IPv6 Test Bed for Testing Aeronautical Applications

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Abstract— Aviation industries in United States and in Europe are undergoing a major paradigm shift in the introduction of new network technologies. In the US, NASA is also actively investigating the feasibility of IPv6 based networks for the aviation needs of the United States. In Europe, the Eurocontrol lead, Internet Protocol for Aviation Exchange (iPAX) Working Group is actively investigating the various ways of migrating the aviation authorities backbone infrastructure from X.25 based networks to an IPv6 based network. For the last 15 years, the global aviation community has pursued the development and implementation of an industry-specific set of communications standards known as the Aeronautical Telecommunications Network (ATN). These standards are now beginning to affect the emerging military Global Air Traffic Management (GATM) community as well as the commercial air transport community. Efforts are continuing to gain a full understanding of the differences and similarities between ATN and Internet architectures as related to Communications, Navigation, and Surveillance (CNS) infrastructure choices.

This research paper describes the implementation of the IPv6 test bed at NASA GRC, and Computer Networks & Software, Inc. and these two test beds are interface to Eurocontrol over the IPv4 Internet. This research work looks into the possibility of providing QoS performance for Aviation application in an IPv6 network as is provided in an ATN based network. The test bed consists of three autonomous systems. The autonomous system represents CNS domain, NASA domain and a EUROCONTROL domain. The primary mode of connection between CNS IPv6 testbed and NASA and EUROCONTROL IPv6 testbed is initially a set of IPv6 over IPv4 tunnels. The aviation application under test (CPDLC) consists of two processes running on different IPv6 enabled machines.

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Objectives

- Test Bed designed to foster research into using IPv6 for Aeronautical Communications and Services.
- Foster IPv6 research to build towards ICAO standardization activities.
- Understand the transition approach for addressing and interoperability.
- Demonstrate secure ATM applications.
- Publish international proceedings defining the use of IPv6 in Aviation.

Eurocontrol Network

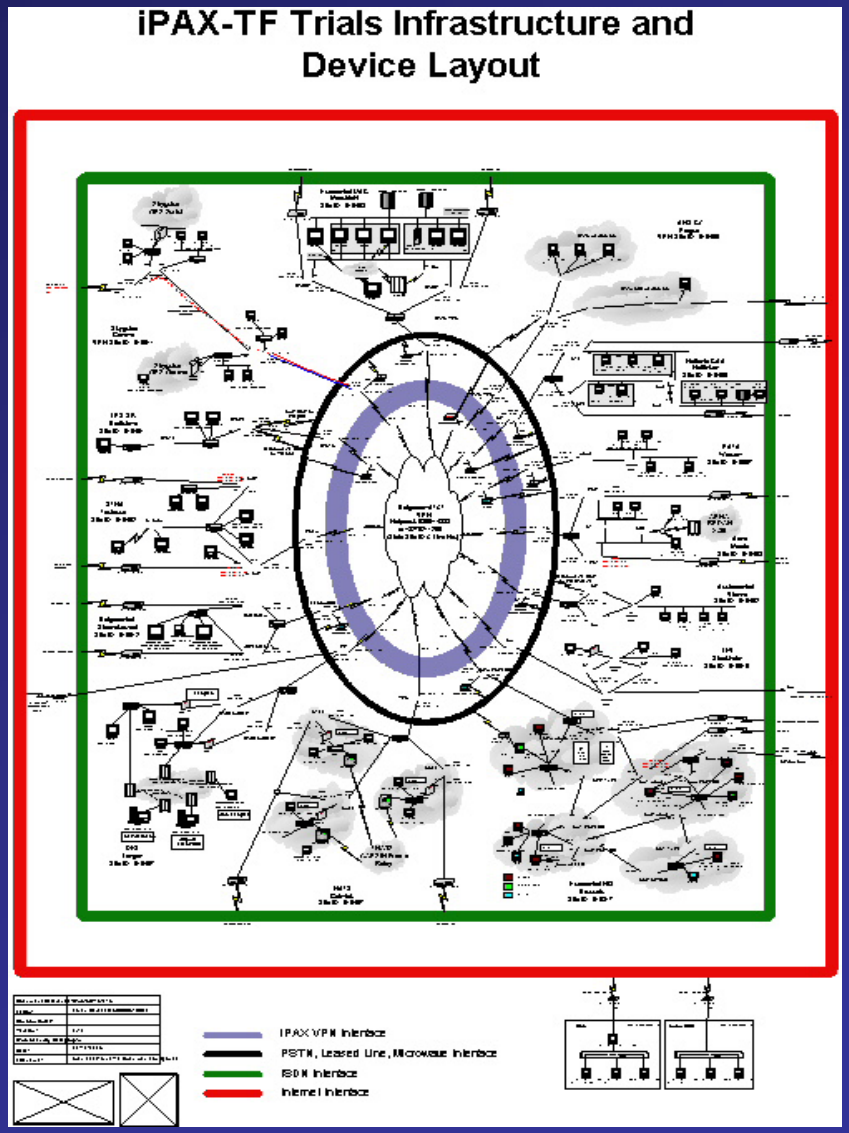
This network map describes the connectivity of the experimental IPv6 network and it's participating neighbors.

There are 18 neighbor sites connecting in a mesh configuration back to Eurocontrol. The neighbor sites are all member states of the Eurocontrol Air Traffic Control network.

Most connections are native IPv6. 6-in-4 tunneling was used only where there was no other reasonable option to connect.

This network test came about because of the announcement by Nortel to discontinue sales and support of legacy X.25 network hardware and software.

The end goal of this network is to verify that IPv6 can be used reliably, and efficiently, as a means to interconnect legacy ATC systems in a modern network world.



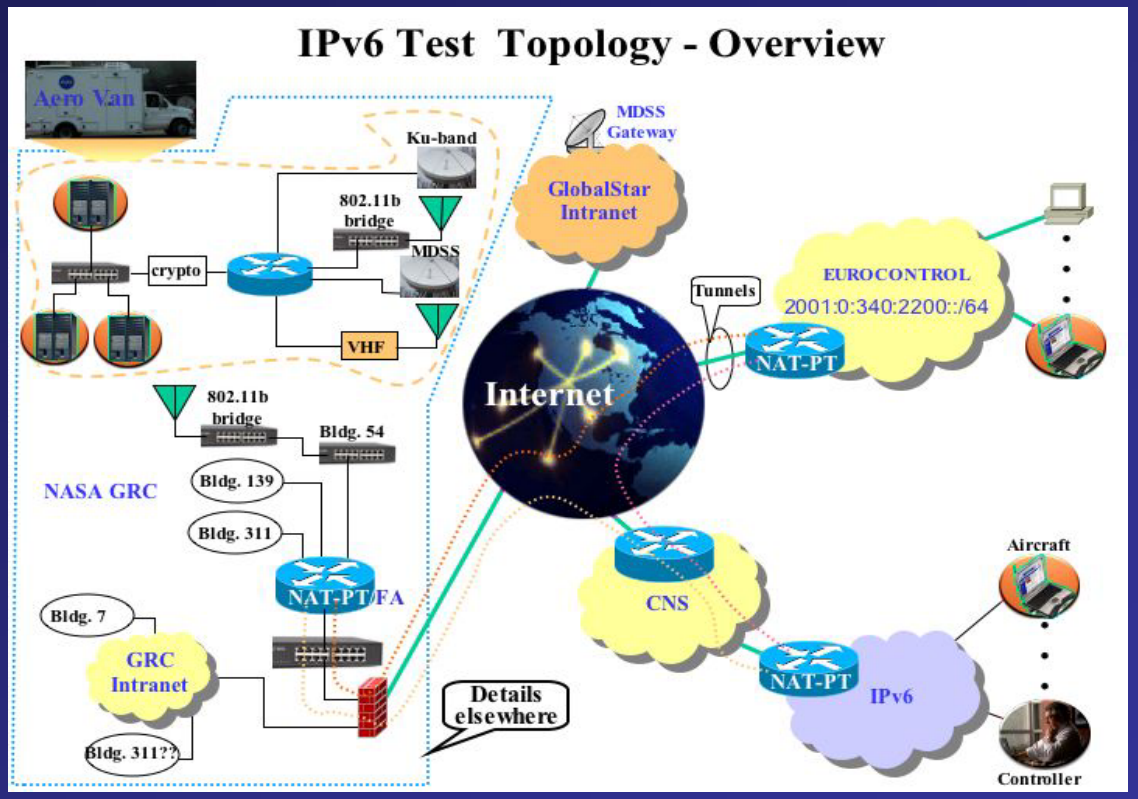
GRC / CNS Network

This diagram describes the network in place between Eurocontrol, CNS, and NASA Glenn.

It relies on the public internet for connecting the different physical locations together.

The Ku-band satellite terminals are Glenn-centric. They are used to communicate between the AeroVan and Building 311 at NASA Glenn.

NAT-PT is used to translate IPv4 to IPv6, and vice versa.



The MDSS (Medium Data-rate Satellite System) is an L-band system designed to be flown on large corporate and transport category jets. Globalstar provides the space segment and ground stations. Their network is NAT'd IPv4. Special arrangements had to be made to allow the MDSS terminal to participate in the IPv6 experimental network.

Mobile IPv4 (NEMO) is currently used to support network mobility requirements. A transition to Mobile IPv6 is planned.

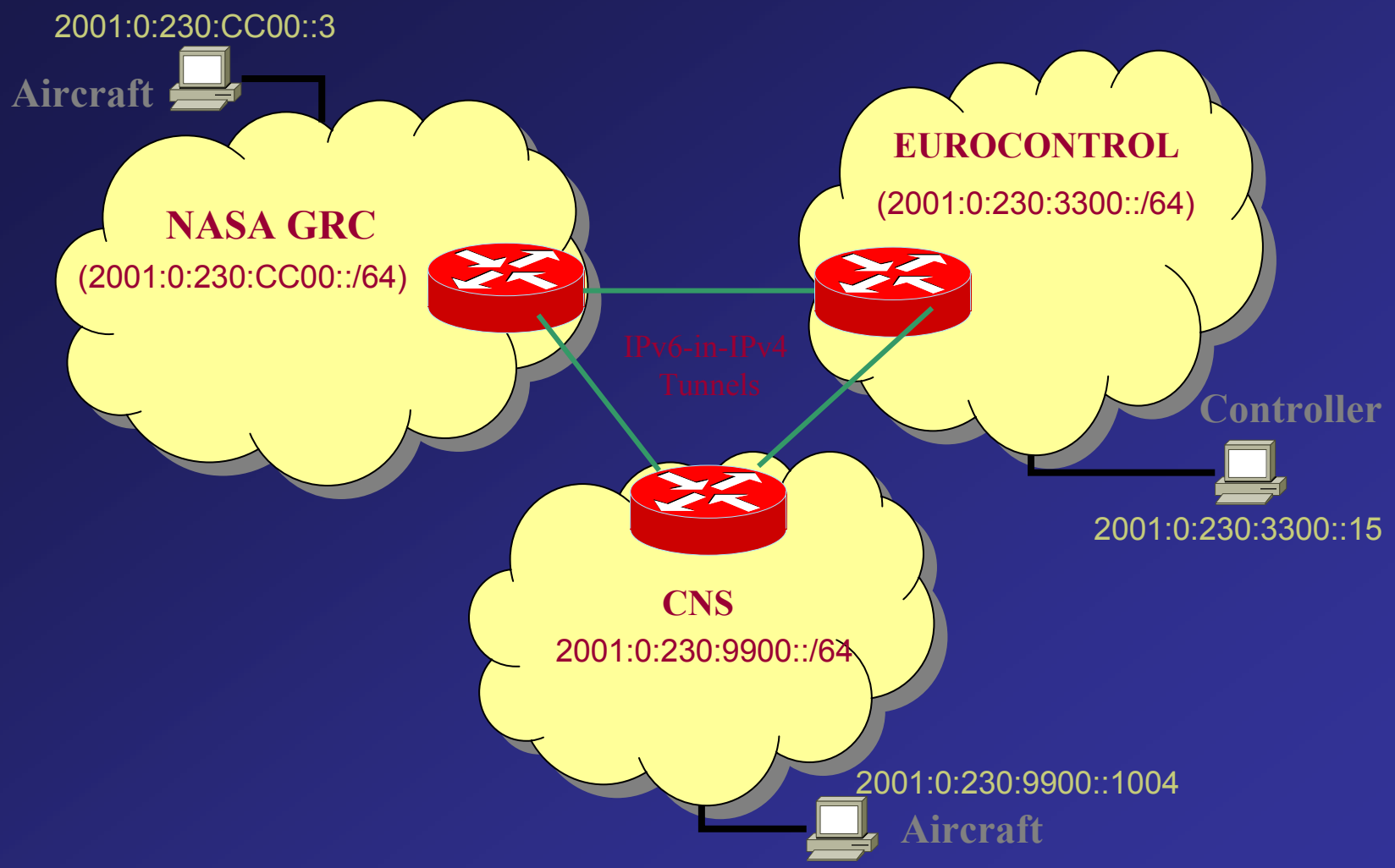
Phase I - Project Status

Task	Status	Closing Date
• IPv6 Ping		
– Identification and procurement of operating system/test Machines	Updated (Red Hat Linux 8.0)	03/25/2003
– Configuration of IPv6 on Test Machine	Completed	03/06/2003
– IPv6 to IPv6 Ping (Internal test network configuration I)	Completed	03/12/2003
– IPv6 over IPv4 tunnel Ping (Internal test network configuration II)	Completed	03/13/2003
– Request IPv4 Address of tunnel end point at EUROCONTROL from NASA/EUROCONTROL (Configuration I)	Completed	05/12/2003
– IPv6 Address allocation from EUROCONTROL	Completed	04/01/2003
– Testing of IPv6 ping with NASA GRC	Completed	08/07/2003
– Testing of IPv6 ping with EUROCONTROL/NASA	Completed	04/30/2003
• CPDLC Over IPv6		
– Modification to CPDLC application to migrate from IPv4 to IPv6	Completed	03/10/2003
– Testing of CPDLC on IPv6 (Internal test network)	Completed	03/14/2003
– Testing of CPDLC on IPv6 over IPv4 tunnel Ping (Internal test network)	Completed	03/14/2003
– Configuration/Installation of CPDLC on NASA/EUROCONTROL node	Completed	04/15/2003
– Testing of CPDLC over IPv6 with EUROCONTROL	Completed	04/28/2003

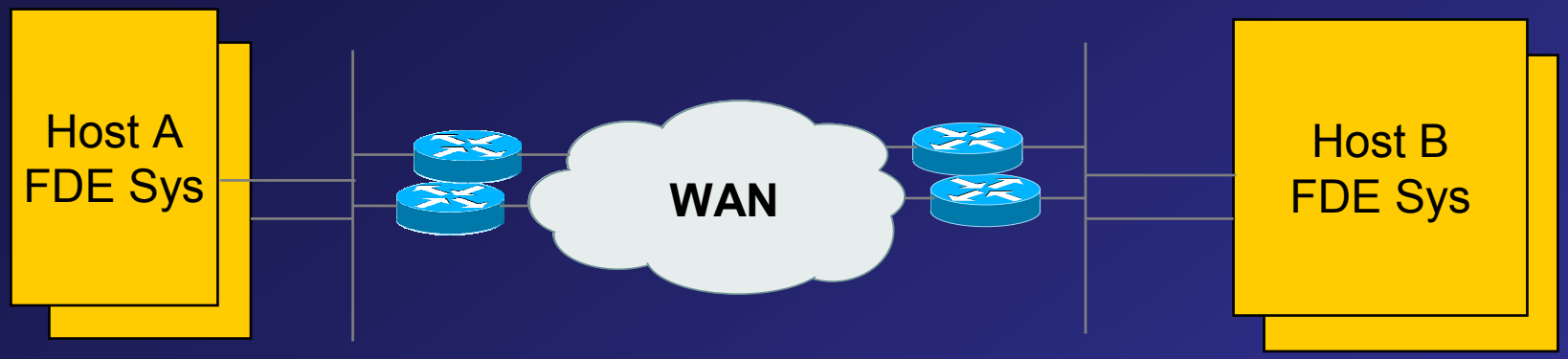
Phase II Overview

- Build on Phase I architecture.
- CPDLC over IPv6 trials.
- OLDI over IPv6 trials.
- Real-time streaming media
- Quality of Service
- Voice over IP
- Public Key Infrastructure and Security

CPDLC over IPv6



OLDI over IPv6



Host A : IP address 194.100.100.2
FDE Sys TCP port = random

Host B : IP address 193.221.168.100
FDE Sys TCP port = 8500 (well known port)

1

IP SRC 194.100.100.2
IP DST 193.221.168.100
TCP Port SRC 15256
TCP Port DST 8500

TCP Client Connect Request

2

3

IP SRC 193.221.168.100
IP DST 194.100.100.2
TCP Port SRC 8500
TCP Port DST 15256

4 TCP informs FDE Sys of an established connection

Summary

- Identified an area for innovation in Aviation.
- Established relationships with industry partners and organizations.
- Verified basic IPv6 connectivity requirements
- CPDLC over IP, and OLDI over IP tests are ramping up.
- The use of Mobile-IPv6 to connect different ATC networks is being tested.

Questions and Contact Info

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