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An automated cleaning system for pyranometers

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Instruments need to be kept clean

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Why do we need to clean instruments?

- Reduce uncertainty in measurements
- Better estimation of the cleaning uncertainty
- Reduction in "bad data" being rejected from sites with poor cleaning
- Will be able to clean instruments more often when sites or conditions need it, such as when site works are being conducted nearby
- Determine when we need to clean instruments
- The Bureau of Meteorology is reducing the manned hours that sites will operate at, and in the future these sites will be unmanned

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Our Sites are remote

Alice Springs

Cape Grim

Coco Island

Darwin

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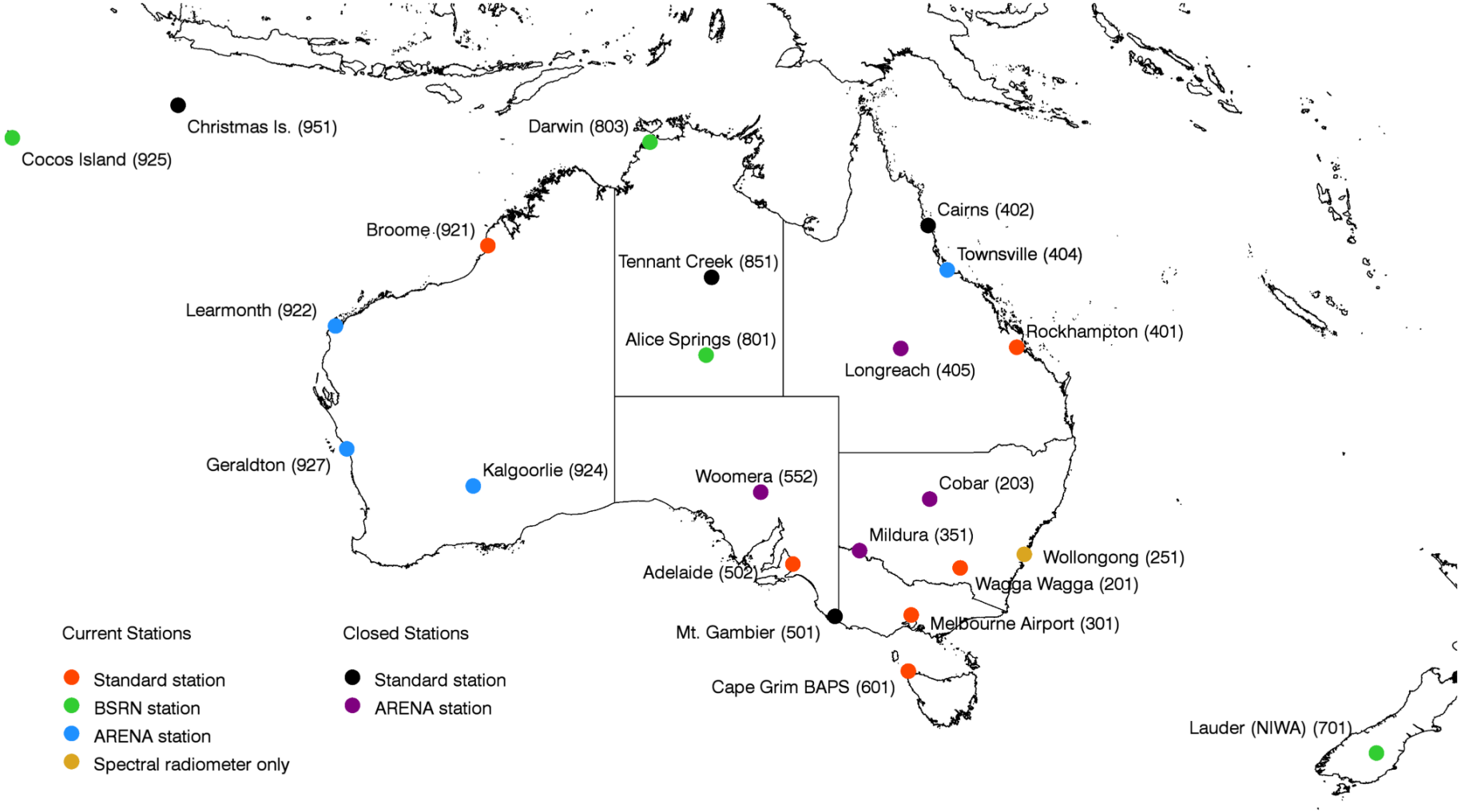
Sites are geographically distant



Current as at: 16 Nov 2015

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Challenges

- No or very low impact on the measurement of irradiance and the climate record with other sensors located in the instrument enclosure where our site is located
- We need remote monitoring and control of the cleaning device
- Sites are located remotely with minimal infrastructure and resources
- One design to suit all instruments classes and scalable to number of instruments
- Use off the shelf components to keep costs down and faster design work.
- Reliable and durable so as to survive hash environments between visits

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Some of our instruments to clean

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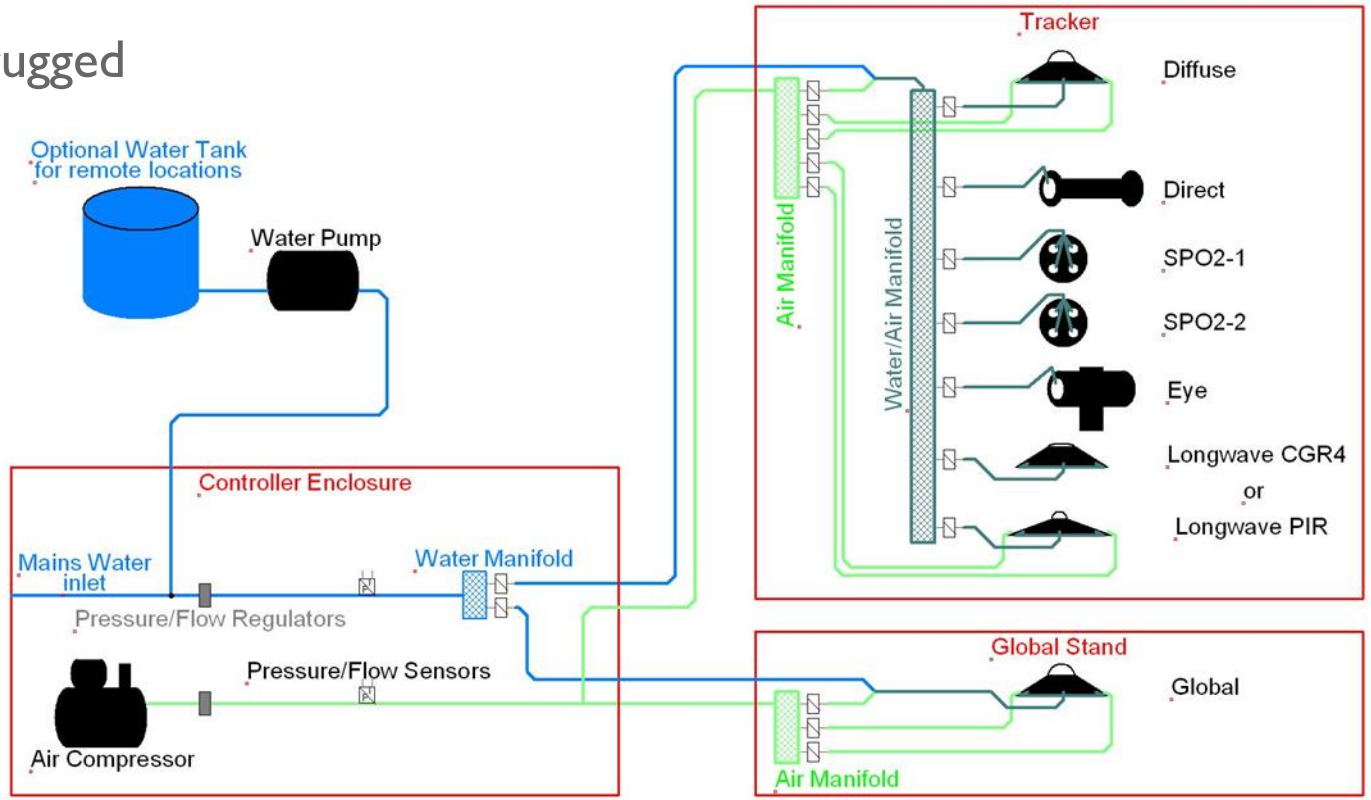
Hardware Design

- Standardised components
- Minimal modification or fabrication
- Environmentally rugged
- Safe
- Scalable
- Simple
- Cheap



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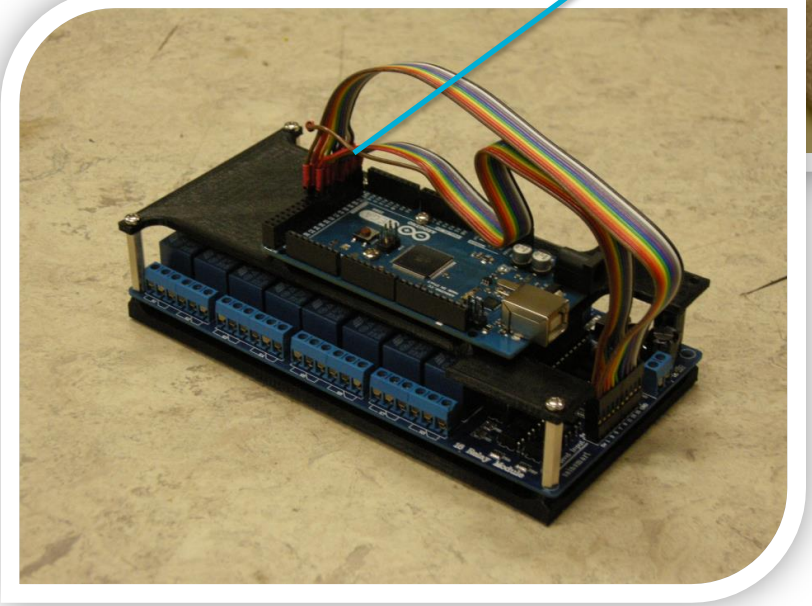
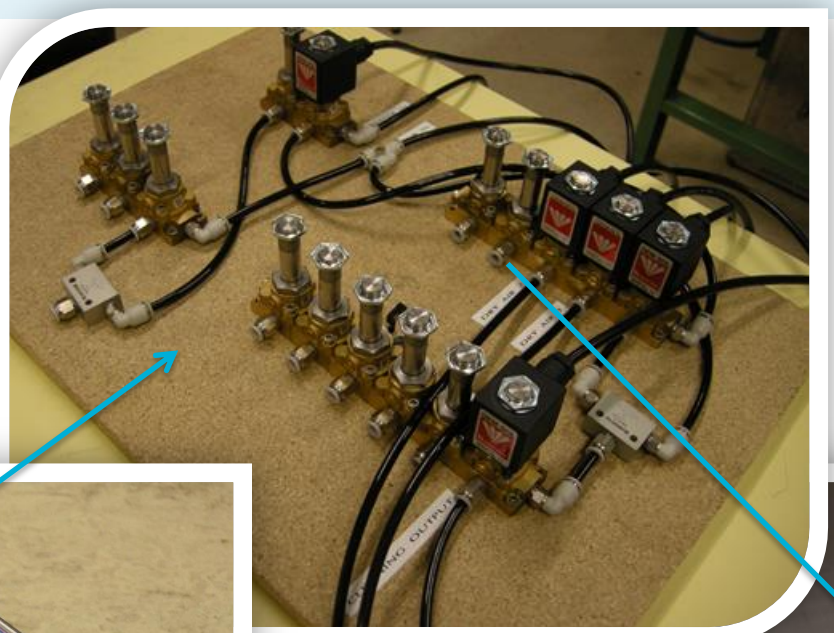
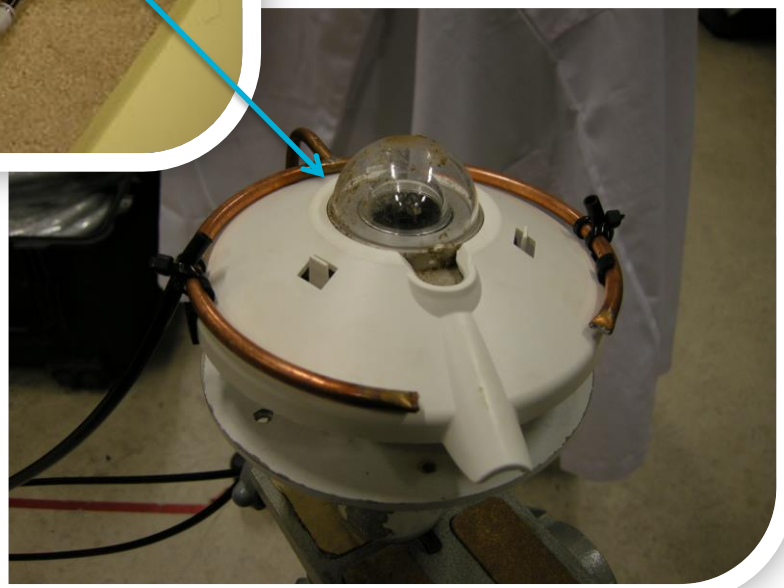
Hardware Design







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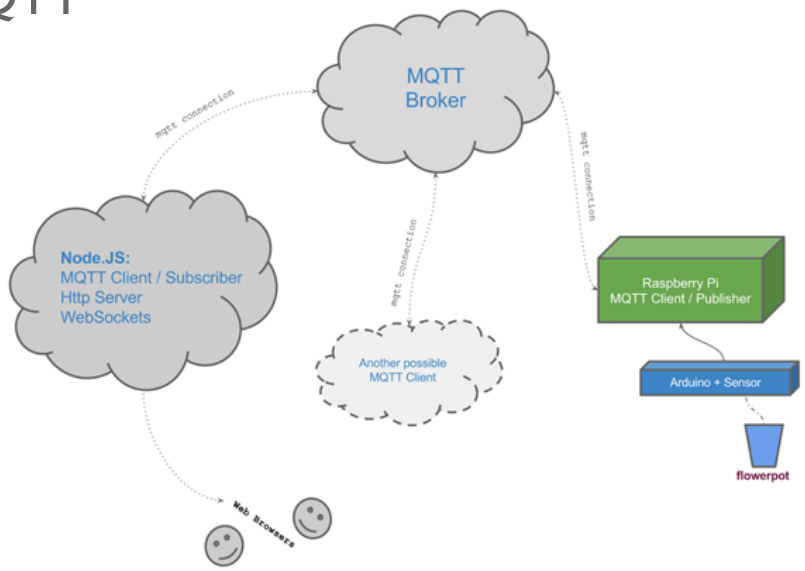
Software Design

- Open source software (Node.js, Node-RED, Elastic Search)
- Easy to program
- Control/display via webpage or mobile app
- Stores data for quality control/quality assurance verification
- Standardised protocols such as SCPI, MQTT
- Build on top of Node.js (Node-RED)



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Prototypes

Pyranometer

- A ring with three or four water nozzles
- at least two dry air lines, pulsing the drying air

Pyrheliometer

- Single water/air line
- The drying air will pulse while drying the sensors

Pyrgeometer

- CGR4 etc. with a small dome we can use a single ring with a single water/air line
- PIR which have a large dome we use the dual water/air design of the pyranometer

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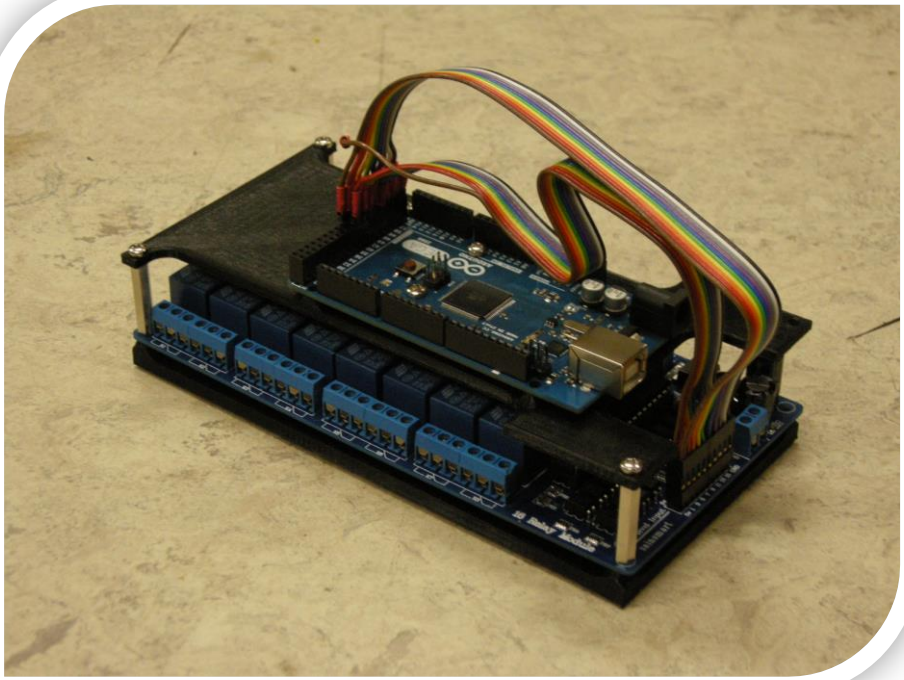
Controller

Controller

- Arduino with relay control boards to drive the required number of solenoids
- Control syntax is SCPI (Standard Commands for Programmable Instruments)
- Physical communications link is either RS232/485 or some Ethernet protocol.



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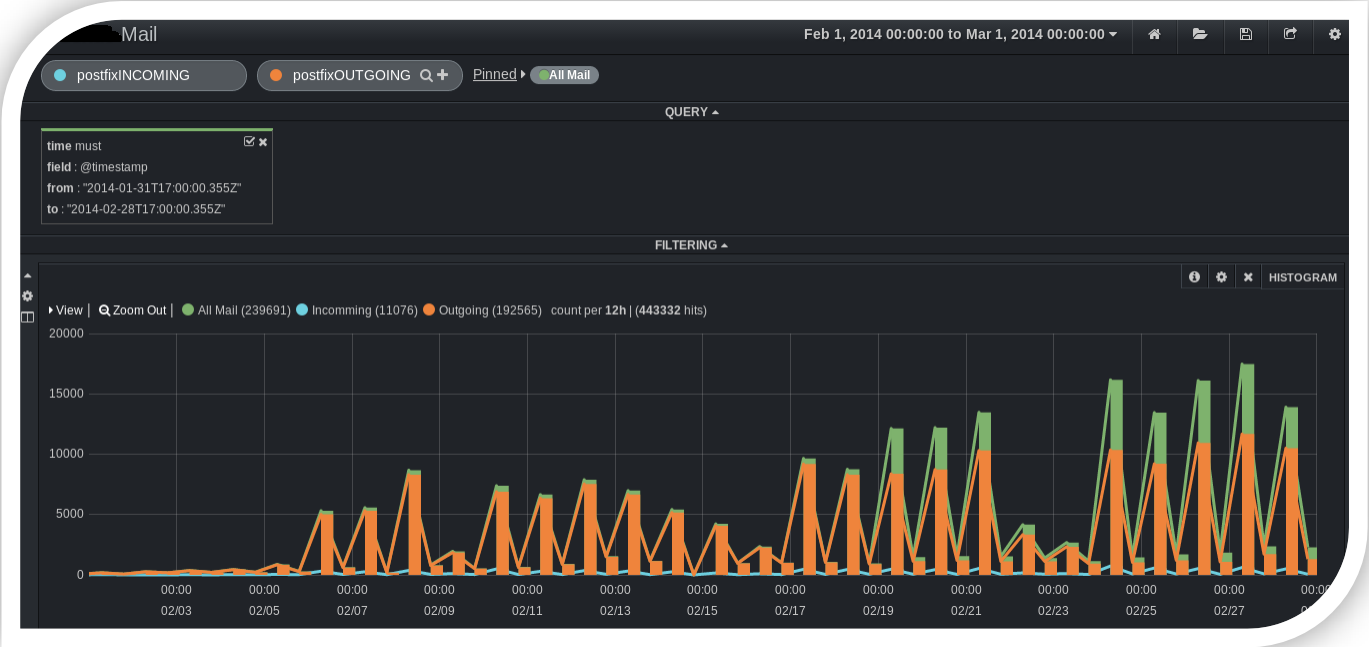
Display/Logging

Display/Logging

- A basic web page with monitoring statics and controls for manual cleaning
- Cleaning schedule is initiated via a SCPI command sent via a job scheduler
- Data logging is through the MQTT message broker to a Elasticsearch database.



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Results and Problems

- What does the cleaning? The low pressure water line or the high pressure water/air mix in the lines before drying?
- What is the affect of various physical design parameters?
- How to get a better clean?
- What is clean?
- Etc …

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Further Work

- A more robust working design to test parameters
- Quantitative measurements of cleaning
- Prototype of the software to collect and control the cleaning/display
- Field trials

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References

Arduino

- https://www.arduino.cc/

Node-RED

- http://nodered.org/

MQTT

- http://mqtt.org/

SCPI

- http://www.ivifoundation.org/scpi/

Elasticsearch

- https://www.elastic.co/products/elasticsearch

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Thank you…

Any questions or queries?

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