Application and STANAG 5066 performance over Wide-Band HF

Steve Kille

CEO - Isode Ltd

isode

Overview

- ESII Maritime Wideband HF Project
- Applications Run over WBHF
  - The Headline Success
- Detailed Findings: not all good news
  - New capabilities needed
- STANAG 5066: performance implications
- STANAG 5066 enhancements needed for WBHF

isode

ESII Maritime Wideband HF Project

- Seven companies funded through ESII programme
- Research was commissioned by the Defence Science and Technology Laboratory (Dstl)
- Funded by the Ministry of Defence (MOD) Research and Development budget through the MOD's Chief Scientific Advisor.
- The aim was to investigate and demonstrate Commercial off the Shelf (COTS) alternatives to providing Beyond Line of Sight (BLOS) and reach-back capability at lower cost than extant maritime and land-based reach-back systems in a Satellite Communications (SATCOM) denied and/or bandwidth constrained environment.

Rockwell Collins

QinetiQ

roke

BAE SYSTEMS

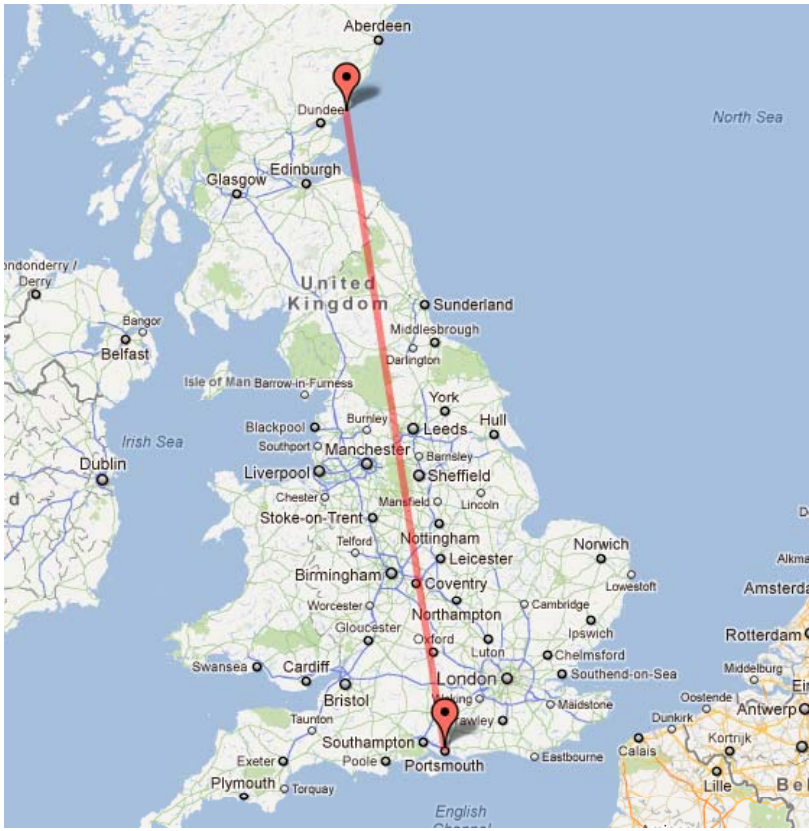
SELEX Communications
A Finmeccanica Company

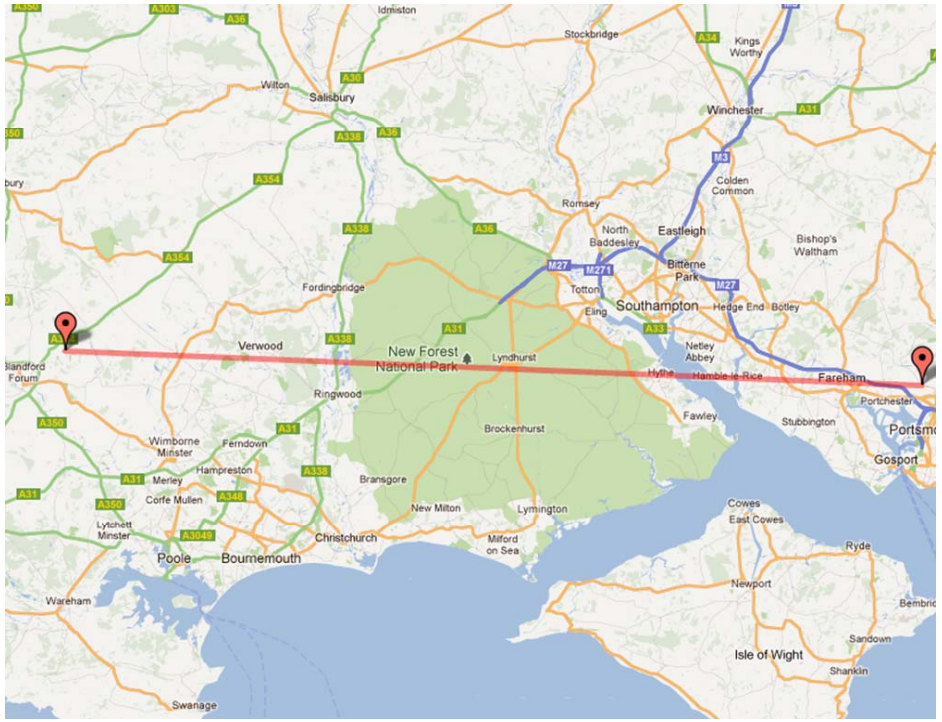
NEXOR

isode

The Infrastructure

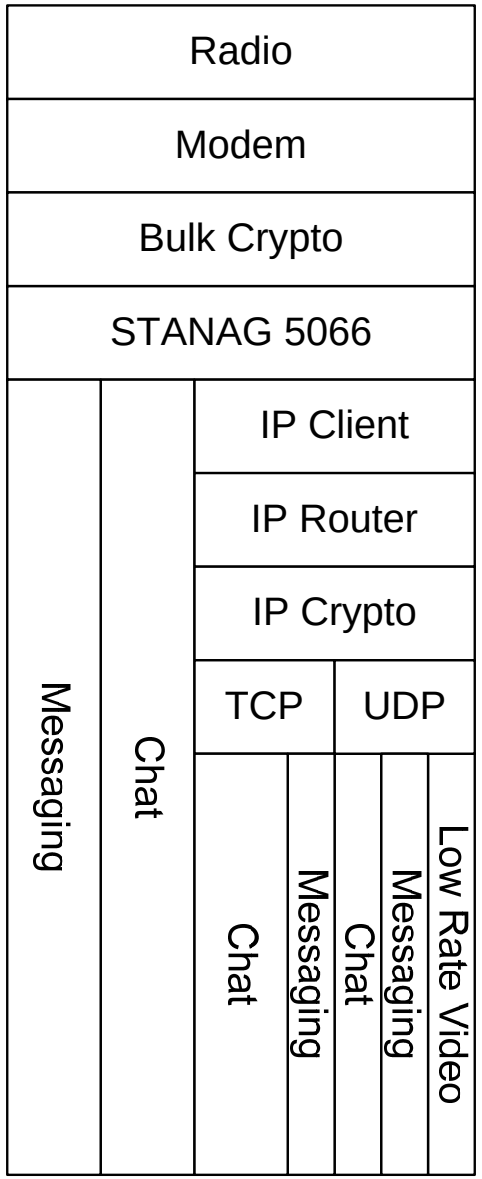
- Groundwave and Skywave
- Rockwell Collins VHSM 5000 Modems
- Up to 24 kHz band
- 128 kbps achieved
- 64 kbps maintained





Applications Tested

- Demonstration was a Success
  - Looked good to observers
  - Will discuss things under the hood
- Isode Applications
  - Messaging
  - Directory Synchronization
  - XMPP (Chat)
- IP vs Direct
  - Setup was able to look at operation over IP vs Direct over STANAG 5066
- Low Rate Video
  - Rockwell Collins Demo
  - Observers liked this



isode

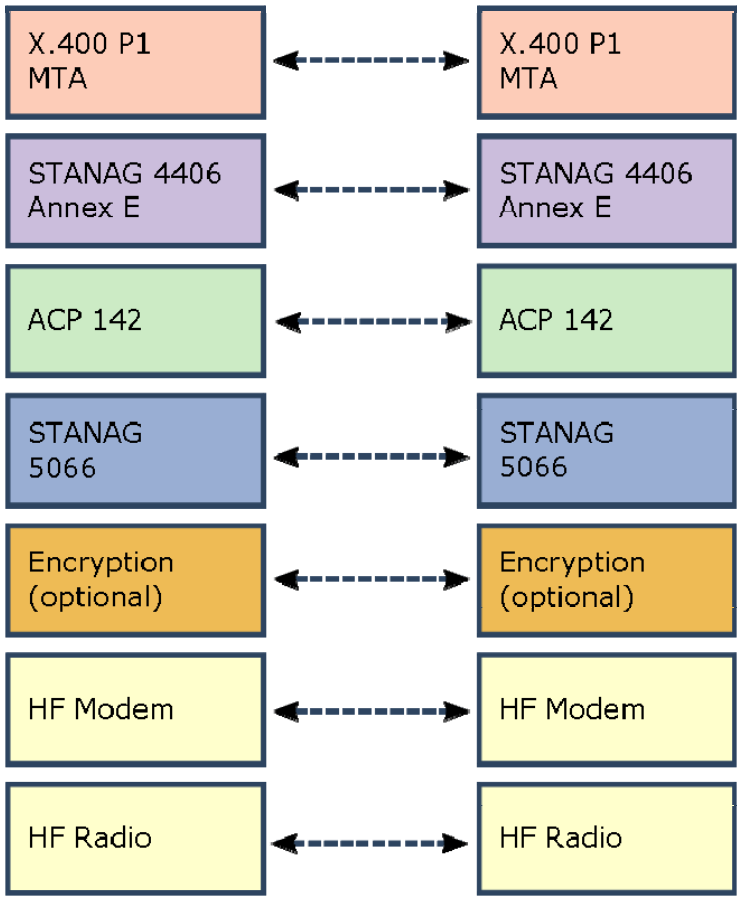
Key Conclusion: Optimized Protocols

- Data there to support applications
  - There is little point in finely tuning Modem protocols, if your applications are inefficent
  - Even WBHF is slow compared to modern networks, so tuning applications is key
- Tests with Messaging and Chat demonstrated that protocols optimized for HF give vastly superior performance
- Previous tests with standard messaging protocols running over IP over HF had concluded that the approach was not viable

isode

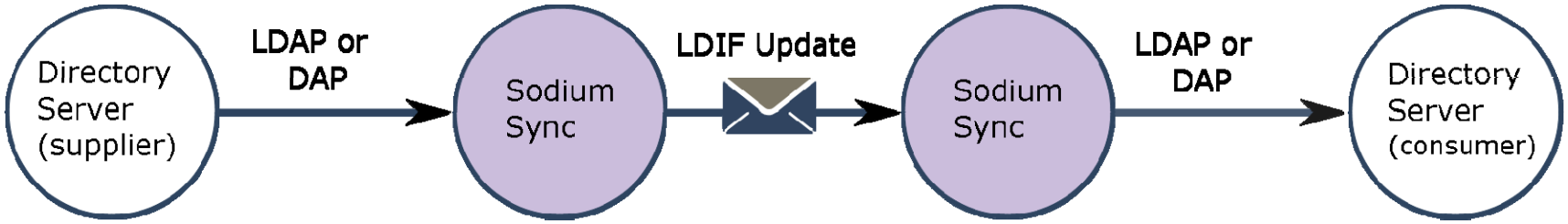
ACP 142 & Messaging

- ACP 142 ("P-Mul") is a CCEB (five nations) protocol designed for multicast transfer of STANAG 4406 over constrained links
  - Can also be used for Internet email
- Operates over datagram protocol
  - UDP over IP; or
  - UDOP over STANAG 5066 (as shown)
- Gives effective utilization of up to 50%
  - This is seen as acceptable: MUCH better than previous results
  - Some tests gave lower results
  - Not all data clearly explained
- I would expect higher results to be achievable (70%)



isode

Directory Synchronization

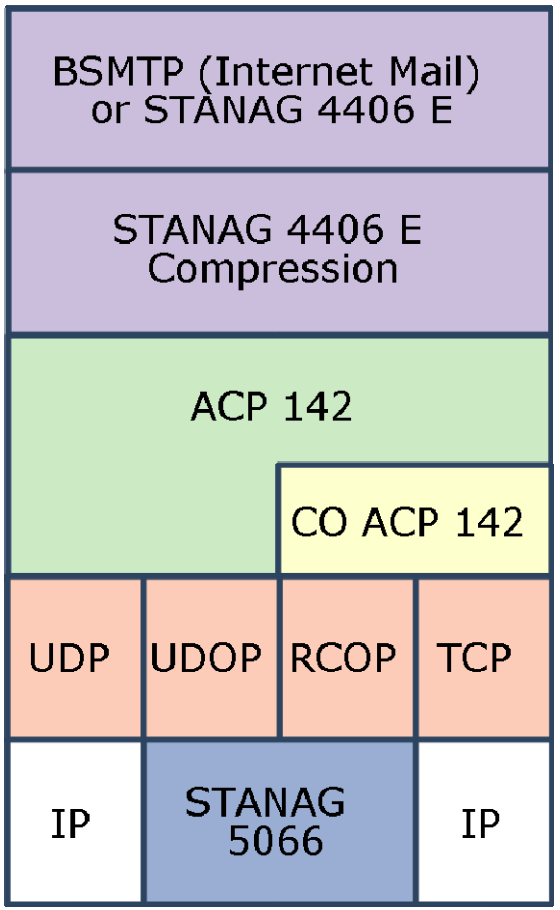


- Standard directory access (LDAP) and replication work badly over HF
- Isode's Sodium Sync approach allows incremental replication of directory over email
- Operationally can lead to massive cost savings (why it was in the demo)
- Uses messaging over HF, so protocol measurements are uninteresting

isode

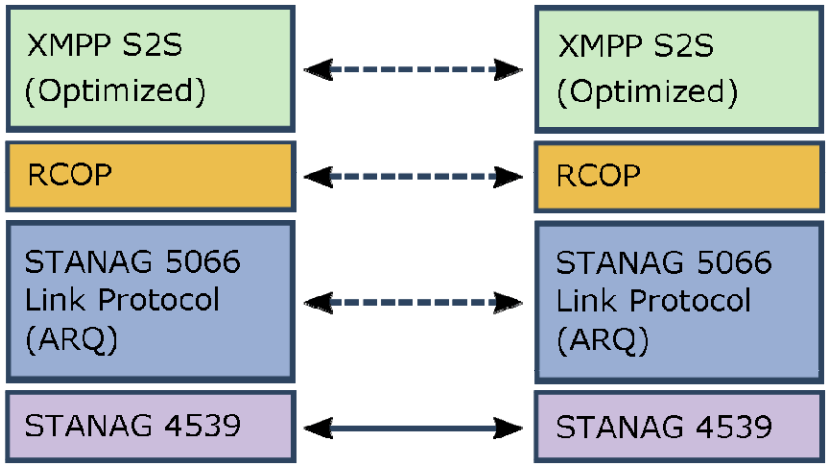
ARQ Messaging

- ACP 142 is designed to operate over datagram (multicast)
- Datagram service naturally maps to non-ARQ
- Point to Point links can use STANAG 5066 ARQ
- Isode's Connection Oriented ACP 142 optimizes ACP 142 for ARQ links
- CO ACP 142 achieved trial utilization of up to 75% (as opposed to 50% for ACP 142)



isode

XMPP



- XMPP (eXtensible Messaging and Presence Protocol) is open standard being widely adopted by military, for 1:1 chat, multi-user chat and presence
- Instant messaging is relatively easy over HF
  - Data Volumes are low
  - Just need to avoid handshakes
- Standard XMPP has a lot of handshakes on startup
- General approach is to communicate Server to Server (S2S) over the slow link to isolate users from the network
- Isode's optimized S2S Protocol is zero handshake
- Good performance demonstrated in the trials
  - User delays tie to HF radio turnaround times

isode

IP over HF

- Use of IP over HF appears “politically desirable”
- ACP 142 measurements were typically 10-20% worse when using IP
- The difference will be accentuated if:
  - Link speed varies (very likely with HF)
  - Error conditions or other applications
- We did not get much time for application testing when operating OTA
- Key problems:
  - Lack of flow control with IP makes it hard to optimize link utilization
  - Hard to benefit from STANAG 5066 ARQ
    - Unreliable Datagram (IP) is an architecturally poor choice over ARQ

isode

Application Conclusions

- Use application protocols optimized for HF to gain best performance
  - ACP 142 (Non-ARQ)
  - Connection Oriented ACP 142 (ARQ)
  - Optimised XMPP S2S (ARQ)
- Use ARQ whenever possible (and protocols optimized for ARQ)
- Avoid use of IP over HF

isode

STANAG 5066: Link Protocol is Key

- HF Modems (and Radios) present awkward characteristics to the layers above:
  - Variable speed (e.g., with STANAG 4539 or MIL-STD-110-110C)
  - Long turnaround times
- An optimized link protocol is vital. Standardized choices:
  - STANAG 5066 (used here)
  - STANAG 4538
- Details of the implementation matter
  - This layer has at least as much impact on the performance as applications

isode

STANAG 5066 Performance Results

	ESII Pilot	Isode Tests
Non-ARQ Raw	90%	90%
ARQ Raw	80%	85%
CO ACP 142	75%	85%

- "Raw" STANAG 5066 numbers tested using Isode STANAG 5066 Console
- Comparative Tests in Isode labs using RapidM RC66 STANAG 5066 Server
  - Believe that the STANAG 5066 Server was the only difference
- Suggests that details of STANAG 5066 server can significantly impact performance
- I suspect that a number of detailed anomalies in the pilot tests (performance much lower than expected) were down to STANAG 5066 issues
- STANAG 5066 Tracing is Important

isode

STANAG 5066 Queue Length

- Queue Strategy & Queue Length is a key design decision for a STANAG 5066 server (stack) implementation
  - APDUs provided by S5066 Client are queued for transmission
  - When queue is full, S5066 server flow controls the application
  - Choice of queuing approach left to implementer by the standard
- The ESII S5066 Server used very long queues (effectively infinite)
  - This made application tuning very difficult
  - Led to suboptimal applications performance
  - Would have caused many more problems in challenging radio conditions

isode

STANAG 5066: Why Short Queues?

- Application Timers
  - Applications need timers to deal with error situations
  - Short timers lead to better responsiveness
  - Timer need to allow for data in S5066 queues, so long queues are awkward
- Bandwidth Adaptation
  - HF Bandwidth can vary significantly (75 bps -128 kbps; outages; sharing with voice)
  - Application cannot determine effective bandwidth
  - STANAG 5066 Flow Control from Queue allows application to react to changes
- Priority Handling
  - If a FLASH message arrives, short queue allows the application to send the data out as quickly as possible

isode

STANAG 5066: DPDU Size Tuning

	4800 bps	9600 bps
CO ACP 142 Utilization (ARQ)	75%	50%

- Utilization at 9600 seemed very low
- Increasing DPDU size from 273 to 1023 (Max) led to better throughput at 9600 than 4800
- Analysis of max transmit time (constrained by 128 window) shows why

	4800 bps	9600 bps
273 byte DPDU	58 seconds	29 seconds
1023 byte DPDU	127.5 seconds **	109 seconds

- With reduced transmit time, turnaround time is significantly impacting performance

isode

STANAG 5066 degradation over WBHF: Theory

	9600 bps	20 kbps	64 kbps	128 kbps
Max Transmit Time	109 seconds	52 seconds	16 secs	8 secs

- STANAG 5066 Designed for Maximum Speed of 20 kbps
  - STANAG 5066 Annex G, Section 3.1
  - These max transmit times show why: because of long turnaround times you need long transmit time (1-2 minutes) to get good link utilization over HF
- We estimated that for WBHF at top speed, that performance for ARQ traffic would be significantly degraded by this, and that link utilization of 30-50% would be expected at 128 kbps
  - Exact utilization will be critically dependent on turnaround time

isode

STANAG 5066 degradation over WBHF: Observations

	ARQ	Non-ARQ
Utilization at 128 kbps	42%	62%

- Performance measurements made at STANAG 5066 Layer, using Isode STANAG 5066 Console tool
- Measurements made over Skywave link under good conditions
- ARQ number fits with the theory
- Non-ARQ number should be much higher
  - Perhaps an S5066 implementation issue

isode

STANAG 5066 enhancements needed for WBHF

- We need to update STANAG 5066 to efficiently support WBHF
- Changes straightforward, but backwards compatibility is not possible
- Two options:
  1. Increase Max DPDU Size.
  2. Increase Window Size
- It may make sense to do both
  - Useful to repeat tests on optimum DPDU size
    - 1992/93 Studies (Annex H Section 7 of STNAG 5066) suggest 100-200 bytes is the optmum
    - For higher speeds it is possible that a larger DPDU size is optimal
- Likely to be desirable to increase Window Size
  - Analogous to TCP Extended Window

isode

STANAG 5066 Conclusions

- STANAG 5066 Server is as important as Application and Modem for performance tuning
- Recommend that future pilots measure using more than one STANAG 5066 server
- Good tracing and diagnostics are vital for performance analysis
- STANAG 5066 Servers should have short queues
- STANAG 5066 needs protocol modifications to support WBHF efficiently
  - NATO needs to take an Action here

isode

Isode Product Pre-Announcement

- We are building an Isode STANAG 5066 Server
  - Cross Platform
  - Client/Server Management (key for large systems)
  - Modem Independent:
    - RapidM Modems are initial target
  - Optimized for WBHF
  - STANAG 5066 ed3 support, including Annex L (WRTP)
    - Key for interoperable multi-node deployments
- Target 1: Ability to deploy Isode applications over any Modem set
- Target 2: Adoption as OEM product by Modem Vendors
- We are looking for partners

isode

Any Questions?

isode