

A Forrester Consulting Thought Leadership Paper Commissioned By Cisco Systems

# Exploring The Potential Benefits Of End-To-End Convergence Of Data Center Networks

February 2011

**FORRESTER**

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## Executive Summary

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In the fall of 2010, Cisco Systems commissioned Forrester Consulting to evaluate end-to-end storage area network/local area network (SAN/LAN) networking issues including Fibre Channel over Ethernet (FCoE) adoption.

In conducting in-depth surveys and phone interviews in the US, Canada, and Europe with 106 IT decision-makers with storage and network knowledge, Forrester found that these companies do believe that convergence will happen over the next five years, but that they face barriers to adoption such as organizational challenges and concerns over technology maturity. Based on the results of these surveys, Forrester concludes the following:

- **Most users believe that there are benefits to be gained through convergence.** Around 80% of respondents across a variety of questions state that they think that there are benefits to be had from the convergence of SAN and LAN on a common network or through adoption of common protocols. This shows interest in the benefits as well as confidence that they are attainable, which is significant given the conservative nature of data center buyers. It's also notable that this confidence exists in spite of the fact that options for and experience with end-to-end convergence remain limited to date.
- **Organizational barriers to convergence are significant but appear to be diminishing.** Respondents indicate that organizational issues related to a common team managing both SAN and LAN are not trivial. Most respondents state that they currently have separate teams, although many point to a fairly deep connection between teams in current reporting structures. Early movers toward convergence point to success in combining the teams, with this combination leading to synergies and positive outcomes. Role-based access controls built into the management tools of FCoE-capable network equipment may help to ease the transition and ease the division of labor in newly converged organizations.
- **Refresh is seen as a key catalyst for adoption of converged architecture.** Most survey respondents point to significant change within their data center environment as a strong catalyst for consideration of migration to a converged architecture. Both refresh within an existing center and the need to build a greenfield data center site are indicated as likely events that could spur adoption of converged network infrastructure. This viewpoint represents a cost pragmatism common in IT, with longer-term benefits needing to wait for opportunistic capital spending. This also points to refresh or builds as key opportunities to evaluate new technologies, processes, and management structures.

## Definitions

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- Forrester defines SAN/LAN convergence as traffic for storage and application networking being carried on a common physical network infrastructure or on separate but technologically common networks.
- The transport network for convergence is generally expected to be Ethernet.

- Current options for storage protocols that can use an Ethernet transport fabric include Fibre Channel over Ethernet (FCoE), Internet SCSI (iSCSI) or Network File System (NFS).
- FCoE implementations today can interoperate with traditional Fibre Channel (FC) networks, allowing for a gradual change from separate, dedicated SAN to converged SAN/LAN over time.
- The benefits of such convergence would potentially include reduced cost of acquisition for network equipment, less equipment overall from shared redundancy, reduced overall network staffing, and lower complexity of management.
- Barriers to this convergence currently include: organizational issues with change of reporting and budgeting structures that are likely to be requirements for this convergence, resistance to the technology change, and some degree of confusion in the market about just what SAN/LAN convergence will look like.

## Introduction

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Data centers are becoming increasingly complex as businesses rely more heavily on IT for critical operations, data growth is tremendous, and budgets are tight. Constant availability is a requirement for most firms, limiting windows for maintenance and lowering tolerance for outages.

For years, data traffic from servers to centralized storage has been carried on specialized FC networks, designed to provide maximum performance and availability characteristics. Conversely, application networking for user-to-server and server-to-server traffic has run on Ethernet links. Ubiquitous, fairly easy to manage, and low cost, Ethernet has become the LAN network standard worldwide, displacing most every alternative. Purchase, deployment, and management of these two networks have been completely separate, with different teams concentrating on each and practically no crossover of tools, methodologies, or operations.

Recent innovations in Ethernet networking present the possibility of network unification through the use of a single technology for both SAN and LAN. Advances in Ethernet technology and the maturation of protocols such as iSCSI and FCoE offer deterministic performance, low latency, and constant data availability on Ethernet. An enhanced lossless version of Ethernet is at the heart of enabling FCoE, which offers current users of FC SANs a path to move to network convergence while maintaining zoning practices, skill sets, and management tools that are already familiar. On the server side, the prospect of shared redundant ports for both front-end LAN traffic as well as back-end SAN networking promises cost savings as well as an increased ability to virtualize server I/O. The adoption path of FCoE is manifesting in two phases, motivated by the availability of supporting technology from network, server, and storage vendors; Forrester sees the two phases of adoption emerging along the following lines:

- **The first phase involves modification of the I/O stream at the server.** Storage vendors have been somewhat slow to adopt FCoE capabilities directly in the array. As an interim step toward full network unification, common network interfaces for both LAN and SAN traffic from servers have been available in advance of storage array support. Called converged network adaptors (CNAs), these new interfaces allow servers to use the same redundant ports for both types of traffic, with load balancing and prioritization as part of the

equation. Once the traffic reaches the server access layer or edge switches, it is directed between traditional FC for packets destined for storage arrays and Ethernet for LAN traffic to users and other servers. This phase of network unification can be seen as a first step toward full convergence.

- **The next phase takes the transformation all the way to the storage array.** With broader support for FCoE from storage vendors emerging, the possibility of multitier FCoE becomes a viable option. It's taken time for storage vendors to prioritize the inclusion of FCoE capabilities in their arrays, but support is increasing. iSCSI capabilities are fairly ubiquitous in the midrange and low end, so options do exist. Whether users decide to separate traffic on distinct physical switches or combine traffic on switches, the ability to use common technology throughout represents a significant step toward the vision of converged networking. The replacement can happen gradually as current FCoE capable switches still support FC transport traffic to arrays as well, so older arrays and older FC switches with remaining usable life can still be used.

## Potential Benefits Of SAN/LAN Convergence

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Storage and LAN networking are both critical aspects of any firm's data center operations. Keeping them up and running, eliminating performance barriers, and enabling smooth expansions and refreshes are top priorities for environment managers. To this end, there must be significant benefit to any major changes that outweigh the potential risks and disruption. Because the potential benefits from network convergence are significant, many firms appear to be giving it serious consideration in spite of the natural conservatism inherent with storage administration. There are several key benefits:

- **Network hardware acquisition costs decrease due to the cost effectiveness of Ethernet.** While the cost of FC switching has come down over time, Ethernet is cheaper on a per-port basis and is likely to continue to be less expensive due to the higher volumes and larger pool of vendors serving the space compared with the relatively narrow and low-volume field of FC. Moving storage traffic to a form of Ethernet, a technology that is ubiquitous in data centers today, is seen by many as a move toward more use of industry standards and reduction of costs overall.
- **Convergence onto a common technology could also lower hardware costs.** Maintaining two separate technologies is expensive. Buyers have to negotiate separately among distinct vendors for both Ethernet and FC today. With convergence, port utilization could be increased with demand spread across a common pool of ports, and total-parts sparing could be reduced as the spare pool could be shared.
- **Ethernet is widely thought to offer simpler management than Fibre Channel.** There is no degree that prospective administrators can get in FC technology, and most end up learning the craft on the job. Firms generally struggle to hire qualified experts that can manage their critical data network environments. While it's not the only potential solution, a move to Ethernet for both application and data networking could reduce the reliance on dedicated, and sometimes complex, specialized toolsets.
- **Server-side network components and cabling can be reduced and simplified.** For some buyers, the tactical goal of reducing server-side network interfaces and cabling is enough of a motivator to get started on

network convergence, regardless of the progress for end-to-end convergence. With the need for redundancy, servers today have at least two Ethernet network interface controllers (NICs) and two FC host bus adaptors (HBAs) and many more in virtualized environments. The ability to reduce to two CNAs and cables instead can lead to a significant cost reduction, as well as reduce the speed and complexity of server deployment and ongoing management. Secondary benefits to reducing cables can selectively be significant if airflow is impeded by cable bulk. Energy used to drive cool air past impediments can be reduced for entire racks and pods.

- **Ethernet is better integrated than Fibre Channel.** Fibre Channel almost always comes as a stand-up card or other specialized adapter. It is not integrated onto motherboards because only components that apply to 100% of the application of the server as intended by the manufacturer will command the real estate and expense on the motherboard. Ethernet is on 100% of motherboards. For those servers directed at virtualization and other high performance tasks, 10 gigabit Ethernet (10 GbE) is on the motherboard. FCoE, as a 10 GbE technology is becoming increasingly available along with the 10 GbE controller. This means the price for FCoE is dramatically reduced from that of a specialty card. Similarly FCoE drivers are becoming embedded in operating systems. This results in simpler support and a lower price for the end user.
- **FCoE provides better support for server virtualization.** One of the more compelling features of server virtualization is the ability to relocate a running application using virtual machine mobility. Users should be interested in having the same capabilities available on every system where an application may reside. “Wiring once” with 10 GbE and FCoE as an Ethernet technology makes it possible to support this requirement with minimum incremental infrastructure and as a simpler data center standard than Fibre Channel technology.

## Barriers To Network Convergence

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The benefits above need to be balanced against the risks associated with changing the network to a converged design. Any change in network configuration requires consideration, but the changes associated with network configuration should be seen as significant — requiring new topologies, new technologies, and new processes for management. While the benefits do resonate, some of the barriers seen in the market include the following:

- **Storage and network buyers are conservative.** Network teams, especially for storage, are notoriously conservative, and with good reason: Sustained operation of equipment and environments is critical. Purchase decision-makers and implementers of these technologies find solutions that work and are generally resistant to change. While the benefits are not trivial, they are big-picture benefits that will take time to be realized. Many purchase decision-makers may see risk and high effort in getting to those benefits — and take a pass.
- **Separate organization structures between storage and LAN make convergence harder.** Most enterprise organizations have separate teams that manage SANs and LANs, with different people, methodologies, tools, and, possibly most importantly, budgets. Getting these teams, which historically have not gotten

along in many shops, to be on the same page, agree on processes, and make common decisions is no small task.

- **Maturity of FCoE tools and products remains a concern for buyers.** FCoE is a relatively new technology, with limited deployments to date. Buyers that like to hear about implementation experiences from reference customers are not likely to find many to rely on. Many buyers are looking ahead to end-to-end convergence, but available references mainly use FCoE for edge-only (access layer) deployments, so experience with long-term convergence remains limited.

## Organizational Considerations

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Among the current barriers to adoption of converged network infrastructures for SAN and LAN, Forrester sees the organizational considerations as among the most significant. To further get a sense for the magnitude and character of this issue, we explored the following questions:

- **Most firms have separate SAN and LAN management teams.** When we asked survey respondents about the setup of their network management teams, 75% of them stated that they had separate teams for the two disciplines (see Figure 1). In interviews with selected respondents, several of those who have moved forward with FCoE deployment stated that prior to implementation, they merged these teams and pointed to the merger as a key success factor in their implementations.

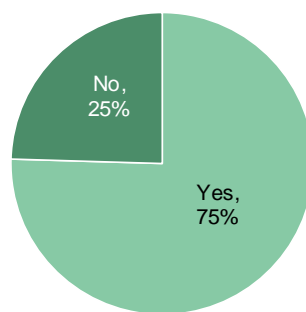
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**Figure 1**

Current State Of Separate SAN And LAN Teams

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“Does your firm currently have separate teams for storage network and LAN network management?”



Base: 106 IT decision-makers with storage and network knowledge

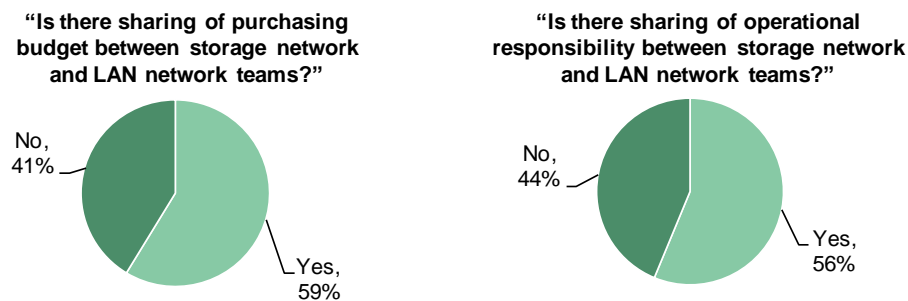
Source: A commissioned study conducted by Forrester Consulting on behalf of Cisco Systems, November 2010

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- **While the teams are separate, they do share budget and reporting in many cases.** Respondent budgeting and shared focus concerns diminished to some extent depending on the team setup. Fifty-nine percent of respondents stated that there is sharing of budgets between SAN and LAN teams, and 56% said that there is sharing of operational responsibility (see Figure 2). This would indicate that while there may be some degree of divergent priorities, the problem does not appear to be intractable, and the idea of moving toward greater cooperation and unification of technology and goals might not be seen as such a stretch.

**Figure 2**

Sharing Of Responsibilities And Budgets



Base: 80 IT decision-makers with storage and network knowledge

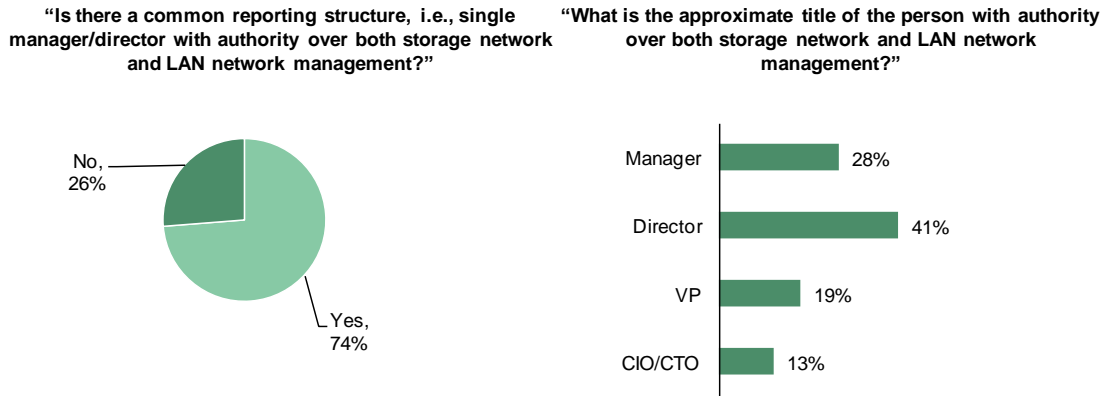
Source: A commissioned study conducted by Forrester Consulting on behalf of Cisco Systems, November 2010

- **SAN and LAN teams share manager or director-level leadership in most cases.** Digging deeper into the issue of who controls both SAN and LAN teams, we asked what title level has responsibility over both teams. Interestingly, director (41%) and manager (28%) led the responses, with VP and CIO having far lower numbers (see Figure 3). This would indicate that the connection between the teams is not just at the top levels of the organization where there is little visibility to day-to-day activities, but further into the trenches at the middle management layer. This bodes well for the chances of changing operating procedures and sharing budgets across a shared network layer.



**Figure 3**

Convergence Of Teams At Director Level



Base: 80 IT decision-makers with storage and network knowledge (percentages may not total 100 because of rounding)

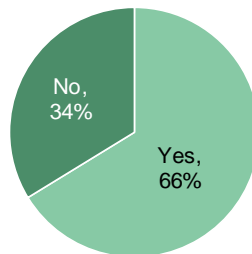
Source: A commissioned study conducted by Forrester Consulting on behalf of Cisco Systems, November 2010

- **There is belief that convergence could work.** As a general rule, IT people are fairly cynical and resistant to change, embracing pragmatic defense mechanisms that prevent untested approaches and unjustified changes from entering the critical environment. However, 66% of respondents indicated that they think that even separate teams could work together toward common objectives in support of convergence (see Figure 4). Forrester sees this as a high number and as a good sign for the viability of convergence in the face of organizational change.

**Figure 4**

Could The Teams Work Together?

“If you converged core networks, do you believe that your organization’s SAN and LAN teams share similar priorities and skill sets and could cooperate effectively toward common goals?”



Base: 80 IT decision-makers with storage and network knowledge

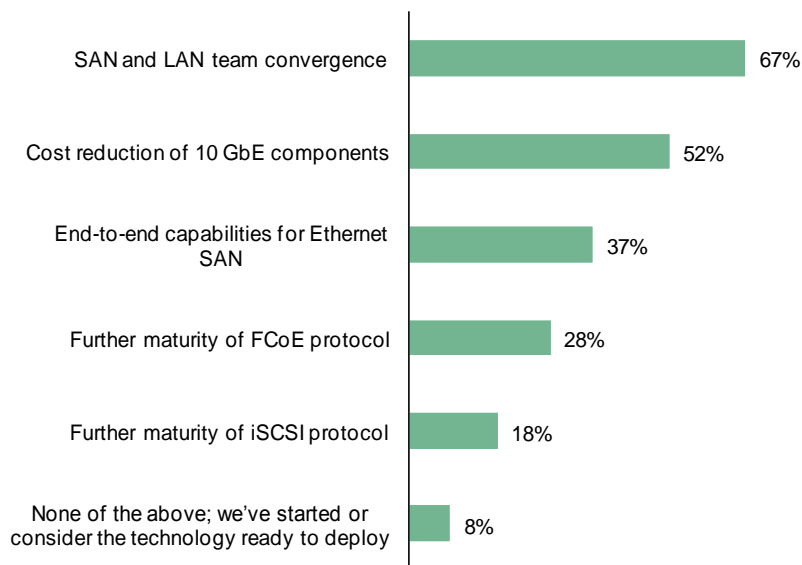
Source: A commissioned study conducted by Forrester Consulting on behalf of Cisco Systems, November 2010

- **Convergence of the SAN and LAN teams are seen as the top pre-requisite for network convergence.** Forrester asked respondents about a number of potential requirements necessary for moving forward with the implementation of a converged network. The leading response, accounting for 67% of respondents, was the convergence of the teams managing SAN and LAN networks (see Figure 5). Cost reduction of 10 GbE components, required for FCoE deployment, and end-to-end Ethernet SAN capabilities were also strong responses.

**Figure 5**

Convergence Of Teams Is Key

“Which of the following do you see as a prerequisite for effective transition to an end-to-end converged storage and LAN network?”



Base: 106 IT decision-makers with storage and network knowledge  
(multiple responses accepted)

Source: A commissioned study conducted by Forrester Consulting on behalf of Cisco Systems, November 2010

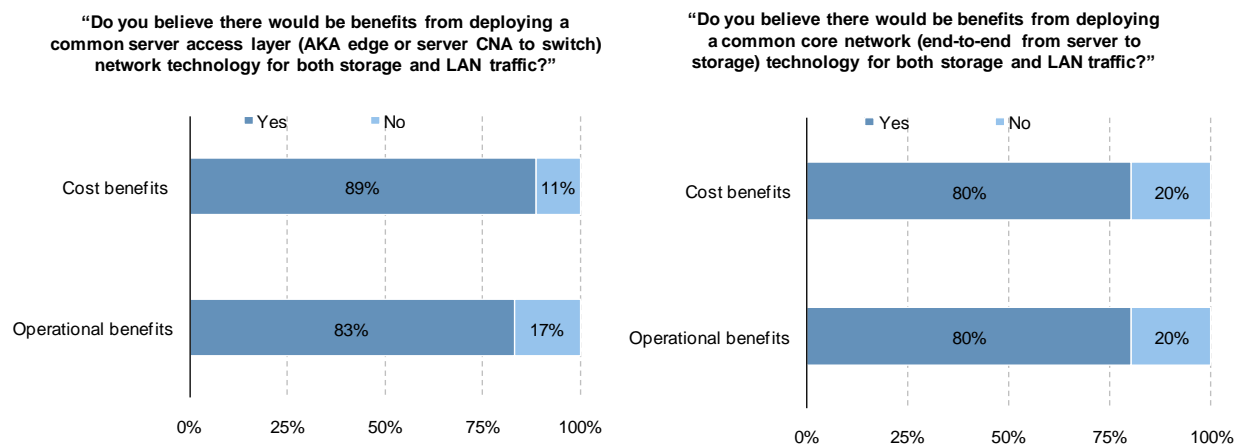
## Technology Considerations

The organizational issues are significant, but respondents were generally positive about their ability to work to eliminate those barriers. But what about the perceived viability of the technology itself, and the current thinking on what it needs to look like to move to broader adoption? Some of the findings in this area of the study include the following:

- Most think that benefits are there for both phases of convergence (access layer versus end-to-end).** We asked respondents simply whether they thought there would be cost or operational benefits associated with either edge-only (access layer) convergence or for end-to-end convergence. Interestingly, perceptions of benefits are fairly consistent between capital cost and operational efficiency, as well as between the two phases of adoption. Phase one benefits at the server access layer are slightly stronger in the mind of respondents: 89% responded that there would be cost benefits, and 83% reported confidence in the likelihood of operational benefits (see Figure 6). Considering phase two, respondents were also fairly confident: 80% of respondents reported seeing both cost and operational benefits in the prospect.

**Figure 6**

## Belief In Operational And Cost Benefits



Base: 106 IT decision-makers with storage and network knowledge

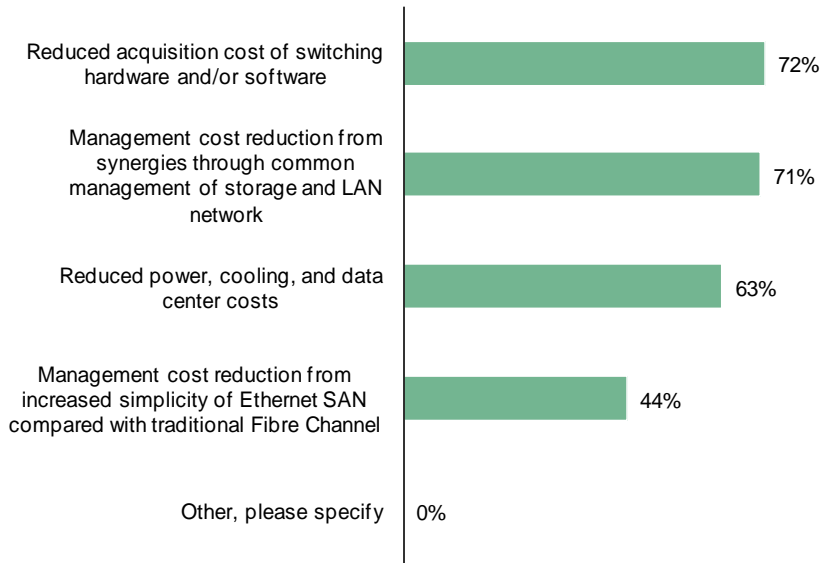
Source: A commissioned study conducted by Forrester Consulting on behalf of Cisco Systems, November 2010

- Likely convergence benefits involve hardware and management synergy.** We asked respondents to rank the likely benefits of convergence separately for each phase of adoption. Regarding phase one benefits, respondent perception leaned toward benefits related to the reduced cost of hardware and management synergies (see Figure 7). In addition to these benefits, phase two responses also included consideration of power, cooling, and data center benefits (see Figure 8). In both phases, the notion that the simplicity of Ethernet would provide inherent benefits appears to have a much weaker likelihood of providing significant benefits.
- Interviewees pointed to concerns about maturity of the technology as a barrier.** In our interviews with users that have not yet adopted converged network environments, the interviewees stated that they felt that there was not yet broad enough adoption of the supporting technologies to make it ready for their consideration. This is in keeping with the conservatism of buyers in this category, who prefer not to be early adopters of technology so central to critical operations. With the benefits case resonating with most

buyers, proving that the technology works and is supported by a broad ecosystem of vendors and by the experience of multiple reference customers are important factors for further adoption.

**Figure 7**  
Differences In Perceptions From Edge-Only To End-To-End

**“What types of benefits do you think are likely to result from convergence of storage and LAN networks at the server access layer?”**



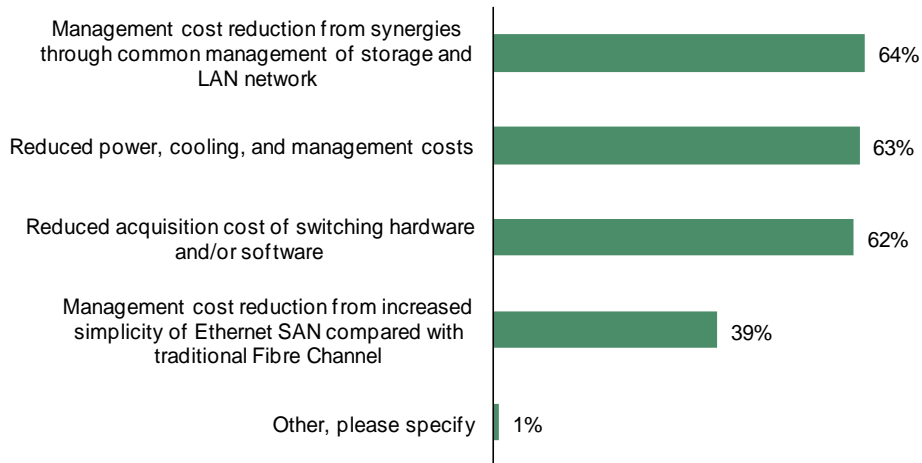
Base: 106 IT decision-makers with storage and network knowledge  
(multiple responses accepted)

Source: A commissioned study conducted by Forrester Consulting on behalf of Cisco Systems, November 2010

**Figure 8**

## Differences In Perceptions From Edge-Only To End-To-End

“What types of benefits do you think are likely to result from end-to-end convergence of storage and LAN networks?”



Base: 106 IT decision-makers with storage and network knowledge  
(multiple responses accepted)

Source: A commissioned study conducted by Forrester Consulting on behalf of Cisco Systems, November 2010

## Will Network Convergence Happen?

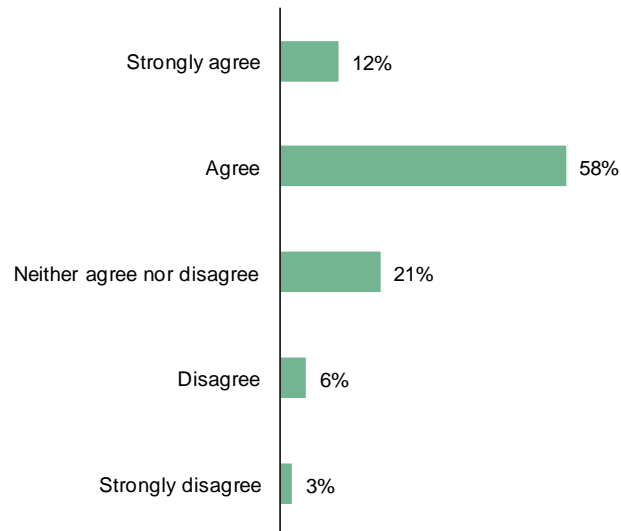
As with any possible changes in enterprise technology, momentum is critical to broad adoption. To gain insight into the likelihood of end-to-end SAN/LAN network convergence, we asked respondents specific questions about whether they think this will happen in their environments, and what it would look like when it happened. The responses to these questions are as follows:

- Most respondents believe that convergence will happen within the next five years. When we asked respondents whether they agreed with the statement “Convergence of SAN and LAN on some form of Ethernet will happen within the next five years,” 58% said they agree, and 12% said they strongly agree (see Figure 9). Only 9% stated that they disagree or strongly disagree. For a category of technology that is so conservative and slow to change, Forrester sees this as fairly strong positive sentiment. Based on this data and ongoing conversations with vendors and users, Forrester believes that convergence of storage traffic on Ethernet is likely to happen over the next several years, although the timing and the exact form it will take is still uncertain. Questions around Ethernet speed (1 GbE, 10 GbE, or faster), features (lossless or not), and protocol (FCoE, iSCSI, NFS, or a yet to emerge option) remain to be resolved for mainstream adoption direction.

**Figure 9**

Strong Belief That Convergence Is Coming

“How much do you agree or disagree with this statement: Convergence of SAN and LAN on some form of Ethernet will happen within five years.”  
(1 [strongly disagree] to 5 [strongly agree])



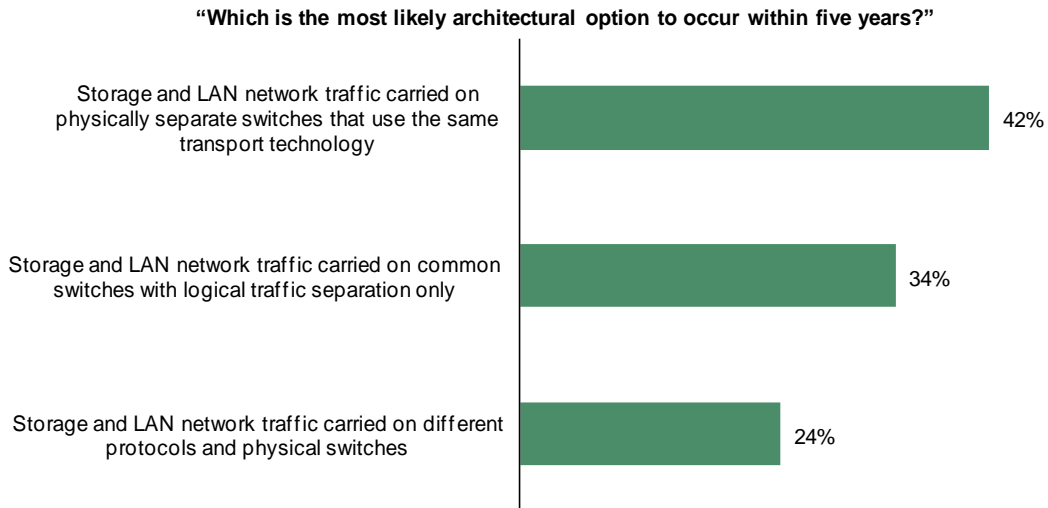
Base: 106 IT decision-makers with storage and network knowledge

Source: A commissioned study conducted by Forrester Consulting on behalf of Cisco Systems, November 2010

- **Physical separation of traffic on common protocols seems most likely.** We asked respondents which of three network architecture scenarios they predicted would happen within five years: common protocols and switches, common protocols on separate physical switches, and separate protocols and switches (nonconvergence). The most popular selection is the middle ground, of common protocols but physical traffic separation (see Figure 10). Of the 76% of respondents that indicated an interest in convergence, a slight majority (55%) indicated a preference for separate networks. This indicates an interest in convergence, but some desire for a conservative approach to it. Physical separation provides less benefit, but appears to be seen as having less risk and complexity as well, which seems to resonate with respondents at least for the moment.

**Figure 10**

What Will Network Architecture Look Like In Five Years?



Base: 106 IT decision-makers with storage and network knowledge

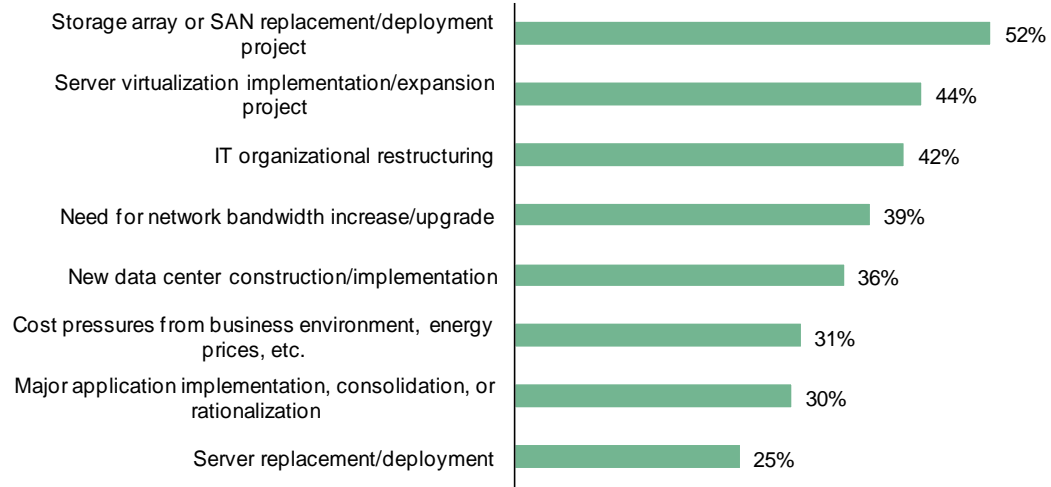
Source: A commissioned study conducted by Forrester Consulting on behalf of Cisco Systems, November 2010

- **Refresh seems to be the most likely catalyst for convergence.** We gave respondents a variety of options for events that would lead to implementation of convergence. Among these, storage deployment and refresh projects ranked the highest, followed by server virtualization expansion (see Figure 11). Interestingly, organizational convergence, which previously appeared as a prerequisite for convergence, also appears fairly strongly as a possible catalyst. This indicates that the organizational shift may be happening anyway and may drive further interest in convergence.

**Figure 11**

## Catalysts To Move Forward

“In your IT environment, which of the following do you see as likely catalysts to converge storage and LAN networking?”



Base: 106 IT decision-makers with storage and network knowledge  
(multiple responses accepted)

Source: A commissioned study conducted by Forrester Consulting on behalf of Cisco Systems, November 2010

- **Complexity seems to be the biggest potential downside.** In spite of the positive outlook, respondents still seem concerned about making convergence work for them. Complexity of operations ranks as the highest concern, which is not surprising given the concern for high performance and availability, as well as the criticality of network operations (see Figure 12).

Complexity could refer to technology concerns related to redesigning functionality within a changed environment, or it could refer to organizational challenges, with potential users expressing concern over how to design their departments and processes to accommodate the new tools and new cooperation required between SAN and LAN teams. Budgetary and organizational issues follow, which indicates that changing the politics and process associated with management won't be easy for big firms with mature staff and established modes of operation.

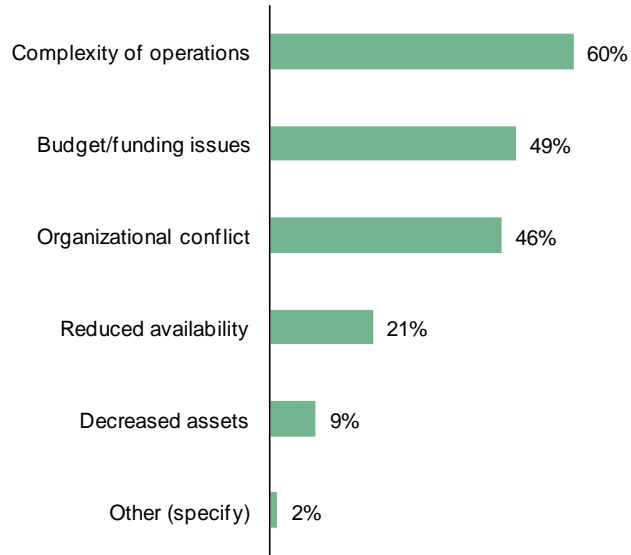


**Figure 12**

Downsides To The Convergence

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“What downsides do you see to end-to-end convergence of storage and LAN networks?”



Base: 106 IT decision-makers with storage and network knowledge  
(multiple responses accepted)

Source: A commissioned study conducted by Forrester Consulting on behalf of Cisco Systems, November 2010

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## KEY RECOMMENDATIONS

- **Convergence of SAN and LAN on a common network is likely.** In the technology world where ubiquity and cost reduction are the ongoing goal, movement away from specialized technology is inevitable. While specialized FC network technology has been a requirement for years to deliver effective storage performance and reliability, Forrester sees convergence on Ethernet over the next several years as quite likely. Evaluating the technologies processes and organizational changes necessary to make this a reality should be a priority for forward-looking infrastructure organizations.
- **Organizational change should not be overlooked.** It's easy to think of SAN/LAN convergence as a technology shift, but realistically, the shift will require new cooperation and organizational alignment among SAN and LAN teams to make the change effectively. Given the fact that organizational power revolves around budget size in many organizations, passing budget from one team to another will not be easy; although it may be easier when both teams report into the same manager or director. Similarly, getting disparate teams onto the same page is no simple task. However, the benefits of this shift can't be achieved without an organization that is ready for the change. Start early to build an organization that's compatible with convergence as it will take significant time and energy to pave the road for convergence effectively.
- **The benefits are not all in end-to-end convergence.** In a perfect world, end-to-end convergence would allow for the complete elimination of any specialized networks. However, survey and interview respondents pointed to significant benefits from access-layer-only convergence. Forrester recommends that both vendors and end users take a pragmatic approach to achieve near-term benefits with existing options, recognizing that complete convergence may take additional time.

## Appendix A: Methodology

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In this study, Forrester conducted an online survey of 106 IT decision-makers in France, Germany, the UK, and the US to evaluate organizations' storage network environments. Survey participants included those from organizations with 500 or more employees with a network storage environment of 100 TB or more. Questions provided to the participants asked about the current state of their SAN and LAN teams, as well as the benefits of convergence of storage and LAN networking, including catalysts for adoption. In addition, Forrester conduct four telephone interviews with IT decision-makers in various industries to capture in-depth information on their storage environment and future strategy. The study began in May 2010 and was completed in August 2010.

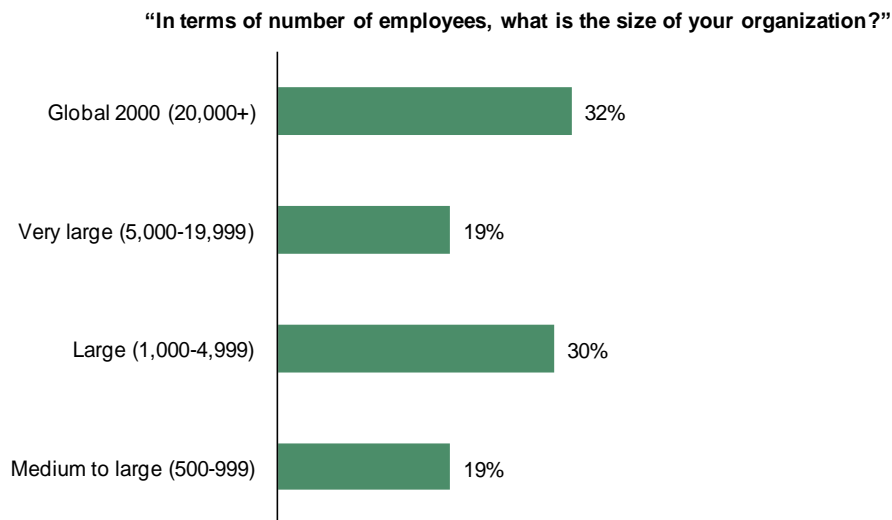
## Appendix B: Demographics

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**Figure 13**

Company Size

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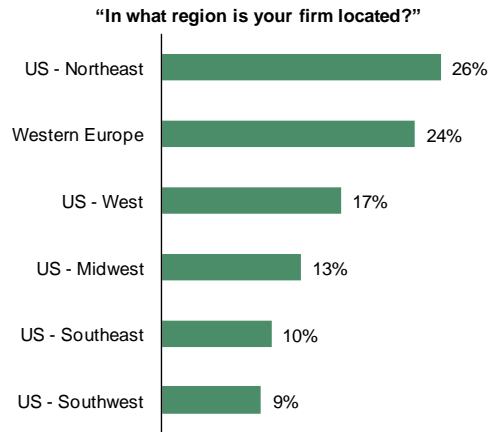


Base: 106 IT decision-makers with storage and network knowledge

Source: A commissioned study conducted by Forrester Consulting on behalf of Cisco Systems, November 2010

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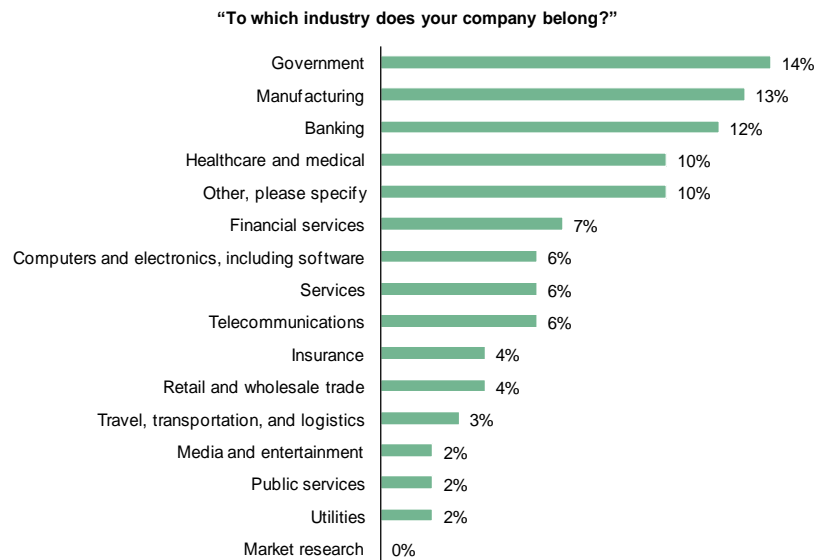
**Figure 14**  
Geographic Distribution



Base: 106 IT decision-makers with storage and network knowledge  
(percentages may not total 100 because of rounding)

Source: A commissioned study conducted by Forrester Consulting on behalf of Cisco Systems, November 2010

**Figure 15**  
Industry



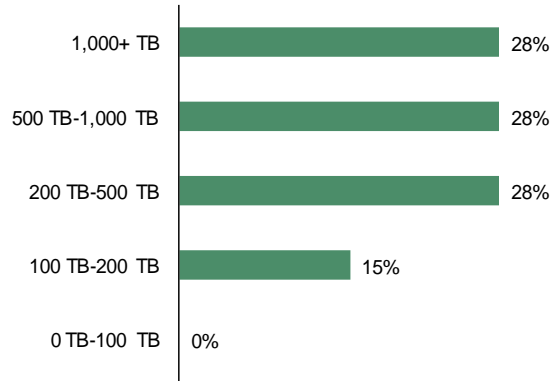
Base: 106 IT decision-makers with storage and network knowledge  
(percentages may not total 100 because of rounding)

Source: A commissioned study conducted by Forrester Consulting on behalf of Cisco Systems, November 2010

**Figure 16**  
Size Of Storage Environment

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“What size is your networked storage environment (in raw terabytes)?”



Base: 106 IT decision-makers with storage and network knowledge  
(percentages may not total 100 because of rounding)

Source: A commissioned study conducted by Forrester Consulting on behalf of Cisco Systems, November 2010

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