

## Introduction

This Model form is a short description of the Echo Algorithm model that comes, for the Model Checking Contest @ Petri Nets, with: a set of PNML files, a set of properties to be checked (possibly one file per model instance) and an optional set of properties concerning the model (invariants, etc. – possibly one file per model instance). For Coloured Nets, equivalent PNML P/T net files are proposed too.

## Echo Algorithm

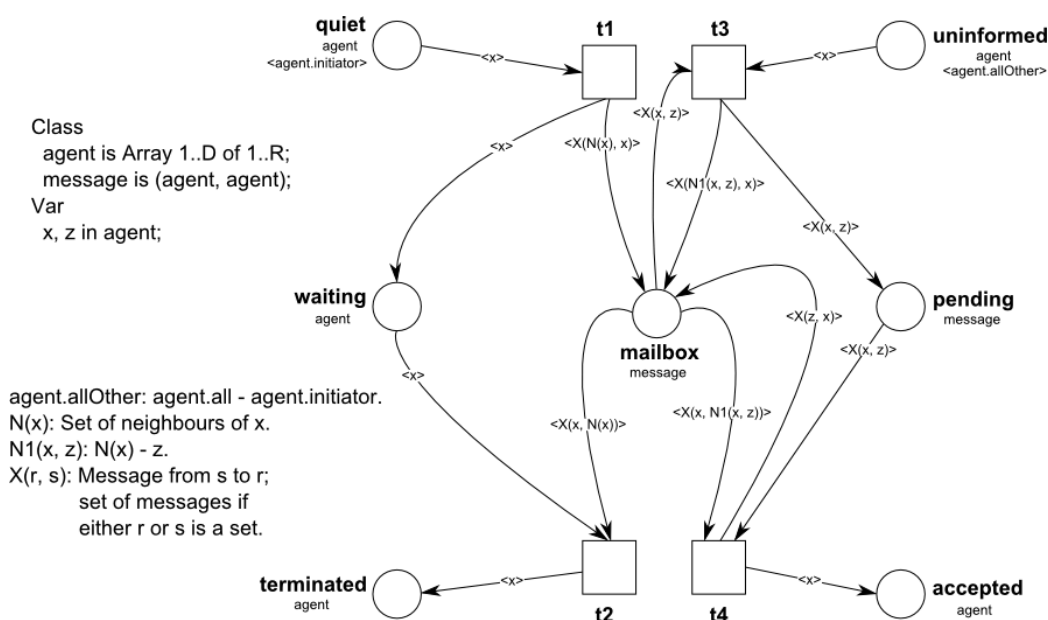


Figure 1: Presentation of the model for instance (generic algebraic description)

## Presentation

**Description:** This file specifies the Echo Algorithm (see [Reisig98]) for grid like networks. Echo is a protocol for propagation of information with feedback in a network. The algorithm operates in an incomplete, but connected bidirectional network of agents. A distinguished agent (initiator), starts the distribution of a message by sending it to all its neighbors. On receiving some first message, every other agent forwards the message to all its neighbors, except the one it received its first message from. Then it awaits messages from all recipients of its forwards (regardless whether these messages had been intended as forwards or acknowledgments) and replies to the agent where it received its first message from. As soon as the initiator receives a message from all its neighbors, the protocol terminates.

In this example, agents are arranged in a hypercube. The network can be scaled in two values: the number of *dimensions* and the number of *agents per dimensions*. For instance, a network with two dimensions and three agents per row would consist of  $3^2 = 9$  agents while a network with three dimensions and 4 agents per row would consist of  $4^3 = 64$  agents.

Regardless of the chosen values for these dimensions, we always connect agents that are immediate neighbors in one of the dimensions of the hypercube. We place the initiator into the center of the cube which means that the number of agents per row should be an odd number.

**Net formalism:** This submission contains unfolded versions of the Echo Algorithm for a variety of scaling parameters. These nets are given in LoLA low-level format and PNML. The original algorithm has been modeled as an algebraic Petri net in LoLA high-level format, see <http://service-technology.org/files/lola/lola.pdf>.

The model is sketched in the figure. The two sorts  $D$  and  $R$  model the scaling factors dimensions and agents per row, respectively. Messages are modeled as pairs (receiver, sender).

**Origin:** Wolfgang Reisig. *Elements of Distributed Algorithms. Modeling and Analysis with Petri Nets.*, Springer, 1998.

### Scaling parameter

Name	Description	Values
(dimensions, agents per row)	see description	(2,9), (2,11), (2,15), (2,19), (3,3), (3,5), (3,7), (4,3), (5,3)

## Information about the Model

### Data on the Model

Number of places	Number of transitions	Number of arcs	Scaling parameter value
265	206	1252	(3,3)

### Stated Properties

safe	✓	free choice	✗	event graph	✗
deadlock	✓	state machine	✗	reversible	✗

### Other Properties (not mandatory)

The intuitive description of the Echo Algorithm can be modeled as CTL formula

$$(\mathbf{AF} \text{ "initiator terminated"}) \wedge (\mathbf{A} \neg \text{ "initiator terminated"}) \mathbf{U} \text{ "all other sites accepted"}$$

This formula is given for the unfolded low-level models.