



Meshed Remote Operation as the Default Mode: From Technical Challenge to Society Opportunities

Anges Peil^(✉) and Michiel Coopman

De Vlaamse Waterweg, Hasselt, Belgium
{agnes.peil,michiel.coopman}@vlaamsewaterweg.be

Abstract. This paper describes the choice of the Flemish waterway authority – De Vlaamse Waterweg – for a new vision on remote operation of its inland waterway infrastructure. From now on, remote control is the default operation mode. As of 2019, a new vision was approved to remotely control all our movable structures (ca.330) by 2032 from 3 remote control centres. The innovative aspect is that they will function as a fully interconnected meshed network and can be used as a back-up for each other. At first glance this may seem a purely technical challenge. It is however shown that by pursuing this goal, it compels us to rethink large parts of our organisation in regards with change management, business processes, roles and responsibilities, training and technical management. At the same time, we see society opportunities revealing themselves. This paper is aimed at sharing our experiences and as a call-to action for other waterway authorities, academic institutions and private companies to help envision and built the future waterway-systems.

Keywords: Future of inland waterway governance · Remote operation · Change management · Innovation · Traffic management

1 Introduction

De Vlaamse Waterweg NV is an Inland Waterway Authority in Belgium that manages almost all inland waterways and infrastructure, excluding the ports, in Flanders, the northern region of Belgium. Flanders has approximately 1,000 kms of navigable waterways within an area of 13,625 km². The organization of shipping- and water management requires approx. 330 bridges, locks, weirs, pumping stations, etc.

De Vlaamse Waterweg has a long history developing remote control systems for bridges, locks and weirs. As with most inland waterway authorities, these systems were implemented using a project-based approach, clustering the operation of infrastructure per waterway or section of a waterway.

We have come to a point that we have outgrown this stage. From now on, remote control is the default operation mode. As of 2019, a new vision was approved to remotely control all our movable structures (ca.330) by 2032 from 3 remote control centres. The innovative aspect is that they will function as a fully interconnected meshed network and can be used as a back-up for each other.

What started as a purely technical story, has evolved into a future full of opportunities. We found that by formulating such a progressive vision and actually getting to work with it, it opened up a lot of new sometimes unexpected challenges but most of all, a lot of unexpected new opportunities. Opportunities for our organisation, for our employees, but above all for society, the logistics sector and shipping in general.

This paper is aimed at sharing our experiences and as a call-to action for other waterway authorities, academic institutions and private companies to help envision and built the future waterway-systems.

2 Towards a Meshed Network

Up until 2019, De Vlaamse Waterweg had a vision of clustering the operation of movable infrastructures per waterway or specific sections of waterways. A total of 13 stand-alone Remote Operation Centers (ROC's) were envisioned. Some of them have already been built and in operation for decades, some of them are in the finale stage of construction and some of them will forever remain on the drawing table.

During 2019, a number of evolutions made that De Vlaamse Waterweg adjusted this vision: the logistics sector is evolving towards supply chain approach and there is a desire to sail more efficiently (fuel consumption, loading and unloading,...); the 13 corridors have different opening hours and traffic intensity which makes the workload for the employees very different and which increases the risk of less readability of the waterway for the skipper; the Flemish Government imposed staff reduction, Based on these evolutions, the Board of Directors chose at the end of 2019 for the new vision where De Vlaamse Waterweg will operate its infrastructure from 3 major ROC's, aiming at 2032 to accomplish this.

From a technical viewpoint, the vision of evolving towards 3 major ROC's starting from several pre-existing stand-alone minor ROC's sparked the idea to approach this in a different way than before. First off, there is the question of availability, redundancy and disaster recovery. By centralising the operations, the impact of an incident in one of the ROC's scales along with the size of the ROC. This will become a major concern in the final state. Secondly, the path towards this finale state of 3 major ROC's, will have to accommodate for the current situation of several minor ROC's and allow for a flexible and smooth migration, preferably with some sort of fall-back plan and stable intermediate situation, all while ensuring continuous service.

These considerations lead to the idea to make both the existing ROC's and the future major ROC's, interoperable and redundant such that they form a meshed network. The idea is that all the operating desks and involved technical systems are interoperable, no matter where they are located.

In doing so it will become possible during the transition stage, to remain in operation until the day of migration and then to turn the switch as a matter of speech. This allows to detach the operational and organizational decision from the technical timeline. And in case of incident or emergency, it will be just as easy to fall-back or to move operations towards one of the other ROC's.

Lessons Learned and Recommendations:

- i. The society and the world we live in are constantly changing and technological developments are having an impact on how we do things and vice-versa.
- ii. As waterway authority, we have a duty towards society and to adjust to these changes.
- iii. It is the challenge to find the balance between continuity of service, building for the future and allowing for change and innovation.

3 Change Management

The new vision from 2019 (to serve 330 infrastructure works from 3 control centres) introduced technical, organisational, communicative, ... challenges within De Vlaamse Waterweg. Between 2019 and 2022, this new vision was translated into a new approach in various areas: ensuring redundancy across the 3 control centres, building long-distance stable network connections, extensive standardization, improving cybersecurity, drawing new organizational charts and business processes, developing a central approach to water management, providing professional training to operators, drafting an implementation plan with a view up to 2032, ...

3.1 Working with Ambassadors

We think that supportive communication and a precise insight in the stakeholders of your change is essential for success. Therefore we make extensive use of various forms of communication and interaction with our stakeholders.

At the end of 2021, an community of ambassadors was set up to extend the diversity in our guiding coalition to Remote control. The community of ambassadors are a group of volunteers within our organization committed to the transformation effort. They promote remote control and share feedback of the business engagement they experience.

This community officially started at a digital (because of COVID-19 measures) seminar attended by approximately 1/10th of the employees of De Vlaamse Waterweg. The Managing Director and the Operations Director shared the change story with the participants to create a sense of urgency. Besides the importance of remote control for society and shipping, the importance for their own employees, the professionalization of the operation, the new opportunities created for collaboration within the organization, the opportunities to standardize processes,... Were discussed in an interactive way.

3.2 Communication

This was followed with an intensive communication through various media. A one-pager was created to promote the change story on various ways throughout the organization explaining the 'what-why-how'. A seperate page Remote control was created on the intranet of De Vlaamse Waterweg. Here colleagues can easily find all the latest information about remote control an get access to the digital workplaces.

3.3 Focus Groups

We use co-creation and interaction to activate our organisation for Remote control. Dedicated ‘focus groups are regularly organized to capture expertise of our operators and their managers. This on numerous strategic subjects such as the organizational chart within a control centre, on the manuals with the operational guidelines, on solving personnel related bottlenecks, etc. The unique concept of collaboration across different functions ensures support and acceptance of the entire transition among staff members and valuable insight we otherwise would miss. The game rules are: a focus group delivers input and advice from the field, makes proposals for solutions, ... But does not have decision-power. The existing decision-making bodies, both at management level and for consultations with the trade unions, will be retained. In the focus groups, the proposals made by the employees are treated with respect, they are explored in depth, and the “why” question is the most frequently asked question in such a focus group: “why are you saying this”, “why is this important to you”, etc.

Lessons Learned and Recommendations:

- i. The implementation of remote control can be worked out as a pure technical story. However, it offers added value to an organization if it is worked out as a program that operates as a catalyst for other developments within the organization.
- ii. It is important that management recognizes and supports the change story and that employees perceive that management makes decisions based on the input that operators provide from their real-world experience.
- iii. It is important to “plant the flag” far enough into the future. That way, space and time can be made to work on the picture of the future and to determine the steps towards it.

4 Tools

4.1 Training Simulator

De Vlaamse Waterweg NV has set up the AWATAR project. AWATAR stands for Automation of Waterways: Training and Reference. The 3 main goals of AWATAR are, to establish and maintain the technical and operational reference, to allow for standardized and professional training, facilitate, professionalize and mature the way remote control is implemented.

We made virtual 3D models of several lock and bridges, together with models of ships, cars, pedestrians, ... inside a gaming engine. We connected these virtual models with real PLC and SCADA software and simulated different camera-viewpoints, traffic situations and weather conditions.

This allows us to discuss and try very different HMI designs, camera-view points, functional behaviour, operational procedures, ... all without disturbing any real-life operation and in great detail. For the development of the simulator, we organized

multiple participation sessions, workshops and feedback-loops with both engineers and operators. We used Virtual Reality Glasses to design the operator desk.

The simulator offers the possibility to employees to train various types of infrastructure (e.g. lift bridge, swing bridge, rolling bridge, ...) and various scenarios in a short period of time. In addition to the normal traffic flow, various weather conditions can be rolled out (rain, fog, etc.), incidents can occur, etc. This allows the operator to practice his skills in a safe environment on generic structures. On the work floor, training is then given on the specific structures in the remote control center.

4.2 Learning Environment

A digital learning platform was set up, tailored to operators. this learning platform uses 12 clickable tiles. The information offered depends on the theme. sometimes a short explanation is given and a link is made to existing tools or internet pages, e.g. for water management, a link is made to the website www.waterinfo.be of the Flemish Government.

In the case of more complex subjects, such as ‘navigation regulations and signaling’, a video film provides a verbal guide to help colleagues navigate through the complex regulations. Basic information can be found, for example, behind the tile ‘naming of waterways’ or ‘languages’ where the most common nautical terms are translated into the languages mainly used by skippers in Flanders. The digital learning platform also offers a ‘do the test’ tile where colleagues can see on the basis of a test on which subjects they should best learn more.

The website <https://www.visuris.be/> developed by De Vlaamse Waterweg, in accordance with a number of agreements at the scale of the European Union, is also a source of information.

Lessons Learned and Recommendations:

- i. Developing a digital learning platform takes the necessary time, also keeping it up to date by supplementing the content and adding new questions to the self-test requires discipline and attention.
- ii. The ownership of the learning platform lies within the business, because the colleagues were allowed to develop this themselves, they are also the most important ambassadors of this learning platform.

5 Technical Implementation

The formulation of the new vision towards large, meshed ROC’s requires a mature technology management.

5.1 Research and Development Center

The changing functional needs of the organization require an specific approach from both the technology and the technical organization. The technical realization evolves towards a continuous-life-cycle-approach with a more centrally coordinated organizational unit. To achieve all this, the need for a proper and in-company research and development centre (R&DC) was identified. Beforehand, the technologies implemented in a ROC were mostly contractor-developments and as such, contractor-specific. These technical systems used to be integrated on the spot, in a live environment.

As of the creation the R&DC, contractors are obliged to develop their systems in cooperation with the waterway authority. A systematic development cycle is used, going from functional requirements to technical requirements to proof-of-concept, prototyping and testing, with multiple feedback loops. Only when this cycle is successfully complement, real-life integration is allowed. Furthermore, a development-version is kept, to test future alternations and updates. The idea is to gradually implement and standardize all systems for the whole infrastructure and keep them evolving at the same pace of technological development, in contrast with just using the new technologies in new projects.

5.2 Innovation

New functionalities are requested to support the operation of and between the remote control centres. A different balance is sought between decentralization and centralization of the infrastructure, between standardization and customization. Demands on availability are increasing, but can be partly mitigated by the network synergies when compared to classic redundancy solutions. The scalability and multi-deployability of the systems are a critical point of attention. Technical systems evolve towards an almost completely network-driven operation.

In 2022, in our R&DC, we successfully accomplished a fully functional prototype of 2 ROC's who function redundant for each other. We found that almost all technical systems to we used this date, like the Supervisory Control And Data Acquisition-system (SCADA), Video-management-system (VMS), Automatic Identification System (AIS) now have the capability to function within a network, as they are becoming more and more IP-based. As a general design approach, we make sure to make as little adaptations as possible on the local infrastructure. It is the overarching systems that offer these functionalities. The only system that we have found that poses problems in realizing the needed new functions, is the VHF-system. Different sections of waterway have different settings of the VHF-equipment and the number of sections this equipment can handle is limited. However this is not problematic for now, since the goal of the network of ROC's is to operate mainly predefined sections of waterways and only switch-over in case of major incidents. In such a case, whole sections of waterways will be redistributed across the remaining ROC's and not isolated specific structures. The work-around for now, is to work with redundant VHF equipment within the ROC to allow for some flexibility on this part and to go for manual configuration in case of larger incidents and thus switch-overs.

5.3 Procurement Management

In order to realize a performant and uniform technological standard across all our infrastructure and across the whole life-cycle of our systems, we had to rethink our procurement management. Contracts are no longer aligned with geographical borders (a specific waterway, a specific ROC, ..) or made to measure for a specific project. Contracts are now framework-contracts focussing on technological-system-borders and include often not only new implementations but also updates, replacements, maintenance etc. during several years. This allows to attract specialised contractors and built a long-term cooperation. The challenge of course, is to coordinate between these different framework contracts while realizing large projects and making sure these different technical systems can fully cooperate. Another reason why the R&DC is a crucial piece of the puzzle.

5.4 Project Management

In order to achieve the goal of remote control as a default mode for our ca. 330 works, a complex task is set out for our organisation as a whole, in regards of project management. As of now, all projects on the movable assets become part of the larger puzzle. The full potential is only reached when all pieces of the puzzle come together and the picture becomes clear. Following the timeline of one project can already be a challenging task but now the timeline of all these projects influence one another. A dedicated team is assigned this daunting task.

Lessons Learned and Recommendations:

- i. Most of the needed technology to accomplish meshed remote operation is available today
- ii. Because of the links on both a technical level as a governance level, meshed remote operation has a tendency to make things more complex and in need of a mature technical management

6 Opportunities

6.1 Service

Remote control offers the opportunity to let the service model of De Vlaamse Waterweg evolve in a future-oriented way. In this matter, too, the involvement of the sector is of great importance. In its service developments, the Flemish Waterway wants to take into account the various players and their possibilities. Companies, logistics players, independent skippers, ... Should be given time and the opportunity to adapt and organize their way of working. By organizing specific board groups, the input of the sector is captured.

Today, the operating hours of navigable waterways in Flanders are very diverse. It must be noted that there is also a large variety of vessels on these waterways. On some

waterways there is mainly commercial shipping, other waterways have mainly recreational boating.

It seems logical to state that operating hours anywhere can expand to 24/7 once the remote control centers are up and running. However, for various reasons, it seems that it is not appropriate to decide this as such and requires further investigation. On the side of the waterway manager, for example, an adapted intervention strategy will have to be worked out if waterways are navigated 24/7, which means that more technicians need to be available to solve technical failures. Against this desired higher availability, there is also a higher cost of operation. On the side of the skipper, attention should be paid to the possible shift in the competitive position of independent skippers who have to take into account rest periods versus companies with many skippers who can sail in shifts.

6.2 Integrating with RIS Smart Shipping and Smart Logistics

By moving from a fragmented approach to an overarching integrated strategy and state-of-the-art overall remote control system, full integration with RIS, Smart Shipping and Smart Logistics, and the physical internet becomes possible. Data from the infrastructure will be gathered and turned into useful information.

The opportunities for the logistics sector and shipping are created by embracing innovative technologies and integrating them within the day-to-day operations. We provide the necessary tools to shipping to plan their journey as effective as possible and the systems in the remote control centres support the operators in offering an optimal locking process.

6.3 Water Management

Remote operation of water-controlling structures is somewhat different from operating locks and bridges. The former focusses on a large area and tries to optimise the water management across this whole area. The operating time of each structure is rather short. The latter focusses on one specific structure and takes a larger amount of time (not taking into account traffic management). The main advantage of remote operation on water-controlling structure is exactly that you can oversee the whole area by gathering and using all available data from all the involved structures and basins. It allows to build a decision-support system based on real-time information and predictions. Climate-change is putting more stress on our infrastructure resulting from more extreme weather and water conditions. Making sure we use the full potential of our infrastructure and basins is a way to mitigate the effects with fairly reasonable effort.

Lessons Learned and Recommendations:

- i. Similarly, so-called “logical decisions” in a service delivery model require both internal research and discussions with stakeholders.
- ii. It is important not to view the technical activities within a remote control program as stand-alone activities but to frame them within larger cross-border projects and programs. Waterways do not stop at a country's borders.

7 Conclusions

The strategy towards all-out meshed remote-control makes a digital evolution possible. As such, this originally technical story will contribute to prosperity and well-being in Flanders. Organizations must dare to dream and dare to seize technical evolutions as a basis for the many opportunities to improve the future for the shipping and logistics sector, while at the same time responding efficiently and effectively to the impact of climate change.

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