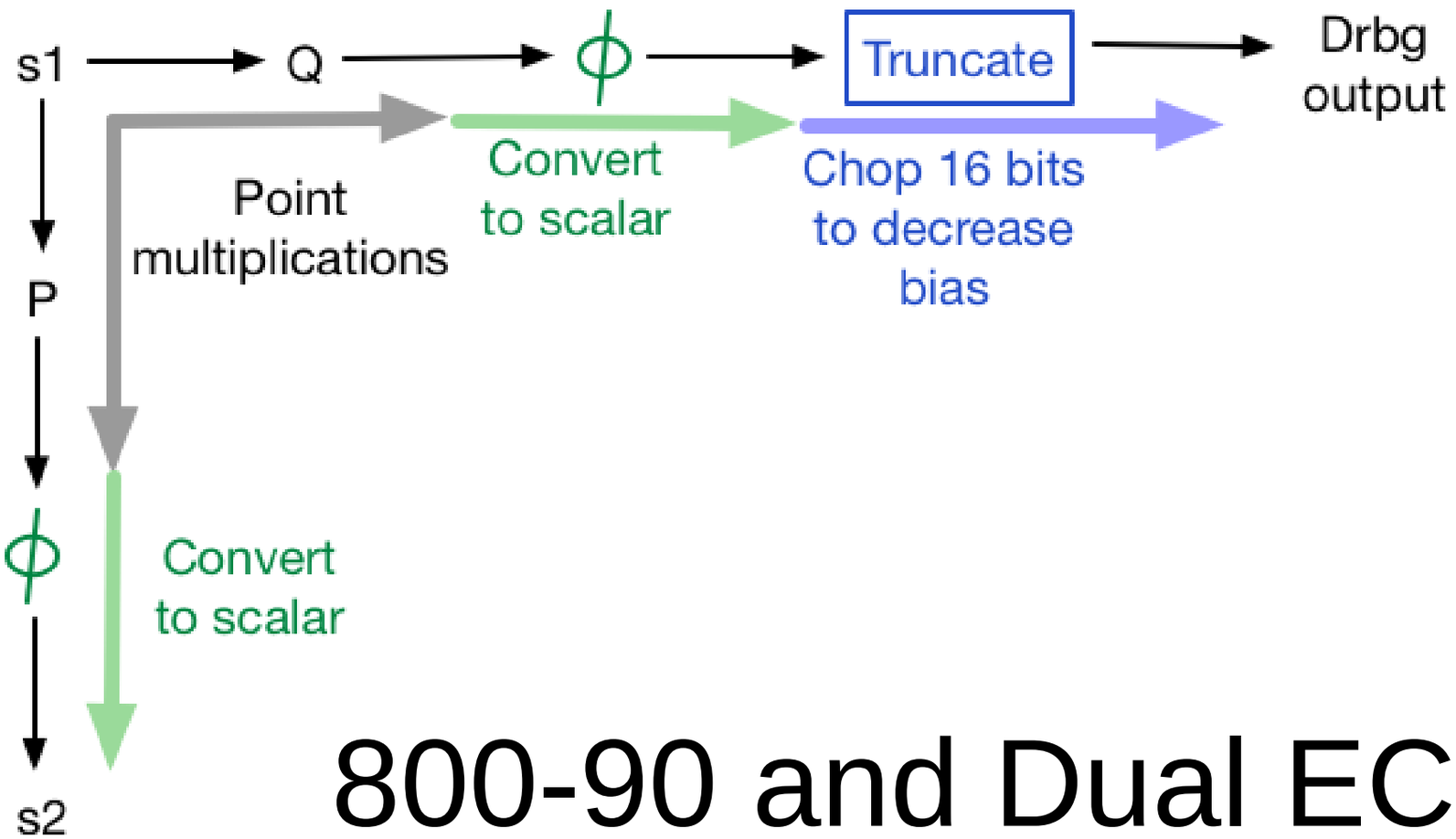


800-90 and Dual EC DRBG

John Kelsey, NIST

RNG Standardization

- Random numbers needed for cryptography
- **X9.82:** Standards effort in X9F1 (banking standards org)
  - Started around 1998 (I came onboard in 2003)
  - Made very little progress early on
  - Eventually became mainly a US government effort
  - NIST and NSA, with some participation from CSE

Moving to NIST Special Publications

- X9 Documents not available to public
    - Hard to get feedback from academics
- X9 process was slow
- X9 not tuned to needs of FIPS validation

Most of work on standards done by US federal employees (NIST and NSA, with some help from CSE)

Three Documents

- ***SP 800-90A: Deterministic Random Bit Generators***
- **SP 800-90B: Entropy Sources**
- **SP 800-90C: Putting it All Together**

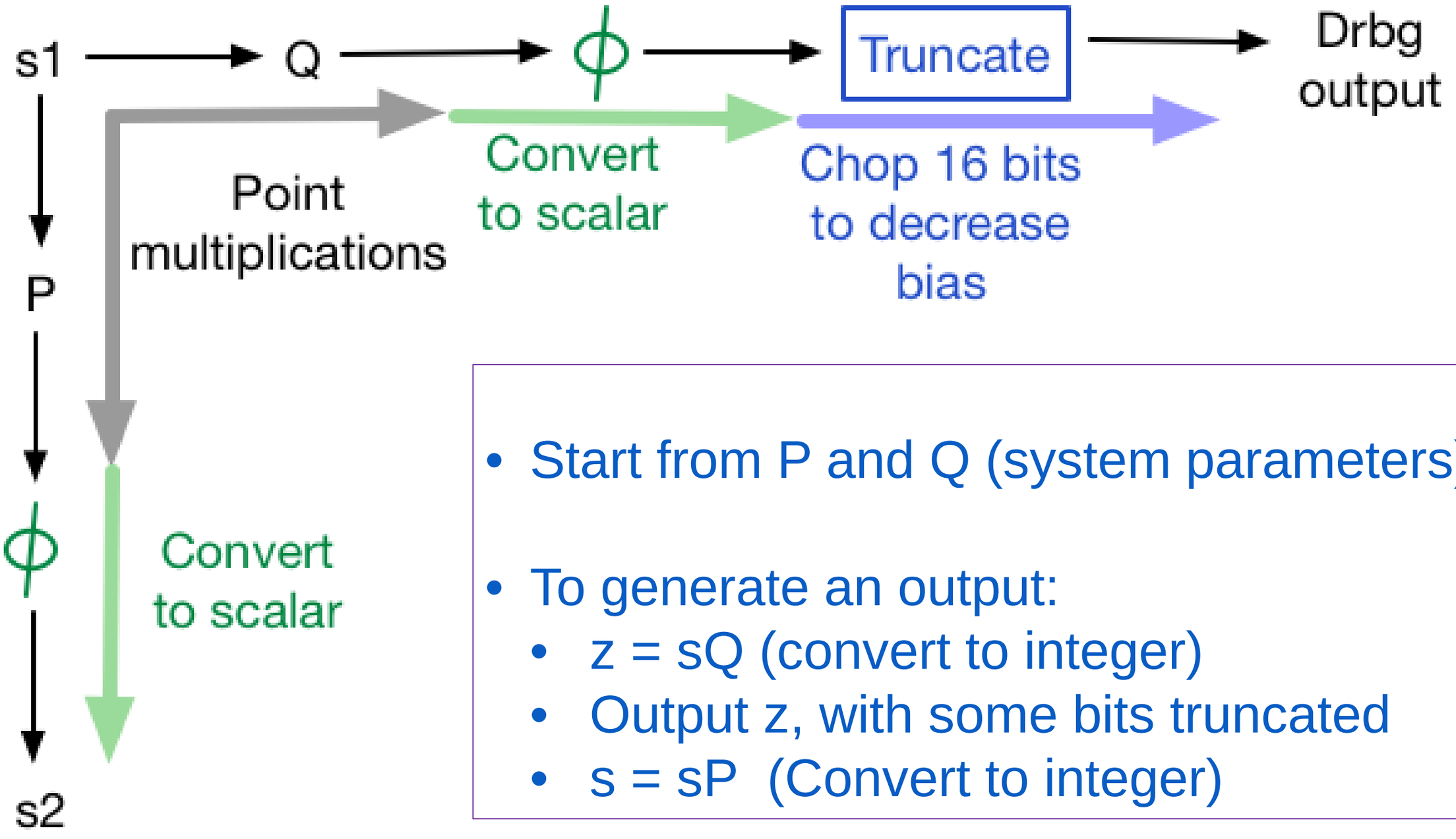
Derived partially from the work done in X9.82.

Algorithms in 800-90A

- CTR-DRBG = block cipher based
- HMAC-DRBG = HMAC (hash function) based
- Hash-DRGB = hash function based
- **Dual-EC-DRBG = elliptic curve based**

Other than Hash-DRBG, same algorithms in X9.82

Dual EC DRBG



- Start from P and Q (system parameters)
- To generate an output:
  - z = sQ (convert to integer)
  - Output z, with some bits truncated
  - s = sP (Convert to integer)

Dual EC DRBG has two parameters, P and Q.

- Can be public and shared with all users

  …but that isn't necessary.

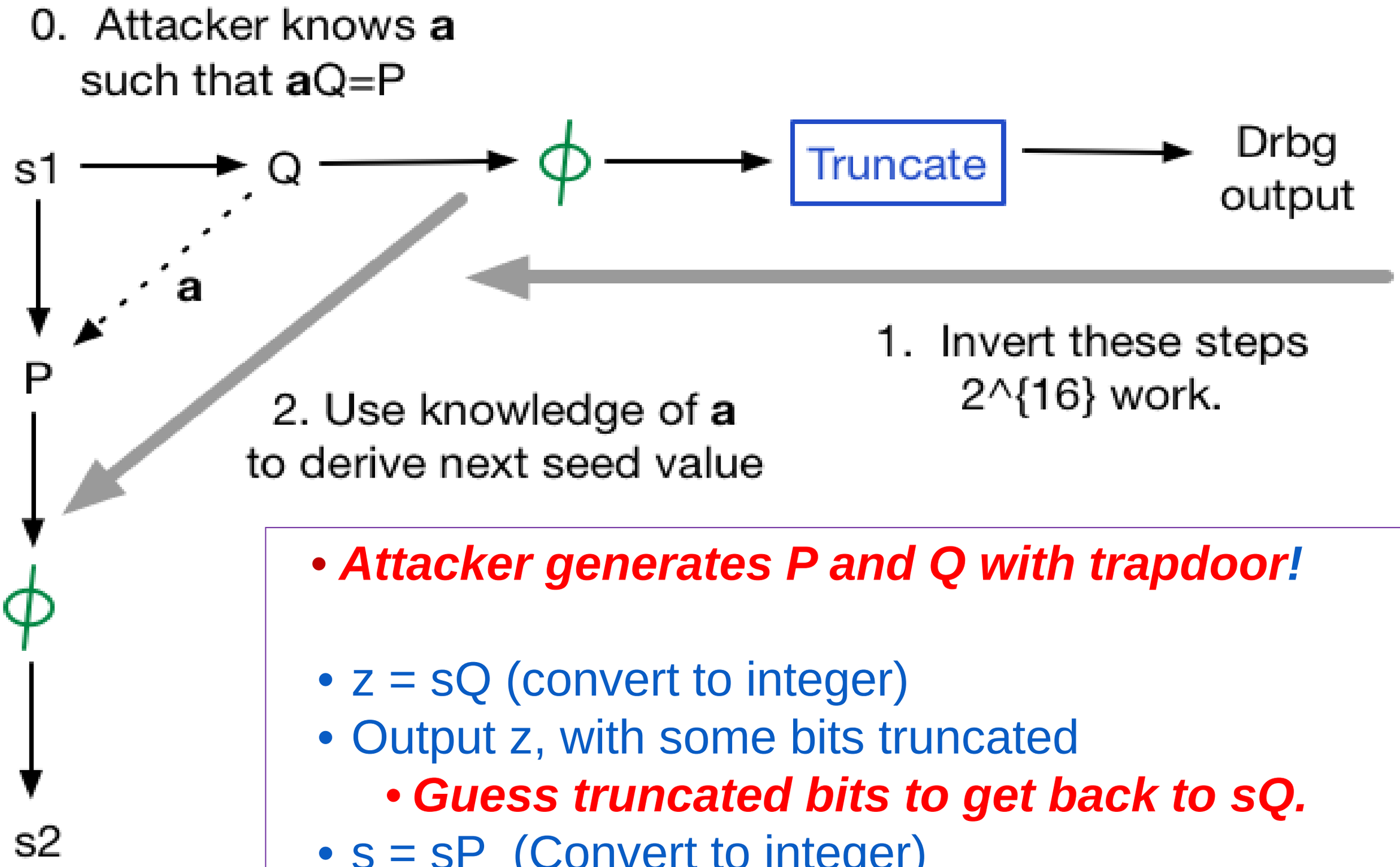
- Where do these come from?
  - Provided in standard
  - Ultimately from designers of Dual EC DRBG at NSA.

- ***What if you don't trust the people who generated P and Q?***

Trusting P and Q

- If P and Q are randomly generated, Dual EC secure.
- ***P and Q can be generated to insert a backdoor.***
- **Issue was first raised in an X9 meeting**
- **Later, issue was described at Crypto 2007 rump session.**

The Possible Trapdoor



- ***Attacker generates P and Q with trapdoor!***

- z = sQ (convert to integer)
- Output z, with some bits truncated
  - ***Guess truncated bits to get back to sQ.***
- s = sP (Convert to integer)
  - ***Use trapdoor: new s = asQ***

Discussed in X9 Meeting

- Didn’t seem like a real threat
- Obvious choice would have been to generate P and Q in a verifiably random way, make those the new system parameters.
    - At least one vendor had implemented with original P,Q.
- Instead, we allowed implementers to generate their own P and Q in a verifiably random way.
    - As far as we know, nobody actually did this..

Snowden Disclosures

- News stories came out strongly suggesting that Dual EC had a trapdoor inserted by NSA

- This put the previous discussions in an entirely new light.

- We responded by:

  - Issuing an ITL bulletin telling everyone to stop using Dual EC DRBG until further notice.

  - Putting all three 800-90 documents up for public comment

Future of 800-90A

- Our current plan is to remove Dual EC DRBG
  - Its performance is pretty slow
  - Many vendors already have scrambled to remove or disable it in their products.
  - Phase-out period

Questions / Lessons Learned

- ***Developing standards in an adversarial world?***
- ***Transitive trust?***