



Influence of Social Networks on Cyber Security

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Study Objective

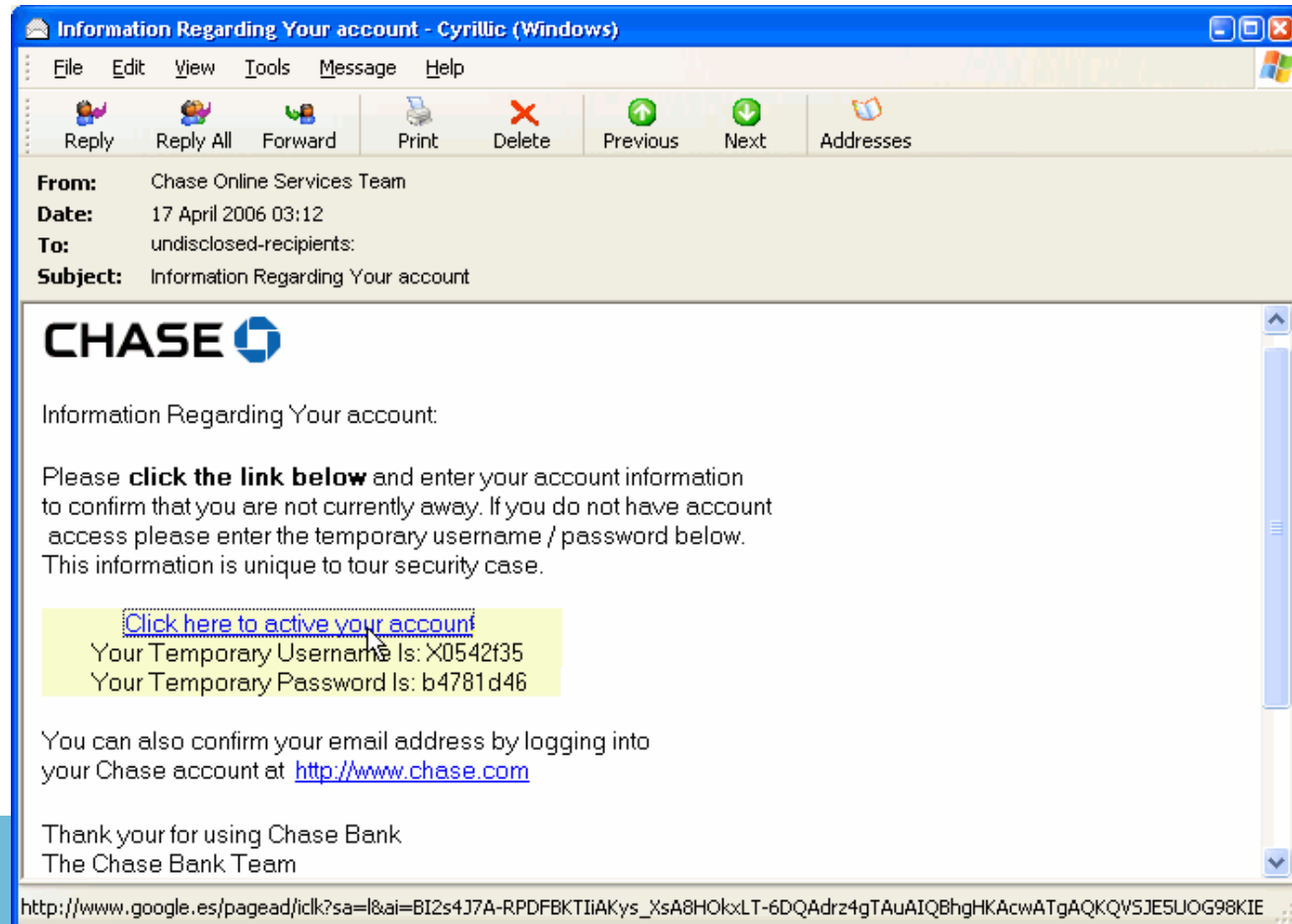
- Examine cadet social networks at the US Military Academy to identify network metrics and processes associated with security vulnerabilities.
- Identify social mechanisms to improve security among college aged cadets at the US Military Academy at West Point.
- Compare processes between formal versus informal networks.



What is Phishing



- Phishing is a form of electronic deception in which an attacker tries to obtain personal information by mimicking a trustworthy entity.



Background

- Phishing attacks are becoming widespread and costly - \$2.4M-\$9.4M in fraud losses per year
- Future military officers are especially vulnerable – access to sensitive data.
- Phishing threaten personal and national security
- Younger generations are more susceptible - more trustworthy and less fearful of technology.
- Homophily around risky behaviors exists among friends but not clear evidence for organizational links.



Study Design

Part of a large scale Army-wide initiative to evaluate security training

- Training Assessment Study (n=894)
 - Send false phishing emails out to students
 - Longitudinal design – 3 time points over 1 year
 - 9 military units assigned to 1 of 3 conditions: (1) no notification, (2) notification, (3) given a 10-minute training module online
 - Findings showed that upper classmen, females and those in cond2 had the greatest reduction in phishing failures (Results published CISSE, 2011)



Social Network Study (n=128)

Network Data

- *INFORMAL NETWORK*
Friendships: “Who do you consider a friend within the company”
- *FORMAL NETWORK*
Chain of command: immediate supervisorial chain

Dependent Variables

- *PHISHING BEHAVIOR*: Detect whether student clicked the embedded link, and entered credentials
- *WARNING ACTIVITY*: Warn another cadet within the company (paper survey)

Analysis:

Correlations & Logistic regression

→ *centrality*

→ *network exposure (# alters that show phishing and warning behaviors)*


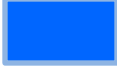


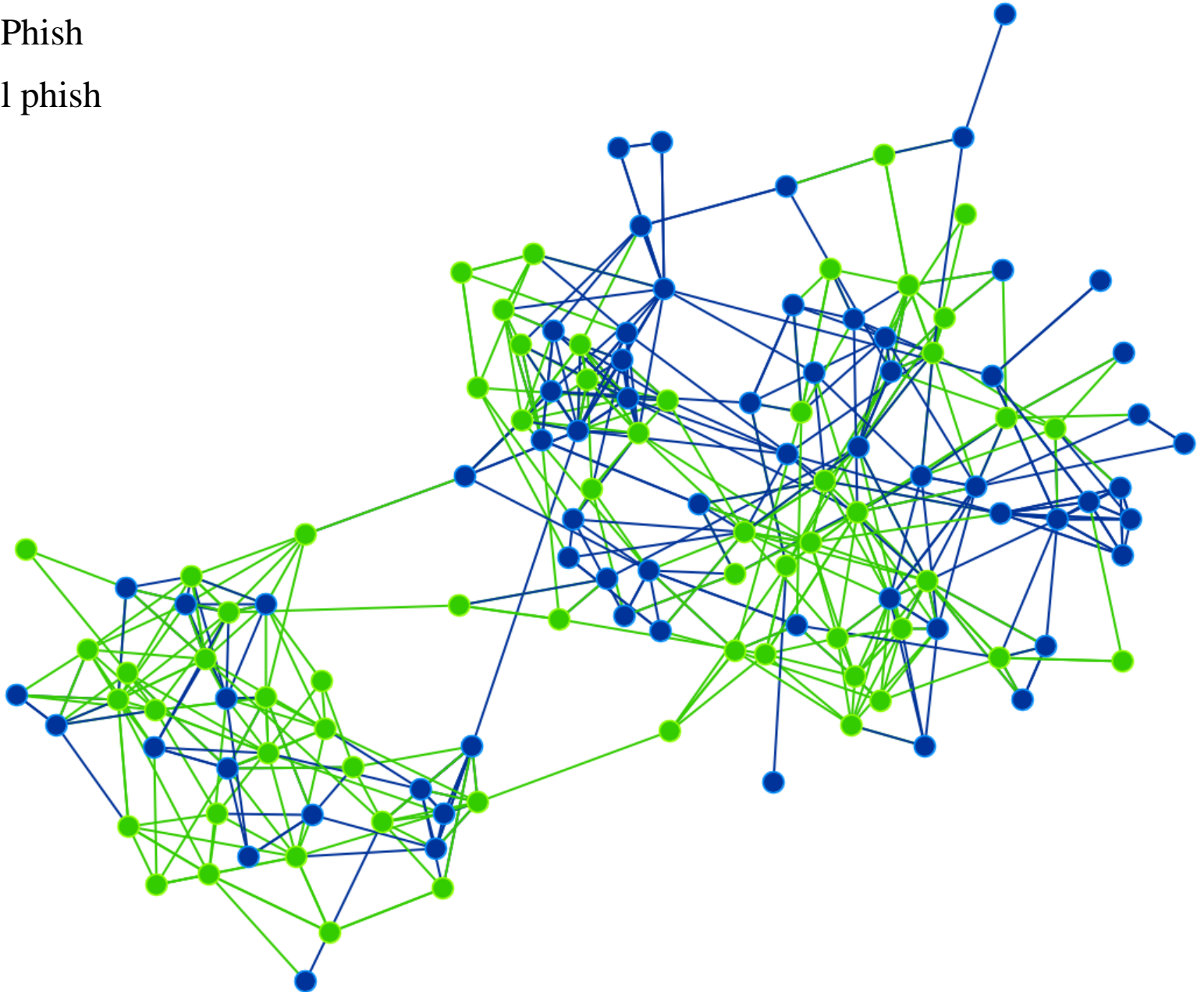
Participants

- Participants:
 - US Military Academy cadets, aged 18-25
 - One complete military unit (n=128)
 - 89% males
 - 30% freshman, 28% sophomore, 22% junior, 20% senior
- Security
 - 48% clicked the embedded link
 - 30% entered credentials
 - 5% warned others



FRIENDSHIP NETWORK

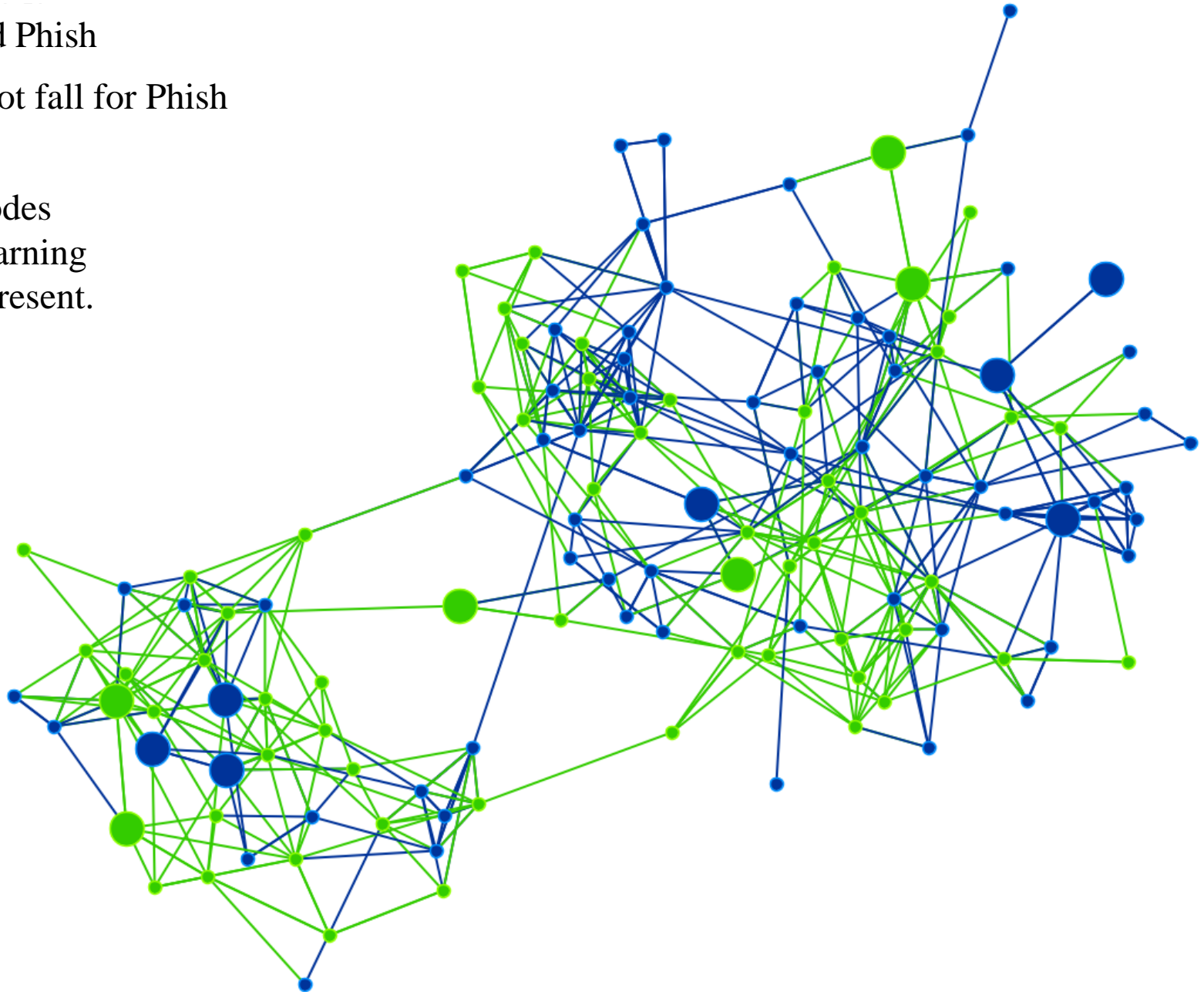
-  Failed Phish
-  No Fail phish





FRIENDSHIP NETWORK

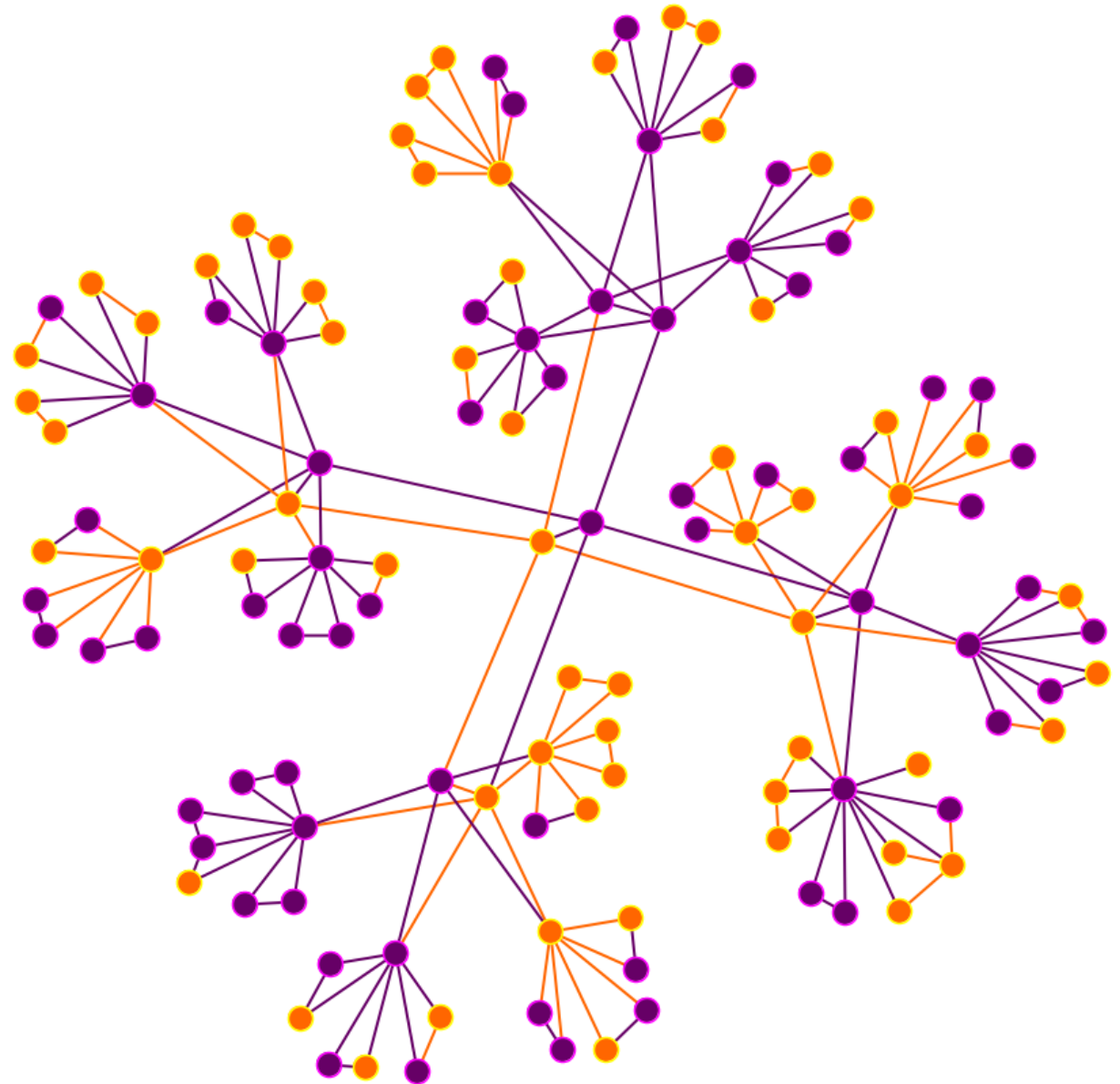
- Failed Phish
- Did not fall for Phish

*Larger nodes indicate warning behavior present.

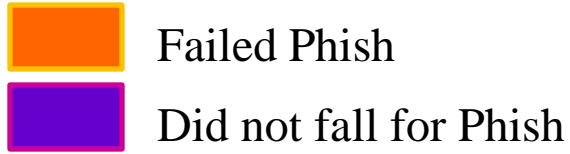


CHAIN OF COMMAND NETWORK

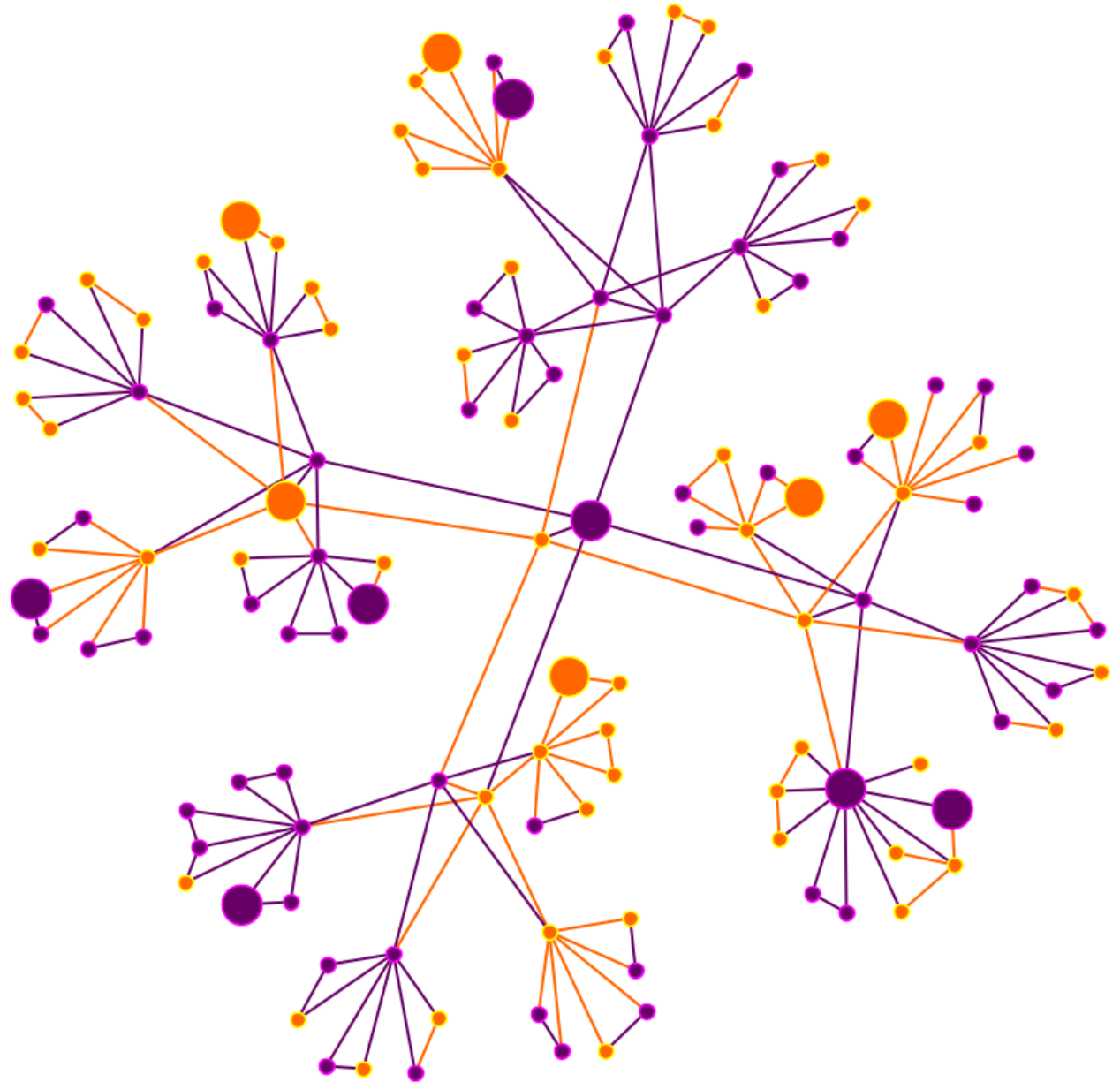
-  Failed Phish
-  Did not fall for Phish



CHAIN OF COMMAND NETWORK



*Larger nodes indicate warning behavior present.



Centrality

CENTRALITY	Failure		Warning	
	<i>Command</i>	<i>Friendship</i>	<i>Command</i>	<i>Friendship</i>
closeness	-0.05	0.08	0.23	-0.19
betweenness	-0.12	0.05	0.01	-0.02
eigenvector	-0.05	0.03	0.11	-0.17
indegree	0.08	0.05	0.04	0.06
outdegree	-0.12	0.16	0.02	-0.02

Command leadership correlates with:

- security resilience (decreased phishing failure)
- warning

Informal leadership correlates with:

- failure
- no warning

Local Network Homophily

Logistic Regression of Failure

	Odds Ratio	se	p-value
warn	1.21	0.75	0.754
male	1.17	0.70	0.795
class year	0.81	-0.15	0.235
CoC failure exposure	0.70	-0.12	0.033
CoC warning exposure	2.28	0.83	0.025
constant	1.62	1.16	0.496

Logistic Regression of Warning

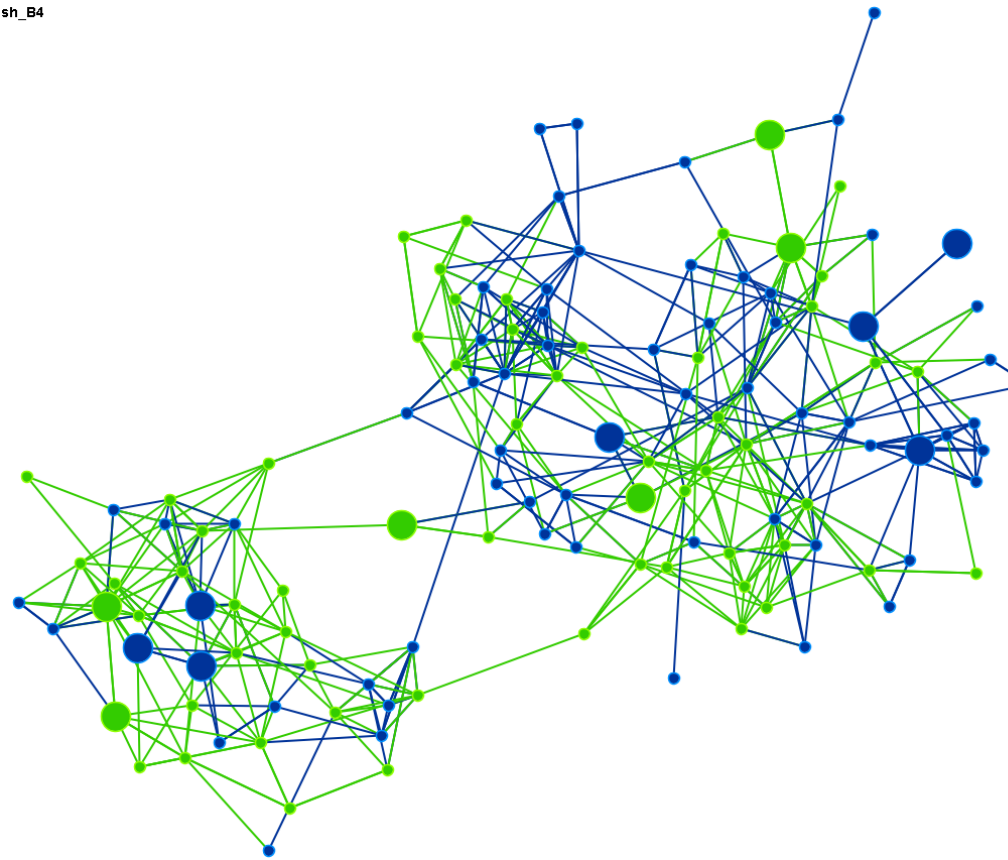
	Odds Ratio	se	p-value
fail	0.80	0.50	0.728
male	0.38	0.29	0.199
class year	1.00	0.28	0.996
friend warning exposure	2.32	0.89	0.028
constant	0.16	0.17	0.092

- Command relations are involved with *phishing vulnerabilities*

- Friend relations are involved with *warning behaviors*

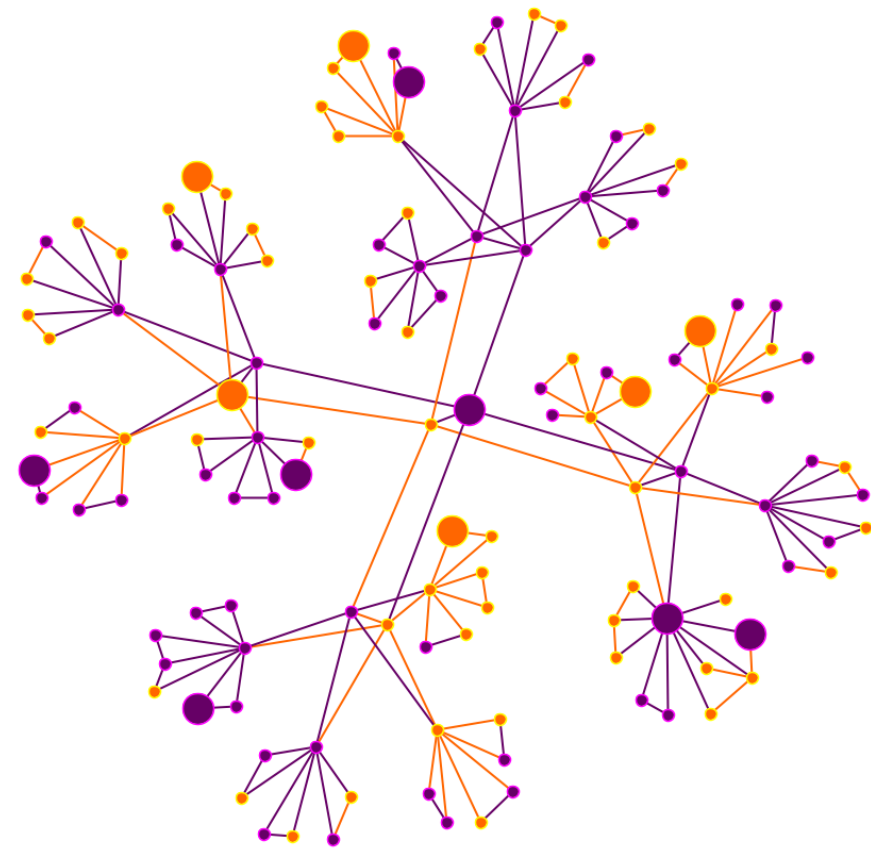
FRIENDSHIP NETWORK

sh_B4



 Failed Phish

COMMAND NETWORK




 Failed Phish

*Larger nodes indicate warning behavior present.

FRIENDSHIP & COMMAND

 Failed Phish


 Did not fall for Phish

*Larger nodes indicate warning behavior present.



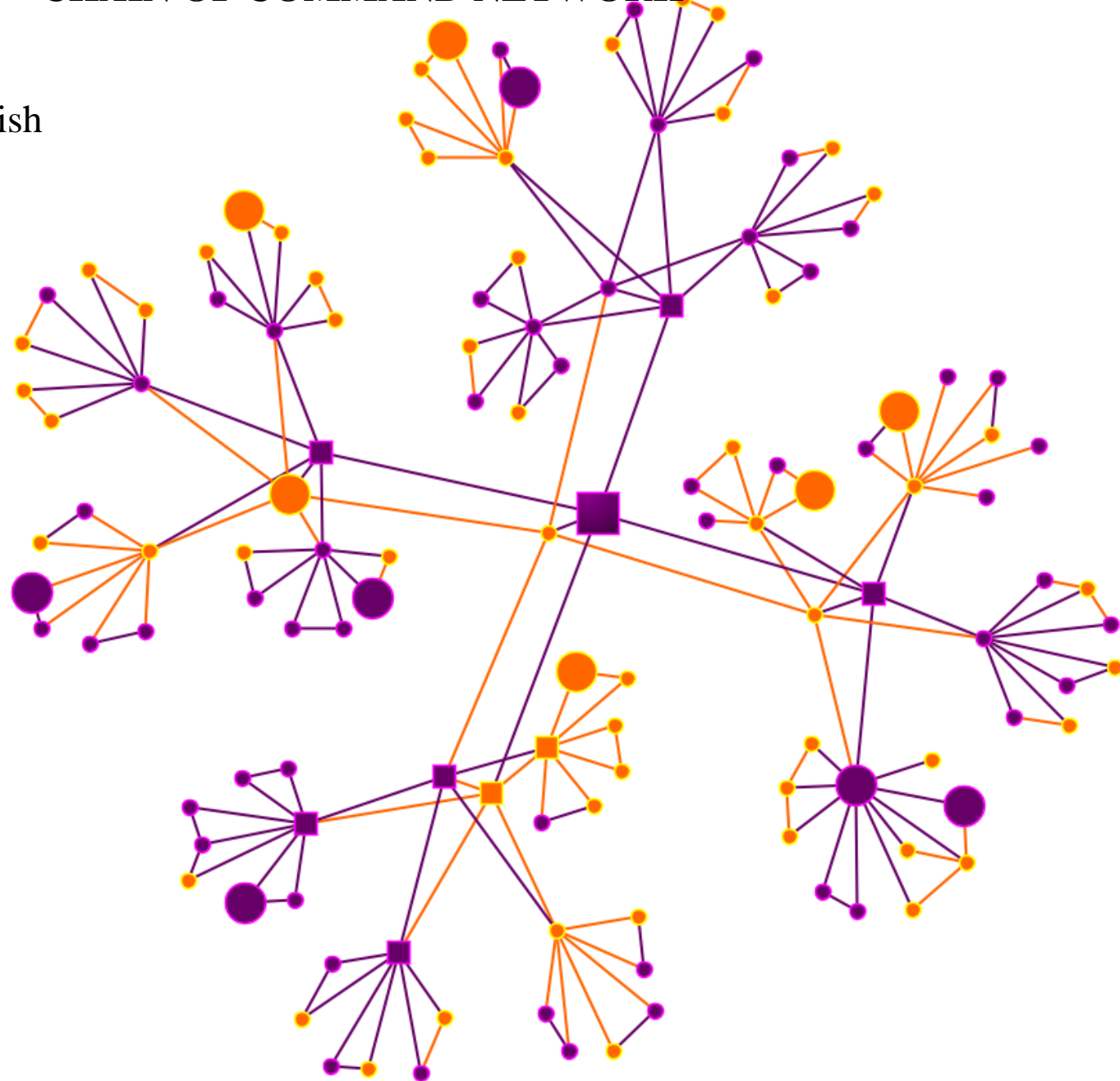
CHAIN OF COMMAND NETWORK

 Failed Phish

 Did not fall for Phish

*Larger nodes indicate warning behavior present.

*Square shaped nodes indicate friendship ties.



Structural Capabilities

- Friendship networks
 - Characterized as being highly centralized and clustered - few individuals have key roles in spreading information.
- Command networks
 - Have the potential to be very efficient - all individuals in the network can be reached with fewer number of steps (2 versus 5 steps, on average).

	Friendship	Command Chain
Link Count	600	198
Density	0.036	0.012
Average Distance	5.020	2.009
Betweenness	0.259	0.002
Closeness	0.042	0.708
Total Degree	0.058	0.036



Summary of Results:

Social determinants of Cyber Security

Informal Social Structure

1. Friendship leadership is vulnerable – more failure, less warning
2. Cyber risk resiliency among friends - while there is less **warning** among friends, there is homophily around this behavior

Formal Command Structure

1. Command leadership is strong – less failure, more warning.
2. Cyber risk vigilance among commanders/subordinates -- reduced security failures ego corresponds to higher **failures** and lower warnings in one's network.

Multiplex Relations

1. Trust improves security coordination -- Warning was likely given and headed among those who share friendship and command links

Future Work

- Security training and research should:
 - Emphasize the importance of security vigilance (failure) among formal leadership structures
 - Harness positive behaviors among informal relations (warning)
 - Further explore the role of multiplex relations in these settings
 - Utilize high betweenness in friendship network, and high closeness in command network
- Currently, conducting phishing study – 3 waves. Collecting network, org identity, and trust survey data.
- Understand other ideological, information exchange and contagion processes among formal and informal networks in military units – leadership, ideology, morale, leadership, performance.



Questions?



References

- Dhamija, R., Tygar, J. D., & Hearst, M. (2006). Why Phishing Works. Computer Human Interaction - Security, (pp. 581-590). Montreal.
- Heim, S. G. The Resonant Interface. Boston, MA: Pearson Education-Addison Wesley, 2008.
- Hicks, D. (2005). Phishing and Pharming: Helping Consumers Avoid Internet Fraud. Communities and Banking , 29-31.
- Jagatic, T. N., Johnson, N. A., Jakobsson, M., & Menczer, F. (2007). Social Phishing. Communications of the ACM , 94-100.
- Kumaraguru, P., Cranshaw, J., Acquisti, A., Cranor, L. F., Hong, J., Blair, M. A., et al. (2009). School of Phish: a real world evaluation of anti-phishing training. 5th Symposium on Usable Privacy and Security. SOUPS.
- Kumaraguru, P., Rhee, Y., Sheng, S., Hasan, S., Acquisti, A., Cranor, L. F., et al. (2007). Getting users to pay attention to anti-phishing education: evaluation of retention and transfer. Anti-Phishing Working Groups 2nd Annual eCrime Researchers Summit.
- Monitor, C. S. (2002). Poverty now comes with a color TV. Retrieved November 29, 2010, from MSN: <http://webcache.googleusercontent.com/search?q=cache:RQYryc3YGVMJ:articles.moneycentral.msn.com/Investing/Extra/PovertyNowComesWithAColorTV.aspx>
- Parrish, J. L., Bailey, J. L., & Courtney, J. F. (2009). A Personality Based Model for Determining Susceptibility to Phishing Attacks . Little Rock: University of Arkansas .
- Phifer, L. (2010, April 12). Top Ten Phishing Facts. Retrieved November 29, 2010, from eSecurity Planet: <http://www.esecurityplanet.com/views/article.php/3875866/Top-Ten-Phishing-Facts.htm>
- (2009). Phishing Activity Trends Report. Anti-Phishing Working Group .
- Sheng, S., Holbrook, M., & Kumaraguru, P. (2010). Who falls for a phish? A demographic analysis of phishing susceptibility and effectiveness of interventions. 28th International Conference on Human Factors in Computing Systems . Atlanta: CHI.