# A Lightweight Message Dissemination Strategy for Minimizing Delay in Online Social Networks

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# Outline

- **1. Introduction**
- 2. Model Description
- 3. Message Dissemination Strategy
- 4. Evaluation

# 1. Introduction

## 1.1 Motivation

- **In Online Social Networks (OSNs), some time-insensitive messages (disaster warnings, virus alerts, and search notices, etc.) are badly in need of being disseminated to specific users or applications as soon as possible.**

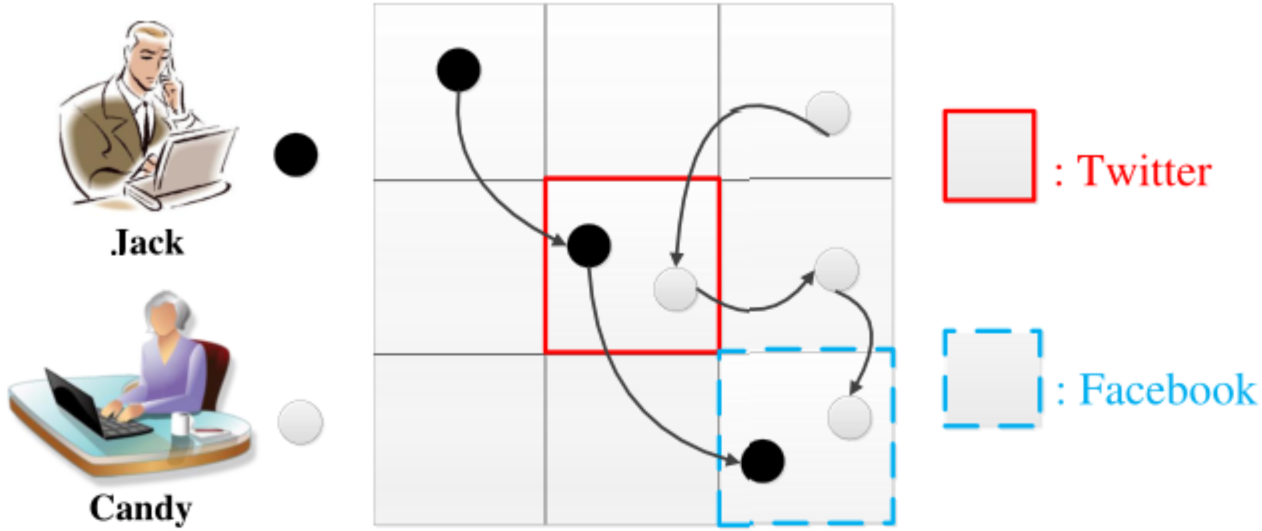
- **Sudden message dissemination among users is bound to put a significant burden on network resources.**

- **A lightweight Message Dissemination strategy for Minimizing Delay in OSNs is required.**

# 1. Introduction

## 1.2 Problem

- **How to disseminate message in Online Social Networks. Each grid represents a kind of social application, each circle represents a user, which could disseminate the message to any other user in the same social application.**



# 1. Introduction

## 1.3 Contributions

- **We define the user's activeness in OSNs according to the switch habit among different social application**
- **According to the user's activeness, a lightweight message dissemination strategy for minimizing delay is proposed in OSNs**
- **We conduct extensive simulations based on the synthetic user's activeness.**

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# 2. Model Description

## 2.1 Continuous-time Markov model

- **We define the parameter of the exponential distribution obeyed by a user's residence time in each social application as user's activeness. According to a user's activeness, we achieve the expectation time for the first meeting between two users, which plays a major role in terms of making a message dissemination strategy, aiming to minimize delivery delay.**

***Theorem 1:*** $\xi^X \sim exp(c_1)$, $\xi^Y \sim exp(c_2)$, *and then* $\xi \sim exp(c_1 + c_2)$.

***Theorem 2:*** $\xi^X \sim exp(c_1)$, $\xi^Y \sim exp(c_2)$, *the earliest time for A and B to meet each other* ($T = inf\{t \geq 0; X_t = Y_t\}$) *satisfies:* $T \sim exp(\frac{c_1+c_2}{n-1})$.

# 2. Model Description

## 2.2 Notations

| Notation | Explanation |
|---|---|
| $n$ | Total number of social applications (i.e., number of grids) in OSNs |
| $e$ | The set of different social applications, $e = \{e_1, e_2, \cdots, e_n\}$ |
| $X_t$ | The user's state (social application being used) at time $t$, $X_t \in e$ |
| $P_{ij}(t)$ | The probability that user's state of time 0 is $i$, the state of time $t$ is $j$ |
| $\tau_i$ | The random residence time for a user in social application $e_i$ |
| $c_k$ | The parameter in exponential distribution of user $k$'s residence times |
| $T$ | The earliest time for two users to meet each other |
| $E_{ij}(T)$ | The expected earliest time for two users to meet each other, with the condition that their initial states are $i$ and $j$ |
| $\xi$ | The first switch time (switch from one social application to another one) for any of the two users |
| $l$ | The total number of users |
| $T_i$ | The first meeting time between user $i$ and user $l$ (destination user) |
| $\lambda_{l,i}$ | The parameter of $T_i$'s exponential distribution, $\lambda_{l,i} = \frac{c_l + c_i}{n-1}$ |
| $T^{(l)}$ | The dissemination delay from the lowest priority user to highest priority user for a $l$-users system |
| $r_l$ | The expectation of $T^{(l)}$ |

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# 3. Message Dissemination Strategy

## 3.1 Strategy

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*Theorem 3:* $P(T_j < T_i, \forall i \neq j) = \frac{\lambda_{l,j}}{\lambda_{l,1}+\lambda_{l,2}\cdots+\lambda_{l,l-1}}$.

*Theorem 4:* $E[T_j \chi_{T_j=\tau}] = \frac{\lambda_{l,j}}{(\lambda_{l,1}+\lambda_{l,2}\cdots+\lambda_{l,l-1})^2}$.

*Theorem 5:* $\lambda_{l,1} > \lambda_{l,2} > \cdots > \lambda_{l,l-1}$, *if we exchange any pair of priorities* $\lambda_{l,i}$ *and* $\lambda_{l,j}$, *then the* $r_l$ *will get bigger.*

- **When the user's activeness is time-constant, we achieve the optimal dissemination strategy, which disseminates the message to the user of highest activeness in the current social application, in order to minimize dissemination delay.**

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# 4. Evaluation

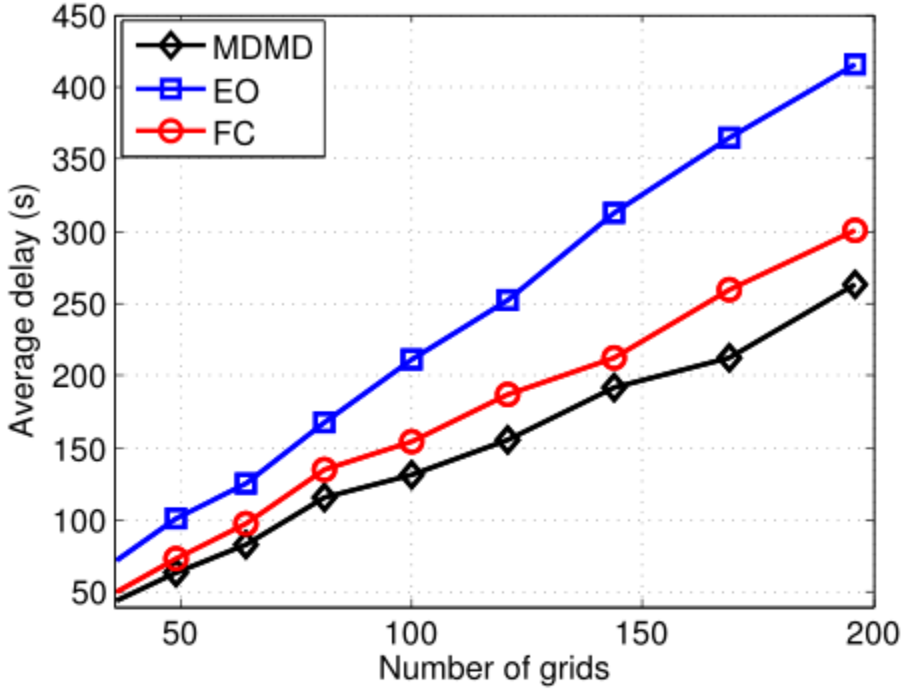
## 4.1 Two performance metrics

- **1. Average delay, which is the average elapsed time of the successfully delivered messages.**

- **2 . Average hopcounts, which is the average forwarding number of the successfully delivered messages.**

# 4. Evaluation

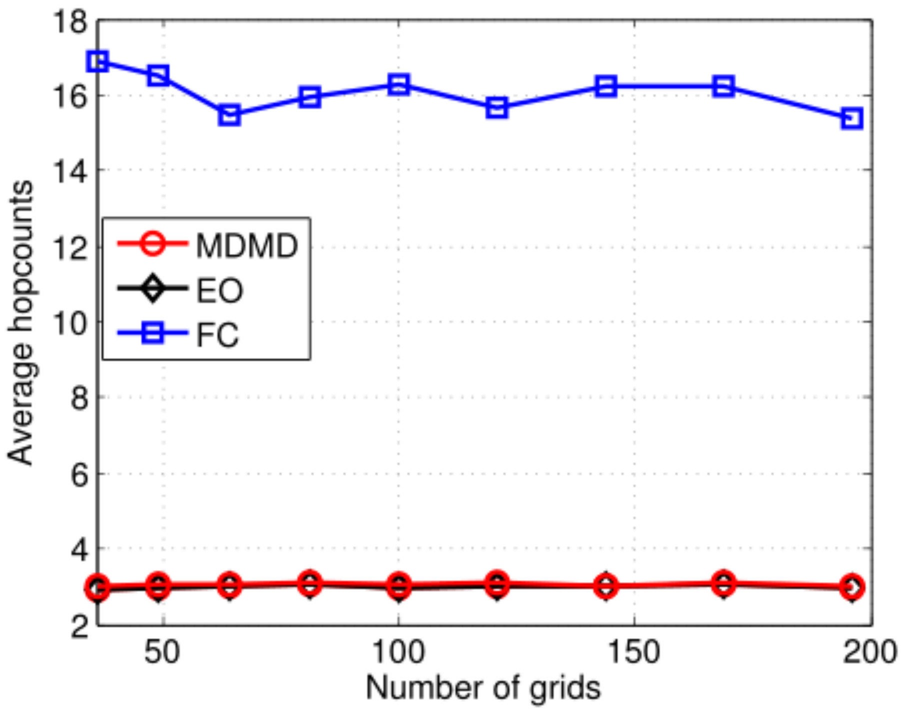
## 4.2 Simulation Results




(a) Average delay

# 4. Evaluation

## 4.2 Simulation Results




(b) Average hopcounts

# Future Work

- Time-varying Activeness

- Real Data

# Thank You