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Part 6: Air-Ground-Air

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Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Terrestrial Trunked Radio (TETRA).

The present document is part 6 of a multi-part deliverable covering Terrestrial Trunked Radio (TETRA); Voice plus Data (V+D); Designers' guide, as identified below:

ETR 300-1: "Overview, technical description and radio aspects";

ETR 300-2: "Radio channels, network protocols and service performance";

TR 102 300-3: "Direct Mode Operation (DMO)";

ETR 300-4: "Network management";

TR 102 300-5: "Guidance on numbering and addressing";

TR 102 300-6: "Air-Ground-Air".

1 Scope

The present document is written as a "Read-me-first" manual or "Getting started with TETRA Air-Ground-Air". It is not intended to be a guide to the TETRA Air-Ground-Air standard nor an authoritative interpretation of the standard. If any conflict is found between the present document and the corresponding sections in the TETRA standard then the standard takes precedence.

The reader of the present document is assumed to have a working knowledge TETRA technology. The guidance provided in the present document is prepared with the experience of implementing an Air-Ground-Air to an existing national network.

The aims of the present document are:

- to introduce and detail the different aspects of Air-to-Ground communication in a TETRA network;
- to show the reader that Air-Ground-Air is an integral part of a TETRA network when required;
- to provide the reader with sufficient knowledge to engage in qualified discussions with the equipment and service suppliers;
- to expose the reader to the specific language and technical terminology used in the present document;
- to enable the reader to understand the flexibility in system design, system network topography, system availability, various modes of operation and security features;
- to provide basic guidance on optimising a TETRA network when including an Air-Ground-Air element.

The present document provides guidance on the requirements for an Air-Ground-Air service and how best to implement an AGA service.

2 References

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the reference document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at http://docbox.etsi.org/Reference.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

2.1 Normative references

The following referenced documents are necessary for the application of the present document.

Not applicable.

2.2 Informative references

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] ECC/DEC/(06)05: "ECC Decision of 7 July 2006 on the harmonised frequency bands to be designated for Air-Ground-Air operation (AGA) of the Digital Land Mobile Systems for the Emergency Services".

[i.2] ETSI EN 300 392-2: "Terrestrial Trunked Radio (TETRA); Voice plus Data (V+D); Part 2: Air Interface (AI)".

[i.3] ETSI EN 300 392-7: "Terrestrial Trunked Radio (TETRA); Voice plus Data (V+D); Part 7: Security".

[i.4] TETRA MoU - TTR 001-16: "TETRA Interoperability Profile - Part 16 (Air to Ground)".

[i.5] ITU-R Recommendation P.528-2: "Propagation curves for aeronautical mobile and radionavigation services using the VHF, UHF and SHF bands".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

path delay function: cell reselection initiated by path delay

NOTE: The time taken for signal to perform a round-trip between the MS and Cell is known as the "Path Delay". When this time exceeds a preset value the SwMI informs the MS that maximum path delay is exceeded and causes the MS to initiate cell reselection.

Preferred Location Area (PLA): set of cells MS prefers against other cells

NOTE: A number of Location Area Codes may be programmed into the MS. The MS on receiving one or more of these LAs in the neighbour list of the cell it is affiliated to will "prefer" to use the cell associated with one of those LAs. Mobility to and away from such cells is defined in EN 300 392-2, clause 18 [i.2] and TETRA Interoperability Profile 16 [i.4]. PLAs may also be known as "Home Location Areas".

RF carrier: distinct radio frequency on which radio channel may be active

Subscriber Class (SC): subdivision of the subscriber population

NOTE: There are 16 subscriber classes defined for use on TETRA networks. Those 16 classes are divided into 3 groups, Highly Preferred Subscriber Class, Preferred Subscriber Class and (Basic) Subscriber Class. Mobility between the 3 groups of subscriber class is defined in EN 300 392-2 [i.2] and TETRA Interoperability Profile 16 [i.4].

V+D operation: mode of operation for communication via the TETRA V+D air interface which is controlled by the TETRA Switching and Management Infrastructure (SwMI)

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AGA	Air-Ground-Air
AGA_MS	Air-Ground-Air Mobile Station
AGL	Above Ground Level
ATG	Air To Ground (Also A2G)
BS	Base Station
DC	Direct Current
DMO	Direct Mode Operation
ECC	Electronic Communications Committee
EIRP	Equivalent Isotropic Radiated Power
EMC	ElectroMagnetic Compatibility
HF	High Frequency
HPSC	Highly Preferred Subscriber Class
LA	Location Area
MCCH	Main Control CHannel
MMI	Man Machine Interface
MS	Mobile Station
PD	Packet Data

PLA	Preferred Location Area
PSC	Preferred Subscriber Class
PSS	Public Safety Spectrum
PTT	Press To Talk switch, otherwise known as pressel
RF	Radio Frequency
RSSI	Radio Signal Strength Indication
RX	Receive
SC	Subscriber Class
SwMI	Switching and Management Infrastructure
SWR	Standing Wave Ratio
TMO	Trunked Mode Operation
TX	Transmit
TX/RX	Transmit/Receive
V+D	Voice plus Data (trunked infrastructure)
VHF	Very High Frequency

4 What is different about Air-Ground-Air operation and why do we need it?

4.1 General

TETRA radio networks are, in the main, built to provide communications where most subscribers are operating terminal equipment at sea or at ground level. There are a number of users, however, whose communication needs require operation at thousands of feet above ground level.

Air-Ground-Air (AGA) operation, also known as Air-To-Ground (ATG or A2G) is a TETRA radio service designed to provide communication between radio users operating from airborne assets and ground based operatives including radio users and dispatchers. The airborne assets typically will be comparatively small in number operating comparatively infrequently. However once they are operational their effectiveness is highly valued.

Most TETRA radio networks are primarily designed as a cellular network providing a land-mobile radio service, so significant design changes have to be implemented to service the requirements for effective AGA use.

The AGA service is provided by deploying an overlay network of Radio Cells or "Air Cells" that provide the user with communications typically from 500 feet (150 m) upwards.

4.2 Spectrum

The spectrum for AGA use is reserved solely for AGA purposes. There are several reasons for this, including;

- Radio channels are a scarce resource. Fortunately they can be re-used at a distance. This is possible due to the path loss caused by distance, landscape and buildings. In land-mobile networks the re-use distance is typically 50 kilometres due to the high path loss of landscape and buildings. Path Loss at altitude is much less than at ground level. Transmitting at altitude on a land mobile network would result in interference on several land-mobile basestations that re-use the same radio channel. The EU-wide network plan, see annex A, if followed closely will minimise co-channel interference to acceptable levels. An internationally agreed frequency allocation is easier to implement to minimise interference between networks, refer to ECC/DEC/(06)05 [i.1].

- A small number of widely spaced radio cells supplying service for AGA purposes.

- The cells will radiate at lower power than cells used in the ground network.

5 Technical Design

5.1 Concept of Overlay Network

Due to the limited range of RF signals radio networks normally have a cellular structure where channels are re-used at a regular distance. If the terrestrial network with typical cell sizes of 8 km radius were planned in such a way that it allowed aircraft communications at normal operational attitudes for public safety or private mobile radio users, then we would require more than 1 000 channels to avoid co-channel interference. As the available spectrum will support many fewer channels, this is clearly a non-viable technical solution. An efficient means of using the available spectrum is outlined in the following paragraphs.

Operators should answer this by deploying two networks - one optimised for terrestrial use and a second network designed for airborne radios.

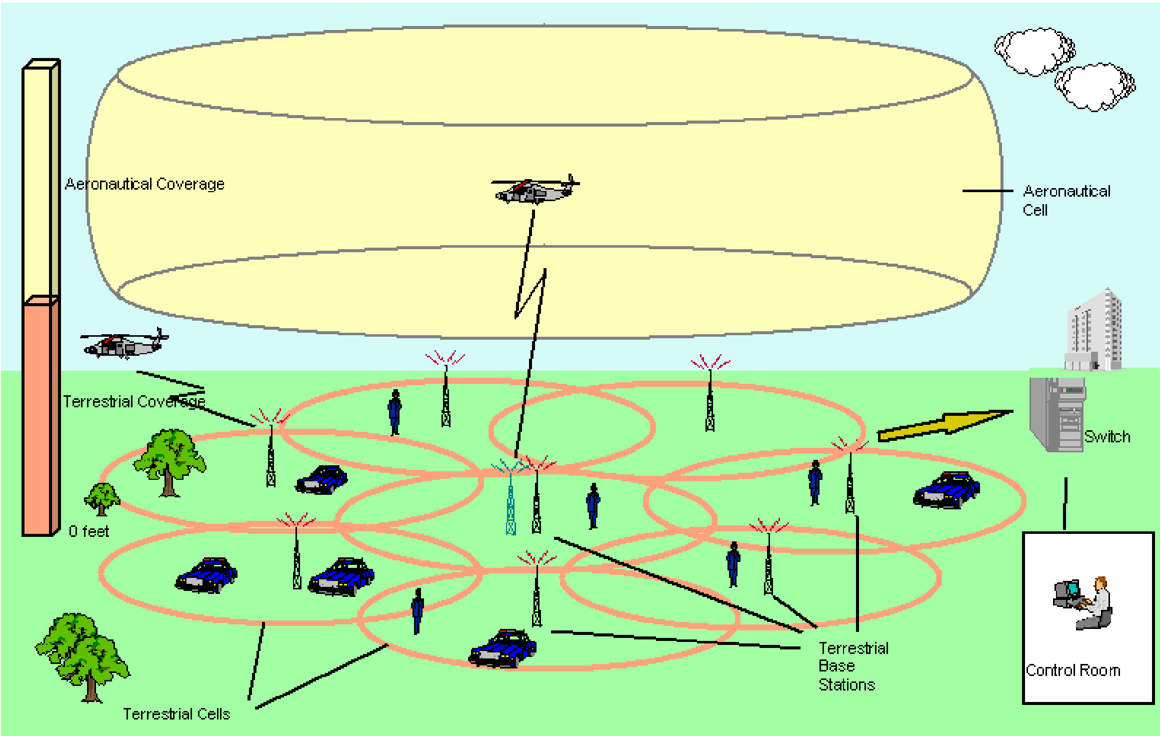

Figure 1: Terrestrial and Air-Ground-Air network

The terrestrial network is planned to the normal guidelines, whilst the AGA network is frequency planned specifically to allow for long frequency re-use distances. In order to maintain spectral efficiency, the AGA cells, here after referred to as "Air Cells" are spaced wide apart and typically have only a single RF carrier at each radio cell.

AGA terminals will roam seamlessly across the two networks without user intervention. The terminals design for use in the AGA service will additionally prefer to use the AGA network, utilising mobility management techniques described later. Similarly, terrestrial terminals will be restricted to the ground network using the same techniques. As both networks will offer the same services and facilities, the user (either ground or Air-Ground-Air) is not expected to be aware of which network they are using.

The operational design is that the aircraft radio(s) will use the terrestrial network from ground level to an altitude where the AGA signal is received at the value "Radio Usable"; to prevent co-channel interference to ground cells the handover to an air cell should occur before an altitude of 500 feet (150 m) is achieved.

On descent, the operational design is that the aircraft radio(s) will use the AGA to an altitude where the AGA signal is received at the value "Radio Relinquishable" and a ground cell signal is received at a stronger level; this design ensures the aircraft radios are most likely to select the local ground cell. Again, this is to prevent co-channel interference to ground cells the handover from an air cell should occur at a low altitude, considerably less than 500 feet (150 m).

All radio cells are configured to broadcast information that allows suitably configured terminals to identify the network type that they belong to them and to handover to the appropriate radio cell. This assumes that certain other conditions are met; for instance, minimum received signal strength.

5.2 Spectrum Allocation

With ECC/DEC/(06)05 [i.1] a quantity of spectrum has been reserved for public safety AGA operational purposes in the PSS allocation. This reserved sub-band is the upper end of the PSS allocation. It consists of 8 channels reserved exclusively for AGA operations and an additional 2 optional ones to be utilised on the operators needs.

Figure 2 illustrates the European-wide harmonised spectrum layout for public safety networks.

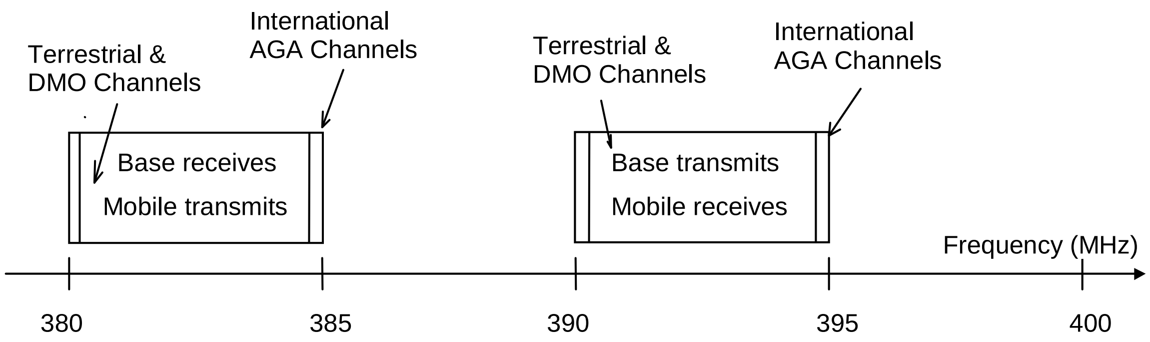

Figure 2: European Harmonised Spectrum Allocation in the 380 MHz to 400 MHz frequency range for Public Safety

5.3 Non-Harmonised Frequencies

Where the service requirements of individual operator or country calls for extra AGA RF carriers are required these additional carriers for AGA use, these carriers will have to be allocated from the terrestrial sub-band then consideration to exported interference to neighbour authorities and operators be undertaken as part of the planning process. It is worthwhile reviewing those frequencies when setting up bilateral agreements between countries.

5.4 Cell Operational Size

Clause 4.2 describes why the operational footprint of an air cell is much larger than a ground cell as in "free space" the path loss is much less. Due to line-of-sight propagation the usable signal from an air cell can extend hundreds of kilometres, depending on altitude; such distances will take the signal a finite time to cover those distances. It is important that the round-trip time of the signal taken to transit between the BS and MS should not exceed the guard time between timeslots.

5.5 Neighbouring

To allow smooth cell reselection in the AGA network and smooth switching between the terrestrial and the AGA network neighbour cell relations have to be defined in the TETRA network.

The neighbouring for AGA purposes needs to be considered in 3 ways.

Unlike the neighbouring for terrestrial cells where the cell to cell neighbouring is normally limited to the immediate, contiguous, neighbouring cells and is reciprocal this is not true of neighbouring to and from air cells. This is due to there being many more ground cells compared to air cells in any network.

Cell neighbouring type 1 - Ground cell to air cell (as known as "Upwards" neighbouring);

> All ground cells that are under the operational area of an air cell should list that air cell in its neighbour list broadcast. If a ground cell is located where more than one air cell may provide service then all these air cells may be included in the neighbour list.

Cell neighbouring type 2 - Air cell to air cell (as known as "Sidewards" neighbouring);

Neighbouring air cell to air cell should list the immediate or contiguous neighbours only, typically no more than eight dependent upon frequency reuse pattern, ground terrain and the number of air cells.

In mountainous regions air cells may be located below the level of the surrounding hills and so may not have truly circular coverage.

Cell neighbouring type 3 - Air cell to ground cell (as known as "Downwards" neighbouring);

Neighbouring from air cell to ground cell should use the following recommended priority order:

1) The ground cell that serves the operating or home location (air field, helipad) of aircraft that operate within the air cells area.

2) Any other regularly used airfields or helipads within the air cells area.

3) A selection of ground cells using different frequencies to the above sites dispersed at intervals within the air cells area. This will allow a better transition to the ground network throughout the air cells operating area. Typically the operating authority will chose no more than 20 ground cells for inclusion in the broadcast neighbour list.

5.6 Subscriber Class

The following information explains how Highly Preferred Subscriber Class operation can be used to aid aircraft communications.

Subscriber class 2 has been adopted and documented in EN 300 392-2 [i.2] and TETRA Interoperability Profile 16 [i.4] as the recommended subscriber class value for AGA operations therefore AGA radios should be configured to be member of Subscriber Class 2, which is defined in EN 300 392-2 [i.2] and TETRA Interoperability Profile 16 [i.4] as a Highly Preferred Subscriber Class (HPSC). Ground radios should be configured not to be member of Subscriber Class 2. Subscriber class 1 is also a HPSC value; typically this subscriber class value will be used for other purposes.

Ground cells should normally be configured to broadcast that they do not support HPSC or PSC classes of subscriber class, but only normal Subscriber Classes, typically SC14 or SC16 only. Air Cells should be configured to broadcast support for the Highly Preferred Subscriber Class SC2.

When an aircraft departs, the AGA radio will most probably be registered to a Ground cell. The Ground cells broadcast neighbour list will contain at least one air cell identity including its subscriber class (flag 2, HPSC). The AGA radio monitoring the neighbour cells will, once the received signal of the air cell has reached "Radio Useable" for over 5 seconds, roam to the air cell even if, or when, the present serving ground cell is received at higher signal strength. For full guidance refer to EN 300 392-2 [i.2].

Air cell to ground cell reselection, i.e. as the aircraft lands, should take place when the air cell received signal strength falls below "Radio Relinquishable" for more than 5 seconds. The radio should select one of the cells specified in the received neighbour list and select the strongest received signal. If the neighbour list contains a PSC cell then the radio terminal should select that cell provided the received signal strength is over Radio Useable in preference to lower priority subscriber class cells that may be received at higher signal strengths.

The selection of Subscriber Class methodology will require the operator to cause the air cell to broadcast SC2 only and ground cells to not broadcast SC2. The aircraft MSs will only require the appropriate subscriber class values, SC2 and the terrestrial cell subscriber class value(s) setting in the MS configuration. There is no limit to the number of cells, due to constraints in MS design that may be used for AGA purposes within a network.

Additional air cells added to a network will not require commensurate programming work to the MSs.

5.7 Preferred Location Area

The following information explains how Preferred Location Area operation may be used to aid aircraft communications.

Aircraft MSs, if capable in the MS design, may be programmed with a number of LAs; these LAs are known as PLAs. In this case the PLAs programmed into the MSs will be those LAs of air cells.

The number of PLAs that can be programmed into a MS is limited to, typically, between 20 and 32 LAs.

When an aircraft departs, the AGA radio will most probably be registered to a Ground cell. The Ground cells broadcast neighbour list will contain at least one air cell LA. The AGA radio monitoring the neighbour cells will, once the received signal of the PLA cell has reached "Radio Useable" for over 5 s, roam to the air cell even if, or when, the present serving ground cell is received at higher signal strength. For full guidance refer to EN 300 392-2 [i.2].

Air cell to ground cell reselection, i.e. as the aircraft lands, should take place when the air cell received signal strength falls below "Radio Relinquishable" for more than 5 s. The radio should select one of the cells specified in the received neighbour list and select the strongest received signal.

The selection of Preferred Location Area methodology does not require the network operator to cause the air cell to broadcast differing (subscriber class) values to ground cells. The limited number of PLAs that may be loaded into a MS will limit either the total number of air cells in an operator's network or limit the operational area of aircraft MSs within a network; should an aircraft venture outside of that area with working radios it should be expected that the aircraft radios will attach to terrestrial cells with the likelihood of causing interference to terrestrial cells over a wide area.

However, should additional air cells be added to an operators network then all MSs used in aircraft will have to be re-programmed to add the additional PLAs to the MS programmed configuration.

5.8 Subscriber Class or Preferred Location Area

The previous 2 clauses describe two different means of identifying the air network from the ground network; a choice of HPSC or PLA, one or the other should be employed only. Both methods offer the same MS roaming performance from terrestrial cell to air cell and air cell to terrestrial cell.

Whilst the choice of air cell selection is left to the discretion of the operator the choice of using subscriber class methodology has benefits with the ease of implementation, network expansion and MS programming. The use of PLA methodology may have a benefit in a small network.

5.9 Radio Handovers

In the terrestrial network, handovers take place when the RSSI on the radio's serving cell drops to a pre-determined level, coupled with a neighbouring cell that has a RSSI that is stronger than the serving cell by a specified margin.

Handovers between the ground network and the AGA "overlay" network will occur, in accordance with the operating description for HPSC or PLA in references EN 300 392-2 [i.2] and TETRA Interoperability Profile 16 [i.4].

Once affiliated to the air cell, there are few obstructions to the signals from AGA radio cells so two unusual characteristics appear:

- Normal RSSI based handovers are less likely to occur in air cells when compare to the ground based network due to the limited effects of terrain and clutter on the radio path and the likelihood of hitting the maximum Path Delay criteria before finding an adjacent air cell of sufficient signal to perform a handover to.

- Roaming to other air cells is expected to be by Path Delay functionality. In this case the radio upon transmitting, when over the defined distance from the serving cell, will receive a "Maximum Path Delay Exceeded" message from the network causing the radio to initiate cell reselection procedures. The "Path Delay Factor" is the TETRA parameter which defines when the Maximum Path Delay Exceeded message is sent and it is this that, for timing reasons, dictates the maximum size of a TETRA cell.

This means that the typical method of cell handover between AGA cells is not by normal terminal reselection but by the action of forced rejection from the serving cell and subsequent attachment to the highest ranking neighbour cell.

It is possible that the aircraft radio may not receive a suitable signal from a ground cell as helicopters can land anywhere and there are a limited number of neighbours available in the broadcast neighbour list of the serving air cell. If, exceptionally, no suitable frequency is received then the radio should remain affiliated to the serving air cell until "radio link failure" is encountered upon which the radio should perform a scan for a suitable cell.

5.10 AGA Cell Aspects

5.10.1 Antenna Type

It is recommended that the antennas for AGA service use are zero downtilt colinears with 6 dBi gain.

Typically AGA radio cells will have a single TX/RX antenna. However it is recommended that the site should be equipped with a second antenna for use as a "Hot Spare" for added resilience. (This may also be helpful to site performance if it can be used for receive diversity).

Some collinear antennas are of such a design that they have built in lightning protection and can replace lightening protectors; consideration should be given to the use of them for replacing the lightening protector where this improves the antenna location on the mast.

5.10.2 Shared Antennas

It is strongly recommended that antennas used for terrestrial radio cells are not shared with AGA sites.

In exceptional circumstances it may not be possible to add an additional antenna to the existing mast. In this case the preferred solution is to replace one of the diversity receive antennas on the site (assuming the site has these) with a zero downtilt antenna recommended above and use this antenna for the AGA radio cell. The effect of this on the terrestrial site clearly needs to be taken into account, however depending on the design of the radio cells it may still be possible to use this antenna for diversity use by connections at the appropriate places in the receivers. If the existing antenna of the terrestrial site has downtilt, removal may give coverage or interference problems and the likely impact of this change assessed before implementation.

5.10.3 Antenna location on masts

To enable cell reselection in the large AGA cells great care should be taken to create a circular radiation pattern for the AGA cell. Wherever possible the AGA antenna should be located at the top of the mast and ideally be the only one. If sole use of the mast top is not possible then the minimum number of other antennas may be allowed with the greatest possible separation.

Where the antenna has to be located on the side of a mast then the maximum stand-off should be utilised for installation and preferably be located in its own aperture. Where the mast is of closed construction, or has wide flat sheet type cable tray risers or many feeder cables within the mast construction then another location should be sought. If not, degradation in system performance should be expected on the sides away from the one which the antenna is mounted on.

5.10.4 Feeder Types and Design Rules vs. Length

Feeder types will match the types already in use by the network operator's design.

5.10.5 Antenna Mounting Arrangement

It is expected that the radio cell antenna mounting arrangements are specified by the operators in co-ordination with the mast manufacturers and site owners.

The mounting design should provide a stable, secure attachment to the mast or mast head which takes into account the prevailing wind speed and direction at the site.

Antenna mounting should be as vertical as possible (i.e. ±1 deg error).

5.10.6 Base Radio RF Parameters

The signal between a radio cell and an aircraft mobile station is not subject to the same degree of attenuation as between a radio cell and a terrestrial mobile station. This may usefully allow the network operator to run the radio cell at a lower transmit power level than might be used in a terrestrial cell. A maximum transmit power of 10 W (+40 dBm) into the antenna is recommended.

5.10.7 Reselection Parameters

The reselection parameters used on an AGA network are likely to be different to those used on the terrestrial network. Clause 5.10.6 discusses that the signal is subject less attenuation in the air and the basestation operates at a lower transmitter output power. To compensate for that lower transmit power the TETRA parameter "Minimum Receive Access Level" may be usefully be set to a lower value than is used on the operators terrestrial network.

Similarly the parameter "Maximum Mobile Station Transmit power" can be set to a lower value, typically +30 dBm. This reduction in these values will reduce interference to other mobile stations and basestations.

By setting the "ACCESS_PARAMETER" a value greater than that broadcast by the operators' terrestrial cells will aid in reducing interference.

Also affected by the reduced attenuation is the ability of the aircraft mobile station to roam between AGA cells by received signal strengths is inhibited. The solution described in TETRA Interoperability Profile 16 [i.4] handover between AGA cells is caused by the "round trip time" for the signal to travel the distance from the radio cell to mobile station and back. Once this time exceeds the "Path Delay Factor" value BS informs it to the MS and the mobile station will initiate a cell handover. The value is set to align with the mobile station capabilities and typically corresponds to a distance from radio cell to mobile station of 83 km.

A guide to determining the "Fast Reselection Threshold" parameter value is to select a value that sets the "Radio Relinquishable" value at the coverage reliability planning level. The intention of that is to ensure the radios can roam at the appropriate signal level to the terrestrial network.

When selecting values for the "Fast Reselection Hysteresis" and "Slow Reselection Hysteresis" parameters it is suggested that consideration is given to the effects on the signal caused by the aircraft body in shadowing the signal path between basestation and mobile station as the aircraft, particularly helicopters, perform turns and the manoeuvre. Such effects may be particularly apparent with multiple radio installations in aircraft.

As previously discussed, handover between air cells is normally initiated by Path Delay Function the "Slow Reselection Threshold" parameter value does not need to be a large value and may be selected such that roaming to a ground cell occurs at a similar level to "Radio Relinquishable".

5.11 AGA network planning

5.11.1 General design considerations for an AGA network

The design for an AGA network plan should consider the following factors:

1) When an aircraft is at operational altitude the signal path is normally, "line of sight", therefore path losses due to "clutter" can be disregarded. At large distances from the basestation and/or at lower altitudes the situation is different. There the signal path extends beyond the horizon where path loss quickly increases.

2) The radio cell used for AGA operations can operate at a lower transmit output power than terrestrial cells.

3) Few frequencies are available for AGA operations hence a frequency re-use plan of 7 channels is normal.

4) The flying speeds of the aircraft of up to 300 km/h.

5) The operating area of an AGA radio cell is large, typically 50 km radius.

6) Affects of antenna "Cross Polarisation" due to the aircraft changing attitude whilst climbing, banking and descending.

Due to the low number of available channels minimising interference caused by co-channel noise requires greater consideration than the possibility of exceeding the reference sensitivity level at the edge of coverage of a cell. The larger cell operational radius has a benefit in reducing such interference.

Additionally the Uplink (aircraft MS to radio cell) link budget includes:

1) The mobile stations when attached to an AGA cell will be operating at a maximum MS transmit power of 30 dBm.

2) The radio cell may not have diversity on the antenna system.

5.11.2 International Frequency Co-ordination

Due to line-of-sight propagation the signal from an AGA user can extend hundreds of kilometres. Therefore a careful, internationally coordinated, planning of AGA channels is necessary. The ECC has harmonised 8 channels with another two preferred extension channels for AGA purposes, refer to ECC/DEC/(06)05 [i.1].

Due to the large signal range and the limited number of available channels it is not possible to plan AGA networks on a national basis. Therefore international agreement is also needed on how and where to use the channels.

Belgium, The Netherlands and UK collaborated on behalf of the TETRA Association and prepared a pan-Europe AGA radio plan using a seven-cell frequency reuse pattern. In this way the 8^{th} channel (plus the two preferred extension channels) are available for cross or close border use or for additional capacity as required.

The operator or licensing authority should negotiate a Memorandum of Understanding with neighbouring countries to minimise the risk of mutual interference.

5.11.3 Design of the pan-European AGA radio plan

The goal was to:

- Design an AGA network based on a 7-cell frequency reuse pattern.
- Allow switching between terrestrial network and AGA network at altitudes of 500 feet.
- Allow interference-free communications (i.e. $\text{Carrier/Interference}_{\text{Static}} > 10$ dB) at flying altitudes as high as possible.

The typical link budget calculation for an AGA network is in table 1.

Table 1: Typical AGA link budget

Link budget AGA			
BS antenna: 5 dBi omnidirectional		**AGA MS antenna: 0 dBi omnidirectional**	
Downlink BS - AGA_MS		Uplink AGA_MS - BS	
BS TX power	40 dBm	AGA_MS TX power	30 dBm
Combiner loss	0 dB	Body loss	0 dB
Duplexer and directional coupler loss	0 dB		
Feeder and connector losses	2 dB	Cable and connector losses	1 dB
BS TX antenna gain	5 dBi	AGA_MS antenna gain	0 dBi
BS TX EiRP (20 W)	43 dBm	AGA_MS TX EiR	29 dBm
AGA_MS sensitivity (dynamic)	-103 dBm	BS sensitivity (dynamic)	-106 dBm
		Duplexor and Splitter loss	0 dB
Cable and connector losses	1 dB	Feeder and connector losses	2 dB
Body loss	0 dB	Diversity gain	0 dB
Margin due to reflection and obstructions	0 dB	Margin due to reflection and obstructions	0 dB
Man-made noise margins	0 dB	Man-made noise margins	0 dB
AGA_MS RX antenna gain (at edge)	0 dBi	BS antenna gain (at edge)	5 dBi
Nominal signal at AGA_MS antenna	-102 dBm	Nominal signal into BS RX antenna	-109 dBm
Maximum allowed downlink path loss	145 dB	Maximum allowed downlink path loss	138 dB
NOTE: There is 7 dB difference between down and uplink. The extra power in the downlink will ease handover from the landmobile to the air layer.			

The calculation shows that the allowable path loss in the AGA network is 138 dB.

ITU-R Recommendation 528-2 [i.5] and simulations using the Longley-Rice Irregular Terrain Model, see below, predict that at 500 feet the combination of propagation beyond the horizon and terrestrial clutter between basestation and the AGA user limit the reliable radio range to 50 km. This was confirmed by measurements.

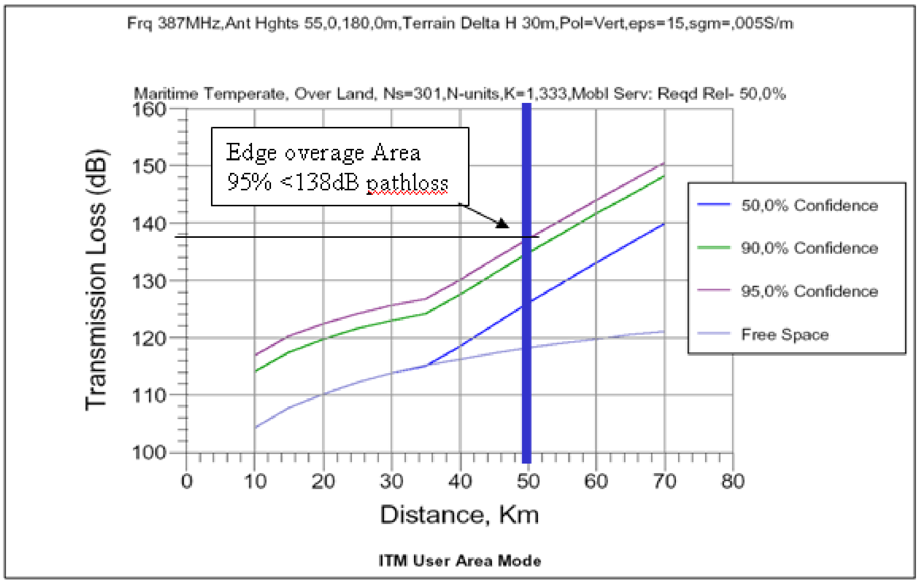

Figure 3: Path loss

The re-use distance in a seven-cell pattern with 50 km cell radius is 50 x √(3 x 7) = 229 km.

ITU528-2 and simulations using the Irregular Terrain Model (Longley-Rice) predict that in a cellular network with a re-use distance of 229 km at the cell edge of the serving cell the C/I protection will drop below 10 dB at altitudes above 4 000 feet AGL.

Annex A provides the resulting pan-European AGA radio plan, listing the WGS84 coordinates of centres of the AGA cells. To allow co-location of AGA basestations with existing terrestrial basestations an implementation circle of 20 km around the centre is available.

The coverage may include operation over the sea up to the international limit out from the coast.

The coverage limit is controlled by timing constraints that are a feature of the TETRA protocol. For AGA use the TETRA Air Interface standard EN 300 392-2 [i.2] specifies extended range with an operating distance from the radio cell to 83 km. Extended range allows for the combination of 50 km cell radius, sufficient room and time for cell reselection and the 20 km implementation room described above.

5.11.4 Characteristics of the pan-European AGA radio plan

The pan-European AGA radio plan is based on the following:

- channels 3793 to 3799 are used in a 7-channel pan-European re-use pattern with 50 km cell radius, detailed in annex A;
- channels 3790, 3791 and 3792 are available for coordination along borders and use in special areas;
- co-location of AGA basestations with existing terrestrial basestations within a 20 km implementation circle around the centre listed in annex A;
- effective antenna height of the AGA site: 55 m to 100 m;
- transmitted power of the AGA site: 20 Watt EIRP;
- support of extended range in the AGA mobile and basestation.

The AGA network based on the plan has the following characteristics:

- service on the AGA cell from 500 feet at the cell edge, to a lower altitude at the centre of the AGA cell;
- service on the AGA cell up to 4 000 feet at the cell edge, up to a higher altitude closer to the centre of the AGA cell.

6 Configuration

6.1 Capacity Planning

Capacity planning for the AGA network does not follow the normal planning rules associated with the terrestrial network. Due to the likelihood of limited spectrum availability for air-ground communications, there may be no limits on the queuing allowed at any one radio cell. Instead, radio cell capacity will have to be agreed between network operator and users or user's representatives.

In the frequency plan described in clause 6.1.1 the spare channels may be available to add capacity to a limited number of cells.

6.2 System Restriction Control

The network operator should configure the network such that the SwMI should reject attachment attempts from terrestrial MSs to air cells. Attachment by a terrestrial MS originating an Emergency Call to an air cell when no other cell is available may be permissible.

6.3 User Priority

User priority may be a useful facility when a talkgroup suffers from high levels of activity and the Air borne user take control of the talk group to impart command intelligence. However, it does not necessarily offer pre-emptive priority.

Emergency call function should use pre-emptive priority.

6.4 Security

The AGA network should comply with the operators security standards. Operators should refer to their own requirements, standards, documentation and EN 300 392-7 [i.3].

6.5 Packet Data

Packet data services may be supported on all AGA sites. It is recommended that the service is supported using dynamic Packet Data channel allocation. The dynamic PD functionality may be selected to give priority to either voice or PD depending upon the requirements of the network operator or user.

It is unlikely that Multi-slot data will be supported on AGA cells due to capacity constraints.

You need a policy - either use AGA throughout the doc or AGA but not both!

6.6 Resilience

The AGA network normally uses one carrier in each radio cell. Therefore the network cannot have a resilient or second carrier available to maintain service should the active radio cell transceiver fail. It may be possible that the radio cell transceiver equipment can be duplicated, using the same frequency, with the second transceiver maintained in a standby state to be brought into service when the main transceiver fails.

6.7 Radio Cell Fallback Strategy

AGA sites will be configured so that if the connection between the SwMI and the cell is disconnected the cell will reject attachment attempts or alternatively stop radiating to ensure communications are possible via operational terrestrial radio cells. Such service should be regarded as "Incidental" as aircraft may receive signals from more than one radio cell using the same frequency.

In the event of a wide area network failure, AGA terminals will move to the terrestrial network. This will allow airborne users to have limited communication with units on the ground.

6.8 Exception Conditions

There will be occasions where an AGA terminal can only receive signals from AGA sites that are greater than the min Rx access level but all exceed the path delay threshold. This might happen when the most appropriate serving cell is shadowed or if the radio cell fails.

Under this condition, the radio will search around all of the neighbouring AGA radio cells. Once it has been rejected by the AGA sites, the terminal will attach to a terrestrial radio cell. The radio will remain attached to the terrestrial network until service is restored at the local air cell, or the aircraft moves into the footprint of a neighbouring AGA cell where the radio will receive a new neighbour list from a ground cell containing a new air cell identity.The neighbour list broadcast of the terrestrial cell that the aircraft MS is attached to contains detail on the service state of the air cell(s).

This method of working requires careful selection of the following parameters:

- Subscriber Class information.
- Site adjacency information.
- Min Rx access level for each cell.
- Path Delay threshold of both the AGA and terrestrial cells.

7 Airframe considerations

The environment in an aircraft may be considered to be very harsh to radio equipment both physically and electrically. The airframe is likely to have limited space for antennas to be located. The actual antenna positions are likely to be closer than is optimal to prevent interference between equipments. Radiation patterns are often altered from the ideal or expected on airframes to the detriment of the service.

It should be expected that there will be considerable vibration therefore a larger than normal MMI is of value to the aircrew for ease of operation. Integration of the audio output and inputs with the aircraft communication system is essential.

7.1 Mobile Stations - General

Radio terminals for use in aircraft may vary from handhelds in car cradles to specifically designed units. All MSs for airborne use should support adaptive and system specified power control, Subscriber Class functionality or Preferred Location Area functionality.

7.1.1 Mobile Stations - Aircraft specific MSs

MSs specifically designed to appropriate standards for installation in aircraft are available.

Aircraft specific MSs have the following characteristics to improve usability in aircraft:

- Large MMIs.
- Night Vision Goggles capable.

- Large button keypad with positive action and "de-bounce".
- Duplicate controllers.
- Multiple radio control availability.
- DO160 D/E environmental qualification.
- Standard Aircraft cockpit mounting compatibility.
- Easily integrates aircraft audio system.
- Quick and easy exchange of components.
- Extra filtering to reduce the possibility of interference to and from other aircraft radio equipment.

MSs of this type should be the preferred radios for use in aircraft.

7.1.2 Multiple Mobile Stations

Aircraft may have several TETRA radios installed for role specific purposes along with (HF & VHF) analogue radios for aircraft operational purposes. Whilst audio from all radios should be available to all members of the aircrew the controls may not be. Purpose designed aircraft TETRA radio terminals may have multiple control facilities to allow control of individual radios from two or more locations within the aircraft.

Using several mobile stations with their antennas in close proximity can be a problem due to the possibility of one mobile transmitting in the same time slot as another is receiving. Some extra filtering may be provided in custom aircraft radio equipments but this will not help with interference between the radio equipments on the same frequency band. The high levels of RF from a transmitting mobile may exceed the blocking level defined in EN 300 392-2 [i.2] of the other mobile's receivers and the wideband noise from the transmitter defined in EN 300 392-2 [i.2] may cause co-channel interference. Both effects will cause receiver desensitisation. To bring both these effects to the level where they are not causing receiver desensitisation can typically require 50 dB to 60 dB of isolation which is difficult to obtain using the antenna spacing likely on an airframe. One solution to this is to use a single antenna with an isolating RF combiner to reduce the number of antennas required. This will add losses into the RF signal path and these are to be accounted for in the link budget calculations. These losses may not be as big an issue in the AGA service as they might be in the terrestrial service due to the lower propagation losses. The mobile transmitter power may also be increased to compensate for the loss. Some loss in the AGA receiver input may also be beneficial in reducing the large signal levels that may be obtained from nearby terrestrial sites and the resultant receiver blocking and intermodulation problems that may result. A problem with these RF combiners can be their weight and sensitivity to vibration.

Where individual antennas have to be used for each radio they should be placed as far apart as possible to achieve the best possible isolation. This may not be enough to bring the isolation up to the required levels, some problems with receiver desensitisation may be expected. This is likely to take the form of a receiving radio losing the control channel or dropping a call under low signal level conditions such as at a cell edge or when the aircraft turns, tilting the airframe so that the antenna is on the side of the aircraft distant from the cell site when another radio is transmitting.

7.1.3 Mobile Stations - Hand Held equipments

Although not recommended (for mechanical and MMI reasons) hand-Held MSs used in car mounting cradles may be an option for installation into aircraft. Where this practice is adopted the cradles should be installed where all the principle (primary) users of the aircrew can access the MMI easily. The car cradle should be suitable for the aircraft DC power circuit (typically 28 volts) or a DC to DC converter, to supply power at the correct voltage for the car cradle, will need to be installed as part of the TETRA radio system. The audio inputs and outputs from the car cradle breakout box should be connected to the aircraft communication system at appropriate levels; corrective or matching circuitry should be employed as necessary.

The car cradle should supply an antenna connection to an antenna which radiates on the outside of the aircraft body. The integral antenna of the hand held mobile station should, where possible be removed and replaced by a blanking plug. The installed handheld MS + cradle should not allow any RF radiation from the handheld antenna and/or connector circuitry during a transmission within the cockpit/cabin area. The ideal system should disconnect the handheld antenna automatically when the handheld MS is fitted to the cradle and automatically connect to the aircraft external antenna.

If this installation practice is adopted then it should be expected that each aircraft requires certification (see clause 7.2.5).

The use of Hand Held MSs in aircraft without connection to an external antenna should not be practiced under any circumstances.

7.1.4 Mobile Stations - Vehicle MSs

MSs designed for use in car vehicles may also be an option for installation into aircraft. To enable vibration-proof installation of the radio unit and easy access to the MMI it is recommended to employ a version with a remote control head. Where this practice is adopted the MMI should be installed where all the principle (primary) users of the aircrew can access it easily. The installation will require a DC to DC converter to be installed as part of the TETRA radio system. The audio inputs and outputs from the vehicle MS should be connected to the aircraft communication system at appropriate levels; corrective or matching circuitry should be employed as necessary.

If this installation practice is adopted then it should be expected that each aircraft requires certification (see clause 7.2.5).

7.1.5 Emergency Call Operation

MSs installed in aircraft should be capable of originating Emergency Calls, however the function will have operating differences to terrestrial MSs. Those differences are no "hot mike" function; requiring the aircraft operator to operate the PTT to talk to others in the talkgroup.

7.2 Mobile Station Configuration

The MS should meet the TETRA conformance specification for a maximum of Mobile Power Class 3 (i.e. 3 Watt nominal) and, at least, Receiver Class B when operational in TMO.

In countries or regions where the licensing authorities allow DMO operation from aircraft the MS should be capable of having the DMO TX power configured by the programming tool; the DMO TX power for DMO TGs used from a flying aircraft should be set at +15 dBm.

Configuration of the AGA Mobile Stations will usually be the terrestrial radio parameter set but with the following exceptions or additions.

7.2.1 Subscriber Class operating methodology configuration

- AGA subscriber class should be used - identified as subscriber class 2.
- Subscriber class 2 should be provisioned into the MS as an additional subscriber class value where the radios will operate on both terrestrial and air service layer and switch between the layers.
- Subscriber class 2 should be solely provisioned where the MS will only operate on the air service layer.

7.2.2 Preferred Location Area operating methodology configuration

- Subscriber class setting not needed.
- The Location Area Codes of the network's air cells should be provisioned into the MS where the radios will operate on both terrestrial and air service layer and switch between the layers.

7.2.3 Common operating methodology configuration

- Support of extended range up to 83 km.
- It is advantageous to be able to program the MCCH frequencies of the operator's air cells into the MSs in addition to the operators downlink frequency band.

NOTE: This procedure expedites service recovery if an AGA MS is restarted when at operational height.

7.2.4 Aircraft Antenna Configuration

Antenna type recommended: Vertically polarised $\lambda/4$.

Cable/connector losses = 2 dB.

The antennas should be mounted on recommended aircraft manufacturers antenna fixing points as these points should have a suitable "ground plane" designed into the bodywork. Where the bodywork is a non-conductive composite a suitable "ground plane" should be affixed to the inner of the body panels and correctly bonded to the airframe ground.

Antennas on aircraft with multiple radio installations should have the antennas widely dispersed around the aircraft body to minimise the possibility of mutual interference. Consideration should be given as to the use of the radios as communications will be necessary both on the ground and in the air. Therefore antennas on both the upper-side and lower-side of the body will be needed to enable good communications from different MSs that may be selectively used in the air and on the ground.

7.2.5 Certification

Operation of TETRA MSs in aircraft will require some form of EMC testing once the installation is complete. Such testing requirement will be guided by the country the aircraft are operational in, aviation safety requirements, the aircraft manufacturers' requirements and the type of MSs installed.

For guidance; any type of MS installed will require aircraft EMC testing to comply with airworthiness certification after the installation work has been completed. The testing will normally take place in a specific order:

1) The installed antennas will be tested for performance and connectivity, e.g. SWR and Isolation.

2) The aircraft will be connected to a "ground power" source and the aircraft powered up. The radios will be switched on and the aircraft systems tested with the MSs firstly in idle, then receiving and finally transmitting.

3) The transmitting tests will take place at least 3 frequencies, bottom, top and mid-point of the frequency band; normally with the MSs operating in DMO and Transmitting at +35 dBm or higher if the licensing authority allows. Post testing and before the aircraft is allowed to become operational the programming of the radio will be changed to reduce the DMO TX power.

4) If the tests in paragraph 2 above are successful and observed not to affect the aircraft systems then they will be repeated on aircraft power i.e. engines running at operational speed but on the ground.

5) If the tests in paragraph 4 are successful and observed not to affect the aircraft systems then they should be repeated with the aircraft airborne; with rotary wing aircraft (helicopters) the airborne tests should take place with the aircraft about 1 metre off the ground; with fixed wing aircraft the tests will take place at a safe operational altitude.

Failure i.e. an unexpected deviation of any aircraft function during any of the tests will require the tests to be stopped and the aircraft systems investigated for the causes. The testing should not restart until causes have been identified and rectification has taken place.

Certification should be provided on successful completion of tests.

7.3 Mobile Station Upgrades

It is normal practice in aviation that any changes to any system in an aircraft of any type should have a detailed change documentation and recording system. TETRA MSs and radio assemblies will be subject to the same rules and recording system. The maintenance companies for the respective aircraft will supply in detail the requirements or advice on request. It is to be expected that a qualified engineer will be required to be present to oversee the MS manufacturer's engineer perform the upgrade process. If the aircraft MS equipment has aircraft equipment approval granted under an airworthiness authority a "Release to Service" certificate may be required to be issued after completion of the upgrade and the equipment may also require a "mod strike" to be entered on the unit ID label in accordance with the upgrade procedure. The release certificate would be issued under the terms of the manufacturer's approval authority as granted by an airworthiness authority in the country of origin.

Changes to the MSs user or operator configuration may also be subject to the same rules.

Annex A: Europe wide AGA frequency plan

The following pages document the pan Europe AGA network frequency plan prepared in 2008.

This plan is based around a seven cell reuse pattern from the designated AGA channels, the unused additional 1 + 2 channels may be used to add capacity over major conurbations or flexibility on border areas. The plan is designed grant an equitable capacity allocation to all users.

It is recommended that the plan is followed aligning the suggested cell locations with the operators site locations. The plan allows some flexibility in the site locations of up to 20 km.

A MoU preferably is implemented between user countries defining "Super Preferential" and "Preferential" channels for each country.

More details on the backgrounds of the plan can be found in clause 5.11.

Figure A.1 presents a pictorial overview of the cell pattern in Europe.

Table A.1 lists the WGS84 coordinates of the centres of the AGA cells of the pan-European AGA network plan.

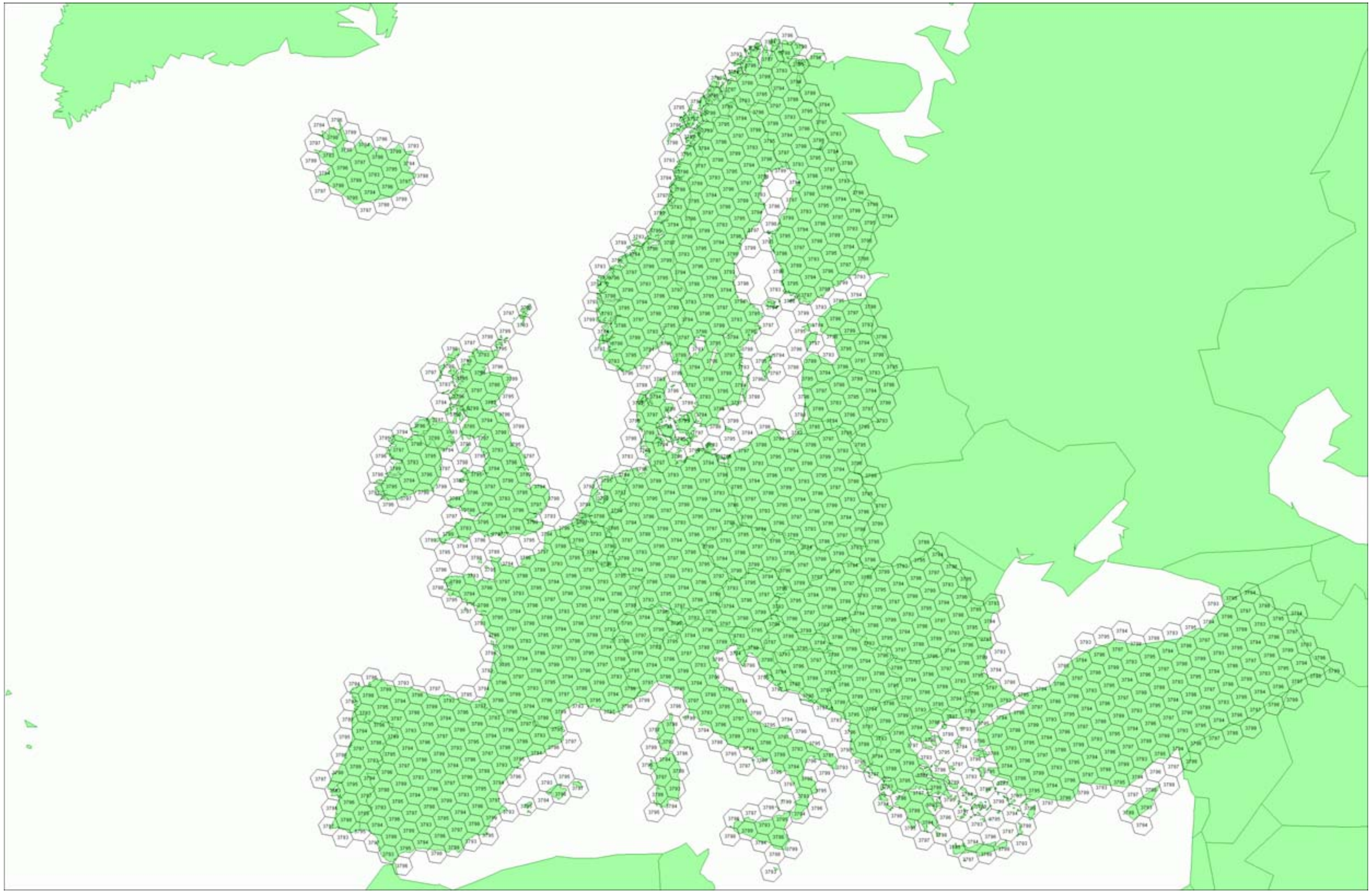

Figure A.1: Overview of the cell pattern in Europe

Table A.1: Pan-Europe AGA cell locations

Channel	Latitude	Longitude
3793	34.944648	33.523981
3794	34.306819	33.016826
3793	35.030420	27.019467
3797	35.628938	33.105179
3795	36.313280	32.676458
3793	36.346311	31.726731
3799	34.986633	32.596705
3796	36.216727	34.571840
3797	36.153268	35.516838
3795	36.850613	35.113175
3793	36.909865	34.156304
3794	36.270075	33.624938
3798	35.581344	34.042215
3799	35.523764	34.977568
3796	36.701455	37.020174
3797	36.611646	37.969645
3795	37.321182	37.592936
3793	37.407152	36.631106
3794	36.781128	36.067909
3798	36.079742	36.459610
3796	37.118558	39.507093
3797	37.002038	40.458772
3795	37.722874	40.110799
3793	37.835948	39.146347
3794	37.224963	38.551707
3798	36.511761	38.916001
3799	36.401865	39.858929
3796	37.466154	42.02739
3797	37.322678	42.978899
3795	38.053848	42.661297
3793	38.194291	41.696683
3794	37.599583	41.071253
3798	36.875479	41.406432
3799	36.738963	42.349770
3796	37.742644	44.575388
3793	38.480512	44.276268
3794	37.903265	43.620967
3798	37.169248	43.925483
3799	37.005963	44.866851
3797	34.918454	24.236185
3795	35.552133	23.712873
3796	35.647890	25.586776
3797	35.680741	26.525710
3795	36.330109	26.020847
3793	36.291695	25.071740
3794	35.605012	24.649057
3798	34.965658	25.162719
3799	35.002988	26.090583
3796	36.376367	27.922006
3797	36.384180	28.873390
3795	37.048728	28.389201
3793	37.035620	27.426923
3794	36.358340	26.971047
3798	35.703542	27.465538
3796	37.043844	30.314206
3797	37.025855	31.276239
3795	37.704981	30.814959
3793	37.717975	29.841344
3794	37.051470	29.351744

Channel	Latitude	Longitude
3798	36.381772	29.824863
3799	36.369146	30.776089
3796	37.647484	32.759961
3797	37.603021	33.730632
3795	38.296033	33.294476
3793	38.335835	32.311577
3794	37.681479	31.787951
3798	36.997514	32.237496
3799	36.958842	33.197631
3796	38.184644	35.255202
3797	38.113135	36.232305
3795	38.819246	35.823426
3793	38.886459	34.833509
3794	38.245624	34.275805
3798	37.548118	34.699612
3799	37.482814	35.666551
3796	38.652903	37.795217
3797	38.553887	38.776368
3795	39.272223	38.396820
3793	39.367335	37.402342
3794	38.741376	36.810783
3798	38.031144	37.206761
3799	37.938727	38.178222
3796	39.050096	40.374672
3797	38.923234	41.357340
3795	39.652835	41.009036
3793	39.776211	40.012616
3794	39.166452	39.387717
3798	38.444395	39.753890
3799	38.324503	40.727440
3796	39.374347	42.987665
3797	39.219428	43.969196
3795	39.959256	43.653866
3793	40.111130	42.658256
3794	39.518850	42.000834
3798	38.785952	42.335380
3799	38.638345	43.308462
3794	39.796875	44.643814
3797	36.115633	22.234260
3795	36.740255	21.678137
3796	36.879805	23.587386
3797	36.934221	24.545148
3795	37.575281	24.006667
3793	37.514872	23.038724
3794	36.815135	22.631605
3798	36.184422	23.178120
3796	37.664805	25.947833
3797	37.693859	26.920349
3795	38.350903	26.401929
3793	38.316106	25.418418
3794	37.625270	24.976487
3798	36.978347	25.504552
3799	37.012154	26.465259
3796	38.388546	28.371666
3797	38.391368	29.357148
3795	39.063842	28.861251
3793	39.055565	27.863984
3794	38.375055	27.386469
3798	37.712413	27.893679
3799	37.720454	28.867463
3796	39.047916	30.855706

Channel	Latitude	Longitude
3797	39.023725	31.852121
3795	39.710978	31.381213
3793	39.730038	30.372261
3794	39.061292	29.858621
3798	38.383519	30.342541
3799	38.365004	31.327475
3796	39.639980	33.396033
3797	39.588092	34.401109
3795	40.289375	33.957624
3793	40.336488	32.939313
3794	39.680952	32.389269
3798	38.988734	32.847479
3799	38.942968	33.841402
3796	40.162017	35.987985
3797	40.081864	36.999237
3795	40.796327	36.585525
3793	40.872096	35.560413
3794	40.231204	34.973983
3798	39.525325	35.404110
3799	39.451722	36.404647
3796	40.611562	38.626171
3797	40.502698	39.640914
3795	41.229396	39.259201
3793	41.334296	38.230060
3794	40.709461	37.607578
3798	39.990801	38.007346
3799	39.888893	39.011931
3796	40.986434	41.304503
3797	40.848547	42.319894
3795	41.586448	41.972228
3793	41.720817	40.942006
3794	41.113414	40.284144
3798	40.382947	40.651423
3799	40.252393	41.657324
3794	41.441068	42.997105
3798	40.699851	43.329949
3793	35.780912	14.171754
3796	38.071071	21.501981
3797	38.148131	22.477728
3795	38.779383	21.904046
3793	38.695898	20.918191
3794	37.983558	20.529067
3798	37.362963	21.109851
3799	37.444083	22.073005
3796	38.914415	23.883648
3797	38.965868	24.876657
3795	39.613892	24.322171
3793	39.556245	23.318145
3794	38.852239	22.892654
3798	38.214686	23.455955
3799	38.270690	24.436305
3796	39.696461	26.335513
3797	39.721324	27.344039
3795	40.385628	26.811440
3793	40.354840	25.790997
3794	39.660642	25.328091
3798	39.006561	25.871302
3799	39.036467	26.867206
3796	40.413812	28.854732
3797	40.411186	29.876750
3795	41.091172	29.368766

Channel	Latitude	Longitude
3793	41.088180	28.333962
3794	40.405290	27.832823
3798	39.735213	28.353273
3799	39.738119	29.362814
3796	41.063229	31.437635
3797	41.032315	32.470840
3795	41.727275	31.990199
3794	41.082853	30.403468
3798	40.397416	30.898463
3799	40.372511	31.919455
3796	41.641676	34.079708
3797	41.581785	35.121526
3795	42.290907	34.670907
3793	42.345912	33.614728
3794	41.690185	33.035786
3798	40.990132	33.502654
3799	40.936713	34.532651
3794	42.224374	35.724673
3798	41.510555	36.160808
3799	41.428038	37.197125
3796	37.242761	14.769860
3795	37.975459	15.080537
3793	37.819554	14.123608
3794	37.084106	13.826001
3798	36.511202	14.467026
3799	36.662765	15.403185
3796	38.256911	17.009405
3795	38.984297	17.355072
3793	38.851913	16.374812
3794	38.121277	16.042572
3797	39.318359	20.321284
3795	39.938244	19.710895
3793	39.830628	18.708329
3796	40.120983	21.726823
3797	40.195976	22.739417
3795	40.833402	22.147075
3793	40.751756	21.123532
3794	40.035052	20.717186
3798	39.408426	21.317321
3799	39.487740	22.316400
3796	40.963273	24.202351
3797	41.011403	25.233254
3795	41.665945	24.661870
3793	41.611410	23.619007
3794	40.903925	23.173485
3798	40.259980	23.754579
3799	40.312947	24.771907
3796	41.740781	26.752848
3797	41.761027	27.800081
3795	42.432149	27.252652
3793	42.405789	26.192466
3794	41.709079	25.706631
3798	41.048281	26.265776
3799	41.073880	27.299488
3793	43.131226	28.840675
3794	42.446875	28.313657
3798	41.769801	28.847881
3796	38.219668	12.504997
3797	38.392930	13.464142
3798	37.477904	12.226253
3799	37.653667	13.172084

Channel	Latitude	Longitude
3797	39.443721	15.726628
3795	40.032113	15.064519
3798	38.556130	14.429028
3799	38.709159	15.399356
3796	40.315231	17.065992
3797	40.440706	18.074107
3795	41.047612	17.425623
3793	40.914851	16.407848
3794	40.179001	16.062677
3798	39.583281	16.715839
3799	39.712279	17.709856
3796	41.280192	19.475157
3797	41.379845	20.506134
3795	42.005027	19.874226
3793	41.898265	18.832482
3798	40.555339	19.086656
3799	40.659047	20.103260
3796	42.184533	21.969139
3797	42.257145	23.021449
3795	42.900256	22.409241
3793	42.820757	21.345037
3794	42.100473	20.919921
3798	41.468308	21.540713
3799	41.545515	22.578478
3796	43.024271	24.546131
3797	43.068691	25.617886
3795	43.729272	25.028638
3793	43.678230	23.943864
3794	42.968111	23.476425
3798	42.318254	24.076408
3799	42.367814	25.133565
3796	43.795534	27.203347
3797	43.810702	28.292284
3795	44.488170	27.729356
3793	44.466692	26.626294
3794	43.768384	26.115299
3798	43.101339	26.691215
3799	43.122190	27.765639
3793	45.182307	29.388546
3794	44.497479	28.833082
3795	38.714816	8.249195
3793	39.687710	9.447390
3794	38.933110	9.202311
3797	40.451846	13.386942
3795	41.025000	12.687468
3796	41.359751	14.713162
3797	41.510913	15.735058
3795	42.103179	15.047253
3793	41.944315	14.016100
3794	41.197742	13.697182
3798	40.616864	14.388151
3799	40.771235	15.395236
3797	42.513036	18.174826
3795	43.124270	17.501776
3794	42.250992	16.084351
3798	41.651117	16.762499
3796	43.355677	19.633328
3797	43.453957	20.705723
3795	44.083901	20.050743
3793	43.978249	18.966647
3794	43.245754	18.565196

Channel	Latitude	Longitude
3798	42.627074	19.227388
3799	42.729673	20.284270
3796	44.259577	22.231047
3797	44.329464	23.326281
3795	44.977743	22.692887
3793	44.900721	21.584687
3794	44.177701	21.139037
3798	43.540519	21.781925
3799	43.615296	22.861464
3796	45.095151	24.918053
3797	45.135442	26.033964
3795	45.801556	25.425829
3793	45.754416	24.295689
3794	45.042570	23.804184
3798	44.387308	24.424240
3799	44.433063	25.524415
3796	45.858333	27.691085
3795	46.551237	28.245970
3793	46.535135	27.096519
3794	45.836204	26.557814
3798	45.163412	27.151378
3799	45.179038	28.269754
3797	40.229231	8.717855
3795	40.765913	7.973850
3799	39.471310	8.480329
3796	41.200725	9.958176
3793	41.748839	9.213157
3794	40.988452	8.962039
3798	40.443626	9.699252
3796	42.346932	12.270054
3797	42.524685	13.303682
3795	43.100619	12.575545
3793	42.914757	11.533199
3794	42.158281	11.243531
3798	41.593892	11.973108
3799	41.774511	12.991266
3797	43.591045	15.744164
3795	44.186578	15.028584
3794	43.275373	13.625077
3798	42.691414	14.344053
3796	44.472052	17.192998
3797	44.597147	18.283768
3795	45.212122	17.584222
3793	45.079176	16.482090
3794	44.335160	16.107786
3798	43.731727	16.812907
3799	43.860828	17.887216
3796	45.441869	19.804618
3797	45.538487	20.921883
3795	46.172627	20.242113
3793	46.068360	19.112084
3794	45.333051	18.691895
3798	44.710348	19.379629
3799	44.811566	20.480100
3796	46.343828	22.515013
3797	46.410621	23.656781
3795	47.063520	23.000761
3793	46.989334	21.844805
3794	46.264475	21.376605
3798	45.622828	22.043172
3799	45.694824	23.167955

Channel	Latitude	Longitude
3796	47.173506	25.321698
3797	47.209213	26.485479
3795	47.880327	25.857360
3793	47.837536	24.677972
3794	47.124928	24.159924
3798	46.464798	24.801340
3799	46.506313	25.948112
3794	47.910033	27.038525
3798	47.232019	27.650654
3795	37.557908	-0.628318
3793	37.241742	-1.511961
3795	38.934007	1.300227
3793	38.635176	0.384178
3796	39.504697	3.161239
3797	39.776198	4.105868
3795	40.274281	3.324752
3793	39.994334	2.375562
3794	39.223907	2.225968
3797	42.291909	8.452823
3799	41.528337	8.209942
3796	43.272563	9.737383
3797	43.477737	10.780341
3795	44.035616	10.011129
3798	42.510257	9.471501
3799	42.717921	10.498402
3796	44.429456	12.138245
3795	45.187372	12.454375
3793	44.999065	11.369603
3794	44.238169	11.070620
3798	43.671865	11.831315
3799	43.854805	12.889939
3796	45.528945	14.647026
3797	45.681943	15.754029
3795	46.280093	15.008339
3793	46.118775	13.890482
3794	45.364044	13.546992
3798	44.777664	14.296338
3799	44.934319	15.385976
3796	46.566214	17.264593
3797	46.690785	18.401983
3795	47.308879	17.673779
3793	47.176150	16.524001
3794	46.429280	16.133207
3798	45.822919	16.867533
3799	45.951760	17.987051
3796	47.536444	19.990727
3797	47.631088	21.156761
3795	48.268828	20.450288
3793	48.166244	19.270278
3794	47.429010	18.829541
3798	46.802888	19.544849
3799	46.902432	20.692643
3796	48.434856	22.823937
3795	49.155101	23.336090
3793	49.084138	22.128121
3794	48.358392	21.635048
3798	47.712863	22.327050
3799	47.781699	23.500993
3799	48.585038	26.408949
3796	35.896946	-4.947378
3795	36.665052	-4.901620

Channel	Latitude	Longitude
3793	36.308951	-5.746655
3796	37.354239	-3.180459
3797	37.686940	-2.304459
3795	38.125836	-3.109362
3793	37.784719	-3.987291
3794	37.013545	-4.046202
3798	36.584996	-3.249666
3799	36.917375	-2.385775
3796	38.783382	-1.322026
3797	39.099423	-0.412808
3795	39.557414	-1.223073
3793	39.232817	-2.135038
3794	38.458788	-2.220911
3798	38.011455	-1.418285
3799	38.327597	-0.522035
3796	40.180213	0.632518
3795	40.955539	0.762015
3793	40.649050	-0.185020
3794	39.873278	-0.300512
3796	41.540387	2.687677
3797	41.818365	3.665948
3795	42.315773	2.850574
3793	42.029030	1.867583
3794	41.252716	1.719636
3797	43.115869	5.861519
3795	43.633493	5.047073
3793	43.368177	4.027435
3796	44.132495	7.116811
3797	44.365821	8.166335
3795	44.903913	7.355635
3793	44.661736	6.298922
3794	43.888327	6.076957
3798	43.361909	6.885020
3799	43.597326	7.917995
3796	45.354899	9.498335
3797	45.563367	10.583618
3795	46.122092	9.779887
3793	45.904789	8.685992
3794	45.135025	8.422220
3798	44.588134	9.225208
3799	44.799268	10.293086
3796	46.521625	11.995256
3797	46.703540	13.115885
3795	47.282965	12.322766
3793	47.092279	11.191980
3794	46.327757	10.883112
3798	45.760270	11.677680
3799	45.945455	12.780111
3796	47.627616	14.609649
3797	47.781297	15.764752
3795	48.381377	14.986306
3793	48.219040	13.819391
3794	47.461459	13.462151
3798	46.873357	14.244543
3799	47.030936	15.380747
3796	48.667760	17.342538
3797	48.791561	18.530706
3795	49.412120	17.771406
3793	49.279836	16.569678
3794	48.530993	16.160876
3798	47.922373	16.926928

Channel	Latitude	Longitude
3799	48.050725	18.095628
3796	49.636941	20.193662
3797	49.729276	21.412892
3795	50.369994	20.677577
3793	50.269410	19.442980
3794	49.531191	18.979614
3798	48.902288	19.724780
3799	48.999842	20.924132
3796	50.530093	23.161245
3797	50.589460	24.408871
3795	51.249856	23.702700
3793	51.182539	22.437871
3794	50.456916	21.917238
3798	49.808112	22.636625
3799	49.873377	23.864170
3797	36.714355	-6.557282
3795	37.112949	-7.379289
3793	36.732807	-8.214888
3796	37.851047	-5.674990
3797	38.208596	-4.806343
3795	38.625651	-5.637672
3793	38.259567	-6.507342
3794	37.485764	-6.532649
3798	37.078780	-5.711303
3799	37.435635	-4.854625
3796	39.333909	-3.864534
3797	39.675671	-2.961180
3795	40.111716	-3.800545
3793	39.761244	-4.705698
3794	38.983834	-4.756720
3798	38.558208	-3.926758
3799	38.899682	-3.036297
3796	40.786979	-1.955919
3797	41.111356	-1.016634
3795	41.566890	-1.862459
3793	41.233647	-2.804436
3794	40.453697	-2.883925
3798	40.008917	-2.046742
3799	40.333443	-1.121317
3796	42.205884	0.056119
3797	42.511221	1.032440
3795	42.986708	0.182066
3793	42.672371	-0.797971
3794	41.891038	-0.908897
3798	41.426624	-0.066192
3799	41.732582	0.895267
3796	43.586043	2.176775
3797	43.870635	3.191066
3795	44.366489	2.338424
3793	44.072793	1.319256
3794	43.291334	1.173708
3798	42.806848	2.019896
3799	43.092565	3.018299
3796	44.922683	4.411058
3797	45.184781	5.464022
3795	45.701357	4.611807
3793	45.430083	3.552657
3794	44.649853	3.369104
3798	44.144910	4.216356
3799	44.408674	5.252399
3796	46.210840	6.763639

Channel	Latitude	Longitude
3797	46.448664	7.855685
3795	46.986242	7.007038
3793	46.739209	5.907347
3794	45.961675	5.682236
3798	45.435956	6.527712
3799	45.676019	7.601813
3796	47.445388	9.238677
3797	47.657135	10.369839
3795	48.215906	9.528381
3793	47.994961	8.387964
3794	47.221697	8.117608
3798	46.674962	8.958016
3799	46.889557	10.070251
3796	48.621056	11.839603
3797	48.804922	13.009454
3795	49.384971	12.179309
3793	49.191970	10.998444
3794	48.424662	10.679081
3798	47.856768	11.510656
3799	48.044121	12.660670
3796	49.732469	14.568876
3797	49.886663	15.776449
3795	50.487948	14.962239
3793	50.324740	13.741764
3794	49.565188	13.369637
3798	48.976104	14.188119
3799	49.134454	15.375051
3796	50.774189	17.427716
3797	50.896960	18.671406
3795	51.519298	17.878244
3793	51.387697	16.619654
3794	50.637810	16.191103
3798	50.027634	16.991750
3799	50.155255	18.214145
3796	51.740770	20.415811
3797	51.830430	21.693293
3795	52.473475	20.926735
3793	52.375237	19.632281
3794	51.637026	19.143874
3798	51.006008	19.921477
3799	51.101231	21.177211
3796	52.626823	23.531024
3795	53.345007	24.105160
3793	53.281797	22.777923
3794	52.557364	22.226592
3798	51.905920	22.975538
3799	51.967166	24.261746
3793	54.101935	26.052662
3797	37.115984	-9.048358
3796	38.278644	-8.210453
3797	38.660978	-7.351719
3795	39.055062	-8.208143
3793	38.664115	-9.066939
3794	37.888874	-9.057522
3798	37.504526	-8.212700
3799	37.885790	-7.365692
3796	39.813948	-6.454586
3797	40.181455	-5.559861
3795	40.594315	-6.427076
3793	40.217986	-7.322581
3794	39.438412	-7.337355

Channel	Latitude	Longitude
3798	39.035664	-6.481331
3799	39.402489	-5.599311
3796	41.322144	-4.599222
3797	41.673206	-3.666977
3795	42.105413	-4.543636
3793	41.745335	-5.477502
3794	40.962441	-5.519275
3798	40.540717	-4.653220
3799	40.891519	-3.734721
3796	42.798862	-2.638369
3797	43.131792	-1.667155
3795	43.583889	-2.551575
3793	43.241770	-3.525390
3794	42.456662	-3.597230
3798	42.015408	-2.722619
3799	42.348534	-1.766244
3796	44.239501	-0.565969
3797	44.552550	0.445537
3795	45.025047	-0.444582
3793	44.702657	-1.459817
3794	43.916540	-1.565058
3798	43.455234	-0.683712
3799	43.768971	0.311815
3796	45.639237	1.623992
3797	45.930599	2.676928
3795	46.423953	1.783608
3793	46.123130	0.725652
3794	45.337314	0.583417
3798	44.855472	1.469283
3799	45.148053	2.505064
3796	46.993024	3.937354
3797	47.260842	5.032599
3795	47.775449	4.139063
3793	47.498084	3.037329
3794	46.713990	2.854262
3798	46.211187	3.741982
3799	46.480791	4.818887
3796	48.295607	6.379598
3797	48.537986	7.517695
3795	49.074163	6.627455
3793	48.822194	5.481219
3794	48.041360	5.253264
3798	47.517237	6.139685
3799	47.762009	7.258264
3796	49.541545	8.955629
3797	49.756563	10.136689
3795	50.314532	9.253832
3793	50.089928	8.062804
3794	49.314014	7.785734
3798	48.768299	8.667161
3799	48.986354	9.827564
3796	50.725232	11.669527
3797	50.910963	12.893115
3795	51.490828	12.022329
3793	51.295573	10.786762
3794	50.526362	10.456246
3798	49.958885	11.328418
3799	50.148333	12.530295
3796	51.840941	14.524226
3797	51.995472	15.789263
3795	52.597200	14.935841

Channel	Latitude	Longitude
3793	52.433272	13.656655
3794	51.672673	13.268359
3798	51.083388	14.126420
3799	51.242349	15.368818
3796	52.882868	17.521188
3797	53.004327	18.825832
3795	53.627726	17.995660
3793	53.497067	16.674563
3794	52.747114	16.224266
3798	52.136119	17.062775
3799	52.262749	18.344032
3796	53.845198	20.660034
3797	53.931787	22.001574
3795	54.576483	21.201073
3793	54.480968	19.840688
3794	53.743810	19.324435
3798	53.111371	20.137394
3799	53.203892	21.455043
3796	54.722182	23.938175
3797	54.772212	25.312945
3795	55.437626	24.548973
3793	55.379027	23.152936
3794	54.656916	22.567223
3798	54.003487	23.348148
3799	54.060223	24.698826
3796	55.508234	27.350459
3795	56.205500	28.033490
3793	56.185443	26.606528
3794	55.480711	25.948500
3798	54.806951	26.690533
3797	39.041988	-9.935149
3796	40.221229	-9.086579
3797	40.614376	-8.203324
3795	41.002890	-9.096824
3798	39.441602	-9.076621
3799	39.833675	-8.205766
3796	41.783120	-7.291739
3797	42.160852	-6.369622
3795	42.568454	-7.275632
3793	42.181602	-8.198223
3794	41.397055	-8.200810
3798	40.999592	-7.307382
3799	41.376654	-6.398765
3796	43.316391	-5.390184
3797	43.677005	-4.427410
3793	43.734364	-6.308682
3794	42.946795	-6.339608
3798	42.530024	-5.434490
3799	42.890406	-4.486391
3796	46.278480	-1.239299
3797	46.599452	-0.190177
3795	47.067922	-1.123700
3793	46.737250	-2.176525
3798	45.490014	-1.351283
3799	45.811742	-0.319379
3796	47.697373	1.024033
3797	47.995681	2.118517
3795	48.485520	1.180639
3793	48.177372	0.081012
3794	47.388042	-0.056781
3798	46.909862	0.872450

Channel	Latitude	Longitude
3799	47.209482	1.948366
3796	49.067799	3.421803
3797	49.341467	4.562752
3795	49.853121	3.623829
3793	49.569510	2.476084
3794	48.782407	2.294329
3798	48.282736	3.226410
3799	48.558314	4.347419
3796	50.384185	5.960480
3797	50.631192	7.148611
3795	51.165021	6.212585
3793	50.908016	5.015789
3794	50.124755	4.785416
3798	49.603189	5.716829
3799	49.852746	6.883652
3796	51.640746	8.645898
3797	51.859039	9.881420
3795	52.415302	8.952927
3793	52.187008	7.706644
3794	51.409337	7.422781
3798	50.865562	8.349363
3799	51.087089	9.562254
3796	52.831504	11.482931
3797	53.019017	12.765417
3795	53.597846	11.849819
3793	53.400391	10.554256
3794	52.630201	10.211889
3798	52.064016	11.128791
3799	52.255487	12.387414
3796	53.950337	14.475116
3797	54.105019	15.803360
3795	54.706392	14.906759
3793	54.541899	13.562927
3794	53.781222	13.157014
3798	53.192560	14.058669
3799	53.351963	15.361970
3796	54.991031	17.624223
3794	54.856155	16.260811
3798	54.245113	17.140938
3799	54.370472	18.487005
3796	55.947355	20.929786
3797	56.030440	22.342098
3795	56.676089	21.504601
3798	55.215563	20.375488
3799	55.304979	21.761433
3796	56.813156	24.388635
3797	56.857682	25.837031
3795	57.524628	25.040815
3793	57.471198	23.568570
3794	56.752602	22.944106
3798	56.097864	23.759718
3799	56.149551	25.181564
3796	57.582467	27.994451
3793	58.261407	27.221255
3794	57.561732	26.516524
3798	56.886127	27.288125
3797	42.571866	-9.118227
3799	41.786473	-9.107369
3796	43.755833	-8.192810
3794	43.358949	-9.129412
3798	42.967901	-8.195558

Channel	Latitude	Longitude
3799	43.355480	-7.259039
3797	47.187770	-3.131219
3795	47.629759	-4.103523
3796	48.320054	-1.970337
3797	48.649184	-0.880937
3795	49.112510	-1.862026
3793	48.773300	-2.955048
3794	47.980161	-3.044585
3798	47.528254	-2.075113
3799	47.858203	-1.004309
3796	49.757684	0.370689
3797	50.063139	1.509938
3795	50.548371	0.523060
3794	49.440723	-0.753380
3798	48.967301	0.223423
3799	49.274158	1.342517
3796	51.144243	2.858667
3797	51.423917	4.049154
3793	51.641523	1.862579
3794	50.852311	1.683189
3798	50.356840	2.664089
3799	50.638545	3.832824
3796	52.473814	5.501286
3797	52.725544	6.743954
3795	53.256013	5.757303
3793	52.993847	4.505397
3794	52.209072	4.273206
3798	51.691091	5.254268
3799	51.945531	6.473587
3796	53.740225	8.305532
3797	53.961809	9.600733
3795	54.515408	8.621698
3793	54.283375	7.314848
3794	53.504884	7.024194
3798	52.964031	8.000710
3799	53.189052	9.271009
3796	54.937087	11.277286
3797	55.126304	12.624611
3795	55.703197	11.659362
3793	55.503587	10.297707
3794	54.733386	9.942738
3798	54.169418	10.909162
3799	54.362847	12.230135
3796	56.057832	14.420845
3797	56.212473	15.818942
3795	56.812652	14.874560
3793	56.647754	13.459205
3794	55.888011	13.034021
3798	55.300840	13.983930
3799	55.460511	15.354409
3796	57.095780	17.738368
3797	57.213688	19.184756
3795	57.836944	18.269209
3793	57.709009	16.802434
3794	56.962051	16.301284
3798	56.351767	17.227371
3796	58.044233	21.229278
3797	58.123338	22.720180
3795	58.769225	21.842226
3794	57.948729	19.745217
3798	57.315636	20.639352

Channel	Latitude	Longitude
3799	57.401507	22.101015
3796	58.896570	24.889657
3797	58.934952	26.419849
3795	59.602759	25.588875
3793	59.555118	24.031769
3794	58.841305	23.363330
3798	58.185950	24.216669
3799	58.231992	25.717461
3793	60.326413	27.907350
3794	59.633198	27.149331
3798	58.956400	27.952514
3796	48.857538	-5.038308
3795	49.652791	-4.981160
3798	48.062930	-5.093565
3799	48.423353	-4.032273
3796	50.361264	-2.766659
3797	50.698818	-1.634070
3795	51.155798	-2.667478
3793	50.807760	-3.803534
3794	50.012496	-3.882408
3798	49.567049	-2.862459
3799	49.905481	-1.750003
3796	51.817221	-0.343374
3797	52.130057	0.844211
3795	52.609511	-0.196770
3793	52.286005	-1.389634
3794	51.492377	-1.514021
3798	51.024891	-0.484837
3799	51.339214	0.680806
3794	52.920742	1.013587
3798	52.430614	2.048438
3796	55.837071	7.929770
3797	56.061981	9.290643
3795	56.611896	8.255332
3798	55.060833	7.616497
3799	55.289391	8.949841
3796	57.039059	11.049524
3797	57.229909	12.468570
3795	57.803916	11.448005
3793	57.602181	10.013186
3794	56.832978	9.644829
3798	56.272213	10.666372
3799	56.467542	12.056175
3796	58.160468	14.360550
3797	58.314870	15.836256
3795	58.912981	14.838716
3793	58.747838	13.343800
3794	57.990083	12.897454
3798	57.405315	13.901060
3799	57.565077	15.346024
3796	59.194089	17.865520
3797	59.309706	19.394973
3795	59.931701	18.429840
3793	59.805592	16.877487
3794	59.061792	16.346353
3798	58.453105	17.323463
3796	60.132674	21.563709
3797	60.207274	23.142380
3795	60.852665	22.220016
3793	60.767937	20.614607
3794	60.040776	19.992379

Channel	Latitude	Longitude
3799	59.490336	22.479470
3796	60.969075	25.450209
3797	61.000597	27.071764
3795	61.668583	26.203295
3793	61.627425	24.551144
3794	60.919742	23.832416
3798	60.264478	24.726898
3799	60.304209	26.315738
3796	61.696403	29.515186
3795	62.372474	30.368349
3793	62.376836	28.677853
3794	61.691587	27.858563
3798	61.014262	28.695426
3794	62.349594	32.057462
3797	51.244660	-4.860790
3798	50.078437	-6.022815
3799	50.448546	-4.922021
3796	52.398948	-3.637192
3797	52.745233	-2.458233
3795	53.194569	-3.549407
3793	52.837376	-4.731583
3794	52.040987	-4.797351
3798	51.603295	-3.721846
3799	51.950506	-2.564733
3796	53.872848	-1.126870
3797	54.193335	0.113023
3795	54.665746	-0.987962
3793	54.334130	-2.233108
3794	53.539827	-2.347767
3798	53.079548	-1.260668
3799	53.401602	-0.044740
3796	57.928218	7.512809
3797	58.156516	8.946286
3795	58.701660	7.847948
3793	58.461898	6.400720
3799	57.385111	8.593911
3796	59.134361	10.795875
3797	59.326786	12.294685
3795	59.896902	11.212112
3793	59.693057	9.695867
3794	58.925902	9.313300
3799	58.566566	11.862731
3796	60.255158	14.293176
3797	60.409113	15.855612
3795	61.004238	14.798567
3793	60.839013	13.214620
3794	60.084348	12.744931
3798	59.502943	13.808663
3799	59.662612	15.336668
3796	61.282785	18.008041
3793	61.891693	16.961774
3794	61.152229	16.396847
3798	60.546012	17.430928
3796	62.209363	21.939553
3797	62.278872	23.616858
3795	62.923017	22.645571
3793	62.842916	20.937779
3798	61.490900	21.263135
3799	61.568169	22.903855
3796	63.027130	26.081484
3797	63.050984	27.805708

Channel	Latitude	Longitude
3795	63.718463	26.896803
3793	63.684570	25.137515
3794	62.984453	24.360783
3798	62.330000	25.300238
3799	62.362670	26.987858
3796	63.728634	30.421331
3793	64.408813	29.549154
3794	63.733159	28.658784
3798	63.055977	29.531463
3799	63.042103	31.256744
3796	51.295354	-9.263132
3797	51.697232	-8.159956
3795	52.092606	-9.279165
3793	51.679978	-10.381766
3796	52.885662	-7.012300
3797	53.265457	-5.848055
3795	53.682857	-6.986730
3793	53.291994	-8.151925
3794	52.494606	-8.156013
3798	52.088401	-7.036947
3799	52.468551	-5.894134
3796	54.429730	-4.592523
3797	54.785093	-3.363722
3795	55.225381	-4.518941
3793	54.858656	-5.750574
3794	54.062210	-5.800236
3798	53.633675	-4.663354
3799	53.990003	-3.458314
3796	55.921218	-1.990224
3795	56.713674	-1.861456
3793	56.373595	-3.163204
3794	55.579678	-3.265424
3798	55.127981	-2.114015
3799	55.458077	-0.843647
3797	58.985738	5.256847
3796	60.010450	7.047519
3797	60.242228	8.561674
3795	60.781438	7.392276
3793	60.537616	5.863129
3794	59.762713	5.553476
3798	59.237200	6.717296
3799	59.473067	8.197268
3796	61.219787	10.511675
3797	61.413744	12.099711
3795	61.978904	10.947150
3793	61.772937	9.339743
3794	61.008926	8.942144
3798	60.457760	10.094968
3799	60.656774	11.646336
3796	62.338669	14.217395
3797	62.491962	15.877392
3795	63.083144	14.753295
3793	62.917997	13.069041
3794	62.167568	12.573490
3798	61.590538	13.704991
3799	61.749928	15.326162
3796	63.358551	18.168892
3797	63.468398	19.896726
3795	64.085362	18.814497
3793	63.963961	17.057115
3794	63.230067	16.453814

Channel	Latitude	Longitude
3798	62.627229	17.551910
3799	62.744271	19.239288
3796	64.270819	22.364982
3797	64.334576	24.153915
3793	64.901861	21.304525
3794	64.187703	20.584468
3798	63.559440	21.635428
3799	63.631535	23.383031
3796	65.066983	26.797649
3797	65.082245	28.638013
3795	65.748520	27.685556
3793	65.722793	25.804640
3794	65.031786	24.960351
3798	64.378870	25.949078
3799	64.403629	27.748246
3793	66.418191	30.542096
3794	65.753907	29.568459
3798	65.077547	30.479024
3796	53.274098	-10.456255
3797	53.687219	-9.313034
3795	54.071012	-10.495614
3798	52.477036	-10.418333
3799	52.889945	-9.295788
3796	54.886195	-8.143274
3797	55.276429	-6.932602
3794	54.484275	-9.330939
3798	54.089241	-8.147681
3799	54.479831	-6.960183
3796	56.449985	-5.645280
3797	56.814831	-4.362855
3795	57.244544	-5.589400
3793	56.867853	-6.874086
3794	56.072490	-6.903924
3798	55.654634	-5.698961
3799	56.020469	-4.442444
3796	57.958756	-2.946008
3795	58.749660	-2.830494
3793	58.400703	-4.193617
3794	57.608297	-4.279982
3798	57.166678	-3.056818
3799	57.505179	-1.727403
3793	59.872256	-1.290083
3797	61.054119	4.643179
3799	60.277766	4.355651
3796	62.080370	6.525026
3797	62.315764	8.129333
3795	62.847791	6.879242
3793	62.599714	5.258545
3794	61.828172	4.943841
3798	61.310239	6.186664
3799	61.549950	7.752532
3796	63.291972	10.191058
3797	63.487439	11.879567
3795	64.046511	10.647410
3793	63.838380	8.937260
3794	63.078653	8.523826
3798	62.534032	9.755629
3799	62.734871	11.402654
3796	64.407616	14.131531
3797	64.560027	15.902082
3795	65.146259	14.701850

Channel	Latitude	Longitude
3793	64.981348	12.903738
3794	64.236354	12.379381
3798	63.664768	13.587851
3799	63.823690	15.314280
3796	65.417912	18.351851
3797	65.524196	20.199451
3795	66.137338	19.047448
3793	66.018885	17.165835
3794	65.291861	16.518581
3798	64.693345	17.689128
3799	64.807352	19.490653
3796	66.313361	22.850465
3797	66.370613	24.766729
3795	67.009974	23.681269
3793	66.941076	21.724266
3794	66.235556	20.943166
3798	65.610532	22.059071
3799	65.676770	23.928296
3796	67.084620	27.616881
3797	67.090224	29.589602
3795	67.754599	28.590384
3793	67.738077	26.570290
3794	67.057852	25.646449
3798	66.407207	26.689260
3799	66.423077	28.615309
3794	67.749513	30.611326
3797	57.273696	-8.128970
3796	58.455819	-6.810628
3797	58.830616	-5.470497
3798	57.662351	-6.843013
3799	58.038144	-5.531189
3797	60.327237	-2.584098
3798	59.191874	-4.103539
3799	59.539213	-2.709966
3798	60.658205	-1.131282
3799	63.612276	7.250433
3797	65.544369	11.629045
3799	64.797398	11.126189
3796	66.458454	14.033422
3797	66.609755	15.930304
3795	67.189980	14.642876
3793	67.025456	12.714407
3794	66.287149	12.157790
3798	65.722144	13.454430
3799	65.880407	15.300737
3796	67.457209	18.561806
3797	67.559407	20.546960
3795	68.167821	19.315675
3793	68.052771	17.290962
3794	67.333988	16.592867
3798	66.740780	17.846091
3799	66.851288	19.778290
3796	68.333086	23.409633
3797	68.382964	25.472440
3795	69.018769	24.320031
3793	68.956644	22.209350
3794	68.261323	21.356283
3798	67.640384	22.545444
3799	67.699979	24.554254
3796	69.075716	28.562893
3795	69.732190	29.638579

Channel	Latitude	Longitude
3793	69.726096	27.457808
3794	69.058489	26.439104
3798	68.410851	27.541330
3799	68.416689	29.612866
3794	69.715263	31.818400
3796	68.487449	13.920259
3797	68.637402	15.962881
3795	69.210500	14.574587
3798	67.758992	13.301091
3799	67.916405	15.285156
3796	69.472578	18.805213
3797	69.570092	20.949963
3795	70.172843	19.627837
3794	69.352626	16.678936
3798	68.765757	18.027385
3799	68.872246	20.110645
3796	70.325819	24.060551
3797	70.367300	26.293728
3795	70.998770	25.066459
3793	70.944376	22.776262
3794	70.260949	21.837193
3798	69.644955	23.109536
3799	69.696995	25.280128
3796	71.035561	29.667158
3794	71.029190	27.364993
3798	70.385294	28.532426
3799	70.379755	30.772283
3797	63.345238	-17.153207
3795	63.642315	-18.771494
3796	64.585076	-15.928380
3797	65.036055	-14.441836
3795	65.357654	-16.123954
3793	64.892626	-17.600538
3794	64.120318	-17.371344
3798	63.809685	-15.742403
3799	64.260655	-14.290203
3793	66.578062	-14.769625
3794	65.808594	-14.601429
3798	65.472713	-12.911047
3797	63.418493	-21.763612
3796	64.690499	-20.723587
3797	65.182858	-19.305872
3795	65.455336	-21.043385
3793	64.949216	-22.444920
3794	64.185423	-22.095916
3798	63.922509	-20.419389
3799	64.414064	-19.032037
3796	66.428069	-18.095626
3794	65.948477	-19.594034
3798	65.661949	-17.841650
3799	66.127209	-16.329880
3797	65.189819	-24.194789
3799	64.430674	-23.799943
3796	66.466449	-23.198246
3794	65.945358	-24.610026
3798	65.709638	-22.811894
3799	66.216789	-21.380003

History

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