Darknet experiment at SINET

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Kensuke FUKUDA
National Institute of Informatics, Japan
kensuke@nii.ac.jp

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Goal of (my) study

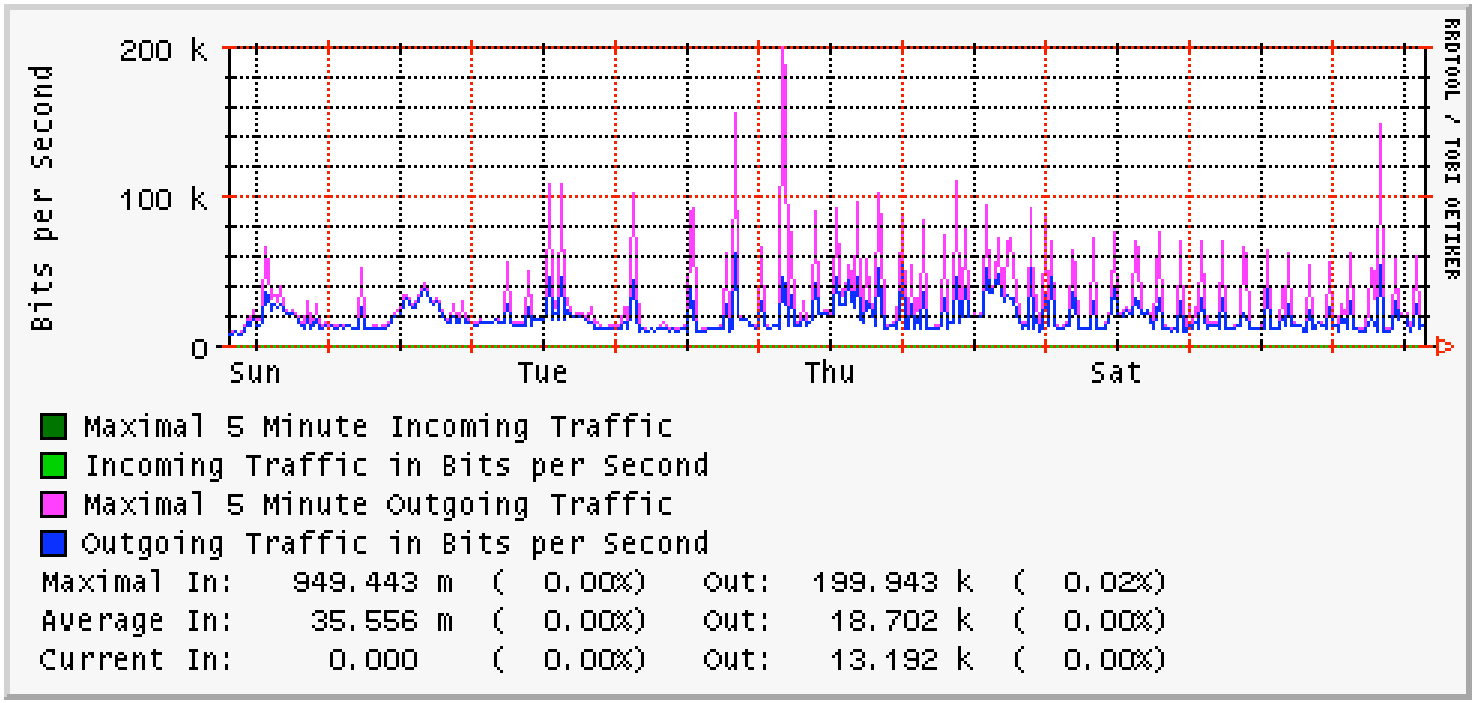
- Effective monitoring for unwanted traffic detection
  - for smaller and distributed address blocks
- Prediction of traffic pattern by using spatial and temporal knowledge of anomaly

As a first step, we try to statistically quantify darknet traffic

Darknet

- Darknet is routed subnet, but with no hosts (network telescope, network sensor system,...)
- Coming packets to Darknet is something wrong
  - portscan, DDoS, worm, misconfiguration
- Experimentally, we run /18 subnet darknet (=16384 addrs) in our network

Weekly darknet traffic



- /18 (16384 addrs) blocks
- mean: 19kbps, max: 200kbps
- dumpfile: 100MB/day

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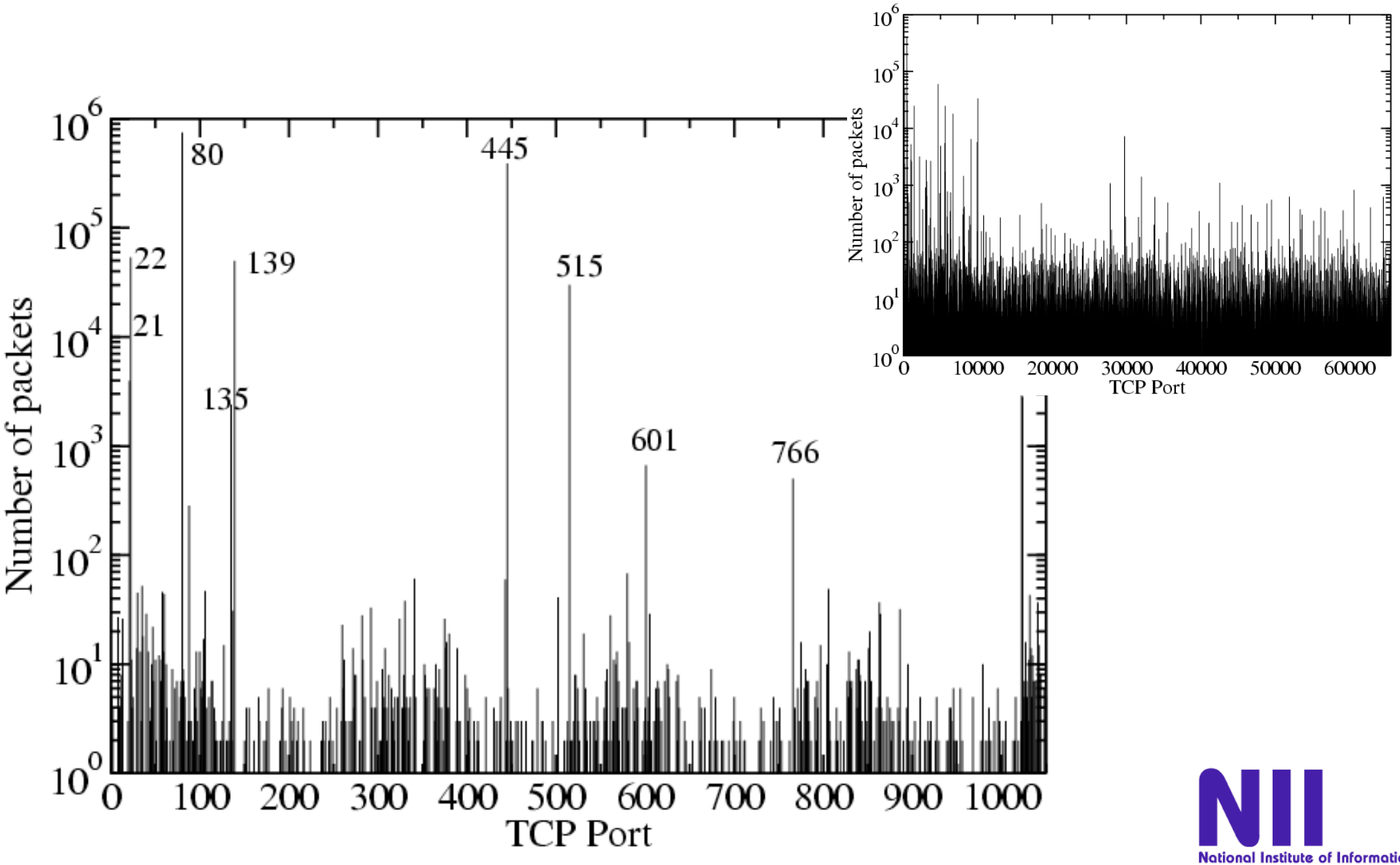
TCP Dport (24h)



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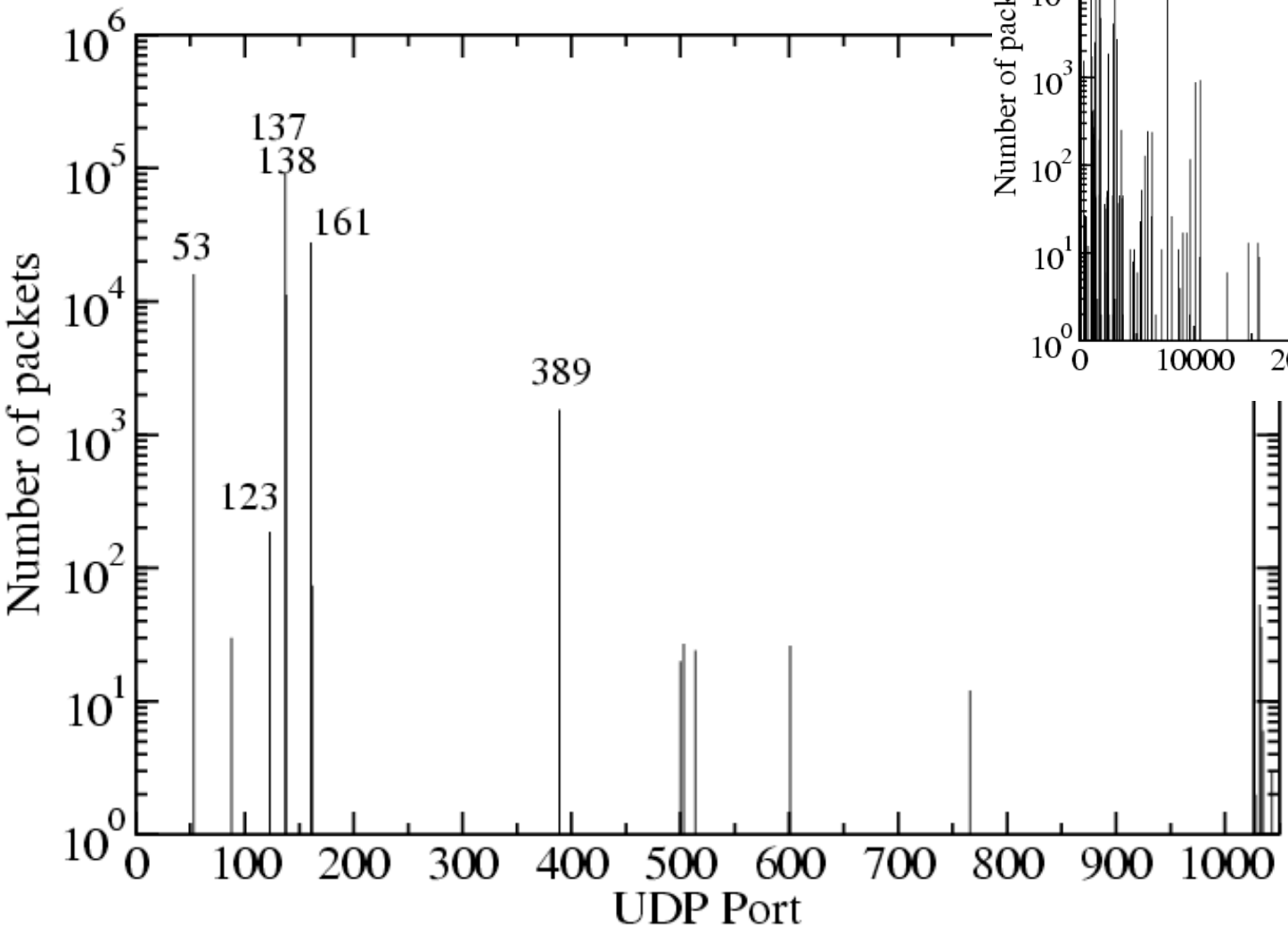
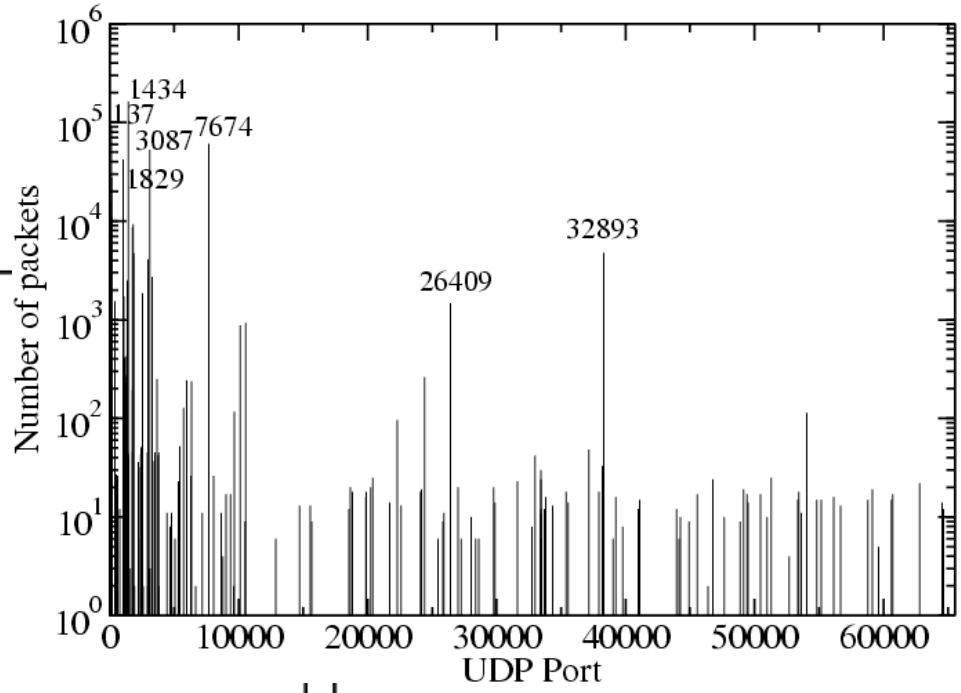
UDP Dport (24h)





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Source addr breakdown (12h)

(IP addr -> ASN -> Country)

- TCP SIP
  - EU(11451), CN(9754), KR(7566), JP(4456), US(4449), TW(1651), DE(528), ZA(399), NL(328), AU(159)
- UDP SIP
  - CN(21422), US(2948), EU(2640), DE(795), PE(729), JP(722), ID(575), CA(410), HK(371), KR(349)
- ICMP SIP
  - US(7391), KR(124), EU(105), CN(51), TH(9), IN(8), NL(5), JP(5), FR(5), TW(4)
- Is there any geographical difference??

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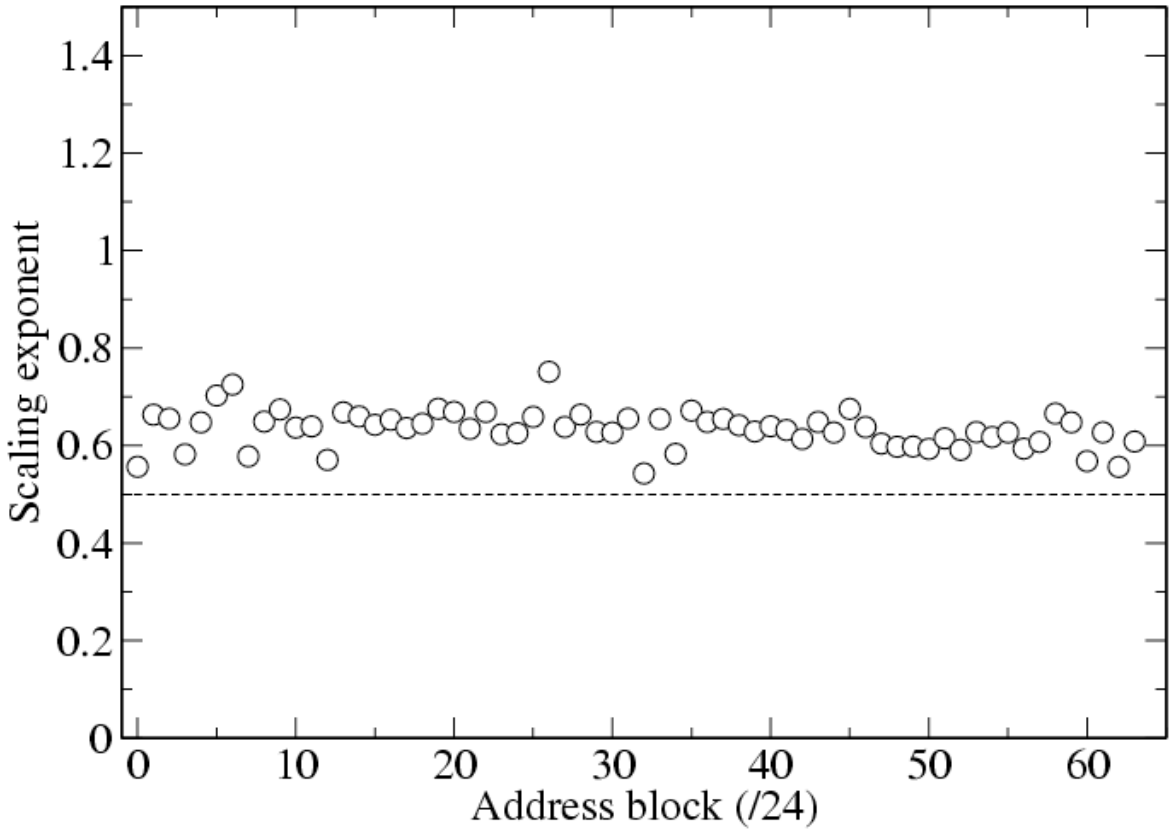
Temporal correlation of traffic time series

Scaling analysis

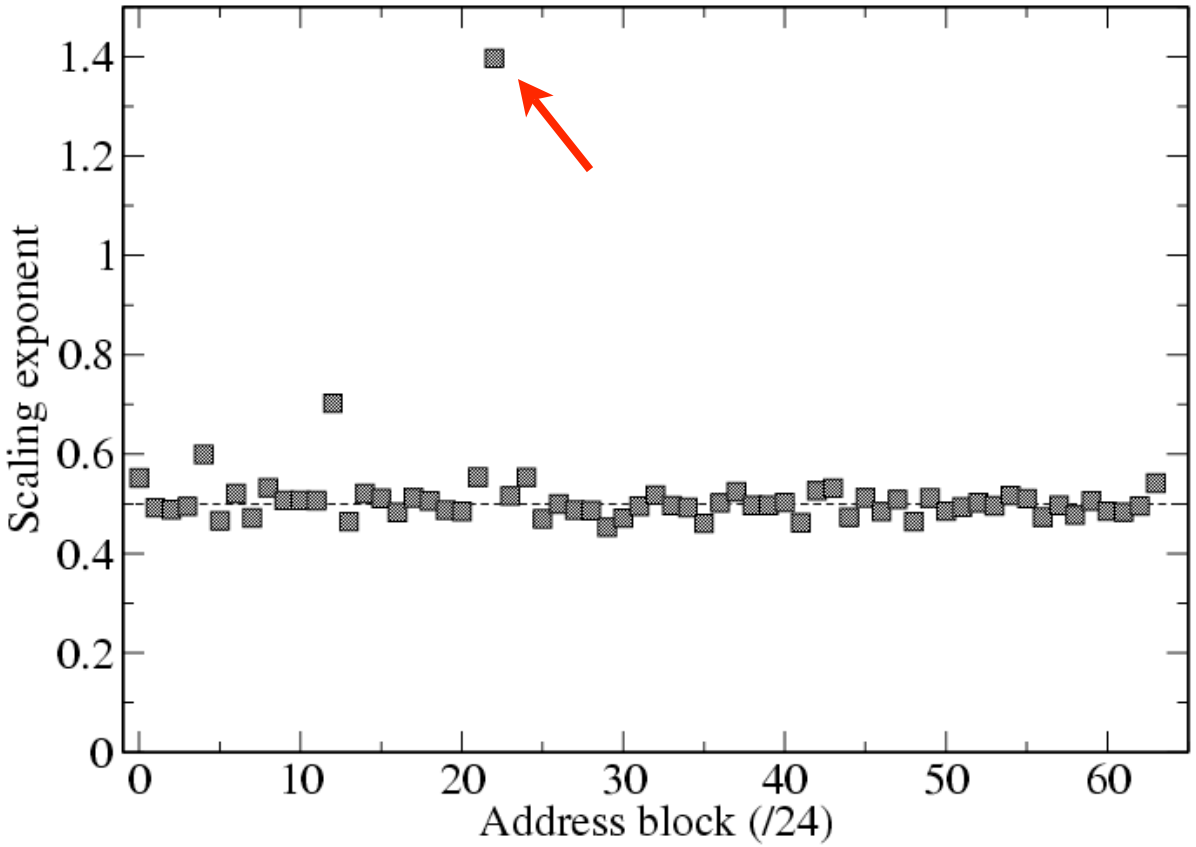
- DFA (Detrended Fluctuation Analysis) [Peng98]
  - Detection of LRD in a given time series
  - Estimated scaling exponent: β
    - β = 0.5: random walk
    - 0.5 < β <= 1.0: LRD (= Hurst parameter)
    - β > 1: non-stationary time series
- Reconstruct /24 block time series (bin = 1 min.) from 1-day trace, then apply DFA to the time series

Scaling exponent (TCP)



- Weaker temporal correlation (!= random fluctuation)
- Possibility of prediction(?)

Scaling exponent (UDP)



- Most values are around 0.5: random fluctuation
- More than 1.0, fluctuation is non-stationary (= anomaly)

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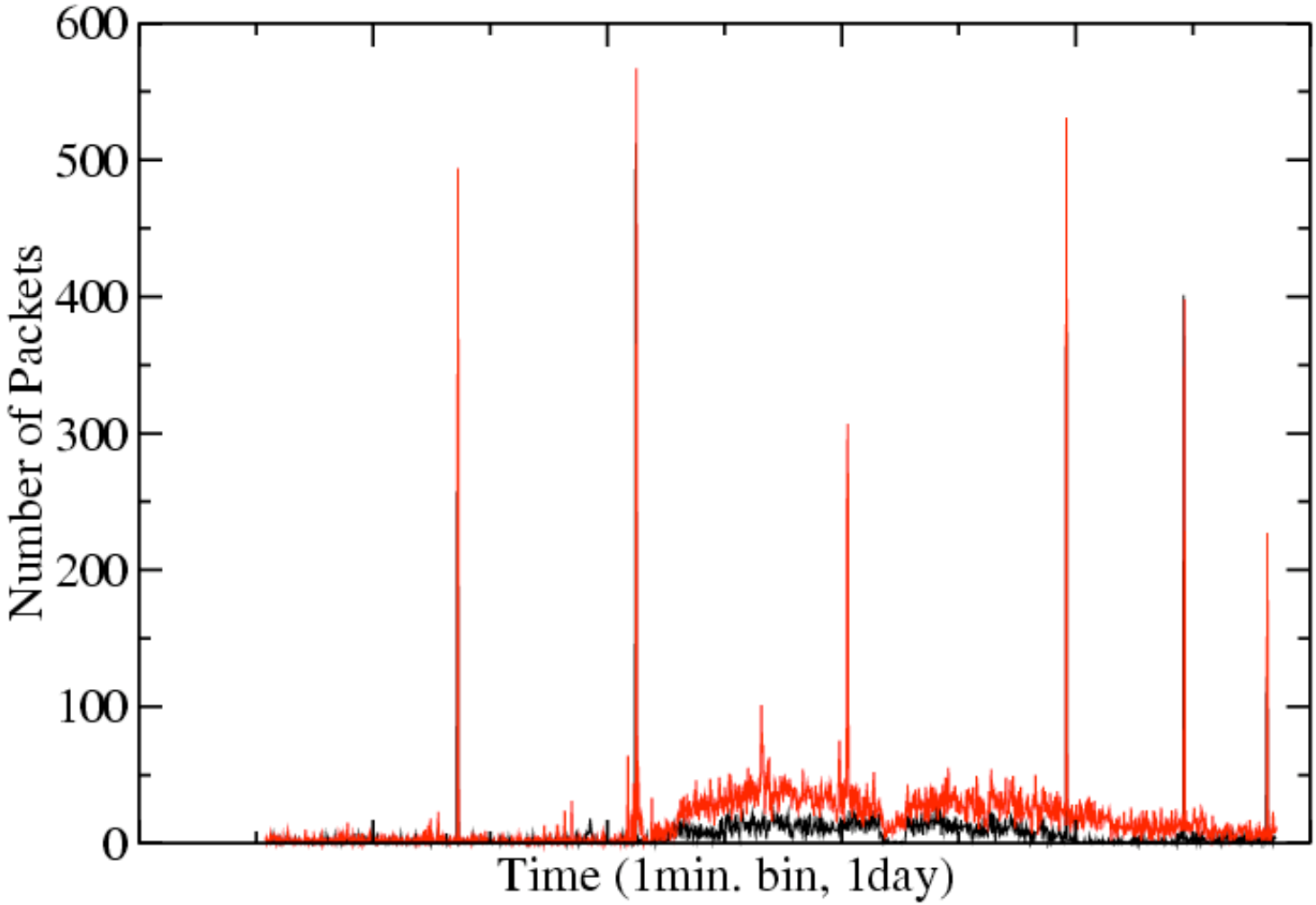
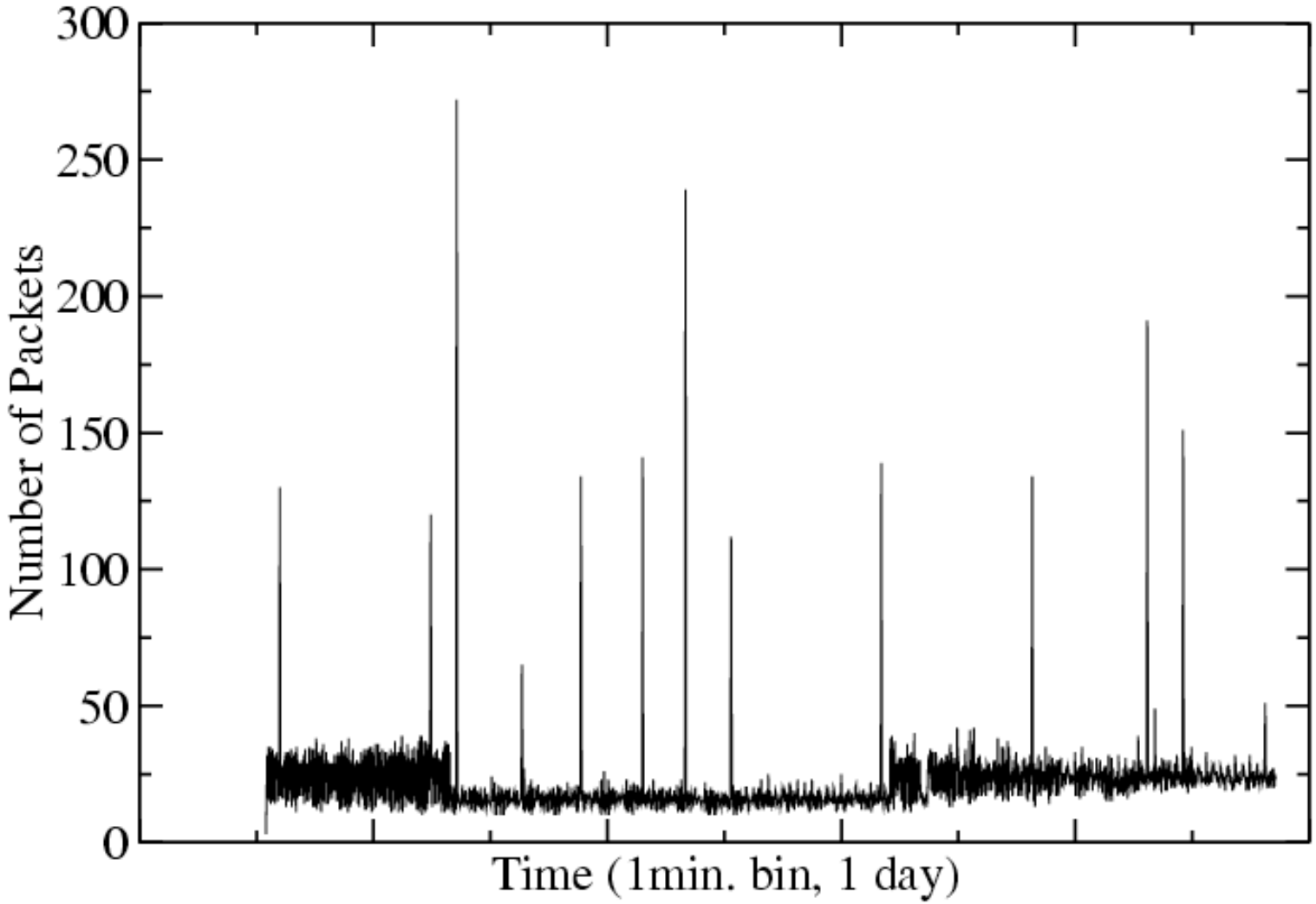
Raw time series (/24)



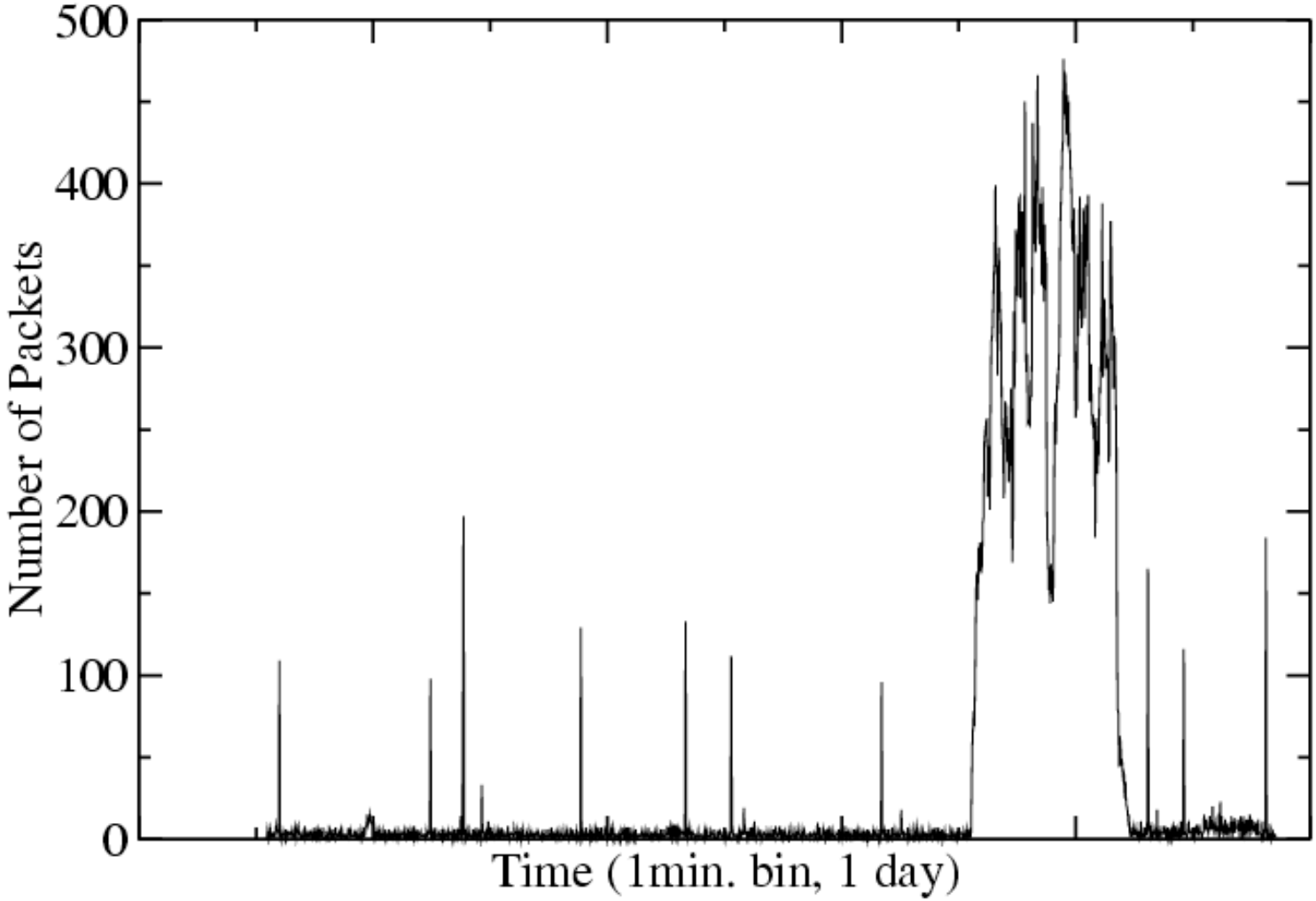
- TCP: correlated fluctuation

Raw time series (/24)



- UDP: random fluctuation

Raw time series (/24)



- UDP: non-stationary fluctuation

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Results

- TCP:
  - Time series is LRD
  - Possibility of prediction by AR model(?)
- UDP:
  - Time series is random
  - Anomaly can be found by DFA
- Further analysis
  - different block size time series (/18 <-> /32)
  - Port-level time series

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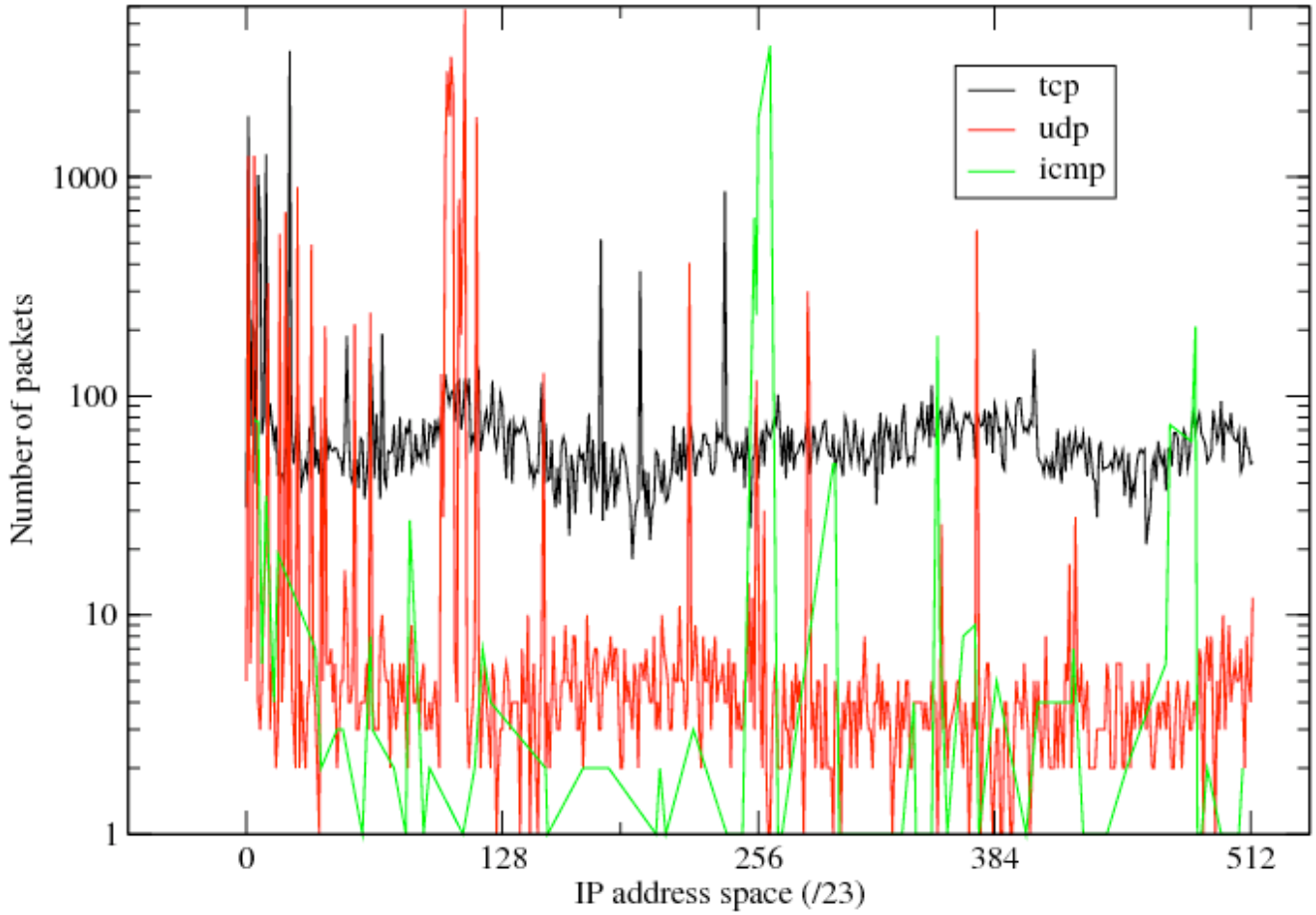
Spatial correlation between two time series of address block

per-address packets (12h)



- Difference between 1st and 2nd /24s
- No widely-spread icmp probes?

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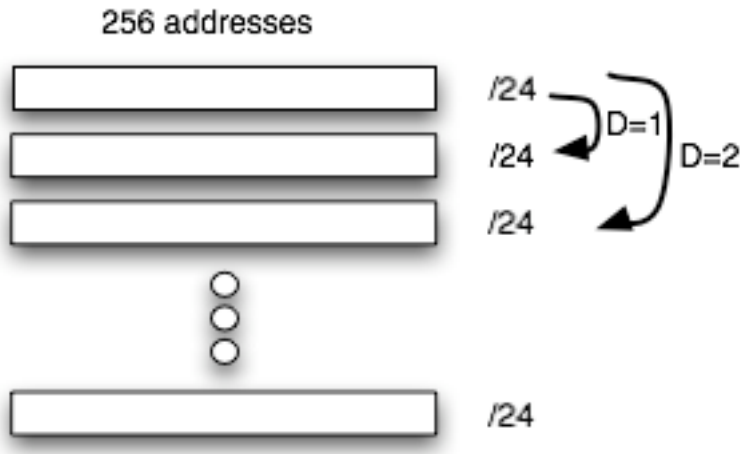
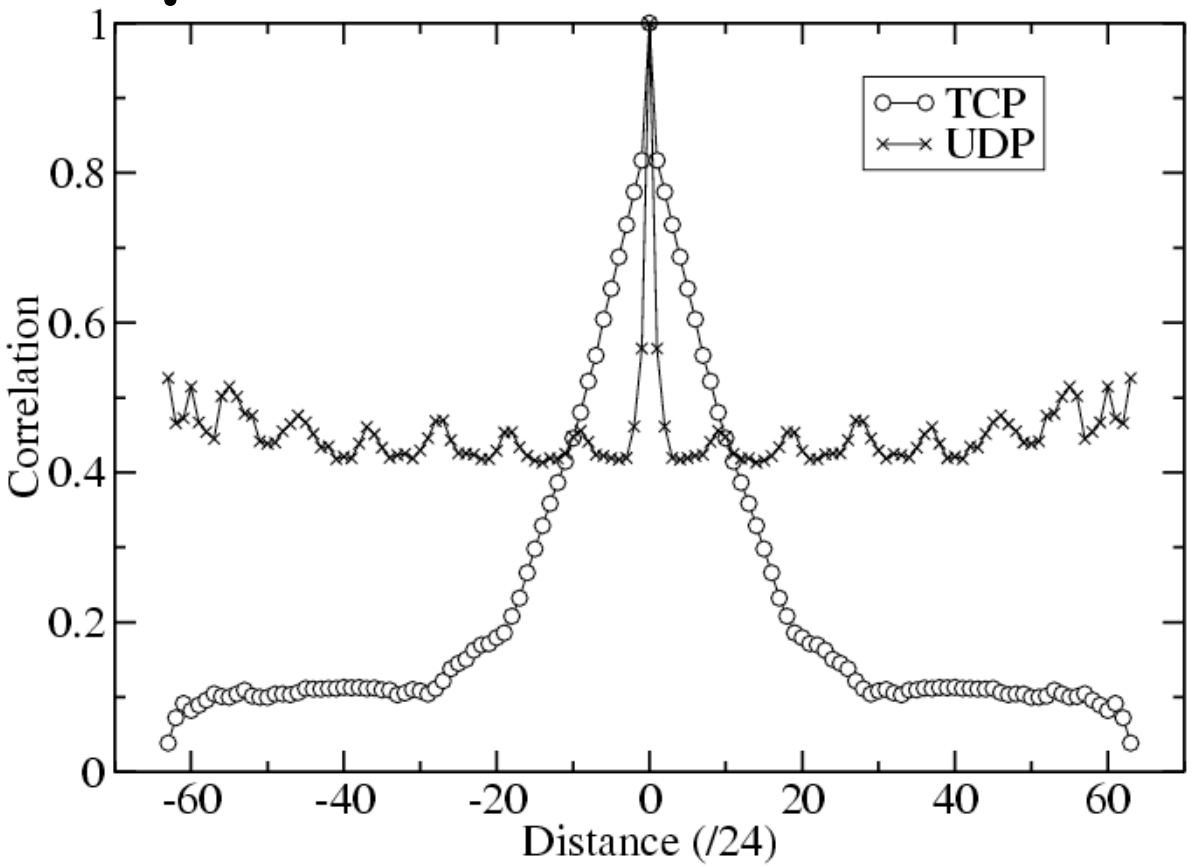
Spatial correlation

- Investigate the similarity of temporal traffic pattern
- Correlation coefficient between two time series of /24 address block apart from distance D
  - -1 <= γ < 0: anti-correlated
  - γ = 0: non-correlated
  - 0 < γ <= 1: correlated



Spatial correlation



- Correlation between two /24 block time series
- TCP: no correlation apart from 20 blocks (6144 addrs)
- UDP: larger correlation and some synchronized blocks

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Results

- TCP:
  - No correlation apart from 20 blocks (6144 addrs)
  - Periodic assignment of monitoring blocks(?)
- UDP:
  - Larger correlation and some synchronized blocks
  - Existence of important/unimportant blocks(?)
- Further analysis
  - Dependency of block size (/17 -> /32)
  - Port-level analysis

Concluding remarks

- Temporal and spatial correlation of darknet traffic time series
  - TCP is weak LRD, UDP is random walk
  - Spatial correlation lasts to only 20 /24-blocks for TCP, and some synchronization of blocks is appeared in UDP
- Future work
  - Port-level and smaller address block analysis
  - Possibility of comparison with CAIDA data? (problem:our measurement started from sept.2006)
    - Geographical and IP addr space differences?

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