Does Making The Kernel Harder Make Making The Kernel Harder?

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Kernel developer from the 1970’s

Supercomputers in the 1990’s

Smack Linux Security Module

Security module stacking

Photo Curtesy Ann Forrister

Why Don’t We Think The Kernel Is “Hard”?

It’s too easy to cause damage

- Buffer overflow
- Index underflow
- Stack stomping

People who want to do damage are too clever

- Buffer overflow attacks
- Invalid parameters
- Return oriented programming

By Producers Releasing Corporation - The Devil Bat movie, Public Domain, https://commons.wikimedia.org/w/index.php?curid=11451565

But that’s not new, is it?

Old as the C compiler

- The C language simplifies
- Memory organization
- Control flow
- C is not strongly typed

Efficient and convenient

```
struct ip_msfilter {
    . . .
    __u32   imsf_numsrc;
    __be32  imsf_slist[1];
};
```

```
u = ipm->imsf_slists[index];
```

Clever and precise

```
union tcp_word_header {
   struct tcphdr  hdr;
   __be32         words[5];
};

twh->words[3] = 0x8675
```

Why would I want to give that up?

You probably don't

- Strongly typed languages have their own issues
- Object oriented programming adds overhead
- The code base is really big

"Strong typing is for weak minds"

–

Tom Van Vleck?
James Gosling?

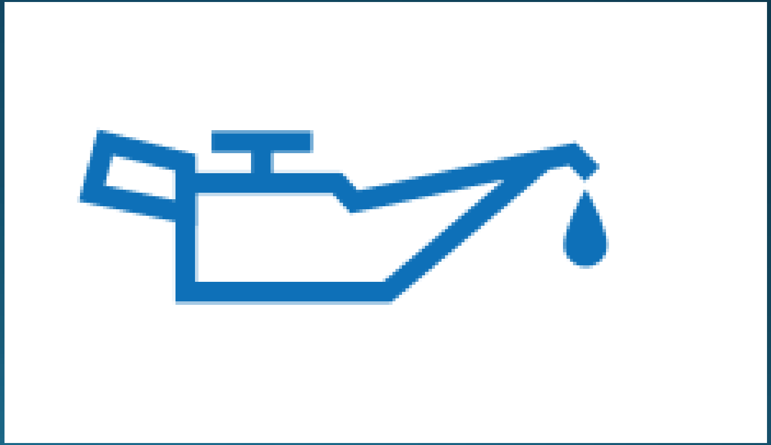
There are things we can do

- Use the typing that is available
- Fix what we know to be dangerous
- Prepare for failures

Typing?
How does that help?

refcount_t

- Allocated object reference counts
- Should never be 0
- Detect use of freed object



What do we know is dangerous?

String functions

- `strcpy(dest, src);`
- `strncpy(dest, src, strlen(src));`

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Automatic arrays

- `int func(struct conp *p, int count)`
- `{`
- `   struct conp controls[count];`

Casts

- `struct cred *cred = (struct cred *cred) &i;`

- `temp = (unsigned short)((int)(temp) + shift);`

It’s not that they can’t be used safely

- Checking may be expensive
- Try to find all the callers

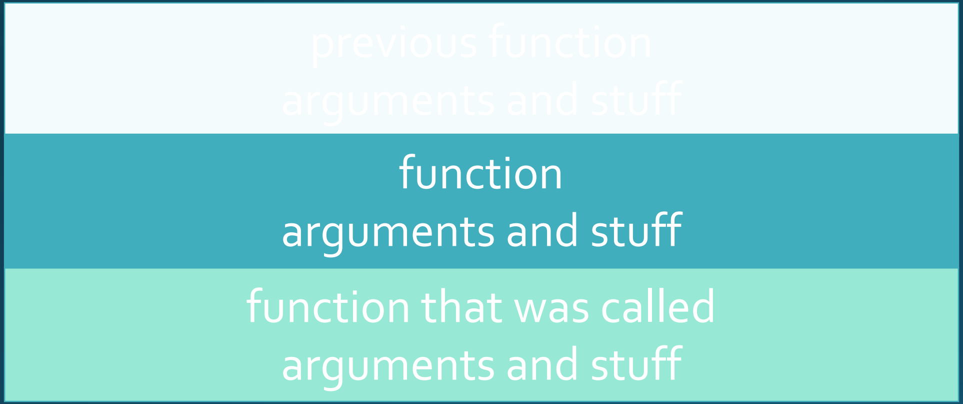
Stacks

Convenient for function parameters

- Push on call
- Pop on return
- Hardware accelerated

Jan Łukasiewicz

Convenient for mucking up

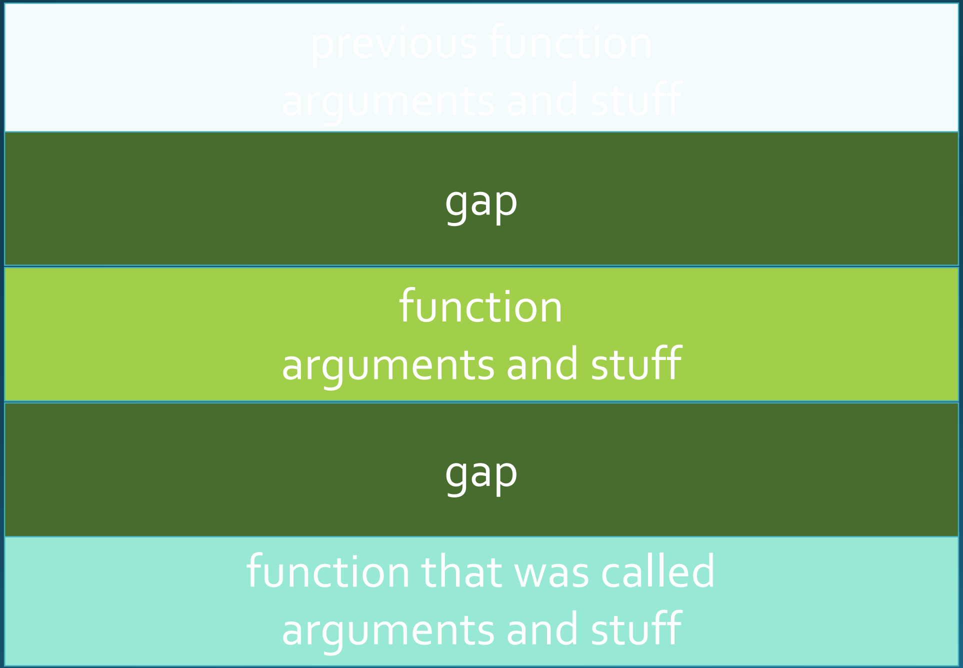


previous function
arguments and stuff

function
arguments and stuff

function that was called
arguments and stuff

Harder to get the wrong stack data



previous function
arguments and stuff

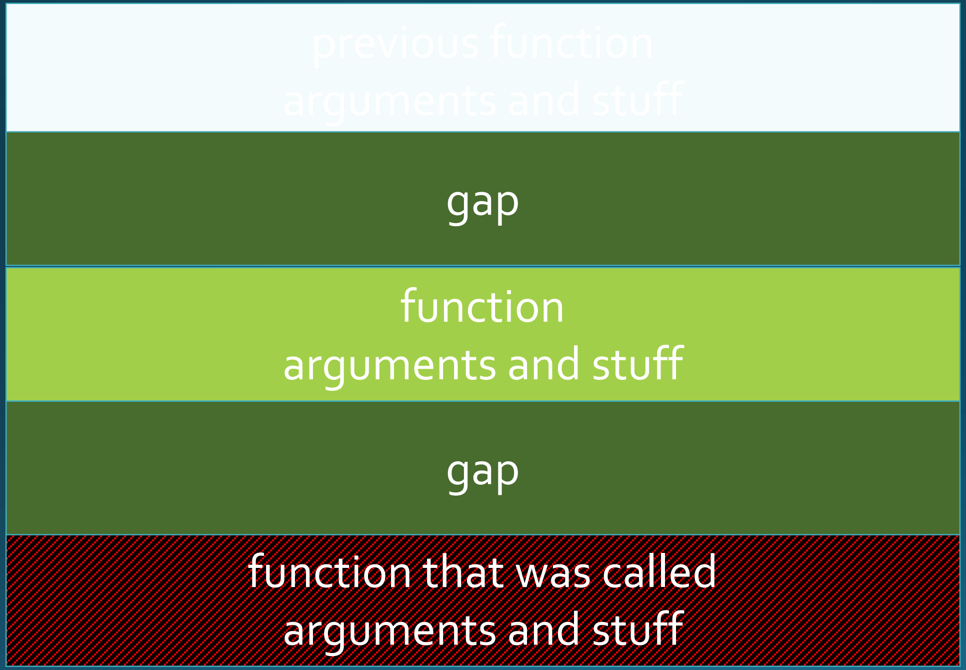
gap

function
arguments and stuff

gap

function that was called
arguments and stuff

Erase what’s no longer needed



previous function
arguments and stuff

gap

function
arguments and stuff

gap

function that was called
arguments and stuff

A random thought

Attackers and developers hate randomization

- For the same reasons
- Real addresses are needed
- Log are less useful
- Debuggers get buggered

Structures

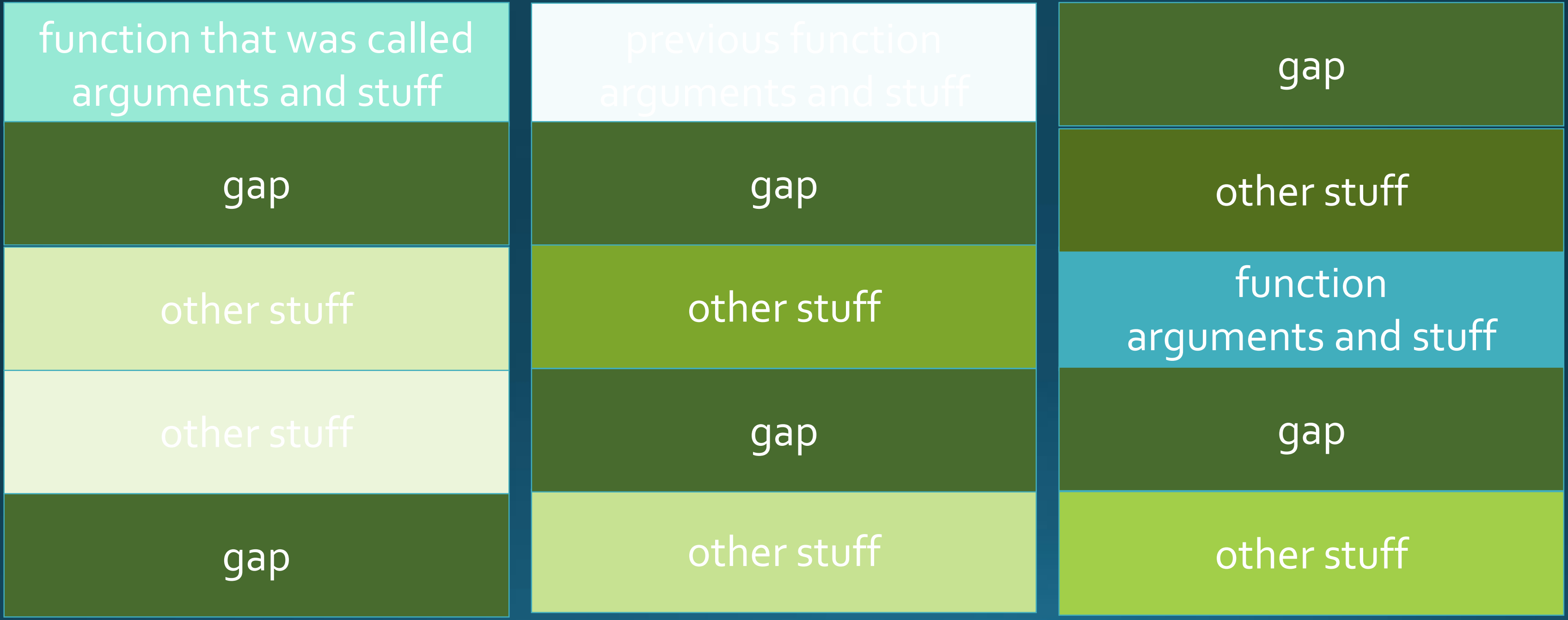
```
struct agamemnon {
      struct list_head *list;
      struct cred      *cred;
      u64              flags;
      u32              banners;
      u32              bunting;
};

__randomize_layout
```

```
struct agamemnon {
    u32                   banners;
    struct list_head      *list;
    u32                   bunting;
    struct cred           *cred;
    u64                   flags;
};

__no_randomize_layout
```

Stack pages are just pages



function that was called arguments and stuff

gap

other stuff

other stuff

gap

previous function arguments and stuff

gap

other stuff

gap

other stuff

gap

other stuff

function arguments and stuff

gap

other stuff

Functions can go in any order

- ssrbq_init
- ssrbq_reset
- ssrbq_rehash
- ssrbq_compute
- ssrbq_teardown

- ssrbq_compute
- ssrbq_teardown
- ssrbq_init
- ssrbq_reset
- ssrbq_rehash

Do I have To Worry About Performance?

Does the sun set in the west?

True story

- There is no measurable impact, can I check in?
- I found one case with 2% impact, can I check in?
- I fixed the performance, can I check in?

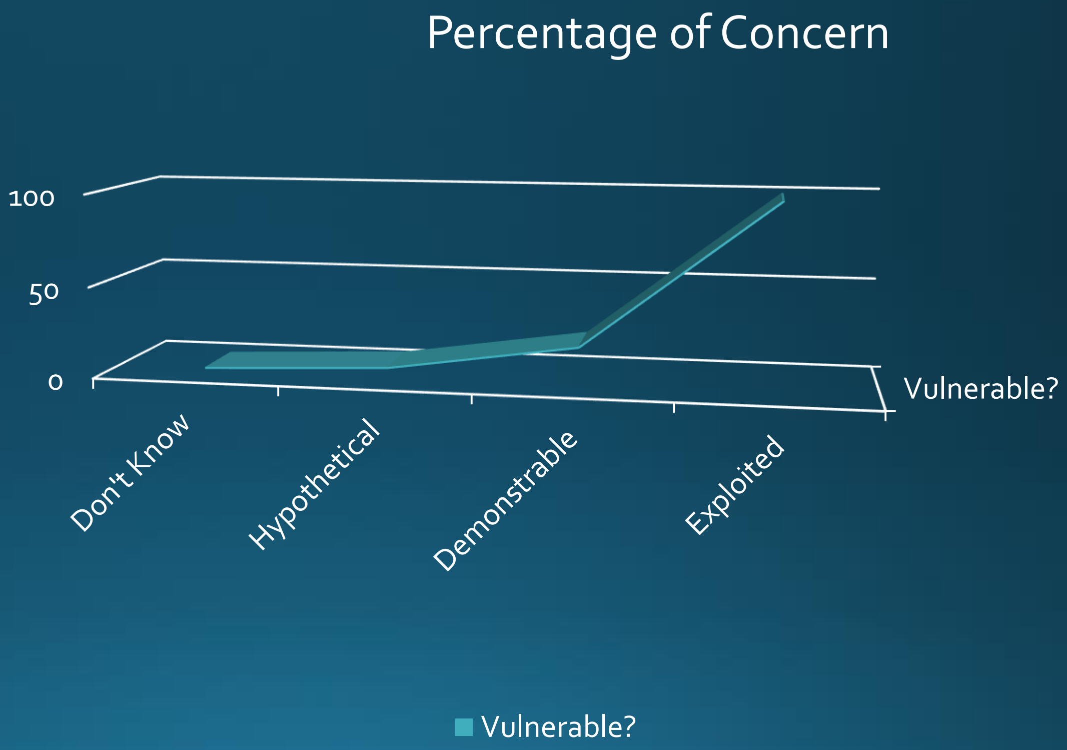
- No, you have inadequate benchmarks.
- No, you have demonstrated negative impact.
- No, your benchmarks are not good enough.

Performance trumps security more often than not

- Performance is quantitative
- Easy to measure

Vulnerability is quantum

- Don’t know how it could possibly be vulnerable
- Hypothetically vulnerable
- Demonstrably vulnerable
- Exploited



Is It Worth The Bother?

Code Churn

- 180+ files with refcount_t
- 500+ instances
- Lots more to do

Runtime overhead

- Hardened user copy
- Checks in a lot of syscalls

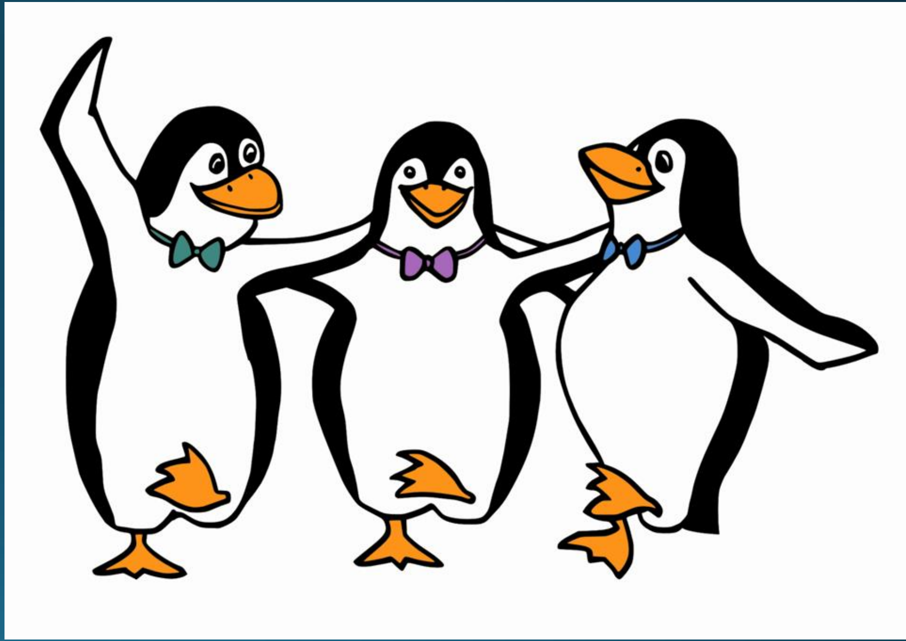
Developer experience

- Simple as checkpatch
- Picky like %p
- Lots of compiler warnings

Harder Is Subjective

Yes, it is harder

- Community is buying in
- Working in the open is huge
- Amount of help has been awesome
- We’re all learning the bounds



Thank You