GSMA 5G TRANSFORMATION HUB The world's most innovative 5G solutions

5G Enables the world's first remote-controlled high-lift wheel loader

Genesis in the mining industry

An SCA timber terminal in Northern Sweden has demonstrated the use of 5G technology to provide the ultra-reliable connectivity required to enable greater automation for timber handling. The trial tested how enhanced 5G connectivity can be used to remotely-control a high-lift wheel loader across all the timber terminals in Sweden to develop safer and more productive timber processes and explore the potential of 5G as an enabler for automation.



SMA 5G Transformation Hub - 5G Enables the world's first remote-controlled high-lift wheel loader

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CASE STUDY LEAD: SCA (SVENSKA CELLULOSA AB)

• CHALLENGE

Inspired by the level of automation and remote control in today's mining operations, the challenge was to investigate how these technologies could be applied in a forestry context. Forestry management is a significantly more complex environment than mining, since the movement and loading of logs requires more precision than does gravel in a mine.

SCA has trialled a 5G-based remote control high-lift wheel loader at a timber terminal located in North Sweden in Timra municipality. The solution harnesses time-sensitive networking (TSN) coordinated multi-point 5G connectivity, and 5G precise positioning to control an assisted guided vehicle (AGV). The timber loader, a converted Volvo L180 high-lift equipped with connected cameras and sensors, was remotely controlled from a control station at a location 400km away.

IMPACT & STATISTICS

The project demonstrated that the remote control of forestry high loaders enabled by 5G can unlock significant benefits including significant efficiency improvement, more flexible operations, the potential for high-lift drivers with certain medical conditions to return to work and also the potential to reduce CO2 emissions. The solution has the potential to transform the cost effectiveness of smaller timber handling terminals and to extend the working hours of terminals.

WIDER IMPLICATIONS

The 5G-enabled and remote controlled high-lifter demonstrates that remote control and automation concepts pioneered in mining can be extended to more complex contexts. The project is a first step towards fully automated supply chains for timber. With an increased number of remotely operated timber loading terminals operating at more flexible times of day, transportation networks for collecting the timber can be better optimised so unlocking sustainability benefits. In the medium term, transportation between terminals can potentially be supported by autonomous vehicles.

• STAKEHOLDERS

Biometria, Mid Sweden University, SCA (Svenska Cellulosa AB), Skogforsk, Telia Company, and Volvo Construction Equipment.

> SOURCES & FURTHER INFORMATION

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5G remote controlled high-lift wheel loader



Genesis in the mining industry

Many of today's open mines rely heavily on remote controlled equipment, particularly including trucks for transportation of gravel and other mined materials. The forestry environment, meanwhile, is considerably more complex since timber and wood must be handled with much more precision than mined materials. Advanced materials management in the mining industry has however highlighted the potential for forestry loading sites to adopt similar technologies.

The purpose of SCA's trial with Mid Sweden University was to demonstrate how the concepts of remote control and 5G communications could be deployed to support a more efficient flow of timber through loading sites and to investigate how the technologies could be adopted further across their entire estate of loading sites.

An SCA timber terminal in Torsboda, in Timrå municipality in Northern Sweden, was chosen to demonstrate the use of 5G technology to provide the ultra-reliable connectivity required to enable greater automation for timber handling. The trial tested how enhanced 5G connectivity can be used to remotely-control a high-lift wheel loader across all the timber terminals in Sweden to develop safer and more productive timber processes and explore the potential of 5G as an enabler for automation.

An important aim of this project was to explore a vehicle operator's perspective to make remote operation a user-friendly and efficient experience. Because each load of timber is so varied (from an unwieldly pile of heavy logs through to just a few short pieces of wood) it is vital that the lifting process is carried out with accuracy and precise handling. The test explored how to mature the various supporting technologies and gathered vital feedback from the operators on the optimum placement of cameras for handling precision.

This is an excellent project where we can assess how we can use 5G technology for remote control and the possibility of working remotely while connected. The project is entirely in line with SCA's ambition to drive the trend toward more autonomous vehicles and improved operator support. This is also a key component of making forestry even more sustainable. Remote-controlled terminals can improve the work environment for operators, increase accessibility at the terminals and ensure efficient utilization of our machines

> Magnus Bergman - Head of staff, technology and digitalization at SCA Skog

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5G was a crucial enabler for the solution

For the solution, Volvo **Construction Equipment** remodelled and equipped an L180 High-lift wheel loader with connected cameras and sensors that make it possible to control the machine remotely over a 5G network, supplemented by a dedicated and local network that Telia has built at SCA's terminal. Through the 5G technology, all data is sent with low latency, which is critical in order to be able to carry out remote control with precision and in a safe manner and so that a remote operator can have almost the same experience as if they were in the driver's cab.

The 5G network was supported by the use of a temporary base station as might be used to provide temporary coverage for a sporting event and was configured as an extension of Telia's existing 5G public network. The use of 5G technology was critical since 4G technologies were unable to meet the solution design constraints, in particular the need for immediate feedback between operator and machine and the transmission of on-board CCTV video images would push available 4G data rates to the limit, leaving little flexibility to accommodate any degradations in a connectivity link. Meanwhile. Wi-Fi was unsuitable for the dynamic operating environment as presented by a loading location.

The new 5G-network was deployed using the 3.5 GHz band that Telia acquired in Sweden's 5G auction early 2021. The frequency band provides more capacity, higher data speeds and lower latency, crucial for industrial services demanding high and secure connectivity for critical assets as remote control and industrial automation. In parallel with the technical development work, two experienced operators evaluated factors such as camera views, camera placement, manoeuvring and ergonomics. The study showed that the driver's working environment can be improved with remote control. The operators found it relatively easy to view their remote 'surroundings', sat comfortably and quickly managed the lifting process with precision. The fact that the work environment became more accessible and ergonomic also means that the often physically challenging work can be made possible for more people, potentially including those with disabilities.

The unique technical qualities that 5G offers are also entirely critical, in which extremely quick response times and high capacity enable immediate feedback between operator and machine, which is a prerequisite for being able to safely control machines remotely

> Magnus Leonhardt - Director, Head of Business Development & Innovation at Telia



Unlocking **efficiency, social** and sustainability benefits

The results of the project showed that there is a potential to reduce costs through remote control of timber loading. The potential was greatest at night and when throughput volumes were low, since with a remote driver able to potentially cover multiple sites the availability of a driver could be guaranteed without the driver needing to be present (and underutilised during quieter periods). Overall, the project demonstrated potential for a significant efficiency improvement during the day and greater savings at night compared to when the driver is in the machine.

Additionally, the remote control of machines can solve specific problems in the industry, such as safety and security related challenges and the staffing of locations in remote areas. For instance, drivers do not need to get into and out of the vehicles, so avoiding fall risks and also allowing drivers with certain medical conditions to again drive vehicles. Also, drivers need no-longer be exposed to noise and vibrations from machines.

Meanwhile the overall timber loading function can become more flexible, as it becomes economic to provide timber handling services in remote locations and at quieter times of day or at night. Such flexibility will ultimately enable more efficient routeing in timber transportation networks, so reducing mileage travelled and fuel consumption and unlocking sustainability benefits.

The experience with remote driving has also highlighted, and provided solutions to, some historic challenges such as the inability of drivers to see certain angles from a vehicle cab which has traditionally meant that a second worker would need to stand next to a high-lift vehicle to provide guidance to the driver. The results show that there is a potential to reduce costs through remote control. The greatest potential is at night because we could offer relief throughout the day, but even during the day there are opportunities to reduce costs

Mikael Sundelin - Head of Business Development Industrial Supply, SCA

A complex task in a difficult environment results in **new challenges**

Challenges associated with the project include the need to transport high volumes of data very reliably and with very low latency between the remote site and the driver located in a control centre. Multiple CCTV feeds are required to provide different views from the driving position in the machine, and also to cover angles that have traditionally been blind spots for any on-board driver. Meanwhile, because each load of timber is so varied (from an unwieldly pile of heavy logs through to just a few short pieces of wood) it is vital that the lifting process is carried out with accuracy and precise handling

A particular challenge encountered was that raw timber was found to be particularly effective at damping cellular radio signals, and so network coverage needed to be based on a line-of-site requirement. Also, in remote locations there can be a lack of access to high-speed fibre connections to support transmission of data between the local 5G network and a the remote control centre.

Also, in connection with the potential commercialisation of the remote timber concept, several laws and regulations must be adhered to, in particular, the Swedish Work Environment Act, the Machinery Directive and the Convention on Road Traffic. The Swedish Work Environment Act and Machinery Directive place significant requirements on procedures and security for machines and their systems, but also on the working area with the purpose of controlling who may be present. This primarily aims to prevent accidents in which people may come to harm. This partnership is a fine example of how remote control with the latest technology can contribute to more efficient and sustainable construction solutions in the forest industry. A secure and robust digital infrastructure is crucial for this. The unique technical qualities that 5G offers are also entirely critical, in which extremely quick response times and high capacity enable immediate feedback between operator and machine, which is a prerequisite for being able to safely control machines remotely

> Magnus Leonhardt - Director, Head of Business Development & Innovation at Telia



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Extending the test and **planning for the future**

Next steps for the project include the refinement of certain key aspects of the remote-control solution. The trial demonstrated that, when compared to an experienced driver on-board, aspects of loading related to approaching the load and gripping the load took longer when high-lifts were controlled remotely. The team is considering developing a haptic feedback mechanism to assist with accurate control of the remote high-lift.

The project also highlighted the need to be able to guarantee physical security on site, preventing access by unauthorised persons. Further measures will also be required to ensure cyber security (including encryption and a dedicated virtual private network). Geofencing should be applied to further enhance security, both guarding against theft and unauthorised usage of equipment. Biometria has also carried out an analysis of the overall market in Sweden, where there is an even greater potential for cost reductions through the inclusion of several logging and forestry companies in a common centre.

Meanwhile, Volvo Construction Equipment has used the trial to test its teleoperation platform in a new application with high precision requirements and learn how the system needs to be designed to meet industry needs across a variety of segments from mining to urban construction. Insights from partial manual and tele-operated management gained in this forestry context will enable Volvo to take further steps towards automation in more complex processes. By remote-controlling processes like timber lifting (which are currently too complex to be fully automated) tele-operation becomes an important enabler for automation, allowing for a more gradual integration of automated processes for technology adopters.

We can see that tele-operation has major future potential for our customers to improve their operations. For operations in hazardous environments, the operator can be relocated to a secure location with better working conditions. In cases where operations are conducted in several different locations, one operator can manage several terminals at the same time. The project provides an opportunity to test our remote-control platform in a new application with high precision requirements and to learn how the system needs to be designed to meet industry needs

> Christian Spjutare - Advanced Engineering Program Manager at Volvo CE

About the GSMA

The GSMA is a global organisation unifying the mobile ecosystem to discover, develop and deliver innovation foundational to positive business environments and societal change. Our vision is to unlock the full power of connectivity so that people, industry, and society thrive. Representing mobile operators and organisations across the mobile ecosystem and adjacent industries, the GSMA delivers for its members across three broad pillars: Connectivity for Good, Industry Services and Solutions, and Outreach. This activity includes advancing policy, tackling today's biggest societal challenges, underpinning the technology and interoperability that make mobile work, and providing the world's largest platform to convene the mobile ecosystem at the MWC and M360 series of events.

For more information, please visit the GSMA corporate website at **www.gsma.com**.

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GSMA 5G Transformation Hub

The GSMA 5G Transformation Hub is a source of information on some of the most innovative 5G solutions in the world. This portal contains case studies detailing design, benefits, key players, measured value and the future impact of scaling up these 5G solutions worldwide. The 5G Era is now firmly established and this family of standardised GSM technologies, including mmWave, are being rolled out successfully across the globe. The GSMA 5G Transformation Hub, launched at MWC Barcelona in 2022, provides details of how 5G is best placed to deliver real value for a range of key sectors including manufacturing, energy, transportation, media and live entertainment, smart cities and construction. Many more case studies will be added, in the coming months, covering even more industries and the GSMA is asking Members to nominate innovative 5G case studies to add to this global digital showcase. The 5G Transformation Hub is sponsored by Qualcomm.

www.gsma.com/5GHub

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