NIST SPECIAL PUBLICATION 1800-21C

Mobile Device Security:

Corporate-Owned Personally-Enabled (COPE)

Volume C:
How-to Guides

Joshua M. Franklin*
Gema Howell
Kaitlin Boeckl
Naomi Lefkovitz
Ellen Nadeau*
Applied Cybersecurity Division
Information Technology Laboratory

Dr. Behnam Shariati
University of Maryland, Baltimore County
Department of Computer Science and Electrical Engineering
Baltimore, Maryland

Jason G. Ajmo
Christopher J. Brown
Spike E. Dog
Frank Javar
Michael Peck
Kenneth F. Sandlin
The MITRE Corporation
McLean, Virginia

**Former employee; all work for this publication done while at employer.*

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FEEDBACK

As a private-public partnership, we are always seeking feedback on our practice guides. We are particularly interested in seeing how businesses apply NCCoE reference designs in the real world. If you have implemented the reference design, or have questions about applying it in your environment, please email us at mobile-nccoe@nist.gov.

All comments are subject to release under the Freedom of Information Act.

National Cybersecurity Center of Excellence
National Institute of Standards and Technology
100 Bureau Drive
Mailstop 2002
Gaithersburg, MD 20899
Email: nccoe@nist.gov

NATIONAL CYBERSECURITY CENTER OF EXCELLENCE

The National Cybersecurity Center of Excellence (NCCoE), a part of the National Institute of Standards and Technology (NIST), is a collaborative hub where industry organizations, government agencies, and academic institutions work together to address businesses' most pressing cybersecurity issues. This public-private partnership enables the creation of practical cybersecurity solutions for specific industries, as well as for broad, cross-sector technology challenges. Through consortia under Cooperative Research and Development Agreements (CRADAs), including technology partners—from Fortune 50 market leaders to smaller companies specializing in information technology security—the NCCoE applies standards and best practices to develop modular, adaptable example cybersecurity solutions using commercially available technology. The NCCoE documents these example solutions in the NIST Special Publication 1800 series, which maps capabilities to the NIST Cybersecurity Framework and details the steps needed for another entity to re-create the example solution. The NCCoE was established in 2012 by NIST in partnership with the State of Maryland and Montgomery County, Maryland.

To learn more about the NCCoE, visit https://www.nccoe.nist.gov. To learn more about NIST, visit https://www.nist.gov.

NIST CYBERSECURITY PRACTICE GUIDES

NIST Cybersecurity Practice Guides (Special Publication 1800 series) target specific cybersecurity challenges in the public and private sectors. They are practical, user-friendly guides that facilitate the adoption of standards-based approaches to cybersecurity. They show members of the information security community how to implement example solutions that help them align with relevant standards and best practices, and provide users with the materials lists, configuration files, and other information they need to implement a similar approach.

The documents in this series describe example implementations of cybersecurity practices that businesses and other organizations may voluntarily adopt. These documents do not describe regulations or mandatory practices, nor do they carry statutory authority.

ABSTRACT

Mobile devices provide access to vital workplace resources while giving employees the flexibility to perform their daily activities. Securing these devices is essential to the continuity of business operations.

While mobile devices can increase efficiency and productivity, they can also leave sensitive data vulnerable. Mobile device management tools can address such vulnerabilities by helping secure access to networks and resources. These tools are different from those required to secure the typical computer workstation.

This practice guide focuses on security enhancements that can be made to corporate-owned personally-enabled (COPE) mobile devices. COPE devices are owned by an enterprise and issued to an employee. Both the enterprise and the employee can install applications onto the device.

To address the challenge of securing COPE mobile devices while managing risks, the NCCoE at NIST built a reference architecture to show how various mobile security technologies can be integrated within an enterprise's network.

This NIST Cybersecurity Practice Guide demonstrates how organizations can use standards-based, commercially available products to help meet their mobile device security and privacy needs.

KEYWORDS

Corporate-owned personally-enabled; COPE; mobile device management; mobile device security, on-premise; bring your own device; BYOD

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The Technology Partners/Collaborators who participated in this build submitted their capabilities in response to a notice in the Federal Register. Respondents with relevant capabilities or product components were invited to sign a Cooperative Research and Development Agreement (CRADA) with NIST, allowing them to participate in a consortium to build this example solution. We worked with:

Technology Partner/Collaborator	Build Involvement
Appthority*	Appthority Cloud Service, Mobile Threat Intelligence
Kryptowire	Kryptowire Cloud Service, Application Vetting
Lookout	Lookout Cloud Service/Lookout Agent Version 5.10.0.142 (iOS), 5.9.0.420 (Android), Mobile Threat Defense
MobileIron	MobileIron Core Version 9.7.0.1, MobileIron Agent Version 11.0.1A (iOS), 10.2.1.1.3R (Android), Enterprise Mobility Management
Palo Alto Networks	Palo Alto Networks PA-220
Qualcomm	Qualcomm Trusted Execution Environment (version is device dependent)

*Appthority (acquired by Symantec—A division of Broadcom)

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1 Introduction

The following volumes of this guide show information technology (IT) professionals and security engineers how we implemented this example solution. We cover all of the mobile device security products employed in this reference design. We do not re-create the product manufacturers' documentation, which is presumed to be widely available. Rather, these volumes show how we incorporated the products together in our environment.

Note: These are not comprehensive tutorials. There are many possible service and security configurations for these products that are out of scope for this reference design.

1.1 Practice Guide Structure

This National Institute of Standards and Technology (NIST) Cybersecurity Practice Guide demonstrates a standards-based reference design and provides users with the information they need to replicate addressing mobile device security (MDS) for Corporate-Owned Personally-Enabled (COPE) implementation challenges. This reference design is modular and can be deployed in whole or in part.

This guide contains three volumes:

- NIST SP 1800-21A: *Executive Summary*
- NIST SP 1800-21B: *Approach, Architecture, and Security Characteristics* – what we built and why
- NIST SP 1800-21C: *How-To Guides* – instructions for building the example solution **(you are here)**

Depending on your role in your organization, you might use this guide in different ways:

Business decision makers, including chief security and technology officers, will be interested in the *Executive Summary, NIST SP 1800-21A*, which describes the following topics:

- challenges that enterprises face in securely deploying COPE mobile devices
- example solution built at the National Cybersecurity Center of Excellence (NCCoE)
- benefits of adopting the example solution

Technology or security program managers who are concerned with how to identify, understand, assess, and mitigate risk will be interested in *NIST SP 1800-21B*, which describes what we did and why. The following sections will be of particular interest:

- Section 3.4, Risk Assessment, describes the risk analysis we performed.
- Section 4.3, Security Control Map, discusses the security mappings of this example solution to cybersecurity standards and best practices.

You might share the *Executive Summary, NIST SP 1800-21A*, with your leadership team members to help them understand the importance of adopting standards-based solutions when addressing COPE mobile device security implementation challenges.

IT professionals who want to implement an approach like this will find this whole practice guide useful. You can use this How-To portion of the guide, *NIST SP 1800-21C*, to replicate all or parts of the build created in our lab. This How-To portion of the guide provides specific product installation, configuration, and integration instructions for implementing the example solution. We do not recreate the product manufacturers' documentation, which is generally widely available. Rather, we show how we incorporated the products together in our environment to create an example solution.

This guide assumes that IT professionals have experience implementing security products within the enterprise. While we have used a suite of commercial products to address this challenge, this guide does not endorse these particular products. Your organization can adopt this solution or one that adheres to these guidelines in whole, or you can use this guide as a starting point for tailoring and implementing parts of this guide's example solution for on-premises mobile device security management. Your organization's security experts should identify the products that will best integrate with your existing tools and IT system infrastructure. We hope that you will seek products that are congruent with applicable standards and best practices. Section 3.6, Technologies, lists the products that we used and maps them to the cybersecurity controls provided by this reference solution.

A NIST Cybersecurity Practice Guide does not describe "the" solution, but a possible solution. Comments, suggestions, and success stories will improve subsequent versions of this guide. Please contribute your thoughts to mobile-nccoe@nist.gov.

1.2 Build Overview

When a business is on the go, mobile devices can serve as a temporary workstation replacement. They provide convenience of use, portability, and functionality. However, in many ways, mobile devices are different from the common computer workstation, and alternative management tools are required to secure their interactions with the enterprise. To address this security challenge, the NCCoE worked with its Community of Interest and build team partners and developed a real-world scenario for mobile deployment within an enterprise. The scenario presents a range of security challenges that an enterprise may experience when deploying mobile devices.

The lab environment used in developing this solution includes the architectural components, functionality, and standard best practices, which are described in Volume B. The build team partners provided the security technologies used to deploy the architecture components and functionality. The standard best practices are applied to the security technologies to ensure the appropriate security controls are put in place to meet the challenges presented in the devised scenario.

This section of the guide documents the build process and discusses the specific configurations used to develop a secure mobile deployment.

Note: Android for Work (AFW) has been re-branded as Android Enterprise. At the time of writing this document, it was named Android for Work.

1.3 Typographic Conventions

The following table presents typographic conventions used in this volume.

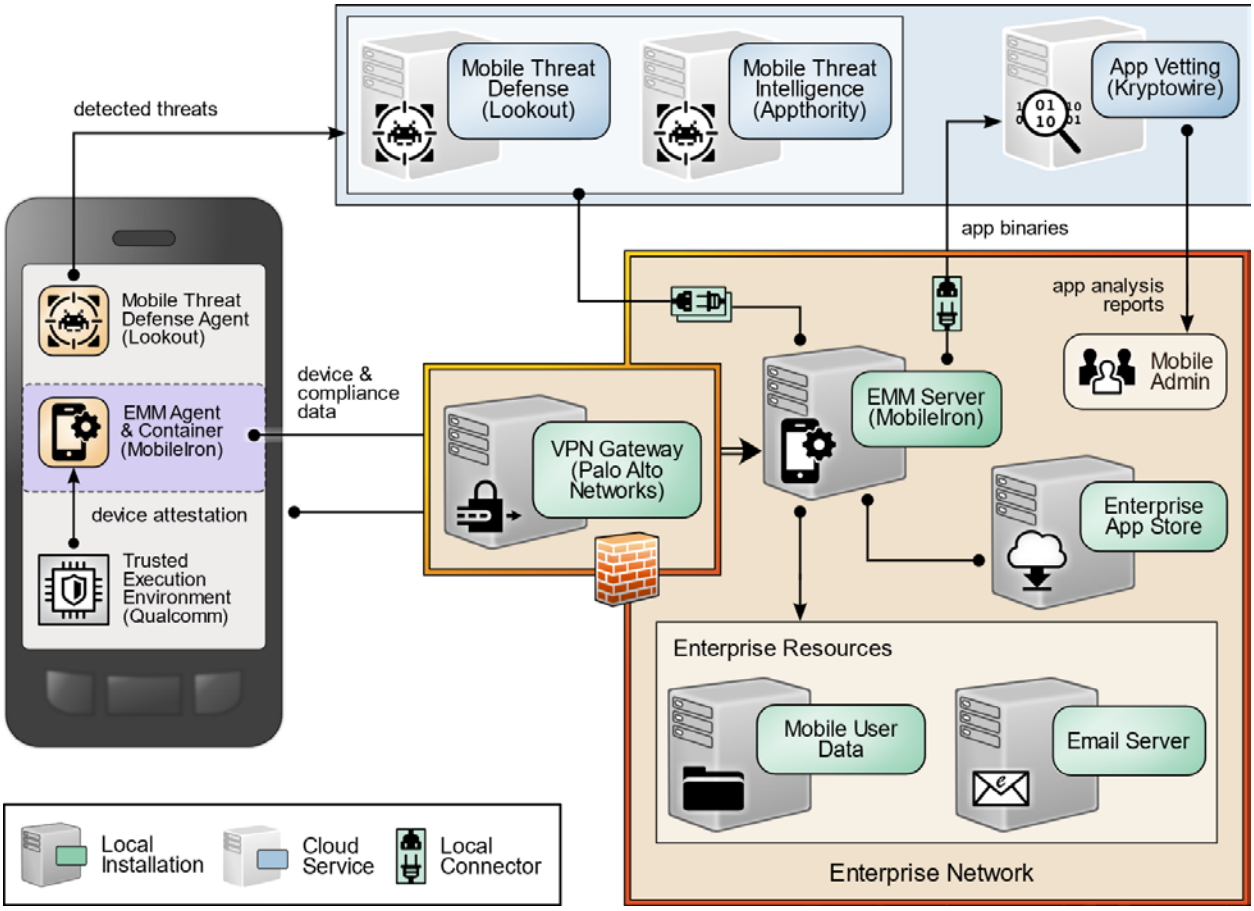
Table 1-1 Typographic Conventions

Typeface/Symbol	Meaning	Example
Italics	file names and path names; references to documents that are not hyperlinks; new terms; and placeholders	For detailed definitions of terms, see the *NCCoE Glossary*.
Bold	names of menus, options, command buttons, and fields	Choose **File** > **Edit.**
`Monospace`	command-line input, onscreen computer output, sample code examples, and status codes	`mkdir`
`Monospace Bold`	command-line user input contrasted with computer output	**`service sshd start`**
blue text	link to other parts of the document, a web URL, or an email address	All publications from NIST's NCCoE are available at https://www.nccoe.nist.gov.

1.4 Logical Architecture Summary

The following graphic illustrates the main components of this example implementation and provides a view of how they interact.

Figure 1-1 Logical Architecture Summary



2 Product Installation Guides

This section of the practice guide contains detailed instructions for installing and configuring key products used for the architecture illustrated below.

In our lab environment, the example solution was logically separated by a virtual local area network (VLAN) wherein each VLAN represented a separate mock enterprise environment. The network perimeter for this example implementation was enforced by a Palo Alto Networks virtual private network (VPN)/firewall appliance. It maintains three zones: one each for the internet/wide area network (WAN), a demilitarized zone (DMZ), and the organizational local area network (LAN).

2.1 Appthority Mobile Threat Detection

Appthority contributed a test instance of its Mobile Threat Detection service. Contact Appthority (Symantec) (https://www.symantec.com/) to establish an instance for your organization.

2.2 Kryptowire EMM+S

Kryptowire contributed a test instance of its EMM+S application-vetting service. Contact Kryptowire (https://www.kryptowire.com/mobile-app-security/) to establish an instance for your organization.

2.3 Lookout Mobile Endpoint Security

Lookout contributed a test instance of its Mobile Endpoint Security (MES) service. Contact Lookout (https://www.lookout.com/products/mobile-endpoint-security) to establish an instance for your organization.

2.4 MobileIron Core

MobileIron Core is the central product in the MobileIron suite. The following sections describe the steps for installation, configuration, and integration with Active Directory (AD).

2.4.1 Installation of MobileIron Core and Stand-Alone Sentry

Follow the steps below to install MobileIron Core:

1. Obtain a copy of the *On-Premise Installation Guide for MobileIron Core, Sentry, and Enterprise Connector* from the MobileIron support portal.
2. Follow the MobileIron Core pre-deployment and installation steps in Chapter 1 of the *On-Premise Installation Guide for MobileIron Core, Sentry, and Enterprise Connector* for the version of MobileIron being deployed in your environment. In our lab implementation, we deployed MobileIron Core 9.5.0.0 as a Virtual Core running on VMware 6.0. Post-installation, we performed an upgrade to MobileIron Core 9.7.0.1 following guidance provided in *CoreConnectorReleaseNotes9701_Rev12Apr2018*. Direct installations to MobileIron Core 9.7.0.1 will experience slightly different results, as some added features in this version are not used with earlier versions of configuration files.

2.4.2 General MobileIron Core Setup

The following steps are necessary for mobile device administrators or users to register devices with MobileIron.

1. Obtain a copy of *MobileIron Core Device Management Guide for iOS Devices* from the MobileIron support portal.

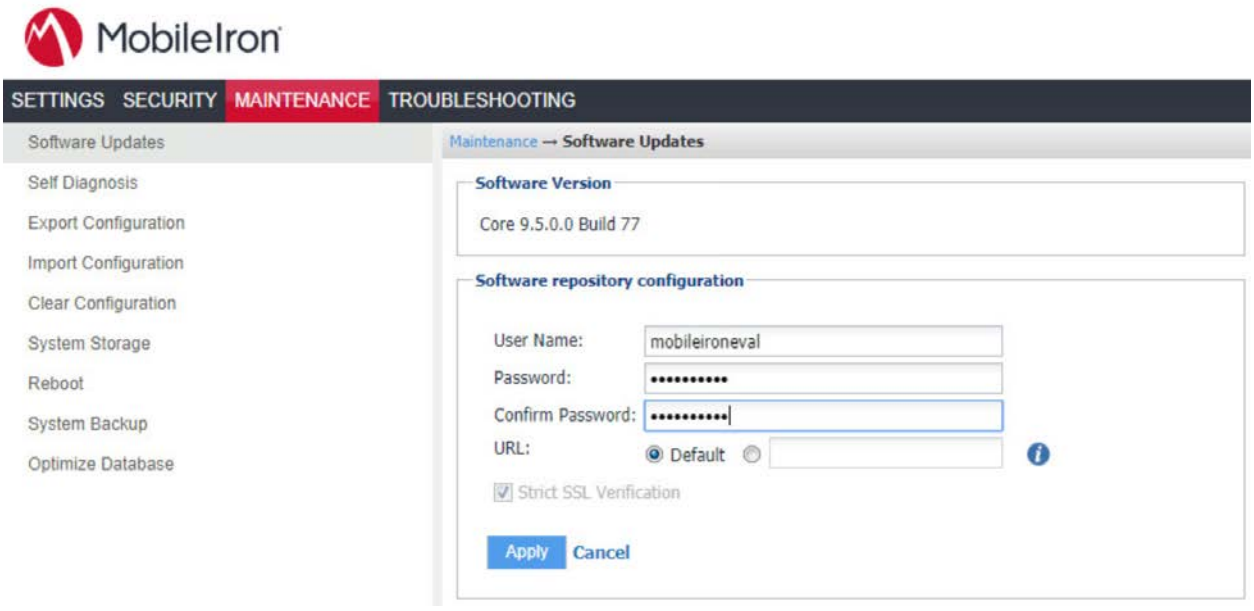
2. Complete all instructions provided in Chapter 1, Setup Tasks.

2.4.3 Upgrade MobileIron Core

The following steps were used to upgrade our instance of MobileIron Core from 9.5.0.0 to 9.7.0.1. Note there was no direct upgrade path between these two versions; our selected upgrade path was 9.5.0.0 > 9.5.0.1 > 9.7.0.1.

1. Obtain upgrade credentials from MobileIron Support.
2. In **MobileIron Core System Manager,** navigate to **Maintenance > Software Updates.**
3. In the **Software repository configuration** section:
   a. In the **User Name** field, enter the username provided by MobileIron Support.
   b. In the **Password** field, enter the password provided by MobileIron Support.
   c. In the **Confirm Password** field, reenter the password provided by MobileIron Support.
   d. Select **Apply.**

Figure 2-1 MobileIron Repository Configuration

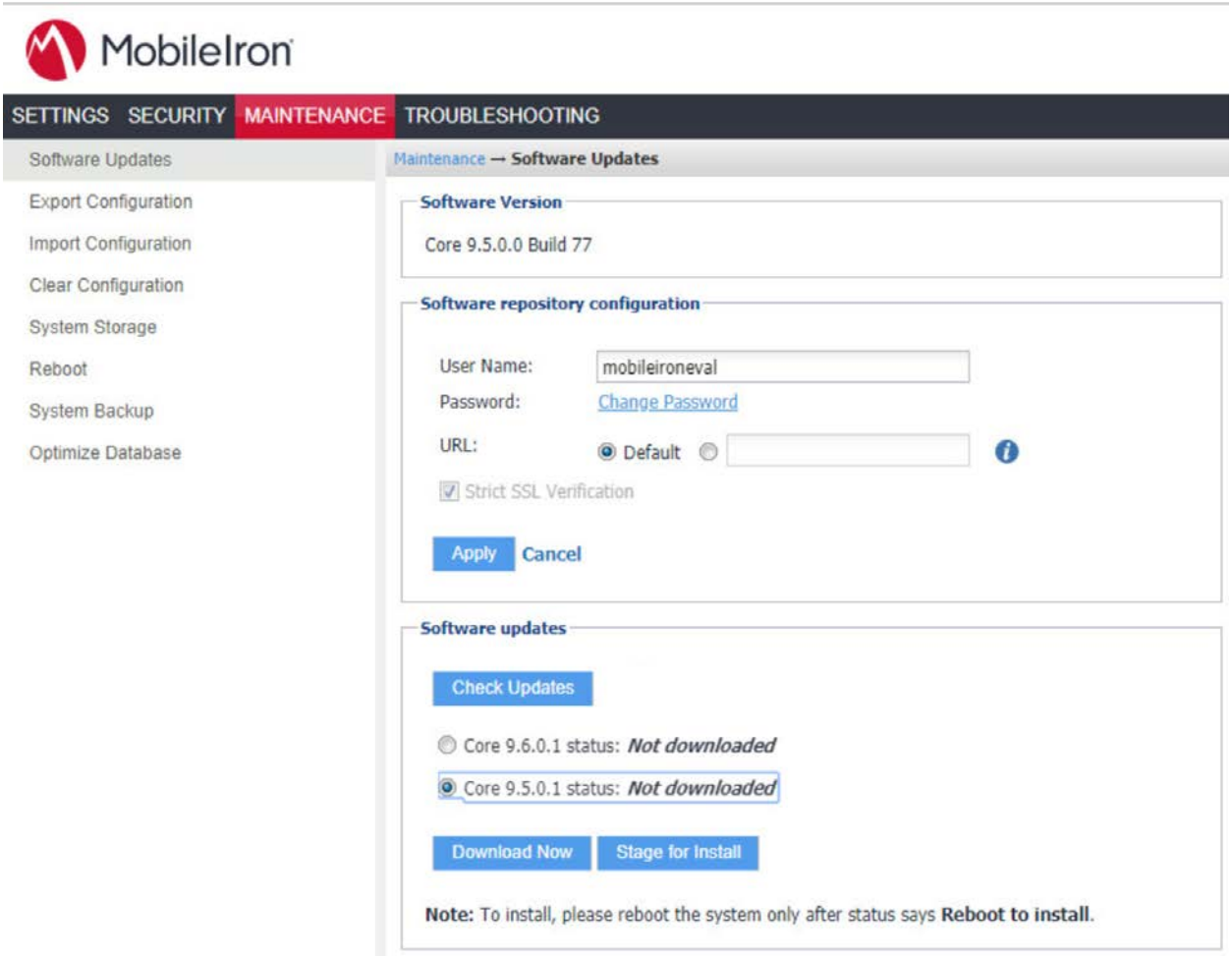


4. In the **Software Updates** section:
   a. Select **Check Updates;** after a few seconds, the available upgrade path options appears.

b. Select the **Core 9.5.0.1 status: Not Downloaded option.**

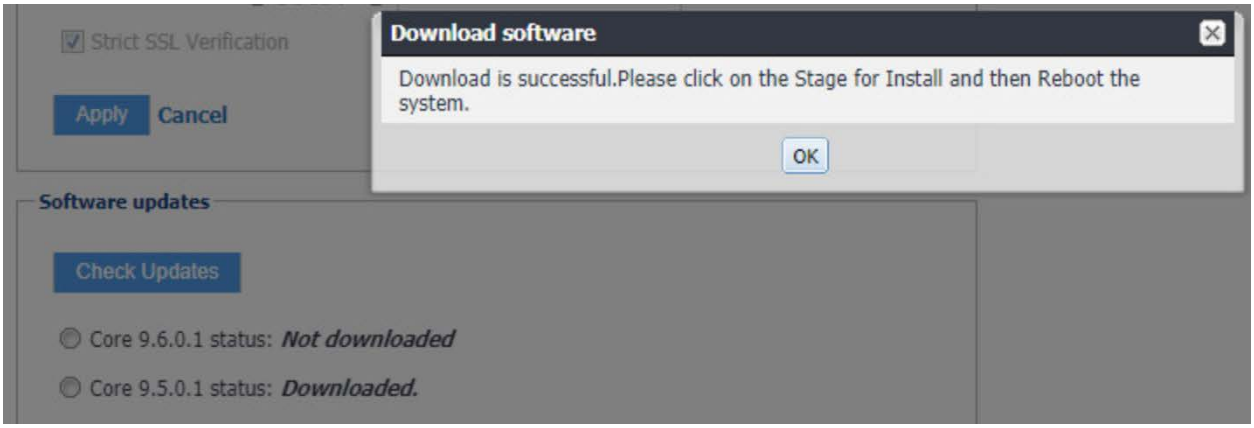
c. Select **Download Now.** After a delay, the Software Download dialogue appears.

Figure 2-2 MobileIron Core Version



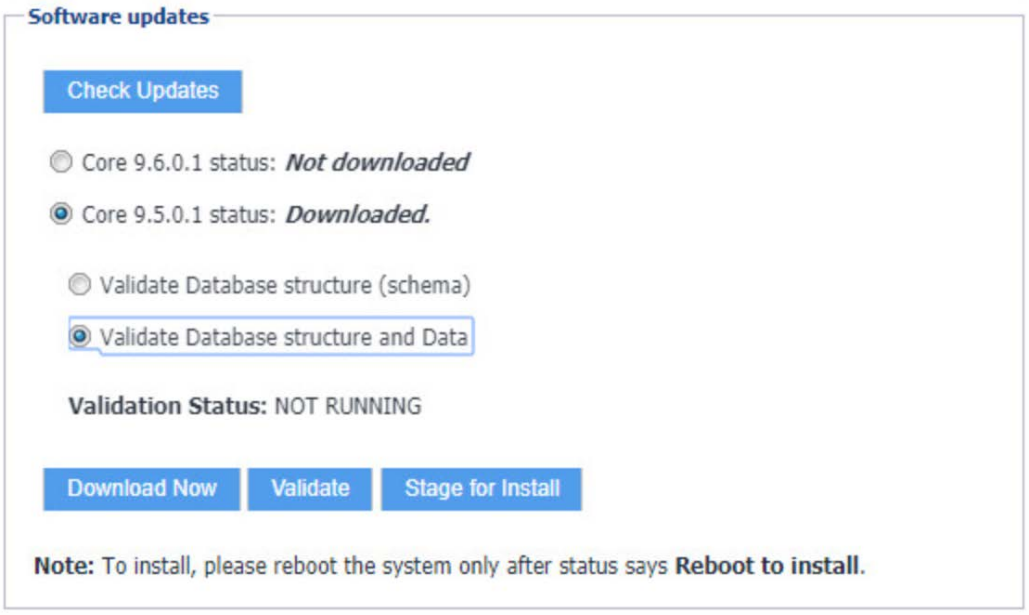
5. In the **Download Software** dialogue, click **OK.**

Figure 2-3 MobileIron Download Status



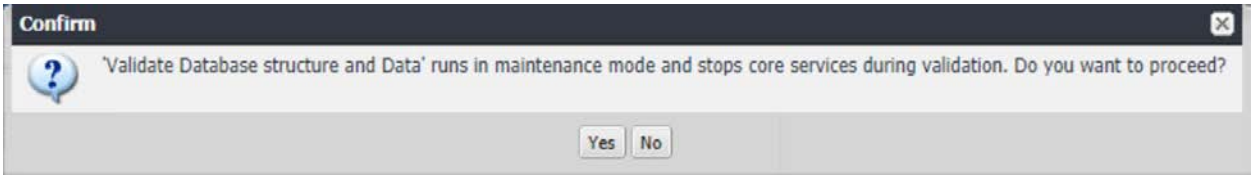
6. In the **Software updates** section:
   a. Select the **Core 9.5.0.1 status: Downloaded** option.
   b. Select the **Validate Database Structure and Data** option.
   c. Select **Validate.**

Figure 2-4 Validating Database Data



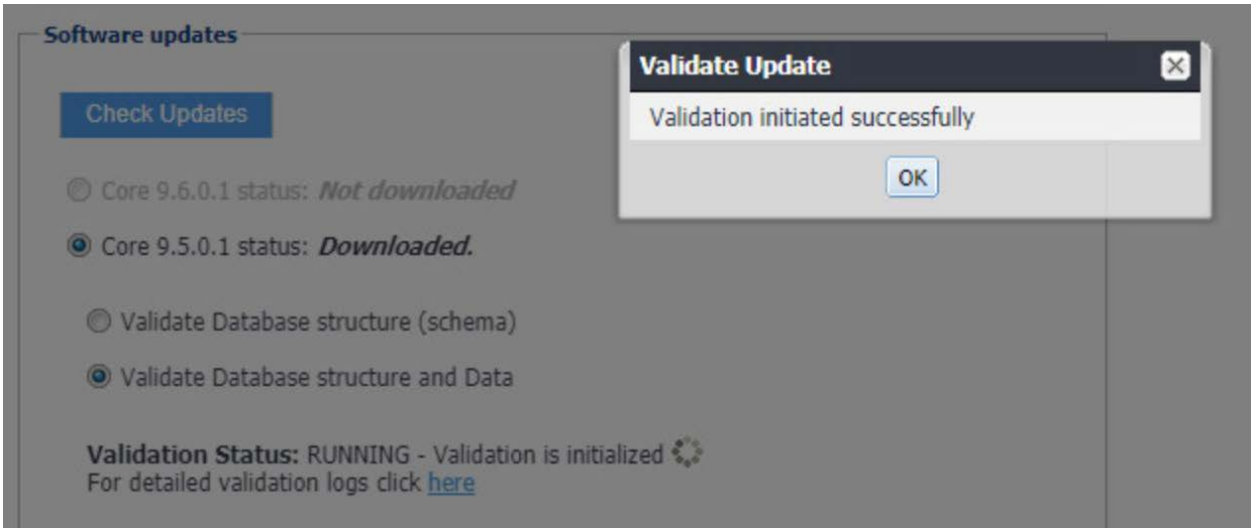
7. In the **Confirm** dialogue, click **Yes** to validate database structure and data.

Figure 2-5 Validating Database Data Confirmation



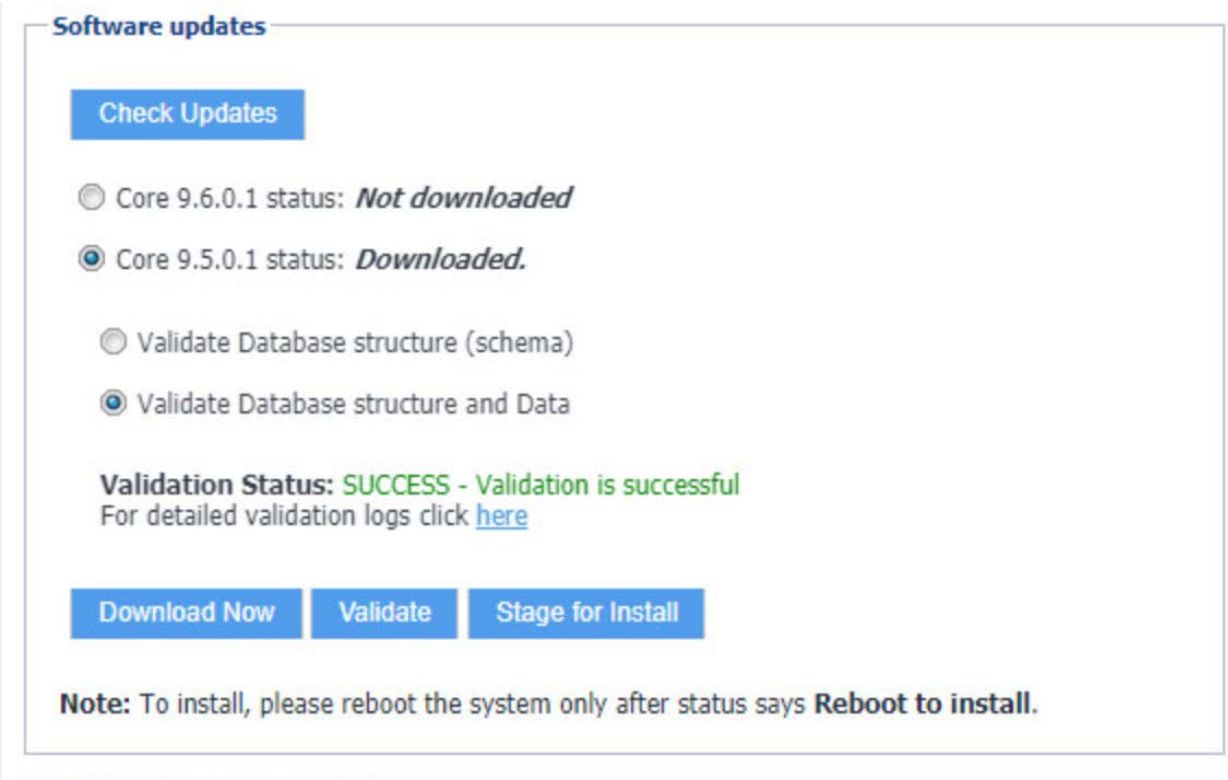
8. In the **Validate Update** dialogue, click **OK.**

Figure 2-6 Database Data Validation Initiation Confirmation



9. In the **Software updates** section, select **Stage for Install**.

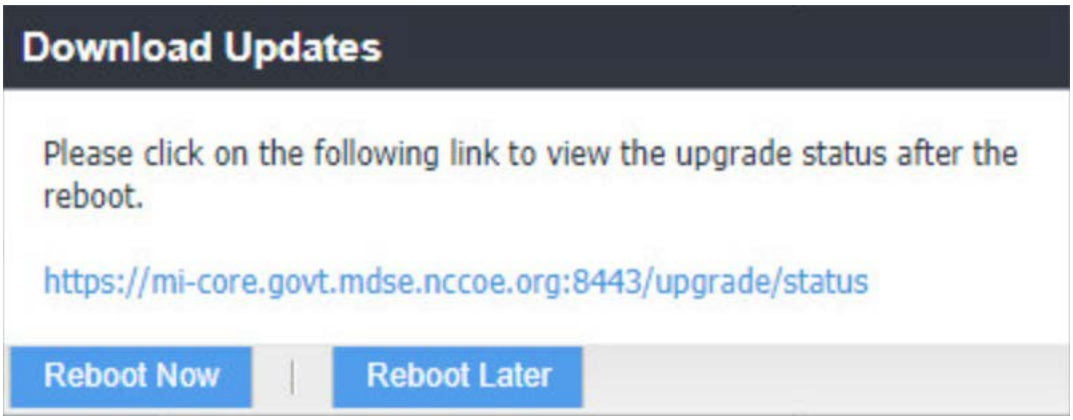
Figure 2-7 Database Data Validation Status



a. The **Download Updates** dialogue appears.

10. In the **Download Updates** dialogue, select **Reboot Now;** a series of dialogues appears.

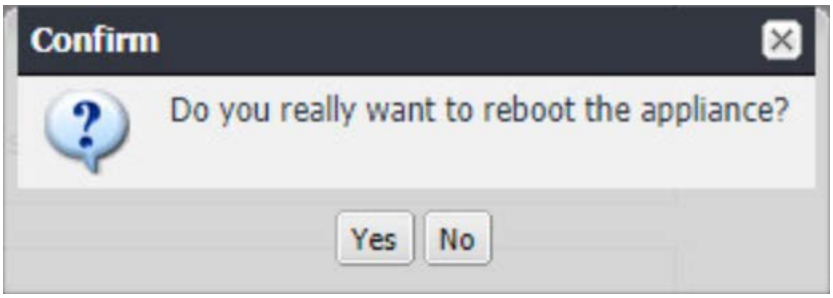
Figure 2-8 Software Updates Reboot Prompt



11. In the **Confirm** dialogues:

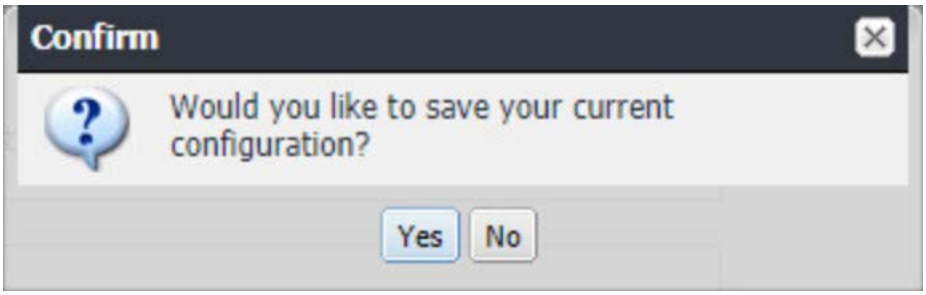
a. Click **Yes** to confirm the appliance reboot.

Figure 2-9 Software Update Reboot Confirmation



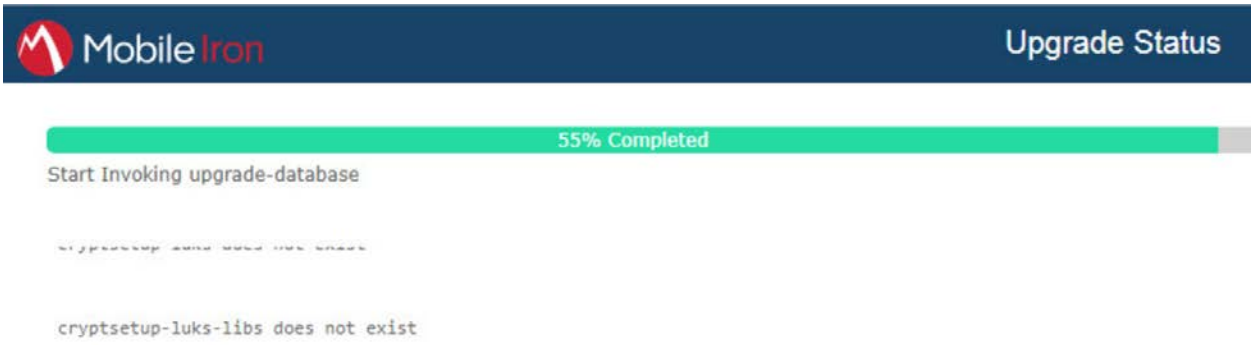
b. Click **Yes** to confirm saving the current configuration.

Figure 2-10 Reboot Configuration Save Prompt



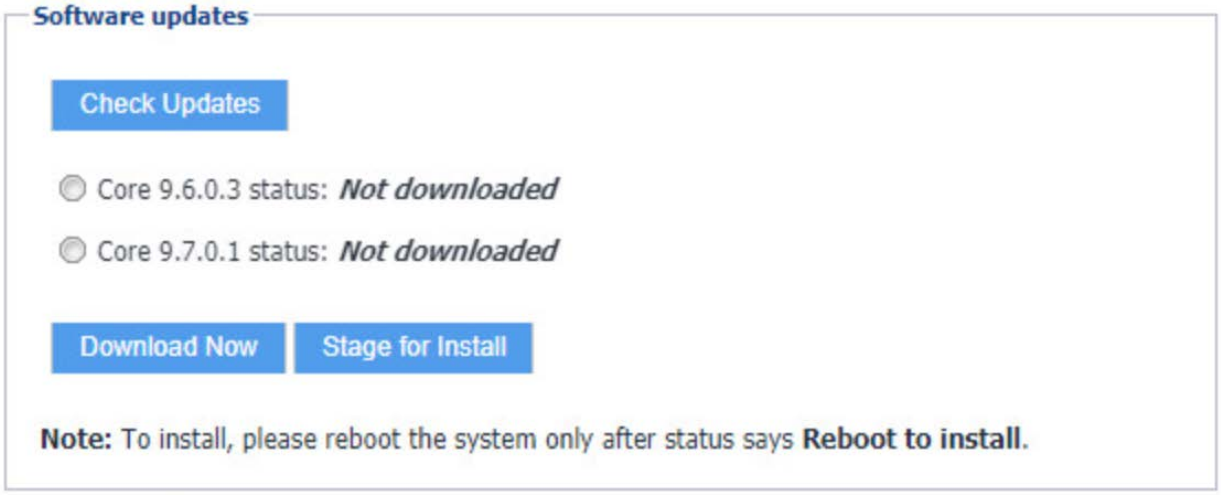
12. The Upgrade Status website hosted by Core automatically opens.

Figure 2-11 Upgrade Status



13. Once the upgrade is complete, **System Manager > Maintenance > Software Updates > Software Updates** now shows the capability to upgrade to 9.7.0.1.

Figure 2-12 Ability to Upgrade to 9.7.0.1



The image shows the Core patch levels this instance can upgrade to. Specifically, it shows Core 9.6.0.3 and Core 9.7.0.1.

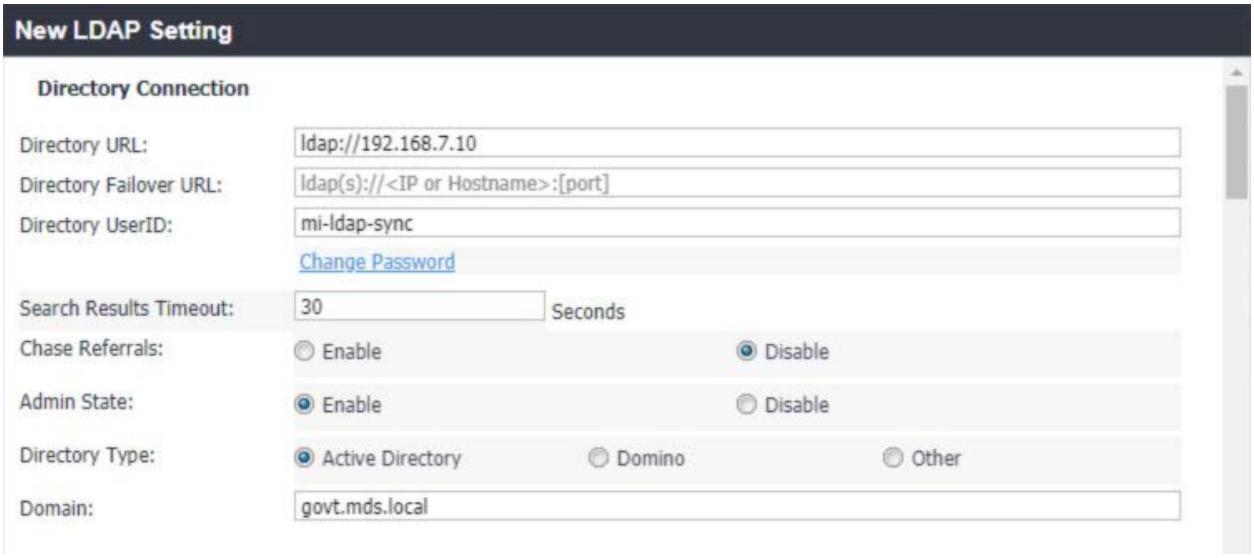
14. Repeat Steps 4b through 11 above, replacing 9.5.0.1 with 9.7.0.1 during Steps 4b and 6; this will complete the upgrade path from MobileIron Core 9.5.0.0 to 9.7.0.1.

2.4.4 Integration with Microsoft Active Directory

In our implementation, we chose to integrate MobileIron Core with Active Directory using lightweight directory access protocol (LDAP). This is optional. General instructions for this process are covered in the *Configuring LDAP Servers* section in Chapter 2 of *On-Premise Installation Guide for MobileIron Core, Sentry, and Enterprise Connector*. The configuration details used during our completion of selected steps (retaining the original numbering) from that guide are given below:

1. From Step 4 in the MobileIron guide, in the **New LDAP Server** dialogue:
   a. Directory Connection:

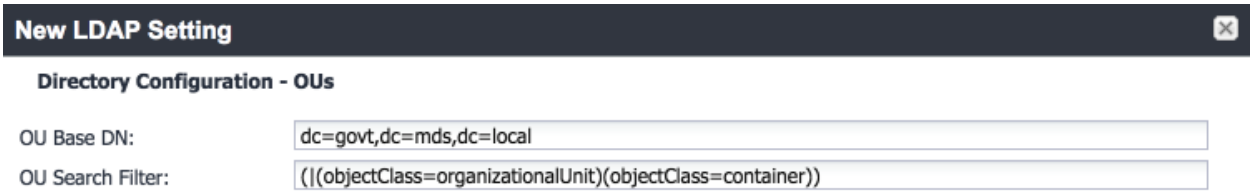
Figure 2-13 LDAP Settings



Note: The light gray text is default text, and your own directory URL should be entered.

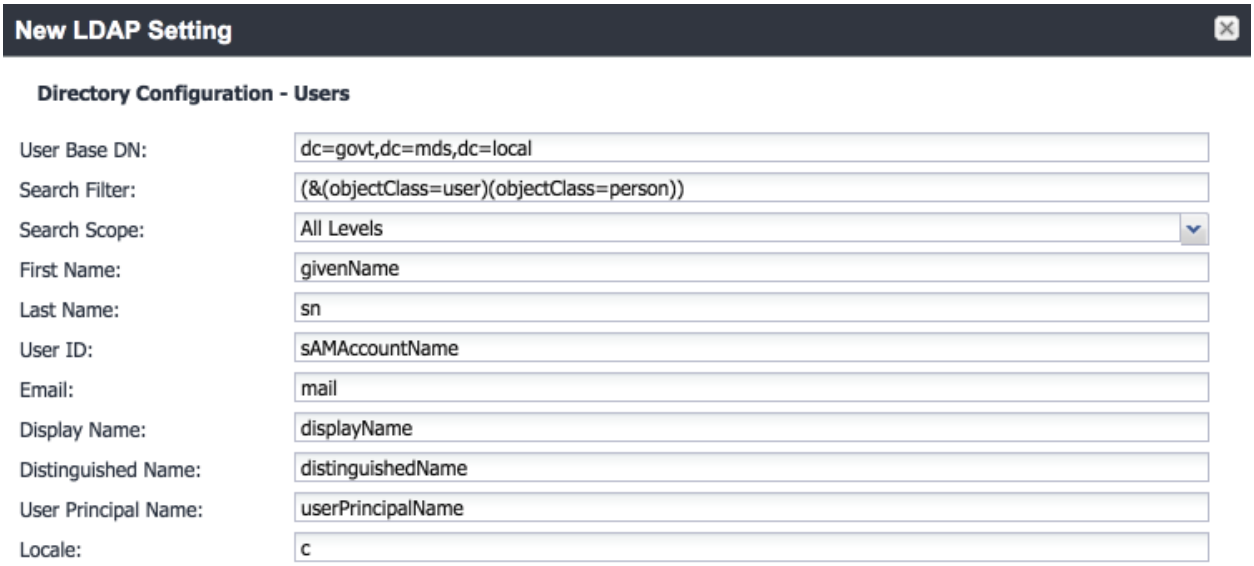
b. Directory Configuration—OUs (organizational units):

Figure 2-14 LDAP OUs



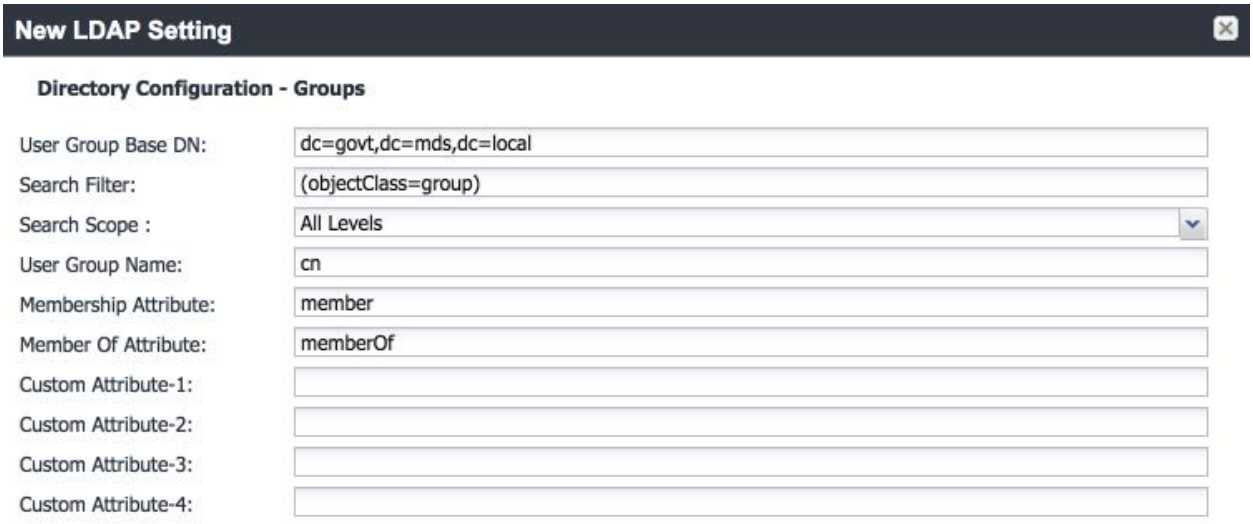
c. Directory Configuration—Users:

Figure 2-15 LDAP User Configuration



d. Directory Configuration—Groups:

Figure 2-16 LDAP Group Configuration



e. LDAP Groups:

i. As a preparatory step, we used Active Directory Users and Computers to create a new security group for mobile-authorized users on the Domain Controller for the *govt.mds.local* domain. In our example, this group is named **Mobile Users.**

ii. In the search bar, enter the name of the LDAP group for mobile-authorized users.

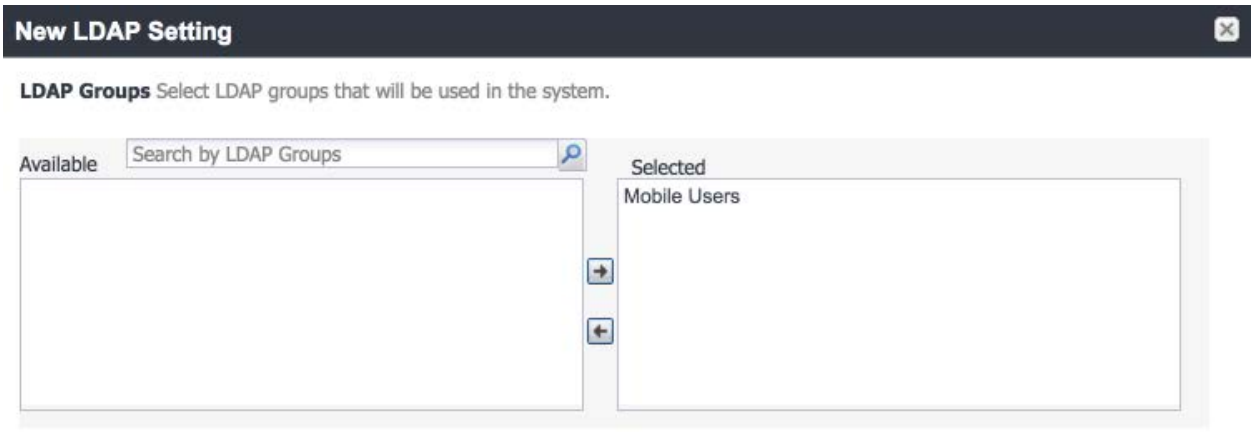
iii. Select the **magnifying glass** button; the group name should be added to the **Available** list.

iv. In the **Available** list box:

1) Select the **Mobile Users** list item.

2) Select the **right-arrow** button; the Mobile Users list item should move to the **Selected** list box.

Figure 2-17 Selected LDAP Group



v. In the **Selected** list:

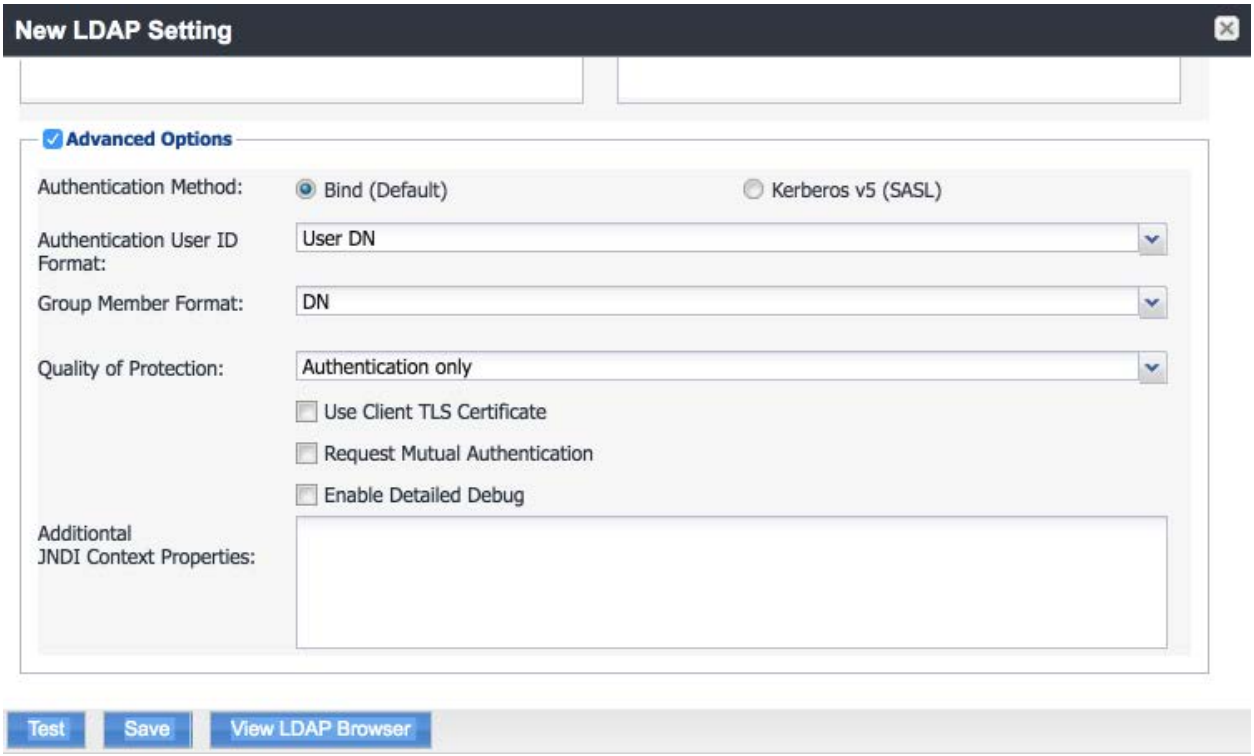
1) Select the default **Users** group list item.

2) Select the **left-arrow** button; the Users list item should move to the **Available** list box.

f. Custom Settings: Custom settings were not specified.

g. Advanced Options: Advanced options were configured as shown in Figure 2-18.

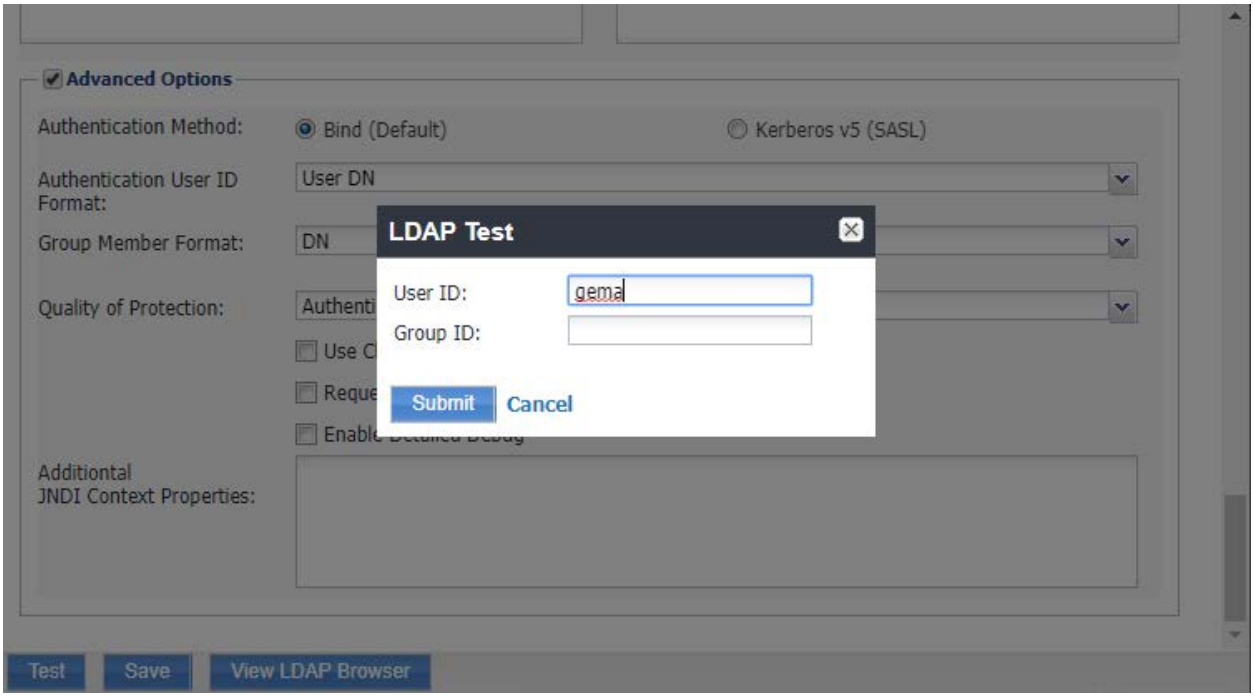
Figure 2-18 LDAP Advanced Options



Note: In our lab environment, we did not enable stronger Quality of Protection or enable the Use of Client Transport Layer Security Certificate or Request Mutual Authentication features. However, we recommend that implementers consider using those additional mechanisms to secure communication with the LDAP server.

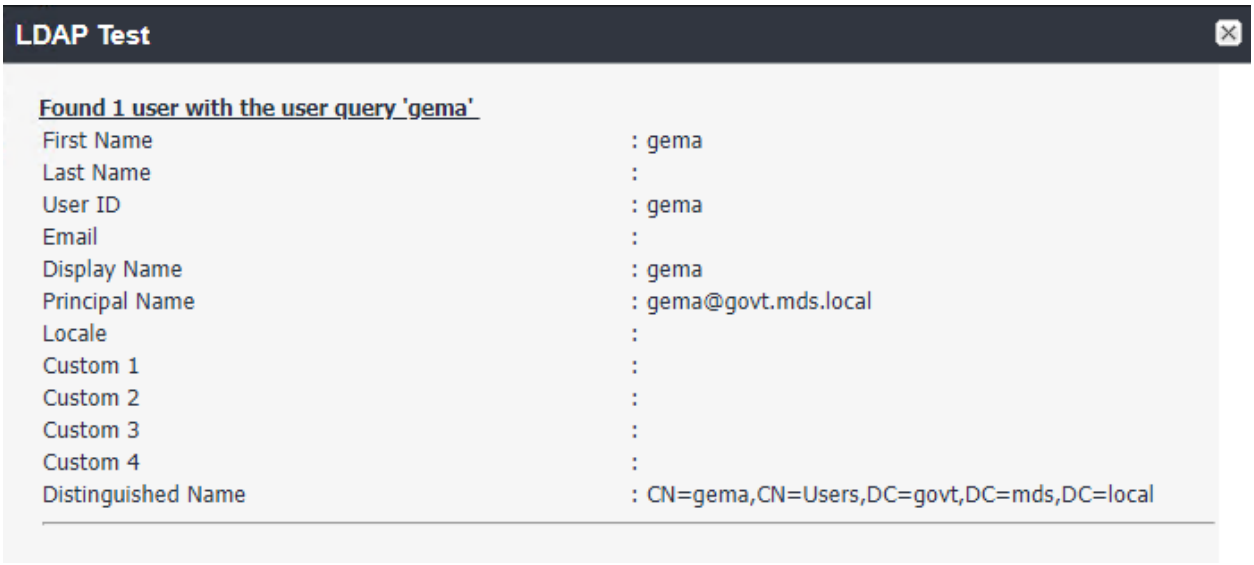
2. From Steps 19 through 21 from the MobileIron guide, we tested that MobileIron can successfully query LDAP for Derived Personal Identity Verification Credential (DPC) Users.
   a. In the **New LDAP Setting** dialogue, click the **Test** button to open the **LDAP Test** dialogue.
   b. In the **LDAP Test** dialogue, enter a **User ID** for a member of the DPC Users group, then click the **Submit** button. A member of the Mobile Users group in our environment is **gema.**

Figure 2-19 Testing LDAP Configuration



c. The **LDAP Test** dialogue indicates the query was successful:

Figure 2-20 LDAP Test Result

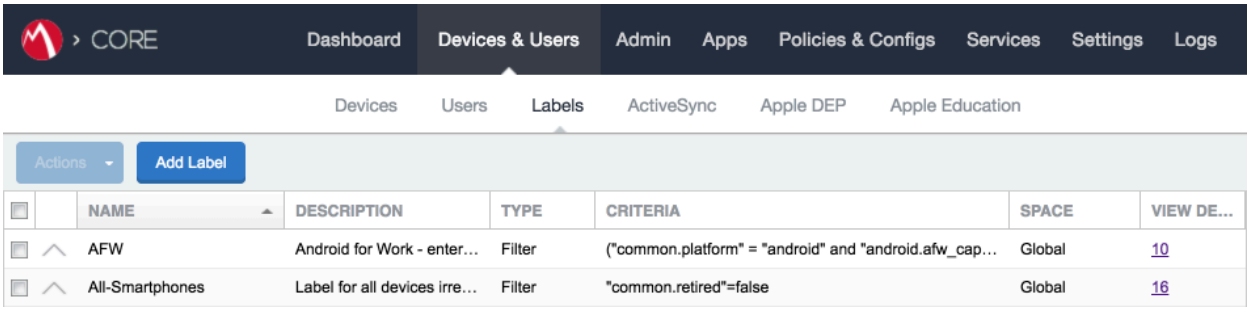


2.4.5 Create a Mobile Users Label

MobileIron uses *labels* to link policies and device configurations with users and mobile devices. Creating a unique label for each category of authorized mobile user allows mobile device administrators to apply a consistent set of controls applicable to users with a common mobile use case. Our limited usage scenario only required a single MobileIron label to be created.

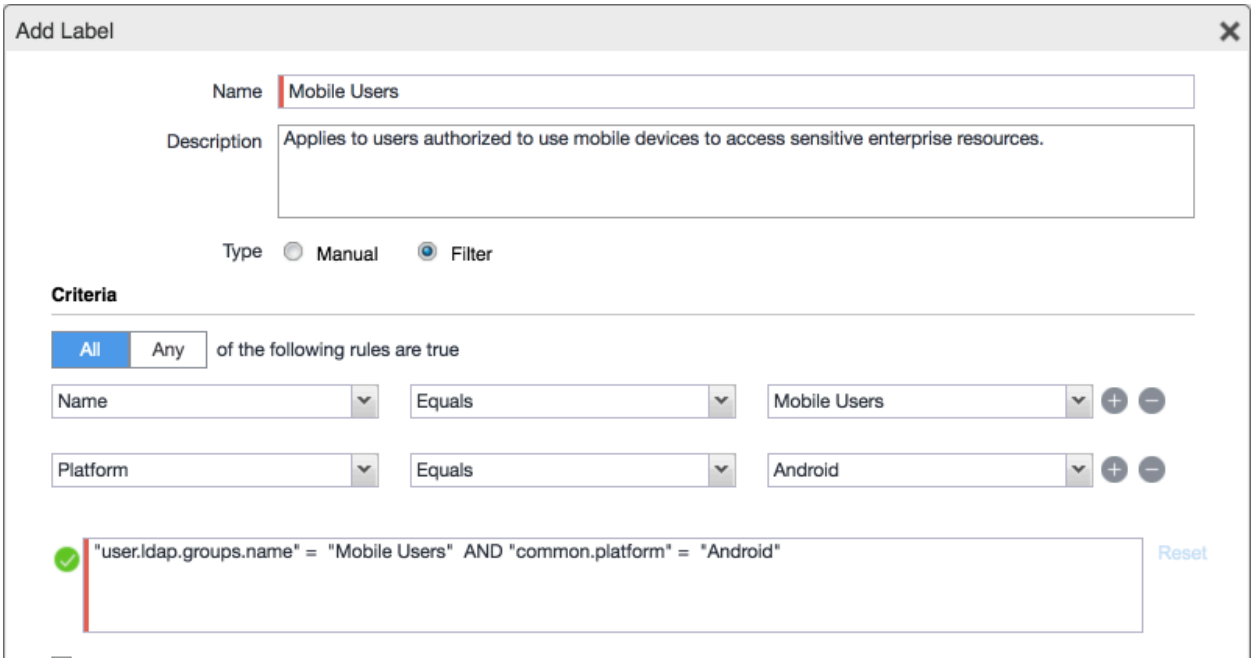
1. In the **MobileIron Core Admin Portal,** navigate to **Devices & Users > Labels.**
2. Select **Add Label.**

Figure 2-21 MobileIron Device Labels



3. In the **Name** field, enter a unique name for this label (**Mobile Users** in this example).
4. In the **Description** field, enter a meaningful description to help others identify its purpose.
5. Under the **Criteria** section:
   a. In the blank rule:
      i. In the **Field** drop-down menu, select **User > LDAP > Groups > Name.**
      ii. In the **Value** drop-down menu, select the Active Directory group created to support mobile user policies (named **Mobile User** in this example).
   b. Select the **plus sign icon** to add a blank rule.
   c. In the newly created blank rule:
      i. In the **Field** drop-down menu, select **Common > Platform.**
      ii. In the **Value** drop-down menu, select **Android.**

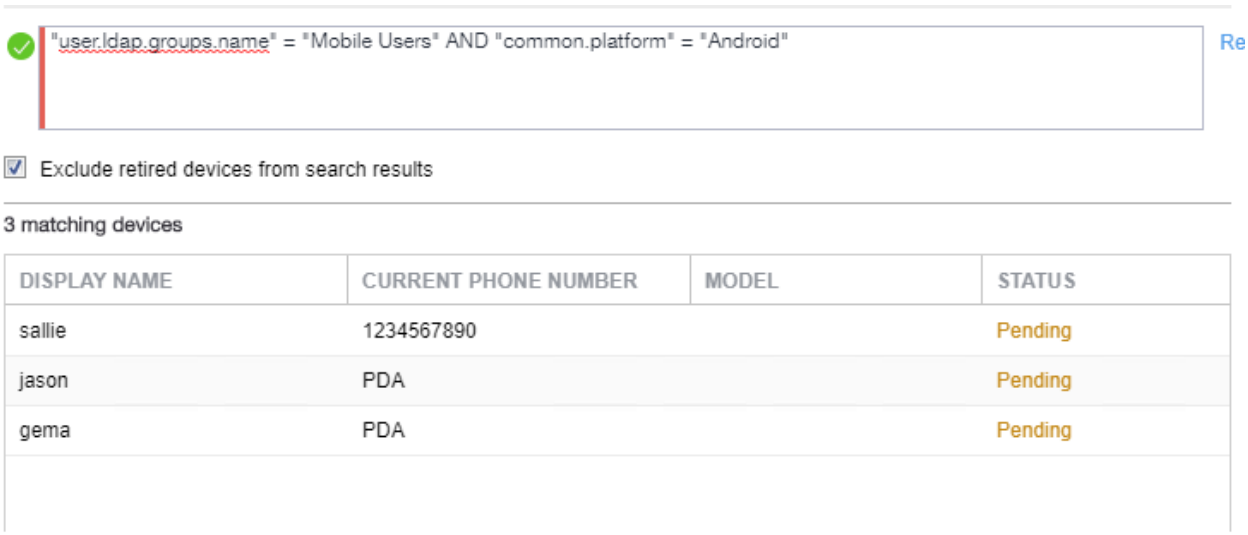
Figure 2-22 Adding a Device Label



d. The list of matching devices appears below the specified criteria.

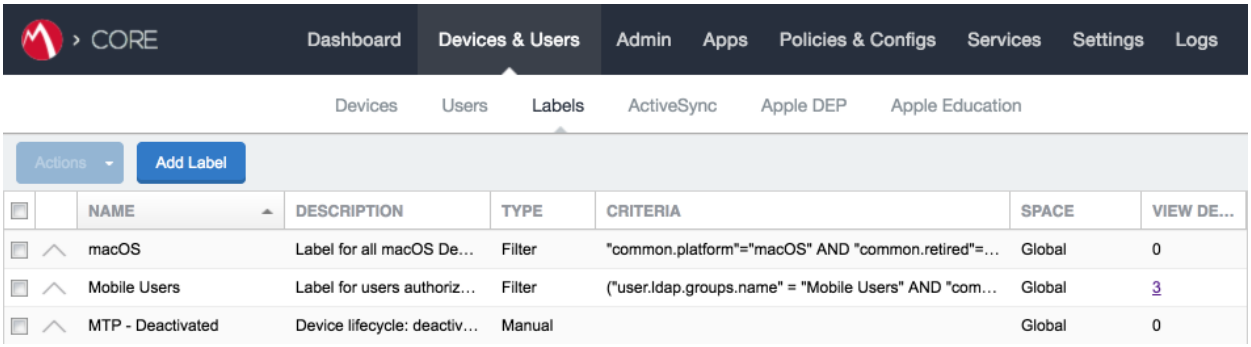
e. Select **Save.**

Figure 2-23 Device Label Matches



6. Navigate to **Devices & Users > Labels** to confirm the label was successfully created.

Figure 2-24 MobileIron Label List



2.5 Integration of Palo Alto Networks GlobalProtect with MobileIron

The following steps detail how to integrate MobileIron Core, Microsoft Certificate Authority (CA), and Palo Alto Networks GlobalProtect to allow mobile users to authenticate to the GlobalProtect gateway using user-aware device certificates issued to mobile devices by Microsoft CA during enrollment with MobileIron Core.

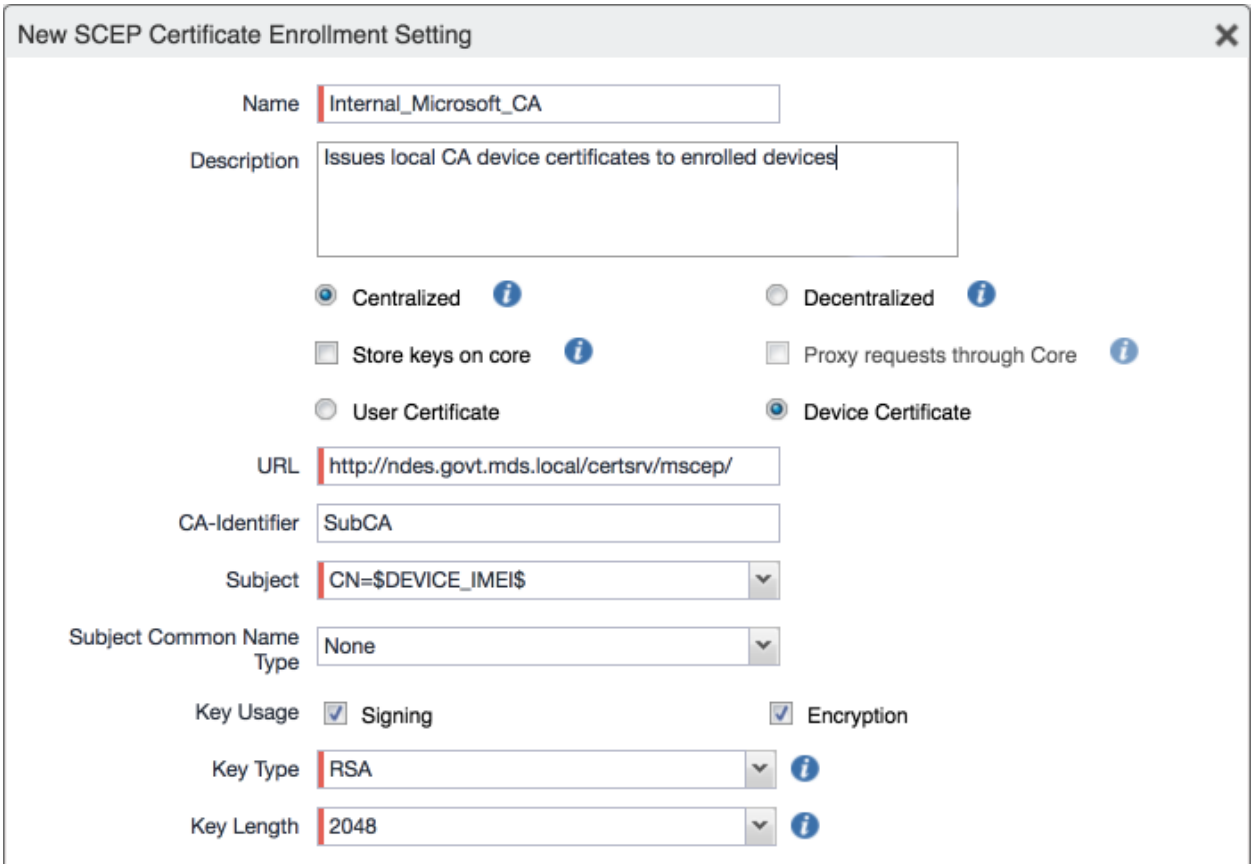
2.5.1 MobileIron Configuration

The following steps create the MobileIron Core configurations necessary to support integration with Palo Alto Networks GlobalProtect and Microsoft CA.

2.5.1.1 Create Simple Certificate Enrollment Protocol (SCEP) Configuration

1. In the **MobileIron Admin Portal**, navigate to **Policies & Configs > Configurations**.
2. Select **Add New > Certificate Enrollment > SCEP**; the **New SCEP Configuration Enrollment Setting** dialogue will open.
3. In the **New SCEP Certificate Enrollment Setting** dialogue:
   a. For the **Name** field, enter a unique name to identify this configuration.
   b. Enable the **Device Certificate** option.
   c. In the **URL** field, enter the URL where SCEP is hosted within your environment.
   d. In the **CA-Identifier (ID)** field, enter the subject name of the Microsoft CA that will issue the device certificates.
   e. In the **Subject** drop-down menu, select **$DEVICE_IMEI$.**

Figure 2-25 MobileIron SCEP Configuration



f. In the **Fingerprint** field, enter the fingerprint of the Microsoft CA that will issue the device certificates.

g. For the **Challenge Type** drop-down menu, select **Microsoft SCEP.**

h. Below the **Subject Alternative Names** list box, select **Add;** a new list item appears.

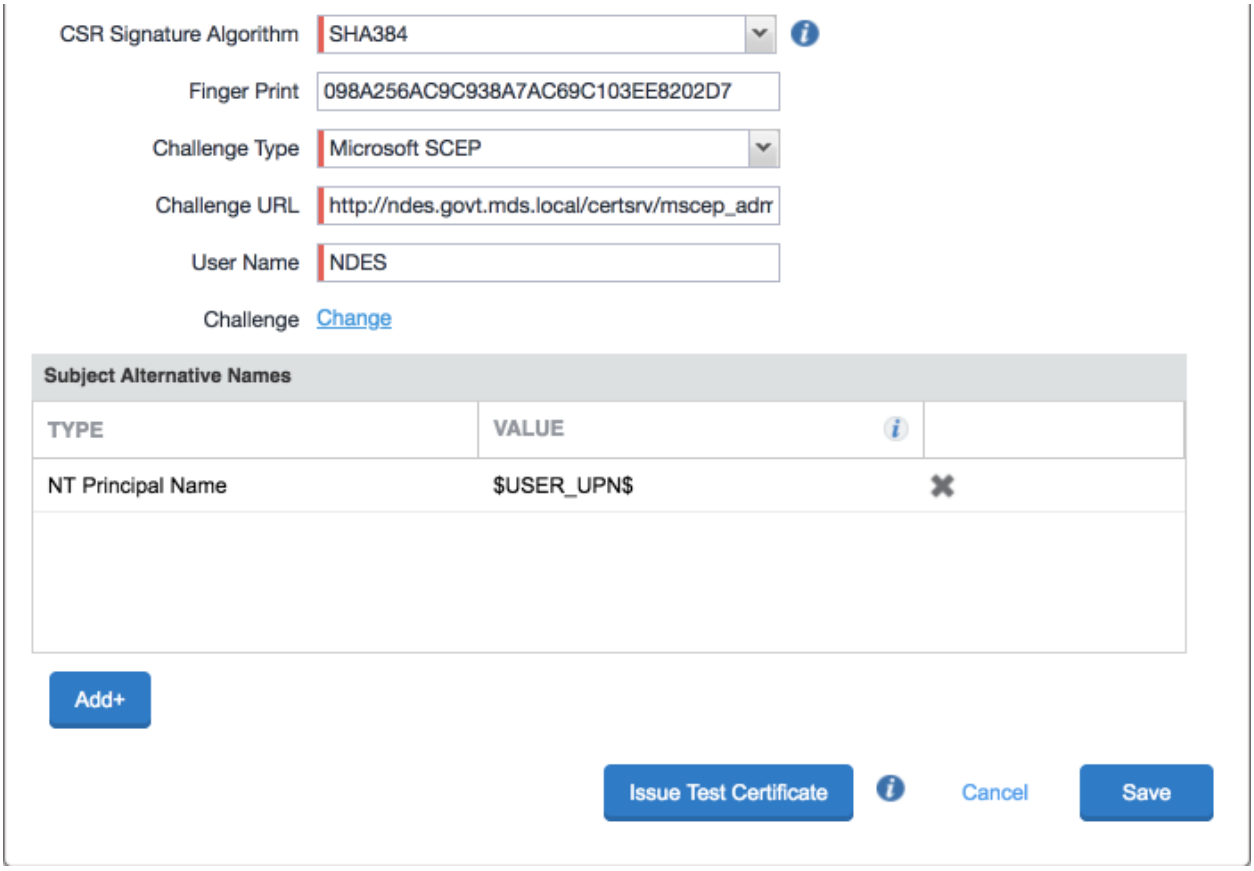
i. For the new list item:

   i. For the **Type** drop-down menu, select **NT Principal Name.**

   ii. For the **Value** drop-down menu, select **$USER_UPN$.**

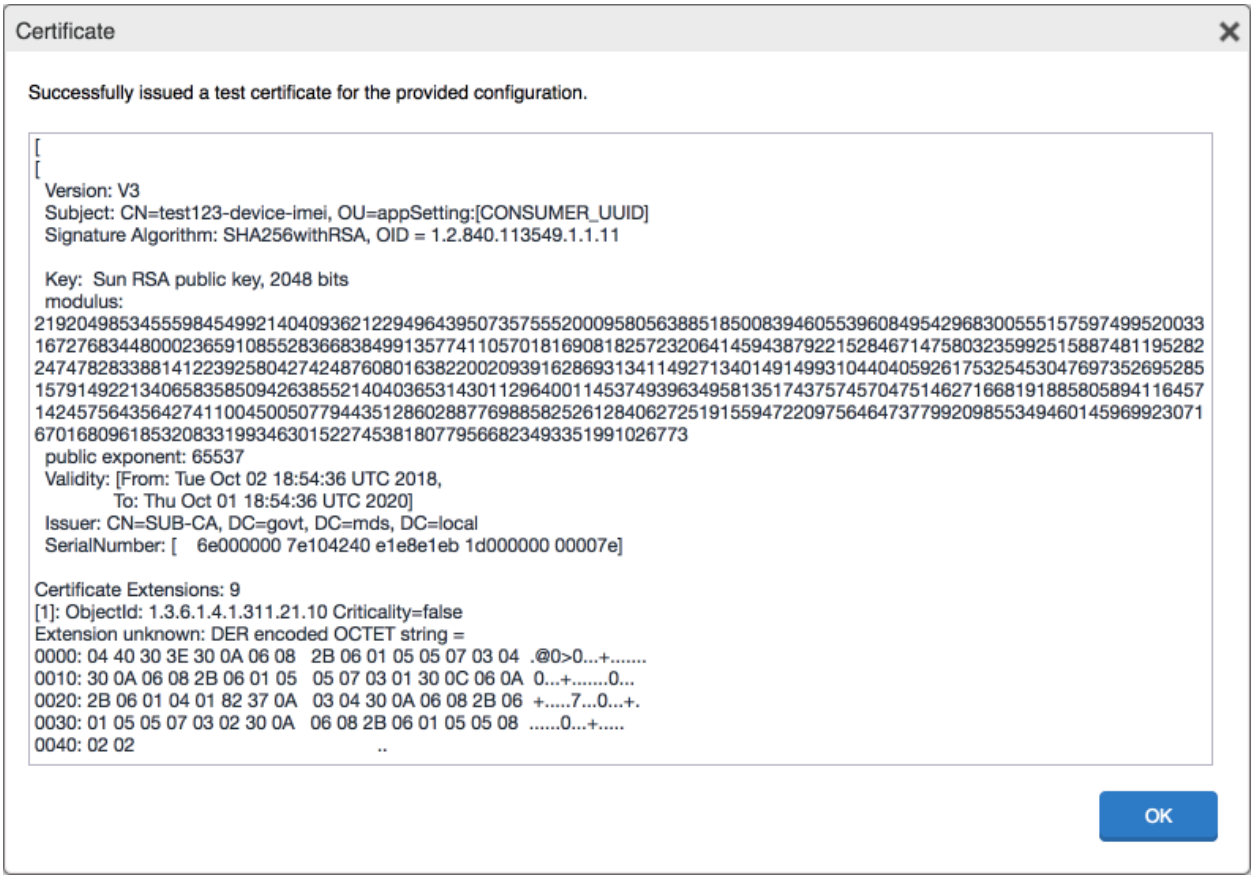
j. Click **Issue Test Certificate;** the **Certificate** dialogue should indicate success.

Figure 2-26 Test SCEP Certificate Configuration



k. In the **Certificate** dialogue, click **OK.**

Figure 2-27 Test SCEP Certificate



4. Click **Save.**

2.5.1.2 Create Palo Alto Networks GlobalProtect Configuration

The GlobalProtect configuration instructs the mobile client to use the provisioned device certificate and to automatically connect to the correct VPN URL; mobile users will not need to manually configure the application. The following steps will create the GlobalProtect configuration.

1. In the **MobileIron Admin Portal**, navigate to **Policies & Configs > Configurations**.
2. Select **Add New > VPN**; the **Add VPN Setting** dialogue will appear.
3. In the **Add VPN Setting** dialogue:
   a. In the **Name** field, enter a unique name to identify this VPN setting.
   b. In the **Connection Type** drop-down menu, select **Palo Alto Networks GlobalProtect.**

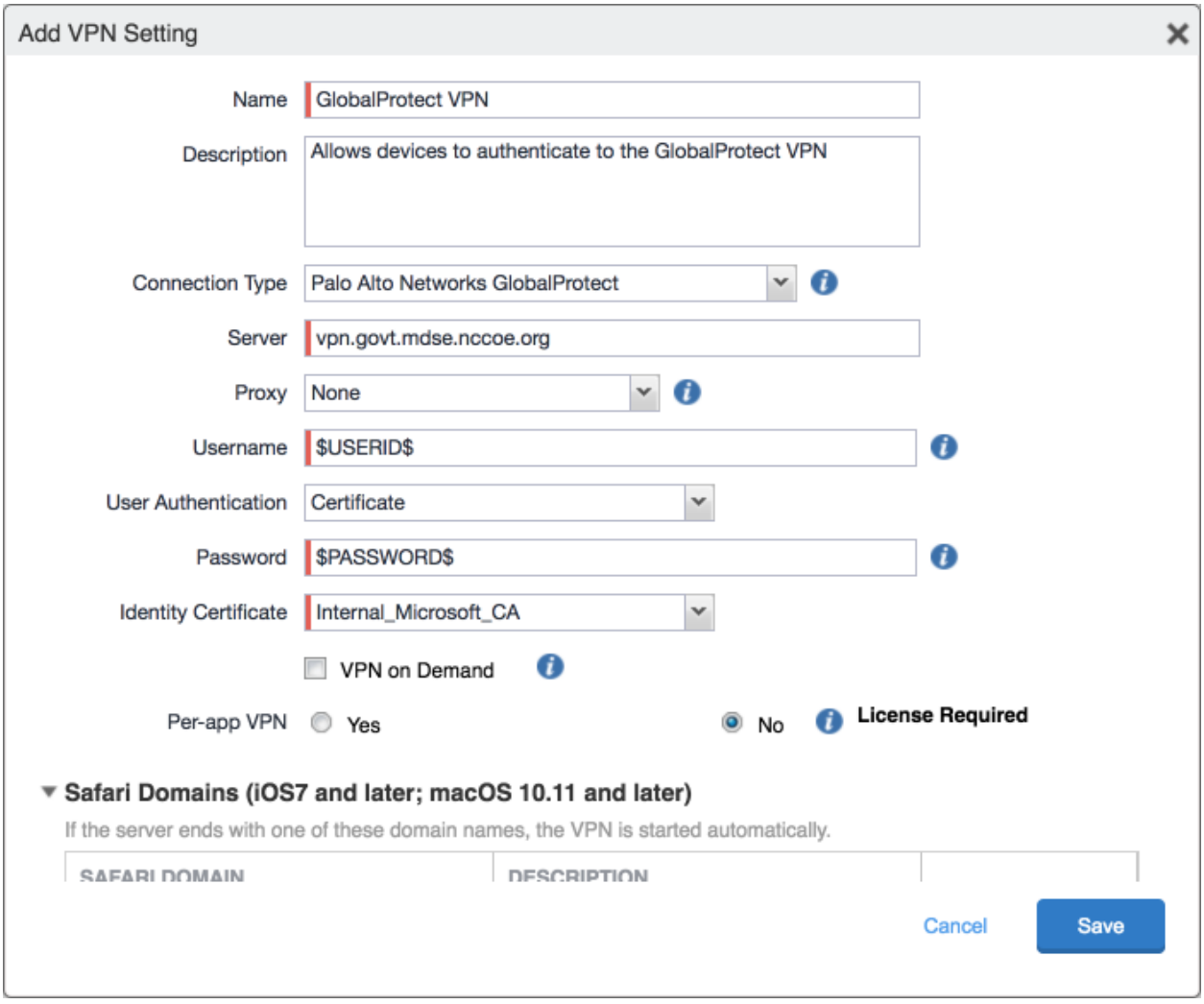
c. In the **Server** field, enter the fully qualified domain name (FQDN) of your Palo Alto Networks appliance; our sample implementation uses **vpn.govt.mdse.nccoe.org.**

d. For the **User Authentication** drop-down menu, select **certificate.**

e. For the **Identity Certificate** drop-down menu, select the SCEP enrollment profile created in the previous section.

f. Click **Save.**

Figure 2-28 MobileIron VPN Configuration



2.5.2 Basic Palo Alto Networks Configuration

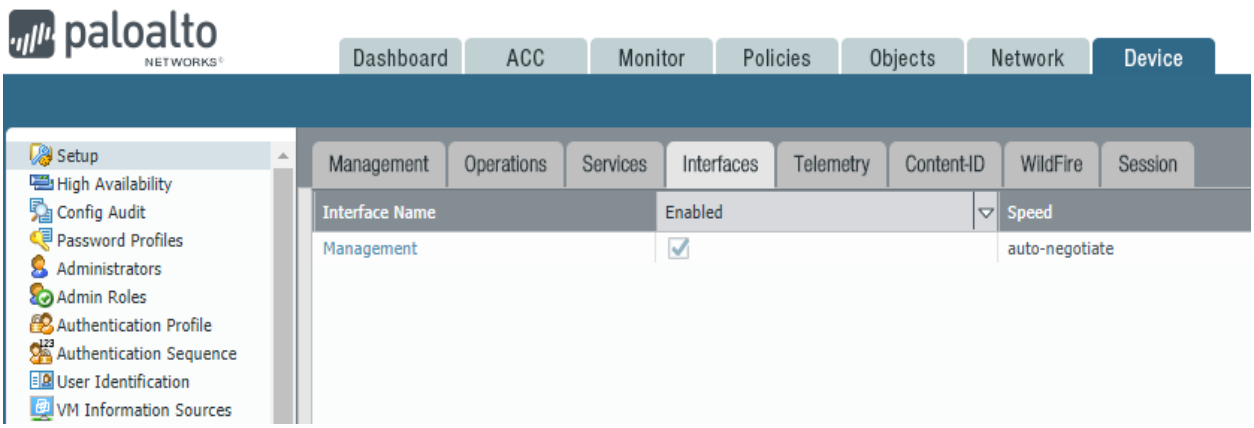
During basic configuration, internet protocol (IP) addresses are assigned to the management interface, domain name system (DNS), and network time protocol (NTP). The management interface allows the administrator to configure and implement security rules through this interface.

2.5.2.1 Configure Management Interface

The following steps will configure the Palo Alto Networks appliance management interface.

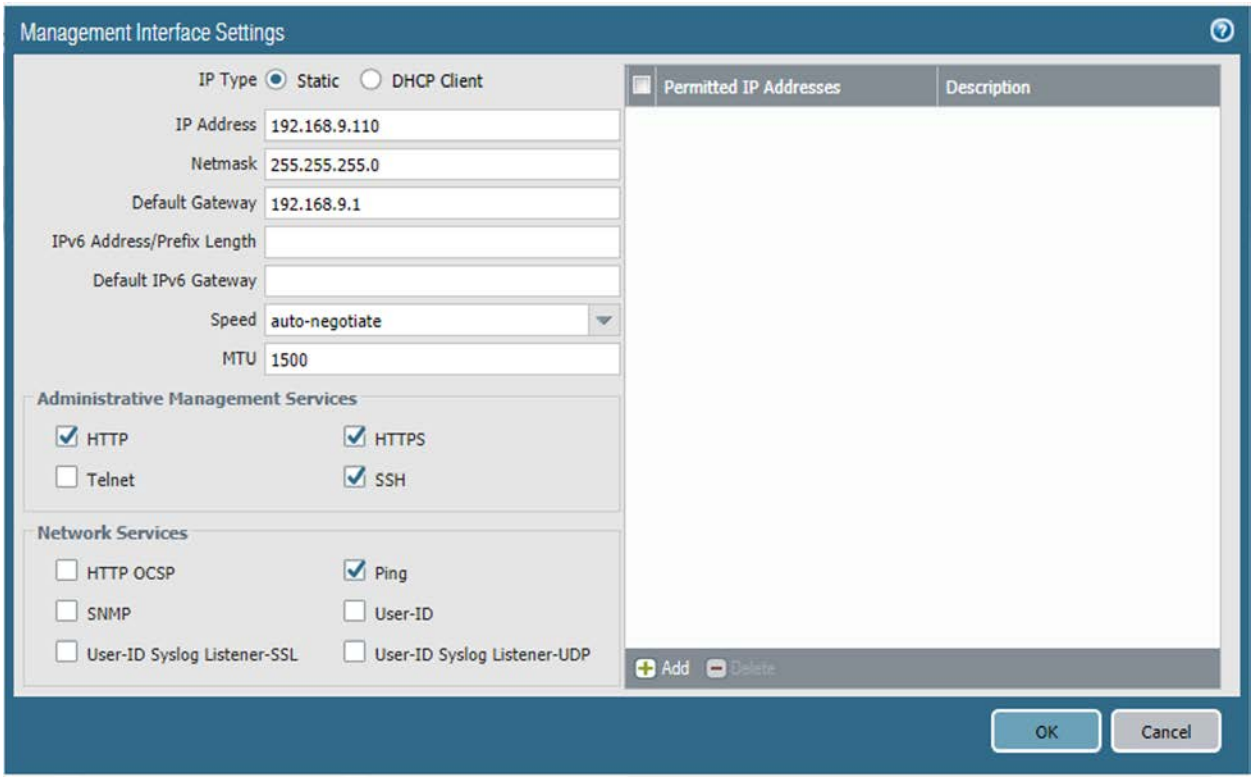
1. In the Palo Alto Networks portal, navigate to **Device > Setup > Interfaces.**
2. On the Interfaces tab, enable the **Management** option; the Management Interface Setting page opens.

Figure 2-29 Palo Alto Networks Management Interface Enabled



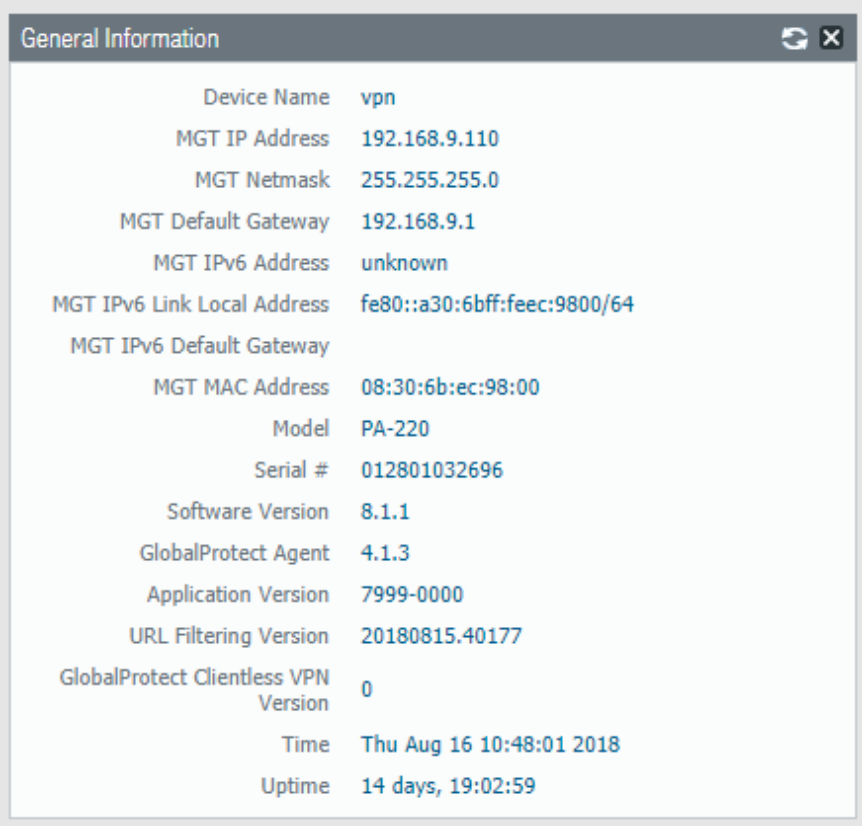
3. On the Management Interface Setting screen:
   a. In the **IP Address** field, enter the IP address for the Palo Alto Networks appliance.
   b. In the **Netmask** field, enter the netmask for the network.
   c. In the **Default Gateway** field, enter the IP address of the router that provides the appliance with access to the internet.
   d. Under **Administrative Management Services:** Enable the **Hypertext Transfer Protocol (HTTP)**, **Hypertext Transfer Protocol Secure (HTTPS)**, **Secure Shell (SSH)**, and **Ping** options.
   e. Click **OK.**

Figure 2-30 Management Interface Configuration



4. To verify the configuration, navigate to **Palo Alto Networks Portal > Dashboard;** the **General Information** section should reflect the appliance's network configuration.

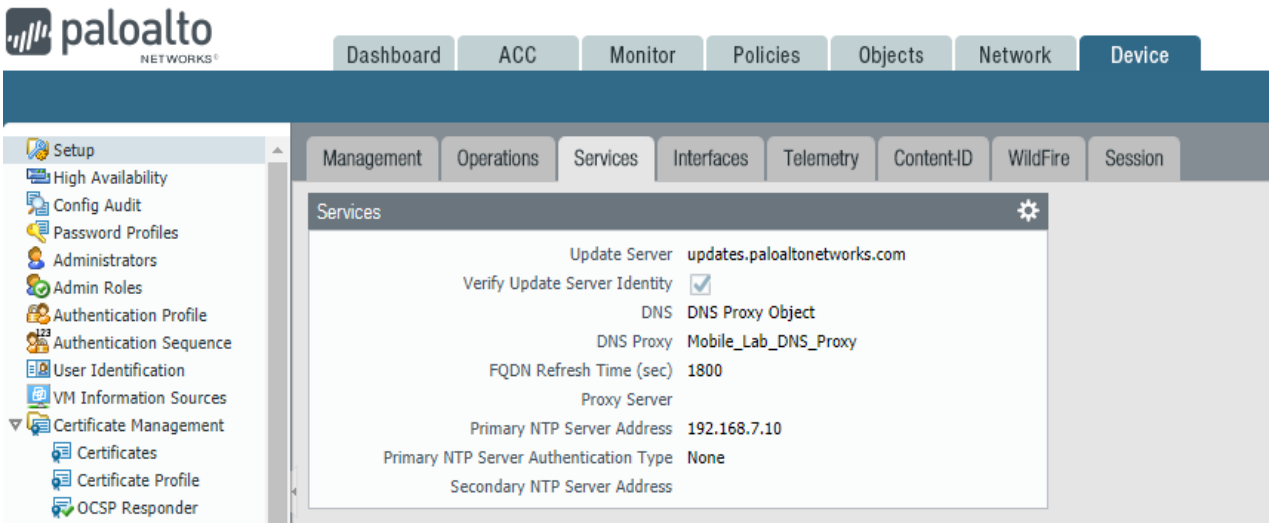
Figure 2-31 Palo Alto Networks Firewall General Information



2.5.2.2 Configure DNS and NTP

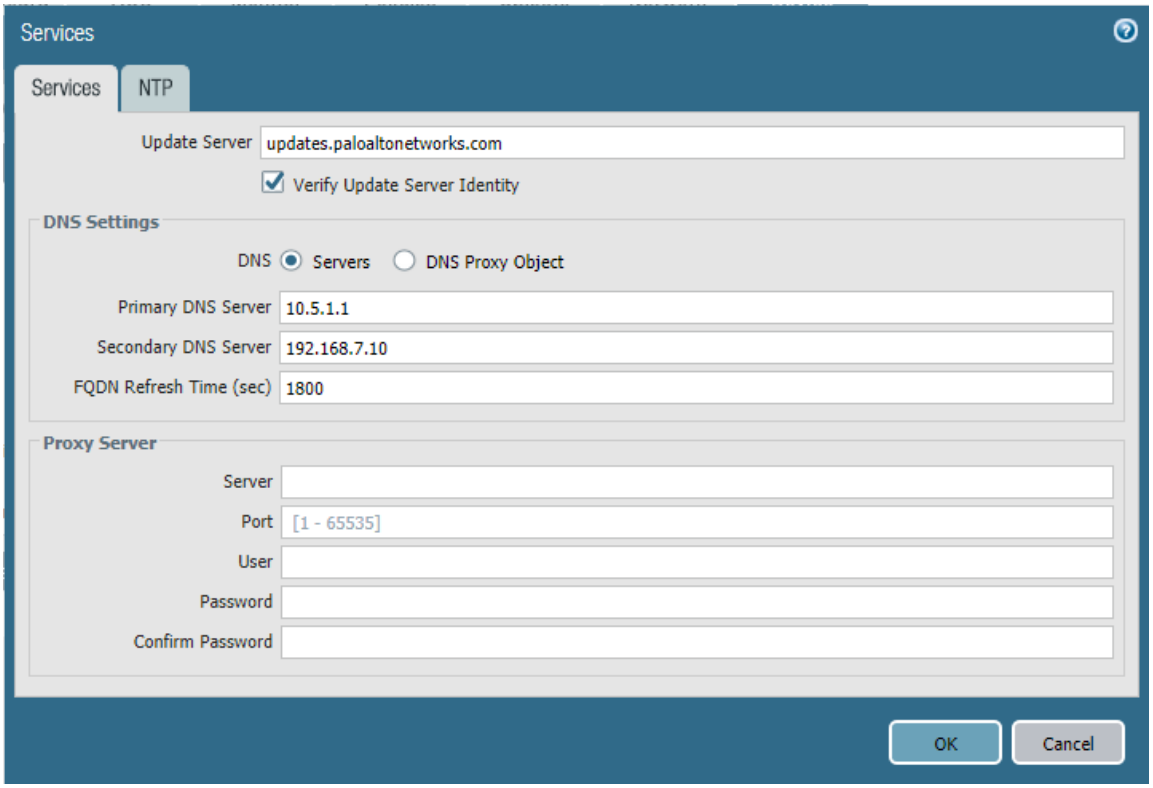
1. In the **Palo Alto Networks Portal**, navigate to **Device > Setup > Services.**
2. In the **Services** tab, select the gear icon.

Figure 2-32 Palo Alto Networks Services Configuration



3. On the Services > Services tab:
   a. For the **Primary DNS Server** field, enter the primary DNS server IP address.
   b. For the **Secondary DNS Server** field, enter the secondary DNS server IP address, if applicable.
4. Select the **NTP** tab.

Figure 2-33 DNS Configuration



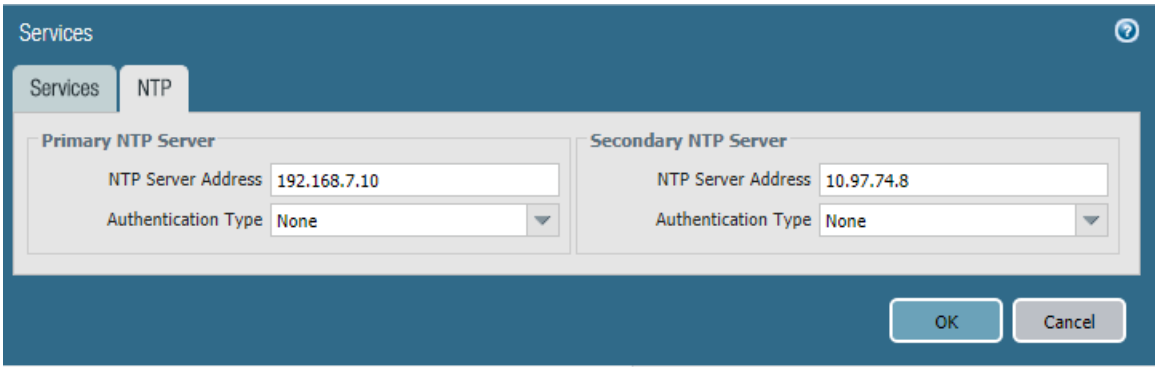
5. On the **NTP** tab:

   a. For the **Primary NTP Server > NTP Server Address** field, enter the IP address of the primary NTP server to use.

   b. For the **Secondary NTP Server > NTP Server Address** field, enter the IP address of the backup NTP server to use, if applicable.

6. Click **OK.**

Figure 2-34 NTP Configuration



2.5.3 Palo Alto Networks Interfaces and Zones Configuration

Palo Alto Networks firewall model PA-220 has eight interfaces that can be configured as trusted (inside) or untrusted (outside) interfaces. This section describes creating a zone and assigning an interface to it.

2.5.3.1 Create Ethernet Interfaces and Addresses

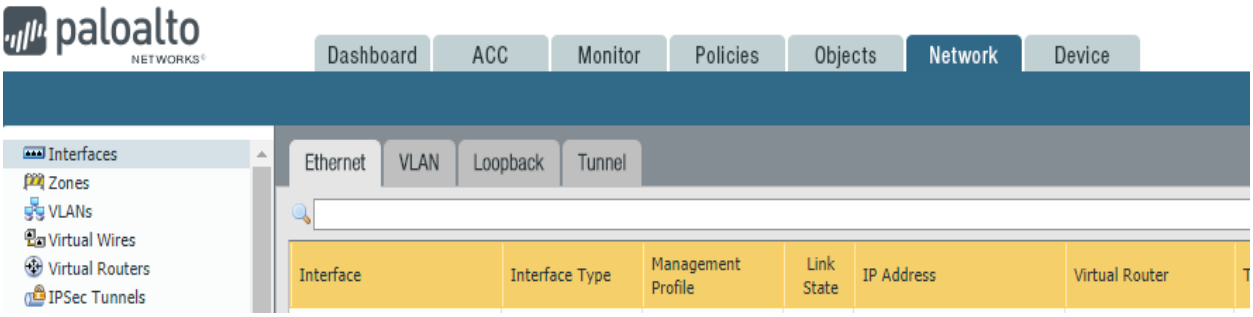
Our example implementation uses three interfaces:

- LAN: Orvilia's LAN, which hosts intranet web and mail services
- DMZ: Orvilia's DMZ network subnet, which hosts MobileIron Core and MobileIron Sentry
- WAN: provides access to the internet and is the inbound interface for secure sockets layer (SSL) VPN connections

To create and configure Ethernet interfaces:

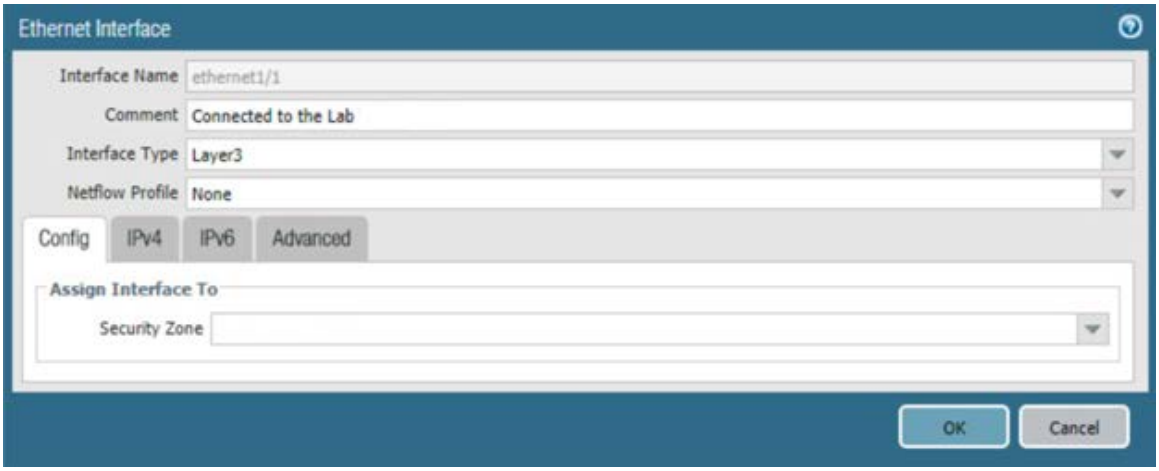
1. Navigate to **Palo Alto Networks Portal > Network > Ethernet > Interfaces > Ethernet.**

Figure 2-35 Ethernet Interfaces



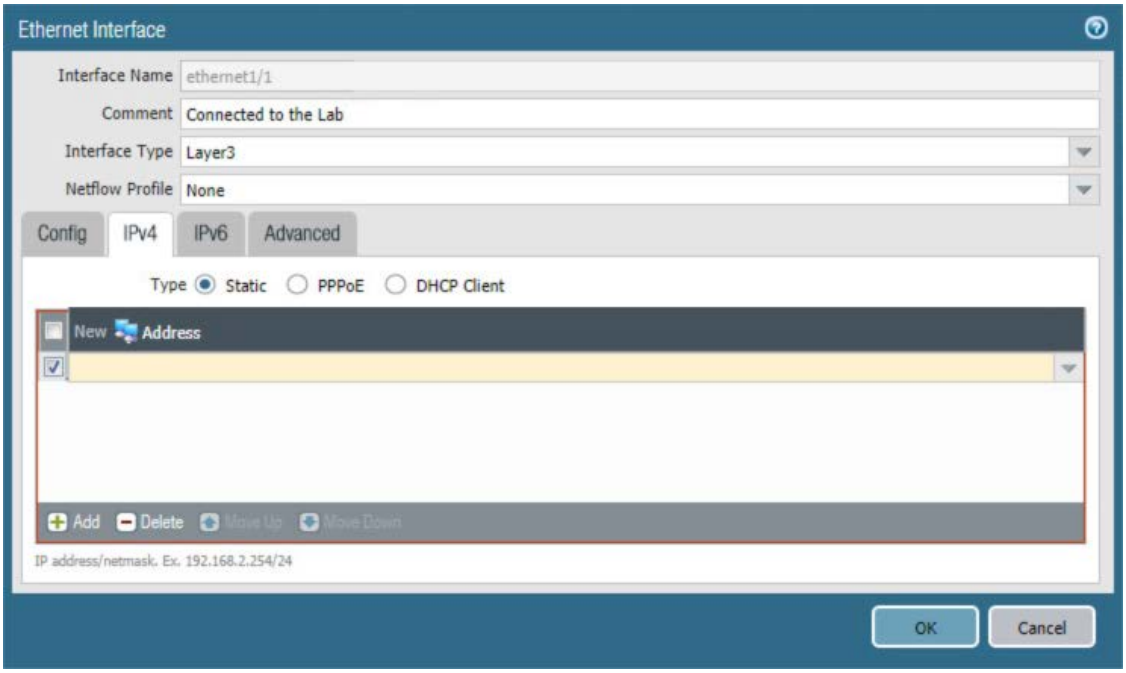
2. In the **Ethernet** tab, select the name of the interface to configure; the Ethernet Interface dialogue will appear.
3. In the **Ethernet Interface** dialogue:
    a. In the **Comment** field, enter a description for this interface.
    b. For the **Interface Type** drop-down menu, select **Layer3.**

Figure 2-36 Ethernet Interface Configuration



    c. Select the **IPv4** tab.
    d. On the **IPv4** tab:
        i. In the **IP** list box, select **Add;** a blank list item appears.
        ii. In the blank list item, select **New Address;** the Address dialogue appears.

Figure 2-37 WAN Interface IPv4 Configuration



iii. In the **Address** dialogue:

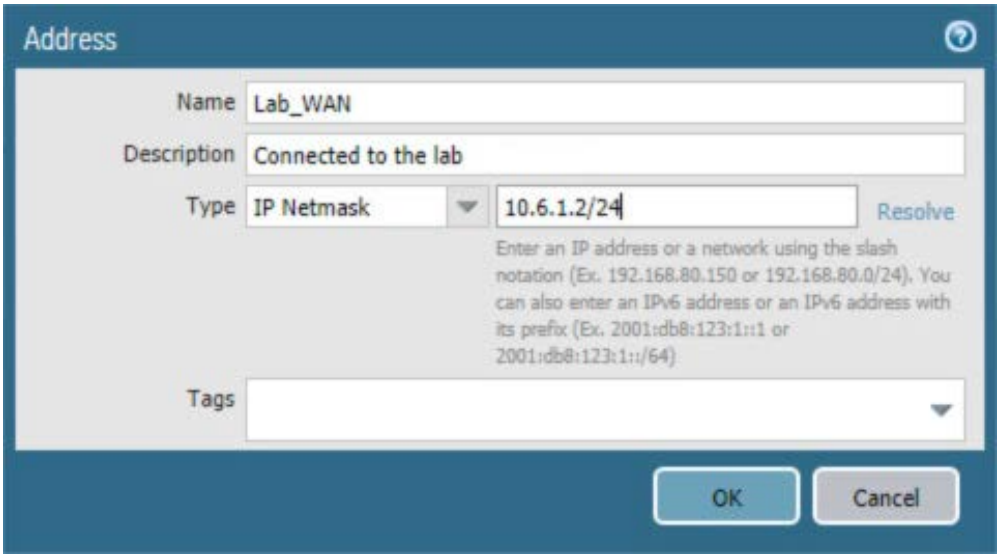
1) For the **Name** field, enter a unique name to identify this address.

2) For the **Description** field, enter a meaningful description of the purpose of this address.

3) In the unnamed field following the **Type** drop-down menu, enter the IPv4 address that this interface will use in **Classless Inter-Domain Routing** notation. This example uses **10.6.1.2/24** for the WAN interface in our lab environment.

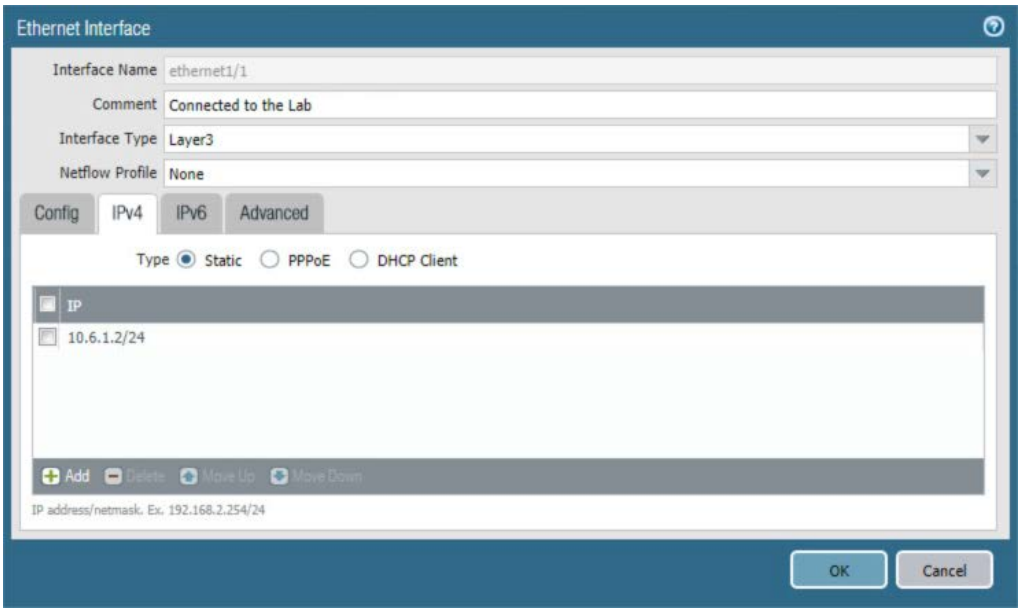
4) Click **OK.**

Figure 2-38 WAN Interface IP Address Configuration



e. The address should now appear as an item in the IP list box; select **OK;** the Address dialogue closes.

Figure 2-39 Completed WAN Interface Configuration



4. Click **OK.**

5. Repeat Steps 2 and 3 for each of the additional Ethernet/Layer3 interfaces.

2.5.3.2 Create Security Zones

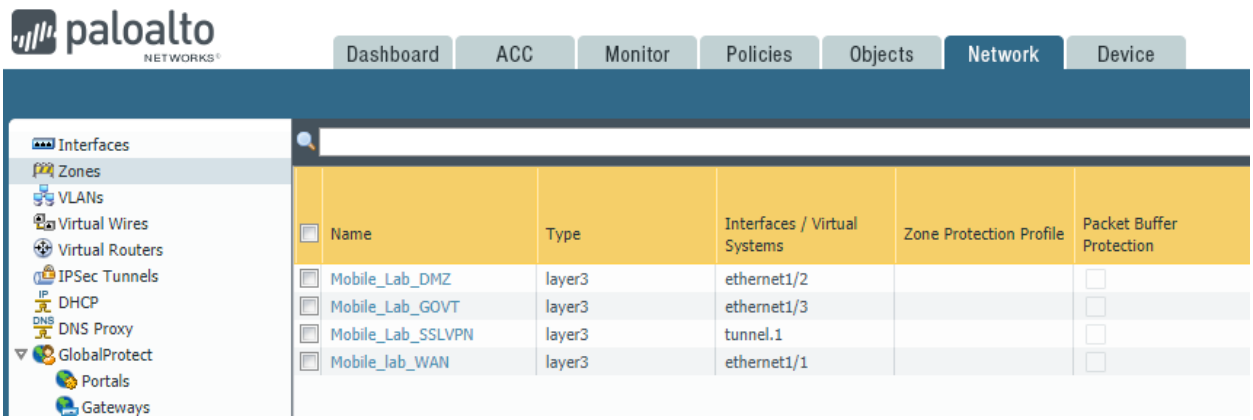
The PA Security Zone is a collection of single or multiple interfaces that have the same security rules. For this setup, four different zones have been configured:

- *Mobile_Lab_GOVT:* inside (trusted) interface connecting to the government (GOVT) segment
- *Mobile_Lab_DMZ*: inside (trusted) interface connecting to the DMZ segment
- *Mobile_Lab_WAN:* outside (untrusted) interface to permit trusted inbound connections (e.g., Lookout cloud service) from the untrusted internet and allow internet access to on-premises devices
- *Mobile_Lab_SSLVPN:* outside (untrusted) interface for VPN connections by trusted mobile devices originating from untrusted networks (e.g., public Wi-Fi)

To configure each zone:

1. Navigate to **Palo Alto Networks Portal > Network > Zones.**

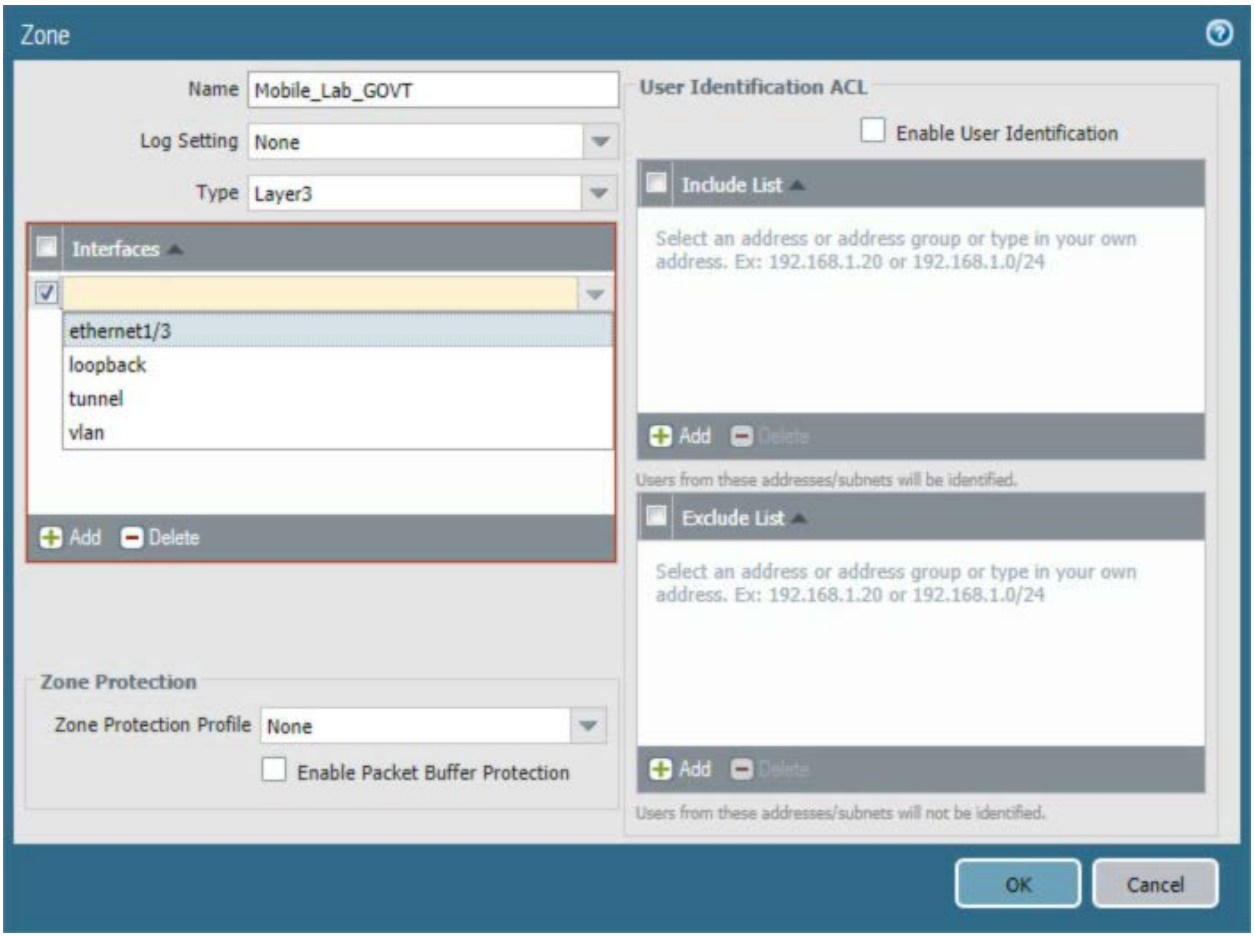
Figure 2-40 Security Zone List



2. In the **Zones** pane, select **Add;** the Zones page opens.
3. On the **Zones** page:
   a. For the **Name** field, provide a unique name for the zone.
   b. For the **Type** drop-down menu, select **Layer 3.**
   c. Under **Interfaces,** select **Add;** a blank drop-down menu appears.
   d. In the drop-down menu, select the interface to assign to this zone; this example shows selection of **ethernet 1/3,** which is associated with the LAN interface.

e. Click **OK.**

Figure 2-41 LAN Security Zone Configuration



f. Repeat Step b for each zone.

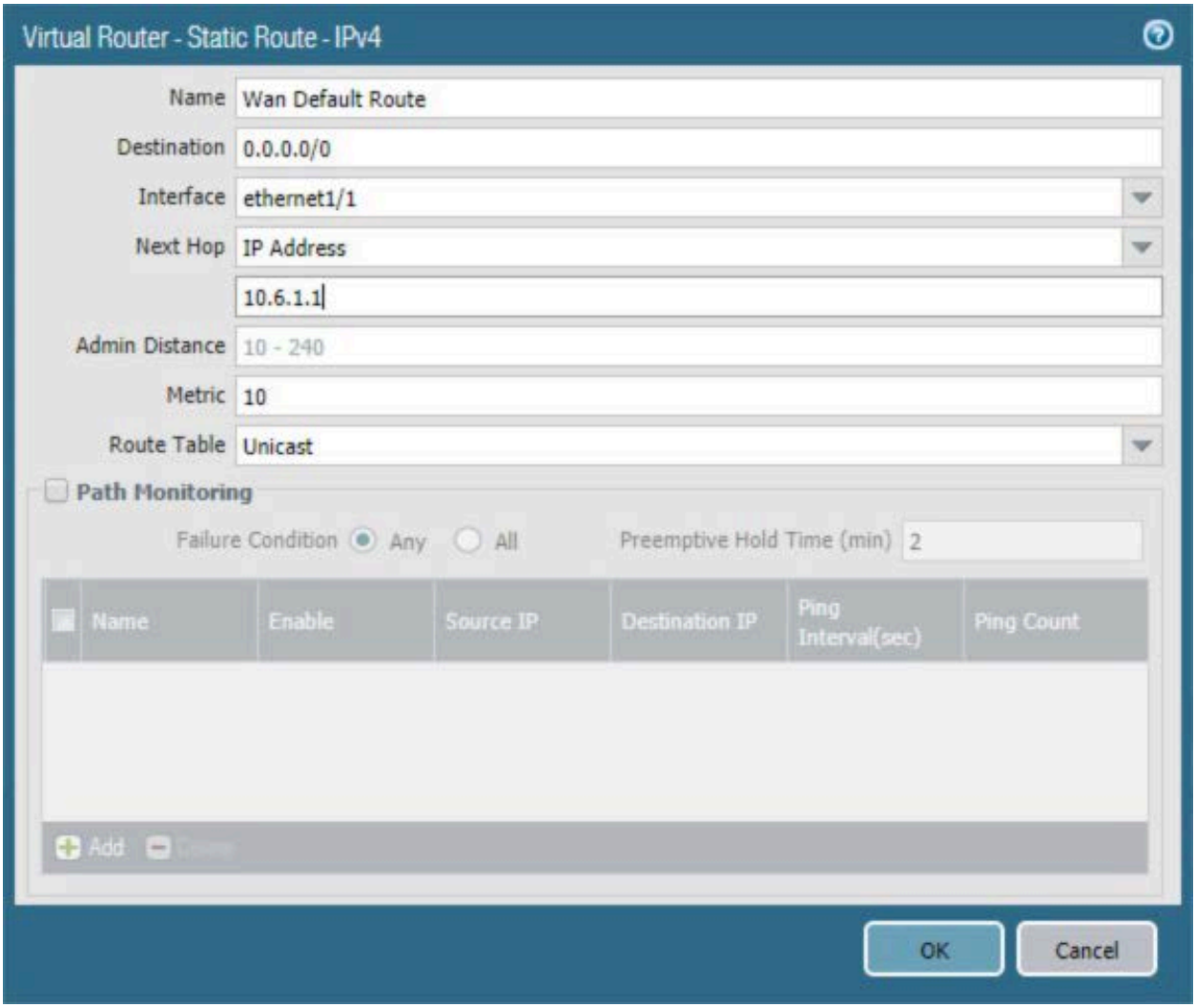
2.5.4 Configure Router

Palo Alto Networks uses a virtual router to emulate physical connectivity between interfaces in different zones. To permit systems to reach systems in other zones, the following steps will create a virtual router and add interfaces to it. The router also sets which of these interfaces will act as the local gateway to the internet.

1. In the **Palo Alto Networks Portal,** navigate to **Network > Virtual Routers.**
2. Below the details pane, select **Add;** the Virtual Router form opens.

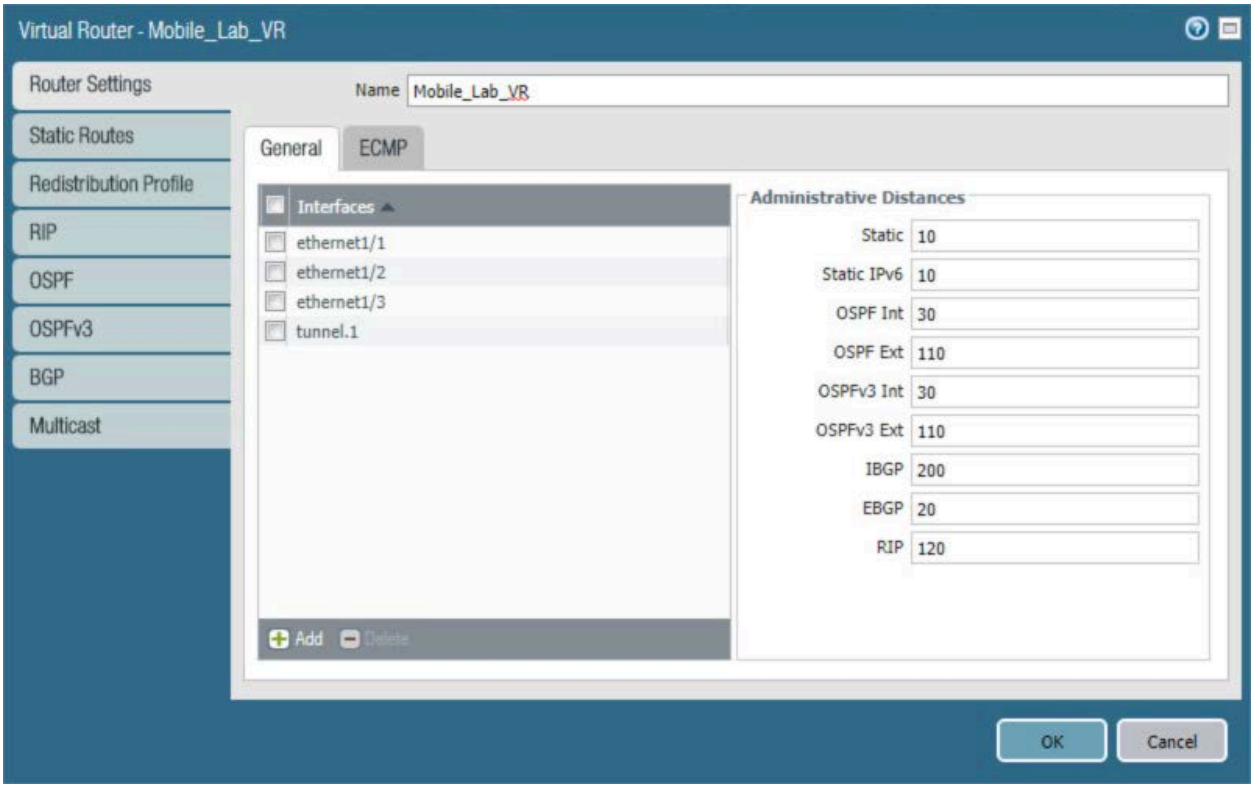
3. In the **Virtual Router** form, on the **Router Settings** tab:
    a. For the **Name** field, enter a unique name to identify this router.
    b. On the **Router Settings > General** tab:
        i. Under the **Interfaces** list box, select **Add;** a new list item appears.
        ii. In the new list item drop-down menu, select an existing interface.
        iii. Repeat **Steps 3a** and **3b** to add all existing interfaces to this router.
4. Select the **Static Routes** tab.
5. On the **Static Routes > IPv4** tab:
    a. Below the list box, select **Add;** the Virtual Router - Static Route - IPv4 form opens.
    b. In the **Virtual Router—Static Route—IPv4** form:
        i. For the **Name** field, enter a unique name to identify this route.
        ii. For the **Destination** field, enter **0.0.0.0/0.**
        iii. For the **Interface** drop-down menu, select the interface that provides access to the internet.
        iv. For the **Next Hop** drop-down menu, select **IP Address.**
        v. In the field below **Next Hop,** enter the IP address of the gateway that provides access to the internet.
        vi. Click **OK.**

Figure 2-42 Virtual Router Configuration



6. Click **OK.**

Figure 2-43 Virtual Router General Settings

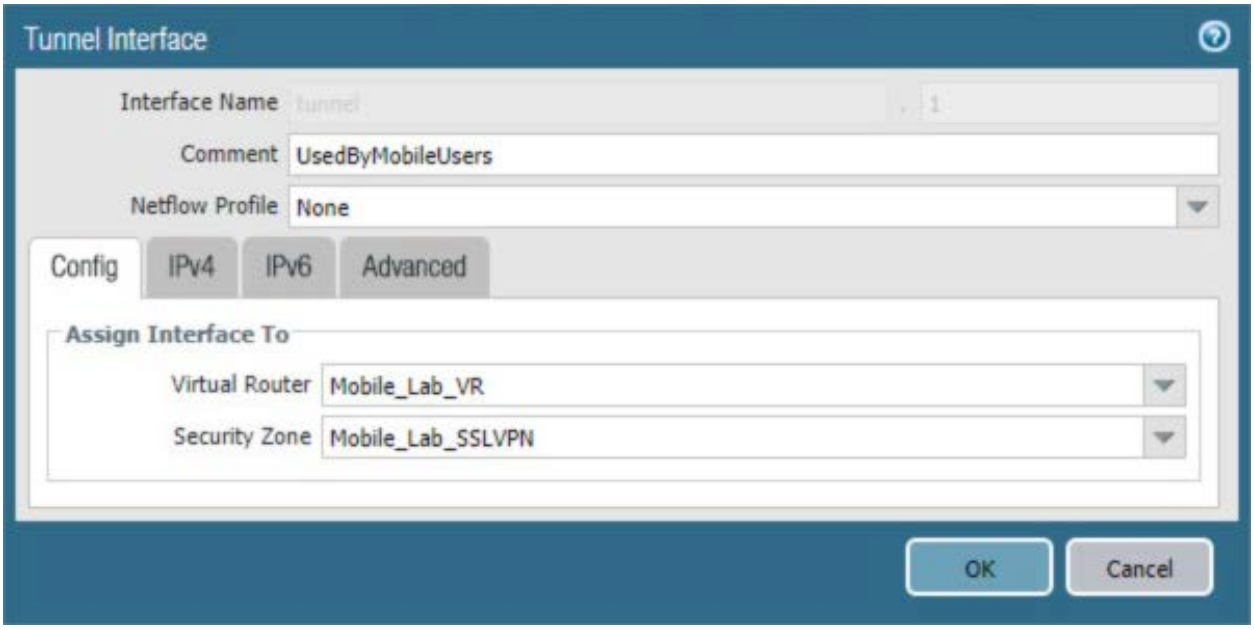


2.5.5 Configure Tunnel Interface

The SSL VPN uses a tunnel interface to secure traffic from the external zone to the internal zone where organizational resources available to mobile users are maintained. To configure the tunnel interface:

1. Navigate to **Palo Alto Networks Portal > Network > Ethernet > Interfaces > Tunnel.**
2. Below the details pane, select **Add;** the Tunnel Interface form opens.
3. In the **Tunnel Interface** form on the **Config** tab:
   a. In the **Assign Interface To** section:
      i. For the **Virtual Router** drop-down menu, select the virtual router created in the previous section.
      ii. For the **Security Zone** drop-down menu, select the security zone created for the SSL VPN.
   b. Click **OK.**

Figure 2-44 SSL VPN Tunnel Interface



2.5.6 Configure Applications and Security Policies

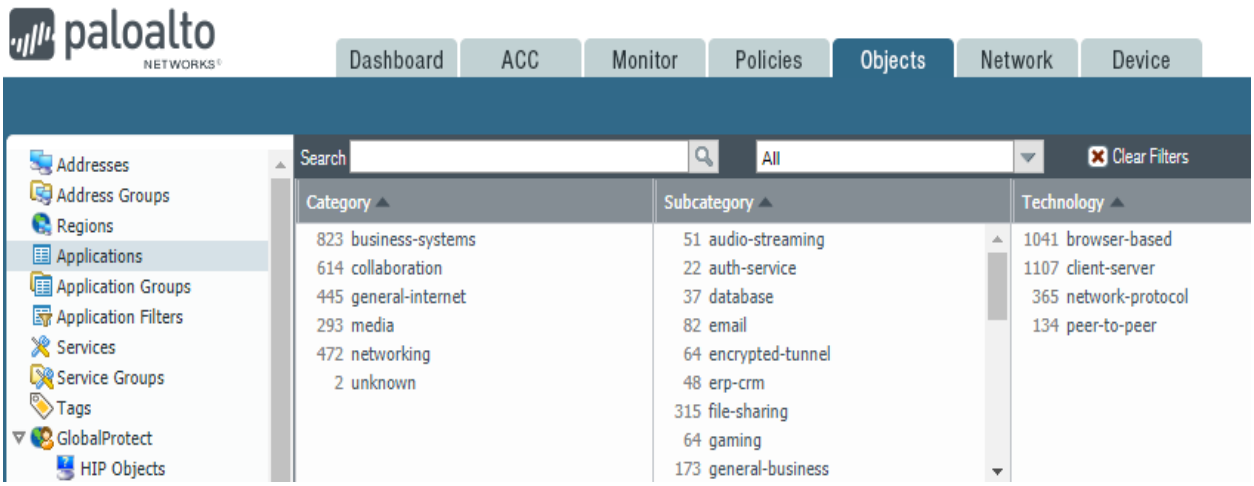
Security policies work similarly to firewall rules; they block or allow traffic between defined zones identified by a source, destination, and application(s) (contextually, Palo Alto Networks' objects define network protocols and ports). Palo Alto Networks has built-in applications for a large number of standard and well-known protocols and ports (e.g., LDAP and Secure Shell), but we defined custom applications for MobileIron-specific traffic.

2.5.6.1 Configure Applications

The following steps will create an application:

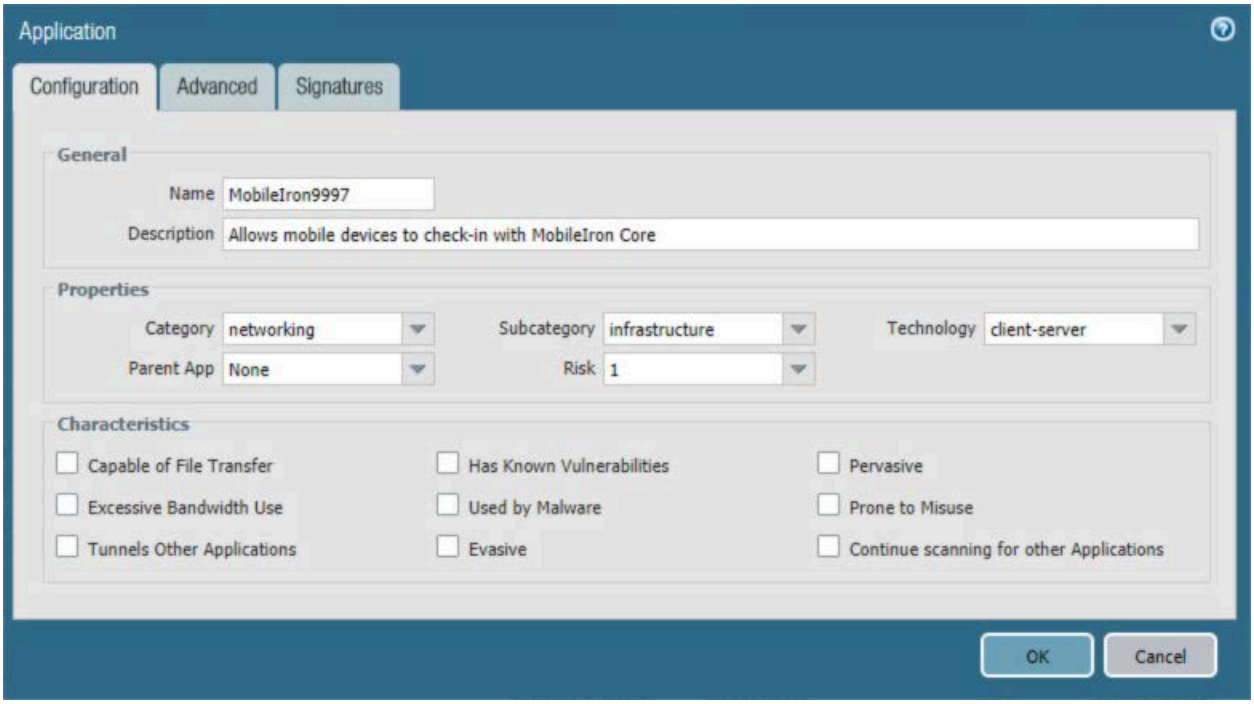
1. In the **Palo Alto Networks Portal,** navigate to **Objects > Applications.**

Figure 2-45 Application Categories



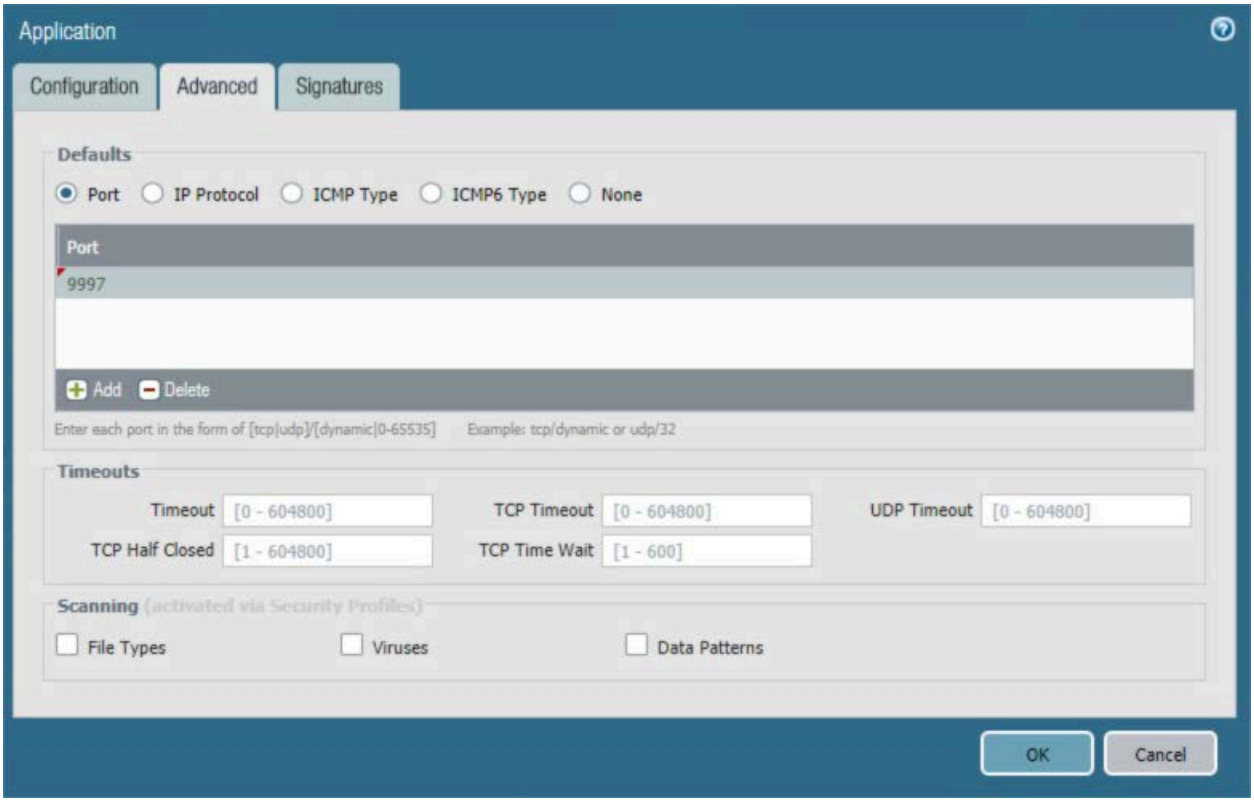
2. On the **Applications** screen:
3. Select **Add;** the Application form opens.
4. On the **Application > Configuration** screen:
    a. In the **General > Name** field, provide a unique name to identify this application.
    b. In the **General > Description** field, enter a meaningful description of its purpose.
    c. For the **Properties > Category** drop-down menu, select a category appropriate to your environment; our sample implementation uses **networking.**
    d. For the **Properties > Subcategory** drop-down menu, select a subcategory appropriate to your environment; our sample implementation uses **infrastructure.**
    e. For the **Properties > Technology** drop-down menu, select a technology appropriate to your environment; our sample implementation uses **client-server.**

Figure 2-46 MobileIron Core Palo Alto Networks Application Configuration



5. Select the **Advanced** tab.
6. On the **Application > Advanced** screen:
   a. Select **Defaults > Port.**
   b. Under the Ports list box, select **Add;** a blank list item appears.
   c. In the blank list item, enter the port number used by the application; this example uses **9997**.
7. Click **OK.**

Figure 2-47 MobileIron Application Port Configuration



8. Repeat Steps 2 through 7 with the following modifications to create an application for the MobileIron Core system administration console:

   a. **Configuration > General > Name is MobileIron8443.**

   b. **Configuration > Properties > Category is business-systems.**

   c. **Configuration > Properties > Subcategory is management.**

   d. **Advanced > Defaults > Port** first entry is 8443.

2.5.6.2 Configure Security Policies

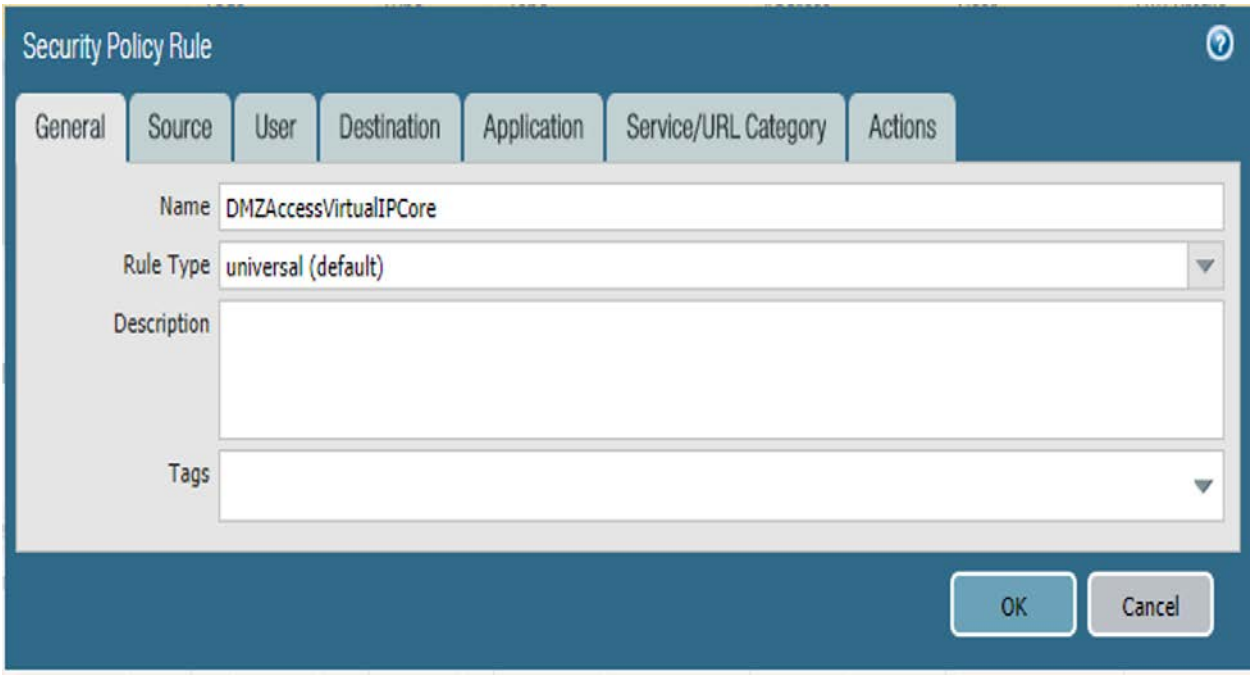
Security policies allow or explicitly deny communication within, between, or (externally) to or from Palo Alto Networks zones. For this sample implementation, several security policies were created to support communication by other components of the architecture. The first subsection covers the steps to create a given security policy. The second subsection provides a table illustrating the security policies we used; these policies would need to be adapted to host names and IP addresses specific to your network infrastructure.

2.5.6.2.1 Create Security Policies

To create a security policy:

1. In the **Palo Alto Networks Portal,** navigate to **Policies > Security.**
2. Select **Add;** the **Security Policy Rule** form will open.
3. In the **Security Policy Rule** form:
   a. In the **Name** field, enter a unique name for this security rule.
   b. For the **Rule Type** drop-down menu, select the scope of the rule, following the guidance provided in the Palo Alto Networks documentation for creating firewall rules.

Figure 2-48 DMZ Access to MobileIron Firewall Rule Configuration

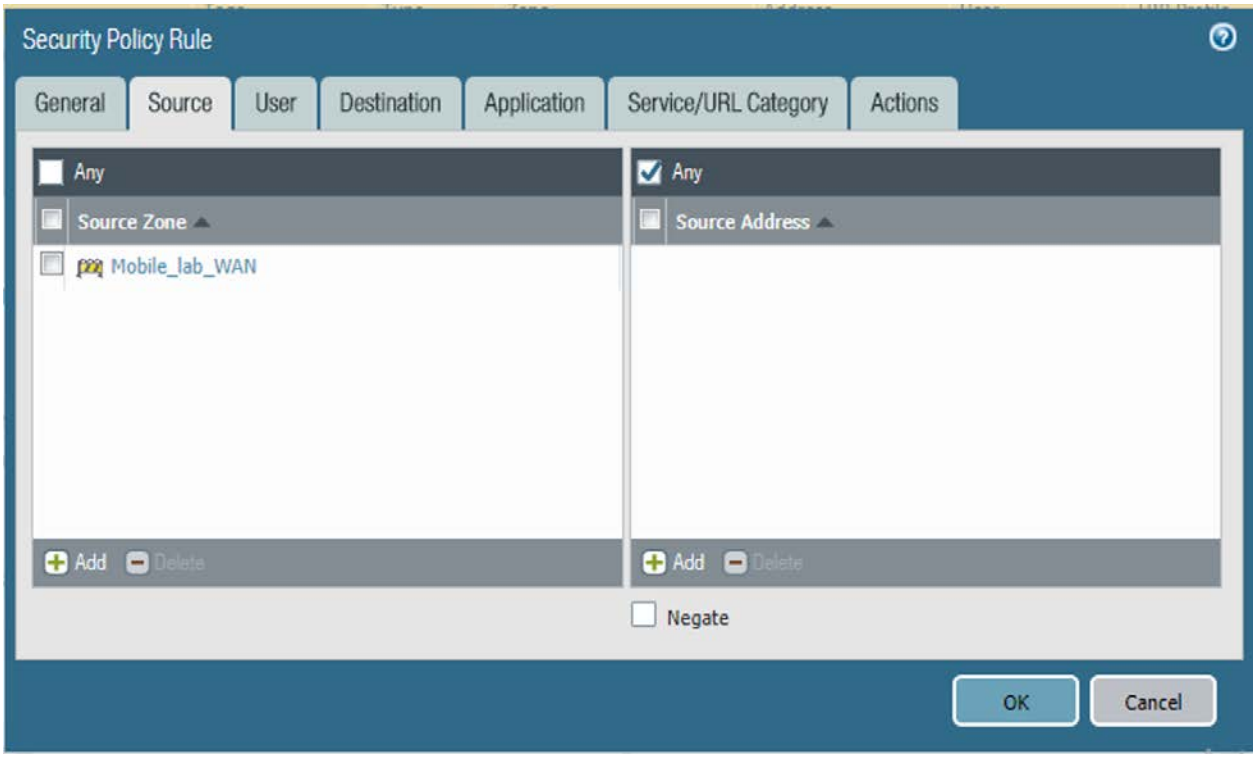


4. Select the **Source** tab.
5. On the **Source** tab:
   a. If the security rule applies to a specific source zone:
      i. Under the **Source Zone** list box, select **Add;** a new entry appears in the list box.
      ii. For the new list item, select the source zone for this rule.
   b. If the rule applies to only specific source IP addresses:

i. Under the **Source Address** list box, select **Add;** a new list item appears.

ii. For the new list item, select the source address for this rule.

Figure 2-49 DMZ Access to MobileIron Security Rule Source Zone Configuration



6. Select the **Destination** tab.

7. On the **Destination** tab:

   a. If the security rule applies to a specific destination zone:

      i. Under the **Destination Zone** list box, select **Add;** a new destination list item appears.

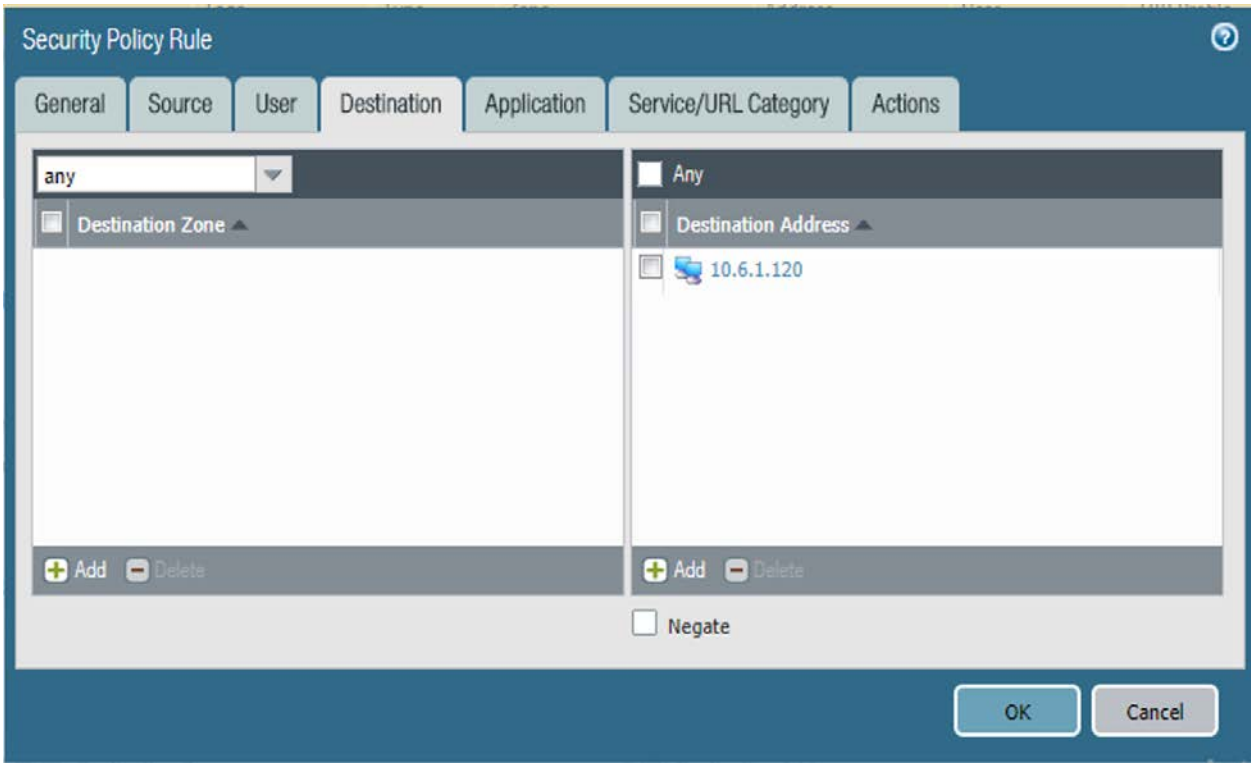
      ii. For the new **Source Zone** list item, select the destination zone for this rule.

   b. If the rule applies to only specific destination IP addresses:

      i. Under the **Destination Address** list box, select **Add;** a new list item appears.

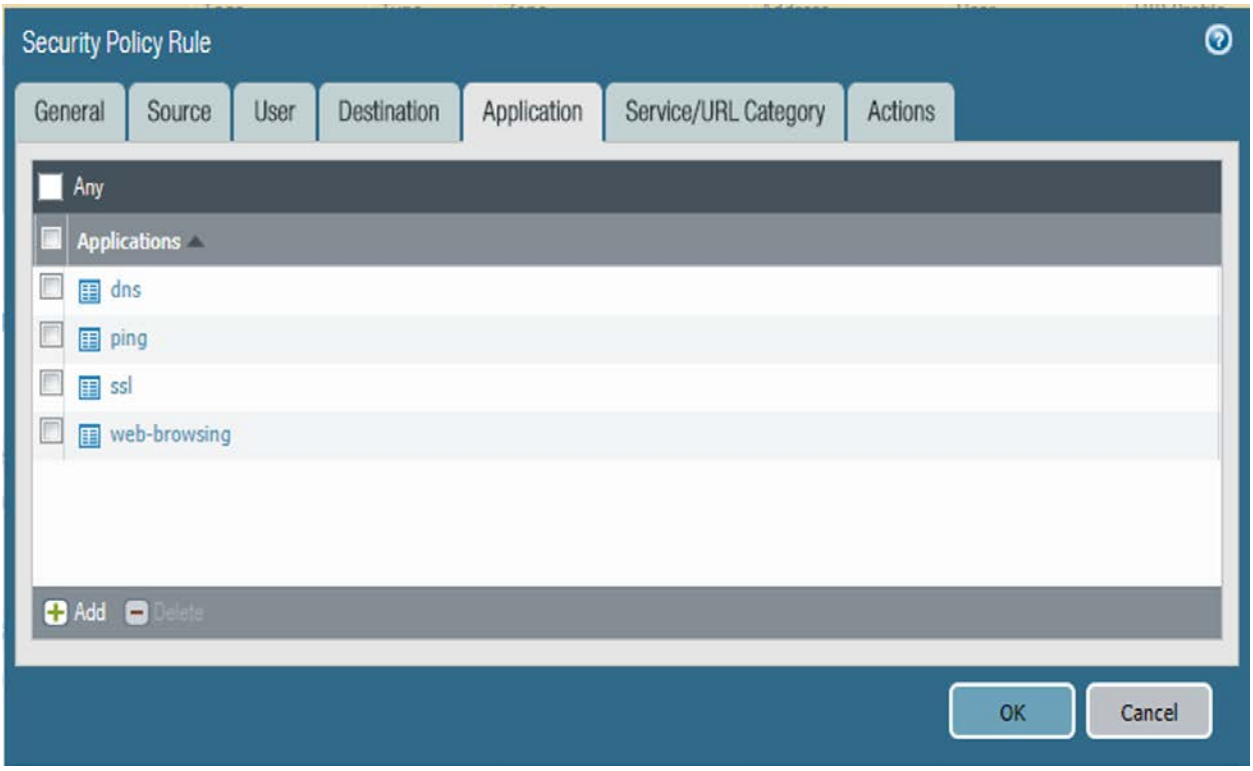
      ii. For the new list item, select the destination address for this rule.

Figure 2-50 DMZ Access to MobileIron Security Rule Destination Address Configuration



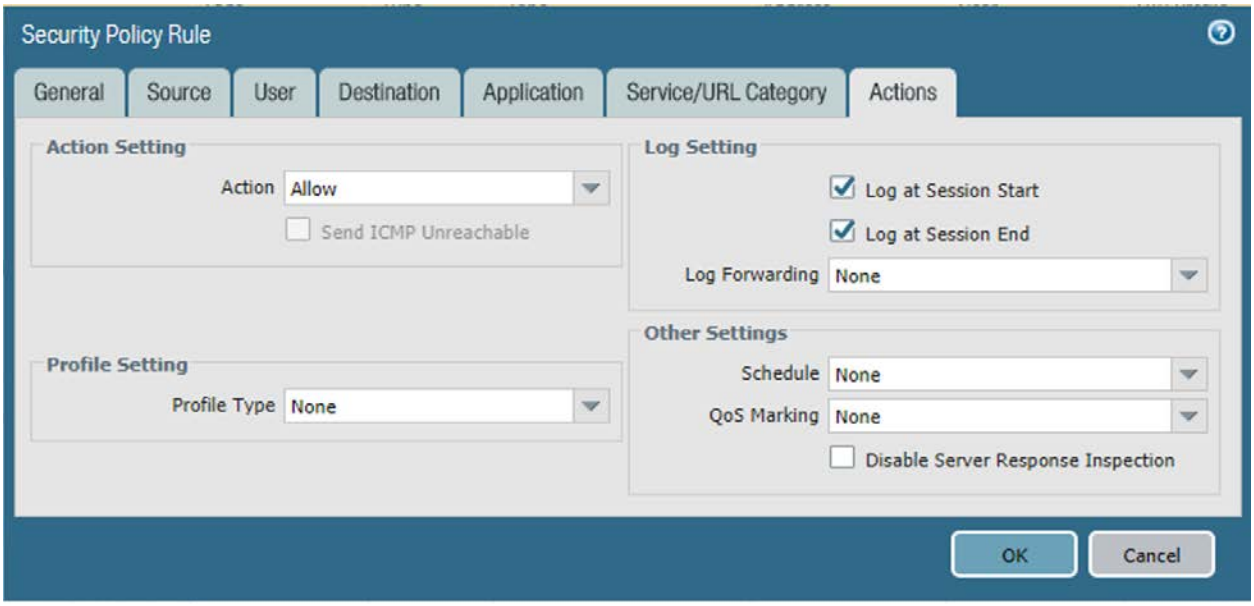
8. Select the **Application** tab.
9. On the **Application** tab:
   a. Under the **Applications** list box, select **Add;** a new list item appears.
   b. For the new **Applications** list item, select the application representing the protocol and port combination of the traffic to control.
   c. Repeat Steps 9a and 9b for each application involving the same source and destination that would also have its traffic allowed or explicitly blocked (if otherwise allowed by a more permissive security rule).

Figure 2-51 DMZ Access to MobileIron Security Rule Application Protocol Configuration



10. Select the **Actions** tab.
11. On the **Actions** tab: Unless explicitly blocking traffic permitted by a more permissive security rule, ensure that the **Action Setting > Action** drop-down menu is set to **Allow.**

Figure 2-52 DMZ Access to MobileIron Security Rule Action Configuration



12. Click **OK.**

2.5.6.2.2 Implemented Security Policies

The implemented security policies are provided in Table 2-1, Table 2-2, and Table 2-3. Configuration options that aren't shown were left as their default values.

Table 2-1 Implemented Security Policies

Name	Tags	Type	Source Zone	Source Address
DMZAccessVirtualIPCore	none	universal	Mobile_lab_WAN	any
CoretoAppleSrvs	none	universal	Mobile_Lab_DMZ	MI_Core
AdminAccessToMI	none	interzone	Mobile_Lab_GOVT	MDS.govt.admin
AppthorityConnectorAccessToMI-Core	none	interzone	Mobile_Lab_GOVT	govt.appthority
MICoreObtainDeviceCERT	none	interzone	Mobile_Lab_DMZ	MI_Core
MICoreAccessDNS	none	interzone	Mobile_Lab_DMZ	MI_Core
MICoreRelaySMSNotifications	none	interzone	Mobile_Lab_DMZ	MI_Core
MICoreSyncLDAP	none	interzone	Mobile_Lab_DMZ	MI_Core

Table 2-2 Implemented Security Policies

Name	Source User	Source Host Infor-mation Protocol Profile	Destination Zone	Destination Address
DMZAccessVirtualIPCore	any	any	any	10.6.1.120
CoretoAppleSrvs	any	any	any	17.0.0.0/8
AdminAccessToMI	any	any	Mobile_Lab_DMZ	MI_Core;MI_Sentry
AppthorityConnectorAccessToMI-Core	any	any	Mobile_Lab_DMZ	MI_Core
MICoreObtainDeviceCERT	any	any	Mobile_Lab_GOVT	SCEP_server
MICoreAccessDNS	any	any	Mobile_Lab_GOVT	DNS_Server
MICoreRelaySMSNotifications	any	any	Mobile_Lab_GOVT	SMTP_Relay
MICoreSyncLDAP	any	any	Mobile_Lab_GOVT	LDAP_Server

Table 2-3 Implemented Security Policies

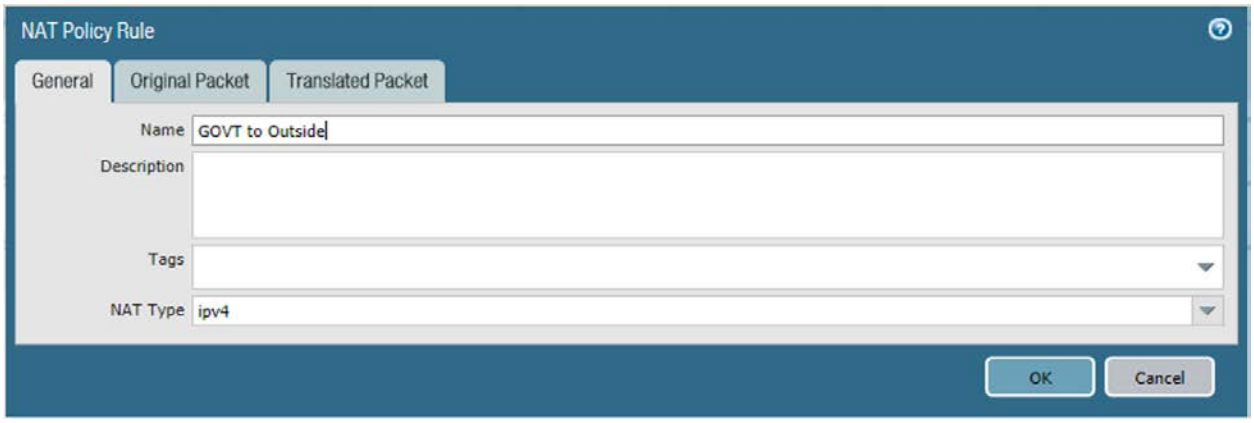
Name	Application	Service	Action	Profile	Options
DMZAccessVirtualIPCore	dns;ping;ssl;web-browsing	any	allow	none	none
CoretoAppleSrvs	any	any	allow	none	none
AdminAccessToMI	AdminAccessMI; ssh;ssl	any	allow	none	none
AppthorityConnectorAccessToMI-Core	AdminAccessMI; ssl;web-browsing	any	allow	none	none
MICoreObtainDeviceCERT	scep;web-browsing	application-default	allow	none	none
MICoreAccessDNS	dns	application-default	allow	none	none
MICoreRelaySMSNotifications	smtp	application-default	allow	none	none
MICoreSyncLDAP	ldap	application-default	allow	none	none

2.5.7 Network Address Translation

To allow communication with external networks over the internet, the appliance also needs to be configured with Network Address Translation (NAT) rules. To configure NAT:

1. In the **Palo Alto Networks Portal,** navigate to **Policies > NAT.**
2. Below the details pane, select **Add;** the **NAT Policy Rule** form opens.
3. In the **NAT Policy Rule** form, on the **General** tab:
   a. In the **Name** field, provide a unique name for this NAT policy rule.
   b. Ensure the **NAT Type** drop-down menu is set to **ipv4.**

Figure 2-53 Outbound NAT Rule



4. Select the **Original Packet** tab.
5. On the **Original Packet** tab:
   a. Under the **Source Zone** list box, select **Add;** a new Source Zone list item appears.
   b. For the new **Source Zone** list item, select the zone that represents your LAN subnet; in this sample implementation, that is **Mobile_Lab_GOVT.**
   c. Repeat Steps 5a and 5b to add the zone that represents your DMZ; in this sample implementation, that is **Mobile_Lab_DMZ.**
   d. Repeat Steps 5a and 5b to add the zone that represents your SSL VPN; in this sample implementation, that is **Mobile_Lab_SSLVPN.**
   e. For the **Destination Zone** drop-down menu, select the zone that represents the internet; in this sample implementation, that is **Mobile_lab_WAN.**

f. For the **Destination Interface,** select the adapter that is physically connected to the same subnet as your internet gateway; in this sample implementation, that is **ethernet1/1.**

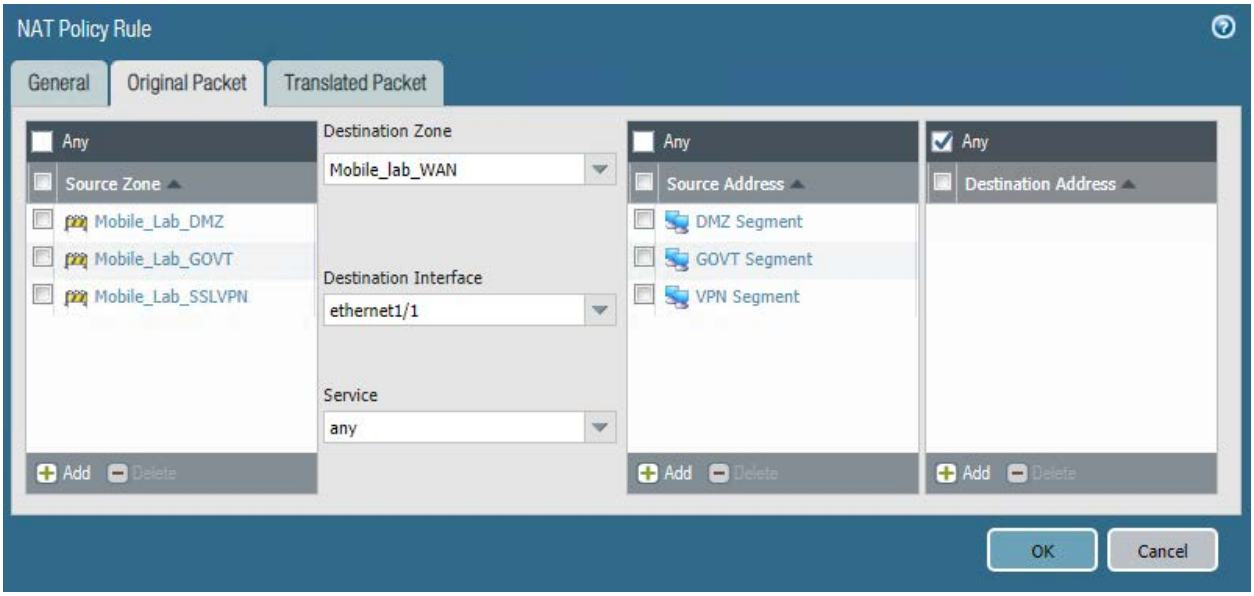
g. Under the **Source Address** list box, select **Add;** a new Source Address list item appears.

h. For the new **Source Address** list item, select the address that represents the subnet (IP address range) for the LAN.

i. Repeat Steps 5f and 5g to add the address representing the DMZ subnet.

j. Repeat Steps 5f and 5g to add the address representing the SSL VPN subnet.

Figure 2-54 Outbound NAT Original Packet Configuration



6. Select the **Translated Packet** tab.

7. On the **Translated Packet** tab, under **Source Address Translation:**

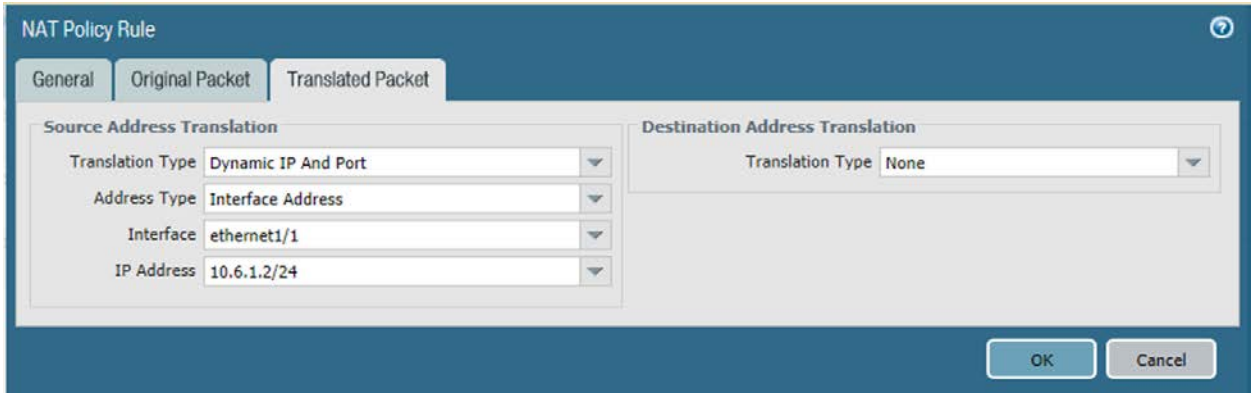
   a. For the **Translation Type** drop-down menu, select **Dynamic IP and Port.**

   b. For the **Address Type** drop-down menu, select **Interface Address.**

   c. For the **Interface** drop-down menu, select the same interface selected in **Step 5e.**

   d. For the **IP Address** drop-down menu, select the IPv4 address on the same subnet as your internet gateway.

Figure 2-55 Outbound NAT Translated Packet Configuration



8. Select **OK.**

2.5.8 Configure SSL VPN

The SSL VPN enables remote mobile device users to create an encrypted connection to the enterprise from unencrypted networks (e.g., public Wi-Fi hot spots).

2.5.8.1 Configure End-User Authentication

The following steps establish the integrations and configurations related to mobile user identification and authentication.

2.5.8.1.1 Configured Server Profile

The following steps integrate this appliance with Microsoft Active Directory Domain Services to manage mobile user permissions via AD groups and roles.

1. In the **Palo Alto Networks Portal,** navigate to **Devices > Server Profiles > LDAP.**
2. Below the details pane, select **Add;** the **LDAP Server Profile** form opens.
3. In the **LDAP Server Profile** form:
   a. In the **Profile Name** field, enter a unique name to identify this profile.
   b. Under the **Service List** box, select **Add;** a new **Server List** item appears.
   c. In the new **Service List** item:
      i. In the **Name** column, enter a name to identify the server.
      ii. In the **LDAP Server** column, enter the IP address of the LDAP server.

iii. The value in the **Port** column defaults to 389; change this if your LDAP server communicates over a different port number.

iv. Repeat Steps 3ci through 3ciii for each LDAP server that you intend to use.

d. Under **Server Settings**:

i. In the **Type** drop-down menu, select **active-directory.**

ii. In the **Base DN** drop-down menu, select the DN for your Active Directory domain users who will use the SSL VPN.

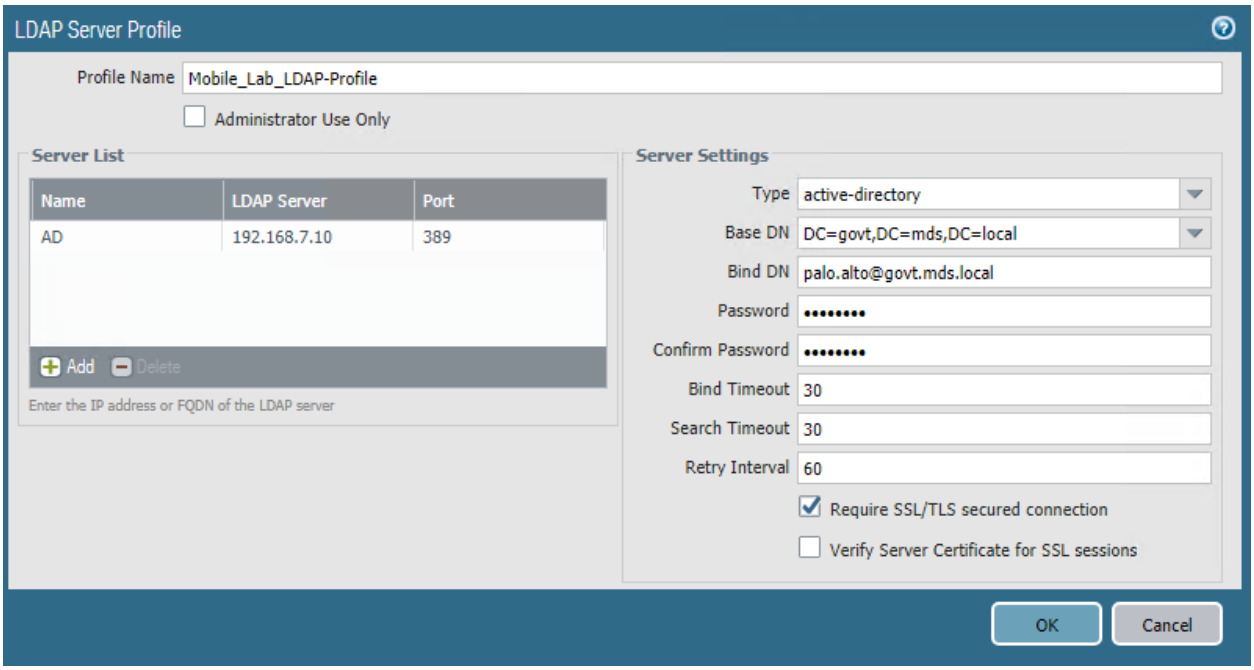
iii. In the **Bind DN** field, enter the Active Directory domain user account that will authenticate to LDAP to perform queries.

iv. In the **Password** field, enter the password for the Active Directory user account specified in the previous step.

v. In the **Confirm Password** field, reenter the password entered in the previous step.

4. Click **OK.**

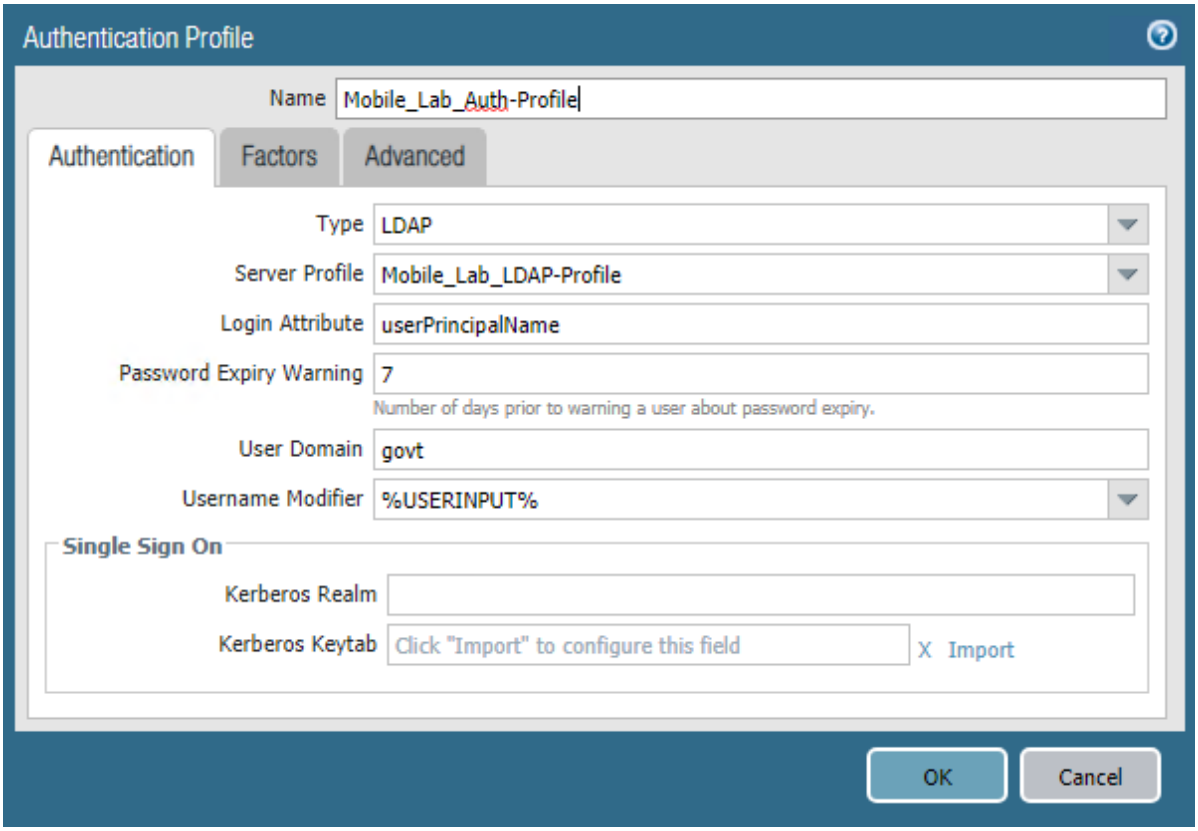
Figure 2-56 LDAP Profile



2.5.8.2 Configure Authentication Profile

1. In the **Palo Alto Networks Portal,** navigate to **Device > Authentication Profile.**
2. Under the details pane, select **Add;** the **Authentication Profile** form opens.
3. In the **Authentication Profile** form:
   a. In the **Name** field, provide a unique name to identify this authentication profile.
   b. On the **Authentication** tab:
      i. For the **Type** drop-down menu, select **LDAP.**
      ii. For the **Server Profile** drop-down menu, select the name of the LDAP Server Profile created in the previous section.
      iii. For the **Login Attribute** field, enter **userPrincipalName.**
      iv. For the **User Domain,** enter the name of your enterprise domain; our sample implementation uses **govt.**

Figure 2-57 Authentication Profile



c. Select the **Advanced** tab.

d. On the **Advanced** tab:

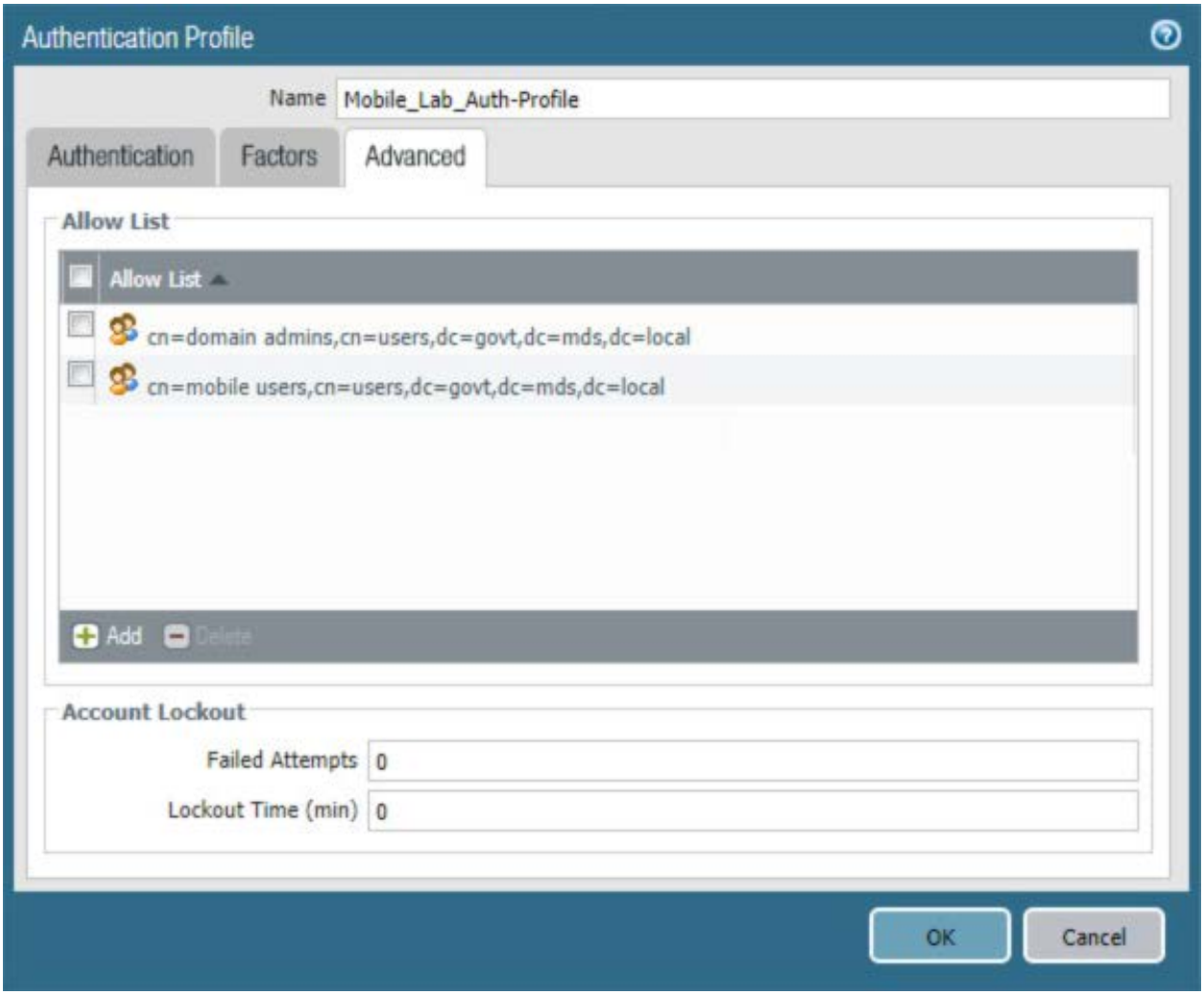
   i. Under the **Allow List** box, select **Add;** this creates a new list item.

   ii. In the new list item, select the Active Directory group for your mobile users.

   iii. Repeat Steps 3di and 3dii for any additional groups that should authenticate to the SSL VPN.

e. Click **OK.**

Figure 2-58 Advanced Authentication Profile Settings



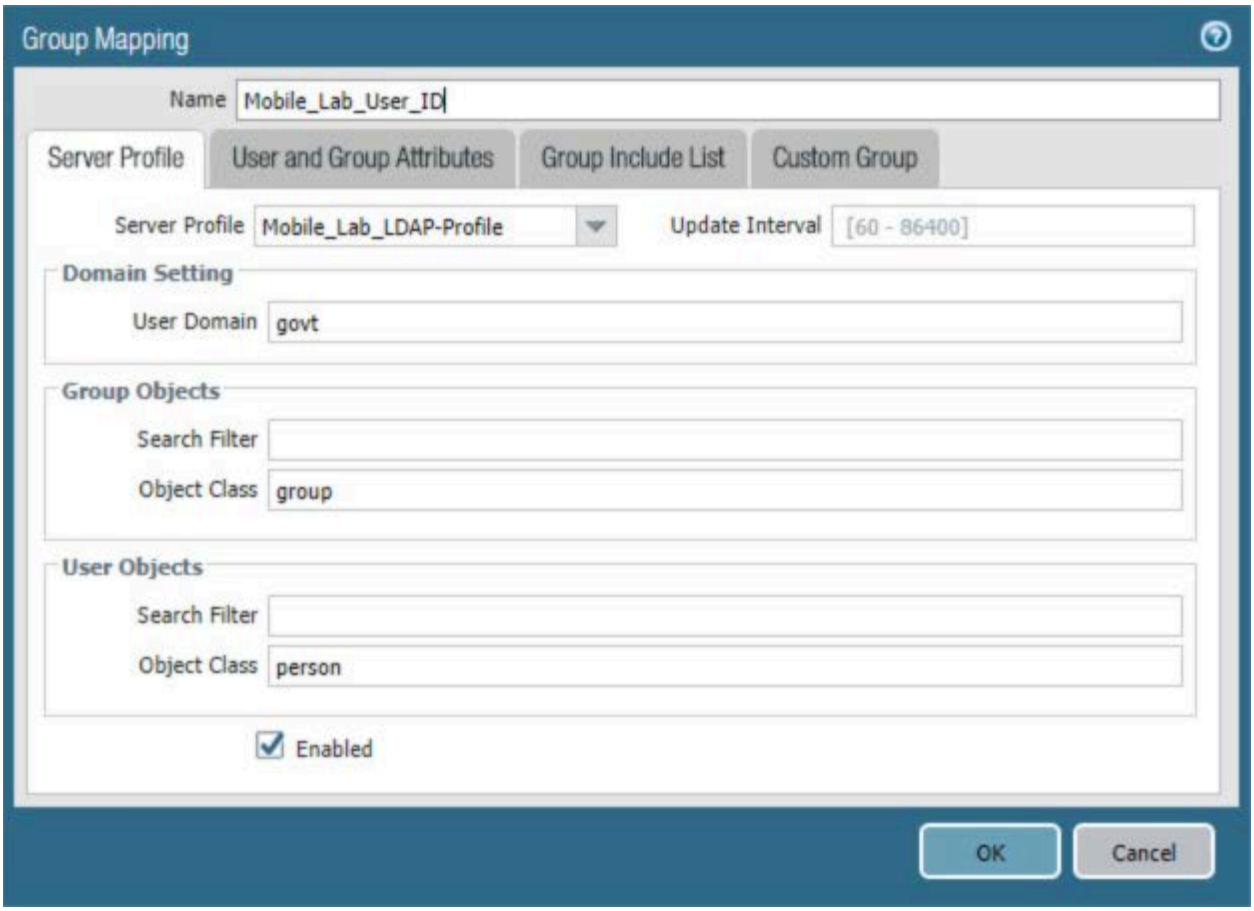
2.5.8.3 Configure User Identification

1. In the **Palo Alto Networks Portal,** navigate to **Device & User Identification.**
2. In the details pane, select the **Group Mapping Settings** tab.
3. Below the details pane, select **Add.** The **Group Mapping** form opens.
4. In the **Group Mapping** form:
   a. In the **Name** field, enter a unique name to identify this group mapping.
   b. In the **Server Profile** tab:

i. For the **Server Profile** drop-down menu, select the LDAP Server Profile created previously.

ii. For **Domain Setting > User Domain,** enter the name of your Active Directory domain; this sample implementation uses **govt.**

Figure 2-59 LDAP Group Mapping



c. Select the **Group Includes List** tab.

d. On the **Group Includes List** tab:

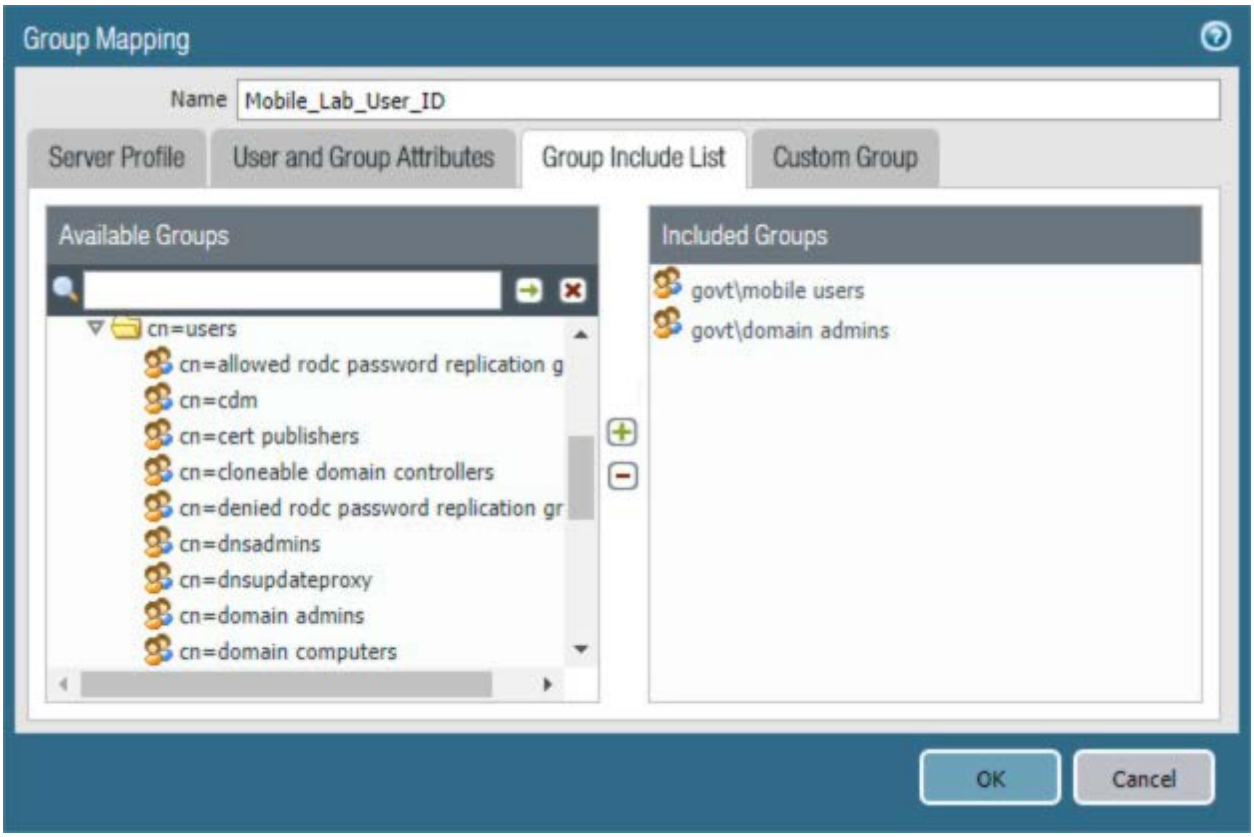
i. In the **Available Groups** list box, expand the Active Directory domain to reveal configured user groups.

ii. For each Active Directory group to be included in this User Identification configuration:

1) Select the **Active Directory** group.

2) Select the **plus icon** to transfer the group to the **Included Groups** list box.

Figure 2-60 LDAP Group Include List

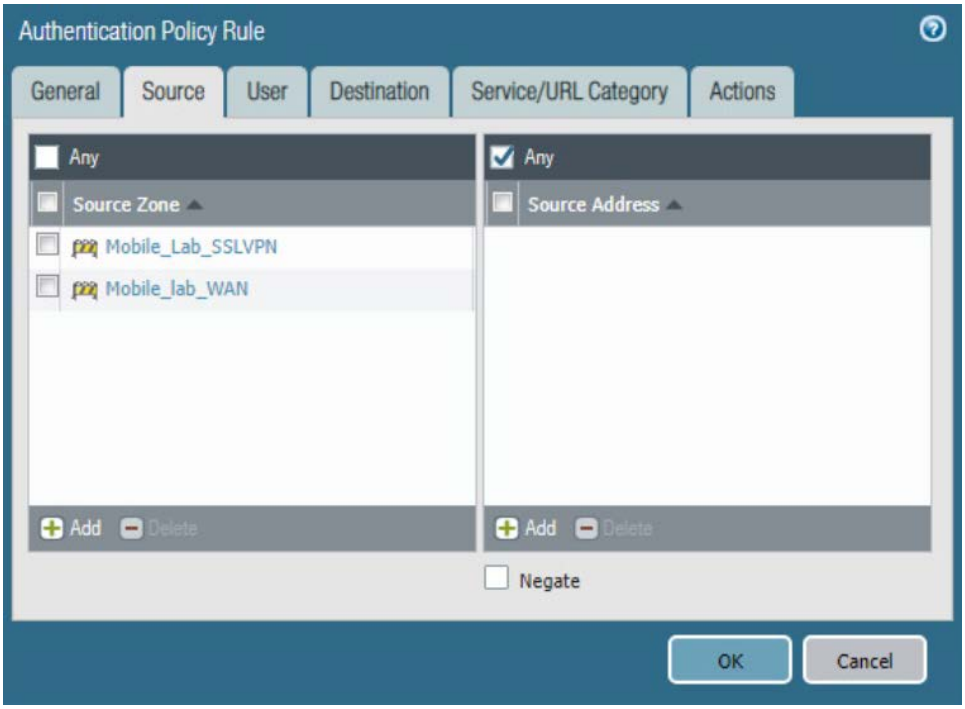


5. Select **OK.**

2.5.8.4 *Configure Authentication Policy Rule*

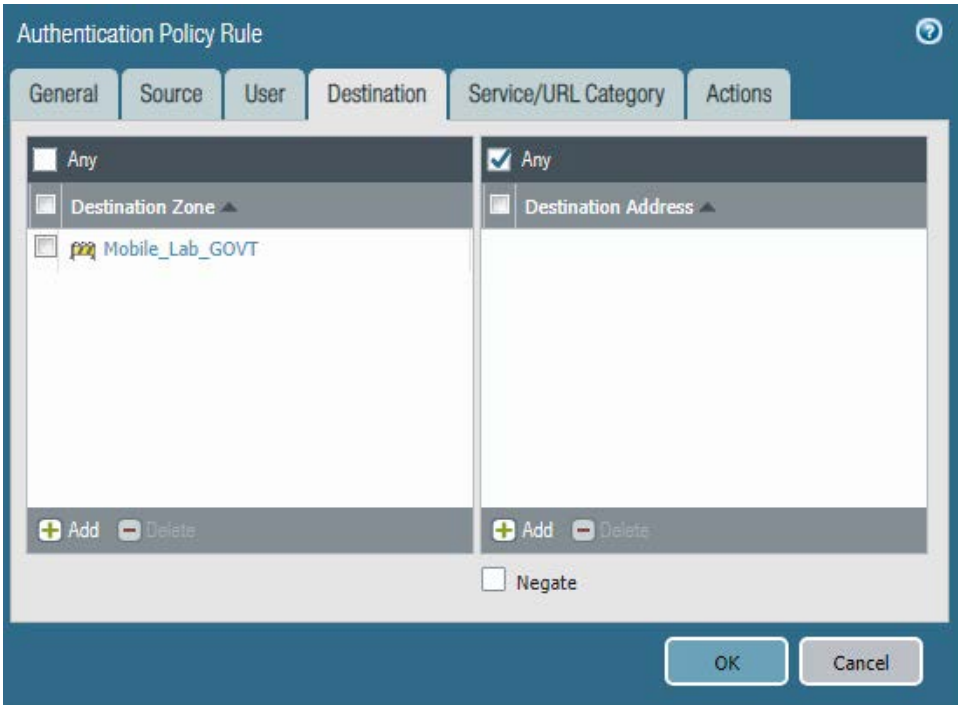
1. Navigate to **Policies** > **Authentication.**
2. Click **Add.**
3. Give the policy a name. In this implementation, **Mobile_Lab_Auth_Rule** was used.
4. Click **Source.**
5. Under Source Zone, click **Add.** Select the **SSL VPN** zone.
6. Under Source Zone, click **Add.** Select the **WAN** zone.

Figure 2-61 Authentication Policy Source Zones



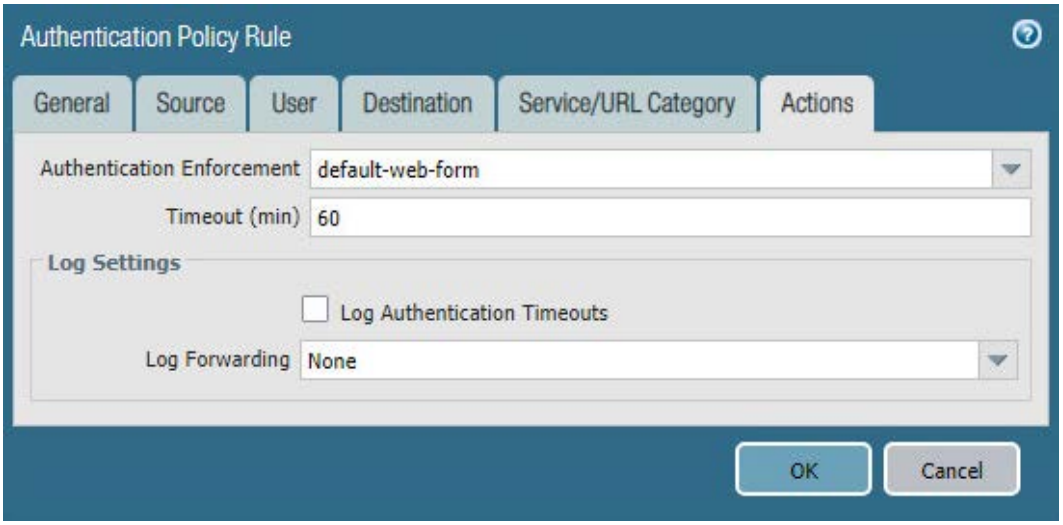
7. Click **Destination.**
8. Under Destination Zone, click **Add.**
9. Select the **LAN** zone (in this implementation, Mobile_Lab_GOVT).

Figure 2-62 Authentication Policy Destination Zones



10. Click **Service/URL Category.**
11. Under service, click **Add.**
12. Select **service-http.**
13. Under service, click **Add.**
14. Select **service-https.**
15. Click **Actions.**
16. Next to Authentication Enforcement, select **default-web-form.**
17. Leave Timeout and Log Settings as their default values.

Figure 2-63 Authentication Profile Actions



18. Click **OK** and commit the changes.

2.5.9 Import Certificates

Certificates need to be imported into the appliance to configure certificate profiles that will affect how they are used in supporting communication with other systems. In particular, device certificates issued to mobile devices will be used to identify and authenticate mobile users.

Note: The certificate private keys must be password-protected to import them into the firewall.

1. In the **Palo Alto Networks Portal,** navigate to **Device > Certificate Management > Certificates.**
2. Under the details pane, select **Import;** the **Import Certificate** form opens.
3. In the **Import Certificate** form:
   a. For the **Certificate Type,** select **Local.**
   b. For the **Certificate Name** field, enter a unique name to identify this certificate.
   c. Next to the **Certificate File** field, Select **Browse...** to specify the full path to the file containing the certificate.
   d. For the **File Format** drop-down menu, select the certificate encoding appropriate to the certificate file; this example assumes the certificate and private key are in separate files, and select **PEM.** Note: The certificate's private key must be password-protected to import it into Palo Alto Networks appliances.

e. If the certificate identifies the Palo Alto Networks appliance:

i. Enable the **Import private key** checkbox.

ii. Next to **Key File,** select **Browse...** to specify the full path to the file containing the private key for the uploaded certificate.

iii. For the **Passphrase** field, enter the pass phrase protecting the private key.

iv. For the **Confirm Passphrase** field, re-enter the pass phrase protecting the private key.

Figure 2-64 Import MobileIron Certificate

f. Select **OK.**

4. Repeat Step 3 for each certificate to import into the Palo Alto Networks appliance. This will include all certificates that the appliance will use to identify itself or authenticate to remote systems, all certificates in the chain of trust for each such certificate, and any chain-of-trust certificates supporting identity verification for remote systems to which this appliance will

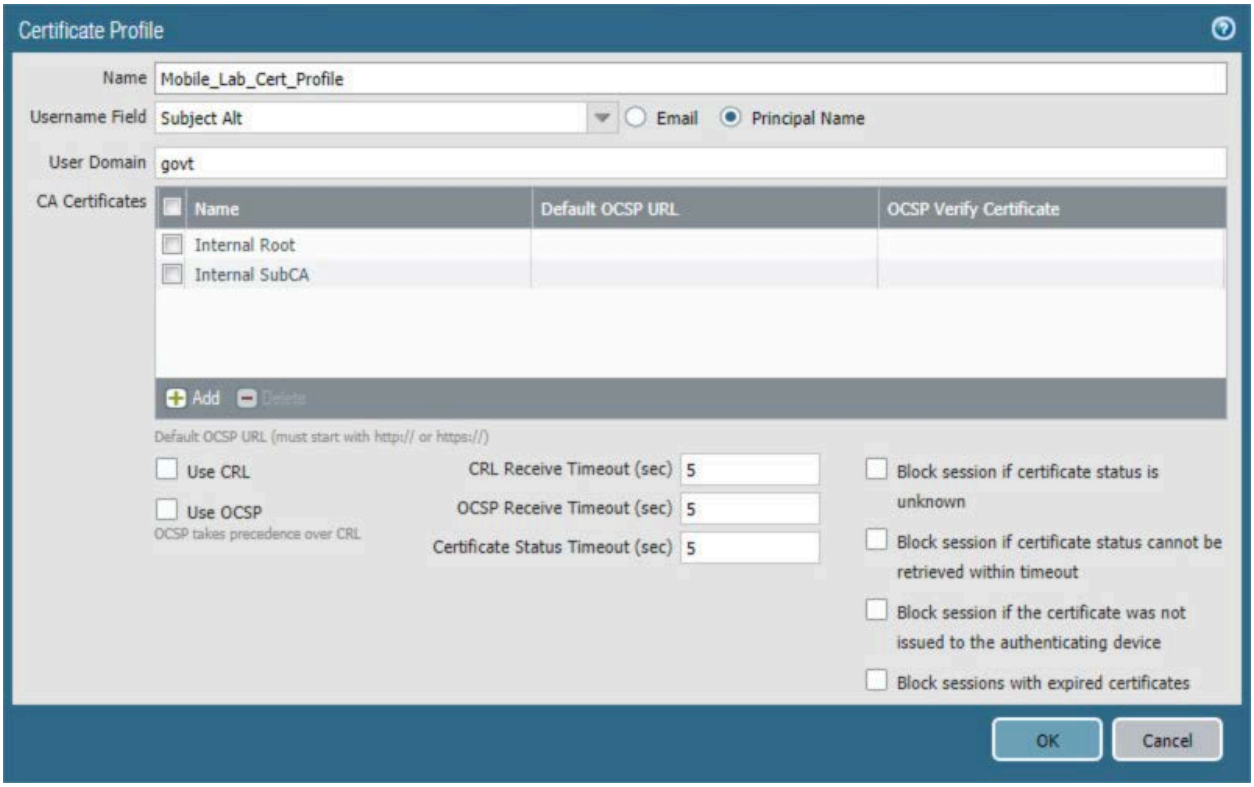
require certificate-based identification and authentication. This sample implementation uses certificates for the following systems:

- server certificate for this appliance issued by DigiCert
- DigiCert root CA certificate
- DigiCert subordinate CA certificate
- Microsoft CA enterprise root certificate
- Microsoft CA enterprise subordinate CA certificate

2.5.10 Configure Certificate Profile

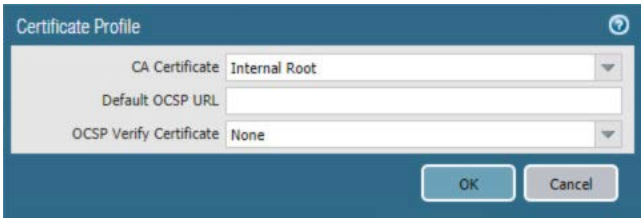
1. In the **Palo Alto Networks Portal,** navigate to **Device > Certificate Management > Certificate Profile.**
2. Under the details pane, select **Add;** the **Certificate Profile** form opens.
3. In the **Certificate Profile** form:
   a. In the **Name** field, enter a unique name to identify this certificate profile.
   b. In the **Username Field** drop-down menu, select **Subject Alt.**
   c. Select the **Principal Name** option.
   d. In the **User Domain** field, enter the Active Directory domain name for your enterprise; this sample implementation uses **govt.**
   e. Under the **CA Certificate** list box, select **Add;** a secondary Certificate Profile form appears.
   f. In the secondary **Certificate Profile** form, in the **CA Certificate** drop-down menu, select the Microsoft Active Directory Certificate Services root certificate uploaded in **Section 2.5.9.**
   g. Click **OK.**
   h. Repeat Step 3f for each intermediary certificate in the trust chain between the root certificate and the subordinate CA certificate that issues certificates to mobile devices.

Figure 2-65 Certificate Profile



i. Click **OK.**

Figure 2-66 Internal Root Certificate Profile



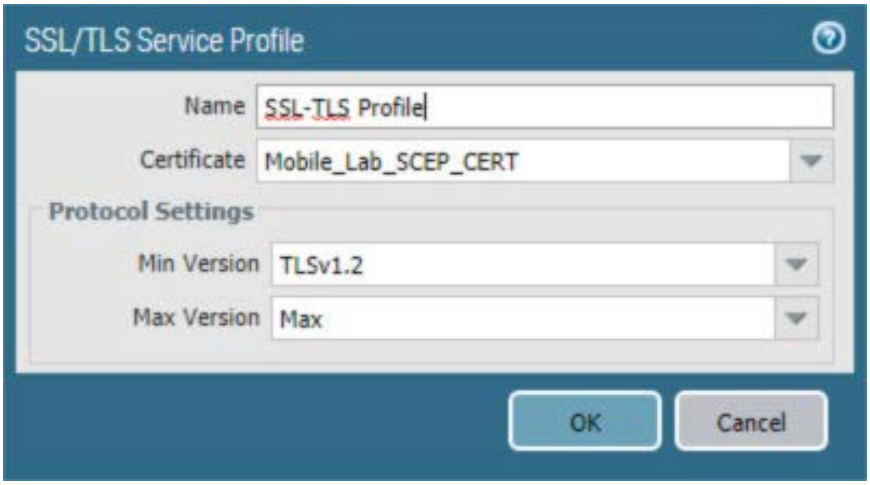
4. Click **OK.**

2.5.11 Configure SSL/TLS Service Profile

The following steps will configure the SSL/TLS profile, which determines what certificates to trust when mobile devices are connecting to the VPN and what certificate to use when establishing outbound SSL/TLS connections.

1. In the **Palo Alto Networks Portal,** navigate to **Device > Certificate Management > SSL/TLS Service Profile.**
2. Below the details pane, select **Add;** the **SSL/TLS Service Profile** form opens.
3. In the **SSL/TLS Service Profile** form:
   a. In the **Name** field, enter a unique name to identify this service profile.
   b. For the **Certificate** drop-down menu, select the certificate to use for this SSL/TLS service profile; our sample implementation uses a client certificate obtained from a Microsoft enterprise CA via SCEP.
   c. For the **Min Version** drop-down menu, select **TLSv1.2.** For **Max Version**, select **Max**.
   d. Select **OK.**

Figure 2-67 SSL/TLS Service Profile

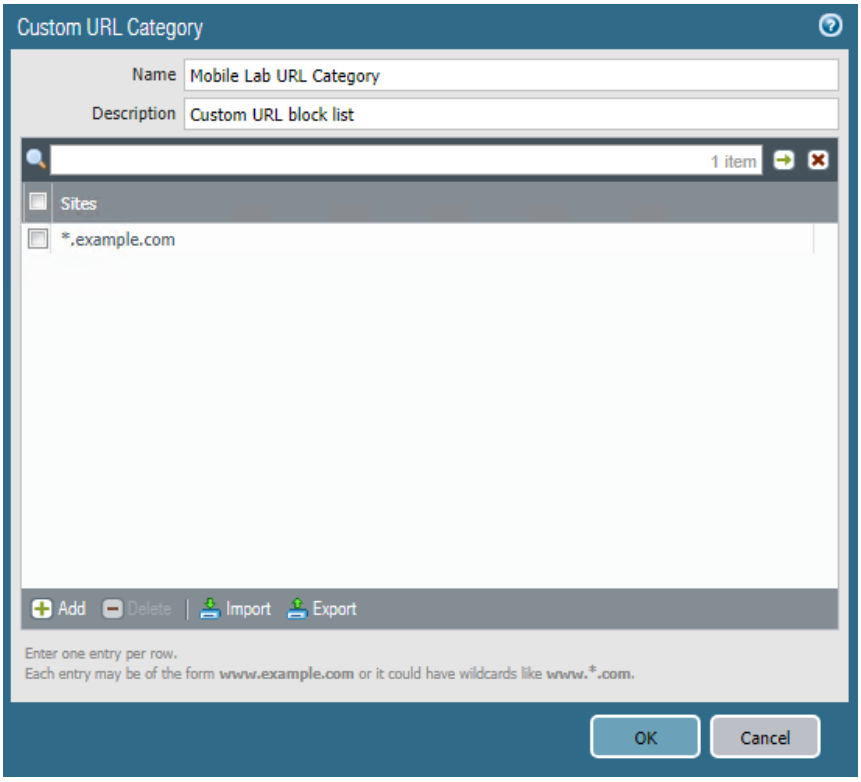


4. Repeat Step 3 to add an identical SSL/TLS service profile for this appliance's server certificate issued through DigiCert.

2.5.12 URL Filtering Configuration

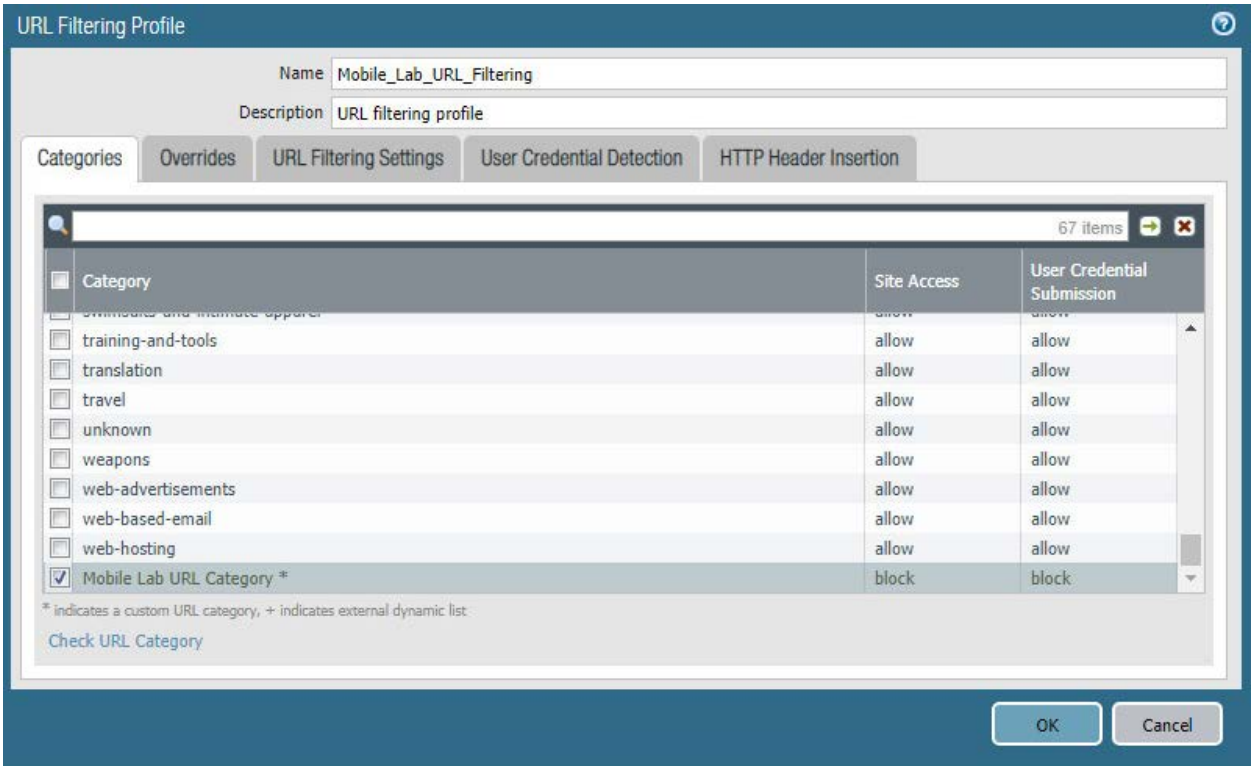
1. Navigate to **Objects > Custom Objects > URL Category.**
2. Click **Add.**
3. Give the category a name and description.
4. Add sites to be blocked. For this example, ***.example.com** was used.

Figure 2-68 Custom URL Category



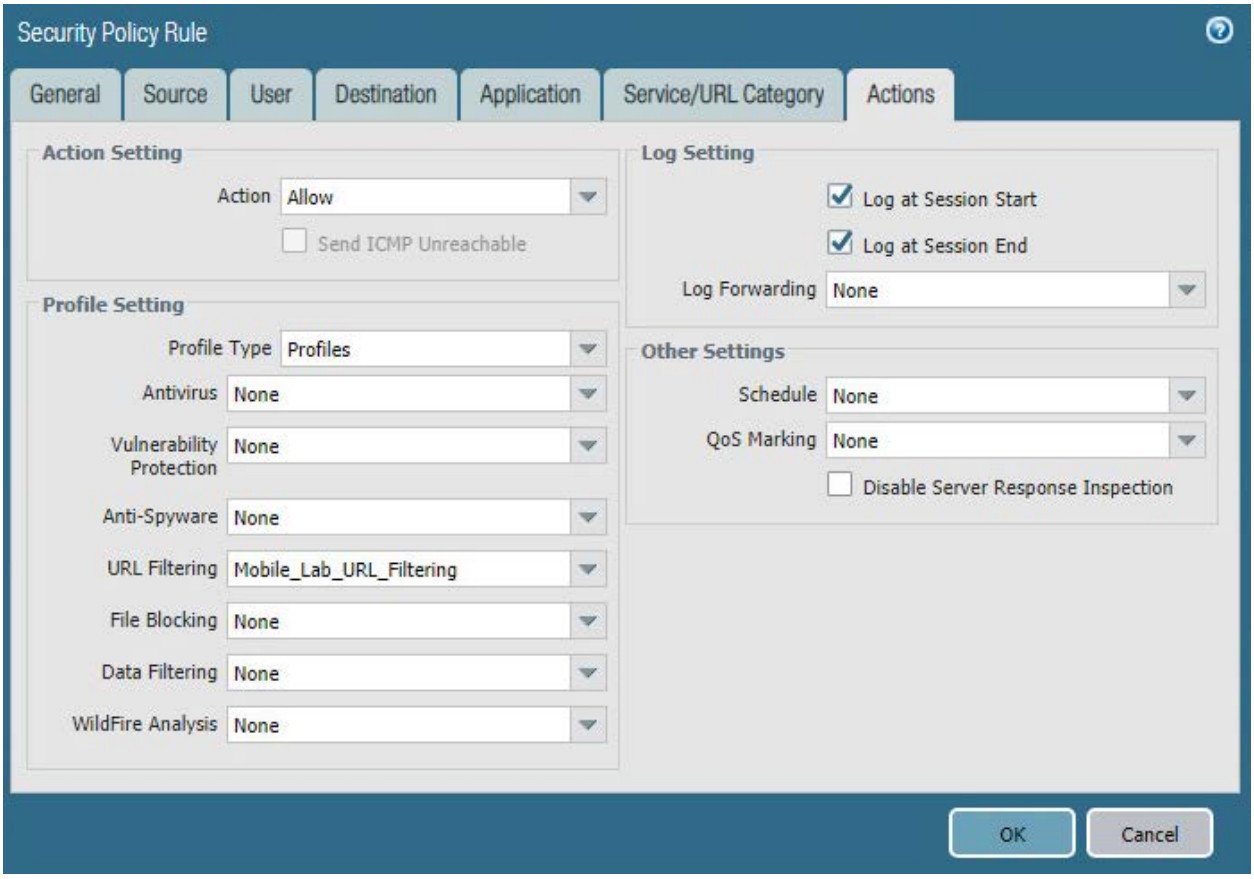
5. Click **OK.**
6. Navigate to **Objects > Security Profiles > URL Filtering.**
7. Check the box next to default and click **Clone.**
8. Select **default** from the window that appears.
9. Click **OK.**
10. Click the newly created profile, **default-1.**
11. Give the newly created profile called **default-1** a meaningful name and provide a description for the new profile.
12. Scroll to the bottom of the list. The name of the created category will be last on the list.
13. Click the option below **Site Access** and next to your created URL category.
14. Set the Site Access option to **block.**

Figure 2-69 URL Filtering Profile



15. Click **OK.**
16. Navigate to **Policies > Security.**
17. Click the default outbound policy for the internal network (not VPN).
18. Click **Actions.**
19. Next to Profile Type, select **Profiles.**
20. Next to URL Filtering, select the newly created profile.
21. Click **OK.**
22. Repeat Steps 18 through 21 for the SSL VPN outbound traffic.

Figure 2-70 URL Filtering Security Policy



23. Click **Commit** in the upper right-hand corner.
24. In the popup window, click **Commit**.

2.5.13 GlobalProtect Gateway and Portal Configuration

The SSL VPN configuration requires creation of both a GlobalProtect gateway and a GlobalProtect portal, the latter of which could be used to manage VPN connections across multiple gateways. In this sample implementation, only a single gateway and portal are configured.

2.5.13.1 Configure GlobalProtect Gateway

The GlobalProtect gateway provides remote users with secure access to internal resources based on their Microsoft AD group. To configure the GlobalProtect gateway:

1. In the **Palo Alto Networks Portal,** navigate to **Network > GlobalProtect > Gateways.**
2. Below the details pane, select **Add;** the **GlobalProtect Gateway Configuration** form opens.

3. In the **GlobalProtect Gateway Configuration** form, on the **General** tab:

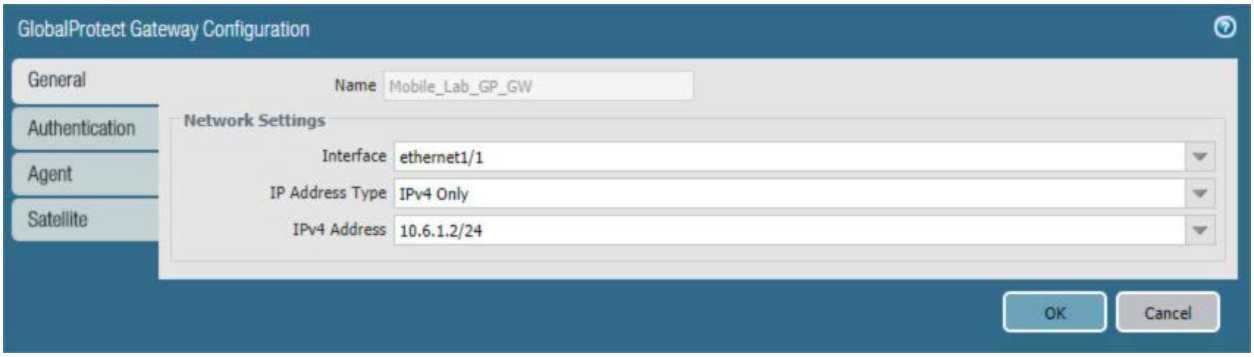
    a. In the **Name** field, enter a unique name to identify this GlobalProtect Gateway.

    b. Under **Network Settings**:

        i. In the **Interface** drop-down menu, select the physical interface connected to the subnet on which the internet gateway device is located.

        ii. In the **IPv4 Address** drop-down menu, select the IP address associated with the physical interface specified in the previous step.

Figure 2-71 General GlobalProtect Gateway Configuration



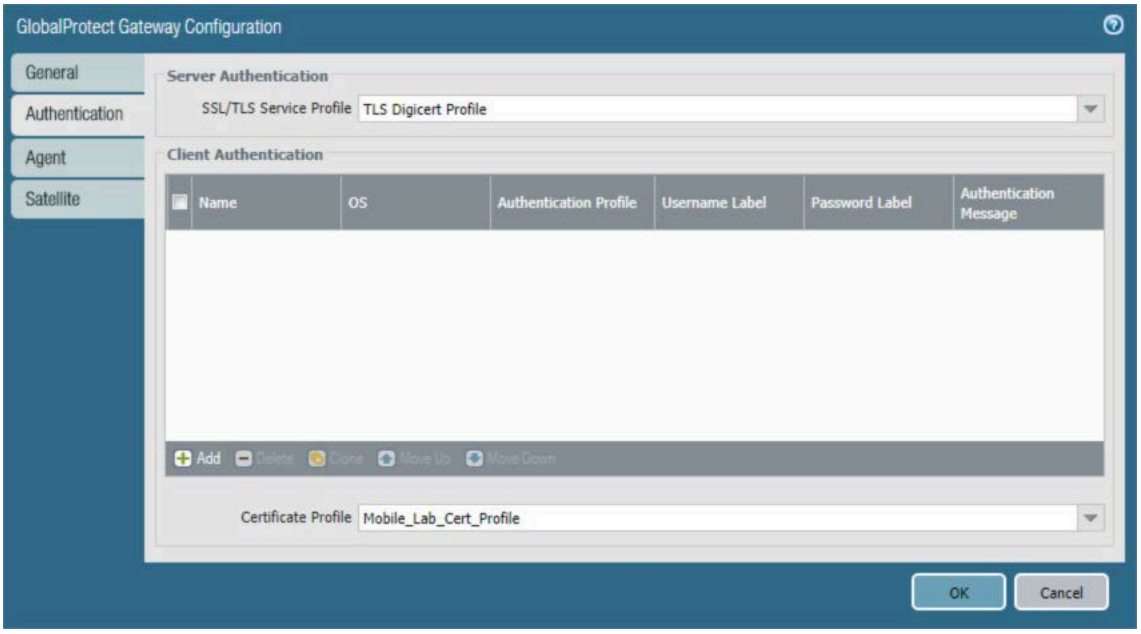
    c. Select the **Authentication** tab.

    d. In the **Authentication** tab:

        i. For the **Server Authentication > SSL/TLS Service Profile** drop-down menu, select the TLS/SSL profile associated with the publicly trusted server certificate for this appliance.

        ii. For the **Client Authentication > Certificate Profile** drop-down menu, select the client TLS/SSL profile associated with the internally trusted client certificates issued to mobile devices.

Figure 2-72 GlobalProtect Authentication Configuration



e. Select the **Agent** tab.

f. On the **Agent > Tunnel Settings** tab:

   i. Select the **Tunnel Mode** checkbox.

   ii. Select the **Enable IPSec** checkbox to disable IPSec.

Figure 2-73 GlobalProtect Tunnel Configuration

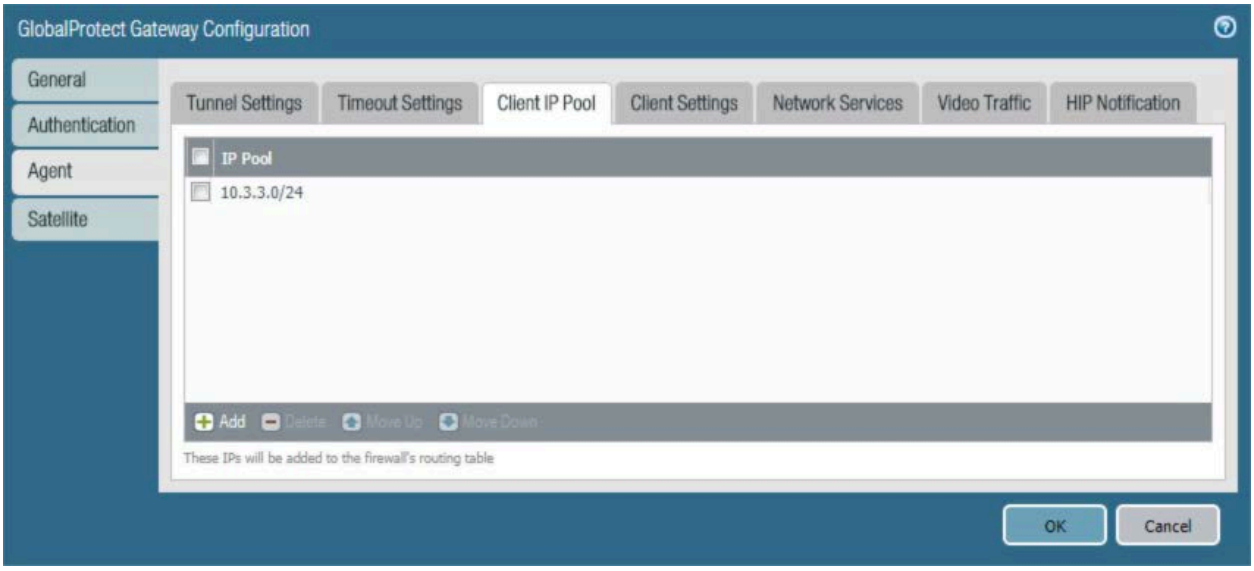
g. Select the **Agent > Client IP Pool** tab.

h. On the **Agent > Client IP Pool** tab:

   i. Below the **IP Pool** list box, select **Add;** a new list item will appear.

   ii. For the new **IP Pool** list item, enter the network address for the IP address pool from which connected devices will be allocated an IP address.

Figure 2-74 VPN Client IP Pool

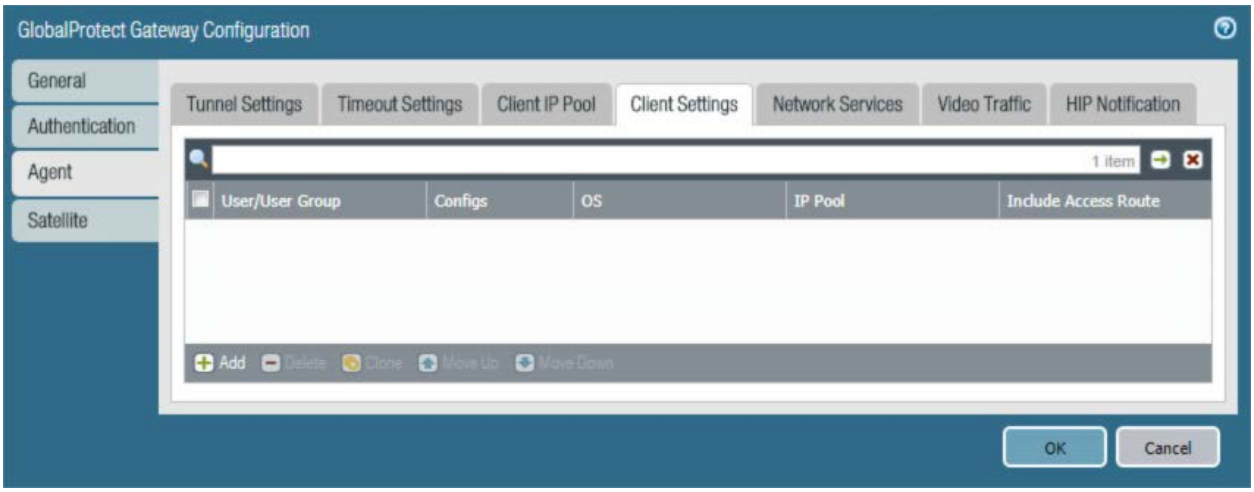


i. Select the **Agent > Client Settings** tab.

j. On the **Agent > Client Settings** tab:

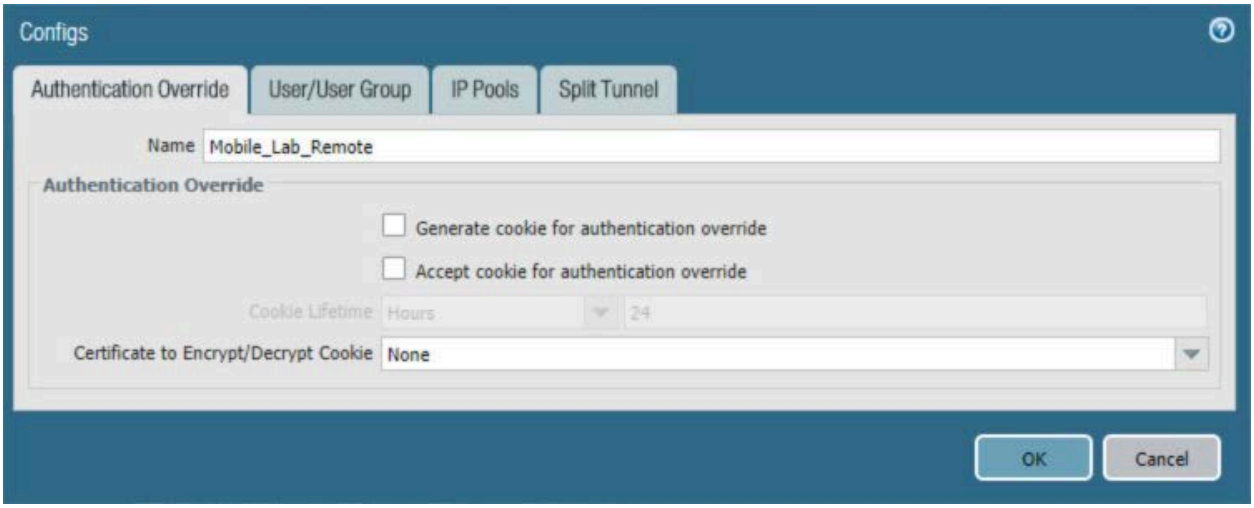
   i. Under the **Client Settings** list box, select **Add;** the **Configs** form opens.

Figure 2-75 VPN Client Settings



   ii. In the **Configs** form on the **Authorization Override** tab, enter a unique name to identify this client configuration.

Figure 2-76 VPN Authentication Override Configuration



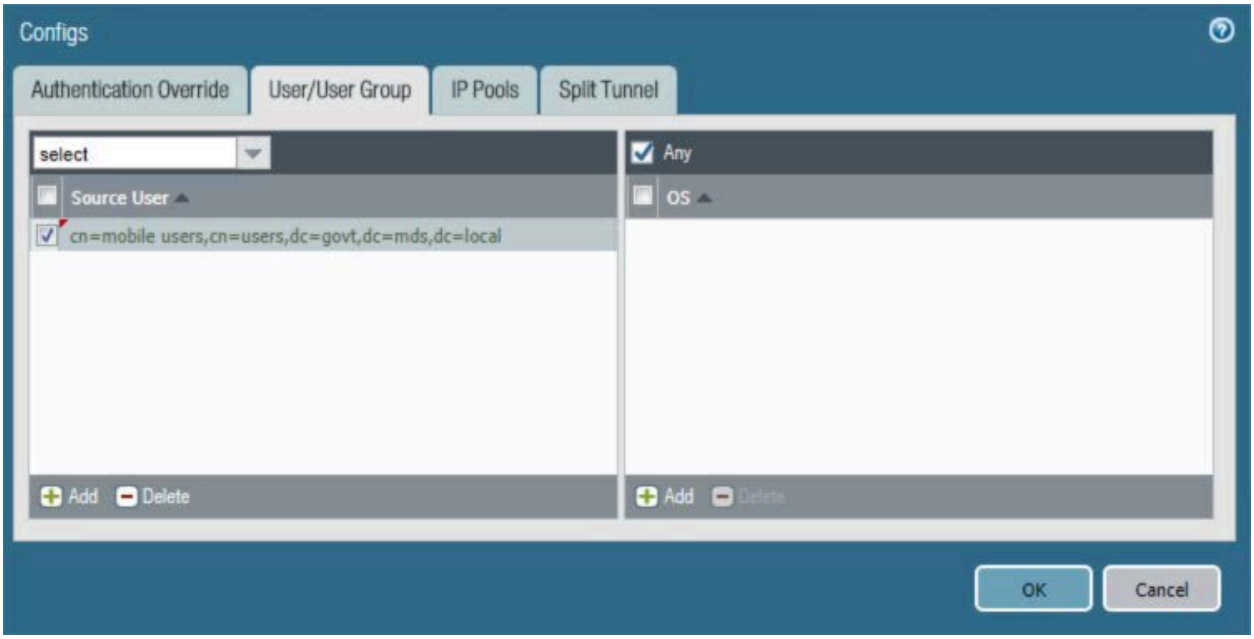
iii. Select the **User/User Group** tab.

iv. On the **User/User Group** tab:

1) Below the **Source User** list box, select **Add;** a new list item appears.

2) In the **Source User** list item, select the Microsoft AD user group to grant access to internal resources through this GlobalProtect gateway.

Figure 2-77 VPN User Group Configuration



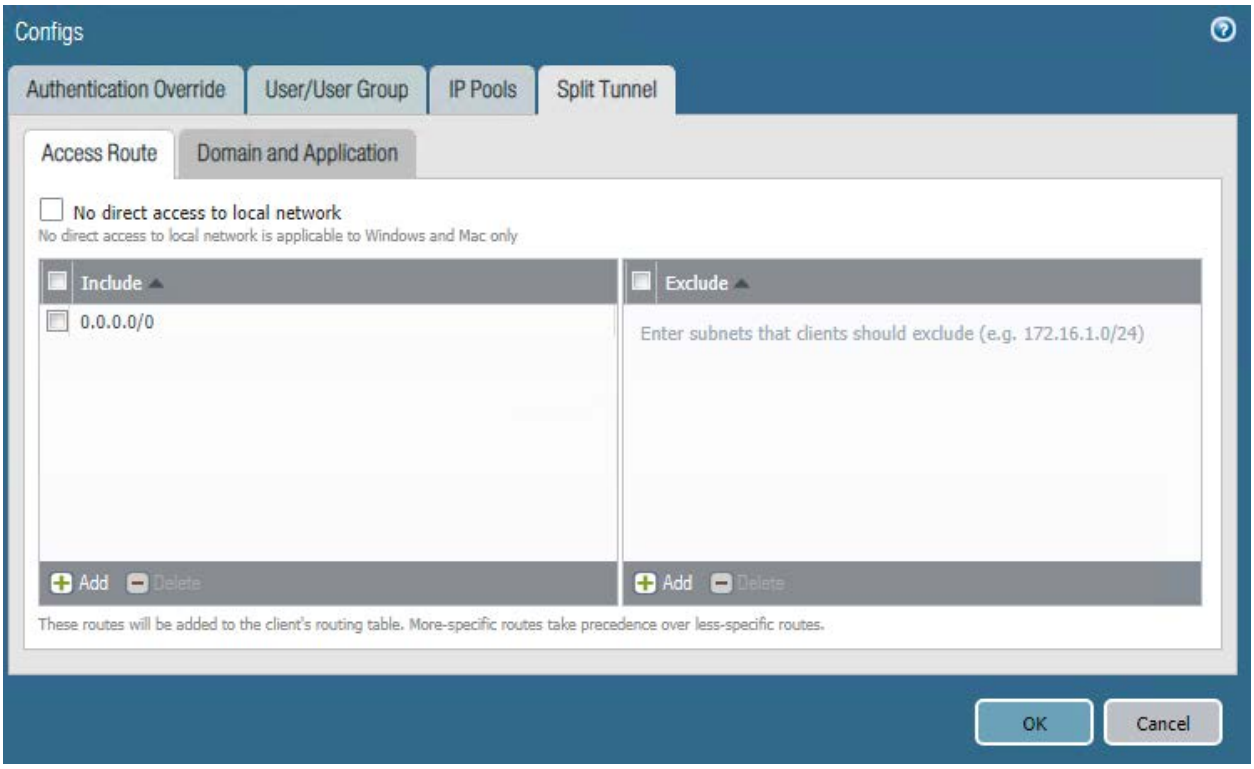
v. Select the **Split Tunnel** tab.

vi. On the **Split Tunnel** tab, on the **Access Route** tab:

1) Under the **Include** list box, select **Add;** a new list item appears.

2) In the new **Include** list item, enter **0.0.0.0/0.** This enforces full tunneling.

Figure 2-78 VPN Split Tunnel Configuration



vii. Click **OK.**

k. Click **OK.**

2.5.13.2 Configure GlobalProtect Portal

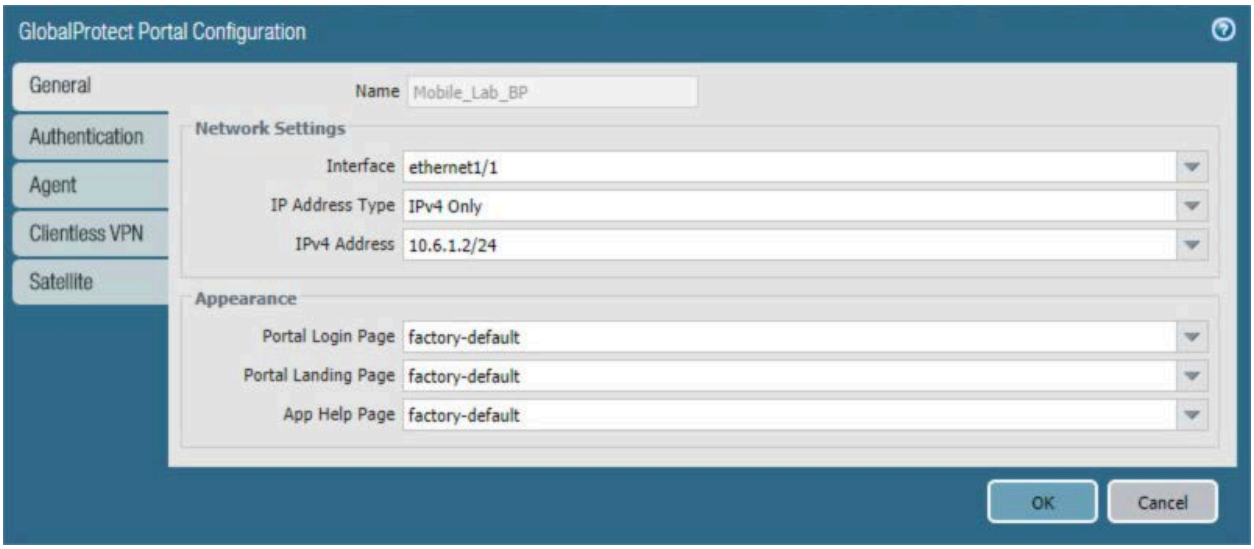
1. In the **Palo Alto Networks Portal**, navigate to **Network > GlobalProtect > Portal.**
2. Below the details pane, select **Add;** the **GlobalProtect Portal Configuration** form opens.
3. In the **GlobalProtect Portal Configuration** form, on the **General** tab:

a. In the **Name** field, enter a unique name to identify this GlobalProtect portal.

b. In the **Interface** drop-down menu, select the physical interface connected to the subnet where the internet gateway device is located.

c. In the **IP Address Type** drop-down menu, select **IPv4 Only.**

Figure 2-79 GlobalProtect Portal Configuration



4. Select the **Authentication** tab.

5. In the **Authentication** tab:

   a. For the **Server Authentication > SSL/TLS Service Profile** drop-down menu, select the SSL/TLS service profile based on your third-party server certificate.

   b. For the **Certificate Profile** drop-down menu, select the client TLS/SSL profile associated with the internally trusted client certificates issued to mobile devices.

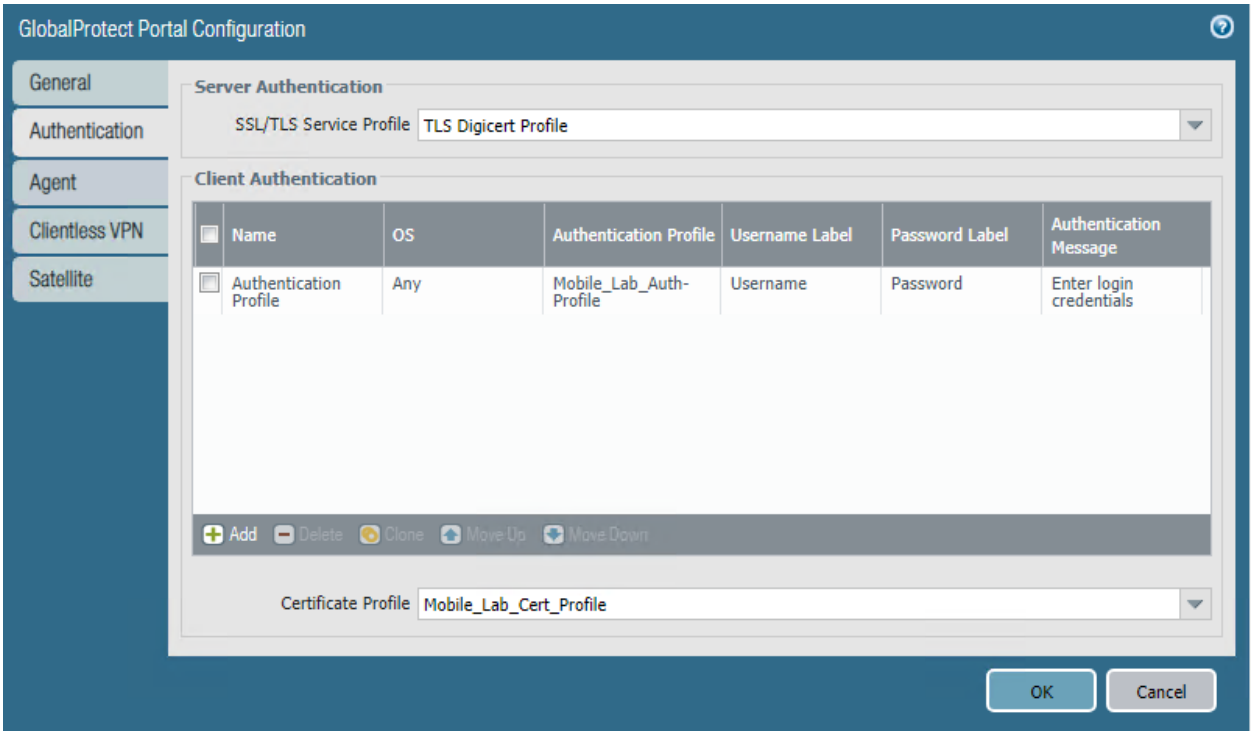
   c. Click **Add.**

   d. Enter a profile name. In this example implementation, Client Authentication was used.

   e. For the **Authentication Profile** drop-down menu, select the previously created authentication profile.

   f. Click **OK.**

Figure 2-80 GlobalProtect Portal SSL/TLS Configuration



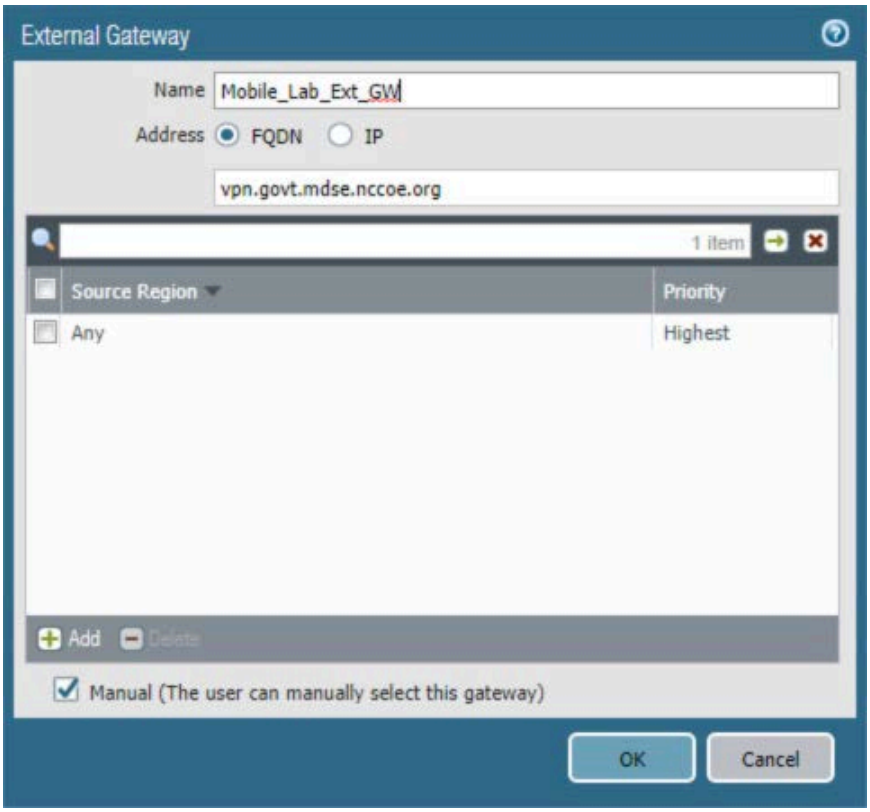
6. Select the **Agent** tab.
7. On the **Agent** tab:
    a. Below the **Agent** list box, select **Add;** the Configs form will open.
    b. In the **Configs** form:
        i. In the **Authentication** tab, below **Components that Require Dynamic Passwords,** check the box next to **Portal.**
        ii. In the **External** tab, under the **External Gateways** list box select **Add;** the **External Gateway** form opens.
        iii. In the **External Gateway** form:
            1) In the **Name** field, enter a unique name to identify this external gateway.
            2) For the **Address** option, enter the FQDN for this appliance; in this sample implementation, the FQDN is **vpn.govt.mdse.nccoe.org.**
            3) Below the **Source Region** list box, select **Add;** a new list item appears.

4) In the new **Source Region** list item, select **Any.**

5) Select the **Manual** checkbox.

6) Click **OK.**

Figure 2-81 GlobalProtect External Gateway Configuration



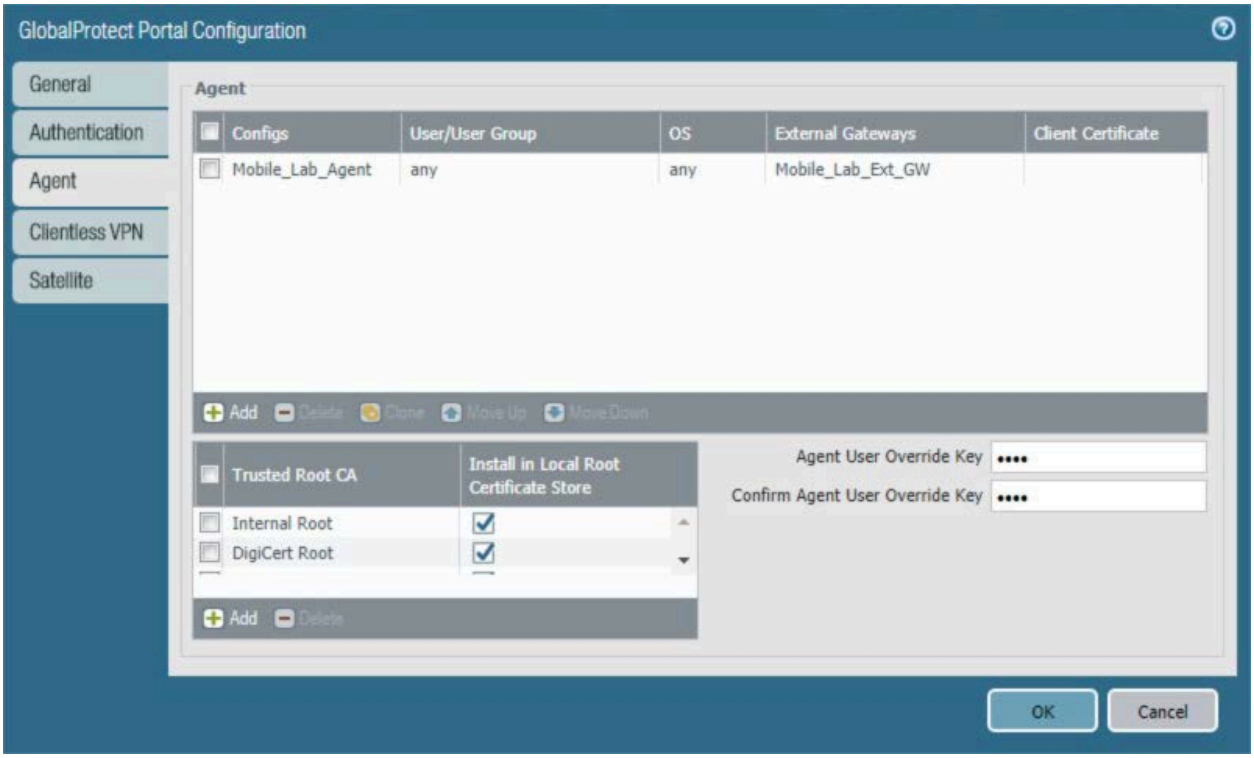
iv. Below the **Trusted Root CA** list box, select **Add;** a new list item appears.

v. In the new **Trusted Root CA** list item, select your internal CA root certificate.

vi. Repeat Steps 7biii and 7biv to add each certificate in your internal or third-party certificate trust chains used when mobile devices contact the GlobalProtect portal.

c. Click **App.** Ensure that Connect Method is set to **User-logon (Always On).**

Figure 2-82 GlobalProtect Portal Agent Configuration

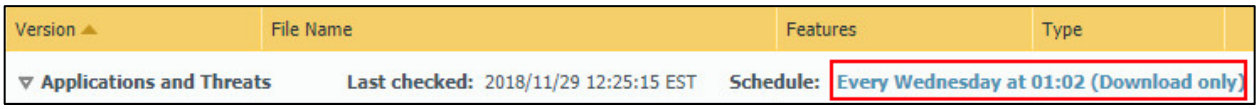


d. Click **OK.**

2.5.14 Configure Automatic Threat and Application Updates

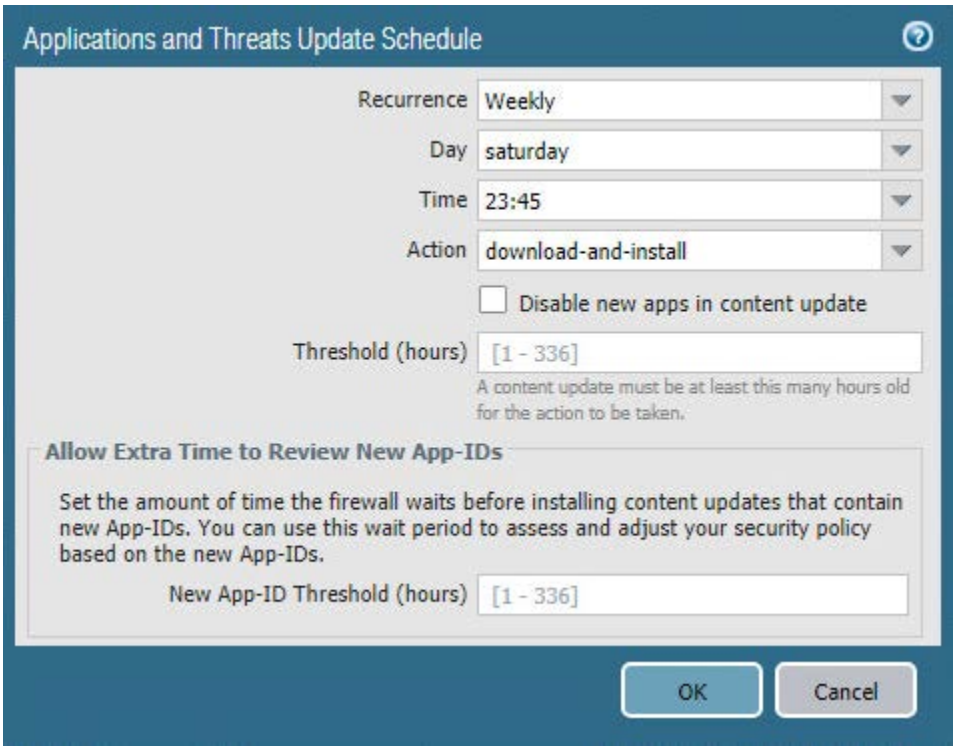
1. In the **PAN-OS portal,** navigate to **Device > Dynamic Updates.**
2. Click **Check Now** at the bottom of the page.
3. Under Applications and Threats, click **Download** next to the last item in the list, with the latest Release Date. It will take a minute to download the updates.
4. When the download completes, click **Done.**
5. Click **Install** next to the downloaded update.
6. Click **Continue Installation.**
7. When installation completes, click **Close.**
8. Next to Schedule, click the link with the date and time.

Figure 2-83 Schedule Link



9. Select the desired recurrence. For this implementation, Weekly was used.
10. Select the desired day and time. For this implementation, Saturday at 23:45 was used.
11. Next to Action, select **download-and-install.**

Figure 2-84 Threat Update Schedule



12. Click **OK.**
13. Click **Commit** in the upper right-hand corner.
14. In the popup window, click **Commit**.

2.6 Integration of Kryptowire EMM+S with MobileIron

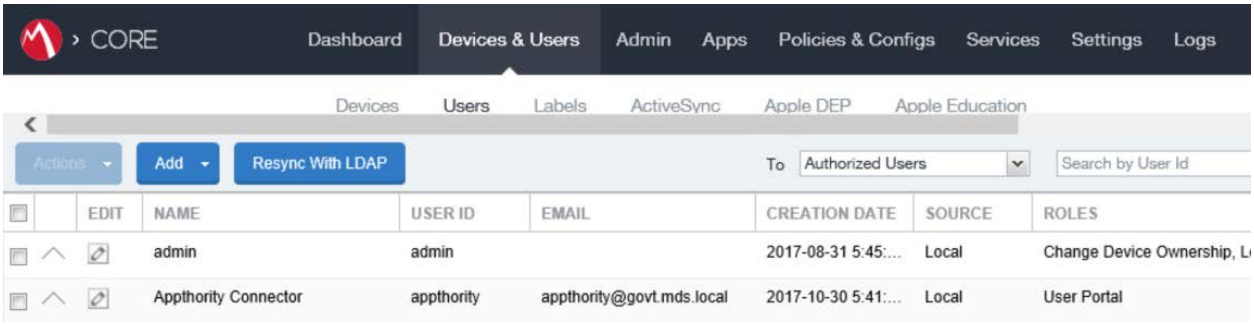
Kryptowire's application vetting service uses the MobileIron application programming interface (API) to regularly pull current device application inventory information from MobileIron Core. Updated analysis results are displayed in the Kryptowire portal.

2.6.1 Add MobileIron API Account for Kryptowire

The following steps will create an administrative account that will grant Kryptowire the specific permissions it requires within MobileIron.

1. In the **MobileIron Admin Portal,** navigate to **Devices & Users > Users.**
2. On the **Users** page:
   a. Select **Add > Add Local User;** the Add New User dialogue opens.

Figure 2-85 MobileIron Users

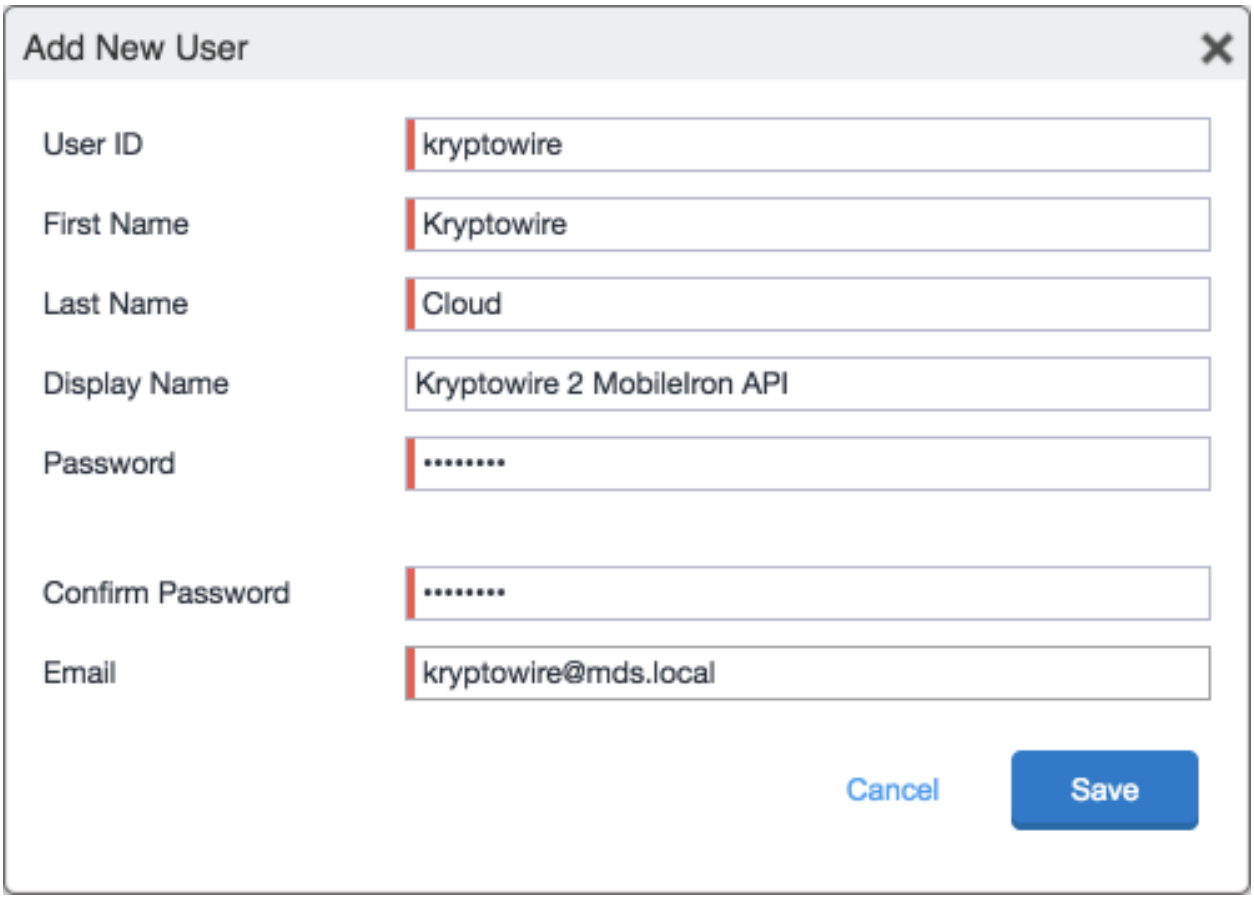


   b. In the **Add New User** dialogue:
      i. In the **User ID** field, enter the user identity that the Kryptowire cloud will authenticate under; our implementation uses a value of **kryptowire.**
      ii. In the **First Name** field, enter a generic first name for **Kryptowire**.
      iii. In the **Last Name** field, enter a generic last name for **Kryptowire**.
      iv. In the **Display Name** field, optionally enter a displayed name for this user account.
      v. In the **Password** field, provide the password that the **Kryptowire** identity will use to authenticate to MobileIron.
      vi. In the **Confirm Password** field, enter the same password as in the preceding step.

vii. In the **Email** field, provide an email account for the **Kryptowire** identity; this could be used in configuring automatic notifications and should be an account under the control of your organization.

viii. Click **Save.**

Figure 2-86 Kryptowire API User Configuration



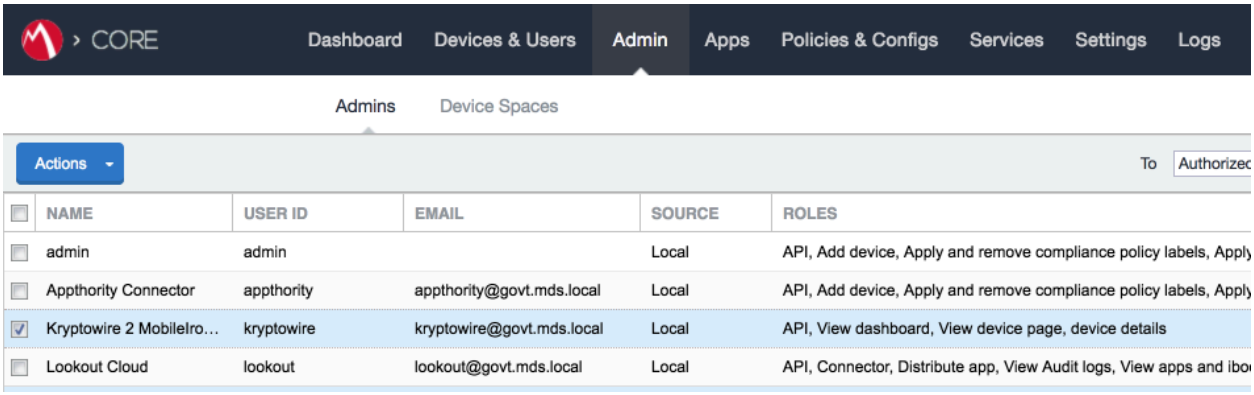
3. In the **MobileIron Admin Portal,** navigate to **Admin > Admins.**

4. On the **Admins** page:

   a. Enable the account you created for Kryptowire during Step 2.

   b. Select **Actions > Assign to Space;** this opens the Assign to Space dialogue for the Kryptowire account.

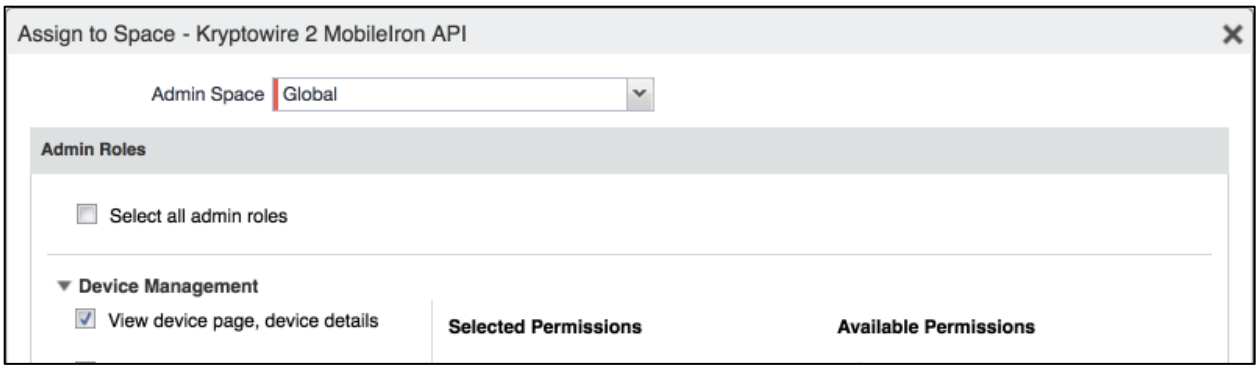
Figure 2-87 MobileIron User List



c. In the **Assign to Space** dialogue:

i. In the **Select Space** drop-down menu, select **Global.**

Figure 2-88 Kryptowire API User Space Assignment



ii. Enable each of the following settings:

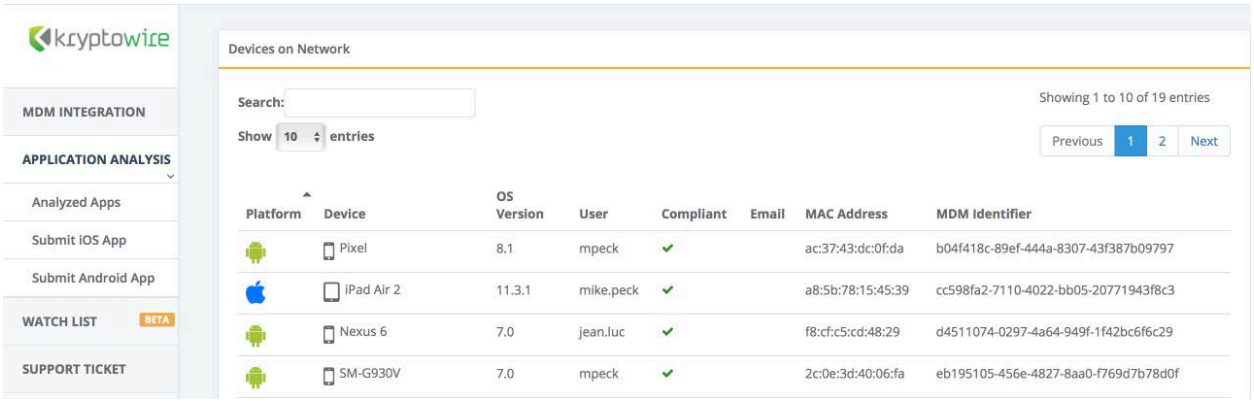
Admin Roles > Device Management > View device page, device details
Admin Roles > Device Management > View dashboard
Admin Roles > Privacy Control > View apps and ibooks in device details
Admin Roles > Privacy Control > View device IP and MAC address
Admin Roles > App Management > View app
Admin Roles > App Management > View app inventory
Other Roles > Common Services Provider (CSP)
Other Roles > API

iii. Click **Save.**

2.6.2 Contact Kryptowire to Create Inbound Connection

Once the MobileIron API account has been created, contact Kryptowire customer support to integrate your instance of MobileIron Core. Note that this will require creation of firewall rules that permit inbound connections from IP addresses designated by Kryptowire to MobileIron Core on port 443. Once the connection has been established, the Kryptowire portal will populate with information on devices registered with MobileIron. The EMM (Enterprise Mobility Management) ID presented by Kryptowire will be the same as the Universally Unique ID assigned to a device by MobileIron Core.

Figure 2-89 Kryptowire Device List



2.7 Integration of Lookout Mobile Endpoint Security with MobileIron

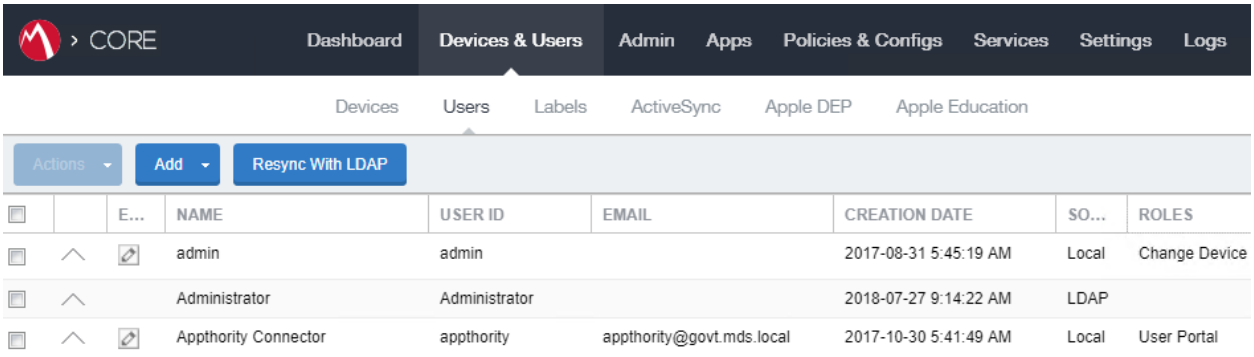
Lookout's Mobile Endpoint Security cloud service uses the MobileIron API to pull mobile device details and app inventory from MobileIron Core. Following analysis, Lookout uses the API to apply specific labels to devices to categorize them by the severity of any issues detected. MobileIron can be configured to automatically respond to the application of specific labels per built-in compliance actions.

2.7.1 Add MobileIron API Account for Lookout

The following steps will create an administrative account that will grant Lookout the specific permissions it requires within MobileIron.

1. In the **MobileIron Admin Portal**, navigate to **Devices & Users > Users**.
2. On the **Users** page:
   a. Select **Add > Add Local User**; the Add New User dialogue opens.

Figure 2-90 MobileIron User List



b. In the **Add New User** dialogue:

   i. In the **User ID** field, enter the user identity that the Lookout cloud will authenticate under. Our implementation uses a value of **lookout**.

   ii. In the **First Name** field, enter a generic first name for **Lookout**.

   iii. In the **Last Name** field, enter a generic last name for **Lookout**.

   iv. In the **Display Name** field, optionally enter a displayed name for this user account.

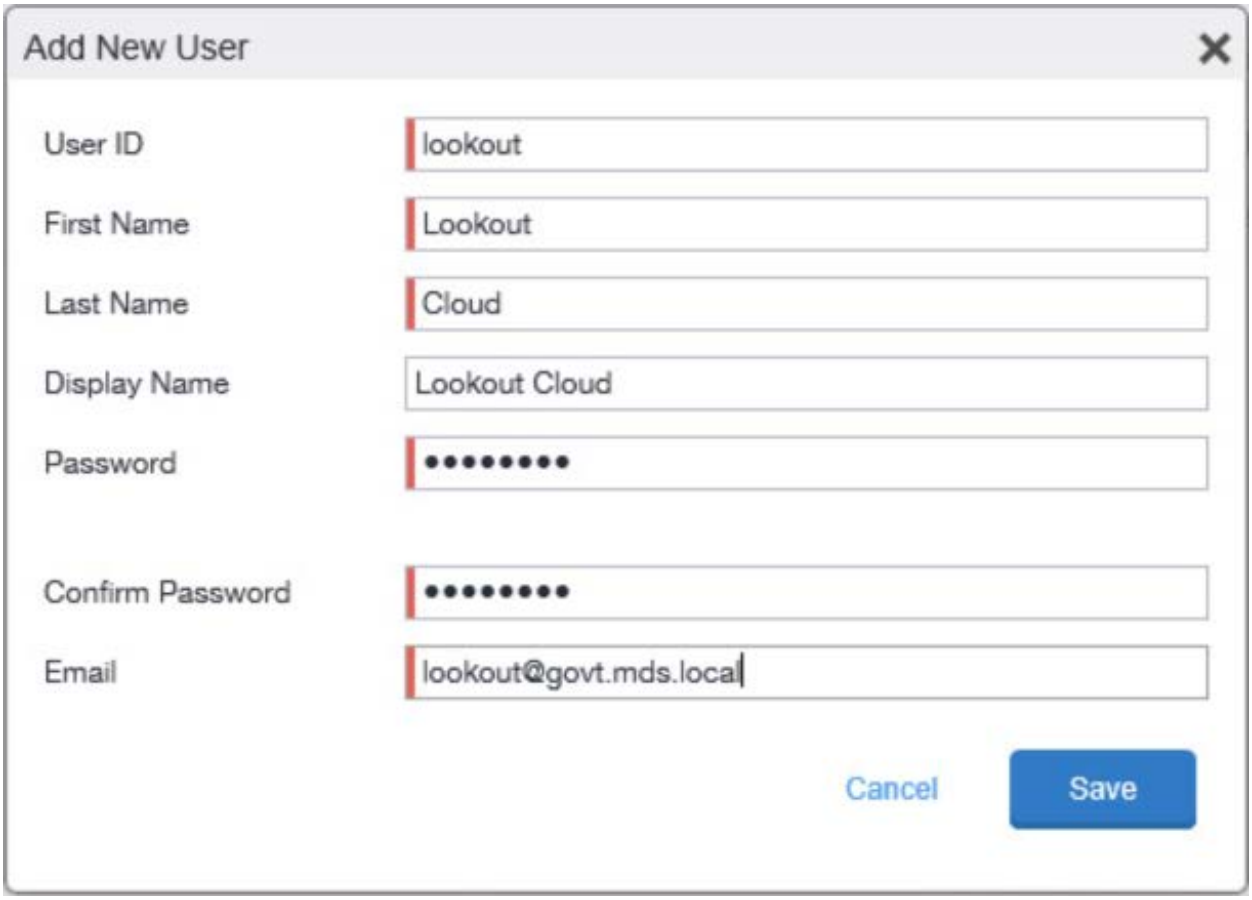
   v. In the **Password** field, provide the password that the **Lookout** identity will use to authenticate to MobileIron.

   vi. In the **Confirm Password** field, enter the same password as in the preceding step.

   vii. In the **Email** field, provide an email account for the **Lookout** identity; since this may be used for alerts, it should be an account under the control of your organization.

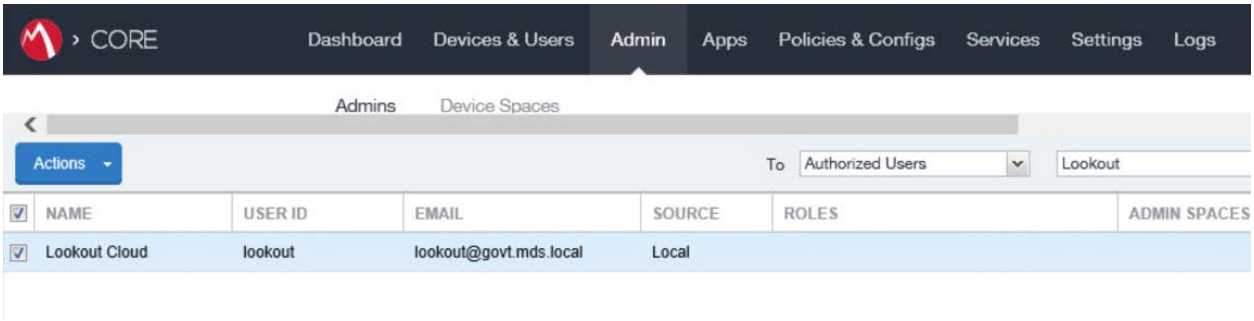
   viii. Click **Save**.

Figure 2-91 MobileIron Lookout User Configuration



3. In the **MobileIron Admin Portal**, navigate to **Admin**.
4. On the **Admin** page:
   a. Enable the account you created for Lookout during Step 2.
   b. Select **Actions > Assign to Space**; this opens the **Assign to Space** dialogue for the Lookout account.

Figure 2-92 Lookout MobileIron Admin Account



c. In the **Assign to Space** dialogue:

i. In the **Select Space** drop-down menu, select **Global.**

Figure 2-93 Lookout Account Space Assignment

ii. Enable each of the following settings:

Admin Roles > Device Management > View device page, device details
Admin Roles > Device Management > View dashboard
Admin Roles > Label Management > View Label
Admin Roles > Label Management > Manage Label
Admin Roles > Privacy Control > View apps and ibooks in device details
Admin Roles > Privacy Control > View device IP and MAC address
Admin Roles > App Management > Distribute app
Admin Roles > Logs and Event Management > View Audit logs
Admin Roles > Logs and Event Management > View events
Other Roles > CSP
Other Roles > Connector
Other Roles > API

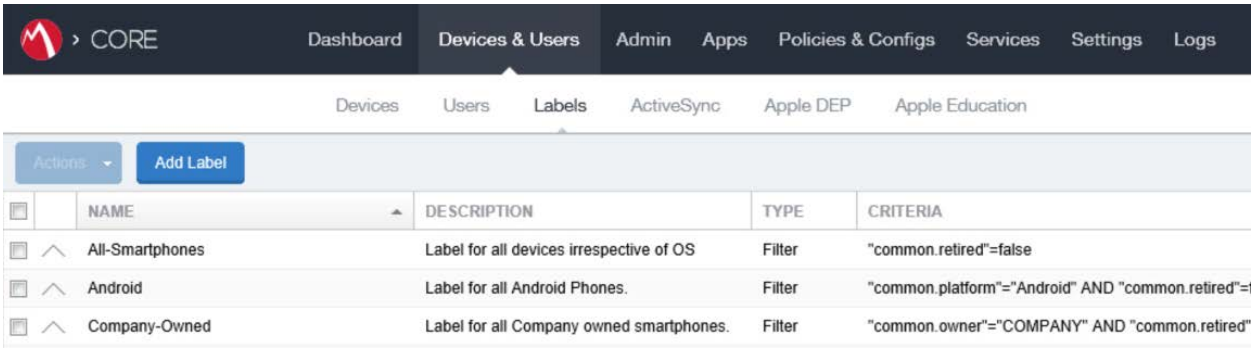
iii. Click **Save**.

2.7.2 Add MobileIron Labels for Lookout

Lookout will dynamically apply MobileIron labels to protected devices to communicate information about their current state. The following steps will create a group of Lookout-specific labels.

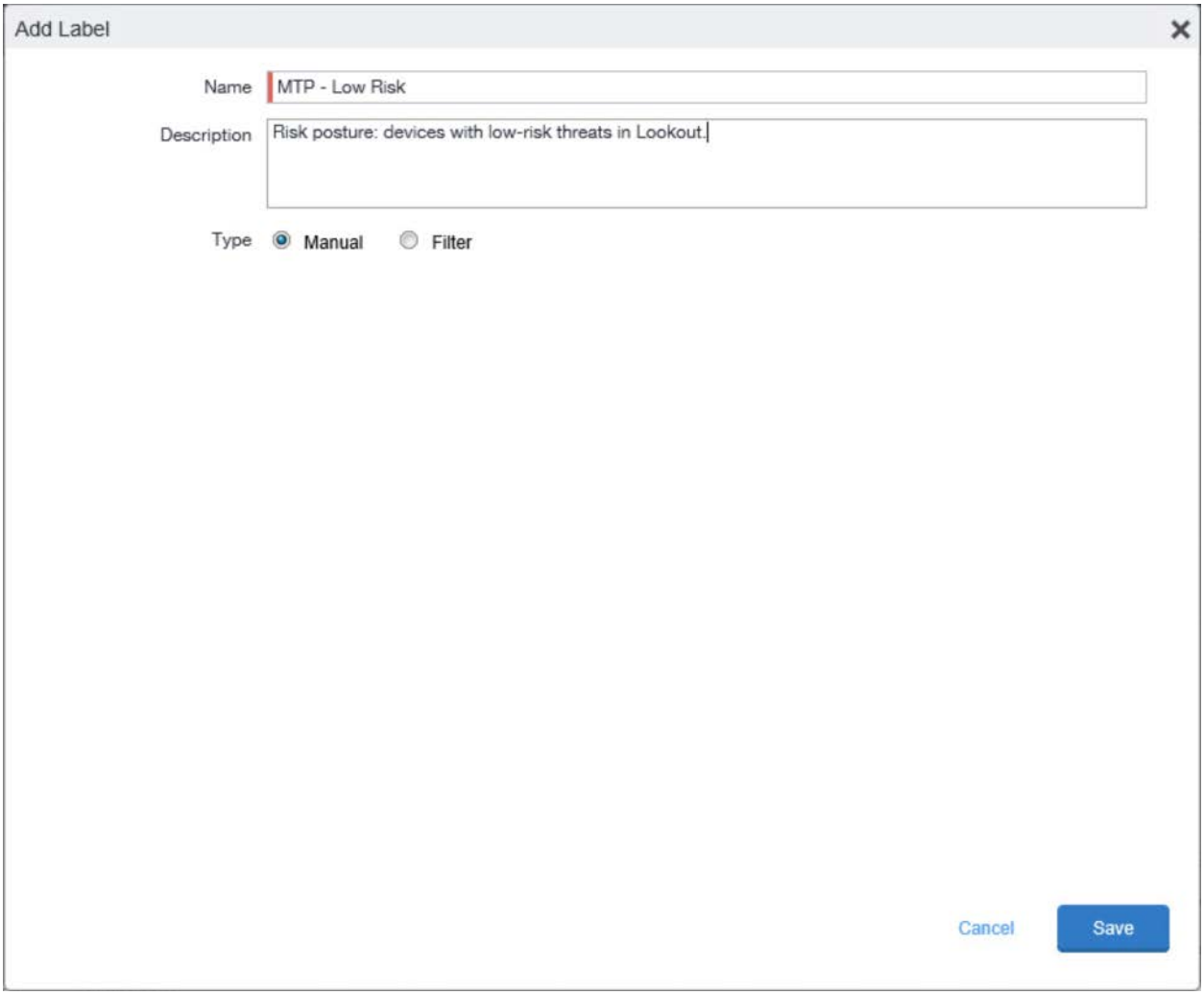
1. In the **MobileIron Admin Portal**, navigate to **Devices & Users > Labels**.
2. On the **Labels** page:
   a. Select **Add Label**; the **Add Label** dialogue appears.

Figure 2-94 MobileIron Label List



   b. In the **Add Label** dialogue:
      i. In the **Name** field, enter the name of the label. Note: future steps will use the Label Names presented here but use of these names is optional.
      ii. In the **Description** field, enter a brief description for this label.
      iii. For the **Type** option, select **Manual**; this hides all other form inputs.
      iv. Click **Save.**

Figure 2-95 MTP Low Risk Label Configuration



c. Complete Step 2 for each label in the following table:

Label Name	Purpose
Lookout for Work	Device enrollment
MTP - Pending	Lifecycle management: devices with Lookout not yet activated
MTP - Secured	Lifecycle management: devices with Lookout activated
MTP - Threats Present	Lifecycle management: devices with threats detected by Lookout

Label Name	Purpose
MTP - Deactivated	Lifecycle management: devices with Lookout deactivated
MTP - Low Risk	Risk posture: devices with a low risk score in Lookout
MTP - Moderate Risk	Risk posture: devices with a moderate risk score in Lookout
MTP - High Risk	Risk posture: devices with a high risk score in Lookout

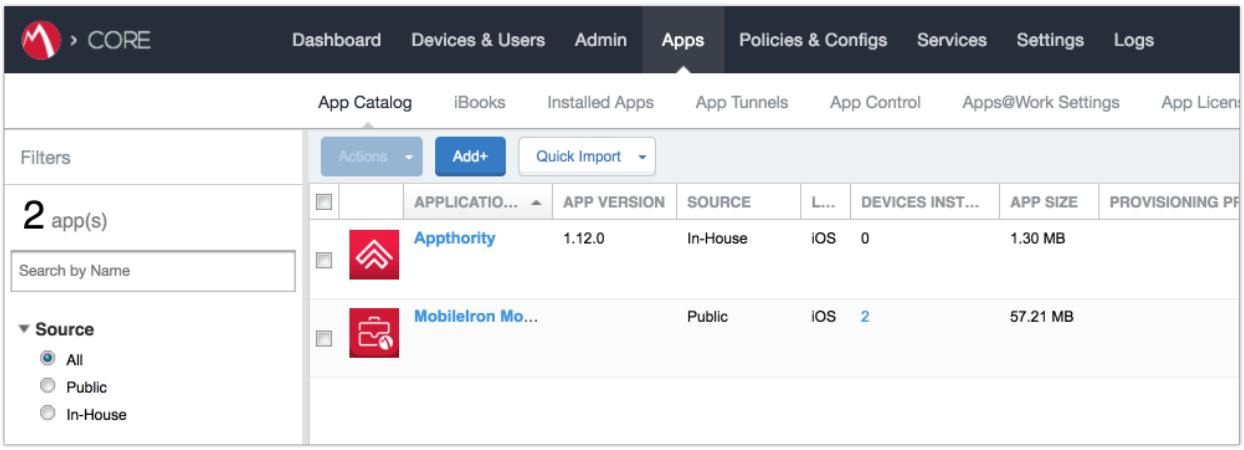
Note: Administrators can choose to alter the label names to something more appropriate for their environment.

2.7.3 Add Lookout for Work for Android to MobileIron App Catalog

The following steps will add the Lookout for Work app for Android to MobileIron.

1. In the **MobileIron Admin Portal**, navigate to **Apps > App Catalog**.
2. On the **App Catalog** page, select **Add**; this starts the workflow to add a new app to the app catalog.

Figure 2-96 MobileIron App Catalog



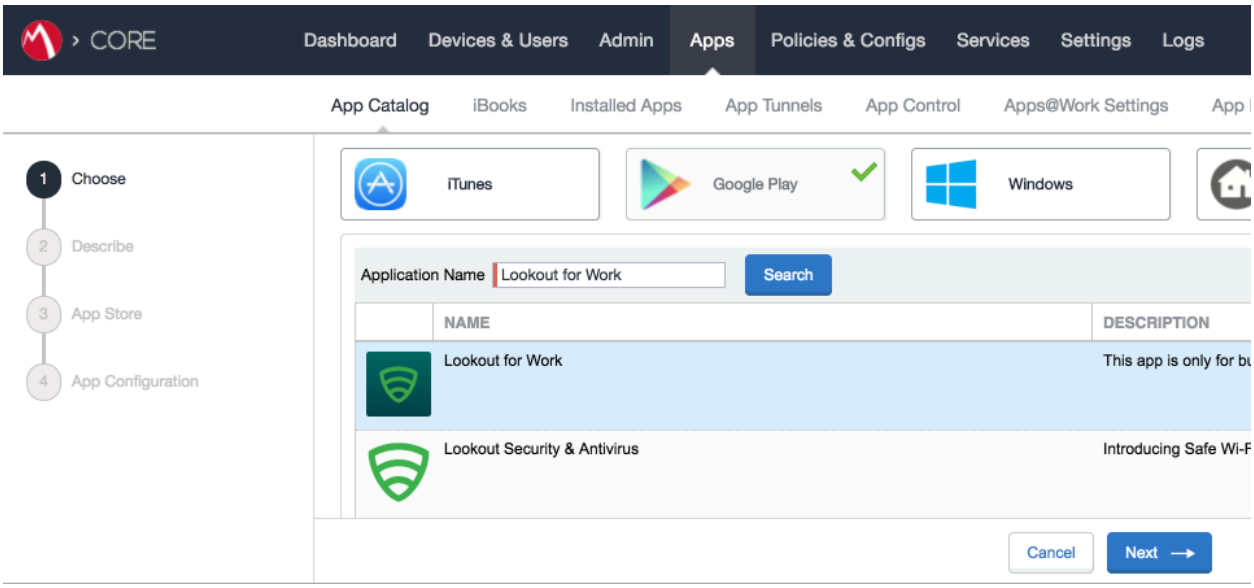
3. On the **App Catalog > Choose** page:
   a. Select **Google Play**; additional controls will be displayed.
   b. In the **Application Name** field, enter **Lookout for Work**.

c. Select **Search**; search results will be displayed in the lower pane.

d. In the list of search results, select the **Lookout for Work** app.

e. Select **Next**.

Figure 2-97 Adding Lookout for Work to the MobileIron App Catalog

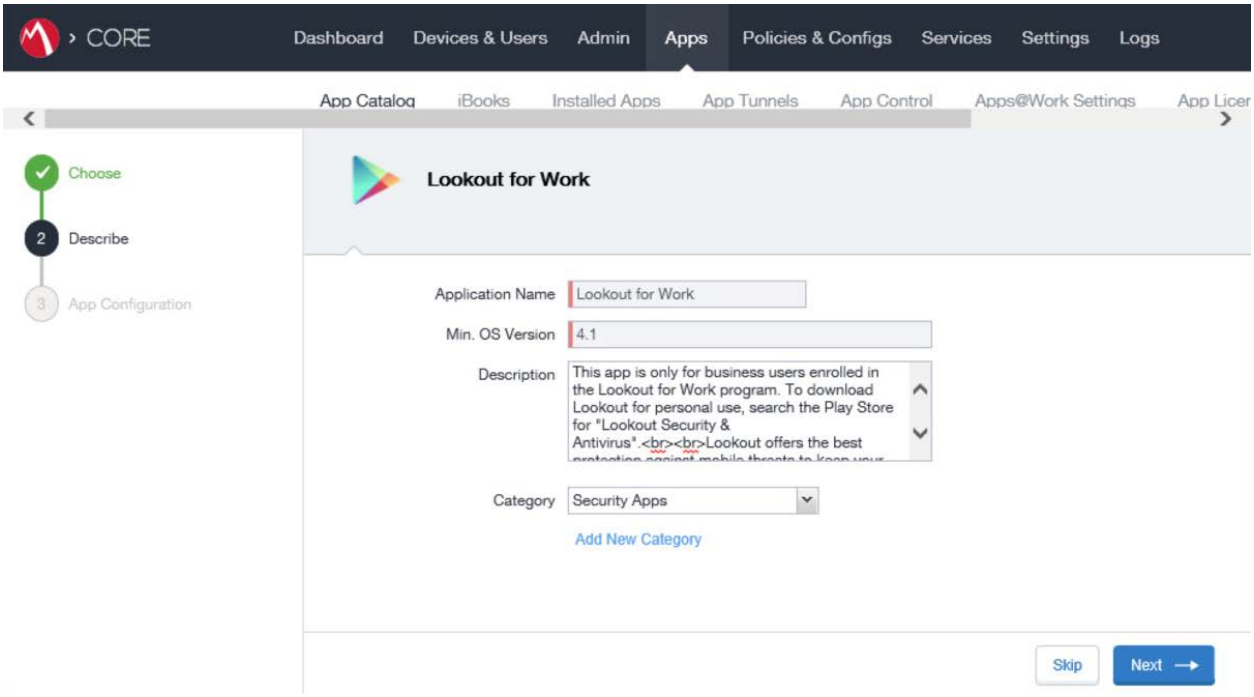


4. On the **App Catalog > Describe** page:

a. In **Category** drop-down menu, optionally assign the app to a category as appropriate to your MobileIron deployment strategy.

b. Select **Next.**

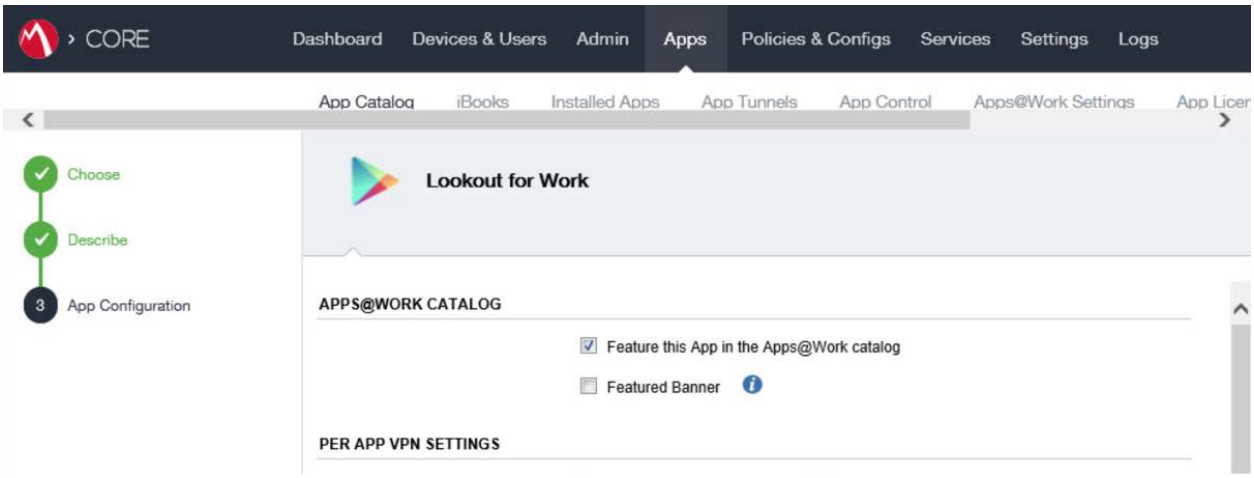
Figure 2-98 Lookout for Work Application Configuration



5. On the **App Catalog > App Configuration** page:

    a. In the **Apps@Work Catalog** section, Enable **Feature this App in the Apps@Work catalog.**

Figure 2-99 Lookout for Work Application Configuration



    b. In the **Android Enterprise (Android for Work [AFW])** section:

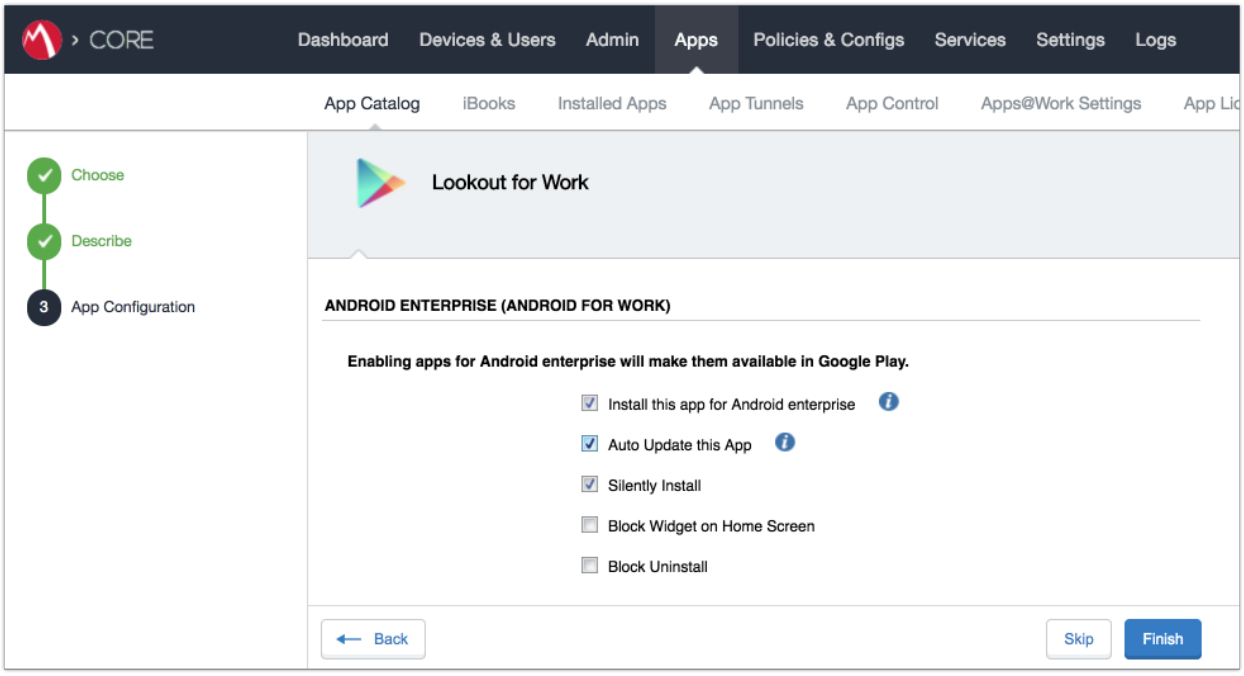
i. Enable **Install this app for Android enterprise**; additional controls display.

ii. Enable **Auto Update this App.**

iii. Ensure **Silently Install** is enabled.

c. Click **Finish.**

Figure 2-100 Lookout for Work AFW Configuration



6. The **Lookout for Work** app should now appear in the App Catalog with the AFW indicator.

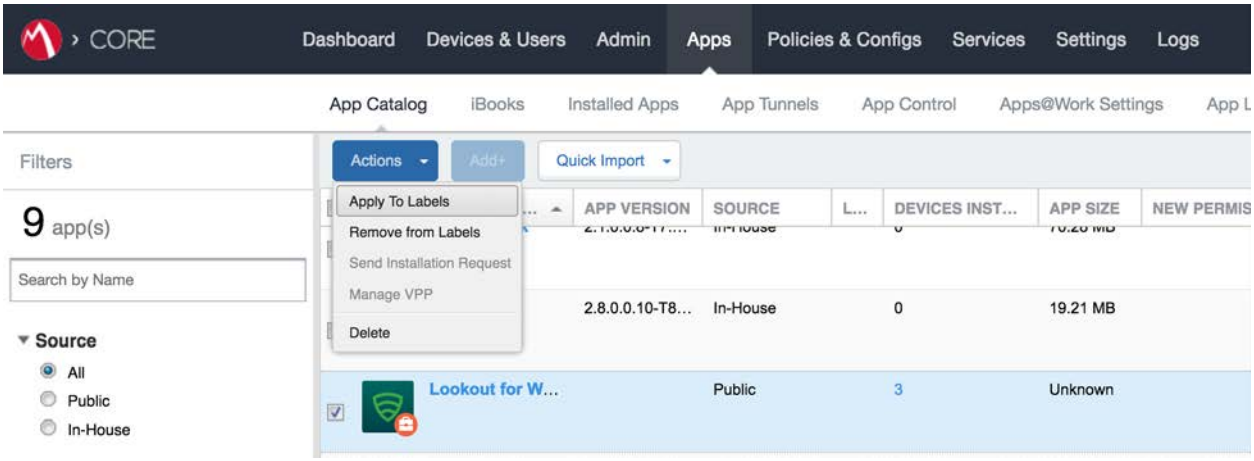
2.7.4 Apply Labels to Lookout for Work for Android

1. On the **App Catalog** page:

   a. Enable Lookout for Work.

   b. Select **Actions > Apply To Labels**; the Apply To Labels dialogue appears.

Figure 2-101 Apply Lookout for Work to Android Devices

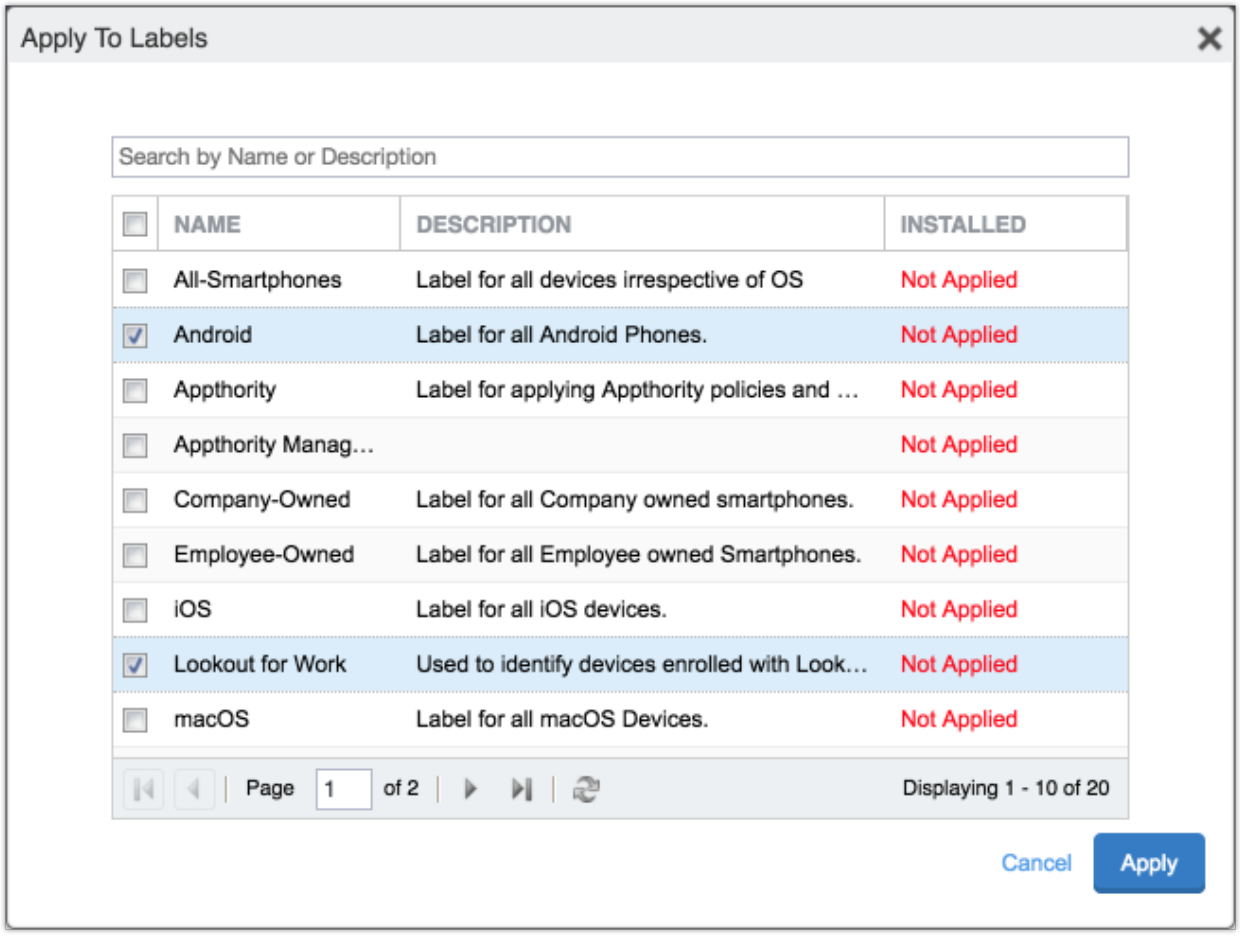


c. In the **Apply To Labels** dialogue:

   i. Enable the **Lookout for Work** and **Android** labels, plus any other labels appropriate to your organization's mobile security policies.

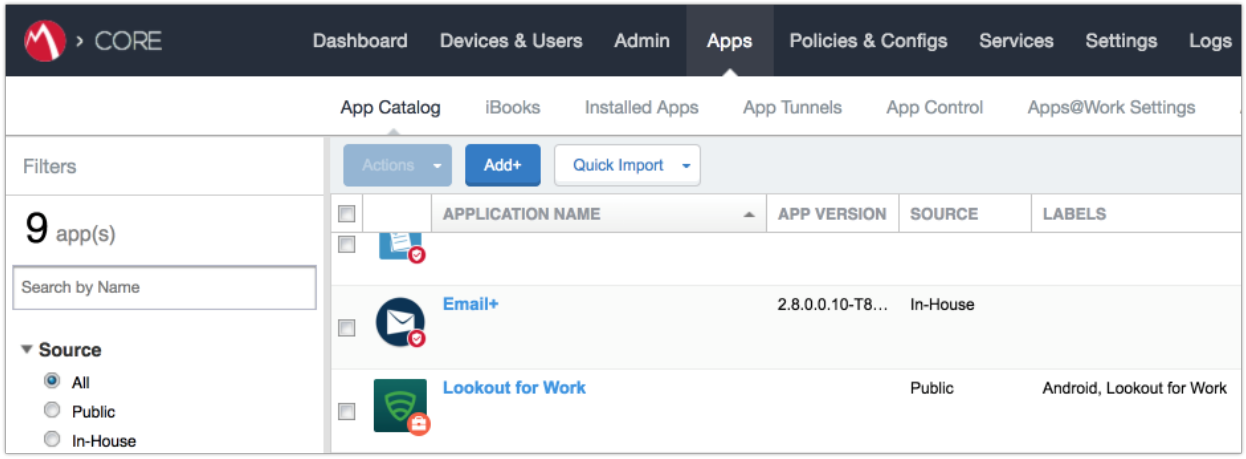
   ii. Select **Apply.**

Figure 2-102 Apply To Labels Dialogue



d. The **Lookout for Work** app appears with the **Lookout for Work** and **Android** labels applied.

Figure 2-103 Lookout for Work with Applied Labels



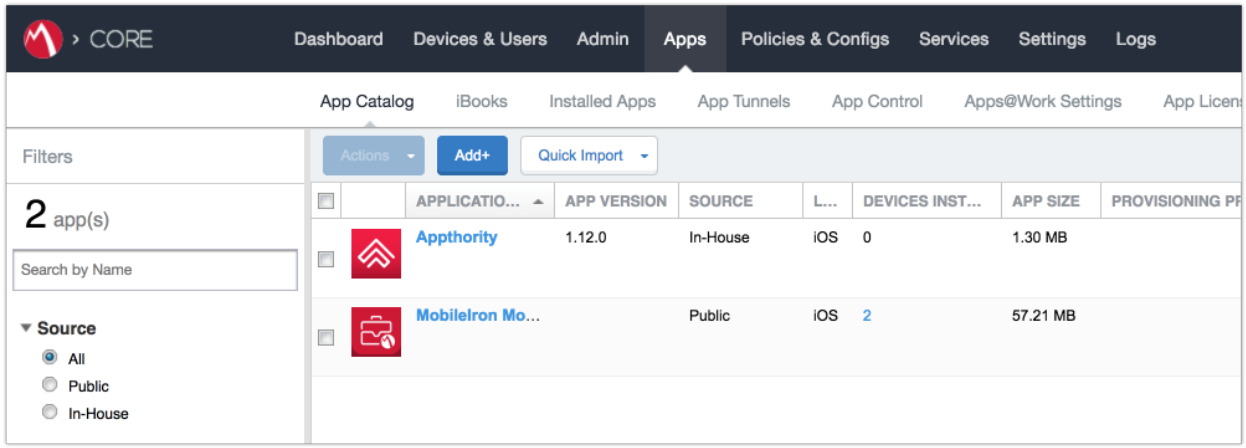
2.7.5 Add Lookout for Work app for iOS to MobileIron App Catalog

The following steps will add the Lookout for Work app for iOS to MobileIron, apply appropriate MobileIron labels, and create and upload a configuration file for one-touch activation of the app.

2.7.5.1 Import Lookout for Work App

1. In the **MobileIron Admin Portal**, navigate to **Apps > App Catalog**.
2. On the **App Catalog** page, select **Add**; this starts the workflow to add a new app to the app catalog.

Figure 2-104 MobileIron App Catalog



3. On the **App Catalog > Choose** page:

a. Select **iTunes**; additional controls display.

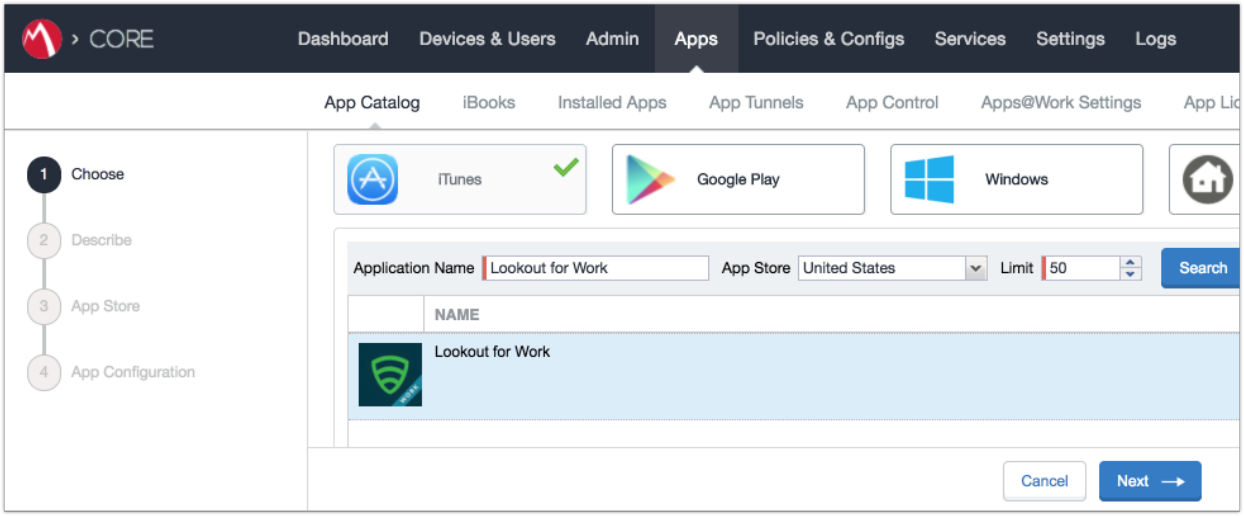
b. In the **Application Name** field, enter **Lookout for Work**.

c. Select **Search**; the search results display in the lower pane.

d. In the list of search results, select the **Lookout for Work** app.

e. Select **Next**.

Figure 2-105 Lookout for Work Selected From iTunes

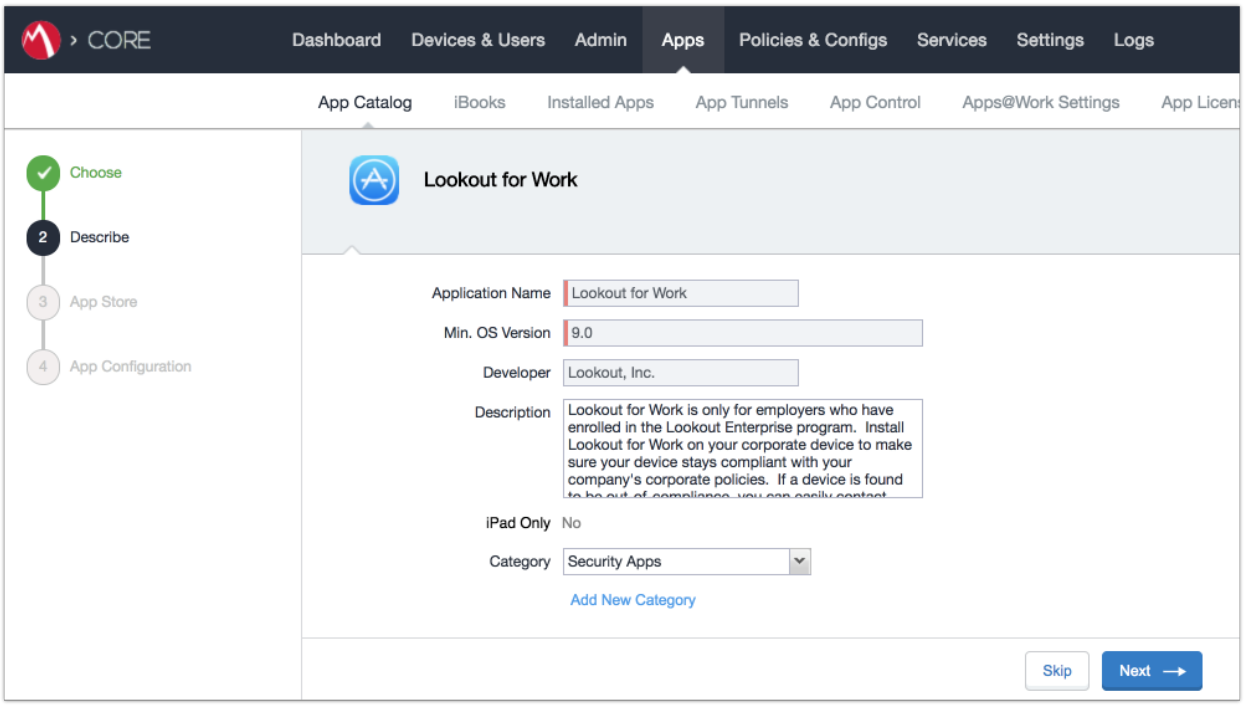


4. On the **App Catalog > Describe** page:

a. In **Category** drop-down menu, optionally assign the app to a category as appropriate to your MobileIron deployment strategy.

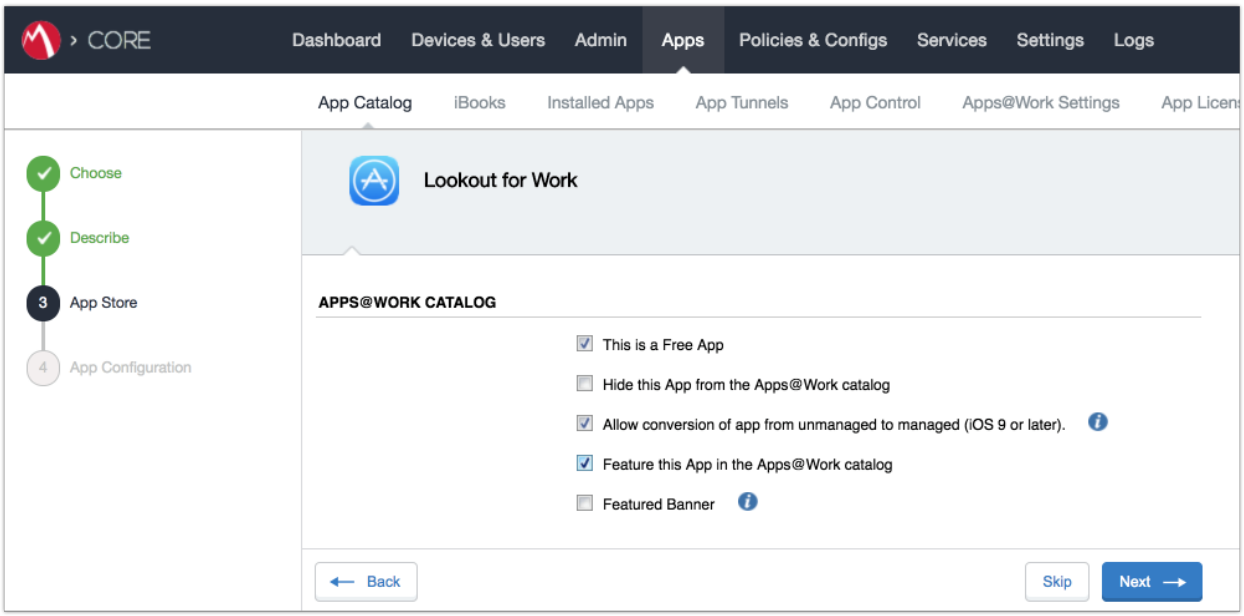
b. Select **Next**.

Figure 2-106 Lookout for Work App Configuration



5. On the **App Catalog > App Store** page:
    a. In the **Apps@Work Catalog** section:
        i. Enable **Allow conversion of app from unmanaged to managed (iOS 9 or later).**
        ii. Enable **Feature this App in the Apps@Work catalog.**
        iii. Select **Next.**

Figure 2-107 Lookout for Work App Configuration



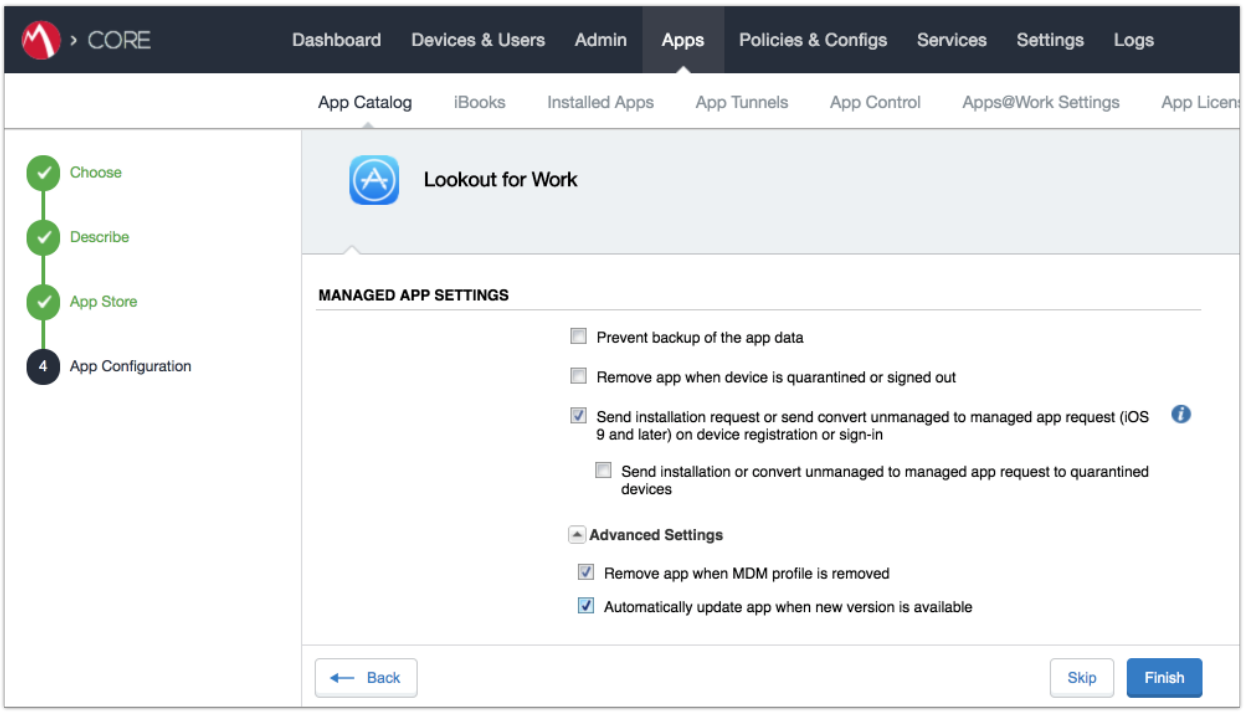
b. In the **App Catalog > App Configuration** section:

   i. Enable **Send installation request or send convert unmanaged to managed app request (iOS 9 and later) on device registration or sign-in.**

   ii. Enable **Advanced Settings > Automatically update app when new version is available.**

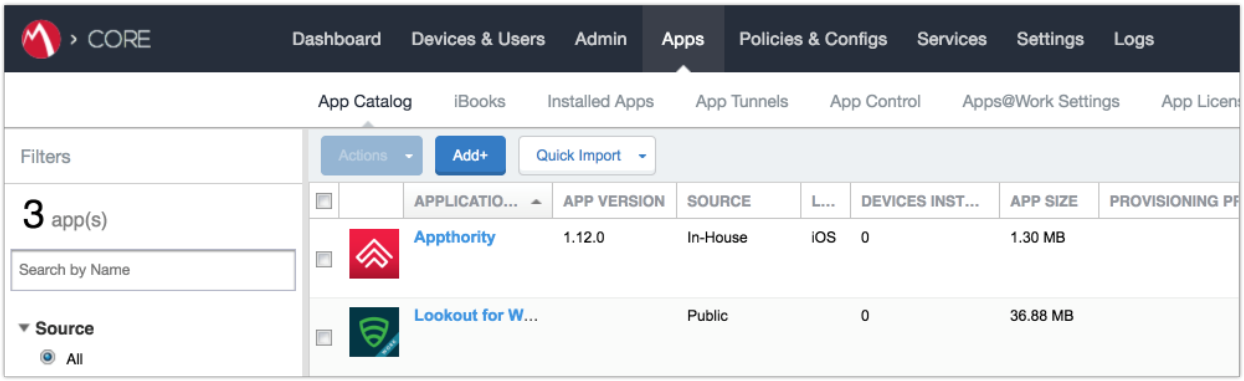
c. Click **Finish**.

Figure 2-108 Lookout for Work Managed App Settings



6. The **Lookout for Work** app should now appear in the App Catalog with AFW indicator.

Figure 2-109 App Catalog with Lookout for Work



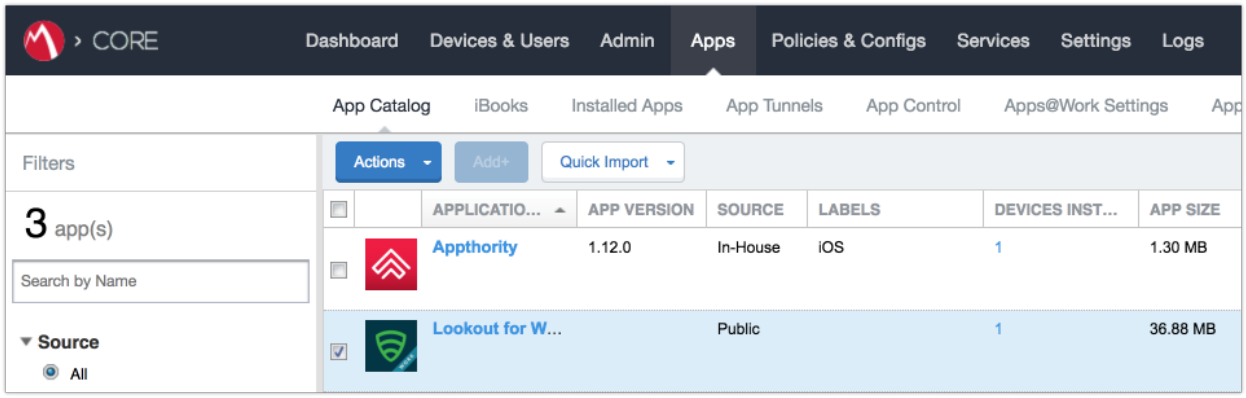
2.7.5.2 *Apply MobileIron Labels to Lookout for Work App*

1. On the **App Catalog** page:

   a. Enable **Lookout for Work**.

b. Select **Actions > Apply To Labels**; the Apply To Labels dialogue will appear.

Figure 2-110 Lookout for Work Selected

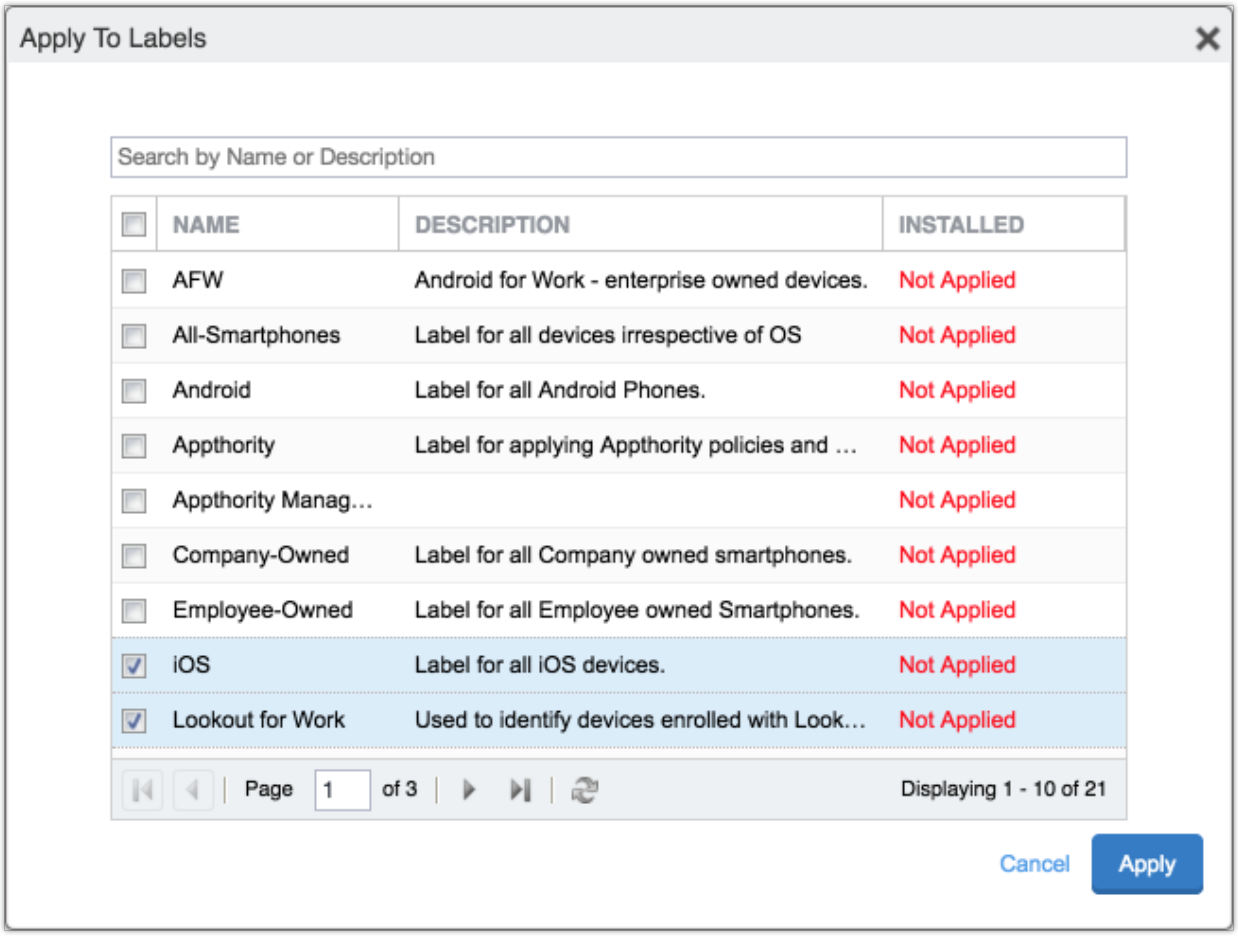


c. In the **Apply To Labels** dialogue:

i. Enable the **Lookout for Work** and **iOS** labels, plus any other labels appropriate to your organization's mobile security policies.

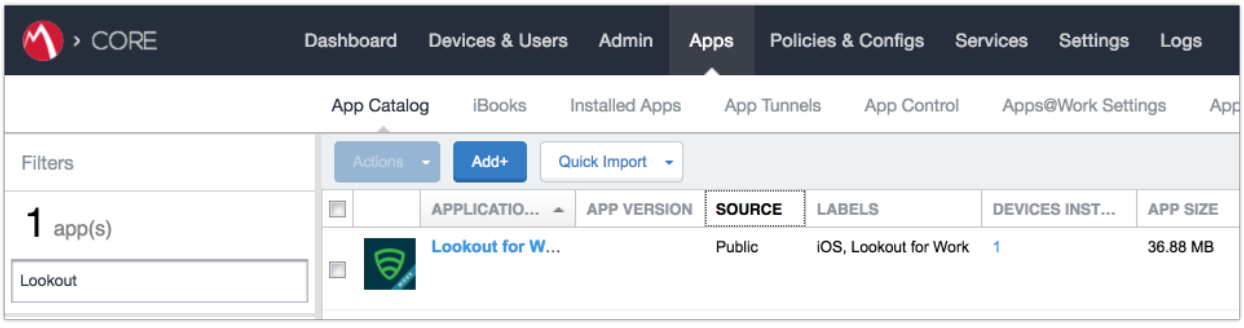
ii. Select **Apply.**

Figure 2-111 Apply To Labels Dialogue



d. The **Lookout for Work** app appears with the Lookout for Work and iOS labels applied.

Figure 2-112 App Catalog with Lookout for Work



2.7.5.3 Create Managed App Configuration File for Lookout for Work

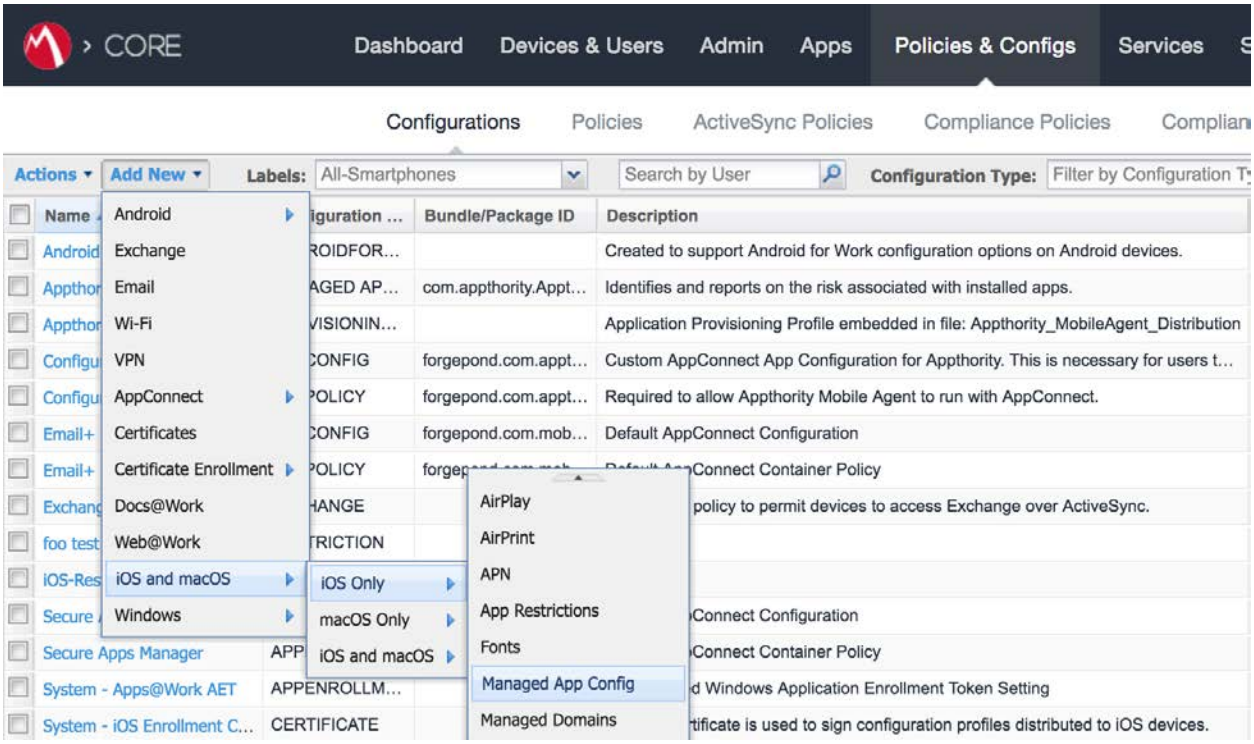
MobileIron can push a configuration file down to managed iOS devices to allow users to activate Lookout for Work. The following steps will create and upload the necessary file.

1. Using a **plain text** editor, create the following text file by **replacing the asterisks on line 13** with your organization's Global Enrollment Code.

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE plist PUBLIC "-//Apple//DTD PLIST 1.0//EN"
"https://www.apple.com/DTDs/PropertyList-1.0.dtd">
<plist version="1.0">
  <dict>
    <key>MDM</key>
    <string>MOBILEIRON</string>
    <key>DEVICE_UDID</key>
    <string>$DEVICE_UDID$</string>
    <key>EMAIL</key>
    <string>$EMAIL$</string>
    <key>GLOBAL_ENROLLMENT_CODE</key>
    <string>*******</string>
  </dict>
</plist>
```

2. In the **MobileIron Admin Portal**, navigate to **Policies & Configs > Configurations**.
3. On the **Configurations** Page:
   a. Select **Add New > iOS and OS X > iOS Only > Managed App Config**; the New Managed App Config Setting dialogue opens.

Figure 2-113 Importing Managed Application Configuration



b. In the **Managed App Config Setting** dialogue:

   i. In the **Name** field, provide a name for this configuration; our implementation used **Activate Lookout**.

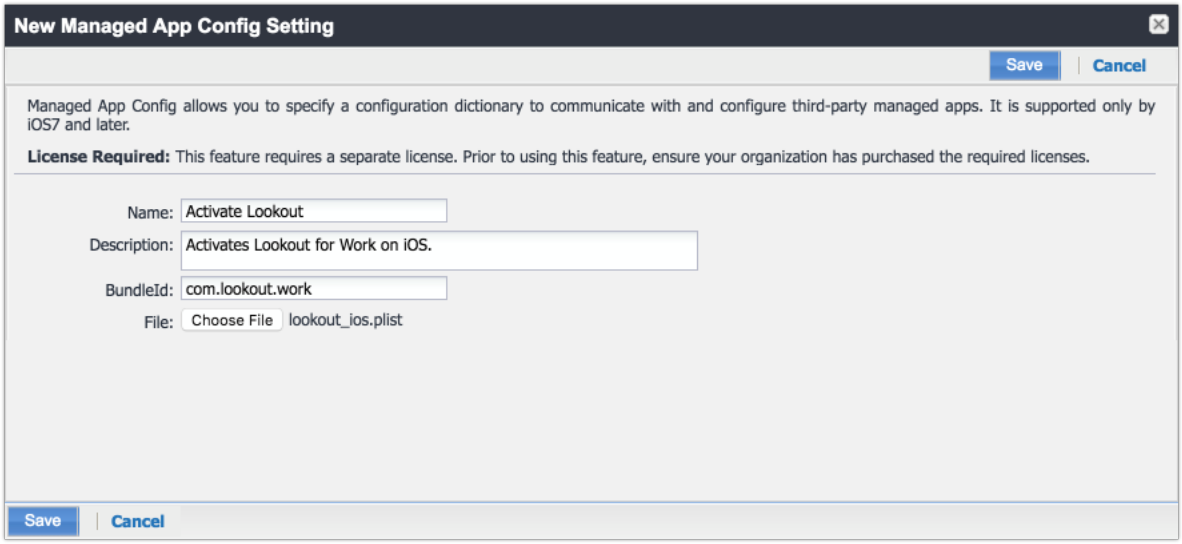
   ii. In the **Description** field, provide the purpose for this configuration.

   iii. In the **BundleId** field, enter the bundle ID for Lookout at Work, which for our version was **com.lookout.work**.

   iv. Select **Choose File...** to upload the plist file created during Step 1.

   v. Click **Save.**

Figure 2-114 plist File Configuration

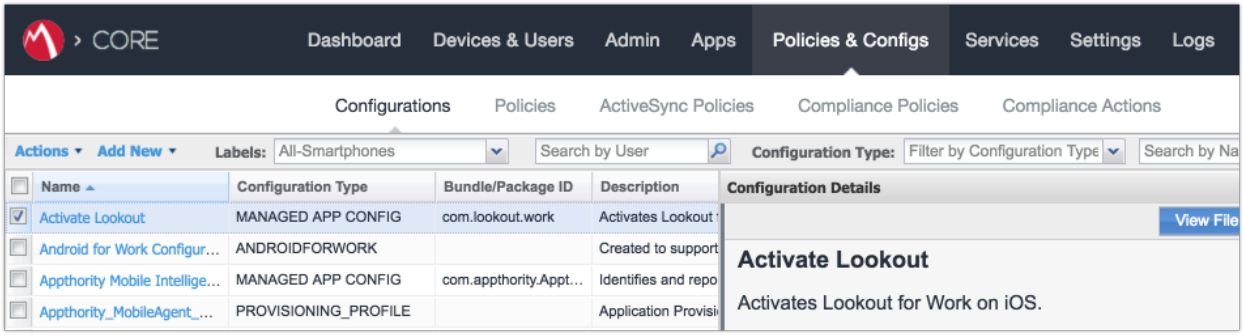


2.7.5.4 *Apply Labels to Managed App Configuration for Lookout for Work*

The following steps will apply the managed app configuration created in the previous section to labels.

1. In the **MobileIron Admin Portal**, navigate to **Policies & Configs > Configurations**.
2. On the **Configurations** page:
   a. Enable the **Lookout Activation** managed app configuration created in the previous section.
   b. Select **Actions > Apply To Label**; the Apply To Label dialogue opens.

Figure 2-115 Lookout Configuration Selected

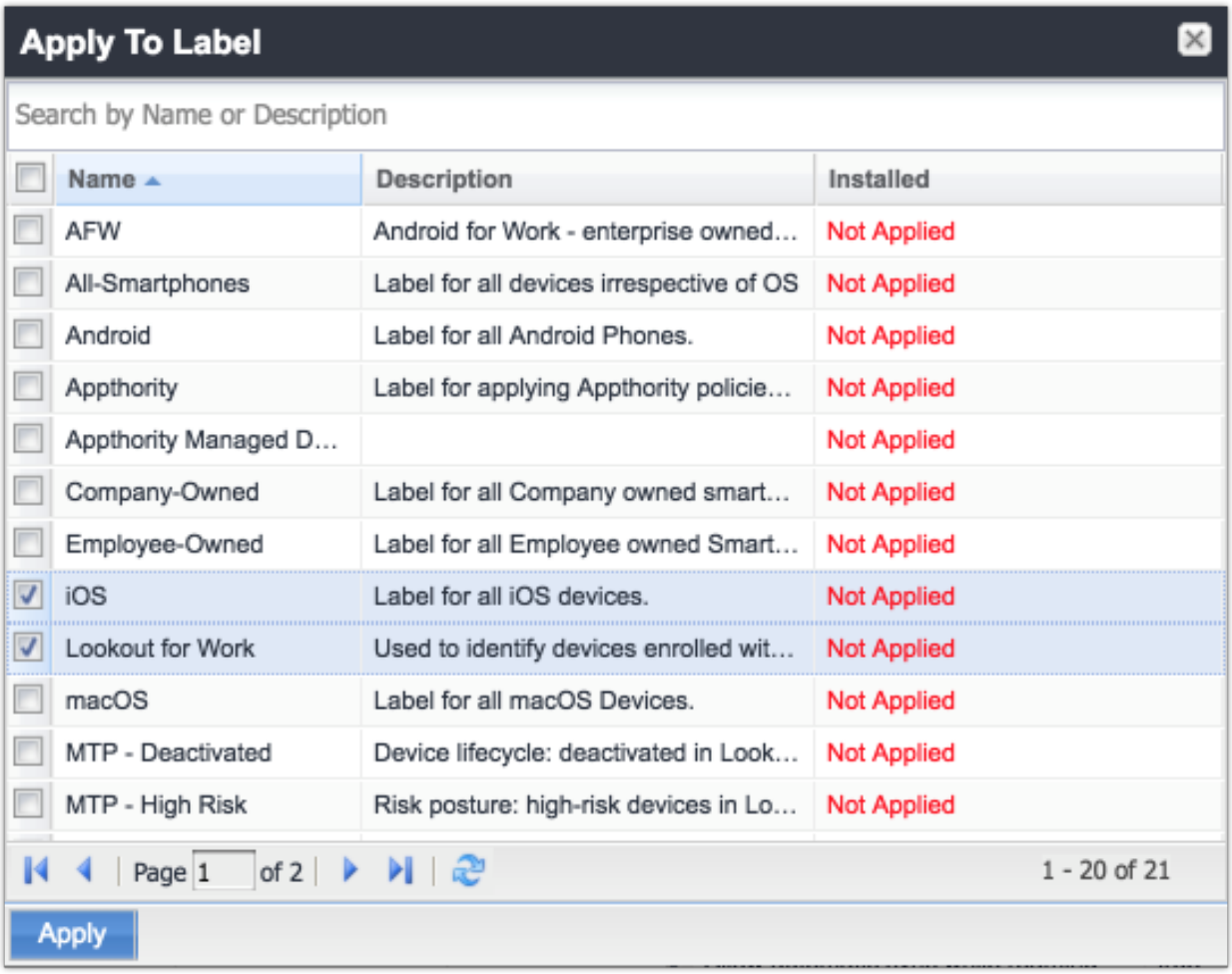


   c. In the **Apply To Label** dialogue:

i. Enable the **iOS** and **Lookout for Work** labels.

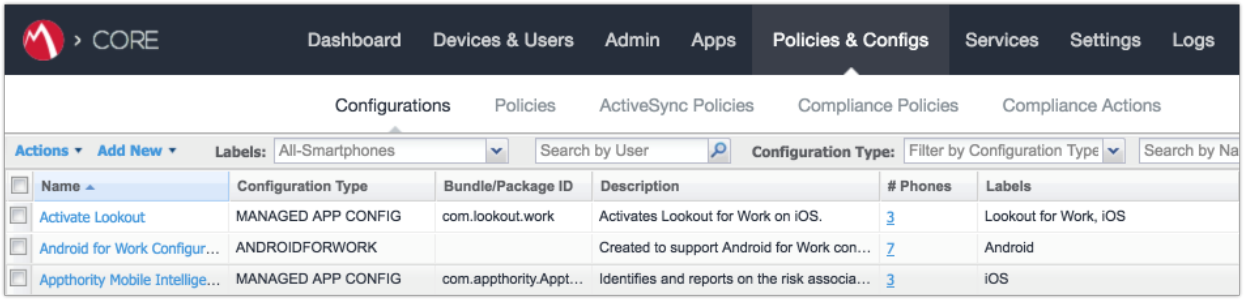
ii. Select **Apply.**

Figure 2-116 Apply To Label Dialogue



d. The system should now reflect that the **Lookout for iOS** and **iOS** labels have been applied to the **Activate Lookout** configuration.

Figure 2-117 Lookout Configuration With Labels

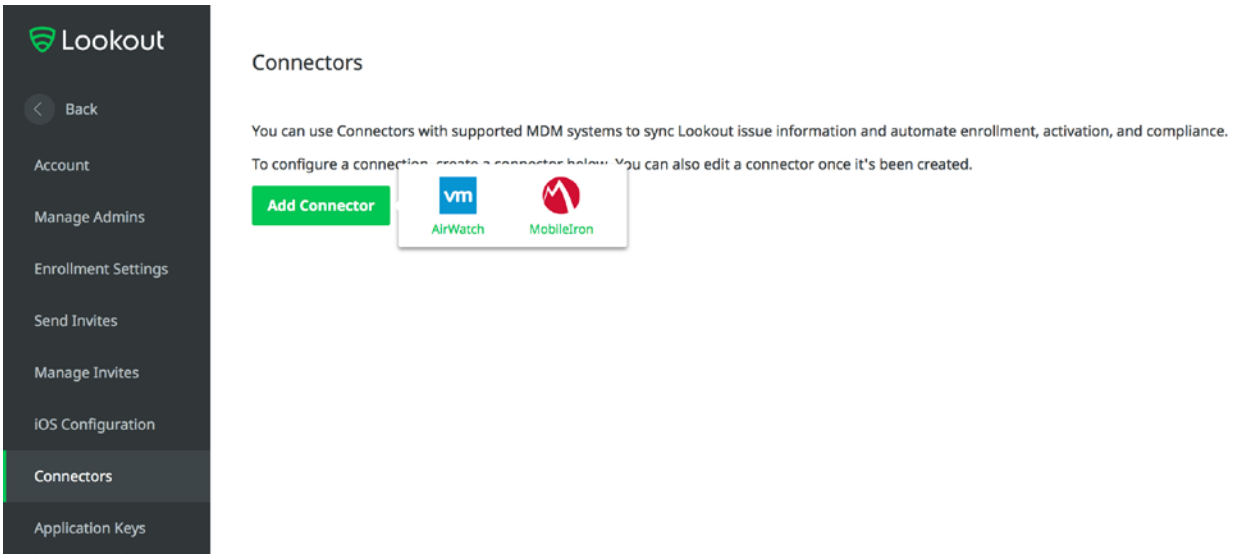


2.7.6 Add MDM Connector for MobileIron to Lookout MES

The following instructions will connect Lookout with your MobileIron instance and associate Lookout device states with the MobileIron labels created previously.

1. Using the most-recent version of *MDM Service IP* allowed addresses available from the Lookout support portal, configure your organization's firewalls to permit inbound connections from the IP addresses provided on port 443 to your instance of MobileIron Core.
2. In the **Lookout MES portal**, navigate to **Lookout > System > Connectors**.
3. On the **Connectors** page:
    a. Select **Add Connector > MobileIron**; a new form opens.

Figure 2-118 Add Lookout Connector Display



b. In the **Connector Settings** section of the form:

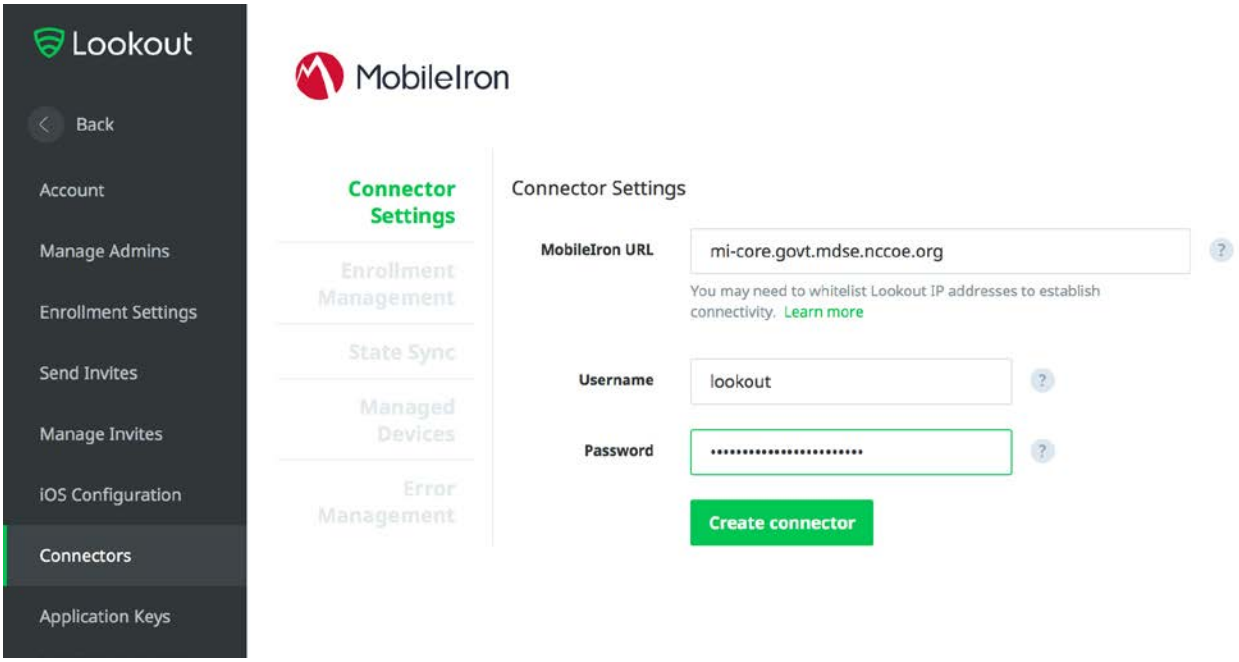
i. For the **MobileIron URL** field, enter the FQDN for your instance of MobileIron. In our example implementation, the URL was **mi-core.govt.mdse.nccoe.org.**

ii. For the **Username** field, enter the User ID of the MobileIron admin account created in 2.7.1. In our example implementation, the **User ID** is **lookout.**

iii. For the **Password** field, enter the password associated with that MobileIron admin account.

iv. Select **Create Connector**; this enables additional sections of the form.

Figure 2-119 Connector Settings



c. In the **Enrollment Management** section of the form:

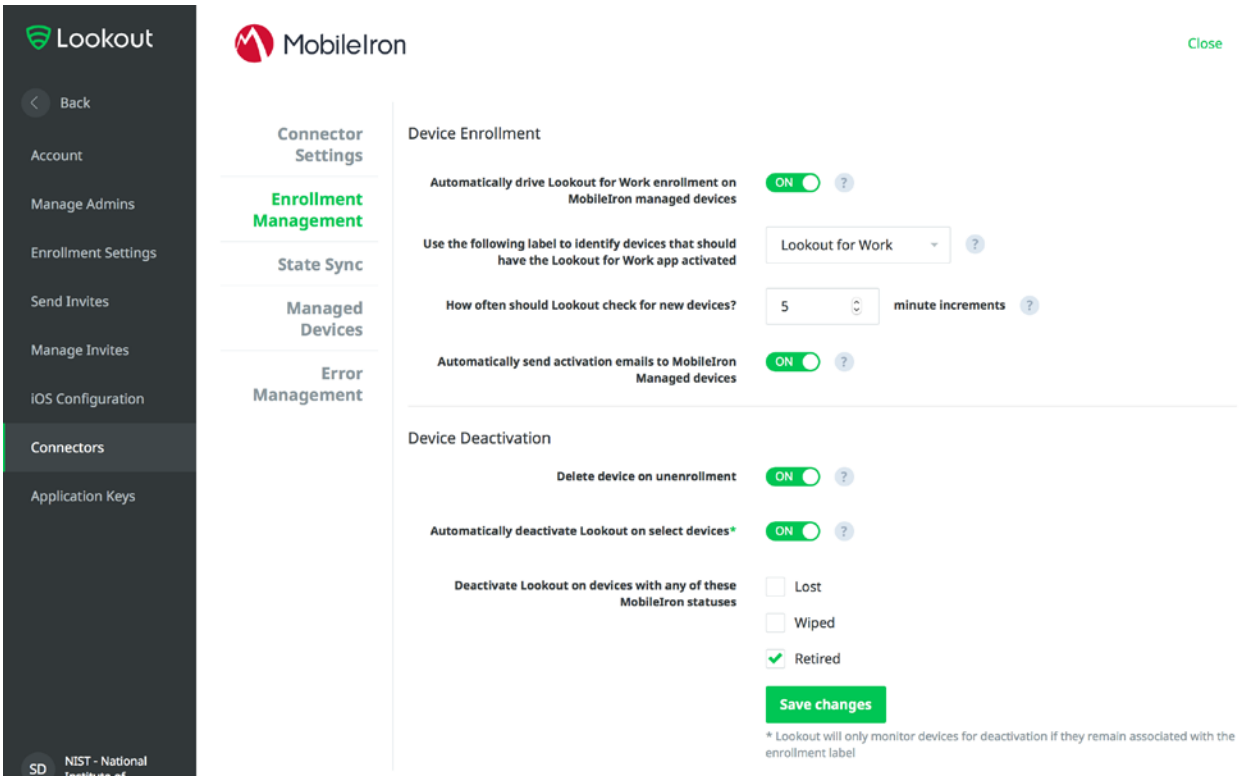
i. Toggle **Device Enrollment > Automatically** drive Lookout for Work enrollment on MobileIron managed devices to **On.**

ii. For the **Device Enrollment > Use the following label to identify devices that should have the Lookout for Work app activated** drop-down menu, select the **Lookout for Work** label.

iii. Toggle **Device Enrollment > Automatically send activation emails to MobileIron managed devices** to **On.**

iv. Select **Save Changes.**

Figure 2-120 Connector Enrollment Settings



d. In the **State Sync** section of the form:

i. Toggle **State Sync > Synchronize Device Status to MobileIron** to **On**.

ii. For each entry in the table below:

1) Toggle the control to **On.**

2) From the drop-down menu, select the **MobileIron Label** with the associated Purpose from the table in **Section 2.6.2 Add MobileIron Labels for Lookout.** We provide the Label Name we used for each Purpose in our example implementation.

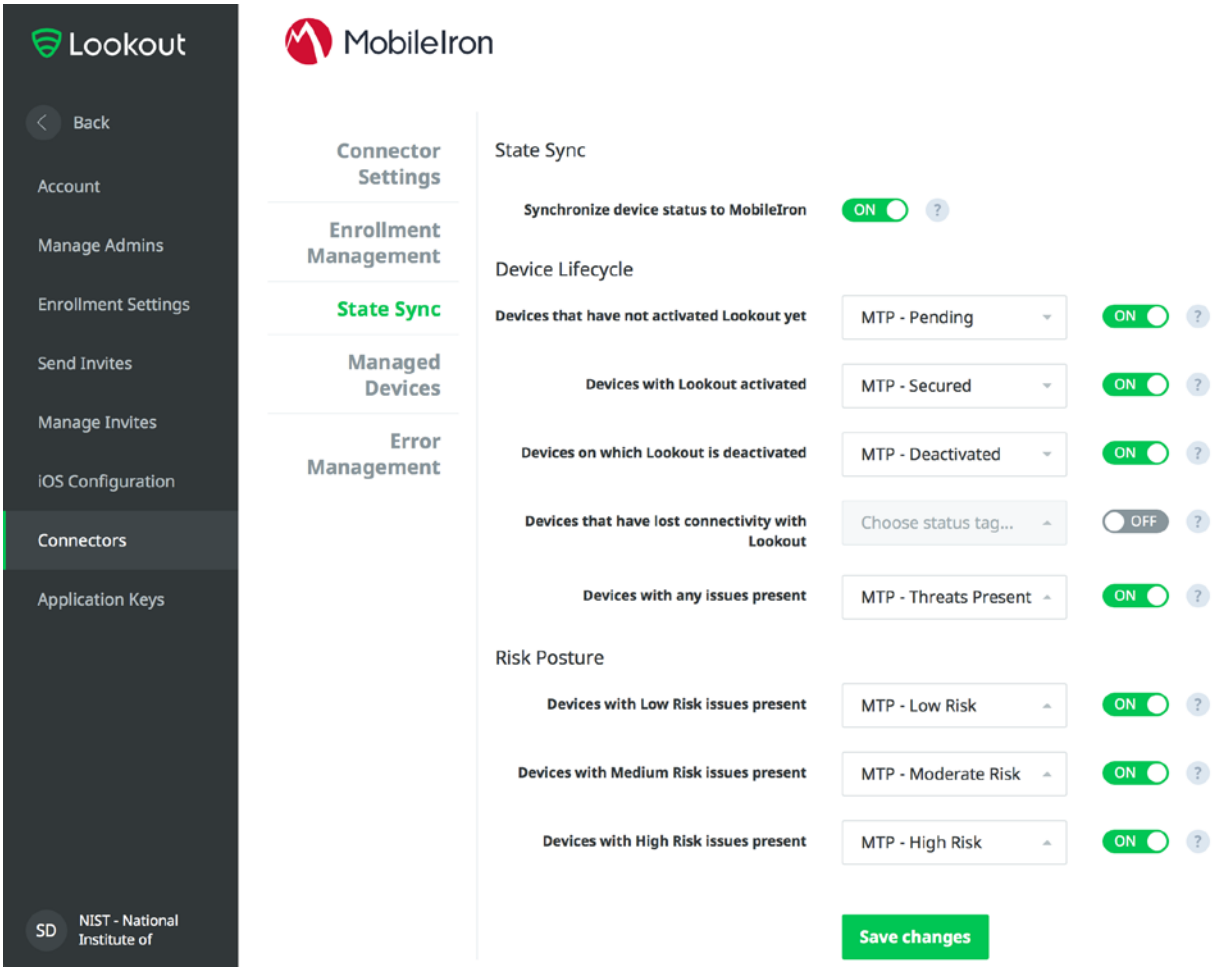
State	Purpose	Label Name
Devices that have not activated Lookout yet	Lifecycle management: devices with Lookout not yet activated	MTP - Pending

State	Purpose	Label Name
Devices with Lookout activated	Lifecycle management: devices with Lookout activated	MTP - Secured
Devices on which Lookout is deactivated	Lifecycle management: devices with Lookout deactivated	MTP - Deactivated
Devices with any issues present	Lifecycle management: devices with threats detected by Lookout	MTP - Threats Detected
Devices with Low Risk issues present	Risk posture: devices with a low risk score in Lookout	MTP - Low Risk
Devices with Medium Risk issues present	Risk posture: devices with a moderate risk score in Lookout	MTP - Moderate Risk
Devices with High Risk issues present	Risk posture: devices with a high risk score in Lookout	MTP - High Risk

Note: Administrators can choose to alter the label names to something more appropriate for their environment.

iii. Select **Save Changes**.

Figure 2-121 Connector Sync Settings



2.7.7 Configure MobileIron Risk Response

The following steps will allow MobileIron to generate responses to various device states as assigned to devices by Lookout (e.g., MTP - High Risk).

2.7.7.1 Add MobileIron App Control Rule

1. In the **MobileIron Admin Portal**, navigate to **Apps > App Control**.
2. Select **Add**; the Add App Control Rule dialogue appears.
3. In the **Add App Control Rule** dialogue:
   a. In the **Name** field, enter **Threats Present Trigger**.

b. Of the **Type** options, select **Required.**

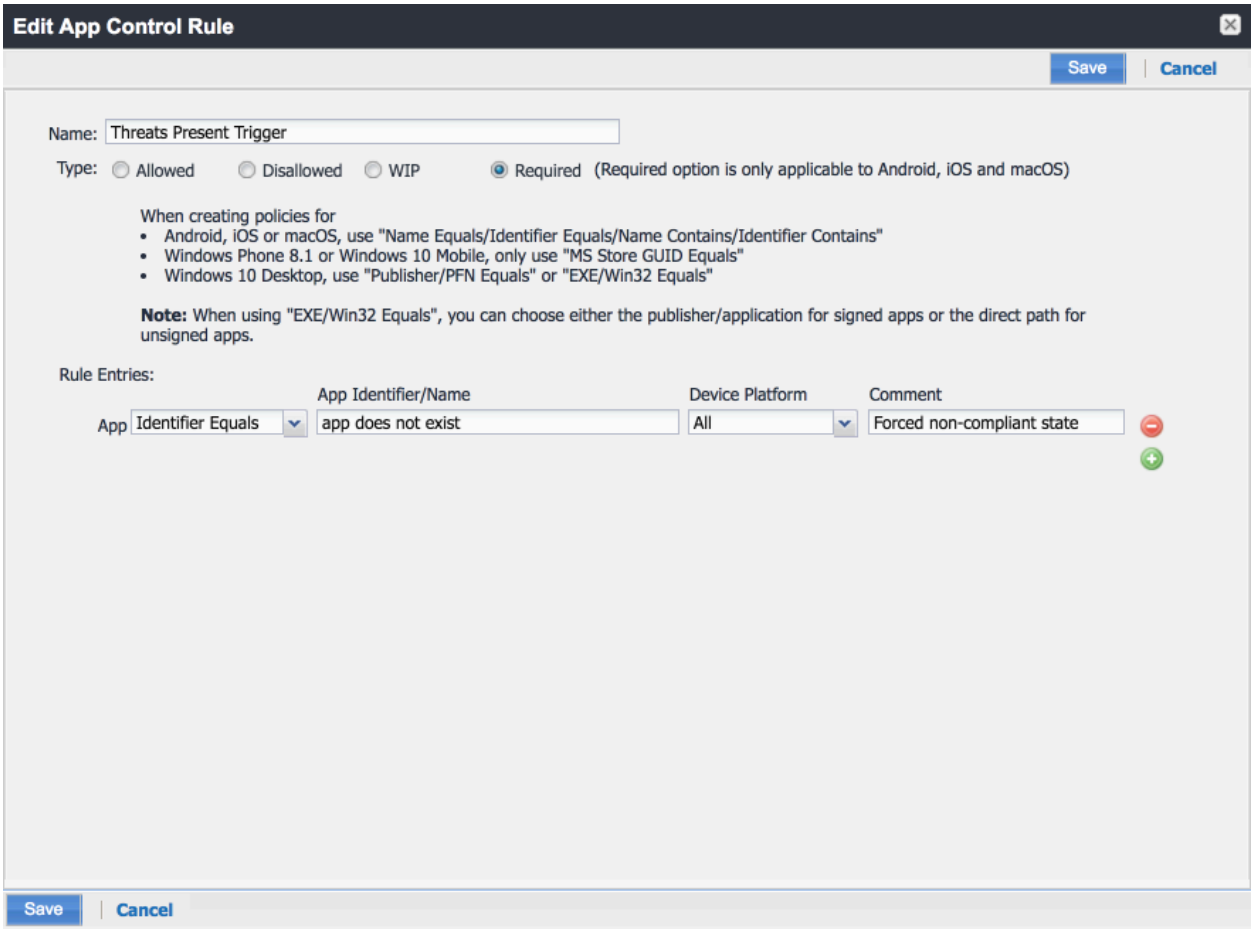
c. In the **App Identifier/Name** field enter **app does not exist.**

d. In the **Device Platform** drop-down menu, select **All**.

e. In the **Comment** field, optionally enter **Forces non-compliant state.**

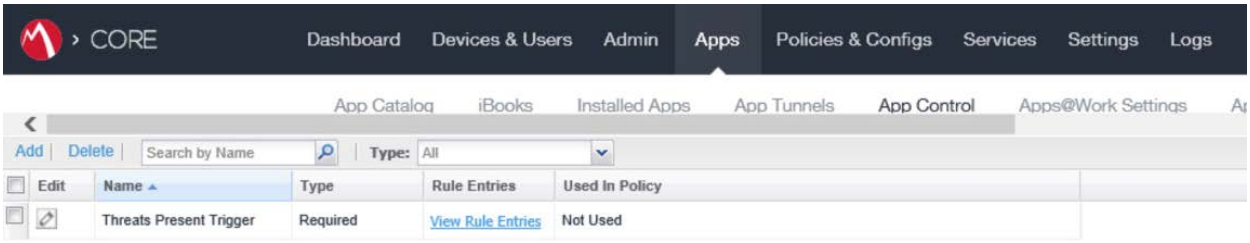
f. Click **Save.**

Figure 2-122 MobileIron App Control Rule



4. The new app control rule should now appear on the **Apps > App Control** page.

Figure 2-123 MobileIron App Control Rule

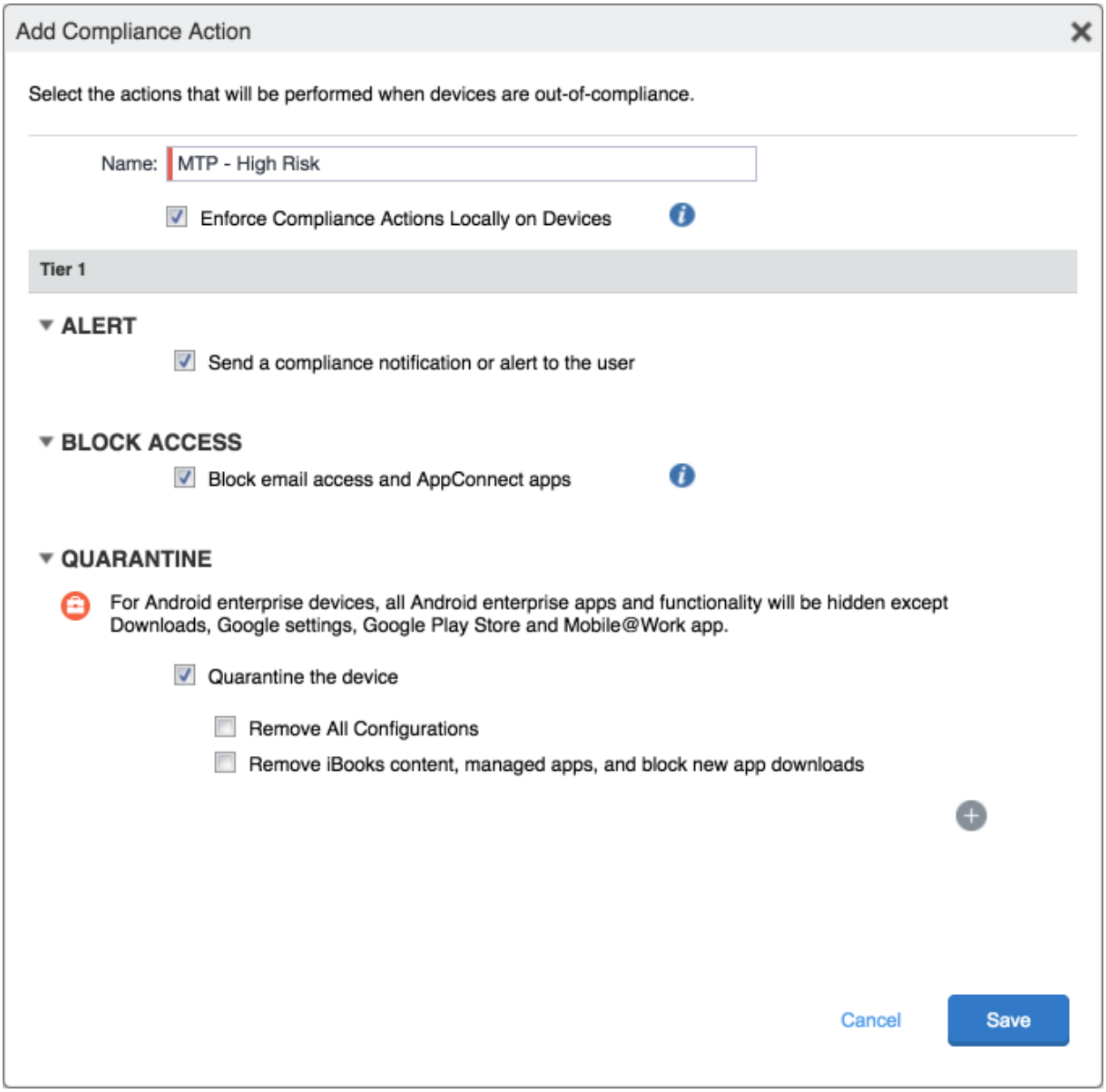


2.7.7.2 Add MobileIron Compliance Actions

A Compliance Action defines what actions MobileIron will take when an App Control policy, like the one created in the previous section, is violated by a managed mobile device. The following steps will create and configure an example Compliance Action in response to the MTP - High Risk App Control rule. Note that a single Compliance Action can be associated with multiple App Control rules if the same response would be configured for each. Otherwise, a new Compliance Action should be created.

1. In the **MobileIron Admin Portal,** navigate to **Policies & Configs > Compliance Actions.**
2. Select **Add;** the **Add Compliance Action** dialogue opens.
3. In the **Add Compliance Action** dialogue:
    a. In the **Name** field, add a description of the compliance action; we recommend indicating the kind of action taken. This example illustrates creating a compliance action that will be associated with the **MTP - High Risk** label.
    b. Select the **Enforce Compliance Actions Locally on Devices** check box.
    c. Select the **Send a compliance notification or alert to the user** check box.
    d. Select the **Block email access and AppConnect apps** check box.
    e. Select the **Quarantine the device** check box.
    f. Deselect the **Remove All Configurations** check box.
    g. Click **Save.**

Figure 2-124 MTP High Risk Compliance Action



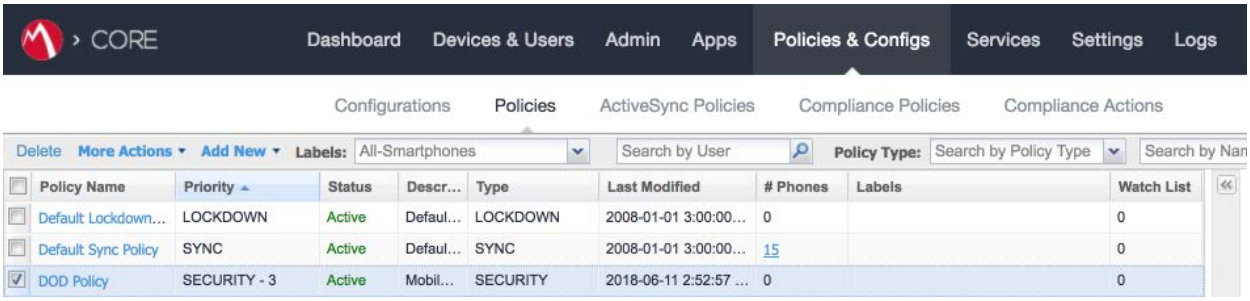
2.7.7.3 Create MobileIron Security Policy for Lookout MES

In addition to potentially defining other controls, such as password requirements, a Security Policy can map a Compliance Action to an App Control rule, enabling MobileIron to execute the configured actions whenever a device that applies the policy violates the App Control rule. The following steps will create a

new Security Policy for Lookout MES High Risk devices using an existing policy as a baseline from which to apply more stringent controls.

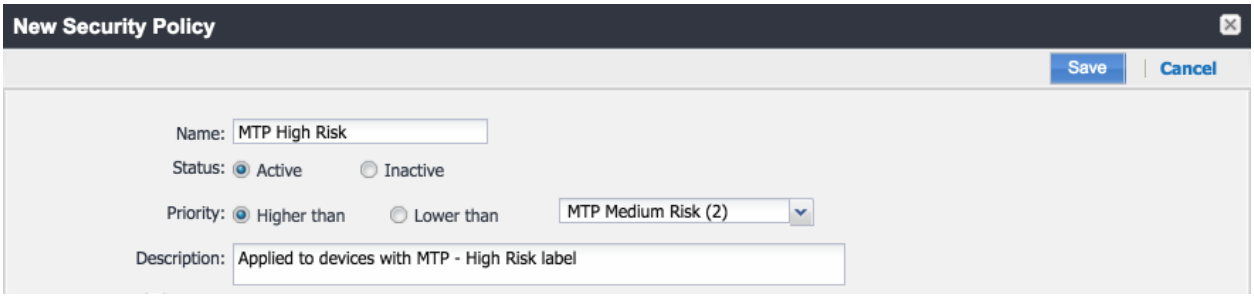
1. In the **MobileIron Admin Portal**, navigate to **Policies & Configs > Policies.**
2. On the **Policies** page:
   a. Select the security policy to use as a baseline.
   b. Select **More Actions > Save As**; this opens the **New Security Policy** dialogue.

Figure 2-125 Baseline Policy Selection



   c. In the **New Security Policy** dialogue:
      i. In the **Name** field, rename the policy to **MTP - High Risk.**
      ii. In the **Priority** drop-down menu, select a current policy. The new policy will be prioritized based on the selection. In this example, the new policy is higher than the **MTP Medium Risk** policy. **Note:** for ease of setting priority, it is recommended to add new security policies in ascending order (lowest to highest priority).

Figure 2-126 MTP High Risk Policy

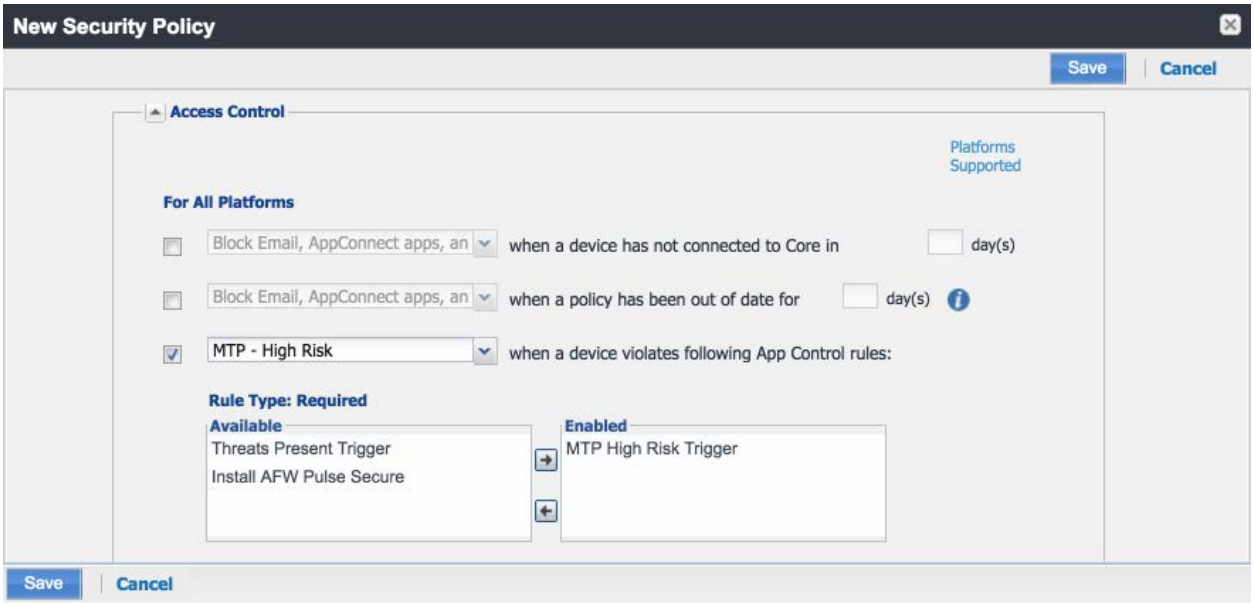


      iii. Under **Access Control > For All Platforms** section:

1. For the **when a device violates the following app control rules** drop-down menu, select the **MTP - High Risk** compliance action.
2. In the **Available** list of app control rules, highlight **MTP High Risk Trigger.**
3. Select the **right arrow** to move MTP High Risk Trigger item into the **Enabled List.**

iv. Click **Save.**

Figure 2-127 Security Policy Trigger

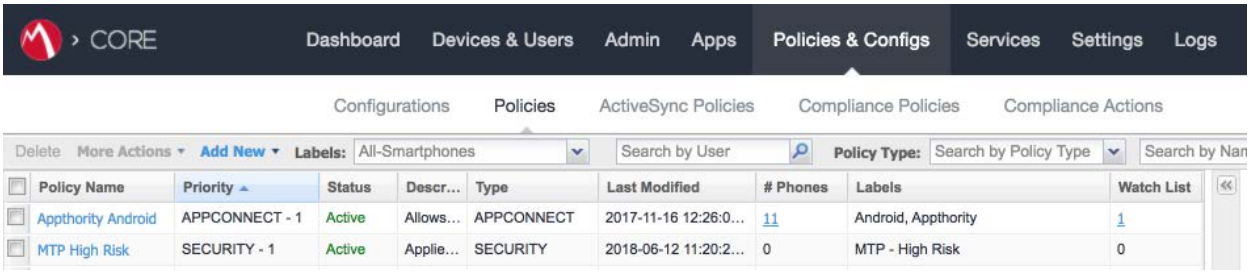


2.7.7.4 Apply Lookout MES Label to MobileIron Security Policy

The following steps will apply the MTP - High Risk label to the security policy created in the previous section. As a result, once the Lookout cloud service applies the label to any device with a detected high-risk threat and such a device checks in with MobileIron, the security policy will automatically be applied to it (provided it is of higher priority than the policy currently applied). In turn, that will cause the MTP High Risk Trigger App Control policy to be violated and the MTP - High Risk Compliance Action to be taken. Once Lookout detects that the threat has been resolved, the Lookout service will remove the MTP - High Risk label, and on device check-in, MobileIron will then apply the next-lower-priority security policy.

1. In the **MobileIron Admin Portal**, navigate to **Policies & Configs > Policies.**
2. On the **Policies** page:
   a. Select the check box in the **MTP High Risk** security policy item.
   b. Select More **Actions > Apply to Label**; the Apply to Label dialogue opens.

Figure 2-128 Policy List

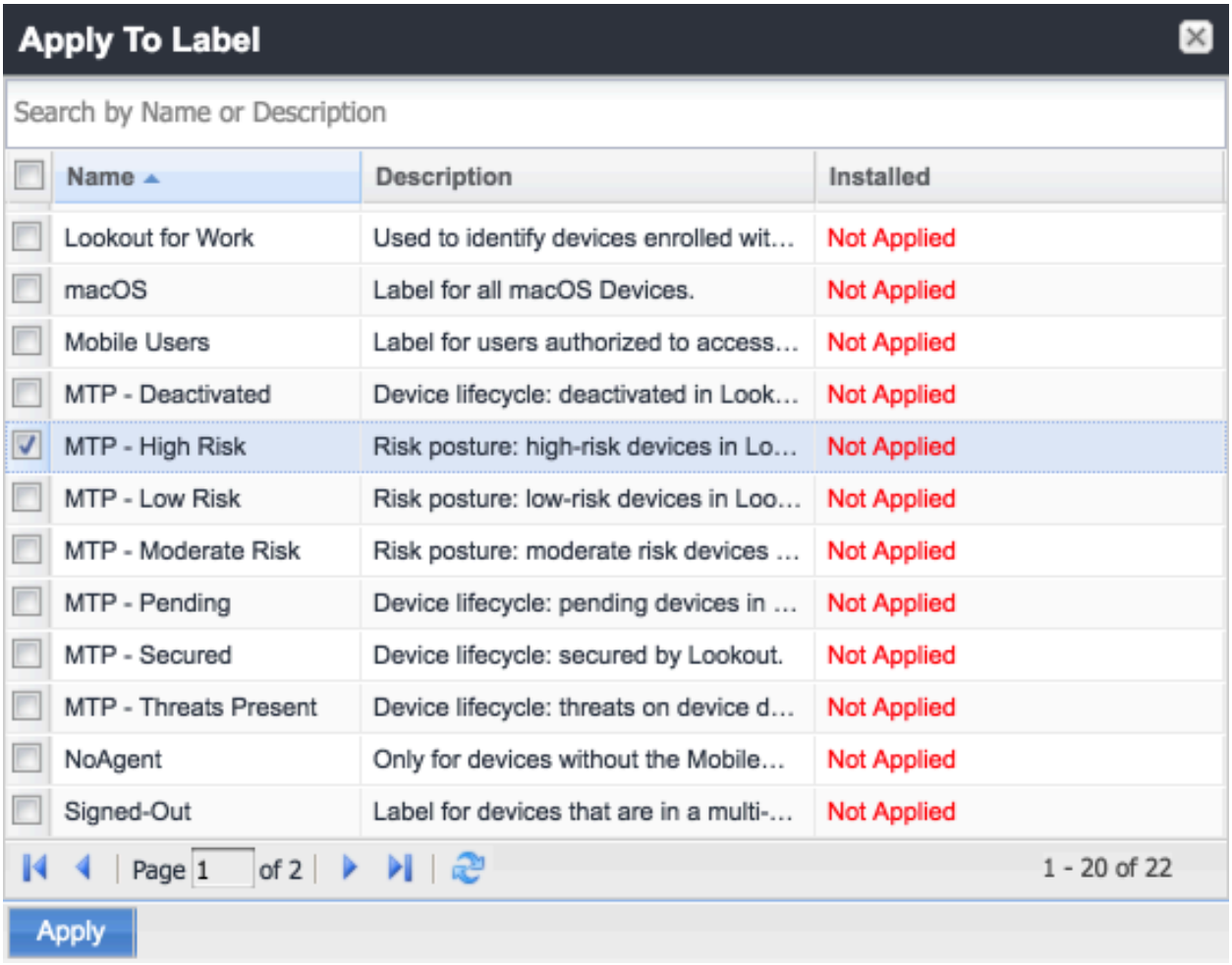


c. In the **Apply to Label** dialogue:

   i. Select the check box for the **MTP - High Risk** item.

   ii. Select **Apply.**

Figure 2-129 Apply To Label Dialogue



2.8 Integration of Appthority Mobile Threat Detection with MobileIron

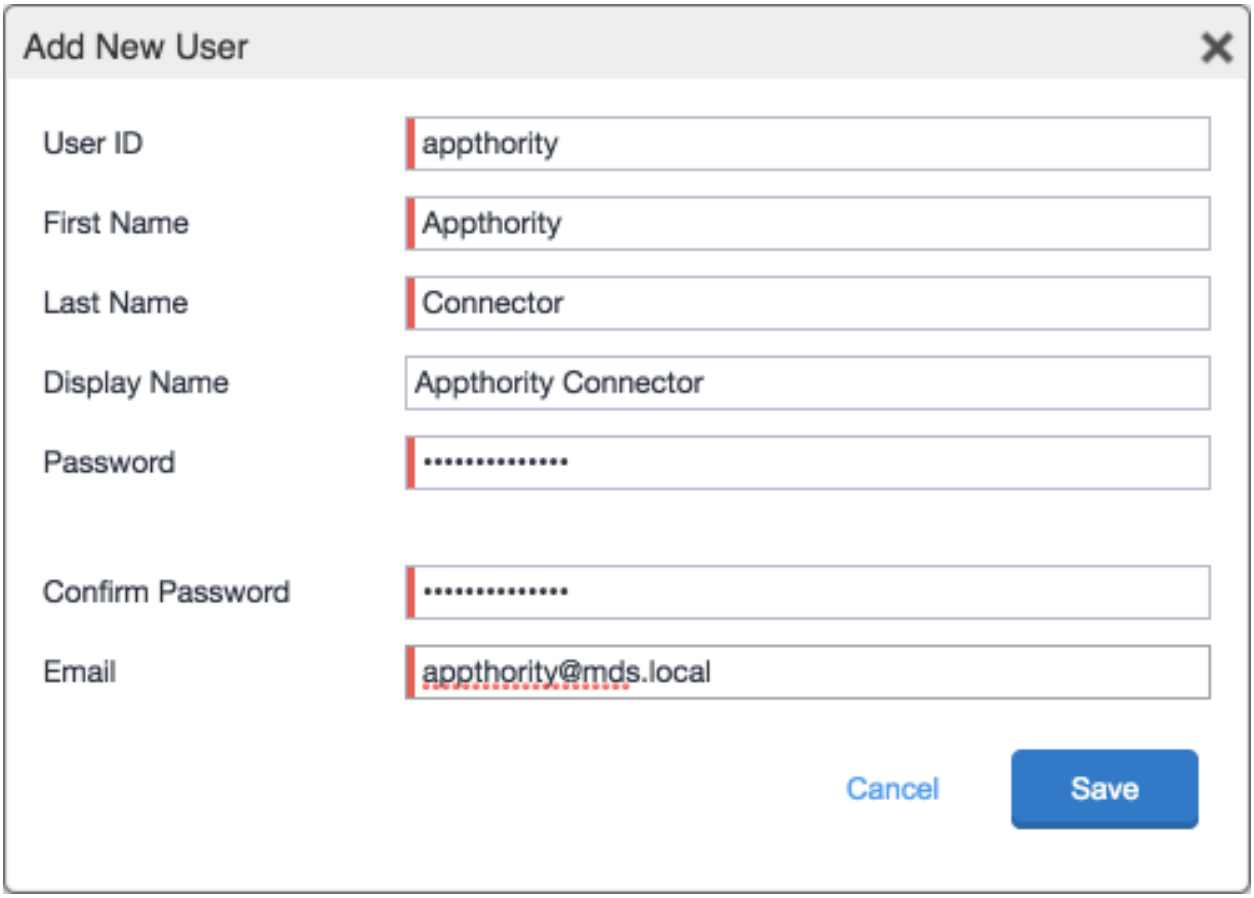
Appthority provides an on-premises connector for MobileIron that runs as a Docker container on RedHat Linux. The connector uses the MobileIron API to obtain information on managed devices and their installed apps, which is then synchronized with the cloud service instance to obtain app and device risk scores, which are assigned to devices using custom attributes. The following sections provide the steps to create a MobileIron API account and deploy and configure the Appthority connector.

2.8.1 Create MobileIron API Account for Appthority Connector

The following steps will create an administrative account that will grant Appthority the specific permissions it requires within MobileIron.

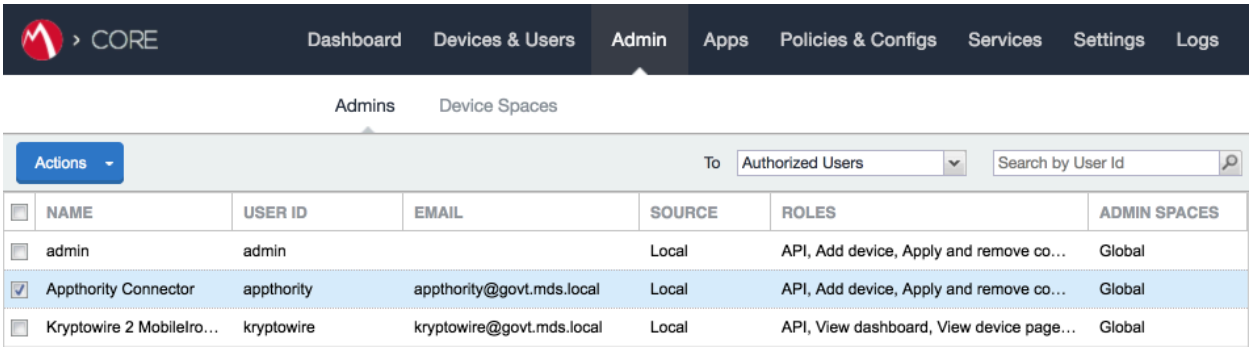
1. In the **MobileIron Admin Portal**, navigate to **Devices & Users > Users.**
2. On the **Users** page:
    a. Select **Add > Add Local User**; the **Add New User** dialogue opens.
    b. In the **Add New User** dialogue:
        i. In the **User ID** field, enter the **user identity** the Appthority connector will authenticate under. Our implementation uses a value of **Appthority.**
        ii. In the **First Name** field, enter a generic first name for **Appthority.**
        iii. In the **Last Name** field, enter a generic last name for **Appthority.**
        iv. In the **Display Name** field, optionally enter a displayed name for this user account.
        v. In the **Password** field, provide the password the **Appthority** identity will use to authenticate to MobileIron.
        vi. In the **Confirm Password** field, enter the same password as in the preceding step.
        vii. In the **Email** field, provide an email account for the **Appthority** identity; this should be an account under the control of your organization.
        viii. Click **Save.**

Figure 2-130 Appthority User Settings



3. In the **MobileIron Admin** Portal, navigate to **Admin.**
4. On the **Admin** page:
   a. Enable the account you created for **Appthority** during Step 2.
   b. Select **Actions > Assign to Space**; this opens the **Assign to Space** dialogue for the **Appthority** account.

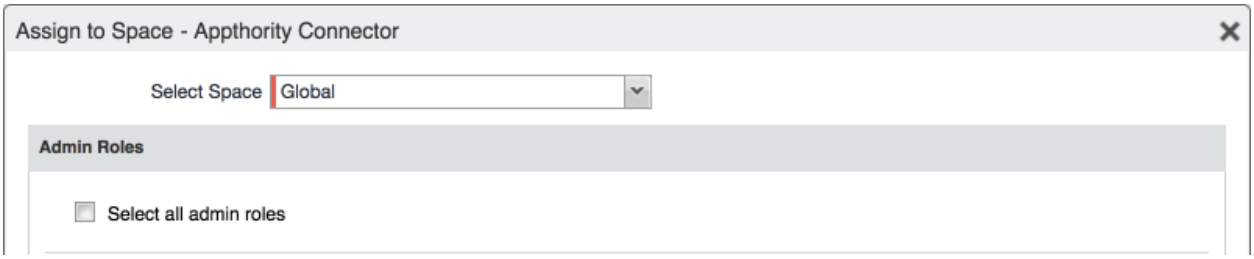
Figure 2-131 Appthority Connector User



c. In the **Assign to Space** dialogue:

i. In the **Select Space** drop-down menu, select **Global.**

Figure 2-132 Appthority Connector Space Assignment



ii. **Enable** each of the following settings:

Device Management > View device page, device details
Privacy Control > View apps and ibooks in device details
App Management > Apply and remove application label
Other Roles > API

iii. Click **Save.**

2.8.2 Deploy Appthority Connector Open Virtualization Appliance

One deployment option for the Appthority connector is a pre-built RedHat virtual machine distributed as an Open Virtualization Appliance (OVA). We imported the OVA into our virtual lab environment following guidance provided in *Connector On-Premises: Virtual Machine Setup* available from the Appthority support portal: https://support.appthority.com/.

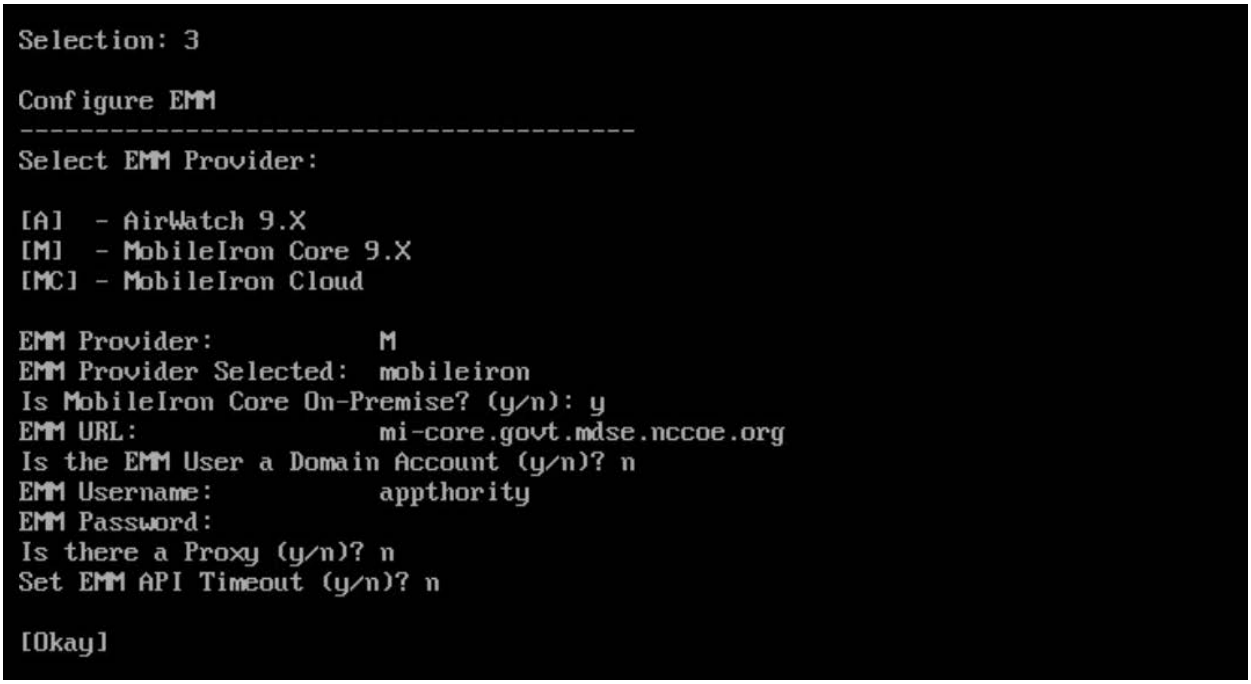
2.8.3 Run the Enterprise Mobility Management Connector Deployment Script

Once the Appthority docker container is running, the setup script will configure it to use the MobileIron API account created previously. Detailed instructions on using the script are available on the Appthority support portal at https://help-mtp.appthority.com/SetUp/EMM/EMM_Script/Run-EMMDeployScript.html. The first two steps ask for Appthority-supplied credentials necessary to verify your subscription and to link the connector with the correct instance of their cloud service. In the third step you will provide details to integrate with your on-premises instance of MobileIron core. Our results from completing the third step are shown below.

1. **Obtain** a copy of *Run the EMM Connector Deployment Script* from the Appthority support portal at https://help-mtp.appthority.com/SetUp/EMM/EMM_Script/Run-EMMDeployScript.html (authentication to the portal is required).

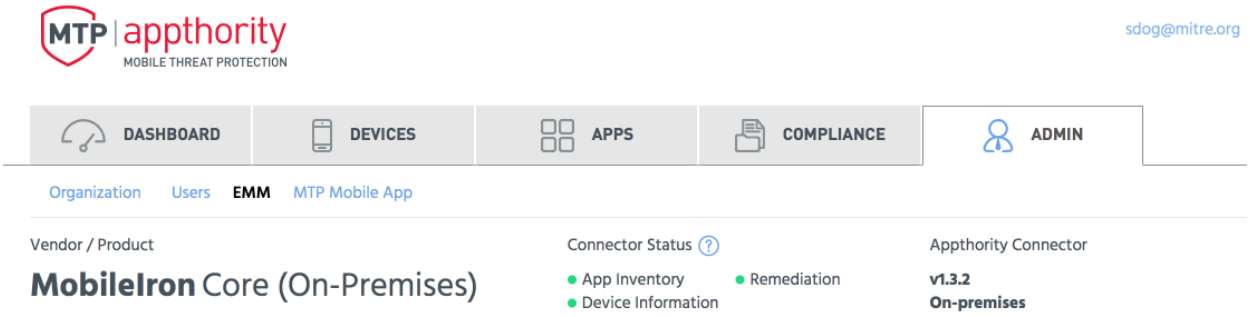
2. **Execute** the script. The third step in the script involves providing settings to enable the Appthority Connector to communicate with MobileIron Core. The results of our completion of that step are provided below as a reference.

Figure 2-133 Appthority Connector CLI Configuration



3. Once the script has been completed, verify successful synchronization with the Appthority cloud service by accessing the Appthority MTP portal and navigating to **Admin > EMM** and viewing items under **Connector Status.**

Figure 2-134 Appthority EMM Connector Status



2.9 Registering Devices with MobileIron Core

In this scenario, the employee manages their own personal apps, data, and many device functions. The organization manages work-related apps and data, and has control over specific device functions, such as requiring a complex device unlock PIN or being able to remotely wipe a lost device. The mechanisms to achieve similar security characteristics between iOS and Android devices differ.

2.9.1 Supervising and Registering iOS Devices

Many MDM-based security controls are only applicable to iOS devices that are running in Supervised Mode. The following steps outline how to place an iOS device into this mode, and then register with MobileIron Core.

2.9.1.1 Resetting the iOS Device

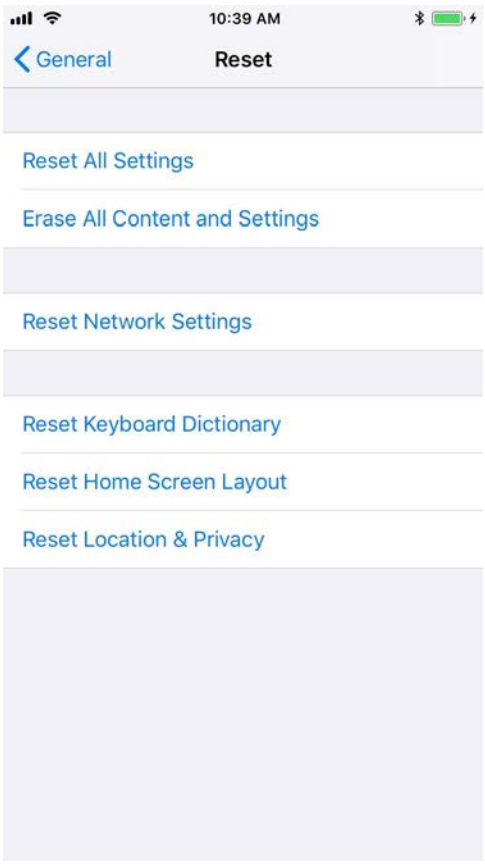
Before a device can be placed into Supervised Mode, it must be in a factory-reset state with the Activation Lock on the device removed. If Activation Lock is in-place, Configurator 2 will be unable to place the device into Supervised Mode.

2.9.1.1.1 Reset an Unsupervised Device Using Settings App

If a device is not already in Supervised Mode, it is recommended to have the current device user manually reset and activate the device to factory settings using the following steps:

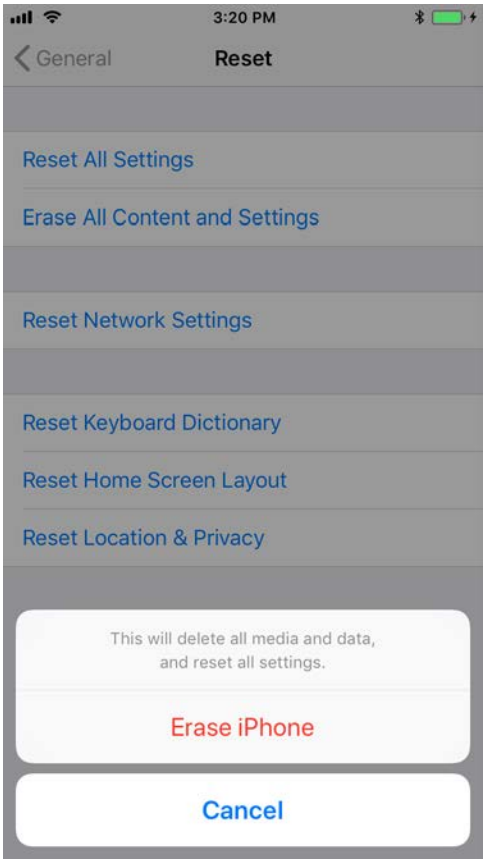
1. Navigate to **Settings > General > Reset.**
2. Select **Erase All Content and Settings.**

Figure 2-135 iOS Reset Screen



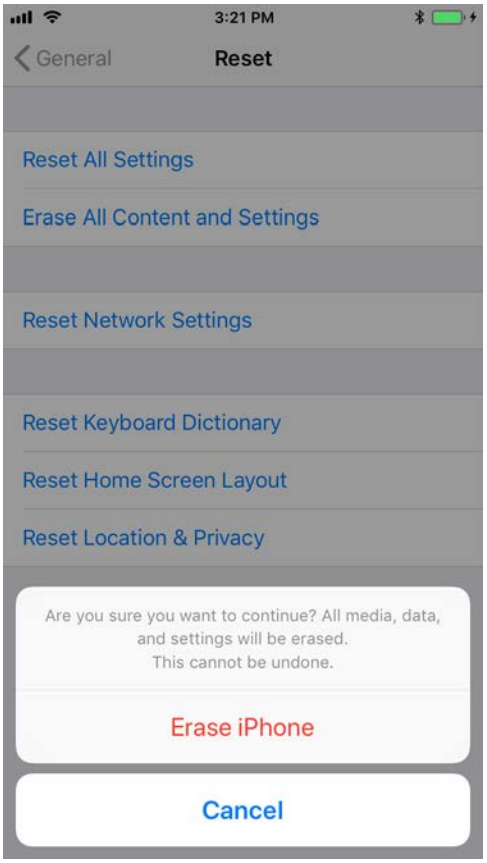
3. At the warning that this will delete all media and data and reset all settings, select **Erase iPhone.**

Figure 2-136 Erase iPhone Confirmation



4. At the warning that all media, data, and settings will be irreversibly erased, select **Erase iPhone.** Once the reset process is complete, the device will reboot and need to be activated.

Figure 2-137 Erase iPhone Final Confirmation



5. Once the device displays the **Hello** screen, press the **Home key.**
6. At the **Select Your Language** screen, select **English.**
7. At the **Select Your Country or Region** screen, select **United States.**
8. At the **Quick Start** screen select **Set up Manually.**
9. At the **Choose a Wi-Fi Network** screen, select the **Service Set Identifier (SSID)** for the network and authenticate to your on-premises SSID Wi-Fi network; the device should indicate it is being activated. **Note:** you may need to attempt activation again if there is a delay in the device establishing connectivity to the internet.
10. **Stop** at the **Data & Privacy** screen. At this point, the device should be placed into **Supervised Mode** using **Configurator 2.**

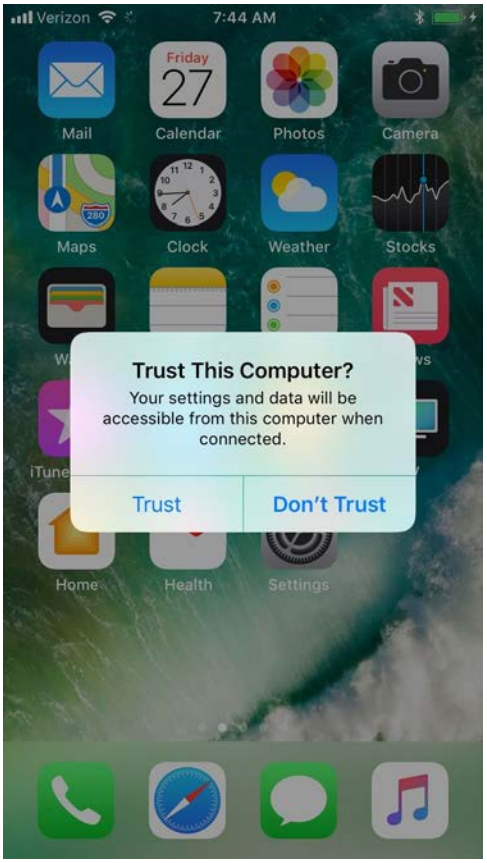
2.9.1.1.2 Reset a Supervised Device Using Configurator 2

1. **Connect** the iOS device with the system running **Configurator 2** over **Universal Serial Bus (USB).**
2. On the device at the **Enter Passcode** screen (if locked), enter the **device unlock passcode.**

Figure 2-138 Entering iOS Passcode

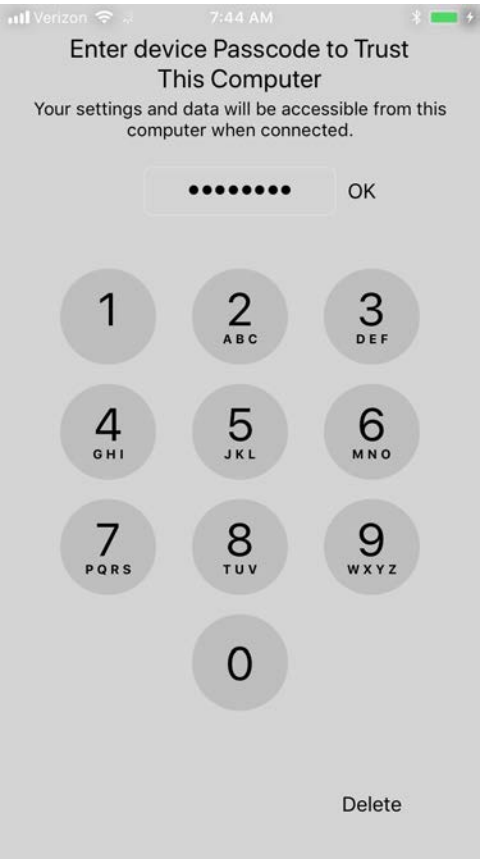
3. At the **Trust this Computer?** dialogue, select **Trust.** Note that this step, along with step that follows, is only encountered the first time a device is paired with a given system.

Figure 2-139 iOS Trust Computer Confirmation



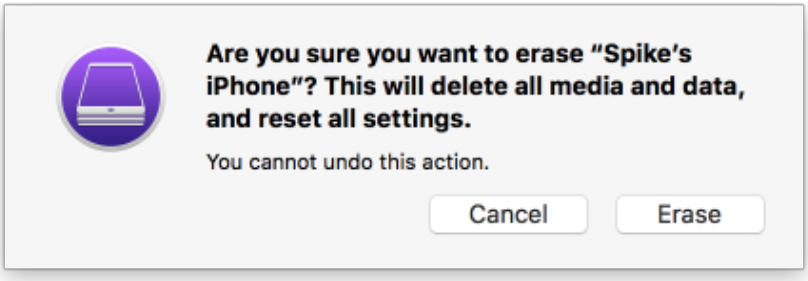
4. At the **Enter Device Passcode to Trust This Computer** screen:
    a. **Enter** the device unlock passcode.
    b. Click **OK**.

Figure 2-140 Entering Passcode to Trust Computer



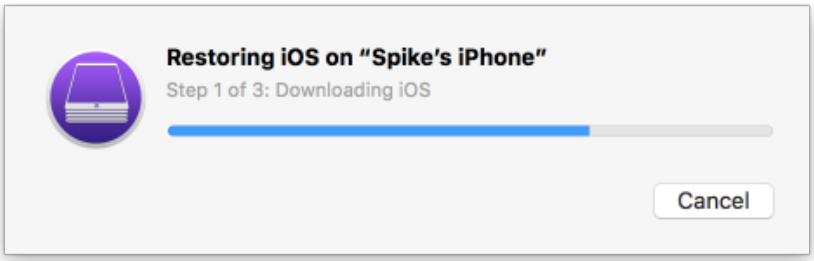
5. In **Configurator 2**, select the **representation** of the connected device.
6. From the **context** menu, select **Advanced > Erase All Content and Settings**.
7. At the **Are you sure you want to erase "<device name>"?** dialogue, select **Erase.**

Figure 2-141 Configurator 2 Erase Confirmation



8. At the **License Agreement** screen:
    a. **Review** the license agreement.
    b. Select **Accept** to agree to the license and continue using the software**.**
9. **Configurator 2** will take several minutes to restore the device to factory default settings. **Configurator 2** will also activate the device following restoration.

Figure 2-142 Restoring iPhone

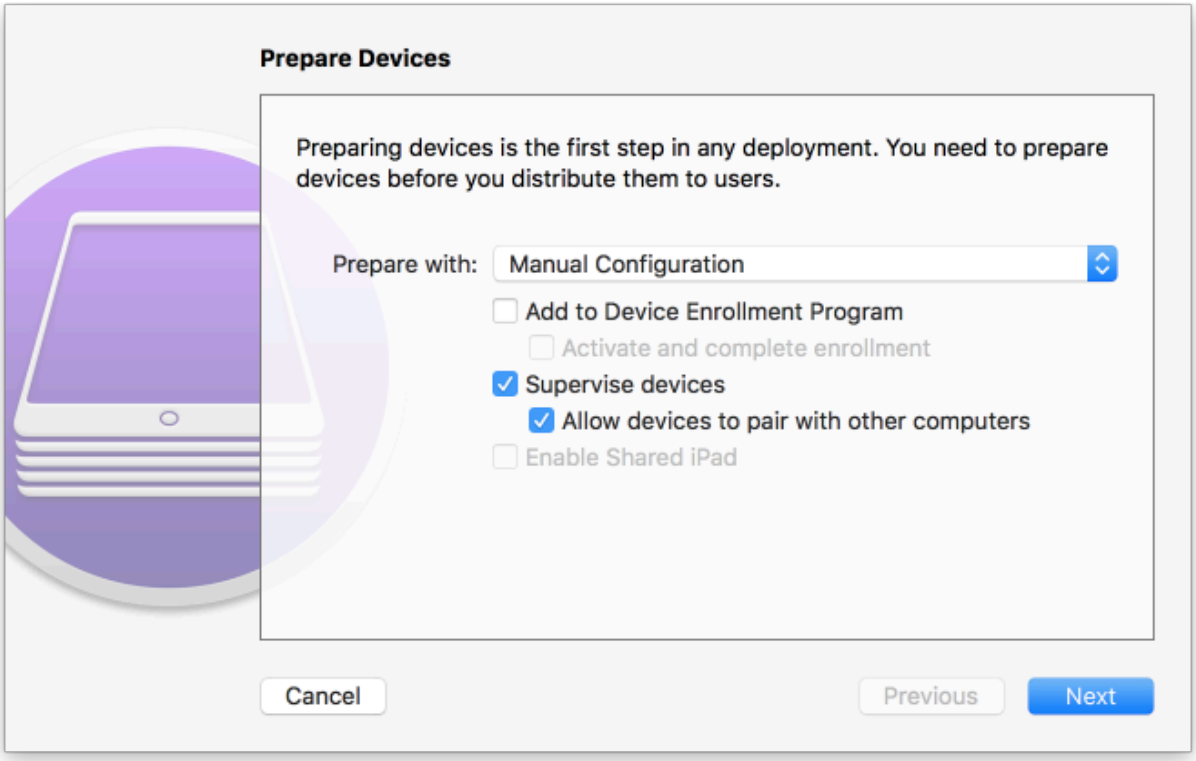


2.9.1.2 Placing an iOS Device into Supervised Mode

iOS devices that have been factory reset and subsequently activated (the Activation Lock has been removed) can be placed into Supervised Mode using software available from Apple, Configurator 2, by the following steps:

1. **Pair** the target iOS device with the system running Configurator 2 over USB.
2. Navigate to **Configurator 2 > Unsupervised**; a representation of the connected device should appear.
3. On the **All Devices** tab:
    a. **Select** the representation of the paired device.
    b. From the **context** menu, select **Prepare**; a wizard opens to guide the process.
4. For the **Prepare Devices** step:
    a. **Enable** Supervise Devices.
    b. Select **Next.**

Figure 2-143 Device Preparation Options

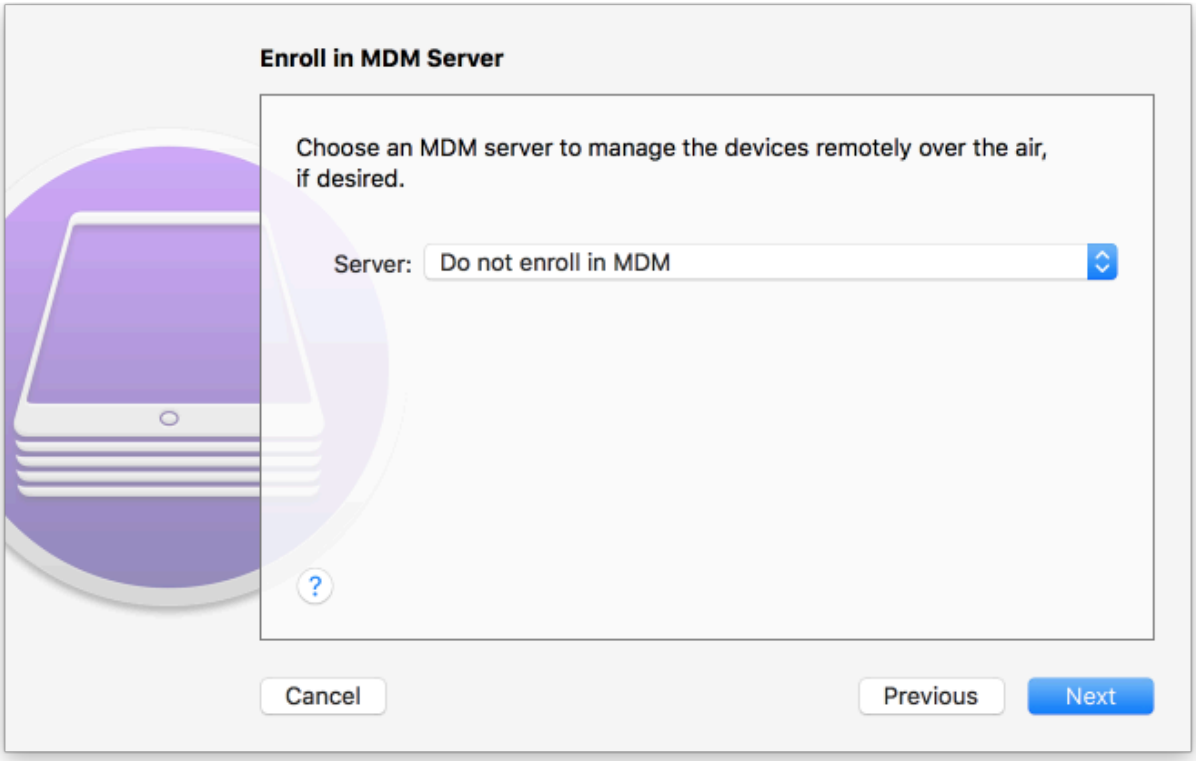


5. For the **Enroll in MDM Server** step:

   a. Ensure the **Server** drop-down menu has **Do not enroll in MDM** selected.

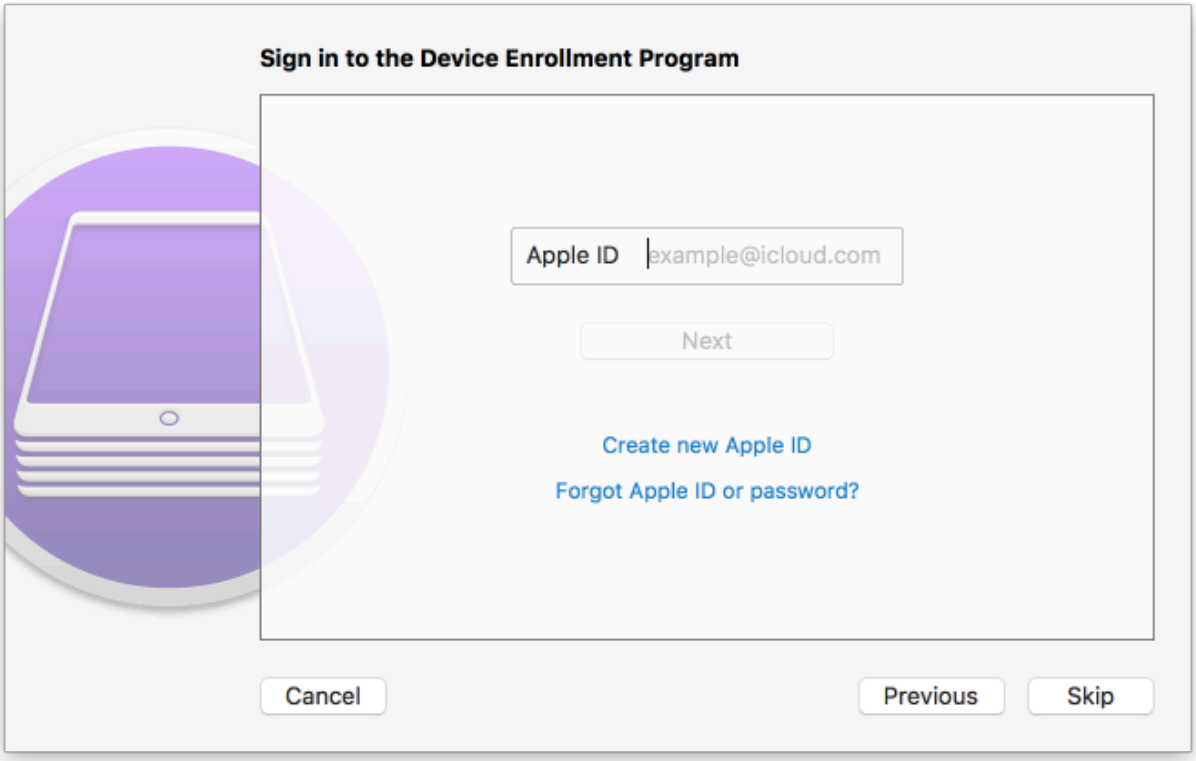
   b. Select **Next.**

Figure 2-144 MDM Server Selection



6. For the **Sign into the Device Enrollment Program** step, select **Skip.**

Figure 2-145 Signing into Apple Account

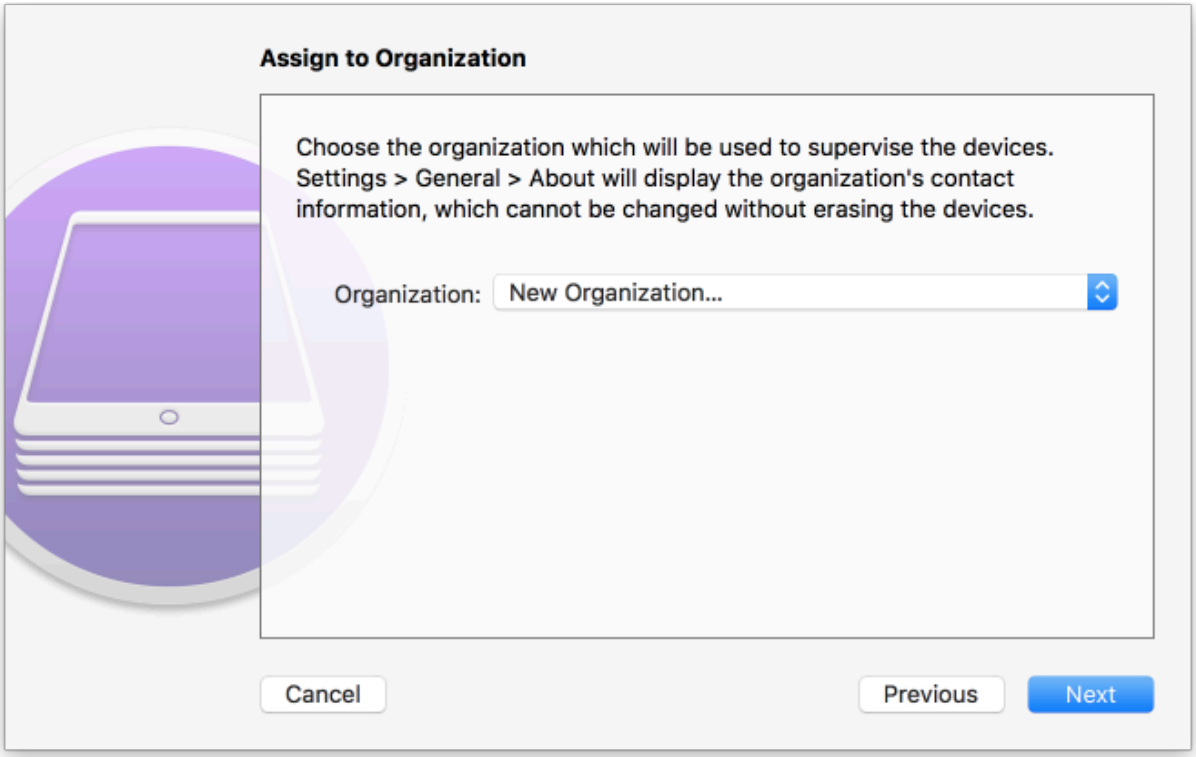


7. For the **Assign to Organization** step:

   a. If you have previously created your organization, select **Next** and continue with Step 9.

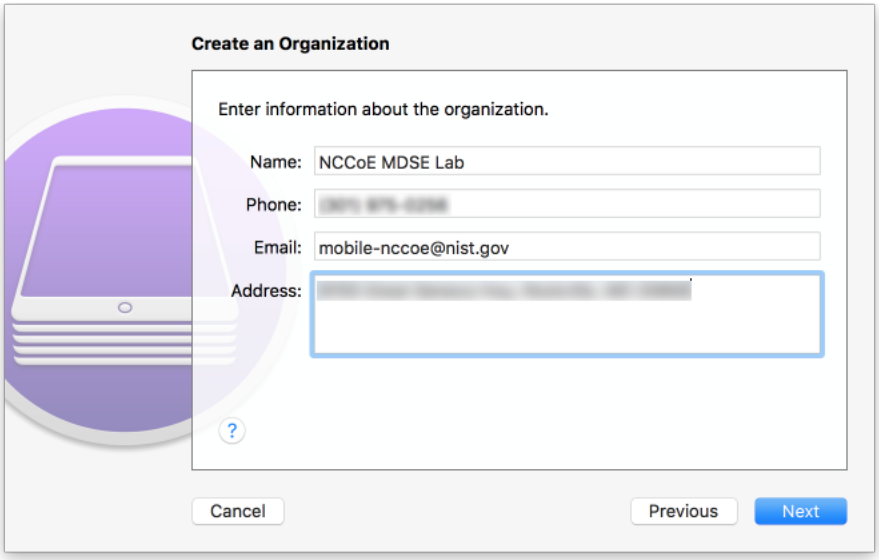
   b. If you have not created your organization, from the **Organization** drop-down menu, select **New Organization...**

Figure 2-146 Organization Assignment Dialogue



8. At the **Create an Organization screen:**
   a. In the **Name** field, enter the name of your organization.
   b. In the **Phone** field, enter an appropriate support number for your mobility program.
   c. In the **Email** field, enter an appropriate support email for your mobility program.
   d. In the **Address** field, enter the address for your organization.
   e. Select **Next.**

Figure 2-147 Creating an Organization



9. If your organization has established a digital identity for placing devices into **Supervised Mode:**

    a. Continue with Step 10. **Note:** that the same digital identity must be used for any given device.

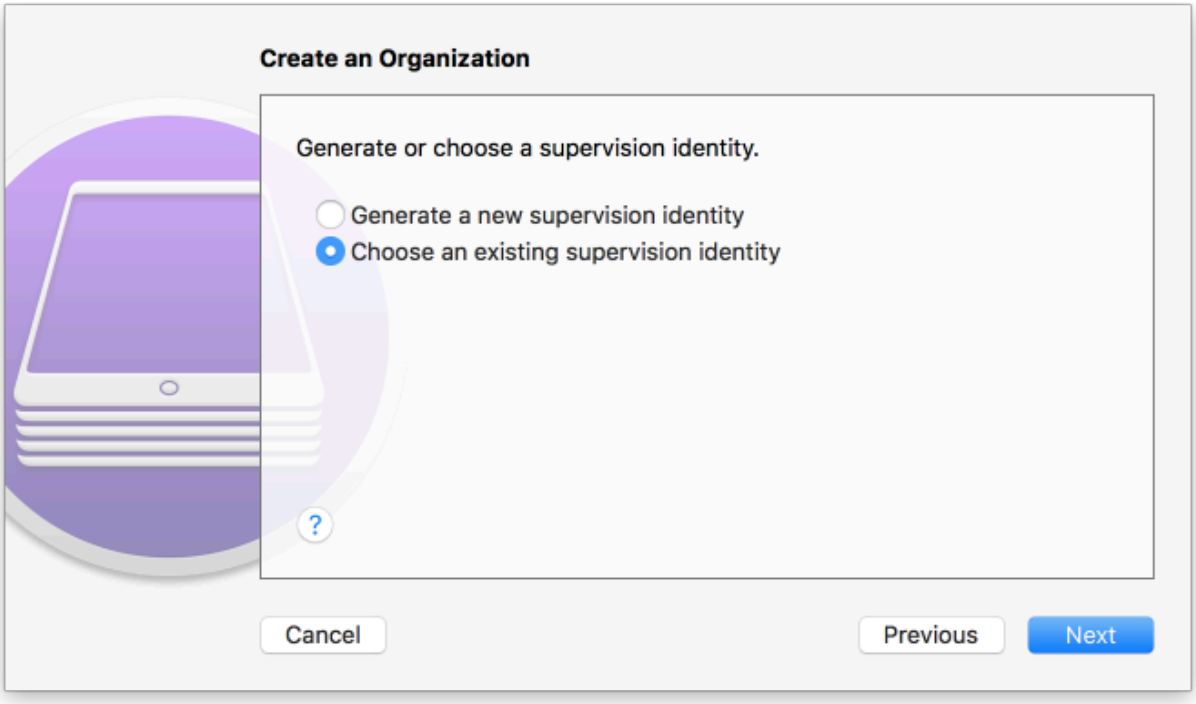
    b. Otherwise, continue with Step 14.

10. In the **Create an Organization** screen:

    a. For the **Generate or choose a supervision identity** option, select **Choose an existing supervision identity**.

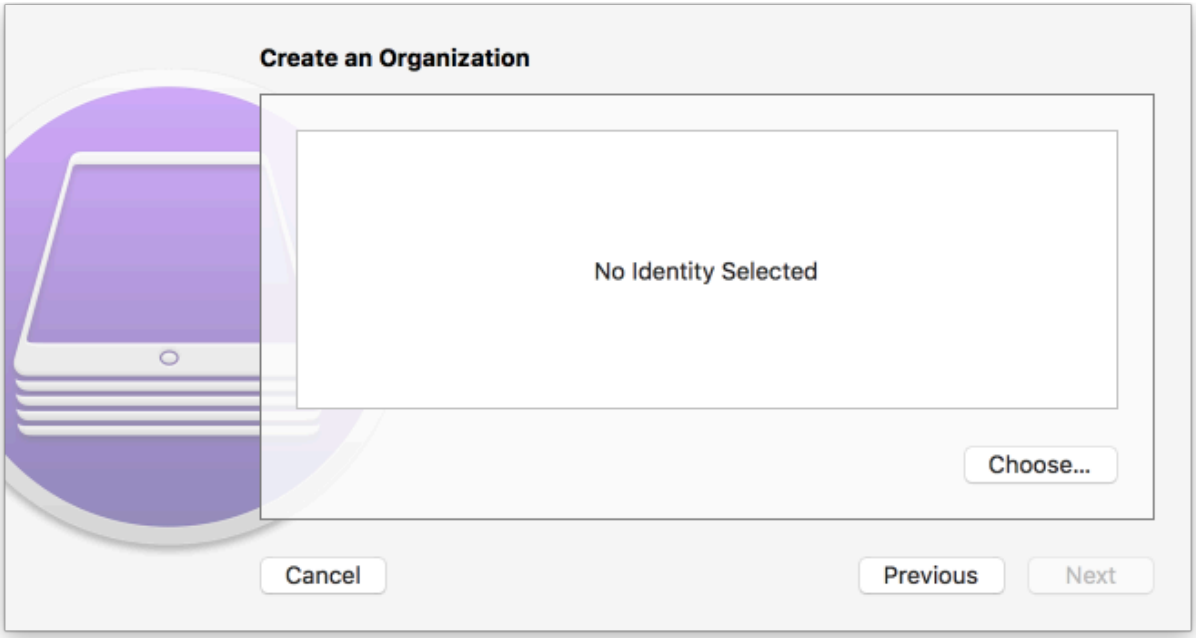
    b. Select **Next.**

Figure 2-148 Supervisory Identity Configuration



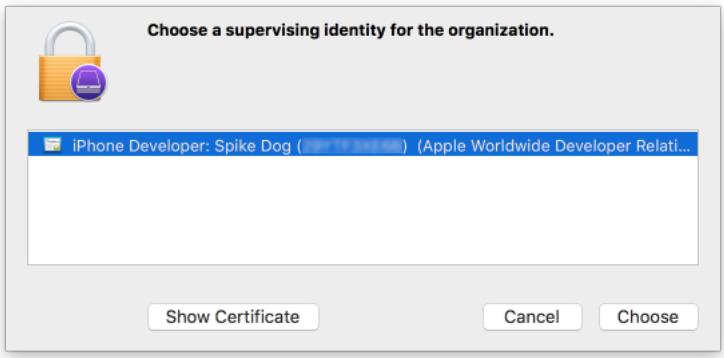
11. Select **Choose...**

Figure 2-149 Organization Selection



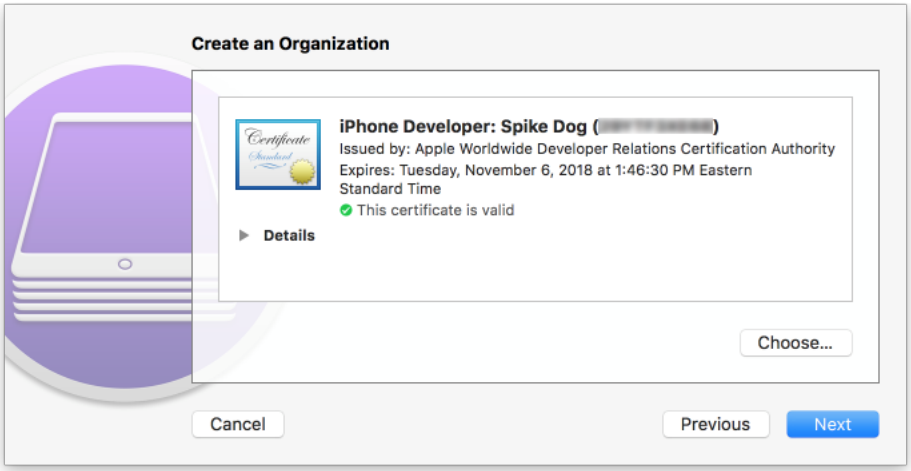
12. At the **Choose a supervising identity for the organization** dialogue:
    a. **Select** the digital certificate from the list of those available to the system.
    b. Select **Choose.**

Figure 2-150 Supervising Identity Selection



13. At the **Create an Organization** screen, select **Next.**

Figure 2-151 Selected Organization

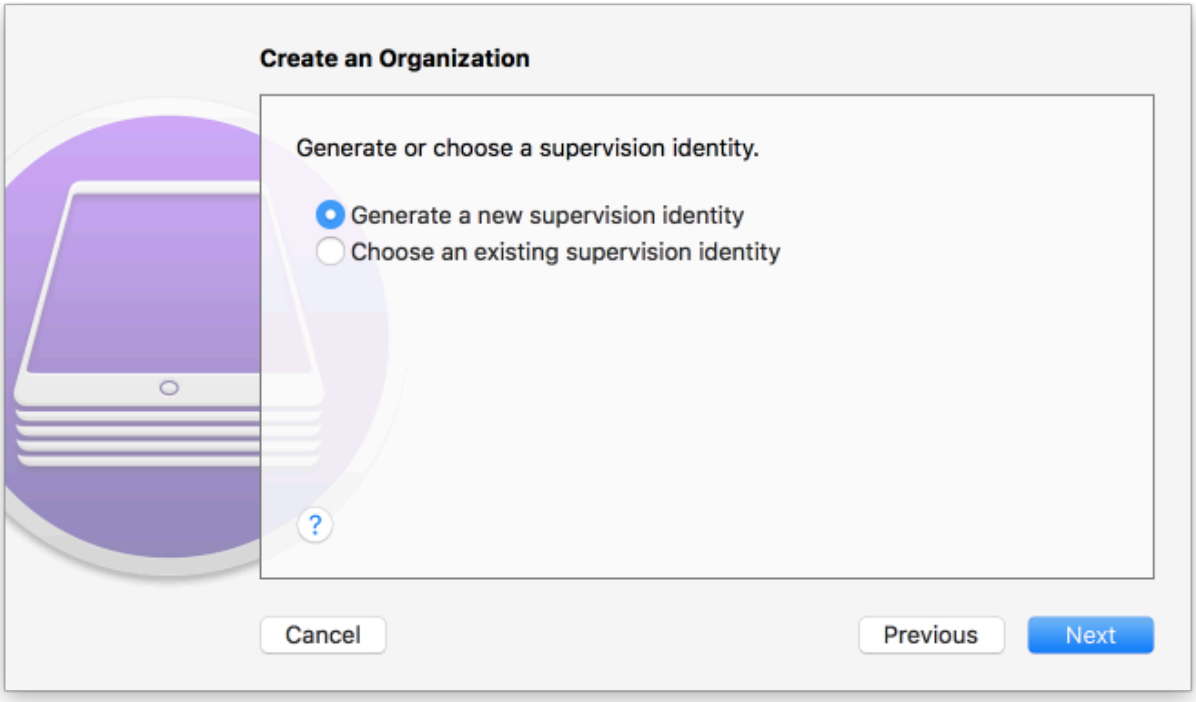


14. In the **Create an Organization** screen:

    a. For the **Generate or choose a supervision identity option**, select **Generate a new supervision identity**.

    b. Select **Next.**

Figure 2-152 Create an Organization Supervision Identity Configuration



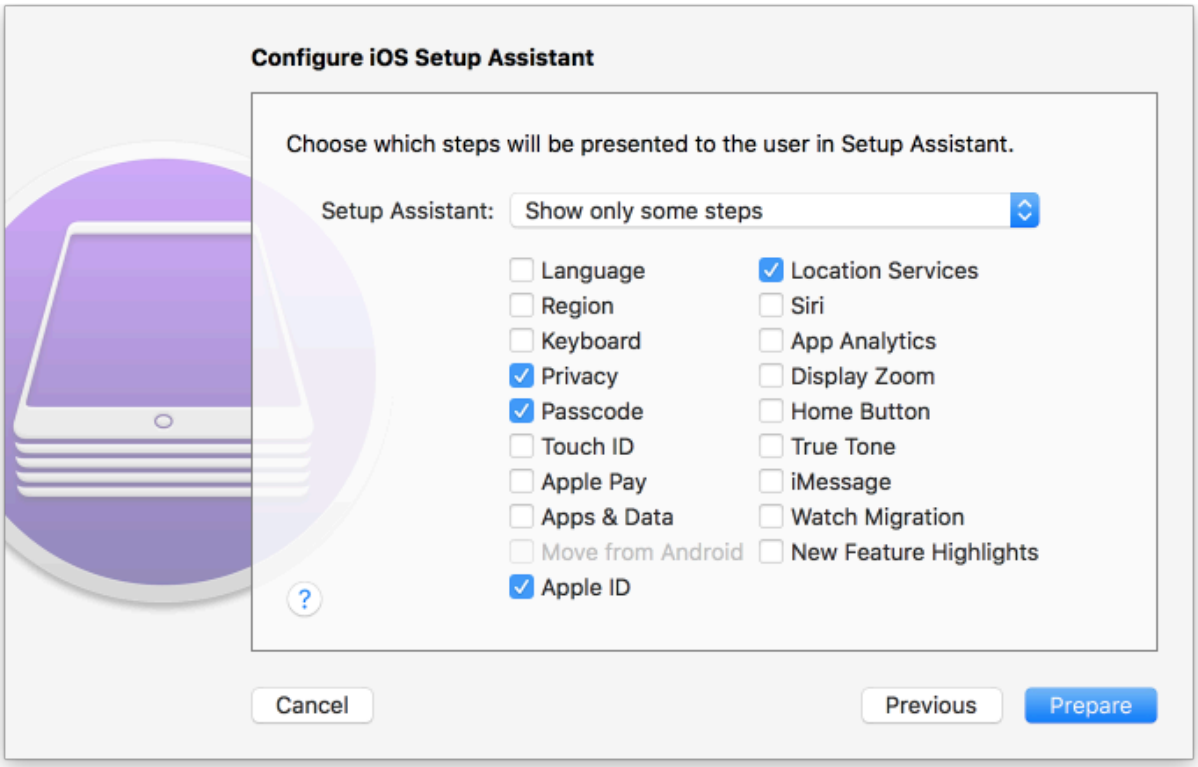
15. For the **Configure iOS Setup Assistant** step:

    a. Ensure the **Setup Assistant** drop-down menu shows **Show only some steps** selected; additional options will appear.

    b. Enable each of the **Privacy**, **Passcode**, **Apple ID**, and **Location Services** check-boxes.

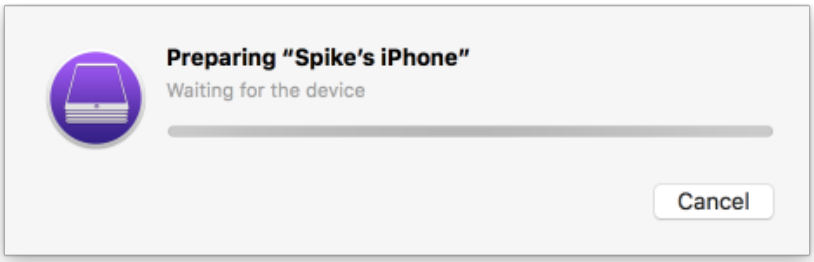
    c. Select **Prepare**.

Figure 2-153 Setup Assistant Configuration



16. **Configurator 2** will take several minutes to prepare the device and place it into **Supervised Mode.**

Figure 2-154 Waiting for iPhone

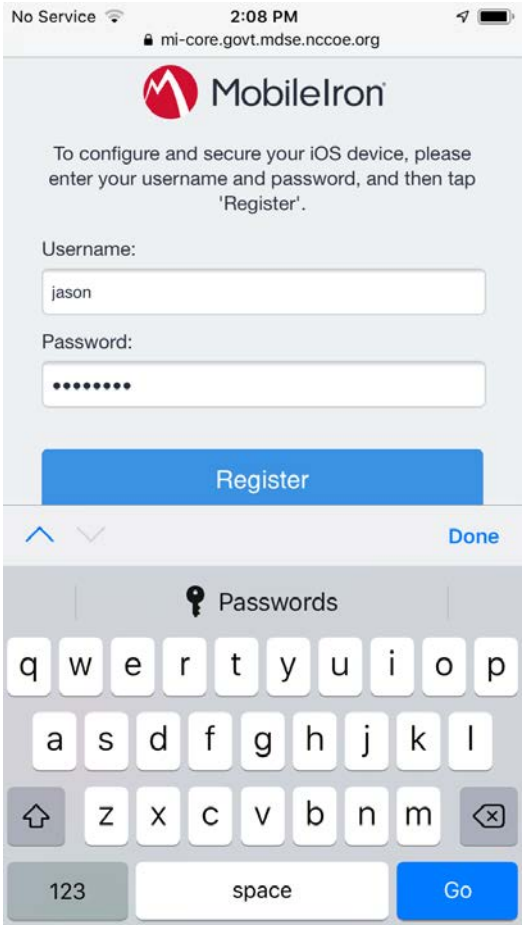


2.9.1.3 Registration with MobileIron Core

The following steps will register an iOS device in Supervised Mode with MobileIron Core, which uses a web-based process rather than the *Mobile@Work* app.

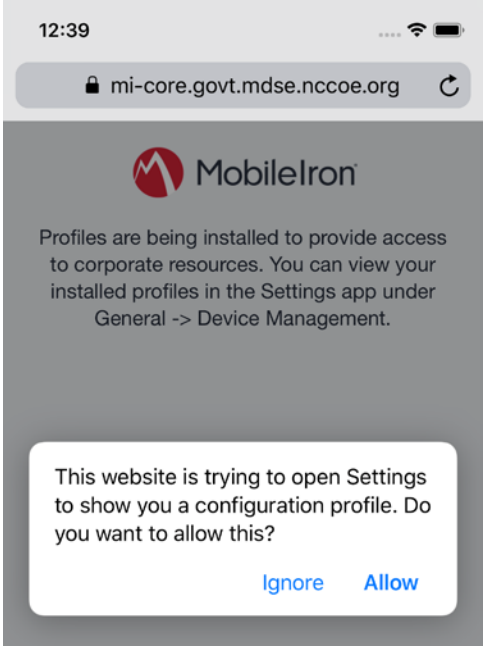
1. Using **Safari**, navigate to the **MobileIron Core** page, substituting <FQDN> for your organization's instance of MobileIron Core. In our example implementation, the resulting URL is *https://mi-core.govt.mdse.nccoe.org/go*.

Figure 2-155 iOS Device MobileIron Registration Page



2. At the **warning** that the web site is trying to open **Settings** to show a configuration profile, select **Allow**; the **Settings** built-in app opens.

Figure 2-156 Opening Settings Confirmation

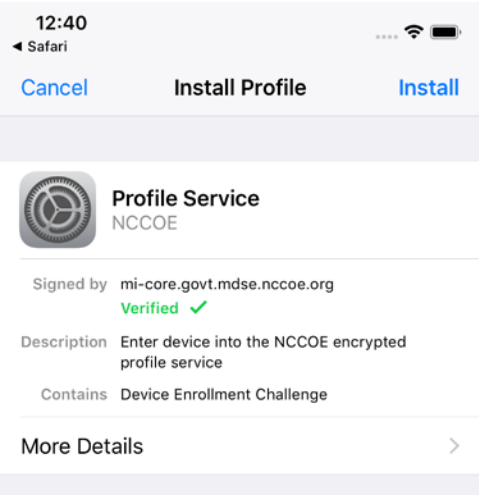


3. At the **Settings > Install Profile** screen:

   a. Verify the **Signed by** field indicates the server identity is **Verified.**

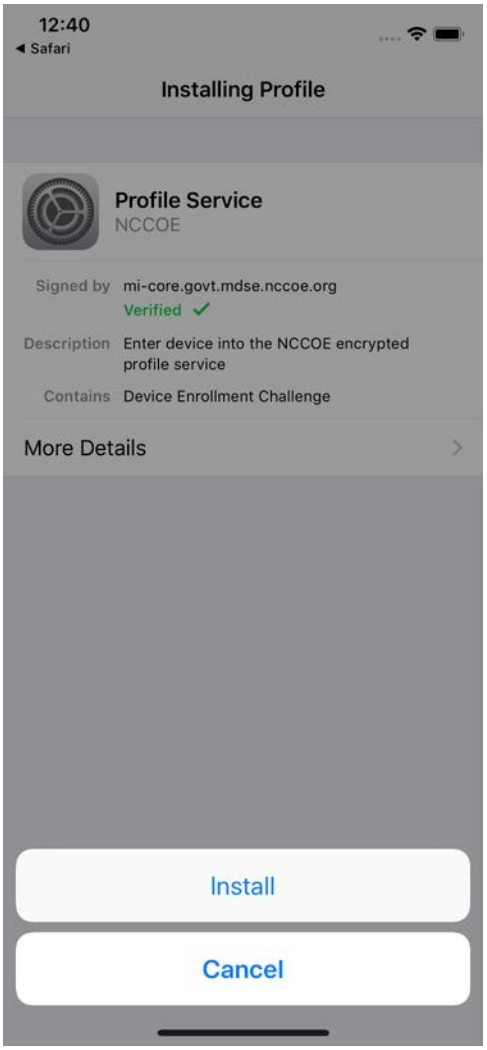
   b. Select **Install**.

Figure 2-157 Profile Installation



4. At the **Installing Profile** screen, select **Install**.

Figure 2-158 Profile Installation

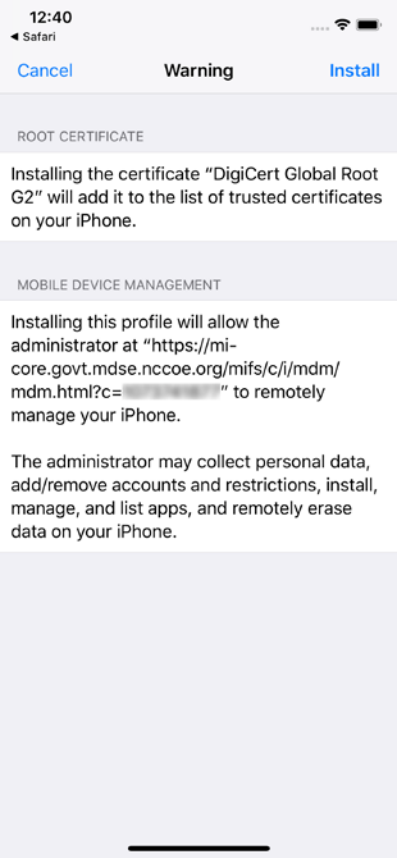


5. At the **Warning** screen:

    a. Verify that information under **Root Certificate** and **MDM** is consistent with information provided by your mobile device administrator.

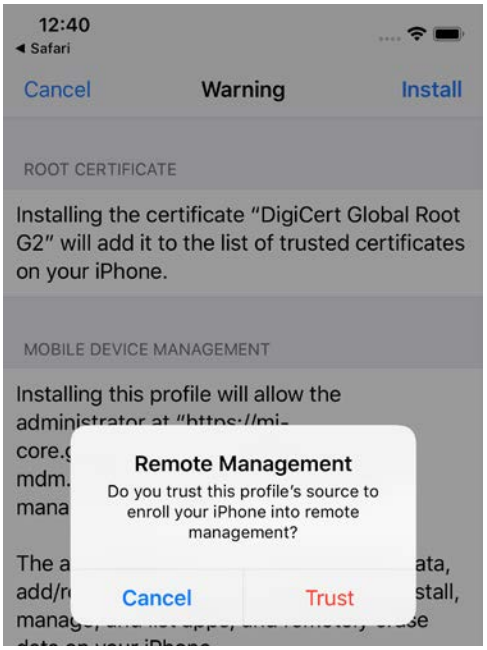
    b. Select **Install**.

Figure 2-159 Profile Installation Warning



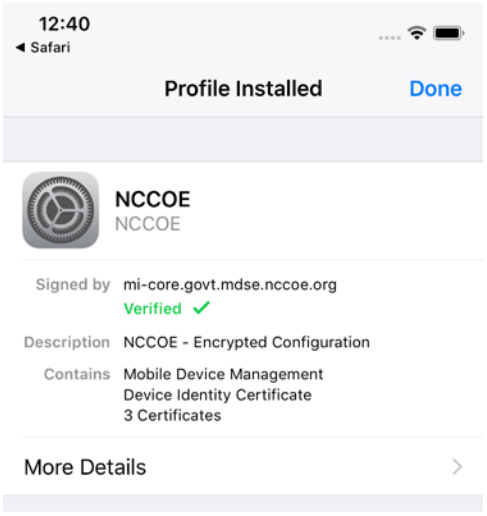
6. In the **Remote Management** dialogue, select **Trust.**

Figure 2-160 Profile Installation Trust Confirmation



7. At the **Profile Installed** screen, select **Done**. The device is now registered with MobileIron.

Figure 2-161 Profile Installation Confirmation



2.9.2 Activating Lookout for Work on iOS

The configuration of the Lookout for Work (iOS) app in the MobileIron app catalogue causes a configuration file to be included during the automatic install.

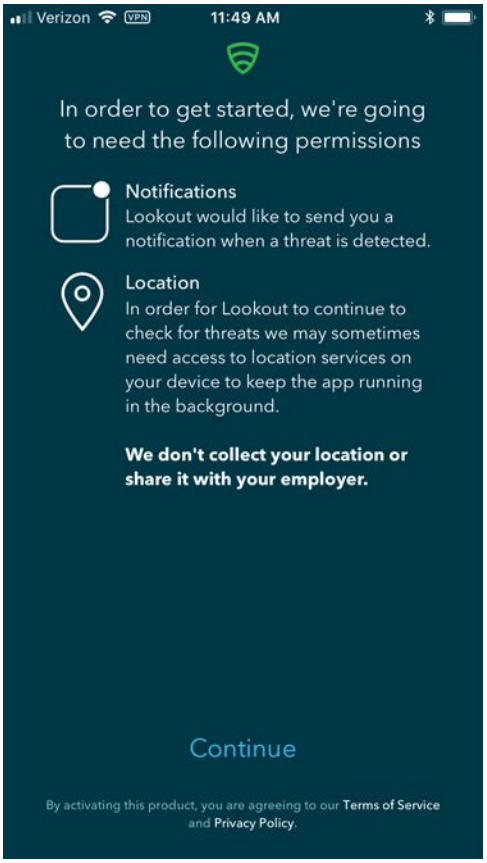
Upon launching the app, additional action is required to grant Lookout for Work the permissions necessary for it to provide optimal protection.

1. Launch the **Lookout for Work** app; activation occurs silently at the **splash** screen.

Figure 2-162 Lookout for Work Splash Screen

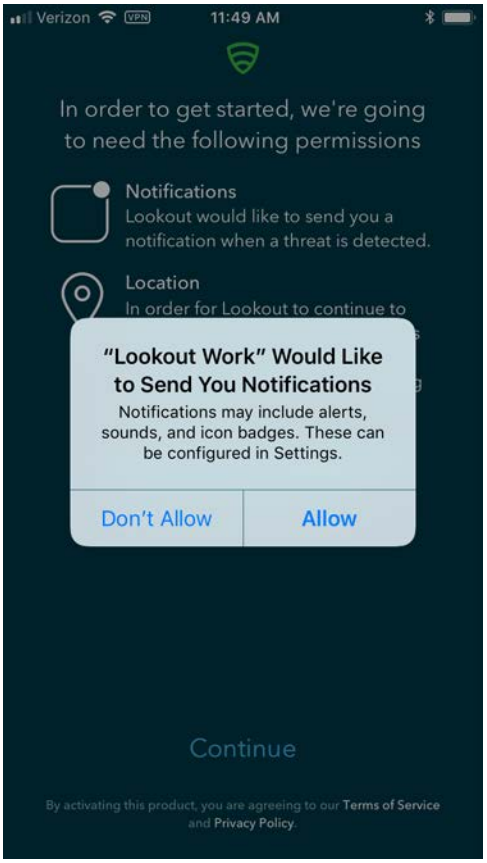
2. At the **welcome** screen, select **Continue.**

Figure 2-163 Lookout for Work Permission Information



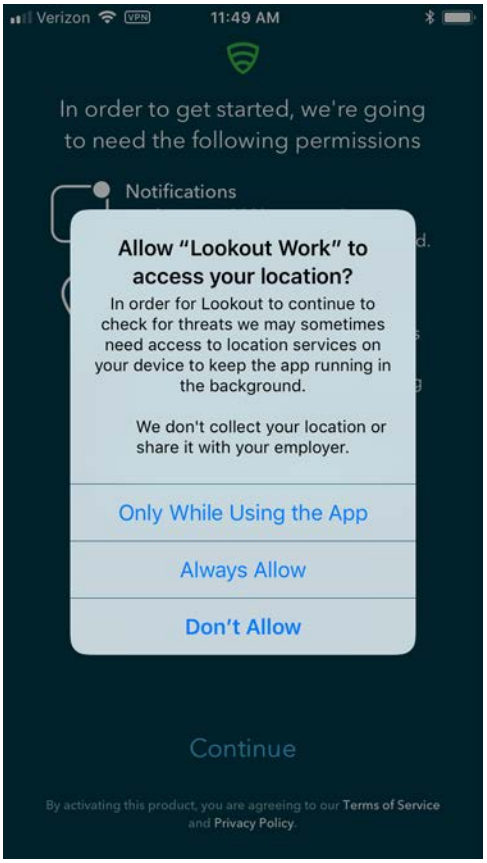
3. At the **"Lookout Work" Would Like to Send You Notifications** dialogue, select **Allow**.

Figure 2-164 Notifications Permissions Prompt



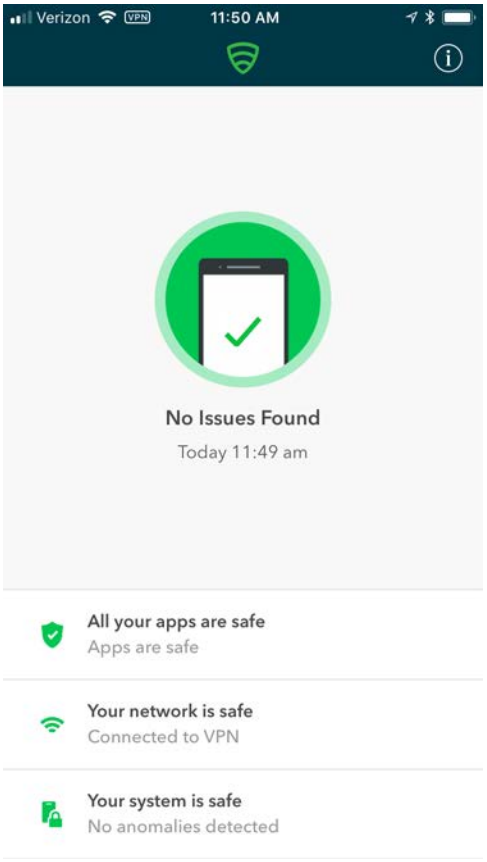
4. At the **Allow "Lookout Work" To Access Your Location?** dialogue, select **Always Allow**.

Figure 2-165 Locations Permission Prompt



5. **Lookout for Work** should automatically perform scans of device and app activity and provide feedback to the user.

Figure 2-166 Lookout for Work Home Screen



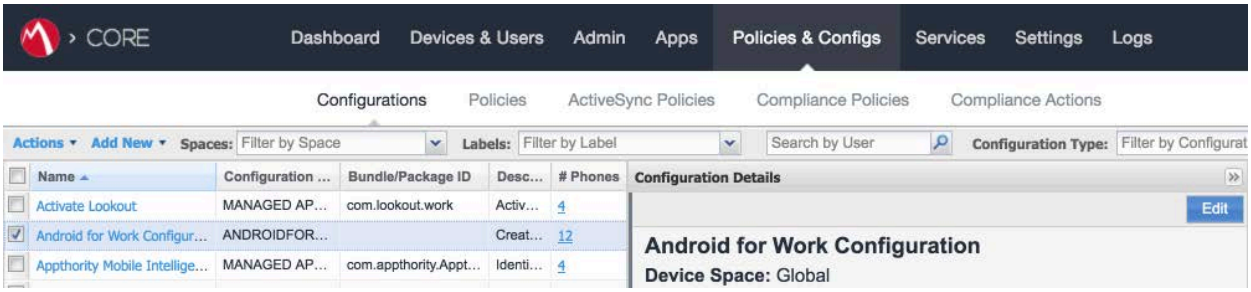
2.9.3 Provisioning Work-Managed Android Devices with a Work Profile

In this scenario, Android devices are deployed as work-managed with a work profile. Enabling this feature for AFW-capable devices requires a change to the AFW configuration. It also requires that the device user already has a personal Google account to provision the work profile; it is not created as part of the workflow to register a device with MobileIron Core.

2.9.3.1 Enable Work Profile on Work-Managed Devices

1. In the **MobileIron Admin** Portal, navigate to **Policies** > **Configs** > **Configurations**.
2. **Enable** the check box in the row for the **AFW** configuration.
3. In the **Configuration Details** pane, select **Edit**.

Figure 2-167 MobileIron AFW Configuration



4. In the **Edit Android enterprise (all modes) Setting** dialogue:

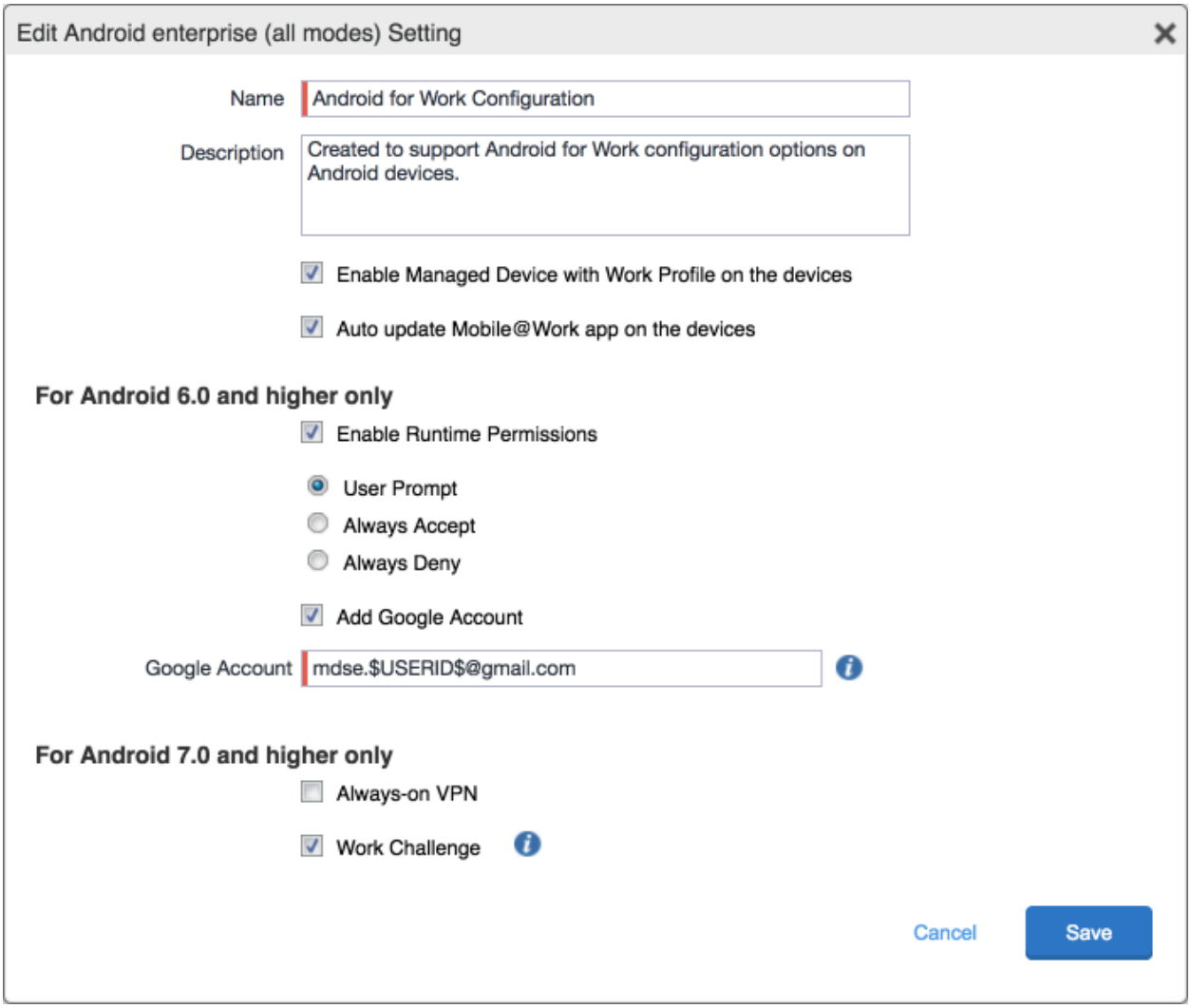
    a. Enable **Enable Managed Devices with Work Profile** on the devices.

    b. Enable **Add Google account**.

    c. In the **Google Account** text box, provide a valid Google domain account. The example in our reference implementation will map a MobileIron user ID of **gema** to an email address of **mdse.gema@gmail.com**. This needs to be done for each user. See *MobileIron Core 9.4.0.0 Device Management Guide for AFW* for a list of variables to appropriately adapt this field to your existing identity management strategy.

    d. Click **Save.**

Figure 2-168 AFW Configuration

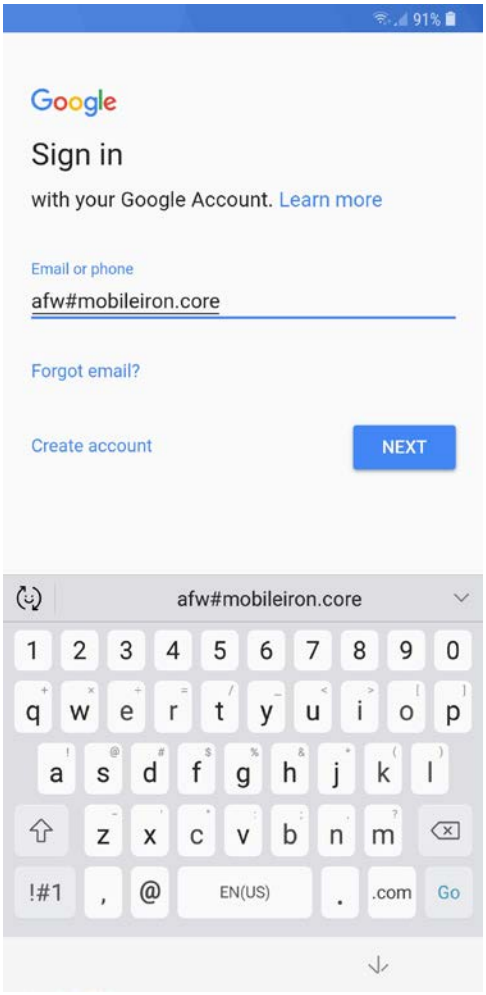


2.9.3.2 Registering Android Devices

The following steps can only be completed when working with an Android device that is still set to (or has been reset to) factory default settings.

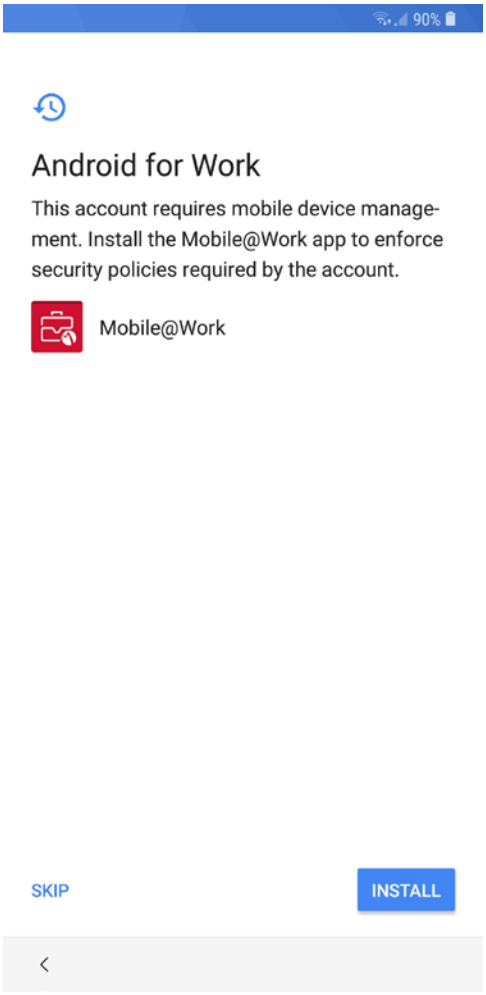
1. When prompted to **sign in** with your Google Account:
   a. In the **Email or phone field,** enter **afw#mobileiron.core**.
   b. Select **Next.**

Figure 2-169 MobileIron Enrollment Process



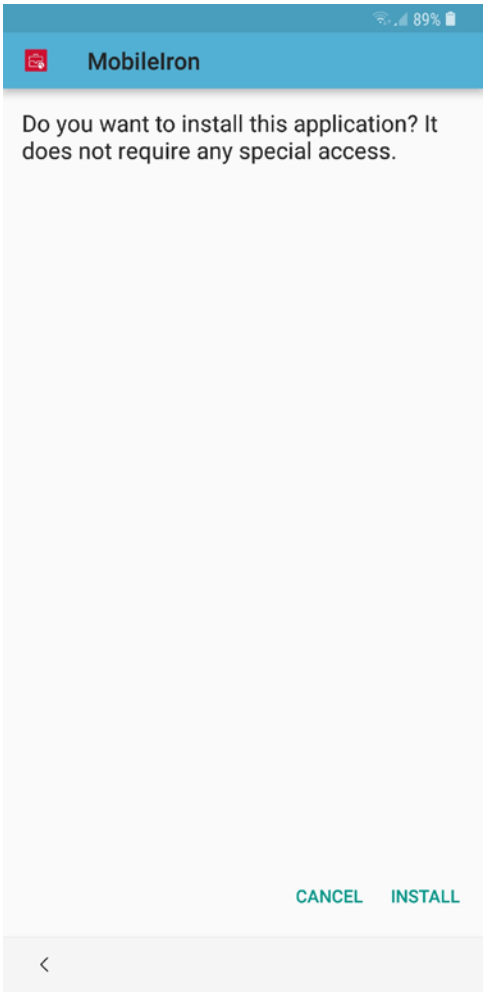
2. When **AFW** prompts you to install *Mobile@Work*, select **Install**; this downloads the Mobile@Work client to the device.

Figure 2-170 AFW Enrollment



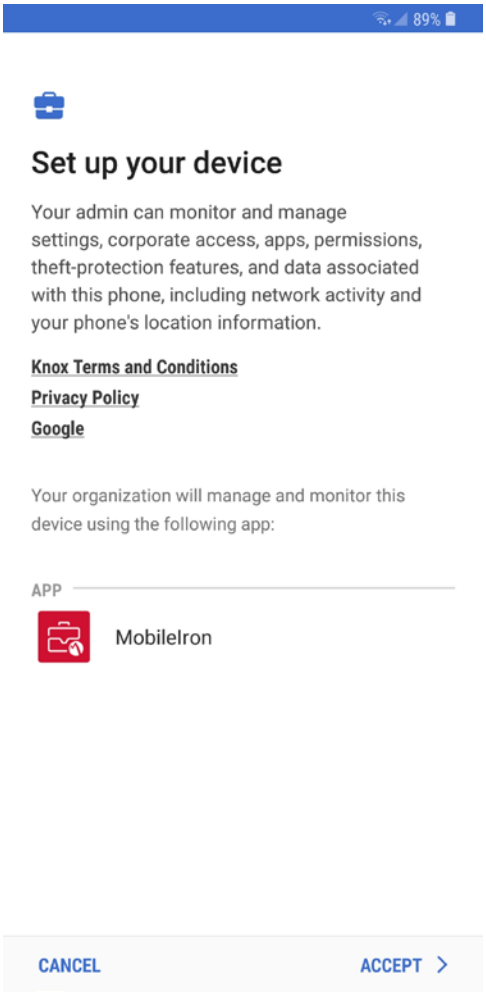
3. At the prompt to install MobileIron, select **Install.**

Figure 2-171 MobileIron Installation



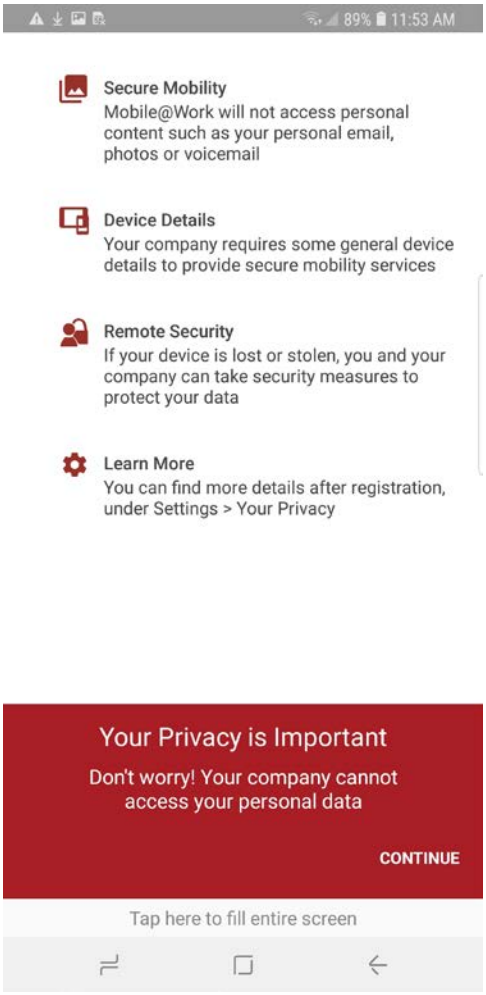
4. At the **Set up your device** screen, select **Accept**.

Figure 2-172 Accepting AFW Terms and Conditions



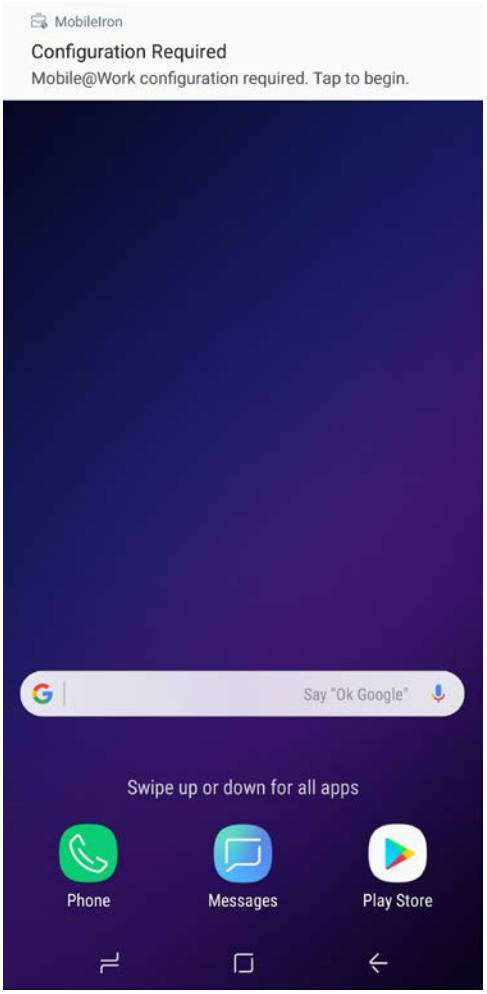
5. This screen notifies the user of the data that *Mobile@Work* collects and how it is used. When this information has been reviewed, select **Accept.** Mobile@Work minimizes and returns to the operating system home screen.

Figure 2-173 MobileIron Privacy Information



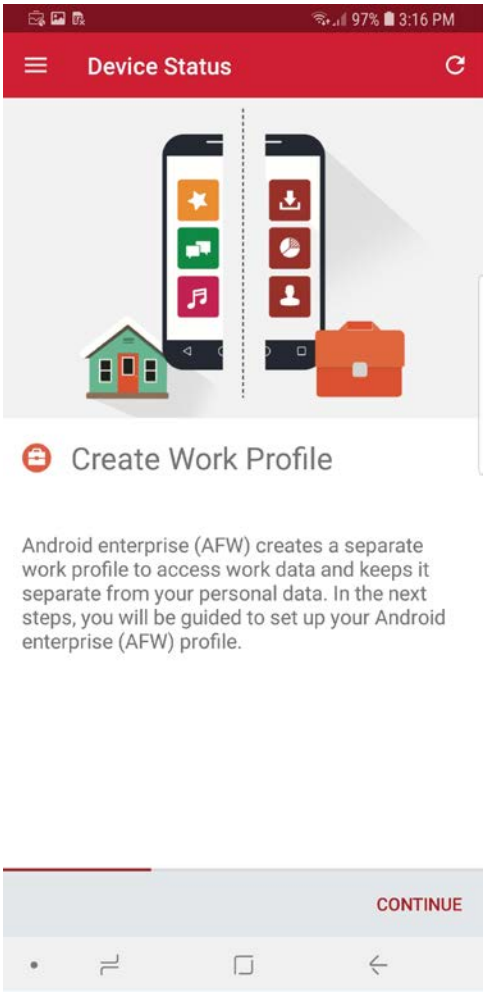
6. When MobileIron sends a **Configuration Required** notification, select the **notification.**

Figure 2-174 MobileIron Configuration Required Notification



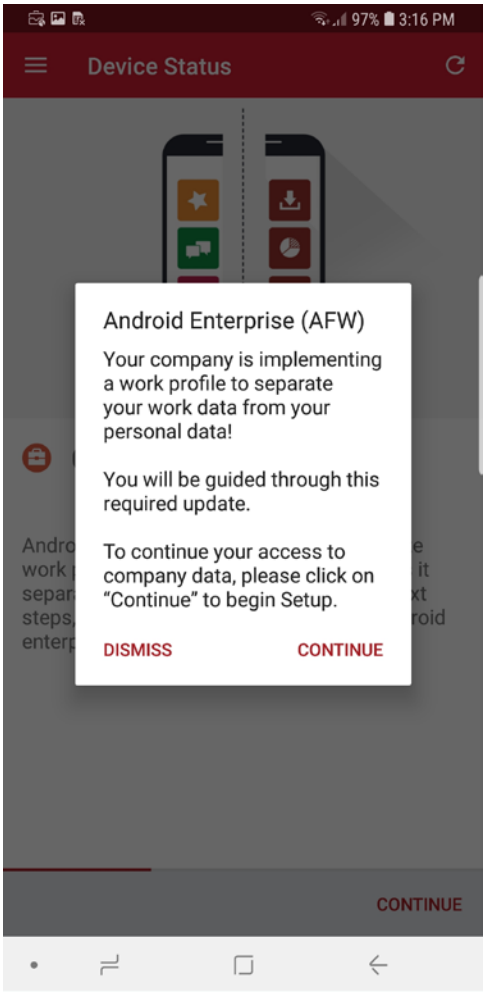
7. On the **Device Status** > **Create Work Profile** screen, select **Continue**.

Figure 2-175 MobileIron Device Status



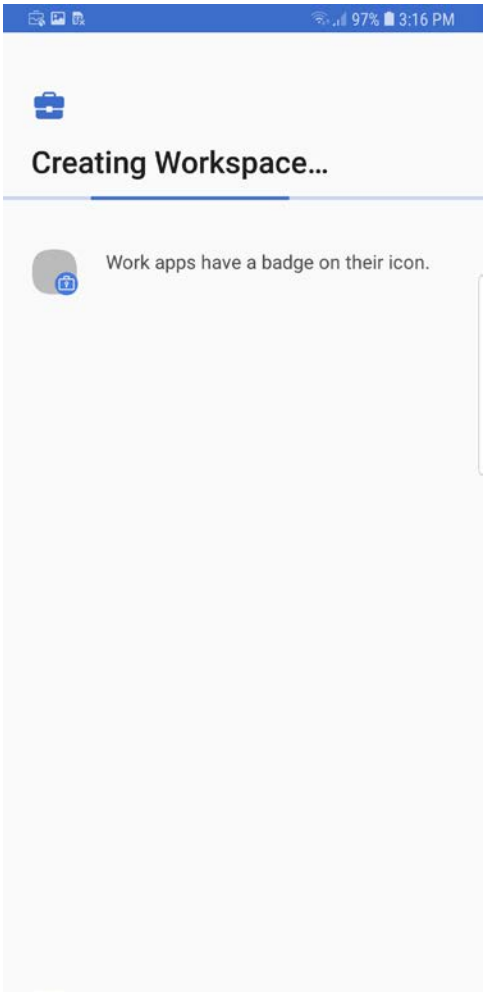
8. At the **AFW** prompt, select **Continue.**

Figure 2-176 AFW Configuration



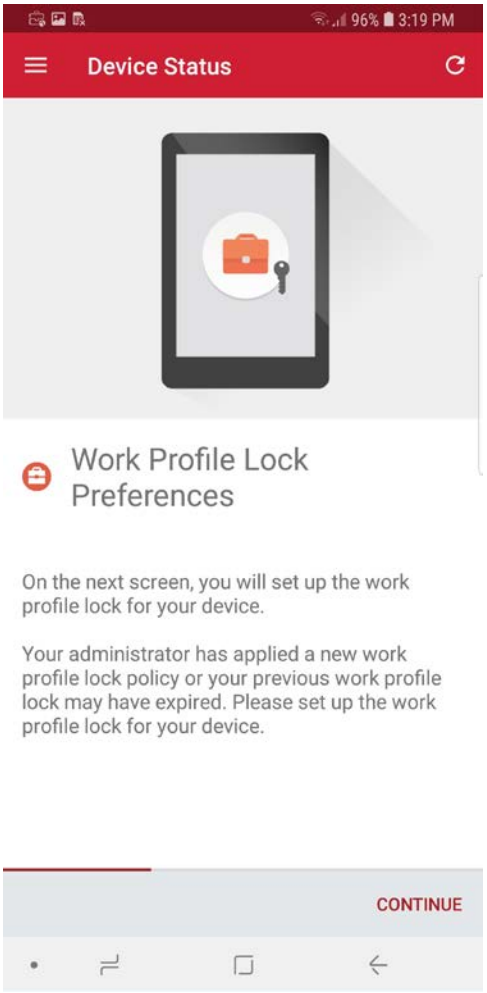
9. **AFW** notifies the user that it is creating the personal workspace. The next two screens repeat Steps 3 and 4 as above.

Figure 2-177 AFW Workspace Creation



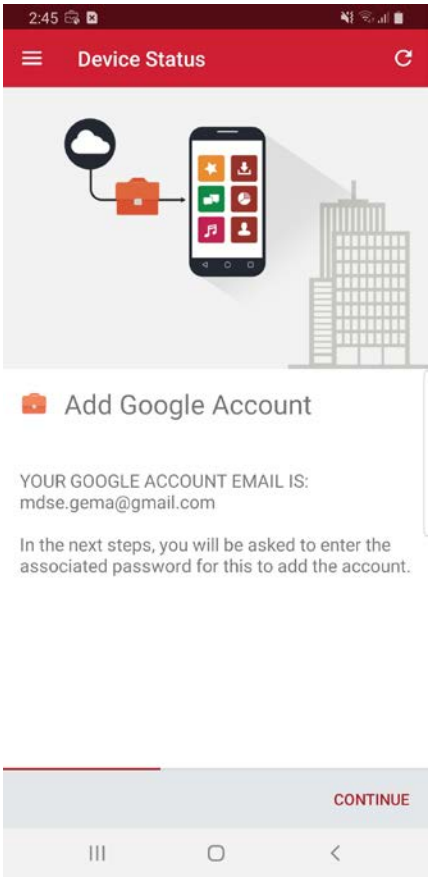
10. At the **Device Status** > **Work Profile Lock Preferences** screen, select **Continue.**

Figure 2-178 MobileIron Work Profile Lock Preferences



11. The user will be prompted to create a passcode to protect the AFW container.
12. At the **Device Status** > **Add Google Account** screen, select **Continue.**

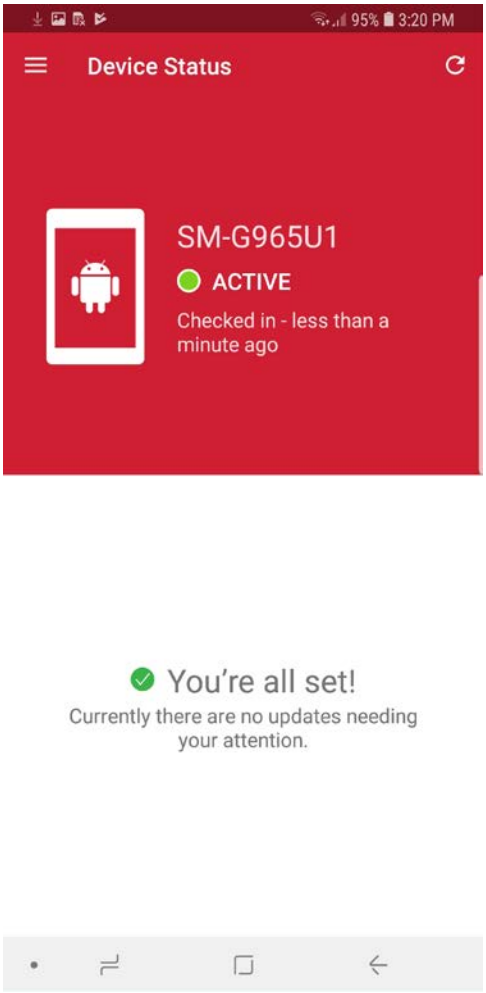
Figure 2-179 MobileIron Google Account Configuration



13. The user will be prompted to authenticate to the same Google domain account mapped to their MobileIron account based on the email address set in the AFW configuration in MobileIron Core. In our example implementation, the mapped Google account is **mdse.gema@gmail.com**.

14. Once the *Mobile@Work* app has been provisioned with the user's account, the Device Status screen should appear; the device has now successfully been provisioned into MobileIron.

Figure 2-180 MobileIron Device Status



Appendix A List of Acronyms

AD	Active Directory
AFW	Android for Work
API	Application Programming Interface
CA	Certificate Authority
COPE	Corporate-Owned Personally-Enabled
DMZ	Demilitarized Zone
DN	Distinguished Name
DNS	Domain Name System
DPC	Derived Personal Identity Verification Credential
EMM	Enterprise Mobility Management
FQDN	Fully Qualified Domain Name
GOVT	Government
HTTP	Hypertext Transfer Protocol
HTTPS	Hypertext Transfer Protocol Secure
ID	Identifier
IMEI	International Mobile Equipment Identity
IP	Internet Protocol
LAN	Local Area Network
LDAP	Lightweight Directory Access Protocol
MDM	Mobile Device Management
MDS	Mobile Device Security
MES	Mobile Endpoint Security
MTP	Mobile Threat Posture
NAT	Network Address Translation
NCCoE	National Cybersecurity Center of Excellence
NIST	National Institute of Standards and Technology
NTP	Network Time Protocol
OVA	Open Virtualization Appliance
PLIST	Property List
SCEP	Simple Certificate Enrollment Protocol
SSH	Secure Shell

SSID	Service Set Identifier
SSL	Secure Sockets Layer
TLS	Transport Layer Security
URL	Uniform Resource Locator
USB	Universal Serial Bus
VLAN	Virtual Local Area Network
VPN	Virtual Private Network
WAN	Wide Area Network

Appendix B Glossary

Application Programming Interface (API)	A system access point or library function that has a well-defined syntax and is accessible from application programs or user code to provide well-defined functionality [1].
App-Vetting Process	The process of verifying that an app meets an organization's security requirements. An app vetting process comprises app testing and app approval/rejection activities [2].
Authenticate	Verifying the identity of a user, process, or device, often as a prerequisite to allowing access to resources in an information system [3].
Certificate	A data structure that contains an entity's identifier(s), the entity's public key (including an indication of the associated set of domain parameters) and possibly other information, along with a signature on that data set that is generated by a trusted party, i.e., a certificate authority, thereby binding the public key to the included identifier(s) [4].
Certificate Authority (CA)	A trusted entity that issues and revokes public key certificates [5].
Corporate-Owned Personally-Enabled (COPE)	A device owned by an enterprise and issued to an employee. Both the enterprise and the employee can install applications onto the device.
Demilitarized Zone (DMZ)	An interface on a routing firewall that is similar to the interfaces found on the firewall's protected side. Traffic moving between the DMZ and other interfaces on the protected side of the firewall still goes through the firewall and can have firewall protection policies applied [6].
Derived Personal Identity Verification (PIV)	A credential issued based on proof of possession and control of the PIV Card, so as not to duplicate the identity proofing process as defined in [SP 800-63-2]. A Derived PIV Credential token is a hardware or software-based token that contains the Derived PIV Credential [7].
Hypertext Transfer Protocol (HTTP)	A standard method for communication between clients and Web servers [8].
Hypertext Transfer Protocol Secure (HTTPS)	HTTP transmitted over TLS [9].

Internet Protocol (IP) addresses	Standard protocol for transmission of data from source to destinations in packet-switched communications networks and interconnected systems of such networks [10].
Lightweight Directory Access Protocol (LDAP)	The Lightweight Directory Access Protocol, or LDAP, is a directory access protocol. In this document, LDAP refers to the protocol defined by RFC 1777, which is also known as LDAP V2. LDAP V2 describes unauthenticated retrieval mechanisms [11].
Local Area Network (LAN)	A group of computers and other devices dispersed over a relatively limited area and connected by a communications link that enables any device to interact with any other on the network [12].
Mutual Authentication	The process of both entities involved in a transaction verifying each other [13].
Passphrase	A passphrase is a memorized secret consisting of a sequence of words or other text that a claimant uses to authenticate their identity. A passphrase is similar to a password in usage, but is generally longer for added security [14].
Personal Identity Verification (PIV)	A physical artifact (e.g., identity card, "smart" card) issued to a government individual that contains stored identity credentials (e.g., photograph, cryptographic keys, digitized fingerprint representation) so that the claimed identity of the cardholder can be verified against the stored credentials by another person (human readable and verifiable) or an automated process (computer readable and verifiable). PIV requirements are defined in FIPS PUB 201 [15].
Risk Analysis	The process of identifying the risks to system security and determining the probability of occurrence, the resulting impact, and the additional safeguards that mitigate this impact. Part of risk management and synonymous with risk assessment [16].
Risk Assessment	The process of identifying risks to organizational operations (including mission, functions, image, reputation), organizational assets, individuals, other organizations, and the Nation, resulting from the operation of an information system [17].
Root Certificate Authority (CA)	In a hierarchical public key infrastructure (PKI), the certification authority (CA) whose public key serves as the most trusted datum (i.e., the beginning of trust paths) for a security domain [18].

Appendix C References

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[4] NIST. ITL Glossary, "Certificate Definition," [Online]. Available: https://csrc.nist.gov/glossary/term/certificate.

[5] NIST. ITL Glossary, "Certificate Authority (CA) Definition," [Online]. Available: https://csrc.nist.gov/glossary/term/Certificate_Authority.

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[7] NIST. ITL Glossary, "Derived Personal Identity Verification (PIV) Credential Definition," [Online]. Available: https://csrc.nist.gov/glossary/term/Derived_PIV_Credential.

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[17] NIST. "NIST Special Publication 800-39, Managing Information Security Risk," March 2011. [Online]. Available: https://nvlpubs.nist.gov/nistpubs/Legacy/SP/nistspecialpublication800-39.pdf.

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