FaaSNet: Scalable and Fast Provisioning of Custom Serverless Container Runtimes at Alibaba Cloud Function Compute

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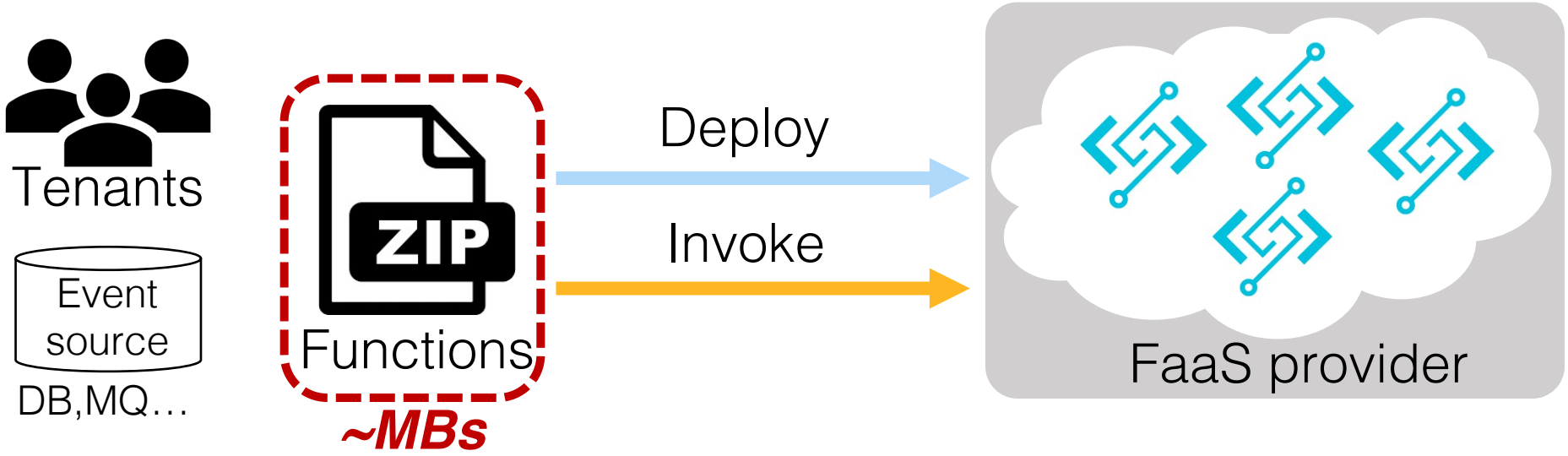
Function-as-a-Service

- FaaS enables cloud tenants to launch short-lived tasks (i.e., Lambda functions) with ***high elasticity*** and ***fine-grained*** resource billing (1ms)
- Function: basic unit of deployment. Application consists of multiple serverless functions
- Popular use cases: Backend APIs, event/async processing…



➢ ***FaaS providers*** normally limit tenants ***code package*** in tens of ***MB level***

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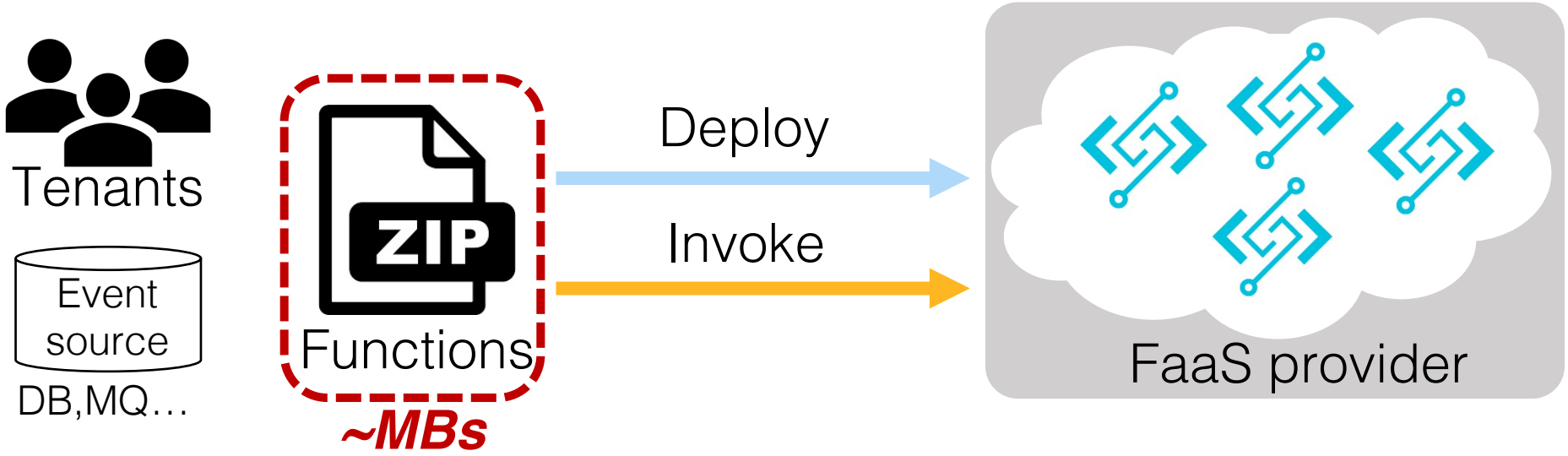
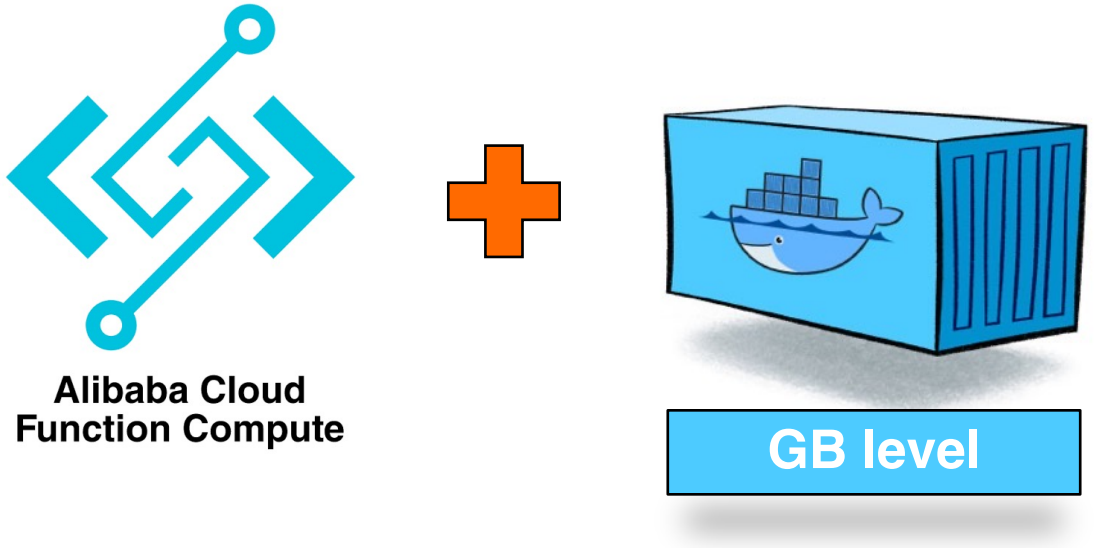


FaaS and custom-container runtimes



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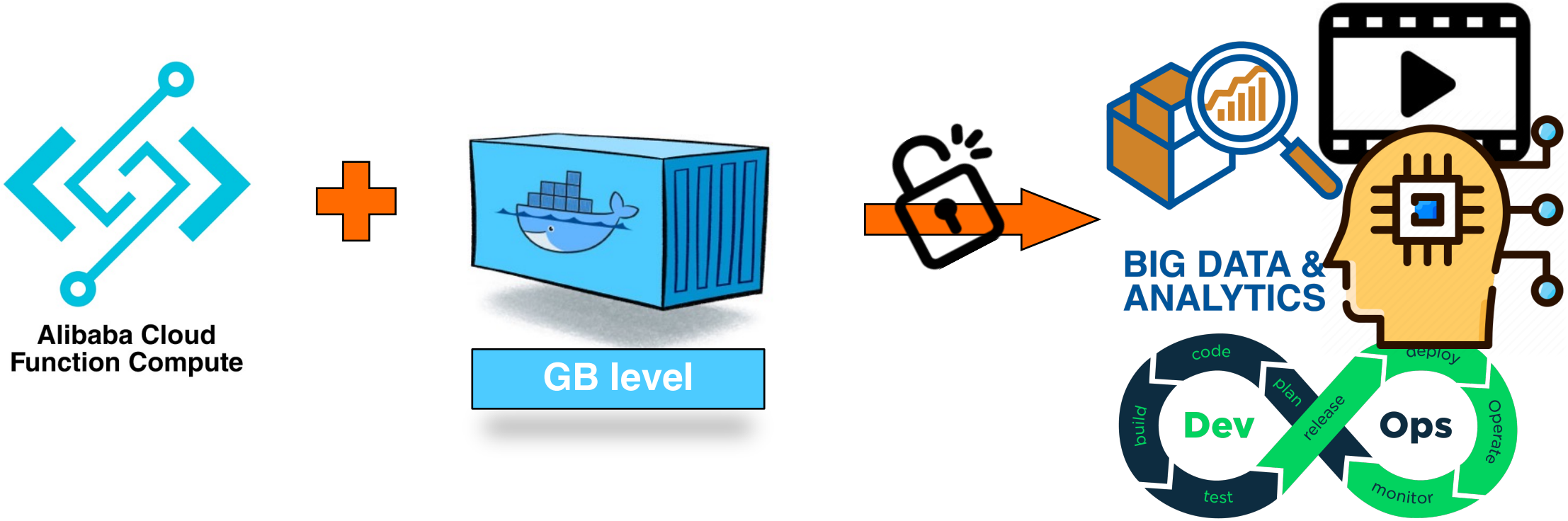


➢ ***FaaS + container*** unlocks new workload possibilities and makes ***serverless*** accessible to ***a broader audience***

FaaS and custom-container runtimes

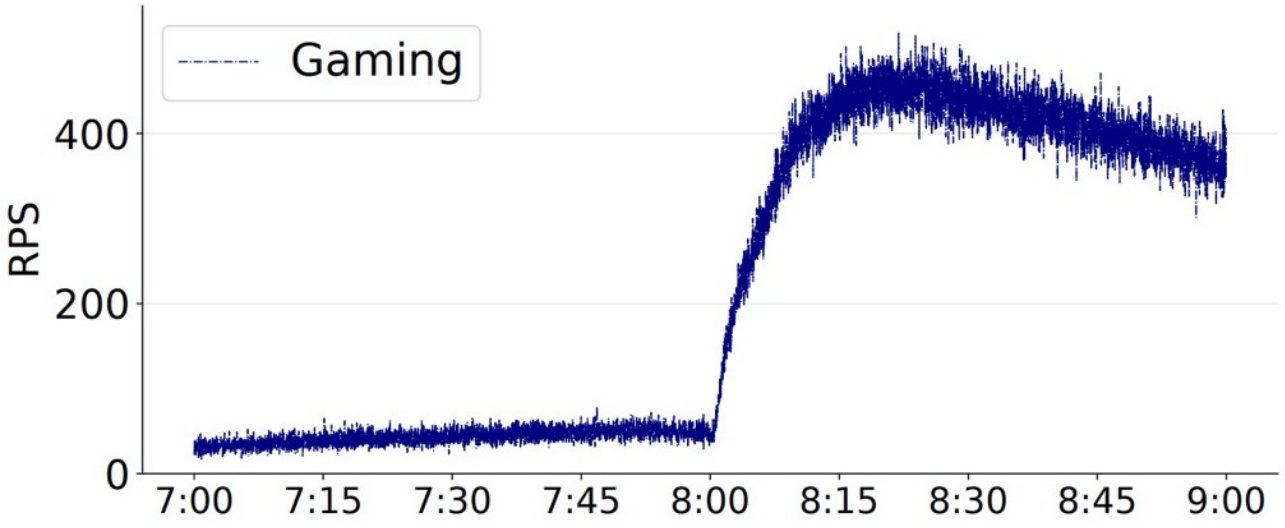
	Container	FaaS
Application transplant	Builds once, runs anywhere	Cloud vendor lock-in
Dev tools	open source ecosystems	Cloud vendor lock-in
CI/CD	open source ecosystems	Cloud vendor lock-in
Scalability	Second level	Millisecond level
Runtimes	Custom	Provided runtimes

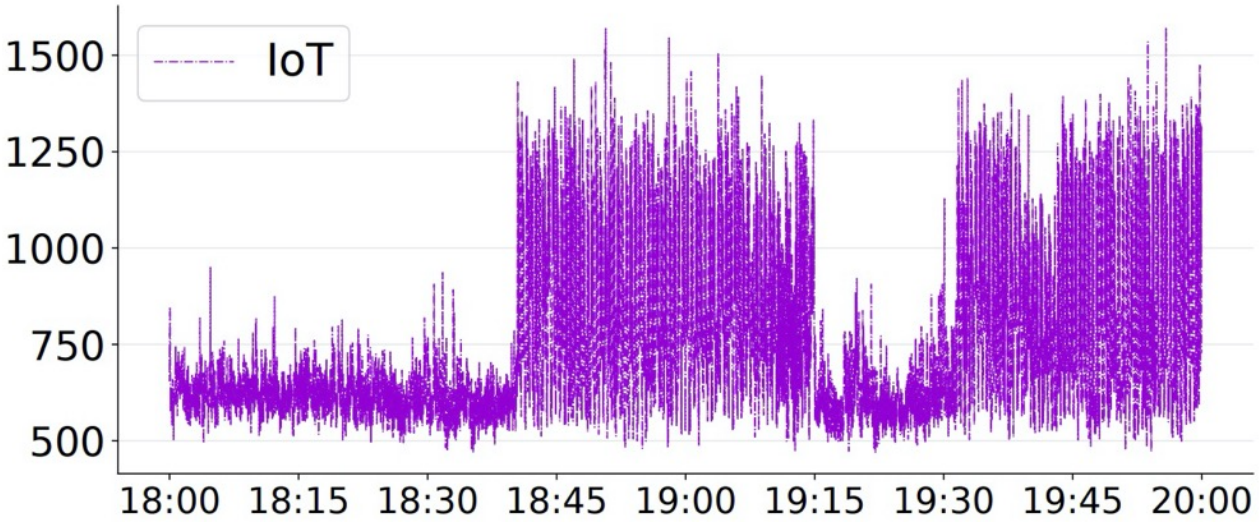
➢ ***FaaS + container*** unlocks new workload possibilities and makes ***serverless*** accessible to ***a broader audience***

Workload analysis

- Alibaba Cloud Function Compute 15-day-production log during May 2021
- Data centers: Beijing, Shanghai

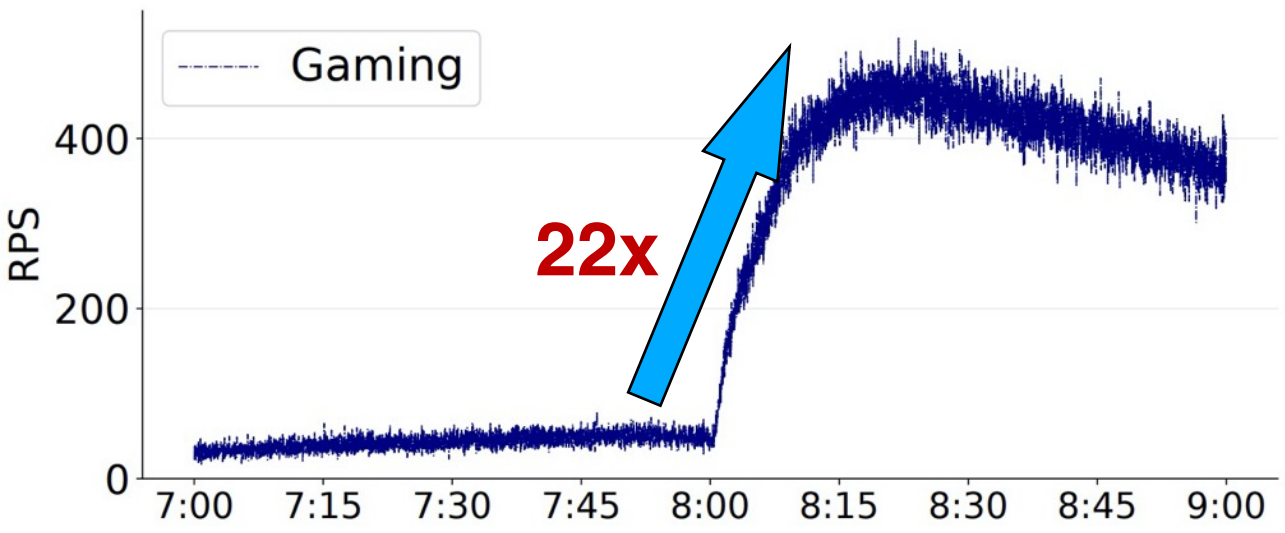
Workload analysis

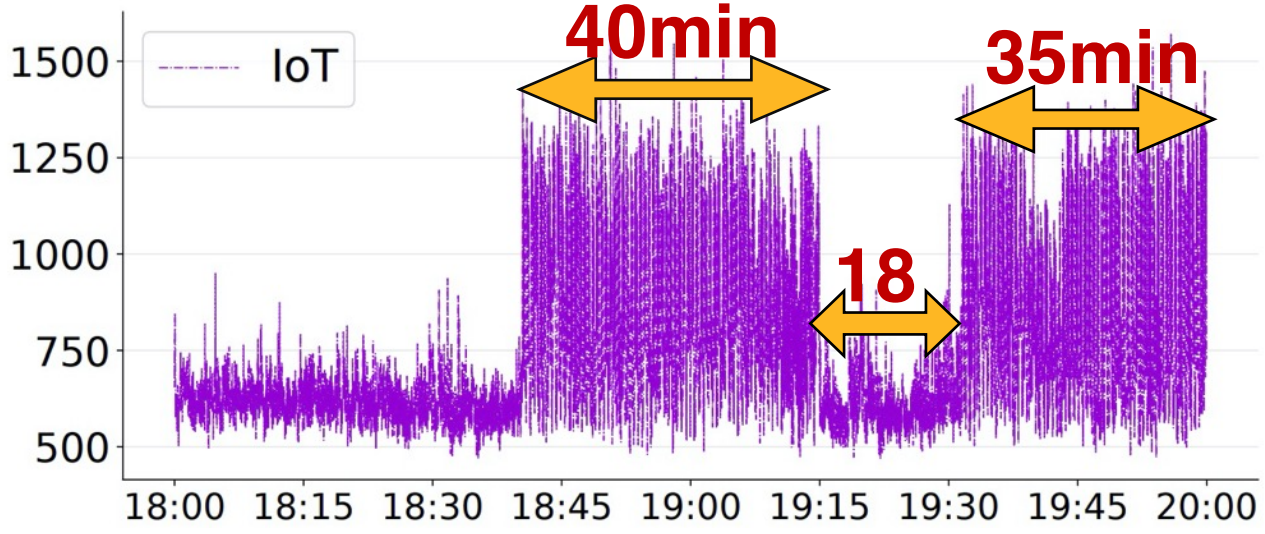




FaaS workloads are ***bursty*** and ***dynamic***

Workload analysis





FaaS workloads are ***bursty*** and ***dynamic***

Workload analysis

- Image pull latency distribution
- Proportion of image pull in function cold start

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Pull image in tens second level

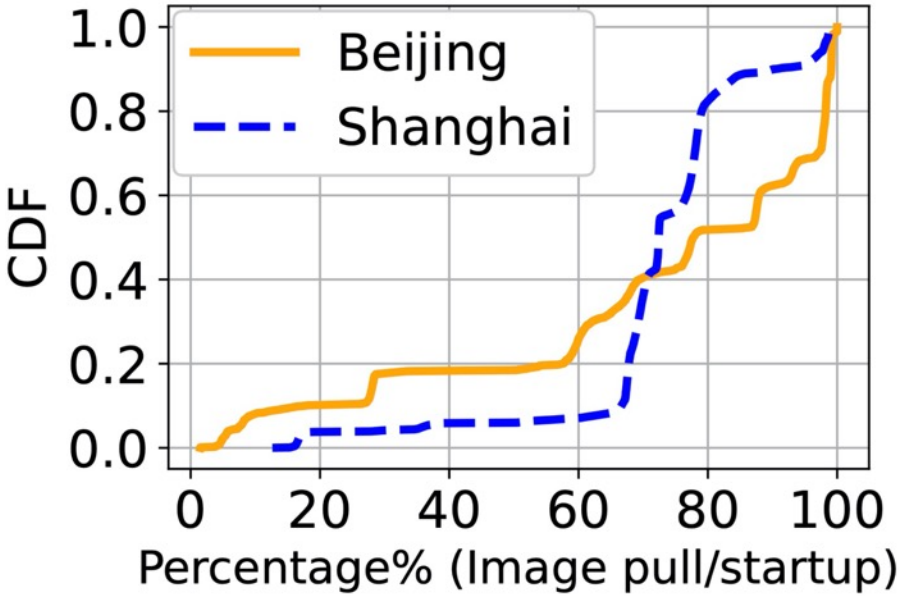
➢ 57% image pulls larger than 45 seconds

Workload analysis

- Image pull latency distribution
- Proportion of image pull in function cold start

Image pull dominates function startup time

➢ A large fraction of startup time is spent on pulling images



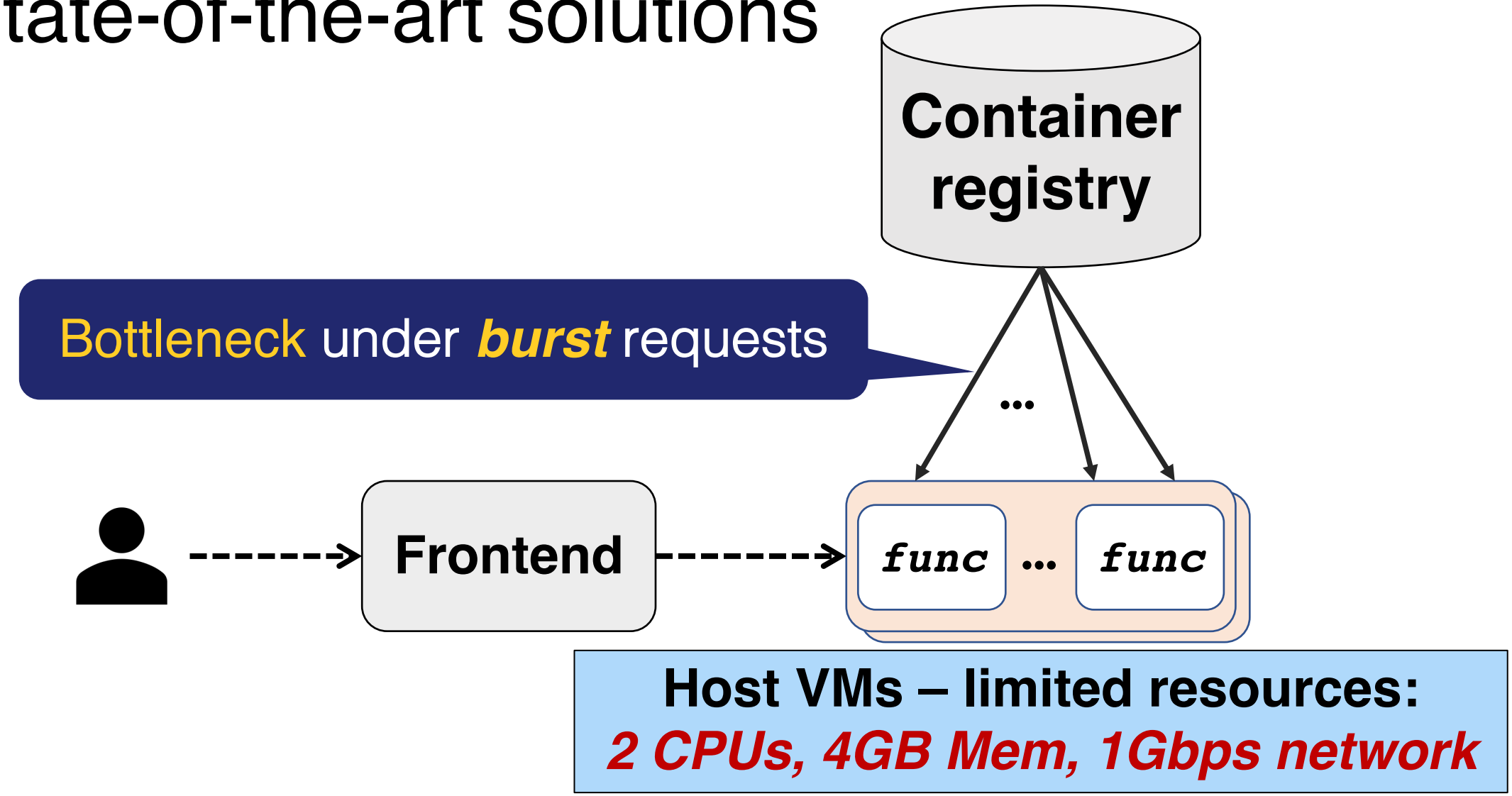
Workload analysis

- Image pull latency distribution

- ***To handle workload dynamicity*** -> Scalable and resilient provisioning of large numbers of function containers

- ***To reduce cold start latency*** -> Optimize the performance of container provisioning process

State-of-the-art solutions



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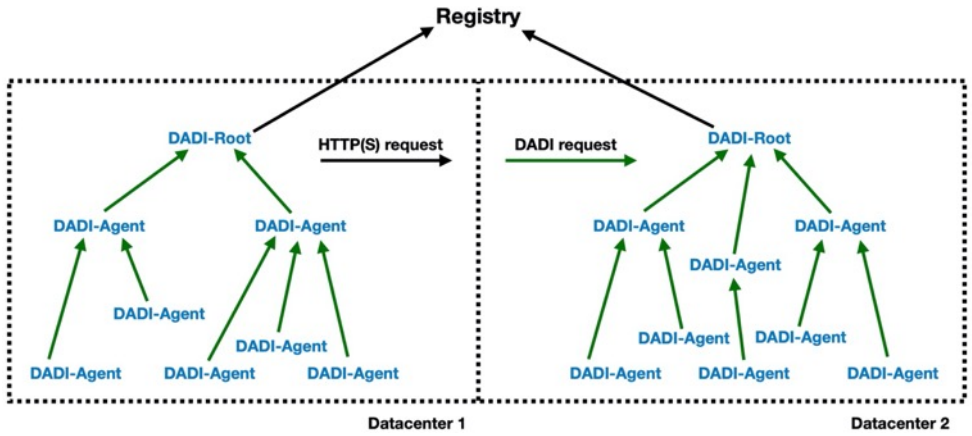

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Problems:

- ***Extra, dedicated, centralized*** components
- ***Limited*** VM resources
- VM's lifecycle is ***unpredictable***
- ***Multi-Tenancy isolation under FaaS*** is not considered

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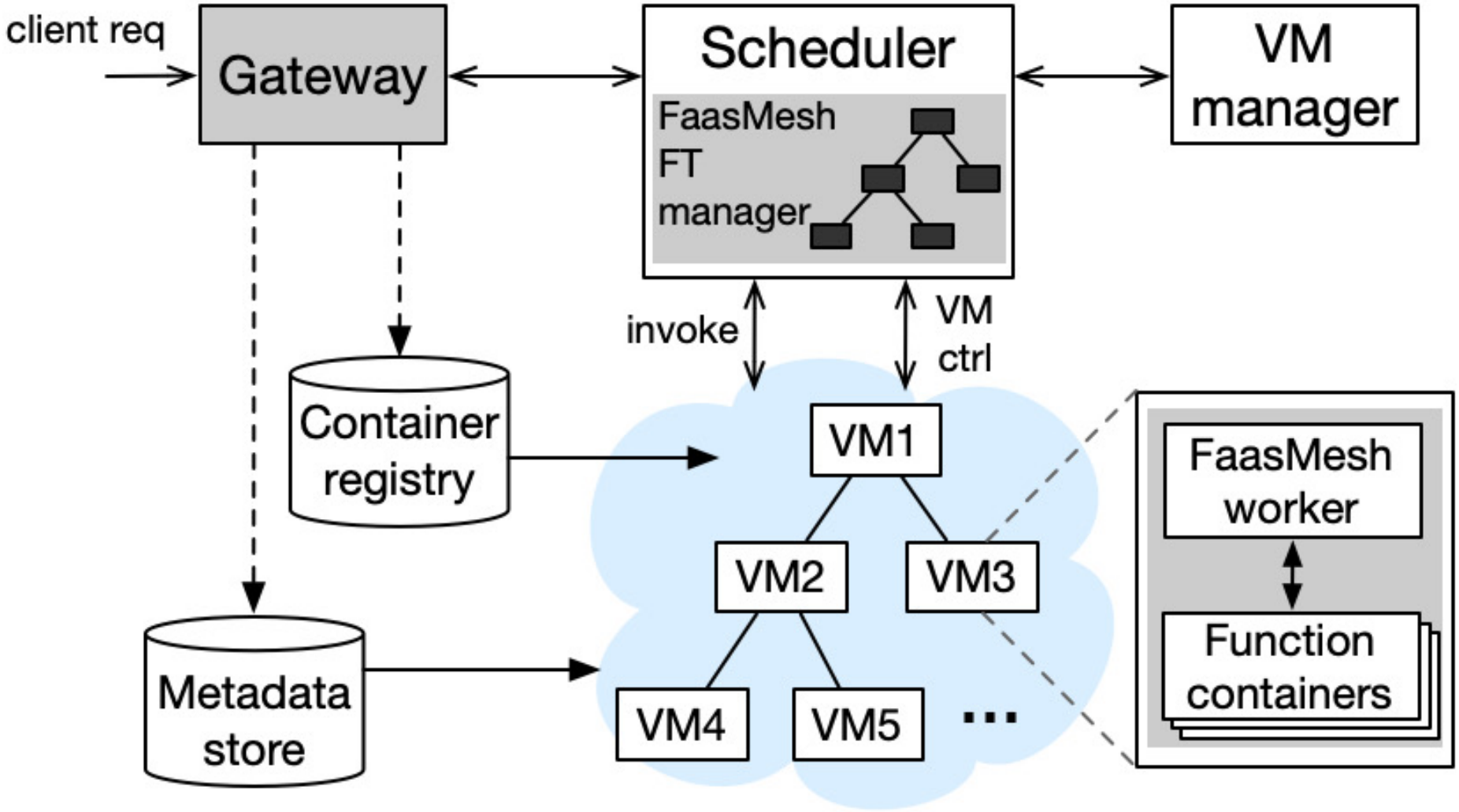
Agenda

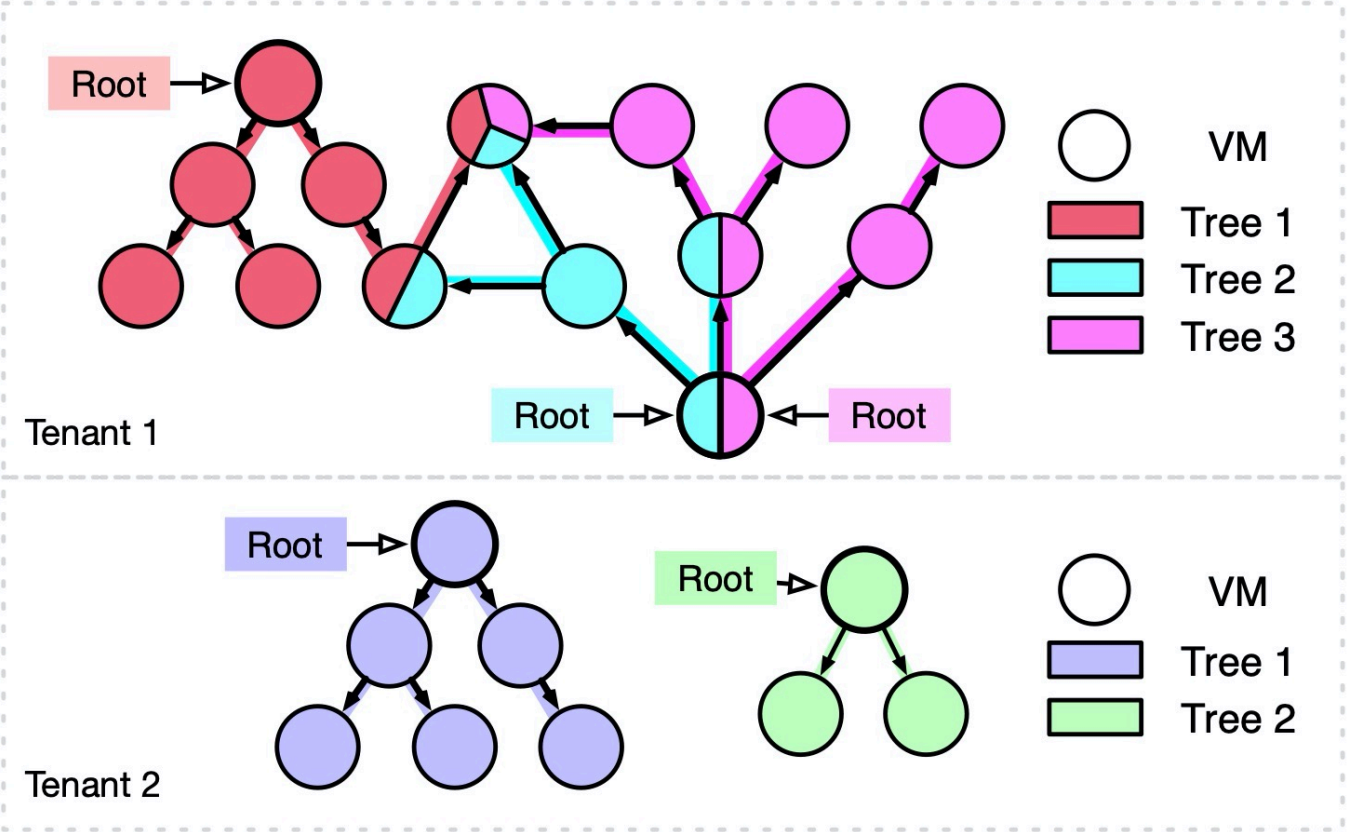
- FaaSNet design
- Evaluation
- Conclusion

FaaSNet design

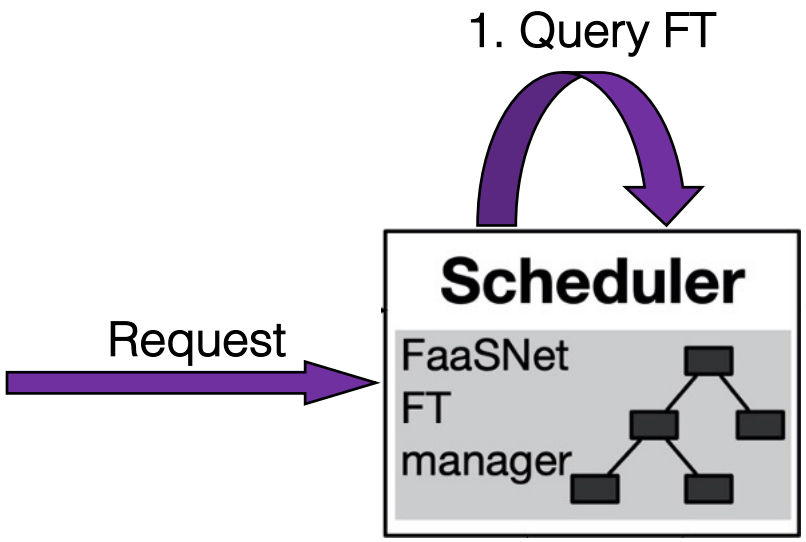


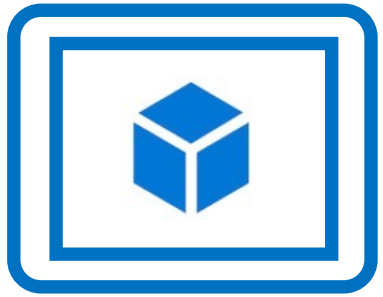
Function tree (FT)

- FT is perfect self-balanced binary tree in ***Function*** level
- Exposed 2 APIs
  - `insert`
  - `delete`

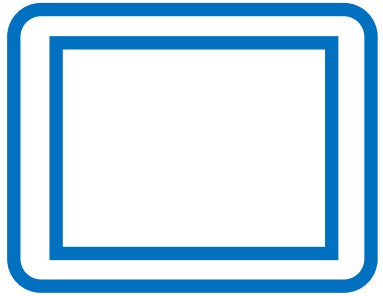


Container provisioning protocol

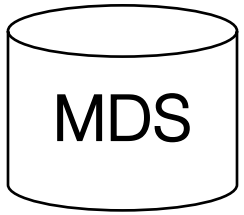




VM2 - Upstream



VM1 - Downstream

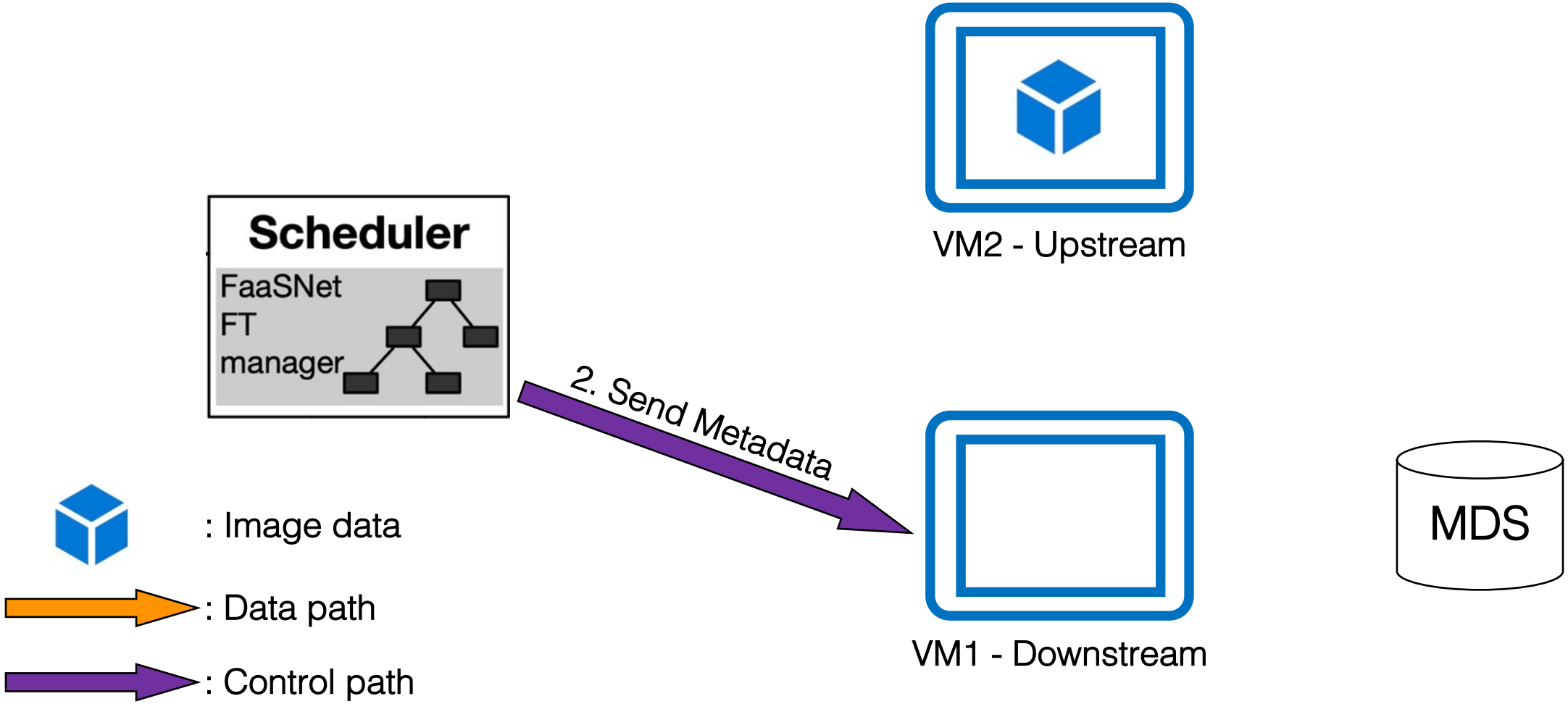


: Image data

: Data path

: Control path

Container provisioning protocol



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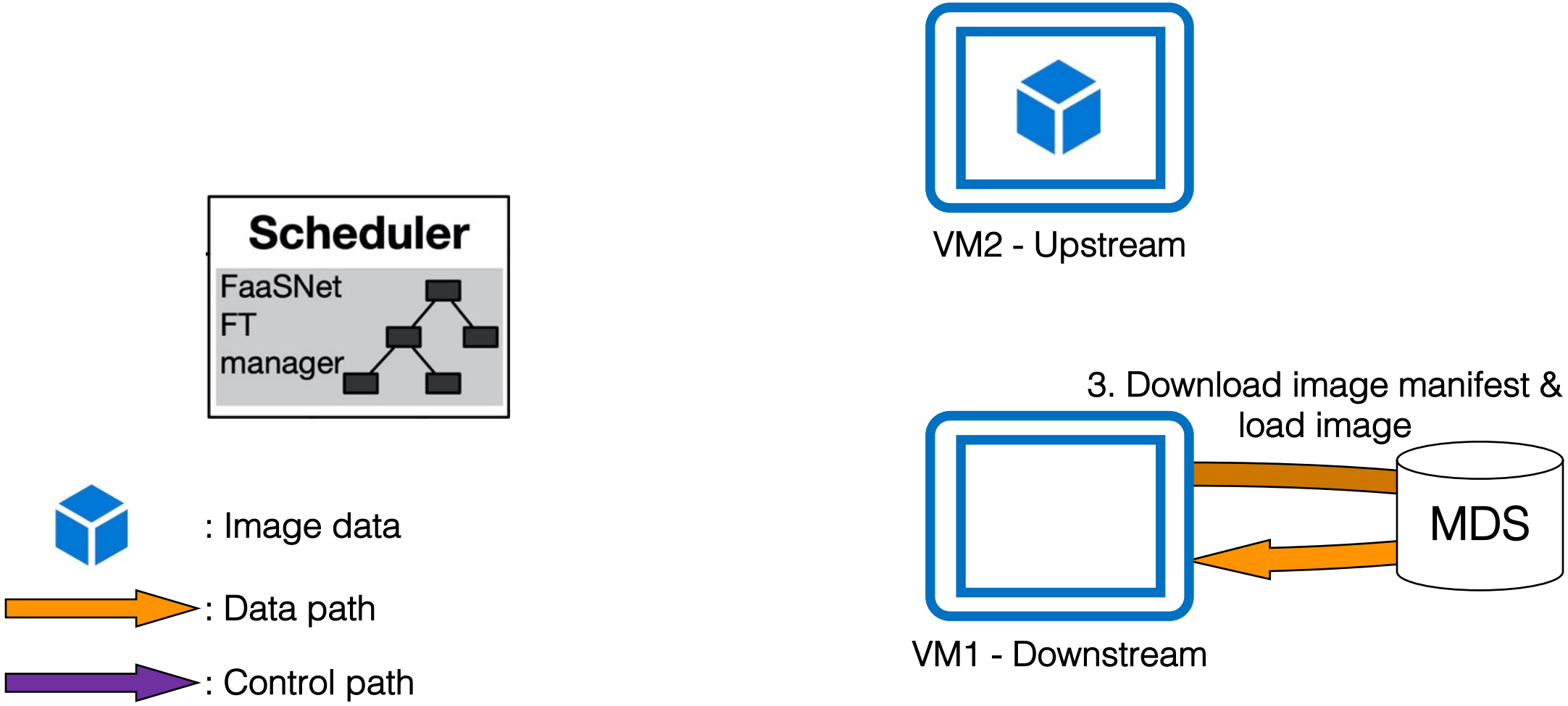

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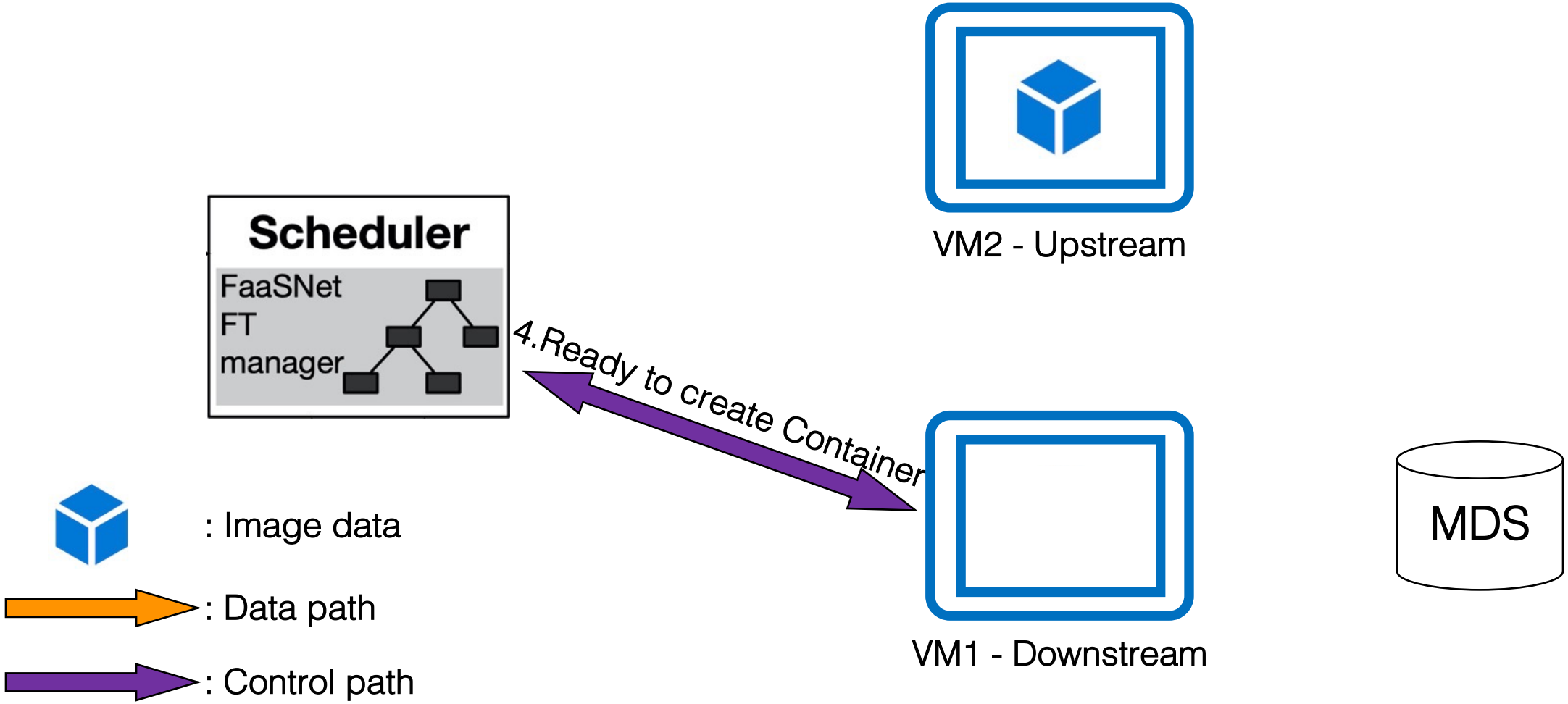

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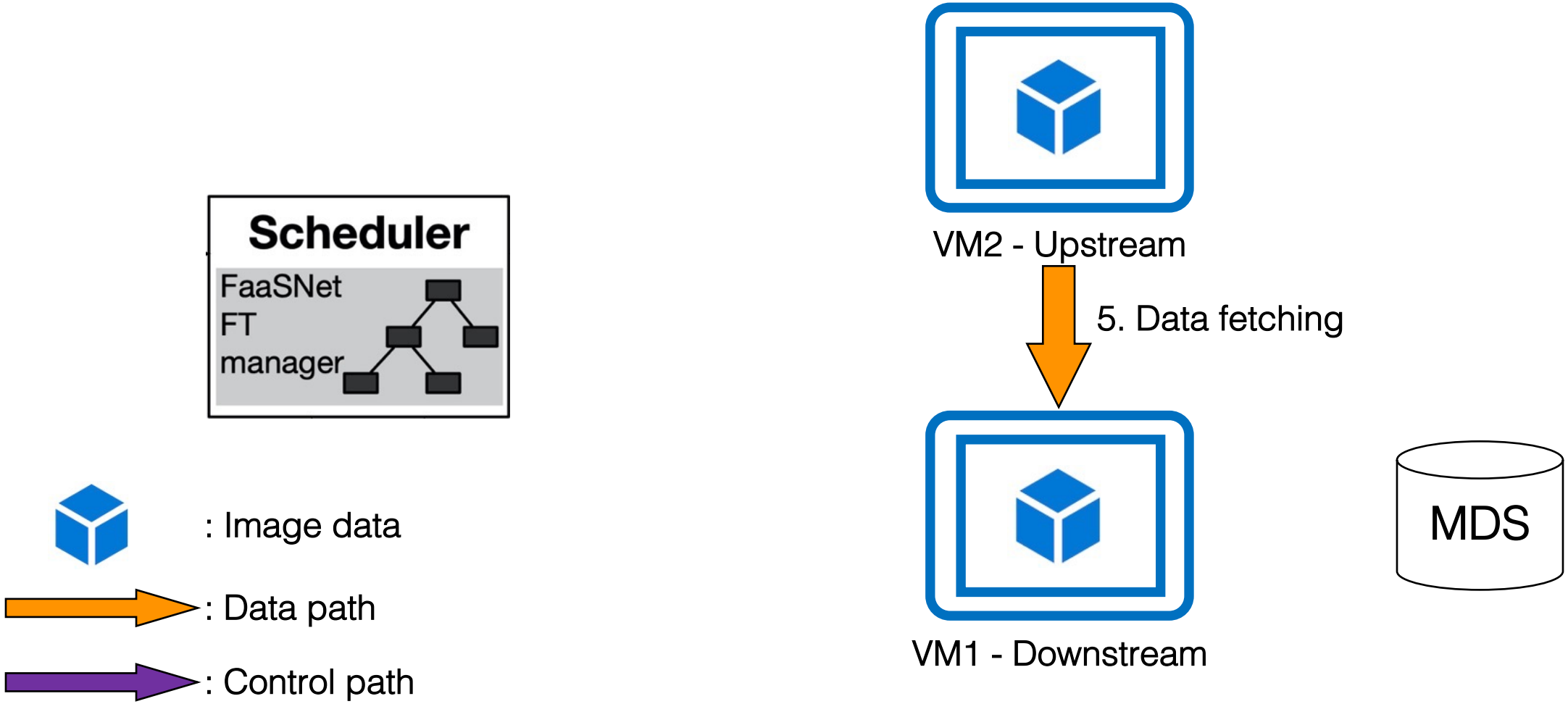

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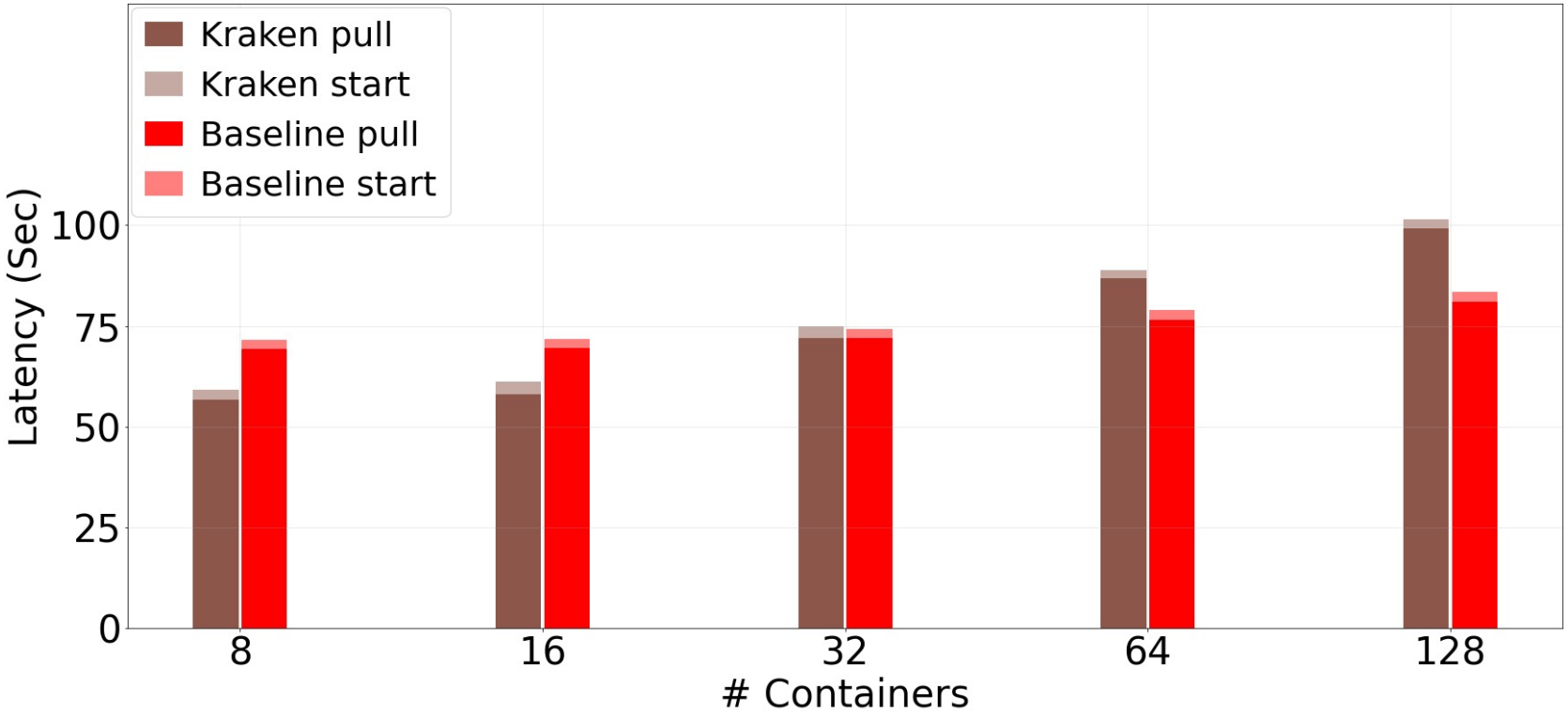
Experimental setup

- Testbed is up to 1,000 VMs
- VM type: 2 CPUs, 4 GB memory, 1 Gbps network
  - Same as our production environment
- Example container image
  - 758 MB python-based function with ~2 sec duration

FaaSNet's performance

Kraken: Kraken dev cluster

Baseline: Original Alibaba Cloud Function Compute



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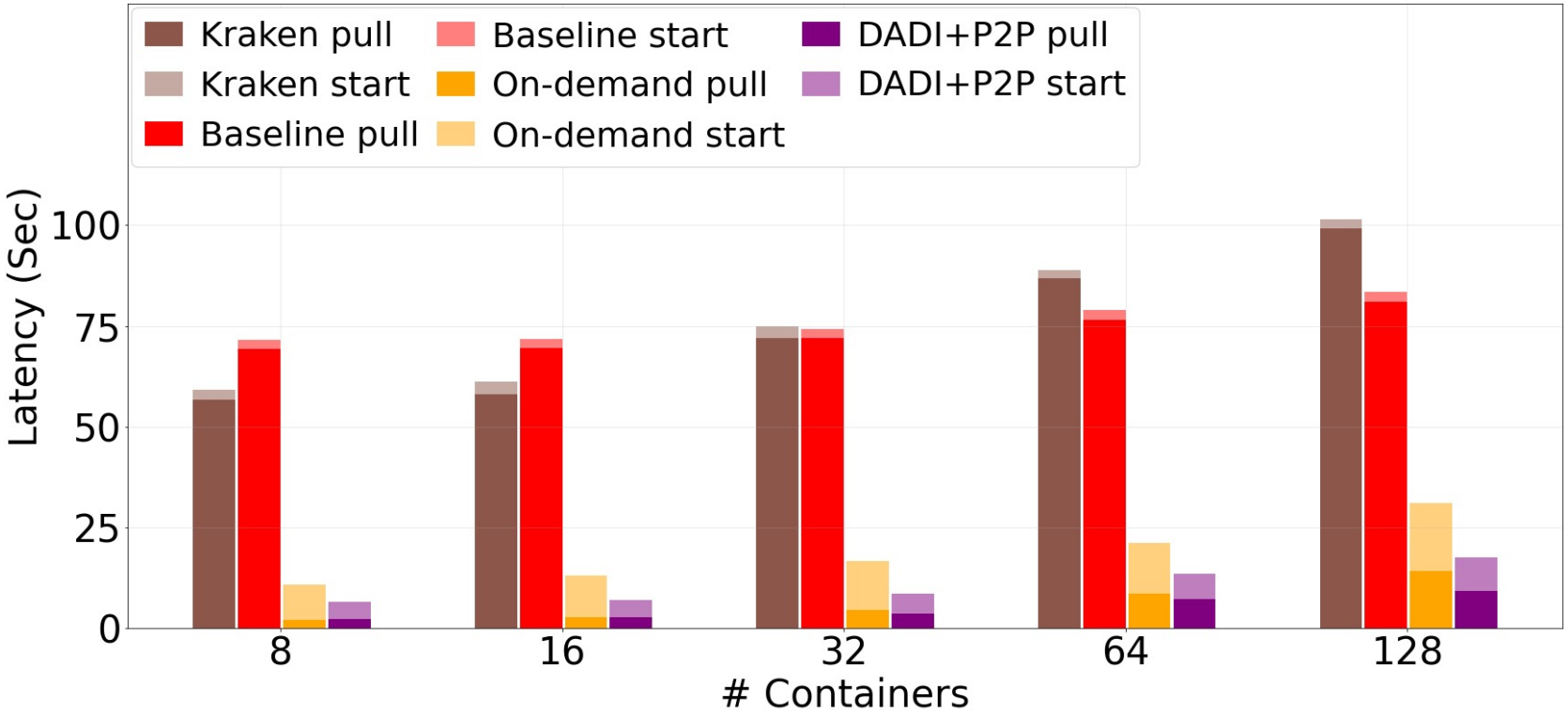
On-demand: FC + I/O efficient format

DADI+P2P: FC + DADI



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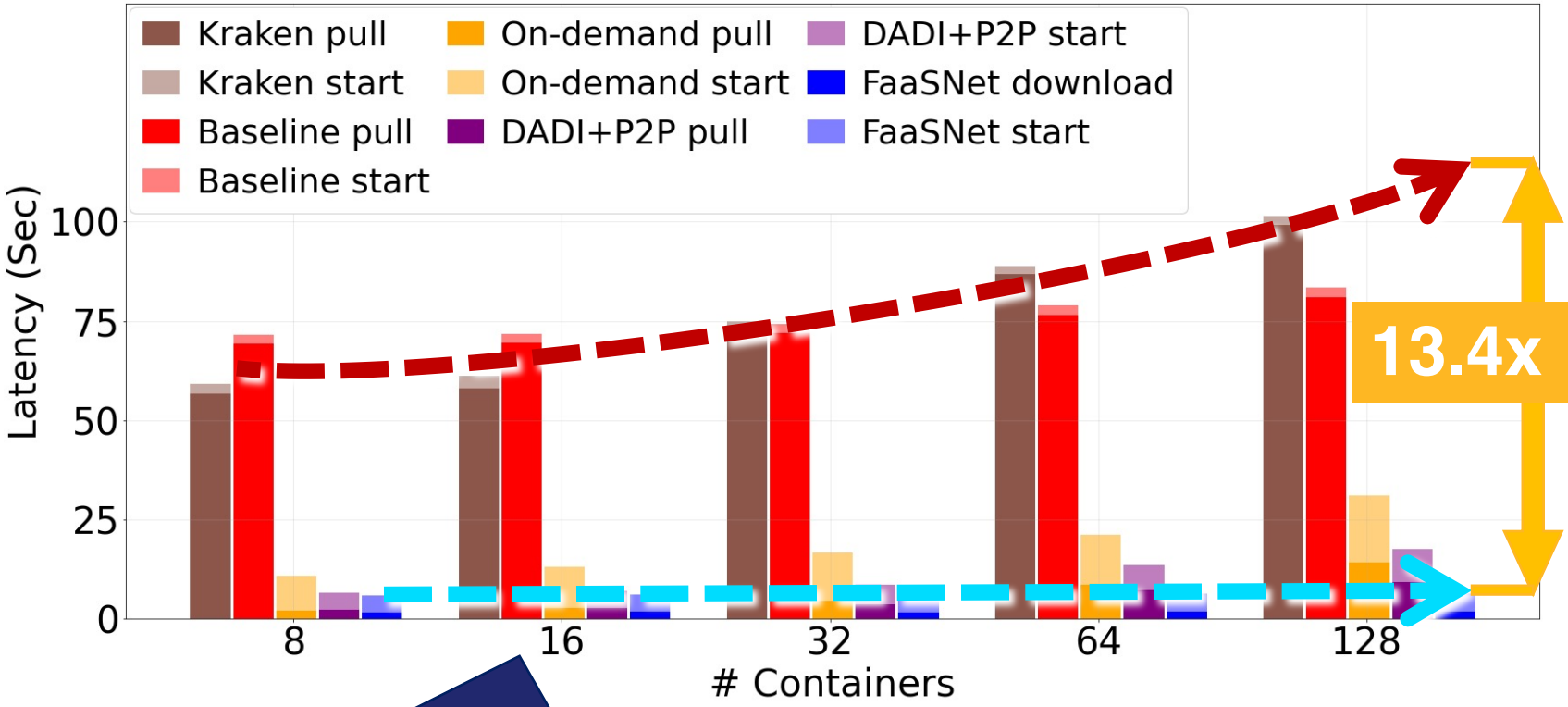
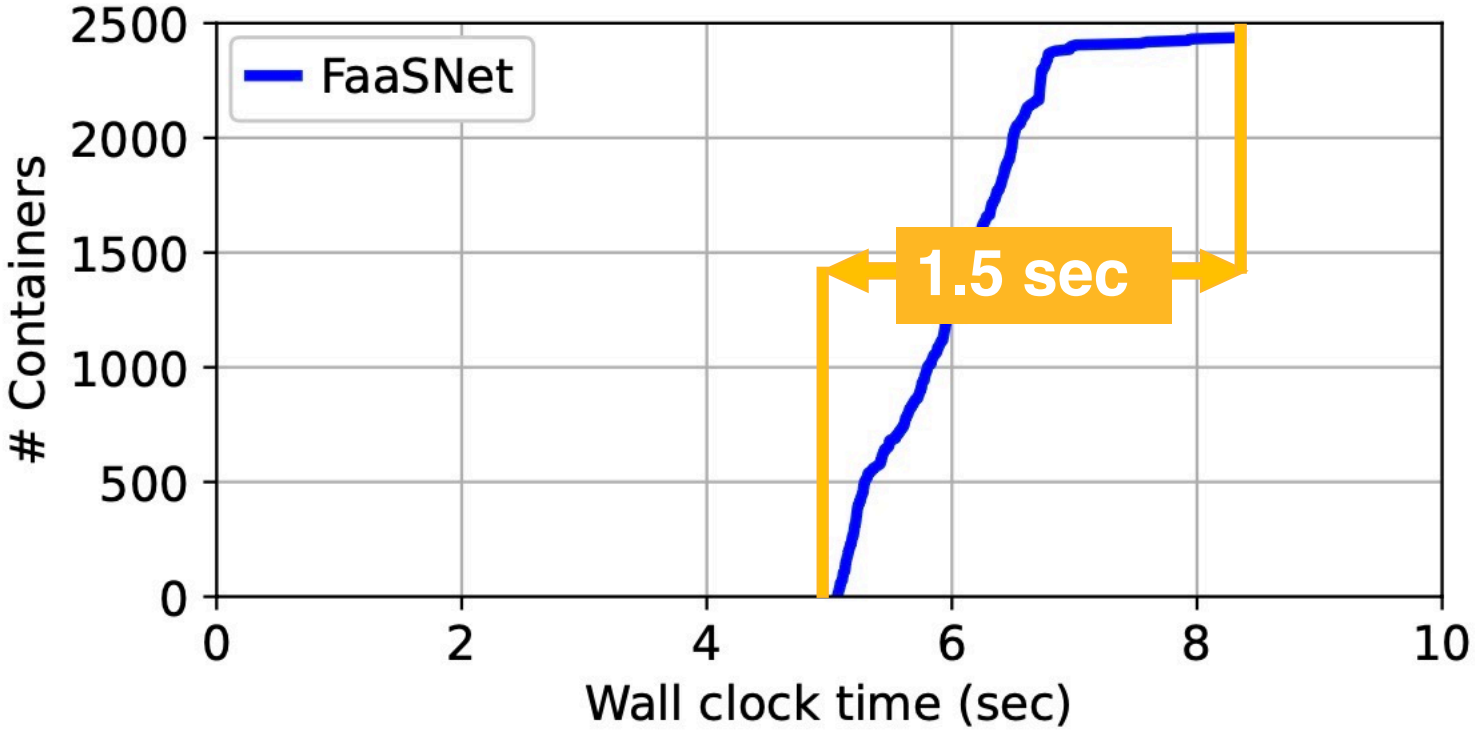
FaaSNet



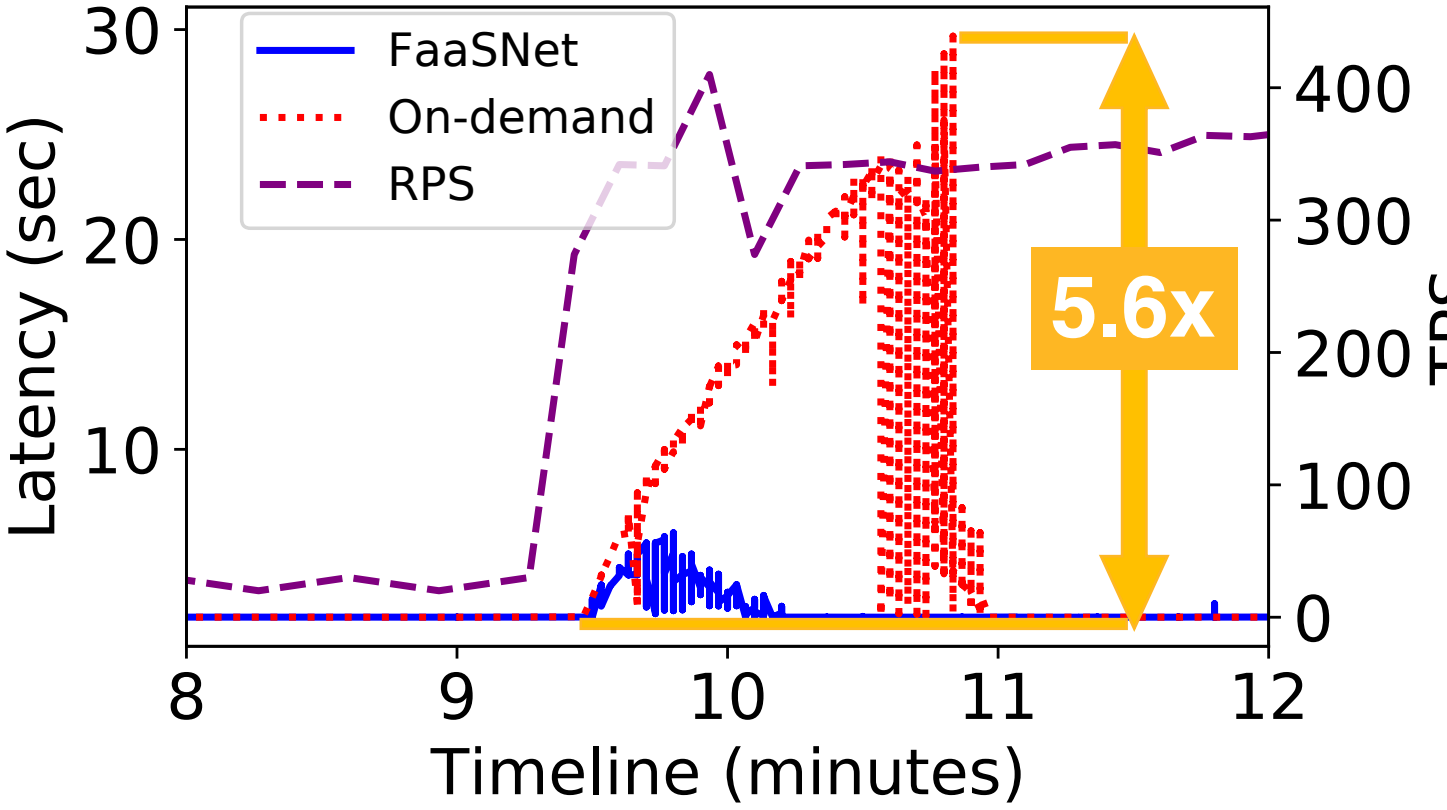
FaaSNet has ***strong scalability***

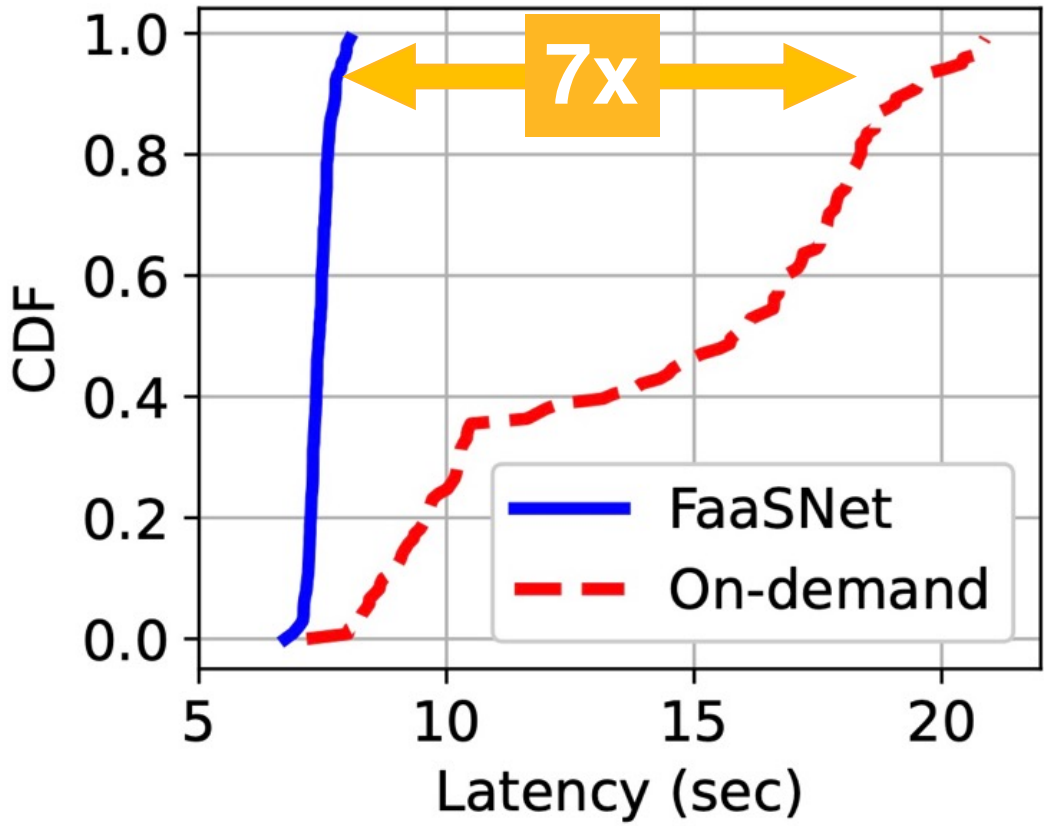
Production workload



Scales thousands of containers in seconds

Production workload





IoT trace

Conclusion

- FaaSNet is the first system that provides an end-to-end, integrated solution for FaaS-optimized container runtime provisioning (Alibaba Cloud Function Compute)
- FaaSNet scales 13.4x faster than Alibaba Cloud's current FaaS platform

Thank you!

- Contact: Ao Wang – awang24@gmu.edu
- FT prototype & Alibaba Cloud Function Compute cold start traces
  - https://github.com/mason-leap-lab/FaaSNet

Q&A

- Local disk full -> cache eviction -> performance degradation
- Bandwidth issues