Link 16
Dynamic Network Management

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Mark Smith
SSC-SD 24525
mark.smith@navy.mil
(858) 537-0542

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Outline

- Why Dynamic Network Management (DNM)
- Link 16 DNM Program
  - Network Controller Technology
  - Time Slot Reallocation
  - Time Slot Reallocation – Receipt Compliance
  - Stochastic Unified Multiple Access (SHUMA) Protocol
  - Multi-netting
- Summary
Why DNM

- Static allocation capacity cannot adapt to real-time operational events
  - Need scalable, flexible and dynamic access protocols
- Unplanned platforms can’t get into the network - requires a new network
- Number of Link-16 platforms increasing dramatically across joint services and coalition partners
- Need efficient use of Link-16 capacity / throughput
- Need a means to reconfigure networks in the deployed environment
DMN Requirements

- Multiple Required Operational Capability (MROC) for JTIDS of 8 August 1989
- JICO Support System (JSS) ORD [DRAFT]
- Northern Watch Link-16 Operations Shortfalls, Tactical Data Link SIO, dated 3-23-00
Link 16 Effective Throughput

Nominal Throughput

- Increased efficiency. (Mitigates wasted capacity)
- JRE eliminates the need for relay capacity
- Multi-Netting and Spatial Reuse Allow for non-interfering simultaneous networks

Current network architecture (Static Design, Paired Slot Relay)

JRE, TSR/SHUMA,
Multi-Nets

JRE and TSR/SHUMA

Dynamic Access Protocols (TSR, SHUMA)

No one Protocol will solve all of the problems.

Predicted, pre-allocated capacity often is unused.

BLOS Connectivity requires almost half of the capacity for relay

Nominal Throughput
Network Controller Technology

- NCT Technology developed under ONR KSA FNC funding
  - Utilizes current network protocols
  - Dynamic entry/exit
  - Network Participation Group (NPG) augmentation (i.e. Surveillance)
  - Robust net monitoring

- Transition Path – Joint Interface Control Officer (JICO) Support System (JSS)
Link-16 Network Controller Example Operation

Current Link-16 Environment
F-14 cannot communicate with other platforms

Unplanned F-14 Platform

New capability enables addition of "unplanned" platforms to Link-16

Additional Capabilities
- Dynamic Time Slot Allocation
- Multinet Switching

Link-16 Network Controller

LMS-16 with Network Controller Technology

Preplanned Link-16 Network
Time Slot Reallocation

- Number of Link-16 platforms increasing dramatically across joint services and coalition partners
- Require a means to reconfigure networks in the deployed environment
- Require scalable, flexible and dynamic access protocols
- Support evolving mission areas, e.g. Time Sensitive Targeting (TST), Sensor Networking, Weapons Networking, etc.
- Fixed, static Networks limit combat flexibility
  - No real-time capability to add or subtract capacity for dynamic units
  - Leaves capability in the form of unused time slots on deck when over-planned units do not launch

“Surveillance Time Slots are never enough”
NCTSI
Time Slot Reallocation (TSR)

Network Protocol - Adapts to dynamic user demands and allows more efficient use of available bandwidth

- Adaptive mode for shared use of a pool time slots
  - Exchange of capacity demand data based on dynamic requirements
  - Redistributes pool capacity based on participant needs
  - Fairly allocates pool capacity, with minimal conflict
- Common Time Slot Assignments
  - Simplifies networks design and initialization process for platforms using TSR

Platform
Host Demand Algorithm (HDA)

Termsinals
JTIDS
MIDS

HDA Conduit (SICP/TIO)
TSR Algorithm (NICP/Core)

Network J0.7s
TSR Overview

- TSR is a dynamic networking asset
- Platforms share a common pool of time slots
- Time Slots (bandwidth) are redistributed on a periodic basis based on each platform’s demand
- TSR allows more efficient use of available capacity
Receipt Compliance in TSR

*C² units will be fully dynamic (ingress/egress) for Single Net Ops*

**Actions**
- Move C2 data to Surveillance NPG
  1. Mission Management – requires TSR mod (JTIDS/MIDS) to support R/C
  2. EW – Host SW mod
  3. PPLI – Terminal SW mod

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TSR

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Requirements

- **Dynamic Ingress/Egress**
  - GIG CRD TDL Transformation CDD
    - Maintain network connectivity on the move to meet Service/JTF requirements in all war fighting environments
    - Scalable and adaptable to meet dynamic needs of users
  - PEO C4I Roadmap
    - Capability on Demand

- **TSR R/C**
  - STANAG 5516
    - DLCP ML236-058-4175-US-M27-R1 of Nov 04
  - MIL-STD-6016
    - ICP TM99-102 Ch3 of Nov 04
Benefits to Link 16

- More efficient use of bandwidth
  - Time slots are allocated based on current need
  - Previously unused capacity is re-allocated to platforms with demand
  - High demand user’s get more bandwidth
- Scalable and supports large scale networks
  - Pool is not limited to a fixed number of platforms
  - When platforms leave the network or do not have a large demand, time slots are “given” to platforms that need them
- Simplifies network initiation process
  - Reduces Network Management and Planning
  - No Need for Surveillance Design Options
  - Less operator entry

Completely Interoperable with non-TSR capable platforms
Stochastic Unified Multiple Access (SHUMA)

- SHUMA protocol developed under ONR KSA FNC funding
  - New Network Protocol Algorithm
  - ONR Funded through FY04
- Expected to provide benefits across various NPGs
  - Effort underway to identify targeted applications
  - Compare to Dedicated, Contention Access, and TSR
- Primarily Lab effort through FY04 and FY 05
SHUMA Overview

Local info only
no distributed control

Terminal Message Queues

Every user can transmit on every time slot

Time Slots

7.8125 msec

128 time slots/sec

\[ p = \text{probability of transmission} \]

\[ p = \frac{1}{n} + (1-\frac{1}{n})(1 - (1-\frac{1}{n})^B) \]

adaptive to load
SHUMA Testing Results

Data for graphs provided by Theater Network Emulator

N = # of aircraft
Benefits to Link 16

- More efficient use of bandwidth
  - Time slots are accessed based on current need
  - High demand user’s get more bandwidth

- Scalable and supports large scale networks
  - Pool is not limited to a fixed number of platforms
  - When platforms leave the network or do not have a large demand, time slots are “given” to platforms that need them

- Simplifies network initiation process
  - Reduces Network Management and Planning
  - No Need for Air Control or Fighter to Fighter Options
  - Less operator entry
  - No requirement for Host Algorithm

Completely Interoperable with non-SHUMA capable platforms
Multi-Net

- Link-16 supports up to 126 different “nets”
  - Nets refer to hopping pattern over 51 Link-16 frequencies
  - Theoretical limit is 20 simultaneous nets without interference
- Current Link-16 networks are designed on 1 main net with very limited multi-netting
  - Each terminal can only transmit or receive in any given time slot
  - Every platform wants to “listen” to everyone’s transmissions all of the time
Multi-net Solution

Random Operational Events

Participant Topologies & Traffic Volume

Predictive Analysis Processes

- Demonstrate J0.3 multi-capability
- Create representative data sets test
  - Sensor to Weapon (WDL, MST)
- Demonstrate Manual Capability
- Develop automated capability based on representative data sets / topologies
Summary

- DNM (NCT, TSR, SHUMA and Multi-Net) technology development and test underway
- Fielding of DNM capabilities is dependent upon other Programs of Record
- Need to continue to obtain Joint and Allied acceptance
- Combination of the DNM technologies increases Link-16 throughput, efficiency and effectiveness

No one technology or protocol is the solution to Link 16 DNM