PROTOCOLS FOR RELIABLE MULTICAST OVER BROADCAST CHANNELS

By

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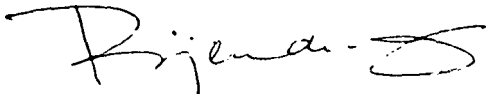
TO MY PARENTS

CERTIFICATE

This is to certify that the thesis entitled "**PROTOCOLS FOR RELIABLE MULTICAST OVER BROADCAST CHANNELS**" being submitted by **Mr. S. RAMAKRISHNAN** to the Department of Electrical Engineering, Indian Institute of Technology, Delhi for the award of the degree of '**Doctor of Philosophy**' is a record of the bonafide research work carried out by him. Mr. S. Ramakrishnan worked under our guidance for the submission of this thesis which to our knowledge has reached the requisite standard.

This thesis or any part thereof has not been submitted to any other university/institution for the award of any degree or diploma.



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ABSTRACT

Broadcasting is considered an essential mechanism for most Local Area Networks (LANs). As such applications demanding (stream-oriented) broadcast based services are emerging.

This thesis concerns a special form of broadcasting called selective broadcasting, more generally referred to as multicasting. Specifically, this study relates to design and analysis of protocols that ensure reliable multicast communication of messages from a source (transmitter) to a group of other stations (receivers), all connected over a LAN that supports an inherent broadcasting capability. The considerations in this study have been to exploit the broadcast feature of the channel to the extent possible. Fundamental to this development are two key points:

i) The responsibility of ensuring that a sequence of messages is indeed received by a receiver rests solely with the receiver itself, rather than with the message transmitter (the latter is the case with one-to-one communication protocols as also with some of the recent protocols for multicast).

ii) Given that a message multicast has not been received by a station, then there are other receivers, who, with non-zero probability, also do not receive it. This can be justified on several accounts.

We design a **simplified protocol** for multicast communication. This protocol is analyzed for two extreme conditions, viz. i) the

responses are fully coordinated, and ii) there is absolutely no coordination among the receivers. A **modified protocol**, that incorporates some suggestions toward exploiting the underlying broadcast capability, is introduced. This protocol attempts to i) minimize the number of response transmissions by secondary stations, and ii) reduce simultaneous transmission attempts.

Both the protocols are analyzed for throughput and delay characterstics. Due to the complexity of an exact performance analysis, this study concentrates on obtaining suitable bounds on performance.

The next stage of this development is a truely multicast **window protocol**. It exploits broadcasting even further, and supports a modulo-N numbering scheme, a window mechanism and a polling scheme. Salient features of this protocol are i) all transmissions are multicast, ii) receivers arbitrate in sending their retransmission requests, iii) information contained in acknowledgements from one station are relayed by other receiver stations, iv) greater redundancy in communicating response transmissions, and v) the acknowledgement scheme may be used to impose flow control. Necessary and sufficient conditions that relate the window size to the numbering scheme are derived. A special case of this protocol is analyzed using an imbedded Markov chain model.

Extensive simulation studies of all the three protocols are carried out and compared with the analytical results, where applicable. Some of the models are also simulated and compared with the simulation of the actual protocol.

In designing the window protocol, a new approach toward reliable communication, viz. Negative Acknowledgements with Periodic Polling (NAPP) is advocated in this thesis. Herein, the receiver polls the transmitter at regular intervals, soliciting (re-)transmission of a group of messages, if any, and if this poll were, however, not to elicit a response from the transmitter, link failure may well be assumed.

Some attempts have been made toward establishing the dual nature of the NAPP scheme and the well known approach used in the design of one-to-one communication protocols, viz. Positive Acknowledgement with Periodic Retransmission. This, we beleive, would allow one to verify the properties of one scheme using that of the other.

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