

# Outsourced signaling teams as a new trend in the 2020s



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# Introduction

Railway transport hasn't lost its relevance, and in fact continues to garner significant investments in global improvements. Despite train networks orientation on increasing the level of connectivity first, signaling systems provide a reliable back for all the transportation processes at any rail development company. At this point, the main emphasis in signaling system design is on the expertise of signaling engineers since it is impossible to design the station automatically.

Current realities offer more opportunities for signaling teams and their management within the rail industry, such as:

- 🔧 outsourcing signaling projects;
- 🔧 employing specialists with Higher Education degrees in signaling;
- 🔧 working at the junction of technologies.

Rail companies involve a team of signaling engineers to design a signaling system for a particular rail section when they need a redesign of the station/line, its expansion, the addition of new tracks, switches; construction of a new railway line; or renovation of old equipment at the station. Each case requires considerable research before starting the project, such as studying environmental conditions, existing equipment, setting business goals, technical requirements, operational rules and more. This will allow the company to clearly define tasks for the signaling team in particular.

Since any rail project has to be delivered with strict adherence to safety standards and technical requirements, it requires rail companies stay highly structured and provide strong control over internal work. Thus, rail companies often adhere to old business workflows, including interactions with signaling teams.

Utilizing the potential of the outsourcing team on signaling projects may not be the obvious decision for a rail company. However, signaling design has its specifics for particular projects, such as unique equipment the team has to operate, or onsite testing which is better to perform with an engineer on-premises. Regardless, considering outsourced signaling teams, the customer has a wider choice of professionals with corresponding higher education levels and relevant experience in delivering signaling projects in various continents. Additionally, outsourced companies that work at the junction of technologies offer unique expertise to their customers, combining the skills of signaling, embedded, and development teams at the same time. Since signaling is based on staff, this is a strong argument.

In this whitepaper, PSA shares our experience on our distant team engagement in various international signaling projects. You will see how to train a distant signaling team and operate at any stage of the project from requirement analysis to factory and field testing, and which benefits it can bring. This approach gives rail companies an opportunity to deliver signaling projects in terms of meeting deadlines and the optimal value for money, as well as reduces the time on the reach of additional specialists to provide hardware and software development solutions for rail.

# Why the importance of Higher Education in Railway Signaling?

Unfortunately, it is almost impossible to employ competent signaling engineers in North America. In the absence of colleges or schools specializing in signaling engineering, rail companies themselves must represent an educational platform for signaling engineers, that requires them to spend extensive resources.

At present time, some countries, especially industrial-oriented, have founded universities that can produce specialists in rail signaling. This tradition is especially strengthened in Eastern Europe, where the rail network is also widespread, and the countries adhere to single standards in the construction of railways, junctions, and signaling systems. The most famous universities that graduate highly competent signaling engineers are:



**Belarusian State University  
of Transport**



**Ukrainian State University  
of Railway Transport**

Both universities offer bachelor's and master's degrees in signaling engineering, providing the students with practical knowledge in automation and remote control of the signaling equipment. A majority of the technical staff of the national railroads for the respective countries are graduates of these universities. They are responsible for the trouble-free operation of software and hardware systems and automated workstations based on personal computers operating autonomously in local information and corporate global networks.

## Why can I rely on highly educated specialists?

- **Deep technical knowledge in railway signaling**

When preparing students, universities pay significant attention to studying the basics of railway signaling, relay and microprocessor technology, software, and gaining skills in working with modern programming tools. The main thing is that these disciplines are studied in close conjunction with signaling design. The graduate is able to create and maintain automated control systems for railway automatics, as well as to develop software, technical and information support for automated control systems of railway automatics. Therefore, the particular rail company won't need to spend quite so many hours explaining this basis to a signaling engineer.

## ● **Field preparation**

In addition to theoretical knowledge, universities conduct mandatory cores in the field for students to get acquainted with the equipment and its operational principles. Practical education in how track circuits, railroad switches, relay and microprocessor based interlockings allows the signaling engineers to see projects wider and offer thoughtful solutions even in non-standard projects.

## ● **Scientific research**

Transport universities are scientific hubs at the same time where advanced methods of solving transportation, safety, and reliability issues are being developed. Having a modern material and technical base, including specialized laboratories equipped with test benches, simulators, and equipment, universities launch research for future implementation in national and global railroads.

The main directions of scientific research of the signaling faculties of correspondent universities are:

- development of modern computer and microprocessor systems for railway automation, remote control, and communications;
- protection for signaling devices against lightning and electromagnetic interference effects;
- improving the reliability and functional safety of microprocessor systems of railway automation;
- telecommunication systems and technologies;
- development of computer information networks and microprocessor devices in process control systems;
- methods and means of technical diagnostics and maintenance of railway automation systems, including thermal imaging and technical vision systems.

The respective developments are aimed at subsequent implementation in the national railroads and railway industrial enterprises. Since about 70% of PSA's outsourced signaling team has a master's degree, they have experience in scientific research connected with improving the safety of the railroads. Such specialists have knowledge of the methodology for evaluating the efficiency of signaling systems, therefore, they can not only deliver the design but also correct the initial request.

Such engineers do not standstill. Teams of highly-educated engineers are dedicated to improving signaling around the world. Read below where you can recruit a ready-made team of engineers for added force on most any rail project.

# On-shore VS Off-shore: pros and cons for a rail signaling team

## Signaling Department on-premises

The core objective for signaling engineers within any rail project is to design the signaling system and its subsystems to be fail-safe to eliminate the possibility of harm to other equipment, the environment, or people. To provide this, various lines across the world still use different types of signal apparatus, both relay, and processor-based systems, and each rail company uses its signaling development solutions. At this point, many of rail companies prefer to organize an internal signaling department to have regular control over it and provide access to the equipment in the field.

### PROS

#### Permanent communication

Having a team in the same territory as you, it seems to be easy to provide full control of a department and fix immediately if something goes wrong. Having access to all team members, it is convenient to directly contact the responsible person for a specific task. It is possible to closely monitor the team from the beginning to the end of the project.

#### Training on-premises

When a company employs a new staff team member, they get an opportunity to train on-premises, having permanent access to mentors, other team members, and signaling equipment. It becomes easy to check their achievements, control their actions as well as study topics deeply in case of need. In addition, having gained in-depth knowledge of working specifically with your equipment, the employee becomes a narrow expert, which reduces staff drain.

#### Confidence in the successful delivery of projects

Delivering projects with one team for tens of years, the company is becoming confident in the department and knows its advantages and disadvantages. Thus, it is easy to establish a management process and follow it strictly. Such a team becomes predictable and reduces the likelihood of unforeseen situations to a minimum.

## CONS

### The indispensability of team members

Every staff signaling engineer is trained for understanding specific requirements of specific signaling systems and equipment. They have the unique scope of skills and knowledge that they got working in specific rail companies. If a team member leaves the company, it becomes impossible to replace them with the new one without spending significant resources on their training. The rail market closure, as well as the fact that every rail company prefers to use their own development, makes it harder to adapt even experienced engineers.

### Need for additional force

The signaling teams in a particular rail company can be rigid and dependent on specific equipment and technologies. Running the signaling system of the station, we imply its connection at least with the wayside controllers, in-cab systems, and dispatching systems. When the project requires establishing an additional connection between subsystems or embedding specific features, companies often engage additional external development teams to deliver the solution. It leads to time losses and additional expenses.

### Cost of human resources

As a complex rail project within signaling requires unique skills and experience from their signaling engineers, it makes the fully prepared on-shore signaling team more expensive. Furthermore, it needs a lot of resources to reclassify the specialist. **According to our data, a rail company spends from 1.5 to 2 years on average to retrain an engineer as a signaling one. During this time, the company loses more than it gains.**

### Unprofitable team expansion

During a significant project, a rail company can suffer from lack of signaling forces. However, for the rail industry, it can be inconvenient to expand the internal team while a project runs. First, it will be necessary to maintain the workload level of the extended team after the delivery of a particularly significant project, which is not always possible. Second, as mentioned above, this need must be foreseen in advance, since the training of a new member requires a lot of time and expenses.

## Why do companies need so many resources for preparing signaling specialists?

Mainly, this is due to the absence of the correspondent higher education programs in North America – schools and universities where students could get a degree in signaling engineering. A general engineer does not understand the principles of signaling by default, has never operated with the signaling equipment, and, therefore, needs to get a new educational basis.

When the company focuses on the signaling engineer preparation, it might be hard for the employees to embrace all the details connected with its specifics. As a result, the company gets a qualified but narrow-oriented team that can cover only a specific part of the rail project. To satisfy all the requirements of the complex rail project and have fewer bottlenecks in the workflow, it can be useful for rail companies to expand their approach to hiring and training signaling teams.

## External signaling team

Rail development does not stand still, offering new opportunities for logistic companies, passengers, network operations, etc. Due to the signaling system having strong connections with other rail systems, it should be adaptable, flexible, and affordable to deploy on various scales and add required features. At this point, the requirements for the signaling team are expanded too, demanding them to adapt to new equipment, technologies, electronics, software, etc. Outsourcing offers a wide choice of professionals that can satisfy a wider request from the rail customer.

### PROS

#### Additional force

When a company completes the training process of operating with specific equipment, it gets a signaling team on tap in the future, that would be able to join the project at any stage on the company's request. This approach is saving while working on a significant project. Realizing that you can always apply to an external team, the company can take on larger projects than before without missing out on lucrative offers.



### A versatile team

Working in the signaling area, every engineer usually has their own unique experience connected with specific equipment, tasks, and locations. Working together on plenty of projects, it is easy for the coordinator to delegate new tasks according to the experience of particular specialists. The experience of working together also makes the team organized, which allows you to avoid unexpected situations and control the process of working on a project.

### Cost-saving operations

The priority for any rail project was and remains safety. In this spirit, companies usually don't intend to save on signaling. However, by utilizing the force of the outsourced signaling team, savings will come naturally. Qualified signaling engineers from Eastern Europe usually cost less than the respective specialists in North America.

After the training period that usually lasts for several months, the outsourced team will be able to deliver signaling projects of the same quality you get by the internal team. The argument in favor of the highest quality of work is the higher signaling education of engineers and direct experience with the equipment. They have learned standards and rules of design in signaling and have worked with the equipment onsite. Even including travels to the site, it is always more profitable to keep a remote team of signaling engineers than to get them in-house.

## CONS

### Uncertainty in contractors

The crucial concern mentioned by rail companies regarding the outsourced signaling team is the lack of control of such a department. However, the company should only accept other methods of control. For example, it can get the information through the Technical Coordinator, PM, or a specialist onsite. Additionally, outsourced signaling teams might have difficulties assessing the scope of the project when companies start working together, due to specifics of new equipment. Therefore, you should devote enough time to training the team.

### Need for team training

Another issue – is it possible to train the distant team to operate with custom apparatus? This question occurs due to the companies' experience in training their signaling engineers – this process is always long and costly. Unlike the local team, no one member of the external team knows the specific signaling equipment of a particular rail company. This means that the company needs to organize team training, that will change their ordinary workflows.

### Impossibility of immediate reaction

When the design team can only be contacted online, this leads to certain difficulties. For example, the difference in time zones may not always allow you to quickly connect in case of some issue, or communication problems may arise. The companies have to coordinate the time and carry out additional technical settings. However, remote signaling teams can send their engineers to the site, who can quickly make and coordinate changes to the project.

## What about the combination?

In general, rail companies that have decided to utilize the potential of outsourced signaling experts, usually work with them in parallel with their signaling department. When the company has a ready-made department it has no need to change it all. Most often, companies do not outsource all signaling but delegate separate assignments to a remote team.

The services of a remote signaling team are most often used by general designers in the following situations:

- the existing team is not enough to cover the scale of a project;
- the company doesn't want to spend much time and resources on training new signaling specialists;
- the company's goal is to save money on the team without sacrificing quality;
- need of additional expertise.

By combining internal and external forces the company can get more diversified expertise, work on projects on a larger scale, and build the most cost-effective model.

# How do I operate an outsourced signaling team?

The outsourced signaling team is well-organized and independent enough to perform the main activities off-premises. If we take the entire technical process, then the share of customer involvement can become minimal over time but with maintaining full control. The customer technically supervises, takes key decisions on the project, and acts as a link to the final customer, while the team is working on the project from the very beginning: discussion, design, testing, supporting. The whole procedure is described further.

The first step when starting the cooperation between the rail company and outsourced signaling team is to determine if training is needed. If the company already has experience in designing the required system, then the training phase is skipped. When it comes to a professional signaling team that sells their services, all the members of the team should have high education in rail signaling that can be got, for instance, in Eastern Europe. Besides, they have similar experiences in mastering new signaling devices. Such a set of specific knowledge and skills allows you to quickly adapt to new working conditions.

Before starting design activities of any signaling projects, the outsourced team should know:

- ✿ the critical info about wayside and house equipment, such as signal control, switch machine control and indication, in/outputs, track circuits or wheel detection and axle counting, crossing control, cab signal, power supply, field cables, etc.
- ✿ internal rules based on general standards, as well as operating rules applied on property
- ✿ software features of the system
- ✿ typical design accepted in the company
- ✿ computer programs the company utilizes

For these purposes, the team is usually assigned a mentor. A mentor should provide the team with the technical documentation on the equipment the company uses for operating the signaling system; set and hold meetings on discussing the main features of the devices, answer the questions of the team; give tasks connected with closed or current projects. To speed up the training process, the company can arrange short-term travel for its mentor.

According to our experience, it takes from 1.5 to 2 months to train the outsourced signaling team to operate with the company's equipment. As we see, it is significantly faster than the 1.5 years needed to reclassify the general engineer to signaling in the internal team.

## How do I check the team before starting a partnership?

Offer a signaling team to deliver a sample of some part of your company's project. After delivering it you can compare the results between internal and external teams to make a decision on the future partnerships.

To maintain full control over the project, it is necessary to build the right workflow. The customer needs to provide materials and updates on the project on a regular basis and upon request, have responsible people. To perform it the outsourcing company should appoint:



### Technical Coordinator

This person is responsible for the technical component of the project, assessing requirements, and holding all the technical discussions. They coordinate the external team and offer solutions that will be proposed to the customer. In case of some issue, the customer can apply to the technical coordinator for solving it.



### Project Manager

This person is responsible for assessing the requirements, keeping track of deadlines, and project data updates, and assisting in connection with the other components of the complex rail project. By determining terms, the company will check the delivery of project milestones, and project updates daily and weekly in PM tools such as Jira, ClearQuest, Targetprocess, and more. Experienced in railway projects, the PM will tell the customer what additional tasks in dispatching, hardware interlocking, and rail testing the outsourcing company can solve.



### Onsite Engineer

This person provides emergency support onsite in case something needs to be fixed. When the majority of the team has been working on the project at distance, the onsite engineer performs their activities in North America, which allows them to go to the place quickly.

Thus, the customer keeps full control of the distant signaling team without engaging additional forces on it.

# What does a typical outsourced railway project look like?

Rail companies are interested in how to manage the railway lines and networks more effectively. Therefore, a signaling system in every rail project, allowing for centrally monitoring of the status of the trackside, location, and speed of the train should exclude the possibility of risks.

Laying new and upgrading existing lines is relevant in the following situations:

- **To simplify logistics and optimize routes between destinations**  
which means to make them more convenient, safer, modern, direct, and less roundabout.
- **To unload certain sections and points**  
to remove the queues, expand the capacity, increase the speed of passage, and so on.
- **Draw railway lines to the mineral deposit**  
from the warehouses of the mining company. A closed or extended transportation system is created that is connected to other routes.

Further, we show step-by-step how the typical project runs with the professional rail team at a distance under the conditions set out above.

## Requirements collection

Usually signaling is the part of some complex project, and respective engineers perform only their narrow part. A signaling system is a complex system that controls all technical processes and goes into safety condition in the event of a malfunction. All the connections must be taken into account in order to complete the task for the signaling department.

Going outsource, the rail company trusts the project to an independent self-organized team that needs maximum input before starting the project to have minimum iterations in the future. It will help the team to evaluate the scale of the project. Before starting to perform a design it is necessary to collect the info and study the documentation about:

- the type of the project;
- recommended vital circuit design guidelines for highway traffic signal;
- track development of the station and proposed track plans;
- field equipment;
- enclosures and house equipment;
- automation and dispatching tools;
- materials that are going to be used in the project;
- maximum speeds of movement set;
- block control lines;
- infrastructure objects.



## Design Group

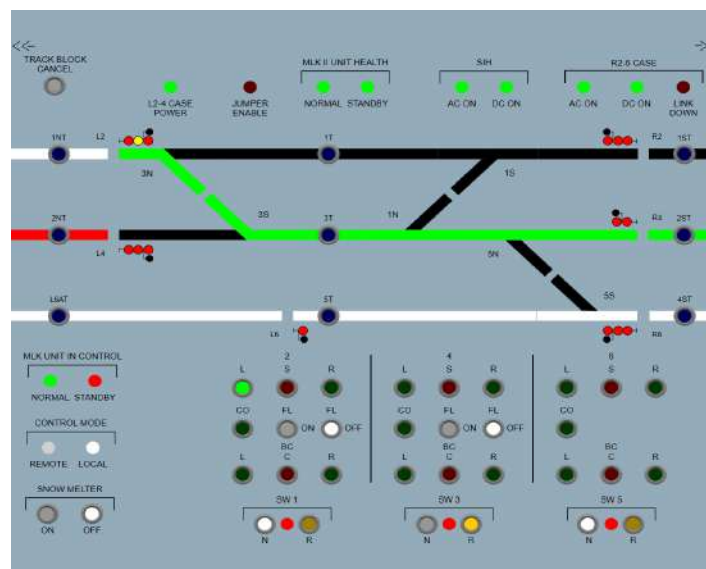
The core task here is to design a drawing set showing the signaling logic of the particular station following the assignments, safety, and railroad requirements, and apply related calculations to them. Having the info, all systems should be protected from human mistakes in particular, because the system should check, for instance, if the railroad switch can be moved safely.

Working internationally, the design group can carry out:

- design of electrical interlocking;
- design of relay-processor and microprocessor system;
- modernization and reconstruction of the existing station and running systems;
- circuits for linking different signaling systems;
- crossing, bridge and tunnel signaling at railway transport facilities and other departments.

The signaling group makes their drawings based on required standards, such as AREMA. At this stage, the team knows the specific requirements of the company's railroad and is ready to perform the design based on it. Regarding hardware, the design group develops full circuit diagrams for the control of track circuits, route set, lock, and cancel, signals, cables, switch lockers, power supply, time locking, traffic exit stick, and more. As signaling is a complex process, diagrams should also show the section blockings and communications with a back-office.

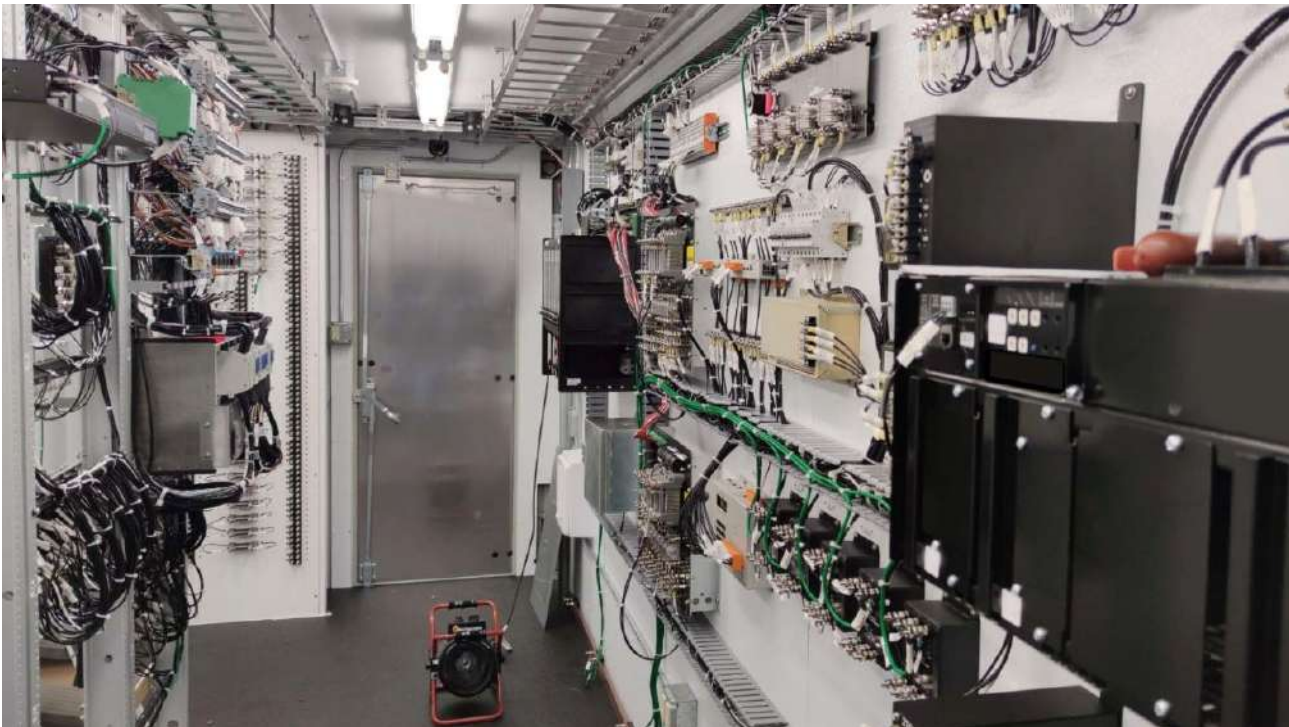
When designing microprocessor systems, most relay logic circuits are described in program logic. However, there are companies that still prefer to use relay based interlocking. Software design here implies a set of algorithms for connections between track equipment and the control center. Having initial conditions and the result, software engineers have to make connections so the system can perform its functions. The program logic describes the algorithms for monitoring and managing objects, such as switch machine, signal, CAB coding, line circuits, crossing, and track circuit coding. In order for the result to be correct, the system has to analyze the train situation, the station's work, the dispatcher's actions, and give the output of moving the railroad switch, turning the signal, and so on. Thus, connections between a dispatcher, station, and microprocessor system are being established. Supporting documentation is always attached.



Engineers use CAD to develop drawings. Specialists can deliver projects in any CAD program, such as Microstation or AutoCAD. This approach allows the company to successfully carry out both standard and individual designs of railway tracks. In the latter case, a non-standard location and size of stations, buildings for passengers, passing points, signal posts, tunnels, bridges, overpasses, and other important objects can be proposed.

When designing, engineers consider many things, such as the size of passages on the location, fire safety, electrical parameters, and so on. The smallest nuances in the arrangement of the schemes are also agreed upon with the customer.

All schemes and drawings created at the previous stages, together with the results of the survey, are subject to mandatory verification to check their compliance with the requirements and regulations. When wiring diagrams are approved, together with the worksheets, and equipment specifications describing these parameters, such as the type of relay, the number of terminals, the type, and the number of wires are sent to the factory for the assembly and installation of the equipment.





## Testing and Support

The outsourced team has to provide a rail company with all the necessary datasheets for testing – a set of algorithms that will help the company to check the functionality and electrical features of the signaling system. However, nobody knows the project better than the engineer who has been performing it. Therefore, to avoid the consequences of mistakes that can be made during the installation process, an engineer or several engineers are sent on a business trip onsite. While installation and testing, signaling engineers can help the customer understand emerging issues, explain the cause of the problem, and carry out testing and commissioning up to the end.

In this way, the outsourced team supervises the installation of the signaling equipment and its testing in the field. It is a common practice for helping the customer to solve some construction and organizational problems. This allows the company to quickly find errors in the installation and make changes in the project.

Remember, only professional development is the key to modern railways.



# Junction of Technologies in Railway Signaling

The successful delivery of the signaling project is now affected by software-based systems, such as CBTC, PTC, or ERTMS. The next generation of such devices is likely to become more communication-based and computer-based. This makes rail companies pay more attention to establishing communication and development of the software. It leads to the involvement of additional specialists in the project competent in embedded devices, hardware and software development, and integration. Probably wayside infrastructure will reduce, which will need another approach to the signaling system. If we take self-driving trains, they have even more safety requirements.

As we mentioned above, signaling engineers work in highly organized structures and use proven and safe schemes while working. Additionally, the signaling department is isolated in the company acting as a general designer of the project. However, such an approach complicates:

- ⚙️ integration with the other parts of the project
- ⚙️ implementation of innovations
- ⚙️ management processes

Since there are no exclusively signaling projects, the issue of quality rail project managers that can integrate signaling within the whole project arises too.

## How can an outsourcing team help me?

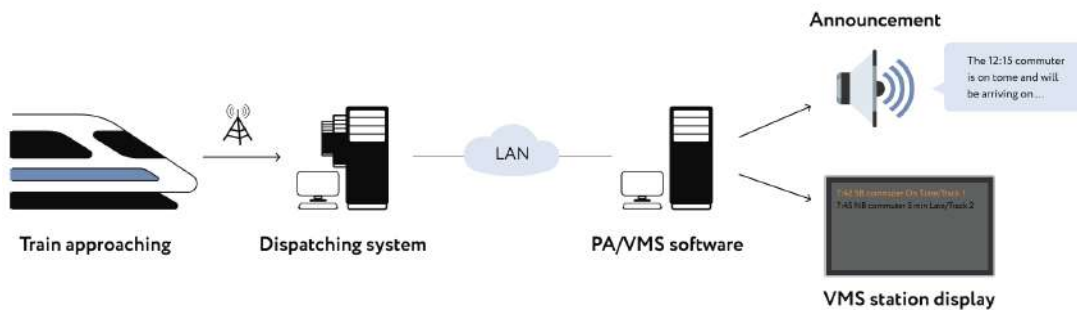
### 1. Dispatching & Software integration

The versatile outsourcing team includes software and hardware engineers experienced in rail projects. Having corresponding skills in programming, it becomes possible to move to the next step of the project for performing signaling operations. Thus, the operation with dispatching can be performed for Class I railroads, cargo railroads, metro, and city lines.

The common examples here are implementation of the wayside controller, PTC, and Train Control Application; mobile application development, implementation, updating legacy systems, or Railroad Simulation implementation, allowing to test a digital twin of a Computer-Aided Dispatching system and for dispatcher training. This approach allows one team to fully provide smooth signaling communications and remote management of distant units.

### Technologies and tools that are mainly utilized in the project:

- Linux, C/C++
- .NET, Python
- CSS,
- JavaScript
- Altera Quartus II
- SQL
- GIT
- Jenkins
- SSH
- VNC
- GCC
- PHP
- C#
- Qt & X Windows
- Oracle
- LabVIEW
- Cyclone II FPGA
- ModelSim 6.1e



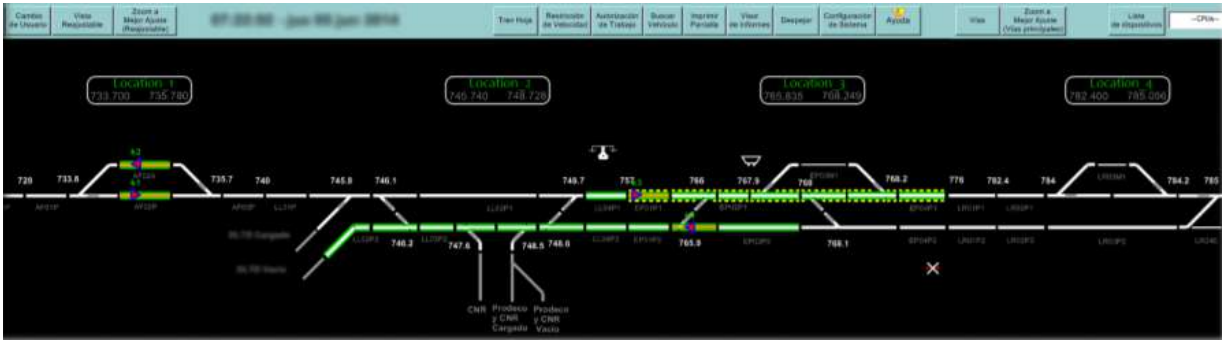
## 2. Interlocking Hardware

In addition, the versatile team includes specialists in boards and processor based modules that are able to embed crucial components into the equipment adding new functionality. There can be programmable hardware for station infrastructure, subsystem development for the logic controller, or other types of hardware.

## 3. Testing

It is common to use VectorCAST to perform White box testing for the firmware and applications. However, outsourced signaling teams can perform test injections in source code compiled for a specific target and installed on real hardware to simulate test and error conditions in cases when the VectorCAST tool cannot be used for system integration testing.

The outsourced team also performs Black Box testing for Class I railroads, cargo railroads, metro, city lines, Dispatching systems, Hardware Simulators, Product monitoring systems, or Train/Wayside communication hardware products.



#### 4. Project Manager of the outsourced team

The main advantage of such PM's is their relevant experience in rail projects. Working with signaling projects for a long time they do not get bogged down in technical details, but they are not superficial either. In general, the PM of the outsourced signaling team leads several significant projects simultaneously, that can last for 4–5 years. Having a dedicated PM on the outsourced team's side, setting milestones, and controlling schedules and due dates, the client is able to keep a hand on the pulse and make proactive decisions.

# Conclusions

Both internal and external signaling departments can successfully deliver correspondent projects within the rail company. However, with the development of communication within trains, tasks for rail projects become more interconnected, which often requires the use of additional competencies. In addition, managing such projects can be quite difficult, especially to ensure connections with other projects.

The combination of these teams can bring the rail company significant results, such as:

- expanding the team without fully changing the workflow;
- savings on the signaling engineers without losing the quality;
- the opportunity of taking on larger complex projects;
- the opportunity of getting unique expertise.

By analyzing our experience, we recommend involving outsourced signaling teams, especially for the general designers, in cases when the existing team is not enough to cover the scale of the project. Thus, the company won't need to spend much time and resources on training new signaling specialists. After spending this time, the rail company will have a team on standby that is always ready to apply their knowledge and skills for providing safe operations on the railways.

