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

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Outline

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

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

3. Achievements
   - Capacity Building
   - Projects
   - Training

4. Conclusion
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
    - Handicapped/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
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.

Source: The Economist

Source: The Atlantic,
Implications

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

A new Internet Structure

A new Internet Architecture
Reality Check

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

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

Source: 2014 World Economic Forum
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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 Access 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.

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 involve 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 embedded devices, mobile phones, desktop computers, etc.
- **Data Dissemination:**
  - Models: Realtime or Opportunistic
  - Technologies: Internet, Drones or Other
  - Access to Data: Data transfer (Globus tools) or Software migration (Docker systems)
- **Efficient Middleware Designs:**
  - Exclusion avoidance: Handicapped learners/people
  - Literacy issue: focus on voice rather than written reporting
  - Localization: local languages, practices, etc.
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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:
    - Underground Mining Safety using Gas Sensors, RFID and Robots.
    - IoT-in-Motion Platform for Cooperative Data Mulling and Sensing using drones and ground-based sensors.
  - Mobile learning:
    - Mobile learning platforms for handicapped learners
    - Mobile learning platforms for the deaf community
    - Mobile learning platform for knowledge exchange: telegram robots
  - Community Cloud Computing:
    - Lightweight cloud computing for drought mitigation
    - Lightweight cloud computing for Public health
  - Cyber Healthcare:
    - Big Data for Bioinformatics
    - Patient Prioritizations
    - Medical Decision Support
  - Many Others: Smart Energy, Pollution Monitoring, Public Safety, etc.
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 at ICTP/Trieste in Italy
  - Current trainings in
    - Big Data
    - 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.