IT Infrastructure Roadmap

## Summary

The University has an ambitious agenda to improve its position in world higher education rankings, through expanding its research, enhancing its student experience and increasing its overall impact through knowledge exchange and commercialisation. In addition, its vision for 2025 includes challenging targets in:

* Digital education with taught online undergraduate, postgraduate and flexible PhDs;
* Data driven research;
* Internationalisation - deep partnerships with peer universities and overseas experience for students.

This agenda is not feasible without a robust IT infrastructure that: underpins a very wide range of services; has the capacity to meet the University’s growing needs; and which is available 24 x 365.

Our current infrastructure does not have these characteristics.

This paper presents a costed five-year roadmap for University of Edinburgh’s IT Infrastructure to bring that infrastructure up to the desired standard. We have divided the IT Infrastructure into four domains and, within each domain, used the standard IT industry “Run, Grow and Transform” model to differentiate activity. The likely investment required over the next 5 years is around £23m, a little over £4m pa. This includes the project costs associated with the Roadmap activities and the change to IS operational costs. All capital costs are contained within the project costs.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **2015/16** | **2016/17** | **2017/18** | **2018/19** | **2019/20** |
|  | **Project** | **Op** | **Project** | **Op** | **Project** | **Op** | **Project** | **Op** | **Project** | **Op** |
|  | **£000** | **£000** | **£000** | **£000** | **£000** | **£000** | **£000** | **£000** | **£000** | **£000** |
| Run | 2,180 | 4 | 3,415 | (52) | 2,570 | (160) | 1,205 | (198) | 960 | (198) |
| Grow | 1,060 | 52 | 1,800 | 194 | 800 | 220 | 1,100 | 245 | 130 | 270 |
| Transform | 973 | 184 | 772 | 208 | 760 | 221 | 1,760 | 271 | 1,760 | 261 |
| **Total**  | **4,213** | **240** | **5,987** | **350** | **4,130** | **281** | **4,065** | **318** | **2,850** | **333** |
| **TOTAL** |  |  |  |  |  |  |  |  | **22,767** |

Within the Run activity, that is investment required to sustain current business function, we have identified some technical debt or maintenance backlog, particularly in the Network Domain. It is essential that we repay this debt by replacing equipment which is beyond its normal replacement cycle. An example of this is the University telephone system which will be at serious risk of catastrophic failure within the 5 year horizon of the roadmap. Additionally, we will see increasing unreliability and poor performance in our edge network. Users would be likely to experience disconnections at peak times and frustrating delays when accessing their data, which would be felt most acutely by those with large research data sets.

When considering Grow activity, related to the expansion of the University’s current business, and Transform activity, related to the investment required to develop new University activity, we have used a project approach to both identify costs and demonstrate the business need for each activity, linking them to University strategy. Project costs include consideration of the impact on ongoing operational costs; increases in costs; and a projection of efficiency savings. This has allowed us to show the impact on our Run costs of implementing the projects.

For each project there is a ‘data sheet’ in Appendix A which presents: a brief description; costs; and linkages to the University strategy.

We asked our colleagues from the Colleges and Support Groups to prioritise the transform project activities. The analysis shows that there are different priorities for the different areas and those activities which occur earlier on the road map are seen as more important, at this time, than those which are further into the future. This diversity of need and uncertainty re the future, are strong indicators that we need to retain flexibility in our approach. To do this we are recommending that the funding is seen as an envelope against which IS can ‘call off’ projects rather than funding only to do the things we can foresee today. In order to effect changes to the roadmap, a governance process overseen by KSC will be put in place. It is anticipated that this will be an annual review process covering a 5 year forward look.

## Infrastructure Context

To understand the roadmap it is useful to consider how IT Infrastructure underpins the overall function of University and to explain the separate infrastructure domains. We also present how the infrastructure can be separated into different business activities and the metrics that are used to guide our investment.

#### Operating Model

The following diagram shows a simplified representation of how the central IT Infrastructure underpins the University’s core digital services, the digital research and teaching activities across the academic colleges and the administrative functions of the other support groups.

Figure 1: Digital Services Delivery Model



Information services is organised into seven divisions, each aligned to a different business function. Applications delivering the enterprise services; Teaching learning and the web – the web and technology enhanced learning services e.g. Learn and University web site; Library and University Collections the services to discover and borrow library resources; with User Services providing a common front door to all institutional services . Edina and DCC are a little different as they deliver services to the UK higher education community and as such have a different engagement model with users. All of these business functions are underpinned by an IT Infrastructure which provides common platforms and services for all of this activity, and so delivers the efficiencies of consolidation and the skills benefit of centralisation. Alongside this, the central IT infrastructure is consumed by the colleges and support groups, both to host their own services - such as researchers running simulations on central infrastructure - and for the data and voice networks used by all.



This model shows that how each layer of the IT ‘stack’ is used to deliver services to the layer above it in the model and those services are also offered directly to users as services in their own right. For example IS operates a virtual server hosting service in the infrastructure layer which is made available to users to run their own applications, and the same service is also used to provide the servers to run the University’s enterprise services – e.g. the MyEd portal or the Finance systems.

#### IT Infrastructure Architecture

Within the IT infrastructure we again subdivide into domains. The following diagram shows the domains and the main services that are delivered from each.



The components that make up the domains are shown in the following diagram.



The desktop domain delivers the “pane of glass” through which all digital services are viewed – either through the support University’s desktop environment or through the supply of personal computers in open access student study spaces. It also provides technologies to deliver applications to mobile devices or user owned devices.

The hardware domain consists of the server and storage infrastructure which hosts all the University’s central digital services and is made available for schools as platforms on which to run their own services. Key to this is the provision of *virtual server hosting* environment, which opens up the central compute and storage infrastructure to be used by others.

 It also provides the central University research data analysis and simulation services and holds the University’s research data services.

The network and telecommunications domain provides all of the University managed data and voice networks. The *core* network delivers the institution’s Internet connectivity and the main links between University campuses; the *edge* network provides internal building data networks which connect edge devices such as desktop PCs or personal tablets. It also provides the University’s fixed telephones.

The data centre domain contains the three physical environments which contain the University’s central server and storage infrastructure, and the core network. They provide the necessary resilient power, cooling and connectivity to deliver our services.

These domains are more fully described in Appendix E.

The audio-visual technology used across the estate in teaching and learning spaces was not considered in this review.

#### Roadmap planning

In this section we look at what drives the roadmap. We have used a Run, Grow, Transform analysis to categorise activities and used replacement cycles and performance metrics to assess service levels against capital investments.

##### RGT Framework

We have chosen to use the RGTframework to categorise the breakdown of the planned IT infrastructure investment, ensuring we clearly determine the business value of any specific IT investments which the Infrastructure review and resulting roadmap recommend.



*Run* investment sustains the University’s current business activity, *Grow* investment facilitates the increase in demand for existing services, e.g. through increased undergraduate numbers using online learning environments or increasing numbers of researchers using current data analysis platforms for quantitative analysis, *Transform* investment enables the University to deliver new activities.

##### Replacement Cycles and KPIs

The majority of the infrastructure investment is in *Run*, to provide stable environments on which services are delivered. It is necessary to invest in a rolling refresh programme for each of the infrastructure areas. This ensures that the infrastructure is maintainable and is compatible with the changing technology environment. Infrastructure which is beyond its maintainable life will no longer supported by its supplier; will fall behind in integrating with the changing technology environment and will be more prone to failure.

The refresh cycle is a combination of the expected useful life of the item and of the support provided by the supplier. Detail of infrastructure replacement cycles is presented in Appendix F.

Alongside the planned refresh cycle used to deliver a sound platform for IT services, a number of metrics are used to ensure that the infrastructure has sufficient capacity to meet needs. Much of the growth in the capacity required can be met as a result of the replacement cycles, new IT equipment invariably has a greater capacity/performance than the old equipment it replaces. However, the following metrics can be used to ensure that we have sufficient capability to meet growth which is not contained within the equipment replacement cycles.



Capacity planning metrics ensure that the infrastructure has enough headroom to cope with expected growth; service availability metrics ensure that the underlying infrastructure is accessible when needed; efficiency metrics ensure the infrastructure is shaped to deliver best value; effectiveness metrics confirm if the services we are offering are being well used. A fuller list of metrics is available in Appendix G.

**Roadmap**

We have used our infrastructure domains and the run, grow, transform framework to classify activities that are required to deliver the roadmap for the next five years. Through the review process the activities or projects have been discussed with the review group and with representatives of the Colleges and Support groups who prioritised the transformational projects. For each project there is an associated data sheet in Appendix A giving more details including investment needs. This section presents the roadmap in the form of a timeline chart, strategy, the dependencies between activities, priorities and the investment required .

**Infrastructure Roadmap Timeline**



## Strategy

The IT Infrastructure is a key enabler for the University’s goals of excellence in research and learning. We all recognise that without IT infrastructure these activities would be impossible and that a properly performing infrastructure becomes almost invisible. Key aims of the IT infrastructure strategy are to

* Enable a uniform service delivery across the estate so that user location does not materially disadvantage access to service.
* De-duplication of service provision to drive effectiveness (more sharing) and efficiency (economies of scale) and use of appropriate security standards
* Support for new transformational activity.

We are going through a period of significant change as more of the business of the University is digitally delivered, this perhaps best demonstrated by the move to online learning, particularly at distance and the use of large data sets for research. Unless we transform our infrastructure to meet these needs we will fail to maximise our capability, will continue to duplicate activity and provide sub optimal user experiences.

While the strategic links of a number of the proposed projects are self-evident: the central provision of Data Science services is obviously underpinning the University’s ambitions to be a world leader in Data Analytics, others are more nuanced.

 The ability to investigate correlations between large numbers of data-sets is critical to Data Science. Deficiencies in infrastructure which lead researchers to hold their data in local private infrastructure rather than in centralised data storage, from which they can be shared and analysed, are barriers to Data Science. The path from data to discovery, requires researchers to trust central infrastructure and so the fear of losing access to data through the loss of campus links inhibits the centralisation of data. The project to “Extend Core Network” which provides resilient links to our major campuses addresses this issue, builds trust, and so supports Data Science activity.

The University’s ambitions for delivery digital education, and in particular online distance education, are supported by projects which provide flexible access to University resources. The “Apps to User Devices” project provides the mechanism to present learning applications to user devices any time, any place or any device. A distance learner who needed access to a sophisticated modelling application would be provided with an interface to access this application running in a secure and well managed environment, rather than having to install and managed a complex software application on their own device.

The project data sheets presented in Appendix A show how each project is linked to the University’s strategy.

## Project Dependencies

There is only one true hard dependency between the projects and that is, we cannot progress the “Soft Phones” project unless we have already engaged with the replacement of the analogue phone system with a VoIP system. However, there are a number of soft links between other projects. In these cases, each project can be progressed independently, however, benefits will be maximised by doing all of the connected projects, i.e. the overall impact is greater than the sum of the parts.

A good example of this is the link between “Desktop Virtualisation” and “Data Science Services”. Desktop virtualisation allows the desktop environment to be run in a well-protected data centre environment. This secure cordon permits flexible user access to sensitive research data which cannot be shared to the standard physical desktops across the University.

The following chart shows the dependencies between projects.

**Infrastructure Roadmap Project Dependencies**



## Priorities

The highest priority is to secure the Run activities which include the areas of technical debt in the edge network; and the need to replace the analogue telephone system

We rank the Grow activity above doing Transform activity. There is, however, uncertainty about the scale of the changes that will be needed to keep pace with the growth in the University’s business, because the predictions of University growth are themselves to some extent uncertain. It is essential that we keep pace with change in the University, and therefore we have identified the activities and the scale of the changes that we believe are appropriate. However, it is to be expected that the Grow activities will shift and will need to be revisited regularly.

We asked the College and Support Group representatives on the group to prioritise the Transform projects. The following table shows the rank of the projects determined by totalling the rankings of the Colleges and Support Groups, where 1 is the highest priority.

|  |  |  |  |
| --- | --- | --- | --- |
| **Rank** | **Transform Projects** | **Rankings** | **Total** |
|  |  | **SCE** | **HSS** | **MVM** | **ISG** | **USG** | **CSG** |  |
| 1 | Apps to user devices | 4 | 1 | 1 | 3 | 1 | 1 | 11 |
| 2 | Desktop virtualisation | 2 | 1 | 3 | 4 | 2 | 3 | 15 |
| 3 | Data Science Services | 1 | 6 | 2 | 1 | 5 | 2 | 17 |
| 4 | Private Cloud Provisioning | 3 | 4 | 4 | 2 | 4 | 4 | 21 |
| 5 | Increase Wifi density to meet hotspot needs | 5 | 3 | 5 | 5 | 3 | 5 | 26 |
| 6 | Provide soft phone clients | 7 | 8 | 6 | 6 | 6 | 6 | 39 |
| 7 | Unified communications | 6 | 7 | 7 | 7 | 7 | 7 | 41 |
| 8 | External Wireless | 8 | 5 | 8 | 8 | 8 | 8 | 45 |

With such a small number of elements to rank it is difficult to draw conclusions from this scoring but two things are clear: that there is a difference in the prioritisation of these projects across the University and that there is a relationship between a project’s rank and its immediacy.

Each College or Support Groups top priority project is ranked at most 4th by another group, and if we wanted to implement each unit’s top three projects we would need to implement the top five.

Projects which are scheduled earlier in the roadmap are seen as higher priority. This is likely due to their need being more pressing. The appetite for implementing the later projects may change as these technologies become more common place or indeed more important ideas may emerge.

As a consequence of this analysis we decided not to take any projects out of the roadmap. We reflected that retaining flexibility was important for those projects falling later in the roadmap schedule. This will allow us to: take new opportunities; deal with changing costs, views of priorities or changing technology. We need to keep an envelope of expected investment to deal with the difficulty of seeing further into the future. By retaining these projects we have provided that envelope.

* 1. **Investment**

The investment levels recommended to maintain and develop the IT infrastructure over the next 5 years are shown in the following table. The total spend over the 5 years is estimated at around £23m.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **2015/16** | **2016/17** | **2017/18** | **2018/19** | **2019/20** |
|  | **Project** | **Op** | **Project** | **Op** | **Project** | **Op** | **Project** | **Op** | **Project** | **Op** |
|  | **£000** | **£000** | **£000** | **£000** | **£000** | **£000** | **£000** | **£000** | **£000** | **£000** |
| Run | 2,180 | 4 | 3,415 | (52) | 2,570 | (160) | 1,205 | (198) | 960 | (198) |
| Grow | 1,060 | 52 | 1,800 | 194 | 800 | 220 | 1,100 | 245 | 130 | 270 |
| Transform | 973 | 184 | 772 | 208 | 760 | 221 | 1,760 | 271 | 1,760 | 261 |
| **Total**  | **4,213** | **240** | **5,987** | **350** | **4,130** | **281** | **4,065** | **318** | **2,850** | **333** |
| **TOTAL** |  |  |  |  |  |  |  |  | **22,767** |

1. The costs are divided between Run, Grow and Transform activities and between project and changes to our operational costs. We agreed that we would adopt the approach of showing change in operational costs for this paper, as we were unable to attribute our existing operational costs between Run Grow and Transform activities in the time available. The approach to costing is broken down in much more detail in Appendix A where data sheets for individual projects are presented, showing both the project costs and the impact on operational costs, i.e. the change in operational cost as a result of the changes introduced in the project. As you can see in the table above there are some negative numbers, shown in red brackets. This shows operational savings achieved as a result of the project investments.

By presenting project costs, the capital costs are no longer identified explicitly at this level. There are some relatively small project revenue costs included alongside the capital costs. There are no capital costs included in the operating costs. A full breakdown is available at Appendix A.

A summary of Run, Grow and Transform project costs (excluding operational costs) is presented in the following table:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Project Name** | **Project Type** | **2015/16****(£000)** | **2016/17****(£000)** | **2017/18****(£000)** | **2018/19****(£000)** | **2019/20****(£000)** | **Total****(£000)** |
| Desktop domain spend1 | Run | 180 | 180 | 180 | 180 | 180 | 900 |
| Hardware domain spend1 | Run | 290 | 1,240 | 1,040 | 440 | 240 | 3,250 |
| Network domain spend1 | Run | 235 | 235 | 275 | 435 | 390 | 1,570 |
| Data centre domain spend1 | Run | 15 | 0 | 15 | 0 | 0 | 30 |
| Edge network, technical debt2 | Run | 760 | 760 | 760 | 150 | 150 | 2,580 |
| Telephony: Analogue to VoIP | Run | 700 | 1,000 | 300 | 0 | 0 | 2,000 |
| Enterprise & server storage | Grow | 70 | 85 | 35 | 100 | 130 | 420 |
| Additional file storage | Grow | 0 | 400 | 0 | 1,000 | 0 | 1,400 |
| Application file-store | Grow | 115 | 0 | 0 | 0 | 0 | 115 |
| Infrastructure monitoring | Grow | 0 | 160 | 160 | 0 | 0 | 320 |
| Extend core network | Grow | 650 | 750 | 0 | 0 | 0 | 1,400 |
| Network capacity upgrades | Grow | 75 | 75 | 75 | 0 | 0 | 225 |
| Wi-Fi coverage | Grow | 80 | 80 | 80 | 0 | 0 | 240 |
| Edge coverage re Estates3 | Grow | 0 | 0 | 0 | 0 | 0 | 0 |
| Strengthen network security | Grow | 0 | 200 | 400 | 0 | 0 | 600 |
| Data-centre network resilience | Grow | 70 | 50 | 50 | 0 | 0 | 170 |
| Research Data at JCMB4 | Grow | 0 | 0 | 0 | 0 | 0 | 0 |
| Apps to user devices | T/form | 211 | 49 | 0 | 0 | 0 | 260 |
| Desktop virtualisation | T/form | 52 | 13 | 0 | 0 | 0 | 65 |
| Private cloud provisioning | T/form | 100 | 100 | 0 | 0 | 0 | 200 |
| Data science services | T/form | 300 | 300 | 450 | 450 | 450 | 1,950 |
| Telephony: Soft Phones5 | T/form | 0 | 0 | 0 | 0 | 0 | 0 |
| Unified communications | T/form | 0 | 0 | 0 | 1,000 | 1,000 | 2,000 |
| Increase Wi-Fi density | T/form | 30 | 30 | 30 | 30 | 30 | 150 |
|  External wireless | T/form | 280 | 280 | 280 | 280 | 280 | 1,400 |
| **Total Project expenditure** |  | **4,213** | **5,987** | **4,130** | **4,065** | **2,850** | **21,245** |

**Notes**

1. We have included in the projects the Run activity identified in the previous version of the roadmap. These are equipment costs that are driven by our replacement cycles and are needed to maintain our current infrastructure. The list of projects that make up these ‘projects’ are included in Appendix B
2. The edge network contains a significant element of technical debt which we intend to repay over the next 3 years.
3. We have not presented any project costs for extending the edge network as the size of the Estate grows. This is because to date the funding for networking in new build or refurbished space has been met by the building projects.
4. The research data at JCMB will be externally funded and so requires no investment from the University.
5. Costs for ‘Soft Phones’ have not been included because the license costs will be included in the procurement of a new digital phone system and any changes to our operational costs will be at the margin

## Appendix A – Project Data Sheets

The costing methodology and assumptions are given in Appendix C and the description of the Strategy Themes used to link projects to the University Strategy are shown in Appendix D

#### Project: Rolling refresh of edge network, including technical debt (Run)

**Infrastructure Category: Network**

This *Run* project will refresh the obsolete network edge switches which comprise the majority of the distributed network. This project is presented as there is an operational cost, for additional project management staff to manage the increased rate of change in the edge network.

|  |  |
| --- | --- |
| **Strategic Goals** |  |
| **Strategic Enablers** | *Infrastructure*: Infrastructure Power and Resilience |
| **Strategic Themes** |  |

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Edge Network, Technical Debt****Project Expenditure** |  | **2015/16****(£000)** |  | **2016/17****(£000)** |  | **2017/18****(£000)** |  | **2018/19 (£000)** |  | **2019/20 (£000)** |
| Capital project expenditure |  | 760 |  | 760 |  | 760 |  | 150 |  | 150 |
| Revenue project expenditure |  | 0 |  | 0 |  | 0 |  | 0 |  | 0 |
| **Total project expenditure** |  | **760** |  | **760** |  | **760** |  | **150** |  | **150** |
| **Operational Opportunity Costs of Project** |  | **2015/16****(£000)** |  | **2016/17****(£000)** |  | **2017/18****(£000)** |  | **2018/19 (£000)** |  | **2019/20 (£000)** |
| Staff Costs (IS) |  | 25 |  | 25 |  | 25 |  | 0 |  | 0 |
| Efficiencies – Maintenance (IS) |  | (36) |  | (72) |  | (108) |  | (108) |  | (108) |
| Depreciation Charge\* (Central) |  | 0 |  | 190 |  | 380 |  | 570 |  | 608 |

\*Remaining Dep’n Charge for period 2021/22 to 2023/24 is £832k

|  |  |
| --- | --- |
| **Cost Category** | **Confidence** |
| Project costs | High |
| Operational costs | Medium |

#### Project: Move telephony from analogue to VoIP (Run)

**Infrastructure Category: Network**

This project will ensure the University’s telephone system can continue to provide stable service the ageing analogue telephone network should be replaced. Approach will be to replace the current system with a like-for-like VoIP system to minimise cost, whilst providing a path to adoption of improved function. Requirement is for VoIP servers, handsets, appropriate software and provision of IP based external telephony links.

This project also includes the costs (primarily license costs) required to deliver the “Soft Phones” project.

Operational costs consist of 0.5 FTE staff from 15/16 to 17/18 to project manage the installation; staff savings rising to 1FTE in 18/19 and maintenance saving on the analogue phone system.

|  |  |
| --- | --- |
| **Strategic Goals** |  |
| **Strategic Enablers** | *Infrastructure*: Infrastructure Power and Resilience |
| **Strategic Themes** |  |

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Move Telephony from Analogue to VOIP****Project Expenditure** |  | **2015/16****(£000)** |  | **2016/17****(£000)** |  | **2017/18****(£000)** |  | **2018/19 (£000)** |  | **2019/20 (£000)** |
| Capital project expenditure |  | 700 |  | 1,000 |  | 300 |  | 0 |  | 0 |
| Revenue project expenditure |  | 0 |  | 0 |  | 0 |  | 0 |  | 0 |
| **Total project expenditure** |  | **700** |  | **1,000** |  | **300** |  | **0** |  | **0** |
| **Operational Opportunity Costs of Project** |  | **2015/16****(£000)** |  | **2016/17****(£000)** |  | **2017/18****(£000)** |  | **2018/19 (£000)** |  | **2019/20 (£000)** |
| Non recurrent staff costs (IS) |  | 25 |  | 25 |  | 13 |  | 0 |  | 0 |
| Efficiencies – staff costs (IS) |  | 0 |  | 0 |  | (50) |  | (50) |  | (50) |
| Efficiencies – maintenance (IS) |  | (10) |  | (30) |  | (40) |  | (40) |  | (40) |
| Depreciation Charge\* (Central) |  | 0 |  | 175 |  | 425 |  | 500 |  | 500 |

\* Remaining Dep’n Charge for the period 2021/22 to 2022/23 is £400k

|  |  |
| --- | --- |
| **Cost Category** | **Confidence** |
| Project costs | High |
| Operational costs | High |

#### Project: Enterprise server and storage – capacity (Grow)

**Infrastructure Category: Hardware**

The University's enterprise applications deliver a wide range of business functions: from corporate services such as HR and finance; IT functions such as Identity Management and Web Portals; and Online teaching and learning such as Virtual Learning Environments. This investment will deliver the capacity growth to deliver new enterprise services, and in particular the growth of on-premises infrastructure to support on-line learning and teaching.

The portfolio of enterprise services is growing – we are running approximately £3m of business change IT projects every year. At the same time the demand for those services to be highly available 24\*7 is growing eg DEI students are expected to grow from circa 2,000 to 10,000 and are distributed through all time zones. Meeting these increases in usage and service availability requires faster growth in our server and storage capacity than will be met from increases in technical capability per £.

|  |  |
| --- | --- |
| **Strategic Goals** | *Excellence In Education*: Distance Education Provision ; New Technologies in Education |
| **Strategic Enablers** | *Infrastructure*: Infrastructure Power and Resilience |
| **Strategic Themes** |  |

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Enterprise and Server Storage****Project Expenditure** |  | **2015/16****(£000)** |  | **2016/17****(£000)** |  | **2017/18****(£000)** |  | **2018/19 (£000)** |  | **2019/20 (£000)** |
| Capital project expenditure |  | 70 |  | 85 |  | 35 |  | 100 |  | 130 |
| Revenue project expenditure |  | 0 |  | 0 |  | 0 |  | 0 |  | 0 |
| **Total project expenditure** |  | **70** |  | **85** |  | **35** |  | **100** |  | **130** |
| **Operational Opportunity Costs of Project** |  | **2015/16****(£000)** |  | **2016/17****(£000)** |  | **2017/18****(£000)** |  | **2018/19 (£000)** |  | **2019/20 (£000)** |
| Maintenance Costs (IS) |  | 15 |  | 15 |  | 15 |  | 15 |  | 15 |
| Efficiencies  |  | 0 |  | 0 |  | 0 |  | 0 |  | 0 |
| Depreciation Charge\* (Central) |  | 0 |  | 17 |  | 39 |  | 48 |  | 72 |

Remaining Dep’n Charge for the period 2021/22 to 2022/23 is £244k

|  |  |
| --- | --- |
| **Cost Category** | **Confidence** |
| Project costs | Medium |
| Operational costs | Medium |

#### Project: Additional file storage (Grow)

**Infrastructure Category: Hardware**

We expect the uptake and population of the current free at point of use 0.5TB allocation to researchers to increase, which will require additional storage to honour this allocation. Alongside this growth, individual researcher demands on storage are also expected to increase which may warrant an increase in the per user allocation. The provision of free at point of use services promotes de-duplication and delivers institutional efficiency

Expansion of file-storage to meet increased data needs of research. In many areas the year on year increase in capacity and performance units per pound allows for the growth in requirements to be met by a flat or reduced spend over time. We currently predict that the requirements for research storage will outstrip the capacity increase which flat spend would deliver. This investment will increase the free at point of use storage capacity available to researchers. Investment would be guided by capacity planning.

|  |  |
| --- | --- |
| **Strategic Goals** | *Excellence In Research*: Support for Pioneering Research *;* Efficiency in Research Support |
| **Strategic Enablers** | *Infrastructure*: Infrastructure Power and Resilience |
| **Strategic Themes** |  |

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Additional File Storage****Project Expenditure** |  | **2015/16****(£000)** |  | **2016/17****(£000)** |  | **2017/18****(£000)** |  | **2018/19 (£000)** |  | **2019/20 (£000)** |
| Capital project expenditure |  | 0 |  | 400 |  | 0 |  | 1,000 |  | 0 |
| Revenue project expenditure |  | 0 |  | 0 |  | 0 |  | 0 |  | 0 |
| **Total project expenditure** |  | **0** |  | **400** |  | **0** |  | **1,000** |  | **0** |
| **Operational Opportunity Costs of Project** |  | **2015/16****(£000)** |  | **2016/17****(£000)** |  | **2017/18****(£000)** |  | **2018/19 (£000)** |  | **2019/20 (£000)** |
| Costs  |  | 0 |  | 0 |  | 0 |  | 0 |  | 0 |
| Efficiencies |  | 0 |  | 0 |  | 0 |  | 0 |  | 0 |
| Depreciation Charge\* (Central) |  | 0 |  | 0 |  | 100 |  | 100 |  | 350 |

\* Remaining Dep’n Charge for the period 2021/22 to 2022/23 is £850k

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| **Cost Category** | **Confidence** |
| Project costs | Medium |
| Operational costs | High |

#### Project: Resilient application file-store (Grow)

**Infrastructure Category: Hardware**

There is growth of the number and an increase in importance of enterprise applications where as well as transactional data held in databases there are documents or files associated with a transaction e.g. on-line applicants supporting documentation, invoices scanned into the finance system, web pages in the University web site. To achieve the levels of availability we expect to deliver for these applications we need to make the file system the documents are stored on resilient. At present the file systems present a single point of failure. Requires investment into the enterprise application storage infrastructure.

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| **Strategic Goals** |  |
| **Strategic Enablers** | *Infrastructure:* Infrastructure Power and Resilience |
| **Strategic Themes** |  |

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| **Resilient application file-store****Project Expenditure** |  | **2015/16****(£000)** |  | **2016/17****(£000)** |  | **2017/18****(£000)** |  | **2018/19 (£000)** |  | **2019/20 (£000)** |
| Capital project expenditure |  | 115 |  | 0 |  | 0 |  | 0 |  | 0 |
| Revenue project expenditure |  | 0 |  | 0 |  | 0 |  | 0 |  | 0 |
| **Total project expenditure** |  | **115** |  | **0** |  | **0** |  | **0** |  | **0** |
| **Operational Opportunity Costs of Project** |  | **2015/16****(£000)** |  | **2016/17****(£000)** |  | **2017/18****(£000)** |  | **2018/19 (£000)** |  | **2019/20 (£000)** |
| Recurrent staff costs (IS) |  | 10 |  | 10 |  | 10 |  | 10 |  | 10 |
| Efficiencies  |  | 0 |  | 0 |  | 0 |  | 0 |  | 0 |
| Depreciation Charge\* (Central) |  | 0 |  | 28 |  | 29 |  | 29 |  | 29 |

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| **Cost Category** | **Confidence** |
| Project costs | Medium |
| Operational costs | High |

#### Project: Infrastructure Monitoring (Grow)

**Infrastructure Category: Hardware**

The number and complexity of service and infrastructure components is increasing, and the ability to manually collate this information is problematic, especially during service events. This project will improve infrastructure and service monitoring and will provide support for “self-healing” services. Infrastructure and service monitoring currently use a large number of disparate tools to gather information, which means analysis of failures is difficult. An IS project is currently underway to investigate if an aggregation layer can capture existing information to provide a single monitoring dashboard. If this is not possible, this project would deliver an integrated environment. Requirement will be for specialist software and appropriate infrastructure.

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| **Strategic Goals** |  |
| **Strategic Enablers** | *Infrastructure*: Infrastructure Power and Resilience |
| **Strategic Themes** |  |

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| **Infrastructure Monitoring****Project Expenditure** |  | **2015/16****(£000)** |  | **2016/17****(£000)** |  | **2017/18****(£000)** |  | **2018/19 (£000)** |  | **2019/20 (£000)** |
| Capital project expenditure |  | 0 |  | 0 |  | 0 |  | 0 |  | 0 |
| Revenue project expenditure |  | 0 |  | 160 |  | 160 |  | 0 |  | 0 |
| **Total project expenditure** |  | **0** |  | **160** |  | **160** |  | **0** |  | **0** |
| **Operational Opportunity Costs of Project** |  | **2015/16****(£000)** |  | **2016/17****(£000)** |  | **2017/18****(£000)** |  | **2018/19 (£000)** |  | **2019/20 (£000)** |
| Recurrent staff costs (IS) |  | 0 |  | 100 |  | 100 |  | 100 |  | 100 |
| Maintenance costs (IS) |  | 0 |  | 40 |  | 40 |  | 40 |  | 40 |
| Efficiencies  |  | 0 |  | 0 |  | 0 |  | 0 |  | 0 |
| Depreciation Charge |  | 0 |  | 0 |  | 0 |  | 0 |  | 0 |

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| **Cost Category** | **Confidence** |
| Project costs | Medium |
| Operational costs | Medium |

#### Project: Extend core network (Grow)

**Infrastructure Category: Network**

This project will provide full network resilience to major campuses. Little France/Bio-Quarter and Western General campuses do not have full network protection, as the fibres which connect these sites to the core network run via single ducts. As the importance of these sites has risen and all aspects of the business have become more digitally dependent, the cost of disruption caused by campus disconnection is no longer an acceptable. Provision of campus network redundancy also removes a barrier to adoption of central services and so promotes de-duplication which delivers institutional efficiency.

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| **Strategic Goals** | *Excellence In Research*:Efficiency in Research Support |
| **Strategic Enablers** | *Infrastructure*: Infrastructure Power and Resilience |
| **Strategic Themes** |  |

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| **Extend Core Network****Project Expenditure** |  | **2015/16****(£000)** |  | **2016/17****(£000)** |  | **2017/18****(£000)** |  | **2018/19 (£000)** |  | **2019/20 (£000)** |
| Capital project expenditure |  | 650 |  | 750 |  | 0 |  | 0 |  | 0 |
| Revenue project expenditure |  | 0 |  | 0 |  | 0 |  | 0 |  | 0 |
| **Total project expenditure** |  | **650** |  | **750** |  | **0** |  | **0** |  | **0** |
| **Operational Opportunity Costs of Project** |  | **2015/16****(£000)** |  | **2016/17****(£000)** |  | **2017/18****(£000)** |  | **2018/19 (£000)** |  | **2019/20 (£000)** |
| Costs |  | 0 |  | 0 |  | 0 |  | 0 |  | 0 |
| Efficiencies |  | 0 |  | 0 |  | 0 |  | 0 |  | 0 |
| Depreciation Charge\* (Central) |  | 0 |  | 162 |  | 350 |  | 350 |  | 350 |

\* Remaining Dep’n Charge for the year 2021/22 is £188k

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| **Cost Category** | **Confidence** |
| Project costs | High |
| Operational costs | High |

#### Project: Edge Network Capacity Upgrades (Grow)

**Infrastructure Category: Network**

Improve bandwidth and resilience to campus buildings to support the increase in campus network traffic due to centralisation of research data and services and increase use of VoIP and video for online teaching. Limited network capacity will encourage duplication via local infrastructure, inhibit a rich digital learning experience and will be a barrier to adoption of new technologies.

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| **Strategic Goals** | *Excellence In Research*: Support for Pioneering Research; Efficiency in Research Support*Excellence in Education:* New Technologies in Education |
| **Strategic Enablers** | *Infrastructure*: Infrastructure Power and Resilience; Responding to Future Technologies |
| **Strategic Themes** |  |

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| **Edge Network Capacity****Project Expenditure** |  | **2015/16****(£000)** |  | **2016/17****(£000)** |  | **2017/18****(£000)** |  | **2018/19 (£000)** |  | **2019/20 (£000)** |
| Capital project expenditure |  | 75 |  | 75 |  | 75 |  | 0 |  | 0 |
| Revenue project expenditure |  | 0 |  | 0 |  | 0 |  | 0 |  | 0 |
| **Total project expenditure** |  | **75** |  | **75** |  | **75** |  | **0** |  | **0** |
| **Operational Opportunity Costs of Project** |  | **2015/16****(£000)** |  | **2016/17****(£000)** |  | **2017/18****(£000)** |  | **2018/19 (£000)** |  | **2019/20 (£000)** |
| Maintenance Costs (IS) |  | 2 |  | 4 |  | 5 |  | 5 |  | 5 |
| Efficiencies |  | 0 |  | 0 |  | 0 |  | 0 |  | 0 |
| Depreciation Charge\* (Central) |  | 0 |  | 19 |  | 38 |  | 56 |  | 56 |

\* Remaining Dep’n Charge for the period 2021/22 to 2022/23 is £56k

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| **Cost Category** | **Confidence** |
| Project costs | Medium |
| Operational costs | High |

#### Project: WiFi coverage (Grow)

**Infrastructure Category: Network**

We have wireless coverage of approximately 80% across the estate. Our target is 95% plus i.e. near 100%. This will ensure that we meet student and staff expectations of being able to work and learn anywhere on campus using their own devices. This could be seen as technical deficit but we think it clearer in this case to separate the activity from the Run costs.

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| **Strategic Goals** |  |
| **Strategic Enablers** | *Infrastructure*: Infrastructure Power and Resilience |
| **Strategic Themes** | Outstanding Student Experience |

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| **Wifi Coverage****Project Expenditure** |  | **2015/16****(£000)** |  | **2016/17****(£000)** |  | **2017/18****(£000)** |  | **2018/19 (£000)** |  | **2019/20 (£000)** |
| Capital project expenditure |  | 74 |  | 74 |  | 74 |  | 0 |  | 0 |
| Revenue project expenditure |  | 6 |  | 6 |  | 6 |  | 0 |  | 0 |
| **Total project expenditure** |  | **80** |  | **80** |  | **80** |  | **0** |  | **0** |
| **Operational Opportunity Costs of Project** |  | **2015/16****(£000)** |  | **2016/17****(£000)** |  | **2017/18****(£000)** |  | **2018/19 (£000)** |  | **2019/20 (£000)** |
| Efficiencies |  | 0 |  | 0 |  | 0 |  | 0 |  | 0 |
| Depreciation Charge\* (Central) |  | 0 |  | 18 |  | 37 |  | 55 |  | 55 |

\* Remaining Dep’n Charge for the period 2021/22 to 2022/23 is £55k

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| **Cost Category** | **Confidence** |
| Project costs | High |
| Operational costs | High |

#### Project: Growth in edge capacity to match estate growth (Grow)

**Infrastructure Category: Network**

The edge network wired and wireless will grow in direct proportion to the size of our estate. The capital costs involved in this expansion are expected to be met as part of the building programme, but it is important to recognise this requires IS to find the operating costs of the projects and the increased running costs in the long term.

The scale of expansion and rate of change within the network as a consequence of the estates expansion will determine the profile of the capital and operational costs over the next five years and beyond. In estimating the additional operational effort required to service the expanded estate, we have assumed 30% growth over five years.

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| **Strategic Goals** |  |
| **Strategic Enablers** | *Infrastructure*: Infrastructure Power and Resilience |
| **Strategic Themes** |  |

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| **Edge Network, Technical Debt****Project Expenditure** |  | **2015/16****(£000)** |  | **2016/17****(£000)** |  | **2017/18****(£000)** |  | **2018/19 (£000)** |  | **2019/20 (£000)** |
| Capital project expenditure |  | 0 |  | 0 |  | 0 |  | 0 |  | 0 |
| Revenue project expenditure |  | 0 |  | 0 |  | 0 |  | 0 |  | 0 |
| **Total project expenditure** |  | **0** |  | **0** |  | **0** |  | **0** |  | **0** |
| **Operational Opportunity Costs of Project** |  | **2015/16****(£000)** |  | **2016/17****(£000)** |  | **2017/18****(£000)** |  | **2018/19 (£000)** |  | **2019/20 (£000)** |
| Staff Costs (IS) |  | 25 |  | 25 |  | 50 |  | 75 |  | 100 |
| Efficiencies  |  | 0 |  | 0 |  | 0 |  | 0 |  | 0 |
| Depreciation Charge\* (Central) |  | 0 |  | 0 |  | 0 |  | 0 |  | 0 |

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| **Cost Category** | **Confidence** |
| Project costs | High |
| Operational costs | Medium |

***Project: Strengthen Network Security (Grow)***

**Infrastructure Category: Network**

Due to the increase in importance of the digital services to all aspects of the University’s business and the increase in the number and sophistication of security attacks, we require to improve the service and data security by introducing additional network controls, such as Intrusion Detection and Prevention services. As threat levels rise so the risk of business disruption and or loss of reputation increase, failure to invest appropriately could be very damaging.

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| **Strategic Goals** |  |
| **Strategic Enablers** | *Infrastructure*: Infrastructure Power and Resilience |
| **Strategic Themes** |  |

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| **Strengthen Network Security****Project Expenditure** |  | **2015/16****(£000)** |  | **2016/17****(£000)** |  | **2017/18****(£000)** |  | **2018/19 (£000)** |  | **2019/20 (£000)** |
| Capital project expenditure |  | 0 |  | 200 |  | 400 |  | 0 |  | 0 |
| Revenue project expenditure |  | 0 |  | 0 |  | 0 |  | 0 |  | 0 |
| **Total project expenditure** |  | **0** |  | **200** |  | **400** |  | **0** |  | **0** |
| **Operational Costs of Project** |  | **2015/16****(£000)** |  | **2016/17****(£000)** |  | **2017/18****(£000)** |  | **2018/19 (£000)** |  | **2019/20 (£000)** |
| Efficiencies |  | 0 |  | 0 |  | 0 |  | 0 |  | 0 |
| Depreciation Charge\* (Central) |  | 0 |  | 0 |  | 50 |  | 150 |  | 150 |

\* Remaining dep’n charge for the period 2020/21 to 2021/22 is £250k

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| **Cost Category** | **Confidence** |
| Project costs | Low |
| Operational costs | Medium |

#### Project: Data-centre networking resilience (Grow)

**Infrastructure Category: Network**

The demand for resilient services that do not have single points of failure is steadily increasing. We need to adopt new approaches to deliver the desired levels of service.

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| **Strategic Goals** |  |
| **Strategic Enablers** | *Infrastructure*: Infrastructure Power and Resilience |
| **Strategic Themes** |  |

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| **Data-centre networking resilience****Project Expenditure** |  | **2015/16****(£000)** |  | **2016/17****(£000)** |  | **2017/18****(£000)** |  | **2018/19 (£000)** |  | **2019/20 (£000)** |
| Capital project expenditure |  | 70 |  | 50 |  | 50 |  | 0 |  | 0 |
| Revenue project expenditure |  | 0 |  | 0 |  | 0 |  | 0 |  | 0 |
| **Total project expenditure** |  | **70** |  | **50** |  | **50** |  | **0** |  | **0** |
| **Operational Costs of Project** |  | **2015/16****(£000)** |  | **2016/17****(£000)** |  | **2017/18****(£000)** |  | **2018/19 (£000)** |  | **2019/20 (£000)** |
| Additional costs |  | 0 |  | 0 |  | 0 |  | 0 |  | 0 |
| Efficiencies identified |  | 0 |  | 0 |  | 0 |  | 0 |  | 0 |
| Depreciation Charge\* (Central) |  | 0 |  | 17 |  | 29 |  | 43 |  | 43 |

\* Remaining dep’n charge for the period 2021/22 to 2022/23 is £38k

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| **Cost Category** | **Confidence** |
| Project costs | High |
| Operational costs | High |

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|  | Project: Research Data at JCMB (Grow)**Infrastructure Category: Data Centre**Data centre modification to support the national Research Data Facility (RDF) funded by EPSRC. Requirement is for an offsite copy of data currently held at the ACF at Easter Bush to be housed at Kings Buildings for disaster recovery purposes. The University will leverage this investment via “Director’s Time” which provides 5% of RDF capacity for institutional use.This capital and operational costs of this work will be funded by EPSRC, and as such no costs are presented. |
| **Strategic Goals** | *Excellence In Research*: Support for Pioneering Research; Efficiency in Research Support |
| **Strategic Enablers** | *Infrastructure*: Infrastructure Power and Resilience |
| **Strategic Themes** |  |

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| **Cost Category** | **Confidence** |
| Project costs | High |
| Operational costs | High |

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|  | Project: Apps to user devices (Transform)**Infrastructure Category: Open Access**Delivery of applications to user devices via ‘browser’ mechanisms. This will free the user from location and device to access specialist software and is an essential component for DEI where students cannot use on premises services. The increased flexibility will enable new methods of managing our desktop infrastructure and will so reduce reliance on Open Access desktops and local PC labs giving us economies of scale and improved user experience. Requires server farms and licensing, with medium term benefit of reducing costs on desktop PCs. This project has been costed to provide 500 simultaneous users access to the service, with an expected concurrency of 10:1 (ie for every 10 users who have access to the service, only one would be accessing the service at any given time). This would support a user population of 5,000. |
| **Strategic Goals** | *Excellence in Education:* Distance Education Provision; New Technologies in Education |
| **Strategic Enablers** | *Finance:* Financial efficiency |
| **Strategic Themes** | Outstanding Student Experience |

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| **Apps to User Devices****Project Expenditure** |  | **2015/16****(£000)** |  | **2016/17****(£000)** |  | **2017/18****(£000)** |  | **2018/19 (£000)** |  | **2019/20 (£000)** |
| Capital project expenditure |  | 173 |  | 0 |  | 0 |  | 0 |  | 0 |
| Revenue project expenditure |  | 38 |  | 49 |  | 0 |  | 0 |  | 0 |
| **Total project expenditure** |  | **211** |  | **49** |  | **0** |  | **0** |  | **0** |
| **Operational Opportunity Costs of Project** |  | **2015/16****(£000)** |  | **2016/17****(£000)** |  | **2017/18****(£000)** |  | **2018/19 (£000)** |  | **2019/20 (£000)** |
| Recurrent staffing costs (IS) |  | 40 |  | 40 |  | 40 |  | 40 |  | 40 |
| Maintenance costs (IS) |  | 8 |  | 15 |  | 25 |  | 25 |  | 25 |
| Efficiencies  |  | 0 |  | 0 |  | 0 |  | 0 |  | 0 |
| Depreciation Charge (Central) |  | 0 |  | 43 |  | 43 |  | 43 |  | 44 |

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| **Cost Category** | **Confidence** |
| Project costs | High |
| Operational costs | High |

#### Project: Desktop Virtualisation (Transform)

**Infrastructure Category: Open Access**

Delivery of virtualised desktops hosted in the data-centre to fixed user desktops. This will support research into sensitive data, which cannot be allowed to leave a controlled environment, such as non-anonymised patient data. An enabler to allow greater engagement with sensitive data whilst reducing risk of unauthorised disclosure. There may be a longer term benefit in deploying the technology more widely as a cost reduction method by replacing desktops with cheaper “thin client” devices which have reduced capital cost and use less energy. Any such wider deployment would require full analysis of cost benefits which is not included in the current thinking. Requires server infrastructure and appropriate software licensing. This project has been costed for a small deployment to meet a limited research use-case for sensitive access to medical data and for supporting a small number of medical placement students.

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| **Strategic Goals** | *Excellence In Research:* Support for Pioneering Research |
| **Strategic Enablers** | *Finance:* Financial efficiency |
| **Strategic Themes** | Social Responsibility (Green IT) |

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| **Desktop Virtualisation****Project Expenditure** |  | **2015/16****(£000)** |  | **2016/17****(£000)** |  | **2017/18****(£000)** |  | **2018/19 (£000)** |  | **2019/20 (£000)** |
| Capital project expenditure |  | 39 |  | 0 |  | 0 |  | 0 |  | 0 |
| Revenue project expenditure |  | 13 |  | 13 |  | 0 |  | 0 |  | 0 |
| **Total project expenditure** |  | **52** |  | **13** |  | **0** |  | **0** |  | **0** |
| **Operational Opportunity Costs of Project** |  | **2015/16****(£000)** |  | **2016/17****(£000)** |  | **2017/18****(£000)** |  | **2018/19 (£000)** |  | **2019/20 (£000)** |
| Recurrent staff costs (IS) |  | 10 |  | 10 |  | 10 |  | 10 |  | 10 |
| Maintenance costs (IS) |  | 1 |  | 3 |  | 6 |  | 6 |  | 6 |
| Efficiencies |  | 0 |  | 0 |  | 0 |  | 0 |  | 0 |
| Depreciation Charge (Central) |  | 0 |  | 9 |  | 10 |  | 10 |  | 10 |

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| **Cost Category** | **Confidence** |
| Project costs | Medium |
| Operational costs | Medium |

#### Project: Private Cloud Provisioning (Transform)

**Infrastructure Category: Hardware**

To provide and open and agile server infrastructure, through deployment of private cloud technologies that will allow users to self-provision the services they require. This will remove one of the barriers to users duplicating infrastructure and will provide long term benefits of cost reduction to the University. Investment will be appliances or software layer. This project will also deliver a free at point of use capacity to colleges to promote adoption of central provision.

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| **Strategic Goals** |  |
| **Strategic Enablers** | *Infrastructure:* Agile Infrastructure*Finance:* Financial efficiency |
| **Strategic Themes** | Social Responsibility (Green IT) |

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| **Private Cloud Provisioning****Project Expenditure** |  | **2015/16****(£000)** |  | **2016/17****(£000)** |  | **2017/18****(£000)** |  | **2018/19 (£000)** |  | **2019/20 (£000)** |
| Capital project expenditure |  | 100 |  | 100 |  | 0 |  | 0 |  | 0 |
| Revenue project expenditure |  | 0 |  | 0 |  | 0 |  | 0 |  | 0 |
| **Total project expenditure** |  | **100** |  | **100** |  | **0** |  | **0** |  | **0** |
| **Operational Opportunity Costs of Project** |  | **2015/16****(£000)** |  | **2016/17****(£000)** |  | **2017/18****(£000)** |  | **2018/19 (£000)** |  | **2019/20 (£000)** |
| Maintenance costs (IS) |  | 15 |  | 30 |  | 30 |  | 30 |  | 30 |
| Efficiencies |  | 0 |  | 0 |  | 0 |  | 0 |  | 0 |
| Depreciation Charge\* (Central) |  | 0 |  | 25 |  | 50 |  | 50 |  | 50 |

\* Remaining Dep’n Charge 2020/21 is £25k

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| **Cost Category** | **Confidence** |
| Project costs | Medium |
| Operational costs | Medium |

#### Project: Data Science Services (Transform)

**Infrastructure Category: Hardware**

To provide core infrastructure for flexible computational and data researcher services, in particular to address Data Science needs. Services would be provided free-at-point-of-use, catering to 90% of use-cases across all three colleges. The infrastructure would support extension by researcher investment for use-cases not catered for. This project would also support distance education initiatives in Data Science and on-line teaching of Data Analytics, and provide a platform to support external collaborations.

Further work is required to understand the services and platforms required by Data Science, and so these capital costs are very much initial estimates. As such, the operational software maintenance and infrastructure staffing costs are also hard to predict.

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| **Strategic Goals** | *Excellence In Research:* Support for Pioneering Research*Excellence in Education:* New Technologies in Education; Distance Education Provision |
| **Strategic Enablers** | *Infrastructure*: Infrastructure Power and Resilience; Responding to Future Technologies |
| **Strategic Themes** |  |

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| **Data Science Services****Project Expenditure** |  | **2015/16****(£000)** |  | **2016/17****(£000)** |  | **2017/18****(£000)** |  | **2018/19 (£000)** |  | **2019/20 (£000)** |
| Capital project expenditure |  | 300 |  | 300 |  | 450 |  | 450 |  | 450 |
| Revenue project expenditure |  | 0 |  | 0 |  | 0 |  | 0 |  | 0 |
| **Total project expenditure** |  | **300** |  | **300** |  | **450** |  | **450** |  | **450** |
| **Operational Opportunity Costs of Project** |  | **2015/16****(£000)** |  | **2016/17****(£000)** |  | **2017/18****(£000)** |  | **2018/19 (£000)** |  | **2019/20 (£000)** |
| Recurrent staff costs (IS) |  | 100 |  | 100 |  | 100 |  | 100 |  | 100 |
| Efficiencies |  | 0 |  | 0 |  | 0 |  | 0 |  | 0 |
| Depreciation Charge\* (Central) |  | 0 |  | 75 |  | 150 |  | 262 |  | 262 |

\* Remaining Dep’n Charge for the period 2021/22 to 2023/24 is £1.2m

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| **Cost Category** | **Confidence** |
| Project costs | Low |
| Operational costs | Low |

#### Project: Soft Phones (Transform)

**Infrastructure Category: Network**

Linked to the transition to VoIP infrastructure, provide better integration of personal devices with the University’s phone system, such as provision of “soft-phone” apps for mobiles which allow incoming and outgoing calls to be routed via the University’s phone system. Over time, this will reduce the need for fixed desktop phones equipment and improve service for staff who work in multiple locations.

The capital costs for this project are included in the previous analogue to VoIP project where it is expected that licenses for soft phones will be included or offset against a reduced need for physical handsets. Operational cost impact is low as the majority of the activity will be through self service by the end users. Our help and support organisation, User Services Division, expect to meet any increase in demand for support from existing resources.

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| **Strategic Goals** |  |
| **Strategic Enablers** | *People:* Promoting flexible and interdisciplinary working |
| **Strategic Themes** |  |

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| **Cost Category** | **Confidence** |
| Project costs | High |
| Operational costs | High |

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#### Project: Unified communications (Transform)

**Infrastructure Category: Network**

Provide integration of telephony with on-line communications technologies, integrating video, voice and instant messaging. We believe that demand for this kind of service will grow as staff and students experience using these services in other settings and become more comfortable with the benefits of improved collaboration that can be achieved with multi modal integrated communications.

Capital costs are for data-centre infrastructure and licenses.

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| **Strategic Goals** |  |
| **Strategic Enablers** | *Infrastructure:* Responding to Future Technologies*People*: Promoting Flexible and interdisciplinary working |
| **Strategic Themes** |  |

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| **Unified Communications****Project Expenditure** |  | **2015/16****(£000)** |  | **2016/17****(£000)** |  | **2017/18****(£000)** |  | **2018/19 (£000)** |  | **2019/20 (£000)** |
| Capital project expenditure |  | 0 |  | 0 |  | 0 |  | 1,000 |  | 1,000 |
| Revenue project expenditure |  | 0 |  | 0 |  | 0 |  | 0 |  | 0 |
| **Total project expenditure** |  | **0** |  | **0** |  | **0** |  | **1,000** |  | **1,000** |
| **Operational Costs of Project** |  | **2015/16****(£000)** |  | **2016/17****(£000)** |  | **2017/18****(£000)** |  | **2018/19 (£000)** |  | **2019/20 (£000)** |
| Recurrent staffing costs (IS) |  | 0 |  | 0 |  | 0 |  | 50 |  | 50 |
| Efficiencies |  | 0 |  | 0 |  | 0 |  | 0 |  | 0 |
| Depreciation Charge\* (Central) |  | 0 |  | 0 |  | 0 |  | 0 |  | 250 |

\* Remaining dep’n charge for the period 2021/22 to 2023/24 is £1.75m

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| **Cost Category** | **Confidence** |
| Project costs | Low |
| Operational costs | Low |

#### Project: Increase Wifi density to meet hotspot needs (Transform)

**Infrastructure Category: Network**

Enable mass usage in settings like lecture theatres and library study space. We expect students to use their own mobile devices for tasks like viewing content, voting in lectures (replace clickers), tweeting their impressions, as well as checking information and the backchat between themselves. This project will provide the infrastructure in specific areas to support these use case.

Capital costs are for

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| **Strategic Goals** | *Excellence in Education:* New Technologies in Education |
| **Strategic Enablers** | *Infrastructure*: : Infrastructure Power and Resilience |
| **Strategic Themes** | Outstanding Student Experience |

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| **Increase Wifi density****Project Expenditure** |  | **2015/16****(£000)** |  | **2016/17****(£000)** |  | **2017/18****(£000)** |  | **2018/19 (£000)** |  | **2019/20 (£000)** |
| Capital project expenditure |  | 30 |  | 30 |  | 30 |  | 30 |  | 30 |
| Revenue project expenditure |  | 0 |  | 0 |  | 0 |  | 0 |  | 0 |
| **Total project expenditure** |  | **30** |  | **30** |  | **30** |  | **30** |  | **30** |
| **Operational Costs of Project** |  | **2015/16****(£000)** |  | **2016/17****(£000)** |  | **2017/18****(£000)** |  | **2018/19 (£000)** |  | **2019/20 (£000)** |
| Non recurrent staff costs (IS) |  | 10 |  | 10 |  | 10 |  | 10 |  | 0 |
| Efficiencies identified |  | 0 |  | 0 |  | 0 |  | 0 |  | 0 |
| Depreciation Charge\* (Central) |  | 0 |  | 8 |  | 15 |  | 22 |  | 30 |

\* Remaining dep’n charge for the period 2021/22 to 2023/24 is £75k

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| **Cost Category** | **Confidence** |
| Project costs | High |
| Operational costs | Medium |

#### Project: External Wireless (Transform)

**Infrastructure Category: Network**

To provide wireless, eduroam, in outside space on campus and in the local area, café bars, etc. Driven particularly by student experience and expectation that they should be able to use wireless at all times. This may be a project that is overtaken by delivery of high speed data to mobile devices (4G), it is recommended that the requirement is reviewed over time.

Capital is for contractor effort to install external wireless and for wireless infrastructure.

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| **Strategic Goals** |  |
| **Strategic Enablers** |  |
| **Strategic Themes** | Outstanding Student Experience |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **External Wireless****Project Expenditure** |  | **2015/16****(£000)** |  | **2016/17****(£000)** |  | **2017/18****(£000)** |  | **2018/19 (£000)** |  | **2019/20 (£000)** |
| Capital project expenditure |  | 280 |  | 280 |  | 280 |  | 280 |  | 280 |
| Revenue project expenditure |  | 0 |  | 0 |  | 0 |  | 0 |  | 0 |
| **Total project expenditure** |  | **280** |  | **280** |  | **280** |  | **280** |  | **280** |
| **Operational Costs of Project** |  | **2015/16****(£000)** |  | **2016/17****(£000)** |  | **2017/18****(£000)** |  | **2018/19 (£000)** |  | **2019/20 (£000)** |
| Efficiencies |  | 0 |  | 0 |  | 0 |  | 0 |  | 0 |
| Depreciation Charge\* (Central) |  | 0 |  | 70 |  | 140 |  | 210 |  | 280 |

\* Remaining dep’n charge for the period 2021/22 to 2023/24 is £700k

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| **Cost Category** | **Confidence** |
| Project costs | Medium |
| Operational costs | Medium |

**Appendix B – Run Projects**

At the second meeting of the Review Group a set of activities comprising of the capital cost of a series of run activities was presented. These activities could be presented in the same way as the project data sheets in Appendix A. However when we reviewed the projects we identified that with the exception of the “Rolling refresh of edge network, including technical debt” project none of the projects had impact on our operational costs, they are all things that we would expect to do from within our operational budget apart from funding the cost of the equipment. As a consequence the projects are presented in the same tabular form as at the previous meeting with the one exception “Rolling refresh of edge network, including technical debt” where we have prepared a data sheet which is included in Appendix A.

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| --- | --- | --- | --- | --- | --- | --- |
| **Infrastructure Domain** | **Project** | **15/16****(£000)** | **16/17****(£000)** | **17/18****(£000)** | **18/19****(£000)** | **19/20****(£000)** |
|
| **Data Centres** | UPS battery replacement |  15 |   | 15 |   |   |
| Total | 15 | 0 | 15 | 0 | 0 |
| **Network** | Rolling refresh of core network routers | 50 | 50 | 50 | 50 | 50 |
| Rolling refresh of wireless edge network | 185 | 185 | 185 | 185 | 140 |
| Wireless controller replacement |   |   |   | 200 |   |
| Virtual Private Network replacement |   |   | 40 |   |   |
| Total | 235 | 235 | 275 | 435 | 190 |
| **Hardware** | Rolling refresh of enterprise server infrastructure | 160 | 160 | 160 | 160 | 160 |
| Database appliance refresh | 80 | 80 | 80 | 80 | 80 |
| Application storage environment refresh |   | 800 | 200 | 200 |   |
| Application Switching replacement |   | 150 |   |   |   |
| Door and Alarm appliance replacement | 50 | 50 |   |   |   |
| File-storage refresh |   |   | 600 |   |   |
| Total | 290 | 1,240 | 1,040 | 440 | 240 |
| **Open Access** | Rolling refresh of open access computers | 180 | 180 | 180 | 180 | 180 |
| Total | 180 | 180 | 180 | 180 | 180 |

## Appendix C - Costing Methodology and Assumptions

We have consulted with the Finance department and our approach to costing is based on that advice.

Project costs have been calculated and split between capital and revenue costs of undertaking the project to completion. Where possible, maintenance costs have been treated as revenue however some suppliers do not itemise this cost separately from their hardware products.

Changes in operational costs and savings have been included where there is a change to the normal level of expenditure as a result of the projects. This is referred to as the opportunity cost. Where opportunity costs and savings have been identified, these have been attributed to the relevant University budget areas.

In accordance with University capital policy, equipment has been depreciated over four years rather than the useful economic life of the asset.

Operational costs are initial estimates and are provided as initial indications of level of spend. A level of confidence is provided for capital and operational costs, indicating the scale of variation in cost possible for the project.

## Appendix D - Strategy Themes

We have used the themes, objectives, strategies and goals from the University’s Strategic Plan 2012 – 2016 to demonstrate the business need for the proposed IT Infrastructure projects. These projects are a reaction to developments within the University’s business and will underpin strands of institutional activity in both education and research.

The strategic “tags” (in bold below) used to link projects to business need, are listed below with the relevant text from the Strategic Plan.

* **Outstanding Student Experience** : “Outstanding student experience” (S*trategic Theme)*
* **Social Responsibility (Green IT)** : “Social responsibility” *(Strategic Theme)*
* **Distance Education Provision** : “expanding and enhancing our distance education provision" (*Excellence in Education Strategic Goal*)
* **New Technologies in Education** : “enabling our staff to embrace new technologies as part of enhancing the learning experience, and to deliver prompt and effective feedback" (*Excellence in Education Strategic Goal*)
* **Efficiency in research support** *:* “driving forward sustainable use of equipment, and efficiency in other research costs” (*Excellence In Research Strategy)*
* **Support for Pioneering Research** *:* “pioneer new and emerging areas of research across the boundaries of traditional disciplines” *(Excellence In Research Strategic Objective)*
* **Promoting flexible and interdisciplinary working** *:*  "promoting flexible and interdisciplinary working" (*Strategic Enabler: People*)
* **Financial efficiency** : "keeping the balance between our recurrent and capital spend under review" (*Strategic* *Enabler: Finance*)
* **Agile Infrastructure** *:* “adapting our infrastructure to meet the changing needs, approaches and working patterns of our diverse population of staff and students and the wider community we serve to best support our world-class academic activity” (*Strategic Enabler: Infrastructure*)
* **Infrastructure Power and Resilience** : “putting in place information and communications technology with the power and resilience to provide easy access to resources, and to support individual and group study and working, both on-campus and mobile” (*Strategic Enabler: Infrastructure*)
* **Responding to Future Technologies** : “identifying future technological developments and positioning ourselves to rapidly and flexibly respond to these”(*Strategic Enabler: Infrastructure*)

## Appendix E – Infrastructure Domains

The following sections provide simple descriptions of the current arrangements for each infrastructure domain.

* **Desktop**

The desktop service comprises of two main components –

* the delivery of software – 3 operating systems, applications like browsers, Microsoft office, and specialist applications such as SPS for statistical analysis.
* The supply of hardware for open access areas for student use – this varies from machines in libraries through to specialist suites, currently about 1500 seats with over 95% of the systems running Windows.

The pcs and software licenses used by staff are purchased from their School or research group budgets so it is only the cost of the open access machines which have been considered in the roadmap.

* **Hardware**

This is our server and storage estate. We have divided the servers into 3 categories

* Research platforms, such as high through put and high performance machines. These are the platforms that researchers can use to perform analysis and visualisation tasks that are generally beyond the computational power of desktop machines.
* Virtual servers – our workhorse platform to run the enterprise applications. Our switch from physical machines to virtual machines is around 80% complete. We used to have about 150 physical servers, this has reduced to about 50 machines whilst at the same time the number of servers we need to run the enterprise has increased to around 600 virtual servers. So a 3 fold reduction in machinery and capital cost whilst accommodating a 4 fold increase in demand. We have largely reached the end of server virtualisation savings.
* Appliances – these are specialist servers where virtualisation is not feasible examples include access door management, VoIP telephone exchanges, Oracle database servers. The strategy is to minimise the need for appliances.

The server estate is divided over the three machine rooms so that we can provide disaster recovery at an appropriate service level for differing services.

Storage also has three categories:

* File storage – this is the biggest volume of data and is where working research data is stored, web pages, office documents, etc. Currently 1.6PB and expected to double every couple of years.
* Enterprise data storage – typically this is highly structured data held in databases used by transactional systems such as student records, virtual learning environments, MyEd, etc. Compared to file storage the volumes are small but the performance needed is much greater to both ensure application level performance and the necessary resilience to provide continuity in the event of a disaster. Storage volumes are 250TB
* Backup – we are consolidating to have a single backup service running across both file and enterprise data storage. Backup provides the ultimate disaster recovery platform.
* **Network and Telecommunications**

Our network design is constructed around the concept of the core and the edge. The core connects the main campuses with the internet and the edge distributes the data to and from the core network to the individual devices.

The core is constructed in a mesh topology such that a single break in the mesh does not compromise the delivery of service. We have 2 nodes in the core network –

* Kings Buildings - JCMB
* Central Area - Appleton Tower

Each of those nodes is connected by dual path fibre, ie the fibre is not all in the same trench. We are connected to the Internet from both nodes. Losing a connection or a node will not stop the core service.

Core network



The edge network is the wiring necessary to connect to the core network and to do the distribution within the buildings. The way this is done is dependent on a combination of factors, such as proximity of buildings, where we already have fibre in the ground, etc. The result is pragmatic with many important buildings eg Old College with more than one connection to the core and some buildings eg School of Divinity fed from others, in this case Old College. In general it is expected that failure of connections or edge equipment in a building will result in the loss of service to the building concerned and any other buildings that may be daisy chained from it.

With relatively recent changes in the way the University operates, both Little France and the Western General Hospital have grown in importance. Neither of these campuses have dual fibre path connections to the core network but it would appear sensible that this work is included in the roadmap so that they are not vulnerable to loss of service as a result of loss of a connection.

The wireless network is delivered as a part of the edge. The wireless access points are connected to the wired network through standard network ports. They are centrally managed and deliver the eduroam service as a single network identity. It is the expectation that we will have near 100% wireless coverage throughout the estate. Currently it is around 80%.

Traditionally network and telecommunications may have been seen as two separate domains, however with the advent of digital telephony the two have merged into a single domain with telephony delivered using the same network as data, analogue private branch telephone exchanges being replaced by server technology and specialist software. We are part way through the transition from analogue to digital telephony and have a significant challenge to accelerate the changeover before the analogue service becomes unsupportable.

The final aspect of the network and telecommunications domain is the security layer. We have a number of services within the layer – authentication and authorisation, virus and malware scanning, firewalls and external threat or penetration testing. This is an area where the University’s openness is in direct conflict with operating to the highest security levels. It is quite correct and necessary that students and staff should bring their own devices onto the University network so that the concept of a hard perimeter is inappropriate and unachievable. The consequence of this is that most spending to date in this area is on services and user education rather than technology. As a consequence there has been relatively little demand for capital spend beyond firewalls.

The network has been underinvested over the years so there is a significant technical deficit coming mainly through not replacing edge network equipment and not reflecting changes both in the estate and in the use of the network.

* **Data Centres**

We have 3 data centres, the Advanced Computing Facility at Easter Bush, in the James Clerk Maxwell Building at Kings Buildings and in Appleton Tower in the Central Area. This gives a good geographical spread with sufficient distance between centres for disaster recovery purposes. All three centres are modern, with well balanced power, cooling and space and good efficiency. The ACF was refurbished specifically to house national services and has been mainly funded from external grants. There is no expectation of any significant further capital spend on these facilities within the next 5 years unless there is a need for a new national research infrastructure at the ACF which should bring its own funding.

The difference in funding and management of the ACF to the other two sites has limited its usefulness to the University, eg all power costs are recovered at ACF, whereas they are not at JCMB/AT, making the ACF less attractive as a place to host non-national ie university equipment.

## Appendix F – Replacement Cycles

1. The average standard refresh cycle for infrastructure components is as follows:

|  |  |
| --- | --- |
| **Infrastructure Area** |  **Refresh Cycle** |
| Data-centre |  20 years |
| Core network | Core network routers = 7 years Inter-campus fibre links = 20 years (\*1) |
| Edge network  | Edge switches = 7 years Wireless Access Points = 7 years |
| Telephones | Core VOIP exchange = expected 10 yearsVOIP phone handset = 15 years |
| Servers |  5 years |
| Storage |  5 years |
| Open Access Lab desktops |  5 years |

\*1 The recommended refresh cycle for inter-campus fibre cabling is currently estimated at 20 years. However, the oldest fibre cabling installed by the University is over 20 years old and shows no sign of degradation. Fibre manufacturer testing suggests lifetime may well be 30+ years. We have taken the view that this is a truly unknown quantity – fibre optic cable simply hasn’t been around for long enough. It is our opinion that the best strategy is to wait and see, once there is evidence of fibres failing either from our own infrastructure, but more likely from other earlier adopters we should plan for replacement.

Where supplier maintenance support for an item extends beyond the expected refresh cycle and this poses no issue for infrastructure manageability, we may choose to extend its lifetime to reduce costs.

In certain areas, investment has not kept pace with the required refresh cycle, and the University has acquired a current *technical debt.* This has occurred mainly in the edge network where the cost of catchup is around £2,5m.

Additionally, the investment in the wireless network has been focused on increasing the wireless coverage in campus buildings and in installing wireless in the new-build estate. The investment in rolling refresh has not kept pace, and increased investment will be required leading up to 2018.

## Appendix G – Performance Metrics

| **Infrastructure Area** |  **Performance Metrics** | **Purpose** |
| --- | --- | --- |
| All live service infrastructure | All service infrastructure used for live services must be under maintenance contract. 95% of IT infrastructure in replacement cycle | These metrics ensure that the infrastructure can underpin the service availability targets, and will deliver the appropriate levels of capacity and performance. |
| Data-centre | PUE (< 1.5)  | This indicator is a measure of the effectiveness of energy use in the data centre. It is a quick way of understanding that power use is appropriate for the size of the infrastructure being used.  |
| Availability > 99.99% when measured over 5 years | The data-centres in which the core infrastructure is sited must achieve these levels of availability to deliver our overall service availability targets of less than 9 hrs down time pa as required by the business. |
| 20% headroom in physical, power and cooling capacity. | Predicting future capacity is uncertain so this is a margin that we need to retain so that once capacity reaches 80% full we have sufficient time to increase capacity or to remove redundant equipment such that we do not lose service. |
| Network and telecommunications : Core networkNetwork and telecommunications : Core network(CONTINUED) | Availability > 99.95% measured over 1 year | The core network is the key component which supports the institutions digital activity. This metric underpins our overall service availability targets and ensures a good user experience. |
| All major campuses with fully redundant connections | This metric guides the construction of campus networks to protect large numbers of staff and students from being disconnected from the University network and the Internet for extended periods of time.In event of damage to the cabling services to the campus will cease until the cable can be repaired – internet access, access to storage, enterprise applications, telephones, etc. Repairs may take several days. We have had an example of this recently when cables were damaged by digging as part of road works and we lost service to the Western General Hospital for about 24hrs |
| External JANET traffic < 75% link capacity (based on short and long term congestion and traffic levels ) | This aids the capacity planning of the University’s Internet connections, and guards against a poor user experience when accessing external digital services. Predicting future capacity is uncertain so this is a margin that we need to retain so that once capacity reaches 75% full we have sufficient time to increase capacity by ordering additional circuits. |
| Network and telecommunications: Edge network Network and telecommunications: Edge network (CONTINUED) | Local edge network achieving > 99.95% availability measured over 5 years | The edge network connects users to services and data – and this availability metric guides investment to deliver a good user experience . As the edge network is a distributed network it will only affect people directly connected to the affected equipment so the impact will be very uneven. |
| 95% plus wireless coverage of campus estate | Connectivity from mobile devices is now considered essential for many University staff, and is important to the student experience. Wireless coverage is currently approx. 80% of the estate and this metric guides the expansion necessary to deliver a digitally enabled University. |
| Network and telecommunications: Telephones | VOIP exchanges availability > 99.95% measured over 1 year | Telephones are expected to ‘always’ work – this availability metric guides the level of redundancy required to provide this level of service. |
| Direct dial in range in use < 85% | Effectively this is the capacity of our telephone system to add more extensions. This is the margin that we need to retain so that we have sufficient time to increase capacity to meet demand by expanding the telephone exchange  |
| Hardware: Servers | 80% of all servers are virtualised | This is an efficiency measure – the more servers that are virtualised the greater the efficiency in the server infrastructure. Achieving 100% is not feasible as there is a need for specialised servers or appliances e.g. door controllers, load balancers, firewalls.  |
| Underlying server platforms achieving 99.95% availability | This availability metric supports the overall service delivery target of 99.9%. |
| Hardware: StorageHardware: Storage(CONTINUED) | 95% of enterprise applications using central storage | This is an efficiency measure – the more services that use the central storage the greater the efficiency. Achieving 100% is restricted by some legacy issues so that over time it may be possible to achieve 100%. |
| 75% of research community using Datastore | This is an effectiveness measure – the more researchers that use the central storage the greater the efficiency and the lower the risk of accidental loss of data. 75% is a stretch target at present a long term objective would be to achieve a significantly higher level e.g. 95%. |
| Storage utilisation < 80% capacity – enterprise and file-store | Predicting future capacity is uncertain so this is a margin that we need to retain so that once capacity reaches 80% full we have sufficient time to increase capacity by ordering additional storage. |
| Open Access | Average student use per semester > 40 hours and *%* students using labs > 65% | Effectiveness measures ensuring that there is a need |
| Peak usage in open access computers in high-use labs > 90% | Capacity measure - If the peak use is not greater than 90% and if we run at >90% for significant periods we have too few. |