UMassAmherst

MDR: Camera Trap 3D

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Xiaoyang Pan, Minting Chen

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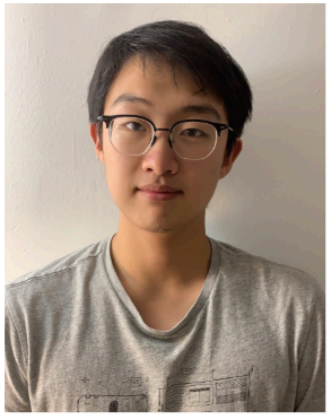
Team Members

Anamitra Datta
CSE and CS

Max Haimowitz
CSE and Team Manager



Xiaoyang Pan
CSE and PCB Lead

Minting Chen
CSE

Advisors

Professor Marco Duarte,
ECE Dept.

Professor Duncan Irschick,
Biology Dept.

Professor David Schmidt,
MIE Dept.

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Problem Statement

- Biologists who are researching endangered animals have limited tools at their disposal. Many current research practices (e.g. Tranquilization) have the downsides of being invasive, manpower intensive, or requiring specialized skills on the part of the researcher.

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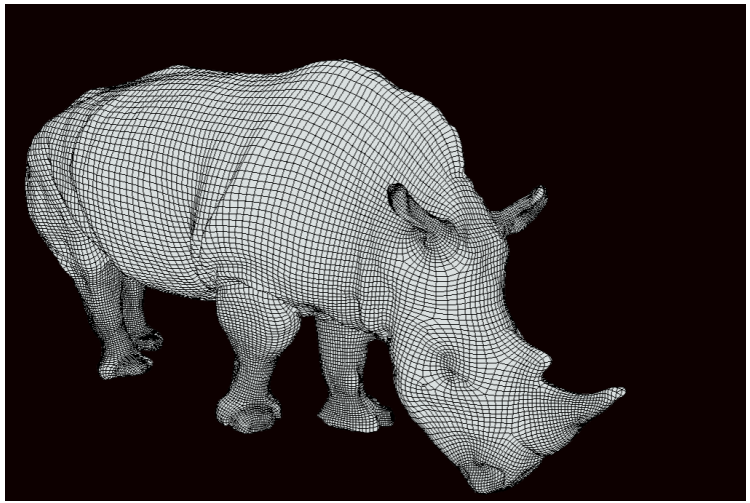
Basic Requirements for Final Product

- Creates high quality 3D Models of Animals from multiple synchronized 2D images
- Triggers cameras successfully using motion sensor(s)
- Easy to set-up and use
- Able to be deployed remotely



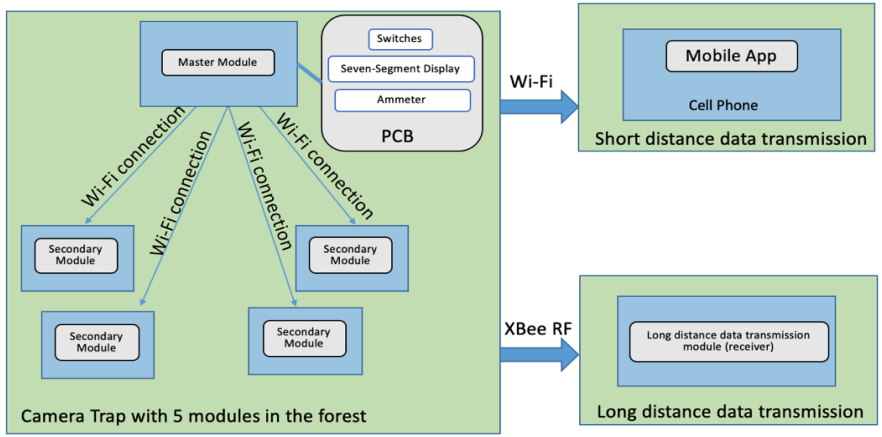
Specifications for Final Product

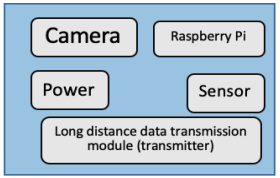
- Easy to deploy and operate (Non-expert can read and understand how to set-up system in less than 45 minutes)
- System is portable, and can be deployed remotely (No power outlets or internet connection)
- Photographs from cameras synchronized to within .1s (95% of the time)
- Detects presence of animals at appropriate range (1 - 5m, 95% of time)
- Camera modules are networked wirelessly, and can be up to 8m apart
- Scalable System (Number of camera modules can be increased without affecting performance in other specifications)

Specifications for Final Product (Continue.)

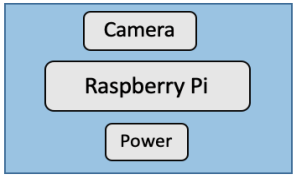
- Power lasts for at least 72 hours (based on average power consumption)
- Power Monitoring gives information on battery life (to within 10% accuracy)
- Software UI for viewing photos taken and statistics on activity
- Hardware UI for manually triggering system and testing out taking photos from individual cameras
- Long-distance transmission of statistics on battery life and statistics on taken photos in range of 1 - 3 km

Old Block Diagram





Master Module



Secondary Module

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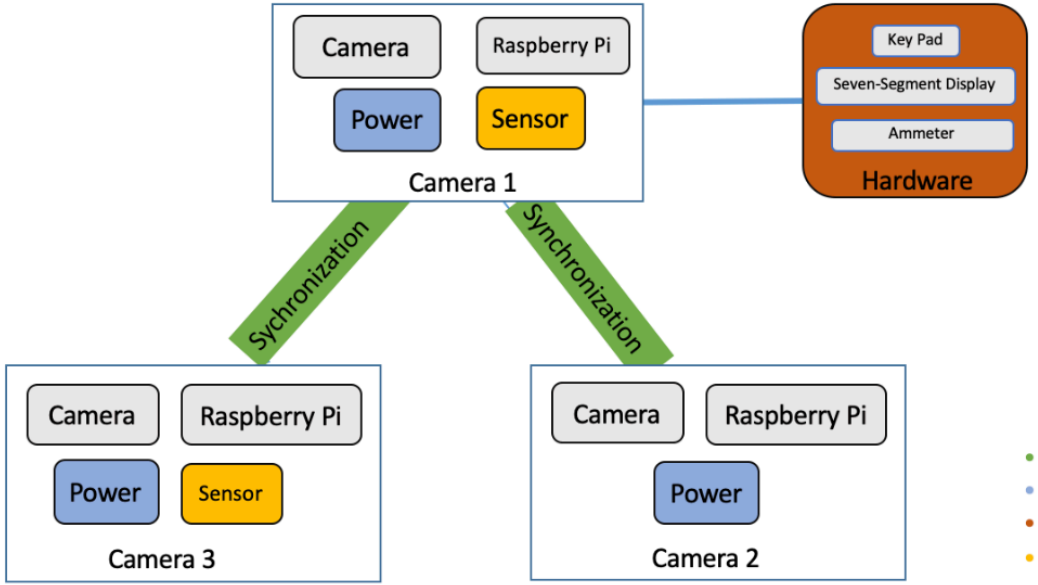
MDR Block Diagram



- Anamitra
- Max
- Xiaoyang
- Minting

Team Responsibilities and Schedule

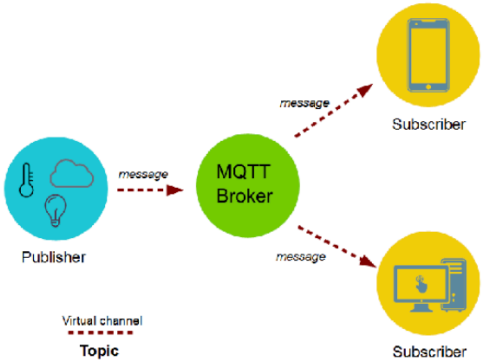
- Anamitra - Networking and Camera Synchronization
- Max - Photography Settings/3D Reconstructions, Power Management, Software UI (Spring)
- Minting - Multiple Sensor IR Triggering System, Website
- Xiaoyang - Hardware Lead, Keypad, PCB (Spring)

MDR Deliverables promised in PDR

- A synchronized network of three camera modules: photo capturing latency within 0.2s (95% of the time)
- The power of each camera module lasts 24 hours on average
- Cameras modules can be triggered wirelessly from module with IR sensor
- Triggering system works on large animal-like object at 1 - 3 meters distance in center of field of view
- Collecting photos from each camera module by taking out the SD card
- Good enough image quality to create 3D reconstruction
- Manual control of cameras using Hardware UI

Networking Software

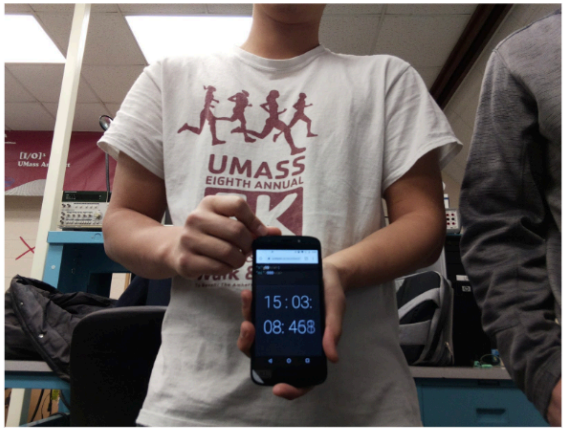
- MQTT - Message Queuing Telemetry Transport
  - Protocol that sends messages between devices over WiFi through a publish/subscribe model
- We are using Mosquitto as our MQTT broker
  - Free, open-source software



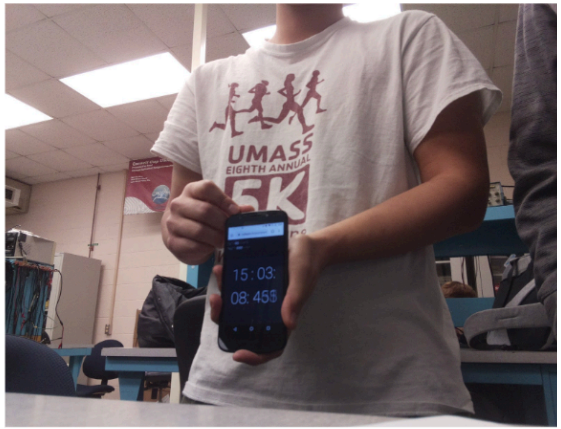
Demoing Synchronization (Spec 1)

- Taking Pictures of Clock to within 200 ms

455 ms

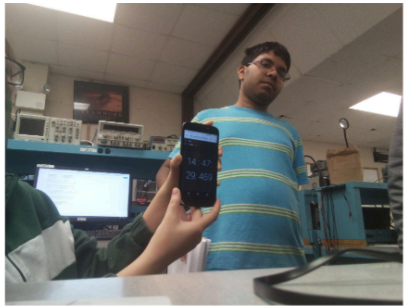


468 ms

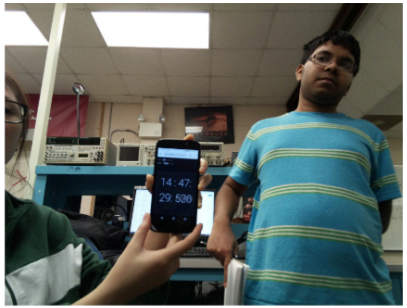


455 ms

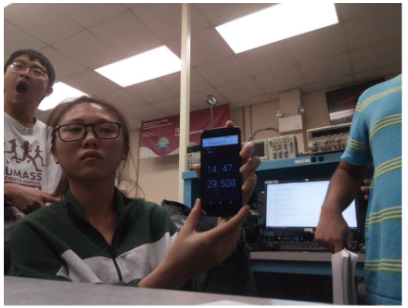
More Synchronization Photos



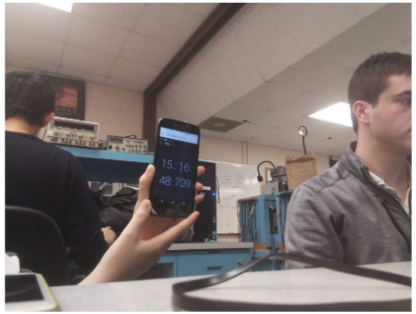
469 ms



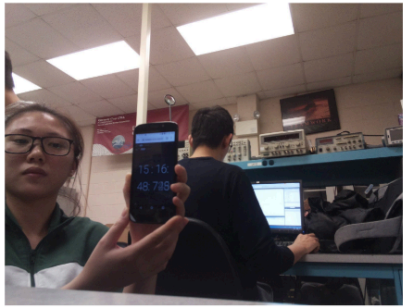
526 ms



524 ms



709 ms

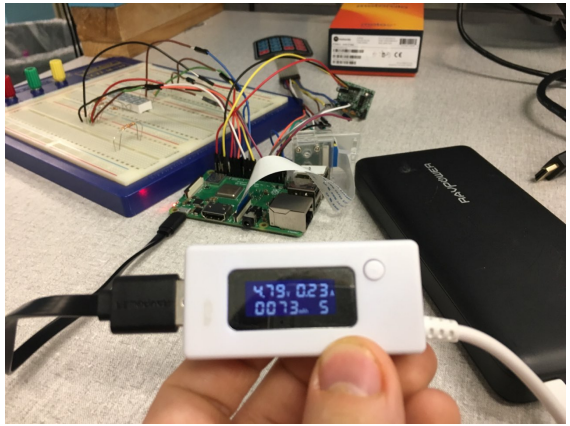


760 ms

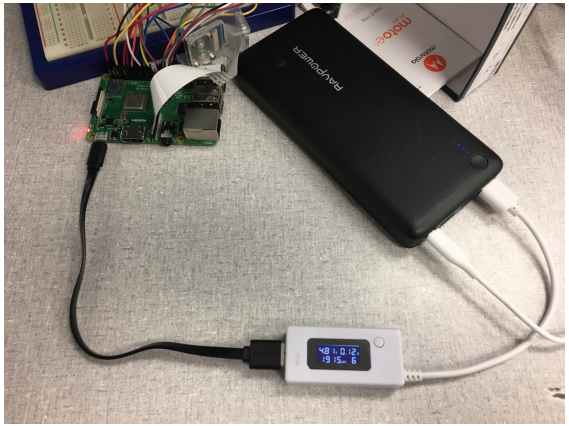
728 ms

Demoing Power Consumption (Spec 2)

- Our battery is 26800mAh so anything averaging below 1100mA will last at least 24 hours
- To get our final spec of 72 hours we need below 370mA



Code running in Low-power Mode: 230mA



15 hour test on idle: 1915mAh (127mA)

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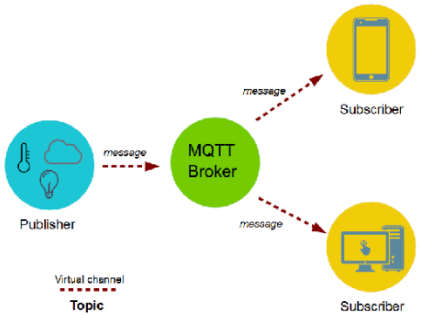
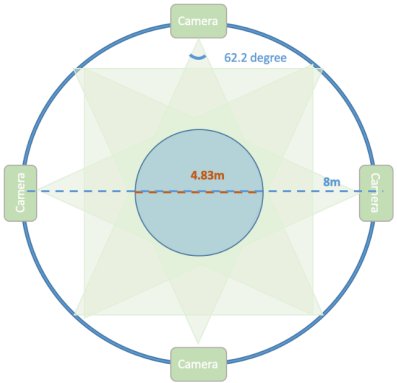
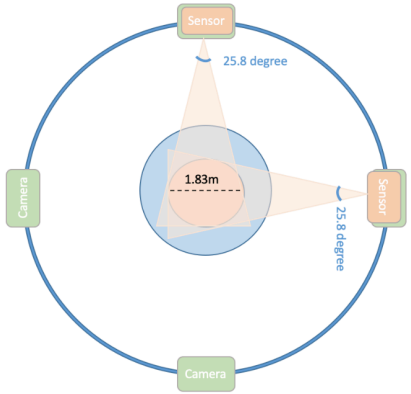
Demoing Infrared Triggering (Spec 3 & 4)

- PIR Sensor connected to Master detects motion of object emitting infrared radiation (human or animal) in appropriate range
- Transmits to slaves using MQTT protocol
- Can also optionally configure system to use two PIR sensors







Example of Simultaneous Photos Triggered by IR Sensor (Specs 3 & 4)

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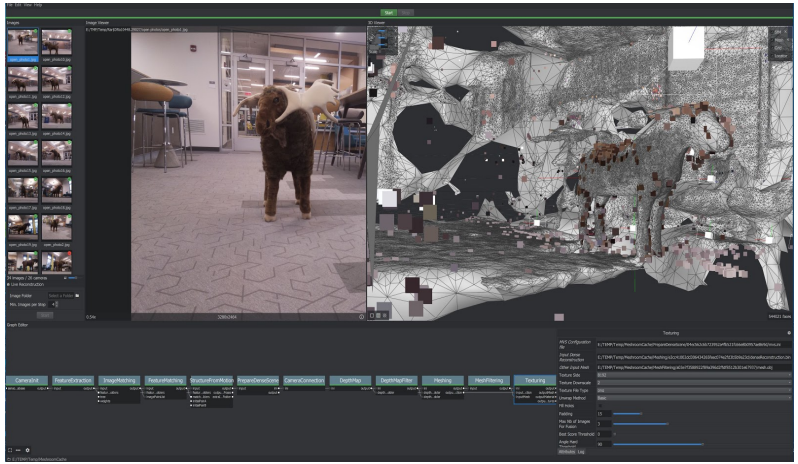
Cam 1

Cam 2

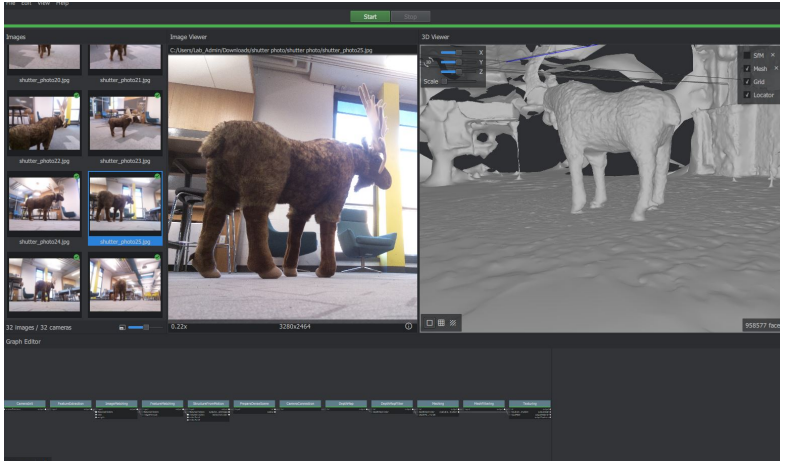
Cam 3

Demoing 3D Reconstruction (Spec 6)

- Raspberry Pi Photos are good enough for 3D reconstruction
- Tested making models with different number of photos, and using different shutter speeds



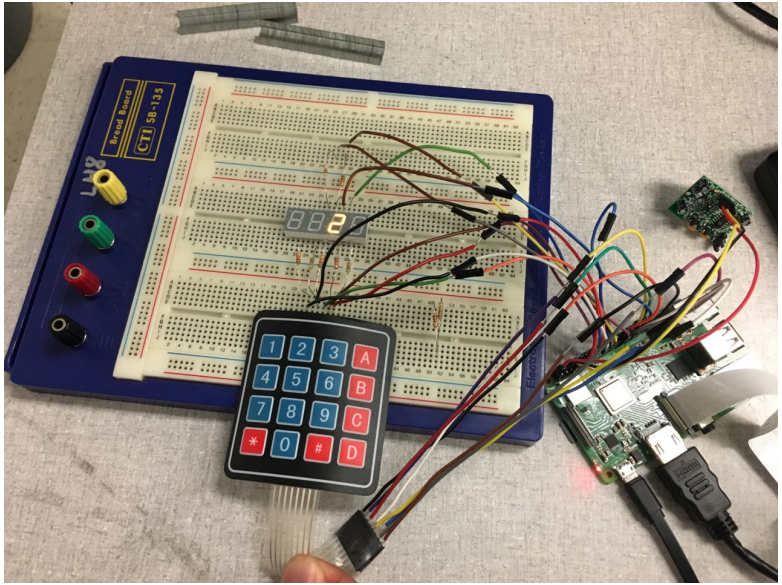
Reconstruction with 26 photos



Reconstruction from 32 photos with fast shutter speed

Demoing Hardware User Interface (Spec 7)

- Three Raspberry Pis correspond to numbers from 1-3.
- User enter a number (0-9) from keypad
- Number will be shown on seven segment display
- Corresponding Raspberry Pi will take one picture and transfer the picture to the master Raspberry Pi



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Proposed: CDR Deliverables

- A synchronized network of three camera modules (The photo capturing latency within 0.1s 95% of the time)
- The whole system fits is portable and compact (can fit in a bag and be relocated and reassembled)
- Scale to 5 cameras and the capturing latency is kept within 0.1s
- Mobile User Interface allows users to view photos on phones
- Battery Monitoring System using ammeter

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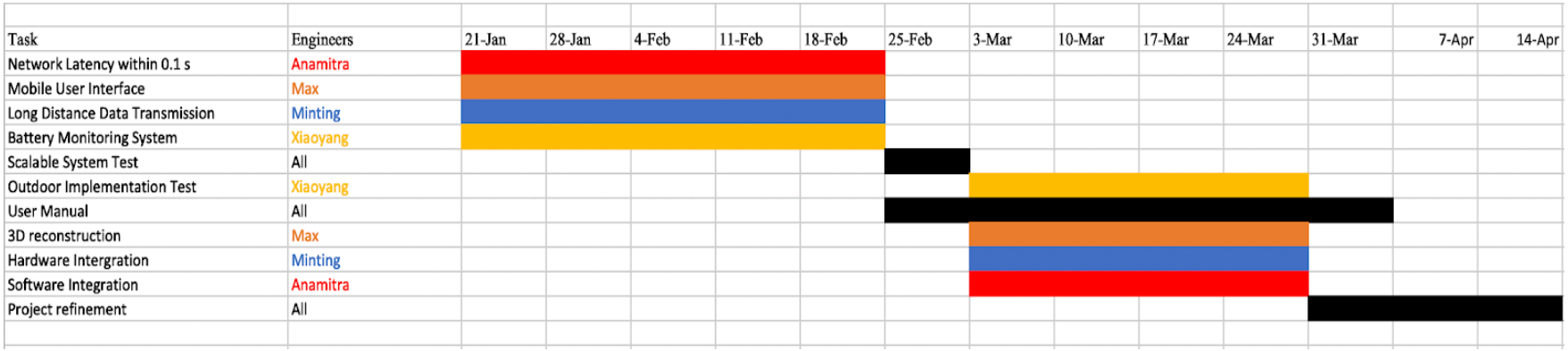
GANTT Chart



Task	Engineers	21-Jan	28-Jan	4-Feb	11-Feb	18-Feb	25-Feb	3-Mar	10-Mar	17-Mar	24-Mar	31-Mar	7-Apr	14-Apr
Network Latency within 0.1 s	Anamitra													
Mobile User Interface	Max													
Long Distance Data Transmission	Minting													
Battery Monitoring System	Xiaoyang													
Scalable System Test	All													
Outdoor Implementation Test	Xiaoyang													
User Manual	All													
3D reconstruction	Max													
Hardware Intergration	Minting													
Software Integration	Anamitra													
Project refinement	All													

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Thank you! ! !

Question?

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