HTTPS 憑證簽署架構
Certificate Chain

臺灣大學計資中心

網路組

游子興

大綱

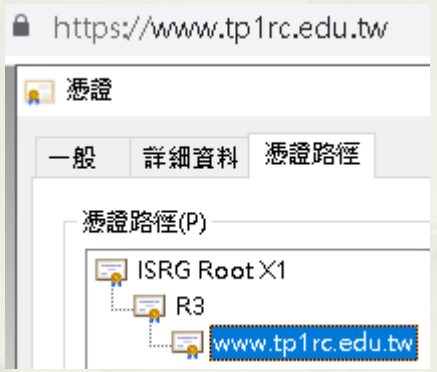
* Certificate Chain
* Certificate Chain Problems
* How to Fix Certificate Chain Problems

Certificate Chain

Certificate Chain Example

* www.ntu.edu.tw

* www.tp1rc.edu.tw

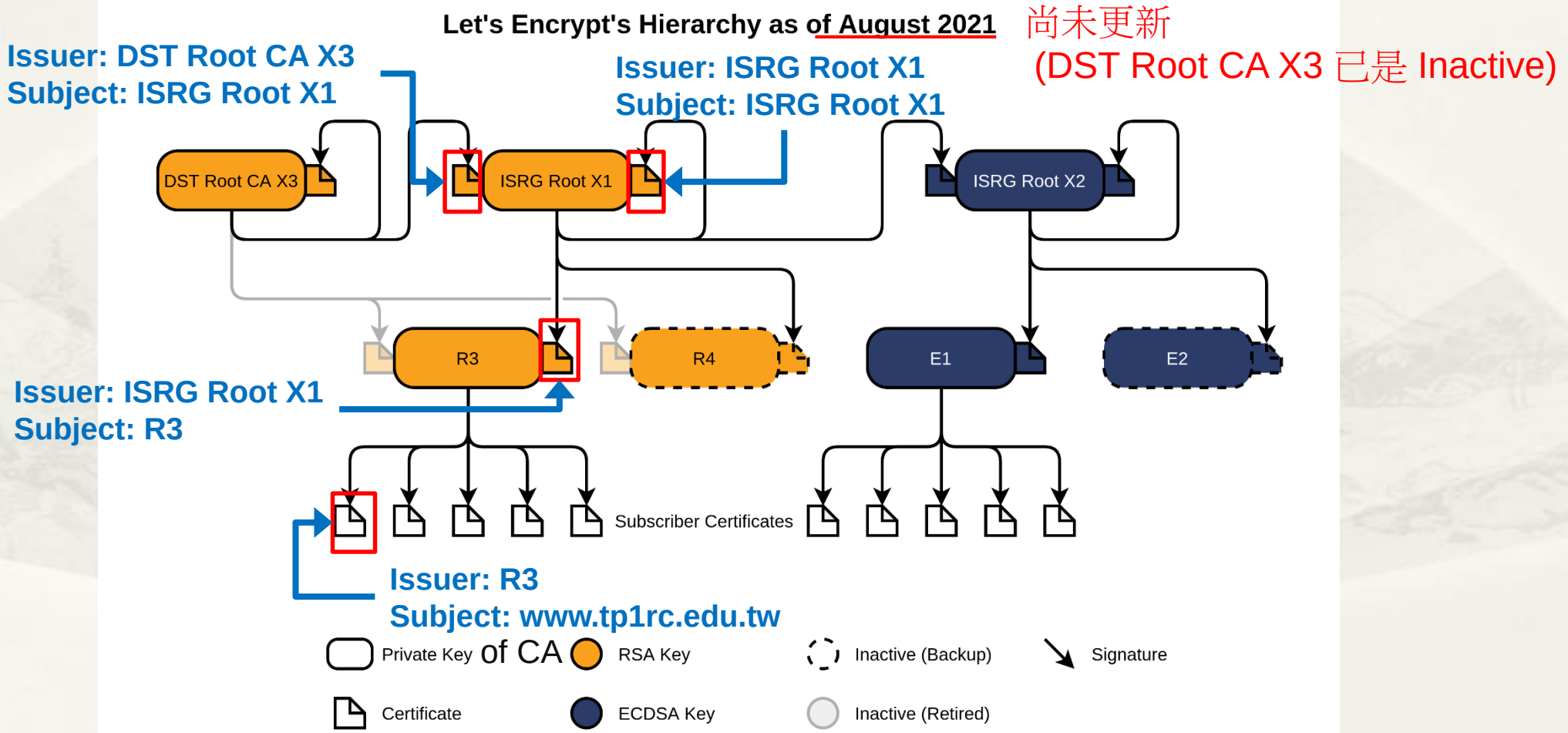


Certificate Chain Problems

- All operating systems contain a set of default trusted root certificates.
- But Certificate Authorities usually don't use their root certificate to sign customer certificates.
- They use so called intermediate certificates instead, because these can be rotated more frequently(有效日期較短).
- If not all intermediate certificates are installed on your server,
  - Some clients(Old browsers, curl, Line API) will think it's an insecure connection.
  - 新版瀏覽器(Chrome. Firefox)都很 "聰明"，會自動修正或補齊 web server 提供的錯誤憑證鏈。
- Best Practice
  - Server should always send a complete trust chain. The trust chain contains your certificate concatenated with all intermediate certificates.

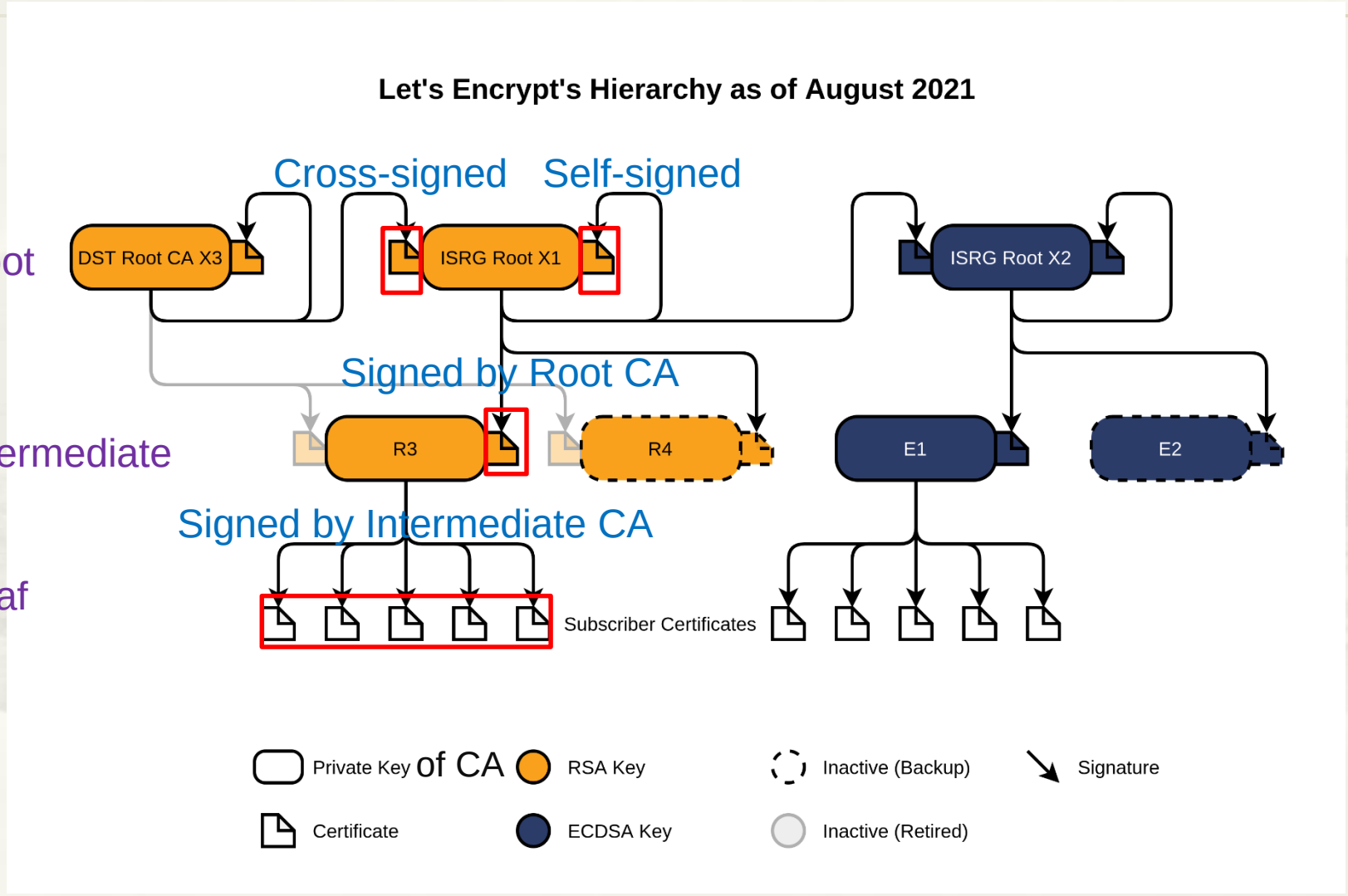
Let's Encrypt Chain of Trust

https://letsencrypt.org/certificates/



尚未更新
(DST Root CA X3 已是 Inactive)

Let's Encrypt Chain of Trust



Leaf Certificate (Server Certificate) CN=www.tp1rc.edu.tw

* https://crt.sh/?id=5372942977

Server Certificate Download (PEM format)

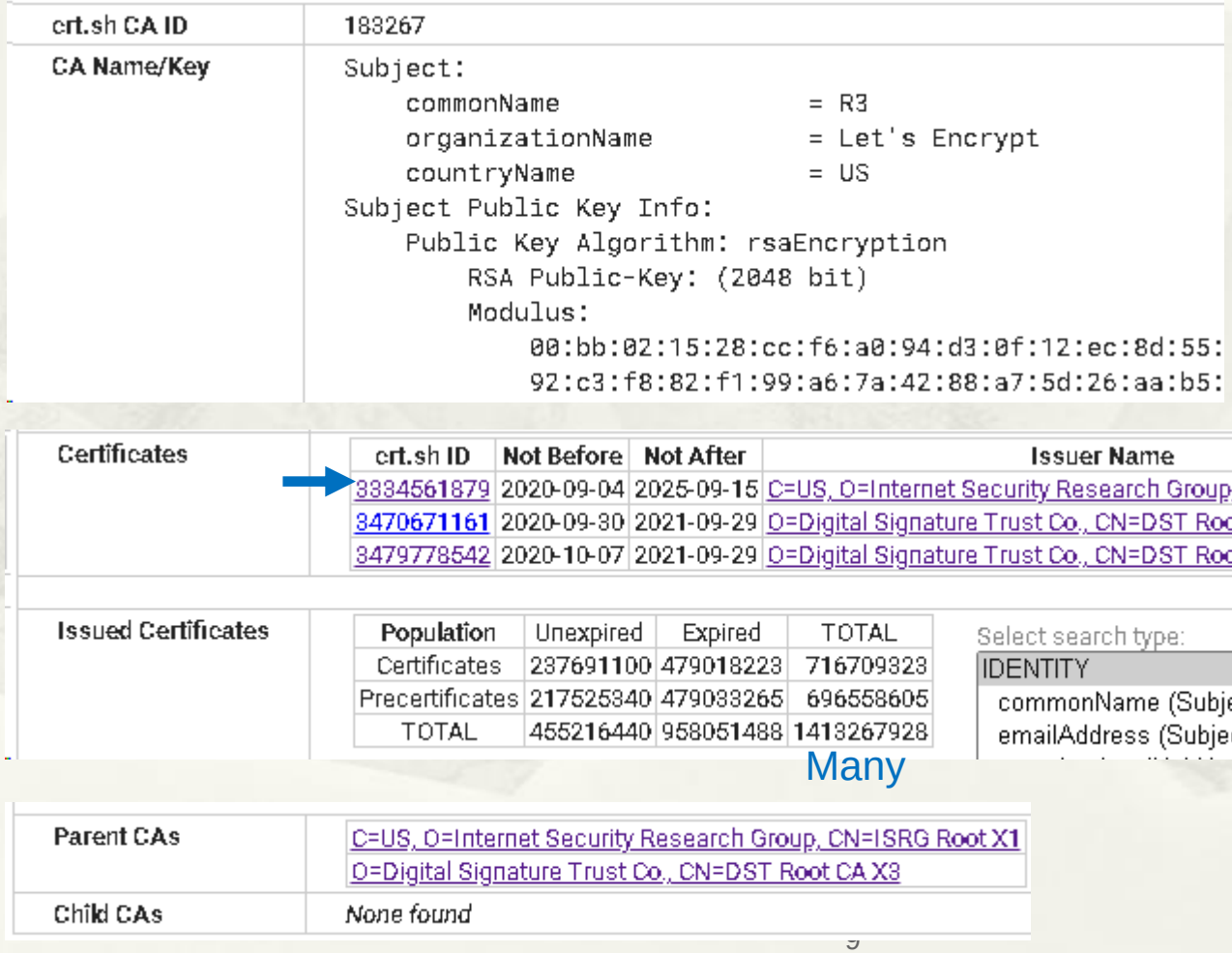
```
Certificate:
    Data:
        Version: 3 (0x2)
        Serial Number:
            03:34:d3:01:86:14:a3:22:e0:a4:bb:61:a4:ab:dc:c3:bc:a3
        Signature Algorithm: sha256WithRSAEncryption
        Issuer: (CA ID: 183267)
            commonName               = R3
            organizationName         = Let's Encrypt
            countryName              = US
        Validity
            Not Before: Oct  8 01:50:56 2021 GMT
            Not After : Jan  6 01:50:55 2022 GMT
        Subject:
            commonName               = www.tp1rc.edu.tw
        Subject Public Key Info:
            Public Key Algorithm: rsaEncryption
                RSA Public-Key: (2048 bit)
                Modulus:
                    00:b6:18:39:2b:53:32:fd:e9:b8:66:3d:4b:71:82:
                    76:cd:55:b8:a5:4e:87:d4:f8:ff:19:d0:77:a8:16:
```

Signed by Intermediate CA

效期 3個月

Intermediate CA
CN=R3 O=Let's Encrypt

* https://crt.sh/?caid=183267



crt.sh CA ID	183267
CA Name/Key	Subject: commonName = R3 organizationName = Let's Encrypt countryName = US Subject Public Key Info: Public Key Algorithm: rsaEncryption RSA Public-Key: (2048 bit) Modulus: 00:bb:02:15:28:cc:f6:a0:94:d3:0f:12:ec:8d:55: 92:c3:f8:82:f1:99:a6:7a:42:88:a7:5d:26:aa:b5:

Certificates	crt.sh ID	Not Before	Not After	Issuer Name
	3334561879	2020-09-04	2025-09-15	C=US, O=Internet Security Research Group, CN=ISRG Root X1
	3470671161	2020-09-30	2021-09-29	O=Digital Signature Trust Co., CN=DST Root CA X3
	3479778542	2020-10-07	2021-09-29	O=Digital Signature Trust Co., CN=DST Root CA X3

Signed by Root
Signed by Root
Signed by Root

Issued Certificates	Population	Unexpired	Expired	TOTAL
	Certificates	237691100	479018223	716709323
	Precertificates	217525340	479033265	696558605
	TOTAL	455216440	958051488	1413267928

Select search type:
IDENTITY
commonName (Subject)
emailAddress (Subject)

Many

Parent CAs	C=US, O=Internet Security Research Group, CN=ISRG Root X1 O=Digital Signature Trust Co., CN=DST Root CA X3
Child CAs	*None found*

Intermediate Certificate CN=R3

* https://crt.sh/?id=3334561879

Intermediate Certificate Download (PEM format)

```
Certificate:
    Data:
        Version: 3 (0x2)
        Serial Number:
            91:2b:08:4a:cf:0c:18:a7:53:f6:d6:2e:25:a7:5f:5a
        Signature Algorithm: sha256WithRSAEncryption
        Issuer: (CA ID: 7394)
            commonName                = ISRG Root X1
            organizationName          = Internet Security Research Group
            countryName               = US
        Validity
            Not Before: Sep  4 00:00:00 2020 GMT
            Not After : Sep 15 16:00:00 2025 GMT
        Subject: (CA ID: 183267)
            commonName                = R3
            organizationName          = Let's Encrypt
            countryName               = US
        Subject Public Key Info:
            Public Key Algorithm: rsaEncryption
                RSA Public-Key: (2048 bit)
                Modulus:
                    00:bb:02:15:28:cc:f6:a0:94:d3:0f:12:ec:8d:55:
                    92:c3:f8:82:f1:99:a6:7a:42:88:a7:5d:26:aa:b5:
```

Signed by Root CA

效期 5年

Root CA
CN=ISRG Root X1 (1/2)

* https://crt.sh/?caid=7394

crt.sh CA ID	7394
CA Name/Key	Subject: commonName = ISRG Root X1 organizationName = Internet Security Research Group countryName = US Subject Public Key Info: Public Key Algorithm: rsaEncryption RSA Public-Key: (4096 bit) Modulus: 00:ad:e8:24:73:f4:14:37:f3:9b:9e:2b:57:28:1c: 87:be:dc:b7:df:38:90:8c:6e:3c:e6:57:a0:78:f7:

CA 有效日期

Certificates	crt.sh ID	Not Before	Not After	Issuer Name
	9314791	2015-06-04	2035-06-04	C=US, O=Internet Security Research Group, CN=ISRG Root X1
	3958242236	2021-01-20	2024-09-30	O=Digital Signature Trust Co., CN=DST Root CA X3

Self-signed
Cross-signed

Issued Certificates	Population	Unexpired	Expired	TOTAL
	Certificates	5	5	10
	Precertificates	0	0	0
	TOTAL	5	5	10

Select search type:
IDENTITY
commonName (Subject)
emailAddress (Subject)

Enter sea
(% = All ce

Very few

Root CA
CN=ISRG Root X1 (2/2)

Trust

Purpose	Context (Version) Shortest Path Disabled From NotBefore Until									
	360 Browser (2021-08-05)	Apple (macOS 11.2)	Microsoft (2021-09-10)	Mozilla (2021-09-17)	Chrome (2020-05-15)	Android (2021-10-06)	Java (16.0.1)	Adobe CDS	Adobe AATL (2021-09-22)	Adobe EUTL (2021-10-01)
Server Authentication	No	Valid [1]	Valid [1]	Valid [1]	Defer to OS	Valid [1]	Valid [1]	n/a	n/a	n/a
Client Authentication	n/a	n/a	Valid [1]	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Secure Email	n/a	Valid [1]	Expired [2]	No	n/a	n/a	n/a	n/a	No	No
Code Signing	n/a	Valid [1]	No	n/a	n/a	n/a	Valid [1]	n/a	No	No
Kernel Mode Code Signing	n/a	n/a	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Time Stamping	n/a	Valid [1]	Expired [2]	n/a	n/a	n/a	n/a	n/a	n/a	n/a
OCSP Signing	n/a	n/a	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Document Signing	n/a	n/a	Expired [2]	n/a	n/a	n/a	n/a	n/a	No	No
Encrypting File System	n/a	n/a	Expired [2]	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IP security end system	n/a	n/a	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IP security IKE intermediate	n/a	n/a	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IP security tunnel termination	n/a	n/a	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a
IP security user	n/a	Valid [1]	No	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Adobe Authentic Document	n/a	n/a	n/a	n/a	n/a	n/a	n/a	No	No	No

Parent CAs

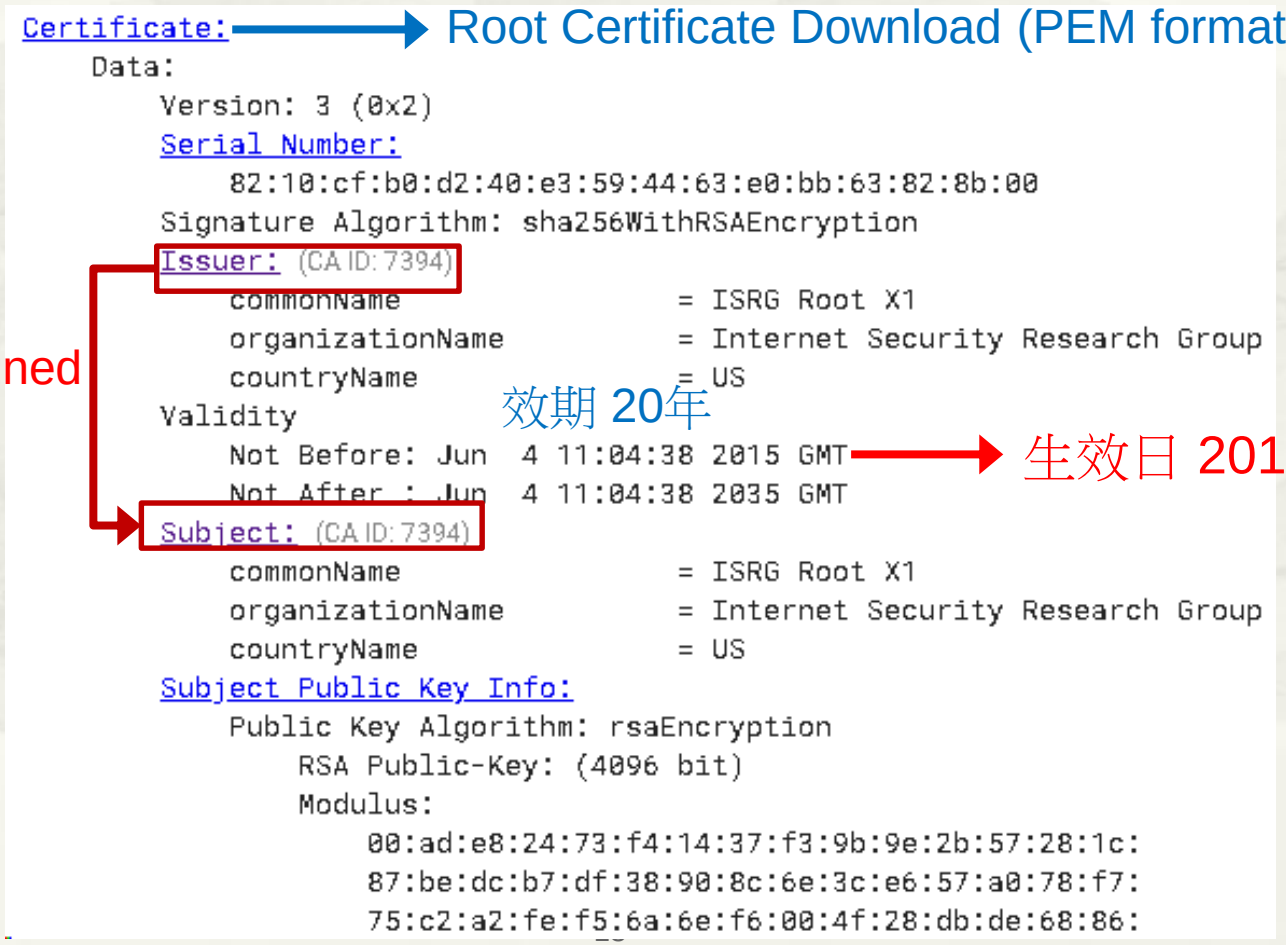
O=Digital Signature Trust Co., CN=DST Root CA X3

Child CAs

C=US, O=Internet Security Research Group, CN=ISRG Root X2
C=US, O=Let's Encrypt, CN=Let's Encrypt Authority X1
C=US, O=Let's Encrypt, CN=Let's Encrypt Authority X2
C=US, O=Let's Encrypt, CN=Let's Encrypt Authority X3
C=US, O=Let's Encrypt, CN=Let's Encrypt Authority X4
C=US, O=Let's Encrypt, CN=R3
C=US, O=Let's Encrypt, CN=R4

Root Certificate
CN=ISRG Root X1

* https://crt.sh/?id=9314791



Root Certificate
CN=ISRG Root X1

* https://crt.sh/?id=3958242236

Cross-signed

```
Certificate:
    Data:
        Version: 3 (0x2)
        Serial Number:
            40:01:77:21:37:d4:e9:42:b8:ee:76:aa:3c:64:0a:b7
        Signature Algorithm: sha256WithRSAEncryption
        Issuer: (CA ID: 276)
            commonName                = DST Root CA X3
            organizationName          = Digital Signature Trust Co.
        Validity
            Not Before: Jan 20 19:14:03 2021 GMT
            Not After : Sep 30 18:14:03 2024 GMT
        Subject: (CA ID: 7394)
            commonName                = ISRG Root X1
            organizationName          = Internet Security Research Group
            countryName               = US
        Subject Public Key Info:
            Public Key Algorithm: rsaEncryption
                RSA Public-Key: (4096 bit)
                Modulus:
                    00:ad:e8:24:73:f4:14:37:f3:9b:9e:2b:57:28:1c:
                    87:be:dc:b7:df:38:90:8c:6e:3c:e6:57:a0:78:f7:
```

效期 3.5年

Root CA
CN= DST Root CA X3

* https://crt.sh/?caid=276

crt.sh CA ID	276
CA Name/Key	Subject: commonName = DST Root CA X3 organizationName = Digital Signature Trust Co. Subject Public Key Info: Public Key Algorithm: rsaEncryption RSA Public-Key: (2048 bit) Modulus: 00:df:af:e9:97:50:08:83:57:b4:cc:62:65:f6:90: 82:ec:c7:d3:2c:6b:30:ca:5b:ec:d9:c3:7d:c7:40:

CA 有效日期

Certificates	crt.sh ID	Not Before	Not After	Issuer Name
	8986898	2000-09-30	2008-01-21	C=us, ST=Utah, L=Salt Lake City, O=Digital Signature Trust Co., OU=DSTCA X1, CN=DST RootCA X1, emailAddress=ca@digsigtrust.com
	8376050	2004-09-08	2008-11-28	C=us, ST=Utah, L=Salt Lake City, O=Digital Signature Trust Co., OU=DSTCA X1, CN=DST RootCA X1, emailAddress=ca@digsigtrust.com
	12729327	2004-09-08	2008-11-27	C=us, ST=Utah, L=Salt Lake City, O=Digital Signature Trust Co., OU=DSTCA X1, CN=DST RootCA X1, emailAddress=ca@digsigtrust.com
	8395	2000-09-30	2021-09-30	O=Digital Signature Trust Co., CN=DST Root CA X3

全部已過期

* CA 已過期，所簽發之 Certificate 有效 or 無效？

Root Certificate
CN=DST Root CA X3

* https://crt.sh/?id=8395

```
Certificate:
    Data:
        Version: 3 (0x2)
        Serial Number:
            44:af:b0:80:d6:a3:27:ba:89:30:39:86:2e:f8:40:6b
        Signature Algorithm: sha1WithRSAEncryption
        Issuer: (CA ID: 276)
            commonName                = DST Root CA X3
            organizationName          = Digital Signature Trust Co.
        Validity (Expired)
            Not Before: Sep 30 21:12:19 2000 GMT
            Not After : Sep 30 14:01:15 2021 GMT
        Subject: (CA ID: 276)
            commonName                = DST Root CA X3
            organizationName          = Digital Signature Trust Co.
        Subject Public Key Info:
            Public Key Algorithm: rsaEncryption
                RSA Public-Key: (2048 bit)
                Modulus:
                    00:df:af:e9:97:50:08:83:57:b4:cc:62:65:f6:90:
                    82:ec:c7:d3:2c:6b:30:ca:5b:ec:d9:c3:7d:c7:40:
```

效期 21年

到期日 2021/09/30

Certificate Chain Problems

Certificate Chain Check

* Online Service
  * https://www.ssllabs.com/ssltest/analyze.html
  * https://www.digicert.com/help/
  * https://ssltools.godaddy.com/views/certChecker
  * https://www.sslchecker.com/sslchecker (有時怪怪的)
  * https://check.twnic.tw/

Certificate Chain Check

- Client Program (需提供正確 Intermediate Certificate 才能連線)
  - 使用舊版 Browser, wget
  - curl -v https://www.ntub.edu.tw
  - curl -v https://incomplete-chain.badssl.com

```
* successfully set certificate verify locations:
*   CAfile: /etc/ssl/certs/ca-certificates.crt
  CApath: /etc/ssl/certs
* TLSv1.3 (OUT), TLS handshake, Client hello (1):
* TLSv1.3 (IN), TLS handshake, Server hello (2):
* TLSv1.2 (IN), TLS handshake, Certificate (11):
* TLSv1.2 (OUT), TLS alert, unknown CA (560):
* SSL certificate problem: unable to get local issuer certificate
* Closing connection 0
curl: (60) SSL certificate problem: unable to get local issuer certificate
More details here: https://curl.haxx.se/docs/sslcerts.html
```

發生錯誤, 無法連線

Certificate Chain Check
人工自行檢查

* openssl s_client -connect www.ntu.edu.tw:443 -servername www.ntu.edu.tw

```
Certificate chain
 0 s:C = TW, ST = Taiwan, L = Taipei, O = National Taiwan University, OU = Computer and Information Networking Center, CN = *.ntu.edu.tw
   i:C = TW, O = TAIWAN-CA, OU = Secure SSL Sub-CA, CN = TWCA Secure SSL Certification Authority
 1 s:C = TW, O = TAIWAN-CA, OU = Secure SSL Sub-CA, CN = TWCA Secure SSL Certification Authority
   i:C = TW, O = TAIWAN-CA, OU = Root CA, CN = TWCA Global Root CA
 2 s:C = TW, O = TAIWAN-CA, OU = Root CA, CN = TWCA Global Root CA
   i:C = TW, O = TAIWAN-CA, OU = Root CA, CN = TWCA Root Certification Authority
 3 s:C = TW, O = TAIWAN-CA, OU = Root CA, CN = TWCA Root Certification Authority
   i:C = TW, O = TAIWAN-CA, OU = Root CA, CN = TWCA Root Certification Authority
```

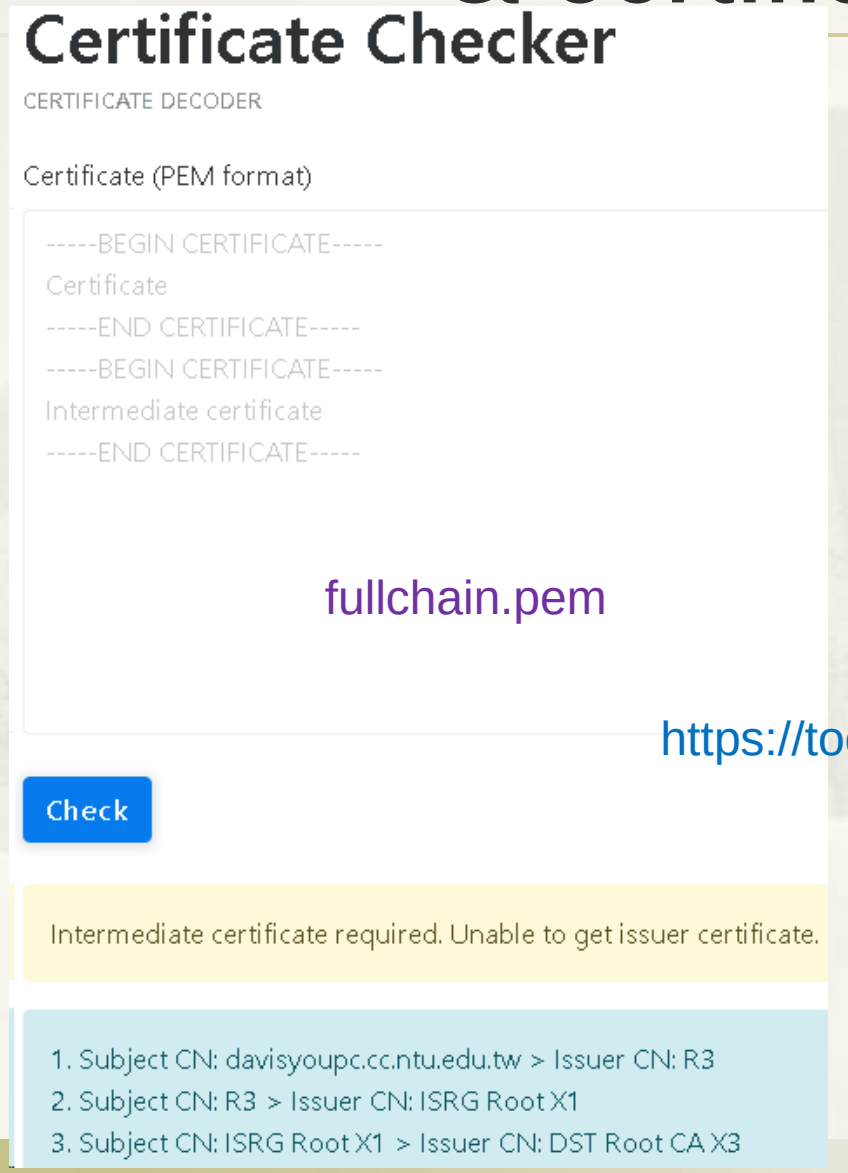
正確

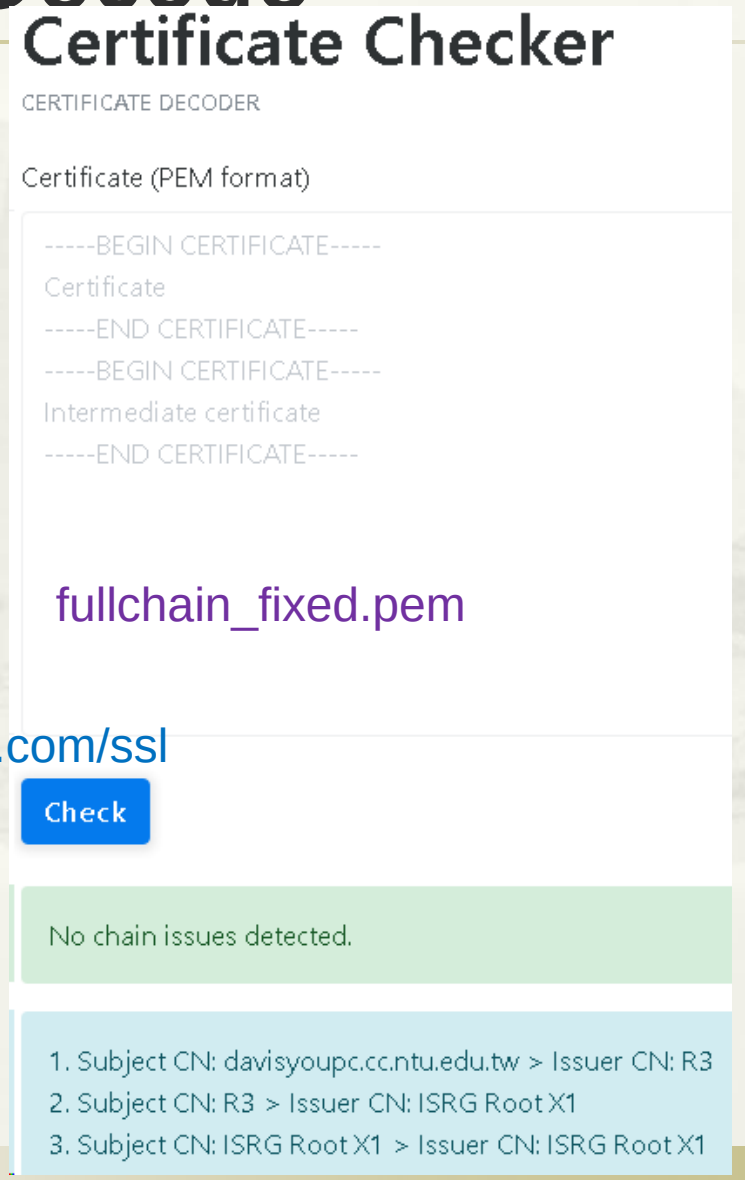
* openssl s_client -connect www.ntub.edu.tw:443 -servername www.ntub.edu.tw

```
depth=0 CN = *.ntub.edu.tw
verify error:num=20:unable to get local issuer certificate
verify return:1
depth=0 CN = *.ntub.edu.tw
verify error:num=21:unable to verify the first certificate
verify return:1
---
Certificate chain
 0 s:CN = *.ntub.edu.tw
   i:C = US, O = DigiCert Inc, CN = RapidSSL TLS DV RSA Mixed SHA256 2020 CA-1
 1 s:C = US, O = DigiCert Inc, OU = www.digicert.com, CN = DigiCert Global Root G2
   i:C = US, O = DigiCert Inc, OU = www.digicert.com, CN = DigiCert Global Root G2
 2 s:C = US, O = DigiCert Inc, OU = www.digicert.com, CN = RapidSSL TLS RSA CA G1
   i:C = US, O = DigiCert Inc, OU = www.digicert.com, CN = DigiCert Global Root G2
```

異常

Certificate Chain Check & Certificate Decode





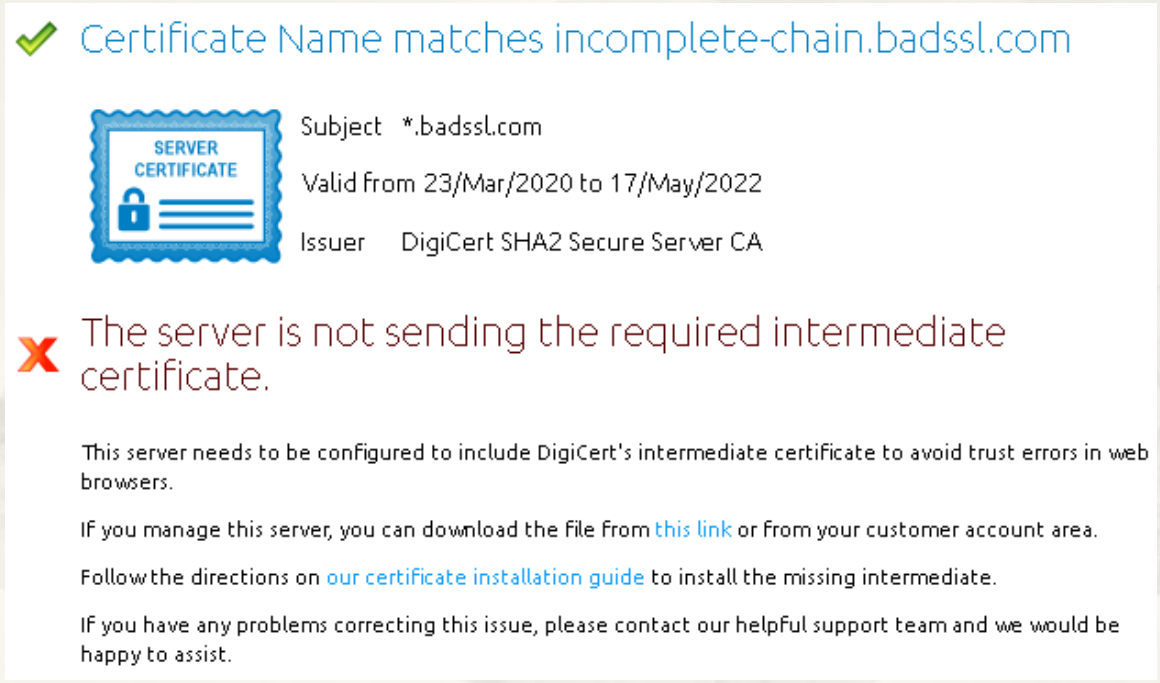
https://tools.keycdn.com/ssl

案例: 未提供 Intermediate Certificate

僅提供自身 Server Certificate

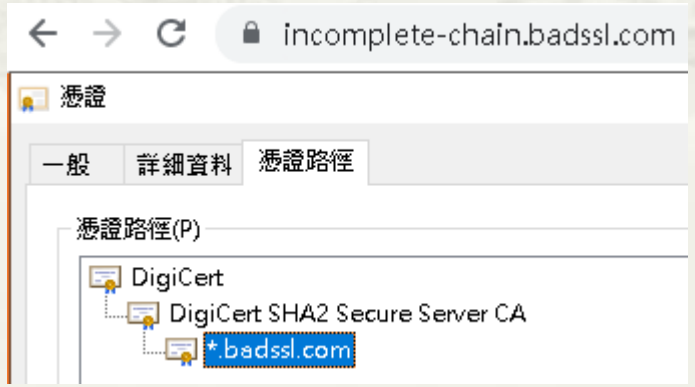
未提供 Intermediate Certificate
Test Site: incomplete-chain.badssl.com

* https://www.digicert.com/help



* https://check.twnic.tw

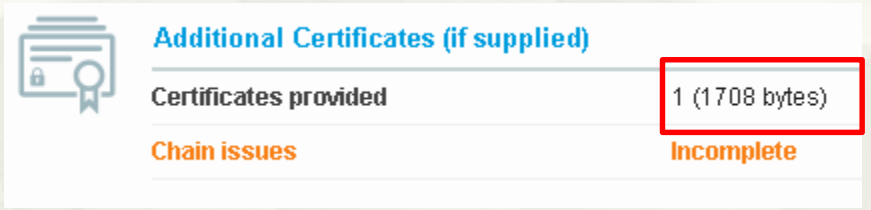
* Chrome 會自行修正



未提供 Intermediate Certificate

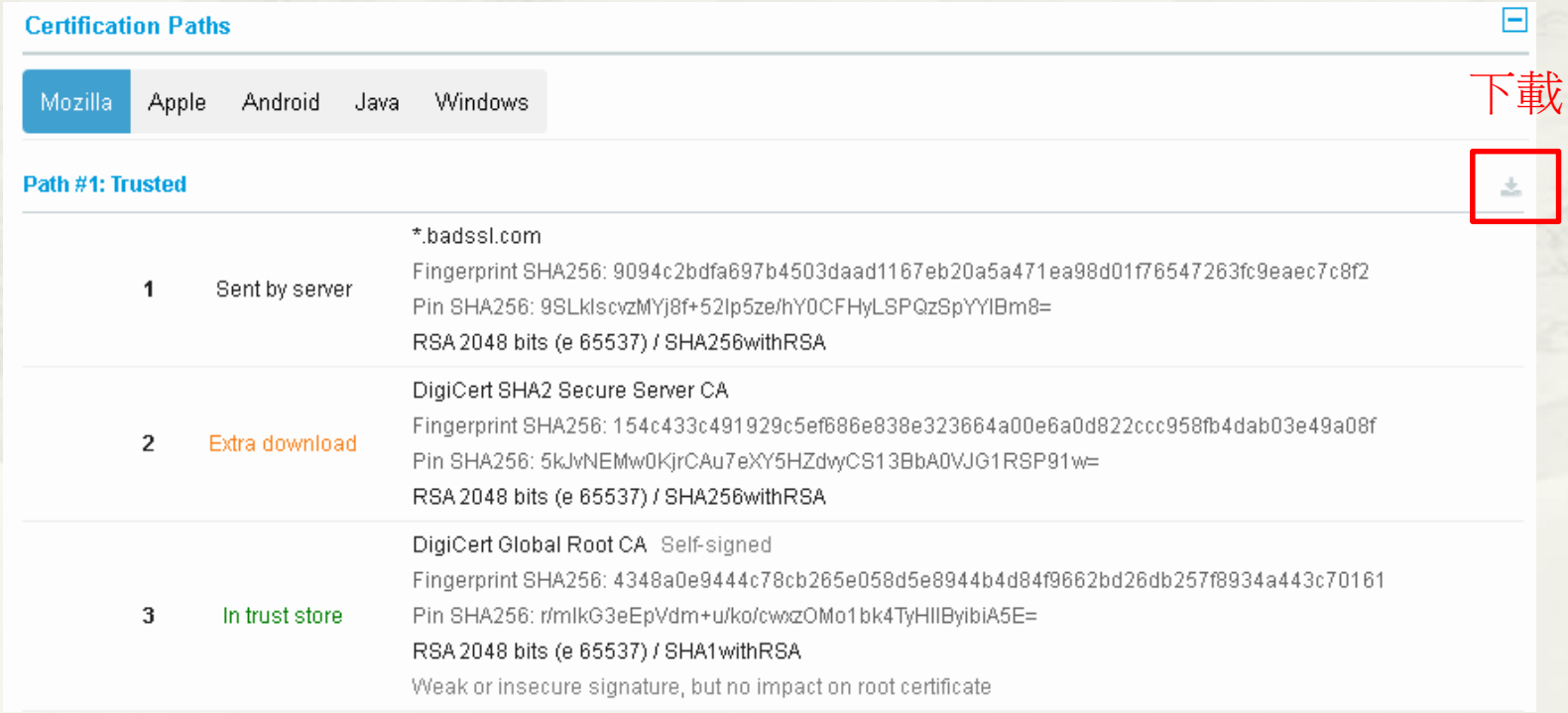
Test Site: incomplete-chain.badssl.com

* https://www.ssllabs.com/ssltest/analyze.html?d=incomplete-chain.badssl.com



僅提供自身 Server Certificate

* 修正後 Certificate Chain

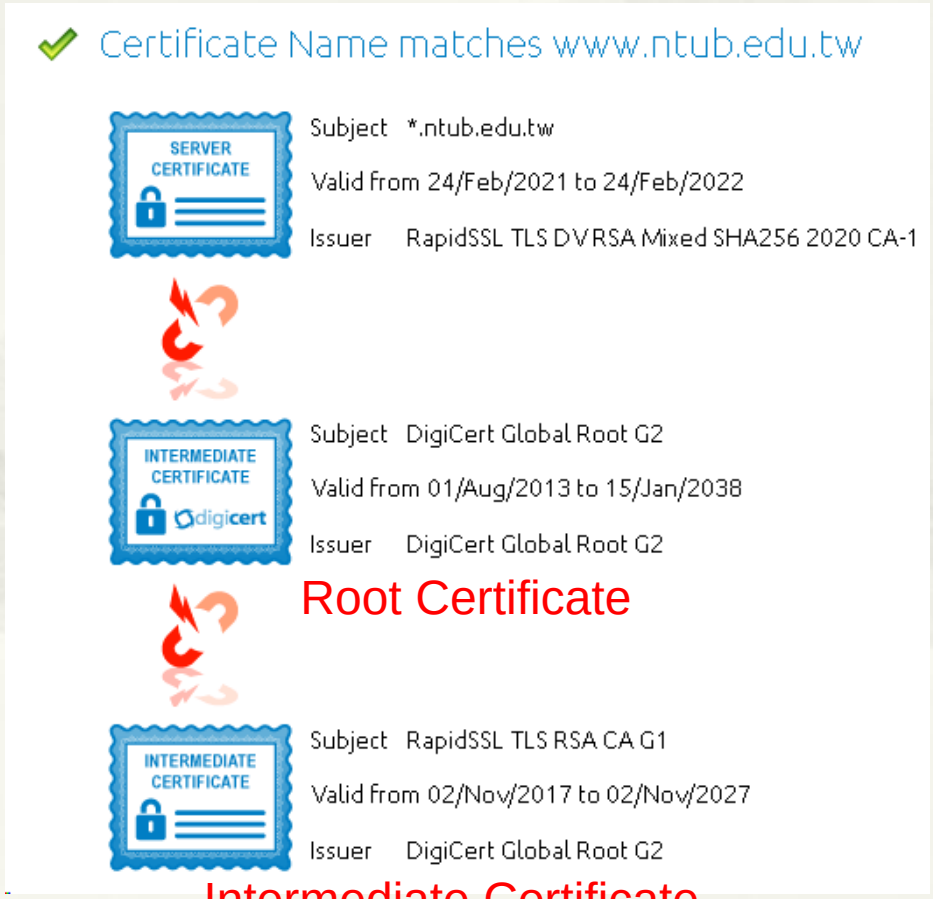


下載

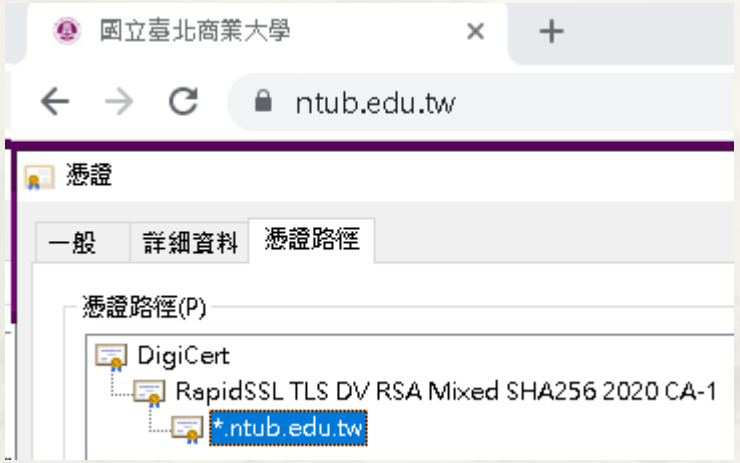
案例: 提供錯誤 **Intermediate Certificate**

提供錯誤 Intermediate Certificate
Test Site: www.ntub.edu.tw

* https://www.digicert.com/help/



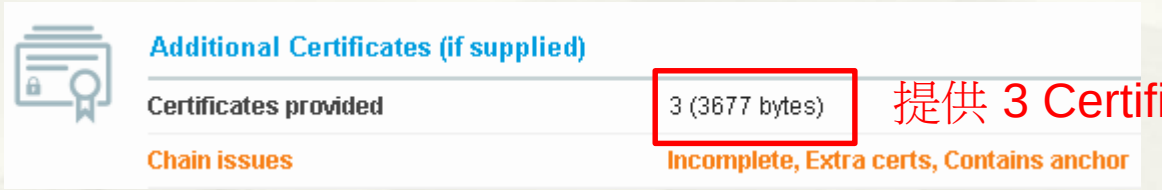
* Chrome 會自行修正



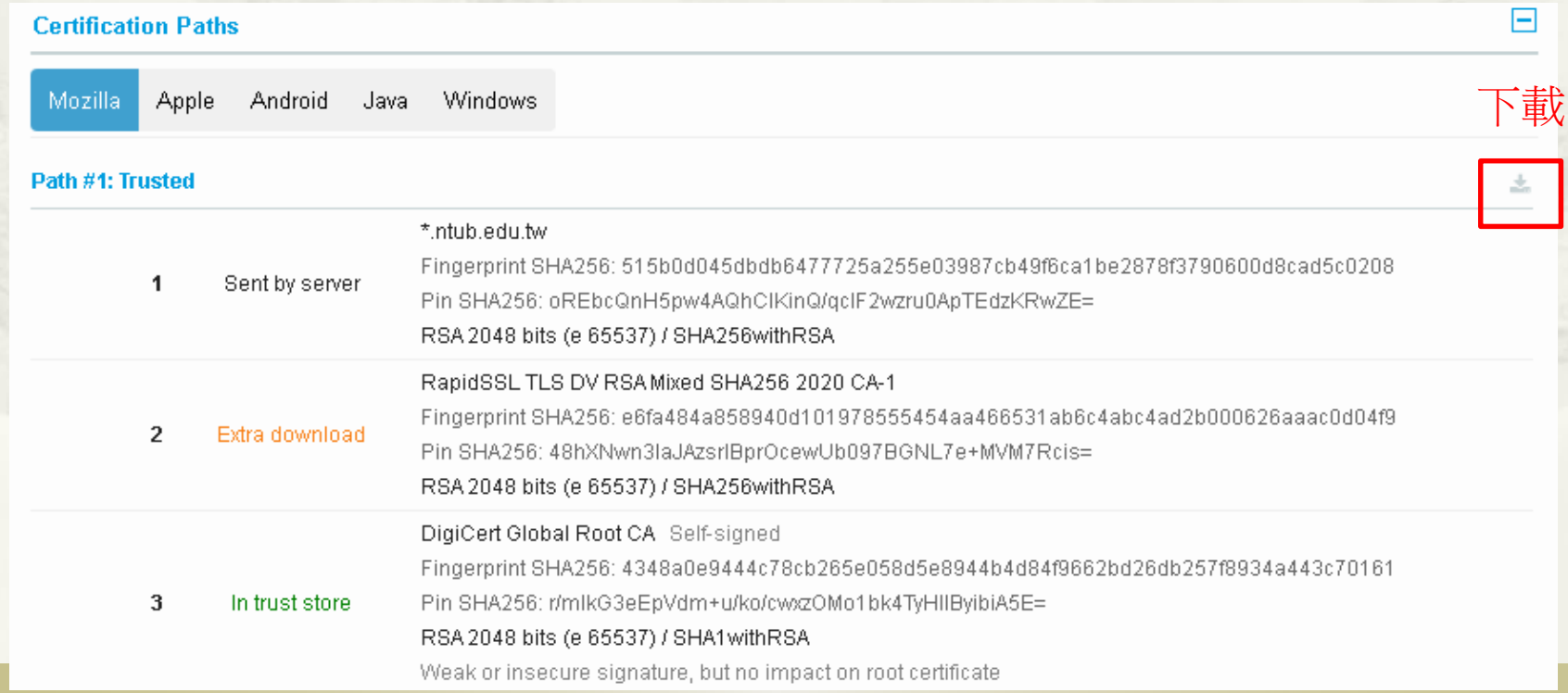
提供錯誤 Intermediate Certificate

Test Site: www.ntub.edu.tw

* https://www.ssllabs.com/ssltest/analyze.html?d=www.ntub.edu.tw



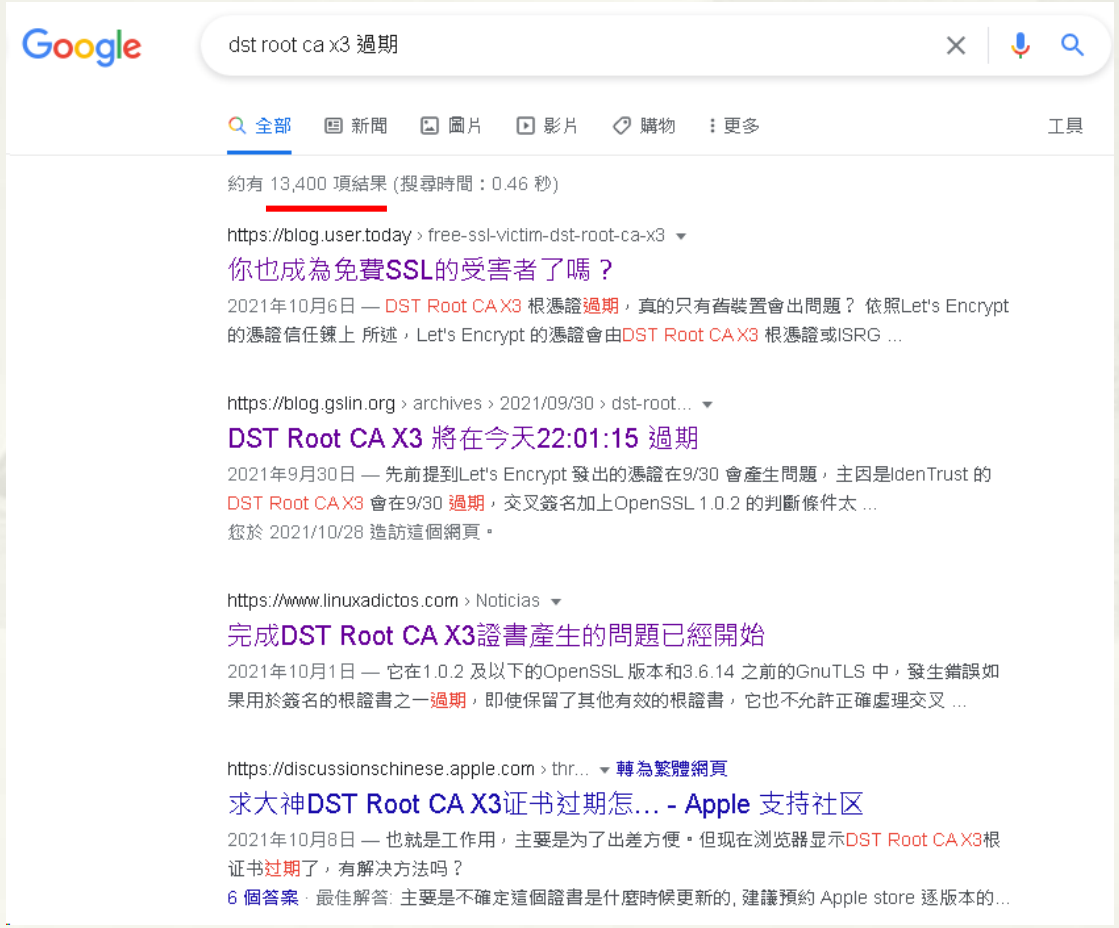
* 修正後 Certificate Chain



案例: Root Certificate 過期

根憑證到期日
≈ SSL 數位憑證審判日

* 2021/09/30 DST Root CA X3 根憑證過期



* 2020/05/30，串流製造商Roku、支付業者Stripe與Spreedly、雲端儲存服務SugarSync等數十種服務，都在同一個時間停擺
* https://www.ithome.com.tw/news/138197

SSL 數位憑證審判日

* https://letsencrypt.org/docs/certificate-compatibility/

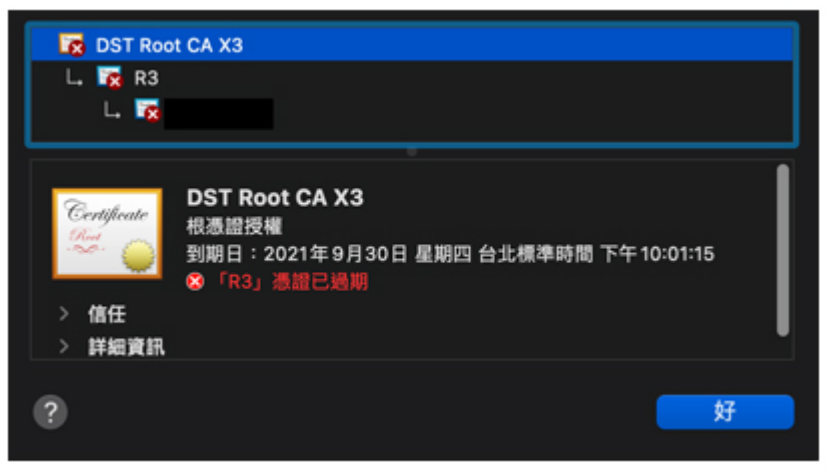
Platforms that trust DST Root CA X3 but not ISRG Root X1

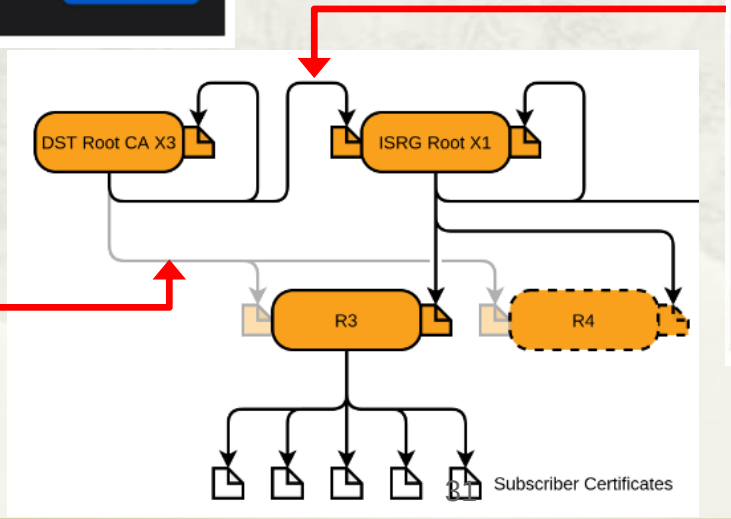
These platforms would have worked up to September 2021 but will no longer validate Let's Encrypt certificates.

- macOS < 10.12.1
- iOS < 10
- Mozilla Firefox < 50
- Ubuntu >= intrepid / 8.10
- Debian >= squeeze / 6 and < jessie /8
- Java 8 >= 8u101 and < 8u141
- Java 7 >= 7u111 and < 7u151
- NSS >= v3.11.9 and < 3.26
- Amazon FireOS (Silk Browser) (version range unknown)
- Cyanogen > v10 (version that added ISRG Root X1 unknown)
- Jolla Sailfish OS > v1.1.2.16 (version that added ISRG Root X1 unknown)
- Kindle > v3.4.1 (version that added ISRG Root X1 unknown)
- Blackberry >= 10.3.3 (version that added ISRG Root X1 unknown)
- PS4 game console with firmware >= 5.00 (version that added ISRG Root X1 unknown)

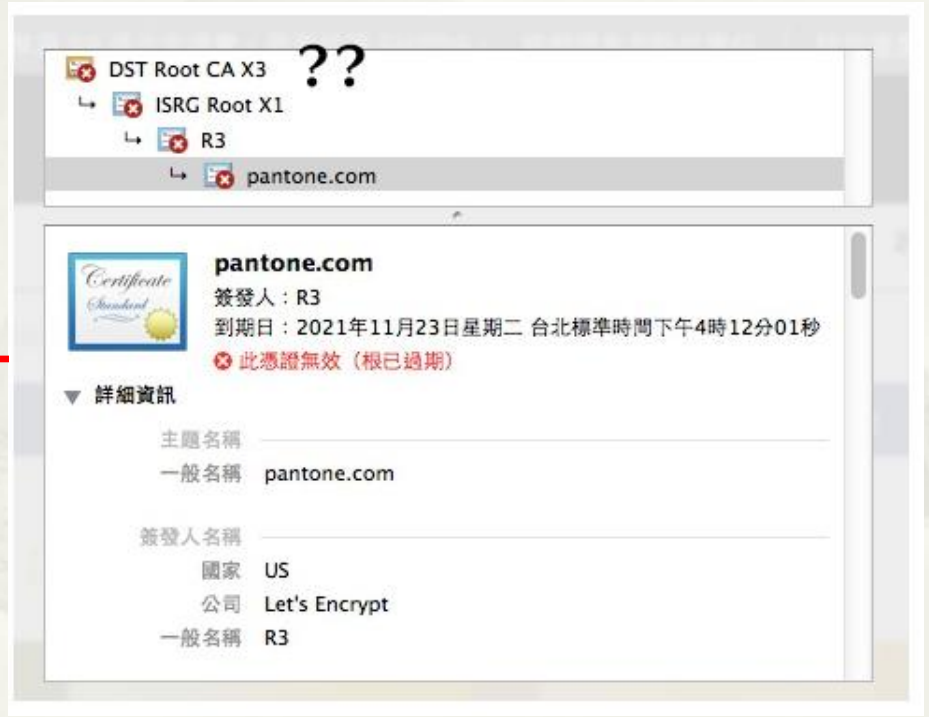
SSL 數位憑證審判日

* 使用已過期之 Certificate Chain



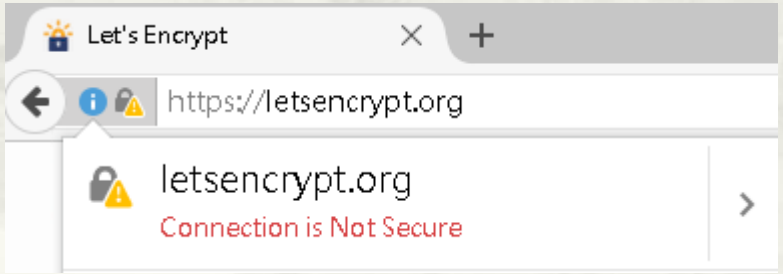


* 系統太舊(早於 2015年)，尚未包含 ISRG Root X1 根憑證，視為中繼憑證



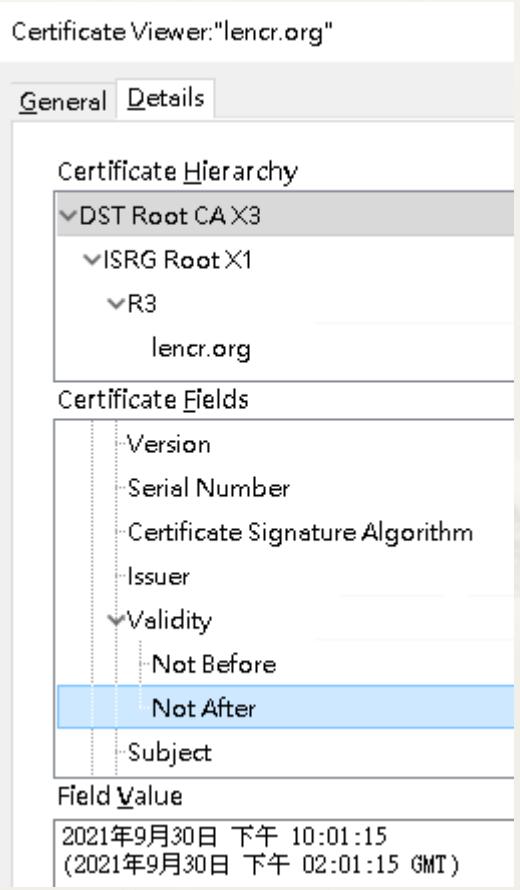
體驗 SSL 數位憑證審判日
使用舊版 Firefox 49

* Firefox 49 下載
  * https://ftp.mozilla.org/pub/firefox/releases/49.0/win64/en-US/
* 連線顯示不安全
  * https://letsencrypt.org/



* 原因: 未包含 ISRG Root X1 根憑證

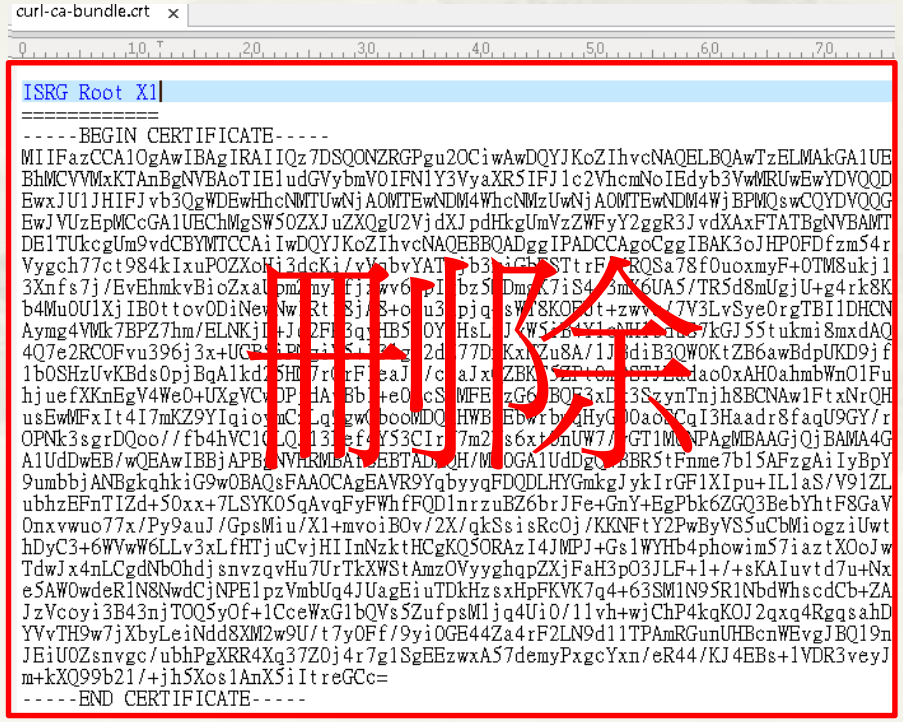
未包含 ISRG Root X1



根憑證已過期

使用 curl 模擬
無 ISRG Root X1 根憑證

- curl for Windows
  https://curl.se/windows/
- Edit curl-ca-bundle.crt



- curl -v https://letsencrypt.org

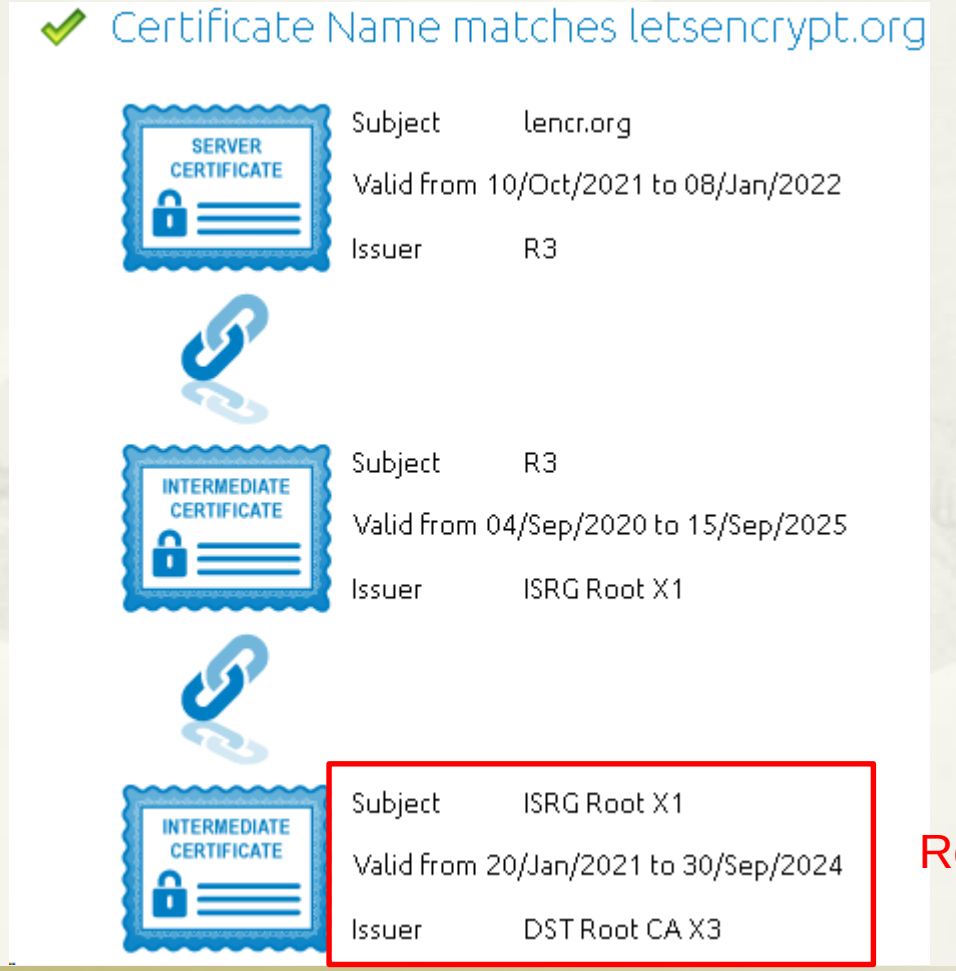
```
D:\curl-7.79.1-win64-mingw\bin>curl -v https://letsencrypt.org
*   Trying 3.0.239.142:443...
* Connected to letsencrypt.org (3.0.239.142) port 443 (#0)
* ALPN, offering h2
* ALPN, offering http/1.1
*  CAfile: D:\curl-7.79.1-win64-mingw\bin\curl-ca-bundle.crt
* TLSv1.0 (OUT), TLS header, Certificate Status (22):
* TLSv1.3 (OUT), TLS handshake, Client hello (1):
* TLSv1.2 (IN), TLS header, Certificate Status (22):
* TLSv1.3 (IN), TLS handshake, Server hello (2):
* TLSv1.2 (IN), TLS header, Finished (20):
* TLSv1.2 (IN), TLS header, Supplemental data (23):
* TLSv1.3 (IN), TLS handshake, Encrypted Extensions (8):
* TLSv1.2 (IN), TLS header, Supplemental data (23):
* TLSv1.2 (IN), TLS header, Supplemental data (23):
* TLSv1.2 (IN), TLS header, Supplemental data (23):
* TLSv1.2 (IN), TLS header, Supplemental data (23):
* TLSv1.3 (IN), TLS handshake, Certificate (11):
* TLSv1.2 (OUT), TLS header, Unknown (21):
* TLSv1.3 (OUT), TLS alert, unknown CA (560):
* SSL certificate problem: unable to get local issuer certificate
* Closing connection 0
curl: (60) SSL certificate problem: unable to get local issuer certificate
More details here: https://curl.se/docs/sslcerts.html
```

發生錯誤, 無法連線

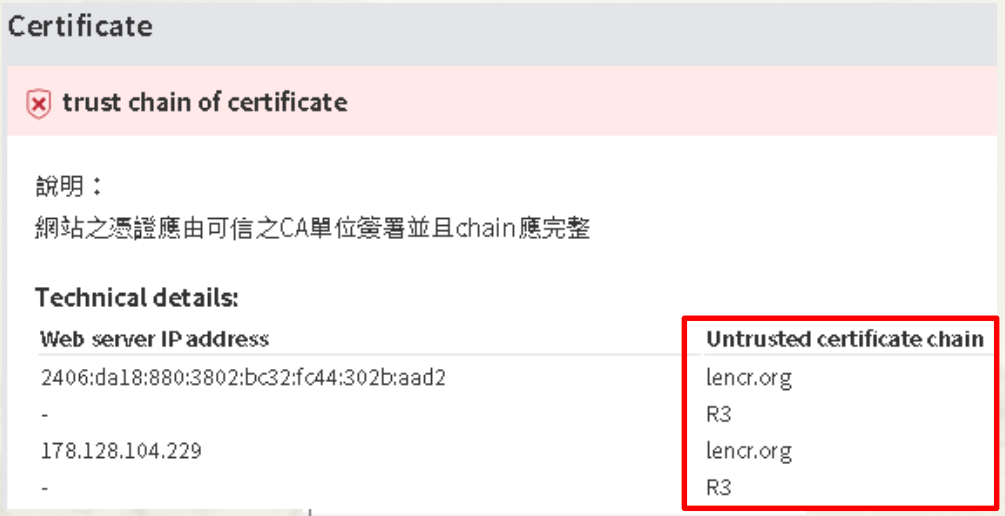
案例: Root Certificate Cross-signed With Expired CA

Root Certificate Cross-signed With Expired CA
Test Site: letsencrypt.org

* https://www.digicert.com/help



* https://check.twnic.tw/



* Chrome

Root Certificate 不相同

Root Certificate Cross-signed With Expired CA

Test Site: letsencrypt.org

* https://www.ssllabs.com/ssltest/analyze.html?d=letsencrypt.org

Additional Certificates (if supplied)

Certificates provided	3 (3881 bytes)
Chain issues	None

* 修正後 Certificate Chain

Certification Paths

Mozilla | Apple | Android | Java | Windows

Path #1: Trusted

1	Sent by server	lencr.org Fingerprint SHA256: d353c3ef9e6bfa93d4d8df09ecc625f5d2199014d97727f29b5f3df9524bcfdb Pin SHA256: vPAsw8+5GrAkQqC5zMfST4GbVSLEShowOeWW7+GAnA= EC 256 bits / SHA256withRSA
2	Sent by server	R3 Fingerprint SHA256: 67add1166b020ae61b8f5fc96813c04c2aa589960796865572a3c7e737613dfd Pin SHA256: jQJTblh0grw0/1TkHSumWb+Fs0Ggogr621gT3PvPKG0= RSA 2048 bits (e 65537) / SHA256withRSA
3	In trust store	ISRG Root X1 Self-signed Fingerprint SHA256: 96bcec06264976f37460779acf28c5a7cfe8a3c0aae11a8ffcee05c0bddf08c6 Pin SHA256: C5+lpZ7tcVwmwQIMcRtPbsQtWLABXhQzejna0wHFr8M= RSA 4096 bits (e 65537) / SHA256withRSA

* 網站提供 Certificate Chain

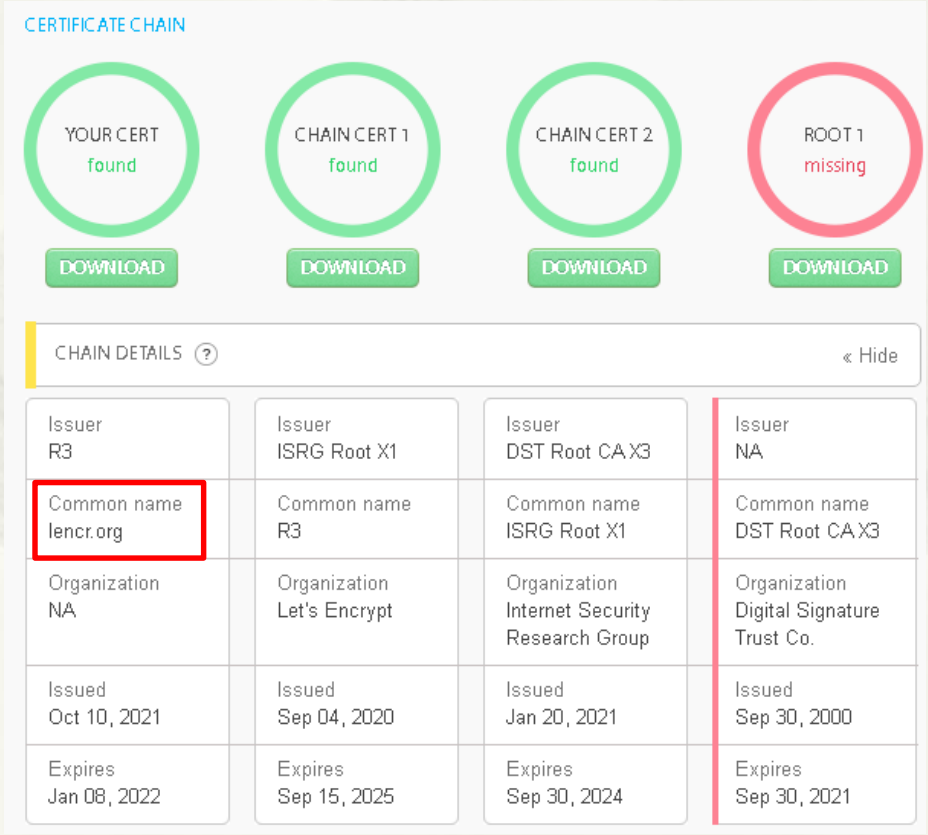
Path #2: Not trusted (invalid certificate [Fingerprint SHA256: 0687260331a72403d909f105e69bcf0d32e1bd2493ffc6d9206d11bcd6770739])

1	Sent by server	lencr.org Fingerprint SHA256: d353c3ef9e6bfa93d4d8df09ecc625f5d2199014d97727f29b5f3df9524bcfdb Pin SHA256: vPAsw8+5GrAkQqC5zMfST4GbVSLEShowOeWW7+GAnA= EC 256 bits / SHA256withRSA
2	Sent by server	R3 Fingerprint SHA256: 67add1166b020ae61b8f5fc96813c04c2aa589960796865572a3c7e737613dfd Pin SHA256: jQJTblh0grw0/1TkHSumWb+Fs0Ggogr621gT3PvPKG0= RSA 2048 bits (e 65537) / SHA256withRSA
3	Sent by server	ISRG Root X1 Fingerprint SHA256: 6d99fb265eb1c5b3744765fcbc648f3cd8e1bffafdc4c2f99b9d47cf7ff1c24f Pin SHA256: C5+lpZ7tcVwmwQIMcRtPbsQtWLABXhQzejna0wHFr8M= RSA 4096 bits (e 65537) / SHA256withRSA
4	In trust store	DST Root CA X3 Self-signed Fingerprint SHA256: 0687260331a72403d909f105e69bcf0d32e1bd2493ffc6d9206d11bcd6770739 Pin SHA256: Vjs8r4z+80wjNcr1YKepWQboSIRi63WsWXhIMN+eWys= RSA 2048 bits (e 65537) / SHA1withRSA Valid until: Thu, 30 Sep 2021 14:01:15 UTC **EXPIRED** Weak or insecure signature, but no impact on root certificate

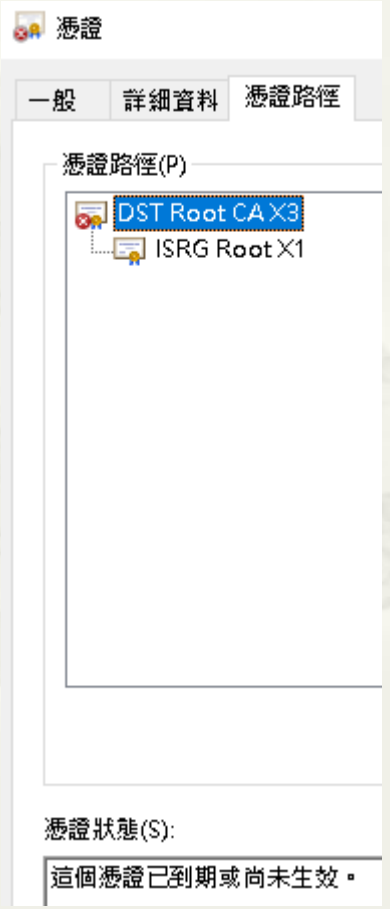
建議使用: ISRG Root X1(Self-singed)

Root Certificate Cross-signed With Expired CA
Test Site: letsencrypt.org

* https://www.sslchecker.com/sslchecker

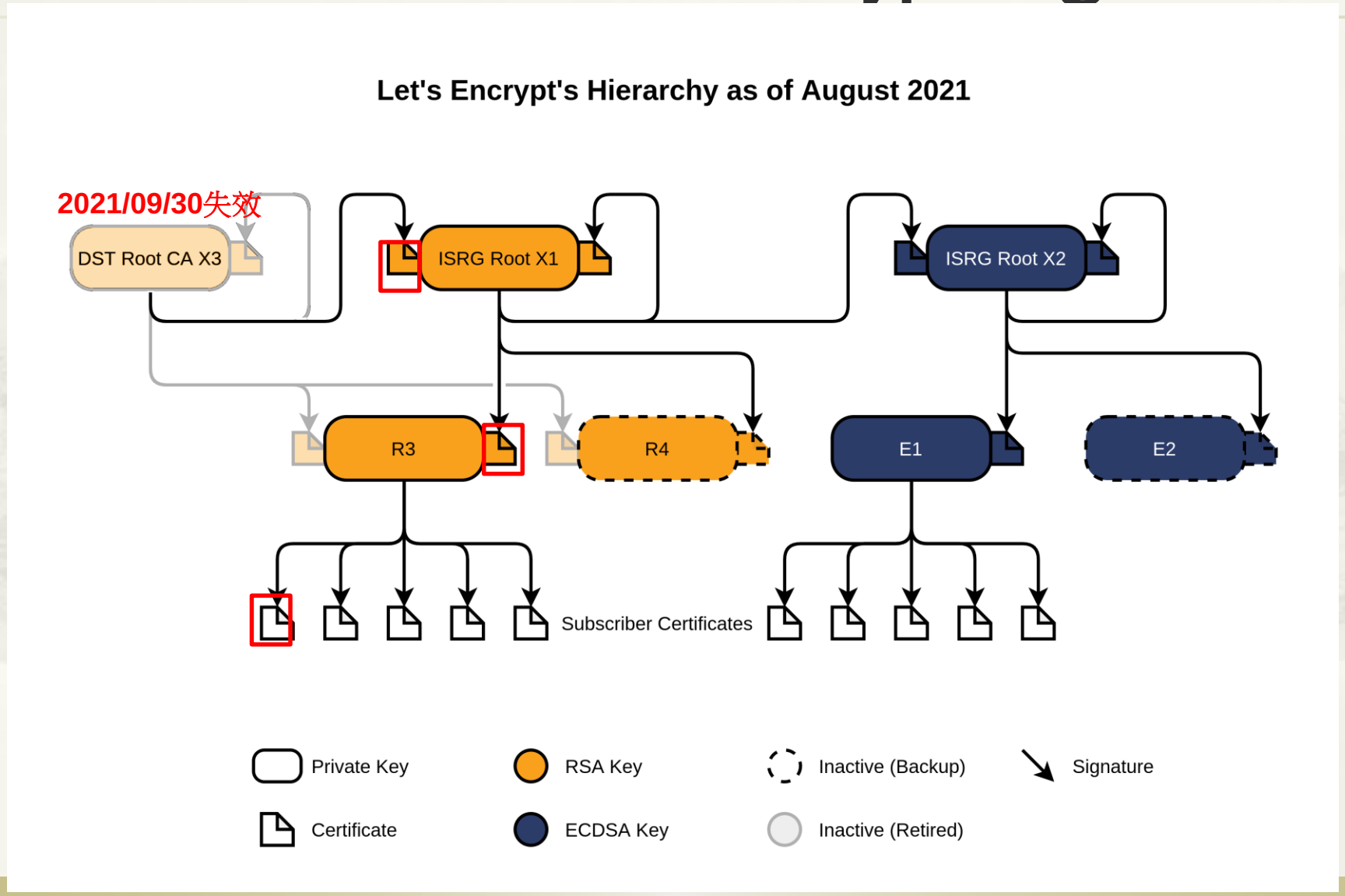


* 自行測試



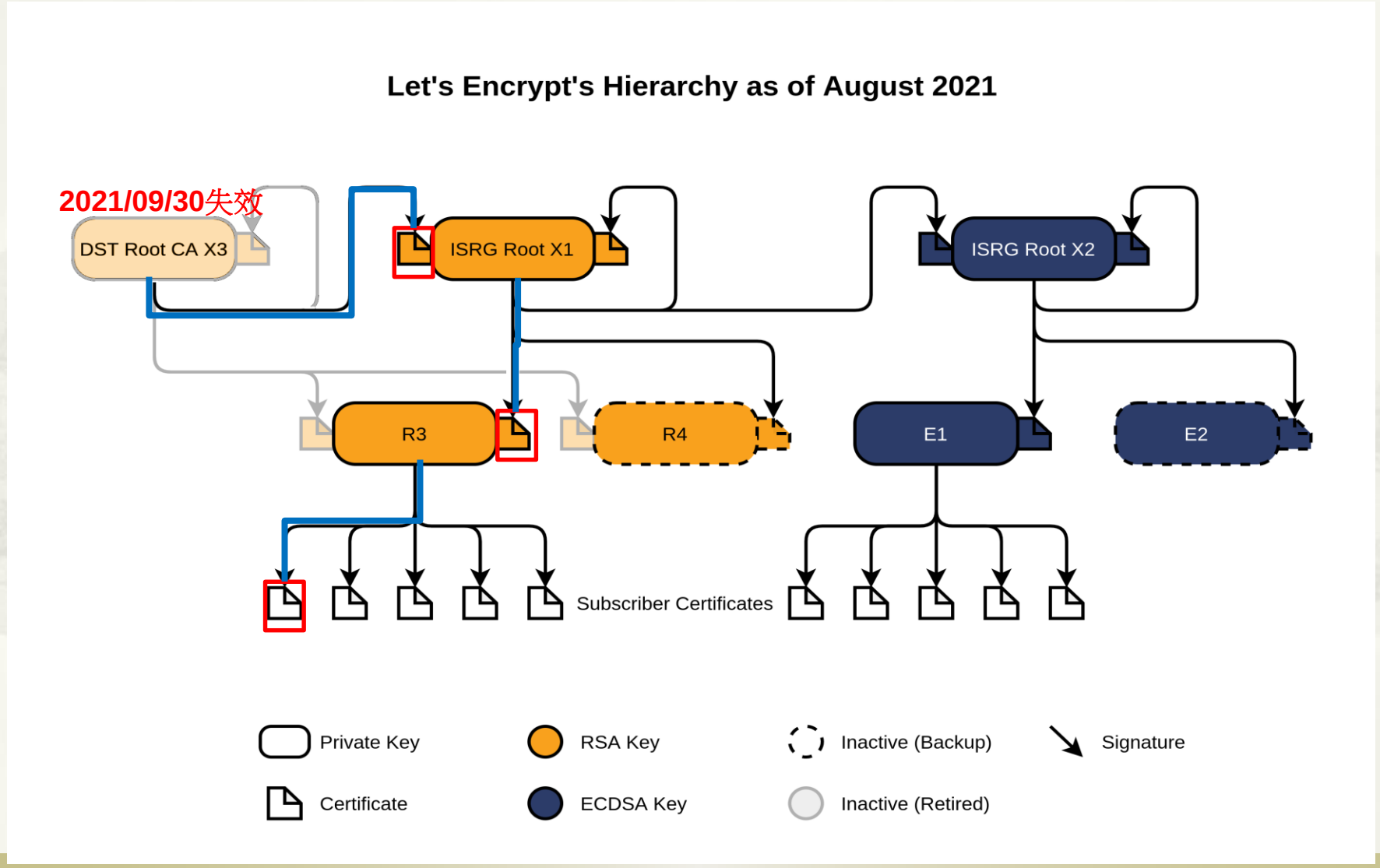
Root Certificate Cross-signed With Expired CA

Test Site: letsencrypt.org



Root Certificate Cross-signed With Expired CA

Test Site: letsencrypt.org



Root Certificate Cross-signed With Expired CA

- 所有使用 Let's Encrypt 憑證之網站皆有相同問題
- TANet NOC
  - https://noc.tanet.edu.tw/
- 政大區網
  - https://tp2rc.tanet.edu.tw/
- 交大區網
  - www.hcrc.edu.tw

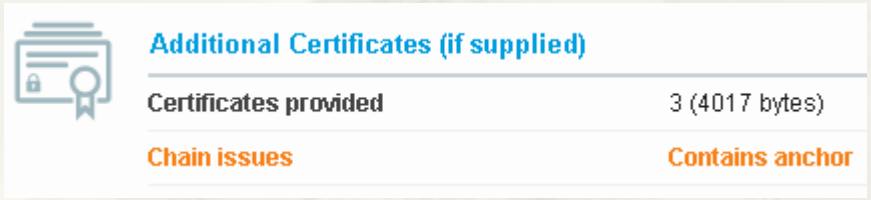
案例: Extra Root Certificate

Should Certificate Chain Need Include Root Certificate ?

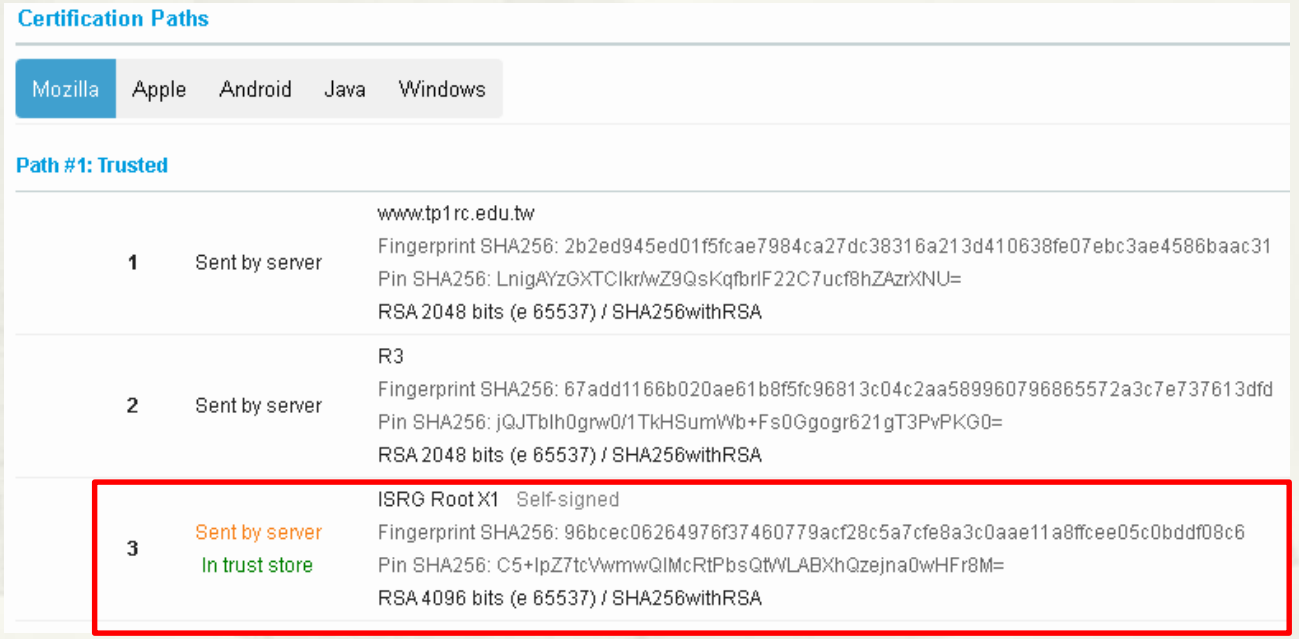
* You do not need to include the root certificate in the certificate chain.
* Since clients already have the root certificate in their trust stores.
* Including the root is inefficient since it increases the size of the SSL handshake and browsers will simply ignore it.

Extra Root Certificate
Test Site: www.tp1rc.edu.tw

* https://www.ssllabs.com/ssltest/analyze.html?d=www.tp1rc.edu.tw



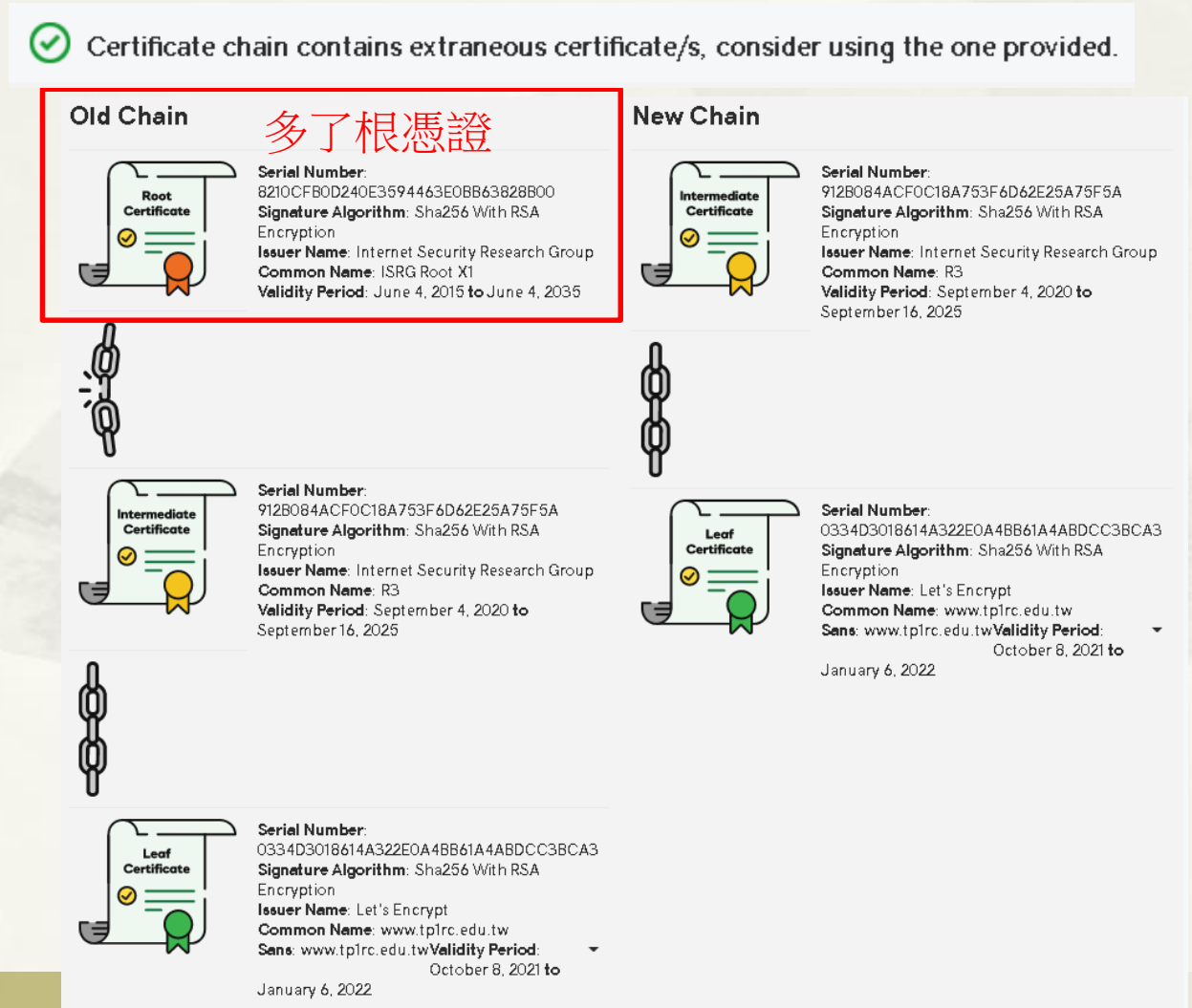
* Add Intermediate as well as Root CA
* Only need the Intermediate as the client will already have Root CA.
  * https://success.qualys.com/support/s/article/000003197



多餘根憑證

Extra Root Certificate
Test Site: www.tp1rc.edu.tw

* https://ssltools.godaddy.com/views/certChecker

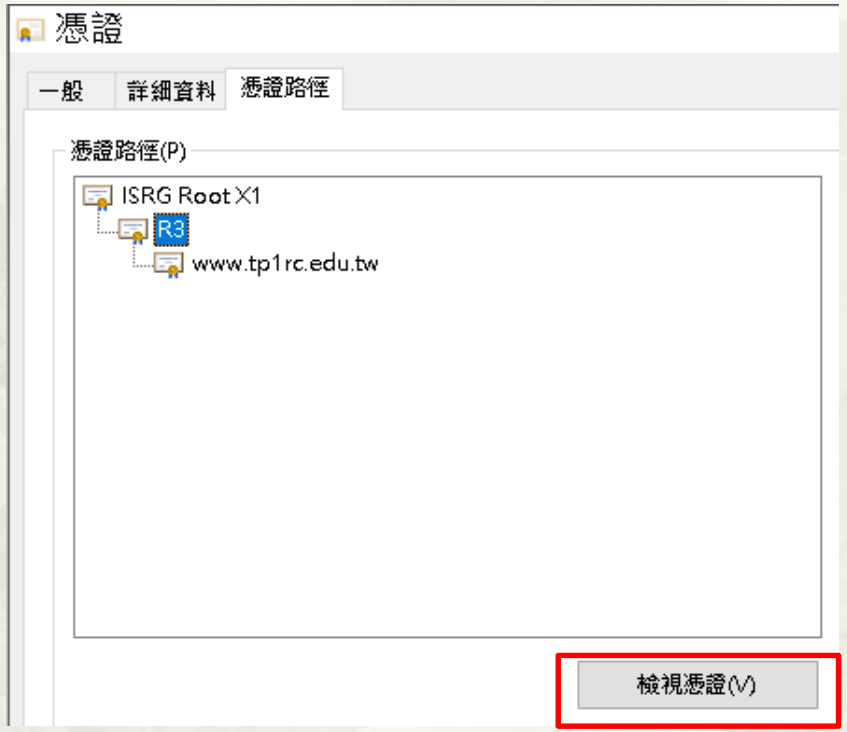


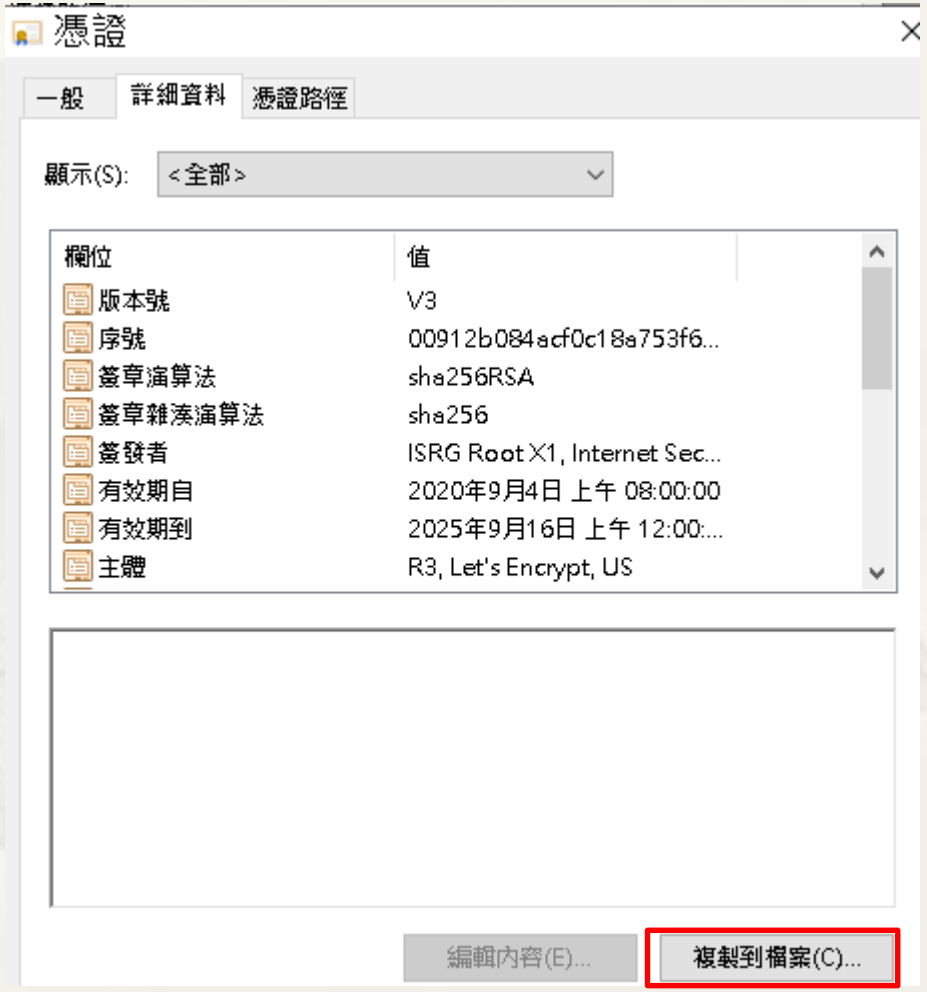
How to Fix Certificate Chain Problems

Generate Intermediate Certificate

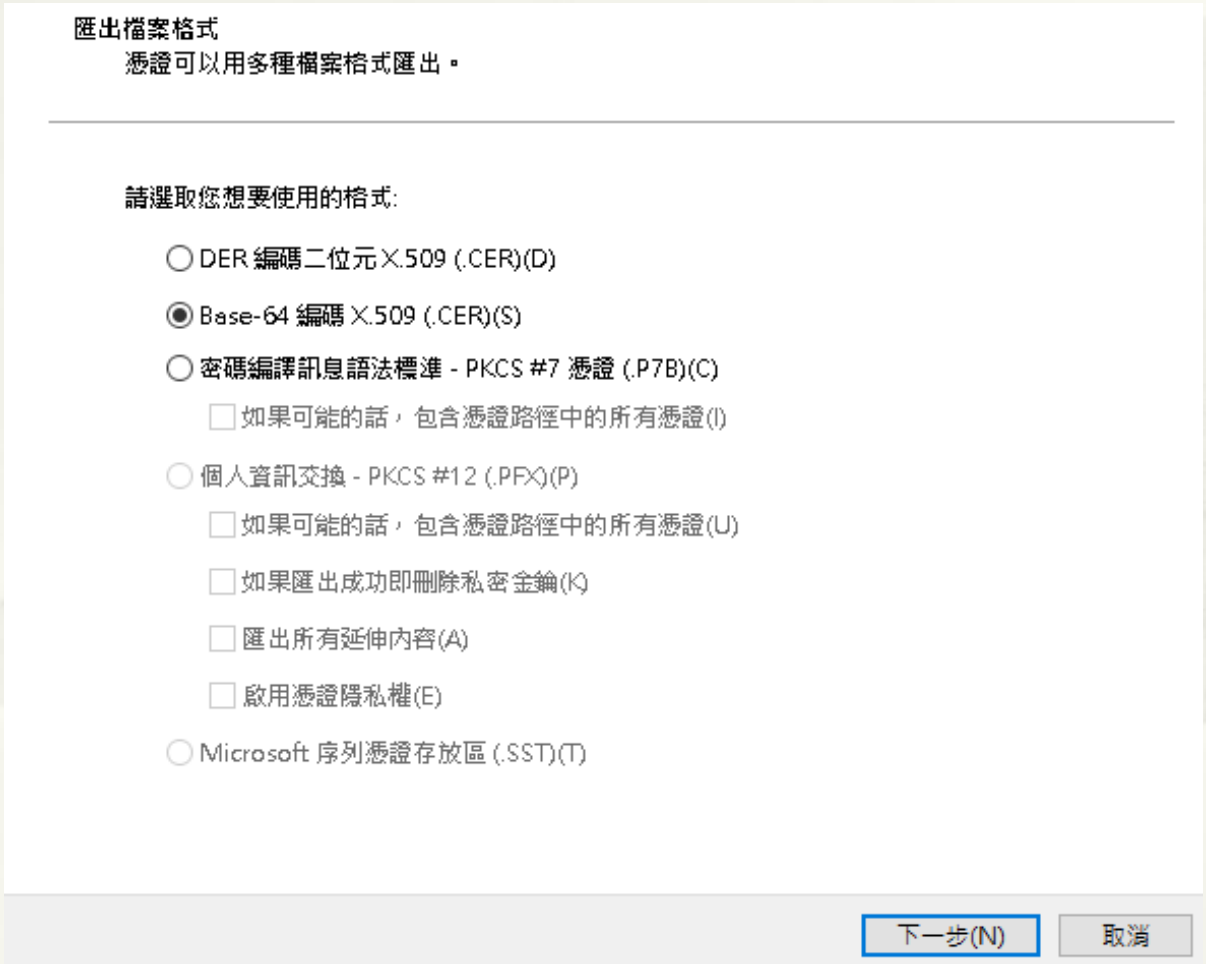
- Browser
  - Chrome
  - Firefox
- Online Websites
  - https://www.ssllabs.com/ssltest/analyze.html
  - https://whatsmychaincert.com/
    - Certificate (PEM format)
    - Online use hostname
  - https://tools.keycdn.com/certificate-chain
    - Certificate (PEM format)
  - https://certificatechain.io/
    - Certificate (PEM format)

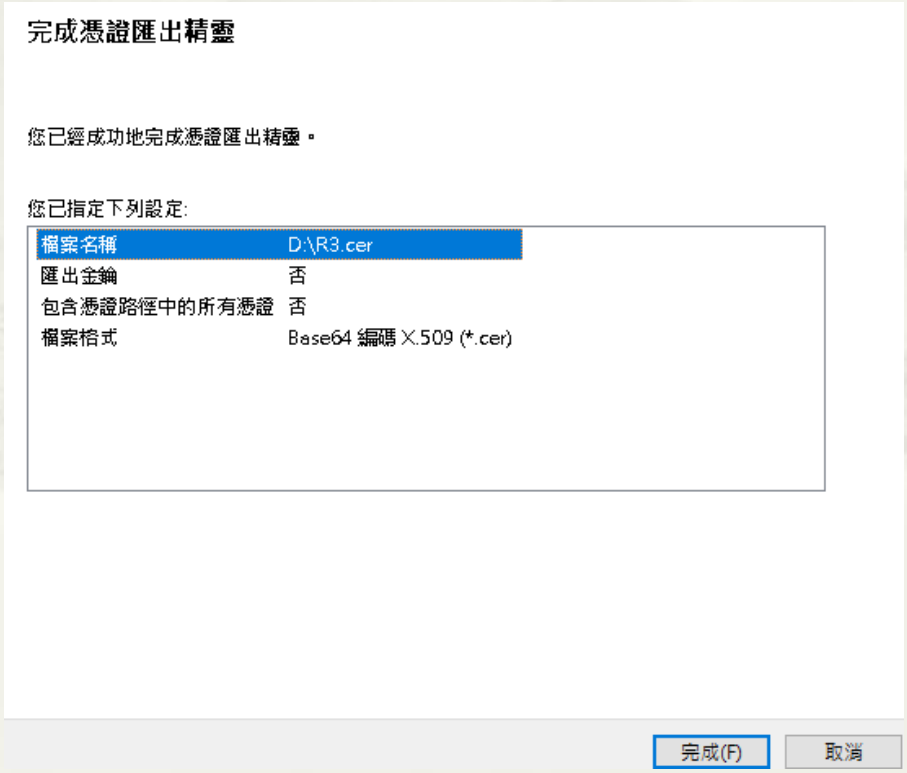
Generate Intermediate Certificate Chrome



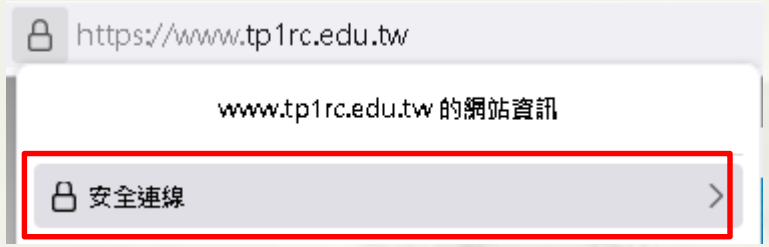


Generate Intermediate Certificate Chrome





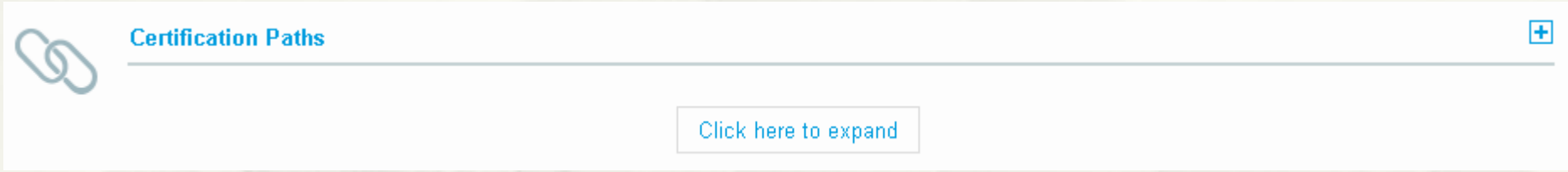
Generate Intermediate Certificate Firefox

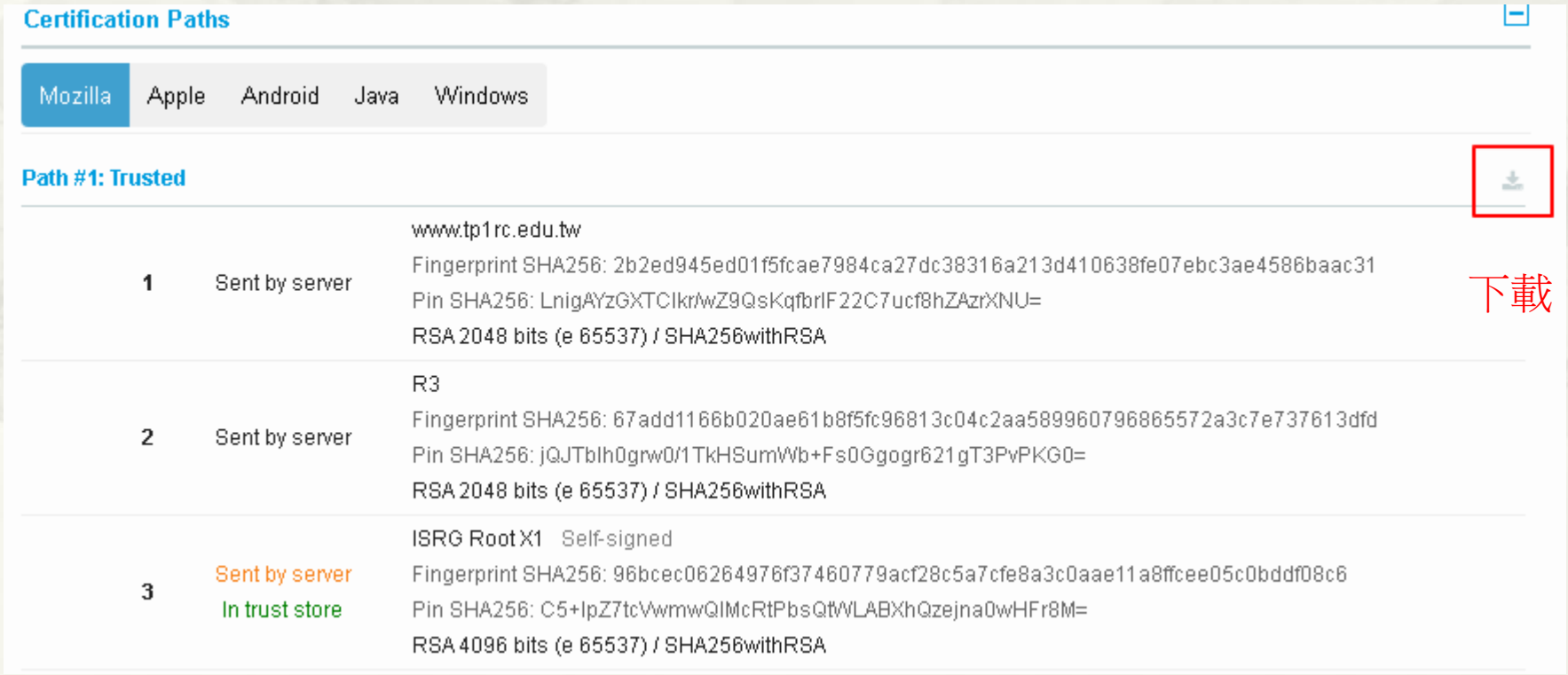


Generate Intermediate Certificate Online

Qualys. SSL Labs

* https://www.ssllabs.com/ssltest/analyze.html?d=www.tp1rc.edu.tw





簡報完畢
謝謝