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Hughes Europe: Satellite On-the-Move

Meeting the challenge of mobile broadband

Hughes Europe: Satellite On-the-Move

Satellite on-the-move technology has come a long way in recent years. On the one hand, technology development has brought down both the size and cost of equipment and of implementation, broadening the customer base for these systems.

At the same time, business demands in such areas as improving crew welfare in tough maritime environments for example, as well as consumer demands, have resulted in companies looking for consistent availability of greater bandwidth on-the-move. Yet the challenge remains for providers to maintain contact with the satellite throughout the particular environment in which they operate, whether supporting land, sea or air travel.

This White Paper looks at where satellite provision is today, the hurdles still to be overcome and how providers such as Hughes Europe are working to achieve the ultimate goal of 'anywhere, anytime' communications for any user.

Evolution or Revolution?

The development of satellite on-the-move technology in recent years, though rapid, has been essentially evolutionary.

Yet there have been some major changes along the way. The ability to change modulation and coding schemes, for example, has enabled much greater flexibility in linking into the network, irrespective of the particular environment.

This means that coding schemes can mitigate for those geographies experiencing excessive fading or adverse weather conditions. Similarly, in a clear sky environment, coding can be changed so that more core user data can be transferred rather than error correction coding. In both cases this is handled dynamically, driving significant efficiency improvements.

And, this highlights a real advantage for satellite. Unlike terrestrial communications provision, which by definition is linked to a fixed location such as a specific line of railway track, satellite today has the flexibility in real-time to allocate bandwidth dynamically to whichever geography is experiencing demand.

Different Modes of Transport, Different Challenges

All modes of transport, whether rail, air or maritime, offer significant opportunities for growth to both communications providers and systems integrators.

Each presents its own particular challenges as a result of the widely-differing speeds and degrees of stability – a fast train is substantially more stable, for example, than a much slower ship which is subject to significant pitching and rolling. In addition, communications providers must meet strict sector-specific regulatory demands, particularly stringent in the aeronautical industry.

Though antenna pointing systems have improved substantially in ensuring consistent satellite links, maritime and air transport inherently have the more consistent line of site needed to support satellite communications than trains (or road-based transport for that matter), which have to cope with a variety of obstacles including trees, tunnels, buildings and stations.

Here, the service provider will integrate alternative technologies such as wireless, in order to fill the gaps and so maintain connectivity. Examples of low gain antennae with broad radio beams have also been developed which help to some degree, as the signal can be deflected rather than requiring direct line of sight.

Supporting continuous broadband satellite connectivity to mobile devices can be particularly challenging. Whilst traditional mobile satellite services at lower satellite frequencies (L-Band and S-band in particular) have been available for some time, such services tend to provide lower rates of speed (less than 400kbps) and tend to be very expensive.

Satellite broadband using higher frequency services, such as Ku-band, can provide more bandwidth at lower cost. Yet the very nature of these higher frequency services presents a significant challenge for the size of coverage areas. As a result, higher frequency Ku-band is better suited to regional coverage, whereas lower frequency C-band provides more global coverage.

The issues faced are many and varied. They include:

Changing Transmission Path

As mobile broadband terminals travel, they will move through various contours of the satellite footprint, causing the path to the satellite to change. The challenge here is for the satellite broadcast system to dynamically adapt to changing link conditions, in order to maintain and optimise both throughput and availability as the vehicle moves across the footprint in varying weather conditions.

Frequent Blockage

As mobile vehicles travel, they will pass under various obstacles such as trees, overpasses and through tunnels, which will obstruct the channel path to the satellite. The challenge in meeting high user expectations is to be able to maintain service using alternative technologies for the duration of the blockage and then to recover the link as quickly as possible once the blockage is passed. This demands good system design, configured to meet the particular challenges of the transport medium in question.

Antennae

Particularly for trains, the antenna must be of a very low profile as the clearance between the top of the train carriage and tunnels and overpasses is often as little as 50cm. The antenna must conform to these height restrictions whilst providing the performance demanded to close the link. In addition, the faster the vehicle, the more antennae need to be aerodynamically efficient.

Harsh Locations

Mobile vehicles inherently provide a harsh environment for any type of electronics. This can include continuous vibrations, dust and extreme temperatures. For electronics to work well in this challenging environment, they must be of robust design, tested against the relevant demanding standards and adapted as required for the specific application.

Best Practice Responses

So what should an ideal solution look like? Leading-edge manufacturers have fully optimised their existing satellite broadband products and services to address the key requirements found in many mobile applications.

In meeting these challenges, key features of such solutions are likely to include:

- **DVB-S2/ACM** — The use of Adaptive Coding and Modulation (ACM) of the outbound channel enables the remote terminal to continually monitor the received signal level of the outbound channel and to dynamically request changes to the continuation of coding and modulation. This allows the downstream channel to be continually optimised as the mobile terminal travels through the various contours of the satellite footprint and fade conditions.

- **AIS** — With the adoption of Adaptive Inroute Selection (AIS) functionality provided by IPoS compliant systems, the TDMA channel (uplink from the mobile device) is continually monitored by the hub and the remote terminal is therefore continuously advised of its optimal TDMA transmission coding and power levels.

  Similar to the DVB-S2/ACM for the outbound channel, this feature means that the TDMA channel is also continually optimised as the remote terminal travels through the various contours of the satellite footprint and fade conditions.

- **TDMA Channel Spreading** — To overcome issues with off-axis transmissions, today's best systems support spreading of the TDMA channel by two times and four times the nominal channel bandwidth.

  A 256kbps TDMA channel with a nominal channel spacing of 320 kHz can be spread to either 640 kHz (2x spreading) or 1,280 kHz (4x spreading). This feature enables the use of very small antennae, lower in cost and easily installed on vessels and vehicles, as it mitigates adjacent satellite interference.

- **Doppler Compensation** — Modern systems can be used to support aeronautical broadband for commercial airliners and similarly for faster trains. As these vehicles move at high speed, enhancements have been made to compensate for the Doppler frequency variations at the hub.

- **Outbound Flywheel and Fast Reacquisition** — As land mobile units will frequently encounter obstructions (trees, bridges, etc.) which prevent receipt of the outbound channel, the best solutions incorporate a 'flywheel' for the timing synchronisation of the outbound channel. The flywheel can 'spin' for as long as 30 seconds, which means that if the outbound signal is seen again within this period, the reacquisition of the outbound channel occurs immediately upon receipt of the first superframe marker.

- **External 10 MHz Reference** — To ensure fast TDMA transmit capability, the latest solutions are capable of accepting an external 10 MHz reference. This eliminates the need for frequency stability to be derived off the outbound carrier – which tends to be less accurate during the flywheel period – and enables the remote terminal to transmit the TDMA carrier immediately upon reacquisition of the outbound channel.

- **IP Steady State** — By maintaining the IP session during periods of outages, even if the signal is lost for more than 30 seconds (e.g. a train in a tunnel), once the link is restored the users do not have to re-establish IP connectivity.

- **Ruggedised Chassis** — Remote terminals should be configured with a ruggedised chassis, permitting mounting in a substantial 19 inch rack, for example - especially as mobile terminals are often installed in environments with high heat, humidity, dust and vibration.

It is also important to integrate the remote terminal with antennae that are designed to support mobility. Such terminals should support an industry-standard L-band Block Upconvertor (BUC), enabling it to operate with antennae that have an integrated BUC.

The Hughes Approach

Hughes Europe's expertise lies in working with partners to tailor and integrate its core satellite network into the client's particular land, sea or air-based environment, at the same time, meeting all the relevant regulatory demands.

In providing connectivity services, Hughes has become well established as a partner of choice for integrators for satellite on-the-move implementations. The pioneer in VSAT technology for more than two decades, Hughes continues to drive technology standards and remains the global leader in providing broadband satellite networks and services for large enterprises, governments, small businesses and consumers.

In supporting satellite on-the-move communications' provision, Hughes can offer near-global coverage very quickly from a selection of geo-stationary satellites integrated into a single network. This removes the operational headache of dealing with multiple parties in providing consistent high quality coverage for trains, boats or planes travelling across multiple geographies.

Other benefits include:

- Optimisation of applied coding schemes for both the inroute and outroute direction through the use of the ACM and AIS features of the Hughes platform. This maximises the useful throughput of the system resulting in cost savings for the partner, while at the same time increasing overall availability and enhancing the end-user experience.

- Implementation of Best Practice features and functionality as described earlier, utilising Hughes extensive experience at the leading edge of system development and implementation in the mobile satellite services marketplace.

- A focussed Service Management approach ensuring that partners get a first class managed service upon which they can build their business, secure in the knowledge that end users get a service they can rely upon and which the partner can be proud to be a part of.

- An integrated systems approach, working with many specialist vendors in the delivery of mobile solutions, making available a wide pool of additional expertise upon which to draw, and enabling partners to benefit from an established and proven group of best-in-class companies providing additional related services and products.

And this is supported by Hughes' unique Integrated Network Services (INS) Suite – a comprehensive 'one stop shop' set of connectivity, technical support and management services designed to ensure optimum delivery of Hughes' multi-national communications network.

Delivery in Practice

People on the move today, whether travelling by air, sea or land demand access to high quality mobile communications, even in the remotest locations. In response, the following brief examples involving Hughes mobile solutions show how satellite technology is being adapted to meet the individual needs of three very different environments:

1. Air

- In providing in-flight WiFi on Alaska and SouthWest Airlines fleets, the underlying technology consists of a small number of in-cabin wireless hotspots together with sophisticated satellite uplink-downlink technology. By using a blister antenna on the outside of the aircraft, passengers pay once to access the system - much as they would when staying in a hotel. The result is similar to surfing the web at any other location.

2. Maritime

- For more than 20 years, Hughes has worked successfully with Rome-based Telespazio, a joint venture between Finmeccanica and Thales and one of the world's largest and most advanced satellite service operators. As part of this long-standing partnership agreement, Hughes provides the following mobile satellite solutions for the maritime market:

  — **Global C-band coverage** for cargo, oil & gas and cruise ships. Using Intelsat satellites, this provides advanced broadband services via three HughesNet HX NOCs, including two in Fucino (Italy) and one in Riverside (USA)

  — **Ku-band coverage for the Mediterranean region,** for commercial shipping and yachts. Using a W3A satellite, this is provided via an NOC in Fucino, Italy.

- In a separate development, Hughes Europe has developed a new VSAT-based offering targeted at the mid-size yacht market, working with Global Marine Communications (GMC), specialists in providing merchant and private vessels with high quality Ku-band satellite communications.

  With GMC's established Sea Access solution based on Hughes' satellite technology, those onboard cargo ships, tankers, fishing vessels, cruise ships or large yachts in frequently challenging environments can access email, browse the Internet and conduct online business with consistent broadband connectivity.

  As a result of the new joint technology initiative incorporating smaller, lighter satellite dishes, this communications service will be extended to the important mid-size yacht market. Tests have already been successfully completed to include TV and video conferencing as part of the broader voice and data communications offering. This means that owners who want to stay in touch, whether for business or social purposes, will for the first time be able to benefit from consistent and cost-effective communications, irrespective of location.

3. Rail

- In supporting rail services in both the USA and India, in each case the antenna mount is bolted to a steel plate attached to the top of the train via mounting brackets with rubber pads, in order to provide the necessary stability and rigidity. The BUC is also mounted as close as possible to the ceiling point of entry to minimise the cable length and loss.

  A gateway and WiFi access point are used to throttle each individual user's throughput and provide access throughout the length of the train, respectively. WiFi repeaters are also required to strengthen the WiFi signal toward the back of the train.

  The QoS is set at 1.5Mbps downstream (to the train) and 380kbps upstream (to the Internet). As a result, throughout the train's movement, connectivity is continuous and passengers are provided with unbroken broadband coverage throughout the journey.

  In Europe, building on their established relationship in the maritime market, Hughes Europe and Telespazio are at an advanced stage of development in providing mobile broadband solutions to the rail sector, based on the HughesNet HX platform. Following a four-year research programme, initial customer testing has now been successfully completed.

Future Developments

Today, it is fair to say that supporting technologies are able to provide the user with an equivalent quality experience to that of GSM-based terrestrial communications services, with line of sight limitations being the only significant distinguishing factor.

There are however a number of developments likely to underpin the growing availability of these services to the broader market.

The growth in higher frequency bands such as Ka-band provides a higher gain beam from the satellite, so enabling the adoption of smaller sized dishes. Moving to such frequency bands brings benefits in terms of terminal size, ensuring they can be accommodated on smaller ships, as well as planes and trains.

So, what might not be economically viable initially, in terms of an automated pointing system on a ship requiring a 1.2 meter dish, will become much more affordable and practical if connectivity can be delivered using a 60cm dish.

In another development, the military have used spread spectrum technologies for some time for encrypted communications. Here, the sender uses coding systems to spread the power across the frequency band and the receiver uses the same coding to retrieve the message. However, by spreading the power across a wider bandwidth from a given terminal, it is possible to minimise interference to adjacent satellites.

Again, this makes it possible to adopt a smaller dish size as transmission does not have to be so precise or selective in identifying the relevant satellite. This technology is available today on the Hughes platform, contributing significantly to reducing terminal size and the associated costs.

Suitable Business Model

In these and other developments however, it will be equally important to create a compelling business model in order that the technology addresses an identified and viable need. And this is critical as the set-up costs - including regulatory approvals in the case of air travel, for example - can be significant, presenting a real challenge to successful market entry.

A number of questions need to be answered for both the business and domestic markets. How much demand is there for TV or teleconferencing, for example, in addition to voice and data services? What charging model is likely to be more attractive – a slightly higher ticket price or a per hour or per day pricing model?

Early attempts such as the Boeing 'Connections Service', launched in 2004 and withdrawn two years later, sought unsuccessfully to establish a viable market. Yet the picture is changing rapidly, as both business and domestic users have become used to the almost ubiquitous availability of Internet-based services.

As technology continues to bring down the cost of connectivity, there is no doubt that there is an increasing 'pull' from both the low volume/high income commercial market and high volume/low income domestic users – driven in large part by the explosion in social networking – for high quality 'anywhere communications' whist they are on the move.

As a result, Hughes is working with partners such as Row 44 in the air travel market, Telespazio and GMC in the maritime arena and Telespazio in the rail environment to develop compelling integrated broadband propositions for each sector.

In using the generic term 'satellite on-the-move', it is important to recognise that air, sea and rail/road travel each present distinct challenges to communications providers. Yet satellite on-the-move represents a valuable and growing market opportunity for providers who recognise and address the specific demands of business and individual users in each case.

In summary, we believe that advances in broadband satellite technology are keeping pace with market needs in today's mobile environments, as providers such as Hughes and its partners look to overcome the main hurdles to consistent high quality satellite on-the-move communication across all transportation sectors.

For more information, please contact us at sales@hugheseurope.com or visit our website at www.hugheseurope.com.

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