PRODUCT VALIDATION FOR STANDARDIZED NETWORK PROTOCOL

Tadao Saito, Toshihiko Kato, and Hiroshi Inose

Faculty of Engineering
University of Tokyo
Bunkyo-ku, Tokyo 113, Japan

ABSTRACT

To connect a new node to an established computer network, it is needed to confirm that the new node is constructed conforming to the network protocol. This paper describes a method to validate the protocol of the product based on an automaton model. The node to be tested is connected to protocol tester which applies a test sequence and observes the response from the node. Considering the fact that protocols are specified in terms of the responses to inputs from higher level as well as external inputs, to validate the protocol for input from higher level, an additional higher level program called validation task may be needed. This paper describes two method for validation of HDLC-BA* protocol. The first method uses the validation task and the second method does not use the validation task. Detail of test sequence and the completeness of the validation are described in this paper.

1. INTRODUCTION

To construct and maintain a large-scale computer network, the establishment of network protocol and to exact conformity to the established protocol is essential. If a node which does not conform to the protocol is connected to the network, various difficulties may happen in the network.

Therefore, if a new node is to be connected to an established computer network, the new node is to be tested if the node is implemented conforming to the established network protocol. In the implementation process of a node, tests to verify correctness should be performed in various phases. The programs used to implement the protocol must be intensively tested from the view point of program debugging. In the last phase of the test the node is to be tested by connecting the node to the network or the network simulator and by applying various signals to the node in the real network or a network simulator which can simulate the network environment in a controlled manner. If the network simulator is designed to generate a test sequence which can validate all the specification in the network, the node can be completely validated.

The present paper proposes a method to validate the protocol implemented in a node. The validation in this sense may be called a "product validation of the protocol" [Kawao (1978)].

Recently various standardization activities are made to establish internationally or nationally standardized network architecture. If the protocol of the standard architecture can be validated by a product validation procedure, the usefulness of the standard will be great. For this purpose, the description of the standard itself should be formalized to support the product validation.

The product validation described in this paper is based on an automata model. The model is established assuming that the protocol is defined in terms of state transition matrix. The formulation of the validation model, the environment of the validation and an example to apply the model to HDLC-BA protocol are described in this paper.

* High Level Data Link Control Procedure — Ballanced Asynchronous.
This procedure is defined by IS 3309, 4335, 6159, 6256, JIS 6363, 6364, 6365, and CCITT X.25.
2. PRODUCT VALIDATION PROCEDURE OF A PROTOCOL

The protocol validation of this paper is assumed to be performed by connecting the node to be tested to a protocol tester through a communication channel. Protocol tester will apply various test sequences to the tested node and will receive the response from the tested node.

The protocol implemented in the node can be modeled as a finite state automaton. The automaton is called the protocol machine. Thus the validation procedure can be reduced an identification problem of an automaton.

The automaton is defined by a set of states and transitions between states. The transitions are caused by the input to the automaton. Figure 1 shows three classes of inputs to the protocol machine.

The input from the protocol tester is the external input. In addition to this, input from the higher level protocol is applied to the automaton. The input from higher level is not directly controlled by external input. The input is also applied from timers which is to be implemented as a part of HDLC control program. The input from timer is controlled indirectly by the external input but they can be controlled by external input without additional programming effort for the validation.

To control the input from higher level directly by the external input, some programs which controls the HDLC level from higher level must be implemented which is not needed in usual operating environment. This is called higher level test aid or validation task. To generate input from higher level to control the HDLC level control information should be imbedded in the incoming HDLC frame applied from the protocol tester. The higher level test aid generates higher level input in response to the control information.

In this paper a validation scheme using the higher level test aid is described first. Although nearly complete validation is possible using this scheme, to eliminate the necessity of additional programming, a validation scheme which does not use the higher level test aid is also described. The completeness of the validation schemes is evaluated at the conclusion.