IoT challenges

State of the art

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August 6, 2019

Outline

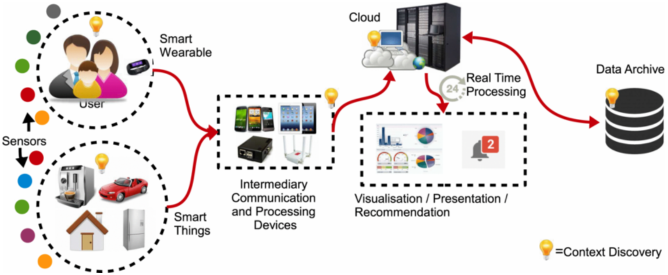

Figure 1: IoT platform.

Figure 2: IoT challenges.

Problematic

Where is the problem ?

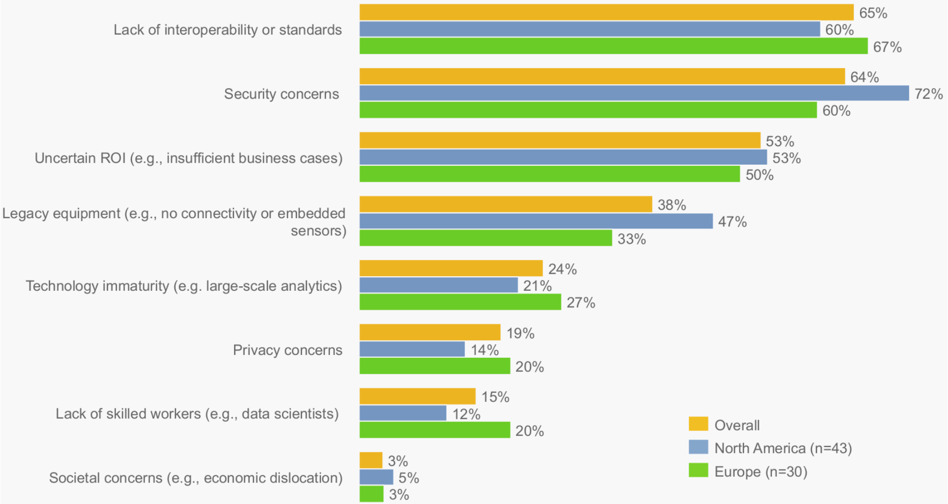

Figure 3: Key barriers in adopting the Industrial Internet [**industrialinternetofthings_executive_**].

Problematic

Where is the problem ?

- Some network configuration are static and not adptive to the application
  - Decision and optimisation problem..
  - Various network acces
  - Various configuration of each network acces
  - Lake of selection tools
- Users have to select the network and the application
  - How to select the **best** network.
  - How to select the network required by the application.

Context

Introduction

- IoT Applications
  - Health care
  - **Transportation**
  - Industry
  - Market
  - Scool
  - Vehicles
  - Smart Home
  - Agriculture

Figure **??**: IoT Applications

Problematic

Where is the problem [2] ?

Bandwidth (*BW*) Spreading Factor (*SF*) Coding Rate (*CR*) Transmission Energy (*Tx*) Receiver Sensitivity (*RS*) Signal Noise Rate (*SNR*) Data Rate (*DR*) ,Air Time (*AT*)

Setting	**Values**	**Rewards**	**Cost**
BW	7.8 ➠ 500kHz	*DR*	*RS*, Range.
SF	2^6 ➠ 2^{12}	*RS*, Range	*DR*, *SNR*, longer packets, *Tx*.
CR	$4/5$ ➠ $4/8$	Resilience	longer packets, *Tx*, *AT*.
Tx	-4 ➠ 20dBm	*SNR*	*Tx*

Table 1: [1]

Technical choice

Implementation

- ZOLERTIA RE-MOTE
  - Low consumption component
  - ADC port for placing sensors on it
- CONTIKI OS
  - Operating system for wireless and low power development
  - Support for newer standards (6LowPAN, RPL, CoAP, MQTT)
- 6LowPAN
  - Based on IPv6 and IEEE 802.15.4
  - IPv6-based network with low power consumption
  - Ability to create a mesh network
- Sending packages
  - UDP in the 6LowPAN network
  - MQTT between the cloud platform and the router

Motivations

Who & why cares with such problems ?

- ➠ a
  - ➠ Lake of selective tools
  - ➠ How to select the **best** access point
- QoS Analysis
  - ➠ a
  - ➠ Lake of selective tools
  - ➠ How to select the **best** access point
- Threats
  - ➠ a
  - ➠ Lake of selective tools
  - ➠ How to select the **best** access point

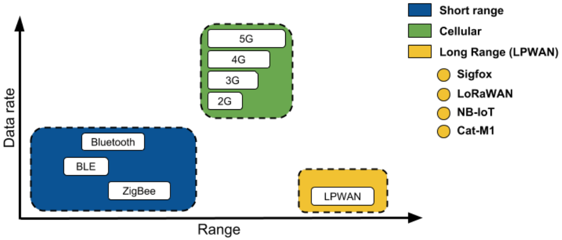

Figure 4: Communication diversity.

Goal

What is the goal ?

-
    - Allow heterogeneous network to communicate
    - QoS Analysis
    - Threats
- How to select the **best** access point
    - Allow heterogeneous network to communicate
    - QoS Analysis
    - Threats

Figure 5: wsn-IoT.

Goal

What is the goal ?

-
  - Allow heterogeneous network to communicate
  - QoS Analysis
  - Threats
- How to select the **best** access point
  - Allow heterogeneous network to communicate
  - QoS Analysis
  - Threats

Figure 5: wsn-IoT.

Map the network to service requirement ?

Challenges

Where is the difficulty ?

- Reasonable and acceptable delay before the decision appears.
- Cope with the different view points and goals of the operators and the users.
- React to the changing environment conditions.
- Allow any type of inputs and to be applicable to any type of ANs.
- Handle the increasing number of RATs and the large number of criteria.

Contributions

Contributions

- Use cases (Requirements)
  - Smart building: Videos, Voice, Text.
  - Smart trafic: Videos, Voice, Text
- Environnements
  - Rural/Urban
  - Static/Mobile
  - Tempirature
- Senarios
  - For each application protocol (MQTT, COAP, XMPP)
  - For each network protocol (Start, Mesh)
  - For each MAC protocol (LoraWan, Sigfox, ...)
- Algorithms
  - Input:
    - Service QoS metrics requiremnts
    - MAC configuration (SF, CR, BW, ...)
    - Network QoS metrics
  - Method:
    - MADM, Game, Neural
  - Outputs:
    - Ranked networks

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$\boxed{\text{Theoretical, Simulation \& Real environnement}}$

Outline

Outline

1. Introduction

2. First contribution

3. Conclusion

1. Related work
2. Contagion process
3. Experimentation
4. Results exploitation
5. Discussion

Outline

Related work

Comparison

Paper	A1	A2	A3	A4

Table 2: An example table.

Related work

Comparison

Paper	A1	A2	A3	A4

Table 3: An example table.

Outline

Multi-Armed-Bandit Algorithm
Methods

- Arms: K = 1, ... , K
- Decision: T = 1, ... , T
- Reward: X_t^k with μ_t^k = E $[X_t^k]$
  - Best reward: X_t^* with μ_t^* = max μ_t^k, k∈K

Genetic Algorithm

Methods [**alkhawlani_access_2008a**]

- Heterogeneous wireless network: (RAT 1 ,RAT 2 ,...,RAT n)
- Criteria up to i (c 1 ,c 2 ,...,c i) the operators, the applications, and the network conditions.
-
- The different sets of scores (d 1 , d 2 ,...,d i) are sent to the MCDM in the second component.
- GA component assigns a suitable weight (w 1 ,w 2 ,...,w i)

$$V(s,\pi) = \mathbb{E}_s^{\pi}\left(\sum_{k=0}^{\inf} \gamma^k \cdot r(s_k, a_k)\right), s \in \mathbb{S} \tag{1}$$

$$r(s_k, a_k) = G_k \cdot PRR(a_k) \tag{2}$$

$$\pi^* = \arg\max_{\pi} V(s,\pi) \tag{3}$$

$$PRR = (1 - BER)^L \tag{4}$$

$$BER = 10^{\alpha e^{\beta SNR}} \tag{5}$$

Marcov chain
Methods

HGHGJ

$$V(s,\pi) = \mathbb{E}_s^{\pi}\left(\sum_{k=0}^{\inf} \gamma^k \cdot r(s_k, a_k)\right), s \in \mathbb{S} \quad (1)$$

$$r(s_k, a_k) = G_k \cdot PRR(a_k) \quad (2)$$

$$\pi^* = \arg\max_{\pi} V(s,\pi) \quad (3)$$

$$PRR = (1 - BER)^L \quad (4)$$

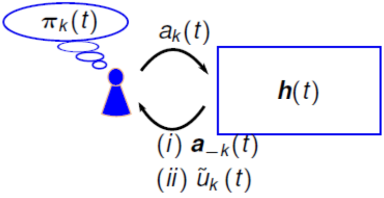
$$BER = 10^{\alpha e^{\beta SNR}} \quad (5)$$

Marcov chain

Methods

Learning Iterative Steps:

- **Choose** action $a_k(t) \sim \pi_k(t)$.
- **Observe** game outcome, e.g.,
  $\boldsymbol{a}_{-k}(t)$
  $u_k(a_k(t), \boldsymbol{a}_{-k}(t))$.
- **Improve** $\pi_k(t+1)$.



Thus, we can expect that: $\forall k \in \mathcal{K}$,

$$\pi_k(t) \xrightarrow{t \to \infty} \pi_k^* \tag{1}$$

$$\bar{u}_k\left(\pi_k(t), \pi_{-k}(t)\right) \xrightarrow{t \to \infty} \bar{u}_k\left(\pi_k^*, \pi_{-k}^*\right) \tag{2}$$

where, $\pi^* = (\pi_1^*, \ldots, \pi_K^*)$ is a NE strategy profile.

Figure 6: .

Genetic Algorithm

Methods

-
- S = SF12, BW125, 4/8, 17 dBm
- Input:
  - Problem: f(x) = max(x^2), x ∈[0,32]
    - $x_1 : 01101_b$
    - $x_2 : 11000_b$
    - $x_3 : 01000_b$
    - $x_4 : 10011_b$
- Method: Genetic algorithm
  - Generate a set of random possible solution
  - Test each solution and see how good it is (ranking)
    - Remove some bad solutions
    - Duplicate some good solutions
    - Make small changes to some of them (Crossover, Mutation)
- Output:
  - x_1: 01101 (169) (14.4)
  - x_2: 11000 (576) (49.2)
  - x_3: 01000 (64) (5.5)
  - x_4: 10011 (361) (30.9)

Game theory
Methods

- Players: $K = \{1, ..., K\}$
- Strategies: $S = S_1 \times \ldots \times S_K$
  - S_k is the strategy set of the k^{th} player.
- Rewards: $u_k : S \longrightarrow R_+$ and is denoted by $r_k(s_k, s_{-k})$
  - $s_{-k} = (s_1, \ldots, s_{k-1}, s_{k+1}, \ldots, s_K) \in S_1 \times \ldots \times S_{k-1} \times S_{k+1} \times \ldots \times S_K$

... (step 2)

Methods

... (step 3)

Methods

➠

➠

... (step 4)

Methods

➠

➠

Results

Comparison

Table 4

Outline

Experimentation

Experimentation

- a
- b

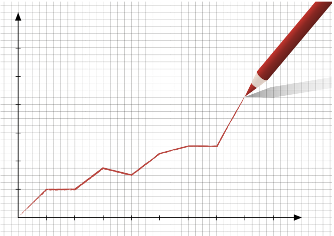


Figure 7: .

Outline

Results

Comparison

- a
- b

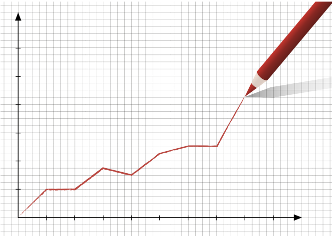


Figure 8: .

Outline

Discussion

- a
- b

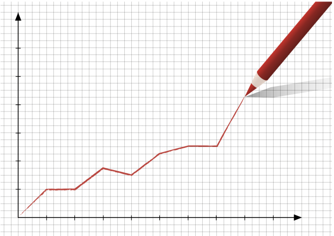


Figure 9: .

Outline

Conclusion

Our main goal was

-
-

Our main contribution was

-
-

Our main results was

-
-

Future Challenges
Conclusion

Our future goal was

-
-

Future Challenges
Conclusion

Our future goal was

-
-

Thank you !

References

[1] Marco Cattani, Carlo Boano, and Kay Römer. "An Experimental Evaluation of the Reliability of Lora Long-Range Low-Power Wireless Communication". In: *Journal of Sensor and Actuator Networks* 6.2 (2017). 00042, p. 7 (p. 7).

[2] B. Di Martino et al. "Internet of Things Reference Architectures, Security and Interoperability: A Survey". In: *Internet of Things* 1-2 (Sept. 2018). 00006, pp. 99–112 (p. 7).