Most Common Cryptography Mistakes

4/2/2014

#1: Don't Roll Your Own

- Don't design your own crypto algorithm
- Use a time-honored, well-tested system
  - e.g., SSL, PGP, SSH

#2: Don’t Encrypt without Auth

- Common mistake: encrypt, but no authentication
  - A checksum does not provide authentication
- If you’re encrypting, you probably want authenticated encryption
  - Encrypt-then-authenticate: $E_{k1}(M)$, $F_{k2}(E_{k1}(M))$
  - Or, use a dedicated AE mode: GCM, EAX, …

#3: Be Careful with Randomness

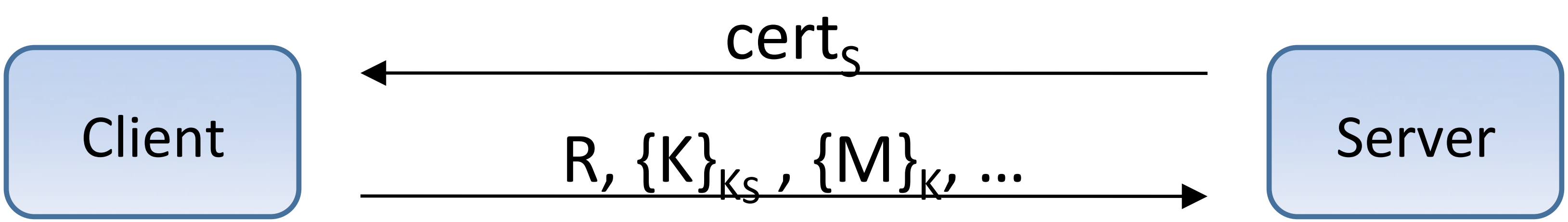
- Common mistake: use predictable random number generator (e.g., to generate keys)
- Solution: Use a crypto-quality PRNG.
  - /dev/urandom, CryptGenRandom, …

Netscape Navigator

```
char chall[16], k[16];

srand(getpid() + time(NULL)
      + getppid());
for (int i=0; i<16; i++)
  chal[i] = rand();
for (int i=0; i<16; i++)
  chal[i] = rand();
```

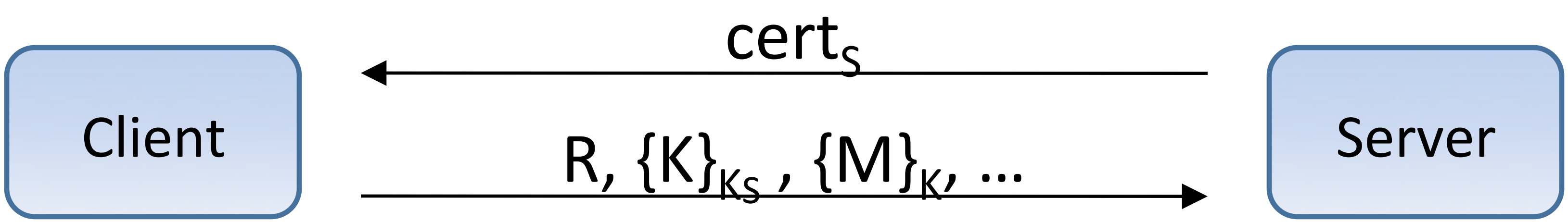
Netscape Navigator 1.1



where (R, K) = hash(microseconds, x)

x = seconds + pid + (ppid << 12)

Netscape Navigator 1.1



where (R, K) = hash(microseconds, x)

x = seconds + pid + (ppid << 12)

Attack: Eavesdropper can guess x (≈ 10 bits) and microseconds (20 bits), and use R to check guess.

Bad PRNGs = broken crypto

- Netscape server's private keys ($\approx$ 32 bits)
- Kerberos v4's session keys ($\approx$ 20 bits)
- X11 MIT-MAGIC-COOKIE1 (8 bits)
- Linux vtun ($\approx$ 1 bit)
- PlanetPoker site ($\approx$ 18 bits)
- CryptoAG – NSA spiked their PRNG

#4: Passphrases Make Poor Keys

- Common mistake: Generate crypto key as Hash(passphrase)
- Problem: ≈ 20 bits of entropy; even with a slow hash, this is not nearly enough. Human-generated secrets just don't have enough entropy.
- Solution: Crypto keys should be random.

#5: Be Secure By Default

- Common mistake: Security is optional, or configurable, or negotiable
- Fix: There is one mode of operation, and it is secure. No human configuration needed.
  - e.g., Skype

Wardriving / Access Point Mapping

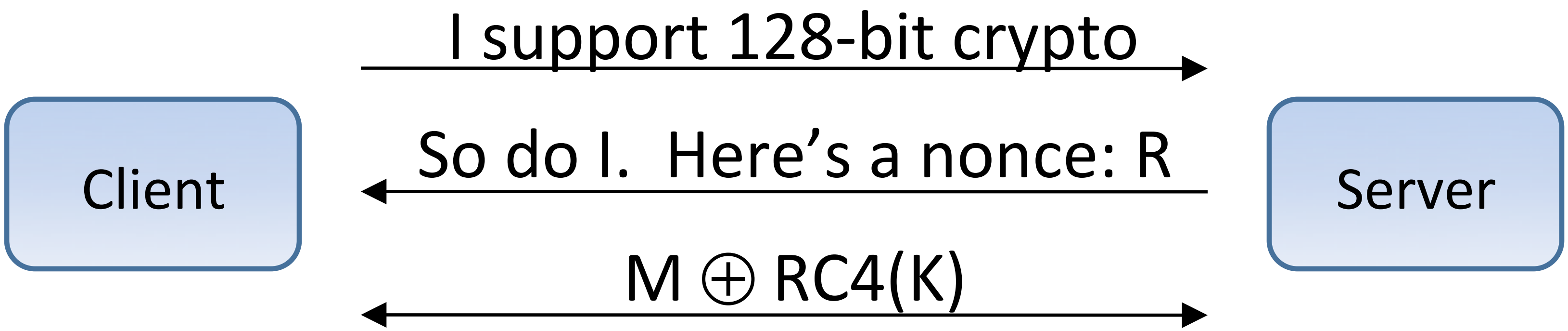
468 WEP

1,265 Clear

1,733 Total

MS Point-to-Point Encryption (MPPE)

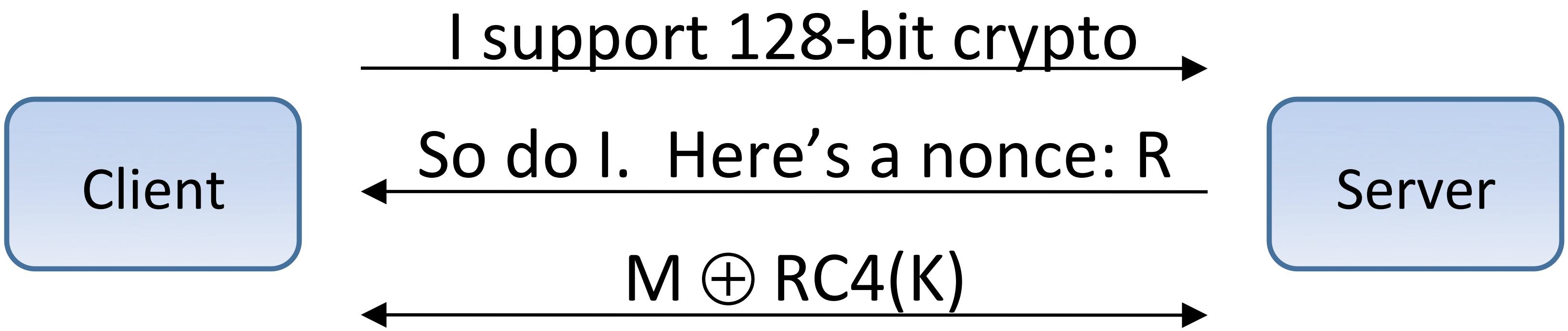
If both endpoints support 128-bit crypto:



where $K = \text{hash}(\text{password} \mid\mid R)$

MS Point-to-Point Encryption (MPPE)

If both endpoints support 128-bit crypto:



where K = hash(password || R)

Attack 1: Eavesdropper can try dictionary search on password, given some known plaintext.

MS Point-to-Point Encryption (MPPE)

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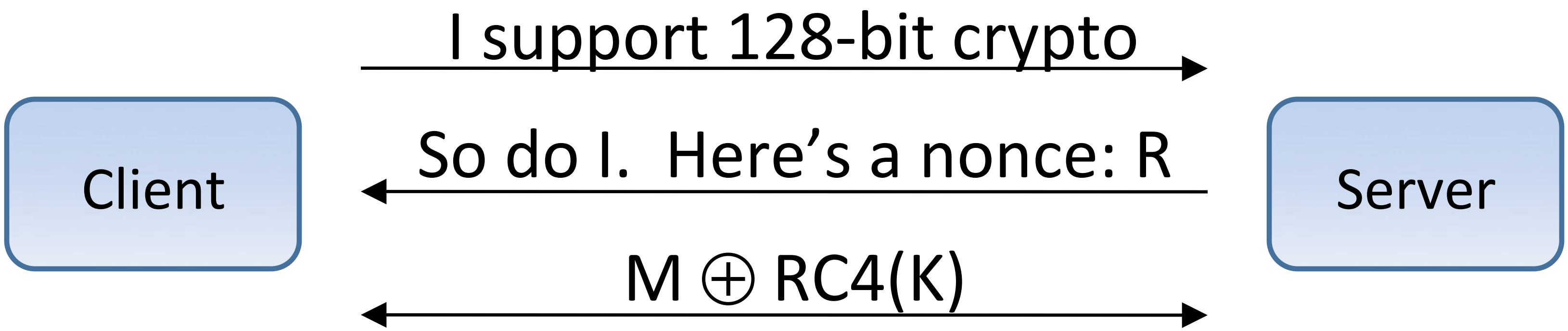
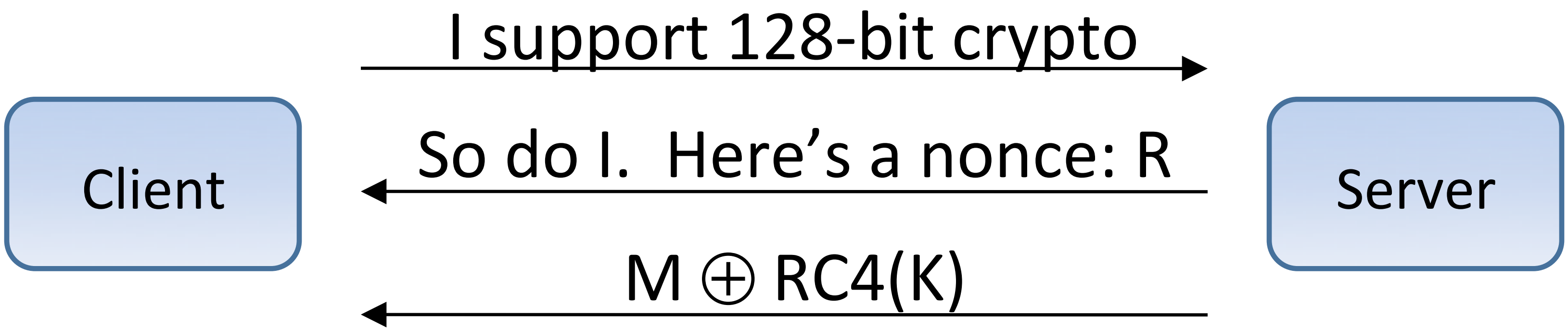
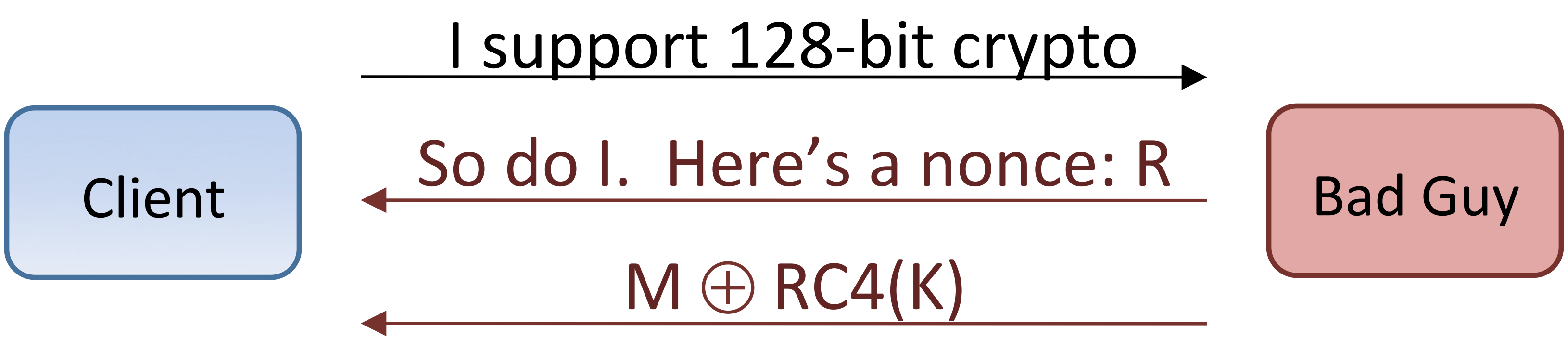


where K = hash(password || R)

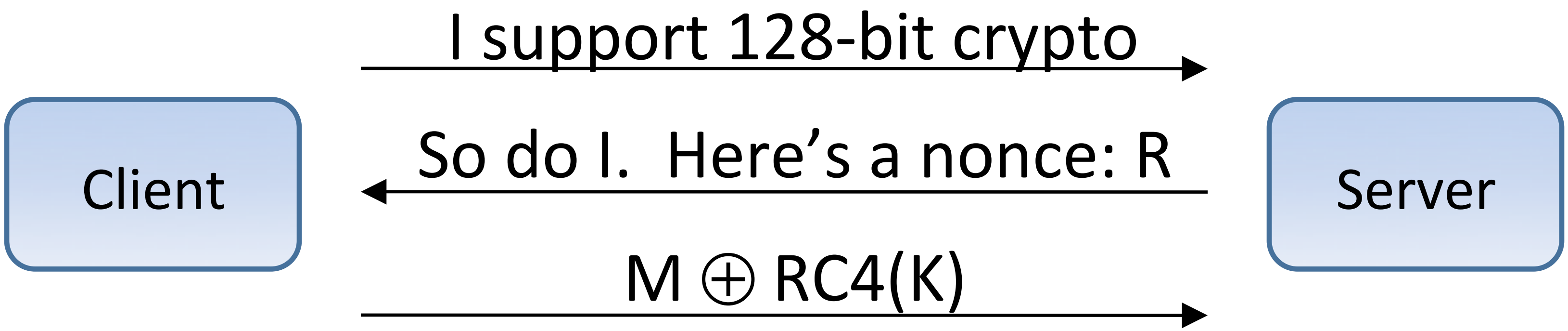
Attack 2: Active attacker can tamper with packets by flipping bits, since there is no MAC.



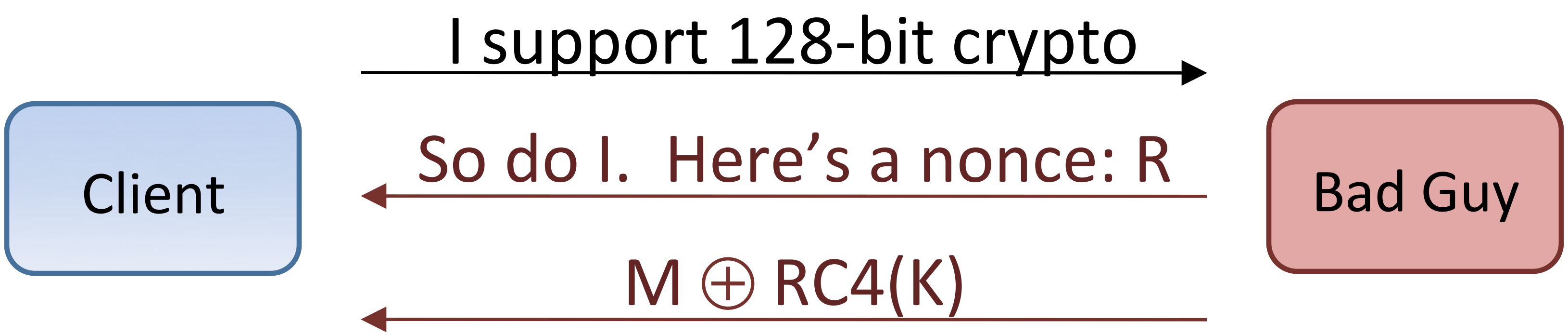
where K = hash(password || R)



Attack 3: Bad guy can replay a prior session, since client doesn't contribute a nonce.



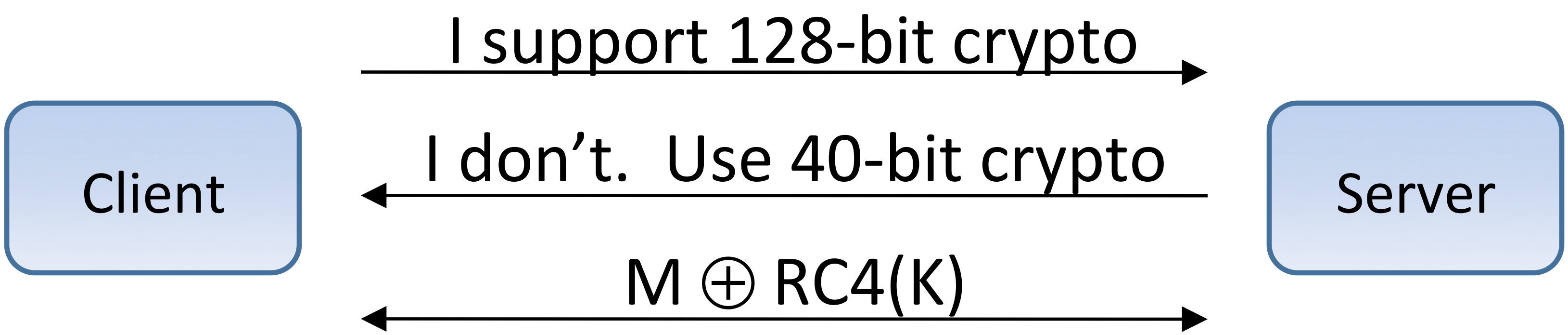
where K = hash(password || R)



Attack 4: Bad guy can replay and reverse message direction, since same key used in both directions.

MS Point-to-Point Encryption (MPPE)

If one endpoint doesn't support 128-bit crypto:



where K = hash(uppercase(password))

MS Point-to-Point Encryption (MPPE)

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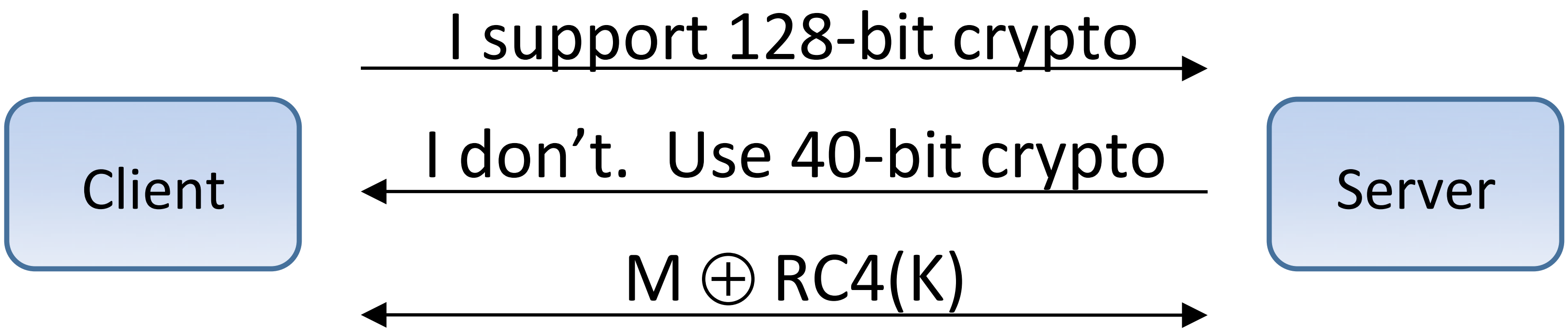
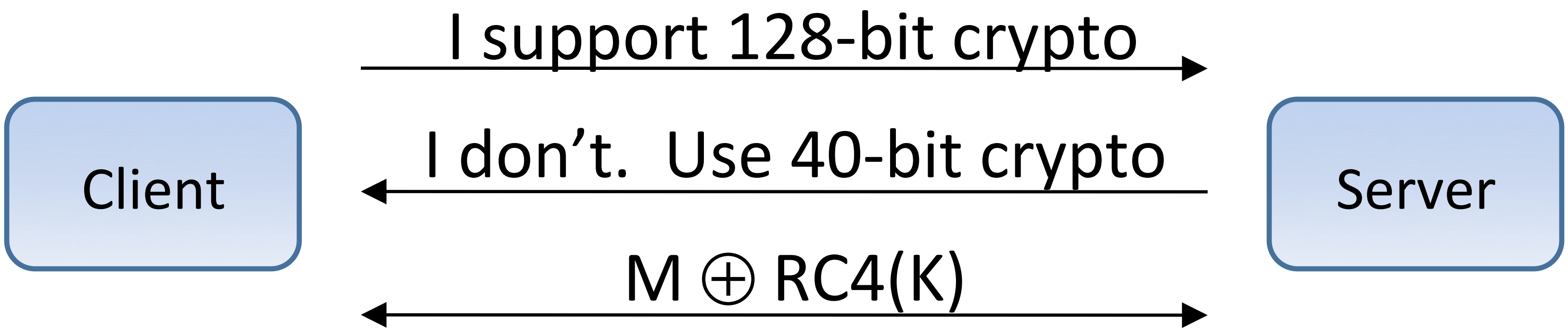


where K = hash(uppercase(password))

Attack 1: Eavesdropper can try dictionary search on password, given some known plaintext.

MS Point-to-Point Encryption (MPPE)

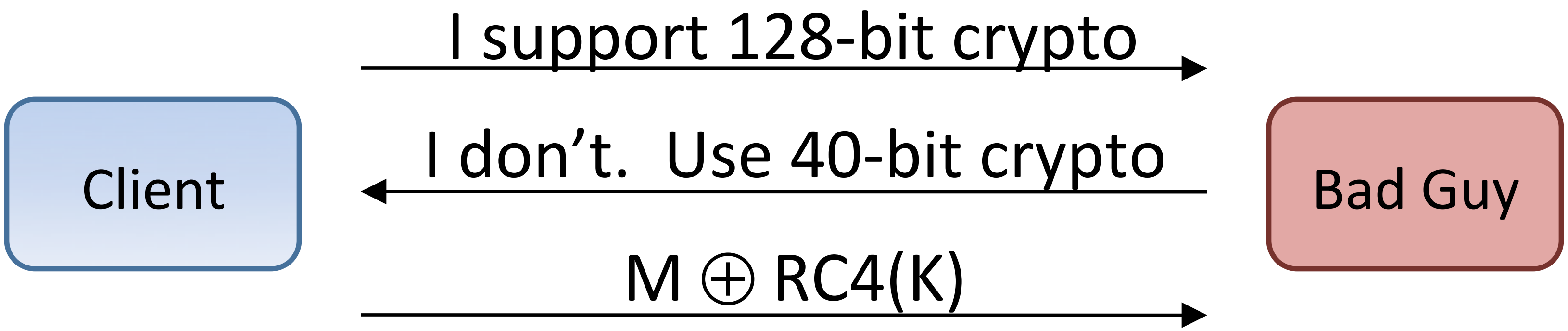
If one endpoint doesn't support 128-bit crypto:



where K = hash(uppercase(password))

Attack 2: Dictionary search can be sped up with precomputed table (given known plaintext).

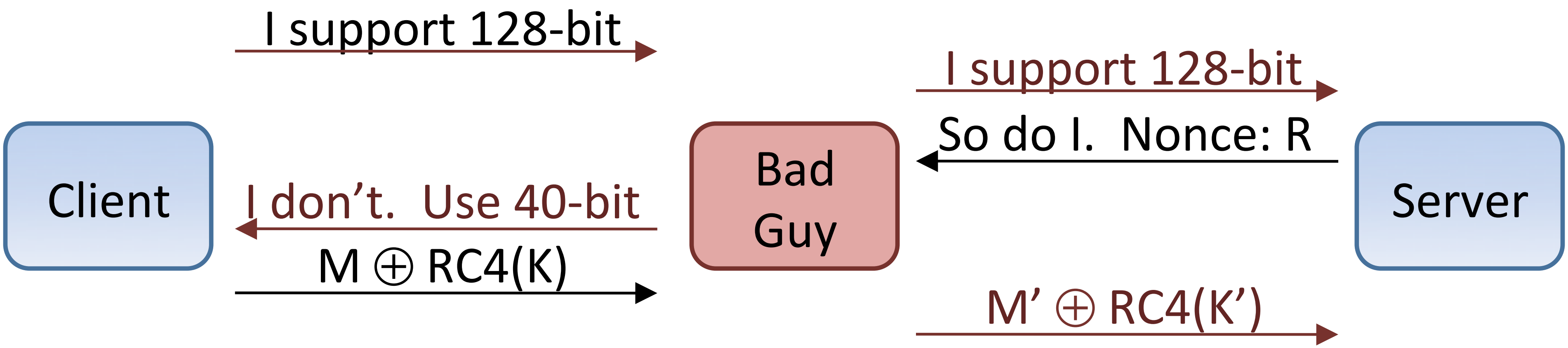
MS Point-to-Point Encryption (MPPE)



where K = hash(uppercase(password))

Attack 3: Imposter server can downgrade client to 40-bit crypto, then crack password.

MS Point-to-Point Encryption (MPPE)



where K = hash(uppercase(password)),
K' = hash(password || R)

Attack 4: Man-in-the-middle can downgrade crypto strength even if both client + server support 128-bit crypto, then crack password.

#6: Careful with Concatenation

- Common mistake: Hash(S||T)
  - “builtin” || “securely” = “built” || “insecurely”

Amazon Web Services

http://amazon.com/set?u=daw&n=David&t=U&m=...

MAC(K,"udawnDavidtU")

Amazon Web Services

://amazon.com/set?u=daw&n=DavidtAq&t=U&m=…

MAC(K,"udawnDavidtAqtU")

://amazon.com/set?u=daw&n=David&t=A&qt=U&m=…

#6: Careful with Concatenation

- Common mistake: Hash(S||T)
  - “builtin” || “securely” = “built” || “insecurely”
- Fix: Hash(len(S) || S || T)
- Make sure inputs to hash/MAC are uniquely decodable

#7: Don’t re-use nonces/IVs

- Re-using a nonce or IV leads to catastrophic security failure.

Credit card numbers in a database

dgaTkyuPS8bs4rPXoQn3
dgaalSeET8Hv4rvfpQrz
cQGakyuFQcri6brfoAH6Jg==
dgWdmSuESsro4bfXpQj0
cQSYmCKLScDt4bDXqAj2Ig==
cQWTlCKNSsfr5bDfqAnzIw==
cAKdkyOMT8Ti6LvQpwj2IA==

After Base64 decoding

76	06	93	93	2b	8f	4b	c6	ec	e2	b3	d7	a1	09	f7	
76	06	9a	95	27	84	4f	c1	ef	e2	bb	df	a5	0a	f3	
71	01	9a	93	2b	85	41	ca	e2	e9	ba	df	a0	01	fa	26
76	05	9d	99	2b	84	4a	ca	e8	e1	b7	d7	a5	08	f4	
71	04	98	98	22	8b	49	c0	ed	e1	b0	d7	a8	08	f6	22
71	05	93	94	22	8d	4a	c7	eb	e5	b0	df	a8	09	f3	23
70	02	9d	93	23	8c	4f	c4	e2	e8	bb	d0	a7	08	f6	20