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AUTHOR	S.R.Dawes
	Signed.....
APPROVED	D Job
	Signed.....
APPROVED	M Bateson
	Signed.....
APPROVED	H-W Häfner
	Signed.....

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Drawing Office	Master
M Bateson	1
D Job	2
S.R.Dawes	3
H-W Häfner	4

Siemens Datatrak Location & Information Systems Limited., County Park, Shrivenham Road, Swindon, Wiltshire. SN1 2NR
Telephone: 01793 500100, Fax: 01793 500117

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1. SCOPE

Under Article 4.2 of the Radio and Telecommunications Terminal (R&TTE) Directive 1995/5/EC, Member States must ensure that Public Network Operators (PNO) publish all offered types of interface. Under the obligation of the directive, this document details the radio access interface for the Datatrak Network.

This document defines the applicable radio, EMC and safety test limits to which equipment using the Datatrak Network must be compliant.

This document contains a general description of the Datatrak Network and its major component parts with the aid of an accompanying diagram.

The radio access interface developed for the Datatrak Network is described in the document in sufficient detail to meet the requirements of Article 4.2 of the Radio and Telecommunications Terminal (R&TTE) Directive.

2. REFERENCES

The equipment must meet the following standards.

ETS 300 113 – Technical Characteristics and Test Conditions for Radio Equipment Intended for the Transmission of Data and Having an Antenna Connector.

ETS 300 279 – Electromagnetic Compatibility (EMC) standard for Private Land Mobile Radio (PMR) and ancillary equipment (speech and/or non-speech)

EN60065 1998 – Safety Requirements for Mains Operated Electronic and Related Apparatus for Household and Similar General Use

The equipment must meet the basic requirements of the R&TTE Directive 99/5/EC. The equipment has been declared under annex IV of the Directive.

3. DEFINITIONS, SYMBOLS AND ABBREVIATIONS

5k	The 2-level FSK over-air channel data rate for the TWD system
10k	The 4-level FSK over-air channel data rate for the TWD system
ACK	Acknowledgement, a packet type used in the messaging protocol
ATB	ACK To Base, an ACK or NAK transmitted by a Mobile to a Base Station
ATM	ACK To Mobile, an ACK or NAK transmitted by a Base Station to a Mobile
AVL	Automatic Vehicle Location, a generic name applied to the mobile positioning system and the positioning data packets
bps	Bits per second, a measure of the signalling speed of a communications link
bit	A binary digit, which can take the value of 0 or 1
byte	A group of 8bits which represent a data character
CC	Central Computer
CRC	Cyclic Redundancy Code/Checksum
Cycle	A 1/64th sub-division of the 108second Datatrak timing sequence, equal to 1.68 seconds.
DCX	Data Concentrator eXchange,

DTB	Data To Base, a messaging frame transmitted by a Mobile to a Base Station
DTM	Data To Mobile, a messaging frame transmitted from a Base Station to a Mobile
EMC	Electro Magnetic Compatibility
Fixed User	A line connection to the Datatrak network
Frame	A term used to describe a portion of a two way data message. Within the Datatrak Network each two way data message is divided into manageable units or 'frames'. A message can be made up of between one and seven frames.
FSK	Frequency Shift Keying
Gold Code	A symbol pattern used for symbol clock synchronisation
Guard Period	A timing pause, usually to allow for hardware switch on/off times.
LF	Low Frequency
Message	A block of user data of between 1 and 245 bytes, typically a collection of between 1 and 7 TWD packets
MDLU	Mobile Data Locator Unit
MDT	Mobile Data Terminal
Mobile User	An over-air connection to the Datatrak network
NAK	Negative acknowledgement, a packet type used in the messaging protocol
NET	NETwork packet, a network information frame transmitted by the base station
Packet	A generic term that describes a block or unit of data of a controlled size and format. In terms of the Datatrak Network, this data can be a position or alarm update (AVL), an ACK (acknowledgement) or the frame of a TWD message.
R&TTE	Radio and Telecommunications Terminal Equipment
RC	Regional Computer
Region	An ‘area’ of coverage of the Datatrak network, i.e. where the Base Stations link to a single Regional Computer.
TDMA	Time Division Multiple Access
TWD	Two Way Data; a generic term describing the messaging capability of the Datatrak system.
UHF	Ultra High Frequency

4. BACKGROUND INFORMATION

4.1 INTELLECTUAL PROPERTY RIGHTS

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All tradenames/trademarks and associated marks of Siemens Datatrak Location & Information Systems Limited mentioned in this document have to be acknowledged and intellectual property rights relating thereto must be respected.

4.2 CONTACTS

Any questions that may arise from the content of this document, please contact:-

Steve Dawes
Siemens Datatrak Location & Information Systems Ltd
Wiltshire House
County Park
Shrivenham Road
Swindon
Wiltshire
SN1 2NR

Tel: +44 (0)1793 500100
Fax: +44 (0)1793 500117

e-mail: steve.dawes@siemens-datatrak.com

4.3 SPECIFICATION UPDATES

Siemens Datatrak will notify all NRA's via the in country PNO of any updates to this specification. Updates will also be posted on the following Siemens Datatrak web site:-

www.siemens-datatrak.com

5. DESCRIPTION

This document describes the radio access interface of the Datatrak UHF Data Network. This network is used by Datatrak customers to transmit and receive sensitive information, often related to security or emergency applications.

5.1 NETWORK SCHEMATIC

The diagram above shows that the Datatrak system is actually built from a number of separate networks, each fulfilling a specific role :-

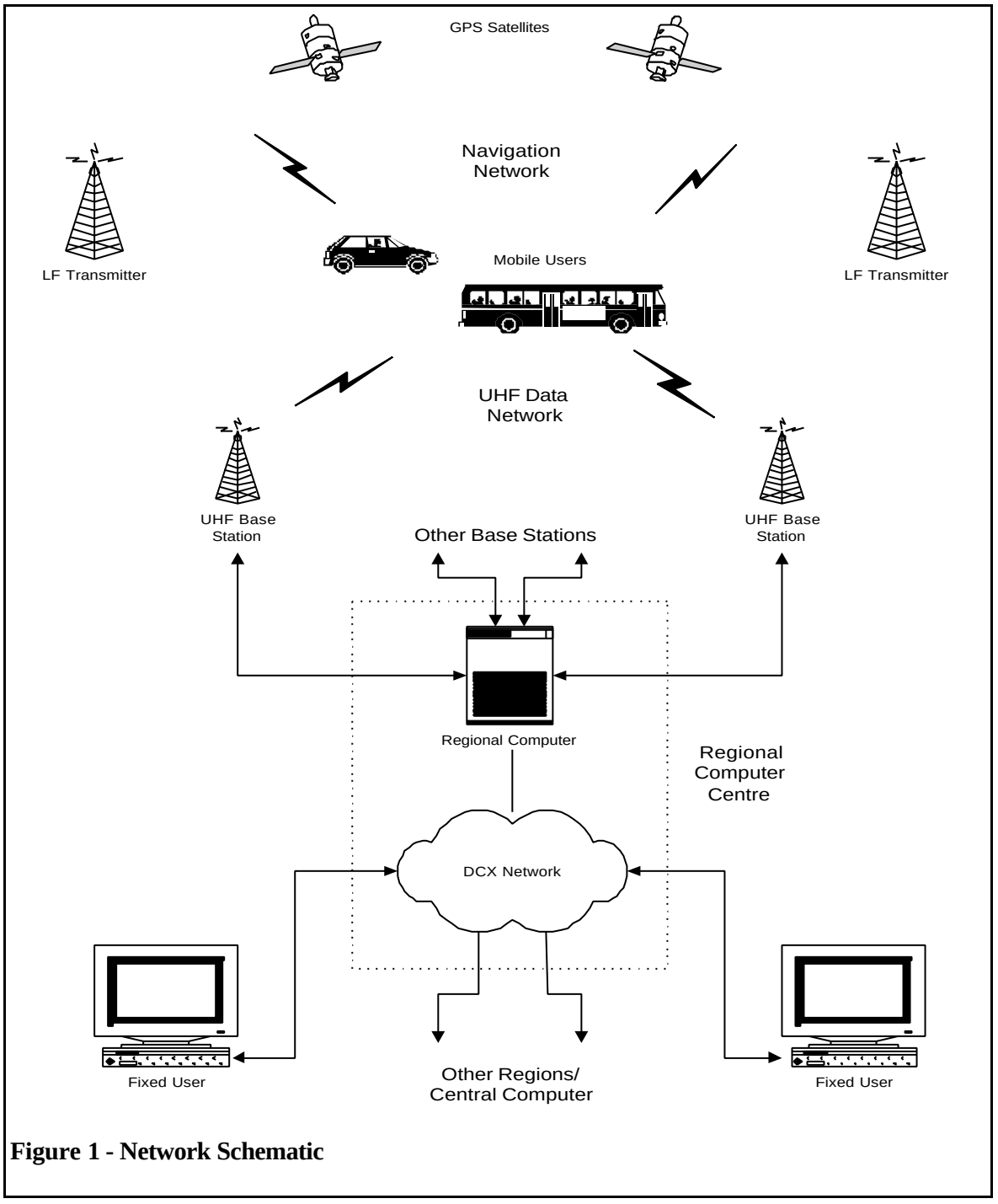


Figure 1 - Network Schematic

- The **LF Navigation Network** provides the main positioning capability for the Datatrak network, as well as time synchronisation for users of the UHF network. This Navigation Network may also be augmented by GPS to provide wide area coverage.
- The **UHF Data Network** provides the capability for data to be transmitted to and from Mobile Users, via a network of Base Stations. The UHF network is typically split into Regions, each containing a number of Base Stations connected to a Regional Computer system. Each group of Base Stations provides overlapping radio coverage for the region
- A **Regional Computer** (RC) provides the gateway between a region of the UHF network and the 'fixed' data network. Each Regional Computer controls the data received and transmitted from the Base Stations in its region. It also controls the routing of data to and from Fixed Users and other regions, via a connection to the DCX Network.
- The **DCX Network** (Data Concentrator/Exchange) is a WAN (Wide Area Network) and provides the reliable means for data to be transferred between each element of the fixed data network, i.e. between Regional Computers, Central Computer and Fixed Users.
- The **Central Computer** (CC) provides inter-region messaging and system control facilities within a country's network.

5.2 MOBILE DATA LOCATOR UNIT

Each Mobile user on the network is fitted with a Mobile Data Locator Unit (MDLU), which is a fully integrated Datatrak LF navigation receiver and UHF data transceiver.
The MDLU uses the LF radio signals to obtain time synchronisation and to compute a hyperbolic grid position based on lines of equal phase difference. This position is then converted to either a map grid reference in eastings and northings, or a position in latitude and longitude.
Once the vehicle's position has been obtained, the MDLU transmits this position, together with status information, in its allocated time slot via the UHF network.

The MDLU can also receive and transmit short data messages to and from other Fixed and Mobile users. Formatted messages are passed to and from the MDLU via the dedicated communications port. The MDLU then handles the exchange of data packets over the UHF radio network. Feedback is given to the user, as to whether the message has been successfully or unsuccessfully received into the network via the Base Stations.

5.3 RADIO ACCESS INTERFACE

The radio access interface for the Datatrak Network interface has been developed specifically for providing a spectrum efficient Automatic Vehicle Location and Two Way Mobile Data service for a high number of users.
Each UHF 12.5kHz channel dedicated to the Datatrak Network is divided in time, into 1.68s Cycles, each containing a number of discrete data "slots" as shown in the diagrams below. These timing slots are used for the transmission of AVL(Automatic Vehicle Location), TWD (Two Way Data) and NET (NETwork) packets between mobiles and base stations.
Each user of the network then accesses the channel on a time division multiplexed basis (TDMA). All mobiles using AVL transmissions are allocated a unique time slot of 12ms or 24ms, dependant on the selected data rate, at binary multiples of the timing cycles, giving update rates of between 1.68s and 28minutes. For the transmission of an AVL packet, or any other packet type, the user has the whole channel allocated to them during the unique time slot.

To allow users to achieve this type of access, time synchronisation is provided via the LF Navigation network. A number of transmitting stations within the network are designated as “trigger” stations, and will transmit an encoded signal indicating time zero of the UHF 1.68s Cycle. All users must then track this synchronisation signal to a resolution of +/- 1ms.

5.4 UHF DATA PACKETS

There are three main UHF data packet types used throughout the network; these are AVL, TWD and NET. These packets are shown on the format diagram on the following pages.

The UHF data packets can either be transmitted at a data rate of 5kbps or 10kbps depending on either, the application for the case of AVL packets, or Network service level in the case of the TWD packets.

AVL Data Packets

AVL data is originated from an MDLU only (i.e. from a Mobile User), and is automatically routed through the network to one or more Fixed Users. These packets are uni-directional and require no acknowledgement from the destination.

The data packets themselves are either regular position updates, event generated alarm packets or for some applications contain user configurable data. There are a number of different formats for the vehicle data but usually it consists of a scaled position, status information, speed and direction (*Vehicle Data* field in the packet format diagrams below).
The format of the position information depends on the country of operation; either a grid reference as an easting/northing value in metres, or a latitude/longitude value.
The 5K AVL packets also contain the MDLU address, which allows the packets to be transmitted on a random basis, rather than in a predefined time interval for the 10K AVL packets.

TWD Packets

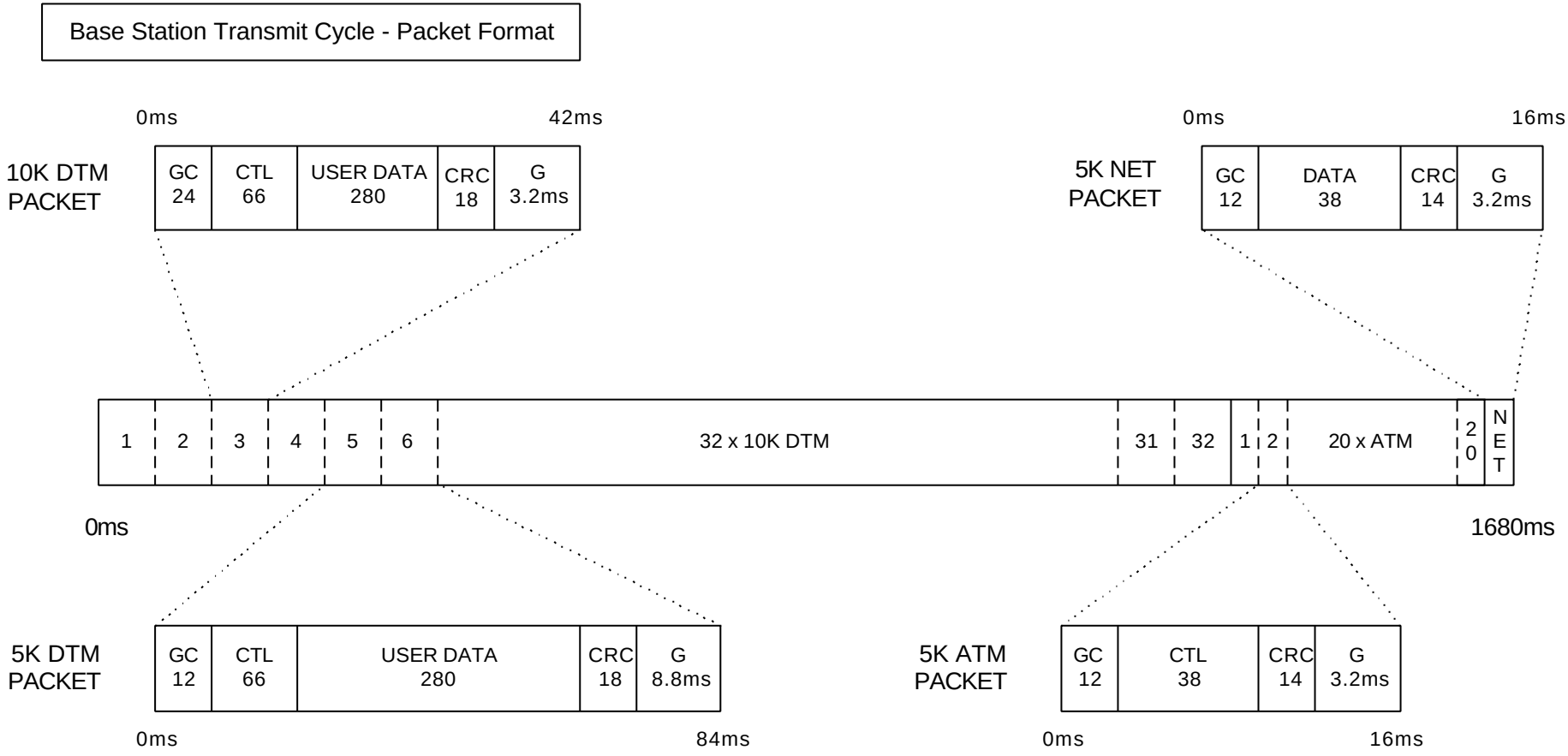
There are two main TWD messaging packet types, data frames (DTM and DTB) and acknowledgements (ATM and ATB). These provide the building blocks for the messaging protocols used throughout the Datatrak network.

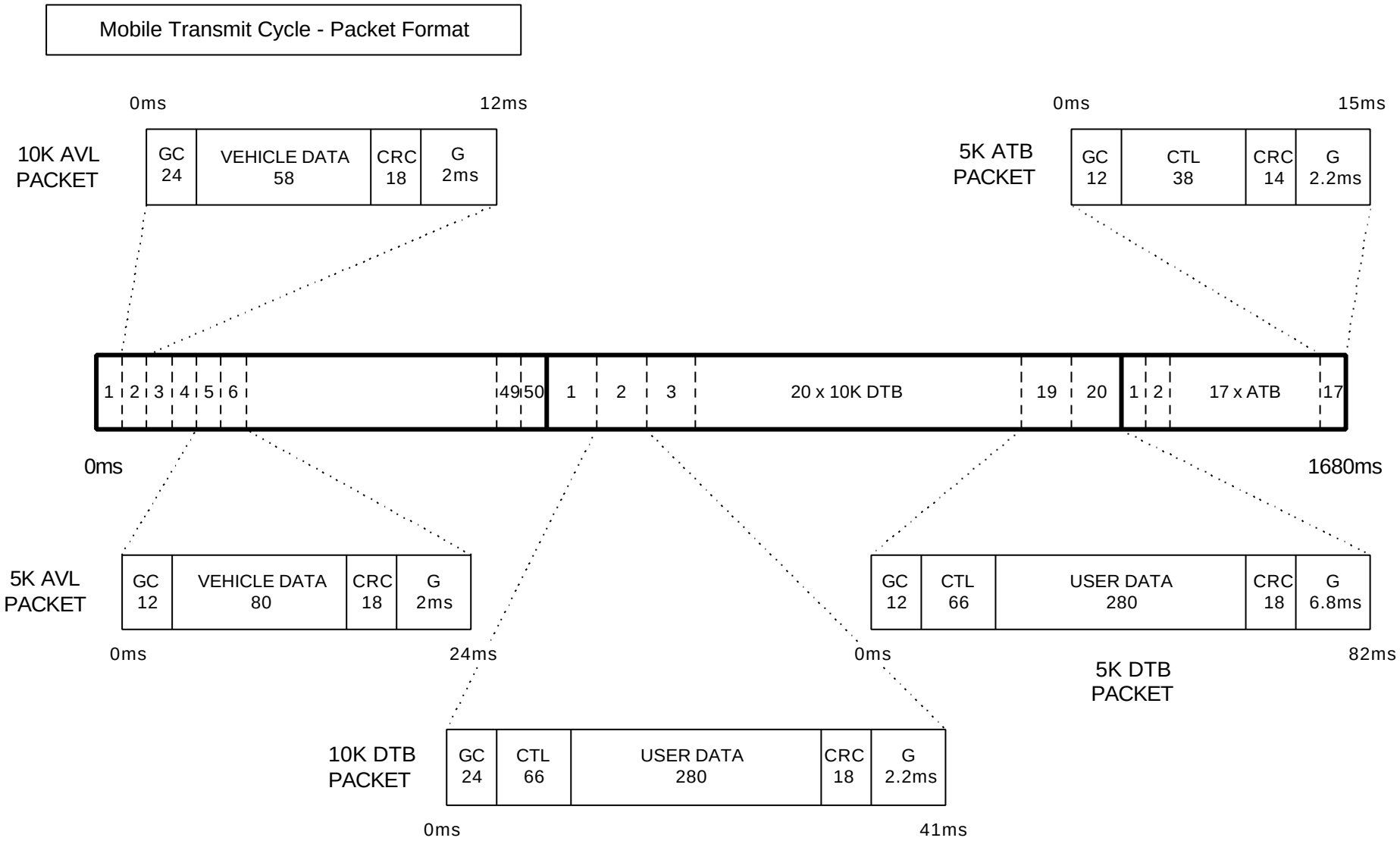
User’s messages are broken down into a sequence of up to *seven* frames for transmission through the network. Each frame can contain a maximum of 280 bits (35 bytes) of user data, giving a maximum message length of 245 bytes. In addition to the raw message data, each data frame contains message control information, e.g. source id, destination id, etc., and frame control information, e.g. data type, data length, frame id, etc. These packets can be transmitted at either the 10kbps or 5kbps data rate depending on the network service level available to the mobile at the time.
Each DTM and DTB packet also contains fixed information comprising source/destination address and network protocol control data (*CTL* field in the packet format diagrams below) to try to ensure the successful delivery of messages in a mobile environment.

Acknowledgement packets (ACKs) and Negative Acknowledgements (NAKs), are used to indicate various success or failure conditions to a message originator. These packets are only transmitted at the 5kbps data rate.
Again each ATM and ATB packet also contains fixed information comprising unit address and network protocol control data (*CTL* field in the packet format diagrams below).

NET Packets

The NET packet is used to transmit system timing and network information from each base station to all mobile users. The cycle in which a base station transmits this slot is determined by the RC, so that 2 base stations in the same region, cannot transmit at the same time. These packets are only transmitted at the 5kbps data rate.


Base Station Transmit Cycle - Packet Format
0ms
42ms
10K DTM PACKET
GC 24
CTL 66
USER DATA 280
CRC 18
G 3.2ms
0ms
16ms
5K NET PACKET
GC 12
DATA 38
CRC 14
G 3.2ms
1
2
3
4
5
6
32 x 10K DTM
31
32
1
2
20 x ATM
20
NET
0ms
1680ms
5K DTM PACKET
GC 12
CTL 66
USER DATA 280
CRC 18
G 8.8ms
0ms
84ms
5K ATM PACKET
GC 12
CTL 38
CRC 14
G 3.2ms
0ms
16ms


Mobile Transmit Cycle - Packet Format
0ms
12ms
10K AVL PACKET
GC 24
VEHICLE DATA 58
CRC 18
G 2ms
0ms
15ms
5K ATB PACKET
GC 12
CTL 38
CRC 14
G 2.2ms
1 2 3 4 5 6
49 50
1 2 3
20 x 10K DTB
19 20
1 2
17 x ATB
17
0ms
1680ms
5K AVL PACKET
GC 12
VEHICLE DATA 80
CRC 18
G 2ms
0ms
24ms
GC 12
CTL 66
USER DATA 280
CRC 18
G 6.8ms
0ms
82ms
5K DTB PACKET
10K DTB PACKET
GC 24
CTL 66
USER DATA 280
CRC 18
G 2.2ms
0ms
41ms

6. UHF RADIO PARAMETERS

6.1 OPERATING FREQUENCIES

The channel frequencies allocated for the Datatrak UHF Network within Austria are as follows:-

Chan.	*Base Tx (MHz)*	*Base Rx (MHz)*
1	460.4250	450.4250
2	460.5375	450.5375
3	460.1375	450.1375
4	460.1500	450.1500

The MDLU transmitter design has an alignment range of 431.5MHz to 469.5MHz. The receiver design is available in 2 bands, 447MHz to 457MHz and 451MHz to 461MHz.

The Base Station equipment is limited to 1MHz bands due to the “roofing” filters used in the design. The transmitter design however has an alignment range of 455MHz to 465MHz, and the receiver design can be tuned over the range of 450MHz to 465MHz.

6.2 CHANNEL SEPARATION

The equipment is designed for 12.5kHz channel separation.

6.3 RADIATED POWER

The output power from the MDLU is 10W (measured at the antenna socket).

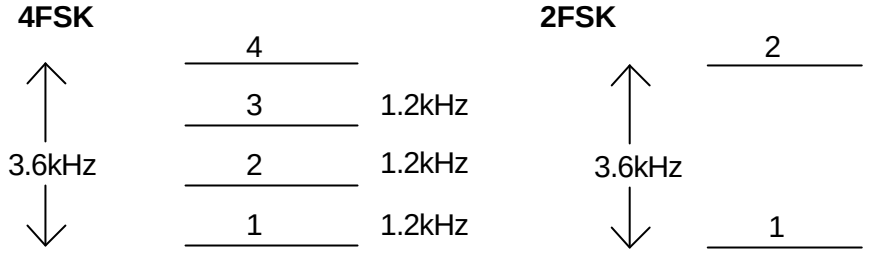
For the Base Station the maximum E.R.P. is 10W.

6.4 DATA RATE

The Datatrak UHF Network operates at two data rates, 5k bits per second and 10k bits per second (bps).

6.5 MODULATION

There are two types of modulation used on the Datatrak UHF Network. For the 10k bps data rate Quarternay Frequency Shift Keying (QFSK) or 4-level FSK (4FSK) as it is more commonly known, is used. For the 5k bps data rate, Binary 2-level FSK (2FSK) is used. Both types of modulation can exist on the same channel, as the peak symbol deviation remains the same, as shown in the diagram below, and the packet lengths are simply doubled if a 5k bps packet is selected, i.e. one 5k packet = two 10k packets.



The above diagram shows the frequency deviation levels, in Hz, used for both 2FSK and 4FSK modulation. As the diagram shows, 2FSK modulation only uses the two outer levels of the 4FSK scheme (levels 1 and 4).

The ITU designation for this type of modulation is F1D.

6.6 MODULATION BANDWIDTH

The modulation bandwidth is:-
4kHz at -3dBc
6kHz at –20dBc

6.7 APPLICABLE STANDARDS

Both the Mobile and Base Station equipment are designed, and independently tested, to meet the relevant requirements of ETS 300 113 (Technical Characteristics and Test Conditions for Radio Equipment Intended for the Transmission of Data and Having an Antenna Connector).

7. MOBILE UHF TRANSMIT CONTROL

All equipment that uses the UHF network must receive the time synchronisation signals (trigger signals) broadcast by the Low Frequency Navigation Network before transmitting. Once time synchronisation has been acquired, the equipment can then transmit in pre-allocated or reserved time slots as shown in the diagrams above. The Mobile equipment will also transmit, only when they are within the permitted operating geographical boundaries (geofence) i.e. within Austrian territories. Geofence data is also broadcast by the Low Frequency transmitters and received by the Mobile equipment. This data is then compared with the Mobile's computed position to enable or disable UHF transmissions.
If the Locator fails to receive the time synchronisation signals (trigger signal), or the signal degrades below strict quality limits, then it will not transmit.

8. LOW FREQUENCY RADIO PARAMETERS

8.1 OPERATING FREQUENCIES

The LF transmitters operate at 2 frequencies between 130kHz and 170kHz. The separation between the 2 frequencies is typically between 9% and 11% of the lowest frequency, which generally works out to be about 13kHz.
The precise operating frequencies allocated to the Datatrak Network are not published in this document for security reasons.

8.2 CHANNEL SEPARATION

The LF transmitter operates in a 500Hz channel.

8.3 RADIATED POWER

The maximum radiated power (EIRP) is 500W.

8.4 MODULATION

The time synchronisation signals, and data transmitted by the LF stations use a very narrow band, low speed Phase modulation.

The ITU designation for this type of modulation is Q8X.

8.5 MODULATION BANDWIDTH

The modulation bandwidth is :-
300Hz at –3dBc