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ACME Integrations
draft-friel-acme-integrations-02

Abstract

This document outlines multiple advanced use cases and integrations that ACME facilitates without any modifications or enhancements required to the base ACME specification. The use cases include ACME integration with EST, BRSKI and TEAP.

Status of This Memo

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

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This Internet-Draft will expire on April 26, 2020.

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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 integration with EST [RFC7030]
- ACME integration with BRSKI [I-D.ietf-anima-bootstrapping-keyinfra]
- ACME integration with BRSKI Default Cloud Registrar [I-D.friel-anima-brski-cloud]
- ACME integration with TEAP [RFC7170]
- ACME integration with TEAP-BRSKI [I-D.lear-eap-teap-brski]

The integrations with EST, BRSKI (which is based upon EST), and TEAP enable automated certificate enrolment for devices. ACME for subdomains [I-D.friel-acme-subdomains] outlines how ACME can be used by a client to obtain a certificate for a subdomain identifier from a certificate authority where client has fulfilled a challenge against a parent domain but does not need to fulfil a challenge against the explicit subdomain. This is a useful optimisation when ACME is used to issue certificates for large numbers of devices as it reduces the

domain ownership proof traffic (DNS or HTTP) and ACME traffic overhead, but is not a necessary requirement.

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 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:

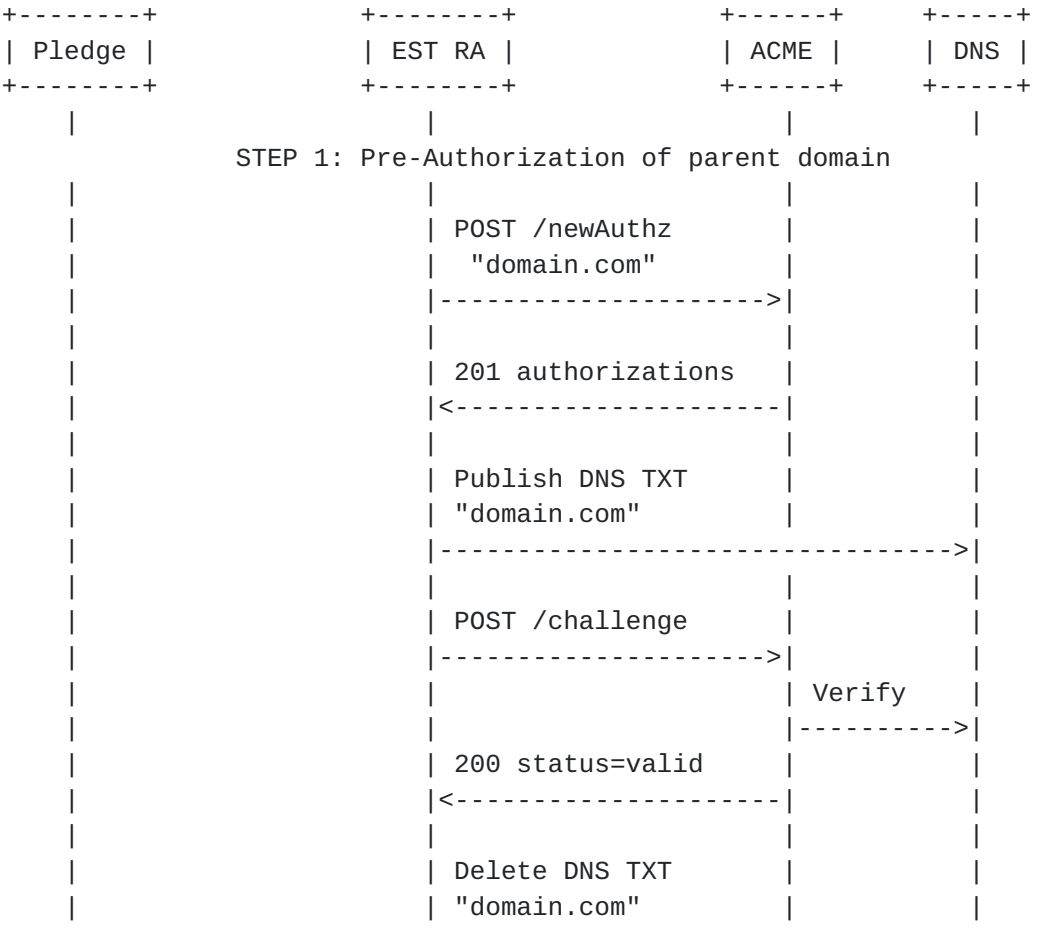
"For certificate issuing services, the EST CA is reached through the EST server; the CA could be logically "behind" the EST server or embedded within it."

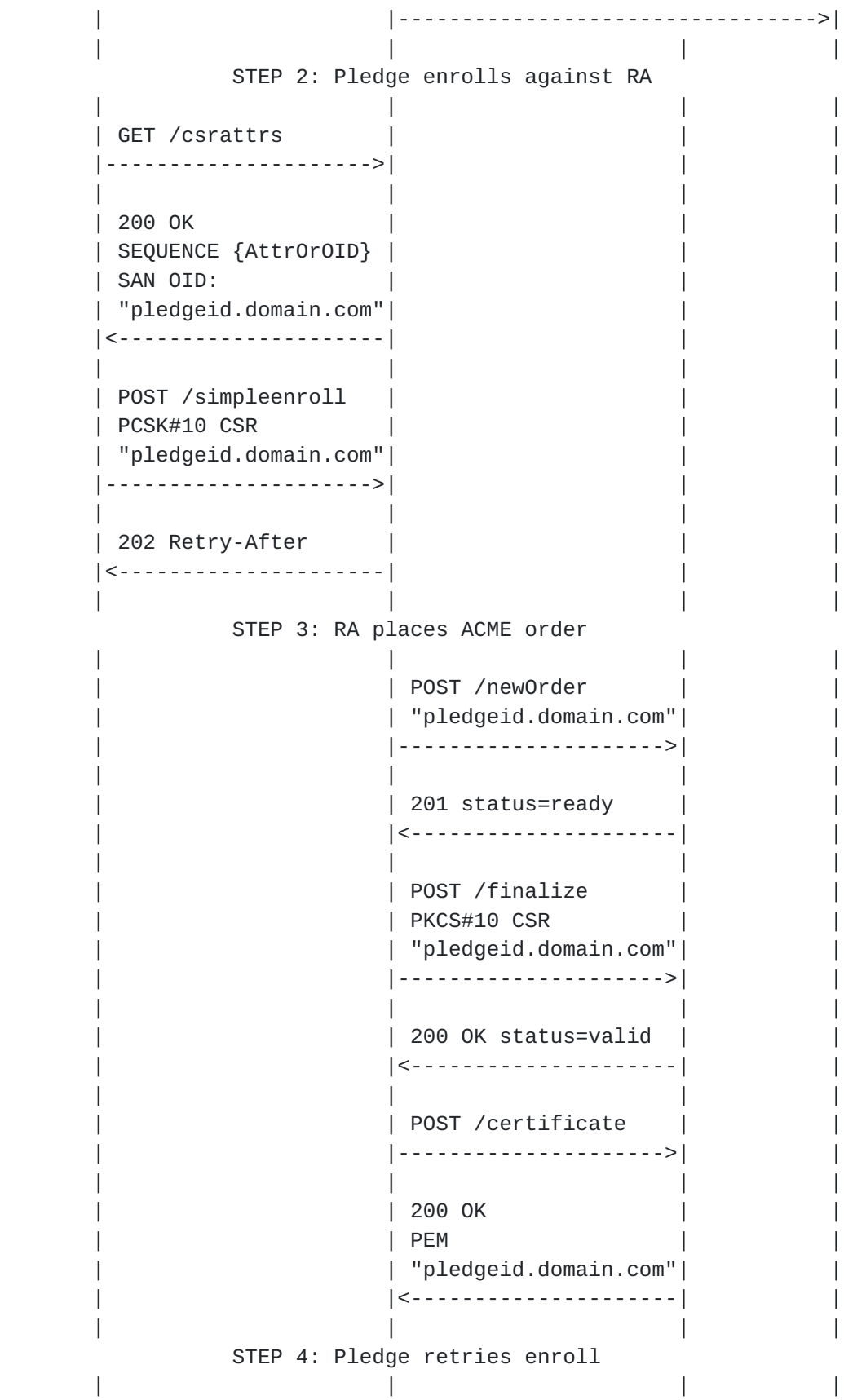
When the CA is logically "behind" the EST RA, EST does not specify how the RA communicates with the CA. EST section 1 states:

"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 leverages [I-D.friel-acme-subdomains] and 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 illustrates the client calling the EST /csrattrs API before calling the EST /simpleenroll API. This enables the EST server to indicate to the client what attributes it expects the client to include in the CSR request send in the /simpleenroll API. For example, EST servers could use this mechanism to tell the client what fields to include in the CSR Subject and Subject Alternative Name fields.



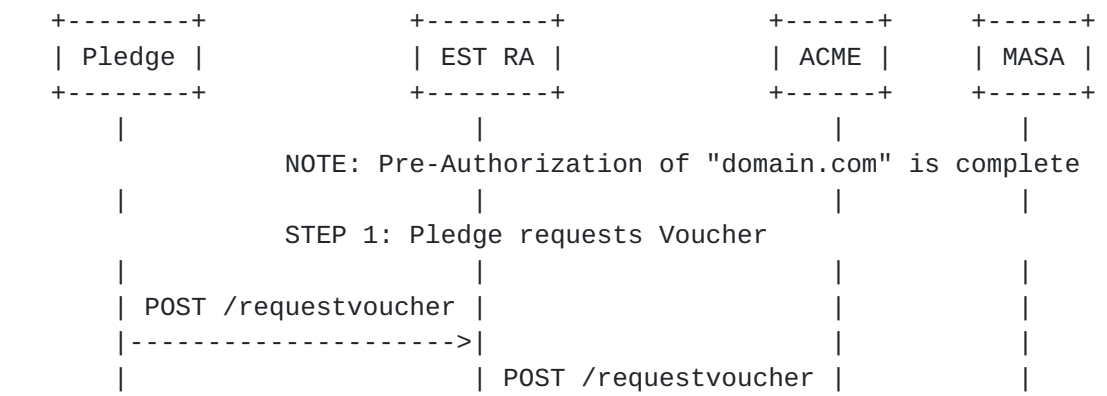

STEP 2: Pledge enrolls against RA
GET /csrattrs
200 OK
SEQUENCE {AttrOrOID}
SAN OID:
"pledgeid.domain.com"
POST /simpleenroll
PCSK#10 CSR
"pledgeid.domain.com"
202 Retry-After
STEP 3: RA places ACME order
POST /newOrder
"pledgeid.domain.com"
201 status=ready
POST /finalize
PKCS#10 CSR
"pledgeid.domain.com"
200 OK status=valid
POST /certificate
200 OK
PEM
"pledgeid.domain.com"
STEP 4: Pledge retries enroll

4. ACME Integration with BRSKI

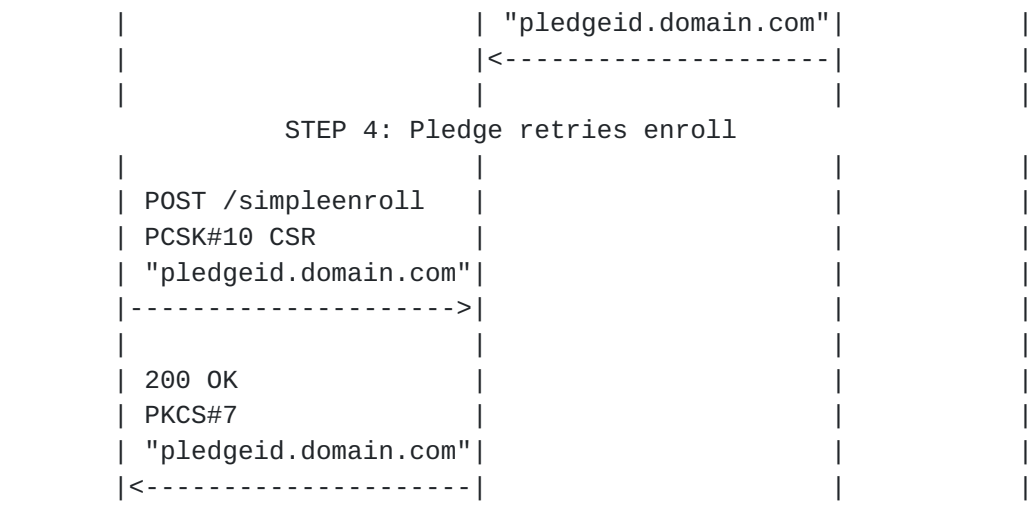
BRSKI [I-D.ietf-anima-bootstrapping-keyinfra] is based upon EST [RFC7030] and defines how to autonomically bootstrap PKI trust anchors into devices via means of signed vouchers. EST certificate enrollment may then optionally take place after trust has been established. BRKSI voucher exchange and trust 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.

Similar to the EST section above, the client calls EST /csrattrs API before calling the EST /cimpleenroll API. This enables the server to indicate what fields the pledge should include in the CSR that the client sends in the /simpleenroll API.



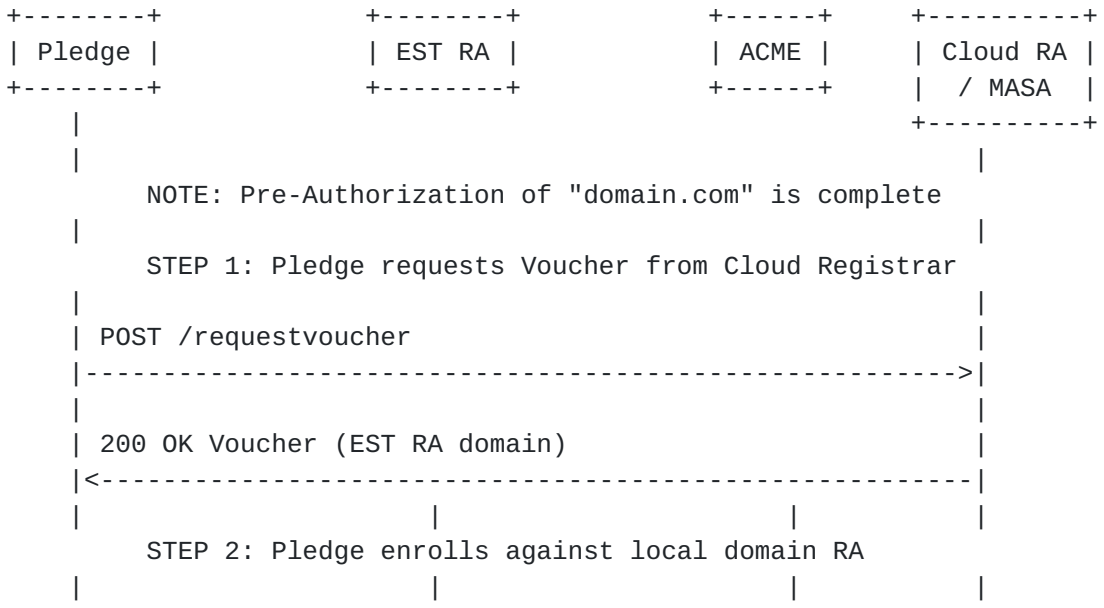

200 OK Voucher
200 OK Voucher
STEP 2: Pledge enrolls against RA
GET /csrattrs
200 OK
SEQUENCE {AttrOrOID}
SAN OID:
"pledgeid.domain.com"
POST /simpleenroll
PCSK#10 CSR
"pledgeid.domain.com"
202 Retry-After
STEP 3: RA places ACME order
POST /newOrder
"pledgeid.domain.com"
201 status=ready
POST /finalize
PKCS#10 CSR
"pledgeid.domain.com"
200 OK status=valid
POST /certificate
200 OK
PEM

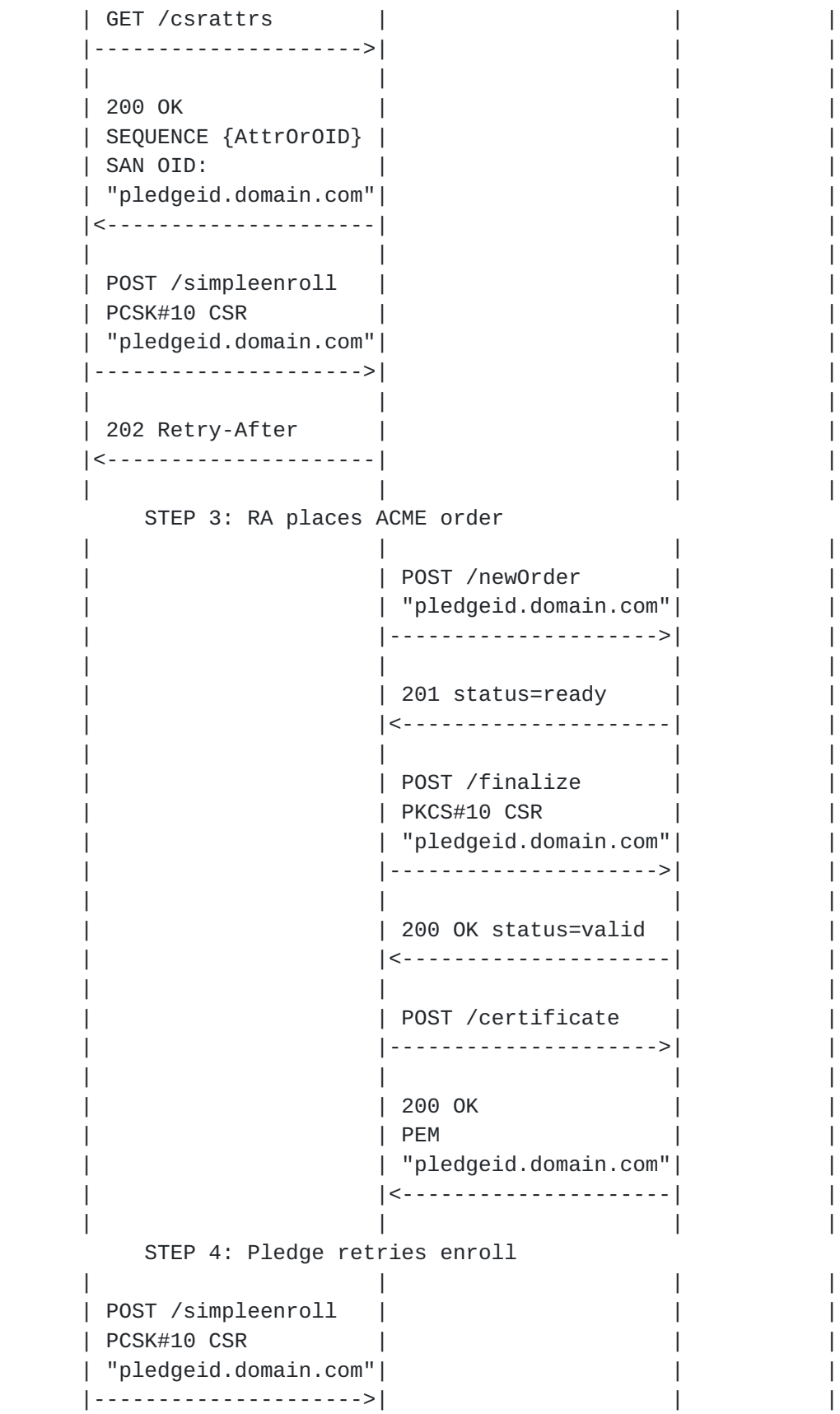


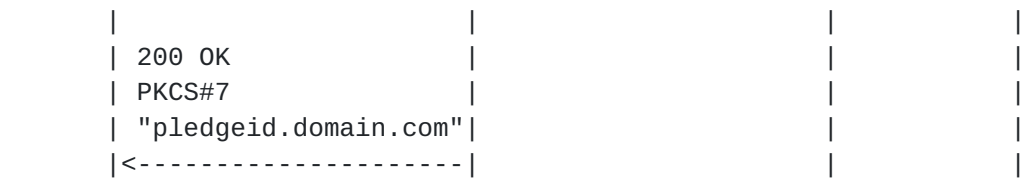
5. ACME Integration with BRSKI Default Cloud Registrar

BRSKI Cloud Registrar [I-D.friel-anima-brski-cloud] specifies the behaviour of a BRSKI Cloud Registrar, and how a pledge can interact with a BRSKI Cloud Registrar when bootstrapping. Similar to the local domain registrar BRSKI flow, ACME can be easily integrated with a cloud registrar bootstrap flow.

BRSKI cloud registrar is flexible and allows for multiple different local domain discovery and redirect scenarios. In the example illustrated here, the extension to [RFC8366] Vouchers which is defined in [[TODO ID-TBD]] and allows the specification of a bootstrap DNS domain is leveraged. This extension allows the cloud registrar to specify the local domain RA that the pledge should connect to for the purposes of EST enrollment.




GET /csrattrs
200 OK
SEQUENCE {AttrOrOID}
SAN OID:
"pledgeid.domain.com"
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
POST /simpleenroll
PCSK#10 CSR
"pledgeid.domain.com"

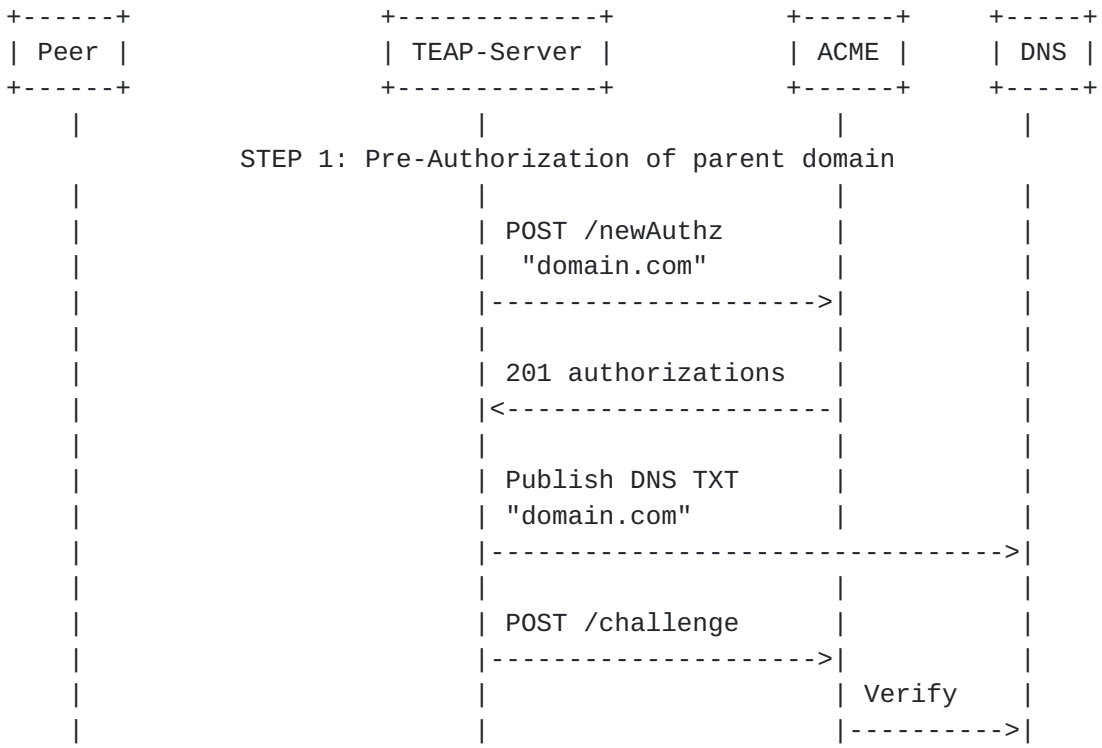


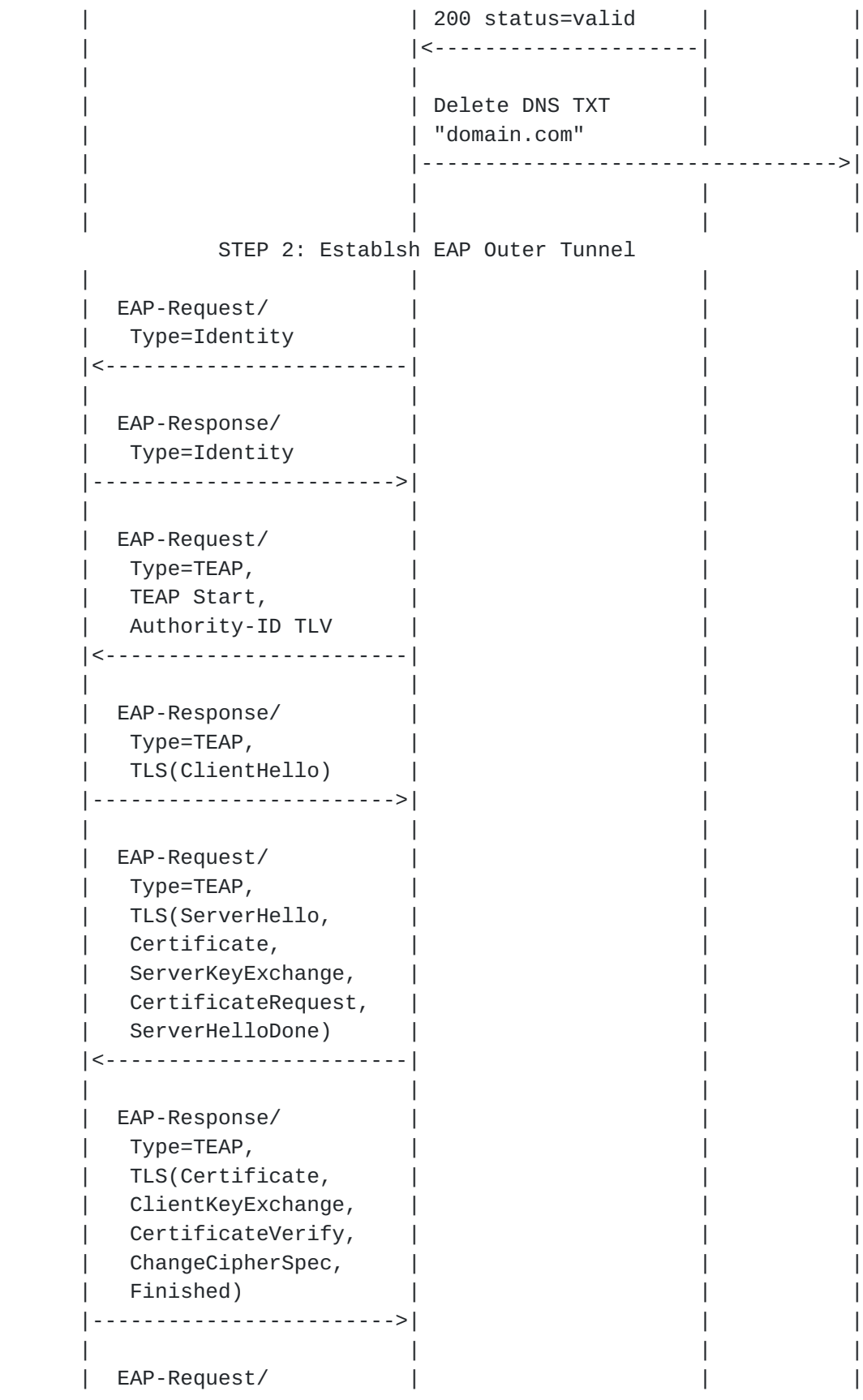
6. ACME Integration with TEAP

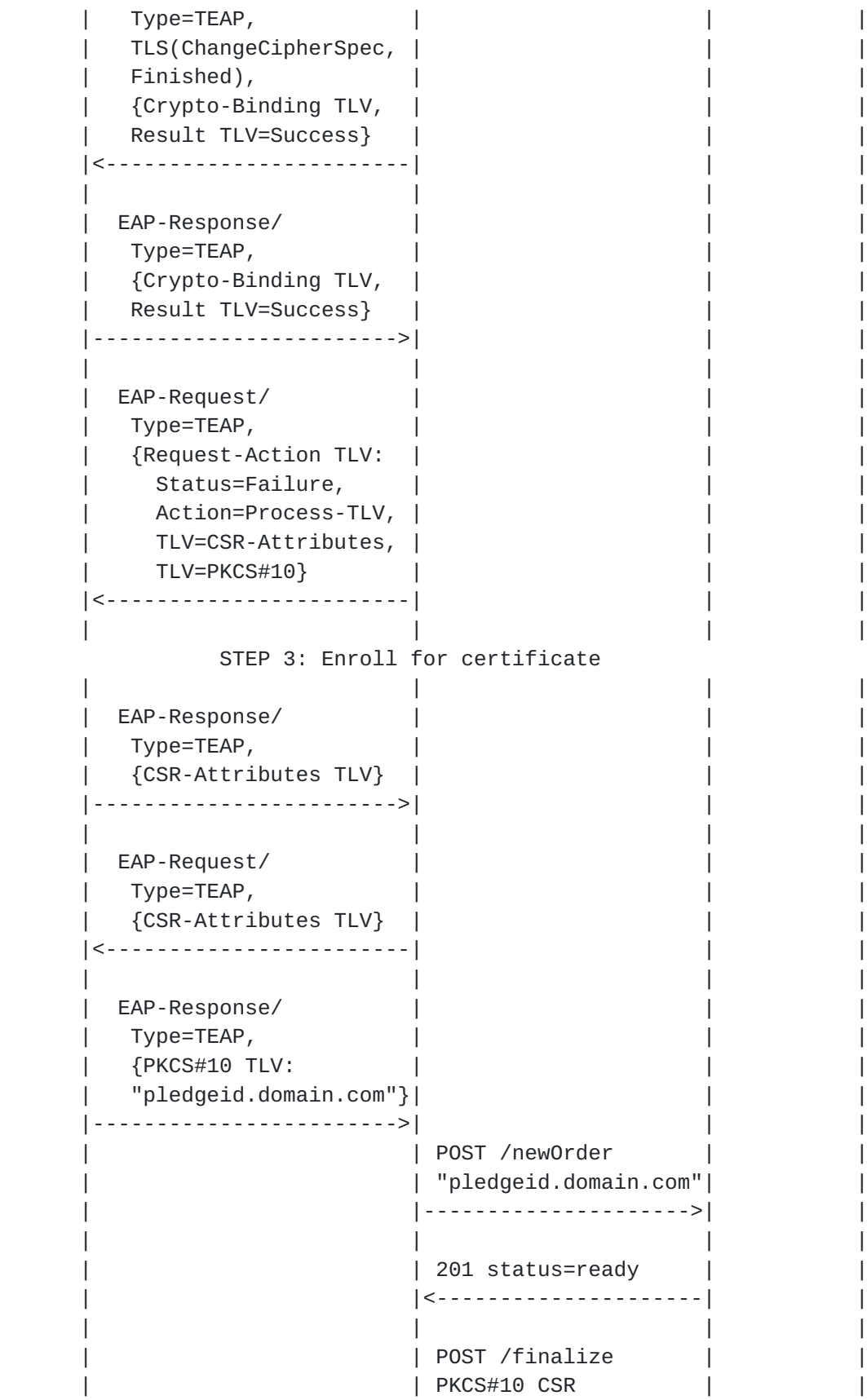
TEAP [RFC7170] defines a tunnel-based EAP method that enables secure communication between a peer and a server by using TLS to establish a mutually authenticated tunnel. TEAP enables certificate provisioning within the tunnel. TEAP does not define how the TEAP server communicates with the CA.

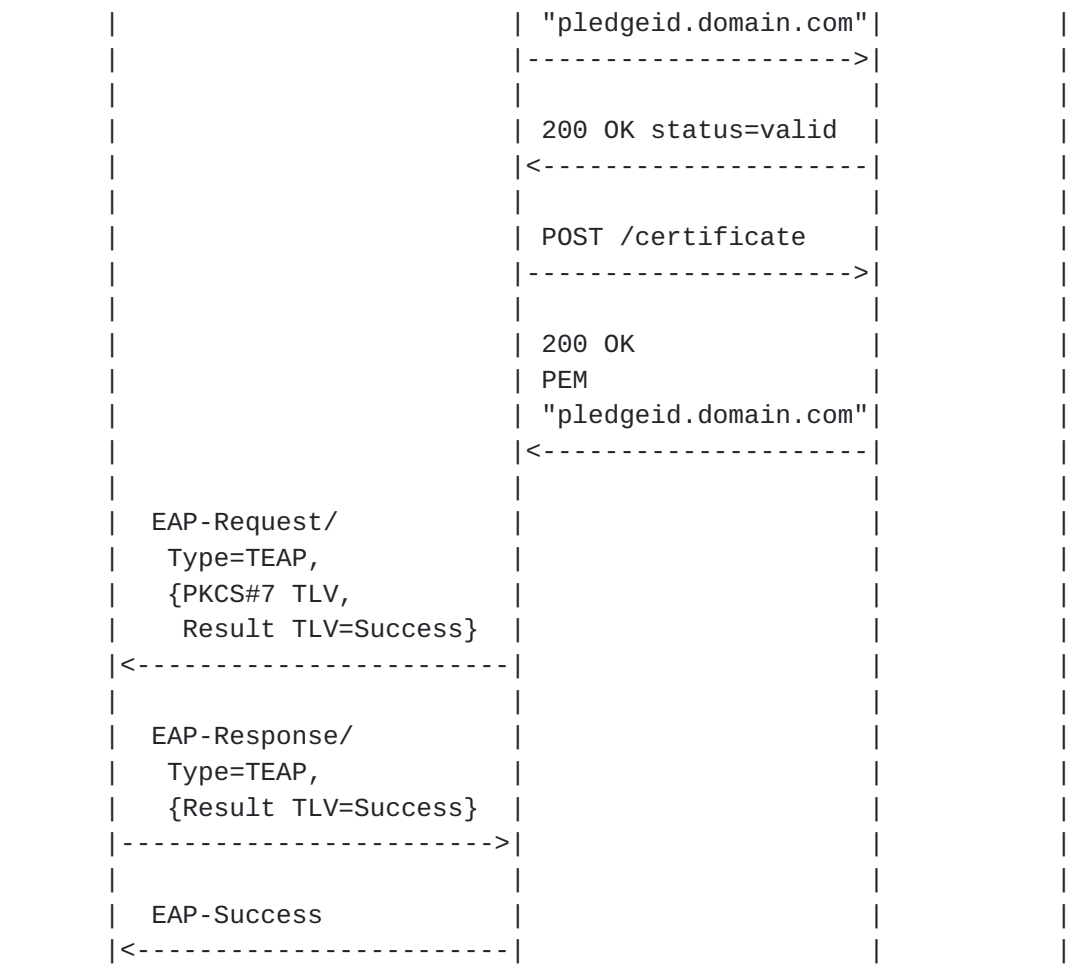
This section outlines how ACME could be used for communication between the TEAP server and the CA. The example call flow leverages [I-D.friel-acme-subdomains] and shows the TEAP server proving ownership of a parent domain, with individual client certificates being subdomains under that parent domain.

The example illustrates the TEAP server sending a Request-Action TLV including a CSR-Attributes TLV instructing the peer to send a CSR-Attributes TLV to the server. This enables the server to indicate what fields the peer should include in the CSR that the peer sends in the PKCS#10 TLV. For example, the TEAP server could instruct the peer what Subject or SAN entries to include in its CSR.




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=CSR-Attributes,
TLV=PKCS#10}
STEP 3: Enroll for certificate
EAP-Response/
Type=TEAP,
{CSR-Attributes TLV}
EAP-Request/
Type=TEAP,
{CSR-Attributes TLV}
EAP-Response/
Type=TEAP,
{PKCS#10 TLV:
"pledgeid.domain.com"}
POST /newOrder
"pledgeid.domain.com"
201 status=ready
POST /finalize
PKCS#10 CSR

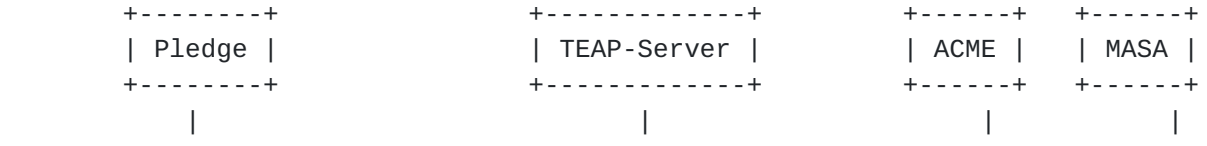


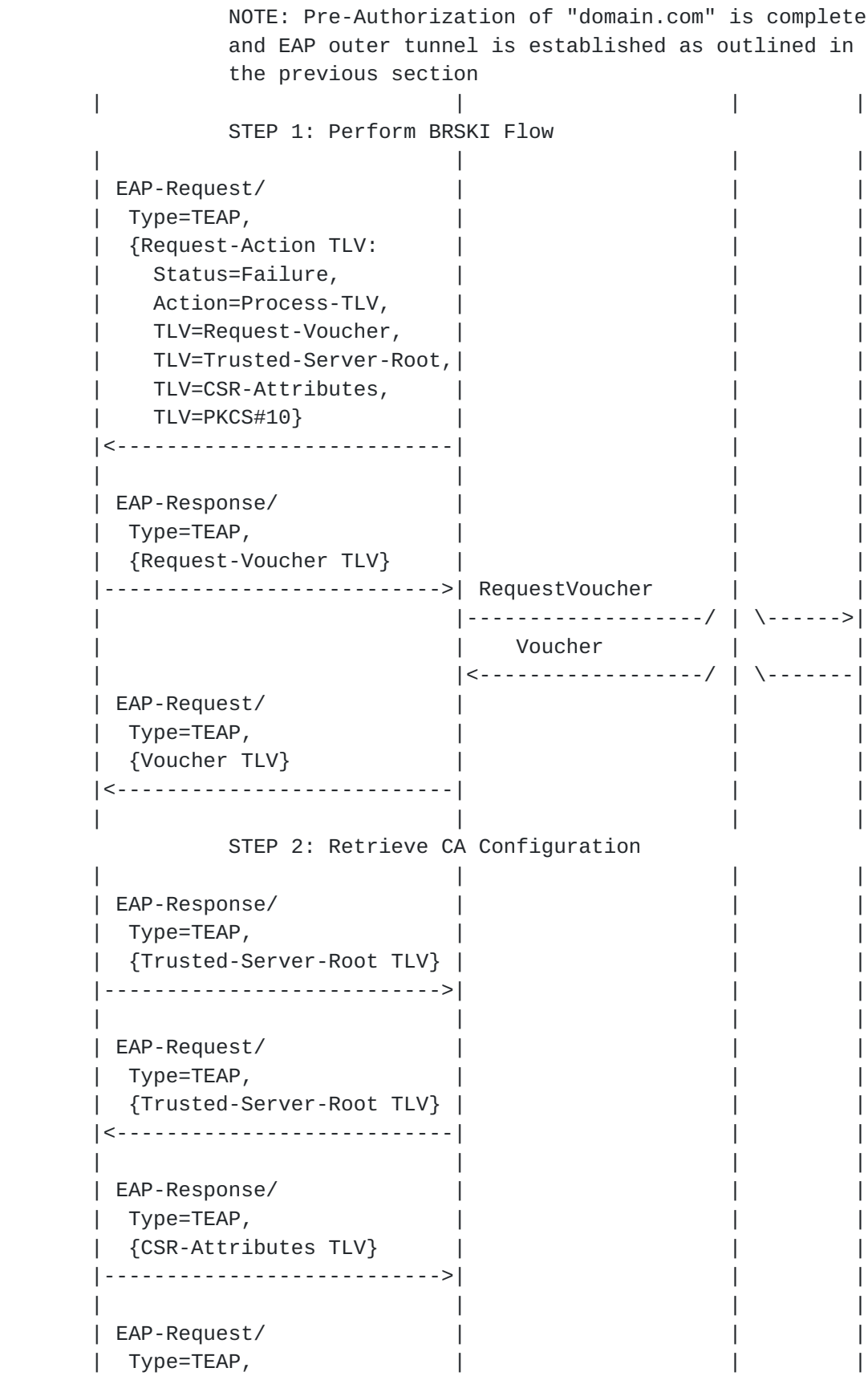
7. ACME Integration with TEAP-BRSKI

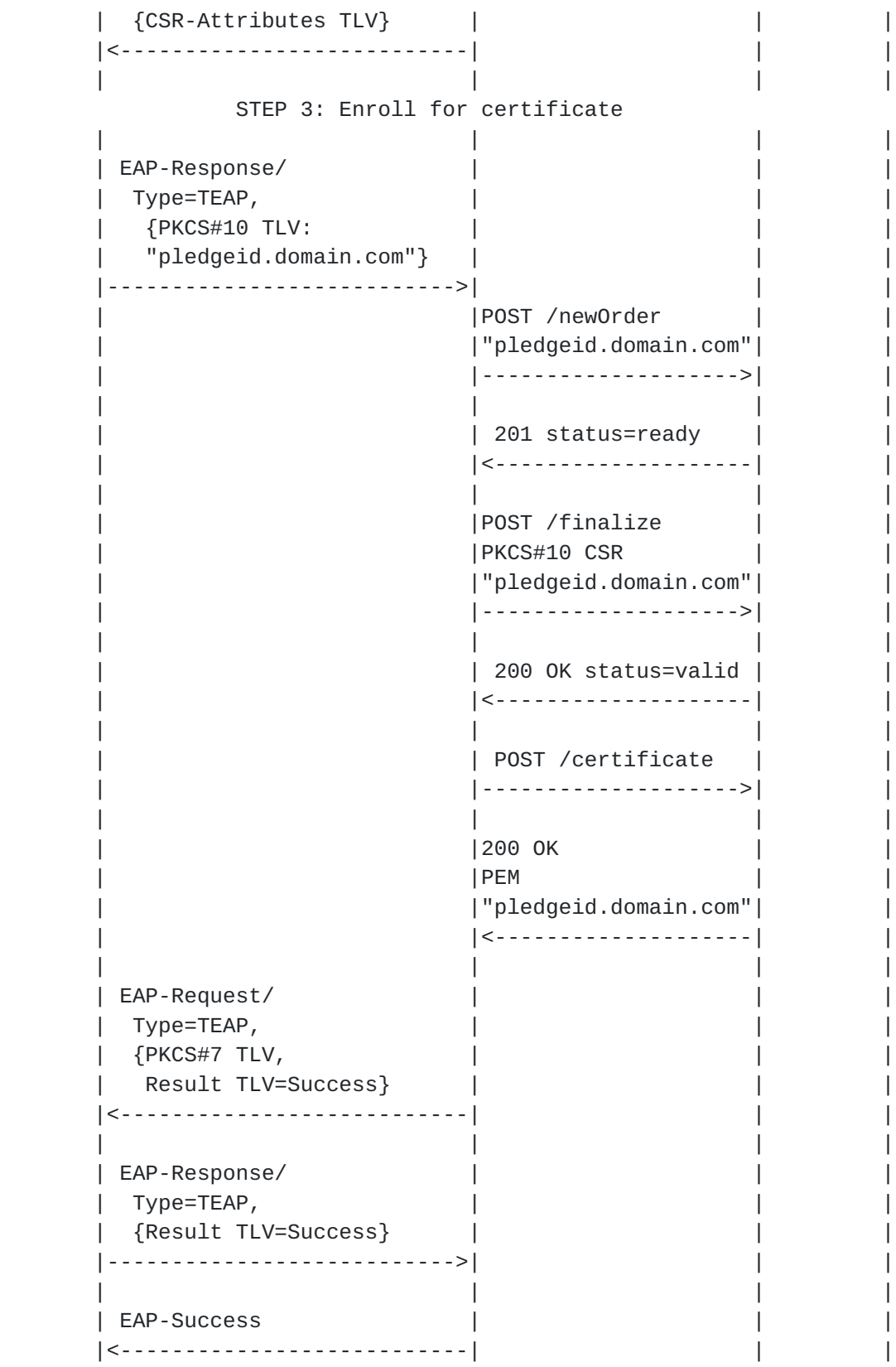
TEAP-BRSKI [I-D.lear-eap-teap-brski] defines how to execute BRSKI at layer 2 inside a TEAP tunnel. Similar to the TEAP proposal in the previous section, BRSKI-TEAP leverages the existing TEAP PKXS#10 and PKCS#7 mechanisms for certificate enrollment, and does not define how the TEAP server communicates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

Similar to baseline TEAP, the TEAP server can use the CSR-Atributes TLV to tell the peer what attributes to include in its CSR request.




NOTE: Pre-Authorization of "domain.com" is complete
and EAP outer tunnel is established as outlined in
the previous section
STEP 1: Perform BRSKI Flow
EAP-Request/
Type=TEAP,
{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:
"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
200 OK
PEM
"pledgeid.domain.com"
EAP-Request/
Type=TEAP,
{PKCS#7 TLV,
Result TLV=Success}
EAP-Response/
Type=TEAP,
{Result TLV=Success}
EAP-Success

8. IANA Considerations

[todo]

9. Security Considerations

[todo]

10. Informative References

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[I-D.ietf-anima-bootstrapping-keyinfra]
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[RFC8366] Watsen, K., Richardson, M., Pritikin, M., and T. Eckert, "A Voucher Artifact for Bootstrapping Protocols", RFC 8366, DOI 10.17487/RFC8366, May 2018, <https://www.rfc-editor.org/info/rfc8366>.

[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

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