A *First* Look at Modern Enterprise Traffic

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The Question

"What does the traffic look like in today's enterprise networks?"

- Previous work
  - LAN traffic [Gusella 1990, Fowler et.al. 1991]
  - More recent work on individual aspects:
    - Role classification [Tan et.al. 2003],
    - Community of interest [Aiello et.al. 2005]
- Wide area Internet traffic measurements
  - First study: [Cáceres 1989]

    … when the size of Internet was ~130,000 hosts

    … about the size of a large enterprise network today

Our *First* Look

- Which applications account for most traffic?
- Who is talking to whom?
- What's going on inside application traffic?
  - Esp. ones that are heavily used but not well studied: Netware Core Protocol (NCP), Windows CIFS and RPC, etc.
- How often is the network overloaded?

For all above, compare internal vs. wide area

Trace Collection

- Where: Lawrence Berkeley National Lab (LBNL)
  - A research institute with a medium-sized enterprise network
- **Caveat: one-enterprise study**
  - "The traffic **might** look like …"

- How: tapping links from subnets to the main routers
- Caveat: only traffic *between* subnets

LBNL Trace Data

	D0	D1	D2	D3	D4
Date	Oct 4, 04	Dec 15, 04	Dec 16, 04	Jan 6, 05	Jan 7, 05
Duration	10min	1 hour	1 hour	1 hour	1 hour
Subnets	22	22	22	18	18
Traced Hosts	2,531	2,102	2,088	1,561	1,558
Packets	18M	65M	28M	22M	28M
Snaplen	1500	68	68	1500	1500

- Five data sets
- Over three months: Oct 2004 -- Jan 2005

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- Each trace covers a subnet
- Lasts ten minutes or one hour

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- Two sets of subnets
- 2,000 hosts traced per data set

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- Subnets are traced **two at a time**
  - With four NIC's on the tracing machine

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- Packets with **full payloads** allow application-level analysis

Outline of This Talk

- Traffic breakdown
  - Which applications are dominant?
- Origins and locality
- Individual application characteristics

Network Layer: Is IP dominant?

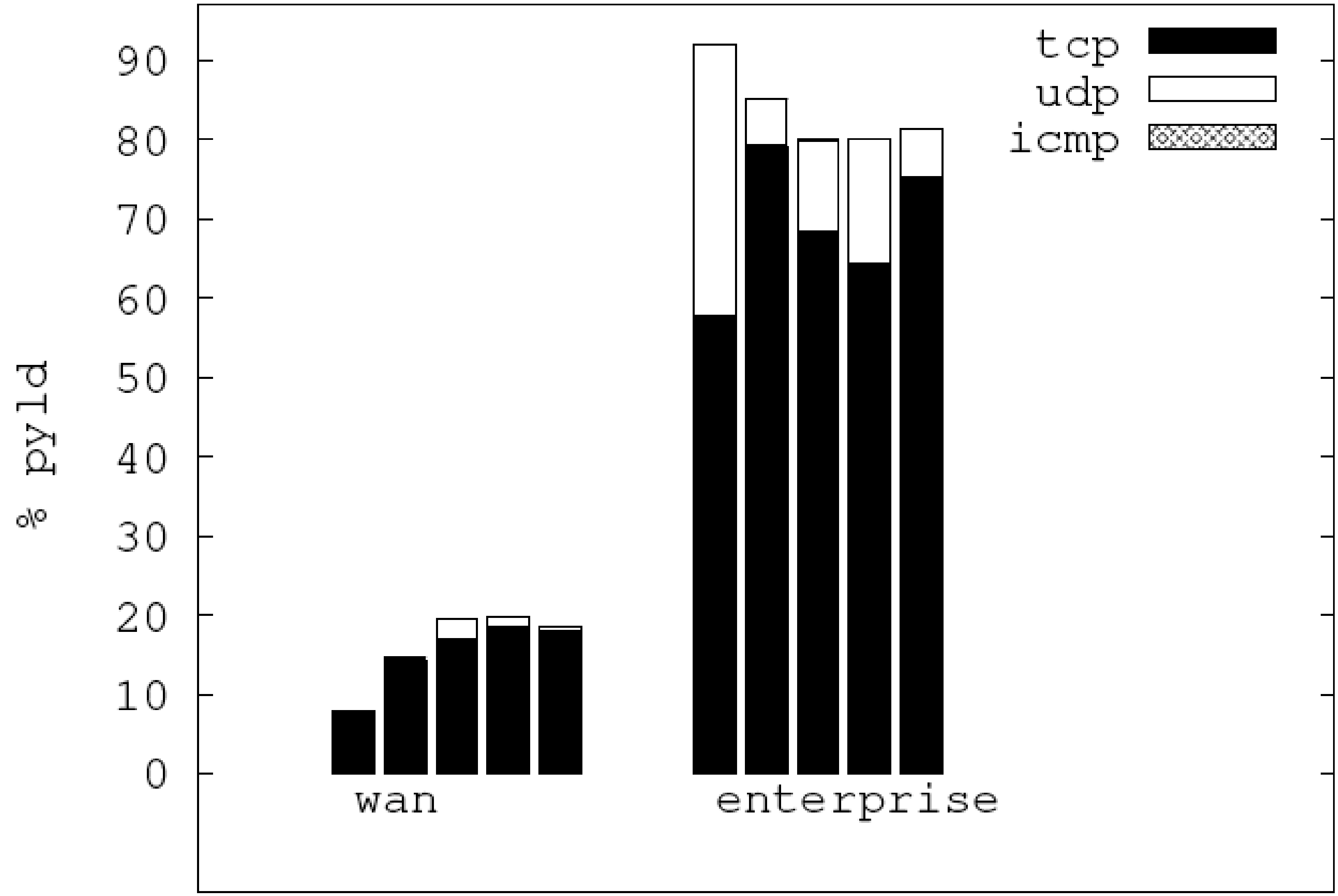
- Yes, most packets (96-99%) are over IP
  - Caveat: inter-subnet traffic only

- Aside from IP: ARP, IPX (broadcast), etc.

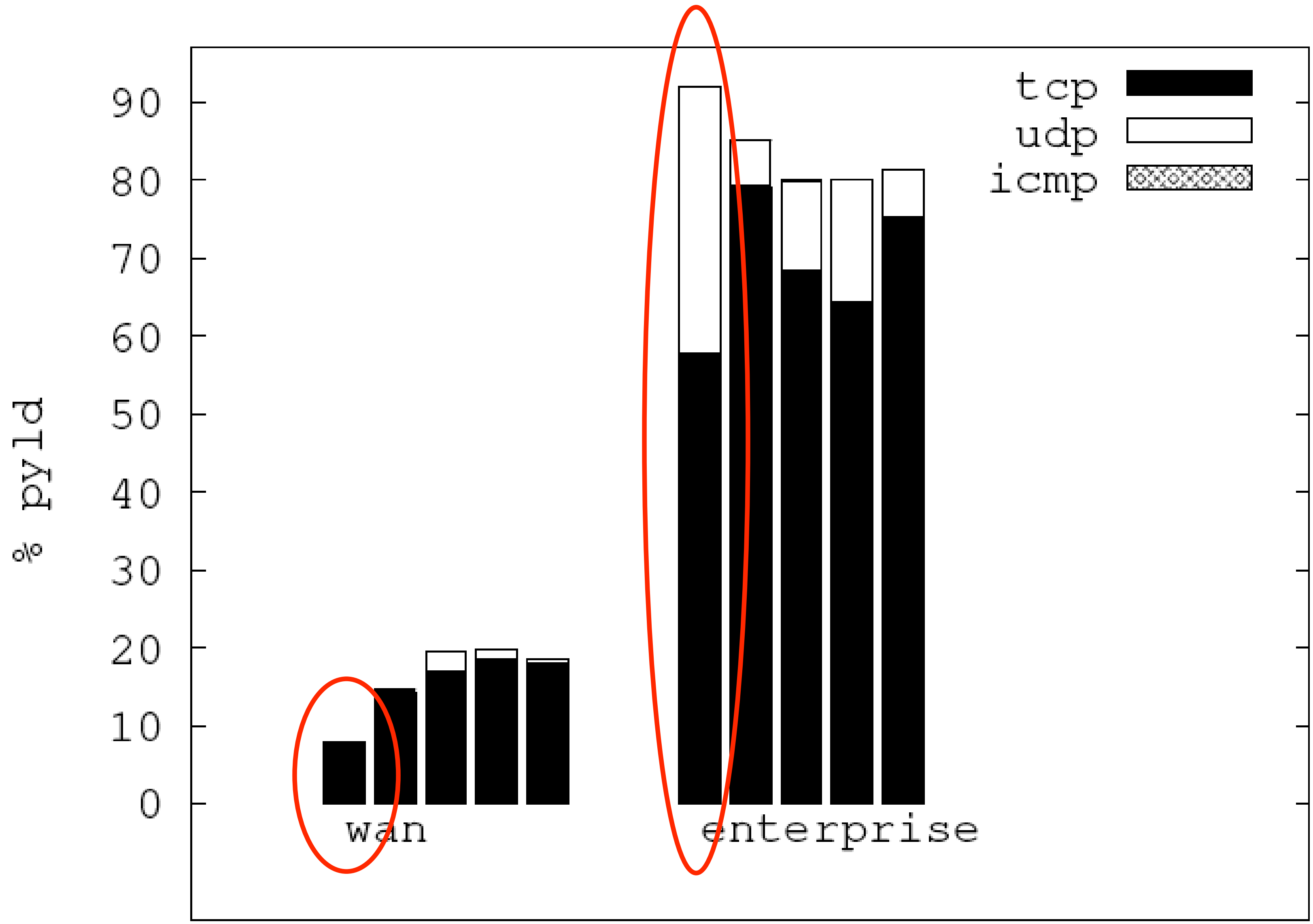
Transport Layer

- Protocols seen:
  - TCP, UDP, ICMP
  - *Multicast*: IGMP, PIM
  - *Encapsulation*: IP-SEC/ESP, GRE
  - IP protocol 224 (?)

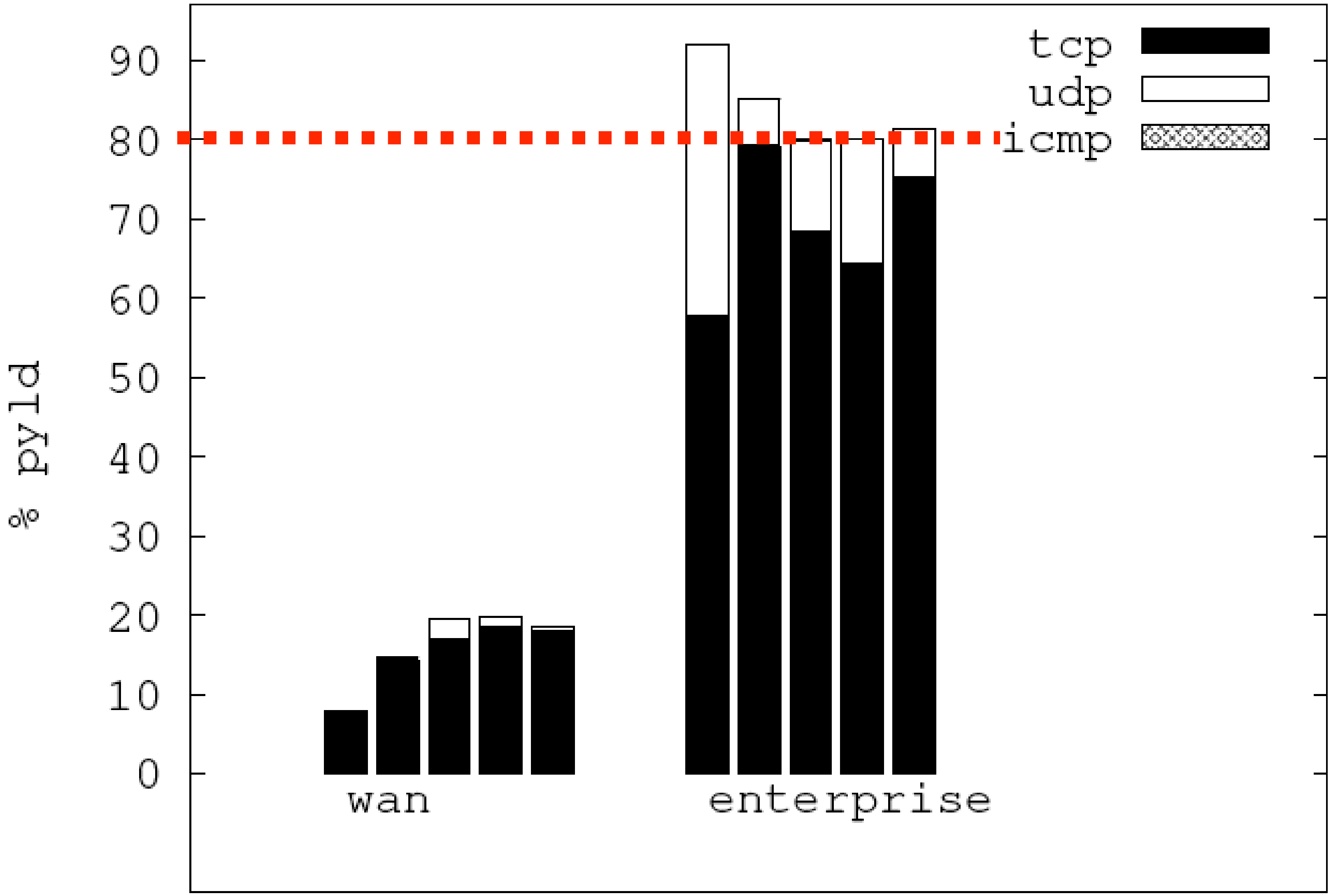
- Is UDP used more frequently inside enterprise than over wide area Internet?



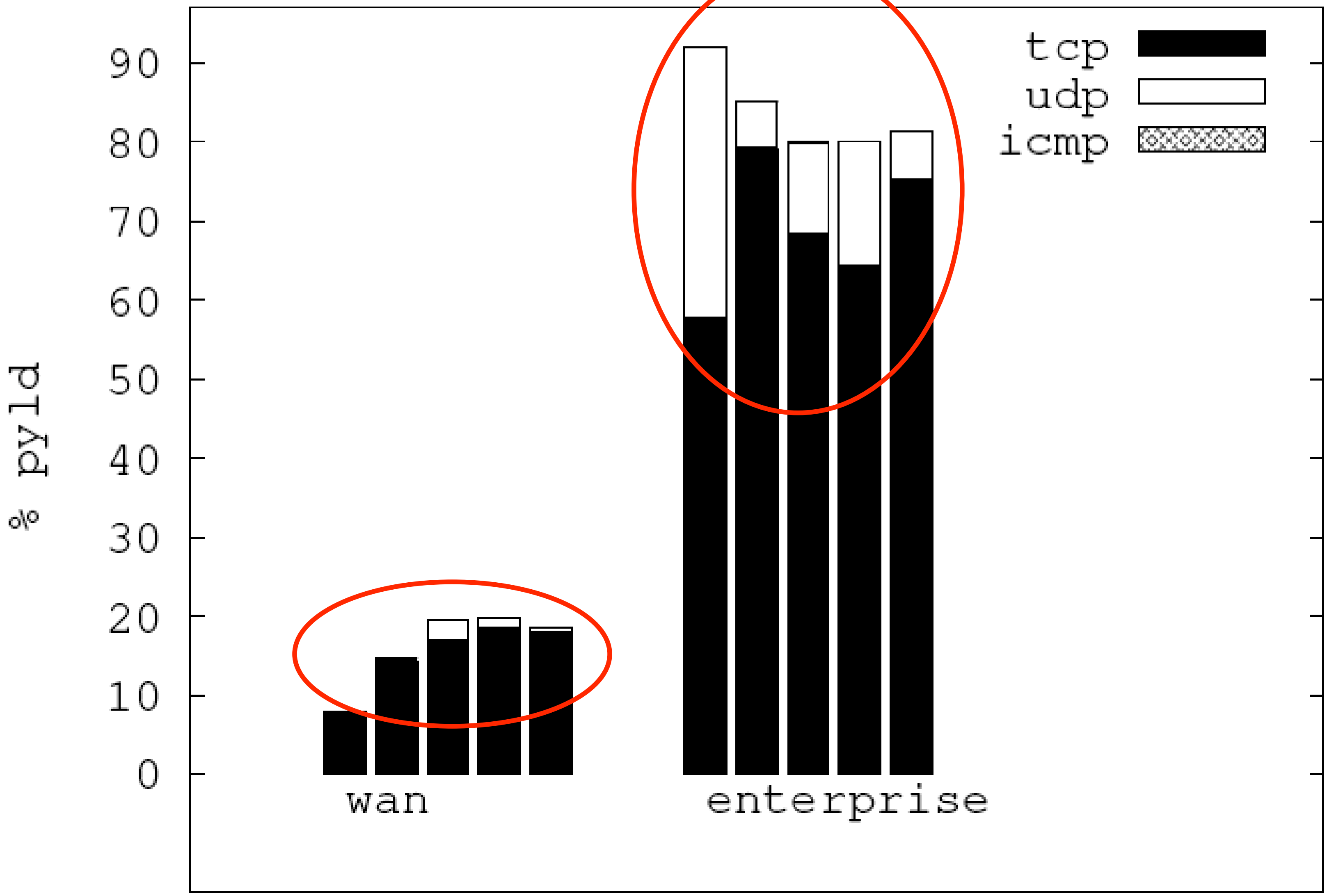
TCP vs. UDP / WAN vs. Enterprise
Breakdown by Payload Bytes



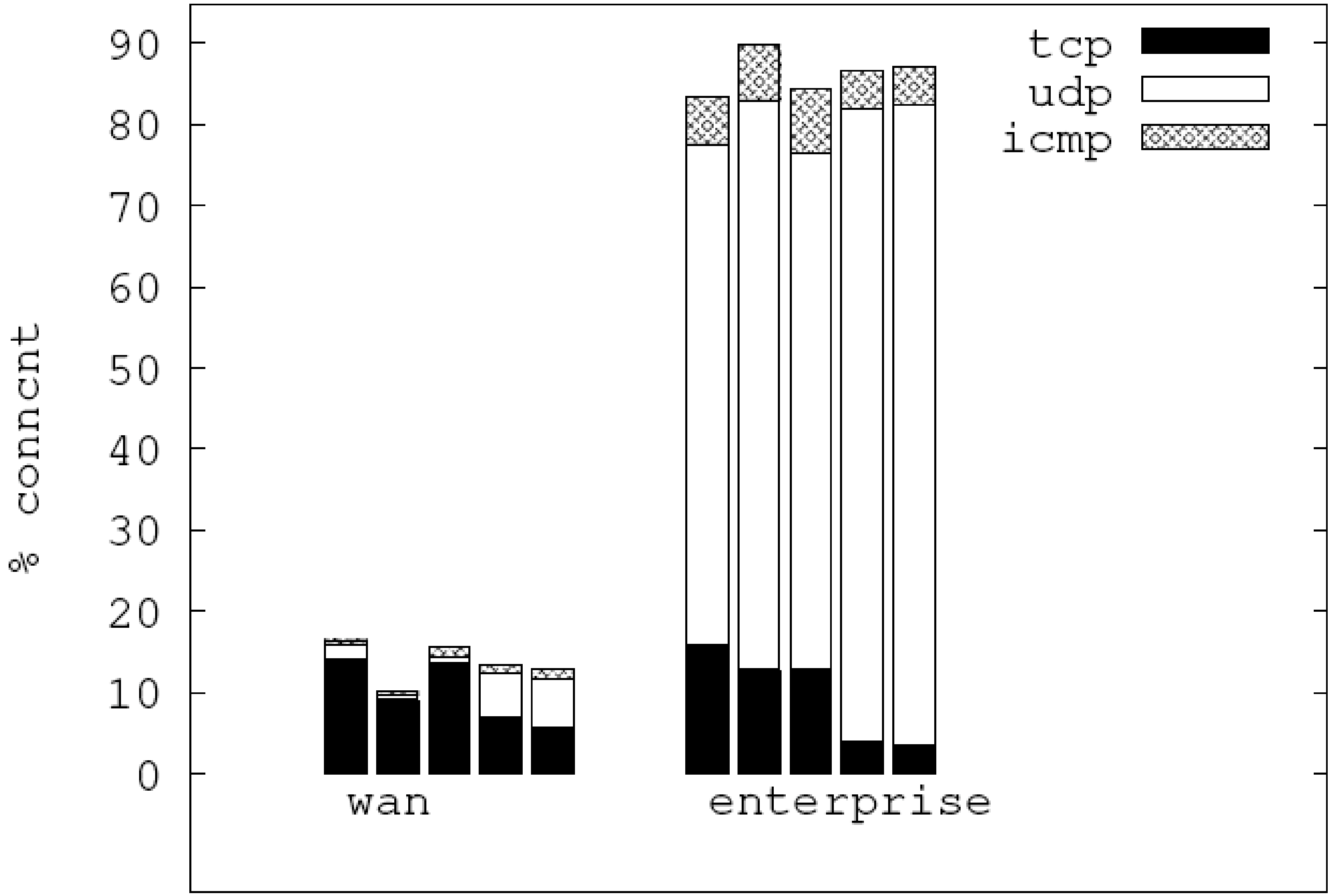
Breakdown of the first data set (D0)
(Bars add up to 100%)



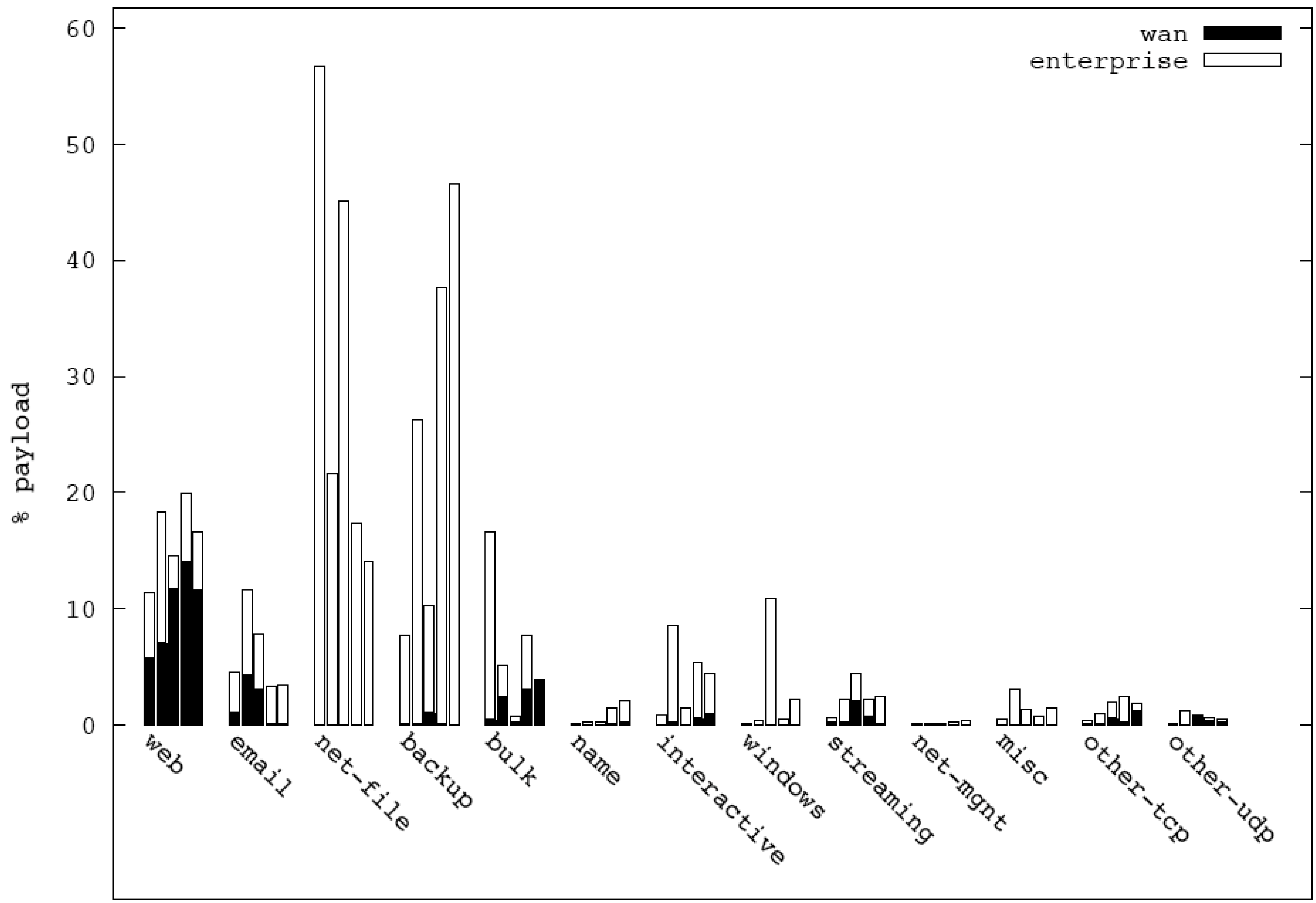
80% (or more) payloads are sent within the enterprise.



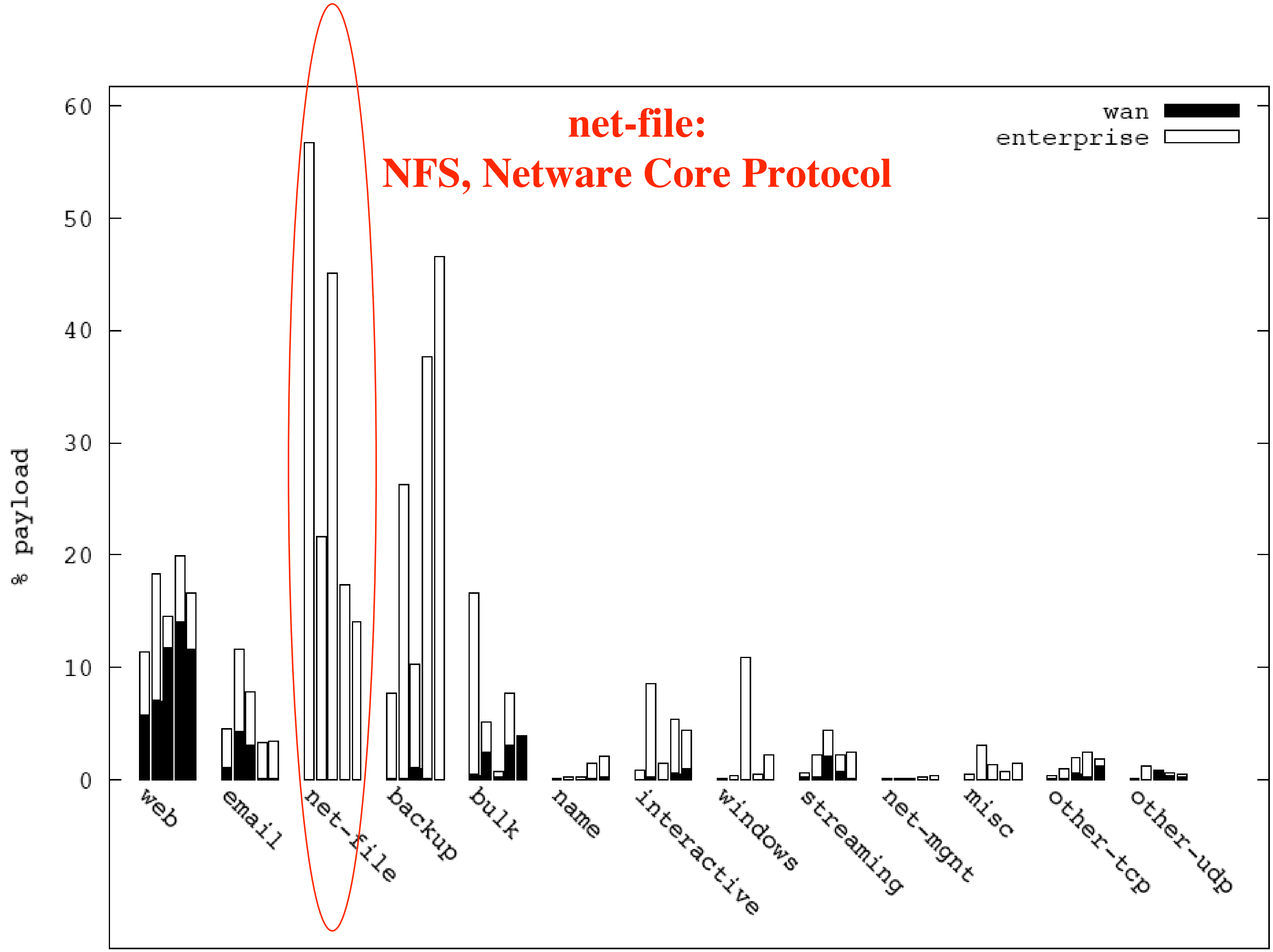
Yes, UDP is used more frequently inside the enterprise.



Breakdown by Flows



Application Breakdown by Bytes



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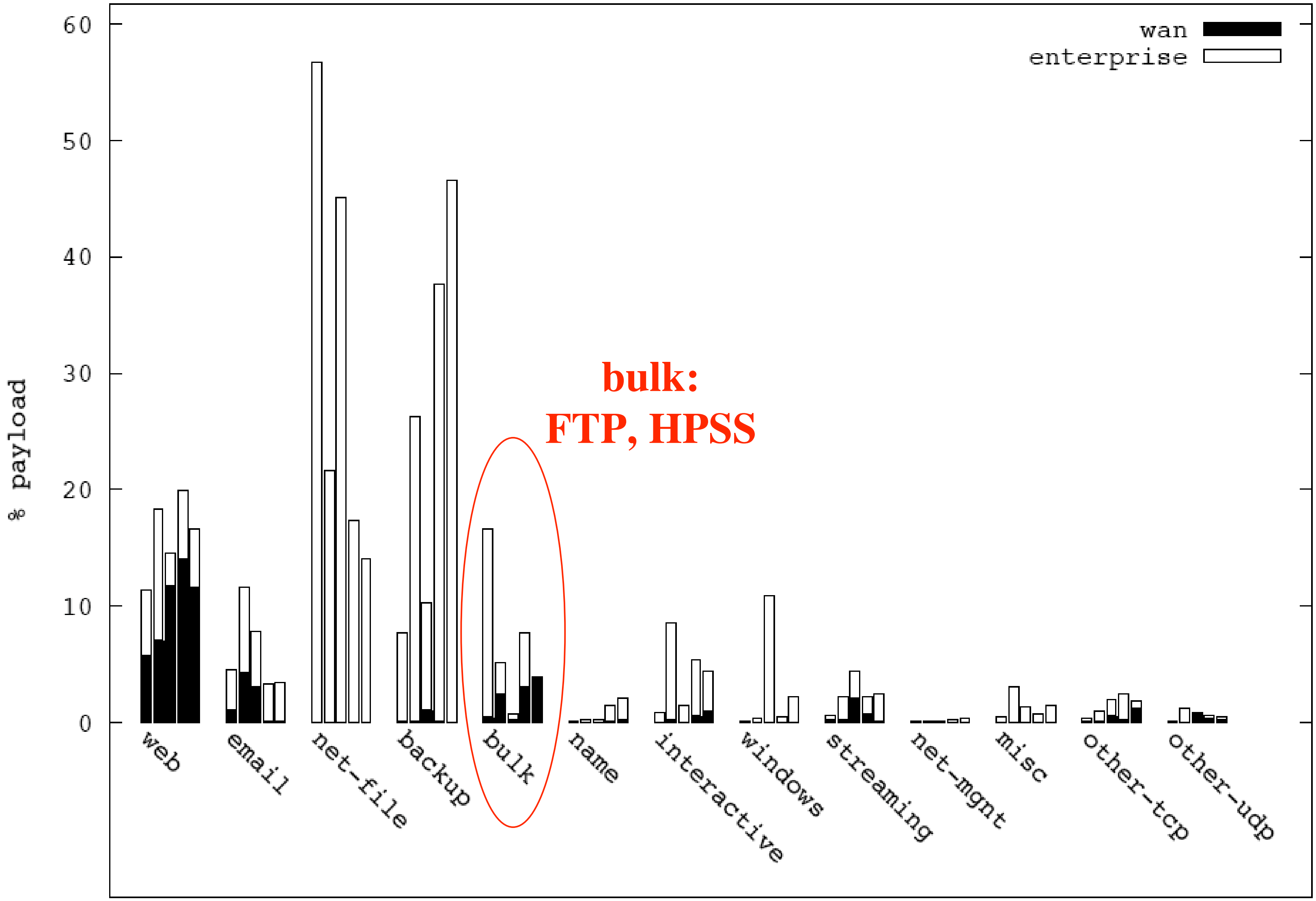

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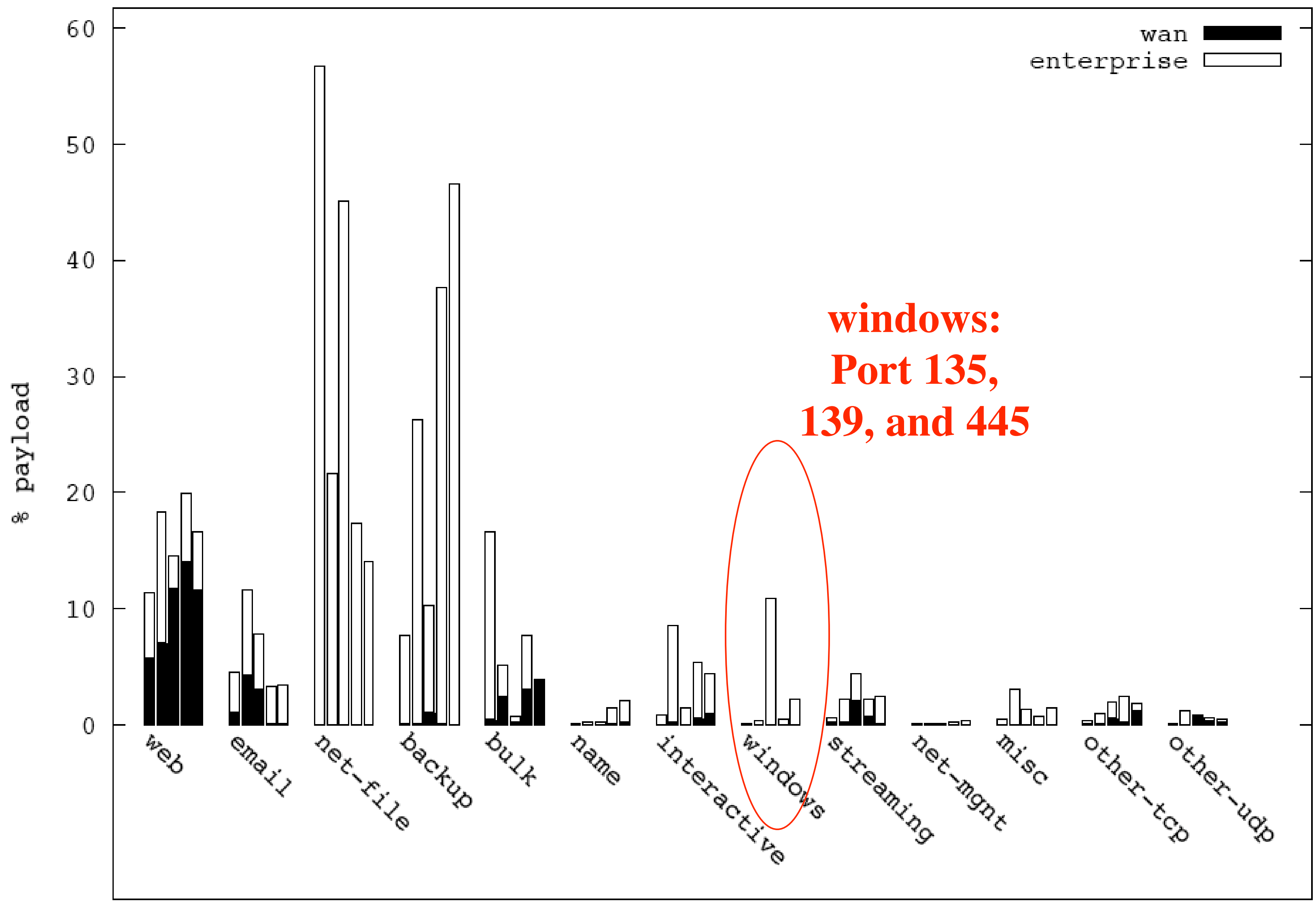
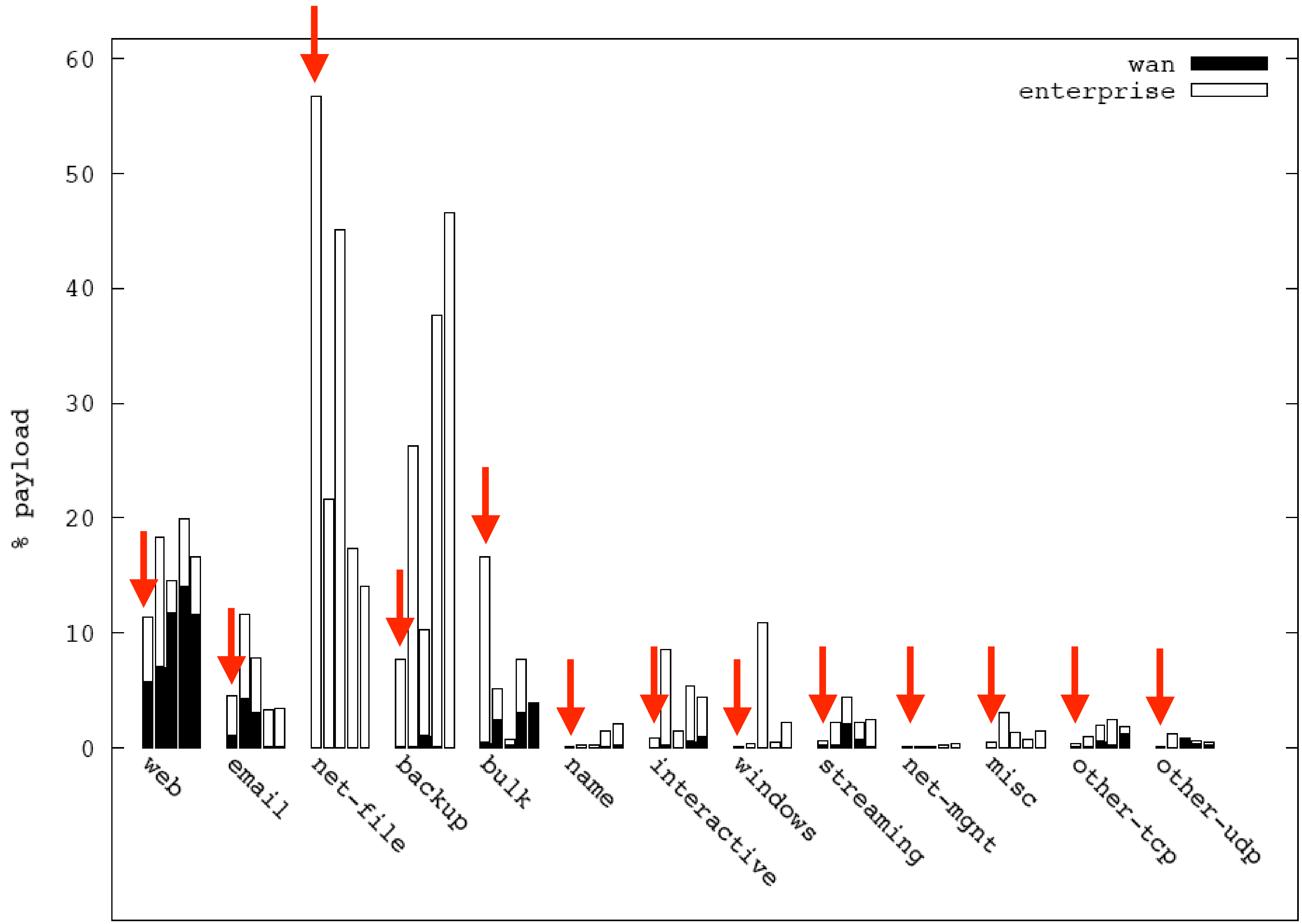
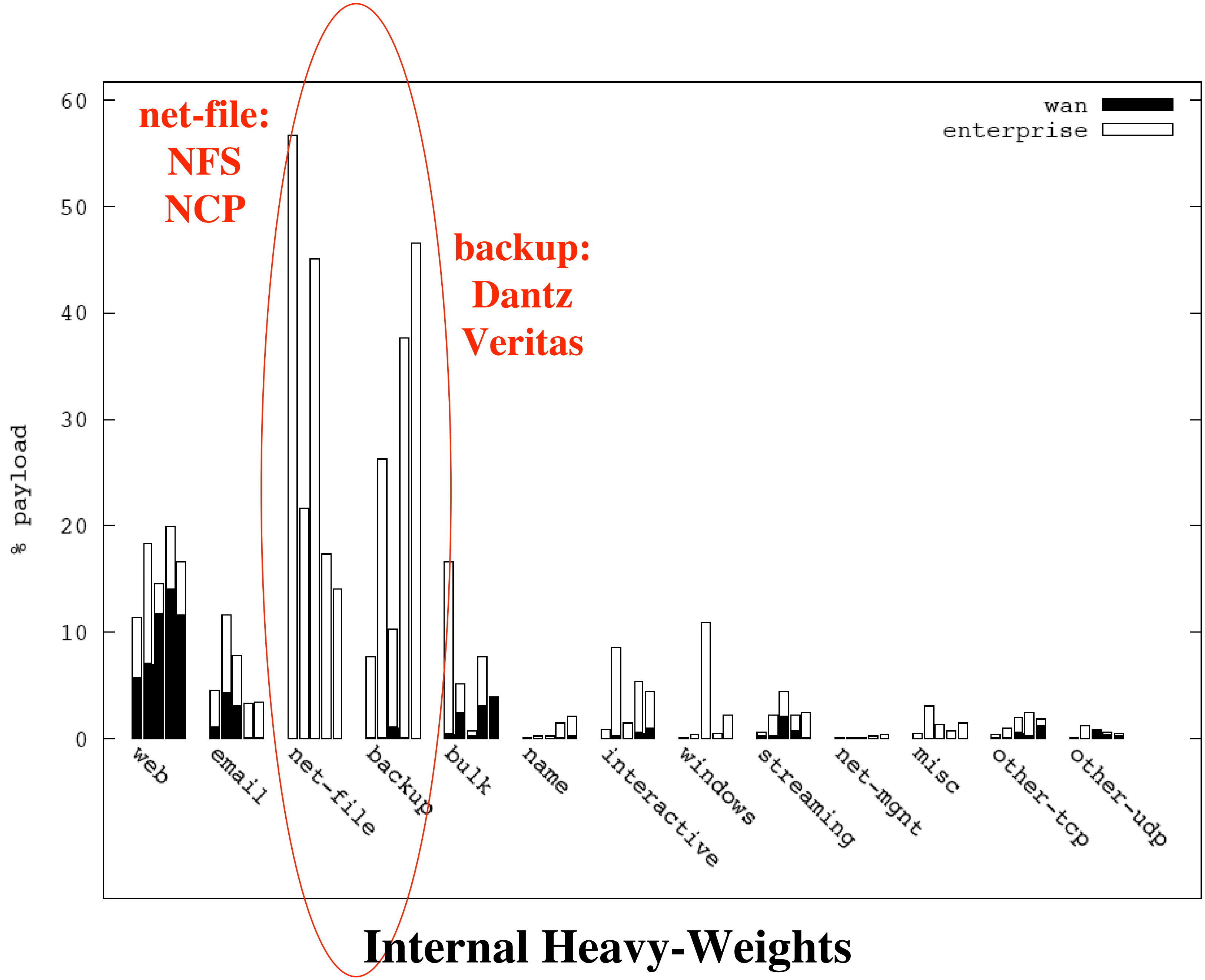


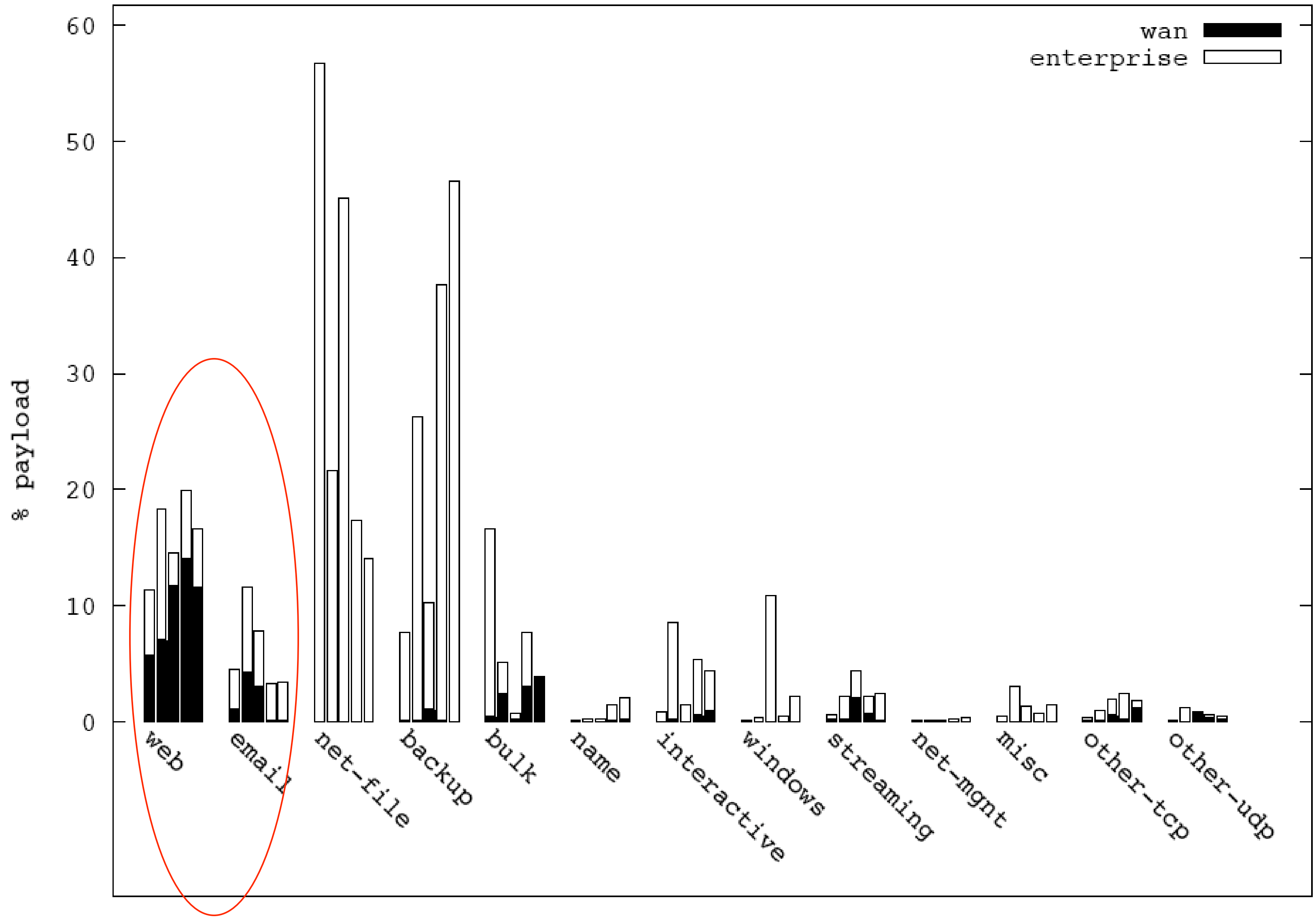
Application Breakdown by Bytes



Bars for each data set add up to 100%

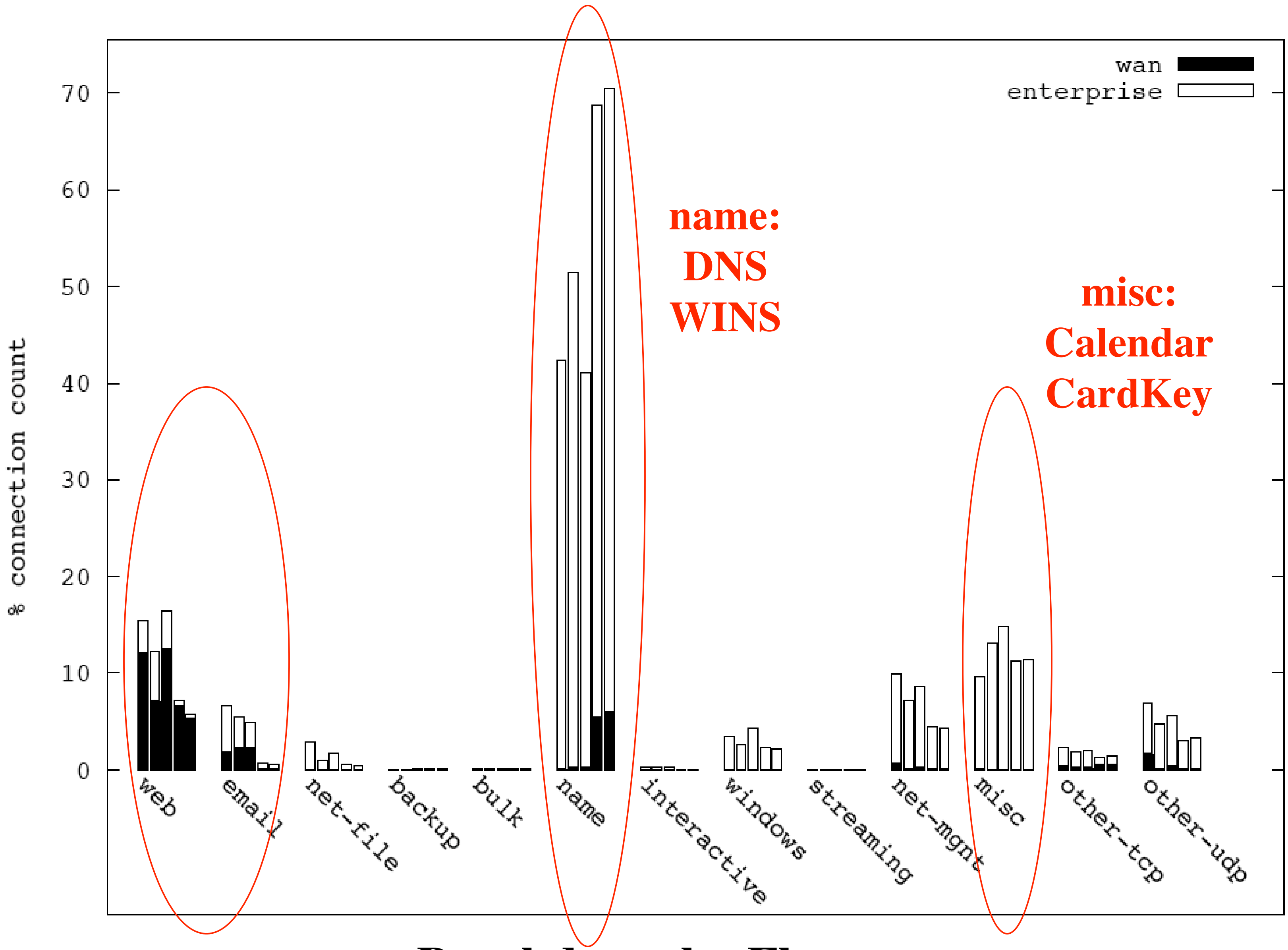


Internal Heavy-Weights



WAN ≈ web + email

WAN Heavy-Weights



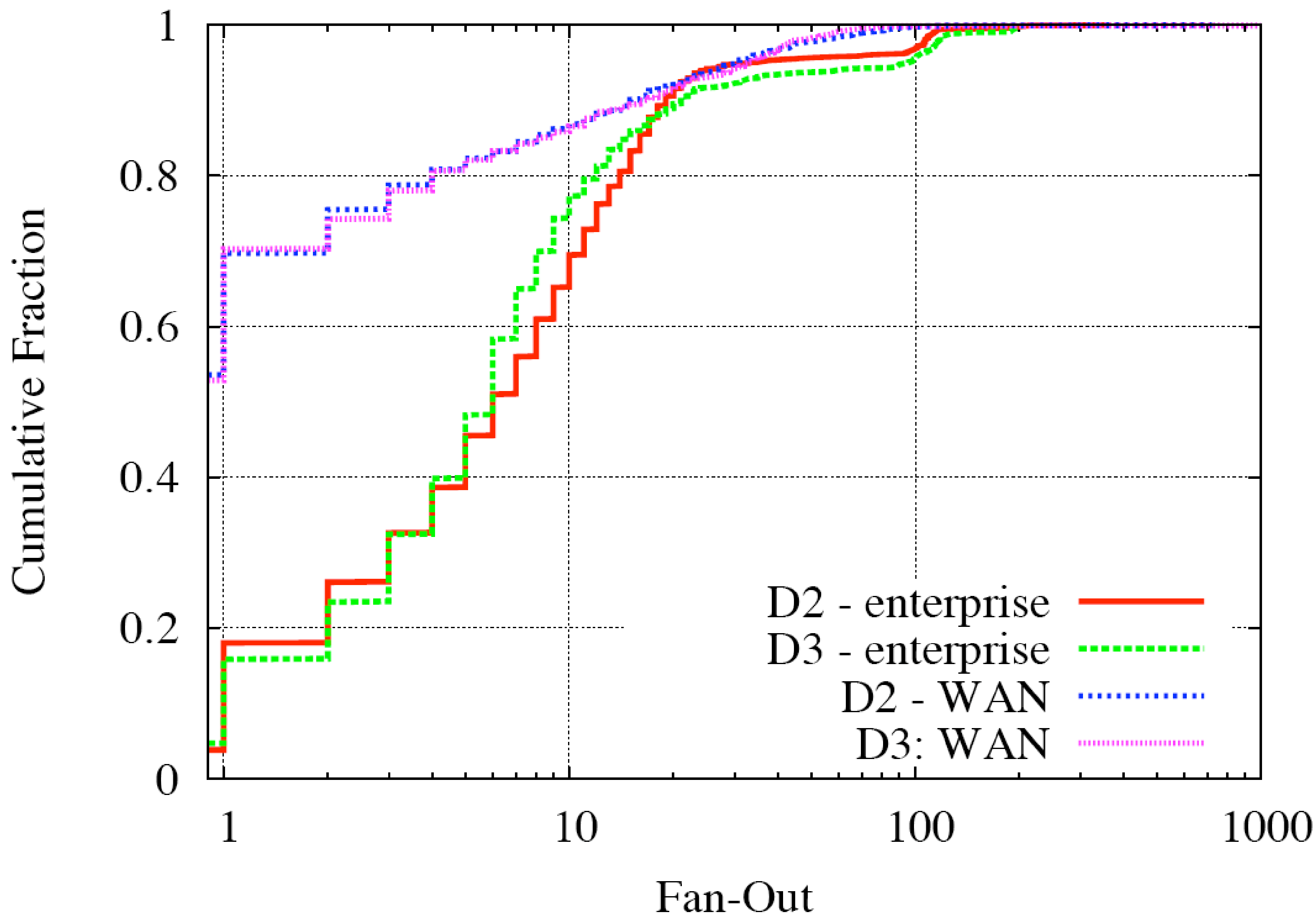
Breakdown by Flows

Summary of Traffic Breakdown

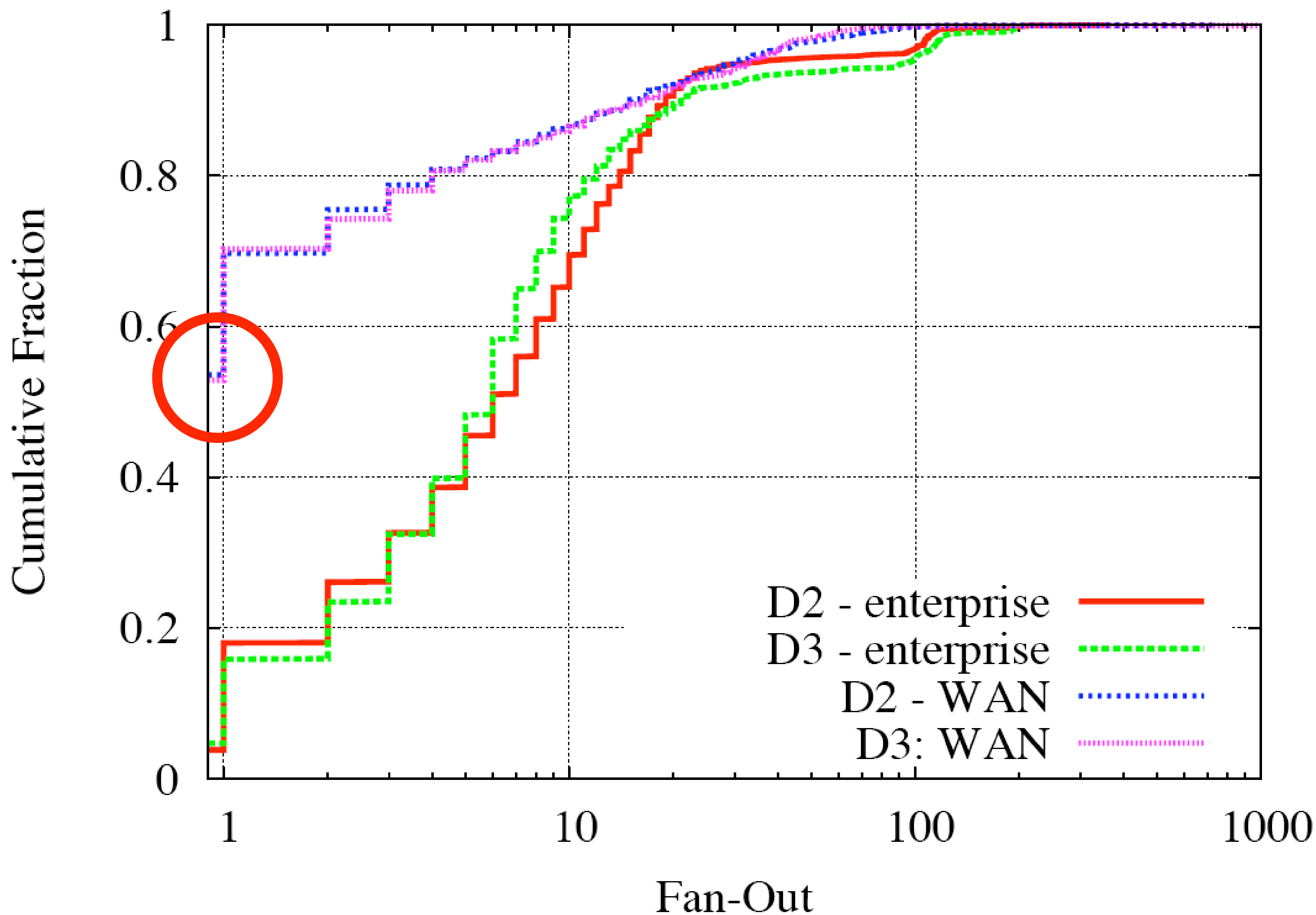
- Internal traffic (vs. wide area)
  - Higher volume (80% of overall traffic)
  - A richer set of applications
- Traffic heavy-weights
  - Internal: network file systems and backup
  - WAN: web and email

Outline

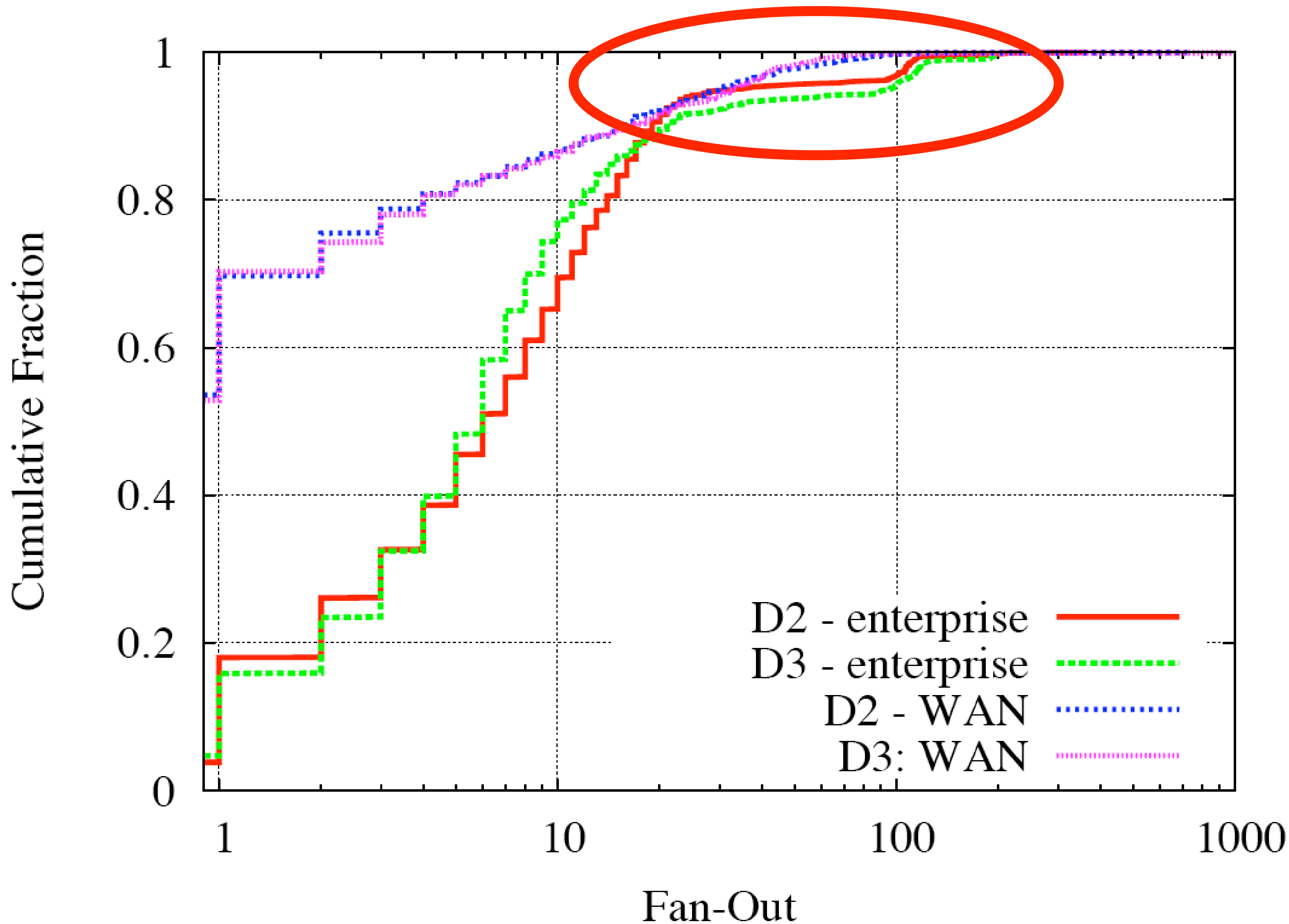
- Traffic breakdown
- Origins and locality
  - Fan-in/out distribution
- Individual application characteristics



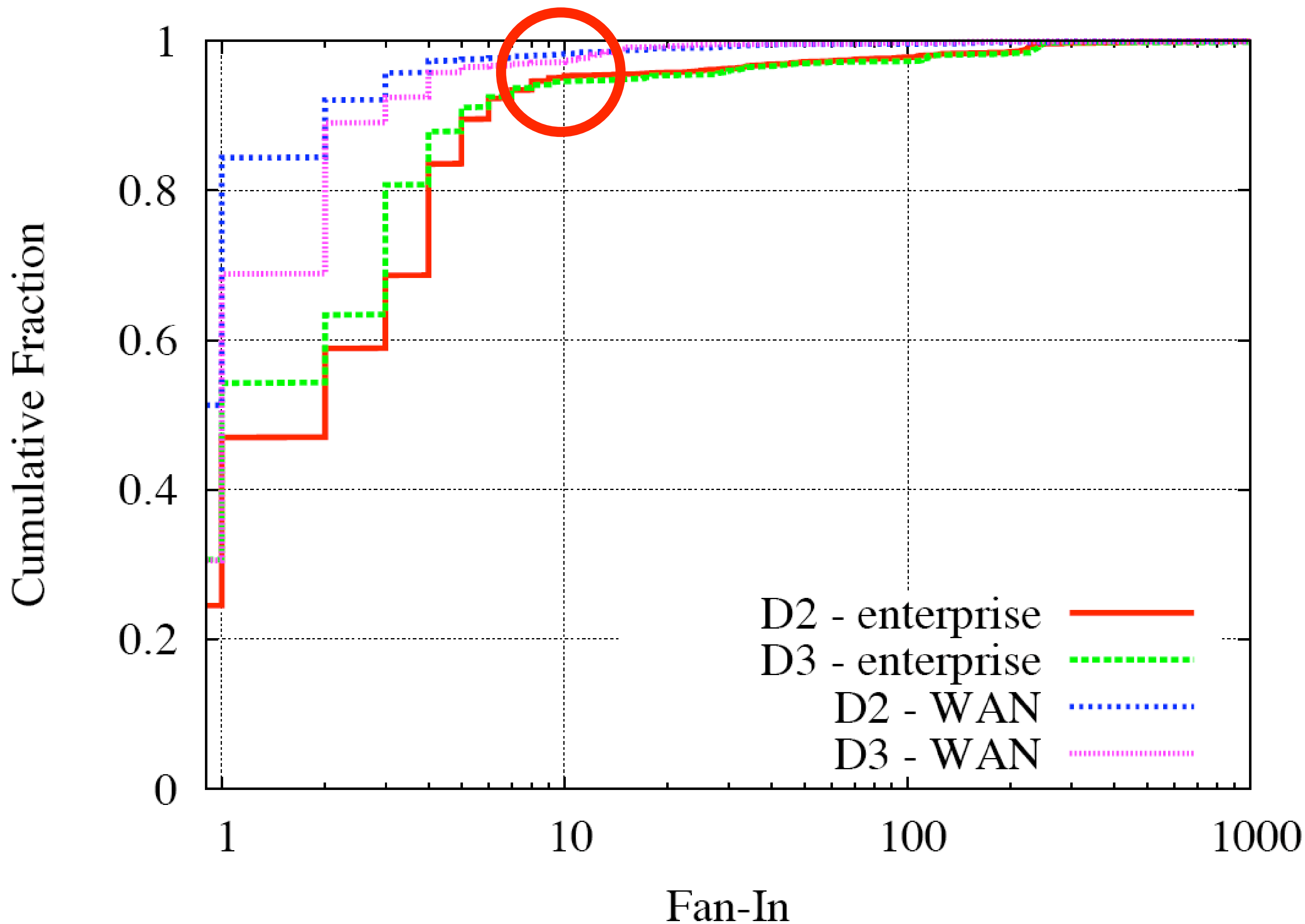
Cumulative Fraction
Fan-Out
0
0.2
0.4
0.6
0.8
1
1
10
100
1000
D2 - enterprise
D3 - enterprise
D2 - WAN
D3: WAN



Half of hosts have no wide-area fan-out (in one hour).



Internal fan-out has a fat tail.



Most hosts have fan-in of no more than 10.

Outline

- Traffic breakdown
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Example Questions

- Is there a big difference between ***internal*** and ***wide area*** HTTP traffic?
- How different are ***DNS*** and ***WINS*** ***(netbios/ns)***?
- What does ***Windows*** traffic do?

Internal HTTP traffic

Automated clients vs. the rest:

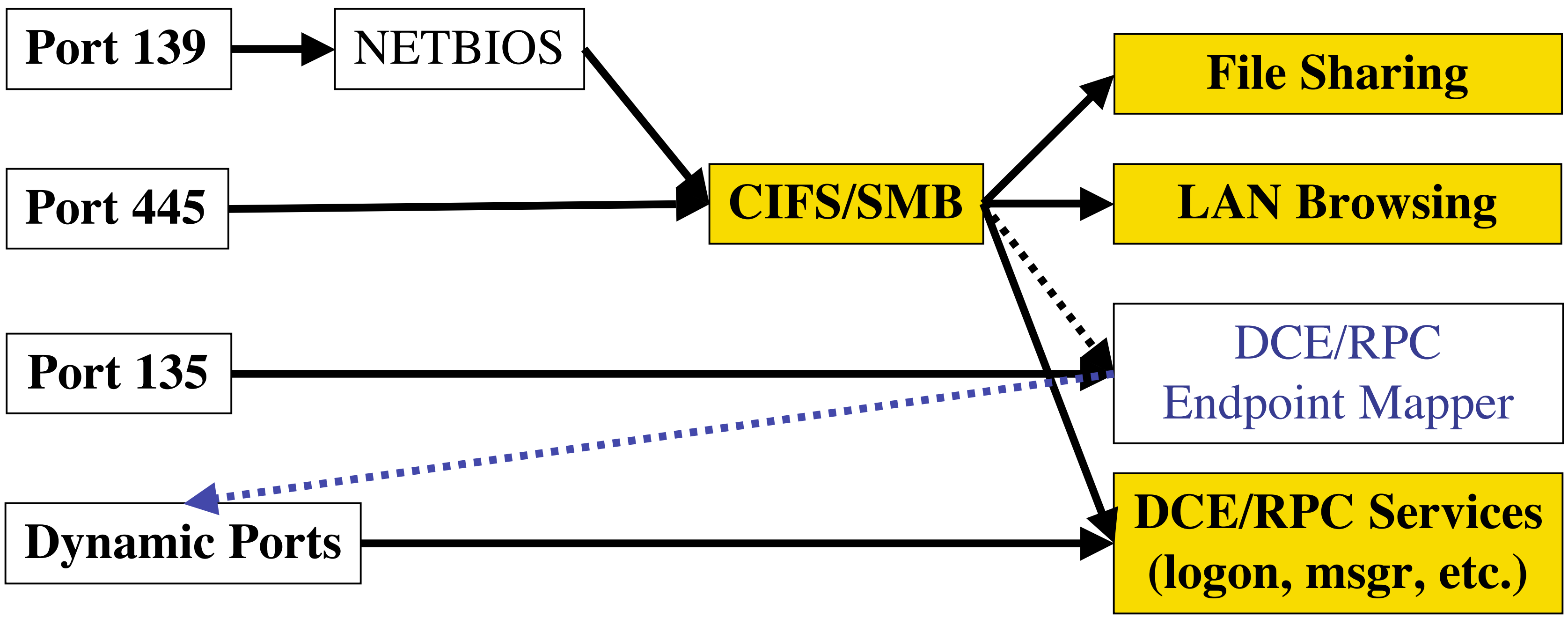
	Requests			Bytes		
	D0	D3	D4	D0	D3	D4
Internal Scanners	**20%**	**49%**	**19%**	0.1%	0.9%	1%
Google Devices	**37%**	8%	5%	**96%**	**69%**	**48%**
Netware iFolder	1%	0.2%	10%	0.0%	0.0%	9%
All other clients	**42%**	**43%**	**66%**	**4%**	**30%**	**41%**

Automated clients *dominate the traffic.*

DNS vs. WINS

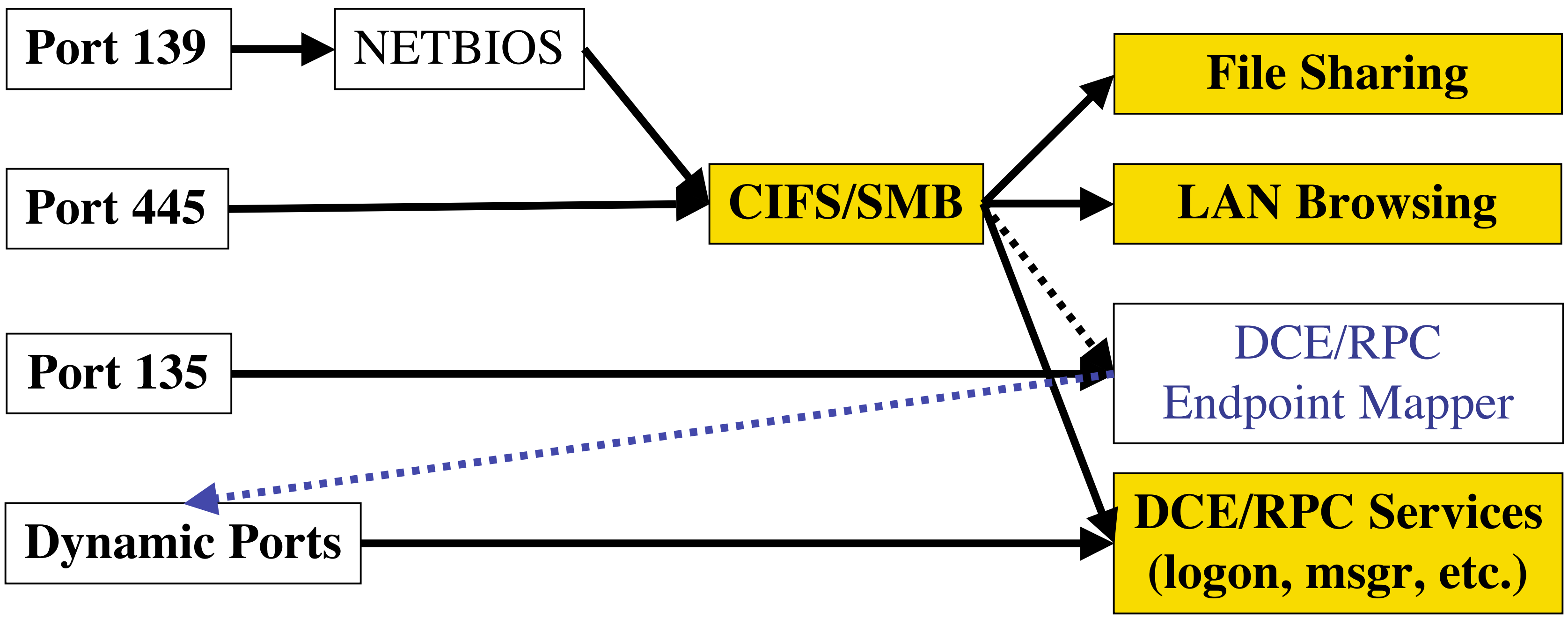
- Where do queries come from?
  - **DNS**: both local and remote; most queries come from two mail servers
  - **WINS**: local clients only; queries are more evenly distributed among clients
- Failure rate (excluding repeated queries)
  - **DNS**: 11-21%
  - **WINS**: 36-50% (**!**)

Windows Traffic



Port numbers don’t tell much…

Windows Traffic



Application level analysis: Bro + binpac

Windows Traffic Breakdown

- Majority of CIFS/SMB traffic is for **DCE/RPC services**
  - Rather than file sharing

- Majority of RPC traffic
  - By request: **user authentication (netlogon), security policy (lsarpc) and printing (spoolss)**
  - By size: **printing (spoolss)**

Not Covered in This Talk …

- Characteristics of more applications
  - Email
  - Network file systems: NFS and NCP
  - Backup
  - Further details about HTTP, DNS/WINS, and Windows traffic
- Network congestion

Conclusion

- A lot is happening inside enterprise
  - More packets sent internally than cross border
  - A number of applications seen only within the enterprise
- Caveats
  - One enterprise only
  - Inter-subnet traffic
  - Hour-long traces
  - Subnets not traced all at once
- Header traces released for download!
  - To come: traces with payloads (HTTP, DNS, …)

The End

To download traces:

http://www.icir.org/enterprise-tracing

(or search for "LBNL tracing")