IoT challenges

State of the art

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August 23, 2019

Outline

Context

What is IoT ?

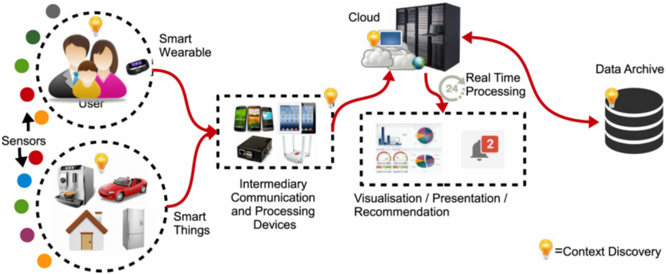

Figure 1: IoT platform.

Figure 2: IoT challenges.

Problematic

Where is the problem ?

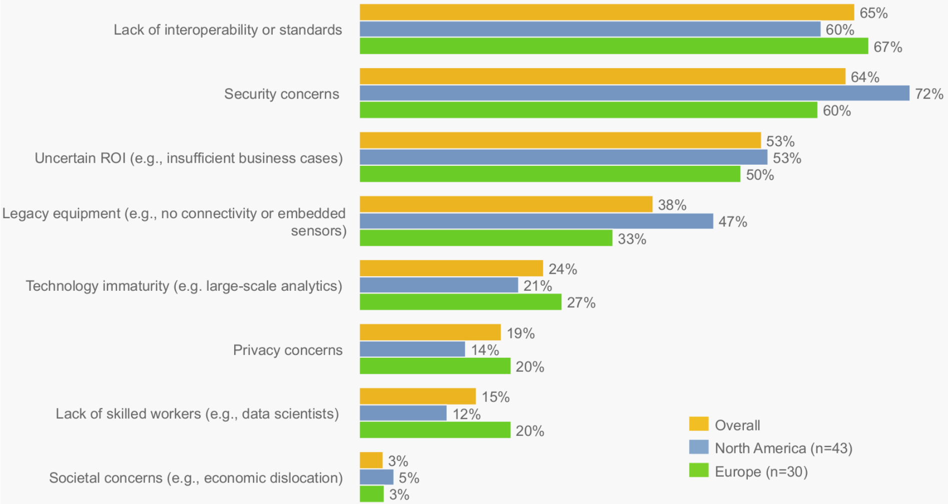

Figure 3: Key barriers in adopting the Industrial Internet [**industrialinternetofthings_executive_**].

Problematic

Where is the problem ?

- 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.

- 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 Power (*Tx*) Receiver Sensitivity (*RS*) Signal Noise Rate (*SNR*) Data Rate (*DR*) ,Air Time (*AT*), Payload length (*PktL*)

Setting	Values	Rewards	Costs
BW	$7.8 \Rightarrow 500kHz$	*DR*	*RS*, Range
SF	$2^6 \Rightarrow 2^{12}$	*RS*, Range	*DR*, *SNR*, *PktL*, *Tx*
CR	$4/5 \Rightarrow 4/8$	Resilience	*PktL*, *Tx*, *AT*
Tx	$-4 \Rightarrow 20dBm$	*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

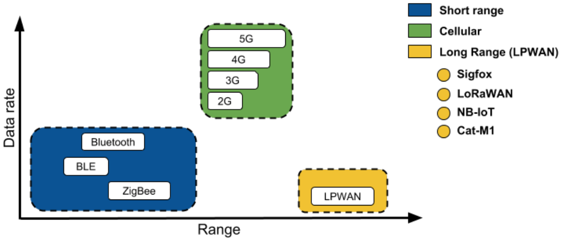

Figure 4: Communication diversity.

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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Theoretical, Simulation & Real environnement

Outline

1. Introduction
2. First contribution
3. Second contribution
4. Third contribution
5. Conclusion
6. First contribution

Outline

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

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

Binary code analysis: Why?

jh

Multiple criteria decision making

Multiple criteria decision making

Genetic algorithm to determine weights of criteria (w1, ..., wn)

Outline

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)

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)

Outline

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

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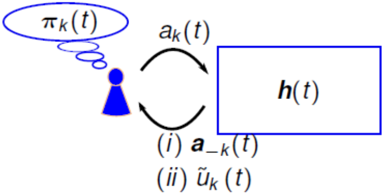
Learning Iterative Steps:

- **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: .

Outline

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

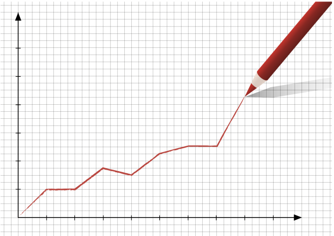


Figure 7: .

Outline

Results
Comparison

- a
- b

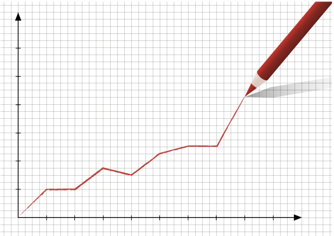


Figure 8: .

Outline

Discussion

- a
- b

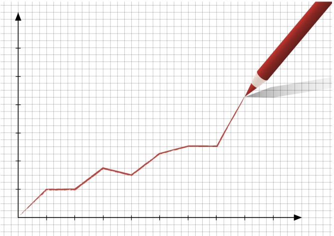


Figure 9: .

Outline

1. Introduction
2. First contribution
3. Second contribution
    1. Related work
    2. Contagion process
    3. Experimentation
    4. Results exploitation
    5. Discussion
4. Third contribution
5. Conclusion
6. First contribution

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Table 5: An example table.

Related work
Comparison

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Table 6: An example table.

Outline

... (step 2)

Methods

... (step 3)

Methods

... (step 4)

Methods

Results

Comparison

Table 7

Outline

Experimentation

Experimentation

- a
- b

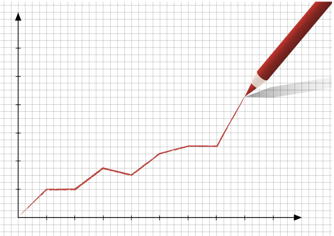

Figure 10: .

Outline

Results
Comparison

- a
- b

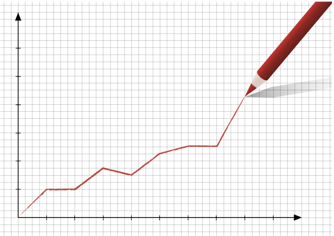

Figure 11: .

Outline

Discussion

- a
- b

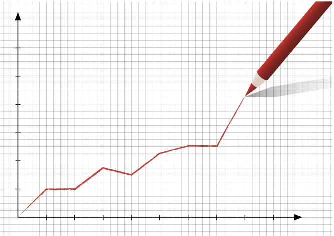

Figure 12: .

Outline

Outline

Related work

Comparison

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Table 8: An example table.

Related work
Comparison

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Table 9: An example table.

Outline

... (step 1)

Methods

... (step 2)

Methods

... (step 3)

Methods

... (step 4)

Methods

Results

Comparison

Table 10

Outline

Experimentation

Experimentation

- a
- b

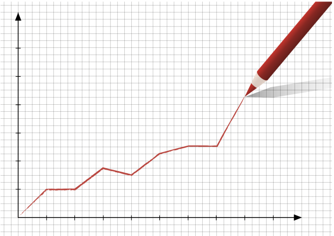


Figure 13: .

Outline

Results
Comparison

- a
- b

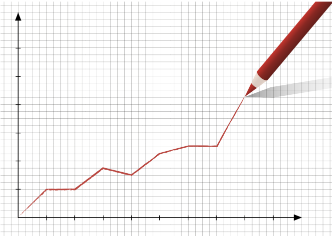


Figure 14: .

Outline

Discussion

- a
- b

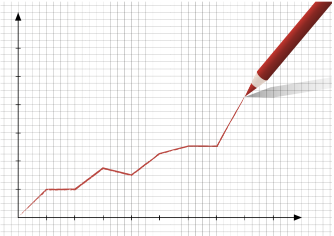


Figure 15: .

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 !

Outline

Outline

Works	Contribution	Goal
[3] **Protect U**	Classification of interlocutors	Friends lists management
[4] **Privacy Wizard**	Friends Classification	Permission Configuration
[5] **SocialMarket**	Common Interests	Assessment of Trust Relationships
[6] **PARE**	Information Leakage	Evaluation of Information Dissemination
[7] **LENS**	Spam Protection	Trusted Emitters Evaluation
[8] **SocialEmail**	Classify msg by paths	Evaluate message reliability
[9] **Privacy Index**	Visibility, sensitivity	Msg exposure assessment

Table 11: Contributions from existing work.

Outline

Step 1: Individual vulnerability measurement
Method

Parameter	Value	
Network connection	Private, Public	1,2
Technology	Ethernet, 5G, 4G, Wifi	[1:4]
Operating system	Windows, Unix, Mac	[1:3]
Web browser	Firefox, Chrome, Opera, ...	[1:10]
Password strength	low, medium, strength	[1:3]
Sessions opened	counter	[1:10]
TLS version	v1.0, v1.1, v1.2, v1.3	[1:4]

Table 12: Individual Vulnerability parameter

$$Y = \sum_{i}^{n} \frac{w * V}{n} \tag{6}$$

- **Y:** Individual vulnerability
- **w:** Weight of each vulnerability
- **V:** Scores mentioned above

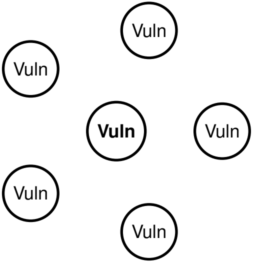


Figure 16: Individual vulnerability level.

Step 2: Users reputation estimation
Method

Parameter	Value	
Frequency of msg exchanged	continuous	N
Discussion time	continuous	N
% of messages exchanged	cipher, signed or clear	[1:3]
Message type exchanged	Text, images, videos, script	[1:4]

Table 13: Trust grant features

$$\alpha = P(reputation) = P(X \geq 1) = 1 - (1 - P(trust))^n \quad (7)$$

- Where,
  - **X**: trust grant, random variable, X ~B(n,p)
  - **n**: deg(node)
  - **P(X=1)**: The probability of being assigned one trust grant by an interlocutor

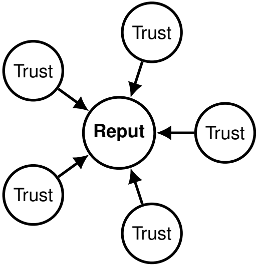


Figure 17: Reputation level.

Step 3: Social vulnerability measurement

Freidkin's theory of social influence

- Input (Features):
  - $Y^{(1)}$ = Vector of the individual vulnerabilities of N users (eq 6)
  - α= The level of reputation (influence) of each user (eq 7)
  - M = Adjacency matrix N x N

- Model:

$$Y^{(t)} = \alpha M Y^{(t-1)} + (1-\alpha) Y^{(t-1)} \tag{8}$$

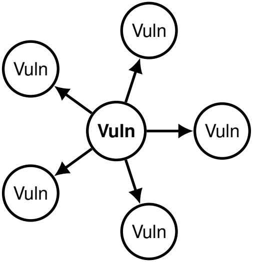


Figure 18: Social vulnerability.

- Output:
  - $Y^{(t)}$ = Vector of the social vulnerabilities of the N users

Step 3: Social vulnerability measurement

Freidkin's theory of social influence

Formal properties of the model:

- When a user's influence is high, the model is reduced to:
  - average vulnerabilities of his friends weighted by their trust levels.

$$Y^{(t)} = 1 * MY^{(t-1)} + (1-1)\,Y^{(t-1)} \tag{8}$$
$$Y^{(t)} = MY^{(t-1)}$$

- In the absence of influence, the model is reduced to:
  - his own vulnerability weighted by the level of mistrust of his friends

$$Y^{(t)} = 0 * MY^{(t-1)} + (1-0)\,Y^{(t-1)} \tag{8}$$
$$Y^{(t)} = Y^{(t-1)}$$

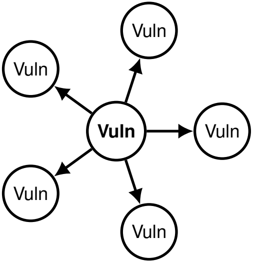


Figure 19: Social vulnerability.

Outline

Email datasets

Experimentation

Parameter	Value
Users	958
Messages	6966
Diameter	958
# of msg on average	2.413361
Msg density	0.00252
Modularity	0.654600
Average distance	3.042114

Table 14: Enron dataset properties.

Figure 20: Enron logo.

Parameter	Value
Users	5885
Messages	26547
Diameter	2096
# of msg on average	9.02192
Msg density	0.001533
Modularity	0.86526
Average distance	3.914097

Table 15: Caliopen dataset properties.

Figure 21: Caliopen logo.

Outline

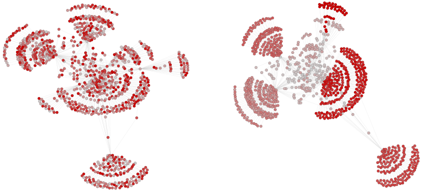
Results
Comparison

Initial values:

- generated randomly (normal distribution)
- represent individual vulnerabilities.
- dark color = highly infected

Final values:

- obtained after convergence.
- represent social vulnerabilities.



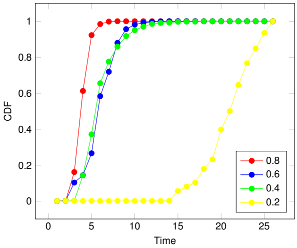
(a) Individual privacy vulnerability. (b) Social privacy vulnerability.

Figure 22: Individual & Social privacy vulnerabilities.

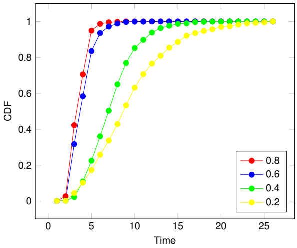
User ID	Individual Vul	Social Vul
34	0.84	0.67
67	0.12	0.87
206	0.76	0.33
588	0.23	0.78

Table 16: Individual and social privacy vulnerabilities.

Results exploitation



(a) Enron dataset.

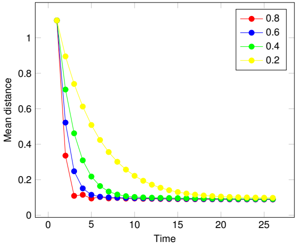


(b) Caliopen dataset.

Figure 23: Cumulative distribution function of infected users.

- Figures shows the CDF of the vulnerability diffusion process.
- The vulnerability diffusion process increases as the reputation level of vulnerable users increases.
- Users with high reputation values contribute significantly to the diffusion
  - They spread their vulnerabilities quickly and widely through the network.

Results exploitation



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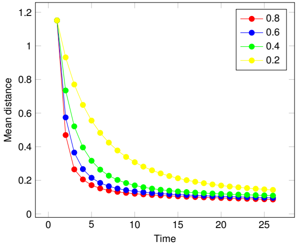

(b) Caliopen dataset.

Figure 24: Convergence of the diffusion process.

- The process converge when the mean distance between social vulnerability scores is the minimum.
- Assigning trust to vulnerable users allows them to achieve a high level of reputation.
- Consequently, they infect all other vulnerability values.

Outline

Discussion

- The purpose of this work is to simulate a diffusion process of individual vulnerabilities.
  - The vulnerability of one user is the vulnerability of all users.
  - At the end of the diffusion (convergence), all users gets their social vulnerability scores.

- Future work
  - To propose mechanisms to improve the reputation of non-vulnerable users.
    - Suggest well known interlocutors with acceptable vulnerability scores.

  - To propose mechanisms to improve the vulnerability of reputed users.
    - recommend configurations and softwares.

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Thank you

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