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Subject: containers access control 'roadmap'

Posted by [serue](#) on Thu, 06 Sep 2007 16:55:34 GMT

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Roadmap is a bit of an exaggeration, but here is a list of the next bit of work i expect to do relating to containers and access control. The list gets more vague toward the end, with the intent of going far enough ahead to show what the final result would hopefully look like.

Please review and tell me where I'm unclear, inconsistent, glossing over important details, or completely on drugs.

#### 1. introduce CAP\_HOST\_ADMIN

acts like a mask. If set, all capabilities apply across namespaces.

is that ok, or do we insist on duplicates for all caps?

brings us into 64-bit caps, so associated patches come along

As an example, CAP\_DAC\_OVERRIDE by itself will mean within the same user namespace, while CAP\_DAC\_OVERRIDE|CAP\_HOST\_ADMIN will override users equivalence checks.

#### 2. introduce per-process cap\_bset

Idea is you can start a container with cap-bset not containing CAP\_HOST\_ADMIN, for instance.

As namespaces are fleshed out and proper behavior for cross-namespace access is figured out (see step 7) I expect behavior under !CAP\_HOST\_ADMIN with certain capabilities will change. I.e. if we get a device namespace, CAP\_MKNOD will be different from CAP\_HOST\_ADMIN|CAP\_MKNOD, and people will want to start keeping CAP\_MKNOD in their container cap\_bsets.

#### 3. audit driver code etc for any and all uid==0 checks. Fix those immediately to take user namespaces into account.

#### 4. introduce inode->user\_ns, as per my previous usersns patchset from April (I guess posted in June, according to: <https://lists.linux-foundation.org/pipermail/containers/2007-June/005342.html>)

For now, enforce roughly the following access checks when inode->user\_ns is set:

```
if capable(CAP_HOST_ADMIN|CAP_DAC_OVERRIDE)
    allow
if current->usersns==inode->usersns {
    if capable(CAP_DAC_OVERRIDE)
        allow
    if current->uid==inode->i_uid
        allow as owner
    inode->i_uid is in current's keychain
        allow as owner
    uid==inode->i_gid in current's groups
        allow as group
}
treat as user 'other' (i.e. usually read-only access)
```

5. Then comes the piece where users can get credentials as users in other namespaces to store in their keychain.

6. enforce other usersns checks like signaling

7. investigate proper behavior for other cross-namespace capabilities.

---

Containers mailing list

Containers@lists.linux-foundation.org

<https://lists.linux-foundation.org/mailman/listinfo/containers>

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Subject: Re: containers access control 'roadmap'

Posted by [Herbert Poetzl](#) on Thu, 06 Sep 2007 17:10:31 GMT

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On Thu, Sep 06, 2007 at 11:55:34AM -0500, Serge E. Hallyn wrote:

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> of work i expect to do relating to containers and access control. The  
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> will override usersns equivalence checks.

what does that mean?

guest spaces need to be limited to a certain (mutable)  
subset of capabilities to work properly, please explain  
how this relates?

> 2. introduce per-process cap\_bset  
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> Idea is you can start a container with cap-bset not containing  
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> start keeping CAP\_MKNOD in their container cap\_bsets.

doesn't sound like a good idea to me, ignoring caps  
or disallowing them seems okay, but changing the meaning  
between caps (depending on host or guest space) seems  
just wrong ...

> 3. audit driver code etc for any and all uid==0 checks. Fix those  
> immediately to take user namespaces into account.

okay, sounds good ...

> 4. introduce inode->user\_ns, as per my previous usersns patchset from  
> April (I guess posted in June, according to:  
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> allow  
> if current->usersns==inode->usersns {  
> if capable(CAP\_DAC\_OVERRIDE)  
> allow

- > if current->uid==inode->i\_uid
- > allow as owner
- > inode->i\_uid is in current's keychain
- > allow as owner
- > uid==inode->i\_gid in current's groups
- > allow as group
- > }
- > treat as user 'other' (i.e. usually read-only access)

what about inodes belonging to several contexts?  
(which is a major resource conserving feature of OS  
level isolation)

- > 5. Then comes the piece where users can get credentials as users in
- > other namespaces to store in their keychain.

does that make sense? wouldn't it be better to have  
the keychains 'per context'?

- > 6. enforce other users checks like signaling
- >
- > 7. investigate proper behavior for other cross-namespace capabilities.

please elaborate ....

---

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---

Subject: Re: containers access control 'roadmap'  
Posted by [serue](#) on Thu, 06 Sep 2007 18:26:11 GMT  
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Quoting Herbert Poetzl (herbert@13thfloor.at):

- > On Thu, Sep 06, 2007 at 11:55:34AM -0500, Serge E. Hallyn wrote:
- > > Roadmap is a bit of an exaggeration, but here is a list of the next bit
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- > > ahead to show what the final result would hopefully look like.
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- > > important details, or completely on drugs.

Thanks for looking this over, Herbert.

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> > namespaces.  
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> > is that ok, or do we insist on duplicates for all caps?  
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> > will override users equivalence checks.  
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> what does that mean?  
> guest spaces need to be limited to a certain (mutable)  
> subset of capabilities to work properly, please explain

(note that that mutable subset of caps for guest spaces is what item #2,  
the per-process cap\_bset, implements)

> how this relates?

capabilities will give you privileged access within your own container.  
Also having CAP\_HOST\_ADMIN will mean that the capabilities you have can  
also be used against objects in other containers.

Now maybe you prefer a model where a "container" is owned by some user  
in some namespaces. All capabilities apply purely within their own  
namespace, and a container owner has full rights to the owned  
containers. That makes container vms more like a qemu vm.

Or maybe I just punt this for now altogether, and we address  
cross-namespace privileged access if/when we really need it.

> > 2. introduce per-process cap\_bset  
> >  
> > Idea is you can start a container with cap-bset not containing  
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> doesn't sound like a good idea to me, ignoring caps

> or disallowing them seems okay, but changing the meaning  
> between caps (depending on host or guest space) seems  
> just wrong ...

Ok your 'doesn't sound like a good idea' is to my blabbing though, not the the per-process cap\_bset. Right? So you're again objecting to CAP\_HOST\_ADMIN, item #1?

> > 3. audit driver code etc for any and all uid==0 checks. Fix those  
> > immediately to take user namespaces into account.  
>  
> okay, sounds good ...

Ok maybe i should make that '#1' and get going as it's the least contraversial :)

Though I think I still prefer to start with #2.

> > 4. introduce inode->user\_ns, as per my previous userns patchset from  
> > April (I guess posted in June, according to:  
> > <https://lists.linux-foundation.org/pipermail/containers/2007-June/005342.html>)  
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> > allow as group  
> > }  
> > treat as user 'other' (i.e. usually read-only access)  
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> what about inodes belonging to several contexts?

There's no such thing in the way I was envisioning it.

An inode belongs to one context. A user can belong to several.

> (which is a major resource conserving feature of OS  
> level isolation)

Sure. Let's say you want to share /usr among many servers. It exists in the host user namespace. In guest user namespaces, anyone including root will have access to them as though they were user 'other', i.e. if a directory has 751 perms, you'll get '1'.

> > 5. Then comes the piece where users can get credentials as users in  
> > other namespaces to store in their keychain.  
>  
> does that make sense? wouldn't it be better to have  
> the keychains 'per context'?

Either you misunderstood me, or I misunderstand you.

What I am saying is that there is a 'uid' keychain, which holds things like (usernamespace 3, uid 5), meaning that even though I am uid 1000 in usernamespace 1, I am allowed access to usernamespace 3 as though I were uid 5.

I expect the two common use cases of this to be:

1. uid 5 on the host system created a virtual server, and gives himself a (usernamespace 2, uid 0) key so he is root in the virtual server without having to enter it. (Meaning he can signal all processes, access all files, etc)

2. uid 3000 on the host system is given (usernamespace 2, uid 1001) in a virtual server so he can access uid 1001's files in the virtual server which has usernamespace 2.

> > 6. enforce other users checks like signaling  
> >  
> > 7. investigate proper behavior for other cross-namespace capabilities.  
>  
> please elaborate ....

Just that we need to go through the list of capabilities and consider what they mean with and without CAP\_HOST\_ADMIN. For instance CAP\_IPC\_LOCK doesn't really matter for CAP\_HOST\_ADMIN since the namespaces prevent you cross-ns access. Implications for CAP\_NET\_ADMIN remain to be seen, when network namespaces are complete.

-serge

---

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---

Subject: Re: containers access control 'roadmap'

Posted by [Herbert Poetzl](#) on Thu, 06 Sep 2007 20:23:31 GMT

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> > subset of capabilities to work properly, please explain

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> (note that that mutable subset of caps for guest spaces is what item

> #2, the per-process cap\_bset, implements)

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suid-root properly?

> > how this relates?

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> capabilities will give you privileged access within your own

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> you have can also be used against objects in other containers.

also, please make sure that you extend the capability

set to 64 bit first, as this would be using up the last capability (which is not a good idea IMHO)

> Now maybe you prefer a model where a "container" is owned by some  
> user in some namespaces. All capabilities apply purely within their  
> own namespace, and a container owner has full rights to the owned  
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no, actually it is to the idea having capabilities which  
mean different things depending on whether they are  
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> > what about inodes belonging to several contexts?
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> There's no such thing in the way I was envisioning it.
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> An inode belongs to one context. A user can belong to several.

```

well, at least in Linux-VServer, inodes are shared on a per inode basis between guests, which drastically reduces the memory and disk overhead if you have more than one guest of similar nature ...

```

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> > level isolation)
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> It exists in the host user namespace.
> In guest user namespaces, anyone including root will have
> access to them as though they were user 'other', i.e.
> if a directory has 751 perms, you'll get '1'.

```

no, the inodes are shared in a way that the guest has (almost) full control over them, including copy on write functionality when inode contents or properties change (see unification for details)

i.e. for us, the ability to share inodes between

completely different process \_and\_ user spaces is essential because of resource consumption.

> > > 5. Then comes the piece where users can get credentials  
> > > as users in other namespaces to store in their keychain.

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> 2. uid 3000 on the host system is given (usernamespace  
> 2, uid 1001) in a virtual server so he can access  
> uid 1001's files in the virtual server which has  
> usernamespace 2.

do you mean files here or actually inodes or both?  
why shouldn't the host context be able to access  
any of them without acquiring any credentials?

> > > 6. enforce other usersns checks like signaling

> > >

> > > 7. investigate proper behavior for other cross-namespace capabilities.

> >

> > please elaborate ....

>

> Just that we need to go through the list of capabilities  
> and consider what they mean with and without CAP\_HOST\_ADMIN.

see 'bad idea' above: I think they should \_exactly\_  
mean the same, inside and outside a guest ...

> For instance CAP\_IPC\_LOCK doesn't really matter for  
> CAP\_HOST\_ADMIN since the namespaces prevent you cross-ns  
> access.

hmm? maybe I am misunderstanding the entire concept of CAP\_HOST\_ADMIN here ... maybe an example could help?

TIA,  
Herbert

> Implications for CAP\_NET\_ADMIN remain to be seen,  
> when network namespaces are complete.  
>  
> -serge

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Subject: Re: containers access control 'roadmap'  
Posted by [serue](#) on Thu, 06 Sep 2007 21:10:45 GMT  
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> > (note that that mutable subset of caps for guest spaces is what item  
> > #2, the per-process cap\_bset, implements)  
>  
> how is per-process supposed to handle things like  
> suid-root properly?

Simple. It's inherited at fork, and you can take caps out but not put them back in.

> > > how this relates?  
> >  
> > capabilities will give you privileged access within your own  
> > container. Also having CAP\_HOST\_ADMIN will mean that the capabilities  
> > you have can also be used against objects in other containers.  
>  
> also, please make sure that you extend the capability  
> set to 64 bit first, as this would be using up the  
> last capability (which is not a good idea IMHO)

Of course - unless you talk me out of defining the capability :)

> > Now maybe you prefer a model where a "container" is owned by some  
> > user in some namespaces. All capabilities apply purely within their  
> > own namespace, and a container owner has full rights to the owned  
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> no, actually it is to the idea having capabilities which  
> mean different things depending on whether they are  
> available on the host or inside a guest (because that  
> would mean handling them different in userspace software  
> and for administration)

Whoa - no i am not saying caps would be handled differently based on whether you're in a container or not. In fact from what I've introduced there is no such thing as a 'host' or 'admin' container.

Rather, the single capability, CAP\_HOST\_ADMIN, just means that your capabilities will also apply to actions on objects in namespaces other than your own. If you don't have CAP\_HOST\_ADMIN, then capabilities will only give you privileged status with respect to objects in your own namespaces.

So in theory you could have a child container where admin has CAP\_HOST\_ADMIN, while the initial set of namespaces, or what some might be tempted to otherwise call the 'host container', have taken CAP\_HOST\_ADMIN out of their cap\_bset (after spawning off the child container with the CAP\_HOST\_ADMIN bit in it's cap\_bset).

Is that clearer? Is it less objectionable to you?

> > > > 3. audit driver code etc for any and all uid==0 checks. Fix those  
> > > > immediately to take user namespaces into account.  
> > >  
> > > okay, sounds good ...  
> >  
> > Ok maybe i should make that '#1' and get going as it's the least  
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> > > if current->uid==inode->i_uid
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> > > well, at least in Linux-VServer, inodes are shared
> > > on a per inode basis between guests, which drastically
> > > reduces the memory and disk overhead if you have more
> > > than one guest of similar nature ...

```

And I believe the same can be done with what I am suggesting.

```

> > > (which is a major resource conserving feature of OS
> > > level isolation)
> > >
> > > Sure. Let's say you want to share /usr among many servers.
> > > It exists in the host user namespace.
> > > In guest user namespaces, anyone including root will have
> > > access to them as though they were user 'other', i.e.
> > > if a directory has 751 perms, you'll get '1'.
> > >
> > > no,

```

Well, yes: I'm describing my proposal :)

```

> > the inodes are shared in a way that the guest has
> > (almost) full control over them, including copy on
> > write functionality when inode contents or properties
> > change (see unification for details)

```

In my proposal, the assignment of values to inode->usersns, and

enforcement, is left to the filesystem. So a filesystem can be written that understands and interprets global user ids, or, to mimic what you have, a simple stackable cow filesystem could be used.

> i.e. for us, the ability to share inodes between  
> completely different process \_and\_ user spaces is  
> essential because of resource consumption.  
>  
> > > 5. Then comes the piece where users can get credentials  
> > > as users in other namespaces to store in their keychain.  
> > >  
> > > does that make sense? wouldn't it be better to have  
> > > the keychains 'per context'?  
> >  
> > Either you misunderstood me, or I misunderstand you.  
> >  
> > What I am saying is that there is a 'uid' keychain, which  
> > holds things like (usernamespace 3, uid 5), meaning that  
> > even though I am uid 1000 in usernamespace 1, I am allowed  
> > access to usernamespace 3 as though I were uid 5.  
> >  
> > I expect the two common use cases of this to be:  
> >  
> > 1. uid 5 on the host system created a virtual server,  
> >     and gives himself a (usernamespace 2, uid 0) key  
> >     so he is root in the virtual server without having  
> >     to enter it. (Meaning he can signal all processes,  
> >     access all files, etc)  
> >  
> > 2. uid 3000 on the host system is given (usernamespace  
> >     2, uid 1001) in a virtual server so he can access  
> >     uid 1001's files in the virtual server which has  
> >     usernamespace 2.  
>  
> do you mean files here or actually inodes or both?  
> why shouldn't the host context be able to access  
> any of them without acquiring any credentials?

Because there is no 'host context', just an initial namespace.

> > > 6. enforce other usersns checks like signaling  
> > >  
> > > 7. investigate proper behavior for other cross-namespace capabilities.  
> > >  
> > > please elaborate ....  
> >  
> > Just that we need to go through the list of capabilities  
> > and consider what they mean with and without CAP\_HOST\_ADMIN.

>  
> see 'bad idea' above: I think they should \_exactly\_  
> mean the same, inside and outside a guest ...

See my explanation above: there is no 'inside and outside a guest'.

There is just 'with our without the CAP\_HOST\_ADMIN' capability', where the CAP\_HOST\_ADMIN can be irrevocably removed from a process tree using prctl(PR\_SET\_CAPBSET, new\_set).

> > For instance CAP\_IPC\_LOCK doesn't really matter for  
> > CAP\_HOST\_ADMIN since the namespaces prevent you cross-ns  
> > access.  
>  
> hmm? maybe I am misunderstanding the entire concept  
> of CAP\_HOST\_ADMIN here ... maybe an example could help?

I've obviously botched this so far... Let me whip up some examples of how it all works together and email those out tomorrow.

thanks,  
-serge

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Containers mailing list  
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Subject: Re: containers access control 'roadmap'  
Posted by [serue](#) on Fri, 07 Sep 2007 18:18:42 GMT  
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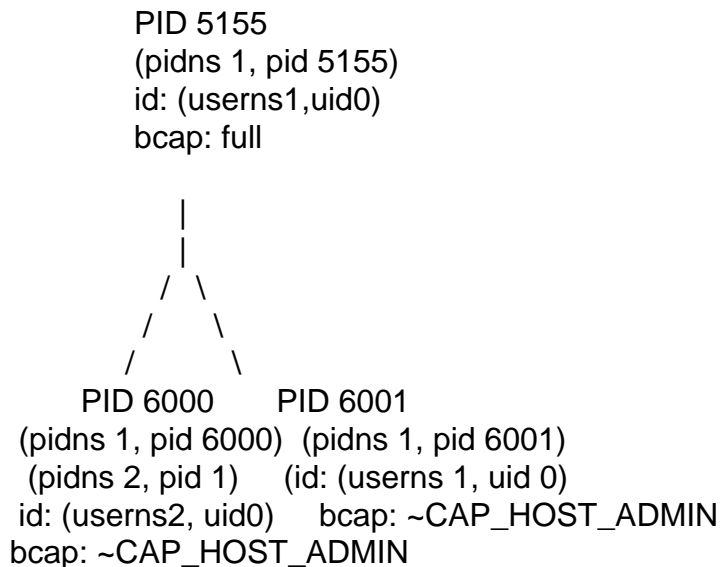
Quoting Serge E. Hallyn (serue@us.ibm.com):  
> Quoting Herbert Poetzl (herbert@13thfloor.at):  
> > > For instance CAP\_IPC\_LOCK doesn't really matter for  
> > > CAP\_HOST\_ADMIN since the namespaces prevent you cross-ns  
> > > access.  
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>  
> I've obviously botched this so far... Let me whip up some examples of  
> how it all works together and email those out tomorrow.  
>  
> thanks,  
> -serge

Ok here is some ranting with an example:

System boots. All processes have all caps in their cap\_bset.  
Process 5155 does a clone(CLONE\_NEWUSER|CLONE\_NEWPID), returning pid 6000, then does prctl(PR\_SET\_BCAP, ~CAP\_HOST\_ADMIN) to take CAP\_HOST\_ADMIN out of it's bounding set, meaning it can never, in any way, gain that capability.

pid 6000 is also (pidns 2, pid 1). The user owning that process is (usersn 2, uid 0).

Process 5155 does a simple clone(), returning pid 6001, and that process does prctl(PR\_SET\_BCAP, ~CAP\_HOST\_ADMIN).



Process 6000 as root owns a file in its own chroot, let's call it /vm1/foo. If process 5155 is still owned by root and tries to access /vm1/foo, then since it has (CAP\_HOST\_ADMIN|CAP\_DAC\_OVERRIDE) it will be able to access the file as root.

If process 6001 is still owned by root, it may have CAP\_DAC\_OVERRIDE, but doesn't have CAP\_HOST\_ADMIN, so can't cross the usersn boundary into usersn 2. So it will get the 'other' perms to /vm1/foo. However CAP\_DAC\_OVERRIDE will apply to let it access files in its own user namespace.

Note that if we were talking about 'host' versus 'guests', then 6001 would be a root process in the 'host'.

Note also that if pid 6000 hadn't dropped CAP\_HOST\_ADMIN, it would be a 'guest' which was able to access other namespaces as though it were the 'host' in a host-guest scheme.

When process 6000 access /vm1/foo, it is in the same usersn,

and owns the file, so it can access it. If it does `setuid(1000)`, then it can only access `/vm1/foo` if it has `CAP_DAC_OVERRIDE`. It doesn't need `CAP_HOST_ADMIN` because it is not trying to cross a user namespace boundary.

(From here on, I'm \*really\* speculating, pie in the sky)

I've mentioned - and in previous patchsets started to implement - that the inode would have a `users` pointer. The filesystem would pick who to assign an inode to - i.e. based on the superblock, based on who mounted it, based on who created the file, whatever. And users would get credentials for `userids` in other namespaces through their keyrings.

Right now I'm thinking of taking the same idea but more generally. Putting the `users` in the inode is too restrictive. For instance a novel filesystem might well want to ignore `uids` altogether and use the keyring to determine file access. So I'm thinking the filesystem both assigns and checks credentials for an inode. For starters, `ext2` just

1. assigns the user namespace of the process doing the mounting to the superblock  
OR  
if so specified at mounttime, assigns no `users` so that all user namespaces may access the fs.
2. uses the `sb->users` to enforce user namespace checks

Then as a next step it can continue to do the above, but also allow use of credentials. Maybe the user who created a `users` with a `clone(CLONE_NEWUSER)` automatically gets a `uid=0` credential for the new user namespace. Or some other scheme.

Then, we can get into actually storing key hashes in an inode `xattr`, and anyone with a key which hashes to the stored hash gets access. Or some more cryptographically sound method of doing that, please don't bother telling me all the ways that particular example doesn't work :)

-serge

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