Comparing Isolation Mechanisms with OSmosis

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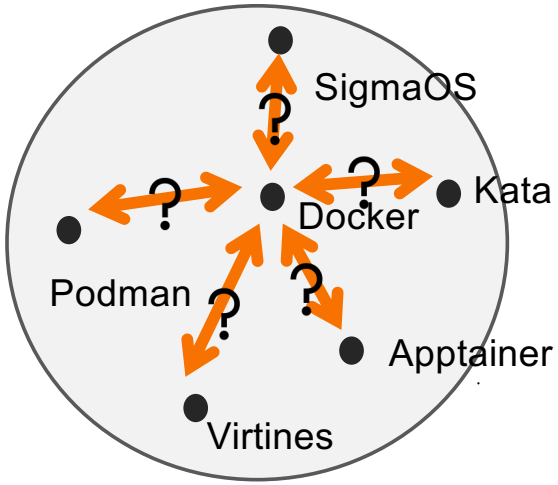
No way to compare different isolation mechanisms



What should the comparison tell us?

- Can one task affect another task?
  - Sharing resources, or pools of resources
- How do tasks depend on each other?
  - Providing services to each other
  - Ability to control each other

Two View Points

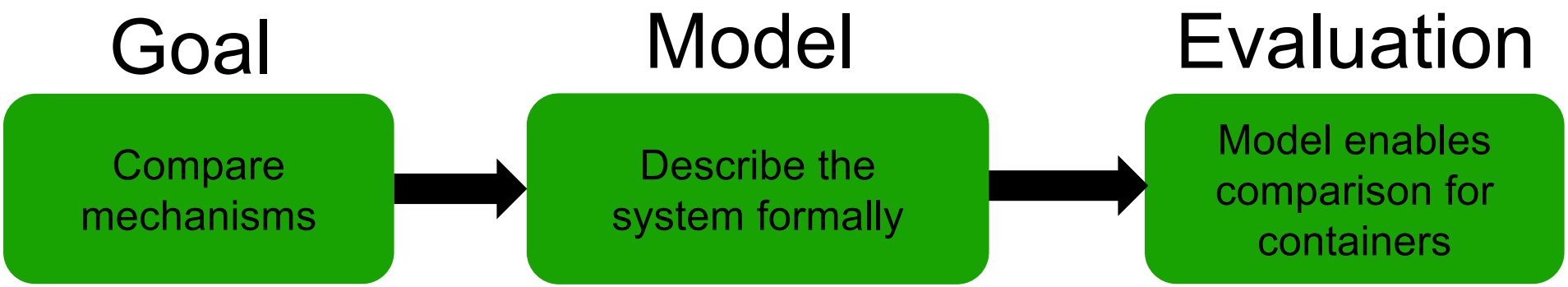
Trusted Computing Base (TCB)

- A set of domains upon which a protection domain relies
- Typically of interest to developers

Impact Boundary (IB)

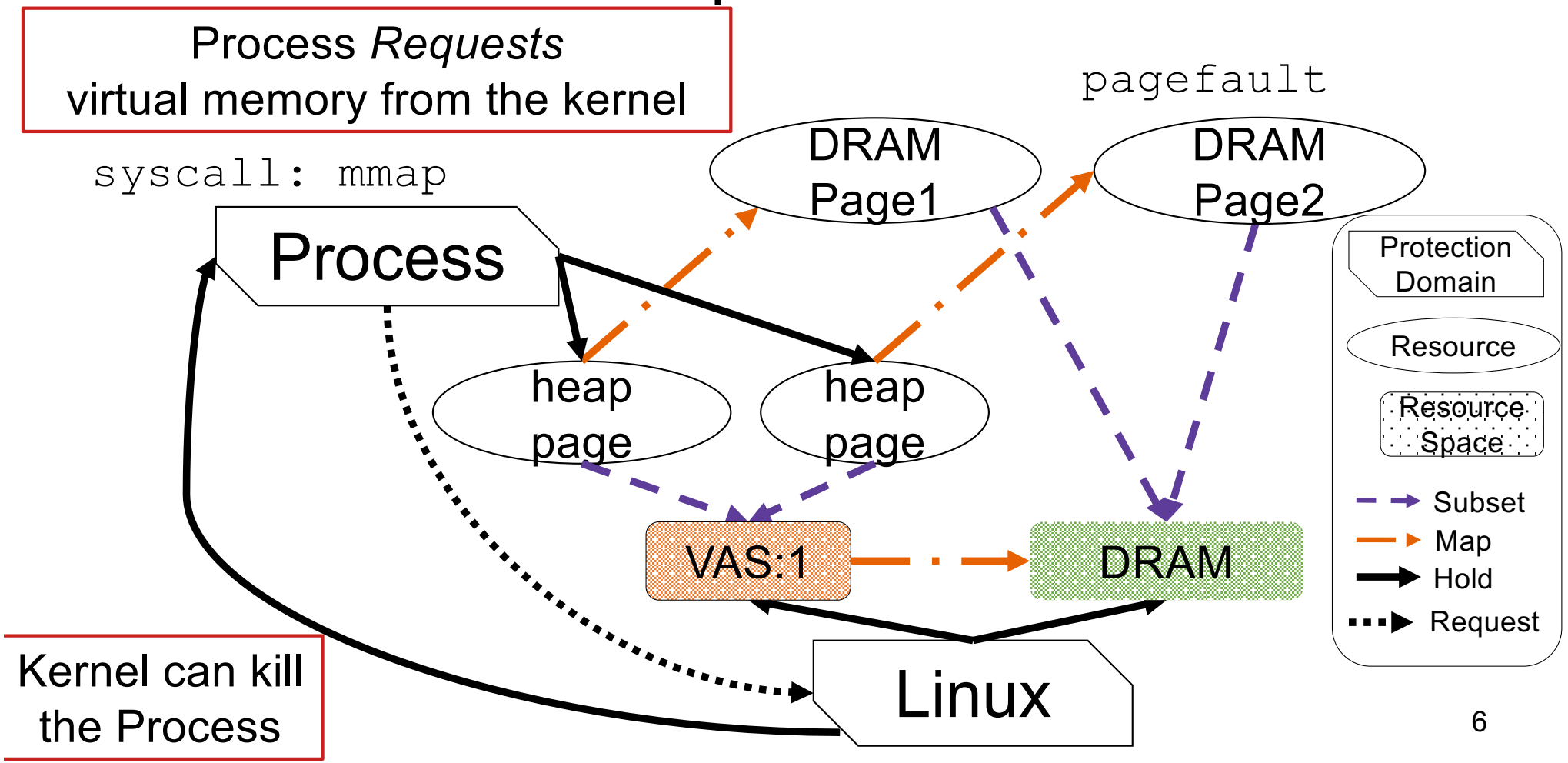
- A set of domains affected by a faulty or malicious domain
- Typically of interest to infrastructure providers

Contributions



OSmosis Model Graph of a Linux Process

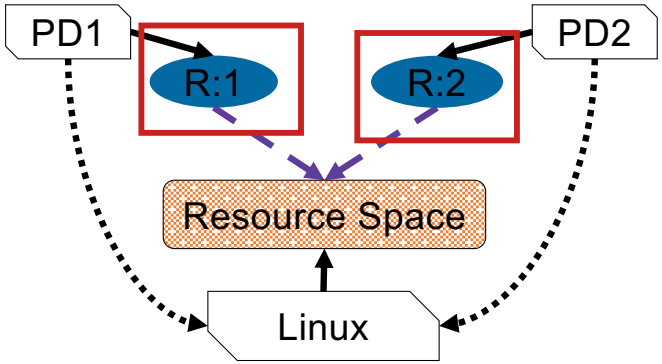
Process *Requests*
virtual memory from the kernel



Kernel can kill the Process

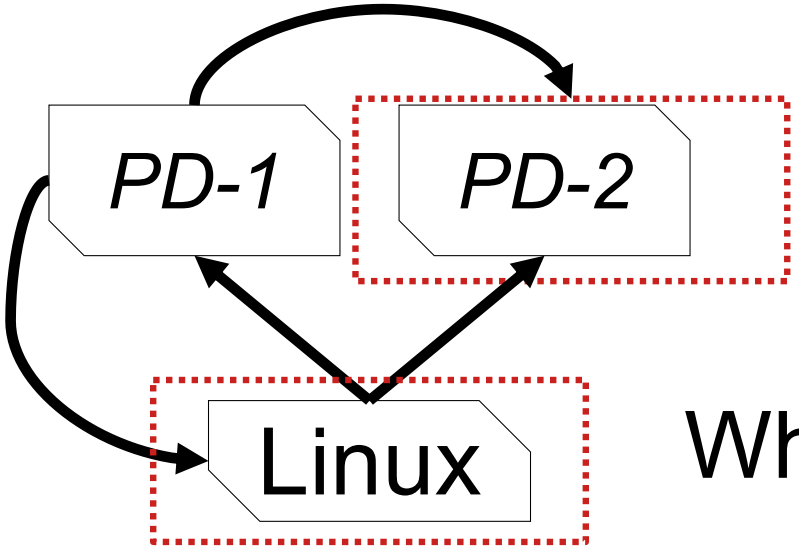
Finding Dependencies: Shared Resources

$$\textbf{SharedResources}(PD_x,\ \texttt{ResourceTypes},\ \texttt{AccessMode}) =$$
$$\{\ PD_i\ \mid\ PD_i \neq PD_x \wedge (\ BFS(PD_x,\ \{\texttt{hold},\ \texttt{map}\},\ \texttt{fwd},\ \texttt{ANY},\ \infty,\ \{\texttt{Resource}\},\ \texttt{ResourceTypes})$$
$$\cap$$
$$BFS(PD_i,\ \{\texttt{hold},\ \texttt{map}\},\ \texttt{fwd},\ \texttt{AccessMode},\ \infty,\ \{\texttt{Resource}\},\ \texttt{ResourceTypes})$$
$$\neq \emptyset\ )\ \}$$



Finding Dependencies: PD Control

Who can kill *PD-1*?



Who can be killed by *PD-1*?

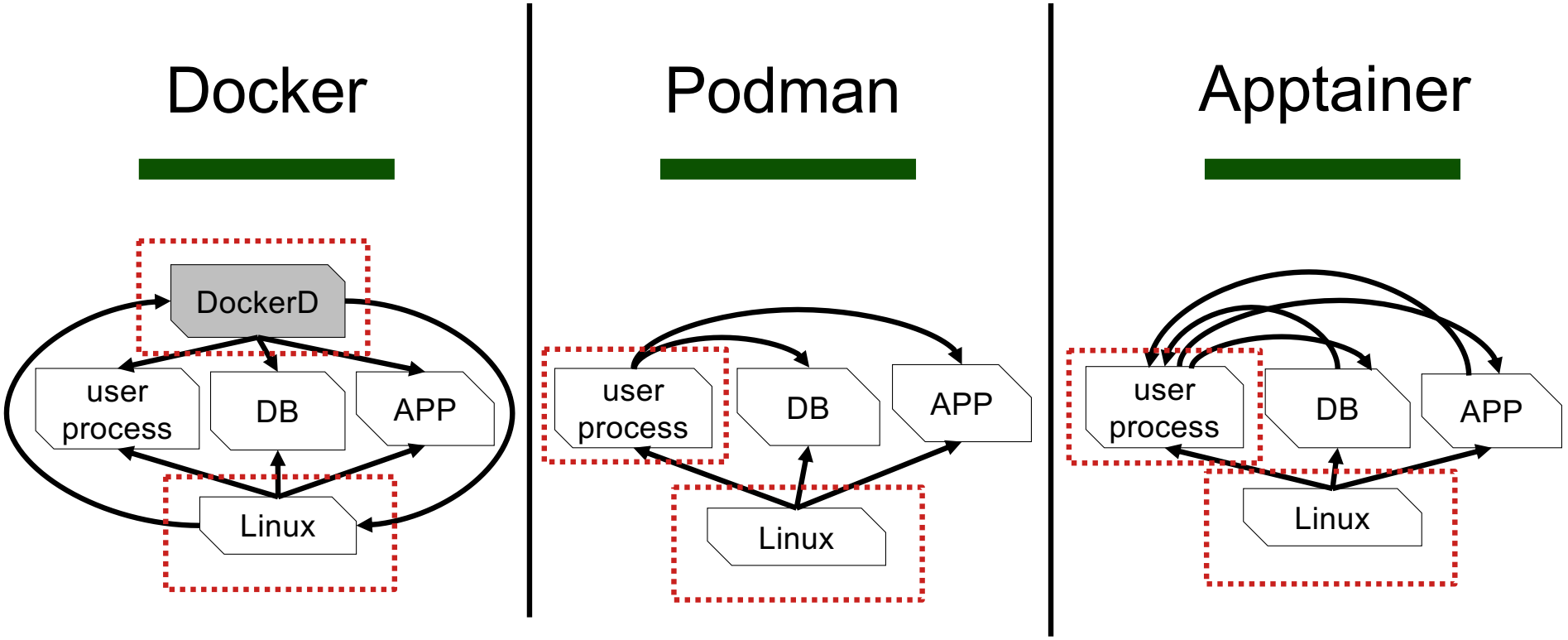
Precise TCB Definition as a Graph Query

$$\mathbf{TCB}(PD_x) = \texttt{SharedResources}(PD_x) \cup \texttt{CanControl}(PD_x)$$

Evaluation

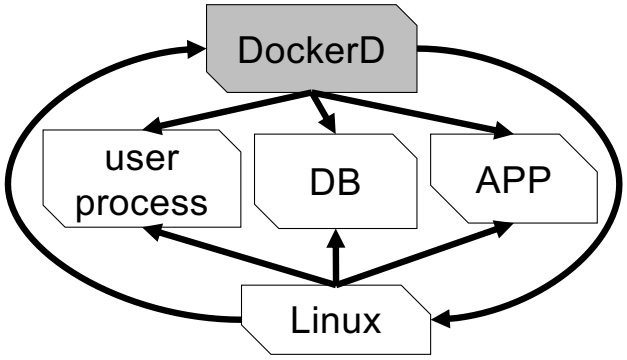
How does *TCB/IB* change from

Docker → Podman → Apptainer



What is the *Trusted Computing Base* of the DB Process?

Docker



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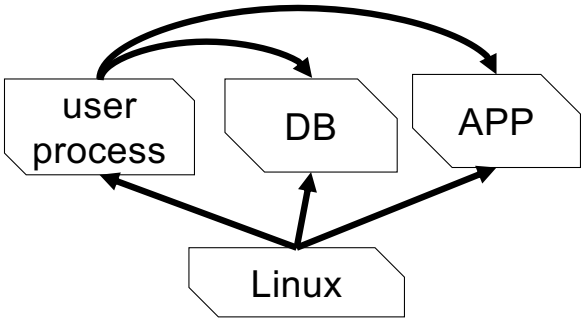
Podman



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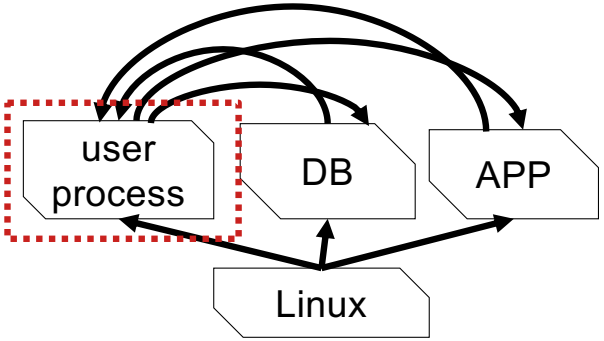
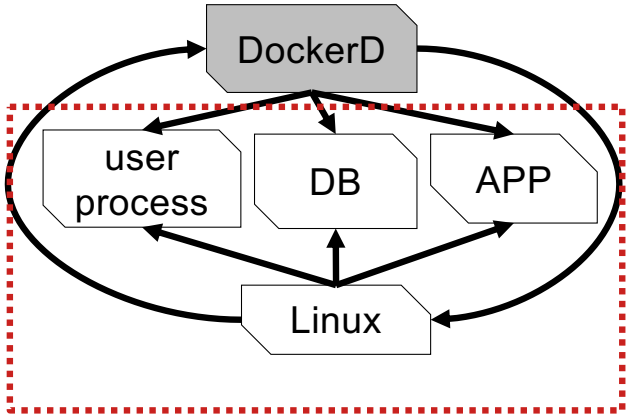
Apptainer

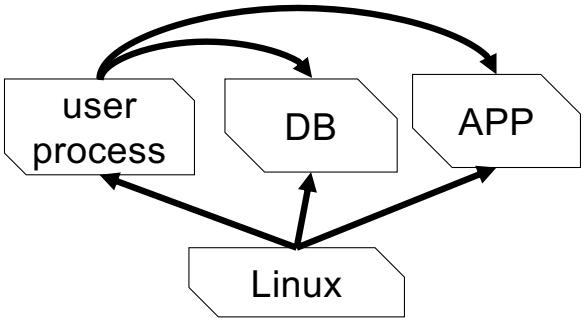


What is the Impact Boundary of the DB Process?

Docker



Podman



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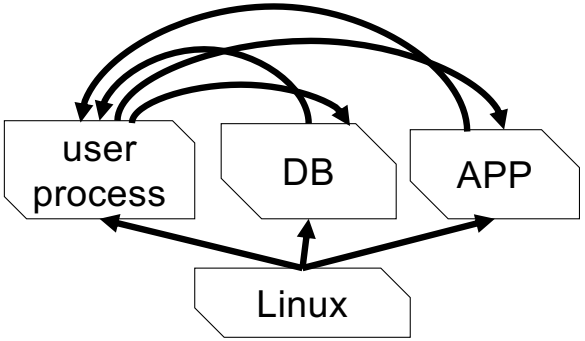
Apptainer



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What is the *Impact Boundary* of the Docker Daemon?

Getting OSmosis State of a Linux System

- Linux has no central place to track resources.

- Our Approach
  - Gobble whatever info available in `/proc`
    - `/proc/pid/maps`: Address Space Layout
    - `/proc/pid/pagemap`: Virtual Memory to Physical Memory mapping
    - `/proc/pid/status`: Signal Masks, User ID, Namespace Information

- **Lintool** is our Python script that reads `/proc` and generates the graph

Key Takeaways

- **OSmosis model** enables precise isolation comparison
- **Lintool** enables the OSmosis model extraction from Linux
- We leverage both to compare container technologies
- Refer to the paper for additional examples and queries

Paper