SoCC'22 serverless session notes

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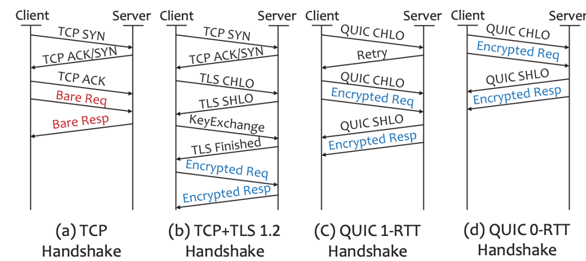
Serverless session in SoCC'22

1. QFaaS: Accelerating and Securing Serverless Cloud Networks with QUIC
2. Cypress : Input size–Sensitive Container Provisioning and Request Scheduling for Serverless Platforms
3. Method Overloading the Circuit
4. Hermod: Principled and Practical Scheduling for Serverless Functions
5. SIMPPO: A Scalable and Incremental Online Learning Framework for Serverless Resource Management
6. SimLess: Simulate Serverless Workflows and Their Twins and Siblings in Federated FaaS

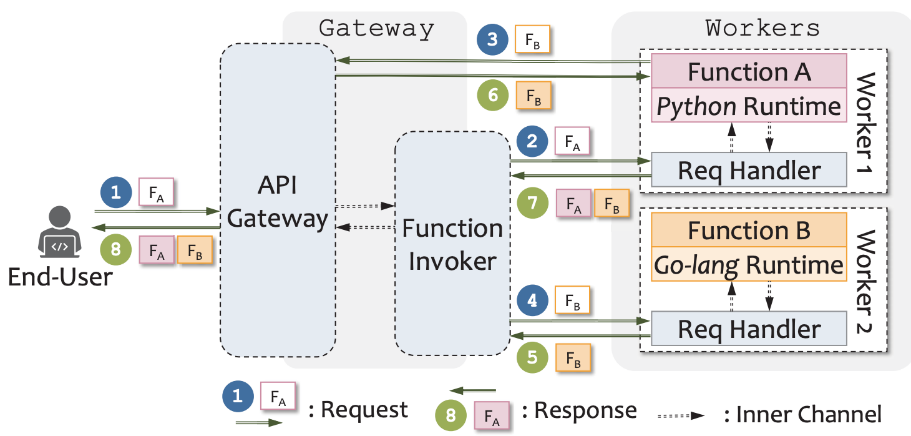
QFaaS: Accelerating and Securing Serverless Cloud Networks with QUIC

- QUIC-based FaaS framework on **OpenFaaS** platform
- **Problem they claim**
  - huge internal network communications between latency sensitive serverless features such as agile autoscaling and function chains;
  - Currently serverless providers sacrifice security for performance by keeping those communications unencrypted
- **Proposed solution**
  - Using QUIC instead of TCP for internal communication
  - Define Serverless Architecture in Network-centric View
  - Optimize Internal communication on top of QUIC(QUIC Server, QUIC Client)
- Their tests show QFaaS can reduce communication latency for single functions and function chains by 28% and 40%, respectively, and save up to 50 ms in end-user response time.



Scheme	TCP	TCP + TLS 1.2	QUIC 1-RTT	QUIC 0-RTT
New Session	1	3	1	-
Recover Session	1	2	1	0

Figure 1: Round-trips in different transport protocols: **(a)** insecure TCP incurs 1 extra RTT; **(b)** in TCP+TLS 1.2 scheme, the encrypted request is sent after 3 RTTs; **(c)** in QUIC 1-RTT mode (new session establishment), the encrypted request is sent after 1 RTT; **(d)** in QUIC 0-RTT (session resumption), the encrypted request is sent immediately.



(b) Serverless Architecture in Network-centric View

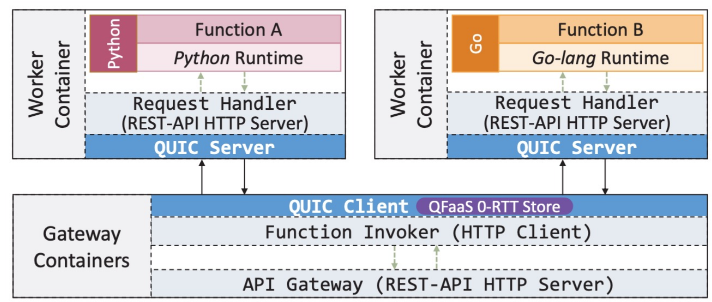


Figure 3: System Design of QFaaS. QUIC client and QUIC servers are integrated into Function Invoker and worker request handlers to replace the TCP/TLS client and servers. This modification is transparent to cloud tenants and ensures the activation of the QUIC 0-RTT feature.

[Cypress : Input size–Sensitive Container Provisioning and Request Scheduling for Serverless Platforms](#)

- **Problem**
  Existing serverless resource management frameworks are agnostic to the input size–sensitive nature of these apps

- Cypress propose an input size-sensitive resource management framework

- Their experimental results show up to 66% less container spawns, improving container utilization and saving cluster-wide energy by up to 2.95X and 23%

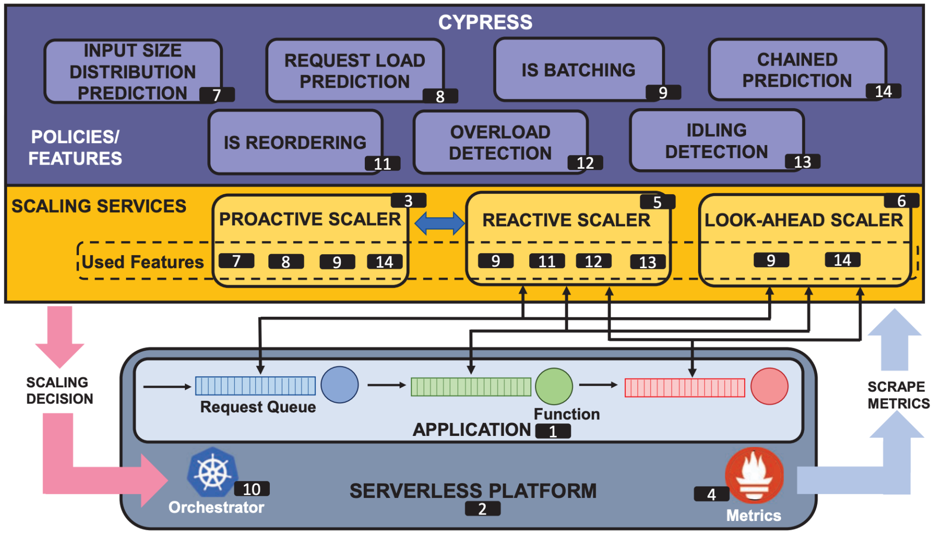
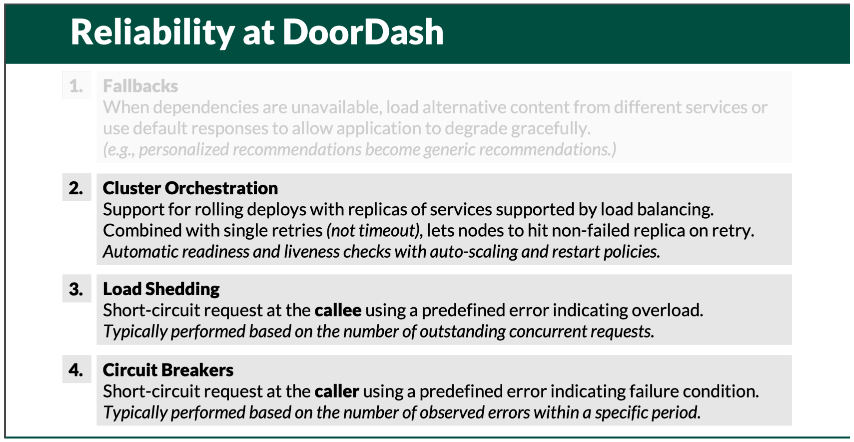
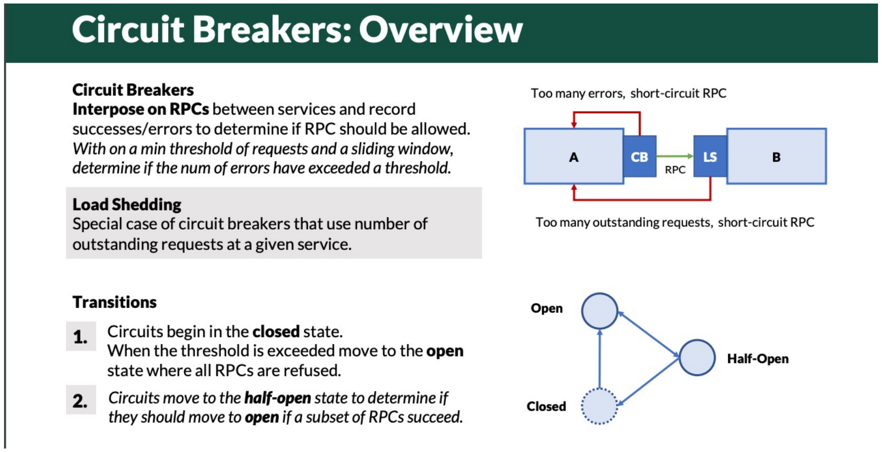


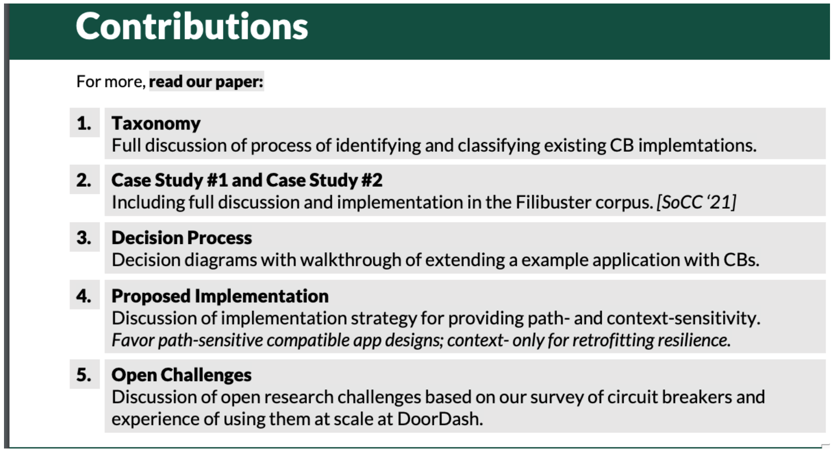
Figure 7: High-level view of *Cypress*'s design.

Method Overloading the Circuit

Case study for DoorDash's Circuit breaker behavior in its microservice architecture composed of 500+ services.







Hermod: Principled and Practical Scheduling for Serverless Functions

A **Scheduler for Serverless Functions** with two key characteristics

- a combination of early binding and processor sharing for scheduling at individual worker machines to avoid head-of-line blocking due to high function execution time variability.
- Cost, load, and locality-aware. It improves consolidation at low load, it employs least-loaded balancing at high load to retain high performance, and it reduces the number of cold starts compared to pure load-based policies.
- Build on open-source serverless platforms, Apache ***OpenWhisk***(it powers IBM's commercial serverless offering).

Serverless schedulers need to be:

- Load-aware
- Cost-aware
- Locality-aware

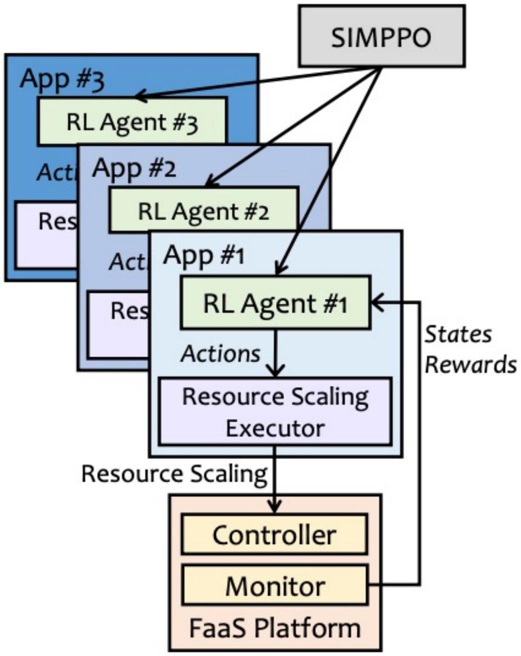
Hermod achieves these goals using three key techniques:

✓ Early Binding
✓ Hybrid Load Balancing
✓ Processor Sharing

SIMPPO: A Scalable and Incremental Online Learning Framework for Serverless Resource Management

SIMPPO: Scalable and Incremental MARL

- Two building blocks of SIMPPO
  - Virtual agent
  - Auxiliary global system states
- Applied SIMPPO to multi-dimensional autoscaling of serverless platforms
  - Based on the state-of-the-art RL algorithm – PPO (Proximal Policy Optimization)
  - Serverless platform: OpenWhisk
- Evaluated SIMPPO on 12 open-source serverless benchmarks
  - Function invocation patterns from Azure Functions traces
- **RQ1: Incremental training?**
- **RQ2: Online policy-serving performance?**



[SimLess: Simulate Serverless Workflows and Their Twins and Siblings in Federated FaaS]

An FC(function choreographies) simulation framework for accurate FC simulations across multiple FaaS providers with a simple and lightweight parameter setup with two light concepts:

- ***Twins***, representing the same function deployed with the same computing, communication, and storage resources, but in other regions of the same FaaS provider,
- ***Siblings***, representing the same function deployed in the same region with different computing resources.

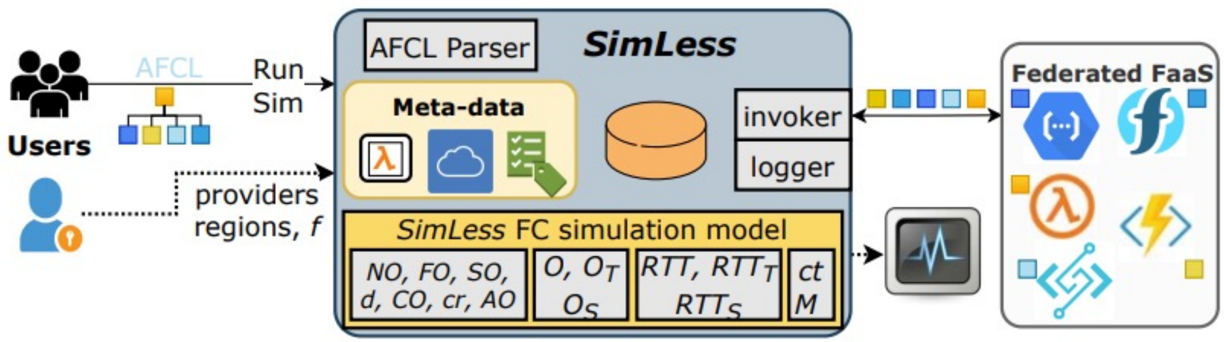


Figure 4: *SimLess* system architecture.

Current Serverless Limitation and how XDP/eBPF may help?

- Existing framework limitations
  - Still in the early stage, mostly suitable to simple workload of independent tasks and/or well tailored proprietary service offerings from the vendors
  - Limitation in AWS Lambda(2019):
    - Limited Lifetimes – 15 mins
    - I/O Bottlenecks -- 538Mbps network bandwidth, an order of magnitude slower than a single modern SSD
    - Communication Through Slow Storage
    - No Specialized Hardware
  - Academia think existing serverless offering is "***one step forward, two steps back***", more to be studied

- Use Case deep dive
  - QFaaS as an example, tries to address both security and latency issues in serverless framework

- Which serverless frameworks to start?
  - Opensource frameworks:
    OpenFaaS, OpenWhisk
  - Cloud provider solutions:
    AWS Lamba, Azure Functions, Google Cloud Functions, etc.

- Potential approach
  - ***Target desirable application in a particular serverless framework, analyze it and try further optimize overall performance with XDP/eBPF technologies***