dbg/ttb

The Erlang text based tracer and trace tool builder

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What we will cover ...

1. dbg Introduction and Basics
2. Match Specifications
3. dbg Extended
4. ttb Introduction and Basics
5. Where to go from here ...

1

dbg Introduction and Basics

Getting started

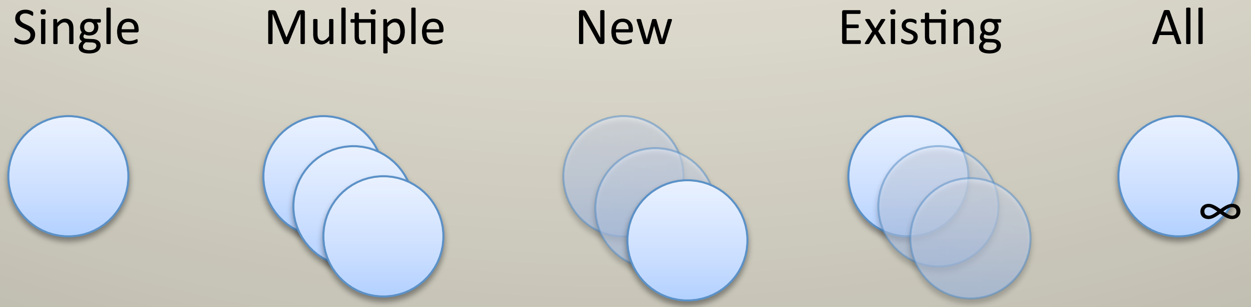
dbg Introduction and Basics

`dbg` is ...

- A textbased tracer
- Suitable for low level tracing in the shell
- Built on the trace BIFs (no “trace-compile”)
- Small system impact (if done right)
- Flexible and extendable
- Part of the `runtime_tools` application

dbg Introduction and Basics

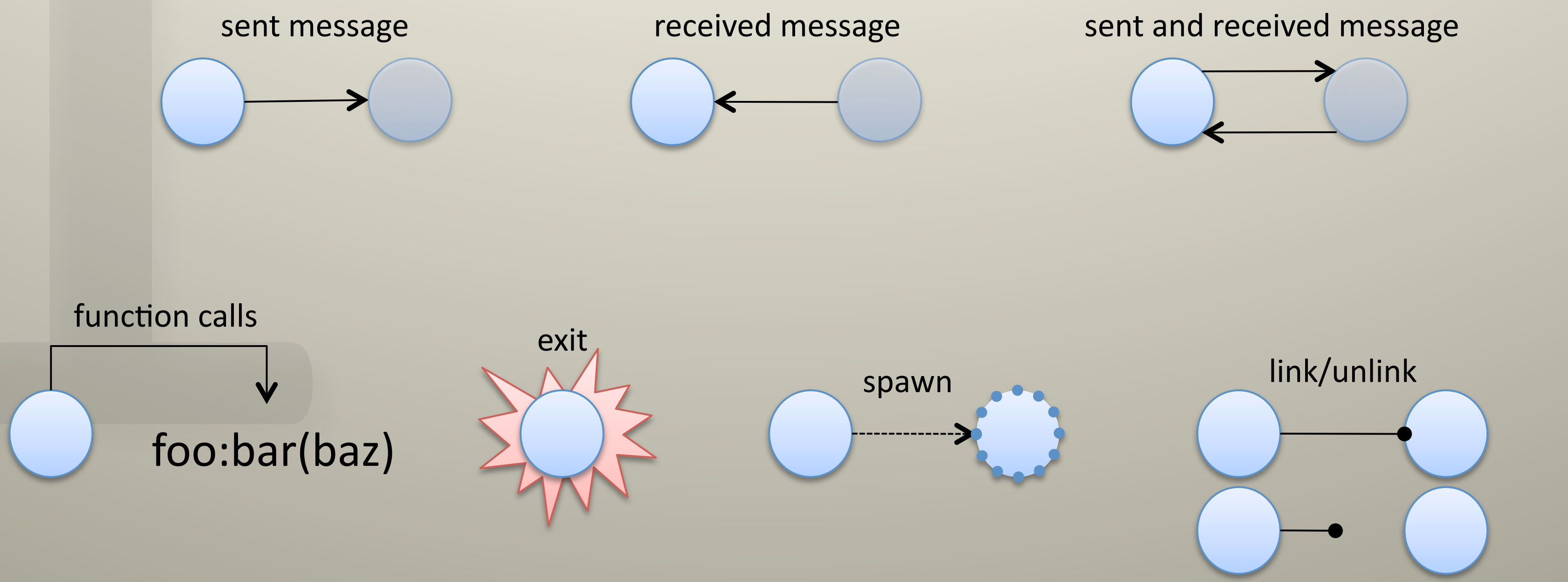
First of all:
We only trace processes!



We **don’t** trace functions!

dbg Introduction and Basics

Each trace has flags for what behaviour to trace on, E.g ...



sent message

received message

sent and received message

function calls

foo:bar(baz)

exit

spawn

link/unlink

and more ...

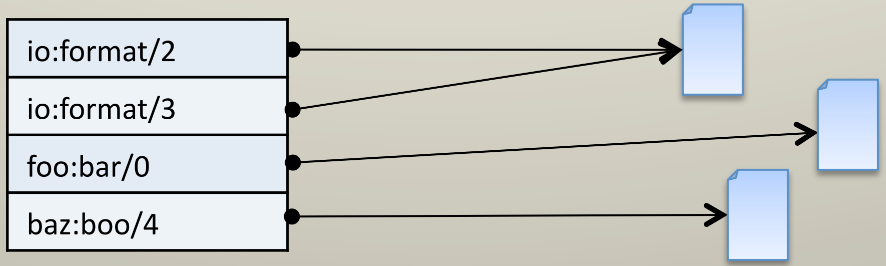
dbg Introduction and Basics

A trace emits trace messages,
one process receives these messages

This process is usually the `dbg` process
(but can be another one)

dbg Introduction and Basics

When tracing calls, a pattern table is created to know which module, function and arity to react on



io:format/2

io:format/3

foo:bar/0

baz:boo/4

A match specification is then used to perform some additional checks, filtrations and side effects *when a trace has been triggered*

dbg Introduction and Basics

A typical way to use `dbg`

1. Start the tracer process
2. Specify which processes to trace and how (using flags)
3. Specify *trace patterns* and *match specifications*
4. Observe trace
5. Clear the traces
6. Stop the tracer process

dbg Introduction and Basics

1. Start the tracer process
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`dbg:tracer()`

- Starts a process that will recieve all the trace messages
- Only one can be active on local node
- Only one will receive trace messages in a cluster
- No options simply prints out the trace using `io:format`

```
> dbg:tracer().
{ok,<0.33.0>}
```

dbg Introduction and Basics

1. Start *the* tracer process
2. Specify which processes to trace and how (using flags)
3. Specify *trace patterns* and *match specifications*
4. Run/Observe trace
5. Clear the traces
6. Stop the tracer process

```
dbg:p(Item, FlagList)
```

- Defines a trace for a process (`p` for process?)
- `Item` is a term that identifies one or more processes
- `FlagList` is a list of options to enable in the trace
- Comes into effect immediately

dbg Introduction and Basics

1. Start *the* tracer process
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`dbg:p(`**`Item,`**` FlagList)`

`Item` can be one of the following:

- `pid()`
- `all`, `new` or `existing`
- A Registered name (except for mentioned keywords)
- An integer (meaning `<0.int().0>`)
- `{X,Y,Z}` or "`<X.Y.Z>`" (meaning `<X.Y.Z>`)

dbg Introduction and Basics

1. Start *the* tracer process
2. Specify which processes to trace and how (using flags)
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4. Run/Observe trace
5. Clear the traces
6. Stop the tracer process

```
dbg:p(Item, FlagList)
```

`FlagList` is a list of zero or more of:

- `s` – Sending messages
- `r` – Receiving messages
- `m` – Sending and receiving messages
- `c` – Calls to functions
- `p` – Process related events (spawn, links etc)
- `so[f]s` – Set on [first] spawn. Inherit flags for new processes
- `so[f]l` – Set on [first] link. Inherit flags when linking new process
- `all` – Set all flags
- `clear` – Clear all flags

dbg Introduction and Basics

1. Start *the* tracer process
2. Specify which processes to trace and how (using flags)
3. Specify *trace patterns* and *match specifications*
4. Run/Observe trace
5. Clear the traces
6. Stop the tracer process

```
dbg:p(Item, FlagList)
```

`FlagList` can also include what ever `erlang:trace/2` accepts:

- `running` – Process scheduling
- `garbage_collection` – When GC occurs
- `timestamp` – Attach a timestamp to the trace
- `arity` – Shows arity instead of argument

See documentation for more options

dbg Introduction and Basics

1. Start *the* tracer process
2. Specify which processes to trace and how (using flags)
3. Specify *trace patterns* and *match specifications*
4. Run/Observe trace
5. Clear the traces
6. Stop the tracer process

```
dbg:p(Item, FlagList)
```

- returns `{ok, [{matched, Node, N}]}`
- Shows how many processes `N` that matched on each node `Node`
- More on how to add nodes later.

dbg Introduction and Basics

1. Start *the* tracer process
2. Specify which processes to trace and how (using flags)
3. Specify *trace patterns* and *match specifications*
4. Run/Observe trace
5. Clear the traces
6. Stop the tracer process

`dbg:p(Item, FlagList)`

```
> dbg:p(self(), [m, timestamp]).
...
{ok,[{matched,nonode@nohost,1}]}
```

```
> dbg:p(self(), [garbage_collection]).
{ok,[{matched,nonode@nohost,1}]}
> ls().
...
```

```
> dbg:p(all, [c, timestamp]).
{ok,[{matched,nonode@nohost,26}]}
```

Use the flag `clear` in between the examples

dbg Introduction and Basics

1. Start *the* tracer process
2. Specify which processes to trace and how (using flags)
3. Specify *trace patterns* and *match specifications*
4. Run/Observe trace
5. Clear the traces
6. Stop the tracer process

A word of advice ...

Know what you are tracing, think before you trace!

```
> dbg:p(all, [m]).
...
```

Before you run this ... tell me what you think it does.

dbg Introduction and Basics

1. Start *the* tracer process
2. Specify which processes to trace and how (using flags)
3. Specify *trace patterns* and *match specifications*
4. Run/Observe trace
5. Clear the traces
6. Stop the tracer process

```
dbg:tp({Module, Function, Arity}, MatchSpec)
```

- Defines a trace pattern (`tp`) for global calls
- For local calls use `dbg:tpl`
- Only useful when used together with the `call` flag
- Multiple trace patterns can be defined

dbg Introduction and Basics

1. Start *the* tracer process
2. Specify which processes to trace and how (using flags)
3. Specify *trace patterns* and *match specifications*
4. Run/Observe trace
5. Clear the traces
6. Stop the tracer process

```
dbg:tp({Module, Function, Arity}, MatchSpec)
```

- Module has to be specified
- Wildcards are `{M,F,'_'}` and `{M,'_','_'}`
- No other combination allowed e.g. `{'_',F, '_'}`

Alternative API

```
dbg:tp(Module, Function, Arity, MatchSpec)
dbg:tp(Module, Function, MatchSpec)
dbg:tp(Module, MatchSpec)
```

dbg Introduction and Basics

1. Start *the* tracer process
2. Specify which processes to trace and how (using flags)
3. Specify *trace patterns* and *match specifications*
4. Run/Observe trace
5. Clear the traces
6. Stop the tracer process

`dbg:tp({Module, Function, Arity}, MatchSpec)`

- Will be described later. Use `[]` for now.

dbg Introduction and Basics

1. Start *the* tracer process
2. Specify which processes to trace and how (using flags)
3. Specify *trace patterns* and *match specifications*
4. Run/Observe trace
5. Clear the traces
6. Stop the tracer process

```
dbg:tp({Module, Function, Arity}, MatchSpec)
```

- returns `{ok, [{matched, Node, N}]}`
- Shows how many functions `N` that matched on each node `Node`
- More on how to add nodes later.

dbg Introduction and Basics

1. Start *the* tracer process
2. Specify which processes to trace and how (using flags)
3. Specify *trace patterns* and *match specifications*
4. Run/Observe trace
5. Clear the traces
6. Stop the tracer process

```
dbg:ctp({Module, Function, Arity})
dbg:p(Item, clear)
```

- First command clears the patterns but not the traces
- Second command stops the traces (using the `clear` flag)
- Return the same format as when setting traces/patterns I.e. `{ok, [{matched, Node, N}]}`
- Use `dbg:stop/0`, `dbg:stop_clear/0` to stop the tracer process

Exercises

1. Compile the file `traceme.erl` and load the beam
2. Run: `{P1, P2} = traceme:init/0`
3. Enable tracing you think will answer the questions
4. Run `traceme:runit({P1, P2})` and then `traceme:stopit({P1, P2})`
5. Clear trace and repeat for each in the following list

Using tracing ...

- What functions in `traceme` are being called by the shell process?
- What messages that are sent to and from `P1` and `P2`?
- How often is garbage collection run on each processes
- How long does it take between the two calls the shell does to `init/2`

2

Match Specifications

What and how

Match Specifications

A Match Specification (MS) is ...

- A set of Erlang terms describing a small "program"
- The purpose is to, using this "program", to match input data
    - `dbg` call traces
    - `ets` objects

  and decide on output/actions to take
- More efficient than calling Erlang functions
- Limited in functionality and performs only a few actions
- If the MS match, one or more trace events will be sent

Match Specifications

Matching is done in three steps

```
MatchSpec = [{MatchHead, MatchConditions, MatchBody}]
```

1. Bind variables (`MatchHead`)
2. Check against conditions (`MatchConditions`)
3. Perform actions (`MatchBody`)

Match Specifications

1. Bind variables (`MatchHead`)
2. Check against conditions (`MatchConditions`)
3. Perform actions (`MatchBody`)

`{`**`MatchHead`**`, MatchConditions, MatchBody}`

- A list of values/terms and/or variables; the length of this list must be equal to the arity of the function being matched on
- Matches (binds) variables in the form of `'$N'`
  - `N = 1 ... 100000000` (Doubt you will need it though)
- E.g. `['$1', '$2']` to match function `foo:bar("baz", 3)`
- `'_'` can be used to ignore individual arguments
  - E.g. `['_', '$2']`, `['_', '_']`, `['$1', '_']`
- `'$N'` doesn't have to be in order (E.g. 1, 2, 3 ...)
- `'_'` can be used to ignore the whole MatchHead

Match Specifications

1. Bind variables (`MatchHead`)
2. Check against conditions (`MatchConditions`)
3. Perform actions (`MatchBody`)

```
{MatchHead, MatchConditions, MatchBody}
```

Examples

Function call	MatchHead	Match?
`io:format("hi~n",[])`	`'_'`	`Yes`
`erlang:max(3, 5)`	`[3, '$2']`	`Yes: '$2'==5`
`erlang:now()`	`['$1']`	`No`
`gen_tcp:listen(8000, [binary])`	`['$1', '$2','$3']`	`No`
`erlang:size({one, two})`	`['_']`	`Yes`
`lists:foldl(fun foo/2, [], [1,2,3])`	`['_','$1','_']`	`Yes: '$1'==[]`
`erlang:max(6, 6)`	`['$1', '$1']`	`Yes: '$1'==6`

Match Specifications

1. Bind variables (`MatchHead`)
2. Check against conditions (`MatchConditions`)
3. Perform actions (`MatchBody`)

```
{MatchHead, MatchConditions, MatchBody}
```

- A list of terms to where each one is a matching condition
- Evaluates to either `true` or `false`
- Uses previously bound variables only, no new can be bound
- Only guard functions allowed: `is_integer`, `hd`, `length`, `'>='`
- Functions are specified as a tuple E.g. `{hd, '$1'}`
- Literal tuples are written as: `{{a, b}}`
- Can be nested to perform more complex expressions
- All conditions must evaluate to `true`
- `[]` == No conditions == `true`
- All function names that are language constructs must use single quotes such as `'>'`, `'=='` and `'+'`
- See documentation for full list

Match Specifications

1. Bind variables (MatchHead)
2. Check against conditions (MatchConditions)
3. Perform actions (MatchBody)

```
{MatchHead, MatchConditions, MatchBody}
```

Examples

Function arguments	MatchHead	Condition	Match?
f("",[1])	['_','$1']	[{is_integer, '$1'}]	false
f("",[6])	['_', ['$1']]	[{'<', 5, '$1'}]	true
f(52)	['$1']	[{'==',{rem, 5, '$1'}, 2}]	true
f({["4"]})	'_'	[true]	true
f({["4"]})	'_'	[false]	false
f(52)	['$1']	[{is_integer,'$1'},{'>','$1',0}]	true
f(0)	'_'	[]	true

Match Specifications

1. Bind variables (`MatchHead`)
2. Check against conditions (`MatchConditions`)
3. Perform actions (`MatchBody`)

```
{MatchHead, MatchConditions, MatchBody}
```

- A list of terms where each is an action to perform
- Only when `MatchHead` and `MatchConditions` succeeded
- Actions include
  - Sending messages
  - Printing to stdout
  - Enabling/Disabling additional flags/traces
  - Returning trace information
- Can include conditional expressions
- Literal tuples are written as: `{{a, b}}`
- Actions must always be tuples even if they are of arity 1

Match Specifications

1. Bind variables (`MatchHead`)
2. Check against conditions (`MatchConditions`)
3. Perform actions (`MatchBody`)

`{MatchHead, MatchConditions,` **`MatchBody`**`}`

Action	Description
`{message , term()}`	Appends term() to the trace message
`{return_trace}`	Generates a trace message when the call returns from the function (breaks tail-recursion)
`{enable_trace, TraceFlag} / {enable_trace, Pid, TraceFlag}`	Enables a trace for the given Pid if specified, otherwise self()
`{disable_trace, TraceFlag} / {disable_trace, Pid, TraceFlag}`	Disables a trace for the given Pid if specified, otherwise self()
`{caller}`	Returns the `{M,F,A}` of the function the current function was called from (used with `message`)
`{process_dump}`	Returns a binary textual representation about the current process (used with `message`)
`{display, term()}`	Prints term() out to the stdout

Match Specifications

1. Bind variables (MatchHead)
2. Check against conditions (MatchConditions)
3. Perform actions (MatchBody)

Match Specifications Examples

```
> dbg:tracer().
{ok,<0.430.0>}
250> dbg:p(self(), [c, arity, timestamp]).
{ok,[{matched,nonode@nohost,1}]}
251> dbg:tp(traceme, foo, [{['$1'], [{'>', '$1', 5}], []}]).
{ok,[{matched,nonode@nohost,1},{saved,1}]}
252> traceme:foo(1). %% Not greater than 5
ok
253> traceme:foo(6). %% Greater than 5
ok
(<0.297.0>) call traceme:foo/1 (Timestamp: {1289,134618,807870})
```

Match Specifications

1. Bind variables (MatchHead)
2. Check against conditions (MatchConditions)
3. Perform actions (MatchBody)

Match Specifications Examples

```
> dbg:p(all,clear), dbg:ctp().
{ok,[{matched,nonode@nohost,8830}]}
> dbg:p(self(), [c]).
{ok,[{matched,nonode@nohost,1}]}
> dbg:tp(traceme, bar, [{['$1', '$2'], [{'andalso', {'>=', '$1', 5}, {'not',
{'is_list', '$2'}}}], []}]).
{ok,[{matched,nonode@nohost,1},{saved,2}]}
> traceme:bar(6, {hej}). %% First argument > 4 and second argument not a list
(<0.297.0>) call traceme:bar(6,{hej})
ok
> traceme:bar(6, []). %% Second argument is a list
ok
```

Match Specifications

1. Bind variables (MatchHead)
2. Check against conditions (MatchConditions)
3. Perform actions (MatchBody)

Match Specifications Examples

```
> dbg:p(all,clear), dbg:ctp().
{ok,[{matched,nonode@nohost,8830}]}
> dbg:p(self(), [c, timestamp]).
{ok,[{matched,nonode@nohost,1}]}
> dbg:tp(traceme, baz, [{['_', '_', '$7000'], [{'==', {'element', 1, '$7000'}, ok}],
[{message,{'element',2,'$7000'}}, {return_trace}]}]).
> {ok,[{matched,nonode@nohost,1},{saved,3}]}
> traceme:baz(1,2,3). %% Not tuple but doesn't crash
ok
> traceme:baz(1,2,{ok, msg}). %% Tuple and first element is ok
(<0.297.0>) call traceme:baz(1,2,{ok,msg}) (msg) (Timestamp: {1289,135992,580490})
(<0.297.0>) returned from traceme:baz/3 -> ok (Timestamp: {1289,136400,564081})
>
```

Match Specifications

1. Bind variables (`MatchHead`)
2. Check against conditions (`MatchConditions`)
3. Perform actions (`MatchBody`)

```
dbg:fun2ms(LiteralFun) -> MatchSpec
```

- `LiteralFun` is a fun which is replaced by a Match Specification at compile time
- `LiteralFun` must be declared in the call to `fun2ms`
- The fun translate to different parts of the MS
  - Funtion header translates to `MatchHead` (same rules)
  - Variables are named in a normal way (`A`, `Var` etc ...)
  - Guards allowed and translated into `MatchConditions`
  - Function body translates into `MatchBody`
  - MS functions are written as *`function()`*; E.g. `message()` and `return_trace()` etc

Match Specifications

1. Bind variables (MatchHead)
2. Check against conditions (MatchConditions)
3. Perform actions (MatchBody)

Examples

```
> dbg:fun2ms(fun([A, B]) when is_list(A) andalso is_integer(B) -> message(caller()) end).
[{['$1','$2'],
  [{'andalso',{is_list,'$1'},{is_integer,'$2'}}],
  [{message,{caller}}]}]

> dbg:fun2ms(fun(_) -> return_trace() end).
[{'_',[],[{return_trace}]}]

> dbg:fun2ms(fun([A, A]) -> ok end).
[{['$1','$1'],[],[ok]}]

> dbg:fun2ms(fun([A, B]) when A > B -> enable_trace(garbage_collection) end).
[{['$1','$2'],
  [{'>','$1','$2'}],
  [{enable_trace,garbage_collection}]}]
```

Do not affect tracing

Exercises

1. Compile the file `traceme.erl` and load the beam
2. Run: `{P1, P2} = traceme:init/0`
3. Enable tracing you think will answer the questions
4. Run `traceme:randit({P1, P2})` and then `traceme:stopit({P1, P2})`
5. Clear trace and repeat for each in the following list

Using tracing ...

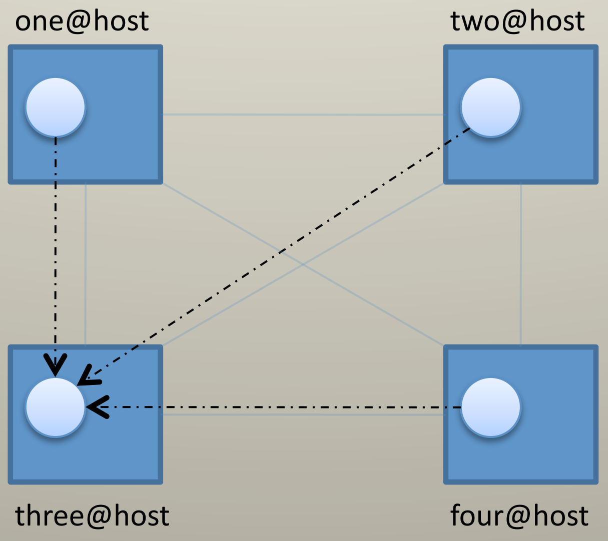
- How long do the `init/2` and `ping/1` functions take to complete (approx)
- What are the return values of the functions being called
- What data is in the process dump binary (display it or return it)
- Trace shell's calls to the traceme:rand1/1 but only show those where the first argument is greater than 400
- Trace shell's calls to the traceme:rand2/1 but only show those where the second element in the argument is less than 100

3 dbg Extended

Handling trace messages manually; tracing to a file or port and tracing in a multinode environment

dbg Extended

Distributed tracing
A cluster can be traced with output going to one node

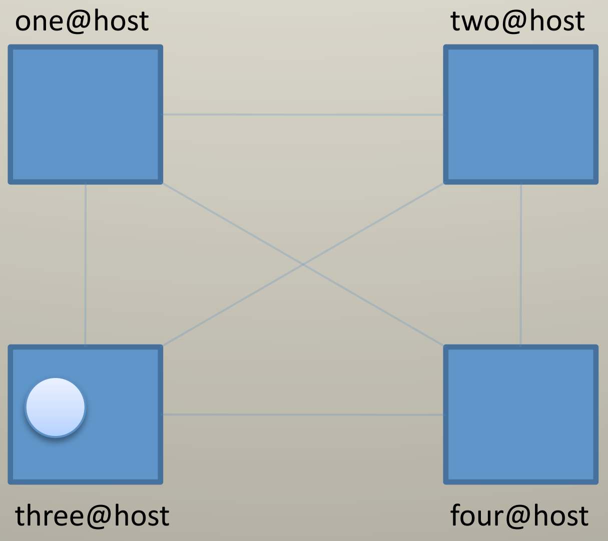


dbg Extended

Distributed tracing

Start a tracer

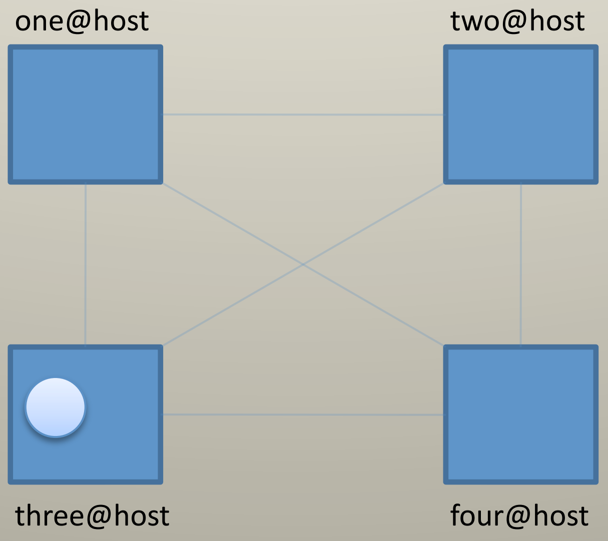
```
dbg:tracer()
```



dbg Extended

Distributed tracing
Add nodes to the list of nodes to start traces on

```
dbg:n(Node)
```



```
[one@host, two@host, four@host]
```

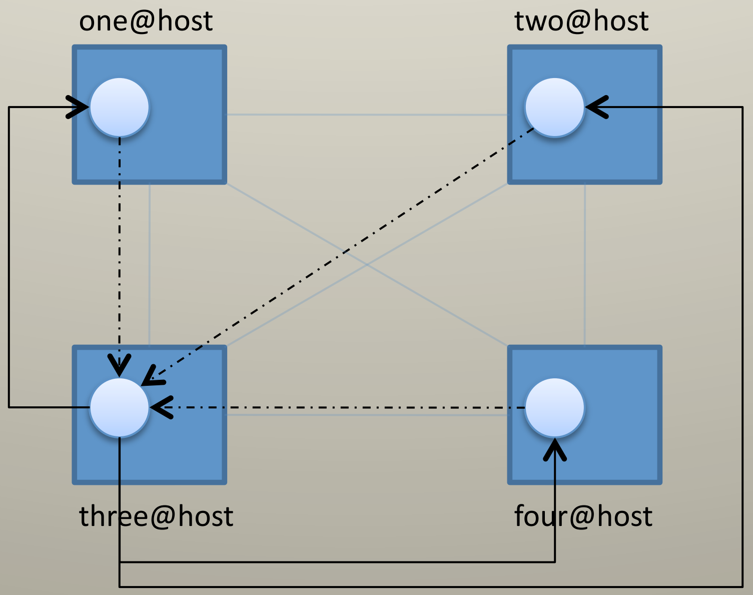
```
dbg:cn(Node) - Removes a node from list
dbg:ln() - List all nodes
```

dbg Extended

Distributed tracing

When a trace starts it will start on all known nodes

```
dbg:p(Item, Flags)
```



Executed on each node

dbg Extended

Distributed tracing; Example

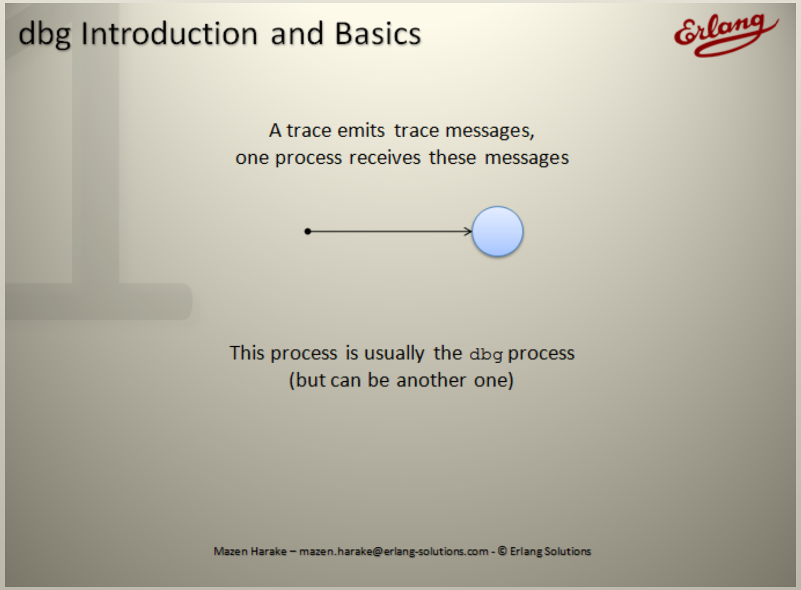
```
1> net_kernel:start([foo, shortnames]).
{ok,<0.33.0>}
(foo@Pasha)2> dbg:tracer().
{ok,<0.40.0>}
(foo@Pasha)3> dbg:n(bar@Pasha).
{ok,bar@Pasha}
(foo@Pasha)4> dbg:p(all, c).
{ok,[{matched,bar@Pasha,34},
     {matched,foo@Pasha,35}]}
(foo@Pasha)5> dbg:tp(traceme, foo, []).
{ok,[{matched,bar@Pasha,1},
     {matched,foo@Pasha,1}]}
(foo@Pasha)6>
(<6566.31.0>) call traceme:foo(bar@Pasha)
(foo@Pasha)6> traceme:foo(node()).
ok
(<0.31.0>) call traceme:foo(foo@Pasha)
(foo@Pasha)7>
```

```
1> net_kernel:start([bar, shortnames]).
{ok,<0.33.0>}
(bar@Pasha)2> traceme:foo(node()).
ok
(bar@Pasha)3>
```

Make sure all nodes have relevant code loaded when using `dbg:tp/2,3,4`

dbg Extended

Remember this?



dbg Introduction and Basics

A trace emits trace messages,
one process receives these messages

This process is usually the `dbg` process
(but can be another one)

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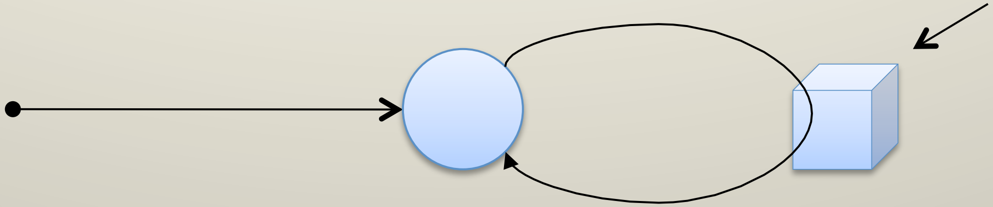
The way to change that is ...

`dbg:tracer/2`

dbg Extended

Handling trace messages manually



Suppose to represent a fun

```
dbg:tracer(process, {HandlerFun, InitialState})
 HandlerFun = fun(TraceMsg, State) -> NewState
```

- `HandlerFun` is a fun of arity 2.
- First argument in `HandlerFun` is the trace message; Second argument is the custom state which initially is `InitialState`
- Side effects are allowed in the `HandlerFun`
- Value returned from `HandlerFun` is the new state

dbg Extended

Handling trace messages manually; Example

```
> dbg:tracer(process, {fun(Trace, N) -> io:format("TRACE (#~p): ~p~n", [N, Trace]), N+1
end, 0}).
{ok,<0.485.0>}
> dbg:p(self(), [c]).
{ok,[{matched,nonode@nohost,1}]}
> dbg:tp(traceme, foo, []).
{ok,[{matched,nonode@nohost,1}]}
> traceme:foo(1).
TRACE (#0): {trace,<0.297.0>,call,{traceme,foo,[1]}}
ok
> traceme:foo(2).
TRACE (#1): {trace,<0.297.0>,call,{traceme,foo,[2]}}
Ok
> dbg:p(all,clear).
{ok,[{matched,nonode@nohost,28}]}
> dbg:p(self(), [c, timestamp]).
{ok,[{matched,nonode@nohost,1}]}
> traceme:foo(10).
ok
TRACE (#2): {trace_ts,<0.297.0>,call,{traceme,foo,"\n"},{1289,139850,193370}}
>
```

dbg Extended

Trace messages; examples

```
{trace, Pid, 'receive', Msg}

{trace, Pid, send, Msg, To}

{trace, Pid, call, {M, F, Args}}

{trace, Pid, return_from, {M, F, Arity}, ReturnValue}

{trace, Pid, exception_from, {M, F, Arity}, {Class, Value}}

{trace, Pid, spawn, Pid2, {M, F, Args}}
```

dbg Extended

Trace messages; with flag `timestamp`:

```
{trace_ts, Pid, call, {M, F, A}, {MegaSec, Sec, MicroSec}}
```

with `message` in the match specification:

```
{trace, Pid, call, {M, F, Args}, Message}
```

With both:

```
{trace_ts, Pid, call, {M, F, Args}, Message, {MegaSec, Sec, MicroSec}}
```

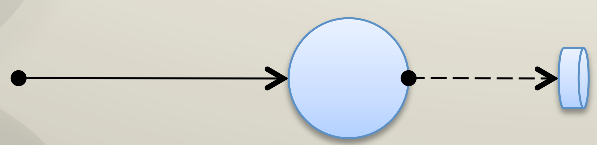
Using flag `arity`:

```
{trace, Pid, call, {M, F, N}}
```

See `erlang:trace/2` for detailed information

dbg Continued

Trace output to a port

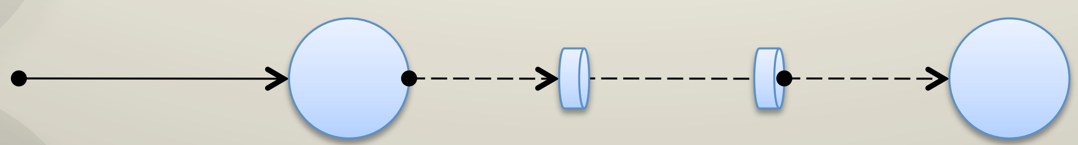


```
dbg:tracer(port, PortGenerator)
```

- Sends trace messages to a port (a file or a socket)
- Much more efficient way of tracing (low overhead)
- `PortGenerator` is a `fun/0` which opens a file or a socket port
- `trace_port/2` should be used to create that fun

dbg Continued

Trace output to a port: Socket



```
trace_port(ip, PortNumber|{PortNumber, QueueSize})
```

- Listens on port for a client to connect
- `PortNumber` is the port to listen on
- `QueueSize` is the max number of messages which will be buffered before trace messages are being discarded
- Any client can connect but should preferably be connecting using `trace_client/2` from an Erlang shell

dbg Continued

Trace output to a port: Socket

```
trace_client(ip, PortNumber|{Hostname, PortNumber})
```

- Connects to a port on a hostname
- Printouts have the same formats as tracing in the shell
- Any client can be used but this is preferred

Warning: Will disconnect silently if connection is broken
or unable to connect

dbg Continued

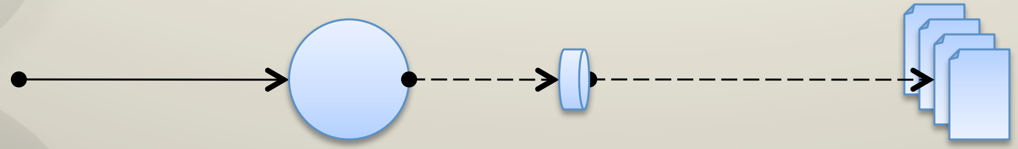
Trace output to a port: Socket; example

```
> dbg:tracer(port,
             dbg:trace_port(ip, 9922)).
{ok,<0.80.0>}
> dbg:p(all, c).
{ok,[{matched,nonode@nohost,26}]}
> dbg:tp(traceme, foo, []).
{ok,[{matched,nonode@nohost,1}]}
> traceme:foo(node()).
ok
> traceme:foo("Hello!").
ok
```

```
> dbg:trace_client(ip, {"localhost", 9922}).
<0.53.0>
> (<0.33.0>) call traceme:foo(nonode@nohost)
(<0.33.0>) call traceme:foo("Hello!")
```

dbg Continued

Trace output to a port: File



`trace_port(file, Filename|WrapFileSpec)`

- Filename is the file to dump traces to
- Using WrapFileSpec one can rotate files based on count and size/time and give it a suffix
- It is recommended to use `trace_client/2` from an Erlang shell read these files (they are in binary format)

dbg Continued

Trace output to a port: File

```
trace_client(file|follow_file, Filename)
```

- Opens the file Filename and prints the tracemessages
- If `follow_file` is used then the file will be continously read (like `tail -f filename` in *nix systems)
- Does not "cross over" to read files when they wrap

dbg Continued

Trace output to a port

```
dbg:trace_client(_, _, {HandlerFun, InitialState})
  HandlerFun = fun(TraceMsg, State) -> NewState
```

- Same concept as when using `tracer/2`
- `{drop, N}` is sent if the ip port is too congested; N is the number of messages dropped.
- `end_of_trace` is sent when trace is finished in file ports

Exercises

Using tracing ...

- Start N number of erlang nodes and trace something you previously traced but from all nodes simultaneously
- Write a custom handler to print the messages you get differently from how they are shown
  - Try adding `timestamp` and/or `message` in your match specification
  - Try writing a handler that measures the avarage runtime for a function over a sample of 100 calls
- Start a tracer using `ip` and connect with `trace_client/2` and `telnet`
- Start a tracer using file
  - Trace to a single file and use `follow_file`
  - Trace to multiple files tweaking rotation, size and time parameters

4

ttb Introduction and Basics

Getting started again

ttb Introduction and Basics

What we know so far ...

- Start a trace with different flags (calls, messages etc)
- Use Match Specifications to refine call traces
- Connect several nodes into a trace
- Observe a trace from a client
- Save trace output to one or more files
- Customize the trace handler to handle the trace messages

So now what?

ttb Introduction and Basics

Building distributed system tracing
Some examples:

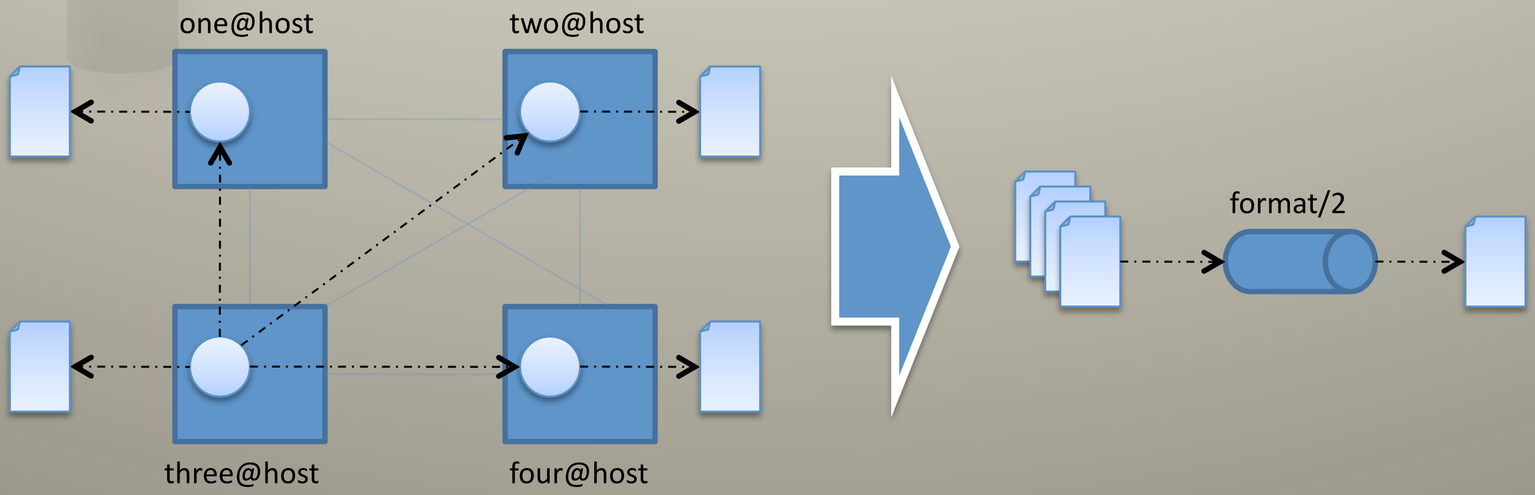
- Trace a specific action of the system (E.g. a session/message)
- Crude system sampling (E.g. How many refill their account with more than £5 per day/hour/second)
- Bug trapping (triggers E.g. on bad ets inserts)
- Any analysis/trace etc that is temporarily enabled
- System testing/verification

Important: This does ***not*** *replace logging*

ttb Introduction and Basics

ttb basics

- Starts one file port tracer on several nodes at the same time
- Starts one or more traces on these nodes
- When tracing is stopped the files are aggregated on the node that started the tracing
- A format function is used to format each entry which can then be written to a file (or whatever we want E.g. write a report)



ttb Introduction and Basics

`ttb` usage

1. Start a tracer on a set of nodes
2. Start a trace (and trace patterns if tracing calls)
3. Stop the trace (automatic aggregation)
4. Format the output

ttb Introduction and Basics

1. Start a tracer on a set of nodes
2. Start a trace (and trace patterns if tracing calls)
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```
ttb:tracer(Nodes, Options)
```

- The first parameter `Nodes` is a list of nodes where the tracer will be started
- Returns `{ok, NNodes}` where `NNodes` is a list of nodes where the tracers were started
- Options is a list of key-value tuples. The common options are:
  - `{file, Filename}` – Saves all files as `<nodename>-Filename`
  - `{handler,{HandlerFun, InitialState}}` – Same concept as when using `tracer/2` but `HandlerFun` differs and is described in later slides.
  - `{process_info, true|false}` – Specifies if extra process info should be included in the trace message; default is `true`
- More variations of these options exist (see the manual)

ttb Introduction and Basics

1. Start a tracer on a set of nodes
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4. Format the output

```
ttb:tracer(Nodes, Options)
```

```
(foo@Pasha)1> ttb:tracer([foo@Pasha, bar@Pasha], [{file,"MyTraceFile"}]).
{ok,[bar@Pasha,foo@Pasha]}
```

ttb Introduction and Basics

1. Start a tracer on a set of nodes
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```
ttb:p(Procs, Flags)
```

- Same functionality as `dbg:p/2`
- `Procs` is a list of process identifiers (or a single item)
  - `registered | atom() | pid() | all | new | existing`
- Registered processes are identified by each node
- Globally registered processes use `{global, RegisteredName}`
- Returns `{ok,[{Procs, MatchDesc}]}` where `MatchDesc` is the same as `dbg:p/2` and `Procs` is which process it started a trace on
- Uses the same flags as `dbg:p/2`

ttb Introduction and Basics

1. Start a tracer on a set of nodes
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4. Format the output

```
ttb:tp|tpl|ctp|ctpl/2,3,4
```

- Same functionality as the `dbg` functions
- Same return value

ttb Introduction and Basics

1. Start a tracer on a set of nodes
2. Start a trace (and trace patterns if tracing calls)
3. Stop the trace (automatic aggregation)
4. Format the output

ttb:p(Procs, Flags)

```
(foo@Pasha)2> ttb:p(all, [c]).
{ok,[{all,[{matched,bar@Pasha,36},{matched,foo@Pasha,37}]}]}
```

ttb:tp|tpl|ctp|ctpl/2,3,4

```
(foo@Pasha)3> ttb:tp(traceme, foo, []).
{ok,[{matched,bar@Pasha,1},{matched,foo@Pasha,1}]}
```

```
(foo@Pasha)4> traceme:foo(node()).
ok
```

```
(bar@Pasha)1> traceme:foo(node()).
ok
```

ttb Introduction and Basics

1. Start a tracer on a set of nodes
2. Start a trace (and trace patterns if tracing calls)
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4. Format the output

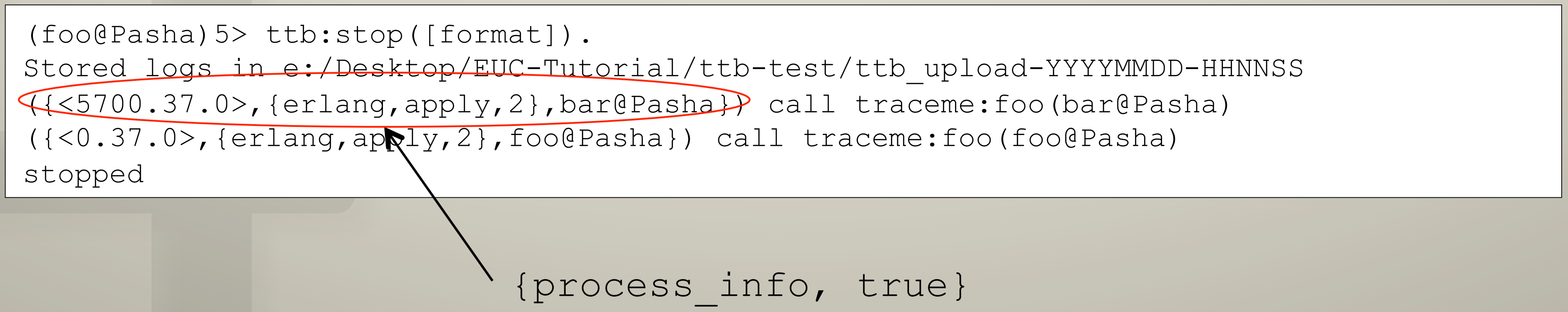
```
ttb:stop(Options)
```

- Stops the tracing
- `Options` is a list of one of two items; `fetch` and `format`
- `format` implies `fetch`
- `fetch` retrieves the files from the remote nodes and stores them in a directory of the node running the command
- `format` first fetches the files just like `fetch` but then automatically calls `ttb:format/1` on the fetched files
- Not specifying an option will leave the files on the remote nodes

ttb Introduction and Basics

1. Start a tracer on a set of nodes
2. Start a trace (and trace patterns if tracing calls)
3. Stop the trace (automatic aggregation)
4. Format the output

`ttb:stop(Options)`



```
(foo@Pasha)5> ttb:stop([format]).
Stored logs in e:/Desktop/EUC-Tutorial/ttb-test/ttb_upload-YYYYMMDD-HHNNSS
({<5700.37.0>,{erlang,apply,2},bar@Pasha}) call traceme:foo(bar@Pasha)
({<0.37.0>,{erlang,apply,2},foo@Pasha}) call traceme:foo(foo@Pasha)
stopped
```

`{process_info, true}`

ttb Introduction and Basics

1. Start a tracer on a set of nodes
2. Start a trace (and trace patterns if tracing calls)
3. Stop the trace (automatic aggregation)
4. Format the output

```
ttb:format(File, Options)
```

- Formats a file, list of files or a directory
- If no options are given this print the trace to stdout
- Options can be
  - `{out, standard_io|Filename}` – Specifies where the formatting should be written to
  - `{handler,{HandlerFun, InitialState}}` - The `fun` to handle the trace messages
  - Graphical interface will not be covered: `{handler, et}`

ttb Introduction and Basics

1. Start a tracer on a set of nodes
2. Start a trace (and trace patterns if tracing calls)
3. Stop the trace (automatic aggregation)
4. Format the output

```
ttb:format(..., [{handler, {HandlerFun, ...}}])
```

- A fun of arity 4: `fun(Fd, Trace, TraceInfo, State)`
- `Fd` – The file descriptor to the file the `out` option specified or `standard_io`
- `Trace` – The trace message according to given flags and events as previously described
- `TraceInfo` – A list of key-value entries which has information about the process in context
- `State` – The custom state
- Last line is used as the new state
- `Trace` = `end_of_trace` when trace is finished from a given file

ttb Introduction and Basics

1. Start a tracer on a set of nodes
2. Start a trace (and trace patterns if tracing calls)
3. Stop the trace (automatic aggregation)
4. Format the output

`ttb:format(File, Options)`

```
HandlerFun =
    fun(Fd, Trace, TraceInfo, _) ->
        io:format(Fd,"= TraceInfo:",[]),
        io:format(Fd,"~1000p~n",[TraceInfo]),
        io:format(Fd,"= Trace    :",[]),
        io:format(Fd,"~1000p~n~n",[Trace])
    end.
```

```
(foo@Pasha)6> ttb:format("ttb_upload-20101113-202517", [{out,"mytrace.log"}, {handler,
{HandlerFun, ok}}]).
ok
```

Examine the output file

ttb Introduction and Basics

1. Start a tracer on a set of nodes
2. Start a trace (and trace patterns if tracing calls)
3. Stop the trace (automatic aggregation)
4. Format the output

`ttb:format(File, Options)`

```
= TraceInfo:[{flags,[{[all],[call]}]},{file,["./bar@Pasha-MyTraceFile"]},{node,[bar@Pasha]}]
= Trace    :{trace,{<5700.37.0>,{erlang,apply,2},bar@Pasha},call,{traceme,foo,[bar@Pasha]}}

= TraceInfo:[{flags,[{[all],[call]}]},{file,["./bar@Pasha-MyTraceFile"]},{node,[bar@Pasha]}]
= Trace    :end_of_trace

= TraceInfo:[{flags,[{[all],[call]}]},{file,["./foo@Pasha-MyTraceFile"]},{node,[foo@Pasha]}]
= Trace    :{trace,{<0.37.0>,{erlang,apply,2},foo@Pasha},call,{traceme,foo,[foo@Pasha]}}

= TraceInfo:[{flags,[{[all],[call]}]},{file,["./foo@Pasha-MyTraceFile"]},{node,[foo@Pasha]}]
= Trace    :end_of_trace
```

Try it again using the `timestamp` flag in your trace

ttb Introduction and Basics

1. Start a tracer on a set of nodes
2. Start a trace (and trace patterns if tracing calls)
3. Stop the trace (automatic aggregation)
4. Format the output

```
ttb:write_trace_info(Key, Info)
```

- Adds a `{Key, Info}` tuple to the `TraceInfo` element
- Useful to "save" enviornment information with the trace
- Must be called on the node that started the `ttb` tracer
- Resets after `ttb:stop` has been called

Exercises

Using the trace tool builder ...

- Use the trace tool builder to run traces you previously used `dbg` for
- Create a module with a simple interface that takes a module, function and arity and traces that for a given number of seconds and then turns the trace of and formats the results to a file

Hardcore:

- Create a trace for all processes calling `traceme:foo/1` on three nodes
- After the trace is active call the the function many times on all nodes with `random:uniform (1000)` as input then stop the trace
- Format the output so that you get a file with 10 lines showing how many calls were within a given range (1-100, 101-200, 201-300 etc)

5 Where to go from here …

What I didn't include

Where to go from here ...

Look into ...

- `dbg:c/3,4`
- Sequential tracing
- Load/Save/Change configuration
-

?

?

?