Subject	**Clarification and Extension of the IARU Locator System**		
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1. Introduction

This paper provides the basis to re-draft and modernise Section 5.11 of the IARU Region-1 VHF Managers Handbook which defines the IARU Locator system. The aim is to clarify and standardise the use of the IARU locator, including its extension to additional characters when specifying more precise positions.

2. Background

The IARU Locator system was defined in 1980 as a World-wide system for radio amateurs to quote their location with sufficient accuracy for practical purposes using a simple alphanumeric scheme related to latitude and longitude The initial specification called for a 6-character code which could define a station's location to a squaroid [(1)] of approximately 4,6 km each side at mid latitudes. The resulting positional accuracy was therefore around 3 km. This was deemed adequate for VHF contest scoring purposes. For lower resolution, for example at HF, a larger squaroid using just four characters would suffice. Even with six digits, it can prove to be inadequate for microwave usage and thus extensions have come into use.

3. Updating the Definition of the IARU locator

The widespread use of GPS and the resulting high accuracy possible in specifying any person's location on the Earth has led to a multiplicity of software and applications for radio amateurs such as path profile plots, terrain mapping as well as applications such as Google maps. The IARU locator is a natural contender as a means of specifying any station's position in a format that is much neater and simpler than quoting a latitude / longitude. However, to use the locator in this way means its resolution has to be extended. It is thus opportune to formally clarify that extension and other inconsistencies that have arisen.

4. Definition of the original IARU locator

Latitude of any station is measured within a range of -90 to +90 degrees, with -90° being the South Pole and +90° being the North Pole. Longitude is defined from -180° to +180° with zero degrees being the Greenwich meridian.

The Locator first divides the latitude/longitude into large 'squaroids' of 10 degrees of latitude and 20 degrees of longitude. There are 18 of these subdivisions for lat and long; each are allocated a letter of the alphabet from A to R.

The first letter of the Locator corresponds to the 20-degree longitude squaroid starting from the antipodal line of +/-180 degrees and counting round the world in units of 20°. Therefore

20 degrees WEST of Greenwich would be the ninth division and gets the letter 'I'

The second character of the locator defines the large squaroid of latitude, counting up from the South Pole up to the North Pole. A latitude of 50 degrees North therefore corresponds to 14 up from the pole and equates to the letter '0'

Each 20 x 10 degree squaroid is then subdivided into 10, measured conventionally from left to right for longitude and bottom to top for latitude. The pair of numbers from 0 to 9 corresponding to this division are appended to the locator as characters 3 and 4 for long / lat respectively. For example, the squaroid whose lower left corner lies at 2° West and 50° North becomes IO90. This four-character format is the lowest resolution used in practice and at mid latitudes gives a positional accuracy of very roughly 80 km, which is usually sufficient for most HF use.

For VHF and up these large squaroids are subdivided into 24 x 24 "sub-squares", with dimensions 5 x 2.5 minutes of arc for longitude/latitude respectively. Again, counting left to right and bottom to top, they are allocated the letters A to X. For example, IO90IV therefore corresponds to the squaroid whose lower left corner sits at 1 degree 20 minutes West and 50 degrees 52.5 minutes North. This six character format represents a positional accuracy of around 3 km at mid latitudes. [(2)]

The original 1980 definition also allowed for a further subdivision into 10 "small squares" of 0.5' x 0.25' for roughly 300 metres positioning accuracy. These appear as another pair of numbers, for example IO90IV58. Eight digit locators started to be used amongst some microwave operators in the 1990s for dish bearing calculations where the normal six-digit format was not accurate enough. It also allowed more accurate distance calculations on short microwave paths. Eight characters can also be useful for defining the location of microwave propagation beacons.

5. Problems with the Existing Scheme

The six or eight-character version only allows positions to be quoted to about 3 km or 300 metres respectively. This can often be insufficient for terrain or path plotting software to work with.

When deriving an (approximate) latitude and longitude from a quoted locator we need a reference point within the squaroid to calculate from. This was originally defined as being the middle of the square. Unfortunately, not everyone has adopted this definition; some software is believed to use the lower left corner. In addition, where locators are quoted to different resolutions, 4, 6 or 8 characters; which 'middle' should be used?

Previous to the introduction of the IARU locator, the old QRA used a scheme where its last letter was traditionally spelt in lower case, eg ZM41f. Despite the definition in the VHF Handbook specifying capital letters, this has carried over into common usage with the 'new' six-digit locator. So, people often write IO90iv instead of the original intended IO90IV. The use of lower case for characters 5 and 6 then extended into many popular software packages.

It is also opportune to clarify how the system converges to a single point at the North and South Poles.

6. New Higher Resolutions

The advent of very high accuracy positioning using GPS and high resolution mapping such as Google Maps has led to an expansion of the use of the Locator scheme. But such expansion has not always been implemented in a coordinated manner.

The majority of schemes in use subdivide the 8 character squaroid into 24 further 'micro-squares' each of 0,5/24 and 0,25/24 minutes of arc (1,25 x 0,625 seconds of arc) and append these as another pair of letters, A-X, to make a 10-digit locator; for example, IO90IV58AH. The resulting accuracy of a position so-defined is now about 13 metres.

Several manufacturers of GPS handhelds have used IARU locator as a display option. Several software packages, many interfacing to Google maps, also adopt the 10 character locators. All software packages that have been verified so far use the sub-divisions described above.

However, at least one manufacturer of GPS receivers that have IARU locator as a display option has used a 25 x 25 division with letters A-Y for the final pair (possibly to gain a squaroid of 0,02 x 0,01 minutes of arc). Some have also added a yet another pair of numbers, for 1 metre accuracy.

7. Mapping and Accuracy

At one time, every country had its own mapping of latitude/longitude due to adopting a localised spheroid model of the Earth's shape. For example, the mainland UK adopted the GBR36 spheroid. This typically leads to errors of a few hundreds of metres when compared with a lat/long mapping extended from another country. The few-kilometres accuracy of the original six-character locator meant that whatever local mapping was in use, any such error would go unnoticed.

However, the GPS system needs a uniform mapping so the world-wide WGS84 standard has now been adopted as an international standard. To make use of higher resolution locators on a world-wide basis, a similar universal spheroid has to be used for all stations.

8. Proposals to Clarify and Standardise the IARU Locator, including Higher Accuracy positioning

1) The definition of the existing 8-character scheme should be extended by adding a further division into 24 lettered squares to give a 10-character locator allowing a positioning accuracy of around 13 metres. Even higher resolution use for future applications should be defined by successively sub-dividing in the same way; alternating 10 and 24 subdivisions using numbers and letter pairs.
2) When the locator is specified at lower resolutions, e.g. 6 characters such as in VHF contests, the centre of the squaroid at that resolution should be taken. This is equivalent to, for example, appending the 6-digit location IO90IV with the mid-range characters 44LL to give IO90IV44LL for the purposes of calculation. A quoted locator of IO90IV58 would have "LL" appended for the calculation.
3) That the WGS84 worldwide spheroid be the standard mapping be used for all locator conversions.

4) IARU Locators should always be quoted and used employing all Upper Case (Capital) letters.

9. Recommendation

In the VHF Managers Handbook - That Section 5.11 regarding the locator system should have 5.11.1 (History) moved to an archive and that 5.11.2 – 5.11.4 be updated/replaced based on the above, including examples / illustration where appropriate.

Foot Notes

(1) The term 'Squaroid' has been used throughout this document in place of the incorrectly used locator 'square.' The small subdivisions of lat/long are three-dimensional projections on a spheroid and are neither square, nor have their sides straight, nor at right angles. On a Mercator map projection, they may appear rectangular, and at 60 degrees' latitude, may even appear square but this is only an artefact of the projection in use. The term 'squaroid' removes this ambiguity.

(2) The system converges to a point at the geographic poles. The origin at the South pole is therefore AA00AA00AA. The squaroids at the North and South Poles locations are of zero "width" as the longitude lines have all converged there.

***Editor's note** – Figures/ Examples to be added in final version for the Handbook*