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DRAFT ATN Scenario Definition

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1. Introduction

The objective of this paper is to define the European ATN scenario, i.e. the expected evolution of the aeronautical communication infrastructure and services in the EUR Region based on the assumed full implementation of ATN in the EUR Region.

The ATN scenario will be used as the operational, technical, infrastructure and volumetric framework and reference for the ATN cost/benefit analysis (CBA). Furthermore, the ATN scenario will be an important element in the preparation of the overall ATN Implementation Plan, being used for the definition of the ATN institutional framework and the ATN administrative structures, as reference for the ATN transition planning, and as input scenario for the simulation exercises in the context of the network design work package.

For the ATN business case development, the ATN scenario will be assessed against a so-called Baseline scenario which is described in the document DED6/ATN/ATNI-TF/DOC/35. The Baseline scenario assumes that the ATN is not implemented and that air/ground data communications will be enabled by means such as FANS-1/A and direct use of both ICAO-compliant (e.g. VDL Mode 2) and non-ICAO compliant (e.g. ACARS, STDMA) mobile subnetworks.

The starting assumption in the definition of both scenarios is that a firm requirement for air/ground data link in the EUR Region exists. This assumption is supported by a number of strategic documents and study reports outlining the communications portion of the future European ATM system (e.g. [1] and [2]). Consequently, the initial driver in both scenarios is the provision of a basic air/ground datalink infrastructure to support enhanced ATM services improving airspace capacity and flight efficiency. This is in line with the general strategy agreed by the Task Force (TF) for the implementation of the ATN [8]; this strategy is based on regional/local ATN implementations from 2000 onwards, focusing on initial air/ground communication services.

This air/ground driven approach is complemented by the requirement for a rationalisation and enhancement of existing ground/ground communications [9] with the objective to integrate multiple communication services within a common ground communication infrastructure and to support improved ATM functions and processes, such as the collaborative decision making of all parties involved in gate-to-gate operations (ATSOs, aircraft operators, airport operators, pilots, etc.). Consequently, the evolution of existing ground/ground communications is another key driver of both scenarios, but with different time scales in the Baseline and ATN scenario.

As the definition of the ATN scenario stretches over a period of almost two decades, it should be noted that the majority of the statements made and volumetric figures presented in this document are based on assumptions and educated guesses from the authors of this document. These assumptions are neither explicitly highlighted nor introduced by terminology such as "it is assumed that..." for presentation reasons. Where available, use has been made of relevant information in other sources; these sources are explicitly identified by appropriate references.

2. Scenario Dimensions

The most significant scenario dimensions are:

- time scale
- geographical scope
- volumetric extension, i.e. numbers of ATN-compliant aircraft and ground systems
- operational context.

2.1 Time Scale

The ATN scenario is developed in three consecutive steps in time; step 1 stretching from 2000 to 2005, step 2 from 2005 to 2010, and step 3 from 2010 to 2015. The differences between these three steps, as far as the scenario is concerned, are mainly in the area of increase of required air/ground (datalink) and ground/ground data communications capacity (i.e. more users, more applications), shape and extension of the ATN infrastructure (more ATN systems) and reduction of existing (conventional) communication systems and services.

A quantitative description of the scenario is given for the following three milestones:

- Year 2005, representing the initial ATN implementation in the EUR Region
- Year 2010, representing the reference implementation for the ATN CBA
- Year 2015, representing the full EUR Region ATN implementation (stable and mature state).

The above dates represent individual snapshots/milestones in time which will be used to provide a quantitative inventory. However, due to the fact that the ATN is an intrinsically modular and scaleable architecture, ATN components will be continuously introduced and integrated during these steps.

2.2 Geographical Scope

The geographical scope of the ATN scenario comprises the whole EUR Region. It is sub-divided into the following areas:

- High Traffic Level Area (HTLA)
- Low Traffic Level Area (LTLA)
- Low Traffic Level Area Remote (LTLA-R).

The differences between these areas are:

- Capacity Requirements (resulting from number of aircraft and number of applications)
- Use of technology (dependent on remoteness of area).

The so-called core area of Europe currently has the characteristics of a High Traffic Level Area. In such an area there is a high capacity requirement and a communication coverage requirement from gate-to-gate. Use will be made of terrestrial mobile subnetworks (e.g. VDL, Mode S) for primary and secondary air/ground communications; satellite-based communication services, such as AMSS, will only be provided for back-up purposes in some borderlands (comprising oceanic-type airspace) but not as primary communication means for ATSC and AOC/AAC.

The Low Traffic Level Areas (LTLAs) are currently the Scandinavian Countries, South European Countries and the East European countries. These areas are interfacing with the HTLAs and have a lower capacity and coverage requirement. Coverage is mainly required in the en-route phase and not down to TMA/airport level. Exceptions are the main airports in this area. Use is made of terrestrial mobile subnetworks (e.g. VDL) for primary and secondary ATSC and AOC/AAC air/ground communications; satellite-based communication services (e.g. AMSS) may only be used for back-up purposes or in some remote areas of LTLAs.

The Low Traffic Level Areas Remote (LTLA-R) have a modest traffic level and a similar capacity and coverage requirement as the LTLAs. Furthermore these areas have a CNS infrastructure comparable with the NAT Region today, i.e. no radar coverage and no line-of-sight CNS systems. In these areas data communication will be used for both communication and surveillance (i.e. ADS). The capacity and coverage requirements are similar to the LTLAs. Use is made of satellite subnetworks, primarily. A Low Traffic Level Remote Area is also the North Sea Lower Airspace which is used by militaries and for offshore operations, for example.

	2005	**2010**	**2015**
VDL Mode 2	coverage over most of HTLA	coverage over whole of HTLA and parts of LTLA	Remaining coverage from on-going out-phasing process
VDL Mode 3	nil coverage	coverage over parts of HTLA	coverage over parts of HTLA and LTLA
VDL Mode 4	coverage over parts of LTLA	coverage over parts of LTLA and LTLA-R	coverage over parts of LTLA-R and LTLA
Mode S Datalink	nil coverage	coverage over HTLA	coverage over HTLA
AMSS[1]	used in parts of LTLA-R (for backup in parts of HTLA and LTLA)	used in LTLA-R (for backup in parts of HTLA and LTLA)	used in LTLA-R (for backup in parts of HTLA and LTLA)
HF Datalink	used in parts of LTLA-R	used in parts of LTLA-R	used in parts of LTLA-R
Gatelink	HTLA airports	HTLA and LTLA airports	coverage over all of Europe

Table 2.2-1: Typical Use of Air/Ground Subnetwork Technology per Area

It should be noted that, given projected growth in air traffic movements, regions classified as LTLA or LTLA-R today may well be classified as HTLA or LTLA respectively in the 2010 and/or 2015 time frame. Such an evolution is reflected in the scenario in the form of a dynamic association of EUR Region States to traffic level areas over time (see Section 3.1).

2.3 Volumetrics

The volumetric dimension of the ATN scenario is characterised by:

- number and type of ATSO communication systems (ATN routers, ATN end systems, mobile subnetwork ground stations, gateways, network management systems, ...) and outsourcing arrangements; this scenario dimension is further developed in the ***ATSO Sub-scenario*** of Section 3.1.

[1] In addition to the AMSS provided by Inmarsat satellites, new emerging commercial satellite constellations operating in the low earth orbit (LEO) or medium earth orbit (MEO), such as Iridium, Odyssey or Globalstar, may provide aeronautical communication services in the future. These systems and their capabilities for support of ATS communications are still under study and will not be reflected in the scenarios until discussions on their availability and suitability for aeronautical communications have converged.

- number and type of AO communication systems (ATN end systems, gateways, ...) and outsourcing arrangements; this scenario dimension is further developed in the ***AO Sub-scenario*** of Section 3.2.
- number and type of APO communication systems (ATN routers, ATN end systems, mobile subnetwork ground stations, gateways, ...); this scenario dimension is further developed in the ***APO Sub-scenario*** of Section 3.3.
- number and equipage type/level of ATN-equipped aircraft operating in the EUR Region airspace; this scenario dimension is further developed in the ***Aircraft Sub-scenario*** of Section 3.4.
- number and type of ATN-compliant communication systems (ATN end systems, gateways, ...) and outsourcing arrangements used by aviation weather service providers; this scenario dimension is further developed in the ***Weather Service Provider Sub-scenario*** of Section 3.5.
- functions, structure and size of the operational unit which will be responsible for the administrative and technical management of the EUR Region ATN on a supra-national level; this scenario dimension is further developed in the ***EACE Sub-scenario*** of Section 3.6.
- air/ground communications traffic volume associated with a typical flight in the EUR Region; this scenario dimension is further developed in the ***Flight Communications Traffic Profile*** of Appendix C.

Another important key player in the implementation and evolution of ATN will be the aeronautical communication services providers (ACSPs). ACSPs will own and operate ATN-compliant and/or other communication equipment and will provide communication services to the aeronautical user community based on this communication infrastructure. In particular, AOs, APOs and even a subset of ATSOs are likely to outsource the provision of ATN-compliant communication services to such ACSPs. The volumetric extension of this communication infrastructure, i.e. ACSP-owned equipment and systems, is not reflected in the ATN scenario in quantitative terms. However, the number of aeronautical users having outsourcing arrangements with such ACSPs (and consequently not directly owning aeronautical communication systems and subnetworks) will be quantified in the scenario.

2.4 Operational Context

To overcome the shortfalls of the present ATM system and to meet the ambitious objectives set up by current forecasts of air traffic movements, changing user needs, and prevailing aviation and ATM related trends, the EATMS target operational concept [10] focuses on providing extra capacity and improving ATM services by:

- managing flights from gate-to-gate;
- enhancing flexibility and efficiency;
- improving collaborative decision making;
- adapting the available capacity to meet demand.

Progressive improvements in these areas will require a series of operational changes in the core processes of the European ATM system. A key theme underlying the planned improvements is integration: integration of planning, integration of information, integration of decision making, integration of the technical systems, etc. This integrated approach to ATM will not be possible without considerable enhancements and also integration of the supporting communication infrastructure (both air/ground and ground/ground) as well as the introduction of more sophisticated communication capabilities, services and applications. Based on information taken from [11], Table 2.4-1 provides a compilation of the planned operational improvements in the four core processes of EATMS and links these planned initiatives to the impacts on aeronautical communications.

Time Frame	Airspace Management, Organisation and Procedures	Flow and Capacity Management	En-route Air Traffic Control	Airport Capacity Management	Impact on Communications
2000 - 2005	Initial Route Optimisation Additional Flight Levels Free Routes in Upper Airspace Enhanced Route Optimisation	Improved Re-Routing Enhanced Tactical ATFM Initial Capacity Management	Initial Automation of Planning Task Automated Arrival Management Enhanced Safety Nets	Improved SMGC	Enhanced ground communications (FDPS, IFPS) Introduction of air/ground data comms Redundant communication paths ADS-B Enhanced Surveillance (Mode S)
2005 - 2010	Integrated National Airspace Planning Extended Free Routes	Tactical ATFM Collaborative Flight Planning	Integrated Arrival and Departure Management Limited Separation Responsibility Transfer	Enhanced Low Visibility Operations	Integration of ground/ground comms Increased implementation of Air/Ground Data Links
2010 - 2015	Integrated European Airspace Planning	Optimised Capacity Management	Enhanced Automation of Planning Tasks Extended Separation Responsibility Transfer	Integrated Slot Planning	Full implementation of air/ ground comms Full integration of air/ground and gr/gr comms

Table 2.4-1: Operational Improvements and Associated Communication Enablers

The ATN scenario assumes the operational ATM context outlined in Table 2.4-1, i.e. the ATN infrastructure and services will have to support the above set of ATM functions. The individual data link and ground/ground communication services which will be supported by the ATN during the three time frames considered in the scenario (c.f. Section 2.1) are detailed in the following sub-sections based on the above overall operational context.

2.4.1 ATSO Communication Services

The following remarks apply to the Tables 2.4-2, 2.4-4 and 2.4-6 presented in the subsequent sections:

- Those data link services which have been defined or are in the process of definition respectively by the ODIAC Task Force for introduction in the ECAC area are presented in italics;
- The last column of these tables provides a classification of each data link service with respect to the geographical scope and relevance of its implementation, being either

local (L) or area-wide (A). The reason for and the relevance of this classification are explained in section 2.4.5 in more detail.

2.4.1.1 Services in HTLA

Table 2.4-2 lists the ATN-compliant data link services which will be provided by ATSOs to ATN-equipped aircraft in HTLAs. A more detailed description of the majority of these services can be found in [18].

2000 - 2005	2005 - 2010	2010 - 2015	
ATC Communications Management (ACM)	*ATC Communications Management (ACM)*	*ATC Communications Management (ACM)*	A
Clearances and Information Communications (CIC)	*Clearances and Information Communications (CIC)*	*Clearances and Information Communications (CIC)*	A
Departure Clearance (DCL)	*Departure Clearance (DCL)*	*Departure Clearance (DCL)*	L
Downstream Clearance (DSC)	*Downstream Clearance (DSC)*	*Downstream Clearance (DSC)*	A
Push-back Clearance Request/ Delivery	Push-back Clearance Request/ Delivery	Push-back Clearance Request/ Delivery	L
Taxi Request/ Delivery	Taxi Request/ Delivery	Taxi Request/ Delivery	L
Controller Access Parameters (CAP)	*Controller Access Parameters (CAP)*	*Controller Access Parameters (CAP)*	L
Data Link Operational Terminal Information (D-OTIS)	*Data Link Operational Terminal Information (D-OTIS)*	*Data Link Operational Terminal Information (D-OTIS)*	L
Data Link Runway Visual Range (D-RVR)	*Data Link Runway Visual Range (D-RVR)*	*Data Link Runway Visual Range (D-RVR)*	L
Data Link Initiation Capability (DLIC)	*Data Link Initiation Capability (DLIC)*	*Data Link Initiation Capability (DLIC)*	L
	Arrival Management[2]	Arrival Management[2]	L
	Dynamic Route Availability (DYNAV)	*Dynamic Route Availability (DYNAV)*	A
	Meteorological Data Downlink (MET)	Meteorological Data Downlink (MET)	L
	Data Link SIGMET	*Data Link SIGMET*	L
	Pilot Preferences Downlink (PPD)	*Pilot Preferences Downlink (PPD)*	L
	System Access Parameters (SAP)	*System Access Parameters (SAP)*	L
	Oceanic Clearance Message (OCM)	Oceanic Clearance Message (OCM)	L
	Surface Movement Guidance and Control Information Exchange	Surface Movement Guidance and Control Information Exchange	L
	Traffic Information (TIF)	Traffic Information (TIF)	L
		Flight Plan Consistency (FLIPCY)	A

2 Will only be used at the busiest airports.

		Conflict Resolution by Negotiation	A
		4D Trajectory Negotiation (4DTN)	A
		GNSS Augmentation Data Uplink	A

Table 2.4-2: Typical HTLA Data Link Services

Table 2.4-3 lists the ATN-compliant ground communication services used by ATSOs in HTLAs for information exchange within the ATSO domain and with other ATN users, e.g. AOs and APOs.

2000 - 2005	2005 - 2010	2010 - 2015
Inter-centre communication (national ACCs and ACFs)	Inter-centre communication (national and international)	Inter-centre communication (national and international)
AMHS (national ACCs and ACFs)	AMHS (national and international)	AMHS (national and international)
	ATFM communications (between FMPs (in ACCs and ACFs), IFPS, DBE)	ATFM communications (between FMPs (in ACCs and ACFs), IFPS, DBE)
	AIS communications (between EAD and EAD client terminals)	AIS communications (between EAD and EAD client terminals)
	ASM communications	ASM communications
	Meteorological information communications	Meteorological information communications
	Exchange of planning information (with AOs)	Exchange of planning information (with AOs)
	Exchange of planning and resource information (with national APOs)	Exchange of planning and resource information (with APOs)
	Radar data exchange (to/from radar data servers)	Radar data exchange (to/from radar data servers)
	GNSS augmentation data transfer	GNSS augmentation data transfer

Table 2.4-3: Typical HTLA Ground Communication Services

2.4.1.2 Services in LTLA

Table 2.4-4 lists the ATN-compliant data link services which will be provided by ATSOs to ATN-equipped aircraft in LTLAs. A more detailed description of the majority of these services can be found in [18].

2000 - 2005	2005 - 2010	2010 - 2015	
Clearances and Information Communications (CIC) (en-route only)	*Clearances and Information Communications (CIC) (en-route only)*	*Clearances and Information Communications (CIC) (en-route only)*	A
Departure Clearance (DCL)	*Departure Clearance (DCL)*	*Departure Clearance (DCL)*	L
Downstream Clearance (DSC)	*Downstream Clearance (DSC)*	*Downstream Clearance (DSC)*	A
Data Link Operational Terminal	*Data Link Operational Terminal*	*Data Link Operational Terminal*	L

Information (D-OTIS)	*Information (D-OTIS)*	*Information (D-OTIS)*	
	Automated Dependent Surveillance (ADS)[3]	*Automated Dependent Surveillance (ADS)*[3]	L
	ATC Communications Management (ACM)	*ATC Communications Management (ACM)*	A
	Oceanic Clearance Message (OCM)	Oceanic Clearance Message (OCM)	L
	Push-back Clearance Request/ Delivery	Push-back Clearance Request/ Delivery	L
	Taxi Request/ Delivery	Taxi Request/ Delivery	L
	Data Link Initiation Capability (DLIC)	*Data Link Initiation Capability (DLIC)*	L
	Controller Access Parameters (CAP)	*Controller Access Parameters (CAP)*	L
	Arrival Management[4]	Arrival Management[4]	L
		Pilot Preferences Downlink (PPD)	L
		System Access Parameters (SAP)	L
		Meteorological Data Downlink (MET)	L
		Data Link SIGMET	L
		Traffic Information (TIF)	L
		GNSS Augmentation Data Uplink	A

Table 2.4-4: Typical LTLA Data Link Services

Table 2.4-5 lists the ATN-compliant ground communication services used by ATSOs in LTLAs for information exchange within the ATSO domain and with other ATN users, e.g. AOs and APOs.

2000 - 2005	2005 - 2010	2010 - 2015
Inter-centre communication (international)	Inter-centre communication (national and international)	Inter-centre communication (national and international)
AMHS (international)	AMHS (national and international)	AMHS (national and international)
	ATFM communications (between FMPs (in ACCs and ACFs), IFPS, DBE)	ATFM communications (between FMPs (in ACCs and ACFs), IFPS, DBE)
	AIS communications (between EAD and EAD client terminals)	AIS communications (between EAD and EAD client terminals)
	Exchange of planning information (with AOs)	Exchange of planning information (with AOs)

3 This service permits the downlink of aircraft data (such as position) for surveillance and other purposes based on a contract between the ATSO and aircraft; it does not include ADS broadcast (ADS-B).

4 Will only be used at the busiest airports.

		ASM communications
		Exchange of planning and resource information (with national APOs)
		Radar data exchange (to/from radar data servers)
		Meteorological information communications
		GNSS augmentation data transfer

Table 2.4-5: Typical LTLA Ground Communication Services

2.4.1.3 Services in LTLA-R

Table 2.4-6 lists the ATN-compliant data link services which will be provided by ATSOs to ATN-equipped aircraft in LTLA-Rs.

2000 - 2005	2005 - 2010	2010 - 2015	
Automated Dependent Surveillance (ADS)[5]	*Automated Dependent Surveillance (ADS)*[5]	*Automated Dependent Surveillance (ADS)*[5]	L
	Oceanic Clearance Message (OCM)	Oceanic Clearance Message (OCM)	L
	ATC Communications Management (ACM)	*ATC Communications Management (ACM)*	A
	Clearances and Information Communications (CIC) (en-route only)	*Clearances and Information Communications (CIC) (en-route only)*	A
	Downstream Clearance (DSC)	*Downstream Clearance (DSC)*	L
	Data Link Operational Terminal Information (D-OTIS)	*Data Link Operational Terminal Information (D-OTIS)*	L
		Controller Access Parameters (CAP)	L
		GNSS Augmentation Data Uplink	A

Table 2.4-6: Typical LTLA-R Data Link Services

For the remote areas (LTLA-Rs), ADS (contract) will be the sole means of surveillance. In the non-remote areas (LTLAs), ADS (contract) will be used as primary or secondary means of surveillance respectively and for the purpose of interfacing with the LTLA-Rs.

Table 2.4-7 lists the ATN-compliant ground communication services used by ATSOs in LTLA-Rs for information exchange within the ATSO domain and with other ATN users, e.g. AOs and APOs.

2000 - 2005	2005 - 2010	2010 - 2015
nil	Inter-centre communication (inter-	Inter-centre communication

[5] This service permits the downlink of aircraft data (such as position) for surveillance and other purposes based on a contract between the ATSO and aircraft; it does not include ADS broadcast (ADS-B).

	national)	(national and international)
	AMHS (international)	AMHS (national and international)
		ATFM communications (between FMPs (in ACCs and ACFs), IFPS, DBE)
		AIS communications (between EAD and EAD client terminals)
		Exchange of planning information (with AOs)
		Exchange of planning and resource information (with national APOs)
		GNSS augmentation data transfer

Table 2.4-7: Typical LTLA-R Ground Communication Services

2.4.2 AO Communication Services

Table 2.4-8 lists the ATN-compliant AOC and AAC services used by AOs for communication with ATN-equipped aircraft both in-flight and at rest at the airport. The last column of this table provides a classification of each data link service with respect to the geographical scope and relevance of its implementation, being either local (L) or area-wide (A). The reason for and the relevance of this classification are explained in section 2.4.5 in more detail.

2000 - 2005	2005 - 2010	2010 - 2015	
Movement Messages (OOOI)	Movement Messages (OOOI)	Movement Messages (OOOI)	L
Aircraft and Engine Perfor-mance/Trend Monitoring	Aircraft and Engine Performance/Trend Monitoring	Aircraft and Engine Performance/ Trend Monitoring	A
Flight Status Reports (ETA, Delays, Progress Reports, Diversions)	Flight Status Reports (ETA, Delays, Progress Reports, Diversions)	Flight Status Reports (ETA, Delays, Progress Reports, Diversions)	A
Automatic Terminal Information Service (ATIS)	Automatic Terminal Information Service (ATIS)	Automatic Terminal Information Service (ATIS)	L
Fuel Status	Fuel Status	Fuel Status	A
Load Sheet Transfer	Load Sheet Transfer	Load Sheet Transfer	L
Flight Plan Transfer	Flight Plan Transfer	Flight Plan Transfer	A
Flight Log Transfer	Flight Log Transfer	Flight Log Transfer	L
Dispatch/Weather Reports	Dispatch/Weather Reports	Dispatch/Weather Reports	A
Crew and Aircraft Schedule	Crew and Aircraft Schedule	Crew and Aircraft Schedule	A
Maintenance Items	Maintenance Items	Maintenance Items	A
Service Messages	Service Messages	Service Messages	A
Quality Monitoring	Quality Monitoring	Quality Monitoring	A
	Technical Log Book Update	Technical Log Book Update	L
	Cabin Log Book Transfer	Cabin Log Book Transfer	L
	Onboard Documentation Update	Onboard Documentation Update	L
	Real-time Maintenance Information	Real-time Maintenance Information	A

	Graphical Weather Information	Graphical Weather Information	A
		Software Loading	L
		Online Technical Trouble Shooting	A
		Real-time Weather Reports for Met Offices	A
		Telemedicine	A

Table 2.4-8: Typical Aircraft Operator AOC/AAC Services

Table 2.4-9 lists the ATN-compliant ground communication services used by AOs for information exchange with other ground ATN users, e.g. ATSOs and APOs.

2000 - 2005	2005 - 2010	2010 - 2015
nil	Exchange of planning information (with national ATSOs)	Exchange of planning information (with national ATSOs)
	ATFM communications (between FMPs and IFPS/DBE)	ATFM communications (between FMPs and IFPS/DBE)
		Exchange of planning and resource information (with APOs)

Table 2.4-9: Typical Aircraft Operator Ground/Ground Communication Services

2.4.3 APO Communication Services

Table 2.4-10 lists the ATN-compliant data link services used by APOs for communication with aircraft during approach of, movement on, or at rest at the airport.

2000 - 2005	2005 - 2010	2010 - 2015
nil	tbd	tbd

Table 2.4-10: Typical APO Data Link Services

Table 2.4-11 lists the ATN-compliant ground communication services used by APOs for information exchange with other ground ATN users, e.g. ATSOs and AOs.

2000 - 2005	2005 - 2010	2010 - 2015
nil	Exchange of planning and resource information (with national ATSOs)	Exchange of planning and resource information (with national ATSOs)
	ATFM communications (with IFPS, DBE)	ATFM communications (with IFPS, DBE)
		Exchange of planning and resource information (with AOs)

Table 2.4-11: Typical APO Ground/Ground Communication Services

Exchange of planning and resource information with ATSOs will include:

- gate assignment information,
- availability of runways and taxiways,
- weather conditions,
- forecasts of potential shortages in airport resources,
- etc.

Future SMGCSs will require the continuous data exchange between all partners of the overall traffic system, i.e. aircraft, ATSOs, AOs and APOs; the related communication service is listed under the HTLA data link services (in Table 2.4-2).

2.4.4 Other Communication Services

Aeronautical passenger communications (APC) services will be offered by aeronautical communications service providers (ACSPs), such as SATELLITE AIRCOM, SKYPHONE, JETPHONE and FLIGHTLINK, in all periods and in all areas. It is expected that this communications category will produce a large portion of the overall air/ground communications traffic [7] and, consequently, will heavily influence the evolution of the aeronautical communications market and environment. Therefore, APC cannot be omitted from the scenarios. However, APC will not be included in the ATN CBA in quantitative terms, but will be considered in qualitative terms with respect to its institutional, technical and operational impact and market forces on related ATN developments. Due to international frequency allocations, there is a regulatory impact when using APC in the ATN.

2.4.5 Service Deployment Principles

The ATN-compliant data link services listed in the previous sections have been classified into two categories, these being:

- local data link services (marked by "L" in the last column of the relevant tables), and
- area-wide data link services (marked by "A" in the last column of the relevant tables).

Local data link services may be deployed locally, i.e. in a given limited geographical area such as an airport, a terminal manoeuvring area (TMA), or flight information region (FIR), and autonomously, i.e. without co-ordination and overlap of service coverage with adjacent areas, in order to provide full benefits to the service users. An example of a local data link service is the Departure Clearance (DCL) service, which will be offered at airports exclusively. The full operational benefits of this service can be accrued by a given ATN-equipped aircraft at an airport offering the service, independent of the fact whether the service will be offered at other airports too. Consequently, there is no need for a full, i.e. EUR Region-wide implementation of the service to attain 100% benefit. From the perspective of the airspace user, the overall benefit value of this data link service will grow at a linear rate with the number of sites providing the service; from the perspective of the service provider, i.e. ATSO, it will grow proportional to the number of ATN-equipped aircraft visiting the airport. However, for some local data link services the full benefit stack will not be released until a sufficiently large user community has been built up, i.e. before the number of (ATN-)equipped aircraft has crossed a certain threshold value. Arrival management and ADS are examples of such a local data link service with a benefit threshold.

Local data link services without a benefit threshold (e.g. DCL, taxi request/delivery, CAP) will be the first ones to be deployed in the EUR Region due to their independence from other deployment activities and the immediate benefit release to the individual service users. At a later stage, when the number of potential service users has grown sufficiently, the data link services with a benefit threshold will be introduced.

Area-wide data link services require a certain geographical service coverage, which should stretch along the total flight path in the ideal case, in order to accrue full benefits from using the service. An example of such an area-wide data link service is the ATC communications management (ASM) service. This service has to be implemented at least by two adjacent ATS units (ATSUs) along the flight path but should be available by all ATSUs from the departure to the arrival of the flight to ensure service continuity from gate to gate.

The deployment of area-wide data link services needs co-ordination and synchronisation of implementation plans between the individual service providers. Ideally, the area-wide data link services will be introduced almost simultaneously throughout the whole EUR Region, however such a "big bang" solution is not achievable for a number of (obvious) reasons. Nevertheless, a key objective in the introduction of area-wide data link services should be full service coverage for a as large as possible number of flights, right from the beginning. Further evolution of this service coverage should expand this initial coverage in a seamless way. This means that the initial service area will have to grow coherently at its periphery without introducing fragmentation in the overall service area. Fragmentation of the coverage area of area-wide data link services will decrease ATN benefits attained by ATN-equipped airspace users.

A portion of the so-called European core area is likely to be the nucleus for the initial introduction of area-wide data link services in the EUR Region. However, from a co-ordination and managerial point of view, it will not be possible to expand this initial service coverage to a EUR-Region wide coverage following the above deployment principles. Rather there will be several initial clusters spread over the whole EUR Region which will grow at their own pace to finally merge into a EUR Region-wide service area in the long term.

Initial clusters may shape along the territory of a state or a group of adjacent states or may be aligned to major flight routes. In any case, further evolution of this initial coverage area has to be controlled by a co-ordinating entity to ensure seamless expansion and to avoid service gaps. An initial scenario for such a co-ordinating entity is presented in Section 3.6.

3. ATN Network Deployment Scenario

This section presents the individual network deployment sub-scenarios for the:

- air traffic service organisations (ATSOs)
- aircraft operators (AOs)
- airport operators (APOs)
- aviation weather service providers,
- aircaft, and
- European ATN Co-ordinating Entity (EACE).

3.1 ATN Evolution in the ATSO Domain

This section provides a qualitative description of the assumed ATN evolution in the ATSO domain and a quantitative definition of the typical level of ATN involvement of this ATN user group.

3.1.1 Definition

In this document the term Air Traffic Service Operators (ATSOs) collectively refers to the national and supra-national entities which provide the following ATS functions:

- air traffic control (ATC),
- air traffic flow management (ATFM),
- aeronautical information services (AIS), and
- airspace management (ASM).

Consequently, the ATSO domain also includes the following pan-European entities which are referred to as "Pan-European ATS Systems" in the reminder of this document:

- Central Flow Management Unit (CFMU), comprising the Initial Flight Plan Processing Systems (IFPSs) and the Data Base Europe (DBE),
- European AIS Database (EAD),
- European Flight Data Processor (EFDP) [26].

3.1.2 Evolution of ATN Air/Ground Deployment

The deployment of the ground portion of the ATN will be started by the ATSOs through the implementation of ground-based ATN air/ground systems. It will start by individual local initiatives providing initial ATN-compliant mobile communication services on a local/regional basis [15] in the HTLA. From 2000 onwards, HTLA ATSOs will progressively introduce for example in TMAs or at major airports certified ATN equipment on a pre-operational basis. These individual local implementations will support initial ATN air/ground applications, such as DCL and D-OTIS, from 2000 onwards, and will be the nucleus of the ATN ground infrastructure in the EUR Region. These local services will be used by a limited set of aircraft (about 2 % of aircraft operating in EUR Region) that are already ATN-equipped in this time frame. This ATN-equipped aircraft subset will mainly include European and non-European long-haul aircraft which also participate in ATN-compliant communications in other (non-European) regions.

This dispersed initial ground ATN infrastructure will include ATSO-owned ground ATN ESs (about 1 -2 per local implementation) and ATSO-owned air/ground routers (at least 1 per local implementation) as well as VDL Mode 2 ground stations. At this initial stage, the VDL Mode 2 ground stations will be owned by ACSPs who will provide mobile communication services to the ATSOs on a contractual service relationship. The number of such individual and local ground ATN implementations will be less than 10 in the year 2000 but will increase by a rate of 50 % per year during the next 3 years as benefits can be gained and more aircraft will become ATN-equipped.

Furthermore, these individual and local ATN implementations will expand in size and will be interconnected through ATSO ground networks to result in a more integrated ground ATN infrastructure in the EUR Region in the middle of next decade.

This initial ATN ground infrastructure will primarily support air/ground ATSC, but will be the nucleus of the ATS ground/ground communications deployment process which will start as a complementary process around 2002.

3.1.3 Evolution of ATN Ground/Ground Deployment

Contrary to the air/ground environment, an ATS ground data communication infrastructure exists in large parts of the EUR Region and a number of ATS ground communication services are already operational in a non-ATN environment. Radar data, flight plans, ATC co-ordination messages and ATFM data are exchanged successfully through dedicated point-to-point links, X.25 or AFTN/CIDIN networks within the EUR Region and with adjacent ICAO Regions. Moreover, an operational basic ATS messaging service is available to a subset of the ATSOs in the EUR Region.

The introduction of ATN in the ground/ground environment will primarily be motivated by the following two aspects:

- the consolidation of the existing legacy infrastructure by a more homogeneous, integrated, flexible and efficient communication infrastructure, and
- the provision of new ground communication services supporting the advanced ATM functions (e.g. co-operative decision making) planned for introduction to cope with the demanding growth in air traffic [11].

3.1.3.1 ATS Ground Data Communication Services

The set of ATS ground data communication services which are currently operational in the EUR Region and which will start to transition to the ATN in the period 2000 to 2005 comprises:

- ATC Co-ordination and Flight Data Interchange,
- Air Traffic Flow Management Communications,
- Airspace Management Communications,
- Aeronautical Information Service Communications,
- Radar Data Exchange,
- Meteorological Information Exchange, and
- AFTN/CIDIN Message Exchange.

In addition, the following new ATS ground communication services will be introduced in an ATN-compliant manner in the period 2005 to 2010:

- Air Situation Display (ADS) communication,
- Exchange of planning information with Aos, and
- Exchange of planning and resource information with APOs.

3.1.3.1.1 ATC Co-ordination and Flight Data Interchange

The ATC co-ordination and flight data interchange between national ACCs and between adjacent inter-national ACCs includes:

- automatic data exchange between the flight data processing systems (FDPSs) for flight co-ordination and the transmission of flight plan related information,
- exchange of flight notification messages and co-ordination messages (e.g. ACT, LAM and ABI) between the controller working positions (CWPs),
- passing of data on individual flights to the next ACC prior to the actual handover.

The ATC co-ordination and flight data interchange service is currently implemented according to the On-line Data Interchange (OLDI) procedures and connects about 20 pairs of ACCs internationally. Equivalent OLDI links are in operation nationally. Some such OLDI "connections" are of a logical nature, e.g. via national flight plan processing systems and are not necessarily physical connections.

Currently communication across most OLDI links follows the Short term interface control document (ST-ICD). The ST-ICD is an interim standard for point-to-point OLDI connections using the X.25 protocol. In addition, there are OLDI links (mainly intra-national) based on proprietary protocols (such as CAUTRA) which run over dedicated point-to-point circuits or limited networks.

The ATN inter-centre communication (ICC) application provides an advanced method of exchanging flight-related data between ACCs based on an ATN internetwork infrastructure. The ICAO-standardised ICC application exchanges information between ACCs for support of critical ATC functions, such as flight notification, flight co-ordination, transfer of control, transfer of communications, transfer of surveillance data, and general ATS-related information interchange.

The ICC application will be introduced on all new ACC connections which will become operational from 2000 onwards in the HTLA. From this date on, it will also gradually replace existing OLDI links. The transition to ICC will be done by means of ICC interworking units.

In 2005, 10% of all connections between ACCs in the EUR Region will use ICC, the rest will still deploy OLDI. In 2010, the ICC share will have grown to 50% and in 2015 OLDI will have been completely phased out and replaced by ATN-compliant ICC throughout the EUR Region. Table 3.1-1 lists the evolution of ICC in the EUR Region in terms ICC-equipped ACCs for the three geographical areas and the three time spots of the ATN scenario.

Area / Year	HTLA	LTLA	LTLA-R
2005	10%	10%	0%
2010	100%	50%	30%
2015	100%	100%	100%

Table 3.1-1: Percentage of ACCs using ATN-compliant ICC

3.1.3.1.2 Air Traffic Flow Management Communications

Communications play a vital role in the current and future operation of ATFM in the EUR Region. The current ATFM process in Europe is centrally co-ordinated and managed through automated systems, these being the CFMU and IFPSs. Primarily due to safety considerations, there are two IFPS centres each handling about half of the flight plans of the ECAC States. One is located at the CFMU in Brussels and the other at Brétigny-sur-Orge adjacent to the Eurocontrol Experimental Centre.

The CFMU, or the IFPSs respectively, interface with the Flow Management Positions (FMPs) in the ACCs and the Flight Input Workstations (FIW) at the aircraft operators' premises and at the ATS Reporting Offices located at aerodromes. Through the FMPs, ACCs receive the relevant flight plans and notifications on current or planned ATFM measures, and report on ATFM-related events. The FIWs are used by the aircraft operators primarily to submit flight plans and flight data and for co-ordination with the CFMU if corrections or modifications to the filed flight plan have to be made, e.g. due to re-routing or delays.

The CFMU is currently using the services of an international ground data network based on the British Telecom's Network Services (GNS). This network is physically and functionally separated from other ATSO networks. From 2002 onwards, when the interconnection of ATSO networks has progressed towards an initial pan-European ATSO network, the CFMU communication services will start to migrate to this pan-European network infrastructure, mainly for efficiency reasons. The IFPSs and the FMPs will be gradually upgraded to become ATN end systems. They will be users of the ground ATN infrastructure which will be based on the existing interconnected ATSO networks. This infrastructure will support a variety of ATS applications simultaneously resulting in efficiency and cost benefits. The integration of existing CFMU communication services into an ATN ground infrastructure will not change the principles of CFMU operation. The transition will stretch over a period of about 5 years during which existing BT communication services and new ATN-compliant communication services will co-exist. After this period the communication services of the external network provider will be completely phased out in the ATSO domain. The FIWs will continue to be connected through a third party service provider network to the CFMU but will either have been upgraded to ATN end-systems too or will interface with the CFMU through ATN gateways operated by the third party network service provider(s). This non-uniform evolution in the ATSO domain and the aircraft operator domain is tolerable as the CFMU, as the central ATFM entity, is separating the two domains.

Table 3.1-2 presents the evolution of ATN-compliant ATFM ground communications in the EUR Region in terms of ATN-compliant FMPs, i.e. FMPs upgraded to or replaced by ATN ESs, in the three geographical areas and for the three time spots of the ATN scenario.

Area / Year	HTLA	LTLA	LTLA-R
2005	20%	20%	0%
2010	100%	80%	30%
2015	100%	100%	100%

Table 3.1-2: Percentage of ATN-compliant FMPs

3.1.3.1.3 Aeronautical Information Service Communications

Aeronautical information exchange includes:

- the provision of AIS to national airspace users, and
- the exchange of aeronautical information with other states.

Currently most European states have implemented their own AIS infrastructure to provide the above services. Consequently, there is a significant duplication of effort inherent in the collection and maintenance of other states' information. The proposed European AIS Database (EAD) follows the concept of information sharing through a common information pool. The EAD will provide a unique reference database of aeronautical information on behalf of the ECAC states.

EAD input data (such as static data, aeronautical messages, and NOTAMs) will be provided by national ATSOs or designated organisation which have delegated responsibility for special classes of data. Users of the EAD who will consult EAD data will include national administrations, international organisations, aircraft operators, CFMU, commercial users, and private pilots.

The EAD user community has significant overlap with the users of other ATS functions, such as collaborative decision making or ATFM. Consequently, EAD users and operators will benefit from a common ground communications infrastructure which will be shared with other services. Furthermore, the concept of a common information pool is vitally dependant on a networked communications structure which supports a large group of data providers and data users. The ATN provides these features. Given that the development of the EAD is currently in a preparatory phase, the central EAD entity and the EAD Client Interface Terminals are candidates to become early adopters of ATN ground communications. In this case, the ATSO EAD Client Interface Terminals will implement the ATN protocol stack and will be linked to the ATN-compliant central EAD facility through the interconnected existing ATSO ground networks. However, several ATSOs within the EUR Region which have well developed AIS systems will continue to use these systems in parallel to the EAD for a certain transition period (about 5 - 7 years).

The same ATN-compliant approach will be applicable to a subset of the EAD Client Interface Terminals of the remaining EAD users, although they will access the central EAD facility through the ATN-compliant ground network of an aeronautical communications service provider. Another subgroup, in particular the commercial users and authorised members of the general public, which are connected to public data networks will access the EAD services in a non-ATN-compliant manner using standard Internet protocols for example. To support this user (sub-)group two communication stacks will have to be implemented in the central EAD facility.

Table 3.1-3 presents the evolution of ATN-compliant AIS ground communications in the EUR Region in terms of ATN-compliant EAD client terminals in the three geographical areas and for the three time spots of the ATN scenario.

Area / Year	HTLA	LTLA	LTLA-R
2005	30	20	5
2010	100	70	50
2015	150	100	70

Table 3.1-3: Number of ATN-compliant EAD Client Terminals

3.1.3.1.4 Radar Data Exchange

Radar data exchange includes the following three flows of traffic:

- Transmission of radar data from the national ATC radar sites (i.e. the radar sensors and RMCDEs) to the radar data servers (i.e. ATC radar tracker and server (ARTAS)) located in the national ACCs
- Transmission/reception of radar data to/from national military radar sites
- Transmission/reception of processed radar data (plots or filtered plots) between radar data servers (i.e. RMCDEs and ARTAS) of adjacent states.

Dedicated X.25 networks (e.g. RADNET), X.25 networks (e.g. RENAR) or leased lines are currently used as underlying communication infrastructure for radar data exchange in the EUR Region. Whereas the choice of the communication infrastructure and data format for the transmission of radar data from the national ATC radar sites to the radar data servers as well as between the radar data servers of a given state is left to each individual ATSO, the exchange of radar data between adjacent countries has to be harmonised.

Besides the standardisation of a common format for the radar data, the implementation of common communication protocols is a pre-requisite for the inter-connection of the national radar data networks. The ASTERIX format seems to emerge as the European standard for radar data, whereas the ATN provides by definition the appropriate internetwork solution between the individual radar data servers.

ATN-compliant radar data exchange will start on the inter-national level first (around 2003), i.e. between the radar data servers of adjacent states, and will expand to include transmission/reception of radar data between national radar data servers and from national radar sites to the ACCs some years later. Around 2005 about 20 % of the HTLA radar data servers will have been upgraded to ATN ESs. These ATN ESs will be attached to the ARTAS network or interconnected by dedicated point-to-point links. In 2010 about 80 % of the HTLA radar data servers and 20% of the national radar data sites will have become ATN users. Finally, in 2015 all radar data servers and 50% of the radar ground stations will be integrated in the European ground ATN. They will profit from the additional robustness of the network made possible by dynamic ATN routing techniques, and from the efficiency achieved in sharing a common infrastructure by a number of users, in particular in the exchange of processed radar data across national boundaries.

Table 3.1-4 presents the evolution of ATN-compliant radar data exchange in the EUR Region in terms of ATN-compliant radar data servers and radar ground stations, i.e. radar data servers or radar ground stations upgraded to or replaced by ATN Ess respectively, in the three geographical areas and for the three time spots of the ATN scenario.

Area / Year	HTLA	LTLA	LTLA-R
2005	20% of servers	10% of servers	nil
2010	80% of servers 20% of ground stations	50% of servers 20% of ground stations	nil
2015	100% of servers 50% of ground stations	90% of servers 30% of ground stations	nil

Table 3.1-4: Percentage of ATN-compliant Radar Data Servers and Radar Ground Stations

3.1.3.1.5 AFTN/CIDIN Message Exchange

The AFTN/CIDIN message exchange is not an operational ATS communication service itself, but provides a basic message handling service for a number of operational ATS ground communication services. The operational ATS ground communication services which are currently implemented using the messaging infrastructure provided by AFTN/CIDIN include:

- flight plan exchange,
- AIS distribution, and
- OPMET distribution.

This is partly due to the fact that these operational services have message handling characteristics but also due to historical reasons because, at the time of their implementation, the messaging infrastructure was the only one which was widely available for use.

Until 2000, ATS messages (such as flight plan, NOTAMs, etc.) will be conveyed through the AFTN/CIDIN network exclusively. From 2000 onwards, the AFTN/CIDIN messaging service will be complemented and gradually replaced by the ICAO-standardised AMHS in the HTLA.

The transition to the AMHS will occur in two parallel streams. In the first stream which will be applicable primarily to the LTLA and some parts of the HTLA, the AFTN/CIDIN applications and infrastructure will continue to be used for a transition period of about 7 years, and will interface with the ATN-compliant ground infrastructure through AFTN/ATN gateways. These gateways are special ATN ESs which will be implemented at the boundaries of the current AFTN/CIDIN and will perform a protocol conversion which maps the AFTN message format into the AMHS message format and vice versa. This will allow the existing AFTN/CIDIN messaging service to co-operate with the ATN-based AMHS. AFTN/CIDIN users and ATS Message Servers will be able to communicate in a transparent manner, whatever the communication infrastructure(s) between them will be.

In a second stream, ATN ESs running the AMHS (i.e. ATS Message Servers) will be implemented to provide the communication service for new ATS ground applications and/or to replace existing AFTN/CIDIN switches. These ATS message servers will be full ATN-compliant end systems. Full replacement of the AFTN and CIDIN will be completed in the HTLA by 2012 and in the remaining areas by 2015.

Table 3.1-5 lists the evolution of AMHS in the EUR Region in terms AFTN/CIDIN systems replaced by AMHS ESs (ATS message servers) or connected to an ATN ground infrastructure by ATN/AFTN gateways respectively, in the three geographical areas and for the three time spots of the ATN scenario.

Area Year	HTLA	LTLA	LTLA-R
2005	10% replaced by AMHS ESs 40% attached to ATN/ AFTN GW	20% attached to ATN/ AFTN GW	10% attached to ATN/ AFTN GW
2010	90% replaced by AMHS ESs 10% attached to ATN/ AFTN GW	50% replaced by AMHS ESs 30% attached to ATN/ AFTN GW	50% replaced by AMHS ESs 30% attached to ATN/ AFTN GW
2015	100% replaced by AMHS ESs	100% replaced by AMHS ESs	100% replaced by AMHS ESs

Table 3.1-5: Percentage of AFTN/CIDIN Systems Replaced by AMHS or Using ATN

3.1.3.2 ATN Ground Traffic

Besides the traffic associated with the above ATS ground communication services, the following traffic flows will have to be accommodated in the ground ATN. These additional ATN traffic flows will evolve over time and are listed in timely order.

- 1st type of ground ATN traffic will be the **terrestrial feeder traffic of the initial ATS data link services**. This traffic will be between the ACC and the VDL ground station(s) (and/or the satellite GES). There are two possible configurations:

  a) In the case that the VDL ground stations are owned by ATSOs, this traffic will be carried by the national WAN, assuming that ATSOs will follow the general trend to network their communication resources by a shared WAN instead of deploying dedicated point-to-point lines

  b) In the case that the VDL ground stations (or the satellite GES respectively) are owned by ACSPs, access to the ACSP ground network will be provided at the ACC by an ATN router and the complete feeder traffic will be carried by ACSP ground network

- 2nd type of ground ATN traffic will be the **intra-national routing information traffic** exchanged between BISs located at different national ACCs. It is assumed that the national BISs initially belong to the same national RD and later form own RDs. This has impact on the volume of the routing traffic but not on the general nature of this type of traffic. This traffic will carried by the national WAN.

- 3rd type of ground ATN traffic will be the **inter-national routing information traffic** exchanged between the exit/entry BISs of adjacent States and between these BISs and the pan-European BB. Whereas the first type of traffic will be carried by interconnected ATSO WANs (which will be interconnected by local subnetwork means in most cases and by ATN routers in some rare cases), the BB traffic will most likely be carried by dedicated point-to-point lines or public data networks. (The reason for this assumption is that it is not expected that national WANs will extend to the location(s) of the BB router(s) and that no agreement for inter-national pass-through traffic will have been achieved between ATSOs).

- 4th type of ground ATN traffic will be the **terrestrial feeder traffic for enhanced ATN-compliant AOC/AAC applications**. This traffic will be between the AO's ground facilities and the VDL ground stations (and/or the satellite GES(s)). This traffic will be carried by the ground network of the ACSP to which the AO has outsourced its AOC/AAC datalink communications.

Figure 3.1-0 illustrates the chronological sequence of the individual traffic flows and indicates the starting point from which onwards the European ATN ground infrastructure has to support the respective traffic flow.

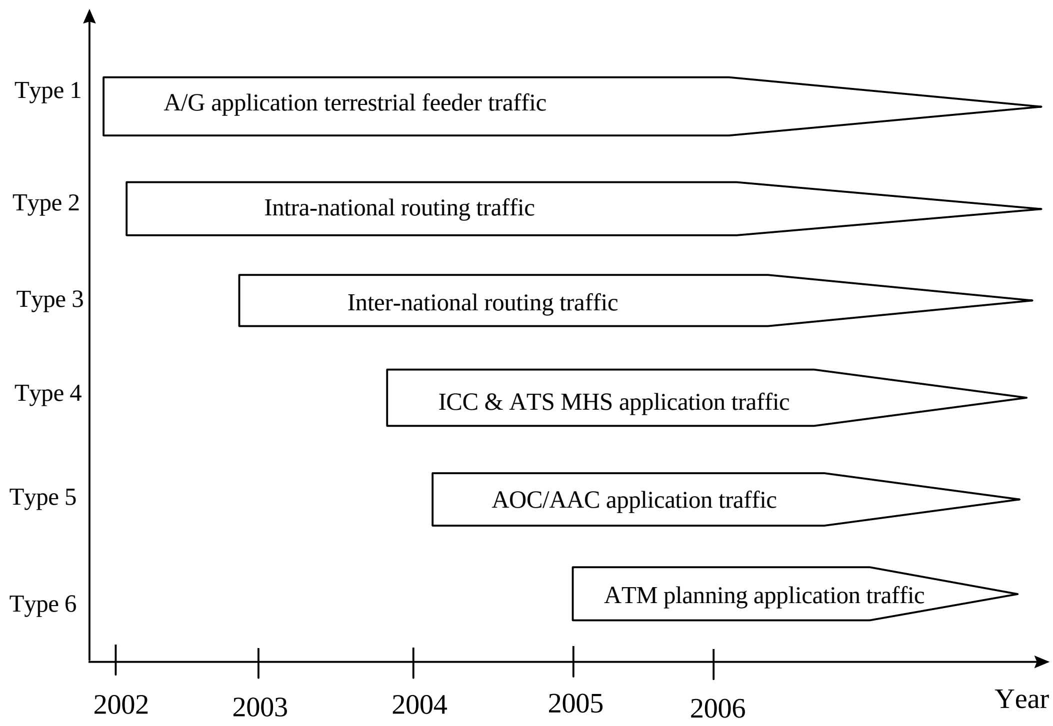

Figure 3.1-0: Schematic Representation of Evolution of ATN Ground/Ground Communications Over Time

3.1.4 2005 Scenario

Table 3.1-6 groups the states of the EUR Region into the three traffic level areas which have been defined as the geographical dimension of the ATN scenario (see Section 2). This grouping is dynamic, in principle. Table 3.3-1 represents the year 2005 snapshot of the grouping based on the air traffic level forecasts for this year (c.f. [23], [5], [6] and [7]).

HTLA	LTLA	LTLA-R
Austria	Bosnia and Herzegovina	Albania
Belgium	Bulgaria	Armenia
France	Croatia	Azerbaijan
Germany	Czech Republic	Belarus
Greece	Denmark	Cyprus
Ireland	Finland	Estonia
Italy	Hungary	Georgia
Netherlands	Luxembourg	Kazakhstan

Portugal	Monaco	Kyrgyzstan
Spain	Norway	Latvia
Switzerland	Poland	Lithuania
United Kingdom	Romania	The former Yugoslav Republic of Macedonia
	Sweden	Malta
	Turkey	Republic of Moldova
		Russian Federation
		San Marino
		Slovakia
		Slovenia
		Tajikistan
		Turkmenistan
		Ukraine
		Uzbekistan
		Federal Republic of Yugoslavia

<This grouping is initial and has to be validated by the Flights & Country Data Sub-Model of the ATN CBA Model>

Table 3.1-6: Classification of European States into Traffic Level Areas (Year 2005)

3.1.4.1 High Traffic Level Areas (HTLA)

3.1.4.1.1 National ATN Infrastructure and Services

Figure 3.1-1 provides a generic representation of the typical ATN infrastructure of a HTLA State in the year 2005 with respect to ATSC. The list of HTLA States at this point in time is compiled in the 1st column of Table 3.3-1.

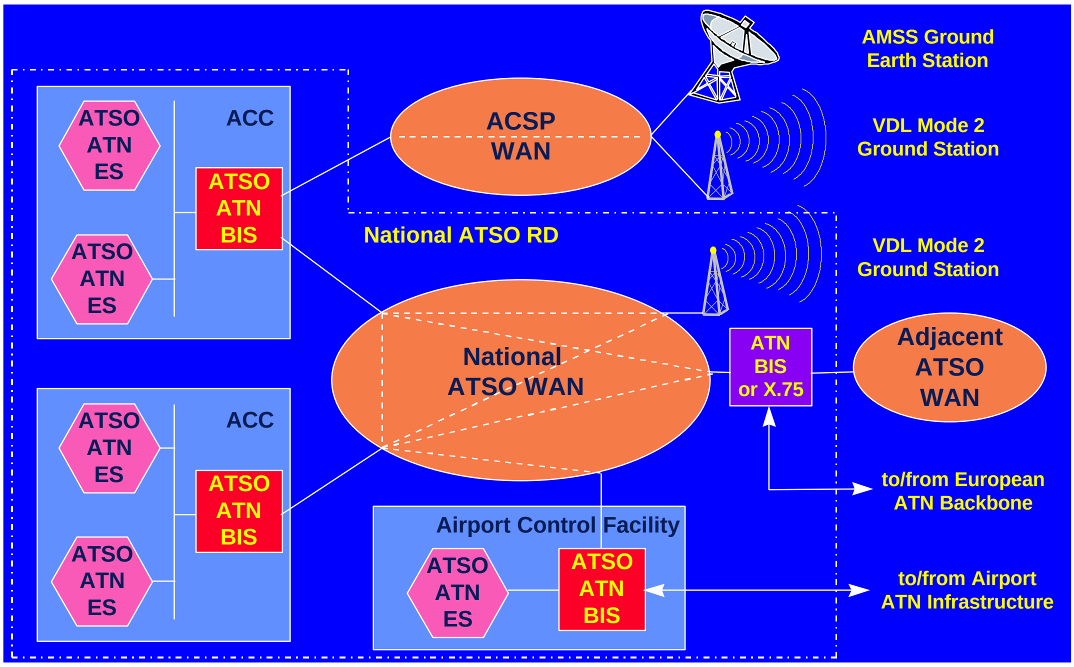

Figure 3.1-1: Typical HTLA State ATN Infrastructure (Year 2005)

Each area control centre (ACC) in a HTLA State will operate at least one ATN router[6]. In 2005 the number of HTLA ACCs in the EUR Region will amount to 35 ACCs as compiled in Table A-1 of Appendix A. This ATN router will typically be connected to two local ATN ESs[7] via the ACC-internal LAN and to at least one en-route VDL ground station via the national ATSO WAN or the ground WAN of an ACSP.

Half of the HTLA ATSOs will have implemented own VDL Mode 2 ground stations. These ATSOs will have integrated these ground stations into their national WAN and will provide physical (and logical) connectivity to these VDL ground stations from each ACC. Some few ATSOs (mainly those with oceanic airspace) may in addition have a direct connection between its (oceanic) ACC and an AMSS ground earth station (GES) owned and operated by an ACSP.

The remaining HTLA ATSOs will neither own nor operate mobile subnetwork ground stations, but will have outsourced the provision of mobile communication services to an ACSP. In this case, all ACCs of the ATSO will be inherently connected to all mobile subnetwork ground stations attached to the ACSP network. These ACSP-owned ground stations will include both VDL Mode 2 and AMSS GESs.

Through the national ATSO WAN, the ATN router of each ACC will be linked to all other ATN routers residing in the remaining national ACCs. This means that the typical ATN network structure on the national level will be a meshed ground topology with some few nodes (number typically corresponds to the number of national ACCs), as illustrated in Figure 3.1-1. These nodes are the ground anchor points for ATS data link communications with aircraft under control (see section 2 for the list of relevant services) and the sources and sinks of ATS ground/ground communications (see section 2 for the list of relevant services).

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[6] Depending on the availability requirements and redundancy concept of the individual ATSO, this may be a fault-tolerant system or may be backed-up by a secondary ATN router.

[7] Depending on the number and type of ATN applications supported by the ATSO and the availability requirements and operational concept of the national ATSO, more than two ATN ES may be operated in the ACC.

In addition to the national ACCs, HTLA ATSOs will operate ATN systems in the airport control facilities (ACFs) of the major national airports (for details see Section 3.3). Typically, an ACF implementation will comprise one ATN router and one ATN ES and will have evolved from the initial local ATN implementations deployed prior to 2005 (see Section 3.1.2). The ATN router at the ACF will be connected to the local airport infrastructure (see Section 3.3) to provide ATN data link services in the TMA and on the airport surface. Furthermore, it will be integrated in the national ATSO WAN for ATS ground communications with national ACCs.

About 70 % of the HTLA ATSOs will have interconnected their national ATSO WANs with the WANs of adjacent ATSOs. About half of these interconnections will have been achieved on the subnetwork level (e.g. through X.75 switches) resulting in a HTLA ATSO backbone (sub-)network merging about 6 national ATSO WANs. The remaining ATSO WANs will use ATN routers for the interconnection. This ATN router will act as the entry/access point of the national RD to/from other adjacent ATSOs and to the European ATN Backbone.

Due to the limited number of ATN routers and ESs per ATSO and the limited number of ATN-equipped aircraft which will be connected to an ATSO's ATN ground infrastructure at a given point in time, all national ATN routers will typically belong to the same routing domain. This means, that there is no need for the establishment of individual routing sub-domains per ATSO at this point in time, but each HTLA State will form a single national ATSO routing domain.

Whereas all HTLA ATSOs will provide ATN data link services within their airspace, the number of HTLA ATSOs who will provide ATN-compliant ground communication services in addition will be limited to about 50 % of HTLA ATSOs. These ATSOs will operate AFTN/ATN gateways at their ACCs to run existing CIDIN applications over ATN-compliant ground subnetworks. In addition, 10 % of the HTLA ATSOs will deploy ICC and AMHS applications over the national WAN both between ACCs and ACFs on a national level and between adjacent interconnected ACCs on a supra-national level. These new ATN-compliant ground/ground applications will gradually replace current AFTN communications and OLDI point-to-point links.

In addition, the existing ground communication services linking the Global European ATS Systems, such as the CFMU, with the remote national users will start to migrate towards ATN communications around the middle of the next decade. In 2005 about 10 % of the flow management positions (FMSs) in the ACCs and ACFs will have become ATN ESs. At the same time about 20 % of the radar ground stations and radar trackers will have been upgraded to ATN ESs and will be connected to ACCs and other ATS control facilities through the ARTAS network or dedicated point-to-point links respectively. In the second half of this decade air situation displays (ASDs) and meteorological offices will start to become additional ATN users. Meteorological authorities will implement ATN ESs at their offices and exchange meteorological information with ATSOs. Initially, this meteorological information exchange will be limited to ground/ground communications and the MET ATN ESs will directly connect to the national ATSO WAN.

The main ATN traffic flows will be focused between the ATN ES(s) of a given ACC or ACF respectively and the ATN ES onboard of aircraft currently under air traffic control by the ATC facility. A second, although minor, main ATN traffic stream will exist between the ATN ESs hosting ATS ground/ground applications. These ATN ESs will communicate:

- with national peer ATN ESs in other ACCs/ACFs and national meteorological offices across the national ATSO WAN (ICC, AMHS);
- with national radar ground stations via the ARTAS network;
- with peer ATN ESs in adjacent states across the interconnected WANs of the concerned ATSOs (ICC, AMHS);
- with ATN ESs located in the CFMU and IFPSs via the national WAN or the European ATSO backbone network (this ATSO backbone network should not be confused with the European ATN backbone described in the next section).

3.1.4.1.2 Pan-European ATN Infrastructure

Some ATSOs of adjacent HTLA States (about 6 ATSOs) will have interconnected their national ATSO WANs on the subnetwork level (e.g. through X.75) to form the so-called ATSO backbone (sub-)network. This network will allow transparent ATN communications between the ATN ESs of these ATSOs across national boundaries and will support international ICC and AMHS communications (replacing outdated AFTN and OLDI connections).

Another group of ATSOs of HTLA States (about 5 ATSOs) will have interconnected their national WANs by ATN routers. These ATN routers will link dissimilar ATSO subnetworks and enable ATN-compliant ICC and AMHS communications between the interconnected States (and even further on, if the States accept to act as transit communication providers).

The remaining HTLA States will be limited to ATN data link communications and intra-national ATN ground communications (ICC, AMHS) at this point in time; however, they will have access to the European ATN Backbone (through a dedicated link).

All HTLA States will be connected to the European ATN Backbone either via their national WANs (nominal case) or by dedicated point-to-point lines (some few exceptions).

The European ATN Backbone will consist of two fault-tolerant, high performant ATN ground routers (BISs), which will be located in the Northern and Southern part of the HTLA. The two ATN Backbone BISs will be operated by the European ATN Co-ordinating Entity (EACE) (see Section 3.6) and will be interconnected by a high-speed data link. This link may either be a dedicated point-to-point connection (with appropriate backup) or a packet switched network (offering appropriate throughput on a permanent basis). Given the expected continuous traffic load between these two BB routers, a dedicated line may be the more cost-effective solution in the long-term, whereas use of a PSN (operated by a third-party CSP) may be the right approach during the start-up phase.

This means that the pan-European ATN network structure in the HTLA will be arranged in a double star-type network topology (comprising a "South-European" star and a "West-European" star) with some few interconnections between both star structures, as illustrated in Figure 3.1-2.

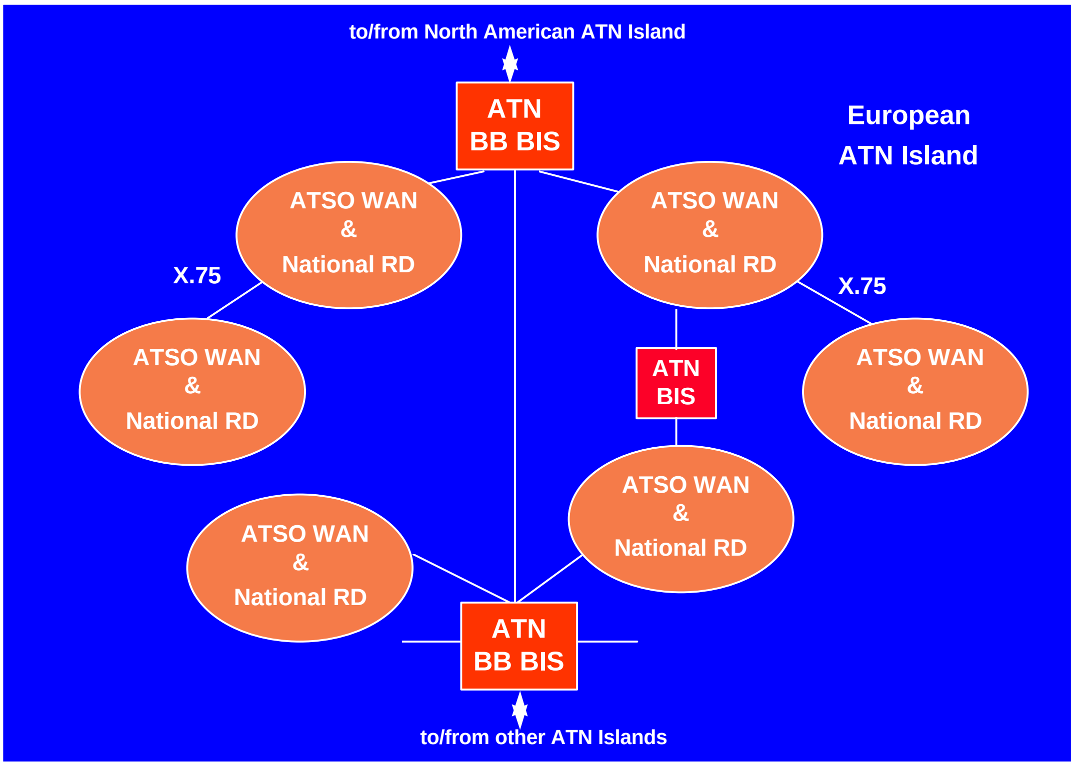

Figure 3.1-2: Typical Pan-European ATN Infrastructure (Year 2005)

Both ATN BB BISs will act as the ground entry points of the European ATN Island providing connectivity to/from other ATN Islands. Due to its geographical location, the „Northern“ BB BIS will be the primary (default) interface to the North American ATN Island and will convey the majority of the inter-Island ATN traffic at this point in time.

3.1.4.2 Low Traffic Level Areas (LTLA)

3.1.4.2.1 National ATN Infrastructure and Services

With some few exceptions, LTLA States will not have introduced ATN communications on an operational basis. However, they will have started to offer ATS data link communications through FANS-1/A compliant ground systems. The list of LTLA States at this point in time is compiled in the 2nd column of Table 3.1-6.

About 10 % of LTLA States will operate one ATN router and at least one ATN ESs in selected ACCs (e.g. the primary ACC of the state). In 2005 there will be a total of about 24 LTLA ACCs in the EUR Region as compiled in Table A-1 of Appendix A. This ATN router will be attached to an ACSP WAN to support ATN data link communications (using the mobile subnetwork ground stations of the ACSP) and to the national WAN for ATN ground communications (ICC) with adjacent (HTLA and LTLA) ATSOs. Dedicated point-to-point link may be used for international ICC instead of the national WAN in some cases. Consequently, the typical ATN infrastructure of these LTLA ATSOs will be similar to the structure outlined in Figure 3.1-1 above, but scaled down to one ATN-equipped ACC per country.

As an alternative to the implementation of own ATN routers, some other LTLA States (about 10 %) will contract an ACSP for ATN-compliant data link communications and inter-national ICC with adjacent HTLA and LTLA ATSOs. In this case, the ATSOs will completely outsource all ATN communications to an ACSP and use the ACSP ground network and its mobile subnetwork facilities in shared operation with other users and other traffic.

The ATN-equipped ACCs in the LTLA will primarily provide ATN data link communications to aircraft currently operating in the FIR of the concerned ACC offering the ATS data link services listed in Table 2.4-4. Furthermore, half of the ATN-equipped LTLA ACCs will use ATN-compliant ground communication services (ICC, AMHS) for international inter-centre communications with ACCs in adjacent HTLA and LTLA States.

3.1.4.2.2 Pan-European ATN Infrastructure

With the exception of the few ATN ground/ground links between the small number of ATN-equipped LTLA ACCs and adjacent HTLA (and LTLA) ACCs no international ground ATN infrastructure will exist in LTLAs. Furthermore, no connection to the European ATN Backbone will exist, except for those ATSOs having outsourced the provision of ATN communication services to an ACSP which will inherently provide access to the European ATN Backbone.

3.1.4.3 Remote and Low Traffic Level Areas (LTLA-R)

In 2005 the ATN will not have been deployed in LTLA-R states in the form of ATSO-owned ATN systems. However about 30 % of LTLA-R states (e.g. those having ATS responsibility in the NAT Region) will have contracted an ACSP for the provision of ATN-compliant ADS contract (and potentially OCM) services in their airspace. These ATSO will have implemented ADS applications on conventional end systems and will access the ATN-compliant communication services of the ACSP through a gateway operated and provided by the ACSP.

In LTLA-R use will be made of the ACSP satellite subnetwork to support ADS services. There will be no ATN-compliant ground communication services nor access to the European ATN Backbone at this point in time.

The list of LTLA-R states in 2005 is compiled in the 3rd column of Table 3.1-6.

3.1.5 2010 Scenario

The following table groups the states of the EUR Region into the three traffic level areas which have been defined as the geographical dimension of the ATN scenario (see Section 2). This grouping is dynamic, in principle. Table 3.1-7 represents the year 2010 snapshot of the grouping based on the forecasted air traffic level for this year (c.f. [23], [5], [6] and [7]).

HTLA	LTLA	LTLA-R
Austria	Bosnia and Herzegovina	Albania
Belgium	Croatia	Armenia
Bulgaria	Czech Republic	Azerbaijan
France	Denmark	Belarus
Germany	Finland	Cyprus
Greece	Georgia	Estonia
Hungary	Latvia	Kazakhstan
Ireland	Lithuania	Kyrgyzstan
Italy	Malta	Republic of Moldova
Luxembourg	The former Yugoslav Republic of Macedonia	San Marino
Netherlands	Monaco	Tajikistan

Poland	Norway	Turkmenistan
Portugal	Russian Federation	Uzbekistan
Romania	Slovakia	
Spain	Slovenia	
Sweden	Turkey	
Switzerland	Ukraine	
United Kingdom	Federal Republic of Yugoslavia	

<This grouping is initial and has to be validated by the Flights & Country Data Sub-Model of the ATN CBA Model>

Table 3.1-7: Classification of European States into Traffic Level Areas (Year 2010)

3.1.5.1 High Traffic Level Areas (HTLA)

The national ATN network structure in HTLA States in 2010 will still be compliant with the principles outlined in Figure 3.1-1. This means that in particular all HTLA ACCs will be ATN-equipped and all HTLA ATSOs will be connected to the European ATN Backbone. In 2010 there will be a total of about 48 HTLA ACCs in the EUR Region as compiled in Table A-1 of Appendix A.

As compared to the 2005 scenario:

- the number of HTLA States will have grown. The first column of Table 3.1-7 lists the set of HTLA States in 2010.
- the number of ATN ESs attached to the ACC-LAN will have grown (up to three or four ATN ESs per ACC). This increase will mainly be due to the fact that
    - all HTLA ACCs will operate ATN CM servers
    - 80 % of HTLA ACCs will use ATN ground/ground communication services for inter-centre communications and data exchange with the Global European ATS Systems (such as CFMU and AIS Database)
    - 80 % of flow management positions and radar trackers will have been upgraded to ATN ESs
    - 50 % of ACCs will exchange data with Aircraft Operators and Airport Authorities via the ATN (to improve the ATM planning process).
- the number and type of mobile subnetwork ground stations will have grown. In particular, ATSO VDL ground stations will provide full en-route, terminal and airport coverage over all of the HTLA (with two-fold overlap in most regions) and Mode S ground stations will complement the VDL coverage in wide portions of the HTLA. 70 % of ATSOs own and operate VDL Mode 2 ground stations whereas 30 % still have outsourcing arrangements with ACSPs.
- many of the ACCs will be own Routing Domains and form a national ATSO RDC with the rest of the national ATN facilities.
- all ACFs at major European airports and at half of the large European airports will be ATN equipped typically comprising one ATN router and one or two ATN ESs.
- ATN-compliant communications has reached a standing within the ATSO community that provides incentives for other members of the aeronautical community (e.g. AOs, APOs, aviation weather service providers) exchanging data with ATSOs to comply with this standard. Traffic associated with the exchange of planning information, resource information and meteorological information will be either carried by national

ATSO WANs which will be interconnected with the ground networks of the national AOs and aviation weather service providers (either directly on the subnetwork level or by ATN routers) or by a public national data communications network which will link the national ATSO facilities and the national AO facilities. With respect to ground communications between APO and ATSO facilities a public national data communications network is assumed as bearer network.

With respect to the evolution of the pan-European ATN in the HTLA, Figure 3.1-2 is still applicable. The star around each of the Backbone BISs will have grown in terms of states connected to the European ATN Backbone. Furthermore, the Backbone BISs will offer connectivity to several other ATN Islands.

3.1.5.2 Low Traffic Level Areas (LTLA)

The status of ATN deployment in the LTLA in the 2010 time frame will be similar to the situation in the HTLA in the year 2005. This means that the ATN network structure illustrated in Figure 3.1-1 will be applicable to a typical LTLA ATSO in 2010.

The number of ATN-equipped ACCs will not comprise all ACCs per State for most of the LTLA ATSOs, but will have significantly increased with respect to the 2005 situation.

The 2010 ATN deployment scenario in the LTLA can be characterised by the following figures:

- about 40 % of the LTLA ATSOs will have implemented ATN systems (at least one ATN router and one ATN ES) in all national ACCs to provide ATN-compliant data link services
- about half of these ATSOs use in addition ATN ground communication services (ICC and AMHS) for inter-centre co-ordination (both nationally and with adjacent HTLA and LTLA ATSOs) and to exchange ATM-related planning information with the Global European ATS Systems and AOs and APOs respectively
- about 30 % of LTLA ATSOs will have contracts with ACSPs for ATN-compliant data link communications services, ICC, AMHS, and information exchange with the Global European ATS Systems and AOs and APOs respectively
- about 60 % of the LTLA ATSOs will be connected to the European ATN Backbone
- connection to the European ATN Backbone will be achieved by dedicated point-to-point lines in 50 % of the cases, and using ATSO ground networks which are on the path to the European ATN Backbone as transit networks in the remaining half of the cases
- only one ATN BIS per ATN-equipped LTLA State will have direct access to the European ATN Backbone.

The list of LTLA States in the 2010 scenario is compiled in the 2nd column of Table 3.1-7.

3.1.5.3 Remote and Low Traffic Level Areas (LTLA-R)

The typical ATN deployment scenario in LTLA-R in the year 2010 will be characterised by:

- 10 % of ATSOs having implemented and operating ATN systems (at least one ATN router and one ATN ES) in the primary national ACC to provide ATN-compliant ADS contract and en-route CPDLC services (see Table 2.4-6 for detailed list of services)
- 30 % of ATSOs having contracts with ACSP(s) for ATN-compliant ADS contract and en-route CPDLC services as well as international ICC and AMHS services
- 30 % of ATSOs being connected to the European ATN Backbone.

3.1.6 2015 Scenario

The following table groups the states of the EUR Region into the three traffic level areas which have been defined as the geographical dimension of the ATN scenario (see Section 2). This grouping is dynamic, in principle. Table 3.1-8 represents the year 2015 snapshot of the grouping based on the forecasted air traffic level for this year (c.f. [23], [5], [6] and [7]).

HTLA	LTLA	LTLA-R
Austria	Bosnia and Herzegovina	Albania
Belgium	Croatia	Armenia
Bulgaria	Czech Republic	Azerbaijan
France	Denmark	Belarus
Germany	Finland	Estonia
Greece	Georgia	Kazakhstan
Hungary	Latvia	Kyrgyzstan
Ireland	Lithuania	Republic of Moldova
Italy	Malta	San Marino
Luxembourg	The former Yugoslav Republic of Macedonia	Tajikistan
Netherlands	Monaco	Turkmenistan
Poland	Norway	Uzbekistan
Portugal	Russian Federation	
Romania	Slovakia	
Spain	Slovenia	
Sweden	Turkey	
Switzerland	Ukraine	
United Kingdom	Federal Republic of Yugoslavia	

<This grouping is initial and has to be validated by the Flights & Country Data Sub-Model of the ATN CBA Model>

Table 3.1-8: Classification of European States into Traffic Level Areas (Year 2015)

3.1.6.1 High Traffic Level Areas (HTLA)

The typical ATN network structure illustrated in Figure 3.1-1 will be applicable to the 2015 HTLA ATSO scenario too. Changes in the scenario will be limited to volumetrics only.

The set of HTLA States will have slightly increased as compared to the year 2010. The set of 2015 HTLA States is listed in the 1st column of Table 3.1-8.

Furthermore, there will be an increase in the number of ATN intra-domain routers and ATN ESs per ACC (up to 3 routers and 5 ESs). A considerable growth in the traffic volume related to ATS data link communications and ATS ground communications in particular will require an upgrade to a next (more performant) ATN equipment generation.

Increase in ATN traffic levels in HTLA will be mainly due to

- full replacement of AFTN, OLDI and CFMU communications by ATN-compliant ground communications
- complete transition to ATN-based radar data exchange
- introduction of new sophisticated ATS data link applications
- large-scale integration of AOs, APOs and meteorological facilities in ATM planning process.

This ATN traffic growth will be reflected in a further sub-partitioning of the national ATN routing structure and potentially in the partitioning of the ATN routing structure local to an ACC. This may result in the additional deployment of intra-domain ATN routers within an ACC.

All HTLA States will deploy WANs to interconnect the national Routing Domains and Routing Areas and to interconnect to adjacent RDs of other ATSOs. Dedicated point-to-point links will have disappeared and will have been replaced by interconnected ATSO networks. Interconnection of ATSO networks will have been achieved by ATN routers at WAN boundaries or by integration of similar WANs on the subnetwork level.

3.1.6.2 Low Traffic Level Areas (LTLA)

The 2015 ATN deployment scenario in LTLA will progressively evolve from the corresponding 2010 scenario. Changes will mainly be limited to the number and type of supported ATS data link and ground communication services and the associated volumetrics concerning involved ATSOs. The relevant ATS communication services are compiled in the 3^{rd} column of Tables 2.4-4 and 2.4-5 respectively, the changes in volumetrics in the 3^{rd} column of Table 3.1-9.

3.1.6.3 Remote and Low Traffic Level Areas (LTLA-R)

The 2015 ATN deployment scenario in LTLA-R will progressively evolve from the corresponding 2010 scenario. Changes will mainly be limited to the number and type of supported ATS data link and ground communication services and the associated volumetrics concerning involved ATSOs. The relevant ATS communication services are compiled in the 3^{rd} column of Tables 2.4-6 and 2.4-7 respectively, the changes in volumetrics in the 3^{rd} column of Table 3.1-9.

3.1.7 Summary of ATSO Sub-Scenario

The above descriptive presentation of the ATN evolution in the ATSO domain is synthesised in the ATSO sub-scenario given in the following table. This table provides assumed quantitative figures as input to the CBA.

It should be noted that the listed number of ATN systems has been derived based on functional requirements only. It does not reflect any redundancy or backup considerations. Given the safety-critical nature of ATS communications all systems should be assumed to be fault-tolerant. In the case of alternative strategies for ensuring system availability and integrity the listed numbers have to be increased accordingly.

	2005	2010	2015
HTLA	100 % of ATSOs operate ATN systems: • 1 ATN BIS and 2	100 % of ATSOs operate ATN systems: • 1 ATN BIS and 3 ATN	100 % of ATSOs operate ATN systems: • 1 ATN BIS and 3 ATN

	ATN ESs per ACC • 1 ATN BIS and 1 ATN ES per MAAP 100 % of ATSOs connected to European ATN BB 50 % of ATSOs operate ATN/AFTN gateways	ESs per ACC • 1 CM Server per ACC • 1 ATN BIS and 1 ATN ES per MAAP & LAAP 100 % of ATSOs connected to European ATN BB 40 % of ATSOs operate ATN/AFTN gateways	ESs per ACC • 1 CM Server per ACC • 1 ATN BIS and 1 ATN ES per MAAP & LAAP 100 % of ATSOs connected to European ATN BB 30 % of ACCs equipped with ATN intra-domain router(s)
LTLA	10 % of ATSOs operate ATN systems: • 1 ATN BIS in prim. ACC • 1 ATN ES in prim. ACC 10 % of ATSOs contract ATN services from ACSP(s) No connection to ATN BB	40 % of ATSOs operate ATN systems: • 1 ATN BIS and 1 ATN ES per ACC • 1 ATN BIS and 1 ATN ES per MAAP/LAAP 30 % of ATSOs contract ATN services from ACSP(s) 60 % of ATSOs connected to European ATN BB	50 % of ATSOs operate ATN systems: • 1 ATN BIS and 2 ATN ES per ACC • 1 ATN BIS and 1 ATN ES per MAAP/LAAP 50 % of ATSOs contract ATN services from ACSP(s) 100 % of ATSOs connected to European ATN BB
LTLA-R	30 % of ATSOs contract ATN services (primarily for ADS) from ACSP(s)	10 % of ATSOs operate ATN systems: • 1 ATN BIS in prim. ACC • 1 ATN ES in prim. ACC 30 % of ATSOs contract ATN services from ACSP(s) 30 % of ATSOs connected to European ATN BB	20 % of ATSOs operate ATN systems: • 1 ATN BIS per ACC • 1 ATN ES per ACC 80 % of ATSOs contract ATN services from ACSP(s) 100 % of ATSOs connected to European ATN BB

Table 3.1-9: ATSO ATN Scenario

In addition to the ATN systems listed in Table 3.1-9 network management systems (NMSs) will be required to ensure the correct operation of the individual systems and the overall network. It is assumed that each ATSO who will own and operate ATN routers and ATN ESs will deploy an ATN NMS for local monitoring and control of its ATN resources.

These national ATN NMSs will be complemented by a European ATN Co-ordination Entity (ECAC) which will be provide ATN network management services on a pan-European level. This operational unit will also be responsible for administrative functions, such as billing and access control (see Section 3.6 for more details).

3.2 ATN Evolution in the Aircraft Operator Domain

This section provides a qualitative description of the assumed ATN evolution in the aircraft operator (AO) domain, i.e. at the aircraft operators' ground facilities, and a quantitative definition of the typical level of ATN involvement of this ATN user group.

3.2.1 Definition

The group of Aircraft Operators considered in this study encompasses:

- commercial air transport operators (including international, regional, commuter and air freight carriers),
- business aviation, and
- general aviation.

Within these categories the following individual interest groups [16] are contained as potential ATN users:

- scheduled airlines (providing scheduled passenger/cargo services and typically operating jet aircraft of more than 100 certified seats);
- regional carriers (providing scheduled passenger/cargo services and typically operating jet aircraft of 70 - 100 certified seats and turboprop aircraft of 20 - 70 certified seats);
- charter airlines (providing non-scheduled passenger/cargo services and typically operating jet aircraft of more than 100 certified seats);
- air taxi operators (providing non-scheduled passenger/cargo services and typically operating jet/turboprop aircraft up to 15 certified seats);
- executive/corporate aircraft operators (performing on-demand flights and typically operating well equipped jet/turboprop aircraft);
- civil helicopter operators (covering the special needs associated with commercial helicopter operations and operating helicopters up to 40 certified seats).

Intentionally not included in the group of Aircraft Operators considered in this study are military aircraft operators, private air travel, sporting and recreational aviation, and other special interest groups (such as airship operators, aerial work, etc.) as they are either not considered to become ATN users (even in the long term) or not enough information on their involvement in ATN is currently available in order to prepare sound estimates on their level of ATN involvement.

In order to adequately characterise and size the ATN evolution at AOs' ground facilities for the CBA, the following generic AO classes have been defined which include the above listed AO groups:

Class	Description	Fleet Size	No. of Aircraft Operators
1	Major Aircraft Operators (MAAO)	70 < Fleet Size	30
2	Large Aircraft Operators (LAAO)	30 < Fleet Size < 70	77
3	Medium Aircraft Operators (MEAO)	10 < Fleet Size < 30	105
4	Small Aircraft Operators (SMAO)	Fleet Size < 10	about 250

Table 3.2-1: Aircraft Operator Classes and Number of Members per Class

The classification has been made along the existing fleet size (neglecting announced aircraft orders) of the AOs. The population per class is based on statistics compiled and published in [14] and represents the fleet size at the end of 1997.

According to a survey made in [21], 78 of the world's 246 largest aircraft operators are domiciled in Europe (not including the CIS region). These European AOs have a total fleet of 2,405 passenger aircraft (with at least 70 seats) and account for about 95% of the currently active passenger jetliners within this aircraft category. These AOs are consolidated in the Classes 1 and 2 above.

A growth factor of 2 % per annum is considered adequate to model the future evolution of the AO population and to derived the AO population for the three ATN scenario time scales (c.f. section 2.1).

3.2.2 Scenario Description

Although the aircraft will be the first ATN users (talking to ground ATS facilities) there are currently no ATN applications standardised or in the process of (pre-operational) development which will support airline operations (both air/ground and ground/ground). Consequently, there is no immediate need and motivation for AO ground facilities to participate in ATN communications.

However, such a motivation may be fostered in the short term by the increasing shortage of ACARS capacity in Europe and the consequential need for a change in the technology supporting AOC and AAC in the future. Two alternatives are currently under consideration with respect to the replacement of the existing ACARS system; this being (1) VDL Mode 2 as air/ground data link and AOC/AAC applications directly interfacing to this subnetwork technology and (2) VDL Mode 2 integrated as subnetwork in an ATN architecture offering a standardised and subnetwork independent interface to new ATN-compliant AOC/AAC applications. This second alternative is assumed for the ATN scenario.

This technology change towards the ATN for AOC/ AAC data communications will create a considerable momentum for the implementation of the ATN in the EUR Region and will establish the AOs as another major ATN user group. Further incentive for ATN-compliant AOC/ AAC is likely to grow from:

- positive experience with initial ATN applications in the ATS domain, such as PDC and CPDLC, which may trigger a transition of a subset of current ACARS AOC/AAC applications for execution over an ATN protocol stack (in particular those having more demanding QoS requirements)
- continuous pressure for increased efficiency in airline operations due to market forces which may trigger the development and introduction of new ATN-compliant AOC/AAC applications (both air/ground and ground/ground) which cannot be provided by the existing ACARS and the emerging FANS-1/A system
- intensified involvement of aircraft operators in the ATM planning process which may trigger the integration of AOs in an ATN-compliant ATSO ground communications environment. This closer integration of the AO (and other concerned parties) in the ATM planning process will commence in 2000 and will progress to a fully integrated European airspace planning system around 2015. It will include an extensive dialogue and information exchange between the AO and ATSO(s) in the preparation of the flight and as the flight progresses through the ATM system to accommodate the individual AO's preferences and up-to-date planning information, as well as collaborative planning and decision making.

The above developments will be driven by the forces of natural law (or the market respectively), i.e. benefits will prove requirements. These developments will require the implementation of ATN ESs at AOs' ground facilities or gateways connecting non-ATN compliant ESs which host AOC and AAC applications to the ATN. This ground deployment process will start in the early 2000's (around 2002-2003) at major AOs first (both scheduled and charter airlines) and will expand to include all major European AOs and about half of the medium European AOs around 2010.

All AOs will completely outsource ATN communications (both air/ground between the AO ground facilities and the aircraft, and ground/ground between the AO ground facility and the relevant ATSO facility or airport respectively) to a selected ACSP as it is not part of their core business. There will be two typical alternatives for the outsourcing arrangement which are illustrated in Figure 3.2-1:

1. AOs will implement and own ATN ESs at their ground facilities which will host ATN-compliant AOC/AAC applications and ATM planning applications; these ATN ESs will be attached to the AO-internal network. For external communications (with aircraft, other AO facilities, ATSOs and APOs) the contracted ACSP will provide access to its next ATN router and via this ATN router to the ACSP mobile and ground communication services.

2. AOs will run AOC/AAC applications and ATM planning applications on conventional (non-ATN-compliant) ESs which are interconnected through the AO-internal LAN. For external, ATN-compliant communications (with aircraft, ATSOs and APOs) the AO will use an ATN gateway which will be either owned and operated by the AO itself or by the contracted ACSP and which will provide access to network infrastructure of the ACSP and the ATN-compliant mobile and ground ATN communication services of the ACSP.

In both cases AOs will neither implement and operate ATN routers nor data link ground stations. This will be done by one (or more) ACSP(s) on behalf of the AOs. Economies of scale are clearly pointing to such a scenario which would continue existing practice in this industry community.

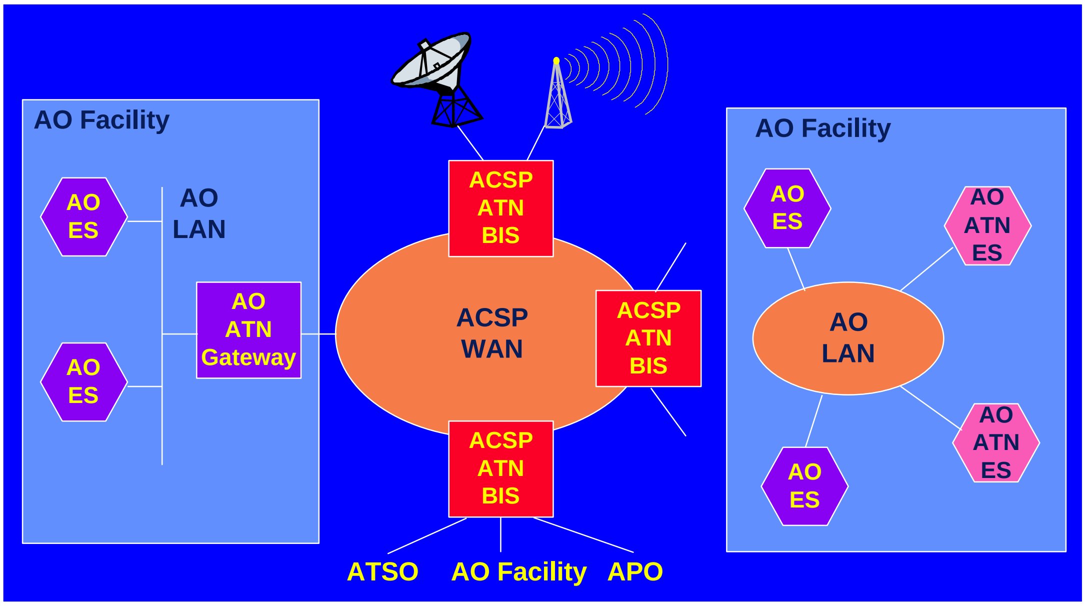

Figure 3.2-1: Typical Aircraft Operator ATN Deployment Scenario

ATN-compliant services will be first available to the AO's headquarters and will rapidly expand to include all other (distributed) AO ground facilities. The number of ATN ESs or gateways to the ATN located at the AO's premises will be limited to a total of 1 to 2 per AO ground facility[8]. These ATN ESs or gateways respectively will be connected to the local access node of the ACSP's ground network which will comprise a number of ATN routers and ground stations providing access to ATN-compliant air/ground subnetworks (VDL and AMSS). Figure 3.2-1 illustrates the typical ATN deployment scenario in the AO domain.

[8] The exact number of involved AO ground facilities depends on the level of decentralisation applied by a given AO.

Demonstrated benefits from ATN-compliant AOC/AAC communications but also demonstrated benefits from integrated ATM planning (taking into account the individual AO's preferences) will stimulate medium and smaller AOs as well as executive/corporate aircraft operators to follow the path traced out by the market leaders and will cause these AOs to contract ATN services (and equipment) from ACSPs. These AOs will fully rely on the communication network infrastructure and services of a the ACSP, i.e. they will not operate own ATN ESs or routers at their premises. In most cases gateways will be used to interconnect the AO-internal communication infrastructure to the ATN infrastructure of the ACSP(s).

The demonstrated benefits from ATN-compliant AOC/AAC air/ground communications will also foster the installation process of ATN equipment onboard aircraft from about 2007 onwards. Until this time the number of aircraft being equipped with ATN-compliant systems will almost completely be driven by ATS communications and ICAO-standardised ATN applications.

Private air travel and sporting/recreational aviation are not expected to use AOC/AAC communications or to participate by direct (i.e. online) ground ATN communications in the integrated ATM (planning) process in Europe. They will file their flight plans through local airport flight offices which may be ATN-equipped at a given point in time, depending on the evolution of ATS ground/ground communications with respect to the ATN. However, some of the above airspace users in HTLAs may opt to equip their aircraft with ATN systems to receive ATN-compliant ATS data link services in the period from 2010 onwards. The number of ATN-equipped aircraft of this airspace user group will heavily depend on the market price of relevant equipment, but is believed to be extremely small.

3.2.3 Summary of AO Sub-Scenario

The above descriptive presentation of the ATN evolution in the AO domain is synthesised in the AO sub-scenario given in the following table. This table provides assumed quantitative figures as input to the CBA.

	2005	2010	2015
No. of European AOs contracting ATN services from ACSPs	MAAO: 80 % LAAO: 20 % MEAO: nil SMAO: nil	MAAO: 100 % LAAO: 50 % MEAO: 20 % SMAO: 5 %	MAAO: 100 % LAAO: 80 % MEAO: 40 % SMAO: 10 %
No. of ATN ESs or ATN gateways deployed per AO using ATN services	MAAO: 10 LAAO: 2 MEAO: nil SMAO: nil	MAAO: 20 LAAO: 10 MEAO: 3 SMAO: 1	MAAO: 20 LAAO: 10 MEAO: 5 SMAO: 1
No. of ATN routers owned and operated by AOs	nil	nil	nil

Table 3.2-2: Aircraft Operator ATN Scenario

3.3 ATN Evolution at Airports

This section describes the assumed ATN evolution at airports in qualitative terms, with particular focus on the role and involvement of the airport operators (APOs), and provides a quantitative definition of a typical ATN airport infrastructure for the three time scales of the ATN scenario (c.f. section 2.1).

3.3.1 Definition

Airport operators (APOs) are the managers of airport operations; they operate the airport as a (commercial) business providing services to passengers and airspace users, i.e. aircraft.

In this document, airport operations entail all activities needed to keep an airport working, with the exception of ATC services. Different models exist for sharing the responsibilities for the airport related ATC services, such as ground movement control on runways, taxiways and aprons, approach/departure control, and tower control, between ATSOs and APOs. In this study, this group of functions is considered being part of the responsibilities of the national ATSO and will be provided by an ATSO airport control facility (ACF) located at (major and large) airports.

In this document the term airport operator (APO) is used collectively for a number of special interest groups having individual responsibilities in airport operations. These special interest groups include:

- airport authorities,
- handling agents,
- customs,
- immigration,
- commercial service providers.

In order to adequately characterise and size the ATN evolution at airports for the CBA, the total set of European airports is classified into 4 distinct classes. The classification of airports has been made along the number of movements, i.e. take-offs and landings, per airport. The population per class is based on statistics compiled and published in [13] for the year 1996. The individual classes and the members per class are shown in Table 3.3-1.

A growth factor of 2 % per annum is considered adequate to model the future evolution of the airport population and to derive the airport population for the three ATN scenario time scales (c.f. section 2) from Table 3.3-1.

Class	Description	No. of Movements (per Year)	No. of Airports
1	Major airports (MAAP)	100,000 < Movements	36
2	Large Airports (LAAP)	40,000 < Movements < 100,000	67
3	Medium Airports (MEAP)	10,000 < Movements < 40,000	59
4	Small Airports (SMAP)	Movements < 10,000	several hundred

Table 3.3-1: Airport Classes and Number of Members per Class

Major airports (MAAPs) are high density and very busy airports where a predominance of users are scheduled airlines. On the basis of the selected airport classification and statistics, the busiest MAAPs would be London Heathrow, Frankfurt/Main, and Paris CDG. The least busy MAAP would be Montpellier.

Large airports (LAAPs) typically have a mix of international and national scheduled and charter flights, and regional flights. On the basis of the selected airport classification and statistics, the busiest LAAPs would be Edinburgh, Birmingham, and Lyon. The least busy LAAP would be Milan.

Medium airports (MEAPs) typically have a traffic mix of commercial air transport and general aviation. On the basis of the selected airport classification and statistics, the busiest MEAPs would be Dortmund, Larnaca and Alicante. The least busy MEAP would be Saarbruecken.

Small airports (SMAP) include both airports with and without commercial air transport activity and are characterised by some few movements per day (27 and less). On the basis of the selected airport classification and statistics, the busiest SMAPs would be Oestersund, Toulon, and Nimes. The least busy SMAPs would be airfields and private aerodromes.

3.3.2 2005 Scenario

Due to the fact that (1) AOC/AAC communications is and will even grow in value as critical success factor for AOs' fleet management and (2) about 60 % of AOC/AAC communications takes place at or in the vicinity of airports, all Class 1 airports and about 10 % of Class 2 airports will be equipped with Gatelink and VDL Mode 2 ground stations to provide data link services to and from aircraft approaching the airport, parked at the gate or on the apron, moving on the airport surface, queued up for take-off, or departing from the airport.

These airport data link facilities will be used by ACSP to provide existing, ACARS-based AOC/AAC services and APC services on behalf of AOs in a direct-mode (non-ATN-compliant) manner, i.e. by direct access of the applications to the subnetwork services.

At the same time these airport data link facilities will be connected to an ATN router which will complement the typical Airport ATN Infrastructure in the year 2005. This typical Airport ATN Infrastructure is illustrated in Figure 3.3-1.

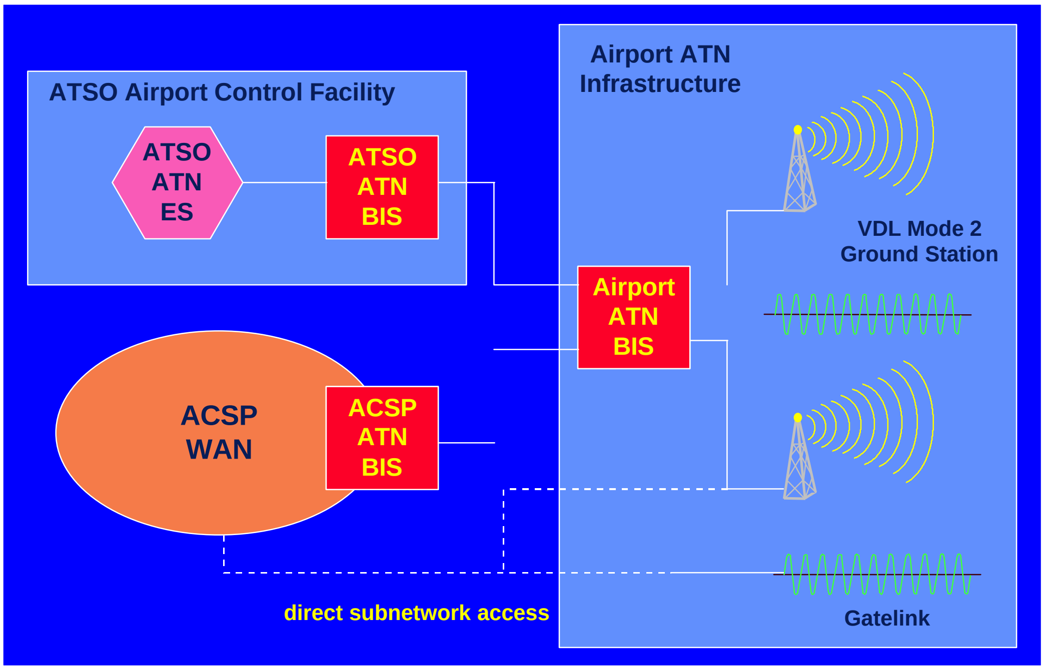

Figure 3.3-1: Typical Airport ATN Infrastructure (Year 2005)

The above Airport ATN Infrastructure will be set up and operated by the local APOs (at about 50 % of equipped airports) or by joint ventures between existing ACSPs and local APOs (at the remaining half of ATN-equipped airports).

The Airport ATN Infrastructure will be used by:

- ACSPs to provide initial ATN-compliant AOC/AAC services on behalf of AOs. For this purpose an ACSP ATN router (which will be part of the ACSP's ground network infrastructure) will be connected to the ATN router of the Airport ATN Infrastructure;

- ATSOs to provide initial ATN-compliant data link services (such as DCL) to a small number of ATN-equipped aircraft. For this purpose the ATN infrastructure of the ATSO ACF, comprising a single ATN router and a single ATN ES, will be attached to the Airport ATN Infrastructure, as illustrated in Figure 3.3-1. The type of ownership and operation of the ACF ATN router will not be uniform across all concerned airports. In some cases the ATSO ATN router will be owned by the ATSO and will be part of the ATSO WAN, in some other cases the ATSO ATN router will be owned by the ATSO but a stand-alone component of the ATSO ACF, in some other cases the ATSO will contract an ACSP to provide the communications equipment and services in support of these local and initial ATN data link services.

In summary, the data link facilities of the concerned Class 1 and Class 2 airports will be shared by ATSOs and ACSPs on the one hand and will be shared by ATN traffic (for AOC/AAC and ATSC) and non-ATN traffic (for AOC/AAC and APC) on the other hand. No own data link facilities (i.e. VDL ground stations) for ATSC will be set up by ATSOs at airports prior to 2005.

In 2005 all ATN and data link equipped Class 1 and Class 2 airports will be located in the HTLA. There will be no ATN communications at non-HTLA airports in this time frame.

3.3.3 2010 Scenario

Figure 3.3-2 illustrates the typical Airport ATN Infrastructure in the year 2010. This scenario is applicable to all Class 1 airports and about half of the Class 2 airports. It should be noted that in 2010 a considerable number of these airports will be found in LTLAs too.

The ATN-related portion of the 2010 communications infrastructure at airports, as depicted in Figure 3.3-2, will consist of a high performance local area network which links a number of VDL ground stations (about 5 per typical airport) and Gatelink installations (about 30 per typical airport) to an ATN router which provides access to ATN-compliant communication services for a number of users belonging to different user groups. These users will be ATSOs, AOs, and companies involved in airport operations (such as airport authorities and handling agents) which will either be located on the airport or will access the airport ATN router through a WAN.

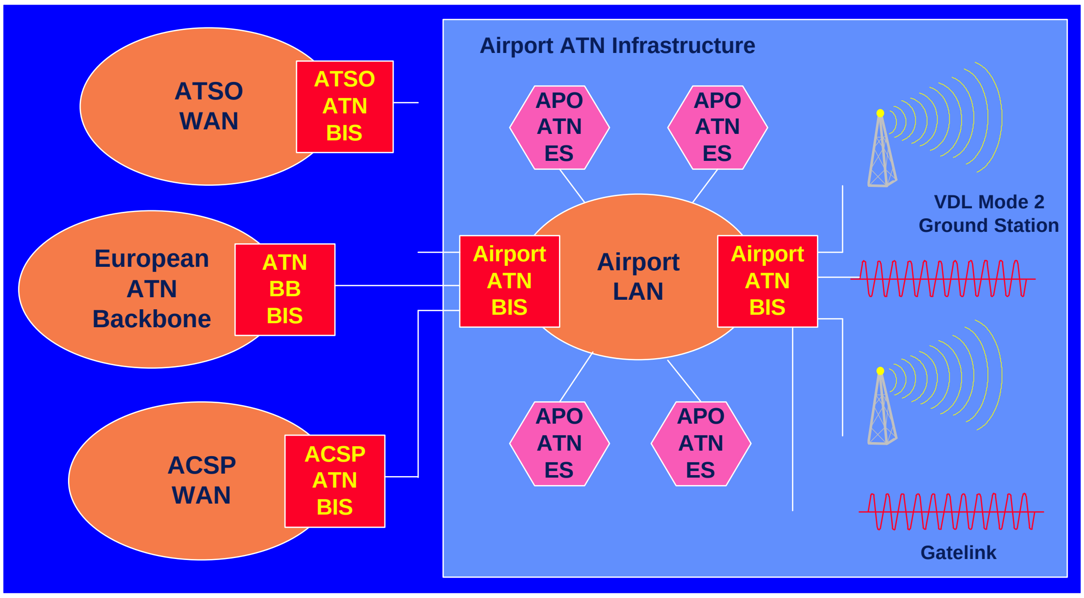

Figure 3.3-2: Typical Airport ATN Infrastructure (Year 2010)

The Airport ATN Infrastructure will be owned and operated by the local APOs (at about 50 % of equipped airports) or by joint ventures between existing ACSPs and local APOs (at the remaining half of ATN-equipped airports) and is made available to the users based on contractual arrangements between the Airport ATN Infrastructure provider and the users.

The data link communication services offered to aircraft through this common airport ATN infrastructure will include:

- new ATN-compliant AOC/AAC data exchange (and current AOC/AAC applications migrated to the ATN) between AO ground facilities and aircraft to increase the efficiency of aircraft operations. The provision of these communication services will be completely outsourced by the AO to a given ACSP (which may be the same ACSP that operates the airport comms infrastructure or which may have a contractual agreement with this ACSP);
- ATSC services, as listed in Tables 2.4-2 and 2.4-4 (relevant for TMA). These services will be provided by ATN ESs located in the national ACCs and connected via the national ATSO WAN to the airport ATN router or by ATSO ATN ESs directly located on the airport premises in the ATSO ACF;
- new data link services between the local APO and the aircraft (*these services are still to be defined in more detail*).

In addition, APC services will be provided to aircraft through the airport Gatelink and VHF/VDL facilities by ACSPs/APOs in a proprietary, non-ATN compliant manner.

In the 2010 scenario all Class 1 and Class 2 airports will have started to communicate planning and airport resources information via the ground ATN to national ACCs, the Global European ATS Systems (such IFPS) and AOs. This increased use of ground/ground communications will be a logical consequence from the implementation of the gate-to-gate concept and collaborative decision making between the various parties [11]. Exchanged information will include availability on runways, taxiways and gates, weather conditions, and forecasts of potential shortages in airport resources. For this reason, APOs will implement airport information servers on ATN ESs which will connect to the airport ATN router and from there onwards to ATSO ESs and AO ESs. Consequently APOs will become ATN users and service providers at the same time.

Intra- and inter-APO communications will continue to be done by non-ATN compliant means.

3.3.4 2015 Scenario

The volume of (mobile) data link services will have increased to a level which makes it economically interesting to deploy air/ground subnetwork technology dedicated to data link communications in the airport environment, i.e. at the gate, on the airport surface and possibly in the TMA, for all Class 1 and 2 airports and even some Class 3 airports (about 30 %). Demand has grown due to:

1. increased number of ATN/data link equipped aircraft (see figure in aircraft scenario)

2. additional ATS and AOC/AAC data link applications (see list in Section 2) and

3. additional mobile users operating on the airport surface, e.g. airport service vehicles.

Air/ground communication technology deployed in the airport environment will include:

- gatelink, and

- at least one of the following air/ground subnetwork technologies: VDL, SSR Mode S, cellular mobile radio (private and/or trunk systems).

Deployed mobile airport communication system types will not be uniform across all European airports. Selection of air/ground subnetwork type will be influenced by the majority technology available in aircraft visiting the airport (the scenario assumes VDL as the majority technology), the air traffic level at the airport, and the extent mobile land-based users will have to be served.

New mobile airport communication systems (i.e. gatelink and other air/ground subnetwork technologies) will be owned and operated by ACSPs (most likely in close co-operation with the APO).

The introduction of 4-D Trajectory Negotiation, autonomous aircraft operation and extended use of free routing and the full integration of the European airspace planning will mandate full communication networking and integrated data exchange capabilities. All Class 1 and Class 2 airports and about 30 % of Class 3 airports will be integrated in this collaborative decision making and planning process. In this context, the APOs of these airports will have installed and will operate ATN ESs (1-2 ESs per airport) hosting relevant databases, planning applications and information servers. These ATN ESs will be attached to the airport LAN and will be connected via the airport ATN router to ATSO and AO planning systems.

ACSPs will extend the airport ATN infrastructure in terms of mobile subnetworks integrated into this infrastructure, performance of this infrastructure and number of ATN ESs linked to this infrastructure. The evolution of this infrastructure and associated traffic levels may require to split this infrastructure into multiple sub-domains with one or more ATN routers per sub-domain. This ACSP-provided and -operated airport ATN infrastructure will

- connect to national ATSO router(s) in ACCs
  - to forward ATS application data (e.g. PDC) exchanged between the national ATSO and the aircraft in the flight preparation phase;
  - to provide backup paths for ATS message exchanges between the ACC and the aircraft in the TMA;
  - to support relevant ground-ground information exchange in the context of integrated planning between the national ATSO and the airport operator and handling agents located at the airport (c.f. [3] for more information)
- connect to router(s) of ACSP(s)
  - to forward AOC and AAC application data for which Gatelink has been chosen as „air/ground“ subnetwork to and from aircraft
  - to provide backup paths for AOC/AAC message exchanges to and from aircraft flying in the TMA or at rest on the apron
  - to forward data from APC applications which require high-speed and high-bandwidth „air/ground“ subnetworks, such as Gatelink, to and from aircraft.

The majority of intra- and inter-APO communications will continue to be done by non-ATN compliant means.

3.3.5 Summary of APO Sub-Scenario

The above descriptive presentation of the ATN evolution at airports is synthesised in the APO sub-scenario illustrated in the following table. This table provides assumed quantitative figures as input to the CBA.

	2005	2010	2015
No. of European airports equipped with mobile communication systems (Gatelink and VDL)	MAAP: 100 % LAAP: 10 % MEAP: 0 %	MAAP: 100 % LAAP: 50 % MEAP: 20 %	MAAP: 100 % LAAP: 100 % MEAP: 30 %
No. of mobile communi-cation systems (Gatelink and VDL) per equipped airport	MAAP: 20 (GL), 5 (VDL) LAAP: 10 (GL), 3 (VDL) MEAP: nil	MAAP: 30 (GL), 5 (VDL) LAAP: 20 (GL), 4 (VDL) MEAP: 5 (GL), 2 (VDL)l	MAAP: 30 (GL), 5 (VDL) LAAP: 20 (GL), 4 (VDL) MEAP: 10 (GL), 2 (VDL)
No. of European airports equipped with Airport ATN Infrastructure (ATN router, ATN ESs, ATN-compliant mobile communication systems)	MAAP: 100 % LAAP: 10 % MEAP: nil	MAAP: 100 % LAAP: 50 % MEAP: nil	MAAP: 100 % LAAP: 100 % MEAP: 10 %
No. of ATN routers per Airport ATN Infrastructure	MAAP: 1 - 2 LAAP: 1 MEAP: nil	MAAP: 2 -3 LAAP: 2 MEAP: nil	MAAP: 3 - 5 LAAP: 2 - 3 MEAP: 1
No. of APO ATN ESs attached to Airport ATN Infrastructure	MAAP: 1 LAAP: nil MEAP: nil	MAAP: 10 LAAP: 5 MEAP: nil	MAAP: 10 - 15 LAAP: 5 - 8 MEAP: 2 -3

Table 3.3-2: Airport ATN Scenario

3.4 Aircraft Sub-Scenario

A detailed analysis and forecast of the future aircraft demand and fleet growth in the EUR Region is provided in Appendix B. This section lists the synthesised results of this forecast and presents the typical level of aircraft ATN-equipage.

Initial demand for the implementation of ATN-compliant systems onboard aircraft (i.e. in the 2000 - 2005 time frame) will be 'benefits driven', i.e. the number of aircraft being ATN-compliant will largely develop on the forces of natural law where benefits prove requirements. ATN-equipage during this time period will mainly be a result of retrofitting current a/c (both replacement of ACARS equipment and new installation of ATN systems). Increasing demand will cut down the commercial cost per unit of equipment.

Besides the retrofitting of the existing fleet (at a linear rate), half of all new aircraft will be ATN-compliant from 2005 onwards. This figure will grow at a linear rate to 100% until 2010.

It is expected that this demand driven evolution will be complemented by a regulatory measure at a later time. But an official regulation which mandates ATN equipment onboard aircraft in the EUR Region will not likely being effective before 2010.

	2005	2010	2015
No of aircraft operating in EUR Region airspace (= Total fleet)	19,080	21,330	23,740

No of EUR Region aircraft (= Total European fleet)	17,384	19,393	21,536
Number of ATN-compliant aircraft (equipped with mobile data link technology, ATN systems and ATN applications) operating in EUR Region airspace	1,085	5,625	11,225
Number of ATN-compliant European aircraft	911	4,741	10,022
Percentage of ATN-compliant (European) aircraft of total (European) fleet	5,6 % (5,2 %)	26 % (24 %)	47 % (46 %)

Table 3.4-1: Aircraft Scenario

The above total number of aircraft operating in the EUR Region airspace includes the total European fleet, i.e. all IFR aircraft owned and operated by European AOs, according to statistics published in [14], [21] and [22], plus those aircraft not registered in Europe but operating in the EUR Region airspace. This latter group are mainly commercial jet aircraft and amount to about 10% of the non-European passenger jetliners or about 40% of the non-European long haul fleet [22].

An average annual growth rate of 3.1% or 1.7% respectively has been assumed for the calculation of the number of aircraft listed in Table 3.4-1 above (for details see Appendix B). The annual growth rate of 3.1% is identical to the growth rate of the base scenario of the COPICAT study [17].

The typical ATN-related aircraft equipage will vary between short- and long-range aircraft and will consist of the following data link equipment, ATN equipment (i.e. communications management unit, ATN end systems) and associated peripheral systems [19]:

System	Long-range Aircraft	Short-range Aircraft
SSR Mode S	2	2
AMSS	1	nil
Gatelink	1	1
HF Data Link	nil - 1	nil
CMU (ATN BIS)	2	2
FMS and other ESs	3	3
Printer	1	1
CDU/MCDU	1	1

Table 3.4-2: Typical Aircraft Equipage

Contrary to the tables in the previous sections, listing the volumetrics of the other sub-scenarios, the number of systems compiled in Table 3.4-2 includes back-up systems as required by air traffic safety regulations.

As presented in Appendix B in more detail, 47% of the passenger jetliners or 10% of the total number of aircraft respectively operating in the EUR Region will be long-range aircraft; the rest will be short-range aircraft.

3.5 Aviation Weather Service Provider Sub-Scenario

This section provides a qualitative description of the assumed ATN evolution in the domain of weather service providers for aviation and a quantitative definition of the typical level of ATN involvement of this potential ATN user group.

3.5.1 Definition

Weather service providers are the sources of aviation weather information for all parties dealing with flight planning and flight operations, i.e. ATSOs, AOs, APOs. Increased co-operation among these three parties and the weather service providers will lead to more accurate and more up-to-date weather information, to the benefit of all.

Currently, meteorological data originate at meteorological authorities (World and Regional Area Forecast Centres (WAFC, RAFC) and are distributed among these using dedicated networks. They are made available to aeronautical meteorological offices of EUR Region States which distribute operational meteorological data (OPMET) among each other and to airspace users for pre-flight and in-flight briefing. OPMET distribution between aeronautical meteorological offices is implemented as a messaging application. In the case of the satellite distribution system (SADIS), OPMET reports and WARF products are collated in Bracknell and broadcast via satellite.

Increasingly, AOs perform distribution of meteorological information themselves for their own purposes by collecting OPMET data at a central site and transmitting it via ACARS to aircraft in flight- The major OPMET reports are routine aerodrome reports, METARs, aerodrome forecasts, SIGMETs, TAFs and special air reports.

Automated real-time meteorological measurements provided by aircraft represent a new source of high-quality meteorological data which will become an alternative for a partial replacement of the traditional upper air meteorological network. The possibility to downlink on request aircraft meteorological observations to weather service providers and other entitiesis likely to improve dramatically the efficiency of current aviation weather forecasts ("now-casting") and is the starting-point for considering the weather service providers as potential ATN user group.

3.5.2 Scenario Description

<Section to be developed>

3.5.3 Summary of Aviation Weather Service Providers Sub-Scenario

	2005	2010	2015
No. of European Weather Service Providers contracting ATN services	tbd	tbd	tbd
No. of ATN ESs or ATN gateways operated per weather service provider using ATN services	tbd	tbd	tbd
No. of ATN routers operated by weather service providers	tbd	tbd	tbd

Table 3.5-1: Aviation Weather Service Provider ATN Scenario

3.6 European ATN Co-ordinating Entity

This section defines the scope, services and organisation of the European ATN Co-ordinating Entity (EACE) which will act as the high-level body for the promotion, implementation and management of the ATN in the EUR Region. The definition of this new entity does not preclude that it may be part of an existing European organisation, such as the CRCO is an operational entity within the Eurocontrol Agency. The approach taken for the ATN can also be used for other Communication Infrastructure developments and even for developments in the Surveillance and Navigation Domains.

Please note that the material contained in this section is an initial proposal and should not be considered as fixed and complete. It provides an initial and potential shape and structure of such an organisation and will be progressed along the comments received.

3.6.1 Scope

The scope is defined in the following dimensions:

1. Roles and responsibilities
2. Geographical
3. Types of infrastructure
4. Institutional/authority.

The EACE role is limited to the tasks of multi-national or of inter-domain importance. A domain is defined in this context as an organisational domain e.g. airline. The EACE is not responsible for the national and intra-Domain infrastructures but may provide, on request, advise/services in these areas.

In principle, the geographical scope of the EACE covers the whole EUR Region. The actual geographic scope of the EACE will evolve with the transition schedule.

The ATN includes applications, end-systems (including gateways), routers, subnetworks (including ground and mobile subnetworks) and network management systems. The scope of the EACE is limited to the ATN including all its components. ATN components can be owned by service users or service providers.

The definition of the EACE does not preclude that it may be part of an existing European organisation, such as the CRCO and CFMU. Given the fact that EUROCONTROL provides an institutional framework which seems to be appropriate for pan-European operational units like CFMU and CRCO, it is assumed that the EACE will be an EUROCONTROL operational unit.

3.6.2 EACE Core Tasks

The core tasks of the EACE fall into three domains:

- administrative
- operational, and
- regulatory.

3.6.2.1 Operational Domain

The Operational Domain provides the following services:

- Network Performance and Requirements Review
- Network Design and Implementation Planning
- Implementation Project Management
- Testing - CAERAF operation
- Network Management (including the Backbone)
- Help desk.

On a continuos basis, the EACE will evaluate network performance and will capture new or changes to existing requirements. On a regular basis this information will be consolidated into requirements for the ATN infrastructure.

The consolidated requirements will be used to (re-)design the network using network design and evaluation tools. The resulting network upgrades can for example include software upgrades in network systems or topology changes. Whenever necessary proposed changes to infrastructure will be subject of consultation with users and providers.

Implementation Management is responsible for timely implementation of infrastructure systems and services. It provides project management services including planning, budget management and Quality Management.

An major service is testing. This will be based on the Common American European reference ATN Facility (CAERAF) test environment. This test environment can be used locally or remotely. The CAERAF can run defined test scenarios and produce test reports which can be used for operational approval or certification. Industry may also use the CAERAF test environment for testing outside the formal context of certification and operational approval.

Network Management monitors on a continuous basis various parameters within the infrastructure. By means of Network management actions it ensures that the service levels are being maintained irrespective of changing demands. Network Management is furthermore responsible for collecting information for non-real-time performance analysis, statistics and accounting.

Help desk provides on-line responses to technical and administrative questions.

3.6.2.2 Administrative Domain

The Administrative Domain is responsible for the following core tasks:

- Accounting,
- Contract management with communication service providers and users,
- Address Registration and Access Control,
- Safety and Security.

Accounting is responsible for invoicing users and paying service providers. The charging regulations will specify the charge basis. Various alternatives exists such as charging on actual use of the infrastructure or charging on the basis of flat service rates.

The EACE will have various types of contracts with users and providers. The Contract service is responsible for determining the terms and conditions and for conclusion of contracts. Close co-ordination is required with the operational services.

Address Registration and Access Control is responsible for the management of the available address space and assigns addresses or address sub-spaces to users within the frame of the ICAO ATN addressing plan. Access Control is an audit to verify whether all the procedures have been followed and all certificates have been obtained for integration in the infrastructure. Audits can be conducted prior to integration but also on an already integrated system or service.

The Safety and Security service is responsible for analysing the operational use of the infrastructure and on that basis determining safety rules and procedures.

3.6.2.3 Regulatory Domain

With respect to regulatory aspects, the EACE will be responsible for:

- Institutional and Regulatory issues,
- Legal issues,
- Certification.

The Institutional and Regulatory Issues service is responsible for defining and maintaining an institutional framework for the EACE which enables the EACE to provide the services and to operate in a cost/effective manner. Whenever necessary, this service will initiate co-ordination with the European Regulatory bodies.

The Legal Issues service is covering all legal issues of the EACE and is for example involved in contract negotiations .

The Certification service is responsible for conducting the verifications and tests necessary for full certification of an ATN system or service.

3.6.3 EACE Non-Core Tasks

Besides the core tasks the EACE may provide services to users to assist them in for example planning, designing and implementing their ATN infrastructures.

The EACE scenario does not include the provision of these services.

3.6.4 External Organisation

The (possible) external organisation of the EACE is shown in the Figure 3.6-1.

In the Operational Domain the EACE provides an as thin as possible layer between the Service Providers and the Service Users. Users and Providers have also direct contacts with the Administrative and Regulatory Services (for e.g. invoicing, safety, addresses).

The Administrative and Regulatory Domain will liase with international bodies and bodies from other Regions on Institutional /regulatory and cross-Regional issues.

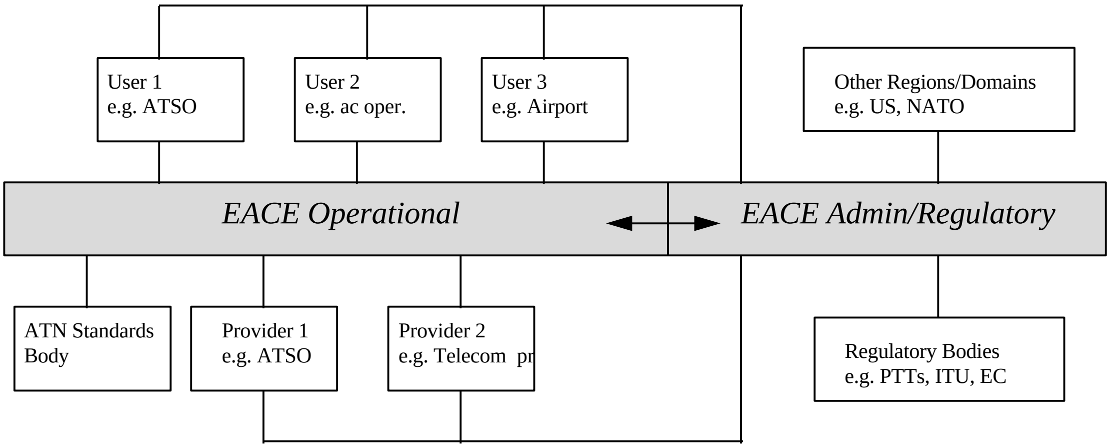

Figure 3.6-1: Possible external organisation of the EACE

3.6.5 Dimension

The size of the organisation will be dependent on the size of the ATN. The EACE should have been established before the first deployment of the operational ATN.

The following table provides an initial overview of the core tasks and the number of persons necessary for each task. The numbers should be considered as an indication and are not based on a detailed analysis of the task.

Core Task	2005	2010	2015
Network Performance and Requirements Review	2	3	4
Network Design and Implementation Planning	2	3	4
Implementation Project Management	3	3	3
Testing - CAERAF operation	3	4	4
Network Management (including the Backbone) and Help desk	10	10	10
Accounting	5	5	5
Contract management with communication service providers and users	3	3	3
Address Registration and Access Control	3	3	3
Safety and Security	2	2	2
Institutional and Regulatory issues	2	2	2
Legal issues	2	2	2
Certification	3	3	3
Overhead (direct and indirect)	5	10	10
TOTAL	**45**	**53**	**55**

Table 3.6-1: Staffing of the EACE

Appendix A - EUR Region ACCs

This appendix lists the en-route centres of the ICAO member states located in the EUR Region. The en-route centres are grouped in Table A-1 along the states in which they are situated, in alphabetic order.

The en-route centres considered may be Area Control Centres (ACCs), Upper Area Centres (UACs) or combined ACC/UACs. In the following table, UACs are marked by the complement "(UAC)" attached to the name of the en-route centre; all other en-route centres in the table are ACCs, combined ACC/UACs or other ATS units providing, de facto, area control services and considered as ACCs for the purposes of the ATN scenario.

State	En-Route Centres (ACCs and UACs)				
Albania	Tirana				
Armenia	Yerevan				
Austria	Vienna				
Azerbaijan	Baku				
Belarus	Minsk				
Belgium	Brussels				
Bosnia and Herzegovina	----				
Bulgaria	Sofia	Varna			
Croatia	Zagreb				
Cyprus	Nicosia				
Czech Republic	Prague				
Denmark	Copenhagen				
Estonia	Tallin				
Eurocontrol	Maastricht (UAC)				
Finland	Rovaniemi	Tampere			
France	Bordeaux	Brest	France (UAC)	Marseille	Paris
	Reims				
Georgia	Sukhumi	Tbilisi			
Germany	Berlin	Bremen	Duesseldorf	Frankfurt	Karlsruhe (UAC)
	Munich				
Greece	Athens				
Hungary	Budapest				
Ireland	Shannon				
Italy	Brindisi	Italy (UAC)	Milan	Rome	Padua
Kazakhstan	-----				
Kyrgyzstan	-----				
Latvia	Riga				
Lithuania	Vilnius				

Luxembourg	-----				
Malta	Malta				
Monaco	-----				
Netherlands	Amsterdam	Nieuw Milligen			
Norway	Bodo	Oslo	Stavanger	Trondheim	
Poland	Warsaw	Poznan (Sub-ACC)[9]			
Portugal	Lisbon				
Republic of Moldavia	-----				
Romania	Arad	Bacau	Bucharest	Cluj	Constanta
Russian Federation	Arkhangelsk	Mineralnye Vody	Moscow	Murmansk	Rostov
	Sochi	Leningrad			
San Marino	-----				
Slovakia	Bratislava				
Slovenia	Ljubljana				
Spain	Barcelona	Canarias	Madrid	Seville	
Sweden	Malmo	Stockholm	Sundsvall		
Switzerland	Geneva	Zurich			
Tajikistan	-----				
The former Yugos-lav Republic of Macedonia	Macedonia				
Turkey	Ankara	Istanbul	Izmir (Sub-ACC)[10]		
Turkmenistan	-----				
Ukraine	Kiev	Lvoy	Odessa	Simferopol	
United Kingdom	London	Manchester	Scottish		
Uzbekistan	------				
Federal Republic of Yugoslavia[11]	Belgrad				

Table A-1: En-Route Centres of EUR Region States/ATSOs

[9] Warsaw ACC has entrusted the control of the western sectors of Warsaw FIR to the sub-centre in Poznan.

[10] Istanbul ACC has delegated en-route services to Izmir (APP) in the southern part of its FIR.

[11] The Federal Republic of Yugoslavia is currently an ICAO non-contracting state.

As illustrated in Table A-1 the total number of en-route centres in the EUR Region amounts to 81 ACCs and 4 UACs as of 1997. In addition there are a number of separate approach units controlling major TMAs which are not listed in Table A-1.

Table A-1 does not include the ACCs of Algeria, Morocco and Tunisia which are situated in the ICAO African Region (AFI) and the ACC of Iceland situated in the ICAO North Atlantic Region (NAT), but which are served by the ICAO European and North Atlantic (EUR/NAT) Office in Paris. Including these states the total number of ACCs increases to 84.

Further evolution of the ACC population in the EUR Region will experience a slight decrease in the number of ACCs, as there is a general trend in the ATS domain to consolidate ATS units, especially where ACCs have less than 4 sectors [20]. Certain states (e.g. Bulgaria, Finland, Norway, Romania and Switzerland) have or are considering plans to reduce their number of ATS units. Germany, for example, has already firmly announced to re-organise its ATC structure within the next few years; the new ATS structure in Germany will cut down the number of ACCs from currently 6 to 3 ACCs (Bremen, Langen, Karlsruhe or Munich) [24].

On the other hand, there are some new ACCs planned or under construction in some states (e.g. Bulgaria, Cyprus, Denmark, France, Hungary, Italy, Latvia, Malta, Norway and Romania). Furthermore, an UAC for Central Europe[12] is planned to be provided and operated by Eurocontrol on behalf of a group of Central and Eastern European states in the next decade.

[12] The creation of a Central European Air Traffic Services (CEATS) UAC in the Eastern part of Europe was decided upon by the Ministers of Austria, Croatia, the Czech Republic, Hungary, Italy, Slovakia and Slovenia in March 1994 [25].

Appendix B - Aircraft Population in EUR Region

In the context of the ATN CBA it is most important to set up a proper picture of the aircraft population that would be affected by the introduction of the ATN. This is due to the fact that this group will be the largest set of potential ATN users in terms of figures and consequently represents the greatest sensitivities to the CBA. Therefore, this appendix presents in some detail the current situation and the assumed evolution of the size of the aircraft fleet in the EUR Region.

To increase traceability of the analysis and to facilitate comparison with other forecasts, four categories of aircraft are considered:

- Passenger Jetliner
  This category includes all commercial aircraft with more than 100 certified seats. These aircraft are typically operated by scheduled airlines and charter airlines. The main manufacturers of aircraft of that category are Airbus and Boeing. The most frequent aircraft types are B737, MD80, B757, B747, B767, A300, A320, and A310.

- Commuter
  This category includes all commercial aircraft, either jet or turbine-powered, with more than 15 (but less than 100) certified seats. These aircraft are typically operated by scheduled airlines, regional carriers and charter airlines. The main manufacturers of aircraft of that category are ATR, BAE, Embraer, Dornier, Saab, Canadair and de Havilland. The most frequent aircraft types are AT42, BA46, F50, DHC8, SF34, and SB20.

- Business Aircraft
  This category includes all executive/corporate aircraft with more than 5 certified seats. These aircraft are typically operated by private enterprises and air taxi operators. The main manufacturers of aircraft of that category are Dassault, Gulfstream, Beechcraft, Canadair and Cessna.

- Private Aircraft
  This category includes all remaining aircraft not considered in the previous categories but equipped for IFR operation.

B.1 Current Situation

Table B-1 lists the number of aircraft per category which have been in service in 1996. Within each aircraft category figures are given for (1) the world-wide fleet, (2) those aircraft registered in the EUR Region, and (3) those aircraft registered outside the EUR Region but operating in this region

Aircraft Category	World-wide fleet	No. of a/c regis-tered in EUR Region	No. of a/c regis-tered out-side EUR Region but operating in EUR Region	Source
Passenger Jet-liners	11,000	2,700	800	[21], [22]
Commuters	7,800	2,000	100	[22]
Business Aircraft	30,000 (7,000 jets, 8,000	3,300 (1,000 jets, 1,000	300	[22]

	turbine-powered, 15,000 piston-powered)	turbine-powered, 1,300 piston-powered)		
Private Aircraft	115,000 (IFR-equipped)	6,000 (IFR-equipped)	100	[22]

Table B-1: Current Aircraft Population in EUR Region

Statistics of the Eurocontrol STATFOR group concerning the total number of IFR flights in the entire CRCO area in 1997 indicate that about

- 50% of all flights (transatlantic and non-transatlantic) are accomplished by a set of 8 aircraft types only, comprising B737, MD80, A320, BA46, B757, B747, AT42, B767.
- 70% of all flights (transatlantic and non-transatlantic) are accomplished by a set of 21 aircraft types only, comprising B737, MD80, A320, BA46, B757, B747, AT42, B767, F50, DC9, DHC8, B727, SF34, EA32, AT72, CARJ, F100, SB20, A310, BE20, SHD3.
- 95% of all flights (transatlantic and non-transatlantic) are accomplished by a set of less than 100 aircraft types
- 90% of all transatlantic flights to and from Europe are accomplished by a set of 10 aircraft types only, comprising B757, B747, B767, DC10, MD11, A340, L101, B777, A310 and A300.

As illustrated in Table B-2, the total number of deliveries within the group of long-haul aircraft (comprising the above 10 members) amounts to 3450 aircraft world-wide. According to [21], the share of the world passenger fleet operated by European airlines is about 25% resulting in about 860 long-haul aircraft operated by European aircraft operators in 1996.

Aircraft Type	B757	B747	B767	DC10	MD11	A340	L101	B777	A310	A300	Total
Total number of aircraft	696	794	661	228	128	88	136	140	209	370	3450

Table B-2: Total Number of long-haul aircraft per aircraft type

Following the assumption that all passenger jetliners which are registered outside the EUR Region but flying into the EUR Region (see Table B-1) can be classified as long-haul aircraft, the total number of long-haul aircraft operating in the EUR Region amounts to about 1660 aircraft in 1996. This figure represents about 47% of the total number of passenger jetliners operating in the EUR Region and about 10% of the total number of aircraft (falling into the four aircraft categories of Table B-1) operating in this part of the world. This ratio of long-haul aircraft to total number of aircraft is assumed to stable over the time period considered by the ATN scenario.

B.2 Aircraft Demand and Fleet Development

The global market forecast 1997 - 2016 [21] projects the evolution of the world's jetliner fleet (with at least 70 seats) over the next 20 years. This survey covers about 98% of the currently active passenger fleet (with at least 70 seats). It should be noted that this forecast does not embrace the total market for passenger jetliners, since considerable demand for small jets (with less than 70 seats) is likely to come from aircraft operators not covered by the survey. However, the majority of the findings of this survey may be transferred to the remaining commercial jet aircraft market.

In summary, the global market forecast predicts that from end 1996 to end 2016:

- the total fleet capacity will more than double, representing an average annual (seat) capacity growth rate of 4.5%
- the active fleet will grow by 83% from world-wide 9,400 to 17,200 (passenger and combi jet) aircraft with 70 seats and above
- 86% of the currently active passenger jet fleet will be either retired from passenger service or replaced by more modern types, resulting in the retirement and replacement of more than 8,000 jetliners world-wide
- airlines will take delivery of an additional 7,700 passenger aircraft (of at least 70 seats) to accommodate traffic growth
- thus, of the total of 15,700 aircraft acquired world-wide during the next 20 years, 49% will be to accommodate growth and 51% to replace ageing aircraft withdrawn from passenger service
- the airlines in Europe will take 31% of all aircraft delivered during the forecast period
- the share of the airlines in Europe will grow from 25% to 29% during the forecast period
- the proportion of wide-bodied aircraft in the fleet will grow from 28% to 44%; however, most demand (about 70%) for small jetliners (70- and 100-seaters) will come from Europe and North America.

According to [21], most passenger aircraft are expected to remain in service for up to about 30 years. Freighter aircraft are expected to remain in service longer. On average, aircraft of Western European aircraft operators are expected to be replaced at an age of 22 years and at an age of 27 years for Eastern European aircraft operators. The overall result is an average replacement age of about 24 years in Europe [21]. Historically, aircraft have spent on average a further 7 years in less productive non-passenger services, resulting in an average operational life of about 31 years.

From 1987 onwards the European aircraft operators (without the CIS region) have initiated a major fleet renovation process, which has stabilised the average age of their fleet at 9 years [21].

B.3 Forecast of ATN Aircraft Operating in EUR Region

Based on the current active fleet in the EUR Region (as documented in Table B-1) and the information provided in [21], forecasts are presented in Table B-2 for the number of (European and non-European) aircraft operating in the EUR Region and the number of those aircraft which will be ATN-equipped. Figures are calculated for the three milestones of the ATN scenario, i.e. year 2005, 2010 and 2015. To facilitate traceability, the results are consolidated into the four aircraft categories introduced earlier in this appendix.

Year / Aircraft Category	2005		2010		2015	
	Total No.	**ATN-Equipped**	**Total No.**	**ATN-Equipped**	**Total No.**	**ATN-Equipped**
Passenger Jetliners	4,750	855	5,530	3,320	6,400	6,080
Commuters	2,850	140	3,320	995	3,800	2,280
Business Aircraft	4,260	90	4,630	920	5,040	2,015
Private Aircraft	7,220	0	7,850	390	8,500	850
Sum	19,080	1,085	21,330	5,625	23,740	11,225

Table B-3: Forecast of Total Number and Number of ATN-equipped Aircraft Operating in EUR Region

The following key assumptions have been made in the extrapolation of the 1996 figures listed in Table B-1 into the numbers of Table B-3:

- the active fleet of Passenger Jetliners and Commuters will grow at an average annual rate of 3.1%. This annual growth rate is identical to the figure assumed for the base scenario in the COPICAT study [17] and yields to the 83% increase in fleet size predicted by the Airbus Industrie Global Market Forecast during the next 20 years (1996 - 2015) [21]. Furthermore, this figure is consistent with the forecast of the average annual growth rate of the number of IFR flights in Europe (which is 3.8% for the year 2015 as compared with 1996 according to [23]), as increasing operational efficiency will allow a modest increase in the number of flights made by each aircraft per year, resulting in a slightly higher increase in flight frequencies as compared to the aircraft fleet growth.

- the active fleet of Business Aircraft and Private Aircraft will grow at an average annual rate of 1.7% resulting in an increase of 40% during the next 20 years (1996 - 2015). This growth rate is smaller than that assumed for the above aircraft categories as business and private aircraft are not likely to participate in the overall air travel growth at the same scale as passenger jetliners and commuters will do.

- the portion of aircraft registered outside the EUR Region but operating in the EUR Region does not change over time, i.e. the ratio of these non-European aircraft as compared to the aircraft registered in the EUR Region which has been established in Table B-1 is applicable for all columns of Table B-3.

- based on the financial capabilities of the relevant aircraft operators and the relevance of air traffic to their core business, a different pace in the installation of ATN equipment onboard their aircraft and a different equipage level in the end-state (i.e. year 2015) has been assumed for the four individual aircraft categories. Forecasts for the portion of the total (European and non-European) aircraft operating in the EUR Region and equipped with mobile data link technology (VDL, AMSS, Gatelink) and ATN-compliant systems (end systems and routers) are given in the following table:

Year / Aircraft Category	2005	2010	2015

Passenger Jetliners	ATN: 18% VDL: 30% AMSS: 20% Gatelink: 10%	ATN: 60% VDL: 60% AMSS: 30% Gatelink: 40%	ATN: 95% VDL: 80% AMSS: 30% Gatelink: 50%
Commuters	ATN: 5% VDL: 30% AMSS: 10% Gatelink: 10%	ATN: 30% VDL: 50% AMSS: 20% Gatelink: 30%	ATN: 60% VDL: 70% AMSS: 20% Gatelink: 30%
Business Aircraft	ATN: 3% VDL: 10% AMSS: 10% Gatelink: 0%	ATN: 20% VDL: 20% AMSS: 20% Gatelink: 10%	ATN: 40% VDL: 30% AMSS: 20% Gatelink: 10%
Private Aircraft	ATN: 0% VDL: 2% AMSS: 2% Gatelink: 0%	ATN: 5% VDL: 10% AMSS: 5% Gatelink: 0%	ATN: 10% VDL: 15% AMSS: 8% Gatelink: 0%

Table B-4: Assumed Aircraft Equipage Level

Appendix C - Flight Communications Traffic Profile

This appendix provides quantitative data on typical traffic volumes and information exchange frequencies per flight as input to the Flight Communication Profile Sub-Model of the ATN CBA.

C.1 Categories of Exchanged Data

There are four distinct categories of data which contribute to the overall ATN data traffic volume exchanged over the air/ground link during a typical flight in the assumed ATN scenario. These are:

- user data, i.e. those data representing the information which the user/application wishes to transfer to the peer communication partner
- data transfer protocol overhead, i.e. those data which are added by the ATN protocol stack to each individual packet of user data in order to ensure correct delivery of the user data across the communication network and correct handling of the received data by the individual ATN layers in the receiving ATN ES
- traffic related to reliable and QoS-compliant end-to-end data transfer, i.e. the traffic overhead which is due to connection set-up/release, negotiations, acknowledgements and retransmissions on the level of the communication stack
- routing and systems management traffic, i.e. traffic in order to ensure correct operation of the overall network.

C.1.1 User Data

This section lists for each ATS and AOC/AAC data link service which is contained in section 2.4

- the average number of transactions per flight
- the average number of messages per transaction
- the average message size (user data only), and
- the flight phase during which (or area over which) the service will be required.

An average flight duration of 78 minutes is assumed. This figure is the average duration of a typical flight over the ECAC area according to [Ref x].

C.1.1.1 ATS Data Link Services

Based on an analysis of the communication requirements of

- the ODIAC data link services performed in [27]
- additional future ATS data link services performed in [3] and [7]

and some best guesses for future more advanced ATS data link services, the following typical communication characteristics per data link service can be derived:

Data Link Service	Transactions Per Flight	Messages Per Transaction	Message Size (Bytes)	Flight Phase
ATC Communications Management (ACM)	6	8	15	En-route
Departure Clearance (DCL)	1	6	40	Prior to departure (at airport)

Clearances and Information Communications (CIC)	16 (every 5 minutes)	6	38	En-route, TMA
Downstream Clearance (DSC)	2	8	31	En-route
Controller Access Parameters (CAP)	40	1	9	En-route
Data Link Operational Terminal Information (D-OTIS)	2	3	50	En-route, TMA
Data Link Runway Visual Range (D-RVR)	2	4	15	En-route, TMA
Data Link Initiation Capability (DLIC)	5	4	25	All
Pushback Clearance request/delivery	1	4	20	Airport
Taxi request/delivery	1	4	20	Airport
Arrival Management	2	4	25	TMA
Dynamic Route Availability (DYNAV)	1	3	140	En-route
Pilot Preferences Downlink (PPD)	40	1	10	En-route
System Access Parameters (SAP)	40	1	10	En-route
Oceanic Clearance Message (OCM)	1 (only for trans-atlantic flights)	8	31	En-route
Automatic Dependent Surveillance	78 (every minute)	1	25	En-route
Surface Movement Guidance and Control Information Exchange	1 every second	2	25	Airport
Meteorological Data Downlink (MET)[13]	26 (every 3 minutes)	1	26	En-route
Traffic Information (TIF)	5	4	30	En-route / TMA
Data Link SIGMET	2	4	63	En-route
Flight Plan Consistency (FLIPCY)	1	4	260	En-route
Automated Dependent Surveillance (ADS)	78 (every minute) in LTLA 16 (every 5 minutes) in LTLA-R	2	25	En-route
Conflict Resolution by Negotiation	3	4	40	En-route
4D Trajectory Negotiation (4DTN)	2	8	35	En-route

13 Service provided by 15 % of flights only.

GNSS Augmentation Data Uplink	78 (every minute)	1	8	All

Table C-1: Typical Communication Parameters of ATS Data Link Services

The above parameters of ATS data link services are assumed to be more or less stable over the time, i.e. during the three ATN deployment phases (as defined in [6]). Major variations over time will occur in the number of data link services offered during the individual deployment phases and the number of aircraft using the offered services. The first aspect is reflected in the tables of section 2.4.1 and the second aspect is detailed in the aircraft sub-model (Section 3.4).

C.1.1.2 AOC/AAC Data Link Services

Based on an analysis of the AOC/AAC communication requirements performed in [2] and some best guesses for future more advanced AOC/AAC data link services, the following typical communication characteristics per data link service can be derived:

Data Link Service	Transactions Per Flight	Messages Per Transaction	Message Size (Bytes)	Flight Phase
Movement Messages (OOOI)	4	1	40	Airport, TMA
Aircraft and Engine Performance/Trend Monitoring	3	1	100	En-route
Flight Status Reports (ETA, Delays, Diversions, Progress Reports)	5	1	80	En-route, TMA
Automatic Terminal Information Service (ATIS)	2	3	50	En-route, TMA
Fuel Status	2	1	40	En-route
Load Sheet Transfer	1	1	80	Airport
Flight Plan Transfer	1	2	200	Airport
Flight Log Transfer	1	2	100	Airport
Dispatch/Weather Reports	2	1	80	En-route
Crew and Aircraft Schedule	1	1	100	En-route, TMA
Maintenance Items	1	1	100	En-route, TMA
Service messages	2	2	100	En-route, TMA
Quality Monitoring	2	1	50	En-route, TMA
Technical Log Book Update	0 - 1	1	400	Airport
Cabin Log Book Transfer	1	1	400	Airport
Onboard Documentation Update	0 - 1		1000	Airport
Real-time Maintenance Information	1	5	50	En-route, TMA

Graphical Weather Information	2	2	2000	En-route
Software Loading	0 - 1	2	4000	Airport
Online Technical Trouble Shooting	0 - 1	5	500	En-route, TMA
Real-time Weather Reports for Met Offices[1]	26 (every 3 minutes)	1	26	En-route
Telemedicine	0 - 1	8	4000	En-route

Table C-2: Typical Communication Parameters of AOC/AAC Data Link Services

The relevant deployment phase of the above data link services is defined in Table 2.4. The above listed parameter values hold for the initial deployment phase of each data link service. As a rough approximation, an average growth factor of 10 % per year in the number of transmitted bytes per message can be assumed (c.f. [28]).

C.1.2 Protocol Overhead During Data Transfer

Based on an analysis of the protocol overhead of the ATN communication stack performed in [7] and [29], the following figures can be derived for the typical protocol overhead which is added by the individual ATN communication layers to each transmitted user data packet:

ATN Protocol Entity	Overhead per Message (Bytes)
Control Function	2
ACSE (ISO/IEC 8649)	-----
Presentation (ISO/IEC 8823)	-----
Session (ISO/IEC 8327)	-----
CLTP (ISO/IEC 8602)	14
COTP (ISO/IEC 8073)	10
CLNP (ISO/IEC 8473) plus Mobile SNDCF	20
SNAcP (ISO/IEC 8208)	6
Total	38 (for COTP) 42 (for CLTP)

Table C-3: Typical Overhead per User Data Packet Introduced by ATN Communication Protocols

The above table indicates that the ATN protocol stack typically introduces an overhead of 38 bytes (if the connection-oriented transport protocol is used) or 42 bytes (if the connection-less transport protocol is used) respectively. This overhead has to be systematically added to each transmitted user data packet. For the CBA, it is proposed to model the ATN protocol overhead during the data transfer by an average figure of 40 bytes per user data message.

C.1.3 Protocol Overhead Due to Communication Setup and Release

Based on an analysis of the protocol overhead of the ATN communication stack performed in [29], the following figures can be derived for the typical protocol overhead which is introduced by the individual ATN communication layers for the establishment and release of connections or associations between peer ATN communication entities:

ATN Protocol Entity	Overhead per Connection/Association Establishment/Release (Bytes)
Control Function	8
ACSE (ISO/IEC 8649)	17
Presentation (ISO/IEC 8823)	2
Session (ISO/IEC 8327)	2
IDRP (ISO/IEC 10747)	120 (tbc)
CLTP (ISO/IEC 8602)	----
COTP (ISO/IEC 8073)	125
CLNP (ISO/IEC 8473) plus Mobile SNDCF	----
SNAcP (ISO/IEC 8208)	85
Total	359

Table C-4: Typical Overhead per ATN Connection/Association Establishment and Release

The above table indicates that the ATN protocol stack typically introduces an overhead of 359 bytes if a complete (i.e. throughout the whole ATN protocol stack) communication association is established/released between two peer ATN ESs and the connection-oriented transport protocol is used. The establishment/release of a subnetwork connection is assumed to cause 85 bytes of overhead data to be transmitted.

For the ATN CBA model it is proposed to differentiate between the following four types of connection/associations which are listed in Table C-5. Furthermore, this table provides estimates for the

- number of bytes associated with the establishment/release of each such type
- number of connections established/released per type during a typical flight in the year 2005, 2010 and 2015 respectively.

Connection Type	Overhead per Establishment/ Release (Bytes)	Number of Connections/ Flight in 2005	Number of Connections/ Flight in 2010	Number of Connections/ Flight in 2015
Subnetwork Connection	85	8	12	20
IDRP Connection	120 (tbc)	6	8	10

Application Association over CLTP	29	20	40	50
Application Association over COTP	154	6	10	20

Table C-5: Typical Connection Profile Per Flight

C.1.4 Routing and Systems Management Traffic

The ATN routing and systems management traffic over the air/ground link will be a negligible small portion as compared to the overall data amount resulting from the traffic categories discussed in the previous sections. For the ATN CBA model it is proposed to assume the typical ATN routing and systems management traffic to amount to about 300 bytes/flight in 2005, to about 2000 bytes/flight in 2010, and to about 3000 bytes/flight in 2015.

Appendix D - Ground Communication Traffic Profile

This appendix provides initial quantitative figures on typical ground data traffic volumes and ground data exchange frequencies as input to the Ground Communication Profile Sub-Model of the ATN CBA. The information provided in this appendix is largely based on material contained in [4].

The emphasis of this initial ground data traffic analysis is placed on international traffic. While it is recognised that ground/ground applications which have only national significance may be important contributors to the overall ATN ground communication load, they need a much more detailed and extensive study.

Furthermore, it is recognised that a significant volume of data transferred across the existing ATSO ground networks is "non-operational" in character. This administrative traffic which is not directly relevant to flight operations is not considered in this analysis.

D.1 Air Traffic Flow Management Communications

ATFM communications is primarily concerned with ground communications except for the future possibility of flight plan and slot allocation messages between aircraft and ATC. There are three major types of traffic flows within this category of ground data communications:

- transmission of flight plans and associated data to/from the IFPS (Initial Flight Plan Processing System) using file transfer and message exchange,
- exchange of airspace capacity information between the CFMU and FMPs located at ACCs and major control units using interactive transactions
- transmission of tactical flow management information from CFMU to AOs and ATC units and vice versa using message exchange.

D.1.1 Flight Plan Transmission

The transmission of flight plans is a messaging service. Flight plans and associated messages (such as CHG, DEP, CLN, etc.) are submitted by AOs and national FPSs (Flight Plan Processing Systems) to the two IFPS units, one co-located with the CFMU at Haren and the other at Brétigny. The organisation which filed the flight plan is informed with a message about the result of the flight plan processing (acceptance, rejection, request for additional data, etc.) Prior to the flight the IFPS distributes the flight plan and associated data to all ATC units responsible for the flight.

About 150,000 messages per day are received and submitted respectively by the IFPS. There is a distribution of small (e.g. ACK length: 42 octets), medium (e.g. RPL length: 303 octets) and large (e.g. IFPL/IRPL length: 1400 octets) information sizes. In average, a message typically contains about 250 characters.

D.1.2 Airspace Capacity Information Exchange

The interaction between the CFMU and the FMPs is in the form of a dialogue. The FMPs supply up-to-date ATC and airspace sector capacity information to the CFMU and retrieve the overall capacity situation from the CFMU. There are approximately 60 FMPs in operation in the EUR Region.

The use of FMPs is sporadic during the day. There are about 5 sessions per day between each FMP and the CFMU. During each session a data volume of about 5 kbyte is exchanged.

D.1.3 Tactical Flow Management Information Exchange

The transmission of flight plan related information is a messaging service. The CFMU receives slot request messages from AOs and flight plan activation messages from ATS units. The CFMU sends slot allocations, reroutings and alternative flight profiles to AOs and ATC units.

The number of messages per day is dependent on the number of flights but also, more sensitively, on the number of regulations being activated/deactivated. Typical message volumes are of the order of 40,000 messages sent and 40,000 messages received per day. The messages are short, of the order of 100 bytes.

D.2 Aeronautical Information Service Communications

AIS communications mainly includes the distribution of NOTAMs to airspace users and other ATSOs. Currently this is done on a national basis by each ATSO individually. Consequently the number of AIS systems in the EUR Region corresponds approximately with the number of EUR Region states.

There is a nearly uniform distribution of message sizes found in AIS, ranging from information requests (typically less than 20 bytes), through NOTAMs to AIS bulletins (typically several hundreds of bytes). NOTAMs are short text messages, having a typical length of between 200 and 300 characters. A typical AIS systems handles of the order of 1,000 NOTAMs per day.

D.3 Inter-Centre Communications

For the co-ordination of flight data between ACCs, in particular for flight handover, co-ordination messages are exchanged between pairs of sites.

The number of exchanged messages can be roughly correlated with the number of flights in progress. Assuming that a typical flight in the EUR Region involves 5 ATC units, about 15 messages per flight will be exchanged. The data volumes are small; a typical message contains of the order of 100 bytes.

D.4 Air Space Management Communications

ASM communications is exclusively concerned with ground communications. The exchange of notifications has been identified so far as the only transaction type in ASM data communications. Both point-to-point and multicast transfers are required.

Two distinct types of messages are involved in ASM data communications:

- short messages of tactical data typically under 200 bytes in length
- very long messages of strategic data of tens (or even hundreds) of kilobytes.

D.5 Radar Data Exchange

Target information is normally extracted from raw radar signals close to the radar sensor. From there it is transmitted to radar processing and display systems at ATC units. Furthermore processed radar data are exchanged between adjacent ATSOs in some cases.

Radar data transmission involves relatively large data volumes. An almost continuous flow of data at a rate of 40 kbit/s can be assumed to be transmitted by a RMCDE (radar message conversion and distribution equipment). Approximately 30 RMCDEs are in operation in the Four States Integration Project.

D.6 Meteorological Information Communications

Meteorological information communications comprises the distribution of operational meteorological reports (OPMET) among aeronautical meteorological offices and the retrieval of this information by users for pre-flight and in-flight briefing.

OPMET distribution is implemented as a messaging service. To get a feeling for the volume of data involved the MOTNE system is taken, which, until recently, distributed OPNET data in Europe among 10 major aeronautical meteorological offices more or less continuously at a rate of 100 bit/sec in each direction. A factor of 4 may be applied to estimate the current data volume. OPMET reports typically have a size of 100 - 200 bytes.

D.7 Integrated and Collaborative Planning Information Exchange

This category of ground traffic includes the

- exchange of planning information between ATSOs and AOs
- exchange of planning and resource information between ATSOs and APOs
- exchange of planning and resource information between AOs and APOs

in the frame of the envisaged integrated planning and collaborative decision making process between these parties. This process will place increasing emphasis on three-party exchanges and may require additional supporting communication services not in place today.

The interaction between these parties will be in the form of a dialogue between automated ground systems including centralised (pan-European) information servers. Table D-1 illustrates an assumed communication profile for this category of traffic.

Year Traffic	2005	2010	2015
No of ATSO/AO sessions per ATSO	160	300	400
No of ATSO/APO sessions per ATSO	60	80	200
No of AO/APO sessions per AO	40	80	120
No of octets per session	2 kbytes	4 kbytes	8 kbytes

Table D-1: Typical Communication Profile for Planning Information Exchange

D.8 ATN Backbone Communications

This category of ground traffic comprises the routing information exchange between ATSOs and the European ATN Backbone to support mobile routing in an ATN environment as specified in the ATN SARPs. The main traffic flow is from the ATSOs towards the ATN Backbone.

The volume of this traffic category is directly related with the number of ATN-equipped aircraft operating in the EUR Region and the number of ATSOs connected to the ATN

Backbone. Using the figures listed in the ATSO sub-scenario (in Table 3.1-4) and the aircraft sub-scenario (in Table 3.4-1) and a pan-European ATN infrastructure and organisation as outlined in section 3.1.4.1.2, the following number of routing messages (IDRP Update PDUs) will be received or distributed respectively by the ATN Backbone:

	2005	2010	2015
Towards Backbone	2 messages/sec	10 messages/sec	18 messages/sec
From Backbone	10 messages/min	30 messages/min	50 messages/min

Table D-2: Typical Communication Profile for Routing Information Exchange with ATN Backbone

The average length of a typical routing information message is about 150 bytes.

Appendix E - Abbreviations

AAC	Aeronautical Administrative Communications
ACARS	Aircraft Communications Addressing and Reporting System
ACC	Area Control Centre
ACF	Airport Control Facility
ACM	ATC Communications Management
ACSP	Aeronautical Communications Service Provider
ADS	Automatic Dependent Surveillance
AFTN	Aeronautical Fixed Telecommunication Network
AIS	Aeronautical Information Services
AMHS	Aeronautical Message Handling Service
AMSS	Aeronautical Mobile Satellite Service
AO	Aircraft Operator
AOC	Aeronautical Operational Communications
APC	Aeronautical Passenger Communications
APO	Airport Operator
ARTAS	ATC Radar Tracker and Server
ASD	Air Situation Display
ASM	Air Space Management
ATC	Air Traffic Control
ATFM	Air Traffic Flow Management
ATIS	Automatic Terminal Information Service
ATM	Air Traffic Management
ATN	Aeronautical Telecommunication Network
ATNI	ATN Implementation
ATS	Air Traffic Service
ATSO	Air Traffic Service Organisation
BB	Backbone
BIS	Boundary Intermediate System
CAERAF	Common American European Reference ATN Facility
CAP	Controller Access Parameters
CBA	Cost/Benefit Analysis
CEATS	Central European Air Traffic Services
CFMU	Central Flow Management Unit
CIC	Clearances and Information Communications
CIDIN	Common ICAO Interchange Network
CM	Context Management
CMU	Communications Management Unit
CPDLC	Controller-Pilot Data Link Communications

CRCO	Central Route Charge Office
CSP	Communications Service Provider
DAP	Downlink of Aircraft Parameters
DBE	Data Base Eurocontrol
DCL	Departure Clearance
DLIC	Data Link Initiation Capability
D-OTIS	Data Link Operational Terminal Information
D-RVR	Data Link Runway Visual Range
DSC	Downstream Clearance
DYNAV	Dynamic Route Availability
EACE	European ATN Co-ordinating Entity
ES	End System
ETA	Estimated Time of Arrival
EUR	Europe
FANS	Future Air Navigation System
FLIPCY	Flight Plan Consistency
FMP	Flow Management Position
FMS	Flight Management System
GA	General Aviation
GES	Ground Earth Station
HF	High Frequencies
HTLA	High Traffic Level Area
ICAO	International Civil Aviation Organisation
ICC	Inter-Centre Communications
IFPS	Initial Flight Plan Processing System
IS	Intermediate System (= Router)
LAAO	Large Aircraft Operators
LAAP	Large Airport
LTLA	Low Traffic Level Area
LTLA-R	Low Traffic Level Area (Remote)
MAAO	Major Aircraft Operators
MAAP	Major Airport
MEAO	Medium Aircraft Operators
MEAP	Medium Airport
NMS	Network Management System
OCM	Oceanic Clearance Message
OLDI	Online Data Interchange
OOOI	Out-Off-On-In
PDC	Pre-departure Clearance
PPD	Pilot Preferences Downlink

PSD	Pilot Selections Downlink
PSN	Public Switched Network
QoS	Quality of Service
RD	Routing Domain
SAP	System Access Parameters
SMAO	Small Aircraft Operators
SMAP	Small Airport
SMC	Systems Management Centre
SMGCS	Surface Movement Guidance and Control System
STDMA	Self-organising Time Division Multiple Access
TF	Task Force
TIF	Traffic Information
TMA	Terminal Control Area
VHF	Very High Frequencies
VDL	VHF Digital Link
WAN	Wide Area Network

Appendix F - References

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