

VDL Mode 3 Modeling

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WINCOM VDLM2/3

Modeling & Simulations

- FIS and TAMDAR data
 - Performance, Optimal Formatting and Packet Size
 - Maintain latency requirements
 - Data integrity
- Explore IP as network
 - Performance
 - Limitations
 - Potential benefits

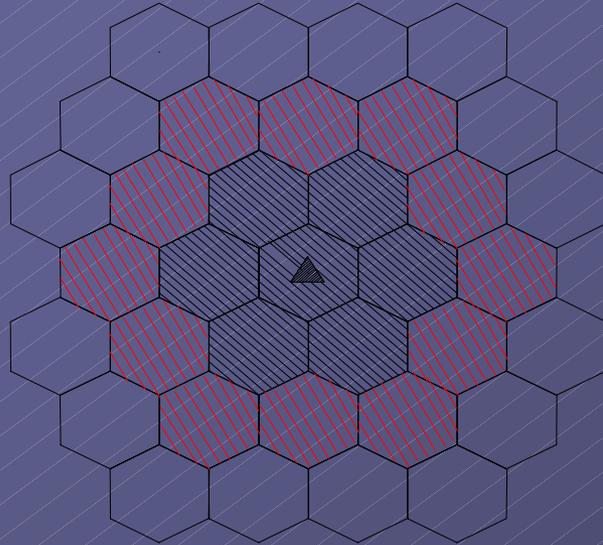
WINCOM Models & Simulations

- Evaluate MITRE CASSD VDL3 models and simulations as baseline
- Build new models & simulations as necessary
- Data Types
 - FIS
 - Background loading of other relevant traffic
 - CPLDC
 - AOC

FIS, CPDLC & AOC Traffic Requirements

- CPDLC & AOC message set and size
 - Petal trials conducted by Euro Control
 - Miami CPDLC build 1 & 1A
- FIS Traffic requirements
 - Lockheed requirements study

Baseline FIS Deployment



- Interference
 - 1st layer of interference at adjacent cells
 - 2nd layer of interference one cell out
 - Combination of multiple transmitters
- Drawbacks
 - Bandwidth intensive ground-to-air link is not well suited to this implementation

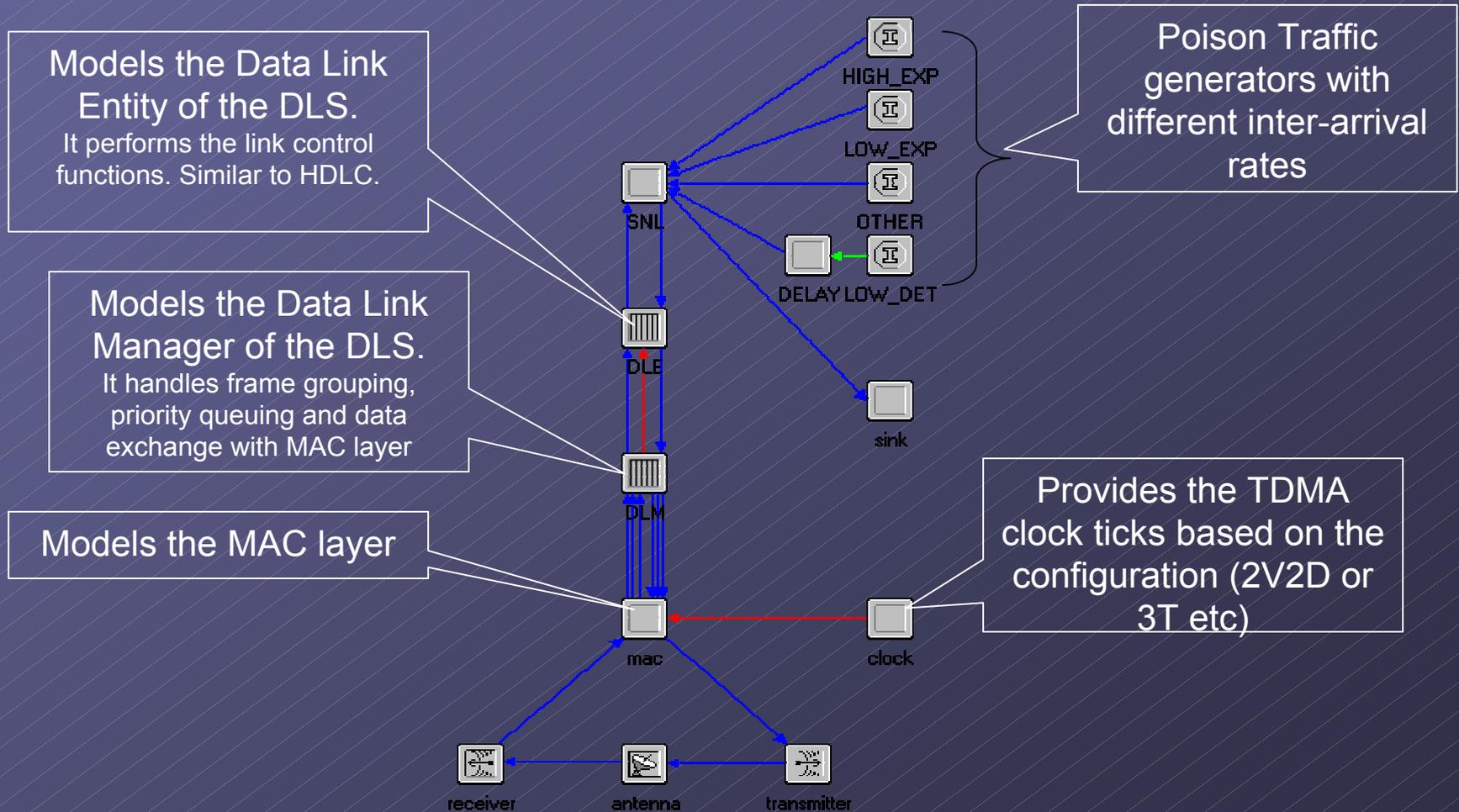
- Current Scheme
 - Ground stations (GS) use same frequency
 - Spacing of GSs is ~100-200 miles

Alternative Approaches to Optimize Network to Support Bandwidth

- Alternative Approaches
 - Different cell reuse pattern IE 7-Cell, 9 Cell, 12 Cell, etc.
 - Collocation of multiple frequencies time sharing
 - Predictive scheduling algorithms guaranteeing a minimum level of service
- ATN priority scheme; currently not implemented
- Evaluation
 - Test different approaches with mixed traffic and priority levels
- Investigate differences between TCP/IP and ATN that would provide a performance benefit of one over the other

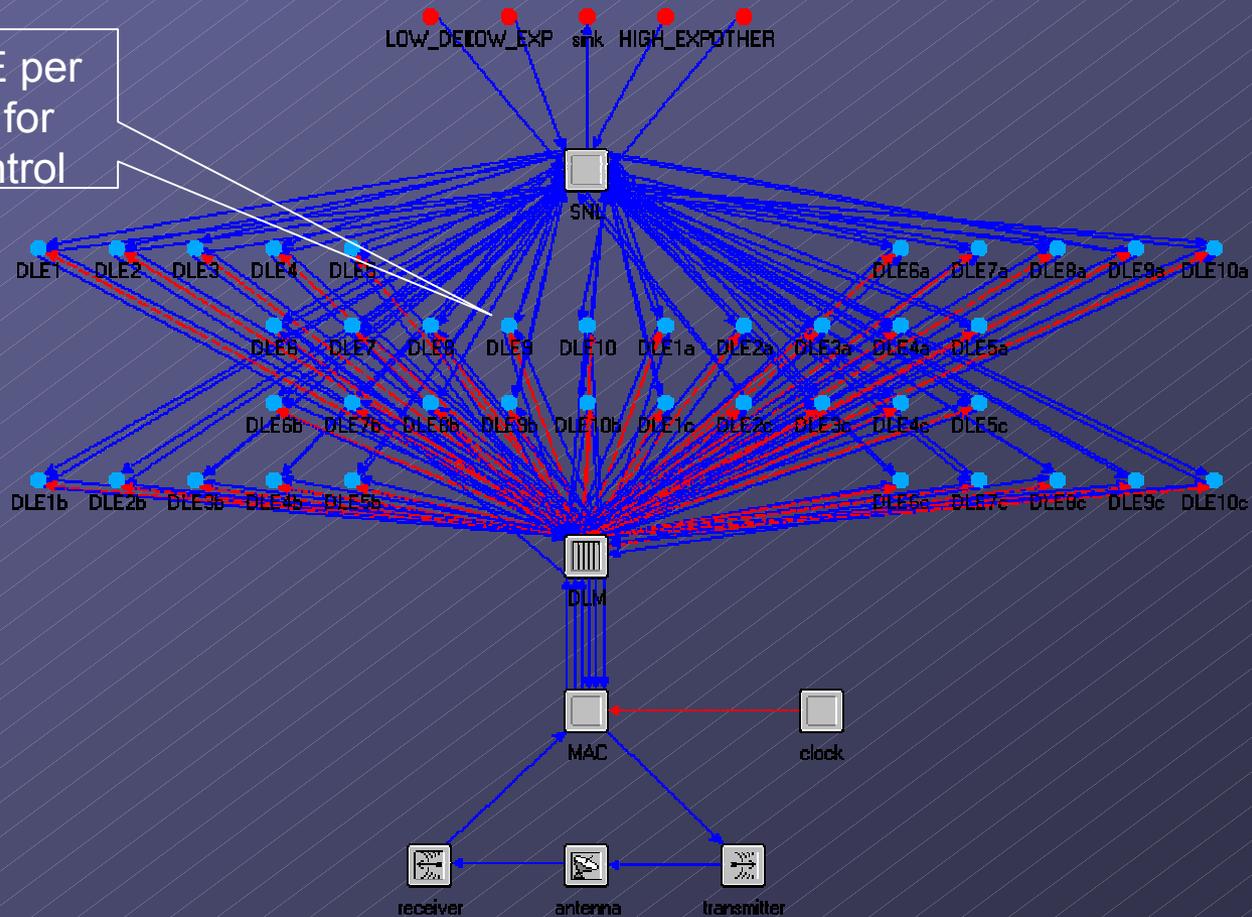
MITRE's VDL mode 3 Model

Aircraft Model



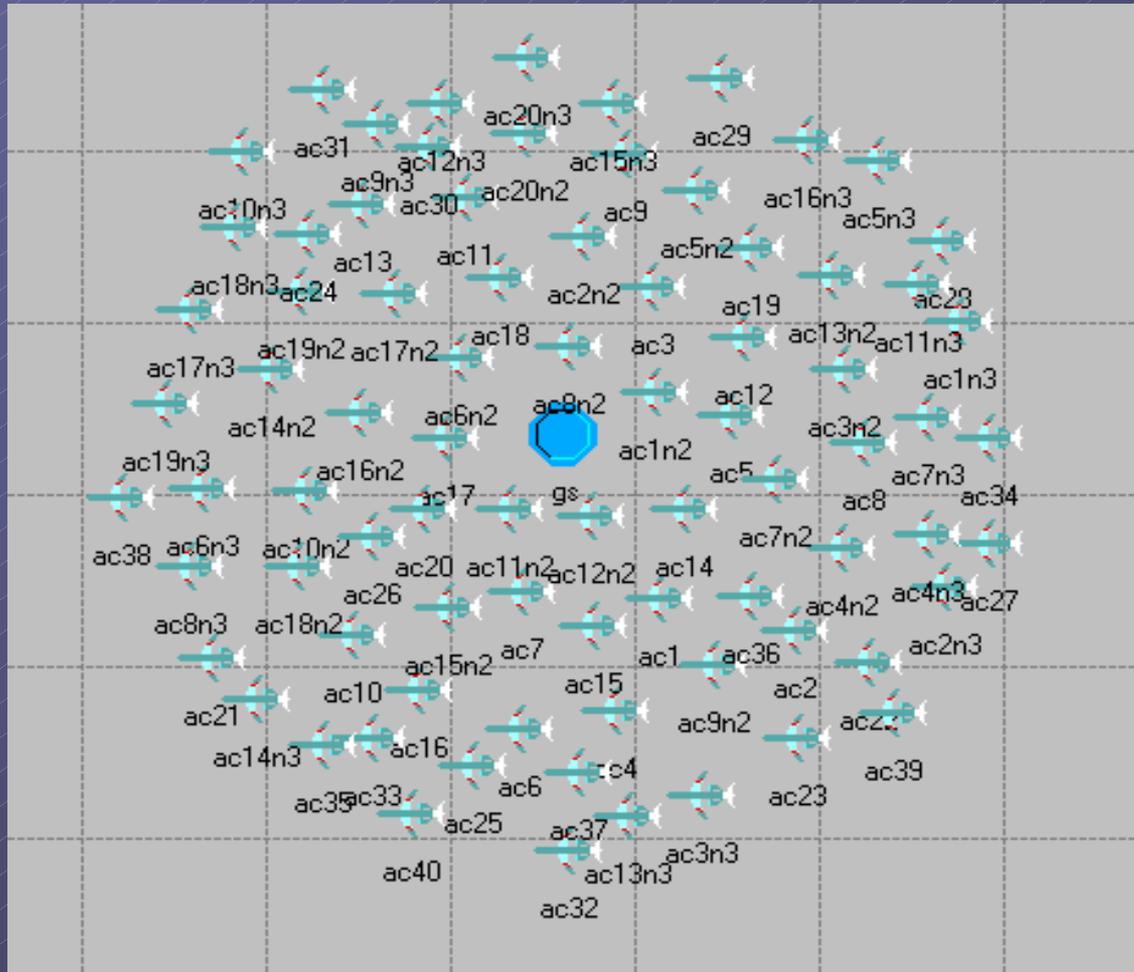
Ground Station Model

One DLE per aircraft for Link control



Network Model

One Ground Station with 80 stationary Aircrafts

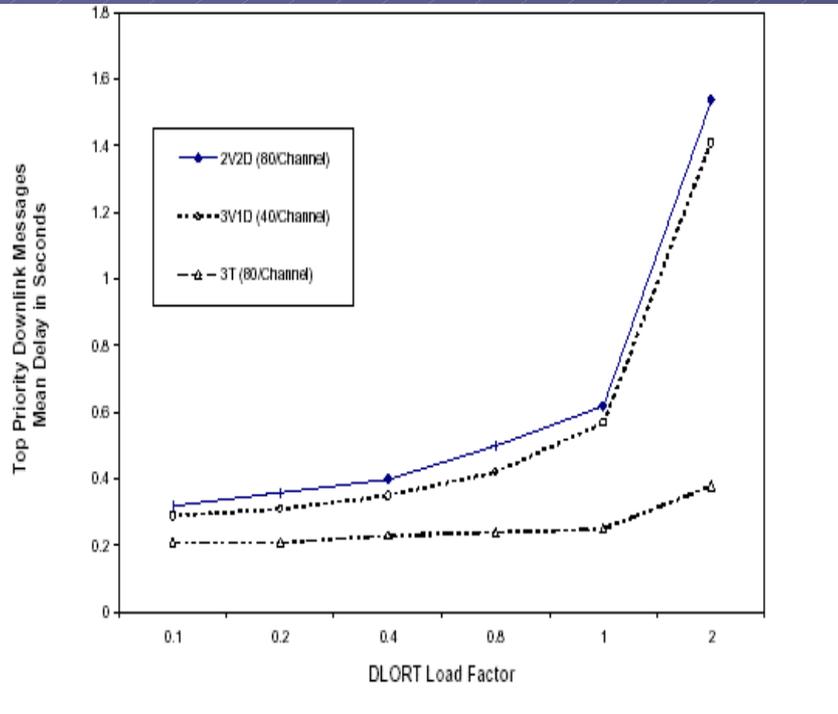


Experience with MITRE's Models

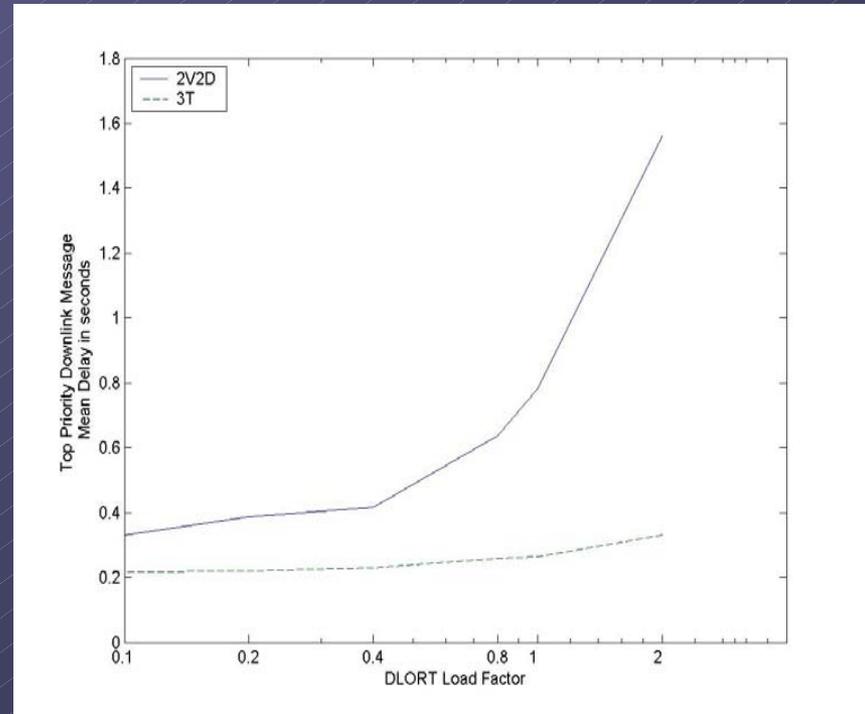
- Model was built with OPNET 7
- Compilation errors and some other Bugs (we fixed them)
- 3V1D configuration does not work (run time errors)
- In the 2V2D configuration, simulations do not give the expected results for medium priority packets
- Other than that the results obtained by running simulations gave similar results as those published by MITRE

Simulation Results

MITRE



HL

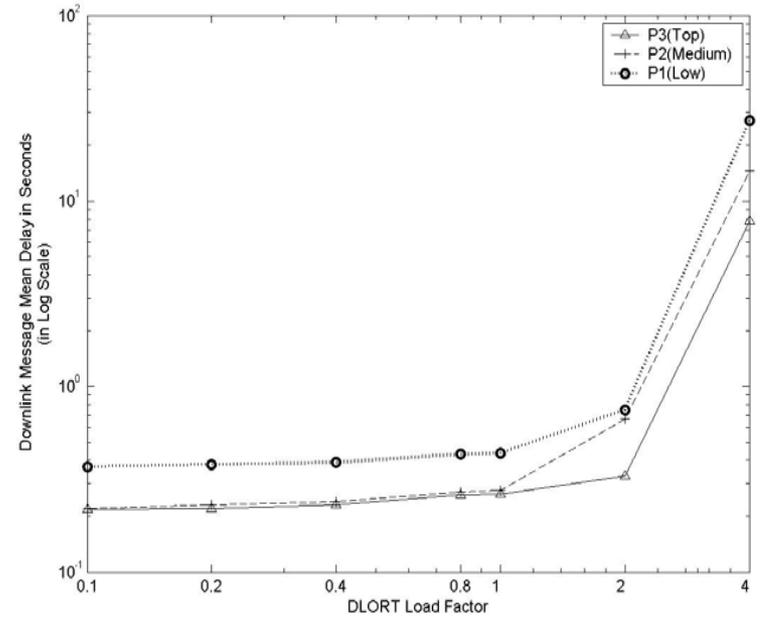
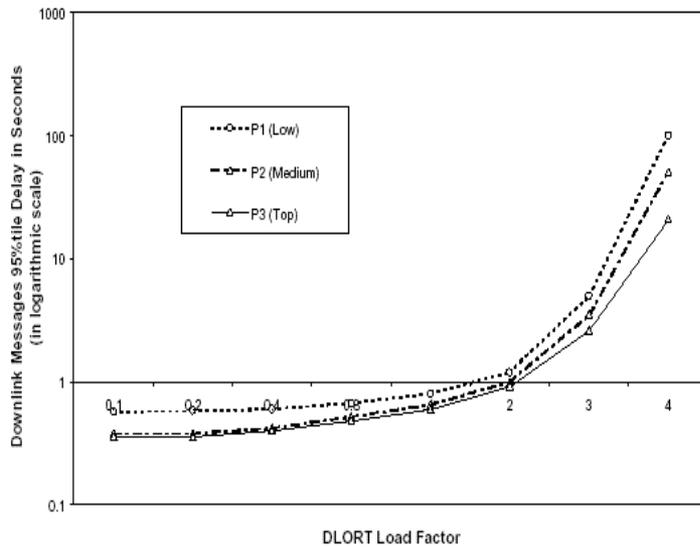


Simulation Results

MITRE

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VDL Mode 3 Priority Queuing Simulation
(3T with 80 aircraft in one user group)



Limitations of MITRE's models

- Does not model aircraft mobility.
 - Only simulates a single ground station with a max of 80 stationary aircrafts.
- Not Scalable
 - The ground station node model has a fixed number of DLE's (one per aircraft).
 - DLEs must be created dynamically for each aircraft as they enter the Ground station's coverage area.
- Does not assign aircrafts to different channel groups
- Does not assign IDs to aircrafts dynamically based on Net Entry Requests

Limitations Cont...

- Very centralized implementation
 - For example information about who has access to the next M channel random access slot is kept in a global variable.
- Does not adhere to the proposed packet formats.
- A different clock model must be used for each configuration (2V2D, 3T, 3V2D etc)
- Does not handle Fragmentation:
 - Does not break data packets into bursts at the MAC layer.
 - Does not re-assemble bursts into a data frame at the MAC layer before sending to DLS layer.

More Limitations

- Does not make use of several OPNET features like ICIs, packet time stamping etc
- Does not use OPNET's statistics collection libraries.
 - Instead it writes statistics to an external file which must later be processed by an independent program to calculate overall statistics and generate graphs.

A Positive Look at MITRE's model

- A Good starting point for our work in spite of the various limitations.
- Implements the following optimizations:
 - New requests for data slots are piggybacked in current data frame transmission.
 - ACKs for multiple aircrafts sent together, by the ground station in one M_UP control slot.