

Athens Living Lab Ideathon

Institute of communication and computer systems (**ICCS**)

10 October 2022

Dr. Pavlos Basaras

Project Manager at ISENSE Group of ICCS



5GLOGINNOV



ICCS -- Πανεπιστημιακό Ινστιτούτο Συστημάτων Επικοινωνιών και Υπολογιστών (ΕΠΙΣΕΥ)



Institute of Communication and Computer Systems

A public scientific and technological institute which undertakes advanced research in the field of electrical, electronic and computer engineering and technologies.

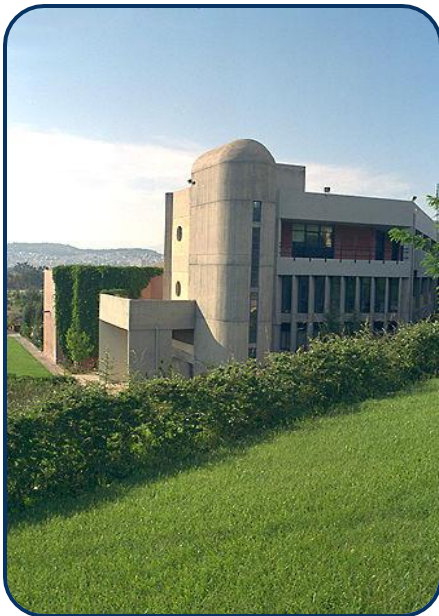
150
People

43/93
Ongoing/Finished
Projects

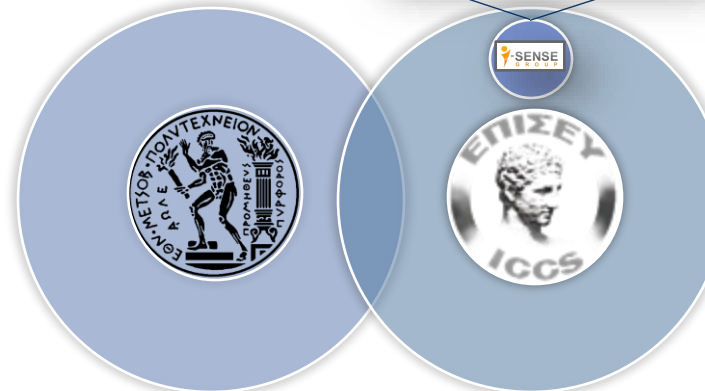
191
Partners

6G SNS
IA
Full Research
Member

ETSI
World Class Standards
Participant
MEC, ZSM, ENI, NFV ISGs



National Technical
University Athens



Institute of
Communication &
Computer
Systems

- 600+ Scientific Personnel
- 1400+ Completed Projects
- 190+ On-going Projects
- 41 Labs
- 6 Hubs, Innovation Centers and Start-ups/Spin-off



5G LOGINNOV

Ideathon Speakers and Agenda (1/3)



5G/6G Management and Orchestration Support for Vertical Services



10:10 – 10:40: The « Edge » Compute Continuum

Dr. Konstantinos V. Katsaros



10:40 – 11:15: Management and Orchestration Technologies: Kubernetes

Dr. Pavlos Basaras



11:15 – 11:30: Machine Vision : Artificial Intelligence, Machine Learning and Computer Vision Challenges

Georgios Drainakis



5GLOGINNOV

Ideathon Speakers and Agenda (2/3)



Use Case Session: Athens Living Lab in 5G-LOGINNOV Project



Dr. Pavlos Basaras



11:30 – 11:45: Athens Living Presentation (Piraeus Container Terminal) and Pilot Site Demo : Use cases, architecture, platforms and demo presentation.



Athanasios Balomenos



11:45 – 12:00: RESONATE-Real time E drow Siness detectiON, AlerTing and rEorting

12:00 – 12:15 Break!



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Ideathon Speakers and Agenda (2/3)



Hands-on Training Demo



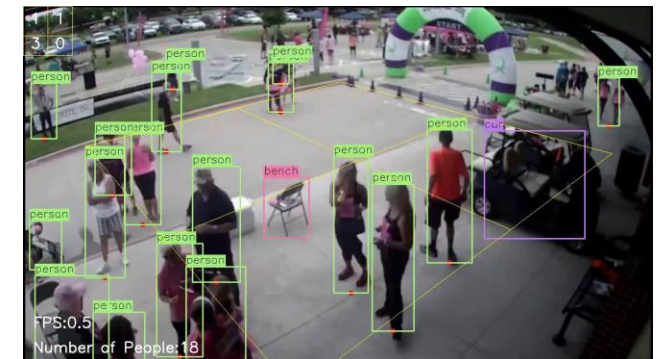
Dr. Pavlos Basaras



12:15 – 12:45: Live demonstration of service orchestration and lifecycle management of AI/ML services at GPU enabled (far-)edge nodes.



12:45 – 13:30: Team Challenge : Hands on exercise on kubernetes for service orchestration and life cycle management.



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Management and Orchestration Technologies: Kubernetes, Openstack and Opensource MANO

Athens Living Lab Ideathon

10 October 2022



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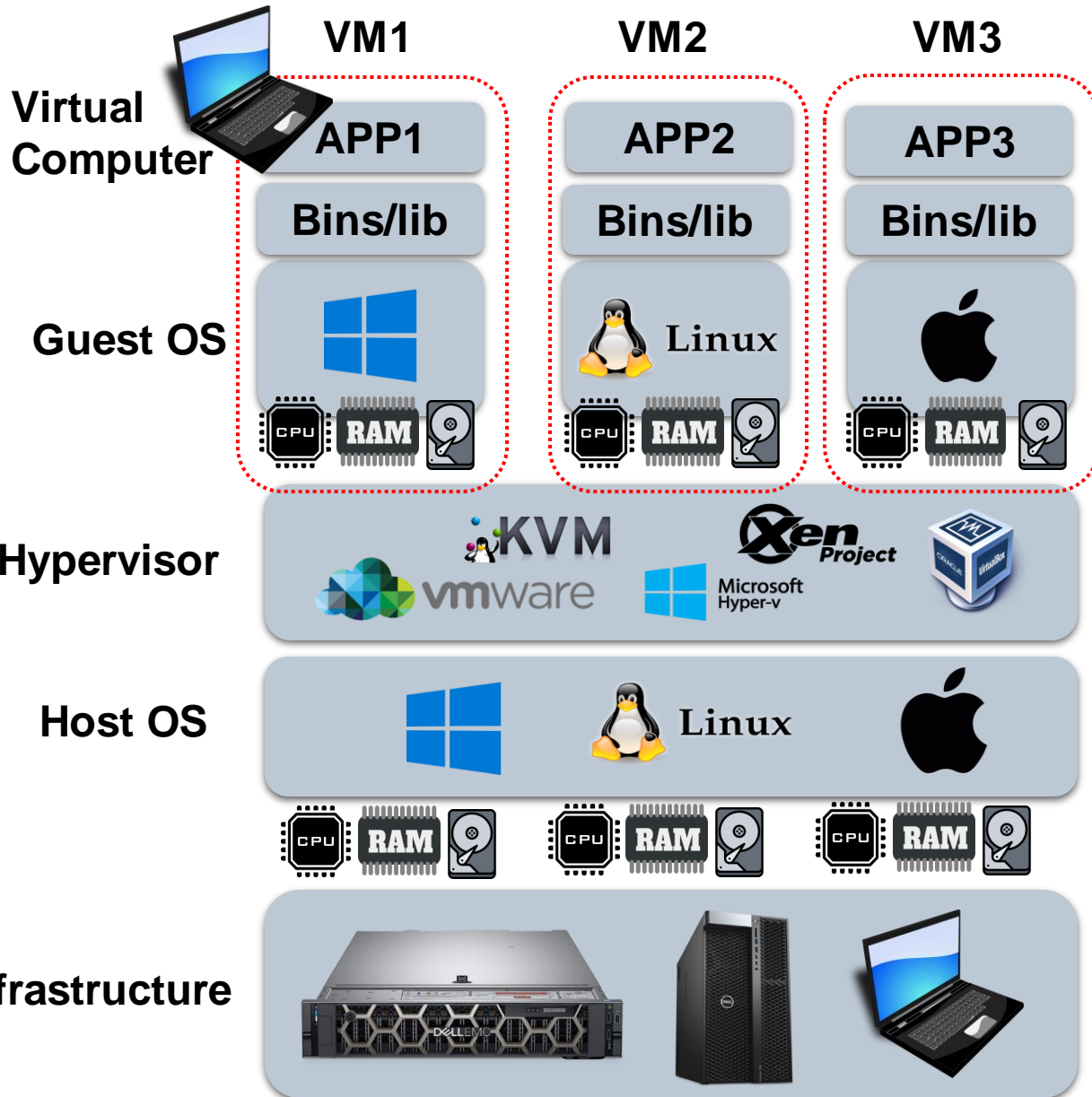


Agenda

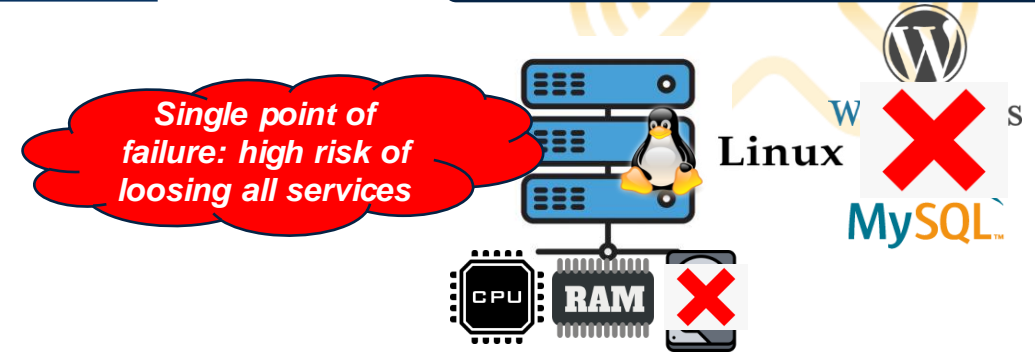


- Virtual Machines and Containers
- Monolithic and micro-service based applications
- Orchestration technologies
- Kubernetes lifecycle management demo

Virtualization with Virtual Machines



Without Virtualization



With Virtualization

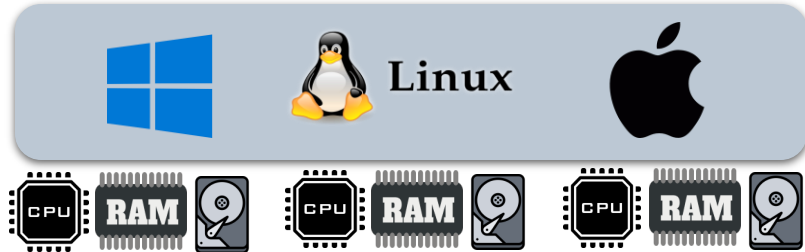
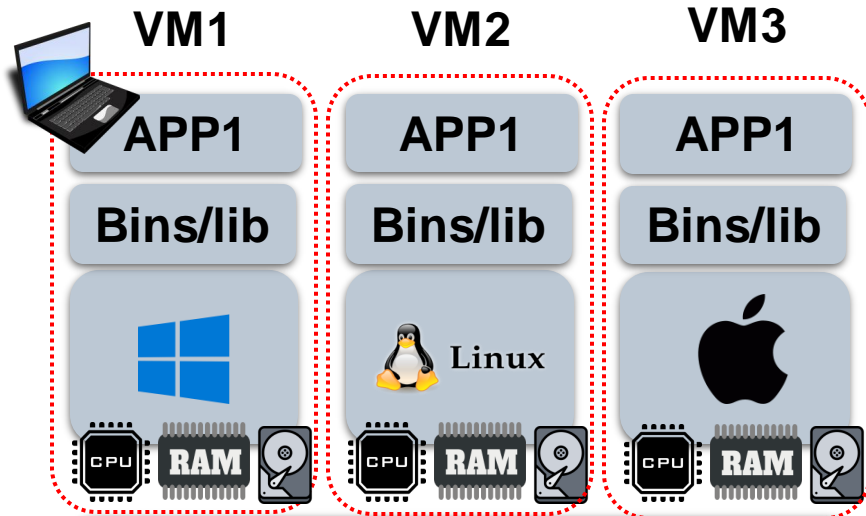


Virtual Machine Image (VMI)

- OS as a **portable file system**
 - all applications and application dependencies/configurations, packaged



Virtualization with Containers



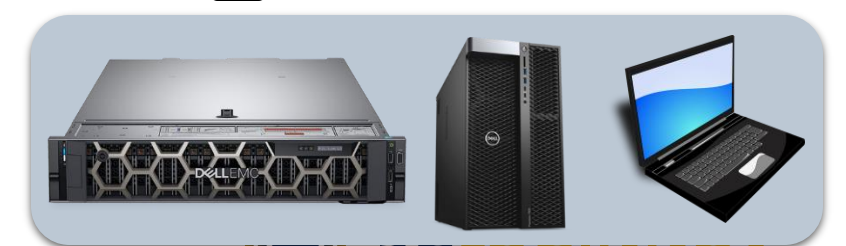
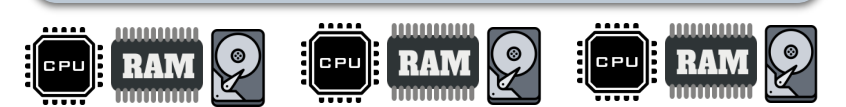
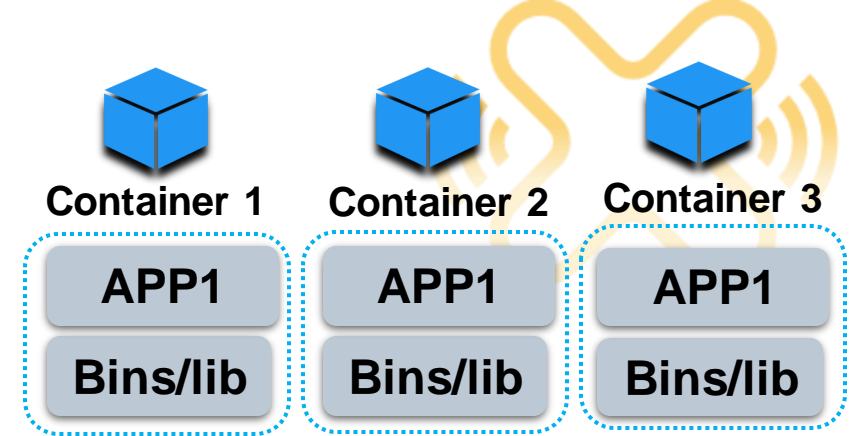
Virtual Machines

Guest OS |

Hypervisor | Container Runtime

Host OS

Infrastructure



Containers

Pros and Cons



Virtual Machines

- Startup time
- Disk Space
- Portability
- Efficiency
- Operating system

x Minutes



x Gigabytes



x Hypervisor dependencies



x Higher CPU, RAM, disk



- Dedicated

Containers

✓ Milliseconds



✓ Megabytes



✓ High interoperability



✓ Lower CPU, RAM, disk

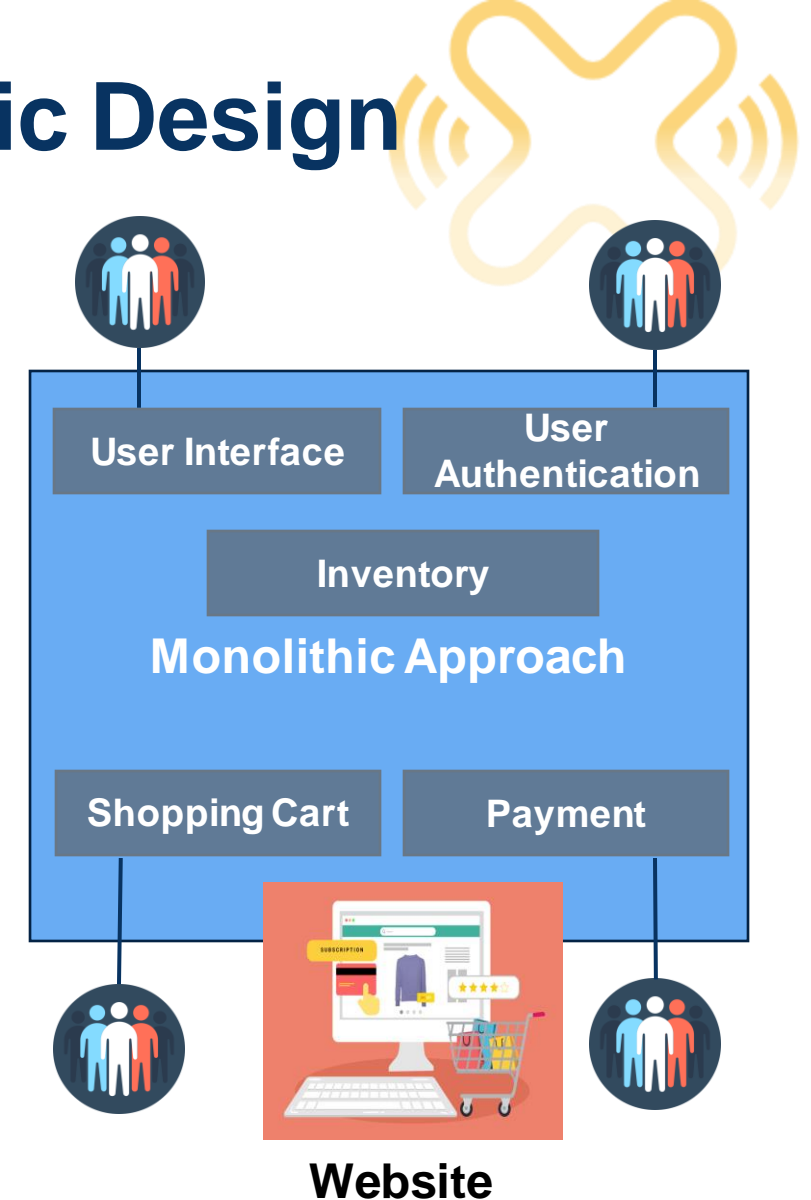


- Shared



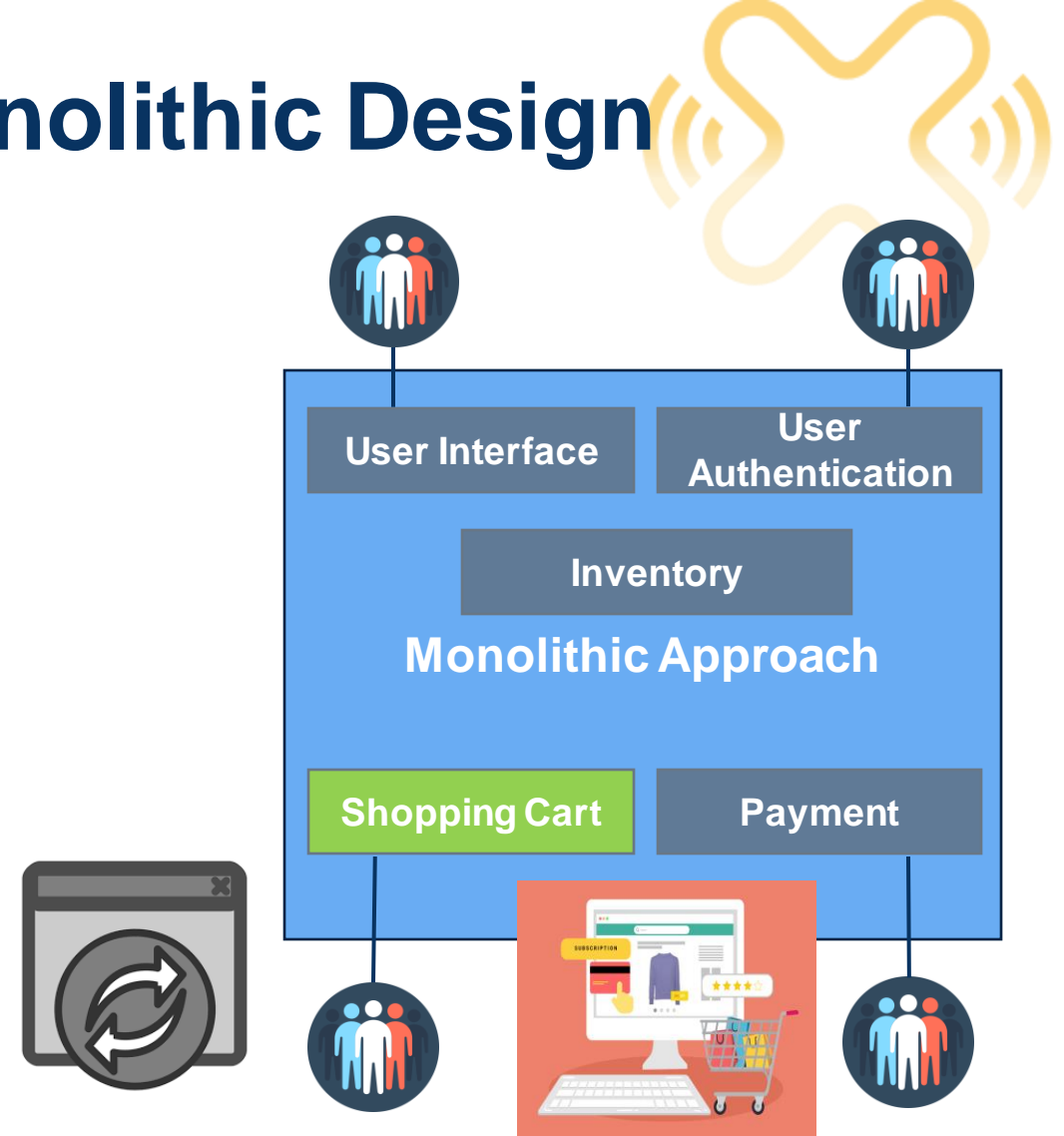
Building Applications – Monolithic Design

- **Traditional** model of a software program
 - APP developed in a single tech stack
 - Separate teams need to coordinate
 - built as a single unit – *one code base* of tightly connected components (developed, deployed, scaled)
 - Changes in one component requires updating the entire stack
 - recompile, deploy, etc.
- As applications grow in **size** and **complexity**..



Building Applications – Monolithic Design

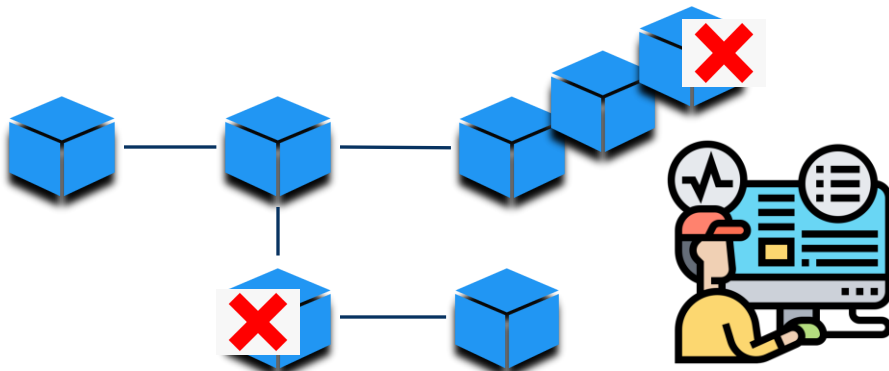
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- As applications grow in **size** and **complexity**..



Building Applications – Microservice Design

- Divide application into smaller independent parts/services, e.g., **containers**
- 1 micro-service for 1 specific work item
- Self-contained and independent
- Each service can have different tech stack (e.g., Java, Python, Go, etc.)
- Developed, deployed and scaled separately – **loosely coupled**

New Challenges



Connectivity

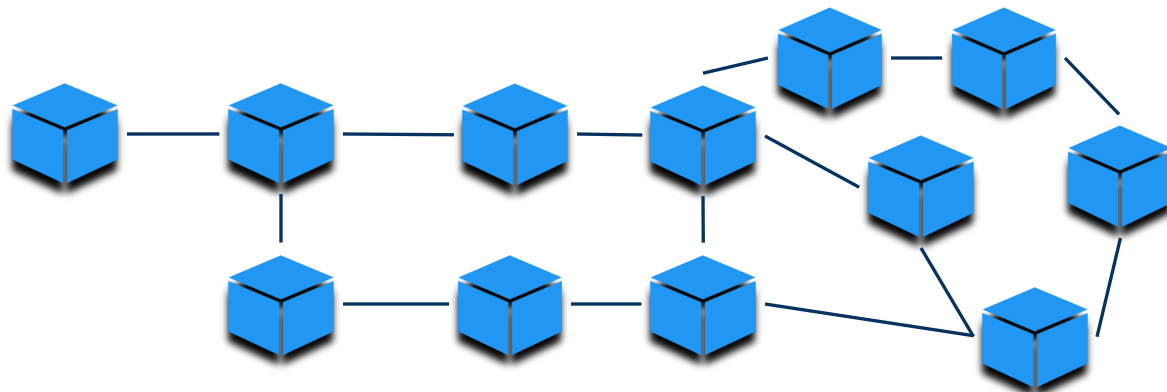


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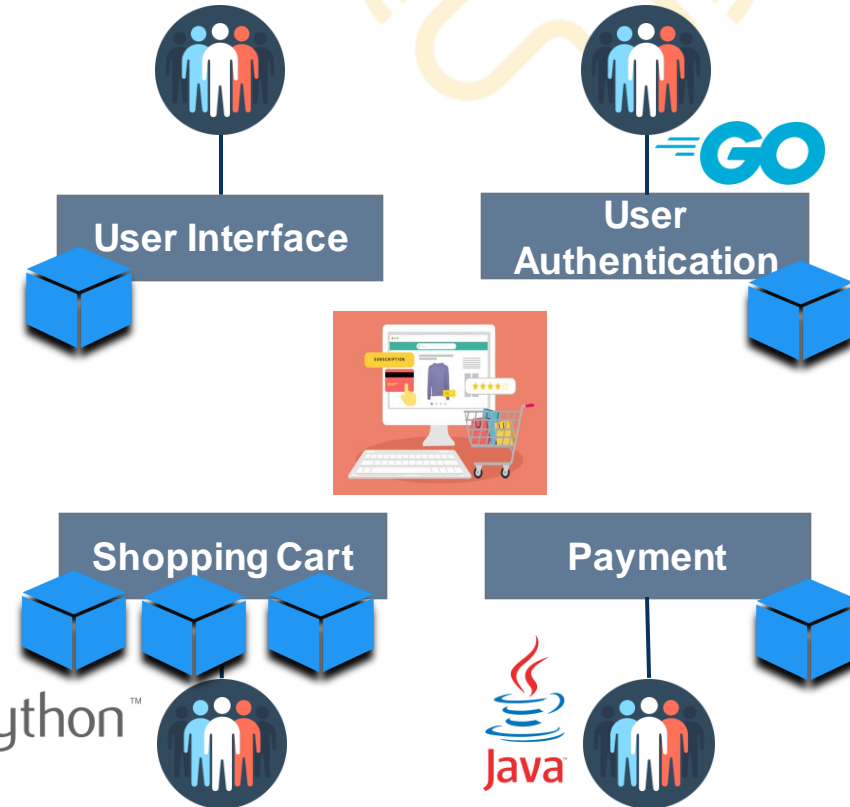
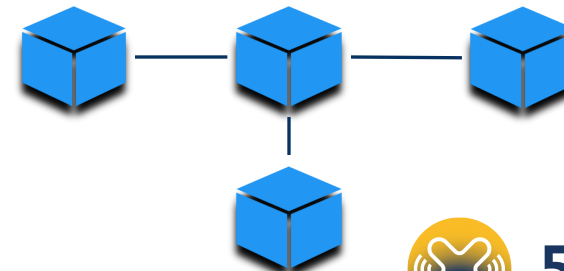
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New Challenges



...



Connectivity

Scale

Monitor

Size..



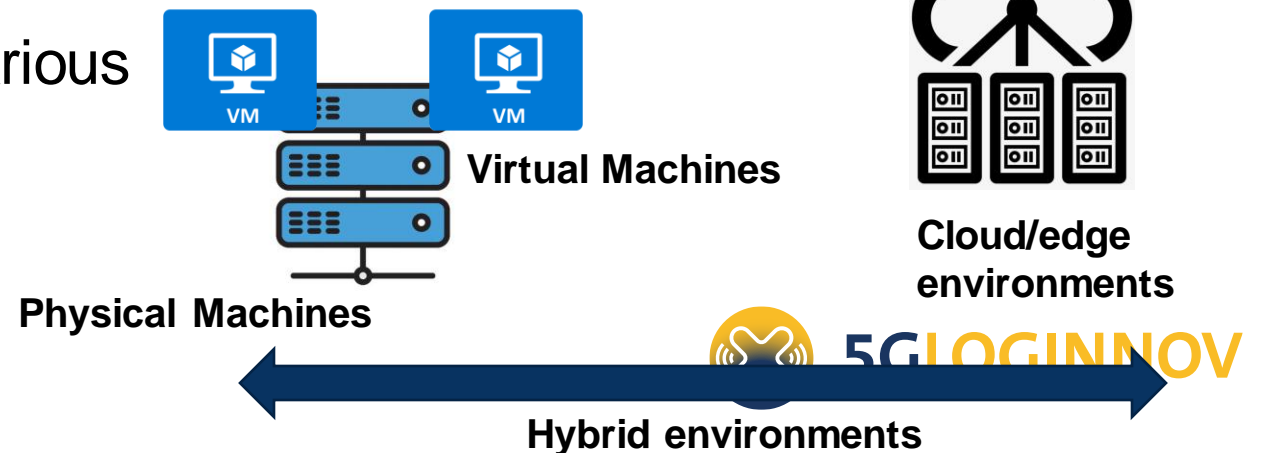
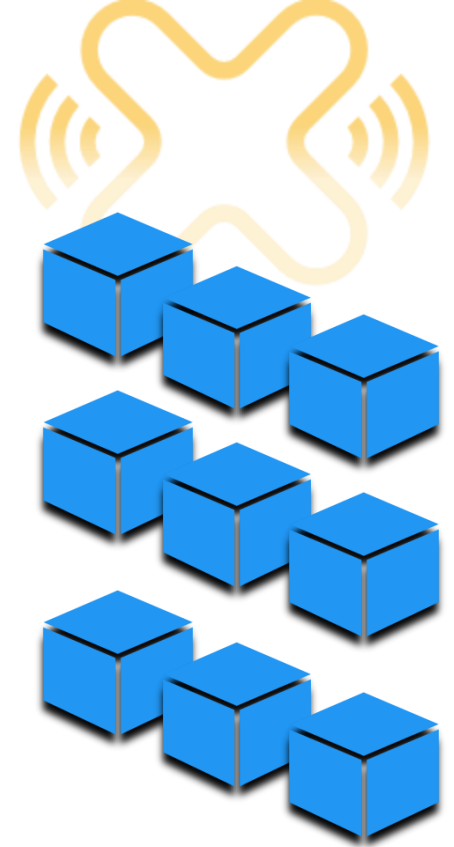
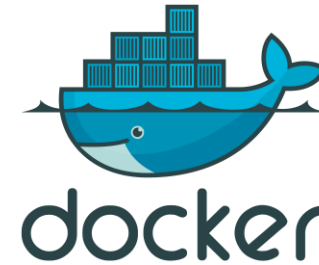
5G LOGO



Kubernetes

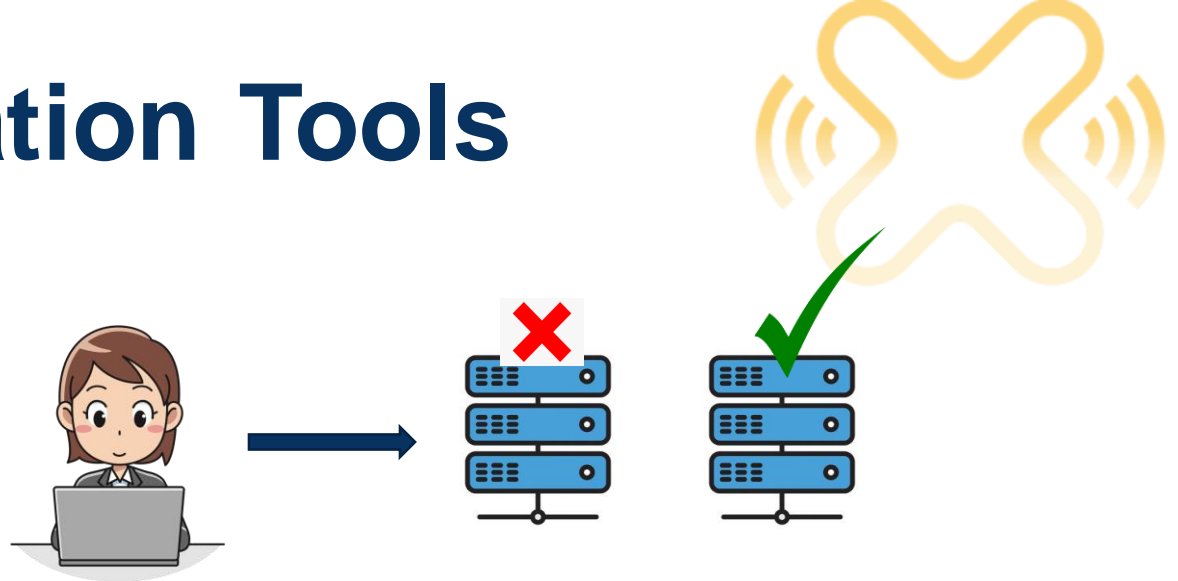
Definition

- Opensource container orchestration framework
 - automating software deployment, scaling, and management
- Initially developed by Google (7 June 2014)
- Manage applications (composed of various containers) in different environments

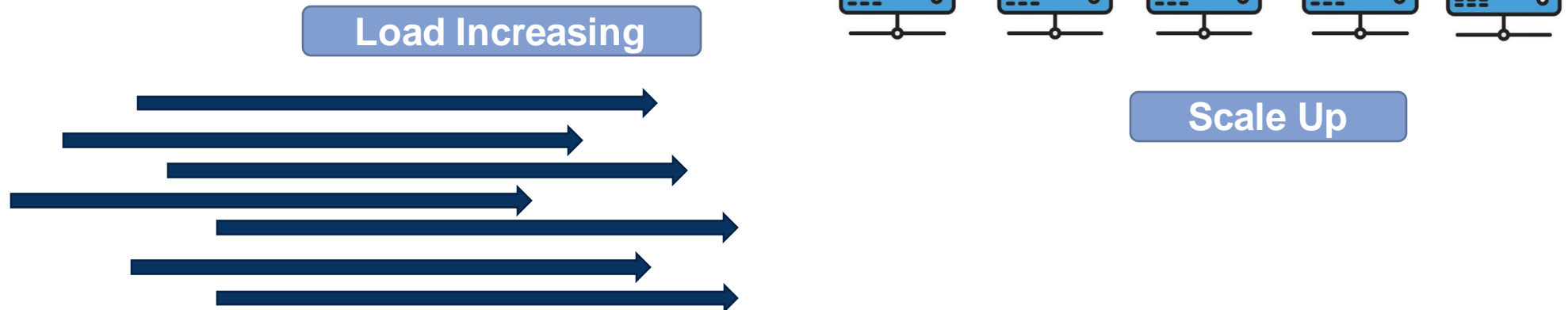


Features of Orchestration Tools

- High **availability** or no downtime

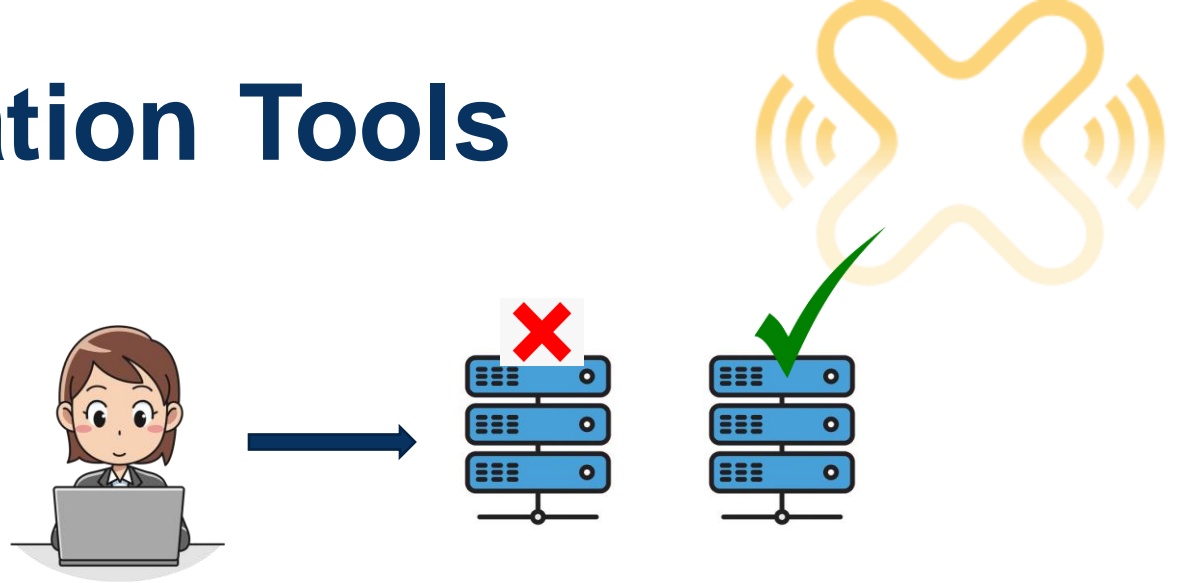


- **Scalability** or efficient performance

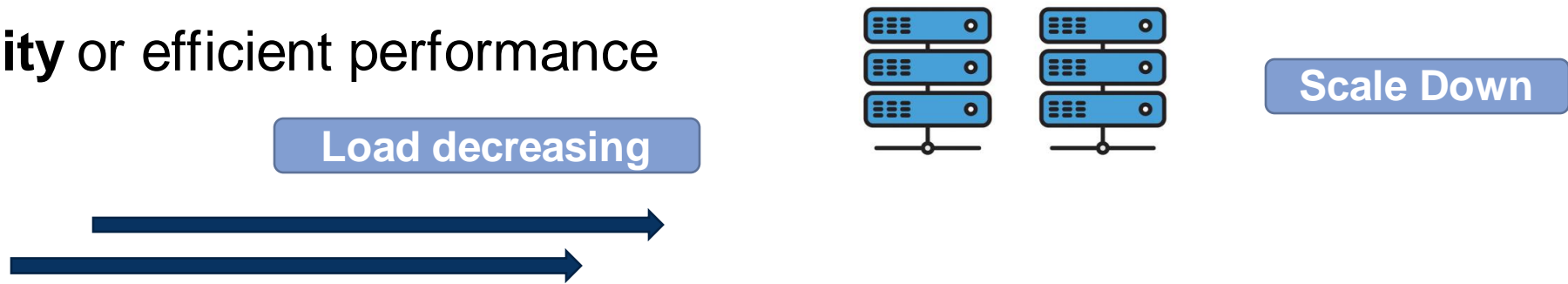


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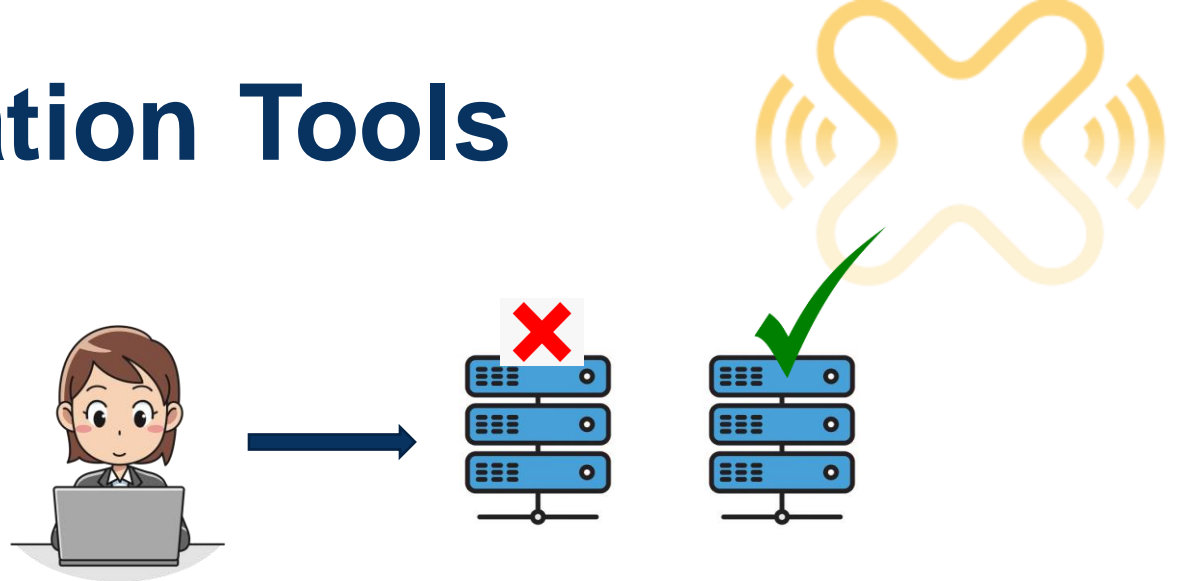


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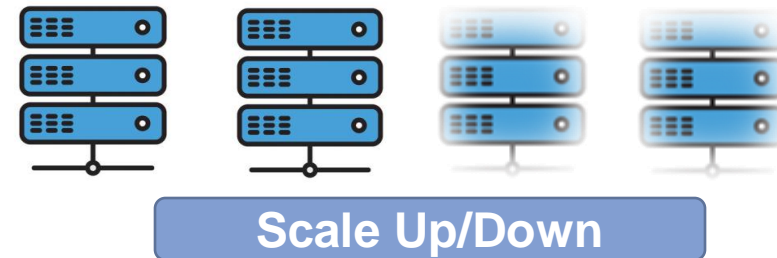


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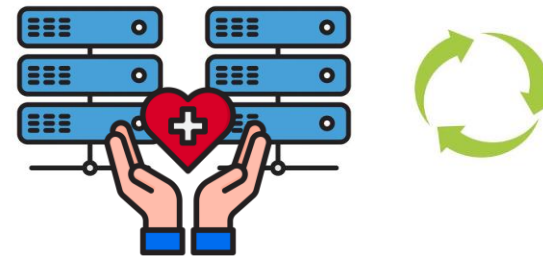
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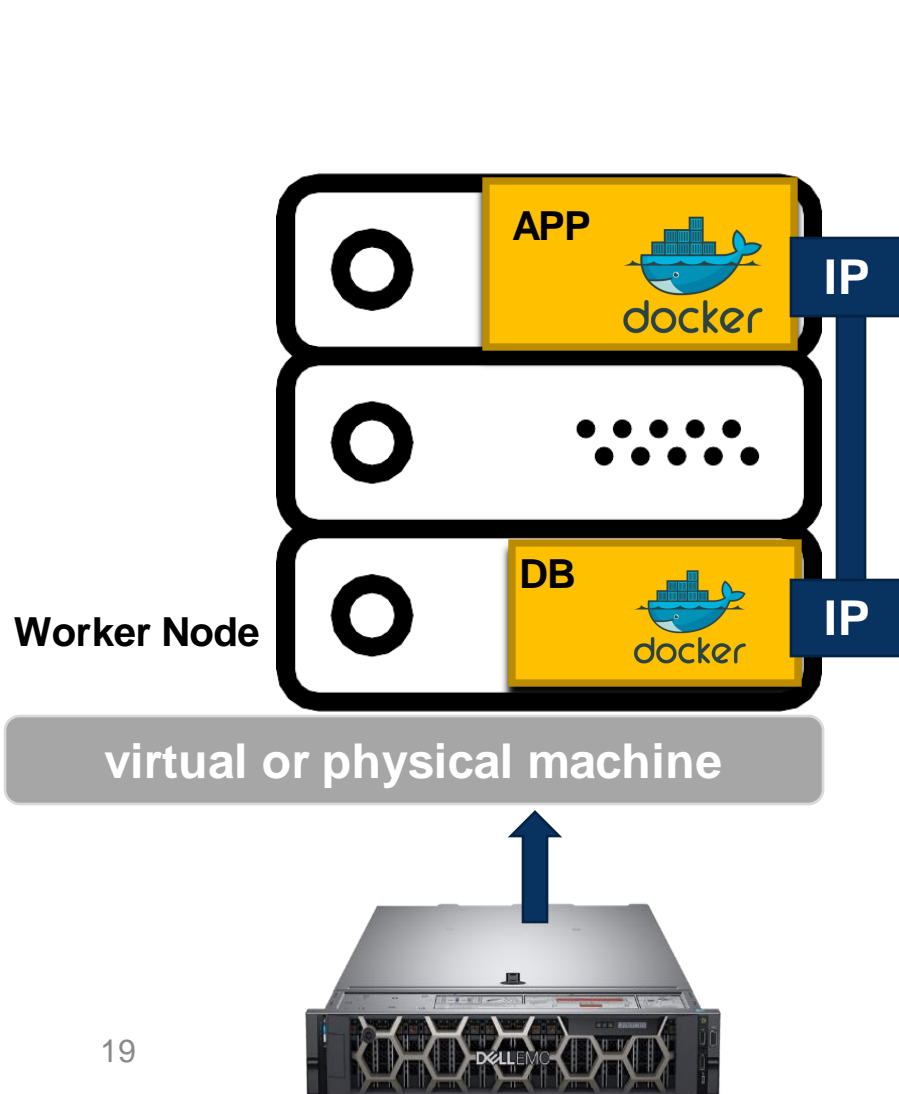


- Disaster **recovery** – back up and restore





Kubernetes Architecture (basic)

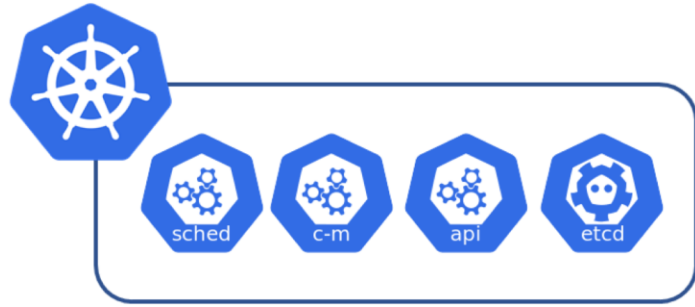
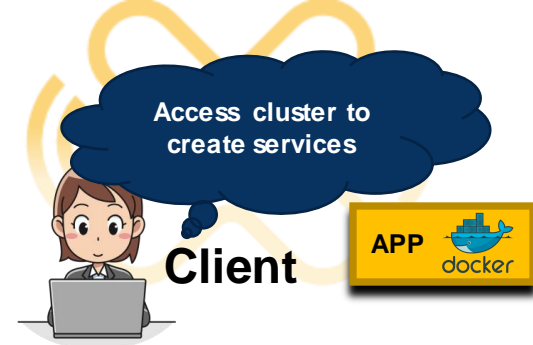


- Smallest unit in kubernetes
- Abstraction (running environment) of a container
- Usually 1 APP per pod
- Each **Pod** gets its own IP address

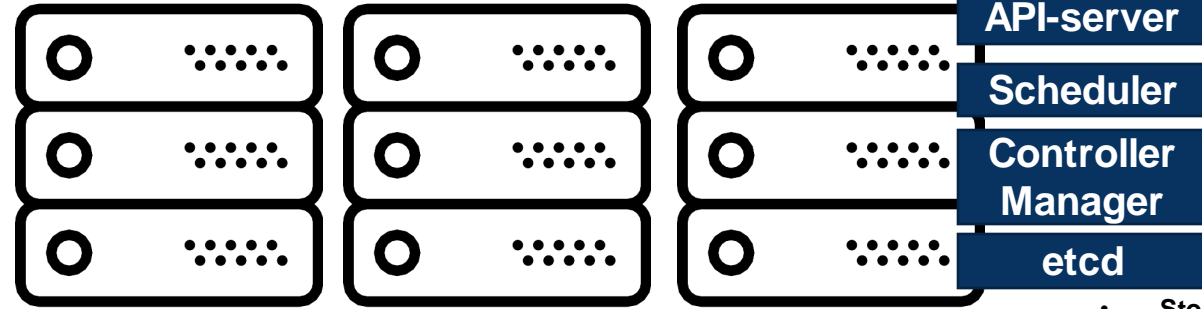




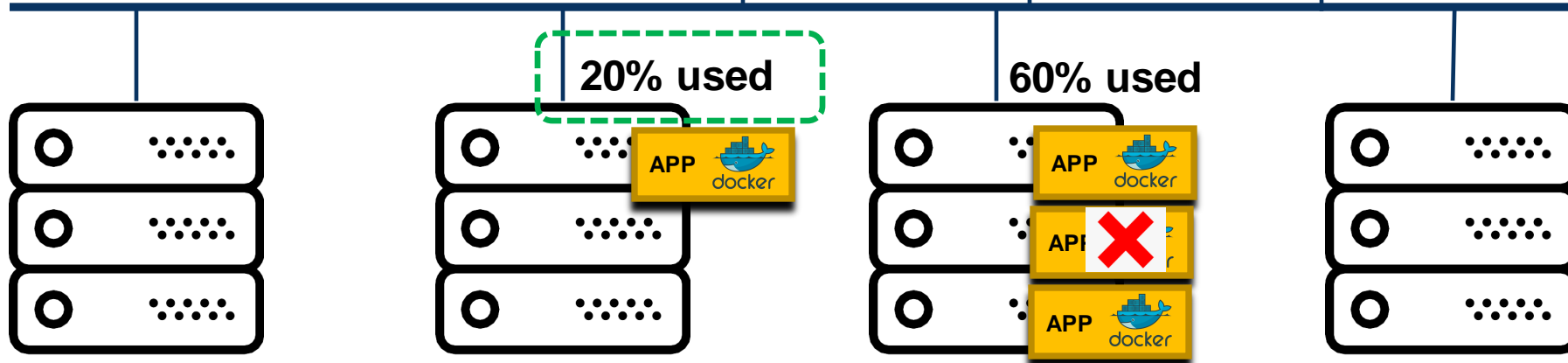
Kubernetes Architecture (basic)



Master Nodes (control plane)



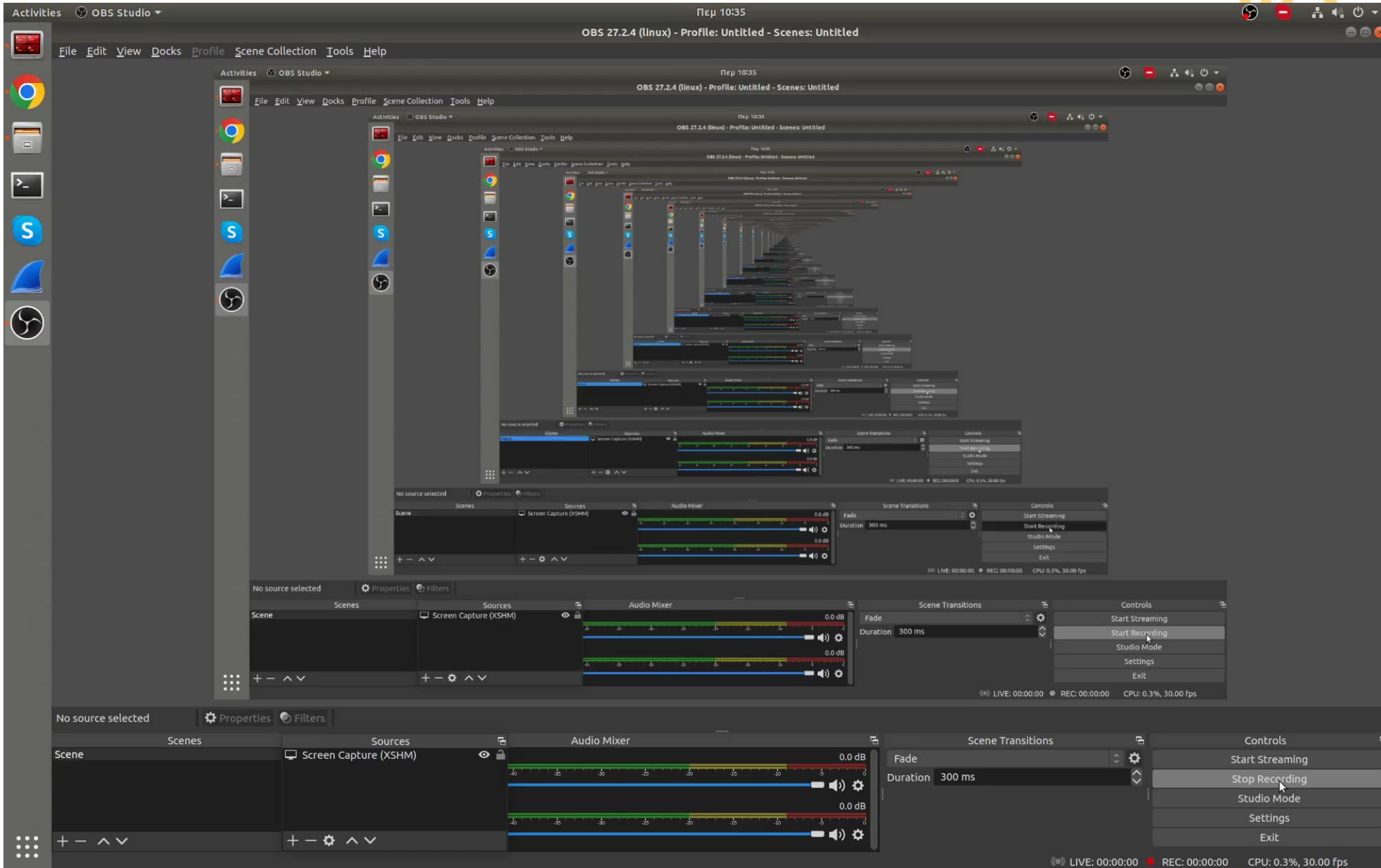
- Stores cluster changes/data
 - Available resources
 - Pod crashed/failed
 - Cluster health state



containerd cri-o

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High availability or no downtime demo (nginx-service)



Use Case Session: Athens Living Lab in 5G-LOGINNOV Project

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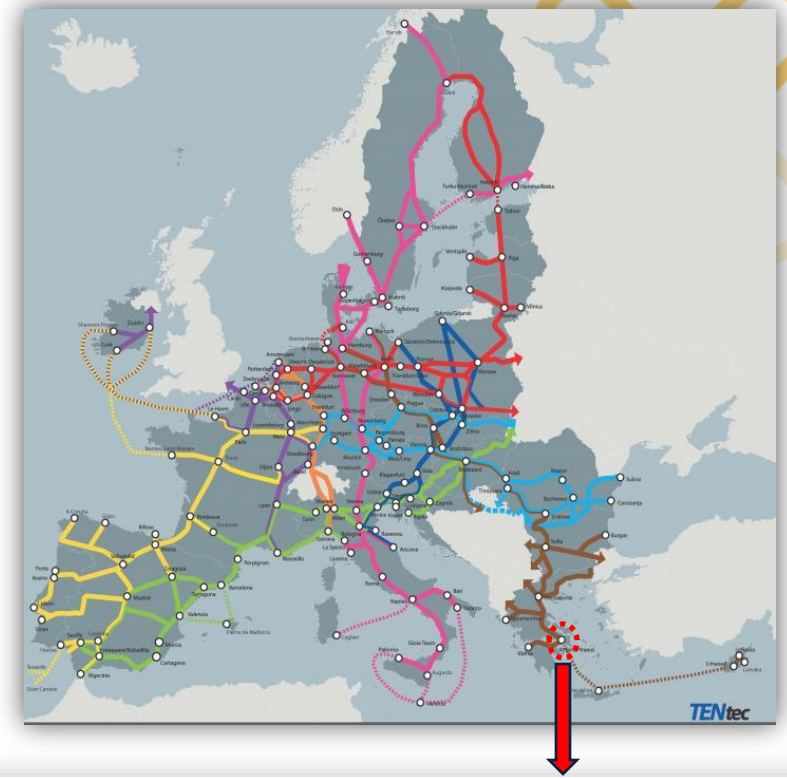


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Athens Living Lab: Piraeus Container Terminal (PCT)

- TEN-T core port
- Port consolidation and distribution services
- ISPS certified (security and risk management regulations)
- Road/Rail connection to Balkans and central Europe
- Free zone area type 1
- Container and RO-RO
- Car terminal, Cruise terminal, Oil terminal
- 1st in Mediterranean and 5th in Europe in terms of container throughput



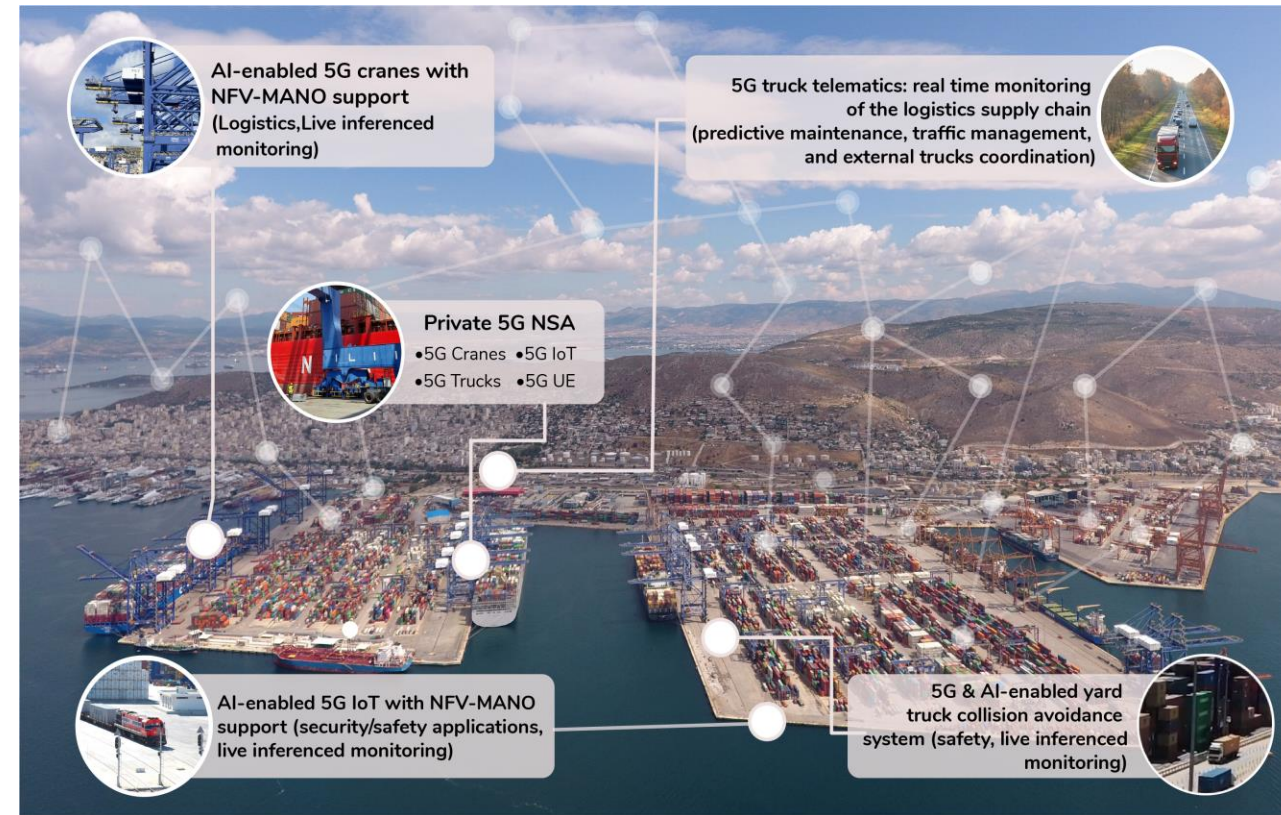
5G-LOGINNOV Use Cases



Truck telematics

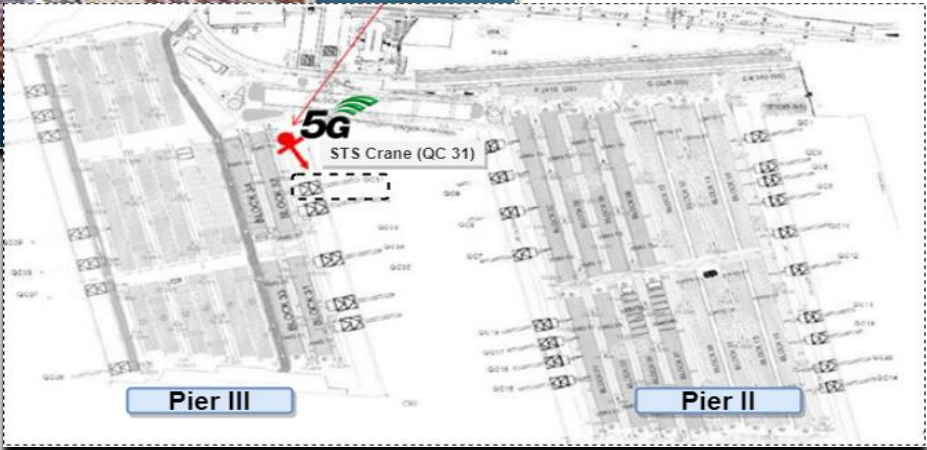
- **UC2:** Device management platform ecosystem
- **UC7:** Predictive Maintenance
- **UC3:** 5G&AI enabled rapid alert system in yard truck operations for collision avoidance
- **UC4:** 5G&AI Enabled Surveillance and Video Analytics
- **UC5:** 5G&AI Enabled Automation for ports: port control, logistics and remote automation

5G&AI-enabled services with NFV-MANO support

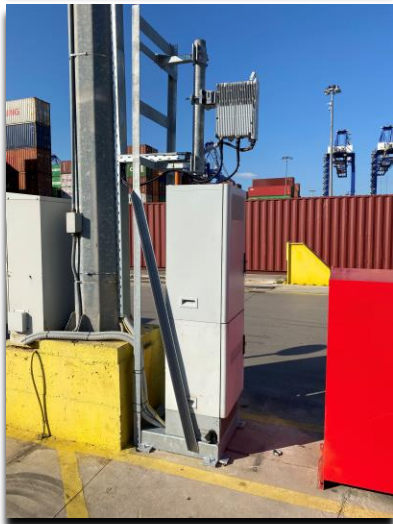


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Vodafone's Private 5G NSA Network



RRU AAU 5639w

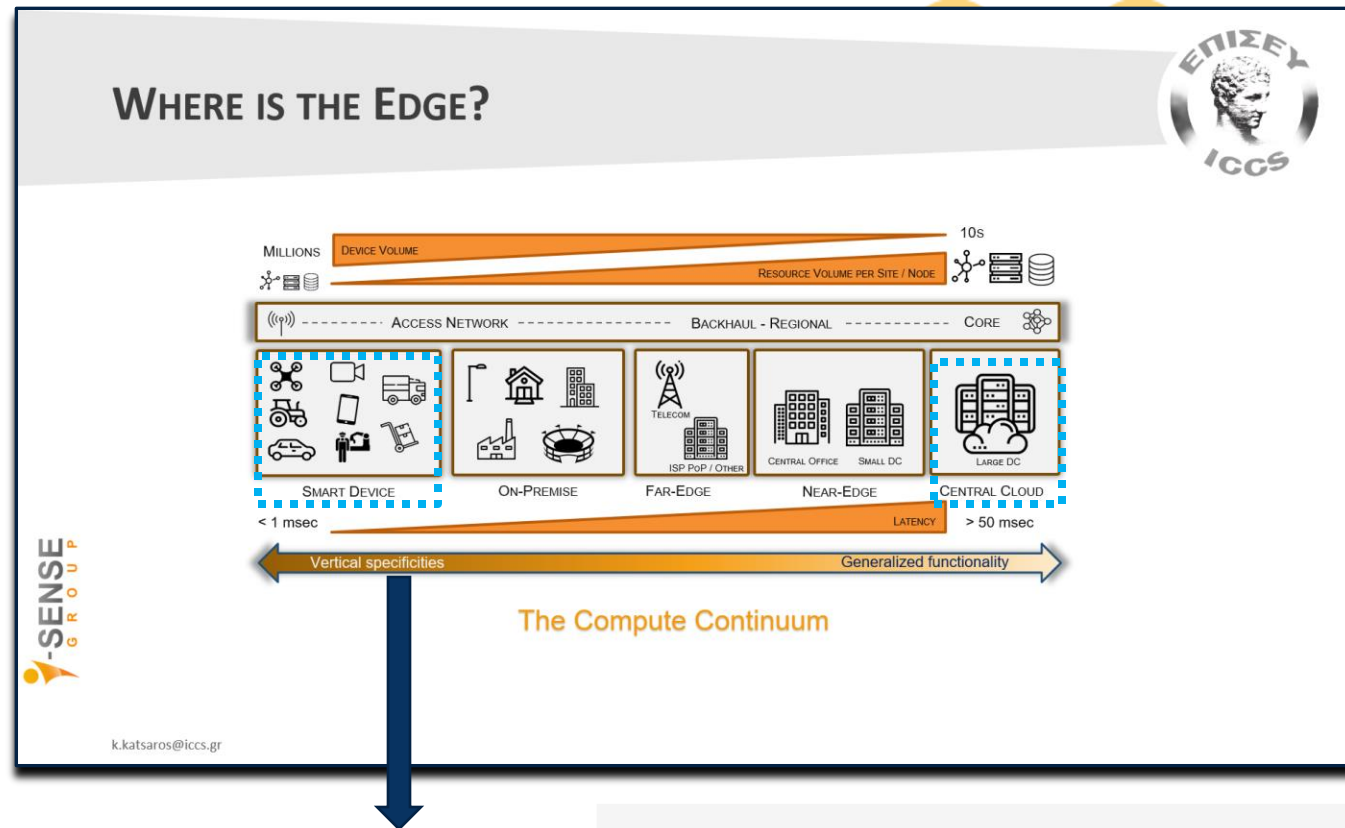
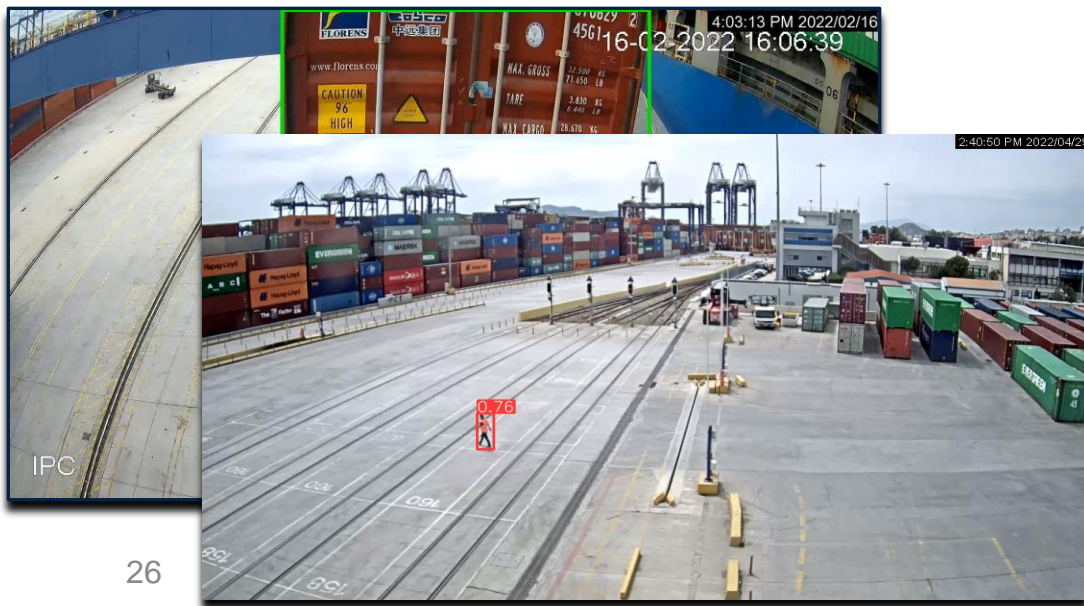


Private 5G Network (NSA Mode)

Radio Access Network	CN	Frequency Bands	Channel BW	Max Throughput	Other
5G NR (Release 15) NSA	5G Core (Release 15) NSA	n78, @3.7Ghz	100Mhz	1500 Mbps DL and 150 Mbps UL (average IP rates)	Capable up to 64x64 MIMO

PCT Deployment

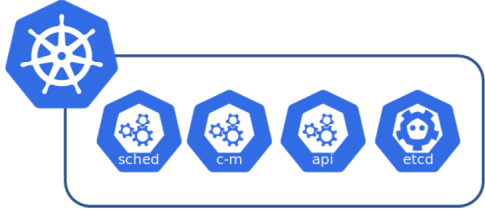
- Focusing on two main options
 - **Central Cloud**
 - Datacenter at PCT premises
 - **Smart Device** (5G Truck, 5G Crane, 5G-IoT device)
- AI-enabled **video analytics** services
 - Container seal detection
 - Human presence detection



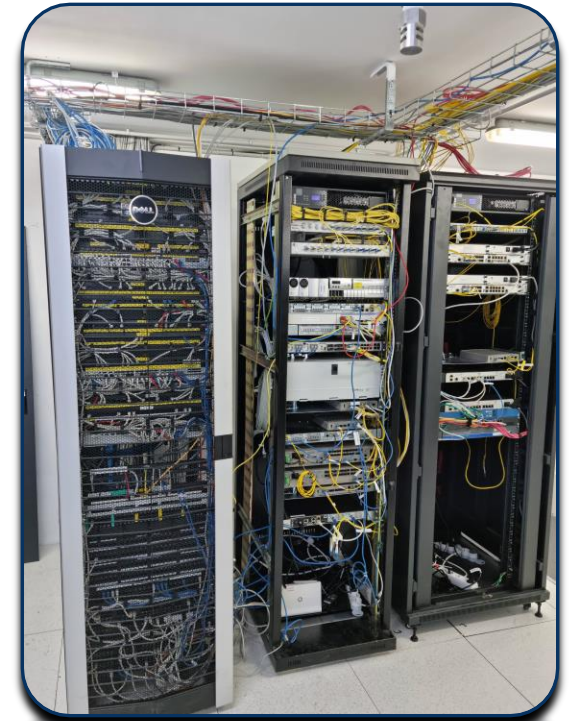
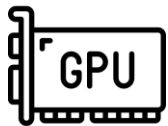
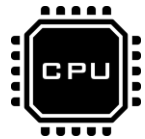
Jetson AGX Xavier

GPU	512-core Volta GPU with Tensor Cores
CPU	8-core ARM v8.2 64-bit CPU, 8MB L2 + 4MB L3
Memory	32GB 256-Bit LPDDR4x 137GB/s
Storage	32GB eMMC 5.1
DL Accelerator	(2x) NVDLA Engines
Vision Accelerator	7-way VLIW Vision Processor
Encoder/Decoder	(2x) 4Kp60 HEVC/(2x) 4Kp60 12-Bit Support
Size	105 mm x 105 mm x 65 mm
Deployment	Module (Jetson AGX Xavier)

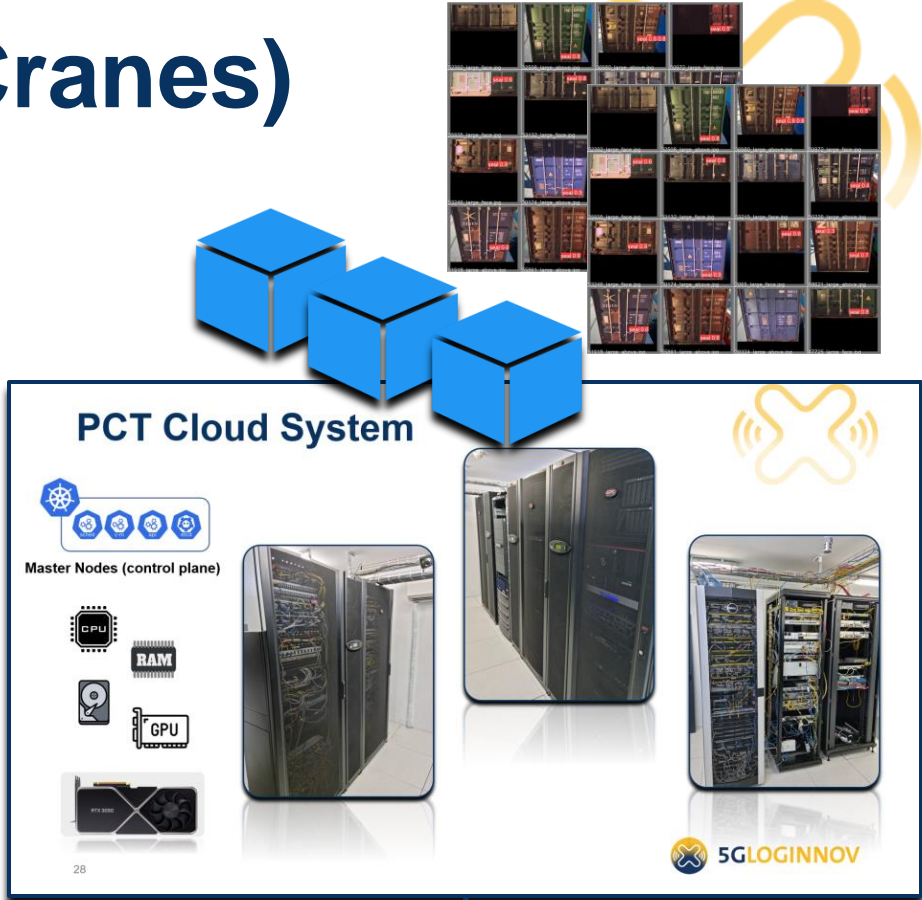
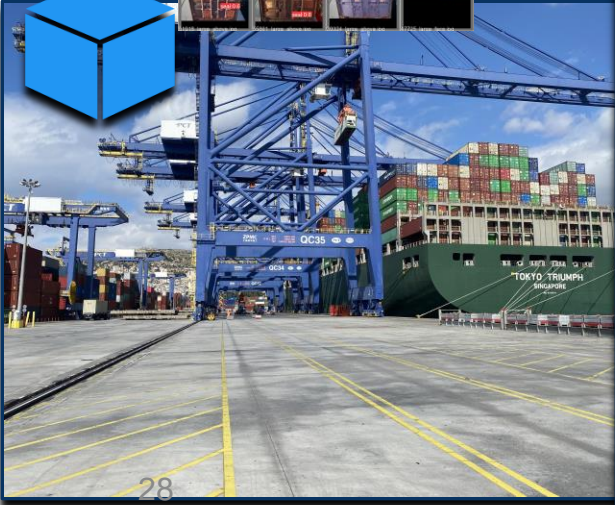
PCT Cloud System



Master Node (control plane)



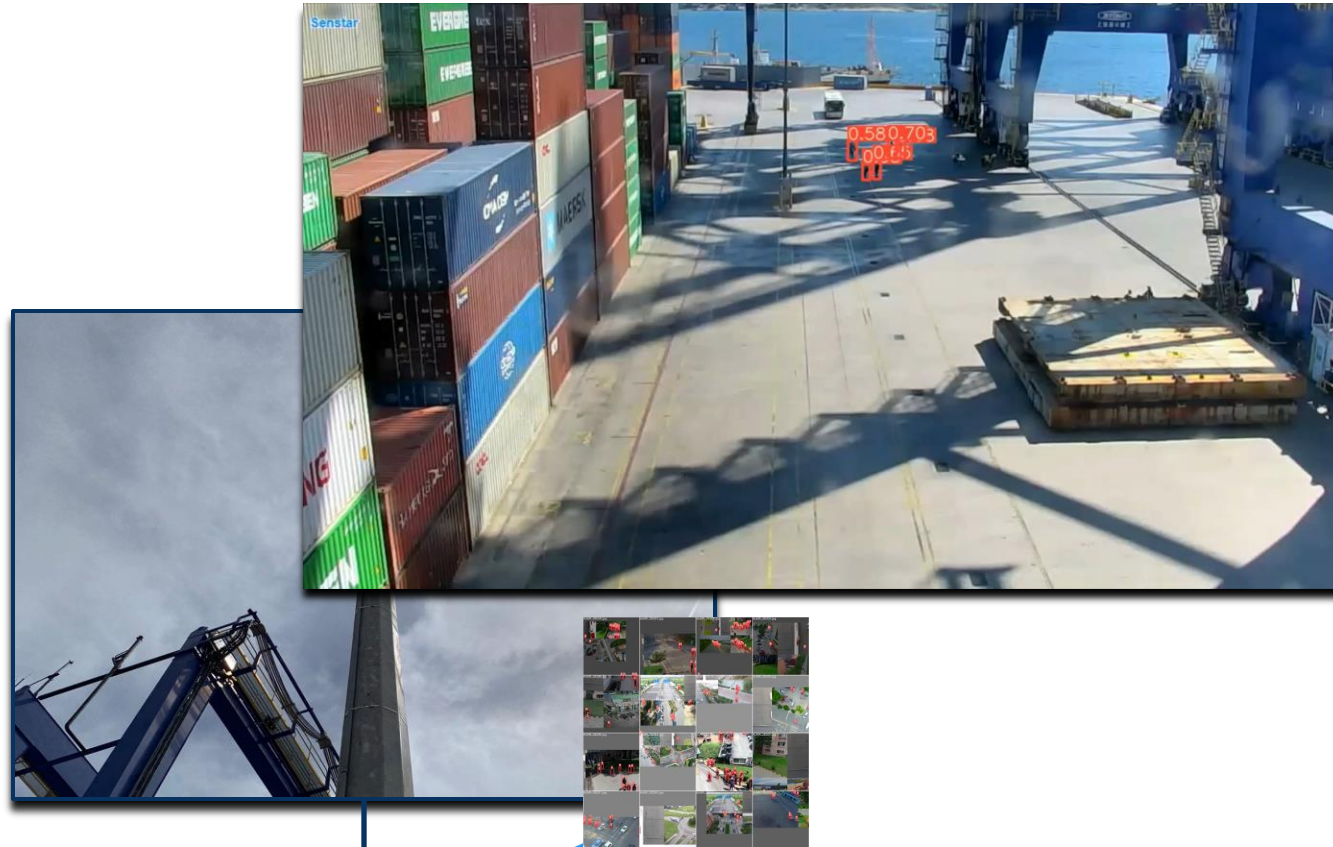
5G LOGINNOV Port Assets (5G Cranes)



Worker Nodes



5G&AI Enabled Surveillance and Video Analytics



Worker Node on
Smart Device



Worker Node
on Cloud

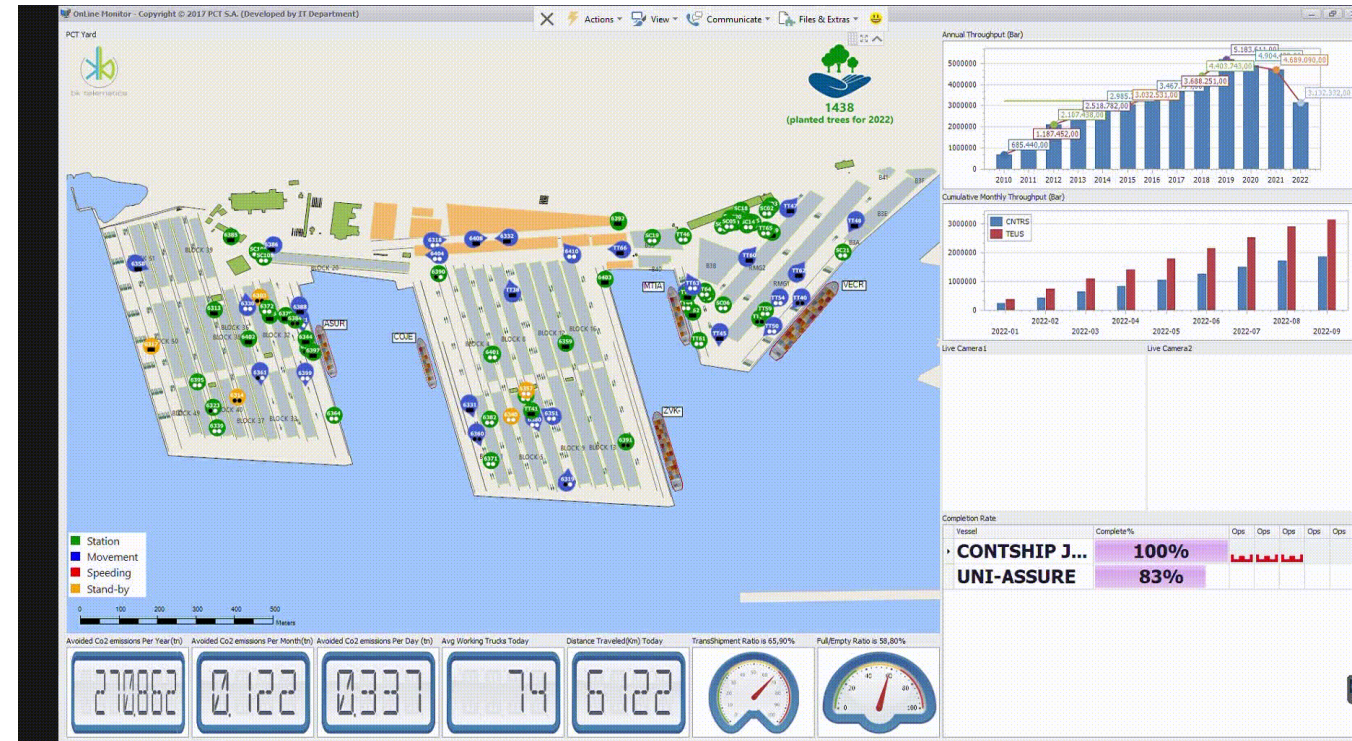


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Yard truck telematics use cases



- A fleet of about 192-trucks (currently communicating over 4G and 5G)
- Telematics device installed on trucks
 - Telemetry data: CAN-Bus, GNSS, container presence sensors
- Applications
 - **UC3:** Real time job allocation and traffic coordination within Piraeus port (about 2,5km area)
 - **UC7:** AI/ML predictive maintenance services



UC3: Optimal Selection of Yard Trucks

UC7: Predictive Maintenance

Live demonstration of service orchestration and lifecycle management of AI/ML services at GPU enabled (far-)edge nodes.

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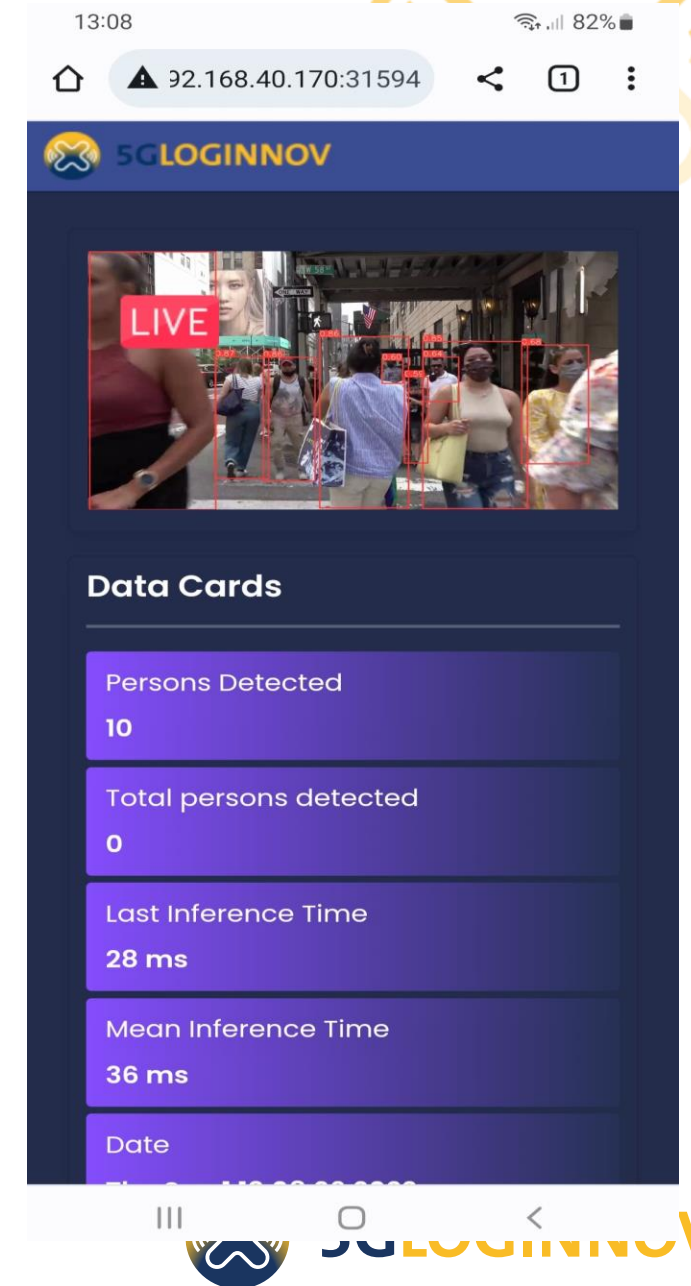
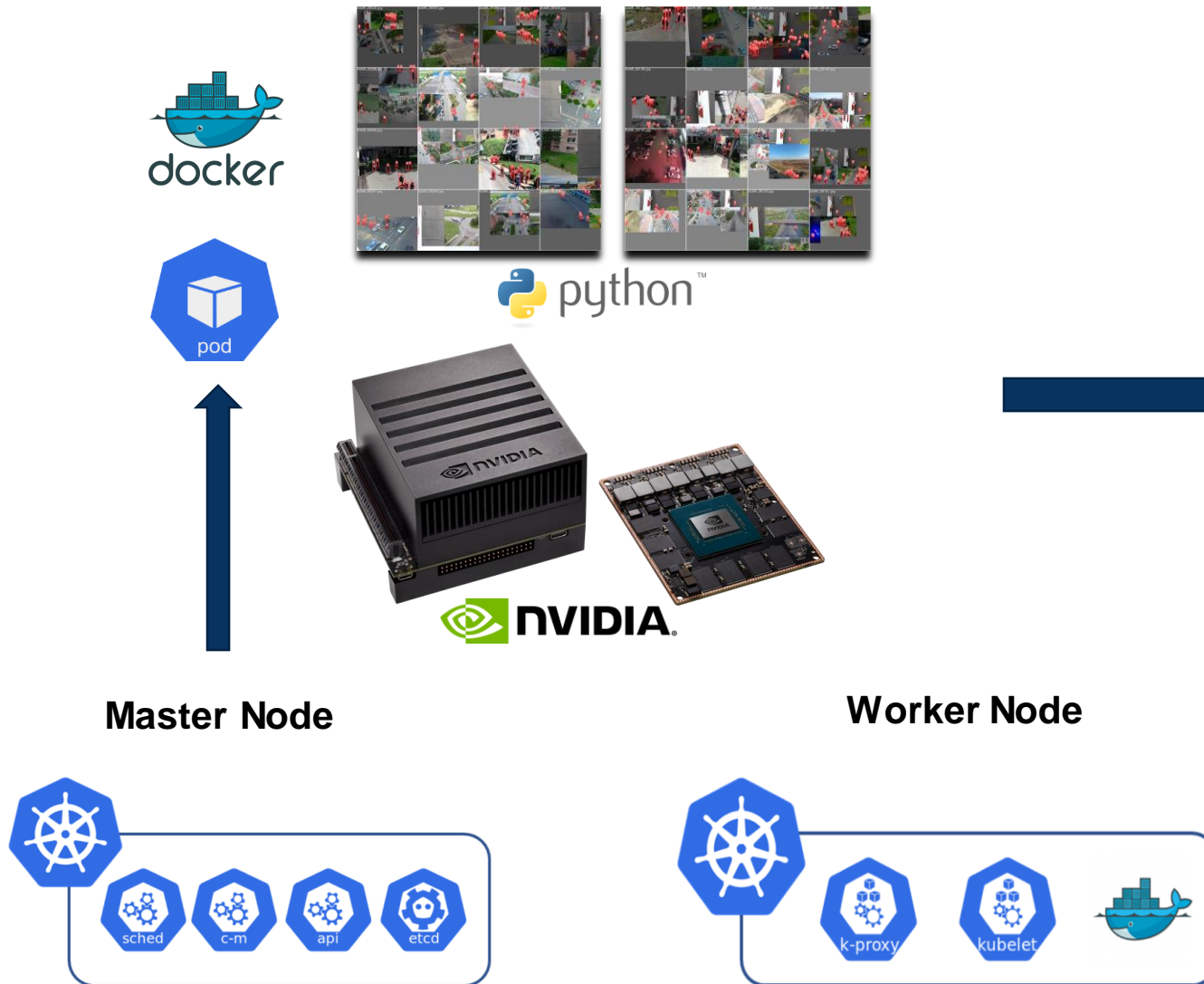


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MicroK8s

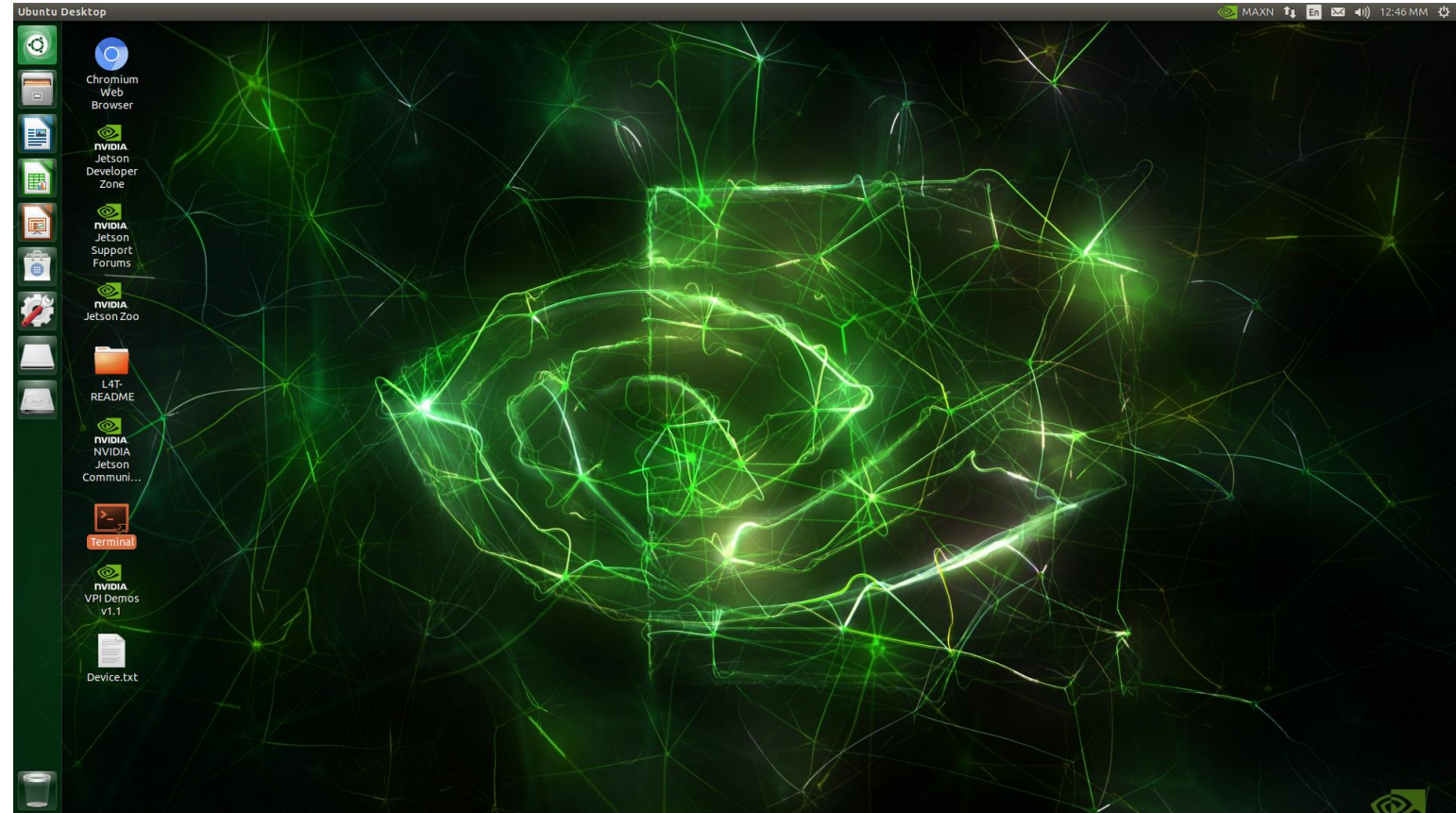
Demo Setup



Log in to the Device



- User: **iccs**
- Password: **jetson**



Microk8s command line

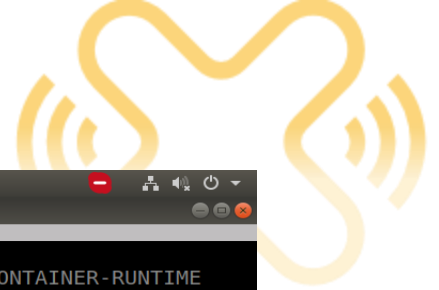


```
Activities Terminator Πεμ 16:03
iccs@edge-iot-cs: ~
iccs@edge-iot-cs: ~ 131x40
iccs@edge-iot-cs:~$ microk8s status
microk8s is running
high-availability: no
addons:
  enabled:
    dns                # CoreDNS
    helm3              # Helm 3 - Kubernetes package manager
    metallb            # Loadbalancer for your Kubernetes cluster
    storage             # Storage class; allocates storage from host directory
  disabled:
    dashboard          # The Kubernetes dashboard
    ha-cluster          # Configure high availability on the current node
    helm                # Helm 2 - the package manager for Kubernetes
    host-access         # Allow Pods connecting to Host services smoothly
    ingress             # Ingress controller for external access
    linkerd             # Linkerd is a service mesh for Kubernetes and other frameworks
    metrics-server      # K8s Metrics Server for API access to service metrics
    openebs             # OpenEBS is the open-source storage solution for Kubernetes
    portainer           # Portainer UI for your Kubernetes cluster
    prometheus          # Prometheus operator for monitoring and logging
    rbac                # Role-Based Access Control for authorisation
    registry            # Private image registry exposed on localhost:32000
    traefik             # traefik Ingress controller for external access
iccs@edge-iot-cs:~$
```

microk8s status



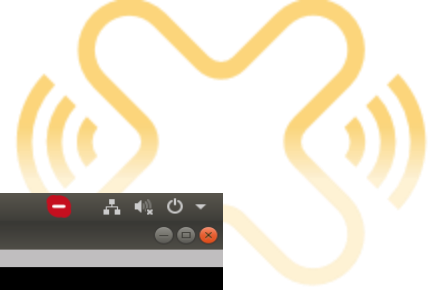
Microk8s command line (cont.)



```
Activities Terminator Πεμ 18:47
iccs@iccs-node: ~
iccs@iccs-node: ~ 153x46
iccs@iccs-node:~$ microk8s kubectl get nodes -o wide
NAME          STATUS    ROLES    AGE   VERSION          INTERNAL-IP    EXTERNAL-IP    OS-IMAGE          KERNEL-VERSION    CONTAINER-RUNTIME
iccs-node     Ready    <none>   24h   v1.22.15-3+587c2595d08afb  192.168.40.129 <none>         Ubuntu 18.04.6 LTS 4.9.253-tegra     docker://20.10.18
iccs@iccs-node:~$
```

microk8s kubectl get nodes -o wide

Microk8s command line (cont.)



```
Activities Terminator
iccs@edge-iot-cs: ~
iccs@edge-iot-cs: ~ 131x40

iccs@edge-iot-cs:~$ microk8s kubectl get all -A

NAMESPACE      NAME                                     READY   STATUS    RESTARTS   AGE
kube-system     pod/coredns-7f9c69c78c-99rlh           1/1     Running   63 (63m ago)  267d
kube-system     pod/hostpath-provisioner-976f6d665-xd8v9 1/1     Running   4 (63m ago)   8d
metallb-system  pod/controller-559b68bfd8-z8pc7        1/1     Running   71 (63m ago)  274d
metallb-system  pod/speaker-d2kzm                      1/1     Running   7 (70s ago)   8d

NAMESPACE      NAME      TYPE          CLUSTER-IP    EXTERNAL-IP    PORT(S)          AGE
default        service/kubernetes ClusterIP      10.152.183.1    <none>          443/TCP          274d
kube-system    service/kube-dns ClusterIP      10.152.183.10  <none>          53/UDP,53/TCP,9153/TCP 267d
kube-system    service/kubelet ClusterIP      None           <none>          10250/TCP,10255/TCP,4194/TCP 259d

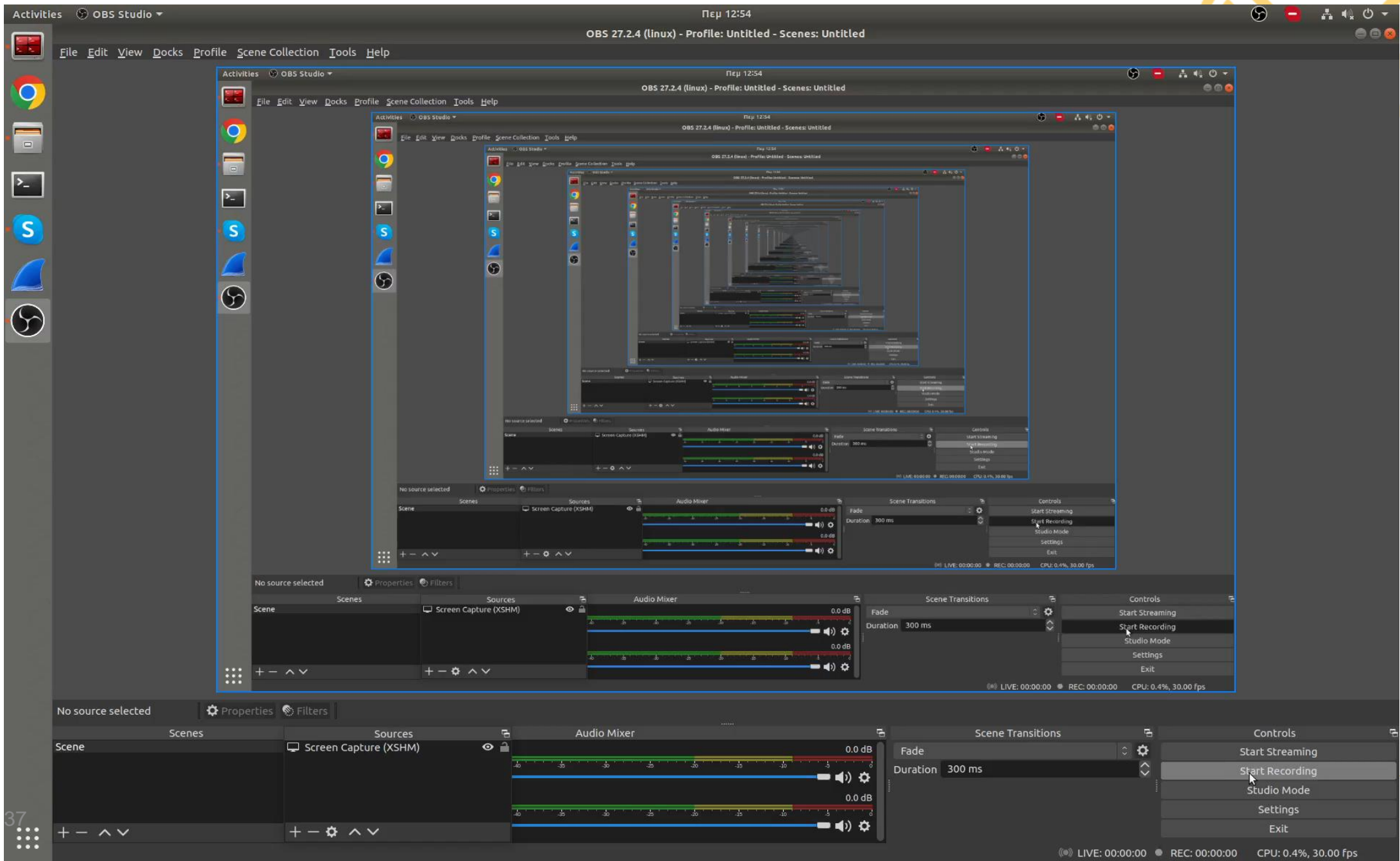
NAMESPACE      NAME                DESIRED   CURRENT   READY   UP-TO-DATE   AVAILABLE   NODE SELECTOR   AGE
metallb-system  daemonset.apps/speaker 1          1         1       1             1           beta.kubernetes.io/os=linux 274d

NAMESPACE      NAME                READY   UP-TO-DATE   AVAILABLE   AGE
kube-system     deployment.apps/coredns 1/1      1             1           267d
kube-system     deployment.apps/hostpath-provisioner 1/1      1             1           274d
metallb-system  deployment.apps/controller 1/1      1             1           274d

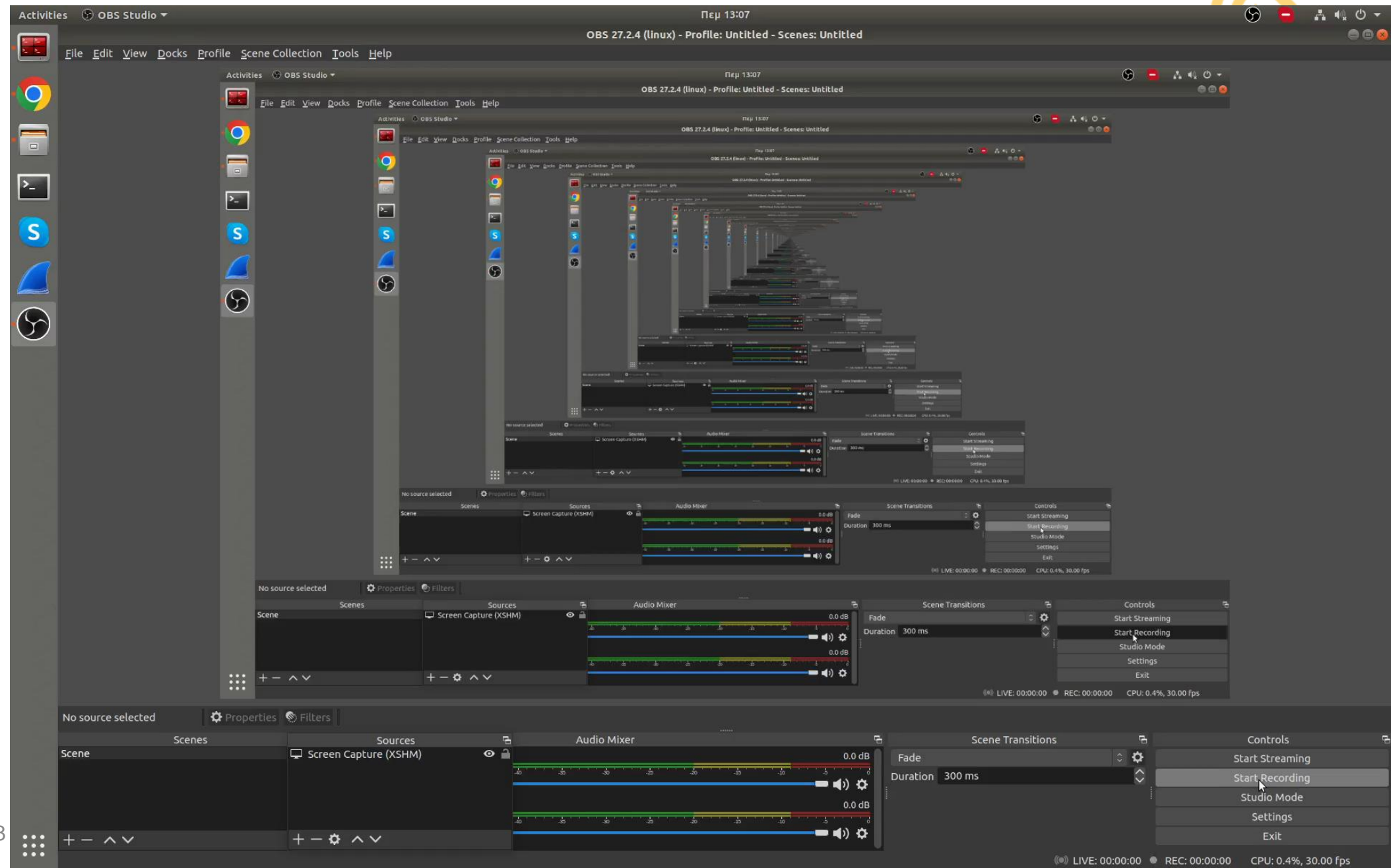
NAMESPACE      NAME                DESIRED   CURRENT   READY   AGE
kube-system     replicaset.apps/coredns-7f9c69c78c 1          1         1       267d
kube-system     replicaset.apps/hostpath-provisioner-976f6d665 1          1         1       274d
metallb-system  replicaset.apps/controller-559b68bfd8 1          1         1       274d
iccs@edge-iot-cs:~$
```

microk8s kubectl get all -A

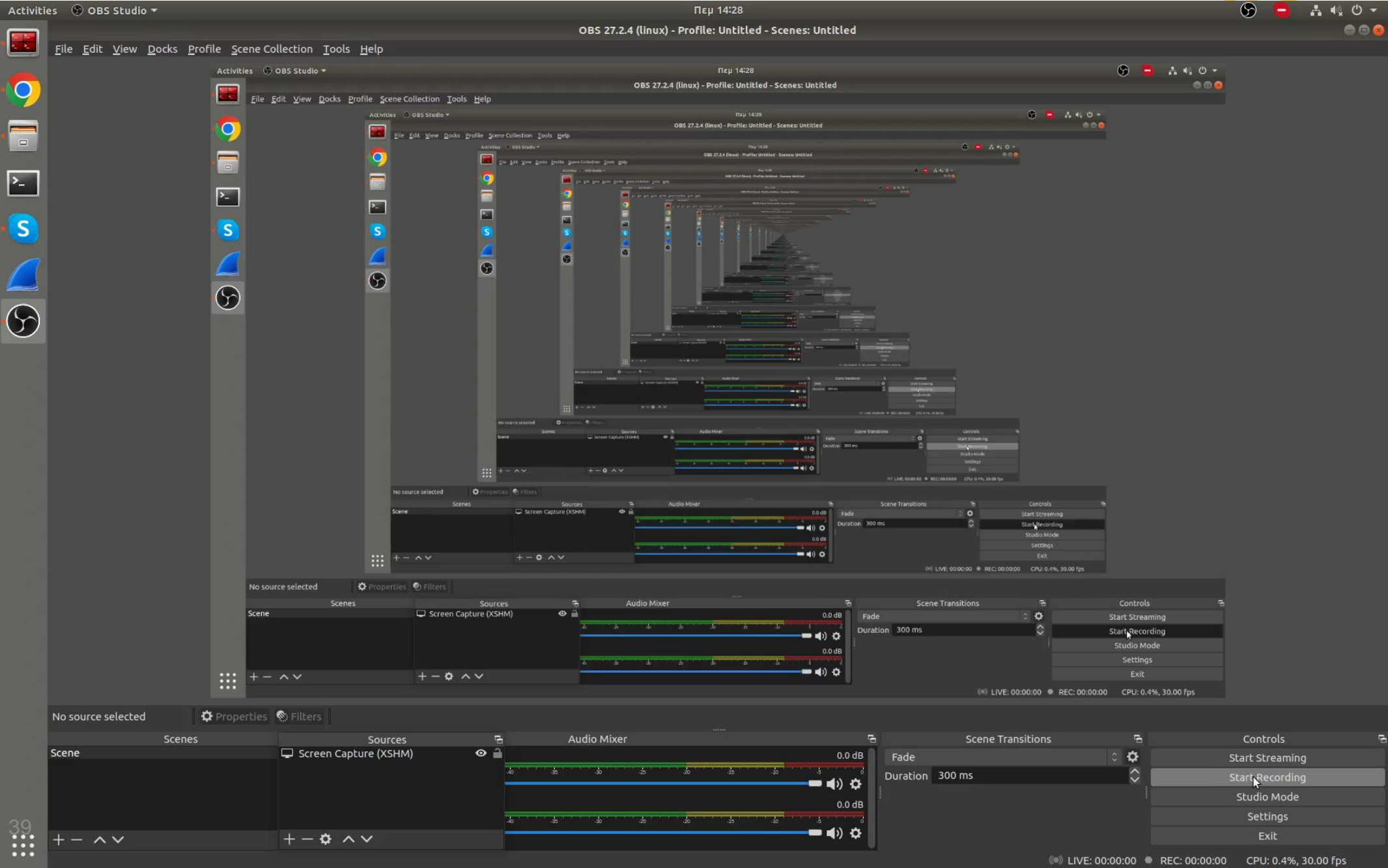
Initiate Service Through Microk8s



AI-enabled Human Presence Detection



Energy Aware k8s Cluster





Questions ? 😊



Thank You

Pavlos Basaras, PhD
pavlos.basaras@iccs.gr

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