



KubeCon



CloudNativeCon

Europe 2022

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Crack the FaaS Cold Start and Scalability Bottleneck

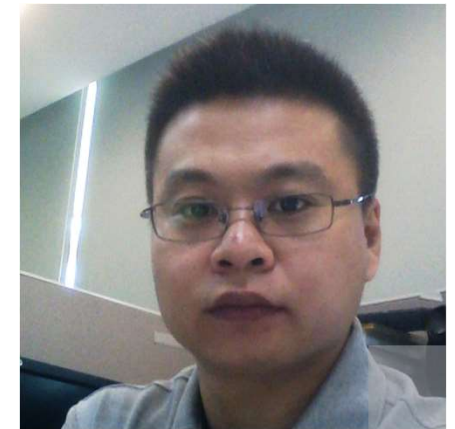
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Crack the FaaS Cold Start and Scalability Bottleneck



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Agenda

FaaS Overview and Major Challenges

Function Cold Start Anatomy

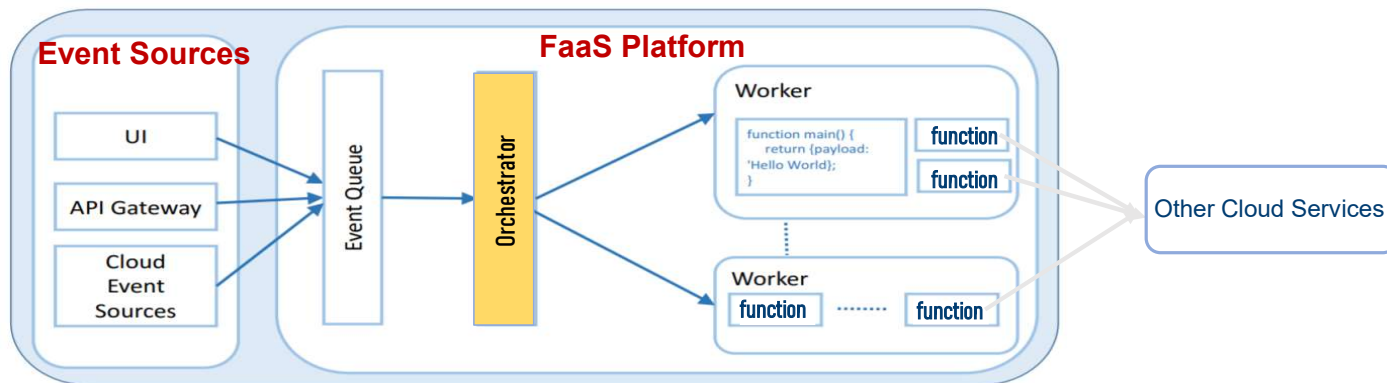
Cold Start from Snapshots

Autoscaling

■ Test Result and Cold Start Latency Comparison

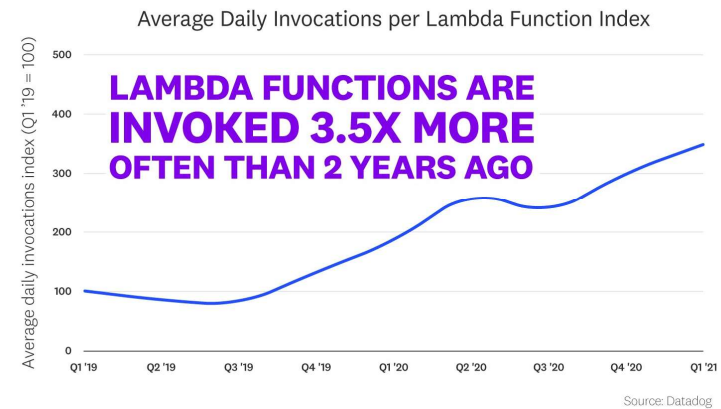
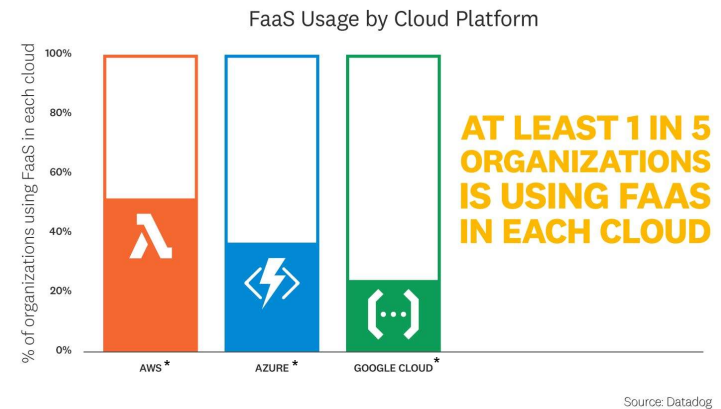
FaaS Overview

An event-driven architecture based computing service provided by CSPs which allocates containers/microVMs on demand to run the developer's function code in response to event requests.



FaaS Overview

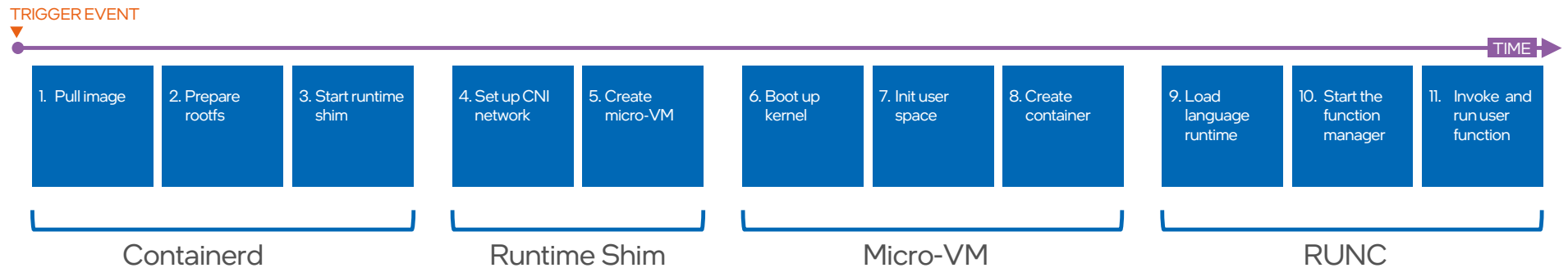
- Adoption gaining momentum
- Function typically isolated in Micro-VM like sandbox
- Main pain points:
 - Cold start
 - Auto-scaling



*Other names and brands may be claimed as the property of others.

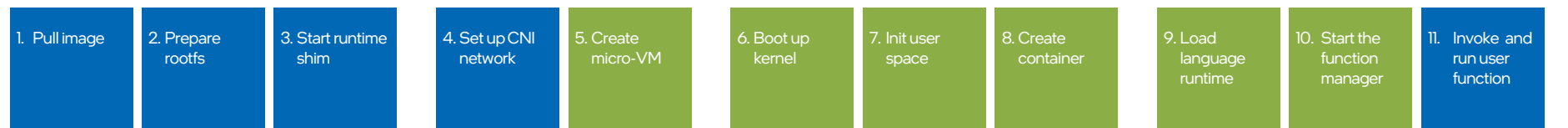
Source: <https://www.datadoghq.com/state-of-serverless/>

Function Micro-VM cold start breakdown in containerd context



Snapshot Based Approach

▼ TRIGGER EVENT



Existing Way of Starting a New Function Instance

▼ TRIGGER EVENT



Snapshot Based Way of Starting a New Function Instance

Fewer steps (shorter startup time) by restoring from VM snapshot

Function Snapshot



1. What is a function snapshot

- A snapshot of the micro-VM memory and virtual HW states after the function microVM is created

2. How to get the function snapshot

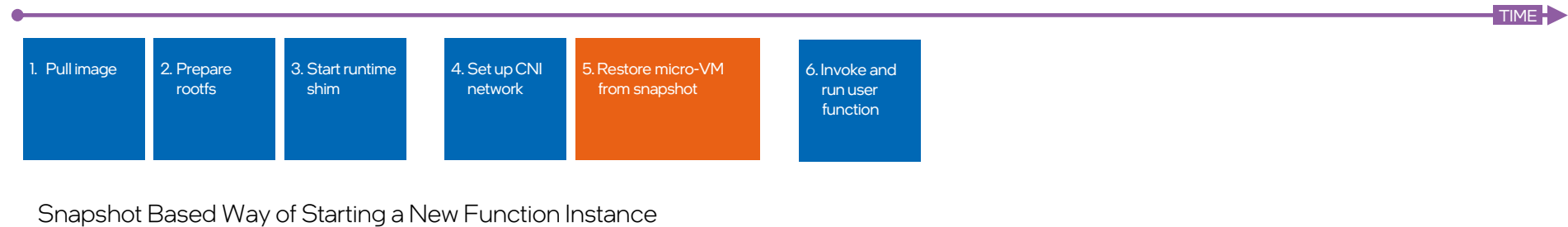
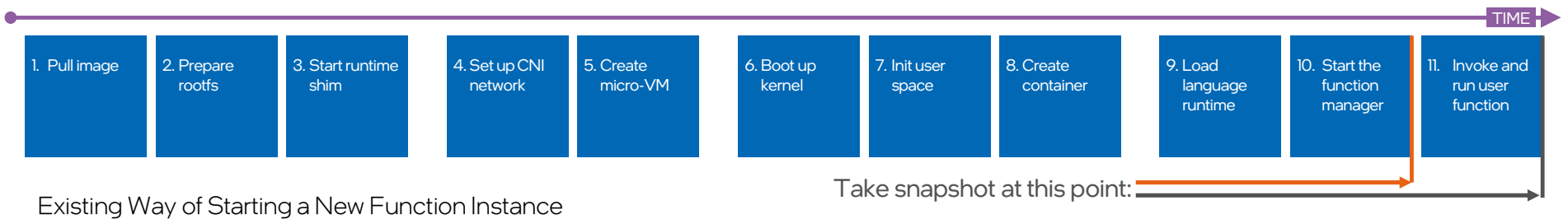
- Test run the function for a complete life cycle
- Snapshot the micro-VM memory and virtual HW states when the function finishes the execution and returns to idle state waiting for the next trigger event

Challenges of Creating a New Function Instance From Its Snapshot

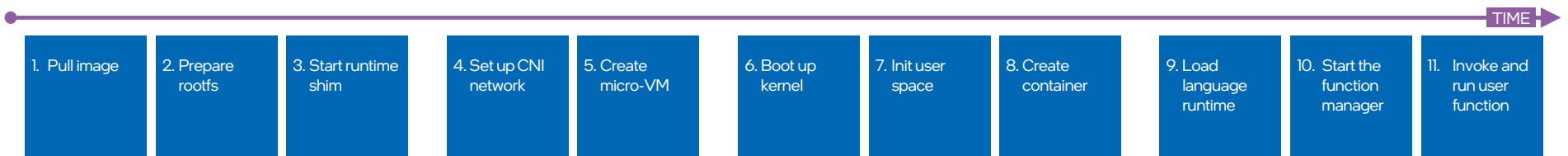


1. User Sensitive Data
 - keys, certificates, password, secrets, etc.
2. Unique Data Associated with the Function Instance at Test Run
 - UUIDs, cryptographic nonce
 - Network connections to backend database, external services, etc.
3. Unique Data Associated with the MicroVM Instance at Test Run
 - IP addresses, timer, hostname, UUIDs
4. Latency Due to Larger Function Code Package
 - Function image + snapshot data

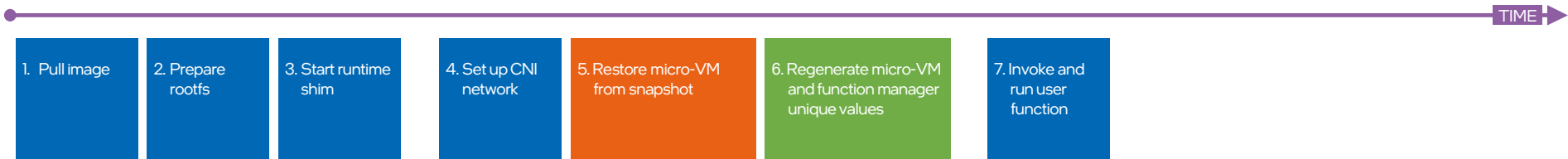
Address challenges 1 and 2



Address challenges 3

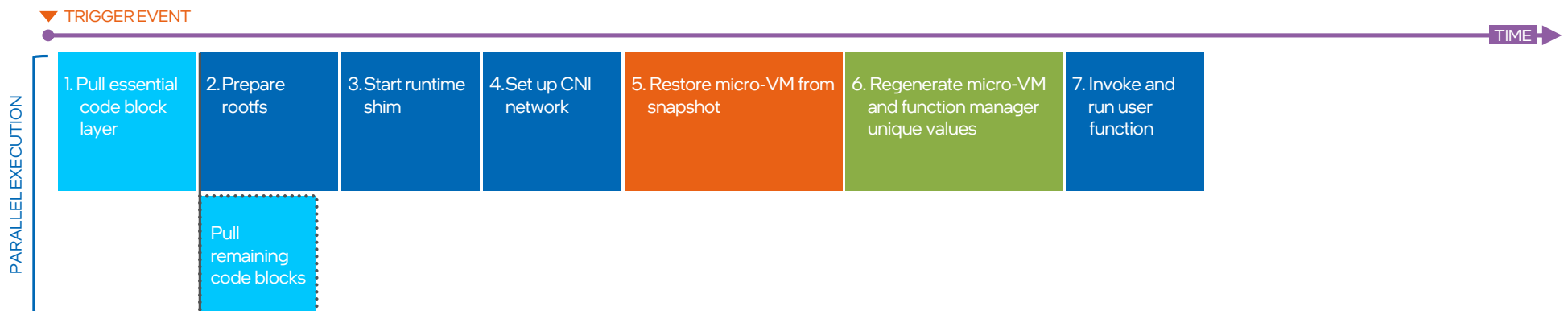
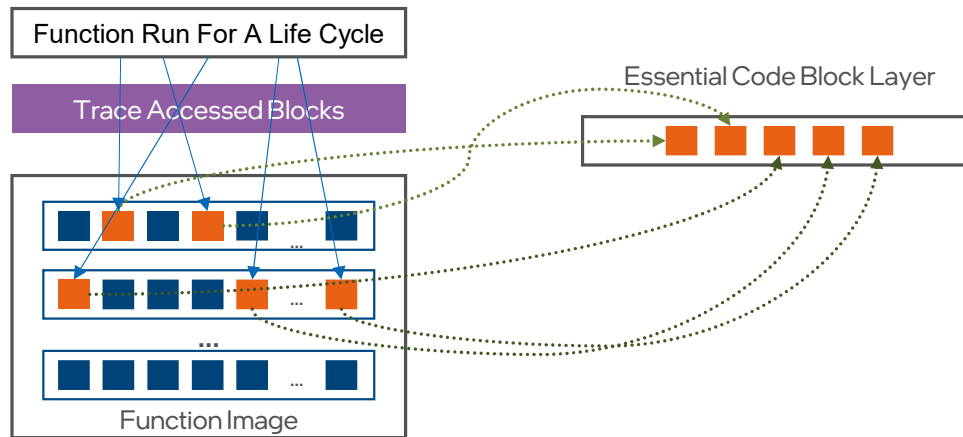


Existing Way of Starting a New Function Instance



Snapshot Based Way of Starting a New Function Instance

Address challenge 4



Enhanced Function Creation From Snapshot

Challenges of snapshots

1: User Sensitive Data

✗ Keys, certificates, password, secrets, etc.

✓ No user sensitive data

2: Unique Data Associated with the Function Instance at Test Run

✗ UUIDs, cryptographic nonce
Network connections to backend database,
external services, etc.

✓ No unique data associated with any specific
function instance

3: Unique Data Associated with the MicroVM Instance at Test Run

✗ IP addresses, timer, hostname, UUIDs

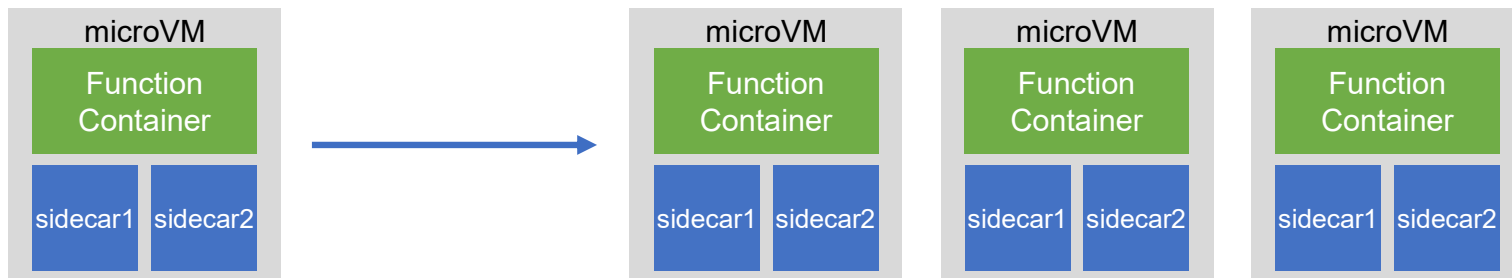
✓ Regenerate micro-VM unique values

4: Latency Due to Larger Function Code Package

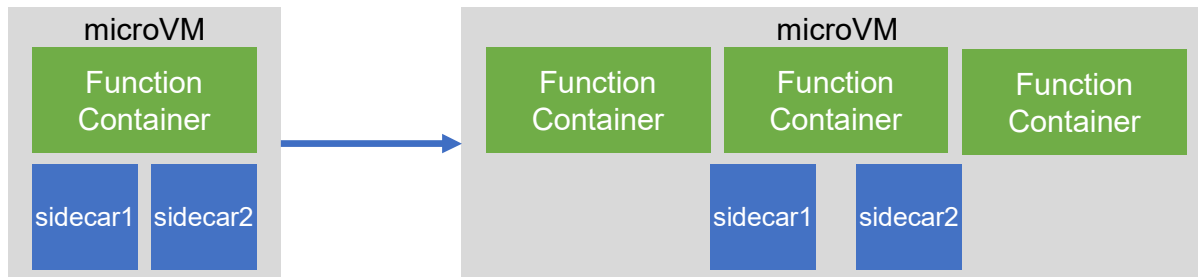
✗ Function image + snapshot data

✓ New micro-VM is started at an earlier time point

Autoscaling



Existing Way of Scaling Out Application Containers



New Way of Scaling Out Containers

Testbed

HARDWARE

CPU: Intel(R) Xeon(R) Gold
6238 CPU @ 2.10GHz,
HT enabled

DRAM: 264GB

SSD: INTEL SSDSC2KB48
(6Gbps SATA)

HOST SOFTWARE

Operating system:
Ubuntu 20.04.2 LTS

firecracker-containerd @
b9f4c9b

firecracker @ 176c655

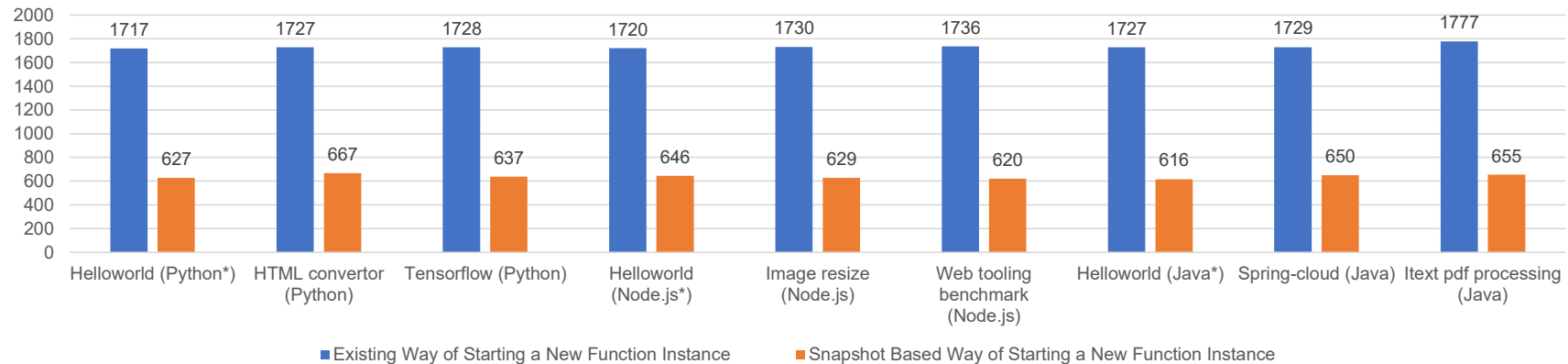
CNI config: "ptp", "firewall",
"tc-redirect-tap"

GUEST KERNEL

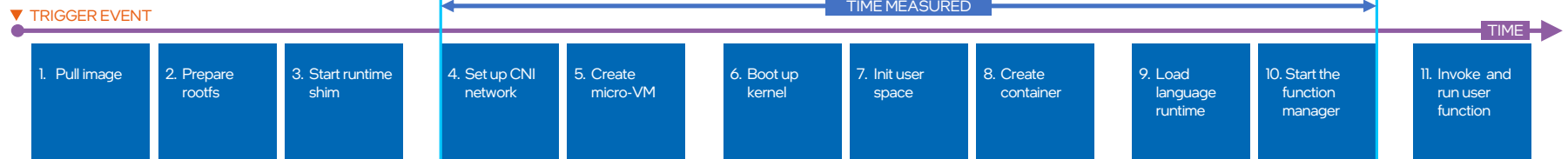
https://s3.amazonaws.com/specc.ccf.c.min/img/quickstart_guide/x86_64/kernels/vmlinux.bin
(v4.14.174)

Function cold start latency comparison

Function cold start time in milliseconds



Existing Way of Starting a New Function Instance



Snapshot Based Way of Starting a New Function Instance

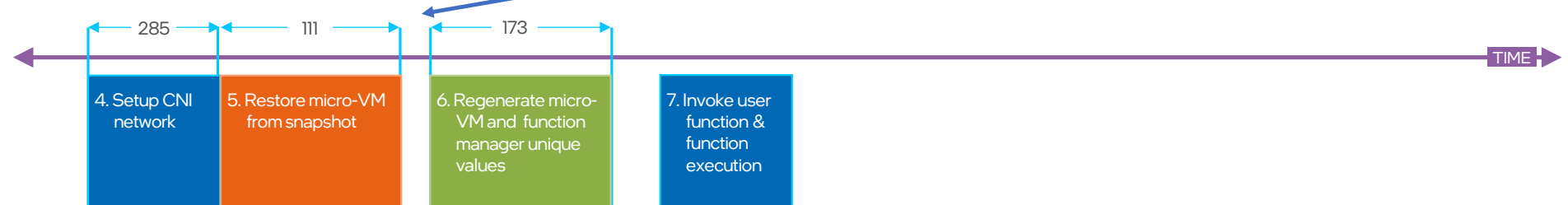
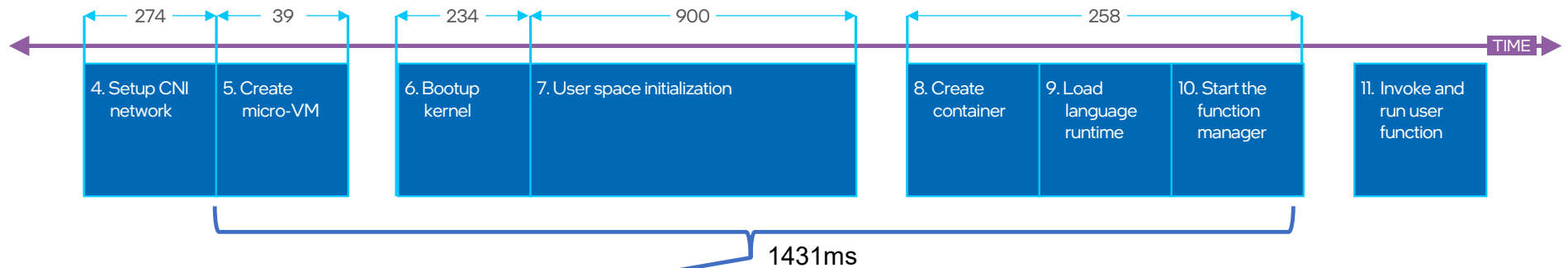


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Example function startup breakdown



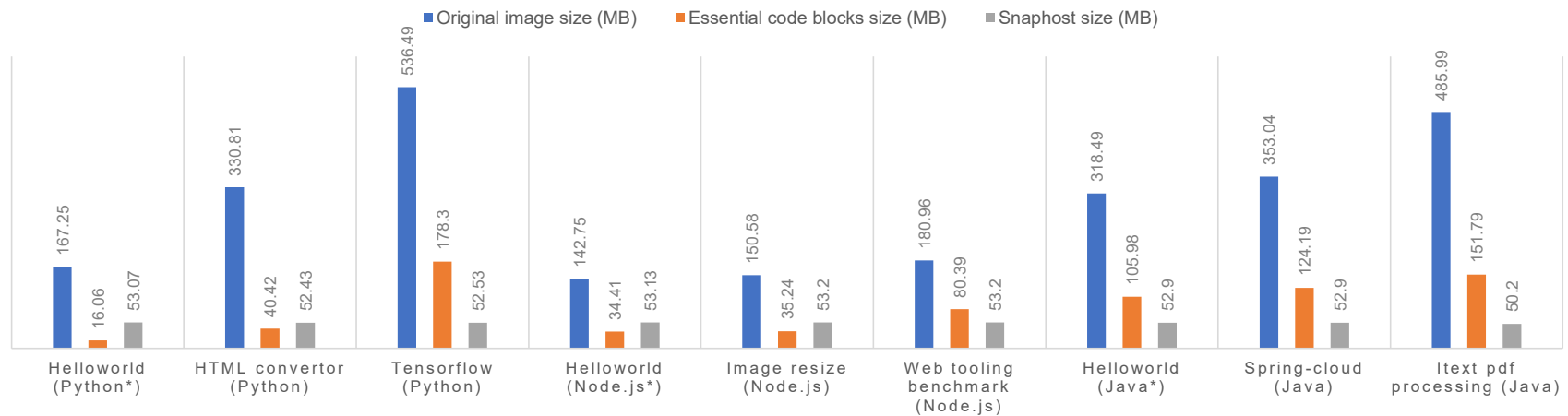
Existing Way of Starting a New Function Instance: total 1,705 ms



Snapshot Based Way of Starting a New Function Instance: total 569 ms

Reduced Function Code Image Size

REDUCED FUNCTION CODE IMAGE SIZE



- Snapshot taken with firecracker micro-VM memory size 128M
- The size is the compressed size

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Thank You!

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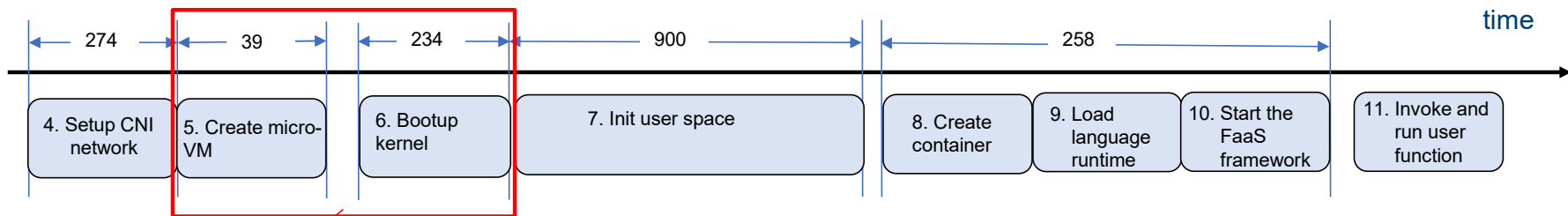
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Example function startup breakdown

HelloWorld.js cold start time breakdown in milliseconds

Normal startup: total 1705 ms



- Time ≤ 125 ms according to AWS measurement
- AWS used minimal kernel