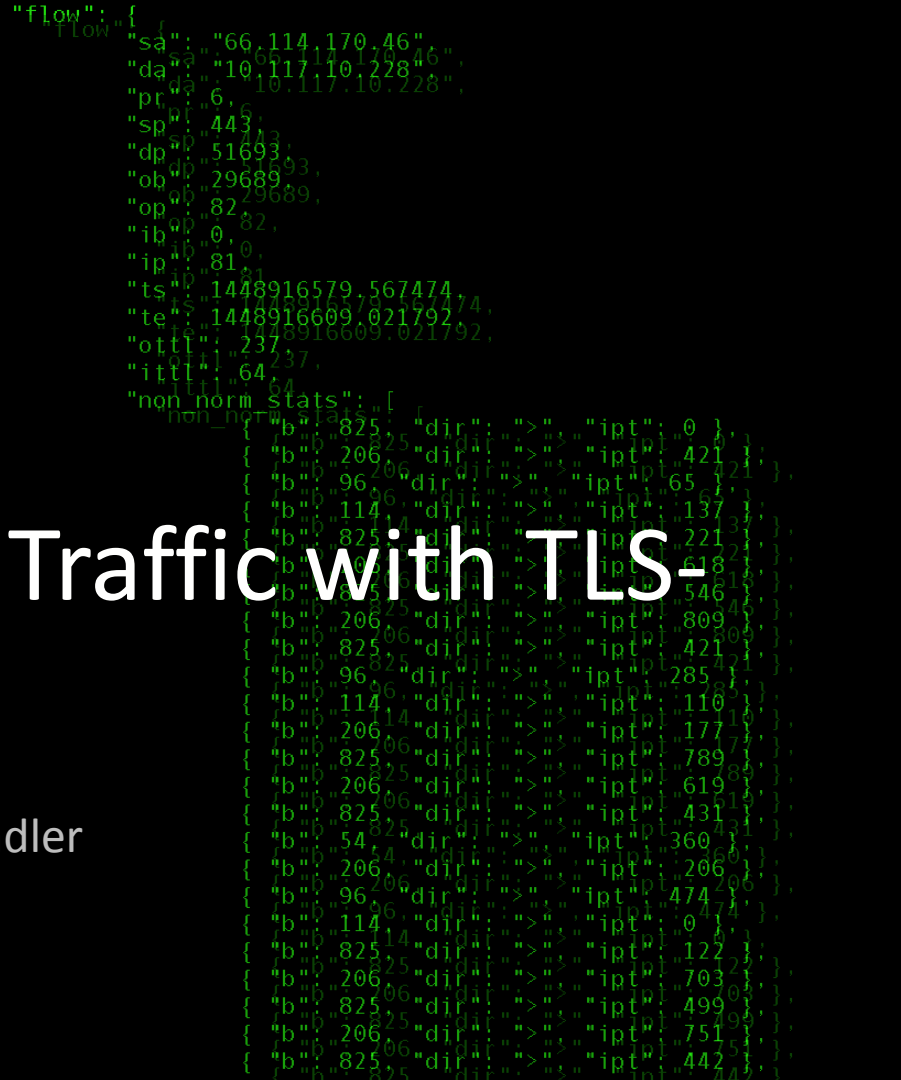



# Classifying Encrypted Traffic with TLS-aware Telemetry

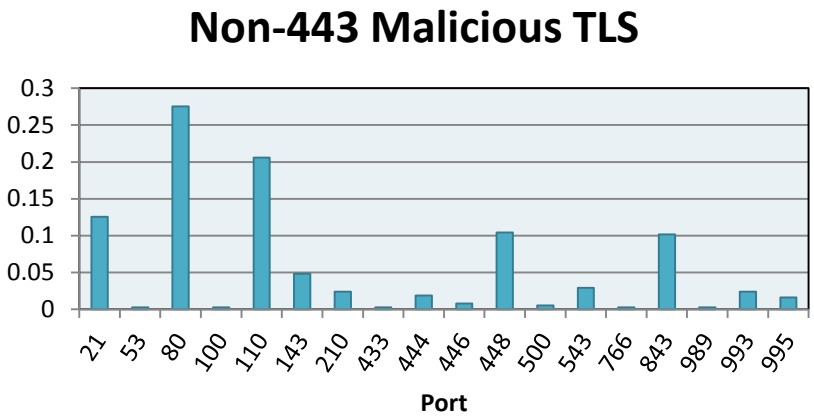
Blake Anderson, David McGrew, and Alison Kendler

blaander@cisco.com, mcgrew@cisco.com, alkendle@cisco.com

FloCon 2016

# Problem Statement

- "*I need to understand traffic even when it is encrypted*"
  - Malware detection
  - Application identification
- "*I need to understand how crypto is being used on my network*"
  - Weak crypto algorithms and/or key sizes
  - Vulnerable cryptographic library detection
  - The ports where TLS shows up

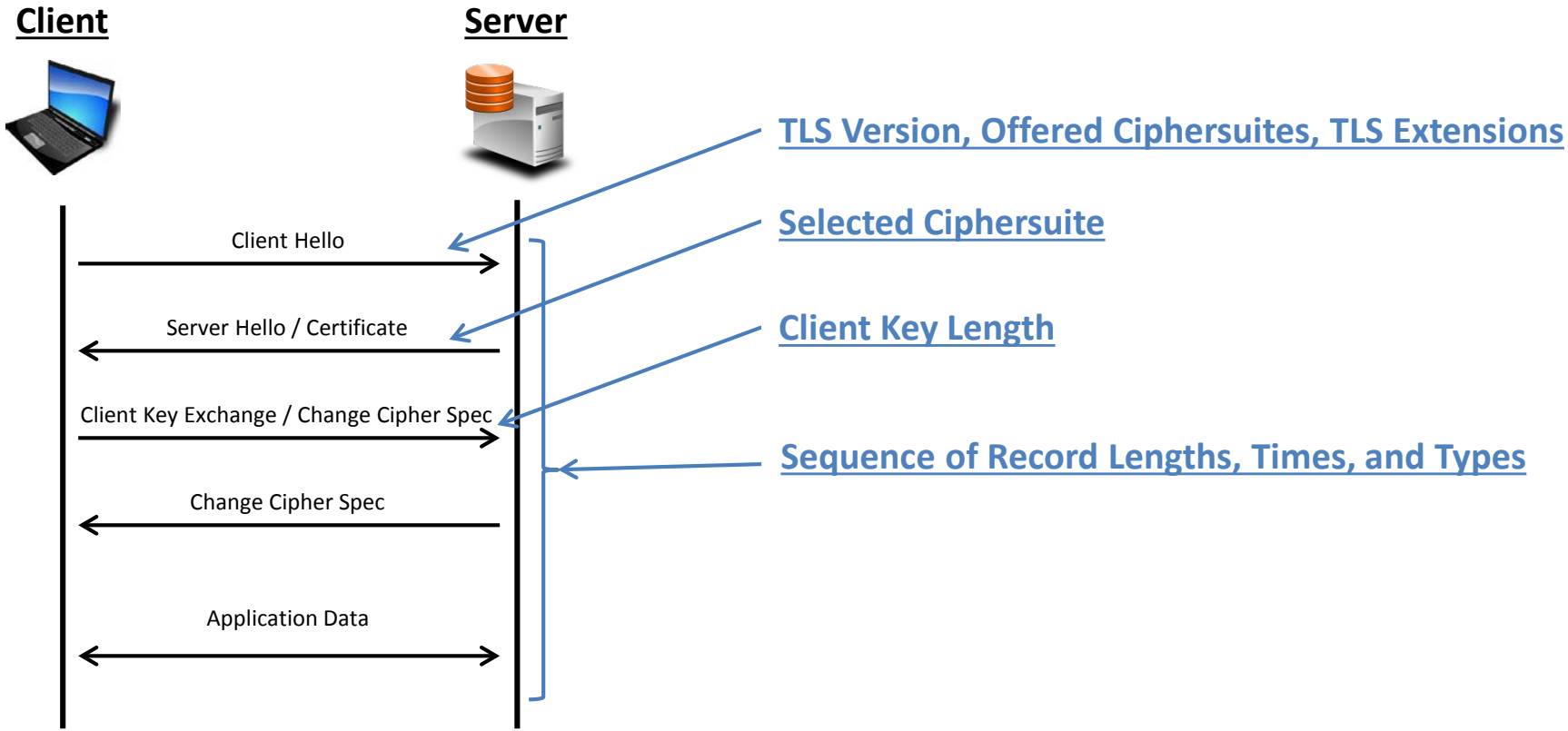



cisco

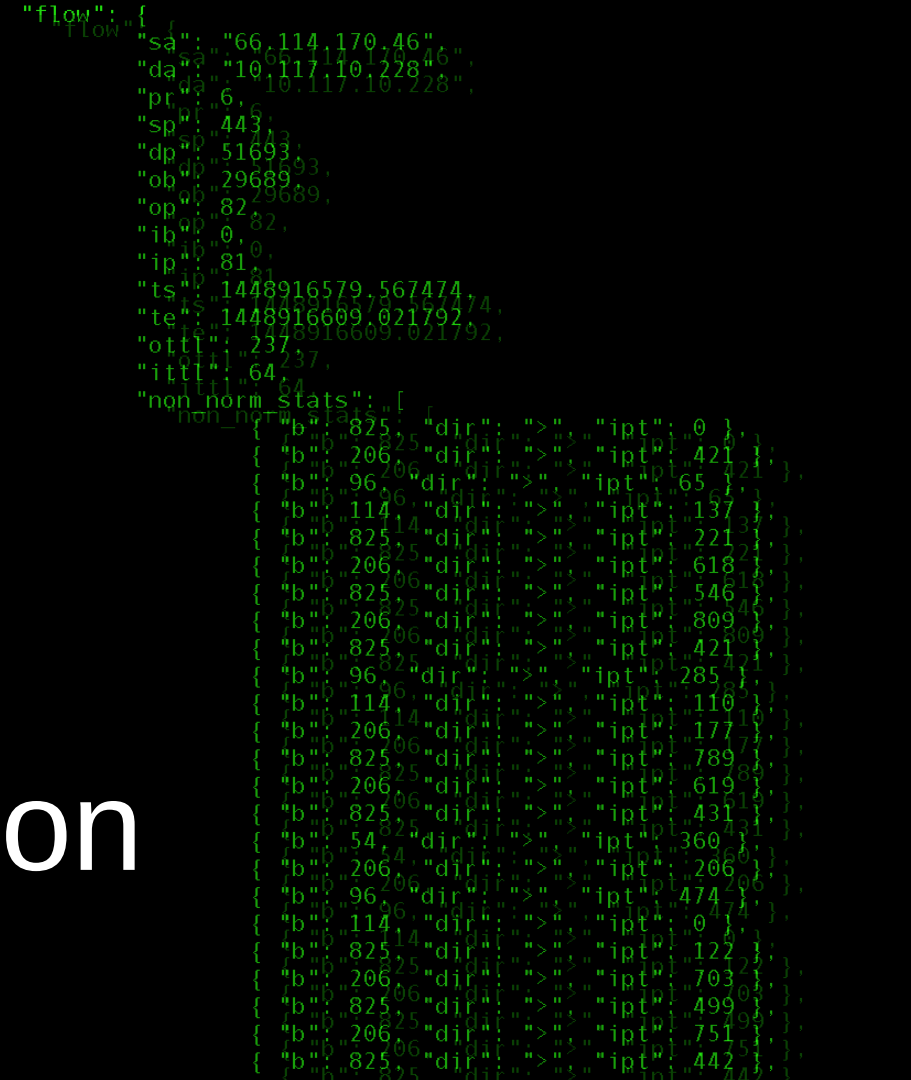
# Solution

- Our solution is to gather additional, TLS-aware telemetry.
- This solution:
  - Could be baked into a flow telemetry exporting device
  - Can be run in a VM off a SPAN port (with our open source package)
- Passive monitoring is used to gather all data.
  - Not costly or difficult to deploy (as opposed to MITM solution)

# TLS-aware Telemetry Data Types



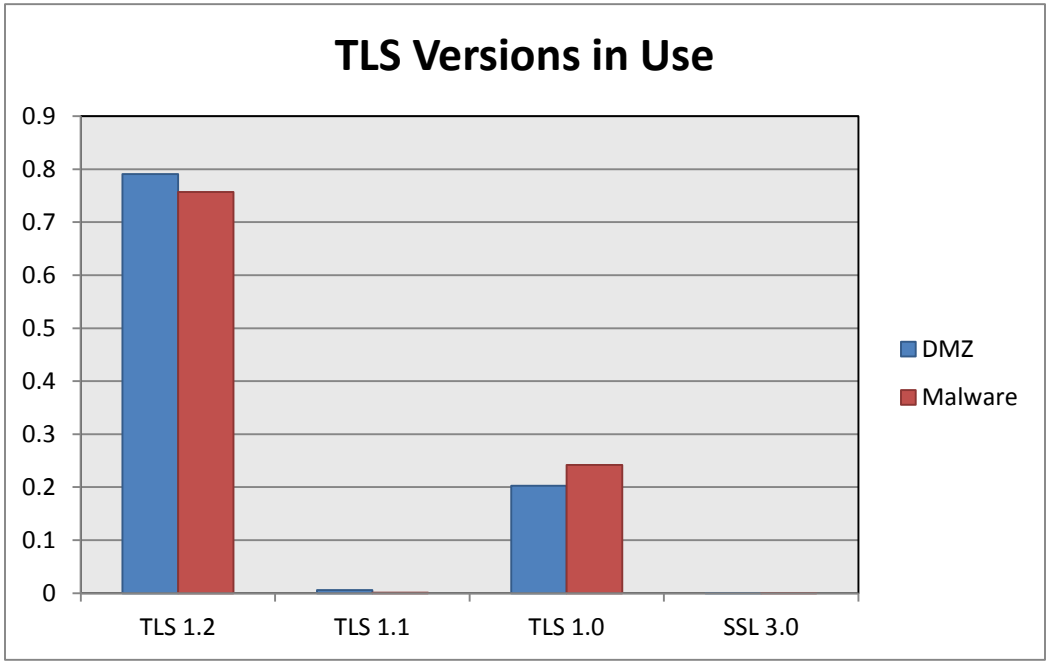
# Malware Detection



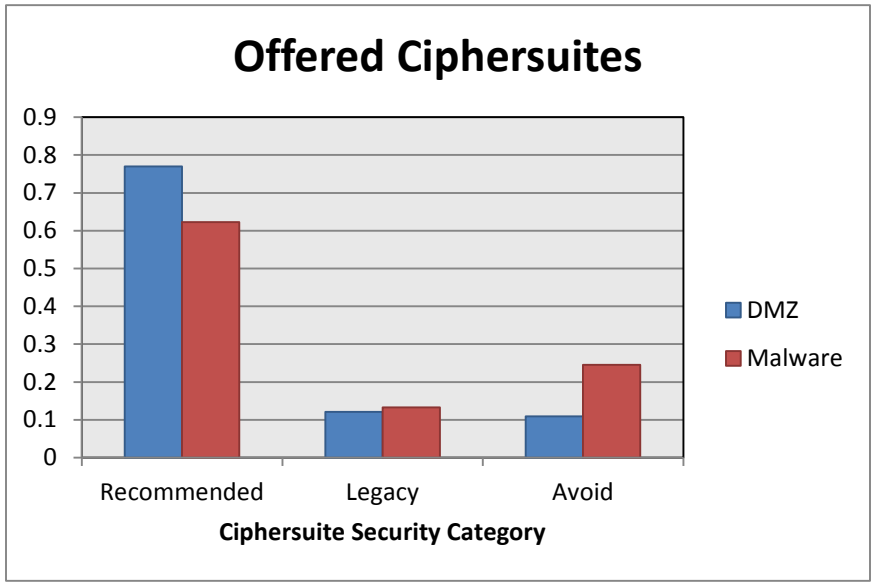
# Malware Detection

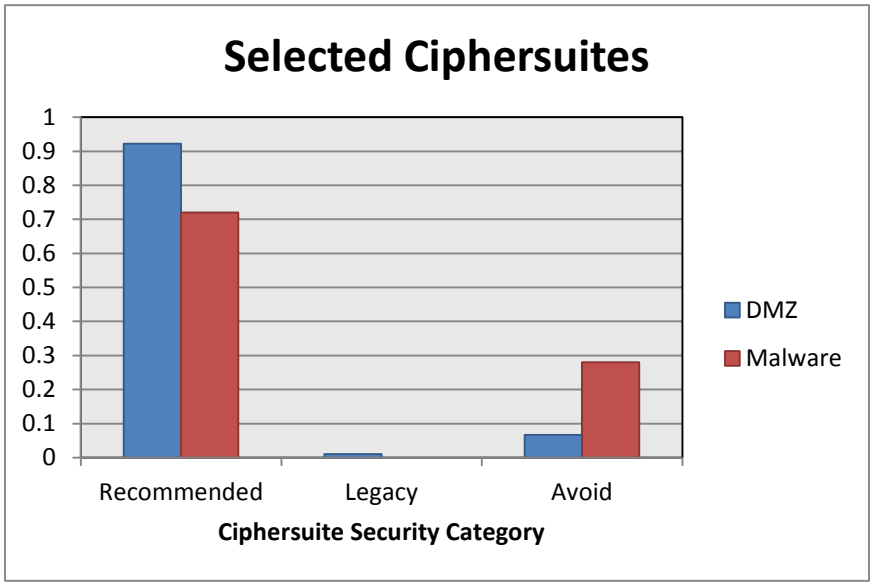
- Malware is making use of TLS to communicate.
  - We observed that 7-13% of malware communication is over TLS
- Traditional IPS/IDS signatures fail.
  - Malicious communication is encrypted
- We leverage TLS-aware telemetry for malware classification.
  - Increases classification accuracy
  - Reduces false positives

# TLS Versions

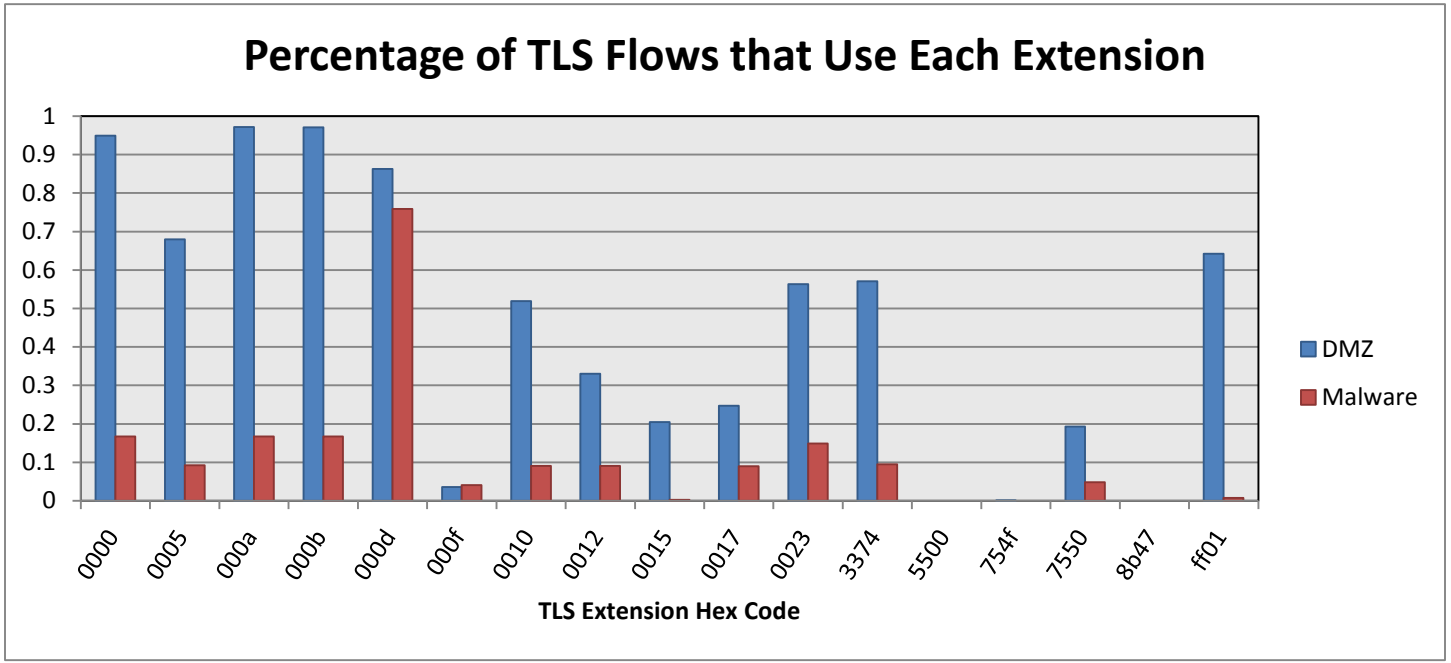


# Ciphersuites

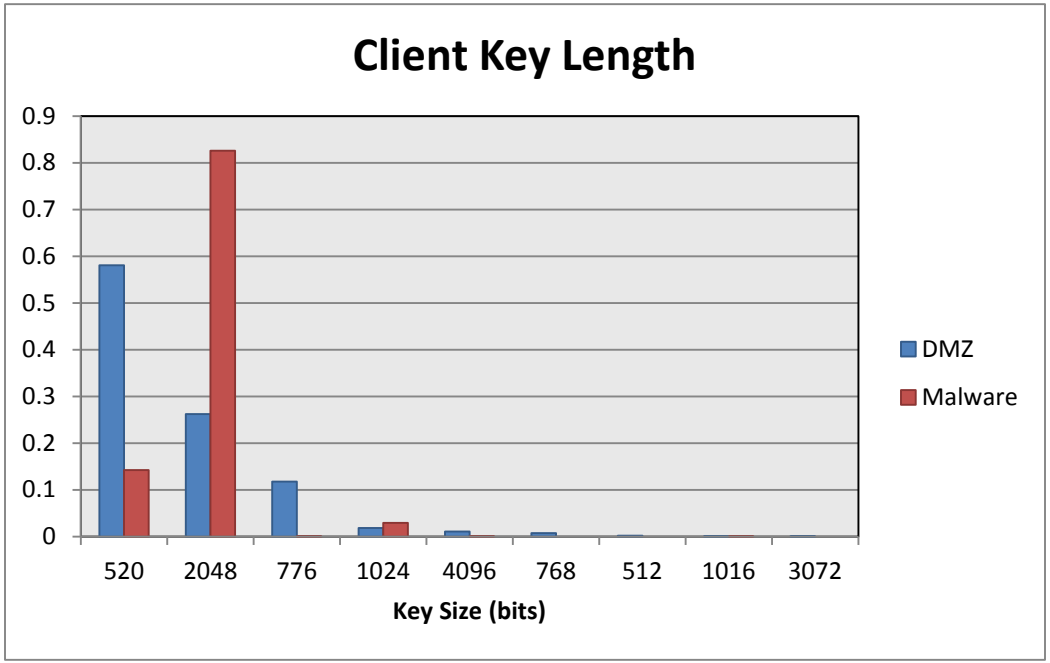


# TLS Extensions



# Client Key Lengths

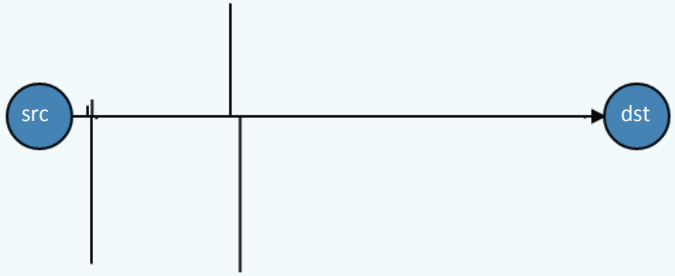


# Test Setup

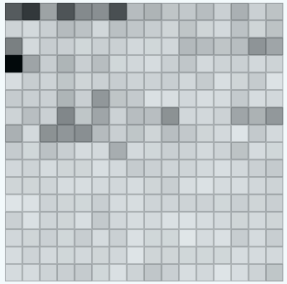
- Malware
  - September 2015 pcaps from ThreatGRID
  - TLS (443) traffic, > 100 in and out bytes
  - 26,404 flows, Telemetry enhanced with TLS extensions, ciphersuites, and client key lengths
- Benign
  - traffic taken from a large enterprise DMZ
  - TLS (443) traffic, > 100 in and out bytes
  - 50,848 flows, Telemetry enhanced with TLS extensions, ciphersuites, and client key lengths
- 10-fold CV

# Telemetry Data Types

- SPLT – Sequence of Packet Lengths and Arrival Times




- Byte Distribution
  - Relative frequency for each byte in a flow



- traditional: sp, dp, prot, ib, ip, ob, op, dur

# Results

- L1-logistic regression
- SPLT + 7-tuple + BD

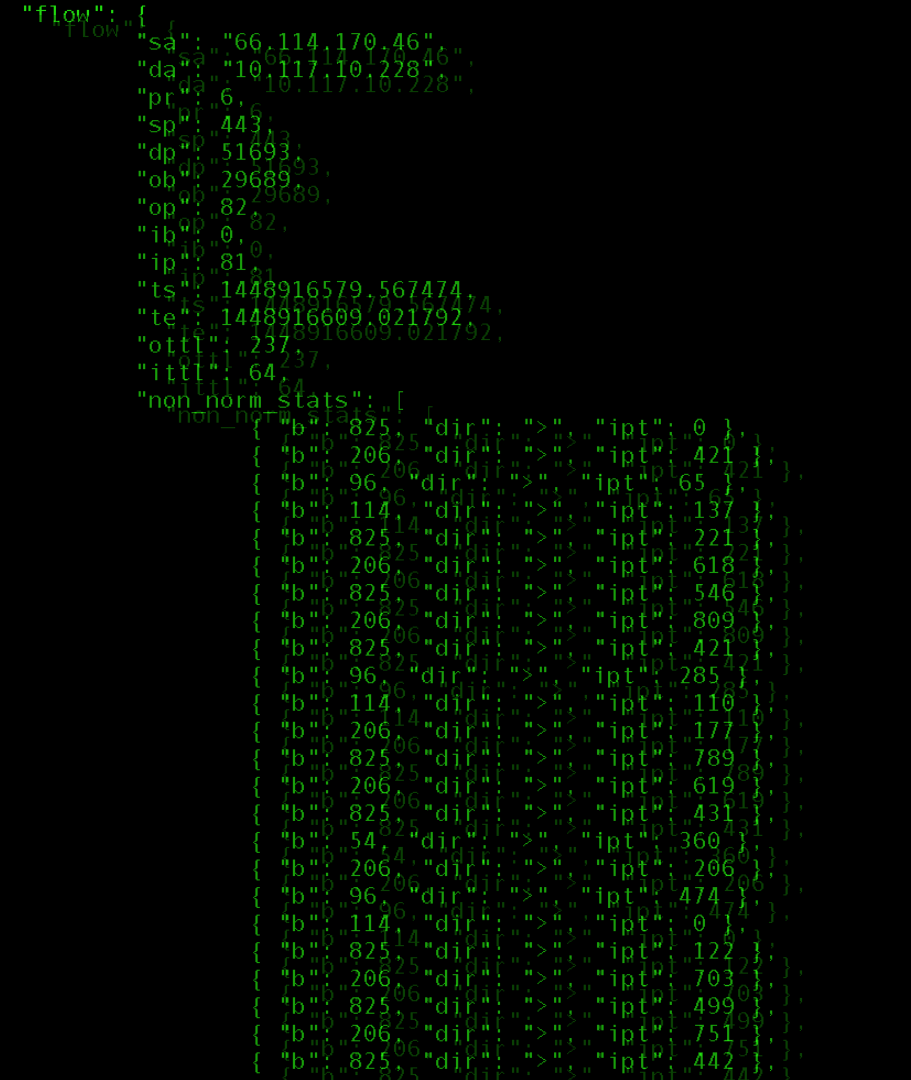
- L1-logistic regression
- SPLT + 7-tuple + BD + TLS

# Results

- L1-logistic regression
- SPLT + 7-tuple + BD
  - 172.2 non-zero parameters
  - 0.01 FDR: 0.1%
  - Total Accuracy: 96.1%

- L1-logistic regression
- SPLT + 7-tuple + BD + TLS
  - 138.1 non-zero parameters
  - 0.01 FDR: 90.4%
  - Total Accuracy: 99.7%

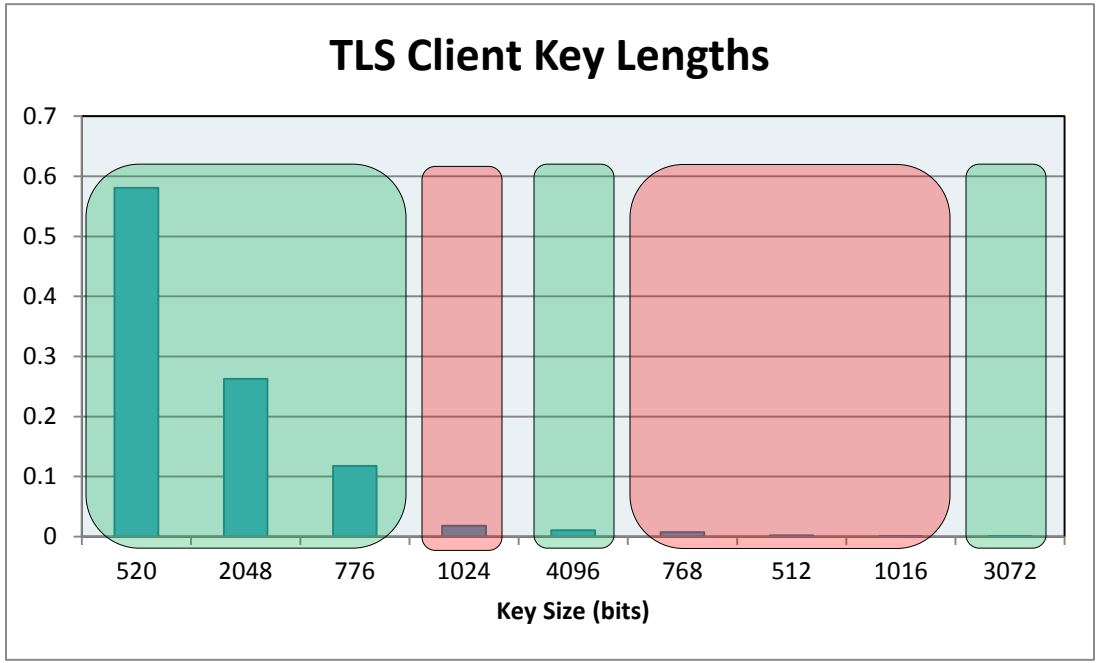
# Crypto Audit



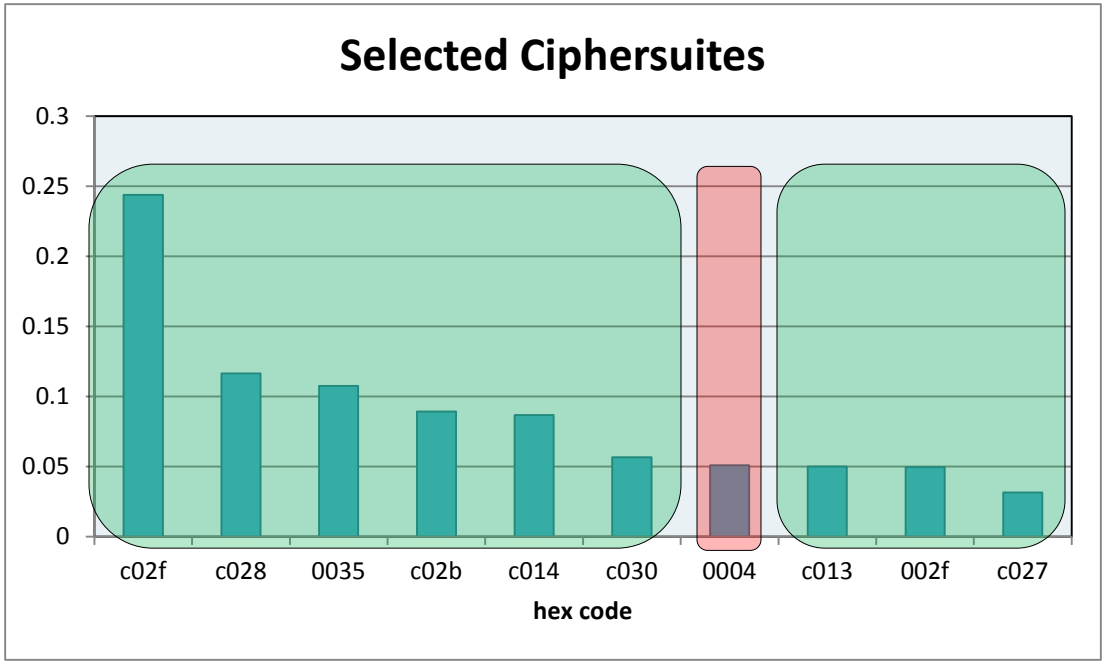
# Crypto Audit

- We observe what cryptography is being used in TLS (same principles can be applied to SSH, IPsec, etc.).
  - Who is using weak crypto on my network?
- We infer the version of the cryptographic library in use.
  - Initial results with OpenSSL
  - Vulnerable implementations, not active attacks
- We passively monitor traffic, no active probing.

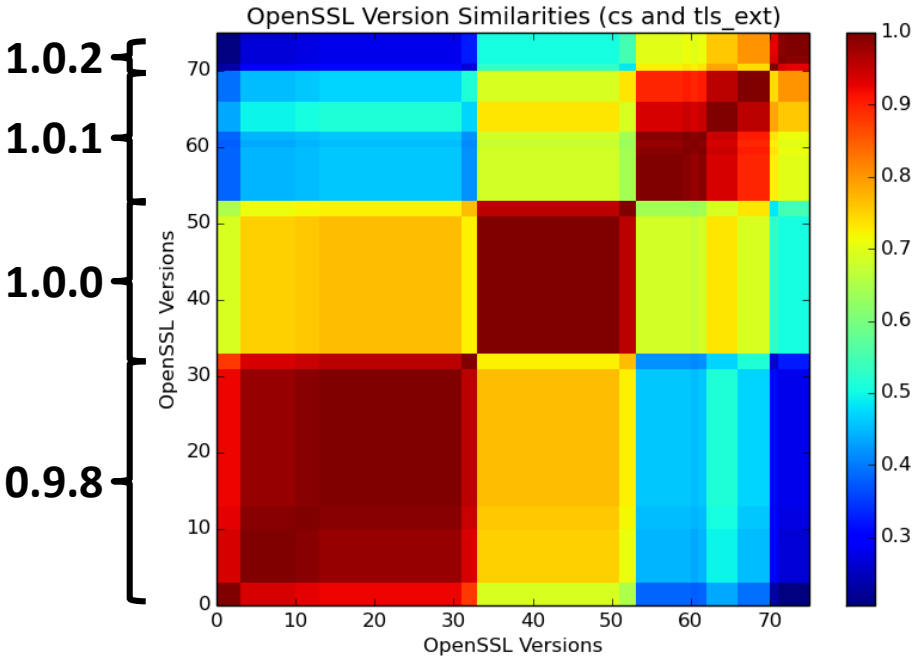
# Client Key Lengths (DMZ)



# Selected Ciphersuites (DMZ)

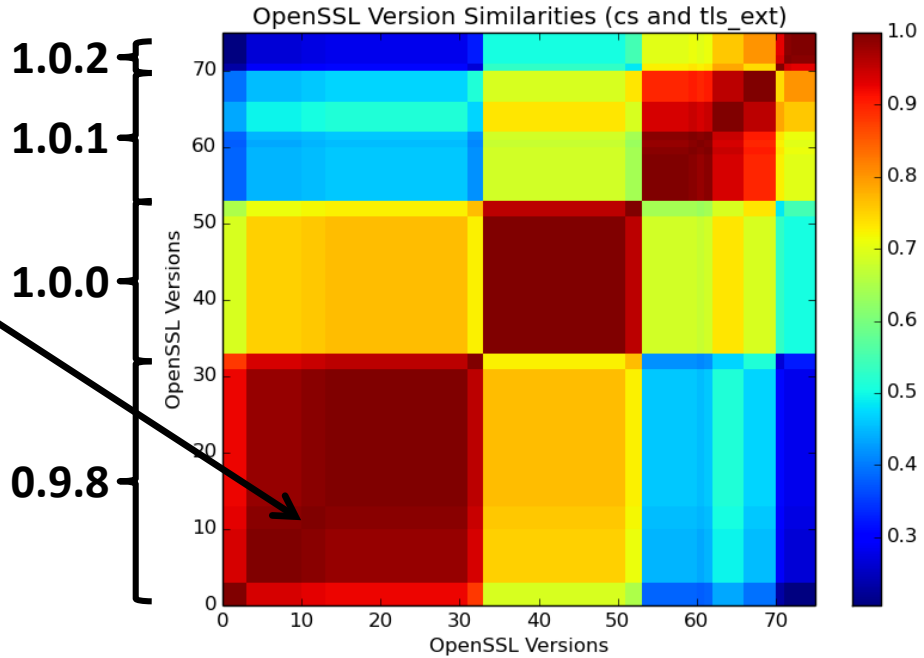


# OpenSSL Similarity Matrix

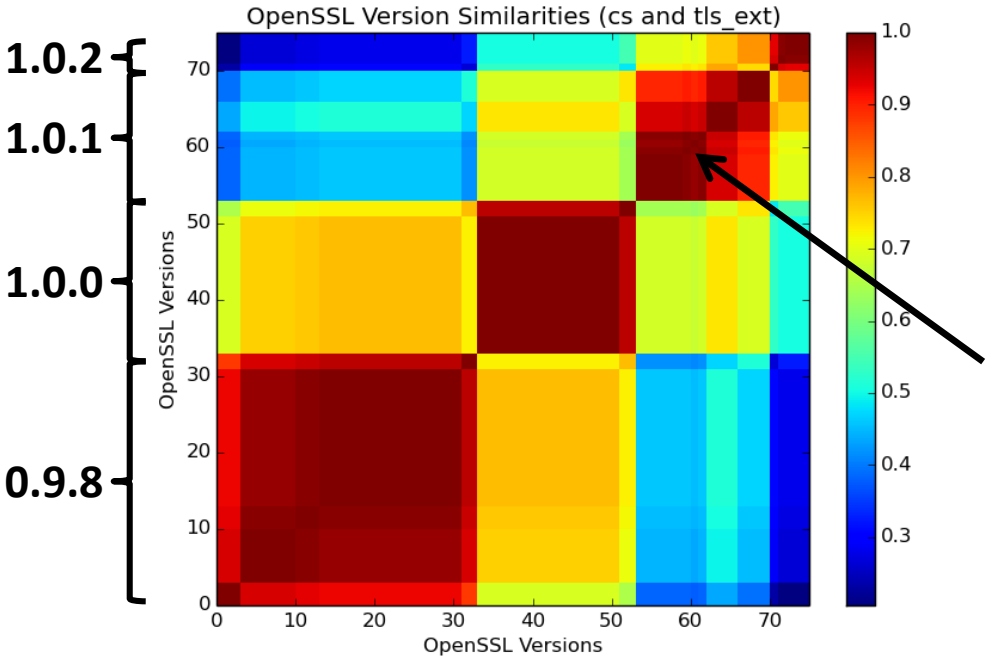


# TLS Extensions

**TLS Extensions by Default**

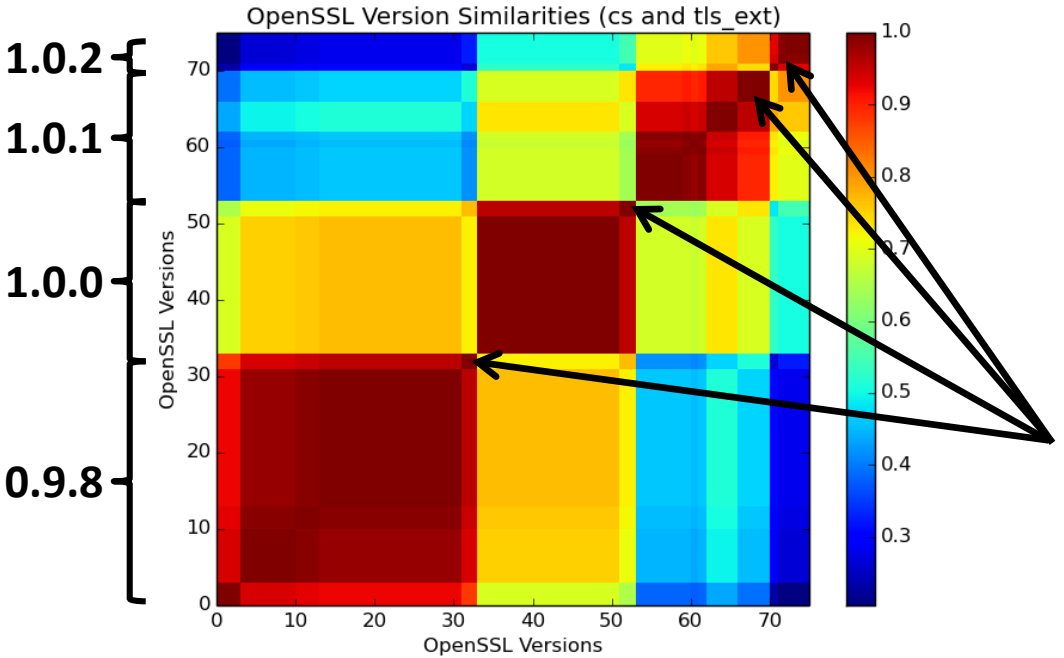


# Heartbleed




**TLS pad extension to fix TLS hang bug**

# logjam




**Removed the export ciphers from the DEFAULT ciphers**

# Benefits of TLS-awareness

- TLS-aware telemetry provides a passive monitoring approach for:
  - Improved malware classification
  - The ability to audit an enterprise network's crypto usage
- TLS-aware telemetry is a relatively light weight system compared to MITM solutions or full packet capture.
- joy (our open source package) currently implements the described functionality (https://github.com/davidmcgrew/joy).


"flow": {
"sa": "66.114.170.46",
"da": "10.117.10.228",
"pr": 6,
"sp": 443,
"dp": 51693,
"ob": 29689,
"op": 82,
"ib": 0,
"ip": 81,
"ts": 1448916579.567474,
"te": 1448916609.021792,
"ottl": 237,
"ittl": 64,
"non_norm_stats": [
{ "b": 825, "dir": ">", "ipt": 0 },
{ "b": 206, "dir": ">", "ipt": 421 },
{ "b": 96, "dir": ">", "ipt": 65 },
{ "b": 114, "dir": ">", "ipt": 137 },
{ "b": 825, "dir": ">", "ipt": 221 },
{ "b": 206, "dir": ">", "ipt": 618 },
{ "b": 825, "dir": ">", "ipt": 546 },
{ "b": 206, "dir": ">", "ipt": 809 },
{ "b": 825, "dir": ">", "ipt": 421 },
{ "b": 96, "dir": ">", "ipt": 285 },
{ "b": 114, "dir": ">", "ipt": 110 },
{ "b": 206, "dir": ">", "ipt": 177 },
{ "b": 825, "dir": ">", "ipt": 789 },
{ "b": 206, "dir": ">", "ipt": 619 },
{ "b": 825, "dir": ">", "ipt": 431 },
{ "b": 54, "dir": ">", "ipt": 360 },
{ "b": 206, "dir": ">", "ipt": 206 },
{ "b": 96, "dir": ">", "ipt": 474 },
{ "b": 114, "dir": ">", "ipt": 0 },
{ "b": 825, "dir": ">", "ipt": 122 },
{ "b": 206, "dir": ">", "ipt": 703 },
{ "b": 825, "dir": ">", "ipt": 499 },
{ "b": 206, "dir": ">", "ipt": 751 },
{ "b": 825, "dir": ">", "ipt": 442 },

# Thank You