TLS Metadata for Load Balancers

draft-schwartz-tls-lb

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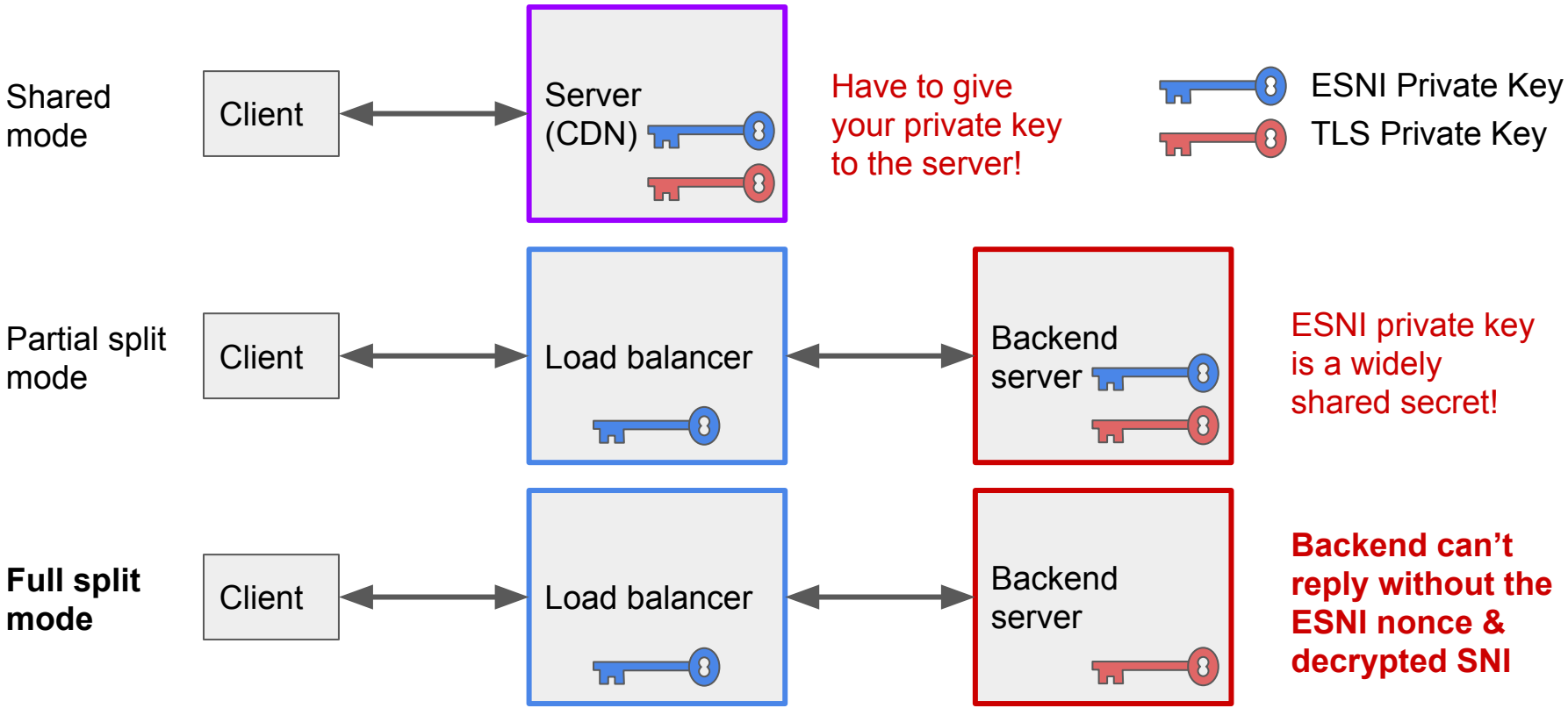
What is a “load balancer”?

- Definition: A load balancer is a server that forwards connections from clients to appropriate backends.
- Balancing loads is the main purpose but not the only purpose: also DDoS defense, access control, etc.
- A load balancer can operate at many levels in the protocol stack. We use different terms depending on which protocol the load balancer “terminates”:
  - IP: “ECMP router”
  - TCP: “TCP load balancer”, “reverse tunnel”
  - **SNI: “SNI proxy”**
  - TLS: “TLS load balancer”, “TLS termination proxy”
  - HTTP: “Reverse proxy”, “CDN”
- **Goal**: Make it easier and safer to use **SNI proxies**, to **reduce the need for TLS termination** by load balancers.

Motivating use case: **Full** Split-mode ESNI



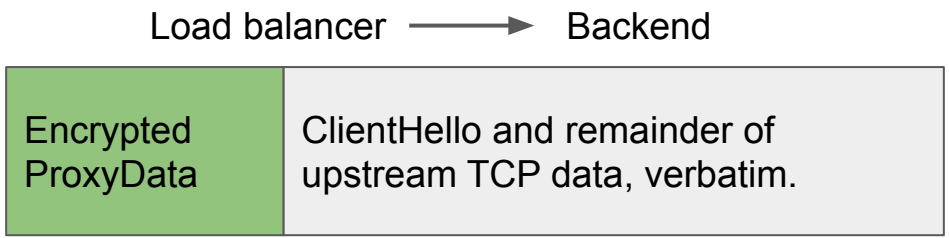
State of the art: PROXY protocol

```
PROXY TCP4 192.168.0.1 192.168.0.11 56324 443\r\n
GET / HTTP/1.1\r\n
Host: www.example.com\r\n
\r\n
```

- For TCP reverse tunnels.
- Prepends info in cleartext (even if the contents are encrypted)
  - **Not encrypted or authenticated in any way.**
- Originally only carried the client IP and port.
  - Now extended to forward ALPN, SNI, etc. (when used by a TLS-terminating load balancer)
- Implemented by HAProxy, NGINX, Stunnel, Postfix, Squid, Jetty, etc.
- Deployed by Amazon Elastic Load Balancer, Google Cloud Load Balancing, etc.

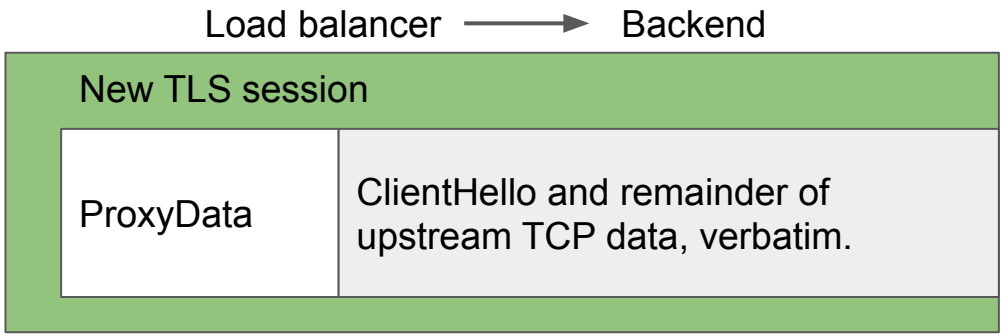
Proposed architecture: Like PROXY but encrypted

1. Load balancer and backend share a **long-lived symmetric* PSK**.
2. On each connection, the load balancer packages the needed metadata into a ProxyData struct.
3. Load balancer prepends ProxyData, AEAD encrypted and bound to the ClientHello.
4. Backend decrypts and uses the info.



*Static Diffie-Hellman is also possible.

Alternative architectures: TLS-in-TLS



+ Defends ESNI privacy against a trivial two-point surveillance attack.
  + Makes padding possible, for stronger defenses in the future
+ Potentially immune to replay attacks (after 0-RTT)
+ Offers a clear way to implement a public, free load balancer (no PSK)
- Greatly increases load balancer costs
  - 16-32x based on AWS prices
- Not clear how to extend to QUIC

Alternative architectures: ESNI Oracle

Load balancer → Backend

ClientHello and remainder of upstream TCP data, verbatim.

Backend → Load balancer

GET /oracle?esni=NzYsMTgyLDg...
Host: load-balancer.example
Authorization: Bearer LDcwLDI3k...

+ Excellent architectural clarity
- Imposes a latency penalty OR creates a lot of potential complexity
    - e.g. H2 PUSH and a cache on the backend
- Not clear how to support other metadata (e.g. client IP)
    - Might require a very fast database on the load balancer

Questions for the group

- Should we try to standardize a solution?
- Which architecture should we pursue?