AUSTRALIA, CANADA, NEW ZEALAND, UNITED KINGDOM, UNITED STATES

(AUSCANNZUKUS)

Maritime Information Warfare

Trident Warrior 11

Final Report

SharePoint/Lync Experimentation

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1. EXECUTIVE SUMMARY

AUSCANNZUKUS (A-Z) participated in Trident Warrior 2011 (TW11) during June 2011. This report describes the Coalition initiatives regarding Microsoft SharePoint and Lync conducted by the AUSCANNZUKUS Naval C4 Organization during TW11, and provides recommendations in relation to these initiatives.

Trident Warrior 2011 initiatives were developed from the experimentation areas listed in the AUSCANNZUKUS Trident Warrior Experimentation Plan. This plan was approved during Supervisory Board 26 and lists AUSCANNZUKUS experimentation targets for three years of Trident Warrior experimentation. The experimentation plan breaks down research goals into five key areas: Network Design, Application & Services Design, Computer Network Defence (CND), TTPs, and Non-AUSCANNZUKUS Initiatives. Having a three year roadmap provides the opportunity for Nations to align resources for research and technology spirals in order to increase multinational interoperability and the speed-to-capability of successful technologies.

The TW11 initiatives were aimed at providing a robust enhanced tactical network with increased survivability and tactical flexibility in a satellite restricted or denied environment. This was pursued through three principal avenues: increasing the throughput of the horizontal pipes, providing appropriate routing, and providing applications suited for use in a distributed environment. Several initiatives extended work begun in previous years. In addition, two initiatives looked ahead to future requirements.

Two Line of Sight (LOS) technologies were examined to increase IP networking throughput, one in the military UHF (225-400 MHz) band and one in the 2.4 GHz (WIFI) band. A third bearer technology looked towards extending the reach of the horizontal pipes to Beyond LOS (BLOS), with the ultimate goal of providing non-satellite reach back to shore.

The ability of applications to be effectively used in a distributed, meshed, and disconnected environment was reflected in one initiative designed to provide multi-bearer routing and one looking specifically at allowing core CENTRIXS-M applications to be used in a NOC-less, CTG-centric environment. The importance of providing interoperability outside of the A-Z arena was highlighted by work to prove a gateway between the Sametime Chat and the NATO chat application, work to demonstrate interoperability with a COP tool in use by some NATO nations, and a verification of inputs into the A-Z-endorsed COP tool.

The final initiative investigated the ability of SharePoint, the enterprise collaboration tool in use by most nations, to be extended to the maritime tactical environment, potentially providing savings in licensing, training and infrastructure. Previously, it was not possible to extend SharePoint over low-bandwidth, high-latency links, but replication technologies such as Syntergy and Infonic have made significant inroads in this area.

Overall; TW exposure to developments and the exchange of ideas continues to aid all nations in their research and development ventures in addition to ensuring continuing C4 interoperability. Continued participation in the TW experimentation series is recommended.

AUSCANNZUKUS INITIATIVES

The following initiatives were conducted during TW11 by AUSCANNZUKUS:

a. COAL 01 – High Data Rate Sub Net Relay
b. COAL 02 – SPatially Aware Wireless Network (SPAWN)
c. COAL 03 – Multi-bearer Routing
d. COAL 04 – Enhanced Collaboration at Sea (CaS)
e. COAL 05 – MS SharePoint / Lync
f. COAL 06 – GCCS-M v4.1 Unit Level COP Interoperability
g. COAL 07 – GCCS-M v4.1 Unit Level Serial Interfaces
h. COAL 11 – Wideband HFIP
i. COAL 13 – Sametime / JChat Gateway

This report shall focus on COAL 05 – MS SharePoint and Lync experimentatoin.

The majority of AUSANNZUKUS TW11 initiatives were hosted at the Royal New Zealand Navy's (RNZN) Range Facility on Great Barrier Island (GBI) off the east coast of New Zealand's North Island, not far from Auckland city. GBI offers a low noise RF environment, isolation from large populations and convenient shore based access to the maritime environment. The summary of AUSCANNZUKUS participation in TW11:

a. AU: Land Mobile Unit and three virtual ships (GBI and Australia):
b. CA: No national involvement; represented by EWG Chairman;
c. NZ: Two ships, one virtual ship (GBI);
d. UK: Three virtual ships (UK); and
e. US: Equipment and engineering support to GBI.

Personnel support from AUSCANNZUKUS nations is the key to successful experimentation. Canada did not participate in the individual initiatives in TW11, but was represented by the EWG Chairman. Technical support from nations was always available and continued to be of a very high quality. This outstanding support extended from concept and design to the Risk Reduction Limited Objective Experimentation (RRLOE), and on into Execution. It allowed the EWG to realign, reconfigure, and troubleshoot the network installation as required and resolve instabilities or loss of connectivity quickly with as minimal disruption to operations as possible. As always, operator support was critical in the support of AUSCANNZUKUS initiatives. Experience and expertise level ranged from newly trained through to highly trained and experienced warfare operators. The input from the operators was key in determining the utility of various technologies tested.

CAPABILITIES AND FINDINGS

1. **Microsoft SharePoint / Lync.** MS-SharePoint and Lync are complimentary business collaboration suites that can provide information and communications services and resources similar to those currently provided on CENTRIXS-M by Domino and Sametime. The TW11 aim was to assess the suitability of MS-SharePoint and Lync as a collaboration suite for use in the maritime environment. This initiative was spawned by the desire to investigate potential cost savings by using the enterprise collaboration tool (SharePoint) vice the current Domino CaS suite. SharePoint requires the use of a replication engine to operate over high-latency, low-bandwidth links. Two were initially tested at the LOE. The Infonic Geo-Replicator provided outstanding data compression but was not well suited to the meshed LOS environment. Syntergy's replicator, which was used in the TW11 execution, proved intuitive to use, and reliable in a meshed environment. Lync Chat was intuitive and easy to use, and provided stable and reliable communications and useful integrated collaboration tools. Neither Lync voice nor video worked reliably through the experimentation period. Together, SharePoint and Lync provide an opportunity for significant improvement in user experience compared to existing CMFP tools. However, their setup was very burdensome, and there are a myriad of governance, IM, and cost issues to be considered before any decision can be made on its adoption.

RECOMMENDATIONS

The following general recommendations are made:

AUSCANNZUKUS endorse Syntergy as a SharePoint replication engine able to provide reliable and timely transfer of documents and information in a Maritime Tactical Networking environment, while working to reduce the installation effort, implement Active Directory federation, and rectify the remaining minor technical issues;

AUSCANNZUKUS monitor Infonic Geo-replicator product development with a view to revisiting its suitability in a meshed network environment;

AUSCANNZUKUS conduct further testing in conjunction with Microsoft to address the performance issues induced by the operation of the codec dynamic configuration functions when used over HDR SNR LOS connections;

AUSCANNZUKUS pursue the implementation of Quality of Service on Maritime Tactical Wide Area Network connections;

AUSCANNZUKUS continue participation in the Trident Warrior experimentation.

Section 1

1. Introduction

1.1. Trident Warrior (TW) is the United States Navy's annual FORCEnet Sea Trial event. Led by US Fleet Forces, the TW series is intended to create an environment in which to assess, in quantitative and qualitative terms, FORCEnet systems including technology, tactics/techniques/procedures (TTPs) - providing specific insights and dedicated procurement and development decision information. It also intends to provide "speed to capability" (S2C). S2C is the rapid fielding of improved FORCEnet C2 warfighting capability to the fleet, with full supportability and maintainability.

1.2. TW integrates stand-alone systems and efforts to achieve substantially enhanced capability, demonstrate and test these capabilities in both laboratory and operational environments, and evaluates their effectiveness. It coordinates FORCEnet efforts with other services and national efforts to ensure applicability and interoperability with Joint, Interagency, Allied and Coalition partners.

1.3. This report describes the Coalition initiatives conducted by the AUSCANNZUKUS Naval C4 Organization during TW11, and provides recommendations in relation to these initiatives. The Coalition TW11 initiatives were aimed primarily at testing line of sight (LOS) technologies in satellite restricted and satellite denied environments.

2. Background

2.1. Trident Warrior 11, led by Fleet Forces Command in conjunction with C2F and C5F, was executed in three separate AORs. The main US execution took place in the Virginia Capes Operating Area 18-31 Jul 11, with a second component occurring off of Bahrain in early June.

2.2. The AUSCANNZUKUS participation, 20-30 Jun 11, took place primarily in the vicinity of Great Barrier Island (GBI), New Zealand, but also involved virtual ships operating in Portsmouth, UK, and Canberra, AU. Coalition participation in TW11 consisted of:

- New Zealand
  - VS KIWI (GBI)
  - HMNZS HAWEA, MANAWANUI (GBI)
- Australia
  - VS WOMBAT Land Mobile Unit (GBI)
  - VS NCI, NGUNNAWAL, GALIPOLI (Canberra)
- United Kingdom
  - VS PRINCE OF WALES, DAUNTLESS, DARING (Portsmouth)
- United States
  - Equipment and Personnel Support (GBI)

3. Aim

3.1. The overall aim of TW11 was to assess the ability of the Coalition to maintain operational networking facilities in a satellite restricted and satellite denied environment (SDE), specifically the use of LOS network technologies, routing and distributed applications to ensure CENTRIXS-M connectivity.

3.2. TW demonstrates the value of a rigorous experimentation design, analysis, and reporting process. The AUSCANNZUKUS Naval C4 organization provided the lead for the Coalition forces participation in TW11.

4. Experimental Process

4.1. The Coalition initiatives were subdivided into measurable, specific objectives with definable attributes and metrics. From this level of decomposition, individual experiment threads were developed to design experiment procedures and to guide specific planning requirements for experiment execution. For each objective, a Network Exercise (NETEX) was developed that became an input to the overall TW11 Schedule of Events (SOE).

4.2. Additionally, the FORCEnet Innovation Research Enterprise (FIRE), a Naval Postgraduate School (NPS) developed web-based collaborative tool, supported all phases of planning and provided a permanent repository for all aspects of the design, execution, and analysis of TW11.

4.3. The Risk Reduction Limited Opportunity Experiment (RR LOE) was held prior to execution to provide necessary time to rectify identified discrepancies and included establishment of risk-handling measures during execution. During the RR LOE, TW networks and ships were emulated to the extent required to test identified risks. This also established the target date for systems to commit to an architecture and configuration. Each system was given identified time periods where they were the priority to control variables affecting the outcome.

5. Network Overview

5.1. The TW11 CMFP at-sea trial network employed the High Data Rate UHF Subnet Relay (HDR SNR) as an added RF bearer over and above shipboard SATCOM. Border Gateway Protocol (BGP) continued to be used between PRNOC and the AUSCANNZUKUS national NOCs.

5.2. On the shipboard side, two Open Shortest Path First (OSPF) processes were created, one for SATCOM and the other for the LOS links. Both LOS links were part of OSPF Area 1. Ship Local Area Networks (LANs) were statically routed and “area-less”. To make SATCOM preferred, a summary /24 route was redistributed into the LOS OPSF process while the SATCOM OSPF process had a /25 route (more specific route). LOS/ELOS link state information was filtered before being redistributed into the SATCOM OSPF process. NOC routers ashore injected an external Type 1 default route into their OSPF processes so that ship to shore traffic would be routed to the closest shore node and then would be routed to its destination using terrestrial assets, such as NOC-NOC links.

5.3. The GBI venue had High Data Rate Subnet Relay (HDR SNR) with tactical connectivity up to 1.92 Mbps between all platforms; WOMBAT had reach-back to the AU NOC, while the remaining platforms had reach-back to the NZ TACNOC.

5.4. The Australian lab at Canberra included three virtual ships connected by a simulated HDR SNR network. The UK laydown consisted of a simulated three-platform LOS network, employing a COTS dynamic routing solution. The architecture is depicted in Figure 5-1.

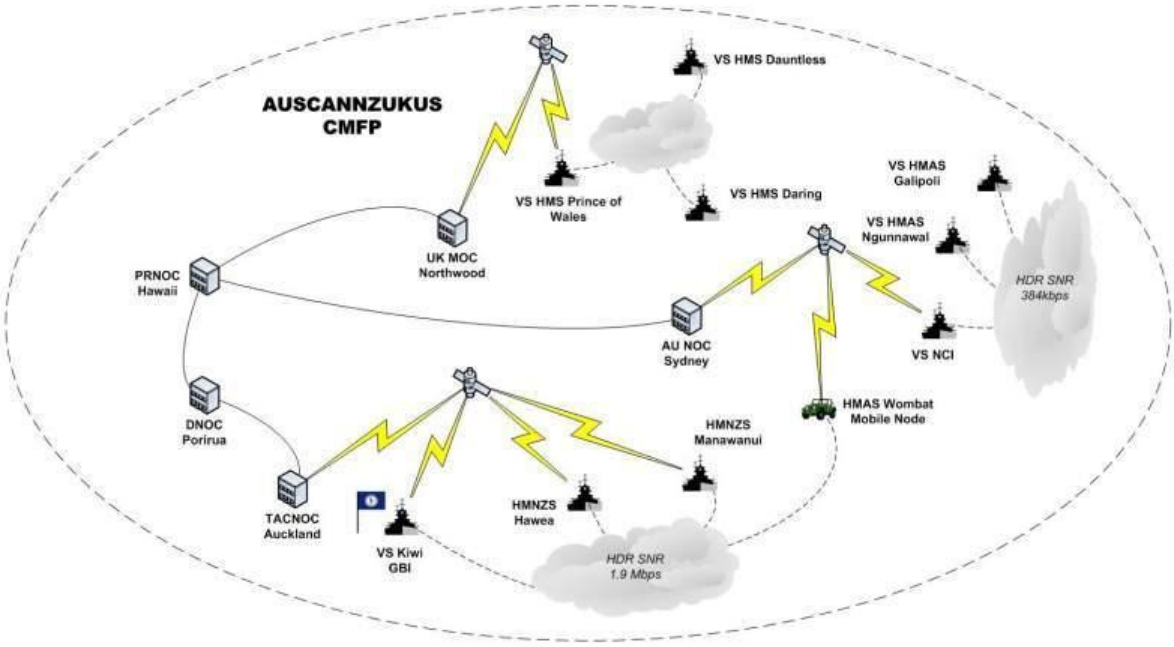

Figure 5-1: A-Z TW11 Architecture

6. COAL 05 – SharePoint/ Lync

6.1. **Experiment Purpose / Objective** – Assess the suitability of MS-SharePoint and Lync as a collaboration suite for use in the maritime environment.

6.2. **Initiative Description** – MS-SharePoint and Lync are complimentary business collaboration suites that can provide information and communications services and resources similar to those currently provided on CENTRIX by Domino and Sametime.

6.2.1. SharePoint provides a document repository with advanced information management capabilities as well as the ability to create lists of people, events or forms, and manage workflows. Lync software is the next generation collaboration tool that includes ad-hoc text chat, voice, and video conferencing. Lync Group chat is an associated software tool that provides persistent chat in established chat rooms.

6.2.2. All AUSCANNZUKUS nations have invested in SharePoint technologies to some extent with their own national networks, therefore this initiative aimed to determine if these applications could be applied to support CENTRIX operations. If successful, this would have obvious benefits for user familiarity, training, administration and support.

6.2.3. Because native SharePoint does not support replication between distributed servers in a WAN environment, third party replication engines are needed to provide this functionality. Two main contenders were tested, Syntergy and Infonic.

6.3. **Experiment description and context** – Experimentation for this initiative was conducted both during the LOE and the execution phase, with early experimentation focusing more on measuring bandwidth requirements and system stability in a controlled environment, and latter experimentation on obtaining subjective measurements of operational usability.

6.3.1. **Syntergy SharePoint Replicator Software Overview**. Syntergy replicator for SharePoint is an enterprise replication solution that supports Net Transmit and Receive (NTR) document-level synchronization of any network of distributed SharePoint farms.

6.3.1.1. SharePoint Replicator installs and is managed in the same way as SharePoint, with full integration into the administration console. Replicator detects changes in the SharePoint environment as they occur and batches these changes into replication packages. Windows Background Intelligent Transfer Service (BITS) is employed by Replicator as transport for downloading replication packages over fast, slow or unreliable network connections.

6.3.1.2. BITS is the same content downloading technology used by Microsoft's Windows Server Update Service (WSUS) and optionally uses Remote Differential Compression (RDC) as well as 3rd party hardware or software network compression solutions to make efficient use of WAN bandwidth.

6.3.2. **Infonic Geo-Replicator Software Overview**. The Infonic Geo-Replicator platform replicates website content to distributed servers across the WAN, with the goal of providing remote users with faster access to content.

6.3.2.1. The technology can be configured to deliver replication over a variety of delivery modes, including server, virtual server and laptop; as well as a variety of web and data formats, including Lotus Notes and file based repositories. Geo–Replicator uses Infonic's patented Epsilon compression technology for data de-duplication.

6.3.2.2. Epsilon provides byte-level differencing, supported by pattern matching. This differs from other delta-based differencing in the fact that it does not simply work within a single file, web page or document. Infonic claims the Epsilon technology compresses across an entire set of SharePoint content included as part of a Geo-Replicator Publication. For instance, if a new presentation is published in the portal, traditional differencing techniques would have no baseline to difference the presentation against. With Epsilon Compression, the presentation is differenced against all the other content already held in the Geo-Replicator Publication, regardless of file or data type. Epsilon would find that a great majority of the content of a new presentation already exists in other presentations or documents in the data store, and would reduce the amount of data replicated. Using Epsilon's byte-level compression algorithms, the data is compressed further. On low data rate, high latency tactical networks this data de-duplication should translate to decreased bandwidth utilization and much faster file transfers.

6.3.2.3. Infonic Geo Replicator is currently deployed by the US Navy as part of the Distance Support program, with the Royal Navy as part of ATLAS DII (F) as well as other military deployments including NATO, USACE, and USSOCOM.

6.3.3. **LOE Equipment Configuration**. For the LOE a testbed was established with four network nodes and simulated SATCOM and LOS links. Replication of data between nodes was

achieved using both Syntergy and Infonic. The applications were configured to replicate SharePoint site collections in both hub-spoke and mesh configurations.

6.3.3.1. SharePoint 2010 supports a number of installation scenarios. For this experimentation the SharePoint 2010 single farm scenario was used with a separate SQL 2008 sever database, supported with virtual servers.

6.3.3.2. The following network configuration was established:

Platform	SATCOM	UHF SNR	HF IP
High Bandwidth Platform (Bon Homme Richard)	SATCOM simulator 1024 kbps 400msec latency (one-way)	64 kbps modem setting, inherent system latency	12.8 kbps modem setting, inherent system latency
Medium Bandwidth Platform (ALGONQUIN)	SATCOM simulator 128 kbps 400msec latency (one-way)		
Medium Bandwidth Platform (NEWCASTLE)	SATCOM simulator 32 kbps 400msec latency (one-way)		
Low Bandwidth Platform (SAN JACINTO)	SATCOM simulator 8 kbps 400msec latency (one-way)		

Table 6.1: RRLOE Network Configuration - SharePoint

6.3.3.3. The TW11 LOE test bed equipment consisted of the following:

- Five (5) Exchange Server 2008 R2 Servers configured for Active Directory and DNS server with Microsoft Office 2010 and Communicator Client installed.
- Five (5) SharePoint 2010 and one (1) SharePoint 2007 (one SharePoint 2007 in NOC) with Lync Servers, Infonic Replicator and Syntergy Replicator installed as virtual machines. The BHR (Ship1) also included a virtual SharePoint 2007 server which was used for Infonic and Syntergy replication testing in a combined SharePoint 2007 and 2010 environment.
- Five (5) (SQL) 2008 Enterprise Edition Servers.
- Five (5) 5 Dell laptops
- Five (5) Cisco routers
- One (1) SATCOM simulator
- Two (2) audio mixers
- Four (4) UHF Subnet Relay controllers
- Four (4) UHF Subnet Relay modems
- Four (4) HFIP controllers
- Four (4) HFIP modems
- One (1) Cisco VLAN switch
- Five (5) Ethernet hubs

6.3.3.4. The LOE testing was performed over Simulated SATCOM, UHF Subnet Relay, and HF IP links.

6.3.3.5. The simulated SATCOM links used bandwidth and network latencies normally experienced onboard ships at sea. Shipboard representative HFIP and UHF SNR equipment was used to emulate all but over the air transmissions of these Line of Sight/Extended Line of Sight (LOS/ELOS) shipboard networking systems.

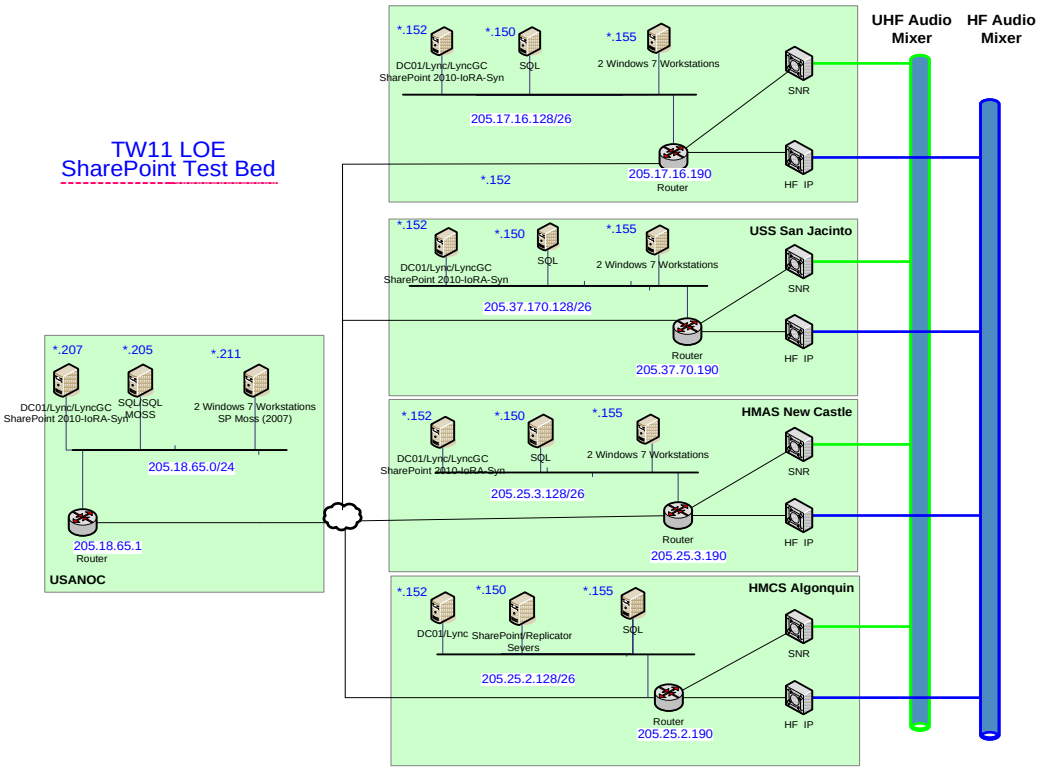

Figure 6-1: LOE Lab Configuration

6.3.4. **LOE Experimental Procedures**. Specific procedures to perform replication using the Infonic and Syntergy software packages were provided by each respective vendor prior to the beginning of the TW11 LOE. SPAWARSYSCEN personnel were trained by Infonic and Syntergy representatives during a 2-day period prior to the beginning of the LOE.

6.3.4.1. LOE tests included the uploading, editing and replication of documents on SharePoint 2010 websites. JPEG file attachments of various sizes, representative of those used onboard ships, were added to the document store and replicated to the other test nodes. Test files were uploaded into the SharePoint environment as directed in the TW11 LOE Test Plan. The times taken to replicate with other SharePoint servers were recorded. Before each test was started, documents for loading on the SharePoint 2010/2007 server databases were prepared and WireShark sniffer sessions were started to record the network traffic.

6.3.4.2. The test topologies emulated a geographically dispersed Task Group, supported by a server-to-server replication solution. Tests performed were primarily designed to answer the first two objective questions. The four topologies were:

6.3.4.2.1. Replication Scenario 1, Hub-Spoke with the NOC: All units replicating with a shore server (classic hub and spoke topology), with each unit contributing and modifying documents on the Task Group web site (Figure 6-2).

6.3.4.2.2. Replication Scenario 2, Tiered Replication in a SATCOM-Restricted Environment: All units without SATCOM access replicate with Task Group Hub ship, who then replicates changes ashore via SATCOM, with each unit contributing and modifying documents on the Task Group web site (Figure 6-3).

6.3.4.2.3. Replication Scenario 3, Hub-Spoke Replication in a SATCOM-Denied Environment: Information is replicated to a Command ship hub server via a Line of Sight network, with no reach back to the shore databases. Each unit contributes and modifies documents on the Task Group web site (Figure 6-4).

6.3.4.2.4. Replication Scenario 4, Full-Mesh Replication in a SATCOM-Denied Environment: All units replicate with each other in a Line of Sight meshed network (Figure 6-5).

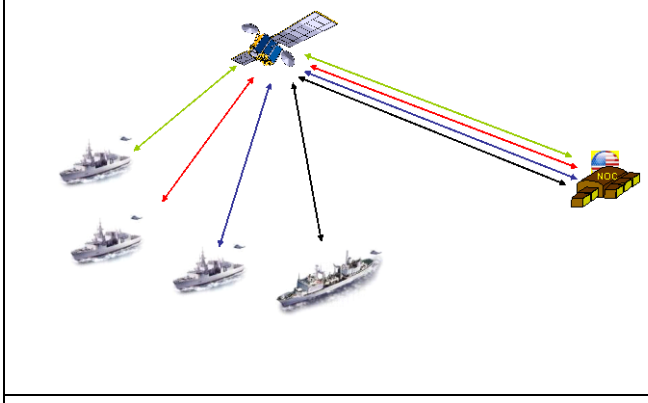

Figure 6-2: Replication Scenario 1, Hub-Spoke with the NOC.

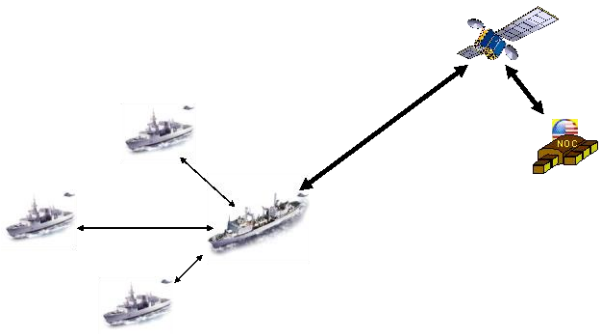

Figure 6-3: Replication Scenario 2, Tiered Replication in a SATCOM-Restricted Environment.

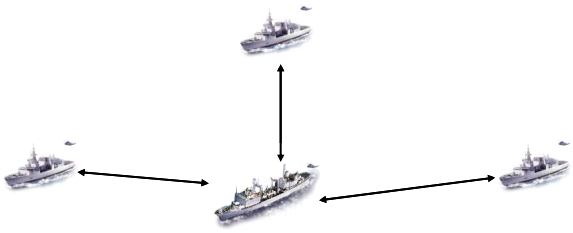

Figure 6-4: Replication Scenario 3, Hub-Spoke Replication in a SATCOM-Denied Environment.

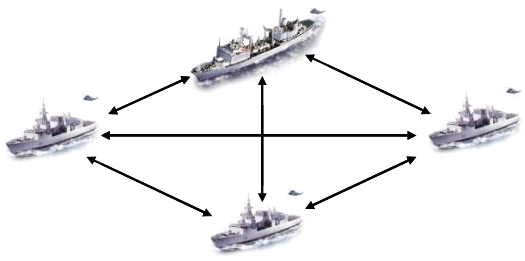

Figure 6-5: Replication Scenario 4, Full-Mesh Replication in a SATCOM-Denied Environment.

6.3.5. **Main Execution Period Equipment Configuration**. During execution SharePoint and Lync servers were installed at KIW, MAN, HAW, WMB, GPL, NGU and NCX. Syntergy was used as the replication engine between these nodes. Unfortunately, setup and configuration issues with SharePoint prevented the network nodes in Australia (GPL, NGU and NCX) from being fully operational until near the end of the execution period, so these nodes did not participate in any of the scheduled SharePoint NETEXs, although they did participate with Lync.

6.3.5.1. Several basic site collections were established at KIW using the inbuilt SharePoint templates. The sites contained simple home pages and document libraries, as well as some basic lists including key contacts and a feedback form. These sites are considered typical of what would exist on a real operational network, although very light on content. The sites were replicated to all other nodes using Syntergy.

6.3.5.2. NETEXs were conducted throughout the execution period in a range of different scenarios and network topologies, including SATCOM only, fully meshed LOS, and mixed topologies. During the NETEXs operators uploaded files of various sizes to the document libraries and measured the time taken to replicate to other nodes. They also made changes to web pages, experimented with forced replication conflicts, and used Lync to conduct and assess the usability of chat, voice and video conferencing, screen sharing, and whiteboarding.

6.3.5.3. It was noted that the setting up SharePoint and Lync servers was an extremely technical and challenging process. Multiple VMs were required to run the various servers (SharePoint, SQL, Exchange, Lync and Lync edge servers) and all took a significant amount of effort to build and configure. In particular a number of prerequisite products need to be installed prior to installing the MS Lync software, which is challenging without an internet connection. It should also be noted that changes to Active Directory can only be made once, so expert assistance is necessary to ensure this is done correctly. Whilst this is to be expected for an enterprise level system, effort will be required to reduce the admin burden if this system is to be deployed widely on ships.

6.3.5.4. Local DNS was used in authoritative mode for all domains due to the large DNS queues created by Synergy replication when nodes were disconnected. Certificate files were saved and distributed to every node and client PC as without doing this the clients would not connect.

6.3.5.5. Lync provides two logging options in the client. The first is a summary type log file that appears on the local hard drive and the other is a special Lync file that also appears on the local hard drive. These logs allowed for the diagnosis of issues.

6.4. COAL 05.01 – SharePoint– Replication Reliability

6.4.1. **Objective question:** Can MS-SharePoint reliably replicate document stores in a maritime mobile ad-hoc networking environment using the Syntergy replication engine?

6.4.2. **Summary of data collected, including survey reports:** Detailed data on system performance was collected by hand during the NETEXs, with additional usability information measured using survey reports on completion of each NETEX.

6.4.2.1. Data on the speed of replication proved unexpectedly challenging to measure. In some instances the system performed so well that it was difficult for operators to measure the time taken for files to replicate (i.e. one unit would upload a file and instruct the others to refresh their screens, whereupon the file had already arrived). In addition, operators had to be reminded repeatedly that they could not use the 'date modified' timestamp as a reliable indicator of time of arrival onboard their unit – since this timestamp is in fact replicated across the network and reflects the time the file was modified by the originator. To overcome these difficulties, more reliable metrics were derived from inspection of the system admin logs.

6.4.3. **Results:**

6.4.3.1. **NETEX Results**. The basic NETEX associated with this objective asked users to upload files ranging in size from 100-400kB, and measure the time taken for these files to replicate to other units. More advanced NETEXs were also conducted which examined the ability of Syntergy to handle replication conflicts when a file is simultaneously edited by two different users,

6.4.3.2. Using 64k SATCOM, replication times for 100-200kB files (both images and documents) were typically 2-3 and never greater than 4 minutes. Similar sized files marked for priority replication were consistently received in less than 1 minute. Changes to SharePoint sites, such as changes to text banners or background colours were replicated 'more or less instantly'.

6.4.3.3. Using HDR-SNR, these files replicated so quickly that it was difficult for users to measure exact timings. This occurred regardless of the topology of the physical SNR network.

6.4.3.4. To obtain more quantitative results, larger files were used for the final few NETEXs. On average, using a fully satellite denied SNR network including network relays running at 450kbps on a 300kHz waveform, 1000kB jpeg files replicated in 3 minutes. This is a great result with much operational potential.

6.4.3.5. It was noted that Syntergy compression algorithms reduced typical MS Word file sizes by around 70%.

6.4.3.6. Notwithstanding the quick and reliable file replication, some issues were encountered, particularly with regard to priority replication, replication conflicts, and user permissions.

6.4.3.7. An initial misconfiguration resulted in priority files being handled no differently to others. This was fixed with a work-around that required users to select high or low prioritisation for every file uploaded, rather than simply defaulting to low priority. Whilst this did fix the problem, it was burdensome on users, particularly when uploading large batches of files.

6.4.3.8. Due to the speed of replication, it proved quite difficult to force replication conflicts. When these did occur they were not handled gracefully, with neither user aware a conflict had occurred. The only evidence of the conflict was buried in an admin log. The software did not work as advertised in this respect, and will require a fix from the vendor.

6.4.3.9. Administrators also encountered some difficulties with some changes to user permissions not persisting. A workaround was to give admin rights to these users, a solution that obviously would not be acceptable operationally. The reason for this problem is unclear and was not resolved during the exercise.

6.4.3.10. **Survey Results**. Surveys on SharePoint were completed by respondents with varying degrees and training and familiarity with the system. Notably, 75% agreed that 'When I add information to SharePoint I am confident that other units will receive it'.

6.4.3.11. Even more importantly, 100% of respondents agreed or strongly agreed that 'SharePoint replicates information between units quickly enough to be operationally useful'.

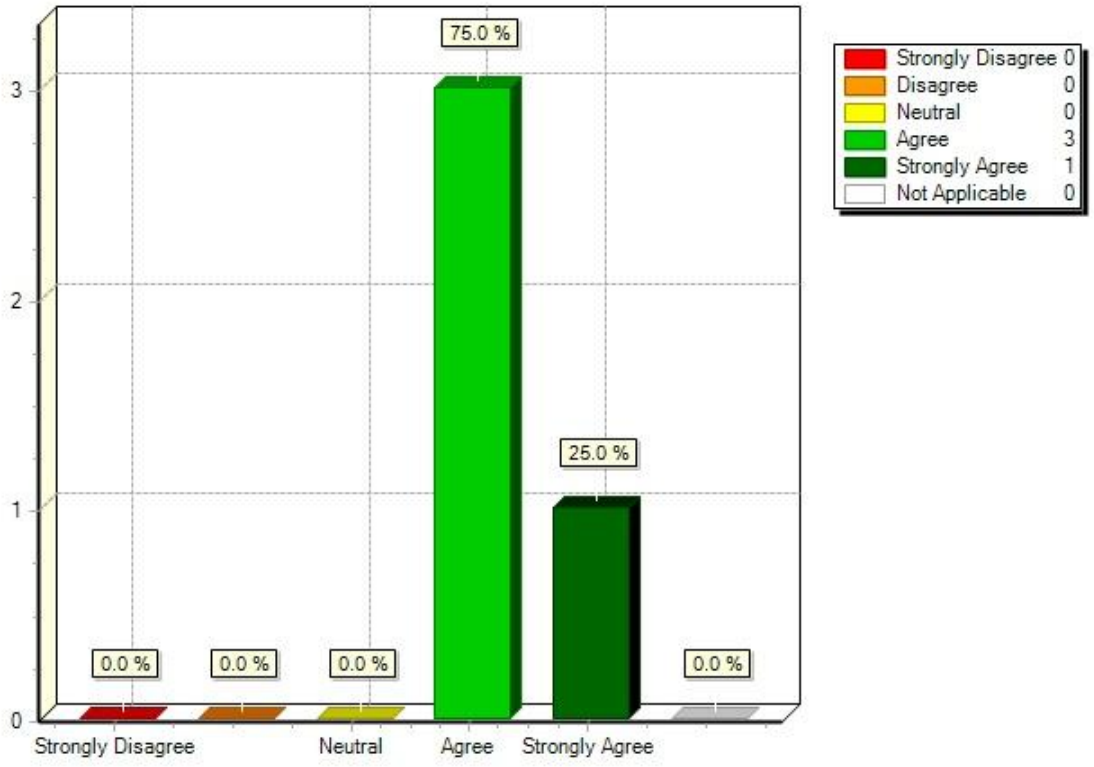

Figure 6.4-1: Responses to the statement 'SharePoint replicates information between units quickly enough to be operationally useful'

6.4.4. **Recommendations**: It is recommended that Syntergy be endorsed by AUSCANNZUKUS as a product suitable for quickly and reliably replicating SharePoint information in a Maritime Tactical Networking environment, noting some effort is required from Syntergy and Microsoft to rectify the minor remaining technical issues.

6.5. COAL 05.02 – SharePoint– Replication Bandwidth

6.5.1. **Objective question:** What are the bandwidth requirements for MS-SharePoint to reliably replicate document stores in various network topologies using Infonic and Syntergy replication engines?

6.5.2. **Summary of data collected, including survey reports:** Due to the challenges of measuring the bandwidth requirements of a single application in a live network, data for this

objective was principally collected during the LOE. The TW11 LOE SharePoint evaluation efforts were focused on the software package's ability to replicate documents over shipboard representative SATCOM, HFIP and UHF SNR links in a variety of network topologies.

6.5.2.1. WireShark sniffers were used to capture packet data flow between servers to assist in determining bandwidth costs associated with changing the replication topology.

6.5.3. **Results:**

6.5.3.1. **Syntergy - SATCOM Hub-Spoke Architecture Replication Testing**

6.5.3.1.1. In this topology, all ships replicated in a server-to-server configuration with the NOC over simulated SATCOM channels. The Syntergy replication engine on each test node was configured to replicate with the hub server at the NOC. All documents were uploaded into the NOC SharePoint environment and the times taken for successful replication of the files (from the NOC to the targeted node) were recorded.

JPEG File	Ship	Bearer Data Rate (kbps)	Total Time to Replicate (min:sec)	Actual Data Transferred (kBytes)	Effective Throughput (kbps)
100kB	Ship 1	1024	22 sec	138.4	50.3
	Ship 2	8	3 min 18 sec	143.8	5.8
	Ship 3	32	1 min 38 sec	147.2	12
	Ship 4	128	1 min 5 sec	148.4	18.3
500kB	Ship 1	1024	1 min 7 sec	601	71.8
	Ship 2	8	12 min 46 sec	630	6.6
	Ship 3	32	7 min 27 sec	596	10.7
	Ship 4	128	4 min	612	20.4
1400kB	Ship 1	1024	1 min 36 sec	1800	150
	Ship 2	8	48 min 13 sec	1910	5.3
	Ship 3	32	14 min	1800	17
	Ship 4*	N/A	N/A	N/A	N/A

** Ship included in network, but unavailable to receive.*

Table 6.5.1: Replication Times - NOC to Ships 1-4 over SATCOM (Syntergy)

6.5.3.2. **Syntergy - SATCOM-Restricted Environment - Tiered Replication**

6.5.3.2.1. Test personnel recorded the processes required by each node to shift the replication engine from a hub-spoke with the NOC topology, to a tiered replication topology. The replication engines were configured so that the BHR maintained replication with the NOC and the BHR in turn acted as the hub for the rest of the Task Group. The San Jacinto, Newcastle and Algonquin nodes replicated with the BHR.

6.5.3.2.2. The topology in the tiered replication scenario had the NOC maintaining the role as the master hub for the "Fleet Enterprise", replicating with the CTG ship over SATCOM. The CTG Command platform then performed the duties of the local "Task Group Hub"; replicating to the non-SATCOM ships over the LOS/ELOS subnets. All documents were uploaded into the

NOC SharePoint 2010 environment and the times taken for successful replication of the files were recorded.

Replication Times – HF IP

JPEG File	Ship	Bearer Data Rate (kbps)	Total Time to Replicate (min:sec)	Actual Data Transferred (kBytes)	Effective Throughput (kbps)
97kB	Ship 1	1024	23 sec	148	51.5
	Ship 2	12.8	9 min	152	2.3
	Ship 3	12.8	8 min	133	2.2
	Ship 4	12.8	13 min	150	1.5
500kB	Ship 1	1024	2 min	618	41.2
	Ship 2	12.8	30 min	622	2.8
	Ship 3	12.8	18 min	584	4.3
	Ship 4*	N/A	N/A	N/A	N/A
1200kB	Ship 1	1024	1min 45 sec	1400	106.6
	Ship 2	12.8	1 hour 4 min	1480	3.1
	Ship 3	12.8	35 min	1450	5.5
	Ship 4*	N/A	N/A	N/A	N/A

Replication Times – UHF SNR

JPEG File	Ship	Bearer Data Rate (kbps)	Total Time to Replicate (min:sec)	Actual Data Transferred (kBytes)	Effective Throughput (kbps)
100kB	Ship 1	1024	2 min	135	9
	Ship 2	64	2 min	141	9.4
	Ship 3	64	2 min	120	8
	Ship 4	64	2 min	119	7.9
500kB	Ship 1	1024	1 min 24 sec	561	53.4
	Ship 2	64	5 min	578	15.4
	Ship 3	64	6 min	572	12.7
	Ship 4*	N/A	N/A	N/A	N/A
856kB	Ship 1	1024	4 min	938	31.5
	Ship 2	64	12 min	947	10.5
	Ship 3	64	10 min	946	12.6
	Ship 4*	N/A	N/A	N/A	N/A

** Ship included in network, but unavailable to receive.*

Table 6.5.2: Replication Times - NOC to Ship1 over SATCOM, Ship 1 to Ships 2, 3 and 4 over HFIP and UHF SNR (Syntergy)

6.5.3.3. Syntergy - SATCOM-Denied Environment - Hub-Spoke Replication

6.5.3.3.1. Test personnel recorded the processes required by each node to shift the replication engines from a tiered-replication topology (in a SATCOM-restricted environment), to a hub-spoke replication topology (in a SATCOM-denied environment). The replication engines were configured so that the NOC no longer replicated with any ship, and that BHR in turn replicated with San Jacinto, Newcastle and Algonquin.

6.5.3.3.2. This replication scenario simulated a hub-spoke replication topology in a satellite-denied environment, where a CTG ship or equivalent Command Platform serves as the hub. CTG Ship (BHR) replicated with San Jacinto, Newcastle and then Algonquin over HFIP links, with the tests repeated over UHF SNR links. Documents used for this test were uploaded into the BHR SharePoint 2010 environment and the times taken for successful replication of the files were recorded.

Replication Times – HFIP

JPEG File	Ship	Bearer Data Rate (kbps)	Total Time to Replicate (min:sec)	Actual Data Transferred (kBytes)	Effective Throughput (kbps)
285kB	Ship 2	12.8	19 min	305	2.1
	Ship 3	12.8	23 min	324	1.9
	Ship 4	12.8	19 min	327	2.3
500kB	Ship 2	12.8	41 min	601	2
	Ship 3	12.8	21 min	563	3.6
	Ship 4	12.8	23 min	593	3.4
1262kB	Ship 2	12.8	1 hour 20 min	1500	2.5
	Ship 3	12.8	50 min	1450	3.9
	Ship 4	12.8	53 min	1460	3.7

Replication Times – UHF SNR

JPEG File	Ship	Bearer Data Rate (kbps)	Total Time to Replicate (min:sec)	Actual Data Transferred (kBytes)	Effective Throughput (kbps)
151kB	Ship 2	64	5 min	194	5.2
	Ship 3	64	3 min	197	8.7
	Ship 4	64	4 min	185	6.2
500kB	Ship 2	64	8 min	571	9.5
	Ship 3	64	4 min	571	19
	Ship 4*	N/A	N/A	N/A	N/A
1500kB	Ship 2	64	15 min	1900	16.8
	Ship 3	64	14 min	1870	17.8
	Ship 4*	N/A	N/A	N/A	N/A

** Ship included in network, but unavailable to receive.*

Table 6.5.3: Replication Times - Ship 1 to Ships 2, 3 and 4 over HFIP and UHF SNR (Syntergy)

6.5.3.4. Syntergy - SATCOM-Denied Environment - Fully-Meshed Replication

6.5.3.4.1. Test personnel recorded the processes required by each node to shift the replication engine from the Task Group hub-spoke replication topology (in a SATCOM-denied environment), to that of a fully-mesh replication topology in a SATCOM-denied environment. The replication engines were configured so that the NOC no longer replicates with any ship, and that BHR, San Jacinto, Newcastle and Algonquin replicated with each other in a peer-peer fully-meshed topology.

6.5.3.4.2. This replication scenario simulated a fully-meshed topology in a satellite-denied environment when no CTG or equivalent Command Platform is present. All ships replicate with each other (peer-to-peer) over HFIP links, with the experiment repeated over UHF SNR links. Documents were uploaded into the SharePoint environments as indicated in the TW11 LOE Test Plan. The times taken for successful replication of the files were recorded.

Replication Times – HFIP

JPEG File	Ship	Bearer Data Rate (kbps)	Total Time to Replicate (min:sec)	Actual Data Transferred (kBytes)	Effective Throughput (kbps)
200kB	Ship 1-2*	12.8	Cache cleared	N/A	N/A
	Ship 1-3*	12.8	Cache cleared	N/A	N/A
	Ship 1-4	12.8	51 min	284	0.7
	Ship 4-1	12.8	38 min	265	0.9
	Ship 4-2	12.8	34 min	279	1.1
200kB (2 files)	Ship 4-3	12.8	1 hour 1 min	498	1.1
500kB	Ship 1-2	12.8	40 min	598	2.0
	Ship 1-3	12.8	43 min	601	1.9
	Ship 1-4	12.8	25 min	569	3.0
	Ship 3-1	12.8	26 min	592	3.0
500kB	Ship 3-2	12.8	1 hour 3 min	1290	2.7
(2 files)	Ship 3-4	12.8	1 hour 8 min	1256	4.4
200kB	Ship 1-2	12.8	7 min	298	5.7
	Ship 1-3	12.8	6 min	274	6.1
	Ship 2-1	12.8	6 min	295	6.6
	Ship 1-2	12.8	7 min	267	5.1
	Ship 1-3	12.8	6 min	254	5.6
200kB (2 files)	Ship 2-3	12.8	9 min	565	8.4

Replication Times – UHF SNR

JPEG File	Ship	Bearer Data Rate (kbps)	Total Time to Replicate (min:sec)	Actual Data Transferred (kBytes)	Effective Throughput (kbps)
500kB	Ship 1-2	64	5 min	651	17.4
	Ship 1-3	64	6 min	689	15.3
	Ship 2-1	64	7 min	654	12.5
	Ship 1-2	64	5 min	585	15.6
	Ship 1-3	64	6 min	610	13.6
500kB (2 files)	Ship 2-3	64	8 min	1301	21.7

**** Note**: Testing of 200kb files over an HFIP fully mesh topology created a situation where the same file was attempted to be replicated at the same time from two different nodes. This created a replication conflict that halted replication and required the cache and queue to be cleared in order for the file to be replicated.*

Table 6.5.4: Replication Times - Fully Meshed - Ship1 through Ship 4 (Syntergy)

6.5.3.5. Infonic - SATCOM Hub-Spoke Architecture Replication Testing

6.5.3.5.1. In this topology, all ships replicated in a server-to-server configuration with the NOC over simulated SATCOM channels. The Infonic replication engine on each respective test node was configured to replicate with the hub server at the NOC. All documents were uploaded into the NOCs SharePoint environment and the time taken for successful replication of the files from the NOC to the targeted node was recorded.

Replication Times

JPEG File	Ship	Bearer Data Rate (kbps)	Total Time to Replicate (min:sec)	Actual Data Transferred (kBytes)	Effective Throughput (kbps)
101kB	Ship 1	1024	19 sec	148	62.3
	Ship 2	8	2 min 25 sec	141	7.8
	Ship 3	32	1 min 2 sec	131	17
	Ship 4	128	56 sec	130	18.6
671kB	Ship 1	1024	1 min 1 sec	755	99
	Ship 2	8	12 min 43 sec	763	8.5
	Ship 3	32	3 min 40 sec	826	30
	Ship 4	128	1 min 5 sec	829	102
1260kB	Ship 1	1024	40 sec	1400	280
	Ship 2	8	24 min 32 sec	1440	7.8
	Ship 3	32	6 min 57 sec	1460	28
	Ship 4	128	1 min 36 sec	1490	124.2

Table 6.5.5: Replication Times - NOC to Ships 1-4 over SATCOM (Infonic)

6.5.3.6. Infonic - SATCOM-Restricted Environment - Tiered Replication

6.5.3.6.1. Test personnel recorded the processes required by each node to shift the replication engine from a hub-spoke NOC topology, to a tiered replication topology. The replication engines were configured so that the BHR maintained replication with the NOC and the BHR in turn acted as the LOS/ELOS hub for the rest of the Task Group. The San Jacinto, Newcastle and Algonquin nodes replicated with the BHR.

6.5.3.6.2. The topology in this replication scenario had the NOC maintaining the role as the "master hub" for the Fleet Enterprise, replicating with the CTG ship over SATCOM. The CTG Command platform then performed the duties as the local "Task Group Hub"; replicating to the non-SATCOM ships over the LOS/ELOS subnets. All documents were uploaded into the NOC SharePoint 2010 environment and the time taken for successful replication of the files was recorded.

Replication Times – HF IP

JPEG File	Ship	Bearer Data Rate (kbps)	Total Time to Replicate (min:sec)	Actual Data Transferred (kBytes)	Effective Throughput (kbps)
101kB	Ship 1	1024	5 sec	142	227.2
	Ship 2	12.8	8 min 23 sec	138	2.2
	Ship 3	12.8	8 min 22 sec	141	2.25
	Ship 4	12.8	8 min 21 sec	138	2.2
671kB	Ship 1	1024	1 min 57 sec	774	52.9
	Ship 2	12.8	40 min	774	2.6
	Ship 3	12.8	40 min 14 sec	775	2.6
	Ship 4	N/A	36 min 12 sec	774	2.9
1262kB	Ship 1	1024	1 min 59 sec	1460	98.2
	Ship 2	12.8	1 hour 13 min	1470	2.7
	Ship 3	12.8	1 hour 16 min	1460	2.6
	Ship 4	N/A	1 hour 9 min	1460	2.8

Replication Times – UHF SNR

JPEG File	Ship	Bearer Data Rate (kbps)	Total Time to Replicate (min:sec)	Actual Data Transferred (kBytes)	Effective Throughput (kbps)
101kB	Ship 1	1024	5 sec	142	227.2
	Ship 2	64	3 min 45 sec	137	4.9
	Ship 3	64	2 min 45 sec	131	6.4
	Ship 4	64	4 min 35 sec	137	4
671kB	Ship 1	1024	1 min 57 sec	774	52.9
	Ship 2	64	5 min 56 sec	737	16.6
	Ship 3	64	10 min 33 sec	746	9.4
	Ship 4	N/A	9 min 37 sec	742	10.3
1262kB	Ship 1	1024	1 min 59 sec	1460	98.2
	Ship 2	64	11 min 53 sec	1400	15.7
	Ship 3	64	15 min 15 sec	1400	12.2
	Ship 4	N/A	13 min 47 sec	1400	13.5

Table 6.5.6: Replication Times - NOC to Ship1 over SATCOM, Ship 1 to Ships 2, 3 and 4 over HFIP and UHF SNR (Infonic)

6.5.3.7. Infonic - SATCOM-Denied Environment - Hub-Spoke Replication

6.5.3.7.1. Test personnel recorded the processes required by each node to shift the replication engine from a tiered-replication topology in a SATCOM-restricted environment, to a hub-spoke replication topology in a SATCOM-denied environment. The replication engines were configured so that the NOC no longer replicated with any ship, and that the BHR replicated with the San Jacinto, Newcastle and Algonquin.

6.5.3.7.2. This replication scenario simulated a hub-spoke replication topology in a satellite-denied environment, where a CTG ship or equivalent Command Platform serves as the hub.

CTG Ship (BHR) replicated with San Jacinto, Newcastle and then Algonquin over HFIP links, with the tests repeated over UHF SNR links. Documents used for this test were uploaded into the BHR SharePoint 2010 environment and the time taken for successful replication of the files was recorded.

Replication Times – HFIP

JPEG File	Ship	Bearer Data Rate (kbps)	Total Time to Replicate (min:sec)	Actual Data Transferred (kBytes)	Effective Throughput (kbps)
101kB	Ship 2	12.8	7 min 34 sec	143	2.5
	Ship 3	12.8	6 min 35 sec	134	2.7
	Ship 4	12.8	7 min 26 sec	137	2.5
671kB	Ship 2	12.8	35 min 13 sec	764	2.9
	Ship 3	12.8	34 min 49 sec	769	2.9
	Ship 4	12.8	33 min 30 sec	763	3
1262kB	Ship 2	12.8	1 hour 2 min	1440	3.1
	Ship 3	12.8	1 hour 23 sec	1440	3.2
	Ship 4	12.8	1 hour 1 min	1440	3.1

Replication Times – UHF SNR

JPEG File	Ship	Bearer Data Rate (kbps)	Total Time to Replicate (min:sec)	Actual Data Transferred (kBytes)	Effective Throughput (kbps)
101kB	Ship 2	64	2 min 52 sec	126	5.9
	Ship 3	64	2 min 50 sec	126	5.9
	Ship 4	64	2 min 6 sec	125	8
671kB	Ship 2	64	6 min 25 sec	735	15.2
	Ship 3	64	6 min 25 sec	735	15.2
	Ship 4	N/A	8 min 54 sec	735	11
1262kB	Ship 2	64	14 min 22 sec	1390	12.9
	Ship 3	64	9 min 44 sec	1390	19
	Ship 4	N/A	13 min 13 sec	1390	14

Table 6.5.7: Replication Times - Ship 1 to Ships 2, 3 and 4 over HFIP and UHF SNR (Infonic)

6.5.3.8. Infonic - SATCOM-Denied Environment - Fully-Meshed Replication

6.5.3.8.1. Test personnel recorded the processes required by each node to shift the replication engine from the Task Group hub-spoke replication topology in a SATCOM-denied environment, to that of a fully-meshed replication topology in a SATCOM-denied environment. The replication engines were configured so that the NOC no longer replicated with any ship, and that BHR, San Jacinto, Newcastle and Algonquin replicated with each other in a peer-to-peer fully meshed configuration.

6.5.3.8.2. This replication scenario simulated a fully-meshed topology in a satellite-denied environment when no CTG or equivalent Command Platform is present. All ships replicate with each other in a peer-to-peer configuration over HF IP links, with the experiment repeated over

UHF SNR links. Documents were uploaded into the SharePoint environment of the nodes indicated in the test plan. The time taken for successful replication of the files was recorded.

Replication Times – HFIP

JPEG File	Ship	Bearer Data Rate (kbps)	Total Time to Replicate (min:sec)	Actual Data Transferred (kBytes)	Effective Throughput (kbps)
200kB	Ship 4-1	12.8	31 min 40 sec	635	2.7
	Ship 1-2	12.8	17 min 18 sec	280	2.2
	Ship 1-3	12.8	17 min 11 sec	297	2.3
	Ship 1-4	12.8	15 min 10 sec	265	2.4
200kB	Ship 4-2	12.8	22 min 7 sec	457	2.8
(2 files)	Ship 4-3	12.8	28 min 45 sec	480	2.3
500kB	Ship 4-1	12.8	32 min 59 sec	650	2.7
	Ship 1-2	12.8	37 min 13 sec	641	2.3
	Ship 1-3	12.8	38 min 8 sec	659	2.3
	Ship 1-4	12.8	36 min 40 sec	680	2.5
500kB	Ship 4-2	12.8	55 min	1248	3.0
(2 files)	Ship 4-3	12.8	46 min 20 sec	1250	3.6

Replication Times – UHF SNR

JPEG File	Ship	Bearer Data Rate (kbps)	Total Time to Replicate (min:sec)	Actual Data Transferred (kBytes)	Effective Throughput (kbps)
200kB	Ship 4-1	64	5 min 25 sec	250	6.7
	Ship 4-2	64	5 min 45 sec	264	7.0
	Ship 4-3	64	2 min 41 sec	278	18.5
	Ship 1-4	64	5 min 31 sec	254	6.8
200kB	Ship 1-2	64	5 min 56 sec	498	11.1
(2 files)	Ship 1-3	64	5 min 40 sec	487	13.0
500kB	Ship 4-1	64	8 min 21 sec	671	11.2
	Ship 4-3	64	6 min 22 sec	650	14.4
	Ship 1-2	64	10 min 3 sec	678	9.0
	Ship 1-4	64	11 min 22 sec	689	8.4
500kb	Ship 4-2	64	10 min 53 sec	1254	15.2
(2 files)	Ship 1-3	64	9 min 40 sec	1258	18.6

Table 6.5.8: Replication Times - Fully Meshed - Ship1 through Ship 4 (Infonic)

6.5.4. **Summary of results.** Both Infonic and Syntergy were able to successfully replicate over all TW11 LOE test topologies. Both products were observed to have a replication overhead, sending 30% to 40% more data than the size of the transmitted file. This overhead would be expected to reduce over time as the compression and optimization schemes are more effective with modified files than new ones.

6.5.4.1. The figure below shows the average effective throughput in the various network topologies that were tested, and demonstrates that there is little to differentiate the products in terms of bandwidth requirements.

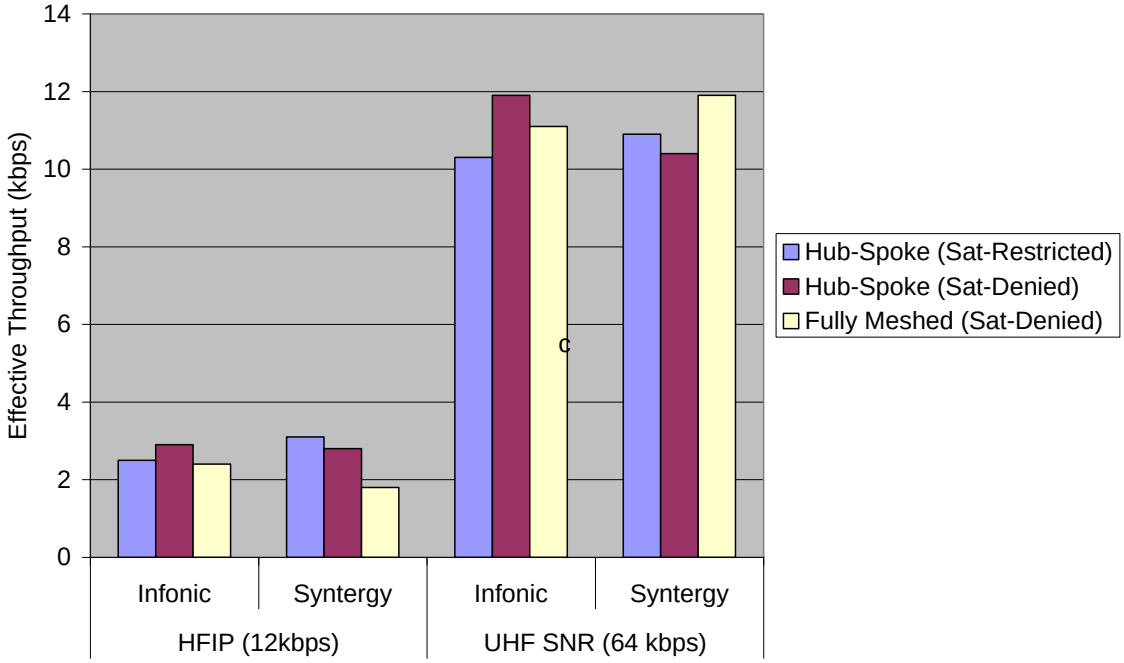

Figure 6.5-1: Comparison of observed throughput in various network topologies

6.5.4.2. It is important to note that although Infonic fully-meshed replication was successful, the way that the replicator was able to support this was by creating multiple SharePoint 2010 web sites, one for each ship in the network. This situation is viewed as difficult to implement with large groups of ships, as well as cumbersome for administrators and users to handle. By comparison, Syntergy is relatively easy to configure for a fully meshed scenario and is well integrated with SharePoint.

6.5.4.3. For this reason it was decided that the main focus of operational testing during the execution period would be on Syntergy only, with the UK conducting some simple (non-SharePoint) file replication using Infonic.

6.5.5. **Recommendation:** AUSCANNZUKUS monitor Infonic Geo-replicator product development with a view to revisiting its suitability in a meshed network environment.

6.6. COAL 05.03 – SharePoint/Lync – Lync Chat Bandwidth

6.6.1. **Objective question.** What are the bandwidth requirements for Unified Comms Chat?

6.6.2. **Summary of data collected, including survey reports.**

6.6.2.1. Due to the challenges of measuring the bandwidth requirements of a single application in a live network, data for this objective was principally collected during Lab testing conducted

at the Australian Networks Lab at Campbell Park, Canberra. Since Lync does not rely on defined topologies like Sharepoint with Syntergy or Infonic it was unnecessary to replicate the connection scenarios of the previous sections. Results for this experiment are based primarily on Lab testing using a simple hub spoke topology. All spokes were connected to the hub via an Apposite Linktropy 4 channel WAN simulator to control the data rate and the characteristics of the connections. Data collected during execution was used to validate Lab results and gather evidence regarding the actual performance and user experience of the applications when used in an operational environment. The Lab based experiments were conducted at network speeds of 64 kbps, 128 kbps and 10 Mbps.

6.6.3. **Lab Equipment and configuration.**

6.6.3.1. **Hardware.** Hardware was chosen by a mix of Microsoft documented system requirements, future Australian Fleet system specifications and the constraints of the mandated Australian ICT procurement procedures. These procurement processes and vendors item availability meant that hardware was not available for initial build purposes until approximately 4 weeks before shipping. This led to a much reduced timeframe in which to produce results.

6.6.3.2. **The system comprised the following per node:**

1 x IBM x3650M3 server with dual Quad core processors, 24GB of RAM and 8 SAS 15k rpm HDD's.

Cisco 2811 series routers and 3750 series managed switches

6.6.3.3. **RAID Subsystem and Disk usage.** Due to performance recommendations from Microsoft's representatives and minimum specification documentation, it was decided to reconfigure the disk arrays in the following format:

System: RAID 1, 2 disk, 1 array

Data: RAID 0, 1 disk, 6 arrays

Virtual servers were provided with a fixed size (static) virtual disk on each of the 6 physical disks. This provided the full resources of a SAS data channel to each virtual server.

6.6.3.4. **CPU and RAM allocation.** The servers arrived with 24 GB RAM. Using less than the recommended RAM allocation for each server, meant that not all virtual machines could be hosted on the one physical server. While Hyper-V 2008 SP1 supports dynamic RAM allocation it was recommended by Microsoft to not use this feature due to stability reasons.

6.6.3.5. **Software.** The following releases of software were used in the Australian builds:

Microsoft Windows Server 2008R2 SP1 (Aust Defence SOE version)

Microsoft Hyper-V 2008R2

Microsoft Sharepoint Server 2010

Microsoft Lync Server 2010

Microsoft Lync Communicator 2010

Microsoft Lync Group Chat Client 2010.

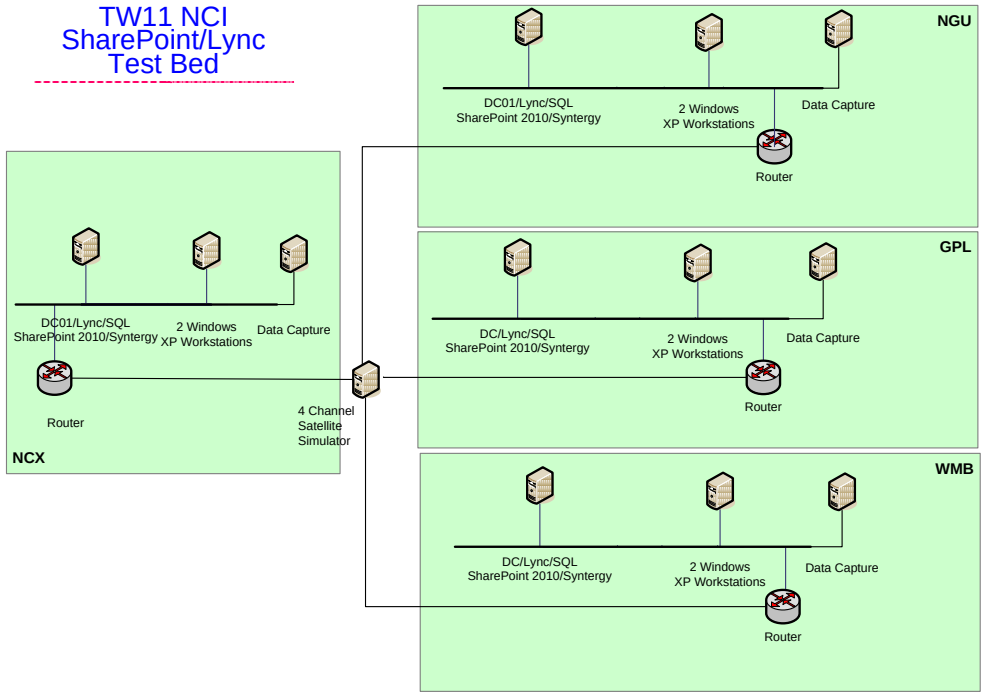

Figure 6.6-1: Australian Lab Configuration

6.6.3.6. Microsoft Windows Server 2008 R2 SP1 – Defence 2008 Server SOE Beta was used in the Australian nodes as it provided the platform requirements for the applications under test, as well as Australian specific SOE security implementations.

6.6.3.7. The lab system was constructed so that every connection could be individually configured via the WAN simulator, however for the purposes of collecting raw throughput data the only parameter varied was each link's data rate. The physical configuration is shown in Figure 6.6-1.

6.6.3.8. In order to establish the full bandwidth implications of using the Lync software it is important to know what bandwidth, if any, is consumed when the system is idle, as well as when in use. This is an important consideration when using high cost commercial bearers.

6.6.3.9. The following tests were carried out;

System idle with no clients connected – Baseline Test 1

System idle with Lync clients logged in – Baseline Test 2

Lync IM Chat between 2 clients.

Lync IM Chat between 3 clients.

Lync IM Chat file transfer between 2 clients.

Lync IM Chat file transfer between 3 clients.

6.6.4. **Results.**

6.6.4.1. **Baseline Test 1.** The first test was conducted with Lync servers operating, WAN connections up, Sharepoint servers off and Lync clients off. Wireshark was used to capture all network traffic and analyse the data. Over the duration of this test there was no Lync traffic passed across the bearers by any Lync servers however there was some activity generated by Lync within each LAN. It was also revealed on the testbed that a large amount of general LAN traffic was being generated such as NBNS, ARP and ICMP and in some cases a large number of re-transmissions. These were removed from the captured data as they did not relate directly to the operation of Lync. The same filtering criterion was applied to all captured data.

	Ship	Total LAN Traffic (kbps)	Lync Server LAN Traffic (kbps)	Lync WAN Traffic (kbps)
64kbps	WMB	0.48	0.02	0
	GPL	10.66	10.40	0
	NCX	3.75	0.06	0
	NGU	0.34	0.06	0
128kbps	WMB	0.49	0.02	0
	GPL	10.60	10.11	0
	NCX	3.73	0.05	0
	NGU	0.85	0.63	0
10Mbps	WMB	0.53	0.04	0
	GPL	0.36	0.02	0
	NCX	4.21	0.58	0
	NGU	0.35	0.01	0

Table 6.6-1: Lync Baseline 1. Servers Only

6.6.4.2. **Baseline Test 2.** The second part of the experiment was conducted with Lync servers operating, WAN connection up, Sharepoint servers off and Lync clients on and logged in. When the Lync clients were started the amount of LAN traffic increased substantially. This can be attributed to the registering of users and terminals within the system. The average figure shown for the bandwidth between units is misleading as this is the average over the short duration of the test. The majority of the data passed between nodes in a short burst as clients were started but reduced once connections were established. This was most likely due to the exchange of presence data between servers and is shown in Figure 6.6-2. The large amount of data shown for GPL was found to be data exchanged between the host and the VM. The reason for this in this instance is unknown.

	Ship	Total LAN Traffic (kbps)	Lync Generated LAN Traffic (kbps)	Lync Generated WAN traffic (kbps)
64kbps	WMB	7.68	7.33	0.26
	GPL	14.17	13.80	0.22
	NCX	1.03	0.52	0.22
	NGU	0.53	0.51	0.22
128kbps	WMB	3.35	3.04	0.20
	GPL	13.20	12.13	0.20
	NCX	7.23	2.98	0.20
	NGU	1.34	1.03	0.18
10Mbps	WMB	7.38	6.62	0.38
	GPL	2.84	2.67	0.45
	NCX	9.21	4.84	0.42
	NGU	3.34	3.26	0.46

Table 6.6-2: Lync Baseline 2. Servers and Clients

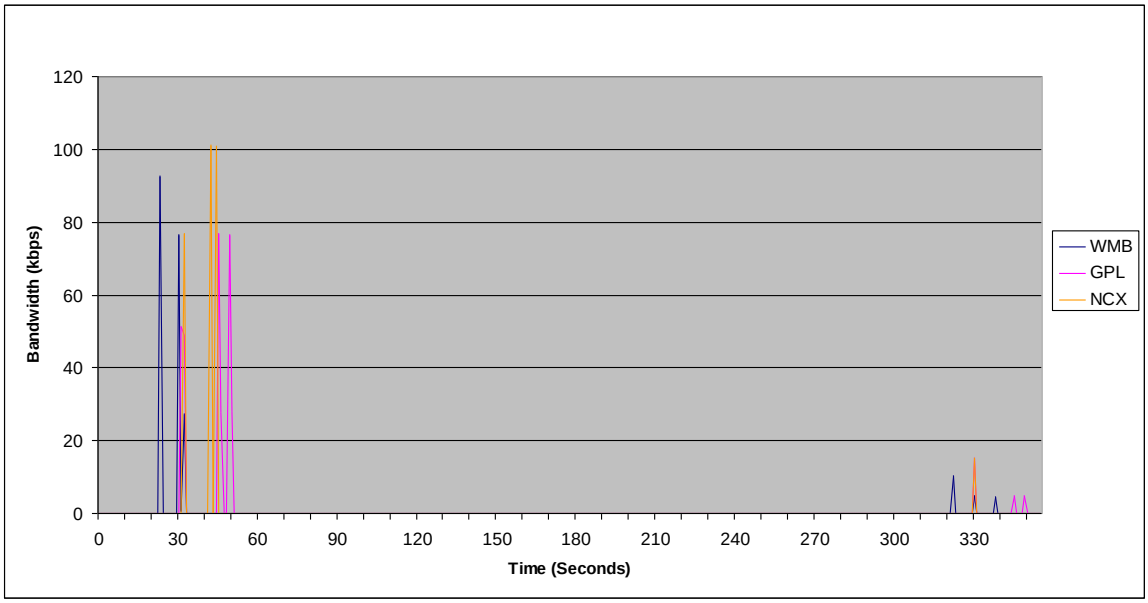

Figure 6.6-2: Lync Baseline with Servers and Clients

6.6.4.3. **Lync Chat.** This testing was carried out in two configurations. The first consisted of a two way chat between two nodes, WMB and GPL. The second consisted of a three way chat with NCX being dragged into the chat by WMB. In all cases WMB initiated the chat. This appeared to have no significant affect on the results. As clients initiated a connection a large spike in traffic occured as the call was established. This was followed by a consistent bit stream as the chat was conducted. There was not a significant difference in the bandwidth required

between the different capacity bearers. The different averages shown could be attributed to the extra time taken to receive a message over the slower links and hence a longer time to respond, thereby producing a lower average throughput.

Two way	Ship 1	Ship 2	Total Average WAN traffic (kbps)
64kbps	WMB	GPL	2.16
128bps	WMB	GPL	1.18
10Mbps	WMB	GPL	1.64

Table 6.6-3: One to One Lync Chat Bandwidth Measurements

Three way	Ship 1	Ship 2	Average Traffic each way (kbps)
64 kbps	WMB	GPL	1.03
	WMB	NCX	1.12
128kbps	WMB	GPL	1.82
	GPL	NCX	1.99
10Mbps	WMB	GPL	2.32
	GPL	NCX	2.92

Table 6.6-4: Three Way Lync Chat Bandwidth Measurement

6.6.4.4. **Document transfer.** This test was again attempted in two configurations. One to one between WMB and GPL, and WMB to both GPL and NCX. This was conducted to determine the overheads associated with transferring a document using Lync Chat instead of using Sharepoint. Files transferred successfully in the one to one scenario; however the data transfer to multiple clients failed in all attempts. The cause of this failure is yet to be determined.

Two Way	File Size (kB)	Total Data Transferred (kB)	Total Overhead (%)	Time Taken (mm:ss)
64kbps	500kB	563.12	12.64	1:40
	1000kB	1124.81	12.48	3:43
128kbps	292	328.63	12.54	0:26
	500	568.50	13.69	0:47
	10,000	Incomplete	Capture	13:45
10Mbps	292	332.95	14.0	00:02
	400	462.16	15.55	00:05
	500	575.83	15.2	00:06
	750	856.63	14.2	00:05
	1,000	1138.04	13.8	00:06
	2,000	2264.43	13.22	00:10
	4,000	4512.03	12.8	00:19
	6,000	6760.31	12.67	00:27
	8,000	9012.88	12.66	00:35
	10,000	11250.21	12.5	00:41

Table 6.6-5: Document Transfer One to One TwoUsing Lync Chat

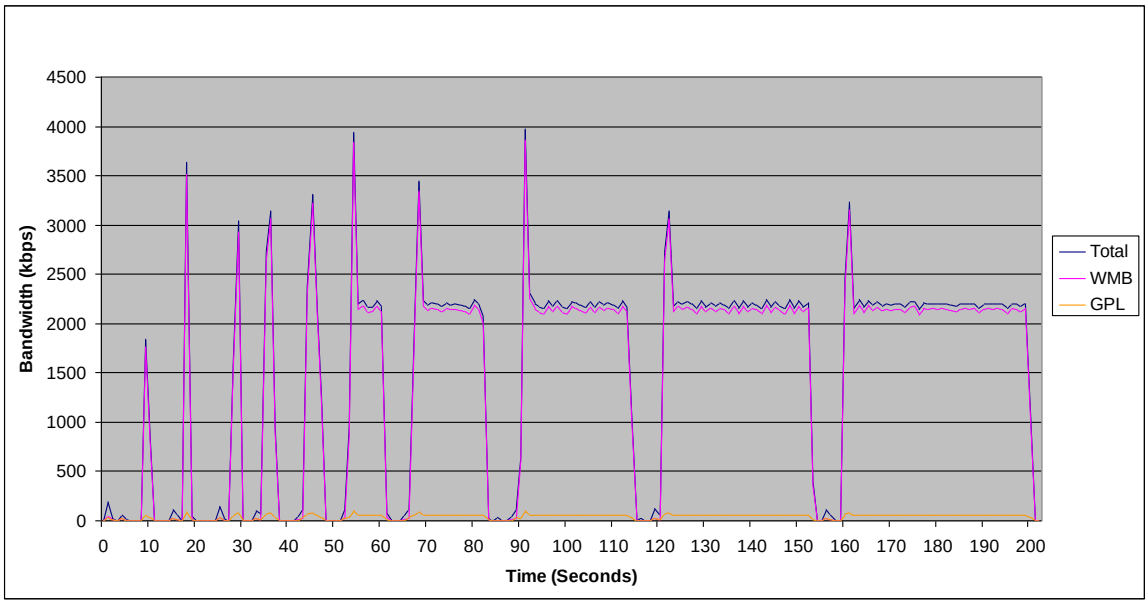

Figure 6.6-3: File Transfers at 10Mbps

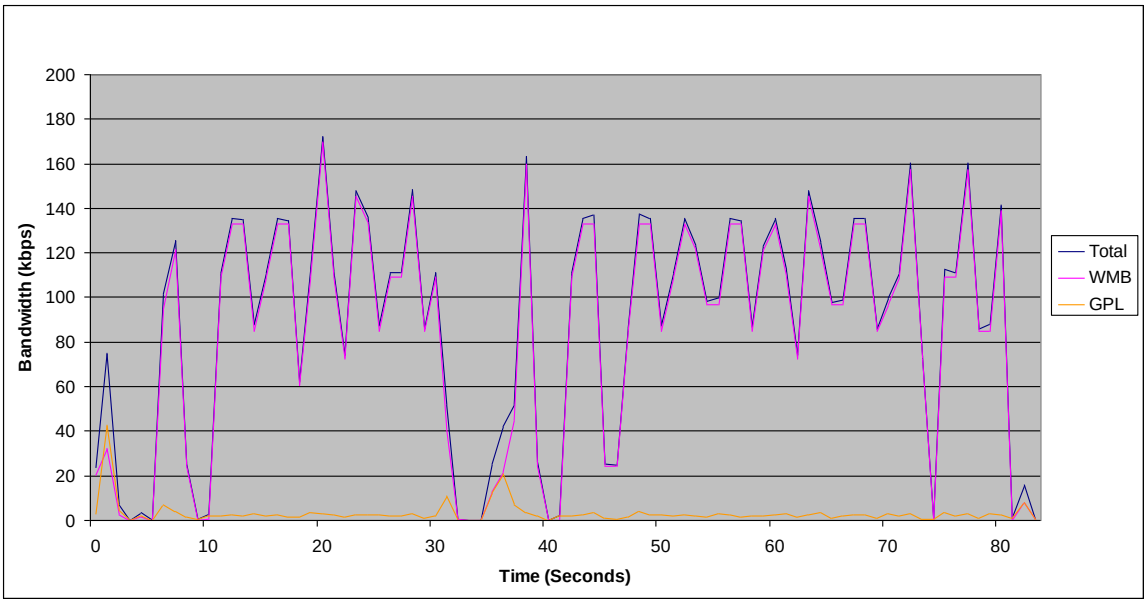

Figure 6.6-4: File Transfers at 128kbps (292kB and 500kB)

6.6.4.5. It can be seen from Table 6.6-5, Figure 6.6-3and Figure 6.6-4 that the overheads associated with transferring a document using Lync chat are not excessive at around 13-15%. Inspection of the captured data revealed these overheads are due to normal TCP protocol exchanges.

6.6.4.6. Lab testing proved that the overheads and bandwidth required for Lync IM Chat to operate are not excessive and are suitable for use in a maritime environment. It also proved that file transfer during a Lync chat session is an effective and efficient means by which to transfer even large documents, however the length of time required to deliver large documents may result in unsatisfactory performance at very low data rates.

6.6.5. **Recommendation.** It is recommended that further testing be carried out in conjunction with Microsoft to determine if system changes required to address the presence issues encountered will have an adverse effect on bandwidth usage.

6.7. COAL 05.04 – SharePoint/Lync – Lync Voice Bandwidth

6.7.1. **Objective question.** What are the bandwidth requirements for Unified Communications Voice?

6.7.2. **Summary of data collected, including survey reports.**

6.7.2.1. The test setup for this experiment was the same as described for COAL 05.03. To establish the bandwidth requirements to operate the Lync Voice capability the following tests were carried out:

Lync Voice calls between 2 clients

Lync Voice calls between 3 clients.

6.7.2.2. During lab testing the following observation were made. At speeds above 128 kbps audio quality was good in both 2- and 3-way scenarios. This is in line with Microsoft's bandwidth estimates of 39kbps for narrowband and 57kbps for Wideband codecs when used in peer to peer connections. This typical average bandwidth (according to Microsoft) is determined by taking 61% of the codec's full bandwidth requirement. In peer-to-peer conversations each endpoint only streams data when the user speaks. This was evident at 64kbps, where audio quality was good as long as the non talking party muted their microphone. If the microphone was not muted, background noise caused major distortion to the other stream. A similar experience occurred in the 3 way audio. In a typical press to talk environment this would not be a substantial issue if suitable headset hardware was used. It can be seen in Figure 6.7-1 the increase in bandwidth used at 128kbps is due to the adaptive codec used by Lync.

6.7.3. **Results.**

Two Way	Ship 1	Ship 2	Average Maximum per Person (kbps)	Average Traffic per Conversation (kbps)
64kbps	WMB	GPL	26.99	41.34
	GPL	WMB	22.32	
128kbps	WMB	GPL	52.55	55.90
	GPL	WMB	43.98	
10Mbps	WMB	GPL	77.94	83.89
	GPL	WMB	60.26	

Table 6.7-1: Lync Voice – Typical Two Way Conversation Bandwidth Usage

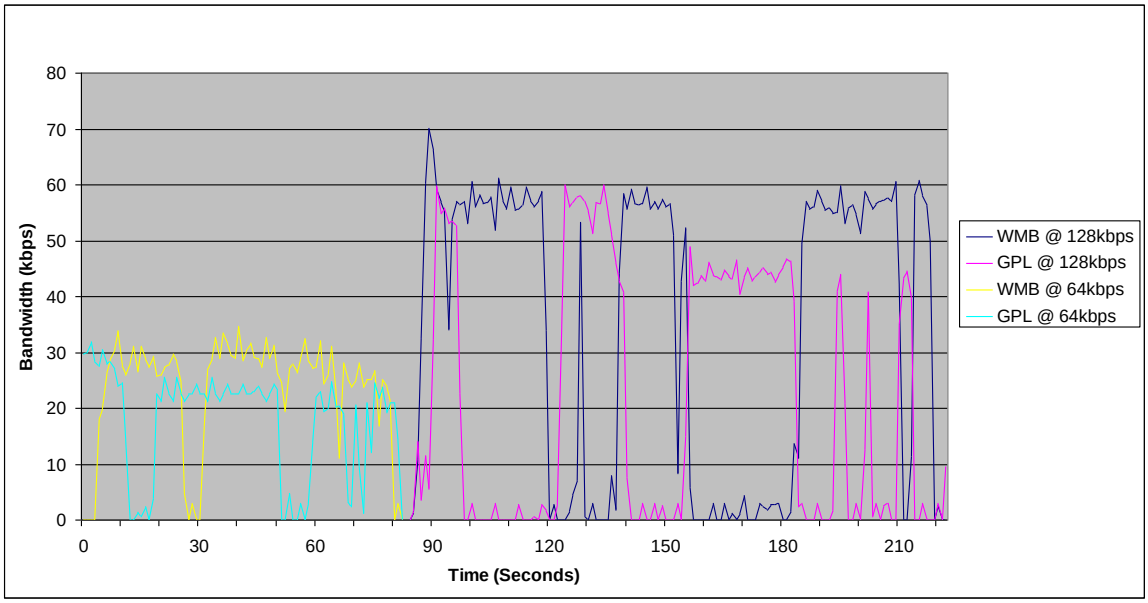

Figure 6.7-1: Lync Voice Bandwidth Usage at 64 kbps and 128 kbps

Three way	Ship 1	Ship 2	Average Traffic - One Way Streams (kbps)	Average Traffic per Conversation (kbps)
64kbps	WMB	GPL	31.53/15.42	46.91
	WMB	NCX	28.04/15.56	41.97
128kbps	WMB	GPL	44.37/33.69	73.99
	GPL	NCX	39.31/52.82	97.07
10Mbps	WMB	GPL	Not Recorded	152.07
	GPL	NCX	Not Recorded	135.45

Table 6.7-2: Lync Voice Three Way Bandwidth Measurement

6.7.4. **Live results and observations.** Live testing did not affect the overall bandwidth requirements, however, audio performance degraded whenever a LOS link was used. This is believed to be a result of the program's adaptive codec. This codec adapts to suit the perceived bandwidth available and is highlighted by the different bandwidths recorded in Figure 6.7-1 and Table 6.7-1. When operating over the UHF SNR LOS bearer, the low bandwidth and inherent characteristics of the TDMA system caused instability and poor audio quality. It does not appear possible to select a specific codec or bandwidth usage in the current version of the software.

6.7.4.1. It was determined that Lync Voice is capable of operating in a "stable" low bandwidth environment, however further development needs to be carried out to address the instability of the codec along with other domain presence reporting issues. These issues will need to be addressed before it could successfully be deployed in an operational environment.

6.7.5. **Recommendations.**

6.7.5.1. It is recommended that further testing be carried out in conjunction with Microsoft to address the performance issues induced by the operation of the adaptive audio codec function of Microsoft Lync.

6.7.5.2. It is recommended that Quality of Service be implemented on Tactical Wide Area Network connections to prioritise audio traffic if the audio conferencing functionality of Lync is to be considered for use.

6.8. COAL 05.05 – SharePoint/Lync – Lync Chat Teleconferencing

6.8.1. **Objective question.** What are the bandwidth requirements for Unified Comms Teleconferencing?

6.8.2. **Summary of data collected, including survey reports.**

6.8.2.1. The test setup for this experiment was the same as described for 05.03. To establish the bandwidth requirements to operate Lync Video Teleconferencing the following tests were carried out:

Lync video call between 2 clients.

Lync video call between 3 clients.

6.8.3. **Results.**

6.8.3.1. The results shown in Table 6.8-1 refer to the constant data stream used to support a video session. Unlike audio where the data only flows when a user talks, video data flows in a continuous stream, one way until the connection is lost or closed.

6.8.3.2. At speeds below 128 kbps it was not possible to conduct a two way Lync Video Teleconferencing. Again this is in line with Microsoft's typical bandwidth estimates of up to 250 kbps. However, at 128 kbps, in the stable lab environment it was possible to conduct a one way video stream. When changing the simulated WAN connection speed the program automatically changed the codec to best suit the bandwidth available. This resulted in a 10 – 15 second blank screen before video was re-established.

Two way	Ship 1	WAN traffic per stream (kbps)	Ship 2	WAN traffic per stream (kbps)
64kbps	WMB	Not supportable	GPL	Not supportable
128kbps	WMB	37.86	GPL	2.96 Tried but couldn't connect
10Mbps	WMB	292.61	GPL	275.11

Table 6.8-1: Lync Video Two Way Conference Bandwidth Measurements

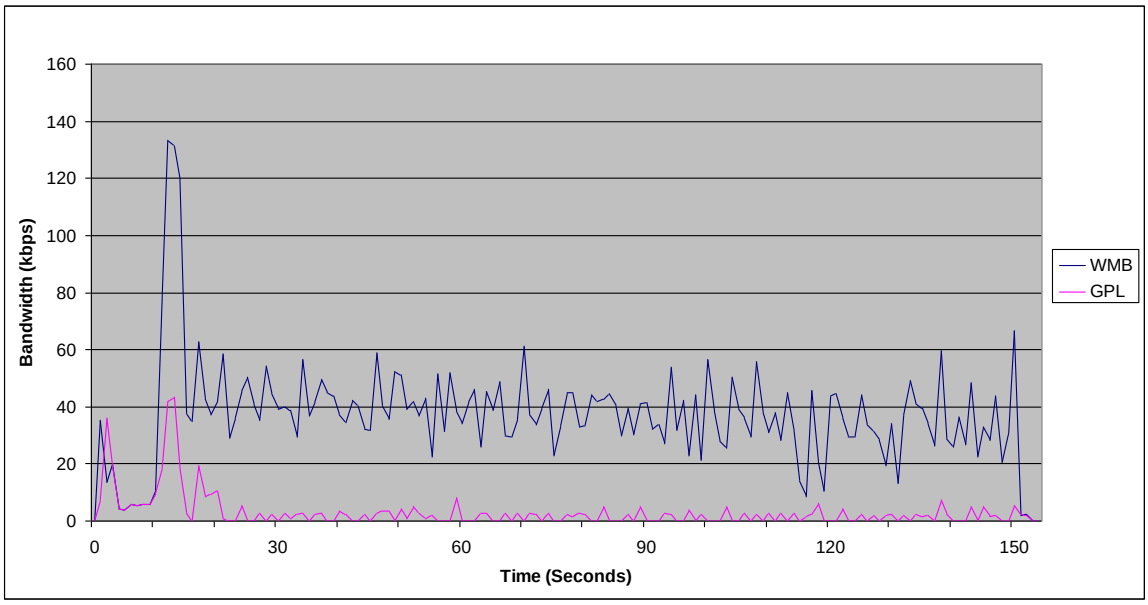

Figure 6.8-1: Lync Video Bandwidth at 128kbps

Three way	Ship 1	Averge Traffic per Stream (kbps)	Ship 2	Average Traffic per Stream (kbps)
64kbps	WMB	Not Supported	GPL	Not Supported
	WMB	Not Supported	NCX	Not Supported
128kbps	WMB	33.65	GPL	14.83 Tried but couldn't Connect
	WMB	Not Supported	NCX	Not Supported
10Mbps	WMB	304.07	GPL	189.15
	WMB	256.29	NCX	137.22

Figure 6.8-2: Lync Video Three Way Conference Bandwidth Measurements

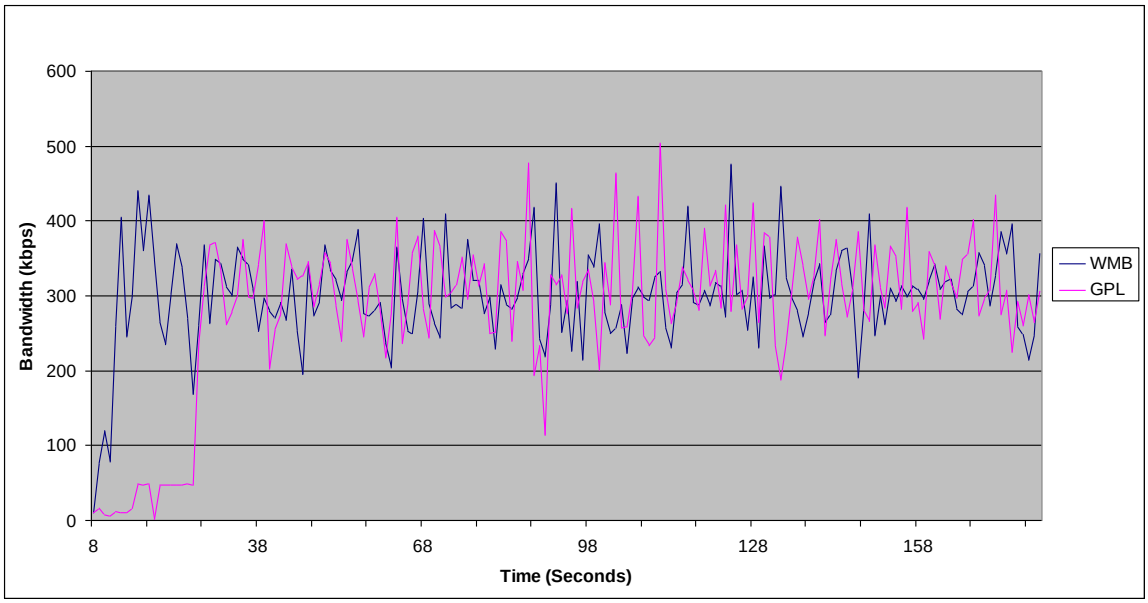

Figure 6.8-3: Lync Two Way Video Bandwidth at 10Mbps

6.8.3.3. During live testing the results were unacceptable for operational use. When using the SATCOM connections video could be established but was poor quality and either froze or dropped out frequently. When a LOS link was utilized, even with sufficient average bandwidth available, the performance of video suffered as a result of the program's dynamic codec selection. It is believed the inherent characteristics of the SNR TDMA system caused instability and poor video quality as the program constantly changed the codec to suit the perceived bandwidth. It does not appear possible to select a specific codec or bandwidth usage in the current version of the software.

6.8.3.4. The bandwidth requirements of Lync Teleconferencing are sufficient to allow a one way video broadcast at speeds as low as 128kbps in a stable environment. It is currently not suitable for use in a low bandwidth tactical environment. To enable operation at typical speeds and over bearers encountered in the maritime environment further development needs to be carried out. In particular to address the automatic codec selection issues. It is considered that implementation of Quality of Service on all bearers would also improve the performance.

6.8.4. **Recommendations.**

6.8.4.1. It is recommended that further testing be carried out in conjunction with Microsoft to address the performance issues induced by the operation of the codec dynamic configuration function when used over SNR LOS connections.

6.8.4.2. It is recommended that Quality of Service be implemented on all WAN connections if the teleconferencing functionality of Lync is to be considered for use.

6.9. COAL 05.06 – SharePoint/Lync – Usability

6.9.1. **Objective question:** What is the usability of SharePoint/Lync in a maritime network environment?

6.9.2. **Summary of data collected, including survey reports:** Due to the very subjective nature of this objective, data was primarily collected from user surveys. Users ranged in proficiency from novice to expert, although 70% of survey respondents had not encountered the tools prior to TW11 and identified their level of proficiency as 'Novice'.

6.9.2.1. The survey data was augmented with comments and reports from other TW11 participants, particularly with respect to the issues encountered by network administrators.

6.9.3. **Results:**

6.9.3.1. **SharePoint.** In general, users adapted quickly to SharePoint, enjoying the easy to use interface and familiarity of Microsoft software design. Notably, 100% of respondents (7 individuals) either agreed or strongly agreed that 'SharePoint is intuitive and easy to use'.

6.9.3.2. Despite this strongly positive result, users appeared unwilling to immediately endorse SharePoint as a replacement for CAS, with 71% of users responding 'Neutral' to the statement 'SharePoint is a better information management tool than the current Collaboration-at-Sea (CAS) portal on CMFP' (the other 29% responded 'Agree').

6.9.3.3. Comments included: "I have not used the current version [of CAS]"; "This is my first use of SharePoint. I need more experience with the system, including use of Lync Chat before I can render an objective opinion"; "[SharePoint is] much more user friendly, also appears to work faster"; and "[It is] too early to tell. CAS has evolved over 10+ years compared to an out of the box SharePoint initiative."

6.9.3.4. **Lync**. Lync is similar to other common applications available like Windows Live Messenger and as such it is relatively simple for users to navigate with little or no training. The integrated collaboration tools such as whiteboarding and screen sharing were an unexpected hit with users, and were used to advantage during the course of the experimentation and the VIP demonstration scenarios, which involved finding and prosecuting a Contact of Interest.

Figure 6.9-1: Operator onboard HMNZS Manawanui using Lync tools.

6.9.3.5. Many users noted that the capabilities of Lync are broadly similar to those of Sametime, with the main advantage being deeper integration with MS Office products (presence is shared with other applications and SharePoint).

6.9.3.6. The limitations of Lync are also broadly similar to Sametime, with both tools causing problems when users drop out of active sessions. Users are unable to re-enter a pervious chat window and another user is required to add lost users back into the session, losing previous chat history. This is likely to be a limitation of all instant messaging applications and is a key reason that operationally critical chat should be conducted in persistent chat rooms.

6.9.3.7. Administrators noted that the creation of 'Buddy Lists' was somewhat cumbersome and labour intensive, as was the standing up of Group Chat rooms, although workarounds exist and scripts could probably be created to automate this.

6.9.3.8. **Voice**. Lync voice proved unreliable at all but the most optimum network conditions. Whilst audio was often clear, conversations were difficult to maintain due to the significant time lag experienced by users.

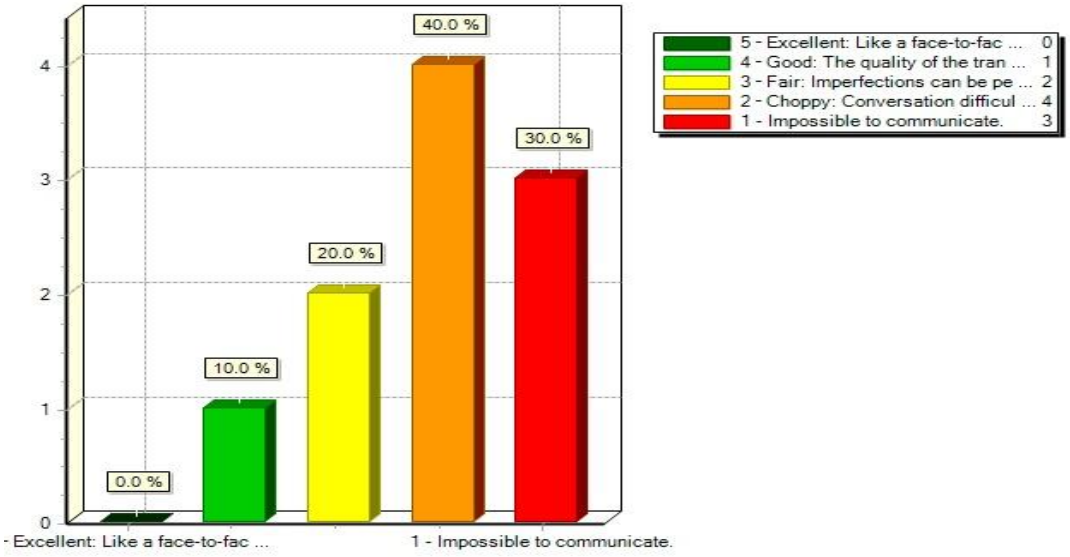

Figure 6.9-2: Responses to the statement 'Please rate the quality of the voice Chat communications'

6.9.3.9. **Video**. Lync video was not reliable, particularly over reduced bandwidth links. At times video could not be established and when established frames would often freeze eliminating any benefit.

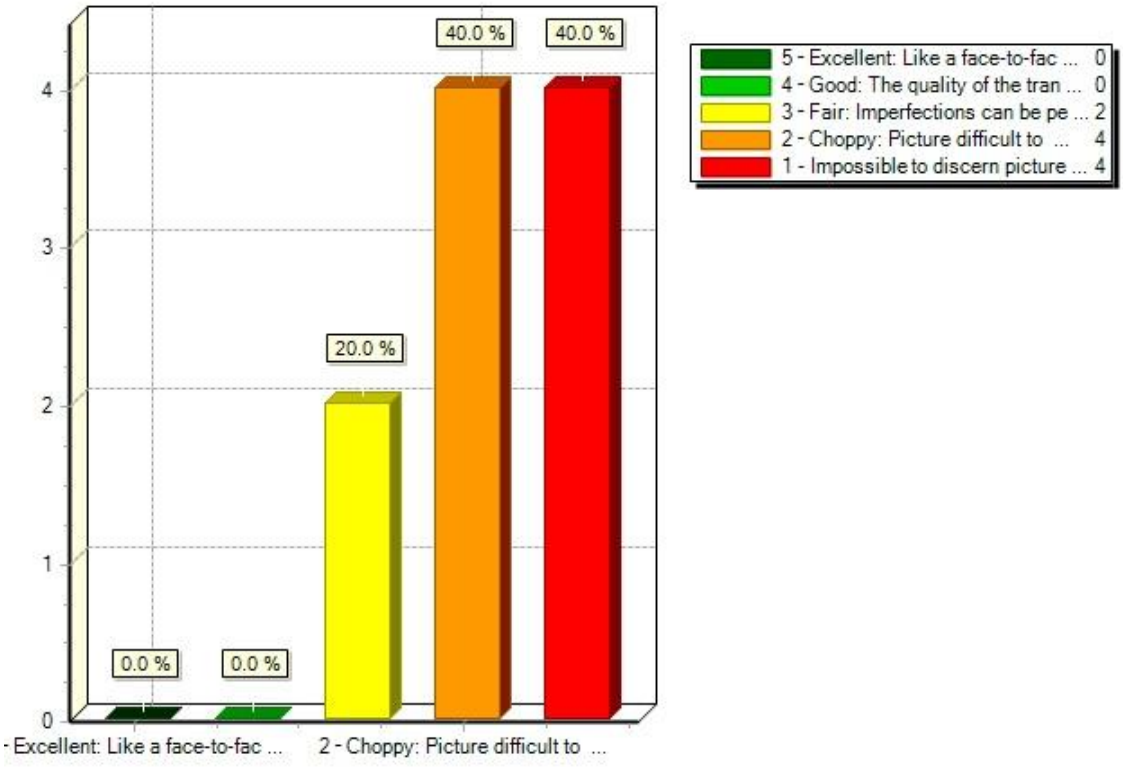

Figure 6.9-3: Responses to the statement 'Please rate the quality of the picture of Video communications'

6.9.3.10. **Lync Group Chat**. Overall the operator reaction to Lync Group Chat was very positive. Operators found the interface much more intuitive and easy to use than the current Sametime Instant Teamsessions (PChat) client. The key benefit of group chat is the ability to view chat history, a feature which proved stable and much more reliable than PChat.

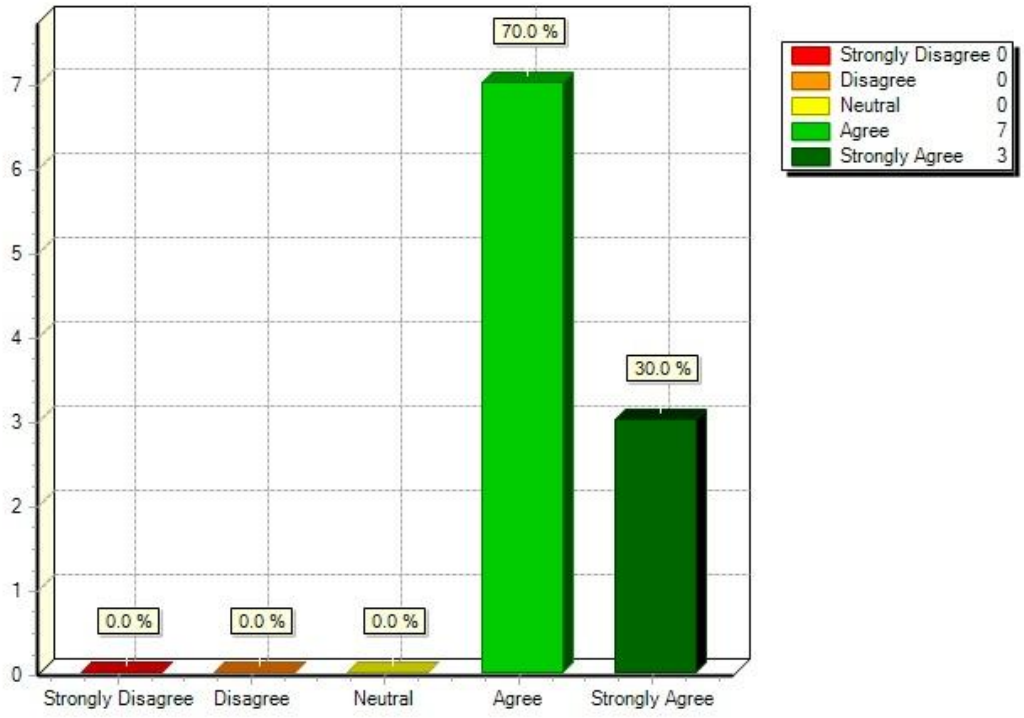

Figure 6.9-4: Responses to the statement 'Lync Group Chat is a suitable text chat tool for use in a Tactical Maritime Networking Environment'

6.9.3.11. Despite this, there were some noticeable flaws. In particular, presence information was unreliable for users outside the users own AD domain. A workaround 'hack' for this was discovered and implemented for some users but remains less than ideal.

6.9.3.12. Some users noted that the procedure for inviting users into a chatroom was somewhat buried within the interface.

6.9.4. **Recommendation**: AUSCANNZUKUS note that feedback indicates the user experience with Microsoft SharePoint and Lync tools is superior to that of the current collaboration suite of CAS and Sametime, however note that voice and video cannot be reliably used in a typical Maritime Tactical Networking environment.

6.10. COAL 05 – SharePoint/Lync – Initiative Summary

6.10.1. **Initiative Results** – SharePoint is used by A-Z nations to provide enterprise-wide collaboration services, but has not traditionally been able to be used in low bandwidth, high latency networks. The objective of TW11 experimentation was to investigate the suitability of MS SharePoint 2010 and MS Lync communication services for use in the maritime tactical networking environment, using the Syntergy replication engine. Operators found SharePoint intuitive and easy to use, and the Syntergy engine provided reliable and timely transfer of documents and information. However, the setup was extremely burdensome and there were some administrative concerns. Significant effort will be required to develop governance and IM procedures.

6.10.2. Lync Chat also proved intuitive and easy to use, and provided stable and reliable communications. The integrated collaboration tools such as whiteboarding and screen sharing were used to advantage during the course of the experimentation. However, some faults were noted include unreliable presence information across domains.

6.10.3. Neither Lync voice nor video worked reliably through the experimentation period. Some audio calls were established, but not with any regularity or consistency. Lync video calls could be established, but the video quality was poor and not synchronized with the audio portion. Lync uses adaptive codec technology to optimise performance based on the bandwidth available for both Audio and Video. Further research needs to be conducted to optimise the use of these codecs in the maritime tactical environment.

6.10.4. Together, SharePoint, Lync, and Lync Group provide an opportunity for significant improvement in user experience compared to existing CMFP tools, with plenty of scope for additional functionality beyond what was tested during TW11. The potential power of these tools is reflected by the investment already made by individual nations in their national networks, and the benefits of a ‘common look and feel’ across both national and coalition networks cannot be overstated.

6.10.5. **Initiative Recommendations** –

6.10.5.1. AUSCANNZUKUS endorse Syntergy as a SharePoint replication engine able to provide reliable and timely transfer of documents and information in a Maritime Tactical Networking environment.

6.10.5.2. AUSCANNZUKUS monitor Infonic Geo-replicator product development with a view to revisiting its suitability in a meshed network environment.

6.10.5.3. AUSCANNZUKUS EWG liaise with Syntergy and Microsoft to rectify the remaining minor technical issues.

6.10.5.4. AUSCANNZUKUS conduct further testing in conjunction with Microsoft to address the performance issues induced by the operation of the codec dynamic configuration functions when used over SNR LOS connections.

6.10.5.5. AUSCANNZUKUS pursue the implementation of Quality of Service on Maritime Tactical Wide Area Network connections.

6.10.5.6. AUSCANNZUKUS liaise with Microsoft to determine ways to reduce the installation effort required and implement Active Directory federation.

6.10.5.7. AUSCANNZUKUS note the significant benefits to user experience that can be gained from shifting to MS SharePoint and Lync toolsets.

6.10.5.8. AUSCANNZUKUS endorse SharePoint and Lync as a suitable and potentially very powerful toolset for future Collaboration-at-Sea capability.

6.10.5.9. AUSCANNZUKUS support development of a business case for SharePoint as the next generation CAS tool.

6.10.5.10. AUSCANNZUKUS support development of governance and IM procedures for Collaboration-at-Sea on SharePoint.