Revocation protocols of WebPKI and Revocation Transparency

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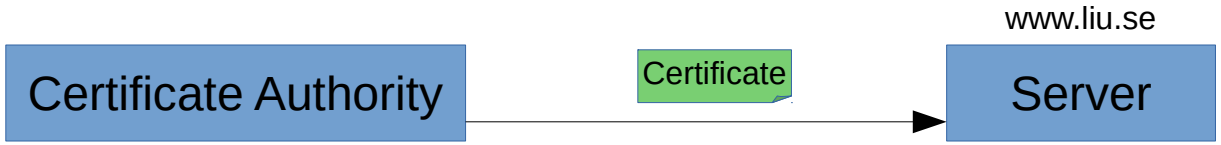
Lifecycle of a typical WebPKI certificate

1. Issuance

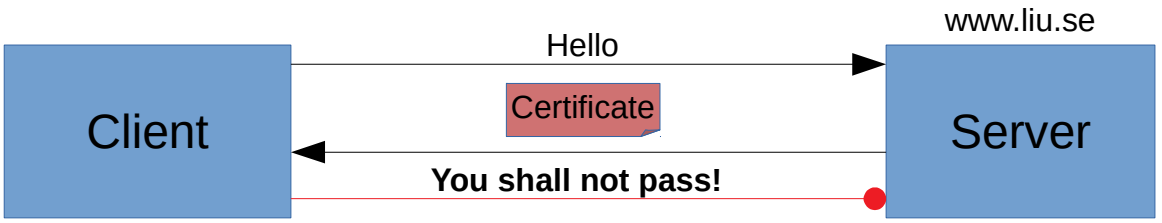


2. Use

...

3. Expiration

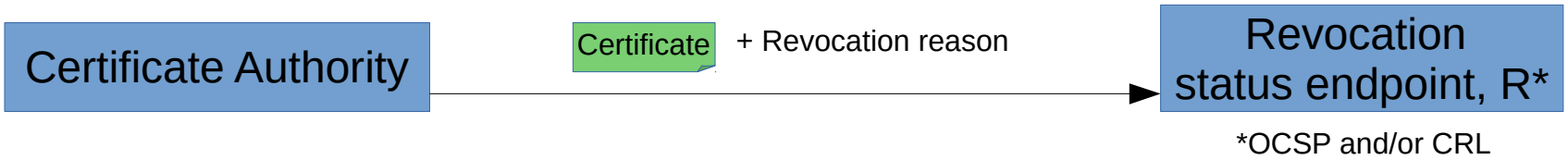
April, 1st



Revoking a certificate

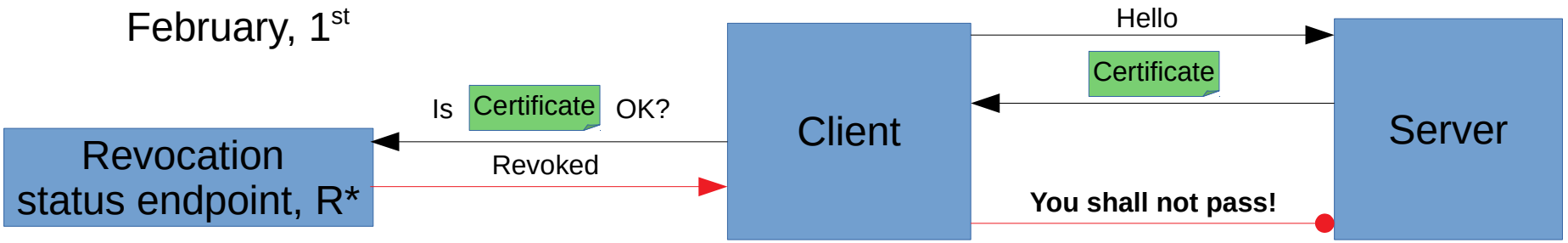
1. Revocation – is a process of invalidating a certificate prior its expiration.

Let the private key of the certificate be compromised, and the certificate owner asks the CA to revoke the certificate. Then:



2. Status delivery

February, 1st



Certificate Revocation List (RFC 5280)*

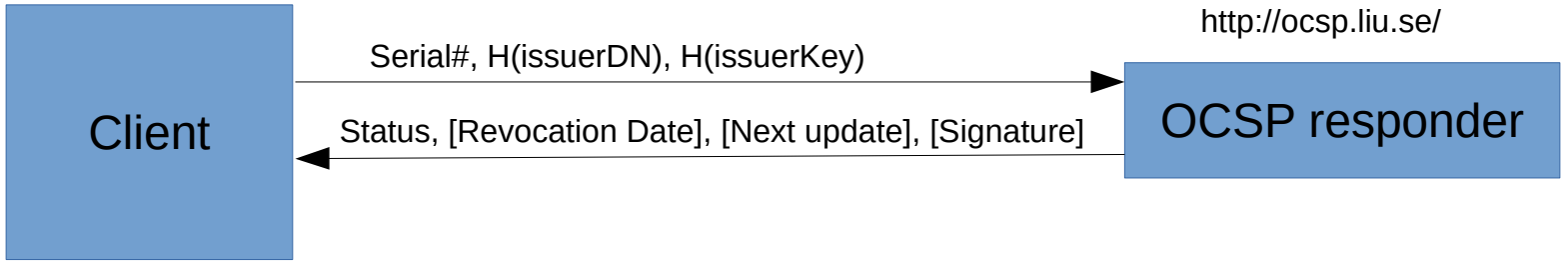
http://ca.liu.se/revoked.crl

serial#	[issuer]	[date]	[reasonCode]
52	liu.se	Feb, 4	1
412	liu.se	Feb, 9	5
...			

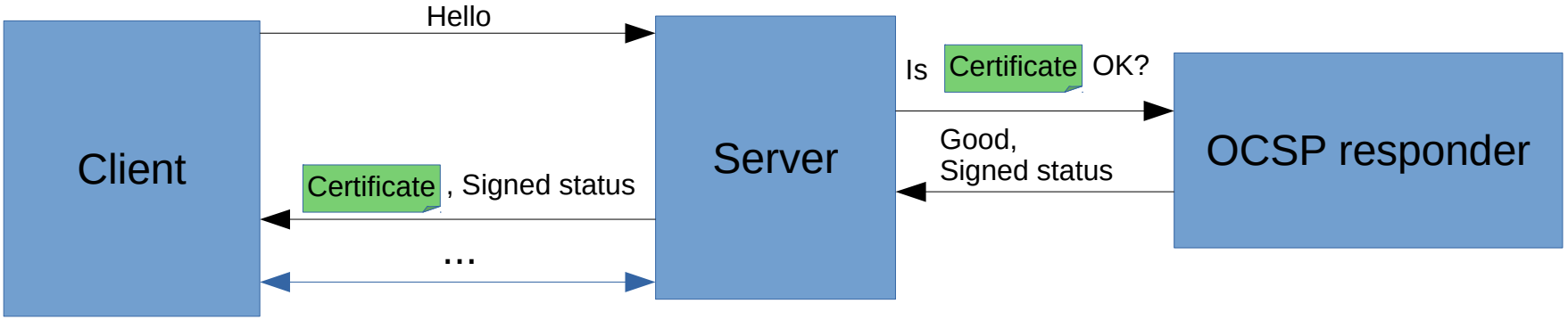
CRL date, next update, signature

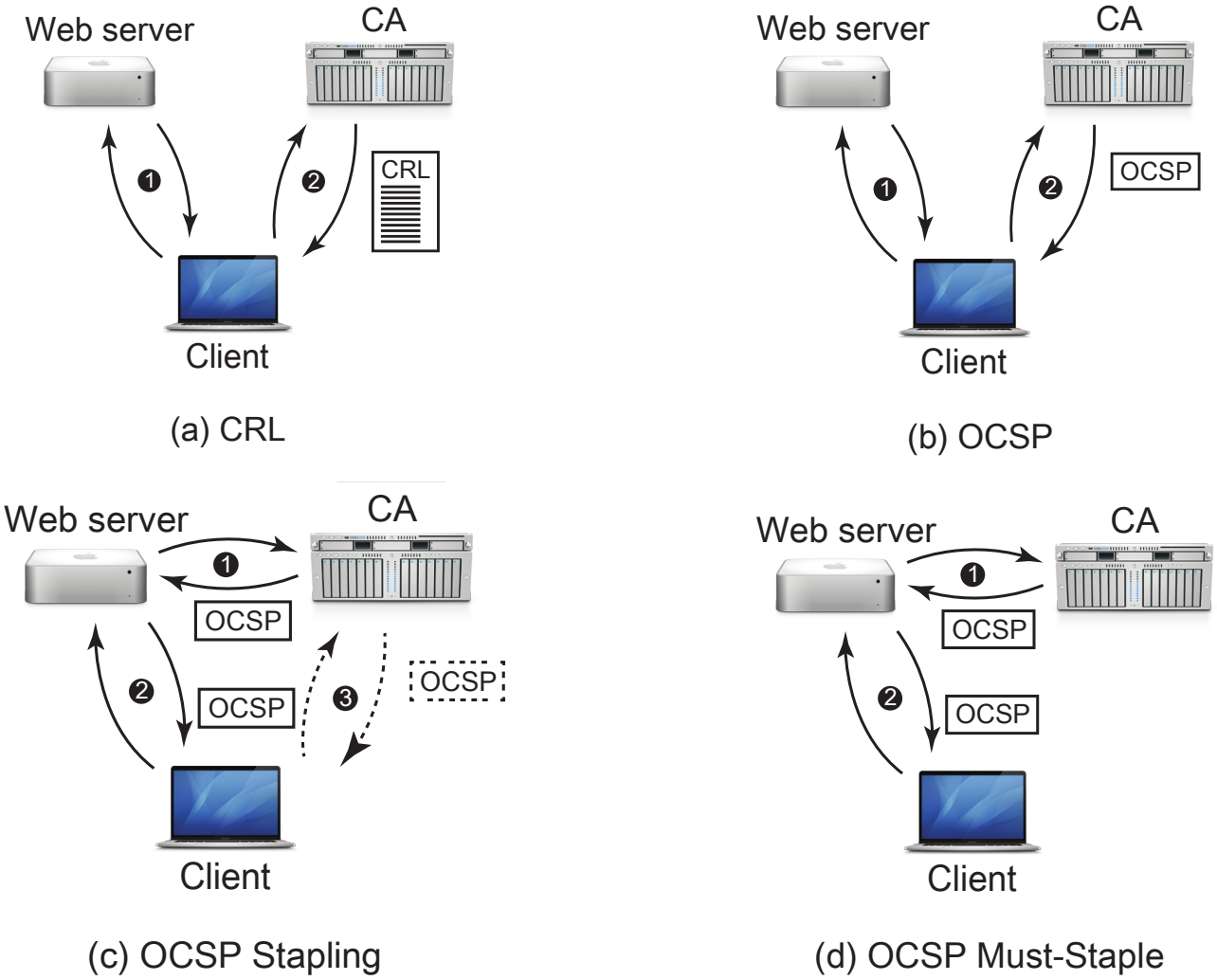
*CRLs are being phased out.

Online Certificate Status Protocol (RFC 6960)



OCSP ”stapling” (RFC 6066, 6961)





Steps in the process of checking revocation status with different protocols: (a) with CRLs, the client fetches the (potentially large) CRL after obtaining the certificate in the TLS handshake; (b) with OCSP, the client asks for the revocation status of only the particular certificate; (c) with OCSP Stapling, the server is supposed to prefetch the OCSP response and provide it in the handshake, and if it does not, the client can fetch the OCSP response as in (b); and (d) with OCSP Must-Staple, the server *must* provide an OCSP response in the handshake or the client will reject the certificate.

Revocation does not work

- **Liu et al., *An End-to-End Measurement of Certificate Revocation in the Web's PKI*, IMC 2015**
  – obtaining certificate status is expensive
  – most browsers don't check certificate status
  – custom revocation set (CRLSet by Google) only covers 0.35% of all revocations
- **Chung et al., *Is the Web Ready for OCSP Must-Staple?* IMC 2018**
  – not yet
- Mass revocations happen, and their exact scale is unclear
  - **Zhang et al., *Analysis of SSL Certificate Reissues and Revocations in the Wake of Heartbleed*, IMC 2014**
  - **https://arstechnica.com/information-technology/2019/03/godaddy-apple-and-google-goof-results-in-1-million-misissued-certificates/**

Other issues with current revocation status protocols:

- Performance (OCSP, CRL)
- Availability (OCSP, CRL)
- Replay attacks (OCSP, CRL)
- Privacy (OCSP)
- Soft-fails (Browsers ignore failed status requests)
- Transparency

Revocation does not work – Fixes

Possible fixes:

- Must-staple
- Custom revocation sets (CRLSet, OneCRL, …)
- Short validity periods
- A totally new WebPKI …
  - Yu et al., *DTKI: a new Formalized PKI with Verifiable Trusted Parties*, 2016
  - Kubilay et al., *CertLedger: A new PKI model with Certificate Transparency based on blockchain*, 2019
- Revocation Transparency

Revocation Transparency

- Broadly, a mechanism for logging (and optionally, delivery) of revocations.
- Could be used to create up-to-date revocation sets, detect revocation-related misbehavior by CAs, immutably preserve revocation history.
- Several schemes, standalone or as a part of a new PKI:
  - Laurie & Kasper, *Revocation Transparency*, Google, 2012
  - *CertLedger* (Kubilay et al., 2019), *AKI* (Hyun-Jin Kim et al., 2013), *DTKI* (Yu et al., 2016), *CertChain* (Chen et al., 2018)

- Our research goal:
  - Motivate the need for Revocation Transparency through (an ongoing) measurement
  - Develop a feasible and low-deployment-cost Revocation Transparency scheme on top of existing Certificate Transparency
  - Compare with other proposals

Thank you!

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