



Hexagon MineProtect Personal Alert: How NuttX can save lives

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Challenges in the Open Pit Traffic



Close Proximity/Blind Spots



Over-Speeding



High traffic density/Unknown Events



Fatigued Operators



Personnel Interaction



Poor Visibility

Outline

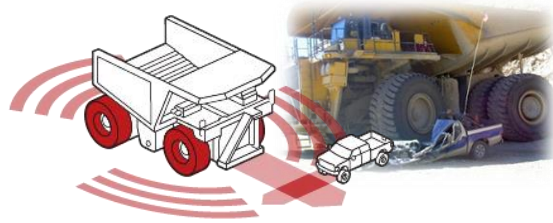
- What is Personal Alert?
- Why is NuttX used for this project?
- Leveraging POSIX compliance
- Software architecture
- Simulation framework
- Conclusions



Challenges in the Open Pit Traffic



Safety Technology Portfolio



Vehicle Intervention System



Tracking Radar

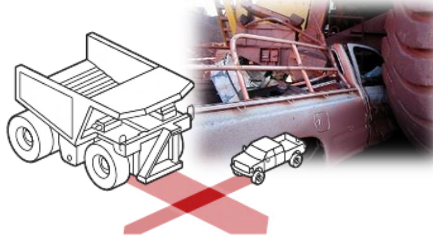


PersonalAlert



Vision

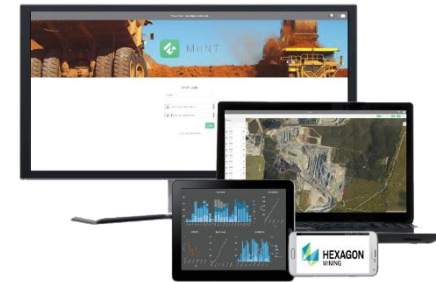
Collision Avoidance System



Fatigue



Wi-Fi
LTE



Monitoring and Analytics

HxGN MineProtect Personal Alert



Tag

- Wearable battery-powered device
- Ultra-Wideband (UWB) time-of-flight (ToF) measurements & comms with anchors
- Wearer alerted through LEDs, vibration and buzzer

Anchor

- Permanently mounted to a vehicle
- Communicating via UWB link with tags
- Communicating via CAN bus with main unit

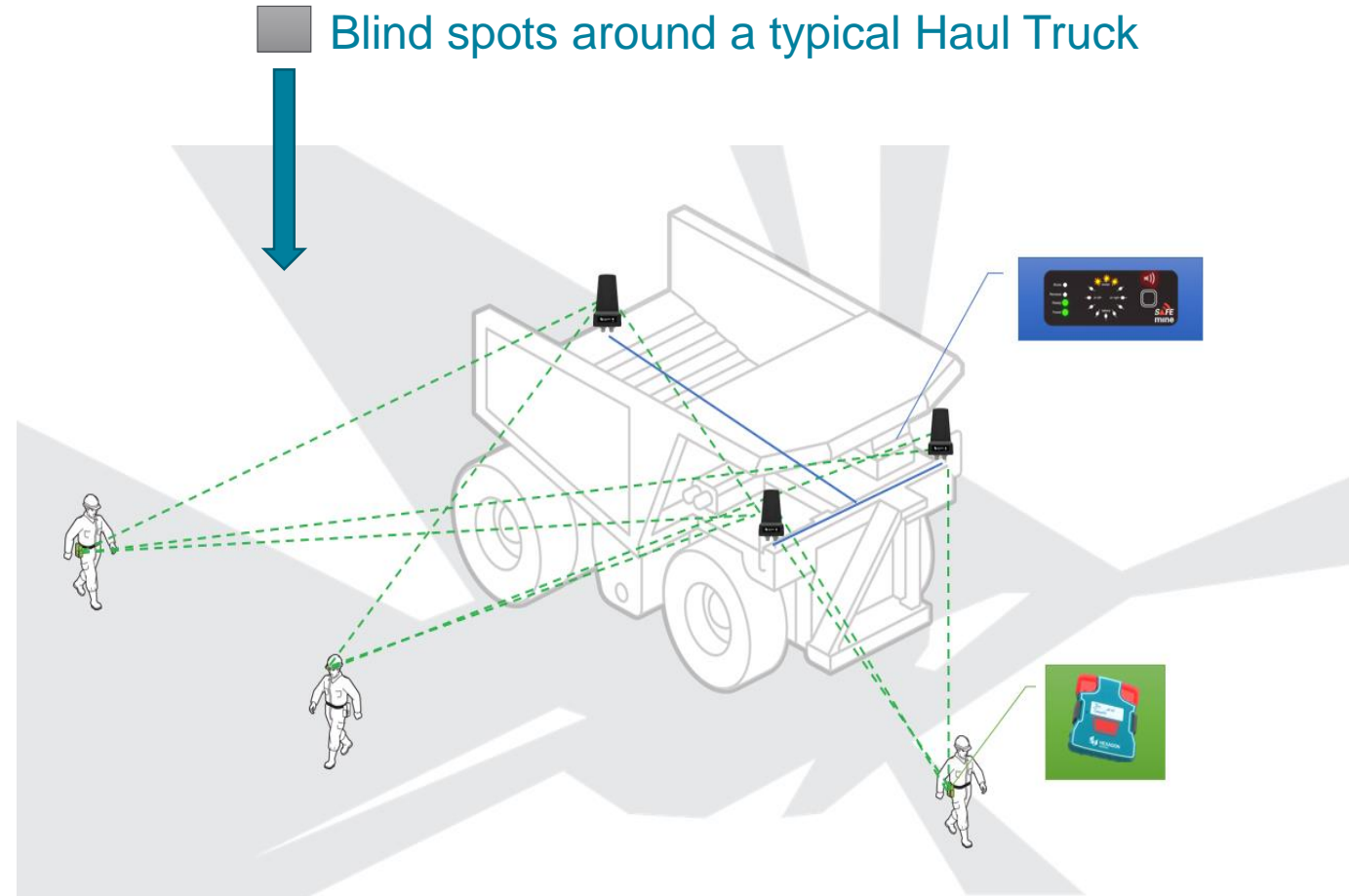
Main unit

- Processing of ToF measurement data
- Alerting of vehicle operator
- Back-to-base communications for reporting/analysis

Anchor

How does HxGN Personal Alert work?

- Uses Time-of-Flight (ToF) UWB technology on a two-way ranging
- Precise distance measurement between vehicles and pedestrians
- Configurable zones provide awareness and protection in case of imminent danger
- Faced with imminent danger, pedestrians are now empowered to act, regardless of the machinery operator



Highly Configurable Protection Zones

Cabin Detection Zone



User Interfaces

Distance Far

Visual

Distance Near

Visual

Distance Close

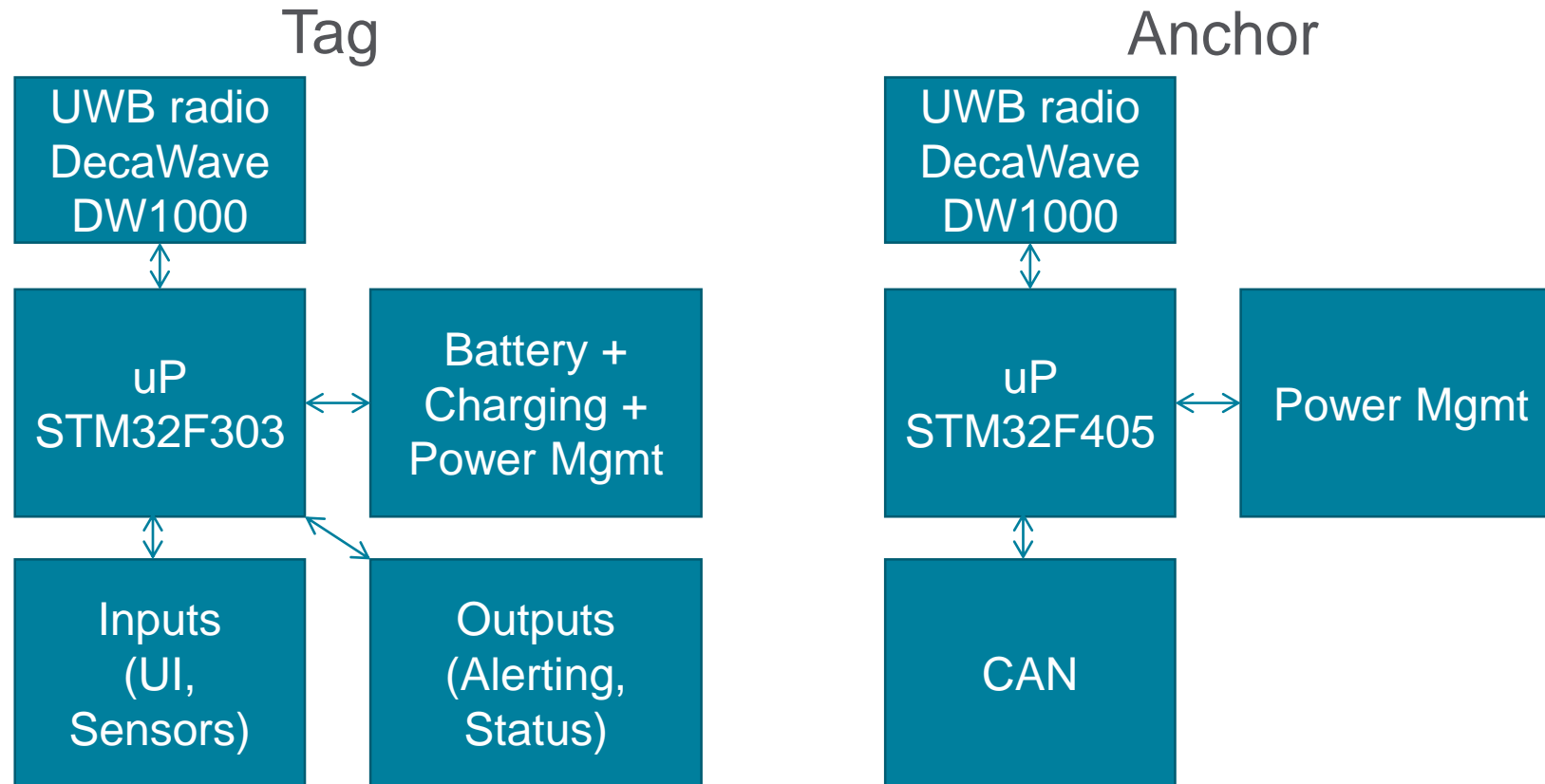
Visual

Audible

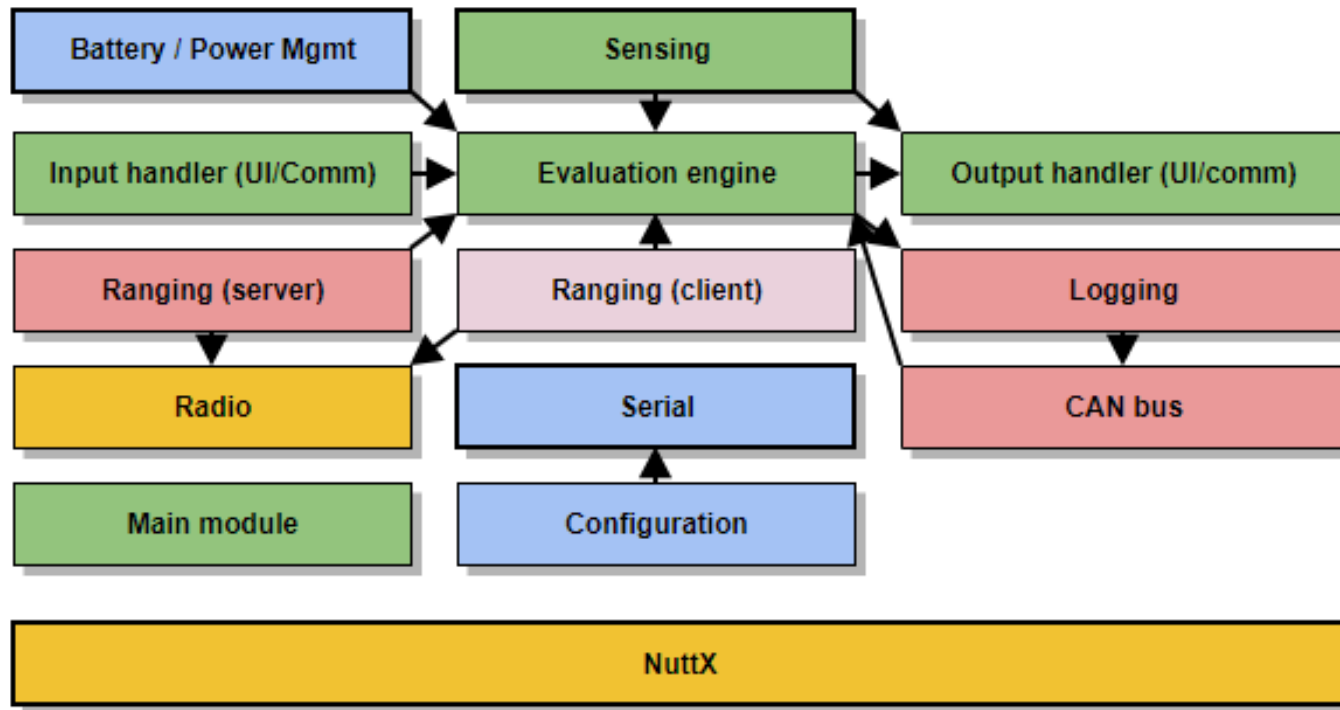
Vibration

Highly configurable to prevent nuisance alarms, and meet safety requirements

Hardware architecture



Software architecture



- Simple, clean interfaces between modules
- Each module has its own internal pthreads
- Usage of POSIX standard features for synchronization and data exchange:
 - message queues
 - semaphores
 - signals

Why NuttX for this project?

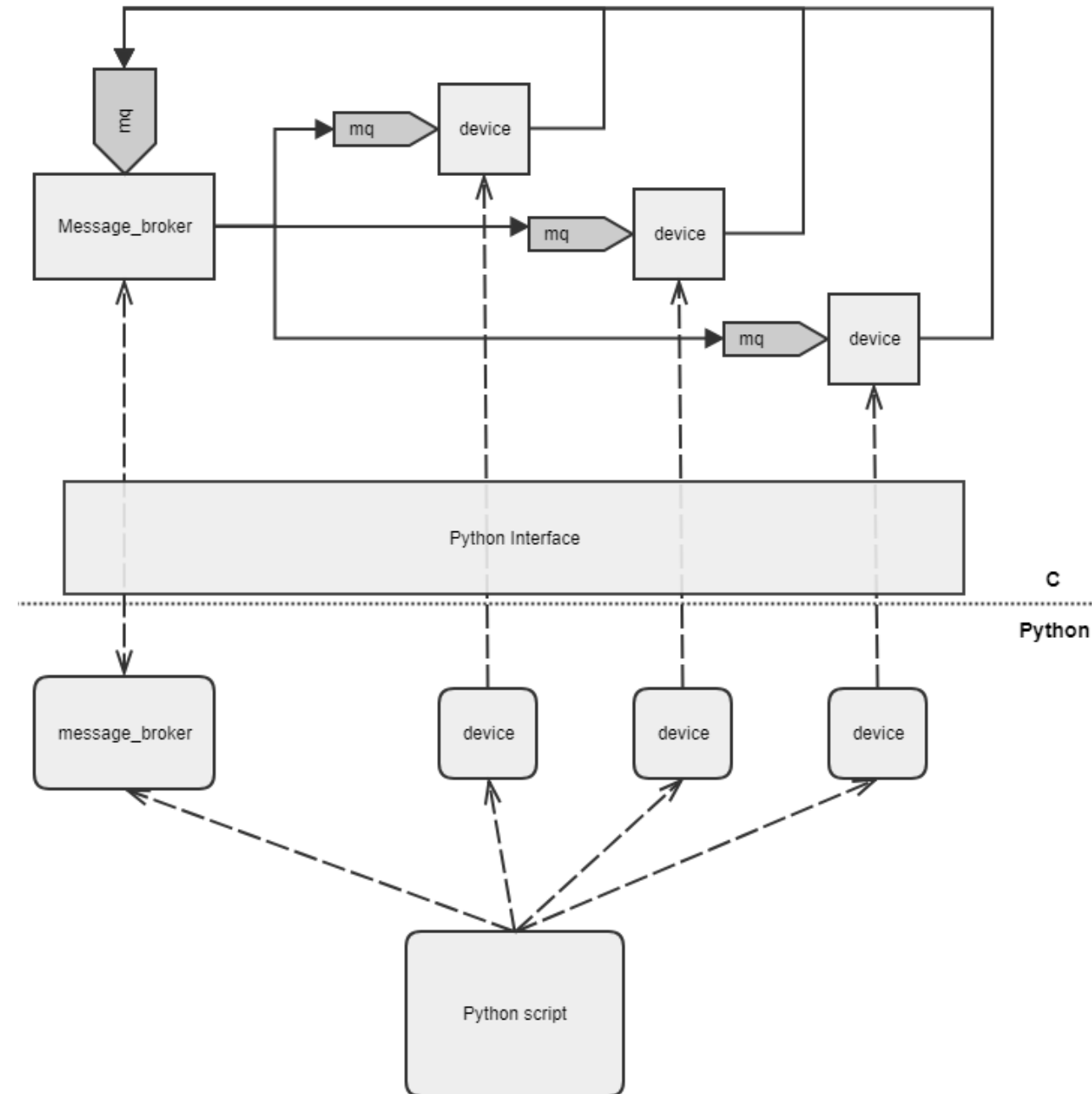
- Personal Alert is time-critical, e.g. UWB ranging has hard real-time requirements
→ RTOS to the rescue!
- Multiple RTOSes have been evaluated
- And the winner was... NuttX!
 - The most comprehensive RTOS among our candidates
 - Many features not used here, but highly interesting for follow-up projects:
e.g. network stack, wear-leveling file system
 - The only RTOS offering POSIX compliance
 - Small footprint
 - Open-source, BSD license
 - Simple build process

Leveraging POSIX compliance

- Application can be run under NuttX on embedded target and under Linux
- Implementing, debugging and testing application code under Linux
→ huge development speed-up
- Plenty of documentation for POSIX APIs available online
- Unit testing under Linux is straightforward
- Application code can be integrated in a Linux-based simulation framework

Simulation framework

- Run multiple instances of our application under Linux
- Hardware-related functionality is mocked
 - e.g. UWB communication is replaced by a message broker based on POSIX message queues
- C code is integrated in a Python simulation framework
 - Allows easy scripting of scenarios in Python
 - Multiple application instances (“devices”) are wrapped as Python objects
 - Used CFFI (C Foreign Function Interface) for C/Python interface



Conclusions

- NuttX was a very good choice for this project
- Leveraging NuttX functionality greatly reduced implementation effort compared to previous bare-metal projects
- Product has been successfully launched with multiple customers
- NuttX also selected for our follow-up project which is much more involved than Personal Alert
- Currently 6 developers working on NuttX-based application development
- Started porting our changes to the NuttX master branch



HEXAGON
MINING