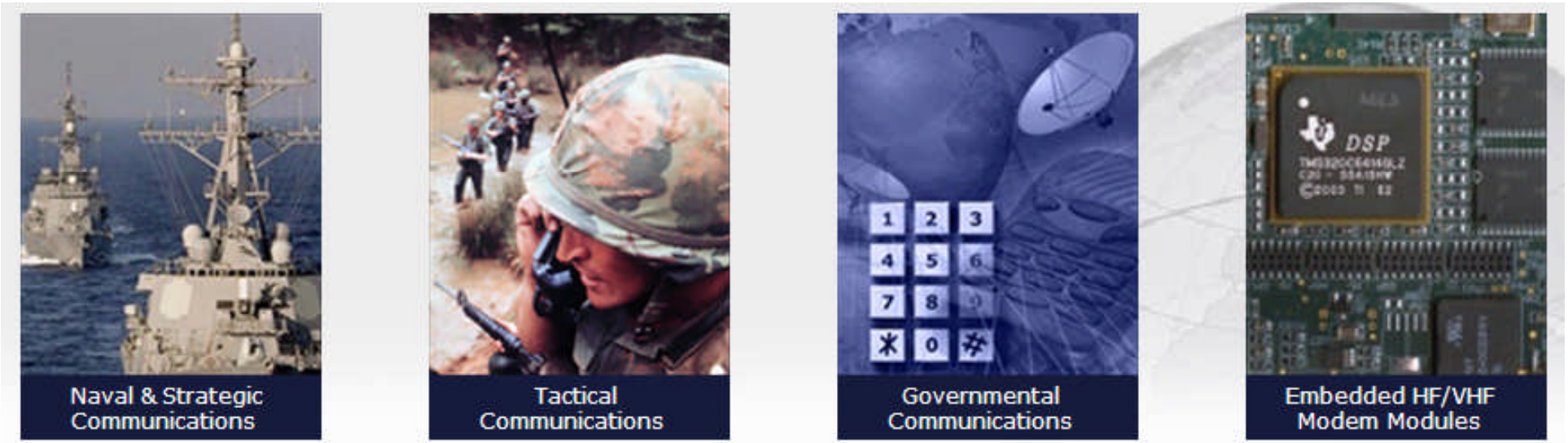
Test Results for 2G/3G Communications over Tactical NVIS Links



Dr Danie van Wyk (CTO)

HFIA - August 2010

RapidM

accelerate. persist. perfect.

Contents:

- **Background**
  - Motivation
  - 3G ARCS Products
  - 2G/3G Standards & Comparisons
- **Over-the-Air Testing**
  - Test Cases and Criteria
  - Equipment and Test Sites
- **Performance Results**
  - Link Setup
  - Data Modem
- **Summary and Conclusions**

Motivation for Study

Tactical HF Radio Systems

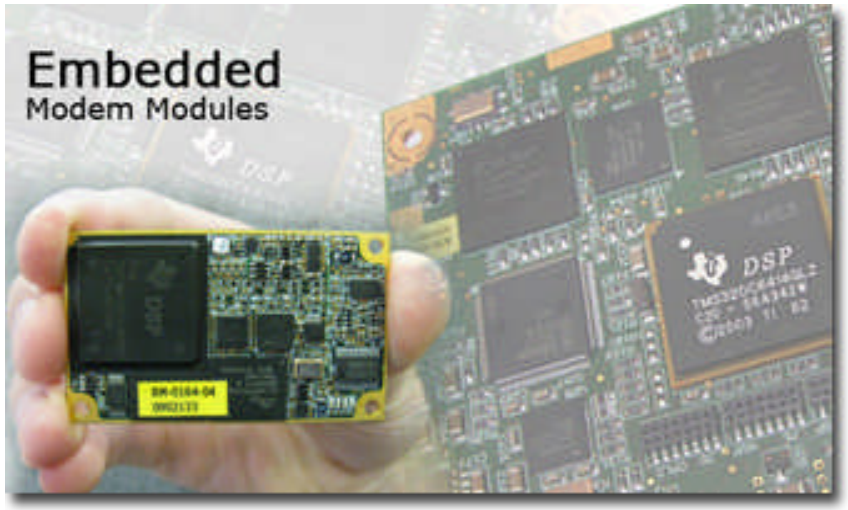
- 3G HF based on S4538
  - Developed for TACTICAL HF Communications
  - Short messaging (< 1kByte)
- 2G HF based on S5066 + MS110B
  - Widespread use, specifically for NAVAL Communications
  - Mixed messaging (> 5kByte)

Previous Work

- QinetiQ (U.K.) "On-air test and Evaluation of STANAG 4538", 2003
  - Tri-country study: UK, Norway & Netherlands
  - 3 day testing of 2G ALE and 3G FLSU
- Harris (U.S.A.) "STANAG 4538 Implementation and Field Testing Lessons Learned", 2003
  - Rochester-Stockbridge Link
  - 3 day testing, 3G FLSU Link setup time

RapidM

RapidM 3G ARCS Products

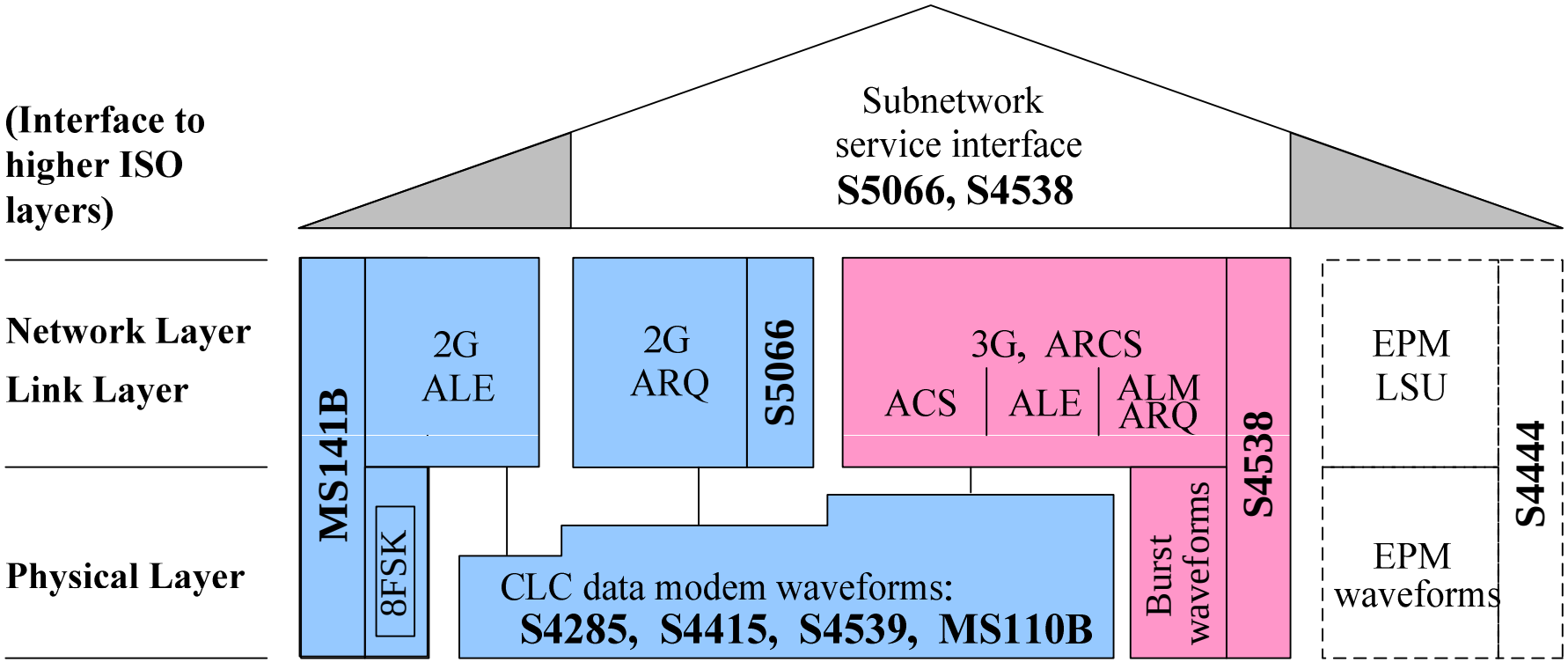


TC4 Module

RM8 SDM

RT1-M

HF House: 2G/3G Standards



Relationship of 2G & 3G Standards to NATO HF HOUSE

- 2G Standards
  - 2G ALE: MS141B
  - 2G ARQ: S5066
  - CLC Data Modems: MS110B
- 3G ARCS
  - S4538

Link Setup Comparison

Attribute	2G ALE	3G ALE
Waveform	8-FSK	8-PSK Burst Waveform
Mode	Asynchronous	Synchronous (also asynchronous)
Linking Protection	YES, but not widely used	YES, widely used
Channel Evaluation	LQA and LBT	LQA and LBT
Link Robustness	0 dB (3 kHz BW)	-8 dB (3 kHz BW)
Link Time	15 to 20 seconds	4 to 8 seconds

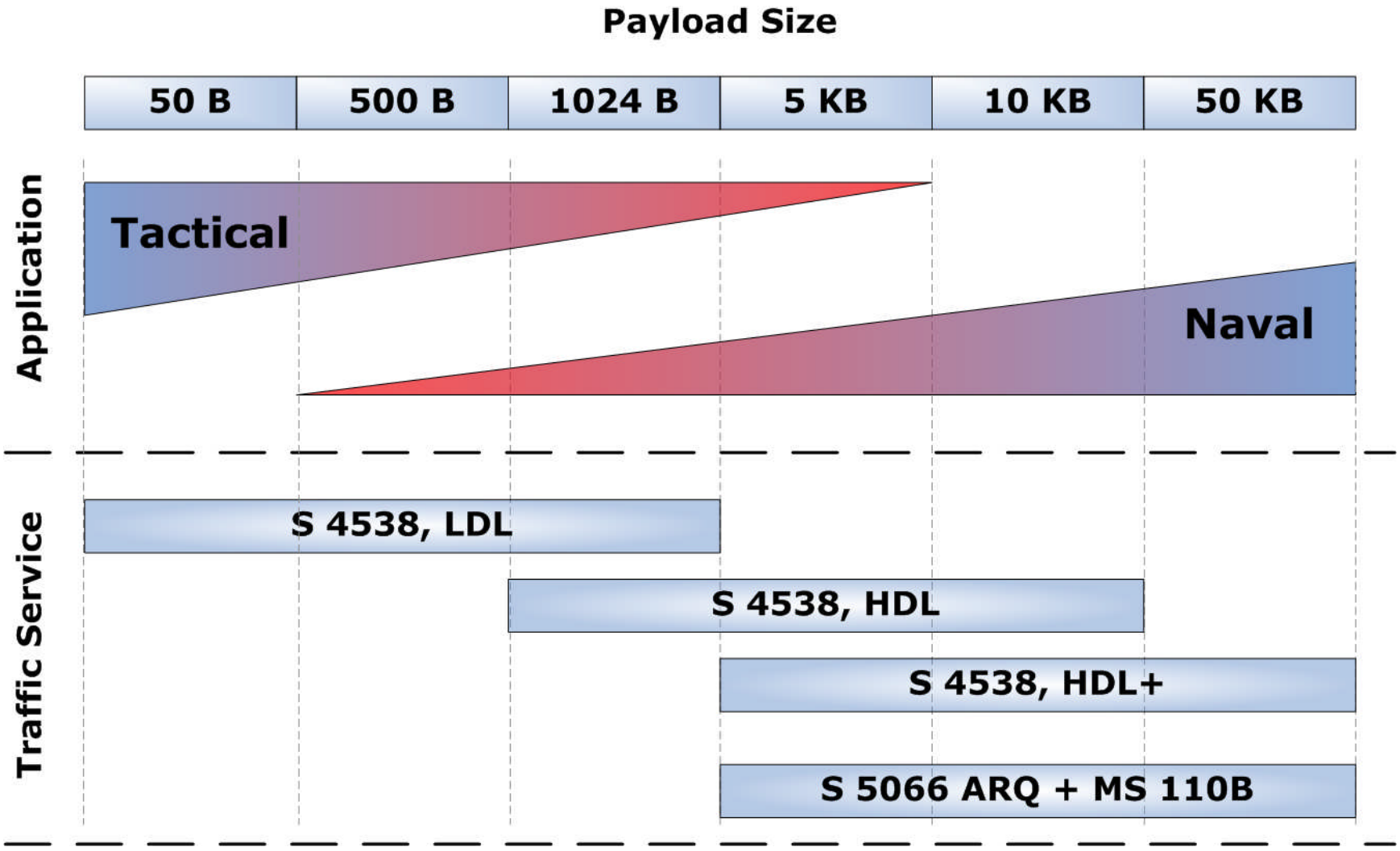
RapidM

Data Modem Comparison

Attribute	S5066 (2G) Broadcast	S5066 (2G) ARQ	S4538 (3G) XDL
Data rate adaptation algorithm	None	Data rate change	Incremental redundancy
Fixed / varying payload size	Fixed	Fixed	Varying (function of traffic service)
Integrated solution	No	No	Yes
Message delivery time	High redundancy	High latency	Low to high latency
Delivery Confirmation	No	Yes	Yes
Message size	< 100 Bytes	> 10 k Bytes	1 to over 50 k Bytes

RapidM

Data Messaging: Tactical vs Naval



RapidM

OVER-THE-AIR TESTING

Naval & Strategic Communications

Tactical Communications

Governmental Communications

Embedded HF/VHF Modem Modules

Test Objectives

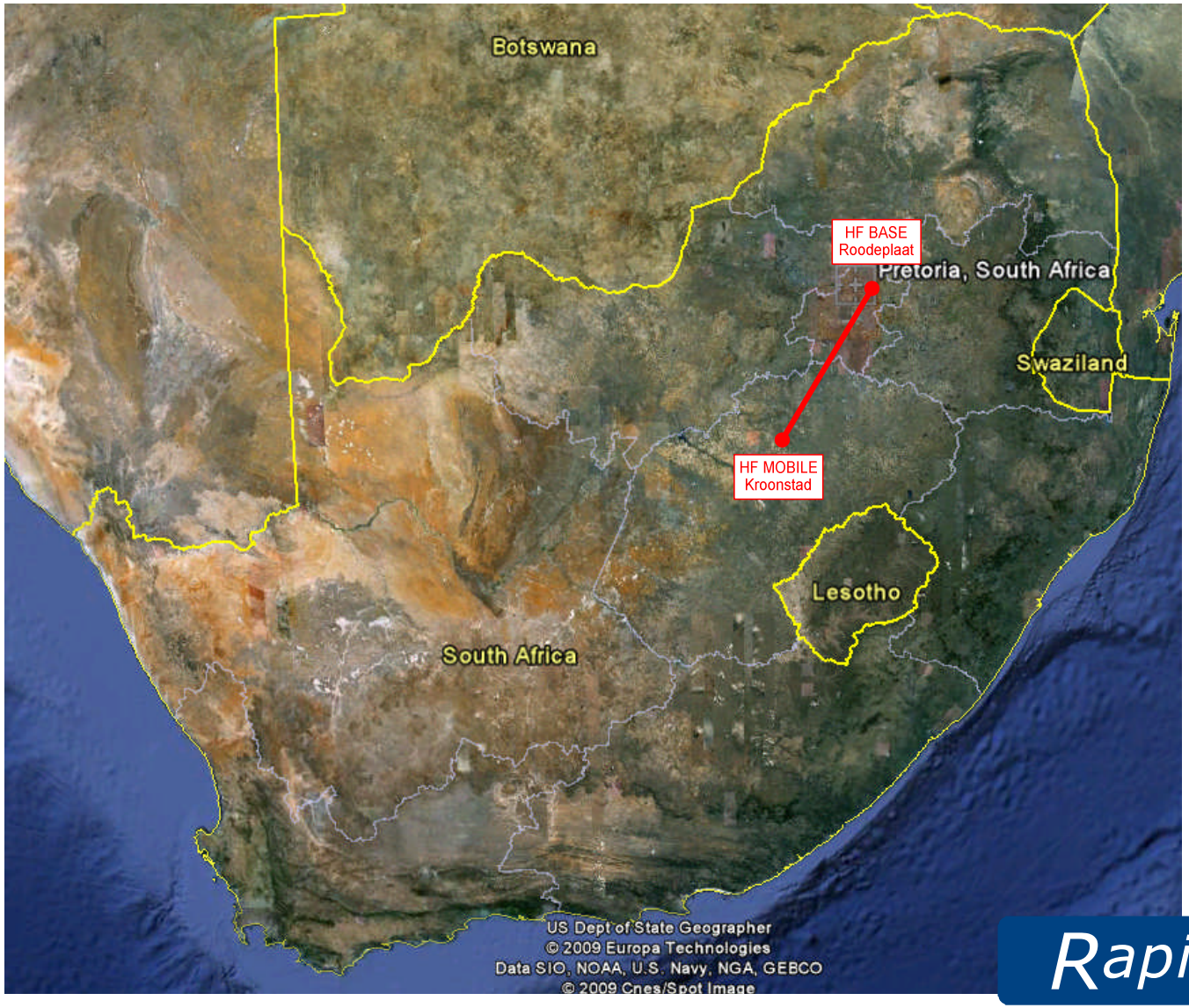
2G/3G ALE and Data Modem Performance Comparison

- Same equipment
  - COTS/MOTS HF Radios
  - Tactical Equipment (limited link budget):
    - Power (30 - 50 Watt)
    - Broadband antenna - low gain
    - Limited frequency pool
- Similar propagation and weather conditions
  - Time-of-Day & Ambient Noise and interference
  - Location – Latitude, season, sunspot
- Day/night testing
- Minimum of <u>6 weeks</u> testing

RapidM

Test Sites: HF Base & HF Mobile

- 220 km NE to SW mid-latitude NVIS link.



RapidM

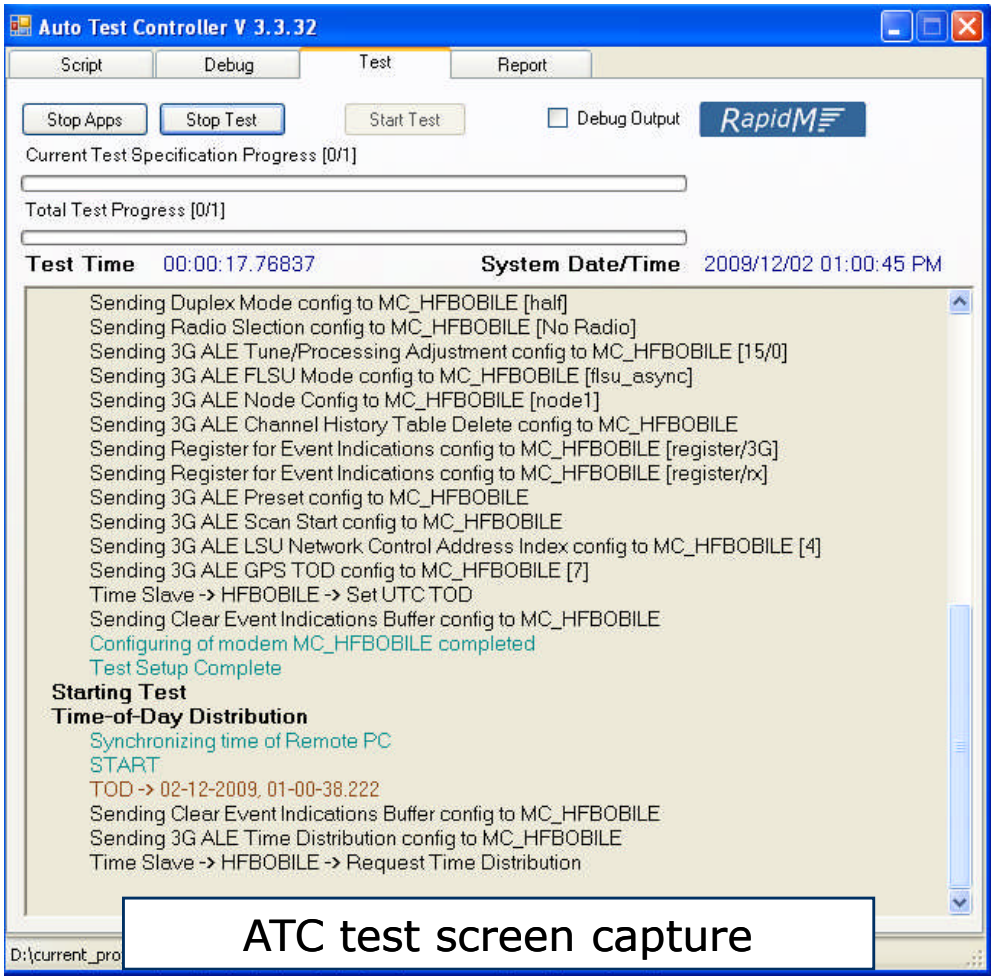
Test Equipment: COTS Station

- **RM8 SDM**
- ICOM IC-78 (3kHz) & PSU (50 Watt)
- Military Broadband Antenna (3-30 MHz)
- Test PC running ATC
- Wireless Internet for control of test station

RapidM

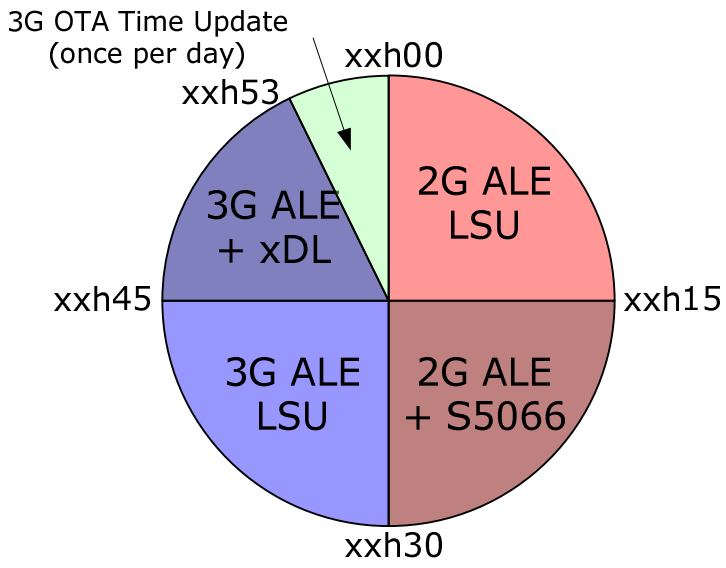
Automated Test Controller: ATC

- Configuration & Control of OTA testing
- Distributed installations
- Auto restart after power-down (cycle or failure)



ATC test screen capture

Test profile: Hourly



RapidM

OVER-THE-AIR TEST RESULTS

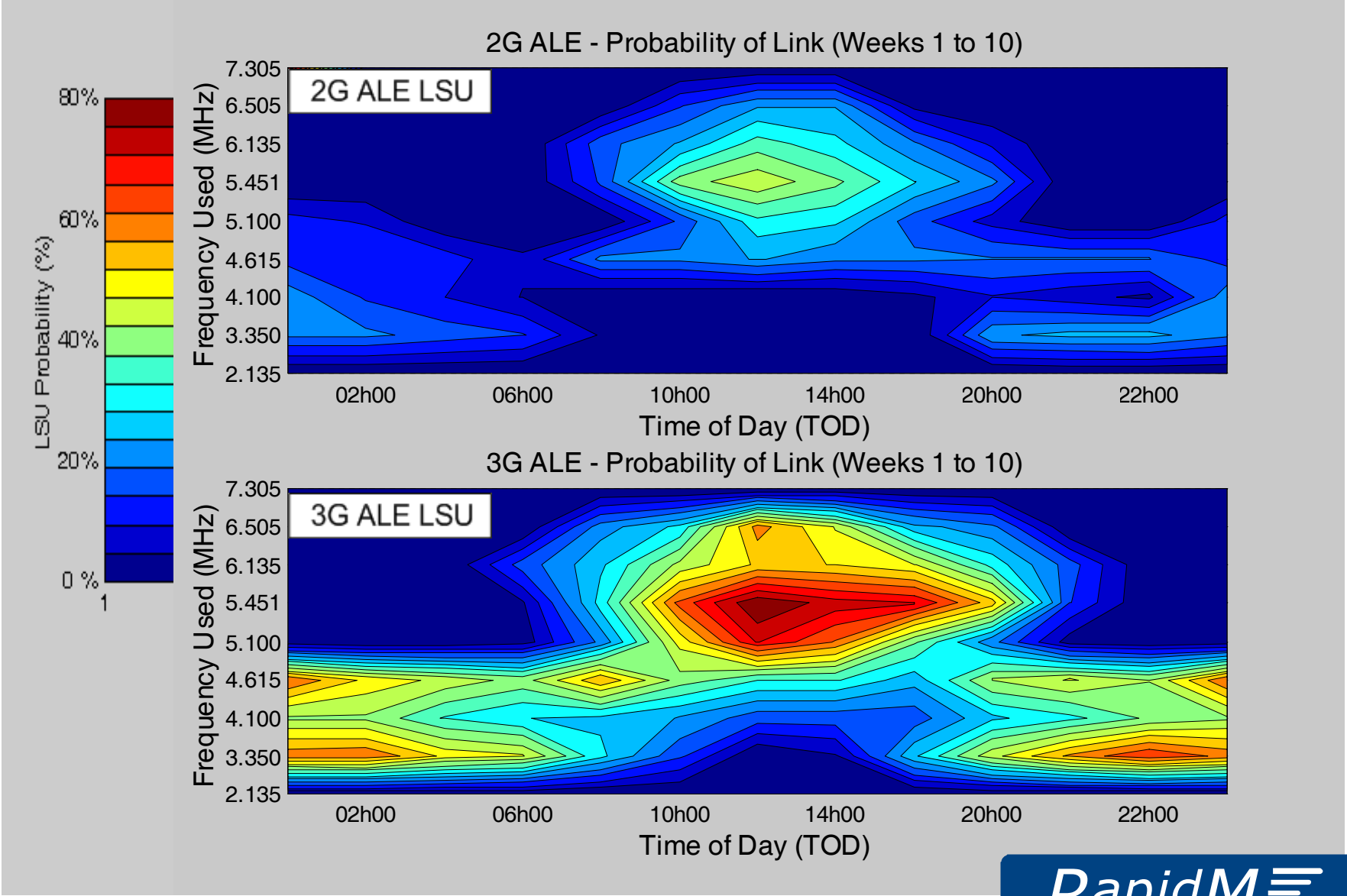
Naval & Strategic Communications

Tactical Communications

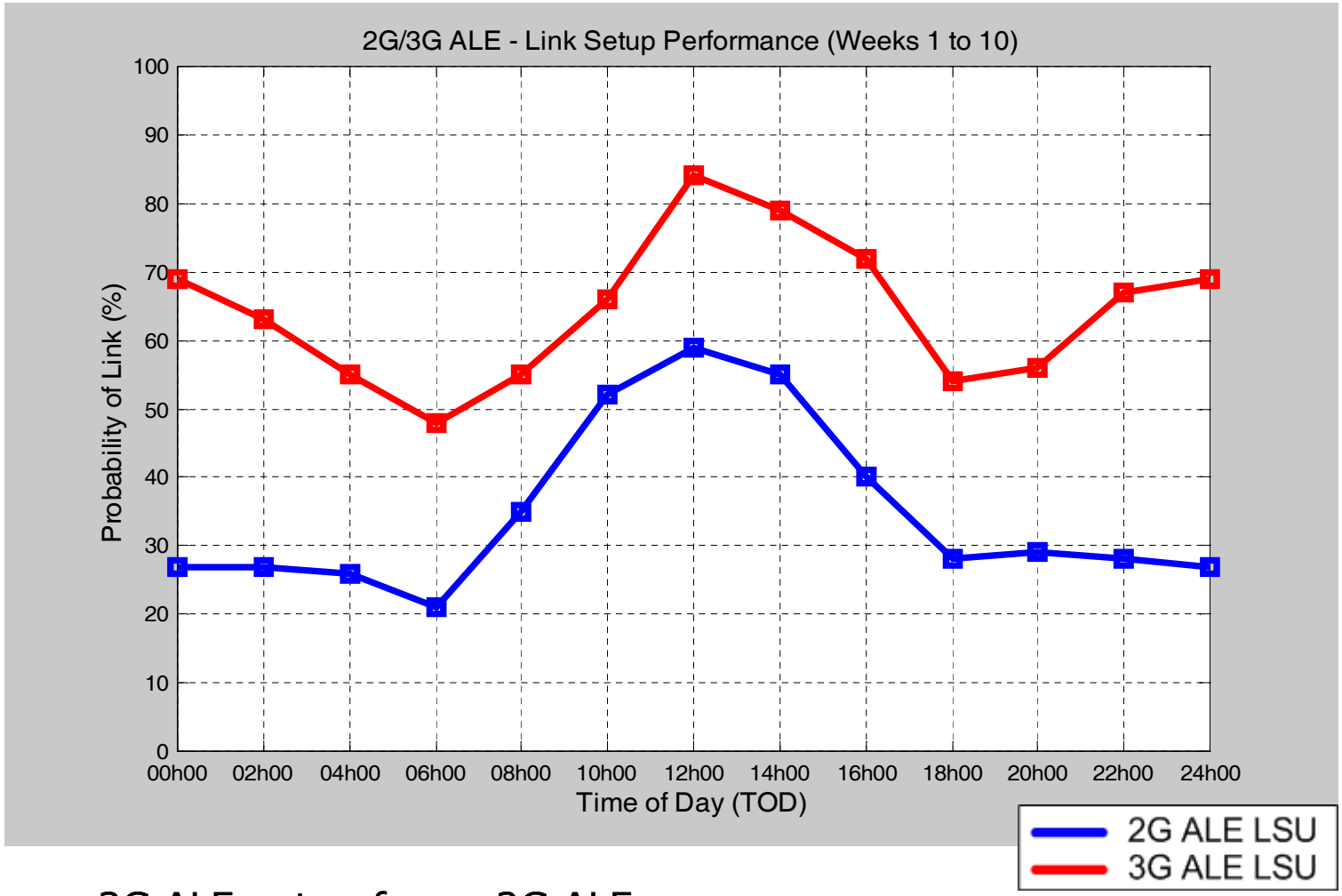
Governmental Communications

Embedded HF/VHF Modem Modules

Link Setup "Hot Spots"



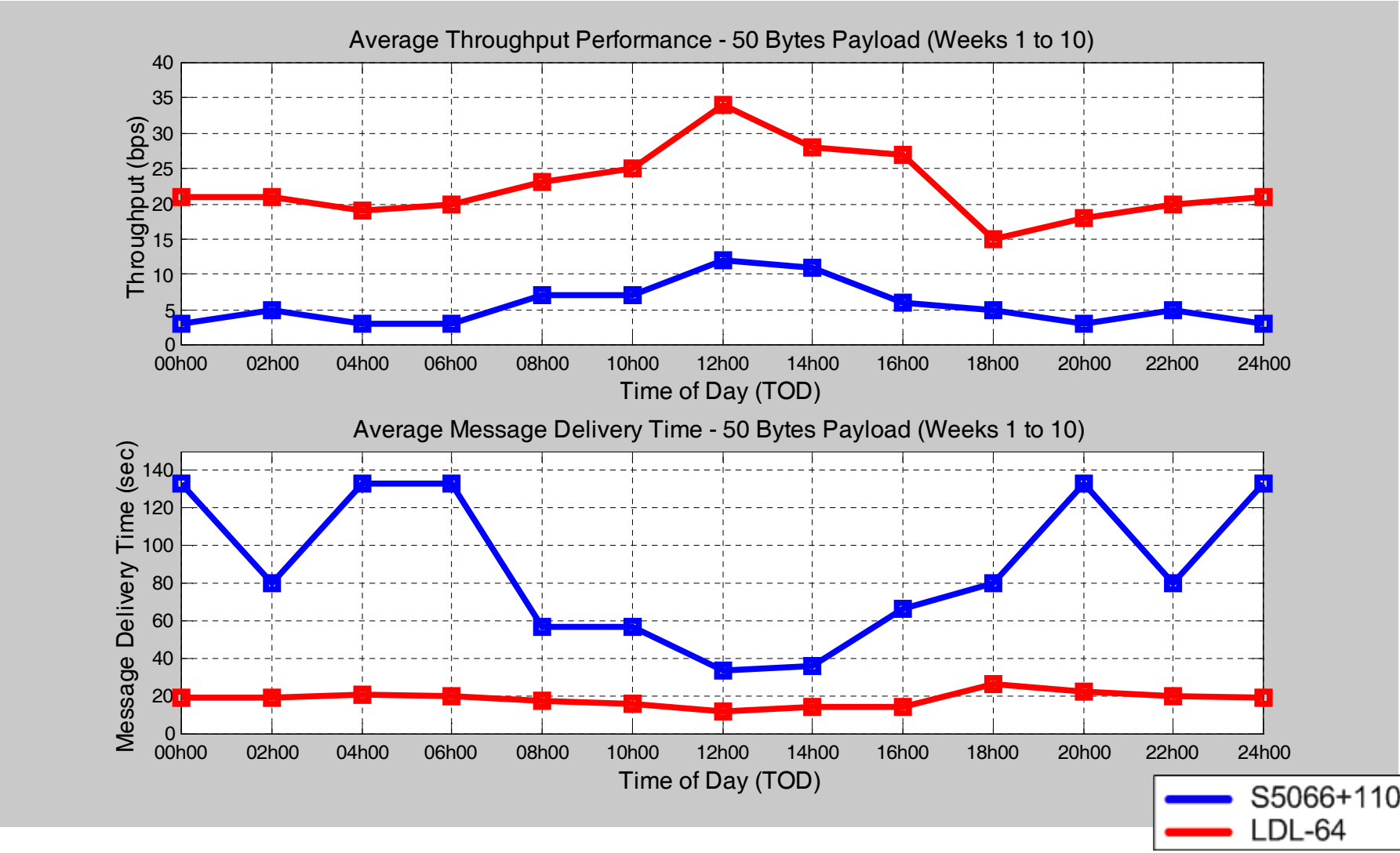
Link Setup Performance



- 3G ALE outperforms 2G ALE
  - 2G ALE Probability of Link is 21% to 58%
  - 3G ALE Probability of Link is 48% to 85%

    * Single linking attempt, No LBT

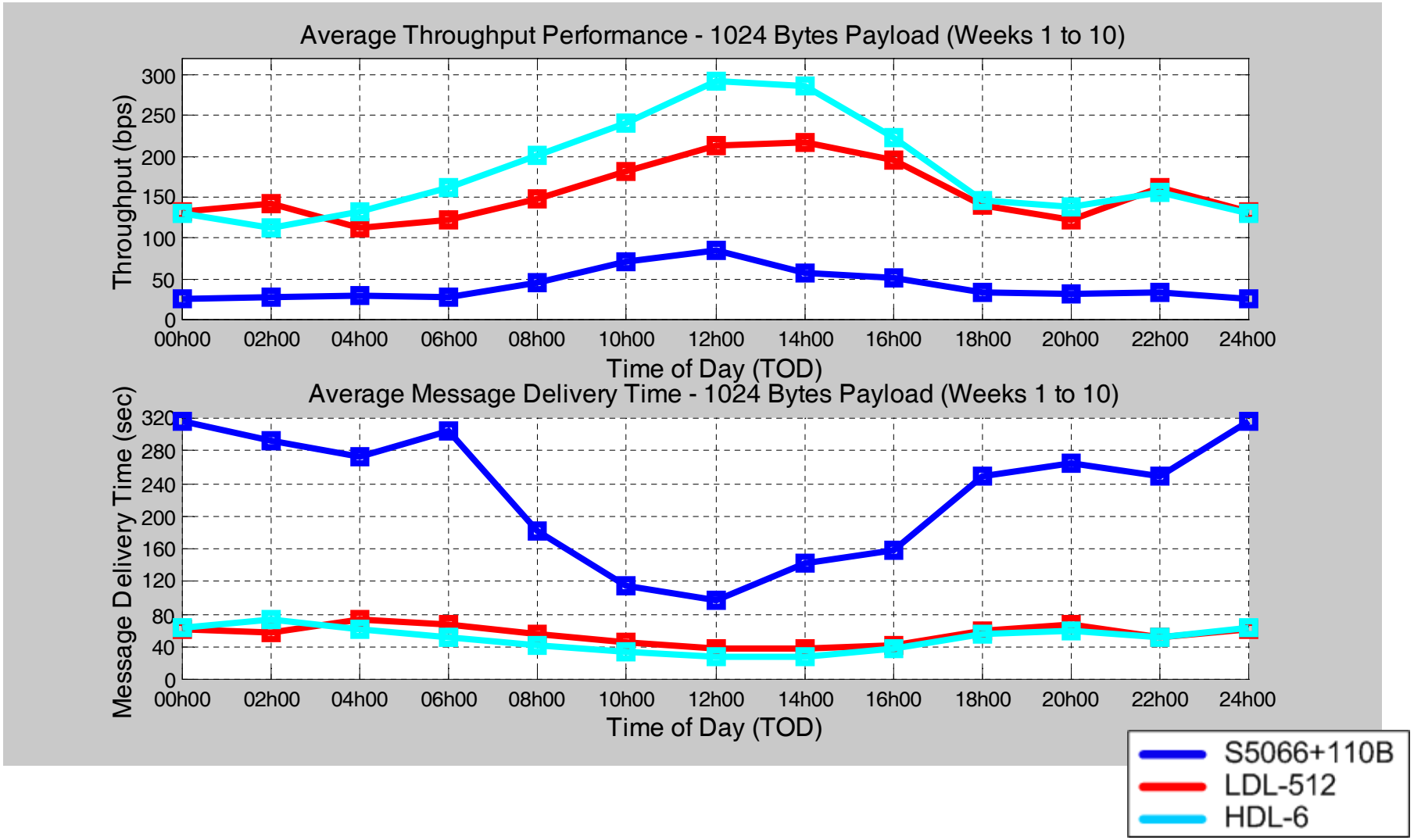
Data Performance: 50 Bytes



- 2G: S 5066+MS110B (Init DR=150 bps)
- 3G: LDL-64

RapidM

Data Performance: 1024 Bytes



- 2G: S 5066+MS110B (Init DR=150 bps)
- 3G: LDL-512 & HDL-6

RapidM

SUMMARY & CONCLUSIONS

Naval & Strategic Communications

Tactical Communications

Governmental Communications

Embedded HF/VHF Modem Modules

Link Setup Performance

- **3G ALE versus 2G ALE**
  - 2G LSU is compromised by physical layer (8-FSK)
  - 3G LSU is superior - use of burst waveforms (spread spectrum)
  - 3G ALE offers a 6 - 9 dB performance improvement over 2G ALE
  - 3G ALE (synchronous LSU) results in faster linking times

- **Channel Evaluation**
  - Performance of ALE is function of the LQA metrics.
  - 3G ALE provides improved LQA metrics which are better matched to the propagation predictions.

RapidM

Data Modem Performance

- **3G Packet Switched Data**
  - **Good short message** data throughput - Integrated ARQ (known as xDL) and burst waveforms
  - Strongly influenced by xDL type:
    - LDL or HDL
  - Uses incremental redundancy
  - Developed for TACTICAL HF Comms

- **2G Circuit Linked Controlled Data**
  - **Poor short data message** throughput - combination of S 5066 (ARQ) and MS-110B data
  - Strongly influenced by:
    - DRC: Initial data rate, steps in data rate change
    - Message payload size
  - Developed for NAVAL/STRATEGIC platforms
    - Good propagation, radio & antenna equipment
    - Large data sets (Emails ++)

RapidM

Conclusion

3G ARCS is the answer for Tactical HF

RapidM

Questions?

Email: danie@rapidm.com or info@rapidm.com

RapidM