

eSAAM 2023

on Cloud to Edge Continuum

Unikernels Motivations, Benefits and Issues: A Multivocal Literature Review

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- Edge Computing Require Lightweight containers
- Unikernels can be a potential solution

Highly-specialized **single-address space**, **immutable** and lightweight images.

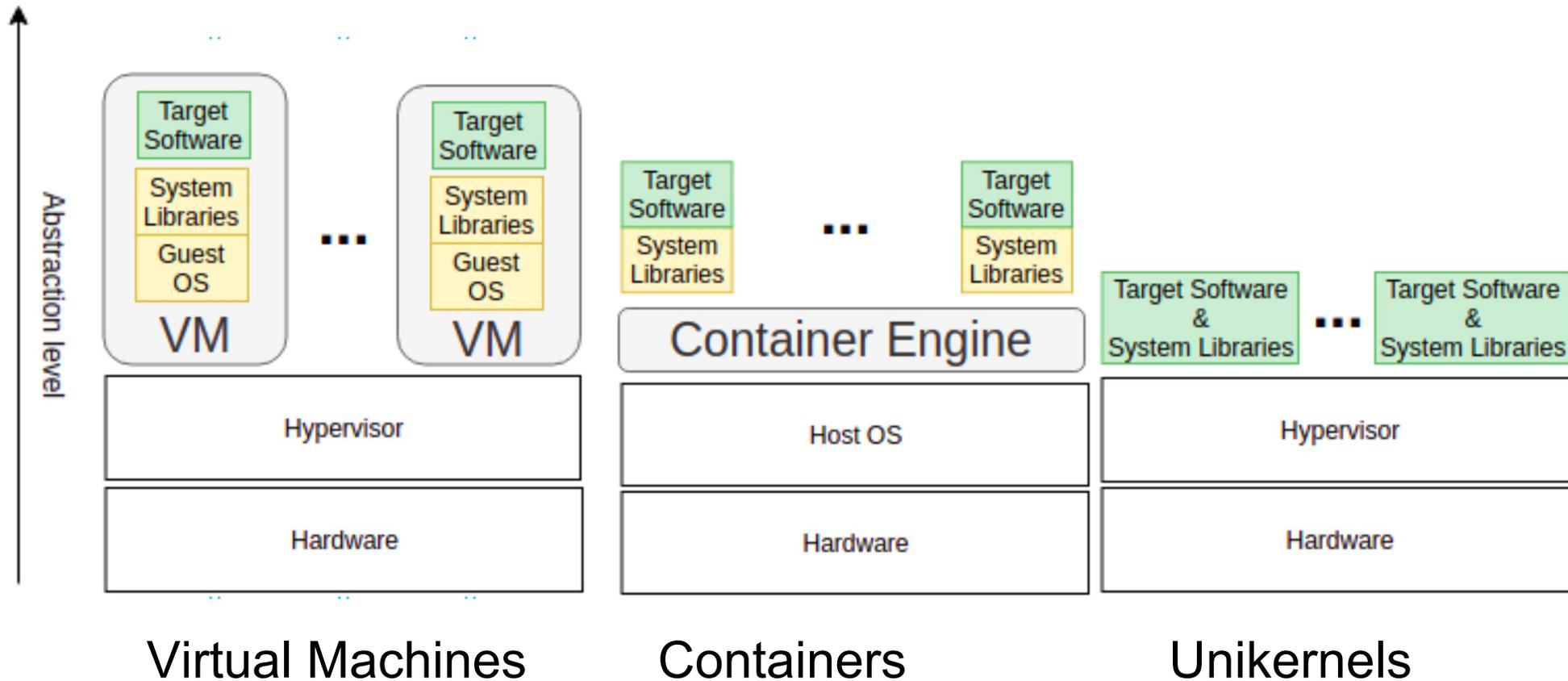
Linking an application only with its necessary **libraries at compile-time**

All the services, from device drivers to schedulers moved to the network stack

Two categories

- Language-based: Tied to single technology
- POSIX-like: single address space and a single privilege level

VM, Containers and Unikernels



Goal and RQs

- What are the motivations for the adoption of Unikernels?
- What benefits are achieved by using Unikernels?
- What are the major issues of Unikernels

Multivocal Literature Review

Method

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Analysis of **Grey Literature** and **Peer-Reviewed Literature**

Search String:

unikernel* AND (motivations OR benefits OR problem* OR issue* OR “operating system”).

- **PR:** ACM digital Library, IEEEXplore Digital Library, Scopus, Springer link
- **GL:** Google Search, Twitter, Search, Reddit Search, Medium Search, LinkedIn Search, Quora, Hacker News Algolia Search

Multivocal Literature Review

Method

Snowballing, Quality Assessment of GL, Inter-rater reliability, Open/Selective Coding...

Results:

590 initial sources

- Inclusion/Exclusion:
 - 528 excluded
 - 62 included
 - 40 (64.51 %) peer-reviewed-conference papers
 - 22 (35.49 %) grey literature

Unikernels Results

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Unikernel Framework	Targets	Programming Languages	Project Status	# Sources
HermiTux	Xen, KVM	C, C++, Fortran, Python	4 active contributors	2
Lupine-linux	KVM	language independent	4 active contributors	1
Rumprun	Xen, KVM	C, C++, Java, Go, JavaScript, Node, Python, Ruby	last commit was on May 11, 2020, 25 contributors	16
IncludeOS	KVM, ESXi, OpenStack	C++	last commit was on May 11, 2020, 60 contributors	10
MirageOS	KVM, Xen	OCaml	last commit was on December, 2020, 52 contributor	16
OSv	VirtualBox, ESXi, KVM	Java, C, C++, Node	very active project with 103 contributor and +44 releases	11
RustyHermit			active 9 contributors	1
Hermitcore	KVM	C, C++, Fortran, Go	active 10 contributors	5
ClickOS	Xen	C++	supported by NEC	3
MiniOS	Xen	C++	supported by XEN project, active project	2
Ling	Xen	Erlang	has not been updated since 2015	1
HaLVM	Xen	Haskell	has not been active since 2018	1

Table 4. Unikernel Frameworks

Motivations

Results

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- **Security**
- **Performance**
- **Supporting Technology**
- **Resource Optimization**
- **Service Modularity**
- **Service Isolation**
- **Reduced Costs**
- **Personal Motivations**

Benefits Results

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- **Performance** ↑
- **Resource Optimization** ↑
- **Security** ↓
- **Service Isolation**
- **Deployment**
- **Supporting Technologies**
- **Reduced Costs**
- **Service Modularity**

Issues Results

- **Maturity**
- **Technologies**
 - Lack of Multi-Processing
 - Development Process
 - Vendor Lock-in
- **Compatibility**
- **Management**
- **Security**
- **Resource Utilization**
 - Throughput is slightly higher than containers due to the lack of a userspace copy
 - Transmission performance is lower due to higher CPU usage

Open Questions

- Security threats are not clear
- Not clear when unikernels should be used
- Unikernels management not clear
 - Do they need a separate management layer?
 - Do we need a K8 like platform?

Conclusions

- Promising technology
- Multiple implementations
- Still in a early development stage
- Not easy to use and manage

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