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1. INTRODUCTION

The University’s Information Technology (IT) Strategy aims to maximise the positive impact of IT in the delivery of the University’s strategic plan and its associated strategies for Learning and Teaching, Research and Knowledge Exchange and Internationalisation. By creating a dynamic environment in which IT underpins almost all University activity but retains the flexibility to enable performance improvement and to respond positively to new opportunities and challenges, this strategy will play a key role in delivering the University’s vision.
1.1 GLASGOW 2020 A GLOBAL VISION

The University Strategic Plan, Glasgow 2020 a Global Vision, sets out an ambitious agenda for the University as it seeks to *enhance its position as one of the world’s great broad-based research-intensive universities*. It recognises the central importance of *fit-for-purpose IT systems* as a key enabler in providing *flexible and responsive human and computer based systems* and the *robust, reliable and integrated management information systems* that *underpin the core business activities of the University*. It further commits to *streamline our systems and processes to make the most of our resources* while ensuring the University community benefits from *continuous improvements to all IT systems*.

This IT strategy builds on and supports the vision and commitments contained within Glasgow 2020 by providing a holistic vision for the future IT environment that will support the University in delivering on its aspirations across its full range of activity and sets the direction the University will follow to deliver the vision.

Key to supporting Glasgow 2020 and helping deliver the ambitious objectives will be a range of IT activities targeting:

- Provision of a scalable, flexible, agile, resilient, secure and robust infrastructure capable of supporting leading edge Learning & Teaching and Research regardless of the location of end users.
- Access to data and applications in a manner that takes advantage of flexible, mobile and personalised user interfaces and the opportunities provided by the concept of the personal internet.
- As part of the Campus Estates Strategy, the creation of an intelligent Campus supporting pervasive access (not just mobile), increased collaboration and delivery of services / information to all end users.
- Exploitation of the potential of disruptive influences emerging from the digital world to improve performance by transitioning from structured applications to digitised processes where appropriate.
- Delivery of comprehensive Business Intelligence capabilities supporting complex modelling and predictive analytics in support of L&T, Research, all aspects of planning and service delivery.
- Support of Transnational activities including new partnerships and operating models - Distance Learning, activities at partner locations.
- Delivery of an overall IT architecture that positions the University in a manner that it can react and take advantage of new opportunities as and when they appear and not be a constraint.

1.2 IT STRATEGY – WHERE ARE WE NOW

Recent years have seen a range of significant changes to the University’s IT ecosystem:

- Continued investment in networking and infrastructure to support L&T, Research and operations has provided a solid strategic network platform on which to build for the future, e.g.
  - Comprehensive Fibre Optic Cabling Infrastructure linking all University Buildings
  - Standards based high capacity data cabling systems within University buildings
  - Resilient IP Routing backbone operating at 40Gbs
  - 20Gbs links to SuperJANET Six
• Comprehensive WiFi provision

• Standardisation on a range of core business applications, replacing many local systems in Faculties / Colleges, removing duplication, improving end to end process capabilities, and delivering an integrated information platform which can form a stable, and flexible foundation on which developments identified in this strategy can be built.

• Increased use of the fundamental services provided by IT Services to Colleges delivering greater consistency, improved governance, enhanced security and better value for money.

• The introduction of on-going process improvement activities, with the prospect of greater consistency and sharing of best practice across the University.

Despite the above progress, key challenges remain, especially around change management and improved communication, and are referenced in the remainder of this document. Having established a strategic IT platform the key theme is for all communities of the University to work together to ensure processes, services, innovation and the overall user experience are designed, fully co-ordinated and implemented in a manner that allows the University to progress and meet its strategic objectives as defined in Glasgow 2020. Where new solutions involve the introduction of new, or amended processes, and adoption is not consistent any planned improvements in efficiencies or service levels will not be delivered.

Business analysts (e.g. Gartner) argue that 2013 marked the end of an era in terms of enterprise IT, which focused on business processes and industrialisation of IT. 2014 marks the start of a new era where digital innovation and end-user experience / engagement become key. The University is well placed to enter this new digital era in parallel with the completion of the planned process improvement initiatives which will deliver consistent best practice.

### 1.3 DISRUPTIVE INFLUENCES

Looking outward, a number of changes in the world of IT have the potential to fundamentally alter the education ecosystem. These changes will impact how the University’s vision of IT as an enabler and provider of added value is delivered.

Social networking, cloud, mobile, information (inc big data) and BI / analytics are already making an impact on the way the world comes together, not only in the personal lives of individuals but increasingly in business and education. The term consumerisation is increasingly used to describe the increase in choice that is available to students and staff in terms of devices, data and applications and how they are used. The table below is a high level sketch of a few key themes under each of the headings.

<table>
<thead>
<tr>
<th><strong>Social</strong></th>
<th><strong>Mobile</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Extreme networking</td>
<td>Information sharing</td>
</tr>
<tr>
<td>Collaboration options</td>
<td>New relationship opportunities</td>
</tr>
<tr>
<td><strong>Cloud</strong></td>
<td><strong>Mobile</strong></td>
</tr>
<tr>
<td>Personal choice rules (when, where, how)</td>
<td>Personal Devices otherwise known as: Bring Your Own Device (BYOD)</td>
</tr>
<tr>
<td>Personal cloud</td>
<td>Personal internet</td>
</tr>
<tr>
<td>Software as a Service (SaaS)</td>
<td>Faster innovation</td>
</tr>
</tbody>
</table>
In isolation, each of the above may be easily understood as they are now commonplace in other areas of peoples’ lives, but their combination results in a scenario where end users will expect to have more control in constructing their own working models. Students are no longer limited to the Common Student Computing Environment as their only launch pad for work, instead they will utilise a combination of mobile, cloud and social technologies accessing a much wider range of information sources and collaborating in new and different ways with a more diverse range of contacts. This may be viewed as a change from the University pushing information and services out to the end user communities, to a model where end users are pulling selected services and information into environments and collaboration areas of their choice. Those Universities who move with the behavioural changes of students, and how they wish to interact with each other and their academic leaders, will greatly benefit from being positioned as an integrated part of student life, rather than as an outsider looking in. The Academic and Research community and Administrators are likely to modify their behaviour in a similar manner.

1.4 COMBINING EFFICIENCY, USER EXPERIENCE AND PROGRESS

The diagram below is a simplified view of the University’s current position and how ongoing work will be targeted.

- “Infrastructure” represents subjects such as middleware, hardware networking etc. Although largely taken for granted by end users and management, ongoing investment is critical and underpins all of IT.
- “Strategic Software Applications” typically include core software systems (Finance, HR, Student etc.) which have a direct impact on information quality and administrative processes but are frequently considered to be constraining by end users in Schools and Colleges. Ongoing investment in the implementation of new releases, tighter integration and limited customisations will be key. If such developments are aligned with the opportunities provided by the disruptive forces and ongoing improvements to change management there is the potential to enhance user satisfaction and overall ROI.
- “Staff / Student choice” has typically been manifest in their use of tools such as those embedded in consumer technologies but that were rarely integrated into an organisation’s operational model. Issues of support, integration and consistency that previously acted as barriers to institutional adoption are rapidly reducing in significance as external disruptive forces change the fundamental nature of the relationship between the personal and business environment. As a consequence, there is now a real opportunity to improve the benefits and outcomes of adopting technologies that are driven by end user demands / choice.
- “Disruptive Forces” refers to technologies that rate high on both axes and typically include a combination of consumer orientated tools and organisational processes. Mobile, social, and cloud all appear here, as well as in other quadrants, and if utilised positively can play a significant role in helping deliver greater efficiencies and end user experience.
This strategy attempts to identify how the various quadrants can be brought together to focus on outcomes that deliver improved user interaction and overall experience coupled with enhanced services that deliver efficiency gains.

Over the past ten years or so, IT Strategies have followed a path of “enabling” the business to advance in terms of efficiency and effectiveness. In the particular case of the University of Glasgow the general theme of enablement will continue, however, greater focus will be placed in assisting the University to position itself in order to react to new challenges, threats and opportunities. In addition, the construct of the world of IT is changing dramatically as the impact of recent initiatives start to seriously influence the manner in which both students and staff use technology both in their personal lives and when at work.

The HE ecosystem is changing in profile, advancing in terms of capability, and competitiveness. With these changes in mind this strategy attempts to provide the University with a broad based IT platform that is secure, robust, flexible and innovative.

1.5 SPEED OF CHANGE

Planned changes will need to be delivered in a disciplined manner which reflects their complexity and impact. The University's approach is to utilise new technologies that have reached a degree of maturity in each of the particular solutions, to ensure unnecessary risks are avoided as a result of too early or trail blazing adoption.

1.6 ENSURING DELIVERY

Project Management, governance, standards, and methodologies, all play a vital role in the delivery of IT related projects regardless of size. Of equal importance is the need to ensure the University and all its constituent parts work together to achieve agreed goals. Change management is therefore key to achieving the maximum return on any investment or change.
The diagram below is taken from McKinsey and Company and serves as a guide on how to manage the health and prospects of any project. By combining this approach with ongoing improvements to methodologies etc and improved change management, project failures will be avoided due to greater consistency in the adoption of new processes and improvements in the overall quality of project deliverables.

<table>
<thead>
<tr>
<th>Categories</th>
<th>Overarching goal is project success</th>
</tr>
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<tbody>
<tr>
<td>Managing strategy and stakeholders</td>
<td></td>
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<tr>
<td>• Clear objectives</td>
<td></td>
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<tr>
<td>• Well-defined business case</td>
<td></td>
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<tr>
<td>• Alignment of major stakeholders</td>
<td></td>
</tr>
<tr>
<td>• Minimized, stable project scope</td>
<td></td>
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<tr>
<td>• Robust vendor contracts with clear responsibilities</td>
<td></td>
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<tr>
<td>• Executive support</td>
<td></td>
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<tr>
<td>Mastering technology and content</td>
<td></td>
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<tr>
<td>• Standardized, proven software technology</td>
<td></td>
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<tr>
<td>• User involvement to shape solution</td>
<td></td>
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<tr>
<td>Building team and capabilities</td>
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</tr>
<tr>
<td>• Experienced project manager</td>
<td></td>
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<tr>
<td>• Qualified and motivated project team</td>
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<tr>
<td>• Sustainable mix of internal and external resources</td>
<td></td>
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<tr>
<td>Excelling at project-management practices</td>
<td></td>
</tr>
<tr>
<td>• Reliable estimates and plans, appropriate transparency about project status</td>
<td></td>
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<tr>
<td>• Proven methodologies and tools</td>
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</table>
2. MEETING THE NEEDS OF THE UNIVERSITY STRATEGIC DIRECTION

Out of the Glasgow 2020 vision and its key strategies and themes emerge a number of IT related challenges in the areas of:

- Learning and Teaching
- Research
- Administration

As progress is made in delivering ongoing IT strategic initiatives in support of the above, regular consultation will take place with the Deans of Learning & Teaching, Deans of Research, the Information Policy & Strategy Committee, Project Boards, College Management and other key stakeholders.
2.1 LEARNING AND TEACHING CHALLENGES

In making its commitment to “Visionary Course Development, Delivery and Review”, Glasgow 2020 recognises the need to harness the benefits of the latest technologies. Consistent with this, the Strategic Plan also recognises the importance of delivering an excellent student experience. Students now need the flexibility to learn where and when it is convenient for them to do so, with less emphasis on the traditional physical attendance at lectures, tutorials and practical sessions at specified times. That is not to say that these elements are no longer important, but we now have a very diverse mixed economy, with high expectations of IT by both staff and students.

The key challenges in relation to IT in Teaching are therefore:

- To provide a joined-up set of services in teaching rooms, taking account of the need for increased collaboration and supporting University developments in trans-national and distance education, so that staff and students can be confident that the technology will not let them down, whether it be Audio-Visual, Video-Conferencing, Lecture Capture or on-line.

- To meet the aspirations of the e-learning strategy published by the Vice-Principal for Learning and Teaching in 2013.

- To respond creatively to the steady increase in demand for support for mobile working, whether on campus or elsewhere, from a wide and rapidly changing variety of devices.

- To harness the disruptive forces described in Section 1 to help drive improvements and positively respond to new challenges / opportunities.

- To continue to improve and evolve our Virtual Learning Environment, so giving students and staff ready access to an enhanced range of technology-based learning and teaching tools in a manner that supports flexible learning and is responsive to student behaviours and needs.

- To provide support for the learning and teaching of students and staff involved in Trans-National Education (TNE) through flexible and adaptable services and systems.

- To provide academic and administrative staff with appropriate support and training to address change in processes and availability of new tools and techniques.

2.2 RESEARCH CHALLENGES

- Increasingly research is collaborative, across disciplines, institutions and sectors. Researchers need a flexible and configurable research data storage environment for active data, accessible using an authentication model which makes it straight-forward to provide read and write access for collaborators from: the University of Glasgow, other HE Institutions and other non-HE partners. The services provided need to be responsive, accessible to collaborators wherever they are and able to satisfy the requirements of funders and the needs of researchers in relation to confidentiality and security and be able to handle significant quantities of data if required.
The key challenges for IT in relation to Research are:

- To meet the requirement of the research funding bodies to make datasets produced as part of publicly funded research more accessible. This includes assessing the infrastructure required to host the data associated with publications over the long-term and producing guidance to staff on when and how to store and share their data.

- To support the networking, high performance computing (HPC) and simulation modelling needs of research that uses very large datasets (often referred to as ‘Big Data’), including those involving images, stored in different locations both in the University and the NHS and at other institutions and facilities around the world.

- To improve compliance and contribute to the University’s need to correctly manage and maintain research data. A research data planning model and associated services will be introduced.

- To support the need for widespread dissemination of research outputs in a variety of interactive and rich-media forms.

- To improve competitiveness by offering an increased range of services delivering more flexible, scalable and better supported IT environments / platforms on which advanced research can be undertaken and maintained. Efficiencies would also result both at project start-up phase and on an on-going basis.

2.3 ADMINISTRATIVE CHALLENGES

The major administrative challenge is around the management of the information that staff need. It is agreed that the University needs a more coherent and unified approach to organising information to better enable staff to perform their jobs. There is currently no consistent approach with information variously accessible via many different systems and routes and this makes it difficult for staff to find the information they seek and/or need.

The key challenges in relation to IT in Administration are:

- To use the data in individual business systems in ways that make for better management, planning and service delivery, through business intelligence, data mining and large data manipulations.

- To deliver the capability for staff and students to interact with University information and systems in ways that are convenient and timely and from wherever they need to do it using devices readily available to them.

- To ensure the integrity and security of University data and information notwithstanding the fact that the University will have decreasing control over the devices that are being used to access it.

The business requirement is an information architecture: that has no requirement to know which system has which information; that is delivered through appropriate channels; and on devices preferred by those accessing it. Such an architecture should be based around the activities and tasks that users of information are engaged on (a consumer view), rather than around the needs of the information owners.

These key challenges, for Learning & Teaching, for Research, and for Administration, are addressed in the following sections on the ‘Components of the Strategy’ and the ‘Strategic Infrastructure’.
3. KEY COMPONENTS OF THE STRATEGY
3.1 COLLABORATION: WORKING TOGETHER ACROSS BOUNDARIES

The world in which the University of Glasgow now operates is one where boundaries and borders are very porous. This results in a need for collaboration between students, between staff, between students and staff, between Subjects, between Colleges, between disciplines, between Institutions, with other organisations such as the NHS or Government Agencies, between countries and between sectors. The majority of research applications involve such collaboration and a great deal of both administrative and teaching work involves external collaborators, such as those in business, professional practice or the NHS.

The University’s approach to meeting the four requirements in this area is:

- Learning opportunities should be accessible regardless of location; Whether that be for an external lecturer addressing a class from another site, institution or country, for a class split between lecture rooms at different locations or for students to be working together from their places of residence. The rise of Trans-National Education initiatives (such as those with Nankai and Singapore) is providing added impetus to this agenda.

  Significant investment in equipping major teaching spaces in the University to facilitate multi-location teaching (using Video-Conferencing and multi-room teaching) has already taken place over the last two or three years and attention is now focussed on increasing the flexibility, ease of use and crucially, the reliability of all services in this area.

- Administrative, Governance and Research group meetings need to have participants who are not physically present in the University because they are not able to travel to the University on that particular day, but are willing and able to join the meeting remotely.

  There are many tools available which can assist, with new ones appearing frequently, The University will produce a set of services that make setting up and administering group meetings straightforward and a sufficient number of suitably equipped rooms of meeting size to satisfy the increasing demand.

- Shared work-space for groups of students, researchers, administrators or simply those working together on a common project.

  The University will deliver a collaboration space that is easy to tailor to the specific needs of the collaborators, with the tools and storage resources required. The service must be able to operate seamlessly across role, School, College and Organisational boundaries.

- The ‘Impact’ agenda in funded research, frequently requires research proposals to deliver their outputs via web sites that often need interactive elements. Whilst this was often a fairly niche activity in the past and was handled on an individual basis by Schools or Colleges, this is no longer sufficient, particularly in view of the Research Council agenda for more openness.

  The University will introduce a new central service for research data storage and publication, coordinated by IT Services and the Library. This will link to the current Enlighten research output and data repository facilities.

In this area as in many others, the constantly evolving nature of the user needs requires constant vigilance and requirements sensing in collaboration with colleagues in Schools and Colleges and other University Services.
3.2 BYOD, MOBILE AND SOCIAL WORKING: DOING IT MY WAY ON THE MOVE

The majority of our students and many of our staff have mobile devices: Smart Phones, Tablets, Notebooks and Laptop computers. They expect to be able to use devices and ways of working that are part of the rest of their lives. This new way of working is not optional, it is a given and it requires that whilst as a University we may store and manage information within large complex systems, we need to surface at least some of the ‘products’ of these systems via mobile apps and user interfaces that can be used conveniently, safely and securely on such devices.

Staff and students will expect that they can use their own devices for interacting with University data and systems and that is a considerable challenge for security, since it is never going to be possible to exercise as much control over devices that belong to individuals (usually referred to as “Bring your Own Device” BYOD) as would be possible on desktop computers owned and managed by the University.

- The technical infrastructure for delivery of mobile services is already established in the University via the wireless network. Continuing investment will ensure this network is increasingly pervasive and reliable.
- The University will promote service delivery in a way that allows staff and students to do what they need to do, in the most convenient way, by aligning services and interfaces to expectations and preferred ways of working.
- In order to deal with the diversity and change in the devices in use, apps and other interfaces will be developed that are generic and standardised. In developing these facilities, the importance of functionality and ease of use are recognised as key in stimulating uptake. The University Mobile Strategy is focussed on enabling the delivery of information and services via this channel to meet demonstrable demand.
- IT Services will provide a suite of services that are cross-platform, and device agnostic, with the emphasis on making it convenient for users to be able to do key things on the go (email and other aspects of communication, network access, apps for specific tasks, search for info to satisfy immediate need), whilst continuing to facilitate more substantial tasks on other platforms such as desktop PCs.

There is a wide range of exciting possibilities for mobile delivery of information, which have the potential to provide more efficient and effective working (particularly for students) and the aim is for mobile delivery to be seen as the norm for access to ‘read-only’ information by the end of 2014, with an increasing emphasis on information input during 2015.
3.3 RESEARCH

Other sections of this strategy paper including: Infrastructure, Cloud, Storage, Virtualisation, Collaboration and Security all have a direct impact on improving IT support for research activities. As each theme is planned in association with Colleges and the research community the aim will be to reduce the number of dispersed servers spread across the Colleges where limited back-up, resilience and appropriate security is in place. Whilst the Infrastructure, Cloud, Storage, Virtualisation, Collaboration and Security sections below contain further detail, the main areas to be addressed in relation to the ICT support for research are:

- A new data centre is part of the Campus strategy providing space and connectivity for greatly enhanced provision of cloud services and other services to support remote access.
- An improved and more responsive range of services making use of the potential of virtualisation will be available to researchers on demand.
- A development strategy for the provision of High Performance Computing (HPC) capabilities will be produced following a careful review of current provision and evaluation of future need in consultation with the research community.
- Research data planning building on the work that researchers have to do as part of funding applications will be introduced and services for data sharing across school, college, institutional and other organisational boundaries will be developed to meet the needs of collaborative research.
- Network services will be further developed in response to College priorities as the University’s network is continually upgraded to ensure capacity, speed and resilience is maintained at sector-leading levels.
- Collaboration tools, workspaces and related services will be further developed in consultation with the research community to meet their needs and will include increased availability of videoconferencing, shared file and messaging options.

3.4 INNOVATION IN LEARNING AND TEACHING

Continuous innovation in learning and teaching is essential if learning is to be enhanced by pedagogies that harness new technology. It also ensures that modes of teaching evolve to exploit opportunities for growth domestically and internationally. A major focus for the University in the coming years will be growth in online delivery to enhance capability and capacity for distance- and campus-based learning. This growth will balance risk in the taught portfolio, strengthen existing and new markets, grow the student population beyond the physical constraints of the campuses, alleviate timetabling pressures on-campus by offering a limited number of courses wholly online, enable new in-country TNE supported by blended learning, and connect high-value professionals to the University through the provision of online CPD. To take forward this important agenda, the University will launch an initiative in Online Learning that will:

- provide local resource to support the appointment of academic staff to develop distance-learning courses and programmes
- provide local resource to support the online development and enhancement of existing campus-based courses and programmes
- strengthen and evolve central support for innovation, possibly through an Innovation Centre, to provide local areas with specific expertise in the design and implementation of the online provision.
3.5 BUSINESS APPLICATIONS: THE FOUNDATIONAL INFORMATION SOURCES

Over the past five or six years in-house developed business systems have been replaced by best of breed packaged software solutions. Not only has this changed the profile of development work, the impact on the various business areas has been to help introduce more tightly defined business processes, enhanced integration and a reduction in the number and range of local solutions. There is therefore an increased emphasis on collaborative development, maintenance and support, and good mechanisms for liaison between IT Services and College IT teams.

Although there is still work to be done to complete the transition of the University’s core software business applications (e.g. implementation of Agresso Research system planned for 2014), these changes have in general been widely adopted leading to greater consistency in processes and quality / availability of data.

Current and future priorities are to:

- Drive the consistent adoption of new processes, with associated change management and process improvement, in order to exploit more fully the functionality of the University’s business systems.
- Introduce the disruptive forces in a manner that assists end users of all types to access information and processes. These should be delivered in a manner that is more people centric and goal orientated.
- Prepare to allow students and staff to pull information and goal orientated tasks into their own personal internet / cloud rather than the current model where the majority is “pushed” by the University.
- Continue to invest in the development of core applications and their integration.
- Develop Apps and other light-weight access techniques for accessing the information held in these important and authoritative systems.
3.6 BUSINESS INTELLIGENCE: SMARTER USE OF INFORMATION

Business intelligence (BI) is a broad category of software applications and technologies used to gather, store, analyse, and access data to help organisations make better business decisions. BI capabilities have progressed significantly over the years allowing easier access and consolidation of data from multiple sources (internal and external) and delivery of flexible analytical tools.

Intelligence and Analytics:

<table>
<thead>
<tr>
<th>BI &amp; Analytics</th>
<th>Business Intelligence</th>
<th>Business Analytics</th>
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</thead>
<tbody>
<tr>
<td>Answers the questions:</td>
<td>What happened?</td>
<td>Why did it happen?</td>
</tr>
<tr>
<td></td>
<td>When?</td>
<td>Could / will it happen again?</td>
</tr>
<tr>
<td></td>
<td>Who?</td>
<td>What will happen if we change xyz?</td>
</tr>
<tr>
<td></td>
<td>How many?</td>
<td>What else does the data tell us that we never thought to ask?</td>
</tr>
<tr>
<td>Includes:</td>
<td>Reporting (KPIs, metrics)</td>
<td>Statistical/Quantitative Analysis</td>
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<tr>
<td></td>
<td>Automated Monitoring /Alerting (thresholds)</td>
<td>Data Mining</td>
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<td></td>
<td>Dashboards Scorecards</td>
<td>Predictive Modelling</td>
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<td></td>
<td>OLAP (Cubes, Slice &amp; Dice, Drilling)</td>
<td>Behavioural Modelling</td>
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<tr>
<td></td>
<td>Ad hoc query</td>
<td>Multi-variable testing</td>
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BI is recognised as one of the top concerns for industry leaders and is consistently high on corporate agendas. This is the right time for the University to develop its BI capability, in order to benefit from the investment it has made in best of breed core software applications.

- The University will implement a Business Intelligence initiative, adopting BI tools that will capitalise on the investment it has made in business systems and deliver a step-change in the quality of its management information and analytics to support more timely and effective decision making. The outcome will be to deliver information that will meet managers’ needs and that is accessible, consistent and trusted.
4. STRATEGIC INFRASTRUCTURE

To support the IT-based services required to meet the University’s expectations and ensure that it meets its strategic goals, a robust infrastructure has been established and needs continual development to meet the rapid process of change in technology and the development of the campus onto the Western Infirmary site.
4.1 CAMPUS DEVELOPMENT

The University will deliver an improved IT infrastructure within its plans for campus development, following the acquisition of the Western Infirmary Site and developments associated with the Combined Heating and Power (CHP) project. As buildings are designed, infrastructure cabling and WiFi provisioning will be addressed. As part of the Campus Estates Strategy, plans will be developed for a Data Centre, to enable the University to raise its capacity to undertake internationally leading research. A Data Centre would deliver additional storage / server capacity, adherence to increasing demands from research funders on data centre provisioning, and increased capacity to attract major research funding initiatives, and leading international academics, to Glasgow.

4.2 NETWORK INFRASTRUCTURE

The University’s data communications and Network Infrastructure is a key part of the technical infrastructure and underpins all of the IT services and systems in the University. Over the last few years significant investment has funded a fast and reliable Network Infrastructure employing both fixed and wireless technologies and resilient connections to the Global Internet, in particular:

- Comprehensive, single mode and multimode, Fibre Optic Cabling infrastructure linking all University Buildings
- Standards based high capacity, data communications, cabling systems within University buildings
- High speed Local Area Network switching and Routing services within University Buildings;
- Resilient IP Routing backbone operating at 40Gbs
- WiFi networks within University Buildings delivering the ‘Eduroam’ service for staff and students and Guest Access for visitors;
- High speed resilient links to ClydeNET and SuperJANET Six, operating at 20Gbs

With constant change in demands and evolving technologies in networking, the University will invest continuously in enhancing network capacity.

This investment will ensure that the University’s data communications and Network Infrastructure provides the connectivity, bandwidth, reliability and security required to support the wide range of services and applications which currently depend on it and new services as they develop.

4.3 CLOUD SERVICE PROVISION

The term ‘Cloud Computing’ is used to bring together a number of IT service delivery paradigms into a collective framework, which enables on-demand access to a pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be provided easily and quickly. This presents significant opportunities for the University to deliver;

- Flexibility and agility for scaling services over time, in relation to new requirements and changes in demand.
- Speed with which new services can be delivered.
- High availability and disaster recovery.
- Potential energy, space and cost savings, though these need to be assessed on a case by case basis.
Cloud Computing includes a number of different deployment models:

- **Public Cloud** – commercial offerings, services that we can buy or obtain from the commercial market.

- **Community Cloud** – shared Services, that we could share with other partners, possibly via a Cost Sharing Group (CSG).

- **Private Cloud** – in-house services, that we currently provide.

- **Hybrid Cloud** – a combination of the above.

Standardisation of services and approaches to service delivery associated with University restructuring and the significant uptake of centrally provided IT services places the University in a strong position to take advantage of the benefits of ‘Cloud Computing’

- A thorough review of the services that the University provides to users will be undertaken to identify those that would be more efficiently and/or effectively delivered via the cloud e.g. student email, collaborative data sharing, etc.

- The most appropriate Cloud computing deployment model will be adopted in each case such that the model that best matches the University’s strategic need will be used. In doing so the University will seek to achieve the optimal balance of cost, risk, efficiency and service quality between Public, Community and Private Cloud services.

- The University’s Private Cloud Infrastructure will be developed to provide cost-effective solutions for a number of College-specific service and storage requirements.

### 4.4 VIRTUALISATION

Virtualisation is the term used to describe the process of creating multiple logical computing ‘devices’ from available physical devices, i.e., CPUs, memory, disk storage, Network and other peripheral devices. Virtualisation is a key enabling technology within the University’s Cloud and Technical infrastructure strategies. There are two distinct components: Virtual Machines (VMs) and a Virtual Desktop Infrastructure (VDI).

**A Virtual Machine** is a software application which presents all the characteristics of a physical computer. Sophisticated virtualisation software also called hypervisors, create and manage the VMs by pooling resources from the available physical hardware, either traditional single servers or a more integrated server farm. The VMs can then be used provide: Windows servers, UNIX and Linux servers, configured in a variety of different ways to meet the specific needs of specialist applications in research, teaching or administration. This type of architecture provides additional benefits in terms of higher availability and disaster recovery. In order to derive the full benefits of Virtual Machines and Server Virtualisation, it is essential that workload characteristics are fully assessed and understood to determine whether a Virtual Server implementation is compatible with delivering the performance and security required.

**Virtual Desktops** provide a user desktop environment where the processing and software are hosted on a server rather than on the machine that the user is sitting at. They can be delivered to a wide range of devices such as tablets, laptops and desktop machines on almost any platform. The
University’s CSCE-Remote and SSD-Remote services are virtualised desktop environments, which provide staff and students with access to a familiar managed desktop comparable with the physical CSCE and SSD services available on Campus. Virtual Desktops are key elements of the Cloud computing, BYOD and Technical infrastructure strategies.

Virtualisation is a key enabling technology within the University’s Cloud and Technical infrastructure strategies.

- **Virtual Machines and Virtual Server** solutions will be implemented for workloads which are suited to and benefit from such provisioning and all new server requirements will be tested against whether a virtual solution would be advantageous.
- **Virtual machines** will be employed to allow flexible rapid deployment and reconfiguration of services as demand patterns change or new requirements emerge and specifically will be made available to meet the needs of researchers who need to run specialist applications and teachers who wish to use new teaching methods that require the support of a specific application.
- A Virtual machine approach is currently used to support a number of services including:
  - Identity management service
  - Alumni service
  - Agresso service
  - ID card system
  - Electronic Document Management System (EDRMS)
- **Virtual desktops Infrastructure (VDI).** The University will implement a Virtual Desktop Infrastructure based on Virtual Machines which can scale in numbers to support staff and student demand. This VDI will provide staff and students with the following benefits:
  - Access to a wide range of site licensed software
  - Access to personal and shared filestore
  - Enhanced security
  - Access from anywhere via a wide range of operating systems and devices including smart phones and tablets
  - Additional management benefits in terms of security patching and application deployment
5. SECURITY IN THE NEW WORLD

Organisations, such as universities, face a dilemma: they must protect information from unauthorised access and data-stealing malware, whilst at the same time allowing staff and students to access services and data efficiently and conveniently, in order to do their work.
5.1 CYBER SECURITY

The University has a robust layered approach to Cyber Security involving systems and network administrators, postmasters, webmasters, IT support staff in University Services and Colleges and the individual staff and students of the University. A comprehensive set of policies and procedures apply to all users of University systems and networks, irrespective of who is responsible for their day-to-day management. More demanding policies and procedures apply to confidential information. The Information Security Team work with data providers and owners to secure and facilitate access to information which requires higher levels of protection. They also manage security incidents and advise IT staff across the University as to the appropriate safeguards to put in place for their systems and processes.

The University’s Cyber Security is based around identifying and combating the main risks which include:

- Inappropriate handling of confidential data e.g. storing on a mobile device which is later lost.
- Compromise of credentials via social engineering attack "phishing"
- Corruption of important data by malware on workstation
- Compromise of web applications
- Inability to upgrade old/vulnerable software versions due to incompatibility with software elsewhere in the University.
- Preventing malicious intrusion and filtering out the large amount of malware contained in emails.
5.2 THE MOBILE AND PERSONAL DEVICE DIMENSION

Organizations, such as universities, face a dilemma: they must protect information from unauthorised access and data-stealing malware, whilst at the same time allowing staff and students to access services and data efficiently and conveniently, in order to do their work. The increasing use by staff and students of their own computing devices (now predominantly portable devices) raises considerable security challenges.

The use of someone’s own device (BYOD) is nothing new in Universities. In BYOD and mobile environments, which make extensive use of cloud storage and services, the ease with which central control can be exercised is reduced when compared to the desktop environments that have been in widespread use for the last 15-20 years. Insecure devices and connections provide new opportunities for hackers and increase the cost of defending against cyber-attacks, whilst all devices and environments are equally vulnerable to phishing attacks and those based on social engineering.

The University will oversee the policy, technical and organisational measures required to protect the security of University information systems as staff and students move into the new ICT environment, and to counter its associated cyber-threats. This will involve action in the following areas:

- Data - assist information owners in creating rules/guidelines for use of data for which they are responsible. It is these ‘soft measures’ that determine when and how people access data and what they do with the data once they have accessed it.
- People - require all staff and students to take system and data security seriously and accept that they have a part to play. There is an important educative role here for central and college IT staff.
- Mobile Devices - facilitate access to services and data: from anywhere; at any time; from any device; in a secure manner. This will involve a combination of both technical and organisational controls and an increasing use of virtual desktops.
- Cloud - identify what types of data may safely be stored in a private cloud, the public cloud, community cloud and hybrid cloud, and develop services to use such storage solutions as are appropriate to the material being handled.
- Policies - keep security and related policies under review so as to ensure that they maintain an appropriate balance between addressing the changing risk landscape and keeping pace with changing technologies and user expectations.

Whatever developments take place, many of the services and capabilities that staff and student use today will be required in the future. However these services are delivered, there will be a continuing need for security measures and an element of monitoring of activity and compliance.
6. GOVERNANCE AND CONTROL
6.1 ORGANISATIONAL STRUCTURE

Following the restructuring of the University into the current College model, effective partnership between IT Services and College IT staff has succeeded in promoting greater standardisation across a number of platforms, including email, backup, incident reporting and helpdesk activities. This has removed duplication and released staff resources. The organisational model involves a strong central IT function, enhanced by College IT resources, which are required to address specific IT needs in each College. IT Services work closely with College IT teams, an approach that has delivered significant advances since restructuring and, with improved communication and tighter integration during planning on both sides, will deliver further improvements. Oversight of the IT Strategy and its implementation is the responsibility of the Information Policy & Strategy Committee which reports to the Senior Management Group.

6.2 SERVICE DELIVERY

There is an increasing need to ensure that all IT developments and service enhancements are aligned to the University’s Business Goals and to the major strategic challenges outlined in Section 2. Clearly these strategic directions need to be well founded through appropriate consultation and communicated with all those that they affect. Neither IT Services nor College IT teams can afford to attempt to support every technology or to provide all possible services.

ITIL 3 (The Information Technology Infrastructure Library) is a set of practices for IT service management (ITSM) that focuses on aligning IT services with the needs of business. ITIL underpins ISO/IEC 20000 (previously BS15000) and specifies an integrated process approach to the effective and efficient delivery of IT services. It defines the major process elements and controls for all aspects of service management. Alignment to ITIL demonstrates unequivocally that the quality of IT service management is being taken seriously in the University.

The University is working to align services and their development and support to the principles of ITIL 3. This gives service users a clear view of the goals of services, the responsibilities of all parties and what can reasonably be expected in terms of delivery. Whilst following the principles of ITIL 3, this re-orientation of service development and delivery seeks to ensure that the bureaucratic overhead is as small as possible for all parties.

A number of benefits accrue:

For customers:

- The quality of service provided by IT is evident and demonstrable
- Their confidence in the support, delivery and management of services is improved
- The reputation of IT and consistency of services is improved

For IT Services and other providers

- Management and staff understand their business, their roles and their processes better
- Clearer interfaces and improved cooperation amongst staff are facilitated
- Staff morale is improved
6.3 STAFF DEVELOPMENT / TRAINING

It is inevitable that changes to business processes and the supporting IT systems will require different ways of working. This will have a direct impact on job roles and operational models. As part of the tactical planning, it is imperative that stakeholders, project teams and process owners in each Division, College or School develop plans to address the impact on staff. Appropriate staff development and training must be delivered to all those who are impacted by change. IT and project teams will play a significant part in delivering the Strategy, however, they are only part of a much larger picture.

Staff development is therefore a further key theme if the initiatives outlined in this strategy are to deliver success. Staff development / training may also be used as an indicative measure of success. If it is lacking in terms of coverage or involvement, planned changes will almost certainly be adopted in an inconsistent manner and benefit realisation will be slower than expected.
The University is continually facing and responding to change across the entire spectrum of its activities. The rapidly changing world of IT, and in particular the expectations of Staff and Students who access information and communicate wherever they are with devices in their pockets, is both a challenge and an opportunity for rethinking how services and information access are designed and delivered. What is certain is that the next five years will see enormous change in how the University uses IT to meet its goals and aspirations.