The Role of High-Frequency Communications in the Future
NATO Network Enabled Capability (NNEC)

A presentation to the NATO HF Policy Workshop
11 October 2004
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NATO UNCLASSIFIED
• NNEC
  • Where did it come from?
  • What is it?
  • Why do we care?
  • What will it do to/for us?
  • NATO Network Information Grid (‘ENGINE’)

• NNEC-HF Component
  • Desiderata for Net-Readiness
  • Current status & Future Vision
  • Enabling technologies – what they were, what they’ll become

• Is There a Way Ahead for HF?
North Atlantic Council Meeting of 21 November 2002

- invited Bulgaria, Estonia, Latvia, Lithuania, Romania, Slovakia and Slovenia to begin accession talks
- Determined that in order to carry out the full range of its missions, they needed to:
  - Create a NATO Response Force (NRF):
    - technologically advanced, flexible, deployable, interoperable and sustainable force including land, sea, and air elements ready to move quickly to wherever needed
  - Streamline NATO’s military command arrangements.
    - Created ACO w/ two Joint Force HQ for land-based or sea-based CJTF operations
    - Created ACT w/ responsibility for force transformation and the promotion of force interoperability
Bi-SC Strategic Vision:
- Effects-based approach
- 2020 target state

NNEC encompasses the elements involved in linking sensors, effectors and decision makers together.
Developing A Technology Vision

- **DECONFLICT**
  - Operational
  - Functional Area Services: Standalone Applications
  - Information Integration Services: Standalone Information
  - Communication Services: Multiple types of Networks

- **COORDINATE**
  - Operational
  - Functional Area Services: Integrated and Web Based applications
  - Information Integration Services: Database Centric Information sharing
  - Communication Services: Migrate to a Single network type

- **INTEGRATE**
  - Operational
  - Functional Area Services: Applications as Services
  - Information Integration Services: Service Oriented Architectures
  - Communication Services: Mobile Software defined networks

- **COHERENT Effects-Based**
  - Operational
  - Functional Area Services: Self orchestrating Applications
  - Information Integration Services: Semantic Web capabilities
  - Communication Services: Self managing Adaptive networks

Integrated technology vision for the NNEC infrastructure
Information Integration Services

- Standalone Information
  - segregated data and delivery systems
    - TARE, BRASS, SSB, CUDIXS, LINK 11, LINK 16)
  - incompatible formats
    - (ACP127, X400, SMTP, TADIL-A, OTH-G …)

- Database-Centric Information Sharing
  - linked networks
  - enhanced access (linked databases)
  - self-describing data (SGML, XML, XHTML …)

- Service Oriented Architecture
  - defined, published interfaces for services
    - by functional area, bearer, core services and specialized
  - network as ‘market-place’ for end and bearer services

- Semantic Web
  - ubiquitous connectivity, w/ information portals and hubs
  - query/discover knowledge centers by meaning, information type
    - query by text / audio / video pattern match
NNEC Notional Transmission Component

SPACE TRANSPORT

AD HOC DEPLOYED NETWORK

AIR TRANSPORT

TERRESTRIAL TRANSPORT

TERRESTRIAL, AIR

AIR NETWORK

DEPLOYED NETWORK

SPACE

TERRESTRIAL

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NNEC Global Infrastructure

- Black core
- IPv6
- New protocols, e.g. routing (R&TO)
- Ubiquitous access
- Convergence - QoS
- Physical diversity
- Architecture for system of systems

Nation A | Nation B | NATO
---|---|---
National Network Management | National Network Management | Grid Related INFOSEC
facilities | facilities | Core Services
QoS | QoS | End-to-end Coalition CIS Services control
Transm | Transm | CIS Management based on modular Service

Automatic Service Configuration
Net centric Communication Intelligence
QoS Capability
Converged IPv6
Transmission & Access
Special Comms
New technologies

Standards Policies, procedures NC3B – MIP - STGP

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NNEC Communication-Service Tenets

- **Philosophy**
  - Follow the Internet Model
  - Build from smaller component blocks
  - Design w/ interoperability, evolvability, & simplicity in mind

- **Tenets**
  - Evolve to packet-switching infrastructure
  - Build-layered, modular, components, upgradable in simple steps
  - Trend towards convergence of voice, video, and data
  - Trend towards IPv6 for NATO standard comms
  - Provide network connectivity for all end-points
  - Support differentiated management of Quality of Service
Communication Services

- **Migration to a Single Network Type …**
  - does not (cannot?) mean convergence to:
    - a common frequency band
    - waveform
    - media-access control protocol
  - should (must?) mean convergence to:
    - a common user interface between end systems and bearers
    - a common interface between bearers
    - a common network architecture

- **The Single Network will be …**
  - a network of networks (hierarchical, concatenated, meshed)
  - common architectural features and management
  - ad-hoc, adaptive, self-organizing
NNEC ‘House’

Warriors Combat Power

Networked Applications

Enabling Technologies

Requisite Systems and Information Repositories

Foundation Technologies

- Security - Directory Services - Storage
- Network and Communication

Networked applications address the business goals.

Prerequisite and existing systems provide information for the networked applications.

Enabling technologies allow you to build the networked applications.

Foundation Technologies provide seamless connectivity and security.
Fast Rewind to ...
The ‘HF-House’ STANAG Suite

- ACS
  - Automatic Channel Selection
- ALE
  - Automatic Link Establishment
- ARQ
  - Automatic Repeat Request
- ALM
  - Automatic Link Maintenance
- EPM
  - Electronic Protection Measures

- STANAG 5066 - Profile for HF Radio Data Communications
- STANAG 4539 - HF Waveforms (PSK, QPSK, QAM)
- STANAG 4538 - Automated Radio Control System (ARCS)
- STANAG 4444 - HF EPM Waveform (FH-PSK/FH-QPSK)
- STANAG 4415 – Robust HF Waveform
- STANAG 4203 - HF Radio Standards (~ 3 kHz, ~1.4 kHz)
- MIL-STD-188-110A/B - HF Waveforms (PSK/QPSK/QAM)
- MIL-STD-188-141A - Automatic Link Establishment

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‘Enabling Technologies’ for BRASS (noted circa 1995 !)

- **Improved Throughput**
  - done that … S’4285 / S’4539 / S’4538 HDL+ …
  - BUT … still constrained to 3 kHz !!!!! … and thus < 9600 bps … and then only if BRASS contracts are modified for S’4539 …

- **Network-Ready Interface at Shore**
  - done that … accepts message traffic over NGCS in a variety of formats (X.400, SMTP, ACP127)
  - BUT, still uses ACP127 text formats over the HF interface

- **Improved Protocols for Reliability**
  - done that … S’5066 ARQ for Ship-Shore and MRL circuits
  - BUT … ALE integration is minimal if at all

- **Improved Messaging Protocols**
  - well … we’ve defined S’4406 A-E, but deployed only S’4406 A-D
    - no over-the-air S’4406E capability yet specified in BRASS
  - defined and used with S’5066F CFTP … but only for informal messaging, and only on bi-directional S/S & MRL circuits

- **Integrated Compression**
  - only if using S’5066 CFTP

  - if only ….
Talking points

- HF House is necessary but not sufficient to bring HF into the NNEC
  - improved waveforms, link automation, standardized interface a pre-requisite
  - BUT
    - little focus on operational/system concepts
    - devoid of knowledge or recognition of net-ready requirements
    - needs to address mobility, self-configuration, integration issues in a larger network
- Without:
  - recognition of the NNEC operational requirements by the HF community, HF will not grow (alternatively, will not be supported w/in NATO ... )
  - a statement by the strategic commanders that HF can/must play a role in NNEC, it WILL die ...
- With:
  - a proactive policy and interest in growth, AND
  - a strategic vision and set of MMRs that allow growth,
  - THEN --- HF will play a continued, viable, valuable role
What are the pre-requisites for defining an IP-over-HF NNEC component?

- Agreement on the vision
  - is it worth doing
- Agreement on an architecture
  - operational concepts
  - components, systems, interfaces
  - services provided
- Agreement on technological approach(es)
  - do we (how do we) pick winners?
  - do we (how do we) prune for efficiency?
  - how do we transition?
**DC/ 04/ MD15 - JWID ‘At-Sea’ Demonstration: Status / Wrap-Up**

**Status:**
- Completed JWID 2004 Demonstration Exercise:
  - In US JWID exercise as Coalition Interoperability Trial 02.10 (AHFWAN66) (see 1Q rpt)
  - In NATO JWID Exercise as NNATO-3 - Allied High Frequency Wide Area Network (see 1Q rpt)
  - Developed the NC3A-NL JWID Demonstration Area: ‘The CAVE’ (first major demo, w/ SCOBE)

**Lessons Learned (many!)**
- IP-over-HF subnetworks are viable for some services: COP dissemination, multicast e-mail, other delay-tolerant applications
- HF wireless token-ring protocol is a viable self-organizing, self-healing network architecture supporting let-net entry and error-recovery
- Viable configurations for mobile-IP (requires black-infrastructure support), HFIP-router, multicast
- Proxies and QoS support required for delay-intolerant applications

**Recommendations**
- adopt the HF WTRP and HF-IP router architecture for STANAG 5066 Edition 2
- adopt the AHFWAN architecture as a comms component for NATO Network-Enabled Capability

**Way Ahead:**
- Spread the Good Word!
- Other exercises (Combined Endeavor, CWID 2005, CATHEM, TRIDENT WARRIOR ’05)
- Insert requirements/capabilities into STANAG 5066 Ed2 NATO MMR, Maritime Reference Arch.
2004 Target
- Participate in an “At Sea” JWID 2004 demonstration of Allied HF Wide Area Networking using IP over HF (STANAG 5066 (Ed 2)) and
- provide a TP supporting the results of the demonstration. (DC 3)
- deliverable 2Q/3Q

Operational Concept:
- NATO Maritime Communications Architecture:
  - as a deployed NATO Expanded Task Force (NETF) (w/ IP mobility pre/during/post deployment)
  - as an IP-based wireless wide area network
  - as a mix of large-deck/small-deck platforms
- Seamless Tactical Wireless WAN connectivity amongst shore-based HQ and Deployed Maritime Forces
Notional View (s):

- As prototype of the Goal NATO Maritime Comms Architecture:
  - as a deployed NATO Expanded Task Force (NETF) (w/ IP mobility pre/during/post deployment)
  - as an IP-based wireless wide area network
  - as a mix of large-deck/small-deck platforms

Node-Edge-to-Node-Edge & System-to-System Interfaces:

- SHF SATCOM (simulated)
- NATO In-Port Connector (100 Mbs FO-link)
- Allied HF Wide-Area-Network using S’5066 Ed. 2
  - High-speed HF (S’4539, MS’188-100B/F)
  - Wireless token ring protocol
  - IP-over-HF w/ performance enhancing proxies

Applications / Core Services:

- Messaging (SMTP-Email; STANAG 4406 Annex E)
- Distributed Collaboration (Domino / Sametime)
- COP (MCCIS R5)
- other
DC/ 04/ 15: AHFWAN66
IP-over-HF Network Architecture

Figure 42 - Overview of the AHFWAN66 Demonstrator IP-Network Configuration
Throughput

MAC-delay (ring-cycle-time)

Round-Trip-Time (end-to-end delay)

Representative data (Week 2 Day 4 shown)

Loaded Performance: simultaneous: mail, COP, and Web
Common IP Subnetwork Architecture
IP Mobility Technology

- IP Mobility conformant w/ NNEC vision
  - self-organizing
  - ubiquitous
- Mobile-IP
- MANET
  - OLSR
  - OSPFv3
  - future ...

Mobile and/or Dynamic Internetwork Domain

Mobile EndNodes (e.g., User Terminal)

Mobile Subnetworks/ASes (e.g., Mobile Platform)
E.G. - MRA NOV-1
Top-Level Operational Concepts
NSV-1b: Intra-Nodal Interfaces

NATO General-Purpose-Segment Communication System (NGCS)
only a single instance of each site is shown—multiple instances are supported as needed to reflect operational architecture

National Defense Network (NDN) national dispositions
National InPort Network

NATO Maritime HQs (Ashore): e.g. CJTF, MCC, SUBOP AUTH BC

ISDN/PCM/Audio

HF Broadcast, SS, MRL
HF Ship/Shore, MRL

ISDN/PCM/Audio

HF Broadcast, BLOS Backup Links

NATO SATCOM

Post 2000

EHF SATCOM

SIF SATCOM

UHF SATCOM

BRASS Sites: ACMS, HF BCS & RCS; VLF

NATO Amphibious Force

Deployed Land Force

ELOSLOS IP Subnetwork Relay

NATO Expanded Task Force (NETF)
## NTV-1 Standards Profile - Transport Services
*(from JWID 2004 demos)*

<table>
<thead>
<tr>
<th>Class</th>
<th>Standards</th>
<th>Non-NCSP Std</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Best-Effort End-to-End</td>
<td>User-Datagram Protocol (UDP) - STD 6 (RFC 768)</td>
<td></td>
<td>point-to-point; point-to-multi-point addressing</td>
</tr>
<tr>
<td>Datagram Delivery</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reliable Connection</td>
<td>Transmission Control Protocol (TCP) - STD 7 (RFC 793)</td>
<td></td>
<td>point-to-point</td>
</tr>
<tr>
<td>Reliable Multicast Delivery</td>
<td>Multicast Dissemination Protocol Version 2 (MDPv2)</td>
<td>X</td>
<td>MDPv2 uses UDP/IP multicast.as the bearer service.</td>
</tr>
<tr>
<td>Compression Services</td>
<td>GNU-ZIP (RFC-1950, RFC-1951, and RFC-1952)</td>
<td>X</td>
<td>Compression used in the MSEG in conjunction with MDPs; compression provided in the Skyways IP client for AHFWAN; compression in S'4406E T-MMHS, compression in S'5066F-CFTP</td>
</tr>
</tbody>
</table>
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</tr>
</thead>
<tbody>
<tr>
<td>Internet Datagram Delivery Service</td>
<td>Internetwork Protocol (IP) - STD 5 (RFC 791)</td>
<td></td>
<td>supports unicast and multicast addressing modes</td>
</tr>
<tr>
<td>IP control/utility services</td>
<td>Internetwork Control Message Protocol (ICMP) - STD 5 (RFC 792)</td>
<td></td>
<td>'ping' protocol uses ICMP-ECHO-REQUEST, and ICMP-ECHO-REPLY</td>
</tr>
<tr>
<td>IP Datagram Broadcast</td>
<td>STD 5 (RFC 919)</td>
<td></td>
<td>IP Broadcast w/ Subnets uses RFC 922</td>
</tr>
<tr>
<td>IP Datagram Multicast</td>
<td>RFC1112</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IP Subnetting</td>
<td>STD 5 (RFC 950), RFC1517, RFC 1518, RFC1519</td>
<td></td>
<td>Classless Inter-Domain Routing Extensions</td>
</tr>
<tr>
<td>Interior Routing Protocol (unicast)</td>
<td>OSPFv2 (STD54 / RFC2328)</td>
<td></td>
<td>activated only on NFIP and CSNFL</td>
</tr>
<tr>
<td>Exterior Routing Protocol (unicast)</td>
<td>BGPv4 (RFC1771)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Generic Routing Encapsulation</td>
<td>GRE (RFC2784)</td>
<td></td>
<td>tunneling protocol between NFIP and NRSSD</td>
</tr>
<tr>
<td>Multicast Routing Protocol</td>
<td>PIM-SM/DM (RFC2362)</td>
<td>X</td>
<td>tunneled through CFBLNet between MNTG NOCs and the NFIP</td>
</tr>
<tr>
<td>IP Mobility Services</td>
<td>RFC2003, RFC2005, RFC2006, RFC3024, RFC3344</td>
<td>X</td>
<td>Mobile-IP and Mobile-Router support now integral to CISCO IOS (12.3 and higher)</td>
</tr>
</tbody>
</table>
## NTV-1 Standards Profile - Subnetwork Protocols
(From JWID 2004 demos)

<table>
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<tr>
<th>Class</th>
<th>Standards</th>
<th>Non-NCSP Std</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local Area Network Protocols</td>
<td>IEEE 802.3</td>
<td></td>
<td>FastEthernet 100/10 BaseT</td>
</tr>
<tr>
<td>SATCOM Link Protocol</td>
<td>Point-to-Point Protocol (PPP) RFC1661/1662</td>
<td></td>
<td>CISCO HDLC encapsulation PPP</td>
</tr>
<tr>
<td>Pierside FO Link</td>
<td>100-BaseFX (IEEE802.3-2002); Connector: MIL-STD-2042 or SMPTE-358M</td>
<td>X</td>
<td>proposed NATO STANAG in draft</td>
</tr>
<tr>
<td>CFBLNet</td>
<td>mixed protocol usage: ATM (IP-over-AAL5); E1 / E3 (IP-over-PPP)</td>
<td></td>
<td>protocol usage varies by POP location and link</td>
</tr>
<tr>
<td>High-Frequency WAN Protocols</td>
<td>STANAG 5066 Edition 2</td>
<td>X</td>
<td>wireless token-ring extensions under study in this JWID are not part of the ratified HF protocol.</td>
</tr>
</tbody>
</table>

**Plus**

VHF, UHF, SATCOM transmission protocols TBS
Role of HF in NNEC / NNI G

“DO MORE WITH LESS ……”
- A reinterpretation of the result of achieving the NNEC strategic vision, NC3A Feasibility Study Guidelines
- we cannot abandon a spectrum resource; we must integrate it into the vision
- solutions for long-thin bearers (e.g., HF) are more scalable to the higher frequency bearers
  - this is a good-news/bad-news issue ...

Must recognize the limitations
- bandwidth cannot compete with fibre, wireless LOS, SATCOM

Must recognize the opportunities / capabilities
- low-end / low-cost access to NNIG
- unique operational scenarios (terrain, platform factors)
- off-load traffic from more capable (and more heavily loaded bearers)
IP-over-HF support

- **Point-to-Point trunking**
  - well-defined (e.g., ACP200, others),

- **Adaptive Multimember Nets**
  - current research & development areas (e.g., S’5066 E2)

- **Proxy support**
  - Translating proxy, e.g.,
    - CFTP or HMTP e-mail connectors
    - Connectivity/neighborhood ‘Hello’ proxy
    - TCP-to-SCPS-TP-4
  - Edge-proxy, e.g.,
    - S’4406 E T-MMHS proxy
    - TCP-to-SCPS-TP-4
  - Direct-IP
    - ACK-Decimation, ROHC
A Strategic Vision for HF-NNEC

- Linked Shore / Terrestrial Infrastructure
- Mobile Nodes / Mobile Networks
  - build on the BRASS infrastructure
  - commit to the identified enhancements
  - identify / define the MMRs that get you there
    - deployed/mobile node and access to fixed infrastructure
    - mobile ad-hoc networking
    - deployment of performance-enhancing proxies
- plug-n-play capabilities
  - pro-active auto-configuration (e.g., DHCP, distributed DHCP)
  - ad-hoc network formation
- asymmetric architecture
  - large G/T fixed and small G/T mobile
- ad-hoc mobile infrastructure extensions
  - protocols to find and use routes back to the NNEC core
When line-encrypted attachments are changed, mobile-IP is managed on the red-side
when IP-encrypted links are changed, mobile-IP may be managed on
- the black-side (trivially) OR on the red-side, if IP-crypto supports multicast
Proxies in IP-over-HF networks

1) **translating proxy**
(e.g., using CFTP/HMTP)

2) **Edge-Proxy** (e.g., S’4406E)

3) **Directly Encapsulated-IP flows**

**Fleet-Interface Point (FIP)**

- **HTTP**
- **FTP**
- **TCP**
- **IP / LAN**
- **S’5066 SPRIMs**
- **Other proxies** (e.g., S’4406-TMMHS, HTTP, FTP)
- **HF Radio Link**
- **AHFWAN66 HF Subnetwork Controller**

**Deployed Maritime Platform**

- **SMTP**
- **Mail-Server**
- **IP / LAN**
- **S’5066 SPRIMs**
- **Other proxies** (e.g., S’4406-TMMHS, HTTP, FTP)
- **AHFWAN66 HF Subnetwork Controller**
IP-over-HF ??
Or Multi-Protocol over-HF??

- An example for discussion from the NC3A AHFWAN project...

---

**STANAG 5066 Subnetwork Interface Sublayer**

- **S_Primitive**
  - **S_Primitive Header**
  - **S_UNIDATA...type Header**
  - **U_DPDU**

**Translation**

- Source and destination address mapping between STANAG 5066 and Ethernet addresses

**Ethernetframe**

- **Preamble**
  - **Destination Address**
  - **Source Address**
  - **Ether Type**
  - **DATA**

- Size of data is 46 to 1500 bytes

---

**Examples:**
- 0x0800: Internet Protocol
- 0x0806: ARP
- 0x876B: TCP/IP Header Compression [RFC 1144]
- 0x880B: PPP
Multiprotocol-over-HF Support: integrated IPv4, ARP, IPv6, ROHC (IPv4/IPv6)

Proxy selection

Ethernet Frame

TYPE

ARP

IPv4

IPv6

OTHER

ARP PROXY

ROHC

DB

Delivery Type?

UNICAST

BROADCAST

MULTICAST
Performance Enhancing Proxies: translating direct-to-HF -- e.g., CFTP

(a) Messaging System

SMTP Mail-Server/Proxy

S_Primitives

DPDUs

S’5066 E2 Protocol Stack

S’5066 E2 Protocol Stack

(b) IP

Email client
(Outlook, Netscape, etc.)

SMTP Email server

Internal/unspecified

IP port 25 (SMTP)

IP port 110 (POP3)

CFTP/HMTP email server/client

STANAG 5066 HF Subnetwork

SIS interface

Network layer (TCP/IP)

IP port 5066 on 'localhost'

Synchronous serial port to HF modem

(b) IP-bearer-service

Non-IP-bearer-service
Performance-Enhancing Proxy: rate-reducing Edge Proxy -- e.g., S’4406E

LMTA

1) TA-OPEN.req
2) TA-OPEN.cnf
3) TA-TRANSFER.req
3a) TA-TRANSFER.req
4a) PM-DATA.ind
5) TA-OPEN.res
6) TA-TRANSFER.ind
7a) PM-DATA.cnf
7b) TA-TRANSFER.cnf

Messaging Sub-Layer

Tactical Adaptation Sub-Layer

P_Mul Sub-Layer

Bearer service

Encapsulated message

DATA

Bearer signaling (as req'd)
SCPS TRANSPORT PROTOCOL

- ISO 15893:2000 Space data and information transfer systems -- Protocol specification for space communications -- Transport protocol
Layer-2 Data: OSPF/OLSR Hello-Proxies

An example from the NC3A AHFWAN project … other protocols offer similar potential

- **RTTs-heard:**
  - known unidirectional link from the source to the recipient

- **ACKs – heard:**
  - known unidirectional link from the source to the recipient
  - known bi-directional link between the source- and destination- addressee
Security Approaches & Compression: a cautionary tale

- **Object Level**
  - Encrypted file or software component
  - ACL + PKI

- **Network Level**
  - Encrypted datagram
  - ACL + PKI

- **Link Level**
  - Encrypted bit-stream

- Compression has classically been cited as a net-enabling technology for low-BW bearers **BUT**
- Trends in security architecture, moving encryption out to the edges, preclude integrating compression with the bearer service
- Future approaches must integrate compression with end-systems and encryption
BLOSCOMMs AHWG to address:
- operational-/system-level issues for HF networks
  - how we can use it
  - how it works
  - why we still need it
- mobility issues
  - ad-hoc radio networks: organization, autoconfiguration
  - asymmetric fixed-/deployed- infrastructure
    - let’s do some work on adaptive antennas
- recognize that Integrated solutions cross NC3B sub-committee responsibilities and TORs
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NATO UNCLASSIFIED
Transformational Strategy

Attributes of a Transforming NATO Force

[Presented by SACT at NNEC Workshop, Norfolk, VA March, 2004]
NNEC Definitions (1)

- NATO Network Enabled Capability:
  - encompasses the elements involved in linking sensors, effectors and decision makers together,
  - enables the development of a NATO, Network-Centric, Effects-Based, Operational capability.
  - involves support for the Joint Deployment and Sustainment of forces
  - translates information into increased combat power and mission effectiveness through Decision Superiority to achieve Coherent Operational Effects.
NNEC Definitions (2)

- **Network Centric, Net-Centric, Netcentric**: 
  - (adj) Indicates that the general concept of a network or networks is central and foundational
- **Net Enable**
  - To make possible or effective by or through a network
- **Net Ready**
  - A certification process that demonstrates the ability of a system or group of systems to access and utilize a set of Enterprise Services.
- **Enterprise Services**
  - Units of information system functionality made available through well defined invokable interfaces by one or more system components belonging to an enterprise.
NNEC Definitions (3)

- **Basic Net-Readiness**
  - certifies the ability of a system or systems to access and utilize enterprise Information Transport Services as well as Core Enterprise Services.

- **Communities of Interest**
  - Groups of users, who must exchange information in pursuit of shared goals, interests, missions, or business processes.
  - Pre-planned COIs based on existing business processes or organizational entities.
  - Ad-Hoc COIs are not pre-planned, but formed to satisfy shared goals or interests for a limited period of time during the conduct of a mission.

- **Advanced levels of Net-Readiness**
  - defined in terms of the ability of COI-related system components to access and utilize COI-Enterprise Services.
NNEC Definitions (4)

- **Service Oriented Architecture**
  - An architecture within which all functions are defined as independent services
  - Has well-defined invokable interfaces, called separately or in sequences to form business processes.
  - Focuses on the interface:
    - defined in terms of the required parameters and the nature of the result when the service is invoked.
    - defined in a neutral manner that is independent of hardware platform, operating system, & programming language by which the service is implemented.