of setting up and managing a storage network. In the long run, it may also reduce component costs, as competition from new market entrants rises. In theory, storage system interoperability should also enable corporations to gain greater value from their information, as data flows more freely between storage systems. On the other hand, there will be initial switching costs associated with any transition, as legacy systems are phased out in favor of standardized components. While this may not be a major factor for companies without large storage installations, switching costs could be significant for those companies that do (although some costs could be mitigated through incremental upgrades).

System support would be another factor for end-users to consider. For example, if the firm's interoperable storage system is made up of heterogeneous components from a large number of small and large manufacturers, who among the vendors is ultimately responsible for system performance and total cost of ownership? Would it be the hardware or software manufacturer, the systems integrator, or the network provider? Will the current practice of negotiating service level agreements with systems integrators scale up to support interoperable solutions?

From the storage system and developer point of view, interoperability presents complex changes in business approach, competition, product R&D and engineering, and customer relationships. In the case of the IBM PC cited above, the personal computer market did experience exponential growth, but at the expense of IBM's own PC market share, which dropped precipitously as the company exposed itself to lower cost competition. Still, the rapid growth in the size of the market enabled IBM, as it did other PC manufacturers, to benefit in the long run, albeit in a fiercely competitive segment.

For storage system vendors and developers to benefit from rapid market expansion, established companies will have to make a similar leap of faith. Moving from competing on proprietary systems to open systems competition could create tremendous opportunities for market leaders, as they are the best positioned to take advantage of a rapidly growing market. Conversely, it could also open them up to smaller and cheaper competition if they failed to move with the market. Too, developers would have to incur their own switching costs, as they direct engineering teams away from their own proprietary product architectures to developing standards-based solutions. In any estimate, these switching costs could be considerable. However, there may also be an important upside, as resources previously dedicated to engineering interfaces could be shifted to product

functionality and customer requirements. Additionally, this change would also present developers the opportunity to bring products to market more quickly.

In the end, the cost – benefit equation for interoperability must provide clear and substantial benefits to existing market leaders for them to seriously consider making such a change in business approach. Such a change has occurred in other IT product sectors, for example high performance computing, but it is hotly debated whether such changes were forced on incumbents by technological and business model disruptions, or led by innovative firms leaving old markets and making new ones. Undoubtedly most transitions have been both, but in the push and pull of change, seeing the opportunities and roadblocks ahead has been critical for market leaders.

ISIC's Research Project on Interoperability

Over the next fifteen months ISIC will explore the key issues and benefits / risks posed by interoperability in storage systems. Our focus will be on understanding what is meant by interoperability, on documenting and researching selected case studies of interoperability solutions in user firms, on defining metrics to enable studying the strategy and economic impacts of interoperability, and on collecting data and testing interoperability models developed to estimate strategy and economic effects.

Phase One

What is interoperability?
What are the benefits and risks of moving to interoperable solutions?

We plan first to systematically collect industry and user definitions of interoperability and assessments of the benefits and risks of moving to interoperable solutions. How is interoperability defined? By whom? To what extent is interoperability a moving target; that is, a continuum of products, standards, architectures and interfaces that interoperate and define a type, level or class of system solution? What are the benefits and risks of moving to an interoperable approach, for manufacturers, software services, integrators, and end users? To what extent can these benefits and risks be empirically verified through analysis of implemented solutions or project proposals that include cost – benefit calculations?

We plan also to survey storage and IT professionals in the startup phase of the project. Our focus will be on asking respondents their definition of interoperability, the challenges it poses, and their assessments of the benefits and risks of moving to interoperable solutions.

Phase Two

What are the appropriate metrics / measures of interoperability?
How can we model the strategy and economic effects of interoperability?
How can we ground our metrics and model in selected case studies?

In the second phase of the project, we will develop quantitative measures of interoperability and/or metrics appropriate to measure and compare interoperability across companies, systems and storage configurations. These metrics will be developed for three purposes; first, to provide a clearer understanding of interoperability and the major issues posed; second, to allow comparisons of classes or levels of interoperability defined by different system configurations; third, to define an economic model of interoperability. We view interoperability as a moving target, not a stable set of system attributes. Therefore, to compare different levels or types of interoperability, we need measures and a model to allow comparison.

In parallel with our focus on defining measures, we will also complete several selected case studies of interoperability in user firms. These case studies will provide examples of interoperable solutions in practice, and the occasion to test and validate our measures of interoperability in the field.

Initially our model of interoperability will be conceptual, based on our understanding of the actual cases and situations in the field. We will look at a sample of firms from a wide spectrum of issues to help define the framework, and refine the model through iterative case sampling and primary and secondary data collection. We view this as an iterative process. Hypotheses relating interoperability measures and economic impacts will be developed and circulated to IT researchers and to industry partners for discussion and validation.

Phase Three

Estimating the strategy and economic effects of interoperability

The final phase of the project will be the most comprehensive. In this phase we will collect empirical data to substantiate the model developed in the second phase. Our objective will be to test models relating a given situation of a firm with the costs and benefits of moving to different levels of interoperability, as defined by our metrics. The purpose of empirical testing is to develop more precise estimates of the economic impacts of different levels or types of interoperability. Our final step will be to interpret statistical results based on understandings taken from field studies.

Timeline and Deliverables

The project will take place over the next fifteen months. We estimate the first two phases of the project will take nine months, and the final phase will add an additional six months. The principal investigators on the project will be R. Balachandra (Northeastern University) and J. Short (UCSD).

Project deliverables include:

- Three research reports, produced at the end of each phase of the project. For example, a report and executive summary will be completed and distributed to sponsors and participants at the conclusion of the startup phase of the project, covering interoperability definitions, benefit and risk assessments, and findings from an Internet-based, professional survey;

- Forum meetings, hosted by ISIC and sponsors as appropriate, bringing together companies and researchers to discuss study progress and results;

- Participation in industry conferences and other forums where study results can be discussed and reviewed;

- In-progress telephone conferences and site visits for companies directly involved in the research.

- At least two academic working papers, for submission to journals and/or academic conferences.

Finally, we will incorporate ideas from the diverse number of industry associations and media with interest in interoperability, including SNIA's (Storage Networking Industry Association) Storage Management Initiative (SMI), End User Council and interoperability test laboratory, and the industry and trade press covering standards, interoperability and IT management policy issues (examples: CIO magazine, ComputerWorld, Storage, etc.).

For More Information

We welcome individuals and companies interested in obtaining further information on the interoperability project, including participation as a case site or as a participant in the web survey, to contact the principal investigators at jshort@ucsd.edu (J. Short) or rbala@ucsd.edu (R. Balachandra).

ABOUT ISIC

The Information Storage Industry Center (ISIC) at the University of California, San Diego is a university-based, management research program studying the business applications and economics of advanced storage technologies in the modern information-intensive corporation. ISIC's program areas include industry studies (competitive dynamics, product innovation and manufacturing, industry structure), business innovation and applications of advanced storage systems (data management, data mining, distributed information management), and the management of storage as an integral part of the firm's IT business resource. ISIC works closely with the Center's StorageNetworking.org community of practice in conducting industry facing, direct observation research.

ISIC RESEARCH SPONSORS

Alfred P. Sloan Foundation
Engenio Information Technologies, Inc.
Hewlett-Packard
Nortel

STORAGENETWORKING.ORG SPONSORS

Storage Networking Industry Association
Hewlett-Packard
McDATA
Computer Associates
Symantec
EMC Corporation
Engenio
Trainer Communications
NeoScale Systems
Rainfinity
Servergraph
NeoPath Networks
eRSVP
Storage Magazine
InfoSTOR
Byte and Switch

ISIC STAFF

Roger Bohn, PhD, Director
James E. Short, PhD, Research Director
Ramaiya Balachandra, PhD, Visiting Researcher
Ron Durbin, Director of Industry Relations

CONTACT INFORMATION

Information Storage Industry Center
9500 Gilman Drive, 0519
La Jolla, CA 9203-0519
Telephone (858) 534-9825
Fax (858) 534-3939
E-mail: isic@ucsd.edu
http://isic.ucsd.edu