Network Working Group
Internet-Draft
Intended status: Standards Track
Expires: January 3, 2020

O. Friel
R. Barnes
Cisco

July 02, 2019

ACME Integrations
draft-friel-acme-integrations-01

Abstract

This document outlines multiple advanced use cases and integrations that ACME facilitates without any modifications or enhancements required to the base ACME specification. These use cases are not immediately obvious from reading the ACME specification and thus are explicitly documented here. The use cases include ACME issuance of subdomain certificates, and ACME integration with EST and TEAP.

Status of This Memo

This Internet-Draft is submitted in full conformance with the provisions of BCP 78 and BCP 79.

Internet-Drafts are working documents of the Internet Engineering Task Force (IETF). Note that other groups may also distribute working documents as Internet-Drafts. The list of current Internet-Drafts is at https://datatracker.ietf.org/drafts/current/.

Internet-Drafts are draft documents valid for a maximum of six months and may be updated, replaced, or obsoleted by other documents at any time. It is inappropriate to use Internet-Drafts as reference material or to cite them other than as "work in progress."

This Internet-Draft will expire on January 3, 2020.

Table of Contents

1. Introduction

ACME [RFC8555] defines a protocol that a certificate authority (CA) and an applicant can use to automate the process of domain name ownership validation and X.509 (PKIX) certificate issuance. The protocol is rich and flexible and enables multiple use cases that are not immediately obvious from reading the specification. This document explicitly outlines multiple advanced ACME use cases including:

- ACME issuance of subdomain certificates
- ACME integration with EST [RFC7030]
- ACME integration with BRSKI [I-D.ietf-anima-bootstrapping-keyinfra]
- ACME integration with TEAP [RFC7170]
- ACME integration with TEAP-BRSKI draft-lear-eap-teap-brski

2. Terminology

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in BCP 14 [RFC2119] [RFC8174] when, and only when, they appear in all capitals, as shown here.

The following terms are used in this document:

- BRSKI: Bootstrapping Remote Secure Key Infrastructures [I-D.ietf-anima-bootstrapping-keyinfra]
- CA: Certificate Authority
- CMC: Certificate Management over CMS
- CSR: Certificate Signing Request
- EST: Enrollment over Secure Transport [RFC7030]
- FQDN: Fully Qualified Domain Name
- RA: PKI Registration Authority
- TEAP: Tunneled Extensible Authentication Protocol [RFC7170]

3. ACME Issuance of Subdomain Certificates

A typical ACME workflow for issuance of certificates is as follows:

1. client POSTs a newOrder request that contains a set of "identifiers"
2. server replies with a set of "authorizations" and a "finalize" URI
3. client sends POST-as-GET requests to retrieve the "authorizations", with the downloaded "authorization" object(s) containing the "identifier" that the client must prove control of
4. client proves control over the "identifier" in the "authorization" object by completing the specified challenge, for example, by publishing a DNS TXT record
5. client POSTs a CSR to the "finalize" API

ACME places the following restrictions on "identifiers":

- section 7.1.4: the only type of "identifier" defined by the ACME specification is a fully qualified domain name: "The only type of identifier defined by this specification is a fully qualified domain name (type: "dns"). The domain name MUST be encoded in the form in which it would appear in a certificate."
- Section 7.4: the "identifier" in the CSR request must match the "identifier" in the newOrder request: "The CSR MUST indicate the

exact same set of requested identifiers as the initial newOrder request."

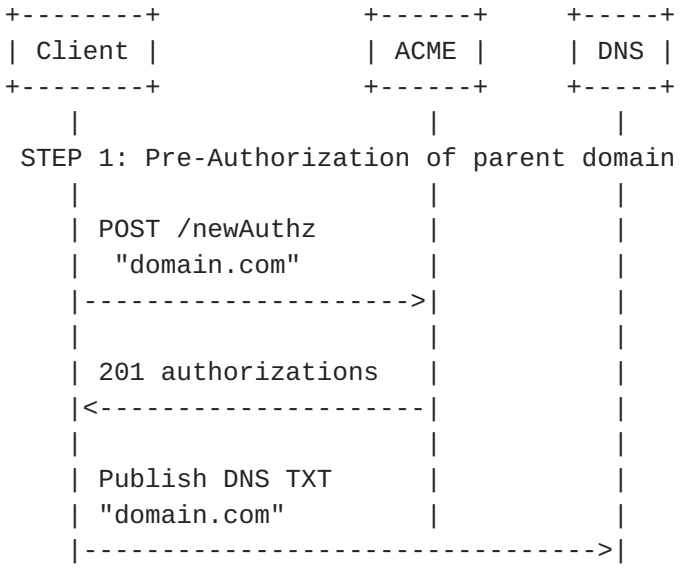
- Sections 8.3: the "identifier", or FQDN, in the "authorization" object must be used when fulfilling challenges via HTTP: "Construct a URL by populating the URL template ... where the domain field is set to the domain name being verified"

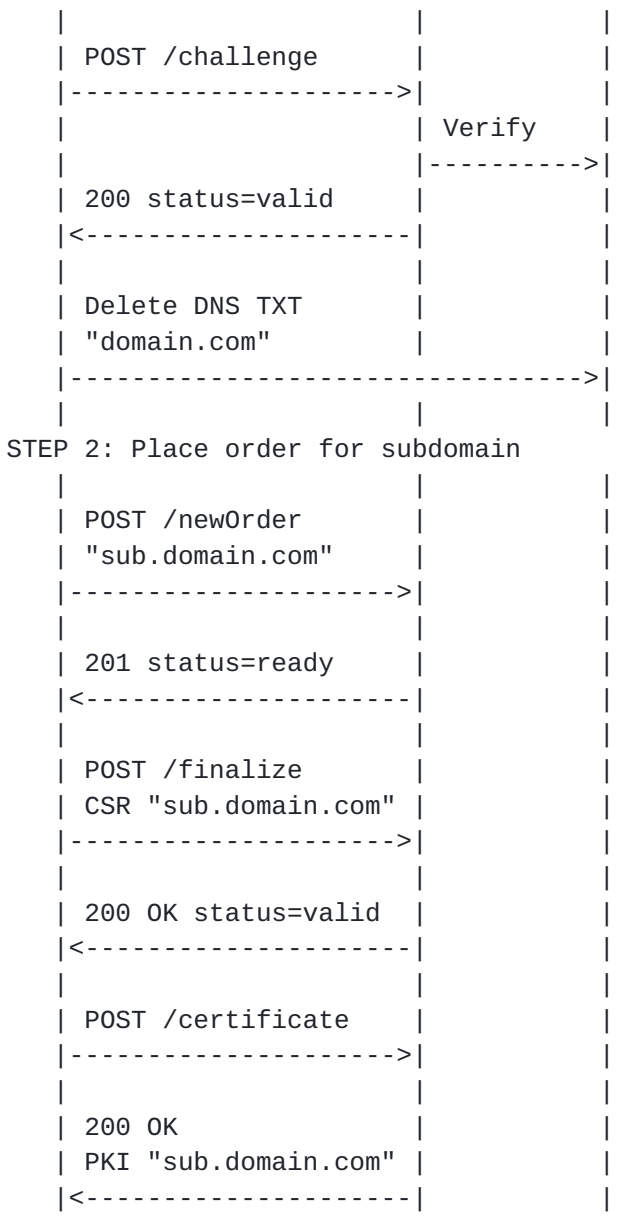
- Section 8.4: the "identifier", or FQDN, in the "authorization" object must be used when fulfilling challenges via DNS: "The client constructs the validation domain name by prepending the label "_acme-challenge" to the domain name being validated."

ACME does not mandate that the "identifier" in a newOrder request matches the "identifier" in "authorization" objects. This means that the ACME specification does not preclude an ACME server processing newOrder requests and issuing certificates for a subdomain without requiring a challenge to be fulfilled against that explicit subdomain. ACME server policy could allow issuance of certificates for a subdomain to a client where the client only has to fulfill an authorization challenge for the parent domain.

This allows a flow where a client proves ownership of "domain.com" and then successfully obtains a certificate for "sub.domain.com". The ACME pre-authorization flow makes most sense for this use case, and that is what is illustrated in the following call flow.

The client could pre-authorize for the parent domain once, and then issue multiple newOrder requests for certificates for multiple subdomains. This call flow illustrates the client only placing one newOrder request.





4. ACME Integration with EST

EST [RFC7030] defines a mechanism for clients to enroll with a PKI Registration Authority by sending CMC messages over HTTP. EST section 1 states:

"Architecturally, the EST service is located between a Certification Authority (CA) and a client. It performs several functions traditionally allocated to the Registration Authority (RA) role in a PKI."

EST section 1.1 states that:

"For certificate issuing services, the EST CA is reached through the EST server; the CA could be logically "behind" the EST server or embedded within it."

When the CA is logically "behind" the EST RA, EST does not specify how the RA communicates with the CA. EST section 1 states:

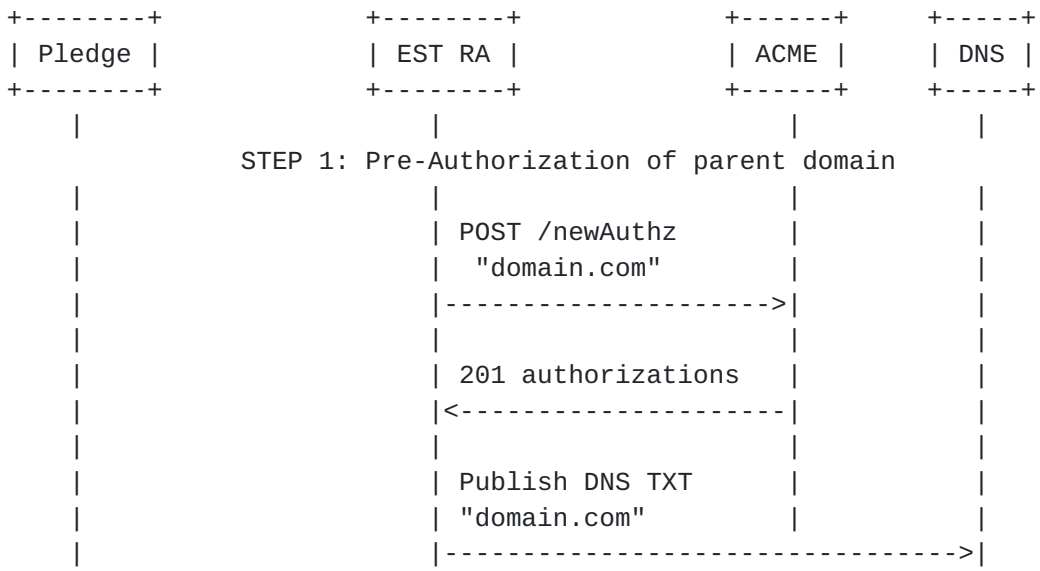
"The nature of communication between an EST server and a CA is not described in this document."

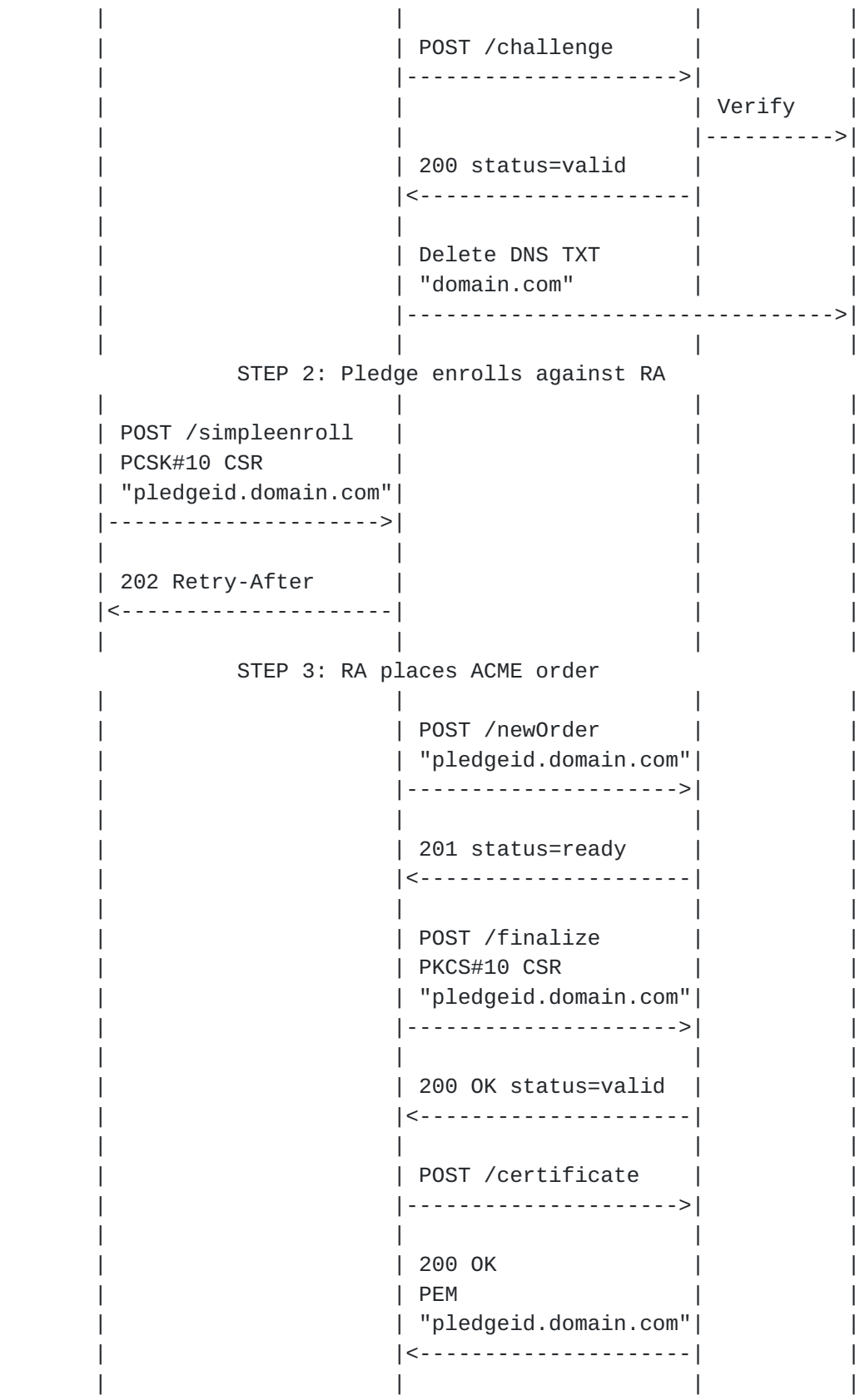
This section outlines how ACME could be used for communication between the EST RA and the CA. The example call flow shows the RA proving ownership of a parent domain, with individual client certificates being subdomains under that parent domain. This is an optimisation that reduces DNS and ACME traffic overhead. The RA could of course prove ownership of every explicit client certificate identifier.

The call flow also illustrates how the Pledge inserts relevant domain information into the CSR Subject and Subject Alternative Name fields.

[todo: The details of how the pledge determines what information to include in the CSR are TBD. For example, the pledge could discover the DNS domain via DHCP Option 15, and prepend the identifier from the IDevID to this.

Note also that EST https://tools.ietf.org/html/rfc7030#section-4.2.1 states that the ChangeSubjectName attribute MAY be used, for example, if the Pledge uses its IDevID when requesting a CSR/LDevID with a different Subject, however this field does not appear to have widespread support across CAs.]



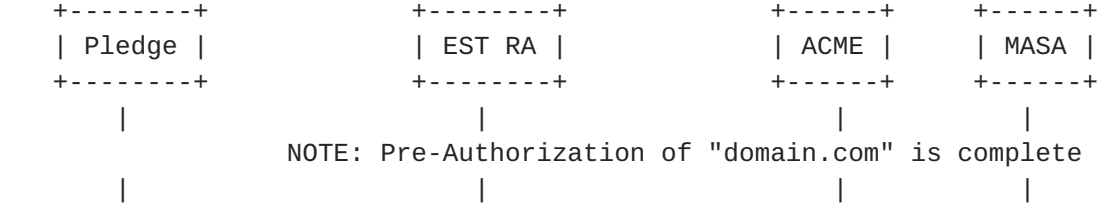

POST /challenge
Verify
200 status=valid
Delete DNS TXT
"domain.com"
STEP 2: Pledge enrolls against RA
POST /simpleenroll
PCSK#10 CSR
"pledgeid.domain.com"
202 Retry-After
STEP 3: RA places ACME order
POST /newOrder
"pledgeid.domain.com"
201 status=ready
POST /finalize
PKCS#10 CSR
"pledgeid.domain.com"
200 OK status=valid
POST /certificate
200 OK
PEM
"pledgeid.domain.com"
STEP 4: Pledge retries enroll

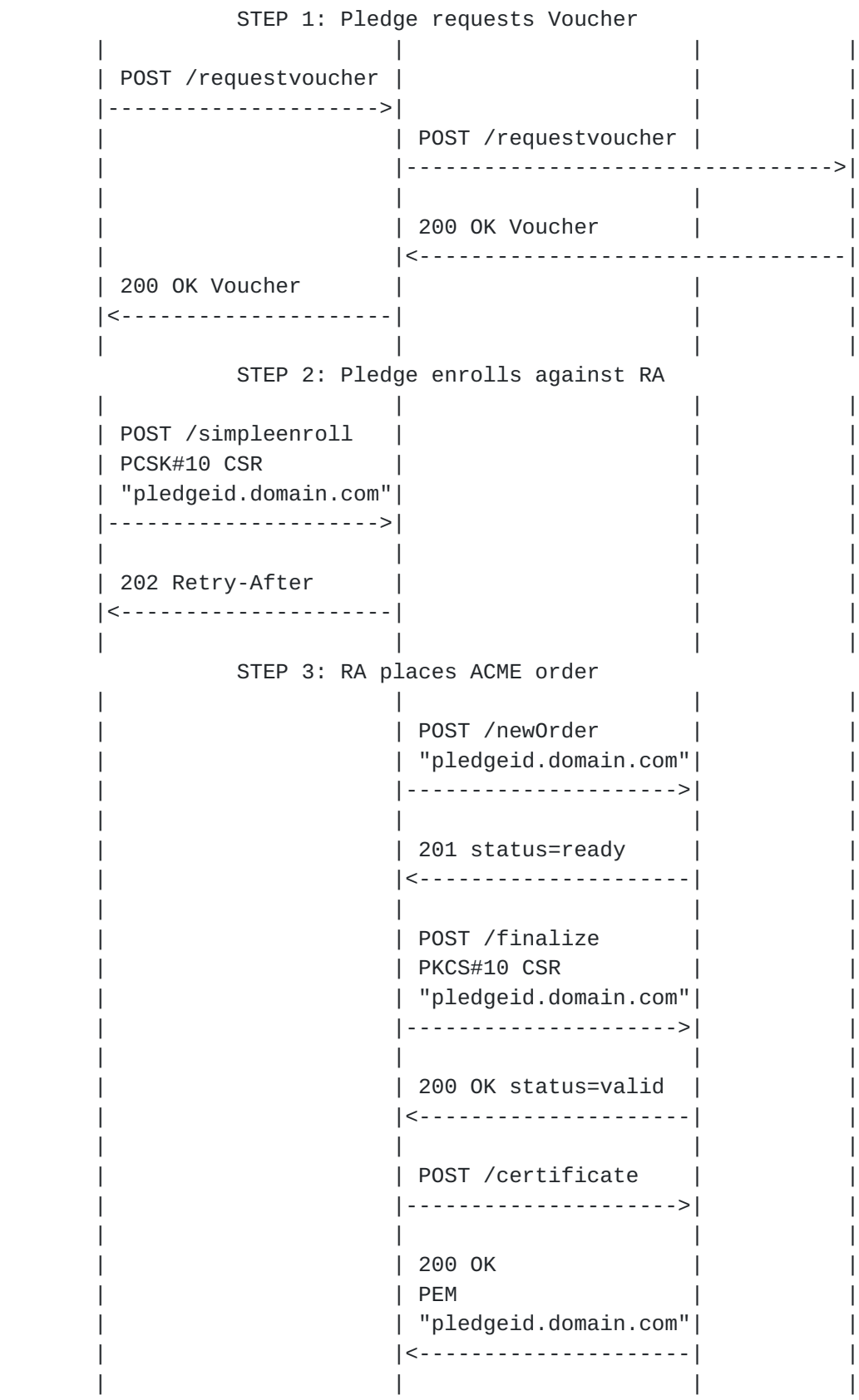
5. ACME Integration with BRSKI

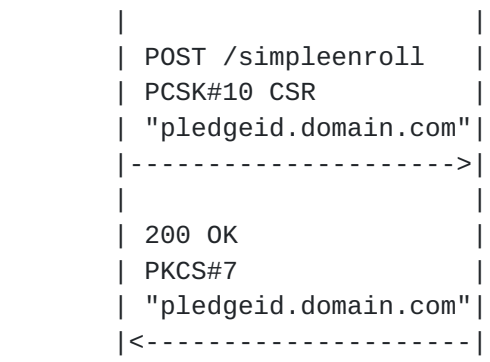
BRSKI [I-D.ietf-anima-bootstrapping-keyinfra] is based upon EST [RFC7030] and defines how to autonomically bootstrap PKI trust anchors into devices via means of signed vouchers. EST certificate enrollment may then optionally take place after trust has been established. BRKSI voucher exchange and trust establishment are based on EST extensions and the certificate enrollment part of BRSKI is fully based on EST. Similar to EST, BRSKI does not define how the EST RA communicates with the CA. Therefore, the mechanisms outlined in the previous section for using ACME as the communications protocol between the EST RA and the CA are equally applicable to BRSKI.

The following call flow shows how ACME may be integrated into a full BRSKI voucher plus EST enrollment workflow. For brevity, it assumes that the EST RA has previously proven ownership of a parent domain and that pledge certificate identifiers are a subdomain of that parent domain. The domain ownership exchanges between the RA, ACME and DNS are not shown. Similarly, not all BRSKI interactions are shown and only the key protocol flows involving voucher exchange and EST enrollment are shown.

[todo: similar to the EST section above, it is TBD exactly how the pledge determines what domain information to insert in the CSR. A possibility is that the Voucher response includes domain information and explicitly instructs the pledge what information to insert in the CSR. The RA could also instruct the Pledge to include a guid or a new unique random identifier in place of its MAC address, serial number, or whatever other identifying information is included in the IDevID.




STEP 1: Pledge requests Voucher
POST /requestvoucher
POST /requestvoucher
200 OK Voucher
200 OK Voucher
STEP 2: Pledge enrolls against RA
POST /simpleenroll
PCSK#10 CSR
"pledgeid.domain.com"
202 Retry-After
STEP 3: RA places ACME order
POST /newOrder
"pledgeid.domain.com"
201 status=ready
POST /finalize
PKCS#10 CSR
"pledgeid.domain.com"
200 OK status=valid
POST /certificate
200 OK
PEM
"pledgeid.domain.com"
STEP 4: Pledge retries enroll

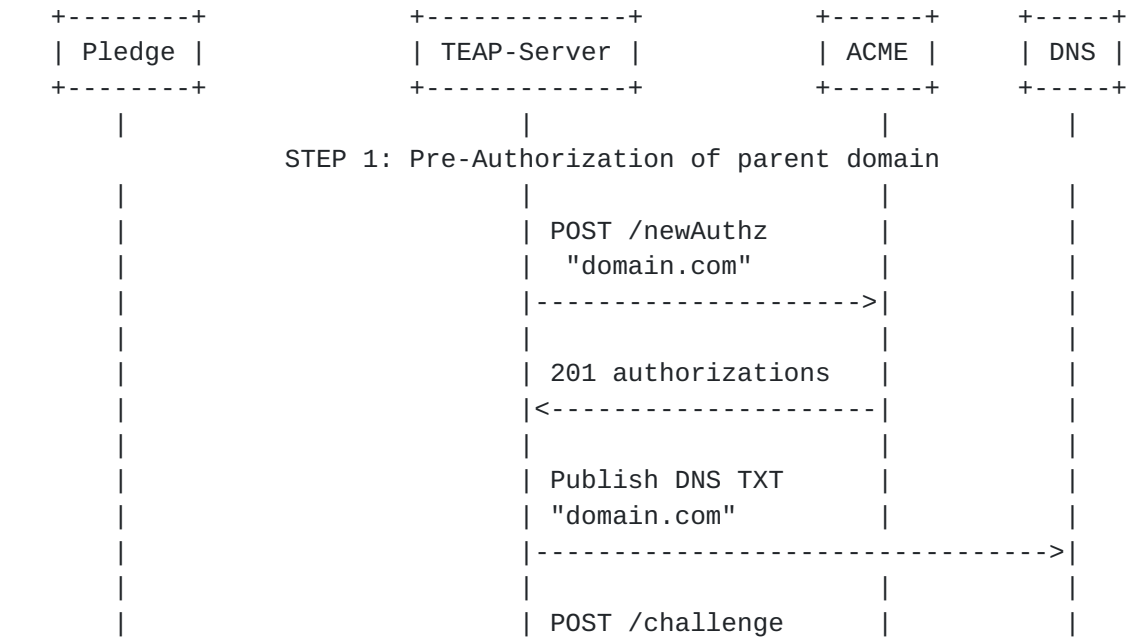


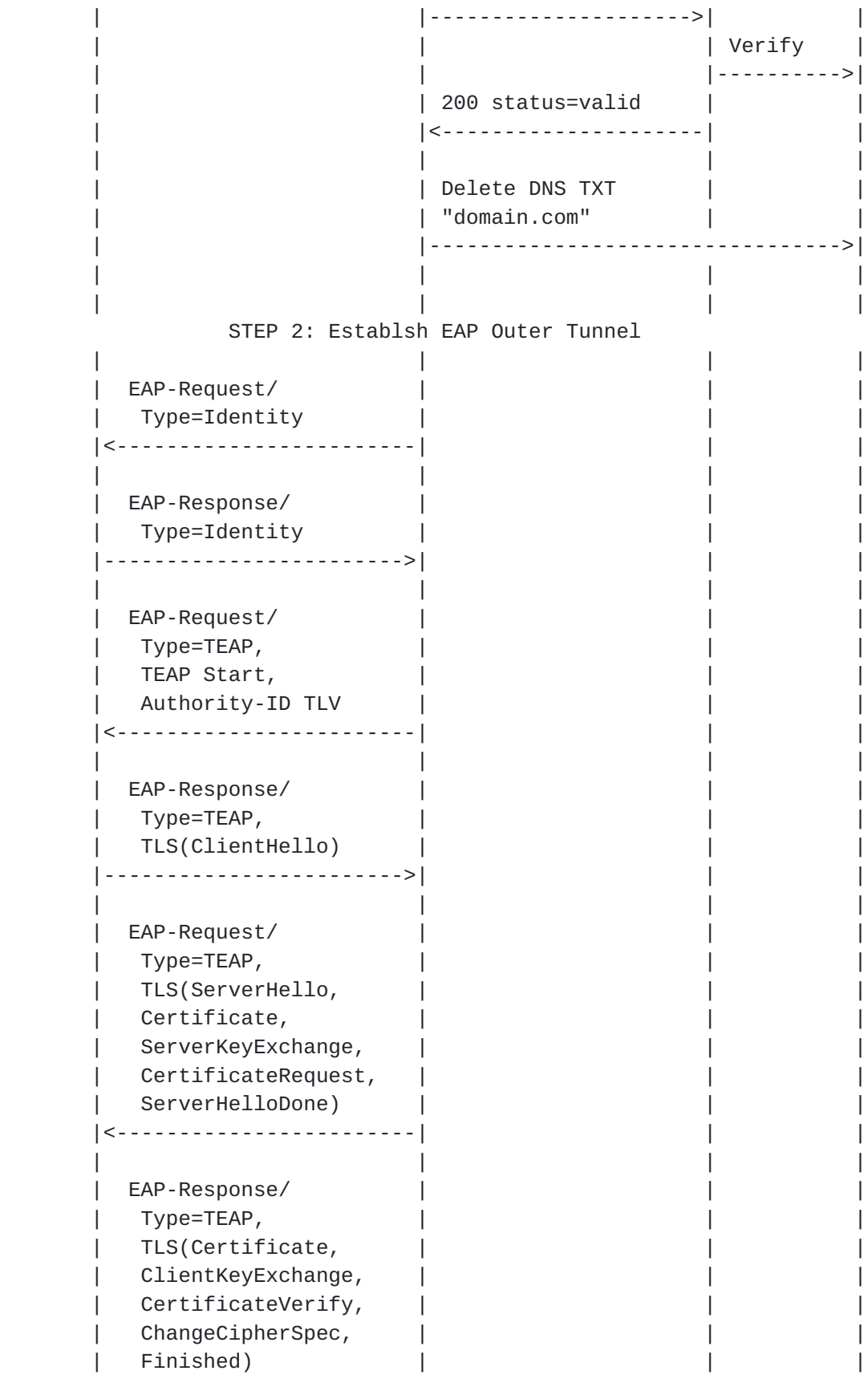
6. ACME Integration with TEAP

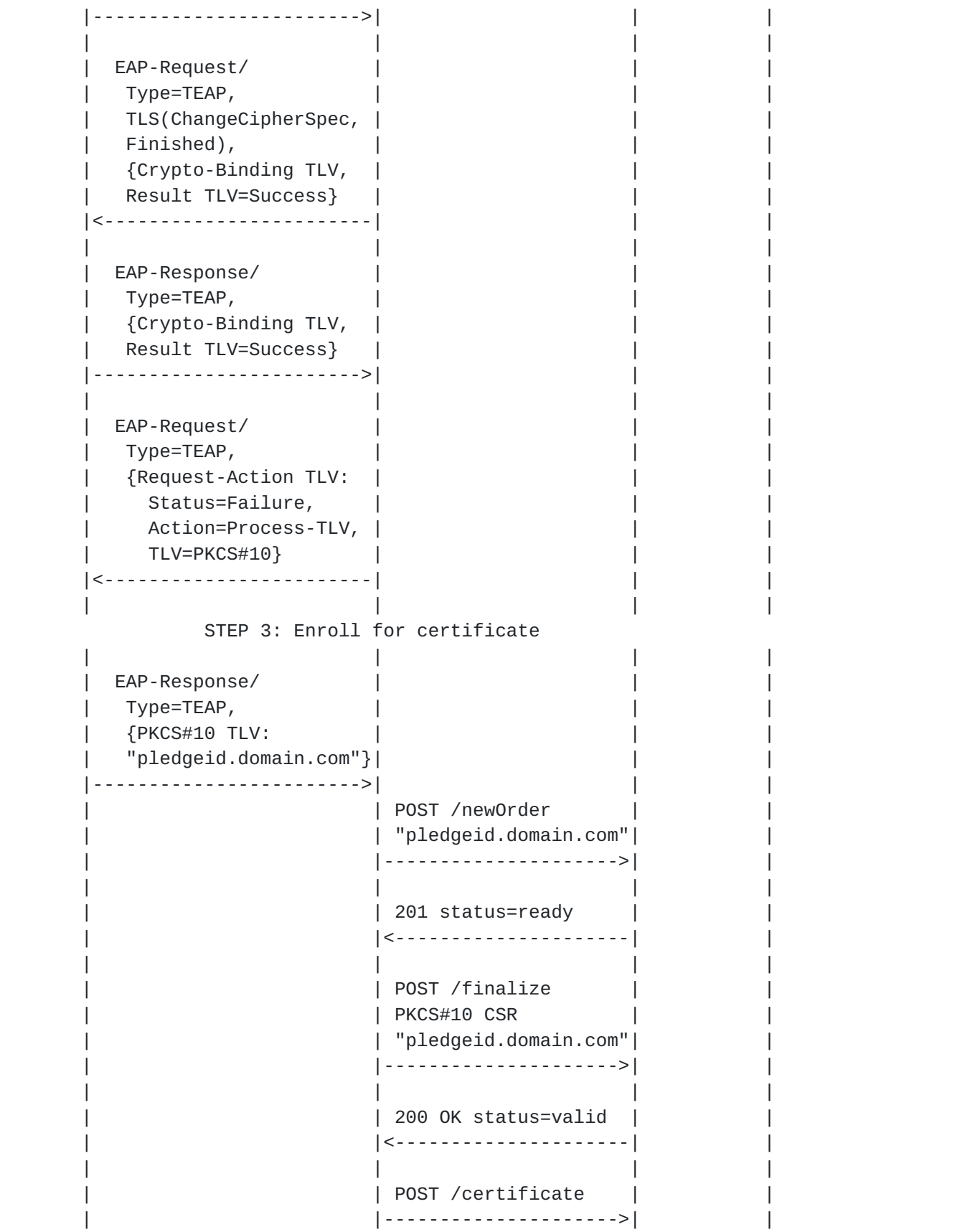
TEAP [RFC7170] define a tunnel-based EAP method that enables secure communication between a peer and a server by using TLS to establish a mutually authenticated tunnel. TEAP enables certificate provisioning within the tunnel. TEAP does not define how the TEAP server communicates with the CA.

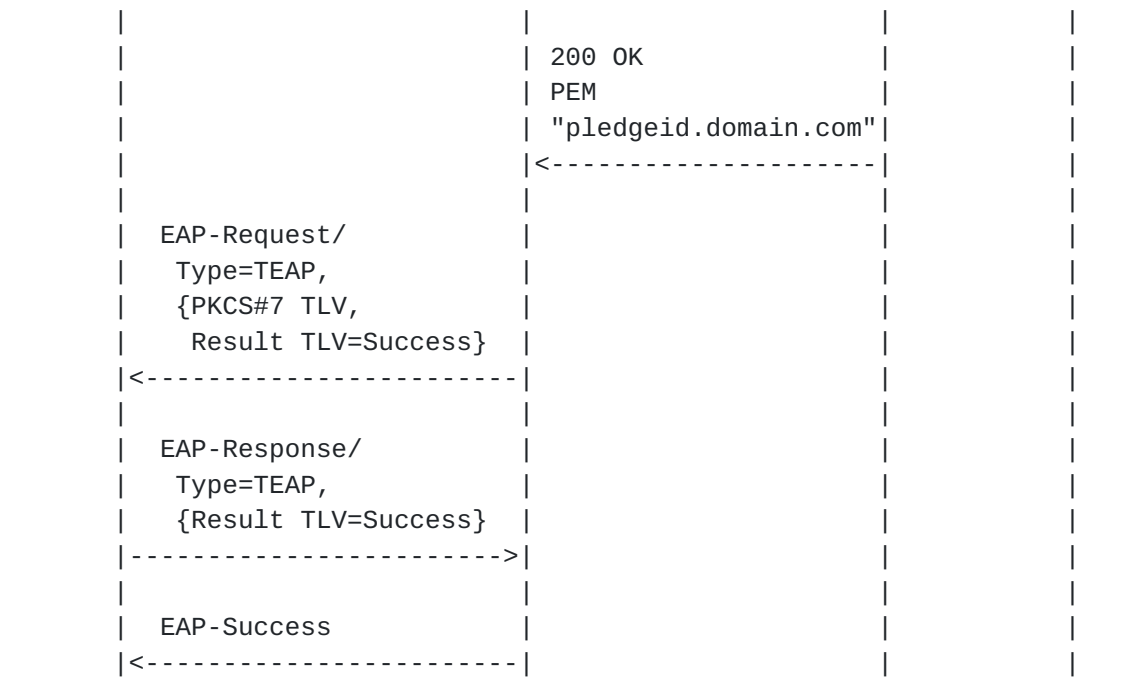
This section outlines how ACME could be used for communication between the TEAP server and the CA. The example call flow shows the TEAP server proving ownership of a parent domain, with individual client certificates being subdomains under that parent domain. This is an optimisation that reduces DNS and ACME traffic overhead. The TEAP server could of course prove ownership of every explicit client certificate identifier.

[todo: Similar to the previous section, it is TBD exactly how the Pledge determines what Subject/SAN to put in the CSR request.]




Verify
200 status=valid
Delete DNS TXT
"domain.com"
STEP 2: Establsh EAP Outer Tunnel
EAP-Request/
Type=Identity
EAP-Response/
Type=Identity
EAP-Request/
Type=TEAP,
TEAP Start,
Authority-ID TLV
EAP-Response/
Type=TEAP,
TLS(ClientHello)
EAP-Request/
Type=TEAP,
TLS(ServerHello,
Certificate,
ServerKeyExchange,
CertificateRequest,
ServerHelloDone)
EAP-Response/
Type=TEAP,
TLS(Certificate,
ClientKeyExchange,
CertificateVerify,
ChangeCipherSpec,
Finished)


EAP-Request/
Type=TEAP,
TLS(ChangeCipherSpec,
Finished),
{Crypto-Binding TLV,
Result TLV=Success}
EAP-Response/
Type=TEAP,
{Crypto-Binding TLV,
Result TLV=Success}
EAP-Request/
Type=TEAP,
{Request-Action TLV:
Status=Failure,
Action=Process-TLV,
TLV=PKCS#10}
STEP 3: Enroll for certificate
EAP-Response/
Type=TEAP,
{PKCS#10 TLV:
"pledgeid.domain.com"}
POST /newOrder
"pledgeid.domain.com"
201 status=ready
POST /finalize
PKCS#10 CSR
"pledgeid.domain.com"
200 OK status=valid
POST /certificate

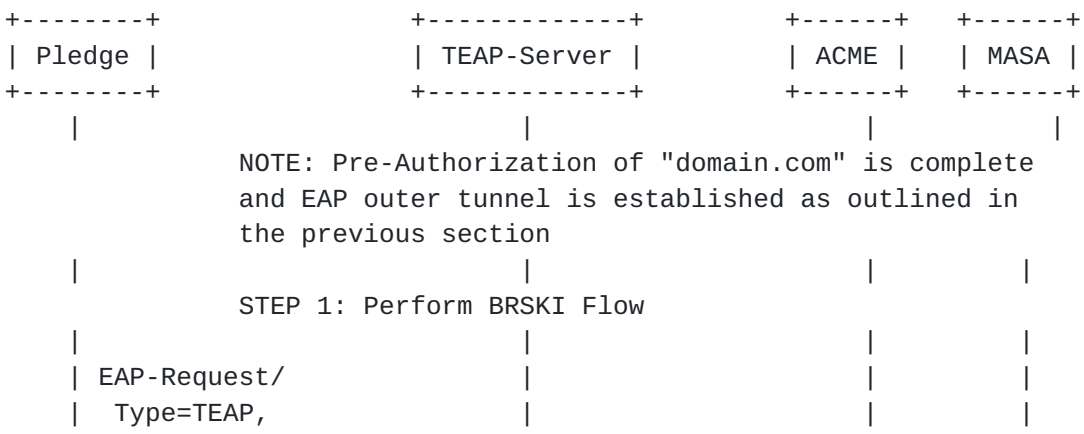


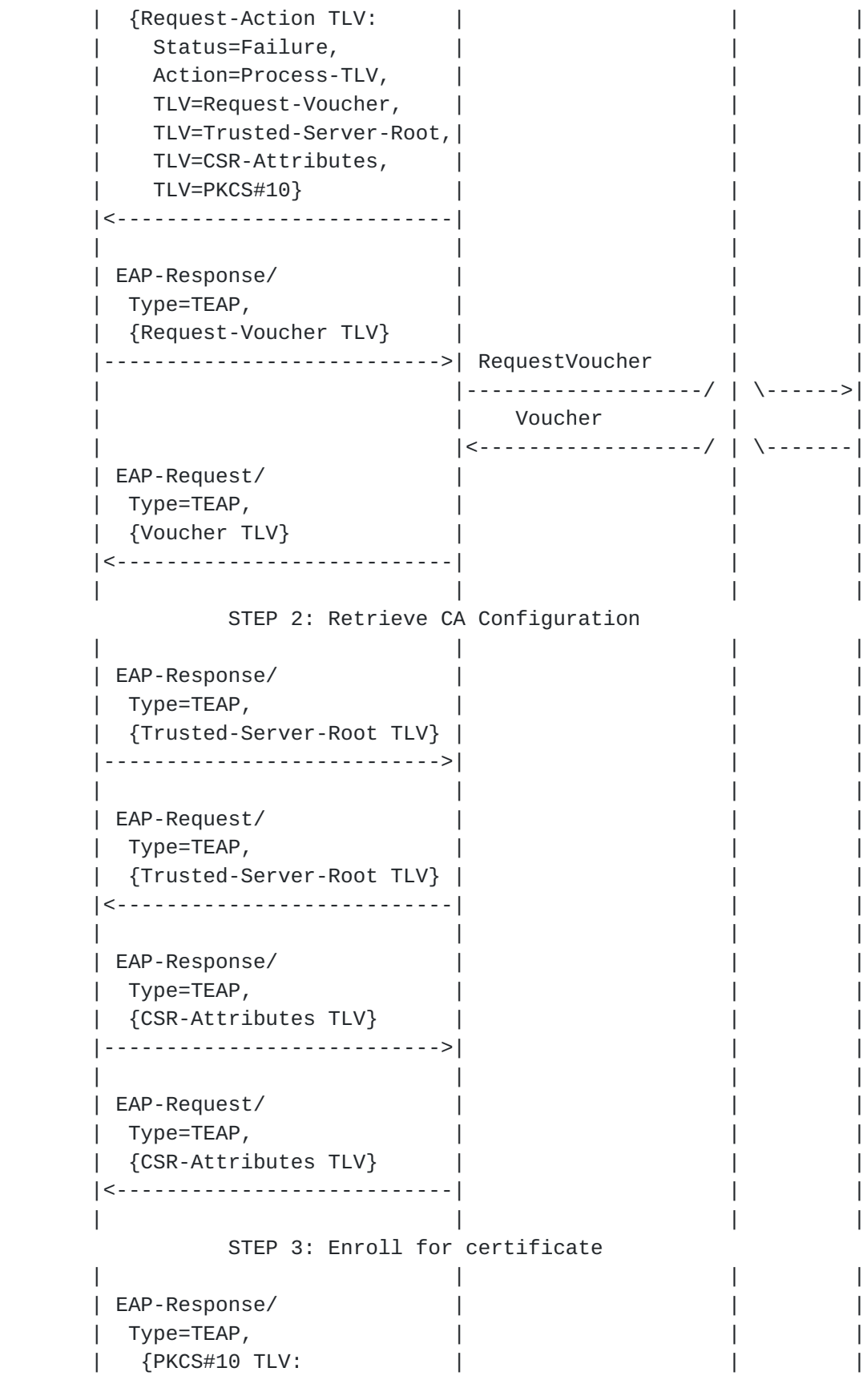
7. ACME Integration with TEAP-BRSKI

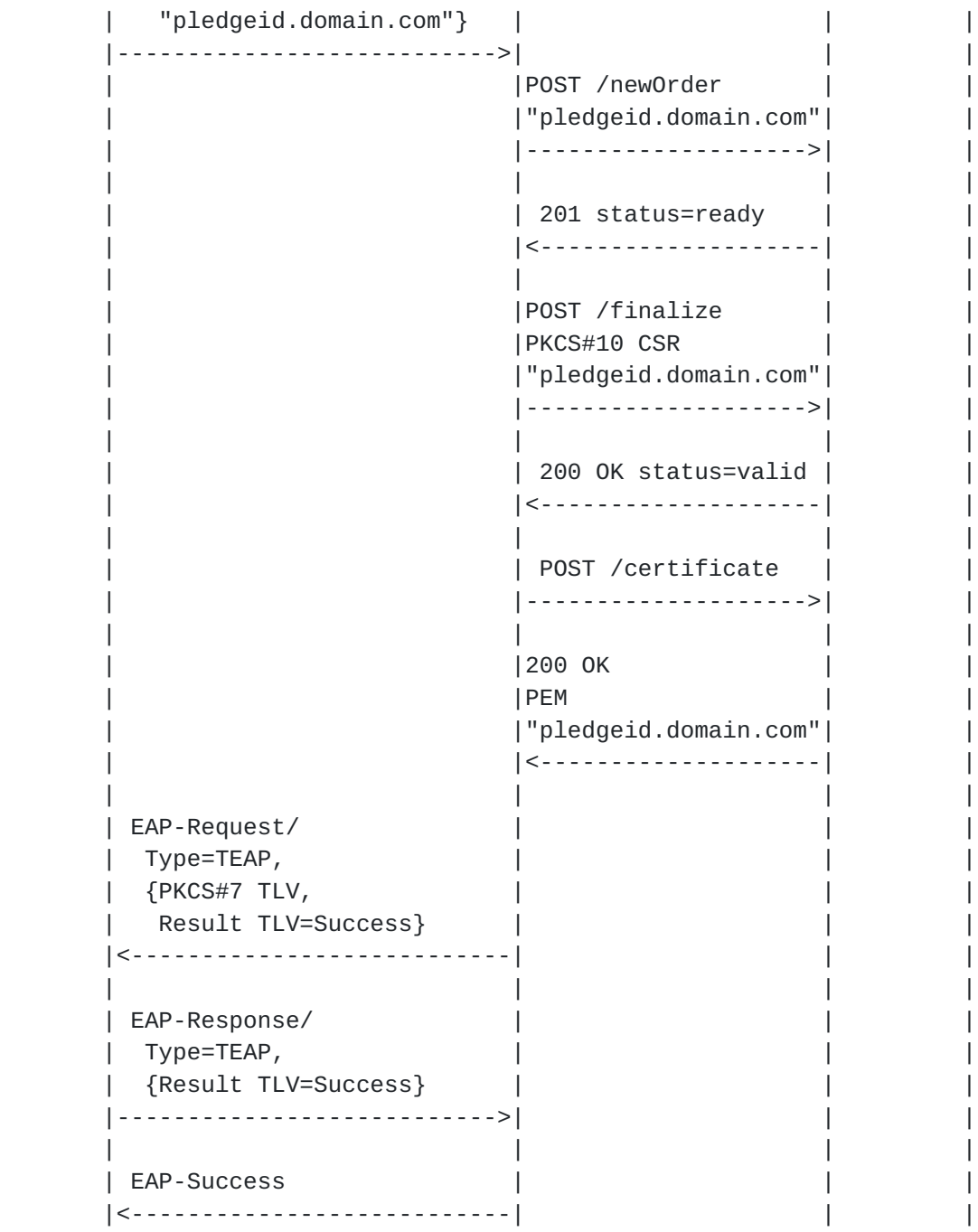
TEAP-BRSKI [I-D.lear-eap-teap-brski] defines how to execute BRSKI at layer 2 inside a TEAP tunnel. Similar to the TEAP proposal in the previous section, BRSKI-TEAP leverages the existing TEAP PKXS#10 and PKCS#7 mechanisms for certificate enrollment, and does not define how the TEAP server communicates with the CA.

This section outlines how ACME could be used for communication between the TEAP server and the CA, and how this fits in with the TEAP-BRSKI proposal.

[todo: Similar to the previous section, it is TBD exactly how the Pledge determines what Subject/SAN to put in the CSR request.]




{Request-Action TLV:
Status=Failure,
Action=Process-TLV,
TLV=Request-Voucher,
TLV=Trusted-Server-Root,
TLV=CSR-Attributes,
TLV=PKCS#10}
EAP-Response/
Type=TEAP,
{Request-Voucher TLV}
RequestVoucher
Voucher
EAP-Request/
Type=TEAP,
{Voucher TLV}
STEP 2: Retrieve CA Configuration
EAP-Response/
Type=TEAP,
{Trusted-Server-Root TLV}
EAP-Request/
Type=TEAP,
{Trusted-Server-Root TLV}
EAP-Response/
Type=TEAP,
{CSR-Attributes TLV}
EAP-Request/
Type=TEAP,
{CSR-Attributes TLV}
STEP 3: Enroll for certificate
EAP-Response/
Type=TEAP,
{PKCS#10 TLV:



8. IANA Considerations

[todo]

9. Security Considerations

[todo]

10. Informative References

[I-D.ietf-anima-bootstrapping-keyinfra]
Pritikin, M., Richardson, M., Behringer, M., Bjarnason, S., and K. Watsen, "Bootstrapping Remote Secure Key Infrastructures (BRSKI)", draft-ietf-anima-bootstrapping-keyinfra-22 (work in progress), June 2019.

[I-D.lear-eap-teap-brski]
Lear, E., Friel, O., and N. Cam-Winget, "Bootstrapping Key Infrastructure over EAP", draft-lear-eap-teap-brski-02 (work in progress), February 2019.

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, DOI 10.17487/RFC2119, March 1997, <https://www.rfc-editor.org/info/rfc2119>.

[RFC7030] Pritikin, M., Ed., Yee, P., Ed., and D. Harkins, Ed., "Enrollment over Secure Transport", RFC 7030, DOI 10.17487/RFC7030, October 2013, <https://www.rfc-editor.org/info/rfc7030>.

[RFC7170] Zhou, H., Cam-Winget, N., Salowey, J., and S. Hanna, "Tunnel Extensible Authentication Protocol (TEAP) Version 1", RFC 7170, DOI 10.17487/RFC7170, May 2014, <https://www.rfc-editor.org/info/rfc7170>.

[RFC8174] Leiba, B., "Ambiguity of Uppercase vs Lowercase in RFC 2119 Key Words", BCP 14, RFC 8174, DOI 10.17487/RFC8174, May 2017, <https://www.rfc-editor.org/info/rfc8174>.

[RFC8555] Barnes, R., Hoffman-Andrews, J., McCarney, D., and J. Kasten, "Automatic Certificate Management Environment (ACME)", RFC 8555, DOI 10.17487/RFC8555, March 2019, <https://www.rfc-editor.org/info/rfc8555>.

Appendix A. Comments

Authors' Addresses

Owen Friel
Cisco

Email: ofriel@cisco.com

Richard Barnes
Cisco

Email: rlb@ipv.sx