

RC6—The elegant AES choice

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RC6 is the right AES choice

- ◆ Security
- ◆ Performance
- ◆ Ease of implementation
- ◆ Simplicity
- ◆ Flexibility

RC6 is simple: only 12 lines

```
B = B + S[ 0 ]
D = D + S[ 1 ]
for i = 1 to 20 do
{
    t = ( B × ( 2B + 1 ) ) <<< 5
    u = ( D × ( 2D + 1 ) ) <<< 5
    A = ( ( A ⊕ t ) <<< u ) + S[ 2i ]
    C = ( ( C ⊕ u ) <<< t ) + S[ 2i + 1 ]
    ( A, B, C, D ) = ( B, C, D, A )
}
A = A + S[ 42 ]
C = C + S[ 43 ]
```

Simplicity

- ◆ Facilitates and encourages analysis
 - allows rapid understanding of security
 - makes direct analysis straightforward (contrast with Mars and Twofish)
- ◆ Enables easy implementation
 - allows compilers to produce high-quality code
 - obviates complicated optimizations
 - provides good performance with minimal effort

RC6 security is well-analyzed

- ◆ RC6 is probably most studied AES finalist
 - RC6 is based on RC5
 - RC6 analysis builds directly on RC5 analysis
 - original RC6 analysis is very detailed
 - RC6 simplified variants studied extensively
 - small-scale versions allowed experimentation

RC6 key schedule is rock-solid

- ◆ Studied for more than six years
- ◆ Secure
 - thorough mixing
 - one-way function
 - no key separation (cf. Twofish)
 - no related-key attacks (cf. Rijndael)

Original analysis still accurate

- ◆ RC6 meets original design criteria
- ◆ Security estimates from 1998 still good today; independent analyses supportive.
- ◆ Secure, even in theory, even with analysis improvements far beyond those seen for DES during its lifetime
- ◆ RC6 provides a solid, well-tuned margin for security

32-bit Performance

- ◆ Excellent performance
- ◆ 32-bit CPUs are
 - NIST reference platform
 - a significant fraction of installed computers throughout the AES lifetime
 - becoming more prevalent in cheaper devices (e.g. ARM)

Smart Card Suitability

- ◆ RC6 fits in the cheapest smart cards, and well-suited for many (e.g. ARM processor)
- ◆ Bandwidth, not CPU, likely to be most significant bottleneck
- ◆ 8-bit CPUs will become far less important over the AES lifetime

Performance on 64-bit CPUs

- ◆ Generally good 64-bit performance
- ◆ IA64-performance only fair but anomalous--slower than Pentium!
 - Note 3x improvement with IA64++
- ◆ Future chips will optimize AES
- ◆ In addition, RC6 gains dramatically with multi-block processing compared to other schemes

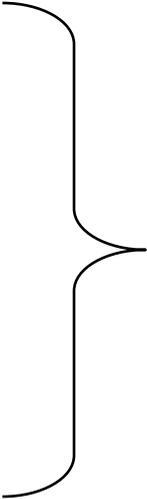
Major Trends: Java and DSPs

- ◆ Increasing use of Java
 - for e-commerce and embedded apps.
 - RC6 provides excellent speed with minimal code size and memory usage
- ◆ Increasing use of DSP chips
 - likely to be more significant than IA64 or 8-bit processors
 - RC6 gives excellent performance

Flexibility

- ◆ RC6 is fully parameterized
 - key size, number of rounds, and block length can be readily changed
 - well-suited for hash functions
- ◆ RC6 is only AES finalist that naturally gives DES and triple-DES compatible variants (64-bit blocks)

How do we grade candidates?

- ◆ Security (corroborated) 
- ◆ Performance (speed+memory)
 - 32-bit  (30%)
 - Java  (20%)
 - DSP  (15%)
 - 64-bit  (15%)
 - Hardware  (15%)
 - 8-bit  (5%)
- ◆ Ease of implementation 
- ◆ Simplicity 
- ◆ Flexibility 
- Overall: 40/25/15/10/10 

Conclusions

- ◆ RC6 is a simple yet remarkably strong cipher
 - good performance on most important platforms
 - simple to code for good performance
 - excellent flexibility
 - the most studied finalist
 - the best understood finalist
- ◆ RC6 is the secure and "elegant" choice for the AES

(The End)
