



R D S I
Research Data Storage
Infrastructure

Call for Node Proposals and Expressions of Interest

18th July 2011

1. Context and Purpose

The RDSI project was established through the Super-Science investment from the Education Infrastructure Fund (EIF) in the 2009 Federal Budget, and is managed through the Department of Innovation, Industry, Science and Resources (DIISR).

The detailed objectives, expected outcomes and process to achieve these are described in the RDSI Project Plan, available from the RDSI website¹. Organisations responding to this call should refer closely to the Project Plan in preparing their responses.

Quoting the Project Plan:

The expected benefits are to:

- *improve the availability of quality research data for sharing and re-use and, as a result, expand the scale and scope of problems that Australian researchers may seek to address;*
- *improve research efficiency; and*
- *reduce institutional data storage costs and enable more extensive collaboration.*

The infrastructure may also assist institutions to:

- *sustain a quality of research in the digital age that includes the reproducibility of results;*
- *meet the storage requirements of key research activities undertaken at that institution; and*
- *comply with the research data provisions of Universities Australia's Australian Code for the Responsible Conduct of Research.*

The RDSI project will be delivered through four key interconnected programmes.

- The Node Development (NoDe) programme will establish a small number of physical sites around Australia to provide baseline storage and access services to the research sector.
- The Data Sharing (DaSh) programme will develop the underlying software infrastructure for inter-node and node-user data movement, access management and sharing functionality for the sector.
 - A subcomponent of this programme will be provided through partnership with the National Research Networks (NRN) project, to support the development of high-bandwidth connectivity between nodes and the Australian Research and Education Network (AREN).
- The Research Data Services (ReDS) programme will support the development of larger collections of value, their infrastructure requirement at nodes and their association with collaboration and analysis facilities.
- The Vendor Panel (VePa) programme provides the public research sector with a set of preferred commercial suppliers for the delivery of storage infrastructure and services, leveraging the economies of scale of both the sector and the RDSI investment.

The goal of RDSI is to ultimately improve research outcomes through the storage of collections. It aims to achieve this by underpinning research activities with a foundational infrastructure, and working through existing or new organisations to deliver services to the research community and their hosting institutions. It is effectively an Infrastructure-as-a-service arrangement that other

¹ <http://rdsi.uq.edu.au/>

programmes and projects can build upon. Ideally it will provide part of a foundation for efforts towards a national research data management framework in institutions, in collaboration with other national, disciplinary and institutional research support programmes.

This call is based on a series of straw-men documents, workshops, consultation meetings around the country, and direct and indirect feedback from a wide range of stakeholders and other interested parties.

2. The NoDe programme

The NoDe programme aims to support the identification, strengthening and development of a set of centres across Australia in support of research data management, both during active collaborative research projects and for subsequent retention and re-use in other projects. RDSI Nodes will provide a range of services to the research community, under the broad coordination of the RDSI project. They are expected to each support multiple institutions, to achieve greater economies of scale, maximise leverage from local investments, and enhance opportunities for collaboration.

The RDSI will ultimately comprise:

- A large set of accessible research data collections of significance, supported through:
- A small number of high-capacity and highly-scalable nodes where each node will contain multiple petabytes of storage configured to support the classes of access and retention appropriate to the research data held;
- A dedicated inter-connection network with high-bandwidth/low-latency connections that will support replication and data transfer between nodes; and
- A common access infrastructure to provide a uniform experience for common researcher access to all the data held.

The resulting data environment is not intended to be exclusive to the use of RDSI Project stakeholders. Rather, the delivery of the RDSI Project is expected to contribute to the development of an open infrastructure that institutions, disciplines and research facilities can expand or extend to meet other requirements and into which other sector interests can add capability over time. Nor does it supplant existing initiatives and research data service providers but should integrate with them as appropriate.

Nodes, working with their participating institutions, will also be expected to develop a model for sustainability and long-term data retention beyond the life of the RDSI project.

RDSI will greatly enhance support for the capture, retention, publication of and access to research data collections of lasting value. These will arise from

- improving access to existing data collections currently invisible,
- enhancing data use through aggregation and co-location with analysis tools, and
- enabling new research to be carried out, through the development of entirely new collections.

Nodes will be required to support and advance each of these.

While the central focus of RDSI is on well-formed data collections, their active use and retention, it will also provide some infrastructure support for the development of new collections as prioritised by researchers, institutions and node organisations. This support is provided through funding for storage specifically for collection development, before they may be formally supported through the ReDS program.

Node categories

The RDSI Project Plan identifies two categories of nodes, the 'Primary' and the 'Additional'. The maximum number of Primary Nodes will be six, and the maximum number of Additional Nodes will be four, unless the RDSI Board recommends a variation of these limits to the Department and the Department agrees. There will be no minimum number for Additional Nodes. Excerpting from the Project Plan:

Primary Nodes will:

- *hold research data sets of lasting value and importance that support research on a multi-institutional basis; and*
- *be connected to the Australian Research and Education Network (AREN) optical backbone or be in the process of being connected to it. Connection to the optical backbone implies the ability to connect to multiple wavelengths at the maximum available bandwidth on the backbone.*

Additional Nodes will:

- *hold research data sets of lasting value and importance that support research on a multi-institutional basis, which are required to be held in the location of the proposed Additional Node. This could be because of jurisdictional restrictions or because of conditions of investment by a state/territory government; and*
- *be connected to the AREN or be in the process of being connected to it. This will not require direct connection to the AREN optical backbone.*

Node Development budget

As described in the Project Plan, the overall RDSI budget for the NoDe programme is anticipated to be \$10.6M over the life of the project, and approximately 90% of that is expected to be spent on Primary Nodes. It is expected that the programme funds will be distributed approximately equally across nodes, in each category (Primary/Additional). Any under-spend of programme funds at the end of the final assessment round will be invested primarily in the approved Additional Nodes.

For each node there will be a funding component for establishing the core infrastructure of the data centre itself, and a funding component for some initial storage to support collection development at a node. It is anticipated that these components are likely to be roughly equal in most proposals; however nodes may suggest a different proportion with appropriate justification.

Node selection process – proposals and expressions of interest

The selection process will look holistically across all applications, at the proposing organisations, their track record in research support, and the level of support from the sector. The assessment criteria will guide the selection process but RDSI will have to consider how the proposals fit together towards the aim of a single nationally coordinated infrastructure.

This call is not seeking tender submissions but is a request for proposals or expressions of interest. Organisations that are interested in becoming a node but have not yet finalised their proposals are strongly encouraged to submit an expression of interest as early as possible, with indicative responses to just the criteria identified in the template below. Organisations formally proposing to be an RDSI node must respond to all of the criteria, and indicate their commitment for the life of the project, to 30th June 2014.

Full proposals will be assessed by the RDSI Director, who may seek clarification and/or discuss any amendments with the proposing organisation. Once the Director is satisfied, it will be formally submitted to the RDSI Infrastructure Advisory Panel (IAP) for detailed assessment. If the IAP is satisfied the proposal is sound it will recommend it to the RDSI Board for approval. The RDSI Board will then also assess the proposal and the advice from the IAP and if satisfied will recommend it to DIISR for approval. Once all approvals have been obtained, the proposing organisation must sign a Node subcontract with The University of Queensland (UQ), based on the template subcontract accompanying this call, before funding can be provided.

3. Node relationships

Nodes will be organisations that have to manage and maintain a set of relationships. These can be broadly classified as follows:

A. Node relationship to RDSI

Nodes will enter into formal subcontracts with the RDSI lead-agent, UQ. These subcontracts will set out requirements and expectations as described below against funding from RDSI. Nodes will support the planning, development and guidance of RDSI programmes, and must, where appropriate, act in accordance with the implementation principles in Section 1.4 of the Project Plan.

B. Inter-node relationships

Nodes may enter into formal or informal relationships with other nodes for mutual benefit, e.g. to enhance their own functionality, performance, and availability. RDSI will not necessarily require such relationships, but recognises and values their benefit, and will facilitate these through the DaSH programme.

C. Node and RDSI external relationships

Nodes, together with the RDSI project, will have to work closely with the research community and vendors to deliver services of ongoing, demonstrable value, and to support their sustainability. This community extends well-beyond university researchers. They may include *'Affiliate' nodes*, i.e. sites that participate in the RDSI infrastructure with possibly some small direct funding from RDSI, *regional federations*, e.g. where institutions have developed a shared infrastructure for regional support that wants to connect into RDSI via a local node, *non-university research sites*, such as government agencies and industry, and *discipline-facilities*, e.g. groups that have developed discipline-specific infrastructure that support research and need to be visible through RDSI. Many of these may not host any data on the RDSI nodes, but could provide access interfaces or mirroring services through the RDSI framework.

4. Why be a Node?

There are at least two major benefits in being a node. The first is that RDSI is the largest cash injection for research storage infrastructure in Australia's history, and per-capita is one of the world's largest. This creates the opportunity to significantly enhance the available infrastructure for the sector and make it world-leading. Organisations participating in the project can expect a significant boost to their own infrastructure capacity, which is retained at the end of the project, their functionality, and the skills of their staff.

The second benefit is that the RDSI project will become deeply engaged with the Australian research community, who have been awaiting this infrastructure for some time. Being a node in the RDSI will make an organisation significantly more visible to the community, boosting the client base, and through the additional functionality it will make the organisation more valuable to the community. For example, holding large quantities of data will make a site an attractive place for researchers doing data-intensive analysis to base their operation. These will boost the organisation's prospects for continued sustainability.

The RDSI project is funded out of the EIF programme, and is limited to funding only the development and implementation of research infrastructure. It cannot fund any operational costs, so these need to be found through in-kind contributions. This means that Nodes will need to co-invest by funding these operational costs.

There are a large number of data centres and service providers around Australia, both within and outside of research institutions, who could potentially become nodes in the RDSI. Becoming a node though may place obligations on those organisations, in terms of direct and indirect costs. The decision to propose being a node should be taken in light of all the known costs, set against any potential benefits to the organisation.

The funding to nodes will come through three channels, as described in the Project Plan. RDSI nodes will be funded through the NoDe programme for both initial infrastructure and storage for collection development, as outlined above. Nodes will also receive support from the National Research Networks (NRN) project to interconnect their nodes at the highest possible speeds on the national backbone. Finally, nodes will also be the *only* organisations to receive funding from the RDSI ReDS programme. The ReDS allocations for meritorious collections will include some additional storage for general collection development above the allocation for the collection itself.

To support the business case for nodes, both the NoDe programme and the ReDS programme will fund storage for collection development. This allows nodes to allocate storage to activities outside of the RDSI framework, to support a wider community at different stages of their research lifecycle, and to seek additional leverage to underwrite operational costs.

5. Next steps

This public and open call will be run over an extended period, staying open for submissions throughout, with a series of assessment points over 12 months. This allows those organisations that are ready now to move quickly towards establishing their node and prepare for the first rounds of DaSH and ReDS activities in early 2012, while other organisations can submit an expression of interest, if they wish, and take additional time to develop their proposals. RDSI strongly encourages

the submission of expressions of interest, where appropriate, to help the overall budget planning and prioritisation of the project, as well as an appropriate coverage of nodes across the country.

This call is being issued to the sector during the week of 18th July 2011, with responses due back by **COB Monday 12th September 2011** to be considered in the first assessment round.

The call will be kept open for submissions at any time, and regular reminders will be distributed to the sector. There will be subsequent assessment cut-off points in November 2011 and April 2012. Each cycle is likely to allocate funding for at least one primary node, but no more than three primary nodes, and one additional node.

Submissions should be sent electronically to office@rdsi.uq.edu.au and will be acknowledged on receipt. Following submission, the RDSI Director will contact each organisation to discuss proposals in more detail as necessary, before formally presenting them to the Infrastructure Advisory Panel.

Full proposals should address all of the criteria set out below, and include supporting statements/references from participating institutions, organisations and/or discipline agencies. Expressions of Interest need only address the first two sections as indicated.

Announcements of successful proposals under the first round are expected by the end of 2011.

Node Proposal and Expression of Interest - Response Criteria

- Organisations making a **Full Proposal** must address **all** of the following criteria.
- Organisations wishing to submit an **Expression of Interest** at this stage must **only address Sections A and B**, as far as possible.
- Neither this call nor any responses will be legally binding on either the proposer or UQ.
- UQ reserves the right to consider all proposals and expressions of interest whether complete or not.

The page limits noted for each section are only guidelines, but responders are encouraged to work to them (with 11pt font and reasonable margins).

A. Executive Summary

To provide a quick overview, and material for publication and promotion, proposals must briefly answer the following questions. (Guideline: 1 page)

1. Who are the participants and who will sign the node contract with UQ? Participants may be organisations who are party to the node proposal, or who would collaborate with the proposing organisation in the node development and implementation.
2. Is this proposal for a Primary or Additional node? For Additional Nodes please outline the reasons of location or jurisdiction that support the need for an Additional Node.
3. Describe the level of RDSI EIF funding being sought, bearing in mind the proposed distribution of funding outlined in the programme budget section above.
4. Describe the relevant history and planned future of your proposed node organisation. Include a summary of its ability to operate at significant scale, or demonstrating the commitment to do so. You may wish to link your response to the strategic direction or plan of the organisation if one exists.
5. Describe your commitment to moving the sector forward through:
 - a. improving access to existing data collections currently “invisible”,
 - b. enhancing data use through aggregation and co-location with analysis tools,
 - c. enabling new research to be carried out, through the development of entirely new collections.

B. Node Prioritisation and Allocation

RDSI needs to ensure that the widest-possible research community is well supported, so that there are as few gaps in coverage as possible, and that the project makes quick progress across a range of disciplines. While nodes are likely to support research data as broadly as possible, some nodes may choose to also specialise, for example:

- Along disciplinary lines, such as bioinformatics, humanities, astronomy, climate, etc.
- Along organisational or thematic lines, e.g. CSIRO, State or Federal Government agencies, etc.
- Over a geographical extent, such as all research centres within a state or territory
- On a strategic alignment, such as support for ARC or NHMRC projects.

Proposals must identify: *(Guideline: 2 pages)*

1. What contribution would this node make to the RDSI mission that would be difficult to achieve otherwise? For example, what evidence is there that the contribution will be both strategic and effective in advancing the RDSI mission?
2. Will your node be fully-open, generalist across all disciplines, or does it intend to specialise in any sense?
3. How will your node manage and prioritise allocations on the infrastructure? i.e. what are the priority areas (if any), and what are the principles and mechanisms that your node organisation will use for deciding on allocations?
4. What initial collections will your proposed node support?

C. Organisational

RDSI is seeking to establish a long-term enduring infrastructure for the research sector. This requires participating organisations to be sustainable and have the trust of the institutions and the research community and be deeply engaged with the research community.

A proposing organisation must outline how it is structured, governed and engaged with the research sector today, as well as its commitment to the formal RDSI processes as defined in the Project Plan and the EIF Funding Agreement between the Commonwealth government and UQ. Proposals must address: *(Guideline: 2 pages)*

1. How is the proposed node of RDSI structured and governed, including sector participation in its planning and management?
2. How will the proposing organisation be informed by and engaged with the research community?
3. What is the track record of the proposing organisation on research data management support with the sector, including any discipline-specialisation where appropriate?
4. What is the legal status of the proposing organisation for the purpose of entering into contracts with UQ? The organisation that would enter into the subcontract with UQ must be a legal entity. Please provide details of how you would manage the process of finalising any contracts with RDSI.
5. Will participation in RDSI potentially cause any significant change to existing organisational structures and processes, and if yes, what would those changes be?
6. Where appropriate, commitment from the proposing organisation to act in accordance with the implementation principles set out in Section 1.4 of the Project Plan.
7. Commitment from the proposing organisation to purchase any RDSI funded infrastructure through the vendor panel established by RDSI. Where proposing organisations can demonstrate that other, perhaps existing, vendor arrangements would lead to a more cost-effective outcome for that node, the Director may ask the Board to approve a variation for that node.
8. Commitment from the proposing organisation to enter into a Node subcontract with UQ on the terms set out in the template subcontract provided with this call, or, if any of the provisions cause concern, a specific list of your requested changes to the template subcontract and reasons for each of the requested changes.

D. Financial

For RDSI to establish a long-term infrastructure will require nodes to attract and manage significant co-investment during and after the project, for both their own costs and for any ongoing coordination and communication activities beyond the term of the project. The RDSI project itself is funded for a fixed-term, and can only expend funds on the creation and development of infrastructure. Other costs for the operation of RDSI during the project have to be found elsewhere.

Because EIF funds are limited to the creation and development of infrastructure, a detailed budget including a discussion about the specific use of EIF funds will be developed during the consultation with the RDSI Director following the submission of a proposal.

It should be noted that the Project Plan states: *“It is an expectation of the Commonwealth that the operators of the resulting Project infrastructure shall make it available at **no or minimal cost** to research activities undertaken by all publicly funded researchers.*

Please indicate: (Guideline: 2 pages)

1. The proposed business model, for attracting and leveraging co-investment. (Which can be cash or in-kind).
2. A financial plan for the node of RDSI through to 2014.
3. The sustainability of the node and sub-contractor
4. If participation in RDSI is likely to lead to a significant change in the business model of the proposing organisation, and if so what that entails.
5. (For Primary nodes): That you commit to an annual contribution to RDSI to maintain the operational role(s) as set out in the project plan, which cannot be funded through EIF. The level of that contribution will be \$50k p.a. per node.

E. Infrastructure and Functionality

The nodes participating in the RDSI will offer a range of services to the research community. To establish trust in that infrastructure will require nodes to be sufficiently robust for research community expectations, and so appropriately designed and constructed. Nodes must also be able to scale in various dimensions, as uptake increases. Nodes should be prepared for at least a doubling in footprint and power/cooling requirements, and a factor of ten in storage demand, over the life of the project.

RDSI will develop a common national foundational framework for research data services, which spans across all nodes and other participating organisations, and extends down to the researchers' desktop. Discipline-specific initiatives can build on top of that foundation, and, possibly through the RDSI DaSh programme, extend it other relevant service providers. To achieve this will require a baseline common model for the services and storage classes at all nodes. Nodes, institutions and other service providers will be able to offer additional value-add and discipline-specific services on top of that framework.

An initial model for service classes for storage and access follows the most common elements of user requirements,

- at one end for active sharing of data (a “Market”) with performance characteristics that support ongoing collaboration around data collections in files and databases, and
- at the other end the more passive retention of data (a “Vault”), with performance characteristics that support preservation of research data after its initial collection, and its eventual re-use, possibly being copied back into a Market space during such periods.

These service classes will be tuned and augmented as appropriate but provide a common framework for researchers to engage with, and a constrained scope of activities that RDSI can readily fund. Some indicative characteristics of both are outlined in the Appendix as a guide.

A simplistic model of star-ratings based on the number of site/replicas can assist with providing researchers a sense of the resilience of Market and Vault services, and their associated costs and benefits. A one-star service has a single site, with a single replica onsite. Two stars indicate two sites and three stars three sites. RDSI will not specify the forms of replication (e.g. realtime mirroring through to various hierarchical backup schemes) but leaves that to nodes to prioritise themselves.

RDSI expects nodes to attain *Tier-II Data Centre*² characteristics, although these will not be formally certified. The node proposal must specify an indicative technical design, including:

(Guideline: 6 pages)

1. The proposed site for the node and noting any (reasonable) site risks from natural or manmade disasters.
2. The building and room characteristics, such as design, physical security, power supplies, environmental controls and energy efficiency.
3. Network connectivity, in particular any optical connectivity or not, to the nearest AREN Point of Presence, any network redundancy, and flexibility in network layering such as multi-wavelength support.
4. Existing and proposed overall storage hardware capacity, as well as capacity for hardware expansion, and the capacity growth plan through to 2014 at the initial funding level. The capacity and scalability should be described both in physical terms (such as racks, etc.) as well as storage volume and I/O performance.
5. How the infrastructure is proposed to be configured and apportioned (e.g. tape, slow disk, fast disk, SSD) to support at least the Market and Vault models of service classes, how data can be moved between them, what levels of replication (“stars”) will be established for each of the service classes, and any additional service classes the node proposes to offer.
6. Any existing or proposed partnerships with other organisations, including other (potential) nodes, specifically to enhance your node’s infrastructure capabilities, such as mirroring and failover arrangements.

² Uptime Institute, <http://www.uptimeinstitute.org/>

Once established, nodes will be required to participate in the wider RDSI project activities, including the DaSh and ReDS programmes, support the planning and implementation of services in a timely fashion, and support the ongoing maintenance of the services. Some of these are yet to emerge in full so commitments may be constrained to a level of resourcing.

A proposal must indicate: *(Guideline: half a page)*

7. A commitment to participate in the RDSI DaSh programme to develop a coherent national framework for access to resources at nodes, i.e. the DaSh technical architecture.
8. A commitment to implement the DaSh technical architecture as it emerges, and support its operation and maintenance
9. A commitment to participate in the DaShNet network infrastructure at a level appropriate for the node (Primary or Additional)

F. Support

To ensure researchers gain the maximum benefit from the infrastructure, and that uptake is commensurate with the scale of the investment will require a range of support mechanisms, from simple marketing to technical support to culture change. These require approaches such as websites and marketing materials, but in particular it requires people with the appropriate skills. RDSI cannot fund people in these roles, so they will be an in-kind contribution to the project, but their value to the project is significant.

A proposal must describe: *(Guideline: 1 page)*

1. How the node plans to support the research community with the uptake and use of the RDSI within and across disciplines.
2. An indication of the number of support staff it will use and their relevant skills.
3. The ability to scale the number and depth of support staff as demand increases.

G. Extending the reach of RDSI

The RDSI project is not alone in providing services for the research community. Other national programmes such as NeCTAR, ANDS, and the AAF are also working with researchers and their institutions, as are many HPC centres and other service providers. At the same time there are many organisations outside of the universities and CSIRO that hold data of interest to researchers, which RDSI could make visible through a range of technical mechanisms. These require engagement and support which the nodes are best placed to provide, and it increases the value proposition to RDSI.

A node proposal should: *(Guideline: 2 pages)*

1. Indicate what additional non-data-storage services you currently, or plan to, offer to researchers. These might include analysis or data management services.
2. Indicate what other research-relevant organisations you work with and could assist to participate in RDSI services, for the provision of data or services. Examples may include local, state/territory and commonwealth government research organisations.
3. Identify and describe how you engage with any other relevant service providers.

H. Accountability

The research community, as well as the government, are keen for a national infrastructure that meets the need of the community, that it is well-used, and does so in a cost-effective fashion. Part of building trust in the infrastructure includes assessing for risk factors and how to mitigate them.

RDSI will identify a set of agreed service levels, which will be specified in the Node subcontract, and set in place a range of formal monitoring mechanisms to measure nodes' performance and usage on a range of factors. Reporting from these will be made public in an ongoing fashion, to inform the research community, institutions, RDSI and the government. This provides a significant level of assurance to the project, the government and the researchers.

A proposing organisation must indicate: *(Guideline: 1 page)*

1. A commitment to support agreed service levels
2. A commitment to implement RDSI service-levels assessment and reporting, and understanding that such reporting will be made public by RDSI.
3. A commitment to carry out an annual overall risk assessment, provided to RDSI, examining ways in which data can be lost, damaged, disclosed without authorisation, or be unavailable, and what steps will be taken to mitigate the risks.

I. EIF Funding Agreement Compliance Requirements

The National Code of Practice for the Construction Industry, in accordance with the Australian Government Implementation Guidelines for the National Code of Practice for the Construction Industry, reissued August 2009, applies to this project.

End of criteria

APPENDIX: Basic RDSI Node service classes for researchers and indicative characteristics

- Protection: Copies (excluding the original) that can be used for failover/quick recovery (lower latency – e.g. disk) or just recovery (higher latency – e.g. tape).
 - 1-star: Onsite copy
 - 2-star: Onsite copy and offsite copy
 - 3-star: Onsite copy and two offsite copies, all different sites
- Access Interfaces: APIs and tools for accessing/moving data. Examples: SAN/iSCSI, Samba/NFS, HTTP, DaSh services, Discipline-specific services.
- Association with other services: Functions that support the use of the stored data. Examples: HPC, visualisation, collaboration, curation.

	Protection:	For files: read/write performance	For databases: Transaction latency	Expected transaction volume	Access Interfaces	Access control management	Association with other service	Uptime	Failover, recovery	Upload hurdles	Metadata support
Too high, unaffordable by RDSI (but could be offered by nodes)	4+ stars					National Security Clearance	Deeply integrated with technologies, instruments, workflows	>99.9%	Ultra-fast; Application- specific		
MARKET <i>Active, sharing</i>	1-3 stars (failover)	Mid- to high performance for both read and write	Low latency for r/w	Mid- to high volumes	Many	Rich	Close, as available and appropriate	99%- 99.9%	Quick, server- level, automatic	Very low	As required for project activities
VAULT <i>Less active, preserving</i>	1-3 stars (recovery)	Mid- to high performance for write, low for read	Possibly high latency for r/w	Low to medium volumes	Few	Simple	Far	95%- 99%	Slow, user- level, manual	Noticeable (to support formal retention)	Rich
Too low, unacceptable	0 stars	Low write performance			No desktop interface	No AAF integration (where available)			No failover, recovery		