NerveNet+LoRa technology was introduced and demonstrated at USM Engineering Campus (Malay Peninsula side) and Penang Campus (Penang Island) on March 25 and 26, 2019. The demonstration was carried out by the National Electronics and Computer Technology Center (NECTEC) in Thailand.

March 25: Prof. Widad Ismail (USM), who is the leader of the ASEAN IVO project "Smart Aquaculture Quality Monitoring System with Internet of Things" that started in 2018, and its members participated in USM Engineering Campus. March 26: At the Computer Science Department of USM Penang Campus, a total of about 12 people from Computer Science Department, Electrical Engineering Department, and mathematical engineering Department participated, and specialized fields were smart city, transportation, cyber security, information retrieval, tourism, Various members such as database, wireless, optimization, natural language participated.

Deputy Director Asai of NICT Asia Center gave an overview of NerveNet+LoRa technology, and two NECTEC engineers who had mastered the technology gave a demonstration of the technology.

The technology called NerveNet+LoRa uses the information synchronization function, which is one of the functions of conventional NerveNet, and applies LoRa, which is being used worldwide, to the part that transmits information between devices. In the above, we adopted a formula that wirelessly diffuses information without specifying the destination. As a result, information can be propagated to other devices one after another. NECTEC engineers connected a monitor to each of the three sets of equipment. One set consisted of a demonstration system that was connected to a sensor board developed by NECTEC (temperature, humidity, etc.). The system configuration, information transmission/reception processing flow, information transmission/reception intervals by LoRa, data operation on the control PC, etc. were explained. The demo showed the information propagation between the two devices and the display of response data to the sensor request for sensor information.
Introduction of NerveNet+LoRa

Presented by NICT Asia Center
Nobuyuki Asai (Non Asia Asai)
< NICT Researcher >
Yasunori Owada : yowada@nict.go.jp
Goshi Sato : sato_g@nict.go.jp
NerveNet concept

Japan has lots experience to suffer the natural disaster and sometime network infrastructure is damaged such as no telephone, no mobile and no internet.

- **Robust Network**
  - Configure mesh topological network.

- **Quick recovery adhoc Network**
  - Potable and connect live network.

NerveNet is designed as Layer 2 switch to enable to configure mesh topological network using VLAN mechanism and attach many type of transmission. And NerveNet is designed as running on the Linux operating system to enable to configure and set up quickly as adhoc network.
NerveNet concept

Mesh topological network. Potable and quick recovery.

< Proven fact of Kumamoto earthquake in 2016 >
14/Apr 21:26 Kumamoto earthquakes occurred.
16/Apr 1:25 Nand biggest occurred.
16/Apr 15:00 NICT decision to dispatch researchers and the network equipment
18/Apr 20:05 Arrive at Takamori town in Kumamoto.
19/Apr 13:30 1 access point was established for the public administration at the disaster countermeasures headquarters (General Administration Division).
19/Apr 14:30 another AP for the residents near the entrance of the town office.
20/Apr 20:30 an internet satellite circuit via Kashima Space Technology Center was provided.
As a result, both networks recorded a maximum of 18 Mbps.
# NerveNet Spec

## High-Performance L2 Switch Type

**NerveNet NPS-108AC (Hirakawa Hewtech)**

<table>
<thead>
<tr>
<th>Type</th>
<th>NPS-108AC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Network Interface</td>
<td>IEEE 802.3at(PoE+) Ethernet (10/100/1000 base-T) 5 ports</td>
</tr>
<tr>
<td>Operation Temp./Humidity</td>
<td>-10 ~ 50°C / 20 ~ 85%</td>
</tr>
<tr>
<td>Power input/consumption</td>
<td>DC12V / 25W average (100W max)</td>
</tr>
<tr>
<td>Protection class</td>
<td>IP65</td>
</tr>
<tr>
<td>Weight</td>
<td>5.5kg</td>
</tr>
<tr>
<td>Other interfaces</td>
<td>Serial ATA, PCI-E, USB, SD, Serial</td>
</tr>
<tr>
<td>Storage</td>
<td>2.5 inch SSD 8GB (default)</td>
</tr>
<tr>
<td>OS</td>
<td>Debian Linux 8 (NerveNet OS)</td>
</tr>
<tr>
<td>RAM</td>
<td>4GB</td>
</tr>
<tr>
<td>CPU</td>
<td>Intel Atom</td>
</tr>
</tbody>
</table>

## All-Software Type

**Raspberry Pi 3 model B (RS Components)**

<table>
<thead>
<tr>
<th>Type</th>
<th>Raspberry Pi 3 model B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Network Interface</td>
<td>Ethernet (10/100/1000 base-T) 1 port, Embedded Wi-Fi (11gn)</td>
</tr>
<tr>
<td>Operation Temp.</td>
<td>0 ~ 70°C</td>
</tr>
<tr>
<td>Power input/consumption</td>
<td>DC5V / 6.5W average (12.5W max)</td>
</tr>
<tr>
<td>Weight</td>
<td>120g</td>
</tr>
<tr>
<td>Other interfaces</td>
<td>USB2.0 x4, micro SD, GPIO</td>
</tr>
<tr>
<td>Storage</td>
<td>2.5 inch SSD 8GB (default)</td>
</tr>
<tr>
<td>OS</td>
<td>Debian Linux 8 (NerveNet OS)</td>
</tr>
<tr>
<td>RAM</td>
<td>1GB</td>
</tr>
<tr>
<td>CPU</td>
<td>Broadcom BCM2837 Quad Core 1.2GHz</td>
</tr>
</tbody>
</table>

※No L2 VLAN Switch hardware
Case study

Measures against natural disasters

Japan has high risk of natural disaster

Earthquake, tsunami
- The Great Hanshin-Awaji Earthquake of 1995
- The 2011 Tōhoku earthquake and tsunami
- The 2016 Kumamoto Earthquake

Heavy rain, typhoon
- 2017 : Northern Kyushu heavy rain
- 2015 : Kanto · Tohoku heavy rain
- 2012 : Kyushu northern heavy rain
- 2011 : Heavy rain caused by Typhoon 12

Medical relief activities at the time of large scale disaster

Wide area disaster Emergency Medical Information System (EMIS)
Information sharing cloud of medical institution, government / administration and related institutions
1. Facility information such as hospitals at the time of disaster
2. DMAT (Disaster Medical Assistance Team) information
3. Emergency notification to the Ministry of Health, Labor and Welfare, etc.
4. Basic information such as the number of beds, doctors, and nurses
Case study
Demand for network in disasters

It is important to grasp resources such as transport vehicles (ambulances) and doctor helicopters managed by each medical institution.

Currently, emergency vehicle management is performed using a mobile phone network, but there is a risk that management of the emergency vehicle can not be performed if the mobile phone network can not be used.

Demand for Emergency Vehicle Management with Private Network Independent of Mobile Phone Network.
Case study

Apply NerveNet+LoRa to Vehicle Management

Establish connection between disaster base hospitals by an independent private network, and share information grasp of vehicle information by NerveNet + LoRa private network with distributed sharing Database. Vehicle information such as ambulance location received at any hospital is shared among hospitals.

→ **Share information such as patient transport instructions and the hospital's acceptance system for patients.**
In-vehicle node

- Raspberry Pi3 Model B
- LoRa module
- Bluetooth LE
- Wi-Fi
- GPS receiver, Battery

Hospital Rooftop nodes

- Intel NUC, GPS receiver
- LoRa module × 2
  (one for In-vehicle node, another is for hospital)
- Wi-Fi

Display notification of hospital status to tablet
Send vehicle status (in transit, standby etc) from tablet

Display vehicle position, route on map
# LoRa module

**Supplier** is RF Link

**LoRa module**: RM-92A

<table>
<thead>
<tr>
<th>Item</th>
<th>Spec</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conformed technical standard</td>
<td>ARIB STD-T108, 920 MHz band specified low power radio station, IEEE802.15.4g adaption</td>
</tr>
<tr>
<td>Transmission output</td>
<td>+13dbm</td>
</tr>
<tr>
<td>Modulation method</td>
<td>LoRa/FSK/GFSK</td>
</tr>
<tr>
<td>Maximum transfer rate</td>
<td>292.97bps ~ 37500bps (Lora mode)</td>
</tr>
<tr>
<td></td>
<td>50kbps ~ 100kbps (FSK/GFSK mode)</td>
</tr>
<tr>
<td>Maximum reception sensitivity</td>
<td>-137dBm</td>
</tr>
<tr>
<td>Antenna gain</td>
<td>3dBi</td>
</tr>
<tr>
<td>Interface</td>
<td>Serial: 115200bps  Connector: USB</td>
</tr>
</tbody>
</table>
For Application development

No need to study complicated LoRa setting
NerveNet provide LoRa Mesh demon and when user configure the LoRa wireless node, user set the parameter onto LoRa Mesh demon. It is not necessary to study in detail interface of LoRa. Node & network topology and configuration will be automitaclly done by NerveNet.

No need to study complicated communication method
NerveNet provide the API for application program. When application program receive/send data from/to another node, application program access to database only. All receive/send data is controlled by Nervenet and put receive/send data into database.

Distributed synchronized database for application
NerveNet provide the database on each node with synchronization of data with other nodes. Application program can be develop on each node as stand alone and it is possible to reduce the communication with other node.
terima kasih
Demo of NerveNet+LoRa

Thanika Duangtanoo
NECTEC
key text in format “destination message” + ENTER
i.e.  nn5  hello world [ENTER]

Display message in text data to other monitor
key text in format “destination  message” + ENTER
i.e.   nn1  $ spi get 0 [ENTER]

Node1 will send “$ spi get 0” to NECTEC’s board.
The board will reply sensor values
Information sharing on LoRa (Flooding)
Send and receive data on LoRa

Interface for send & receive data for application
Mechanism of adjacent node discovery
(communication between rooftop nodes)

Understand the topology of the network by grasping adjacent nodes and sharing it among node
→ No need to define network topology
→ Use for efficiency at the time of flooding

LoRa wireless station
LoRa Mesh demon
LoRa Mesh neigh
LoRa transceiver
Transceiver info
On Shriek protocol
write
read
Application

LoRa wireless station
LoRa Mesh demon
LoRa transceiver
RS232C
LoRa
Transmission Slot allocation

Slot for A
Slot for B
Slot for C
Slot for D

Maximum Transmission duration
Transmission cycle

Time synchronization is done by GPS
terima kasih