CompSci 401: Cloud Computing

Private Clouds

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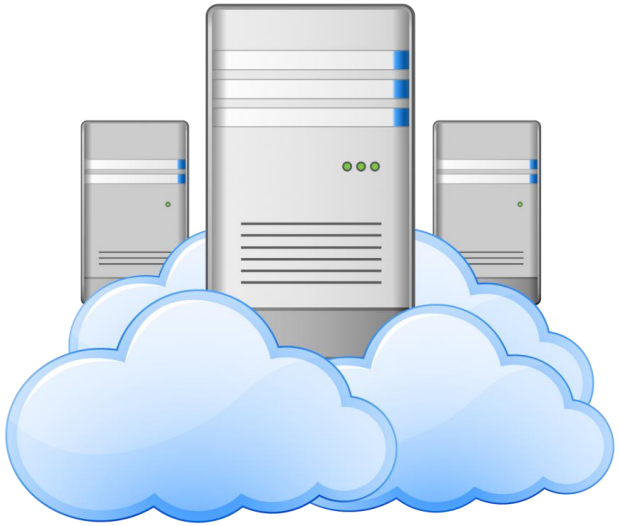
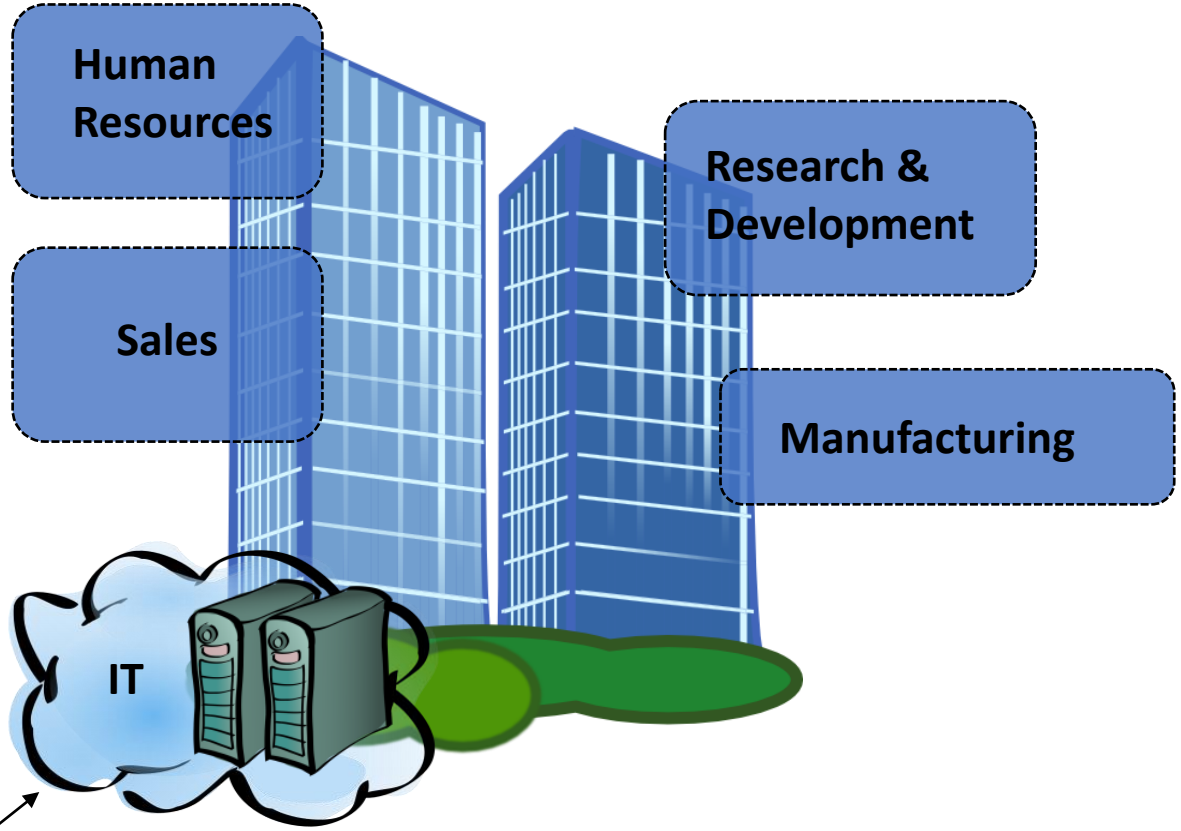
DUKE KUNSHAN UNIVERSITY

Private and public clouds



Third-party infrastructure

Public cloud



Local infrastructure

Private cloud

Private clouds

- Organizations concentrate IT equipment in a private data center
- Cloud technologies can allow further cost reductions

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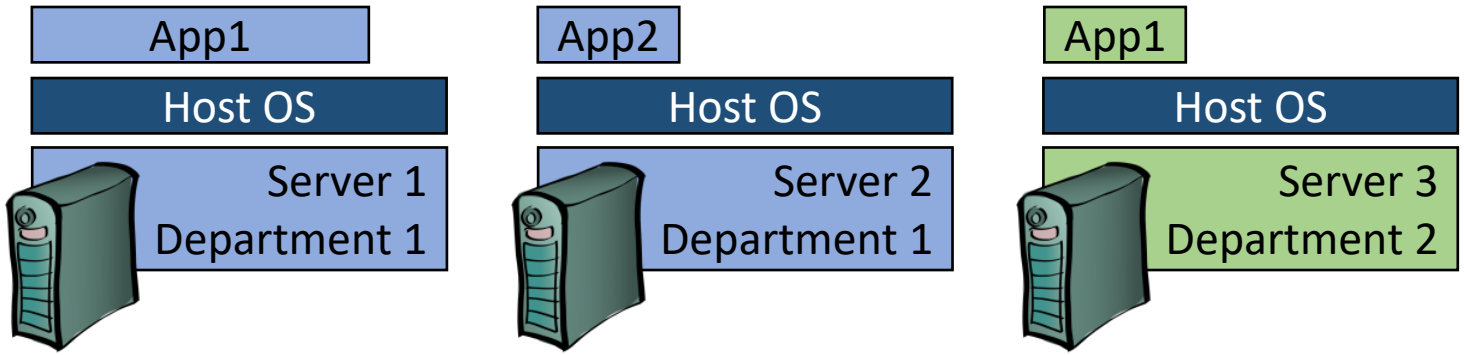

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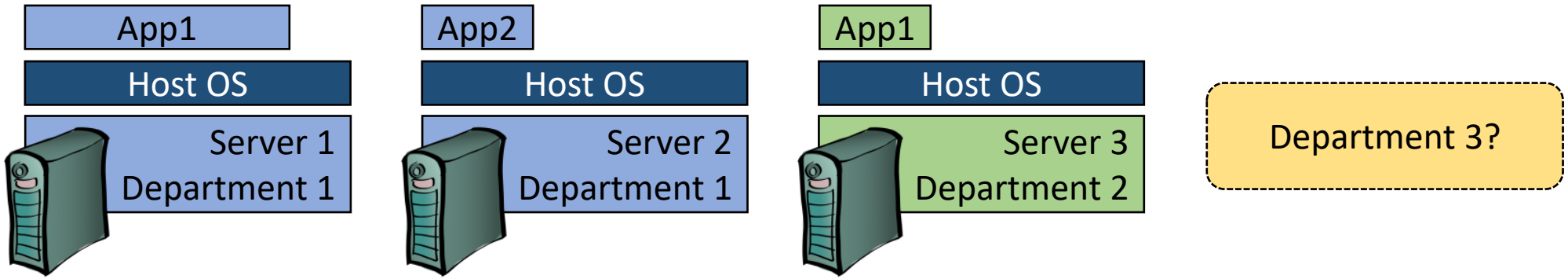
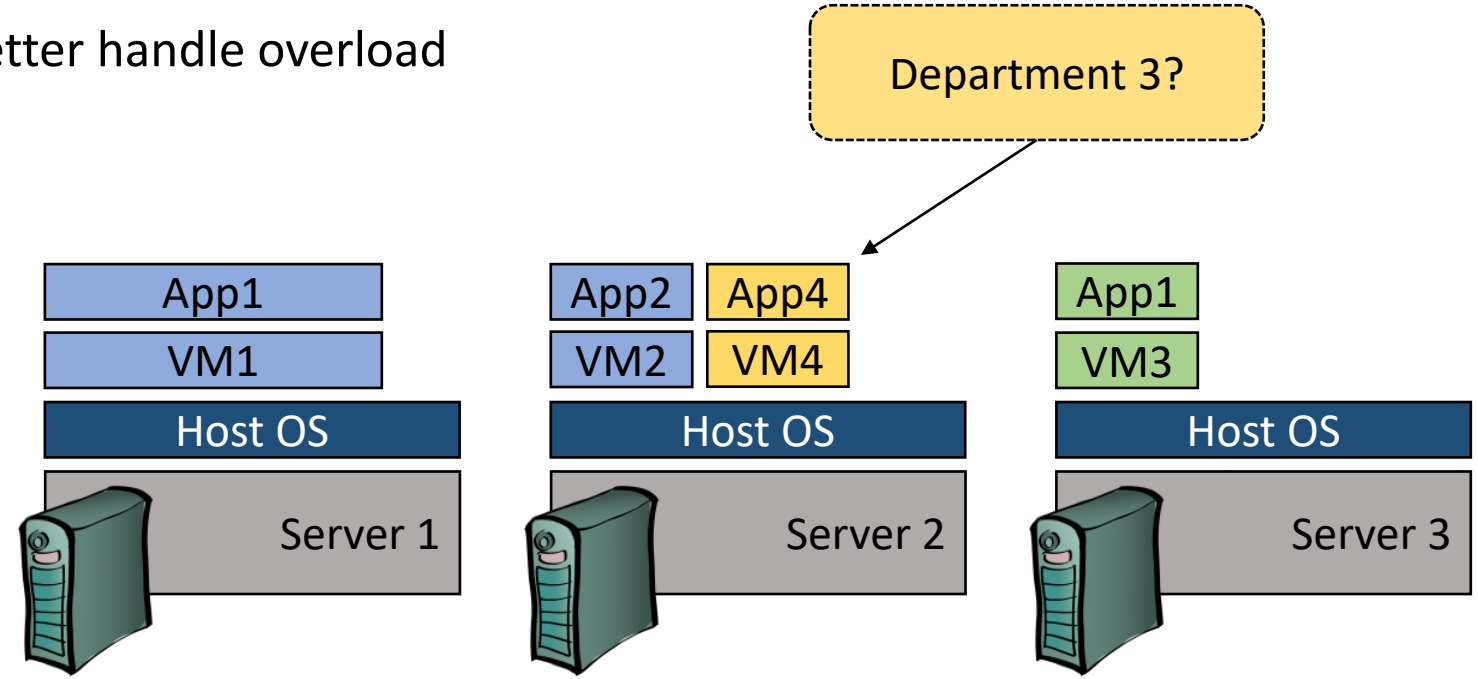


Private clouds

- Organizations concentrate IT equipment in a private data center
- Cloud technologies can allow further cost reductions
  - Virtualization and resource sharing
    - Reduce underutilization
    - Better handle overload



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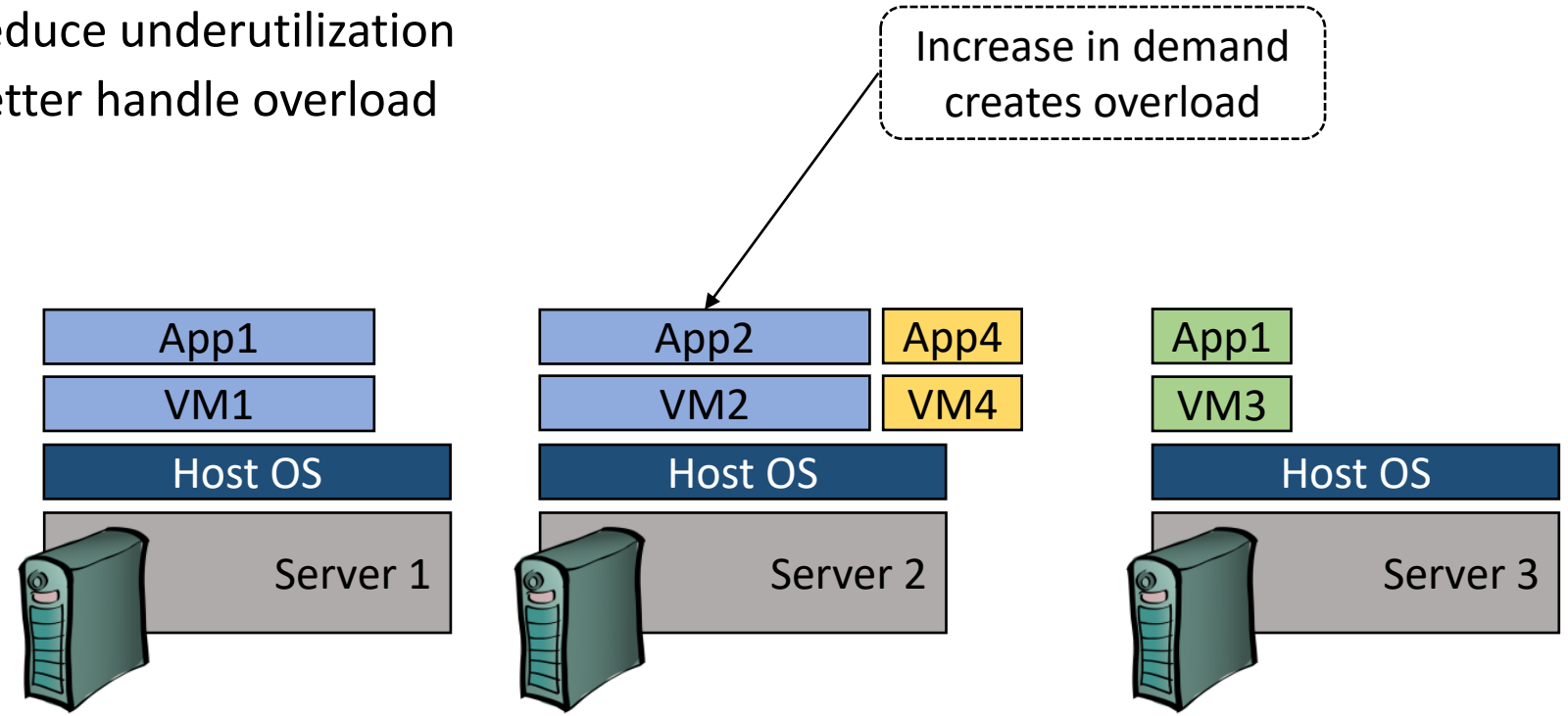

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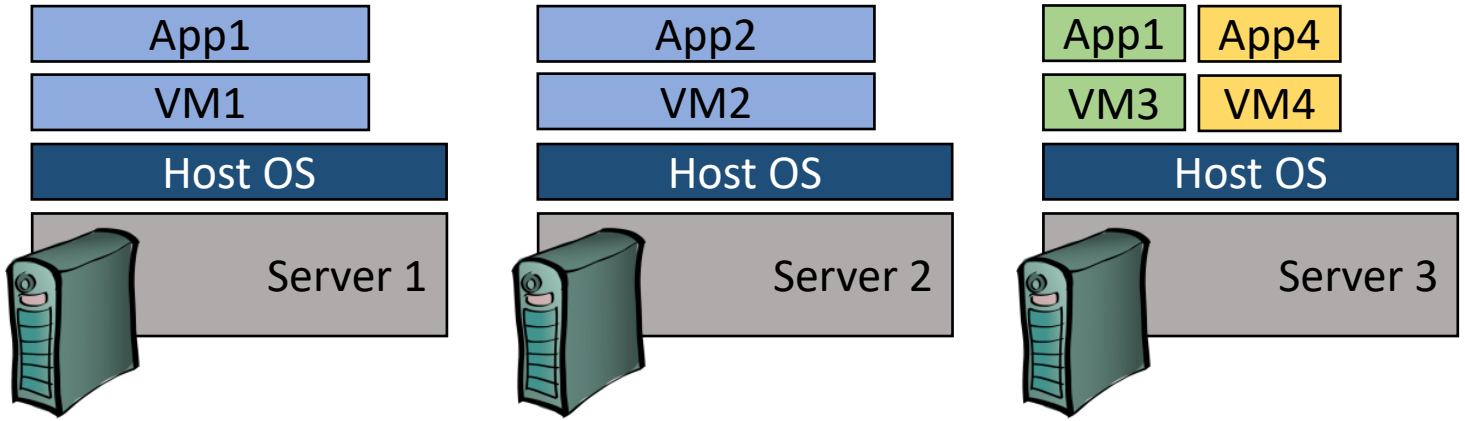

Advantages of a private cloud

- Retention of control and visibility
  - Organization controls the hardware and the network
    - Can troubleshoot problems directly
    - Adapt infrastructure to its own needs
  - Regulations may require the organization to maintain ownership of the data
    - Placement and transfers
- Reduced (network) latency for on-premises facilities
  - A private cloud is usually closer to other facilities of the organizations
  - Even better if a private cloud is located at each facility for local access
- Insurance against public cloud price fluctuations or increases
  - Operating a private cloud may be cheaper or competitive vs public clouds

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Public Clouds

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Public clouds

- Major alternative to running a private cloud
- Organizations need to decide what type of service to use
  - Medium to large organizations
    - May opt for IaaS to get enough flexibility to run all in-house applications and services
    - Possibly additional services like data backup, database administration or network security
  - Startups or companies deploying specific apps
    - May opt for PaaS to reduce overhead and speed up development
  - Small organizations may subscribe to specific SaaS services
    - Web site, e-mail, office suite

Public clouds

- Definitions
  - *Public cloud:* Offers computing to customers
  - *Public cloud facility:* The infrastructure that performs the computing
  - *Public cloud provider:* A company that operates the cloud facilities

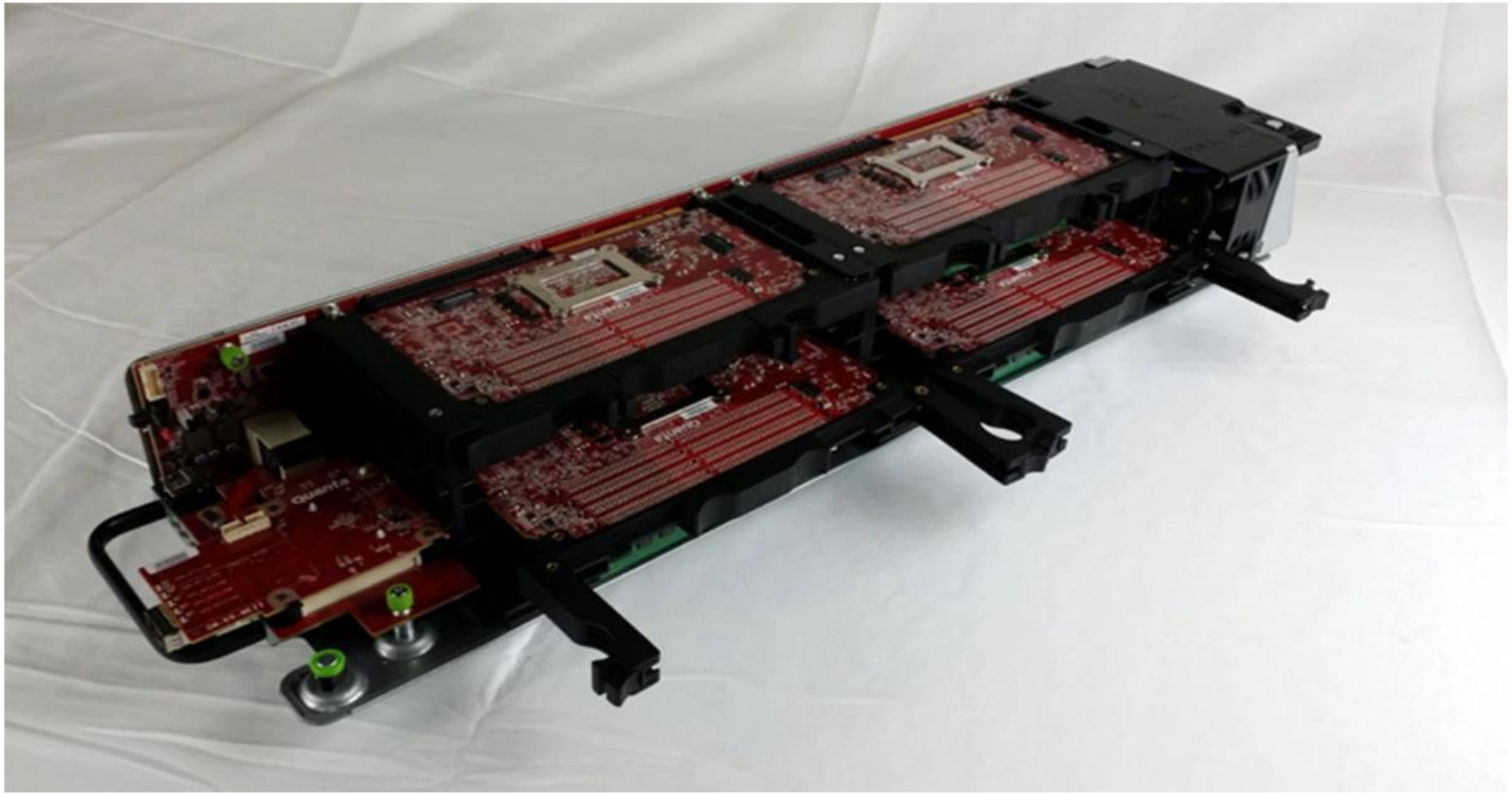
Advantages of public clouds

- Cloud providers advertise three main advantages
  - Economic – lower cost than a private cloud
  - Expertise – access to staff with expertise on many topics
  - Advanced services – offerings not available elsewhere

Economic advantage

- Cloud providers operate very large datacenters
  - Significantly larger than private clouds
  - Benefit from economies of scale
    - Can negotiate better discounts for bulk components (e.g., network cards, transceivers)
    - Can afford to develop in-house solutions or build their own components
      - Facebook designs their own servers, racks, and network switches
      - https://tech.fb.com/open-compute-project/
    - Can design new solutions to problems
      - Google designs custom cooling solutions to achieve very high efficiency

Economic advantage



Facebook server @ 2016
4x Intel Xeon
1x 50Gbps network card
Not 1U

Economic advantage

Facebook F16 Minipack
128x100Gbps switch
Buys transceivers, assembles switch
Software built in-house

Economic advantage

Google engineer in front of wall-sized air filter used. Air is used for cooling.

Facebook’s Fort Worth data center

https://www.facebook.com/FortWorthDataCenter

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The expertise advantage

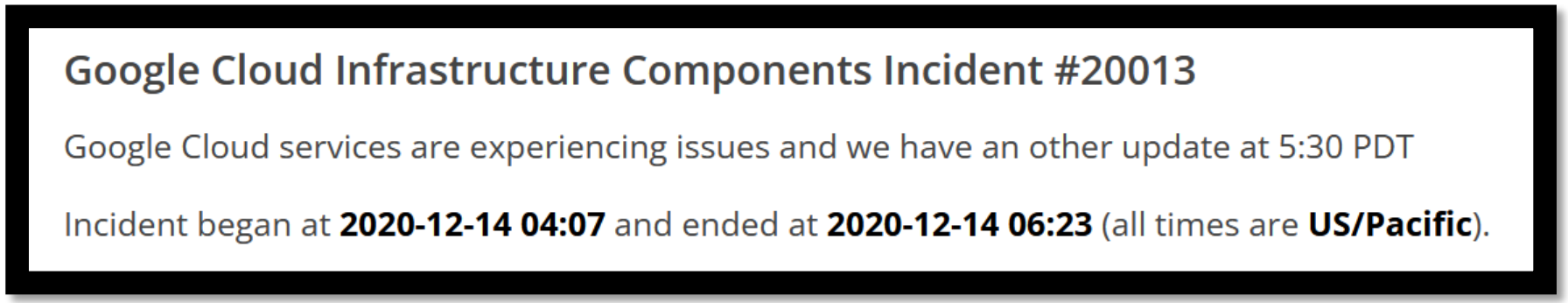
- Not only engineering teams to build custom solutions
- Engineers and experts on many fields, which might be too expensive for a smaller organization to maintain at similar cost
  - Operating systems
  - Artificial intelligence
  - Machine learning
  - Middleware and libraries

Advanced services advantage

- Basic cloud computing promises
  - No maintenance
  - High reliability
  - Limitless scalability
- Service offerings that may be unavailable elsewhere
  - AI-based monitoring of services and network traffic to detect anomalies
  - Automated operating system, middleware, and application updates
- Pervasive best practices
  - 24/7 staff and quick responses to incidents
  - High software and hardware security

Google incident post-mortems

- Google publishes post-mortem analysis of failures in its infrastructure
  - Describes the problem, how it was corrected, assesses impact, and discusses future prevention measures that will be implemented
  - Usually *impressive* monitoring, correction, and remediation mechanisms



Incident report page:
https://status.cloud.google.com/incident/zall/20013

Vendor lock-in

- Lock-in happens when a customer is tied to technologies available at a single cloud provider
  - Some technologies are specific to a cloud provider
    - For example, monitoring or automation frameworks
    - May not be available at other cloud providers
  - Makes it hard for a customer to move to a different provider
- Lock-in applies at all levels: IaaS, PaaS, and SaaS
- Cloud providers make it easy for customers to move in
  - Migration of on-premises computing to the cloud
  - Migration from another cloud provider

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Hybrid Clouds and Multi-Cloud

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Hybrid cloud

- Public cloud for some services, private cloud for others
  - Balance depends on needs vs cost
- Combine the advantages of both
  - Control in the private cloud
  - Scalability in the public cloud

Control in the private cloud

- Some organizations must comply with regulations
  - Controlled access to data
    - For example, classified government or medical information
    - Can be enforced on the private cloud
      - Non-classified data can be pushed to the public cloud

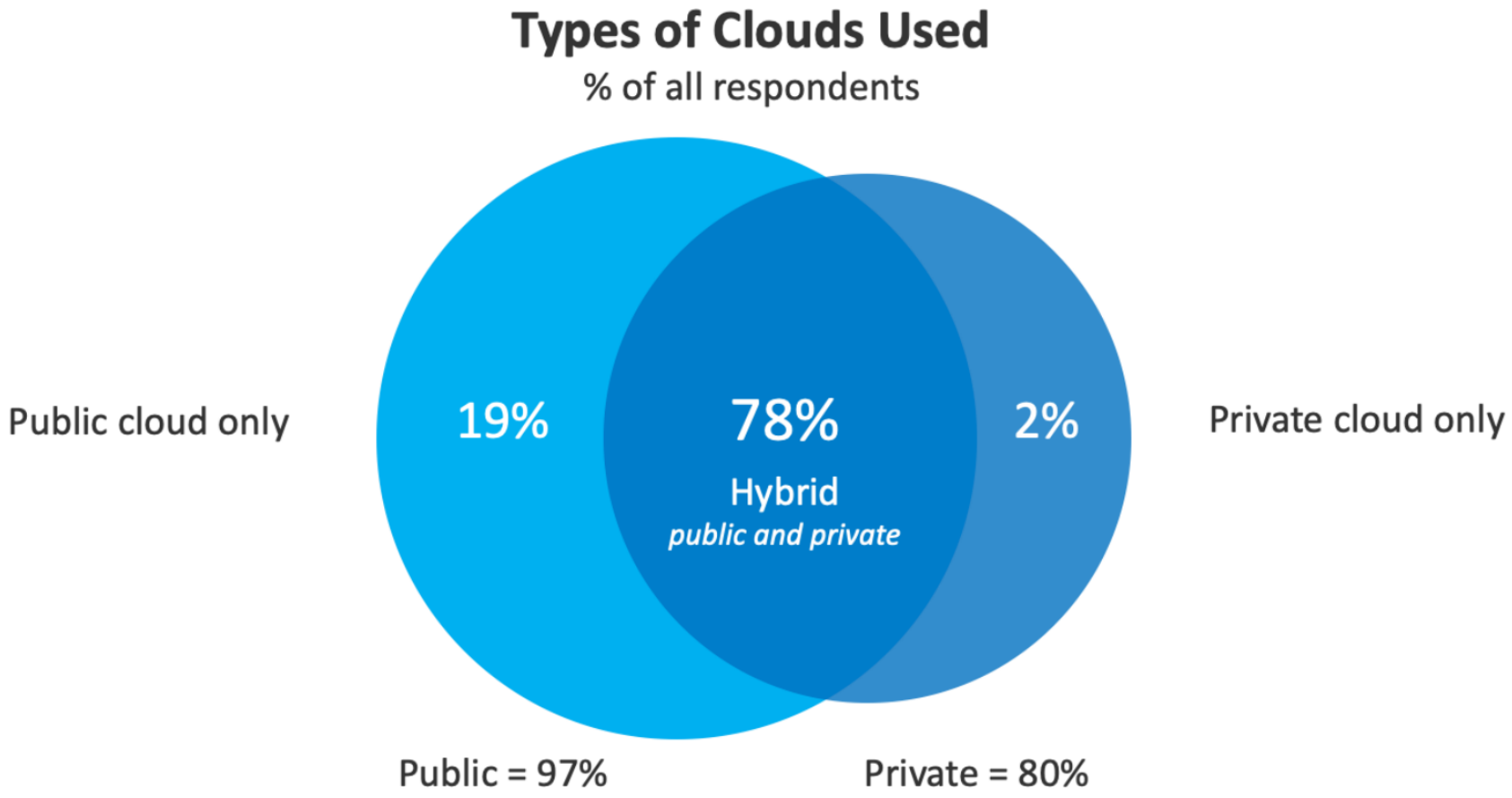
Scalability in the public cloud

- Some organizations may run most computation locally
- Resources may be insufficient during peak business season
  - Black Friday, Super Bowl
- Use public cloud to absorb temporary burst in demand
  - Public cloud must make it convenient to migrate the company's software to the cloud
  - Incurs some management overhead
    - IT team will need to learn how to manage two deployments

Multi-cloud

- Some organizations may use multiple public cloud providers
- Avoid vendor lock-in
- Two approaches
  - Map different applications to different cloud providers
    - For example, map different business units to different public clouds
  - Run all applications on all cloud providers
    - Make applications compatible with multiple clouds
- Challenges
  - Moving data takes time and incurs costs
  - Cloud offerings may differ
    - May require specialized software to make applications compatible or convert data

Most enterprises use at least one cloud



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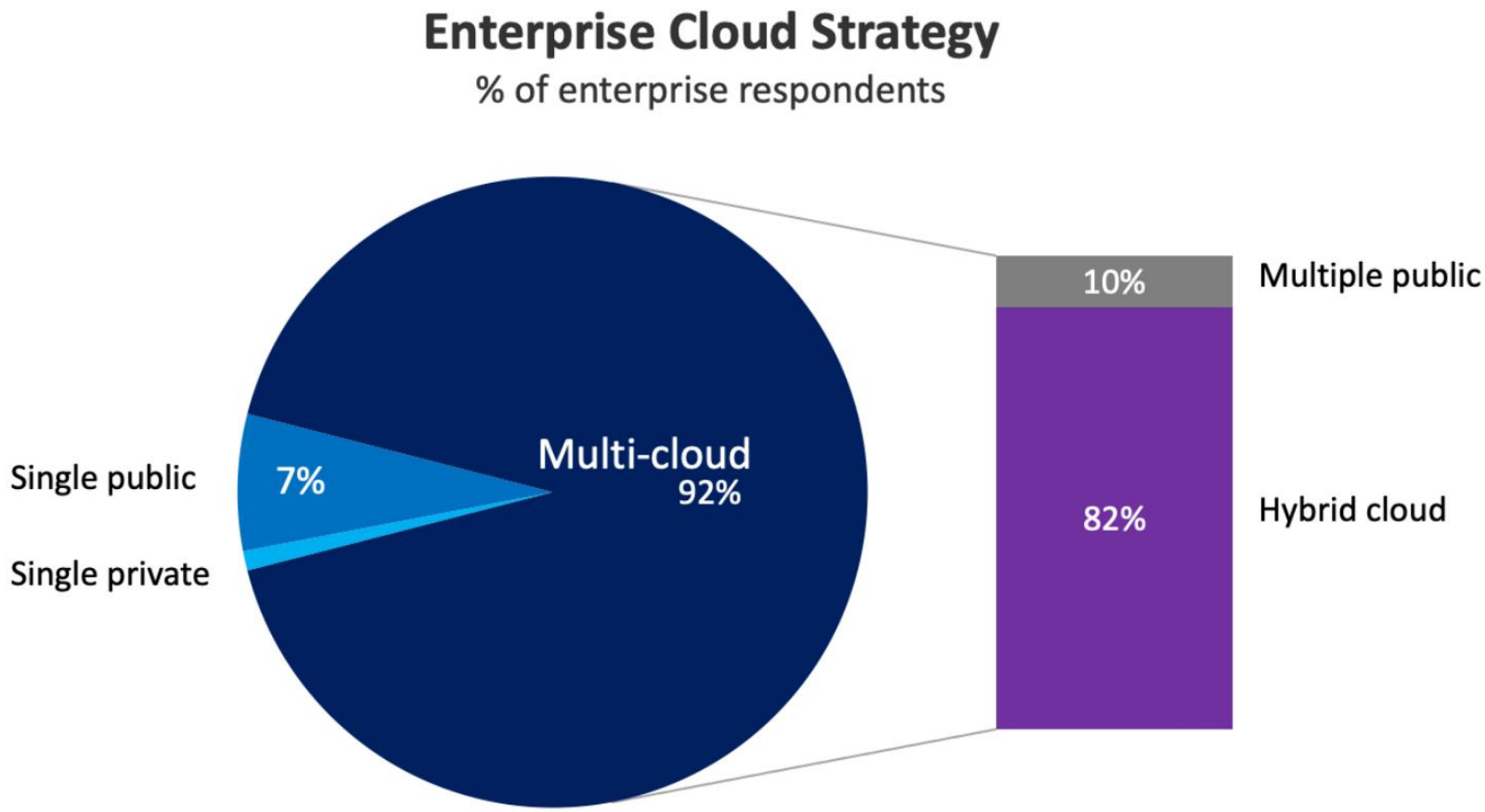
Source: Flexera 2021 State of the Cloud Report

Most enterprises use multiple clouds



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