Transformation of Spatio-Temporal Role Based Access Control Speciation to Alloy

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Presentation Foot Steps

1. Introduction

- STRBAC
- Alloy
- Motivation

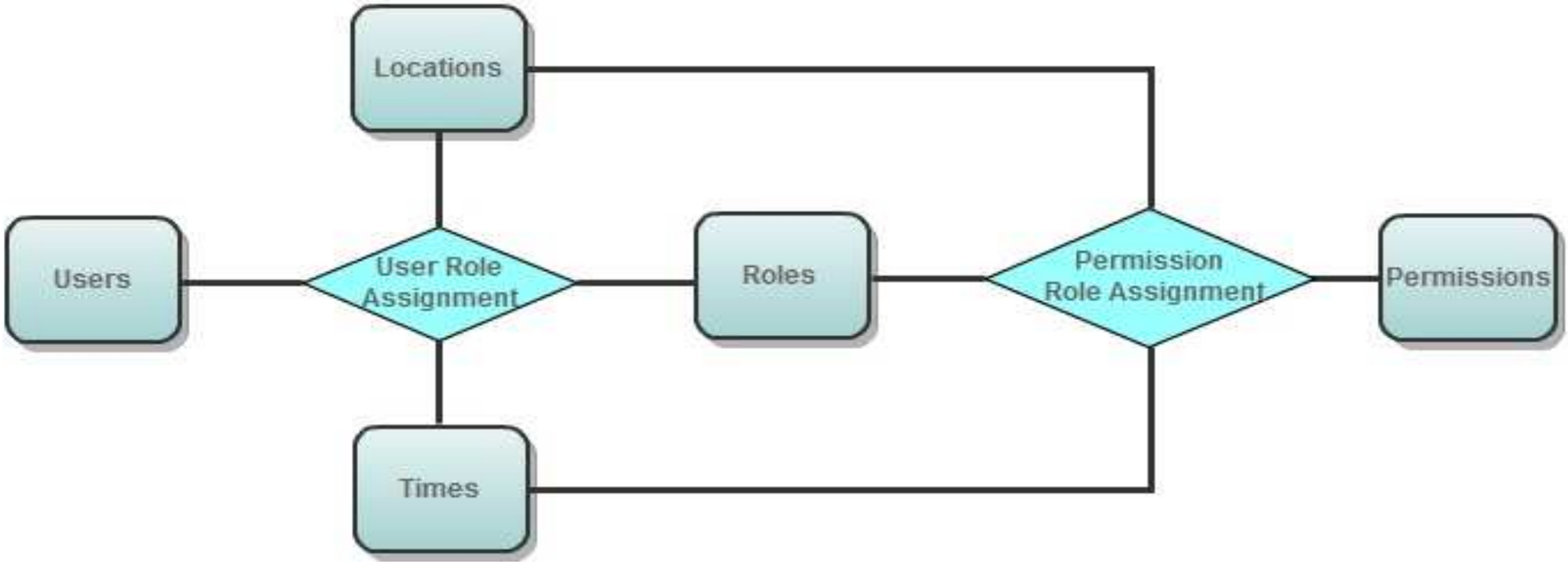
2. Concluded Work

- STRBAC to Alloy Transformation
- AC2Alloy
- Results

3. Conclusions

The Basic Concepts of STRBAC

STRBAC: An extension of the original RBAC model that supports temporal and location constraints.



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Cont…

- Users, Roles, Permissions, Times & Locations

  finite & non-empty sets

- User Role Assignment (URA): Users are assigned to roles based on time and location constraints.

  URA={(u, r, t, l), …….,}

- Permission Role Assignment (PRA): Permissions are assigned to roles based on time and location constraints.

  PRA={(r, p, t, l), …….,}

- Role Hierarchy

  RH={$(r_1 \geq r_2)$, $(r_1 \geq_t r_2)$, $(r_1 \geq_l r_2)$, $(r_1 \geq_{t,l} r_2)$, …….,}

- Location Hierarchy

  LH={$(l_1 \geq l_2)$, …….,}

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The Basic Concepts of STRBAC

- Separation of Duty between Roles

  SoDR={(r_1, r_2, t, l), …….,}
- Separation of Duty between Permissions

  SoDP={(p_1, p_2, t, l), …….,}
- Cardinality Constraints over Roles

  CCR={(r_1, t, l, N), …….,}
- Cardinality Constraints over Permissions

  CCP={(p_1, t, l, M), …….,}

- Separation of Duty and Cardinality constraints can also be unrestricted, Timed dependent, Location dependent, and Time-Location dependent.

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Inconsistencies in STRBAC Specification

- Due to the complexity and the size of modern system, it is possible that several STRBAC polices conflict with each other

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Alloy

- **Alloy is a formal specification language that has developed by Daniel Jackson [1]**
-
- **Alloy is supported by a fully automated constraint solver, called Alloy Analyser, that analyses system properties**
- **Alloy analyser search for model instances that violate checks about them.**
- **Alloy Analyser translates the model into a Boolean expression, and analyses it using embedded SAT-solvers.**

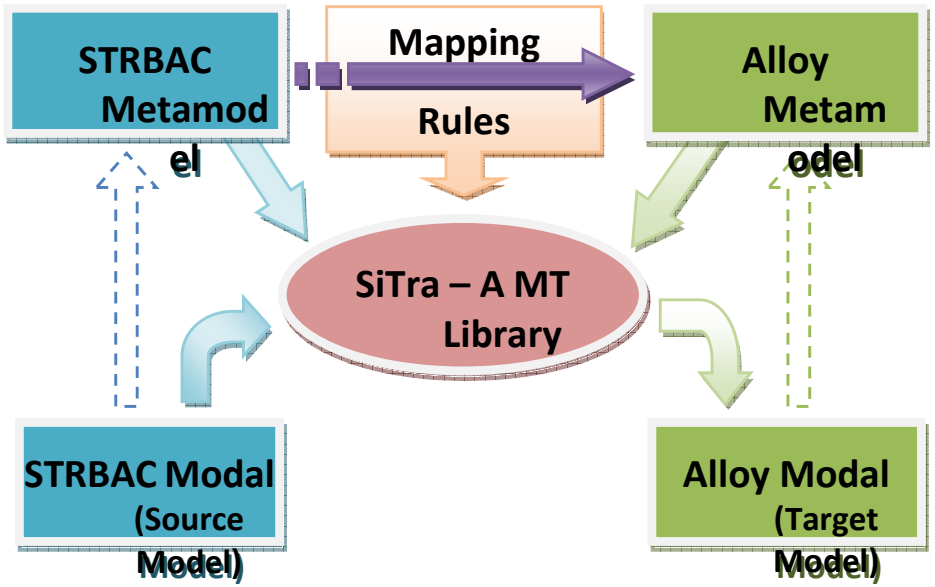
[1] Jackson.Daniel (2006), Software Abstractions Logic, Language, and Analysis, Cambridge: The Mit Press.

Motivation

- The prevention of fraud is more beneficial to organisations than its detection after it had occurred. “Wrong access might result in a huge lose”
- Alloy has been used successfully for automatic verification of Access Control policies.
- Some practically minded software engineers find Alloy hard .
- The Complexity and the size of modern Access control systems.

Idea: provide a tool to assist in writing Alloy to simplify process of Model Analysis

STRBAC to Alloy Transformation



A Model Transformation from STRBAC to Alloy

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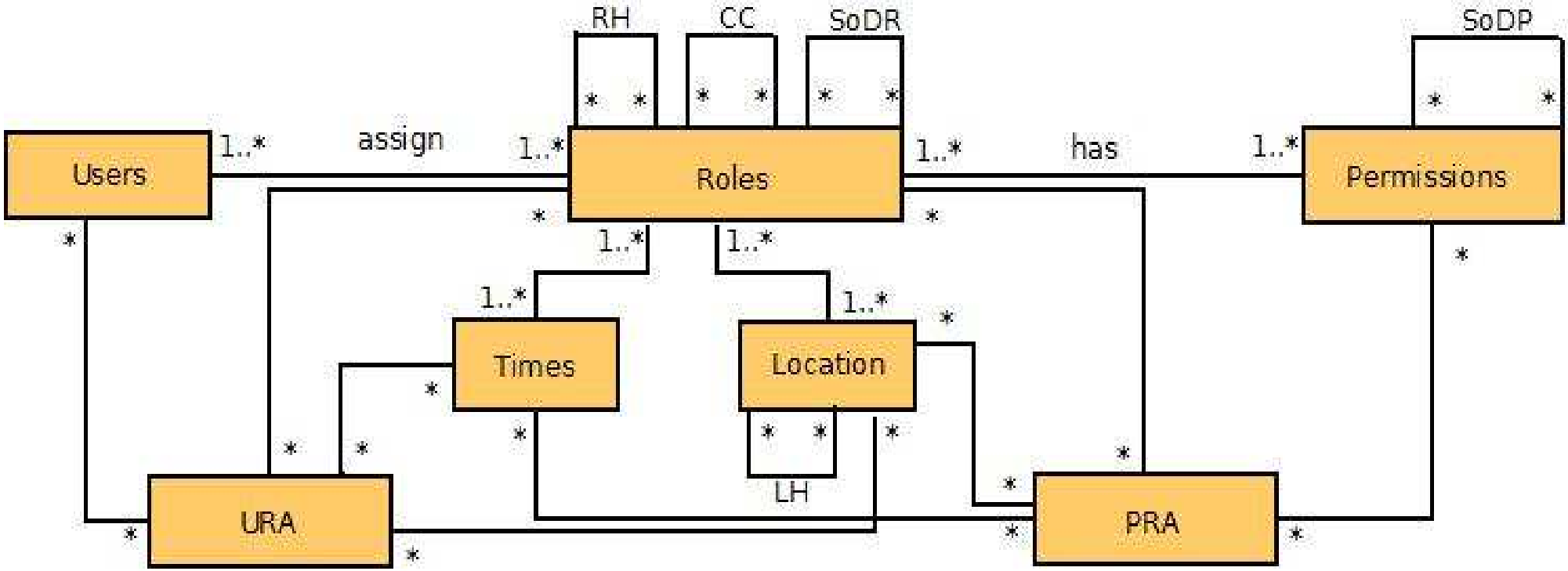
STRBAC Meta Model (A Fragment)



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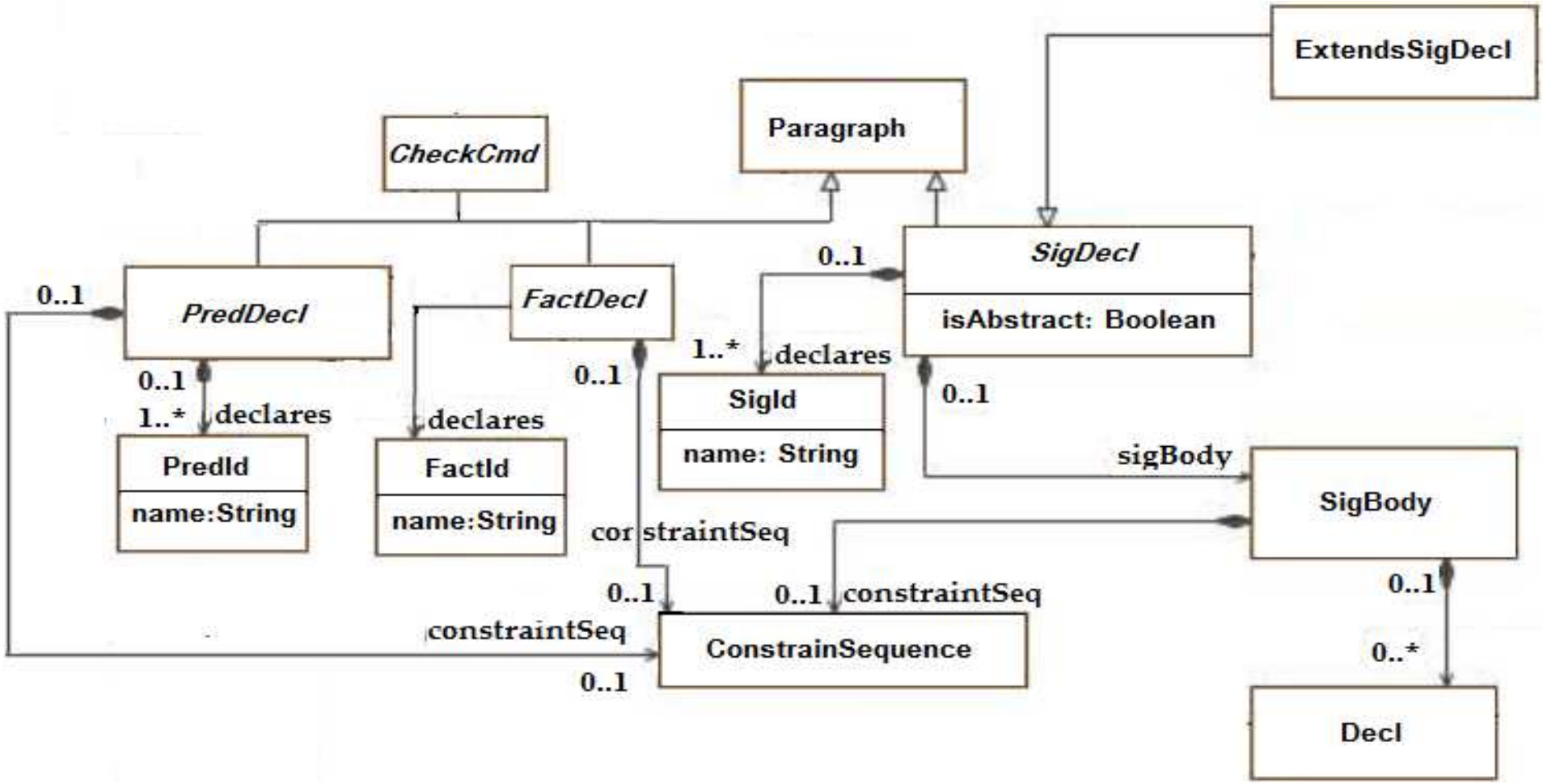
Alloy Meta Model (A Fragment)



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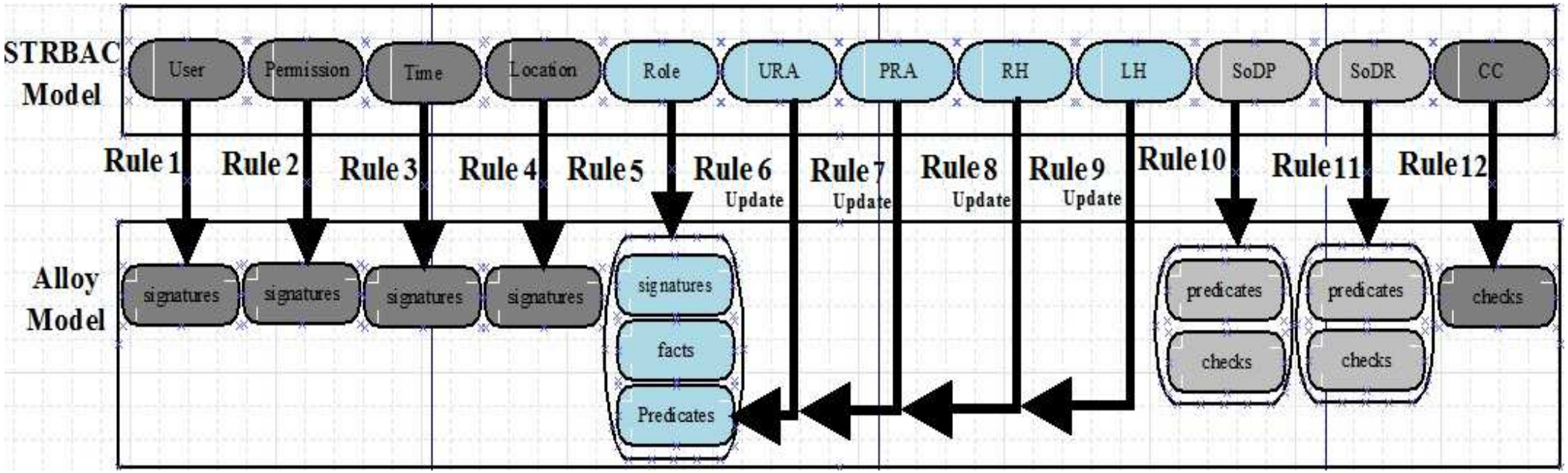
Transformation Rules



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Example

Consider an Access control model system which consists of the following Users: Dave, Mark, Sarah, the following Locations: office1 and office2, the following Times: DayTime and NightTime, the following Permissions: Read and Write Teller Files, Read and Write Loan Files and Read and Write System Operator Manager Files, and the following Roles: Teller, Loan Officers and System Operator Manager (SOM) .

Rule 1:Transformation of Users

```
abstract sig Users {}
One sig Dave, Mark, Sarah extends Users {}
```

Rule 2:Transformation of Permissions

```
abstract sig Permissions{}
One sig ReadWriteTellerFiles, ReadWriteLoanFiles,
ReadWriteSOMFiles extends Users {}
```

Cont…

Rule 5: Transformation of Roles

```
abstract sig Roles{time: lone Times,
        location: lone Locations,
        permissions: set Permissions,
        users: set Users}
one sig teller, LoanOfficer, SOM extends Users {}
fact SOMFact {all self:SOM | SOMCondition[self]}
pred SOMCondition[self:SOM]{((self.permissions=none)&&
(self.location=none)&&(self.time=none)&&(self.users=none))}
```

The transformation of URA, PRA, RH & LH will update the predicates for every role with new user to role assignment and permission to role assignment.

Rule 6: Transformation of User Role Assignment (URA)

For example, URA={(Mark, SOM, DayTime, Office1)

```
pred SOMCondition[self:SOM]{((self.permissions=none)&&
(self.location=Office1)&&(self.time=DayTime)&&(self.users=Mark))}
```


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Cont…

The other STRBAC elements such as SoDR, SoDP, CCR, & CCP will be transformed to Alloy checks.

Rule 10: Transformation of Separation of Duty over Permissions (SoDP)

For example, SoDP={(Read and Write Teller Files, Read and Write Loan Files, DayTime, Office1)

```
pred SODP[p1, p2:Permission, l:Location, t:Time] {all r1:Role |
((p1 in r1.permissions)&&(t in r1.time)&&(l in r1.location)))
((p2 not in r1.permissions)&&(t in r1.time)&&(l in r1.location))}

SoDP1 :check { SODP[ ReadandWriteTellerFiles, ReadandWriteLoanFiles,
DayTime, Office1]}
```


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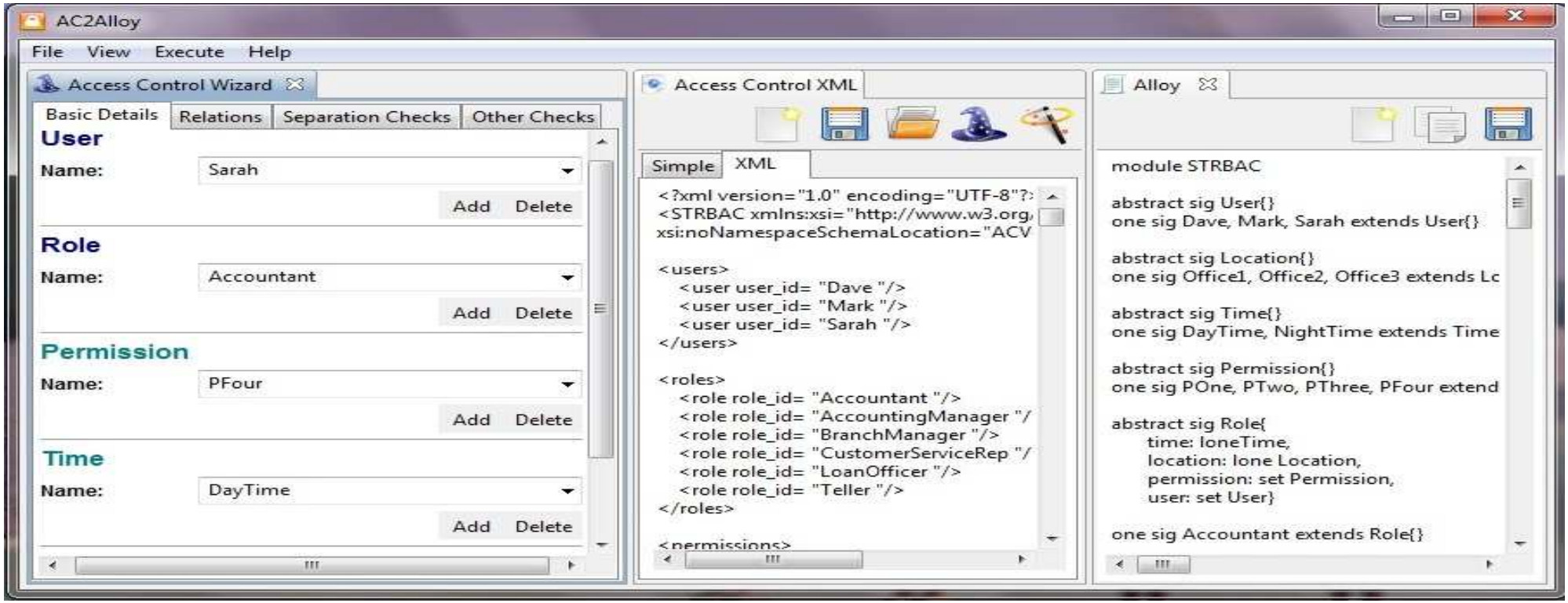
AC2Alloy

- AC2Alloy is a tool for integrating STRBAC and Alloy into a single tool.
- It enables the user to create STRBAC specification and conduct the analysis via Alloy.



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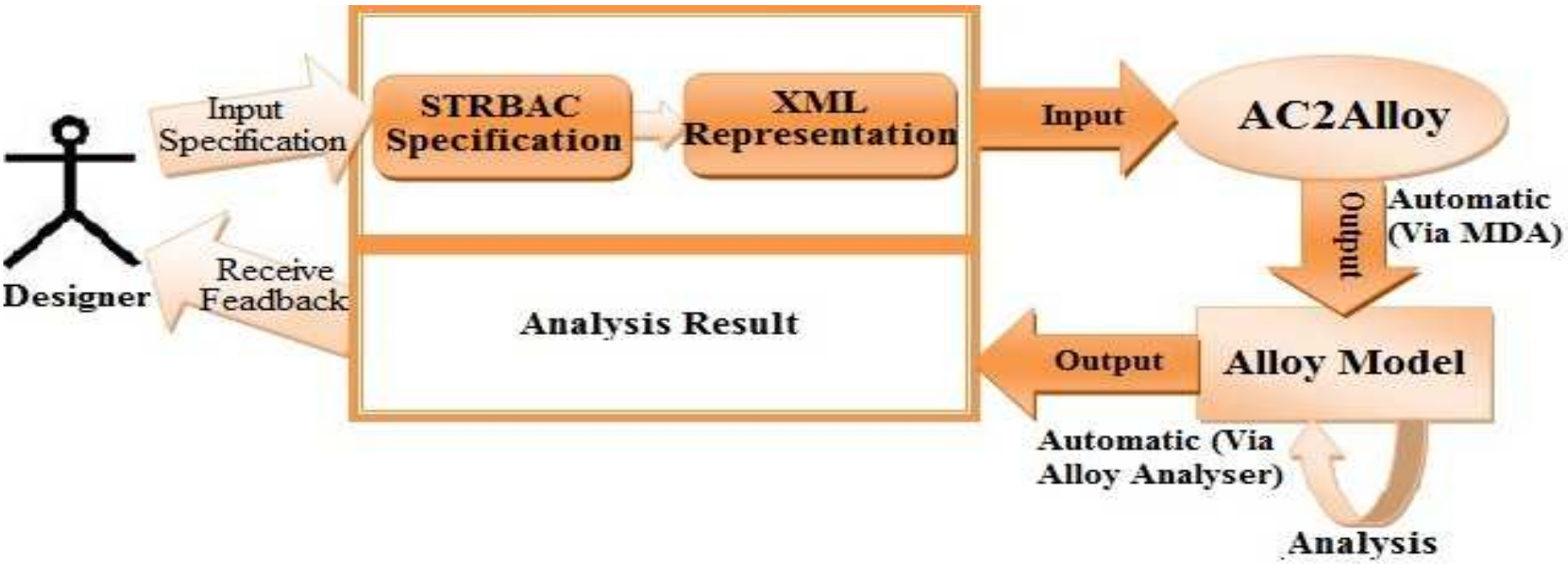
How AC2Alloy works?



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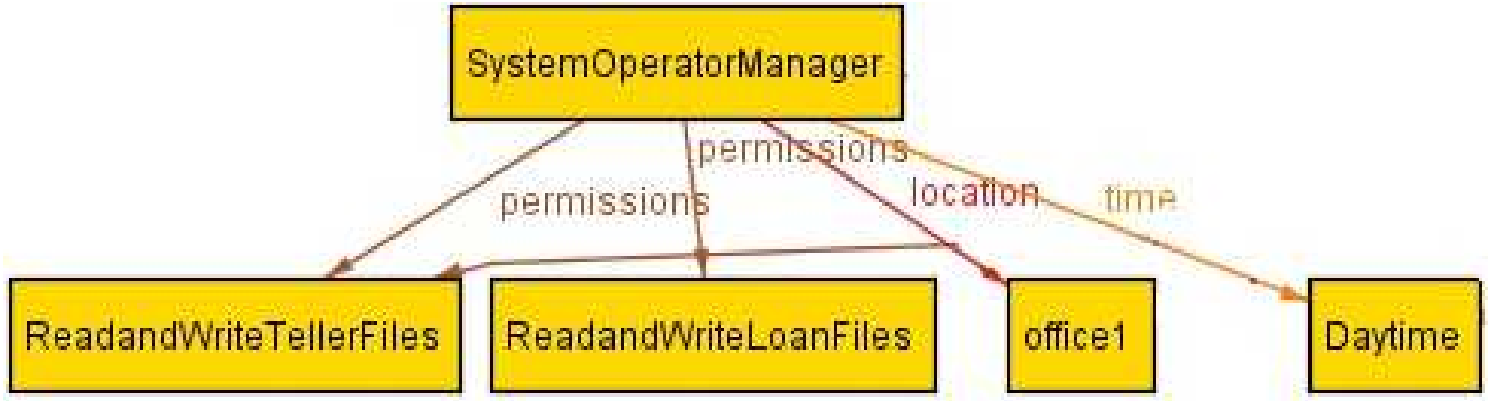
Results

- **Our method has been tested using a simplified SECURE Bank System**
  - **Transform the SECURE Bank Specification successfully and very quickly to Alloy code**
  - **Inconsistencies in the SECURE Bank Specification have been detected**



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Conclusion

- The proposed approach also ensures the creation of consistent Alloy codes.
- AC2Alloy softens the process of Alloy creation
- STRBAC to Alloy Transformation can provide a simple means of analysis and verification of the given STRBAC specification.

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Thank You!

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