



**ITU Kaleidoscope 2011**

The fully networked human?  
Innovations for future networks and services

# MAKING THINGS SOCIALIZE IN THE INTERNET -- DOES IT HELP OUR LIVES?

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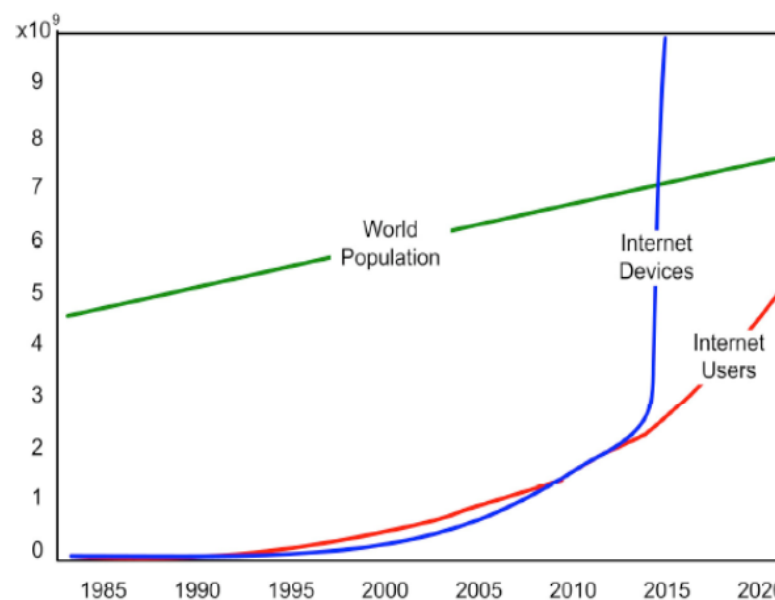
# Outline

- Internet of Things (IoT)
  - Definition, Applications
  - State of the art
- Social Internet of Things (SIoT)
  - Definition
  - Types of Relationships
  - Relationship Models
- Applications
- System
  - Components
  - Architecture
- Simulations and conclusions



# Internet of Things

- It is a world-wide network of interconnected uniquely addressable objects
  - Static fixed nodes
  - Handheld wireless devices
  - Wireless sensor and actuator nodes
  - RFID readers/tags
- Major characteristics
  - Scale - order of magnitude higher than Internet
  - Heterogeneity - very different technologies
  - Pervasivity – ICT embedded in our environments



IMS Research



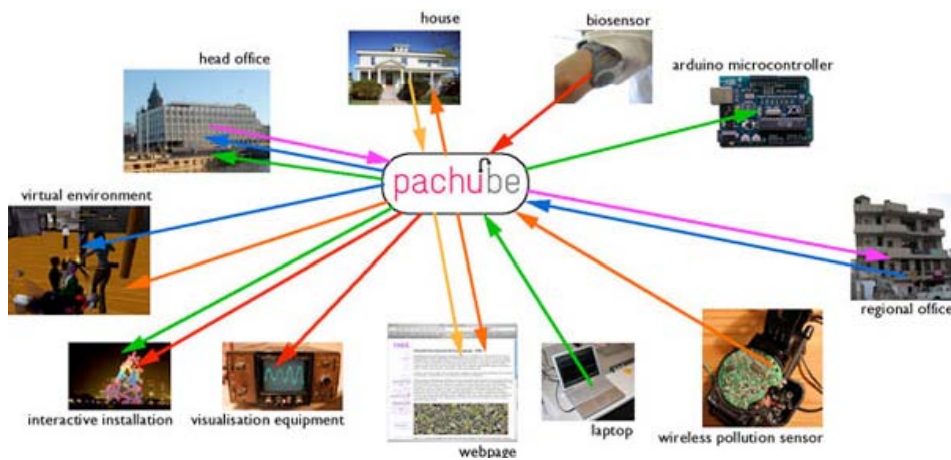
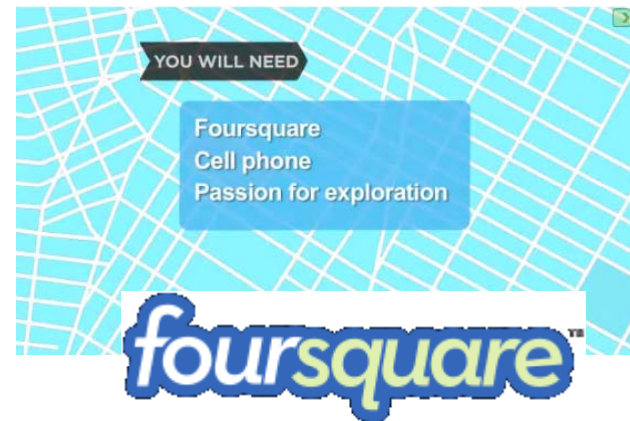
# IoT applications



Nike + shoes



AutoBot



... magic happens...



Arrayent



# IoT - State of the Art

- Social networks and socialization
  - *Homophily*
    - Internet search, p2p and security
  - Routing
    - pocket switched and delay tolerant nets
  - Temporary relationships between nearby objects
    - data exchange
  - Blogject: objects that blog
  - Reachable web of things in human social networks





# Social Internet of Things (1/2)

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



Social networks! **Why not the same for objects?**

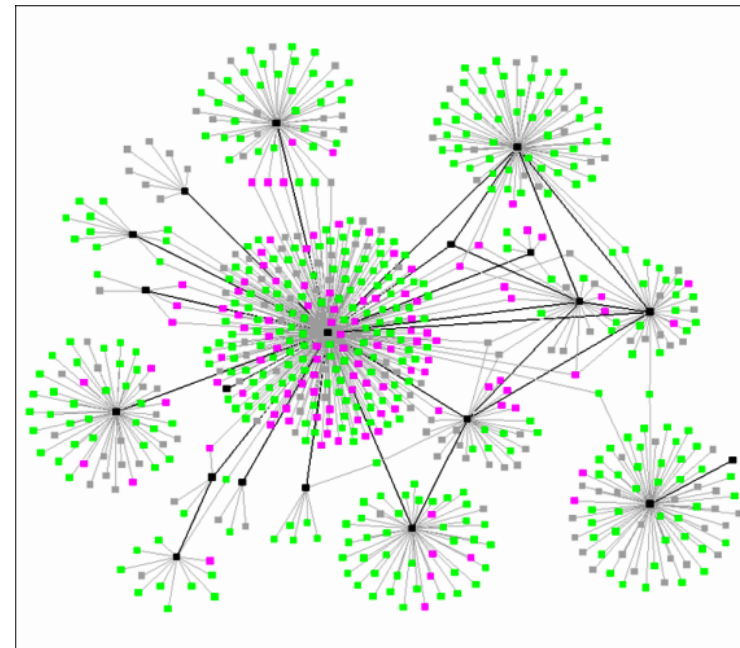


# Social Internet of Things (2/2)

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## Advantages

- Easy to be navigable\*
- Scalable
- Trustworthiness



•J. Kleinberg, "The small-world phenomenon: an algorithmic perspective" in Proc. of ACM Symposium on Theory and Computing, 2000

Reason	Humans	Things
<i>Become visible</i>	Increase popularity	Publish information/services
<i>Find resources</i>	Find old friends	Find information/services
<i>Obtain context information</i>	Get filtered information	Get environment characteristics
<i>Discover new resources</i>	Find new friends	Find new services/updated information

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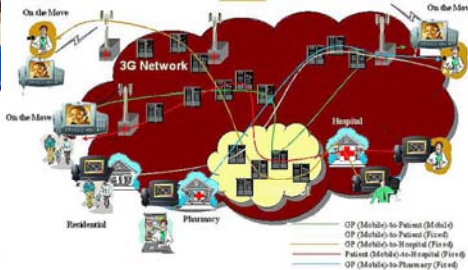
# SIoT - Types of Relationships



Parental object relationship



Co-location object relationship and co-work object relationship



Social object relationship



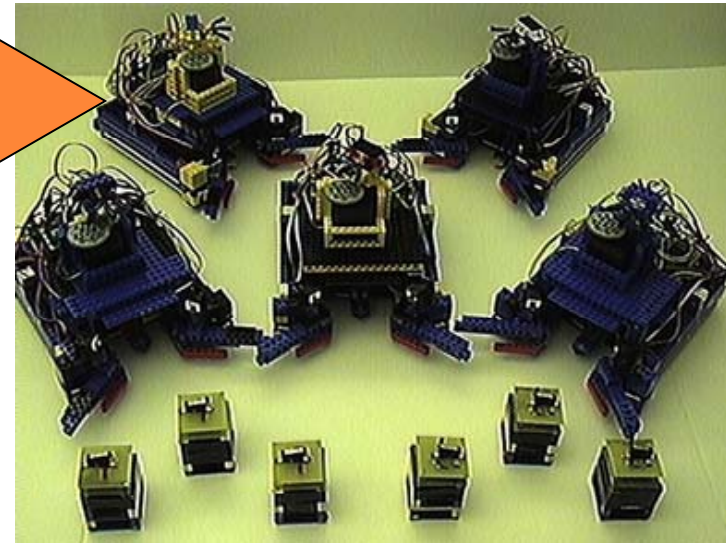
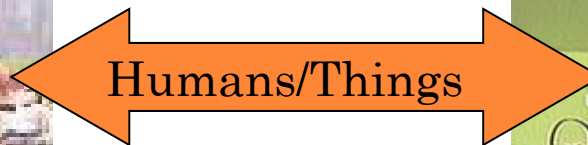
Ownership object relationship





# SIoT - Relationship Models (1/4)

## Communal sharing relationships



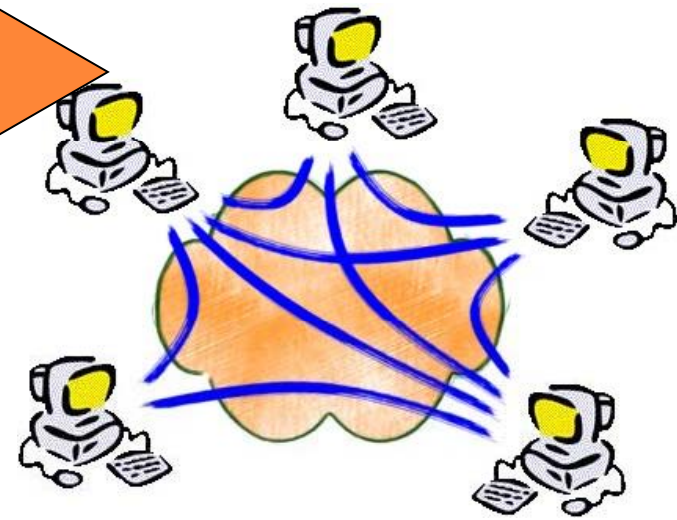
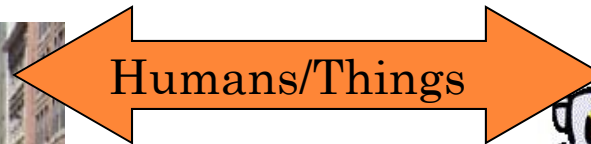
- Behaviors of **objects** with **collective relevance**
- Focus on the service offered by the entire swarm

\* A. P. Fiske, "The four elementary forms of sociality: framework for a unified theory of social relations," *Psychological review*, vol. 99, 1992.



# SIoT - Relationship Models (2/4)

## Equality matching relationships

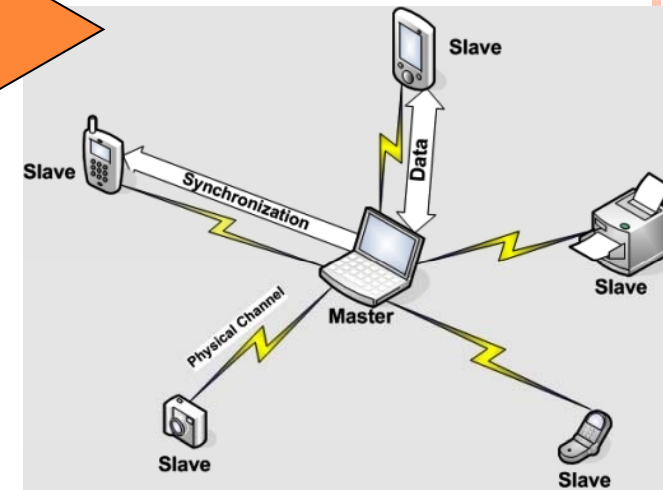
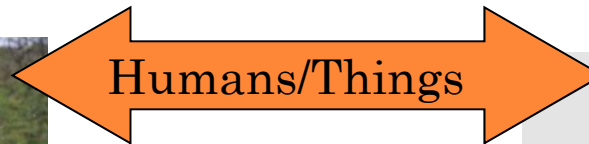


Objects operate as equals and request and provide information among them in the perspective of providing IoT services to users while maintaining their individuality



# SIoT - Relationship Models (3/4)

## Authority ranking relationships



Established between **objects of different complexity and hierarchical levels**

- RFID reader and Tags, Bluetooth master and slave

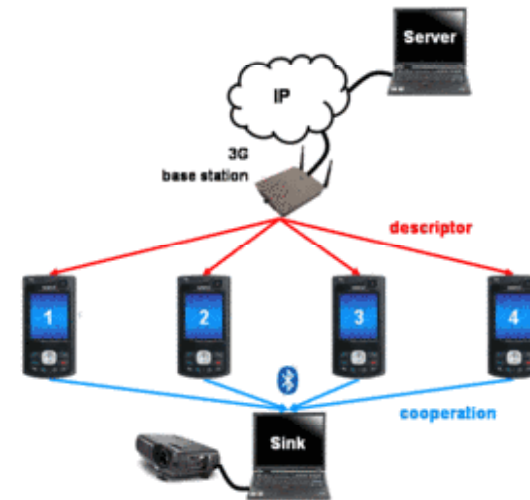
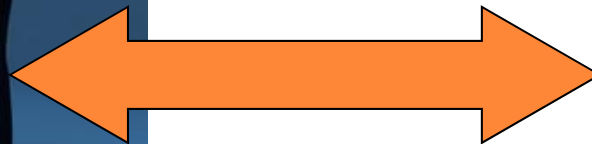


# SIoT - Relationship Models (4/4)

## Market pricing relationships



Humans/Things



- Working together in the view of **achieving mutual benefit**
- Participation in this relationship **only when it is worth the while to do so**

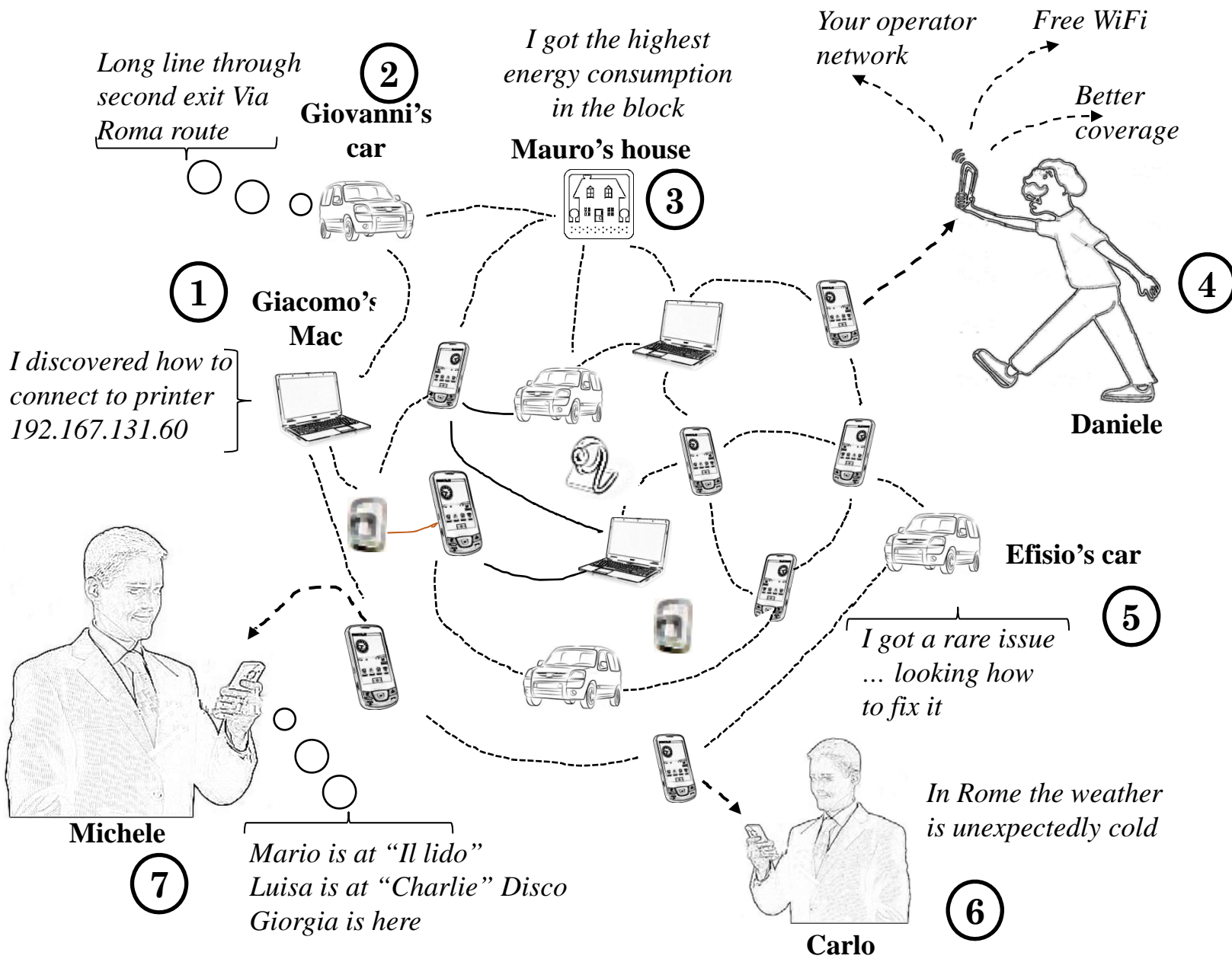




# Applications

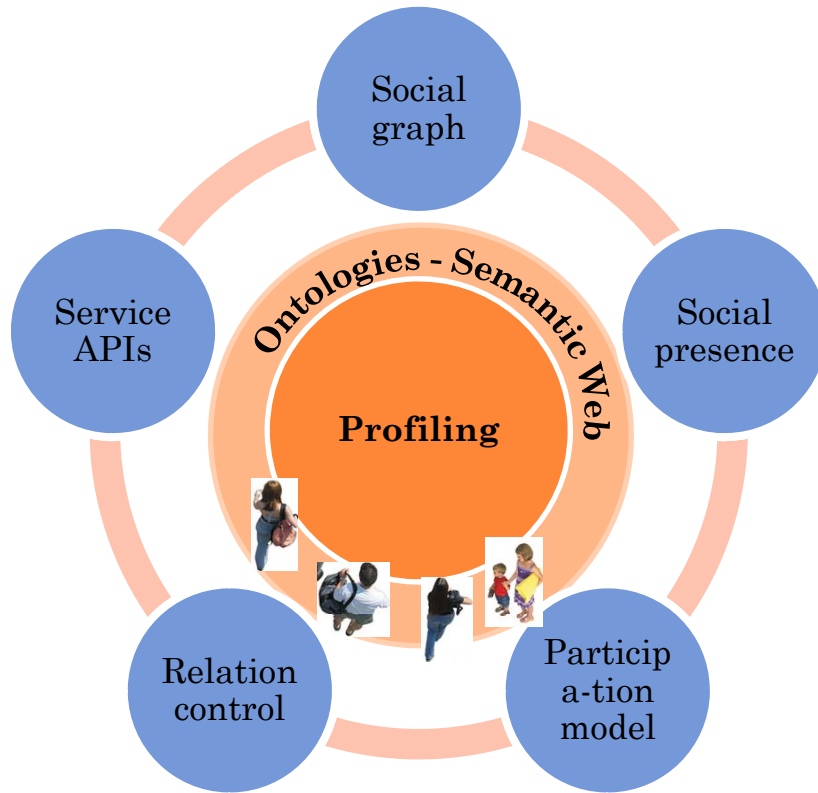
Category of “object relationship”	Applicable relational model	Type of object interaction	Application examples
Parental object relationship	Communal Sharing Equality Matching Market Pricing	Swarm Balanced Cooperative	Best practice sharing
Co-location object relationship	Communal Sharing Equality Matching Authority Ranking	Swarm Balanced Unbalanced	Environmental monitoring Building automation Industrial automation Data fusion Automatic identification of goods
Co-work object relationship	Communal Sharing Equality Matching Authority Ranking	Swarm Balanced Unbalanced	Emergency and first responder deployments Data distribution Telemedicine Military applications Logistics
Ownership object relationship	Equality Matching Authority Ranking	Balanced Unbalanced	Remote control of devices Personal data storing and distribution Multimedia content fruition Infomobility and positioning
Social object relationship	Equality Matching Authority Ranking Market Pricing	Balanced Unbalanced Cooperative	Personal data exchange Cooperative sharing and downloading Distribute gaming Cooperative and hybrid positioning



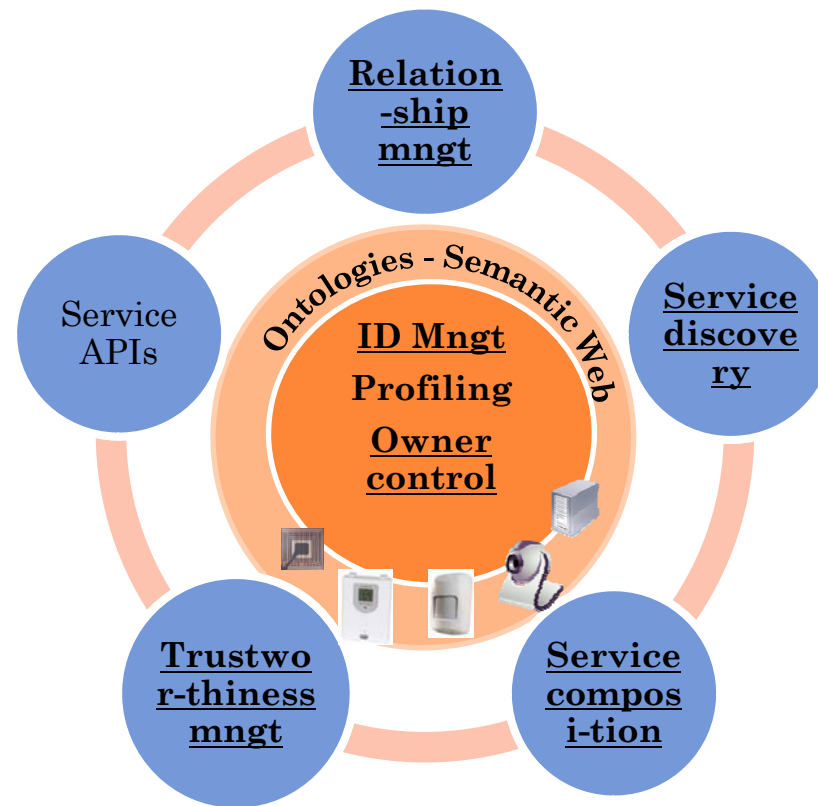


# SIoT Components

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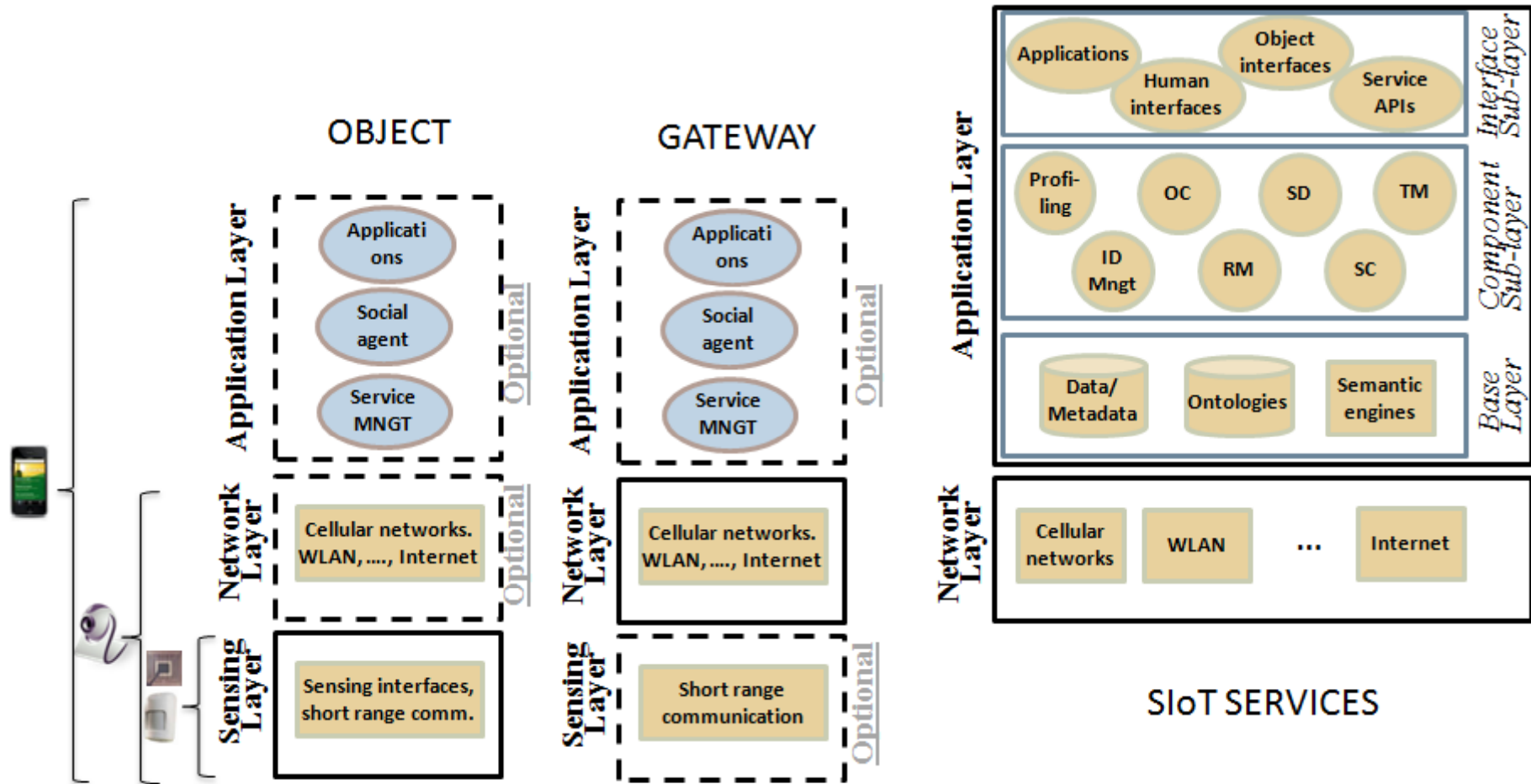
Social Network  
for Humans



Social Networks  
for Things



# SIoT Architecture





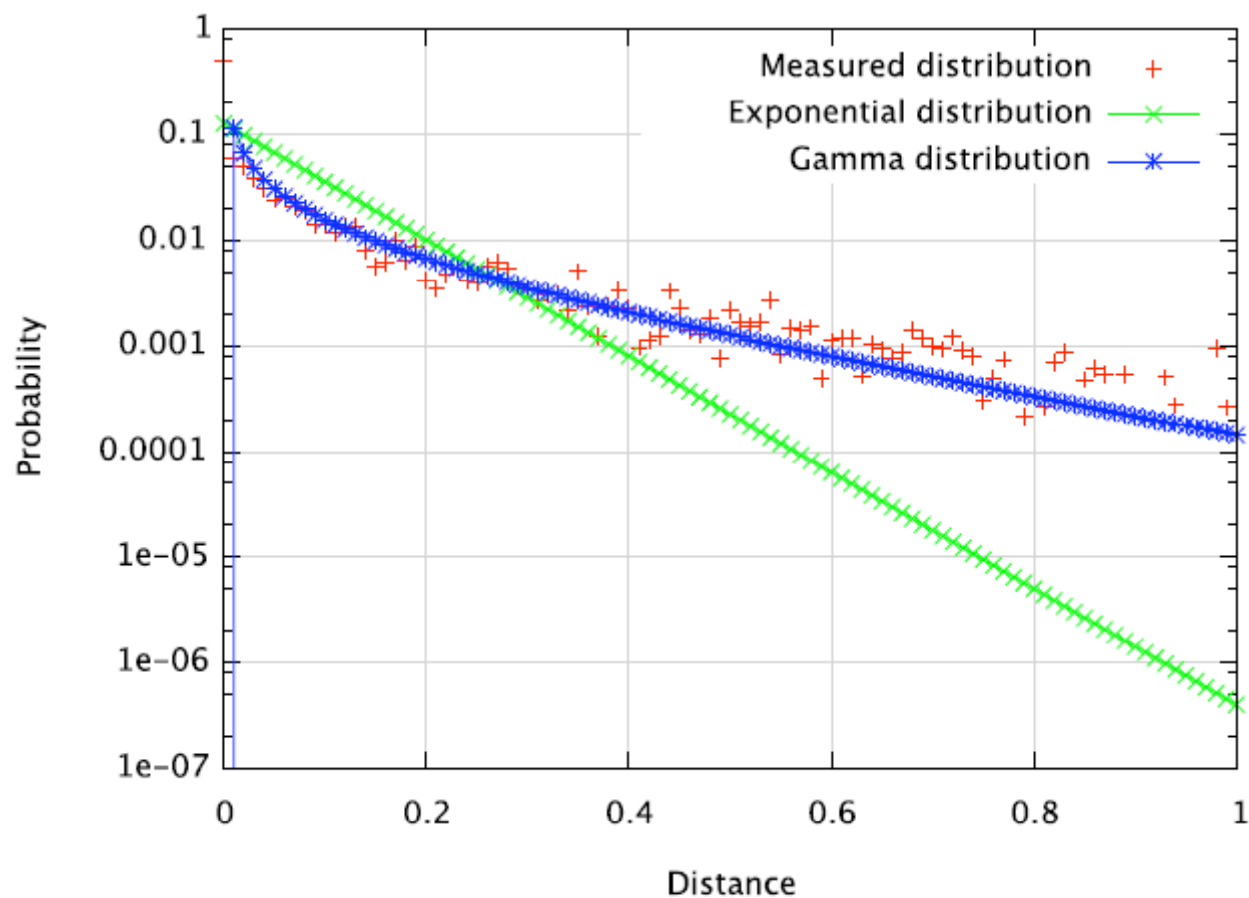
# Simulations (1/3)

- Objective
  - Analyze the social structure in the SIoT
    - $X^{(A)}$  - *probability random variable representing the distance between two nodes that are tied by a social relationship of type A*
- Model used
  - Small World In Motion
  - SWIM simulator (A Mei, J.Stefa, Infocom10)
  - Space divided in cells of equal size
    - Transfers that depend on the cell distance and popularity of target cell
  - Duration: 11 days, Users: 2000



# Simulations (2/3)

- Probability density function of the variable  $X^{(OOR)}$ 
  - OOR -> ownership object relationship

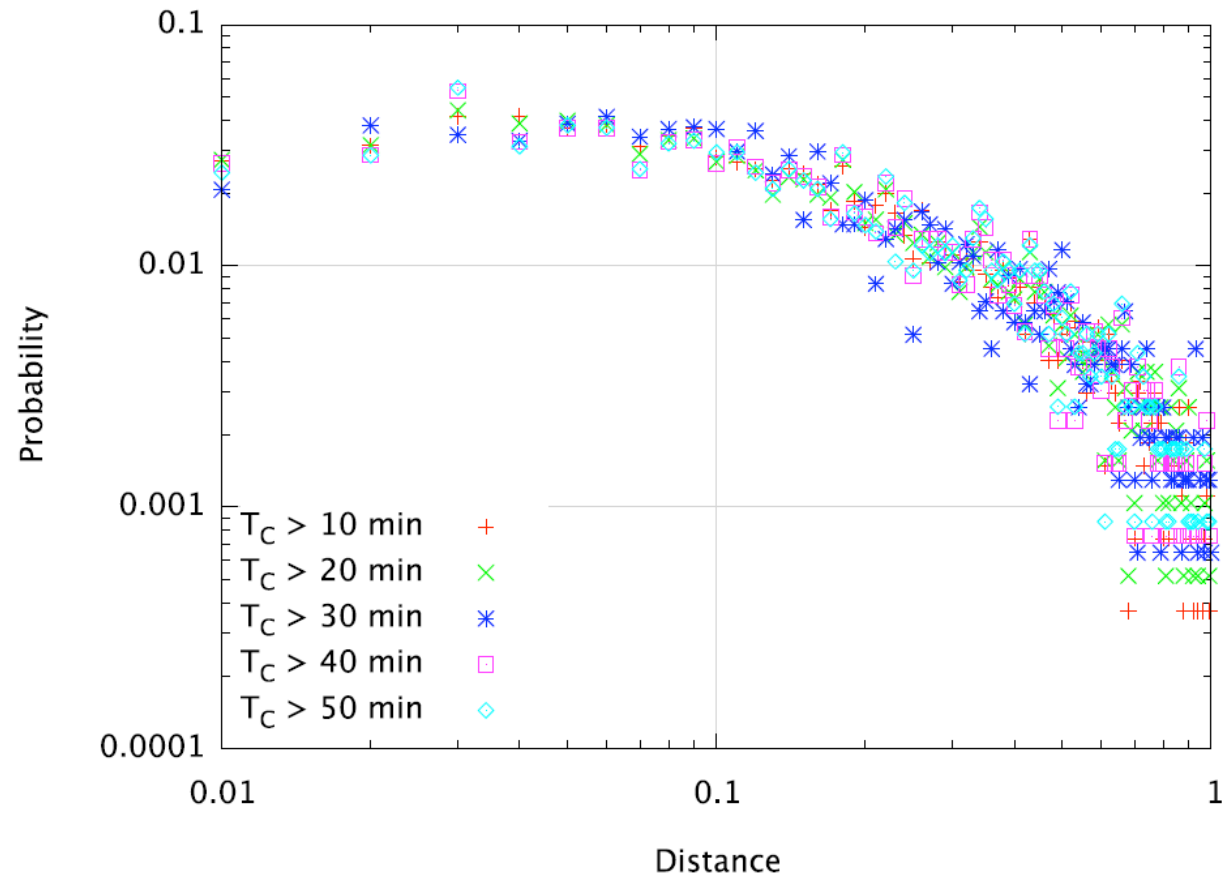


# Simulations (2/3)

- Probability density function of the variable  $X^{(SOR)}$ 
  - SOR -> social object relationship

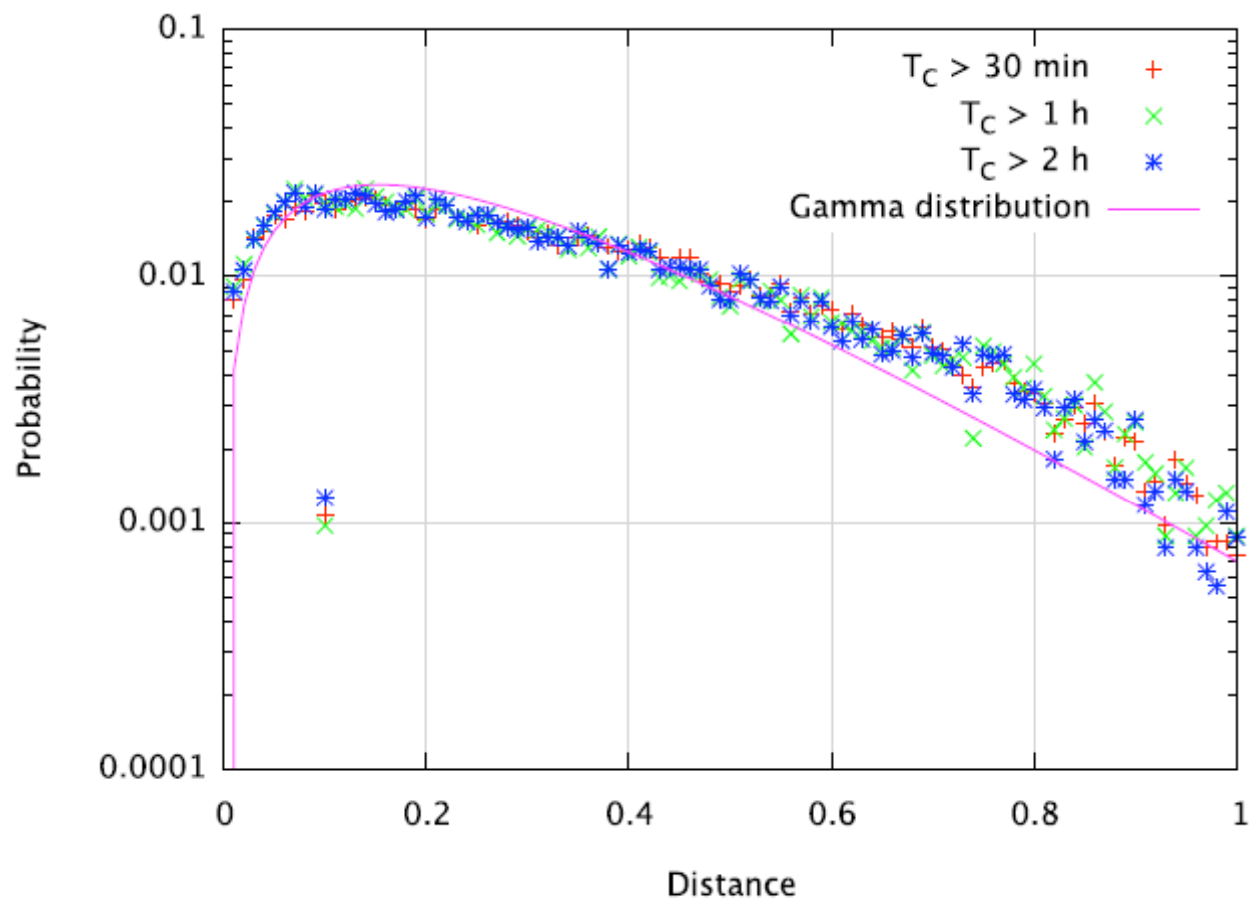
Friends when

- Number of contact  
 $N_c \geq 2$
- Intercontact time  
 $T_I \geq 8$  hours
- At different contact durations  $T_c$



# Simulations (2/3)

- Probability density function of the variable  $X^{(C-WOR)}$ 
  - C-WOR -> co-work object relationship





# Conclusions

- Needs for standards
  - Many SIoT platform working in parallel, with objects belonging to different organizations
  - Crawling of friends in other platforms
    - Accessibility to object profile, friends, activity, trustworthiness,...
  - Services provide by/to third parties
  - Objects may need to move their *history*
- Objective
  - Work towards an ***object open social*** standard



# Conclusions

- What We have Done So Far ...
  - Introducing a fresh new concept of Social Internet of Things
  - Designing a possible architecture
  - Performing simulations to analyse the structure of the object social network
- What Still Need to De Done ...
  - Implement the software platform
  - Realizing key use-cases (hundreds of Things to be involved)
  - Making experiments
  - ... and many other things that still need to be defined!

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**THANKS FOR  
YOUR ATTENTION!**

**Cape Town, South Africa  
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