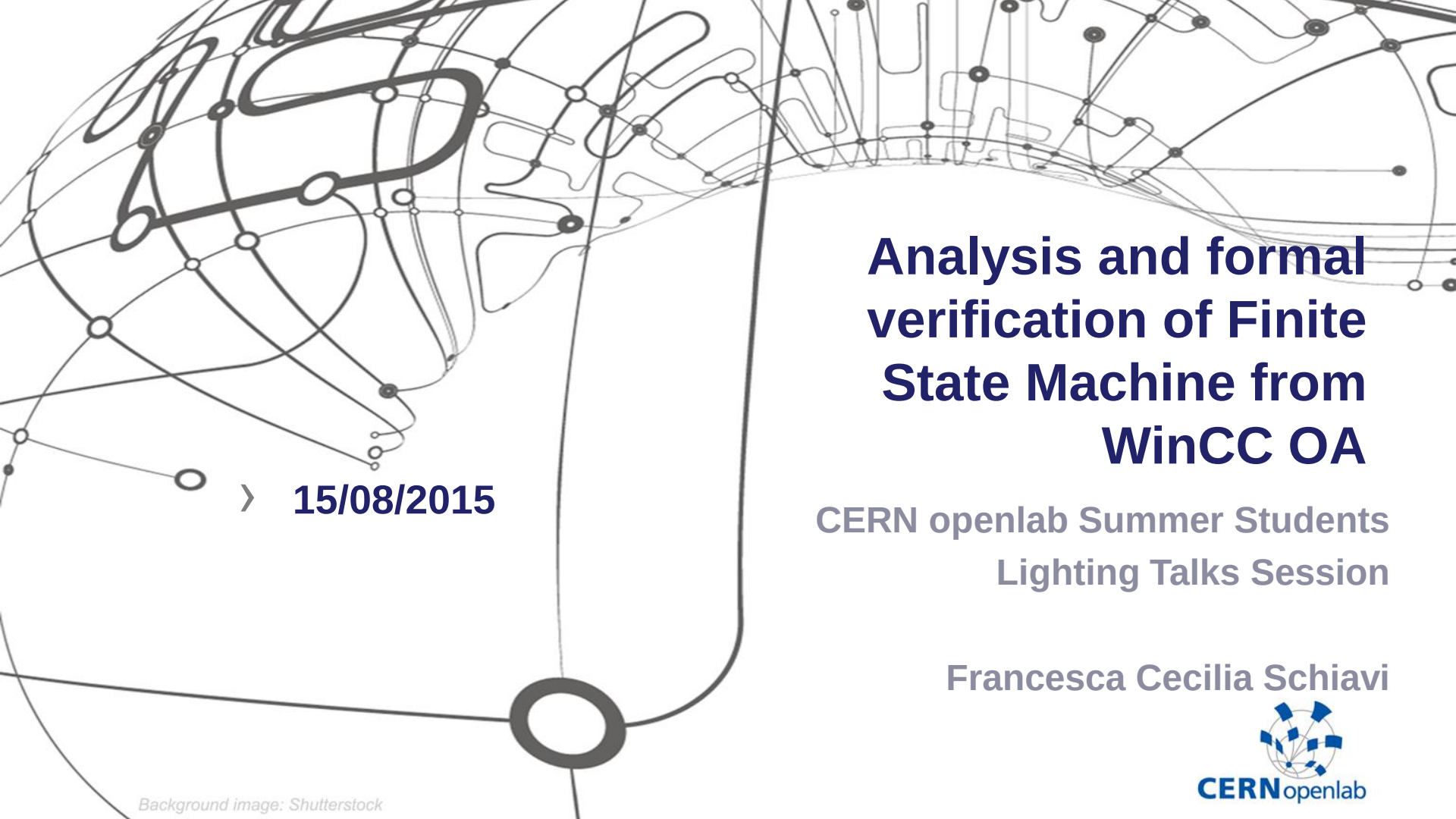

Analysis and formal verification of Finite State Machine from WinCC OA

› 15/08/2015

CERN openlab Summer Students
Lighting Talks Session

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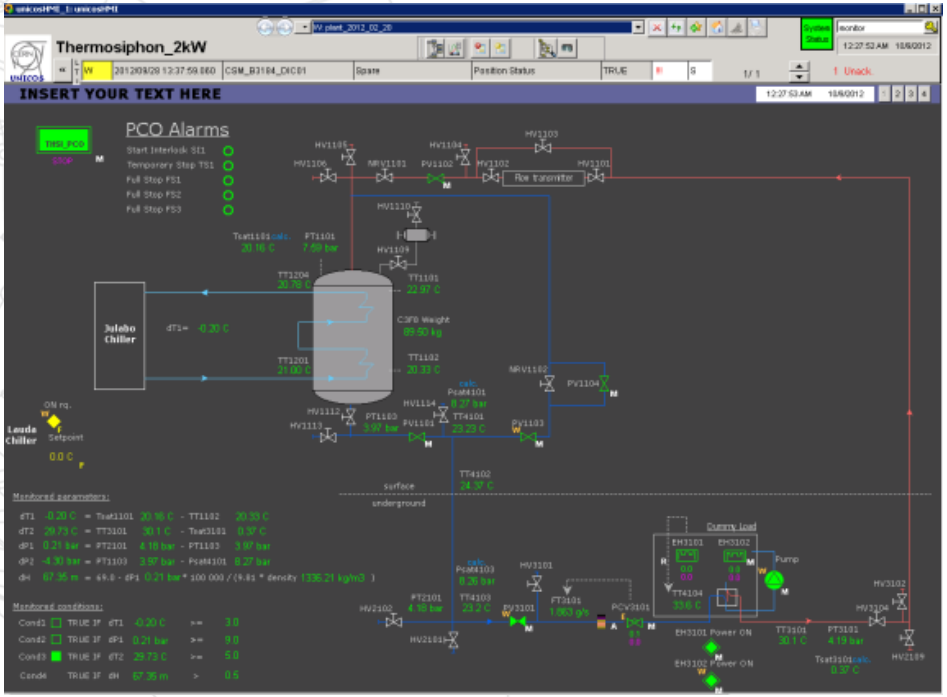
CERN openlab

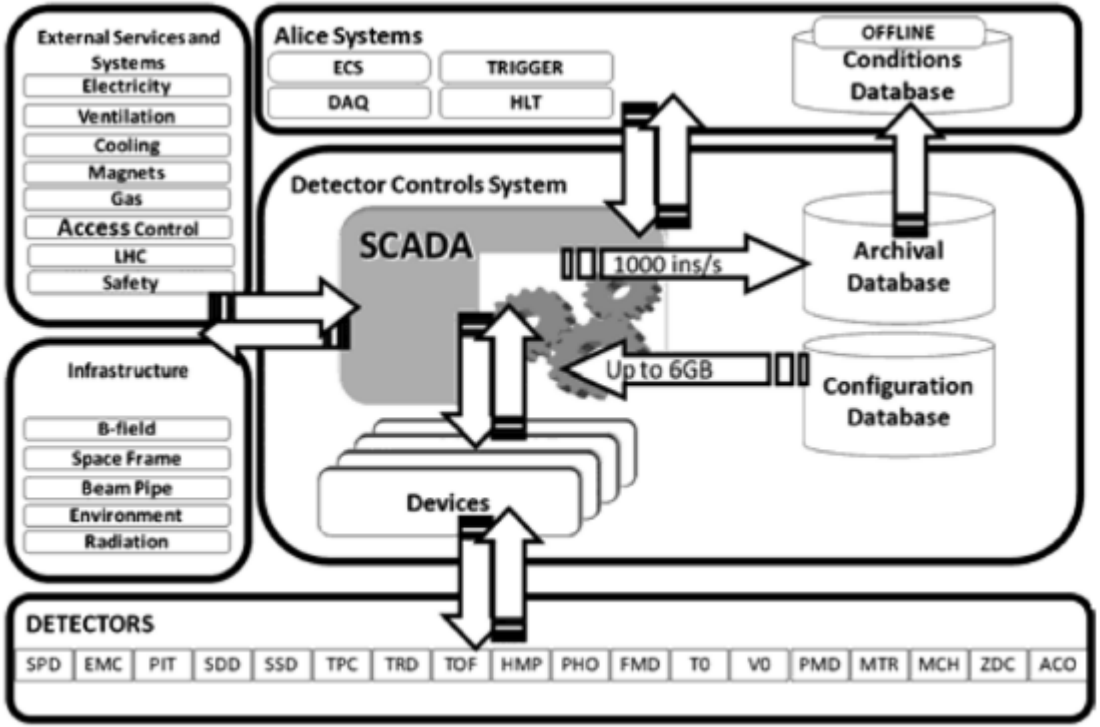
Background image: Shutterstock

WinCC OA



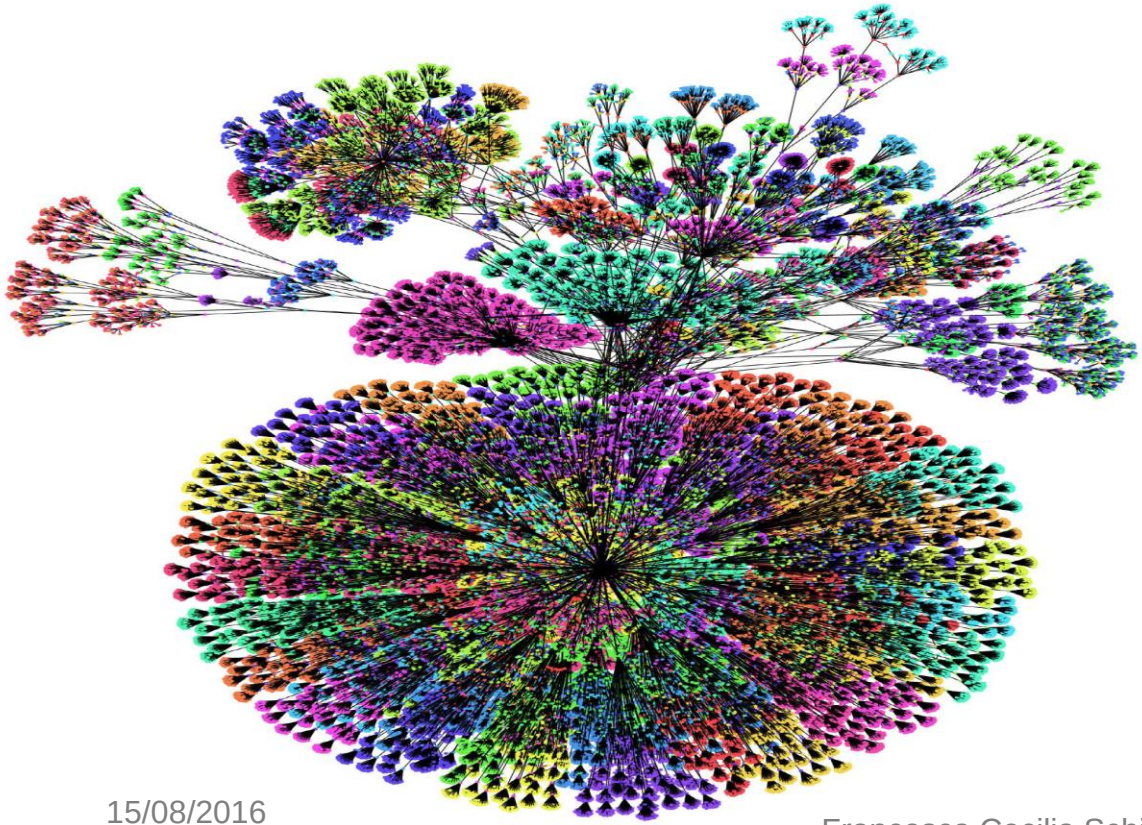
- **Is a software that is used for the development of control system**
- **Use cases:**
  - LHC Experiments (Atlas, CMS, Alice, LHCb)
  - Accelerators: Cryogenics, Vacuum, Interlocks, etc
  - Infrastructure: electrical network, CV, Radiation Monitoring

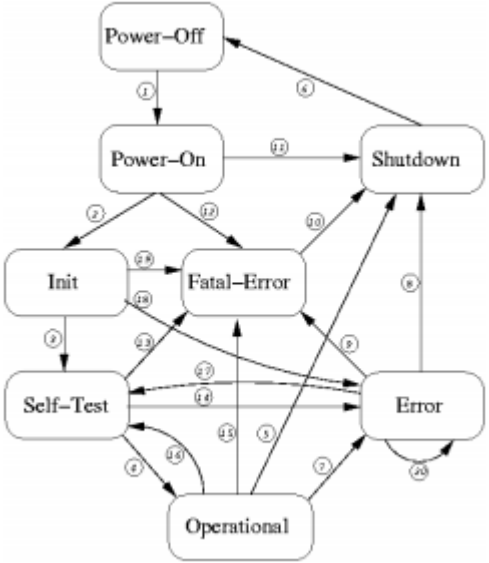
Introduction



In the LHC, a Detector Control System is a hardware and software component that measures and controls millions of parameters concerning the environment variables.

Introduction



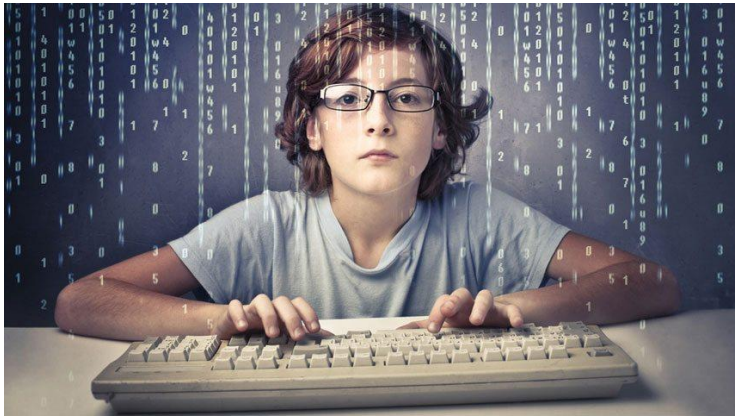


The problem

The CMS group developed a set of tools that periodically checks the semantics of the code of the Control Unit Types defined in a system, but the delay between the modification of the CU and the feedback to developers is too long.

The Project Challenge

To prevent this undesired behaviour, an editor with syntax validation and highlighting for the code of FSM CU type has been developed.



Solution and Personal Contribution

- **ACE for syntax highlighting**
  - Indentation rules
  - Folding
  - Markup naming convention
  - Environment background theme

```
class: $FWPART_$TOP$DcsCuType_CLASS
!panel: DcsCuType.pnl
    state: NOT_READY    !color: FwStateOKNotPhysics
        when ( $ANY$FwCHILDREN in_state ERROR ) move_to ERROR
        when ( $ALL$FwCHILDREN in_state READY ) move_to READY
        action: CONFIGURE   !visible: 1
            do CONFIGURE $ALL$FwCHILDREN
    state: READY    !color: FwStateOKPhysics
        when ( $ANY$FwCHILDREN in_state ERROR ) move_to ERROR
        when ( $ANY$FwCHILDREN in_state NOT_READY ) move_to NOT_READY
        action: RESET   !visible: 1
            do RESET $ALL$FwCHILDREN
    state: ERROR    !color: FwStateAttention3
        when ( $ALL$FwCHILDREN not_in_state ERROR ) move_to NOT_READY
        action: RECOVER !visible: 1
            do RECOVER $ALL$FwCHILDREN
```

- **PEG.js for syntax parsing**
  - RegEx rules
  - FSM node hierarchy relation
  - Error checking and error reporting

FwChildMode.fsm | FwChildrenMode.fsm | FwDevMajority.fsm | FwDevMode.fsm

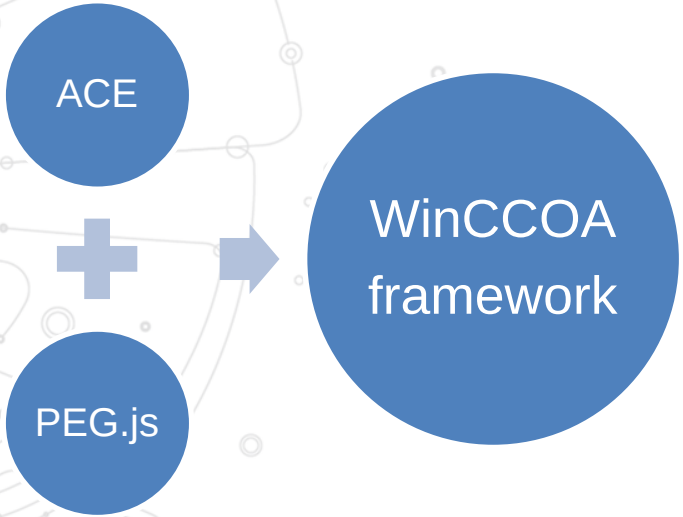
```
class: $FWPART_$ASS_FwChildMode_CLASS

!panel: FwChildMode.pnl
   state: Excluded !color: FwStateOKNotPhysics
      action: Include(string OWNER = "",string EXCLUSIVE = "YES") !visible: 1
         if ( $ASS$FwMode not_in_state {Excluded, Manual} ) then
         !   if ( $ASS$FwMode in_state Manual ) then
         !      do Take(OWNER=OWNER,EXCLUSIVE=EXCLUSIVE) $ASS$FwMode
         !   else
               move_to Excluded
         !   endif
         else
            do Include(OWNER=OWNER,EXCLUSIVE=EXCLUSIVE) $ASS$FwMode
         endif
         move_to Included
      action: Manual  !visible: 0
         do Manual $ASS$FwMode
         move_to Manual
      action: Ignore  !visible: 0
         do Ignore $ASS$FwMode
         move_to Ignored
      action: LockOut !visible: 1
         move_to LockedOut
      action: Exclude(string OWNER = "")  !visible: 1
         do Exclude(OWNER=OWNER) $ASS$FwMode
         move_to Excluded
      action: ExcludePerm(string OWNER = "")  !visible: 0
         move_to ExcludedPerm
      action: Exclude&LockOut(string OWNER = "")  !visible: 0
         move_to LockedOut
   state: Included !color: FwStateOKPhysics
      !when (  $ASS$FwMode in_state Excluded )  move_to EXCLUDED
      when ( $ASS$FwMode in_state Excluded )  do Exclude
      when (  $ASS$FwMode in_state Ignored )  move_to IGNORED

      when (  $ASS$FwMode in_state Manual )  move_to MANUAL

      when ( $ASS$FwMode in_state Dead )  do Manual

      action: Exclude(string OWNER = "")  !visible: 1
         if ( $ASS$FwMode not_in_state Included ) then
            if ( $ASS$FwMode in_state InManual ) then
```

FwChildMode.fsm | FwChildrenMode.fsm | FwDevMajority.fsm | FwDevMode.fsm

```
class: $FWPART_$ASS_FwChildMode_CLASS

!panel: FwChildMode.pnl
   state: Excluded !color: FwStateOKNotPhysics
      action: Include(string OWNER = "",string EXCLUSIVE = "YES") !visible: 1
         if ( $ASS$FwMode not_in_state {Excluded, Manual} ) then
         !   if ( $ASS$FwMode in_state Manual ) then
         !      do Take(OWNER=OWNER,EXCLUSIVE=EXCLUSIVE) $ASS$FwMode
         !   else
               move_to Excluded
         !   endif
         else
            do Include(OWNER=OWNER,EXCLUSIVE=EXCLUSIVE) $ASS$FwMode
         endif
         move_to Included
      action: Manual  !visible: 0
         do Manual $ASS$FwMode
         move_to Manual
      action: Ignore  !visible: 0
         do Ignore $ASS$FwMode
         move_to Ignored
      action: LockOut !visible: 1
         move_to LockedOut
      action: Exclude(string OWNER = "")  !visible: 1
         do Exclude(OWNER=OWNER) $ASS$FwMode
         move_to Excluded
      action: ExcludePerm(string OWNER = "")  !visible: 0
         move_to ExcludedPerm
      action: Exclude&LockOut(string OWNER = "")  !visible: 0
         move_to LockedOut
   state: Included !color: FwStateOKPhysics
      !when (  $ASS$FwMode in_state Excluded )  move_to EXCLUDED
      when (  $ASS$FwMode in_state Excluded )  do Exclude
      when (  $ASS$FwMode in_state Ignored )  move_to IGNORED

      when (  $ASS$FwMode in_state Manual )  move_to MANUAL

      when ( $ASS$FwMode in_state Dead )  do Manual

      action: Exclude(string OWNER = "")  !visible: 1
         if ( $ASS$FwMode not_in_state Included ) then
            if ( $ASS$FwMode in_state InManual ) then
               do Release(OWNER=OWNER) $ASS$FwMode
```

Error detected:
Line: 1 Column: 8
Expected " " or "$FWPART_$TOP$" but "$" found.

The Project Impact



- **This tool proposes a online evaluation and monitoring of the FSM CU Type:**
  - visually comprehensive thanks to the syntax highlighter
  - correct evaluation of the rules, as well as a coherent relation between states of FSM, thanks to the parser.
  - No time delay due to parsing
- **Future work**
  - Finish integration with WinCC OA
  - Visual correlation between FSM hierarchies of instances