ENTIRELY AUTOMATIZED, SECURED DATA RETRIEVAL, PROCESSING AND UPLOADING SYSTEM

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Context & Objectives

- **In the context of global climate warming**, several monitoring scientific stations networks were developed around the world. In Europe, we have an Integrated Carbon Observation System (ICOS) network to which belongs our two cropland stations FR-Lam (class 1) and FR-Aur (class 3).
- **ICOS stations** use an important number of sensors with high sampling rate data recording, especially Eddy Covariance (EC) carbon dioxide measurements setups (10Hz sampling rate). All these data have to be logged and transmitted every day to the ICOS server on Carbon Portal (CP).
- Three distinct but interdependent problems arise:

- Internal station organization of the loggers.
- Collection and transmission of the logged data to the laboratory.
- Transmission of the data to the CP

OBJECTIVES: Build a **robust, automatized**, **"smart"** system to optimize data retrieval and processing.

loggers' organization

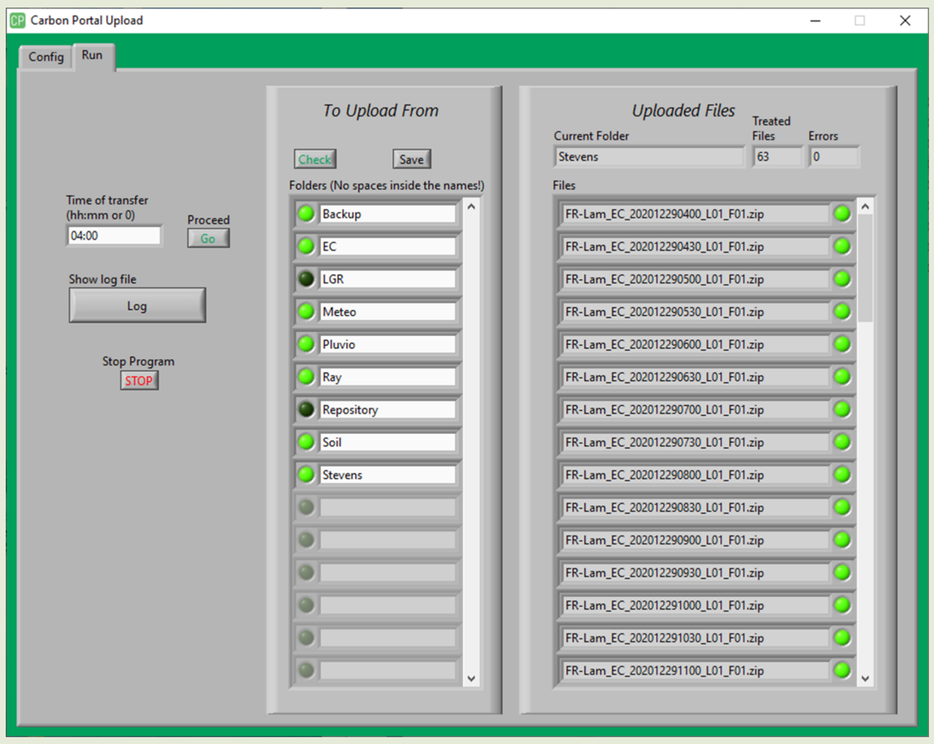
- Each logger (mainly Campbell-Sci. loggers, UK but also SmartFlux2 from Licor, USA) is connected to a router via internet cables. Other devices such as a camera or local PC are also present on the stations and connected via RJ-45 cables.
- Some loggers have its RJ-45 interface others do not have it and the communication with them is insured via their serial port RS-232. To connect it through the internet, a serial server module is used (USR DR-301, China). An internet WiFi relay allows to hard reset each logger via internet commands.
- All RJ-45 cables are plugged into the router of the station Lock 500 from the Tosibox with an embedded 4G LTE modem (no subscription, Finland). This router opens a VPN tunnel through the internet.

Data transmission from the stations to the laboratory

- Tosibox system insure a fast reliable and secured; 256 bits encrypted data transmission via a Virtual Private Network (VPN). In the lab, a PC, a so-called VPN PC, with a matched master key from Tosibox (a USB plug) establishes bidirectional communication between this PC and every device plugged into the router. Official software from Campbell-Sci.; LoggerNet, is retrieving data from Campbell loggers stocking it on the VPN PC. For other data, such as EC data from Smartflux2, an FTP server on VPN PC is embedded and receive files from SmartFlux2 or cameras. **All IP addresses can be static** with a **generic usage SIM card**.

Data transmission to CP

- Some data files, but not all, have to be uploaded every day, around midnight, to the CP. The uploaded data files have to be checked first to correct missing data lines, if any, and to merge fragmented files if any. Indeed, in some cases, it is possible for loggers to produce several fragmented daily files instead of one complete file and to miss a few data lines. In case of incomplete file transmission to the CP, it will be rejected and flagged as comporting errors or fatal errors. To automatize the process a reliable yet simple-to-use software was developed under Labview from National Instrument, USA. This software is distributed freely on CP for the ICOS community (https://fileshare.icos-cp.eu/apps/files/?dir=/ICOS%20RI%20groupdisk/Ecosystem/MSA/Codes%20shared/Files%20Uploader&fileid=1852945) seek for every fragmented file and merge it into one file then scan it determining the right sampling rate and eventually missing data lines. In case of missing lines inserts data lines with the correct timestamp along with agreed virtual data (-9999 for us). Once the file is corrected, it is uploaded on CP. All steps are consigned in a log file to allow accurate tracking.



Conclusion

- Measurements go hand in hand with data collection, verification, and transfer-storage. For this purpose, a robust system should be built on sites and in the lab. Nowadays, solutions derivate from omnipresent IOT technology allow to make an entirely automatized "bulletproof", cost-effective setups.

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