Definition of Managed Objects for the MANET Essential Connected Dominating Set (E-CDS) Process
draft-nguyen-manet-ecds-mib-02

Abstract

This memo defines a portion of the Management Information Base (MIB) for use with network management protocols in the Internet community. In particular, it describes objects for configuring aspects of the Essential Connected Dominating Set (E-CDS) process for Mobile Ad-Hoc Networks (MANETs). The ECDS-MIB also reports state information, performance metrics, and notifications. In addition to configuration, the additional state and performance information is useful to operators troubleshooting multicast forwarding problems.

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1. Introduction

This memo defines a portion of the Management Information Base (MIB) for use with network management protocols in the Internet community. In particular, it describes objects for configuring aspects of a process implementing the Essential-Connected Dominating Set (E-CDS) [RFC5614] algorithm for Mobile Ad-Hoc Networks (MANETs). The E-CDS process transforms a 2-hop neighborhood topology information set for routers to dynamically perform relay self-election to form a Connected Dominating Set (CDS). The ECDS-MIB, an extension to the SMF-MIB [draft-ietf-manet-smf-mib-06], reports state information, performance metrics, and notifications. In addition to configuration, this additional state and performance information is useful to operators troubleshooting multicast forwarding problems.

2. The Internet-Standard Management Framework

For a detailed overview of the documents that describe the current Internet-Standard Management Framework, please refer to section 7 of [RFC3410]. Managed objects are accessed via a virtual information store, termed the Management Information Base or MIB. MIB objects are generally accessed through the Simple Network Management Protocol (SNMP). Objects in the MIB are defined using the mechanisms defined in the Structure of Management Information (SMI). This memo specifies a MIB module that is compliant to the SMIv2, which is described in STD 58, [RFC2578], STD 58, [RFC2579] and STD 58, [RFC2580].

3. Conventions

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [RFC2119].

4. Overview

The E-CDS algorithm provides method for implementing selection of Multipoint Relay nodes that define an estimate of the Minimum Connected Dominating Set (MCDS) flooding. The MCDS provides an efficient and complete coverage of the nodes comprising the MANET. The packet forwarding rules do not require knowledge of the previous hop. Routers that run Simplified Multicast Forwarding (SMF) [RFC6621] and have E-CDS enabled can be mixed with routers that run SMF and Classic Flooding (CF) enabled without a problem, even when the CF nodes are not participating in the Neighborhood Discovery Protocol (NHDP) [RFC6130]. Another benefit is that packets opportunistically received from non-symmetric neighbors may be forwarded without compromising flooding efficiency or correctness.
Furthermore, multicast sources not participating in NHDP may freely inject their traffic and any neighboring E-CDS relays will properly forward the traffic. The E-CDS based relay set selection algorithm is defined in [RFC5614].

4.1. ECDS-MIB Management Model

As mentioned in Overview Section, the ECDS-MIB is an extension to SMF-MIB. The SMF-MIB defines the management interfaces into the SMF process. The SMF process is a framework for efficient broadcast capabilities within a MANET. As part of the management interfaces, the SMF-MIB contains configuration objects required for the common management of all CDS processes. The SMF-MIB contains a capabilities table which lists the set of CDS algorithms supported by the specific router. However, the SMF-MIB does not define objects for configuration which are specific to the particular CDS process in question. Hence, it is required that additional MIB modules be defined for each new CDS process implemented on the router. In this sense, these additional MIB-modules extend the SMF-MIB.

```
<table>
<thead>
<tr>
<th>Neighborhood Discovery</th>
<th>----------- neighbour info</th>
<th>Relay Set Selection Algorithm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
```

```
\[
\begin{align*}
\text{neighbor} \ \text{info}^* & \quad \rightarrow \quad \text{Forwarding Process} \\
\text{incoming packet, interface id}^*, \text{ and previous hop}^* & \quad \rightarrow \quad \text{forwarded packets}
\end{align*}
\]
```

Figure 1: SMF router Architecture.

The various CDS algorithms are referred to as Relay Set Selection Algorithm (RSSA) within the SMF specification. The RSSAs can rely upon topology information gotten from the MANET NHDP, from the specific MANET routing protocol running on the node, or from Layer 2 information passed up to the higher layer protocol processes. In the ECDS process, nodes can select themselves as relays using a router...
identifier and a nodal metric known as "Router Priority" for all one-hop and two-hop neighbors. Changing the Router Priority can result in different realizations of CDSs for a given network topology.

4.2. Terms

The following definitions apply throughout this document:

- **Control Objects** - Objects which are initialized to default settings or set through the management interface defined by this MIB.

- **State Objects** - objects are automatically generated values which define the current operating state of the E-CDS process in the router.

- **Performance Objects** - objects are automatically generated values which help an administrator or automated tool to assess the performance of the CDS multicast process on the router and the overall multicasting performance within the MANET routing domain.

5. Structure of the MIB Module

This section presents the structure of the ECDS-MIB module. The objects are arranged into the following groups:

- **ecdsMIBNotifications** - defines notifications that are associated with ECDS-MIB

- **ecdsMIBObjects** - defines objects as part of the structure of ECDS-MIB. These objects are divided as follows:
  * **Configuration Group** - this group contains ECDS objects that configure specific options that determine the overall operation of ECDS process.
  * **State Group** - this group contains ECDS objects that describe the state of the ECDS process.
  * **Performance Group** - this group contains ECDS objects that help operators to characterize the performance of the ECDS process as configured.

- **ecdsMIBConformance** - defines minimal and full conformance of the implementations of this ECDS-MIB module.
5.1. Textual Conventions

The textual conventions defined within the ECDS-MIB are as follows:

- **EcdsStatus** - is defined within the ECDS-MIB. This contains the current operational status of the E-CDS process on an interface.

5.2. The Configuration Group

The E-CDS device is configured with a set of controls. Some of the prominent configuration controls for the SMF E-CDS device follow:

- **E-CDS Operational Mode (ecdsAdminStatus)** - indicates that the router has E-CDS enabled.

- **Router Identifier (ecdsRouterIDAddrType and ecdsRouterID)** - indicates router’s unique identifier in E-CDS neighborhood.

- **Router Priority (ecdsConfiguredRouterPriority)** - indicates nodal metric value for all one-hop and two-hop neighbors.

- **Configuration method that computes Router Priority (ecdsConfiguredRtrPriMethod)** - indicates what method the Router Priority is computed, i.e., dynamically configured, management configured, or other.

5.3. The State Group

The state of an ECDS device can be retrieved from the following objects:

- **E-CDS Configuration State (ecdsOperationStatus)** - a state that indicates whether or not the ECDS process is enabled or disabled on the node.

- **E-CDS Operational State (ecdsCurrentInEcds)** - a state that indicates whether or not the node currently in or out of the Relay Set

- **E-CDS Current Router Priority Value (ecdsCurrentRtR PriValue)** - the Router Priority that is currently assigned to the device.

5.4. The Performance Group

The E-CDS performance counters consist of per node objects:
5.5. The Notifications Group

The Notifications Sub-tree contains the list of notifications supported within the ECDS-MIB and their intended purpose or utility. These include:

- ecdsAdminStatusChange - this notification is sent when ecdsAdminStatus is changed.
- ecdsConfiguredMemberChange - this notification is sent when ecdsConfiguredMember is changed.
- ecdsIfRtrPriChange - this notification is sent when ecdsIfRtrPri value is changed.
- ecdsRtrPriMethodChange - this notification is sent when ecdsConfiguredRtrPriMethod is changed.

6. Relationship to Other MIB Modules

6.1. Relationship to the SNMPv2-MIB

The ‘system’ group in the SNMPv2-MIB [RFC3418] is defined as being mandatory for all systems, and the objects apply to the entity as a whole. The ‘system’ group provides identification of the management entity and certain other system-wide data. The ECDS-MIB does not duplicate those objects.

6.2. Relationship to the SMF-MIB

This ECDS-MIB module is an extension of the SMF-MIB module in the sense previously discussed. To manage SMF router with ECDS-enabled, both SMF-MIB and ECDS-MIB implementations are required.

6.3. MIB modules required for IMPORTS

The textual conventions imported for use in the SMF-MIB are as follows:

- The MODULE-IDENTITY, OBJECT-TYPE, NOTIFICATION-TYPE, Counter32, Unsigned32, Integer32 and mib-2 textual conventions are imported from [RFC2578].
7. Definitions

ECDS-MIB DEFINITIONS ::= BEGIN

IMPORTS

MODULE-IDENTITY, OBJECT-TYPE, NOTIFICATION-TYPE,
Counter32, Integer32, experimental
FROM SNMPv2-SMI -- [RFC2578]

TEXTUAL-CONVENTION, TruthValue
FROM SNMPv2-TC -- [RFC2579]

MODULE-COMPLIANCE, OBJECT-GROUP, NOTIFICATION-GROUP
FROM SNMPv2-CONF -- [RFC2580]

InetAddress, InetAddressType
FROM INET-ADDRESS-MIB -- [RFC4001]
;

manetEcdsMIB MODULE-IDENTITY
LAST-UPDATED "201301021000Z" -- 2 January 2013
ORGANIZATION "IETF MANET Working Group"
CONTACT-INFO
"WG E-Mail:     manet@ietf.org
WG Chairs:      jmacker@nrl.navy.mil
                 sratliff@cisco.com
Editors:        James H. Nguyen
                 US Army CERDEC
                 Space and Terrestrial Communications
                 6010 Frankford Road
                 Aberdeen Proving Ground, MD 21005
                 USA
                 +1 443 395-5628
This MIB module contains managed object definitions for the Manet E-CDS process defined in: [RFC5614]

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-- revision
REVISION "201301021000Z" -- 2 January 2013
DESCRIPTION
"Initial version of this MIB module, published as draft-nguyen-maney-ecds-mib-02.txt."
 ::= { experimental 9999 } -- to be assigned by IANA

--
-- TEXTUAL Conventions
--

EcdsStatus ::= TEXTUAL-CONVENTION
  STATUS current
  DESCRIPTION
  "An indication of the operability of a E-CDS function or feature or example, the status of an node:
   - 'enabled(1)' indicates that it is performing E-CDS functions
   - 'disabled(2)' indicates that it is not."
SYNTAX INTEGER {
  enabled (1),
  disabled (2)
}

--
-- Top-Level Object Identifier Assignments
--

ecdsMIBNotifications OBJECT IDENTIFIER ::= { manetEcdsMIB 0 }
ecdsMIBObjects OBJECT IDENTIFIER ::= { manetEcdsMIB 1 }
ecdsMIBConformance OBJECT IDENTIFIER ::= { manetEcdsMIB 2 }

--
-- ecdsMIBObjects Assignments:
-- ecdsConfigurationGroup       - 1
-- ecdsStateGroup               - 2
-- ecdsPerformanceGroup         - 3
--
--
-- ecdsConfigurationGroup
--
-- This group contains the E-CDS objects that configure specific
-- options that determine the overall performance and operation
-- of the multicast forwarding process for the router device
--

ecdsConfigurationGroup OBJECT IDENTIFIER ::= { ecdsMIBObjects 1 }

ecdsAdminStatus OBJECT-TYPE
SYNTAX          EcdsStatus
MAX-ACCESS      read-write
STATUS          current
DESCRIPTION
"The configured status of the E-CDS process on this
device.

- Enabled(1) means that E-CDS is configured to run on
this device.
- Disabled(2) mean that the E-CDS process is
configured off.

This object is persistent and when written the entity
should save the change to non-volatile storage.

The default value of ecdsAdminStatus is disabled (2)."
DEFVAL { disabled }
 ::= { ecdsConfigurationGroup 1 }

ecdsRouterIDAddrType    OBJECT-TYPE
SYNTAX          InetAddressType
MAX-ACCESS      read-write
STATUS          current
DESCRIPTION
"The address type of the address that is used for
'ecdsRouterID' of this router as specified in the
'ecdsRouterID' text.

Only ipv4(1) and ipv6(2) are supported.

ecdsRouterIDAddrType can be set by the management station, the ecdsRouterID must be a routable address assigned to this router. If the management station does not assign this value then the router should choose the highest routable IP address assigned to this router. The default value of ecdsRouterAddrType is ipv4.

This object is persistent and when written, the entity should save the change to non-volatile storage.

DEFVAL { ipv4 }
::= { ecdsConfigurationGroup 2 }

ecdsRouterID OBJECT-TYPE
SYNTAX InetAddress (SIZE(4|16))
MAX-ACCESS read-write
STATUS current
DESCRIPTION
"The IP address used as the E-CDS router ID. This can be set by the management station. If not explicitly set, then the device should select a routable IP address assigned to this router for use as the 'ecdsRouterID'. The ecdsRouterID is a logical identification that must be consistent across interoperating E-CDS neighborhoods and it is recommended to be chosen as the numerically largest address contained in a node’s ‘Neighbor Address List’ as defined in NHDP. A ecdsRouterID must be unique within the scope of the operating MANET network regardless of the method used for selecting it.

This object is persistent and when written the entity should save the change to non-volatile storage."
::= { ecdsConfigurationGroup 3 }

ecdsConfiguredRtrPriMethod OBJECT-TYPE
SYNTAX INTEGER {
    dynamicallyConfigured (1),
    managementConfigured (2),
    other (3)
}
MAX-ACCESS read-write
STATUS current
DESCRIPTION
"This object indicates which method Router Priority value is computed."
::= { ecdsConfigurationGroup 4 }

ecdsConfiguredRouterPriority OBJECT-TYPE
SYNTAX          Integer32
MAX-ACCESS      read-write
STATUS          current
DESCRIPTION
"A nodal metric for all 1-hop and 2-hop neighbors. Relay routers use tuple of router identifier and router priority to compute self-election of MPR."
::= { ecdsConfigurationGroup 5 }

dcsConfiguredMember OBJECT-TYPE
SYNTAX  INTEGER {
    potential(1),
    always(2),
    never(3)
}
MAX-ACCESS      read-write
STATUS          current
DESCRIPTION
"The E-CDS downselects a set of forwarders for multicast forwarding. Sometimes, it is useful to force an agent to be included or excluded from the resulting CDS. This object is a switch to allow for this behavior.

- The value potential(1) allows the selected E-CDS to determine if this agent is included or excluded from the E-CDS.

- The value always(1) forces the selected E-CDS process

- The value never(3) forces not to use E-CDS process

- The default setting for this object is 'potential(1)'. Other settings could pose operational risks under certain conditions.

This object is persistent and when written the entity should save the change to non-volatile storage."
DEFVAL { potential }
::= { ecdsConfigurationGroup 6 }
ecdsStateGroup OBJECT IDENTIFIER ::= { ecdsMIBObjects 2 }

ecdsOperationStatus OBJECT-TYPE
SYNTAX EcdsStatus
MAX-ACCESS read-only
STATUS current
DESCRIPTION "The configured status of the E-CDS process on this device.
- enabled(1) means that E-CDS is configured to run on this device.
- disabled(2) mean that the E-CDS process is configured off.
This object is persistent and when written the entity should save the change to non-volatile storage.
The default value of ecdsOperationStatus is disabled (2)."
DEFVAL { disabled }
 ::= { ecdsStateGroup 1 }

ecdsCurrentRtrPriValue OBJECT-TYPE
SYNTAX Integer32
MAX-ACCESS read-only
STATUS current
DESCRIPTION "current Router Priority value"
 ::= { ecdsStateGroup 2 }

ecdsCurrentInEcds OBJECT-TYPE
SYNTAX TruthValue
MAX-ACCESS read-only
STATUS current
DESCRIPTION "This object indicates that the current node has E-CDS configured and in E-CDS. true(1) means the router has E-CDS configured or false(2) otherwise."
 ::= { ecdsStateGroup 3 }
-- E-CDS Performance Group

ecdsPerformanceGroup OBJECT IDENTIFIER ::= { ecdsMIBObjects 3 }

ecdsInEcdsChange OBJECT-TYPE
SYNTAX Counter32
MAX-ACCESS read-only
STATUS current
DESCRIPTION "This object indicates how many times the current node is configured to be in E-CDS."
::= { ecdsPerformanceGroup 1 }

ecdsCurrentRtrPriValueChange OBJECT-TYPE
SYNTAX Counter32
MAX-ACCESS read-only
STATUS current
DESCRIPTION "This object indicates how many times the Router Priority of the current node has been changed."
::= { ecdsPerformanceGroup 2 }

-- E-CDS Notification

ecdsMIBNotifObjects OBJECT IDENTIFIER ::= { ecdsMIBNotifications 0 }

-- E-CDS Notification Objects

ecdsAdminStatusChange NOTIFICATION-TYPE
OBJECTS {
  ecdsRouterID, -- the originator of notification
  ecdsRouterIDAddrType, -- the originator of notification
  ecdsAdminStatus -- the new status of E-CDS
      -- process
}
STATUS current
DESCRIPTION "ecdsAdminStatusChange notification is sent when ecdsAdminStatus is changed."
::= { ecdsMIBNotifObjects 1 }
ecdsConfiguredMemberChange NOTIFICATION-TYPE
OBJECTS {
    ecdsRouterID, -- the originator of notification
    ecdsRouterIDAddrType, -- the originator of notification
    ecdsConfiguredMember -- the indication of being
                         -- included from E-CDS process
}
STATUS          current
DESCRIPTION
"ecdsConfiguredMemberChange notification is sent when
ecdsConfiguredMember is changed."
 ::= { ecdsMIBNotifObjects 2 }

ecdsRtrPriChange NOTIFICATION-TYPE
OBJECTS {
    ecdsRouterID,        -- the originator of
                         -- notification
    ecdsRouterIDAddrType,  -- the originator of
                         -- notification
    ecdsConfiguredRouterPriority -- the priority value
}
STATUS          current
DESCRIPTION
"ecdsIfRtrPriChange notification is sent when
ecdsIfRtrPri value is changed."
 ::= { ecdsMIBNotifObjects 3 }

ecdsRtrPriMethodChange NOTIFICATION-TYPE
OBJECTS {
    ecdsRouterID,         -- the originator of
                         -- notification
    ecdsRouterIDAddrType,      -- the originator of
                         -- notification
    ecdsConfiguredRtrPriMethod -- the method is used to
                         -- calculate router
                         -- priority
}
STATUS          current
DESCRIPTION
"ecdsRtrPriMethodChange notification is sent when
ecdsConfiguredRtrPriMethod is changed."
 ::= { ecdsMIBNotifObjects 4 }

--
-- Compliance Statements
--
ecdsCompliances OBJECT IDENTIFIER ::= { ecdsMIBConformance 1 }
ecdsMIBGroups OBJECT IDENTIFIER ::= { ecdsMIBConformance 2 }

ecdsBasicCompliance MODULE-COMPLIANCE
  STATUS current
  DESCRIPTION "The basic implementation requirements for managed network entities that implement the E-CDS process."
  MODULE -- this module
  MANDATORY-GROUPS {
    ecdsConfigurationComplianceGroup
  }
  ::= { ecdsCompliances 1 }

ecdsFullCompliance MODULE-COMPLIANCE
  STATUS current
  DESCRIPTION "The full implementation requirements for managed network entities that implement the E-CDS process."
  MODULE -- this module
  MANDATORY-GROUPS {
    ecdsConfigurationComplianceGroup,
    ecdsStateComplianceGroup,
    ecdsPerformanceComplianceGroup,
    ecdsNotificationsComplianceGroup
  }
  ::= { ecdsCompliances 2 }

ecdsConfigurationComplianceGroup OBJECT-GROUP
  OBJECTS {
    ecdsAdminStatus,
    ecdsRouterID,
    ecdsRouterIDAddrType,
    ecdsConfiguredRouterPriority,
    ecdsConfiguredMember,
    ecdsConfiguredRtrPriMethod
  }
  STATUS current
  DESCRIPTION "Set of configuration objects implemented in this module"
  ::= { ecdsMIBGroups 1 }

ecdsStateComplianceGroup OBJECT-GROUP
  OBJECTS {
    ecdsOperationStatus,
    ecdsCurrentRtrPriValue,
    ecdsCurrentInEcds
  }
8. Security Considerations

This section discusses security implications of the choices made in this ECDS-MIB module.

There are a number of management objects defined in this MIB module with MAX-ACCESS clause of read-write and/or read-create. Such objects maybe considered sensitive or vulnerable in some network environments. The support of SET operations in a non-secure environment without proper protection can have a negative effect on network operations. These are objects and their sensitivity/vulnerability:

- ecdsAdminStatus - this writable configuration object controls the operational status of the SMF ECDS process. If this setting is configured inconsistently across the MANET multicast domain, then
the delivery of multicast data maybe also be inconsistent across the domain.

- ecdsRouterIDAddrType and ecdsRouterID - these writable configuration objects define the identifier (ID) of the SMF E-CDS process. These objects should be configured with a routable address defined on the local SMF E-CDS device. The ecdsRouterID is the logical identification that must be consistent across interoperating SMF E-CDS neighborhoods. The ecdsRouterID is recommended to be chosen as the numerically largest address contained in a node’s ‘Neighbor Address List’ as defined in NHDP [RFC6130].

- ecdsConfiguredRtrPriMethod - this writable configuration object indicates how the value of Router Priority is computed.

- ecdsConfiguredRouterPriority - this writable configuration object indicates a nodal metric for all 1-hop and 2-hop neighbors. Relay routers use tuple of router identifier and router priority to compute self-election of MPR.

- ecdsConfiguredMember - this writable configuration object defines a set of forwarders for multicast forwarding. Sometimes, it is useful to force an agent to be included or excluded from the resulting CDS. This object is a switch to allow for this behavior. Mis-configuration of the object may cause the MANET flooding to break due to logical splits in the topology.

9. Applicability Statement

This document describes objects for configuring Essential Connected Dominating Set (E-CDS) process parameters on a router. This MIB module, denoted ECDS-MIB module, also reports state, performance information and notifications. Since it is an extension of SMF-MIB module, the same applicability examples can be found in SMF-MIB draft.

10. IANA Considerations

The MIB module in this document uses the following IANA-assigned OBJECT IDENTIFIER value recorded in the SMI Numbers registry:

```
<table>
<thead>
<tr>
<th>Descriptor</th>
<th>OBJECT IDENTIFIER value</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECDS-MIB</td>
<td>{ experimental 9999 }</td>
</tr>
</tbody>
</table>
```

IANA EDITOR NOTE: please assign 9999
11. Contributors

This MIB document uses templates authored by D. Harrington which is based on contributions from the MIB Doctors, especially Juergen Schoenwaelder, Dave Perkins, C.M. Heard, and Randy Presuhn.

12. Acknowledgements

The authors would like to acknowledge the valuable comments from Ulrich Herberg in the early phases of the development of this MIB-module. Further, the authors would like to acknowledge to work of Brian Little and Ryan Morgan on their software development of the ECDS-MIB.

13. Change Log

This section tracks the revision history in the development of this ECDS-MIB. It will be removed from the final version of this document.

These changes were made from draft-nguyen-manet-ecds-mib-01 to draft-nguyen-manet-ecds-mib-02:

1. Added references, applicability statement, security considerations, IANA considerations, acknowledgment.

2. Added ecdsRouterIDAddrType object to go along with ecdsRouterID

These changes were made from draft-nguyen-manet-ecds-mib-00 to draft-nguyen-manet-ecds-mib-01:

1. Initial draft

14. Open Issues

This section contains the set of open issues related to the development and design of the ECDS-MIB. This section will not be present in the final version of the MIB and will be removed once all the open issues have been resolved.

1. Does this MIB module need to include the MDR Level as a state object?

2. Within the Security Section, we need to include a discussion of the problems caused by mis-configuring the ecdsRouterID, the ecdsConfiguredRtrPriMethod, and the ecdsConfiguredRouterPriority objects.
3. Once the SMF-MIB module is published, the references to the RFC must be updated.

4. A careful review by the working group.

15. Title

***************************************************************
* Note to the RFC Editor (to be removed prior to publication) *
*                                                             *
* 1) The reference to RFCXXXX within the DESCRIPTION clauses *
* of the MIB module point to this draft and are to be assigned by the RFC Editor. *
*                                                             *
***************************************************************

16. References

16.1. Normative References


16.2. Informative References


Authors' Addresses

James H. Nguyen
US Army CERDEC
6010 Frankford Road
Aberdeen Proving Ground, Maryland 21005
USA

Phone: +1 443 395 5628
EMail: james.h.nguyen4.civ@mail.mil