



Accelerating CNS

FASTE-CNS: A Tool for Performance Evaluation of CNS Technologies

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**Presented by:
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Outline

- **Background**
- **Objectives**
- **Modeling Tool Architecture**
- **Communication Models**
- **Future Work**



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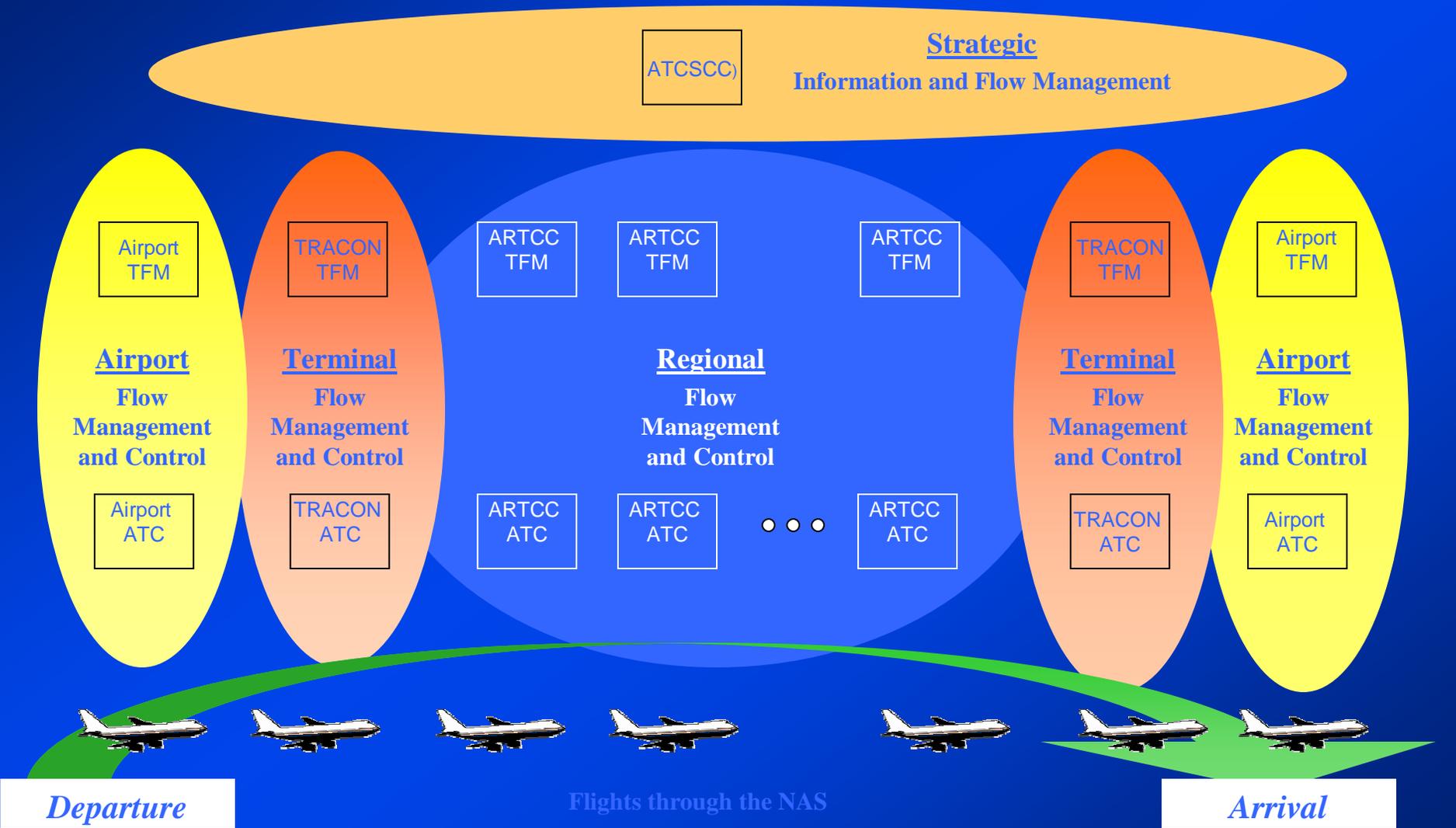
Background

- **Need for effective tools to model and analyze the existing NAS system**
- **NASA initiated Virtual Airspace Modeling and Simulation (VAMS) project with the development of Airspace Concept Evaluation System (ACES)**
- **NASA GRC leading the effort for the development of Communications, Navigation and Surveillance (CNS) models to be integrated into the ACES toolbox**
- **As part of VAMS and VAST efforts NASA sponsored the development of Future Aeronautical Sub-networks Traffic Evaluator (FASTE) for CNS System**



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ACES Agent Architecture and Environment





ACES – Current Communication Status/Limitations

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- **Currently ACES does not support different communication mechanism modeling capability**
- **No differentiation is made between various modes of communication**
- **No delays are associated with message delivery**
 - **Messages are transmitted “instantaneously” to the receiver**
 - **Infinite bandwidth communication medium**
 - **Perfect communication medium**



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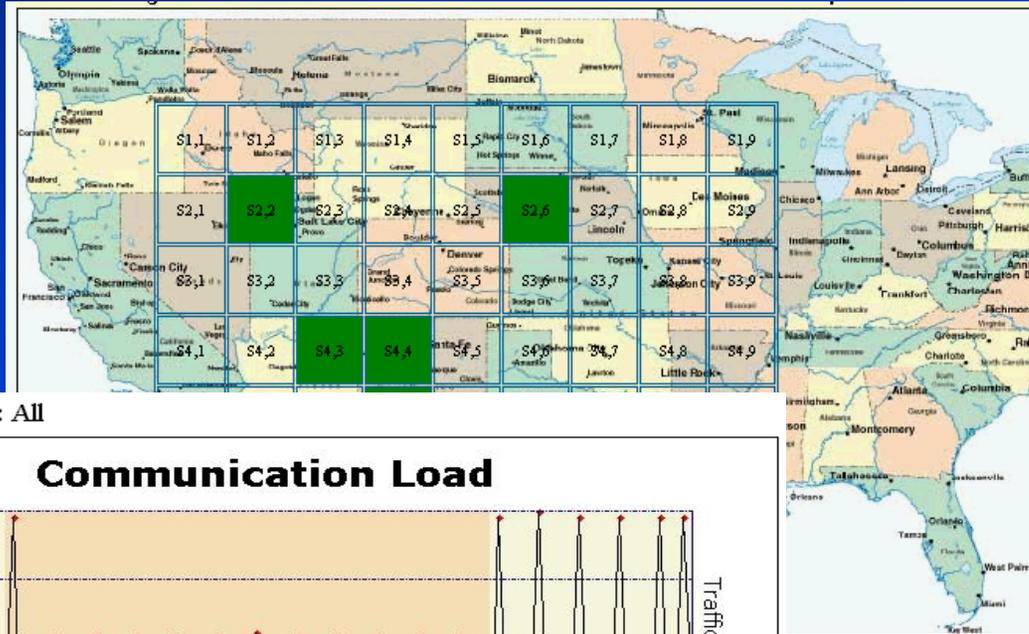
Objectives

- **Supports the usage of ACES data to generate scenarios for the communication models (Post – ACES)**
- **Allows the user to create scenarios by specifying flight profiles, message profiles (Pre-ACES)**
- **Ability to model link performances of Vdl Mode 2, ACARS and Voice**
- **Internet based tool**



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FASTE-C



CfdmAdpInput - Microsoft Internet Ex...

Edit Sub-region(s)

Aircraft

Comm Profile	#
Ground 1A (Library)	20

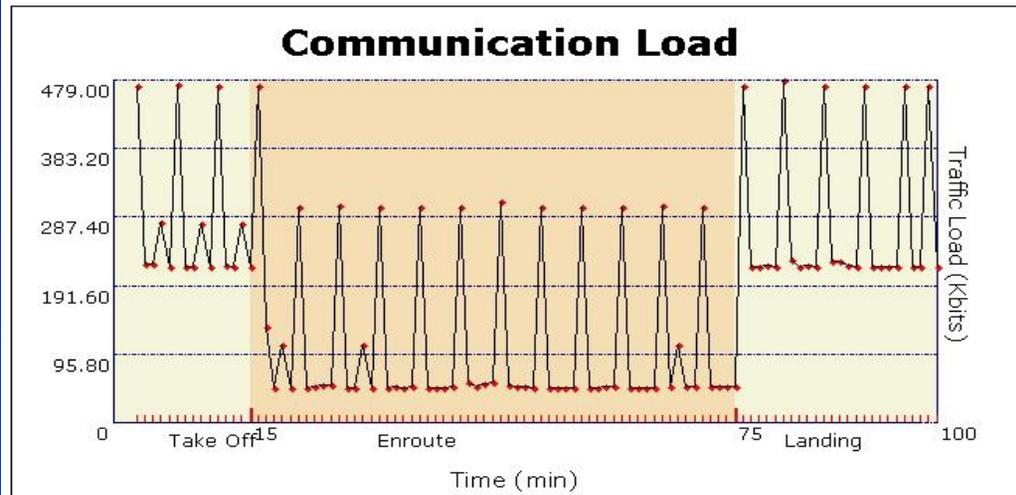
Close Save Add Rows

Ground Station(s)

Comm Profile	#
Ground 1 (Library)	2

Close Save Add Rows

Media Type : All



<u>Message Data</u>	<u>Human Messages</u>	<u>System Messages</u>	<u>Combined Total</u>
Total # of Messages	48	6062	6110
Total Load (Kbits)	59.10	17,662.10	17,721.20
Avg # Msg/Min	0.48	60.62	61.10
Avg Load Kbps	0.010	2.944	2.954

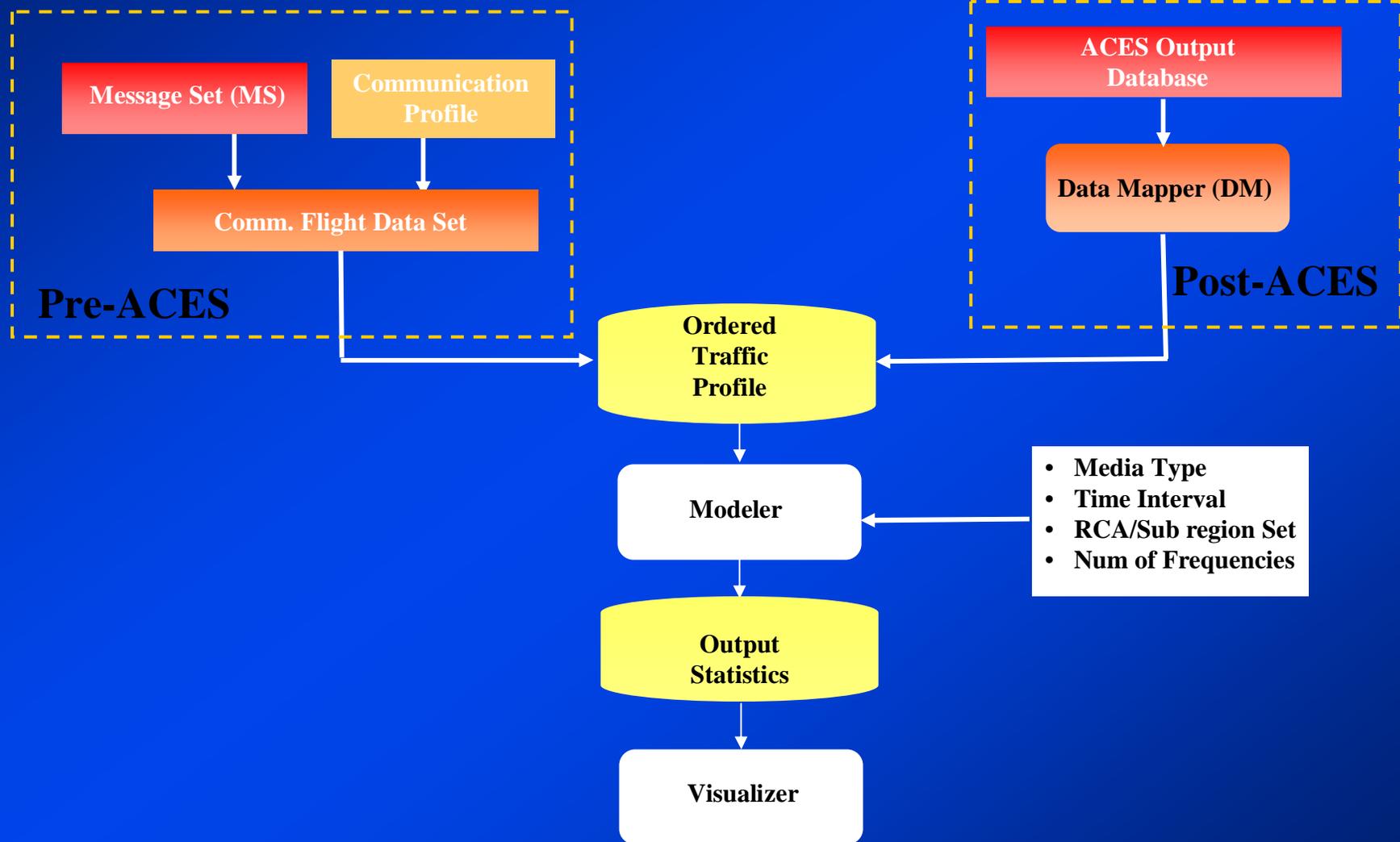
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FASTE-CNS Functional Architecture



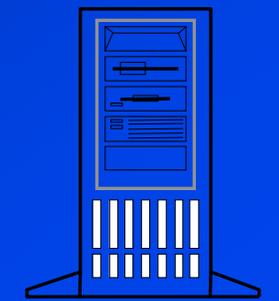


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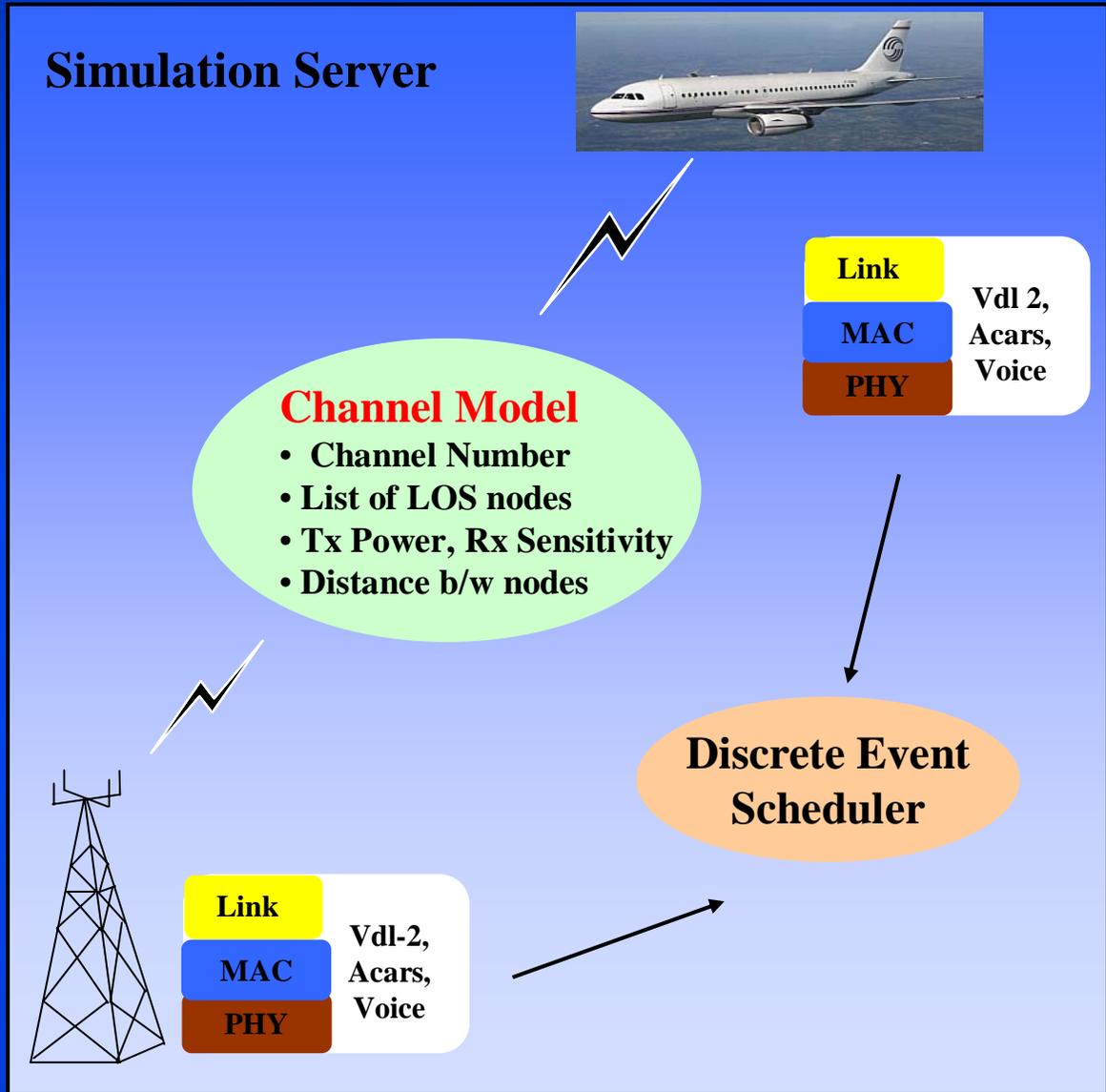
Comm. Model System Architecture



Database Server



Web Server





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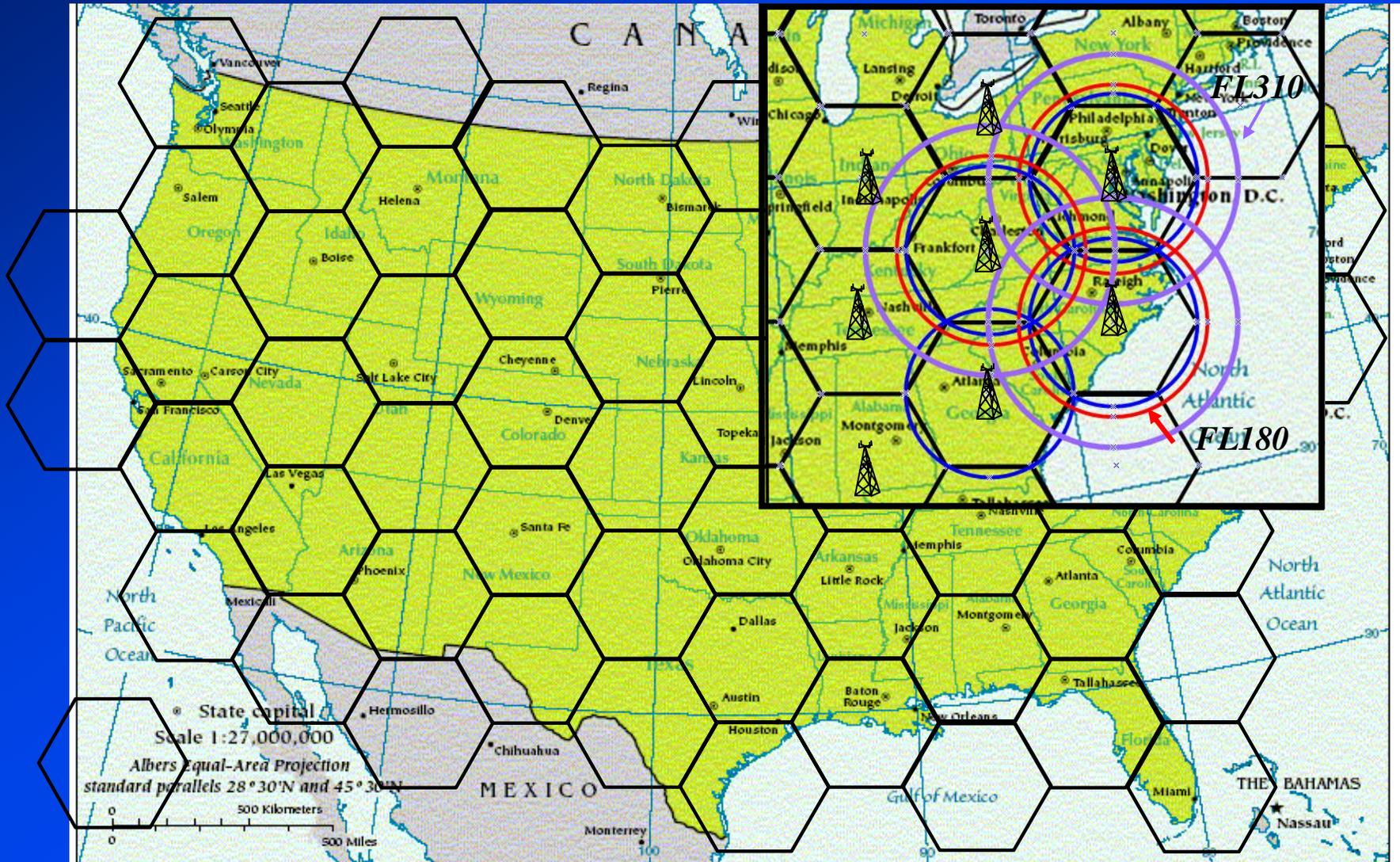
Simulator Design

- **Based on Discrete Event Simulation method**
- **Uses a abstract physical layer model**
- **Each aircraft/ground station has its own copy of the protocol stack**
- **Each layer of the protocol stack is modeled using a Finite State Machine**
- **Aircraft locations updated at regular intervals to support mobility**

Radio Coverage Area (Size 150 NM)

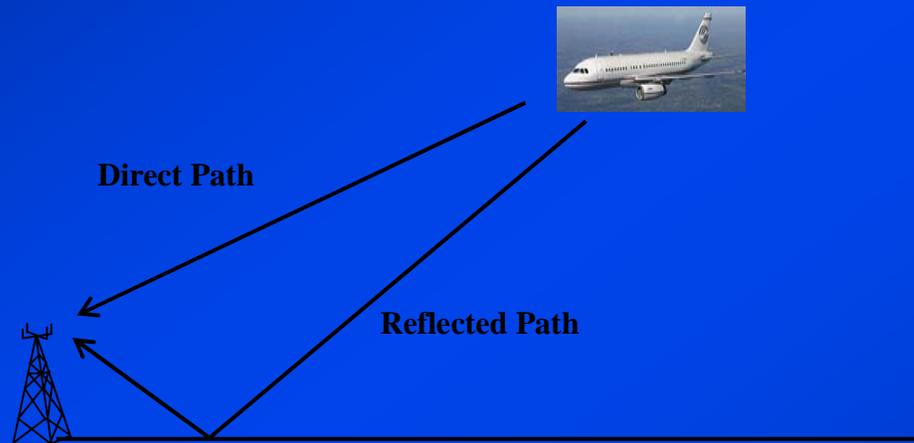


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Radio Propagation Model

- Two Ray Ground Reflection model is used to model the large scale path loss.



- Co-channel interference from nodes within the horizon distance is accounted for calculating SINR.



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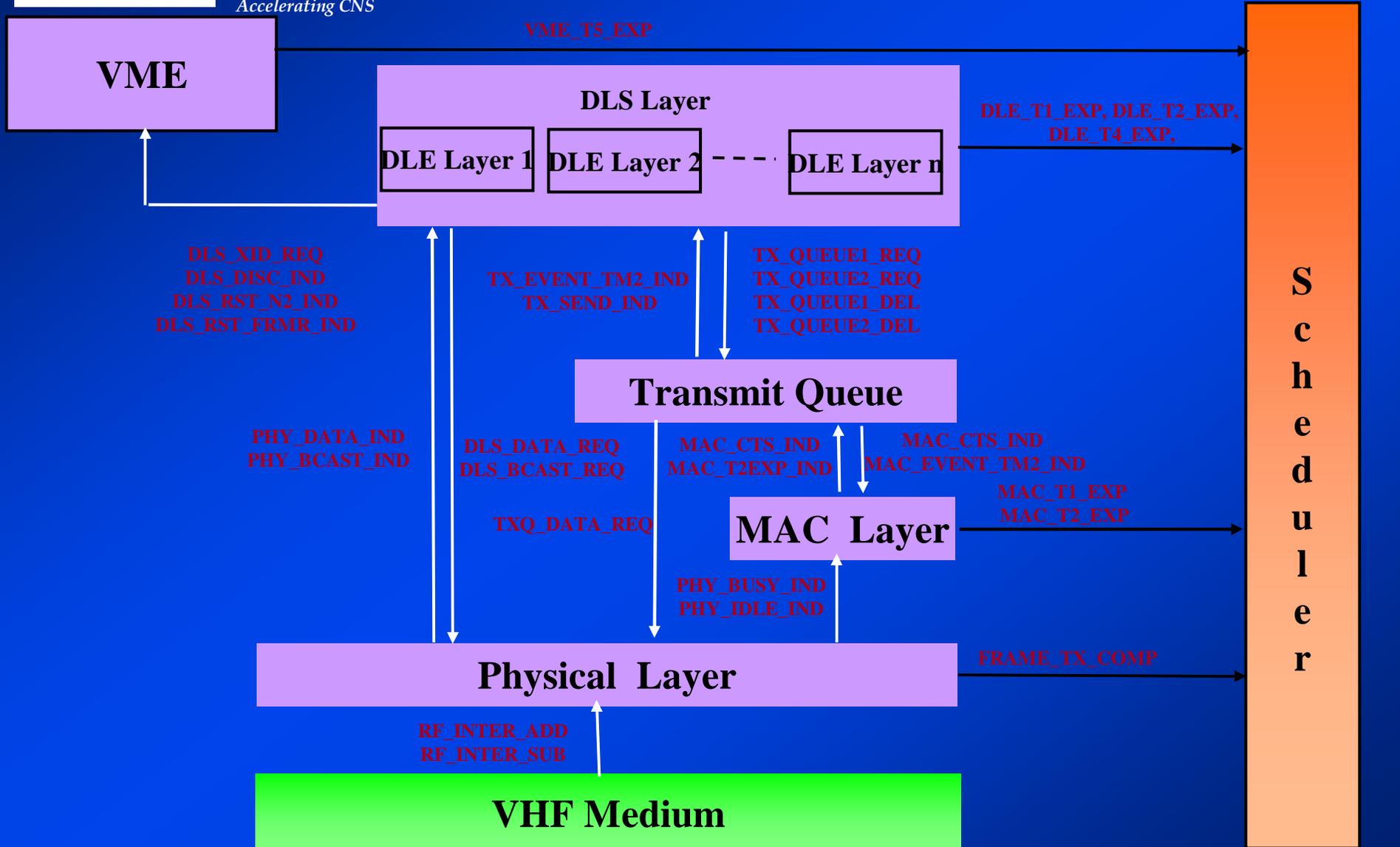
VDL Mode 2 Capability

- **Accurate physical layer model (31.5kbps channel with D8PSK modulation, Reed-Solomon FEC)**
- **p- persistent CSMA protocol based MAC Layer**
- **AVLC protocol with support for SREJ and GOBACK-N mechanism**
- **Priority queuing**
- **Aircraft initiated handoff**
- **Aircraft initiated connection establishment**
- **Support for broadcast data sent by ground station**
- **Multi – frequency support**



VDL Mode 2 Message and Event Diagram

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ACARS Capability

- **Accurate physical layer model (2.4 Kbps channel with MSK modulation)**
- **Non persistent CSMA based MAC Layer**
- **Link layer protocol with Stop and Wait mechanism**
- **Connection less and connection oriented link layer connection mechanism**
- **Aircraft initiated handoff mechanism**
- **Multi-Frequency Support**



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VOICE Capability

- Each voice call is assumed to be a message of a certain duration
- Message is acceptable if received SNIR is above a threshold level
- A message is transmitted immediately if the channel is sensed to be idle else the user waits until the channel is idle
- Link layer protocol with Stop and Wait mechanism
- Aircraft initiated handoff mechanism
- Multi-Frequency Support

Input/Output

- **Simulator Input**
 - Pre ACES or Post ACES data
 - List of RCAs
 - Frequencies associated with each RCA
 - Data Link Type
 - Simulation Time Interval

- **Data Link Performance Parameters (Output)**
 - Message Transmission Delay
 - Network Load
 - Net Throughput
 - Number of Packets Lost
 - Link Utilization



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FASTE CNS Screenshot

Opening Message Set - Microsoft Internet Explorer

Address: http://www.faste-cns.com/PreComAMSOOpen.aspx

Pre-Analysis Communication

Open / Edit Message Set
Open / Edit Message Set

Creator : Sanil Vidyanandan
Email Id : sanil.vidyanandan@cns.w.com
Flight Time: 1 Hour 40 Minutes, Take Off: 15 Minutes , En Route: 60 Minutes , Landing: 25 Minutes

Message Set :
12 sanilv1 (Private - DATA)

Description :
12t- abcd efgh ijklm opqrst uvwxyz abcd efgh ijklm opqrst uvwxyz abcd efgh ijklm opqrst uvwxyz abcd efgh ijklm opqrst

Message	Size(Kbits)	Flight Phase	Freq	Freq Unit	Mode	Type	Comments	Delete
1	1	Take Off	1	Per Minute	Human			
1	1	Take Off	1	Per Minute	Human			
1	1	Take Off	1	Per Minute	Human			
1	1	Take Off	1	Per Minute	Human			
1	1	Take Off	1	Per Minute	Human			
1	1	Take Off	1	Per Minute	Human			
1	1	Take Off	1	Per Minute	Human			
1	1	Take Off	1	Per Minute	Human			
1	1	Take Off	1	Per Minute	Human			
1	1	Take Off	1	Per Minute	Human			
2	2	Take Off	2	Per Minute	Human			

Page 1 of 7
1 2 3 4 5 6 7
Add New Rows Save Print

Address: http://www.faste-cns.com/PreComCFDSOpen.aspx

FASTE - CNS MODELING TOOLS

Home Loading Help Tech Support Logout

Message Sets Application Profiles Flight Data Sets RCA Sets Modeling User Services

Pre-Analysis Communication

Open / Edit Flight Data Set
(VOICE)

Creator : Sanil Vidyanandan
Email Id : sanil.vidyanandan@cns.w.com

Select a Flight Data Set:
Anil3FlightDataSet (Private - VOICE)

Description :

Departure	Arrival	Flight	ID	Dept Time (HH:MM)	Aircraft	Application Profiles	Copy X Times	Delete
file (Private - VOICE)								
file (Private - VOICE)								
file (Private - VOICE)								
file (Private - VOICE)								
file (Private - VOICE)								
file (Private - VOICE)								
file (Private - VOICE)								
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file (Private - VOICE)								
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file (Private - VOICE)								
file (Private - VOICE)								
file (Private - VOICE)								

Opening Flight Data Set - Microsoft Internet Explorer

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Pre-Analysis Communication

Open / Edit Flight Data Set
(VOICE)

Creator : Sanil Vidyanandan
Email Id : sanil.vidyanandan@cns.w.com

Select a Flight Data Set:
Anil3FlightDataSet (Private - VOICE)

Description :

Departure	Arrival	Flight	ID	Dept Time (HH:MM)	Aircraft	Application Profiles	Copy X Times	Delete
IND	CLE	NASA1		08:00	Boeing 777	Anil3AppProfile (Private - VOICE)		
IND	CLE	NASA2		08:20	Boeing 767	Anil3AppProfile (Private - VOICE)		
CLE	IND	NASA3		08:05	Boeing 737	Anil3AppProfile (Private - VOICE)		
ABE	ABE				Airbus 300	Anil3AppProfile (Private - VOICE)		
ABE	ABE				Airbus 300	Anil3AppProfile (Private - VOICE)		
ABE	ABE				Airbus 300	Anil3AppProfile (Private - VOICE)		
ABE	ABE				Airbus 300	Anil3AppProfile (Private - VOICE)		
ABE	ABE				Airbus 300	Anil3AppProfile (Private - VOICE)		
ABE	ABE				Airbus 300	Anil3AppProfile (Private - VOICE)		
ABE	ABE				Airbus 300	Anil3AppProfile (Private - VOICE)		
ABE	ABE				Airbus 300	Anil3AppProfile (Private - VOICE)		
ABE	ABE				Airbus 300	Anil3AppProfile (Private - VOICE)		
ABE	ABE				Airbus 300	Anil3AppProfile (Private - VOICE)		
ABE	ABE				Airbus 300	Anil3AppProfile (Private - VOICE)		
ABE	ABE				Airbus 300	Anil3AppProfile (Private - VOICE)		
ABE	ABE				Airbus 300	Anil3AppProfile (Private - VOICE)		



FASTE CNS Example Model Report

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File Edit View Favorites Tools Help

Address: http://www.faste-cns.com/fastec/PostComModelReport.aspx?id=70

FASTE - CNS MODELING TOOLS Home Help Tech Support Logout

RCA Set Modeling User Services

Post-Analysis Communication

Modeled Report

Applet hexagonApp started

Start Time: 20:00 Duration: 12:00 Acceptable Delay (95th Percentile): 4 (secs)

Aces Data Set: ACES2Data12Mar2004_223600_To_13Mar2004_113000

RCA Set: 10th Ka Example -1

RCA	Frequency	Average Load (bits/s)	Peak Load (bits/s)	Average Delay (sec)	Peak Delay (sec)	Delay Acceptable	Frequency Required	Comm. Errors
RCA2,7	1	10.86	127.85	0.94	6.66	No	1	62
RCA2,9	1	166.00	1769.78	2.10	13.08	No	1	91
RCA3,6	1	3.39	37.14	0.12	0.46	Yes	1	0
RCA3,8	1	1.99	25.69	0.18	4.49	Yes	1	0
RCA3,9	1	27.77	490.76	0.48	4.93	Yes	1	3

Applet hexagonApp started

Internet



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Future Work

- **Benchmark the results of the CNS models**
- **Integrate the FASTE-CNS models into ACES**
- **Incorporate models for other data link protocols such as VDL Mode 3, VDL mode 4, SATCOM.**



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