Information Flow Control Made Simple

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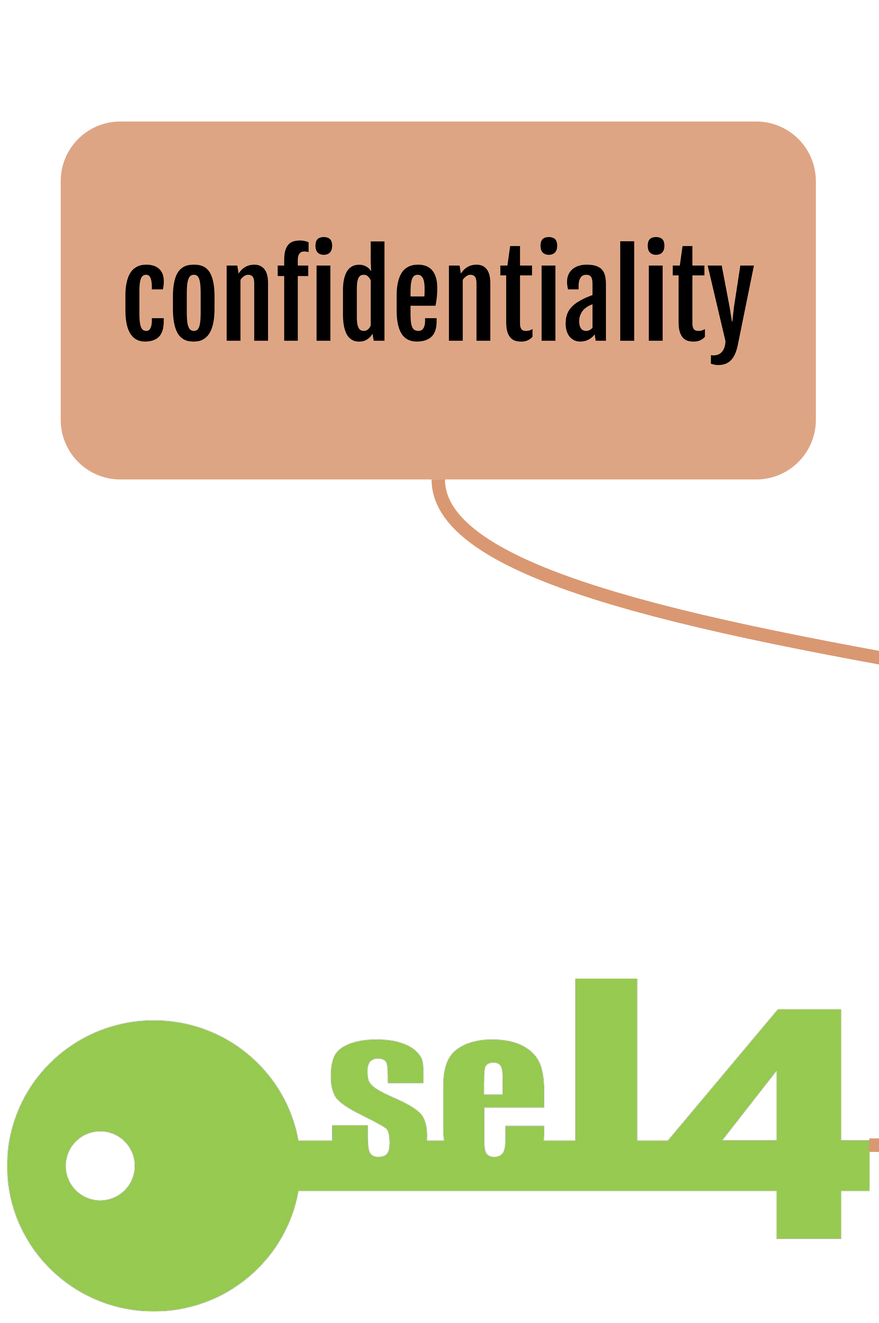
Why bother with information flow?

(Why is it cool? Why did I do any of this?)


seL4
kernel (~10kloc)


seL4
proofs (>1mloc)
kernel (~10kloc)

confidentiality



proofs (>1mloc)

kernel (~10kloc)

confidentiality

integrity

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The part we care about:

confidentiality

integrity

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kernel (~10kloc)

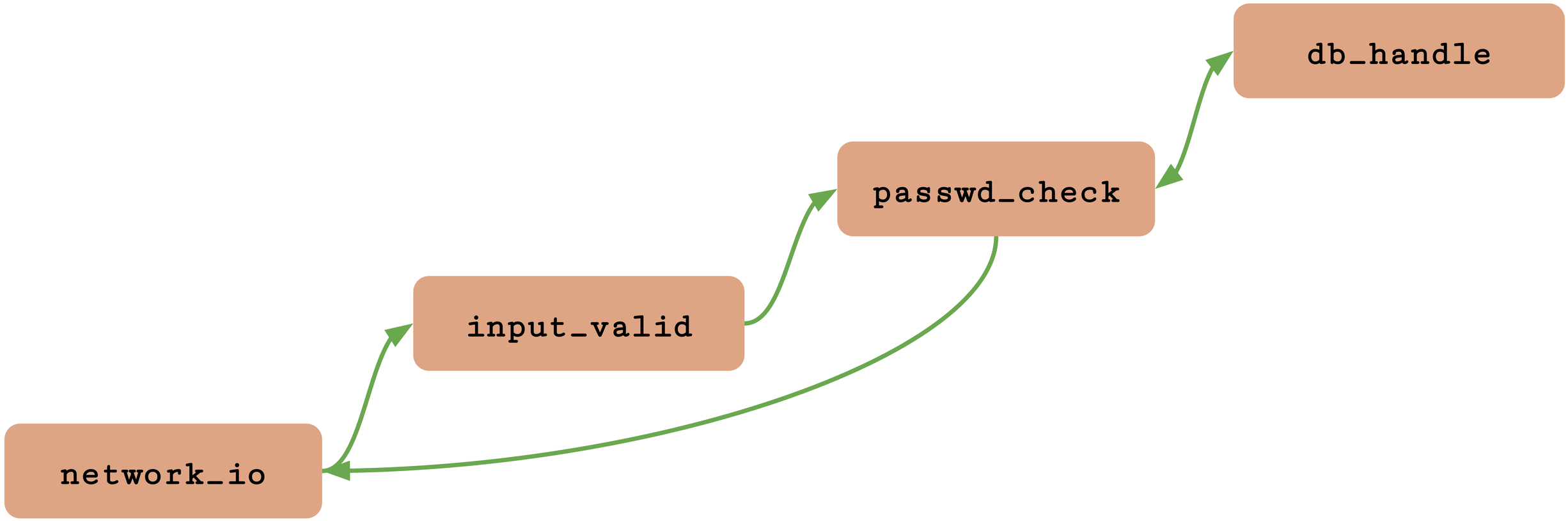
The part we care about:

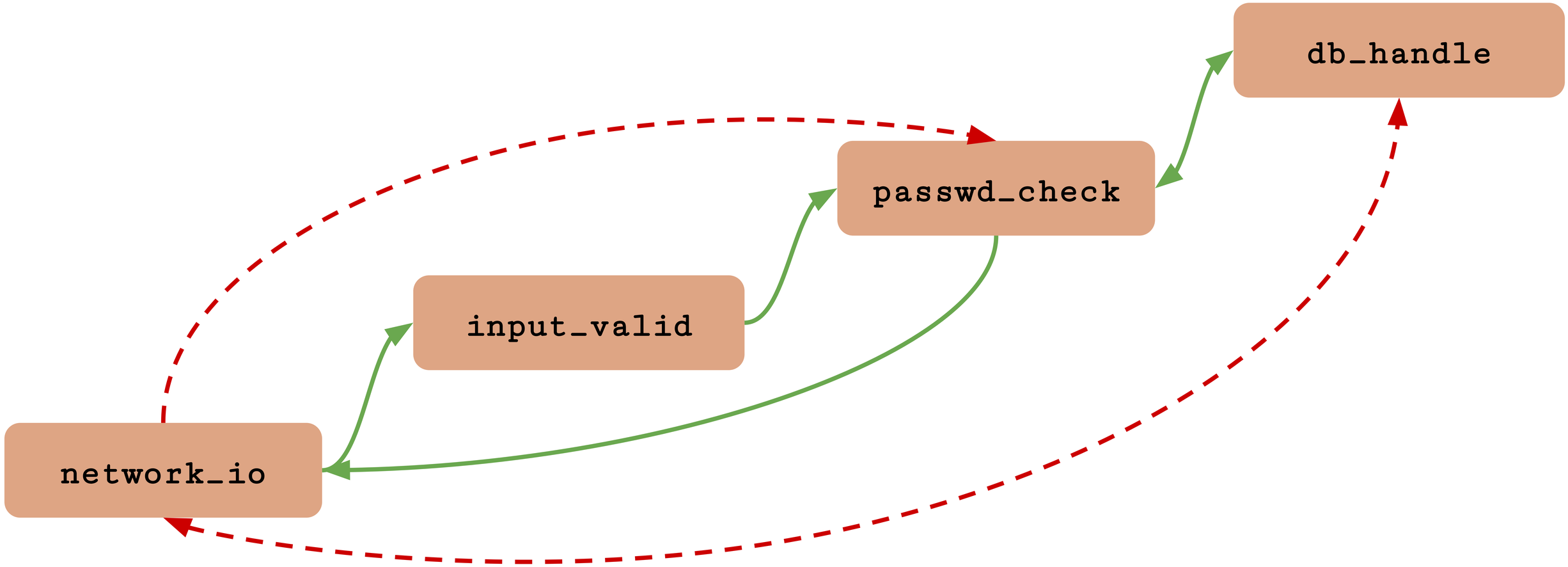
confidentiality

integrity

Information Flow Control!

Why doesn't IFC see more use?


db_handle
passwd_check
input_valid
network_io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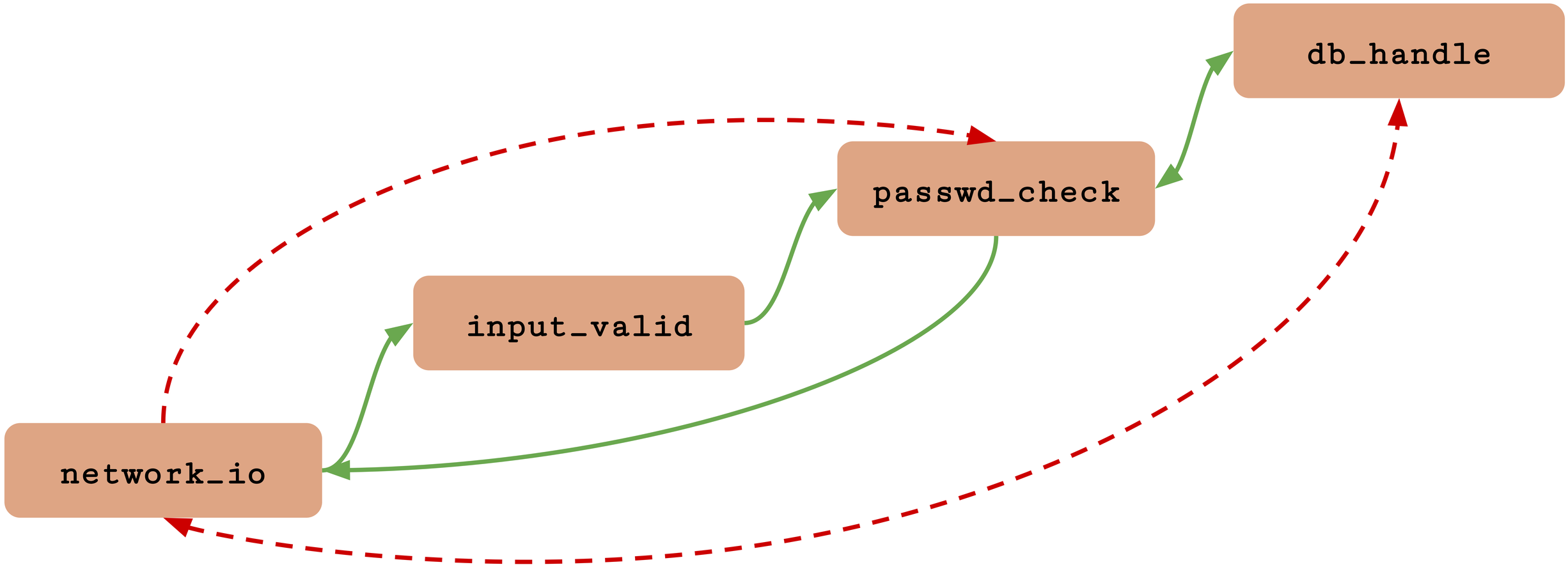

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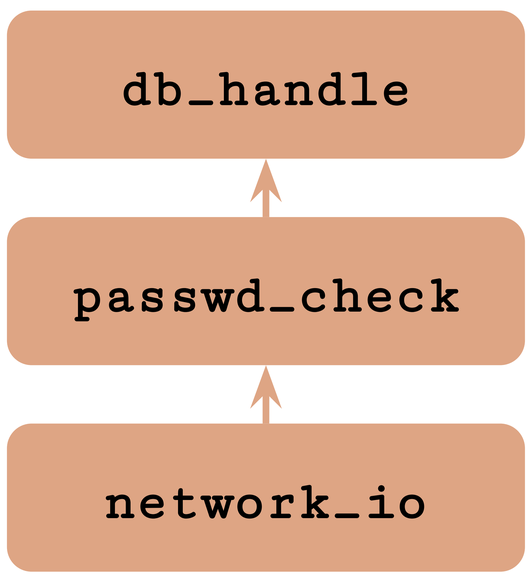

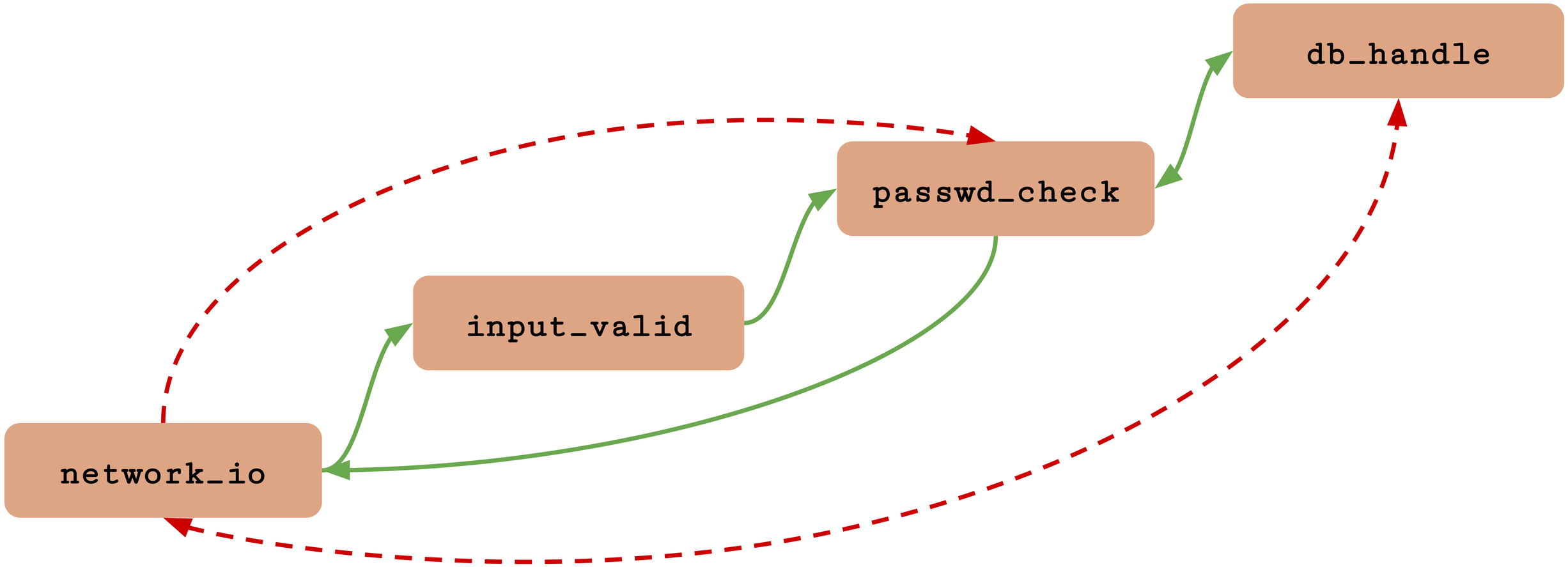

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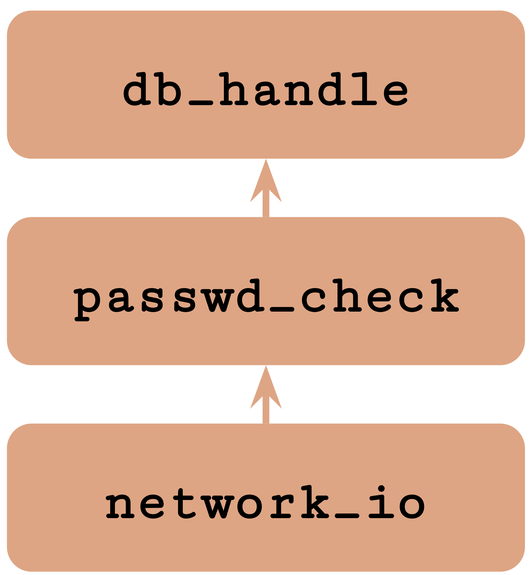
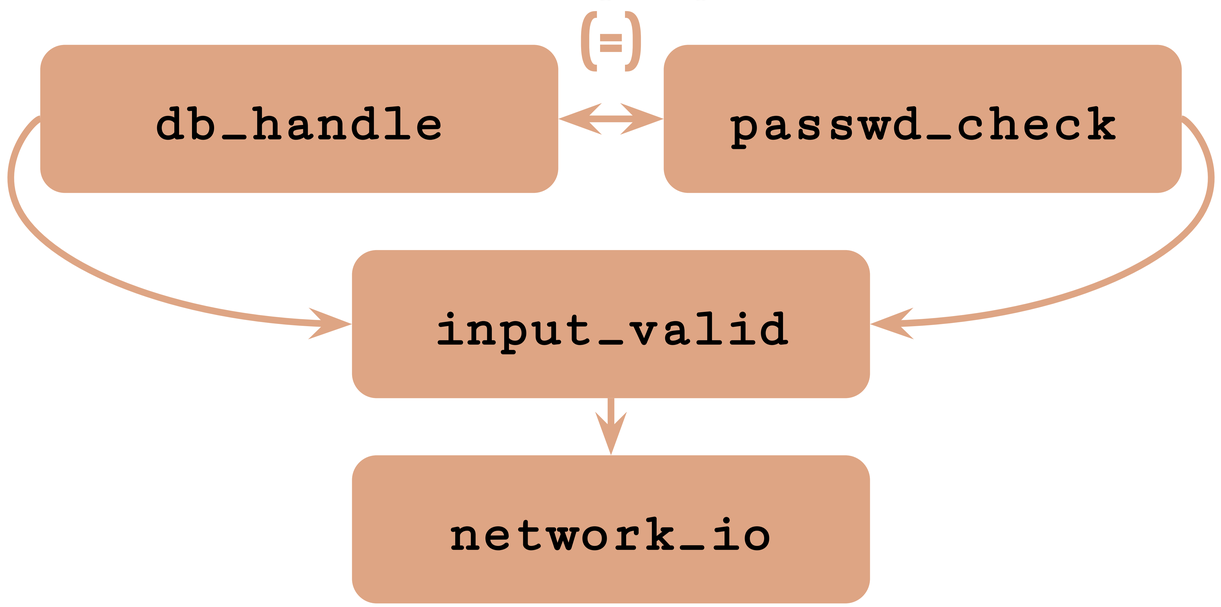
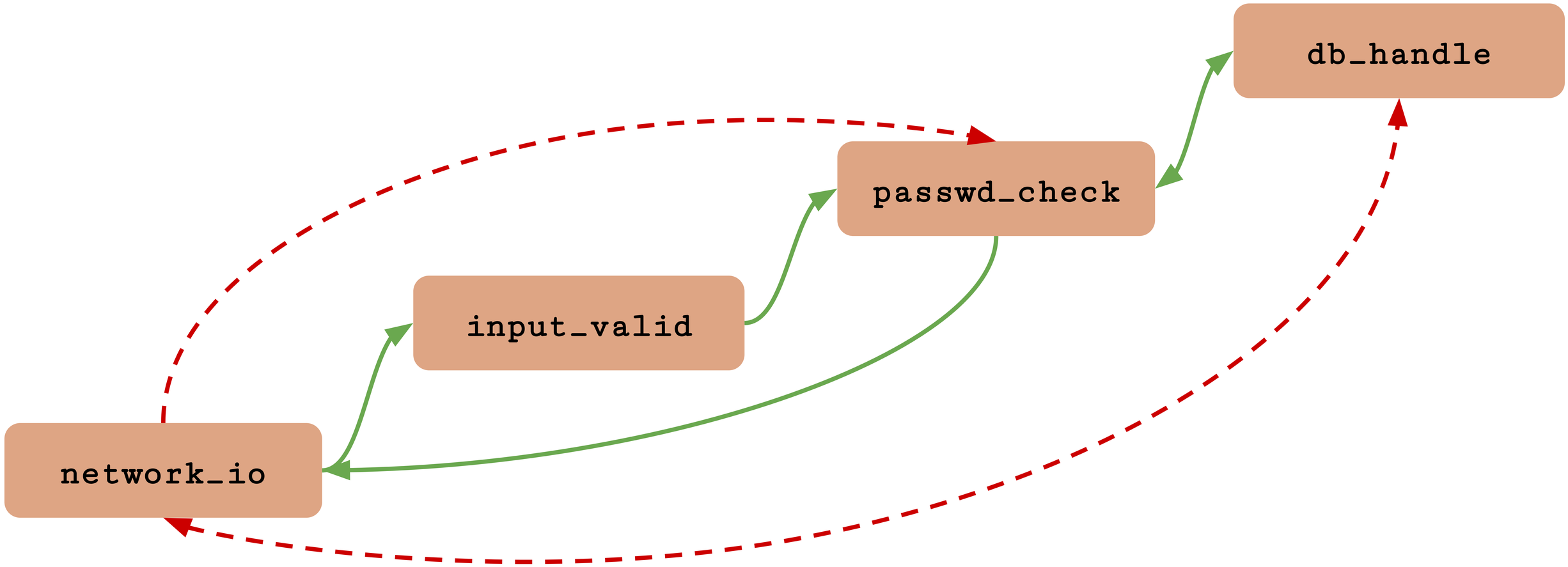


integrity:



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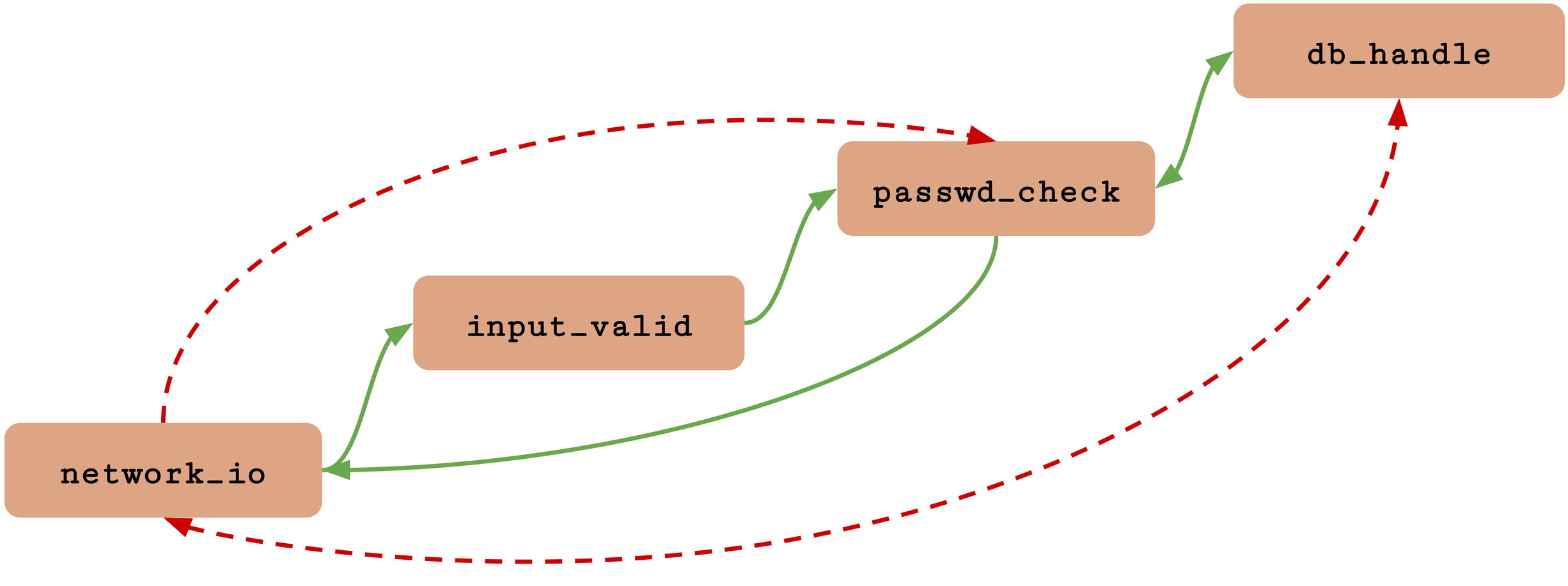
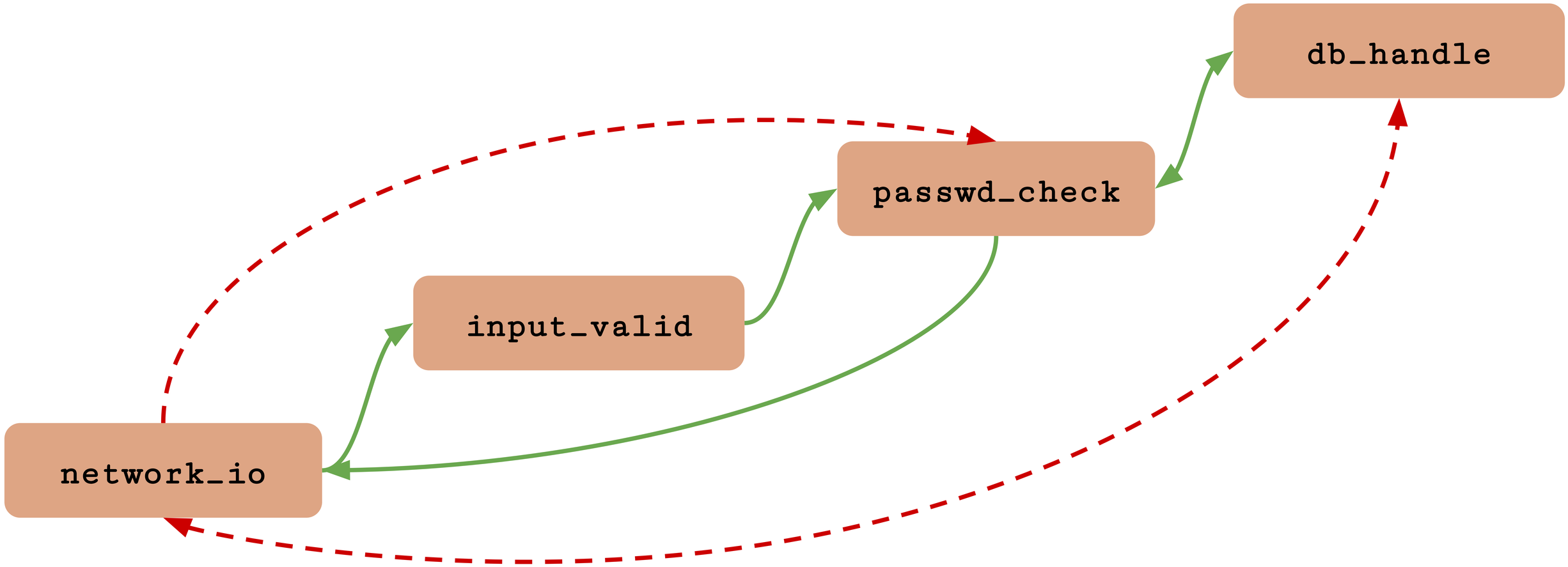


declassify
endorse



declassify
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allow

An observation on software architecture

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Database connectors

Connection multiplexing

State management

HTTP routing

```
rocket::config::
TlsConfig::key()
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3rd party services

Caching

Room and user management

Federating

Reactions

Notifications

```
conduit::Database
.globals.keypairs()
```

A simple flow rule

```
let sec = ("password123", "1.1.1.1");
let sock = Socket::new(...);

flow sec ->! sock;
```

Overriding flow rules

```
{
  flow sec.snd -> sock;
  sock.bind(sec.snd);
}
```

Error!

```
sock.send(sec.snd);
          ^^^^
          |____ error: flow from
                sec.snd to sock
                with rule
                sec ->! sock
```

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let sec = ("password123", "1.1.1.1");
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A flow rule is declared

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The rule is overriden

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A flow rule is declared

The rule is overriden

sec.snd flows to sock

sec.snd can't flow to sock here, error!

Case study: Rocket

This is where Rocket sets up TLS

```
flow self.config.tls.key ->! fn io!();
flow self.config.tls.key ->! *;

...

let mut listener: Either<TcpListener, TlsListener> =
    Left(TcpListener::bind(addr).await.map_err(ErrorKind::Bind)?);

if self.config.tls_enabled() {
    if let Some(ref config) = self.config.tls
        with flow self.config.tls.key -> config {

        let conf = config.to_native_config().map_err(ErrorKind::Io)?
            with flow self.config.tls.key -> conf;

        flow self.config.tls.key -> listener;

        listener =
            Right(TlsListener::bind(addr, conf).await.map_err(ErrorKind::Bind()?);

        }
}

listener = allow listener;

...
```

`self.config.tls.key`
contains raw key data

```
flow self.config.tls.key ->! fn io!();
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            with flow self.config.tls.key -> conf;

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        listener =
            Right(TlsListener::bind(addr, conf).await.map_err(ErrorKind::Bind()?);

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flow self.config.tls.key ->! fn io!();
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        with flow self.config.tls.key -> config {
        let conf = config.to_native_config().map_err(ErrorKind::Io)?
            with flow self.config.tls.key -> conf;

        flow self.config.tls.key -> listener;

        listener =
            Right(TlsListener::bind(addr, conf).await.map_err(ErrorKind::Bind)?);

        }
}

listener = allow listener;

...
```

Bind a variable which initially holds a TCP socket

Check that TLS is enabled

Extract TLS config

Create a TLS socket

```
flow self.config.tls.key ->! fn io!();
flow self.config.tls.key ->! *;

...

let m                                  cpListener, TlsListener> =
    L                                  (addr).await.map_err(ErrorKind::Bind)?);

if self.config.tls_enabled() {
    if let Some(ref config) = self.config.tls
        with flow self.config.tls.key -> config {

        let conf = config.to_native_config().map_err(ErrorKind::Io)?
            with flow self.config.tls.key -> conf;

        flow self.config.tls.key -> listener;

        liste
            R                                  ait.map_err(ErrorKind::Bind()?);

        }
}

listener = allow listener;

...
```

Prevents flows to side-effecting functions

* prevents flows to all variables

`with flow` inserts the flow policy between binding and initialization

```
let conf;
flow self.config.tls.key -> conf;
conf = …;
```

```
let conf = …
    with flow self.config.tls.key -> conf;
```

```
flow self.config.tls.key ->! fn io!();
flow self.config.tls.key ->! *;

...

let mut listener: Ei                    Listener> =
    Left(TcpListener                    p_err(ErrorKind::Bind)?);

if self.config.tls_enabled() {
    if let Some(ref config) = self.config.tls
        with flow self.config.tls.key -> config {

        let conf = config.to_native_config().map_err(ErrorKind::Io)?
            with flow self.config.tls.key -> conf;

        flow self.config.tls.key -> listener;

        listener =
            Right(TlsListener::bind(addr, conf).awa                nd::Bind()?);

        }
}

listener = allow listener;

...
```

These are all overrides

This call is permitted

We allow any further flows here

Weaknesses

Normalizing the use of 'coercions'

No user studies!

Lattices might be neat!

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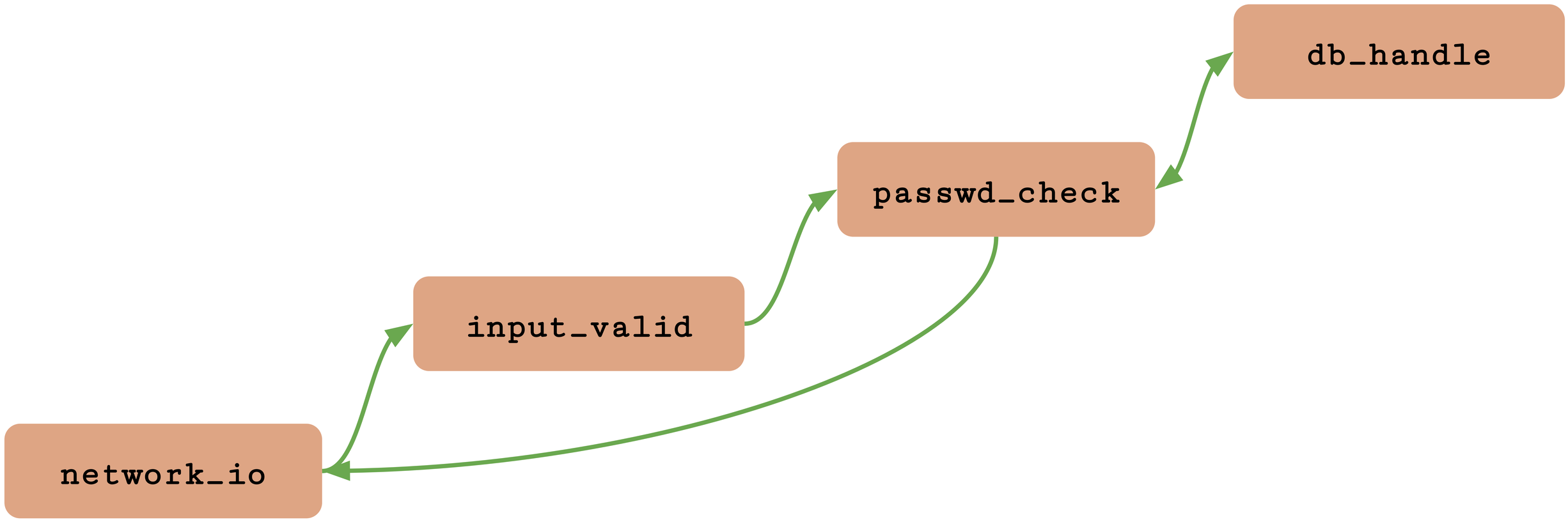
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Green's Cognitive Dimensions of Notations

Progressive evaluation

Consistency

Closeness of mapping

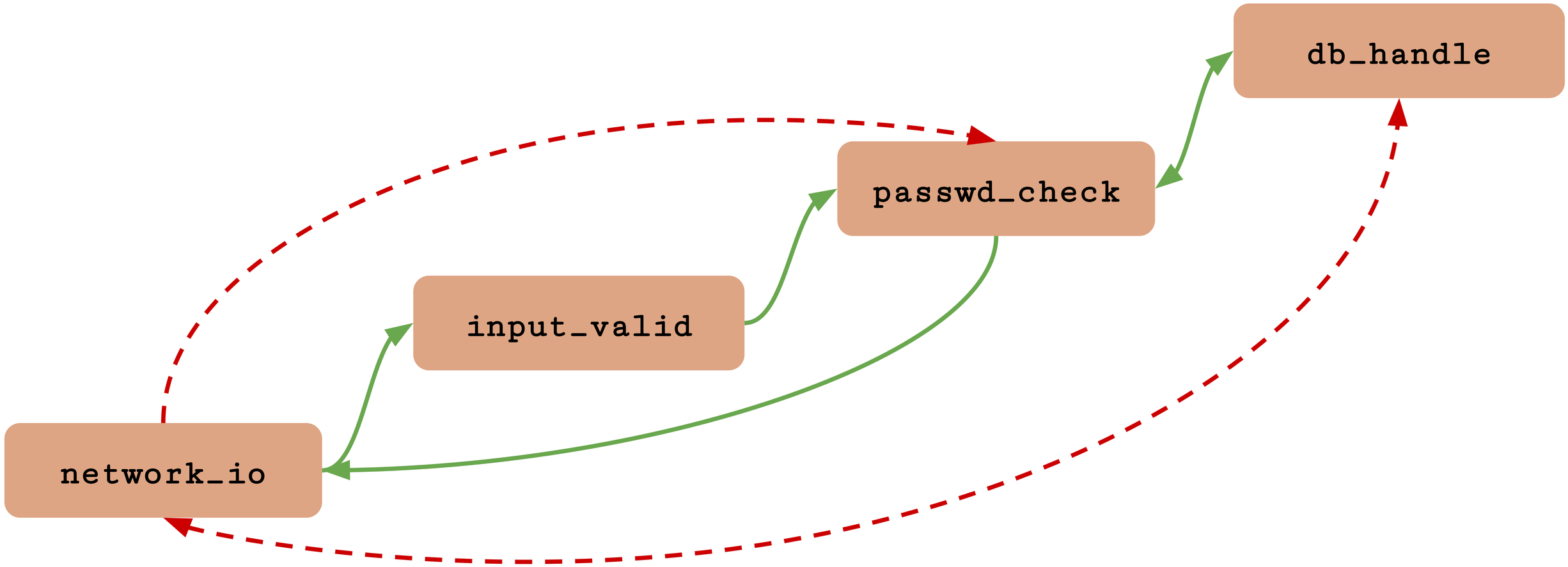
Hard mental operations

Progressive evaluation

"How easy is it to evaluate and obtain feedback on an incomplete solution?"

Consistency

"After part of the notation has been learned, how much can be guessed?"

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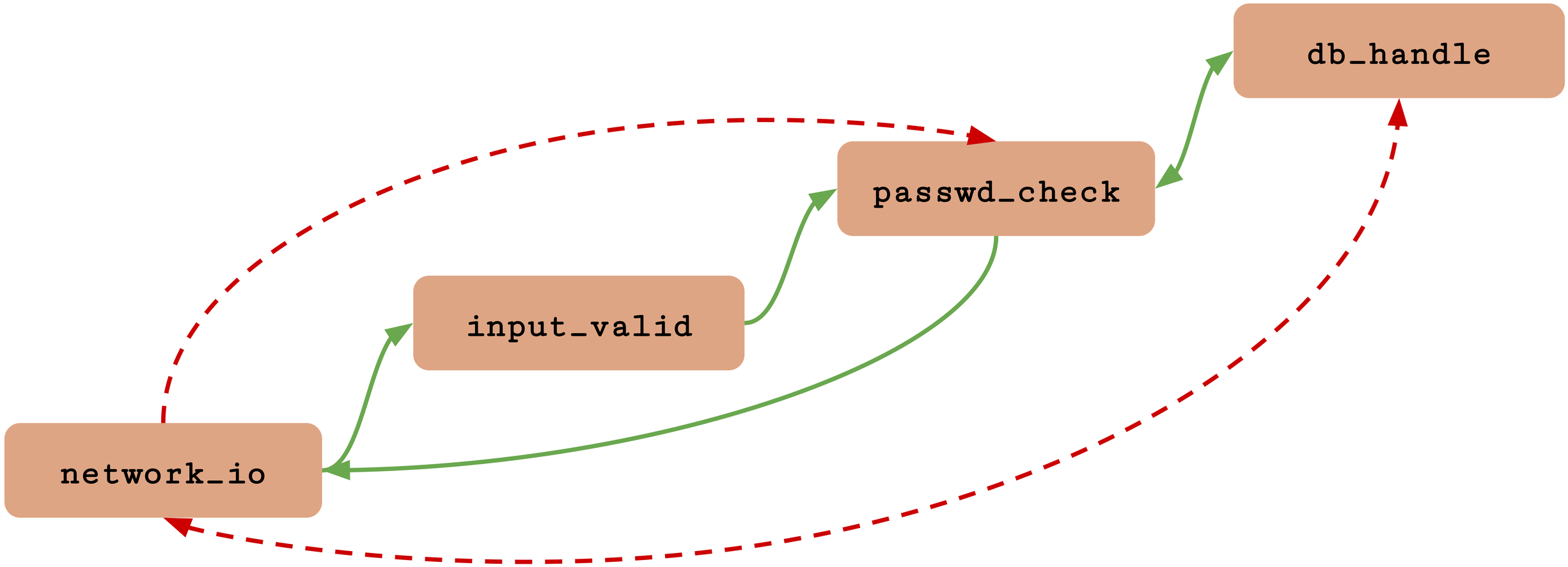
Closeness of mapping

"How closely does the notation correspond to the problem world?"

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```

Hard mental operations

"How much hard mental processing lies at the notational level, rather than the semantic one?"

What's next?

Soundness

User studies

Implementation

What's next?

Soundness

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Thanks

IFC is neat, and it's worth finding ways to make it more accessible and pleasant to use

User-facing lattices do more harm than good