

Dissolved Oxygen Level Monitoring in Shrimp Aquaculture using Embedded System

**NECTEC-ACE 2010
23 September 2010
Science Park**

by Embedded System Technology Laboratory (EST)

NSTDA: National Science and Technology Development Agency

NECTEC: National Electronics and Computer Technology Center

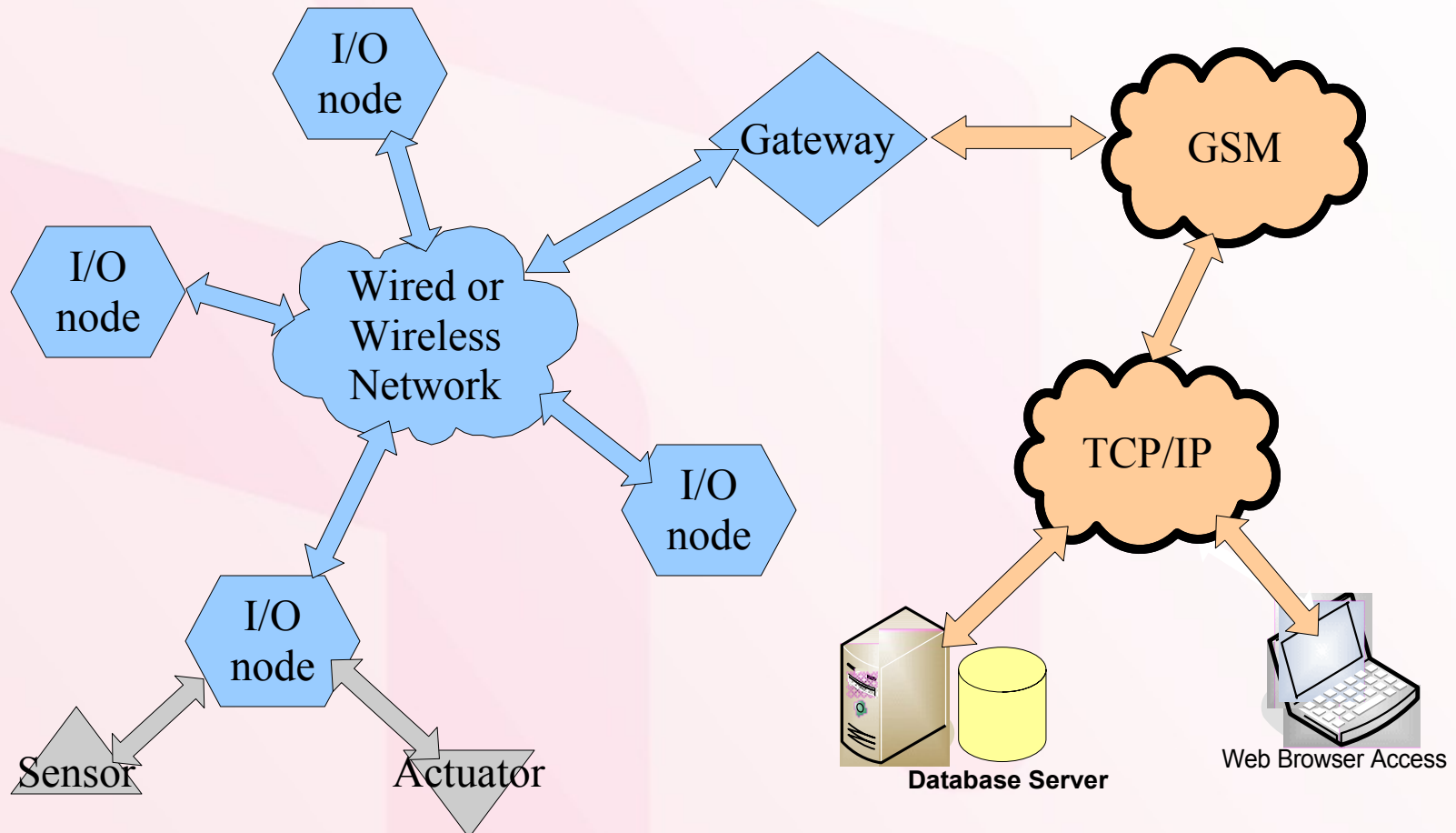
Why do we need Embedded System in shrimp aquaculture?

- 1) To manage the resource usage
- 2) To increase the productivity
- 3) To reduce risk
- 4) To manage the production process
- 5) To collect data for research and analysis

Embedded System Platform Requirements

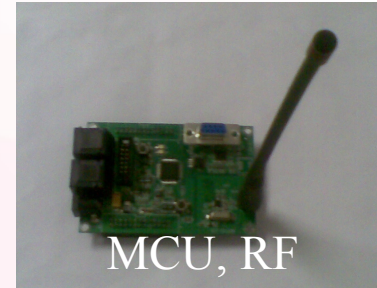
- 1) Sensor interface
- 2) Actuator interface
- 3) Flexible power supply (AC or solar cell)
- 4) Wired and wireless communication
- 5) Internet enabled system

Platform Architecture

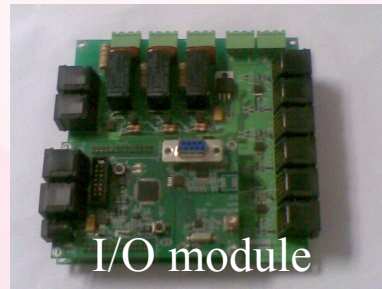


Hardware Platform

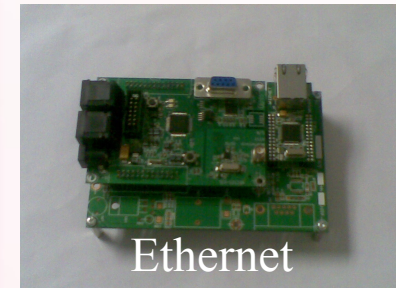
1) MCU and RF mezzanine



2) I/O module



3) Ethernet Gateway module



4) GPRS Gateway module



Software Platform

Distributed Application Framework

Communication Protocol

Non-Preemptive Kernel

Hardware Driver

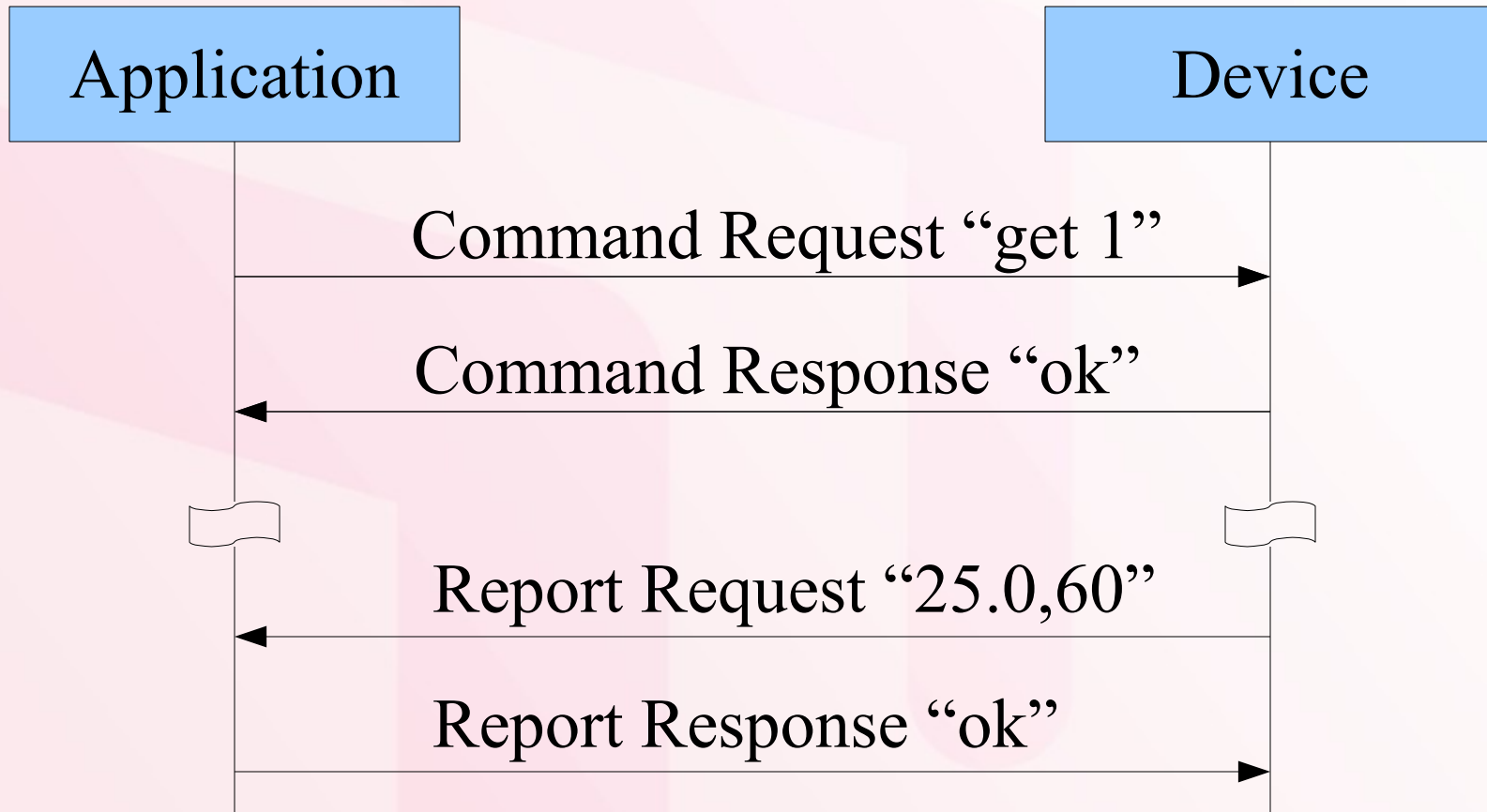
Communication protocol

Application				
Application-Layer			HTTP1.1	
Adaptation-Layer				
MAC Polling			TCP/IP	
RS485	RF 433MHz		GPRS	Ethernet

Intra platform

Gateway

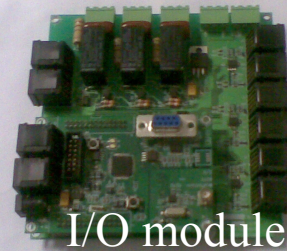
Application layer Message Sequence Chart



Aquaculture monitoring

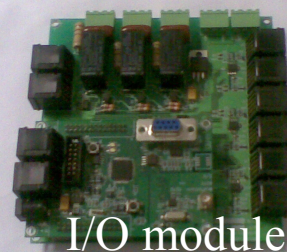
SDI-12
DO

Aerator



RF

Aerator



**For additional
Aerator**

Embedded System in Shrimp Aquaculture

- Thailand is the world leading shrimp exporter
- In 2008
 - there were 25,000 shrimp farms
 - 72,000 hectares used by shrimp farms
- Up to 3 cycles per year
- Utilized high density or intensive production system
 - Deploy higher level of technologies and management



Environmental Management in Shrimp Pond

- Need to control water quality
 - Temperature, dissolved oxygen, pH, CO₂, Salinity, Hardness, Alkalinity, Translucent, Ammonia, Nitrate, and Hydrogen Sulfide
- Most important parameter is Dissolved Oxygen
- Can be controlled by paddlewheel aerator



Suitable Water Quality for White Shrimp

Quality	Suitable Level
Temperature (Celsius)	28-32
Dissolved Oxygen (mg./L.)	> 5
pH	7.5 – 8.0
CO ₂ (mg./L.)	< 20
Salinity (part per thousand)	2-35
Hardness (mg./L. of CaCO ₃)	> 150
Alkalinity (mg./L. of CaCO ₃)	> 100
Translucent of water (cm.)	20-40
Ammonia (free) (mg./L.)	< 0.1
Nitrate (mg./L.)	< 200
Hydrogen Sulfide (mg./L.)	< 0.002

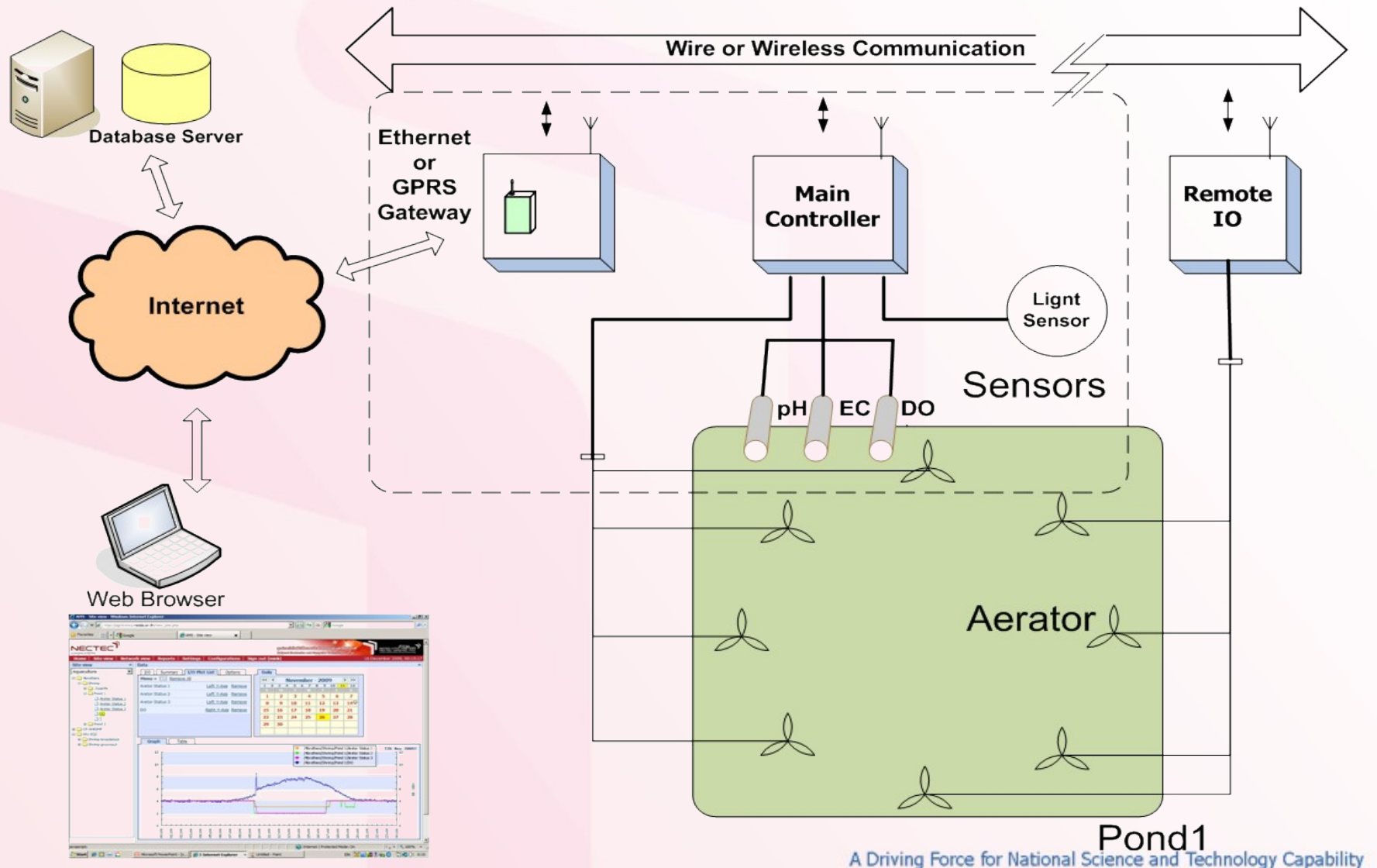
Frequency of Monitoring

Parameter	Frequency	Time of Day
Temperature	Daily	Morning and afternoon (6.00-17.00)
Dissolved Oxygen	Daily	Evening and Early morning
pH	Daily	Morning and afternoon (6.00-17.00)
Ammonia, Nitrate	Every 2-3 days	-
Salinity, Alkalinity, Minerals, Bacteria	Weekly	-

How can embedded system help?

- Automated Monitoring of important parameters
 - Reduce majority of the tasks for shrimp farmers
 - Simplified water quality management
 - Increased productivity
 - Detect unexpected change in water quality to avoid catastrophic mortality of shrimp
- Automated Control of Paddlewheel Aerators
 - Turn on/off aerators when needed
 - Could save energy cost of operating aerators

Embedded System for Shrimp Aquaculture



DO Sensor, GPRS Gateway, & Main Controller

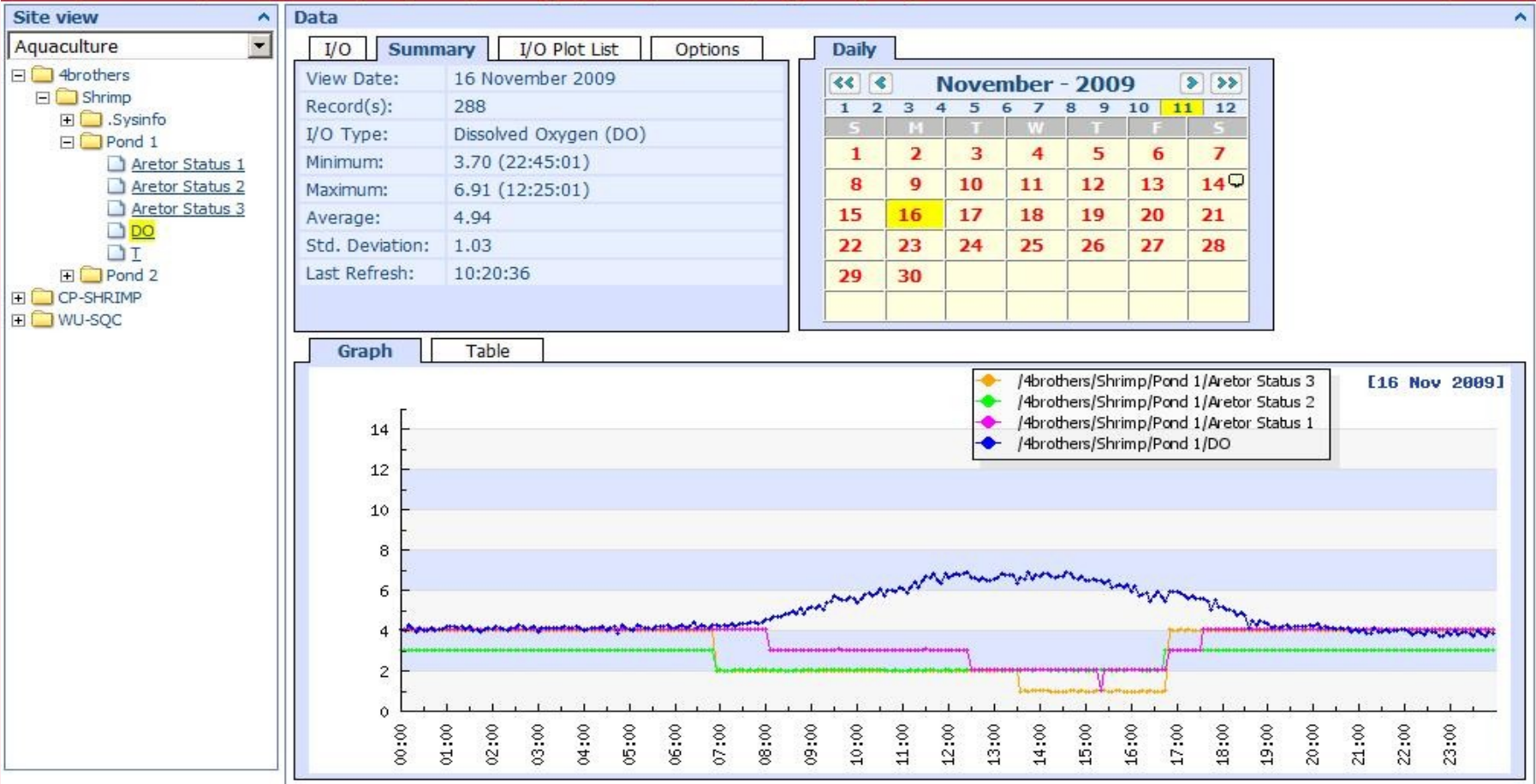


30-35 gram *P. vannamei*

Remote Web Monitoring

Home | Site view | Network view | Reports | Settings | Configurations | Sign out (mink)

03 December 2009, 10:23:06

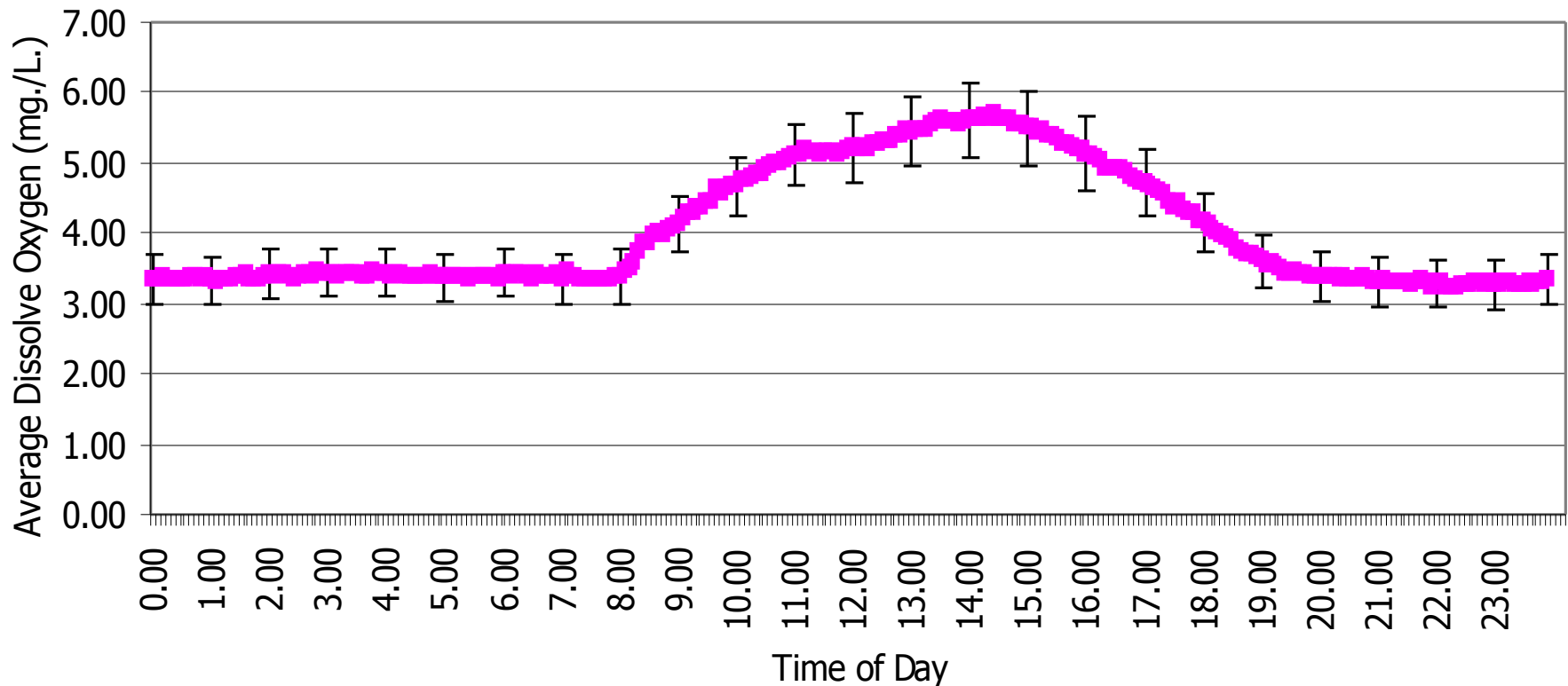


เนคเทคเป็นองค์กรของรัฐที่จัดตั้งขึ้นเพื่อศึกษาวิจัยด้านเทคโนโลยีอิเล็กทรอนิกส์และคอมพิวเตอร์ เพื่อการพัฒนาประเทศไทย ไม่ได้มีวัตถุประสงค์เพื่อแสวงหากำไร หากท่านพบว่ามีข้อมูลใดๆที่ละเมิดทรัพย์สินทางปัญญาปรากฏอยู่ในเว็บไซต์ของเนคเทค โปรดแจ้งให้เนคเทคทราบเพื่อดำเนินการแก้ปัญหาดังกล่าวโดยเร็วที่สุดต่อไป

สงวนลิขสิทธิ์ ตาม พรบ. ลิขสิทธิ์ พ.ศ. 2537 โดย ศูนย์เทคโนโลยีอิเล็กทรอนิกส์และคอมพิวเตอร์แห่งชาติ
112 อุทยานวิทยาศาสตร์ประเทศไทย ถนนพหลโยธิน ตำบลคลองหนึ่ง อำเภอคลองหลวง จังหวัดปทุมธานี 12120

Average Measurement of Dissolved Oxygen from a shrimp ponds

24hrs - DO level (average over 31-day data with 95% Confidence Interval)



Conclusion

- 1) The platform was built and applied to aquaculture applications - Shrimp
- 2) Main sensor device is the DO sensor – an electromechanical type
- 3) Monitoring of DO level over long period of time, e.g. 31 days or more.
- 4) Potential for reduce energy usage of paddlewheel aerators

Future research

- 1) Improve Wireless sensor network
 - New protocol and hardware
- 2) Improve DO sensor with optical type
- 3) Automate control of paddlewheel aerators around shrimp pond
 - Monitor energy saving versus realtime DO level in ponds

Thank you

NSTDA: National Science and Technology Development Agency

NECTEC: National Electronics and Computer Technology Center