A Pragmatic Approach For Securing Systems to Process Big Data

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Target Environment

- Big data and big compute in one system
  - Supports multiple organizations and users
  - Users access system over network such as Internet
  - Users may import and run their own codes
- Data (software, input, output, and other files) has access restrictions
  - Not necessarily accessible to all users
  - May be sensitive
- Data is Moderate or High Sensitivity, but not classified National Defense information
  - As described in Federal Information Processing Standards Publication (FIPS) 199
  - **Moderate Data**: Loss of confidentiality, integrity or availability will have serious adverse effect on organization
  - **High Data**: Loss of confidentiality, integrity or availability will have a severe or catastrophic adverse effect on organization

Example: Supercomputing Center
Main Security Challenges

- System is accessible over the Internet
- Legitimate users must be identified and authenticated
- Users can download their own programs and any additional data that is needed
- Security should not be so onerous that it impedes the use of the system
- Actionable attempts to misuse the system should be identified and acted upon
Security Objectives

- Identify and authenticate legitimate users prior to granting them access to the Enclave
- Ensure that users access only data to which they are authorized
- Identify attacks and block them while minimizing
  - False positives – so that legitimate users are not blocked
  - False negatives – so that dangerous attacks are not missed
- Ensure that backdoors are not planted in system
Pragmatic Solution Will Involve

- A simple architecture for protecting the big data and big processing systems
- Minimizing the exposed surface that can be attacked
- Security situational awareness to identify actionable security events
A Pragmatic Architecture for Protecting Big Data and Big Processing Systems

- Discretionary Access Control (DAC)
- Password Authentication
- Two-Factor Authentication
- DMZ
- Internet
- Processes or Virtual Machine Images Launched by Processor And Data Front End
- Big Data Repositories
- Big Processors
- Processor & Data Front End
- Secure Front Ends
Secure Front End Should be Design to be an Attack-Resistant Security Reference Monitor

- Always invoked
- Tamper proof
- Correctly enforces the desired security policy
Secure Front End As Security Reference Monitor Can be Implemented as follows

Always Invoked Requirement
- Network Access Control Lists (ACLs) ensure that SFEs are only way to access Enclave-resident systems

Tamper Proof Requirement
- Design of the SFE minimizes the opportunity to attack the SFE
- Implemented as a separate device or virtual machine so SFE is isolated from tampering
- Implemented with a jailed (chrooted) environment for all users which limits
  - User access to system directories
  - User access to only those required functions to log in and perform file transfers
- Uses Linux distribution that
  - Allows developer to start with a minimal capability system and
  - Then adds only those additional capabilities that are needed
  - Minimizes the possibility of including unneeded capabilities with potential security vulnerabilities

Correctly Enforces the Desired Security Policy Requirement
- Authenticates users using two-factor authentication
Secure Front End Services Limited to Authentication and File Transfer

- Access to the SFE should be via SSH or some other encrypted connection protocol.

- SFEs should support file transfers using SCP or other appropriate protocol:
  - Should have sufficient storage capacity so that files could be copied into the SFE.
  - Then transferred from the SFE to an Enclave-resident system.
  - This would be a two-stage copy:
    - From Home system to SFE
    - From SFE to Processor & Data Front End.

- SFEs are not the only approach for file transfers:
  - Security policy should allow users to pull data into the Enclave from a Processor & Data Front End.
  - Users should also be able to push data out of the Enclave from a Processor & Data Front End.
The Exposed Surface That Can Be Attacked Should be limited

- The SFEs should be the only system exposed to direct access from the Internet
  - ACLs on network switches/routers should allow Internet access to only the SFEs

- Users on an Enclave-resident Processor & Data Front End can
  - Transfer results out to external systems or
  - Pull in data or programs from external systems

- All originating inbound access from the Internet should be blocked to all Enclave-resident systems
Security Situational Awareness Should
Monitoring and Detect

Objective of Security Situational Awareness System is to protect the Enclave from threats such as

– Policy violations
– Vulnerabilities
– Intrusion attempts
Security Situational Awareness Identifies Actionable Security Intrusion Attempts

I1: Intrusion Detection System (IDS) events should be reported upon for only those that are relevant to
• The organization and
• The organization’s installed systems

I2: Back doors into the Enclave should be identified since these could be used
• By Advanced persistent threats (APTs) or others
• To gain and maintain unauthorized access to Enclave systems

I3: APTs and Trojan horse code that is resident in Enclave systems should
• Be identified
• Have any attempt to communicate with external, hostile controllers blocked
Security Situational Awareness Identifies Actionable Security Vulnerabilities

V1: Misconfigurations that could open Enclave up to a successful attack should be identified
  • Systems or
  • Access Control Lists

V2: Changes in system vulnerabilities that could open Enclave up to successful attack should be identified

V3: New systems that have been attached to the Enclave network should be identified
  • If they are previously unknown
  • If they have not been checked for security compliance
Security Situational Awareness Identifies Actionable Security Policy Violations

P1: System Administrators should be held to auditable actions
- Identified if they accessing systems directly as root
  - Since root actions do not provide audit trail of who actually performed it
- Required to access systems using SU or SUDO,
  - Since these provide audit trail of who actually performed the action

P2: The sharing of accounts should be identified, since this may indicate
- Unauthorized access or
- Unauthorized sharing of access credentials

P3: Long duration logins should be identified, since logged-in system could provide an entry point into the Enclave for a malicious agent
Questions?