Journal of Strategic Information Systems 22 (2013) 137–156

Contents lists available at SciVerse ScienceDirect

Journal of Strategic Information Systems

journal homepage: www.elsevier.com/locate/jsis

Explaining the adoption of grid computing: An integrated institutional theory and organizational capability approach

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ARTICLE INFO

Article history:
Received 14 December 2010
Received in revised form 8 October 2012
Accepted 21 October 2012
Available online 8 December 2012

Keywords:
Adoption
Grid computing
Cloud computing
Inter-organizational linkages
Inter-organizational systems

ABSTRACT

Grid computing can meet computational demands and offers a promising resource utilization approach. However, little research details the drivers of and obstacles to adoption of this technology. Institutional and organizational capability theory suggests an adoption model that accounts for inter- and intra-organizational influences. An empirical study with 233 high-ranking IT executives reveals that adoption results from social contagion, while organizational capabilities such as trust, firm innovativeness, tendency to outsource, and IT department size, influence adoption from an intra-organizational perspective. The findings show that mimetic pressures and trust play major roles in adoption processes, which differentiates grid computing from other inter-organizational systems.

1. Introduction

In the past decade, a networked economy has evolved in which organizations collaborate and create supply chains or value networks. Such networks constitute relationship webs that generate both tangible and intangible value through complex, dynamic exchanges across organizations. The adoption of new technologies in such closely collaborating, networked economies can be consequential. Technologies such as electronic data interchange, voice-over-Internet protocols, and electronic business-to-business marketplaces, constitute a category of such technologies, referred to as inter-organizational systems (IOS) (Eom, 2005). Though the aforementioned have received pertinent research attention, another IOS gaining prominence has not – ‘Grid computing’. This study aims to address this gap by analyzing the influences on the adoption of grid computing.

Specifically, grid computing connects various IT resources through a physical network, offering members of the network the capability to share their IT resources (Foster et al., 2001), potentially improving utilization of otherwise idle resources. Grid computing thus can provide significant advantages to its adopters, especially for organizations that comprise subsidiaries in different time zones (where off-peak resources in one zone can be utilized on-peak in another zone). The concept of cloud computing evolved out of grid computing and often uses a grid as its backbone. This evolution reflects a shift in focus, from an infrastructure that delivers storage and computing resources (i.e., grids), to one that is economy-based and aims to deliver more abstract resources and services (i.e. in clouds) (Foster et al., 2008). Grid and cloud computing both can be employed internally by a firm, or can be exposed to others as an IOS. Furthermore, both grid and cloud computing appear poised to induce paradigm shifts, similar to the shift that marked transition from mainframe to client–server architectures in the

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http://dx.doi.org/10.1016/j.jsis.2012.10.005

early 1980s (Bhardwaj et al., 2010). Yet we know little about prospective users' intentions to participate in this paradigm shift.

On first consideration, grid computing appears similar to other IOS with regards to factors that influence its adoption. On closer scrutiny however, several important differences become apparent. We will discuss these differences in detail in Section 3 and motivate why a distinct adoption model is appropriate for grid computing. We propose a combined model including institutional pressures and factors that are critical for grid computing, highlighting the differences from other IOS adoption models. In Section 2, we introduce the technology underlying grid computing and its strategic impacts on the firm. We highlight differences between grid computing and other IOS, then offer some examples from business practice before discussing the theoretical background for our proposed adoption model. We describe our conceptual model in Section 5 and subject it to several pretests. Section 6 outlines the status quo of grid adoption in business practice and presents the model results based on data from a large field study involving 233 IT managers who have responsibility for IT budgets. Additionally we compare the results of our adoption model with those obtained for other IOS. Finally, Section 7 concludes with a discussion of the implications of our findings and study limitations and future directions.

2. Grid computing

Grid computing, developed in the early 1990s, connects different computing and data resources from several locations, using a network such as the Internet, to create scalable, high-performance computing capabilities. Foster and Kesselman (1999) coined the term "grid computing" to emphasize their belief that it would revolutionize the world, just as the electric power grid did in the late nineteenth century. Researchers also have offered several alternative definitions: Buyya and Venugopal (2005) define grid computing as "a type of parallel and distributed system that enables the sharing, selection, and aggregation of geographically distributed autonomous resources dynamically at runtime depending on their availability, capability, performance, cost, and users' quality-of-service requirements." In this definition, the grid offers the possibility of sharing computing resources (e.g., servers, desktop PCs, computer clusters), storage resources (e.g., hard disk drives), and specific resources (e.g., astronomical telescopes), making them accessible to all participants in the network. Every participant can simultaneously act as supplier and consumer of IT resources. The performance of grid systems is restricted only by the number of currently connected resources.

A department within a single organization that connects resources through an intra-organizational grid may gain access to the computational power of the entire organization. If the organization is also linked to an inter-organizational grid, all departments can access an even larger pool of resources. The possible benefits of the system thus relate strongly to the degree to which the organization is open to intra- or inter-organizational linkages across departments or with external organizations. Challenges for cultivating grid computing adoption include trust and management issues on the intra-organizational side, as well as cross-organizational commitment on the inter-organizational side (Beck et al., 2008).

Although grid and cloud computing have parallels in terms of their vision, architecture, and technology, they differ in terms of security, programming model, business model, compute model, data model, applications and abstractions (Foster et al., 2008). For the purposes of this study, we therefore define grid computing (this definition also was provided to the study participants) as *a technology that allows sharing (consuming and providing) hardware and software resources by using common network technologies*. Whereas the Internet allows access to information, grid computing allows access to different kinds of IT resources. Instead of physically buying IT resources, grid computing enables members to access necessary resources on demand. The sharing of IT resources in a grid thus provides for a more efficient, flexible usage of existing resources.

3. Differences between grid computing and other IOS

A closer comparison of grid computing and other IOS reveals several distinct differences. First, grid computing provides some utility even when it is implemented exclusively for internal usage. Most other IOS provide utility only when they interconnect two or more institutions (e.g. electronic markets).

Second, the IOS that have been examined offer benefits with respect to the same dimension to all adopting organizations. With electronic data interchange (EDI) for example, both adopters enjoy faster, more automatic data exchanges. Voice-over-Internet protocols (VoIP) simplify communications between adopting organizations and reduce related expenses. Electronic business-to-business (B2B) marketplaces accelerate bargaining and transactions, leading to faster exchanges of goods and payment flows. In contrast, grid computing often provides asymmetric benefits for the adopting organizations. One adopting firm might offer vast computing resources and receive monetary compensation in return; its partner does not benefit in monetary terms but gains additional resources. This asymmetric utility gain across different dimensions makes grid computing comparable to service outsourcing.

Third, grid computing links the IT infrastructure – and thus data and computational power – of two or more grid participants which constitutes nowadays often the centerpiece of the business in many industries. Compared to VoIP or EDI, trust in the technology itself and in other participants in the grid thus must play a key role in the grid adoption decision.

Fourth, EDI, VoIP, and electronic B2B marketplaces aim to support core business relationships among retailers, manufacturers, and suppliers (e.g., data exchange, communication, and trading, respectively). Sharing IT resources via grid computing