Implementing Full Duplex with Data Rate Adaption in STANAG 5066

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Nigel Arthur
nigel.arthur@selex-comms.com
• 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?
• 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
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 is 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