Subnet Relay over HF Bearers

July 19, 2007

Rockwell Collins

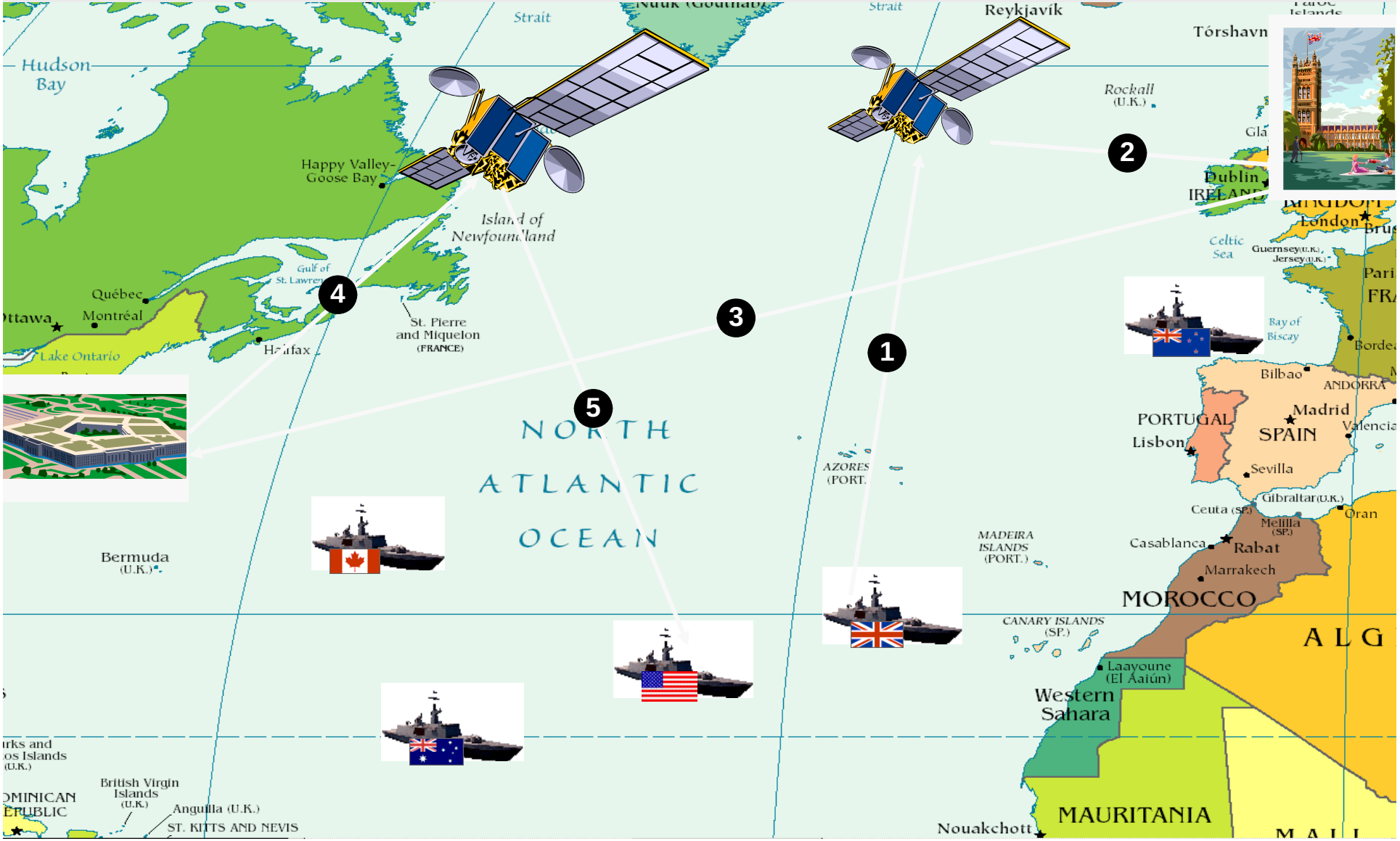
Rockwell Collins

Outline

- Introduction to Subnet Relay
- UHF Results
- HF Trial Results
- Conclusion

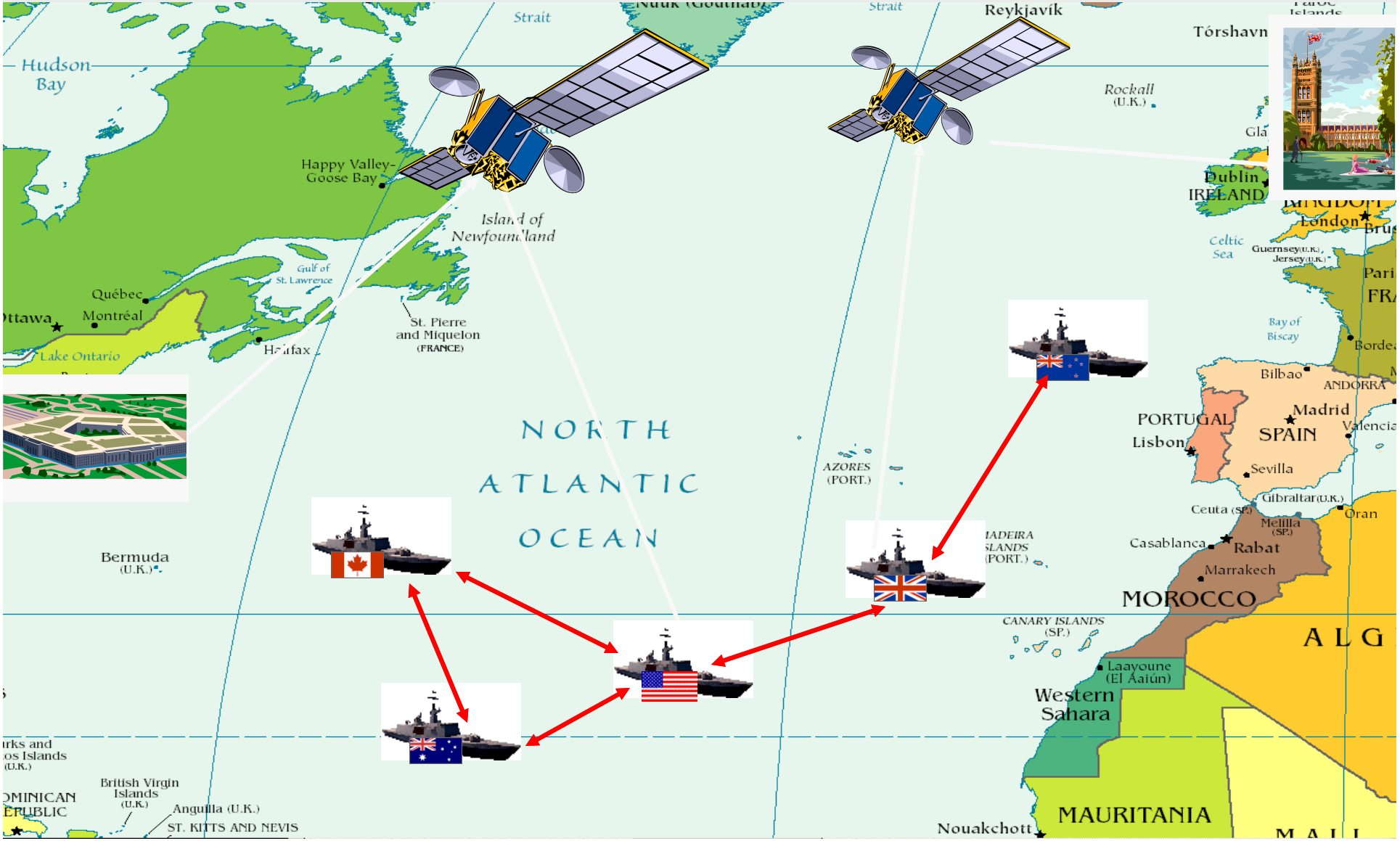
Rockwell Collins

Satellite Networking



Rockwell Collins

SNR/Satellite Networking

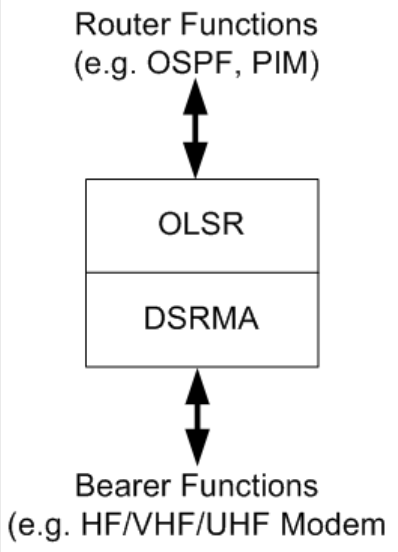


Desired Capabilities

- Complete mobile ad-hoc networking with:
  - Dynamic bandwidth provisioning;
  - Optimal combination of relay (layer 2) and routing (layer 3) to get data between source and destination;
  - Ability to use multiple, standard military LOS/ELOS bearers with existing cryptos, radios, and antennas;
  - Standard use of IP protocols;
  - Highest possible bandwidth available;
  - Completely distributed – No Master Station

Rockwell Collins

SNR Protocol

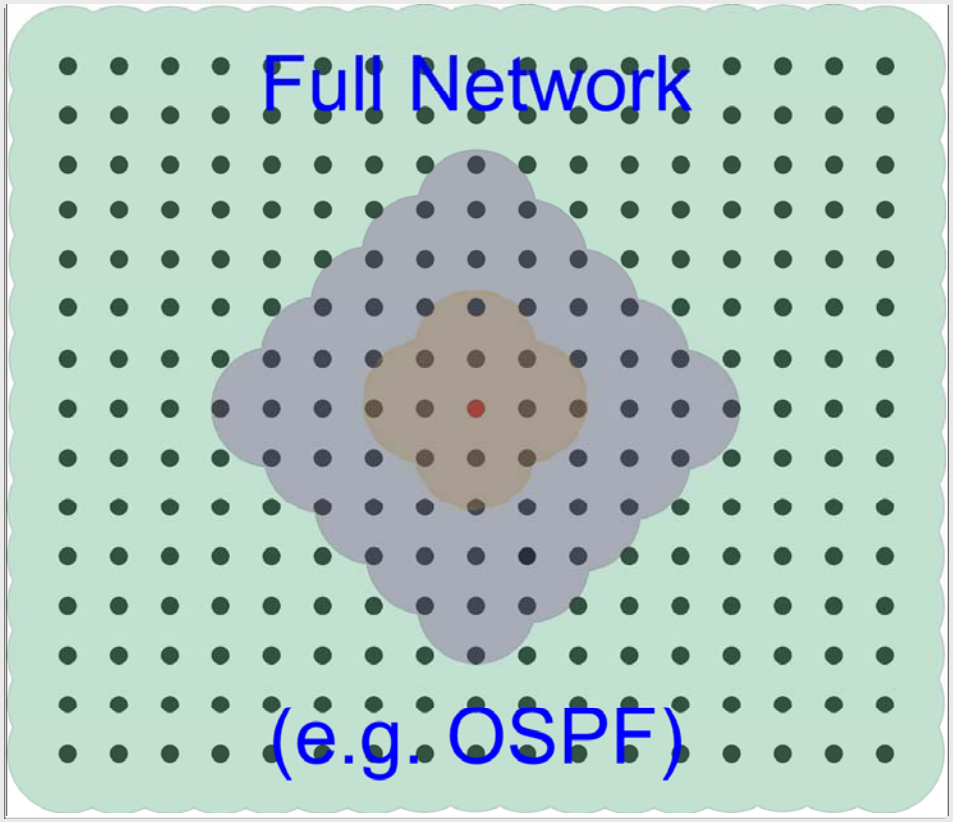


- Mobility and Dynamic Bandwidth Provisioning provided by two main elements working together:
  - Routing Element: OLSR-Like (Optimized Link State Routing); and
  - MAC Element: TDMA based scheme called DSRMA (Distributed Slot Reservation Media Access)

Rockwell Collins

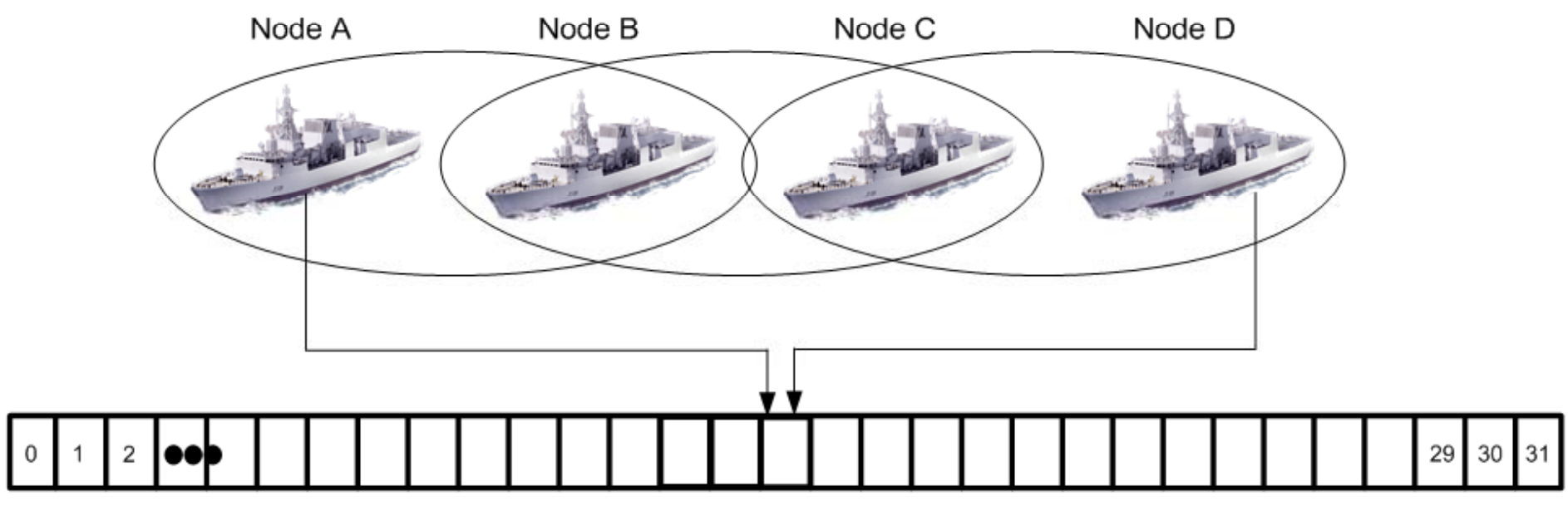
Routing Coverage by Layer

- DSRMA covers routing range of N^2 neighbours,
- OLSR-Like covers range between 1-5 hops.
- Router protocol covers remaining range according to routing protocol.



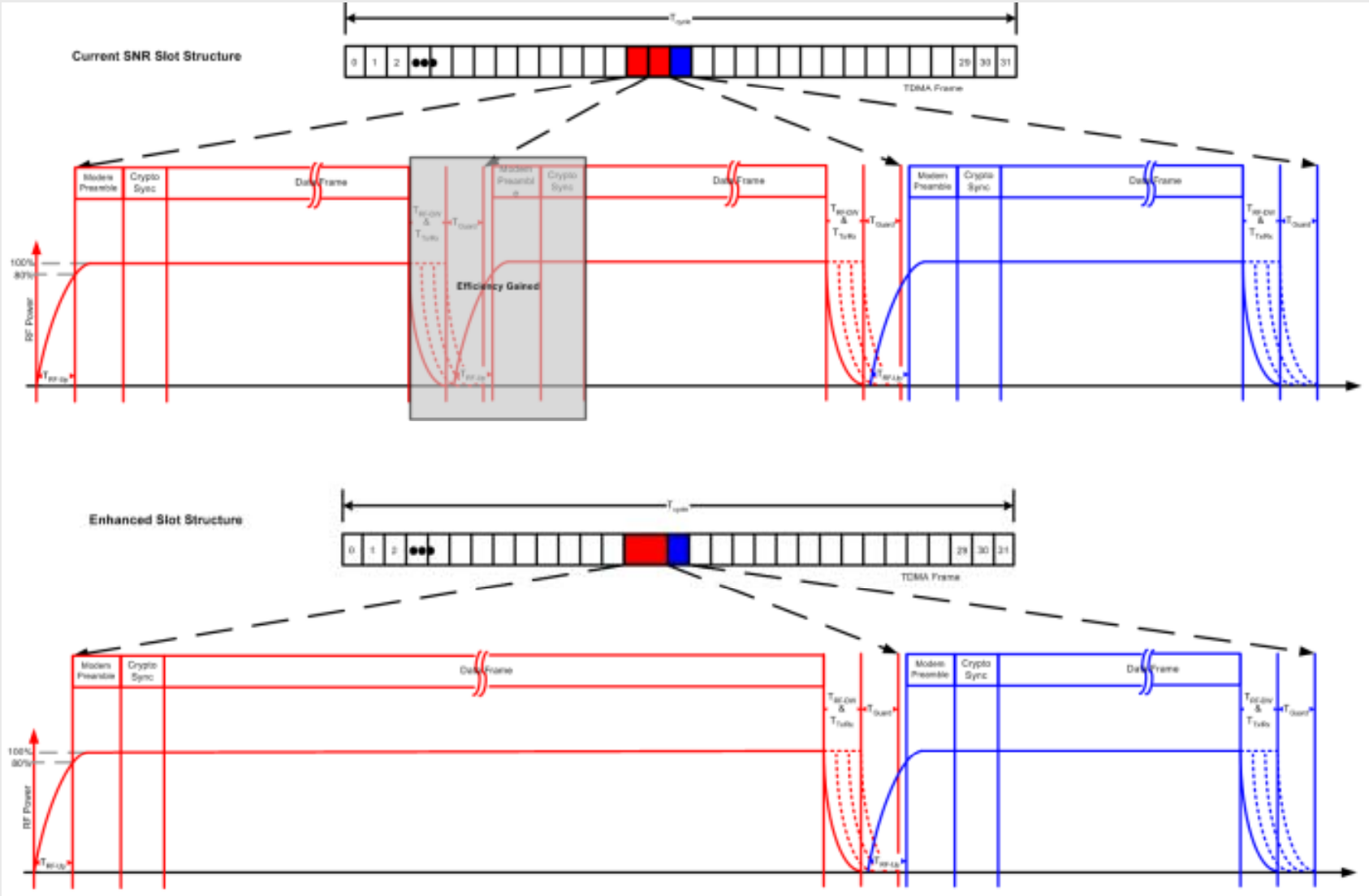
Rockwell Collins

Spatial Slot Re-use

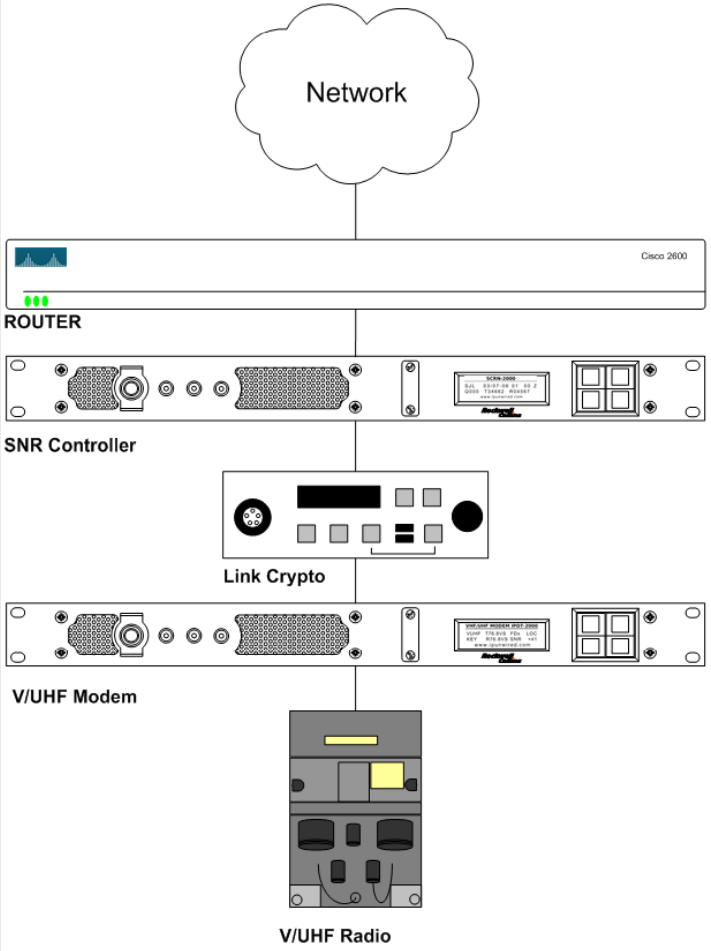


Rockwell Collins

Enhanced Slot Structure – Slot Merging



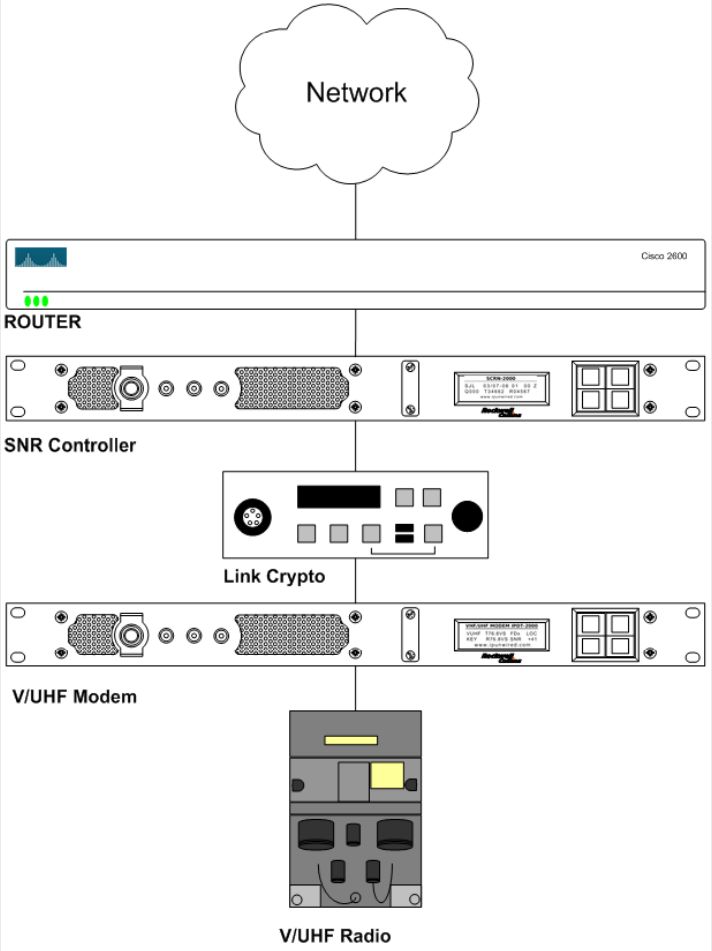
SNR: Equipment Composition



Equipment Includes:

- Standard router (e.g. Cisco);
- SNR Node Controller (NC) with TCP Proxy
- Link Crypto
- HF/VHF/UHF Modem
- HF/VHF/UHF Radio

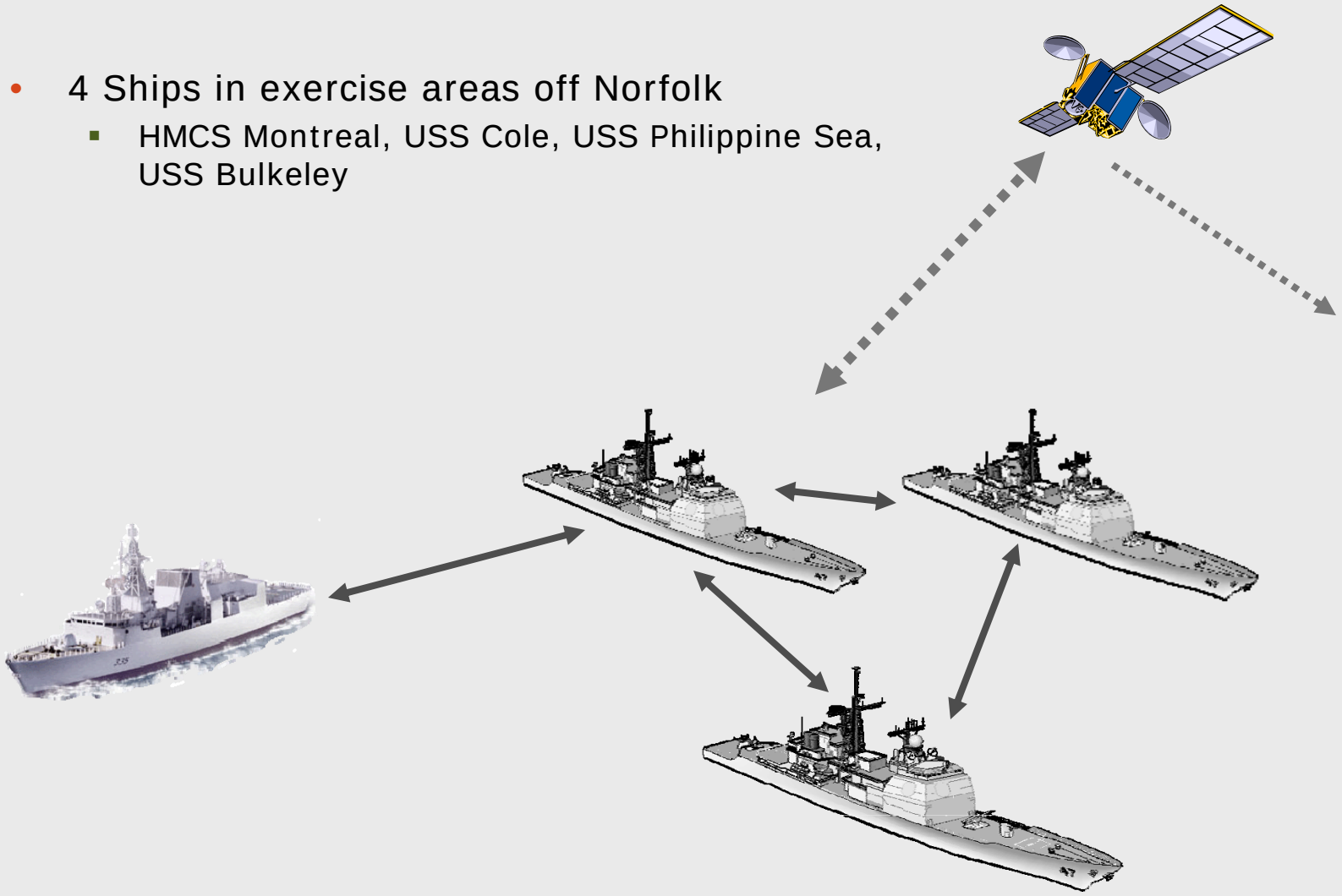
SDCP: SNR Controller



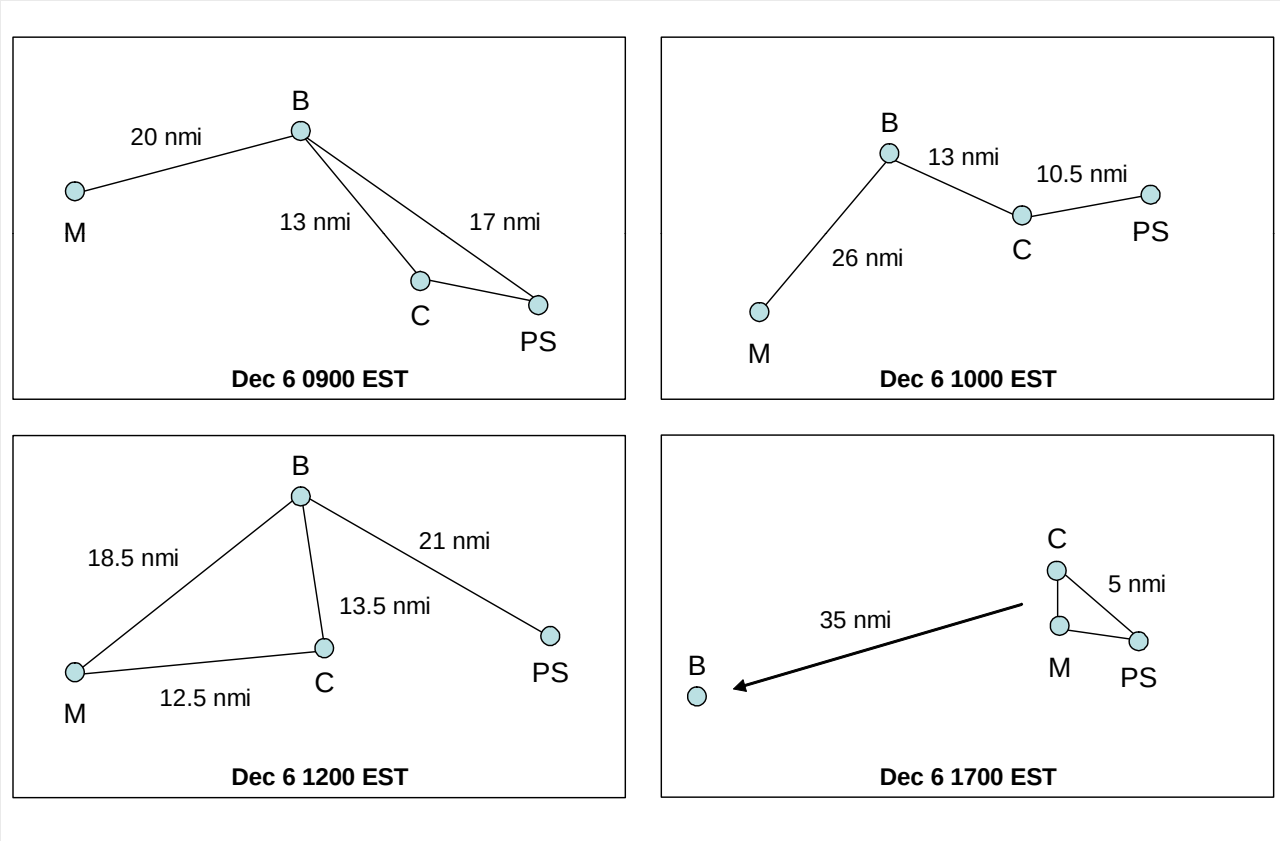
- SubNet Relay Controller Includes:
  - SNR Protocols – ad-hoc network elements;
  - Built-in Data Compression;
  - IP Traffic Manager

Trident Warrior 05 - UHF SNR

- 4 Ships in exercise areas off Norfolk
  - HMCS Montreal, USS Cole, USS Philippine Sea, USS Bulkeley



SNR Topologies



M – Montreal B – Bulkeley

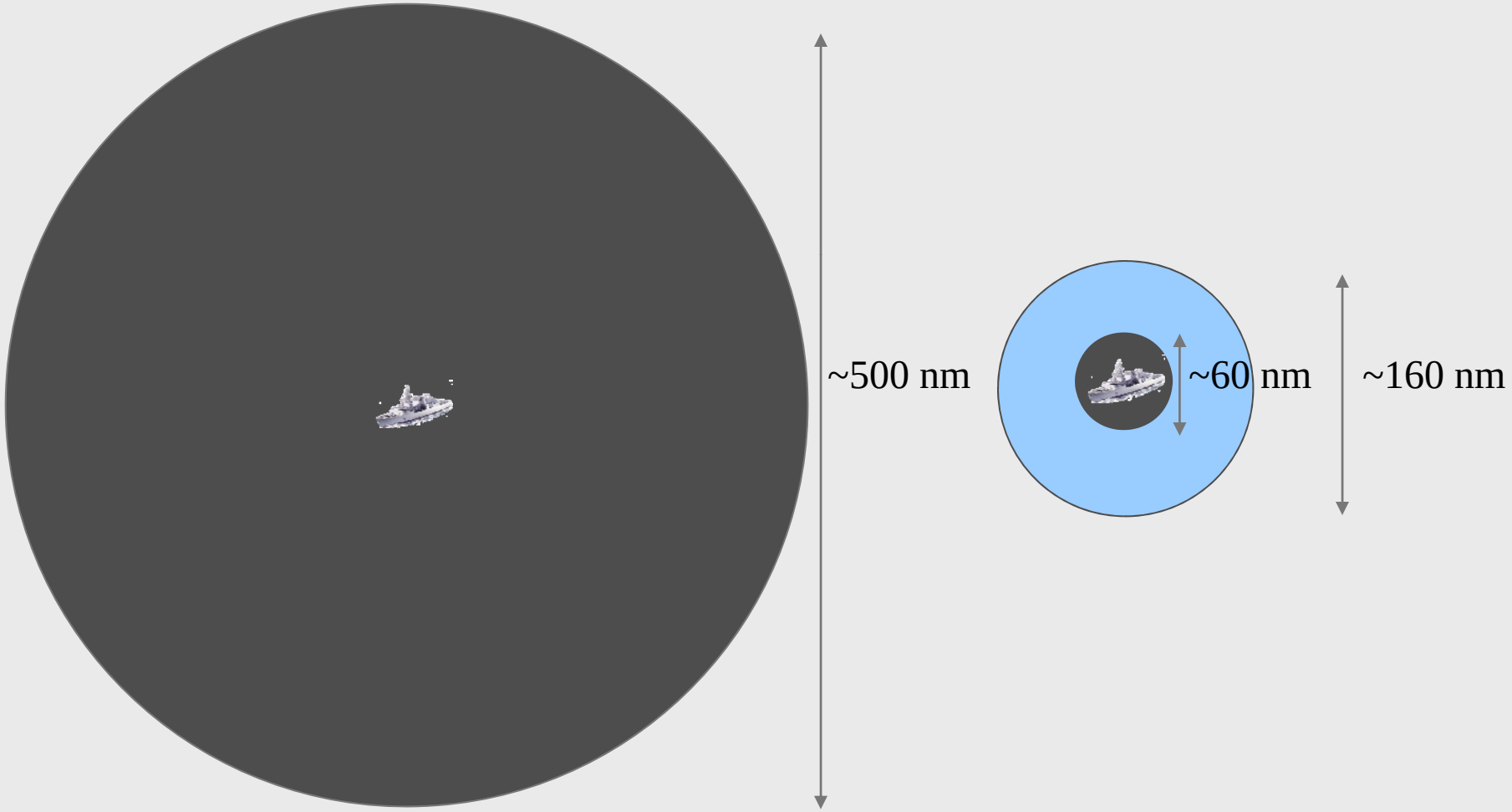
C – Cole PS – Philippine Sea

Rockwell Collins

DRDC-Atlantic Trial Results

- Networked Underwater Warfare
- SNR with UHF bearers
  - 4 platforms with SNR operating at 64 kbps
  - Convair 580, SSK, Quest, MCDV
  - US SSN participating
- Aircraft acted as relay at ranges up to 80 miles
  - Periscope imagery and other data passed over network to Maritime Warfare Centre
- Database on SSK rebuilt by SSHing over SNR network

Why HF?



Rockwell Collins

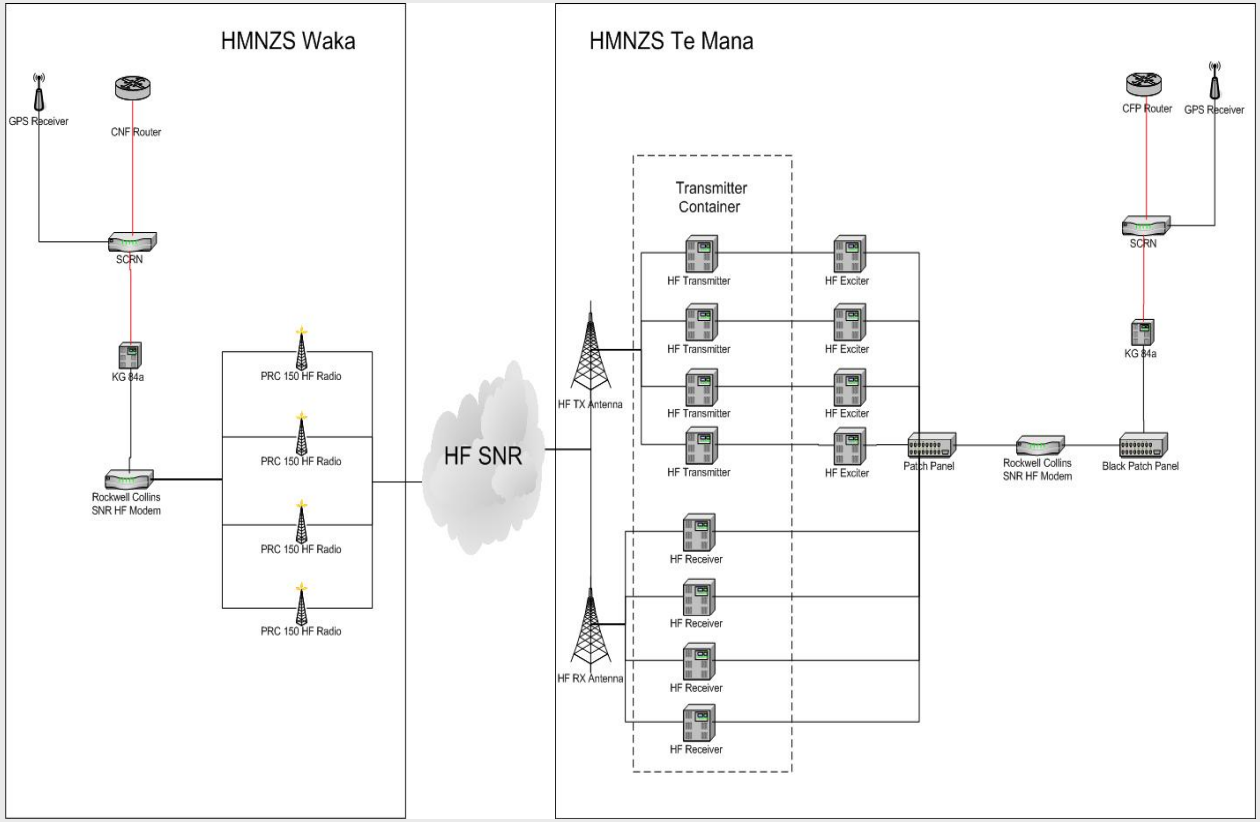
SNR with HF Bearers

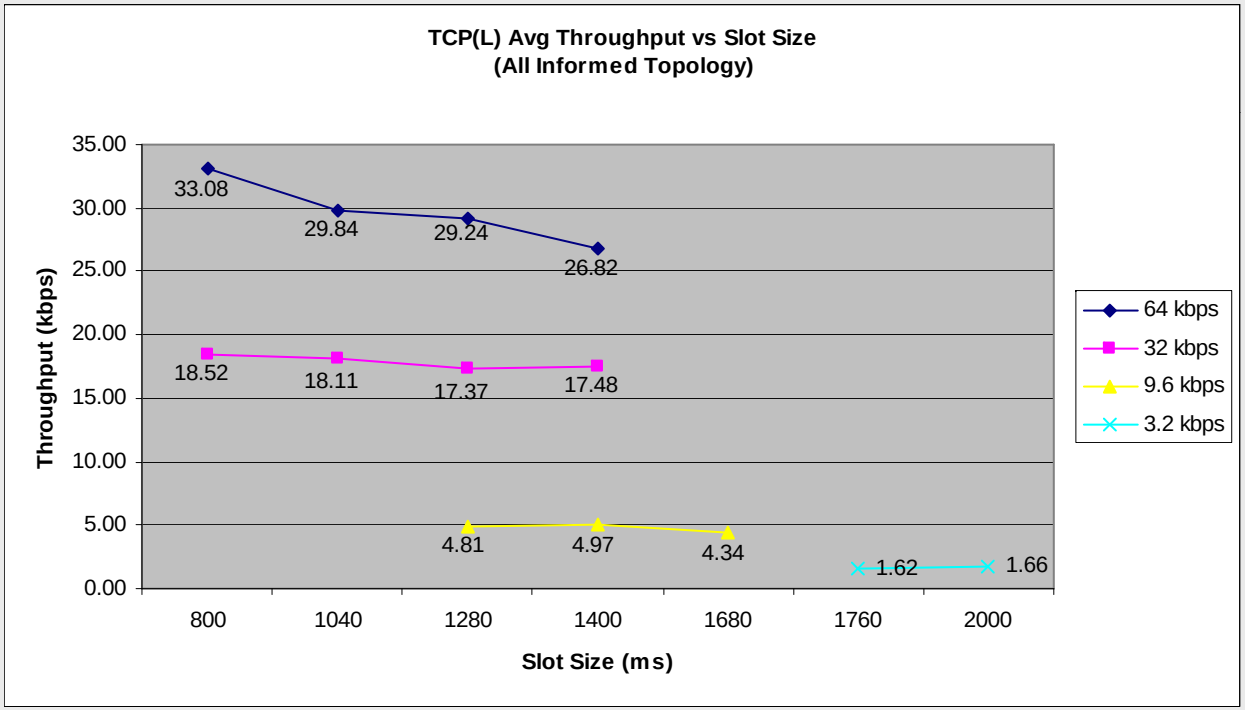
- Slot re-use concerns
- Interference

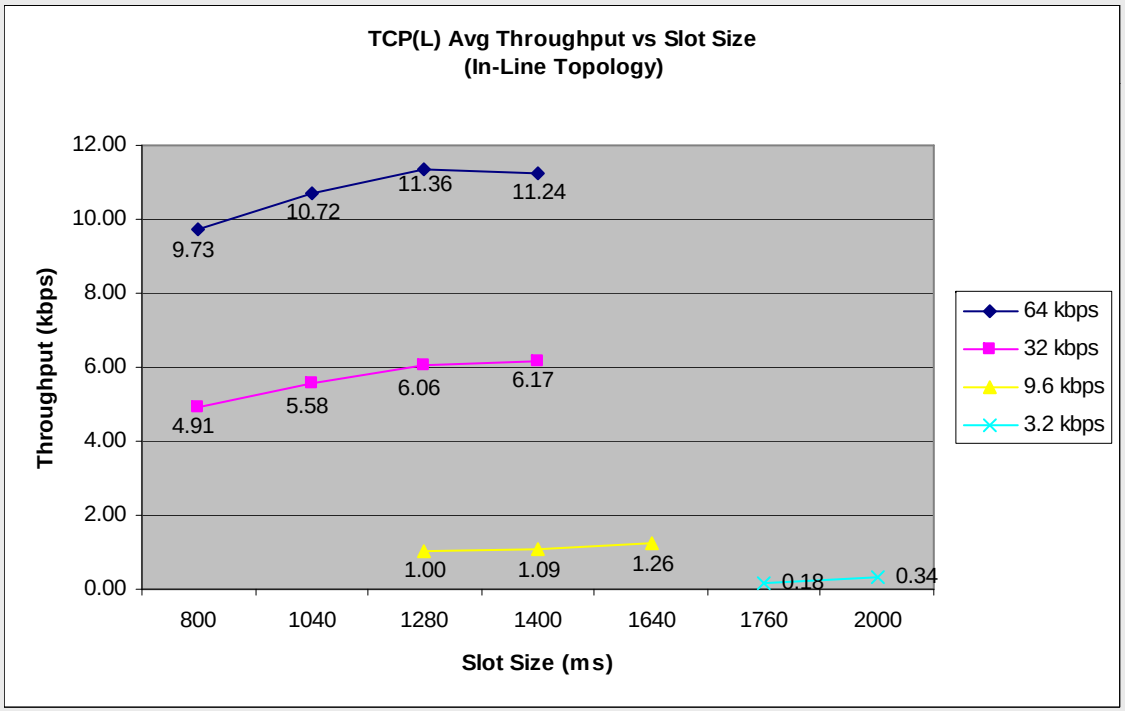
- Overheads and cycle times greater by a factor of 3 or more from UHF
- What is being supported?
  - SNR designed for near-real time services

- Has been used successfully with small networks
- No topological issues if spatial slot re-use is eliminated
  - Poor scaling to larger networks

TW 05 HF Multichannel Trial – New Zealand



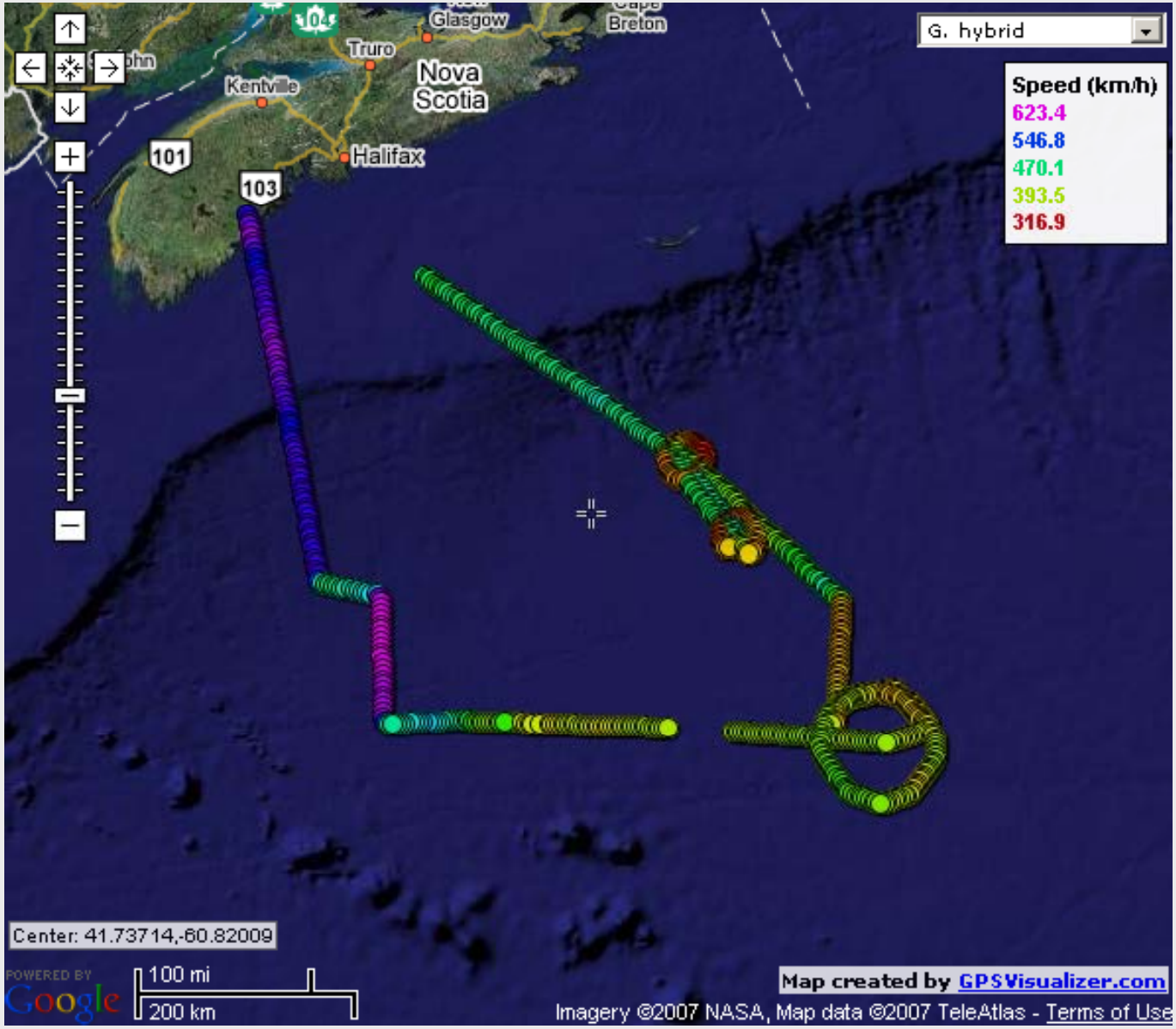




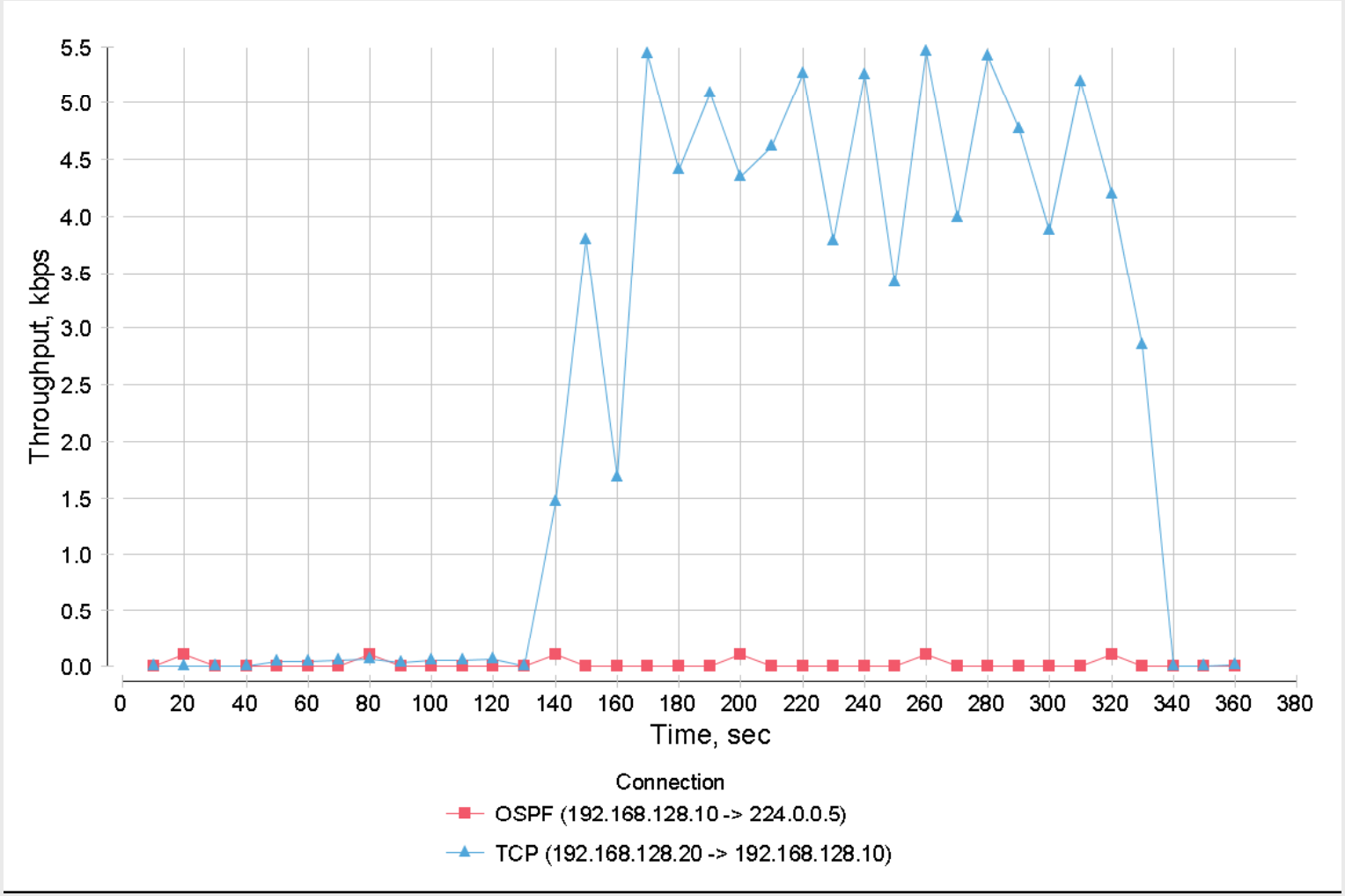
Rockwell Collins

Subnet Relay HF Air Trial

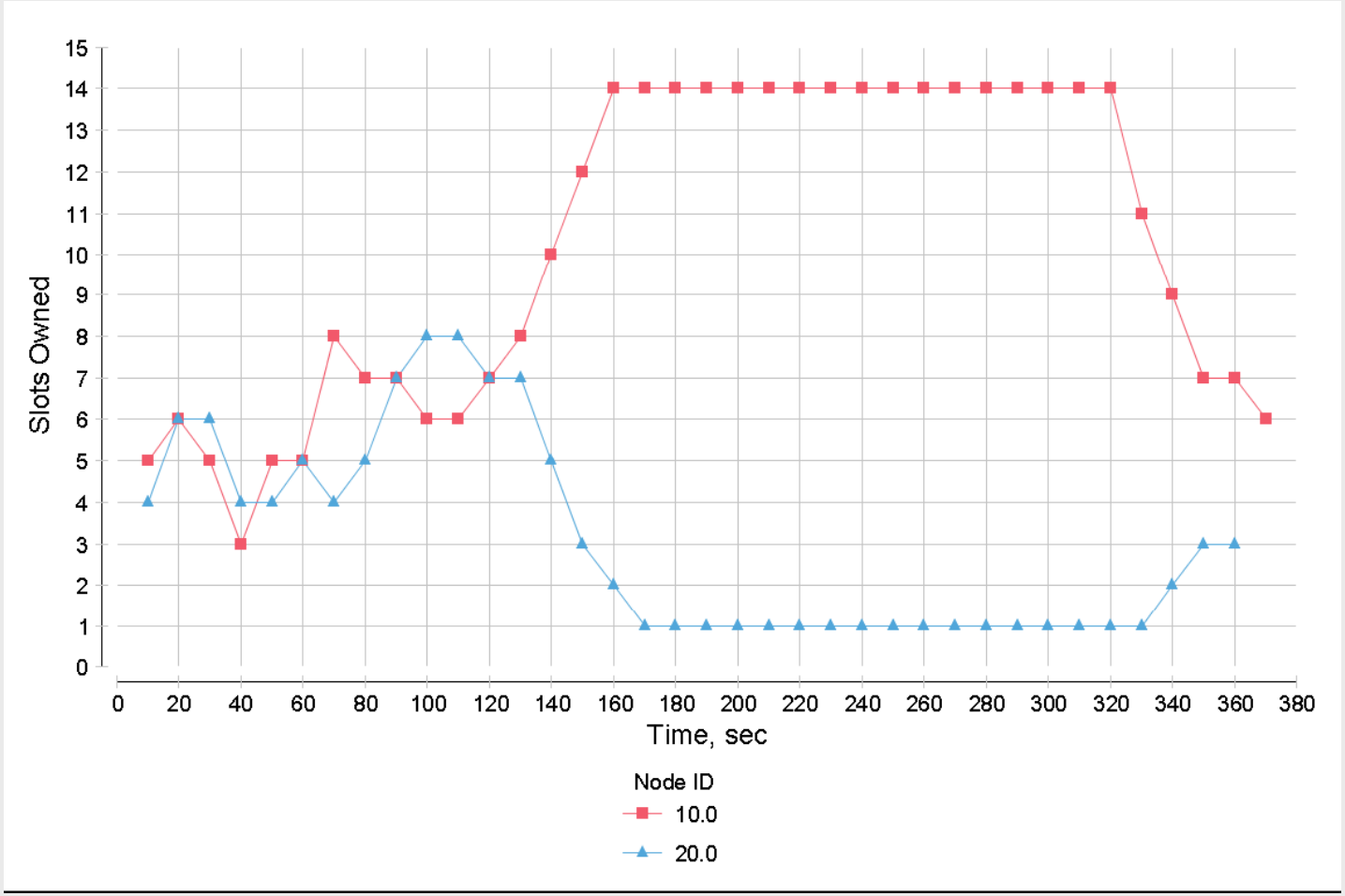
- Conducted using a CP-140 Aurora out of Greenwood, NS
- Temporary Ground Station established at Osbourne Head, NS
- Surface wave range consistent with Barrick Model predictions
  - 200-300 nm
- Altitude varied from 300 – 10000 ft over trial period
  - No discernable impact on signal quality



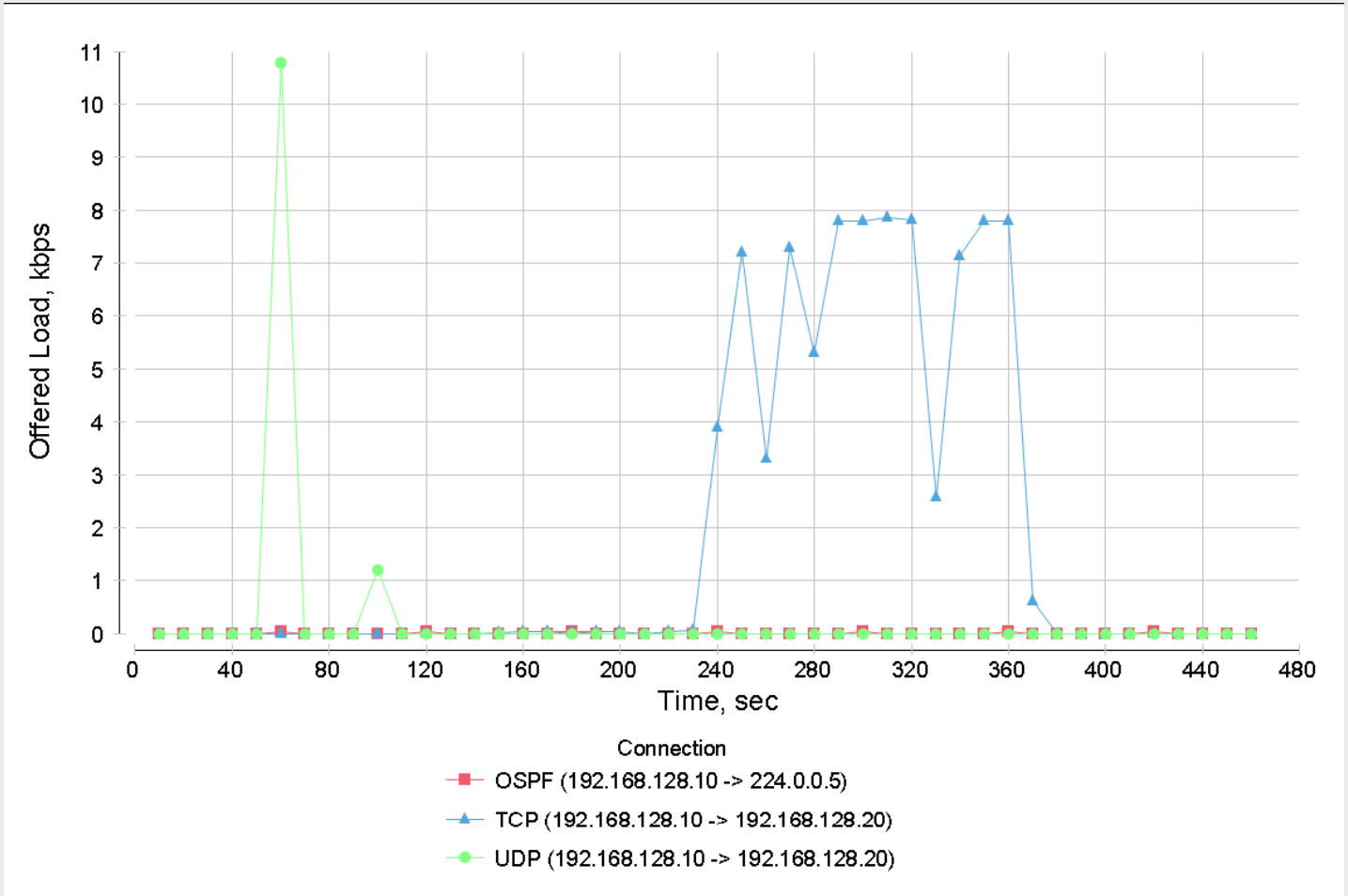
100 kB file transfer from MPA to Groundstation (6.4/3.2)



Slot alloc for previous transfer



100 kB ftp file transfer from MPA to groundstation (9.6/8.0)



Rockwell Collins

Conclusion

- Subnet Relay has been successfully demonstrated with HF bearers
- Surface wave propagation of HF provides ranges which are much greater than those which can be achieved with UHF bearers – even when airborne relays are included
- Lower data rates and higher overheads limits the types of services which can be supported
  - Chat
  - File transfers
  - E-mail
  - Imagery (?)