Implementing Full Duplex with Data Rate Adaption in STANAG 5066

HFIA 14th September 2009 Munich

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Introduction

- The presentation will cover:
  - STANAG 5066 requirement for full duplex
  - SELEX's implementation of full duplex
    - Possible interoperability issues
  - Data rate adaption in full duplex
    - Issues and performance

STANAG 5066 Full Duplex

- Full duplex operation was defined in the original S5066 standard Edition 1
- No changes that affected full duplex operation were included in Edition 2
- It is not very descriptive on how to implement
- Few vendors have implemented it
- Interoperability
  - Is the standard definition adequate to ensure interoperability?

STANAG 5066 Full Duplex Requirements

- What is defined in the standard?
  - Most of the definition of full duplex can be found in Section C ‘Data Transfer Sublayer’ of the standard.
  - Section C.3 defines the D_PDU type 2
    - This PDU type is used to support full duplex operation and allows data and ack to be combined within a D-PDU (combined information and control frame)
  - Section C.3.2.3 End of Transmission (EOT)
    - When a node is configured for full duplex the EOT field is filled with all zeros
    - EOT is not used during full duplex data transfer
  - Section C.3.5 DATA_ACK (type 2) D_PDU (duplex data transfer)
    - Defines the data-ack D_PDU used for full duplex
  - Section C.3.6 RESET/WIN_RESYNC (Type 3) D_PDU
    - A type 3 D_PDU can be used to request/force a reset or resynchronisation of the ARQ machines for both directions of the data flow
  - Section C.5.4 Capability Advertisement (Type 4) EOW Message
    - EOW message is part of all D_PDUs
    - Bit 3 in the message field can be used to advertise full duplex support
    - Bit 2, split frequency operation must also be set

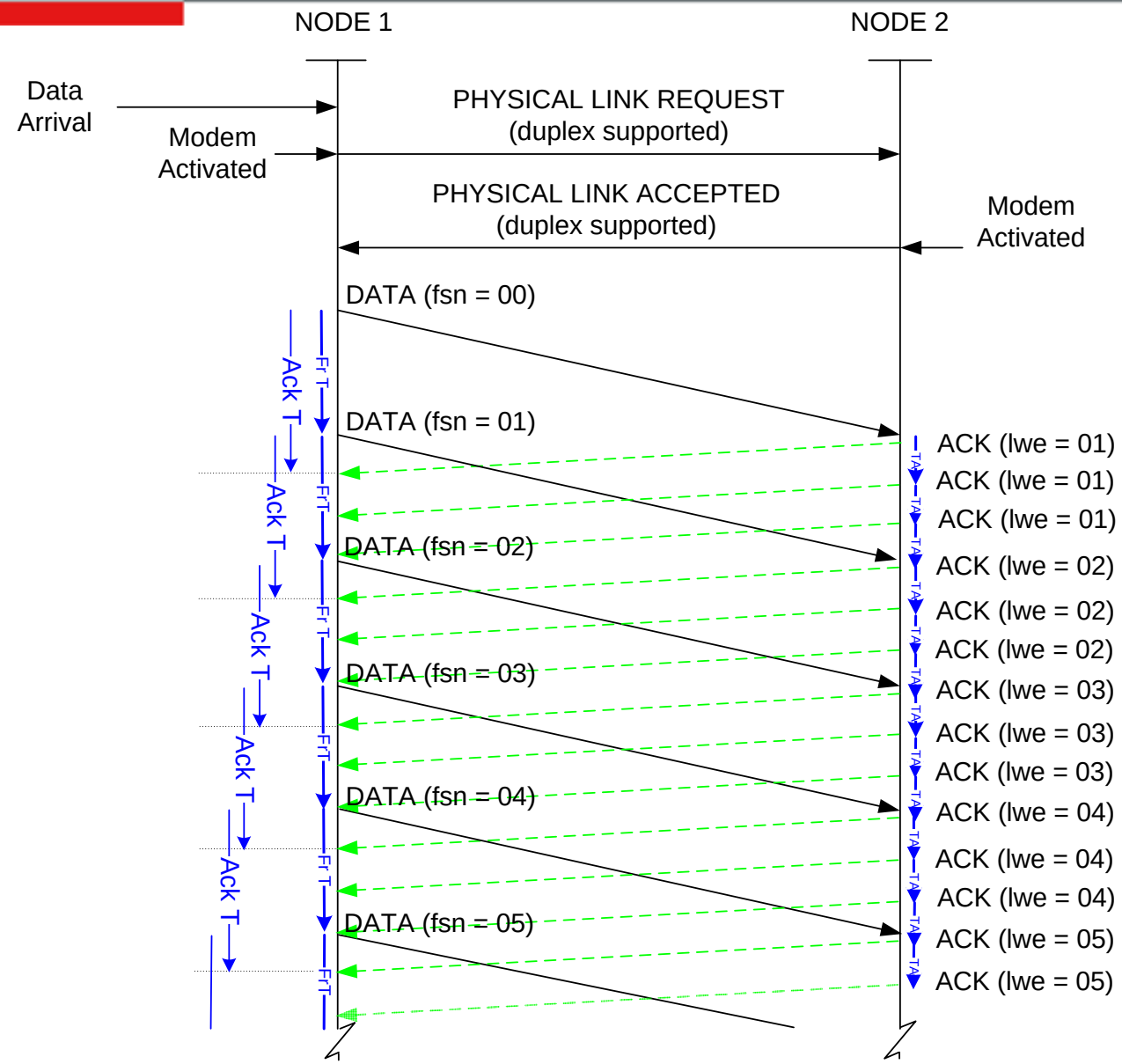
SELEX's Implementation

- SELEX has implemented full duplex operation as part of the HF2000 HF system for the Swedish Armed Forces.
- To support highly loaded strategic links
- Supported in 3G ALE and in manual mode
- Support for IP traffic and email
- HF2000 integrated frequency management system automatically manages frequency pairs to ensure optimum performance

SELEX's Implementation of Full Duplex

- We submit data D_PDU one at a time to the modem queue
  - Can be Data or Data+Ack D_PDU
  - This allows real time reaction to acknowledgements
- Wait for acknowledgement timer associated with each data D_PDU
  - Controls retransmission if required
- ACK frames are sent redundantly if no traffic is queued for transmission
  - Keeps the link alive for LQA and adds robustness to the link
- We insert the ACK in the next available transmit frame
- The modems are held in transmit until the physical link is broken
- We do not assume continuous transmission of data D_PDU
  - There may be breaks between transmit frames when unformatted data is transmitted

Data Transfer in Full Duplex



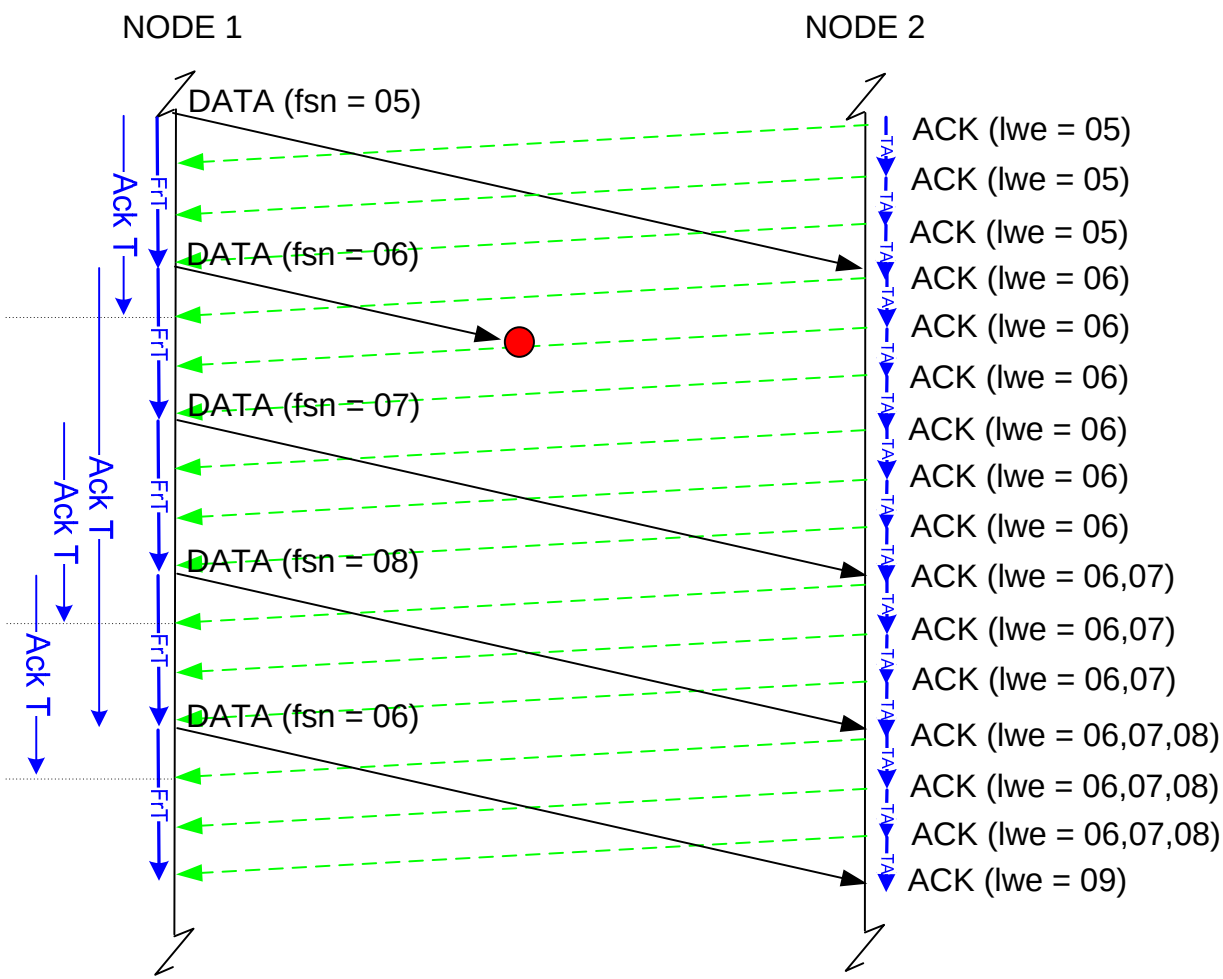
Duplex link is setup during link establishment

As a default state for unidirectional traffic in full duplex links, ACKs are continuously returned during DATA PDU transfer

FrT frame transmission period timer

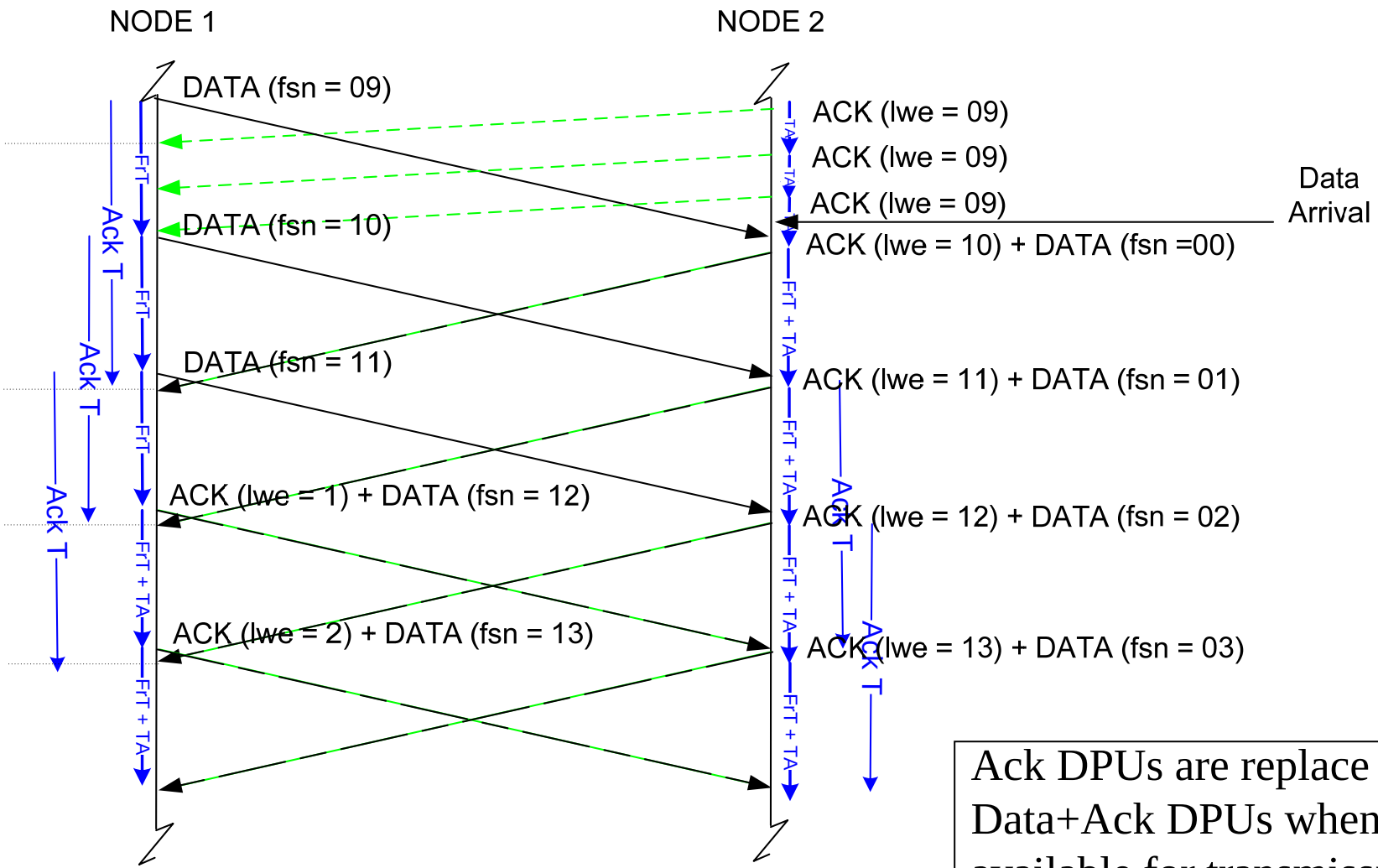
Ack T Wait for ACK timer

Data Lost in Full Duplex



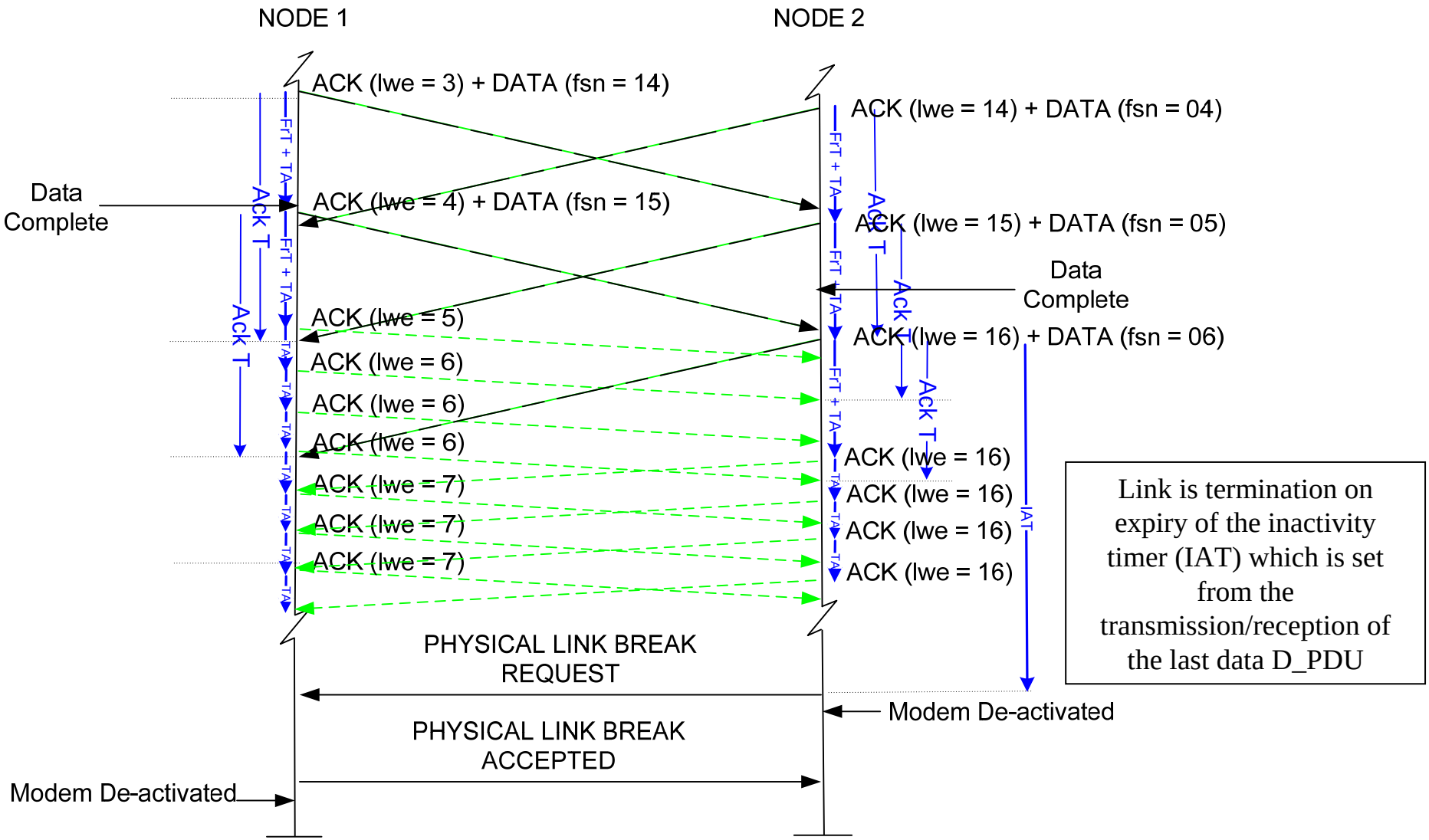
A D-PDU not received will be retransmitted in as the next available frame after the Acknowledgement timer has expired.

Two-way Data Transfer in Full Duplex



Ack DPUs are replace by Data+Ack DPUs when data is available for transmission

Link Termination in Full Duplex



Link is termination on expiry of the inactivity timer (IAT) which is set from the transmission/reception of the last data D_PDU

Interoperability Issues

- STANAG 5066 requires management messages for link maintenance
  - Needed for Data Rate Adaption negotiation (type 6)
  - Also RESET/WIN_RESYNC messages (type 3)
  - Physical link Make and Break (type 8)

- The standard requires that types 3 & 6 D_DPU are sent IRQ protocol and shall operate in half duplex mode
  - Requires agreed method to transfer between full duplex and half duplex

- Possible options
  - Insert a valid (non zero) EOT into the last duplex D_PDU
  - Just send first management messages and wait for other node to transition to half duplex
  - Remove requirement that types 3 & 6 are sent in half duplex mode

Interoperability Issues cntd.

- Timers
  - Timers which are used in HF2000 are a function of how full duplex has been implemented
  - Different implementation would require different timers
    - HF2000 timers are based on single D_PDU transmission
      e.g. Next D_PDU timer and Wait for Ack timers
    -
  - Acks need to be sent within the ‘Wait for Ack’ time frame to avoid unnecessary multiple transmission of the data frames

- Link termination due to poor link conditions is based on the number of negatively acknowledged and/or unacknowledged D_PDUs
  - Link efficiency may benefit by an agreed procedure

Data Rate Adaption in Full Duplex

- Transmit data rate changes are based on advisory messages from the remote node and error statistics at the local node
- Where auto baud is available, both nodes may independently change their data rates
  - This may result in loss of data during modem reconfiguration
  - May impact link stability due to link maintenance timers
- Where auto baud in not available, changes are negotiated in half duplex operation
  - Requires agreed transition between full and half duplex modes

Summary

- SELEX has implemented a full duplex capability into HF2000
- Where the standard is not definitive, SELEX has implemented its own solutions
- Several potential interoperability issues have been identified
- To ensure interoperability between vendors a common approach will need to be agreed