

# Cloud Computing Research Innovation Challenges

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- » Optimal architecture depends on the nature of computational tasks and experiments
    - › Easily compartmentalised data\independent tasks → Cloud\HTC architectures
    - › Need to process entire large data sets\highly interdependent tasks → HPC architectures
  - » HPC centres often receive jobs more applicable to cloud
    - › Ability to determine nature of job and distribute to cloud to keep dedicated HPC facilities available for HPC- optimised jobs
  - » **Challenge: Mechanisms to pre-analyse jobs and determine the optimal architecture (HTC, HPC, GPU, Quantum etc.)**
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- » Cloud computing requires the composition of multiple complex layers
  - » Application may involve components and layers from multiple vendors
  - » Application may dynamically change layer and components between different interoperable vendors\suppliers
  - » Each layer (compute, storage, orchestration, workflow, messaging, database, SDN, etc.) is itself a complex stack of software, operating system, virtual and physical hardware
  - » The complex interaction of these layers may introduce bugs, errors and undesirable behaviours in a non-deterministic manner.
  - » **Challenge: new approaches to handling debugging and profiling of complex cloud systems using mathematical approaches to handling large complex and non-deterministic systems.**
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- » Data may be sensitive (commercially sensitive, personal data etc.)
  - » Compute algorithms may be sensitive (commercially sensitive, commercial IPR, etc.)
  - » Need to be able to run sensitive algorithms or use sensitive data on third party cloud services without compromising algorithms or data
  - » **Challenge: continued research in homomorphic encryption and similar approaches to bring to production services without compromising performance; extension of such techniques to protect algorithms as well as data.**
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- » Software Defined Networking offers the potential for intelligent control and optimisation of networking and network routing
  - » Programmatic configuration allows dynamic SDN programs to manage, secure, and optimize network resources very quickly
  - » **Challenge: make efficient use of SDN to dynamically configure networking and network routing (e.g. reserving dedicate pipelines) to ensure optimal performance of cloud services (particularly hybrid, multi-site or intercloud configurations) and by avoiding network bottlenecks at cloud service deployment or execution. This might involve dynamic optimisation of the network to suit the cloud application or dynamic optimisation of the cloud application deployment to suit the network topology or the dynamic interaction of both.**
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- » The PAYG model of cloud computing is both its strength and weakness
    - › Strength – limit costs to actual use rather than up front capital investment based on peak use
    - › Weakness – costs can be unpredictable and different for long term budgets (unlike capital expense which is fixed and one of)
  
  - » **Challenge: new techniques for pre-analysis of cloud jobs and applications to predict long term costs of cloud services**
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Thank you!

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