International Civil Aviation Organization

North American, Central American and Caribbean Office

Third MEVA II / REDDIG Coordination Meeting (MR/03)

Mexico City, Mexico 26 to 28 July 2006

MR/03-IP/03

20/07/06

Agenda Item 1:   **Follow-up to the Conclusions of GREPECAS, MR/2 and ALLPIRG/5 Meetings on the integration/interconnection of the VSAT MEVA II and REDDIG networks**

AN OVERVIEW OF VSAT FOR AERONAUTICAL COMMUNICATIONS

(Presented by the Secretariat)

1.   Introduction

1.1   This information paper presents to the Meeting an overview of VSAT (Very Small Aperture Terminal) for Aeronautical Communications; a copy of this presentation is included in the **Appendix** to this Paper.
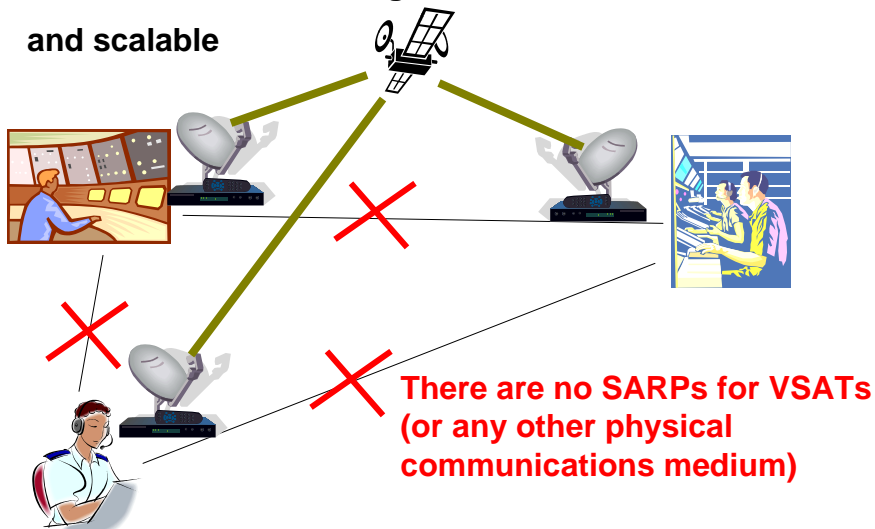
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APPENDIX

An Overview of VSAT for Aeronautical Communications

Very Small Aperture Terminal

By: Masoud Paydar
ICAO Secretariat

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* **VSATs are used in areas where leased circuits (for AFS) are unreliable (or uneconomical)**

* **VSATs networks are, in general, versatile, economical and scalable**

There are no SARPs for VSATs (or any other physical communications medium)
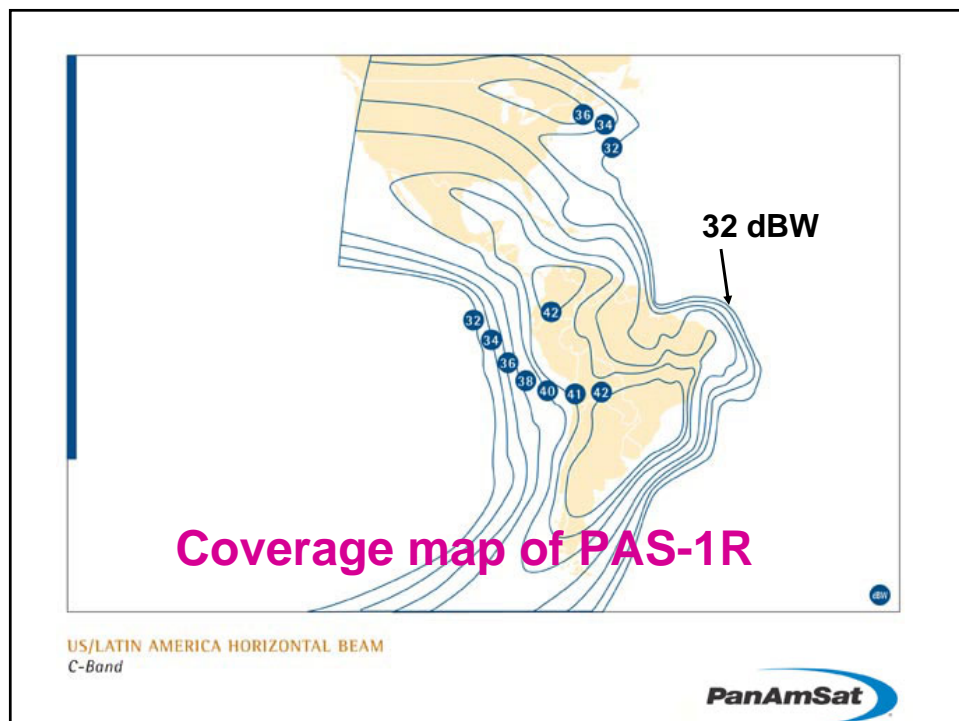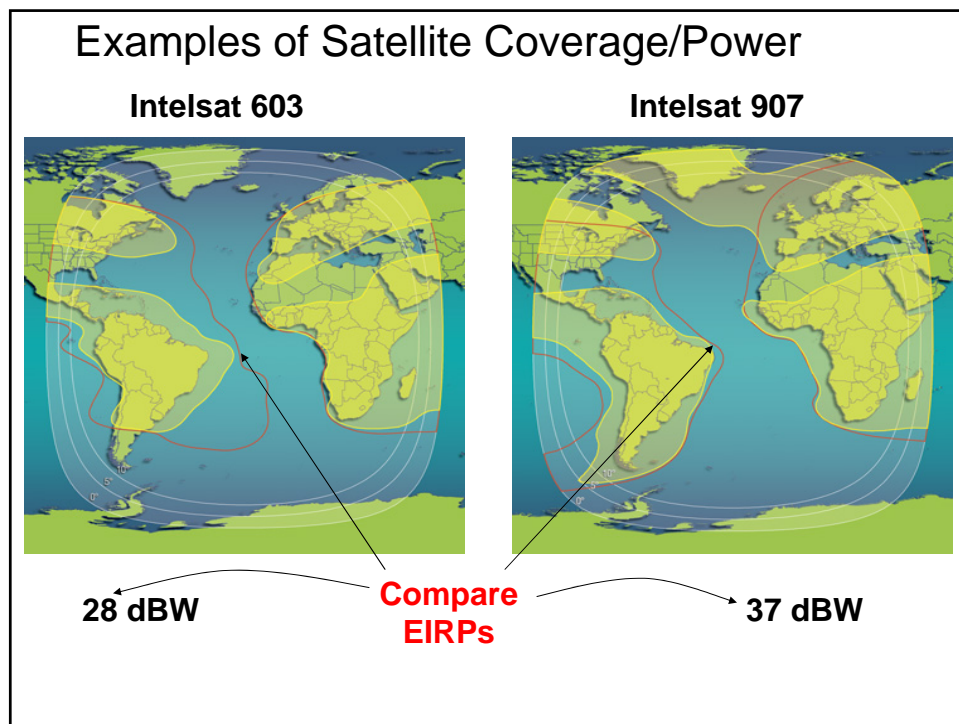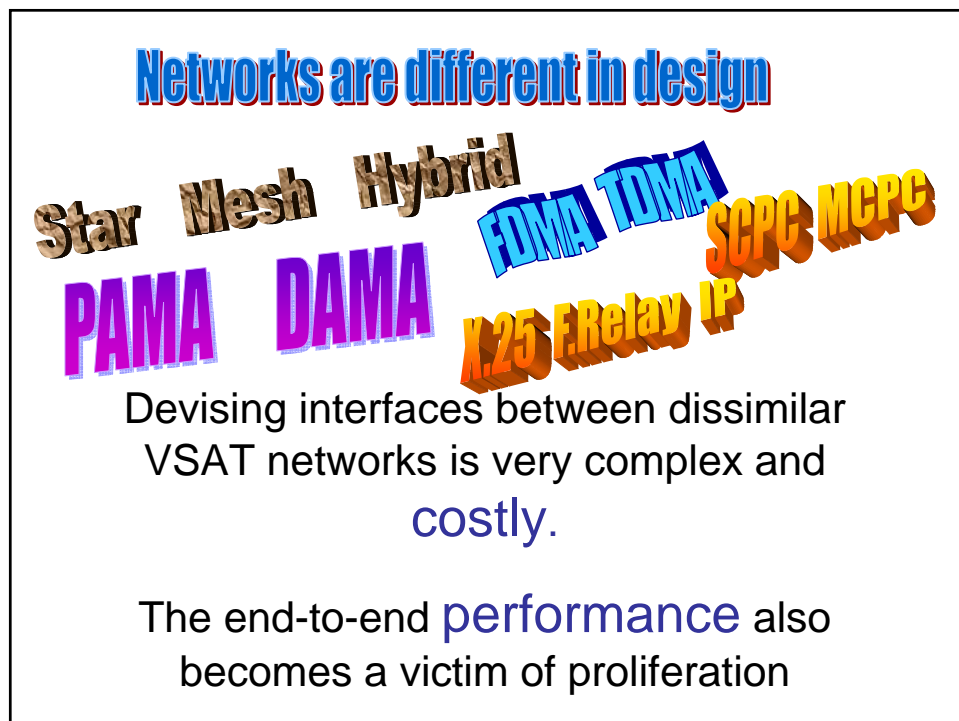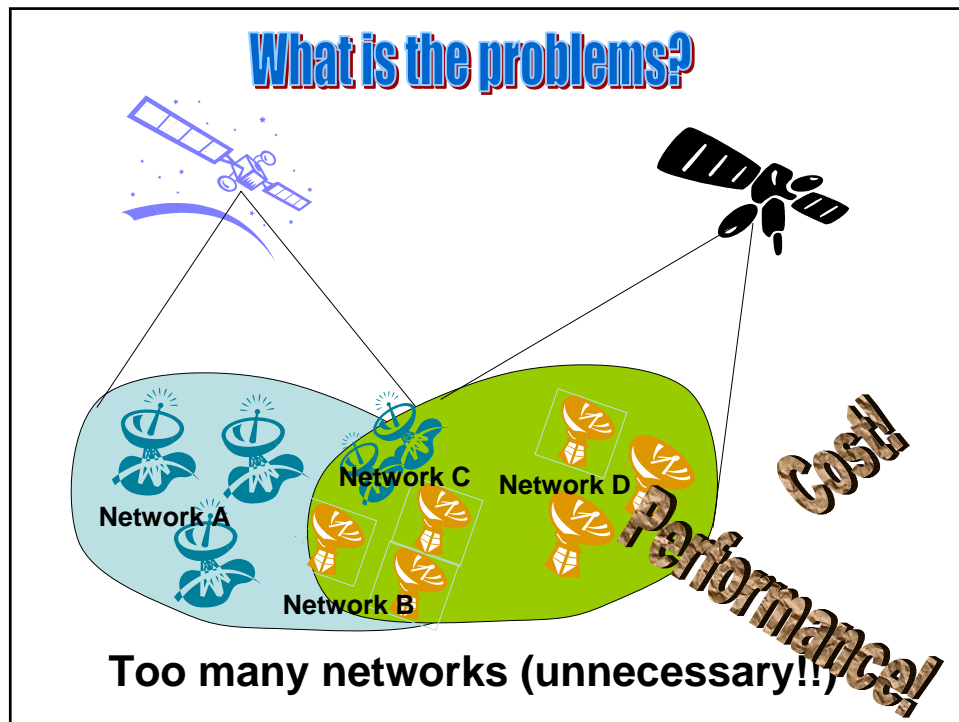
Very Small Aperture Terminal (VSAT)

How small?

* No universal definition!
* ETSI: Up to 3.8 m at Ku band (12-14 GHz)

Up to 7.8 m at C band (4- 6 GHz)
* Typical sizes available today (for C-band):

1.8 and 2.4 m for remote TX/RX

7 to 9 m for HUBs.
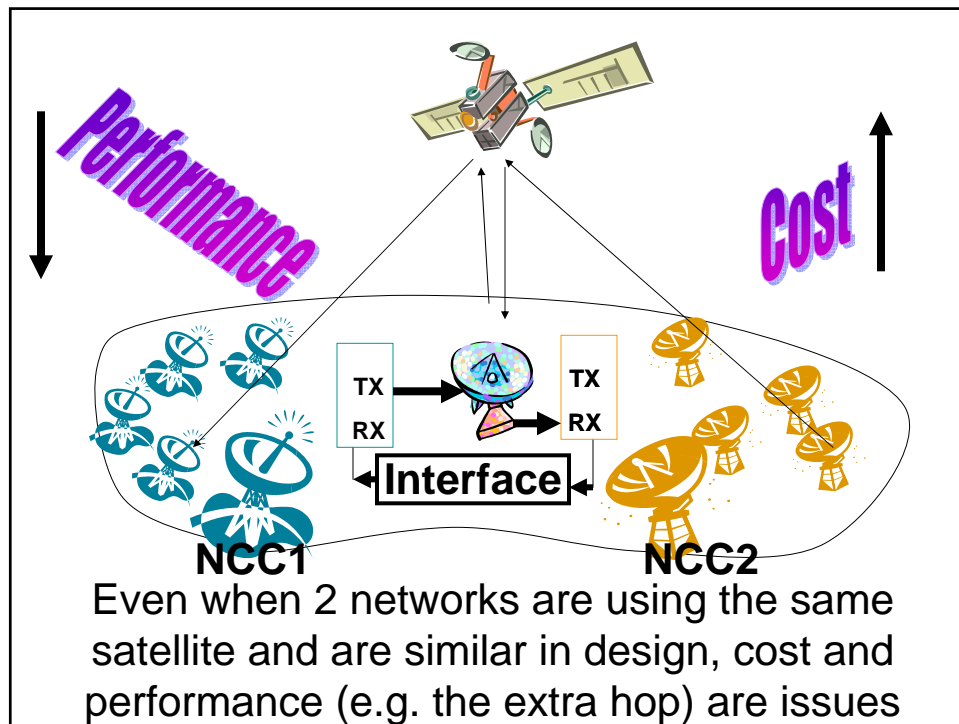

VSAT Design Parameters……….Typical figures

Traffic type and volume ……………..Voice/Data

Bit rate per VSAT terminal……………64 kbps

Band …………………………………C – Band (for CAR/SAM)

Satellite………………………………several choices

Network configuration (Star, mesh, hybrid)……mesh

Antenna size…………………………………2.4 m

Access technique (FDMA, TDMA)………………..TDMA

Mode of assignment………………………………DAMA & PAMA

Protocols supported …………………………Several (e.g. IPS)

Satellite transponder capacity and charges…….Depends

Network Control Centre…………………………..Depends

Examples of Satellite Coverage/Power

Intelsat 603   **Intelsat 907**

28 dBW   **Compare EIRPs**   **37 dBW**

32 dBW

Coverage map of PAS-1R

US/LATIN AMERICA HORIZONTAL BEAM
C-Band

PanAmSat

Performance

Cost

TX
RX

TX
RX

Interface

NCC1

NCC2

Even when 2 networks are using the same satellite and are similar in design, cost and performance (e.g. the extra hop) are issues

Use of correct terminology

Interconnection?

Interoperability?

integration?

Network
A

Network
B

Integration means that the two networks effectively become one! (the preferred option if feasible)

ALLPIRG/5 Conclusions on VSAT (Approved by ICAO Council on 13 June 2006):

5/16 – Implementation of VSATs

That PIRGs

a) discourage the proliferation of VSAT networks where one/some of the existing ones can be expanded to serve the new areas of interest;

b) work towards integrated regional/interregional digital communication networks with a single (centralized) operational control and preferably based on the Internet Protocol (IP); and

c) give due consideration to managed network services (e.g. a virtual private network (VPN)), subject to availability and cost effectiveness.

ALLPIRG/5 Conclusions (cont'd)

Conclusion 5/17 – Provisions for digital communication networks

That ICAO:

a) expedite the development of provisions relating to the use of the Internet Protocol Suite (IPS) in the aeronautical telecommunications infrastructure; and

b) initiate the development of provisions governing the end-to-end performance of digital communication networks, irrespective of the technologies and protocols used therein.
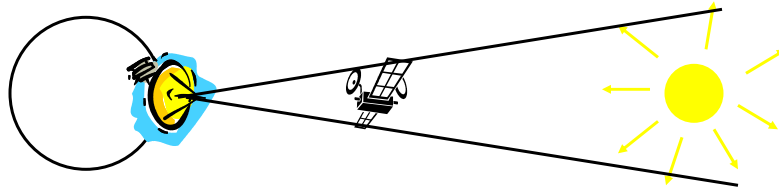
PERFORMANCE PARAMETERS
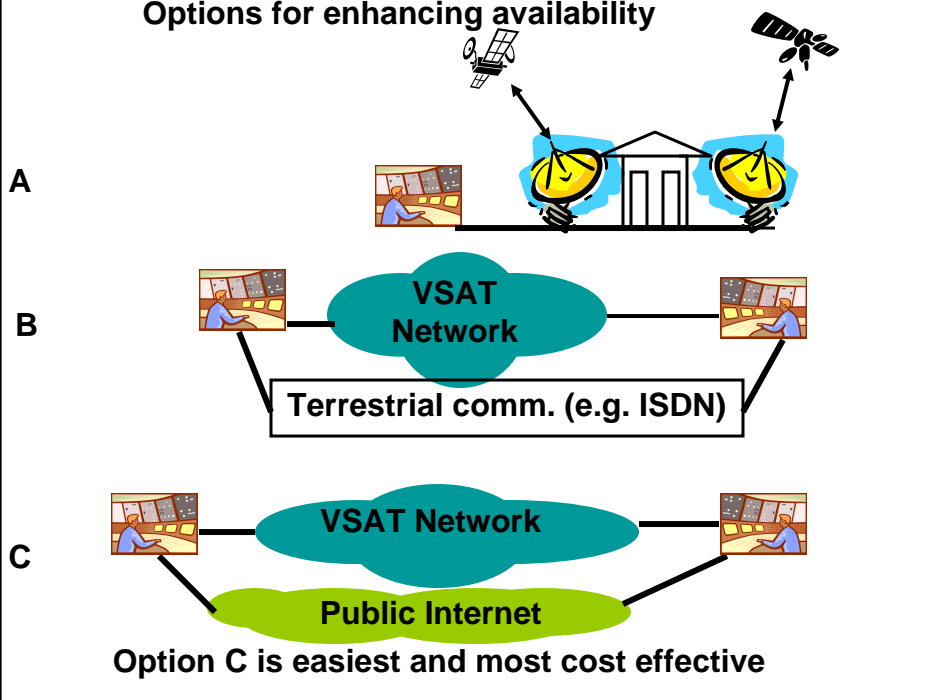
AVAILABILITY

99%? - 99.999%? LET'S BE REASONABLE

Assuming no equipment failure, a single 2.4 m C-band VSAT in Mexico City looking at PAS-1R, will experience sun outages about 2 hours per year.

Maximum availability is therefore 99.97%

Allowing for other expected problems, 99.7% (about 26 hrs of outage per year) is a reasonable figure.
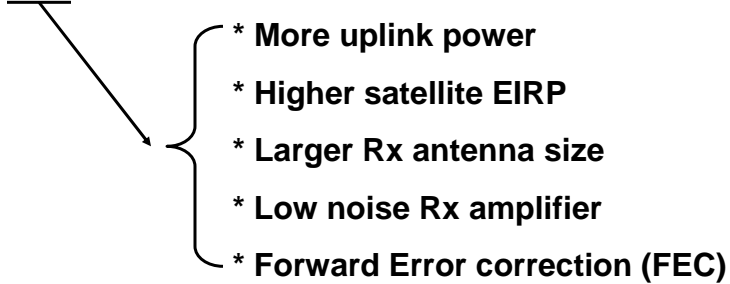
Options for enhancing availability

A

B

VSAT Network

Terrestrial comm. (e.g. ISDN)

C

VSAT Network

Public Internet

Option C is easiest and most cost effective

PERFORMANCE PARAMETERS
Bit Error Rate (BER)

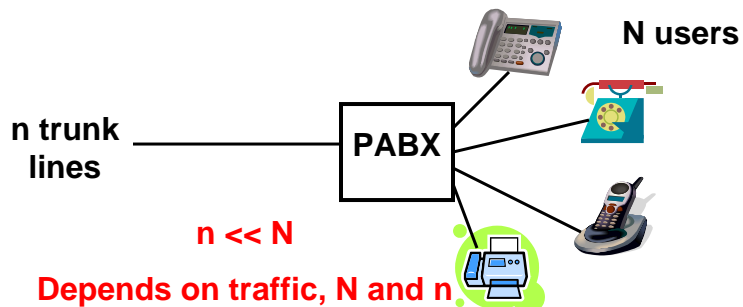**Errors are caused by noise. Higher Signal to Noise Ratio (SNR) reduces BER.**

* More uplink power

* Higher satellite EIRP

* Larger Rx antenna size

* Low noise Rx amplifier

* Forward Error correction (FEC)

A reasonable figure for VSAT BER is 10^{-7}

PERFORMANCE PARAMETERS
Voice Blocking Probability

N users

n trunk lines ⎯⎯⎯ **PABX**

n << N

Depends on traffic, N and n

Similarly, if there are N VSAT terminals, it is too costly (& outdated) to have N voice channels available at all times for ATS-DS circuits (for total non-blocking performance).

In a modern VSAT network, a blocking probability of 0.25% is quite reasonable (i.e. one in 400 attempts will be unsuccessful).

PERFORMANCE PARAMETERS
Voice Delay (latency)

According to ITU-T Rec. G.114, one-way voice latency limits are:

* less than 150 ms for most users

* 150- 400 ms, acceptable if can be tolerated by users

* above 400 ms, unacceptable for general network planning purposes
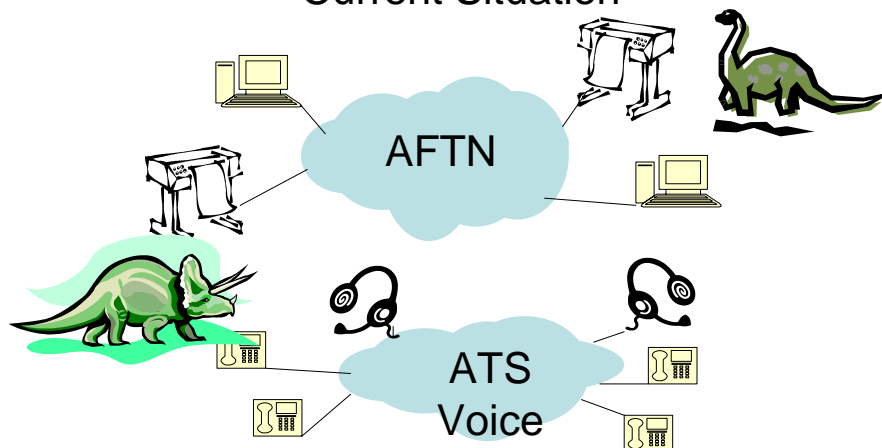**(though may be unavoidable in some cases)**

RF Propagation delay (one hop) >= 240 ms

Hub   **Star**   **Mesh**

delay>=480 ms   **delay>=240 ms**
(unacceptable!!)

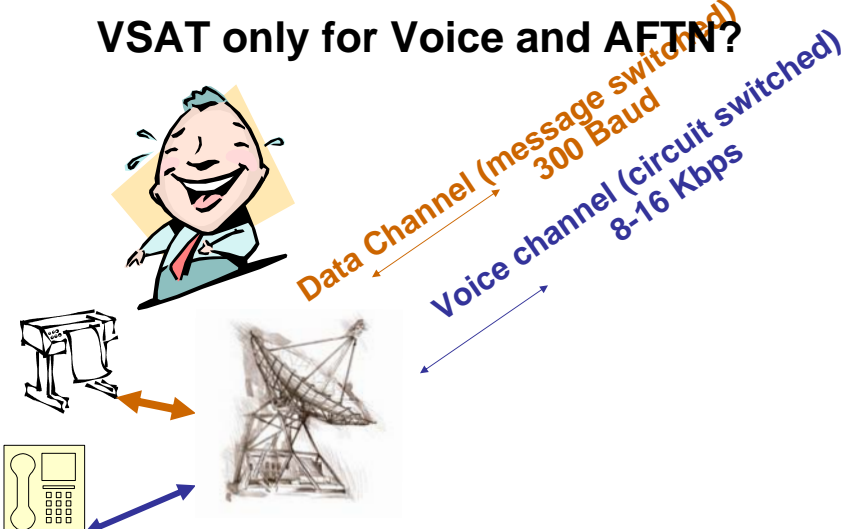**Call set-up delay <= 2 Seconds**

Aeronautical Voice and Data

Current Situation

AFTN

ATS
Voice

Keeping two separate sets of dedicated circuits is too
**expensive. Moreover, the full capacity of circuits/channels**
is seldom used.

VSAT only for Voice and AFTN?

Data Channel (message switched)
300 Baud

Voice channel (circuit switched)
8-16 Kbps

Using expensive satellite resources for occasional voice and low speed AFTN is not cost effective.

Why not use the full potential of a modern VSAT?

Moreover, AFTN cannot support the migration to the use of OPMET data in table-driven (binary) codes which will be phased in (through Annex 3 amendments) between 2007 and 2016.
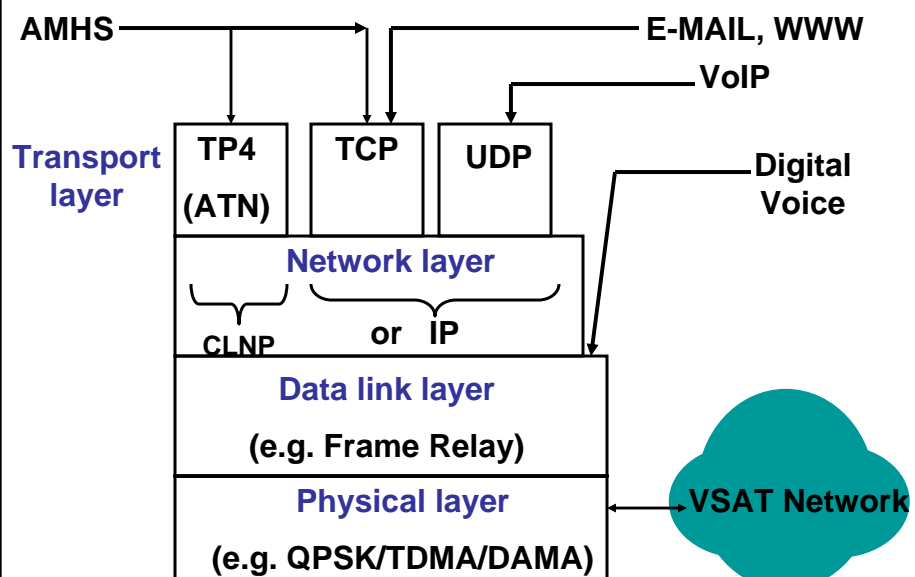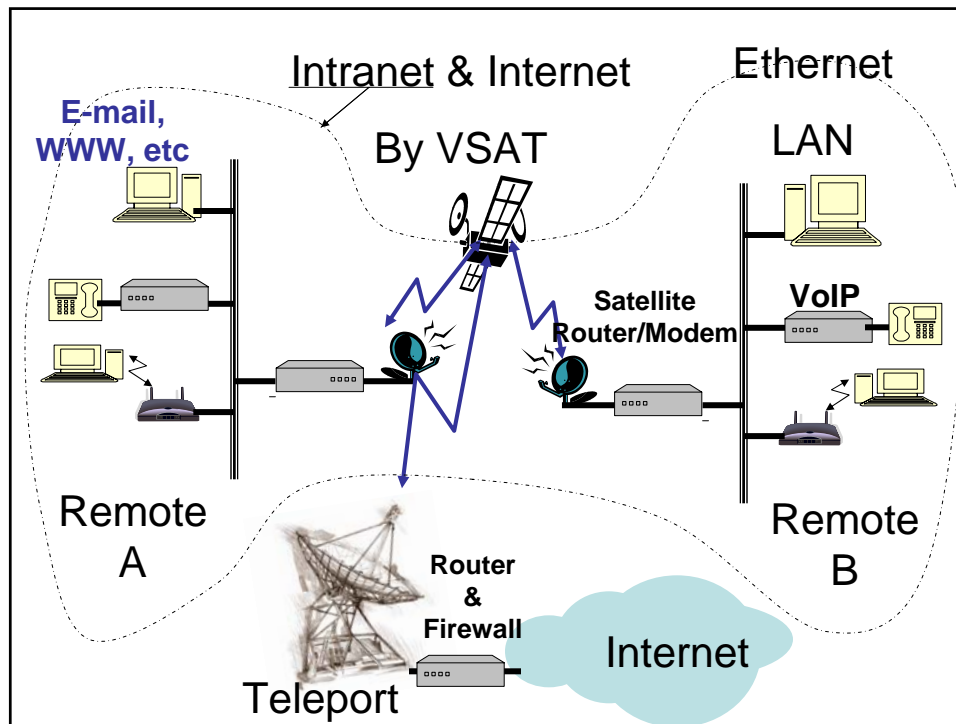
?

Text only!
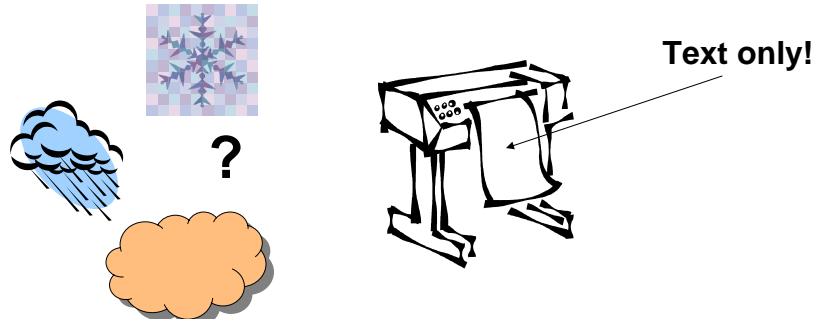
Potential alternative: An IP-based Intranet

IP network

For voice (VoIP), text, graphics, etc.
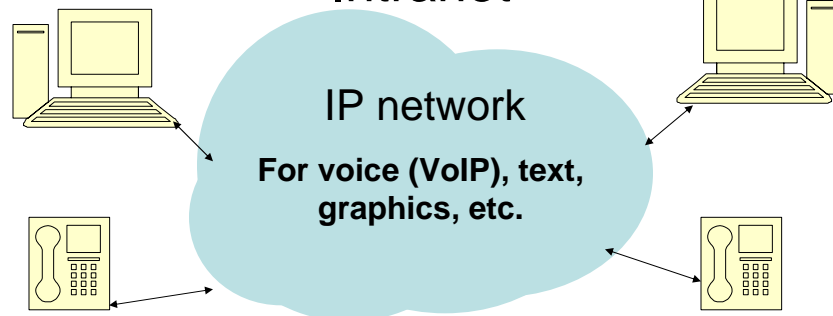
* AFTN messages can be sent via e-mail (before transition to AMHS)

* New MET and other applications supported

OVERVIEW OF COMMUNICATION LAYERS

AMHS ──────────────────→   ────────── **E-MAIL, WWW**

──────── **VoIP**

Transport layer

| TP4 (ATN) | TCP | UDP |

── **Digital Voice**

Network layer

CLNP   or   IP

Data link layer

(e.g. Frame Relay)

Physical layer

(e.g. QPSK/TDMA/DAMA)
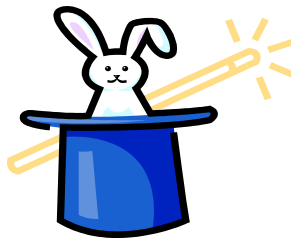
VSAT Network

An IP network?

* **IP can be a subnetwork of the ATN**

* **SARPs for the use of IPS for G-G being developed (adoption expected in 2008)**

* **Already in use in some States/Regions**

* **EUROCAE WG 67 is developing VoIP for ATM – Approval expected in 2008 (ACP is monitoring this activity)**

The future trend is "all IP"

Summary

* Proliferation of VSAT networks should be avoided

* Any upgrade opportunity should be used to integrate (i.e. under a single NCC) existing VSAT networks

* No more dedicated circuits! The trend is an IP-based VSAT network for all voice and data applications

Thank you for your attention

Any Questions?