# The Onion Router:
# Understanding a Privacy Enhancing Technology Community

## Hsiao-Ying Huang, Masooda Bashir

**School of Information Sciences, University of Illinois at Urbana-Champaign**

**School of
Information Sciences**
The iSchool at Illinois

## Introduction

- Today's Internet technologies have given users a convenient way to communicate, connect, and share their daily lives with others around the world.
- While these technological advances have had a positive influence on our daily lives, they collect, share, and process a massive amount of data about users' daily activities.

**Privacy-enhancing Technologies**
- In order to protect users' information privacy, technologists have become dedicated to developing different technologies that protect users' privacy, which are known as Privacy Enhancing Technologies (PETs) [1].

**The Onion Router (TOR)**
- TOR is the most widely adopted PET tool supported by volunteers around the world.
- By deploying transactions through different servers, termed "relay nodes," users may browse and exchange online information anonymously via TOR [2]. Figure 1 exhibits the operating mechanism of TOR.
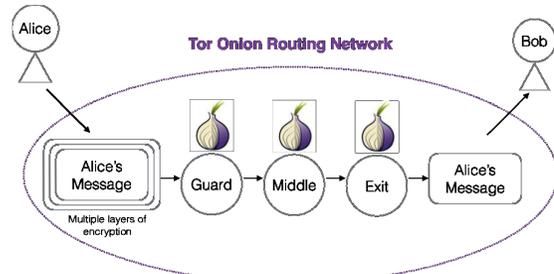


*Figure 1. Sending Alice's Message to Bob via TOR*

- Like a post office, the TOR network is a neutral technology that anyone can use it, even criminals. Thus, TOR-relay operators might be investigated or arrested by law enforcement even though they do not know the contents of their delivery [2].
- In order to run a Tor-relay, operators must contribute their own resources and are willing to take social and, potentially, legal risks.
- The willingness to take these risks distinguishes this PET community from other open-source initiatives.

## Aim

- To the best of our knowledge, no empirical study has examined this particular PET community. We assessed Tor-relay operators from three perspectives:
  1) their motivation for volunteering to participate in the Tor-relay network;
  2) their perception of the attitudes that the current social and legal system has toward the Tor network;
  3) the challenges they face and expectations they have for participation compensation.

## Method

- Online survey questionnaire is disseminated through the TOR-relay mailing list from April to June in 2015.
- There were 50 effective survey participants in total. Demographic details are exhibited in Table 1.

| Object | Category | N=50 (%) |
|---|---|---|
| Gender | Female | 1 (2%) |
| | Male | 38 (76%) |
| | Prefer not to say | 7 (14%) |
| Age | 18-22 | 7 (14%) |
| | 23-27 | 11 (22%) |
| | 28-32 | 8 (16%) |
| | 33-37 | 6 (12%) |
| | Over 38 | 11 (22%) |
| | Prefer not to say | 3 (6%) |
| Current Location | Africa | 1 (2%) |
| | Asia | 1 (2%) |
| | Europe | 23 (46%) |
| | Middle East | 10 (20%) |
| | Oceania Island | 15 (30%) |

*Table 1. Participants' Demographics*

**Measurements**
- Our questionnaire consisted of several section. In this paper, we focus particularly on three aspects:
  1) individual motivation,
  2) perceptions about legal and social systems, and
  3) individual constraints and expectations for participation.

## Results

**Motivation to Participate in the TOR-relay Network**
- We conducted explorative factor analysis (EFA) to determine the dimensions of motivation.
- As shown in Table 2, four dimensions of motivation include: 1) gaining personal rewards, 2) enhancing network, 3) supporting value of information privacy, and 4) enjoying solving privacy problems.

| Individual Motivation | 1 Personal Rewards | 2 Network Enhancement | 3 Value for Information Privacy | 4 Enjoyment in privacy solution |
|---|---|---|---|---|
| Make new friends. | **.868** | .015 | .000 | .165 |
| Be closer with my friends. | **.850** | .089 | -.131 | .010 |
| Get better cooperation or connection in return. | **.831** | -.311 | -.148 | .258 |
| Have recognition from my peer groups. | **.724** | -.309 | .300 | .170 |
| Collect information on the uses of the network or the content being transferred. | **.711** | -.364 | .108 | .325 |
| Gain reputation or praise to a certain extent. | **.645** | -.440 | .409 | .339 |
| Gain financial support. | **.628** | .041 | -.360 | .023 |
| Help Tor project continue to operate and grow. | -.108 | **.865** | .289 | .008 |
| Help Tor project achieve its goals and visions. | -.144 | **.860** | .258 | .020 |
| Provide an opportunity for everyone to access information without interference or censorship. | -.063 | .302 | **.719** | .162 |
| Provide an opportunity for everyone to have a right to privacy. | -.259 | .165 | **.685** | .015 |
| Advocate for the social movement of privacy-enhanced communication. | .171 | .197 | **.523** | .016 |
| Have fun. | .330 | -.073 | -.129 | **.748** |
| Help decrease privacy problems | -.175 | -.095 | .230 | **.706** |
| Be interested in Tor software or network and the associated research problems. | .354 | .181 | .234 | **.664** |

*Table 2. Exploratory Factor Analysis of Individual Motivation*

## Results

**Perceptions about Social and Legal System**
- Figure 2 presents the results of participants' perceptions about the attitudes of their social and legal systems toward TOR.
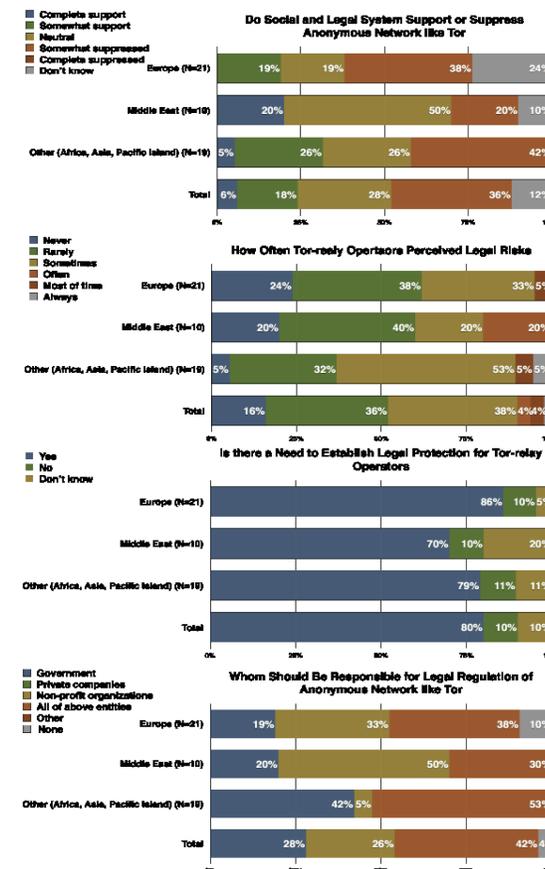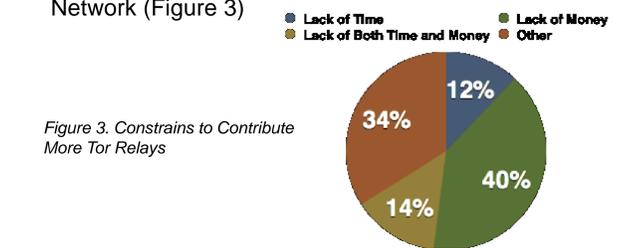


*Figure 2. Perceptions toward Legal Risks, Protection, and Regulation*

**Volunteer Participation: Challenges and Expectations**
- Challenges in Contributing More towards the Tor-Relay Network (Figure 3)



*Figure 3. Constrains to Contribute More Tor Relays*

- Expectations of operators' for Financial Support in return for their Volunteer Participation (Figure 4)



*Figure 4. Expectations for Financial Support*
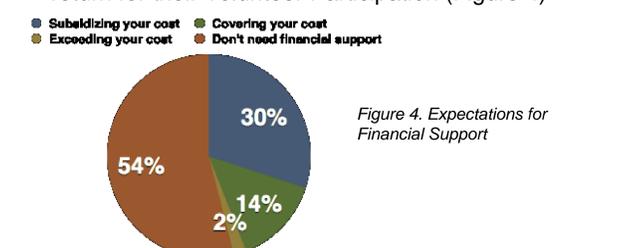
## Results

**Opinions regarding Tor-relay Operators Receiving Monetary Rewards**
- Support for Receiving Monetary Rewards:
  →Seventeen participants (30%) supported the idea of monetary rewards for operators. They considered monetary rewards to be a good approach for developing the Tor network and for motivating operators to contribute more.
- Conditional Support for Receiving Monetary Rewards:
  →Sixteen participants (32%) gave conditional support. They thought that monetary rewards might be good but that they should be restricted. For instance, the rewards must not result in profit.
- Oppose Receiving Monetary Rewards:
  →Twelve participants (24%) who totally opposed monetary rewards were mainly concerned that it might infringe on the privacy of the Tor network.

## Conclusions

- In this study we examined the TOR-relay operators' motivations, perceptions about the attitudes of social and legal systems toward TOR, and the challenges and expectations for their volunteer participation.
- The Tor network goes to great lengths to preserve users' privacy. Nevertheless, the stigma of TOR network hinders the development and adaption of PETs.
- By highlighting the viewpoints of volunteers in the PET community, our findings provide insights for both researchers and policy makers to rethink the future of PETs and their influence on society.
- This work has been published in the proceedings of ASIS&T 2017. For more information of this study, please scan the QR code:

## References

[1] Wang, Y., & Kobsa, A. (2008). Privacy-enhancing technologies. *Social and Organizational Liabilities in Information Security*, 203-227.
[2] Tor Project, (2016). Tor: Overview. Retrieved on April, 12, 2016 at: https://www.torproject.org/about/overview.html.en