Tactical Targeting Network Technology (TTNT)

Communicating at the Speed of Battle

Rockwell Collins

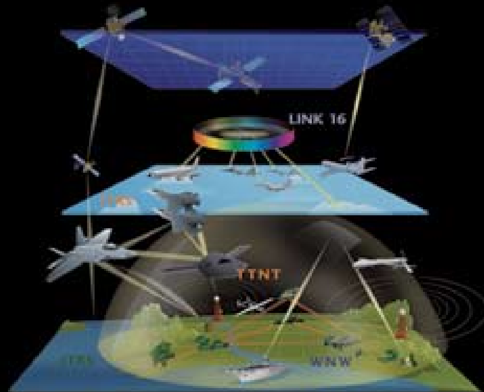
Rockwell Collins

Leveraging Technology to Deliver Best Value

Rockwell Collins is a leader in the design, production and support of communications and aviation electronics solutions for government and commercial customers worldwide. Rockwell Collins strikes a unique balance between government and commercial customers that allows the company to maintain stability and performance in a volatile marketplace. We do this by leveraging technology advances across our commercial and military businesses, which results in providing best value to our customers.

Network Centric Requirements

Market Environment



- Market is in transformation driven by GIG/NCW
  - Mandate driven
    - SCA
    - IPV6
    - WNW Net Services
    - Programmable Crypto
    - ASD (NII): GIG ES
    - CMI Tenants 3-9

NCW is really Decision Centric Warfare, enhanced by Info Flow

Platform Centric → Network Centric
Open Architecture

Fast, Agile, Flexible, Scalable, Adaptable, Plug n Play Capability

Our Solution

Operational Network Domains

Require Optimized Networking Waveforms

- TTNT – Tactical airborne
  - Lowest latencies
  - Efficient networking across airborne ranges
  - High rate broadcast in large networks
  - Supports rapidly changing traffic patterns required for tactical targeting
- MP CDL – Tactical backbone
  - High data rate
  - Trunk backbone network
- WNW – Tactical Wireless Workhorse
  - Works well in a wide mix of air, ground and maritime operational deployments
  - Mitigation for severe ground multi-path RF environment can be turned on or off
  - Adaptable across a wide range of spectrum allocations for global use

Full Net-Centric Operations require deployment of IP-based waveforms optimized for particular military operational needs

Our Solution

Issues that TTNT Originally Addressed

- Slow retargeting
  - Enemies take advantage of delays or shortcomings of U.S. targeting capabilities
- Insufficient bandwidth, high latency
  - Current weapon systems inadequate
- Tedious network replanning
  - Current planning can take weeks
- Incompatible with other assets
  - Current systems still “stovepiped” and service-centric

Warfighters Need Advanced Integrated Networking Capabilities

Our Solution

TTNT Provides Advanced Integrated Networking Capabilities

- Collaboratively find and fix fast pop-up/ moving threats
  - Low latency
- Throughput that supports the entire sensor-to-shooter chain
  - High bandwidth
- Prompt network access enables full collaboration with fellow warfighters
  - “Easy as cell phone” network formation
  - MILS security, with simple keying and authentication
- Seamless networking in the fast and dynamic airborne environment
  - Highly interconnected dynamic networking
- Supports C4ISR applications (e.g., GIG level targeting decisions, mission effectiveness assessment)
  - Standard IP compatibility ensures support of multiple applications
- Uninterrupted use of existing data link capability
  - No interference with Link 16
- Upgrade with minimal group A costs
  - Plug-and-play for tactical airborne platforms

Key Messages

TTNT Mitigating Significant Risk in Getting Airborne Networking to the Warfighter

- TTNT Developed to address ANW/TSTNT/JAN-TE
  - High throughput / AJ / Low Latency / Quick Net Join / Doppler Mitigation
  - IP for connectivity to the GIG
- TTNT is mature (TRL 7); lab and flight demonstrated
  - U.S. Government has invested four years and over $70M to date
- TTNT Program focused on transition
  - Spiral development (insert TTNT into MIDS J without impacting MIDS J “Core” program)
  - Frequency Allocation (through stage 3)
  - NSA involvement
  - SCA waveform
  - Transceiver and PA developments
  - LPI / LPD implementation
  - MIDS JTRS “Hooks” assessment

TTNT Mitigating Significant Risk in Getting Airborne Networking to the Warfighter

Recent Events

- Government ANW team recommended TTNT as solution for JAN-TE / ANW
- Successful flight test at China Lake
  - MIR testing
  - Stress testing
- SCA waveform CDR held October '05… authorized to proceed with design
- USAF XI / XO letter (10/14/05) mandates all airborne JTRS and ICNIA plaforms must incorporate TTNT; any ground platform requiring connectivity to JTRS/ICNIA enabled airborne platforms must also incorporate TTNT
- MIDS JTRS PM budgeting to get TTNT incorporated
- PM Waveform – met with them in preperation for JPEO DAB
- F-22 demo set for end of '06
- F-15 renewed visibility
- TTNT/aADNS demo planning
- PM wf assessment – next step to field

Mandated by USAF

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS UNITED STATES AIR FORCE
WASHINGTON, DC

14 October 2005

MEMORANDUM FOR SAF/AQ

SUBJECT: Airborne Networking Waveform (ANW) Implementation on USAF Platforms

We are committed to achieving an airborne network centric operational environment following the path laid out in the Air Force Joint C4ISR Roadmap. To meet our fielding requirement timelines and pursuant to the recommendations of the Joint Tactical Radio System (JTRS) Joint Program Executive Office (JPEO) ANW assessment team, we will immediately implement the following action:

The Tactical Targeting Networking Technology (TTNT) waveform will be used to satisfy Joint Airborne Networking-Tactical Edge (JAN-TE) requirements and must be incorporated on all airborne platforms planning to field JTRS and/or the Integrated Communications Navigation IFF Avionics (ICNIA) solutions. Any ground platforms requiring direct connectivity to JTRS/ICNIA-enabled platforms must also incorporate TTNT.

TTNT is a technological solution that enables network centric operations among our airborne assets. While using TTNT as our airborne networking waveform, we recognize that there are still a number of challenges to overcome in fielding an airborne networking capability. We will continue to work closely with the JTRS JPEO in order to resolve these issues. POCs for this effort are Col James Henderson, AF/XCIE, DSN 425-6166 and Lt Col Lenny Meyers, AF/XORI, DSN 329-0156.

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Acting Chief of Warfighting Integration and
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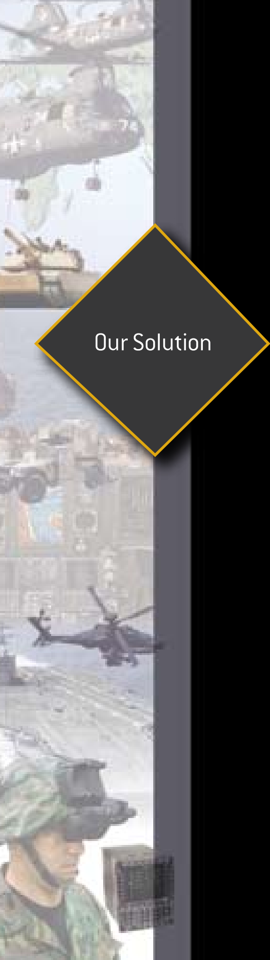
cc:
Navy Staff
Army Staff
Marine Staff
AFPEO F/A-22
F-35 PEO
ESC/CC
ASC/CC
AFC2ISRC/CC
MAJCOM Drs

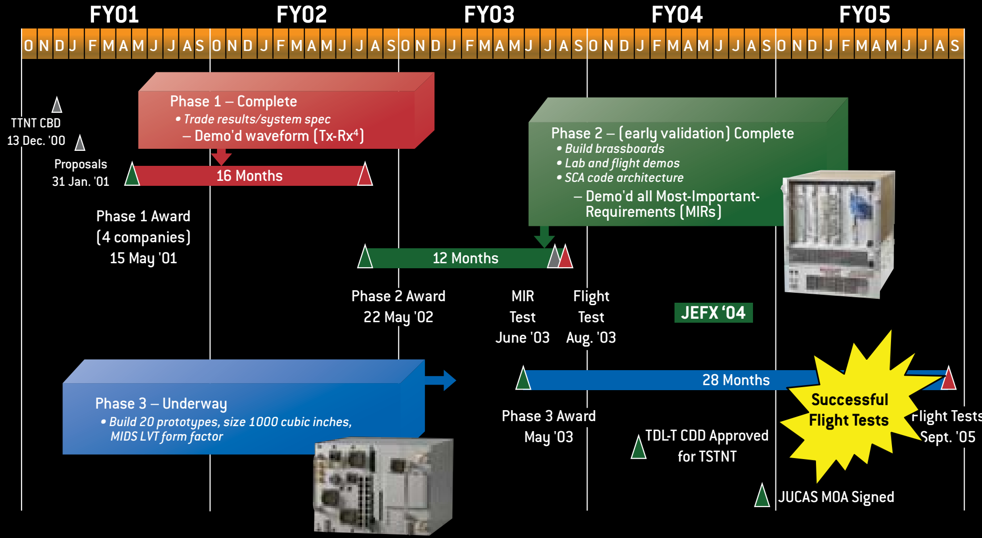
Capabilities

Tactical Targeting Network Technology

- IP based
- Ad hoc joining < 5 secs
- Extremely low latency
- Responsive and robust in dynamic environments (SPMA)
- LO-compatible
- AJ comparable to Link 16
- High throughput
- JTRS compatible
- Min operational support (no network preplanning)
- Link 16 coexistence
- Work up to Mach 8
- Multiple ind levels of security
- Significant growth capability (capable of WDL)

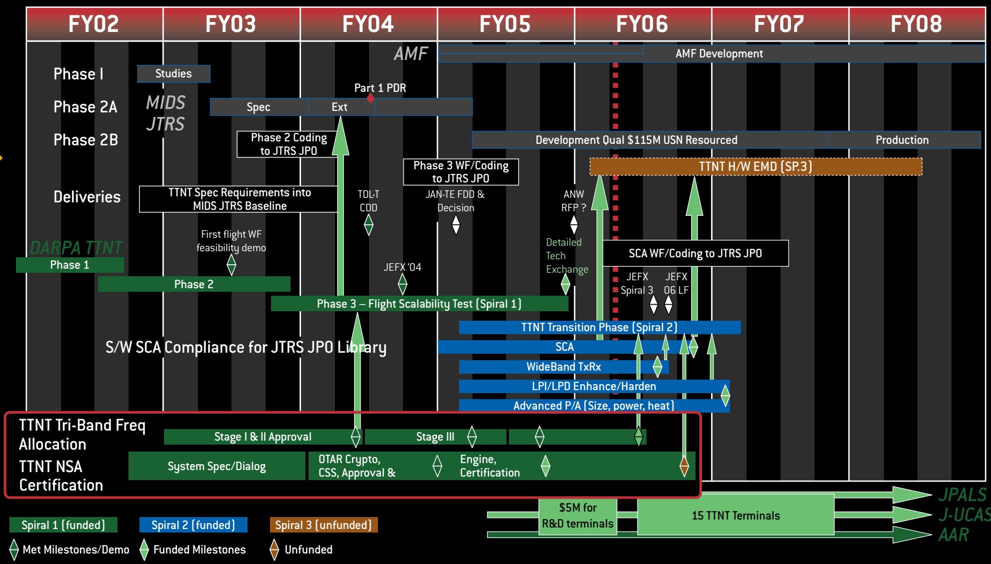


Top Level Schedule



TTNT Phase 3 & Transition

Executing to Spiral Development Plan to Transition TTNT into MIDS-J



Tactical Targeting Network Technology Overview

Most Important Requirements (MIRs)

Phase 2

- 10 megabit per second network throughput
- 2 Mbps at 100 nmi (four simultaneous Rx streams)
- 2 millisecond latency
- 200 active users
- 5 second network ingress
- 10 second dynamic capacity reallocation
- Link-16 RF co-existence
- Also Demonstrated
  - Air-Air and Air-Ground
  - IP based
  - Min operational support (no network preplanning)

Phase 3

- Multiple Independent Levels of Security (MILS)
- Wireless key transfer (COMSEC & TRANSEC)
- Beyond Line-Of-Sight ad hoc routing
- Multicast groups
- Power control
- High speed compatibility (up to 4800 knots - Vc)
- Multi-speed network
- Scalability
- Waveform Assigned Frequency Band Operation With Flexible Frequency Operation
  - Multi-band segments for region specific assignments
  - Waveform capability for frequency adaptability

Transition MIRs

- JTRS compliant waveform
- No new holes, no new cables
- No additional LRUs
- Significant growth capability (capable of Weapons Data Link)

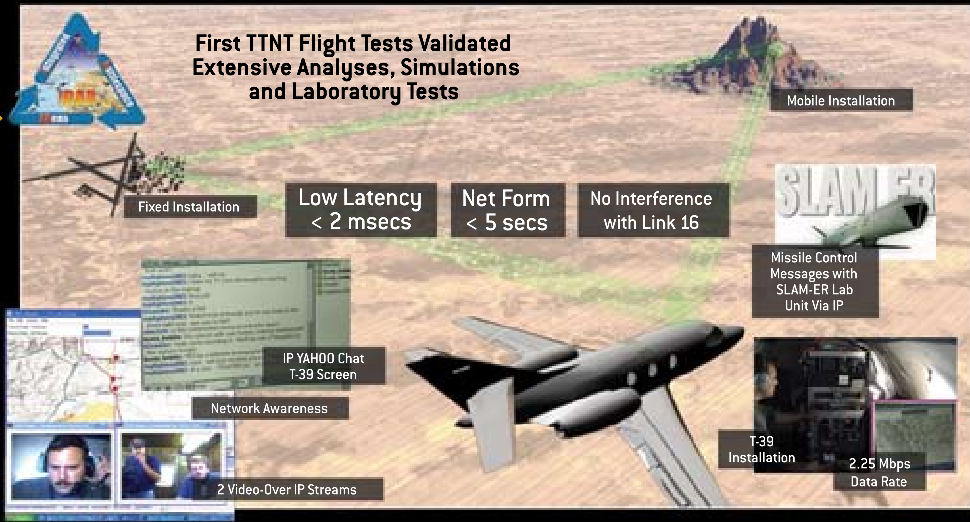
Other Supported MIRs

- AJ > Link 16
- LO (LPI/LPD) Implementation (in progress)

TTNT Test Events

Proven Effectiveness

Phase 2 Testing – August 2003 (China Lake)



Phase 2 Early Validation Testing Results –Surpassed Requirements

MIR Test	Requirement	Lab Testing	Flight Testing
Low latency	*2 msec*	***Surpassed*** *1.64 msec measured*	***Surpassed*** *1.7 msec measured*
100 nm	*2 Mbps/user at 100 nm*	***Surpassed*** *2.25 Mbps transmit at signal strength equal to 100 nm link*	***Surpassed*** *2.25 Mbps transmit at 121 nmi link*
(Total) network throughput	*10 Mbps*	***Surpassed*** *22.5 Mbps demonstrated in laboratory*	
Network ingress	*5 seconds*	***Surpassed*** *Average ingress time of 2.31 seconds max 3.36 seconds*	***Surpassed*** *Average ingress time of 3.0 seconds*
Dynamic capacity reallocation	*10 seconds*	***Surpassed*** *SNMP update in less than 2 seconds measured*	***Surpassed*** *Less than 3.0 seconds*
200 active users	*200 active users*	***Surpassed*** *Multi-strike simulation performed with 10 Mbp spread across 204 active users in high background environment*	
Link 16 co-existence	*No RF impact*		***Meets*** *No RF impact in TTNT-Link 16 operation*

Red - Failed	Orange - Some Failed	Green - Meets	Blue - Surpassed

Legend: "Actual Measurement" Color Code

TTNT Demonstrated Operationally Relevant Airborne Tactical Edge Networking

JEFX 2004 TTNT Assets (Four nodes)

- T-39 with gimbal-mounted sensor – China Lake - USN
- Range vehicle – China Lake – USN, (USAF/USA Special Tactics Team)
- Paul Revere Test Aircraft - ESD Nellis AFB
- CAOC – based on Nellis Black Mountain – Iowa National Guard

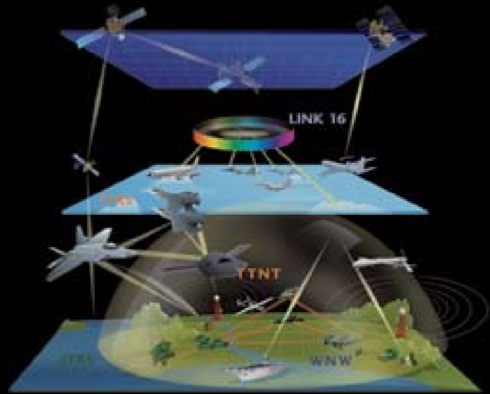
JEFX 2004 Operational Concept

- Gather ISR information from forward sensors
- Route to command center for threat identification
- Set-up communication with forward executors and ground-based targeters
- Coordinate "kill chain" process for executing time sensitive targets

TTNT Applicability

- Fast moving tactical aircraft
- Tactical airborne layer and air-to- ground applications
- Very low latencies
- High dynamics (topology, traffic patterns, and platforms)
- LOS connectivity; networked BLOS

TTNT Demonstrated Operationally Relevant Airborne Tactical Edge Networking



JEFX Network IP Applications

- Text Chat – mIRC, IWS
- Email – SIPRnet (coalition)
- Still imagery file sharing
- Streaming video bi-directional – T-39 to all nodes and Predator/UAV
- Targeting tools such as ADOCS
- Air Tasking Order asset information over IP such as TBMCS FSTATS
- Situational Awareness of track data – Link 16 PPLI's through IP JRE information feed.

Milestones Completed

Spiral 1	January 2004
Spiral 2	CONEMP April 2004
Spiral 3	Live fly dry run May 2004
Spiral 4	Live fly main event, Nellis AFB July/ August 2004

Proven Capabilities

Successful Demonstration at JEFX-04

- **First** use of Global Information Grid (GIG) extended robust Internet Protocol (IP) networking in the forward domain (to the last tactical mile air and ground combat users)
- **First** wideband IP connectivity for a ground mobile node to the AOC (imagery, video and large file Blue Force tracking information)
- **First** streaming video over IP from tactical sensors to command center
- **First** use of Beyond Line Of Sight (BLOS) IP connectivity to mobile IP network using an airborne forwarding node (Paul Revere Boeing 707 with 4 BLOS IP network pipes)
- **First** use of remote IP sensor steering from a command center, from a ground mobile vehicle (TACP) and from a C2 aircraft (Boeing 707 – E-10 risk reduction platform)
- **First** forwarding of significant quantity of Blue Force Tracks from command center to disadvantaged node (TACP vehicle) over IP networking
- **First** IP collaboration with forward air, ground and command center nodes to prosecute and find mobile WMD threats

Proven Effectiveness

Phase III Scalability Flight Test – September 2005

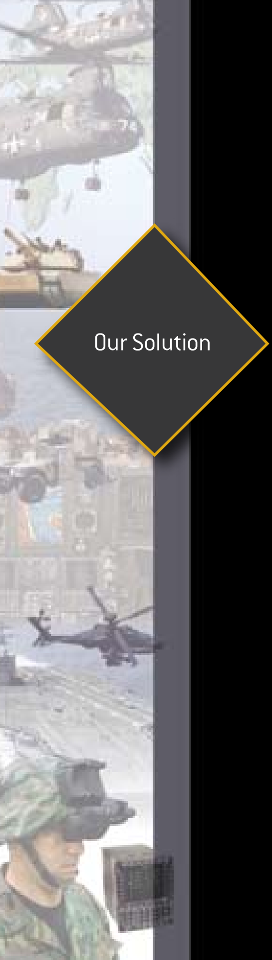
- Broadband for tactical units (2 Meg/sec)
- NT ISR from F-15, F-18
- Voice over IP
- Automated air refueling
- Joint precision approach and landing
- SOFNET wireless reachback
- BLOS with TFPR – Connexion

Our Solution

Phase 3 Flight Test MIR Preliminary Results

MIR	Description	Status	Flight Test Measurment	What this means to the war fighter	Remarks
1	≤ 2 ms low latency		1.7 ms out to 100 nm	– High priority applications sent/received virtually instantly	
2	≥ 2 Mbps throughput		≥ 2 Mbps	– Throughput > most commercial cable modems – >50 times bandwidth increase over legacy tactical data links	@ 90% statistical confidence level
3	≥ 10 Mbps High network throughput		10.5 Mbps	– Reliable message transfer during extremely high network utilization	Normalized 2.8 Mbps on 4 freq/channels (15/4*2.8=10.5)
4	≤ 5 seconds network ingress		Ingress < 2 seconds with preloaded keys	– Quick authentication into network – Enables new ad-hoc networking capabililty	26.4 seconds w/key load (4.1 seconds projected after key-load optimization)
5	Statistical priority multiple access		Low priority traffic appropriately decreased to accommodate access for high priority traffic	– Safety of flight/mission critical messages take priority on the network – Network remains robust during high traffic situations	
6	200 active users		Lab simulation	– The TTNT network can easily support large numbers of aircraft during large strike package operations	Requires more terminals
7	Link 16 co-existence		TTNT and Link 16 run concurrently from same aircraft	– No new holes/cabling required – Maintain legacy Link 16 capability while integrating the new TTNT technology	Need to verify system runs both data links on same antenna
8	Multi-speed network		Simultaneously received 2 Mbps, 500 Kbps, 250 Kbps data rate modes	– Simultaneously operates effectively at various ranges data rate modes	

Key	Good	In process	Not Done	Failed	Cannot Field Test



Flight Test MIR Quick-look Results (Cont.)

MIR	Description	Status	Flight Test Measurment	What this means to the war fighter	Remarks
9	Multiple independent levels of security sequence		Not Tested	– Network can support different levels of crypto classification – Allows operations with joint forces	Demonstrate by end of 2005
10	Wireless Key Transfer		Successfully transmitted cryptographic keys Over the Air (OTAR)	– Keys updated without physical contact with the terminal	Representative test keys
11	Beyond Line-of-Site ad Hoc Routing		Link maintained through ad hoc route change	– Network automatically finds best relay path (route) – Changes paths with no interruption to communications	
12	Multicast Groups		Traffic received by all members of all multicast groups	– Reduced processor usage by addressing groups of terminals – Conserves network capacity	
13	Power Control		Traffic exchanged at multiple power levels and data rates	– Terminals adjust modes based on link quality – Good link quality maintained while conserving network capacity	
14	4800 knots High Speed Compatibility		Lab simulation	– Network passes data with nodes that are traveling up to 4800 Knots	High speed airspace unavailable
15	Scalability of up to 1000 users		Lab simulation	– Sub-networks of 200+ can become a network of 1000+ users – Makes theatre wide on-the-fly network configuration possible	Requires more Terminals
16	Frequency Subset and Excision		Traffic received on a subset while excising one frequency	– Frequency/channel that is jammed, can be excised – Won't affect reliability of the data link	

Key	Good	In process	Not Done	Failed	Cannot Field Test

Terminal Asset List

TTNT for Airborne Networking in JEFX-06

JEFX-06 Airborne Networking (AN) applications

- Blue Force situational awareness
- Collaberative targeting
- Dynamic air tasking order
- Surf combat web for archived imagery
- Non-traditional ISR – targeting pod video
- Voice over IP
- Collaborative tools – text chat
- Graphical weather to the cockpit

Our Solution

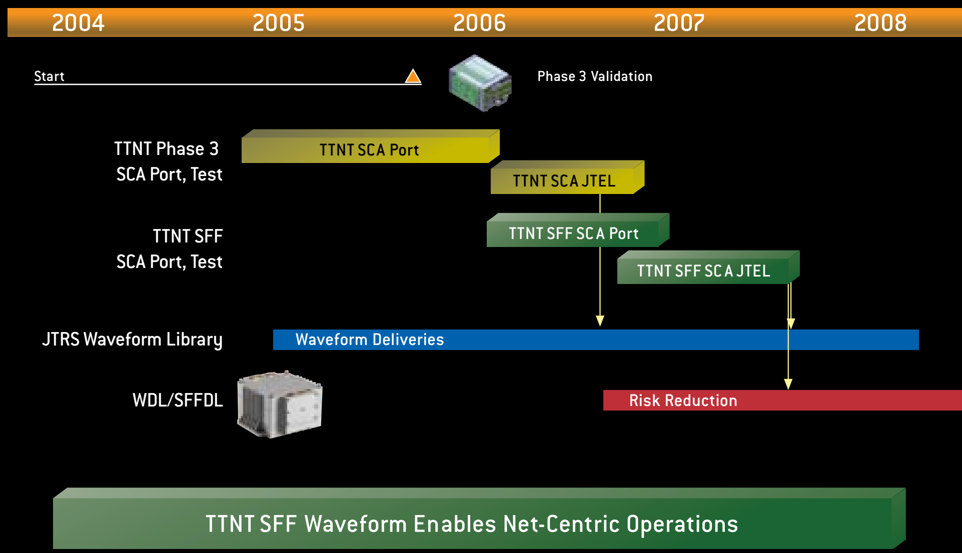
Way Forward – The Art of the Possible

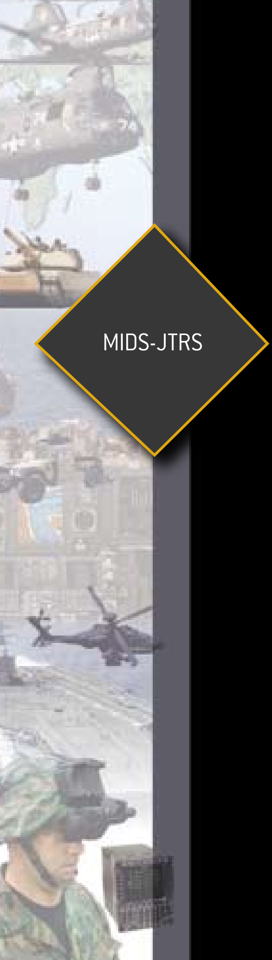
- Additional benefits can be realized through enhancements:
  - – Assured information to all warfighters on "the network"
    - Seamless internetting, GIG enabler
  - – Expanded LO applications
    - Waveform enhancements
    - Directivity (expanded network connectivity)
    - Enables warfighter "silent mode" capability
  - – Network security enhancements
    - Multiple levels of security (MLS)
  - – Next Generation JTRS hardware modules
    - Going to 2 MHz - 3.2 GHz in a 1 card form factor

      * Best Value solution to service warfighters
  - – MIDS-J incorporation
  - – Small Form Factor TTNT
  - – JPALS
  - – UCAV/UAS
  - – AAR

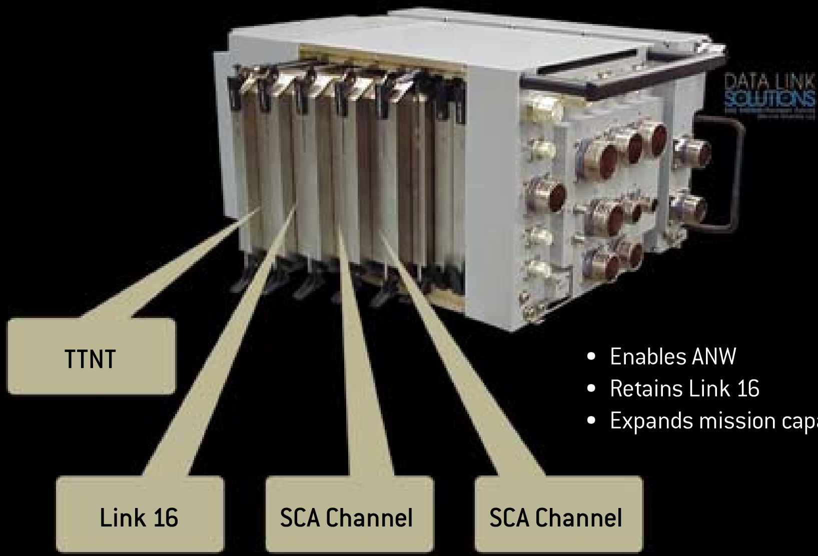
Meeting Milestones

Schedule Synergy





TTNT Transition Path Forward



- Enables ANW
- Retains Link 16
- Expands mission capability

TTNT will bring the warfighter into the 21st century by delivering the state-of-the-art, IP-based, ad hoc airborne networking waveform. This vital capability will increase the survivability and mission effectiveness of warfighters across multiple domains. As the speed of the battle increases, TTNT will be there to continually shrink the sensor-to-shooter chain to mere milliseconds.

TTNT

COMMUNICATING AT THE SPEED OF BATTLE

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