Data Concentrator Unit

Introduction

Data Concentrator Unit (DCU) is an embedded device to collect data, metering or environmental information from other hardware devices and deliver to server for further processing. Its preliminary hardware was used to collect metering data for pilot AMR (Auto-Meter Reading) project of China Light & Power (CLP) in 2005. 5 units were installed and it served 5 buildings of housing estate. It was running on embedded Windows CE platform.

The first generation was released in 2010 and over 100 units were installed in commercial building with shopping mall and government offices in Hong Kong. Some units were also installed for the second pilot of CLP's AMR project. It equipped with 48 MHz ARM CPU and 128 MB flash with memory. It started to serve for different purposes, data collection for Energy Management System (product information in another document) and for external system using Modbus protocol. The design was modular and the configuration files determined what services it provided. Both hardware and software watchdog were employed for its resilience.

Due to the improvement in embedded devices and popularity of mobile network in the past few years, the second generation was developed in 2015. The final hardware design was completed in 2019 using Beaglebone hardware, AM335x 1 GHz ARM Cortex with 4 GB eMMC and 512 MB RAM. These changes can increase the capability of data collection up to real time basis subject to the constraints of the metering protocol and number of devices in data channel.

In addition, another component is developed in Raspberry Pi to collect streaming data from a few number of DCUs and distribute to other data vendors using Modbus protocol. This device is deployed in the sites to alert site management team to take immediate action on special event.

The third generation developed on Raspberry Pi is available and deployed in some sites. It shares same features of the previous generation but collecting metering data through Modbus protocol in additional of EDMI protocol where EDMI is meter provider in Australia. At the same time, it provides data delivery through Green Bird protocol and Modbus TCP protocol. Furthermore, it also collects environmental data such as temperature and IAQ through groove interface. However, GUI administration support is dropped in the third generation of DCU.

While energy management becomes more important, a new framework is being developed and it involves LORAWAN interface to collect environmental data from a set of sensors. The data is then routed through LORAWAN gateway and uploaded to AMR infrastructure.

Though both the second and third generations of DCU are available, all the development is on the third generation. While the third generation is developed in Python, shrink wrap approach can make it easier to be deployed in different Python supported hardware.

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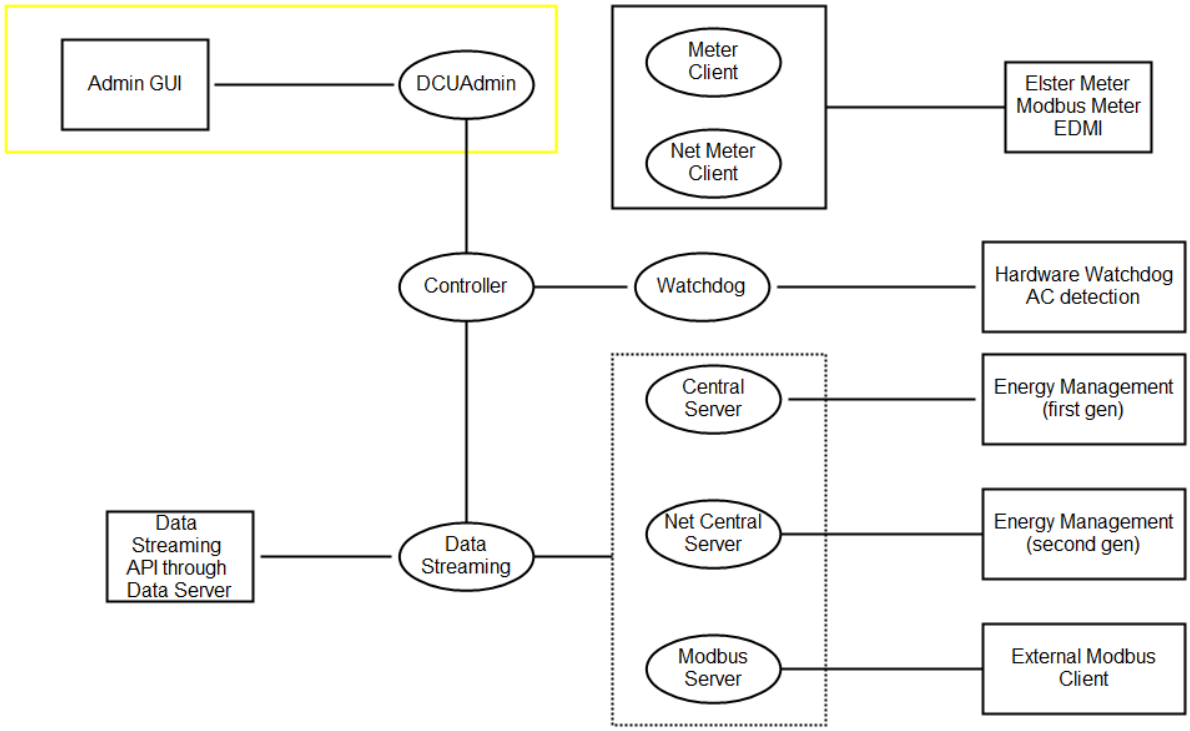
Features

Additional modules were introduced in the second generation to provide high frequency data collection and publishing. The old modules could also be used using configuration files to serve for old environment. This is accomplished by using same sets of interfaces for different kinds of service components, e.g. meter client, distribution server and data streaming.



Data Collection

The existing meter data collection (Meter Client and Net Meter Client) works with Elster meter from UK and Germany and EDMI meter from Australia. In addition, it also collects metering data through modbus protocol such as iMeter6 from CET Electric Technology and A29 from ADTEK. They provide 3 kinds of data, snapshot data initiated from DCU, load profile and instrumentation stored within meter. For Germany meter, the module is capable of using OBIS protocol to collect more than 40 fields of data within 3 seconds using RS485 interface. Load Profile and Instrumentation are processed once a day while the module can retrieve these kinds of historical data before last successful request. In addition, time synchronization is performed to ensure that the meter clock for historical data is correct.

Meter Client supports 2 modes of operation, continuous polling without data storage and periodic polling (at least 15-minute) with data storage. No historical data collection is made for continuous polling mode. Only the latest data is kept in memory for continuous polling. This is mostly used with Modbus Server or Data Streaming to store data in another device.

Net Meter Client supports periodic polling down to 1 minute and it is subject to the number of meters in each communication channel and data retrieval time. The rationale is to ensure that the collection time matches against historical data that is required by many customers for

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data analysis, billing and the cycle stealing technique. This technique is to distribute the historical data collection time to utilize the remaining time gap between each polling cycle. As a result, one snapshot file for the whole channel and two historical files of each meter are produced every day.

The modules communicate with meter through RS485 and TCP network interface according to the installation requirements in each site.

Data Distribution

Three existing data distribution modules are ready. Net Central Server is developed in the second generation. It works with the second generation of Energy Management System by providing data streaming and historical data over same TCP/IP connection at the same time. Whenever data is collected from meter client, it published to the server immediately. It can operate in dynamic IP address or static IP address environment. Dynamic IP address is mostly used in mobile network. The communication protocol is specially designed to better utilize the mobile charge and error prone detection. For Central Server, it supports fixed IP or modem communication that has been used in the first generation of Energy Management System. All data is packed in one single file for transmission. All file transfer is verified by its size and MD5 (Message Digest 5) checksum besides the checksum in each data packet.

Modbus Server works with external Modbus client through Modbus RTU, Modbus ASCII and Modbus TCP. Register Access is commonly used other kinds of access such as bit and file might be implemented in future release. 2 sets of configurations are used to map Modbus register to the field of meter with number of bits of data, decimal point and default value.

Another method to streaming data to another device is through simple TCP/IP connection to deliver to another device. Simple application handshake is required. The objective to introduce this mechanism is to allow the user in site to monitor meter data without surfing through the server of Energy Management System. A simple Java based GUI can be provided upon request. In addition, an embedded device is available to collect a set of DCU using this protocol and distribute to other parties through modbus protocol.

Resilience

The hardware is equipped with hardware watchdog, real time clock and backup battery. The backup battery provides sufficient power to ensure that all data files are saved during sudden power outage to minimize data loss. Hardware watchdog is used to reboot the hardware whenever the software goes wrong.

The software watchdog module works with hardware watchdog to detect any power failure to properly shutdown the whole process. At the same time, it monitors the operating status of other data components. It first tries to restart that components. After several trials, it would request to reboot the whole system. This can ensure the embedded device to work properly without manual intervention.

In the second generation, more LEDs and additional of display panel are installed. Messages on the panel indicate what is going on in the system while LED reveals communication and the healthiness of the process.

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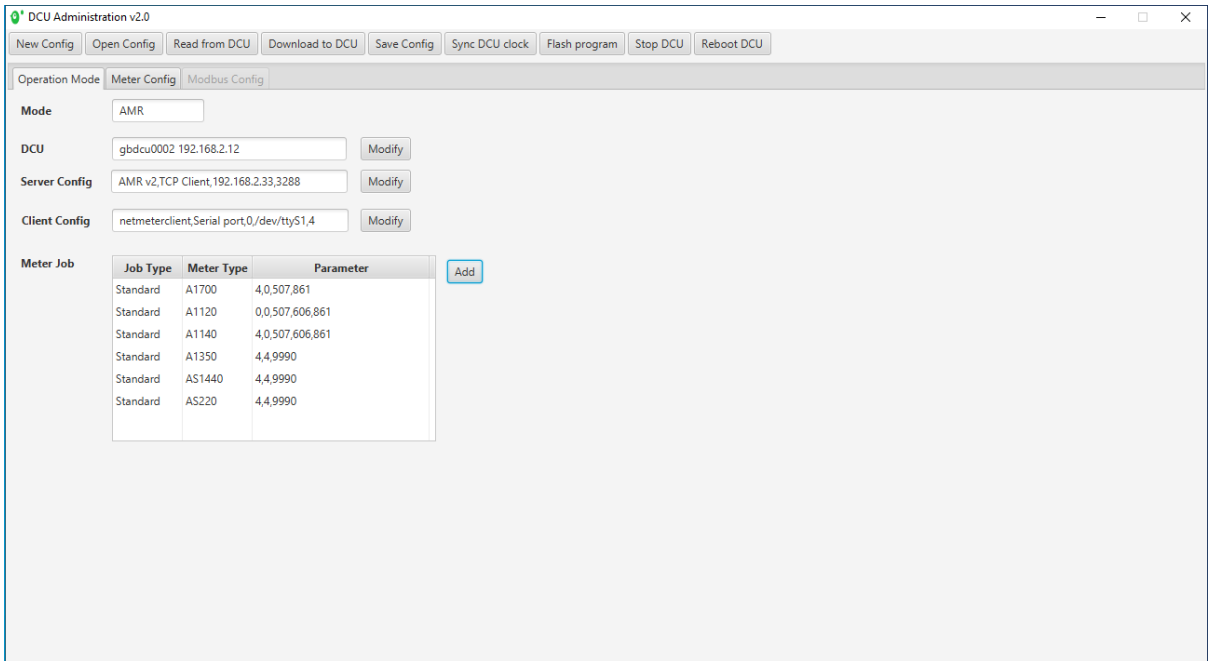
Administration GUI

The administration GUI is redeveloped for the second generation of DCU although it can read back the configuration generated by the first generation of GUI. Thus, it is highly recommended to use old GUI to read the configuration file of the first generation of DCU for DCU upgrade especially for Modbus mode of DCU. This program is pure Java requiring Java 1.8 with Java FX support.



For managing the existing second generation of DCU, it is recommended to proceed first with “Stop DCU” operation which instructs the “DCUAdmin” module to stop all data processing work followed by “Read from DCU” to perform configuration. Afterwards, “Download to DCU” is invoked and followed by “Reboot DCU” to make the configuration effective.

As stated before, this module cannot be used with the third generation of DCU.

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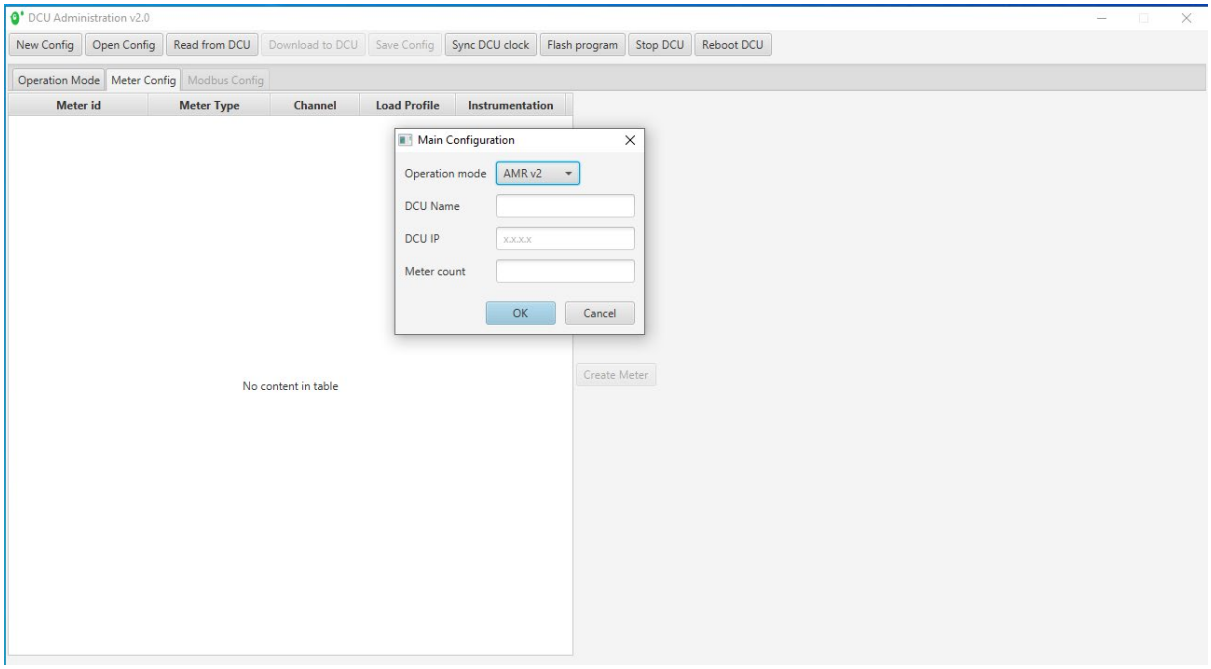
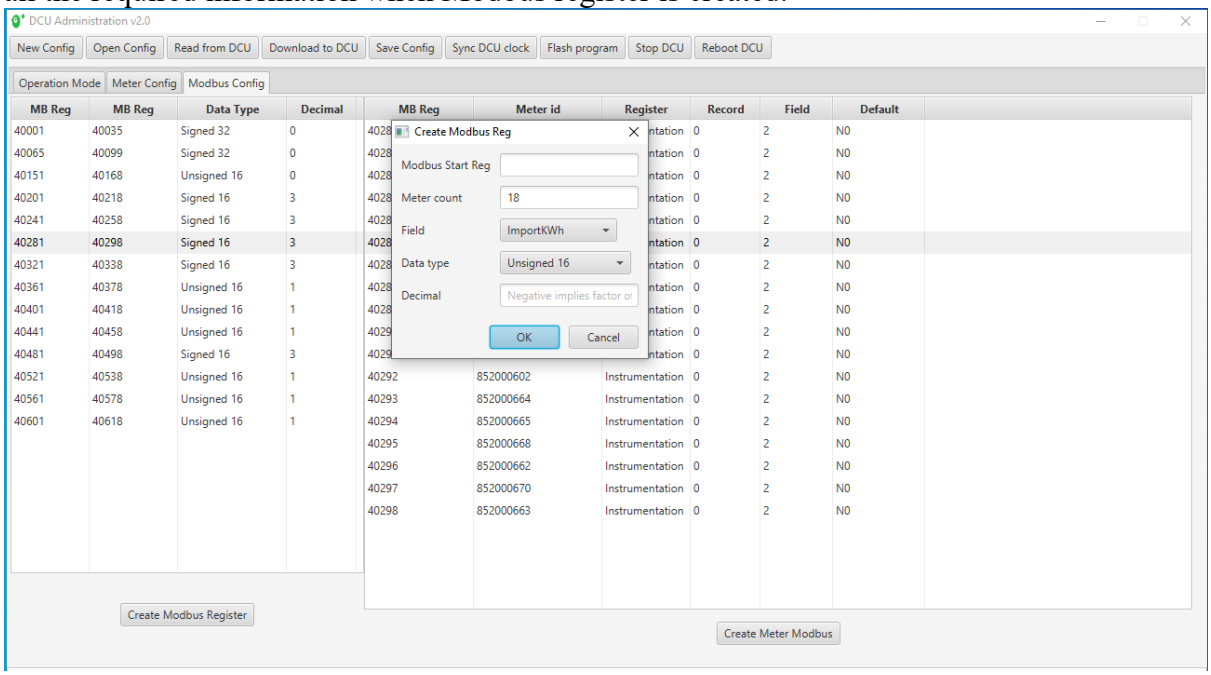


For new DCU configuration, “New Config” is invoked like the above diagram. It is highly recommended to create meter in order in Modbus mode while the application would generate all the required information when Modbus register is created.



Both Modbus register and meter Modbus information can be edited or even deleted. Please verify if the outcome is correct.

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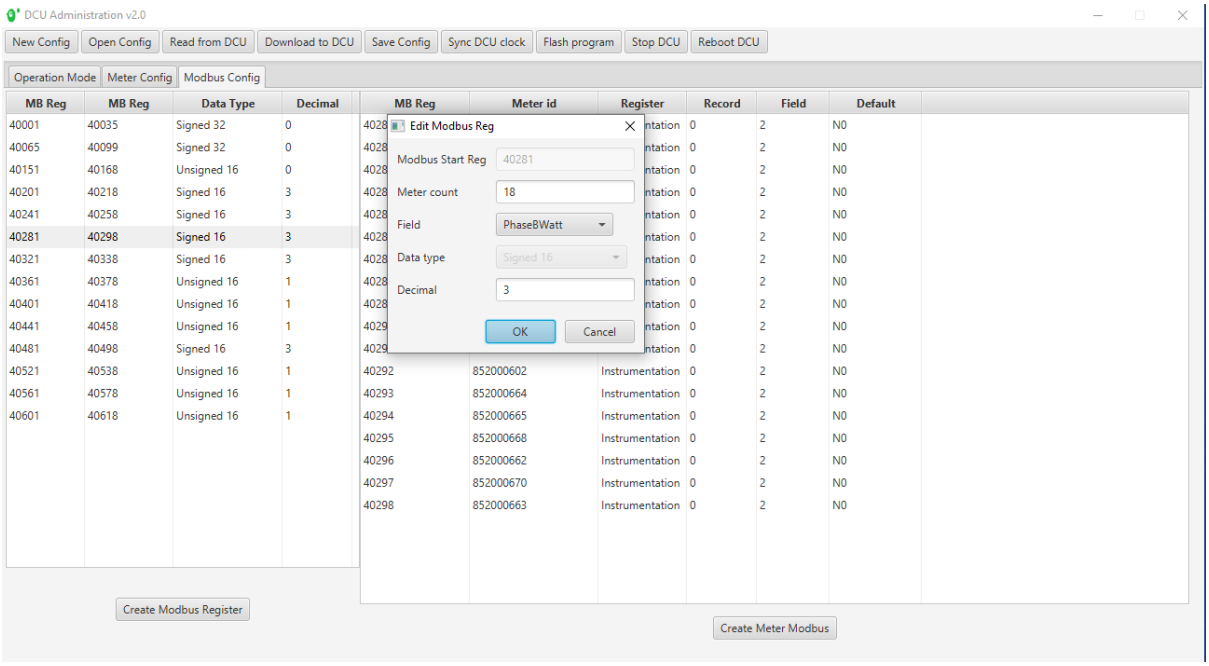
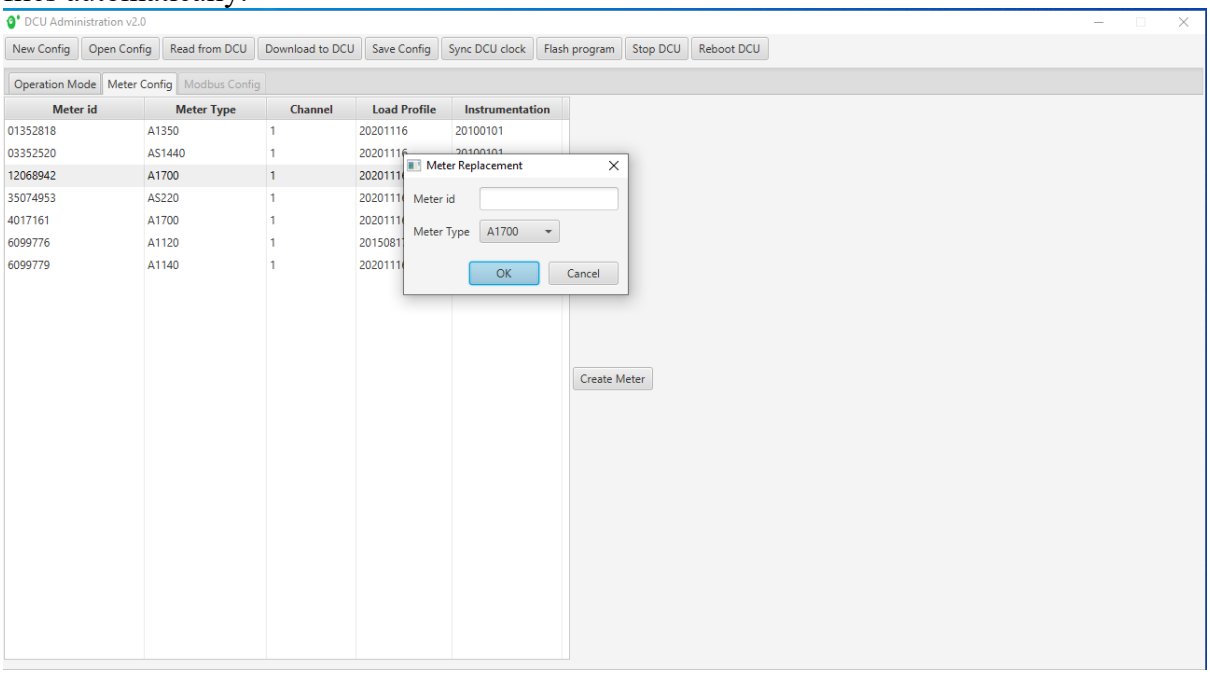


In case of meter replacement or adding meter, the application updates all the configuration files automatically.



Since all operations are stored in cache, the user would be reminded of saving the file or downloading to DCU to make it effective.

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