ICON: Intelligent Container

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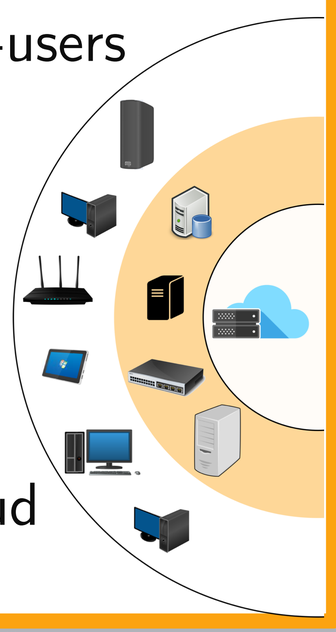
Edge Computing

Edge Compute servers closer to end-users

- Lower application latency
- Data aggregation for lower bandwidth usage
- Locality of computation



Killer Applications

AR/VR, Vehicular networks, Cloud gaming, Industry 4.0, IoT etc.

Design Goals

- **Open infrastructure**. Not CDN for services!
- **Decentralized**. No single point of failure
- **Local decision making**. Better performance
- **High-level objective control**
- **Autonomous operation**. Dynamic adaptation

Independent Edge Providers

Facility where any service can be deployed

Operated by

- **Cloud**: CloudFront, Azure Stack, ...
- **Telco**: MEC, Anveshak [1], ...
- **Crowdsourced**: iExec, Golem, ...

Configuration

- Software: Kubernetes, Mesos, Docker Swarm ...
- Processing: GPU, TPU, mobile CPU ...
- Networking: Any kind, various latencies

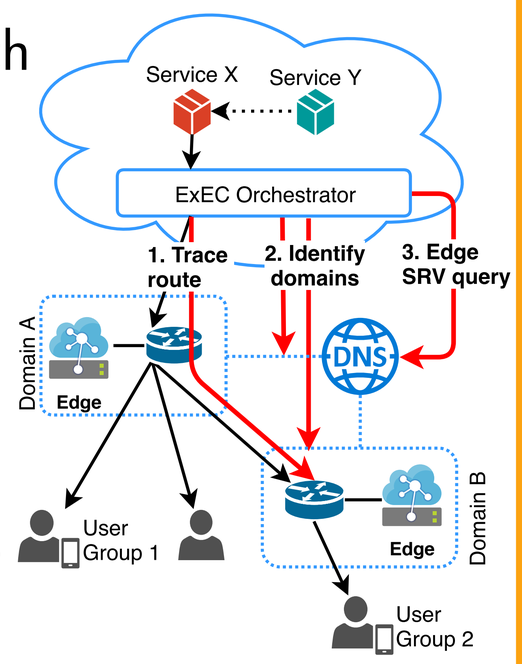
Discovery of Edge Providers

Assumption

Edge providers register with DNS SRV record

ExEC Discovery [2]

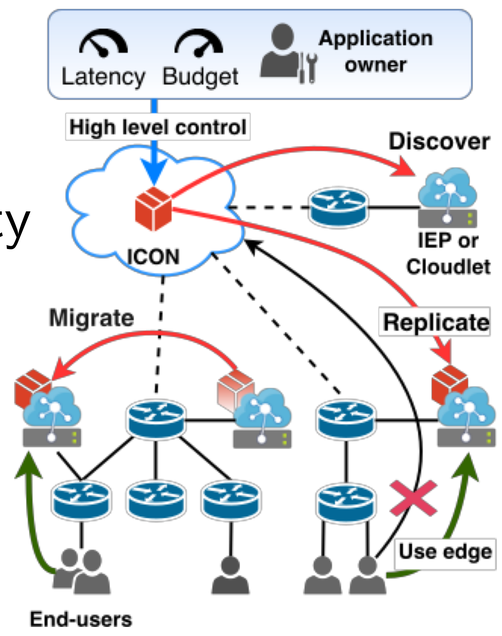
- Traceroute to clients
- Identify on-path DNS domains
- Perform SRV query
- Build network topology of on-path edge providers



System Overview

Self-managing container encapsulating service which adapts to changing environment

Objective ⇣ User latency
⇣ Provider operation cost
⇣ Platform control complexity



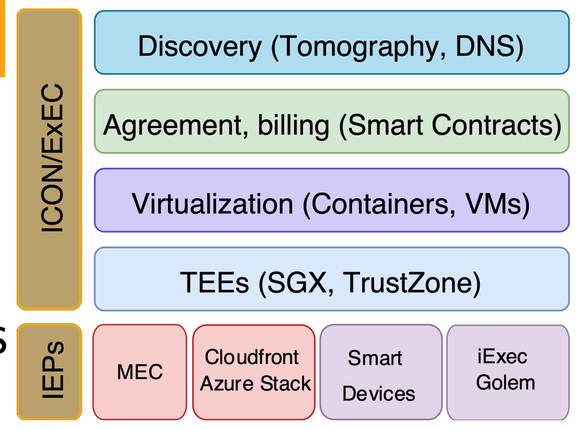
ICON Operation [3]

- Monitoring user requests
- Discover edge providers
- Migrate/Replicate
- User redirection to new edge server

Building Blocks

Based on existing tools & technologies

Migration → Docker
Discovery → traceroute
Security → SGX Enclaves
Agreement → Ethereum



ICON Lifecycle

START

- Deploy origin(s)
- Secure budget from provider
- Activate at provided timeslot

ACTIVE

Constantly monitor IEP locations & user requests

I. Migration

- Move to a new IEP offering better *utility*
- Install redirection stub

II. Replication

- Spawn copy on new IEP
- Split operation budget

TERMINATE

- Assign child ICONs to parent
- Distribute budget to children
- Redirect clients to parent
- Relinquish resources

Open Questions

- Intelligence of the platform
- Negotiation protocol
- Open marketplace for edge providers [4]
- Decentralized agreement
- Billing & payment
- Unfair crowdsourced participants
- Transparent service discovery?

References

[1] Mohan, Nitinder, et al. "Anveshak: Placing edge servers in the wild." 2nd *Workshop on Mobile Edge Communications*
[2] Zavodovski, Aleksandr, et al. "ExEC: Elastic Extensible Edge Cloud." 2nd *Workshop on Edge Systems, Analytics and Networking.*
[3] Zavodovski, Aleksandr, et al. "ICON: Intelligent Container Overlays." *17th ACM Workshop on Hot Topics in Networks.*
[4] Zavodovski, Aleksandr, et al.,"DeCloud: Truthful Decentralized Double Auction for Edge Clouds." ICDCS 2019