# TMT10 - Top 20 Mistakes in Microsoft Public Key Infrastructure (PKI)

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Level: Intermediate


IT AND DEVELOPER TRAINING THAT'S OUT OF THIS WORLD

# About PKI Solutions Inc.

- **10 years as "The PKI Guy" @ Microsoft**
- **Charter – Microsoft Certified Master DS**
- **Numerous books and whitepapers**
- **Services include:**
  - ADCS Architecture, Deployment and Consulting
  - Assessment and Remediation Services
  - In-Depth PKI Training

    **SFO January 2015, NYC February 2015**
  - Retainer and Support Services

# Genesis of The List

- **Compiled Over 10 Years @ Microsoft**
- **Consulting, Engineering and "RedZone"**
- **Private and Public Sectors Around the World**
  - Hundreds of Customer Environments
- **Lead to PKI Best Practice Review**
  - Evolved over the years to ADCS Assessment

# Benefits of ADCS Assessments

- Problems Can Lay-in-Wait
- Many Manifest After First CA Renewal
- Testing and Validation Often Insufficient
- Fresh Perspective to Spot Deficiencies

# #1 - CRL Management

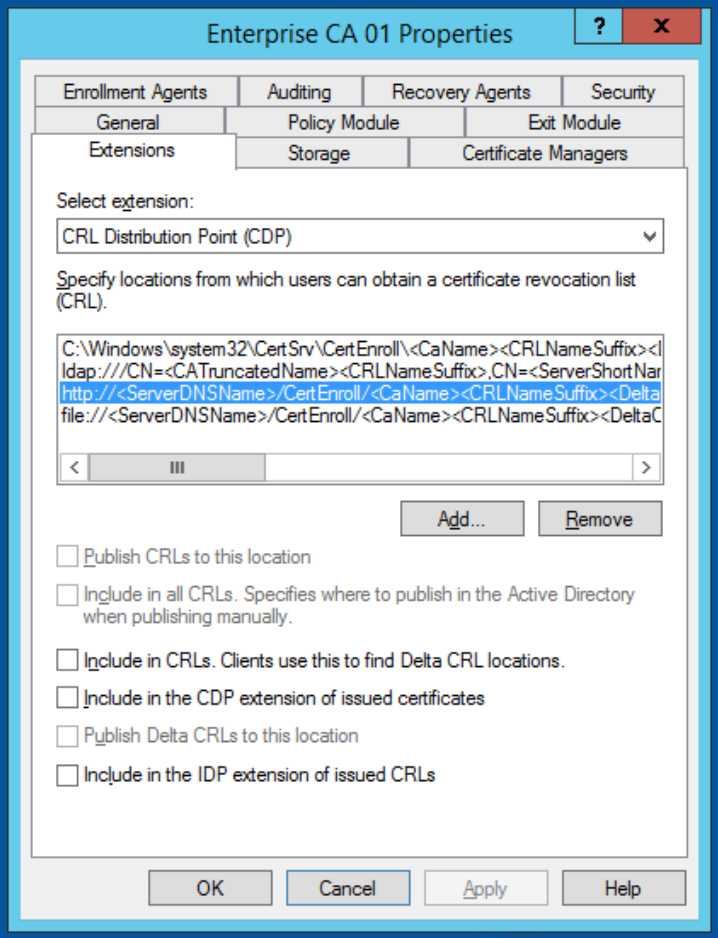
- **Validity & Publishing Intervals**
  - Intervals Balanced with Need To Know
    - **Identification versus Authorization**
  - Highly Affected by Caching Behavior on Clients
    - **Windows Caches for Lifetime of CRL**
    - ***Certutil.exe –setreg chain\ChainCacheResyncFiletime @now***
      - Less Effective: Certutil.exe -URLcache delete
- **Validity versus Publishing**
  - Next Update versus Next CRL Publish
  - Leverage Over-Laps to Provide Redundancy
    - **CRLOverlapPeriod/Units & CRLDeltaOverlapPeriod/Units**

# #1 - CRL Management

- **Availability**
  - CRL Availability versus Issuance Availability
  - Organizational Requirements
  - Options
    - **Active Directory Redundancy**
    - **HTTP Redundancies**
- **Distribution Mechanisms**
  - Active Directory versus HTTP
  - Driven by Accessibility and Client Majorities
- **Delta CRL**
  - Generally Un-Needed in Most Environments.

# #2 - CDP/AIA DNS Alias

- **HTTP Defaults to Local Host Name**
  - No FQDN Compliant
  - Sticky to Specific Server
    - **Difficult to Migrate, Upgrade or Modify**
  - Inaccessibility
- **Alias Provides Portability**
  - Migrate As Infrastructure and Deployment Requires
  - Migrations & Upgrades are Non-Issue
  - Easy to Add Fault Tolerance

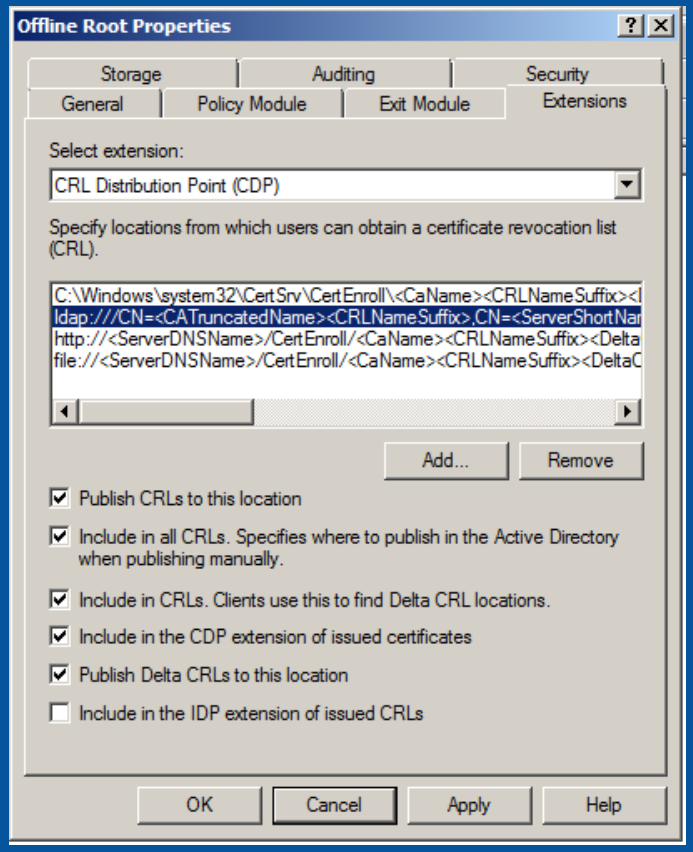


# #3 – CRL/AIA Extension Errors

- **File/URI Location Built by Variables**
  - UI Manipulation Has Challenges
  - Configurable in Registry – Often with a Script
- **Errors Introduced**
  - OCSP Set as AIA Location
    - ~~Include in the AIA extension of issued certificates~~
  - Copy and Paste Between CDP and AIA
  - Lack of CRL Suffix
    - **The Pseudo-Hidden Achilles Heel**
  - Modifying AIA to Remove Server Name
    - **Extension Largely Ignored in Code**
    - **Requires Manual Manipulation**
    - **Results in Published Path and File Mismatch**

# #3 – CRL/AIA Extension Errors

| Setting | Value |
|---|---|
| Publish CRLs to this location | 1 |
| Include in all CRLs. Specifies where to publish in the Active Directory when publishing manually | 8 |
| Include in CRLs. Client use this to find Delta CRL locations | 4 |
| Include in the CDP extension of issued certificates | 2 |
| Publish Delta CRLs to this location | 64 |
| Include in the IDP extension of issued CRLs | 128 |

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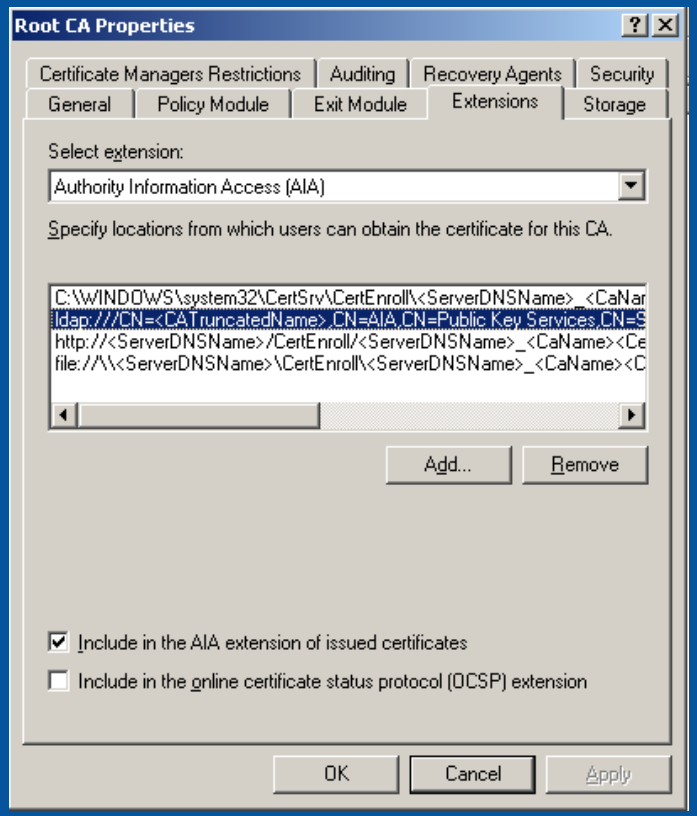
# #3 – CRL/AIA Extension Errors

| Setting | Value |
|---|---|
| Include in the AIA extension of issued certificates | 2 |
| Include in the online certificate status protocol (OCSP) extension | 32 |



# #4 - Misuse of OCSP

- **Designed for Efficient CRL Distribution**
  - Overcomes Large CRL File Transfers (Multi-MB+)
  - Certificate Specific Enquiries from Responder
  - Dependent on CRLs
  - CRL Interval Dependent
- **Not Real-Time Information**
- **Deterministic Results**
  - CAB Forum
  - Available in 2012 R2 & 2008 R2 w/HotFix 2960124

# #5 – OCSP Renewal

- **OCSP Signing Certificate**
  - Required from EACH CA Serviced
  - Signed by CA
- **CA Signs with Current Keypair**
- **Services older Keypairs/CRL**
  - Default Config will Break OCSP on CA Renewal
- **OCSP Requests Specify Correct CA**
  - CA Needs to be Configured Properly

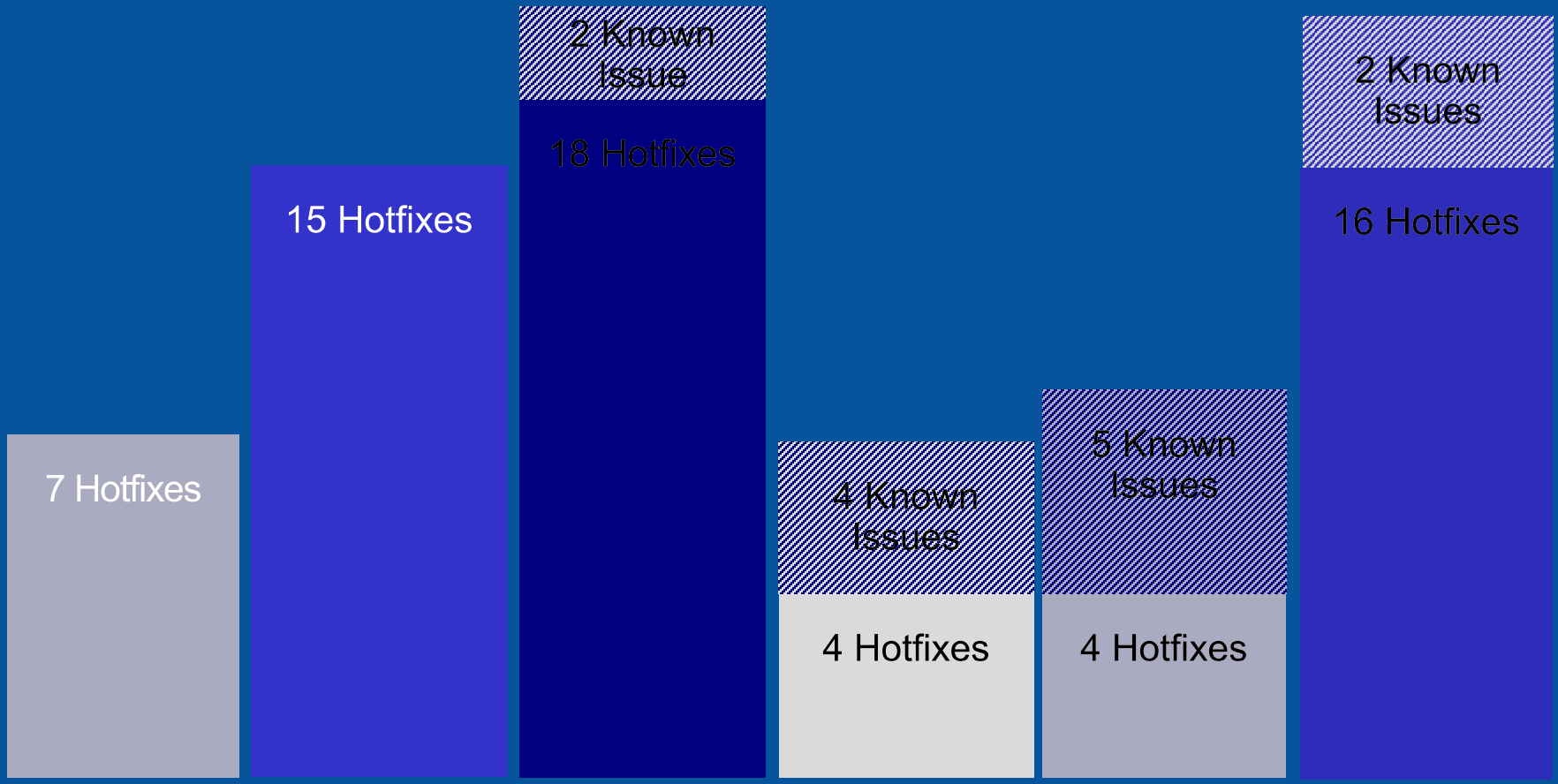
    **certutil -setreg ca\UseDefinedCACertInRequest 1**

# #6 – ADCS Hotfixes

- **Distinct from Updates**
  - Not Distributed by Windows Update
- **Product/Issue Specific Fix**
  - Previously Reported Issue with Remediation
  - Test and Apply Only if Needed Philosophy
- **Preventative Use**
  - If Possible In the Environment, Consider the Hotfix

    **Don't Need to Wait For Problem**
- **Time Consuming to Find**
  - Comprehensive List Available

# http://pkisolutions.com/adcs-hotfixes




**As of October 28, 2014**

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# #7 – Network Device Enrollment Service Security

- **Microsoft's SCEP Implementation**
  - Cisco Designed for Non-Authentication Integrated Devices
    - **Routers & Switches**
  - Available Since Server 2000 in Resource Kit
  - Integrated with Server 2008
- **Leveraged for many BYOD Scenarios**
  - VoIP, Tablets, Phones, Internet of Things
- **Security and Architecture**
  - Authentication and Enrollment Disjointed
  - BYOD Often Necessitates DMZ Exposure Risks

# #7 – Network Device Enrollment Service Security

- **Manage URI Access To Server**
  - Does Solution Require Exposure of Admin Page?
  - Firewall & SSL Protection
- **NDES Key Protection**
  - Hardware Security Module (Think Heartbleed Protection)
- ***NEW* Server 2012 R2 NDES Policy Module**
  - Offloaded Authentication and Enrollment Management
  - Authorization Tied to Enrollment Request
- **New Whitepaper From Microsoft**

# #8 - ADCS & Domain Controllers

- **Don't Do It**
- **Seriously – Don't Do It!**
- **Interaction Issues Largely Resolved**
  - DCOM Group
  - LDAP/S Certificate Selection Process
- **Known Issues**
  - Can't Change Domain Membership (DCPromo Anyone?)

    **DC Upgrades, Re-Hosting, DC Retirement**
  - Domain Admins versus CA Admins

# #9 - Logical Security Controls

- **Remote Desktop Services**
  - Scourge of Physical and Logical Security
  - Most Common Mistake
- **USB/CD Attack Vectors**
  - Easy To Load/Attack/Log/Compromise
  - Disable USB in BIOS (with Password)
  - Disable CDROM AutoPlay
- **Firewalls & Anti-Virus**
  - Microsoft or Other – ENABLE IT!
- **Password Policies**
  - At Least Match Your Organizational Standards
  - Especially Offline Roots!

# #10 - Root Certificate Extensions

- **Properties of Root Certificate – Not CA**
  - Driven by Install Options and CAPolicy.inf
- **CDP & AIA Extensions**
  - Best Practice is a blank CDP/AIA Extension for Root
  - ADCS Behaviors since 2003

    **Old Habits are hard to break**

    ~~[certsrv_server]~~
    ~~renewalkeylength=4096~~
    ~~RenewalValidityPeriodUnits=20~~
    ~~RenewalValidityPeriod=years~~
- **Issuance Policies in Server 2012**
  - Explicit Hierarchy
  - Impact on OCSP

# #11 - SMTP Exit Module

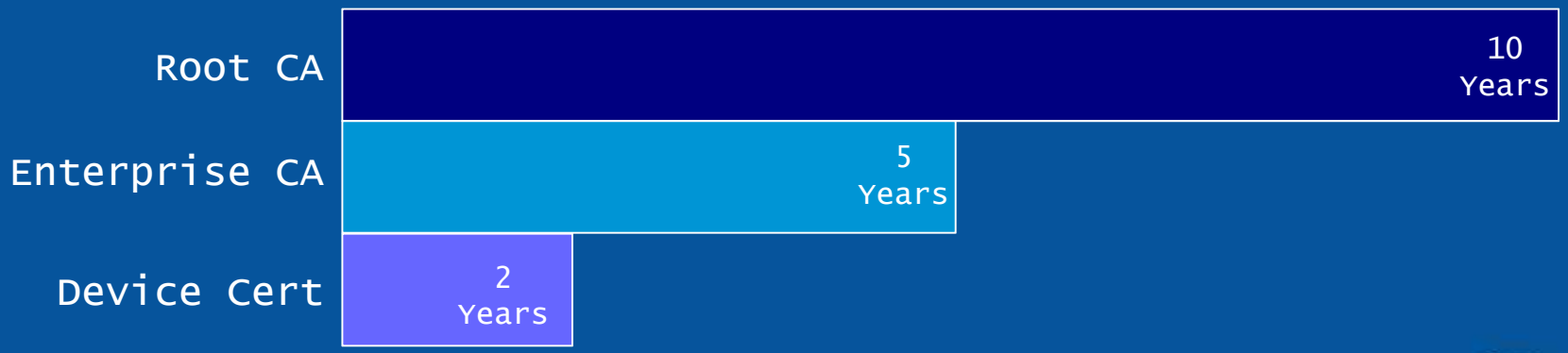
- **Free Monitoring**
  - Built into Service
  - No UI, Use Script or Registry
- **Eliminate Queues of Pending Requests**

  **EXITEVENT_CRLISSUED**
  **EXITEVENT_CERTDENIED**
  **EXITEVENT_CERTISSUED**
  **EXITEVENT_CERTPENDING**
  **EXITEVENT_CERTUNREVOKED**
  **EXITEVENT_CERTRETRIEVEPENDING**
  **EXITEVENT_CERTREVOKED**
  **EXITEVENT_SHUTDOWN**
  **EXITEVENT_STARTUP**

  2003: http://technet.microsoft.com/en-us/library/cc773129(v=WS.10).aspx
  2008+: http://social.technet.microsoft.com/wiki/contents/articles/active-directory-certificate-services-smtp-exit-module-for-windows-server-2008-r2-example.aspx
- **Pseudo Transactional Tracking and Recovery**
  - Use CRLIssued for “Real-time” Database Recovery

# #12 – Certificate Validity Periods

- **Hierarchy Lifetimes Truncate Children**
  - Plan from The Client and Up
  - 2x Child Lifetime
- **Balance with Cryptographic Usefulness**
  - Longer Validity with More Complex Crypto

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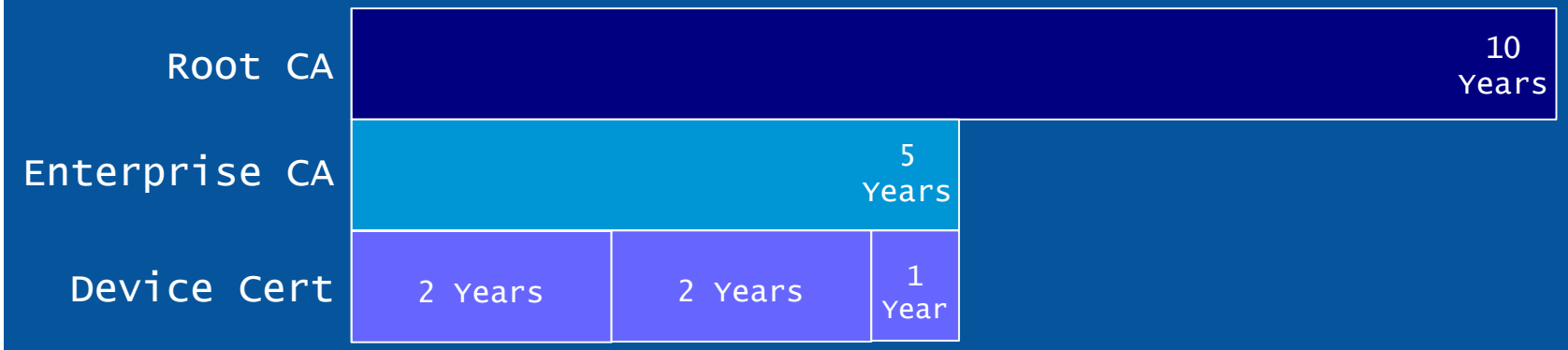
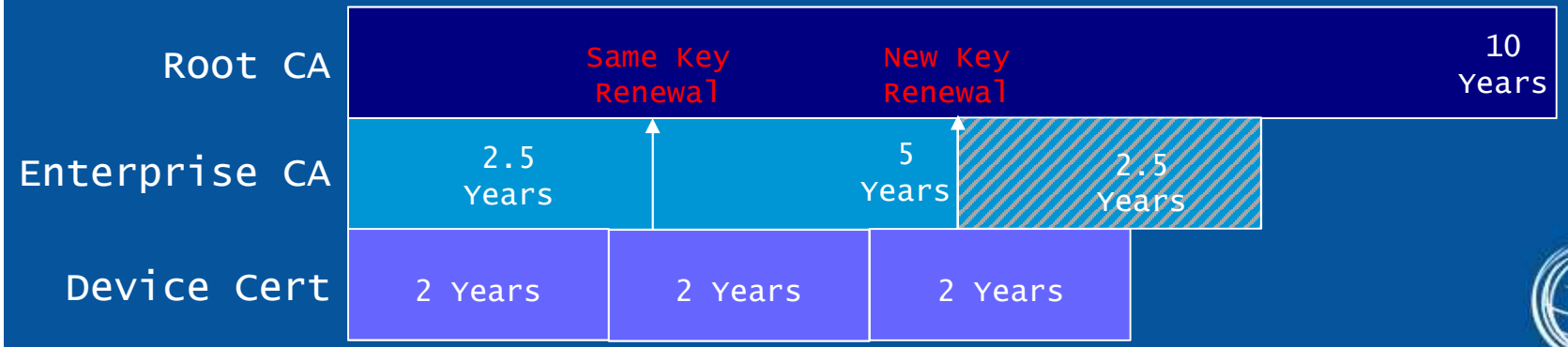
# #12 – Certificate Validity Periods

- **Half-life Renewals with Same Key**
  - Harder to Track but Fewer Keys



# #13 – Certificate Key Lengths

- **Design for Expiration Before Compromise**
  - Balance Key Length, Validity Period and Value
  - Expires before Brute Force Compromise
  - Theoretical Timeline – Could be Lucky #2 Guess
- **Determine Compatibility Matrix**
  - Applications are the Biggest Unknown
  - Deploy Highest Crypto Option Where Able

    **Carve out those legacy crypto needs**
- **RSA 2048 & SHA1**
  - Minimal Commercially Viable Crypto

# #13 – Certificate Key Lengths

## NIST Recommendations 2010

| Date | Minimum of Strength | Symmetric Algorithms | Asymmetric | Discrete Logarithm Key | Discrete Logarithm Group | Elliptic Curve | Hash (A) | Hash (B) |
|---|---|---|---|---|---|---|---|---|
| 2010 (Legacy) | 80 | 2TDEA* | 1024 | 160 | 1024 | 160 | SHA-1**<br>SHA-224<br>SHA-256<br>SHA-384<br>SHA-512 | SHA-1<br>SHA-224<br>SHA-256<br>SHA-384<br>SHA-512 |
| 2011 - 2030 | 112 | 3TDEA | 2048 | 224 | 2048 | 224 | SHA-224<br>SHA-256<br>SHA-384<br>SHA-512 | SHA-1<br>SHA-224<br>SHA-256<br>SHA-384<br>SHA-512 |
| > 2030 | 128 | AES-128 | 3072 | 256 | 3072 | 256 | SHA-256<br>SHA-384<br>SHA-512 | SHA-1<br>SHA-224<br>SHA-256<br>SHA-384<br>SHA-512 |
| >> 2030 | 192 | AES-192 | 7680 | 384 | 7680 | 384 | SHA-384<br>SHA-512 | SHA-224<br>SHA-256<br>SHA-384<br>SHA-512 |
| >>> 2030 | 256 | AES-256 | 15360 | 512 | 15360 | 512 | SHA-512 | SHA-256<br>SHA-384<br>SHA-512 |

- Http://www.keylength.com

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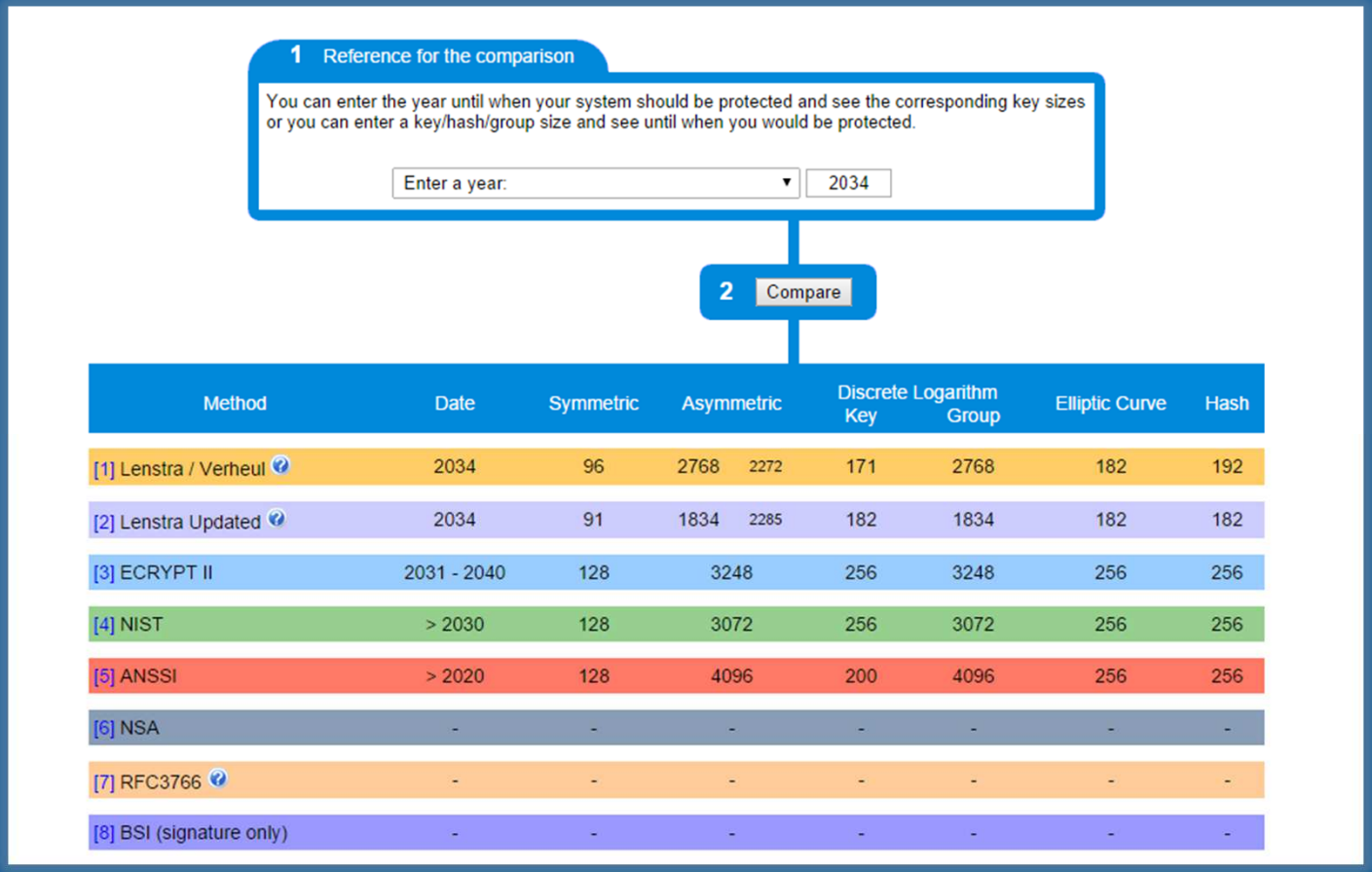
# #13 – Certificate Key Lengths



1 Reference for the comparison

You can enter the year until when your system should be protected and see the corresponding key sizes or you can enter a key/hash/group size and see until when you would be protected.

Enter a year: 2034

2 Compare

| Method | Date | Symmetric | Asymmetric | Discrete Logarithm Key | Discrete Logarithm Group | Elliptic Curve | Hash |
|---|---|---|---|---|---|---|---|
| [1] Lenstra / Verheul | 2034 | 96 | 2768 2272 | 171 | 2768 | 182 | 192 |
| [2] Lenstra Updated | 2034 | 91 | 1834 2285 | 182 | 1834 | 182 | 182 |
| [3] ECRYPT II | 2031 - 2040 | 128 | 3248 | 256 | 3248 | 256 | 256 |
| [4] NIST | > 2030 | 128 | 3072 | 256 | 3072 | 256 | 256 |
| [5] ANSSI | > 2020 | 128 | 4096 | 200 | 4096 | 256 | 256 |
| [6] NSA | - | - | - | - | - | - | - |
| [7] RFC3766 | - | - | - | - | - | - | - |
| [8] BSI (signature only) | - | - | - | - | - | - | - |

- Http://www.keylength.com

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# #14 - CA Key Protection

- **Paramount to Integrity of PKI**
  - Exposure Negates Cryptographic Strength
- **Soft versus Hard Keys**
  - Heartbleed Exploit
- **Easier & Cheaper to Protect Key then Remediate Key Compromise**
- **Hardware Security Modules**
  - CA and NDES Roles
  - Thales e-Security & Gemalto/SafeNet
- **TPM-Based CA – Word of Caution**

# #15 - CRL Publishing to File Share

- **Default Publishing to Local CertEnroll**
  - Works out of the Box
  - No Resilience or Fault Tolerance
  - No External Access

    **At least there SHOULDN'T be**
- **Scripting CRL & Publishing**
  - No Monitoring or Reporting
  - Disconnected from Manual Revocation

# #15 - CRL Publishing to File Share

- **Use CA To Publish For You**
  - Requires SMB Support Between Computers
  - Create FileShare on Target
  - Add CA Computer Object to Share Permissions
  - Add CA Computer Object to NTFS Permissions
  - Define CRL Extension

    **FILE://\\servername.contoso.com\sharename\%3%8%9.crl**
- **AIA Hardcoded – UGH!**
  - Infrequently Updated
  - Include in Procedural Documentation

# #16 - Patch Management

- **ADCS is Not Set and Forget**
  - Vulnerable
  - Prime Target
- **Offline CAs**
  - Physical and Logical Isolation Offer SOME Protection
  - **Maintain Supported Service Pack Level**
  - ADCS Specific Updates
  - Time/Clock Related Updates
- **Online CAs**
  - Above Plus Microsoft Updates/Patches

# #17 - Architecture

- **PKI Hierarchy Deployment Mismatch**
  - Not Designed to Security/Operational Needs
  - Designed on Labs/Books/Whitepapers Blindly
- **Single and Three-Tier Most Often Incorrect**
- **Policy/Intermediate CA**
  - Is there a CAPolicy.Inf?

    **If Not, Most Likely Server is Superfluous**
- **Single Tier/Enterprise Root CA**
  - Using Smart cards, S/MIME, Code Signing, File Encryption, Large Number of Non-AD Clients?

    **If So, PKI Should be Multi-Tier**

# #17 - Architecture

- **“Today, I Just Need a …… Certificate”**
- **Design for Next 12-18 Months Minimum**
  - What Else is Approved?
  - What Does Organization need?
  - Easy to Under-Engineer, Hard to Over Do It
- **Security and Architecture Key Aspects**
  - Security Can Be Improved, But Integrity Can’t
  - Architecture is Generally Inflexible

# #18 – "Offline" Root

- **Physical Isolation of Root**
  - Reduces Attack Surfaces
  - Requires Physical Access
  - Eliminates Remote Attacks
- **"Sometimes" Offline**
  - Turned Off When Unused, Brought On Network for Maintenance

    **You are asking for trouble!**
- **Offline Means OFFLINE!**
  - Define & Use USB Flash/Virtual Floppy Procedures

# #19 - Collusion Requirements

- **Design– No Single Person Access, EVER**
  - Collusion Procedures Define Multi-Person Access
  - Cradle to Grave Operational Control
- **Enforce Procedures**
  - Easily Broken Without Accountability/Controls/Auditing
  - HSMs Enforce Controls
  - Locks and Card keys, Never the Same Person
- **A Moment Alone Can Never Be Undone**

# #20 - Documentation

- **Bane of Every Organization**
  - Challenging Like any other Project
  - Documentation Could Save the Environment Some Day
  - (Almost) Never too Late to Document!
- **Primary Areas to Document**
  - Offline CA Retrieval and Standup
  - Server Rebuild
  - CA Key Renewals
  - Disaster Recovery/Continuity Plan
  - Emergency CRL Signing

# Questions?

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## Wednesday Sessions

**Managing and Deploying BYOD Identity Solutions with a Microsoft PKI**

**Securing Cloud Servers and Services with PKI Certificates**