Towards a Theory of Trust in Networks of Humans and Computers

Jeannette M. Wing
Corporate Vice President, Microsoft Research
President's Professor of Computer Science, Carnegie Mellon University (on leave)

Joint work with Virgil Gligor

Informatics Colloquium
Universite Pierre and Marie Curie, Paris, France
20 May 2014

Motivation (inspired by Manuel Blum)

How can I (a human) trust the information I read over the Internet?

receiver

sender

Networks of Humans and Computers

Battery tricks and tips for the HTC 8X

Printable View

Coolknight1968

I have been using two HTC 8X HSPA+ phones since November 2012.
Here are tricks and tips to improve battery life.

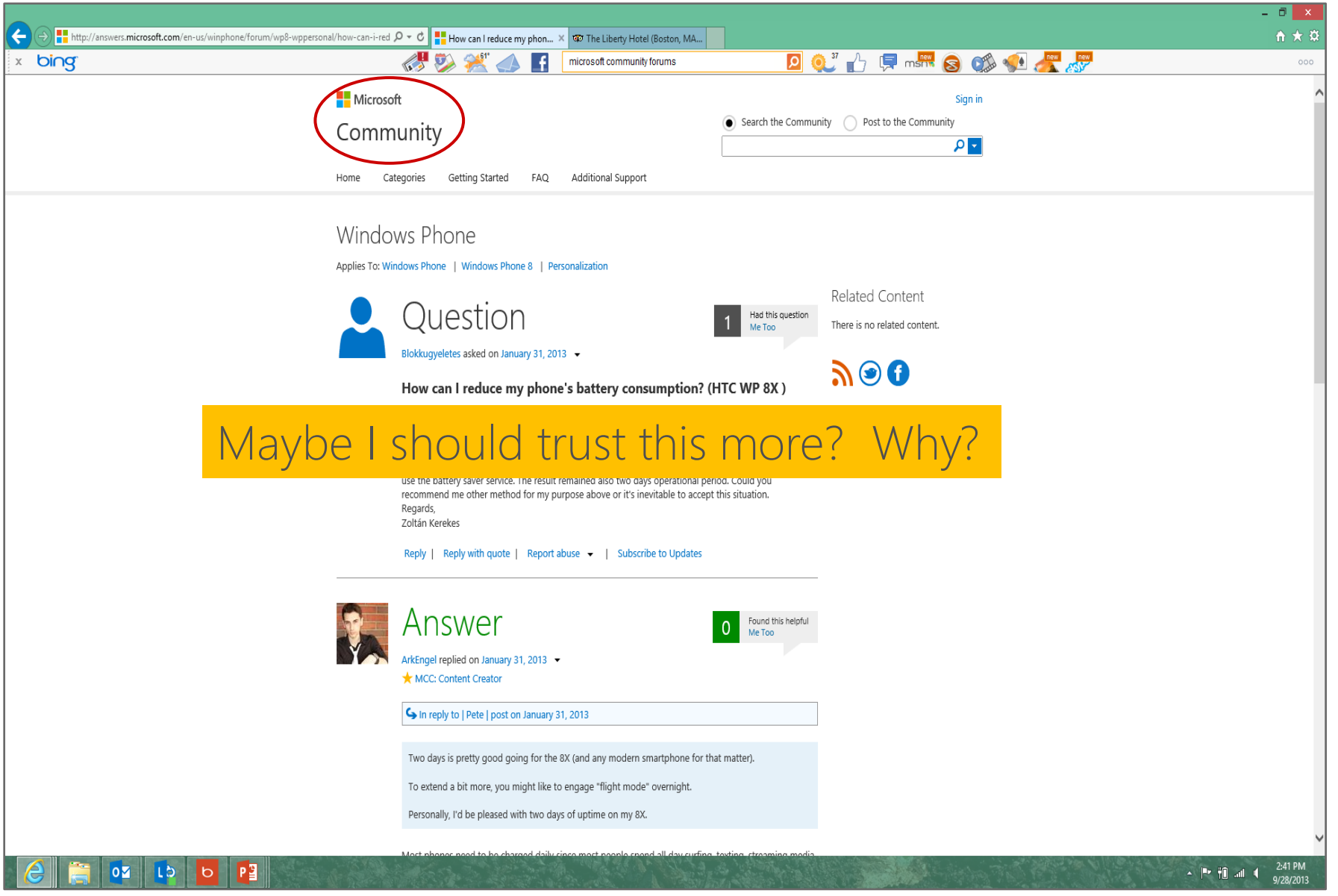
Note: If you have installed the Portico update along with the firmware update, your battery life is generally speaking a
Following problems are solved with Portico: High standby drain in Flight mode, is reduced to 1% for 6 hours. It also s
case that Email will no longer try to sync in WLAN when it switches off in lock-screen. You can Enable WLAN on in lo
GPS power drain has been reduced significantly, you may leave it on. Steps 23 and 24 can be skipped if you have th
that came with Portico like ie. the HTC 8S.

*** First you need the following aps. ***
a) 'Battery Status' from "Tomaz Wisniewski", it seems to have the lowest battery drain of all battery apps.
b) ConnectivityShortcuts from "OU Dev." (FREE) (Setup to show 5 little tiles on start screen, WLAN, Bluetooth, Mobile Network, Location, Flight Mode) *(Thx to HG for finding this one,
cause it is very g
c) Understand ho
c2) Skype: You n
the app running in the background... so... take note until we get out of Beta Skype.

Should I trust this website about Windows phones?

>1. LCD brightness, if you don't live in California and it is currently winter, you might want to set it to "Medium" and leave it there. Maximum brightness is a energy hog and uses a lot of power. If you use the automatic mode, it will go to maximum outside, when in fact you can read "Medium" well in your own shadow.
>1a) Beware of too much color in always "medium brightness"... red and orange affect less your night vision. Grey works great for the always medium setting, when it is dark, cause our eyes see B&W in low light. -> Try it, if find it less blinding when it is dark.
>2. NFC. Switch that thing off. Disable under Settings "Tap and send", then reboot.
>3. Location services... this GPS + Glonass = needs plenty of power = disable when not needed.
>4. Bluetooth, when not needed disable it.
>5. WLAN... when not needed disable it. Also if you have Portico and have WLAN at home and where you work, you might set it to "keep on with locked screen" and simply use 2G when you are in you car. Don't forget to switch off WLAN when you are on the move and no WLAN hotspot is around.
>5a) Under Settings, Wifi: Select Advanced: Disable Notify me when new Networks are found. Disable Send Information about WiFi connections...
>6. Mobile Network... select the lowest data speed or no data (no data only, with manual sync for all email accounts see Point 22!) in order to minimize consumption, when you are not in need of surfing the web. Your phones are CDMA... mine are GSM... So I use 2G most of the time, no data if the connection is real lousy.

http://forums.wpcentral.com/htc-8x/203318-battery-tricks-tips-htc-8x-print.html?pp=100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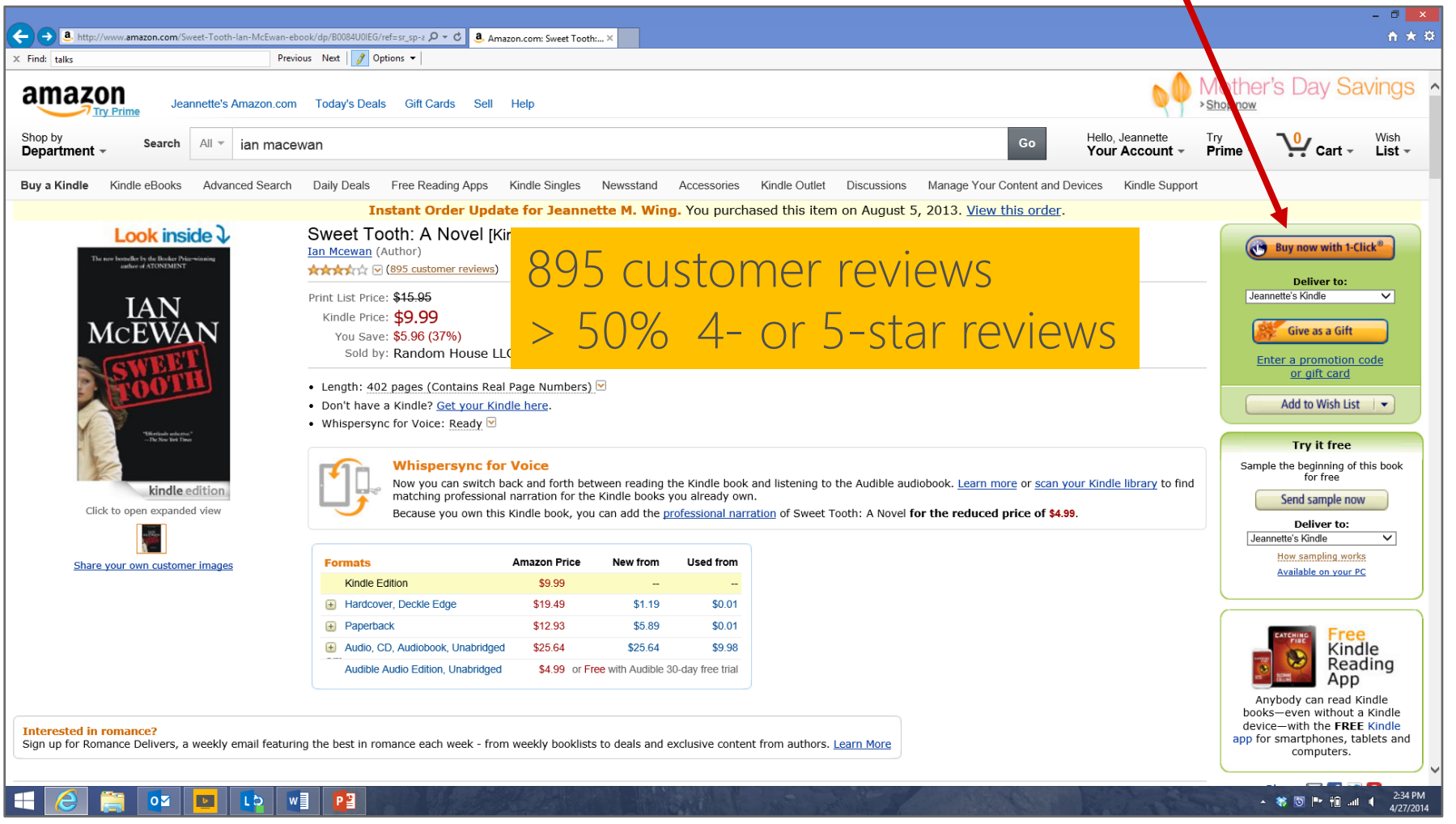
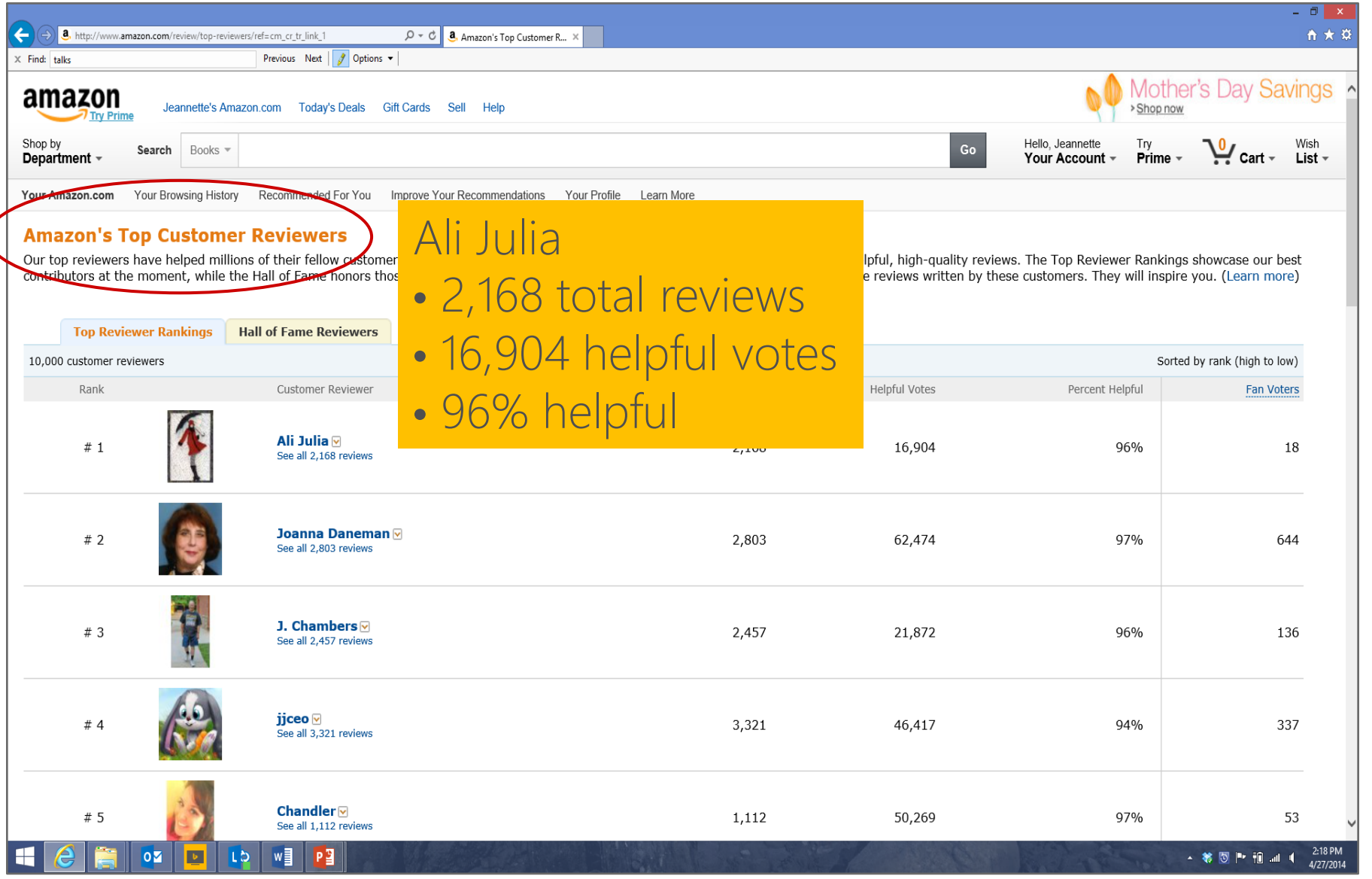
Additional Support
Windows Phone
Applies To: Windows Phone | Windows Phone 8 | Personalization
Question
1
Had this question
Me Too
Blokkugyeletes asked on January 31, 2013
How can I reduce my phone's battery consumption? (HTC WP 8X)
Related Content
There is no related content.
Maybe I should trust this more? Why?
use the battery saver service. The result remained also two days operational period. Could you recommend me other method for my purpose above or it's inevitable to accept this situation.
Regards,
Zoltán Kerekes
Reply | Reply with quote | Report abuse | Subscribe to Updates
Answer
0
Found this helpful
Me Too
ArkEngel replied on January 31, 2013
MCC: Content Creator
In reply to | Pete | post on January 31, 2013
Two days is pretty good going for the 8X (and any modern smartphone for that matter).
To extend a bit more, you might like to engage "flight mode" overnight.
Personally, I'd be pleased with two days of uptime on my 8X.
2:41 PM
9/28/2013

Should I click to purchase?

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contributors at the moment, while the Hall of Fame honors thos
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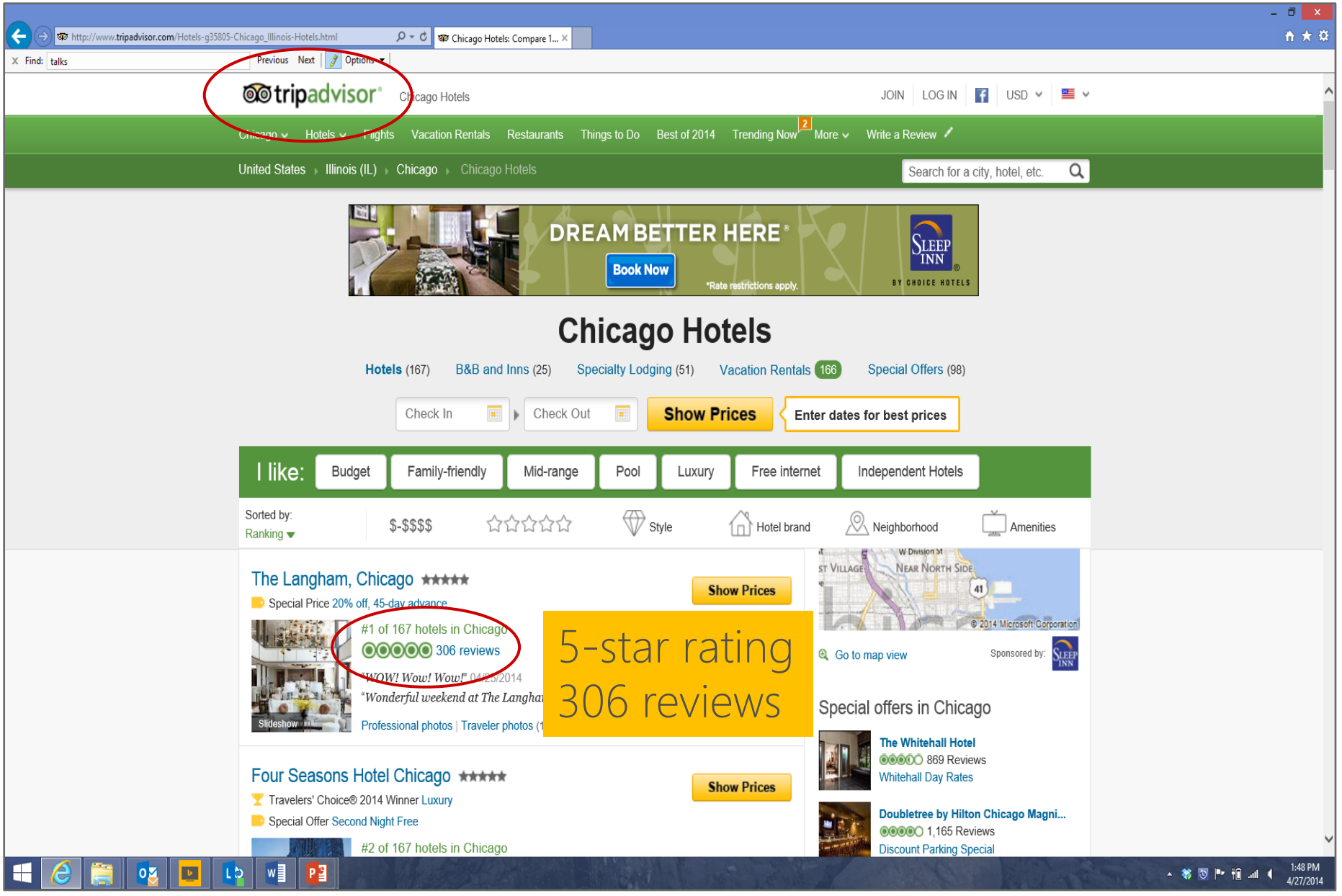
Top Reviewer Rankings
Hall of Fame Reviewers
10,000 customer reviewers
Sorted by rank (high to low)
Rank
Customer Reviewer
Helpful Votes
Percent Helpful
Fan Voters
1
Ali Julia
See all 2,168 reviews
16,904
96%
18
2
Joanna Daneman
See all 2,803 reviews
2,803
62,474
97%
644
3
J. Chambers
See all 2,457 reviews
2,457
21,872
96%
136
4
jjceo
See all 3,321 reviews
3,321
46,417
94%
337
5
Chandler
See all 1,112 reviews
1,112
50,269
97%
53
Ali Julia
• 2,168 total reviews
• 16,904 helpful votes
• 96% helpful
2:18 PM
4/27/2014

amazon.com®

- Fake Reviews: Amazon's Rotten Core *Forbes*, 2012
- The Best Book Reviews Money Can Buy, *The New York Times*, 2012
- How to Spot a Fake Review on Amazon.co, *wikiHow*
- Amazon selects their favorite fake reviews http://goo.gl/sn4S4r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Chicago Hotels: Compare 1...
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Vacation Rentals 166
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Enter dates for best prices
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Neighborhood
Amenities
The Langham, Chicago
Special Price 20% off, 45-day advance
Show Prices
#1 of 167 hotels in Chicago
306 reviews
"WOW! Wow! Wow!"
"Wonderful weekend at The Langha
Slideshow
Professional photos | Traveler photos
5-star rating
306 reviews
Four Seasons Hotel Chicago
Travelers' Choice® 2014 Winner Luxury
Special Offer Second Night Free
Show Prices
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Go to map view
Sponsored by:
Special offers in Chicago
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869 Reviews
Whitehall Day Rates
Doubletree by Hilton Chicago Magni...
1,165 Reviews
Discount Parking Special
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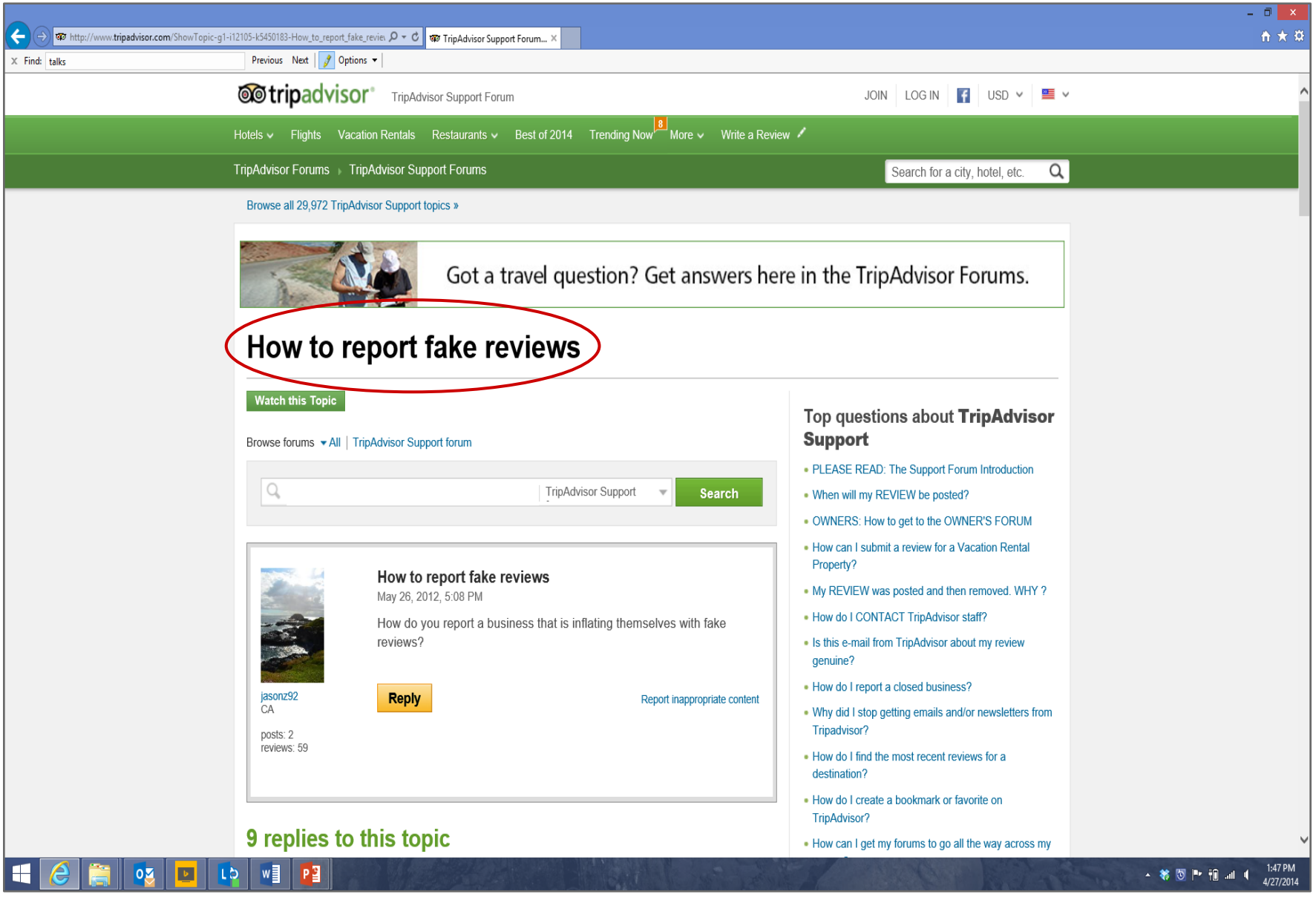
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May 26, 2012, 5:08 PM
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How do I report a closed business?
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How can I get my forums to go all the way across my
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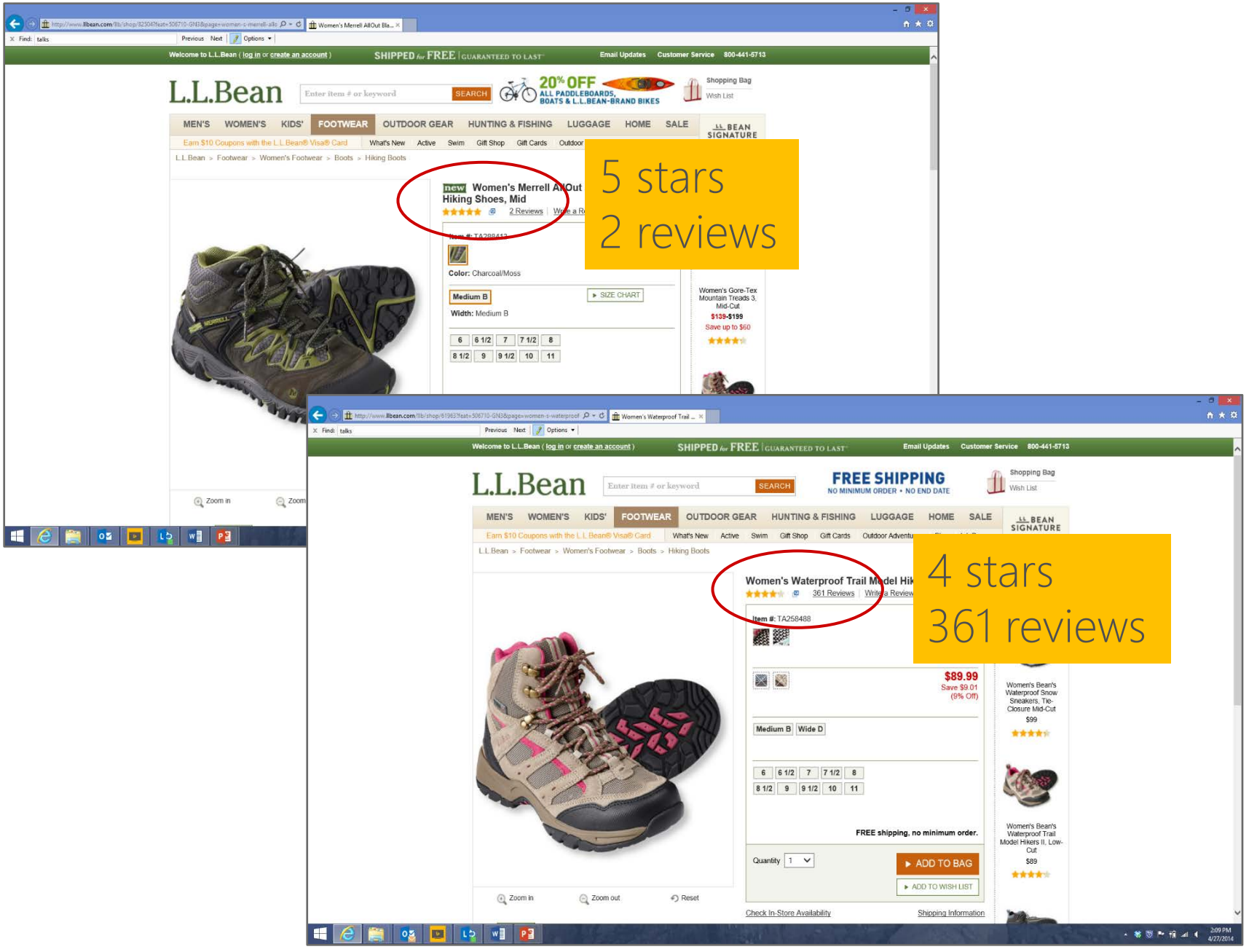
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Women's Merrell AllOut
Hiking Shoes, Mid
2 Reviews
5 stars
2 reviews
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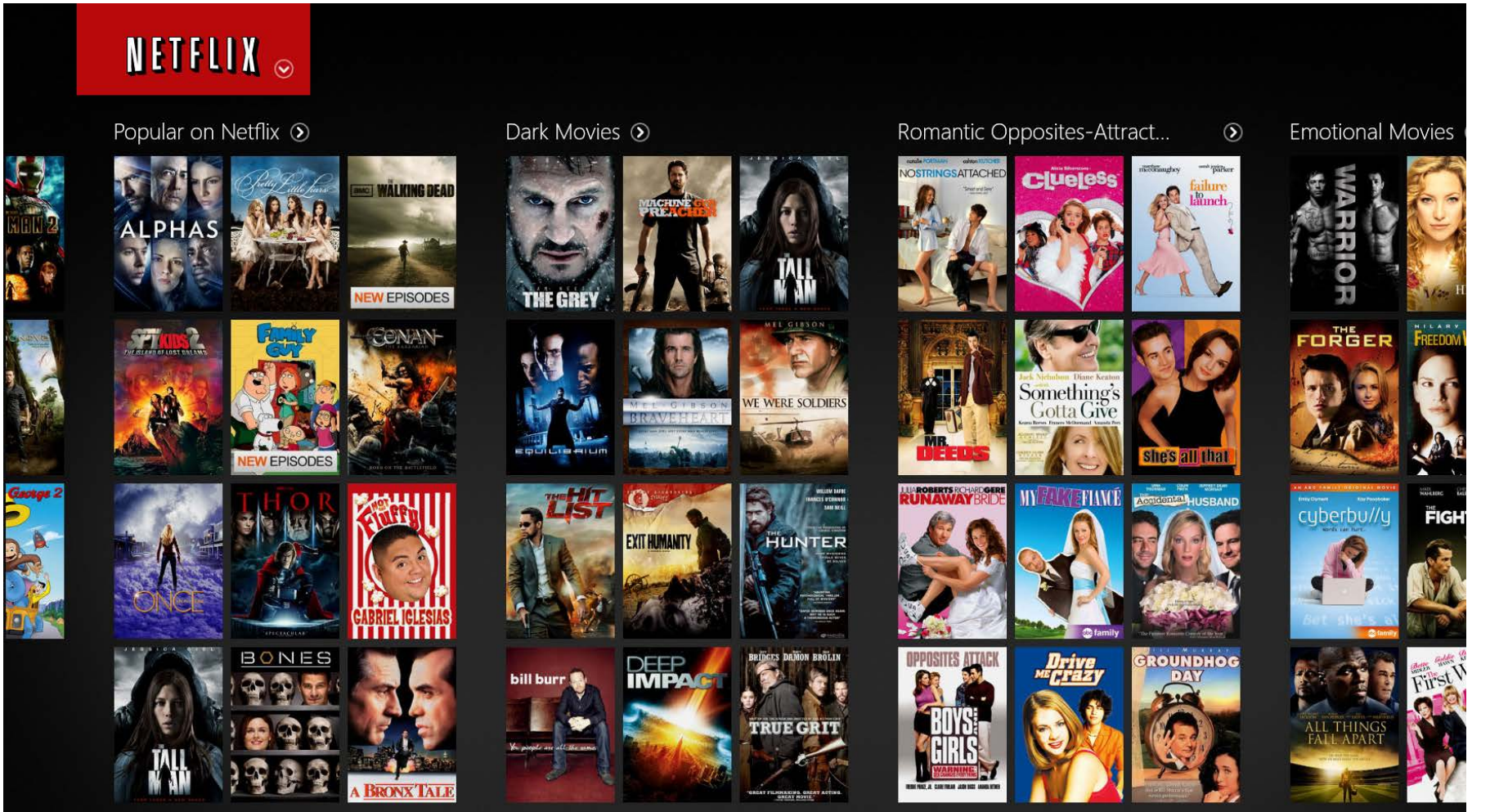
4 stars
361 reviews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Romantic Opposites-Attract...
Emotional Movies
ALPHAS
WALKING DEAD
NEW EPISODES
FAMILY GUY
NEW EPISODES
CONAN
ONCE
THOR
GABRIEL IGLESIAS
TALL MAN
BONES
A BRONX TALE
THE GREY
MACHINE GUN PREACHER
TALL MAN
EQUILIBRIUM
BRAVEHEART
WE WERE SOLDIERS
THE HIT LIST
EXIT HUMANITY
THE HUNTER
bill burr
DEEP IMPACT
TRUE GRIT
NO STRINGS ATTACHED
Clueless
failure to launch
MR DEEDS
Something's Gotta Give
she's all that
RUNAWAY BRIDE
MY FAKE FIANCÉ
Accidental HUSBAND
OPPOSITES ATTACK
BOYS AND GIRLS
Drive ME Crazy
GROUNDHOG DAY
WARRIOR
THE FORGER
cyberbully
ALL THINGS FALL APART

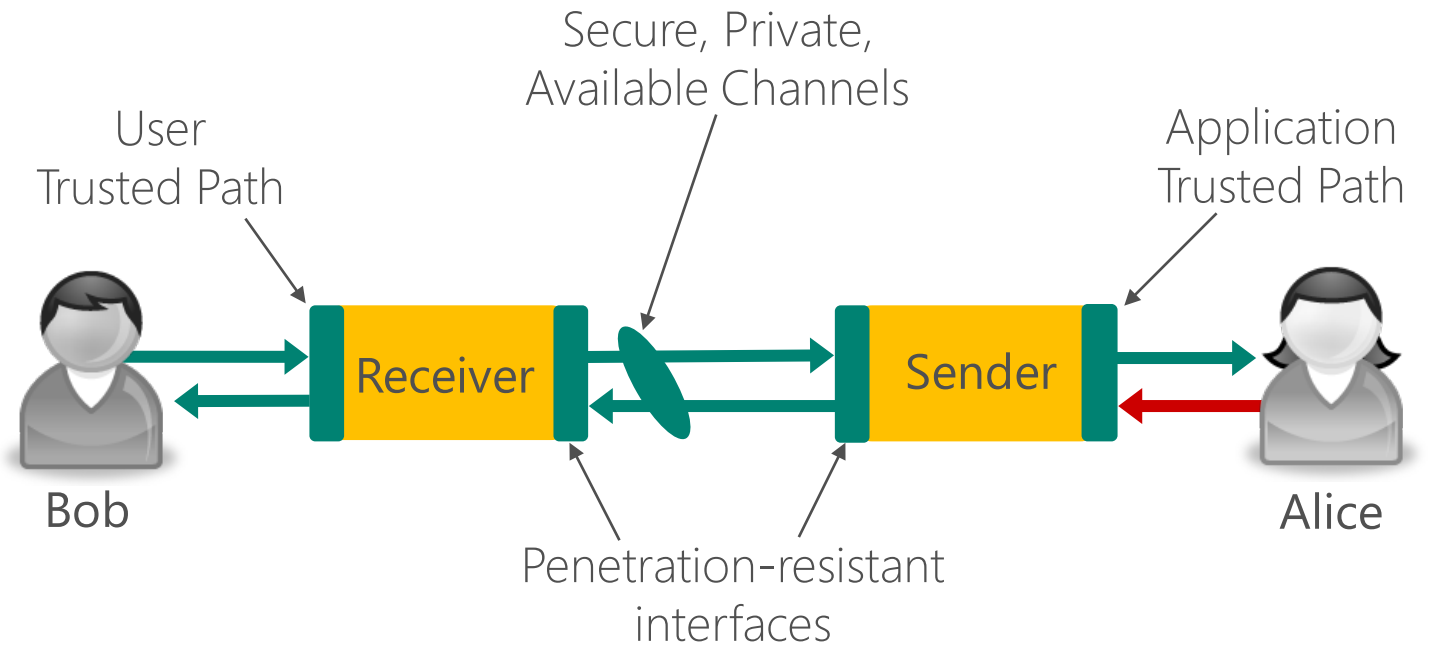
Insight

Computational trust defines trust relations among devices, computers, and networks

Behavioral trust defines trust relations among people and organizations

A theory of trust for networks of humans and computers needs to include elements of both.

Simple Communications Model

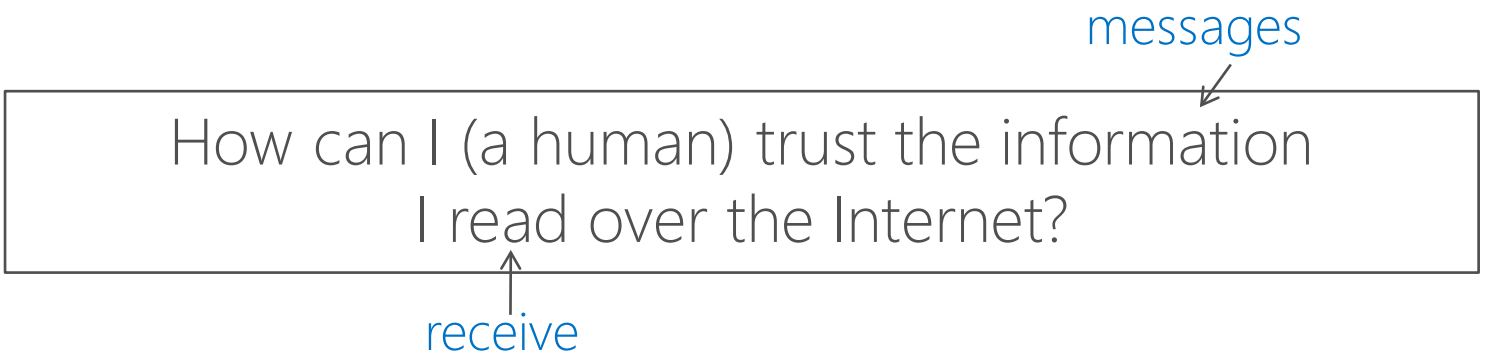


Decomposing Question

Is the communication channel over which I receive messages secure?

How can I trust the sender of the messages I receive?

Decomposing Question



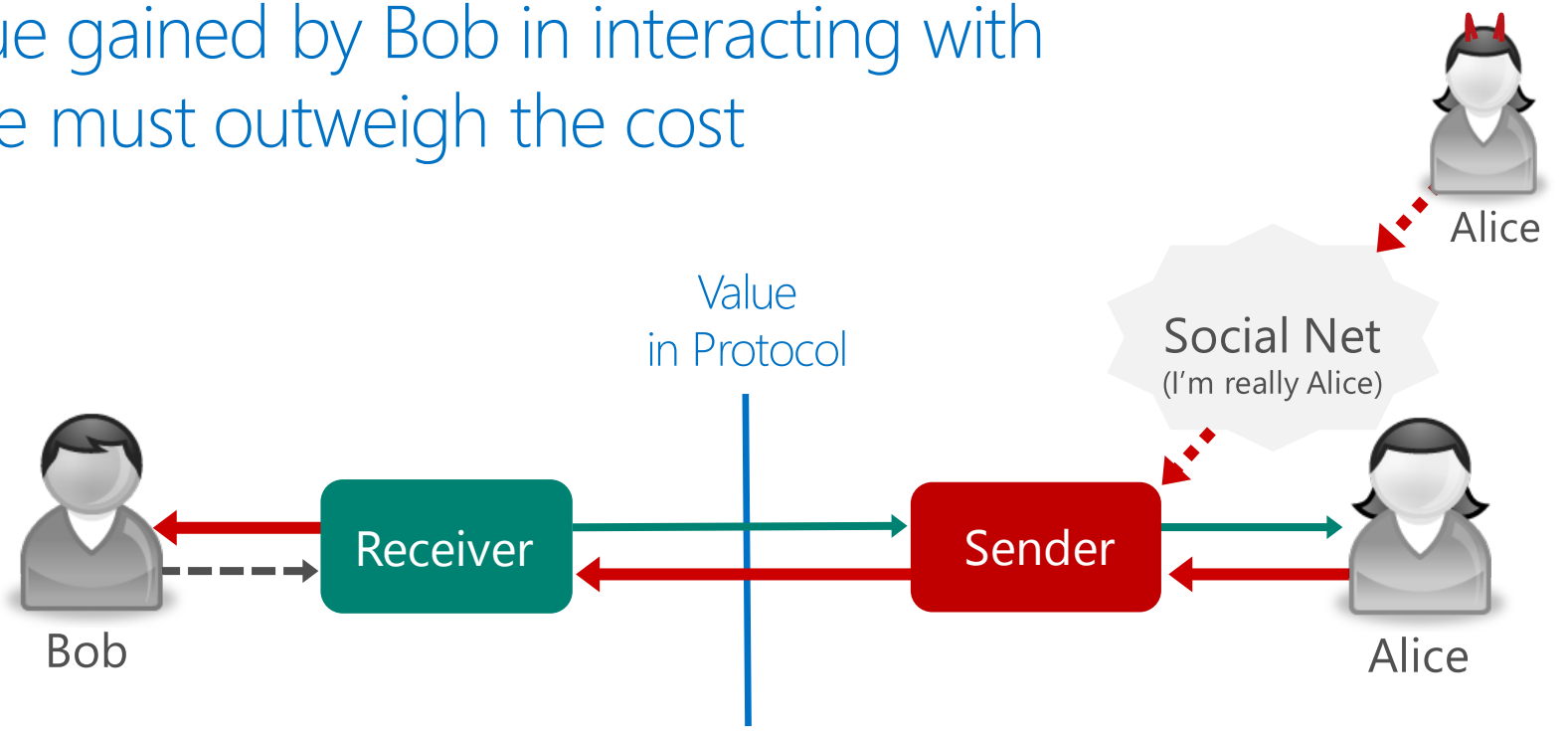
Is the communication channel over which I receive messages secure?

How can I trust the sender of the messages I receive?

The main question boils down to the *act of trusting the sender*

Value to Receiver (Bob) in Interacting with Sender (Alice)

Value gained by Bob in interacting with Alice must outweigh the cost



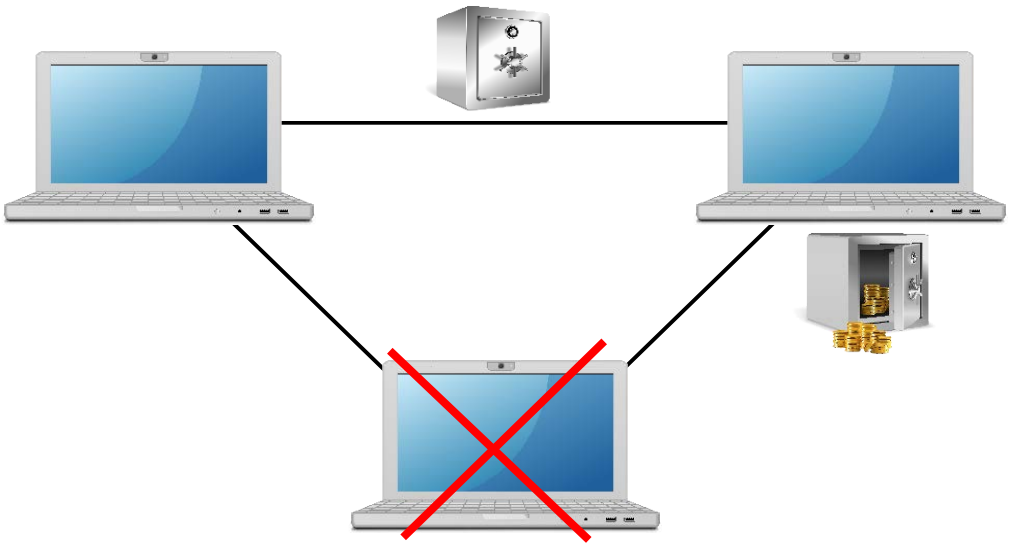
Value in the Act of Trusting the Sender

If Receiver trusts Sender and the Sender is trustworthy
- – **Value gained (**for both)
  - Receiver gets information; Sender monetizes on click

If Receiver trusts Sender and the Sender is untrustworthy
- – Then **Value gained > Cost to engage**
  - Receiver risks getting malware

If Receiver suspects Sender is untrustworthy, then don't engage
- – Then **no Value exchanged**

Computational Trust



Computational Trust

A theory of trust builds on these computational mechanisms

Cryptography

- secure communication, isolation

Verification

- isolation, code correctness, sender trustworthiness

Fault-tolerance

- recovery

Elements of Computational Trust

Isolation

- Receiver could isolate himself from Sender, regardless of what/who the Sender is

Correctness

- Independent verification of correctness of Sender code

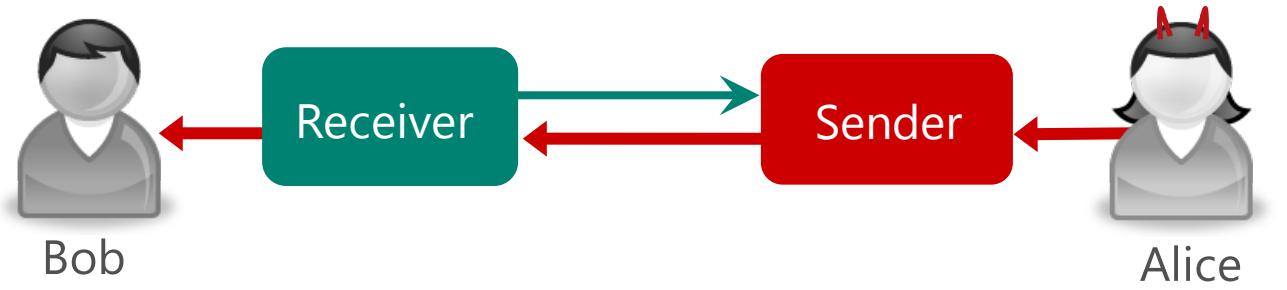
Recovery

- Detect and recover from bad input from Sender

How can I trust the sender of the messages I receive?

Necessary, but Not Sufficient

Receiver Isolation



Isolation from Sender
⇒ Verified input content

Verification (local/outsourced, deterministic/probabilistic, etc.)
⇒ Trust in Sender is *not* needed
⇒ Don't care about Alice's behavior…

Isolation: Always Possible and Efficient?

"All trust is local" [Lampson, CACM 09]

But, can Input *always* be verified?

- *ascii*? … *pdf*? … *doc*, *ppt*, *xls*? … Java and other scripts?

No!

- Input = *arbitrary code*
- i.e., verification of code's "output behavior" by Receiver is undecidable in general

When Input can be verified, is verification *always* efficient?

No, not likely!

- Input = solution to some *co-NP complete* problem

(i.e., efficient solution at Sender & *inefficient* verification at Receiver)

Isolation: Always Practical and Scalable?

When Input verification *is efficient*, is it *always* practical?

No!

- Input = results/output of a computation outsourced to Sender
  efficient result verification by Receiver [Parno 2010]
  ⇒ *fully homomorphic encryption* [Gennaro, Gentry, Parno 2010]

When Input verification *is efficient and practical*,
is it *always scalable (e.g., in the Internet)*?

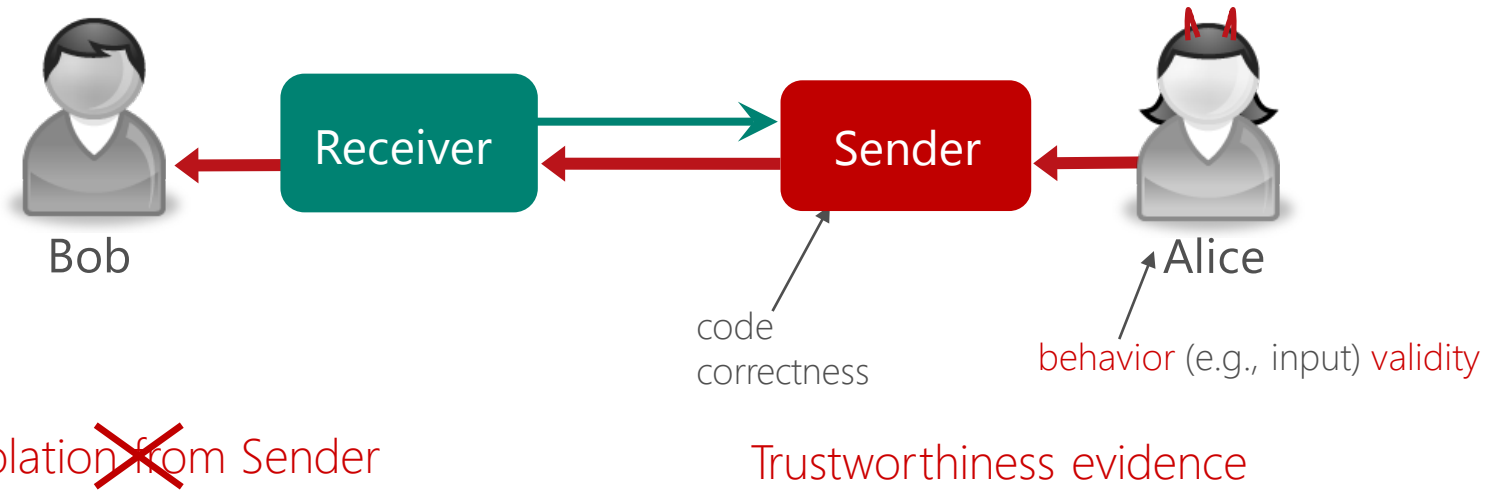
No!

- Input = multi-level integrity, integrity-labeled object [Biba 77]
  ⇒ *integrity-labeled closed input*
- Input = output of a trusted transaction [Clark-Wilson 87]
  ⇒ *application-closed input*

So, Receiver Isolation is Hard

Suppose Sender can provide evidence of trustworthiness?

Sender's Trustworthiness
(more than Correctness)



Sender Trustworthiness

⇒ No Isolation needed

⇒ Input is always accepted

Trustworthiness Evidence: Practical?

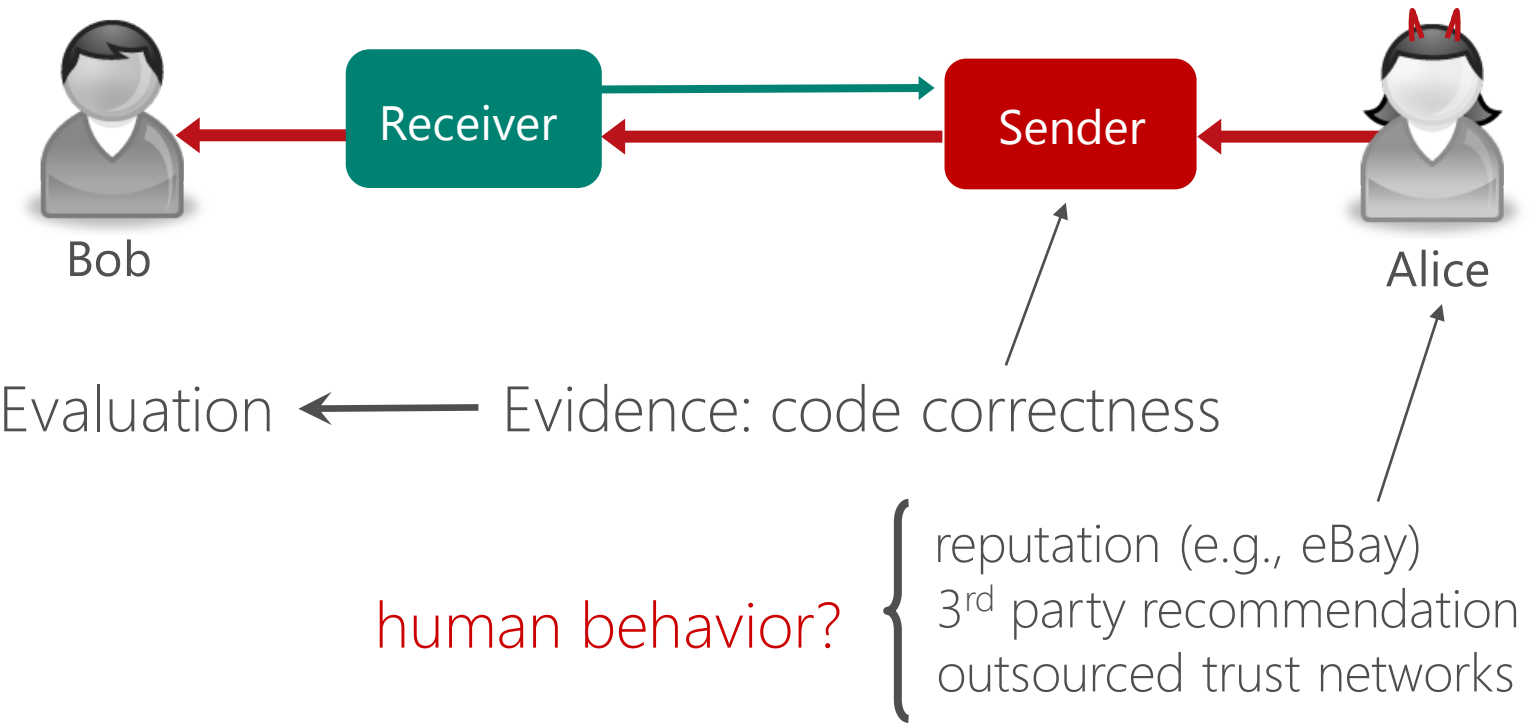
Not usually!

Code-correctness proofs are not "scalable"

- limited to small configurations
  e.g., sender A is dependent on a large OS code base
  Windows, Linux, Xen (HyperVisor + root domain)
- limited to a few properties
  e.g., configuration integrity, execution integrity
- assurance approach
  e.g., TCSEC and common criteria assurance levels very expensive for mid- to high-level assurance
  TCSEC: B2 –> A1, CC: EAL 5 –> EAL 7

Dependency on *behavior* (of many humans) for input validity

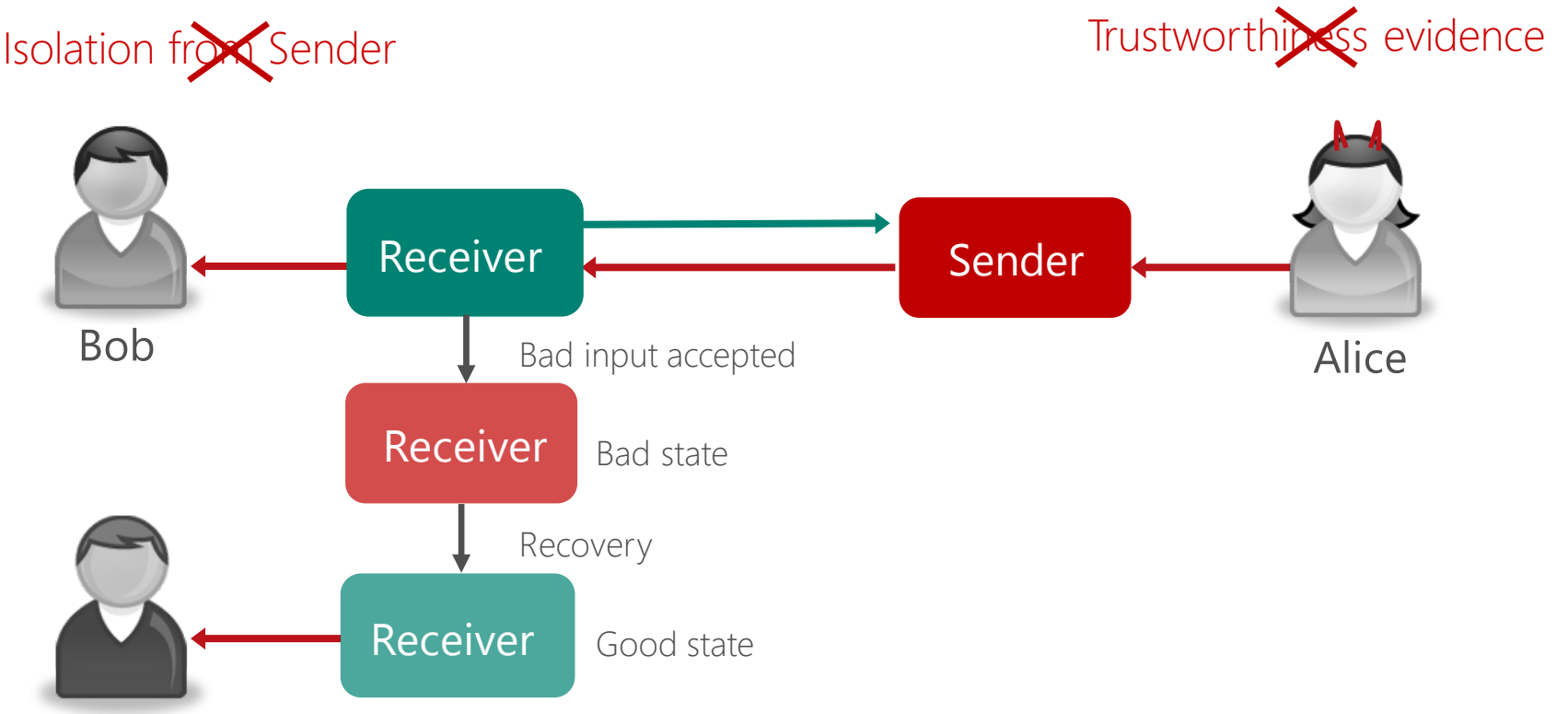
Sender's Trustworthy Behavior



So, it's hard to provide evidence that the Sender is trustworthy

Suppose the Receiver can detect and recover from a Sender's untrustworthiness?

Recovery from Sender Misbehavior



Recovery ⇒ No Isolation, No Trustworthiness Needed;
⇒ Input can *always* be accepted

Recovery: Feasible, Practical and Scalable?

Not usually!

Dependency on receiver state and (human input)

- definition of state invariants
- roll back human inputs (e.g., roll-back ingesting wrong drugs)

It is possible in certain applications

- transaction undo, compensation (finance, banking)
- insurance

  Limited Assurance Approach:

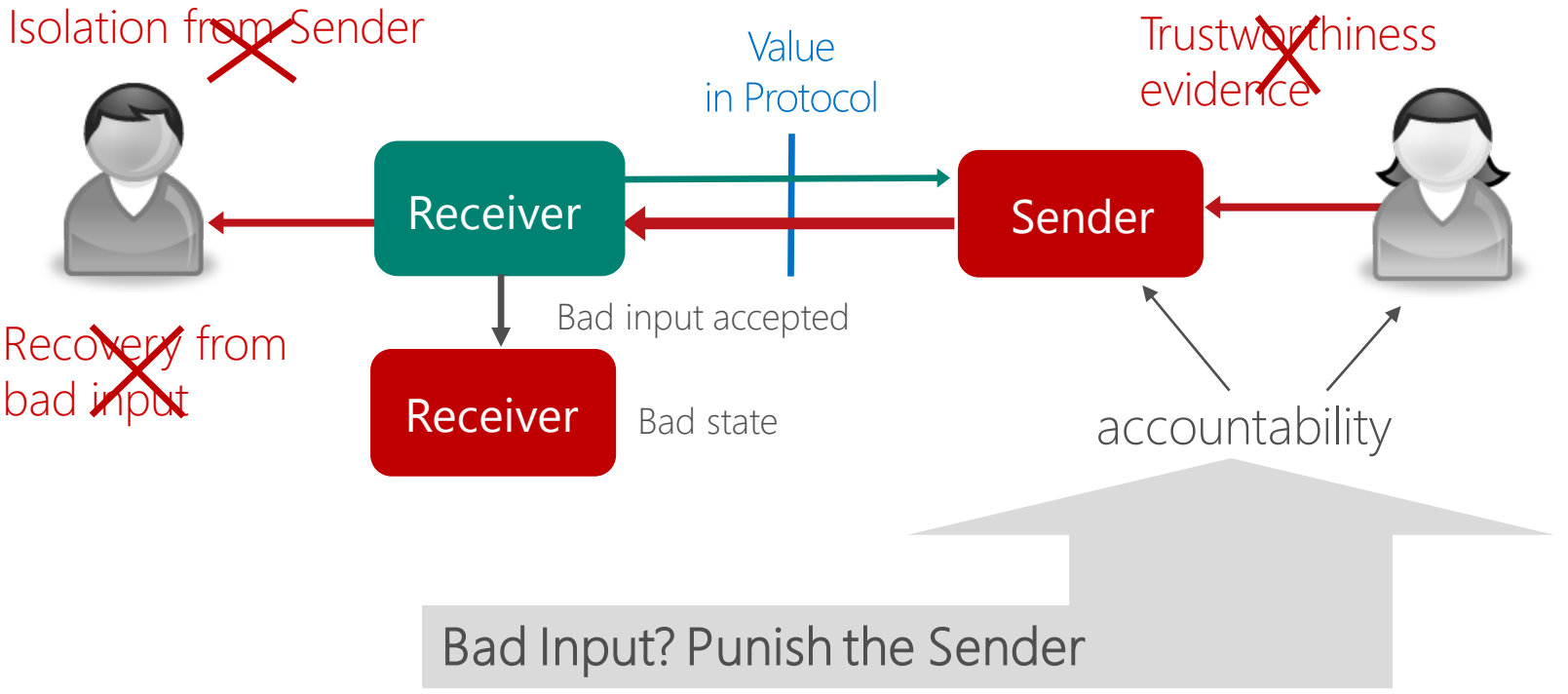
  e.g., TCSEC and Common Criteria Assurance levels

  - trusted recovery

  TCSEC: B2 –> A1, CC: EAL 5 –> EAL 7

Larger Problem: Moral Hazard (always, carelessly click "accept input"?)

Deter Sender (Human) Misbehavior



Deterrence ⇒ Punishment ⇒ Accountability [Lampson05, CACM09]

We need ⇐ ⇐

sufficient **punishment to deter** and
sufficient **accountability to punish**

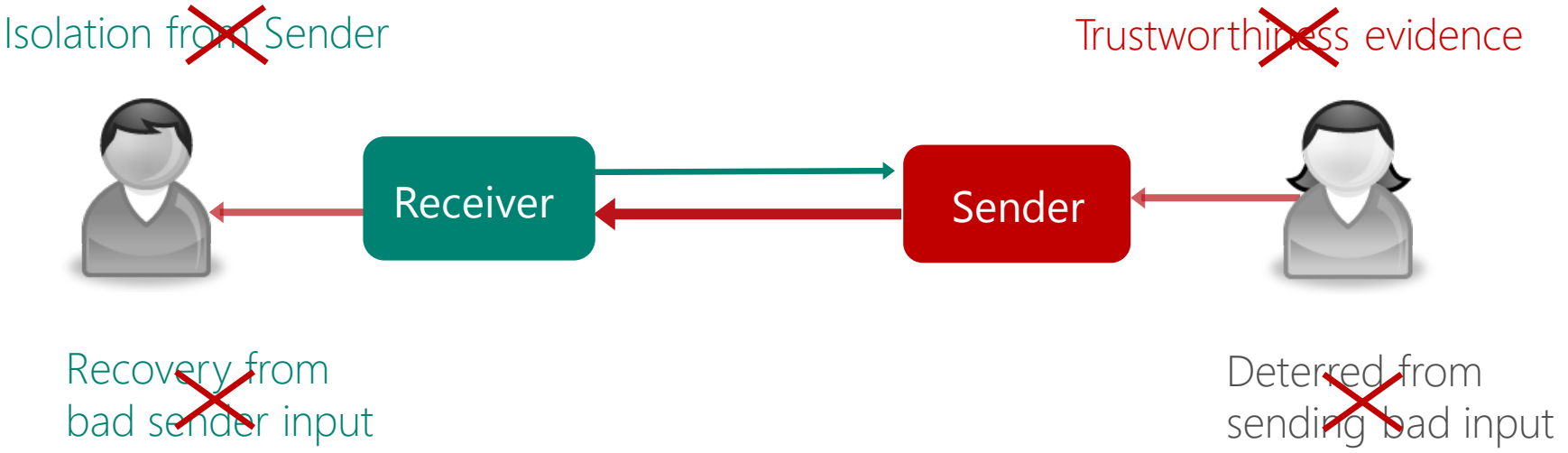
Deterrence: Always Practical, Scalable?

No, not always!

- What deters human *misbehavior*? (legal debate for centuries)

- Social norms, contract enforcement, law
    - some empirical evidence that Social Accountability deters more than the Law [CACM 2011]
    - norms-based punishment [Akerlof 2010]

The Act of Trusting



If 0% Isolation and 0%Trustworthiness Evidence and 0% Recovery and 0% Deterrence,

then the Sender is Trusted 100% . . .

and welcome to the Internet of today!

Is it ever safe to trust the Sender?

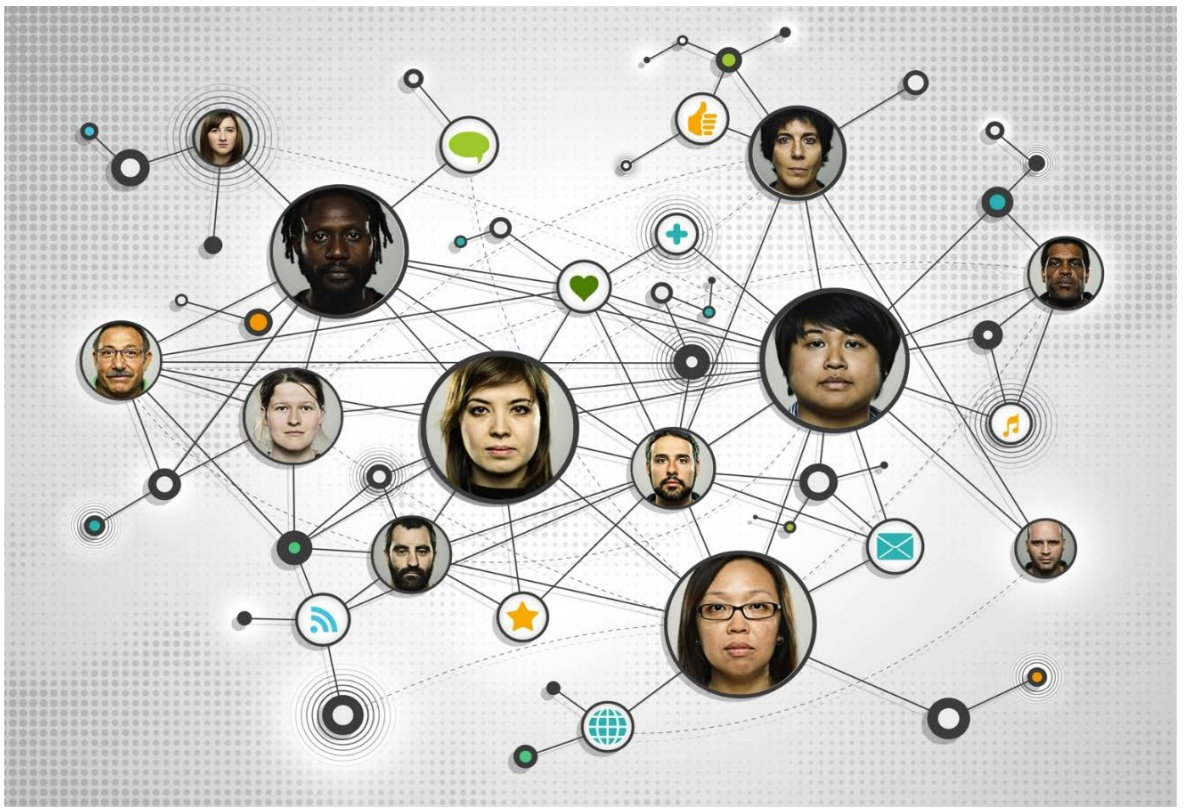
Theory of Trust, So Far

A theory of trust builds on these computational mechanisms

- Cryptography
- Verification
- Fault-tolerance

but we need more, to define trust among humans

Behavioral Trust



The Act of Trusting

What could the *act of trusting* mean?

- Examples/theories of trust in Economics, Sociology, Psychology …… 100's of research articles published to date

Behavioral Trust [Fehr09]

- ***beliefs*** and ***preferences*** (and nothing else)
- commonality with computer security
- explains role of *Deterrence, Trustworthiness, Recovery too*

A Model for Behavioral Trust

Sender is Trustee

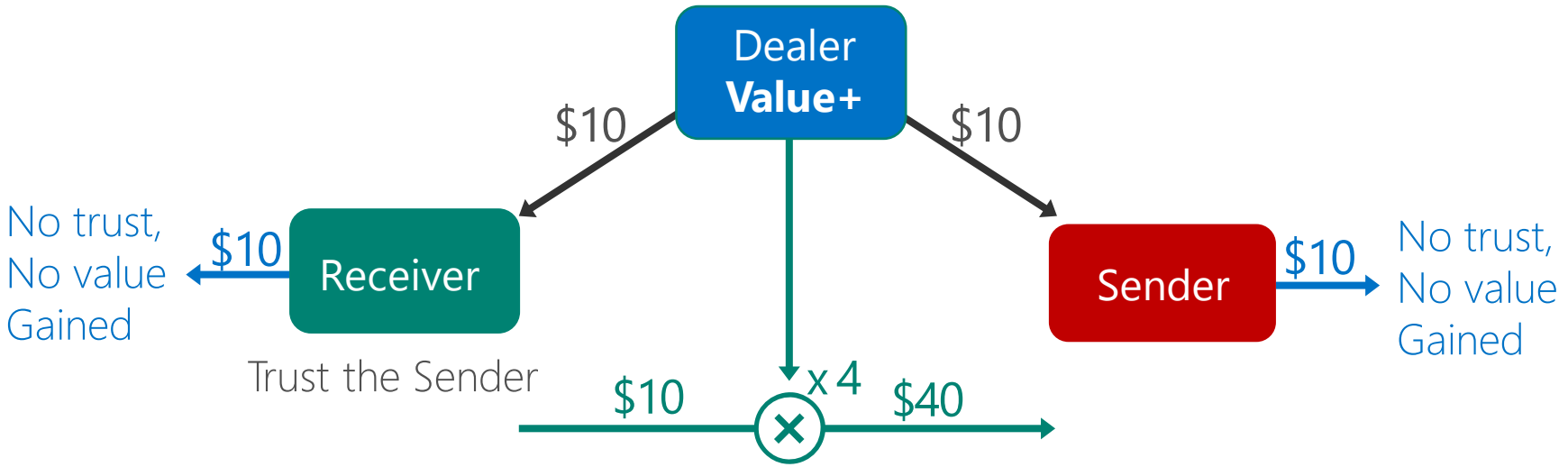
- e.g,. Bank, eBay, Google, Amazon, Microsoft

Receiver is Trustor (aka Investor)

- e.g., bidder, customer

One-Shot Game

One-Shot Trust Game



B gets $25, gaining $15

Receiver

$25

A sends $(10+40)/2 to **B**

Cooperation: Win-Win

Sender

A keeps $25, gaining $15

B gets $0, losing $10

Receiver

A cheats, **B** loses

Non-compliance: Loss-Win

Sender

A keeps $50, gaining $40

$25 - $10 = Value of Trusting Player 2

Possible Value Outcomes

Analogous to Sender-Receiver Interaction in Networks

If trustor trusts trustee and the trustee is trustworthy
- Then trustor and trustee are better off before executing protocol, i.e., cooperation pays off

If Receiver trusts Sender and the Sender is trustworthy
- **Value gained** (for both)
  - Receiver gets information; Sender monetizes on click

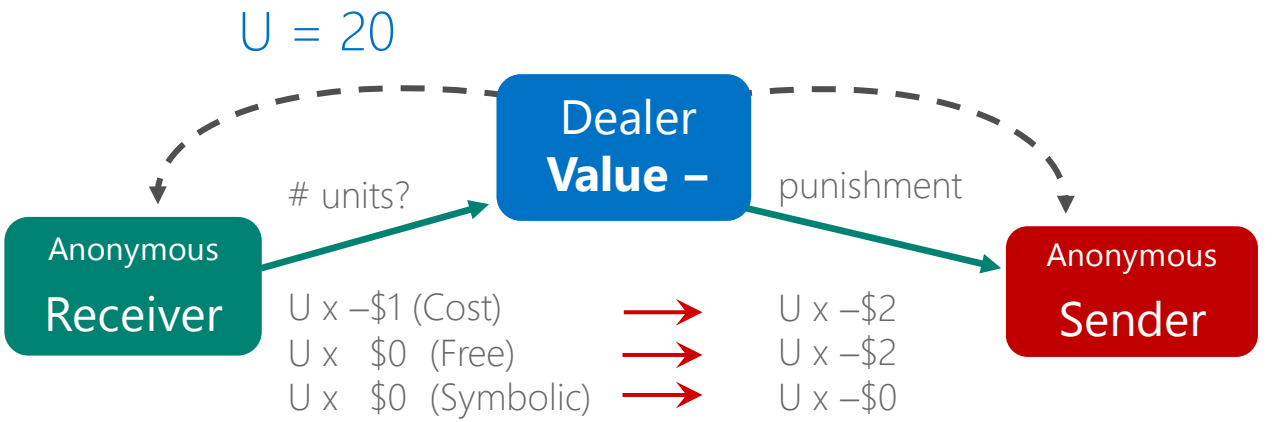
If trustor trusts trustee and the trustee is untrustworthy
- Then trustee is better off and trustor is worse off, i.e., trustee has strong incentive to cheat in the absence of a mechanism that protects the trustor

If Receiver trusts Sender and the Sender is untrustworthy
- Then **Value gained > Cost to engage**
  - Receiver risks getting malware

If trustor suspects trustee will cheat, then don't engage, i.e., no value exchanged

If Receiver suspects Sender is untrustworthy, then don't engage
- Then **no Value exchanged**

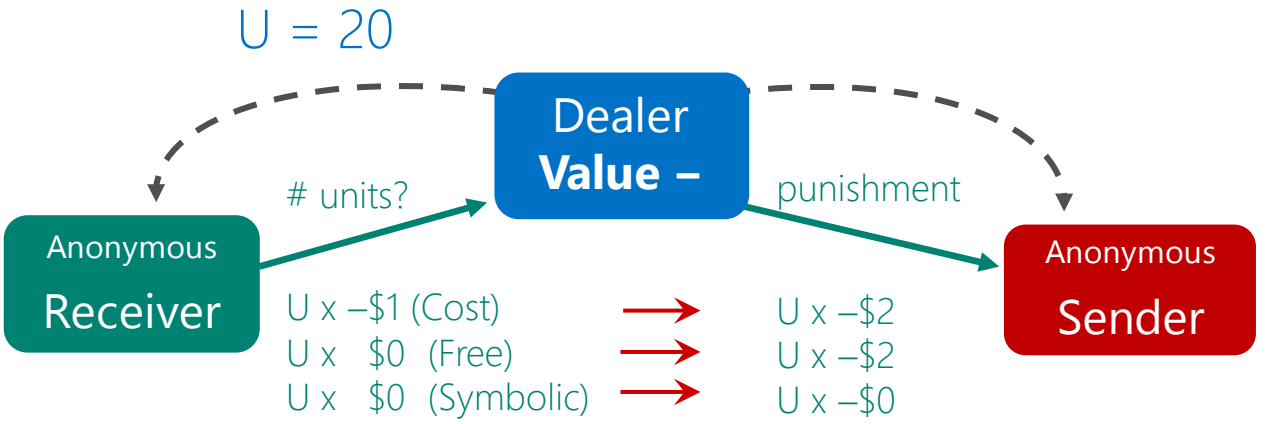
Punishment . . . [de Quervain et al. 04]



Punishment: Most **Receivers** paid **Dealer**
to punish cheating **Senders**

(12/14) **Cost ~ 11 U** punishment: ~ – $22
(14/14) **Free ~ 18 U** ~ – $36
(3/14) Symbolic

Betrayal Aversion



Punishment: Most **Receivers** paid **Dealer** to punish cheating

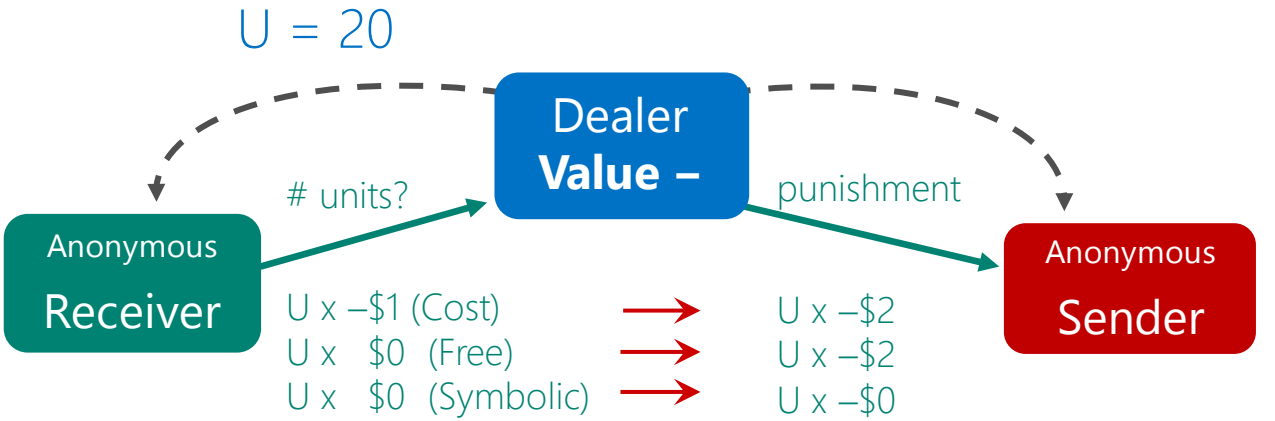
Senders: Cost ~ 11 U (1 U → –$1 cost) punishment: ~ –$ 22

Free ~ 18 U (1 U → $0 cost) ~ –$ 36

PET scan of **Receiver's** brain striatum shows **reward satisfaction**

- **betrayal aversion** (e.g., aversion to being scammed, cheated)
- (biological not psychological) **altruistic punishment**

Betrayal Aversion ≠ Risk Aversion



Punishment: Most **Receivers** paid **Dealer** to punish cheating **Senders**:

Cost ~ 11 U (1 U → –$1 cost) punishment: ~ –$ 22

Free ~ 18 U (1 U → $0 cost) ~ –$ 36

PET scan of **Receiver's** brain striatum shows **reward satisfaction**

- **betrayal aversion** (e.g., aversion to being scammed, cheated)
- (biological not psychological) **altruistic punishment**

1) Betrayal Aversion ≠ Risk Aversion: **Sender** is a *random process*

⇒ **Receiver**: **no** (small desire) to punish and **no** (little reward) satisfaction

cost ~ 2U punishment: < $4

2) Oxytocin affects betrayal, but *not* risk aversion, *nor* trustworthiness beliefs

Summary of Experiment's Results

Trustor/Receiver is willing to incur a cost to punish, and the amount of punishment inflicted was higher when the punishment was free

Trustor/Receiver derived satisfaction (i.e., felt rewarded) proportional to the amount of punishment inflicted on cheating Trustee/Sender

- That is, the stronger the satisfaction Trustor/Receiver derived, the higher the cost he was willing to incur. This indicates the strength of B's aversion to being betrayed by A. It also illustrates the fact that B's punishment is altruistic, since he is willing to pay to punish even though he is not deriving any material gain

When the Trustee/Sender is replaced by a random device, Trustor/Receiver's desire to punish is negligible

- This indicates that B's aversion to the risk of losing money when faced with an ambiguous outcome was different (i.e., lower) from his aversion to being betrayed.

Elements of Behavioral Trust: Preferences and Beliefs

Trustor's beliefs in trustworthiness of trustee
- Probabilistic beliefs about a trustee's actions

Beliefs

Trustor's risk preferences
- Degree of risk aversion

Trustor's social preferences
- Degree of betrayal aversion

Preferences

Toward a Combined Theory of Trust

What Makes This Possible?

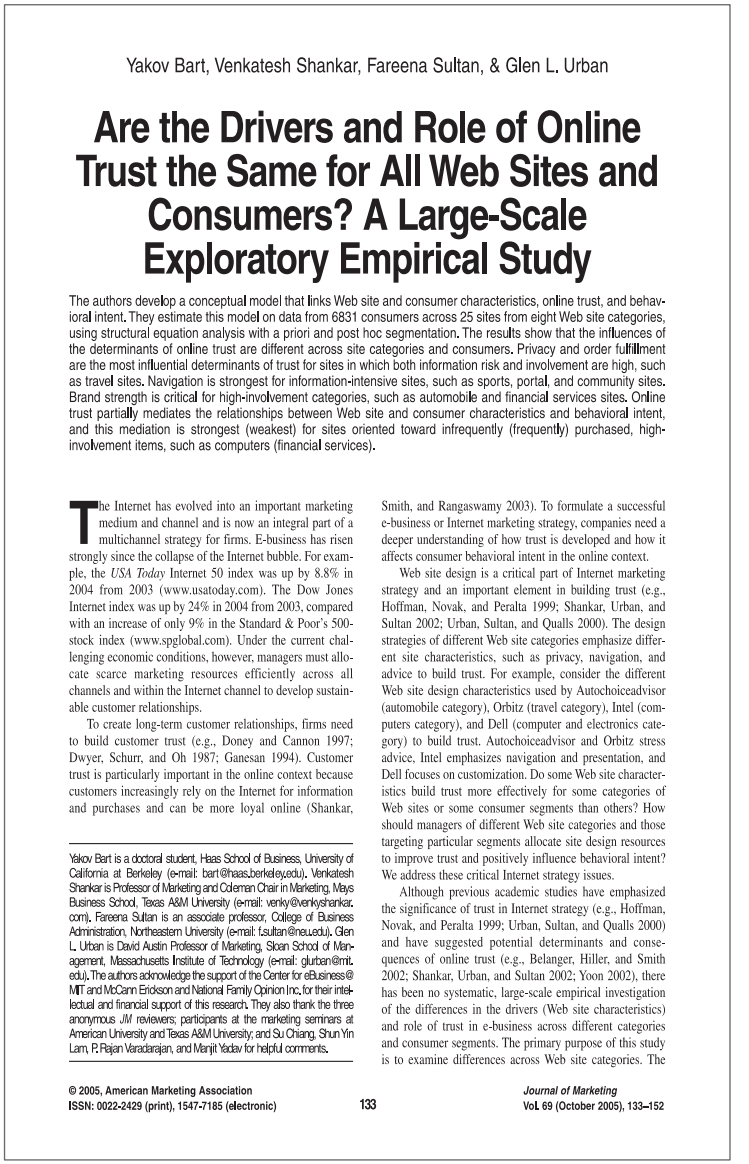
Data about people's behavior at scale

- What they search for
- What they buy
- Where they go
- What their interests are
- Who their friends are
- What movies they watch, books they read, food they buy
- … all correlated

Marketing Studies

For a travel website, privacy and order fulfillment are more influential drivers than navigation to garner trust

Higher-education people are more influenced by brand strength than lower-education people



Yakov Bart, Venkatesh Shankar, Fareena Sultan, & Glen L. Urban

Are the Drivers and Role of Online Trust the Same for All Web Sites and Consumers? A Large-Scale Exploratory Empirical Study

The authors develop a conceptual model that links Web site and consumer characteristics, online trust, and behavioral intent. They estimate this model on data from 6831 consumers across 25 sites from eight Web site categories, using structural equation analysis with a priori and post hoc segmentation. The results show that the influences of the determinants of online trust are different across site categories and consumers. Privacy and order fulfillment are the most influential determinants of trust for sites in which both information risk and involvement are high, such as travel sites. Navigation is strongest for information-intensive sites, such as sports, portal, and community sites. Brand strength is critical for high-involvement categories, such as automobile and financial services sites. Online trust partially mediates the relationships between Web site and consumer characteristics and behavioral intent, and this mediation is strongest (weakest) for sites oriented toward infrequently (frequently) purchased, high-involvement items, such as computers (financial services).

The Internet has evolved into an important marketing medium and channel and is now an integral part of a multichannel strategy for firms. E-business has risen strongly since the collapse of the Internet bubble. For example, the *USA Today* Internet 50 index was up by 8.8% in 2004 from 2003 (www.usatoday.com). The Dow Jones Internet index was up by 24% in 2004 from 2003, compared with an increase of only 9% in the Standard & Poor's 500-stock index (www.spglobal.com). Under the current challenging economic conditions, however, managers must allocate scarce marketing resources efficiently across all channels and within the Internet channel to develop sustainable customer relationships.

To create long-term customer relationships, firms need to build customer trust (e.g., Doney and Cannon 1997; Dwyer, Schurr, and Oh 1987; Ganesan 1994). Customer trust is particularly important in the online context because customers increasingly rely on the Internet for information and purchases and can be more loyal online (Shankar, Smith, and Rangaswamy 2003). To formulate a successful e-business or Internet marketing strategy, companies need a deeper understanding of how trust is developed and how it affects consumer behavioral intent in the online context.

Web site design is a critical part of Internet marketing strategy and an important element in building trust (e.g., Hoffman, Novak, and Peralta 1999; Shankar, Urban, and Sultan 2002; Urban, Sultan, and Qualls 2000). The design strategies of different Web site categories emphasize different site characteristics, such as privacy, navigation, and advice to build trust. For example, consider the different Web site design characteristics used by Autochoiceadvisor (automobile category), Orbitz (travel category), Intel (computers category), and Dell (computer and electronics category) to build trust. Autochoiceadvisor and Orbitz stress advice, Intel emphasizes navigation and presentation, and Dell focuses on customization. Do some Web site characteristics build trust more effectively for some categories of Web sites or some consumer segments than others? How should managers of different Web site categories and those targeting particular segments allocate site design resources to improve trust and positively influence behavioral intent? We address these critical Internet strategy issues.

Although previous academic studies have emphasized the significance of trust in Internet strategy (e.g., Hoffman, Novak, and Peralta 1999; Urban, Sultan, and Qualls 2000) and have suggested potential determinants and consequences of online trust (e.g., Belanger, Hiller, and Smith 2002; Shankar, Urban, and Sultan 2002; Yoon 2002), there has been no systematic, large-scale empirical investigation of the differences in the drivers (Web site characteristics) and role of trust in e-business across different categories and consumer segments. The primary purpose of this study is to examine differences across Web site categories. The

Yakov Bart is a doctoral student, Haas School of Business, University of California at Berkeley (e-mail: bart@haas.berkeley.edu). Venkatesh Shankar is Professor of Marketing and Coleman Chair in Marketing, Mays Business School, Texas A&M University (e-mail: venky@venkyshankar.com). Fareena Sultan is an associate professor, College of Business Administration, Northeastern University (e-mail: f.sultan@neu.edu). Glen L. Urban is David Austin Professor of Marketing, Sloan School of Management, Massachusetts Institute of Technology (e-mail: glurban@mit.edu). The authors acknowledge the support of the Center for eBusiness@MIT and McCann Erickson and National Family Opinion Inc. for their intellectual and financial support of this research. They also thank the three anonymous *JM* reviewers; participants at the marketing seminars at American University and Texas A&M University; and Su Chiang, Shun Yin Lam, P. Rajan Varadarajan, and Manjit Yadav for helpful comments.

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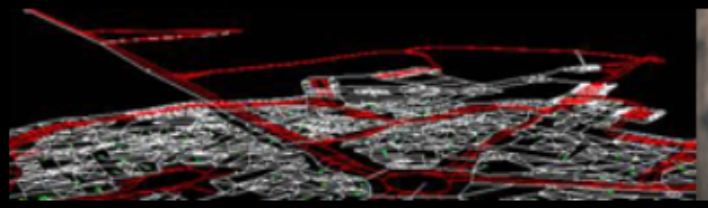
Bart et al, American Marketing Association, 2005

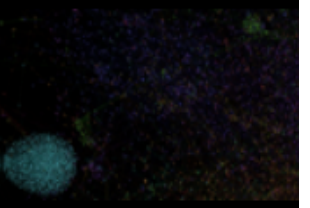
DARPA's Active Authentication Program

Use behavioral traits to determine a "cognitive fingerprint" instead of passwords

DARPA

Information Innovation Office





I2O HOME | PROGRAMS | PERSONNEL | ABOUT I2O

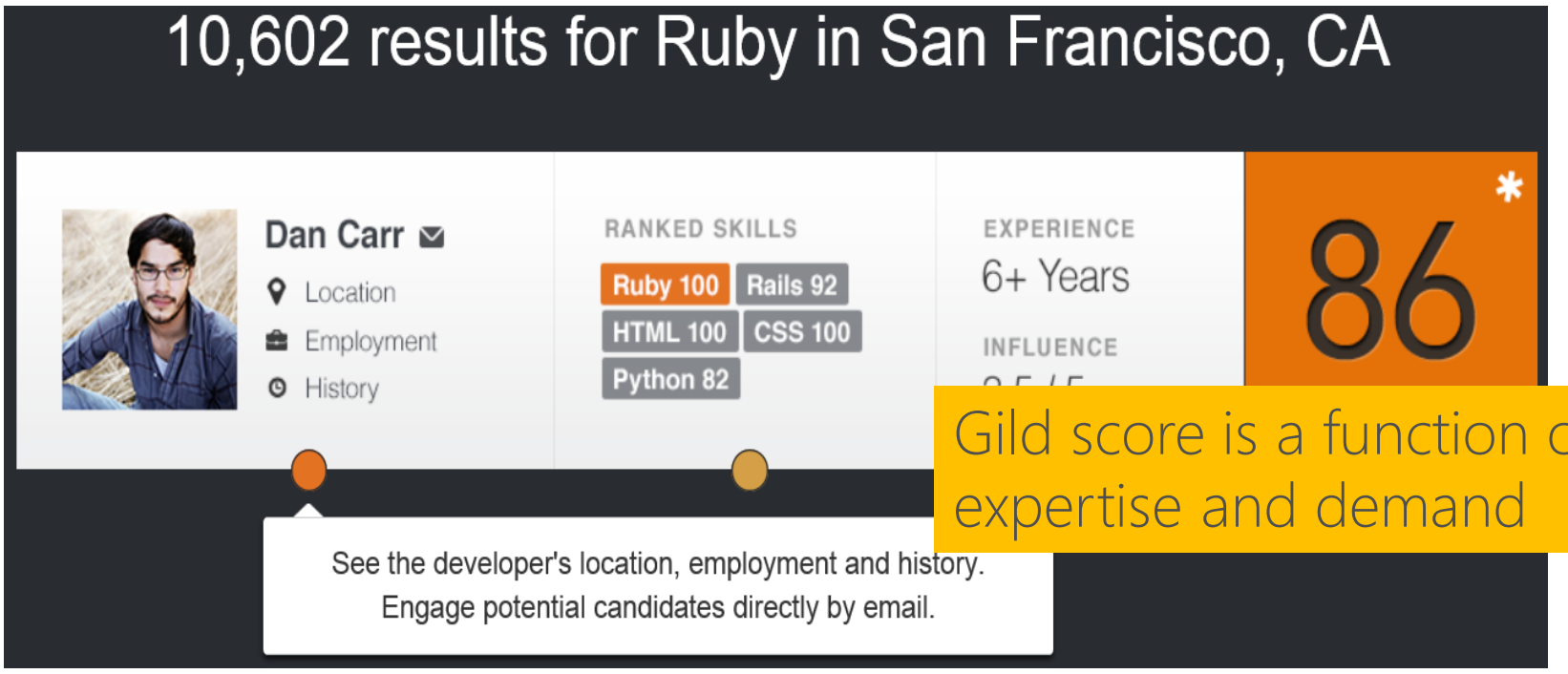
PROGRAM MANAGER

Mr. Richard Guidorizzi
richard.guidorizzi@darpa.mil

ACTIVE AUTHENTICATION

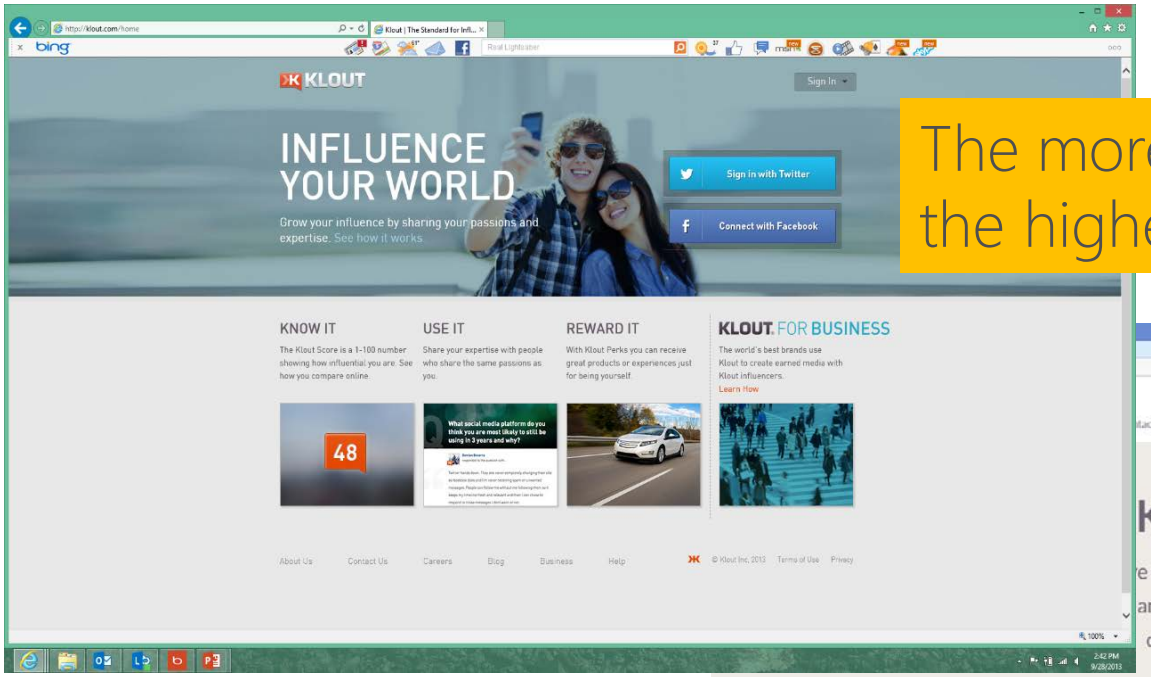
The current standard method for validating a user's identity for authentication on an information system requires humans to do something that is inherently unnatural:

Gild: Finding Talent

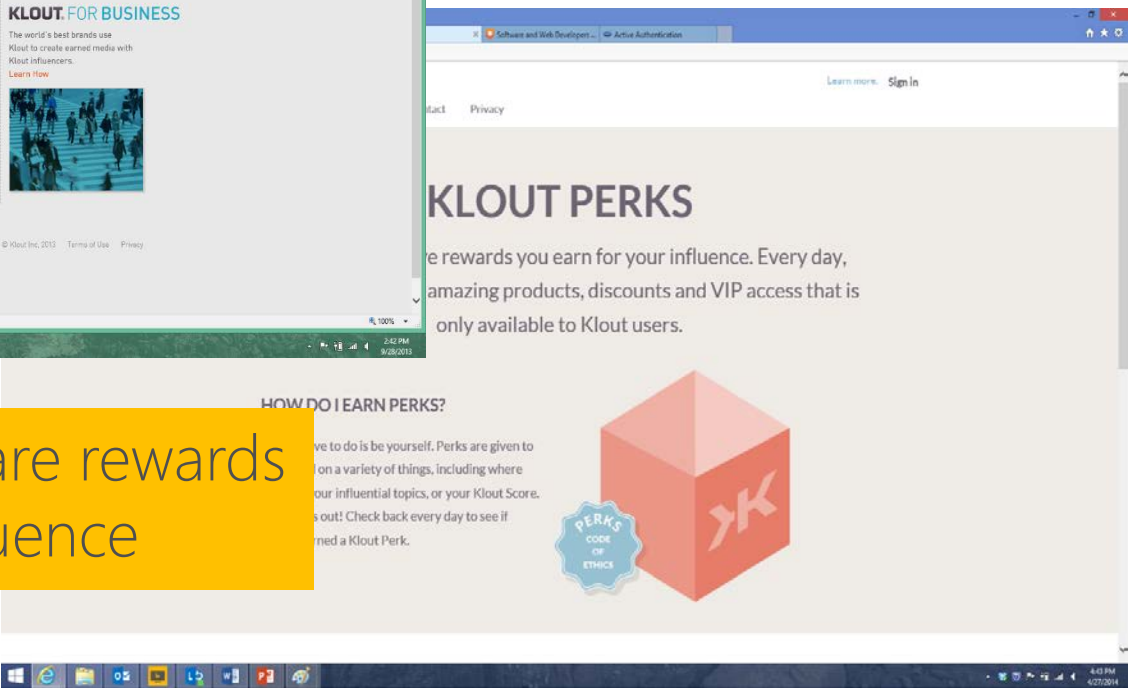


Gild score is a function of expertise and demand

Klout: Measures and Rewards Influence



The more influential you are, the higher your klout score



Klout Perks are rewards for your influence

Swenzy: Buy Friends and Influence

SWENZY®

Buy 1000 Facebook Likes for $9.98

These are not humans, but bot armies!

Buy 500 Twitter Followers for $4.89

Relating Behavioral to Computational Trust

- To increase beliefs in trustworthiness of trustee
  - Use reputation-enhancement protocols
    - E.g., reputation and recommendation services

Beliefs

- To decrease risk aversion
  - Use recovery and resiliency mechanisms
    - E.g., eBay's insurance policy

- To decrease betrayal aversion
  - Build deterrence against non-compliance
    - Yet to be exploited by computer scientists

Preferences

Safety Analogy

Air breaks in railcars (1896), automated railways signals and stops (1882)

⇒ Safe increase in train speeds, railroad commerce, economic opportunities

Towards a Richer Theory of Trust:
New Approach for New Security Research

Past: Security mechanisms to prevent, detect, and recover from security vulnerabilities and attacks

Future: Security infrastructures that promote *new* trust relations (and cooperation)

Goal: Seek security mechanisms that create new value, not just prevent losses

Toward A General Theory of Trust For Networks of Humans and Computers

Needs to build on elements of computational trust and behavioral trust

- Research (foundational): What are those elements? How do they reinforce or complement each other? How do they compose?

Should elucidate new trust relations and show how they provide new economic value

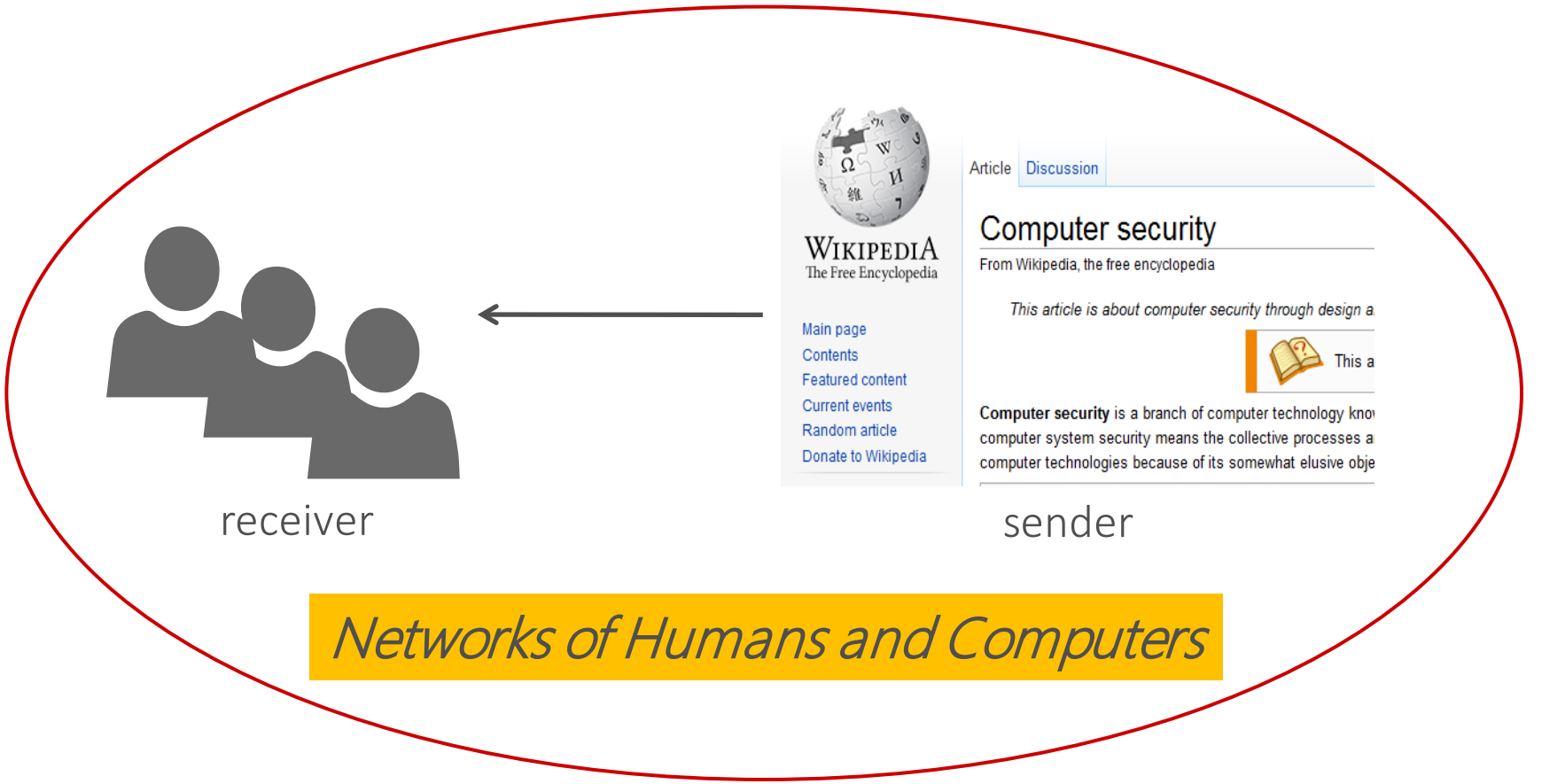
- Research (security economics): What are those new relations and how does one monetize them?

Should thus suggest new computational infrastructure to support behavioral trust in a computational setting

- Research (systems): What new computational mechanisms and systems/ network architectures and protocols could support betrayal aversion?

Motivation

How can I (a human) trust the information I read over the Internet?



Thank you!

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Appendix