Security Technology Group – Cryptographic Standards, Authentication and Infrastructures

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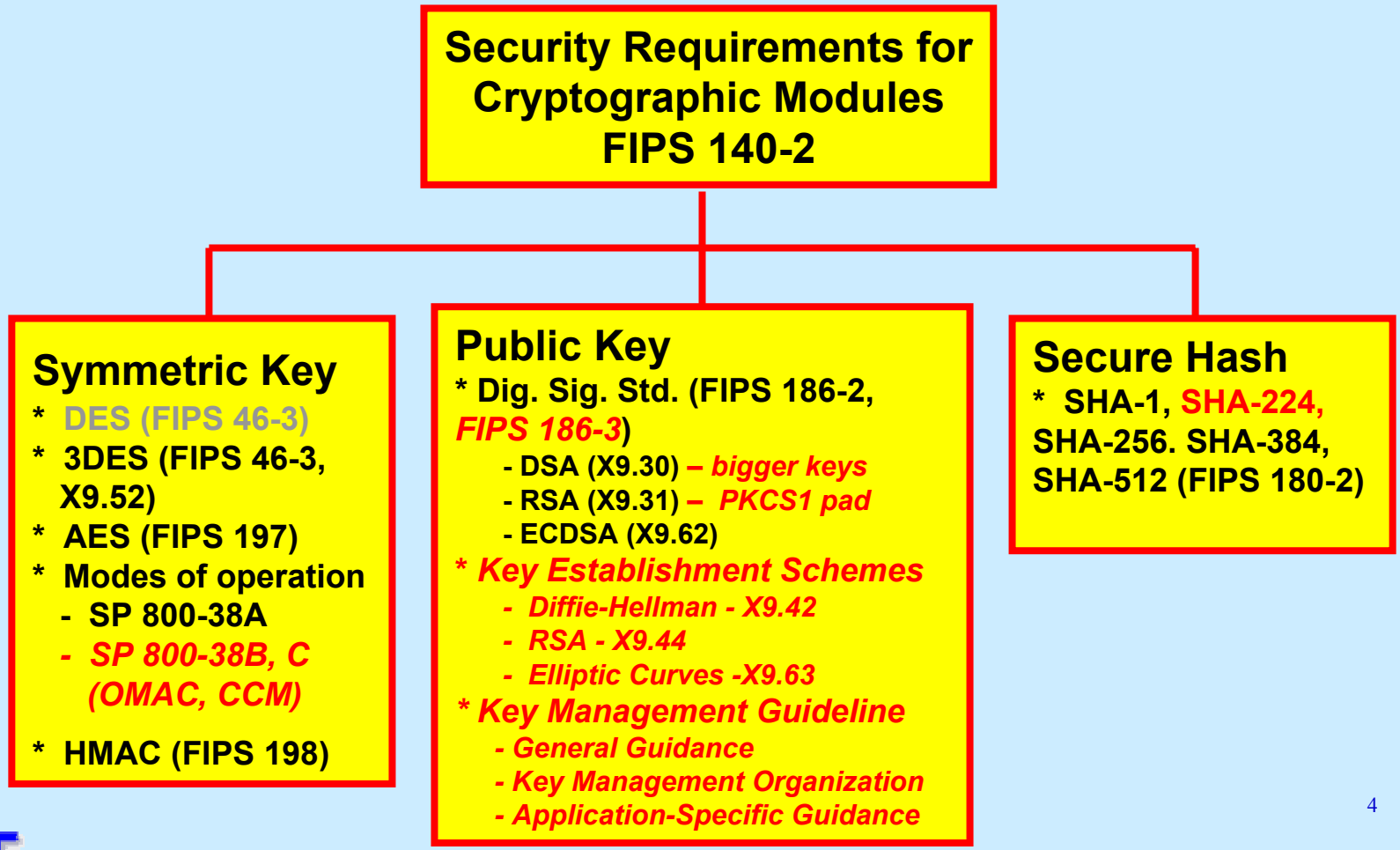
Security Technology Group

- Cryptographic Standards Team
  - Elaine Barker leader
  - 5 FTE (one addition last FY)
- Authentication and Infrastructure Team
  - Tim Polk leader
  - 6.5 FTE (.5 addition last FY)
- Biometrics Standards
  - Fernando Podio leader
  - 1 FTE at the moment

NIST Cryptographic Standards

- First Federal Information Processing Standard (FIPS) in Cryptography in 1977
  - FIPS 46, The Data Encryption Standard (DES)
- Mandatory for Federal use of cryptography to protect unclassified, sensitive data
  - FIPS 140-2
- Standardize a set of strong cryptographic tools
  - Can't test and approve every good algorithm/method
    - Too expensive to study each one
  - Too many would confound interoperability

Cryptographic Standards



Toolkit Advantages

- FIPS 140-2 product testing
  - CMVP Laboratory validation testing
  - Known answer testing for many of the tools
- Confidence in the security of the tools
  - Carefully evaluated and monitored
- Interoperability and acceptance
  - Tools very widely implemented and used
  - Seen as the safe choice
- Use by Federal agencies often required

Sources of Standards & Recommendations

- Public submissions with NIST selection
  - DES, AES, new crypto modes
- Standards Bodies
  - ANSI-X9
    - TDES, ECDSA, ECDH and ECMQV, FFDH and FFMQV, RSA variants
  - IETF
    - HMAC
    - perhaps eventually PKIX, TLS, S/MIME, IKE….
- NSA
  - DSA, SHAxxx, proposed AES Key Wrap

Crypto Standards Participation

- X9F1 has been main venue for NIST participation
  - Financial services industry
  - X9F1 standards used in FIPS
    - X9.52 (TDES), X9.62 (ECDSA), X9.31 (rDSA)
      - NIST did much of the work for several of these
- Other important cryptographic standards venues
  - ANSI INCITS T4 (ISO/IEC JCT1 SC27)
  - IEEE P1363 & IEEE 802.11 tgi (CCM)
  - IETF (HMAC for example comes from RFC 2104)
- NIST can't afford to play everywhere
  - Which is the best place to participate?
    - Broadest & best participation & exposure

Modes of Operation Recommendation

- SP 800-38A 2001 ED, Recommendation for Block Cipher Modes of Operation, 2001(encryption modes)
  - update of FIPS 81
  - 5 modes
    - ECB – Electronic Code Book
    - CBC – Cipher Block Chaining
    - CFB – Cipher Feedback
    - OFB – Output Feedback
    - *Counter*
- Generalized for any block cipher

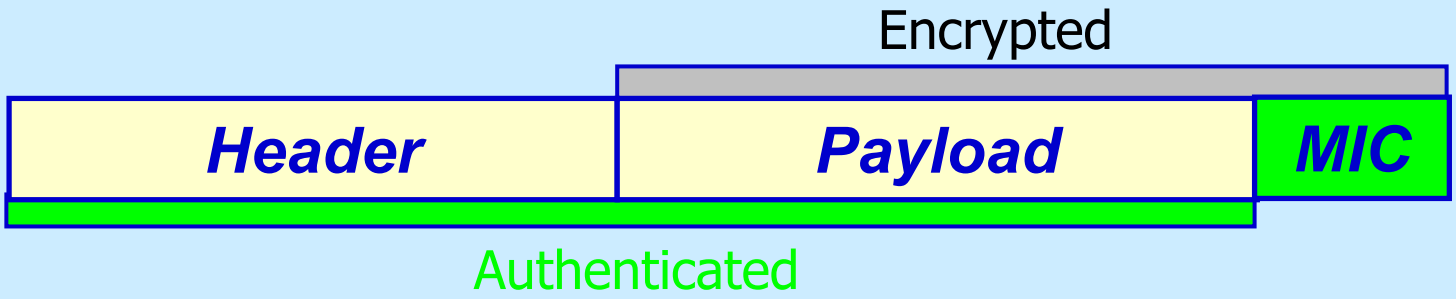
New Modes on Our Plate

- Block Cipher Message Authentication Code
  - Originally proposed RMAC
    - Blocks extension attacks
    - Blocks “birthday” attacks
      - At expense of more tag bits
      - Mainly a problem for TDES
    - Controversy
      - TDES Related key attack
  - Answer: OMAC
    - One key variation on XCBC MAC
- Counter with CBC-MAC mode
  - To be mandatory to implement in 802.11
- AES Key Wrap
  - TDES too?

802.11 WEP Debacle & CCM

- 802.11 wireless Ethernet is huge success, but
  - Wired Equivalency Protocol (WEP) was a disaster
    - Vulnerable to almost every attack known to cryptologists
      - Keystream is more or less guaranteed to repeat
      - "Side-channel" attack exploits non-cryptographic checksum
      - Weak RC4 encryption – can recover the key
      - Encryption but no authentication
    - Can do only so much to patch this
- This is fundamental infrastructure
  - it's worth getting it right
- 802.11i and 802.1x are addressing the problem
  - NIST plans to adopt the CCM mode

CCM Mode Overview



- Use CBC-MAC to compute a MIC (Message Integrity Code) on the plaintext header, length of the plaintext header, and the payload
- Use CTR mode to encrypt the payload
  - Counter values 1, 2, 3, …
- Use CTR mode to encrypt the MIC
  - Counter value 0

Key Management

- Most current drafts posted for comment
  - http://csrc.nist.gov/CryptoToolkit/tkkeymgmt.html
  - Key Establishment Schemes: NIST SP 800-56 Basic public key methods
    - RSA is still the missing piece
  - Guidance: NIST SP 800-57
    - General guidance
    - Best practice for key management organization
    - Application specific guidance (not posted yet)
- Proposed 80-bit crypto end of use date: ***2010***
  - Stop using 1024-bit RSA/DSA or 160-bit EC by 2010

Random Number Generation

- ANSI X9.82: Consists of three parts
  - Part 1: Overview and Basic Principles
  - Part 2: Non-deterministic Random Bit Generators
  - Part 3: Deterministic Random Bit Generators
- Workshop being planned for Summer 2004
- Draft to be made available prior to workshop

Comparable Strengths

Size in bits

Sym. Key	56	80	112	128	192	256
Hash	160		224	256	384	512
MAC	64	160	256		384	512
RSA/DSA	512	1k	2k	3k	7.5k	15k
EC	160		224	256	384	512

Sym. Key: Symmetric key encryption algorithms
MAC: Message Authentication code
RSA/DSA: Factoring or discrete log based public key algorithms using FF arithmetic
EC: Elliptic Curve discrete log based public key algorithms
White background: currently approved FIPS
Yellow background: under development
Black background: not secure now

NIST Crypto Standards Status

	56	80	112	128	192	256
Sym. Key	46-3	185	46-3	FIPS 197 (AES)		
Modes	81			SP 800-38A		
Hash	180-1		180-2			
MAC	FIPS 198 (HMAC)/SP 800-38B					
RSA, DSA, EC-DSA	186-2		186-3			
DH/RSA	Key Management FIPS: Scheme and Guidance					
EC-DH						

White: FIPS approved
Red: working draft phase
Black: no longer secure

Yellow: draft in progress
gray: initial recommendation published, more to come

Authentication & Infrastructure Team: Scope of Current Efforts

- Three overlapping technology areas:
  - Authentication Technologies
  - Cryptographic Infrastructures
  - Crypto-enabled Applications
- Four General Activities
  - Research
  - Standardization & Guidance
  - Testing (Interoperability, Conformance, & Assurance)
  - Deployment

Authentication Technologies, I

- Research
  - Knowledge-based Authentication
  - Strength of Passwords
- Standardization & Guidance
  - E-Authentication Guidance establishes framework for selection of e-Auth mechanisms
  - Updating NIST's password guidance
  - Subject Identification Method standard (with KISA)

Authentication Technologies, II

- Testing & Tools
  - Reference Implementation of the Subject Identification Method standard
- Deployment
  - SAML-based infrastructure for e-Authentication for Federal Government applications

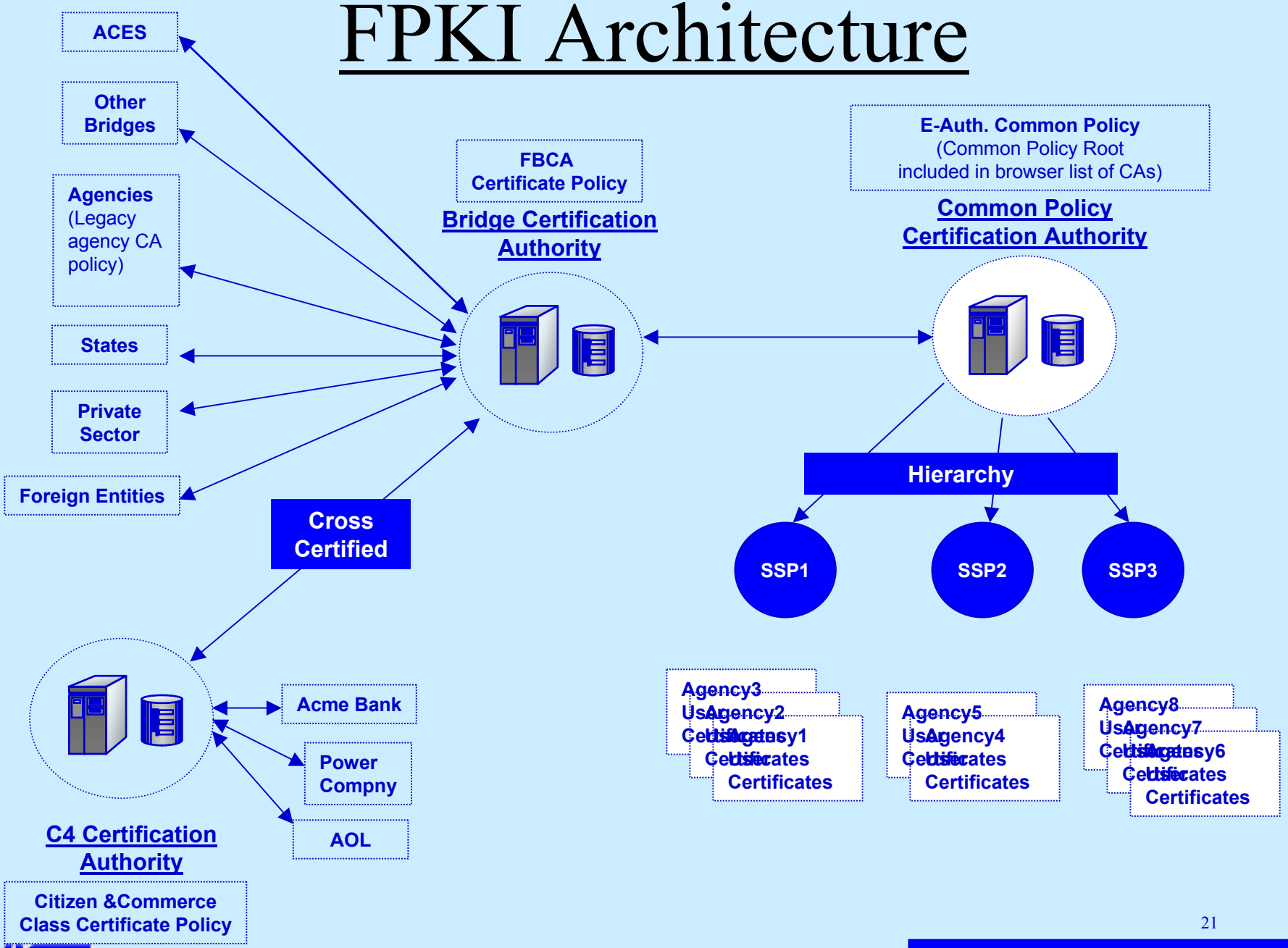
Cryptographic Infrastructures

- Research Activities
  - 3rd Annual PKI R&D Workshop co-sponsored with Internet II
- Standards
  - PKI Standards are mature
  - IETF and ISO PKI standards activities are winding down

Cryptographic Infrastructures, II

- NIST leading PKI Testing Efforts
  - Interoperability testing for IETF PKI standards
  - PKI client conformance tests (Path Validation)
  - Protection Profiles for CAs and PKI clients
- Key Participant in FPKI Deployment Efforts
  - FPKI Policy Authority and Certificate Policy Working Group (Federal Bridge CA)
  - Shared Service Provider Working Group (managed PKI services for Government Smart Card)
  - Path Validation & Discovery Working Group

FPKI Architecture



Legend:
SSP = Qualified Shared Service Providers

NIST National Institute of Standards and Technology

Federal Identity Credentialing Committee (FICC)

- Common physical & logical credentials for Physical & logical access
  - Federal employees & associates
- Combines Federal PKI Steering Committee, HR and Physical Security
- NIST provides technical support
  - Smart card/badge, biometrics & certificate
    - NIST lead in Certificate Policy WG
- Website: http:// www.cio.gov/ficc

Crypto-Enabled Applications

- Standards & Guidance
  - High Level API for Cryptographic Services
  - S/MIME Functional Profile
  - SSL/TLS Selection and Implementation Guidance
- Testing Tools and Services
  - Reference Implementation for High Level API
  - S/MIME Interoperability and Conformance Testing
- Assisting Agencies in Application Deployment
  - FDIC, Army Corps of Engineers,Treasury/Financial Management System

E-Authentication Tech Guidance

- Will Be NIST Recommendation SP800-63
- Puts technical flesh on OMB generated e-Authentication policy guidance
  - Federal Register announcement for comment in July; revised announcement pending
  - Four levels of assurance
    - Defined in terms of the possible risks and consequences of authentication error

Assurance Levels

- OMB guidance defines 4 assurance levels
  - Level 1 is lowest, Level 4 is highest
- Assurance level needed determined by consequences of authentication error
  - Inconvenience, distress & damage to reputation
  - Financial loss
  - Harm to agency programs or reputation
  - Civil or criminal violations
  - Personal safety

Technical Guidance Constraints

- Technology neutral
  - Required (if practical) by e-Sign, Paperwork Elimination and other laws
  - Difficult: many technologies, apples and oranges comparisons
- Practical with COTS technology
  - To serve public must take advantage of existing password based solutions and relationships
- Only for remote network authentication
- Only about identity authentication
  - not about attributes or authorization or access control

E-Auth Guidance Scope

- Remote Authentication over open networks
  - Does not address in-person authentication
    - Consequence is that biometrics are only useful in identity proofing, because
      - Protocols for remote network authentication are based on secret tokens (typically passwords or keys), but;
        - » Biometrics make bad secrets

E-Auth Guidance

- SP 800-63
  - ID Proofing
  - Tokens, credentials and assertions
  - Protocols
    - Required properties at each level
    - Password strength model

ID Proofing

- Level 1
  - Self assertion, minimal records
- Level 2
  - More or less instant gratification possible
    - Some confirmation of address or phone number
- Level 3
  - Substantial checking, multiple sources
- Level 4
  - Level 3 plus in-person appearance
    - Record biometric, give token to a warm body

Token Type by Level

Allowed Token Types	1	2	3	4
Hard crypto token	√	√	√	√
Soft crypto token	√	√	√	
Zero knowledge password	√	√	√	
Strong password	√	√		
PIN	√			

Required Protections by Level

Protection Against	1	2	3	4
Eavesdropper		√	√	√
Replay	√	√	√	√
On-line guessing	√	√	√	√
Verifier Impersonation			√	√
Man-in-the-middle			√	√
Session Hijacking			√	√

Auth. Protocol Type by Level

Allowed Protocol Types	1	2	3	4
Private key PoP	√	√	√	√
Symmetric key PoP	√	√	√	√
Zero knowledge password	√	√	√	
Tunneled password	√	√		
Challenge-reply password	√			

Required Protocol Properties by Level

Required properties	1	2	3	4
Shared secrets not revealed to 3rd parties		√	√	√
Session Data transfer authenticated			√	√

Biometric Standards - Plan for 2004

- Lead national (INCITS M1) & international (JTC 1 SC 37) Biometric standard developments
- Coordinate & participate in the development of an initial portfolio of interoperability & data interchange standards to:
  - ANSI approval status (through M1):
    - Data interchange formats: finger-image, pattern, & minutiae; iris image; face
    - Application profiles: transportation workers, border management)
  - Draft international standard status (through SC 37):
    - BioAPI specification (ANSI INCITS 358-2002)
    - Common Biometric Exchange Formats Framework (CBEFF)
    - Data interchange formats (finger-image, pattern, minutiae; iris image & face)

Biometric Standards - Plan for 2004

- NISP role in the Biometric Consortium (BC) and the BioAPI Consortium
  - Co-chair the Biometric Consortium (with NSA)
    - Annual conference: Week of September 20th.
  - Member of the BioAPI Consortium Steering Committee
- Leverage of Consortia Standards developed by NIST/BC Biometric WG:
  - Complete development of the Common Biometric Exchange Framework Format (CBEFF):
    - Publish as NISTIR 6529-A & submit to INCITS
  - Publish biometric identifier protection and usage techniques as a NISTIR & submit to INCITS T4
- Identify biometric interoperability testing requirements

Questions

Links

- NIST Cryptographic Toolkit
  - http://csrc.nist.gov/CryptoToolkit/
- Federal PKI Steering Committee
  - http://www.cio.gov/fpkisc/
- E-gov project
  - http://www.whitehouse.gov/omb/egov/
- E-authentication
  - http://www.whitehouse.gov/omb/egov/ea.htm
- Federal Identity Credentialing Committee
  - http://www.cio.gov/ficc/

Crypto FIPS

- FIPS 46-3, Data Encryption Standard -1999
  - refers to ANSI X9.52-1998 for triple DES
  - expect to kill 56-bit DES with 46-4 due in 94
    - http://csrc.nist.gov/encryption/TDESGuidance.pdf
- FIPS 81, DES Modes of Operation – 1980
- FIPS 113, Computer Data Authentication - 1985
  - DES MAC for financial apps.
- FIPS 117, Key Management using ANSI X9.17
  - being withdrawn
- FIPS 180-2, Secure Hash Standard – 2002
  - SHA1, SHA-256, SHA-384, SHA-512

Crypto FIPS

- FIPS 185, Escrowed Encryption Alg. – 1994
  - Skipjack
- FIPS 186-2, Digital Signature Standard
  - DSS, RSA: X9.31 & PKCS#1, ECDSA: X9.62
- FIPS 197, Advanced Encryption Standard (AES) 2001
- FIPS 198, HMAC - Keyed-Hash Message Authentication Code, 2002