International Civil Aviation Organization

ATN Seminar and Third ATN Transition Task Force Meeting

Singapore, 26-30 March 2001

Agenda Item 1: Basic ATN Concept

ATN INTERNET COMMUNICATION ARCHITECTURE

(Presented by USA)

ATN INTERNET COMMUNICATION SERVICES

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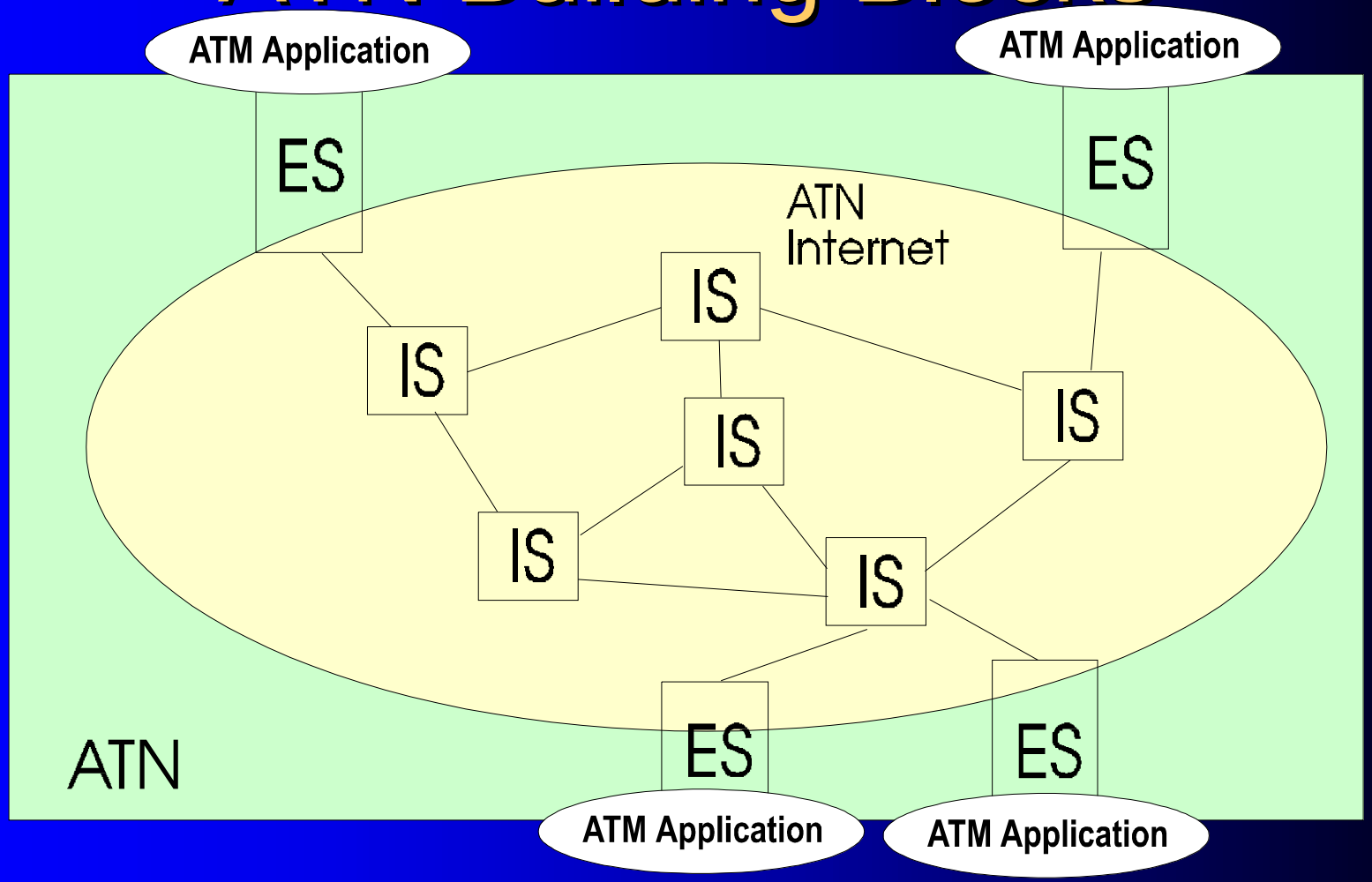
Presentation Objectives

- To **present** ATN Internet communication architecture
- To **describe** ATN routing protocols
- To **discuss** mobile routing issues

Agenda

- ATN INTERNETWORK ARCHITECTURE
- ATN Routing Protocols
- Mobile Routing Issues
- Supporting Mobile Subnetworks
- Open Issues

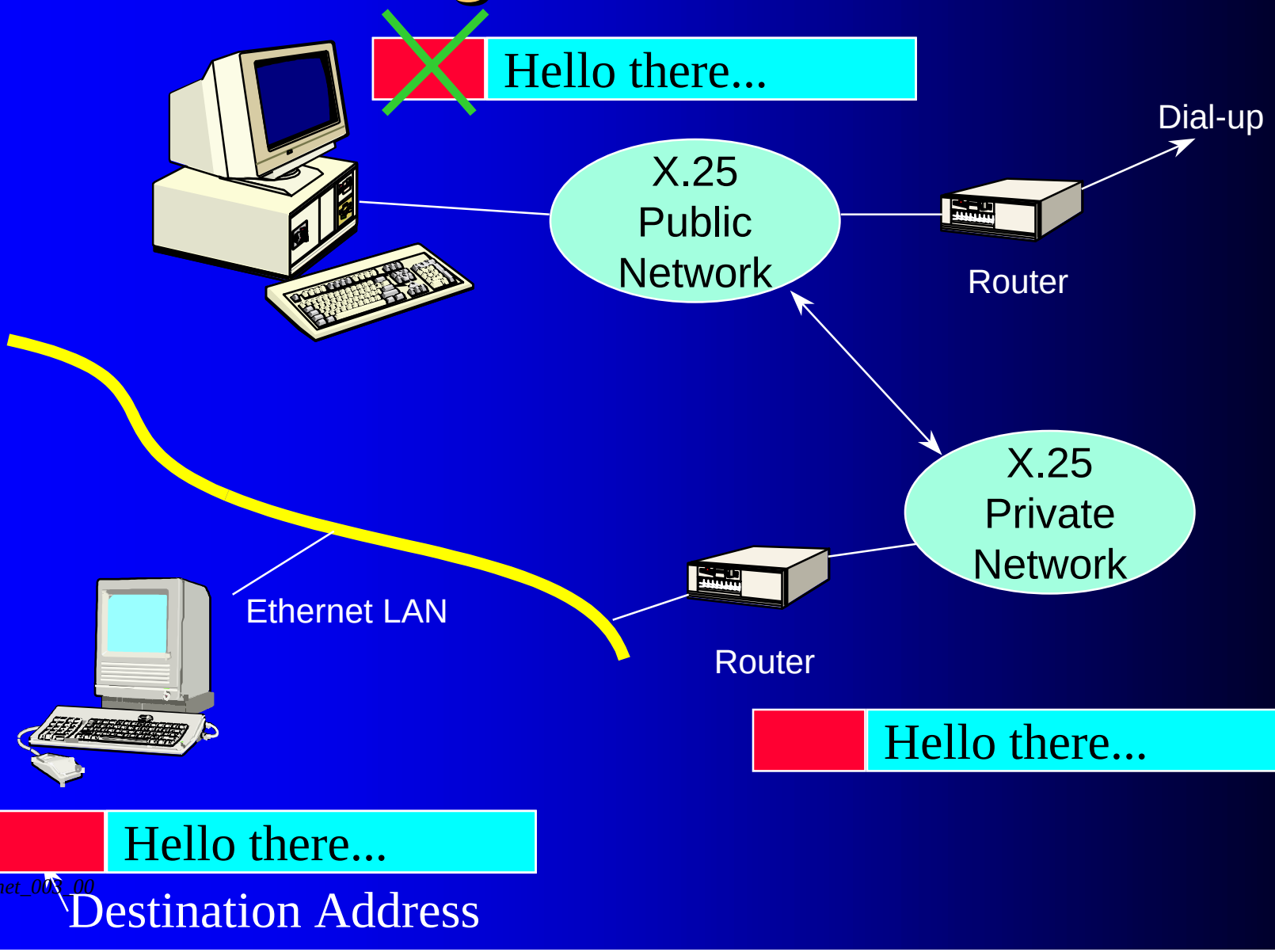
ATN Building Blocks



The Internetworking Problem

- Different Services
  - Reliable Connection Mode (e.g. X.25)
  - Unreliable Connection Mode (e.g. Frame Relay)
  - Connectionless (e.g. Ethernet)
- Different Addressing Plans
  - X.25 DTE Addresses (decimal digits)
  - IEEE LAN Addresses (48 bits)

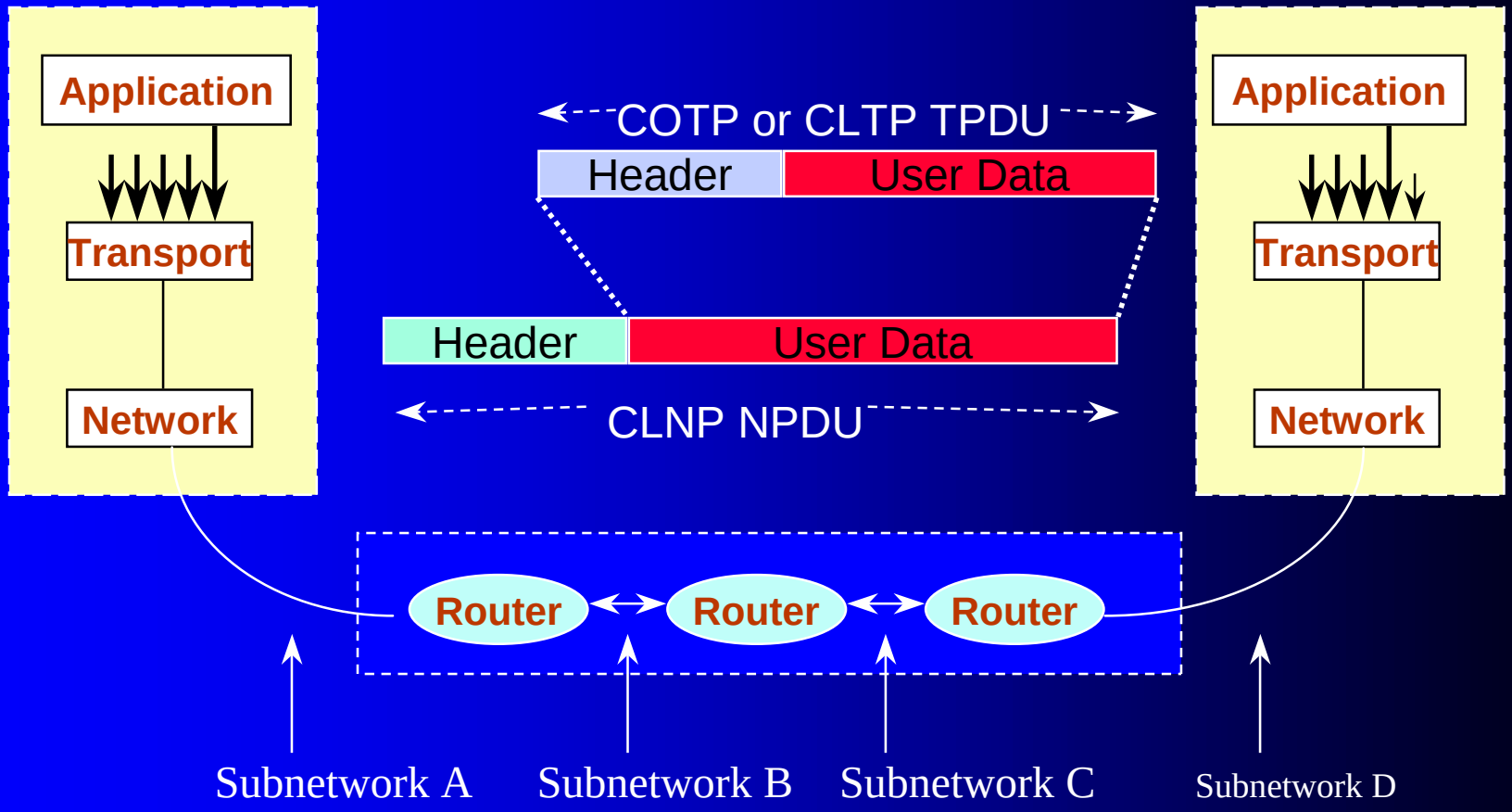
Forming An Internetwork



Why not TCP/IP?

- Historical
  - ATN development started when Governments required OSI
- Technical
  - IP Address Space too small for mobile routing with no single point of failure
  - IP Congestion Management poor to non-existent
  - Mobile IP inefficient and with single point of failure

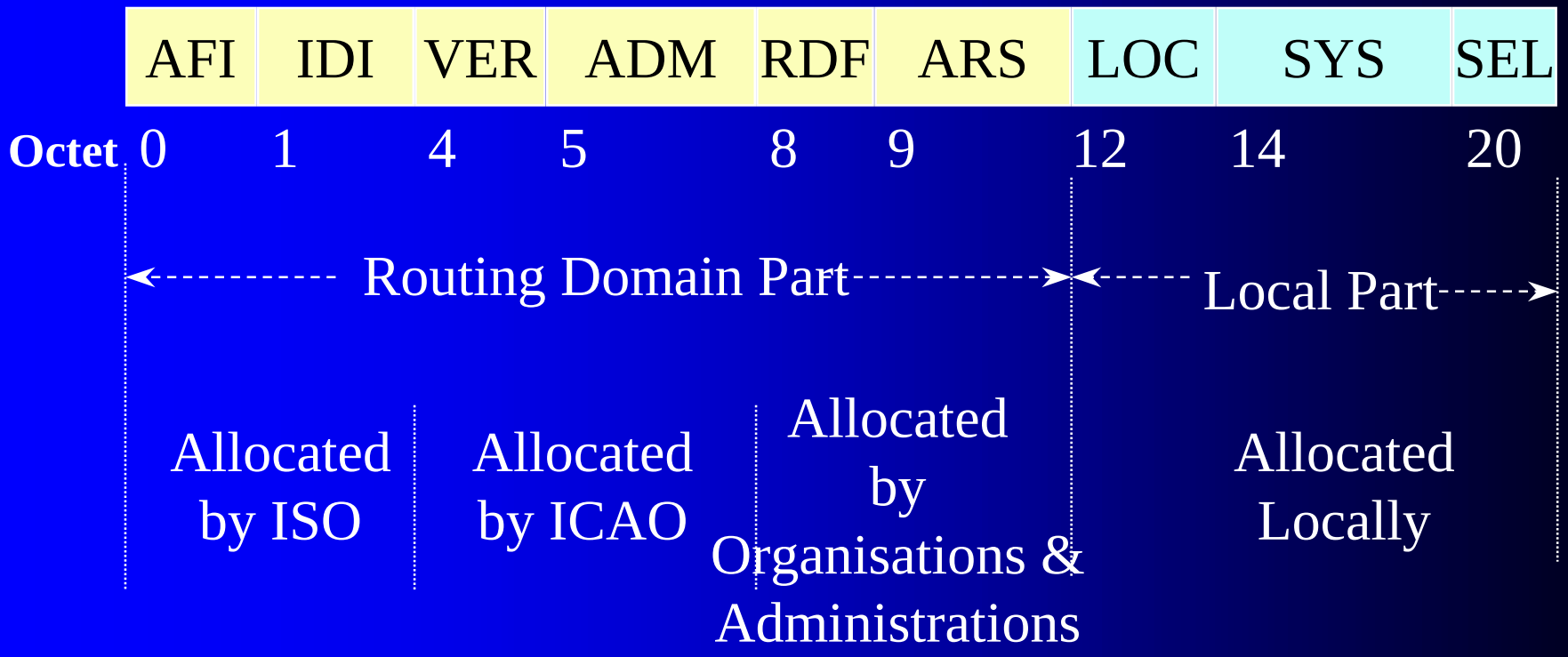
ATN Communications Model



ATN Addressing

- Each ATN System must have a unique ATN Internet Address
  - Separate from any X.25 DTE Address, Ethernet Address, etc. that they may already have
  - Necessary to permit unambiguous routing
- ATN Internet Address is
  - A Sequence of Octets
  - Structured for Devolved Address Allocation and efficient Routing

ATN Address Syntax



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ATN End Systems

- Protocols required
  - TP4 (with mandatory checksum support)
  - CLNP
- Protocols recommended
  - ES-IS

ATN Routers

- CLNP required by all ATN Routers
- IDRP required by all Inter-Domain Routers
  - Air-ground data links
  - Between organisations
- ES-IS required by air-ground routers
- IS-IS and ES-IS recommended within an organisation

TP4 Functions

- Connection Mode Protocol
- Ensures Reliable Delivery
- Provides a Checksum on each Packet
- Retransmits on Packet Loss or corruption
- Provides End-to-End Flow Control

CLNP Functions

- Simple Datagram Format
- Message Header Identifies
  - Source and Destination
  - Priority
  - Traffic Type
  - AOC Routing Requirements
  - ATSC Class

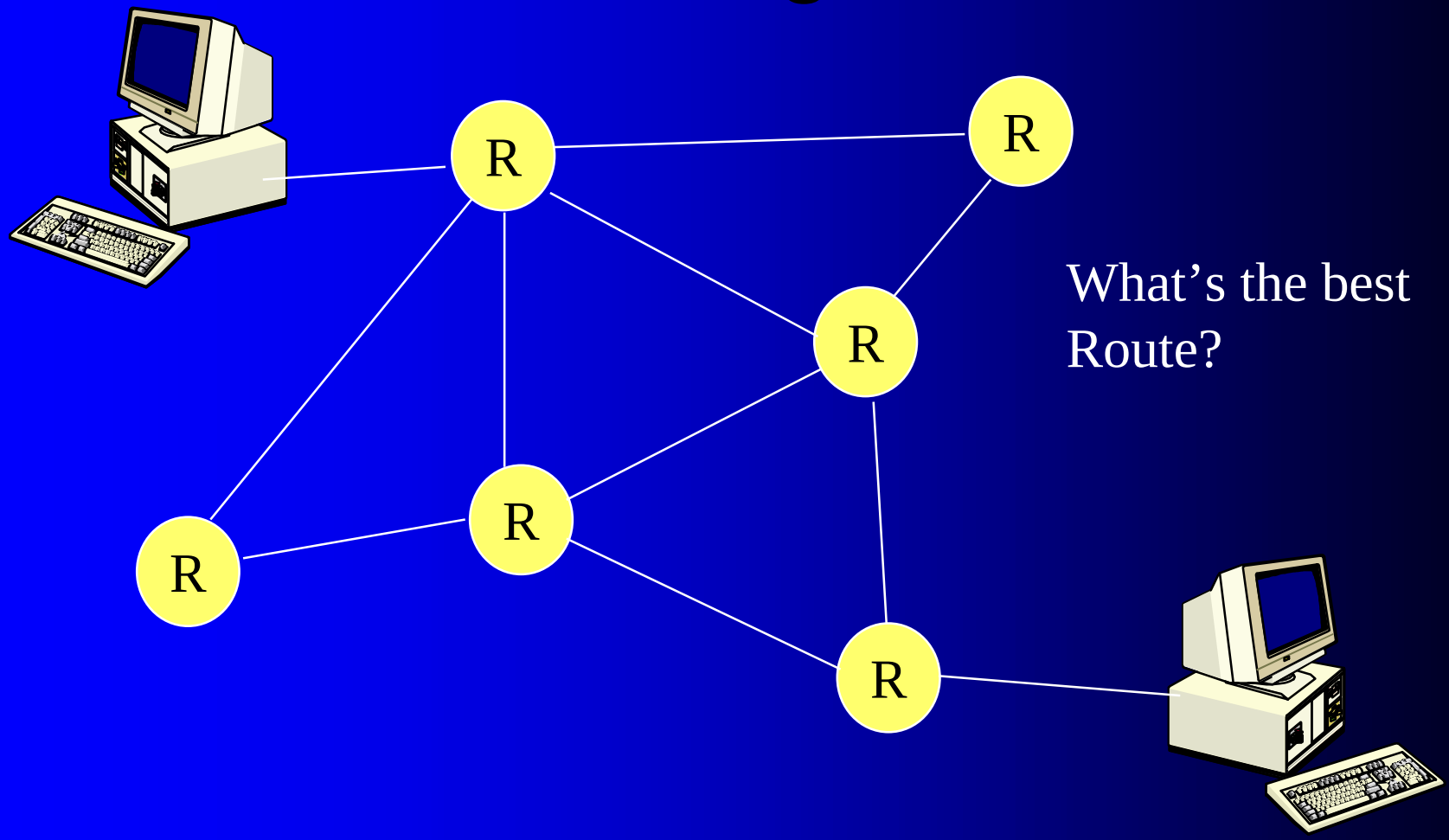
ATN Protocol Overhead

Protocol	Typical Data Header
TP4	11 Octets
CLNP (G/G)	> 60 octets
CLNP (A/G)	6 octets typical

Agenda

- ✔ ATN Internetwork Architecture
- ✈ ATN ROUTING PROTOCOLS
- Mobile Routing Issues
- Supporting Mobile Subnetworks
- Open Issues

The Routing Problem



What's the best Route?

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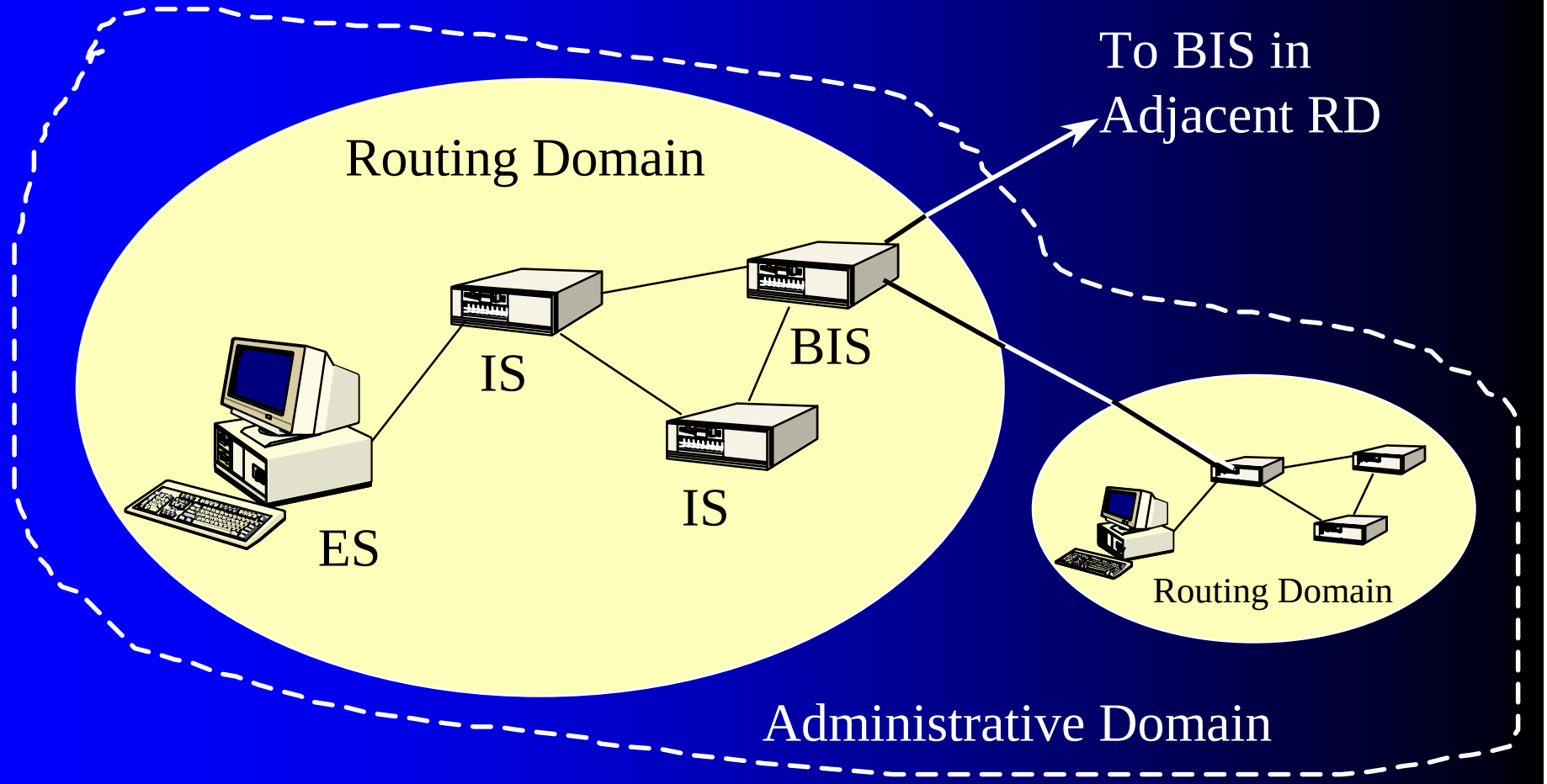
Routing Goals

- Keep “Signposts” (Router Forwarding Tables) up-to-date
- Minimise Information Distributed
- Support Users’ Routing Policies
- Support Organisational Routing Policies

ISO Routing Architecture



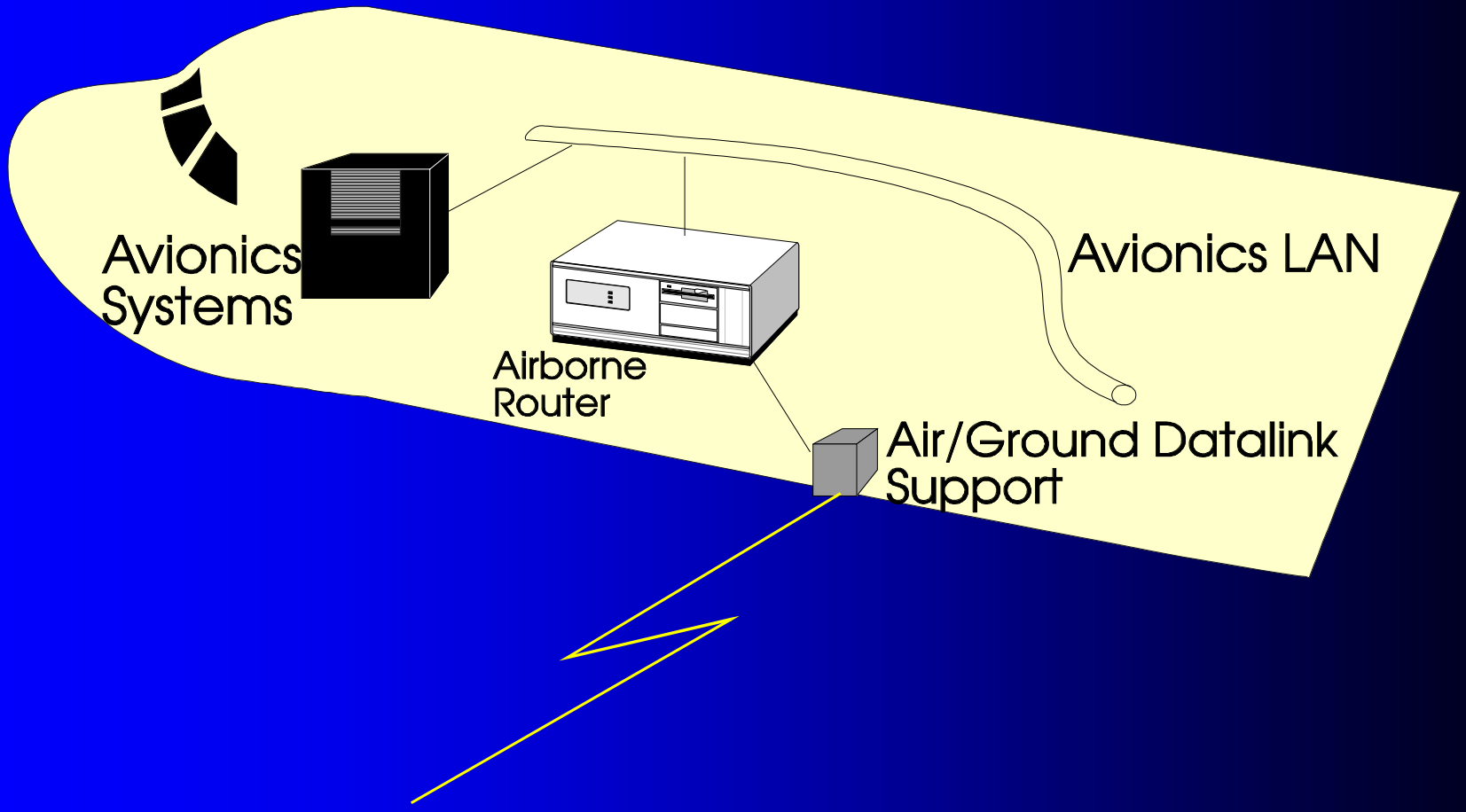
IDRP

- A “Vector Distant” Routing Protocol used to support Policy Based Routing
- Each “Boundary Router” (BIS) advertises to adjacent BISs
  - Routes to Destinations in its own Routing Domain
  - Selected Routes Received from Other BISs
- Provides a scaleable approach to building large Internets

IDRP Routing Policy

- Routing Policy Determines:
  - Choice between routes to the same Destination that have been received from adjacent BISs
  - Selection of Routes to be advertised to each adjacent BIS
  - CLNP Forwarding Decisions
  - Route Aggregation Decisions

The Airborne ATN



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Agenda

- ✔ ATN Internetwork Architecture
- ✔ ATN Routing Protocols
- ✈ MOBILE ROUTING ISSUES
- ● Supporting Mobile Subnetworks
- ● Open Issues

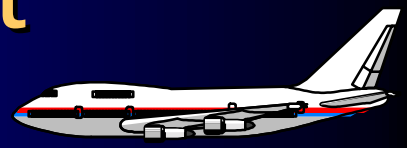
Impact of Mobility

- Aircraft Address and Network Topology cannot be related
  - Non-optimal routing
  - High rate of routing updates
  - Scaleability Problems

Mobility vs Roaming

- A/G Networks already support Mobility
  - Mobility *per se* is not an ATN Internet function
- However, the ATN must support *Roaming* between mobile subnetworks
  - Aircraft may move serially from one mobile subnetwork to another
  - Aircraft may be simultaneously attached to more than one mobile subnetwork

Routing to an Aircraft



RD 1

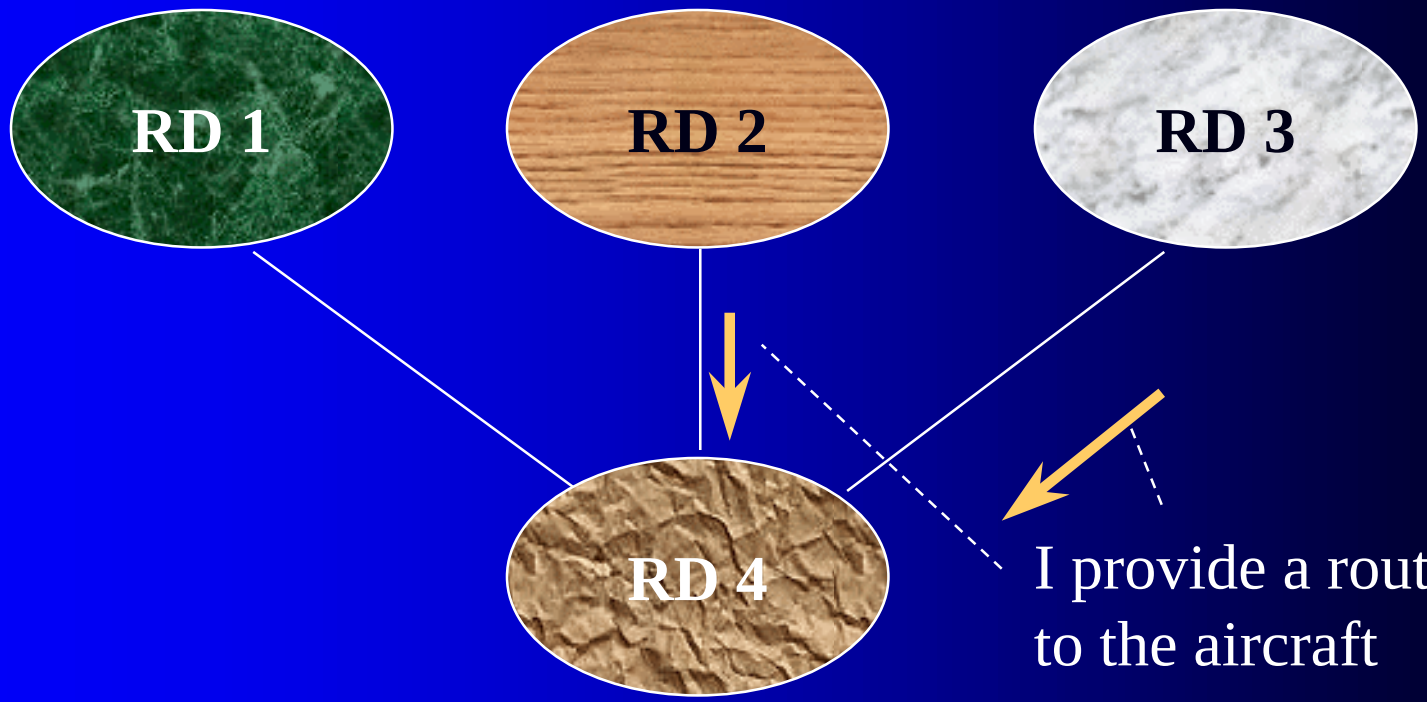
RD 2

RD 3

RD 4

I provide a route to the aircraft

Routing to an Aircraft



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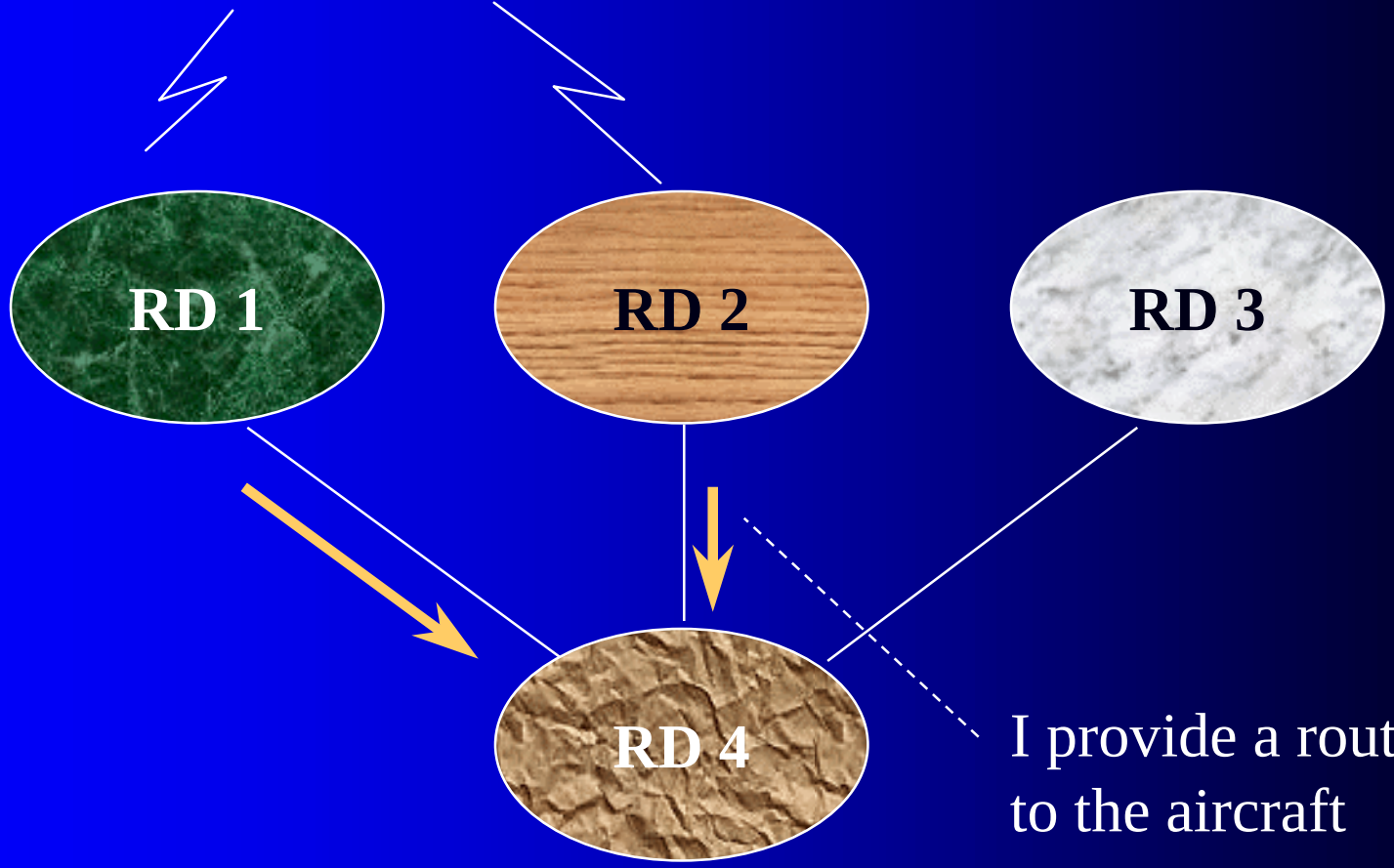
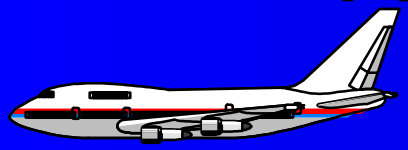
Routing to an Aircraft



Routing to an Aircraft



RD 1

RD 2

RD 3

RD 4

I provide a route
to the aircraft

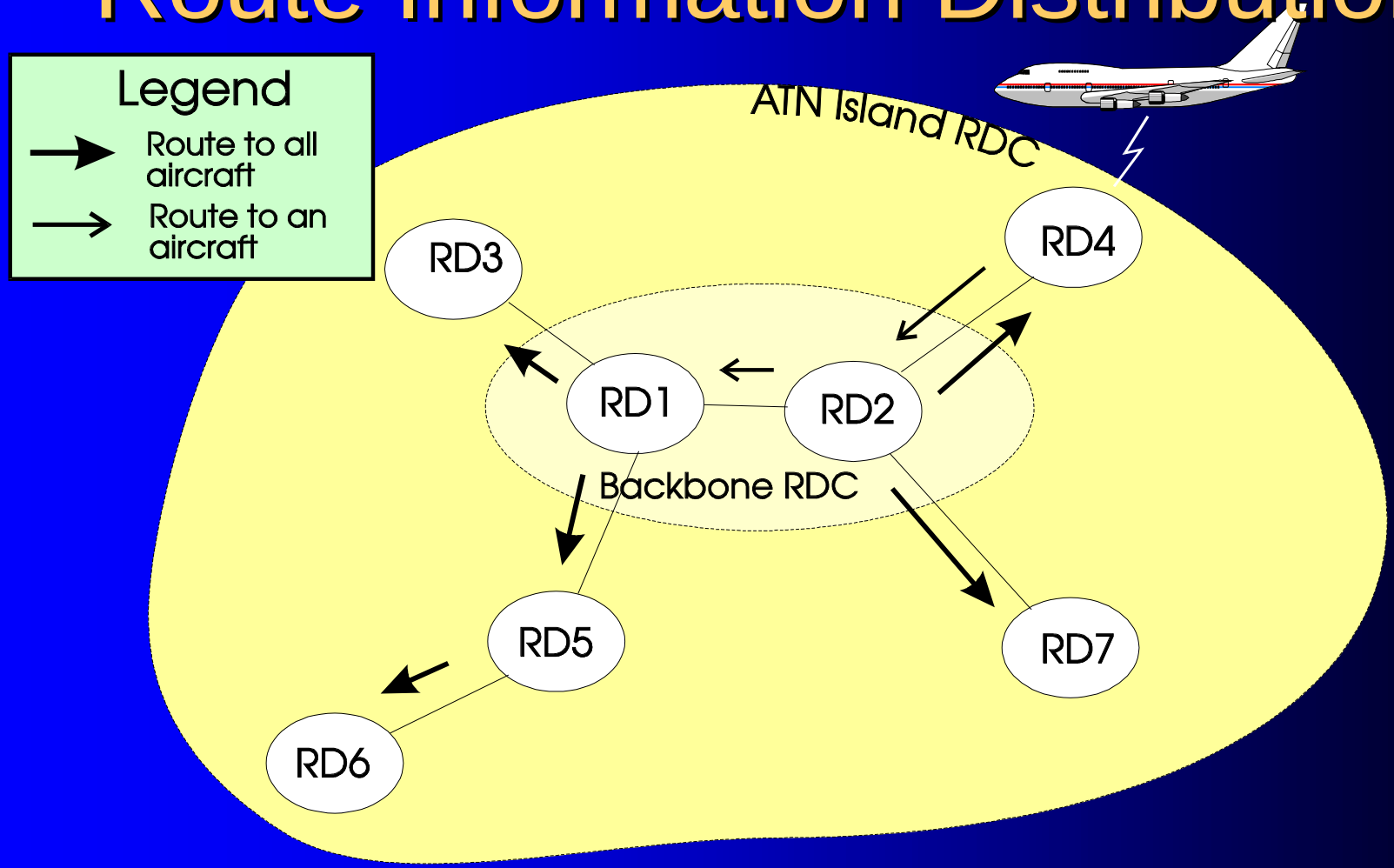
Mobile Routing Issues

- Routes cannot be aggregated
  - Mobile Addresses not related to topology
- Route changes every time aircraft changes point of attachment
  - High routing update rate
  - Although not an ATN Issue
- Routers have to keep a route for each aircraft
  - ATN size limited by router table capacity

ATN Solutions to Mobility

- Distributed “IDRP Directory” implemented by BISs
- Two Level Directory
  - ATN Island Backbone BISs
  - The “Home” BISs
- Scaleability provided by two level structure
- Resilience provided by distributed approach

Route Information Distribution



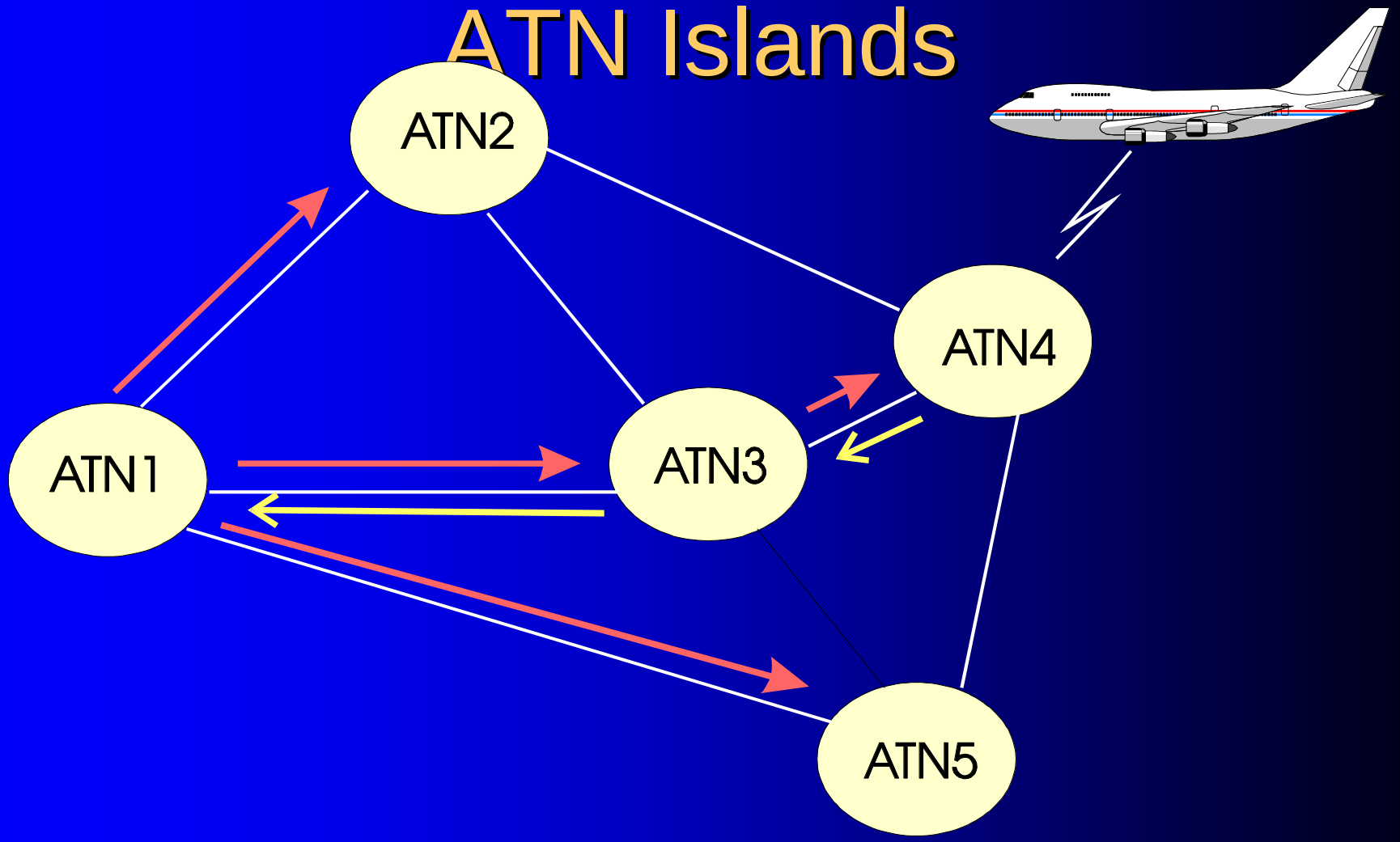
Routing within an ATN Island

- First Step in Mobile Routing Architecture
  - Default route to all aircraft provided by BackboneRouters
  - Ground systems route via backbone Routers to aircraft
  - Size of Island limited by capacity of backbone routers
  - Resilience provided by multiple BISs in backbone

Routing via the "Home"

- Each group of Aircraft has a “Home” on an ATN Island
- Other Islands keep the “Home” informed about the location of each aircraft
- “Home” provides a default route to its Aircraft Group (e.g. aircraft belonging to a given airline)

Routing Distribution Beween ATN Islands



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Inter-Island Routing Issues

- Scaleability limited by Inter-Island Connectivity
  - Each Island's backbone must have capacity to hold routes for
    - Each Aircraft attached to the Island
    - Each Aircraft for which it provides a "Home"
- Facilities for transit routing are strictly limited

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- ✔ ATN Routing Protocols
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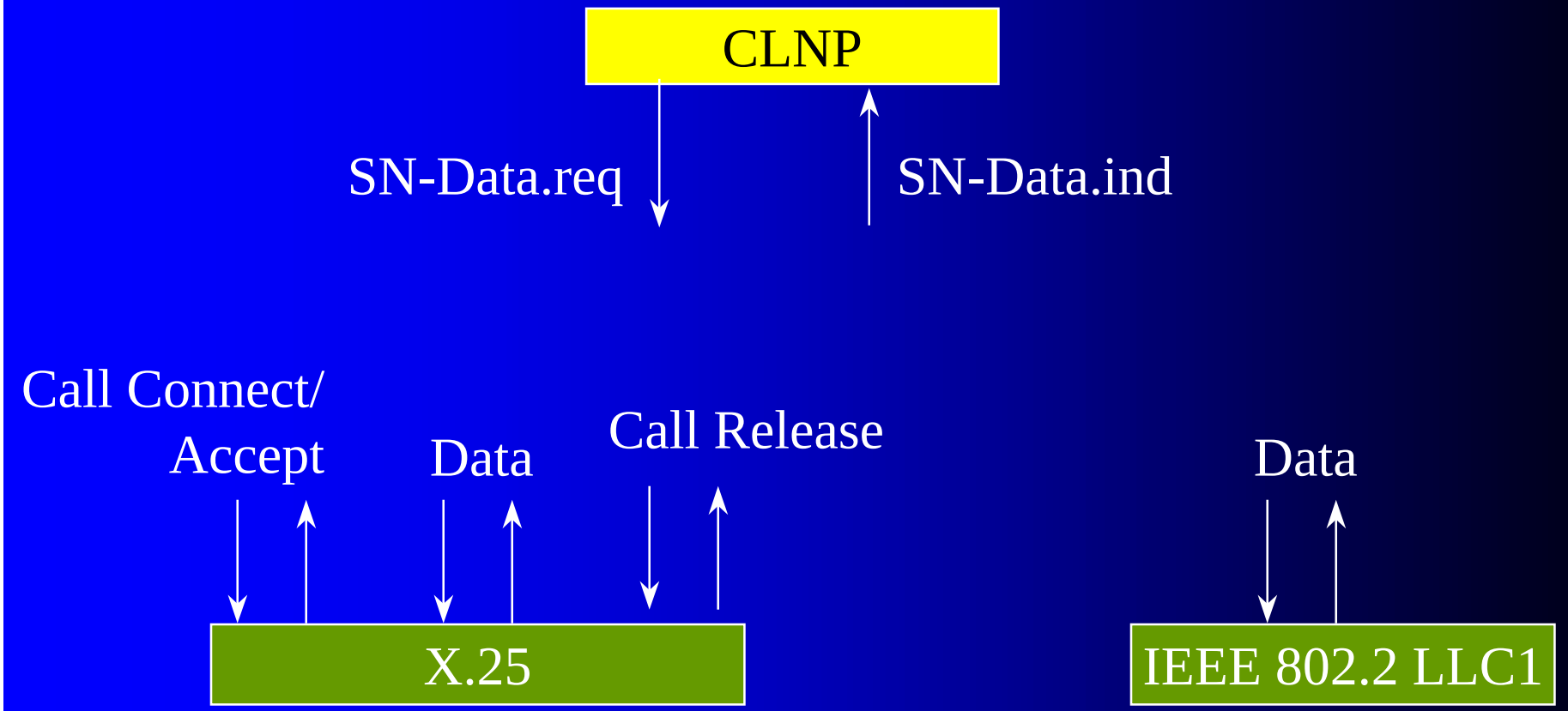
- ✍ SUPPORTING MOBILE SUBNETWORKS
- ● Open Issues

Service Harmonisation



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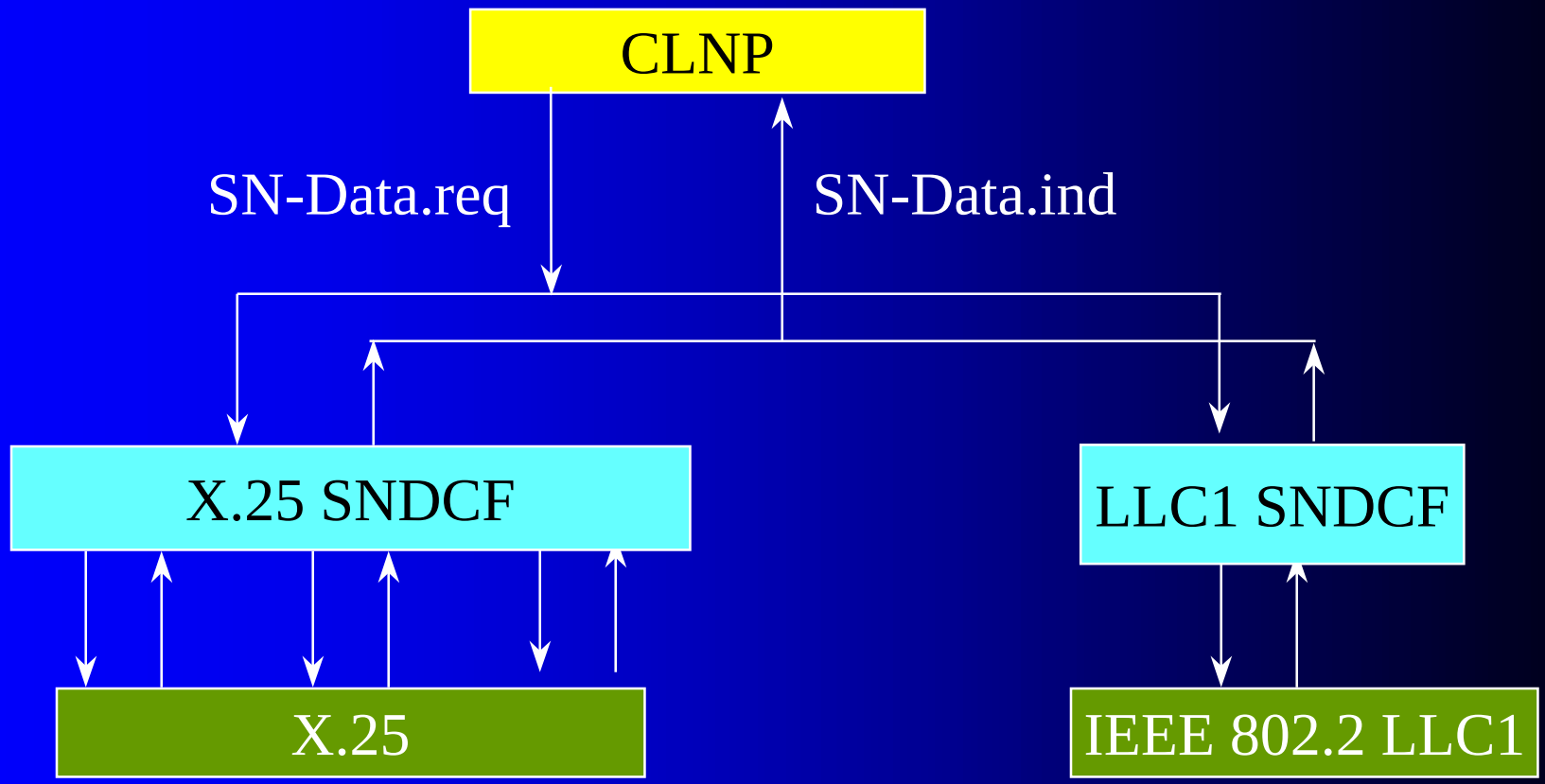
The SNDCF


CLNP
SN-Data.req
SN-Data.ind
X.25 SNDCF
LLC1 SNDCF
X.25
IEEE 802.2 LLC1

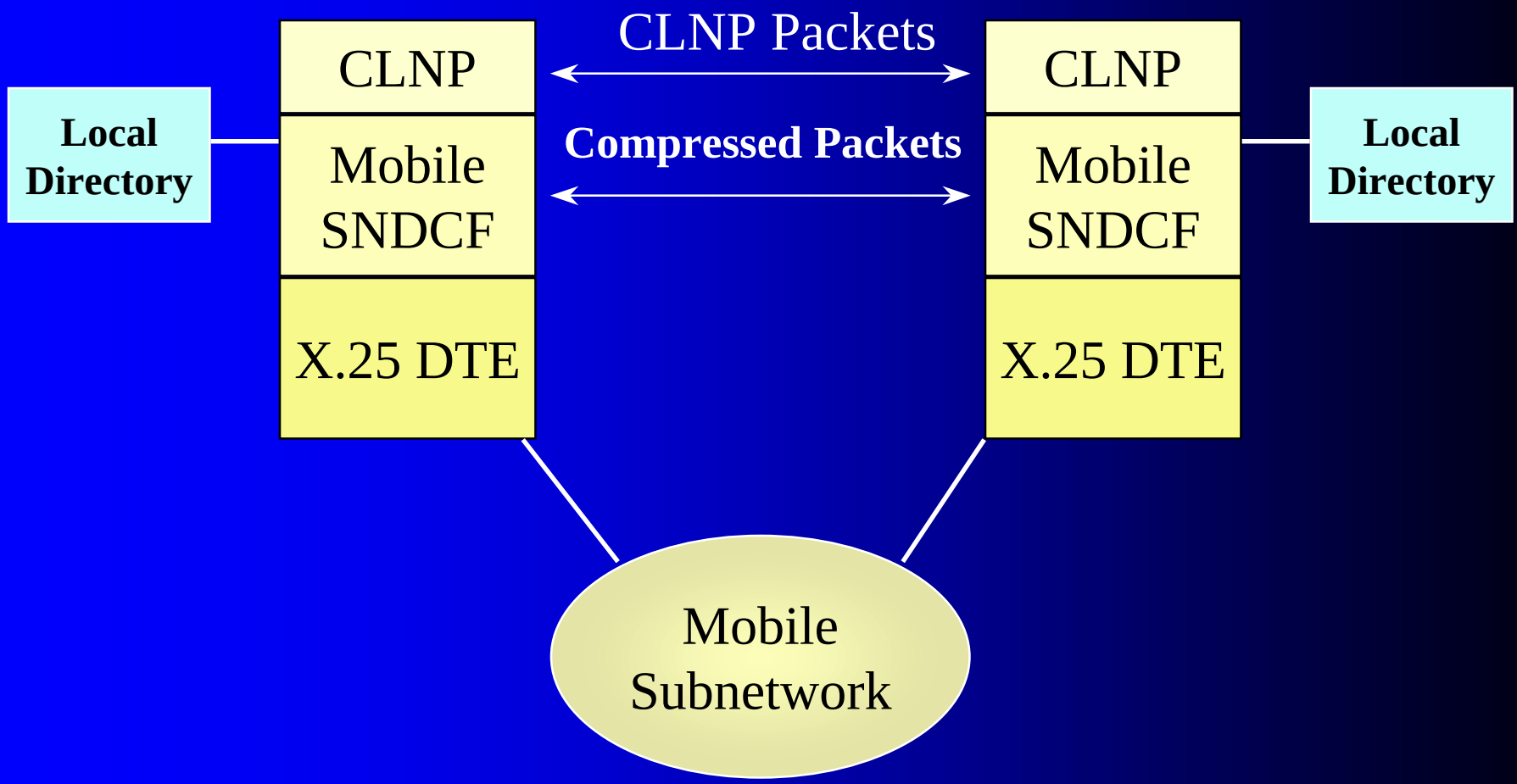
Support for CIDIN

- ATN uses CIDIN as a subnetwork
- CIDIN SNDCF defined by SARPs
  - Uses CIDIN transport connectionless Mode Service
  - CLNP PDU sent as a CIDIN Message with “no acknowledgement”
  - CLNP Priority mapped to CIDIN Priority
  - QoS requirements specified locally

Mobile SNDCF

- Minimise Data Transfer over Air/Ground Data Links
- Support all ICAO Data Links
- Provides For:
  - Header Compression (LREF)
  - Address Compression (ACA)
  - Data Compression

LREF Compression Model



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Open Issues

- Systems Management in SARPs
- Security
- Multicasting
- Air-Air Communications
- Subnetwork Access

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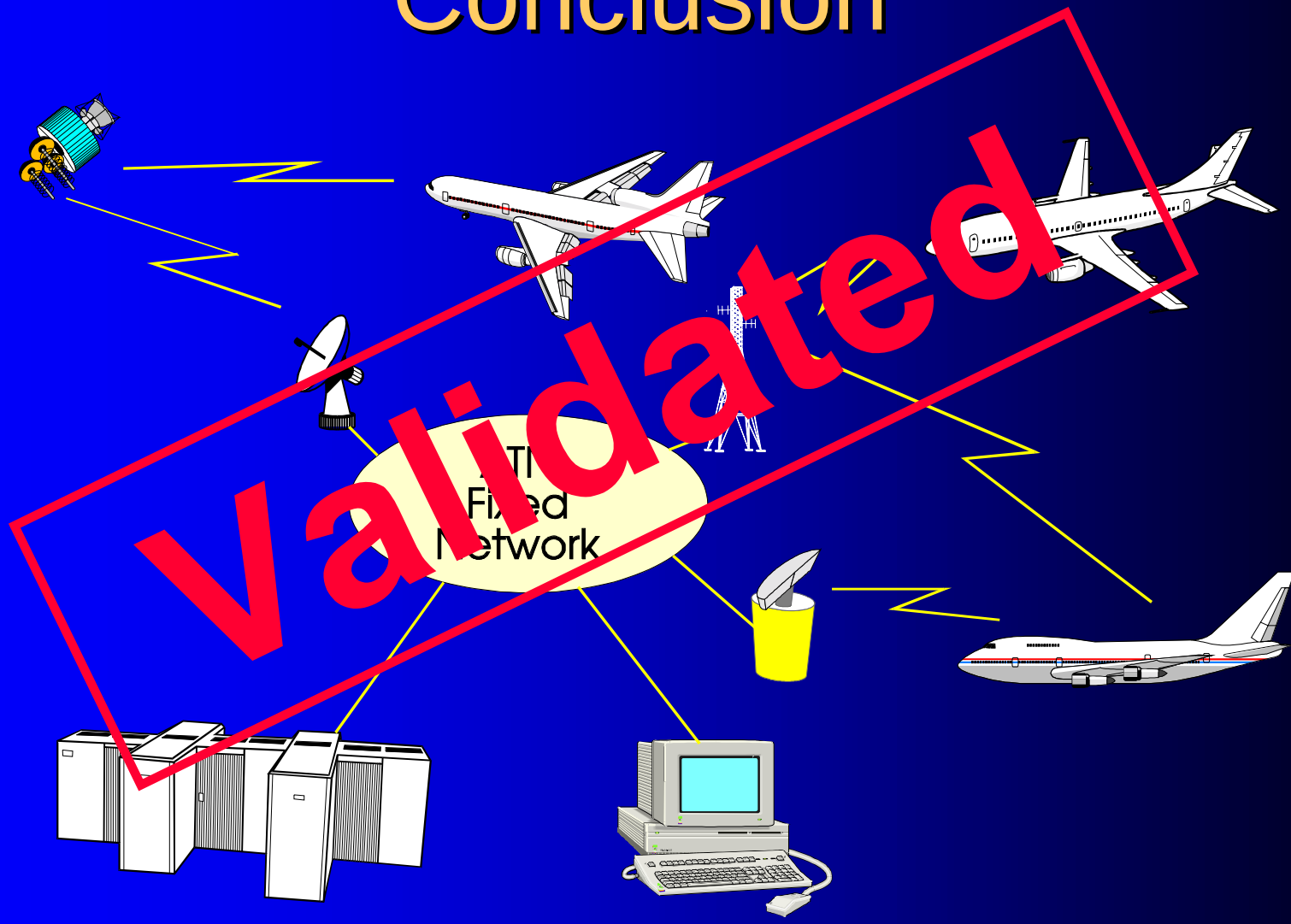
Conclusion



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