



MONASH University

An abstract background image consisting of a dark blue field with numerous thin, light blue lines radiating from a central point at the top, creating a perspective effect that draws the eye towards the center. The lines are slightly blurred, giving a sense of motion or depth.

Information Technology Services

Monash IT Architecture (MITA 2005-1)

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1 Introduction

Monash University's operations are becoming increasingly dependent upon information technology. For many years there has been extensive use of IT in areas such as research, administration and library. Building upon this base, and incorporating advances in computational research, a range of tools are now revolutionising aspects of the University's learning and teaching operations.

The University has embraced information technology at all levels. Rapid uptake of new technologies can result in a tangled maze of incompatible and inefficient systems. Yet the need to communicate information between systems has never been greater. The growth must be guided to ensure long-term interoperability and viability of all University information systems combined with efficiency, flexibility and a timely implementation capability.

The first release of this document, *Monash Information Technology Architecture 2004-1* focussed on; the introduction of the architecture model and preferred application architecture, separation of storage from computing platform, promoting further standardization of computing platforms and formal endorsement of a small number of products, technologies, methods and protocols.

This release, *Monash Information Technology Architecture 2005-1* reflects the significant progress made in the focus areas from 2004-1 and changes in industry trends and standards. It further refines the principles and guidelines that guide IT decision-making within Monash University.

2 Scope

This architecture focuses on the logical organization and management of applications and data as well as the underlying physical infrastructure. Initial versions of the architecture aim to document the best of existing tools and technologies, as well as laying down guidelines at a sufficiently high level to apply to new technologies.

3 Principles

The Monash IT Architecture builds upon a set of principles that are intended to guide university-wide IT decision-making and forms a foundation for more refined planning and implementation of information systems. These principles represent a vision of the characteristics of a target IT architecture. They have been ordered with the most important ones at the top of the list. Where conflicts occur two or more alternative solutions may need to be examined, and some cost/benefit analysis done, and a case made for adopting a particular solution above others.

3.1 University strategic objectives guide IT decisions

Information is stored and managed in support of the business objectives of the university. Information Technology is employed to assist University entities to achieve their objectives in the most efficient and effective manner. Technology decisions must take into consideration business impact.

3.2 Systems are secure

Monash needs to protect its information. This requires careful attention to planning, implementing and managing a range of physical and logical measures.

- The university's IT Security Policy and IT Security Framework documents guide all activities relating to IT security. See <http://www.adm.monash.edu.au/unisec/pol/itec13.html>
- Security of information, and breadth of access to information, must form part of the planning, development and operation for all systems;

- Data integrity provisions must be included in the planning for every system;
- Systems which access information in other systems must follow the business rules associated with that information in the original system;
- Security is the responsibility of all authorised users.

3.3 Designs target high availability and reliability

Core university activities depend on information services and systems. System planning and design should deliver systems whose reliability is matched to the importance of the service, the cost of disruption to the service, and the needs of the users. Appropriate disaster recovery mechanisms should be in place at all times.

3.4 Systems safeguard privacy and intellectual property

In developing and implementing systems, staff should be sure to follow the relevant policies and laws (see <http://www.monash.edu.au/legals/privacy.html>) ensuring that information provided for a specific purpose is not used for other purposes without the explicit consent of the individual to whom that data refers.

The university is both a producer and consumer of intellectual property. As a producer, the university's information systems need to respect the university's intellectual property guidelines with respect to creation, storage, access and use. This includes provision of appropriate copyright and legal disclaimer statements to Monash owned/created intellectual property. Intellectual property guidelines and statutes are at <http://www.adm.monash.edu.au/unisec/pol/acad21.html> and

<http://www.monash.edu.au/pubs/calendar/statutes/statutes11.html#Heading202>

As a consumer Monash purchases or licences use of intellectual property where this fits the university's goals and objectives. The university must store, use or provide access to this information according to the appropriate access and licensing arrangements. Rights management should use standard access mechanisms and should be devolved where possible. Intellectual property issues for the Internet and multimedia are at <http://www.its.monash.edu.au/web/policy/copyright.html>

For guidelines on protection of privacy and management of intellectual property, please refer to the Monash Information Management Strategy

3.5 Systems use the authoritative source for data

One of the governing principles for management information systems is to maintain one primary source for each piece of data. There is a risk that data fetched from a non-authoritative source may be out-of-date or incorrect. Data should never be entered more than once. Other systems that need data should receive it electronically from a source traceable back to the master copy and not by re-keying the data.

For guidelines on data sources, please refer to the Monash Information Management Strategy

3.6 Open Standards are used where possible

It is highly desirable that the University's information systems are built upon Open Standards. The adoption of such standards is expected to have benefits in:

- Protection against vendor lock-in;
- Ability to decouple client hardware and software from server hardware and software;
- Access to increased pools of expertise (given the global trend towards Open Standards).

3.7 A platform-independent user environment which is globally accessible

The University has an increasingly global focus, drawing in people from a diverse range of cultures and expertise. Most people, most of the time, should be able to access a common set of services that provides an intuitive interface for their needs, and these services should be accessible from a variety of platforms, from PCs running various operating systems through to mobile phones and PDAs.

To achieve the benefits of such a homogenous environment, architectural components should be sought which provide core, commonly used functionality through published APIs and a unified, platform-independent interface.

Planning must include making services accessible to special groups, including those with a disability. See <http://www.its.monash.edu.au/web/policy/accessibility.html>

3.8 Purchased software is preferred to in-house development

Where an existing package is available that adequately fulfils requirements, it is preferable to purchase than to develop one in-house. Purchased products should be chosen to complement existing products and services, and should offer a clear price benefit and quicker time to implement. Suppliers should be committed to principles similar to those in MITA, and be in a position to support, maintain and upgrade the product. Where a suitable product is already licensed to Monash, it should be used in preference to buying a second product and licence.

Customize applications only if necessary, as customized programs often require reworking on each vendor software release.

3.9 Standard products and platforms are adopted to limit diversity

In order to reduce the cost of ownership, IT projects should select, whenever possible, from the set of preferred products published in MITA or in the University's standard operating environments (SOEs). Standardizing on IT environments reduces costs through:

- More focussed training for support staff and users;
- Increased flexibility and interworking of environments due to elimination of incompatibilities and harmful interactions; and
- Increased purchasing power.

3.10 Applications share hardware platforms

There is potential to save costs by sharing a common hardware platform across applications. Where feasible applications should share hardware platforms to save costs. Critical applications, and those with large or specific resource requirements will continue to run on their own dedicated servers as an interim step, pending validation of the server consolidation approach.

3.11 Systems are structured for easy extension

When it is necessary to develop in-house applications the goal should be to build generic modules that may be reused or easily modified to cater for expansions and additions to the original specifications. Re-useable building blocks may include data sets, interfaces, code libraries, document templates and operating processes.

3.12 Management of systems is easy to devolve

The size and structure of Monash calls for systems whose management can be devolved to Faculties or departments, and whose management interfaces are easy, fast and intuitive to use.

4 Global Operations

An important goal enunciated in the *University-wide IT Strategic Plan* is for the worldwide deployment of IT systems and infrastructure to create a common set of services with a consistency of content, style and quality to support the university's global operations. It is acknowledged that there will be constraints imposed by the public infrastructure in some locations and by the level of investment available to provide the same level of IT and telecommunications services to a global university. The university will be best served by an appropriate configuration of locally and centrally provided infrastructure and support. The IT Strategic Plan has as its goals:

- Global considerations are embedded in all IT operational planning and service delivery;
- A flexible, scalable and sustainable roll-out methodology supports the establishment of IT technology at new campuses;
- An effective level of IT support is provided to Monash global campuses.

To these ends a Global Operations unit has been formed and an extensive framework of policies and procedures has been developed to expedite the implementation of IT services at new sites. Account managers have been appointed to support offshore campuses and centres, and methodologies are being developed to monitor, maintain and enhance IT operations and services at these overseas locations. See <http://www.its.monash.edu.au/aboutits/global/> for more information.

5 Business Architecture

Monash has a structured planning process, in which *Monash Directions 2025* sets the overall institutional directions and priorities. Plans for key aspects of University activity (Learning and Teaching, Research, Global Development and Support Services) provide additional detail. There are operational plans for faculties and support divisions and a number of enabling plans exist of which the *University-wide Information Technology Strategic Plan* (IT Strategic Plan) is one.

The IT Strategic Plan articulates directions and strategies that support university requirements for information systems and infrastructure that transcend faculty and departmental boundaries. The comprehensive base plan was released in July 2001.

A number of review activities are undertaken annually to ensure that the Plan remains in alignment with other relevant university plans. The outcomes of these review activities are used in preparing the *IT Strategic Plan Annual Update* and developing a portfolio of prioritised IT development initiatives that are directly aligned to the overall mission, strategies and operational needs of the University.

The annual updates should be read in conjunction with the substantive Strategic Plan.

<http://www.monash.edu.au/about/itsp/>

6 Information Architecture

The information architecture deals with information that is controlled or managed by the University but may contain metadata pertaining to information controlled or managed outside which is related to the University operations. The focus is on the logical organization and management of information.

The Information Architecture document will be one of the outputs to be produced by the new department of Information Management and Strategic Planning within ITS, drawing on the Monash University Information Management Strategy.

The Information Architecture is intended to address broad high-level issues relating to the generation, management, storage and dissemination of the University's corporate information, together with the technology used for these processes. In the broadest sense this corporate information may reference items not owned by the University, but widely accessed by members of the University in doing University business.

The categories of corporate information to be included within the architecture include:

- Highly structured information such as student records and financial transactions;
- Unstructured information such as email, lecture notes and research papers that may contain rich data elements such as animations, simulations video and audio clips.

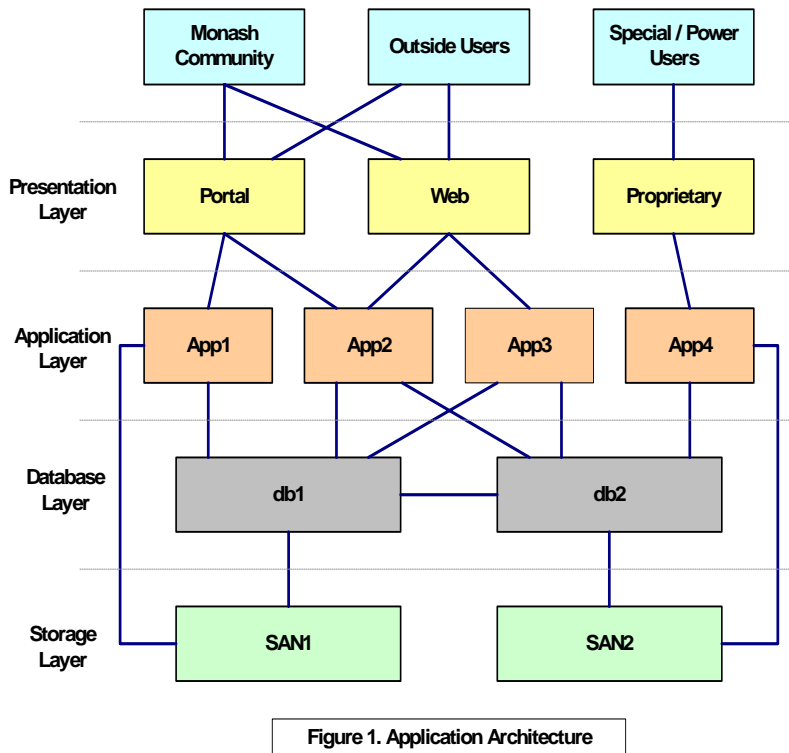
This corporate information may be:

- Stored on primarily on centrally-controlled servers (but also possibly as uncontrolled copies in shadow systems);
- Stored primarily on workstations and notebooks located in offices or staff members' homes (but which may duplicate or supplement information held elsewhere).

The Information Architecture will deal with the issues surrounding the creation, organisation, and disposal of this information, consistent with the theoretical model described in the Monash University Information Management Strategy.

7 Application Architecture

The general structure of the target application architecture is depicted below. Not all applications will conform to this architecture, and some will merge two or more layers. The diagram does not attempt to depict all of the possibilities. Important features are:



- A presentation layer which permits access to information through a variety of interfaces and technologies
- Application services which ideally are hosted on any one or more of a base set of standardized platforms, permitting flexible matching of resources to peaks in demand, continuing growth and effective disaster recovery strategies.
- A small number of database servers to conserve licences, promote sharing of data, and facilitate data integrity measures.
- A storage layer that decouples storage from the processing engines, thereby promoting consolidation of data storage, and uniform backup procedures.

7.1 Presentation Architecture

It is advantageous to separate the presentation layer from the application. Different user classes are best served by different presentation methods:

- The my.monash portal is the standard method of presentation to members of the Monash community, and offers a consistent interface to many commonly used services.
- The Monash web site is the standard method of presentation to the general public.
- Web based interfaces to applications is the preferred presentation model, however proprietary presentation methods may be warranted in some cases to gain full access to all application features, or to address special needs.

“Monash Community” includes all who are eligible for an Authcate account, and may, in the future, be extended to include potential students and alumni. Meanwhile outside users may access some services through one of two mechanisms. One is a “guest” account on the portal. The other is through being added to the External Directory.

Web presentation layers must meet branding, visual design, usability and accessibility requirements as specified in the Web Style Guide. See <http://www.monash.edu.au/staff/web/>

7.1.1 User-Centred Design

In the design of the presentation layer a user-centred design methodology should be adopted to enhance the quality and usability of applications and websites. Users should be involved in all development phases, including requirements analysis, through activities such as contextual inquiry, interviews, focus groups, surveys and usability testing.

7.2 Database Architecture

Oracle is currently the standard database management system for shared applications. Standardization on one version of Oracle would be desirable, but it is recognized that at any one time it may be necessary to run two or three database versions to accommodate the varying revision cycles of application packages.

| Element | Database | |
|-------------|-----------------------------------|---|
| Description | Relational database manager | |
| Class | Product | Notes |
| Preferred | Oracle | Current version and two previous versions supported. |
| Acceptable | SQLserver | Mandatory with CRM, ESS |
| | mySQL | MySQL: use in conjunction with PHP |
| Candidate | postgreSQL | postgreSQL: good ACID compliance Open source, low cost products |
| Maintenance | Oracle rdb, Powerhouse, Foxpro | Formerly digital rdb |
| Prohibited | Access | Not for enterprise systems, may be suitable for rapid development/prototyping/proof of concept and reporting e.g. used for reporting from Callista |

7.3 Application Development

7.3.1 Language

Application development is to be done using one of the supported languages, a factor which should be considered in the decision to purchase products. The prime criterion for selection of applications is their suitability to university needs: the language is a secondary consideration.

| Element | Application Development Language | |
|-------------|---|--|
| Description | | |
| Class | Product | Notes |
| Preferred | | |
| Acceptable | PHP, Perl ColdFusion, Zope, Python, Java, Iviews ASP ABAP Tools Oracle Tools J2EE, .Net | Still important for timetabling. Only for SAP systems. Includes SmartForms, EnjoyScreens, Objects, Sapscripts, WebDynpro and WebFlow. In conjunction with Oracle db. Used extensively for Callista and related systems. Includes Forms, Reports, PL/SQL, HTML/DB and JDeveloper. |

7.3.2 Tools and Utilities

| Tool | Description | Reference |
|--------------------------------|---|-----------|
| RevTrack | Revision tracking and applying updates | SAP |
| QAS | Quick Address System; from Australia Post. Validates mailing addresses and produces unique barcode. | |
| TOAD | Oracle development tool, debugger | |
| LoadRunner | Load simulation | |
| CVS | Version control | |
| Rational Robot | | |
| Telelogic Synergy | Software configuration and change management | |
| Altova Stylevision and XML Spy | Defines XML data definition and translates XML to output formats | |

7.4 Application Support Services and Standards

7.4.1 Access Management

Access Management involves establishing the identity of a user (authentication), and granting of access rights to particular services or resources (authorization). The concept of group membership, where all members of a group inherit a common set of access rights is a powerful management tool. Authentication and authorization should be achieved through the Monash Directory Service whenever possible. When purchasing application software it should be a specific requirement that the package has the capability to authenticate by calling an external LDAP directory.

A working group is examining authentication methods with the view to publishing a Monash standard authentication architecture. Work is also in progress on a Single Sign-On interface. To participate web-based products should be compliant with the Liberty protocol. See <http://www.projectliberty.org/>

| Element | Access Control (including authentication and group management) | |
|-------------|---|--|
| Description | Methods or protocols for authenticating users and authorizing access to resources | |
| Class | Product | Notes |
| Preferred | LDAP to MDS | Monash Directory Service is the natural repository for user information. |
| Acceptable | Kerberos Application-specific user database Novell eDirectory | Logins for Linux Only to be used when necessitated by business rules. |
| Candidate | Liberty Single Sign-on 802.1X EAP | Primarily for web-based products 802.1X offers the option of permitting access to the network only after a user is authenticated. Access rights can be based on individual user or on membership of groups. Uses MDS to store user information. |
| Maintenance | | |
| Prohibited | | |

7.4.2 Directory

The Monash Directory Service (MDS) is a collection of basic information about staff and students. The MDS is used as a central database by many other computer systems. Among other things they use MDS to authenticate users and find information about users (including what resources users have access to). This leads to powerful and universal Authorization and Group Management capabilities (see below).

Monash also allows controlled, devolved, and automatically-expiring entry of external users into the External Directory. This is combined with the Monash Directory to produce the Hybrid Directory. The Hybrid Directory is then used as an authentication source by a number of systems that wish to allow access by designated external users.

Access to the Monash Directory Service is based on the LDAP version 3 directory protocol.

7.4.3 HTTP (web) Server

Web servers have become universal tools in supporting all kinds of applications. In some cases the application vendor specifies a particular web server, so some diversity must be expected.

| Element | Web Server | |
|-------------|---|-------|
| Description | Software that provides HTTP services in sync with the current HTTP standards. | |
| Class | Product | Notes |
| Preferred | Apache | |
| Acceptable | IIS (Microsoft), Netweaver (SAP), OAS (Oracle) | |
| Candidate | Websphere (IBM) | |

7.5 Desktop Applications

Desktop Applications are those that reside on the client computer and are not dependent upon any particular application component on a server (i.e. not part of a client-server architecture). Desktop Applications are part of the Standard Operating Environment (SOE) for Staff. See <http://www.its.monash.edu.au/software/soe/staff-index.html>

7.6 Client Applications

Client applications are the client part of client/server systems. Several important clients such as email, web browsers, and calendar clients are specified in the [Standard Operating Environments](#) (qv).

| Function | Product |
|--|---|
| Web-enabled applications (SAP, Callista, WebCT) | Internet Explorer is the only certified browser for these applications |
| Web-enabled applications (MUTTS, Allocate+, CUPID) | Internet Explorer or Mozilla browser are acceptable for most applications |
| Instant Messaging | IM is not yet a supported service at Monash. (Pending outcome of Workgroup Collaboration Review)) |
| Voice Mail | Monash voicemail. See http://www.its.monash.edu/voice/voicemail/ |

7.7 Workstation Support Services

7.7.1 Shared Remote Print Service

The preferred printing model is that printers are

- Shared by members of a workgroup;
- Connected to their own network port;
- Associated with a print queue;
- Configured to use Internet Printing Protocol (IPP) or LPR/LPD.

Spooling print jobs on a server allows enhancements such as checking that the file is in a printable format, enforcing limits, queuing, accounting, and adding banner pages if required. General purpose print services are maintained primarily on Novell Netware servers (staff and student), but also on most Linux and Unix servers. All printers whose output is charged for should operate through print queues on servers where the accounting function is implemented (currently Netware servers).

Some enterprise applications (SAP and Callista) maintain separate print queues with access restricted to authorized users.

7.7.2 Remote File Service

Individuals and workgroups can store files on a remote file-store with appropriate data security, backup and archiving services. This should be the model for all information that is of value to the university. Individual desktop PCs are generally not backed-up regularly, and it is probably not practicable to enforce a backup regime on all desktops. The Monash Information Management Strategy will be setting policy and determining procedures for file storage.

Shared or remote file-space for desktops is provided through the Novell Netware servers. Access rights can be controlled down to the workgroup or individual, and can allow for read/write or read-only access.

Networked file systems (NFS, AFS) provide another mechanism for file sharing, mainly on Unix and Linux systems.

7.7.3 Remote Management

These remote services should be uniformly available to all user desktops:

- Ability for ITS and faculty service desks to remotely control and monitor workstation behaviour within delegated authority and only to remedy problems or identify breaches of the Acceptable Use Policy (currently achieved through Novell Zenworks for Desktops in conjunction with Novell eDirectory (NDS));
- Ability for programs to be deployed to single workstations on demand by the user or an administrator (currently achieved by Novell Application Launcher (NAL) or other methods);
- Ability for an administrator to deploy individual programs or complete images to a nominated group of workstations using multicast protocols to select the workstations in the target group (method currently under review/development);
- Ability for to deploy images to new computers or as a way of refreshing an existing image in installed computers. In the latter case user data should be preserved. It should be possible to

use stored images that conform to the SOE and are configured in a standard way (method currently under review/development).

7.7.4 Anti-virus Service

An up-to-date antivirus system is essential in any enterprise. Such a system should cover the servers providing services to desktop machines and the desktops themselves. The Monash standard suite is Sophos Sweep Anti-virus. Sophos provides components for use with server-based services such as email and Netware, as well as client-based desktops running Windows, MacOS, and Linux services. The client includes an agent which starts automatically at boot time and runs continuously while the desktop is in use. In networked devices the virus signature files for client-based applications are updated transparently and automatically over the network.

8 Technical Infrastructure Architecture

8.1 Client Platform Architecture

8.1.1 Staff Desktop or Laptop

Staff desktops, laptops and personal printers are the subject of a University policy, which authorizes a Standard Operating Environment. See Monash IT Policy ITEC11, [Standard Operating Environment for Staff Computers](#). Preferred hardware and software is published on the ITS web page [Staff Standard Operating Environment \(SOE\)](#).

Desktop PCs, notebook PCs and printers should all be purchased or leased in accordance with Monash procurement policies from one of the endorsed suppliers published on the Procurement Services website <http://www.adm.monash.edu.au/procserv/suppliers/IT/index.html>.

8.1.2 Staff Handheld Computer

Handheld PCs and PDAs have been assessed by the Mobile Services Working Group. The SOE and endorsed supplier list has been expanded to include handhelds and PDAs. The list of endorsed devices, configuration guides and preferred suppliers is available on the following web page: <http://www.its.monash.edu.au/staff/mobile/pda/>

8.1.3 Student Lab Desktop

More than one environment is used in labs because of different teaching needs. These include Windows and Linux environments. See the ITS website for information on the current state of the [Student Lab SOEs](#).

8.1.4 Student Home Desktop

As far as practicable, students should try to replicate or approach the student lab SOE in home machines.

8.1.5 Student Laptop

Laptop configurations can, and should, include virtually all of the features of the corresponding desktop category, with the obvious exception of screen size and type. Laptops should preferably include either a built-in or PCMCIA wireless card, (802.11b or 802.11g) and VPN client.

Software consistent with that specified in the Student Lab SOE.

8.1.6 Student Handheld

Recommendations for handheld computers are under consideration by the Monash Mobile Devices Working Group, and will be included in the extended SOEs when available.

8.2 Server Platform Architecture

Currently Monash servers may be from two processor families and three operating systems: Intel 80x86 (Pentium, Xeon, Athlon) processor-based systems run Linux, Netware or Windows Server operating systems, while Sun ultraSPARC hardware platforms are used with Solaris operating system software.

For scalability, operating systems and hardware that support multiple-processor configurations and clustering are preferred.

8.2.1 Hardware

The performance and reliability of servers is determined by many factors that affect the selection and configuration of the hardware. High-availability services may include fully duplicated systems, others will have varying degrees of resilience in power-supplies, network cards, disk controllers etc. Resilience and scalability is also achieved when a service is devolved to a “farm” of identical systems and an automatic load-balancing mechanism.

Preference should be given to hardware configurations that reduce the installation and management burden. In this regard, blade servers deserve mention, as do high-density rack-mount servers. SMP (symmetric multi-processor) configurations are available in rack-mount versions, and increasingly in blade configurations also.

| Element | Application Server, web server, file server, etc. | |
|-------------|--|---|
| Description | Included in this class are all general-purpose computers which provide a service to multiple workstations in the course of providing some corporate application. | |
| Class | Standard | Notes |
| Preferred | Intel 80x86 | Rack-mount or blade, Intel/AMD high-end processors, SMP support |
| Acceptable | Sun Microsystems | Mid-range and larger models preferred. |
| Candidate | Intel/AMD 64-bit processors (Itanium, Opteron) IBM PowerPC | |
| Maintenance | | |
| Prohibited | | |

| Element | Database server | |
|-------------|--|--|
| Description | Database servers are characterized by their ability to sustain high rates of disk access; they are transaction processors rather than general computing engines. | |
| Class | Standard | Notes |
| Preferred | Intel 80x86 | SMP and expandable models. |
| Acceptable | Sun Microsystems | Mid-range and larger models preferred. |
| Candidate | | |
| Maintenance | | |
| Prohibited | | |

8.2.2 Operating System

The choice of operating system will sometimes be dictated by application software. With Linux improving in maturity and capability it is likely to be increasingly the operating system of choice.

| Element | Operating system | |
|-------------|---|--|
| Description | The operating system for server class computers (Sec 8.2.1). | |
| Class | Product | Notes |
| Preferred | Red Hat Enterprise Linux ES or AS | Current version, or up to two previous as required by application software compatibility. |
| Acceptable | Solaris Netware Suse LES Windows Server 2003 | NOS for print, file, anti-virus etc. services in student and staff environments. |
| Candidate | | |
| Maintenance | Digital Unix, IRIX, BSD Netware 4 Windows NT, 2000, | Netware 4 and IPX being phased out during 2004. Not recommended because of security concerns, especially the high rate of patching necessary to close security vulnerabilities. |
| Prohibited | | |

8.2.3 Server Consolidation

With the widespread adoption of client-server architecture, the number of servers and server types has exploded, as each new application has resulted in the purchase of extra servers. While this situation minimizes interaction between applications, it results in high IT expenditure, and uneven utilization of resources. The “server per service” approach results in many small servers, and a large investment in memory and disk storage that is not effectively utilized. It leads to the purchase of large numbers of software licences and expenditure of a great deal of manpower on system administration.

Economies can be gained by consolidating operations on a smaller number of platforms, of one or two basic types. Not all applications are candidates for server consolidation. New projects should be planned with the expectation of a consolidated approach. Guidelines and procedures are being developed for migrating existing applications to a consolidated environment.

The selection of server capacity should be driven by the principles of limiting diversity, achieving high availability and re-using general purpose building blocks, while maintaining appropriate levels of performance, security and privacy. The aim should be for the smallest practicable number of powerful platforms. It is to be expected that platforms will increasingly be multi-processor configurations, and that greater use will be made of clustering technology to reduce the number of managed entities. One implication of this policy is that applications will be expected to share hardware platforms where their resource and security requirements are compatible.

8.2.4 Server Procurement

The normal procedure will be for application projects to list their server requirements and request ITS-IS to provide server facilities meeting the project specification. Infrastructure Services can provide a detailed questionnaire. After discussion with the project team, Shared Systems will propose a suitable hosting solution.

8.2.5 Configuration

Operating system and related files including swap files normally reside on direct attached storage (DAS). Applications and data reside on the Storage Area Network (See below).

8.2.6 Management and Monitoring

Where a high degree of service monitoring is required the BMC Patrol monitoring agent should be used.

8.3 Server Storage Architecture

Historically storage has been considered as an integral part of each server, and storage management has been included with server management. Increasingly, storage management is now being regarded as a separate function, and the benefits of providing an integrated storage, backup/recovery and archiving services for the life of the information is being realized.

The Monash IT Architecture makes a clear separation between the storage component and the server (processor) component of systems. The preferred system architecture uses the Storage Area Network (SAN) for data storage, decoupling storage from server, and permitting storage consolidation. The IT architecture promotes storage consolidation.

The establishment of the Monash ITS Data Storage Management Policy recognises the importance of reliable and effective management of stored data across the university. The policy resulted in the formation of:

- A Data Storage Management Steering Committee, which provides strategic direction and authority;
- A Data Storage Management Team, which performs the tactical and operational tasks associated with providing a managed storage facility; and
- A Data Storage Management Framework (Work in Progress), that will define the Service Management model including the policies and procedures underpinning the services.

A central feature of the data management programme is the implementation of a high-performance high-capacity SAN. The SAN comprises disk storage, dedicated interconnects and switching equipment that connects servers to disk storage, backup/recovery services, archive facilities, and management servers. Substantial benefits can be realised from this technology and management structure by:

- Decoupling storage from the server engines, allows server upgrades to take place independently of the storage, and more efficient business continuity strategies to be employed in the event of server failure;
- Consolidation of disk storage leads to more efficient use of disk space and enables a consistent backup mechanism;
- Consistent high-quality storage management for the whole life of the data;
- A range of storage, backup and archiving services to suit different business needs;
- Improved business continuity and Disaster Recovery through the ability to volume mirror across multiple sites.

8.4 Network Architecture

IT Services is responsible for the operation and management of the network infrastructure. This includes all of the intercampus and on-campus switching facilities, and all fixed wiring as far as the wall outlets (or the air interface in the case of wireless networks). Management of workstations, including the network interface card and patch lead, lies with the user.

The Monash network is based on universally accepted standards for the various interfaces and protocols. Standards for some additional services (such as desktop video-conferencing) will be added in future editions.

8.4.1 Network Protocols

Historically the Monash network had supported several protocol families (TCP/IP, Appletalk, IPX/SPX and earlier than that DECnet), but in line with global trends, Monash moved to the architectural simplicity of an IP-only network in 2004. IP (Internet Protocol) is the common unifying protocol layer used by the internet. The power and flexibility of the internet is that IP runs over a multitude of underlying transmission technologies, while supporting a wide variety of “higher-layer” protocols for specific services (such as web, email, multimedia, etc).

All new systems should plan to use only IP protocols, and for continuing systems which use non-IP protocols locally, plans should be made to migrate those systems to IP.

8.4.2 Network Connections

The standard network connection types and network services on offer are described more fully at <http://www.its.monash.edu.au/networks/connections.html>, and in the Network Service Statement <http://www.its.monash.edu.au/management/statements/SSS-05.pdf>

Network connections are designated either as server or workstation, with different security settings and different throughput capabilities. In designing the network a large emphasis has been placed on achieving high levels of availability through resilient (duplicate) paths and equipment, at every level of the network. Critical servers or workstations may be attached to the network by two connections, each to a different network switch.

For staff needing to access sensitive information or systems over an insecure connection (such as dial-up or internet access from outside Monash) the network can provide a secure “tunnel” in the form of a Virtual Private Network (VPN) service. See <https://secure.monash.edu/its/vpn/>

A growing trend in communications is mobility. Most laptop computers and PDA’s include 802.11 wireless connectivity as a standard feature. Wireless network access is available to many of the highly frequented areas of major campuses. See <http://www.its.monash.edu.au/networks/wireless/>

8.4.3 Network Security

A large part of the Monash IT Security Policy and Framework <http://www.its.monash.edu/security/> is about network security, and provides a formal description of the components which make up the network security model. Some important elements of that model include

- A border multi-protocol application-layer gateway (inc. proxy server);
- A border firewall with extensive intrusion-detection and filtering capability;
- A well-developed subnet model with inter-subnet routing and access control;
- An intelligent edge network with extensive filtering capabilities.

8.4.4 Quality of Service

The network can offer different classes of service for demanding applications. This capability is often referred to as Quality of Service (QoS). For example, the network can provide guaranteed low-delay forwarding of real-time voice or video, or high throughput (but with possibly longer delays) for a high volume application such as a network file system. Critical to the deployment of QoS are the ability to classify network traffic into different priority levels, and the ability to rate limit traffic which threatens to interfere with network operation. Importantly, the network architecture allows QoS actions to be implemented at the ingress point where information enters the network.

8.4.5 Multicasting

Some applications such as video broadcasting over the network, and distribution of disk images to multiple workstations, proceed much more efficiently if the same information can be sent simultaneously to a group of destination workstations. The network supports the creation of such groups and the efficient distribution of data just to the specified recipients.

8.5 Environmental Infrastructure

The reliability of a service depends as much on environmental factors as on the reliability of the actual server hardware or software. Information systems providing corporate information services to more than a single workgroup are expected to have:

- Air conditioning
- Resilient and conditioned power supply
- Physical Security
- A formal Data Integrity strategy
- A formal Disaster Recovery Plan.

ITS computer-room environments are designed to provide all of these features, properly maintained and provisioned.

9 Future Work

The development and adoption of an IT Architecture is an ongoing process. The newly formed Information Management and Strategic Planning Department of Information technology Services is charged with the responsibility for ensuring that the IT Architecture is current and relevant. A process of engagement with the wider university IT community is essential for achieving benefits from wide spread adoption.

This document contains elements of vision or target architectures as well as descriptions of the status quo. As the Monash IT Architecture develops it may be desirable to link to detailed documentation targeting the status quo whilst MITA focuses on the target or vision and migration strategies.

10 Appendix I: Classification

| Class | Description |
|-------------|--|
| Candidate | A product not yet classified otherwise, but deemed to have sufficient merit for consideration as a potential preferred product. Candidate products are typically new products or technologies, and may be used in trial or pilot projects. These products will generally not be covered by existing supply or support contracts or by existing licences. |
| Preferred | The product, or products, currently deemed to offer the best combination of value, features, security, etc for application at Monash. Often there will be a single “preferred” product, but occasionally there may be two, in which case they are regarded from an architectural viewpoint as equal, though one may have clear advantages over another for a particular application. Generally supply and support arrangements will exist, and University-wide licensing may have been negotiated. |
| Acceptable | A product deemed to be less attractive in some sense than those in the “preferred” class, but may be used in cases when the preferred products are ruled out for some reason. A situation commonly arises when an application requires the use of a product or standard other than the Monash preferred one. The applications is purchased for its strategic and business benefits and the technologies supporting it are a subsidiary consideration. Nevertheless the supply and support channels need to be assured during the procurement process. |
| Maintenance | Products that are in use at Monash, probably in “legacy” applications, but are deemed to be less suitable than the best currently available. New projects should always use “preferred” or “acceptable” class products. Where projects or services already use a “maintenance” product, its use may be continued until there is a major upgrade or redesign. At this point a switch to a preferred product should be considered. Supply, support and licensing, if they exist at all, may be subject to "sunset" clauses, so these aspects should be reviewed regularly. |
| Prohibited | Products that have serious defects or whose philosophy, structure, or resource requirements make them inappropriate to the Monash enterprise architecture. Should not be used in any sustained production situation. |

11 Appendix II: Methodologies

Some methodologies which have been found valuable at Monash, but which are not part of the Information Architecture and are noted here. Some of these relate specifically to application development, while others are more general in nature.

- ITIL Service Management Methodologies: See <http://www.itil.org.uk/>
- User-Centred Design: See http://www-306.ibm.com/ibm/easy/eou_ext.nsf/Publish/570
- Extreme Programming (XP): see <http://www.extremeprogramming.org/>
- Rapid Application Development (RAD)
- Thomsett Project Management Methodology

12 Appendix III: Specific Products and Protocols

| Element | Network interface – workstation | |
|-------------|---|---|
| Description | A network interface is a point of connection between a workstation and the Monash network. Typically it takes the form of a NIC (network interface card) or an equivalent interface incorporated in a PC motherboard. The interface connects to a network RJ45 wall socket via a UTP patch cable. | |
| Class | Standard | Notes |
| Preferred | 10/100/1000 Mbit/s Ethernet (auto-negotiate ¹) | This is the “default” network service offering. The PC and the network negotiate the highest rate that both support. Data rates may be throttled in the network to prevent resource “hogging” by 1000 Mbit/s ports. |
| Acceptable | 10 Mbit/s Ethernet (switched IEEE 802.3 10Base-T) | Workstations or NICs that cannot operate at a higher rate drop back to 10Mbit/s operation. |
| Prohibited | Any hub or switch “downstream” of the wall outlet | As per the service statement. The network is engineered to perform best with one user device attached to each wall outlet. Unauthorized attachments may jeopardize network operation, and can lead to automatic disabling of network ports. |

| Element | Network interface – server | |
|-------------|--|--|
| Description | A server network interface is a point of connection between a server and the Monash network. Server interfaces connect directly into core network switches, and are provisioned for heavy traffic. | |
| Class | Standard | Notes |
| Preferred | Gigabit Ethernet (1000Base-T) | Default network connection for high volume servers in computer room environment. Dual (resilient) interfaces are preferred for high-availability services. |
| | 1000 Mbit/s Ethernet (IEEE 802.3 1000Base-T) | Default network connection for smaller servers. Dual (resilient) interfaces are preferred for high-availability services. |
| Candidate | 10 Gbit/s ethernet | Emerging for very high-end servers. Dual (resilient) interfaces are preferred for high-availability services |
| Maintenance | Gigabit Ethernet fibre (1000Base-SX) | More expensive. Only provided for servers that do not have a 1000base-T (UTP) interface option. |
| | 10Mbit/s Ethernet (switched) | Only for legacy servers, or very low volumes. |

¹ In a small number of cases, autonegotiation fails and interfaces must be manually configured.

| Element | Protocol Suite | |
|-------------|---|---|
| Description | The allowed protocol suites define the format of all packets sent on the network, and the packet sequences for establishing sessions etc. | |
| Class | Protocol | Notes |
| Preferred | TCP/IP version 4 | Universal standard for Internet and most other uses. |
| Candidate | TCP/IP version 6 | Likely future for all IP applications. |
| Prohibited | IPX/SPX AppleTalk | Only available for use within the local subnet. Continued operation even in that context must not be relied upon because subnet boundaries are always subject to change for operational, security and geographical reasons. In particular the one subnet cannot be relied upon to span outside a small geographical area (group of buildings) nor across organizational boundaries. |
| Prohibited | NETBEUI | Not routable, limited to localized Microsoft-based networks. |

| Element | Wireless NIC | |
|-------------|---|---|
| Description | A wireless NIC (Network Interface Card) is needed to allow a workstation to connect to a wireless network. Increasingly, wireless NICs are included internally in notebook computers. | |
| Class | Product | Notes |
| Preferred | ORiNOCO 802.11b/g (8470-WD or 8471-WD) Cisco 352 | Must comply with IEEE 802.11b or 802.11b/g standard, operating on 2.4 GHz frequency band. |
| Acceptable | Other WiFi-certified NICs. Built-in NICs. | Not all NICs work correctly with the Monash VPN client. Many notebook computers come with a wireless interface already built-in. |
| Candidate | ORiNOCO 802.11a/b/g (8480-WD or 8481-WD) | 802.11a (5.8 GHz) standard not in use at Monash, but card supports 802.11b and g modes also. |

| Element | | |
|--------------------|---|---|
| VPN Client | | |
| Description | A VPN (Virtual Private Network) client is the software required in a workstation to permit the establishment of a secure connection over an unsecured network (VPN). VPN operation is mandatory for Monash wireless networks (until native wireless security meets Monash requirements), and for transferring sensitive information over an untrusted network (Internet or dial-in access). | |
| Class | Product | Notes |
| Preferred | Monash customized Cisco VPN client, Movian client (for PDA) | Customized Cisco clients available for Windows 9x, NT/2000/XP, Mac OS X |
| Acceptable | Other IPSEC-compatible clients | |
| Candidate | Freeswan | |

| Element | | |
|--------------------------|--|---|
| Printing Protocol | | |
| Description | The printing protocol determines how information is exchanged between a server (usually) and a printer. The protocol may allow the user to query printer capabilities, check status, delete jobs etc, as well as outputting print files. | |
| Class | Protocol | Notes |
| Preferred | IPP | IETF standard. |
| Acceptable | Lpr/lpd | Commonly implemented on unix/linux systems. |

| Element | | |
|---|--|---|
| Streaming Protocol (Audio and video streaming) | | |
| Description | This only addresses the transport and control protocol. For higher-level services such as video-conferencing additional protocols govern call control, data compression etc. | |
| Class | Protocol | Notes |
| Preferred | RTP/RTCP H.323 SIP | Real Time Protocol (data transport and control) |

| Element | | |
|--------------------------|--|---|
| Multicast service | | |
| Description | Multicast is an efficient method of simultaneously sending information from one source to multiple destinations. | |
| Class | Protocol | Notes |
| Preferred | IGMP ver 2 or 3 | IGMP is used between computers and their local multicast router to join and leave multicast groups. Multicast routers use other protocols to build and control multicast trees. |
| Acceptable | | |