INTERNET OF THINGS

Recent Advances and Applications

MengChu Zhou, Tongji University and New Jersey Institute of Technology
What is the next Industrial Revolution?
The 1st answer

People producing their own green energy in their homes, offices, and factories, and sharing it with each other in an “energy internet”
Industrial Revolution III =

Industrial Internet =

Intelligent Devices + Intelligent Systems + Intelligent Decisioning
INTERNET OF THINGS (IoT)
Seamlessly Integrated

Object
Smart Objects
Internet of Things: **Anytime, anywhere, by anyone and anything**  
– *ITU, November 2005*
WHAT are the *proper* ARCHITECTURES for such IoT?
ARCHITECTURE

Does it make sense to network physical objects?

Direct connection of physical objects makes little sense!
ARCHITECTURE

It makes sense to connect relevant information of physical objects.

Relevant information of physical objects = status + control information

IoT = integration of sensing, computation, and control
INTRANET of Things or “Net of Things”

specific protocols and vertically integrated

Applications

Network

Sensors/Controllers

Smart-grid

Traffic Control

Environmental Protection

Disaster Recovery
WHAT’S THE PROBLEM?

- **Tightly coupled**
- **Repeated implementation of common functions**
- **High cost and less sharing (of resources)**
INTERNET OF THINGS

Abandon *specific* protocols and *vertical* integration

Apply *generic* protocols and *horizontal* networking

Applications

Network

Sensors/Controllers

Smart-grid
Traffic Control
Environmental Protection
Disaster Recovery

Applications

Network

Sensors and controllers

Internet of Things
ARCHITECTURE OF IoT

Applications

Internet of Things

Sensors and Controllers

Generic protocols & Horizontal networking
HOW can one IMPLEMENT them?
Proposal 1: **Direct Use of Internet**
## Evaluation of Proposal 1

<table>
<thead>
<tr>
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Proposal 2:

Construction of a New Network
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**OVERALL EVALUATION**

- **Proposal 1**: Infeasible
- **Proposal 2**: High risk!
Proposal 3: A Two-Layer System

Lower layer: Use of internet as a communication carrier
Upper layer: IOT services
## Evaluation of Proposal 3

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**OVERALL EVALUATION**

- Infeasible
- High risk!
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W-Internet: An Implementation of Proposal 3
W-Internet

Applications

IoT service

IoT

Communication service

Sensors / Controllers
IoT Service Layer: System Structure
IoT Service Layer: System Structure

- Control Handle
- Models
- Image
- Local Processing Unit
- Control Ports to Members
- Image Ports from Members
- Ports of Physical World
- Control Handle

Link

IoT Server

Link

IoT Server

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IoT Server

Link
IoT Service Layer: Node Design

- Control Handle
- Models
- Image
- Control Ports to Members
- Image Ports from Members
- Local Processing Unit
IoT Service Layer: Node Design

- IoT Server
  - Information Dissemination
  - Data Fusion Engine
  - Data Acquisition
  - Fused Data Model
  - Cyber Control Engine
  - Command Dissemination
  - Command Execution Engine
  - Command Listener
  - Integrated Control Model
  - IoT Service Layer: Node Design

Integrated Control Model

Command Execution Engine

Command Dissemination
WHAT are the *existing* APPLICATIONS showing the promise of IoT
The iDigi® Device Cloud™ allows users to connect a physical device to the cloud and use an online Web application for remote access. The application converts complex device data into simple and useful information for anyone — from business owners who want to get message when refrigerator temperatures fall below a specific threshold to farmers who want to measure soil quality. iDigi also creates Internet of ANYThings content on their community site.
The Connected Home offering of AlertMe is based on ultra-low-power ZigBee-enabled devices scattered around the home, which are turned into internet devices via the proxy of a home gateway.
NIMBITS
Nimbots is an open source data server built on cloud computing architecture that provides connectivity among devices using data points.

THINGSPEAK
ThingSpeak is an open source “Internet of Things” application and API to store and retrieve data from things using HTTP over the Internet or via a Local Area Network. With ThingSpeak, you can create sensor logging applications, location tracking applications, and a social network of things with status updates.

IOT TOOLKIT
The IoT Toolkit is an Open Source project to develop a set of tools for building multi-protocol IoT Gateways and Service gateways that enable horizontal co-operation among multiple different protocols and cloud services. The project consists of the Smart Object API, gateway service, and related tools.
Cyanobacteria Monitoring in Tai Lake Based on WInternet
Collaborative Monitoring and Tracking Vehicles with Multiple Cameras Based on Winternet
Material Tracking, Monitoring and Supervision in Toy Manufacturing

Layered classification identification

Multimodal information perception

Multi-mode integrated transmission

Cloud information processing

Multi-level application services

Barcode
Tag
Barcode

Layer classification
Identification

Raw material
Semi-fin. product
Finished product

Sensing devices
RFID Reader
PDA
Barcode Scanner

Objects in-out warehouse management
Semi-finished products information collection

Cable
Wireless
Wireless
Cable

Transfer Protocol

Warehouse
Management office
Workshop

Data Processing with transmission
Data fusion
Comparison
Toy Design Library

Database 1
Database 2
Database 3

Traceability

Inventory management

Production information transparent

Toys experience and design improvements

Toy Design Library
Collaborative Framework
Questions?