Decentralized Certificate Authority

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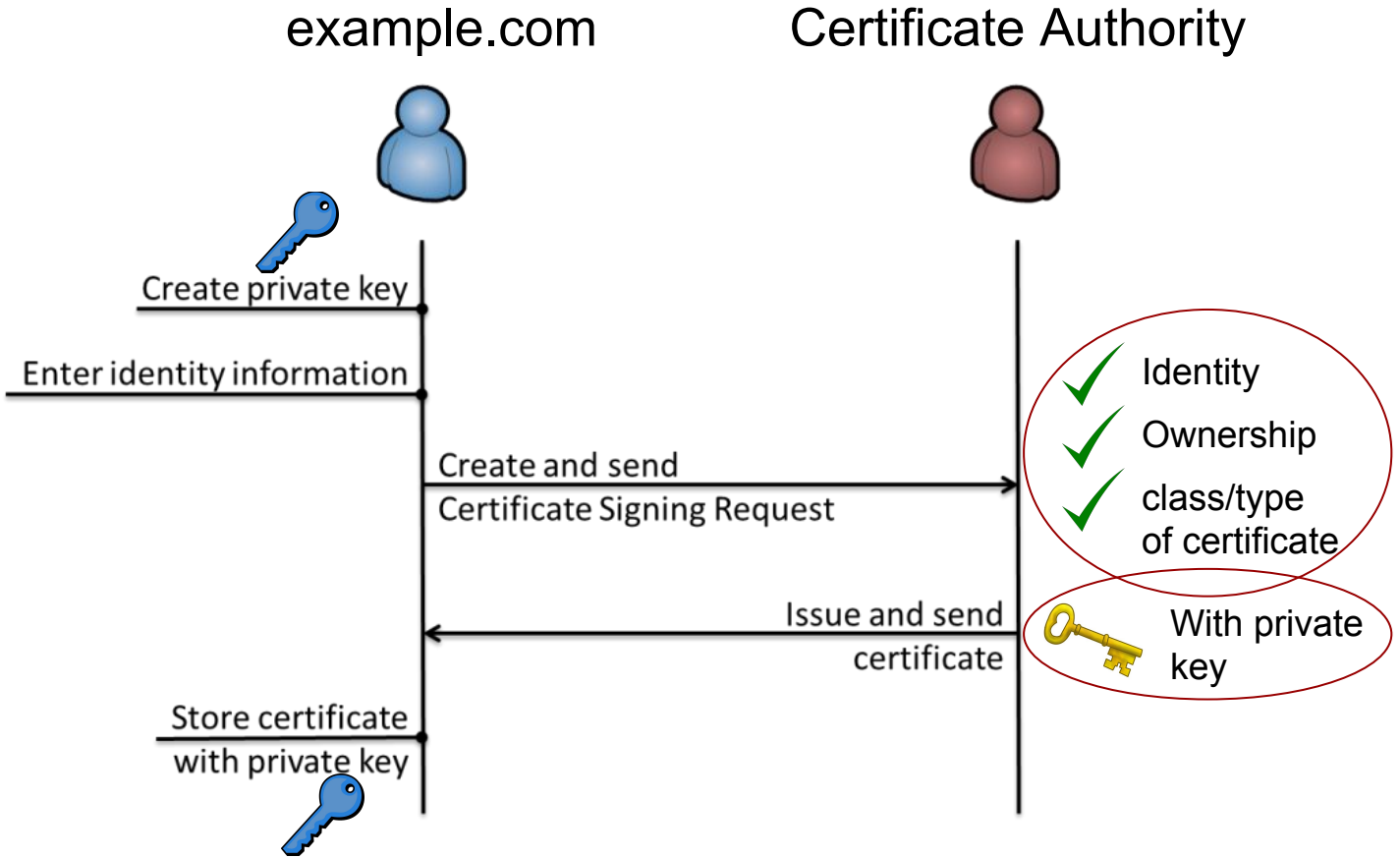
Review - Creating a Certificate



Motivation

Google Reducing Trust in Symantec Certificates Following Numerous Slip-Ups

By Catalin Cimpanu

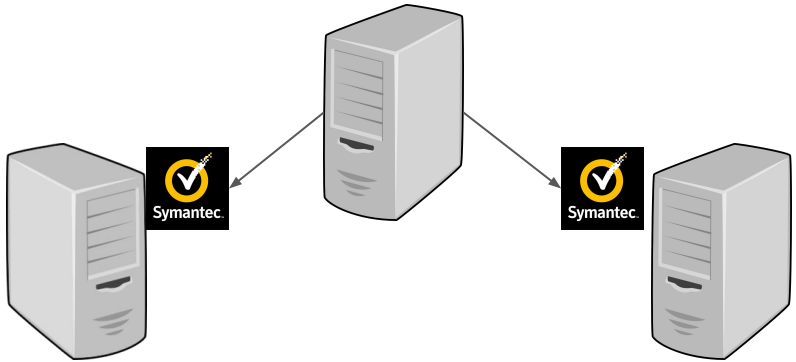
March 23, 2017 04:58 PM

Hacked Certificate Authorities - Nothing Left to Trust

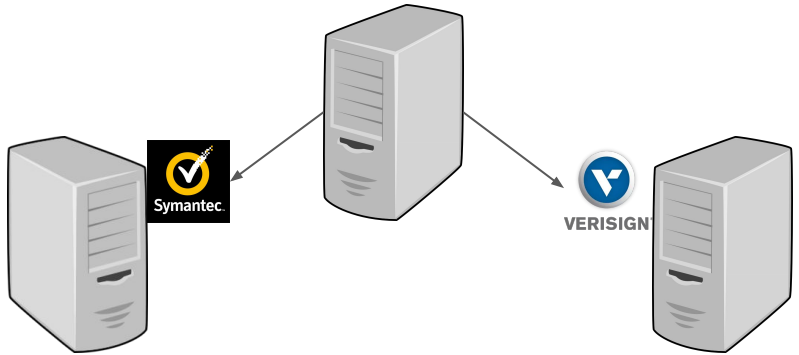
Monday, September 12, 2011

2011 Comodo and DigiNotar

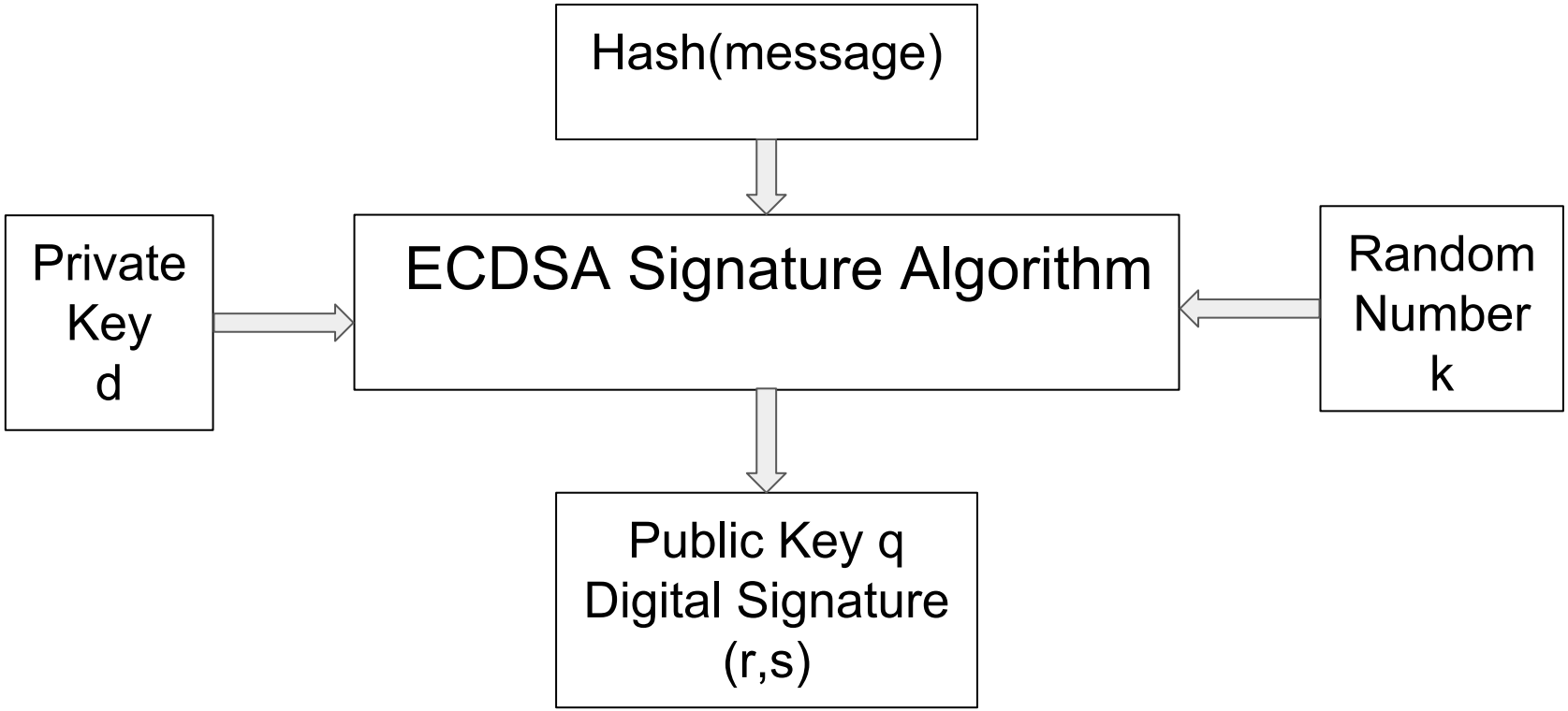
The certificates are only as trustworthy as the weakest CA...



OR

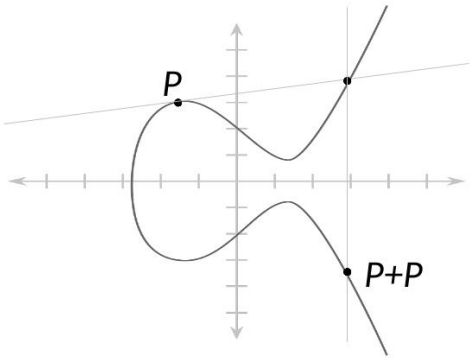


Background - Digital Signature Algorithm (DSA)



Background - Elliptic Curve DSA

Sample Curve



ECDSA Signature Algorithm

Parameters = *(p, b, G, n, h)*

Public Key:

Q = d * G

Signature:

(x, y) = k * G

r = x mod n

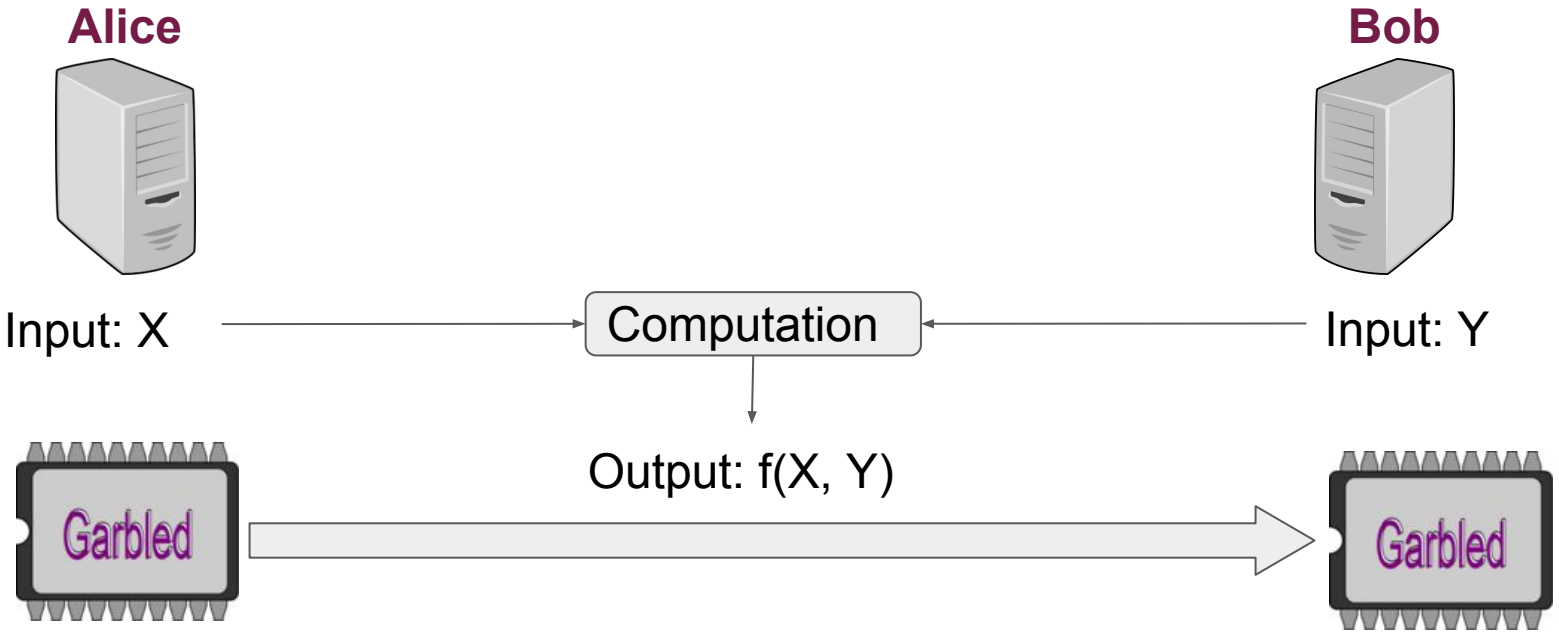
s = k^{-1}(Hash(m) + rd)

d= CA private key

k = Random number

m = info to be signed

Background - Secure Multiparty Computation

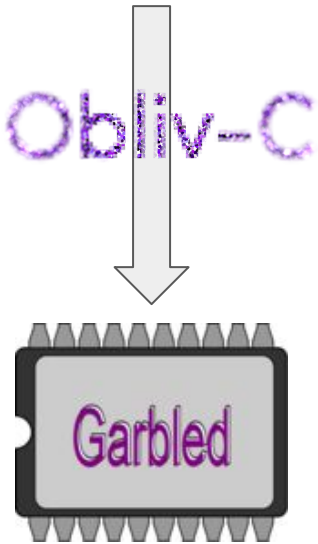


Alice generates the Circuit

Bob evaluates the Circuit

Framework ==> OblivC + Absentminded Crypto

Generic Computation

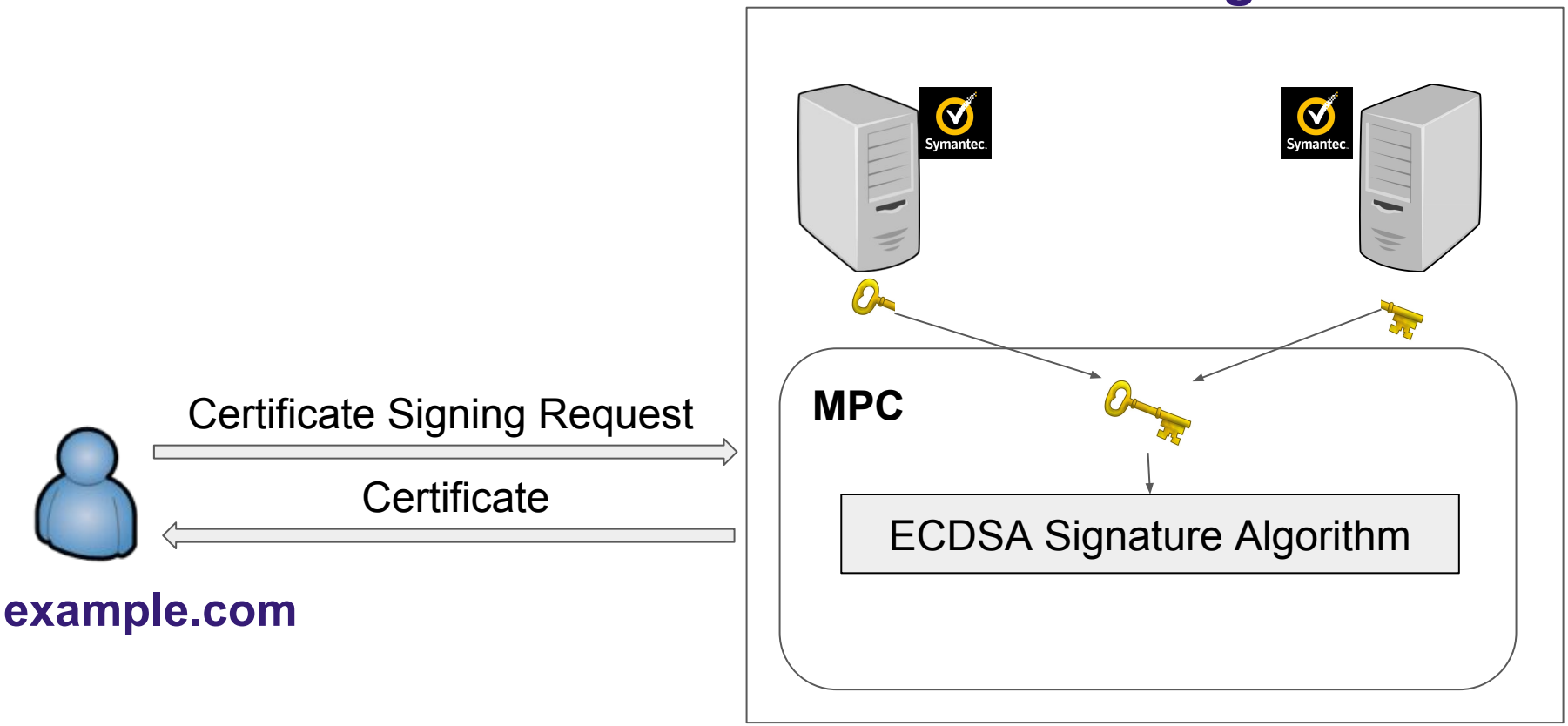



```
obliv int x, y, z;

feedOblivInt(&x, io->x, 1);
feedOblivInt(&y, io->y, 2);

Z = x + y;

revealOblivInt(&io->z, z, 0);
```

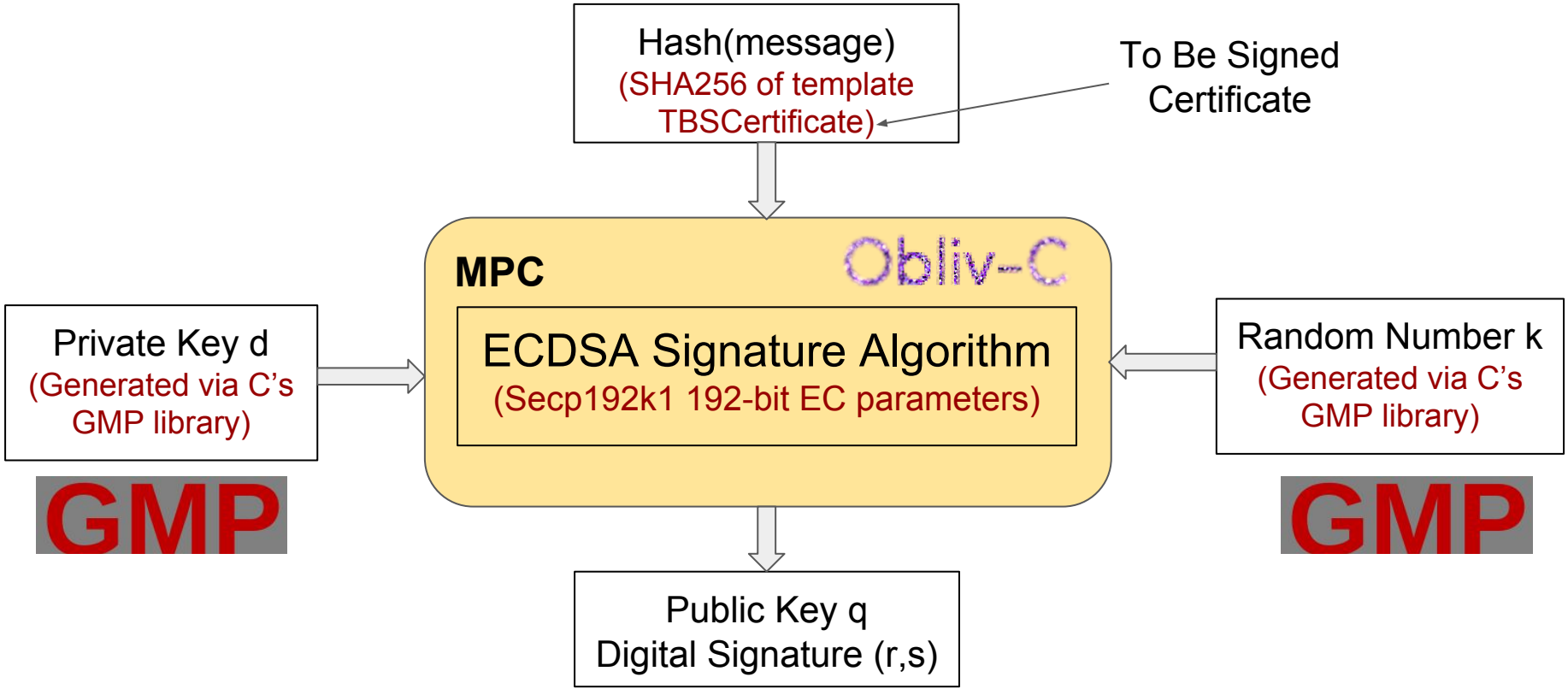
Absentminded Crypto provides ‘big number’ arithmetic over OblivC!

Use **obig** keyword for big numbers..

Decentralized CA using MPC



Implementation in C



Experiments

3-4 hours to perform certificate signing using '*secp192k1*' elliptic curve.

Computation Bottleneck: Curve Point-multiplication!

```
pointMultiplication(G, k):
 N ← G
 Q ← 0
 for i from 0 to m do
    if k_i = 1 then
        Q ← pointAdd(Q, N)
    N ← pointDouble(N)
 return Q
```

Signature:
(x, y) = k * G
r = x mod n
s = k^{-1}(Hash(m) + rd)

pointAdd(P, Q):

$$\lambda = \frac{Q_y - P_y}{Q_x - P_x}$$

$$R_x = \lambda^2 - P_x - Q_x$$

$$R_y = \lambda(P_x - R_x) - P_y$$

pointDouble(P):

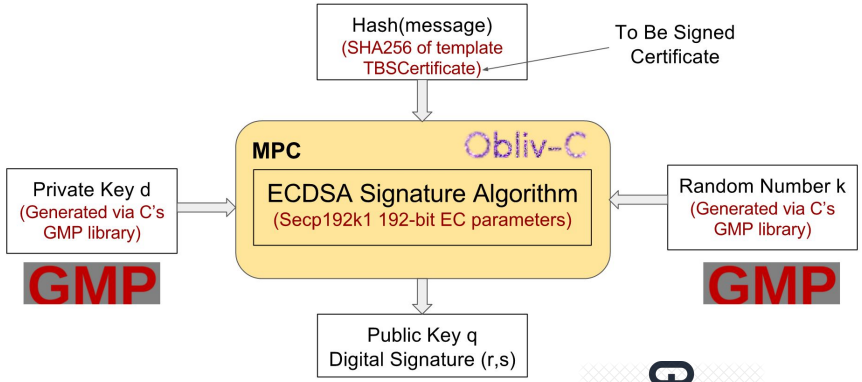
$$\lambda = \frac{3P_x^2 + a}{2P_y}$$

$$R_x = \lambda^2 - 2P_x$$

$$R_y = \lambda(P_x - R_x) - P_y$$

Conclusion

Decentralized CA is feasible in practice



Certificate Signing takes around 3-4 hours, which can be optimized

Deployment in open source tool OpenSSL

OpenSSL
Cryptography and SSL/TLS Toolkit