Authenticated ciphers

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Advertisement: SHARCS 2012 (Special-Purpose Hardware for Attacking Cryptographic Systems) is right before FSE+SHA-3. 2012.01.23 deadline to submit extended abstracts. 2012.sharcs.org
Multiple-year SHA-3 competition has produced a natural focus for security analysis and performance analysis.

Community shares an interest in selecting best hash as SHA-3. Intensive analysis of candidates: hash conferences, hash workshops, active SHA-3 mailing list, etc.

Would have been harder to absorb same work spread over more conferences, more time. Focus improves community’s understanding and confidence.
This is a familiar pattern.

June 1998: AES block-cipher submissions from 50 people ⇒ community focus.

April 2005: eSTREAM stream-cipher submissions from 100 people ⇒ community focus.

October 2008: SHA-3 hash-function submissions from 200 people ⇒ community focus.
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NESSIE was much less focused and ended up in more trouble: e.g., only two MAC submissions.
The next community focus

What’s next after block ciphers, stream ciphers, hash functions?

Proposal: authenticated ciphers.

Basic security goal: two users start with a shared secret key; then want to protect messages against espionage and forgery.

The usual competition: maximize security subject to performance constraints; i.e.: maximize performance subject to security constraints.
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FSE 2011 Krovetz–Rogaway cite EtM, RPC, IAPM, XCBC, OCB1, TAE, CCM, CWC, GCM, EAX, OCB2, CCFB, CHM, SIV, CIP, HBS, BTM; and propose OCB3.

Same paper reports various timings for AES-GCM; better timings for AES-OCB3, “the fastest reported times for AE” (authenticated encryption); within $\epsilon$ of AES.
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“That’s the end! AES-OCB3!”
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Conclusion: No reason to think that existing work is optimal. Ample room for competition.
Changing the components

AES-GCM uses AES-CTR.

Many bits of AES input thus end up as constants, invalidating many differentials.

Can AES-GCM get away with one or two fewer AES rounds while still providing security against differential attacks?

AES-OCB3 doesn’t use CTR. Can it be safely modified to use some constant bits?
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Can we obtain better speeds by replacing AES-CTR with another stream cipher?

Yes, course! See eSTREAM. Example, ARM Cortex A8:
28.9 cycles/byte for AES-OCB3.
25.4 cycles/byte for AES-CTR.
  8.53 cycles/byte for Salsa20/20.
  5.53 cycles/byte for Salsa20/12.
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UMAC, VMAC, etc.: faster than HMAC in software; what about hardware?
(I’m doing a new PEMA design.)
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But is AES actually secure?

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Does efficiency force ciphers to have a scary key schedule?
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E.g. AES-OCB3 theorems allow attack probability $6q^2/2^{128}$ after $q$ blocks of AES input. Is $q \approx 2^{60}$ so hard to imagine?
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128-bit block size for AES is beginning to look rather small. Wouldn’t it be more comfortable to have 256-bit blocks?
What happens to security if the attacker is lucky and succeeds at one forgery?

AES-GCM answer: key recovery.
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How important is this? Do we need high key agility?
What about side-channel attacks?
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How can we design primitives to reduce cost of avoiding hardware side channels?

One approach (e.g., Keccak): maximize bit-level parallelism, minimize degree over $\mathbb{F}_2$. 
Cost metrics

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What is the smallest area for an authenticated cipher?

For each $A$: How fast is an authenticated cipher that fits into area $A$?
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What is most important for performance of authenticated ciphers: normal traffic, or floods of forged traffic?
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Fast MAC of $m_0, m_1, \ldots$ typically looks like $k_0 m_0 + k_1 m_1 + \cdots$.

Use $k_i m_i$ in computing $i$th block of ciphertext?

Compare to 1996 Lucks $HFF$. 
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Does this actually matter?
Fix 1: Give up, and stop feeding plaintext into state.
Fix 2: Use much larger blocks, much stronger map.
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Oh, you *are* a mode designer? Take standard components, submit.
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Mid-2012: ECRYPT workshop.
Mid-2013: Submission deadline.
Mid-2014: Second round.
Mid-2015: Third round.
Most work is volunteered by cryptographers+cryptanalysts designing+attacking submissions. (And we’ll do benchmarking.)

Also need central committee of experienced cryptologists evaluating cryptanalyses and selecting the best submissions.

Is this committee work so much fun that the right people will volunteer for it? Maybe!
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Greg Rose has suggested “eSAFE”. Maybe “ECRYPT Secure Authenticated Fast Encryption”? 
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Orr: “FEAR”? “SHÆ-3”? 