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2019 BMO Business Innovation Conference
Innovation at LaRonde mine: LTE communication for mining

June 4, 2019

Agenda

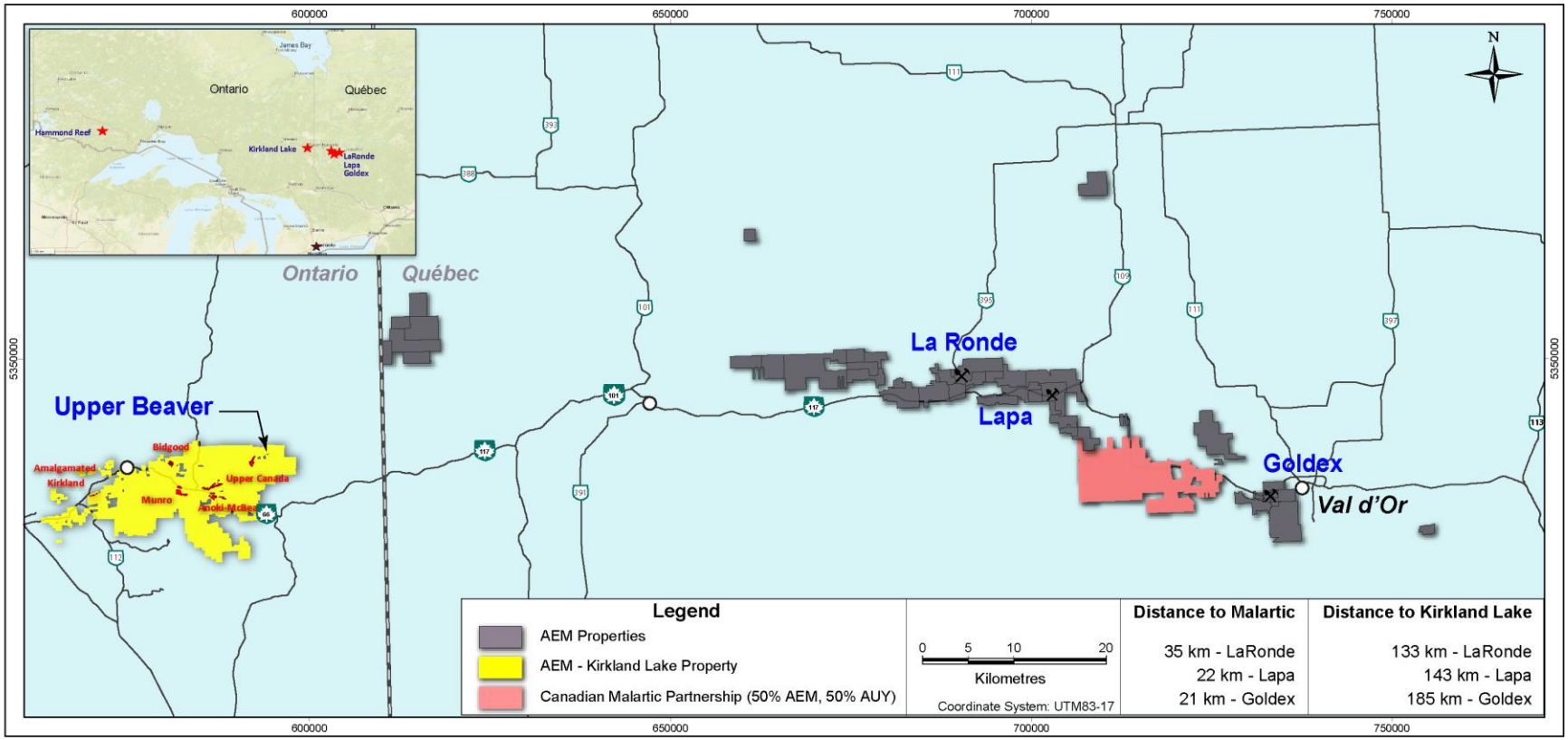






- The LaRonde Complex
- Context and challenges at our mine
- Our needs for the future
- LaRonde 4.0 vision

The LaRonde Complex



The LaRonde Complex



10km East



Lapa

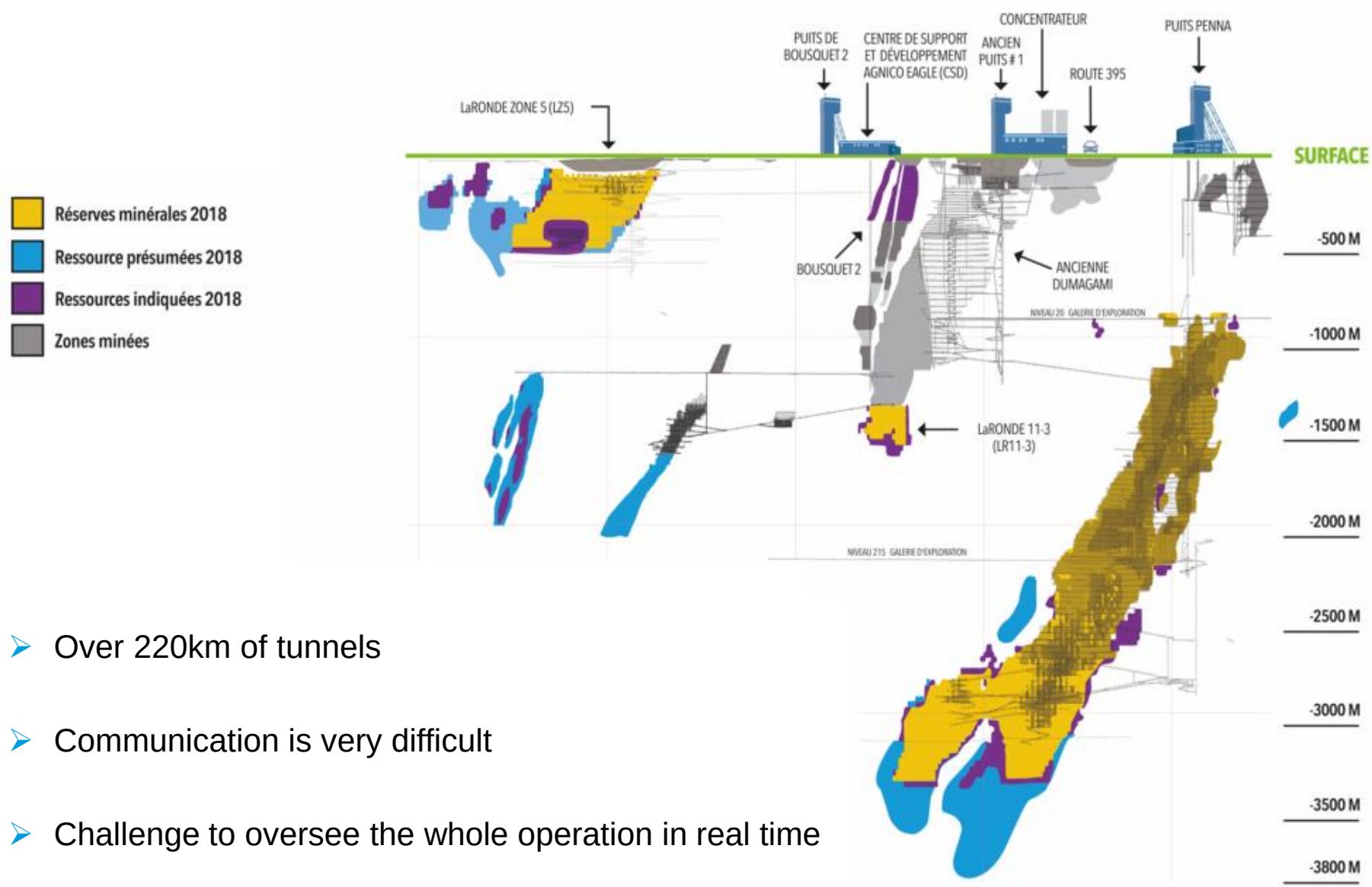
3km West

LZ5



- Two operating mines, two mills, one mine under reclamation and one tailings pond

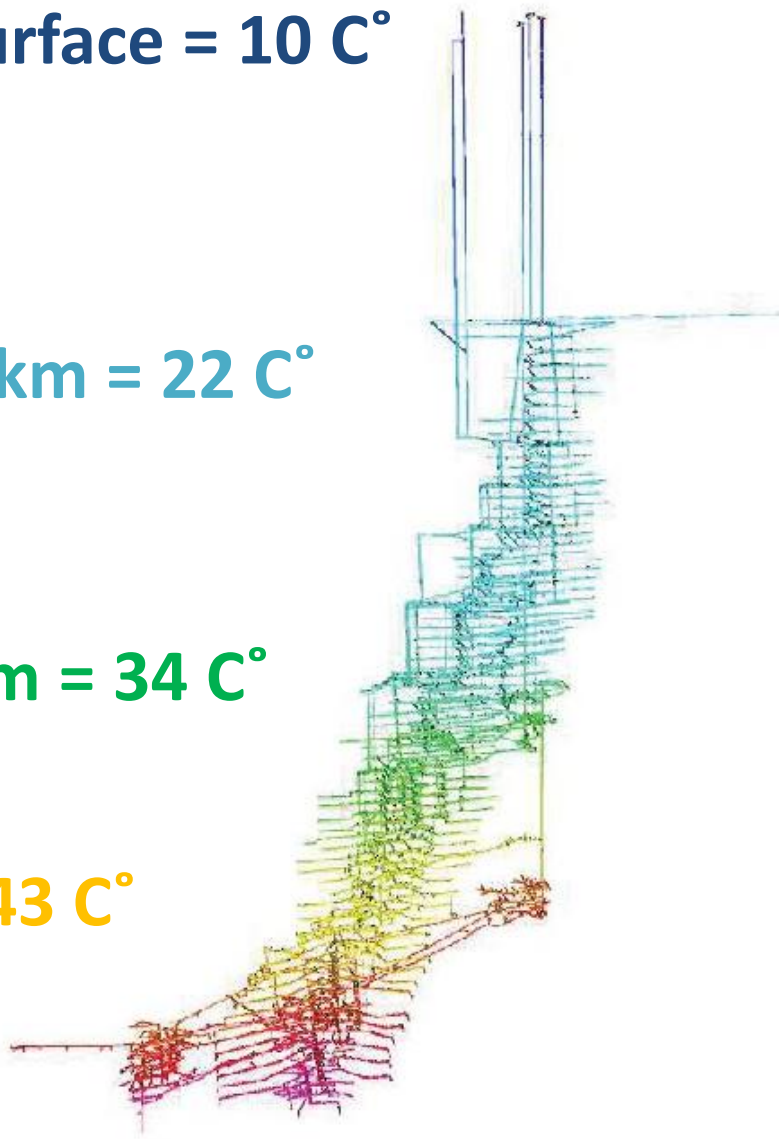
The LaRonde Complex



- Over 220km of tunnels
- Communication is very difficult
- Challenge to oversee the whole operation in real time

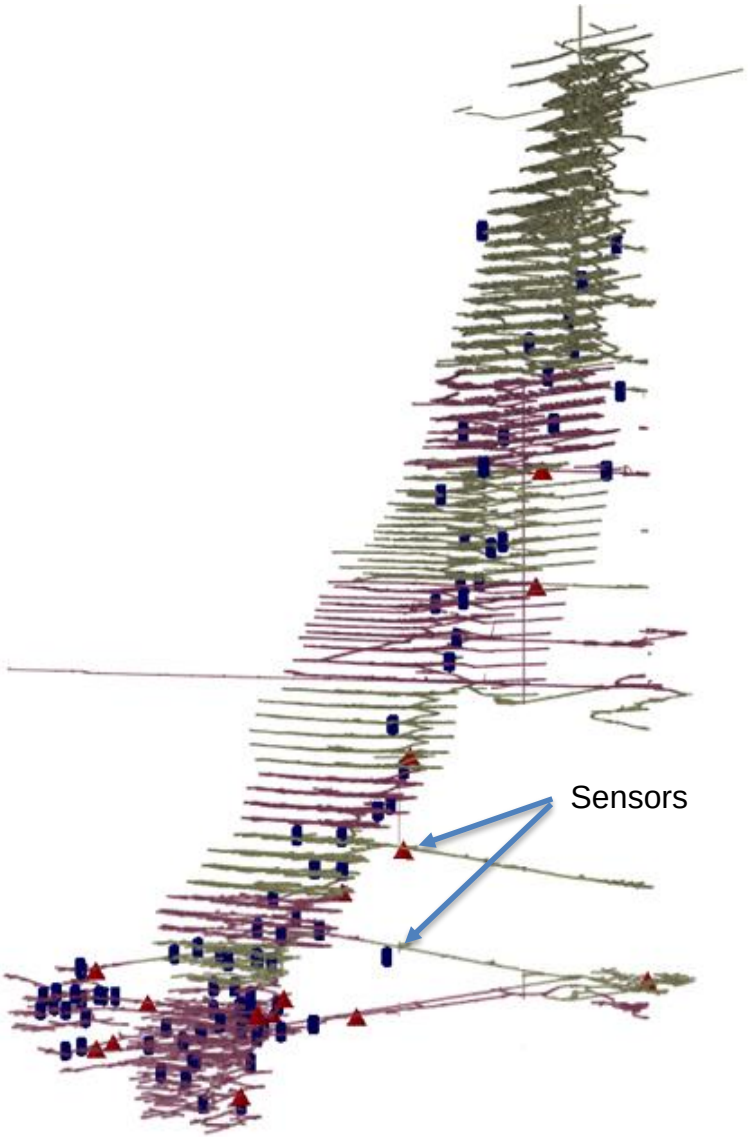
Context and Challenges

- Very hot mine at depth
- Geothermal gradient leads to rock at 52 C˚ @ 3.5 km
- Over 34 000 HP of diesel motors



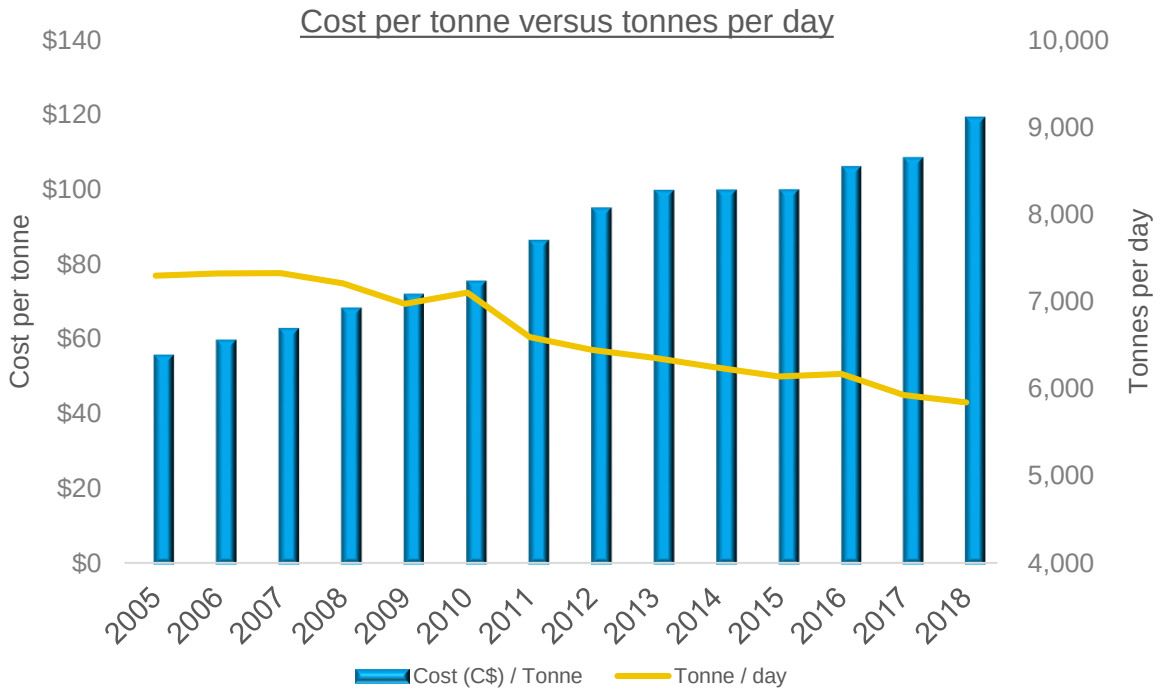
Context and Challenges

- LaRonde has a real time state of the art seismic monitoring network
- The network includes:
  - +100 sensors underground
  - 9 sensors on surface
- The network is able to locate and evaluate the magnitude of seismic events within few minutes
- The control room can visualize seismicity in the mine in real time
- There is always an engineer on call (24/7)

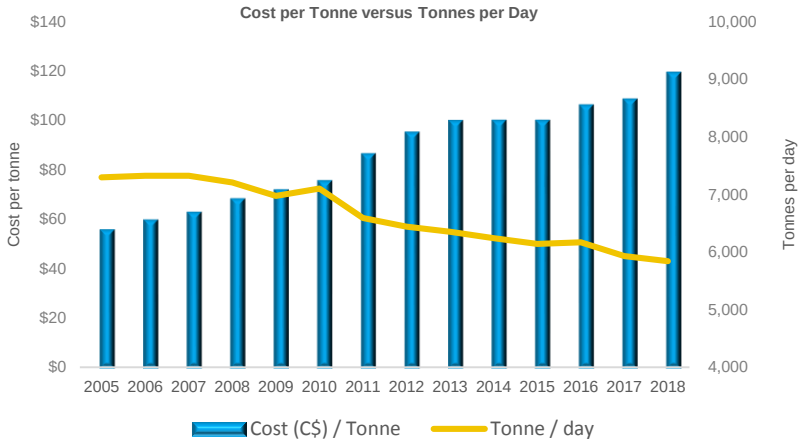


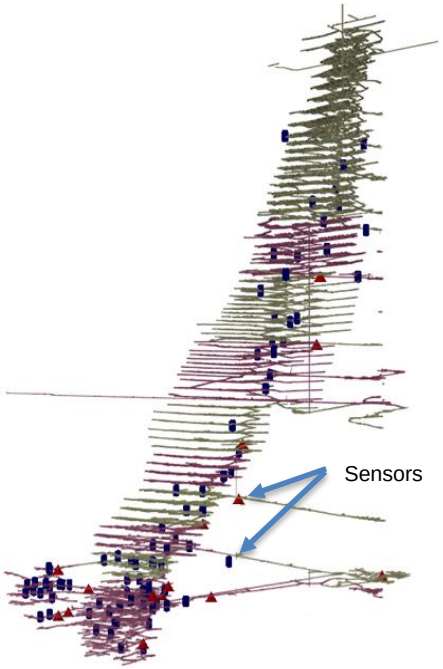
Context and Challenges

- Paste fill, compressed air, mine water and fuel distribution are getting more complex
  - Around 220 km of galleries
- Effective hours underground is constantly decreasing
  - Orebody is getting deeper and further from our shafts and infrastructure
  - ±7.5 hrs worked / shift (60% of day use for production activities)
- Logistics and communication (±300 workers underground)



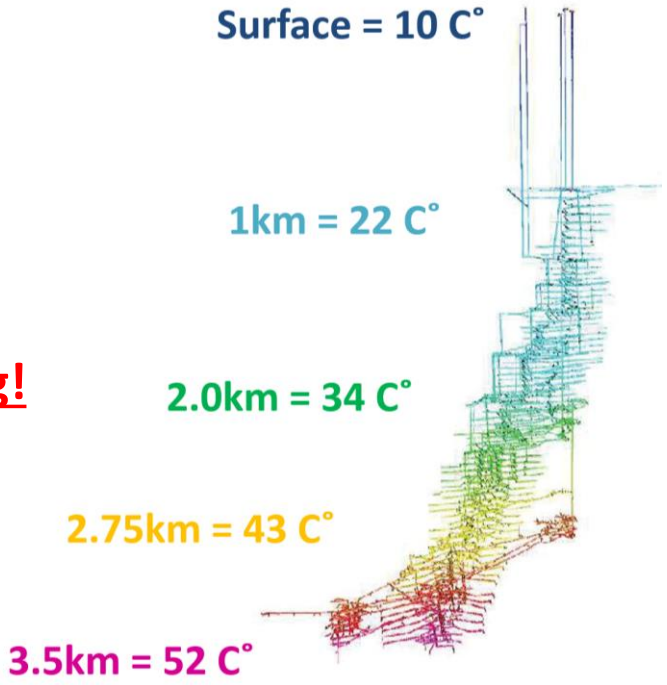
The Context for the Next 10 Years







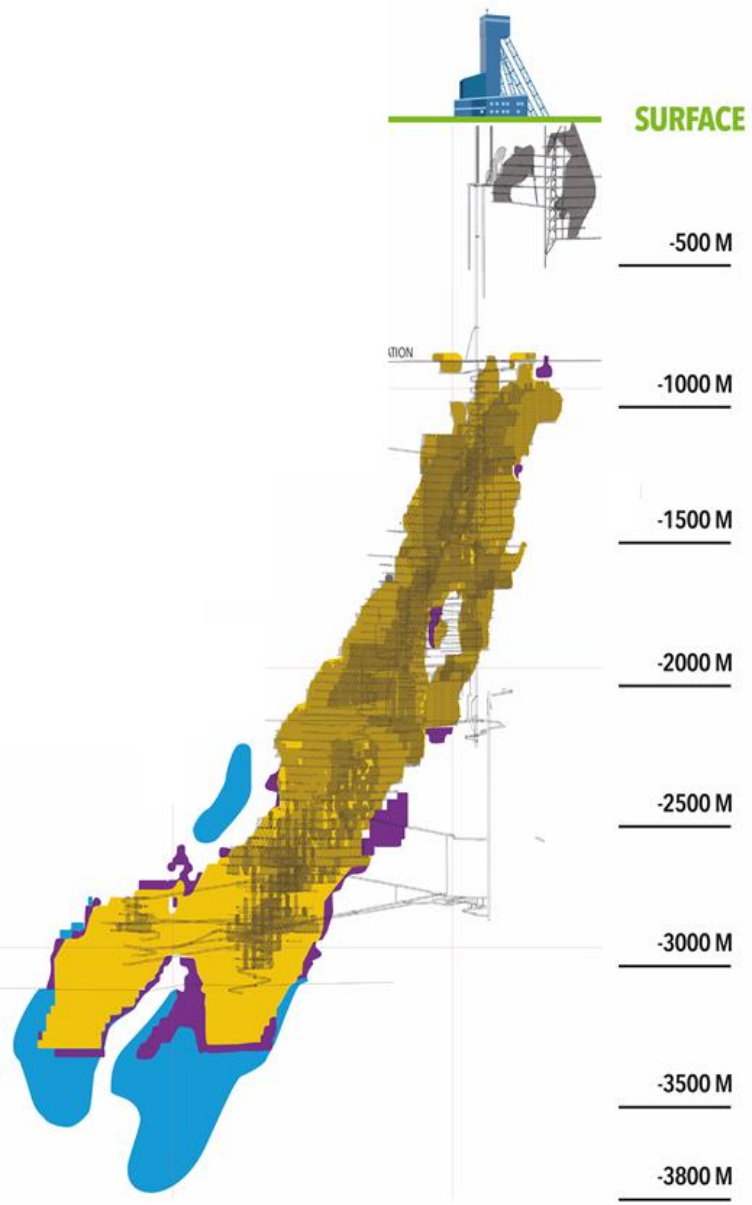
We need to do something!



Needs for the Future

- Modernize our business
  - Reduce exposure of our workforce
  - Promote use of new technologies
  - Attract / retain new employees

- Benefits
  - Reduce the productivity decline
  - Compensate for heat, seismicity and distance travelled
  - Maximize the LaRonde Complex potential (flexibility)



The Decisions

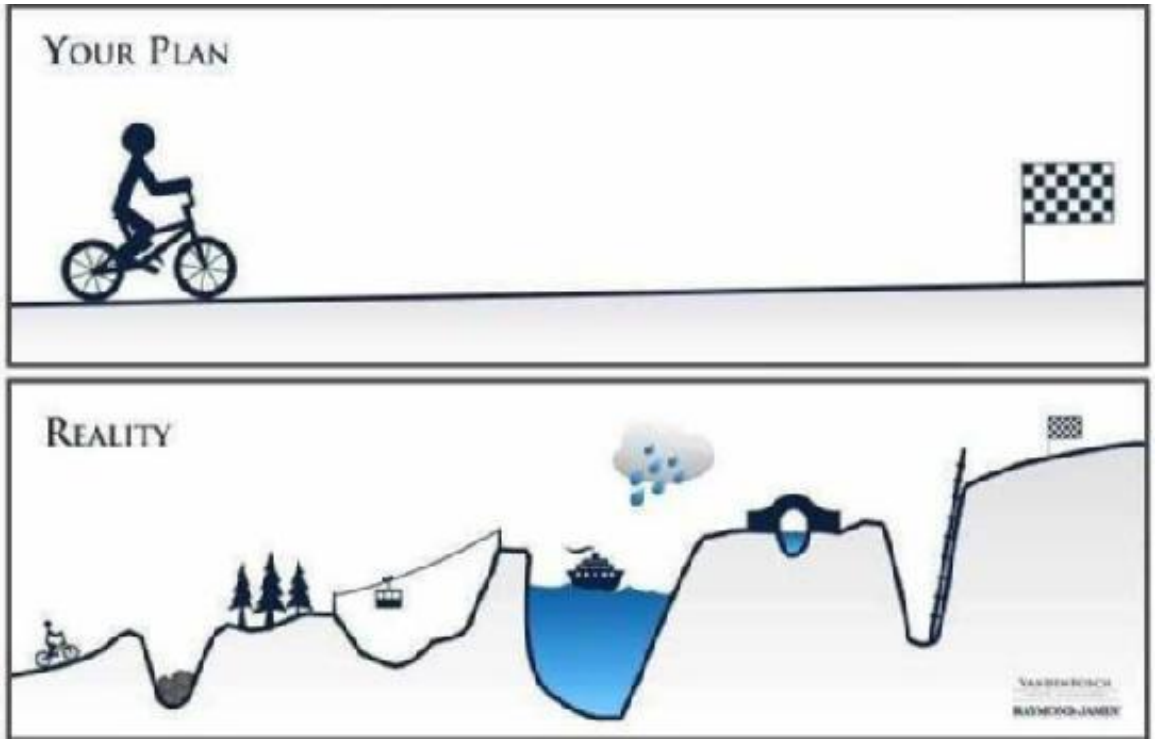
- Deploy LTE at LaRonde Zone 5 (LZ5) then at LaRonde (better communication, bandwidth, 100% coverage, mobile apps, robust, simple and flexible)
- Test and use remote operation on a regular basis
- Improve our emergency procedures
- Build a long term vision of the future operations





LaRonde 4.0 - Roadmap

The Context for the Next 10 years



- It will be tough
- We will likely not be able to operate the mine like we have over the past 30 years
- We need a plan
  - Why? How? What?

The Vision

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LaRONDE 4.0

BUILDING OUR FUTURE

VISION : WHY ?

- Implement automation to make the exploitation of LaRonde 3 resources and Zone 5 low-grade at depth possible;
- Innovate to remain a leader in the industry;
- Increase the flexibility and robustness of the operation;
- Promote retention and attraction of the workforce;
- Improve working conditions by facilitating communication and keeping in touch with our people.

LR 4.0

STRATEGIES : HOW ?

LTE | Newtrax | Remote operation | Mill Control Room
Advance control | Real Time Data Management

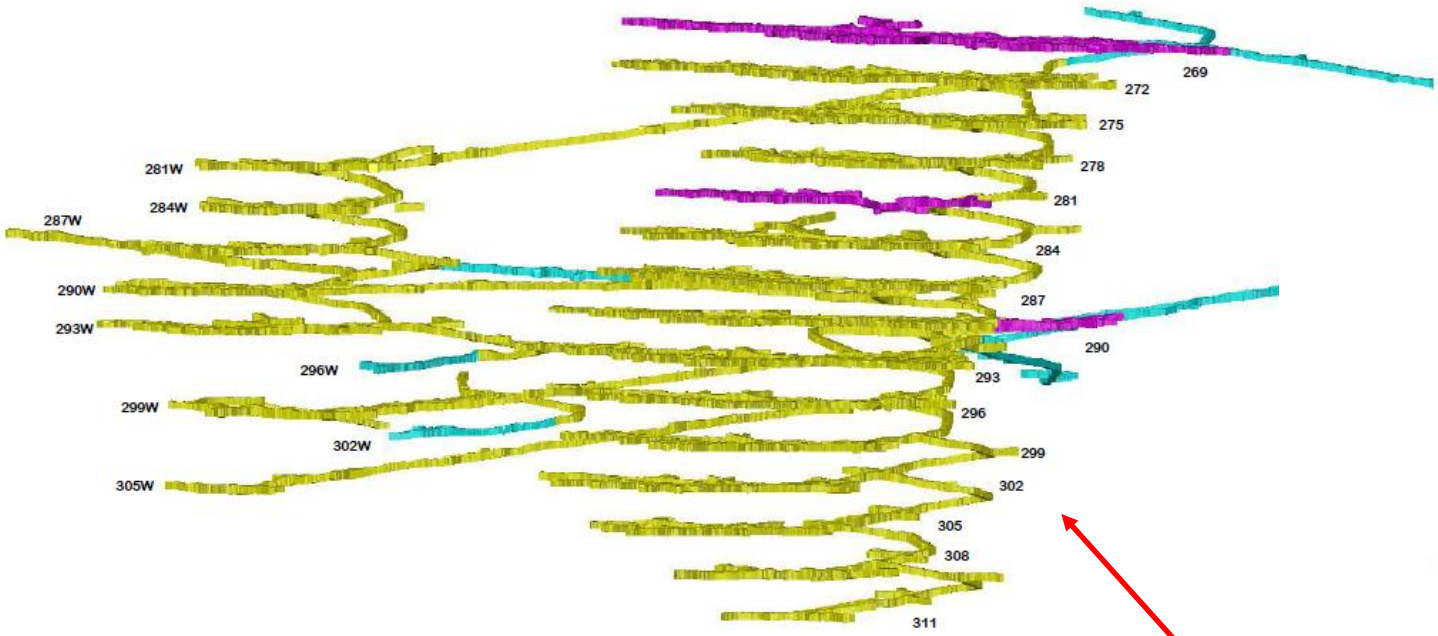
- Work with our people and set up training courses adapted to those new technologies;
- From the perspective that we can not do everything at the same time, we must have an integration plan, respect it and seize opportunities.

TACTICS : WHAT ?

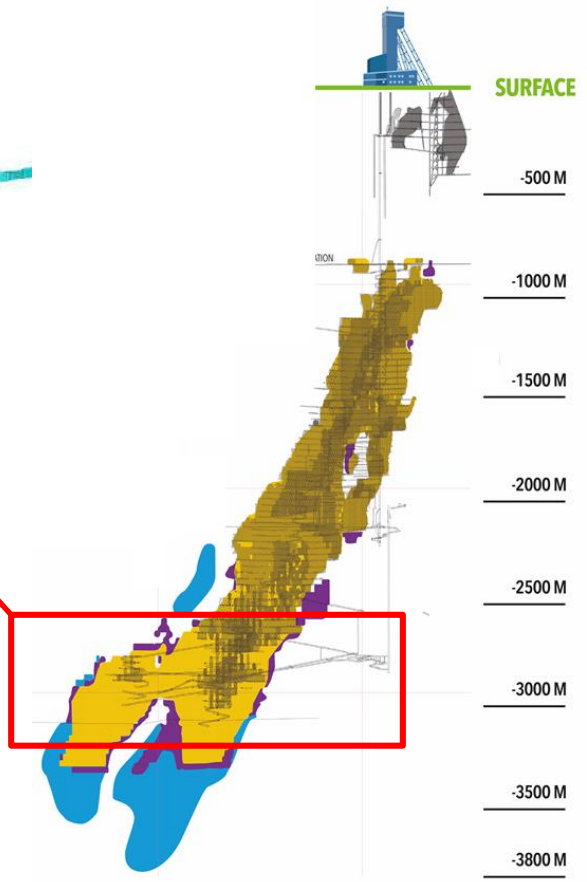
- Maintain and implement the new technology integration plan (Monthly - Heads of Service);
- Communicate changes to the strategy (Quarterly - Management Team);
- Validate the vision (Annually - Management Team).



LTE Network Deployment at LaRonde



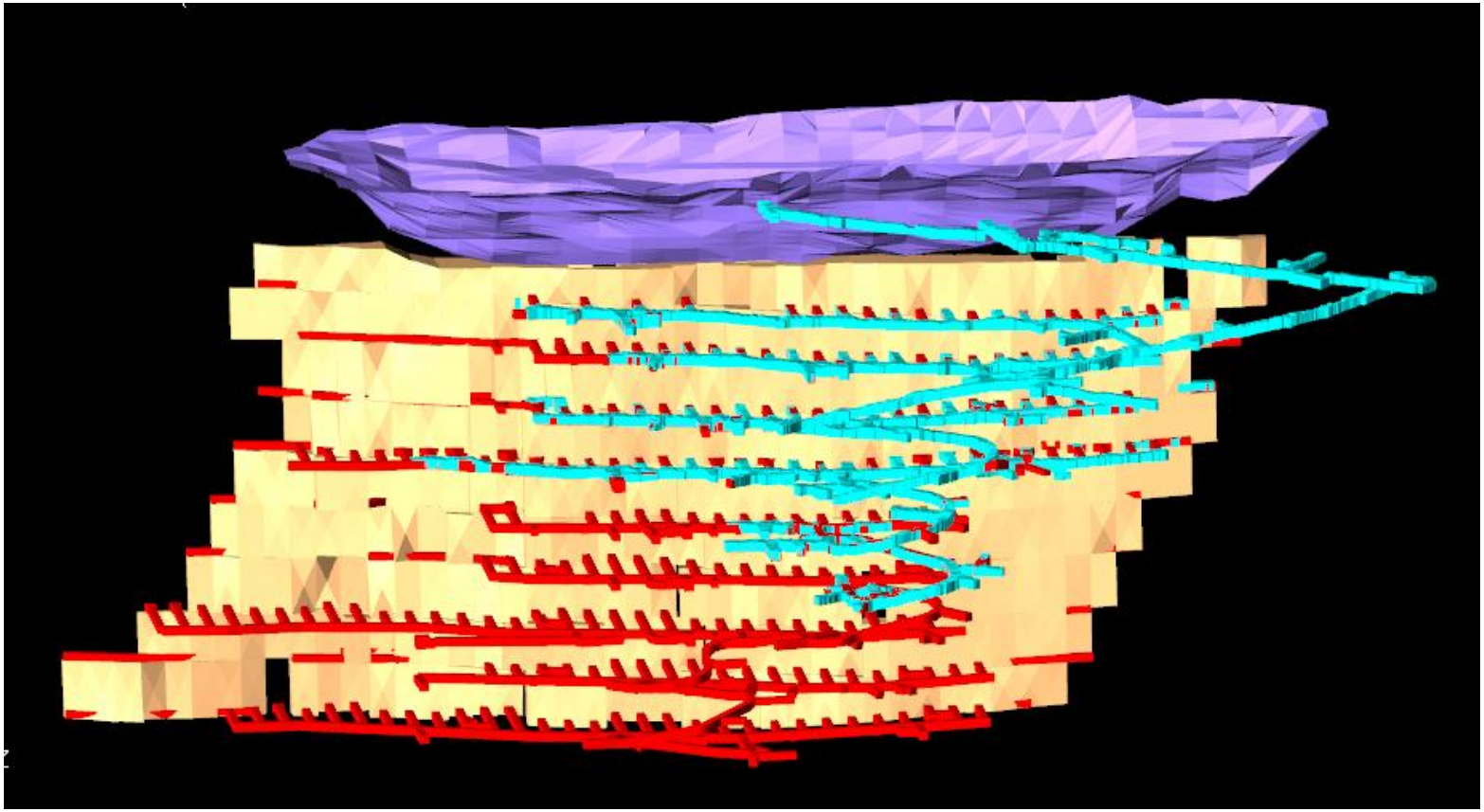
Yellow: completed | Cyan: Ramp to complete | Purple: Level to complete



2018 → Lower coverage will be completed (269 level – 311 level, garage 206 and 278)

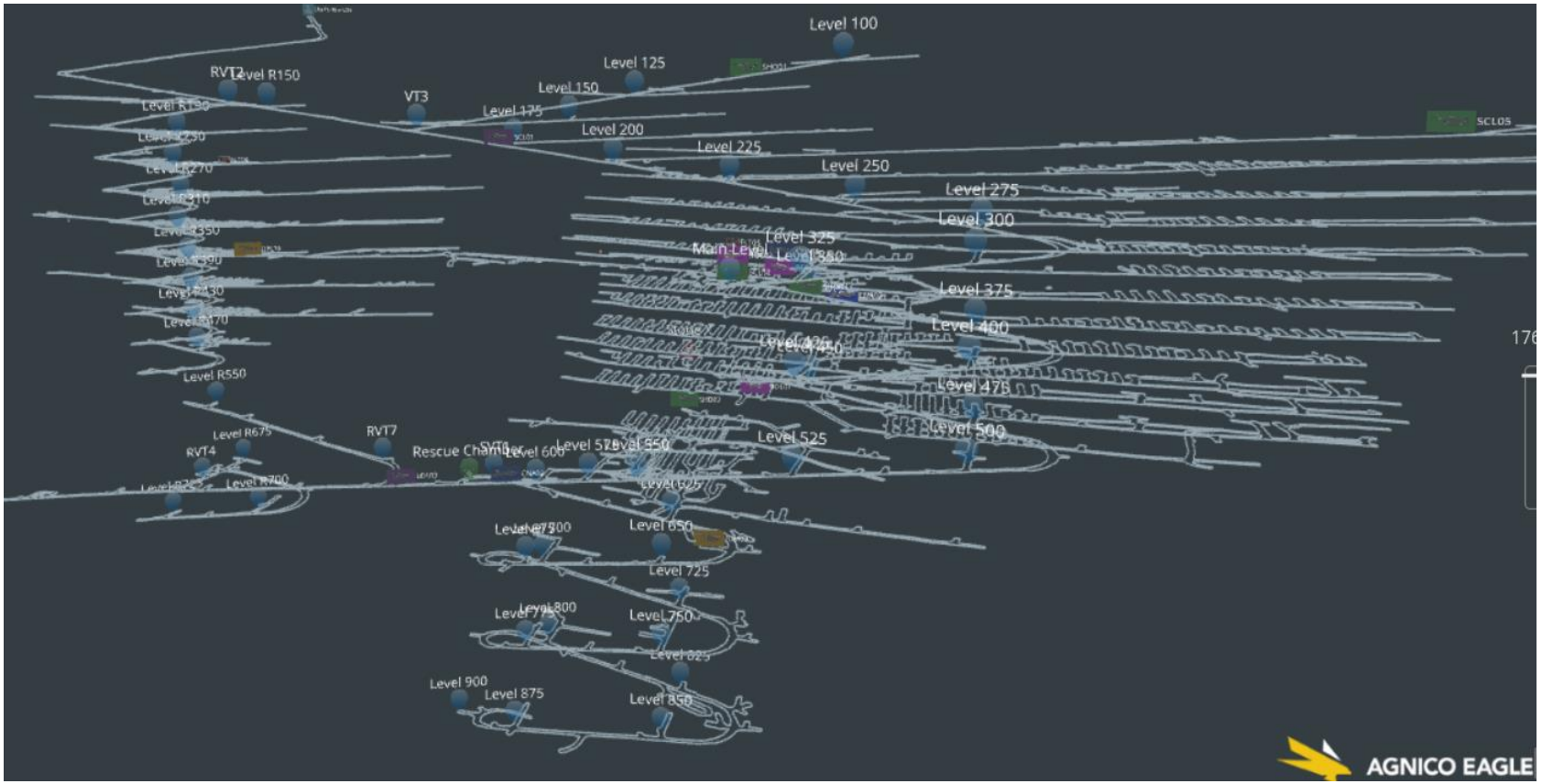
2019 → Main ramp from level 269 to surface (19 km of leaky feeder), main infrastructures and new development

LTE Network Deployment at LZ5



- The network presently covers 98% of the mine
- 5 levels completed (about 6 km)

People and Equipment Localisation in the Mine



Mobilaris mine visualization at Kittilä mine, Finland

- Gives us a clear picture of the mine in real time
- Traffic management to speed up haulage
- Facilitate mine evacuations and mine rescue procedures

Connecting the equipment (telemetry and IOT)

- Link equipment with management system in real time to oversee the fleet
- This data that will allow us to start implementing artificial intelligence



Connecting the equipment (telemetry and IOT)

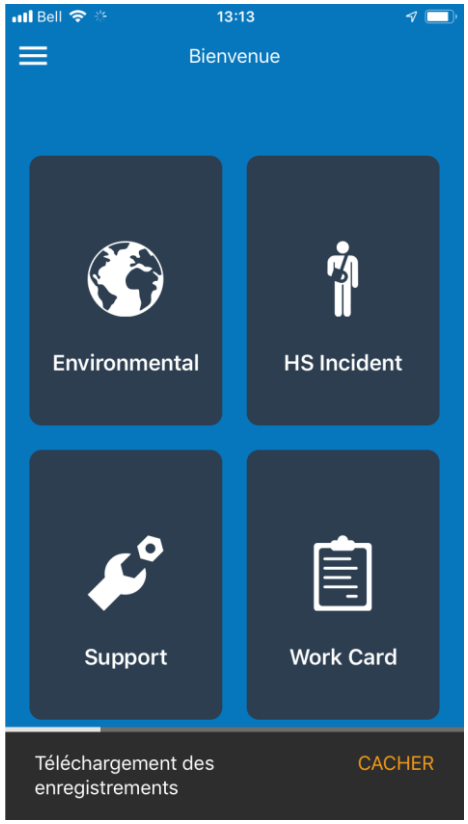
- Robust mobile PLC that uses LTE to communicate real time video / sound / data

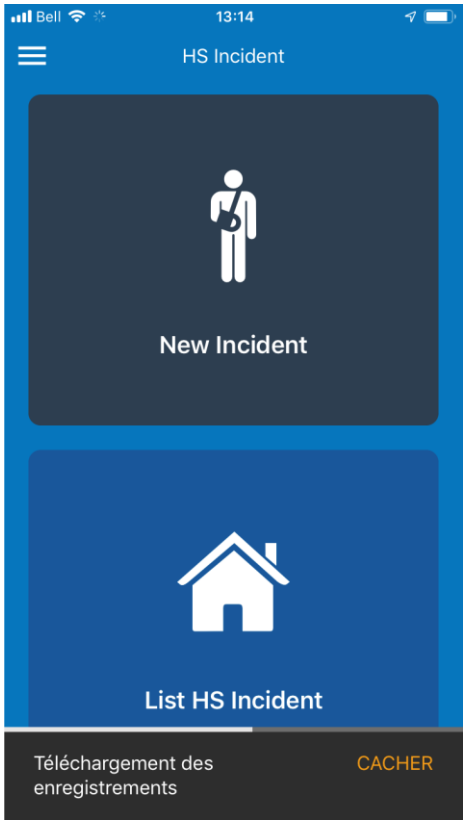


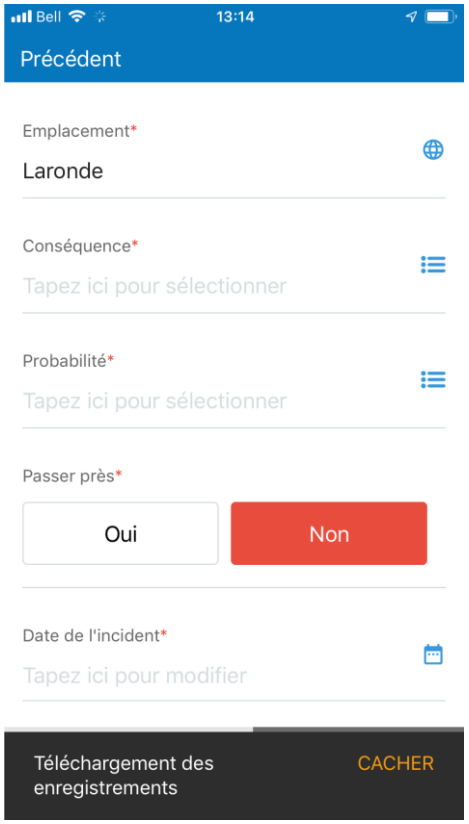




Intelex mobile application – Accident declaration







- In implementation – No more delays

Remote Operation Deployment (Planning)

LR 4.0

Development in progress



Jumbo, production drills
Mechanized bolter and raisebore

1. Drilling assist mode functional
2. Develop mechanized bolter with pumpable resin (2)
3. Drilling at distance possible but limited (Rock tools)
   - Bit changer to be developed
   - Rod handler to be developed

Operational



trucks

1. Loaded by scoop tram underground
2. Drive to surface autonomously
3. Interac with others equipment
4. Interac with humans



Scooptrams

1. Material re-handling between shifts
2. Development
3. Stope mucking
4. Truck loading



UG Crushers



Rock breaker hammers



Conveyors & hoists



Mills

1. Phase 1: Process control Grinding
2. Phase 2: Process control Copper
3. Phase 3: control room
4. LTE Voice system



1. Newtrax (in progress)
2. LTE voice system
3. Workers positioning
4. Electronic tag board
5. Equipment monitoring
6. Ventilation on planning

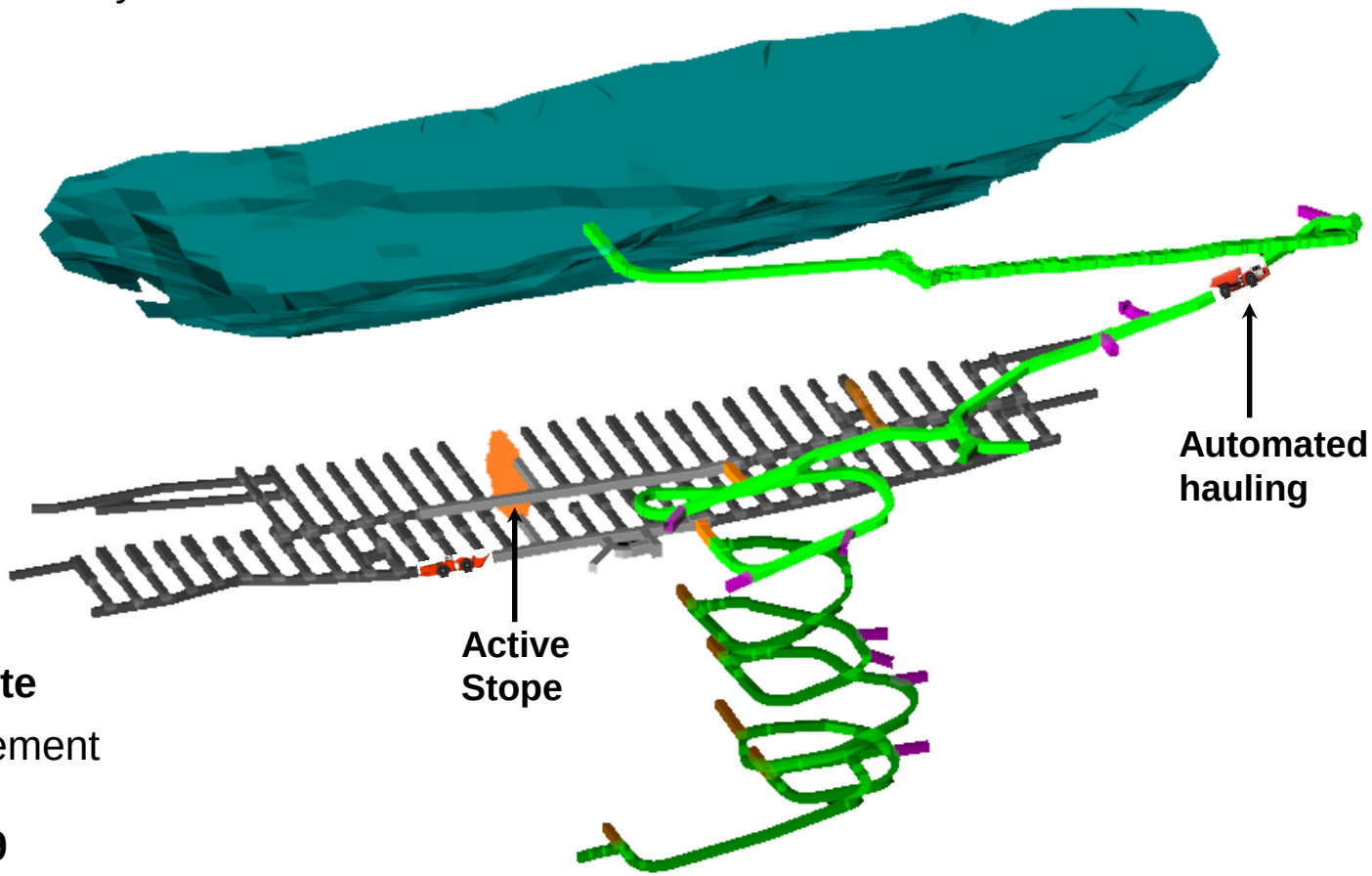
Remote operation deployment (planning)



Remote operation deployment (planning)

Highlights / World Firsts:

- Automated loading and hauling
- Dynamic system for a dynamic mine



Phase #1 – Complete

- No traffic management

Phase #2 – Q3 2019

- Traffic management and more machines

Mine Operation Managing System (MOMS)

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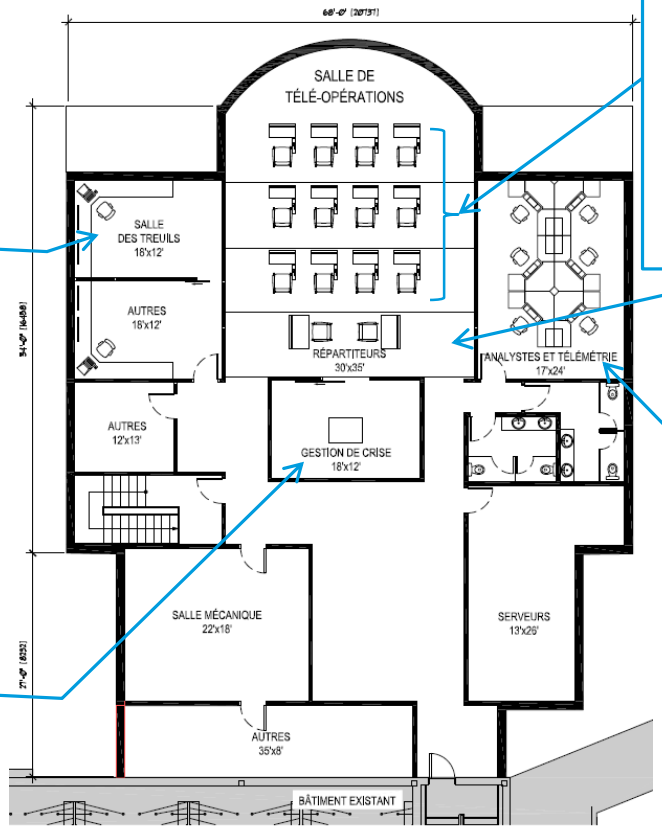
Hoist operator
- ✓ Hoist management
- ✓ Ventilation management
- ✓ Service management
- ✓ Pump management

Remote control
- ✓ Scoops
- ✓ Trucks
- ✓ Drills
- ✓ Hammer
- ✓ Conveyor
- ✓ Crusher
- ✓ Wide 3D view of the mine

Dispatch
- ✓ Traffic awareness
- ✓ Traffic management
- ✓ Situation awareness
- ✓ Evacuation management
- ✓ Dispatch shift activity to personnel
- ✓ Get noticed of disturbance and where it occurred
- ✓ Operational status of machine
- ✓ Fueling coordination



Rez-de-chaussée

Crisis management room
- ✓ People involved in the management of crisis receive all the information and find the good solution (Dynamic electronic table)

Analysts (process and maintenance)
- ✓ In-shift planning and updating jobs
- ✓ Keep track of shift progress
- ✓ Solve problems promptly
- ✓ Awareness about consumables that run out
- ✓ Machine operational data (hours, tons, meters)
- ✓ Machine alarming management (oil, pressure, tire, brake, etc)
- ✓ Analytics for predictive maintenance

**** Reduce lost time and improve coordination**

Conclusion

- We have a plan
- Need to change the way that we operate
- Health and safety will benefit from our improvements
- We are in a good position to improve our performance
- Enhance our productivity





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WORLD GOLD COUNCIL

Appendix


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