# Chapter 1

# Introduction

Reactive systems are event-driven systems, which continuously reacts to external stimuli. Examples of such systems include communication networks, operating systems, and embedded controllers for telephony, automobiles, trains and avionics systems [4]. Modeling reactive system is challenging task because of their inherent concurrency.
Such systems can be modeled by statecharts - a graphically readable model for illustrating system specification introduced by David Harel [12]. Statecharts used in system requirements phase of reactive systems for representing system behavior and interactions with its environment.
It is very important for reactive systems to formally verify that behavior captured by statecharts meet the system properties. Discovering errors and mismatches at early phase of system development reduces cost and also development time.
One way for verify a statechart is by translating into a finite transition system and using verification techniques to check properties. Symbolic Model Checking is a well known technique to verify system properties for finite transitions system. It is based on exhaustive state space exploration of the model of a finite state machine. NuSMV is a system based on symbolic model checking that was developed as a part of joint project between Carnegie Mellon University (CMU) and Istituto per la Ricerca Scientifica e Technologica (IRST), and its goal was the development of symbolic model checker [7].
The inputs of NuSMV are:

1. A transformation system that describes the system to be analyzed.

2. Properties to be verified - logic formulas.

The aim of this thesis is to supply a method for translating statecharts into NuSMV input language in order to enable the usage of verification techniques for checking properties of the original system. In addition, the translation model defines an intermediate language based on XML which helps in translating statecharts to other synchronous languages such as Esterel [1].
Having such translation enables both verifying the model by NuSMV tool and testing it using simulation environment provided by Esterel tools.

Both statecharts and NuSMV have similarities which enable integrating them into single tool with simulation and verification ability. NuSMV input language supports a reactive system by providing parallel assignment syntax which enables describing concurrency and independence properties. To do so, the set of states and transition relations are represented by formulas and a set operations is defined in terms of a formula manipulation.

There are several existing translations of statecharts to NuSMV such as suggested in [5], [2]. This thesis defines a similar translation with focus on statecharts transition priorities and determinism issues. In addition, a tool implementing the translation method was developed in order to simplify the translation by automating it.

The translation tool is an open source tool, so it can be used in future to include new translations of statecharts to other models such as Esterel.

Also, this work material can be used in the Real time and Reactive systems course (22912) at the Open University.

The rest of this work is organized as follows:

**Chapter 2:** Relevant related work, covering literature survey about statecharts, STATEMATE semantics and NuSMV model checker.

**Chapter 3:** Definition of the translation method from statecharts to NuSMV including definition of intermediate language that enables translation to other languages.

**Chapter 4:** Examples of translation of statecharts to NuSMV. In addition I show an example of translating statecharts to Esterel using the intermediate language.

**Chapter 5:** Summary of the work: Conclusions and future work.