mTask

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Schedule

TOP

iTasks

mTask

Architecture

Thermostat

Task Oriented Programming (TOP)

Concept

Coordinate collaboration between people and machines to reach common goal.

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Components

Declarative paradigm:

- Basic tasks: input/output (e.g. web editors)
- Composition: sequential, parallel
- Communication: task results, shared data

Task Oriented Programming (TOP)

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iTasks Generates a multi-user web application from the TOP specification to do the work.

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Implementations

iTasks Generates a multi-user web application from the TOP specification to do the work.

$\widehat{TOP}$ Formally calculus for tasks including operational semantics.

mTask TOP language and ecosystem for microcontrollers.

Tasks

- Model collaboration and interaction

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$$\begin{tikzcd}
\mathit{NoValue} \arrow[r, leftrightarrow] \arrow[rr, bend left] & \mathit{Unstable} \arrow[r] & \mathit{Stable}
\end{tikzcd}$$

Shared Data Sources

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iTasks

What is iTasks

- DSL in Clean

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- TOP for the web

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What is iTasks

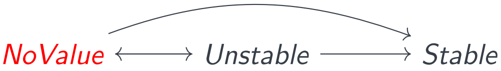
- DSL in Clean
- TOP for the web
- Heavily depends on:
  - Polytypic functions (generics)
  - Dynamic typing (dynamics)
- Generates a multi-user web application from the specification
- Support for distributed operation
- Limited support for peripherals

Basic Tasks

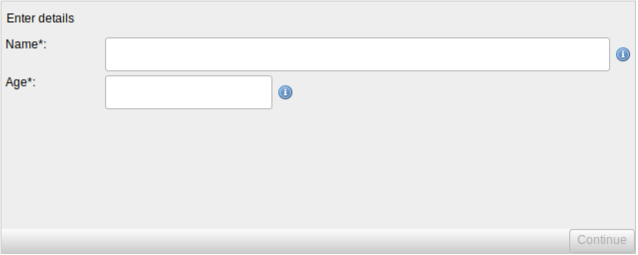
```
return :: a → Task a | iTask a

enterInformation  :: d [EnterOption m]        → Task m | toPrompt d & iTask m
updateInformation :: d [UpdateOption m m] m → Task m | toPrompt d & iTask m
viewInformation   :: d [ViewOption m]     m → Task m | toPrompt d & iTask m


:: ViewOption a  =∃v: ViewAs    (a → v)            & iTask v
                 |∃v: ViewUsing  (a → v) (Editor v) & iTask v
:: EnterOption a =∃v: EnterAs    (v → a)            & iTask v
                 |∃v: EnterUsing (v → a) (Editor v) & iTask v
:: UpdateOption a b
  =∃v: UpdateAs    (a → v) (a v → b)            & iTask v
  |∃v: UpdateUsing (a → v) (a v → b) (Editor v) & iTask v
```

Example Task

```
:: Person = {name :: String, age :: Int}
derive class iTask Person

personTask :: Task Person
personTask = enterInformation "Enter details" []
         >>= viewInformation  "Hello" []
         >>= return
```



NoValue ⟷ *Unstable* ⟶ *Stable*



Enter details

Name*:

Age*:

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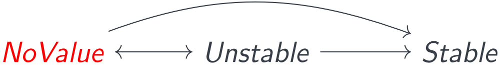

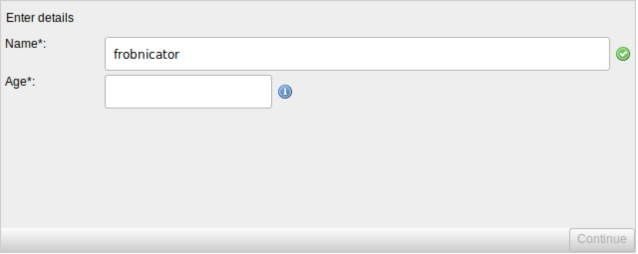

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Name*: frobnicator ✓

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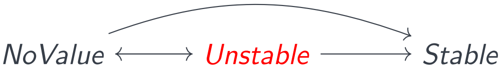

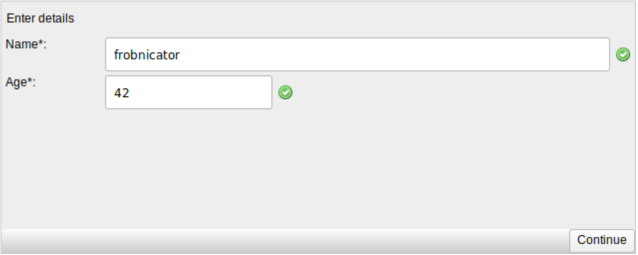
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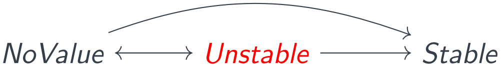

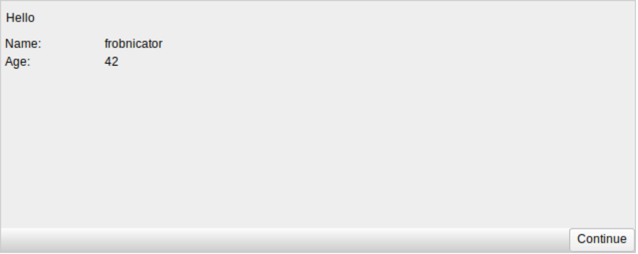
Hello

Name: frobnicator
Age: 42

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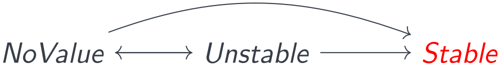

Combinators

Parallel Combinators

```
(-&&-) infixr 4 :: (Task a) (Task b) → Task (a,b) | iTask a & iTask b
(-|| ) infixl 3 :: (Task a) (Task b) → Task a     | iTask a & iTask b
( ||-) infixr 3 :: (Task a) (Task b) → Task b     | iTask a & iTask b
(-||-) infixr 3 :: (Task a) (Task a) → Task a     | iTask a
```

Combinators

Parallel Combinators

```
t :: Task Int
t = enterInformation "Left" [] -||- enterInformation "Right []
  >>= viewInformation "Result" []
```

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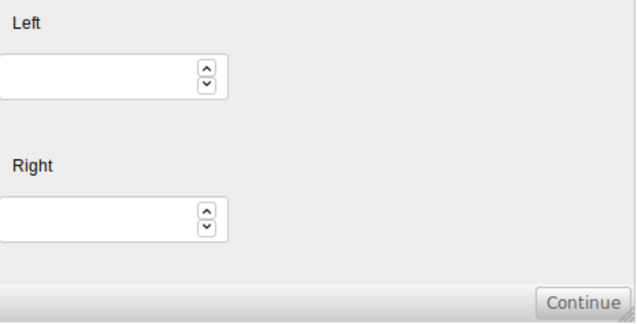

Combinators

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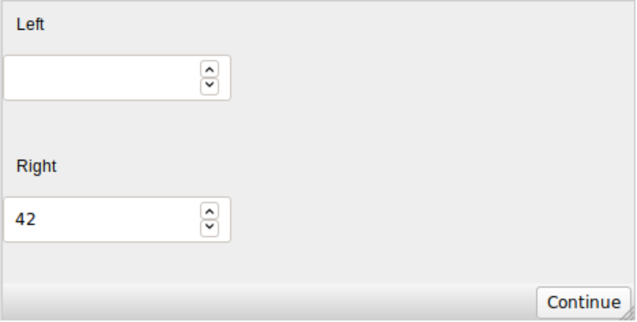

Left

Right

42

Combinators

Parallel Combinators

```
t :: Task Int
t = enterInformation "Left" [] -||- enterInformation "Right []
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```

Result

42

Combinators

Parallel Combinators

```
t :: Task Int
t = enterInformation "Left" [] -||- enterInformation "Right []
  >>= viewInformation "Result" []
```

```
t :: Task (Int, Int)
t = enterInformation "Left" [] -&&- enterInformation "Right []
  >>= viewInformation "Result" []
```

Combinators

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t :: Task (Int, Int)
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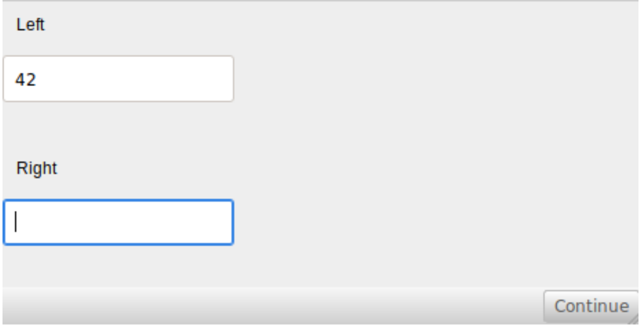

Left

42

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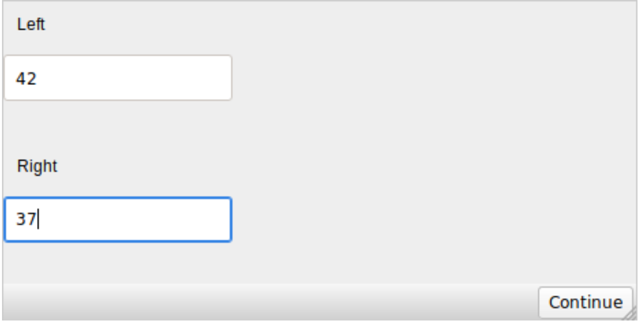

Left

42

Right

37

‘

Combinators

Sequential

```
(>>*) infixl 1 :: (Task a) [TaskCont a (Task b)] → Task b | iTask a & iTask b
:: TaskCont a b
  = OnValue         ((TaskValue a) → Maybe b)
  | OnAction Action ((TaskValue a) → Maybe b)

:: Action = Action String //button
```

Combinators

Sequential

```
always       :: b                  (TaskValue a) → Maybe b
never        :: b                  (TaskValue a) → Maybe b
hasValue     :: (a → b)            (TaskValue a) → Maybe b
ifStable     :: (a → b)            (TaskValue a) → Maybe b
ifUnstable   :: (a → b)            (TaskValue a) → Maybe b
ifValue      :: (a → Bool) (a → b) (TaskValue a) → Maybe b
ifCond       :: Bool b             (TaskValue a) → Maybe b
withoutValue :: (Maybe b)          (TaskValue a) → Maybe b
withValue    :: (a → Maybe b)      (TaskValue a) → Maybe b
withStable   :: (a → Maybe b)      (TaskValue a) → Maybe b
withUnstable :: (a → Maybe b)      (TaskValue a) → Maybe b
```

Combinators

Sequential

```
palindrome :: Task (Maybe String)
palindrome = enterInformation "Enter a palindrome" []
  >>* [ OnAction (Action "Ok")     (ifValue palindrome (λv → return (Just v)))
      , OnAction (Action "Cancel") (always (return Nothing))]
  >>= viewInformation "Result is:" []
where
  palindrome s = s == reverse s
```

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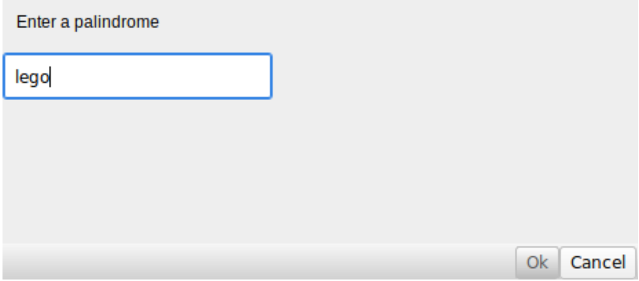

Enter a palindrome

lego

Combinators

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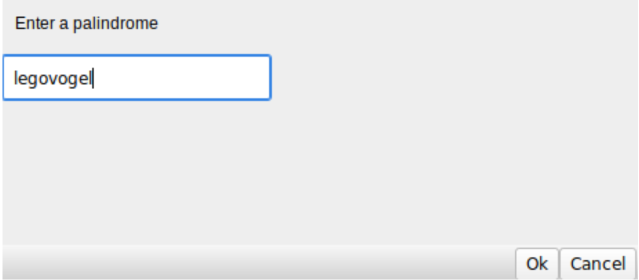

Enter a palindrome

legovogel

Combinators

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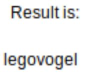


Result is:

legovogel

Combinators

Derived Sequential Combinators

```
(>>=) infixl 1 :: (Task a) (a → Task b) → Task b | iTask a & iTask b
(>>!) infixl 2 :: (Task a) (a → Task b) → Task b | iTask a & iTask b
(>>-) infixl 1 :: (Task a) (a → Task b) → Task b | iTask a & iTask b
(>-|) infixl 1
(>>~) infixl 1 :: (Task a) (a → Task b) → Task b | iTask a & iTask b
(>>^) infixl 1 :: (Task a) (Task b) → Task a| iTask a & iTask b
sequence :: [Task a] → Task [a] | iTask a
```

SDSs

Defining SDSs

```
sharedStore :: String a → SimpleSDSLens a | JSONEncode{|*|} a & JSONDecode{|*|} a & TC a
withShared  :: b ((SimpleSDSLens b) → Task a) → Task a | iTask a & iTask b
```

SDSs

Access Tasks

```
get :: (sds () a w) → Task a | iTask a & Readable sds & TC w
set :: a (sds () r a)  → Task a | iTask a & TC r & Writeable sds
upd :: (r → w) (sds () r w) → Task w | iTask r & iTask w & RWShared sds
watch :: (sds () r w) → Task r | iTask r & TC w & Readable, Registrable sds
```

SDSs

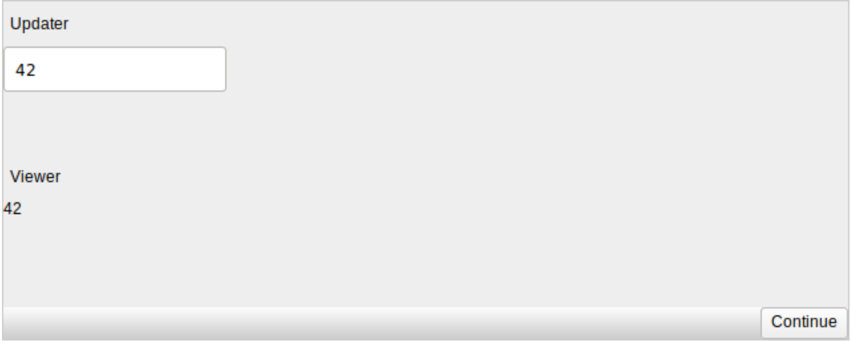
Shared Editors

```
updateSharedInformation :: d [UpdateOption r w] (sds () r w) → Task r | ...
viewSharedInformation   :: d [ViewOption r]     (sds () r w) → Task r | ...

sharedUpdate :: Task Int
sharedUpdate = withShared 42 λsharedInt→
       updateSharedInformation () [] sharedInt
  -||- updateSharedInformation () [] sharedInt
```

Example SDS usage

```
shareTask :: Task Int
shareTask = withShared 42 λsi→
     updateSharedInformation "Updater" [] si
  -|| viewSharedInformation   "Viewer" [] si
```



Updater

42

Viewer

42

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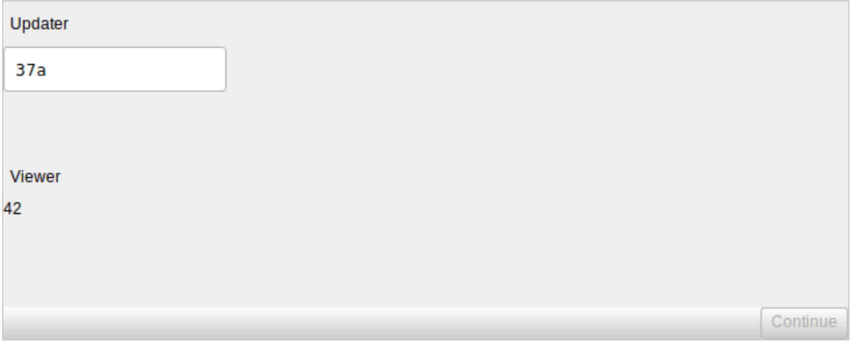

Updater

37a

Viewer

42

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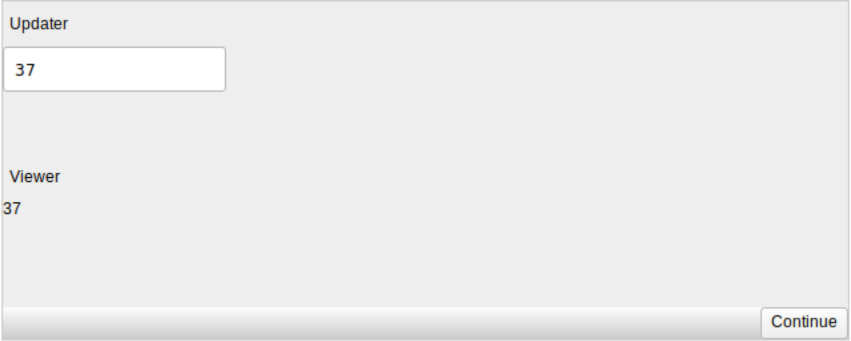

Updater

37

Viewer

37

mTask

mTask design

- Brings TOP to the IOT

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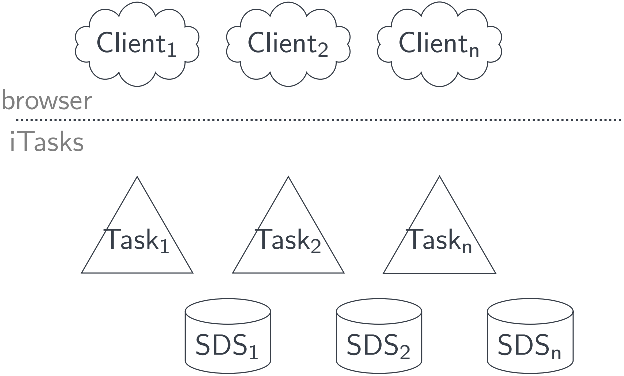
Architecture

Architecture

browser

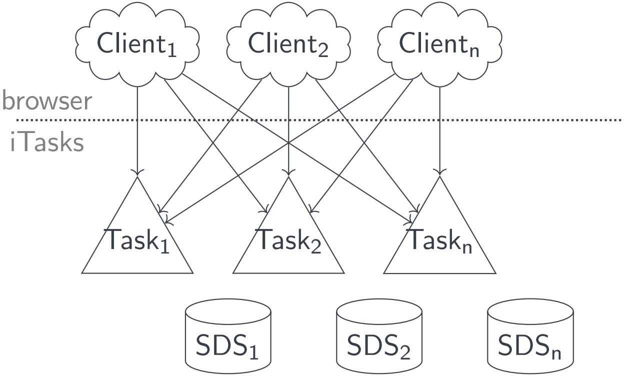
iTasks

Architecture



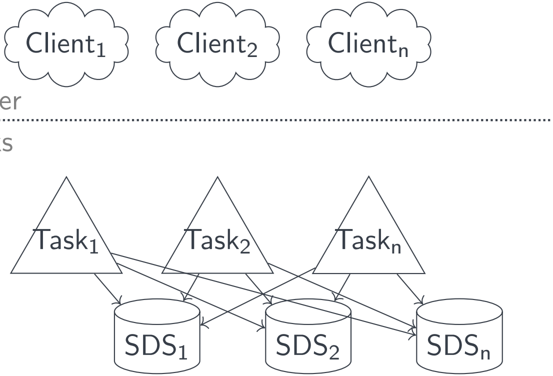
- Javascript
- Clean
- Shared Stores

Architecture



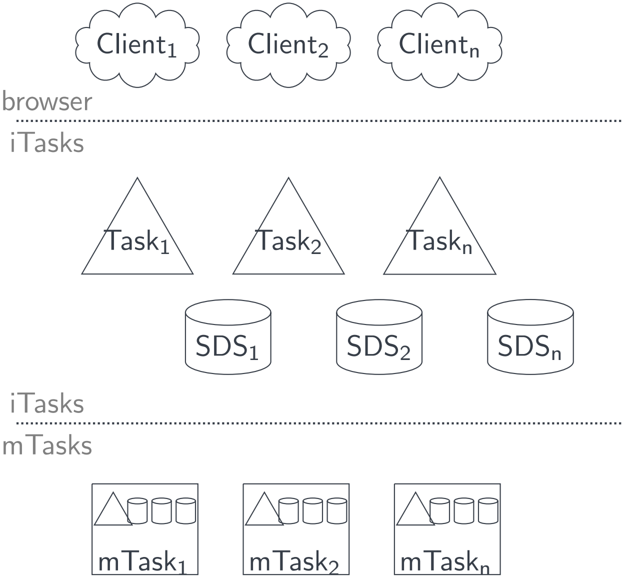
- Type driven UI

Architecture



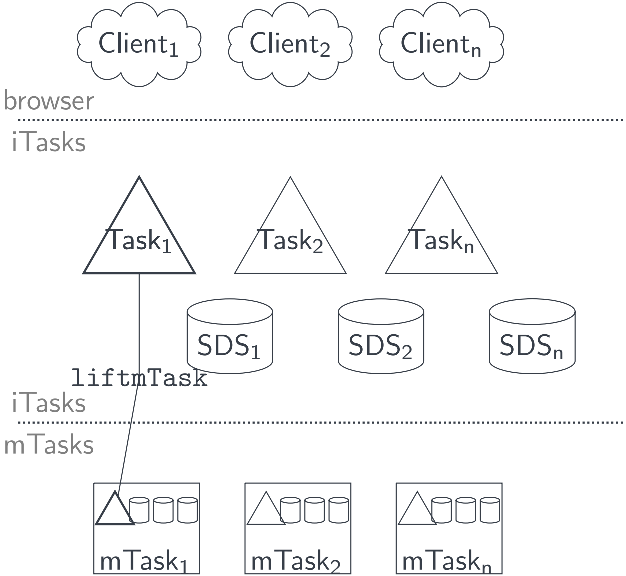
- Synchronization
- Events

Architecture



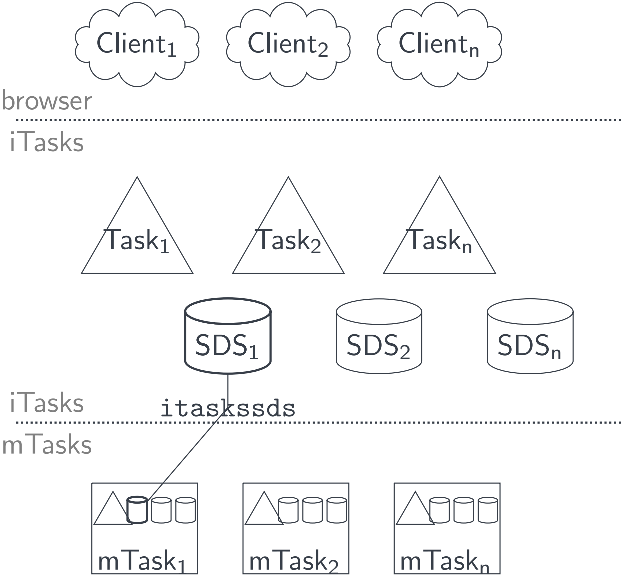
- Devices
- Tasks
- Shared Stores
- RTS/Interpreter

Architecture



- iTasks task as mTask task
- Rewrite task
- Synchronize task value

Architecture



- Synchronize Shared Store
- Publish Subscribe

iTasks interface

Connecting a device: `withDevice`

```
:: MTDevice
withDevice :: (MTDevice → Task b) a → Task b | channelSync a & ...

instance channelSync TCPDevice
instance channelSync TTYDevice
```

iTasks interface

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- Literally a single `parallel`
- Create Channels (`withShared`)
- Setup the connection by running the channel sync
- Ask for a specification (embedded in the `MTDevice`)

iTasks interface

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- Literally a single `parallel`
- Create Channels (`withShared`)
- Setup the connection by running the channel sync
- Ask for a specification (embedded in the `MTDevice`)
- Monitor the channels

iTasks interface

Connecting a device: `withDevice`

```
:: MTDevice
withDevice :: (MTDevice → Task b) a → Task b | channelSync a & ...

instance channelSync TCPDevice
instance channelSync TTYDevice
```

- Literally a single `parallel`
- Create Channels (`withShared`)
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- Ask for a specification (embedded in the `MTDevice`)
- Monitor the channels
- Run the device task

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- Run the device task
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iTasks interface

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- Literally a single `parallel`
- Create Channels (`withShared`)
- Setup the connection by running the channel sync
- Ask for a specification (embedded in the `MTDevice`)
- Monitor the channels
- Run the device task
- Play some trickery to clean up when the argument task is destroyed
- Close the connection when done

iTasks interface

Lifting SDSs: liftSds

```
class liftsds v where
  liftsds :: ((v (Sds t))→In (Shared t) (Main (MTask v u))) → Main (MTask v u) | ...
```

iTasks interface

Lifting SDSs: liftSds

```
class liftsds v where
  liftsds :: ((v (Sds t))→In (Shared t) (Main (MTask v u))) → Main (MTask v u) | ...


:: MTLens sds :== Shared sds String255
lens :: ((Shared s1 a) → MTLens s2) | type, iTask a & RWShared s1 & RWShared s2
lens = mapReadWriteError
  ( λr→Ok (fromString (toByteCode{|*|} r))
  , λw r→Just <$> iTasksDecode (toString w)
  ) Nothing

iTasksDecode :: String → MaybeError TaskException a | type a
```

iTasks interface

Lifting an mTask to iTasks: `liftmTask`

```
liftmTask :: MTDevice (Main (MTask BCInterpret u)) → Task u | iTask, type u
```

iTasks interface

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- Literally a sequence

iTasks interface

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liftmTask :: MTDevice (Main (MTask BCInterpret u)) → Task u | iTask, type u
```

- Literally a sequence
- Compile the task

iTasks interface

Lifting an mTask to iTasks: `liftmTask`

```
liftmTask :: MTDevice (Main (MTask BCInterpret u)) → Task u | iTask, type u
```

- Literally a sequence
- Compile the task
- Retrieve all SDS values

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```
liftmTask :: MTDevice (Main (MTask BCInterpret u)) → Task u | iTask, type u
```

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- Compile the task
- Retrieve all SDS values
- Ask the device to prepare (slow comm, small buffers)

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- Send the task

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- Wait for it to return

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- Literally a sequence
- Compile the task
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- Ask the device to prepare (slow comm, small buffers)
- Send the task
- Wait for it to return
- Watch all linked SDSs both ways

iTasks interface

Lifting an mTask to iTasks: `liftmTask`

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liftmTask :: MTDevice (Main (MTask BCInterpret u)) → Task u | iTask, type u
```

- Literally a sequence
- Compile the task
- Retrieve all SDS values
- Ask the device to prepare (slow comm, small buffers)
- Send the task
- Wait for it to return
- Watch all linked SDSs both ways
- Relay the task value to the task itself

Thermostat

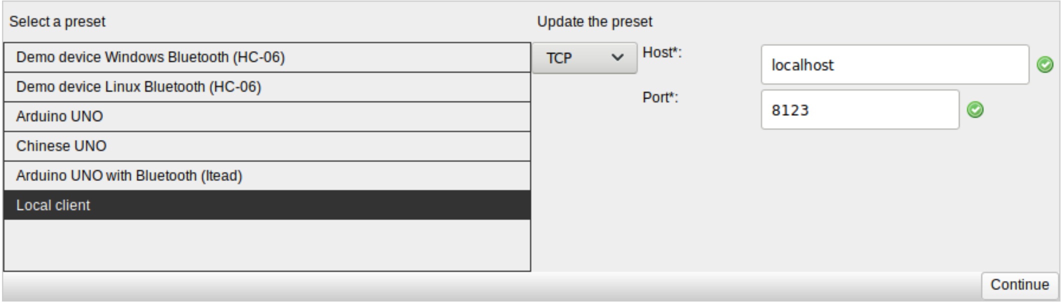
Example: Thermostat

The iTasks part

Example: Thermostat

The iTasks part

```
main :: Task ((), ())
main = enterDevice
  >>= withDevice λdev→
     withShared (160,220) λtargets→
     withShared 420 λtemp→
         updateSharedInformation "Targets" [targetUpdater] targets
      ||- viewSharedInformation "Current" [ViewAs targetView] temp
      ||- liftmTask dev (mTask targets temp)
```



Select a preset

- Demo device Windows Bluetooth (HC-06)
- Demo device Linux Bluetooth (HC-06)
- Arduino UNO
- Chinese UNO
- Arduino UNO with Bluetooth (Itead)
- Local client

Update the preset

TCP

Host*: localhost

Port*: 8123

Example: Thermostat

The iTasks part

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```

- Connect to the device
- Start the synchronization task
- Ask for a specification
- Wait for the specification to return

Example: Thermostat

The iTasks part

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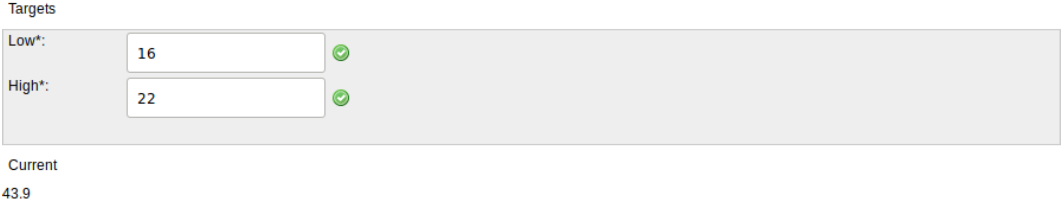

Targets

Low*: 16 ✓

High*: 22 ✓

Current

43.9

Example: Thermostat

The iTasks part

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      ||- liftmTask dev (mTask targets temp)
```

- Compile the task
- Send the task
- Wait for acknowledgement
- Synchronize lifted SDSs

Example: Thermostat

The IOT part

Example: Thermostat

The IOT part

```
mTask targetShare tempShare =
  DHT DHTPIN DHT22 λdht→
  liftsds λtarget = targetShare In
  liftsds λtemp   = tempShare   In
  {main
    =    ever (temperature dht >>~. setSds temp >>|. delay (lit 2000))
    .&&. ever (getSds temp .&&. getSds target >>~. tupopen (temp, target)→λv→
             writeD FANPIN  (temp <. second target)
        .&&. writeD HEATPIN (temp >. first  target)
    )}
```

Example: Thermostat

The IOT part

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Seminar

- Questions?

Seminar

- Questions?
- Write your own mTask applications

Seminar

- Questions?
- Write your own mTask applications
- Use Cloogle

Seminar

- Questions?
- Write your own mTask applications
- Use Cloogle
- Download the material `https://cloo.gl/ODY4`

Future work

- Exceptions/interrupts

Future work

- Exceptions/interrupts
- Event based rewriting

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- Exceptions/interrupts
- Event based rewriting
- Unified peripheral interface

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Future work

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- Collaborate?