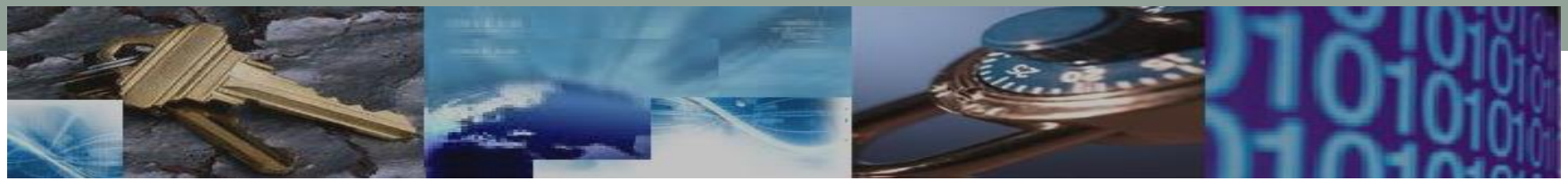

Securely Managing Cryptographic Keys used within a Cloud Environment

Dr. Sarbari Gupta

sarbari@electrosoft-inc.com

703-437-9451 ext 12

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Introduction

- **Federal government moving computing/storage to Cloud**
  - ***Vivek Kundra's Cloud First Strategy***
  - ***OMB M-10-19 – FY 2012 Budget Guidance***

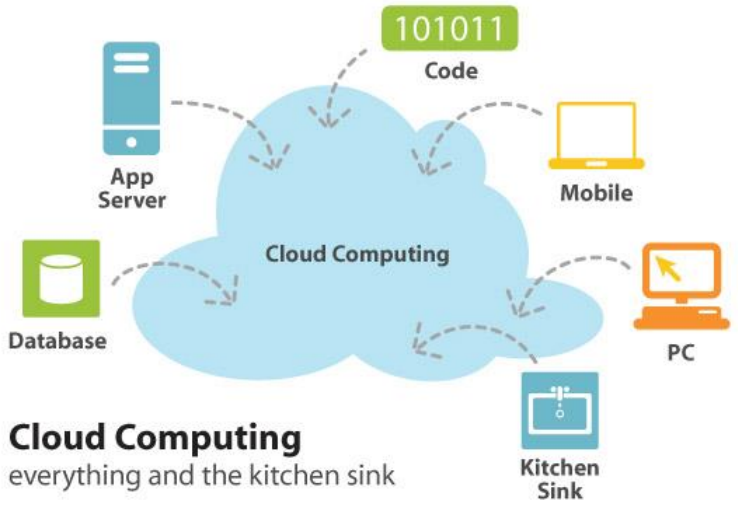
- **Cloud Computing has unique security challenges**
  - ***Remote operations, Co-tenancy, Distributed Management***

- **Cryptography essential to secure cloud operations**
  - ***Use of sound Key Management Practices is critical***
  - ***Yet, limited visibility into Cloud Key Management***

- **FedRAMP streamlines Cloud Authorizations**
  - ***Does it provide enough visibility or assurance for Cloud Key Management?***

Cloud Service Provider (CSP) - Models

- **Cloud Service Models**
  - ***Software as a Service (SaaS) - Access to applications and services hosted in cloud***
  - ***Platform as a Service (PaaS) - Building blocks to rapidly develop/host cloud applications***
  - ***Infrastructure as a Service (Iaas) processing power, storage***
- **Cloud Deployment Models**
  - ***Public Cloud***
  - ***Private Cloud***
  - ***Community Cloud***
  - ***Hybrid Cloud***



- ***Not all Clouds are created equal!***

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Cloud Based Systems – Uncertainties

- **Processor**
  - ***Where is my process running?***
  - ***Am I sharing the processor with other users/organizations?***
- **Data Storage**
  - ***Where does my data reside?***
  - ***Is my data co-resident with other users' data?***
- **Communication**
  - ***How does my CSP know who I am?***
  - ***How is my connection to cloud components protected?***
- **Administration**
  - ***Who administers the Cloud Infrastructure?***
  - ***Who has access to my data? My activity history?***
- **Key Management**
  - ***Where and how are keys: Generated? Stored?***
  - ***How are keys: Distributed? Protected?***
  - ***How are keys and data recovered if lost?***
  - ***When and how are keys destroyed?***

Cloud Systems – Dependence on Browser

- **Browser is integral to Cloud Systems**
  - ***User Interface – Presentation***
  - ***Data input and output from Cloud***
  - ***Communication with Cloud Components***
- **Browsers have significant vulnerabilities**
  - ***Weak implementation of security protocols***
  - ***Man-in-the-middle (MITM) and other attacks***
  - ***Browser contamination from other websites***
- **Browser represents inherent weakness!**

Cryptography Integral to Cloud Operations

- **Supports strong authentication of remote Users, Administrators**
- **Implements strong communication protocols between User (browser) and cloud**
- **Partitions User data in co-tenancy environments**
- **Provides data confidentiality (even from Administrators)**
- **Supports data integrity (tamper-detection)**

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Cryptographic Key Management – Basics (I)

- **Cryptographic Keys - Core Functions**
  - ***Confidentiality***
  - ***Integrity***
  - ***Source Authentication***
- **Key Management - Scope**
  - ***Key Generation***
  - ***Key Storage***
  - ***Key Distribution***
  - ***Key Recovery***
  - ***Key Destruction***

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Cryptographic Key Management – Basics (II)

- **Key Management - Critical Dimensions**
  - ***Key Type, Algorithms, Strength, Crypto-period, Metadata***
  - ***Key Generation, Acquisition***
  - ***Key Use, Users, Applications***
  - ***Key Establishment, Agreement, Distribution***
  - ***Key Material Protection (storage, transit)***
  - ***Key Access Control***
  - ***Key Backup, Recovery***
  - ***Key Renewal, Revocation, Destruction***

Cloud Cryptography – Visibility and Control

- **Remote Authentication; Secure Communication with Cloud**
  - ***Some Visibility***
    - **Use of Third Party Credential Providers; Standard Communication Protocols (TLS/SSL)**
  - ***Some Control***
    - **User may select own Credential Provider, Configure Browser settings**
- **Cloud Data Protection (Confidentiality, Integrity)**
  - ***SaaS - no visibility; no control***
    - **CSP implements all crypto – opaque to Cloud User**
  - ***PaaS – limited visibility; limited control***
    - **CSP implements crypto in lower layers – opaque to Cloud User**
    - **May provide toolset (building blocks) for application development**
  - ***Iaas – limited visibility; more control***
    - **CSP implements infrastructure level crypto – opaque to Cloud User**
    - **Cloud User controls key management for virtualized IT components**

FedRAMP Control for Key Management (based on SP 800-53 R3)

- **SC-12 CRYPTOGRAPHIC KEY ESTABLISHMENT AND MANAGEMENT**
  - ***Control: The organization establishes and manages cryptographic keys for required cryptography employed within the information system.***
  - ***Control Enhancements for MODERATE baseline:***
    - **(2) The organization produces, controls, and distributes symmetric cryptographic keys using [NIST-approved] key management technology and processes.**
    - **(5) The organization produces, controls, and distributes asymmetric cryptographic keys using approved PKI Class 3 or Class 4 certificates and hardware security tokens that protect the user's private key.**
- **SC-13 USE OF CRYPTOGRAPHY**
  - ***Control: The information system implements required cryptographic protections using cryptographic modules that comply with applicable federal laws, Executive Orders, directives, policies, regulations, standards, and guidance.***
  - ***Control Enhancements for MODERATE baseline:***
    - **(1)The organization employs, at a minimum, FIPS-validated cryptography to protect unclassified information.**

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FedRAMP Weaknesses for Key Management

- **No minimum requirements for key parameters**
- **No explicit requirement for Key Management Policy (KMP)**
- **No explicit requirement for Key Management Practices Statement (KMPS)**
- **No requirement for key recovery**

- **Result – Cloud User has:**
  - ***Little visibility into cloud key management***
  - ***Limited assurance of soundness of key management policies, practices and operations***

Way Forward

- **Establish Federal Profile for Cloud Key Management**
  - ***Based on SP 800-152 (being developed)***
  - ***More stringent requirements due to Cloud Environment***

- **FedRAMP require that CSPs**
  - ***Follow Federal Profile for Cloud Key Management***
  - ***Develop Key Management Plan (KMP) and Key Management Practices Statements (KMPS)***
    - **NIST SP 800-57– Part 2: Best Practices for Key Management Organization**
  - ***Have Mandatory 3rd Party Auditing against KMP/KMPS***

Wrap-Up and Contact Information

- **Dr. Sarbari Gupta – Electrosoft**
  - ***Email:*** ***sarbari@electrosoft-inc.com***
  - ***Phone: 703-437-9451 ext 12***
  - ***LinkedIn:*** ***http://www.linkedin.com/profile/view?id=8759633***