# Formal Modeling and Test Generation Automation with Use Case Maps and LOTOS

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September 7th, 2001

# Outline

- Motivation
- Previous work
- Framework of our research
- Contributions, usefulness and limitations
- Case Study
- Perspectives

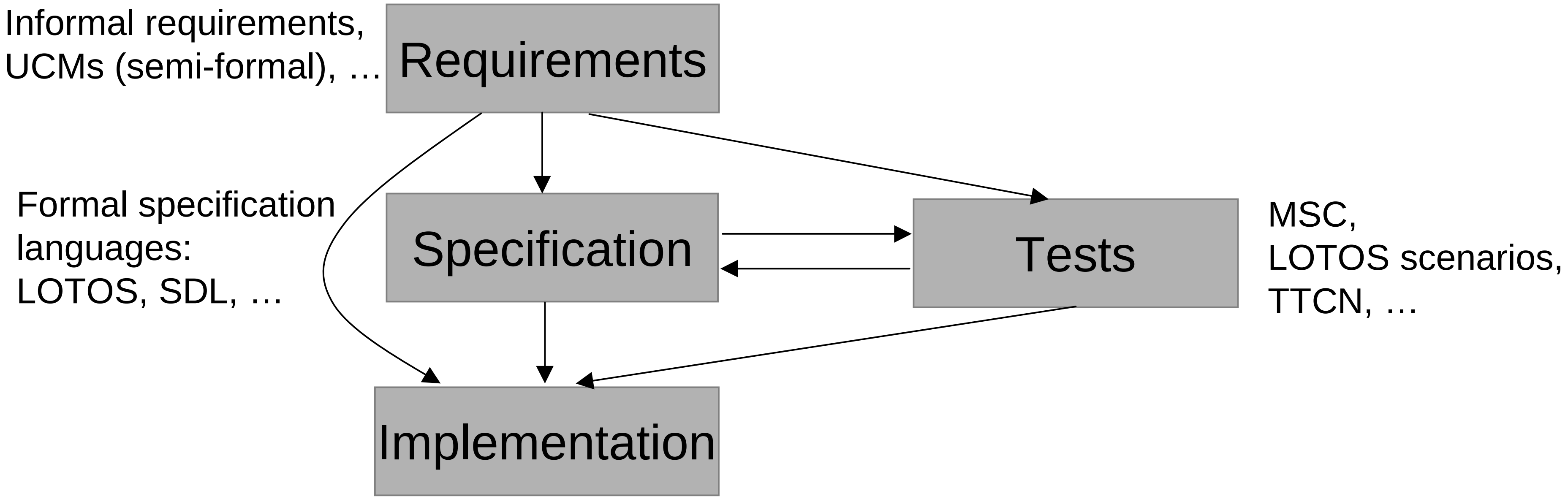
# Motivation

- The thesis addresses the problem of formal modeling and test generation in telecommunication systems
- Telecommunication systems are evolving
- New users requirements have to be met
- Time-to-market

→ Need for development methodologies allowing fast and robust software design

# Previous work

- Existing development methodologies:



- Existing testing tools:
  - LOLA, TGV, TorX for LOTOS specifications and tests
  - TAU for SDL specifications and TTCN test suites

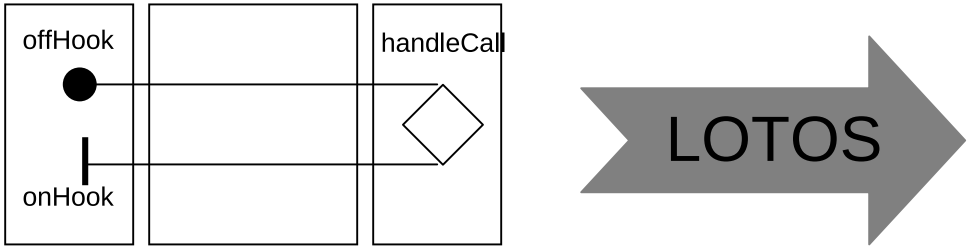
# Framework of our research

- Use existing development methodologies essentially using:
  - UCMs,
  - LOTOS, SDL

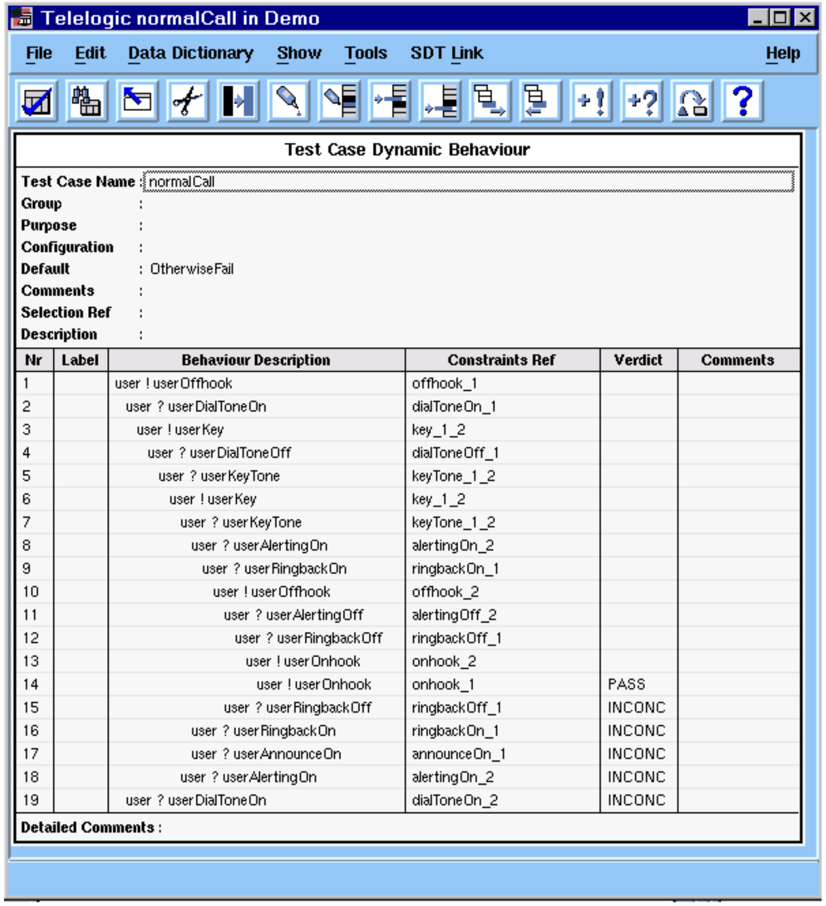
- Develop better solutions to meet the expectations of the industry
  - Better and faster design
  - Better and faster testing

# Contributions

- Design of a LOTOS model for a new Mitel PBX
- Automatic LOTOS scenario generation from UCMs
- New development methodology with fast test suite generation



Use Case Map



Test Case Dynamic Behaviour

Test Case Name : normalCall
Group :
Purpose :
Configuration :
Default : OtherwiseFail
Comments :
Selection Ref :
Description :

| Nr | Label | Behaviour Description | Constraints Ref | Verdict | Comments |
|---|---|---|---|---|---|
| 1 | | user ! userOffhook | offhook_1 | | |
| 2 | | user ? userDialToneOn | dialToneOn_1 | | |
| 3 | | user ! userKey | key_1_2 | | |
| 4 | | user ? userDialToneOff | dialToneOff_1 | | |
| 5 | | user ? userKeyTone | keyTone_1_2 | | |
| 6 | | user ! userKey | key_1_2 | | |
| 7 | | user ? userKeyTone | keyTone_1_2 | | |
| 8 | | user ? userAlertingOn | alertingOn_2 | | |
| 9 | | user ? userRingbackOn | ringbackOn_1 | | |
| 10 | | user ! userOffhook | offhook_2 | | |
| 11 | | user ? userAlertingOff | alertingOff_2 | | |
| 12 | | user ? userRingbackOff | ringbackOff_1 | | |
| 13 | | user ! userOnhook | onhook_2 | | |
| 14 | | user ! userOnhook | onhook_1 | PASS | |
| 15 | | user ? userRingbackOff | ringbackOff_1 | INCONC | |
| 16 | | user ? userRingbackOn | ringbackOn_1 | INCONC | |
| 17 | | user ? userAnnounceOn | announceOn_1 | INCONC | |
| 18 | | user ? userAlertingOn | alertingOn_2 | INCONC | |
| 19 | | user ? userDialToneOn | dialToneOn_2 | INCONC | |

Detailed Comments :

TTCN test case

# Contribution 1

## Design of a LOTOS model

- Follow an existing development methodology that uses:
  - Use Case Maps to express the requirements
  - LOTOS and SDL at specification stage
  - MSCs for verification and validation
  - TTCN for conformance testing with the implementation

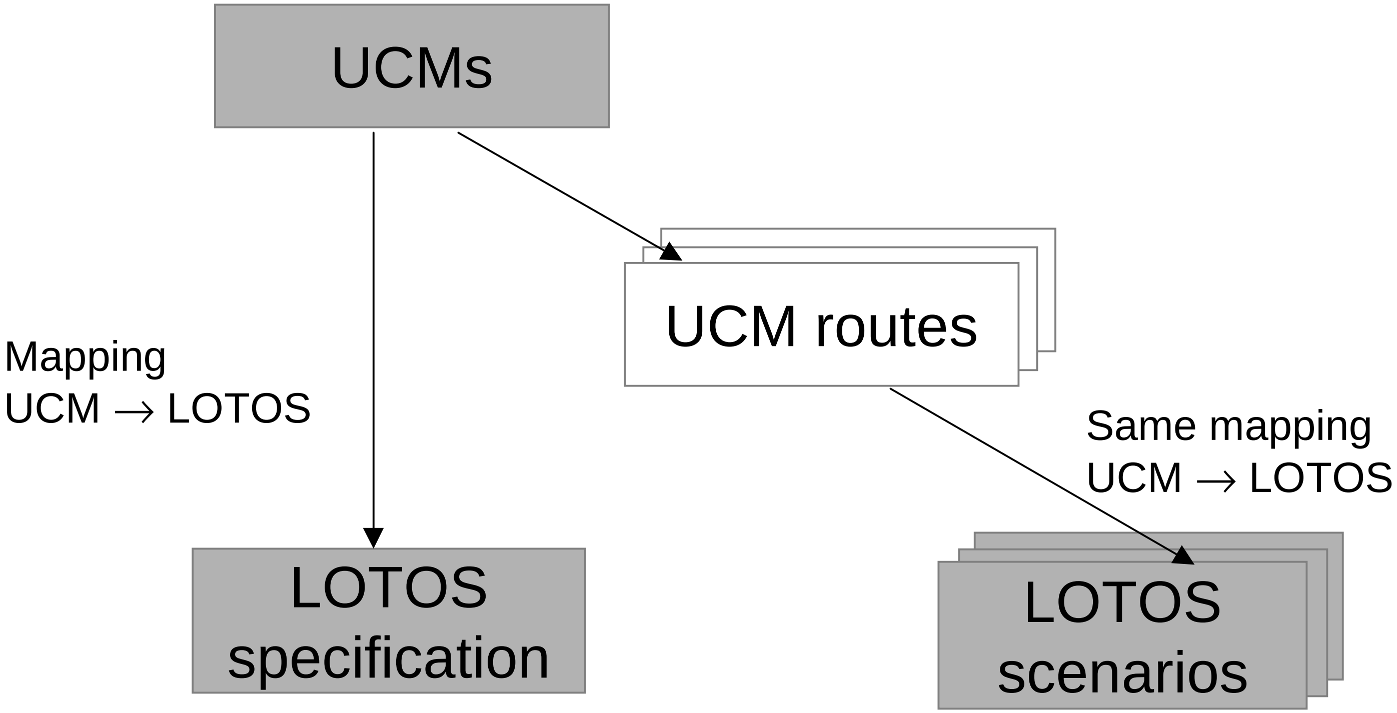
- Build a LOTOS specification that meets the requirements
  - Mapping rules from UCM elements to LOTOS elements

- Build a set of scenarios used for:
  - Validation of the specification
  - Cross validation between the LOTOS and the SDL specifications

# Contribution 2

## Automatic scenario generation from UCMs

- Developed and implemented a tool for the automatic generation of LOTOS scenarios from a UCM map: ***Ucm2LotosTests***



# Contribution 2

## Automatic scenario generation from UCMs

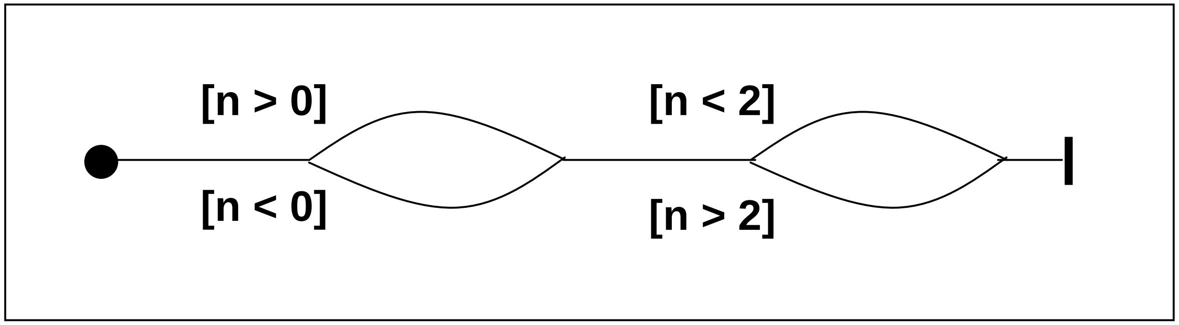
- **Usefulness:**
  - → Automatic generation → saves time
  - → Set of scenarios cover the UCM map since the algorithm visits all the routes
  - → Depending on the UCM to LOTOS mapping provided, the scenarios can be used for:
    - White-box testing
    - Grey-box testing
    - Black-box testing
  - → Obtained LOTOS scenarios useful for:
    - Verification of the LOTOS specification (white-box, grey-box testing)
    - Validation of the LOTOS specification (black-box testing)
    - Conformance testing (by using scenarios as inputs for the TTCN test suite generation)

# Contribution 2

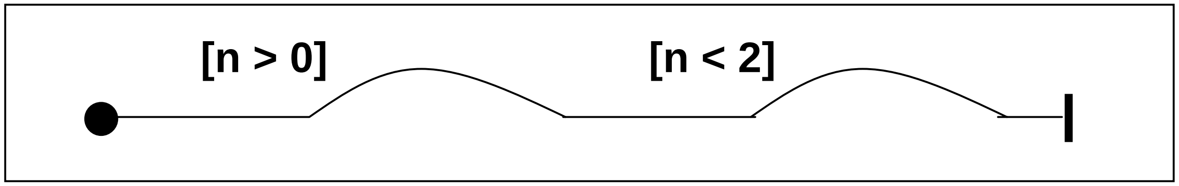
## Automatic scenario generation from UCMs

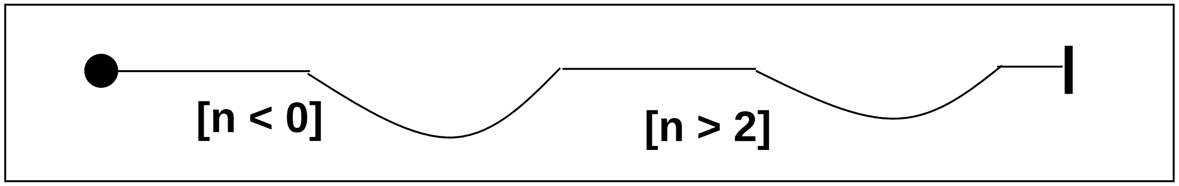
- **Consideration:** Generation of rejection scenarios

UCM



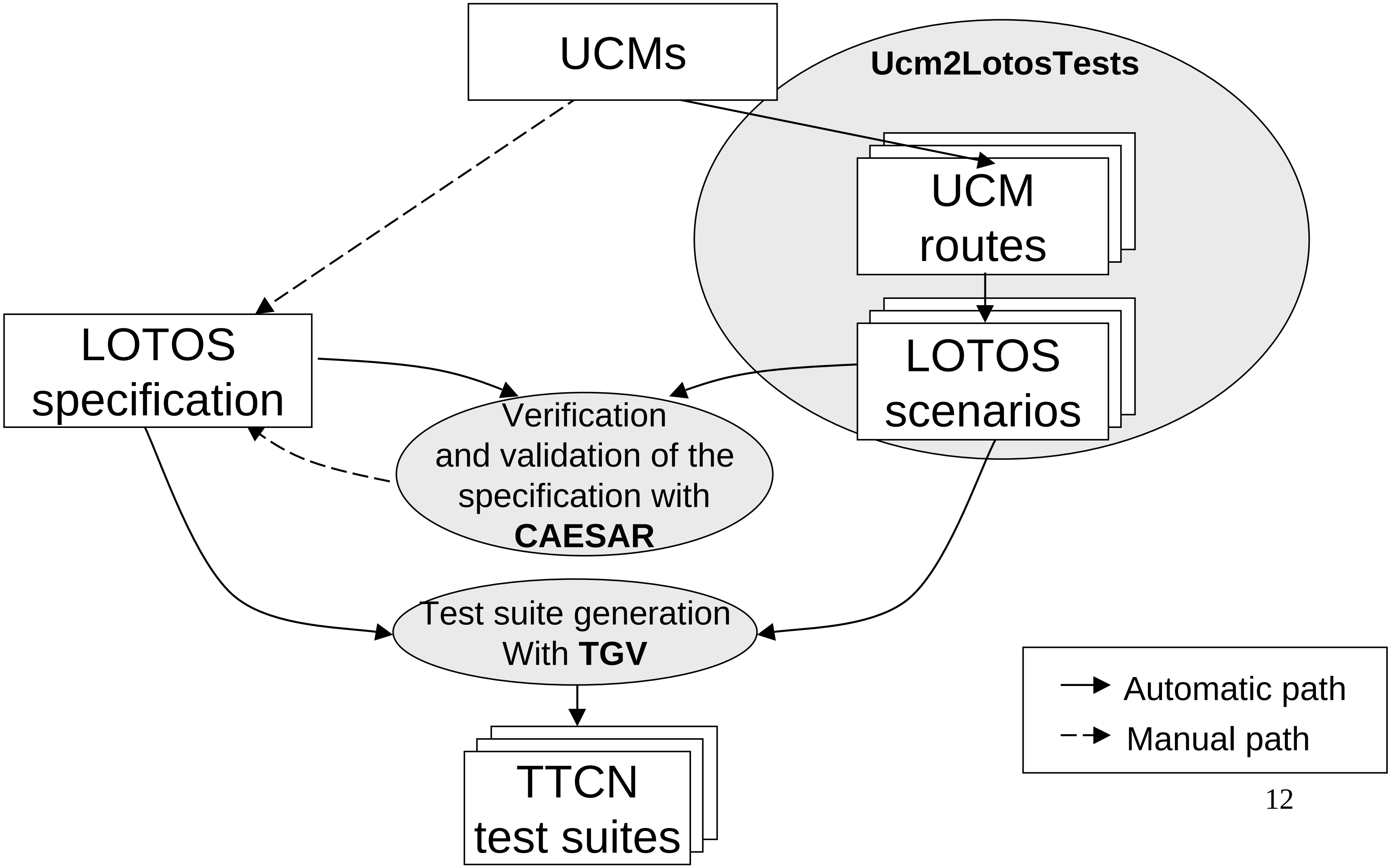
Rejection scenarios





# Contribution 3

## New development methodology with fast test suite generation



# Contribution 3

## New development methodology with fast test suite generation

- **Usefulness:**
  - “Fast” methodology because of automation
  - Use of the semi-formal notation UCMs allows preliminary semantic check of the system’s behavior
  - Use of the formal language LOTOS
    - → Specification is robust and not ambiguous
  - Automatic TTCN test suite generation from UCMs
- **Limitations:**
  - Use of CAESAR implies:
    - The LOTOS specification style is restricted
    - We must build a LOTOS specification that generates a small number of states

# Case Study

- Mitel’s Basic call specification and test generation

→ Tool problems:

  - Use of CAESAR → *Simplified* Basic call specification
  - Use of TGV → LOTOS to TTCN test conversion was not straightforward.

# Perspectives

- Improve Ucm2LotosTest
  - Handling recursive stubs
  - Regression testing
- Improve CAESAR and TGV
- Automate UCM to LOTOS specification
- Investigate the use of LOLA instead of CAESAR
- Investigate the use of SDL and the powerful SDL based tools