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How Lmod Loads a Modulefile, Part 2

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Outline

- Part 1 took us to Master:load() and loadModuleFile(t)
- This part will start with Master:load() and loadModuleFile(t)
- This talk will be about handing off your modulefile to the Lua interpreter and Lmod routines.

Outline (II)

- `main()`: How main() parses the command line
- `...`
- `Master:load(mA)`: Where the heavy lifting is done
- `loadModuleFile()`: Where the modulefile is actually evaluated

Master:load(): getting ready to call loadModuleFile(t)

- src: src/Master.lua
- There is no duplicate sn so we can load the modulefile *foo*.

```
elseif (fn) then
   frameStk:push(mname)
   mt = frameStk:mt()
   mt:add(mname,"pending")
   local status = loadModuleFile{file = fn, shell = shellNm,
                  mList = mList, reportErr = true}
   -- part 2
```

After loading modulefile

```
 -- Now fn is loaded

 mt = frameStk:mt() -- Why?

-- A modulefile could the same named module over top of the current modulefile
 -- Say modulefile abc/2.0 loads abc/.cpu/2.0.  Then in the case of abc/2.0
 -- the filename won't match.
 if (mt:fn(sn) == fn and status) then
    mt:setStatus(sn, "active")
    hook.apply("load",{fn = mname:fn(), modFullName =
                mname:fullName(), mname = mname})
 end
 frameStk:pop()
 loaded = true
```

Notes about loadModuleFile(t) function

- Almost all module commands will eval one or more modules
- This means that loadModuleFile(t) will be called.
- Does not: module list, module -t avail
- Does: module load, module unload, module help, module whatis, ...
- Even if your site uses a system spider cache, you will re-eval modulefiles that change $MODULEPATH (New)

Let's load the modulefile w/ `loadModuleFile(t)`

```
function loadModuleFile(t)
   ------------------------------------------------------------------------
   -- Don't complain if t.file has disappeared when mode() == "unload"
   ------------------------------------------------------------------------
   -- Check for infinite loop on mode() == "load"
   ------------------------------------------------------------------------
   -- Read modulefile into string "whole"

   if (t.ext == ".lua") then
      -- Read complete Lua modulefile into "whole"
   else
      -- Convert TCL modulefile into Lua
   end

   ------------------------------------------------------------------------
   -- Use sandbox to evaluate modulefile

   ------------------------------------------------------------------------
   -- Report any errors and error out

   ------------------------------------------------------------------------
   -- Mark lmodBrk is LmodBreak() is called inside moduleFile
   return not lmodBrk
end
```

- Note that we passed an anonymous table in Master.lua.
- The result is that there is a single argument "t" to the function.

Reading entire modulefile

```
if (t.ext == ".lua") then
  -- Read in lua module file into a [[whole]] string.
  local f = io.open(t.file)
  if (f) then
     whole = f:read("*all")
     f:close()
  end
```

Converting TCL to Lua

- This will be another talk. But TL; DR
- The TCL interpreter run on the TCL modulefile
- But `setenv FOO BAR` is converted to the string `setenv("FOO","BAR")`
- `prepend-path PATH /...` ⇒ `prepend_path("PATH","/..."`
- etc

TCL conversion example

```
---------- Input: -----------------

global env
proc ModulesHelp
puts stderr "Help message..."

set modulepath_root  $env(MODULEPATH_ROOT)
set moduleshome     "$modulepath_root/TACC"

module load Linux
module try-add cluster
module load TACC-paths

---------- Output: -----------------

load("Linux")
try_load("cluster")
load("TACC-paths")
```

What is the sandbox?

- Lua offers the ability to evaluate a string containing Lua code
- *WITH* the possibility of a limited choice of functions.
- In other words, Modulefile evaluation has a limited set of functions.
- They cannot call internal routines Lmod functions.
- I did this once testing Lmod and realized the problem.
- Sites may run their own special function
- BUT: They must be registered with the sandbox
- Sites can use the SitePackage.lua or /etc/lmod/lmod_config.lua to register their own functions
- Note that the sandbox controls what the modulefiles can call
- Once inside however all functions can be called.

status, msg = sandbox_run(whole)

```
local function l_run5_2(untrusted_code)
  local untrusted_function, message = load(untrusted_code, nil, 't', sandbox_env)
  if not untrusted_function then return nil, message end
  return pcall(untrusted_function)
end

--------------------------------------------------------------------------
-- Define two version: Lua 5.1 or 5.2.  It is likely that
-- The 5.2 version will be good for many new versions of
-- Lua but time will only tell.
sandbox_run = (_VERSION == "Lua 5.1") and l_run5_1 or l_run5_2
```

What is sandbox_env (src/sandbox.lua?

```
local sandbox_env = {
  assert   = assert,
  loadfile = loadfile,
  require  = require,
  ipairs   = ipairs,
  next     = next,
  pairs    = pairs,
  pcall    = pcall,
  tonumber = tonumber,
  tostring = tostring,
  type     = type,
  load      = load_module,
  load_any = load_any,

  --- PATH functions ---
  prepend_path         = prepend_path,
  append_path          = append_path,
  remove_path          = remove_path,

  --- Set Environment functions ----
  setenv               = setenv,
  pushenv              = pushenv,
  unsetenv             = unsetenv,

  ...
}
```

- Modulefiles can only execute functions in sandbox_env

Modulefile Evaluation: Who is in charge?

- Once `sandbox_run()` is called then Lua is in charge
- Not Lmod!
- All normal Lua statements are run by Lua.
- Lmod never sees if () stmts etc.
- Lmod code is called when executing setenv(), prepend_path() etc.

Example: StdEnv.lua

```
local hroot   = pathJoin(os.getenv("HOME") or "","myModules")
local userDir = pathJoin(hroot,"Core")
if (isDir(userDir)) then
   prepend_path("MODULEPATH",userDir)
end
haveDynamicMPATH()
```

- Recent change in Lmod 8.7.4: Dynamic Spider Cache
- Lmod remember modules that change $MODULEPATH
- If ~/myModules doesn't exist then Lmod will never know that this module could change $MODULEPATH
- That is why this module needs `haveDynamicMPATH()`.

Suppose your modulefile calls `setenv()`

- Module command functions are implemented in src/modfuncs.lua
- Below is the modfunc.lua function setenv()
- So the arguments are check to be strings and/or numbers with l_validateArgsWithValue()
- Then the start of the work happens with mcp:setenv(...)

```
function setenv(...)
   dbg.start{"setenv(",l_concatTbl(...,", "),")"}
   if (not l_validateArgsWithValue("setenv",...)) then return end

   mcp:setenv(...)
   dbg.fini("setenv")
   return
end
```

mcp:setenv() what is it gonna do?

- `mode() == "load"` ⇒ MasterControl:setenv()
- `mode() == "unload"` ⇒ MasterControl:unsetenv()
- `mode() == "show"` ⇒ MC_Show:setenv()
- `mode() == "refresh"` ⇒ MasterControl:quiet()
- Note that there is NOT if block making these choices
- It depends on which object type `mcp` was build as.

There are ten different types of MasterControl classes

- MC_Access.lua ⇒ whatis, help
- MC_CheckSyntax.lua ⇒ for checking the syntax of a modulefile.
- MC_ComputeHash lua ⇒ Computing the hash value used in user collections.
- MC_DependencyCk.lua ⇒ reloading modules to report any problems with the dependencies.
- MC_Load.lua ⇒ loading modules
- MC_Mgrload ⇒ the loading method when loading a collection (ignore load() type functions inside modulefiles)
- MC_Refresh ⇒ reload all currently loaded modules but only run set_alias() set_shell_function() and nothing else
- MC_Show ⇒ Just print out commands
- MC_Spider ⇒ How to process modules when in spider mode
- MC_Unload ⇒ How Lmod unloads modules (setenv ⇒ unsetenv, prepend_path() ⇒ remove_path() etc)

MasterControl:setenv()

```
function M.setenv(self, name, value, respect)
   dbg.start{"MasterControl:setenv(",name,", ",value,", ",
             respect,")"}
   l_check_for_valid_name("setenv",name)

   if (value == nil) then
      LmodErrormsg="e_Missing_Value", func = "setenv", name = name
   end

   if (respect and getenv(name)) then
      dbg.print"Respecting old value"

      dbg.fini("MasterControl:setenv")
      return
   end

   local frameStk = FrameStk:singleton()
   local varT     = frameStk:varT()
   if (varT[name] == nil) then
      varT[name] = Var:new(name)
   end
   varT[name]:set(tostring(value))
   dbg.fini("MasterControl:setenv")
end
```

Lmod changing your Environment in lmod.in.lua

```
-- Output all newly created path and variables.
Shell:expand(varT)

-- Expand any execute{} cmds
if (Shell:real_shell())then
   Exec:exec():expand()
end
```

- Assuming no errors
- Then Lmod prints out the changes to your env.
- With the above code.
- All changes are in `varT`

module unload foo

```
function M.unsetenv(self, name, value, respect)
   name = name:trim()
   dbg.start{"MasterControl:unsetenv(",name,", ",value,")"}

   l_check_for_valid_name("unsetenv",name)

   if (respect and getenv(name) ~= value) then
      dbg.print"Respecting old value"
      dbg.fini("MasterControl:unsetenv")
      return
   end

   local frameStk  = FrameStk:singleton()
   local varT      = frameStk:varT()
   if (varT[name] == nil) then
      varT[name]   = Var:new(name)
   end
   varT[name]:unset()

   -- Unset stack variable if it exists
   local stackName = l_createStackName(name)
   if (varT[stackName]) then
      varT[name]:unset()
   end
   dbg.fini("MasterControl:unsetenv")
end
```

- Here we unsetenv() by calling varT[name]:unset()

module show foo

```
function M.setenv(self, name,value)
   l_ShowCmd("setenv", name, value)
end
```

- In src/MC_Show.lua the setenv command is printed.

Next time

- How the translation from TCL to Lua is handled
- Why it is not perfect.

Conclusions

- Lmod provide a way to evaluate your modulefile.
- It does so through the sandbox_run() function
- And hands off the evaluation to Lua.

Future Topics

- Next Meeting: September 6th 9:30 US Central (14:30 UTC)
- How the translation from TCL to Lua is handled