ATM/CNS System Architecture

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1 INTRODUCTION

1.1 Context

Through active engagement with the UAE Aviation Community and global aviation stakeholders, the GCAA is able to identify, understand and focus strategic alignment to ensure common objectives are developed within the following:

- ICAO Global Air Navigation Plan
- ICAO MID Region Air Navigation Strategy
- UAE Airspace Policy 2015
- UAE ATM Strategic Plan
- National Airspace Advisory Committee (NASAC)

In 2013 the GCAA contracted a study to evaluate capabilities of the UAE Airspace. This highlighted Fifty-Three (53) recommendations spanning Airspace, ATM, ATFM and CDM capabilities. Fifteen (15) of the recommendations were then adopted by the GCAA as 'Key Recommendations' to ensure action plans were developed to enable these highlighted capability requirements. Within the fifteen (15) recommendations the following key recommendations were highlighted:

4. Develop and implement a plan to manage UAE air navigation service provision that is seamless from a stakeholder perspective, including requirements, system capabilities, and coordination.

5. Develop and implement a UAE-wide Enterprise Architecture for the provision of air navigation services and information, including military.

9. Establish Collaborative Decision Making (CDM) capabilities and processes for exchanging strategic and tactical information and decision making between the ANSPs and stakeholders, including Airport Operators.

14. Foster UAE regional leadership through implementation of leading-edge capabilities and establishment of focused ATFM capabilities.

As part of the Key Recommendation 5: Develop and implement a UAE-wide Enterprise Architecture for the provision of air navigation services and information, including military. NASAC WG 15 is developing an ATM/CNS architecture for the UAE that does not only guarantee safe, secure and effective operations for the UAE, but to also harness future capabilities from modern aircraft and airspace, ensuring enablement of appropriately scalable seamless interoperability and harmonisation to support a State-of-the-Art and Future Proof ATM System.

The aim is that for the ATM/CNS framework is to provide recommendations and best practises to be considered for when ATM/CNS systems are implemented or renewed.

1.2 Definitions

Interoperability	Functional, technical and operational properties which the systems and constituents of ATM/CNS architecture must have and the procedures for operation in order to ensure safe, efficient and seamless operation in the UAE.
System	Ground and airborne constituents to support air navigation services during all phases of flight.
Constituents	Tangible items, such as equipment, and intangible items, such as the software on which the interoperability of the ATM/CNS architecture depends
Seamless operation	Operation of the ATM/CNS architecture in such a way that, for the (airspace) users, it acts as a single entity.

1.3 Scope of this Document

The objective of this document is to complement UAE Aviation Strategy by providing guidance to aviation stakeholders on recommended systems and technologies to build an ATM/CNS infrastructure for air traffic services in the UAE. Despite the recommendations all systems are required to be in line with the national regulations and shall conform to regional and global standards.

In the following is a guidance for Communication, Navigation and Surveillance (CNS) technologies that shall support harmonisation of ATM/CNS in the UAE.

1.4 Airspace in the United Arab Emirates

1.4.1 Emirates FIR

The Emirates FIR is among the smallest and most important blocks of airspace in the world. This is due to the strategic location of the UAE being the link between East and West. Civil Traffic in the UAE airspace controlled by several Air Traffic Service Units that closely work together to safely and efficiently manage the flow of air traffic.

SZC	With a size of approximately 124,000 square km Emirates FIR hosts more than 40 international airways. SZC subdivides the controlled airspace into 11 sector. Depending on traffic demand individual sectors may be combined to increase the efficiency.
ADAC-ANS	ADAC ANS are responsible for all aircraft arriving and departing from Abu Dhabi and Al Ain airport. This includes approach services for the airports at Abu Dhabi CTA and provide tower services at both airports
DANS	Dubai ANS ATC are responsible for all aircraft arriving and departing from Dubai and the northern Emirates. This includes approach services for five airports (DXB, DWC, Sharjah International, Ras Al Khaimah International, and Al Minhad Air Base) from a combined facility at DWC and provide tower services at both Dubai International (DXB) and Al Maktoum (DWC).
Ras Al Khaimah-ANS	Ras Al Khaimah-ANS provides approach and tower services for Ras Al Khaimah airport.
Sharjah -ANS	Sharjah-ANS tower services for Sharjah airport.
Fujairah -ANS	Fujairah-ANS provide approach and tower services for Fujairah airport.

1.5 Periodic Review and Updates

This document will need to evolve as operational needs and technology is evolving. It should be therefore be reviewed and updated as necessary once per year.

1.6 Regulations, Standards and Guidelines

The following list provides the references used within this document. This is a non-exhaustive list of regulations that need to be considered and complied with when CNS and ATM systems are implemented and operated.

1.6.1 Regulations

Having regard to Article 10 of the United Arab Emirates (UAE) General Civil Aviation Authority Law No. 4 of 1996, whereas the General Civil Aviation Authority (GCAA), as the Competent Authority, shall promulgate the necessary regulations to implement the provisions of the Civil Aviation Law No. 20 of 1991.

For the purpose of this document the following Civil Aviation Regulations (CAR) have been considered

/01/ UAE Civil Aviation Regulations (CAR)
https://www.gcaa.gov.ae/en/ePublication/Pages/CARs.aspx

1.6.2 Standards and Guidelines

1.6.2.1 UAE Strategic Framework

/02/ UAE ATM Strategic Plan, Guidance Material No.04

1.6.2.2 ICAO References

/03/ ICAO Doc 4444, Procedure of Air Navigation Services Air Traffic Management (PANS-ATM)
/04/ ICAO Doc 9750, Global Air Navigation Plan
/05/ ICAO Doc 9694, Manual of Air Traffic Services
/06/ ICAO Doc 8400, ICAO Abbreviations and Codes
/07/ ICAO Doc 9694, Manual of Air Traffic Service Data Link Applications
/08/ ICAO Doc 9854, Global Air Traffic Management Operational Concept
/09/ ICAO Doc 9882, Manual on Air Traffic Management (ATM) System Requirements
/01/ ICAO Doc 7192, Training Manual (Part E-2): Air Traffic Safety Electronics Personnel (ATSEP)
/02/ ICAO Doc 9971, Manual on Collaborative Air Traffic Flow Management
/03/ ICAO Doc 9643, Manual on Simultaneous Operations on Parallel or Near Parallel Instrumented Runways (SOIR)
/04/ ICAO Doc 10004, Global Aviation Safety Plan 2014-2016
/05/ ICAO Doc 10039, Manual on System Wide Information Management (SWIM) Concept
/06/ ICAO Annex 2: Rules of the Air
/07/ ICAO Annex 3: Meteorological Service for International Air Navigation
/08/ ICAO Annex 4: Aeronautical Charts
/09/ ICAO Annex 5: Units of Measurement to be Used in Air and Ground Operations
/10/ ICAO Annex 10 Volume I: Radio Navigation Aids
/11/ ICAO Annex 10 Volume II: Communications Procedures including those with PANS status
/12/ ICAO Annex 10 Volume III: Aeronautical Telecommunications, Part 1: Digital Data Communication Systems
/13/ ICAO Annex 10 Volume III: Aeronautical Telecommunications, Part 2: Voice Communication Systems
/14/ ICAO Annex 10 Volume IV: Surveillance Radar and Collision Avoidance Systems
/15/ ICAO Annex 10 Volume V: Aeronautical Radio Frequency Spectrum Utilization
/16/ ICAO Annex 11: Air Traffic Services
/17/ ICAO Annex 14: Aerodromes

/18/ ICAO Annex 15: Security: Safeguarding International Civil Aviation Against Acts of Unlawful Interference

1.6.2.3 References for Surveillance Performance

/19/ Eurocontrol-SPEC-0147: Specification for ATM Surveillance System Performance (ESASSP), Edition 1.1, 01.09.2015

/20/ Eurocontrol Radar Sensor Performance Analysis, SUR.ET1.ST03.1000-STD-01-01, Edition 0.1, 01.06.1997

/21/ Eurocontrol Standard for Radar Surveillance in En-Route Airspace and Major Terminal Areas. Edition May, 1996

1.6.2.4 References for ASTERIX

/22/ Eurocontrol ASTERIX Standard Document for Surveillance Data Exchange, Part 1: All Purpose Structured Eurocontrol Surveillance Information Exchange, SUR.ET1.ST05.2000-STD-01-01, Edition 1.30, 19.11.2007

1.6.2.5 References and Guidance for Safety Nets

/23/ Eurocontrol-SPEC-122, Eurocontrol Specification for Short Term Conflict Alert, Edition 1.1, 19.05.2009 (STCA)

/24/ Eurocontrol-SPEC-124, Eurocontrol Specification for Area Proximity Warning, Edition 1.0, 19.05.2009 (APW)

/25/ Eurocontrol-SPEC-126, Eurocontrol Specification for Minimum Safe Altitude Warning, Edition 1.1, 19.05.2009 (MSAW)

/26/ Eurocontrol-SPEC-126, Eurocontrol Specification for Approach Path Monitor, Edition 0.5, 19.05.2009 (APM)

/27/ Eurocontrol-SPEC-139, Eurocontrol Specification for Medium-Term Conflict Detection, Edition 1.0, 15.07.2019 (MTCD)

/28/ Eurocontrol EAM 4/GUI 6: ESARR Advisory Material/Guidance Material (EAM/GUI) Explanatory material On Ground Based Safety Nets

/29/ ED-99B: User Requirements for Aerodrome Mapping Information

/30/ ED-119A: Interchange Standards for Terrain, Obstacles, and Aerodrome Mapping Data

/31/ DRAFT Eurocontrol Initial Specification for Display of Downlinked ACAS II Resolution Advisories at Controller Working Positions (RA Downlink), Edition 0.4, 15. November 2010

1.6.2.6 Data Link Services

/32/ ARINC 622: ATS Data Link Applications over ACARS Air-Ground Network

/33/ EUROCAE ED-100/RTCA DO-258 Interoperability Requirements for ATS Applications Using ARINC 622 Data Communications

1.6.2.7 Arrival Manager

/34/ Eurocontrol Arrival Manager, Implementation Guidelines and lessons Learned, Edition 0.1, 17. December 2010

1.6.2.8 Ground Based Recording

/35/ ED-111: Functional Specifications for CNS/ATM Recording (including amendment no.1, 30.07.2003)

1.6.2.9 Abbreviations and Acronyms

The following list of abbreviations lists the abbreviations used in this document.

ACAS	Airborne Collision Avoidance System
ACC	Area Control Centre
ADAC	Abu Dhabi Airports Company
AFTN	Aeronautical Fixed Telecommunication Network
AIDC	ATS Interfacility Data Communication
AIM	Aeronautical Information Management
AIXM	Aeronautical Information Exchange Model
AMHS	Aeronautical Message Handling System
ANA	Air Navigation and Aerodrome Department
ANSP	Air Navigation Service Provider
ASBU	Aviation System Block Upgrade
ASTERIX	All Purpose Structured Eurocontrol Surveillance Information Exchange
ATC	Air Traffic Control
ATCO	Air Traffic Control Officer
ATFCM	Air Traffic Flow and Capacity Management
ATFM	Air Traffic Flow Management
ATS	Air Traffic Service
ATSI	Air Traffic Service Instructor
ATSU	Air Traffic Service Unit
CDM	Collaborative Decision Making
CPDLC	Controller-Pilot Data Link Communications
DANS	Dubai Air Navigation Services
DFLOW	Departure Flow Manager
ESASSP	Eurocontrol Specification for ATM Surveillance System Performance
EUROCAE	European Organisation for Civil Aviation Equipment
FIR	Flight Information Region
GANP	Global Air Navigation Plan
GCAA	General Civil Aviation Authority
GCC	Cooperation Council for the Arab States of the Gulf
ICAO	International Civil Aviation Organization
MTCD	Medium Term Conflict Detection
SDPS	Surveillance Data Processing System

STCA	Short Term Conflict Alert
SWIM	System Wide Information Management
SZC	Sheikh Zayed Air Navigation Centre
TBS	Time Based Operation
UAE	The United Arab Emirates
XML	Extensible Markup Language

2 ATM/CNS Architecture Overview

2.1 Current ATM/CNS Architecture

The following table shows an overview of equipment in use at various sites. Depending on the equipment in Abu Dhabi, Dubai and Fujairah, ATC Tower systems are either part of/directly connected to the data processing of the respective approach system or are standalone equipment.

	SZC	Abu Dhabi Approach	Abu Dhabi Tower	Al Ain Tower	Al Bateen Tower	Dubai Approach	Dubai Tower	Al Maktoum Tower	Fujairah Approach	Fujairah Tower	Sharjah Tower	Ras Al Khaimah Tower
Surveillance System												
Air Situation Display	X	X	X	X	X	X	X	X	X	X	X	X
Surveillance Radar	X	X				X						
ADS B Ground Station	X								X			
Multilateration System		X				X			X			
Surveillance Data Processing	X	X				X			X			
A-SMGCS			X			X	X	X				
Communication Systems												
VCCS	X	X				X						
Flight Plan Systems												
AFTN/AMHS Switch	X	X		X		X			X		x	x
Flight Plan Data Processing	X	X				X			X		X	X
OLDI Coordination	X	X				X					X	X
Electronic Flight Strips												
Safety Nets	X	X				X						
Capacity and Flow Management												
Arrival Manager	X											
AMAN Terminal		X				X						

Departure Manager												
DFLOW	X											
DFLOW Terminal			X				X				X	
Data Link												
DCL			X				X	X				
CPDLC												

The system at the different sites are interconnected providing interoperability on several levels.

Application	**Current Status**
Air Surveillance	Surveillance Data is shared amongst the different Air Traffic Service Provides to complement and enhance the quality of the individual air situation picture used by the air traffic service units.
ATS Messages	Air Traffic Services Messages (AFTN) are exchanged using the individual AFTN Switches that form the national AFTN. The data exchange is using AFTN messages following the ICAO formats. AMHS is only supported by Emirates ACC, Dubai APP and Abu Dhabi APP.
Online Coordination	Within the UAE the following OLDI connections are in operation: • Emirates ACC to Abu Dhabi Approach • Abu Dhabi Approach to Emirates ACC • Emirates ACC to Dubai Approach • Dubai Approach to Emirates ACC • Departures from Sharjah with Emirates ACC • Departures from Ras Al Khaimah with Emirates ACC OLDI in Dubai Approach still requires human interaction to synchronise data from an OLDI terminal with the Dubai automation system. OLDI also is used by Emirates ACC to pre-inform Sharjah and Ras Al Khaimah about approaching traffic. However, such traffic is conventionally coordinated with Dubai Approach.
Arrival Manager	The Arrival Manager System provides terminals at Abu Dhabi Approach and Dubai Approach to share information about inbound

	flights sequence and predicted landing times.
DFLOW	The DFLOW uses terminals at Towers and Airspace Users to allow for a collaborative management of departure times during “flow” times.
SWIM	In line with GANP Module B2–FICE **UAE started to support** Improved coordination through multi-centre ground-ground integration (FF-ICE, Step 1 & Flight Object, SWIM).

2.2 Planned ATM/CNS Enhancements and Modernisations

As part of individual initiatives the aviation stakeholders in the UAE have a number of initiatives to improve or renew the infrastructure. These initiatives are expected to be aligned with national, regional and global strategies and timelines.

2.3 Contingency

For contingency purposes in case of major system outages the ATSU have bi-lateral agreements to provide contingency services. The contingency services are limited to capabilities on the respective capabilities of the supporting ATSU. Currently there is no overarching contingency concept within the UAE.

In order to assure continuity and graceful degradation of services the individual ANSP are encouraged to work together to use the potential of a harmonised ANS/CNS architecture with common standards to enhance their contingency plans.

3 Framework Requirements for Communications

3.1 Introduction

The safety and efficiency of air traffic control is directly related to the availability and performance of aeronautical communications and the supporting infrastructure. The importance of communications is highlighted by the scope of air traffic management and airline operations that depend upon it. This scope of operations includes filing and amending flight plans, Air Traffic Services (ATS) communications, and airline operational communications. Implementations of any communication capability can have a wide-ranging effect and thus require proper multidisciplinary coordination involving aircraft operators, avionics manufacturers, flight crews, ANSPs and other agencies providing supporting services and infrastructure.

The following sections identify the ground-to-ground and air-to-ground / ground-to-air subnetworks of the Communication Network, and the various technologies and their deployment.

3.2 Ground–Ground Communications

Ground-ground communications refer to exchanges of ATM-related messages linking ground-based stakeholders concerning planning and movement of aircraft. Such communications are transitioning from analogue to digital format and are becoming increasingly automated.

Technologies and applications reviewed in this section include:

- Aeronautical Fixed Telecommunications Network (AFTN) and ATS Message Handling Services (AMHS);
- Air Traffic Services Inter-Facility Data Communications (AIDC)
- On-Line Data Interchange (OLDI)

3.2.1 Aeronautical Fixed Telecommunications Network and ATS Message Handling Services

The AFTN is a message-handling network that has existed for over 50 years. It is a closed network in the sense that its users belong to ATS authorities and associated organizations such as airline operators, general aviation, and meteorological offices. Access to the network will require the operators of network nodes to actively establish connection to new nodes and/or client systems.

The AFTN is character-based only and cannot carry bit-oriented applications. This is a heritage from the time the ATFN was based in Telex (Teleprinter) networks. While the pure character based ATFN is a limited factor for innovations on the positive side it is a sound bases for a global interoperability. ATS messages as per ICAO or ADEXP format can exchanged globally between organisations and systems of different age and origin.

The aviation industry has adopted AMHS to replace the AFTN. The AMHS can carry digital information such as text, graphics, images, files, databases, audio and video. ICAO has specified standards to ensure interoperability between AMHS and AFTN during the migration period.

UAE Framework Recommendation

Technology	Aeronautical Fixed Telecommunications Network and ATS Message Handling Services
Application	ATS messaging is used worldwide for the communication of flight plans, MET, NOTAMS, etc. over AFTN technology.
Recommendation	AFTN is still a viable technology, but migration towards AMHS (directory, store and forward services) over IP (or using ATN in some regions) shall progress. ATS messaging will migrate to AMHS supported by directory facilities that will include common security management by the end of
Applicable Regulations	UAE CAR Part II Chapter 2
International Standards	ICAO Doc 4444 ICAO Annex 10 Aeronautical Communications, Volume II Communication Procedures

3.2.2 On-Line Data Interchange (OLDI)

Similar to AIDC is a ground-ground data link communication service that provides the capability to automatically exchange data between ATS units for notification, coordination and transfer of aircraft between air traffic service units (ATSU). OLDI supports either an ICAO field format or alternatively ATS Data Exchange Presentation (ADEXP).

OLDI messages are exchanged through ground-ground circuit, and can well be integrated with a TCP/IP network. Similar to AIDC greatly reduces the need for voice coordination between ATC facilities, resulting in fewer errors and reduced workload.

UAE Framework Recommendation

Technology	On-Line Data Interchange (OLDI)
Application	Ground-Ground Coordination Improved and automatic coordination between ATSUs using On-Line Data Interchange (OLDI)
Recommendation	Implementation of OLDI is strongly encouraged. At least a minimal subset of functionality shall be supported by all ATSU owning an ATM automation system. The basic set of messages shall include ABI, ACT, PAC, LAM and COD (Basic OLDI). Implementation shall use FMTP over TCP/IP. The use of obsolete X.25 technology shall be avoided.
Applicable Regulations	N/A
International Standards	Eurocontrol Specification for On-Line Data Exchange (OLDI), Edition 4.30 Eurocontrol Specification of Interoperability and Performance Requirements for the Flight Message Transfer Protocol (FMTP), Edition 2.0, 2007-06-14

3.2.3 Air Traffic Services Interfacility Data Communication (AIDC)

AIDC is a ground-ground data link communication service that provides the capability to automatically exchange data between ATS units for notification, coordination and transfer of aircraft between air traffic service units (ATSU). AIDC message format and procedures is an international standard designed for use through any ground-ground circuit, including the legacy AFTN.

AIDC greatly reduces the need for voice coordination between ATC facilities, resulting in fewer errors and reduced workload.

UAE Framework Recommendation

Technology	Air Traffic Services Interfacility Data Communication (AIDC)
Application	Improved and automatic coordination between ATSUs using Improved and automatic coordination between ATSUs using On-Line Data Interchange (OLDI)
Recommendation	Preference shall be given to OLDI as it assures monitoring of the connections.
Applicable Regulations	N/A
International Standards	ICAO Doc 4444 ICAO Document 9694

3.3 Air–Ground Communications

Current controller-pilot communications use primarily voice links provided by analogue radios operating in the VHF bands. Aviation is moving towards a new communications infrastructure that provides superior quality through use of air-ground data link. A first generation of ATC applications was implemented using Aircraft Communications Addressing and Reporting System (ACARS) air-ground data links. ACARS now needs to transition to modern communications protocols, such as VDL Mode 2, in order to support increasing user traffic and provide the performance needed for today and future air traffic management (ATM).

The objective is to adopt Controller Pilot Datalink Communications (CPDLC) as the primary means of routine communication while maintaining the requirement for voice communications for non-routine, tactical communications and as a backup. Ground-ground communications refer to exchanges of ATM-related messages linking ground-based stakeholders concerning planning and movement of aircraft. Such communications are transitioning from analogue to digital format and are becoming increasingly automated.

Technologies and applications reviewed in this section include:

- Voice Communication
  - ► Very High Frequency (VHF) Voice
  - ► High Frequency (HF) Voice
  - ► Voice Communications through Satellites (SATVOICE)

- Data and Network Communication
  - ► Controller Pilot Data Link Communications (CPDLC)
  - ► Aircraft Communications Addressing and Reporting System (ACARS)
  - ► VHF Data Link (VDL) Modes 2–4
  - ► Aeronautical Telecommunications Network (ATN)

In addition to the above Air-Communication in the vicinity of aerodromes is an emerging element of communications. In this domain two technologies currently are under consideration.

- Communication in the vicinity of aerodromes
  - ► Aeronautical Mobile Airport Communications System (AeroMACS)
  - ► Long Term Evolution (LTE)

At his time, in the UAE Air Air–Ground communications in the vicinity of aerodrome is not used and the UAE Framework does not recommend for a certain technology.

3.3.1 Very High Frequency (VHF) Voice

VHF voice communication systems, used in the International Aeronautical Mobile Service are amplitude modulated (AM) carriers. VHF analogue radios use channels of varying bandwidth. The channel spacing can be defined as 100 kHz, 50 kHz, 25 kHz or 8.33 kHz, depending on the saturation of channels in the region of interest.

UAE Framework Recommendation

Technology	Very High Frequency (VHF)
Application	Voice Air–Ground Communications
Recommendation	N/A
Applicable Regulations	N/A
International Standards	N/A

3.3.2 High Frequency (HF) Voice

HF communications have long-distance coverage and aircraft can use radios operating in the HF radio band for long-range communications because signals are reflected by the ionosphere. Link quality and availability are variable, and influenced by a number of factors, including frequency congestion, sunspot activity, solar cycle, and day/night atmospheric and ionospheric conditions.

UAE Framework Recommendation

Technology	High Frequency (HF)
Application	Voice Air–Ground Communications
Recommendation	N/A
Applicable Regulations	ICAO Manual on Testing Radio Navigation Aids (Doc 8071); Volume III – Testing of Surveillance Radar System
International Standards	N/A

3.3.3 Controller Pilot Data Link Communications (CPDLC)

CPDLC is a method by which the ATC units can communicate with aircraft over a digital datalink. Communication is using pre-defined message sets, with a free-text option for non-routine messages. CPDLC is a desirable form of controller-pilot communications, as it reduces voice errors and misinterpretations. It can be used for routine communications but due to potential delays is less suitable for tactical interventions as compared with VHF voice communications.

UAE Framework Recommendation

Technology	Controller Pilot Data Link Communications (CPDLC)
Application	Air–Ground Data Link Communications
Recommendation	N/A
Applicable Regulations	N/A
Recommended Practises	ICAO Doc 4444 ICAO Document 9694 ARINC 622 EUROCAE ED-100/RTCA DO-258

3.3.4 Aircraft Communications Addressing and Reporting System (ACARS)

Aircraft Communication and Reporting System (ACARS) systems were originally used to exchange messages between aircraft and flight operations centres. Today the ACARS network and avionics are used to support the exchange of FANS 1/A messages (i.e. Automatic Dependent Surveillance-Contract (ADS-C) and Controller Pilot Data Link Communications (CPDLC)) between aircraft and ATS units.

Use of ACARS for ATS communications has reduced potential for error inherent in voice communications, and off-loaded congested ATS voice channels. ACARS is currently available via HF, VHF and satellite data links.

UAE Framework Recommendation

Technology	Aircraft Communications Addressing and Reporting System (ACARS)
Application	Air–Ground Data Link Communications
Recommendation	Based on current equipage ACARS is recommended as the bases for initial datalink within the UAE
Applicable Regulations	N/A
International Standards	N/A

3.3.5 VHF Data Link (VDL) Mode 2

VDL Mode 2 is a bit-oriented air-ground digital data link that was introduced as an VHF Mode 0 (VHF ACARS) upgrade for ATC controller-pilot data communications while still allowing ACARS equipped aircraft to use the same network. Being bit-oriented, it can transmit digital content rather than being limited to characters.

VDL Mode 2 delivers data at 31.5 Kbps, which is over 13 times faster than the VHF ACARS 2.4 kbps rate. This is the highest possible bit rate that can be supported by a 25 kHz channel while providing a range of 200 nautical miles.

VDL Mode 2 has been widely accepted by the industry as the upgrade for VDL Mode 0 (VHF ACARS).

UAE Framework Recommendation

Technology	VDL Mode 2
Application	Air–Ground Data Link Communications
Recommendation	N/A
Applicable Regulations	N/A
International Standards	N/A

3.3.6 VHF Data Link (VDL) Mode 4

VDL Mode 4 is a bit-oriented VHF data link capable of providing air-air and air-ground communications. VDL Mode 4 supports time-critical applications and it is efficient in exchanging short repetitive messages.

Through its self-organizing system Time Division Multiple Access (STDMA, the time available for transmission is subdivided into multiple time-slots. Each time slot is planned and reserved for transmission by users' radio transponders within range of each other. This enables efficient data link use and prevents simultaneous transmission from different users. STDMA allows users to mediate access to discrete time slots without reliance on a master control station.

UAE Framework Recommendation

Technology	VDL Mode 2
Application	Air–Ground Data Link Communications
Recommendation	N/A
Applicable Regulations	N/A
International Standards	N/A

3.3.7 Aeronautical Telecommunication Network (ATN)

ATN is an internetwork architecture that allows ground, air-ground and avionics data sub-networks to interoperate by adopting common interface services and protocols based on the International Organization for Standardization (ISO) Open Systems Interconnection (OSI) reference model.

ICAO has endeavored to transform the ATN into a modern network by specifying use of Internet Protocol Suite (IPS). The relevant ICAO standards have been adopted by the ICAO Council and became applicable in November 2008. The ICAO GANP calls for a converging transition from FANS 1/A and OSI ATN to an ATN IPS.

UAE Framework Recommendation

Technology	Distance Measuring Equipment (DME)
Application	Ground Based Navigation Aid
Recommendation	N/A
Applicable Regulations	N/A
International Standards	Annex 10/III Aeronautical Telecommunications - Part I, Digital Data Communication Systems;

3.4 Other Data Link Services

3.4.1 Digital Automatic Terminal Information Service (D-ATIS)

ATIS is predominantly a voice broadcast service over a dedicated VHF frequency that provides operational information to aircraft operating in the vicinity of an airport, eliminating the need for an ATC controller to transmit the information to each aircraft individually. It is normally accomplished through a voice recording, updated when conditions change.

Data link is an alternative mean of transmitting ATIS to equipped aircraft. It reduces flight crew workload as D-ATIS information is printed on a cockpit printer or is recallable on a data link display.

UAE Framework Recommendation

Technology	Digital Automatic Terminal Information Service (D-ATIS
Application	Automatic Terminal Information Service
Recommendation	The provision of terminal information enhances the service while reducing workload for ATC.
Applicable Regulations	N/A
International Standards	ICAO Annex 11 Air Traffic Services ICAO Annex 10/III Aeronautical Telecommunications - Part I, Digital Data Communication Systems ICAO Annex 10/III Aeronautical Telecommunications - Part II, Voice Communications Systems

3.4.2 Automated Weather Observing System (AWOS)

AWOS is a suite of sensors that measure, collect, and disseminate weather data to help meteorologists, pilots, and flight dispatchers prepare and monitor weather forecasts. The sensors identify elements such as wind velocity, ambient air and dew point temperatures, visibility, cloud height and sky condition, precipitation occurrence and type, as well as icing and freezing conditions.

AWOS systems disseminate weather data in a variety of ways:

- A computer-generated voice message which is broadcast via radio frequency to pilots in the vicinity of an airport. The message is updated at least once per minute, and this is the only mandatory form of weather reporting for an AWOS.
- Optionally, a computer-generated voice message, available over a telephone dial-up modem service. The message is updated at least once per minute.
- Optionally (but frequently done), AWOS messages may be disseminated via ground data link in METAR format, typically once every 30 minutes.

In addition to safety benefits associated with weather, AWOS facilitates potential reduction in flight disruptions.

UAE Framework Recommendation

Technology	Automated Weather Observing System (AWOS)
Application	Weather Observing
Recommendation	The use of AWOS and its integration into automation systems is recommended.
Applicable Regulations	N/A
International Standards	N/A

3.5 System Wide Information Management (SWIM)

System Wide Information Management (SWIM) is an emerging architectural platform as per Global Air Navigation Plan. As part of a global harmonization and improved interoperability it will be deployed worldwide in the coming years and will become an essential the foundations of the ATM system. The development of suitable high level principles or guidelines to identify essential Modules at a global level will be necessary.

Considering safety and interoperability as basic targets, such principles could, focus, for example, on those Modules providing:

- direct and tangible safety improvements;
- interoperability of ground-to-ground systems, recognizing the desirability of automation systems to be able to effectively communicate globally; and
- interoperability of air-to-air systems, recognizing the need for airborne applications to be able to interact without restriction.

As part of ICAO's global strategy SWIM is a technology that will provide the platform for various information and applications. It addresses basic access methodologies and deals with security. As a platform it is the bases for the gradual migration of existing applications to this technology and will enable introduction of new and enhanced applications. On global scale a number of initial applications are already existing, such as the Eurocontrol Network Manager.

UAE Framework Recommendation

Technology	System Wide Information Management (SWIM)
Application	Infrastructure Platform for information exchange and application interconnection
Recommendation	The transition towards SWIM as a platform for new systems is encouraged.
Applicable Regulations	N/A
International Standards	EUROCONTROL Specification for SWIM Technical Infrastructure (TI) Yellow Profile
Recommended Practises	SWIM is an open platform and shall be used in conjunction with

3.5.1 Aeronautical Information Exchange Model (AIXM)

The objective of the Aeronautical Information Exchange Model (AIXM) is to enable the provision in digital format of the aeronautical information that is in the scope of Aeronautical Information Services (AIS). The AIS information/data flows that are increasingly complex and made up of interconnected systems. AIXM shall harmonise the presentation of digital information for aviation stakeholders.

This goes along with an increasingly automated environment, changing from the provision of paper products and messages to the collection and provision of digital data. AIXM supports this transition by enabling the collection, verification, dissemination and transformation of digital aeronautical data throughout the data chain, in particular in the segment that connects AIS with the next intended user.

AIXM takes advantages of established information engineering standards and supports current and future aeronautical information system requirements.

UAE Framework Recommendation

Technology	Aeronautical Information Exchange Model (AIXM)
Application	Data exchange of aeronautical information for the purpose of Aeronautical Information Services (AIS).
Recommendation	The implementation and support of AIXM as a harmonised means of data exchange is strongly encouraged. This shall not only be limited to publication of information but all systems requiring data from AIS should be able to import and process AIXM. Data exchange as a minimum should use XML encoded representation of AIXM data by file transfer. Where applicable static and dynamic AIXM should be made available and consumed via a SWIM enabled infrastructure.
Applicable Regulations	N/A
International Standards	AIXM 5.1 Specification

3.5.2 Flight Information eXchange Model (FIXM)

The Flight Information eXchange Model (FIXM) is intended to become a data model for the exchange of flight data in very much the same way as AIXM is for aeronautical data and WXXM is for weather data. FIXM, AIXM and WXXM should complement each other without overlap and high coherence. FIXM is particular should build upon the data available from AIXM.

FIXM is expected to consist of a core model and a set of extensions to the core model. Extensions may be defined by particular communities for particular needs. The core model will be restricted to those pieces of flight data that can be globally harmonised. And is expected to partially focus on data exchange with stakeholders that operate globally such as the airlines.

The combination of FIXM, AIXM and WXXM is expected to cover the majority of data that needs to be exchanged within ATM. To allow greater interoperability between different data domains the models are expected to be based on common foundations (modelling principles and basic data types).

UAE Framework Recommendation

Technology	Flight Information eXchange Model (FIXM)
Application	Data exchange of aeronautical information for the purpose of Aeronautical Information Services (AIS).
Recommendation	FIXM is a standard that is still developing despite the benefits that can be created even today. Any implementation of FIXM therefore needs to conscious of further developments in coordination with international aviation community. The transition to FIXM for new implementation is encouraged. Introduction of any FIXM applications shall consider the Yellow Profile to assure technical interoperability for the actual message exchange.
Applicable Regulations	N/A
International Standards	FIXM 3.1, FIXM 4.x

4 Framework Requirements for Navigation

4.1 Introduction

Navigation infrastructures are an important backbone of Air Traffic Service (ATS) alongside communication and surveillance systems. Navigation aids comprise legacy ground-based navigation aids such as Distance Measuring Equipment (DME) and VHF Omni-directional Range (VOR) to satellite-based navigation aids such as the Global Navigation Satellite System (GNSS).

Since the implementation of the Airspace Restructuring Project in 2017 Navigation infrastructure has to support the Performance-Based Navigation (PBN) supporting RNAV 1 specification. PBN is a global set of area navigation standards based on navigation performance and functionality required for the proposed operation. PBN concept encompasses two types of navigation specifications:

- **RNAV Specification –** Navigation specification based on area navigation that *does not* include the requirement for on-board performance monitoring and alerting, e.g. RNAV 5, RNAV 2 and RNAV 1.
- **RNP Specification** – Navigation specification based on area navigation that *requires* on-board performance monitoring and alerting, e.g. RNP 4, RNP 2 and RNP APCH.

Within the Emirates FIR the following ground-based navigation aids are considered.

- Distance Measuring Equipment (DME)
- VHF Omni-directional Range (VOR)
- Instrument Landing Systems (ILS)

4.2 Distance Measuring Equipment (DME)

DME is a ground-based navigation aids that helps the aircraft measure its distance from the DME station by timing the propagation delay in the radio signals sent between the station and the aircraft. In area navigation, the aircraft can use multiple DME signals to triangulate its position by utilizing multiple DME-distance measurements and the published locations of the stations. Thus, DME can serve as a contingency navigation aid supplementing GNSS and is also part of navigation infrastructure that supports PBN operations down to RNAV1 specification.

UAE Framework Recommendation

Technology	Distance Measuring Equipment (DME)
Application	Ground Based Navigation Aid
Recommendation	N/A
Applicable Regulations	N/A
International Standards	ICAO Annex 10 Volume I: Radio Navigation Aids

4.3 VHF Omni-directional Range (VOR)

VOR is a navigation aid that transmits VHF navigation signals 360° in azimuth angles. Using signal phase measurement comparison, the aircraft with a VOR receiver can determine its radial from the VOR ground station. When used in conjunction with a collocated DME and the published location of the station stored in the on-board database, the aircraft can determine its coordinate location and thus conforming to RNAV-5 specification. Additionally, VOR frequency may also be used for ATIS delivery.

UAE Framework Recommendation

Technology	**VHF Omni-directional Range (VOR)**
Application	Ground Based Navigation Aid
Recommendation	N/A
Applicable Regulations	N/A
International Standards	ICAO Annex 10 Volume I: Radio Navigation Aids

4.4 Instrument Landing System (ILS)

ILS is a navigation aid enabling precision approach and landing to a runway by a combination of horizontal and vertical guidance. The horizontal guidance signal is transmitted from a localizer (LOC) while vertical guidance signal is transmitted from a glide slope (GS); aircraft avionics process the information and present it as course deviation indicator on cockpit Primary Flight Display (PFD).

Currently, the ILS is the primary technology that enables precision approaches down to Category III limits. It is a proven technology that meets user requirements today and is still considered an essential navigation system where precision approaches are required.

5 Framework Requirements for Surveillance

5.1 Introduction

Surveillance system provides the aircraft position and other related information to ATC and/or airborne users. In essence the surveillance system used in ATC are sensors or communication links that provide aircraft position information and include means of identification to allow ATC.

To allow the implementation of a surveillance-based separations, such as 3-NM or 5-NM, uninterruptible and accurate surveillance needs to be provided. This can be achieved though having either a highly reliable single layer of surveillance sensors or multiple-layers forming a single highly reliable service.

Using surveillance data processing systems information from several sensors is integrated and consolidated to create a coherent positional information of all aircrafts, including current heading and speed information.

ATS surveillance systems can be classified in three categories, depending on how the aircraft signals are received and processed by the ground sensors;

- **Independent Non-Cooperative Surveillance**: The aircraft position is derived from measurement not using the cooperation of the aircraft. An example is a Primary Surveillance Radar (PSR).
- **Independent Cooperative Surveillance:** The position is derived from measurements performed by a local surveillance subsystem using cooperative aircraft transmissions. The Secondary Surveillance Radar (SSR) is an example of this category.
- **Dependent Cooperative Surveillance:** Dependent Cooperative Surveillance derives the aircraft position using subsystem on board the aircraft and the aircraft position is then provided to the local surveillance subsystem, possibly along with additional data. Automatic Dependent Surveillance – Broadcast (ADS-B) is an example of this category.

“Independent” or “Dependent” refers to how the aircraft position is measured; if it is from the ground it is Independent, or if the aircraft position is determined on-board then it is Dependent.

“Cooperative” or “Non-Cooperative” Surveillance refers to the requirement of aircraft equipment; if required, then it is Cooperative, if the surveillance does not require aircraft equipment then it is Non-Cooperative.

Technologies and procedures used for ATS surveillance are varied. This framework addresses the following technologies.

- Primary Surveillance Radar (PSR)
- Secondary Surveillance Radar (SSR) with Mode A, Mode C and Mode S
- Multilateration (MLAT)

- Automatic Dependent Surveillance – Broadcast (ADS-B).
- Automatic Dependent Surveillance – Contract (ADS-C)
- Primary Surveillance Radar (PSR)
- Surface Movement Radar (SMR)

5.2 Primary Surveillance Radar (PSR)

PSR is the only surveillance method that provides position information for Non-Cooperative aircraft. Primary radar surveillance operates by sending a signal and determining the azimuth and distance of an object from the radar site based on the direction the signal echo comes from and how long it takes to return.

By design PSR do not provide identification information together with the position data. Depending on the specifics of a PSR however may also provide information on weather conditions.

In the civil domain PSR systems are frequently co-counted with an SSR system sharing essential elements of the installation. In this case PSR signals supplement the SSR position information for aircraft reconfirming their position independently as well as detect non-cooperative aircrafts in the same airspace.

UAE Framework Recommendation

Technology	**Primary Surveillance Radar**
Application	Air Surveillance
Recommendation	**PSR shall be maintained where applicable.**
Applicable Regulations	CAR PART VIII
International Standards	ICAO Doc 4444 chapter 8 paragraph 8.5.3.3 ICAO Manual on Testing Radio Navigation Aids (Doc 8071); Volume III – Testing of Surveillance Radar System
Recommended Practises	Eurocontrol Standard Document for RADAR surveillance in En-Route airspace and Major Terminal Areas Eurocontrol Specification for ATM Surveillance System Performance

5.3 Secondary Surveillance Radar (SSR) with Mode A, Mode C and Mode S

SSR operates by the radar site sending an interrogation signal which triggers aircraft transponders to send replying signals. Replies are used to calculate aircraft position and provide additional information such as

identification and pressure-altitude reports. The “Mode” of the aircraft transponder determines the information that is sent in response to the interrogation.

Conventional SSR radars commonly support only very limited information to be part of the reply that includes a 12 bit code for identification (Mode A) and the barometric altitude (Mode C). The more modern Mode S (Selective Addressing) will provide for aircraft equipped with Mode S transponders their permanent and unique 24-bit ICAO address as well as additional information. For Mode S Elementary Surveillance (ELS) this includes aircraft identity (e.g. call-sign), altitude (in 25ft intervals), transponder capability, flight status (airborne or on-the-ground) and Surveillance Identifier (SI) code. It is important to note that Mode S radars are still able to support Mode A and Mode C assuring that surveillance is also assured for non-Mode S equipped aircraft.

Moreover, aircraft compliant with Mode S Enhanced Surveillance (EHS) provide the above ELS reporting functionalities plus some or all of the following downlinked aircraft parameters (DAPs):

- Selected Altitude - the flight level which is manually entered in the Flight Management System (FMS) by the pilot.
- Roll Angle, True Track Angle and Track Angle Rate - these parameters may be used to enhance the radar tracking capability and/or tactical trajectory prediction by ATC systems.
- Ground Speed - calculated aircraft speed relative to the ground.
- Magnetic Heading - the aircraft heading relative to magnetic north.
- Indicated airspeed (IAS) and Mach-number - Making this information available to ATCs supports separation provision tasks, reduces the R/T and hence ATC workload.
- Aircraft Vertical rate - barometric rate of climb / descent
- Traffic Collision Avoidance System (TCAS) downlinked resolution advisories (RAs).

Within the UAE the use of Mode S is encouraged. Furthermore CAR PART IV required no foreign registered operator of an aircraft fitted with ACAS II equipment shall undertake a flight unless equipped with a Mode S transponder compliant with Annex 10, Volume IV within the EMIRATES FIR.

UAE Framework Recommendation

Technology	**Secondary Surveillance Radar**
Application	Air Surveillance
Recommendation	**Conventional SSR should be maintained** **New SSR system shall should support Mode S**
Applicable Regulations	CAR PART VIII *CAR PART IV required no foreign registered operator of an aircraft fitted with ACAS II equipment shall undertake a flight unless equipped with a Mode S transponder compliant with Annex 10, Volume IV within the EMIRATES FIR.*
International Standards	ICAO Doc 4444 chapter 8 paragraph 8.5.3.3 ICAO Manual on Testing Radio Navigation Aids (Doc 8071); Volume III – Testing of Surveillance Radar System ICAO Annex 10 Vol 4: Aeronautical Telecommunications - Surveillance Radar & CAS
Recommended Practises	Eurocontrol Standard Document for RADAR surveillance in En-Route airspace and Major Terminal Areas Eurocontrol Specification for ATM Surveillance System Performance

5.4 Multilateration (MLAT)

MLAT is a cooperative surveillance technology based on the time difference of arrival principle. It is a technique where several ground receiving stations listen to signals transmitted from an aircraft; then the aircraft's location is mathematically calculated -- typically in two dimensions, with the aircraft providing its altitude.

Wide Area Multilateration (WAM) is a term commonly used to describe the surveillance of en-route airspace, while the abbreviation MLAT tends to be employed when discussing the monitoring of terminal airspace and in particular airport surface traffic.

UAE Framework Recommendation

Technology	**Multilateration**
Application	Air Surveillance Ground Surveillance
Recommendation	**WAM - The implementation and use of WAM is encouraged where a MLAT system for ground surveillance has a suitable coverage of the vicinity of the aerodrome.** **MLAT (Ground Surveillance) is encouraged at major aerodromes as part of A-SMGCS implementation**
Applicable Regulations	CAR PART VIII
International Standards	ICAO Doc 4444 chapter 8 paragraph 8.5.3.3 ICAO Manual on Testing Radio Navigation Aids (Doc 8071); Volume III – Testing of Surveillance Radar System ICAO Annex 10 Vol 4: Aeronautical Telecommunications - Surveillance Radar & CAS
Recommended Practises	Eurocontrol Specification for ATM Surveillance System Performance

5.5 Automatic Dependent Surveillance – Broadcast (ADS-B)

ADS-B is a surveillance technology by which an aircraft periodically and automatically broadcasts its horizontal and vertical position, its velocity and other aircraft data such as identification. The aircraft's ADS-B transponder uses inputs from airborne navigation sensors, including GNSS receivers, as sources for information on the aircraft's current position, accuracy and integrity performances. Ground stations receive ADS-B reports.

ADS-B uses the Extended Squitter generated by Mode S transponders. Rather than a ground system "requesting" an aircraft signal, on-board ADS-B transponders broadcast aircraft parameters, such as identification (24-bit address and flight identification as per the flight plan), position (latitude, longitude and pressure altitude), 3-D velocity and position integrity, via a broadcast-mode data link. Aircraft identification information is broadcast every 5 seconds while aircraft position and velocity data is approximately broadcast twice per second.

The frequency of position updates by ADS-B in comparison to PSR and SSR contributes to the quality of air surveillance as aircraft manoeuvre are quickly detected and can be tracked accurately.

It shall further be noted that most MLAT systems as well as some Mode S radars are capable to receive ADS-B signals and therefore can serve as ADS-B ground equipment.

The UAE mandated the use of ADS-B as of 2020.

UAE Framework Recommendation

Technology	**ADS-B**
Application	Air Surveillance
Recommendation	**The use of ADS-B as a means of air surveillance is encouraged.**
Applicable Regulations	CAR PART VIII
International Standards	ICAO Doc 4444 chapter 8 paragraph 8.5.3.3 ICAO Manual on Testing Radio Navigation Aids (Doc 8071); Volume III – Testing of Surveillance Radar System
Recommended Practises	Eurocontrol Specification for ATM Surveillance System Performance

5.6 Automatic Dependent Surveillance – Contract (ADS-C)

ADS-C provides information on aircraft position and identification information via a data link. To establish the data link the aircraft has to actively logon to the ATSU. The ATSU then may use the following position report types.

- Periodic contract;
- Demand contract; and
- Event contract.

Update frequency for ADS-C is low and does not support for 3 or 5 miles separation. As a means of surveillance ADS-C

UAE Framework Recommendation

Technology	ADS-C
Application	Air Surveillance
Recommendation	Not recommended to be use as a means of surveillance in Emirates FIR. Surveillance is achieved a multi/layer surveillance coverage.
Applicable Regulations	N/A
International Standards	N/A

In most cases, the position source for ADS-C reports is GNSS. The information is displayed to ATC and can also be used by automated flight tracking and monitoring systems. ADS-C reports are sent from the aircraft to ATC via a VHF or satellite data link and include position, velocity, intent, and weather.

5.7 Surface Movement Radar (SMR)

Surface Movement Radar (SMR) is radar equipment specifically designed to detect all principal features on the surface of an airport, including aircraft and vehicular traffic, and to present the entire image on a radar indicator console in the control tower. It is used to augment visual observation by tower personnel of aircraft and/or vehicular movements on runways and taxi-ways.

SMR and MLAT are typically the sensor technologies that used to implement A-SMGCS systems including dedicated tools and safety nets.

ICAO defines 4 levels of A-SMGCS implementation based on a complexity and traffic density approach:

- A-SMGCS Level 1 (improved Surveillance) makes use of improved surveillance and procedures, covering the manoeuvring area for ground vehicles and the movement area for aircraft. The procedures concern identification and the issuance of ATC instructions and clearances. The controllers are given traffic position and identity information which is an important step forward from the traditional Surface Movement Radar (SMR) image.
- A-SMGCS Level 2 (Surveillance + Safety Nets) adds safety nets which protect runways and designated areas and the associated procedures. Appropriate alerts are generated for the controllers in case of conflicts between all vehicles on runways and the incursion of aircraft onto designated restricted areas.
- A-SMGCS Level 3 (Conflict Detection) involves the detection of all conflicts on the movement area as well as improved guidance and planning for use by controllers.
- A-SMGCS Level 4 (Conflict Resolution, Automatic Planning & Guidance) provides resolutions for all conflicts and automatic planning and automatic guidance for the pilots as well as the controllers.

UAE Framework Recommendation

Technology	Surface Movement Radar (SMR)
Application	Ground Surveillance
Recommendation	The use of SMR highly contributes to the work of the ATC tower contributing to the situational awareness. In combination with an A-SMGCS this increases efficiency and safety.
Applicable Regulations	N/A
International Standards	N/A

5.8 Surveillance Data Sharing

Most surveillance sensor system provide substantially better operational coverage than actually required. This may result supported sensor range or vertical coverage. As a consequence the sensor provides coverage of airspace controlled by an adjacent ATSU that may use the surveillance data to enhance the overall surveillance performance in their airspace.

The sharing of Surveillance Data is made available to complement and enhance the quality of the individual air situation picture used by the ATSU. The sharing of surveillance data a common practise in many areas of the world. By sharing the surveillance data between adjacent Air Traffic Service units and fusing the data in locally integrated air situation pictures are enhanced.

To allow for easy data exchange surveillance data shall use the manufacture independent ASTERIX encoding that fully supports the exchange of multiple data streams for radar, ADS B, Multilateration, Weather Radar and processed air situation pictures together with associated and supplemental information.

For Surveillance Data sharing the ATSUs have to establish respective service levels in particular with respect to performance and quality criteria.

UAE Framework Recommendation

Technology	Surveillance Data Sharing
Application	Air Surveillance
Recommendation	Data Sharing needs to be supported by respective service level agreements that assures that surveillance performance Eurocontrol Guidelines for an agreement for the shared use of radar sensor data.and availability meets the minimal.
Applicable Regulations	N/A
International Standards	N/A

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