

# 研究のいろは

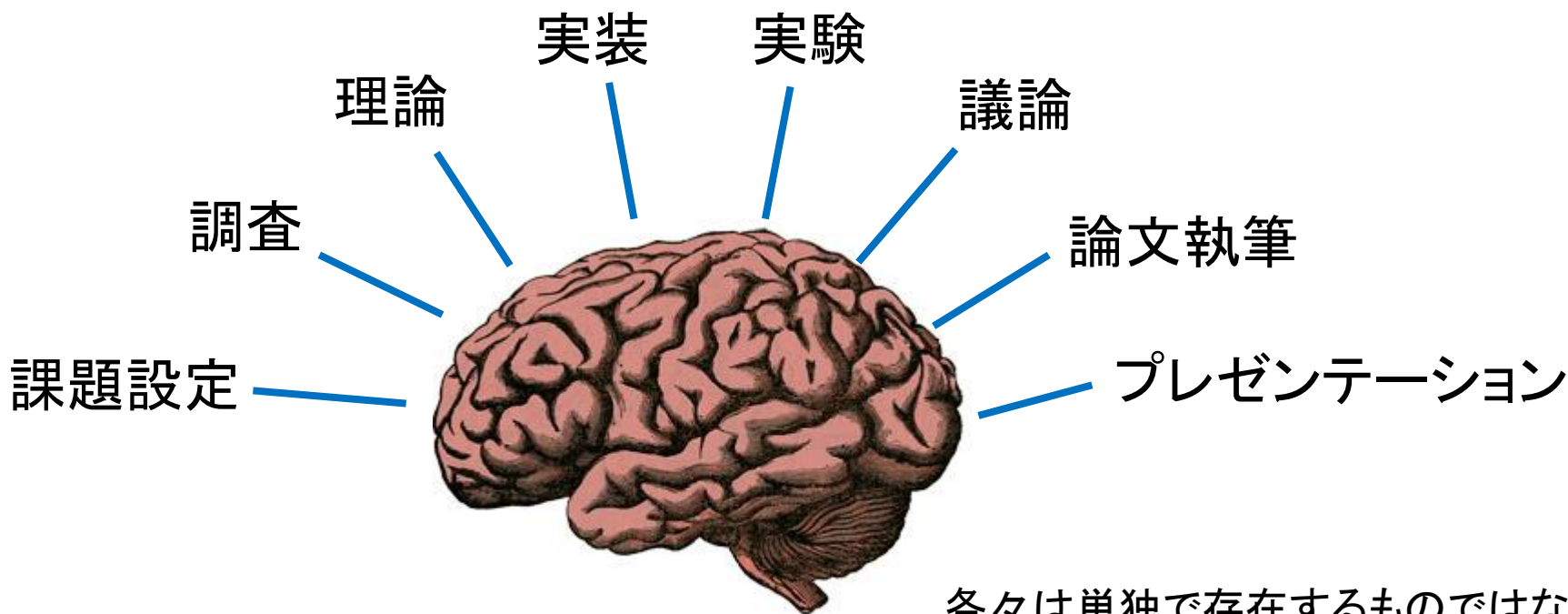
～ これから情報理工研究に携わる者へ～

東京大学大学院 情報理工学系研究科

講師 落合秀也 (Ph.D)

# はじめに -- 大学院は研究をする場所

- 研究は「総合力」で成し遂げるもの
  - 調査、理論、実装、実験、論文、発表、議論、課題設定...
  - すべてが繋がって「研究」となる



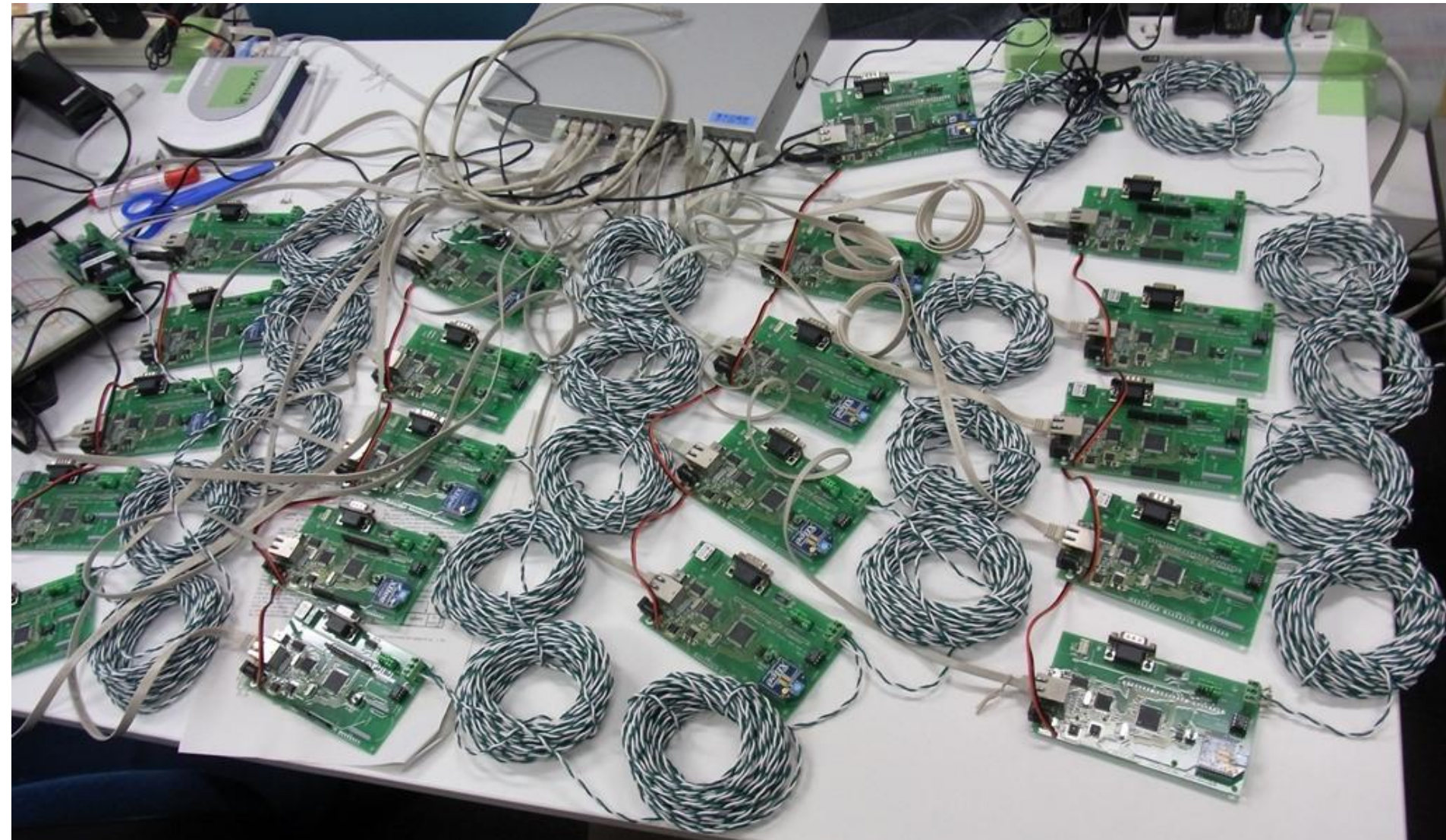
各々は単独で存在するものではない

# 研究を始めるにあたって重要なこと

- 基礎的な知識を持っていること
  - 数学、情報理論、アーキテクチャ、ネットワークオペレーティング・システム …
- 基礎的な技能を持っていること
  - システム構築・プログラムを書く
  - 図式化する・文章を書く・ポイントを説明する
- 行動力があること
  - 十分時間をかけて、じっくりと取り組む
  - 道筋をつけてゴールまで頑張る

(\*) 誰しも完全ではない。日々鍛錬しているかどうか、が鍵。

# 研究の軸1：実験と環境整備



実験環境を整備して、実験を行う

# 研究の軸2: 理論の実装

```
gntp@ubuntu: ~/Desktop/BACnetIP-to-1888_20130328
File Edit View Terminal Help

#include <stdio.h>
#include <stdlib.h>
#include <string.h>

#include "ieee1888.h"
#include "ieee1888_XMLgenerator.h"

int ieee1888_generateXML(ieee1888_object* obj, char* strbuf, int n){

    if(obj==NULL){
        return 0;
    }

    int i,j;
    int offset=0;

    switch(obj->dtype){

    case IEEE1888_DATATYPE_KEY:
        {
            ieee1888_key* key=(ieee1888_key*)obj;
            i=sprintf(strbuf+offset, "<key");  offset+=i;
            if(key->id!=NULL){                i=sprintf(strbuf+offset, " id=\"%s\"", key->id);          offset+=i;        }
            if(key->attrName!=NULL){          i=sprintf(strbuf+offset, " attrName=\"%s\"", key->attrName);  offset+=i;        }
            if(key->eq!=NULL){                i=sprintf(strbuf+offset, " eq=\"%s\"", key->eq);              offset+=i;        }
            if(key->neq!=NULL){               i=sprintf(strbuf+offset, " neq=\"%s\"", key->neq);            offset+=i;        }
            if(key->lt!=NULL){                i=sprintf(strbuf+offset, " lt=\"%s\"", key->lt);              offset+=i;        }
            if(key->gt!=NULL){                i=sprintf(strbuf+offset, " gt=\"%s\"", key->gt);              offset+=i;        }
            if(key->lteq!=NULL){               i=sprintf(strbuf+offset, " lteq=\"%s\"", key->lteq);          offset+=i;        }
            if(key->gteq!=NULL){               i=sprintf(strbuf+offset, " gteq=\"%s\"", key->gteq);          offset+=i;        }
            if(key->select!=NULL){             i=sprintf(strbuf+offset, " select=\"%s\"", key->select);      offset+=i;        }
            if(key->trap!=NULL){              i=sprintf(strbuf+offset, " trap=\"%s\"", key->trap);          offset+=i;        }
            i=sprintf(strbuf+offset, "/>");  offset+=i;
        }
        break;
    }
}
```

プログラムを書いて、アイデアを実装する

# 研究の軸3：理論の開拓

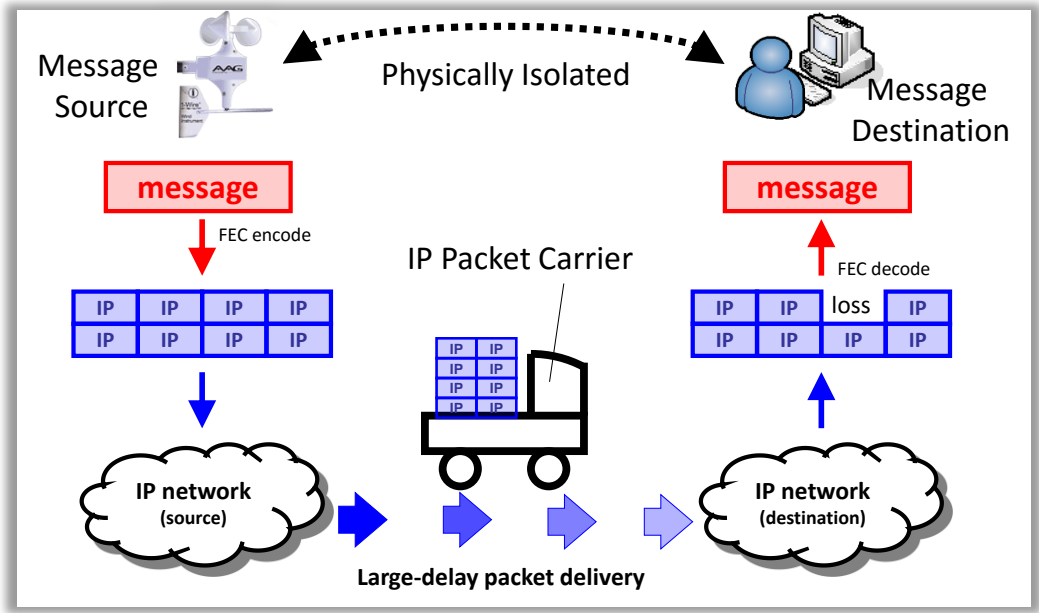
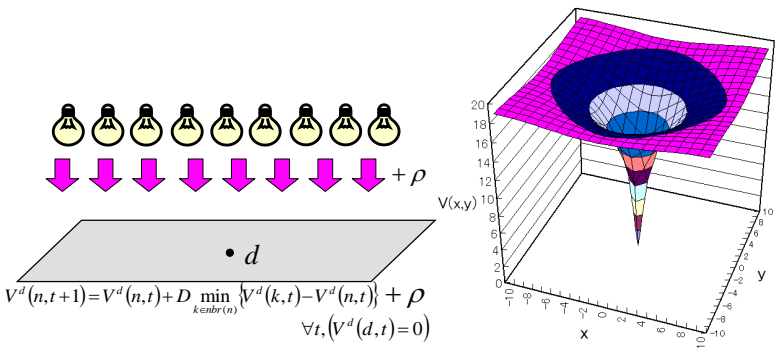
## Potential-Field Construction

$$V^d(n, t + 1) = V^d(n, t) + D \min_{k \in nbr(n)} \{V^d(k, t) - V^d(n, t)\} + \rho$$

$$\forall n \in N, (V^d(n, 0) = 0)$$

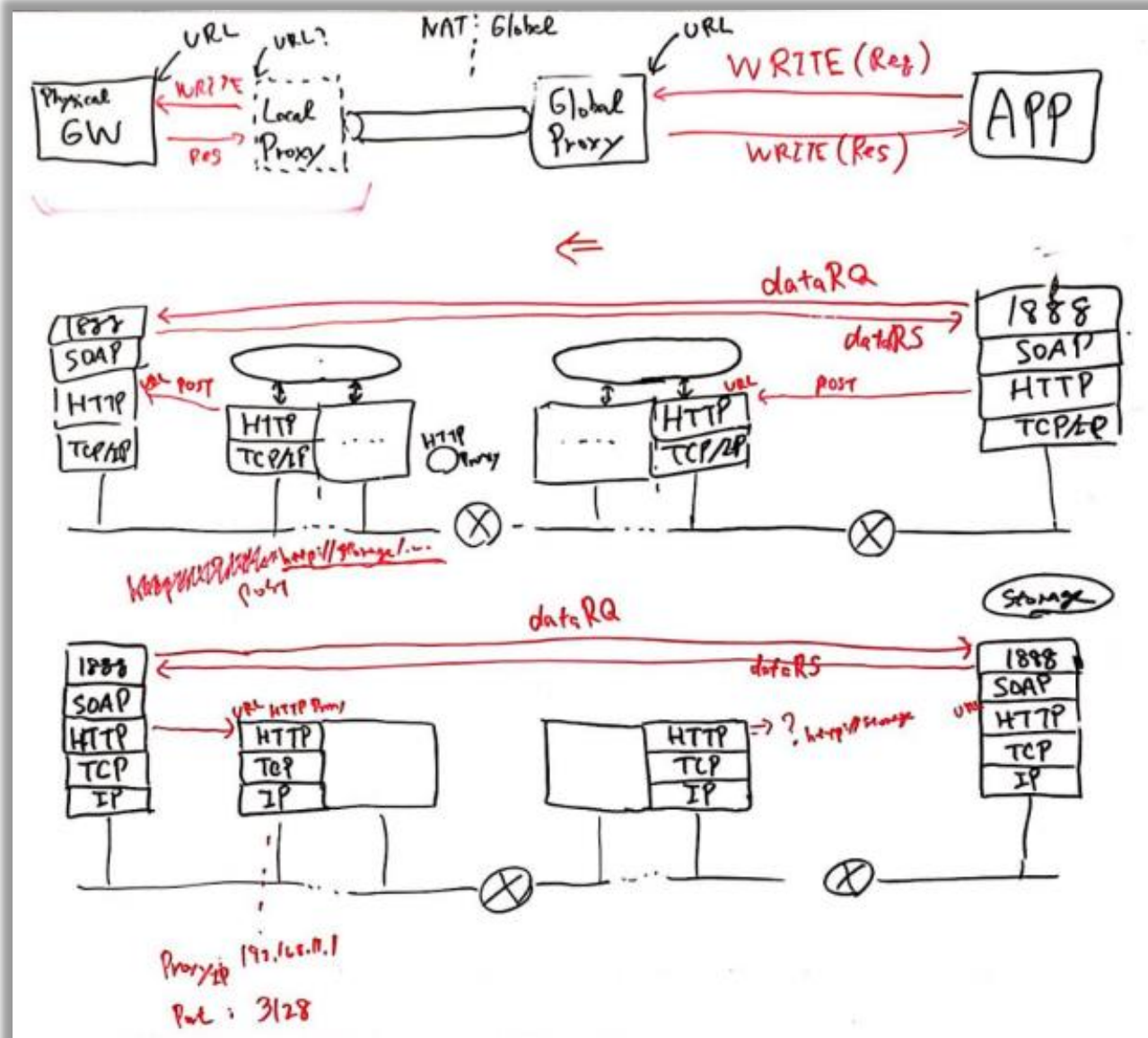
$$\forall t, (V^d(d, t) = 0)$$

$D(> 0), \rho(> 0)$  const.



新しい数学モデルを構築する、新しいアルゴリズムを設計する...

# 研究の軸4：議論



研究を建設的な方向に持っていく議論をする

# 研究の軸5：調査



**A Field Experience on DTN-Based Sensor Data Gathering in Agricultural Scenarios**

Hideo Oshita    Hirotaka Ishikawa    Yuya Kawakami    Hirotaka Imai

The University of Tokyo / NICT    The University of Tokyo / NICT    The University of Tokyo / NICT    The University of Tokyo / NICT

**Abstract:** This paper describes our field experience on data collection from remote sensors in a large-scale, farm-level agricultural scenario. We focus on the design of a DTN-based data gathering system that can collect data from remote sensors in a large-scale, farm-level agricultural scenario. We focus on the design of a DTN-based data gathering system that can collect data from remote sensors in a large-scale, farm-level agricultural scenario. We focus on the design of a DTN-based data gathering system that can collect data from remote sensors in a large-scale, farm-level agricultural scenario.

**1. INTRODUCTION**

Agricultural researchers and farmers deploy sensors at the farm level to monitor the status of crops and soil. These data are used to optimize the cultivation process and to reduce the risk of crop failure. Currently, they are using conventional protocols, for example, periodic broadcast (periodic) or request-response (pull) protocols. However, these protocols are not suitable for the farm-level scenario because of the limited bandwidth and the long delay of the network.

We have designed a DTN-based system that collects sensor data from remote sensors in a large-scale, farm-level agricultural scenario. This system is based on the DTN protocol, which is suitable for the farm-level scenario because of its ability to handle intermittent connectivity and long delays. In this paper, we describe our field experience on data collection from remote sensors in a large-scale, farm-level agricultural scenario. We focus on the design of a DTN-based data gathering system that can collect data from remote sensors in a large-scale, farm-level agricultural scenario.

**A Field Experience on DTN-Based Sensor Data Gathering in Agricultural Scenarios**

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似たようなことを行っている研究を調査(文献等)し、参考にしつつ、その差異を示す



# 研究の軸6：論文執筆

## Facility Networking with IP over RS485: Packet Control for Master-Slave Cascaded Networks

Hideya Ochiai The University of Tokyo / NICT jo2lxq@hongo.wide.ad.jp  
 Hiroki Nakagami The University of Tokyo nkgami@hongo.wide.ad.jp  
 Yuuichi Teranishi NICT / Osaka University teranisi@cmc.osaka-u.ac.jp  
 Hiroshi Esaki The University of Tokyo hiroshi@wide.ad.jp

## Facility Information Management on HBase: Large-Scale Storage for Time-Series Data

Hideya Ochiai The University of Tokyo / NICT jo2lxq@hongo.wide.ad.jp  
 Hiroyuki Ikegami The University of Tokyo ikegam@hongo.wide.ad.jp  
 Yuuichi Teranishi NICT / Osaka University teranisi@cmc.osaka-u.ac.jp  
 Hiroshi Esaki The University of Tokyo hiroshi@wide.ad.jp

**Abstract**—A very large number of sensors on facilities such as HVAC, light control systems and electric power meters, periodically submit their status information to Cloud platforms these days. As the amount of data can easily get petabyte scale, we must consider the use of distributed application layer storage for managing such facility information, which is often formatted on time-series data. This paper describes FIAPStoragePeta, petabyte scale storage for facility information access protocol (FIAP), proposing the architecture and the scheme of such data management on HBase. In this work, we have identified three requirements to the design of HBase row keys for implementing this storage using HBase. Though, we have not finished petabyte scale experiments, our preliminary evaluation results have shown good performance for managing large scale facility information. It has achieved scalable data retrieval on the data of 10 million storages with properly balancing loads on distributed data storages.

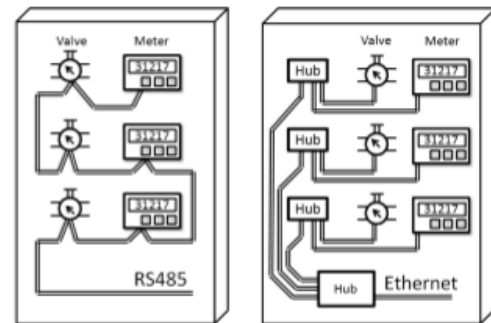
**Keywords**—Internet of Things, Time-Series Data, HBase, Hadoop

HVAC Working Mode		Room Temperature	
Time	Value	Time	Value
2014-07-21 08:00:00	FAN	2014-07-21 08:00:00	25.6
2014-07-21 08:30:00	FAN	2014-07-21 08:30:00	25.8
2014-07-21 09:00:00	DRY	2014-07-21 09:00:00	26.2
2014-07-21 09:30:00	DRY	2014-07-21 09:30:00	26.9
2014-07-21 10:00:00	COOL	2014-07-21 10:00:00	25.5
2014-07-21 10:30:00	COOL	2014-07-21 10:30:00	25.3

Fig. 1. Facilities generate sequences of "time-value" pairs: i.e., time-series data. FIAP manages each sequence by a unique identifier called "Point ID".

FIAP[7] is a communication protocol for data-centric building automation systems. It provides data storage for managing time-series data collected from facilities, which

access end communications). In this paper, we demonstrate the communication of IP over RS485 for packet-control systems, and according to the RS485 standard, any facility can be active or non-active. It had great



(a) Networking with RS485 (b) Networking with Ethernet

Fig. 1. RS485 is one of the most optimal communication media for facility networking. If we use Ethernet, we have to deploy switching hubs and many UTP cables.

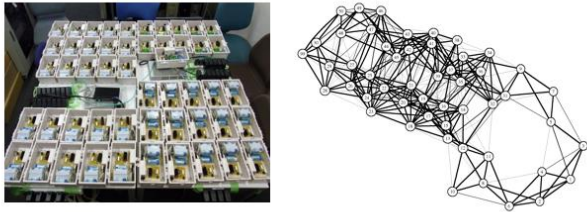
to monitor facilities using to use [16]. IP is connectivity to the

RS485 is a half-duplex, low-speed and multipoint serial communication media. It connects multiple nodes in cascaded manner usually on a single twisted-pair cable. It makes serial communication with differential signaling over 1km. The typical link speed for RS485-based networking is between 9.6kbps

行っている研究を論文に整理する

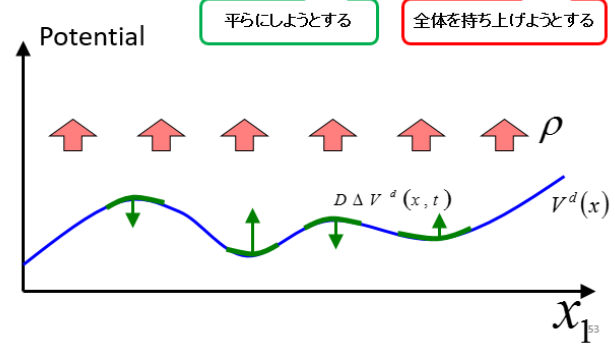
# 研究の軸7：プレゼンテーション

Hop-by-Hop Reliable,  
Parallel Message Propagation for  
Intermittently-Connected Mesh Networks

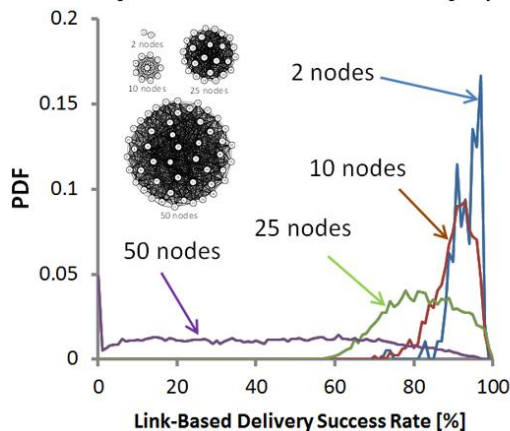


Hideya Ochiai, Masaya Nakayama, Hiroshi Esaki  
The University of Tokyo/NICT, JAPAN  
IEEE WoWMoM 2011, Lucca, Italy on 2011.06.22

$$\frac{\partial V^d(x,t)}{\partial t} = D\Delta V^d(x,t) + \rho$$

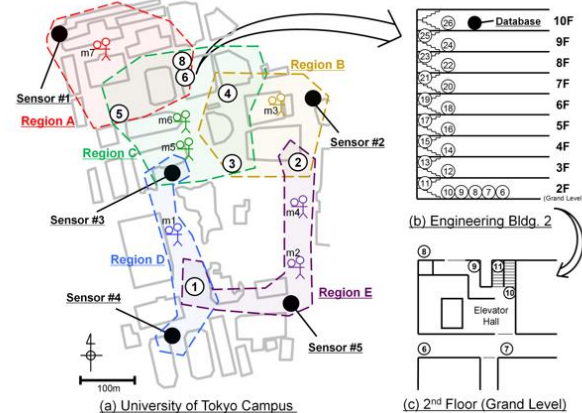


A Study of Link Availability (3/3)



31

Sensor Data Gathering (1/2)



12

自分のアイデアを上手に表現する

# 研究の軸8：課題設定

○○において  
○○を実現する技術  
を提案する

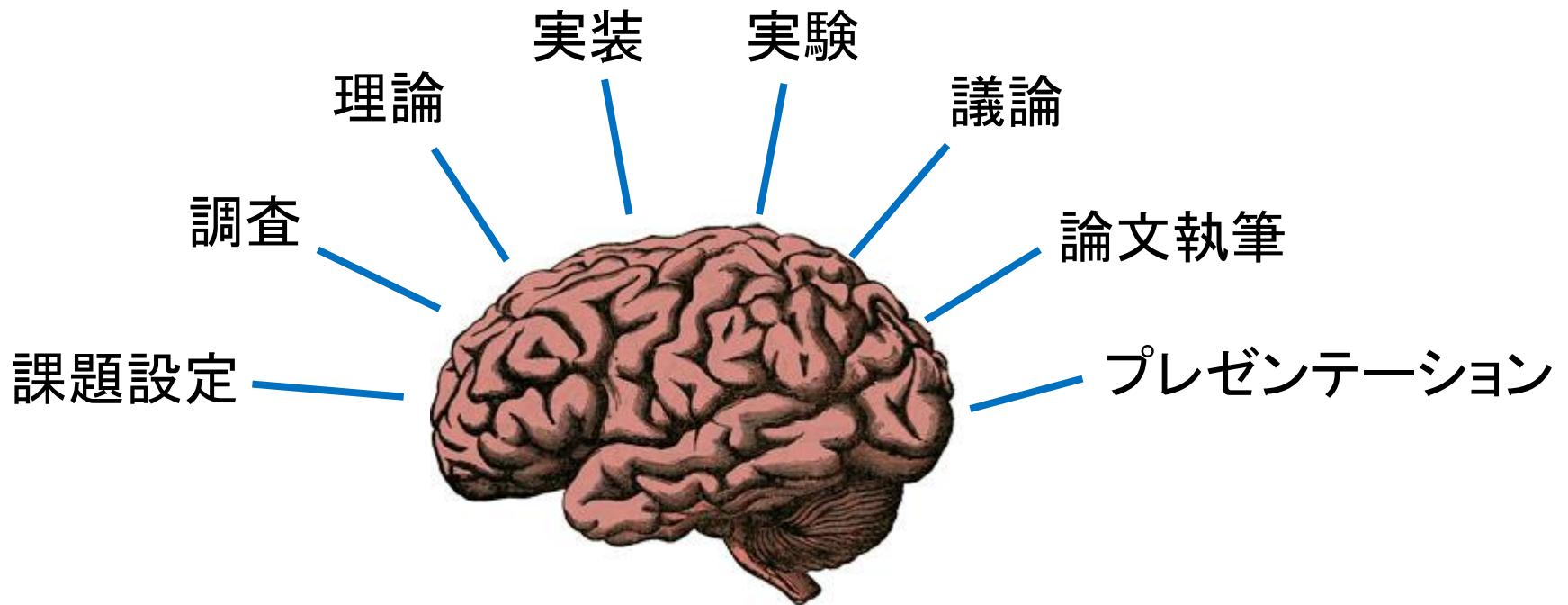
問題を定式化する

# 研究は、すべての総合である

「実験」だけできればよい、というわけではない。

「調査」だけすればよい、というわけではない。

「実装」だけすればよい、というわけではない。

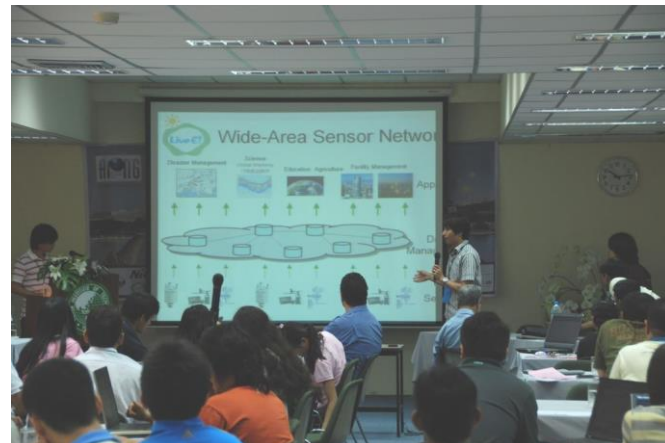


頭の中で、すべてがつながって、研究が成し遂げられる

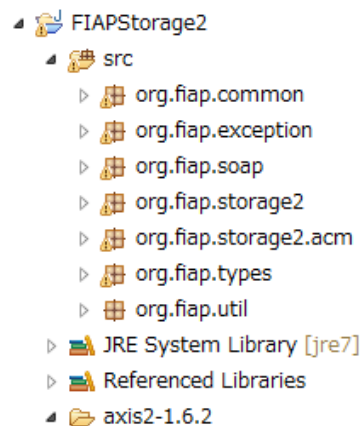
# 研究を後押しするもの1: 行動力



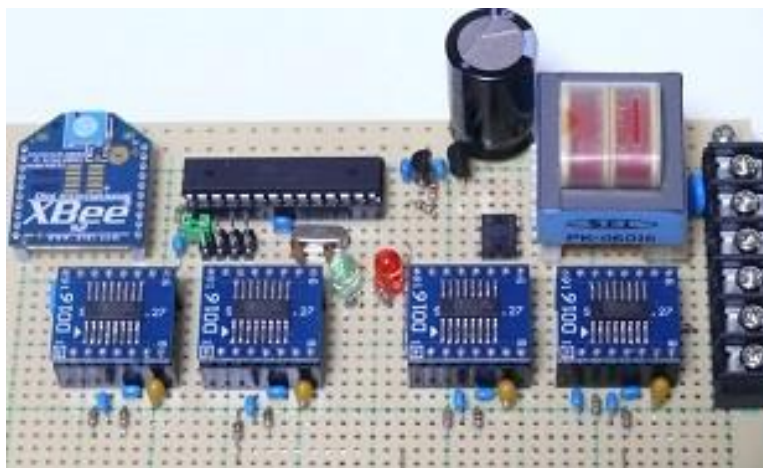
共同研究・学会発表のための出張



ワークショップの開催



プログラミング



製作



フィールドワーク

# 研究を後押しするもの2: 余暇



ゆっくり休んで頭の中をリフレッシュ

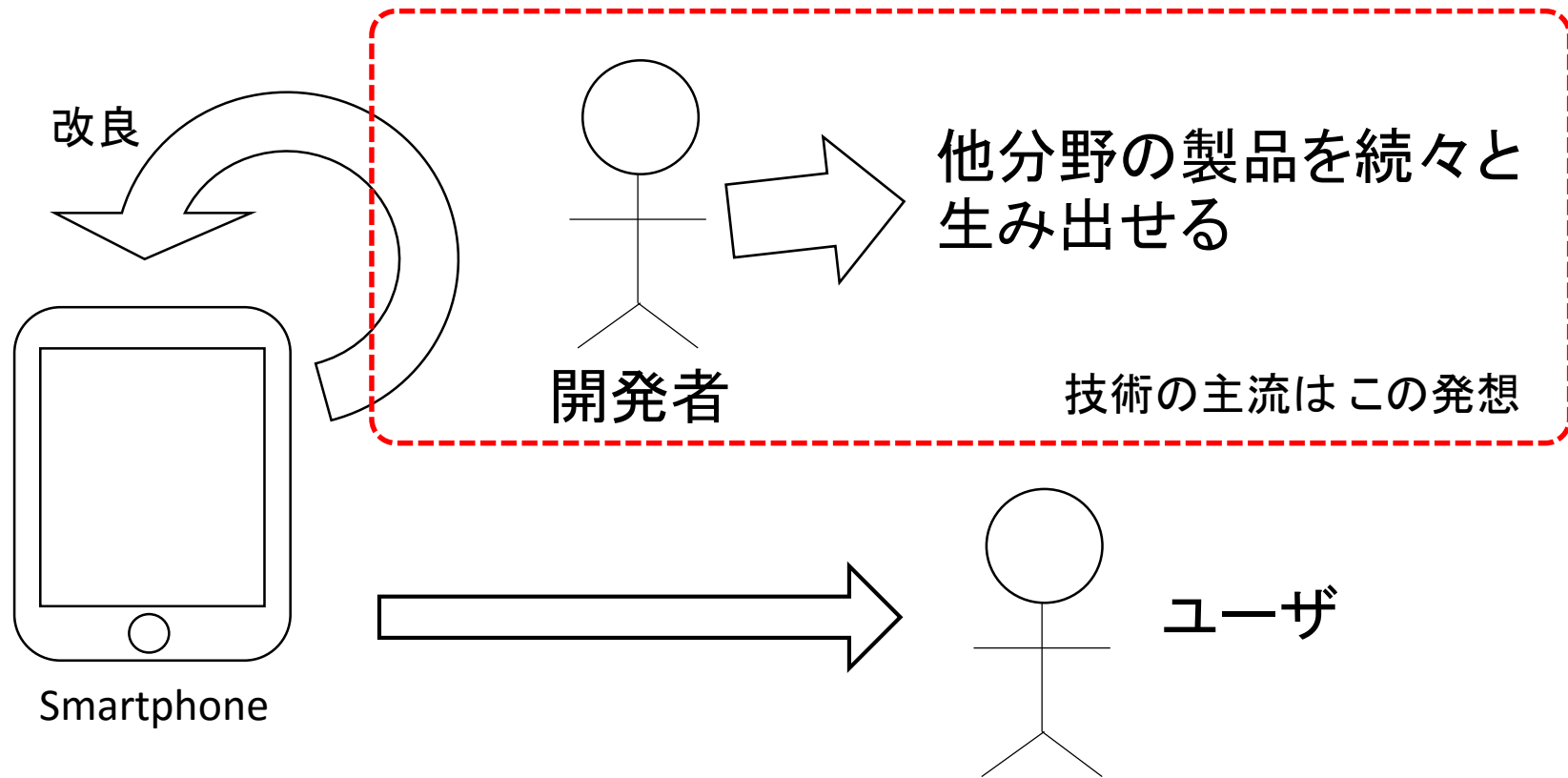
# 研究を後押しするもの3:ぶっ飛んだ発想



**RFC1149: A Standard for the Transmission of IP Datagrams on Avian Carriers**

# 研究を後押しするもの4： プロフェッショナルの世界を常に考える

- 世の中、開発自由自在であることを忘れるな！



- 最先端技術に対して、どのような技術提案ができるか



# 何からスタートすればよいか

研究の軸1: 実験と環境整備

研究の軸2: 理論の実装

研究の軸3: 理論の開拓

研究の軸4: 議論

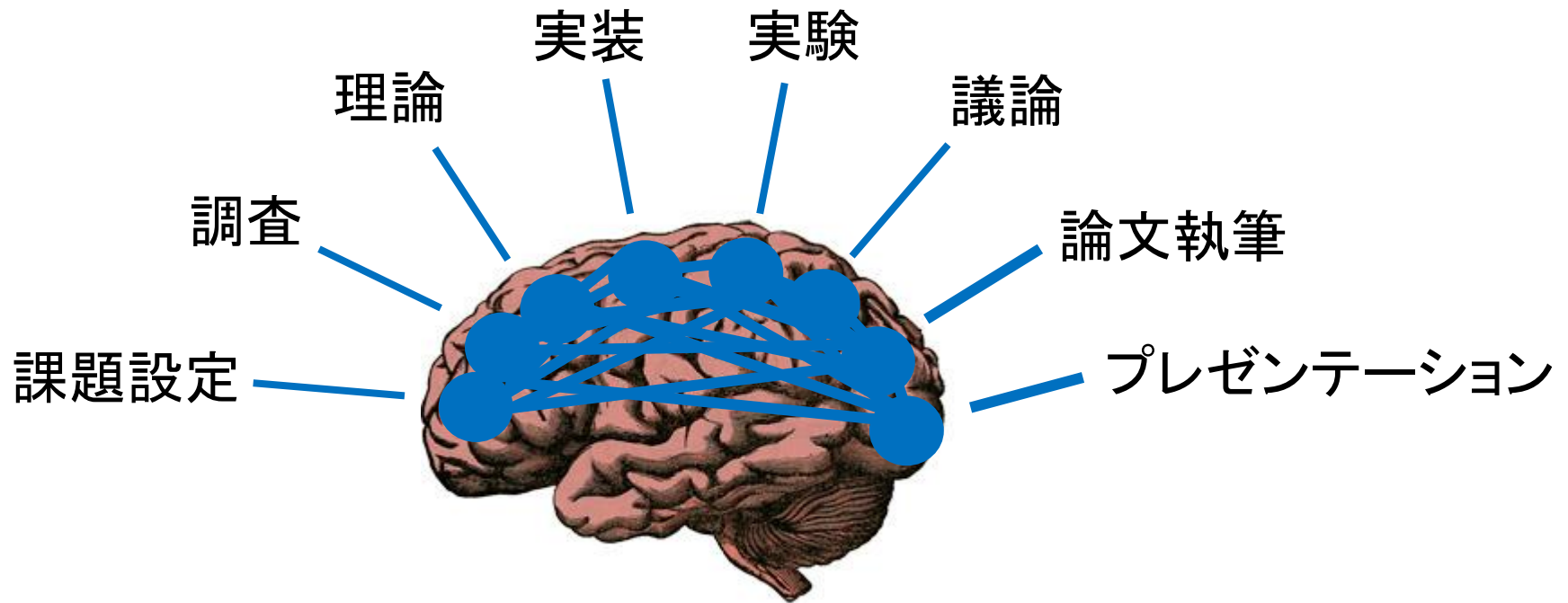
研究の軸5: 調査

研究の軸6: 論文執筆

研究の軸7: プレゼンテーション

研究の軸8: 課題設定

少しずつ、それぞれの神経回路を作る  
そして、それらを接続するネットワークを作る



脳の中に、それぞれの知識・技能の意識空間とネットワークを作り上げる

# 学会で研究発表をしよう！！



IEEE International Conference on Smart Grid Communications  
06 - 09 November 2016 // Sydney, Australia

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