On NDN and ("lack of") Measurement

Thomas Silverston

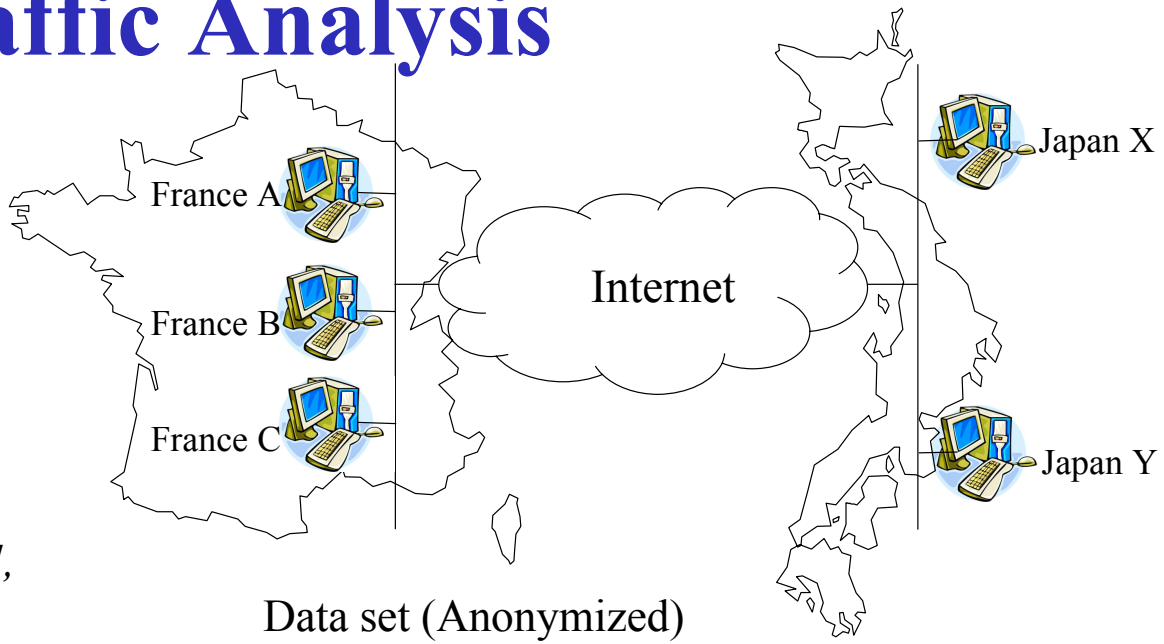
National Institute of Information and Communications Technology (NICT)

ICT Testbed Research, Development and Operation Lab

P2P-TV Measurement Experiments and Traffic Analysis

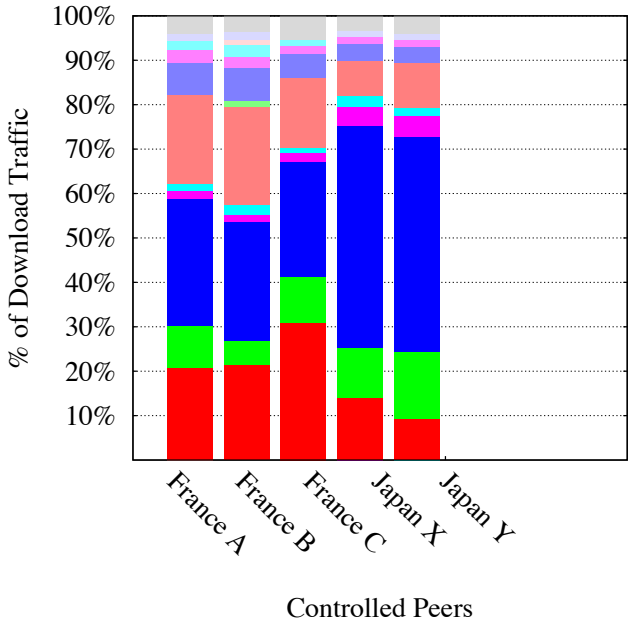
- Experiment Testbed
- Traffic Analysis
- Novel Mechanisms

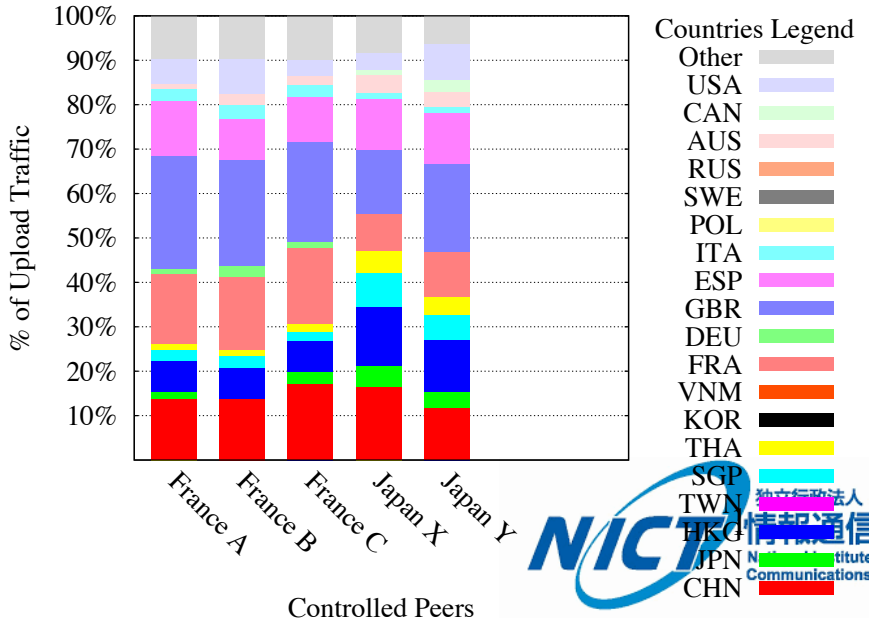
[Measuring P2P IPTV Systems],
ACM NOSSDAV 2007



[Traffic Analysis of P2P IPTV Communities],
Elsevier Computer Networks 2009
with A. Dainotti (Caida)

Data set (Anonymized)
http://content.lip6.fr

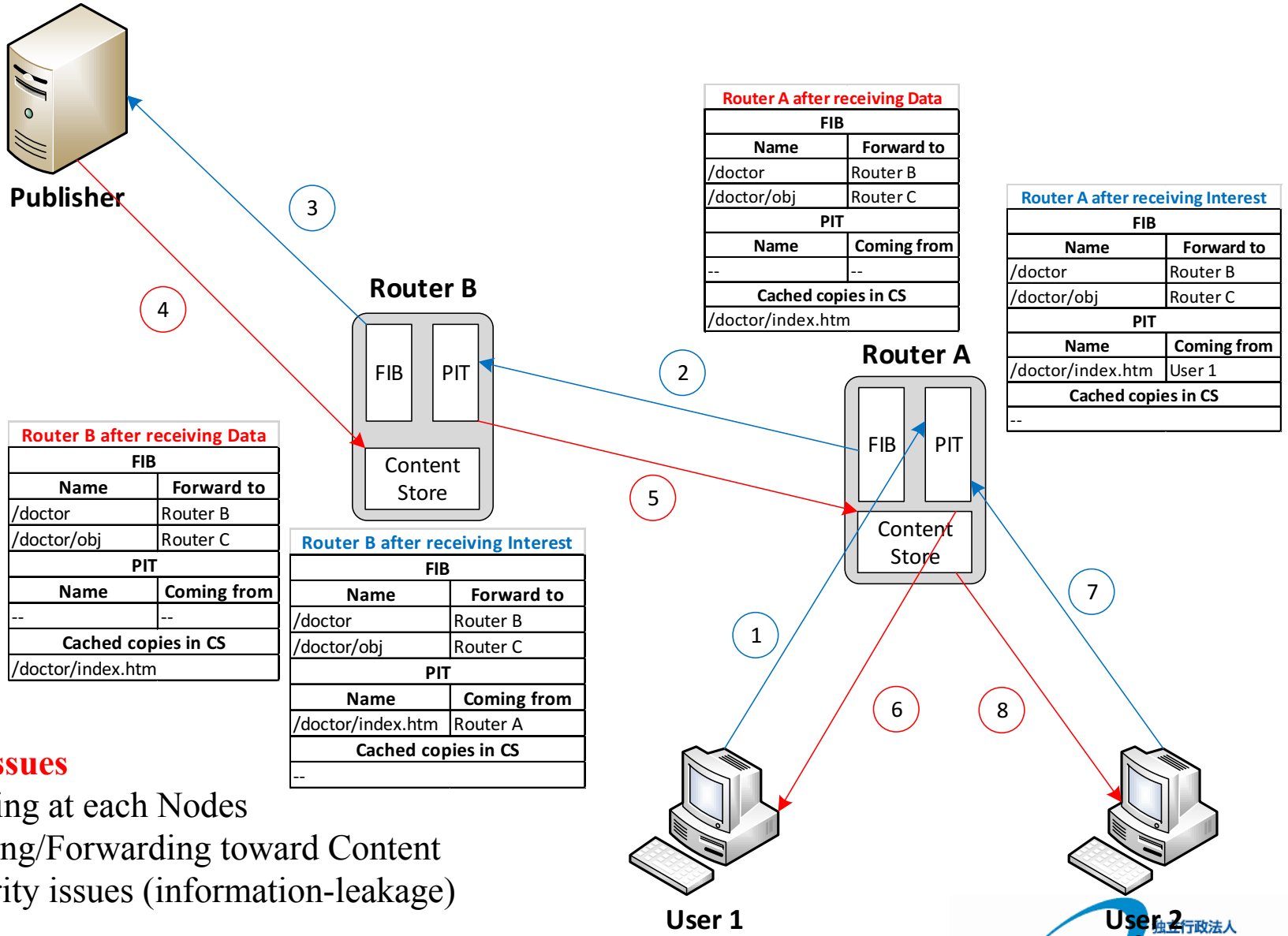




Motivation

- Internet is mostly used to access content
  - Video: 90% of global consumer traffic by 2018
    - [Cisco VNI 2015]
- Users are interested with content, not location
  - TCP/IP (host-to-host communication)
- **Information Centric Networking**
  - Named-Data Networking [CoNext 2009]
  - *Host-to-content* communication
    - Packet address *refers* to content and not location
  - *In-Network* Caching
- New "network layer" for Future Internet
  - Data at the *core* of the communication

NDN Overview



Router A after receiving Data

FIB	
Name	**Forward to**
/doctor	Router B
/doctor/obj	Router C
PIT	
Name	**Coming from**
--	--
Cached copies in CS	
/doctor/index.htm	

Router A after receiving Interest

FIB	
Name	**Forward to**
/doctor	Router B
/doctor/obj	Router C
PIT	
Name	**Coming from**
/doctor/index.htm	User 1
Cached copies in CS	
--	

Router B after receiving Data

FIB	
Name	**Forward to**
/doctor	Router B
/doctor/obj	Router C
PIT	
Name	**Coming from**
--	--
Cached copies in CS	
/doctor/index.htm	

Router B after receiving Interest

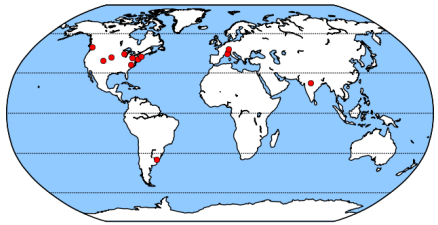
FIB	
Name	**Forward to**
/doctor	Router B
/doctor/obj	Router C
PIT	
Name	**Coming from**
/doctor/index.htm	Router A
Cached copies in CS	
--	

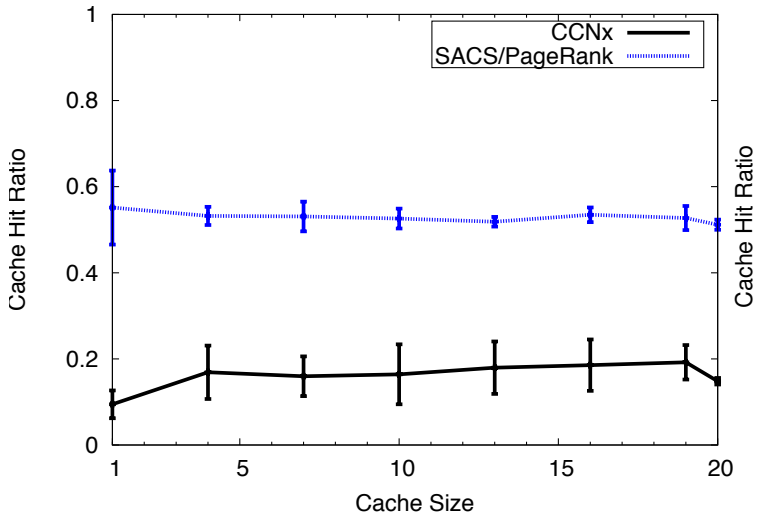
Open Issues

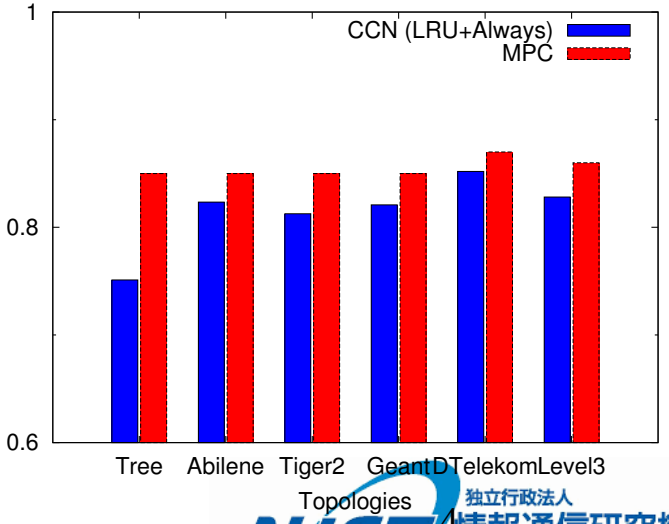
1. Caching at each Nodes
2. Routing/Forwarding toward Content
3. Security issues (information-leakage)

Caching Strategies in NDN

- Popularity-based strategies
  - MPC: Most-Popular Content Caching Strategy [IEEE ICC 2013]
    - Cache only popular Content
  - SACS: Socially-Aware Caching Strategy [IFIP Networking 2014]
    - Cache Content from popular users (Planet Lab experiments)
    - Infer User Traffic from Social Network dump (IEEE ICC 2014)

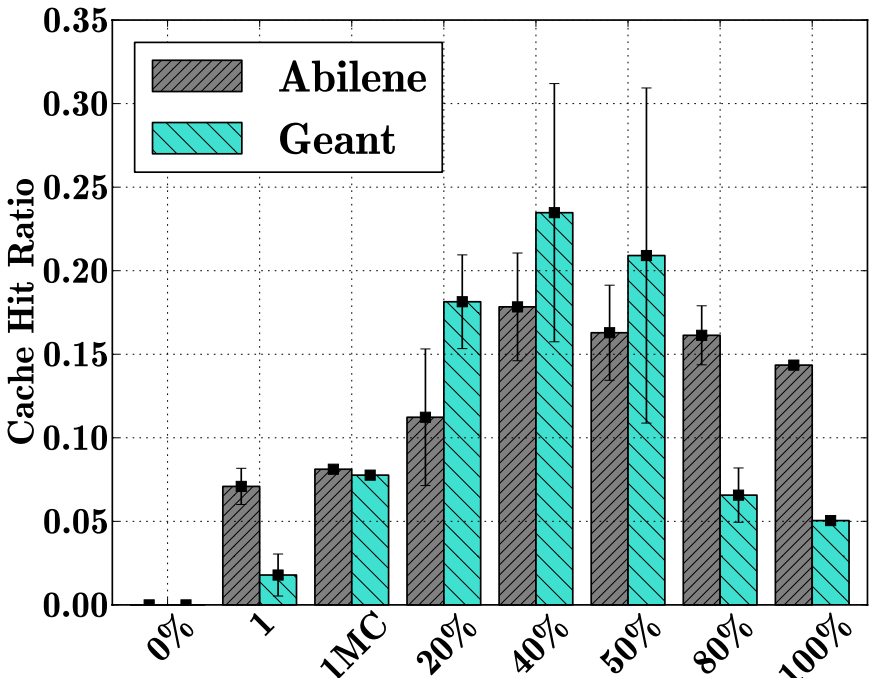


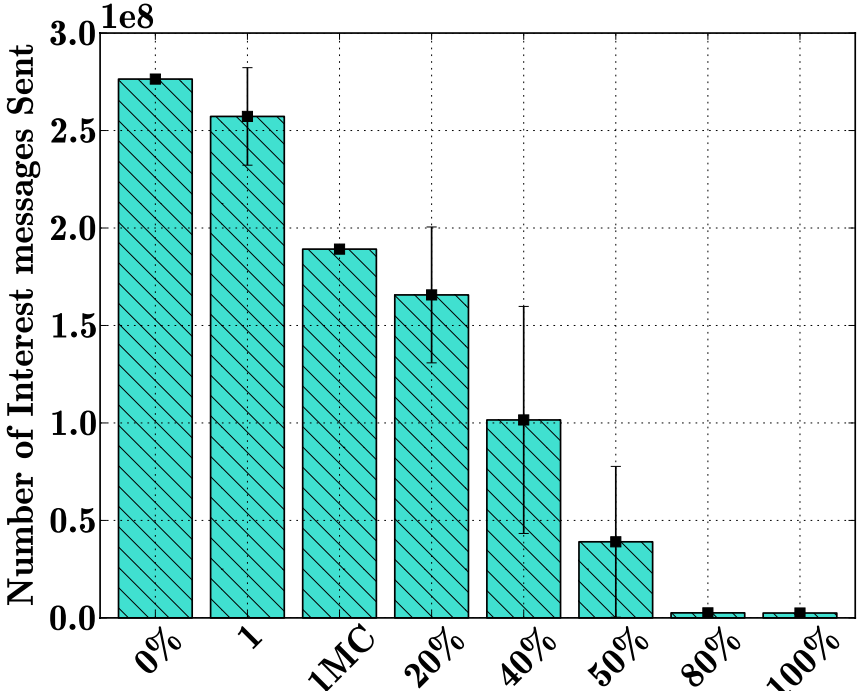




NDN Performances Evaluation

- Architecture evaluation
  - How many Cache Nodes in NDN to be efficient?'
  - Comparison with Client/Server, CDN architecture
- Trade-off 50% of cache nodes for higher performances
  - Deployment at reduced infrastructure cost for ISPs

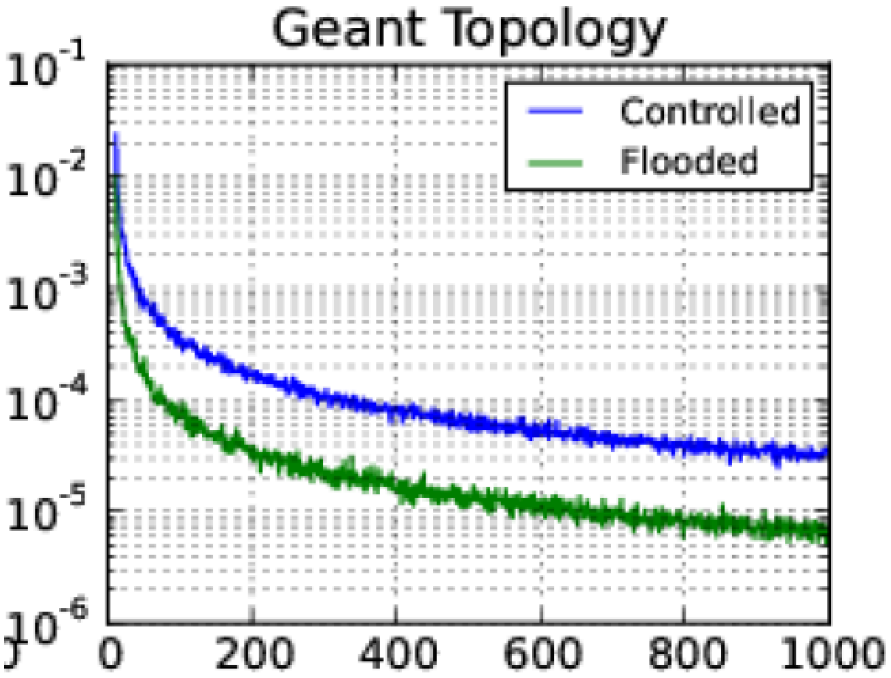


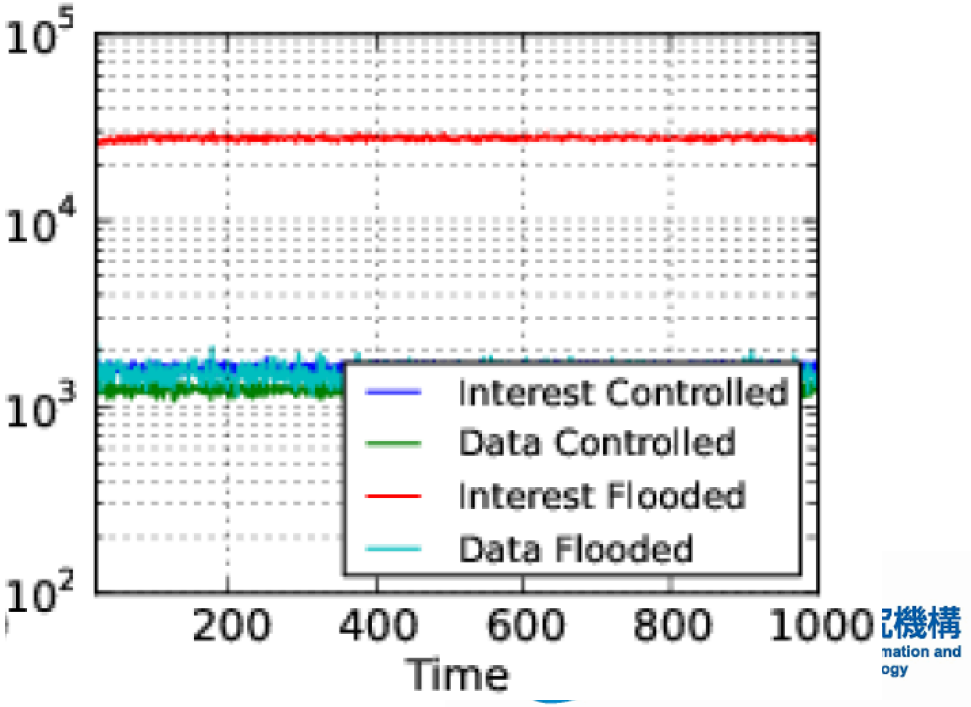


Routing in ICN/NDN

- Routing scheme for NDN
  - Flooding (i.e.: wasting resources)
  - NLSR: in-path caching
- SRSC: SDN-based Routing Scheme for NDN

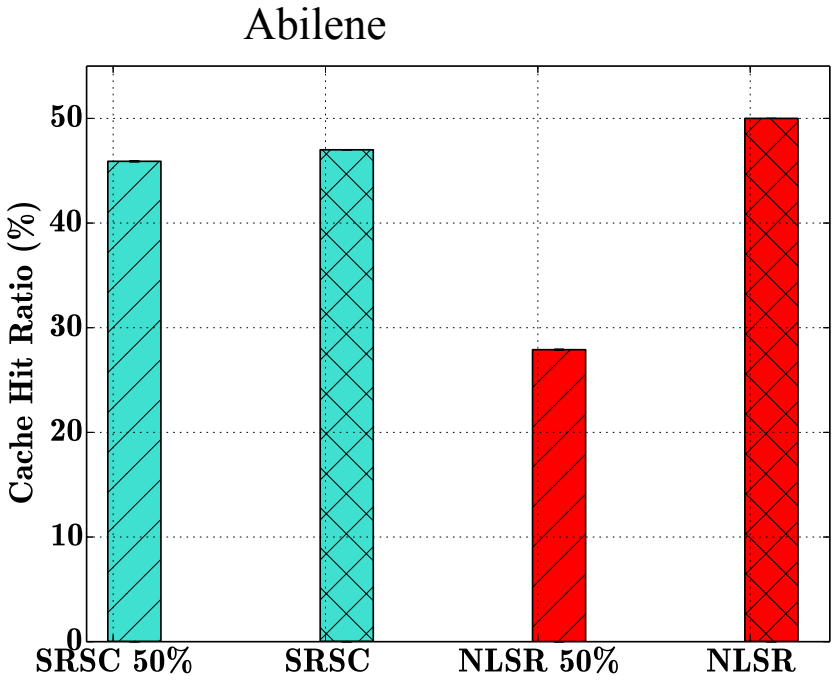
  [IEEE Netsoft 2015] Controller-based (anycast routing)

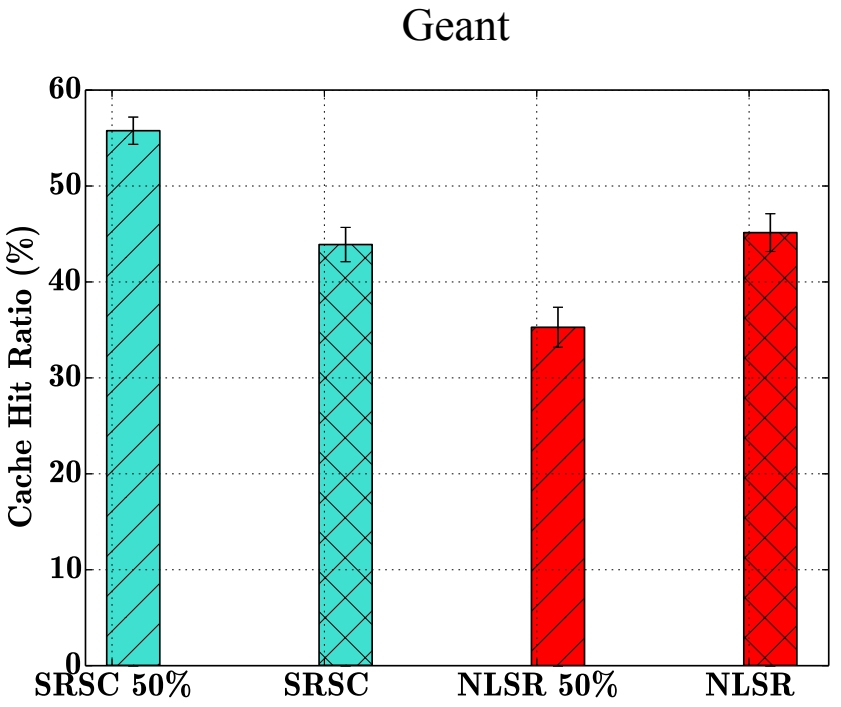




Routing in ICN/NDN

- Implementation on NDNx (NFD)
- Deployment on virtual Testbed with Docker
- Request: Zipf, etc.





Security in NDN
Information-leakage

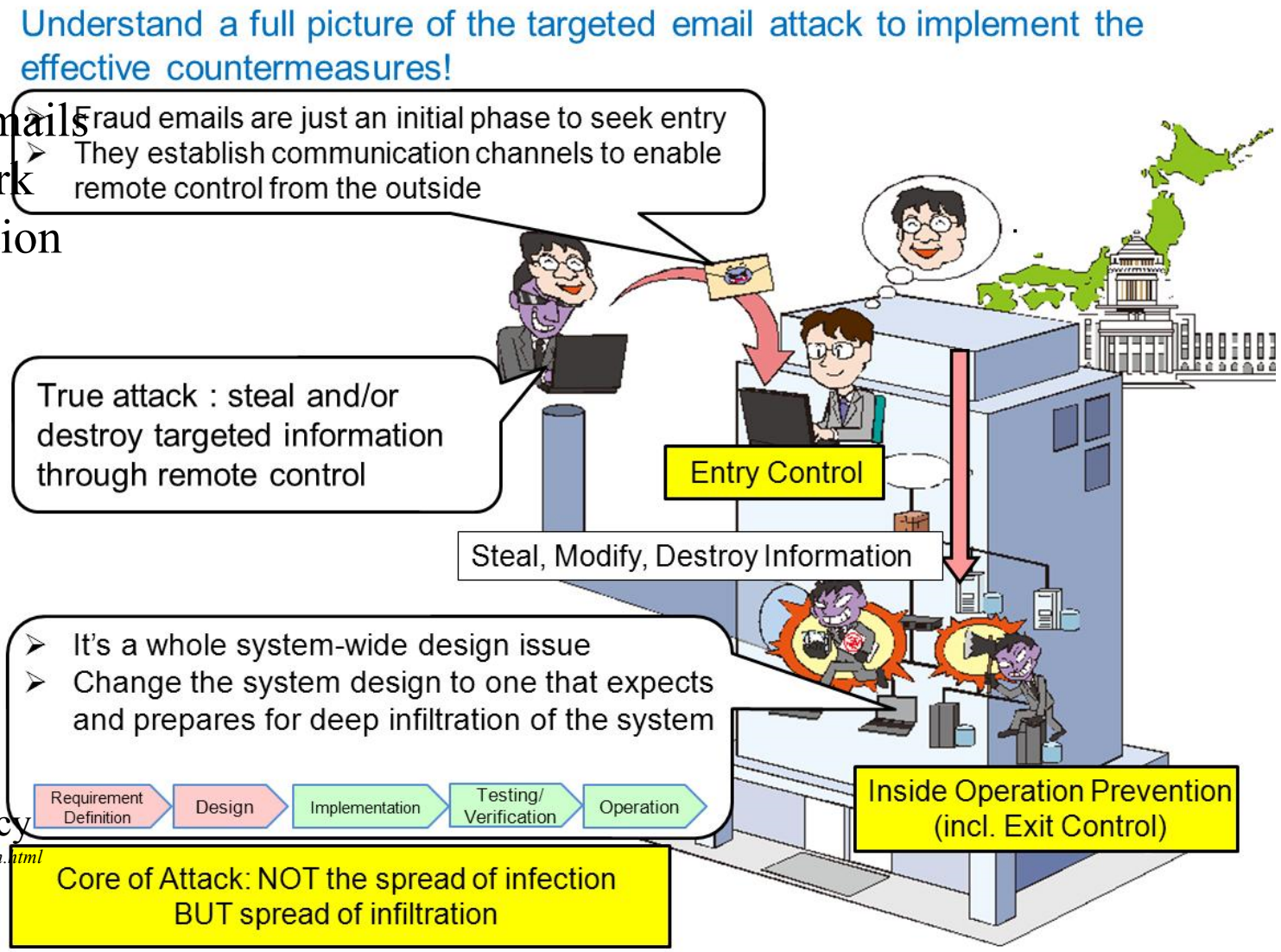
- One of the main security threat in Internet
  - *IT Security Risks Survey 2014: A Business Approach to Managing*
    http://media.kaspersky.com/en/IT_Security_Risks_Survey_2014_Global_report.pdf
- Cyber Espionage
  - Targeted Attacks (phishing, malware, website, external memory device)
- Examples: Sony, Target
  - $100 M upgrading systems
  - 46% drop in benefits
    [*Understanding Targeted Attacks: The Impact of Targeted Attacks*]

Targeted Attacks

- Infects PC via emails
  - Probes network
  - Steals Information

Countermeasures
Train employees?
Human errors

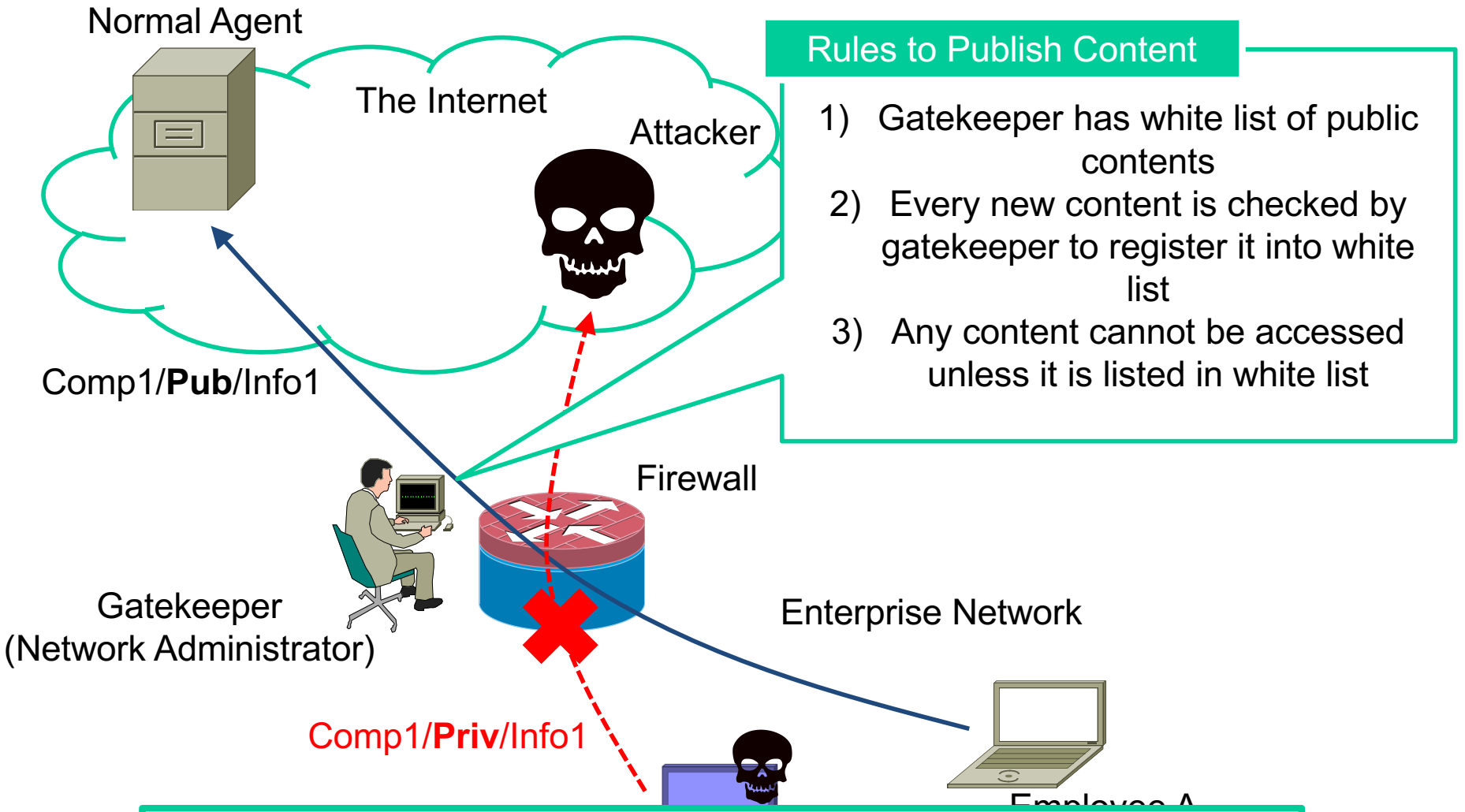
Source:
IT Security Center
IPA: IT Promotion Agency
http://www.ipa.go.jp/security/english/newattack_en.html



Information-leakage through NDN packets

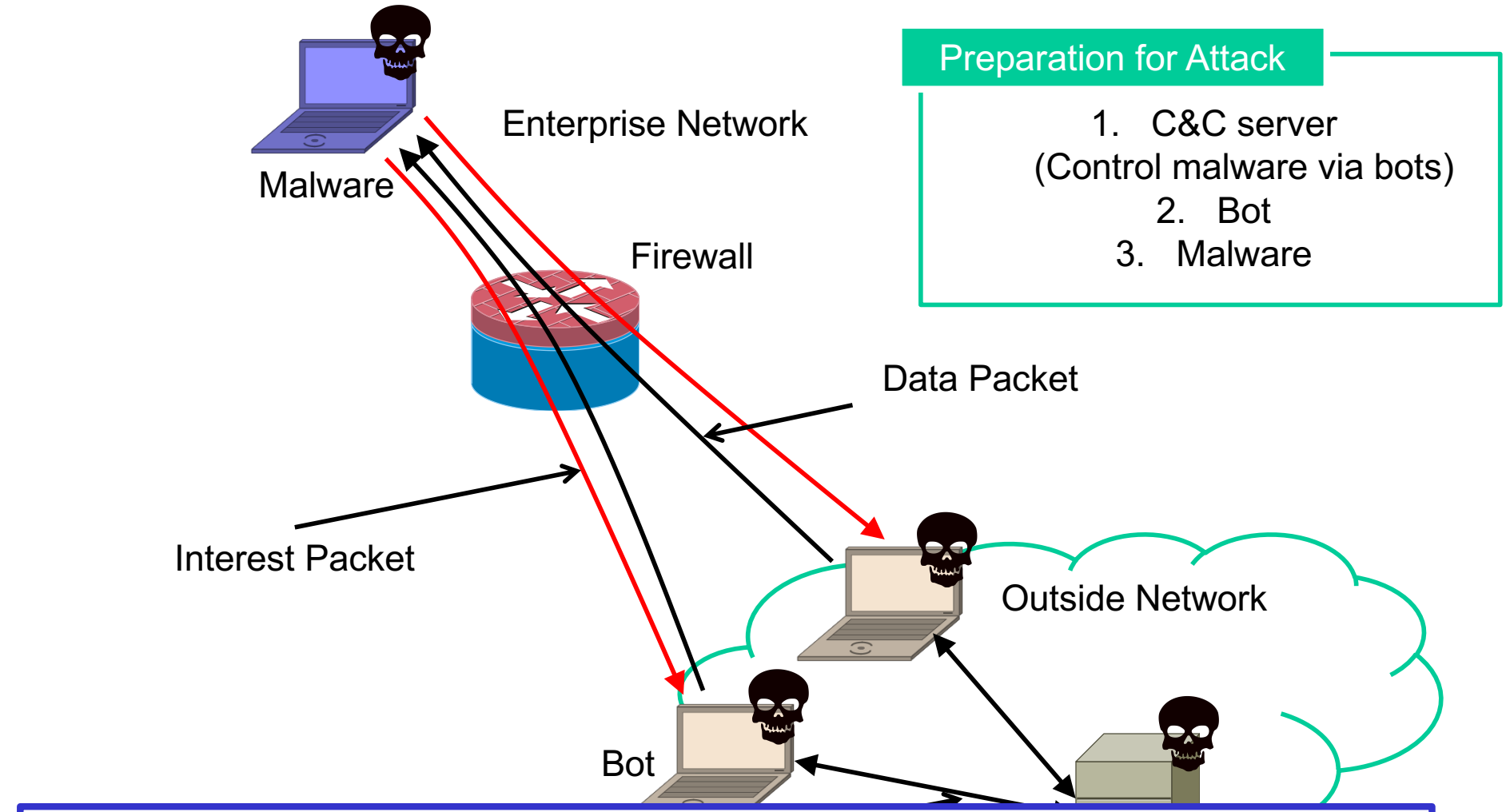
- *Interest/Data* packets are "Request/Reply"
  - Content name, etc.
- *Data* can be **filtered out** out by network admin.
  - White/Black lists of (un)authorized content names
    - *CustomerList*, *BankingInfo*, etc.
- Interest packets are sent out the network to external publishers as requests ("free" names)
  - Malwares can use *Interest* to leak Information through Targeted Attacks

Information-leakage Countermeasure with *Data*



Gatekeeper can prevent information leakage through Data packet (reply messages)

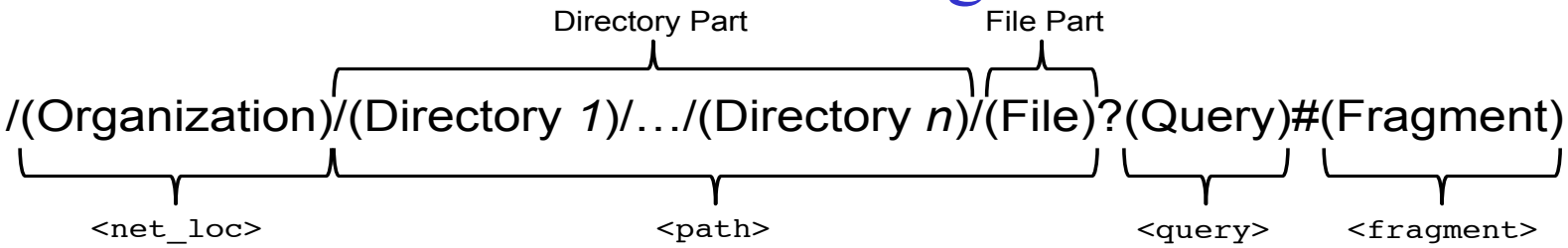
Targeted Attacks in NDN



Interest Name can be used to leak information through Targeted Attacks (request messages)

URLs Dataset

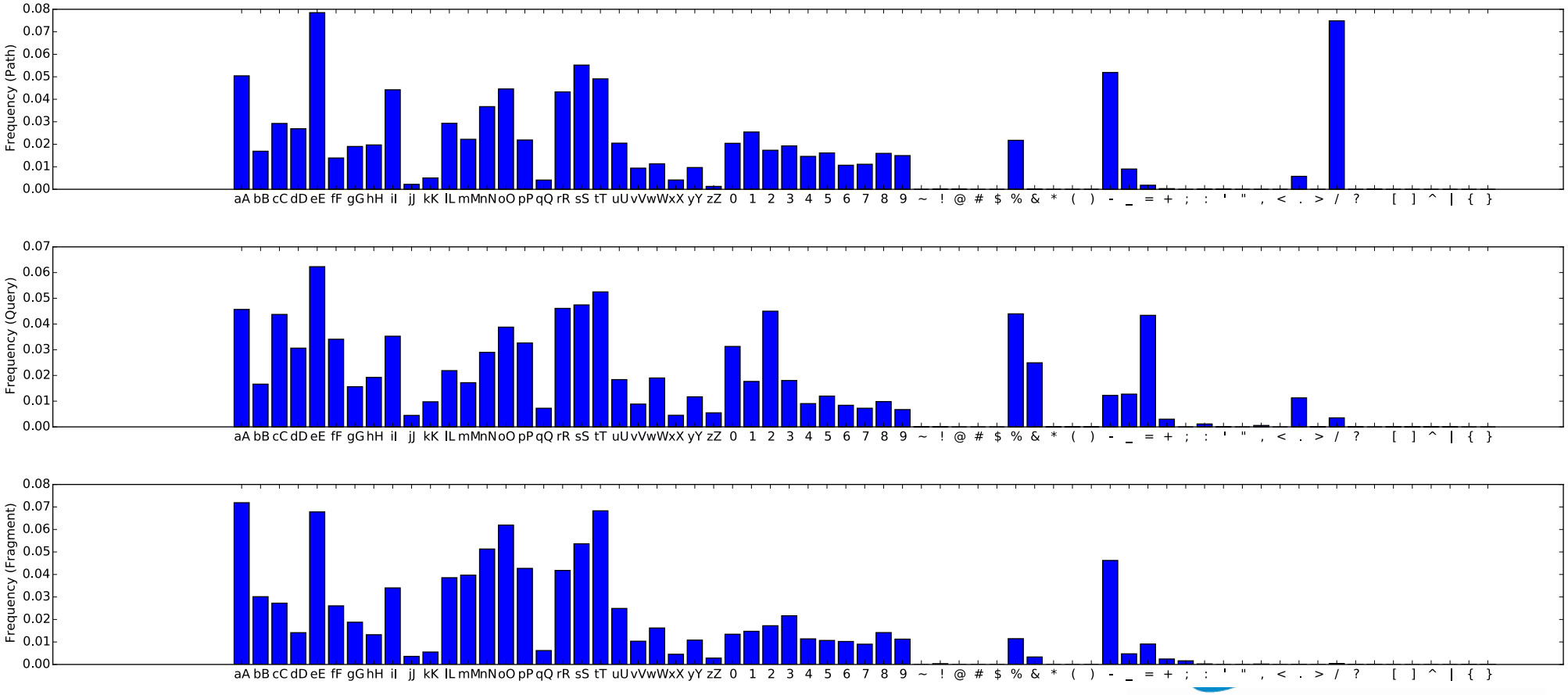
- Web Crawling of 7 main organizations
  - Amazon, Ask, Stackoverflow, BBC, CNN, Google, Yahoo
  - Common Crawl Data Set repository
- 1.73B URLs -> 7M for each organization



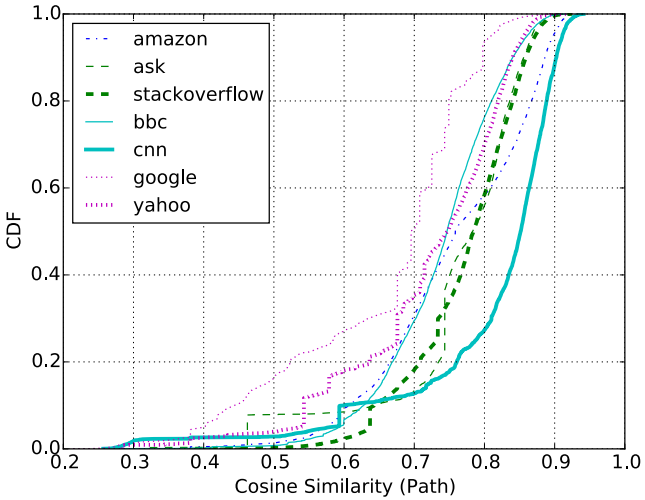
URLs Parameters (RFC 1808)	
Length of <PATH>	Number of '/' in <path>
Length of <QUERY>	Similarity of characters in <PATH>
Length of <FRAGMENT>	Similarity of characters in <QUERY>
Length of Directory	Similarity of characters in <FRAGMENT>
Length of File	

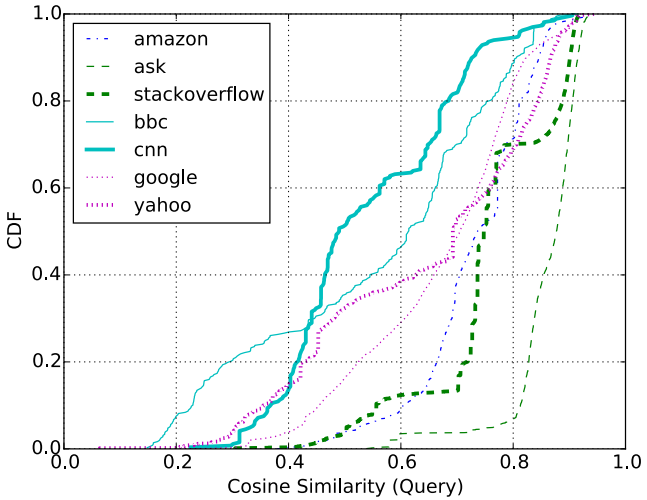
Average Frequencies in Path, Query, and Fragment

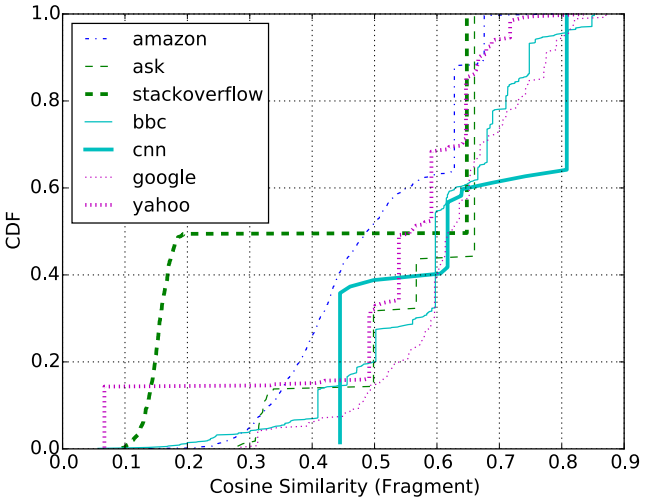
- Calculated average frequencies of characters in path, query and fragment of the URLs in all the organizations



URLs Similarity







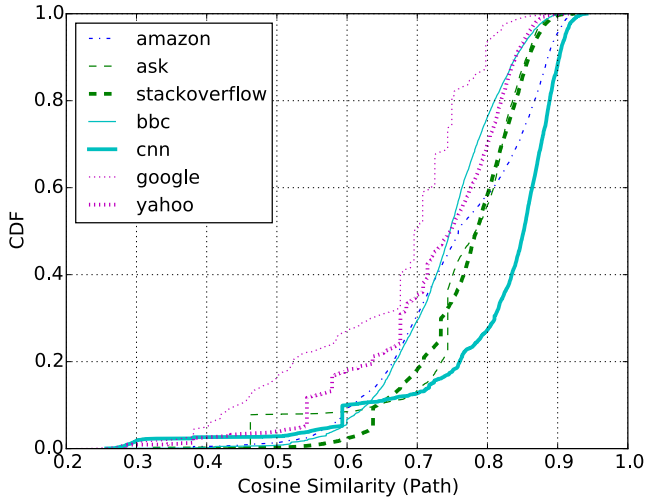
Organization	Average C_{Path}	Average C_{Query}	Average $C_{Fragment}$
Amazon	0.76	0.73	0.5
Ask	0.76	0.86	0.57
stackoveflow	0.77	0.76	0.4
BBC	0.74	0.56	0.6
CNN	0.81	0.54	0.63
Yahoo	0.72	0.64	0.51
Average	0.75	0.68	0.55

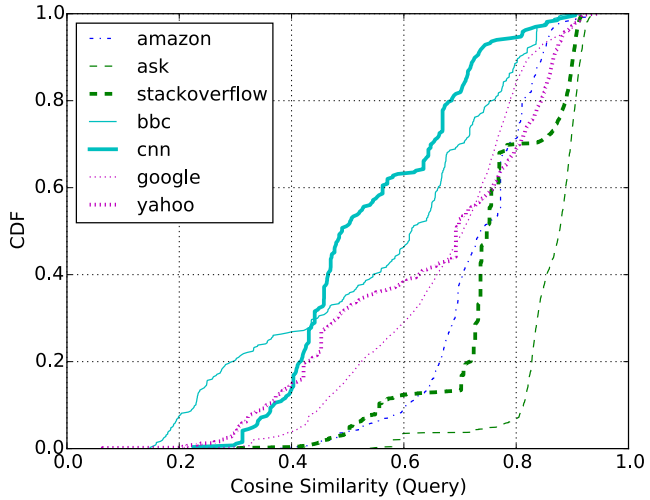
Legitimate names exceed average similarity

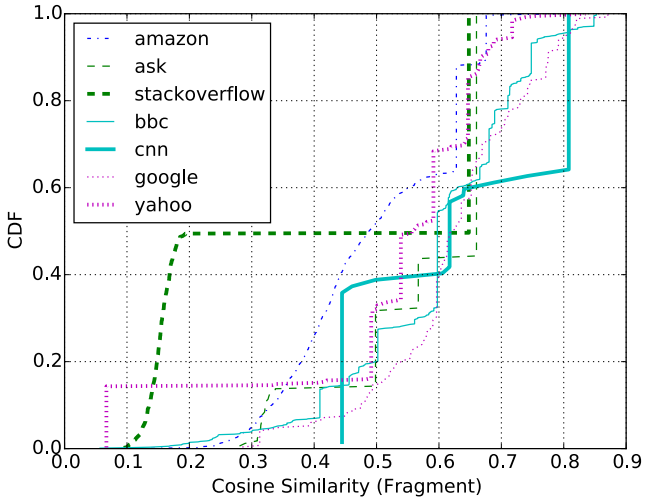
NICT 情報通信研究機構 National Institute of Information and Communications Technology

Anomaly Detection in NDN

- Prevent Information-leakage
  - Internet security threat through Targeted Attacks
- Web Organizations Crawling (Google, CNN, etc.)
  - Statistics on URLs (names) and HTTP traffic
- Malicious Names filtering in NDN (15% misdetection names)
  - **[IEEE Lanman 2016]** with D. Kondo (UL), Prof. Asami (U. Tokyo) , Prof. Tode (U. Pref. Osaka) and Prof. O. Perrin (UL)
  - [**NOM WS – Infocom 2017**] D. Kondo (UL), Prof. Asami (U. Tokyo) , Prof. Tode (U. Pref. Osaka) and Prof. O. Perrin (UL)
  - One–Class SVM

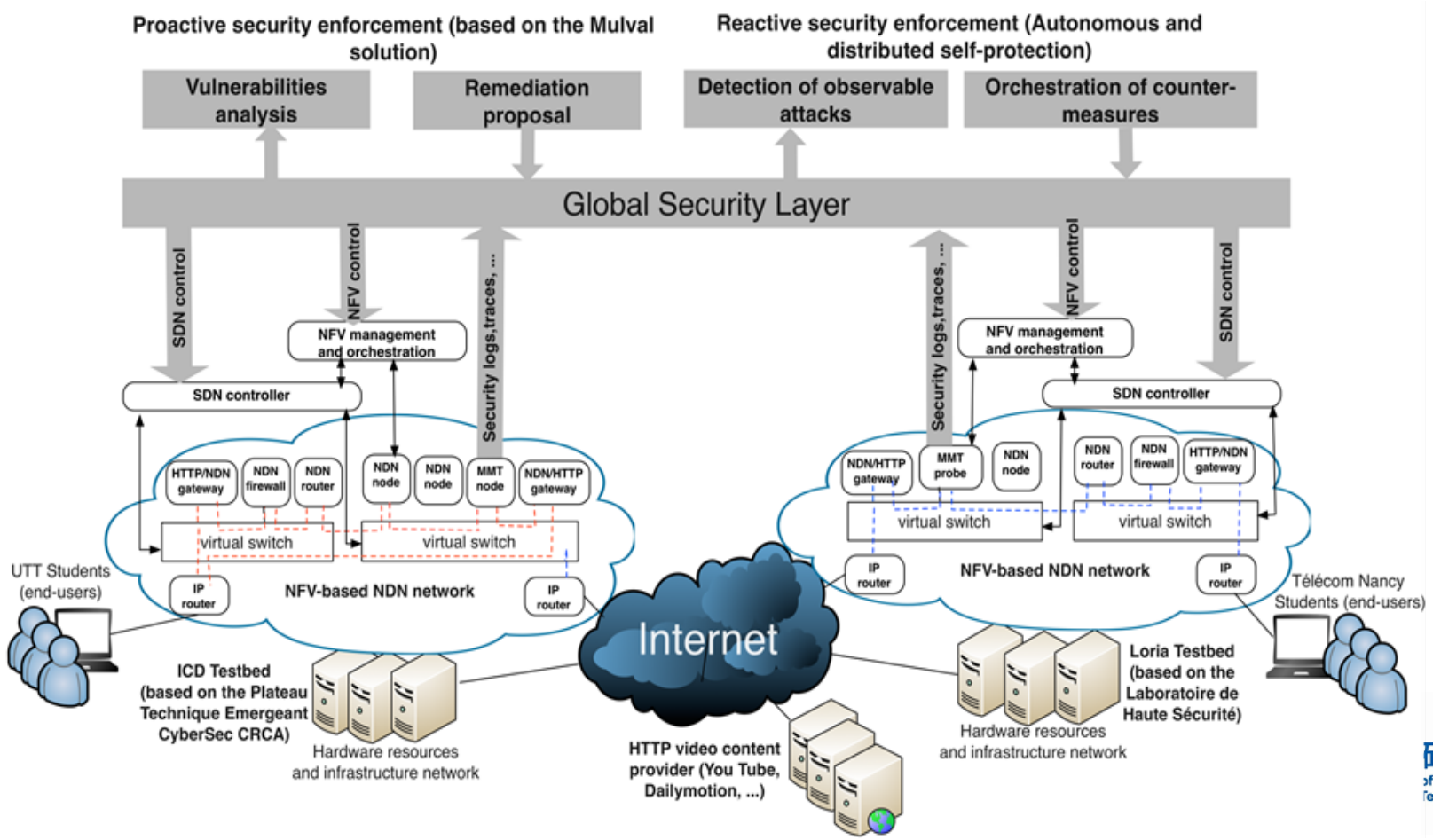






Project ANR Doctor (2014-2017)
http://www.doctor-project.org/

- Deployment of new network functions and protocols (e.g.: NDN) in a virtualized networking environment (e.g.: NFV)
  - Monitoring, managing and securing (using SDN for reconfiguration)
- Partners: Orange, Thlaes, Montimage, UTT, LORIA/CNRS (900k€)
- NDN/HTTP proxy designed in the project



Conclusion

- NDN Architecture
  - Caching: popularity-based
  - Routing: Controller-based
  - Security: Name-Anomaly Detection in NDN

ありがとうございます

thomas@nict.go.jp