



# CNS Modeling



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## VAST Communications, Navigation, and Surveillance Modeling

Steve Mainger

Acting Manager

NASA Glenn Research Center

[steven.w.mainger@grc.nasa.gov](mailto:steven.w.mainger@grc.nasa.gov)

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## OBJECTIVES

- **Develop requirements for CNS modeling that supports evaluation of advanced airspace concepts**
  - Identify and categorize CNS modeling and simulation capabilities and needs
  - Identify CNS modeling approach
  
- **Develop communication, navigation and surveillance models for today's system, technologies currently being considered within the FAA's OEP, and technologies being considered for the future**
  - Develop and demonstrate standard communications traffic model for assessing CNS model elements and architectures
  - Integrate CNS modeling activities into Airspace Modeling Toolbox



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## STATUS

- **Identification and categorize of existing CNS capabilities for modeling and simulation**
  - Exploration for sources of model or simulation needed - Draft study submitted.
- **Identify CNS modeling and simulation needs**
  - Basis of this lays in existing AATT and DAG-TM CNS requirements work
- **CNS modeling approach**
  - Definition being worked.
- **Develop and demonstrate standard communications traffic model for assessing CNS model elements and architectures**
  - FASTE-CNS development to provide communications, navigation or surveillance traffic profiles - Critical Design Review complete(8/23/02).
- **Integrate CNS modeling activities into Airspace Modeling Toolbox**
  - Definition being worked.



## Today's CNS Infrastructure

- **Analog communications links**
  - **Voice - DSB-AM, 25kHz bandwidth**
  - **ACARS - character-oriented data messaging, 25kHz**
- **Digital communication links**
  - **Oceanic SATCOM**
- **Navigation aids**
  - **VOR; ILS**
  - **Loran**
  - **GPS**
- **Surveillance radar**
  - **Primary radar**
  - **Secondary radar - mode A, C and S**
  - **TCAS (collision avoidance transponder)**



## Emerging CNS Infrastructure

- **Analog communications links**
  - **Voice - DSB-AM, 8.33kHz bandwidth**
- **Digital communication links**
  - **Voice - VDL Mode 3**
  - **Bit-oriented data - VDL Mode 2, 3, & 4, UAT, 1090ES, SATCOM**
  - **Communication networks - ATN**
- **Navigation aids**
  - **GPS with WAAS and LAAS**
- **Surveillance radar**
  - **ADS-B/TIS-B, UAT, 1090ES**



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## What CNS “components” need to be modeled?

- **Communications:**
  - Voice - 25kHz BW and 8.33kHz BW
  - ACARS
  - Data links - VDL2; VDL3; UAT; 1090ES; SATCOM
- **Navigation:**
  - VOR
  - ILS
  - GPS w/WAAS & LAAS
- **Surveillance:**
  - Primary Radar
  - Mode S, C or A
  - TCAS
  - ADS-B/TIS-B; UAT; 1090ES



# CNS Modeling



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Future Aeronautical Subnetwork Traffic Emulator for  
Communications, Navigation & Surveillance

Computer Networks & Software, Inc.

Chris Wargo



# CNS Modeling

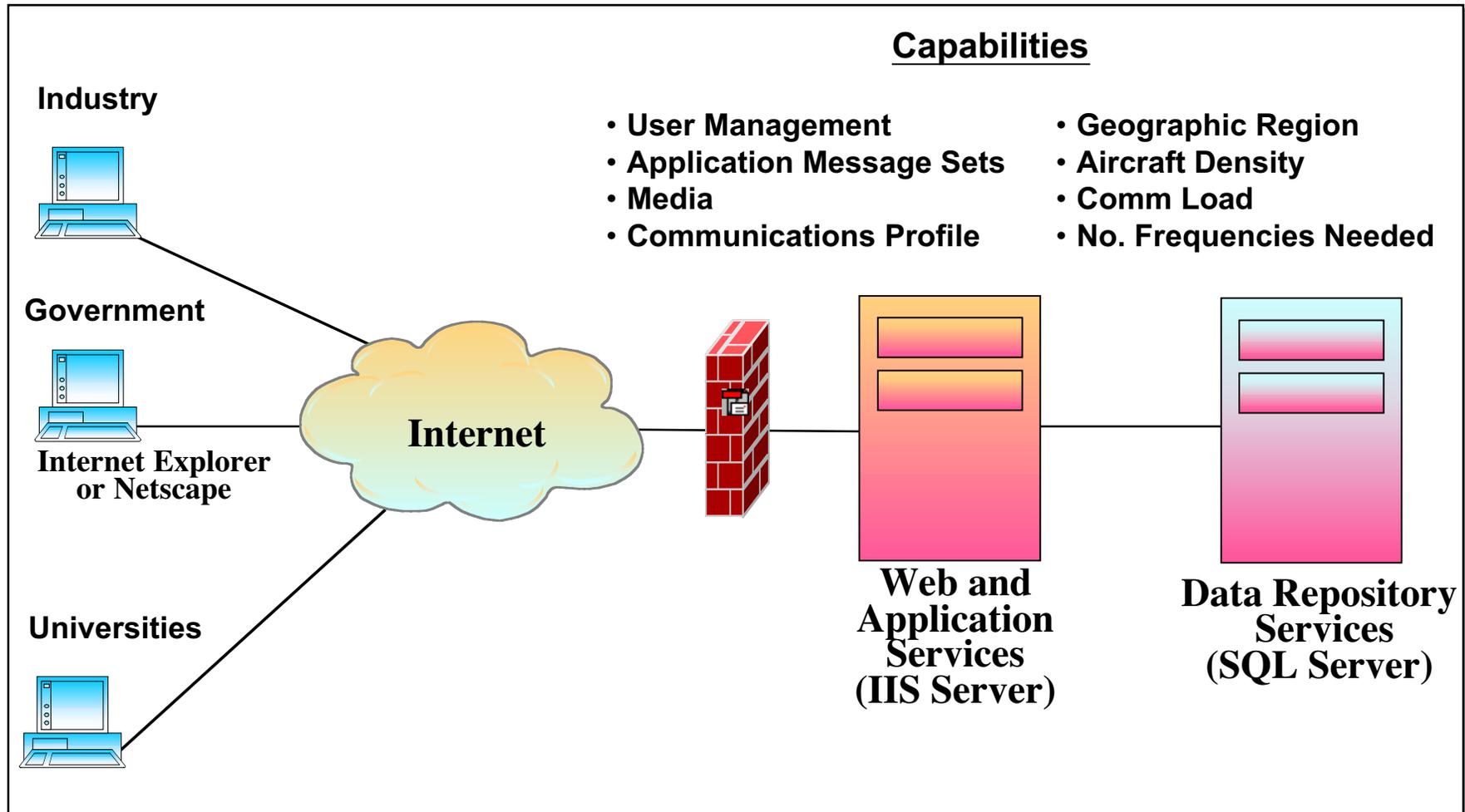


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## Project Summary

- Title: Future Aeronautical Subnetwork Traffic Emulator for Communications, Navigation & Surveillance (FASTE - CNS)
- Project: Develop a dynamic communications estimating tool that is accessible via the Internet. FASTE-CNS supports collaborative research by providing a means to define and assess the communications traffic loading associated with aeronautical related applications.
- Plan/Deliverables:
  - Phase I. System Design/Software Development (Nov 02)
    - System Specification & System Design Drawings & Reviews
    - Software Requirements & Detailed Design Document & Review
    - Software Development, Integration & Test
  - Phase II. Hosting & Evaluation (Planned for 2nd Qtr FY03)
- Today's Status: Critical Design Review Completed

## FASTE-CNS System Architecture





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## Features

- Each application profile may be allocated to different communication subnets.
- Each researcher may keep a number of application profiles on file for later use as well as have access to sets of typical applications profiles.
- Loading displayed for a typical flight profile.
- Airspace model depicts number of aircraft within selected airspace.
- Aggregate assessment of throughput requirements calculated to allow assessment of resources for various subnetworks.
- High-level performance models for the communications subnetworks available.
- Means to collaborate between researches provided.

## Define Application Message Set

Opening Message Set CPDLC\_1 - Microsoft Internet Explorer

Address: http://faste-webserver/Minny/Faste-Dev/AMSOOpen.aspx

**FASTE-CNS**

Home      Member Services      Related Links      Logout

Message Set      Media      Comm Profile      Load/Freq Calc      Help

Open/Edit Message Set

CPDLC 1 (Private)      Open

CPDLC Traffic simulation using SARP version x.y.z. Similarly sized messages have been aggregated together as a single entry.

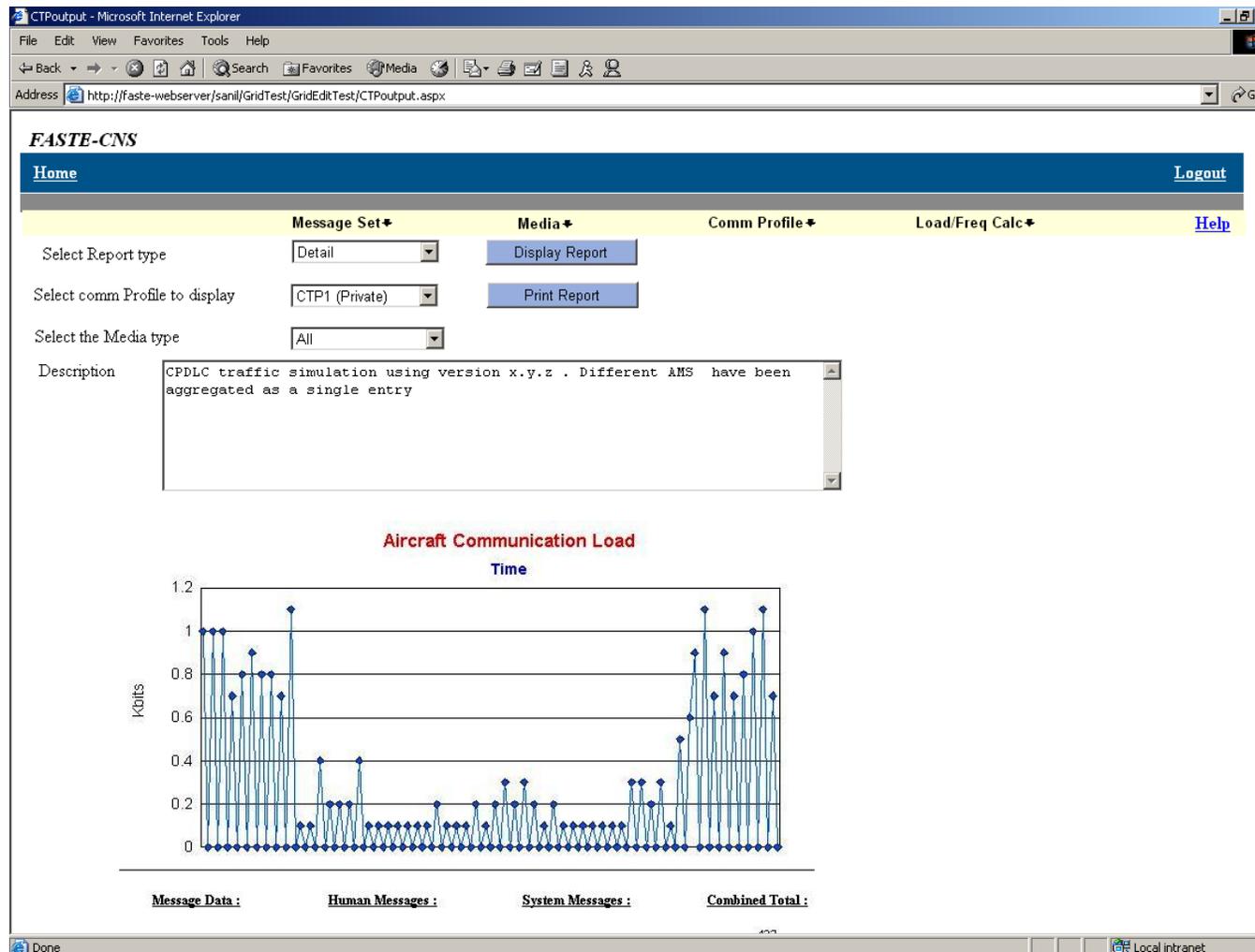
**Message Set : CPDLC 1**  
 Creator : Jill      E-mail : [jill@yahoo.com](mailto:jill@yahoo.com)

Message	Size (Kbits)	Flight Phase	Frequency	Mode	Type	Comments	Delete
UM19	1	Take Off	1	In Phase	Human	Receive	Climb
DM0	3	Take Off	4	In Phase	Human	Transm	Wilco
UM98	1	EnRoute	1	Per Minute	Human	Receive	Turn
DM1	1	EnRoute	1	In Phase	Human	Transm	Unable
UM200	1	EnRoute	1	Per Minute	Human	Receive	No speed limit
DM0	2	EnRoute	2	Per Minute	Human	Transm	Wilco
UM161	5	Landing	5	In Phase	Human	Receive	Cpdlc End
DM0	7	Landing	7	Per Minute	Human	Transm	Wilco
		Take Off		Per Minute	Human	Transm	

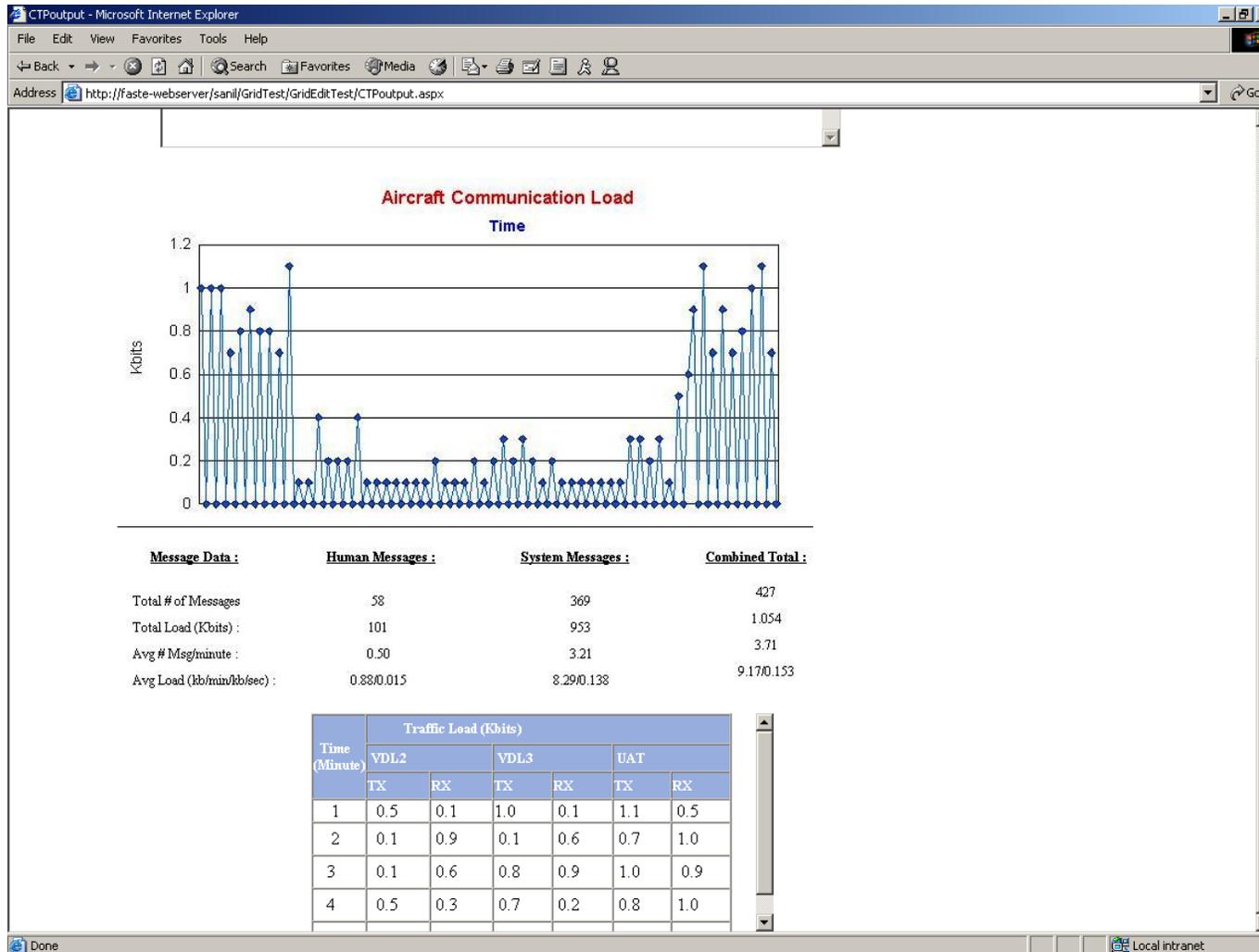
Print      Add New Rows      Delete      Save      Save As

Done      Local intranet

## Comm Profile Report ...



## ...Comm Profile Report



## Aircraft/Comm Profiles

New CFDM: CFDM\_1 - Microsoft Internet Explorer

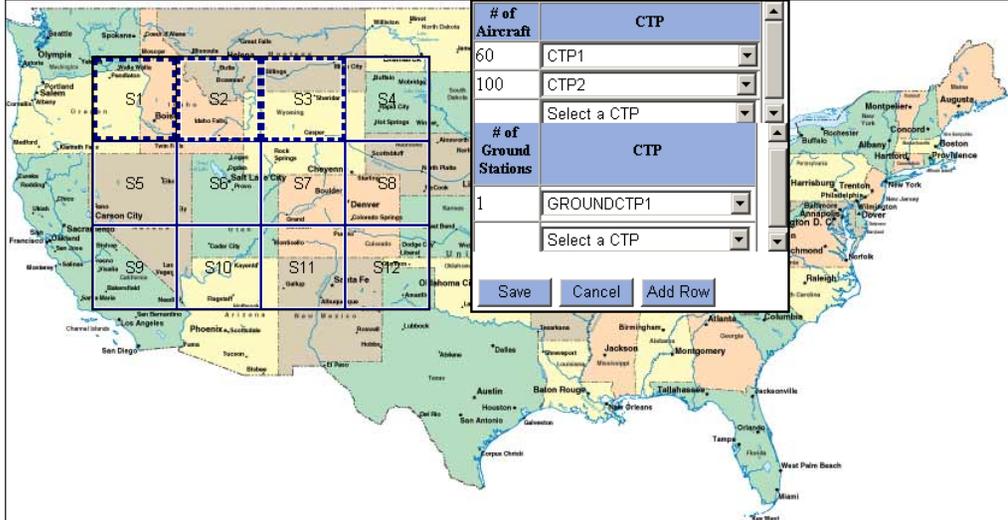
File Edit View Favorites Tools Help

Address <http://faste-webserver/sanil/GridTest/GridEditTest/WebForm2.aspx>

**FASTE-CNS**

[Home](#) [Logout](#)

Message Set\* Media\* Comm Profile\* Load/Freq Calc\* [Help](#)



# of Aircraft	CTP
60	CTP1
100	CTP2
	Select a CTP
# of Ground Stations	CTP
1	GROUNDCTP1
	Select a CTP

Save Cancel Add Row

Note: To create a Region first select the region by clicking and dragging the mouse on the map and then enter the size of the subregion and click Create Subregion.

Enter Subregion size (miles):

Done Local intranet

## Load/Frequency Report ...

WebForm4 - Microsoft Internet Explorer  
 File Edit View Favorites Tools Help  
 http://faste-websrvr/sanll/GridTest/GridEditTest/WebForm4.aspx

**EASTE-CNS** [Home](#) [Logout](#)

[Message Set](#)
[Media](#)
[Comm Profile](#)
[Load/Freq Calc](#)
[Help](#)



Select the Media type:

**Load/Frequency Detail Report For Entire Region**

Media	Total Traffic load	Frequency Required

Local intranet

## ... Load/Frequency Report

WebForm4 - Microsoft Internet Explorer

Address: http://faste-webserver/sanil/GridTest/GridEditTest/WebForm4.aspx



Select the Media type: All

Report Summary

### Load/Frequency Detail Report For Entire Region

Media	Total Traffic load	Frquency Required
VDL2	502	20
VDL3	456	18

### Load/Frequency Detail Report per SubRegion

**SubRegion : S1**

Media	Total traffic load	Frequency Required
VDL2	80.1	3
VDL3	30.5	2

**SubRegion : S2**

Media	Total traffic load	Frequency Required
VDL2	86.4	3
VDL3	51.5	6

Local intranet



## Communication Traffic Generator

### Future Aeronautical Subnetwork Traffic Emulator for CNS (FASTE-CNS)

- Can be viewed as a configuration tool to set-up and define the tests that other CNS models would perform
- Could export configuration data using HLA/RTI
- Could import route models and apply communications traffic loading results from the route concepts developed ACES
- Potential web access mechanism to the Airspace Modeling Toolkit.



# CNS Modeling



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## Modeling Tools

### OPNET Technologies

- Large body of GRC research already done using this modeling software
- Application supports HLA designs/implementation.

### MATLAB

## Issues of Model Realism

In discussing realism of models or simulations, we use two basic terms—Fidelity and Resolution.

- **Fidelity** is the degree to which aspects of the real world are represented in modeling and simulation. Fidelity is a measure of how the model or simulation acts. *Does it act like the real thing?*
- **Resolution** is the degree to which physical (appearance) aspects of the real world would be represented. Resolution is a measure of how the model or simulation looks. *Does it look like the real thing?*

## Issues of Model Accuracy

- How do you know if it is providing an accurate representation of reality?
- Verification is the process of determining that a model implementation accurately represents the developer's conceptual description and specifications. It answers the question, "*Did we build it correctly?*"
- Validation is the process of determining the manner and degree to which a model is an accurate representation of the real-world from the perspective of the intended uses of the model, and of establishing the level of confidence that should be placed on this assessment. It answers the question, "*Did we build the right thing?*"
- Accreditation is the formal certification that a model or simulation is acceptable to be used for a specific purpose. A recognized subject matter expert in the field can accomplish accreditation. Accreditation answers the question, "*Does it meet my needs?*"



## Next Steps

- **Develop CNS Specifications and Requirements** – the CNS work under AATT and DAG-TM is providing direction for these (& other) critical parameters:
  - Message Integrity; Transit Delay (Latency); Precedence
  - Error bands; Position Accuracy; Update rates
  - Process all events vs. an aggregation of events
  
- **Prepare External Interface Details and Specification**
  
- **Define the Appropriate Metrics**

