Can the Wearable be Social?

Michele Nitti
michele.nitti@diee.unica.it

At MCLab
http://mclab.diee.unica.it/
Outline

• **How** the wearable can be social?
  – Concept and types of friendships

• **Why** the wearable should be social?
  – Navigability and Trustworthiness

• **What** could social wearables offer to the IoT?
  – Context awareness

• Conclusions and further challenges
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IoT: number of devices

During 2008, the number of things connected to the Internet exceeded the number of people on earth.

By 2020 there will be:
- >50 billion (Ericsson)
- 75 billion (Morgan Stanley)
- 200 billion (Intel)

These things are not just smartphones and tablets.

Source: Cisco IBSG, Jim Cicconi, AT&T, Steve Leibson, Computer History Museum, CNN, University of Michigan, Fraunhofer. Available at:
Internet of Wearable Things

- Watches and clocks: 50%
- Glucose and blood pressure monitoring meters: 48%
- Car keys: 48%
- GPS and navigation devices: 46%
- Smartphones: 43%
- Identification documents: 42%
- Handheld cameras: 40%
- TV remote: 38%
- Wallets: 37%
- Music players like iPod: 34%
- Tablets: 24%
- Streaming media players like Apple TV, Amazon, etc.: 19%
- Connected TVs: 19%
- Video gaming consoles eg Xbox, PlayStation, etc.: 17%

Base: Smartphone users across Brazil, China, South Korea, UK and the US
How difficult is to cooperate!

- Total number of humans in the world: around 7 billions
- Expected number of objects: hundredths of billions
- How to find the right object?
- Among humans ...

Social networks! Why not the same for objects?

Social Internet of Things

SIoT (Social Internet of Things)
a paradigm of “social network of intelligent objects”, based on the notion of social relationships among objects

<table>
<thead>
<tr>
<th>Reason</th>
<th>Humans</th>
<th>Things</th>
</tr>
</thead>
<tbody>
<tr>
<td>Become visible</td>
<td>Increase popularity</td>
<td>Publish information/services</td>
</tr>
<tr>
<td>Find resources</td>
<td>Find old friends</td>
<td>Find information/services</td>
</tr>
<tr>
<td>Obtain context information</td>
<td>Get filtered information</td>
<td>Get environment characteristics</td>
</tr>
<tr>
<td>Discover new resources</td>
<td>Find new friends</td>
<td>Find new services/updated information</td>
</tr>
</tbody>
</table>
SIoT – Types of Relationships

Parental object relationship

Co-location object relationship and co-work object relationship

Social object relationship

Ownership object relationship
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Reference scenario

Real world objects
Reference scenario

Virtual world objects
Reference scenario

IHEALTH  SMART HOME  POLLUTION MONITORING
Reference scenario: distributed information search

Objects use the social network to:

- Navigate the network
- Look for services
“A network is navigable if and only if there is a short path between all or almost all pairs of nodes in the network”*

Formally:

- There exist a giant component
- The effective diameter is low – bounded by $\log_2(n)$

**RECALL:** we are looking for a distributed solution

Milgram’s experiment demonstrated that people can find a short path efficiently with only local knowledge of the network.
Network Navigability - Properties

Node degree
- Neighborhood average degree

Local clustering

\[ C_{local}(n) = \frac{2 * e_n}{k_n * (k_n - 1)} \]
Average path length using local rules

$x\%$ of the nodes in the network with at least $y\%$ of $N_{\text{max}}$ friends

![Graph showing average path length vs. maximum percentage of hubs in the network.](image-url)
Social IoT - Trustworthiness
Basic Properties for SIoT

• Transitivity
• Composability
• Personalization
• Asymmetry
Social IoT - Trustworthiness

Major trust Elements for SIoT

• Feedback system
• Number of transactions
• Credibility
• Transaction Factor
Social IoT - Trustworthiness

Major trust Elements for SIoT

• Relationship Factor
• Centrality
• Computation Capabilities
Simulations – Success rate

![Graph showing success rate against transaction number for different systems including No Trust, Social IoT, TVM/DTC, and TidalTrust. The lines indicate the increasing success rate as transaction number increases.]
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“Internet of Things is a world-wide network of interconnected uniquely addressable objects, where objects look for others to provide composite services for the benefit of the humans.”

Heterogeneity

Security, trust

Isolation

Solution?

Personalization

Obsolescence

Social wearables kick in!

Social wearables:

• Strengthen the degree of connectivity between users and things

• Turn “communicating objects” into “autonomous decision-making entities”

• Give an accurate view of the user context
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Conclusions (1/2)

The Social Internet of Things

• is a good model to manage objects’ trustworthiness

• is a solution to control network navigability when looking for object services
Conclusions (2/2)

Social wearable

• close the gap between users and IoT
• provide a mean to improve the QoE of IoT applications
What we still need

Real data on objects’ «behavior»!
- Only through applications’ deployments

Object interactions should also include
- Light social objects’ authentication
- Rewards mechanisms
What we are doing

• Implementing a PaaS platform for SIoT
  – http://lysis-iot.com

• Defining a SIoT architecture that exploits the network edge resources

• Deploying applications with industrial partners to collect useful data
Thank you for your attention

If you need more info send an email to:

michele.nitti@diee.unica.it