

RECOMMENDATION ITU-R TF.1011-1

**SYSTEMS, TECHNIQUES AND SERVICES FOR
TIME AND FREQUENCY TRANSFER**

(Question ITU-R 102/7)

(1994-1997)

The ITU Radiocommunication Assembly,

considering

- a) the continuing need in all parts of the world for readily available standard frequency and time reference signals;
- b) that different levels of precision and accuracy, ranging from 1 s down to about 1 ns, are required for the large number of diverse applications for time and frequency;
- c) that, in many time and frequency applications, the selection of an optimum time and frequency transfer system or technique must also take into account other factors, such as availability, reliability, capabilities for automatic operation, convenience of use and cost;
- d) that, throughout the world, many different systems, techniques and services have been used successfully to satisfy a large variety of time and frequency requirements;
- e) that useful systems, techniques and services include both those dedicated for time and frequency needs and others that are designed primarily for other functions, such as navigation or communications,

recommends

- 1 that, when selecting a suitable source of time and frequency reference signals or an optimum technique for time and frequency transfer, each application first be carefully analysed with respect to the relative importance of accuracy and/or precision, geographical coverage, availability (for example, the fraction of time that the signal is available at the stated performance level), ease of use and user costs;
- 2 that, based on such an analysis of specific requirements and their relative importance, suitable systems, techniques or services could be selected from those listed in Annex 1* along with their most important characteristics.

* Additional information is also available in the ITU-R Handbook on selection and use of precise frequency and time systems

ANNEX 1

TABLE 1

Details of various dissemination and comparison methods for time/frequency applications

Type	Typical time accuracy capability, vs universal coordinated time (UTC)	Typical frequency transfer capability	Coverage	Availability	Ease of use	Approximate relative user cost (\$US 1992)	Example system	Comments (1992)
HF broadcast	1 to 10 ms	10^{-6} to 10^{-8} (over 1 day)	Global	Continuous, but operator and location dependent	Depends on accuracy requirements	50 to 5 000	Many services worldwide	Accuracy depends on path length, time of day, receiver calibration, etc.
LF broadcast	1 ms	10^{-10} to 10^{-11}	Regional	Continuous	Automatic	3 000 to 5 000	See Recommendation ITU-R TF.768	Depends on distance from the source and diurnal propagation (ionosphere height)
LF navigation (pulsed)	1 μ s	10^{-12}	Regional	Continuous	Automatic	12 000	LORAN-C	Northern hemisphere coverage. Stability and accuracy based on ground wave reception
Television broadcast terrestrial links	10 ns for common view	10^{-12} to 10^{-14} (over 1 day)	Local	Dependent upon local broadcast schedule	Automatic	5 000		Calibration required for timing
Navigation satellite, broadcast	50 to 500 ns	10^{-10} to 10^{-12}	Global	Continuous	Automatic	3 000 to 15 000	Global positioning system (GPS) and GLONASS	One day averaging necessary to meet specified frequency transfer capability. Best broadcast system available today with commercial receivers
Navigation satellite, common view	5 to 20 ns	10^{-13} to 10^{-15} 1 to 50 days	Intercontinental	Continuous	Automatic data acquisition Requires post processing	10 000 to 20 000 per site	GPS and GLONASS	Most accurate widely used, time synchronization method that is available today (1992) with commercial receivers for baselines less than 8 000 km
Meteorological satellite, broadcast	100 μ s	Not recommended for frequency transfer	Regional (satellite footprint)	Continuous	Automatic	4 000 to 5 000	Geostationary operational environmental satellite (GOES)	May not be available during satellite eclipse