IoMT™ DART

## Electromagnetic Geophysics Systems for Magnetotellurics and Related Investigations

DART™, the *Distributed Architecture for Real-time Telematics* – is *disruptive technology* designed and produced by **IoMT.tech[1]**.

<u>What do we mean by *disruptive* technology?</u> The current electromagnetic geophysics instrumentation business model depends on high priced, high margin, low unit sales to maximize the profit on each sale. Such high cost is a profound barrier to researchers, explorationists and geo-engineers, often with limited budgets, as they require high-resolution data sets that will truly take advantage of the remarkable subsurface imaging and process monitoring capabilities of EM induction methods. This is particularly the case for unlocking the full capability of 3D and 4D magnetotellurics and related methods.

<u>How is our business model different?</u> IoMT.tech's model is to provide world leading technology at extraordinarily *low unit cost* and at *low profit margin* per unit sale. Why are we willing to lower the profit margin in this way? Our goal and mission is to nurture and grow the largest possible community of EM geophysics end-users, providing them with remarkable capabilities to explore the subsurface at previously inaccessible scale. Doing so requires ever larger EM imaging array studies for 3D and 4D exploration and monitoring. **IoMT.tech** has designed next generation, easy to deploy, inexpensive yet remarkably capable instrumentation, with an ecosystem for MT data processing and analysis, optional real-time data telemetry and cloud services to help our community of users grow and flourish.

While we are immensely proud of our instrument design and aesthetics, we understand that to the end-user of MT survey expenditures, *the true value is in the data and the interpretation, <u>not</u> in the shiny expensive equipment*. Our goal is to reduce the cost and speed up the process of acquiring the data and arriving at the interpretation. DART and IoMT Cloud is how we provide the tools to realize that goal.

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[1] IoMT.tech is a US registered limited liability corporation (LLC) dedicated to lowering the total lifecycle cost of MT through innovative engineering and design.
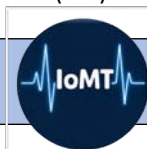
IoMT™ DART Product Description

Introducing the **IoMT™ DART** geophysical receiver. By adopting technologies developed for the Internet of Things (IoT), a low power, high fidelity data acquisition system is now available at an industry leading ultra-low cost.

The **IoMT™ DART** features high-capacity internal data storage and a high-precision triaxial fluxgate magnetometer in an integrated, water-tight package designed for rapid deployment and for reliable, long-term operation. With on-board orientation sensors and vector field rotation algorithms, the **IoMT™ DART** can be deployed rapidly without requiring orienting it in the field.

Optionally, external induction coil magnetic field sensors and high digitization rates are also supported, for wideband and audiofrequency MT applications. Each channel has a dedicated 32-bit digitizer for extended dynamic range and improved SNR enabling operation in areas of high environmental noise.

With remote high-speed LTE communication options, the **IoMT.tech** cloud platform adds real-time internet-accessible data synchronization and on-demand robust, single and multi-station processing to the **DART** system's capabilities. Where LTE is unavailable, third-party provider SpaceX Starlink™ Satellite communications can be linked to the **DART's** built-in WiFi system to provide data synchronization nearly anywhere in the Americas, western Europe, Australasia and parts of Asia and Africa, with additional locations planned. **IoMT.Tech** can also work with clients to transmit the **DART** data stream using satellite terminals from other, client-specified providers.

Fast GPU-accelerated inverse modeling capabilities are also soon to be available through **IoMT** web services.

Product Applications
- Magnetotellurics, CSEM, powerline monitoring; other surveys
- Magnetic variometer deployments
- Ground-level electric field
- Marine MT/CSEM (under development)

| Technical Specifications	
General	
Channels	1 – 10
Sampling Rates/channel	1 Hz – 32 kHz
Timing Accuracy	≤ 20 ns
Communication	WIFI, USB, LTE
Storage	µSD up to 512 GB
Telemetry	
LTE, Starlink™	Optional
Analog	
ADC	32-bit resolution
Selectable Gain	1 – 32
Measured Range	± 2.5 V
Input Impedance	>10 MΩ at DC
Typical Sensor Configuration	
2 electric field channels	
3 fluxgate magnetic field channels DC – 100 Hz (integrated Bartington Mag649)	
3 optional induction coil magnetic field channels for broadband and audio frequencies	
Power	
Supply	10 V – 24 V
Consumption	≤ 0.35 W – 5 W
Package	
Dimensions	13" H x 3" D 330.2 mm x 76.2 mm including connectors
Weight	~2.4 kg
Operating Temperature	-20 °C to +70 °C
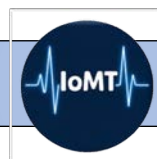
DART SYSTEM CONFIGURATION OPTIONS

I) BASE CONFIGURATION - DART BLUE, WITH DART Connect and DART Process

The base configuration for the **DART** is a 5 channel 32-bit system for long-period magnetotellurics with 3 magnetic and 2 electric channels. Integrating the fluxgate magnetometer into the same water-tight packaging as the data acquisition system provides ease of use and simplicity of deployment, typically by quickly drilling a small diameter hole 30 cm into the ground and inserting the All-in-One **DART** system into the hole, packing the hole for stability, connecting electric field lines, battery supply and antennas. DART BLUE allows for continuous sampling at a user specified sample rate, or sampling on a programmed schedule of sample windows with sample rates defined independently for each window.

Spring loaded terminal posts provide fast, bare wire connections to the electric field lines. There is no need for specialty connectors; just strip ~10 cm off the end of a typical copper dipole wire and insert into the correct post. *User provided strain relief can be utilized to help prevent the dipole wire being pulled out from animals or inadvertent human interaction.

A typical 80 Ah to 120 Ah battery will provide 3-4 weeks of continual operation.

II) Wideband CONFIGURATION - DART PURPLE, WITH DART Connect and DART Process

The wideband configuration for the **DART** is a 10 channel 32-bit system with 6 magnetic and 4 electric channels. While retaining the integrated fluxgate magnetometer of the DART BLUE configuration, DART PURPLE also provides for 3 external induction coil magnetic field sensors. Since the fluxgate provides coverage for the long-period band, this unique hybrid fluxgate + induction coil approach allows for the use of very compact induction coils. DART PURPLE allows for simultaneous sampling of both low frequency band data (3 fluxgate magnetometer channels, 2 electric field channels) and high frequency band data (3 induction coil channels, 2 electric field channels), as well as independent, programmed windowed sampling of low- and high- frequency bands.

A typical 80 Ah to 120 Ah battery will provide 3-4 weeks (low frequency band only) to several days of continual operation (both low- and high frequency bands), with greater durations for lower duty cycle windowed sampling schedules.

Items included in sale:
-**DART BLUE or DART PURPLE, DART Process, DART Connect**
-GNSS Antenna (3 m cable)
-Power Cable (5 m with flying leads)

III) DART Process

As part of the base configuration, for quality control processing in the field we provide **DART Process**, a desktop based multiplatform processing software for single station processing (remote reference processing is planned for release in 2025). **DART Process** provides time series viewing, metadata verification, and MT response function processing based on robust algorithms published by Eisel and Egbert, with multiple views of the apparent resistivity, phase, phase tensors, and tippers.

DART Process is designed to provide field crews with the information they need to rapidly assess data quality.
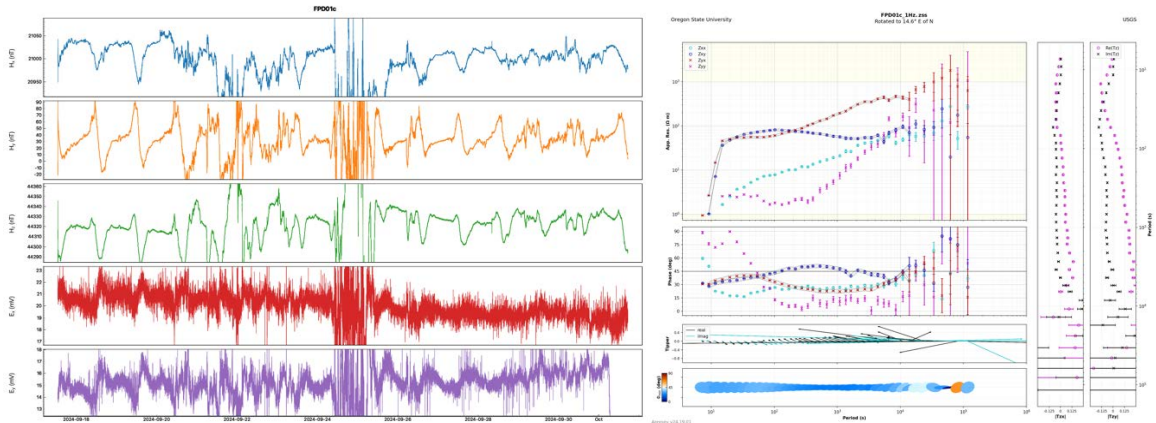

Figure: Examples of the **DART Process** data display for MT time series (left), the four elements of the MT impedance tensor displayed as apparent resistivity (right, top), phase (next down), as well as real and imaginary induction vectors (next down), phase tensors (bottom) and on the extreme right-hand side the real and imaginary components of the two tipper elements.

In addition to supporting **DART** native data format and EDI format, the **DART** and the **IoMT Cloud** (**OPTION** below) ecosystem will soon support compatibility with the emerging MTH5 format.

IV) DART Connect

Rather than requiring field personnel to establish a physical connection to the **DART** to configure the instrument or to extract data or requiring the crew to install an application program with these functions, the **DART Connect** interface to communicate and control the **DART** operations is supported by the **DART**'s built-in WiFi webserver. No more bulky cables to lug around and temperamental software to install. The benefit of the WiFi webserver facilitates the ease of use in communicating by allowing any device, mobile or computer, to establish connection to the WiFi access point provided by an integrated internal WiFi antenna up to ~10 m around the **DART**. The **DART Connect** interface can then be loaded in any modern browser displaying a clean webpage interface which provides all the features needed to control the **DART**, including starting/ending runs, streaming time series, and downloading the data. The **DART Connect** interface is a step forward in ease of use of EM equipment.

## V) OPTION - IoMT™ Cloud Data Archiving and Processing

The **IoMT.tech** web portal provide convenient and inexpensive software for project based real-time and manual data telemetry and aggregation, processing, and data archival needs.

Highlights:

- Single Station Processing
- Remote Reference and Multi-Station Processing
- MTH5 Compatibility (coming soon)
- 3-D Inversion (coming soon)
- More features will be added with each update

Recognizing that some clients may operate in a government or corporate environment requiring cloud data repositories to be country or region specific, by taking advantage of commercial providers like AWS, Azure, or Alibaba cloud data service, **IoMT Cloud** can be geolocated to reside within any country where a server facility is located.

Alternatively, we can install the **IoMT** platform on a compact server and Network Access Filestore at the client's location, optionally with a redundant failsafe clone system running at our facility to provide robustness against single site internet or power failures. For academic research partners, we can also install the IoMT platform at a designated university at very modest cost.
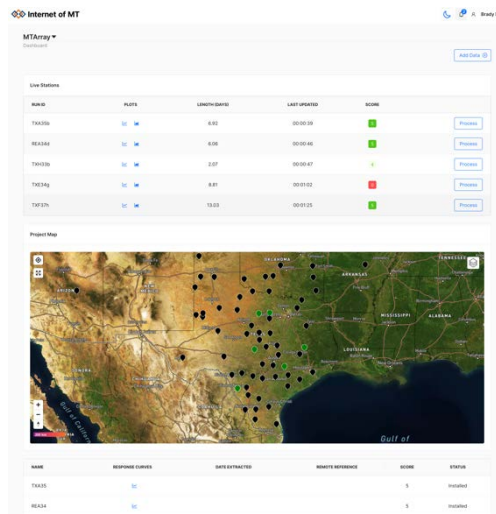
There are three paths to uploading data onto the IoMT Cloud platform via:
- Real-time LTE mobile telephone data network telemetry
- Real-time Third party satellite services including Starlink™
- On demand uploading the data manually through the IoMT web portal
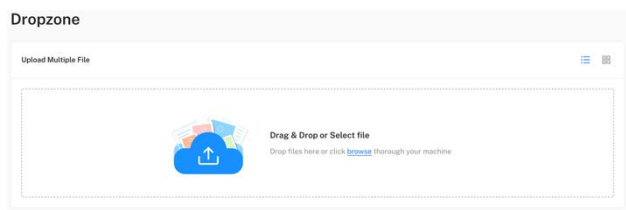
Once uploaded onto **IoMT**, all data in the **IoMT Cloud** portal is handled with multiple levels of security and backup. Data file storage systems are:
- Encrypted at Rest
- Replicated in Multi Availability Zones
- Replicated in Multi Regions (where applicable)
- Replicated in Long-Term, Secure Archiving Focused Storage

Sales Inquiries

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The **DART** system and **the IoMT.tech** platform was developed by the **IoMT**, a collaboration between **Chaytus Research & Engineering LLC** and **Enthalpion Energy LLC**. Pre- and post-sales technical support is provided by **IoMT.tech LLC**.