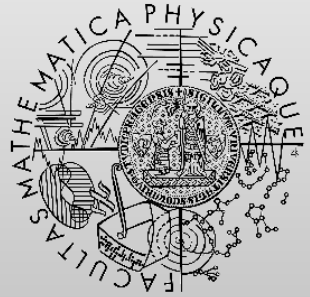
NuXMV System

http://d3s.mff.cuni.cz

Behavior models and verification

Department of Distributed and Dependable Systems

D3S



FACULTY
OF MATHEMATICS
AND PHYSICS
Charles University

NuXMV

- State-of-the-art symbolic model checker
  - Recall: Spin is an explicit model checker
- Based on NuSMV, extending it
- Originally developed at Carnegie Mellon University (SMV)
- Special input language, CTL properties
  - Uses OBDDs for states' manipulation
  - Both synchronous and asynchronous systems may be described

The SMV Input Language

- Parallel assignment syntax
  - In each step all variables are reassigned
    - Issues of circular dependencies, ...
  - Allows for easy OBDD modeling
- Initial values and "*next* " values are specified

Example I.

```
MODULE main
VAR
 request : boolean;
 state : {ready,busy};
ASSIGN
 init(state) := ready;
 next(state) := case
           state = ready & request : busy;
           TRUE : {ready,busy};
       esac;
SPEC
 AG(request -> AF state = busy)
```

Example II.

```
MODULE counter_cell(carry_in)
VAR
 value : boolean;
ASSIGN
 init(value) := FALSE;
 next(value) := value xor carry_in;
DEFINE
 carry_out := value & carry_in;

MODULE main
VAR
 bit0 : counter_cell(TRUE);
 bit1 : counter_cell(bit0.carry_out);
 bit2 : counter_cell(bit1.carry_out);

SPEC AF(bit2.carry_out)
```

Types

- boolean
- enum
- word – specifying bit width
  - e.g. word[3] → three-bit range, i.e., 0-7
  - Cannot create unions thereof → use integer sets instead
- integer
- real – rational numbers ☺
- arrays, wordarrays, intarrays (unbounded arrays)
  - nesting of types
- sets – limited, just sets of boolean, integer, symbolic and mixed enums

FAIRNESS, INIT, TRANS and INVAR

- Propositional way
- **FAIRNESS**
  - A fairness constraint – mostly used with **running**
- **INIT**
  - Initial value of local variables
- **TRANS**
  - Definition of transition relation
    - **next(output) = !input | next(output) = output**
- **INVAR**
  - Conditions restricting valid states

INIT, TRANS and INVAR

- The use of **INIT**, **TRANS** and **INVAR** NOT recommended
  - "Logical absurdities (...) can lead to unimplementable descriptions"
  - Resulting in systems with no transitions, etc.

- However
  - It may be flexible when translating from other languages to SMV

DEFINE

- **DEFINE** – symbols definition
  - **DEFINE**

```
start  := state = 0 & timeout;
 finish := state = 3;
 request := case
              state = 0: 0;
              TRUE : 1;
            esac;
```

Modules

- Encapsulation of a group of declarations
  - Can be parametrized when reusing
  - Can contain instances of other modules
  - Example: see above

- A parameterless **`main`** module has to be in each program

Verification and simulation

- Properties inside models can be verified
  - `nuxmv model.smv`
  - All CTL properties specified inside the models are checked
- Or the model can be simulated
  - `nuxmv -int model.smv`
  - Interactively, randomly, or deterministically

Simulation

- `nusmv –int model.smv`
  - Starts the nuxmv in interactive model
- `go`
  - Prepares the model
- `pick_state -r`
  - Picks up initial state (-r randomly, -i interactively)
- `print_current_state -v`
  - Prints the current state (-v verbosely)
- `simulate -r -k 3`
  - Simulates randomly three steps

SMV Information

- The original tool and manual downloadable at
  http://www.cs.cmu.edu/~modelcheck/smv.html

- Implementations to use: NuSMV and NuXMV

  http://nusmv.fbk.eu/
  http://nuxmv.fbk.eu/

- NuXMV is newer and recommended
  - https://es.fbk.eu/tools/nuxmv/downloads/nuxmv-user-manual.pdf

Department of Distributed and Dependable Systems D3S