On Kernel Safety and Speculative Execution

Work in progress

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Address Space Layout Randomization

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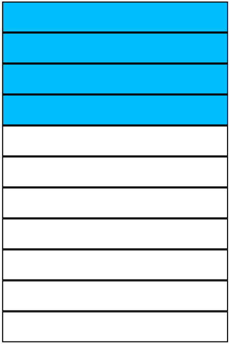
Memory



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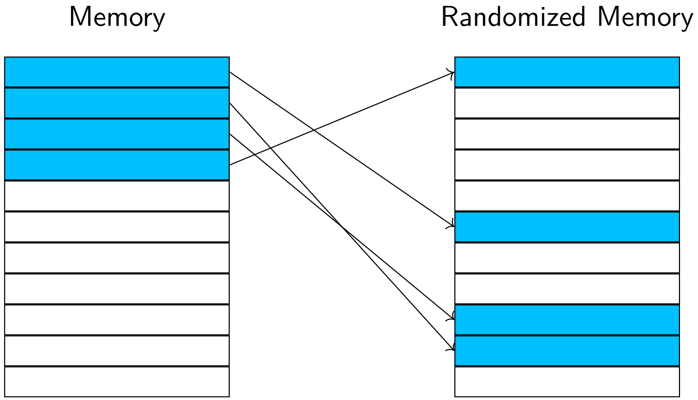

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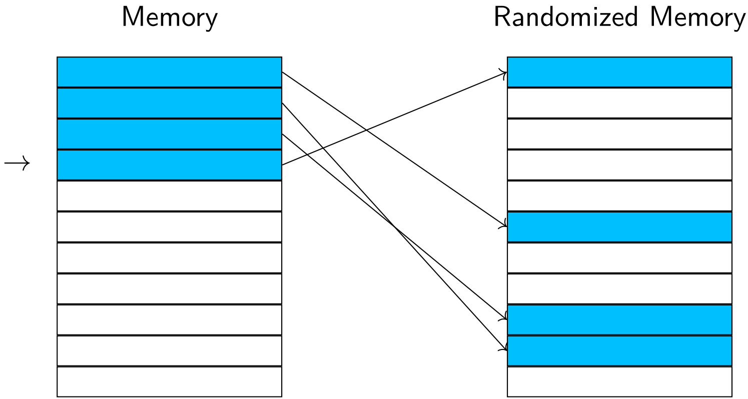

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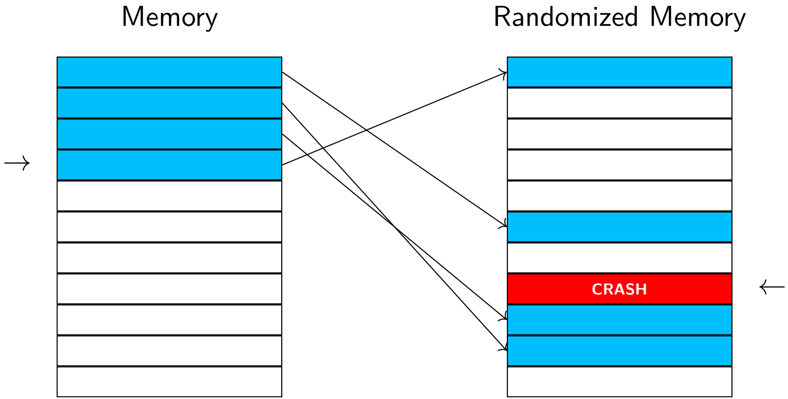

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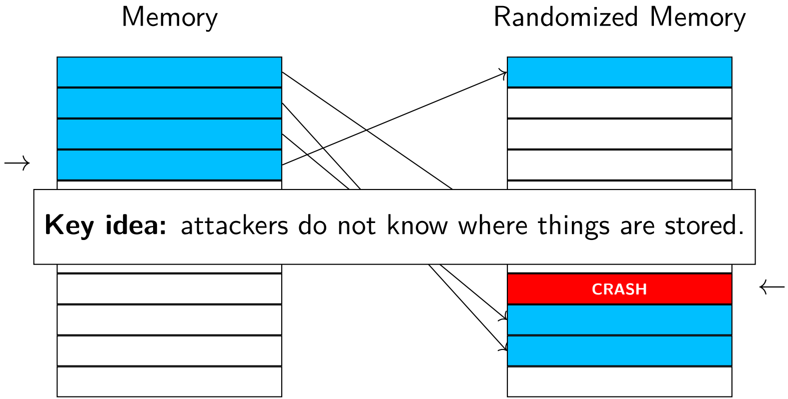

Key idea: attackers do not know where things are stored.

Open Problems, Research Questions and Contributions

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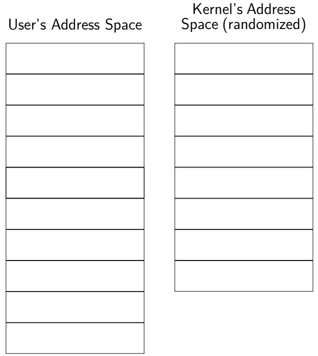

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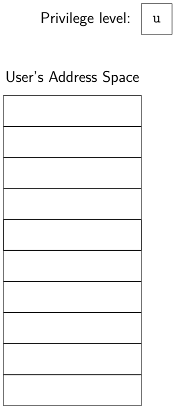

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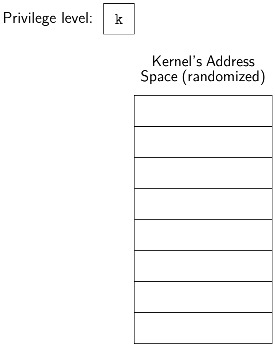

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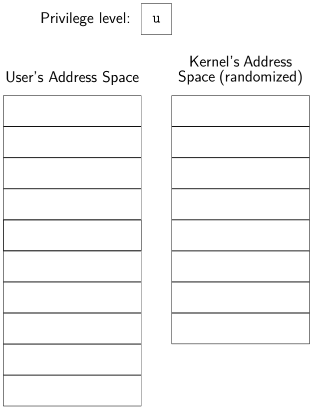

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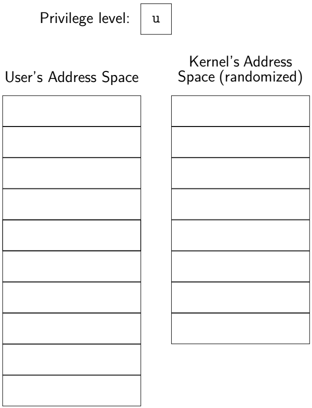

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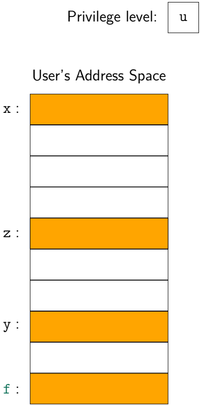

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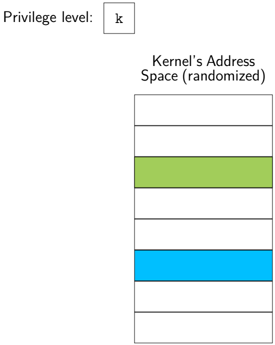

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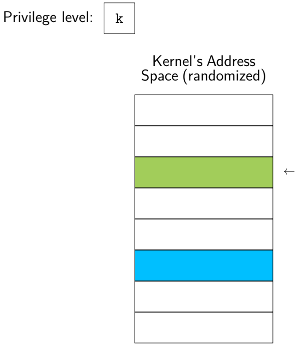

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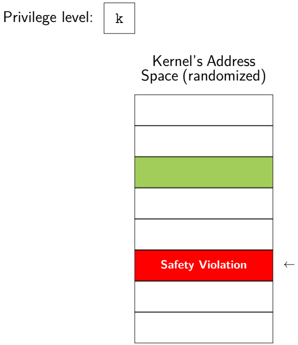

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Victim	LNI
`return p` (*p* array pointer)	no

KASLR in the presence of *Side-Channel* Attackers

Instructions leak information on the layout.

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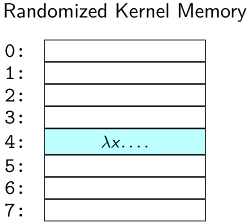

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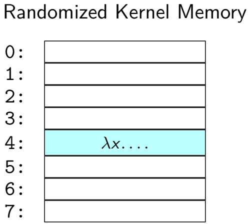

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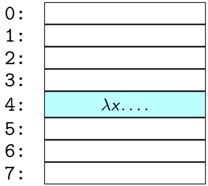

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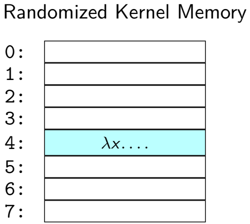

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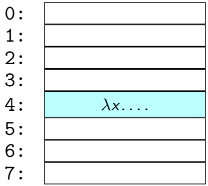

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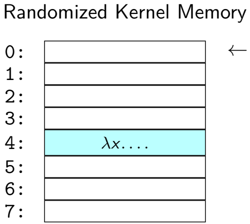

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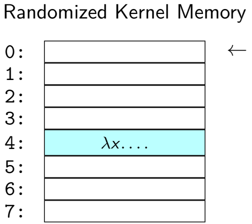

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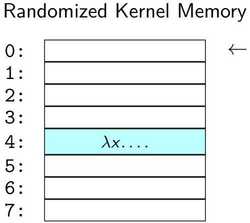

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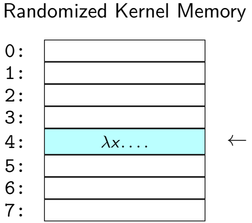

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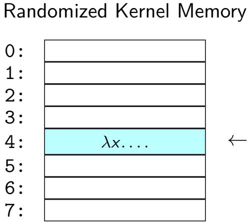

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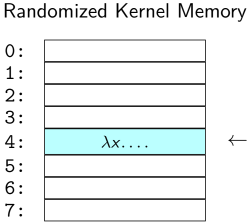

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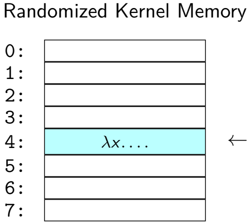

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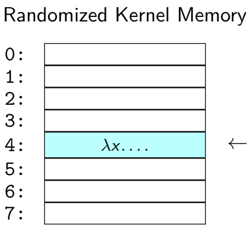

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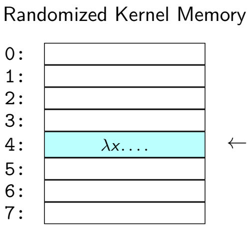

SLNI(γ) := the speculative semantics and the side channel leaks of the syscalls in γ must not depend on the layout

KASLR with Speculative Attackers and Side-Channels

$$\mathsf{SLNI}(\gamma) \Rightarrow \mathsf{safety}$$

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Victim SLNI

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Kernel Safety $\Rightarrow$ *Speculative* Kernel Safety (1/3)

γ is safe against speculative attackers

$\Downarrow$

γ is safe against ordinary attackers

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$\Uparrow$?

γ is safe against ordinary attackers

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Kernel Safety $\Rightarrow$ *Speculative* Kernel Safety (1/3)

$$\gamma \text{ is safe against speculative attackers}$$
$$\not\Uparrow$$
$$\gamma \text{ is safe against ordinary attackers}$$

But maybe there is an instrumentation ζ such that:

$$\gamma \text{ is safe against ordinary attackers}$$
$$\Downarrow$$
$$\zeta(\gamma) \text{ is safe against } \textit{speculative} \text{ attackers}$$

Kernel Safety $\Rightarrow$ *Speculative* Kernel Safety (2/3)

Theorem

If ζ*:*

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and γ *is safe against ordinary attackers, then* $\zeta(\gamma)$ *is safe against speculative attackers.*

Kernel Safety ⇒ *Speculative* Kernel Safety (3/3)

Does such transformation exist?

Kernel Safety $\Rightarrow$ *Speculative* Kernel Safety (3/3)

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$$\zeta(\texttt{if(E) \{C\} else \{D\}}) \triangleq \texttt{if(E)}\ \{\zeta(\texttt{C})\}\ \texttt{else}\ \{\zeta(\texttt{D})\}$$

$$\zeta(\texttt{while(E) \{C\}}) \triangleq \texttt{while(E)}\ \{\zeta(\texttt{C})\}$$

$$\zeta(*\texttt{E} = \texttt{F}) \triangleq \texttt{lfence}; *\texttt{E} = \texttt{F}$$

$$\zeta(\texttt{E} = *\texttt{F}) \triangleq \texttt{lfence}; \texttt{E} = *\texttt{F}$$

$$\zeta((*\texttt{E})(\texttt{F}_1, \ldots, \texttt{F}_k)) \triangleq \texttt{lfence}; (*\texttt{E})(\texttt{F}_1, \ldots, \texttt{F}_k)$$

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- Evaluate the overhead of our instrumentation in practice.