Internet-of-Things and Big Data: Promises and Challenges for the Developing World

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Outline

Internet-of-Things (IoT)

❖ *"The Internet of Things (IoT) is the interconnection of uniquely identifiable embedded computing devices within the existing Internet infrastructure".* (Source: Wikipedia)

❖ *"The Internet of Things is not a single, unified network of connected devices, but rather a set of different technologies which can be put to work in coordination together at the service and to the ultimate benefit of people in both developed and developing economies. This set of Internet of Things technologies is realizing a vision of a miniaturized, embedded, automated environment of devices communicating constantly and automatically".* **(**Source: ITU Secretary-General)
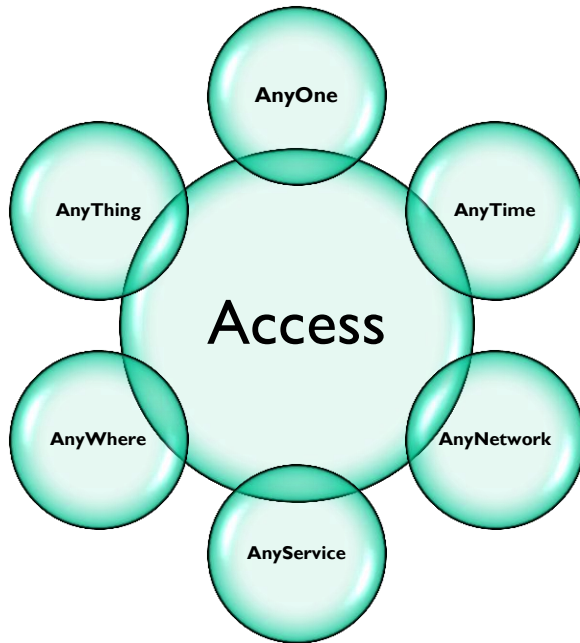
Promises

❖ Access:

- **AnyTime:**
  - Day
  - Night

- **AnyWhere:**
  - One the move
  - Indoors
  - Outdoors
  - Urban areas
  - Rural areas

- **AnyOne:**
  - Old/Young
  - Babies: born/unborn
  - Handicaped/Healthy
  - Illiterate/Literate
  - Male/Female

- **AnyThing:**
  - People
  - Objects
  - Data
  - Programs

- **AnyService:**
  - Pervasive service
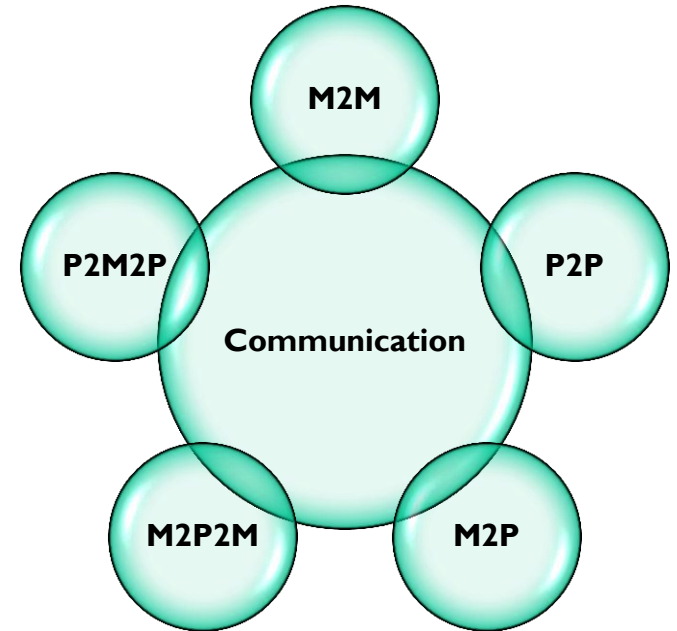 - Explicit service
  - Remote service
  - Local service

- **AnyNetwork:**
  - Multi protocol
  - Multi technologies
 - Multi OS

Promises

❖ Communication:

- Machine-to-Machine (M2M): E.g Washing machine communication with Tumble dryer in order to minimize power load
- Machine-to-People (M2P): Flower asking to be watered by the gardener.
- People-to-People (P2P): Traditional way with VoIP, emails, etc.

- People-in-the-middle(M2P2M): People mediating between smart objects.
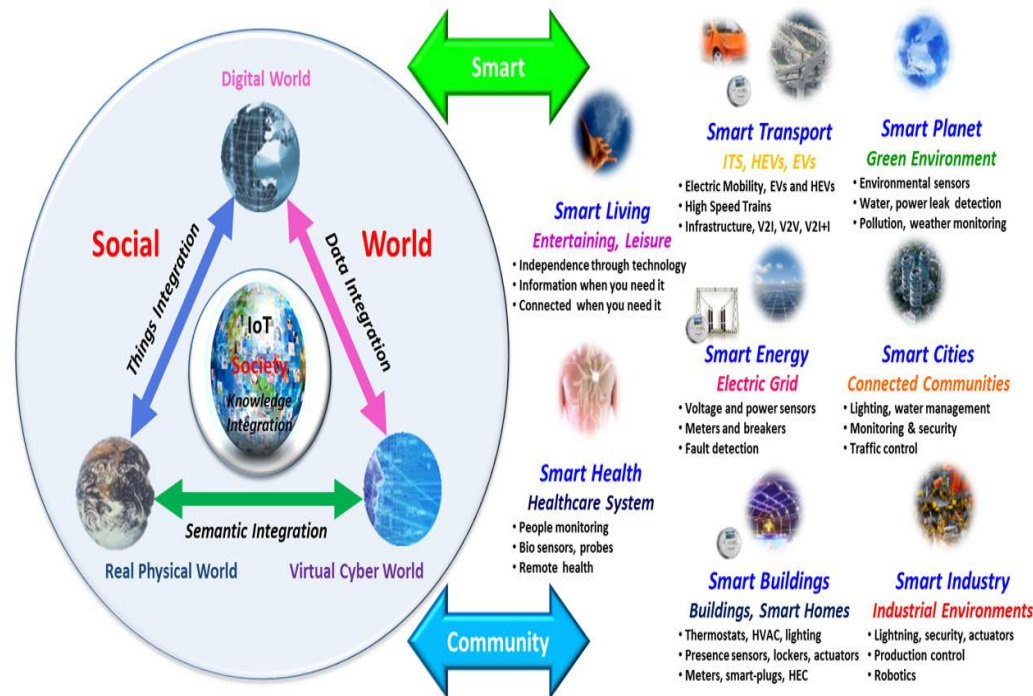- Machine-in-the-Middle (P2M2P): Smart object mediating between people.

What lies ahead

❖ A network of networks in cars, buildings, etc.
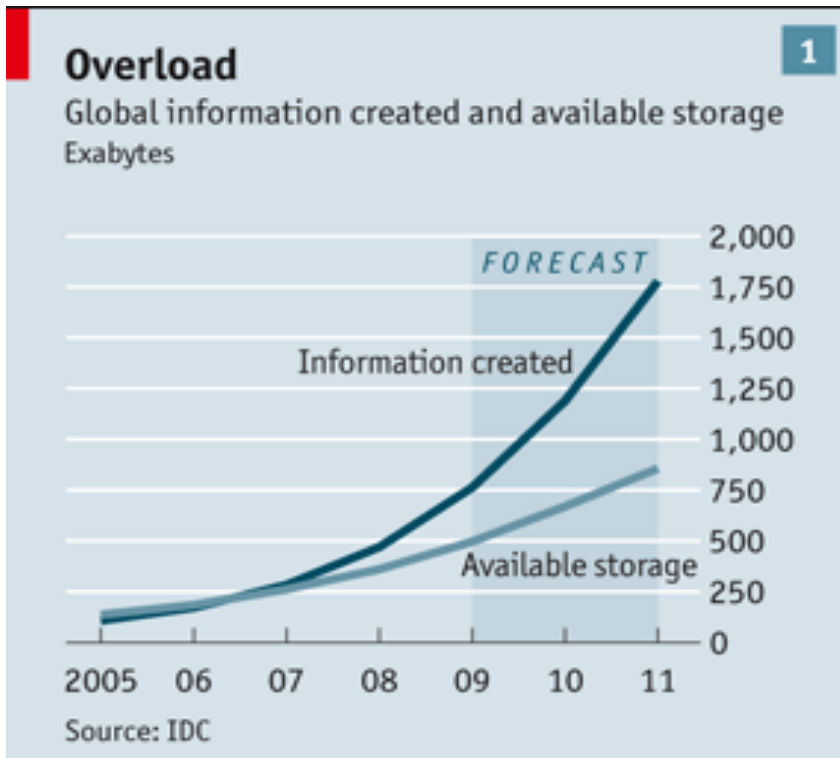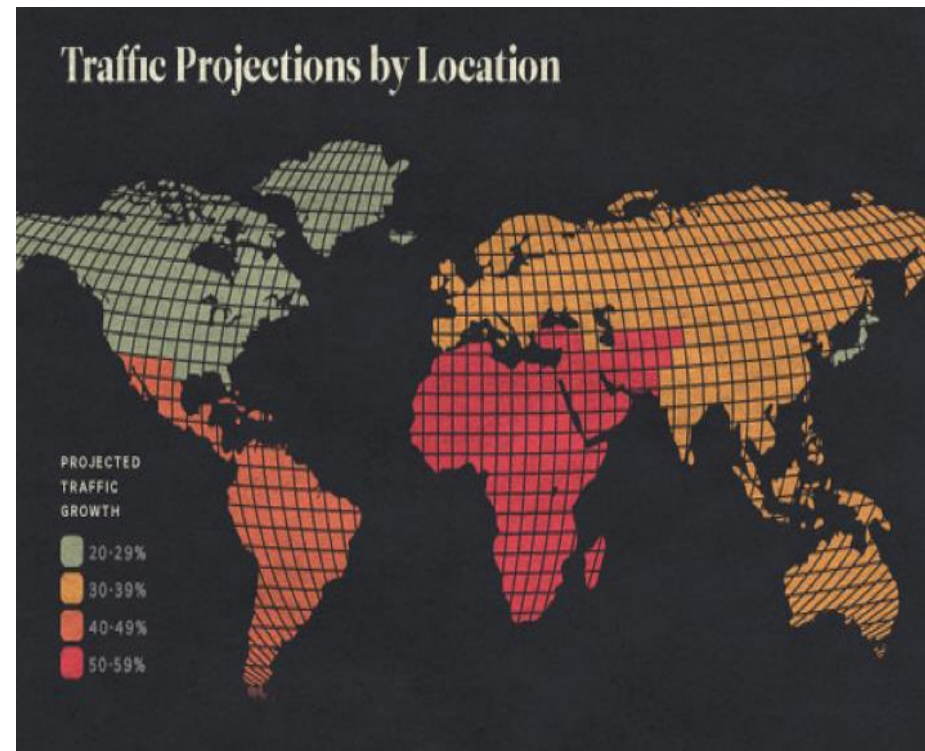❖ A smart world with smarter applications
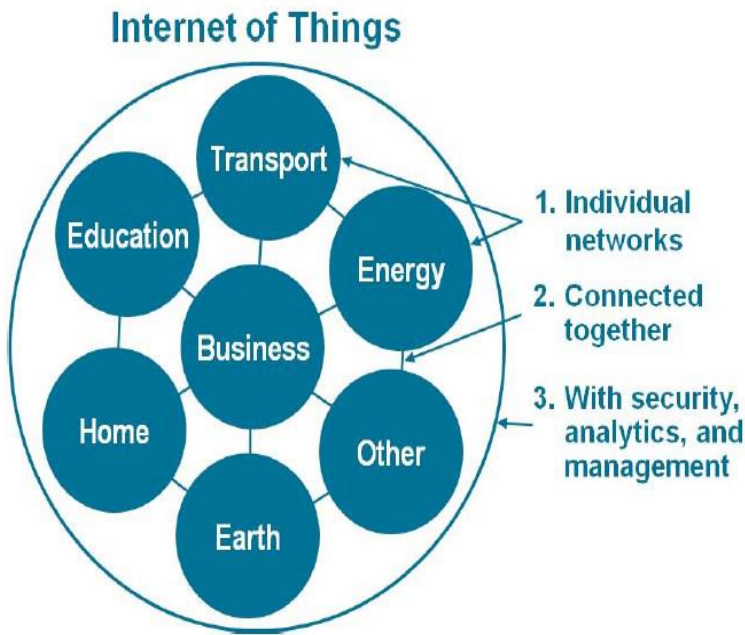
Source: Cisco IBSG

Source: River Pusblishers[1]

What lies ahead

❖ Big Data generated from sensor readings "Over Time" and/or based on given "Sampling Frequency".

❖ Big Data generated from sensor readings, mobile devices, call-in radio shows, information hotlines and kiosks, social networks and messaging systems, etc.

❖ More than 50% in Latin America, the Middle East and Africa between 2011 and 2015. 25-30% elsewhere.

Overload
Global information created and available storage
Exabytes

FORECAST

Information created

2,000
1,750
1,500
1,250
1,000
750
500
Available storage
250
0

2005 06 07 08 09 10 11

Source: IDC

Source: The Economist

Traffic Projections by Location

PROJECTED TRAFFIC GROWTH

20-29%
30-39%
40-49%
50-59%

Source: The Atlantic,

Implications

- ❖ IoT structure with core and en edge with access and fringe internet.
- ❖ IoT architecture with four layers: Device, Network, Service and Application Support, Application

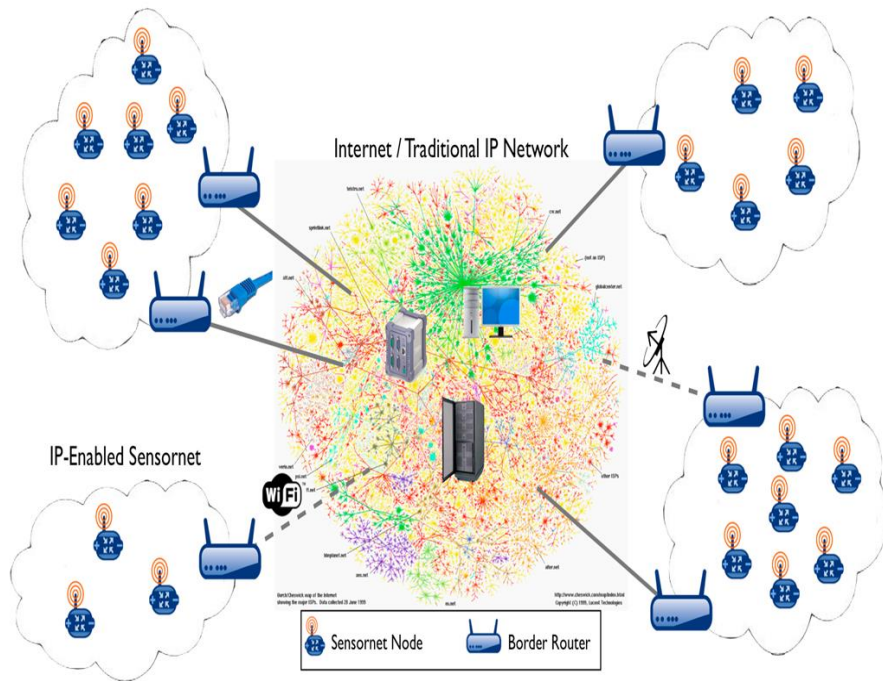## A new Internet Structure

Image Source: IPSO
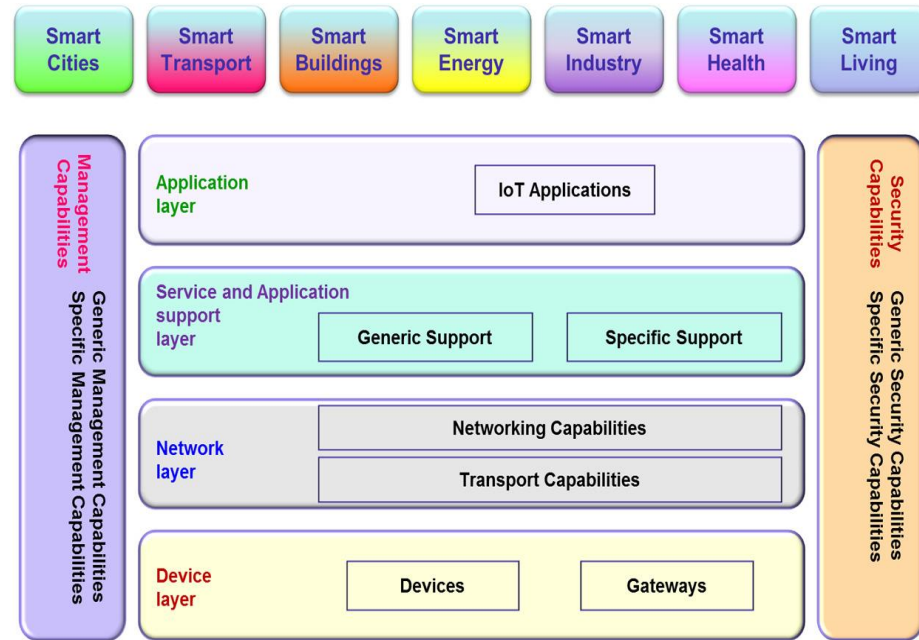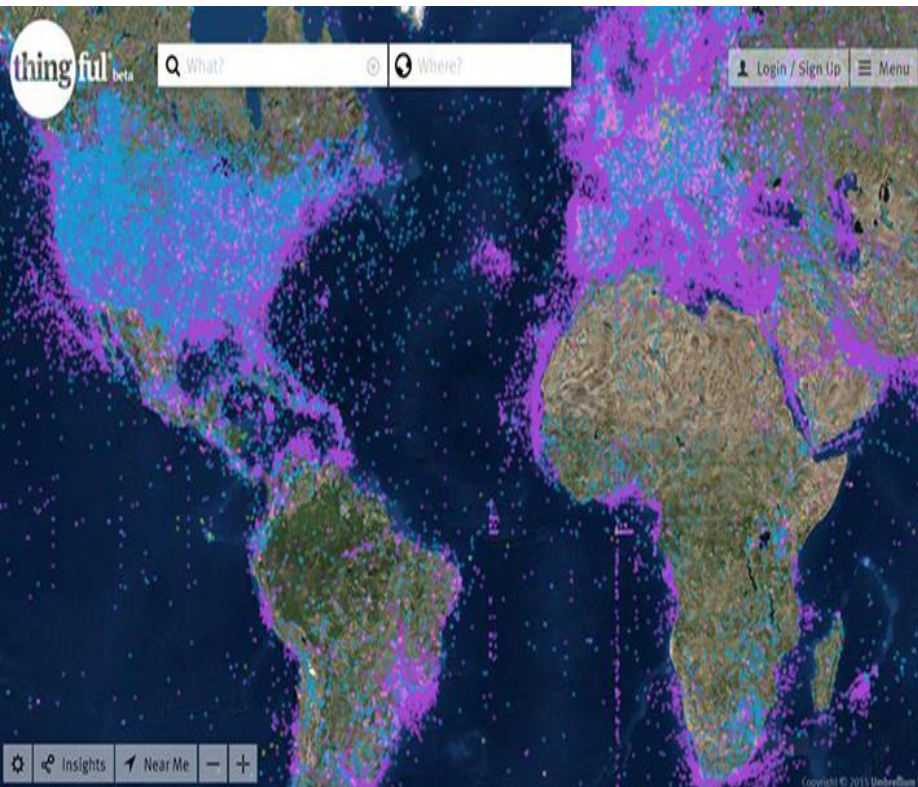
A new Internet Architecture

Image Source: ITU

Reality Check

- ❖ IoT Visibility Gap Between North and South.
- ❖ Low Big Data Networked Readiness Index in the South

IoT Visibility Gap

Source: https://www.thingful.net/

Networked Readiness Index
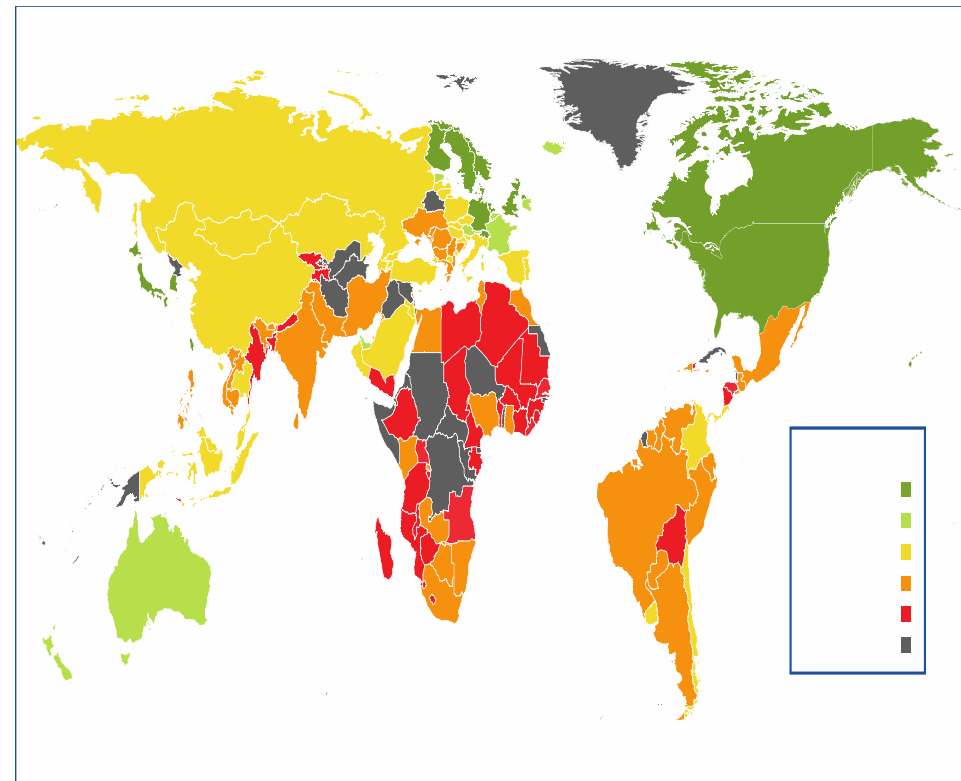
Source: 2014 World Economic Forum

Outline

1. **IoT and Big Data**
   - ❖ Emergence
   - ❖ Promises
   - ❖ What lies ahead
   - ❖ Implications
   - ❖ Reality check

2. **Challenges**
   - ❖ Technical/Policy
   - ❖ IoT4D Deployment
   - ❖ BD4D Deployment

3. **Achievements**
   - ❖ Capacity Building
   - ❖ Projects
   - ❖ Training

4. Conclusion

Challenges

❖ **Technical**
- Reliability
- Scalability
- Power
- Connectivity
- Cost
- Capacity
- Addressing: IPv6
- Innovation to boost local industry

❖ **Hybrid**
- Standards
- Interoperability
- Security
- Privacy
- Spectrum
- Bandwidth constraints

❖ **Policy**
- Data Localization
- Data Acess and/or Openness
- Legacy Regulatory Models
- Cross-border Traffic
- Governance
- Innovation in terms of localization

❖ Many of these challenges are known, some have been addressed and/or are being addressed at a rapid pace in the Developed world.

❖ There remains issues for the developing world.

Technical | Policy

Reliability
Scaling
Power
Connectivity
Cost
Capacity
IPv6

Standards
Interoperability
Security
Privacy
Spectrum & Bandwidth Constraints

Data Localization
Access to data/ Open data
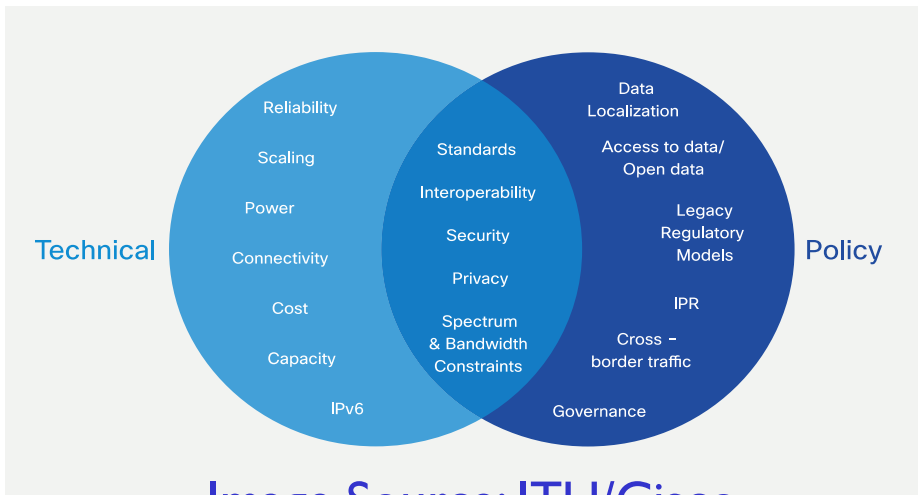Legacy Regulatory Models
IPR
Cross - border traffic
Governance

Image Source: ITU/Cisco

Challenges

❖ IoT deployment Challenges

- Lower cost of deployment: cost matters when resources are limited
- Long distance deployment: distances between villages may be quite long. Long range WSN using lower frequencies could be an option: e.g white space frequencies
- Sensor Interoperability: being able to mix sensors and software from different vendors is a wanted feature.
- Wireless Sensor openness: proprietary solutions could be an issue.
- Field deployment readiness: deployment may invove harsh environments
- Efficient Middleware Designs: adapted middleware to local needs is important.: e.g illiterate users

Challenges

❖ Big Data deployment Challenges
  ▪ Data Storage: Lightweight cloud computing on embeeded devices, mobile phones, desktop computers, etc.
  ▪ Data Dissemination:
    ○ Models: Realtime or Opportunistic
    ○ Technologies: Internet, Drones or Other
    ○ Access to Data: Data trasnfert (Globus tools) or Software migration (Docker systems)
  ▪ Efficient Middleware Designs:
    ○ Exclusion avoidance: Handicaped learners/people
    ○ Litteracy issue: focus on voice rather than written reporting
    ○ Localization: local laguanges, practices, etc.

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   ❖ Projects
   ❖ Training
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Achievements

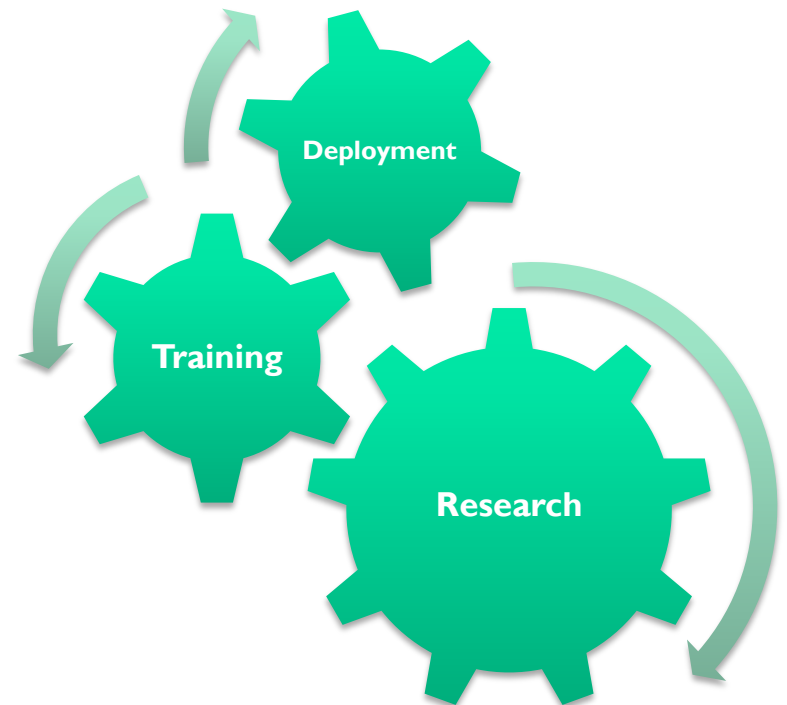❖ A three dimensional capacity building model targeting

- Research through
  - Academic publications
  - Books publications
  - Technology observations
  - Innovation but in the Open source
- Hands-on Training in
  - Wireless communication
  - Internet-of-Things
- Deployment
  - After Training
  - Training independent
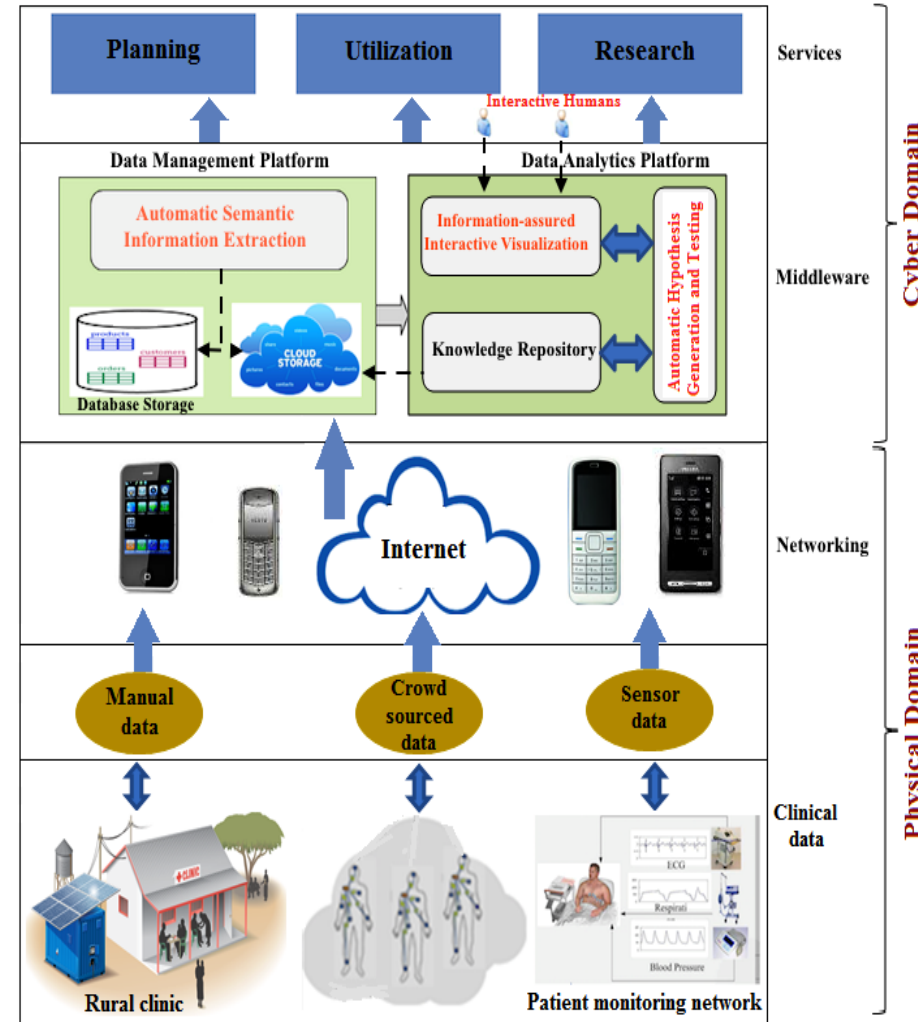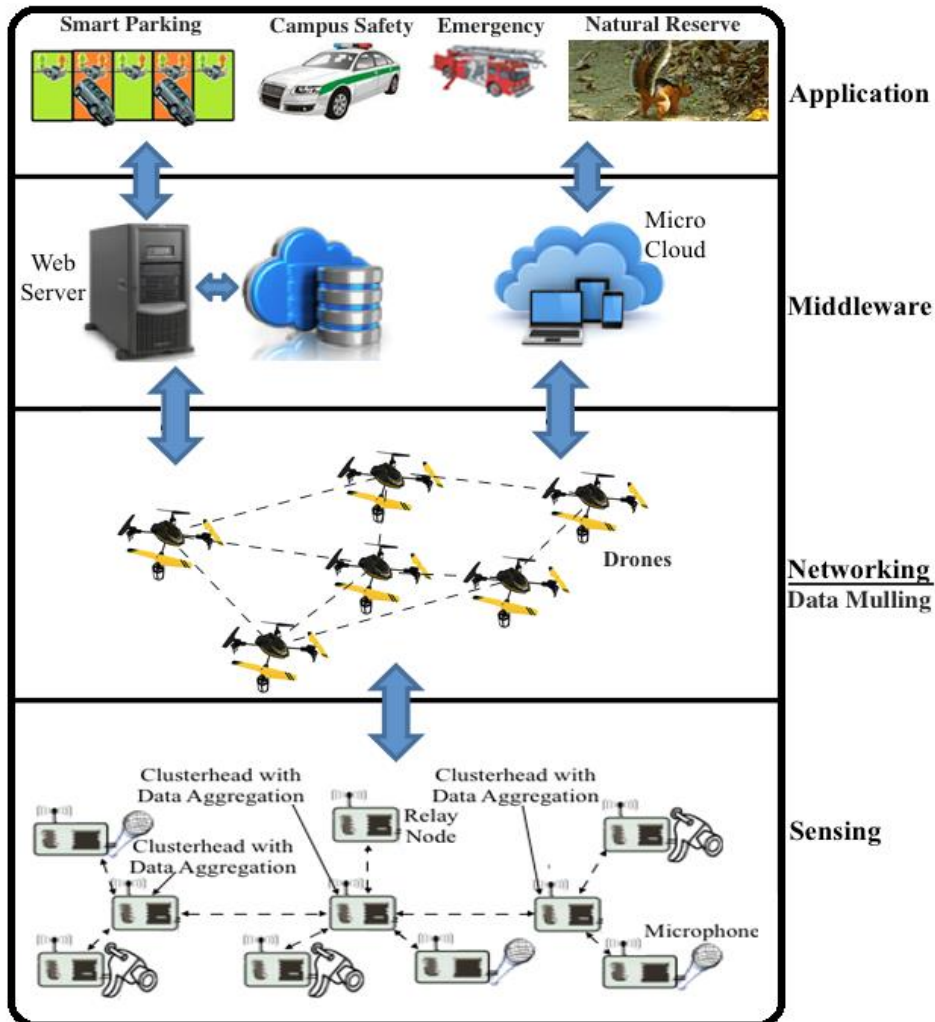
Achievements

❖ Projects

- Robotic:
  - o Underground Mining Safety using Gas Sensors, RFID and Robots.
  - o IoT-in-Motion Platform for for Cooperative Data Mulling and Sensing using drones and ground-based sensors.

- Mobile learning:
  - o Mobile learning platforms for handicapped learners
  - o Mobile learning platforms for the deaf community
  - o Mobile learning platform for knowledge exchange: telegram robots

- Community Cloud Computing:
  - o Lightweight cloud computing for drought mitigation
  - o Lightweight cloud computing for Public health

- Cyber Healthcare:
  - o Big Data for Bioinformatics
  - o Patient Prioritizations
  - o Medical Decision Support

- Many Others: Smart Energy, Pollution Monitoring, Public Safety, etc.

Internet of Things Platforms

IoT in Motion

Cyber-Healthcare

Achievements

❖ Trainings

- South Africa: IoT for public safety

- Benin: IoT for pollution monitoring

- Kenya: IoT for weather monitoring

- Ghana: IoT for pollution monitoring

- Malawi: IoT for water quality monitoring

- Rwanda: IoT for tea management

- DRC: IoT for pollution monitoring

- Senegal: IoT for smart cities

- Many workshops iat ICTP/Trieste in Italy

- Current trainings in
  o Big Data
  o IoT-in-Motion

Conclusion

❖ IoT and Big Data are a great opportunity for developing countries to leapfrog from scientifically disadvantaged nations into technology advanced nations.

❖ They may help closing the technology gap and boost scientific progress as they can help build and expand a knowledge society.

❖ They can, however, become a curse for developing nations if they are not adapted and deployed based on local needs and constraints.

❖ What is needed for developing nations is
- Efficient capacity building and adapted IoT and Big Data deployment models.
- A strong willingness to use the technologies for the improvement of people safety, wellness, protection of the environment and resilience to natural and man-made disasters.
- Moving research from proof-of-concept to the local industry: innovation.
- Designing regulations and policies which are adapted for local needs and constraints.

Reference

[1] O. Vermesan & P. Friess, "Internet of Things – From Research and Innovation to Market Deployment", Rivers Publishers 2014, ISBN: 978-87-93102-94-1