MUD (D)TLS profiles for IoT devices

draft-reddy-opsawg-mud-tls-01

IETF 106, Singapore

Nov 2019

T. Reddy (McAfee)

D.Wing (Citrix)

Agenda

- Recap
  - TLS handshake inspection
  - Observable (D)TLS profile parameters
- Solution overview with examples
- Questions & Comments

TLS handshake inspection

- Detect malware families based on TLS profile.
- Certificate
  - Mismatch between SNI and DNS names in the SubjectAltName(SAN) X.509 extension
  - Self-signed
  - Expired
- Cryptographic parameters
  - Older and weaker cryptographic parameters (e.g., TLS_ECDH_ECDSA_WITH_RC4_128_SHA)
- TLS extensions
  - Low diversity of TLS extensions
  - Extensions used by IoT devices not supported by malware (e.g., Grease)
- Weird hostnames
  - DGA characteristics of SNI and SubjectAltName
- Prevent attacks at TLS layer (expired certificate, weak encryption etc.)
  - Middle-boxes can enforce https://tools.ietf.org/html/rfc7525

Observable (D)TLS profile parameters

- Useful for IoT devices that very broad communication patterns.
- IoT devices vulnerable to MiTM attacks
- IoT devices can learn new skill and the new skill changes the way IoT device communicates with other devices.

Observable (D)TLS profile parameters

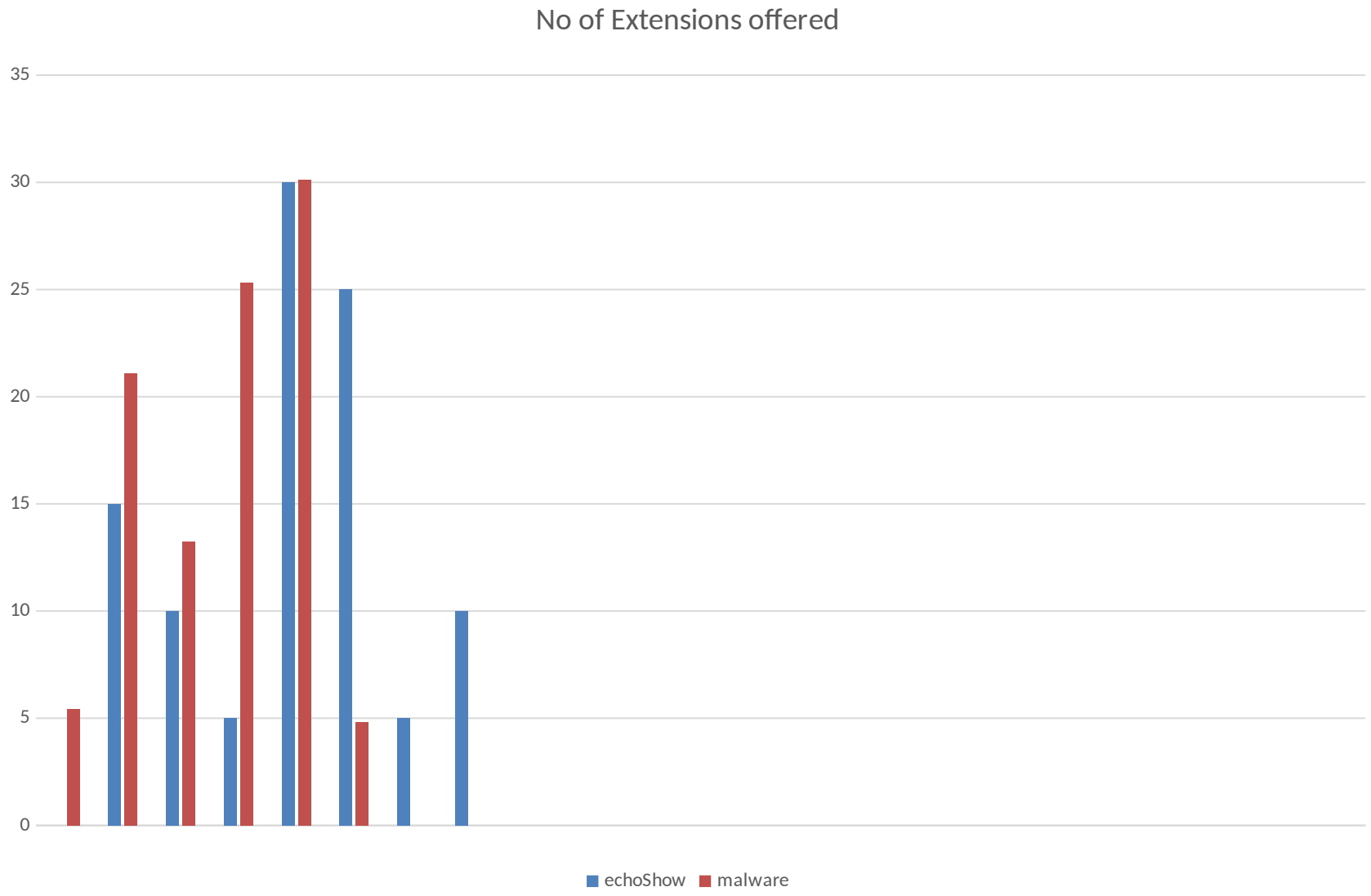
- We profiled several IoT devices: Amazon Echo, Echo dot, Echo Show, Fire TV, Google Home Mini, Google Home and Kindle.
  - Observable (D)TLS profile parameters did not change after learning new skills.
  - (D)TLS profiles for IoT devices based on type, manufacturer and model is also different
- We also observed TLS profile parameters of thousands of malware flows.

Solution overview

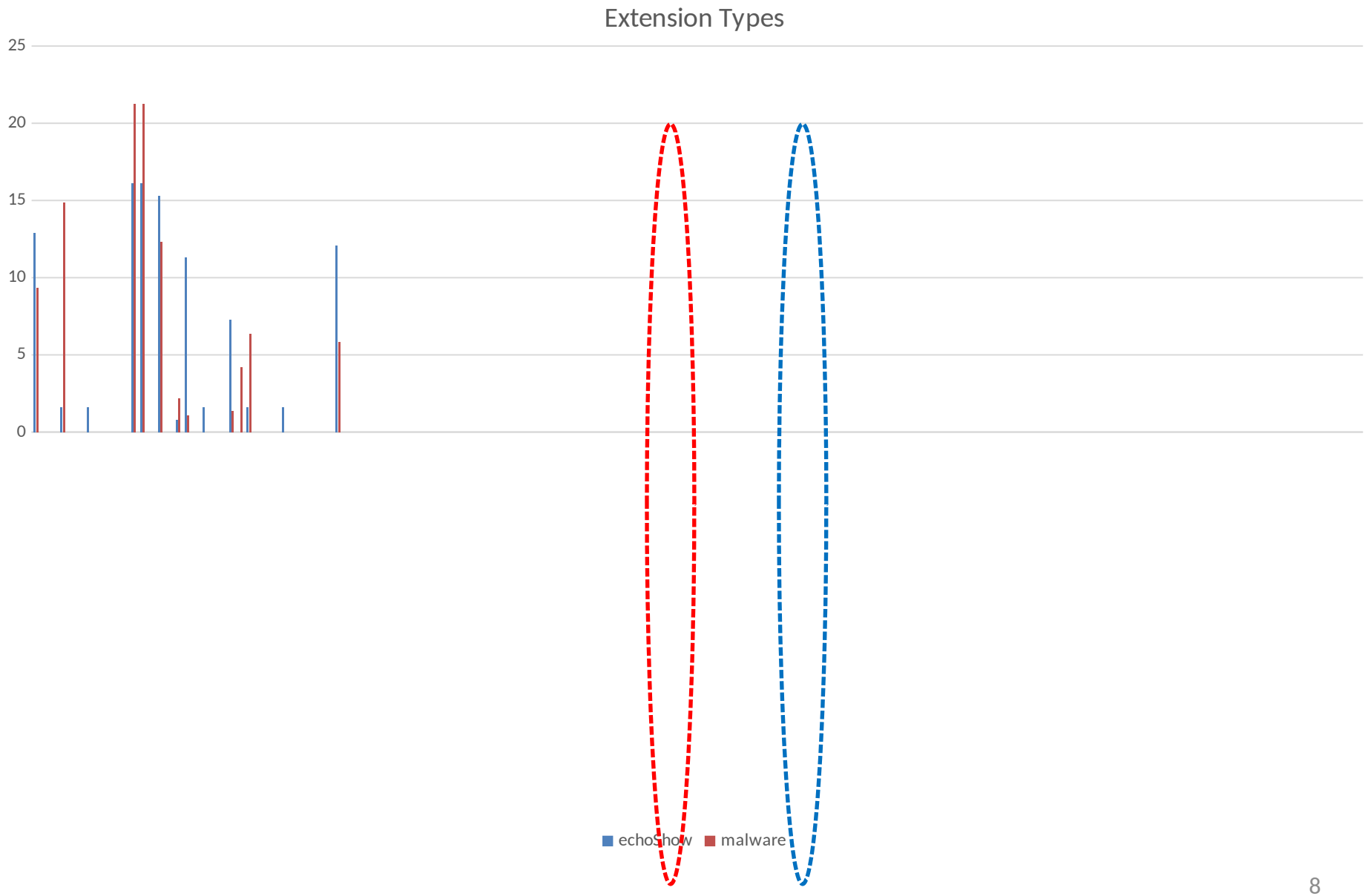
- Extends MUD to model observable (D)TLS profile parameters

```
module: reddy-opsawg-mud-tls-profile
  augment /mud:mud/mud:from-device-policy:
    +--rw client-profile
       +--rw tls-profiles* [profile-name]
          +--rw profile-name                string
          +--rw protocol-version?           uint16
          +--rw supported_versions*         uint16
          +--rw grease_extension?           boolean
          +--rw encryption-algorithms*      encryption-algorithm
          +--rw compression-methods*        compression-method
          +--rw extension-types*            extension-type
          +--rw acceptlist-ta-certs*        ct:trust-anchor-cert-cms
          +--rw SPKI-pin-sets*              SPKI-pin-set
          +--rw SPKI-hash-algorithm         ct:hash-algorithm-t
          +--rw psk-key-exchange-modes*     psk-key-exchange-mode
          +--rw supported-groups*           supported-group
          +--rw signature-algorithms*       signature-algorithm
          +--rw client-public-keys
          |  +--rw key-exchange-algorithms*      key-exchange-algorithm
          |  +--rw client-public-key-lengths*   client-public-key-length
          +--rw actions
             +--rw forwarding    identityref
```

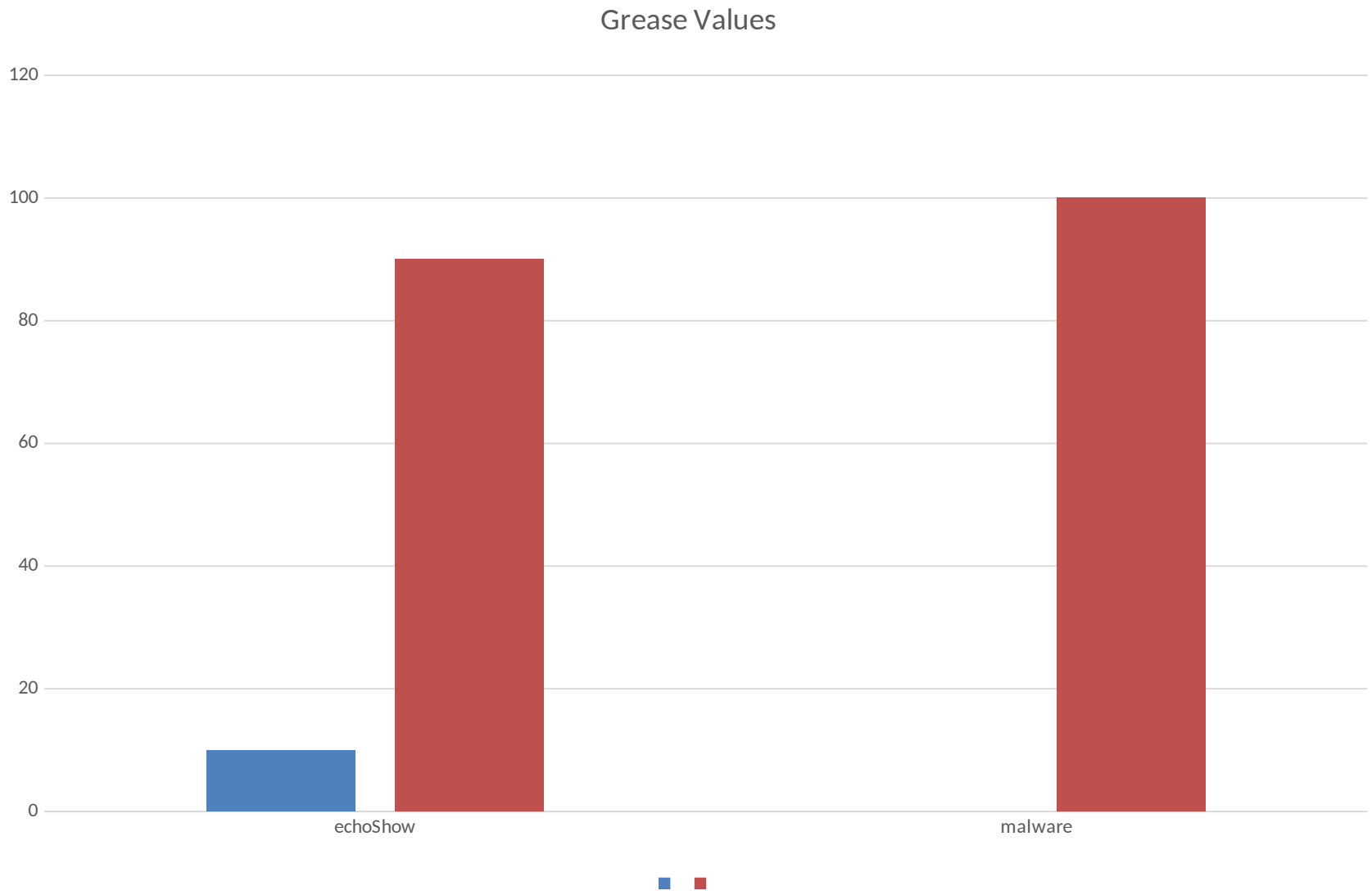
Amazon Echo Show



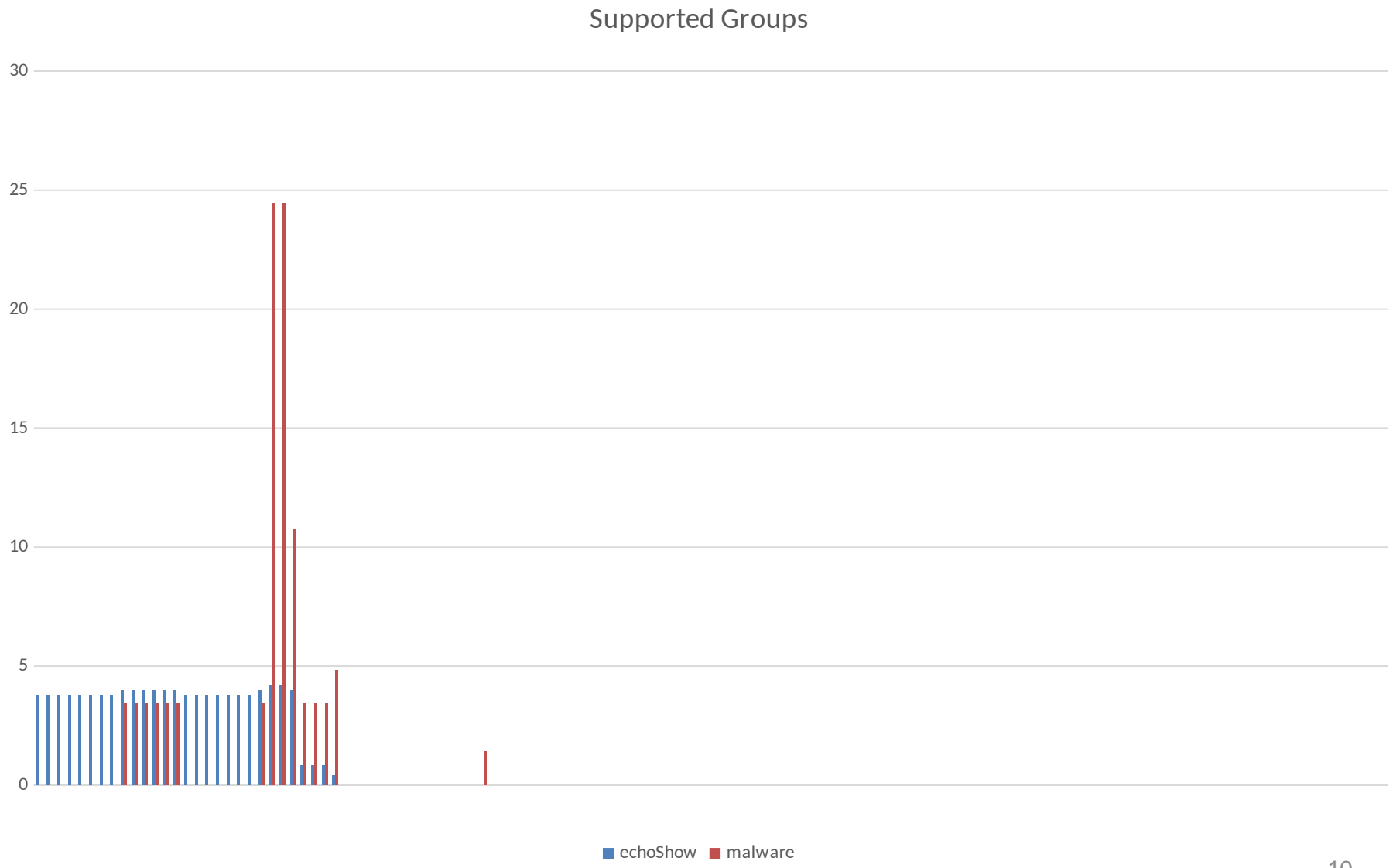
Amazon Echo Show



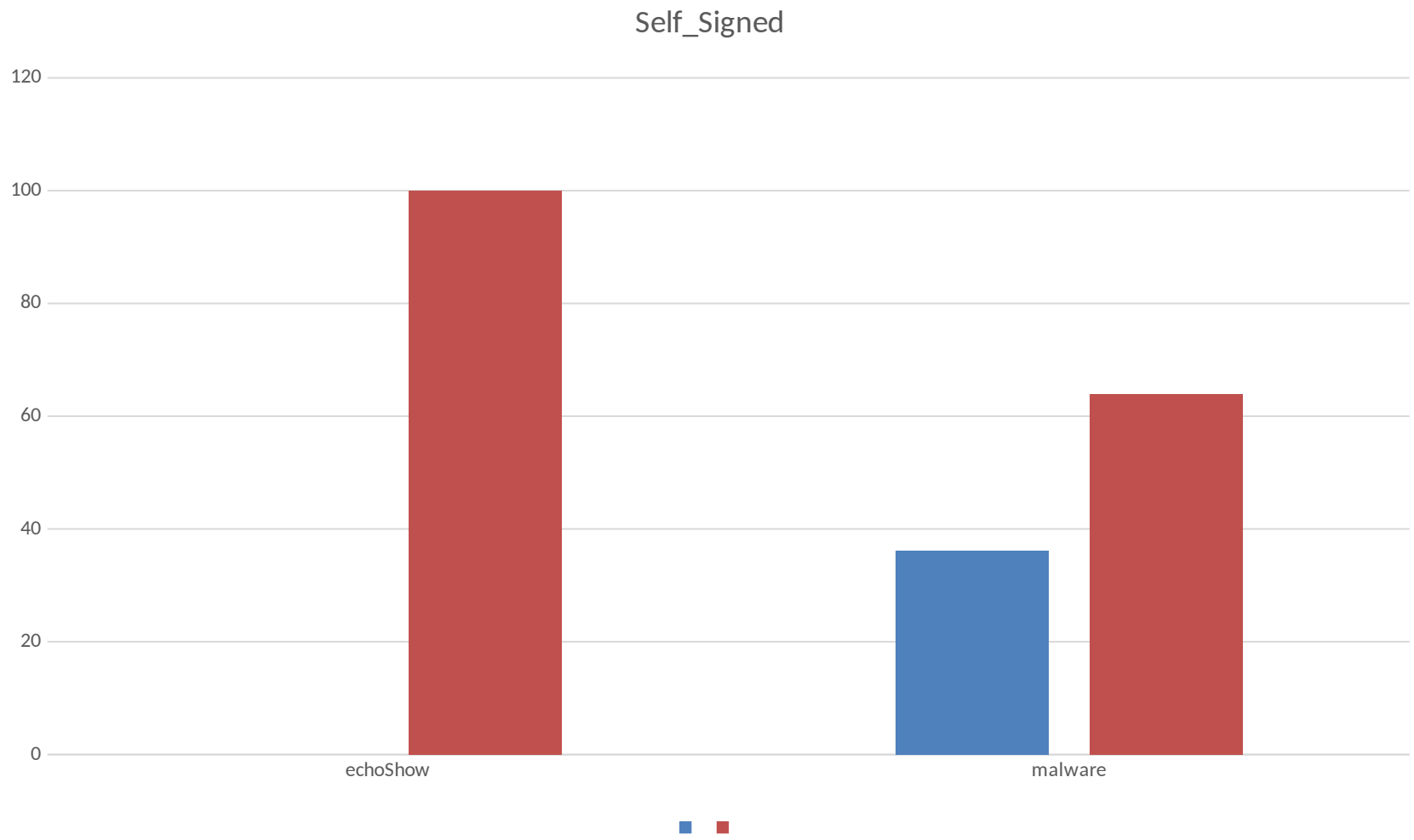
Amazon Echo Show



Amazon Echo Show

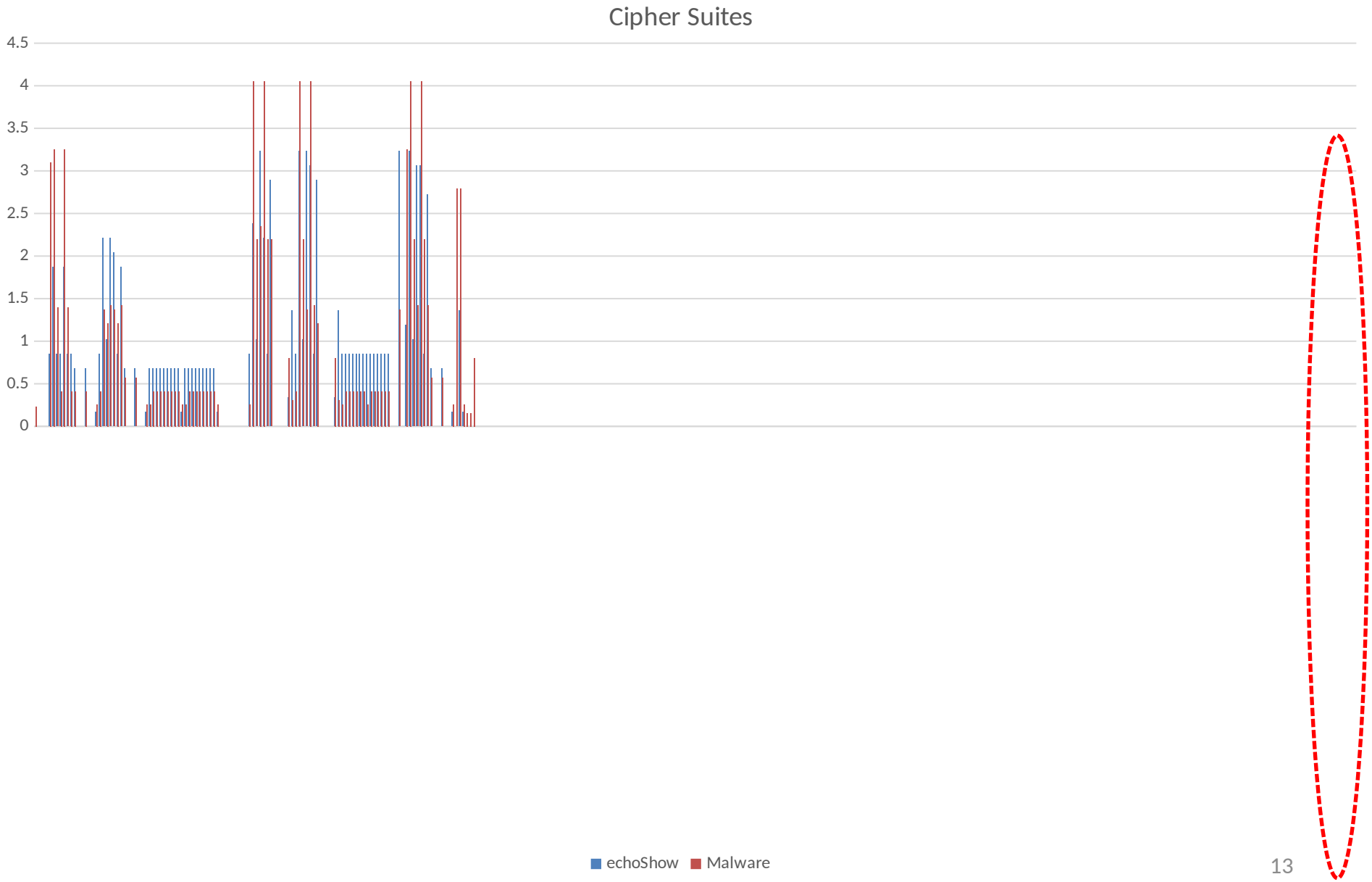


Amazon Echo Show

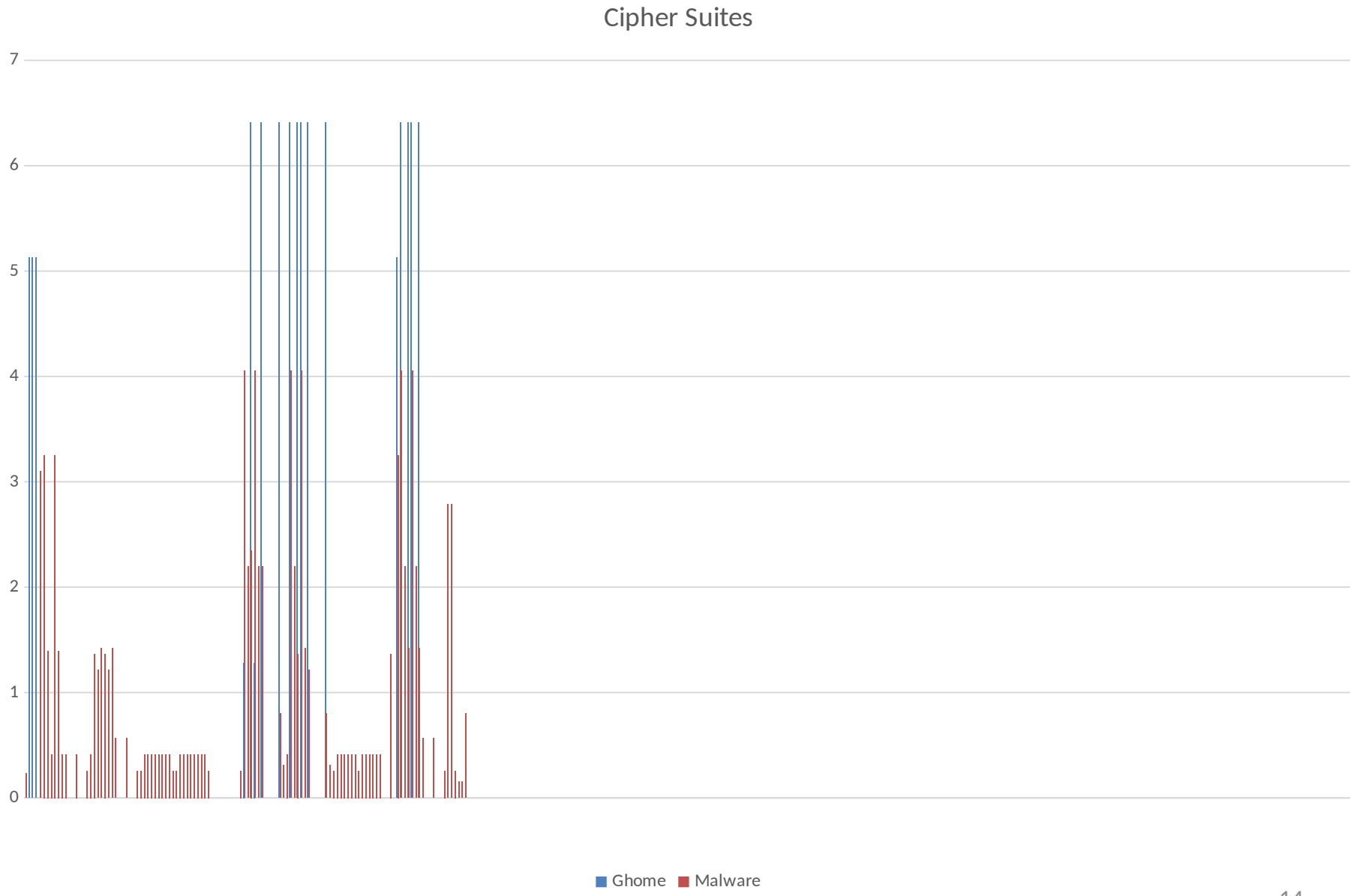


Amazon Echo Show

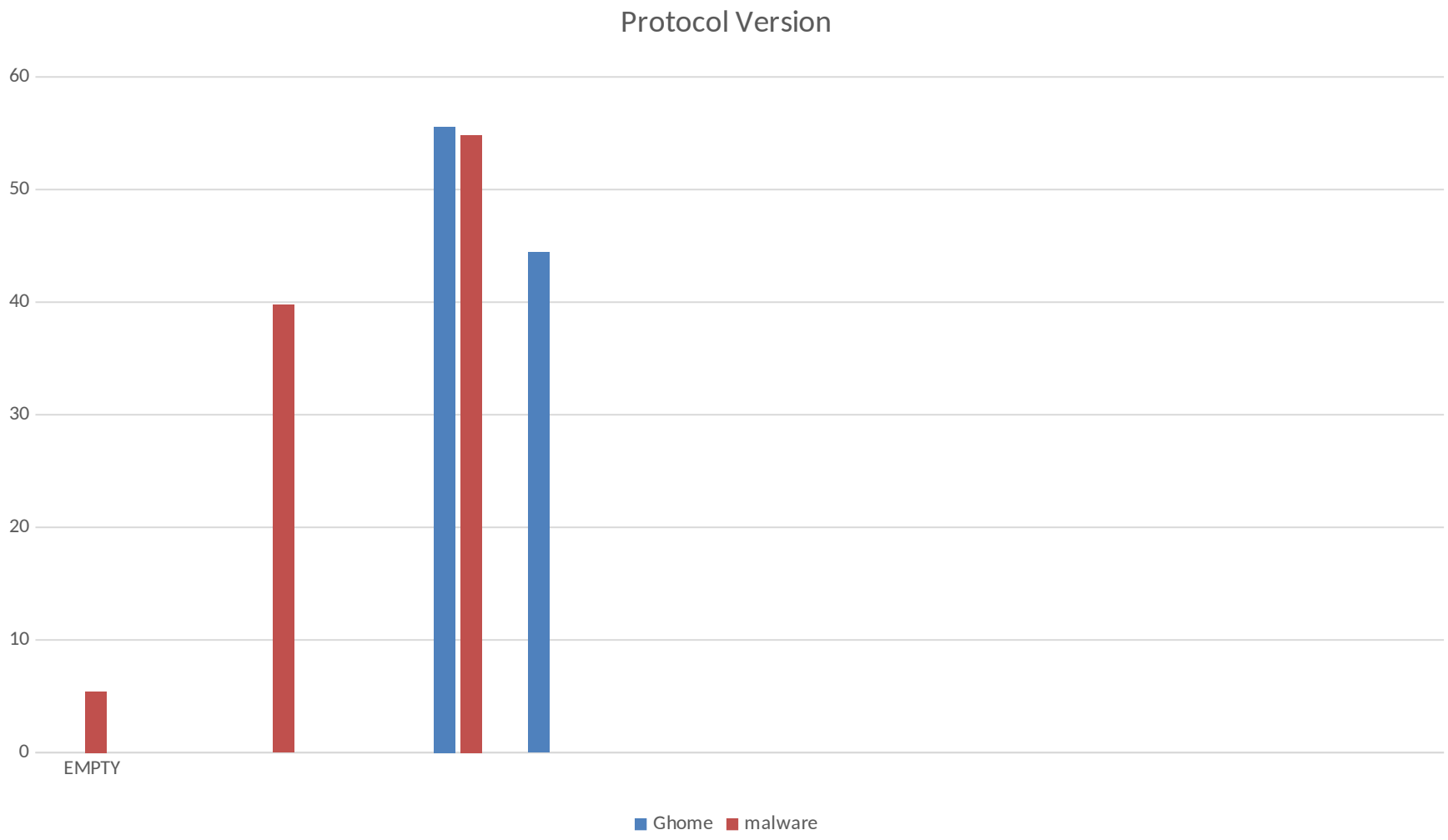
Amazon Echo Show



Google Home



Google Home



draft-reddy-opsawg-mud-tls-01

- Observed (D)TLS profile from several IoT devices and thousands of malware helped conclude intended (D)TLS use can be permitted and malicious (D)TLS can be blocked.
- Malware agents cannot mimic (D)TLS profiles of several IoT devices and cannot keep up with the updates to (D)TLS profile.

draft-reddy-opsawg-mud-tls-01

- Comments and suggestions are welcome
- Collaboration to profile IoT devices
- Request for WG adoption