



INTERNET OF THINGS

Recent Advances and Applications

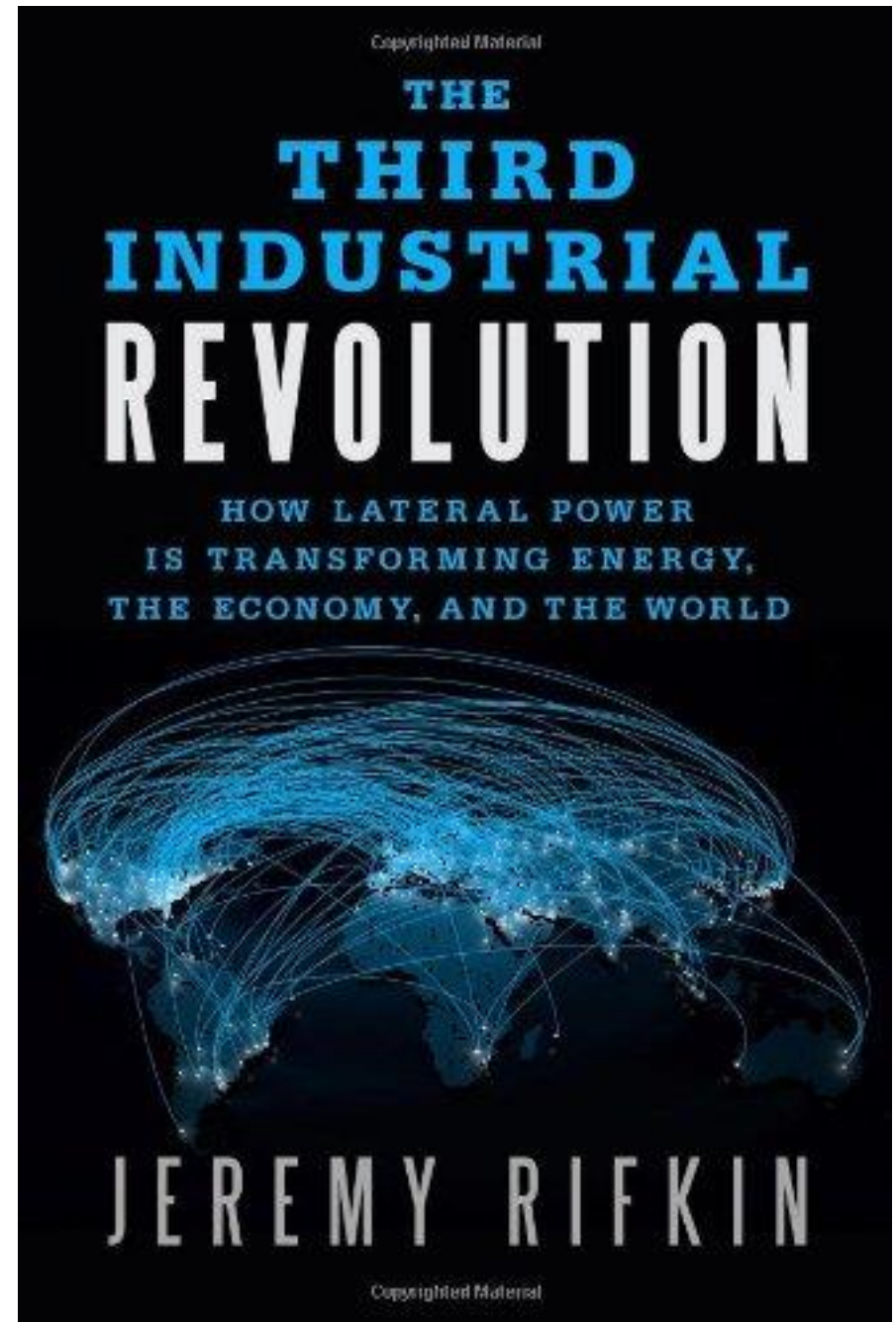
MengChu Zhou, Tongji University and

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”



The 2nd answer is from General Electric:
Peter C. Evans and Marco Annunziata

Industrial Revolution III

=

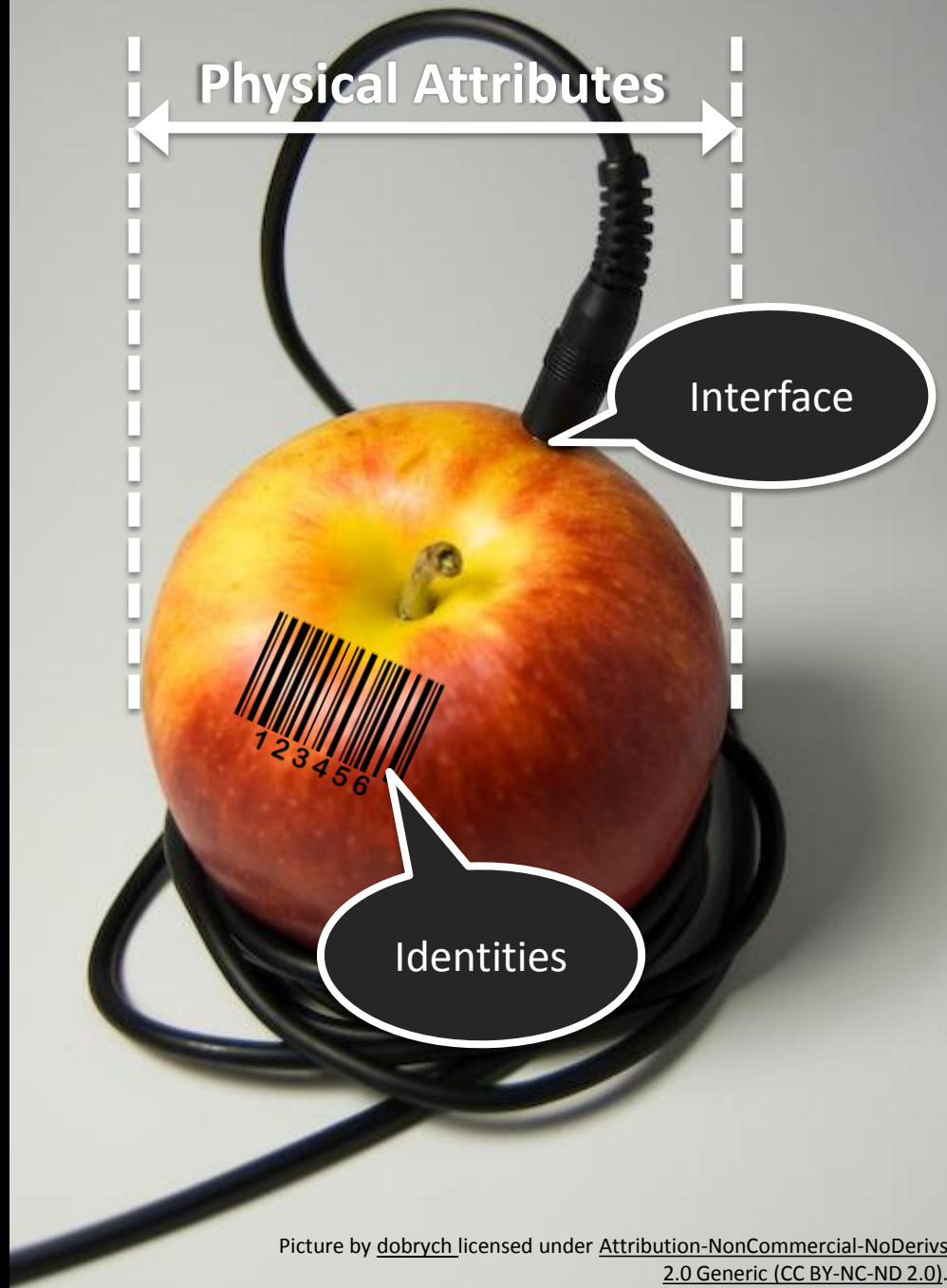
Industrial Internet

=

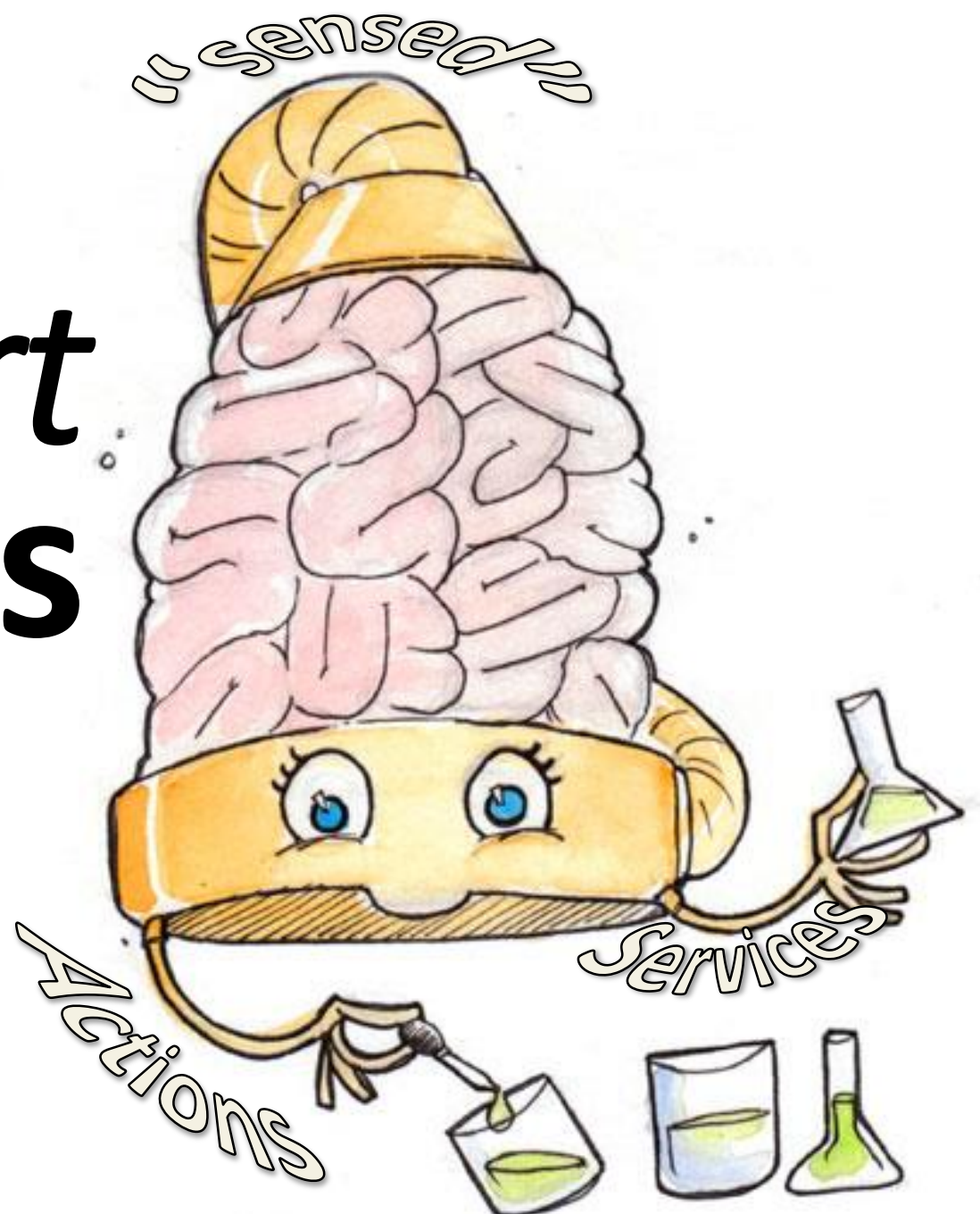
**Intelligent Devices + Intelligent
Systems + Intelligent Decisioning**

INTERNET OF THINGS (IoT)

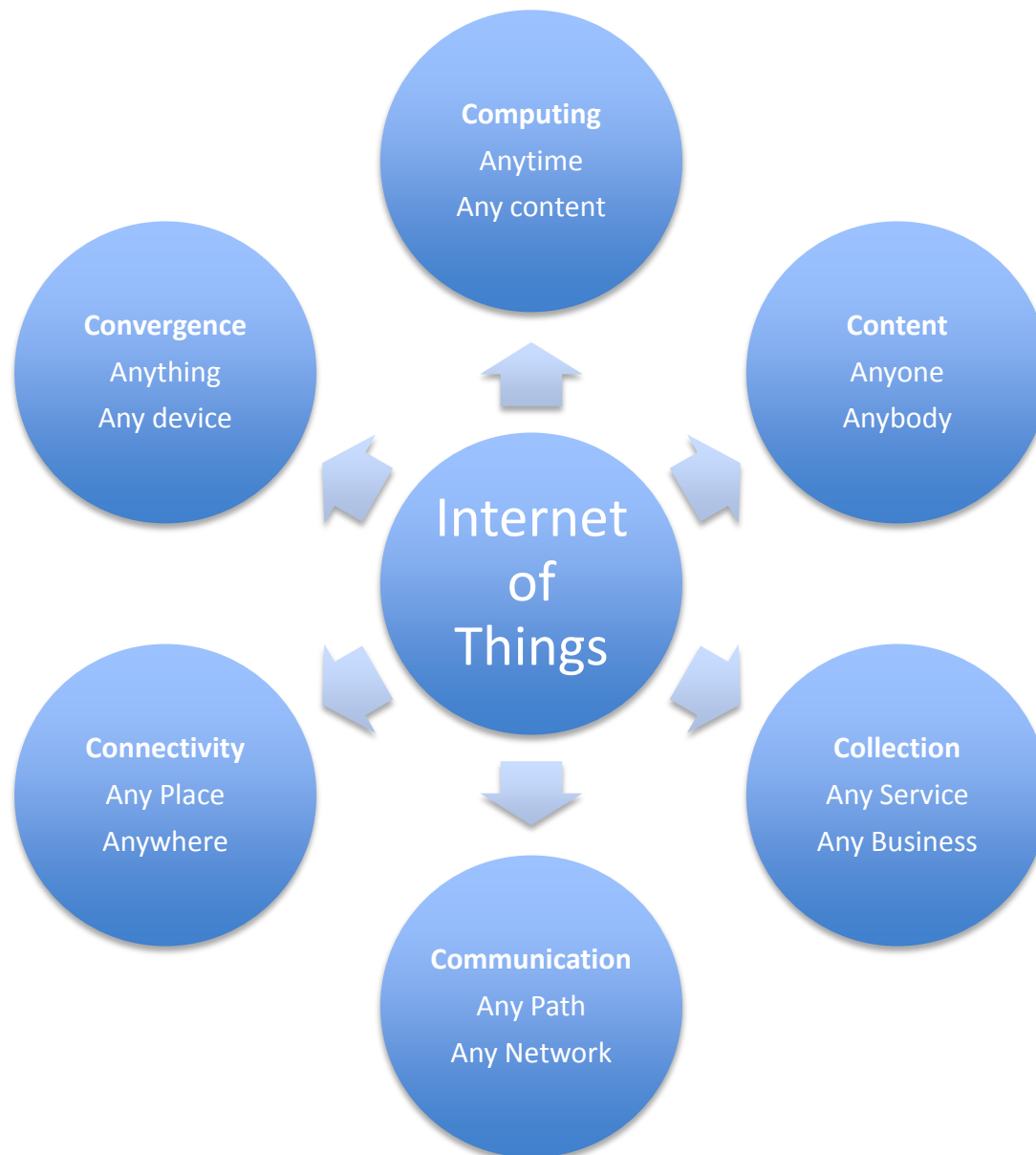
*Seamlessly
Integrated*
Object



Smart Objects



Internet of Things : **Anytime, anywhere, by anyone and anything** – *ITU, November 2005*

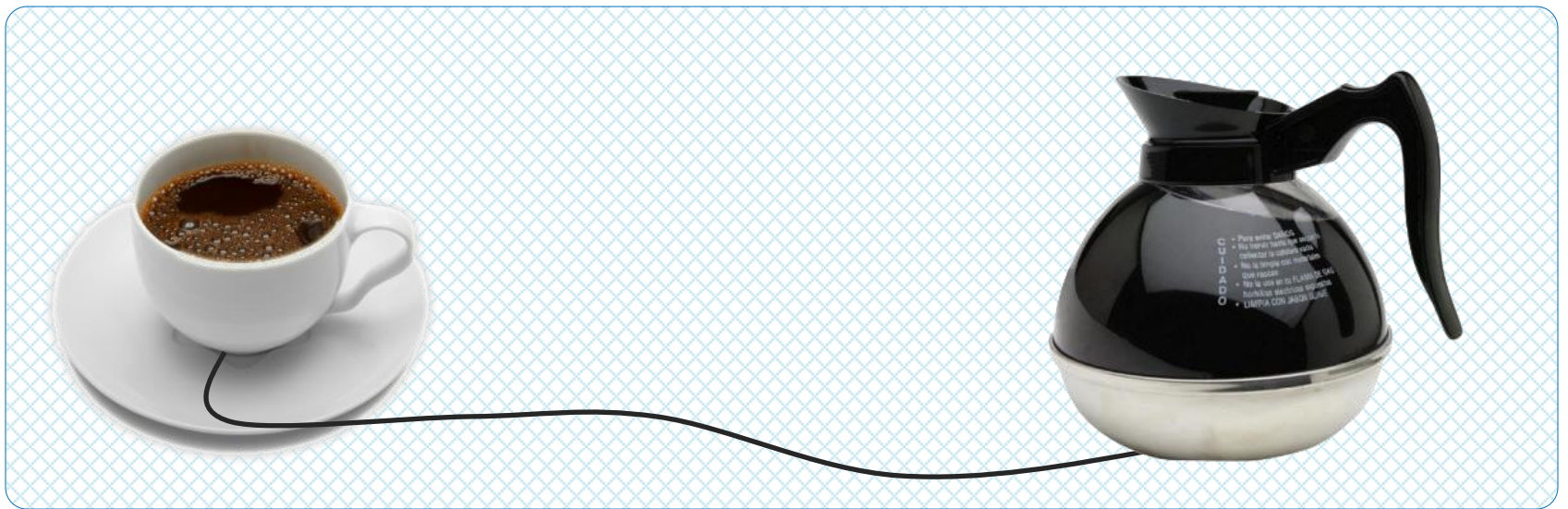


WHAT are the *proper*
ARCHITECTURES
for such IoT



ARCHITECTURE

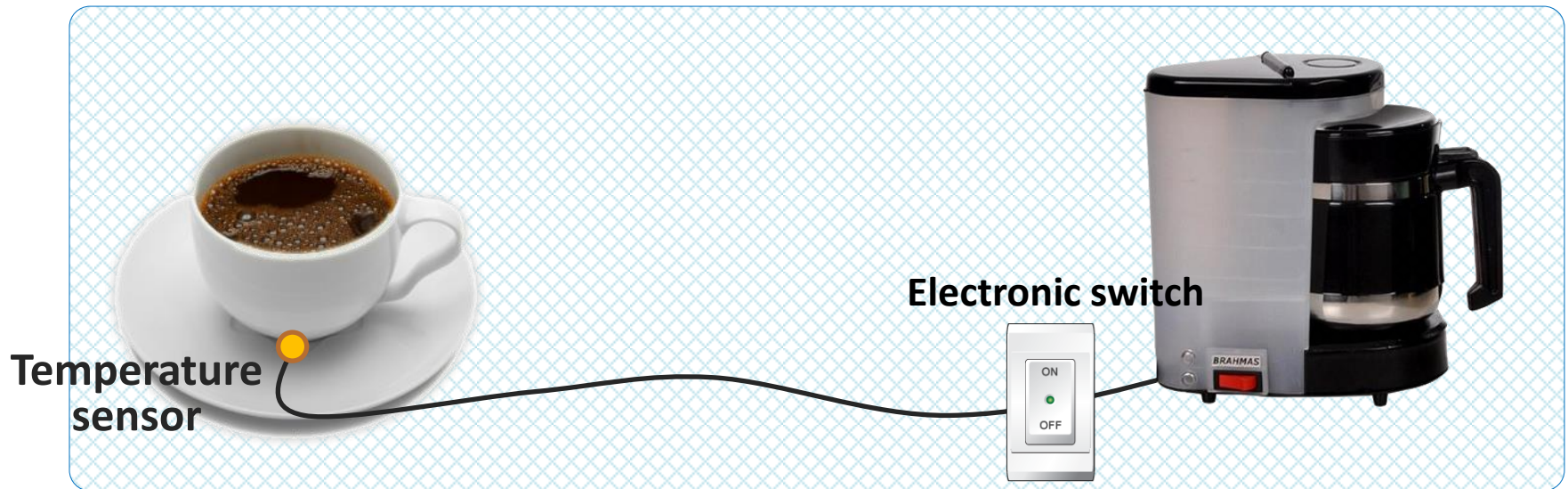
Does it make sense to network physical objects?



**Direct connection of physical objects
makes little sense!**

ARCHITECTURE

It does make sense to connect relevant information of physical objects



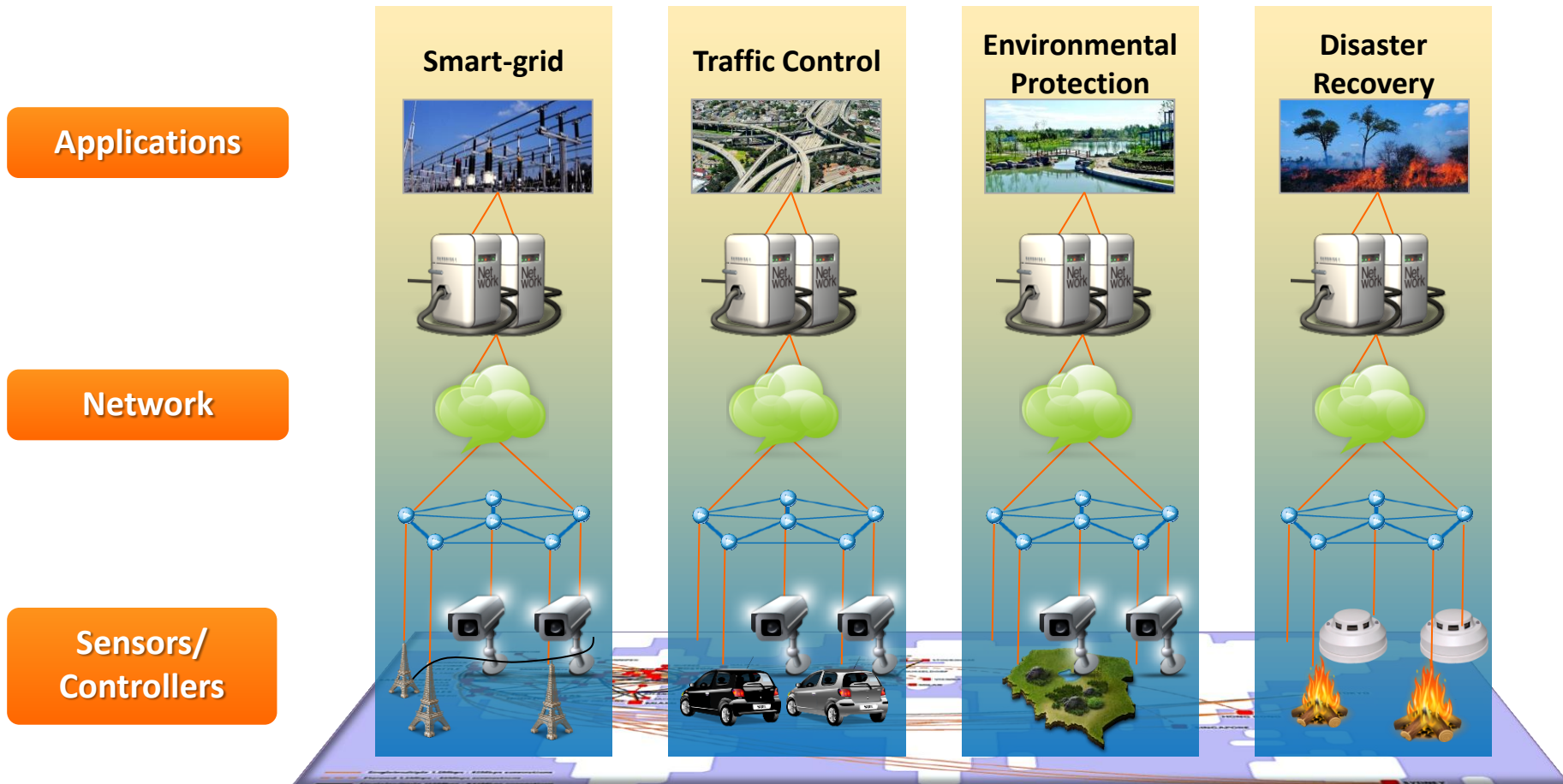
Relevant information of physical objects =

status + control information

IoT = integration of sensing, computation, and control

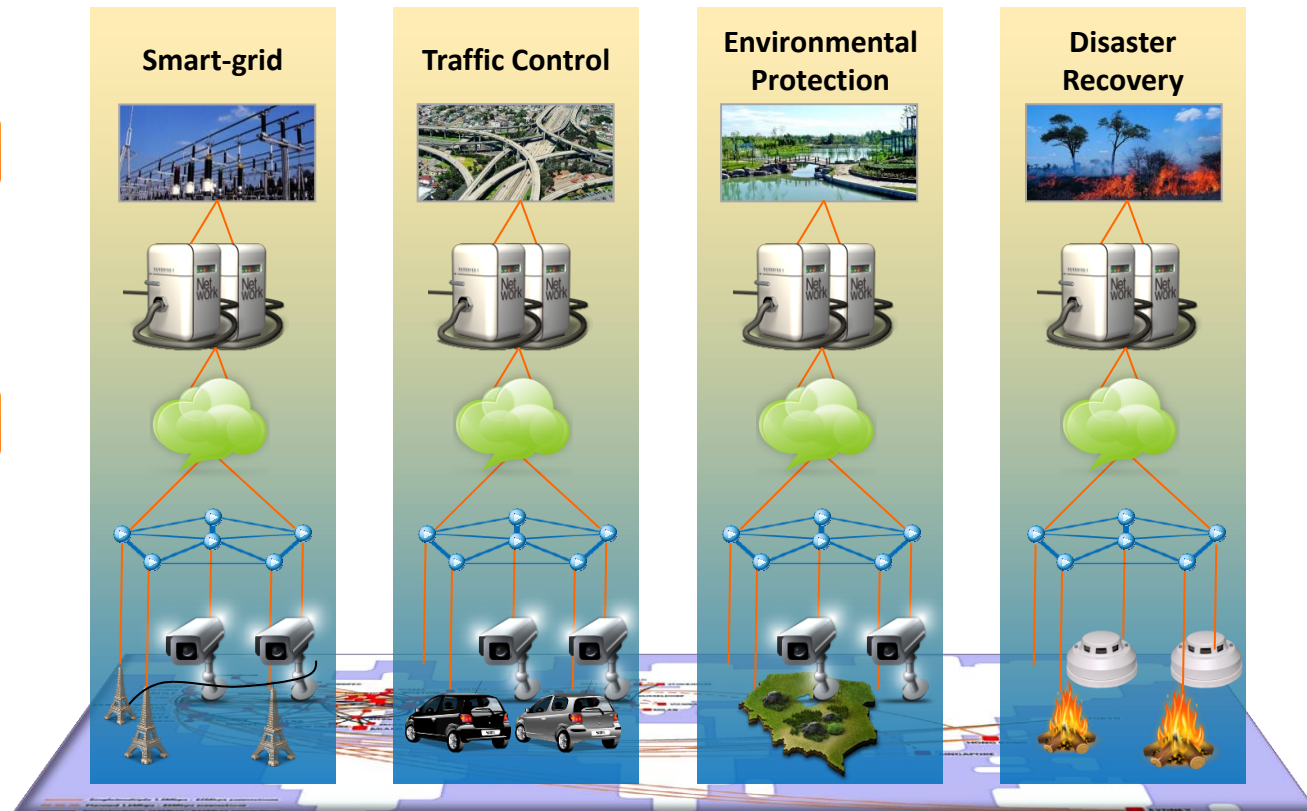
INTRANET of Things or “Net of Things”

specific protocols and vertically integrated



WHAT'S THE PROBLEM?

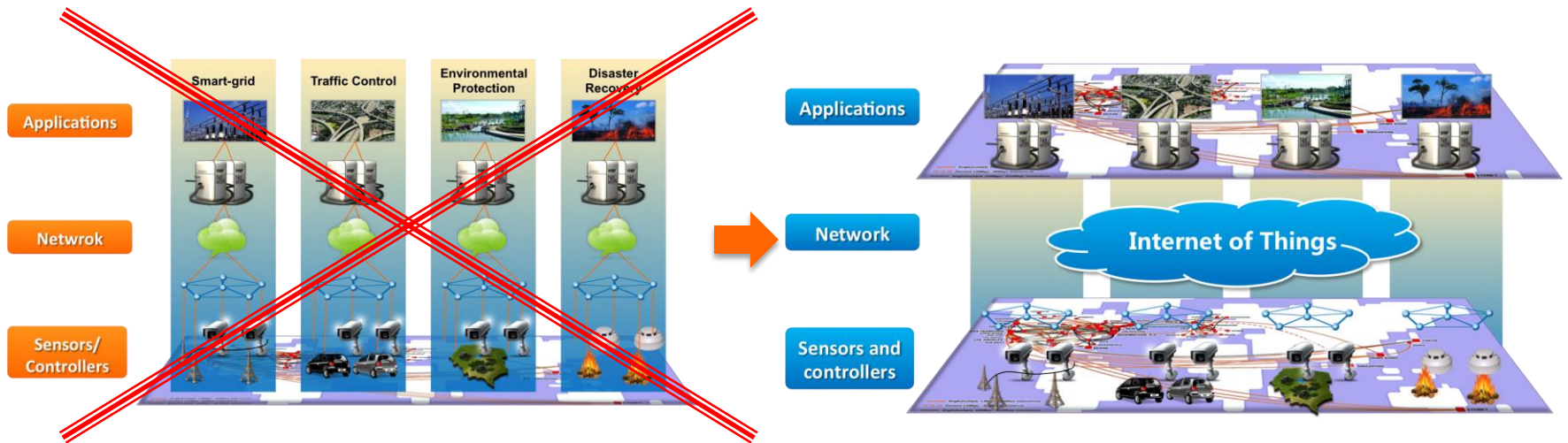
- **Tightly coupled**
- **Repeated implementation of common functions**
- **High cost and less sharing (of resources)**



INTERNET OF THINGS

Abandon *specific* protocols and *vertical* integration

Apply *generic* protocols and *horizontal* networking



ARCHITECTURE OF IoT

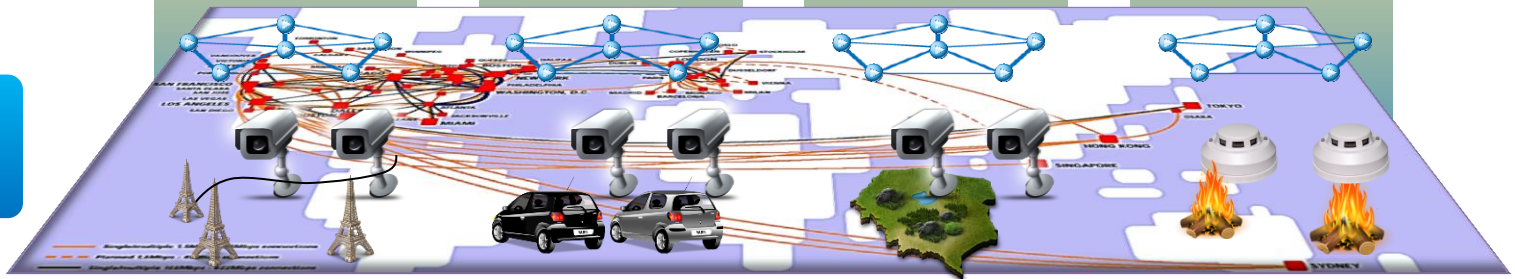
Applications



Internet of Things

Generic protocols & Horizontal networking

Sensors and Controllers

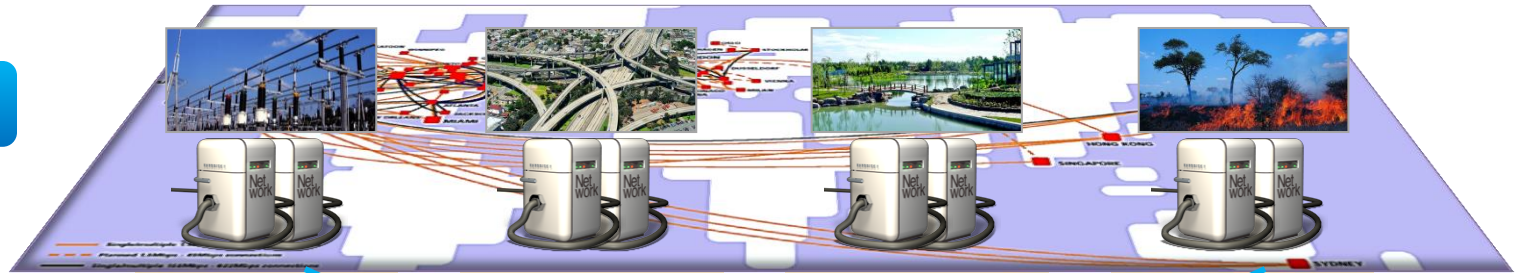


HOW can one
IMPLEMENT
them



Proposal 1: Direct Use of Internet

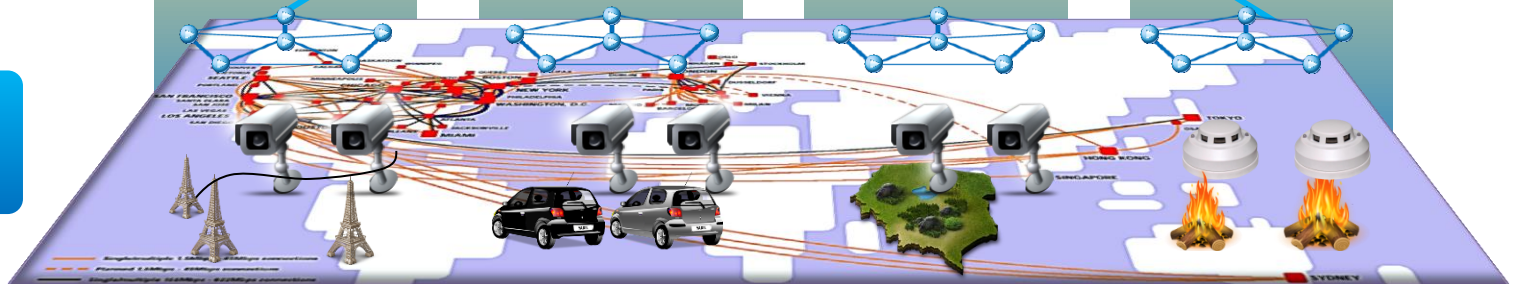
Applications



Internet of Things



Sensors and Controllers



Evaluation of Proposal 1

IoT Requirements	Proposal 1
1. Real-time	
2. Privacy	
3. Embedded computing	
4. Scalable	
5. Low cost, quick start	
6. Marketing and profitable	

Evaluation of Proposal 1

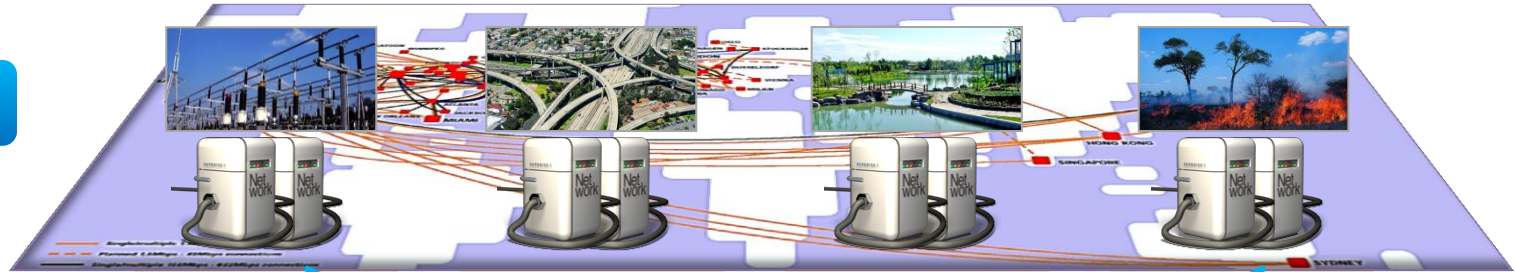
IoT Requirements	Proposal 1
1. Real-time	Not good
2. Privacy	Not good
3. Embedded computing	Impossible
4. Scalable	Good
5. Low cost, quick start	Good
6. Marketing and profitable	Not good

INFEASIBLE

Proposal 2:

Construction of a New Network

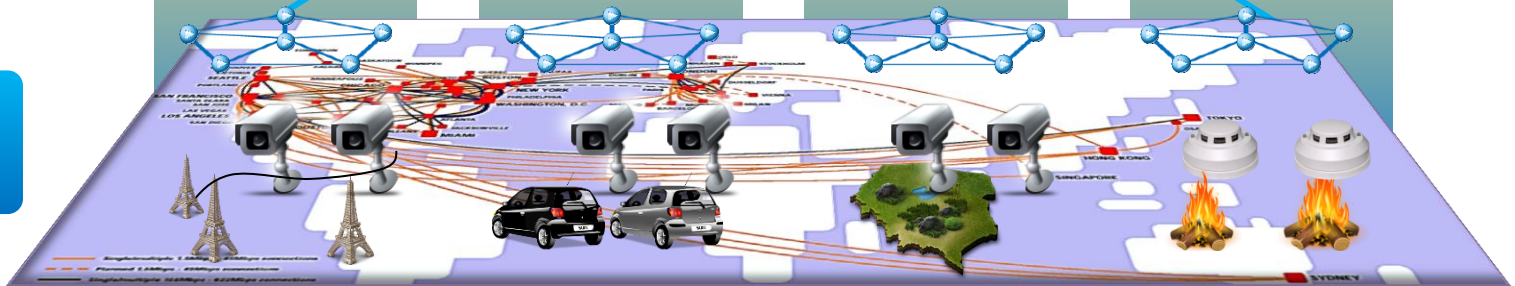
Applications



Internet of Things



Sensors and Controllers



Evaluation of Proposal 2

IoT Requirements	Proposal 1	Proposal 2
1. Real-time	Not good	
2. Privacy	Not good	
3. Embedded computing	Impossible	
4. Scalable	Good	
5. Low cost, quick start	Good	
6. Marketing and profitable	Not good	
OVERALL EVALUATION	Infeasible	

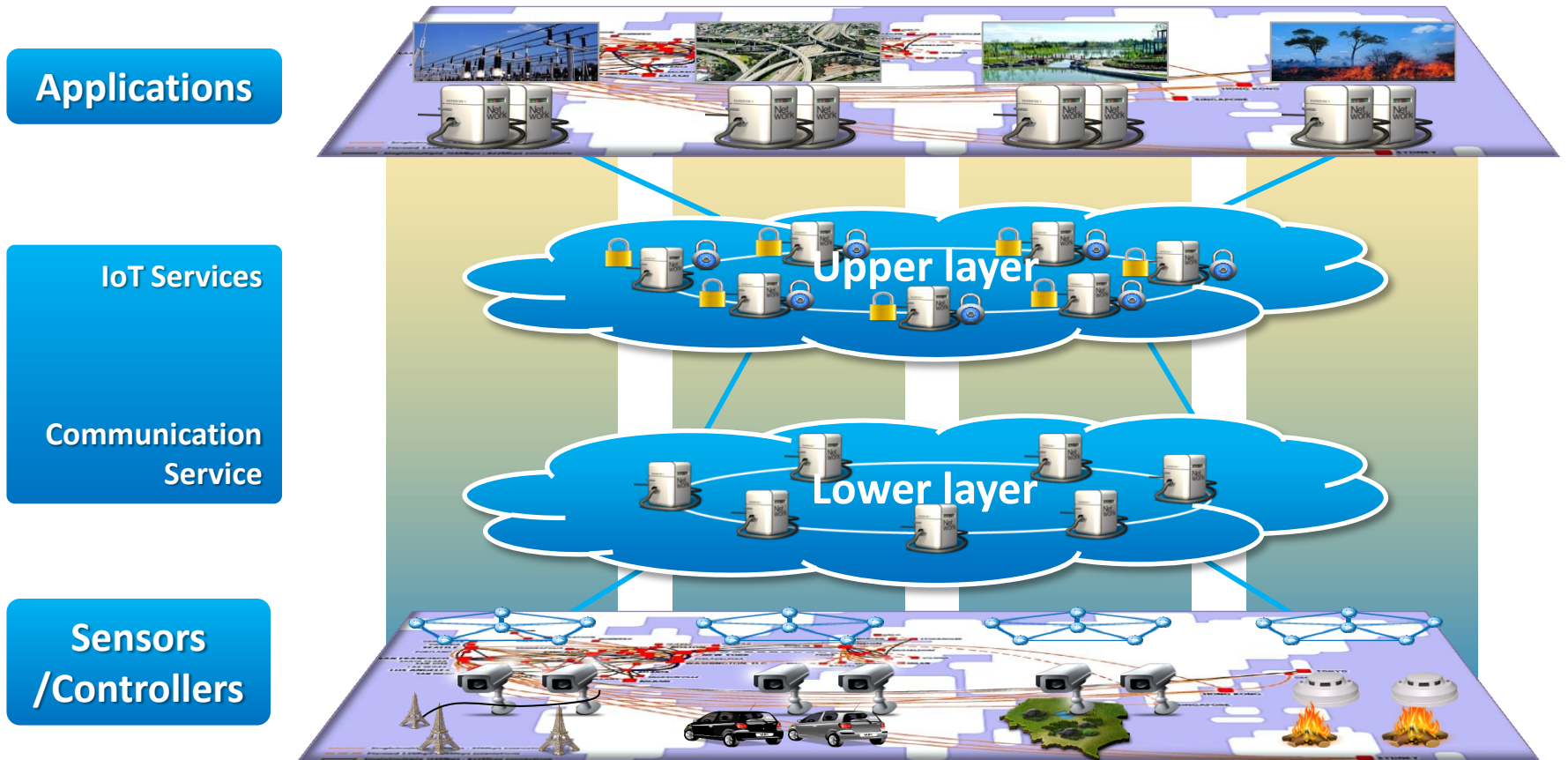
Evaluation of Proposal 2

IoT Requirements	Proposal 1	Proposal 2
1. Real-time	Not good	Possible
2. Privacy	Not good	Possible
3. Embedded computing	Impossible	Possible
4. Scalable	Good	Possible
5. Low cost, quick start	Good	Difficult
6. Marketing and profitable	Not good	Possible
OVERALL EVALUATION	Infeasible	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

IoT Requirements	Proposal 1	Proposal 2	Proposal 3
1. Real-time	Not good	Possible	
2. Privacy	Not good	Possible	
3. Embedded computing	Impossible	Possible	
4. Scalable	Good	Possible	
5. Low cost, quick start	Good	Difficult	
6. Marketing and profitable	Not good	Possible	
OVERALL EVALUATION	Infeasible	High risk!	

Evaluation of Proposal 3

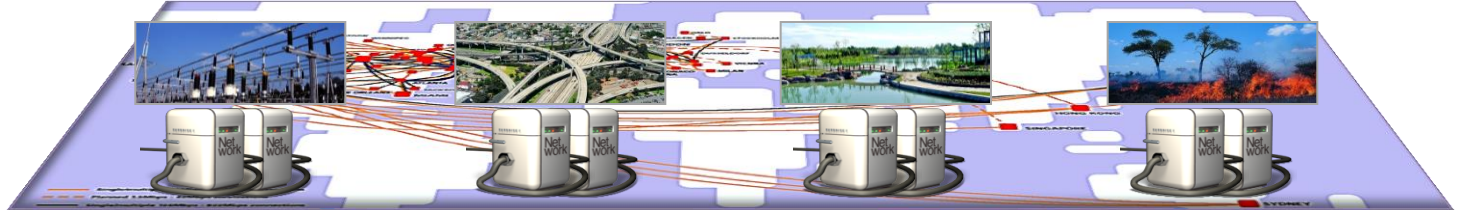
IoT Requirements	Proposal 1	Proposal 2	Proposal 3
1. Real-time	Not good	Possible	Possible
2. Privacy	Not good	Possible	Possible
3. Embedded computing	Impossible	Possible	Possible
4. Scalable	Good	Possible	Good
5. Low cost, quick start	Good	Difficult	Good
6. Marketing and profitable	Not good	Possible	Possible
OVERALL EVALUATION	Infeasible	High risk!	Feasible

W-Internet: An Implementation of Proposal 3



W-Internet

Applications



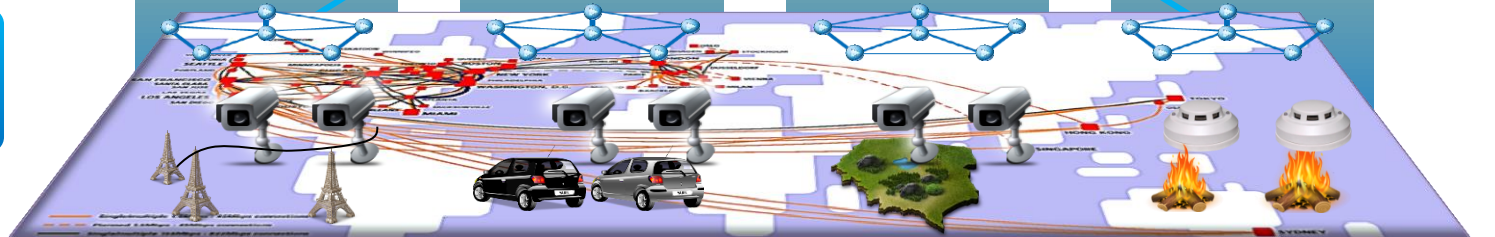
IoT service

IoT

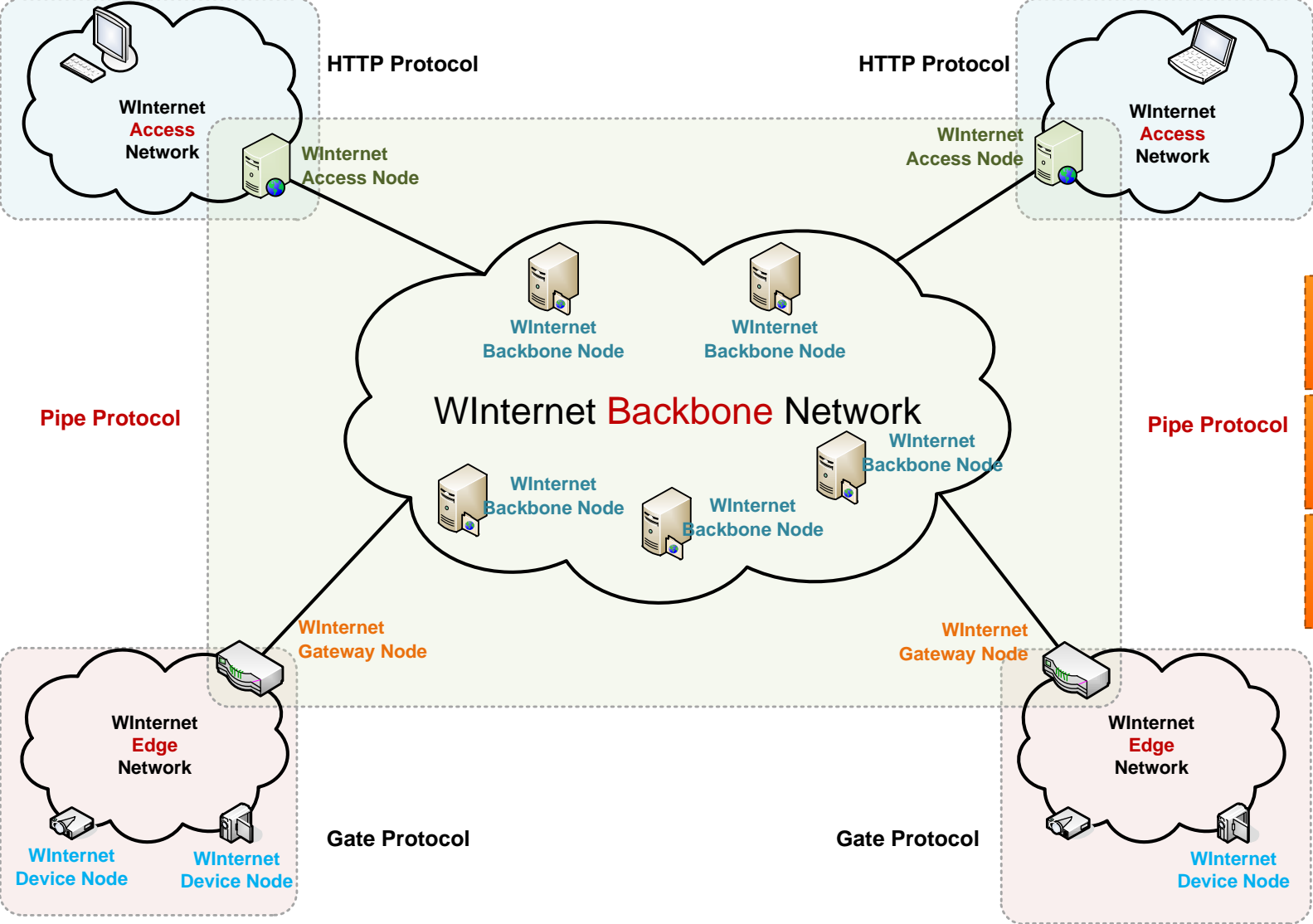
Communication
service



Sensors /
Controllers

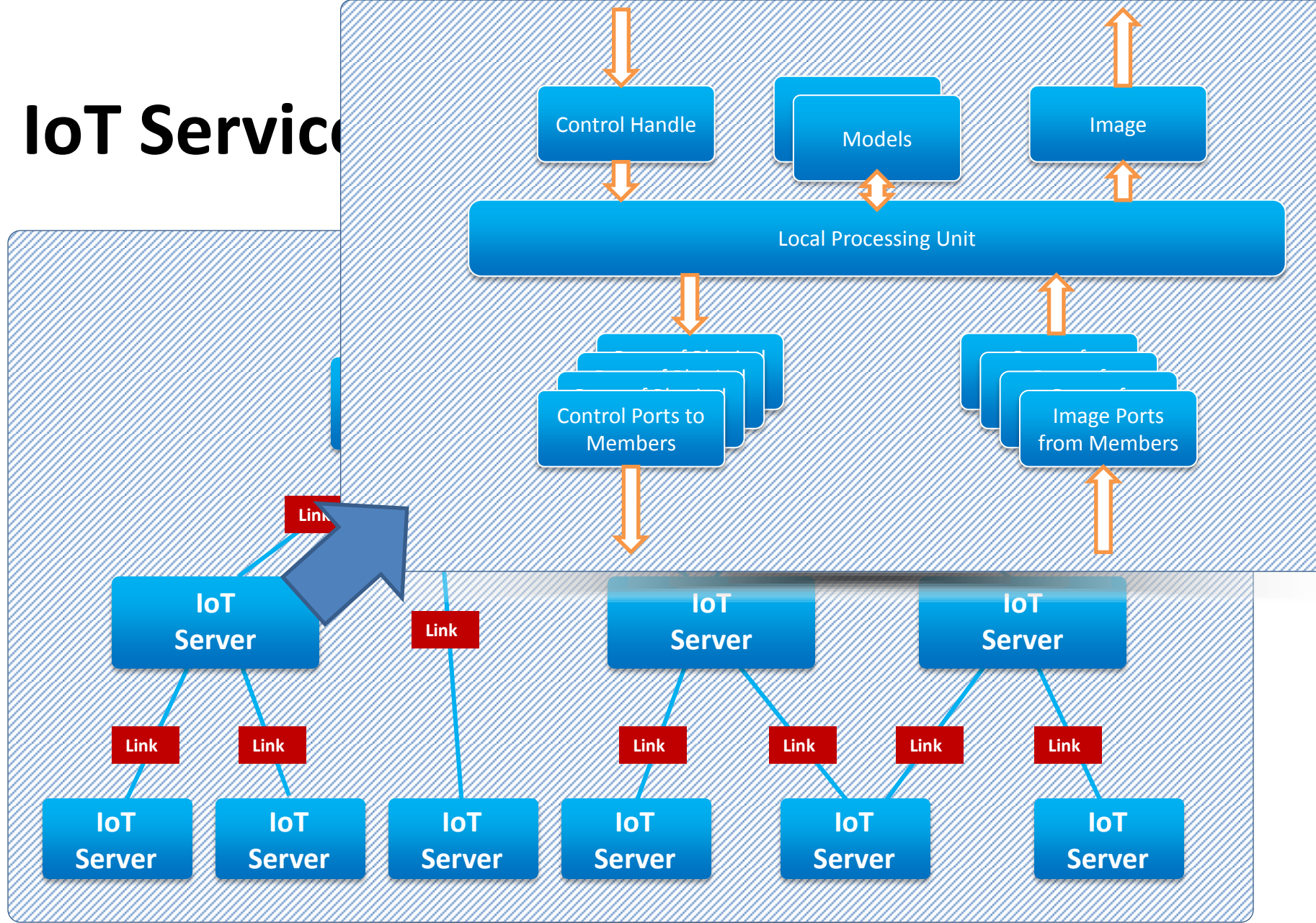


W-Internet Architecture

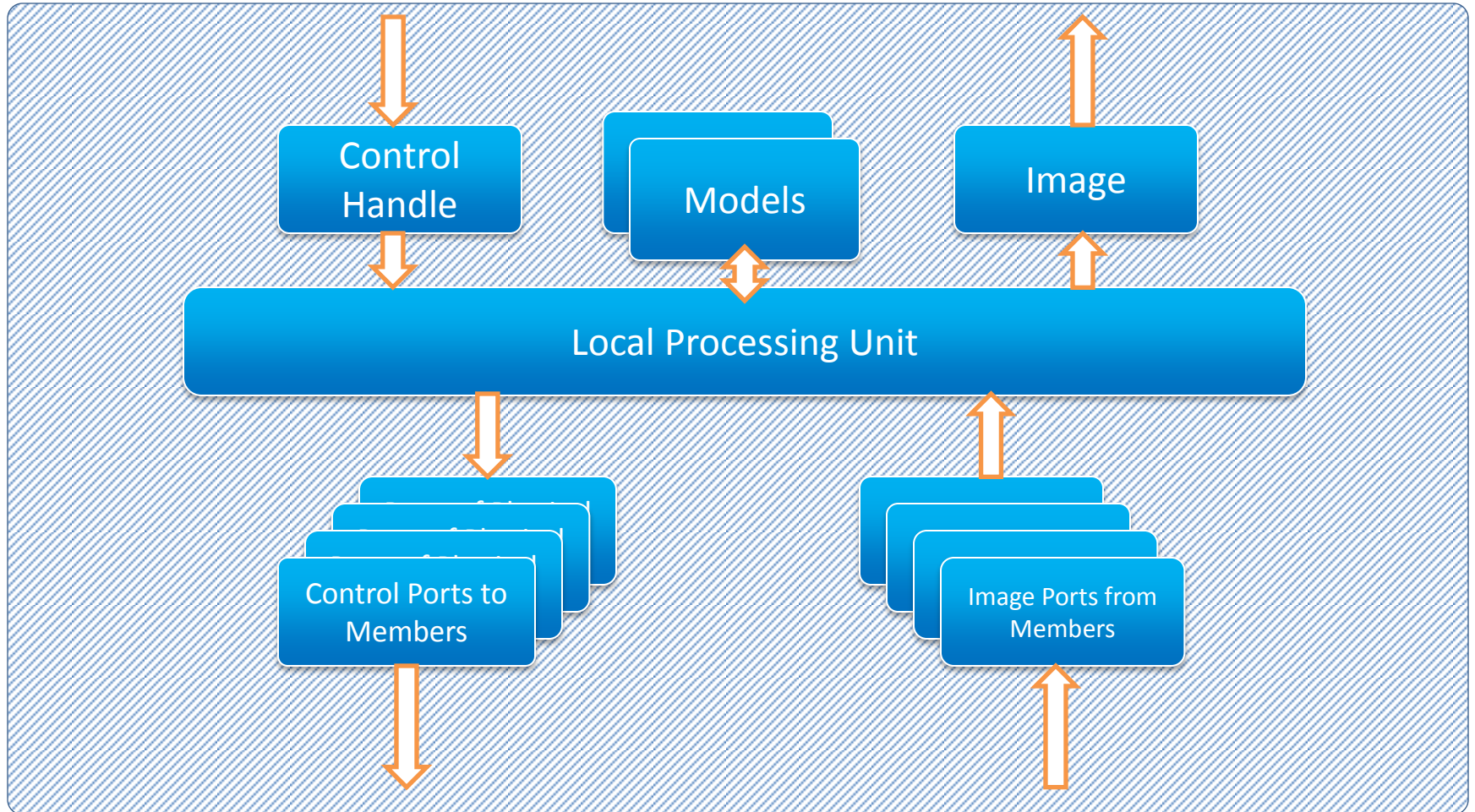


- Netlet Store
- Naming Service
- Search Service

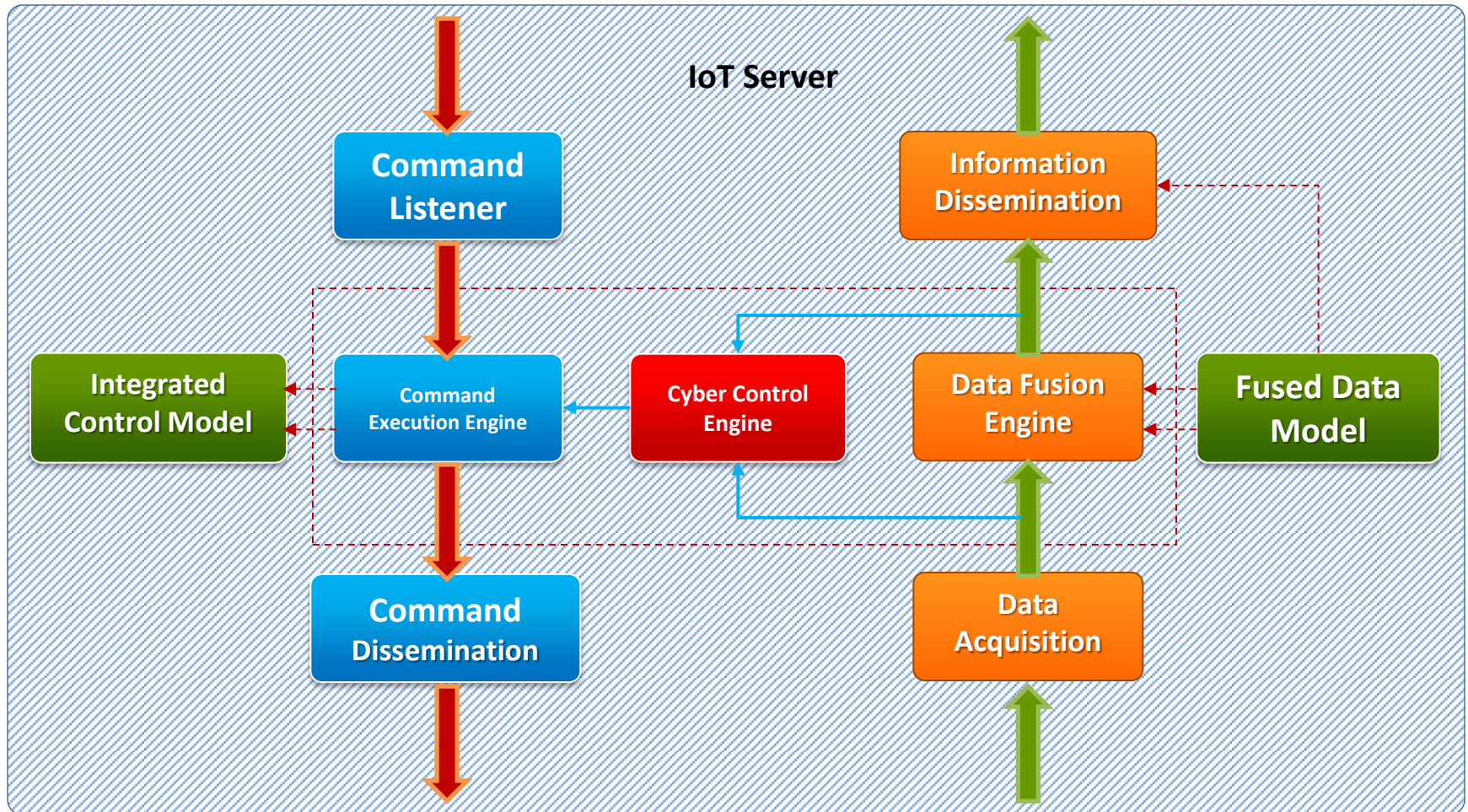
IoT Service



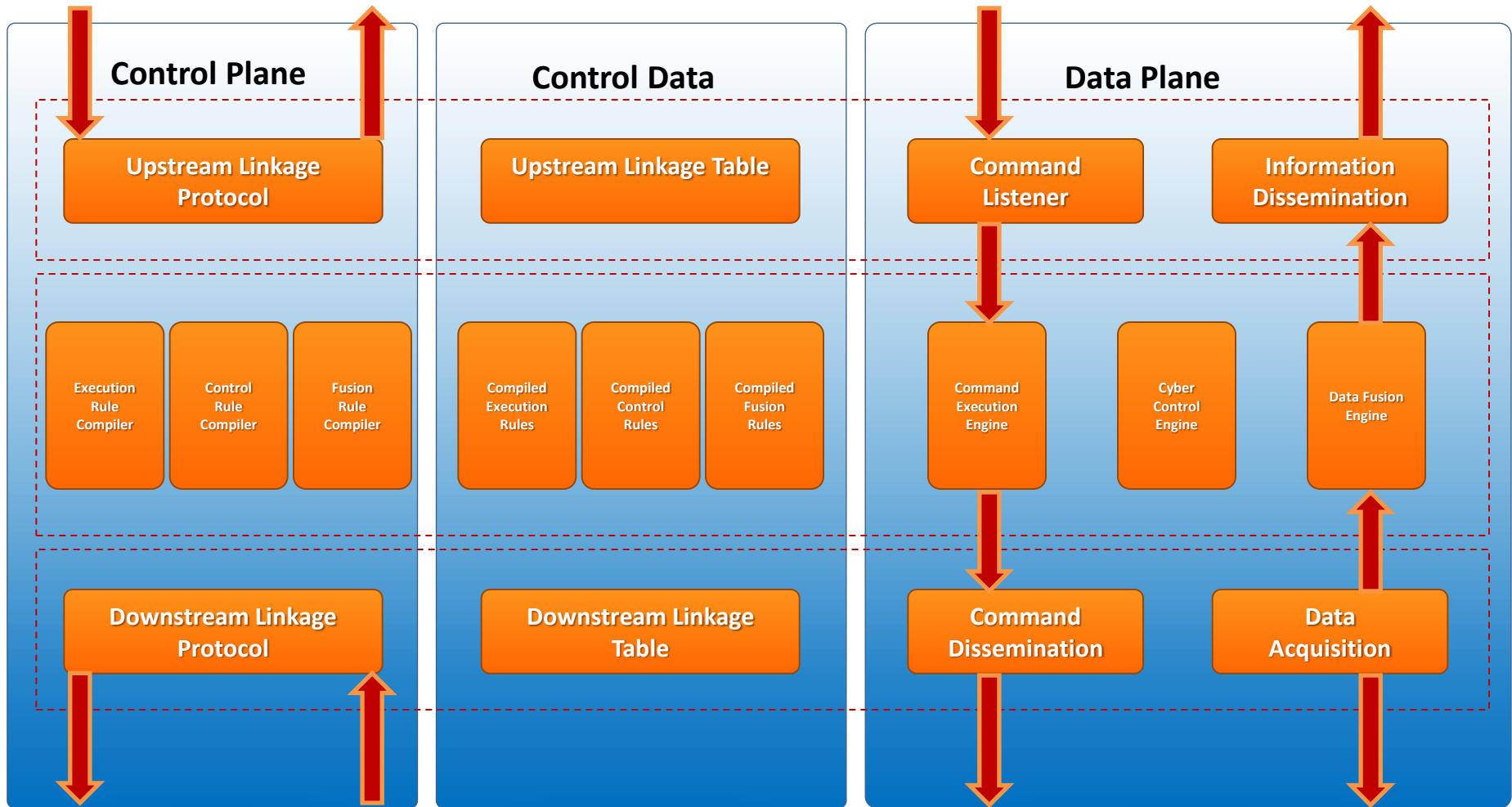
IoT Service Layer: Node Design



IoT Service Layer: Node Design



IoT Service Layer: Node Design Diagram



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.





Creating Smart Homes

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.





SOFTWARE



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.



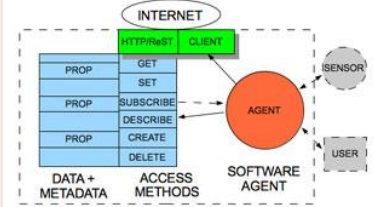
NIMBITS

Nimbits is an open source data server built on cloud computing architecture that provides connectivity among devices using data points.

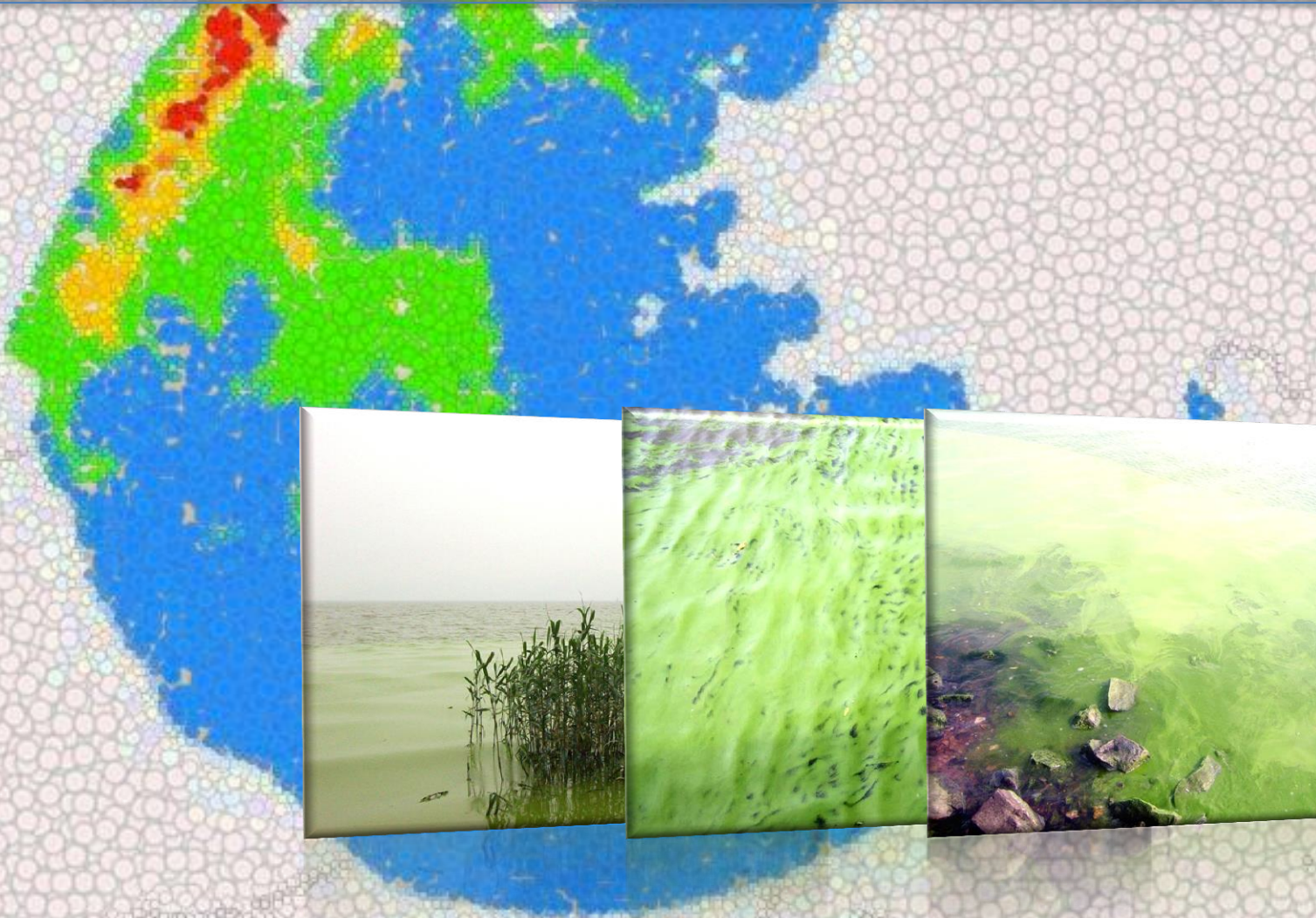
TOOLS FOR THE OPEN SOURCE INTERNET OF THINGS

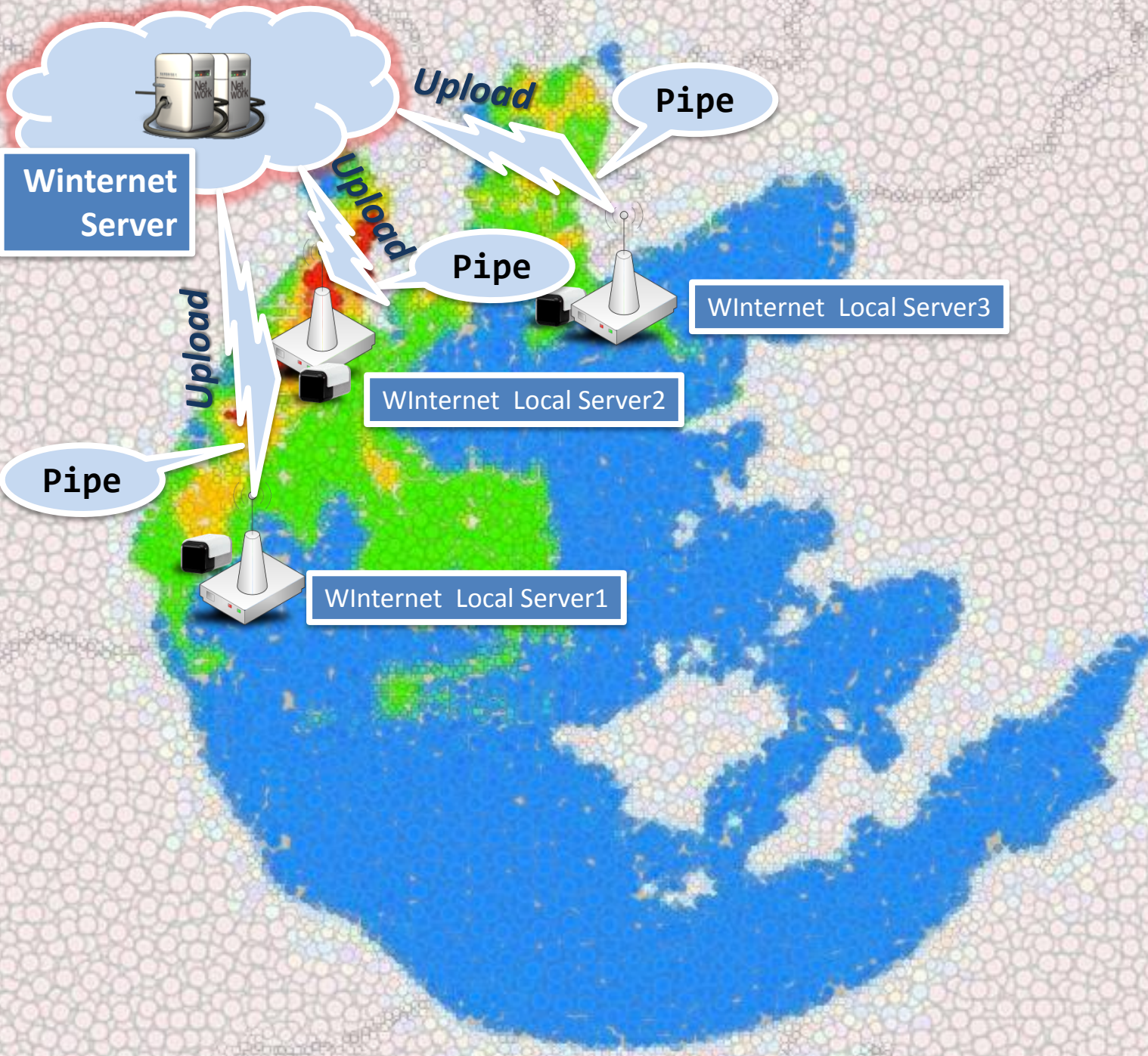
IOT TOOLKIT

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





Winternet Server

Upload

Pipe

Upload

Pipe

Winternet Local Server3

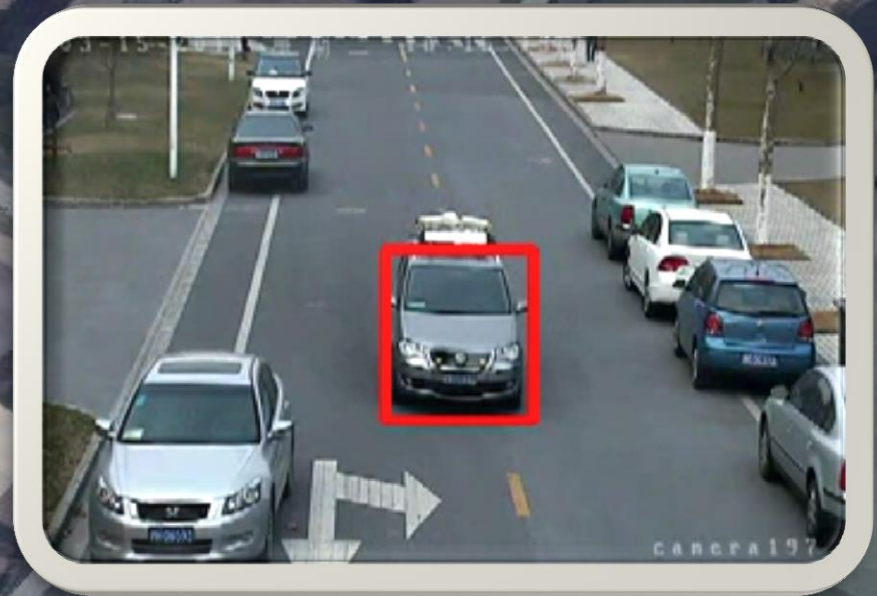
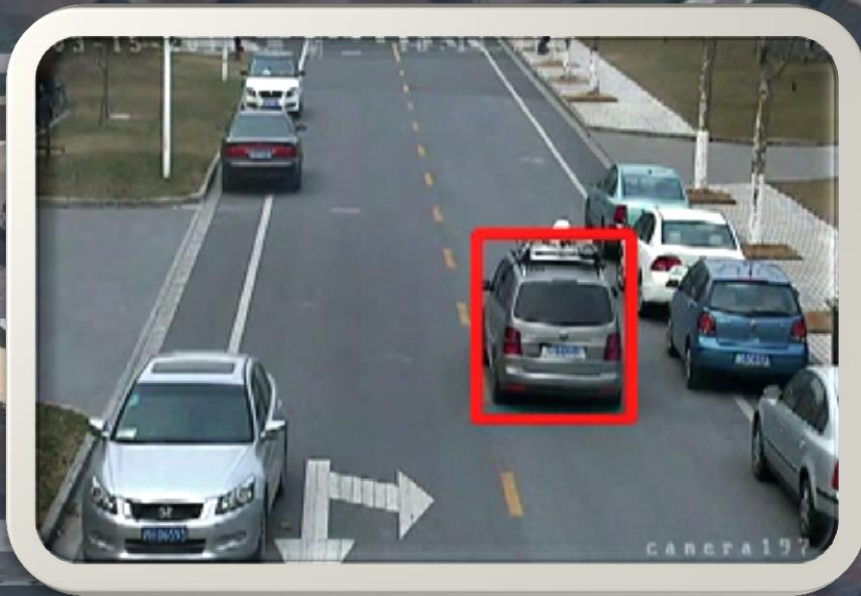
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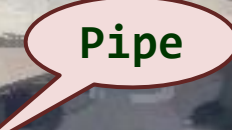
Winternet Local Server2

Pipe

Winternet Local Server1

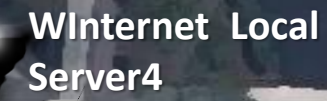
Collaborative Monitoring and Tracking Vehicles with Multiple Cameras Based on Winternet





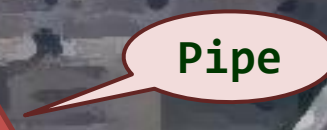
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A yellow text label indicating the direction of data flow.



Upload

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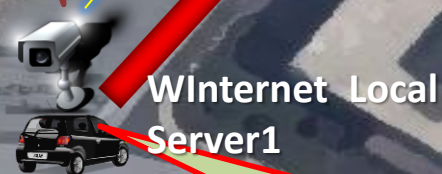
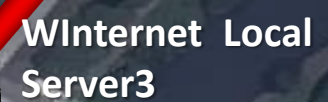
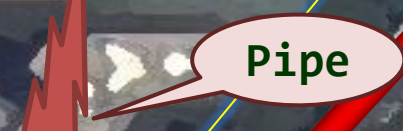
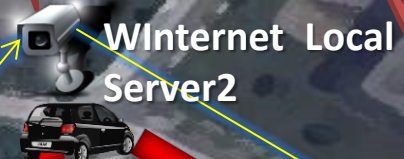


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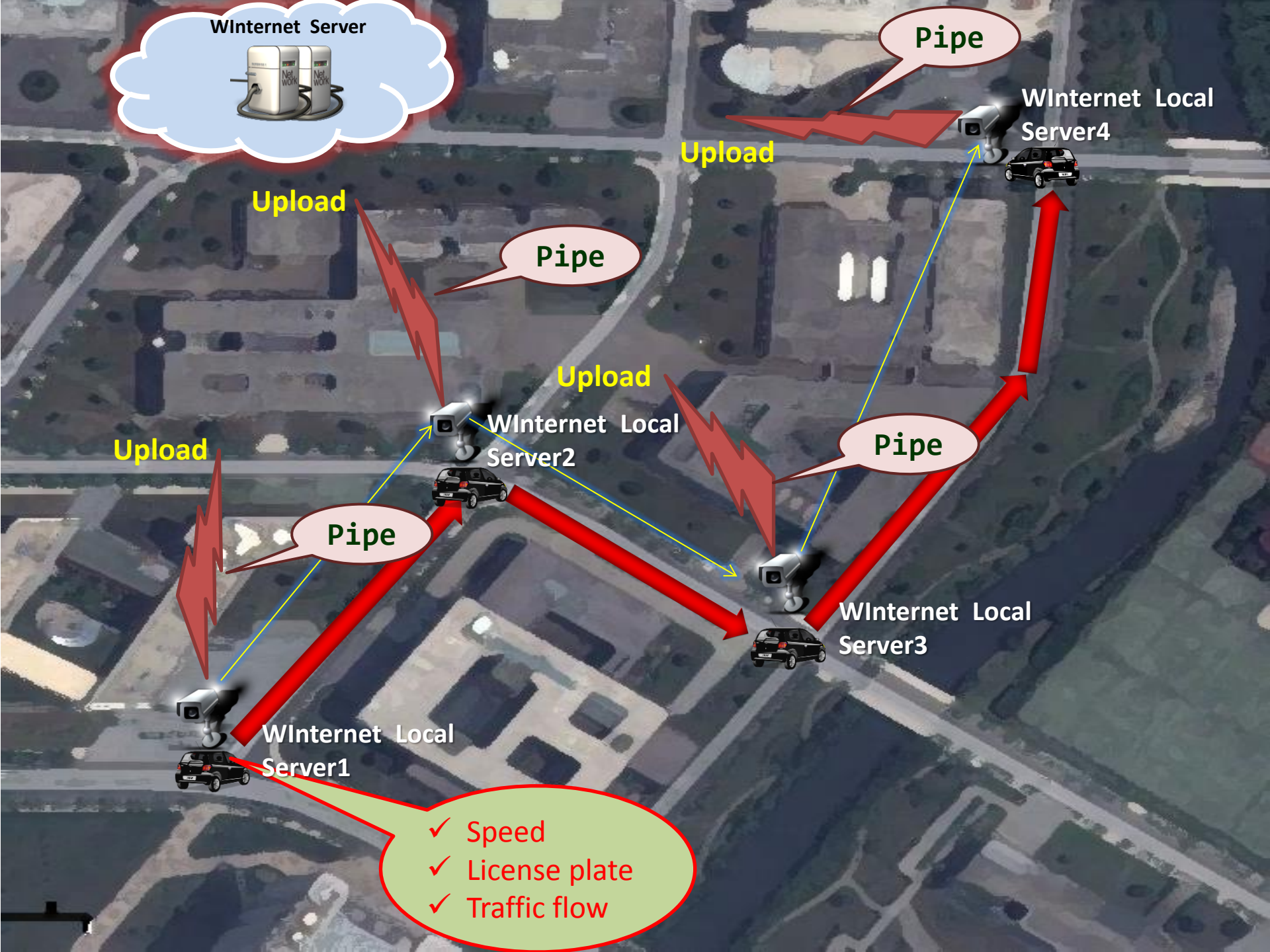
A yellow text label indicating the direction of data flow.

Upload

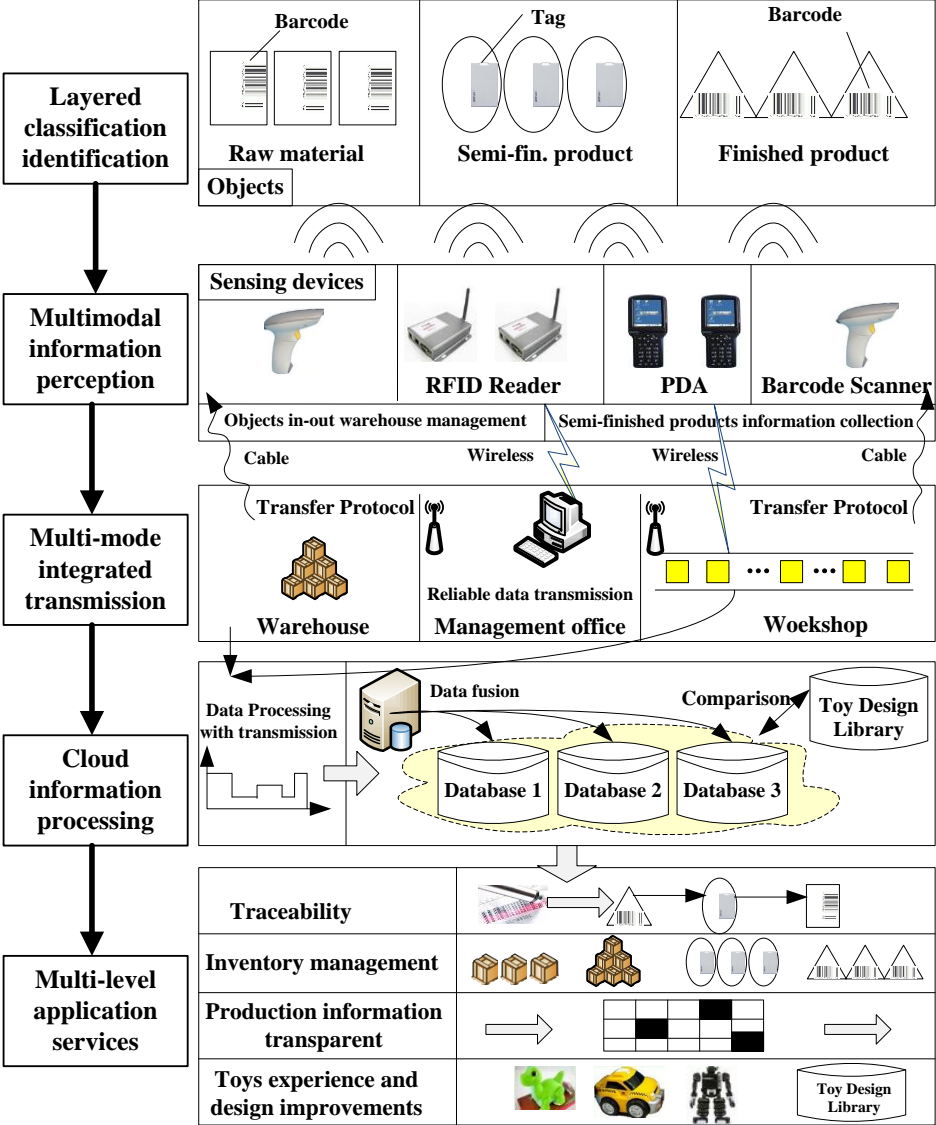
A yellow text label indicating the direction of data flow.



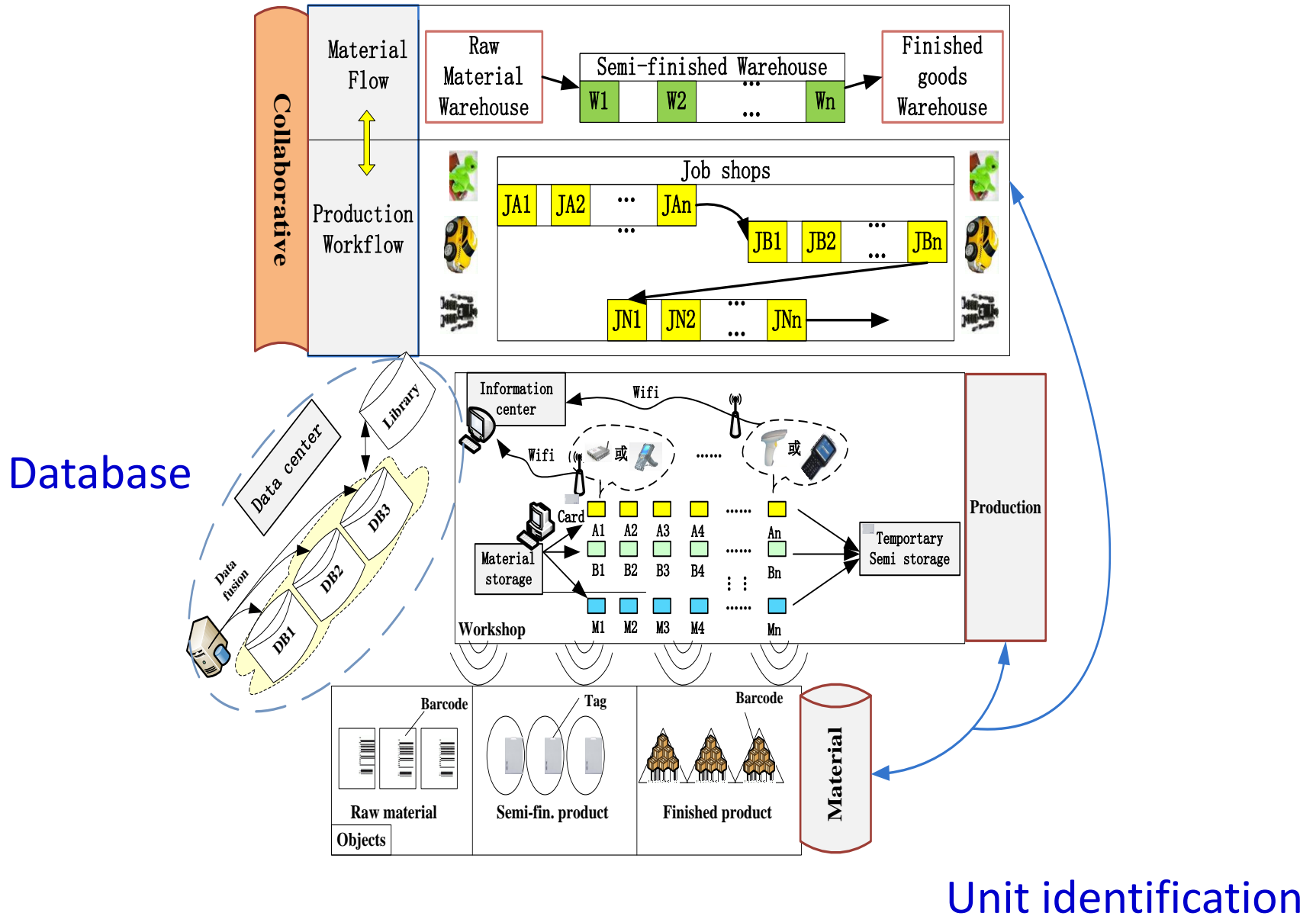
- ✓ Speed
- ✓ License plate
- ✓ Traffic flow



Material Tracking, Monitoring and Supervision in Toy Manufacturing



Collaborative Framework



Unit identification



Questions?