# Understanding the Ethical Frameworks of Internet Measurement Studies

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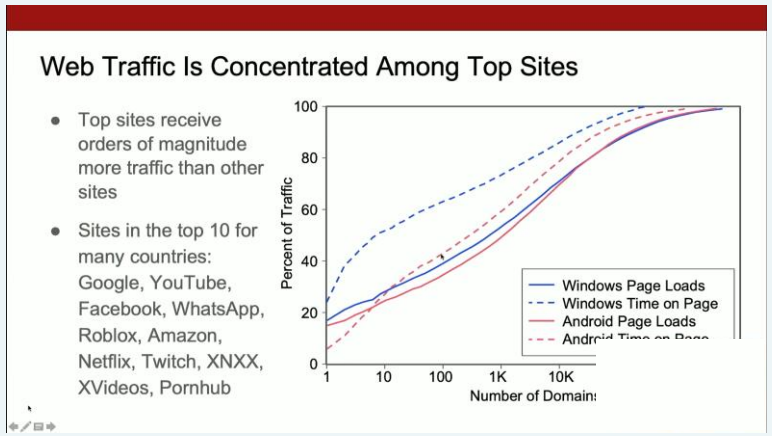
# Applications of Internet Measurement

Botnets (e.g., Mirai)

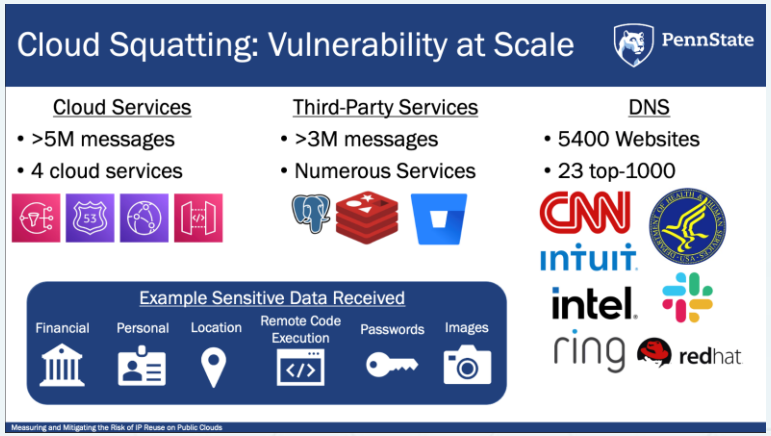

Antonakakis et al. ’17 [1]

User Behavior (e.g., CrUX)




Ruth et al. ’22 [2]

Novel Vulnerabilities




Pauley et al. ’22 [3]


**[1] Understanding the Mirai Botnet**

**[2] A world wide view of browsing the world wide web**

**[3] Measuring and Mitigating the Risk of IP Reuse on Public C**

# Challenge: Ethical measurement

- **Increased focus on ethical security research**
- **Required ethics considerations at conferences**

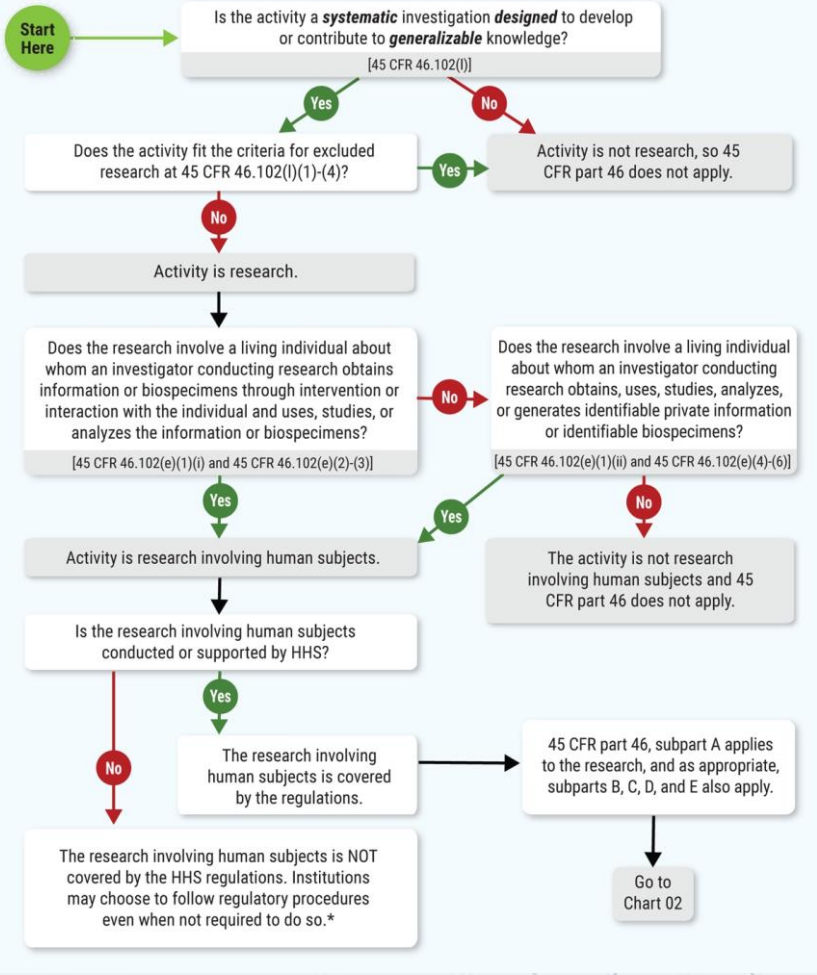
- **But: what does it mean for research to be *ethical*?**
  - Is it legal?
  - Is it IRB-approved (read: *exempt*)?
  - Are reviewers convinced it's ethical?

- **Goal: develop a cohesive, normative framework (a *classifier?*) for ethical Internet measurement**

| Conference | Ethics in CFP since |
|---|---|
| ACM IMC | 2009 [6] |
| USENIX Security | 2013 [7] |
| NDSS | 2015 [8] |
| ACM CCS | 2017 [10] |
| ACM ASIACCS | 2017 [9] |
| IEEE S&P | 2017 [11] |
| IEEE EuroS&P | 2017 [5] |
| ACM SIGMETRICS | 2018 [12] |
| ACSAC | 2021 [2] |

# An existing classifier: Institutional Review Boards (IRB)

- **Required (In US) for federally-funded research**
- **In reality: required by Universities (and conference CFPs)**
- **False Accept (doing unethical research):**
  - Failing to identify human subjects
  - Incomplete/missing anonymization
  - Unforeseen harms
- **False Reject (rejecting ethical research):**
  - Reasonable expectation of measurement
  - Statistically improbable impacts




**Source: HHS.gov**

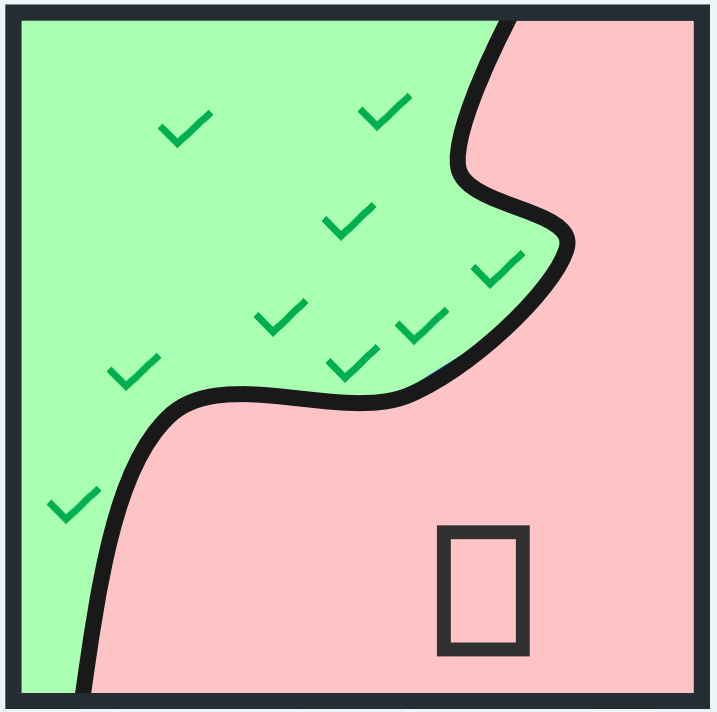
# Towards a framework of IM ethical considerations

**Study Goal: understand considerations and emergent consensus on ethical measurement**

**Broad expectations from venues**

**Ethical risks in papers**

**Considerations by authors**



**Building an Ethical Classifier?**

**Ultimately: develop a cohesive normative framework for ethical Internet measurement**

# Understanding ethical dimensions of measurement studies

| Venue | Vantage Point |
|---|---|
| ASIACCS '18 | Campus Net |
| IMC '19 | DNS Resolver |
| IMC '19 | CDN IPs |
| CCS '21 | Cloud IPs |
| SEC '21 | Cloud IPs |
| EuroS&PW '22 | Campus Net |
| SEC '22 | Container Registries |
| S&P '22 | Cloud IPs |
| IMC '22 | Web Browser |
| IMC '22 | Darknet |

- **Data points: accepted conference papers**

  Venues with ethics in CFP

- **Features: presence and mitigation of possible ethical concerns**

# Understanding ethical dimensions of measurement studies

| Venue | Vantage Point | Data Collected |
|---|---|---|
| ASIACCS '18 | Campus Net | Transport-Layer |
| IMC '19 | DNS Resolver | DNS Queries |
| IMC '19 | CDN IPs | Transport Layer |
| CCS '21 | Cloud IPs | DDoS Traffic |
| SEC '21 | Cloud IPs | Application Layer |
| EuroS&PW '22 | Campus Net | Application Layer |
| SEC '22 | Container Registries | Download counts |
| S&P '22 | Cloud IPs | Application Layer |
| IMC '22 | Web Browser | Aggregate Browsing Behavior |
| IMC '22 | Darknet | Passive IP + DNS |

Works tend to properly scope ethical considerations to data collected.

**Application**
- High Sensitivity

**Transport**
- Medium Sensitivity

**Network**
- Low Sensitivity

**Link**

# Understanding ethical dimensions of measurement studies

| Venue | Vantage Point | Data Collected | Target Parties | Incidental Parties |
|---|---|---|---|---|
| ASIACCS '18 | Campus Net | Transport-Layer | Scanners | End-Users |
| IMC '19 | DNS Resolver | DNS Queries | Recursive Resolvers | End-Users |
| IMC '19 | CDN IPs | Transport Layer | Scanners | |
| CCS '21 | Cloud IPs | DDoS Traffic | Scanners | End-Users |
| SEC '21 | Cloud IPs | Application Layer | Scanners | End-Users |
| EuroS&PW '22 | Campus Net | Application Layer | Scanners | |
| SEC '22 | Container Registries | Download counts | End-Users | |
| S&P '22 | Cloud IPs | Application Layer | Scanners, End-Users | |
| IMC '22 | Web Browser | Aggregate Browsing Behavior | End-Users | |
| IMC '22 | Darknet | Passive IP + DNS | Scanners, DNS Servers | |

Measurement papers often miss risk of incidental end-user data collection.

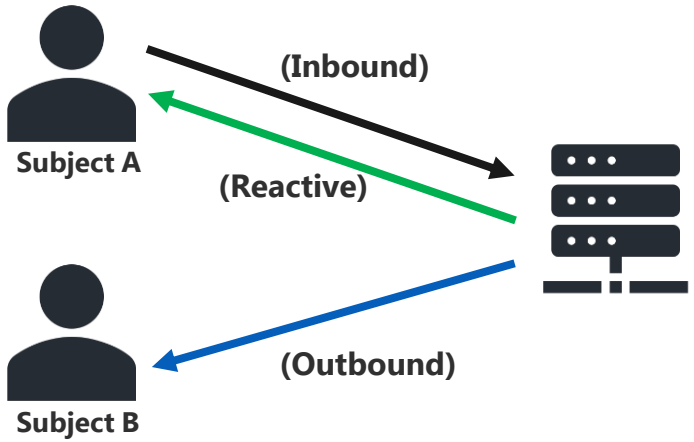
# Understanding ethical dimensions of measurement studies

| Venue | Vantage Point | Data Collected | Target Parties | Incidental Parties | Ethics Sec. | Anon.[1] |
|---|---|---|---|---|---|---|
| ASIACCS '18 | Campus Net | Transport-Layer | Scanners | End-Users | ○ | ◐ |
| IMC '19 | DNS Resolver | DNS Queries | Recursive Resolvers | End-Users | ● | ● |
| IMC '19 | CDN IPs | Transport Layer | Scanners | | ○ | ◐ |
| CCS '21 | Cloud IPs | DDoS Traffic | Scanners | End-Users | ● | ◐ |
| SEC '21 | Cloud IPs | Application Layer | Scanners | End-Users | ● | ◐ |
| EuroS&PW '22 | Campus Net | Application Layer | Scanners | | ○ | ◐ |
| SEC '22 | Container Registries | Download counts | End-Users | | ● | ● |
| S&P '22 | Cloud IPs | Application Layer | Scanners, End-Users | | ● | ◐ |
| IMC '22 | Web Browser | Aggregate Browsing Behavior | End-Users | | ● | ● |
| IMC '22 | Darknet | Passive IP + DNS | Scanners, DNS Servers | | ● | ◐ |

Anonymization can be a *technical* contribution

# Understanding ethical dimensions of measurement studies

| Venue | Vantage Point | Data Collected | Target Parties | Incidental Parties | Ethics Sec. | Anon.[1] | Impact[2] |
|---|---|---|---|---|---|---|---|
| ASIACCS '18 | Campus Net | Transport-Layer | Scanners | End-Users | ○ | ◐ | ○ |
| IMC '19 | DNS Resolver | DNS Queries | Recursive Resolvers | End-Users | ● | ● | ○ |
| IMC '19 | CDN IPs | Transport Layer | Scanners | | ○ | ◐ | ○ |
| CCS '21 | Cloud IPs | DDoS Traffic | Scanners | End-Users | ● | ◐ | ● |
| SEC '21 | Cloud IPs | Application Layer | Scanners | End-Users | ● | ◐ | ◐ |
| EuroS&PW '22 | Campus Net | Application Layer | Scanners | | ○ | ◐ | ◐ |
| SEC '22 | Container Registries | Download counts | End-Users | | ● | ● | ◐ |
| S&P '22 | Cloud IPs | Application Layer | Scanners, End-Users | | ● | ◐ | ●[3] |
| IMC '22 | Web Browser | Aggregate Browsing Behavior | End-Users | | ● | ● | ○ |
| IMC '22 | Darknet | Passive IP + DNS | Scanners, DNS Servers | | ● | ◐ | ●[3] |




Studies sufficiently mitigated harms to users due to interactivity

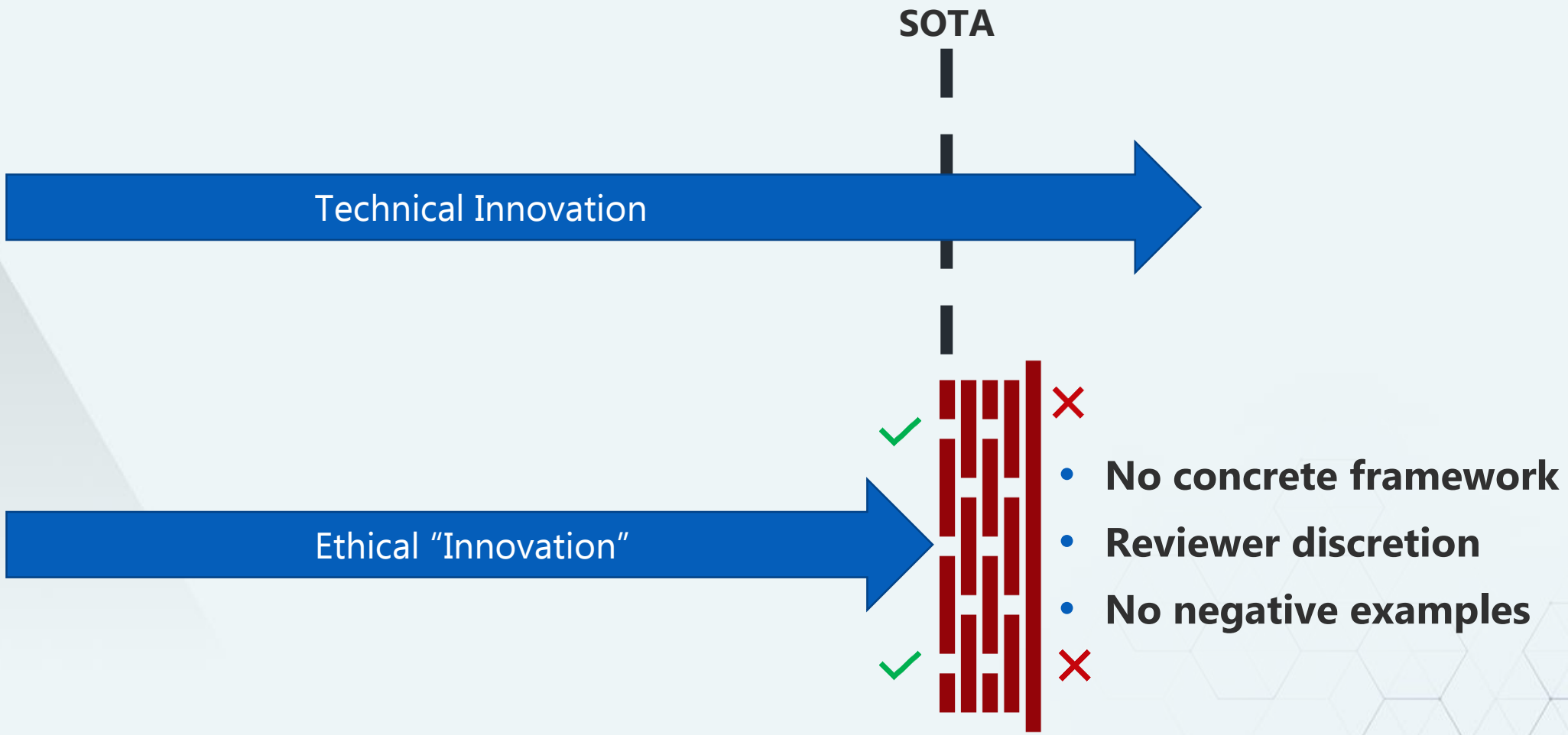
# Examining venue expectations

| Conference | Ethics in CFP since | Latest CFP[8] | IRB[1] | Impact[3] | Disclosure[4] | Legal[5] | REC[6] | Framework[7] |
|---|---|---|---|---|---|---|---|---|
| ACM IMC | 2009 [6] | 2022 | ● | ● | ○ | ○ | ○ | Belmont [28] (B/C) |
| USENIX Security | 2013 [7] | 2023 | ●[2] | ● | ● | ○ | ● | Menlo [22] (B) |
| NDSS | 2015 [8] | 2023 | ● | ○ | ● | ● | ○ | |
| ACM CCS | 2017 [10] | 2022 | ● | ○ | ● | ○ | ○ | |
| ACM ASIACCS | 2017 [9] | 2023 | ○ | ○ | ● | ● | ○ | |
| IEEE S&P | 2017 [11] | 2023 | ●[2] | ○ | ○ | ● | ● | |
| IEEE EuroS&P | 2017 [5] | 2023 | ●[2] | ○ | ● | ○ | ○ | Menlo [22] (B) |
| ACM SIGMETRICS | 2018 [12] | 2023 | ●[2] | ○ | ○ | ○ | ○ | Menlo [22] (B/C) |
| ACSAC | 2021 [2] | 2022 | ● | ● | ● | ○ | ○ | |

## Recommendations:

- **Apply learnings from other venues**
- **Emphasize technical merit in ethical considerations**

# Technical vs. Ethical "Innovation"?



# Soliciting structured feedback from reviewers

- Community survey with hypothetical ethical concerns
- Aggregated feedback on acceptable norms and ethical risks

# Result: criteria with exemplars to clarify expectations at major venues

Future work towards cohesive ethical norms

# Analysis of negative ethical examples

- Paper retractions (rare, low signal)
- Rejected papers (requires PC collaboration)
- **Recommendation**: anonymized ethical post-mortems

# Result: practical negative ethical examples



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