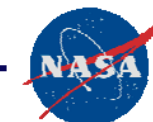




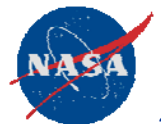
VDL2 on the Airport Surface – A Simulation Study

Steven Bretmersky, CSU
Rafael Apaza, FAA





- The VDL simulations are being performed as part of the VDL Mode 2 spectrum assessment study for the FAA
 - The number of aircraft supported per VDL channel used as input to the spectrum assessment to determine the total bandwidth required
- Scenarios under study:
 - En route, TMA, and airport surface domains
 - 3 segment approach to application deployment
- Studies are based on the Communications Operating Concepts and Requirements (COCR) document
 - Traffic profiles
 - Domain definitions
 - Delay requirements
 - http://nas-architecture.faa.gov/nas/downloads/cocr/COCR_v200.pdf





- Discuss the simulation approach taken in the VDL simulations
 - Simulation models
 - Scenario construction
- Identify how the capacity for a VDL subnetwork is determined
 - Metrics used
 - Variations tested
- Look at an example capacity simulation – the airport surface



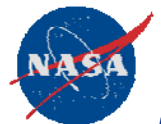


- The VDL Mode 2 model includes:
 - Fully functional MAC sublayer
 - Fully functional AVLC protocol
 - Exception: missing LME-specific features
 - Basic VME/LME operations
 - Link Connection
 - GSIF
- The model does not include:
 - Handoff capabilities
 - Link Parameter Modification and Rejection functionality
 - Subnetwork connection management (ISO-8208)
- Testing / Verification
 - Model tested against the RTCA MOPS (DO-281) for VDL Mode 2
 - Model compared against published results from other VDL Mode 2 simulations





- Create a scenario using the VDL simulation models
 - Single ground station with varying number of aircraft
 - Aircraft randomly placed within
 - En Route: 120 NM of ground radio at 30,000 feet
 - TMA: 60 NM of ground radio at 18,000 feet
 - Airport: 5 NM of ground radio at 1,000 feet
 - All aircraft are assumed identical (commercial aircraft)
- Run simulations with varying number of aircraft
 - Number of aircraft in simulation usually varies in increments of 10
 - Simulations run 5 times each with varying seed values for the RNG
 - Simulation duration chosen to produce ~10,000 total application messages
- Analyze the 95th percentile subnetwork delay
 - Capacity determined by the maximum number of aircraft attained while the 95th percentile delay is below requirements





- Voice co-site interference
 - Adds a voice model to the aircraft that interferes with VDL-2 reception
- ATN and AOA
 - Divides aircraft into those equipped with the ATN stack and those equipped with AOA
 - ATN aircraft equipped with ISO-8208 model
 - AOA aircraft equipped with ARINC-618 model
- Hidden transmitter
 - Adds additional ground stations to the simulation
 - Each ground station supports its own volume of space and aircraft

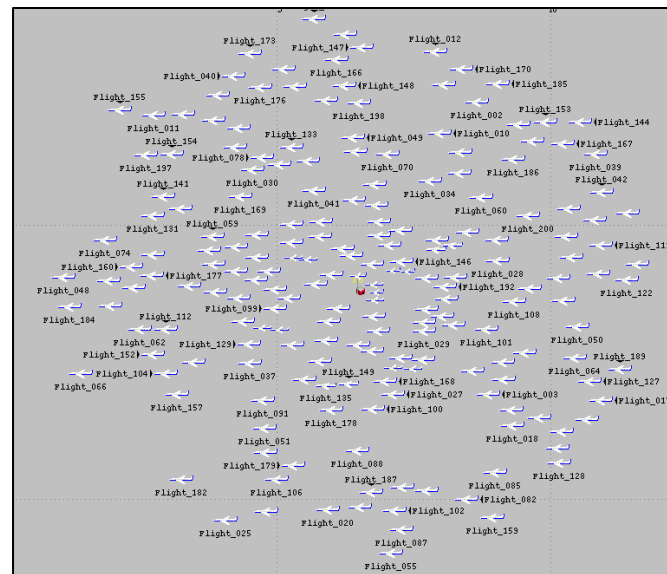


Example Scenario



- Airport Surface

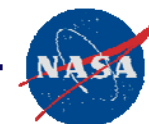
- Maximum of 160 aircraft
 - All at 1,000 feet
 - All within 5 NM of ground radio
- Standard scenario
 - No voice cosite interference
 - No hidden transmitter
 - All aircraft assumed to be ATN equipped



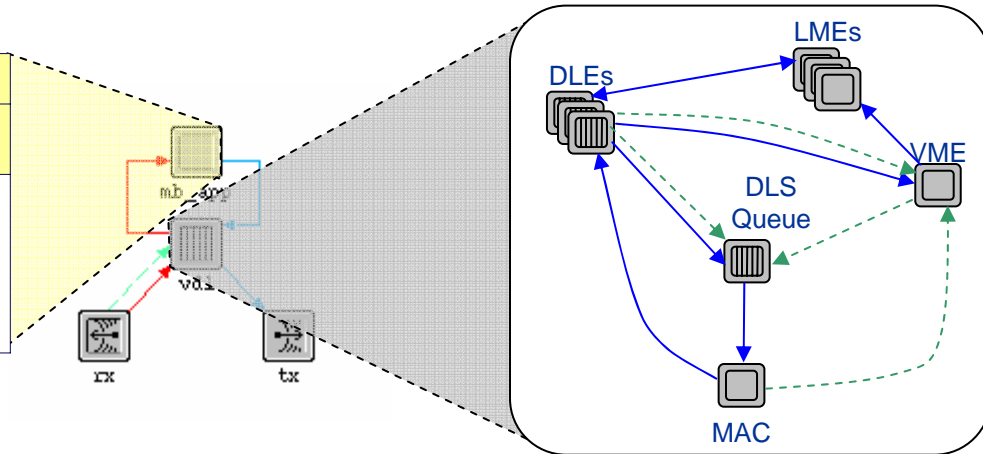
- Traffic Profile

- Represents Segment 3 (2027)

	Uplink		Downlink	
	Mean Rate	Mean Size	Mean Rate	Mean Size
Network	0.001723	924	0.001544	745
High	0.008795	1377	0.008831	1330
Medium	0.002491	3929	0.0019	5091
Low	0.005556	10913	0.014259	1005



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- The aircraft and ground VDL models consist of a traffic generator, the VDL model, and a radio transmitter and receiver
- The traffic generator uses the traffic profile as input to generate the per-aircraft traffic load
- The VDL model includes models for the VDL Mode 2 DLEs, the DLS transmission queue, and the MAC sublayer



- Determine the performance of a VDL subnetwork on the airport surface
 - What subnetwork delays can be expected for a given traffic profile and aircraft load?
 - How many aircraft can be supported with a given 95th percentile delay requirement?
- Determine the effect that frame grouping has on the subnetwork performance and capacity
 - What effect does increasing the ground persistence have?





- VDL Mode 2 MASPS allow more than 1 AVLC frame to be included in a single MAC transmission
 - No recommendation is made on usage
- Without frame grouping, there is an inherent limit to the amount of traffic a radio can transmit
 - Occurs when the rate of frame generation exceeds the rate of frame transmission
- With frame grouping, the limit is increased since multiple frames can be sent in a single transmission
- The limit may also be increased by increasing the rate of transmission
 - Achieved by decreasing the amount of time required to transmit – increasing persistence
- Frame grouping is most likely to benefit uplink traffic, since the ground station has much more traffic to transmit than aircraft



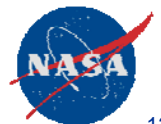


- For this study, 4 sets of simulations were run
 - VDL Mode 2 with frame grouping enabled and default parameters (baseline)
 - VDL Mode 2 without frame grouping and default parameters
 - VDL Mode 2 without frame grouping, ground p increased to 33/256
 - VDL Mode 2 without frame grouping, ground p increased to 65/256
- Each simulation set tested with 10 to 160 aircraft in increments of 10

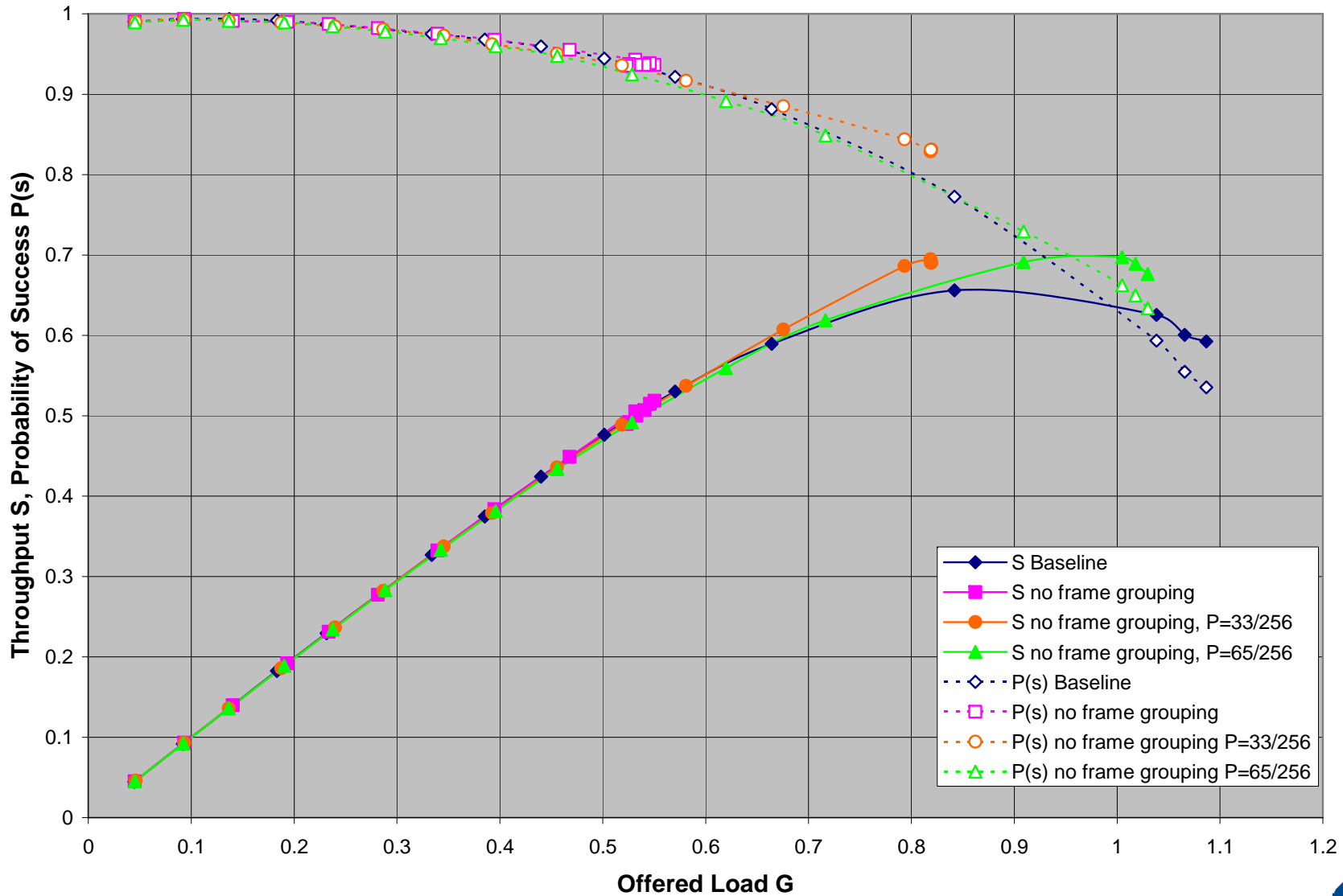




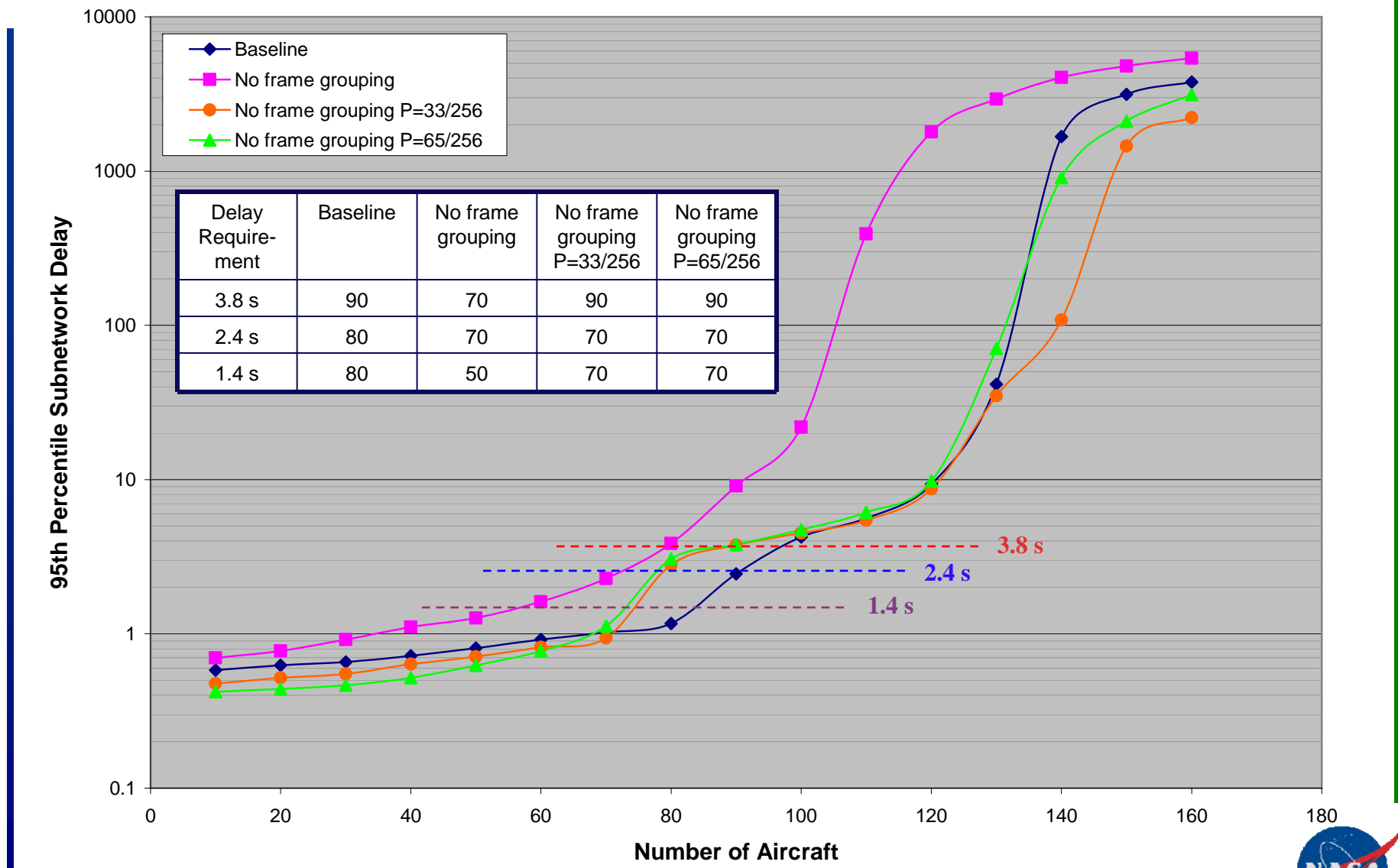
- Offered Load
 - The total amount of traffic transmitted on the channel, normalized to the data rate
- Throughput
 - The total amount of traffic successfully received on the channel, normalized to the data rate
- Probability of Success
 - The probability that a transmission will be successful (no collisions)
- Subnetwork Delay
 - The amount of time required for a data packet to completely traverse the VDL sublayers and radio channel
- Capacity
 - The number of aircraft that can be supported by a VDL Mode 2 channel, based on the 95th percentile subnetwork delay requirements



Throughput Results



Capacity

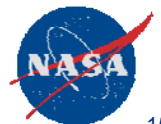


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- VDL simulations are used to determine the number of aircraft that can be supported on a single channel
 - Based on COCR traffic profiles and delay requirements
- Frame grouping improves capacity and should be implemented for uplinks
 - If frame grouping is not possible, increasing the ground persistence parameter is a viable alternative
- Capacity simulations are a work in progress
 - Application traffic profiles are still evolving
 - Capacity numbers are subject to change





Questions?

