Accurate and Generic Sender Selection for Dissemination in Low-Power Wireless Networks

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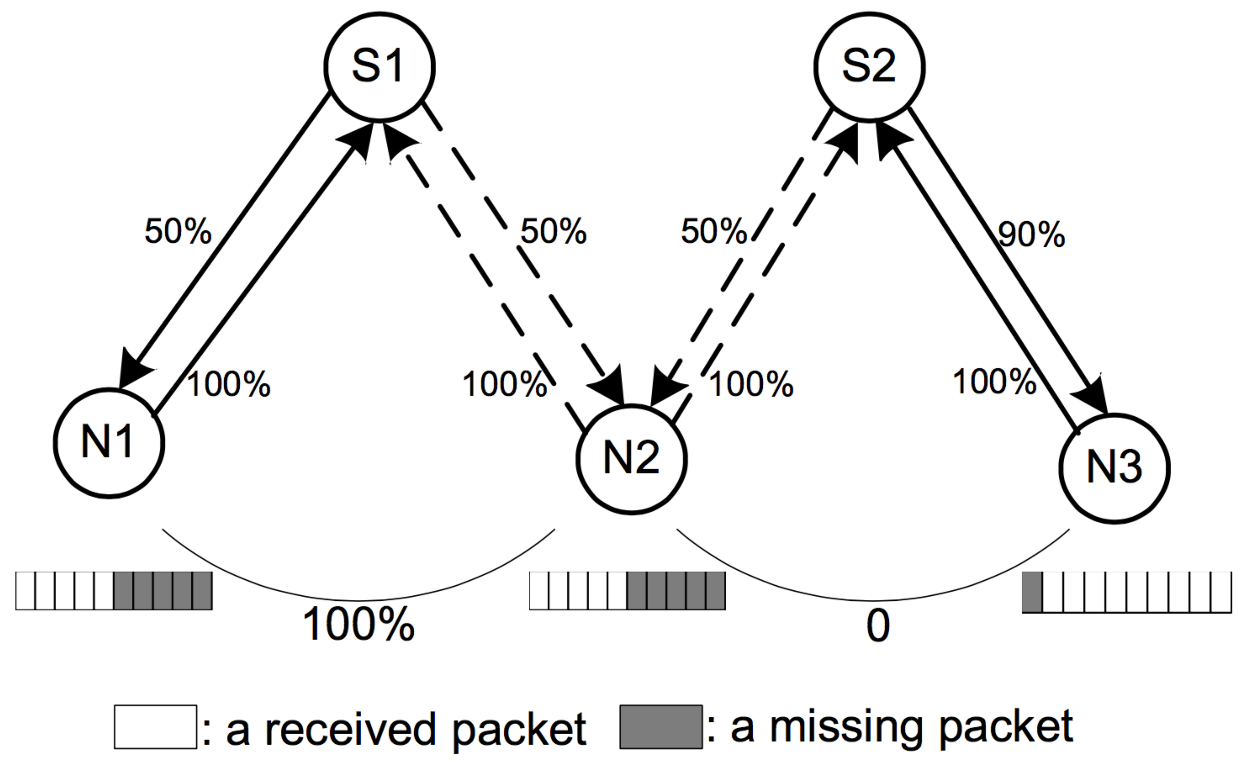
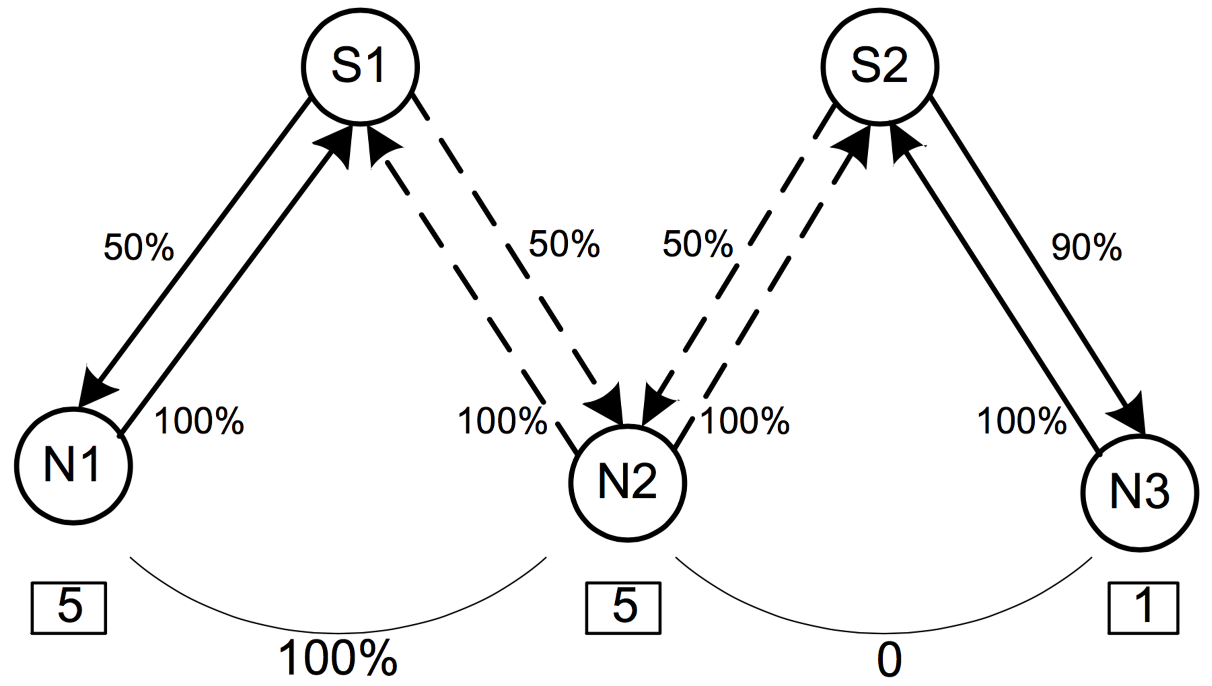
Introduction

Data dissemination is a fundamental service offered by low power wireless networks. Sender selection is the key to the dissemination performance and has been extensively studied. Recent studies have shown that spatial link diversity has a significant impact on the efficiency of broadcast. However, the existing metrics overlook such impact. As a result, these works cannot well support data dissemination, especially for lossy environments. In this paper, we first propose a novel sender impact metric, namely γ, which jointly exploits link quality and spatial link diversity to calculate the gain/cost ratio of the sender candidates. Then we develop a generic sender selection scheme based on γ which supports efficient dissemination protocols. The experiment results show that dissemination based on γ outperform the existing protocols in terms of completion time and transmissions.

Motivation



For dissemination with native packets (without network coding, as shown in the above figure), 11.1 packet transmissions are expected to cover N1, N2 and N3 with all ten packets, if S1 starts retransmission first. Otherwise if S2 starts retransmission first, 21.1 packet transmissions will be expected, which is much larger than 11.1. The difference comes from the correlation among the packet losses on the different links.



When network coding is used, the difference of packet losses among different links seems to have no impact on the transmission efficiency. However, the number of transmissions can still be significantly affected by the correlation. When S1 starts retransmission first, 11.1 transmissions will be expected. When S2 starts retransmission first, 20 transmissions will be expected. We can see that for both cases with and without network coding, selecting the sender for transmissions is of great importance to the transmission efficiency. The sender selection can be greatly affected by the spatial link correlation.

The γ Design

The key idea is to calculate the utility (gain/cost ratio) for each sender and select the sender with the largest utility for each round of transmission. The existing metrics fail to consider the link correlation and may result in inaccurate estimation. For sender selection without network coding, γ is calculated as:

$$\gamma_u = \frac{\sum_{i=1}^{|R_u|} R_u[i] \cdot \mu[i]}{M}$$

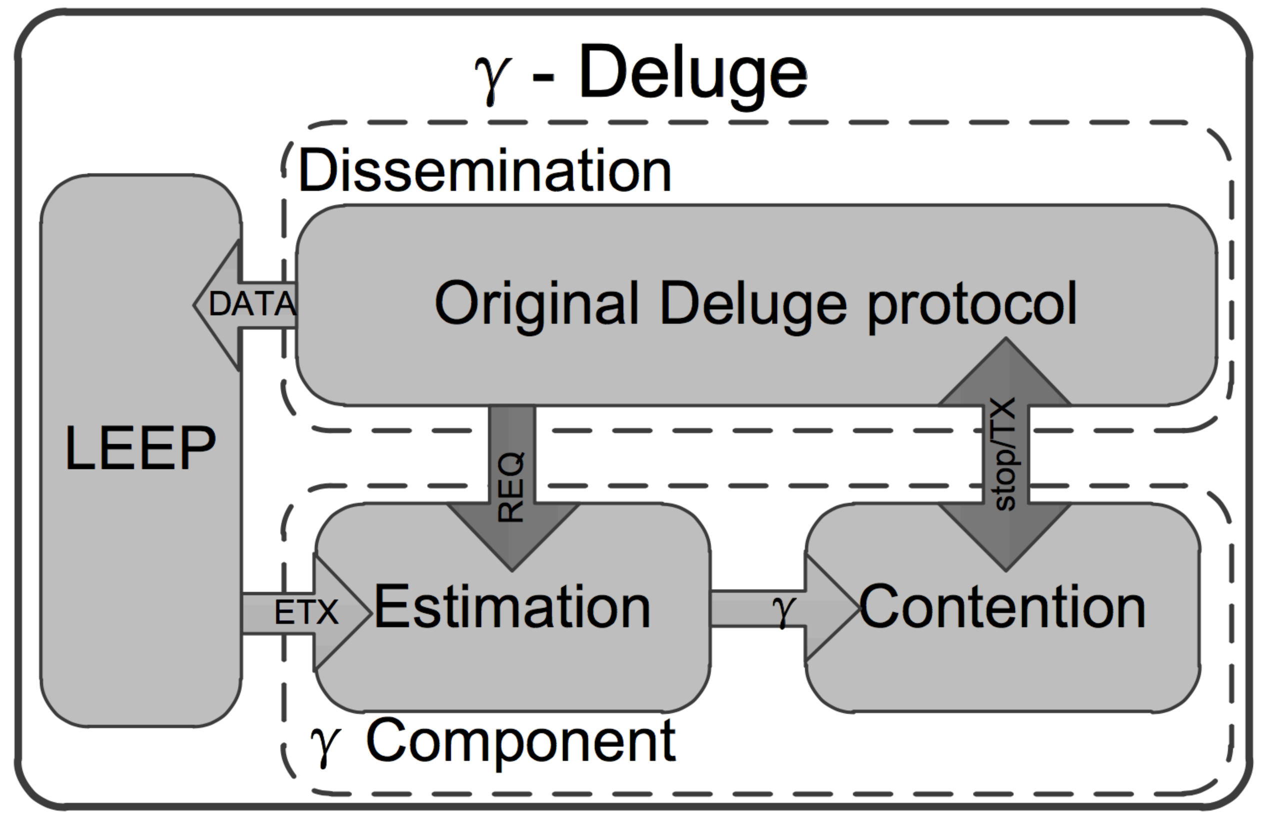
For sender selection with network coding, γ is calculated as:

$$\gamma_u = \frac{\sum_{i=1}^{M} \mu[i]}{M}$$

where μ denotes the utility and is calculated as:

$$\mu[i] = \sum_{k:n_k \geq i} q_{uk}(1-p_l) + \sum_{k:n_k<i} P_{i-1}(k) \cdot q_{uk}(1-p_l)$$

For details about the design of γ, please refer to our paper on *IEEExplore* or *ACM Digital Library*.
Based on γ, we further propose a γ-component that incorporates link estimation, γ estimation and sender transmission contention as shown in the following figure. Dissemination protocols can easily select more efficient senders with γ component.

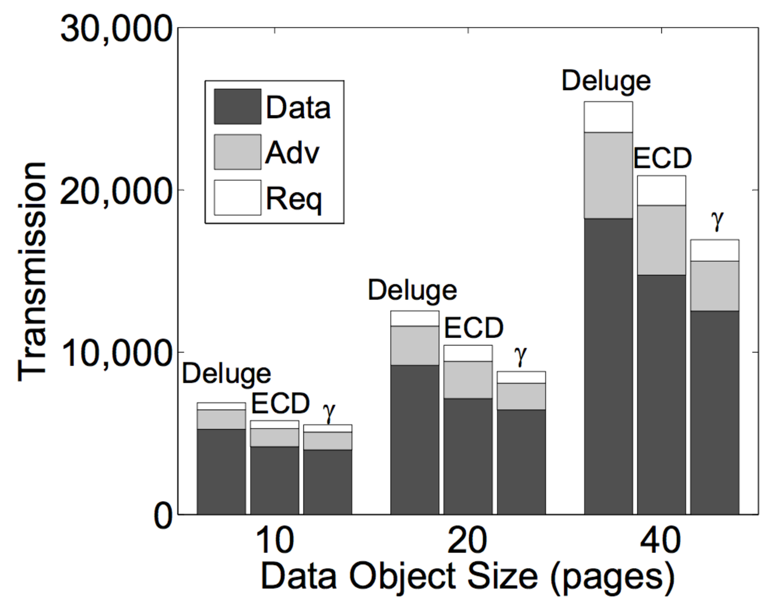


γ-component and its incorporation to Deluge

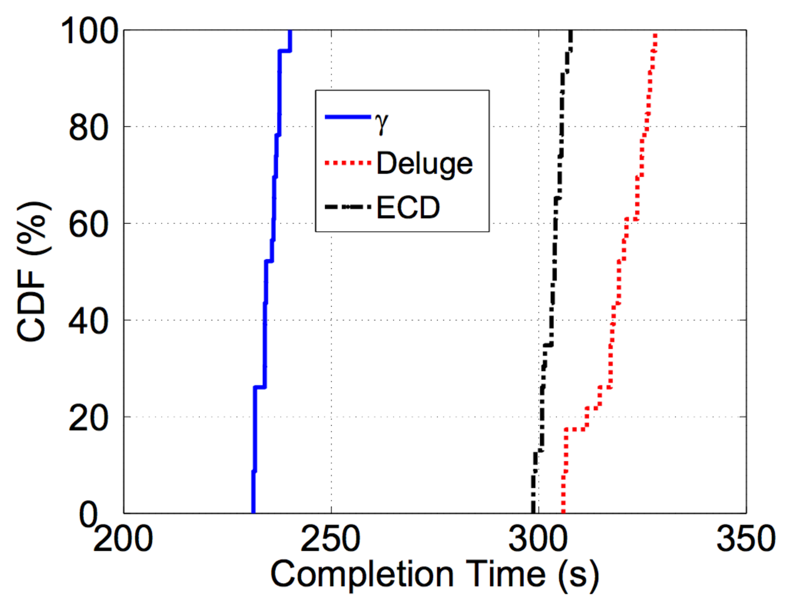
Evaluation Results

Protocols	Selection err.	Estimation err.	Contention err.
γ-Deluge	10.9%	2.1%	8.8%
ECD	29.5%	20.4%	9.1%
MNP	33.2%	21.1%	12.1%
Deluge	64.3%	-	-

Sender selection accuracy



Transmission efficiency



Completion time