Scotland's Digital Future: Data Hosting and Data Centre Strategy for the Scottish Public Sector

Digital Scotland

The Scottish Government
Riaghaltas na h-Alba

Contents

Introduction

Scotland's Digital Future: Delivery of Public Services set out an objective of developing a national strategy for the public sector's data storage focusing on consolidation and re-use. This reflected a recommendation of the Review of ICT Infrastructure in the Public Sector in Scotland report by John McClelland which suggested that significant efficiency and energy savings could be achieved through consolidation.

Traditionally a data centre is a large purpose-built facility which provides a secure and controlled environment that is necessary to support the operation of an organisation's ICT equipment that stores, processes and transmits its information. For the purposes of this strategy, the term data centre is used to cover any dedicated computer room or facility which is used to house operational ICT equipment and systems. This ICT equipment typically includes networking systems (switches, routers), servers and processing equipment, and storage systems (tape and disk).

The successful delivery of digital public services is dependent upon ICT. As the roll out of Digital Services proceeds and the dependency on access to information becomes more critical to the way Government bodies do business and make information available, the rising demand for ICT to be available at all times increases.

Most existing data centres used in the public sector are not capable, without significant investment, of meeting this demand for increased capacity and reliability. Meanwhile, we are seeing development of cloud computing, which is increasingly suited to public sector requirements, for example in terms of scalability and security.

A series of studies have been undertaken to understand the current and future requirements of organisations and it is clear from the findings that as technology has moved on, the public sector in Scotland needs to prioritise cloud computing virtualisation and consolidation to deliver on future requirements.

Through the analysis of the use of data centres throughout the public sector in Scotland we have identified that most do not proactively measure their energy consumption or understand the total cost of running their data hosting facilities. ICT industry financial analysis indicates that power consumption can account for a third of the cost of running such a facility.

The strategy therefor sets the direction and principles against which organisations will shift to service consumption, and cloud provision and away from an individual silo approach by using aggregated demand and economies of scale. It provides guidance and will continue to do so as implementation is progressed and lessons are learned.

The strategy sets out how the public sector will adopt the following approaches for achieving significant efficiency and energy savings: cloud computing, virtualisation and co-location.

CLOUD- Cloud computing is a model for enabling universal, convenient, on-demand network access to a shared pool of resources that can be rapidly deployed and released with minimal management effort or service provider interaction. Cloud computing offers numerous advantages both to end users and businesses of all sizes in terms of scalability, reduction in the requirement to support the infrastructure or the knowledge necessary to develop and maintain the infrastructure, development environment or application. The 3 dominant forms of deployment of cloud computing are Public Cloud, Private Cloud, which can include the concept of Community Cloud and Hybrid Cloud. Further information on cloud is set out in Annex A.

VIRTUALISATION- By using virtualisation technologies, applications can be consolidated onto fewer physical systems but can still be deployed in their own operating system environment. In doing so it is important to consider the licensing arrangements and the impact that virtualisation may have on these. See Annex B for further information.

CO-LOCATION- allows a business to own their own server equipment; and rent space in a co-location hosting centre owned by another organisation. It is clear from surveys that there is space available across the public sector and private sector data centres located in Scotland**. As a priority organisations must make use of those data centres that meet environmental standards, classification and security standards consistent with world class data centres.** Annex G provides further information on co-location, and Annex E describes the standards that will apply.

The public sector's High Level Operating Framework sets out the high level principles for delivering ICT in the public sector. This data centre strategy is aligned with the principles of this Framework. We will develop the Framework with standards for data hosting and data centres.

Who is the strategy aimed at?

In line with the approach of, and commitments in Scotland's Digital Future: Delivery of Public Services, this strategy has been developed with and for the Scottish public sector and their partners to maximise the benefits of an aggregated approach to delivery, and all sectors have signed up to it through the Digital Public Services National Level Actions Board, the sectors in scope are:

- Central Government including Police and Fire
- Local Authorities
- Health
- Further and Higher Education.

The strategy will also be available to the third sector and in particular is appropriate where they are supporting the direct delivery of public services.

Our Vision

Scotland's public sector data hosting is cost-effective, carbon neutral and makes appropriate use of cloud technology, for the delivery of efficient and highly available ICT services.

We will have delivered on our vision when:

- public sector organisations can demonstrate that appropriate cost-effective cloud services are the dominant solution for their organisations' data hosting and storage requirements
- public sector organisations take a service based approach to redesign their requirements
- increased collaboration between public sector organisation and partners is providing efficient and appropriately available ICT services
- individual public sector organisations do not build new data centres but make use of the world class data centres or form significant partnerships to increase the availability of world class data centres in Scotland
- current public sector data centres can demonstrate their viability and route map to world class provision or the plans for decommissioning them that maximises their current investments and optimises their assets

Approach and current environment

The Strategy was developed using a process of consultation, research and analysis.

A cross-Government working group was formed that included ICT industry experts and representatives from public sector groups. The group discussed and advised on best practice for efficient and effective data hosting and storage including:

- best use of the current data centre estate
- any requirement for new facilities
- reduction in energy, carbon and other environmental impacts
- appropriate use of cloud based services
- appropriate use of Business Process Outsourcing services
- requirements for supporting management infrastructure, tools and processes
- future proofing against developing technology and business requirements.

Headline points from consultation, research and analysis were:

- most organisations have their own data centre to meet primary needs but 21% have found other solutions acceptable e.g. managed services, co-location etc
- most data centre owners expect further investment in their own data centre within the next two years
- other or additional options are being considered with a focus on public sector sharing and cloud solutions
- many organisations do not have a clear view of current costs or energy efficiency making their comparison of solutions problematic
- organisations require guidance on the use of cloud computing
- any use of a shared public sector service requires an SLA with explicit allocation of liability for service failure

A report on the public sector approach to data hosting and data centres detailing the existing landscape is available on the Digital Public Services web page for data hosting and data centres.

Key findings relevant to changing behaviour are as follows:

- public sector organisations are not making decisions against any common set of principles, considerations or evidence and generally lack evidence against which to take decisions on future provision. A small but significant number are still considering building their own data centre
- some organisations have their own well designed and provisioned data centres which they intend to continue to use for the foreseeable future. However, many are not housed in appropriately secure and reliable facilities, and this represents a significant business risk for the public sector in their drive to provide a Digital First service

- most organisations and sectors have varying levels of requirements for hosting and delivering services. They would be willing to adhere to a national approach if in doing so they can demonstrate that services can be delivered that are cheaper, secure and highly available
- organisations will be more open to change if guidance and support is available to help them make informed decisions on the best approach for hosting their ICT infrastructure and services. In particular guidance on use of cloud hosting is required
- there is a need to identify how costs can be measured in a consistent way while providing evidence that secure & reliable services can be delivered out with an organisation's own environment and with robust service level agreements
- data centre providers whose core business is to deliver services and space operate at all security levels and with very tightly controlled service level agreements. They have effective strategies for reaching world class PUE (Power usage effectiveness, see Annex D) levels and have a clear understanding of energy consumption at all times

Our strategy addresses the following:

- energy consumption accounts for around one third of the cost of running a data centre and there is little evidence that public sector organisations are controlling this effectively while commercially run facilities are managing this as a priority
- given the extent of organisation specific arrangements there is considerable scope for cost saving through consolidation
- organisations face many options in making arrangements for data hosting but lack both an overall vision and information base for doing so, and wish guidance for the Scottish public sector on use of cloud computing
- some organisations felt that public sector shared service offerings were not attractive in terms of service offered or costs (although noting that full costing of their own facilities may not be available for detailed comparison)
- the promotion of the co-location options available that meet required standards, and the services they can offer in the form of a catalogue, may address this. Cloud services offer scalability and the avoidance of capital expenditure but there is no public sector policy on this at present
- a procurement framework for cloud computing and other related services including hosting is required
- other governments are driving consolidation through provision of new public sector or external data hosting services
- there is an appetite for driving consolidation at sectoral and/or geographic level

While these findings point to the need for change there is existing good practice as set out in Annexes F- I.

For example, there are organisations who have demonstrated savings through their recent approaches to data hosting which can be summarised as follows:

- The Improvement Services (IS) recently looked at the options for renewing a number of their aged services that were delivered through multiple suppliers with individual contracts which were complex to manage. The technology stack and hardware was hosted in co-location facility. The solution is now hosted in a private cloud for less than half the price that IS were previously paying
- Highland Council estimates they will make savings of £1m through a reduction in power and £175,000 through standardising the technology they use
- Scottish Prison Service will avoid costs of upgrading the existing environment and power consumption estimated at £20m by co-locating with Scottish Government backed up to South Lanarkshire Council
- St Andrews University currently run their data centre at a PUE of 1.34 and have a target to run their data centre at less than 1.2 through further programmes of virtualisation and shared and managed services. They will save £1.4m over 10 years and a reduction of 6.8m Kg CO2 emissions

Creating the future data centre environment

Organisations will transition to revised arrangements at different timescales and in different ways because organisations have different existing contractual arrangements. But it is important that the public sector delivers the change required and it will do so by adopting, with consistency, the following set of principles:

Principles

1. **organisations review their current ICT data centre and hosting arrangements**

- these arrangements should be clearly related to an organisation's business requirements deriving from their business strategy. Organisations should maintain their own asset registers and configuration management databases (CMDB)
- see case study from David MacBrayne at Annex H

2. **cost of running data centres and hosting is known**

- the cost of running a data centre consists of a number of elements, these should all be known in order to fully understand the cost of alternative options or any new services

3. **utility and cloud computing is considered in assessing the appropriateness of current arrangements and future investment plans, and a shift to the cloud takes place when this is the most cost-effective option that delivers business requirements**

- as organisations address the need to provide greater continuity and disaster recovery capabilities for both existing and new systems, this will also increase demand for data centre space. In most cases, implementing an improved continuity or disaster recovery strategy for systems will require additional computing hardware and software to be maintained, the use of cloud should be the first consideration for this activity
- see case study from Dundee University and Improvement Service at Annex I

4. **co-location in existing world class data centres is considered where cloud options cannot meet business needs or are not cost-effective**

- a catalogue of public sector facilities that meet the standard should be available and refreshed regularly
- organisations will consider this option in their business case when looking at new services
- see case study from Scottish Prison Services at Annex G

5. **no new data centres should be built to meet the needs of an individual or small number of organisations with new centres only considered if, in line with principles 3 and 4, cloud or existing data centre options do not meet business needs.**

- public sector organisation and partners should collaborate on providing efficient and appropriately available ICT services
- organisations should make use of the world class data centres or form significant partnerships to increase the availability of world class data centres in Scotland
- by understanding their organisational requirements and following the decision roadmap it is expected that organisations will find an appropriate solution that is already available

6. **Organisations measure and continually improve on their data centres PUE**.

- Data centre energy consumption must be measured and reported with organisations taking steps to reduce it (see Annex C)
- See case study from St. Andrews University at Annex F

Delivery models

Commercial data centre utilisation and cloud models.

Organisations that require infrastructure and services run by private organisations offering a comprehensive service can currently utilise procurement frameworks including e.g. g-cloud and Scottish Procurement Framework – IT Managed Services, that offer managed services (see Annex H for definition of managed service) and cloud solutions (see Annex I)

Procurement solutions can be an important enabler to support delivery of the strategy and encourage transformation from a fragmented data centre landscape environment to a service consumption and cloud provision model, taking advantage of aggregated demand and economies of scale.

Continued Investment in the world class data centres that already exist in the Scottish public sector.

Data centres that are run by the Scottish Public Sector should be maintained to recommended standards (see Annex E). If organisations are doing so they should additionally determine whether a programme of **virtualisation**, in line with the guidance (see Annex B.), would be beneficial.

Data centres that meet the standard and are virtualised should be capable of making **co-location** (see Annex G) services available to other public sector organisations.

Where application or infrastructure as a service is being considered there are precedents where a combined model can be deployed using framework suppliers to augment the co-location offering.

Decision making

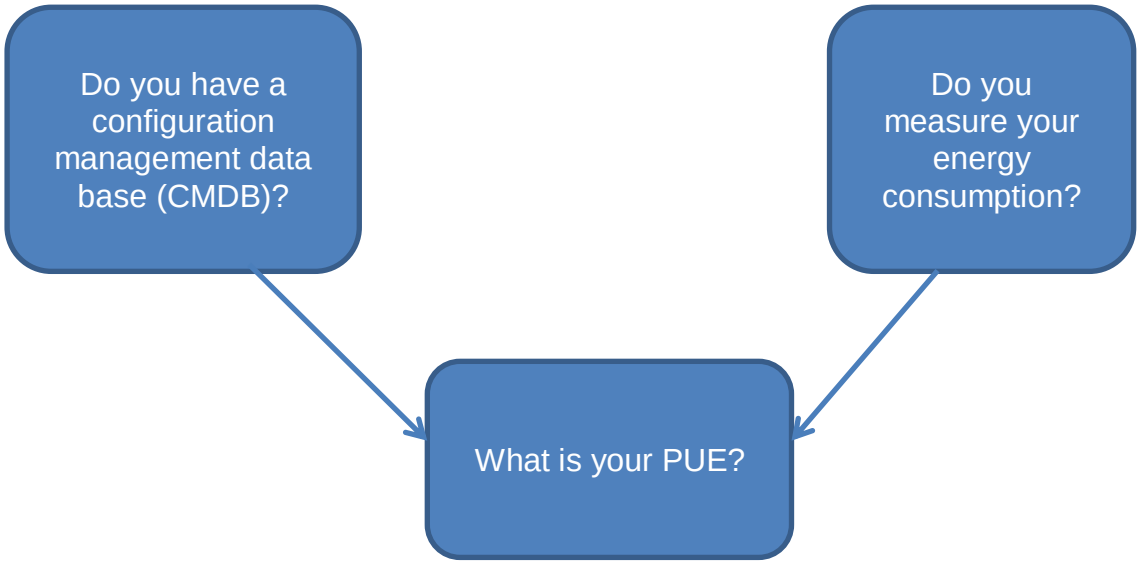
Public sector organisations considering their next investment in delivering their ICT infrastructure or services should make use of the decision roadmap to determine the most appropriate solution.

Private sector solutions offer organisations a number of options that will help them meet their business objectives and allow them to deliver their services without necessarily requiring a capital investment. ICT managed service companies can proactively manage an organisations infrastructure services and applications where the vendor can either take complete end-to-end responsibility or provide facilities for them to use.

Decision Roadmap

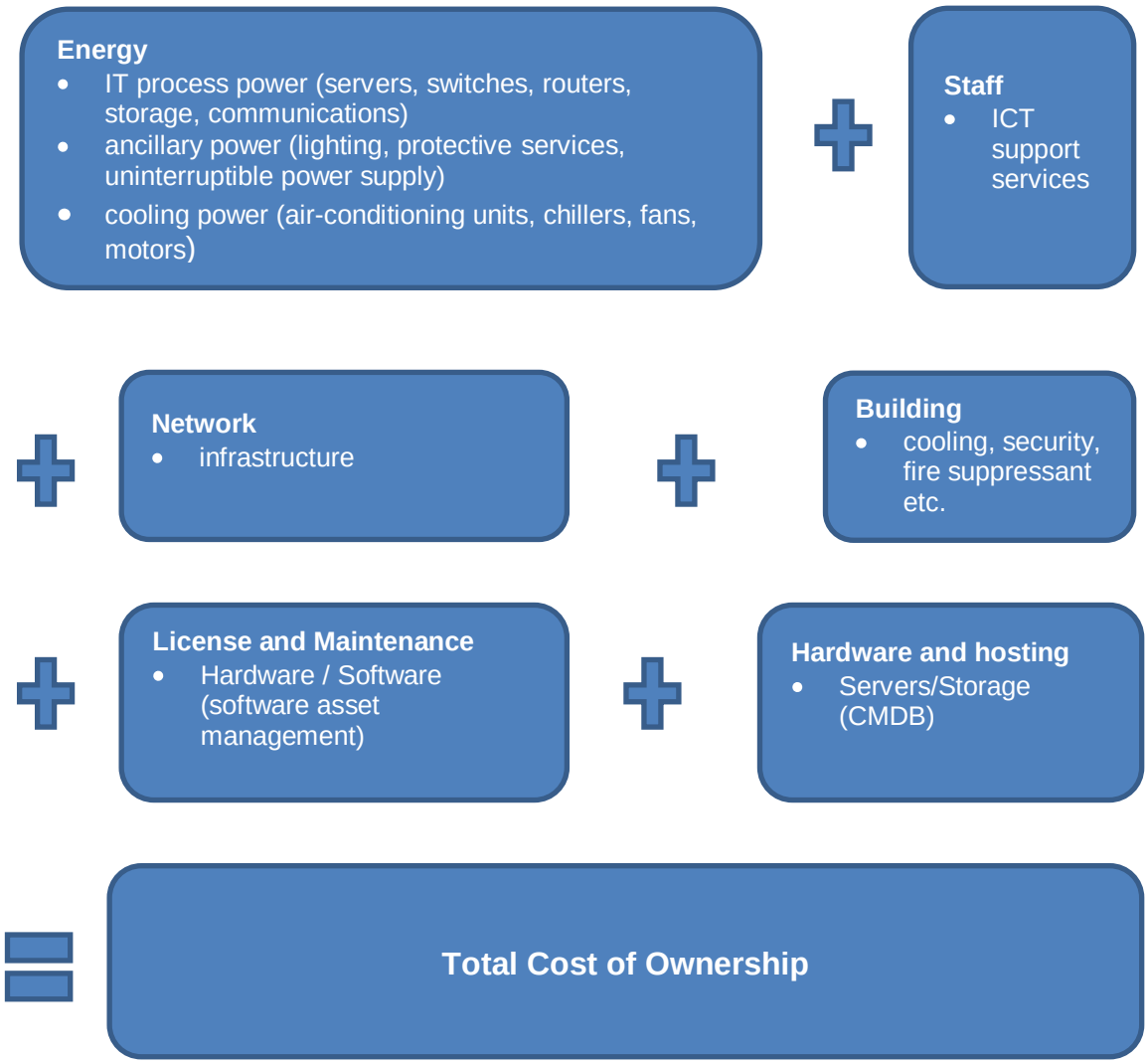
- **Step 1**

Understanding your current estate
Understanding your assets and the efficiency of your data centre makes the identification of the best solution to host your data and services more informed.



- **Step 2**

Understanding the TCO
The total cost of ownership (TCO) can best be summarised for a data centre as the sum of initial capital expenditures (Capex) added to on-going and long-term operational expenditures (Opex).



- **Step 3**

What are the factors to consider?
Once you have identified the total cost of ownership you must decide the best options for data hosting. Provided business requirements are met, the key consideration will be Value for Money (VFM), and the option appraisal should determine best option, and when to make a change from existing arrangements. In some cases, existing assets may be the most cost effective option for a period of time, but bodies should change hosting arrangements as soon as it is cost effective to do so.

Significant Change in Requirements
- Major asset replacement or IT refresh taking place
- Significant increase in data centre capacity
- current ICT environment is inefficient, PUE too high
- New services being delivered

End of life of organisation's data centre
- Current data centre lease expiry
- Outsourcing contract expiry
- Building move

Opportunity for Change
- License renewal
- Maintenance agreements renewal
- Service Level Agreements
- New services being delivered

Connectivity and Resilience
- Network requirements
- Resiliency and recovery requirements
- IT skills requirements
- Flexibility requirements
- Security requirements
- Regulatory constraints
- Compatibility constraints

- **Step 4**

Business Case
The business case for change should consider the priorities set out in the strategy and clearly evaluate these in terms of new investment to deliver on identified actions.

At a high level the business case for change should cover the following:

Options

- **Cloud - Public/private/managed**
- **Co-Location**
- **Virtualised environment**

Note not always mutually exclusive e.g. option maybe a combination of cloud, virtualisation and colocation to meet needs

Benefits expected

- reduced costs
- improved resiliency /disaster recovery availability

Cost

- ensure the total costs of each element are evaluated

Timescale

- assess against the identified actions to plan for delivery to meet critical milestones

Risks

- **Business continuity** - as with all ICT delivery options, business continuity and disaster recovery plans must be well documented and tested
- **Data location and retrieval** – data residence and sovereignty needs to be understood and implications managed
- **Legal and regulatory** - there is still only an emerging understanding of legal risks and issues surrounding cloud, with little legal precedent and many untested areas
- **Information governance and management** – oganisations must ensure cloud computing providers and their service offerings comply with Information best practice
- **Privacy** - organisations must ensure cloud computing providers and their service offerings meet all applicable legislative requirements relating to the privacy of information
- **Security** - organisations must ensure cloud computing providers and their service offerings meet all applicable legislative requirements relating to the security of information
- **Licensing** - existing software licensing models may not seamlessly translate to a cloud deployment solution.

Relationships with other Scottish Digital Futures initiatives

To enable a geographically neutral data centre approach to be a success a reliable and effective infrastructure needs to be in place. The Scottish Government has already recognised this and is in the process of delivering a world class digital network that will enable the public sector, businesses and the individual through a number of projects to deliver and use effective digital services that will allow them to participate in a digital world.

The projects that will deliver this are

Step change 2015

As a first step on our journey to world-class digital connectivity; this project will extend and improve our core national network so that it reaches as far as possible, as fast as possible. It will deliver future proofed and sustainable technologies, such as fibre, that will be capable of coping with significant increases in demand for access and speed in the future.

Digital Scotland 2020

This will deliver availability of next generation broadband to all by 2020. The action plan outlines a commitment to a future-proofed infrastructure that will deliver world-class digital connectivity across the whole of Scotland by 2020. This underpins an ambition for Scotland to become a world-class digital nation and requires that people living, working and visiting Scotland can communicate and connect instantly using any device, anywhere, anytime.

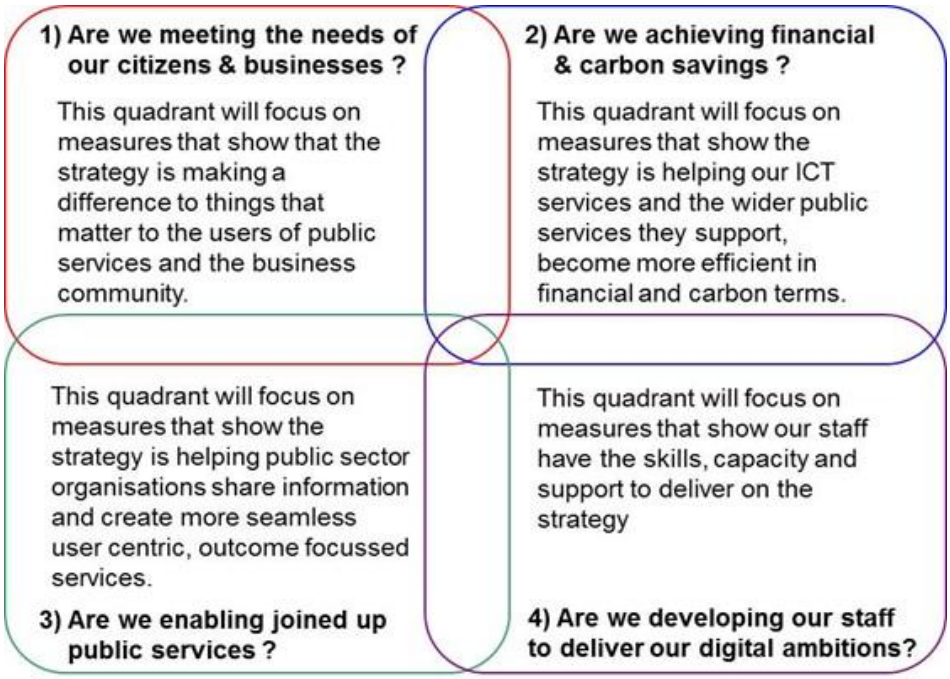
SWAN

The Scottish Wide Area Network (SWAN) Programme is designed to deliver a single public services network for the use of any and eventually all public service providers in Scotland; with aggregated demand delivering both cost and performance advantages. With its high capacity, resilient core infrastructure and its reach out to many public service organisations, SWAN will provide fast, secure and cost effective connectivity between data centres and cloud applications and the users, whether they are within an organisation or a consumer of the service gaining access via the Internet.

Implementation:

Measurement and benefits

This strategy's implementation will deliver against the wider Digital Public Services Measurement and Benefits Framework.
The Measurement and Benefits Framework contains 16 measures which provide comprehensive coverage of the main benefits areas arising from the activity set out in Scotland's Digital Future – Delivery of Public Services Strategy.
The four score quadrants are shown in the diagram below, each of which links to key policy priority areas for the Scottish Government.



This strategy will measure its benefits against quadrant 2 **"are we achieving financial and carbon savings?"**

There are two benefits that we will measure for all digital delivery and they are

Benefit 10 – Our Public Bodies are saving money through increasing collaborative ICT procurement.
Benefit 11 – We are helping to reduce Scotland's carbon footprint.

For data hosting, organisations will need to capture data to ensure we can have an understanding of the trajectory of:

- Total cost of hosting arrangements
- Carbon footprint of hosting arrangements

Monitoring in the following areas will also support assessment of progress (though less so if a cloud service is chosen) :

- efficiency in use of power
- data centre floor space
- efficiency of data centre ICT assets
- matching of data centre ICT facilities to business need
- standardised ICT infrastructure architectures and use of new technologies
- use of cloud services

Governance and implementation

This strategy has been developed with and endorsed by the Digital Public Services Programme Board for National Level Actions and endorsed by the Digital Public Services Strategy Assurance Board. Members have committed to driving implementation across the sectors and bodies whom they represent.

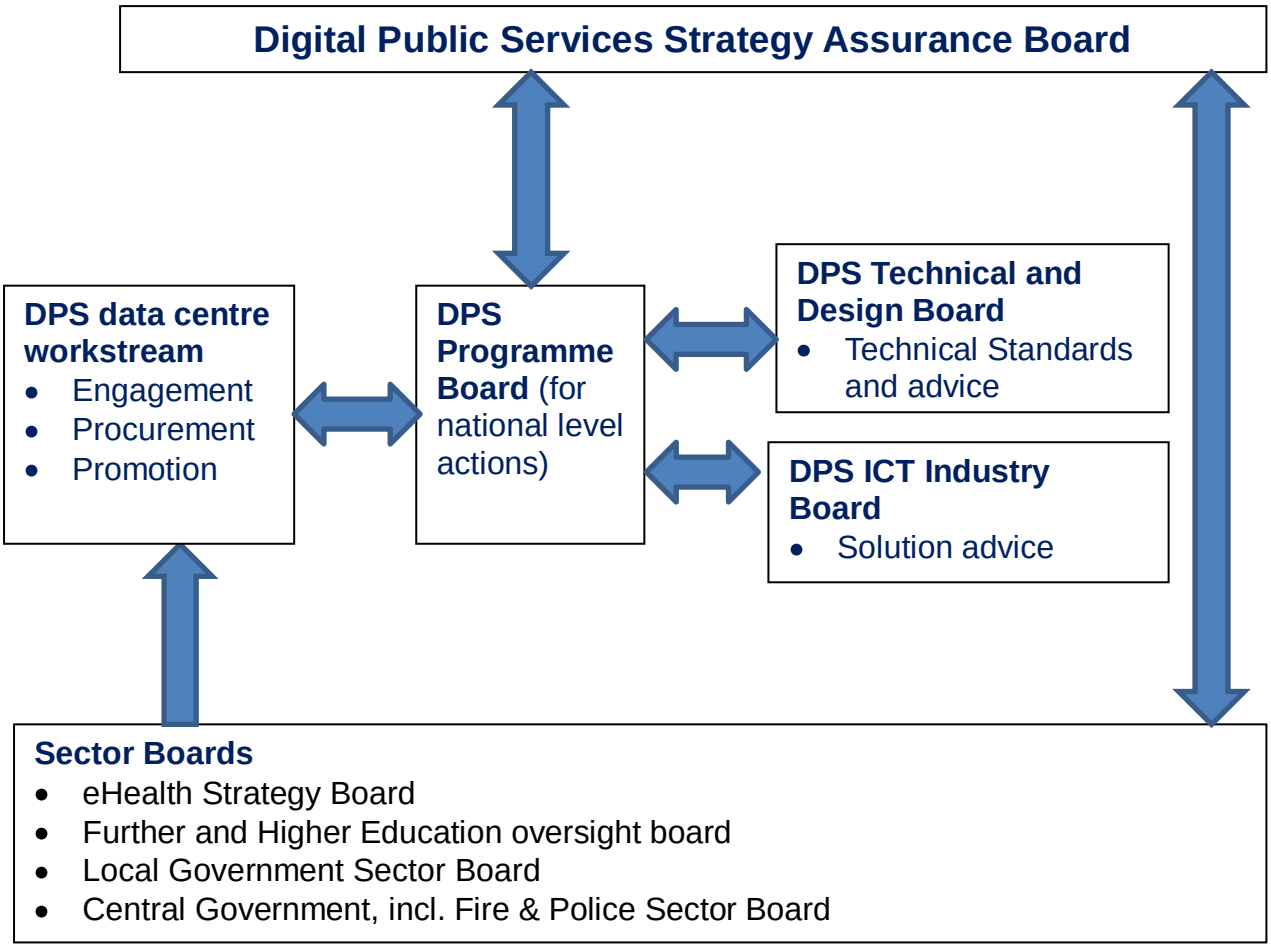
It is for individual organisations to assess their own requirements, understand the cost of their activities, and take action to meet their requirements in a cost effective way. But there are important roles at national level to support this, in particular:

- to provide advice and guidance on key issues, notably use of cloud computing, but also how to assess the cost of data hosting, and the assessment of alternatives based on the decision route maps options
- ensuring that there are straightforward routes to market for cost effective and secure access to cloud computing which do not require individual organisations to build duplicate expertise (through development of appropriate procurement approaches, which should ensure that any cloud options meet the essentials in terms of security, scalability etc., and, potentially, leverage the buying power of the entire public sector)
- to provide a catalogue of existing good quality public sector data centres

It is then for individual organisations to make the most cost-effective choices that meet their business requirements.

Sector boards will monitor progress in implementing the strategy in their sectors. However, collaborative approaches to more efficient data hosting do not need to be pursued only or mainly on a sectoral basis: cross-sectoral cluster or geographic approaches can also be effective.

Progress of sectors to consolidate data centre activities will be considered annually by the Digital Public Services Strategy Assurance Board.



Our National Level Actions which will support change at sector and organisation level.

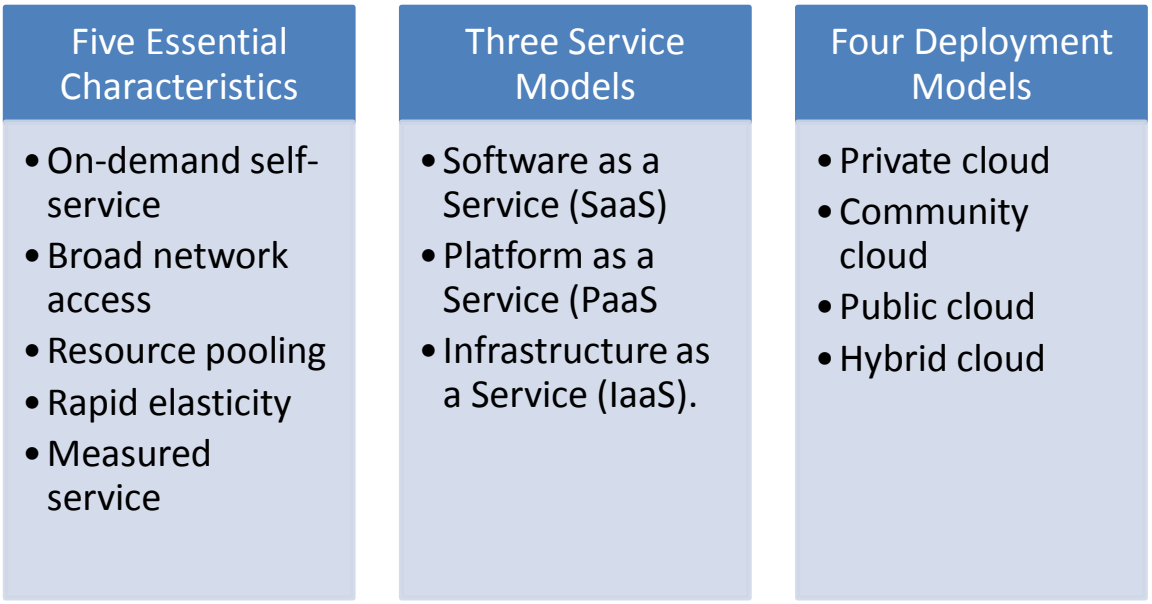
Action	Timescale
Publish and promote the strategy, continually reviewing it to maintain its effectiveness	**April 2014**
Publish a Scottish public sector cloud usage policy	• **Draft April 2014,** • **final version, Q2 2014**
Publish guidance on virtualisation	**Q2, 2014**
Identify and publicise existing Public sector data centres for co-location	**Q2, 2014**
Continue the work with procurement and engage further with Business Strategy and ICT Leads to • understand demand and needs for facilities and services, review procurement solutions, identify gaps, and • put in place procurement solutions to deliver on our strategy and business requirements	**new procurement arrangements by Q4 2014**
Continue engagement across the public sector to • develop the process for measurement of the benefits of the strategy	**Q2 2015**
Review the strategic objectives in line with technology developments and progress across the public sector	**Q1 2016**

Annex A - Cloud Computing

There is a lot of confusion and misunderstanding of what cloud computing means to individuals and organisations. To enable greater understanding and consistency in the language used, the Scottish public sector will adopt the US Government's National Institute of Standards and Technology (NIST) definition of Cloud Computing.

"Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. This cloud model is composed of five essential characteristics, three service models, and four deployment models."

The definitions used are intended to help those discussing cloud computing to develop a consistent framework of understanding, with common frames of reference and simple taxonomies. These are not intended to prescribe or constrain any particular method of deployment, service delivery, or business operation. A fuller explanation of the cloud model components can be found on the NIST website or in the Scottish public sector cloud policy, which can be found at the Digital Public Services web page for data hosting and data centres.



Advantages of Cloud Computing

Cloud computing offers numerous advantages both to end users and organisations of all sizes. One of the biggest advantages is that you would no longer have to support some or all of your ICT infrastructure. As this responsibility is removed it allows organisations to focus on their core business.

Some of the other benefits include: reduced costs, scalability, energy efficient, more resilient and quicker deployment.

Cloud Computing- Challenges to Consider

As made clear from the above, cloud computing is a tool that offers enormous benefits to its adopters. However, being a tool, it also comes with some challenges when deploying in a public sector environment. Some of the challenges organisations must consider include: security and privacy, vendor tie in and other contractual agreements.

Annex B - Virtualisation

Virtualisation allows multiple operating systems to each be run in a protected environment on a single physical server. Traditionally, in order to minimise issues which may arise due to conflicts between applications, many organisations deployed each different application to a different physical server. This can simplify management and deployment issues, but comes at the cost of a large number of servers, many of which may be significantly underutilised. By using virtualisation technologies, applications can be consolidated onto fewer physical systems, but can still be deployed in their own operating system environment and enjoy the benefits of the one application–one environment approach.

From a data centre point of view, this technology can therefore bring significant savings in space, power-usage, heat, and remote management. Virtual servers can also provide benefits in allowing for rapid establishment and re-establishment of testing environments, support for load balancing, and enabling simple and rapid provisioning of servers and systems on demand.

Virtualisation technologies are having and will continue to have a substantial impact on the delivery of ICT services and systems, and will be a key technology in rationalising and consolidating ICT services and investments. In addition to the data centre related savings from reduced hardware devices, virtualisation can dramatically reduce or even eliminate the time taken to commission a new server environment and can allow for greater utilisation of hardware resources.

Challenges to consider

It is important to understand the limitations and extent of existing licensing agreements with suppliers. Virtualisation maybe out with the scope of the existing agreements and therefore may result in additional cost being incurred.

Annex C - Environmental Standards and PUE

Energy use and environmental impact

It is well recognised that data centres are large consumers of energy, the main areas are IT power and ancillary/cooling power.

IT process (rack) power for	Facility (ancillary/cooling power for non IT resource
servers,	Lighting
storage equipment,	Cooling
telco equipment,	Heating
network equipment,	ventilation
Etc.	Computer room air conditioners
	Battery backup (UPS)
	Power distributors
	etc.

The approaches to reduce these costs are expensive and for many organisations prohibitive.

Organisations can reduce the impact of their activities on the environment by taking advantage of the various deployment methods in this strategy.

- **Cloud** computing providers invest in large-scale data centres that offer organisations a greener alternative to that in which they can deliver themselves.
- Organisations can share the cost of energy consumption through the co-location (**consolidation**) of their servers and hosting them in a reduced number of facilities.
- Another method of reducing the amount of energy consumed is through the **virtualisation** of servers where appropriate.

The only credible and widely accepted energy performance rating system for data centres used was introduced by The Green Grid who developed a standard to calculate how much power is being used by the IT equipment in a data centre in relationship to the power used to cool and run the data centre.

PUE rating	Level of Efficiency
>3	**Very Inefficient**
2.5	**Inefficient**
2	**Average**
1.5	**Efficient**
<1.2	**Very Efficient**

This recognised standard is known as the PUE (Power Usage Effectiveness) rating where the most efficient score is 1.

The rating is calculated by dividing the total data centre load by the IT load.

Annex D - Tier Classification

The Uptime Institute who is recognised as the global data centre authority has a widely accepted tiered classification system. This system is an industry standard approach to data centre infrastructure functionality to address common benchmarking standard needs for data centres. It is a four tier system that provides a simple and effective means for identifying different data centre site infrastructure design topologies.

The four tiers, as classified by the Uptime Institute are as follows:

Tier 1	**Tier 2**
•Susceptible to disruptions from both planned and unplanned activity	•Less susceptible to disruption
•Single path for power and cooling disruption	•Single path for power and cooling disruption
•no redundant components (N)	•includes redundant components (N+1)
•UPS or generator	•Includes raised floor, UPS and generator
•Annual downtime 28.8 hours	•Annual downtime 22 hours
•completely shut down for maintenance	•Maintenance requires some processing downtime
•Possible to provide 99.671% availability	•Possible to provide 99.741% availability
Tier 3	**Tier 4**
•planned activity without disrupting operation	•Planned activity does not disrupt critical load
•unplanned events will still cause disruption	•data centre can sustain at least one worst case
•Multiple power and cooling paths - one active	•unplanned event causes no critical load impact
•includes redundant components (N+1)	•Multiple active power and cooling paths
•Includes raised floor	•includes redundant components (2(N+1))
•Annual downtime 1.6 hours	•Annual downtime of 0.4 hours
•carry load on one path while	•Possible to provide 99.995% availability
•performing maintenance on the other	
•Possible to provide 99.982% availability	

*NOTE: The difference between **99.982% (T3)** and **99.995% (T4)**, **0.013%,** while seemingly nominal, it could be significant depending on the application. Looking at one year or 525,600 minutes, in expectation, T3 will be unavailable 94.608 minutes whereas T4 will only be unavailable 26.28 minutes. Therefore, T4 in a year will be available for an expected **68.328** more minutes than T3. Similarly, a T3 data centre would be expected to be **22.6** hrs. more available than a T2.*

Annex E - Public Sector Data Centre standard

Data centres that are used by public sector organisations should meet a minimum standard that is capable of delivering efficient, reliable and highly available services. Some of the standard you should consider when looking at hosting options are:

Security

- Built to comply with **ISO27001** Information Security Standards.

Physical security

One aspect of data centres which is often implemented at a low standard in many public sector-built data centres and computer rooms is physical security. As organisations move to provide appropriate protection of security classified material, delivering this and other security and protection requirements is increasingly expensive and prohibitive on an organisation by organisation basis.

Any Scottish public sector data centres that continue to be used will be designed, constructed and operated to meet the security requirements as demanded by the classification of the information and infrastructure they are required to support.

Support for business continuity and disaster recovery capabilities

A number of data centres provide some level of internal resilience and fault tolerance and this is measured by a tier rating (see Annex D), However many existing public sector data centres are not of a sufficient standard to be considered capable of sustained continuous operation in the event of a disaster, major or otherwise.

Ensuring ICT systems can support continuous business operation is an area of increasing concern, any move to a new infrastructure must have disaster recovery capability built in from the outset.

Environment

- certified to the **ISO14001** standard
- PUE rating – 1.8 or less

Best Practice

- Code of Conduct on Data Centres Energy Efficiency

Annex F - Internal Service Model for the public sector

<table>
<tr><th>Service Model</th><th>Advantages</th><th>Disadvantages</th><th>Exemplar</th></tr>
<tr><td rowspan="2">Internal IT</td><td colspan="3">A facility owned by an organisation for running their own ICT functions where they own and manage the facility including servers, racks, power, UPS, air conditioning, fire detection prevention and suppression, monitoring and alerting, security and network connectivity. They also have their own ICT resource to manage the facility.</td></tr>
<tr><td>• purpose built for an organisations own business requirements and systems
• organisations retain full control and flexibility in how they set-up and operate their servers
• organisations can implement their own risk management policies without the worry about the stability or reliability of the provider
• organisation with ICT spread over multiple locations can benefit from consolidating in one place
• direct IT personnel accountable to the organisation
• upgrades to new technology can be carried</td><td>• lack of scalability - potential space limitations as business demand grows and additional server capacity is required.
• high costs –
• employ/train specialist ICT staff in every discipline
• servers and spare capacity that are not being utilised cost money to purchase and run
• energy prices are increasingly more expensive</td><td><u>University of St. Andrews Data Centre Consolidation</u>

The University of St Andrews underwent a data centre initiative to replace ageing legacy facilities with an efficient, reliable and scalable facility that would support its dedication to academic excellence for more than 8,000 students in around 160 buildings and with over 2,100 staff.
St. Andrews university currently run their data centre at a PUE of 1.34 and have a target to run their data centre at less than 1.2. through further programmes of virtualisation and shared and managed services. They will save over 10 years, £1,400,000 and a reduction of 6.8m Kg CO2 emissions.
At the time the University had 50 campus locations for servers with no fit for purpose server rooms.
A working party of internal stakeholders and external consulting engineers produced a business case for the construction of primary and secondary data centres in order to underpin reliable service delivery. At every stage of the process, energy efficiency was pushed and design decisions taken to minimize overall power consumption. Key parts of the design philosophy are free cooling, fully enclosed hot and cold</td></tr>
</table>

	out at the pace you need to go at, as slow or as fast as you like		air paths & ability to reuse the waste heat generated by the computing facility. The facility has a design for a full-load annualised PUE of 1.2. From an infrastructure perspective, the high efficiency of operation is underpinned by extensive telemetry of the datacentre, allowing optimisation of the equipment. Running parallel with the population of the data centre, a path of increased virtualization and use of shared and managed services to reduce the footprint was undertaken, with great success. The project delivered all the expected benefits and will deliver calculated savings against sector average of £1.4m over 10 years, a reduction of 6.8m kg CO2 emissions and is a stepping stone to the University's aspiration to Carbon Neutrality for Power. Further improvement works are earmarked to optimise the PUE for part-load operations and reduce annual operating costs by a further £10K. The data centre has been awarded the BCS CEEDA Gold award.

Annex G - Co-Location Service Model for the public sector

Service Model	Advantages	Disadvantages	Exemplar
Co-Location	Co-location hosting allows a business to still own their own server equipment; however, instead of storing it in their own data centre, they instead are able to store it in rented space in a colocation hosting centre. This facility provides the infrastructure to run an ICT service where it typically provides, the building, power, UPS, air conditioning, fire detection prevention and suppression, monitoring and alerting, security and network connectivity. The client organisation will provide their own servers, racks, power distribution unit and ICT resource to manage the server.		
	• greater amount of bandwidth is available • no large capital expense that you would need for a new data centre facility or expansion, or renovation of an existing facility • your server is stored in a secure location • greener ICT - organisations can reduce their carbon footprints as number of individual data centres is reduced • ICT staff can be focussed on service delivery and not side-lined by maintenance • organisations can quickly meet increase in demand by renting additional rack	• initial start-up costs can be high • organisations must purchase their own equipment • locating to a co-lo data centre near an organisations main location could be difficult • maintenance to server must be performed off-site at data centre location • time restrictions at data centre might make access for maintenance less convenient • organisations are still responsible for	**<u>Scottish Prison Services (SPS)</u>** Scottish Prison Services had an ageing internal ICT facility and an unreliable expensive offsite disaster recovery function all of which created a number of risks for the organisation in terms of continuity and operations. The nature of the organisation and the sensitivity of their data was the driver to implementing a co-location model as it also avoided the cost of upgrading the existing environment and power consumption estimated at £20m. The solution was to host their primary facility at the Scottish Government data centre at Saughton House and their secondary facility at South Lanarkshire Council's data centre in Hamilton. The solution reused services that were already in existence in terms of infrastructure (cooling, fire suppression systems, power etc.), security and monitoring and allowed SPS to concentrate their resources on the virtualisation of their server estate to further reduce their costs on hardware, power and

	space • 24 hour technical support in the event of outage problems • optimised connectivity to ensure network availability by dealing with congestion and other problems in real time • full 24/7 CCTV, motion detectors, fire protection etc. • secure controlled access to the server room reducing risk of malicious interference	maintaining their own servers • organisations still need to employ skilled ICT staff • scalability can be problematic as it can be difficult to scale down if locked into time-bound contracts • security can also be a drawback as there can be privacy issues with data being kept off site • risk management may also be an issue - what happens if the provider goes out of business? • host is not carrier neutral then connectivity from some telecommunications carriers may not be supported • understanding connectivity and usage charges - If faster response rates are required client costs may increase to	licence requirements. The new architecture has also allowed the secondary site to provide more live services such as an additional live internet link and also to have fewer single points of failure and a higher status in terms of national emergency as they are now a critical facility.

		facilitate faster data transfer	

Annex H - Managed Service Model for the public sector

Service Model	Advantages	Disadvantages	Exemplar
Managed service	ICT managed service companies proactively manage an organisations infrastructure services and applications. Also known as the outsourcing, this is where the vendor takes complete, end-to-end responsibility of a set of deliverables in an organisation. The Vendor may also have complete decision making responsibilities in providing an agreed set of deliverables and is best used when the work can be clearly scoped out with clearly marked out deliverables. For this model to work, the vendor should have an excellent understanding of the client's systems. The client in turn should be confident enough to hand over the piece of work to the vendor. There also needs to be clearly marked out Service Level Agreements (SLAs) for each deliverable and penalties applicable for non-delivery.		
	• Skills required can be easily bought. • IT departments pay only for what they need, freeing up vital funds for other projects and activities. • Helps organisations devote more time to focusing on core activities. • Improved customer service, due to the underlying service level agreement. • Flexibility to grow without worrying about boundaries or restrictions an in-house IT capability.	• Organisations may lose control over customer service issues • An over reliance on a third party may make it difficult to switch poorly performing providers halfway through a contract. • Terms and conditions may also restrict early exit if the business relationship breaks down. • Potential new security threats to sensitive data from a rogue employee of the	**David MacBrayne** Excessive time and capital in the operation and maintenance of a rigid and ageing infrastructure was impacting the organisation ability to focus on its core business. The IT environment was inflexible and incapable of adapting quickly to new needs and demands. The infrastructure was both complex and costly restricting investment and growth into new, flexible methods of working and any new projects were constrained by the limitations of the environment and the expense associated with system deployment on the current legacy infrastructure. David MacBrayne assessed their business options and felt their business objectives would be best served through a managed service. The service provides a modern, flexible, efficient, resilient infrastructure capable of serving the current IT requirements. It will also provide a platform which is optimised for efficient scalability / adaptation to meet the on-going business objectives. Provision of infrastructure capability through industry leading resilient Tier 4 datacentre services

		provider. • Culture mismatch between client and vendor organisation can often result in lack of understanding among both parties, which in turn can affect deliverables.	(including true secondary location live DR capability for top 10 systems, fire suppression, environment monitoring, resilient communications and power) greatly reduces the risk of service outage which was significant with the current in-house computer room facility. **Highland Council** Highland Council implemented a highly resilient managed datacentre facility to replace their existing disparate legacy ICT infrastructure which was outdated, overcrowded with obsolete fire systems and inefficient cooling facilities, lacked resilient power supplies and telecommunication links. The objective of the data centre transformation project was to initiate a transformation in server and storage technology that would allow the council to utilise virtualisation and clustering to bring more standardisation to their infrastructure and enable an easier move to embrace further externally hosted services and cloud offerings. The move ensures Highland Council is well positioned to deliver effective and efficient digital public services. Highland Council estimates they will make savings of over **£1,000,000** through the reduction in power and **£175,000** through standardising the technology they now use.

Strategic Benefits	How
Increased flexibility enabling an improved service delivery.	The use of an externally hosted world class data centre using leading edge technology has enabled the Highland Council to virtualise servers and provide increased flexibility in the deployment of applications to users.
Reduced carbon footprint (CO_2).	The increased clean processing delivered by the datacentre has reduced the carbon footprint and power consumption. The consolidated infrastructure requires less power and cooling, therefore reducing the overall carbon footprint.
Supports business change.	The elimination of the datacentre from Authority accommodation has realised an accommodation saving. The Council ensured this space was used by Service Departments and this has contributed to the Council's Asset Rationalisation Programme.
Better use of ICT infrastructure.	Has led to greater efficiency in deployment of infrastructure and better service.
Improved disaster recovery capability.	The establishment of a contracted DR service is providing greater resilience for the operational service.
Increase service levels.	The service level is achieved via a fully managed, world class data centre.

Financial Benefits	How
Lower power costs.	The lower power consumption is achieved because of the investment in more energy efficient data centre infrastructure and reduced space requirements.
Optimised costs.	The elimination of under used capacity delivered a saving on infrastructure cost. In some cases eliminating capital expenditure cost of additional hardware. This is because of greater virtualisation of servers and the sharing of other data centre infrastructure components (storage, back up etc.) across platforms.
Lower running costs overall.	The increased automation using enterprise management tools has contributed to an overall efficiency gain. Higher levels of embedded management and the ability to centrally deploy applications and manage data centre components remotely.

Annex I - Cloud services for the public sector

Service Model	Advantages	Disadvantages	Exemplar
Platform as a Service	The capability provided to the consumer is to deploy onto the cloud infrastructure consumer-created or acquired applications created using programming languages, libraries, services, and tools supported by the provider. The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, or storage, but has control over the deployed applications and possibly configuration settings for the application-hosting environment. Languages, libraries, services, and tools supported by the provider.		
	• reduced Capex costs for the following reasons: 1. with hosted managed services all hardware and some of the software is rented so the customer pays only for what they use (expenditure may also be more predictable) 2. in addition an added advantage of PaaS is that the provider manages all hardware, software patching and update, physical & software security and day to day routine operational tasks (so there is a reduction in the need for on-site specialist staff)	• potential of vendor lock in	**<u>Improvement Service</u>** The Improvement Services (IS) recently looked at the options for renewing a number of their aged services that were currently delivered through multiple suppliers with individual contracts which was complex to manage. The technology stack and hardware was hosted in co-location facility. IS developed a cost model and business case to understand the cost-benefit of various options for upgrading and simplifying their services in scope ranging from reuse and virtualisation of the existing assets through to renewal based on a managed service wrapped around an open source platform. The solution is now hosted in a private cloud for less than half the price that IS were currently paying. This also included 24/7 telephone support for citizens and public sector service providers. No staff costs were included in this saving as it was agreed upfront that no staff losses would be incurred as part of the “outsourcing” of the service. The existing staff and operating model within the IS has been adapted with key roles to support the new managed service contract.

	Given this PaaS can offer lower Op Ex costs than hosted managed services • convenience and agility is a major advantage of both as neither entail local installation, so the implementation and scale-up speeds can be much quicker than other service types • security is often provided, including data security and backup and recovery • makes research and development possible for 'non-experts' • flexibility - customers can have control over the tools that are installed within their platforms and can create a platform that suits their specific requirements • adaptability - Features can be changed if circumstances dictate that they should • teams in various locations can work together; as an internet connection and web browser are all that is required, developers		

	spread across several locations can work together on the same application build		
Software as a Service	The capability provided to the consumer is to use the provider's applications running on a cloud infrastructure. The applications are accessible from various client devices through either a thin client interface, such as a web browser (e.g., web-based email), or a program interface. The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, storage, or even individual application capabilities, with the possible exception of limited user-specific application configuration settings.		
	• no capex costs as SaaS is subscription based and can also include upgrades, maintenance and customer support depending upon subscription level • easily connected as a browser and an internet connection is all that is required • as software is already up and running on the vendor's data centre, there is a lack of tasks associated with licensed software upgrades and deployment time tends to be much shorter • scalability as the client simply adjusts the monthly subscription fee, thus	• Lack of convenience as not everything can be delivered through SaaS • Software integration can be problematic if the customer adopts multiple SaaS applications, or wishes to connect to existing on-premises applications .	**<u>University of Dundee – Microsoft Office 365</u>** The University of Dundee is a leading university in the United Kingdom, internationally recognized for its expertise across a range of disciplines, including science, medicine, engineering, and art. The university looked to replace its GroupWise Novell email system with a hosted solution to improve reliability and communications and lower IT costs. The university selected Microsoft Office 365 because it gave them an opportunity to go beyond just email (Lync, SharePoint) and broaden the communication capabilities that it offers to students and staff. The case for Office 365 was also about reducing the total cost of ownership of the university's messaging solution. The university expects to reduce costs by £500,000 over five years, based on reduced IT administration and maintenance, lower infrastructure costs, and reduced staffing levels required to support the email system and its users. For hardware, the ICS department no longer has to acquire new servers or support the 40 servers previously dedicated to the GroupWise email system. The university has also avoided costs that would have been

	removing a significant workload from in-house IT department		required had it decided to increase storage for the GroupWise email system
Infrastructure as a Service.	The capability provided to the consumer is to provision processing, storage, networks, and other fundamental computing resources where the consumer is able to deploy and run arbitrary software, which can include operating systems and applications. The consumer does not manage or control the underlying cloud infrastructure but has control over operating systems, storage, and deployed applications; and possibly limited control of select networking components (e.g. host firewalls).		
	• dynamically choose a CPU, memory, and storage configuration to suit your needs • immediate access to unlimited computing power • eliminates the need for investment in rarely used IT hardware • IT overheads handled by the IaaS cloud computing platform vendor • in-house IT can be dedicated to an Organisations core services	• there is a security risk of unauthorised access to an organisations data using IaaS in the public cloud • IaaS cloud computing platform model is dependent on internet availability	

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