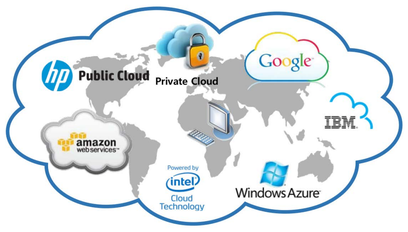
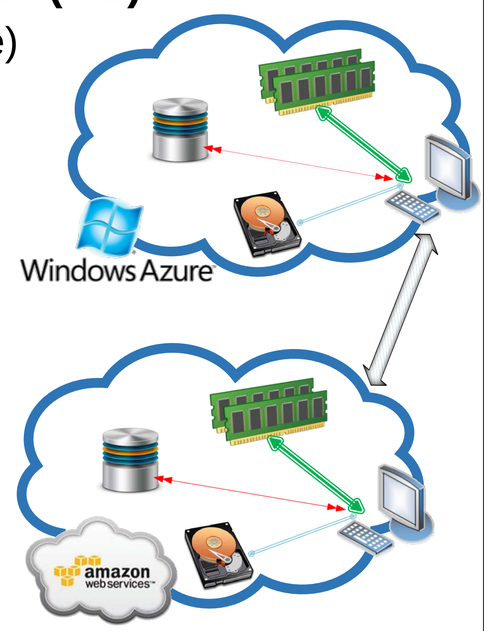
Tiera/Wiera: Towards Flexible Multi-Tiered Geo-Distributed Cloud Storage Instance

Students: Kwangsung Oh, Parag Panda and Ajaykrishna Raghavan
PIs: Abhishek Chandra and Jon Weissman
Department of Computer Science and Engineering
University Of Minnesota. Minneapolis, MN



Motivation

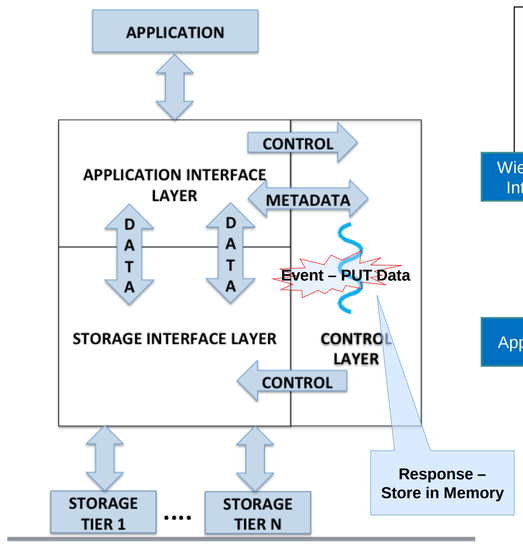
- **Storage Options in a Datacenter (DC)**
  - Memory (Elasticache, Memcache)
  - Block Device (Cinder, EBS)
  - Object Store (Swift, S3)
- **Public DCs and Edge Nodes**
  - Amazon, Microsoft, Google, …
- **Desirable Combinations**
  - Memcache + S3
  - EBS + Edge nodes' resource
  - Amazon memory + Azure disk
  - More combinations



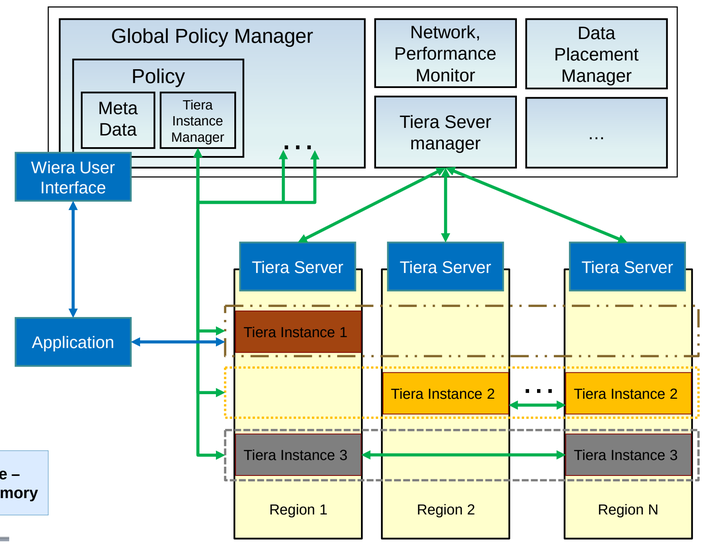
Each offers different performance, cost reliability guarantees, and interface

Tiera / Wiera Design & Architecture

- **Tiera handles multi-tiered storage within a single DC**
- **Wiera handles multiple Tiera instances across DCs**



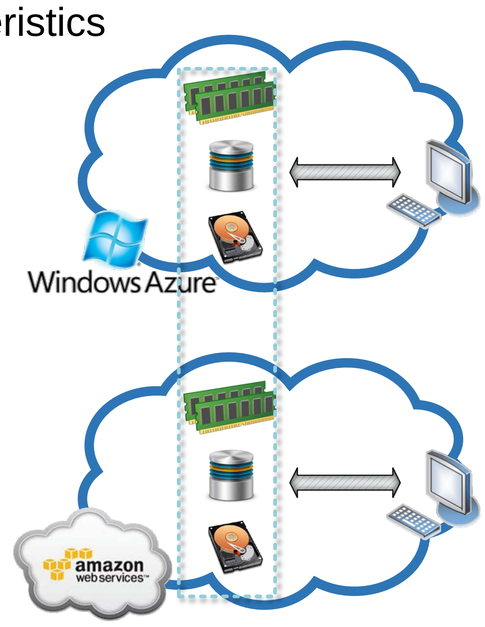
* Single Tiera instance



* Multi Tiera servers and instances managed by Wiera

Finish Line

- **A system that is aware of the different storage's**
  - Performance, Durability characteristics
  - Interfaces
  - Cost model
  - Locations (DCs or Edge Nodes)
- **Also knows the application's**
  - QoS requirements
  - Workload characteristics
  - Consistency model
  - Data durability requirement
  - Fault tolerance requirement



Generates and executes an optimal storage policy that hits the sweet spot in the tradeoff space!

Using Tiera / Wiera

Tiera **LowLatencyInstance**(time t) {
%two tiers specified with initial sizes
tier1: { name: Memory, size: 5G };
tier2: { name: EBS, size: 5G };

% Action event (data into memory first)
```
event (insert.into) : response {
    insert.object.dirty = true;
    store(what:insert.object, to:tier1);
}
```

%Threshold Event (1GB more memory)
```
event(tier1.filled == 75%) : response {
    grow(what: tier1, increment: 1GB);
}
```

%Timer Event (Data copy to disk)
```
event(time=t): response {
    copy(what: object.location == tier1,
         to: tier2);
}
```
}

Tiera **MultiPrimariesConsistency** (time t) {
% tiers on three datacenter (region)
```
region1 = { name: US-West,
            tier1: { name: Memory, size: 5G
            tier2: { name: EBS, size: 5G }};
region2 = { name: US-EAST,
            tier1: { name: Memory, size: 5G
            tier2: { name: EBS, size: 5G }};
region3 = {name: US-CENTRAL,
            tier1: {name: S3, size: 20G}};
```

% Action event (replicating data to other DCs)
```
event (insert.into) : response {
    lock(what:insert.key)
    store(what:insert.oject, to: local.tier1)
    copy(what:insert.object, to: regions.tier1)
    unlock(what:insert.key)
}
```

%Timer Event (for reduced cost)
```
event(time=t): response {
    move(what: cold_object_data,
         to: region3.tier1);
}
```
}

Challenges

- **Scalability**
  - Millions of objects
  - Millions of requests per second

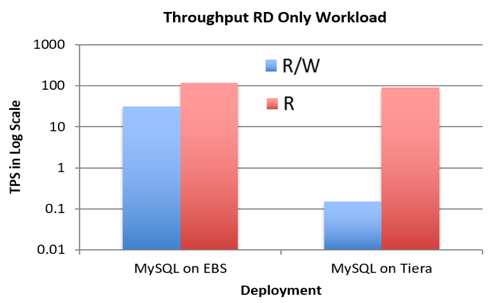
- **Metadata Management and System Monitoring**
  - Ensure durability
  - Efficient metadata lookup
  - Minimizing impact on workload
  - Characterize application workload

- **Detecting and Avoiding Conflicting Policy Actions**
  - Back up data while serving requests
  - Dynamic re-configuration without affecting performance

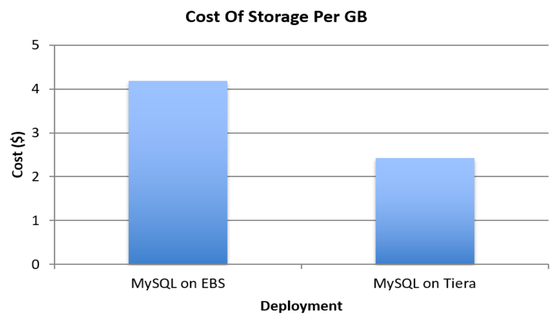
- **Achieving Required Quality of Service**
  - Deal with Multi-tenancy
  - Characterizing cloud storage

Quality of Service

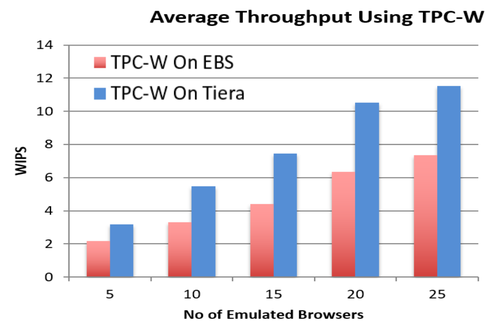
Evaluation



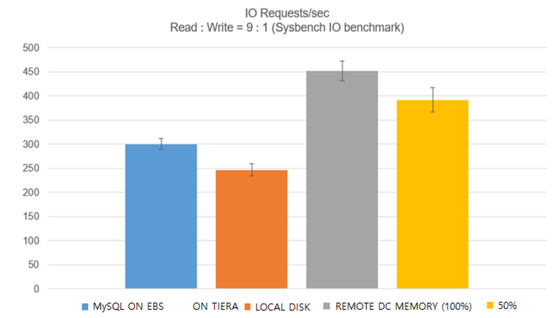
Improve performance for read only Workload



Reducing cost



Better Throughput of TCP-W benchmark



Performance benefit using near DC memory