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Passive OS Fingerprinting Methods in the Jungle of Wireless Networks

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Motivation

- Results from static networks
  - ⇨ dynamic wireless network
- Rapid changes
  - ⇨ continuous passive monitoring
- Large network, lot of traffic
  - ⇨ IPFIX

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Methods

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TCP/IP Parameters

synSize	winSize	TTL	OS	Confidence
52	8192	128	Windows 10.0	55.2 %
52	8192	128	Windows 6.1	31.9 %
52	65535	128	Windows 10.0	74.9 %
60	65535	64	Android 6.0	48.2 %
60	14600	64	Android 4.4	28.4 %
60	29200	64	Ubuntu	20.4 %
64	65535	64	Mac OS X 10.12	26.5 %
64	65535	64	iOS 10.3	10.3 %

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HTTP User-agent

- Mozilla/5.0 (**Windows NT 10.0**; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/65.0.3325.181 Safari/537.36

- Mozilla/5.0 (Linux; **Android 7.0**; SM-G930VC Build/NRD90M; wv) AppleWebKit/537.36 (KHTML, like Gecko) Version/4.0 Chrome/58.0.3029.83 Mobile Safari/537.36

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Specific Domains

msftconnecttest.com
msftncsi.com
update.microsoft.com

swcdn.apple.com
swdist.apple.com

clients3.google.com/generate_204
connectivitycheck.android.com

icc.blackberry.com

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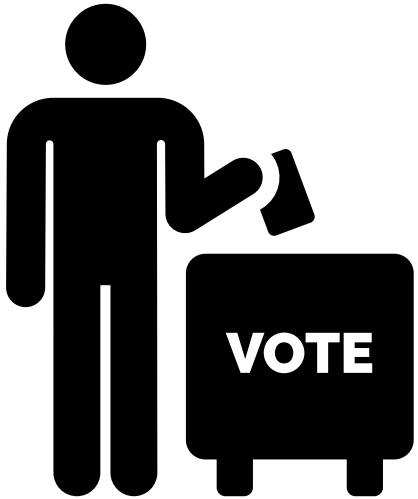
Combination



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Results

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OS hierarchy

Method	Vendor	OS Name	Major Version	Minor Version
TCP/IP	✓	✓	(✓)	(✓)
User-agent	✓	✓	✓	✓
Specific domain	✓	✓	✗	✗
Combination	✓	✓	✓	✓

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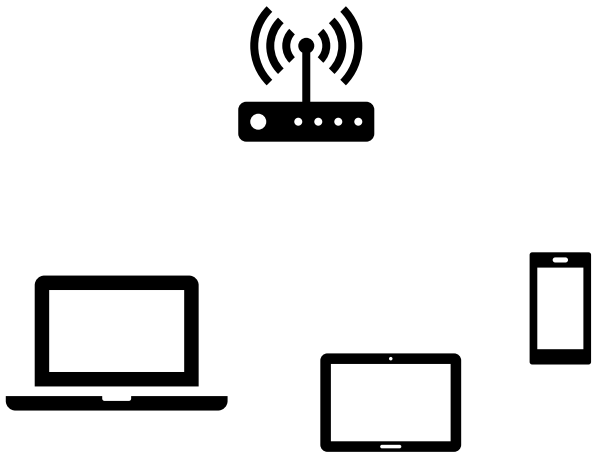
Dataset



- One week of flows + logs
  - 79 087 345 flows
  - 21 746 users
  - 25 642 unique MAC (1 692 vendor prefixes)
  - 253 374 Wi-Fi sessions
  - 6 104 unique IP addresses

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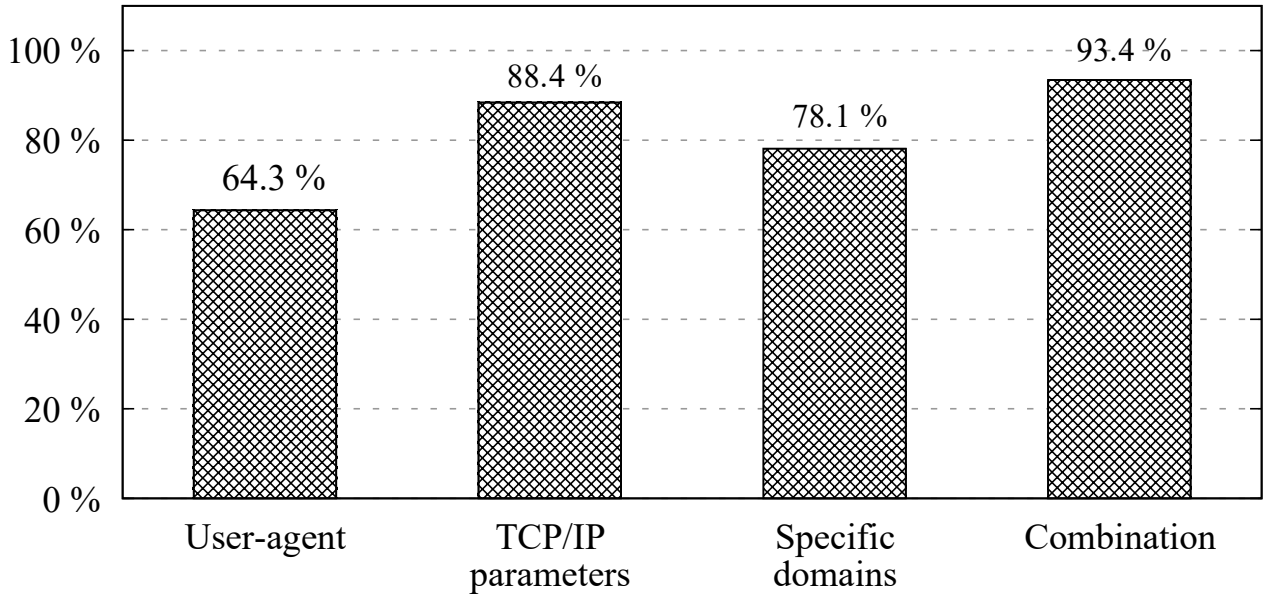
Coverage



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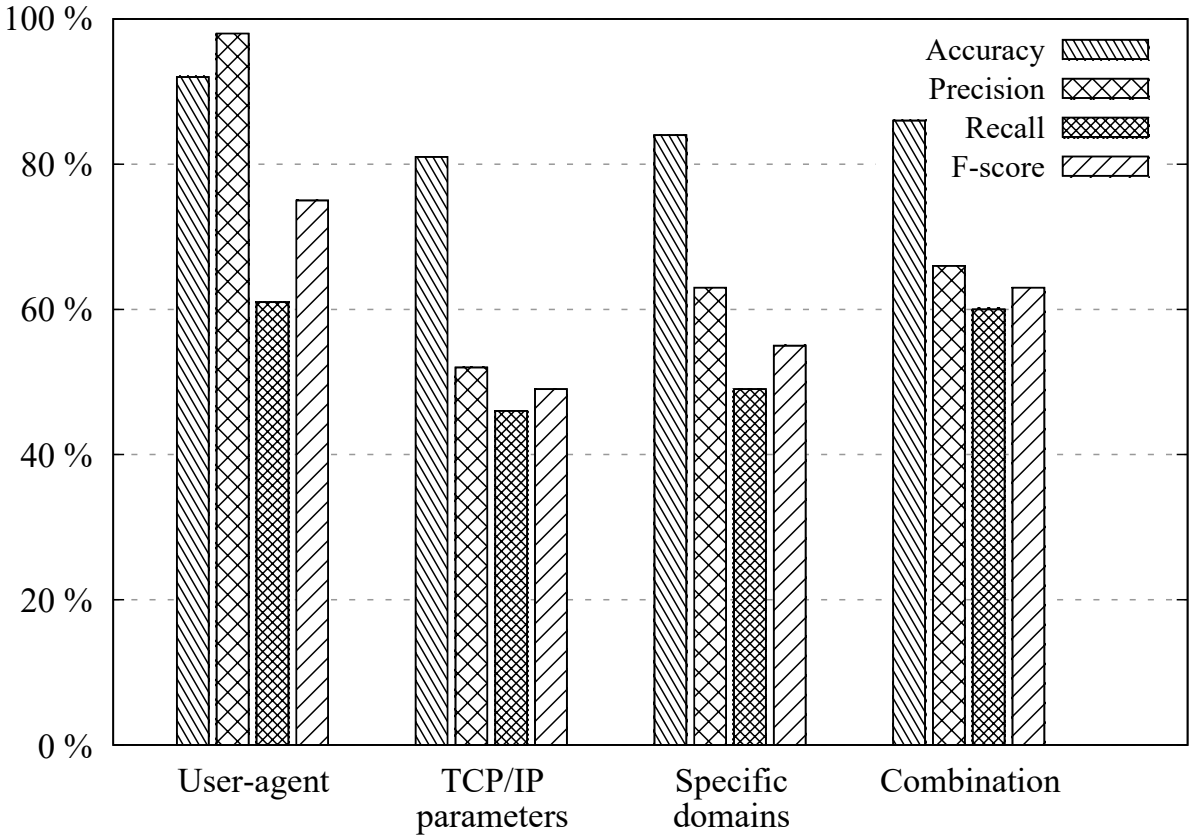
Performance Measures



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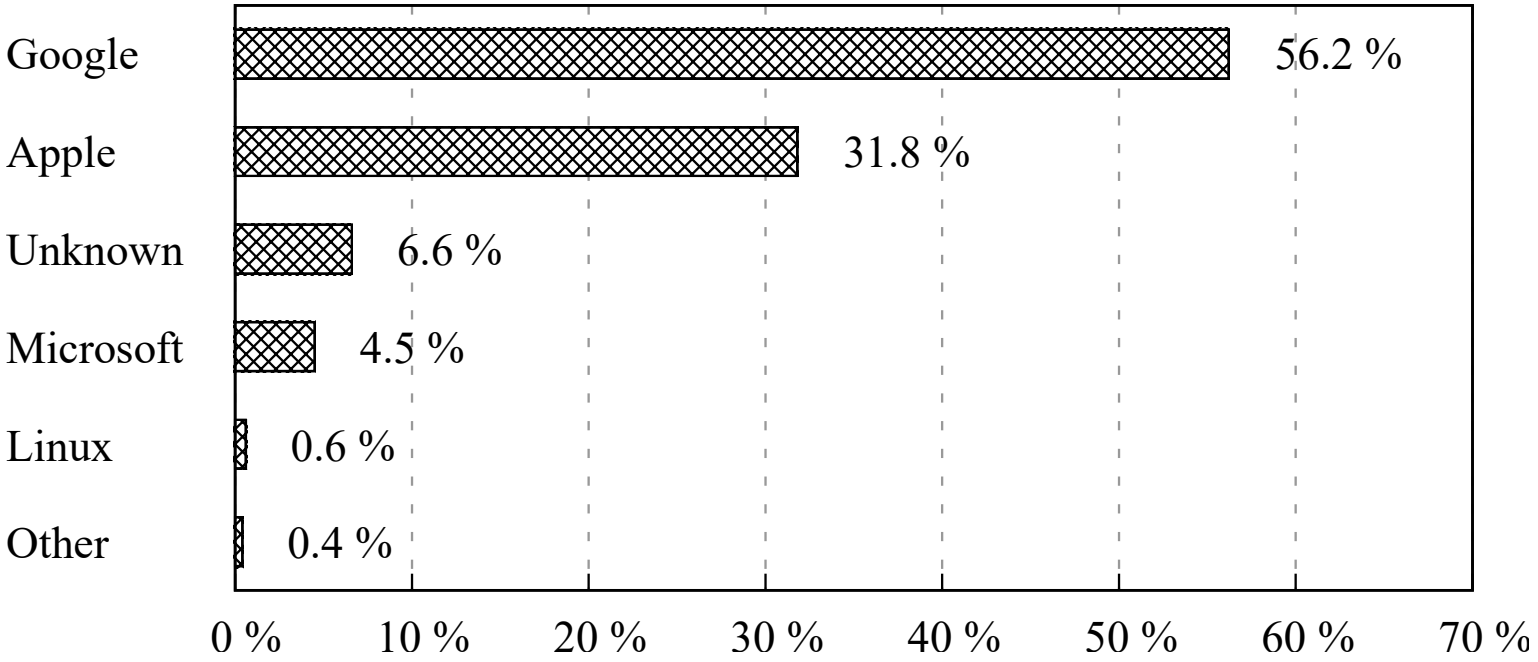
OS Vendor Share



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Lessons Learned

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Coverage Inconsistency

Bit offset	0-7										8-15										16-23										24-31									
0	Source port																				Destination port																			
32	Sequence number																																							
64	Acknowledgment number (if ACK is set)																																							
96	Data offset				Reserved 0 0 0			NS	CWR	ECE	URG	ACK	PSH	RST	SYN	FIN	Window size																									
128	Checksum																				Urgent pointer (if URG is set)																			
160+	Options, Data																																							

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Ground Truth

May	5 06:30:54 krakonos dhcpd: DHCPREQUEST	for 147.251.x.x from	98:0c:a5:x:x:x	(android-22d1bxxx)	via 147.251.x.x
May	5 06:30:54 krakonos dhcpd: DHCPACK	on 147.251.x.x to	98:0c:a5:x:x:x	(android-22d1bxxx)	via 147.251.x.x
May	5 06:31:17 krakonos dhcpd: DHCPREQUEST	for 147.251.x.x from	38:a4:ed:x:x:x	(Redmi3S-Redmi)	via 147.251.x.x
May	5 06:31:17 krakonos dhcpd: DHCPACK	on 147.251.x.x to	38:a4:ed:x:x:x	(Redmi3S-Redmi)	via 147.251.x.x
May	5 06:31:20 krakonos dhcpd: DHCPREQUEST	for 147.251.x.x from	9c:6c:15:x:x:x	(Windows-Phone)	via 147.251.x.x
May	5 06:31:20 krakonos dhcpd: DHCPACK	on 147.251.x.x to	9c:6c:15:x:x:x	(Windows-Phone)	via 147.251.x.x
May	5 06:36:24 krakonos dhcpd: DHCPREQUEST	for 147.251.x.x from	c0:f2:fb:x:x:x	(Barboras-iPhone)	via 147.251.x.x
May	5 06:36:24 krakonos dhcpd: DHCPACK	on 147.251.x.x to	c0:f2:fb:x:x:x	(Barboras-iPhone)	via 147.251.x.x

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Emerging Protocols

Method	HTTP/2.0 + TLS 1.3	IPv6	QUIC
TCP/IP	✓	✗	✗
User-agent	✗	✓	✗
Specific domain	✓	✓	(✓)

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Discussion

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Brno Ph.D. Talent Scholarship Holder
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