Inclined towards radio

John Yates, Senior Vice President (SVP) of Network Engineering, ONDAS Media SA, explains why a Highly Elliptical Orbit (HEO) satellite system could be the system of choice for the delivery of satellite radio services in Europe.

There are a total of 14 million satellite radio subscribers in the US today which is an impressive figure considering that the service was only launched in 2002. The two incumbent operators, Sirius and XM Radio, have adopted quite different approaches in respect of the satellite system architecture - Highly Elliptical Orbit (HEO) and Geostationary Orbit (GEO) respectively, and both seem to have been successful in providing the right mix of service quality and content. And with start-up and operating costs of a similar order of magnitude one could make the reasonable assumption that both approaches seem to provide an equally cost-effective approach to service delivery.

But how effective are these two architectures, HEO and GEO, in providing a satellite platform for the delivery of mobile multimedia content in Europe?

ONDAS has conducted extensive studies comparing the merits of GEO and HEO-based systems for the delivery of satellite-based mobile multimedia in Europe and finds that for a European service the economic model of the GEO-based solution is quite simply just not as cost-effective as a HEO-based system.

Elevation and signal shadowing

One of the principal considerations in designing a mobile, satellite-based broadcast system is the degree of signal shadowing that might occur and how this can be compensated for in order to maintain the high quality of service expected by end-users without interruption. This can be done in several ways – by the use of time-redundancy in the broadcast signal, which will compensate for brief signal losses, for example in the case of ONDAS up to eight seconds, caused by say a vehicle passing behind a building, by the use of multiple satellites to provide signal path diversity and by the use of a terrestrial network of gap-filler repeaters for more dense shadowed areas such as urban environments.

Figure 1 shows the elevation angles for a single GEO satellite placed at 20 degrees East – a good geostationary orbital location for a European coverage. The figure clearly shows that for a GEO-based system as the latitude of the coverage area increases the angle of elevation of the satellite decreases and hence the chance of blockage or shadowing of the line-of-sight to the satellite substantially increases. Conversely, as the geographic latitude of the coverage area decreases (towards the equator) the angle of elevation of the satellite increases and the visibility of the satellite gets better.

So for a country in lower latitudes, say Mexico for example (15 degrees - 30 degrees latitude), a GEO-based solution could provide an efficient and cost-effective platform for the delivery of satellite-based, mobile multimedia services with minimal shadowing.

However, in order to maintain the quality of service from a GEO-based system to users in higher (European) latitudes it is necessary to compensate for this shadowing using an extensive (and expensive) complementary terrestrial network - or alternatively move to a HEO-based architecture.

Figure 1 Elevation Contours for a GEO at 20°E.

ONDAS' HEO Architecture

The ONDAS operational space segment comprises three geosynchronous satellites in Highly-inclined Elliptical Orbits (HEO) with repeating ground traces. The satellite orbital planes are separated by 120 degrees and the satellites are phased in each plane to provide continuous broadcast coverage over Europe. The orbit perigees are maintained at 270 degrees East from the ascending node in order to maintain the apogees over northern Europe.

The satellite broadcast beam is active around apogee and handover is performed such that only one satellite is active at any one given time. The broadcast beam is handed-off between satellites to maximise the elevation angles to receivers in the geographical coverage area. In this way each satellite's broadcast payload is active for eight hours per day with power profiles toggling on and off between satellites in order to cover the entire 24 hour period.

Since the satellites are in constant motion and the slant range is constantly changing, the uplink and broadcast beam will be steerable. It may also be necessary that the broadcast beam shapes be dynamically adjusted to maintain the geographic coverage of the beams and, in addition, the broadcast power of the beams may need to be adjusted to maintain relatively constant power densities on the ground within the coverage area.

Figure 2 shows the elevation angles that would be seen by a mobile user in London for a three satellite HEO constellation. Such

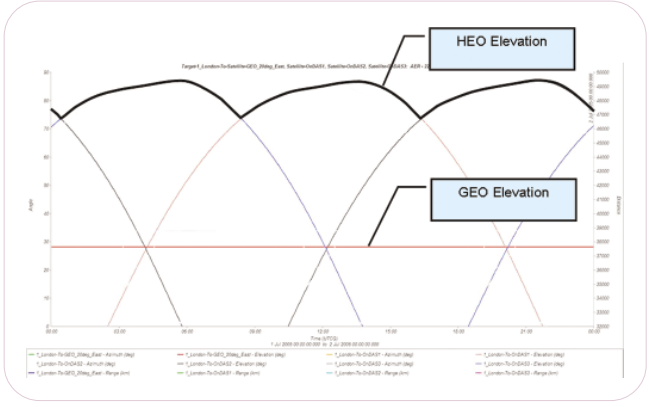

Figure 2 HEO Elevation Profile for a Three HEO Constellation for London.

a user would experience maximum and minimum elevations of 87 degrees and 74 degrees respectively. For comparison the elevation of a GEO satellite is also shown with a constant elevation of 28 degrees. The higher HEO elevation angles translate directly into re-

duced satellite signal blockages and hence improved availability of signal and quality of reception. One can then clearly see the benefit of a HEO system architecture over a GEO system for such latitudes.

The benefits are further illustrated in Figure 3 below, which shows typical satellite shadowing effects at European latitudes caused by urban development and foliage for both GEO and HEO-based solutions and illustrates the significant improvement in signal quality and reception achieved by the use of HEO satellites.

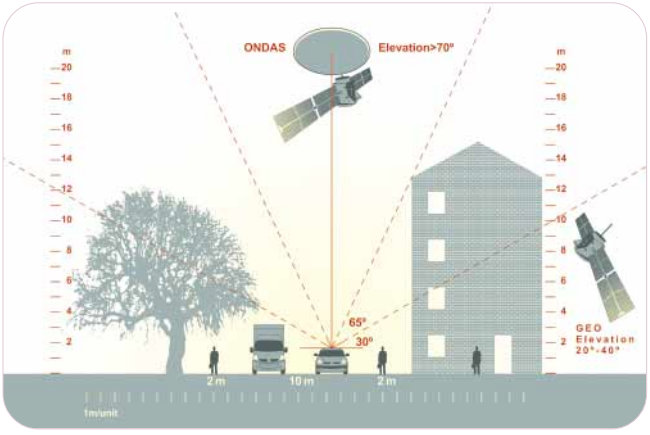

Figure 3 Shadowing in Mobile Systems.

Southern Europe

Basic physics tells us that as the geographic latitude of the coverage area decreases then the elevation of a GEO-based platform increases and so the relative benefit of a HEO architecture decreases. However, even in southern Europe a HEO-based platform provides substantially better elevation angles than a GEO-based solution. This is shown below in Figure 4, which uses as an example Turkey - one of the southernmost countries in the ONDAS HEO coverage area.

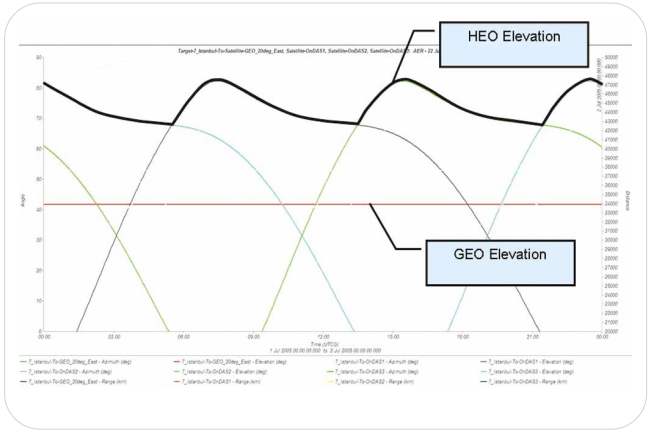

Figure 4 HEO Elevation Profile for a Three HEO Constellation for Istanbul.

One can see that the GEO elevation for Istanbul at 42 degrees is increased and improved compared to the GEO elevation for London which reflects the lower geographic latitude of Istanbul. However, the HEO elevation remains substantially higher than the GEO elevation with maximum and minimum elevations of 82 degrees and 68 degrees respectively thus demonstrating that even for southern European latitudes a HEO-based architecture optimised for central Europe can provide a more effective platform for the delivery of mobile multi-media than a GEO-based system.

Worldwide

By way of further examples, the US, which generally falls between 30 degrees and 50 degrees latitude, is served by two DARS systems – Sirius, a HEO-based system, and XM, a GEO-based system. In order to compensate for shadowing effects XM uses two geostationary satellites for signal path diversity and employs of the order of a thousand terrestrial repeaters. Sirius, which uses a HEO constellation employs in the order of a hundred to achieve a similar coverage.

The US-Canadian border is at about the same latitude as southern Europe and so the shadowing effects associated with a geostationary satellite are far worse in Europe (which falls roughly between 40 degrees and 60 degrees latitude) than in the US. South Korea, located between 35 degrees and 40 degrees latitude and therefore slightly south of European latitudes, is served by the MBSAT geostationary multimedia satellite and uses over 8,000 terrestrial repeaters as gap-fillers.

Using such a GEO-based architecture, the terrestrial network effectively becomes the principal delivery platform and the geostationary satellite the gap filler.

One can clearly see then that a GEO-based solution, with an initial space segment cost of between Euro 130 million and Euro 200 million, may initially be seen as a palatable, low-cost entry into the European mobile multi-media broadcast business. However, when one considers the additional cost of implementing a complementary terrestrial repeater network on a country-by-country basis across Europe the overall project cost quickly escalates. In fact, ONDAS estimates that the cost of implementing a terrestrial infrastructure to complement a GEO-based European mobile multimedia system would be of the order of Euro 200 million – 300 million per country, as opposed to a terrestrial infrastructure cost of around 100 million for the whole of Europe for a HEO-based system such as ONDAS.

One can clearly see then that the cost of installing a such a terrestrial network in just a few Europe countries quickly escalates beyond the cost of a HEO-based system.

It is anticipated that the ONDAS communications infrastructure cost will be of the order of Euro 800 million for the space segment and Euro 100 million for a network of around 300 terrestrial repeaters for a total of Euro 900 million for a European HEO solution.

FRAUNHOFER INSTITUTE TO DEVELOP CORE ELEMENTS OF ONDAS SATELLITE MEDIA SYSTEM

ONDAS Media, (ONDAS) has awarded the contract to design and develop the core RF and Waveform approach for ONDAS' European satellite media system to The Fraunhofer-Gesellschaft Institute (FHG), Germany.

The multimillion Euro FHG contract - which follows recent statements that ONDAS has partnered with Delphi Corp. as a strategic investor and technology provider - will ensure ONDAS has key systems engineering support throughout the product development lifecycle of its state-of-the-art satellite media system.

"Fraunhofer is the clear leader in satellite digital radio technology," confirms Celso Azevedo, Chief Executive Officer (CEO) of ONDAS. "It offers scientific and technical expertise for research and development services specialising in applied research of direct utility to private and public enterprise for the wide benefit to society.

"Our partnership with key industry organisations such as FHG and Delphi ensures we are bringing together all the highest caliber providers to deliver our vision of a full subscription-based, advertising-free satellite radio, video and data service for Europe in 2009."