CHARACTERIZING CYBERLOCKER TRAFFIC FLOWS

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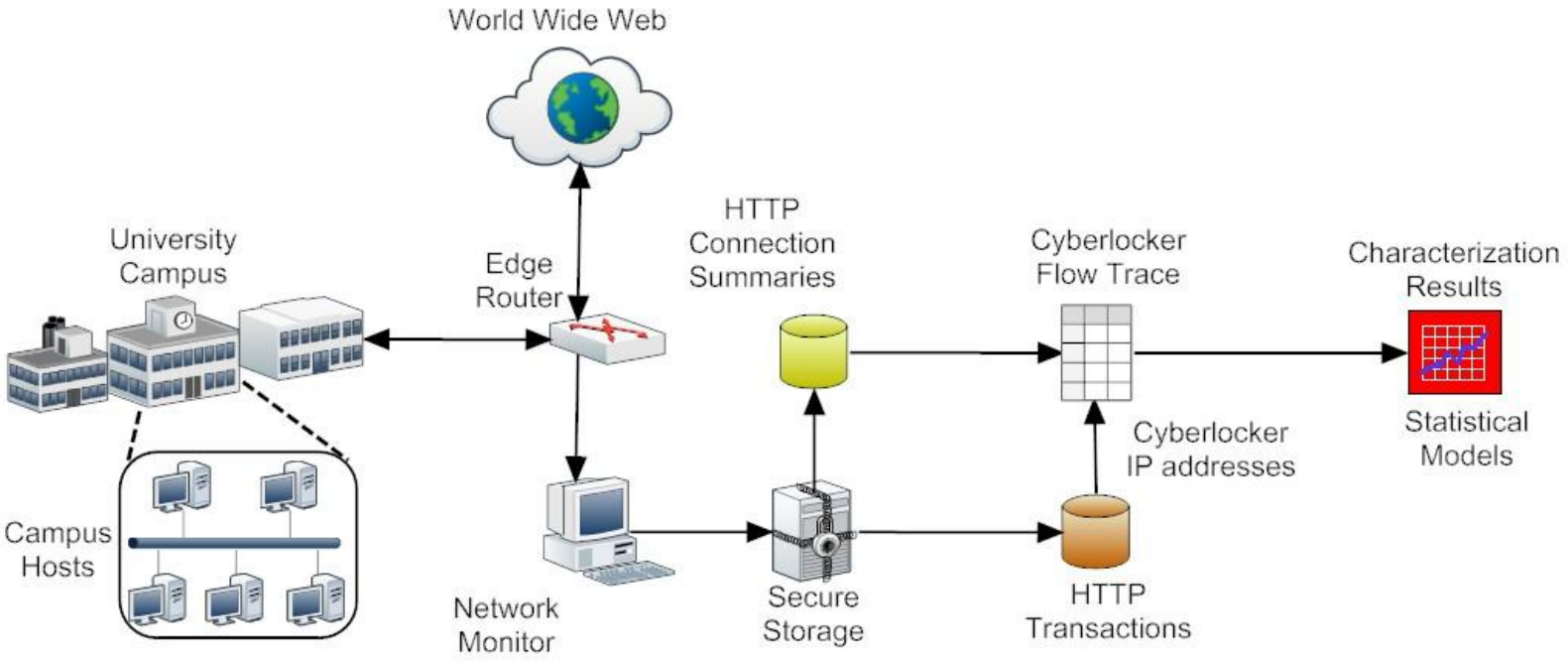
Introduction

- Cyberlocker services provide an easy Web interface to upload, manage, and share content.
- Recent academic and industry studies suggest that cyberlocker traffic account for a significant fraction of the Internet traffic volume.
- Usage, content characteristics, performance, and infrastructure of selected cyberlockers have been analyzed in previous work.
- In this work, we analyze flows originating from several cyberlockers, and study their **properties at the transport layer** and their **impact on edge network**.

METHODOLOGY

Data Collection

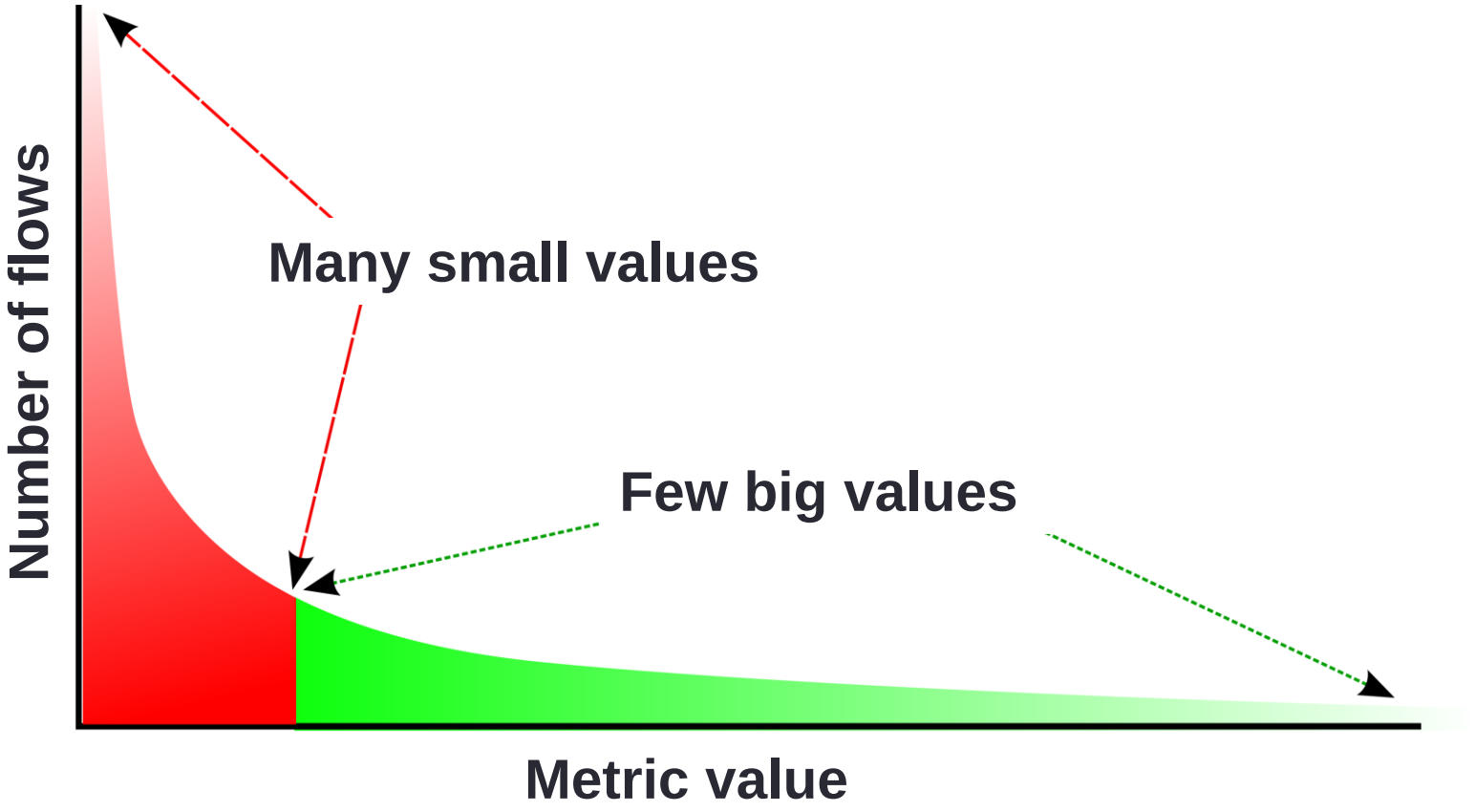


- **Flow-level summaries** were collected using Bro from a *large university edge router* between Jan. 2009 – Dec. 2009
- **HTTP transaction summaries** used to extract IP addresses of *top-10 cyberlocker* services for mapping the flows.

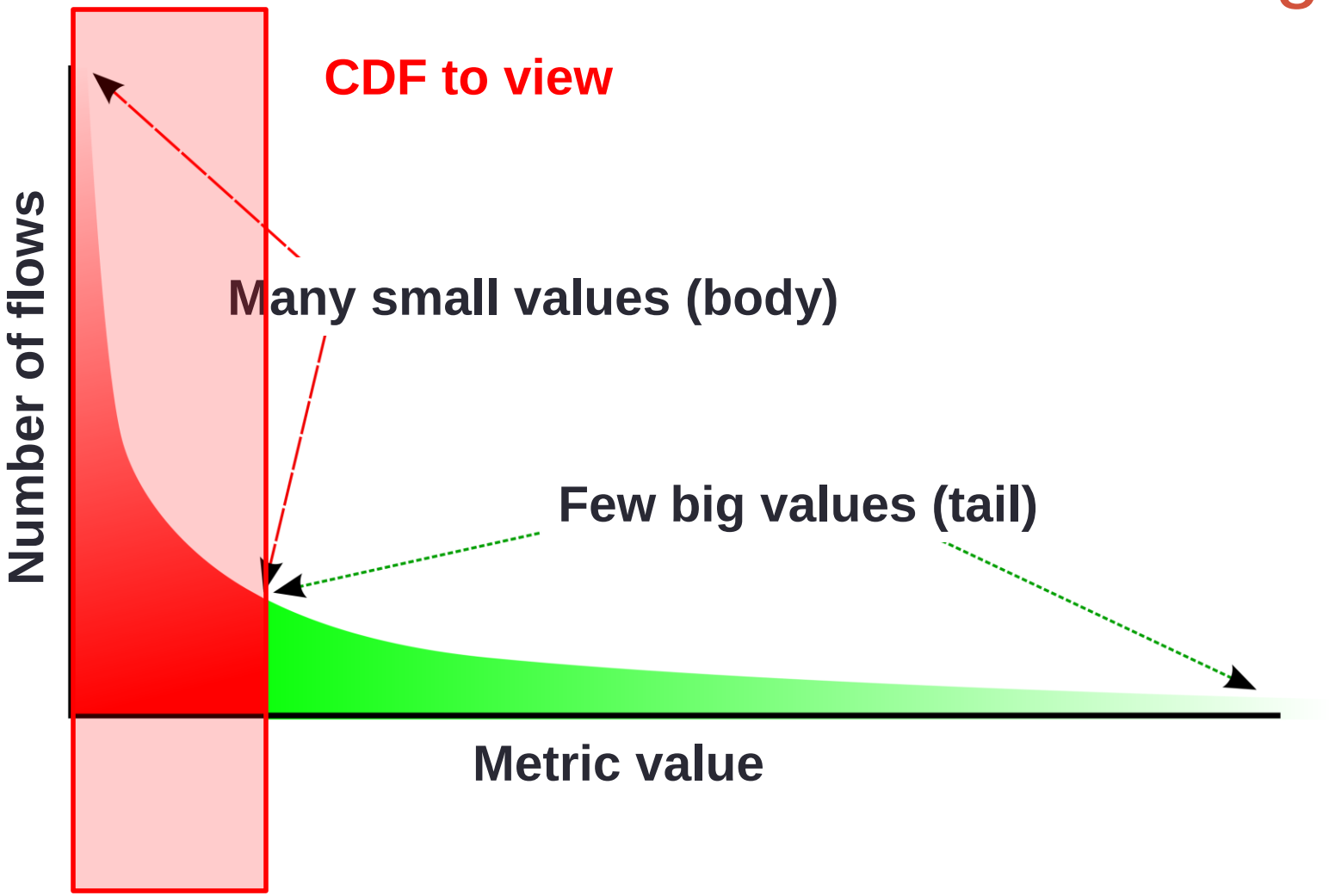
Characterization Metrics

- Flow-level characterization
  - Flow size: The total number of bi-directional bytes transferred within a single TCP flow.
  - Flow duration: The time between start and end of a flow.
  - Flow rate: The average data transfer rate of a TCP connection.
  - Flow inter-arrival time: The time between two consecutive flow arrivals.
- Host-level characterization
  - Transfer volume: The total traffic volume transferred by a campus host during the trace period.
  - On-time: The total time the campus host was active during the trace period.

Distribution Characterization and Fitting



Distribution Characterization and Fitting



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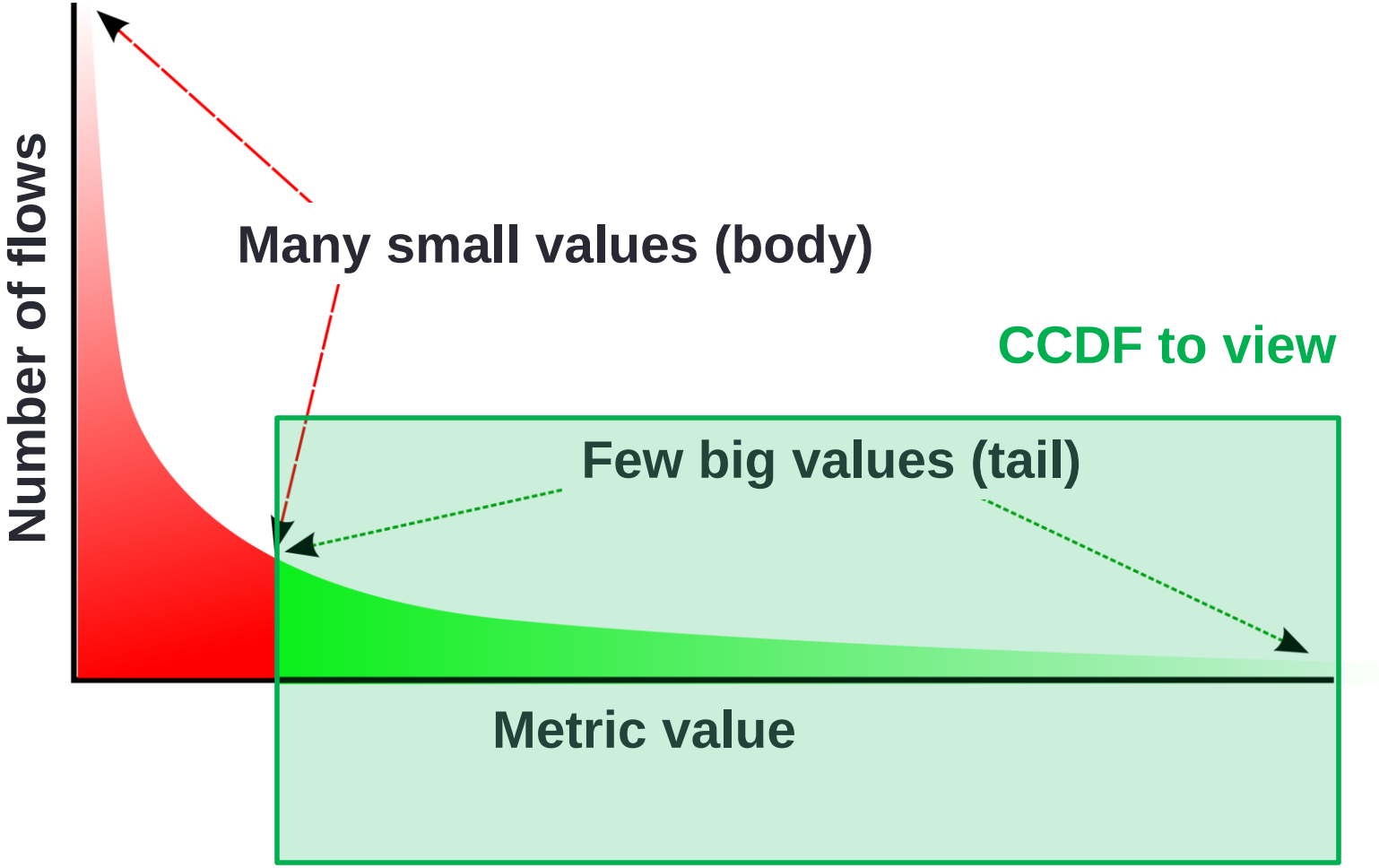

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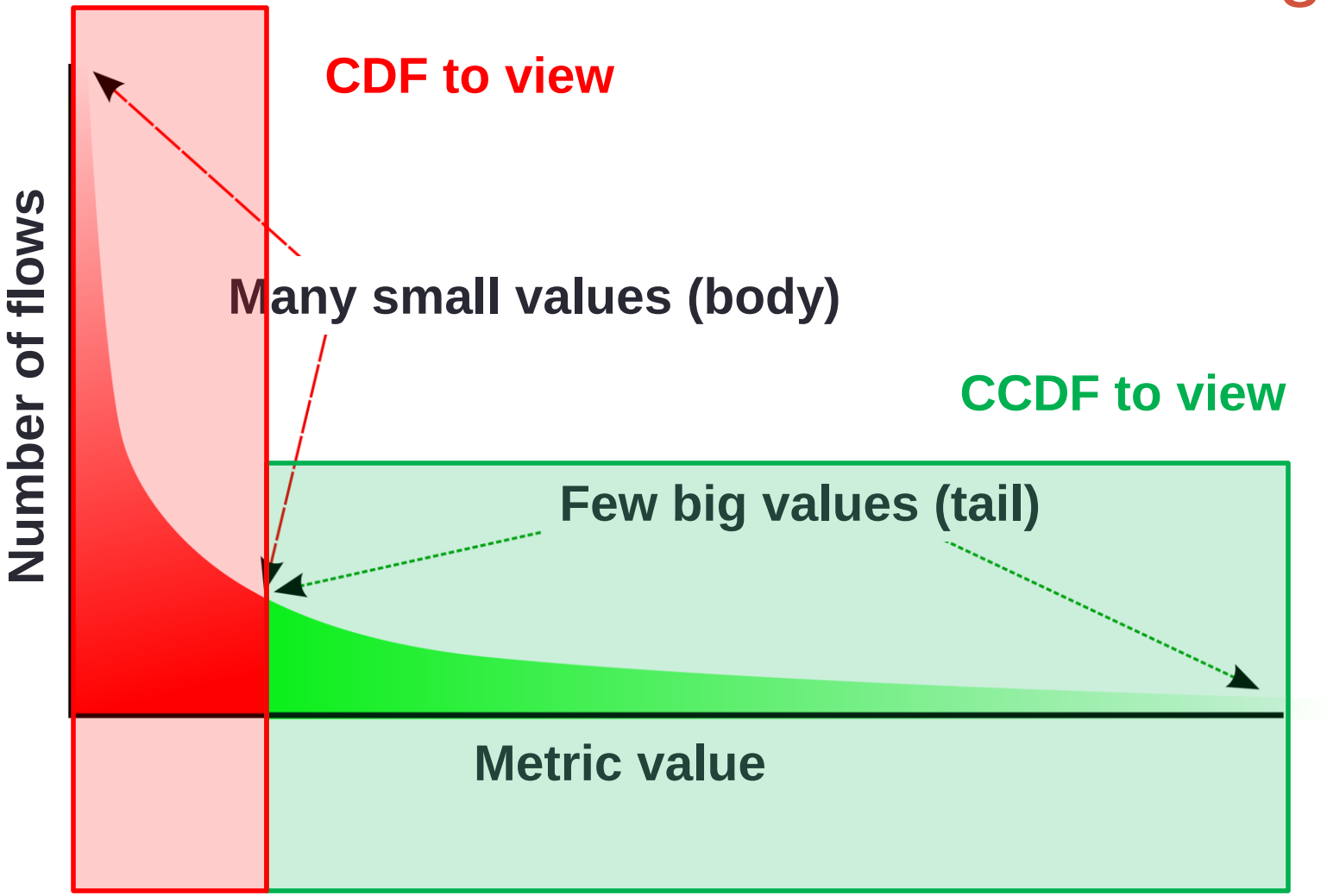
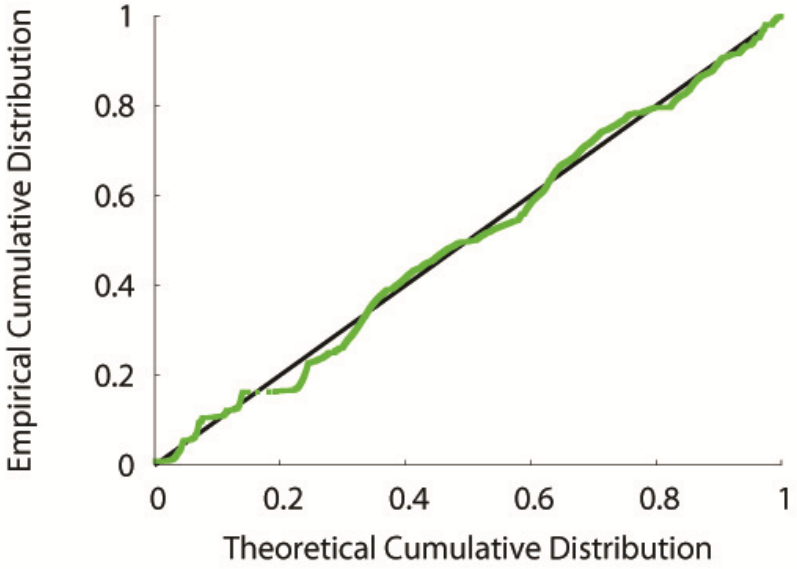


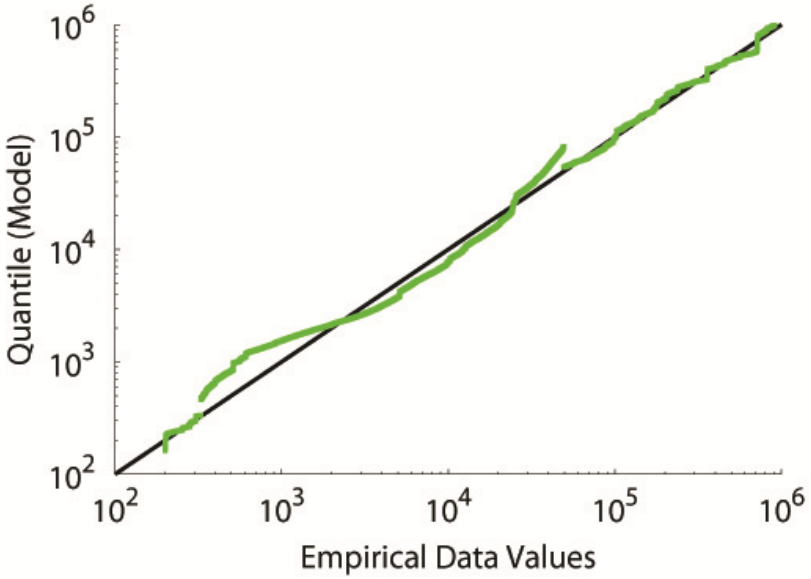
Distribution Fitting and Model Selection

- Complexity of the empirical distribution required us to apply hybrid fits of candidate distributions, where we fit the empirical distributions piece-wise.
- Each empirical distribution was divided into pieces based on manual inspection.
- We fitted seven well-known non-negative candidate statistical distributions (*Lognormal, Pareto, Gamma, Weibull, Levy,* and *Log Logistic*) to each piece and calculated the nonlinear sum of least square error.
- The statistical distribution with the lowest error was chosen.
- After fitting all the pieces of the empirical distribution, we generated the P-P and Q-Q plots; the goodness of the fit was determined by manually inspecting these plots.

Goodness of Fit



(a) Fit of body (majority of flows)



(b) Fit of tail (rare-extreme values)

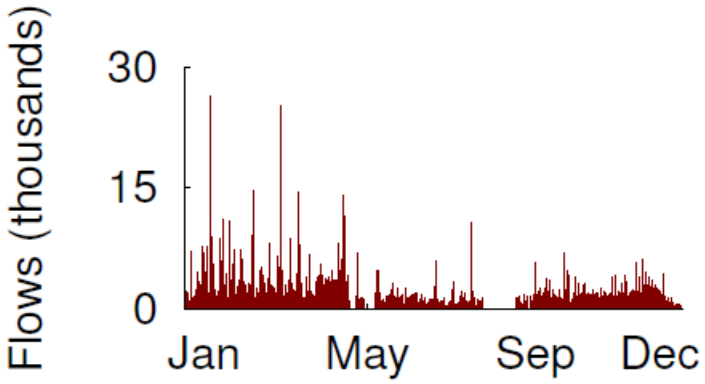
DATASET OVERVIEW

Trace Summary

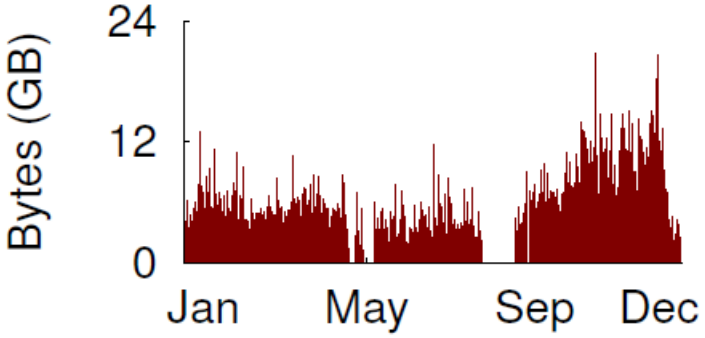
Characteristic	Count
Flow summary log size	1 TB
HTTP traffic	4 billion flows
HTTP traffic volume	488 TB
Top-10 cyberlockers	7 million flows (0.19%)
Top-10 cyberlocker traffic volume	22 TB (4.5%)
Campus hosts using cyberlockers	13,000 hosts

Service	Host	Flows	Bytes
Mega Network (%)	75	43	68
RapidShare (%)	41	42	13
zSHARE (%)	35	4	8
MediaFire (%)	34	8	3
Hotfile (%)	5	0	2
Enterupload (%)	30	1	2
Sendspace (%)	11	1	1
2Shared (%)	7	0	1
Depositfiles (%)	8	1	1
Uploading (%)	5	0	0
Top-10 cyberlockers	13K	7 mil	22 TB

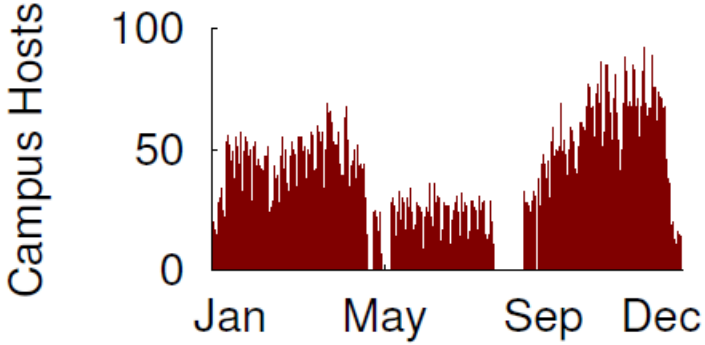
Campus Usage Trends



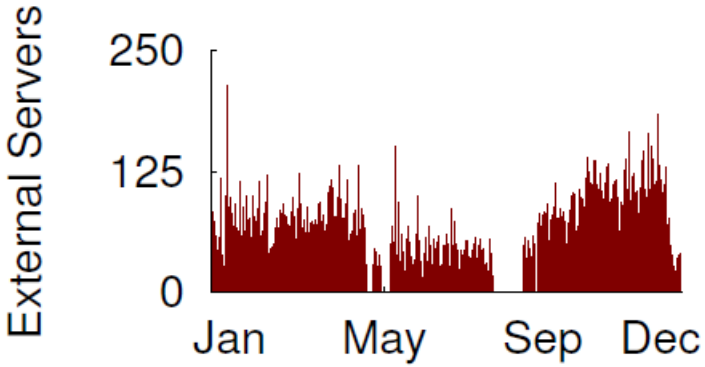
(a) Cyberlocker flows



(b) Bytes transferred by content flow



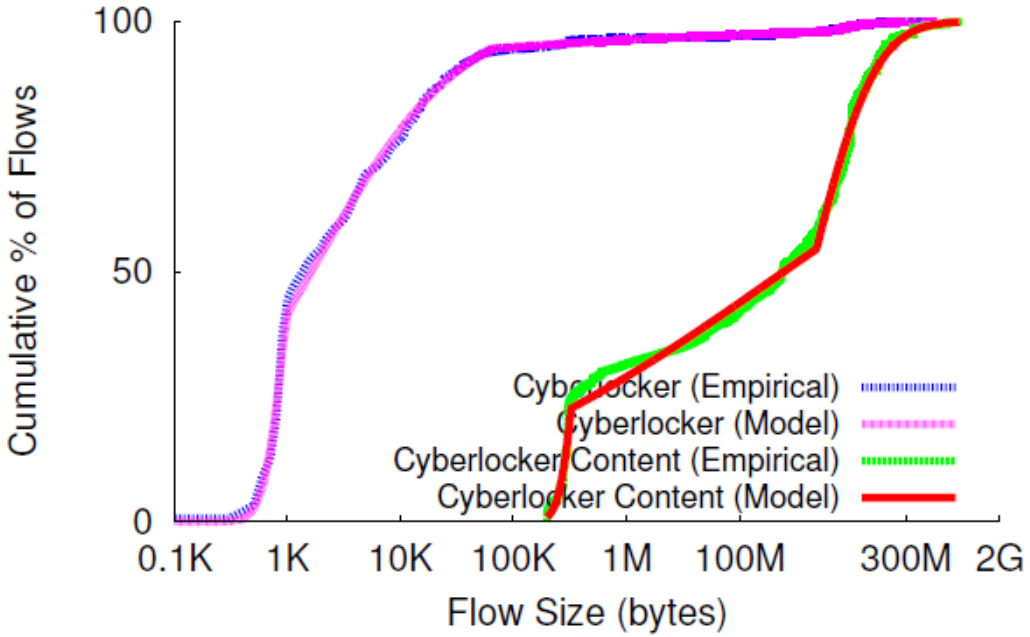
(c) Content flow hosts



(d) Content flow external servers

FLOW-LEVEL CHARACTERIZATION

Flow Size

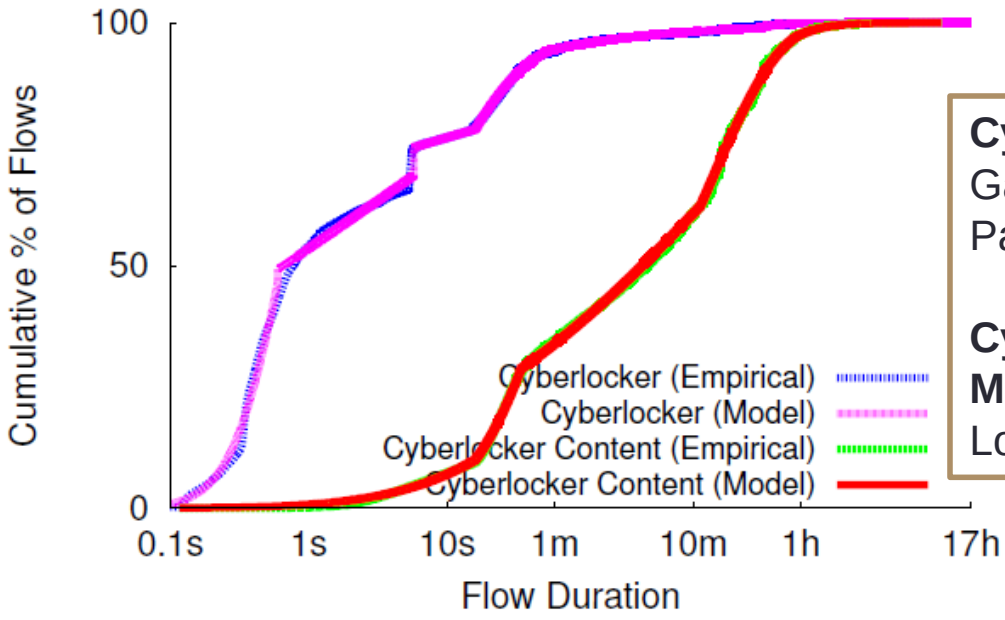


Cyberlocker Model: Lognormal-Pareto

Cyberlocker Content Model: Lognormal

- Content flows only represent 5% of the cyberlocker flows, they consume over 99% of the total traffic volume.
- Content flows are orders of magnitude larger as they transfer large content hosted on the sites.
- Significantly larger flows than typical Web object.

Flow Duration

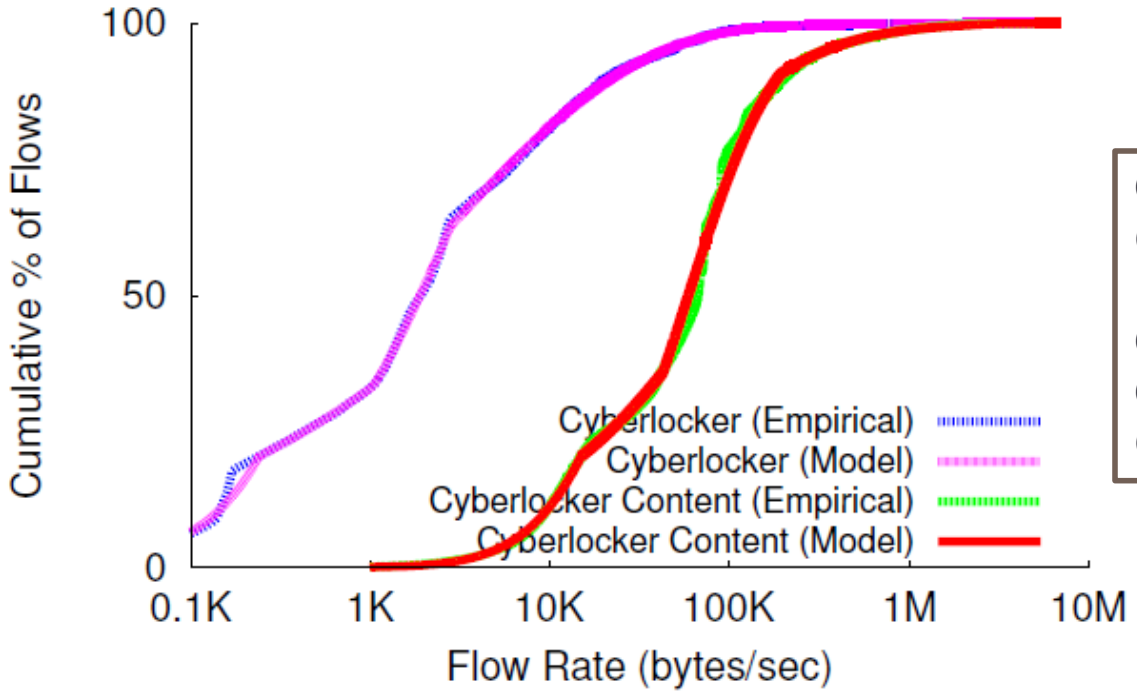


Cyberlocker Model: Gamma-Lognormal-Pareto

Cyberlocker Content Model: Lognormal-Gamma

- Content flows are long-lived, partly due to wait times and bandwidth throttling.
- Most content flows have duration less than 10 minutes due to medium-sized content downloads.

Flow Rate

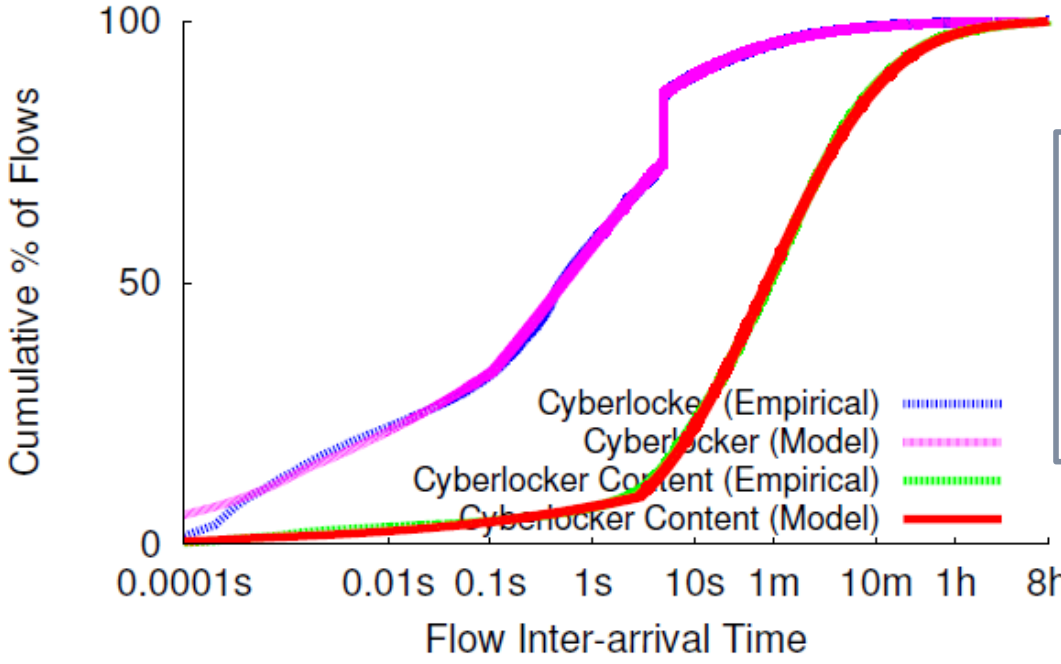


Cyberlocker Model: Gamma

Cyberlocker Content Model: Gamma-Lognormal

- Cyberlocker content flows are larger and long-lived and receive higher flow rates.
- There is presence of both free and premium hosts that download content from the services.

Flow Inter-arrival



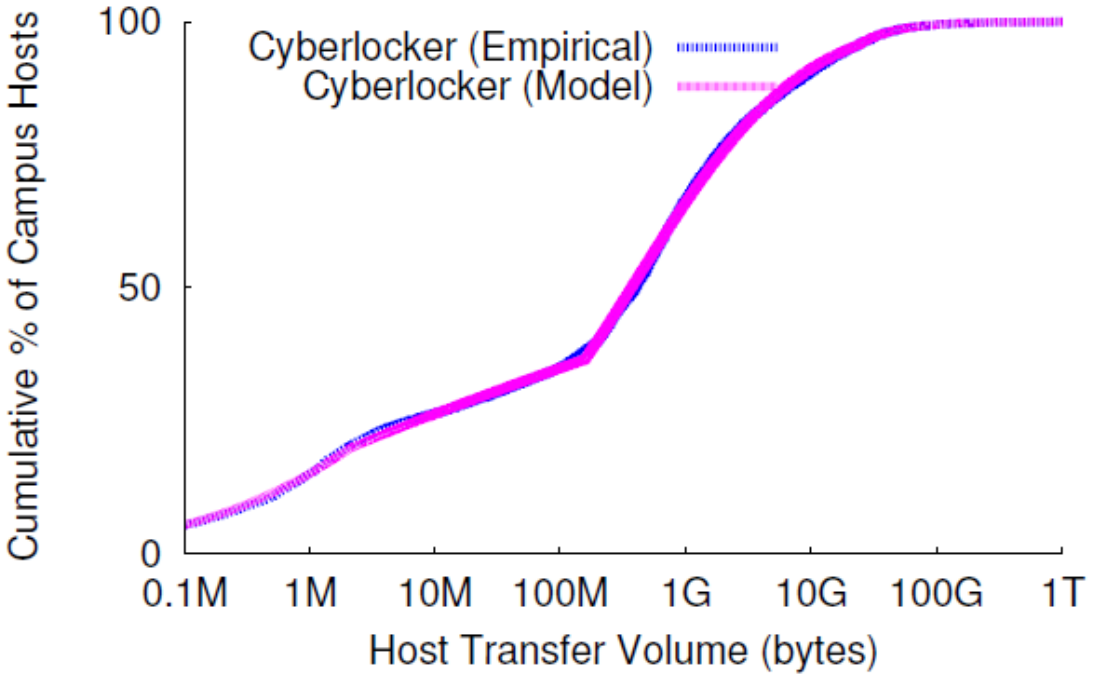
Cyberlocker Model: Lognormal-Gamma

Cyberlocker Content Model: Gamma-Lognormal

- Parallel downloading increases flow concurrency and decreases flow inter-arrivals.
- Content flow inter-arrivals are longer because there are far fewer such flows; most of the flows are due to objects being retrieved from sites.

HOST-LEVEL CHARACTERIZATION

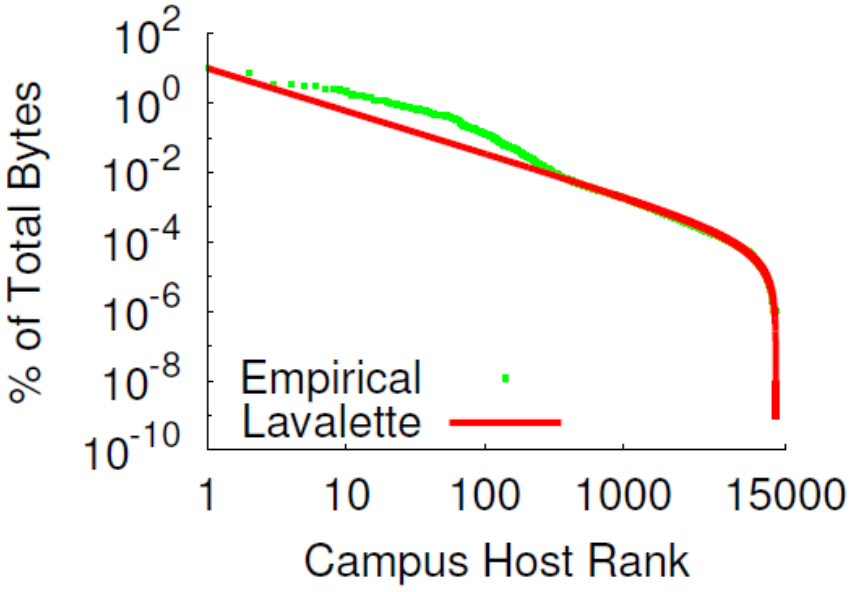
Host Transfer Volume



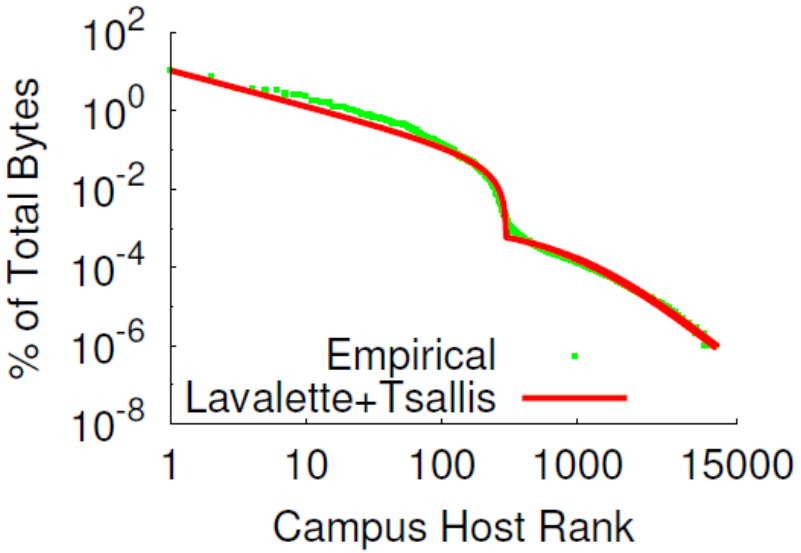
Cyberlocker Model:
Lognormal-Pareto

- There is presence of some hosts that transfer a lot of data as well as hosts that transfer less data.
- Most of the transfer volume is due to content flows.

Heavy Hitters



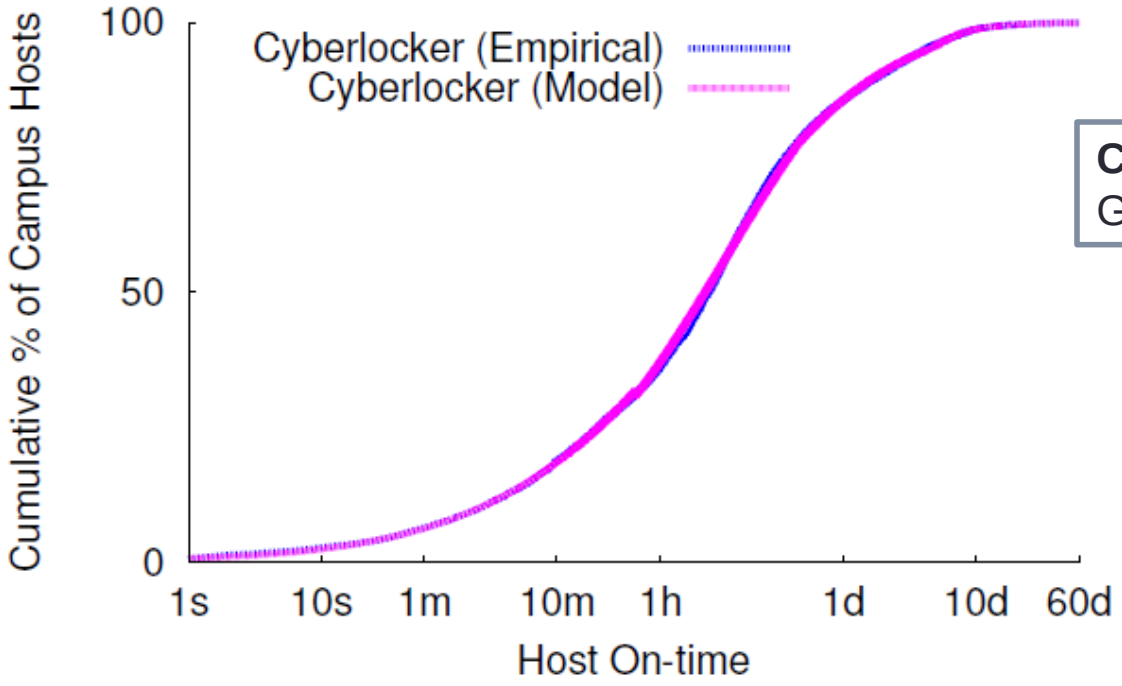
(a) Ranked cyberlocker hosts



(b) Ranked cyberlocker content hosts

- The top-100 ranked hosts account for more than 85% of the cyberlocker and cyberlocker content traffic volume.
- The high skews are well-modeled by non-linear power-law distributions.

Host On-time



Cyberlocker Model:
Gamma-Lognormal

- On-times of cyberlocker hosts are heavy-tailed
- Most of the time spent by hosts is for downloading content.
- Users with premium subscription may spend less time since they can download more content in less time.

CONCLUDING REMARKS

Conclusions

- Cyberlockers introduced many small and large flows.
- Most cyberlocker content flows are long-lived and durations follow a heavy-tailed distribution.
- Cyberlocker flows achieved high transfer rates.
- Cyberlocker heavy-hitter transfers followed power-law distributions.
- Increased cyberlocker usage can have significant impact on edge networks.
- Long-lived content flows transferring large amounts of data can strain network resources.

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QUESTIONS?