IoT challenges

State of the art

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Outline

Context

What is IoT ?

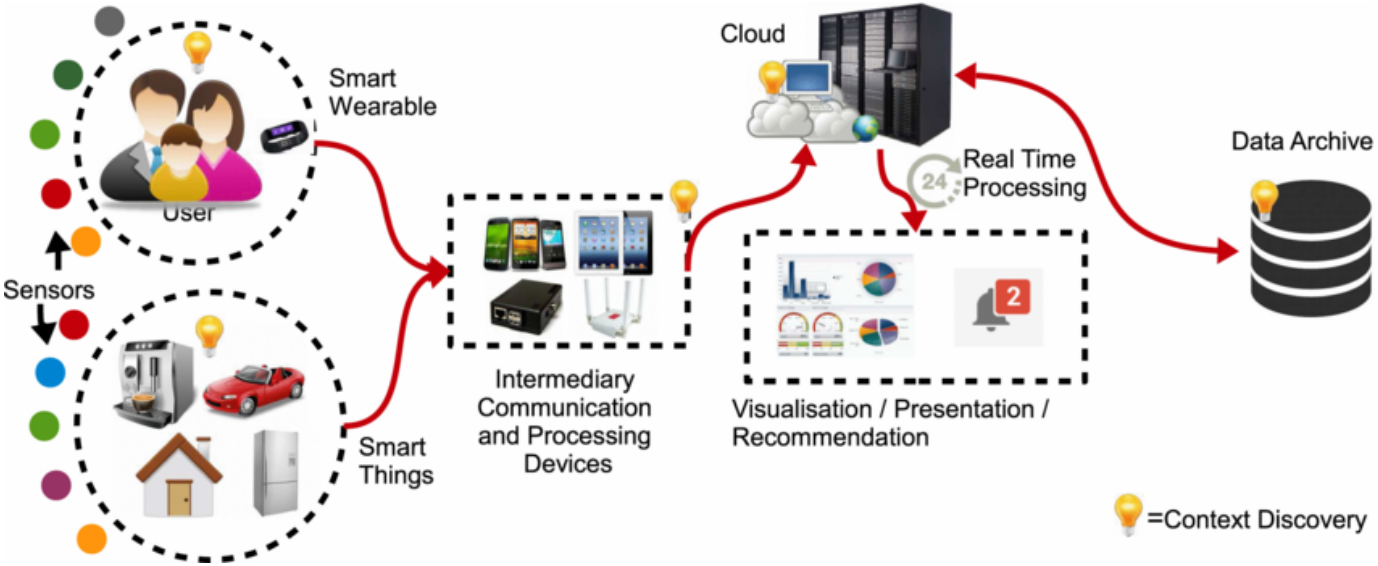

Figure 1: IoT platform.

Figure 2: IoT challenges.

Problematic

Where is the problem ?

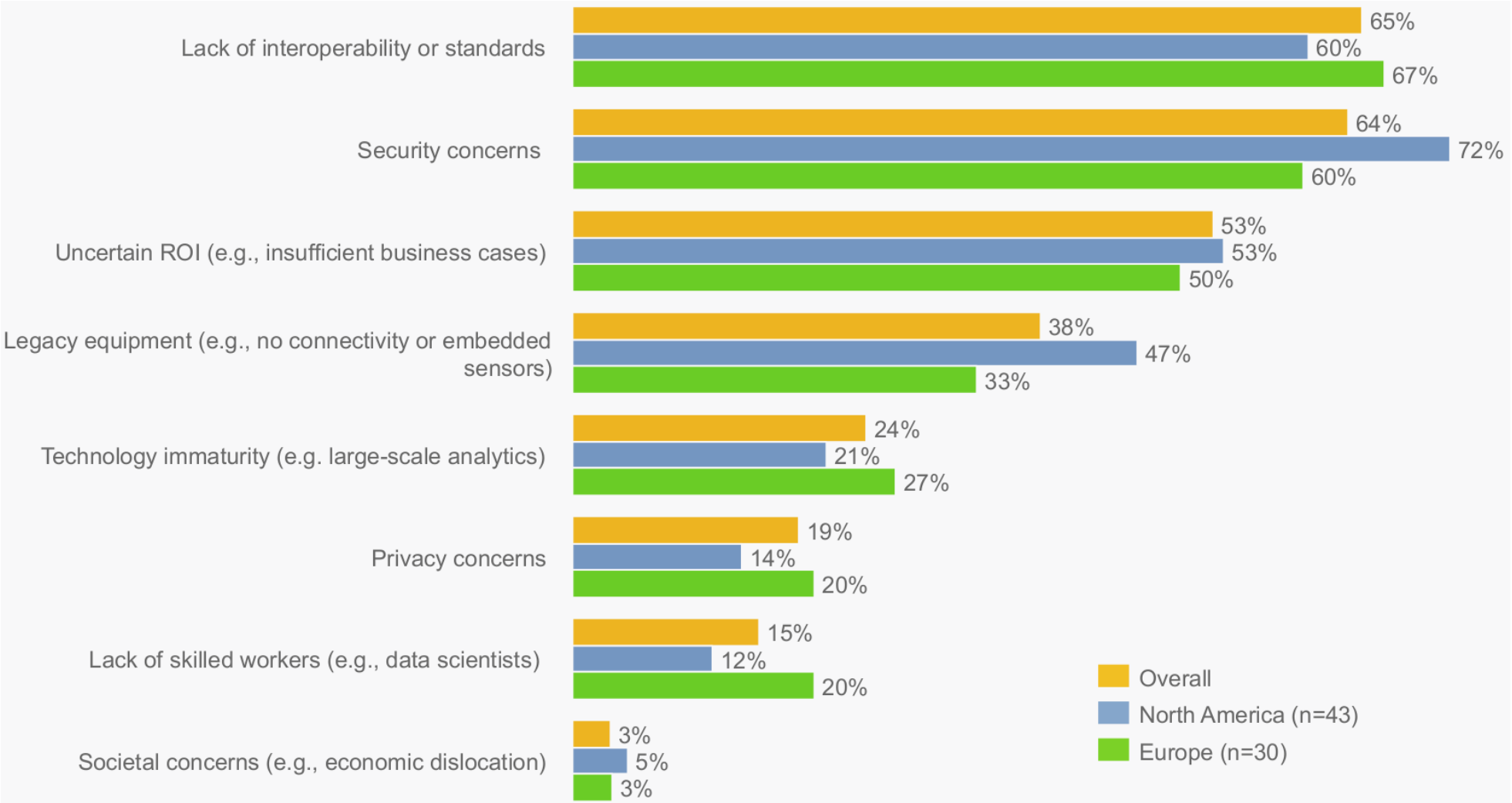

Figure 3: Key barriers in adopting the Industrial Internet [**industrialinternetofthings_executive_**].

Problematic

Where is the problem ?

1. 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
2. Users have to select the network and the application
   - ➟ How to select the **best** network.
   - ➟ How to select the network required by the application.

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	$7.8 \rightarrow 500kHz$	*DR*	*RS*, Range.
SF	$2^6 \rightarrow 2^{12}$	*RS*, Range	*DR*, *SNR*, longer packets, *Tx*.
CR	$4/5 \rightarrow 4/8$	Resilience	longer packets, *Tx*, *AT*.
Tx	$-4 \rightarrow 20dBm$	*SNR*	*Tx*

Table 1: [1]

Motivations

Who & why cares with such problems ?

1. ➟ a
   - ➟ Lake of selective tools
   - ➟ How to select the **best** access point
2. QoS Analysis
   - ➟ a
   - ➟ Lake of selective tools
   - ➟ How to select the **best** access point
3. Threats
   - ➟ a
   - ➟ Lake of selective tools
   - ➟ How to select the **best** access point

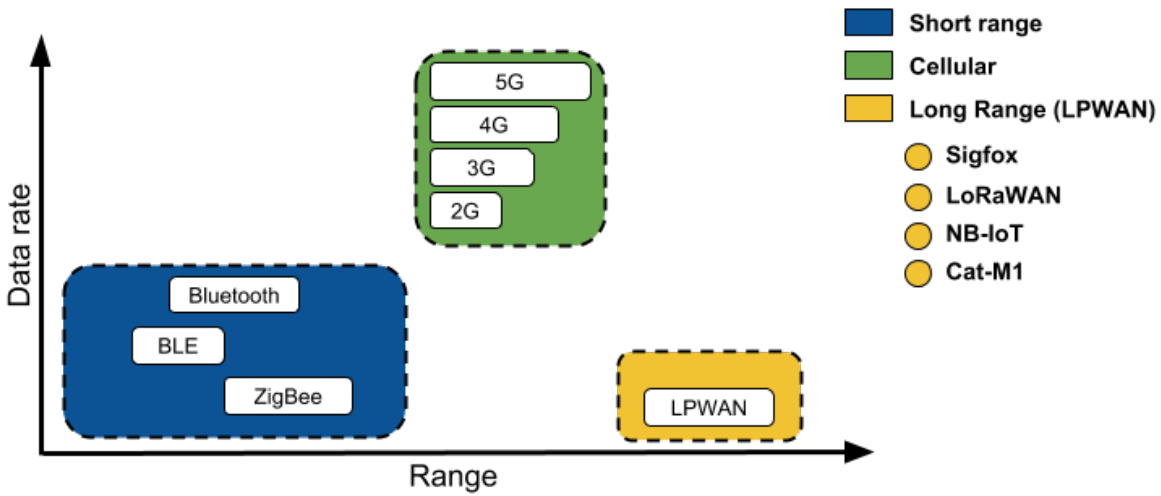

Figure 4: Communication diversity.

Goal

What is the goal ?

- 1. Allow heterogeneous network to communicate
  2. QoS Analysis
  3. Threats
- How to select the **best** access point
  1. Allow heterogeneous network to communicate
  2. QoS Analysis
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Figure 5: wsn-IoT.

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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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Theoretical, Simulation & Real environement

Outline

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Related work

Comparison

Paper	A1	A2	A3	A4

Table 2: An example table.

Related work

Comparison

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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$\in$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)

Marcov chain

Methods

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

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

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

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

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

Marcov chain

Methods

HGHGJ

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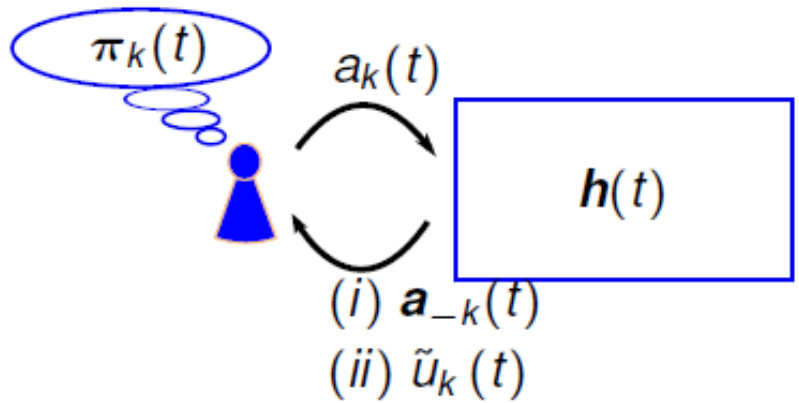
Marcov chain

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: $\forall k \in \mathcal{K}$,

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

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

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 $\in$[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)
    1. Remove some bad solutions
    2. Duplicate some good solutions
    3. 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

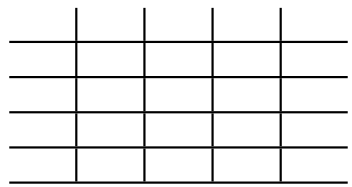


Table 4

Outline

Experimentation

Experimentation

- a
- b

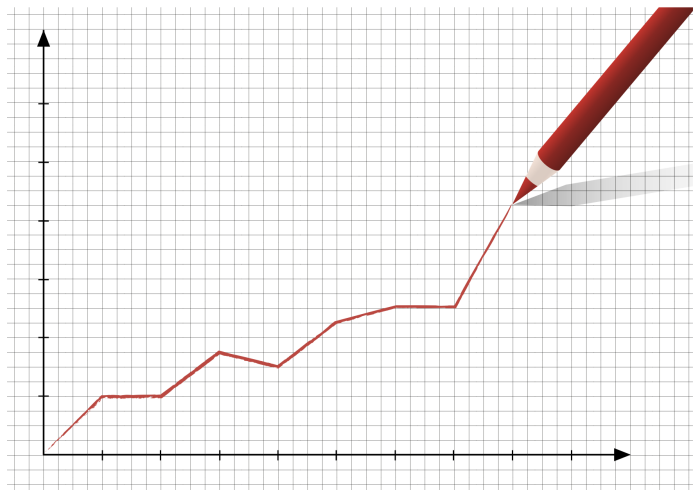


Figure 7: .

Outline

Results

Comparison

- a
- b

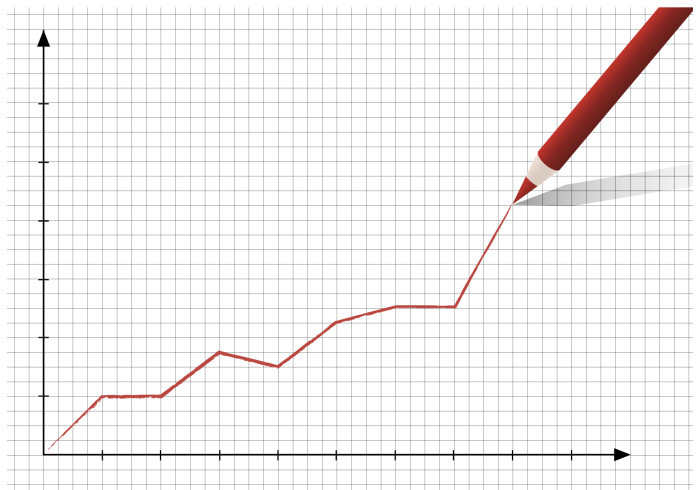


Figure 8: .

Outline

Discussion

- a
- b

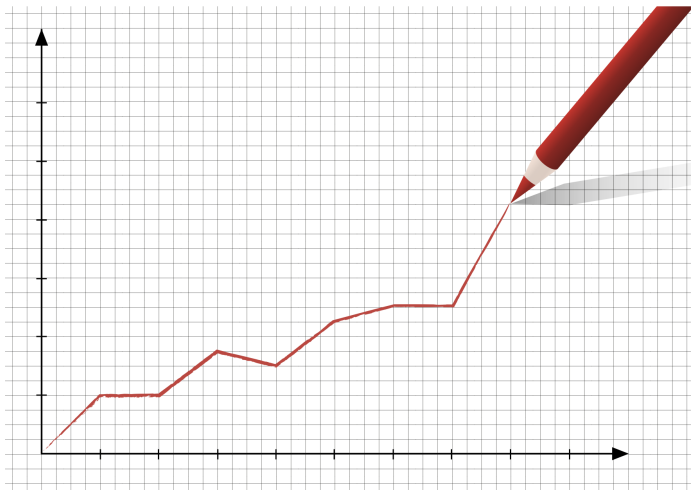


Figure 9: .

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. 6).

[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. 6).