TENA and JMETC Enabling Interoperability Among Ranges, Facilities, and Simulations

Briefing for:
NDIA 27th Annual National T&E Conference
March 16, 2011
Gene Hudgins, TENA SDA User Support Lead
What is JMETC?

• **A corporate approach for linking distributed facilities**
  • Enables customers to efficiently evaluate their warfighting capabilities in a Joint context
  • Provides compatibility between test and training

• **A core, reusable, and easily reconfigurable infrastructure**
  • Consists of the following products:
    • Persistent connectivity
    • Middleware
    • Standard interface definitions and software algorithms
    • Distributed test support tools
    • Data management solutions
    • Reuse repository

• **Provides customer support team for JMETC products and distributed testing**
JMETC Enables Distributed Testing

Joint Operational Scenarios

Systems Under Test

Integrated Test Resources

- Virtual Prototype
- Hardware in the Loop Lab
- Installed Systems Test Facility
- Range
- Environment Generator
- Threat Systems

- TENA Standard Interface Definitions
- TENA Common Middleware

JMETC Infrastructure

- Reuse Repository

Customer Support

- JMETC VPN on SDREN
- Distributed Test Support Tools
- Data Management Solutions
JMETC: Here and Now

- Uses the Secure Defense Research & Engineering Network (SDREN) for connectivity
  - 61 sites currently on-line

- Uses Test & Training Enabling Architecture (TENA)
  - Gateways to link to existing DIS and HLA simulations

- Incorporates InterTEC test tools

- Uses the JNTC-sponsored Network Aggregator to link together other networks

- Being expanded based on customer requirements

- Holding JMETC Users Group meetings to discuss emerging requirements and technical solutions
  - Seeking the “best of breed” solutions across the community
**JMETC Connectivity**

- **Functional Sites:** 61
- **New Sites Planned:** 6
- **Connection Points to Other Networks:** 4

- Dedicated, trusted connectivity on SDREN (part of the GIG)
- Encrypted for Secret – System High
- DISA-registered IP address space
- Active monitoring of network performance
- Capable of supporting multiple simultaneous test events

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**Key Sites**

- Ft Huachuca: (2) JITC, JTDL
- Redstone (6): RTC, DTCC, GMAN
- SED: Patriot, THAAD, FAAD, SIV
- Charleston (2): IPC, MEF, MEU
- Ft Hood (2): CTSF, TTEC
- WPAFB: SIMAF
- As of 09 Dec 2010

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**Sites in SoCal**
- Edwards: Ridley
- China Lake (3): AV-8B, F/A-18
- Point Mugu (2): ITEC, AEA
- El Segundo: NGC B-2
- Camp Pendleton: MCTSSA
- Corona: NSWC
- Point Loma (2): RLATS
- SSC-PAC
- Rancho Bernardo, NGC BAMS
- West Agg Rtr.

**Sites in Hawaii**
- PMRF: Bldg 105
- MHPCC
- Ft. Greely: CRTC

**Site in Alaska**
- Ft. Monmouth: JOIN

**Sites in MD, DC, VA**
- Aberdeen: ACCN
- Pax River (5): ESTEL E2C/D, MCL
- ACETEF, SAIL, ATR
- JMETC SYSCON
- East Agg Rtr.
- Pentagon: WARCAP
- DISA: Sky 7
- Dahlgren (2): CEDL/WSL
- JFCOM: JSIC
- Langley (2): C-2D, TDLTC
- Norfolk: COMOPTEVFOR
- Norfolk:C2F Mitscher Ctr
- Dam Neck: CDSA
- Wallops Island: (2) SCAC, SSDS
- Newport News: NGC VASCIC
- McLean: MITRE NCEL

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**Sites in Gulf Range**
- Hurlbut Field: C2DAC
- Eglin AFB (4): AOC, DTF, GWEF, KHILS

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**As of 09 Dec 2010**

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**Sites**

- Army
- Air Force
- Navy
- Marines
- Joint
- Industry
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JMETC Uses TENA to Integrate Sites
(Can gateway to existing DIS and HLA simulations)

- TENA is:
  - Developed, upgraded, and sustained by CTEIP and JNTC
  - Middleware that provides a single, universal data exchange solution
  - Common for test and for training (core standard in JMETC and JNTC)
  - Available for download at www.tena-sda.org for free

- TENA provides:
  - Interoperability among range systems, hardware-in-the-loop laboratories, and simulations in a quick, cost-efficient manner
  - A capability to rapidly and reliably develop LVC integrations
  - A set of community-agreed object models that define the data elements used in LVC integrations – maximizes reuse from event to event
  - An auto-code generator to drastically reduce TENA incorporation time

- Newest version of TENA (version 6.0) provides:
  - Advanced data filtering (only data of interest sent over the wire)
  - Improved fault tolerance and embedded diagnostics
  - Downloadable on the TENA Website
Gateway Builder

- GWB is focused on integration of distributed live, virtual, and constructive (LVC) systems into a common synthetic battle space that comprises various simulation protocols, training ranges, live systems and platforms.
- Gateway Builder streamlines integration process and reduces time and effort of creating gateways.
- Gateway Builder is a flexible, extensible, graphically driven tool that automatically generates gateways to bridge simulation and live protocols.
- Gateway Builder supports mappings between TENA, DIS, and HLA and message-based protocols using any object model.
TENA Overview

• Requirements
  – Interoperability
  – Reuse
  – Composability
  – Support Rapid Integration
  – Gradual Deployment

• Supports
  – Testers & Trainers
  – Joint, Army, Navy, Air Force, Agencies
  – Live, Virtual, Constructive
  – Range, Laboratories, Simulations
  – Real-Time & Non-Real-Time

• Guiding Principles
  – Provide middleware
  – Use real software objects
  – Maximize code generation
  – Management by users (AMT)
  – No license fee (GOTS)
TENA Architecture Overview

TENA Applications

Range Resource Application

Range Resource Application

Range Resource Application

Management and Monitoring Apps

Management and Monitoring Apps

Analysis and Review Apps

Non-TENA Applications

TENA Middleware

TENA Common Infrastructure

TENA Utilities

Object Model Utilities

Repository Utilities

Logical Range Planning Utilities

Logical Range Data Archive

Data Collectors

Gateway

TENA Utilities

Non-TENA Communications

Non-TENA System

Non-TENA System

Non-TENA Applications
### Key Release 6 Improvements and New Capabilities

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**Key Release 6 Improvements and New Capabilities**

### New Middleware Capabilities
- Advanced Filtering
- OM Subsets Support
- Constant Value Key Registration
- Separate Inbound/Outbound ORBs

**Enhanced data distribution**
- **Optimized network usage**

### Metamodel and Model Improvements
- Fundamental Sized Type Aliases
- Const Qualifier
- Optional Attributes
- SDO Initializers
- Middleware Metadata
- Middleware IDs

**Better ways to define data**
- **Remove ambiguity**

### New Event Management Capabilities
- Object Model Consistency Checking
- Remote Object Termination
- SDO State Processing Support
- Self-Reflection Option
- Object Reactivation
- Separate Inbound/Outbound ORBs

**Improved reliability**
- **Enhanced troubleshooting**

### Usability Improvements
- Observer Pattern (with Callback Aggregation)
- Local Methods Factory Registration
- Code Installation Layout

**Easy to use**
- **Harder to use wrong**
TENA in a Resource Constrained Environment (TRCE) S&T Background

- **Low Data Rate Networks**
  - TENA must be able to establish and maintain data connections on low data rate networks
  - Need to optimize use of low data rate networks to support relevant operational scenarios

- **Wireless Networks**
  - Current range environments use wireless links extensively for various systems under test

- **Variable Quality Networks**
  - T&E systems poorly tolerate high loss, link failure, or heterogeneous links
  - Need to provide data continuity for degraded or heterogeneous networks

- **Specification of Interests**
  - Subscribers must be able to specify data “interests” to more efficiently use available & limited network resources

TRCE Phase 1 will:

- Developed Use Cases and Requirements
- Developed Proof-of-Concept Applications to Investigate Candidate Technologies
- Quantified Benefits of Candidate Technologies
  - Representative Laboratory Environment
- Successful Phase 1 Technology Demonstration
- Recommended Technologies for Further Development and Inclusion in the TENA Middleware

TRCE is providing TENA for variable quality and low data rate network links including wireless networks
TRCE Use Case OV-1
Hands-on TRCE Current “Smartphone” Capabilities at the TENA/JMETC Booth

• Booth Demonstration Capabilities Using TENA RelayNode and TENA Video Distribution System (TVDS) with iPads and iPod Touch Devices
  – Display of Platform positions on static maps stored locally on the handheld devices
  – Selection and real-time viewing of available video streams managed by TVDS on handheld devices (iPhone/iPad/Android)
  – Pan/Tilt control of remote cameras (and firing of Nerf remote “missile launcher”) via TENA remote methods

• Highlights the Flexibility of TENA Middleware
  – Remote control of instrumentation via TENA Remote Methods
  – Use of wireless networks including 3G
  – Middleware implementations on small form factor computers such as Smartphones
TENA and RRRP

- Use of TENA will facilitate Remote Operations and Interoperability of the Ranges’ Radar Systems

- TENA Instrumentation Radar Object Models will be used for all communications external to the individual Radar Systems
  - Pointing data for optics, telemetry, or other radars
  - Remote Single Integrated Air Picture (SIAP)

- Development of TENA Instrumentation Radar Object Models
  - Developed initial Instrumentation Radar TSPI Object Model
    - Received input from Test Center SMEs
    - For CW Doppler and Pulse radar systems
  - Instrumentation Radar Object Models will be finalized after contract award
Common Range Integrated Instrumentation System

- Test Ground Subsystem (TENA)
- Data Throughput 4x Improvement, Software Communication Architecture
- Standardized Protocols and Interfaces
- Improved Reliability
- Miniaturization
- 3x TSPI Accuracy Improvement Level I
- 20x TSPI Accuracy Improvement Level II
- >20x TSPI Accuracy Improvement Level III
- Training (RIW) Waveform with Training Level TSPI
- Updated Encryption Technology
- Improved Reliability
- Improved Reliability

Ground Station/Live Monitoring System

Threat Systems
Alaska Training Range Evolution Program (ATREP) use of TENA

ATREP’s intent is to enhance the existing Pacific Alaska Range Complex air and ground capabilities by providing a force-on-force (FOF) training capability that fully integrates and supports joint and coalition components for both air and ground training in live, virtual, and constructive (LVC) domains.

High Side
- TENA ICADS
- TENA ACMI
- TENA 9C2
- TENA DIADS
- TENA SimShield

Low Side
- TENA MOKKITS
- TENA MILES 2000
- TENA I-HITS
- TENA UMTE
Partial Listing of Recent Testing, Training, and Experiments Using TENA-Compliant Capabilities

• **Test Events**
  - SIAP JDEP Combined Hardware-in-the-Loop Phase 5, Jan-May 09
  - Digital Close Air Support – Integrated Model Test Event, Jan-Mar 09
  - Multi-Service System-of-Systems Test-bed, Jul 09
  - Strategic Integrated M&S Capability, May-Aug 09
  - Joint Electronic Warfare Assessment for Test and Evaluation, Sep 09
  - Tactical End-to-End Closed Loop Sim, Nov 09
  - Joint Distributed IRCM System Test Event, Mar 10
  - Joint Close Air Support Distributed Test, Jun 10
  - Battlefield Airborne Communications Node (BACN) Joint Urgent Operational Need (JUON), Aug 10
  - JIAMDO Air & Missile Defense Correlation / Decorrelation Interoperability Test (CDIT) CONUS, Sept 10
  - Unmanned Aircraft System (UAS) in National Air Space (NAS) Oct 09 and Oct 10
  - JITC Joint Interoperability Test (JIT) Sep-Nov 10
  - JIAMDO CDIT UK, Oct 10
  - Air-to-Ground Integrated Layer Exploration AGILE Fire III, Feb 11

• **Training Exercises**
  - Daily Training, Eielson AFB
  - Daily Training, Fallon AFB
  - Red Flag Alaska (RFA) 09-1, October 08, Pacific Alaska Range (PARC)
  - JDEWR Cope Tiger 09, Mar 09, PARC
  - RFA 09-2, April-May 09, PARC
  - Distant Frontier, May-June 09, PARC
  - Northern Edge 09, June 09, PARC
  - Talisman Sabre 09 - Australian Army and US Army, July 09, Shoalwater Bay, Queensland Australia
  - RFA 09-3, July-Aug 09, PARC
  - JDEWR Talisman Sabre 09, July 09, PARC
  - RFA 10-1, October 09
  - RFA 10-2, April 10
  - Northern Edge, June 10
  - RFA 10-3, Aug 10

• **Experiments**
  - Joint Surface Warfare JCTD, Feb 09 and Oct 10
  - Joint Expeditionary Force Experiment (JEFX) 09-1, 09-2, 09-3, Feb-Apr 09
  - JEFX 09-4 B-2 Test (Spirit ICE), Aug 09
  - JEFX 10-1, 10-2, 10-3, Jan-Apr 10

Distributed Events operated over the JMETC and JTEN Connectivity
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InterTEC Operational View-1
TENAA-Based Integrated Test Tool Applications

**C4ISR Instrumentation & Analysis**
- Data Capture
- Stimulation
- Analysis
- Display

**Virtual Components**
- HWIL Interfaces
- Message Generation

**Live Components**
- Range Interfaces
- Range Instrumentation

**Constructive Components**
- Simulation Interfaces

**Synthetic Battlespace Environment**

**20 Integrated Apps in Spiral 2**

**Test Control**
- Planning
- Rehearsal
- Control
- Monitoring
- Reporting

**Distributed Test Suites**
InterTEC Integration with JMETC
Inextricably Intertwined

4Q 2010
InterTEC Spiral 3

Intel, Net Readiness

4Q 2008
InterTEC Spiral 2

Joint Planning Network

Fielded
InterTEC Spiral 1

Joint Data Network

- JMETC supports InterTEC during their spiral development
- InterTEC expands JMETC toolbox with certified C4ISR Test Tools
TENA Integrated Development Environment (TIDE)

- TIDE is a tool designed to assist developers in the creation, development, testing and deployment of TENA applications

- Initial Capabilities
  - Catalog installed object models on a user’s machine
  - Migrate user applications between object model versions
  - Migrate user applications between middleware versions
  - Browse and download object models available in the TENA Repository
  - Request object model distributions from the TENA Repository

- TIDE 2.0 is the current version
  - Available at http://www.tena-sda.org/tide web site
TENA Tools used by JMETC
Interface Verification Tool (IVT)

- Designed to support the integration testing of TENA applications
  - TENA Standard OM’s
  - JNTC and InterTEC LROM’s

- Provides real-time monitoring, logging and statistics gathering

- Operates in three different roles, either stand-alone or in combination:
  - Data Subscriber Role
  - Data Publisher Role
  - DIS to TENA Gateway Role

- Available at https://www.tena-sda.org/display/Tools/IVT
**SIMDIS Use of TENA**

- **Duration testing using SCORE TSPI data feed**
  - Four consecutive days
    - Win XP, Red Hat 9, Solaris 5.8
    - Processed 180,000+ entities
  - Two consecutive days
    - Win XP, Red Hat 9
    - Processed 53,000+ entities

- **Results and observations**
  - No issues with discovery latency
  - No issues with update latency
  - No issues with CPU usage
  - No issues with memory usage
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Traditional Network Dilemma
Network Aggregation Bridging Networks

Key:
- Available
- Capable

DISN - LES
JTEN
SIPRNet
IO Range
JMTC VPN
3CE

Aggregation Router at Pax River
Network Aggregation
Bridging Networks

Aggregation Router

DISN-LES

SIPRNet

IO Range

JMETC VPN

3CE

JFCOM

PACOM

CENTCOM & SOCOM

Kirtland: DMOC

Ft Huachuca: EPG

Tinker AFB: JITC

Aberdeen: ACCN

Philadelphia: ATEC

Suffolk

Greenville

Melbourne

Boeing

Virginia Beach

USTRANSCOM

EDS

EUCOM

Aberdeen

Dam Neck: CDSA

JMETC SYSCON

Ft Polk

Little Rock

Barksdale

Eglin (3): AOC, DTF, GWEF

Ft Rucker

CEDL, IWSL

Eglin

Ft Sill

Dahlgren (2):

JSTARS

St. Louis: CIDS

USSOUTHCOM

Ft Sill

Ft Hood

Pax River

Charleston (2): IPC, MEF

Camp Lejeune

Ft Bragg

Ft Rucker

29 Palms

Ft Huachuca

JMETC VPN

3CE

JFCOM: JSIC

Hanscom

Huntington Beach

Tucson

Palmdale

Newport News

Suffolk

Seattle

St. Louis

Melbourne

Greenville

Philadelphia

Fort Worth

Bedford

Sunnyvale

Mesa

Orlando

Eglin

Edwards

Kirtland: DMOC

Tinker

Langley

Wright Pat

Hanscom

WARCAP

Dahlgren

China Lake

Corona

SPAWAR,

San Diego

Pax River

Dam Neck

Moorestown

Wallops

JMETC SYSCON

Ft Huachuca

Camp Pendleton

Pt Loma

JFCOM

Pax River

Ft Hood

Yongsan

Eielson

PACOM

Camp Courtney

Camp 
... Lejeune

Ft Bragg

JMCTC

EUCOM

Ft Lewis: EPG

Schriever

Eglin

Dam Neck

Hanscom

Ft Bliss 
DMOC

Ft Huachuca

JMETC SYSCON

Eglin

Dam Neck

Hanscom

Ft Bliss 
DMOC
Available Sites from Integration of Test and Training Networks

- Quantico
- Ft Huachuca
- Camp Pendleton
- JFCOM
- Pax River
- Yongsan
- Camp Courtney
- Camp Roberts
- Ft Irwin
- 29 Palms
- Nellis
- Fallon
- Yuma
- Petersen
- Schriever
- Ft Leavenworth
- USTRANSCOM
- Camp Lejeune
- Schriever
- Dam Neck
- Hanscom
- Pax River
- Quantico
- Ft Huachuca
- JFCOM
- Ft Leavenworth
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JMETC Users Group Meetings

• Identify core infrastructure requirements and use cases
• Identify, investigate, & resolve issues
• Identify opportunities to collaborate
• Discuss available solutions, tools, and techniques
• Share lessons learned

Next JMETC Users Group Meeting #13:
• Scheduled for 22-23 March
• Location: Norfolk, VA
• Potential Tracks:
  • User Requirements
  • Information Assurance / Security
  • Data Management
  • Networking

Users Group #01
• 19-20 Jun 2007
• Dulles, VA
• ~140 participants
• Plenary session:
  • SIAP
  • JSF
  • FCS CTO

Users Group #02
• 14-15 Aug 2007
• San Diego, CA
• ~150 participants
• Plenary session:
  • Navy DEP

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Users Group #03
• 29-30 Jan 2008
• Portsmouth, VA
• ~200 participants
• Plenary briefs:
  • InterTEC Spiral 2
  • AF-ICE
  • JFCOM J84

Users Group #04
• 20-21 May 2008
• Charleston, SC
• ~135 participants
• Plenary session:
  • InterTEC Spiral 2
  • SPAWAR Systems Center - Charleston

Users Group #05
• 9-10 Sep 2008
• Boston, MA
• ~180 participants
• Plenary session:
  • InterTEC Spiral 2
  • Air Force Testing
  • FCS Testing
• Tracks:
  • User Requirements
  • Distrib. Test Tools
  • Service-Oriented Architectures (SOAs)
  • Networking

Users Group #06
• 16-17 Dec 2008
• Austin, TX
• ~180 participants
• Plenary session:
  • GCIC
  • CTSF
  • ATEC
• Tracks:
  • User Requirements
  • Security
  • Service-Oriented Architectures (SOAs)
  • Networking

Users Group #07
• 24-25 Mar 2009
• Ft. Walton Beach, FL
• ~210 participants
• Plenary session:
  • 46 TS
  • 505 CCW
• Tracks:
  • User Requirements
  • Security
  • GIG-Enabled T&E
  • Networking

Users Group #08
• 30 Jun – 1 Jul 2009
• Portsmouth, VA
• ~280 participants
• Plenary session:
  • TRMC
  • JFCOM J7
  • JFCOM J8
  • JEFX 09-02/03
• Tracks:
  • User Requirements
  • Security
  • GIG-Enabled T&E
  • Networking
  • SOA

Users Group #09
• 20-21 Oct 2009
• Ventura, CA
• ~240 participants
• Plenary session:
  • NAVAIR
• Tracks:
  • User Requirements
  • Security
  • GIG-Enabled T&E
  • Networking
  • SOA

Users Group #10
• 23-24 Feb 2010
• Orlando, FL
• ~300 participants
• Plenary session:
  • TRMC
  • Navy T&E
• Tracks:
  • User Requirements
  • IA / Security
  • Object Models
  • Networking
  • SOA
Architecture Management Team (TENA AMT)

- **AMT Members:**
  - 329 Armament Systems Group (329 ARSG)
  - Aberdeen Test Center (ATC), Aberdeen Proving Ground, MD
  - Air Armament Center (AAC), Eglin AFB, FL
  - Air Force Flight Test Center (AFFTC), Edwards AFB, CA
  - Army Operational Test Command (OTC), Fort Hood, TX
  - Common Training Instrumentation Architecture (CTIA)
  - Dugway Proving Ground (DPG)
  - Electronic Proving Ground (EPG)
  - integrated Network Enhanced Telemetry (iNET)
  - Interoperability Test and Evaluation Capability (InterTEC)
  - Joint Fires Integration & Interoperability Team (JFIIT)
  - Joint National Training Capability (JNTC)
  - Naval Air Warfare Center – Aircraft Division
  - NAWC – Weapons Division
  - Naval Aviation Training Systems Program Office (PMA-205)
  - Naval Undersea Warfare Center (NUWC)
  - NAVSEA Warfare Center - Keyport
  - P5 Combat Training System (P5CTS)
  - Pacific Missile Range Facility (PMRF)
  - Redstone Technical Test Center (RTTC)
  - T&E/S&T Non-Intrusive Instrumentation
  - White Sands Missile Range (WSMR)

- **Meetings every 3 months**

- **US Advising Members:**
  - BMH Associates, Inc.
  - Boeing
  - Cubic Defense
  - DRS
  - Embedded Planet
  - EMC
  - Kenetics
  - MAK Technologies
  - NetAcquire
  - Science Applications International Corporation (SAIC)
  - Scientific Research Corporation (SRC)
  - Scientific Solutions, Inc. (SSI)

- **International Participation**
  - Australia
  - Denmark
  - France
  - Singapore
  - Sweden
  - United Kingdom

Summary

- **JMETC** supports the full spectrum of Joint testing, supporting many customers in many different Joint mission threads
  - CVN-21, JSF, MMA, NECC, DD1000, WWF, BAMS, JIAMDO
- **TENA** is the CTEIP architecture for future instrumentation, the JNTC architecture for Live integration and an enabling technology for JMETC
- **TENA and JMETC:**
  - Being built based on customer requirements
  - Partnering with Service activities and leveraging existing capabilities
  - Coordinating with JFCOM to bridge test and training capabilities
  - Provide a forum for users to develop and expand the architecture
    - JMETC User Groups, TENA AMT Meetings
    - Next Meeting is week of March 21 in Norfolk, VA
Important Contact Information

- TENA Website: [www.tena-sda.org](http://www.tena-sda.org)
  - Download TENA Middleware
- JMETC Website: [www.jmetc.org](http://www.jmetc.org)
- TENA Feedback: [feedback@tena-sda.org](mailto:feedback@tena-sda.org)
  - Provide technical feedback on TENA Architecture or Middleware
- JMETC Feedback: [jmetc-feedback@jmetc.org](mailto:jmetc-feedback@jmetc.org)
- TENA SDA Contact
  - Telephone: (703) 601-5202
- JMETC Program Office Contact
  - Telephone: (703) 601-5280