eLoran Maritime Service Provision: Initial Thoughts

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The world of Loran is moving fast (PPT1). There is an accelerating pace of activity, as important decisions approach on both sides of the Atlantic. Those decisions are based on the Enhanced Loran that came from the remarkable work undertaken under Mitch Narins' leadership here in the US, a programme many of us were proud to have taken part in.

For the UK and Ireland, now the investment in our new Loran station at Anthorn has been secured and it is on the air, we must develop our eLoran capability. For maritime use, we need a differential Loran service. I want to focus on that word "service". The General Lighthouse Authorities provide safety-critical services. They have a total maritime service-provision requirement with institutional, regulatory, commercial, operational and user facets, in addition to the technology we have all focussed on so far (PPT2).

Let us step back for a moment to the report of the Loran Technical Evaluation Team, published in 2004 (PPT3). This investigated whether a Loran system could satisfy the needs of aviation non-precision approaches, maritime harbor entrances and approaches, and the precise timing and frequency of the communications world. In short, its object was to establish technically whether or not Loran could be a safe, accurate, reliable, and cost-effective alternative source of position, navigation, and time, in a GPS outage. The conclusion, as you know, was that a modernised Loran system could indeed meet the needs of those users. That modernised system is what we now call "eLoran".

This study examined the accuracy, integrity, availability and continuity of Loran. For maritime applications, the performance parameters included the requirements of the International Maritime Organization (IMO) and the United States Coast Guard (PPT4). The key question for maritime users turned out to be whether modernised Loran could meet the exceptional accuracy requirements of harbour entrance navigation, which are at least an order of magnitude more stringent than those of aviation approaches. This was the task of the Loran Accuracy Panel (LORAPP). As for integrity, availability and continuity, the aviation specifications were the demanding ones. If eLoran could meet aviation needs, it could certainly meet maritime needs.

So, maritime development focused on accuracy. As Wouter Pelgrum has shown here (PPT5), the LORAPP concluded that high accuracy needed not just eLoran but two other components: careful mapping of additional secondary factors across harbours in the spatial domain, and real-time differential operation to monitor their variations in the temporal domain. Given careful attention to these factors, modernised Loran promised remarkable accuracy: 1-2 orders of magnitude better than traditional Loran-C.

And so it has proved. I have now identified four demonstrations of harbour entrance and approach operation that meet not merely the sub-20m, 95%, accuracy target of the LORAPP, but the sub-10m of the newer IMO specification. Two of these demonstrations come from the United States Coast Guard Academy team: Dick Hartnett, with Peter Swaszek in Rhode Island, and Greg Johnson and Ken Dykstra at Alion (PPT6).

Wouter Pelgrum, and his Reelektronika and Megapulse colleagues, also achieved that target in Tampa Bay (PPT7). And in Europe, the General Lighthouse Authorities, again with Reelektronika, showed sub-10, 95%, accuracy along the approach channel into Harwich (PPT8).

But the Blue Riband goes to the Coast Guard Academy (PPT9)! A few months ago, they demonstrated real-time operation (not just post-processing) with a live reference station a Loran data channel, and on a moving vessel.

Now it seems to us that, although sub-10m performance is demanding, it has been convincingly demonstrated. But can it be done long-term? Can a team of normal human beings sustain it, when these high achievers move on to other challenges?! Can the GLAs meet all those institutional, regulatory, commercial, operational and user requirements? In short, can we move from technology demonstrators to a total maritime safety-of-life service? That is the challenge now.

Let us think about just what shape such a service might take. Last winter, an ILA team put together the Enhanced Loran Definition Document (PPT10). They proposed a Core eLoran Service Provider (PPT11), who would deliver a highly precise version of the signal originally described in the US Coast Guard Specification of the Transmitted Loran-C Signal. Then, Application Service Providers would deliver data for specific applications (maritime, aviation, or timing) via a Loran data channel. Here is the model for a maritime eLoran service (PPT12). The Application Service Provider would generate the differential Loran corrections and provide the ASF maps, and probably early skywave warnings, too. The maritime Application Service Provider would be a specifically maritime organisation, like the GLAs. The Core Service Provider would be radio transmission specialists like VT Communications who run the GLAs' Loran station and might run a whole network of Loran stations.

The eLoran Definition Document also reminds us that we need documentation to define the eLoran service (PPT13). It proposes what it calls a *Plan*, a *Performance Specification* and an Interface Control Document. The *Plan* sets out policy, operational matters, a service description, and possibly future developments, in the way the US Federal Radionavigation Plan does. The *Performance Specification* defines the level of performance and the coverage area within which it would be provided. It would be like the specification for the SPS GPS service. These documents will be owned by the service providers. Each Core Service Provider and each Application Service Provider would develop their own service definition documents based on these international standards, and on local service requirements. Finally, there would be an eLoran *Interface Control Document* (ICD), like the GPS ICD, standardized globally to ensure interoperability.

We do not yet have any of these documents, neither in the US, nor in Europe, nor elsewhere. So, who is to draft them, and who is to review them? Is this work for the ILA, perhaps for the GAUSS group?

The General Lighthouse Authorities have many other things to learn and develop as they create an effective maritime dLoran service. To check whether they have covered all aspects and a service is ready for launching, the GLAs work to a model (PPT14). This model specifies six facets of service provision that should be secured before a service is declared operational with its service level agreement in terms of performance, cost and risk. Let us look briefly at the kinds of things we will all need to get right before launching dLoran services, over and above the technology on which we have focussed so far.

First, Institutional matters (PPT15). Does the international environment within which the GLAs operate, and do the rules of the IMO, IALA and the European Commission, allow them to provide a dLoran service? Do they have international agreements for frequency coordination? Is it legal for the GLAs to provide the service under the Merchant Shipping Act?

Are the frequencies available and protected - globally from the International Telecommunication Union, nationally from the UK and Irish agencies that coordinate the spectrum (PPT16)? Have those bodies set any limitations?

Is eLoran part of the GLAs' overall policy and plans (PPT17)? Do they have a full description of it and an approved Interface Control Document? Is it in the Admiralty List and on the Hydrographic Office charts? Does its quality depend on the performance of third-parties and are there service level agreements with those bodies? And does it fail gracefully, or catastrophically?

Can the GLAs run the system (PPT18)? Have they planned the maintenance, health & safety and environmental aspects? Do they have spares and trained operators?

And do the users have all the information they need, including Notices to Mariners (PPT19)?

Now, we already know the answers to many of these questions. But this is a new technology and there are questions we cannot answer, possibly questions that no-one can yet answer. The GLAs need to conduct trials, starting where those technology demonstrators left off. Here are some of the questions to which they will seek answers from the trials.

How many reference stations will be needed (PPT20)? The GLAs serve 34 harbours that handle SOLAS vessels, places where they would probably want a dLoran service of harbour-level quality. But what is the effective range of each reference station? Could Southampton share one with Portsmouth? The US is gathering good data on this topic, but there are no clear answers yet. We need such answers in order to design our dLoran system.

Our weather in the UK and Ireland is often wet and windy (PPT21). We do not get deep freezing and thawing. But other low-frequency radionavigation systems in Britain show that weather fronts cause significant temporal variations in pseudo-ranges. So, how effective will the reference stations be? What if a user is on the opposite side of a front from the reference station? We need to get some reference stations running long-term, and measure this.

Like other European Loran stations, Anthorn transmits Eurofix (PPT22); this immediately gives the GLAs a Loran Data Channel for their trials. In the long term, of course, Europe may or may not switch to 9th-pulse, or use both, or even add more pulses. How many reference stations can Eurofix support? More, or fewer, than 9th-pulse? We must learn!

Do the GLAs need atomic clocks and UTC at their reference stations (PPT23)? For maritime navigation alone, probably not. But the timing community do need the higher stability that atomic clocks bring. We must experiment with reference station clocks.

And how many new Loran stations does Europe need (PPT24)? That depends on how strong Loran signals need to be to support harbour-entrance performance? The Coast Guard Academy got much poorer dLoran performance in Norfolk, Virginia, than on the Thames River in Connecticut or in New York Harbor, even though Norfolk had six Loran stations with good geometry. Those stations were too distant and some had poor signal-to-noise ratios. Our trials will help us estimate how many additional stations a Europe-wide eLoran service would need, and what that would cost.

These are some of the questions we plan to explore in the near future (PPT25). At the same time, the GLAs have the big task of spreading the message of the effectiveness of eLoran as a GNSS backup to other European countries. Their eyes are often still on Galileo. We need really good dLoran demonstrations that will influence the future European Radionavigation Plan.

As you have seen, all of us who look to create working dLoran systems have a journey ahead. It starts from here: our solid demonstrations of the potential of differential eLoran to provide a high-performance backup for GNSS. For the GLAs, it will end in a dLoran service of high quality and reliability that, day-in and day-out, will bring enhanced safety and security to mariners sailing the waters around the coasts of the United Kingdom and Ireland.

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