Hardware-based Watchdog for Raspberry Pi Nodes in Malawi

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# Project Need

* **Problem addressed**: unexpected crashes of the deployed RPi (device). Problems with hardware or software can lead to unexpected device crashes or freezes while deployed in the field. Device freezes cannot be addressed in software running on the RPi as connections are destroyed and the device can no longer run software. Therefore, we require some form of external intervention to address potential device freezes. Generally, these issues may be addressed by manually powering down, and powering up the device. Due to the remote nature of the project, device freezes or crashes cannot be addressed via physical intervention. Additionally, we cannot fix problems within the system remotely as the RPi is disconnected from the network and software cannot execute on the device during freezes. Therefore, a mechanism to automatically detect and address device crashes in the field is required.
* **Additional functionality**: periodic reboots of the system are created by the RPi to reduce the risk of future device crashes.
* **Functional requirements**:
  1. External monitoring device observes RPi failure within reasonable timeframe post-failure.
  2. Upon device failure, external monitoring device intervenes and triggers RPi to restart.
  3. External monitoring device periodically (once every 12-hours) reboots RPi system.
  4. During system reboot, all scripts running on RPi are restarted and LoRa connection is reestablished.
  5. *Optional functionality*: external monitoring device monitors health parameters of the device and reboots if the metrics are not what is expected.
  6. *Optional functionality*: some form of restart on failure of internet connection (see here: <https://pysselilivet.blogspot.com/2021/10/raspberry-pi-reboot-or-restart-network.html>).
* **Testing requirements:**
  1. Watchdog unit test: verify RPi restarts after shutdown and reboot.
  2. Watchdog unit test: verify external monitoring device periodically reboots RPi system.
  3. Watchdog component test: verify python scripts restart after shutdown and reboot.
  4. Watchdog + LoRa integration test: verify that RPi shutdown & reboot reestablishes the connection between field station and service station. (Setup separate tests for each station).

# Research

* A hardware-based watchdog is a specialized piece of hardware that is integrated with a RPi and are capable of rebooting the device.
* RPi has a built-in hw watchdog that, once enabled, will observe system activity and power cycle the RPi when stuck. When the RPi freezes, the built-in watchdog will restart it automatically after 15 seconds.
  1. To handle WiFi driver crashed, an additional line must be added to the watchdog.conf file.
* Test method: run fork bomb program from terminal to crash device.

# Implementation

<https://mender.io/blog/raspberry-pi-in-production#:~:text=A%20Raspberry%20Pi%20hardware%20watchdog,device%2C%20within%20a%20given%20timeframe>.

# Sources

* <https://mender.io/blog/raspberry-pi-in-production#:~:text=A%20Raspberry%20Pi%20hardware%20watchdog,device%2C%20within%20a%20given%20timeframe>.
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* <https://medium.com/@arslion/enabling-watchdog-on-raspberry-pi-b7e574dcba6b>
* <https://www.crawford-space.co.uk/old_psc/watchdog/Linux-Watchdog.html>
* <https://pysselilivet.blogspot.com/2021/10/raspberry-pi-watchdog-made-simple.html>