Deadlock Prevention in the ÆTHEREAL Protocol

Biniam Gebremichael, Frits Vaandrager & Miaomiao Zhang
ICIS, Radboud University Nijmegen, The Netherlands.

Kees Goossens, Edwin Rijpkema & Andrei Rădulescu
Philips Research Laboratories, Eindhoven, The Netherlands.

CHARME'05, Saarbrüken, Germany. October 3-6 2005

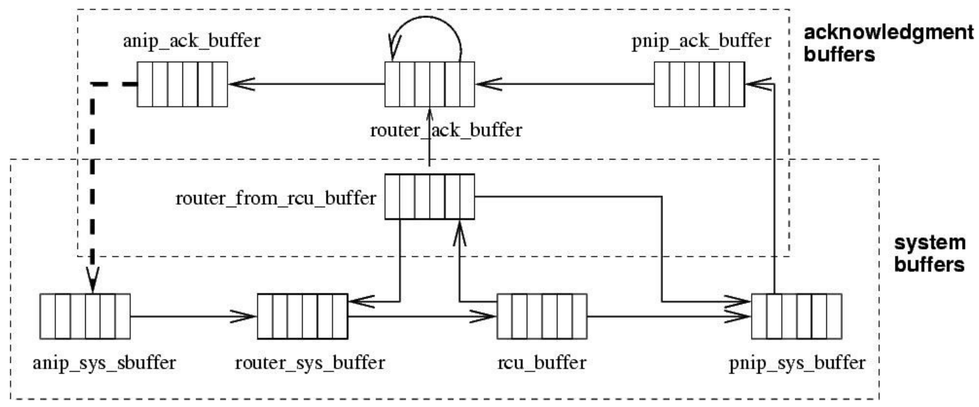
Introduction

Network on Chip(NOC) is an alternative means of communication between individual blocks inside a chip [Hermani et al. 2000].

- It uses packet-switching communication, like TCP/IP.
- It solves the problem of scalability that is present in the traditional point-to-point communication.
- Packet-switching may lead to deadlock.

Results

- Complete and formal model (in PVS) of NOC and ÆTHEREAL.
- A systematic way of keeping track of the design alternatives (modularity of the model).
- A proof that the system is deadlock free. Done in an abstracted version of the model.



What is ÆTHEREAL protocol?

ÆTHEREAL protocol is a protocol that is designed to realize correct functionality of NOC and avoid any circumstance that lead to deadlock [Goossens et al. 2000].

This is done by providing:
1. Best effort service (BE), and
2. Guaranteed-throughput service (GT)

GT connections are established by BE packet transfer between the sender (ANIP) and the receiver (PNIP) blocks.

Deadlock prevention criteria

1. Use separate buffers for ANIP-to-PNIP and PNIP-to-ANIP communications.
2. Do not allow ANIP to send more packets than it can accommodate their acknowledgment packets.

```
%when ever there is a packet coming to anip_sys_buffer,
%there will be always a space to accommodate it.

Inv1(s):bool = ee(s) + g(s) + m(s) + l2(s) <= C(l2(s))
property1: LEMMA  reachable_path(sl) IMPLIES
   (FORALL i: i< length(sl) IMPLIES Inv1(nth(sl,i)))
```

Research problem

Is ÆTHEREAL protocol deadlock free?

Formal specification is useful to document complex designs, force designers to clarify design choices, and resolve problematic inconsistencies in the early stage of the design process.

`http://www.cs.ru.nl/ita/publications/papers/fvaan/noc.html`