

INNOVATION IN PRIVATE NETWORKS

LESSONS LEARNED FROM 5G PRIVATE NETWORKS IN QUARRYING



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CEPT WORKSHOP ON 6G

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Introduction

- There are 25,000 quarries in Europe
 - A quarry is used for extracting sand, rocks and mineral from the surface
 - Not all of them are open and used for the moment, some are dormant (and can be dormant for years)
 - The construction industry opens and closes quarries based on needs for, e.g., building a new road
- The construction industry is also on a decarbonisation journey
 - The manufacturing of building material and products accounted for 11% of all CO2 emissions during 2018
 - Producing one ton of concrete generated 72.2 kg of CO2 emissions in 2019, and concrete is fundamental for the construction industry
 - The efforts for reducing emissions start already in the quarry
 - Electrifying machinery and using renewable energy will contribute to substantial reduction in climate impact

What do we do?

- We provide a transport as a service solution for reducing the CO2 emissions and increasing the productivity in quarries by downsizing using electrical autonomous construction machinery
- The Volvo TA15 machine is an automated, connected and electrified hauler
- It transports raw material to a crusher in quarries
- The machine is equipped with lidar, radar, emergency stop system, cameras, connectivity technologies (e.g., 4G/5G, WiFi), and remote control transceiver
- When not in autonomous mode, it is controlled using a remote control (e.g., to and from parking)
- Capable of running 24/7
- Dangerous working tasks conducted by people today can be shifted to autonomous operation increasing safety for personnel



How do we do?

- The autonomous machine is constantly connected to the control room using long-range connectivity (4G/5G)
 - It receives driver assignment and reports back about progress
 - Can be teleoperated if bumping into problems
- The TA15 machine is currently being loaded by a manually operated wheel loader
- The TA15 machine drives in speeds of up to 25 km/h
- It can operate backward and forward
 - It has the same properties in both directions



Downsizing

- Traditionally, quarrying and mining are using as large machines as possible for optimizing productivity
 - Large machines are not electrified yet
 - One machine broken and the whole production might be preempted depending on the number of machines being operated at the same time
- Smaller machines can be electrified for the moment but they can not carry as much load as larger machines (of course) and they need to be charged often
 - Sites are electrified already but not always connected
- Going from work-harder elephants to smart-worker ants
- Downsizing to accommodate electrification can only be performed with autonomous vehicles



Proof of concept for autonomous operation of TA15 machines using WiFi at 2.4 GHz

The machines travel approx 600 meters between "Loading" and "Unloading".



- WiFi Access Point
- Cameras
- Cabinets

5 access points necessary to cover the route of 600 meters.

Challenges with sites and connectivity infrastructure

- Many sites have substantial height differences between loading and unloading
 - Challenging environment for connectivity infrastructure
- WiFi would not be an option for the site in the figure to the right given the short communication range
- 1-2 5G base station(s) can be used on the brink above tilting antennas downwards towards the site

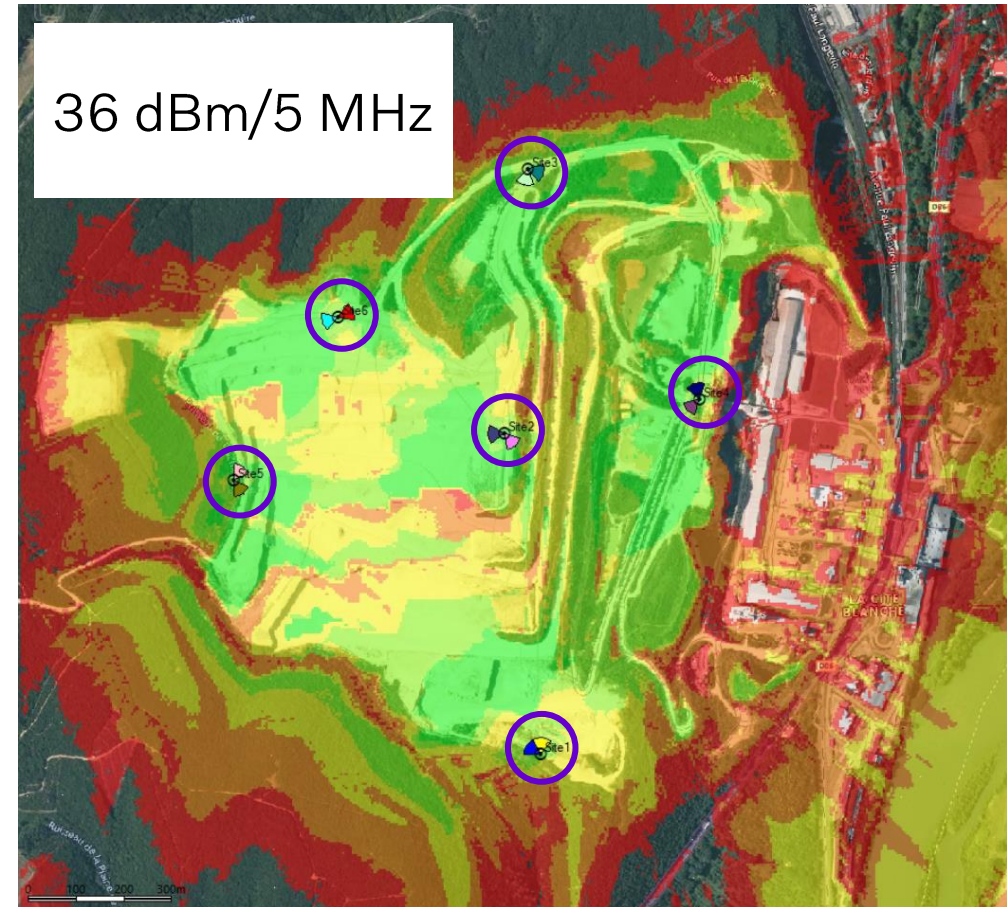
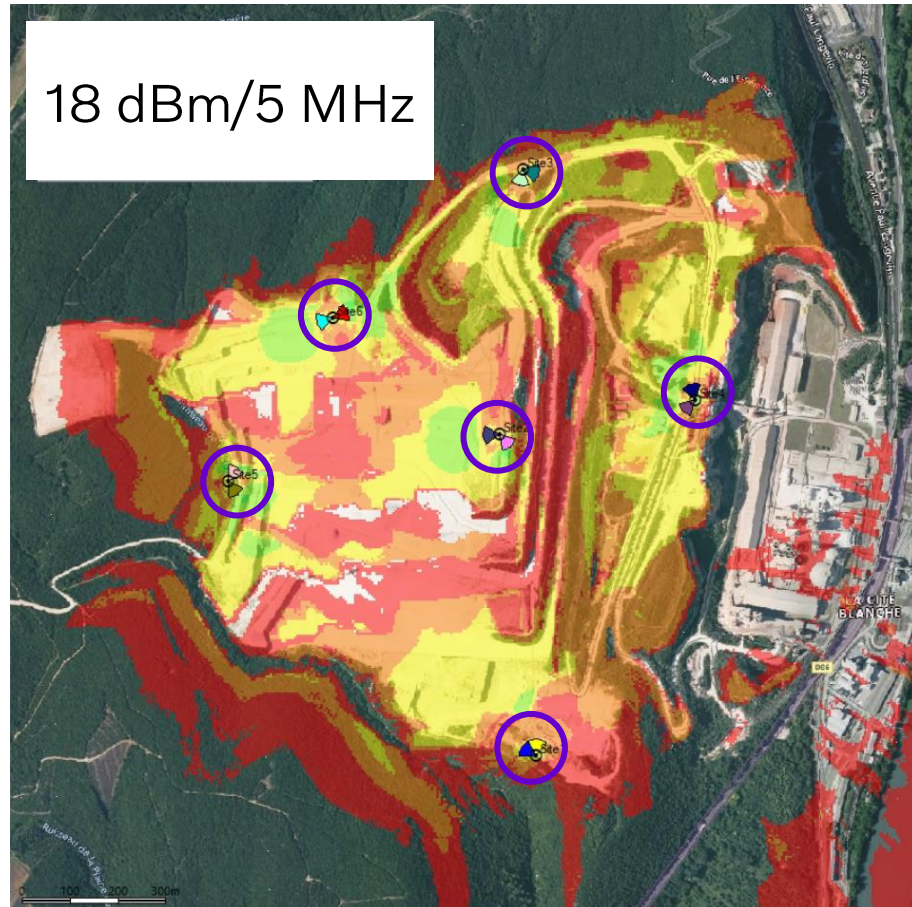


WiFi and 5G private networks

- WiFi has been designed for lower output power 20-23 dBm/20 MHz and license-exempt band
- WiFi requires much more infrastructure closer to the machines due to the lower output power
 - This is a challenge since sites are constantly changing
 - Requiring movement of infrastructure since communication infrastructure needs to be close to the machines
 - At many sites, blasting affects the infrastructure (e.g., infrastructure is hit by flying material)
- 5G private networks can be used with higher output power providing better coverage (less infrastructure) placed further away from, e.g., blasting areas
- 5G private networks will minimize the installation of fiber (meter wise)

Low power versus medium power regime for 5G private networks

The site is 1.5 km and there is 100 meters of height difference between the bottom and top.



Low power regime (18 dBm) would require at least 4-5 more base stations to get the same coverage as medium power regime (36 dBm).

Why private networks?

- Facilitates a better QoS control over network resources
 - Far from perfect but much better than public networks
 - Autonomous operation of machines and trucks in confined areas consists of a diverse set of applications using the long-range connectivity capability
 - QoS is essential given the safety aspects of autonomous operation but also for productivity
- Great opportunity for verticals to enjoy advanced wireless technology in a cost-efficient way



Food for thoughts

- Focus in 5G is on downlink capacity, which is of course a given due to the nature of data traffic for consumers
- Uplink is in many cases much more important for verticals than downlink
 - More flexibility needs to be in place in terms of how downlink and uplink can be configured
- Simpler QoS handling locally for private networks from a configuration and technical point of view
- Not all vertical applications are bandwidth demanding rather very time sensitive
 - Possibility to use 5-10 MHz below 1 GHz would be immensely useful

Conclusions

- Reduction of CO2 emissions from the construction industry starts already in the quarry
- Downsizing of machines in the construction industry is the current viable solution for electrification
 - Leads to autonomous machines to avoid an increase in driver cost
- Autonomous machines must be connected to the control tower for safe operation
- 5G private networks provide good coverage in the medium power regime
- The low power regime discussed in Europe for 5G private networks would require the same amount of network equipment as WiFi
 - This is not feasible in quarries, which are constantly changing because material is moved around and blasting is taking place

V O L V O

THANK YOU FOR LISTENING