User-Defined Cloud

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Cloud Computing Market Size

Cloud Computing Market Size, 2021 to 2030 (USD Billion)

- 2021: $380.25
- 2022: $446.51
- 2023: $524.32
- 2024: $615.68
- 2025: $722.97
- 2026: $848.95
- 2027: $996.88
- 2028: $1,170.59
- 2029: $1,374.57
- 2030: $1,614.10
Cloud Computing Companies
Cloud Service Ecology

Cloud Provider identifies the need
- cloud provider identifies the need to support a new type of application workload or a new type of hardware

Cloud Provider develops/adapts infrastructure
- cloud provider develops new software or adapts an existing software/hardware infrastructure

Cloud provider launches service
- cloud provider launches a new service or extend an existing service to integrate the new hardware/software.
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Why is this a Problem?
Problems for the Users

**Overspending Resource**
Users pay unnecessary expenses on additional computing resources due to the lack of cloud services that align perfectly with their specific requirements.

**Hardware Limitation**
Users in specialized domains face challenges executing their workloads optimally on cloud platforms due to a lack of precise hardware configurations or the slow adoption of new hardware features by cloud services.

**Security**
Users are unable to precisely articulate their security requirements, leaving them to rely on the cloud provider’s default protections.
Problems for the Provider

Demanding Integration

Cloud provider needs to integrate new hardware or security features across all their services.

Compatibility

Cloud provider needs to ensure a new service must be compatible with different types of hardware, system software, and security features that users would want to access.
What are some challenges of hospitals utilizing traditional cloud computing?
Aspects to Consider

1. Data Privacy
2. High Availability
3. Complex Data Analysis
4. Cost-Effectiveness
Solution

User-Defined Cloud
Each user defines what computing resources and features of these resources the cloud should provide for their own workloads, and cloud providers take care of how these resources are provided by supplying software and hardware infrastructures under the hood.
# Benefit for the Users

<table>
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<tr>
<th><strong>Saving Resource</strong></th>
<th><strong>Customization</strong></th>
<th><strong>Security</strong></th>
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<tbody>
<tr>
<td>users obtain and pay only for the resources and features they need,</td>
<td>customize the entire stack from software to hardware of a public cloud in a way that matches exactly what they need.</td>
<td>security can be granted according to the needs of the users, enabling security-critical applications to move to the cloud.</td>
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Benefit for the Provider

**Easy add/remove**

By decoupling different layers in the stack and allowing users to define each of them separately, cloud providers can independently add/remove a hardware/software feature without the need to change the rest of the system.

**User/Revenue Growth**

UDC enables significantly more users to use the cloud, which directly creates revenue for cloud providers.

**Efficient Utilization**

without resource wastes, providers could potentially consolidate more applications to the same amount of computing resources and shutting down the remaining ones.
How do we achieve User-Defined Cloud?
User-Defined Cloud
- Giving control to cloud users and keeping management for cloud providers

- Application Semantics
  - Hardware Resource Specification
  - Execution Environment & Security Specification
  - Distributed Semantics Specification

- System Software
- Hardware Platform

Application Developer Team
IT Team
Design Principles

1. Expressing definitions of low-level layers as runtime aspects.
2. Decouple specifications from their realization and decouple different aspects.
3. Fine granularity at each layer.
User-Defined Cloud

01: Specifying Application Semantics
02: Defining Hardware Resources
03: Defining Execution Environment
04: Defining Distributed Semantics
Hardware Resource Specification

New images taken

Medical Images
- SSD
- FPGA
- Image Preprocessing
- Image Classification
- GPU
- Image Processing
- GPU
- Diagnosing
- CPU

Patient Medical Records
- HDD+SSD
- GPU
- Natural Language Processing

Anonymized Patient Medical Records
- SSD

Staff Information
- HDD
- SSD
- Predict Hospital Staffing Plan
- CPU
- Decide Patient Acceptance
- CPU

Weather and Environment
- HDD
- GPU
- Geospatial data processing
- CPU
- Emergencies
Execution Environment & Security Specification

New images taken

Medical Images
- SSD

Image Preprocessing
- FPGA
  - single tenant

Medical Images
- Image Classification
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Patient Medical Records
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Anonymized Patient Medical Records
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Staff Information
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Weather and Environment
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Predict Hospital Staffing Plan
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Diagnosing
- CPU
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Emergencies
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<tr>
<th>Possibilities</th>
<th>Challenges</th>
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<tr>
<td>DAG of modules, Actor model, Autoscaled modules</td>
<td>Finding the scope of modules, Properly handle module dependency</td>
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<td>Hardware resource disaggregation</td>
<td>Integration with other cloud infra Performance, Scalability</td>
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<tr>
<td>Virtualization environments, TEEs, Data encryption</td>
<td>Verifying user definitions are met Adapting virtualization/security techniques to disaggregation</td>
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<td>APIs and program annotation with dist impl underneath</td>
<td>Conflicting user specifications Fine-grained distributed system</td>
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What are the advantages of using UDC in Hospitals
Discussion and Conclusion

- Do you think UDC would be the future?
- What are the potential security benefits and risks associated with giving users the ability to define their own cloud environments?
- What challenges do cloud providers face in implementing UDC?
Thank you!