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# Communication Requirements of DAG-TM

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# DAG-TM Concept of Operations Will Evolve

- DAG-TM is predicated upon increased information exchange (i.e., flight deck, AOC, ATSP)
- The information to be distributed and the frequency are research topics:
  - State information
  - Intent information
  - Constraint information
    - SUA
    - Weather
    - ATM
  - User preferences



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# Concept of Operations Affects Communication Requirements

- Increased information exchange will influence communications requirements
  - Demand for timely data will influence communications requirements
  - For a given communications bandwidth will affect message latency
  - Costs of communication must be considered in design
- The final concept of operations must be benefits driven



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## Communication Costs Affect Benefits

- Communications requirements should be considered as a part of OpsCon refinement
- The costs associated with communicating additional information might be prohibitive
- Data comm. demand might introduce unacceptable comm. delays



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# Simulation is a Means of Assessing Communication Requirements

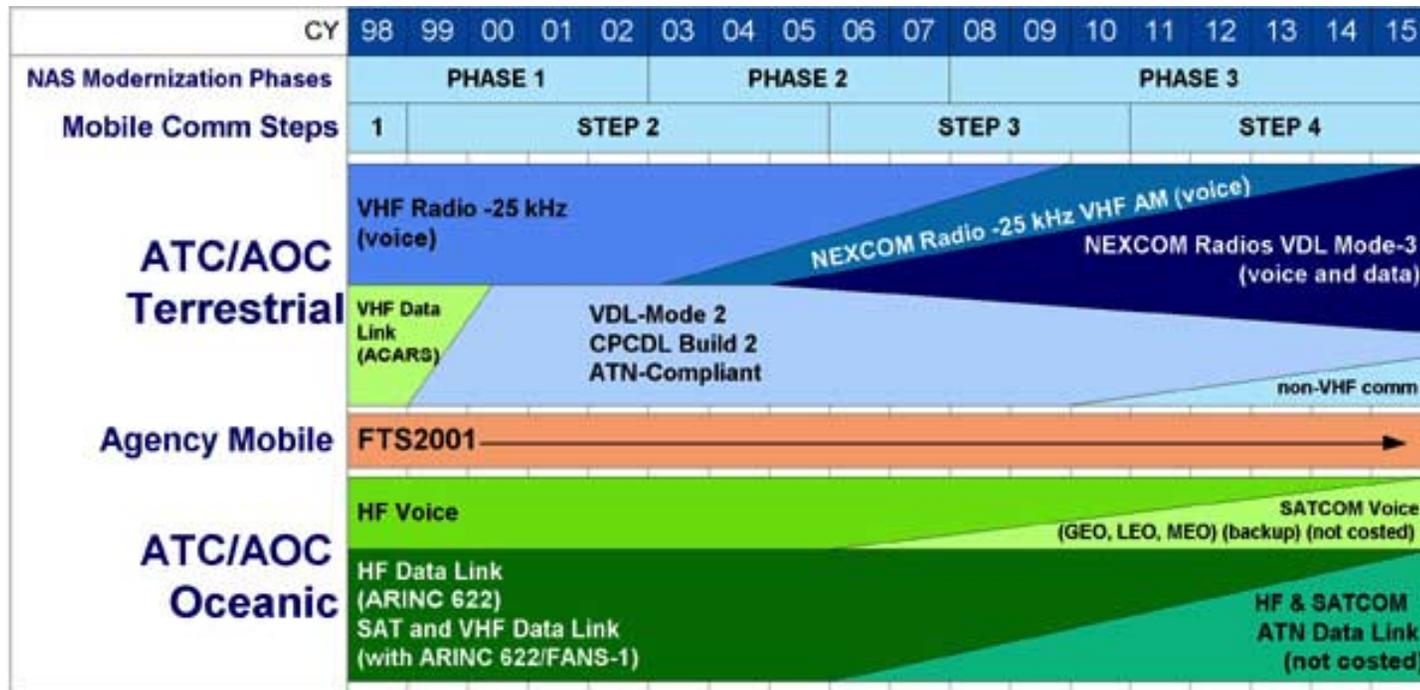
- Different message sizes
  - State vs. Intent
  - Level of Intent
- Message frequency
- Broadcast vs. addressed
- Does the communications infrastructure enable the DAG-TM concept of operations under projected demand?



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# NAS Architecture Defines Baseline for Communications Infrastructure

MOBILE COMMUNICATION TRANSITION DIAGRAM



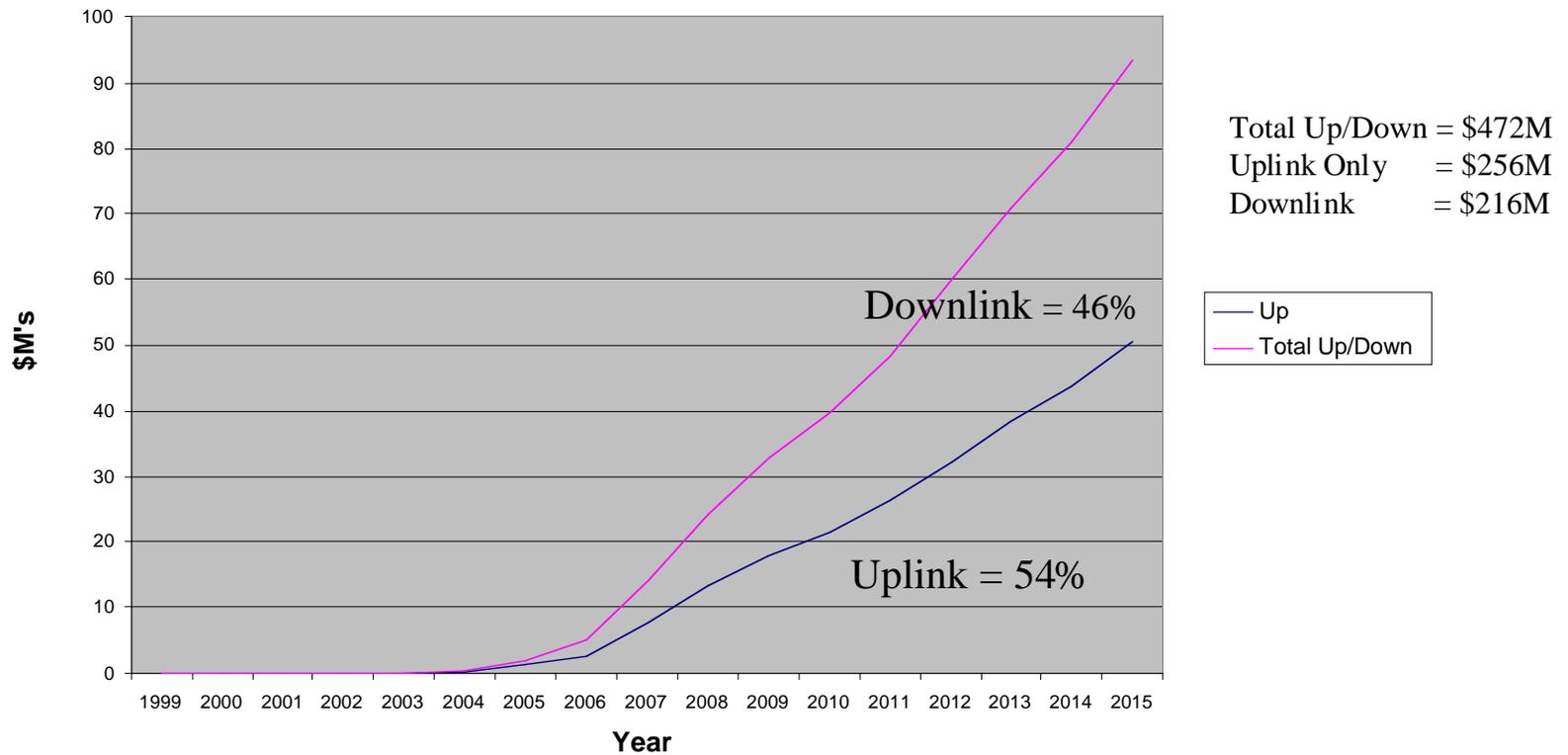
Source: NAS Architecture Version 4.0



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# Projected VDL-2 Message Costs

Projected VDL-2 Message Costs (Budget Year, 80/20 Estimate)

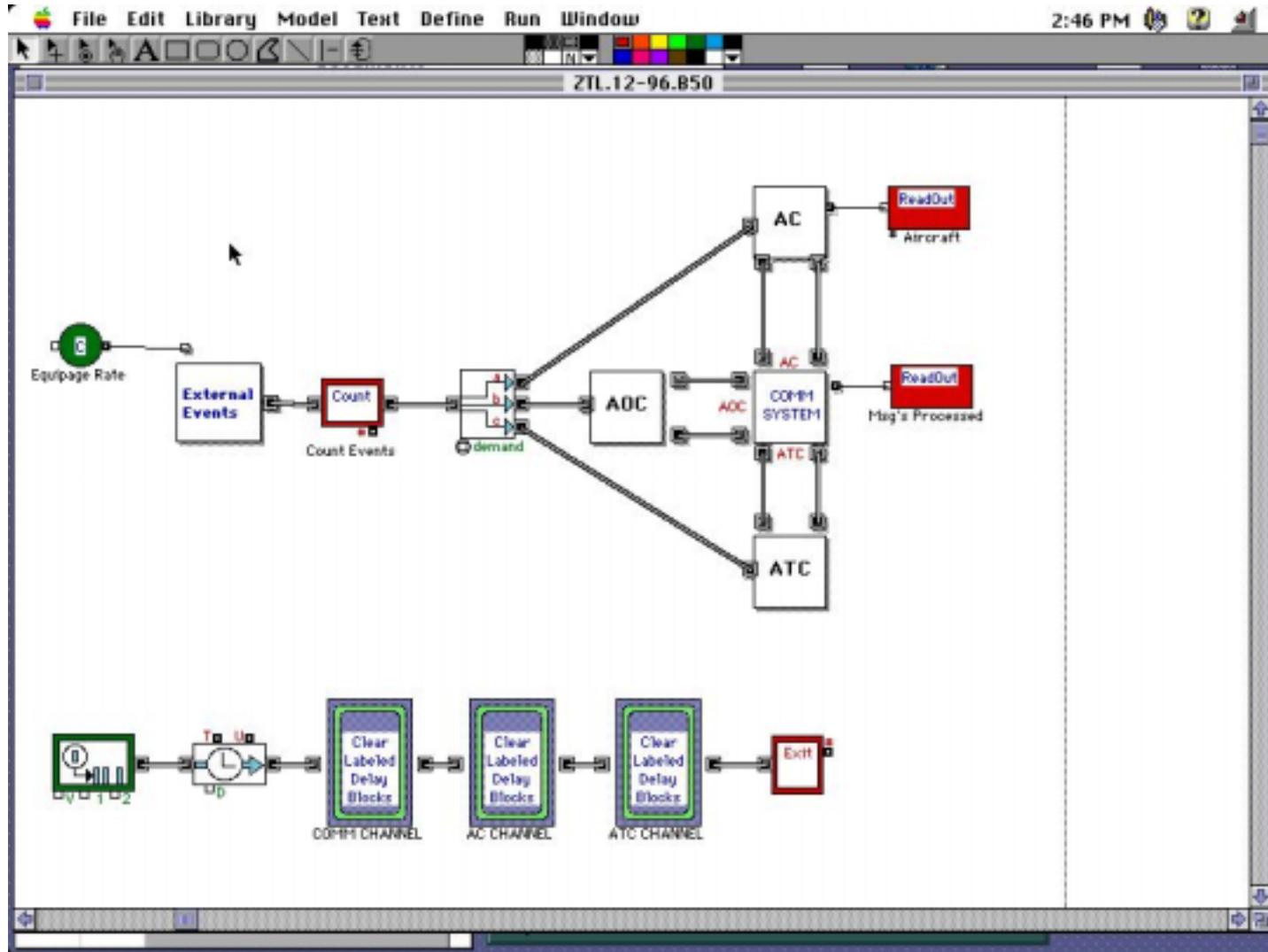


Source: FAA Briefing at Second CA/FT Focus Group Meeting, September 1999, Seattle WA



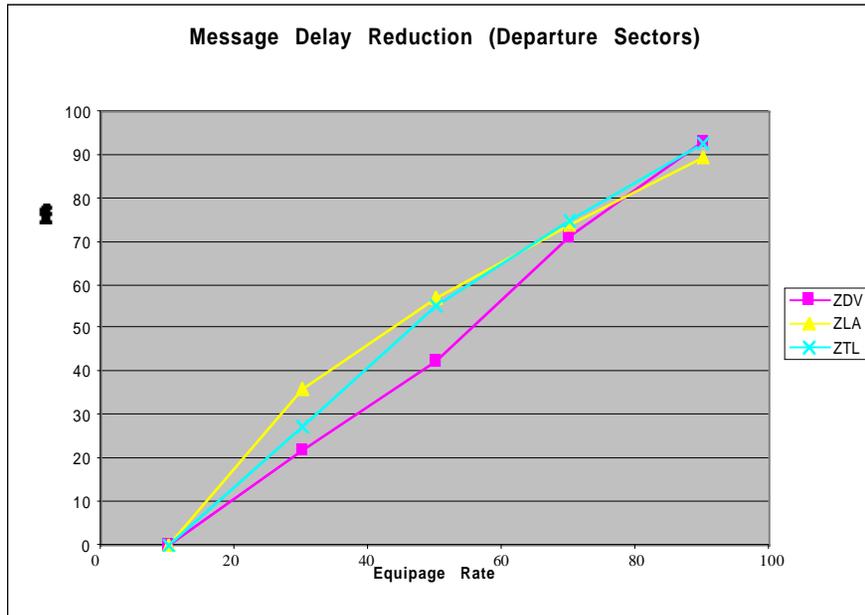
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# High-level Models Can Be Powerful Tools





# Example Analysis Results: Data Link Impacts



Objective: Assess the impact of data link equipage rates and differences between FAA facilities on data link benefits.

The Study: Develop a model (NASSIM) that uses actual demand data as input to quantitatively assess the benefits of data link.

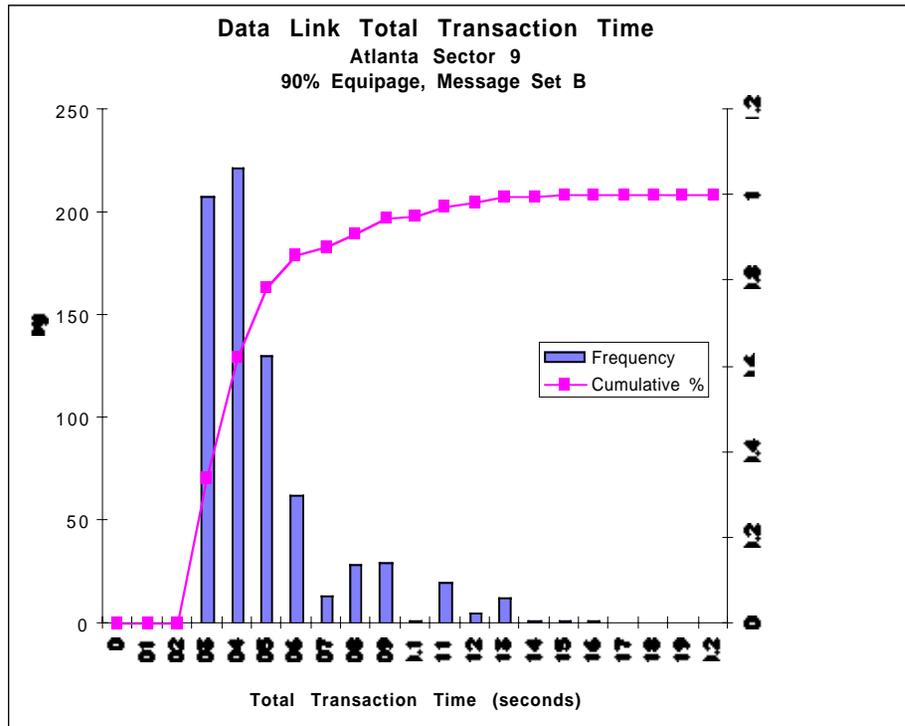
**Conclusion:** Even low levels of data link equipage significantly reduce voice message delays. Data link delays were insignificant.

Reference: Rodgers, Embt, Colligan, "A Multi-Center NASSIM Analysis of the Effects of Data Link Equipage Rates on Voice Communications," Draft Version 1.1, February 1998



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# Simulated Data Link Delays



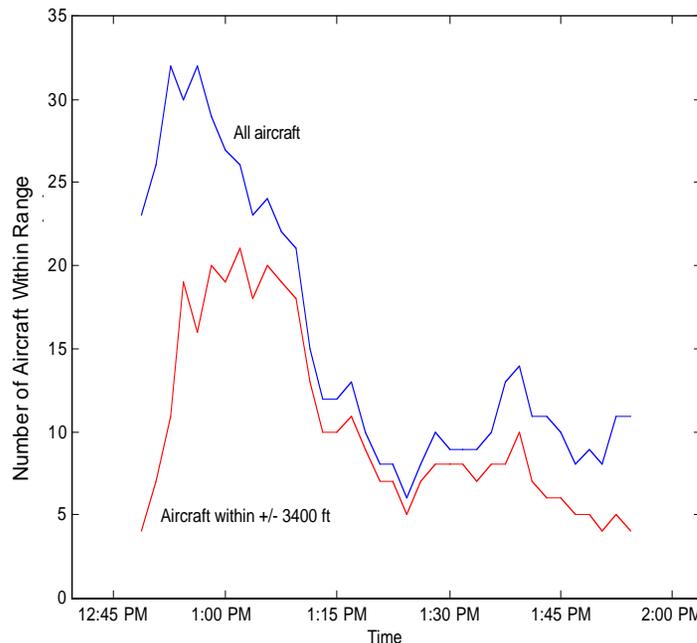
Objective: Determine if TDMA will satisfy the communications media requirement for air/ground communications.

The Study: Model (NASSIM in Extend™) both the voice channel and data link channel for the busiest sector (from Multi-Center Study) assuming TDMA performance to assess communications media delay.

**Conclusion:** All messages during the busiest three hours of one day were delayed less than .13 seconds.



# Communication Requirements – One Aircraft

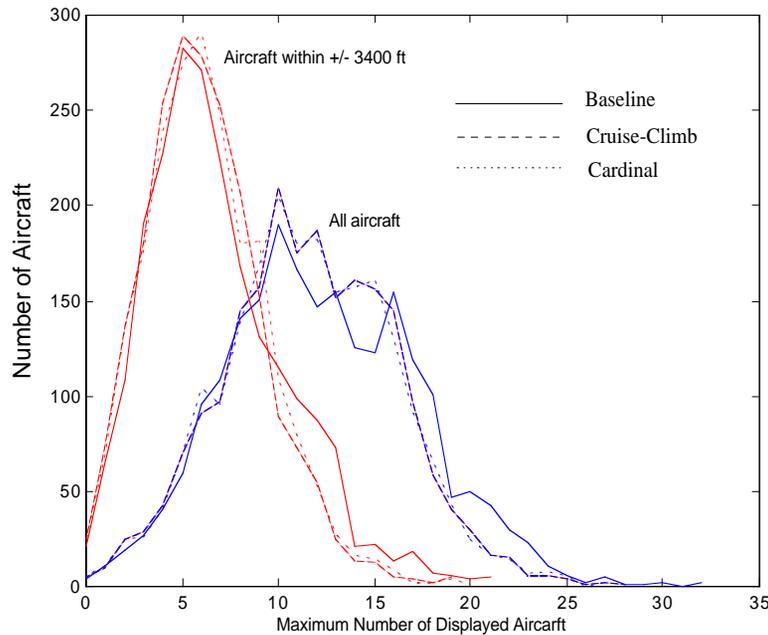


This graphic shows the number of aircraft that one aircraft within a particular dense region of airspace must display on its CDTI based on ADS-B MOPS.

The top line shows the number of aircraft that must be displayed if there is no altitude filtering. The bottom line shows the number of aircraft that must be displayed if the concept of operations is to include altitude filtering.



# Communication Requirements – Entire Center



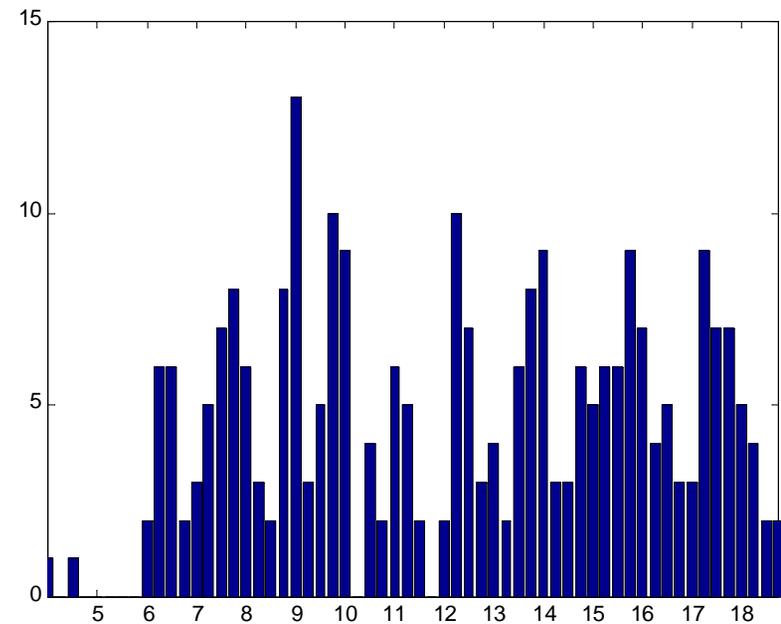
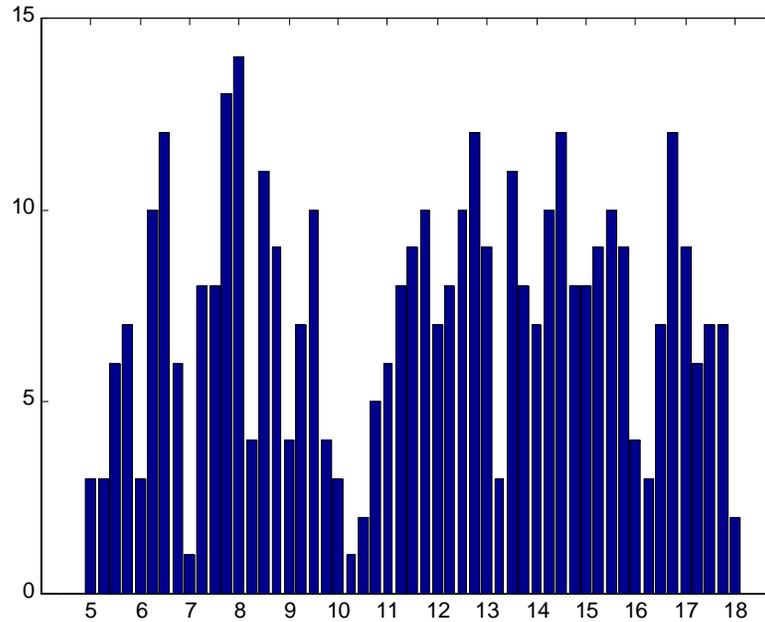
While the previous graphic illustrated display requirements for what might be identified as a particularly bad individual this graphic is intended to provide an indication of what portion of the user population display requirements apply to.

The abscissa of this plot illustrates maximum CDTI display requirement (number of aircraft) over the course of the seven scenarios. The ordinate represents number of aircraft within the single center (ZTL) that display requirement corresponds to.



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# Communication Requirements – Ground Side





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## Summary

- Communication costs represent a significant portion of the life-cycle costs of DAG-TM
- Decisions made in refining the concept of operations will affect benefits and user acceptance
- The benefits of additional information must be weighed against the costs of providing it
- Simulation modeling could be a valuable tool during the systems engineering process