Per-arg kfunc flags

Enabling kfuncs to specify flags per-arg, in addition to per-kfunc

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Agenda

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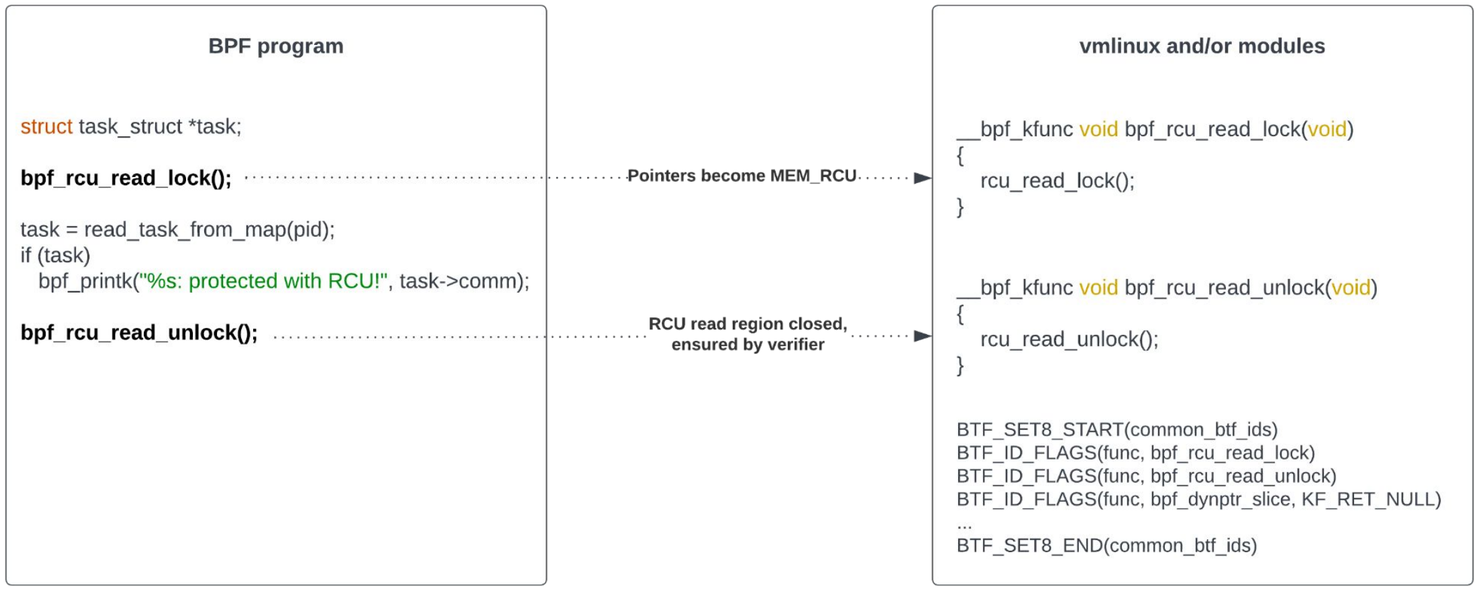
03 How do we do it?

01 kfunc background

kfuncs are the “modern” version of BPF helpers

- Allow BPF programs to call into the main kernel
- Hard dependency on BTF
  - Defined in BTF sets
- No ABI stability guarantees. See https://docs.kernel.org/bpf/kfuncs.html#kfunc-lifecycle-expectations for more information



kfunc properties can be statically defined with flags

- All flags are static, and defined for the whole kfunc
  - **KF_ACQUIRE**: kfunc acquires a reference to the first argument of the kfunc
  - **KF_RELEASE**: kfunc releases a reference to the first argument of the kfunc
  - **KF_RET_NULL**: kfunc may return NULL (i.e. the return type's pointer will include `PTR_MAYBE_NULL` modifier)
  - **KF_TRUSTED_ARGS**: kfunc takes only trusted pointer arguments (deprecated, will eventually be removed)
  - **KF_SLEEPABLE**: kfunc may sleep
  - **KF_DESTRUCTIVE**: kfunc may perform destructive actions – used with graph-type data structures
  - **KF_RCU**: Pointer arguments, when not NULL, are guaranteed to be valid in an RCU read region
  - **KF_ITER_NEW**: kfunc is a BPF iterator constructor
  - **KF_ITER_NEXT**: kfunc implements BPF iterator next() method
  - **KF_ITER_DESTROY**: kfunc implements a BPF iterator destructor
- Some flags make sense for whole kfunc (e.g. `KF_RET_NULL`, `KF_SLEEPABLE`, etc), others are really specific to individual arguments (`KF_ACQUIRE`, `KF_RELEASE`, `KF_RCU`, etc)
- kfunc flags defined in a single `.long` following the BTF ID of the kfunc itself

02 Why is this useful?

Better UX and future proofing

- Not immediately pressing, but has come up before
  - https://lore.kernel.org/bpf/20221217082506.1570898-2-davemarchevsky@fb.com/
  - Being hacked around with annotations like `__sz` and `__k`
- Current API requires internal knowledge of the verifier
  - kfunc authors should ideally need to know very little, if anything, about verifier internals
  - Why does arg 0 correspond to “acquire” arg or “release” arg? Purely an implementation detail.
  - Thankfully everything is very well documented at the moment, but we can do better
- Helpers are now tentatively frozen. Need to get kfuncs to feature parity
  - This is supported for helpers, should be supported for kfuncs (luckily not blocking anything yet)

03 How do we do it?

How do we do this with BTF?

- The single `.long` following the BTF ID of the kfunc is fine for kfunc global flags, doesn't work for per-arg
- In general, not sure how this would work with BTF sets
  - BTF set for each kfunc, where index `n` are the flags for arg `n`?
- More generally, the API for defining kfuncs is arguably clunky and error prone
  - Something closer to EXPORT_SYMBOL_GPL would be ideal. Hide all of the complexity behind a macro
    - Not sure how this would work with register_btf_kfunc_id_set() expecting a BTF set.
    - Seems like we'll require some post-processing ELF magic?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