

Cardano.BM - benchmarking and logging

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Abstract

abstract ...

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Chapter 1

Cardano BM

1.1 Introduction

introduction ...

1.2 Overview

In figure 1.1 we display the relationships among modules in *Cardano.BM*. The arrows indicate import of a module. The relationship with a triangle at one end would signify "inheritance", but we use it to show that one module replaces the other in the namespace, thus refines its interface.

1.3 Examples

examples ...

1.4 Code listings

1.4.1 Cardano.BM.Observer.STM

```
stmWithLog :: STM.STM (t,[LogObject]) → STM.STM (t,[LogObject])
stmWithLog action = action

bracketObserveIO :: Trace IO → Text → STM.STM t → IO t
bracketObserveIO logTrace0 name action = do
  (traceTransformer,logTrace) ← transformTrace name logTrace0
  bracketObserveIO' traceTransformer logTrace action
bracketObserveIO' :: TraceTransformer → Trace IO → STM.STM t → IO t
bracketObserveIO' NoTrace _ action =
  STM.atomically action
bracketObserveIO' traceTransformer logTrace action = do
  countersid ← observeOpen traceTransformer logTrace
  -- run action, returns result only
  t ← STM.atomically action
```

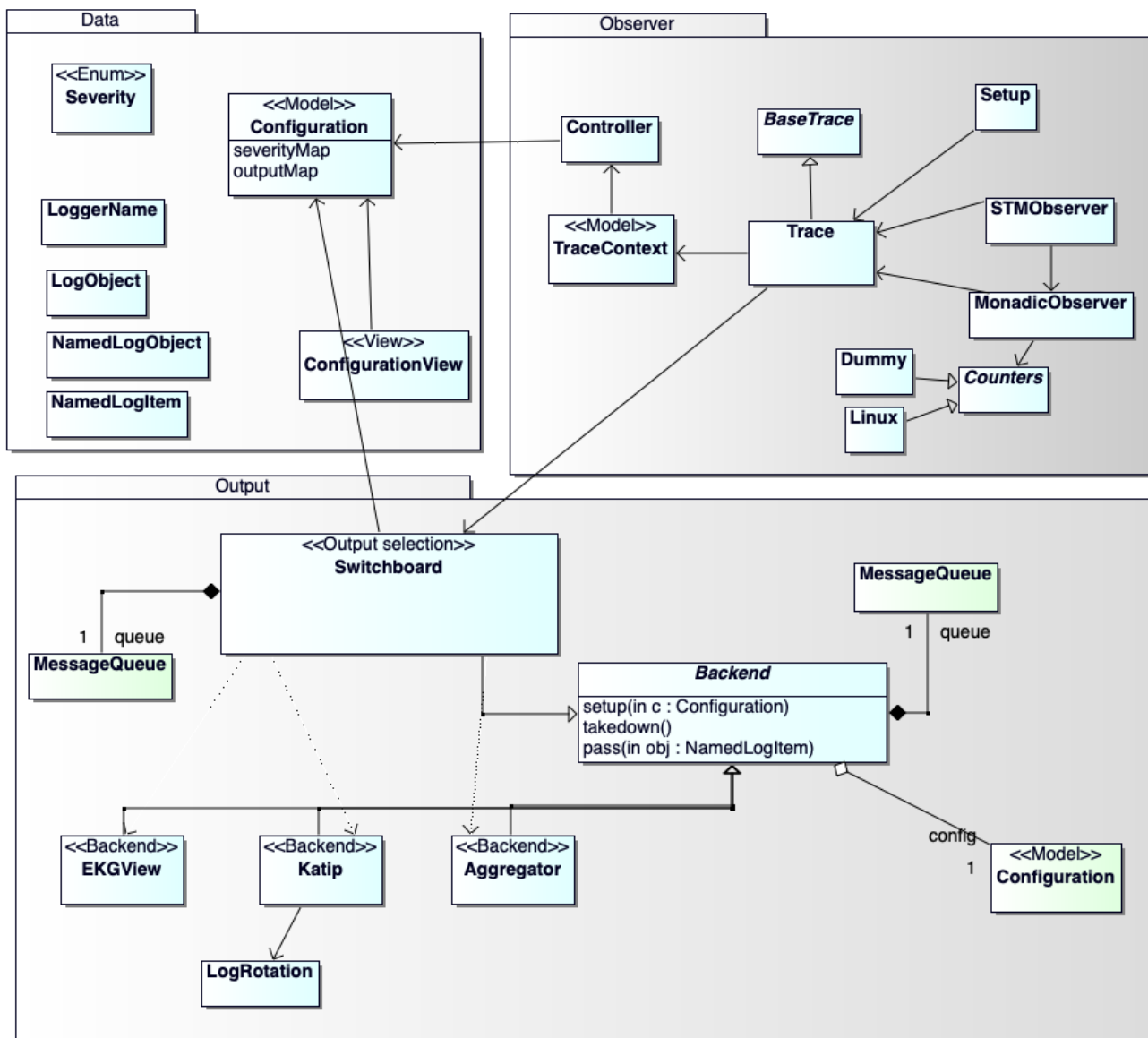


Figure 1.1: Overview of module relationships

```

    observeClose traceTransformer logTrace countersid [ ]
    pure t

bracketObserveLogIO :: Trace IO → Text → STM.STM (t,[LogObject]) → IO t
bracketObserveLogIO logTrace0 name action = do
    (traceTransformer,logTrace) ← transformTrace name logTrace0
    bracketObserveLogIO' traceTransformer logTrace action
bracketObserveLogIO' :: TraceTransformer → Trace IO → STM.STM (t,[LogObject]) → IO t
bracketObserveLogIO' NoTrace _ action = do
    (t,_) ← STM.atomically $ stmWithLog action
    pure t
bracketObserveLogIO' traceTransformer logTrace action = do
    countersid ← observeOpen traceTransformer logTrace
    -- run action, return result and log items
    (t,as) ← STM.atomically $ stmWithLog action
    observeClose traceTransformer logTrace countersid as
    pure t

```

1.4.2 Cardano.BM.Observer.Monad

```

-- Observes an action and adds name given in the logger
-- name of the given Trace. If the empty Text is
-- given as name then the logger name remains untouched.
bracketObserveIO :: Trace IO → Text → IO t → IO t
bracketObserveIO logTrace0 name action = do
    (traceTransformer,logTrace) ← transformTrace name logTrace0
    bracketObserveIO' traceTransformer logTrace action
bracketObserveIO' :: TraceTransformer → Trace IO → IO t → IO t
bracketObserveIO' NoTrace _ action = action
bracketObserveIO' traceTransformer logTrace action = do
    countersid ← observeOpen traceTransformer logTrace
    -- run action
    t ← action
    observeClose traceTransformer logTrace countersid [ ]
    pure t

observeOpen :: TraceTransformer → Trace IO → IO CounterState
observeOpen traceTransformer logTrace = do
    identifier ← newUnique
    logInfo logTrace $ "Opening: " <> pack (show $ hashUnique identifier)
    -- take measurement
    counters ← readCounters traceTransformer
    let state = CounterState identifier counters
    -- send opening message to Trace

```

```

    traceNamedObject logTrace $ ObserveOpen state
    return state

```

```

observeClose :: TraceTransformer → Trace IO → CounterState → [LogObject] → IO ()
observeClose traceTransformer logTrace (CounterState identifier _) logObjects = do
    logInfo logTrace $ "Closing: " <> pack (show $ hashUnique identifier)
    -- take measurement
    counters ← readCounters traceTransformer
    -- send closing message to Trace
    traceNamedObject logTrace $ ObserveClose (CounterState identifier counters)
    -- trace the messages gathered from inside the action
    forM_ logObjects $ traceNamedObject logTrace

```

1.4.3 BaseTrace

Contravariant

A covariant is a functor: $F A \rightarrow F B$

A contravariant is a functor: $F B \rightarrow F A$

$Op\ a\ b$ implements the dual to 'arrow' " $getOp :: b \rightarrow a$ ", which when applied to a *BaseTrace* of type " $Op\ (m\ ())\ s$ ", yields " $s \rightarrow m\ ()$ ". In our case, Op accepts an action in a monad m with input type *LogNamed LogObject* (see 'Trace').

```

newtype BaseTrace m s = BaseTrace {runTrace :: Op (m ()) s}

```

contramap

A covariant functor defines the function " $fmap :: (a \rightarrow b) \rightarrow f\ a \rightarrow f\ b$ ". In case of a contravariant functor, it is the dual function " $contramap :: (a \rightarrow b) \rightarrow f\ b \rightarrow f\ a$ " which is defined.

In the following instance, *runTrace* extracts type " $Op\ (m\ ())\ s$ " to which *contramap* applies f , thus " $f\ s \rightarrow m\ ()$ ". The constructor *BaseTrace* restores " $Op\ (m\ ())\ (f\ s)$ ".

```

instance Contravariant (BaseTrace m) where
    contramap f = BaseTrace ∘ contramap f ∘ runTrace

```

traceWith

Accepts a *Trace* and some payload s . First it gets the contravariant from the *Trace* as type " $Op\ (m\ ())\ s$ " and, after " $getOp :: b \rightarrow a$ " which translates to " $s \rightarrow m\ ()$ ", calls the action on the *LogNamed LogObject*.

```

traceWith :: BaseTrace m s → s → m ()
traceWith = getOp ∘ runTrace

```

natTrace

Natural transformation from monad m to monad n .

```
natTrace :: (forall x o m x → n x) → BaseTrace m s → BaseTrace n s
natTrace nat (BaseTrace (Op tr)) = BaseTrace $ Op $ nat o tr
```

noTrace

A *Trace* that discards all inputs.

```
noTrace :: Applicative m ⇒ BaseTrace m a
noTrace = BaseTrace $ Op $ const (pure ())
```

1.4.4 Cardano.BM.Trace

```
appendName :: MonadIO m ⇒ LoggerName → Trace m → m (Trace m)
appendName name (ctx, trace) = do
  -- append the name to the existing one
  let previousLoggerName = loggerName ctx
      newLoggerName = appendWithDot previousLoggerName name
      ctx' = ctx {loggerName = newLoggerName}
  -- inherit the Severity of the given Trace.
  mPreviousSeverity ← liftIO $ getNamedSeverity ctx' previousLoggerName
  case mPreviousSeverity of
    Nothing → return (ctx', trace)
    Just sev → liftIO $ setNamedSeverity ctx newLoggerName sev
                >> return (ctx', trace)
  -- return a BaseTrace from a TraceNamed
named :: BaseTrace m (LogNamed i) → LoggerName → BaseTrace m i
named trace name = contramap (LogNamed name) trace
```

TODO remove *locallock*

```
locallock :: MVar ()
locallock = unsafePerformIO $ newMVar ()
```

Concrete Trace on stdout

This function returns a trace with an action of type $"(LogNamed LogObject) \rightarrow IO ()"$ which will output a text message as text and all others as JSON encoded representation to the console.

```
stdoutTrace :: TraceNamed IO
stdoutTrace = BaseTrace $ Op $ \lognamed →
  case lnItem lognamed of
    LP (LogMessage logItem) →
      withMVar locallock $ \_ →
```



```

        output (lnName lognamed) $ liPayload logItem
    obj →
        withMVar locallock $ \_ →
            output (lnName lognamed) $ toStrict (encodeToLazyText obj)
where
    output nm msg = TIO.putStrLn $ nm <> " :: " <> msg

```

Trace into katip's queue

```

katipTrace :: {-MVar LoggingHandler -} TraceNamed IO
katipTrace = BaseTrace $ Op $ \lognamed → do
    lh ← readMVar Internal.loggingHandler
    mayEnv ← Internal.getLogEnv lh
    case mayEnv of
        Nothing → error "logging not yet initialized. Abort."
        Just env → logItem'
            lognamed
            (K.Namespace (T.split (≡ ' . ') (lnName lognamed)))
            env
        Nothing
            (Internal.sev2klog Info)
            (K.logStr (" " :: Text))

```

Every *Trace* ends in the switchboard which then takes care of dispatching the messages to outputs

```

mainTrace :: TraceNamed IO
mainTrace = BaseTrace $ Op $ \lognamed → do
    Switchboard.pass lognamed

```

Concrete Trace into a TVar

```

traceInTVar :: STM.TVar [a] → BaseTrace STM.STM a
traceInTVar tvar = BaseTrace $ Op $ \a → STM.modifyTVar tvar ((:) a)
traceInTVarIO :: STM.TVar [LogObject] → TraceNamed IO
traceInTVarIO tvar = BaseTrace $ Op $ \ln →
    STM.atomically $ STM.modifyTVar tvar ((:) (lnItem ln))
traceNamedInTVarIO :: STM.TVar [LogNamed LogObject] → TraceNamed IO
traceNamedInTVarIO tvar = BaseTrace $ Op $ \ln →
    STM.atomically $ STM.modifyTVar tvar ((:) ln)

traceConditionally
    :: (MonadIO m)
    ⇒ TraceContext → BaseTrace m LogObject → LogObject
    → m ()

```

```

traceConditionally ctx logTrace msg@(LP (LogMessage item)) = do
  flag ← liftIO $ checkSeverity ctx item
  when flag $ traceWith logTrace msg
traceConditionally _ logTrace logObject = traceWith logTrace logObject

```

Enter message into a trace

The function *traceNamedItem* creates a *LogObject* and threads this through the action defined in the *Trace*.

```

traceNamedItem
  :: (MonadIO m)
  ⇒ Trace m
  → LogSelection
  → Severity
  → Text
  → m ()
traceNamedItem (ctx, logTrace) p s m =
  let logmsg = LP $ LogMessage $ LogItem { liSelection = p
    , liSeverity = s
    , liPayload = m
  }
  in
    traceConditionally ctx (named logTrace (loggerName ctx)) $ logmsg
logDebug, logInfo, logNotice, logWarning, logError
  :: (MonadIO m) ⇒ Trace m → Text → m ()
logDebug logTrace = traceNamedItem logTrace Both Debug
logInfo logTrace   = traceNamedItem logTrace Both Info
logNotice logTrace = traceNamedItem logTrace Both Notice
logWarning logTrace = traceNamedItem logTrace Both Warning
logError logTrace  = traceNamedItem logTrace Both Error
logDebugS, logInfoS, logNoticeS, logWarningS, logErrorS
  :: (MonadIO m) ⇒ Trace m → Text → m ()
logDebugS logTrace = traceNamedItem logTrace Private Debug
logInfoS logTrace   = traceNamedItem logTrace Private Info
logNoticeS logTrace = traceNamedItem logTrace Private Notice
logWarningS logTrace = traceNamedItem logTrace Private Warning
logErrorS logTrace  = traceNamedItem logTrace Private Error
logDebugP, logInfoP, logNoticeP, logWarningP, logErrorP
  :: (MonadIO m) ⇒ Trace m → Text → m ()
logDebugP logTrace = traceNamedItem logTrace Public Debug
logInfoP logTrace   = traceNamedItem logTrace Public Info
logNoticeP logTrace = traceNamedItem logTrace Public Notice
logWarningP logTrace = traceNamedItem logTrace Public Warning
logErrorP logTrace  = traceNamedItem logTrace Public Error
logDebugUnsafeP, logInfoUnsafeP, logNoticeUnsafeP, logWarningUnsafeP, logErrorUnsafeP
  :: (MonadIO m) ⇒ Trace m → Text → m ()

```

```

logDebugUnsafeP logTrace = traceNamedItem logTrace PublicUnsafe Debug
logInfoUnsafeP logTrace  = traceNamedItem logTrace PublicUnsafe Info
logNoticeUnsafeP logTrace = traceNamedItem logTrace PublicUnsafe Notice
logWarningUnsafeP logTrace = traceNamedItem logTrace PublicUnsafe Warning
logErrorUnsafeP logTrace  = traceNamedItem logTrace PublicUnsafe Error

```

```

traceNamedObject
  :: Trace m
  → LogObject
  → m ()
traceNamedObject (ctx, logTrace) = traceWith (named logTrace (loggerName ctx))

```

transformTrace

```

-- Transforms the Trace given according to content of
-- TraceTransformerMap using the logger name of the
-- current Trace appended with the given name. If the
-- empty Text is given as name then the logger name
-- remains untouched.
transformTrace :: MonadIO m ⇒ Text → Trace m → m (TraceTransformer, Trace m)
transformTrace name tr@(ctx, _) = do
  traceTransformer ← liftIO $ findTraceTransformer tr $ appendWithDot (loggerName ctx) name
  case traceTransformer of
    Neutral      → do
      tr' ← appendName name tr
      return $ (traceTransformer, tr')
    UntimedTrace → do
      tr' ← appendName name tr
      return $ (traceTransformer, tr')
    NoTrace      → return (traceTransformer, (ctx, BaseTrace $ Op $ \_ → pure ()))
    DropOpening  → return (traceTransformer, (ctx, BaseTrace $ Op $ \lognamed →
      case lnItem lognamed of
        ObserveOpen _ → return ()
        obj           → traceNamedObject tr obj))
    ObservableTrace _ → do
      tr' ← appendName name tr
      return $ (traceTransformer, tr')

```

1.4.5 Cardano.BM.Controller

Add a TraceTransformer to this Trace

It will get activated once we enter the named context.

```

insertInController :: Monad m ⇒ Trace m → Text → TraceTransformer → IO ()
insertInController (ctx, _) name trans = do

```

```

let currentLoggerName = loggerName ctx
    name' = appendWithDot currentLoggerName name
    modifyMVar_ (controller ctx) $ λtc →
        return $ tc {traceTransformers = insert name' trans (traceTransformers tc)}

setMinSeverity :: Trace m → Severity → IO ()
setMinSeverity (ctx, _) newMinSeverity =
    modifyMVar_ (controller ctx) $ λtc →
        return $ tc {minSeverity = newMinSeverity}

setNamedSeverity :: TraceContext → LoggerName → Severity → IO ()
setNamedSeverity ctx name newSeverity =
    modifyMVar_ (controller ctx) $ λtc →
        return $ tc {severityMap = insert name newSeverity (severityMap tc)}

getNamedSeverity :: TraceContext → LoggerName → IO (Maybe Severity)
getNamedSeverity ctx name = withMVar (controller ctx) $ λtc →
    return $ lookup name (severityMap tc)

findTraceTransformer :: Trace m → Text → IO TraceTransformer
findTraceTransformer (ctx, _) name =
    withMVar (controller ctx) $ λtc →
        return $ findWithDefault Neutral name (traceTransformers tc)

appendWithDot :: LoggerName → LoggerName → LoggerName
appendWithDot "" newName = take 50 newName
appendWithDot xs "" = xs
appendWithDot xs newName = take 50 $ xs <> "." <> newName

```

checkSeverity

```

checkSeverity :: TraceContext → LogItem → IO Bool
checkSeverity ctx item = do
    let name = loggerName ctx
        itemSev = liSeverity item
    withMVar (controller ctx) $ λtc → do
        let globalSev = minSeverity tc
        case lookup name (severityMap tc) of
            Nothing → return (itemSev ≥ globalSev)
            Just specificSev → return ((itemSev ≥ globalSev) ∧ (itemSev ≥ specificSev))

```

1.4.6 Cardano.BM.Counters

Here the platform is chosen on which we compile this program.

Currently, we only support *Linux* with its 'proc' filesystem.

```
{-# LANGUAGE CPP #-}
```

```

# if defined (linux_HOST_OS)
# define LINUX
# endif
module Cardano.BM.Counters
(
    Platform.readCounters
    ,diffTimeObserved
    ,getMonoClock
) where
# ifdef LINUX
import qualified Cardano.BM.Counters.Linux as Platform
# else
import qualified Cardano.BM.Counters.Dummy as Platform
# endif
import Cardano.BM.Counters.Common (getMonoClock)
import Cardano.BM.Data (Counter (..), CounterState (..))
import Data.Time.Units (Microsecond)

```

Calculate difference between clocks

```

diffTimeObserved :: CounterState → CounterState → Microsecond
diffTimeObserved (CounterState id0 startCounters) (CounterState id1 endCounters) =
    let
        startTime = getMonotonicTime startCounters
        endTime = getMonotonicTime endCounters
    in
        if (id0 == id1)
        then endTime - startTime
        else error "these clocks are not from the same experiment"
    where
        getMonotonicTime counters = case (filter isMonotonicClockCounter counters) of
            [(MonotonicClockTime _ micros)] → micros
            _ → error "A time measurement is missing!"
        isMonotonicClockCounter :: Counter → Bool
        isMonotonicClockCounter (MonotonicClockTime _) = True
        isMonotonicClockCounter _ = False

```

1.4.7 Cardano.BM.Counters.Common

Common functions that serve *readCounters* on all platforms.

```

nominalTimeToMicroseconds :: Word64 → Microsecond
nominalTimeToMicroseconds = fromMicroseconds ∘ toInteger ∘ ('div' 1000)

getMonoClock :: IO [Counter]
getMonoClock = do

```

```

t ← getMonotonicTimeNSec
return [ MonotonicClockTime "monoclock" $ nominalTimeToMicroseconds t ]

```

1.4.8 Cardano.BM.Counters.Dummy

This is a dummy definition of *readCounters* on platforms that do not support the 'proc' filesystem from which we would read the counters.

The only supported measurement is monotonic clock time for now.

we could well imagine that some day we support all platforms

```

readCounters :: TraceTransformer → IO [Counter]
readCounters NoTrace      = return []
readCounters Neutral      = return []
readCounters UntimedTrace = return []
readCounters DropOpening  = return []
readCounters (ObservableTrace tts) = foldrM (λ(sel,fun) a →
  if sel 'member' tts
  then (fun ≧ λxs → return $ a ++ xs)
  else return a) [] selectors
where
  selectors = [ (MonotonicClock, getMonoClock)
    -- , (MemoryStats, readProcStatM)
    -- , (ProcessStats, readProcStats)
    -- , (IOStats, readProcIO)
  ]

```

1.4.9 Cardano.BM.Counters.Linux

we have to expand the *getMonoClock* and *readMemStats* functions with ones that read full data from *proc*

```

readCounters :: TraceTransformer → IO [Counter]
readCounters NoTrace      = return []
readCounters Neutral      = return []
readCounters UntimedTrace = return []
readCounters DropOpening  = return []
readCounters (ObservableTrace tts) = foldrM (λ(sel,fun) a →
  if sel 'member' tts
  then (fun ≧ λxs → return $ a ++ xs)
  else return a) [] selectors
where
  selectors = [ (MonotonicClock, getMonoClock)
    , (MemoryStats, readProcStatM)
    , (ProcessStats, readProcStats)
    , (IOStats, readProcIO)
  ]

```

```

pathProc :: FilePath
pathProc = "/proc/"
pathProcStat :: ProcessID → FilePath
pathProcStat pid = pathProc </> (show pid) </> "stat"
pathProcStatM :: ProcessID → FilePath
pathProcStatM pid = pathProc </> (show pid) </> "statm"
pathProcIO :: ProcessID → FilePath
pathProcIO pid = pathProc </> (show pid) </> "io"

```

Reading from a file in /proc/<pid >

```

readProcList :: FilePath → IO [Integer]
readProcList fp = do
  cs ← readFile fp
  return $ map (\s → maybe 0 id $ (readMaybe s :: Maybe Integer)) (words cs)

```

readProcStatM - /proc/<pid >/statm

```
/proc/[pid]/statm
```

Provides information about memory usage, measured in pages. The columns are:

size	(1) total program size (same as VmSize in /proc/[pid]/status)
resident	(2) resident set size (same as VmRSS in /proc/[pid]/status)
shared	(3) number of resident shared pages (i.e., backed by a file) (same as RssFile+RssShmem in /proc/[pid]/status)
text	(4) text (code)
lib	(5) library (unused since Linux 2.6; always 0)
data	(6) data + stack
dt	(7) dirty pages (unused since Linux 2.6; always 0)

```

readProcStatM :: IO [Counter]
readProcStatM = do
  pid ← getProcessID
  ps0 ← readProcList (pathProcStatM pid)
  ps ← return $ zip colnames ps0
  forM ps (\(n,i) → return $ MemoryCounter n i)
where
  colnames :: [Text]
  colnames = ["size", "resident", "shared", "text", "unused", "data", "unused"]

```

readProcStats - //proc//<pid >//stat

```
/proc/[pid]/stat
```

Status information about the process. This is used by ps(1). It is defined in

fs/proc/array.c.

The fields, in order, with their proper scanf(3) format specifiers, are listed. Whether or not certain of these fields display valid information is governed by the `PTRACE_MODE_READ_FSCREDS | PTRACE_MODE_NOAUDIT` check (refer to `ptrace(2)`). If this check fails, then the field value is displayed as 0. The affected fields are indicated with a 0.

(1) pid %d

The process ID.

(2) comm %s

The filename of the executable, in parentheses. This is visible only if the process's comm cutable is swapped out.

(3) state %c

One of the following characters, indicating process state:

R Running

S Sleeping in an interruptible wait

D Waiting in uninterruptible disk sleep

Z Zombie

T Stopped (on a signal) or (before Linux 2.6.33) trace stopped

t Tracing stop (Linux 2.6.33 onward)

W Paging (only before Linux 2.6.0)

X Dead (from Linux 2.6.0 onward)

x Dead (Linux 2.6.33 to 3.13 only)

K Wakekill (Linux 2.6.33 to 3.13 only)

W Waking (Linux 2.6.33 to 3.13 only)

P Parked (Linux 3.9 to 3.13 only)

(4) ppid %d

The PID of the parent of this process.

(5) pgrp %d

The process group ID of the process.

(6) session %d

The session ID of the process.

(7) `tty_nr %d`

The controlling terminal of the process. (The minor device number is in bits 31 to 20 and 7 to 0; the major device number is in bits 31 to 20.)

(8) `tpgid %d`

The ID of the foreground process group of the controlling terminal of the process.

(9) `flags %u`

The kernel flags word of the process. For bit meanings, see the kernel source file `include/linux/sched.h`. Details depend on the kernel version.

The format for this field was `%lu` before Linux 2.6.

(10) `minflt %lu`

The number of minor faults the process has made which have not required a disk I/O.

(11) `cminflt %lu`

The number of minor faults that the process's waited-for children have made.

(12) `majflt %lu`

The number of major faults the process has made which have required a disk I/O.

(13) `cmajflt %lu`

The number of major faults that the process's waited-for children have made.

(14) `utime %lu`

Amount of time that this process has been scheduled in user mode, measured in clock ticks (divide by `sysconf(_SC_CLK_TCK)`). This includes guest time, `guest_time` (time spent running a virtual CPU, see below), so that applications that are not aware of time not lost due to paging do not lose that time from their calculations.

(15) `stime %lu`

Amount of time that this process has been scheduled in kernel mode, measured in clock ticks (divide by `sysconf(_SC_CLK_TCK)`).

(16) `cutime %ld`

Amount of time that this process's waited-for children have been scheduled in clock ticks (divide by `sysconf(_SC_CLK_TCK)`). (See also `guest_time`, `cguest_time` (time spent running a virtual CPU, see below), and `stime`.)

(17) `cstime %ld`

Amount of time that this process's waited-for children have been scheduled in kernel mode, measured in clock ticks (divide by `sysconf(_SC_CLK_TCK)`).

- (18) `priority %ld`
 (Explanation for Linux 2.6) For processes running a real-time scheduler (see `sched_setscheduler(2)`), this is the negated scheduling priority; for processes running under a non-real-time scheduling policy, this is the priority(2) as represented in the kernel. The kernel stores nice values in the range 0 (high) to 39 (low), corresponding to the user-visible nice values in the range -20 to 19.
- (19) `nice %ld`
 The nice value (see `setpriority(2)`), a value in the range 19 (low priority) to -20 (high priority).
- (20) `num_threads %ld`
 Number of threads in this process (since Linux 2.6). Before kernel 2.6, this field was coded to 0 as a placeholder for an earlier removed field.
- (21) `itrealvalue %ld`
 The time in jiffies before the next SIGALRM is sent to the process or the signal alarm goes off. Since kernel 2.6.17, this field is no longer maintained, and is hard-coded to 0.
- (22) `starttime %llu`
 The time the process started after system boot. In kernels before Linux 2.6, this value is expressed in jiffies. Since Linux 2.6, the value is expressed in clock ticks (see `sysconf(_SC_CLK_TCK)`).

 The format for this field was `%lu` before Linux 2.6.
- (23) `vsize %lu`
 Virtual memory size in bytes.
- (24) `rss %ld`
 Resident Set Size: number of pages the process has in real memory. This includes pages which count toward text, data, or stack space. This does not include pages which have been demand-loaded in, or which are swapped out.
- (25) `rsslim %lu`
 Current soft limit in bytes on the rss of the process; see the description of `getrlimit(2)`.
- (26) `startcode %lu [PT]`
 The address above which program text can run.
- (27) `endcode %lu [PT]`
 The address below which program text can run.
- (28) `startstack %lu [PT]`
 The address of the start (i.e., bottom) of the stack.

- (29) `kstkesp %lu [PT]`
The current value of ESP (stack pointer), as found in the kernel stack.
- (30) `kstkeip %lu [PT]`
The current EIP (instruction pointer).
- (31) `signal %lu`
The bitmap of pending signals, displayed as a decimal number. Obsolete; use `/proc/[pid]/status` instead to provide information on real-time signals; use `/proc/[pid]/status` instead.
- (32) `blocked %lu`
The bitmap of blocked signals, displayed as a decimal number. Obsolete; use `/proc/[pid]/status` instead to provide information on real-time signals; use `/proc/[pid]/status` instead.
- (33) `sigignore %lu`
The bitmap of ignored signals, displayed as a decimal number. Obsolete; use `/proc/[pid]/status` instead to provide information on real-time signals; use `/proc/[pid]/status` instead.
- (34) `sigcatch %lu`
The bitmap of caught signals, displayed as a decimal number. Obsolete; use `/proc/[pid]/status` instead to provide information on real-time signals; use `/proc/[pid]/status` instead.
- (35) `wchan %lu [PT]`
This is the "channel" in which the process is waiting. It is the kernel where the process is sleeping. The corresponding symbolic name is `/proc/[pid]/wchan`.
- (36) `nswap %lu`
Number of pages swapped (not maintained).
- (37) `cswap %lu`
Cumulative `nswap` for child processes (not maintained).
- (38) `exit_signal %d` (since Linux 2.1.22)
Signal to be sent to parent when we die.
- (39) `processor %d` (since Linux 2.2.8)
CPU number last executed on.
- (40) `rt_priority %u` (since Linux 2.5.19)
Real-time scheduling priority, a number in the range 1 to 99 for processes with real-time policy, or 0, for non-real-time processes (see `sched_setscheduler(2)`).
- (41) `policy %u` (since Linux 2.5.19)
Scheduling policy (see `sched_setscheduler(2)`). Decode using the `linux/sched.h` header.
- The format for this field was `%lu` before Linux 2.6.22.

- (42) `delayacct_blkio_ticks %llu` (since Linux 2.6.18)
Aggregated block I/O delays, measured in clock ticks (centiseconds).
- (43) `guest_time %lu` (since Linux 2.6.24)
Guest time of the process (time spent running a virtual CPU for a
measured in clock ticks (divide by `sysconf(_SC_CLK_TCK)`)).
- (44) `cguest_time %ld` (since Linux 2.6.24)
Guest time of the process's children, measured in clock ticks
(divide by `sysconf(_SC_CLK_TCK)`).
- (45) `start_data %lu` (since Linux 3.3) [PT]
Address above which program initialized and uninitialized (BSS) data
begins.
- (46) `end_data %lu` (since Linux 3.3) [PT]
Address below which program initialized and uninitialized (BSS) data
ends.
- (47) `start_brk %lu` (since Linux 3.3) [PT]
Address above which program heap can be expanded with `brk(2)`.
- (48) `arg_start %lu` (since Linux 3.5) [PT]
Address above which program command-line arguments (`argv`) are placed.
- (49) `arg_end %lu` (since Linux 3.5) [PT]
Address below program command-line arguments (`argv`) are placed.
- (50) `env_start %lu` (since Linux 3.5) [PT]
Address above which program environment is placed.
- (51) `env_end %lu` (since Linux 3.5) [PT]
Address below which program environment is placed.
- (52) `exit_code %d` (since Linux 3.5) [PT]
The thread's exit status in the form reported by `waitpid(2)`.

```
readProcStats :: IO [Counter]
```

```
readProcStats = do
```

```
    pid ← getProcessID
```

```
    ps0 ← readProcList (pathProcStat pid)
```

```
    ps ← return $ zip colnames ps0
```

```
    forM ps (\(n,i) → return $ StatInfo n i)
```

```
where
```

```
colnames :: [Text]
```

```
colnames = [ "pid", "unused", "unused", "ppid", "pgrp", "session", "ttynr", "tpgid", "flags", "minfl",  
            , "cminflt", "majflt", "cmajflt", "utime", "stime", "cutime", "cstime", "priority", "nice", "num",  
            , "itrealvalue", "starttime", "vsize", "rss", "rsslim", "startcode", "endcode", "startstack", "
```

```
, "signal", "blocked", "sigignore", "sigcatch", "wchan", "nswap", "cnsnap", "exitsignal", "proc
, "policy", "blkio", "guesttime", "cguesttime", "startdata", "enddata", "startbrk", "argstart"
, "envend", "exitcode"
]
```

readProcIO - //proc//<pid >//io

/proc/[pid]/io (since kernel 2.6.20)

This file contains I/O statistics for the process, for example:

```
# cat /proc/3828/io
rchar: 323934931
wchar: 323929600
syscr: 632687
syscw: 632675
read\_bytes: 0
write\_bytes: 323932160
cancelled\_write\_bytes: 0
```

The fields are as follows:

rchar: characters read

The number of bytes which this task has caused to be read from storage.
of bytes which this process passed to read(2) and similar system calls.
as terminal I/O and is unaffected by whether or not actual physical disk
read might have been satisfied from pagecache).

wchar: characters written

The number of bytes which this task has caused, or shall cause to be v
caveats apply here as with rchar.

syscr: read syscalls

Attempt to count the number of read I/O operations-that is, system calls
pread(2).

syscw: write syscalls

Attempt to count the number of write I/O operations-that is, system ca
pwrite(2).

\usepackage{verbatim}

read_bytes: bytes read

Attempt to count the number of bytes which this process really did cause
storage layer. This is accurate for block-backed filesystems.

write_bytes: bytes written

Attempt to count the number of bytes which this process caused to be ser

cancelled_write_bytes:

The big inaccuracy here is truncate. If a process writes 1MB to a file, it will in fact perform no writeout. But it will have been accounted of write. In other words: this field represents the number of bytes written to not happen, by truncating pagecache. A task can cause "negative" I/O, truncates some dirty pagecache, some I/O which another task has been write_bytes) will not be happening.

Note: In the current implementation, things are a bit racy on 32-bit systems. process B's /proc/[pid]/io while process B is updating one of these 64-bit counters see an intermediate result.

Permission to access this file is governed by a ptrace access mode PTRACE_MODE_ptrace(2).

```
readProcIO :: IO [Counter]
readProcIO = do
  pid ← getProcessID
  ps0 ← readProcList (pathProcIO pid)
  ps ← return $ zip colnames ps0
  forM ps (\(n,i) → return $ IOCounter n i)
  where
    colnames :: [Text]
    colnames = [ "rchar", "wchar", "syscr", "syscw", "rbytes", "wbytes", "cxwbytes" ]
```

1.4.10 Data

type aliases and empty types

```
type NamedLogItem = LogNamed LogObject
```

Trace

A *Trace* consists of a *TraceContext* and a *TraceNamed* in *m*.

```
type Trace m = (TraceContext, TraceNamed m)
```

TraceNamed

A *TraceNamed* is a specialized Contravariant of type *LogNamed* with payload *LogObject*.

```
type TraceNamed m = BaseTrace m (LogNamed LogObject)
```

LogObject

```

data LogPrims = LogMessage LogItem
  | LogValue Text Integer
  deriving (Generic, Show, ToJSON)
data LogObject = LP LogPrims
  | ObserveOpen CounterState
  | ObserveClose CounterState
  deriving (Generic, Show, ToJSON)

```

TraceTransformer

```

data TraceTransformer = Neutral
  | UntimedTrace
  | NoTrace
  | DropOpening
  | ObservableTrace (Set ObservableInstance)
  deriving (Show)
data ObservableInstance = MonotonicClock
  | MemoryStats
  | ProcessStats
  | IOStats
  deriving (Eq, Ord, Show)

```

TODO *lnName :: Text*
 storing a concatenation of names might be cheaper than rebuilding it for every log message

LogNamed

A *LogNamed* contains of a list of context names and some log item.

```

-- Attach a 'ContextName' to something.
data LogNamed item = LogNamed
  { lnName :: LoggerName
  , lnItem :: item
  } deriving (Show)
deriving instance Generic item  $\Rightarrow$  Generic (LogNamed item)
deriving instance (ToJSON item, Generic item)  $\Rightarrow$  ToJSON (LogNamed item)
-- Attach a 'ContextName' and Katip related info to something.
data LogNamedPlus item = LogNamedPlus
  { lnpName :: LoggerName
  , lnpItem :: item
  } deriving (Show)

```

LogItem

TODO *liPayload* :: *ToObject*

```

-- log item
data LogItem = LogItem
  {liSelection :: LogSelection
  ,liSeverity :: Severity
  ,liPayload :: Text-- TODO should become ToObject
  } deriving (Show, Generic, ToJSON)

-- output selection
data LogSelection =
  Public -- only to public logs.
  | PublicUnsafe-- only to public logs, not console.
  | Private-- only to private logs.
  | Both -- to public and private logs.
  deriving (Show, Generic, ToJSON)

-- severity of log message
data Severity = Debug | Info | Warning | Notice | Error
  deriving (Show, Eq, Ord, Generic, ToJSON)

instance FromJSON Severity where
  parseJSON = withText "severity" $ \case
    "Debug"    → pure Debug
    "Info"     → pure Info
    "Notice"   → pure Notice
    "Warning"  → pure Warning
    "Error"    → pure Error
    _          → pure Info-- catch all

```

Observable

```

data Counter = MonotonicClockTime Text Microsecond
  | MemoryCounter Text Integer
  | StatInfo Text Integer
  | IOCounter Text Integer
  | CpuCounter Text Integer
  deriving (Eq, Show, Generic, ToJSON)

instance ToJSON Microsecond where
  toJSON = toJSON ∘ toMicroseconds
  toEncoding = toEncoding ∘ toMicroseconds

data CounterState = CounterState {
  csIdentifier :: Unique
  ,csCounters :: [Counter]
  }
  deriving (Generic, ToJSON)

```



```

instance ToJSON Unique where
  toJSON = toJSON ◦ hashUnique
  toEncoding = toEncoding ◦ hashUnique
instance Show CounterState where
  show cs = (show ◦ hashUnique) (csIdentifier cs)
    <> " => " <> (show $ csCounters cs)

```

TraceContext

We keep the context's name and a reference to the *TraceController* in the *TraceContext*.

```

type LoggerName = Text
data TraceContext = TraceContext {
  loggerName :: LoggerName
  , controller :: MVar TraceController
}

```

TraceController

TODO replace the *TraceController* with access to ??

```

type TraceTransformerMap = Map LoggerName TraceTransformer
type SeverityMap = Map LoggerName Severity
data TraceController = TraceController {
  traceTransformers :: TraceTransformerMap
  , severityMap :: SeverityMap
  , minSeverity :: Severity
}

```

TraceConfiguration

```

data TraceConfiguration = TraceConfiguration
  { tcOutputKind :: OutputKind
  , tcName :: LoggerName
  , tcTraceTransformer :: TraceTransformer
  , tcSeverity :: Severity
}

```

TraceConfiguration

```

data OutputKind = StdOut
  | TVarList (STM.TVar [LogObject])
  | TVarListNamed (STM.TVar [LogNamed LogObject])
  | Null
deriving Eq

```

Backend

A backend is referenced through the function *pass'* which accepts a ??.

```
data Backend = Backend {pass' :: NamedLogItem → IO ()}
```

ScribeKind

This identifies katip's scribes by type.

```
data ScribeKind = FileTextSK
  | FileJsonSK
  | StdoutSK
  | StderrSK
  | DevNullSK
deriving (Eq, Show)
```

BackendKind

This identifies the backends that can be attached to the ??.

```
data BackendKind = AggregationBK
  | EKGViewBK
  | KatipBK
  | DevNullBK
deriving (Eq, Show)
```

1.4.11 Cardano.BM.Configuration

see Cardano.BM.Configuration.Model for the implementation.

```
getOptionOrDefault :: CM.Configuration → Text → Text → IO (Text)
getOptionOrDefault cg name def = do
  opt ← CM.getOption cg name
  case opt of
    Nothing → return def
    Just o → return o
```

1.4.12 Cardano.BM.Configuration.Model

The configuration is a singleton.

```
-- internal access to the configuration
{-# NOINLINE configuration #-}
configuration :: MVar ConfigurationInternal
configuration = unsafePerformIO do
  newMVar $ error "Configuration MVar is not initialized."
```

```

-- Our internal state
data ConfigurationInternal = ConfigurationInternal
  {cgMapSeverity :: HM.HashMap Text Severity
  ,cgMapOutput  :: HM.HashMap Text [Backend]
  ,cgOptions    :: HM.HashMap Text Aeson.Object
  ,cgMinSeverity :: Severity
  ,cgDefBackends :: [Backend]
  }
-- options:  config.logrotation =  maxFiles = 10; maxSize = 5000000
-- config.logprefix =  path = "/mnt/disk/spacy"
type Configuration = MVar ConfigurationInternal

getBackends :: Text → IO (Maybe [Backend])
getBackends name =
  withMVar configuration $ λcg → do
    let outs = HM.lookup name (cgMapOutput cg)
    case outs of
      Nothing → do
        return $ Just (cgDefBackends cg)
      Just os → return $ Just os

{-defaultBackends :: IO [Backend] defaultBackends = do – read configuration? return [ Backend pass' = C
setDefaultBackends :: [Backend] → IO ()
setDefaultBackends bes = do
  cg ← takeMVar configuration
  putMVar configuration $ cg {cgDefBackends = bes}

registerBackend :: Text → Maybe Backend → IO ()
registerBackend kn f = pure ()-- TODO
  -- registerBackend "some" (Just Backend pass' = Katip.pass (show StdoutSK) )
  -- registerBackend "severe.error" (Just Backend pass' = Katip.pass "StdoutSK::severe.l

getOption :: Configuration → Text → IO (Maybe Text)
getOption mcg name = do
  withMVar mcg $ λcg →
    case HM.lookup name (cgOptions cg) of
      Nothing → return Nothing
      Just o → return $ Just $ pack $ show o

inspectSeverity :: Text → IO (Maybe Severity)
inspectSeverity name =
  withMVar configuration $ λcg →
    return $ HM.lookup name (cgMapSeverity cg)

-- if Maybe Severity given is Nothing then the entry for this name is deleted.
setSeverity :: Text → Maybe Severity → IO ()
setSeverity _name _sev = do

```

```

cg ← takeMVar configuration
putMVar configuration $ cg {cgMapSeverity = HM.update (const _sev) _name (cgMapSeverity cg)}

setup :: Text → IO Configuration
setup _ = do
  _ ← takeMVar configuration
  putMVar configuration $ ConfigurationInternal HM.empty HM.empty HM.empty Debug []
  return configuration

```

1.4.13 Cardano.BM.Aggregated

```

module Cardano.BM.Aggregated
(
  Aggregated(..)
, Stats(..)
, updateAggregation
) where

data Stats = Stats {
  fmin :: Integer,
  fmax :: Integer,
  fcount :: Integer,
  fsum_A :: Integer,
  fsum_B :: Integer
} deriving (Show, Eq)

data Aggregated = Aggregated {
  fstats :: Stats,
  flast :: Integer,
  fdelta :: Stats
} deriving (Show, Eq)

```

Update aggregation

We distinguish an uninitialized from an already initialized aggregation:

```

updateAggregation :: Integer → Maybe Aggregated → Maybe Aggregated
updateAggregation v Nothing =
  Just $
    Aggregated {fstats = Stats {
      fmin = v, fmax = v, fcount = 1
      , fsum_A = v, fsum_B = v * v}
    , flast = v
    , fdelta = Stats {
      fmin = 0, fmax = 0, fcount = 0
      , fsum_A = 0, fsum_B = 0}
    }

```

```

    }
    updateAggregation v (Just (Aggregated (Stats _min _max _count _sumA _sumB)
      _last
      (Stats _dmin _dmax _dcount _dsumA _dsumB)
    )) =
    let delta = v - _last
    in
    Just $
      Aggregated {fstats = Stats {
        fmin = (min _min v)
        ,fmax = (max _max v)
        ,fcount = (_count + 1)
        ,fsum_A = (_sumA + v)
        ,fsum_B = (_sumB + v * v)
      }
        ,flast = v
        ,fdelta = Stats {
          fmin = (min _dmin delta)
          ,fmax = (max _dmax delta)
          ,fcount = (_dcount + 1)
          ,fsum_A = (_dsumA + delta)
          ,fsum_B = (_dsumB + delta * delta)
        }
      }
  }

```

1.4.14 Cardano.BM.Output.Switchboard

State representation

The switchboard is a singleton.

```

-- internal access to the switchboard
{-# NOINLINE switchboard #-}
switchboard :: MVar SwitchboardInternal
switchboard = unsafePerformIO $ do
  newMVar $ error "Switchboard MVar is not initialized."
-- Our internal state
data SwitchboardInternal = SwitchboardInternal
  { sbQueue :: TBQ.TBQueue (Maybe NamedLogItem)
  , sbDispatch :: Async.Async ()
  , sbBackends :: [Backend]
  }

```

Starting the switchboard from configuration

The queue is initialized and the message dispatcher launched. TODO: the backends should be connected according to configuration.

```

setup :: Configuration → IO ()
setup _ = do
  _ ← takeMVar switchboard
  q ← atomically $ TBQ.newTBQueue 2048
  d ← spawnDispatcher q
  -- TODO connect backends according to configuration
  let be = [ Backend {pass' = Katip.pass "StdoutSK"} ]
  putMVar switchboard $ SwitchboardInternal q d be
spawnDispatcher :: TBQ.TBQueue (Maybe NamedLogItem) → IO (Async.Async ())
spawnDispatcher queue = Async.async qProc
  where
    qProc = do
      nli' ← atomically $ TBQ.readTBQueue queue
      case nli' of
        Just nli → do
          putStrLn $ "dispatcher read: " ++ (show nli)
          withMVar switchboard $ λsb →
            forM_ (sbBackends sb) (dispatch nli)
          qProc
        Nothing → return () -- end dispatcher
    dispatch :: NamedLogItem → Backend → IO ()
    dispatch nli backend = (pass' backend) nli

```

Process incoming messages

Incoming messages are put into the queue, and then processed by the dispatcher.

```

pass :: NamedLogItem → IO ()
pass item = do
  putStrLn $ "Cardano.BM.Output.Switchboard.pass " ++ (show item)
  withMVar switchboard $ λsb →
    atomically $ writequeue (sbQueue sb) item
  where
    writequeue :: TBQ.TBQueue (Maybe NamedLogItem) → NamedLogItem → STM ()
    writequeue q i = do
      nocapacity ← TBQ.isFullTBQueue q
      if ¬nocapacity
      then TBQ.writeTBQueue q (Just i)
      else return ()

```

Halting the switchboard

The queue is flushed before the dispatcher terminates.

```

takedown :: IO ()
takedown = do
  (q,d) ← withMVar switchboard $ λsb →

```

```

    return (sbQueue sb, sbDispatch sb)
-- send terminating item to the queue
atomically $ TBQ.writeTBQueue q Nothing
-- wait for the dispatcher to exit
_ ← Async.waitCatch d
return ()

```

1.4.15 Cardano.BM.Output.Katip

Katip is a singleton.

```

-- internal access to katip
{-# NOINLINE katip #-}
katip :: MVar KatipInternal
katip = unsafePerformIO $ do
    newMVar $ error "Katip MVar is not initialized."
-- Our internal state
data KatipInternal = KatipInternal
    { kLogEnv :: K.LogEnv }

```

Setup *katip* and its scribes according to the configuration

```

setup :: Config.Configuration → IO ()
setup config = do
    setDefaultBackends [ Backend { pass' = Cardano.BM.Output ∘ Katip.pass (pack (show StdoutSK)) }
                        , Backend { pass' = Cardano.BM.Output ∘ Katip.pass (pack (show FileTextSK)) }
                        , Backend { pass' = Cardano.BM.Output ∘ Katip.pass (pack (show FileJsonSK)) }
                        ]
    cfoKey ← Config.getOptionOrDefault config (pack "cfokey") (pack "<unknown>")
    -- TODO setup katip
    le0 ← K.initLogEnv
        (K.Namespace [ "ouroboros-bm" ])
        (fromString $ (unpack cfoKey) <> " : " <> showVersion mockVersion)
    -- request a new time 'getCurrentTime' at most 100 times a second
    timer ← mkAutoUpdate defaultUpdateSettings { updateAction = getCurrentTime, updateFreq = 10000 }
    let le1 = updateEnv le0 timer
    stdoutScribe ← mkStdoutScribeJson K.V0
    le ← register [ (StdoutSK, "stdout", stdoutScribe) ] le1
    _ ← takeMVar katip
    putMVar katip $ KatipInternal le
where
    updateEnv :: K.LogEnv → IO UTCTime → K.LogEnv
    updateEnv le timer =
        le { K._logEnvTimer = timer, K._logEnvHost = "hostname" }
    register :: [ (ScribeKind, Text, K.Scribe) ] → K.LogEnv → IO K.LogEnv
    register [ ] le = return le
    register ((kind, name, scribe) : scs) le =
        let name' = pack (show kind) <> " : " <> name in

```

```

    register scs ≡ K.registerScribe name' scribe scribeSettings le
mockVersion :: Version
mockVersion = Version [0,1,0,0] []
scribeSettings :: KC.ScribeSettings
scribeSettings = KC.ScribeSettings bufferSize
  where
    bufferSize = 5000 -- size of the queue (in log items)

example :: IO ()
example = do
  config ← Config.setup "from_some_path.yaml"
  setup config
  pass (pack (show StdoutSK)) $ LogNamed
    {lnName = "test"
    ,lnItem = LP $ LogMessage $ LogItem
      {liSelection = Both
      ,liSeverity = Info
      ,liPayload = "Hello!"
      }
    }
  pass (pack (show StdoutSK)) $ LogNamed
    {lnName = "test"
    ,lnItem = LP $ LogValue "cpu-no" 1
    }

-- useful instances for Katip
deriving instance K.ToObject LogObject
deriving instance K.ToObject LogItem
deriving instance K.ToObject (Maybe LogObject)
instance KC.LogItem LogObject where
  payloadKeys _ = KC.AllKeys
instance KC.LogItem LogItem where
  payloadKeys _ = KC.AllKeys
instance KC.LogItem (Maybe LogObject) where
  payloadKeys _ = KC.AllKeys

pass :: Text → NamedLogItem → IO ()
pass backend namedLogItem = withMVar katip $ λk → do
  -- TODO go through list of registered scribes
  -- and put into queue of scribe if backend kind matches
  -- compare start of name of scribe to (show backend <> "::")
  let env = kLogEnv k
  forM_ (Map.toList $ K._logEnvScribes env) $
    λ(scName, (KC.ScribeHandle _ shChan)) →
      -- check start of name to match ScribeKind
      if backend `isPrefixOf` scName

```



```

then do
  let item = lnItem namedLogItem
  let (sev,msg,payload) = case item of
    (LP (LogMessage logItem)) →
      (liSeverity logItem,liPayload logItem,Nothing)
    _ → (Info,"",Just item)
  threadIdText ← KC.mkThreadIdText < $ > myThreadId
  let ns = lnName namedLogItem
  itemTime ← env ^. KC.logEnvTimer
  let itemKatip = K.Item {
    _itemApp      = env ^. KC.logEnvApp
    ,_itemEnv     = env ^. KC.logEnvEnv
    ,_itemSeverity = sev2klog sev
    ,_itemThread  = threadIdText
    ,_itemHost    = env ^. KC.logEnvHost
    ,_itemProcess = env ^. KC.logEnvPid
    ,_itemPayload = payload
    ,_itemMessage = K.logStr msg
    ,_itemTime    = itemTime
    ,_itemNamespace = (env ^. KC.logEnvApp) <> (K.Namespace [ ns ])
    ,_itemLoc     = Nothing
  }
  atomically $ KC.tryWriteTBQueue shChan (KC.NewItem itemKatip)
else return False

```

Scribes

```

mkStdoutScribe :: K.Verbosity → IO K.Scribe
mkStdoutScribe = mkTextFileScribeH stdout True
mkStdoutScribeJson :: K.Verbosity → IO K.Scribe
mkStdoutScribeJson = mkJsonFileScribeH stdout True
mkStderrScribe :: K.Verbosity → IO K.Scribe
mkStderrScribe = mkTextFileScribeH stderr True
mkJsonFileScribeH :: Handle → Bool → K.Verbosity → IO K.Scribe
mkJsonFileScribeH handler color verb = do
  mkFileScribeH handler formatter color verb
where
  formatter :: (K.LogItem a) ⇒ Handle → Bool → K.Verbosity → K.Item a → IO ()
  formatter h _ verbosity item = do
    let tmsg = case KC._itemMessage item of
      K.LogStr "" → K.itemJson verbosity item
      K.LogStr msg → K.itemJson verbosity $
        item { KC._itemMessage = K.logStr (" " :: Text)
          , KC._itemPayload = LogItem Both Info $ toStrict $ toLazyText msg
        }
    TIO.hPutStrLn h (encodeToLazyText tmsg)

```

```

mkTextFileScribeH :: Handle → Bool → K.Verbosity → IO K.Scribe
mkTextFileScribeH handler color verb = do
    mkFileScribeH handler formatter color verb
  where
    formatter h colorize verbosity item =
      TIO.hPutStrLn h $! toLazyText $ formatItem colorize verbosity item
mkFileScribeH
  :: Handle
  → (forall a ◦ K.LogItem a ⇒ Handle → Bool → K.Verbosity → K.Item a → IO ()) -- format and output f
  → Bool -- whether the output is colourized
  → K.Verbosity
  → IO K.Scribe
mkFileScribeH h formatter colorize verbosity = do
  hSetBuffering h LineBuffering
  locklocal ← newMVar ()
  let logger :: forall a ◦ K.LogItem a ⇒ K.Item a → IO ()
      logger item = withMVar locklocal $ \_ →
        formatter h colorize verbosity item
  pure $ K.Scribe logger (hClose h)
mkTextFileScribe :: FileDescription → Bool → Severity → K.Verbosity → IO K.Scribe
mkTextFileScribe fdesc colorize s v = do
  mkFileScribe fdesc formatter colorize s v
  where
    formatter :: Handle → Bool → K.Verbosity → K.Item a → IO ()
    formatter hdl colorize' v' item = do
      let tmsg = toLazyText $ formatItem colorize' v' item
      TIO.hPutStrLn hdl tmsg
mkFileScribe
  :: FileDescription
  → (forall a ◦ K.LogItem a ⇒ Handle → Bool → K.Verbosity → K.Item a → IO ()) -- format and output f
  → Bool -- whether the output is colourized
  → Severity
  → K.Verbosity
  → IO K.Scribe
mkFileScribe fdesc formatter colorize _ v = do
  let prefixDir = prefixPath fdesc
  (createDirectoryIfMissing True prefixDir)
  'catchIO' (prtoutException ("cannot log prefix directory: " ++ prefixDir))
  let fpath = filePath fdesc
  h ← catchIO (openFile fpath WriteMode) $
    λe → do
      prtoutException ("error while opening log: " ++ fpath) e
      -- fallback to standard output in case of exception
      return stdout
  hSetBuffering h LineBuffering
  scribestate ← newMVar h
  let finalizer :: IO ()

```

```

    finalizer = withMVar scribestate hClose
let logger :: forall a . K.LogItem a => K.Item a -> IO ()
    logger item =
        withMVar scribestate $ \handler ->
            formatter handler colorize v item
return $ K.Scribe logger finalizer

formatItem :: Bool -> K.Verbosity -> K.Item a -> Builder
formatItem withColor _verb K.Item {..} =
    fromText header <>
    fromText " " <>
    brackets (fromText timestamp) <>
    fromText " " <>
    KC.unLogStr _itemMessage
where
    header = colorBySeverity _itemSeverity $
        "[ " <> mconcat namedcontext <> ":" <> severity <> ":" <> threadid <> " ]"
    namedcontext = KC.intercalateNs _itemNamespace
    severity = KC.renderSeverity _itemSeverity
    threadid = KC.getThreadIdText _itemThread
    timestamp = pack $ formatTime defaultTimeLocale tsformat _itemTime
    tsformat :: String
    tsformat = "%F %T%2Q %Z"
    colorBySeverity s m = case s of
        K.EmergencyS -> red m
        K.AlertS      -> red m
        K.CriticalS   -> red m
        K.ErrorS      -> red m
        K.NoticeS     -> magenta m
        K.WarningS    -> yellow m
        K.InfoS       -> blue m
        _ -> m
    red = colorize "31"
    yellow = colorize "33"
    magenta = colorize "35"
    blue = colorize "34"
    colorize c m
        | withColor = "\ESC[" <> c <> "m" <> m <> "\ESC[0m"
        | otherwise = m
-- translate Severity to Katip.Severity
sev2klog :: Severity -> K.Severity
sev2klog = \case
    Debug -> K.DebugS
    Info -> K.InfoS
    Notice -> K.NoticeS
    Warning -> K.WarningS
    Error -> K.ErrorS

```

```

data FileDescription = FileDescription {
  filePath :: !FilePath}
  deriving (Show)

prefixPath :: FileDescription → FilePath
prefixPath = takeDirectory ∘ filePath

-- display message and stack trace of exception on stdout
prtoutException :: Exception e ⇒ String → e → IO ()
prtoutException msg e = do
  putStrLn msg
  putStrLn ("exception: " ++ displayException e)

```

1.4.16 Cardano.BM.Output.Aggregation

The aggregation is a singleton.

```

-- internal access to the aggregation
{-# NOINLINE aggregation #-}
aggregation :: MVar AggregationInternal
aggregation = unsafePerformIO $ do
  newMVar $ error "Aggregation MVar is not initialized."

-- Our internal state
data AggregationInternal = AggregationInternal
  { agMap :: HM.HashMap Text Aggregated
  , agSome :: [Int] -- TODO
  }

inspect :: Text → IO (Maybe Aggregated)
inspect name =
  withMVar aggregation $ \ag →
    return $ HM.lookup name (agMap ag)

setup :: Configuration → IO ()
setup _ = do
  _ ← takeMVar aggregation
  -- TODO create thread which will periodically output
  -- aggregated values to the switchboard
  putMVar aggregation $ AggregationInternal HM.empty []

pass :: NamedLogItem → IO ()
pass item = do
  ag ← takeMVar aggregation
  putMVar aggregation $ AggregationInternal (updated $ agMap ag) (agSome ag)
where
  updated agmap = pass' (lnItem item) (lnName item) agmap
  pass' :: LogObject → LoggerName → HM.HashMap Text Aggregated → HM.HashMap Text Aggregated

```

```
pass' (LP (LogValue iname value)) logname agmap =  
  let name = logname <> "." <> iname  
  in  
    HM.alter ( $\lambda m \rightarrow \text{updateAggregation value } m$ ) name agmap  
-- TODO for text messages aggregate on delta of timestamps  
pass' -- agmap = agmap
```