

Locality Based Analysis of Network Flows

SEI/CERT

21 July 2004

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Why Locality

- Locality is an entropy based characterization that allows prediction of future behavior based on past observations.
 - It captures the degree to which the behavior of a system is regular in some sense
 - It appears to be scale free, appearing in internet, subnet, and node scale behaviors.
 - It promotes clustering allowing the use of sets and multisets to abstract group behaviors.

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Report Documentation Page

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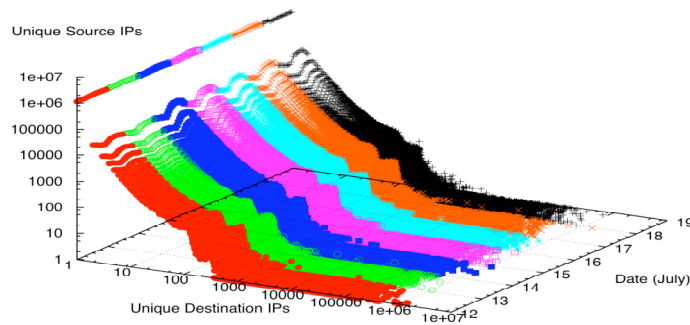
Eye Candy vs. Insight

- Locality often manifests as patterns in some space.
 - If we select the appropriate dimensions, we may achieve either understanding or puzzlement.
 - The next three pictures show persistent structure where none might be expected.
 - This can be viewed as a summary of a time series of connection matrices.
 - Graphics by Carrie Gates

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First you see it ...

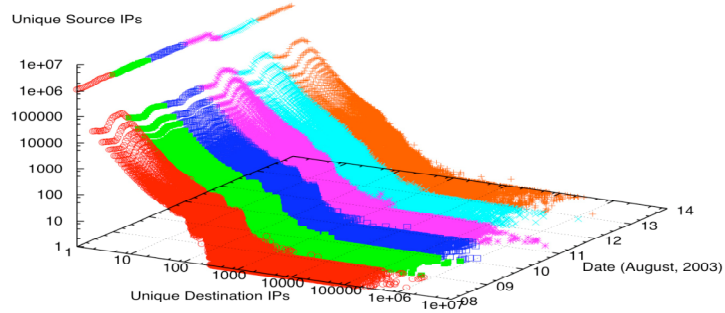
Number of Unique Source IPs that Contacted X Destination IPs Per Hour
(jis routed, TCP only)



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Then it goes away ...

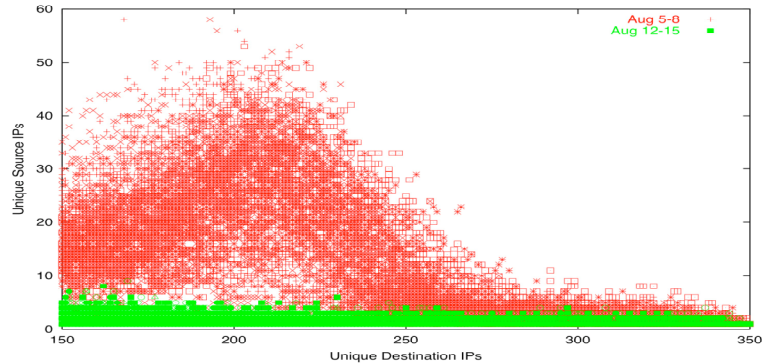
Number of Unique Source IPs that Contacted X Destination IPs Per Hour
(jis routed, TCP only)



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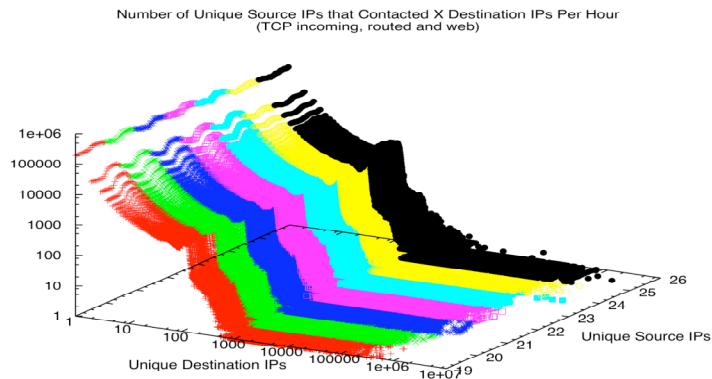
(rather abruptly)

Number of Unique Source IPs that Contacted X Destinations Per Hour
(TCP-Incoming, SYN and SYN-RST flows only)



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Only to return (months later).



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Williamson's Locality

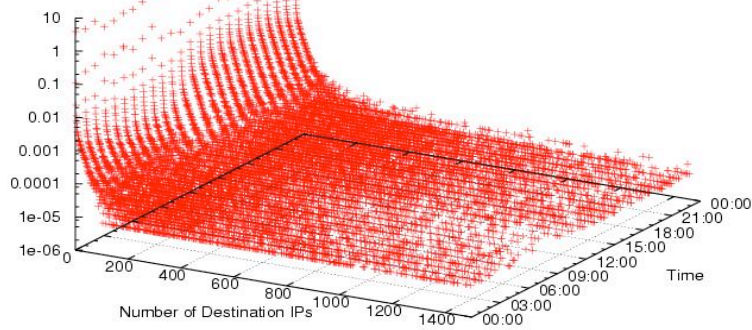
- Matt Williamson, late of HP Bristol, noted address locality in a 2002 ACSAC paper.
 - For browsing, last 10 IPs visited constitute an effective working set.
 - Working set violations relatively rare, bursts rarer yet.
 - Delay on violation is effective “soft” mitigator
- What is the locality of trans border data?

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Detail of Inside to Outside Day

Number of Destination IPs Contacted Per Source Over Time
(14 January 2003, all outgoing TCP traffic, calculated on a per hour basis)

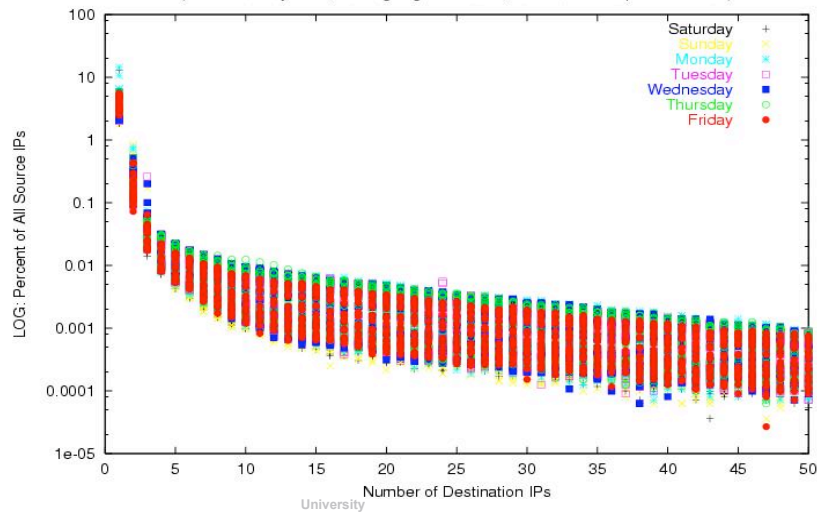
LOG: Percent of All Source IPs



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Weekly In/Out Locality Range

Number of Destination IPs Contacted Per Source Over Time
(11-17 January 2003, all outgoing TCP traffic, calculated on a per hour basis)

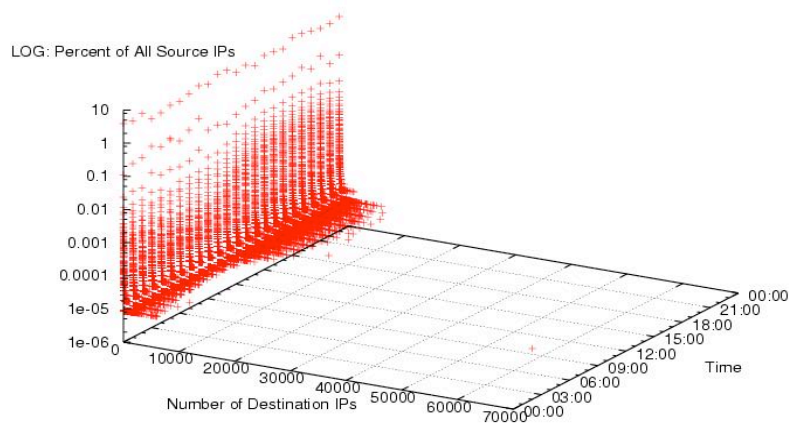


Williamson Confirmed (mostly)

- With the caveat that we are not seeing internal connections, the vast majority of the flows arguably follow Williamson's working set model.
- As usual, there are outliers ...

One Day of Inside to Outside

Number of Destination IPs Contacted Per Source Over Time
(14 January 2003, all outgoing TCP traffic, calculated on a per hour basis)



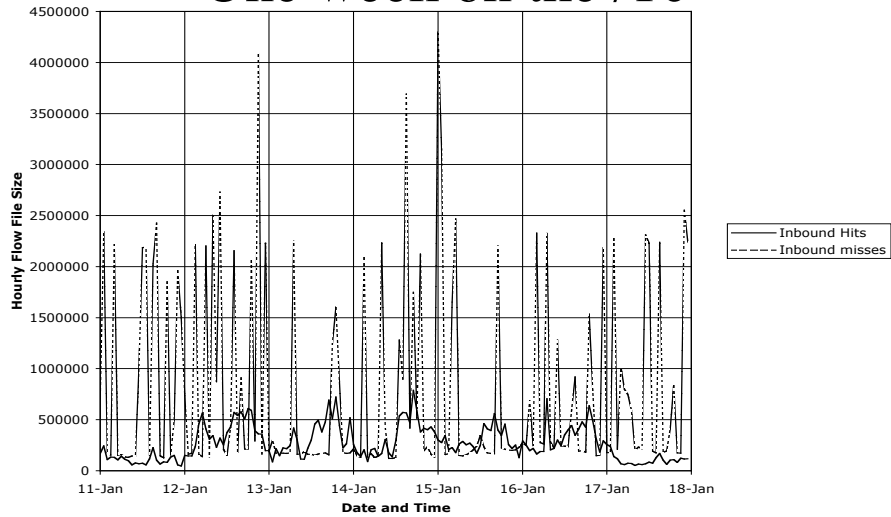
Noise localities

- We have been characterizing modest subnets in support of the traffic generation that will be used in the DARPA DQ system evaluations.
 - Attempting to avoid mistakes of DARPA IDS evaluation.
 - Striving for a realistic noise environment, among other things.

Crud and Noise

- In January, we observed a /16 for a week, and the whole customer net for a minute
- For the /16
 - MMM.NNN.24.x - 66 hosts MMM.NNN.25.x - 60 hosts
 - MMM.NNN.26.x - 46 hosts MMM.NNN.27.x - 49 hosts
 - MMM.NNN.28.x - 57 hosts MMM.NNN.29.x - 7 hosts
 - MMM.NNN.30.x - 70 hosts MMM.NNN.31.x - 67 hosts
 - MMM.NNN.32.x - 54 hosts MMM.NNN.33.x - 62 hosts
 - MMM.NNN.34.x - 50 hosts MMM.NNN.35.x - 4 hosts
 - MMM.NNN.120.x - 2 hosts MMM.NNN.127.x - 1 host
 - MMM.NNN.140.x - 1 host MMM.NNN.251.x - 4 hosts
 - Total 600 hosts in 16 /24s

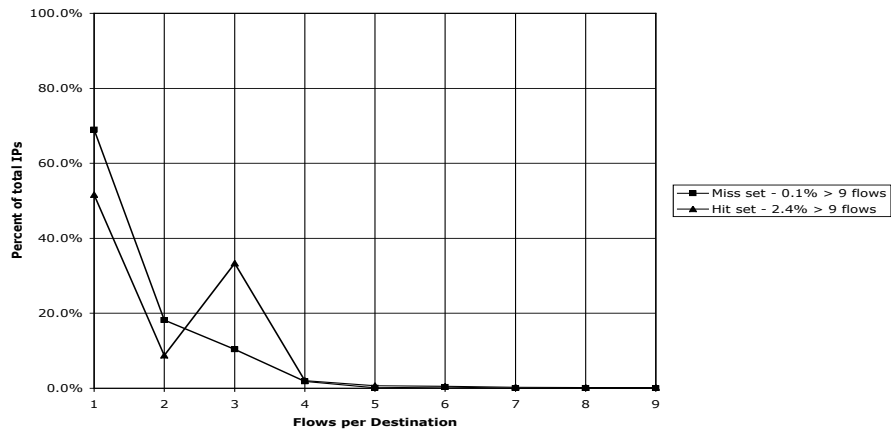
One week on the /16



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1 Min sample - destinations

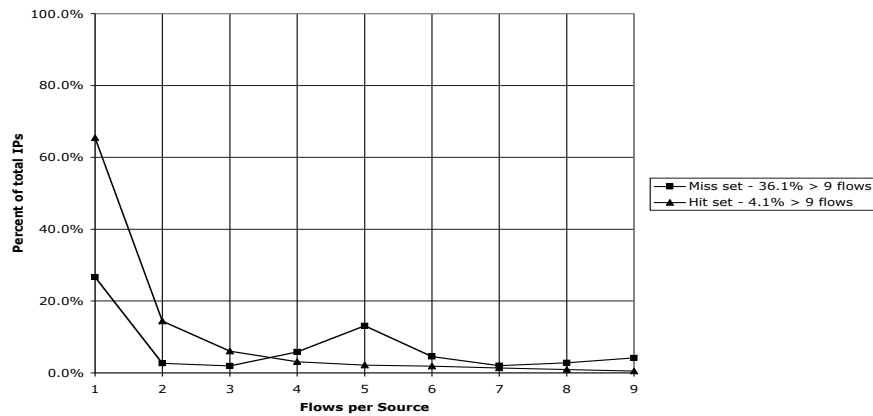
IP Destination Analysis



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1 Min Sample - sources

IP Source Analysis



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top 5 in 1 min sample

- Created a “bag” for source and destination addresses in the 1 minute sample. The annotated top 5 are:
- (39) lip \$ readbag --count --print jcm-tcp-s-10+.bag| sort -r -n | head
 - 12994 AAA.BBB.068.218 - scan 4899 (Radmin)
 - 6598 CCC.DDD.209.215 - scan 7100 (X-Font)
 - 5944 EEE.FFF.125.117 - scan 20168 (Lovegate)
 - 5465 GGG.HHH.114.052 - ditto
 - 5303 III.JJJ.164.126 - scan 3127 (My doom)

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Bottom of bag in 1 min sample

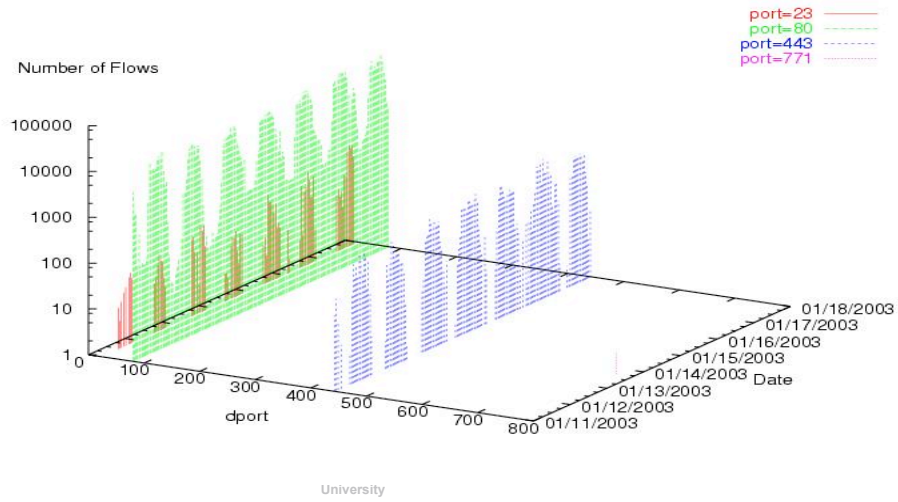
- 3335 external hosts sent exactly one TCP flow
 - SYN probes for port 8866 449 times
 - W32.Beagle.B@mm is a mass-mailing worm-back door on TCP port 8866.
 - SYN probes for port 25 are seen 271 times.
 - Most remainder are SYNs to a variety of ports, mostly with high port numbers.
 - There are a number of ACK/RST packets which are probably associated with responses to spoofed DDoS attacks.

Individual host profiles

- These were done by Capt. Damon Becknel, USA.
 - He was looking for ways of characterizing the role of a node based on it's activity patterns
 - As usual, surprising results are sometimes observed.

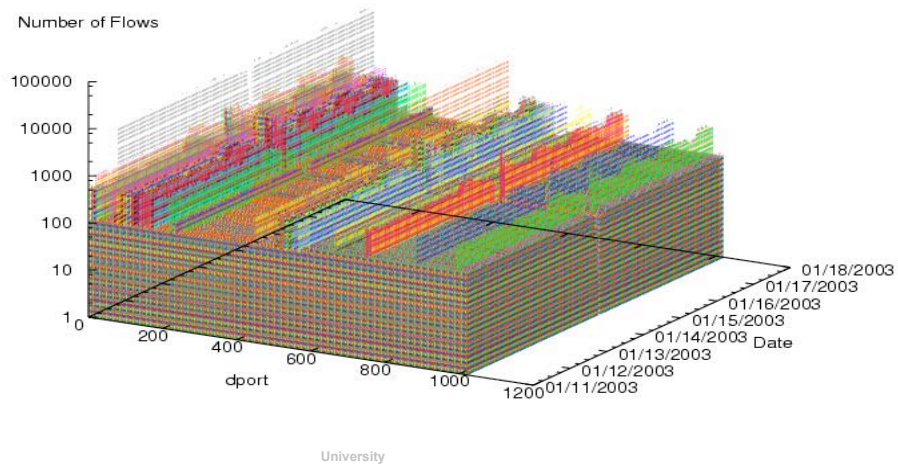
Workstation?

Workstation? - Distribution of dport



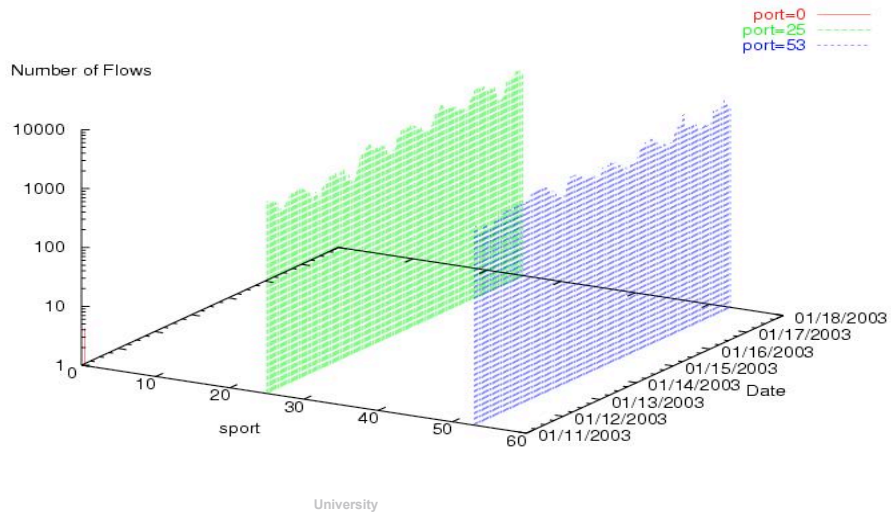
Scanner

Scanner - Distribution of dport



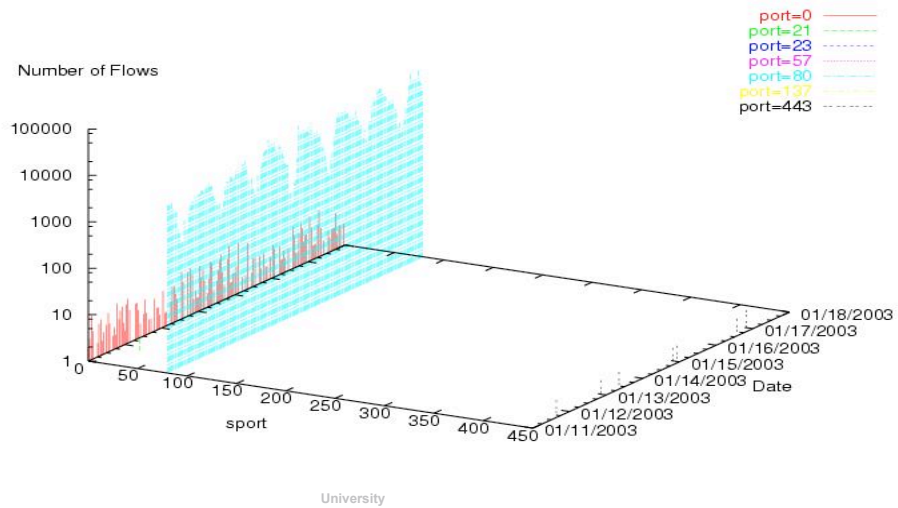
Mail Server?

Mail Server - Distribution of sport



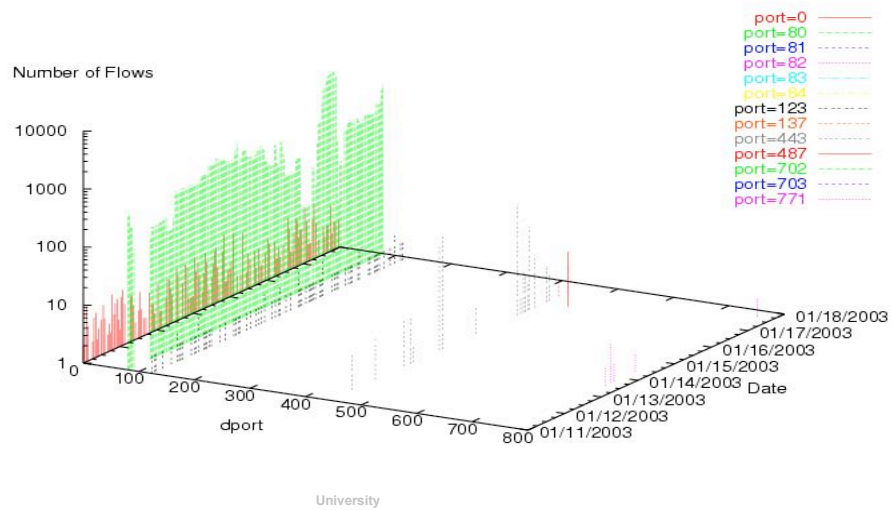
Web Server

Web Server - Distribution of sport



Web Server

Web Server - Distribution of dport



Summary

- We have provided some examples of locality on a variety of scales for a variety of representations.
- It is our hope that the general notions of locality, and clustering will provide a basis for reducing the complexity of analysis.