mining social contact with active RFID

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in collaboration with

Wouter Van den Broeck, Alain Barrat, Jean-François Pinton, Vittoria Colizza, Alessandro Vespignani, OpenBeacon/OpenAMD team @ 25C3

- detecting face-to-face social contacts
- distributed contact detection
- a case study at a conference
- contact networks, contact duration
- outlook

25C3, Berlin, December 30th, 2008

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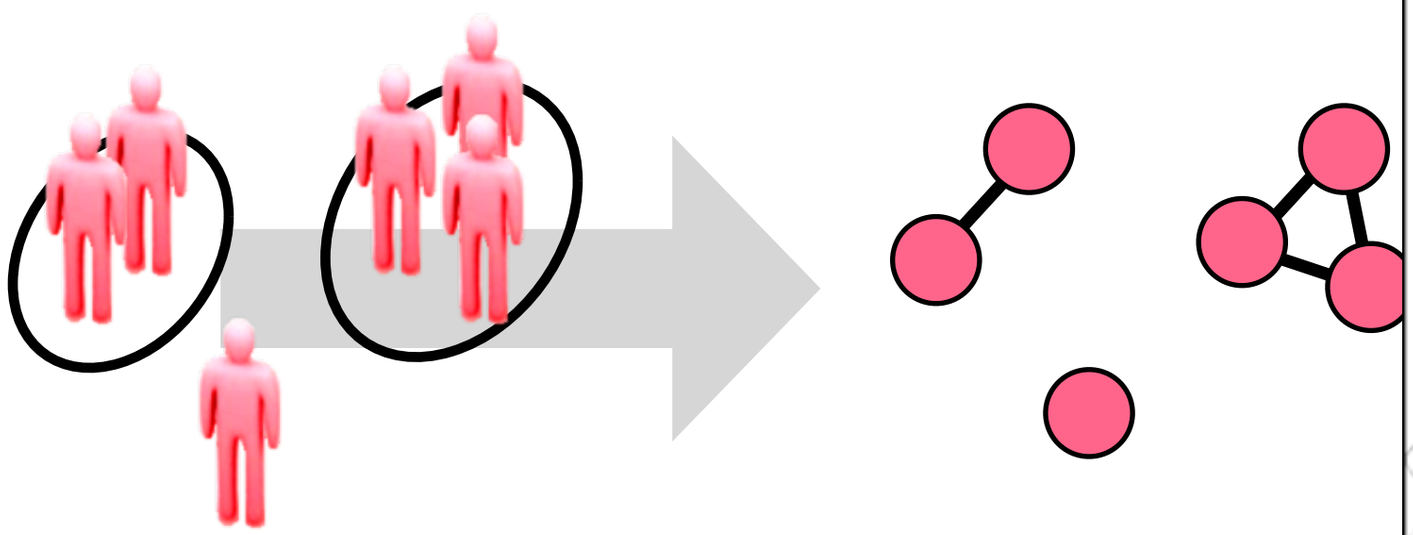
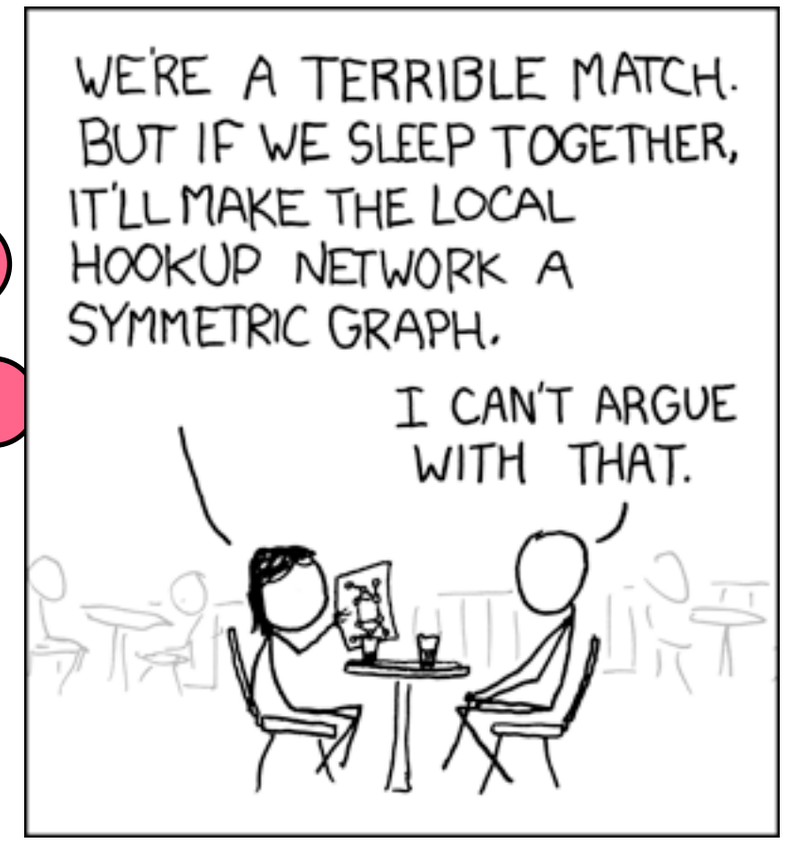
contact detection: motivations

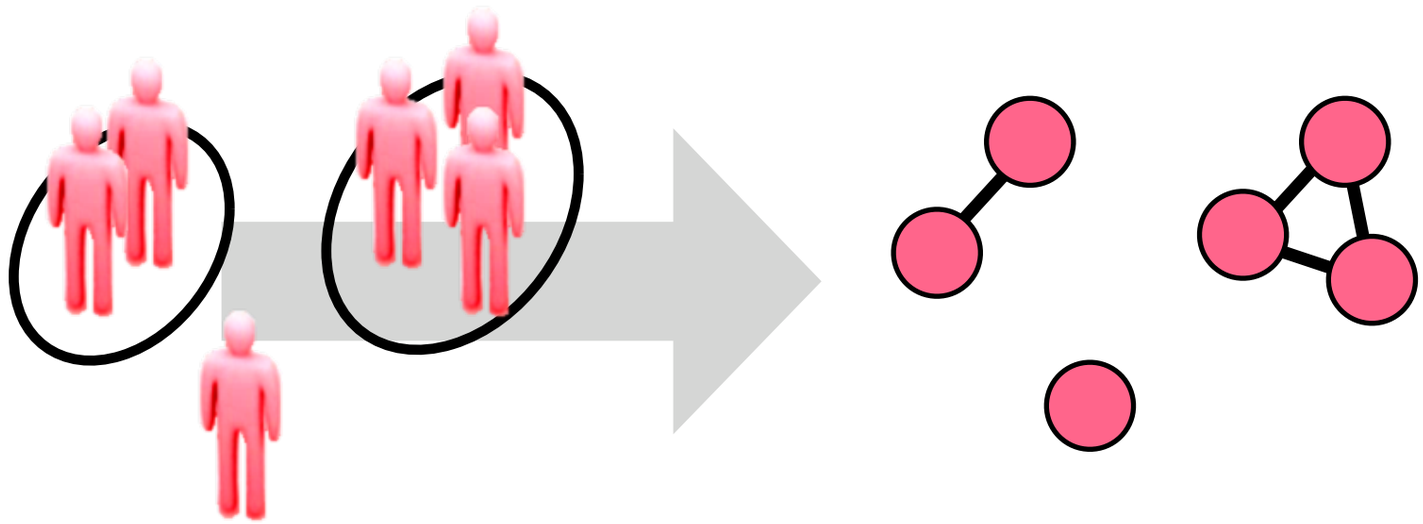




R. Munroe, `http://xkcd.com/403/`

- ★ fundamental knowledge on human contact
- ★ epidemiology
- ★ design of p2p mobile sharing schemes
- ★ integration with on-line information
- ★ enhanced user experience

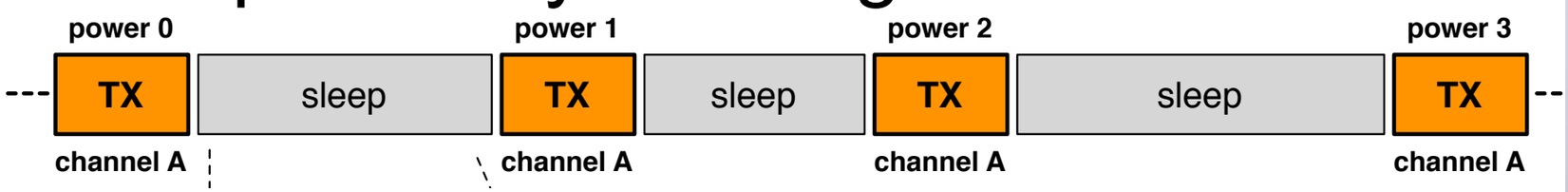
contact detection: requirements



- spatial resolution ~ 1 meter
- anisotropy
- temporal resolution ~ 5-20 seconds
- unobtrusive
- scalable
- very low cost
- open (hardware and software)

active RFID tags & OpenBeacon

- beacon RFID tags
  - active RFID
  - RF broadcast of tag ID
  - very low power consumption
  - long range
  - possibility of triangulation



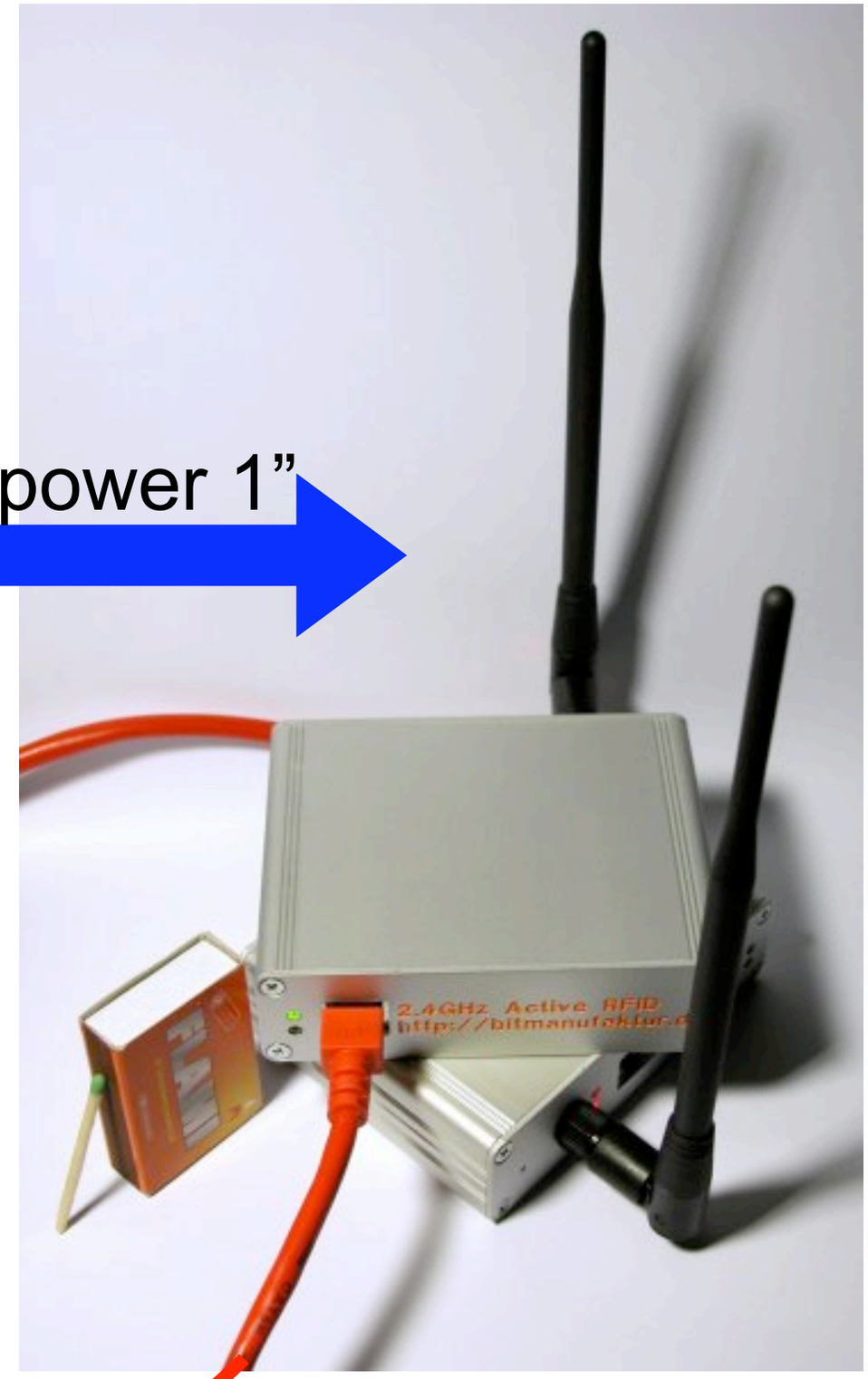
courtesy M. Meriac

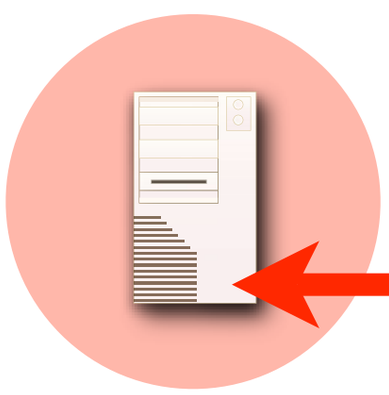
- OpenBeacon
  - open hardware and software design
  - 2.4 GHz microwave ISM band
  - PIC microcontroller + RF chip
  - easily reprogrammable
  - 128 bytes RAM, 2 kB flash program memory
  - low power-consumption
  - inexpensive

data collection pipeline

active RFID device, 2.4 Ghz

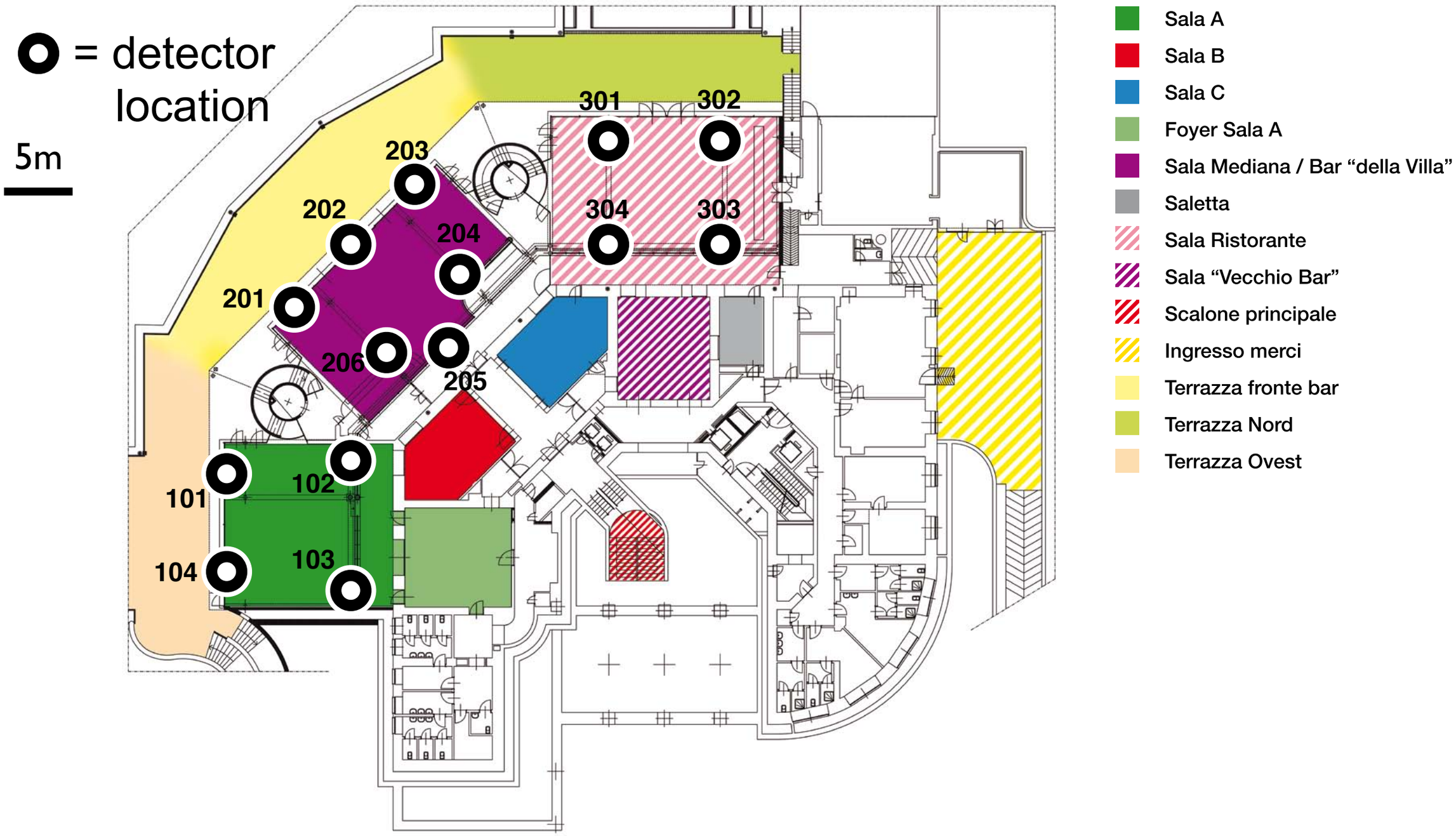
“tag 42 at power 1”





LAN

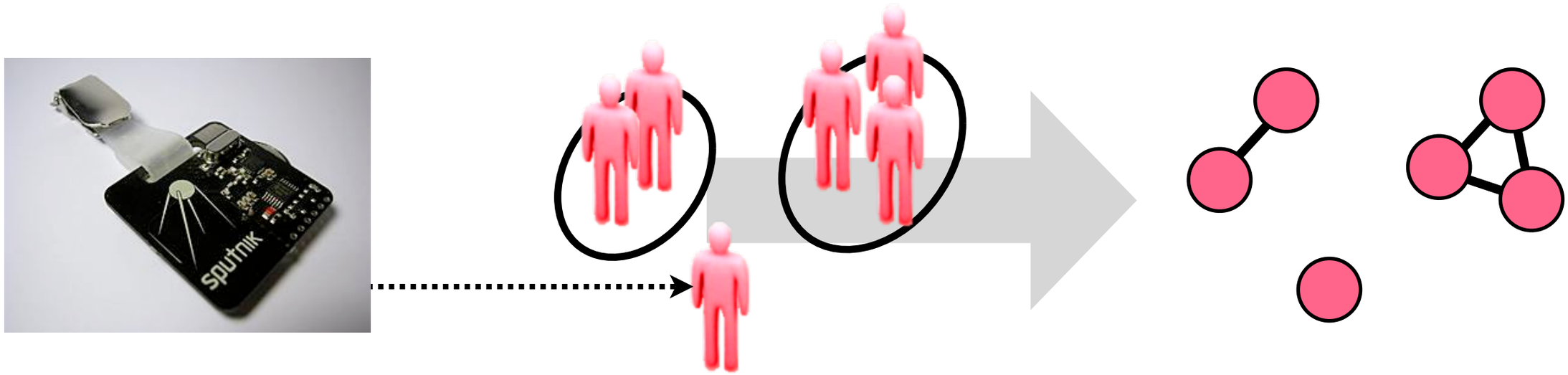
experiment layout (may '08)



co-presence at stations

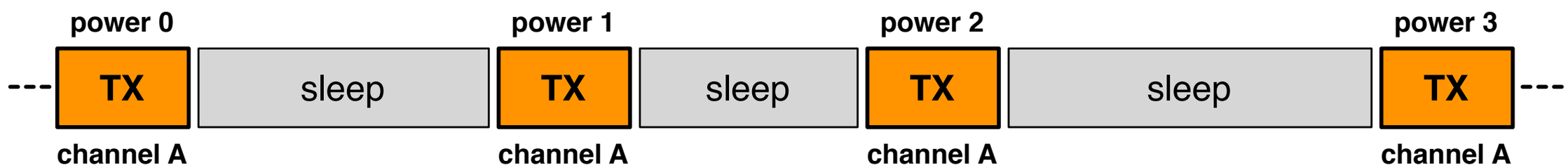
see also: V. Kostakos et al., “*Brief encounter networks*”, `http://arxiv.org/abs/0709.0223`

RFID-based contact detection: strategy

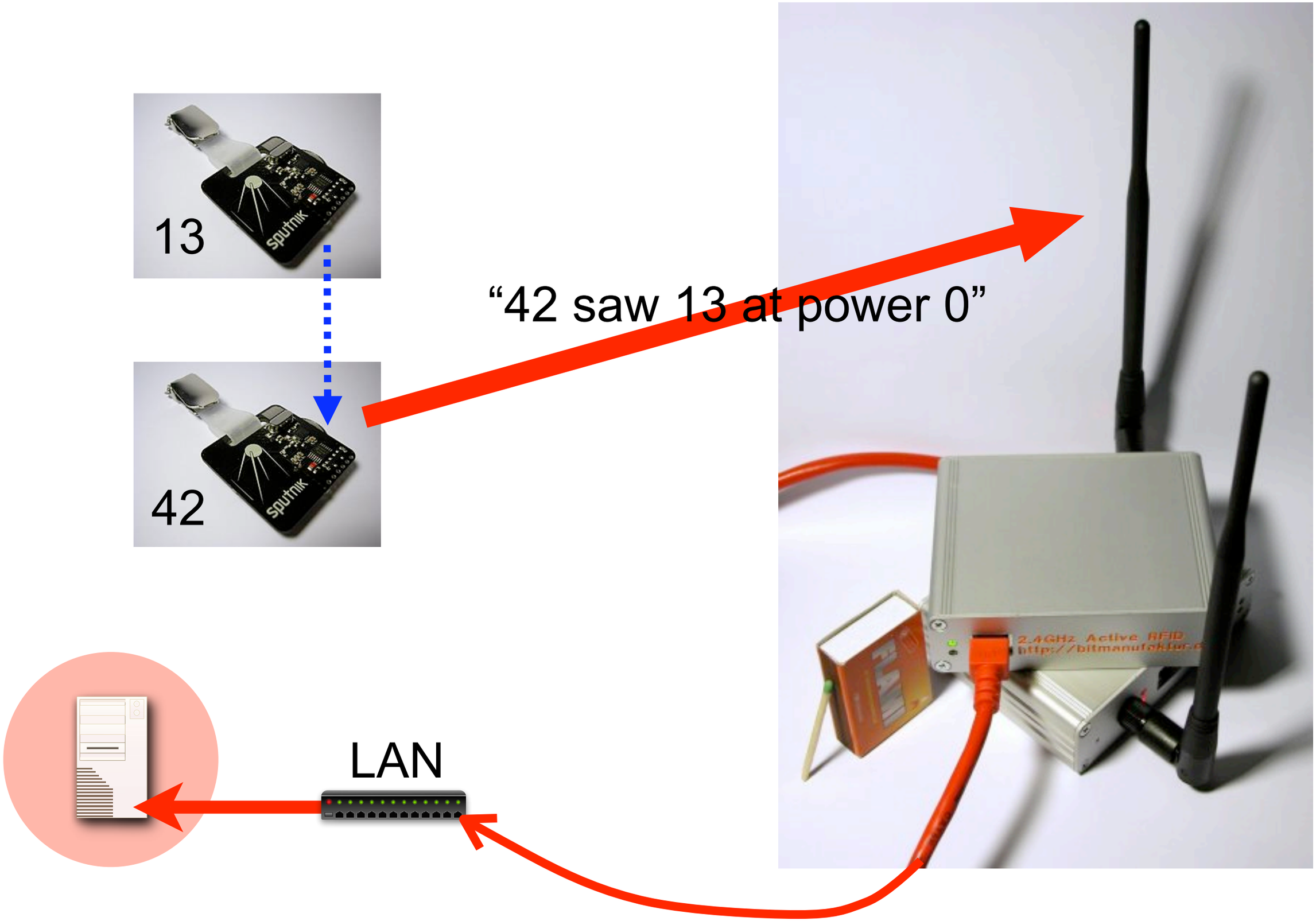


- ✓ unobtrusive
- ✓ scalable
- ✓ very low cost
- ✓ open (hw and sw)
- ❖ spatial resolution ~ 1 meter
- ❖ anisotropy
- ❖ temporal resolution ~ 5-20 seconds

direct contact detection



data collection pipeline

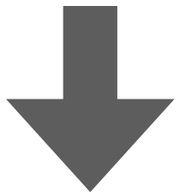


direct contact detection

fine-grained **spatial** (~ 1m) and **temporal** (~ 10s) resolution

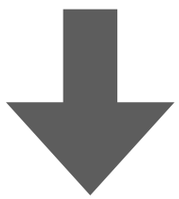
on-line post-processing @ 25C3

readers



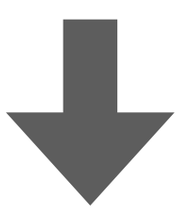
UDP

Python/Twisted aggregator



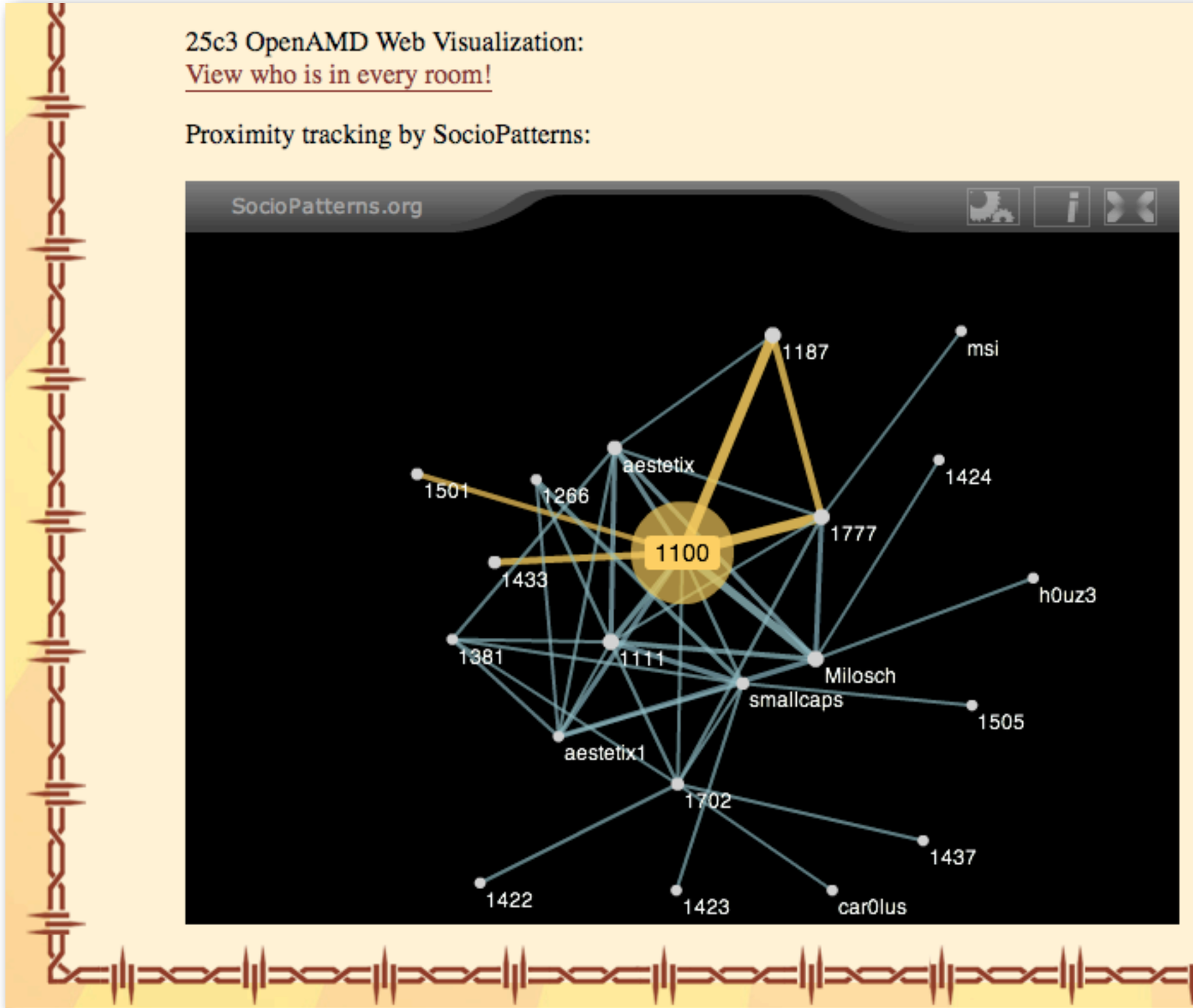
TCP

Python/Twisted backend engine: real-time views

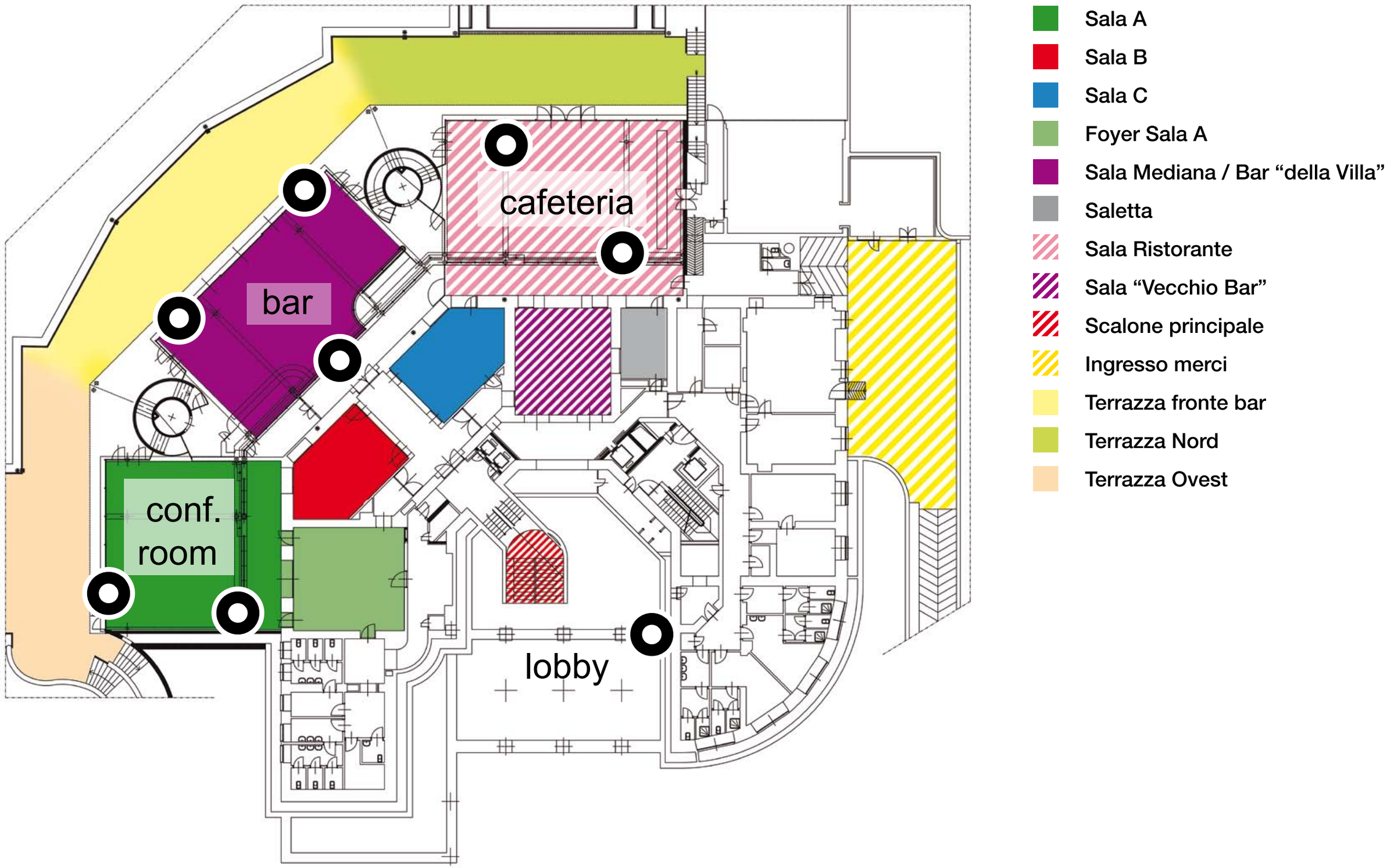


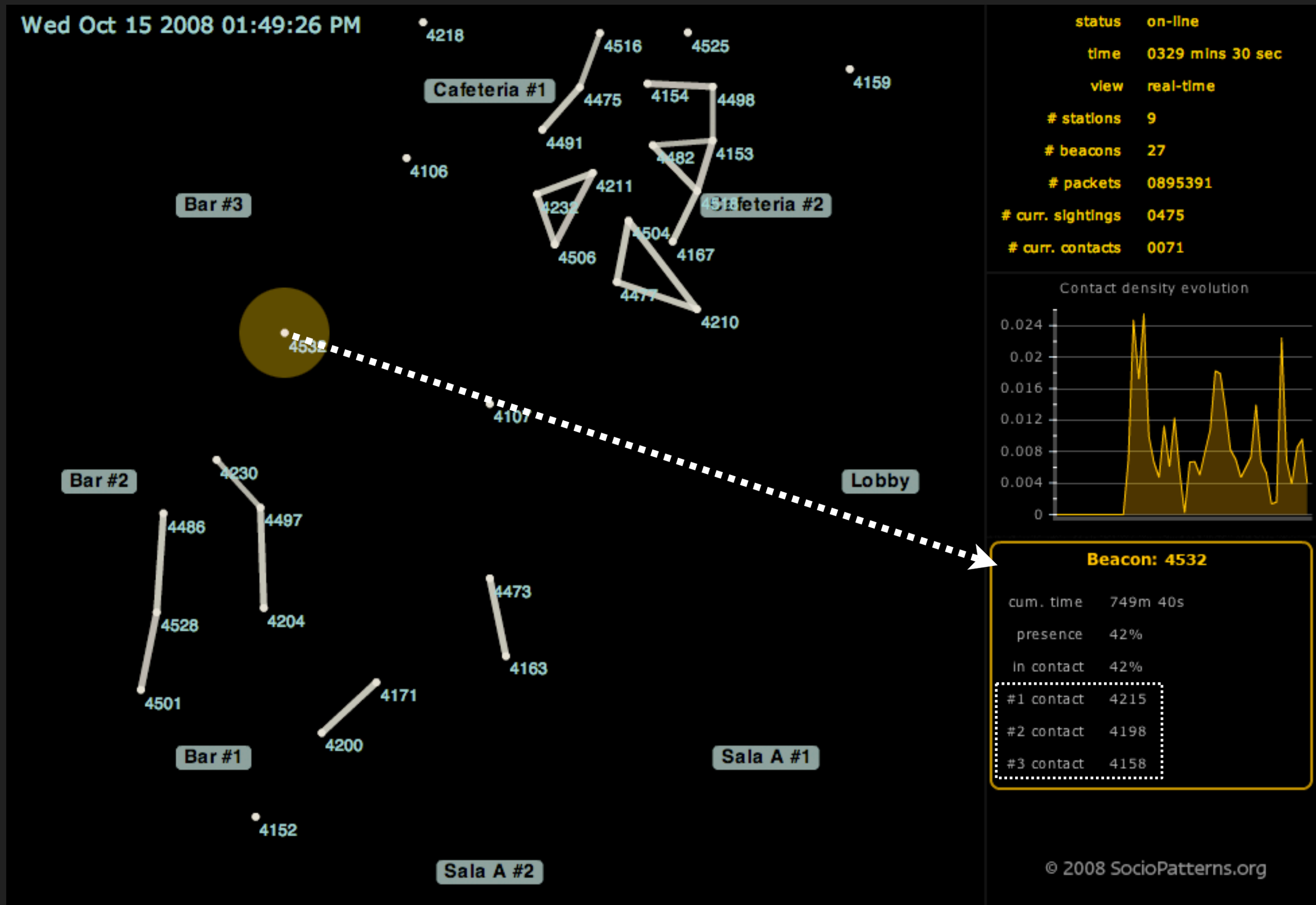
AMF socket

web-based Flash viz



experiment layout (oct '08)




Wed Oct 15 2008 01:49:26 PM
Cafeteria #1
Cafeteria #2
Bar #3
Bar #2
Bar #1
Lobby
Sala A #1
Sala A #2
4218
4516
4525
4159
4475
4154
4498
4491
4482
4153
4106
4211
4232
4504
4167
4506
4477
4210
4532
4107
4230
4497
4486
4473
4528
4204
4163
4501
4171
4200
4152
status on-line
time 0329 mins 30 sec
view real-time
stations 9
beacons 27
packets 0895391
curr. sightings 0475
curr. contacts 0071
Contact density evolution
0.024
0.02
0.016
0.012
0.008
0.004
0
Beacon: 4532
cum. time 749m 40s
presence 42%
in contact 42%
#1 contact 4215
#2 contact 4198
#3 contact 4158
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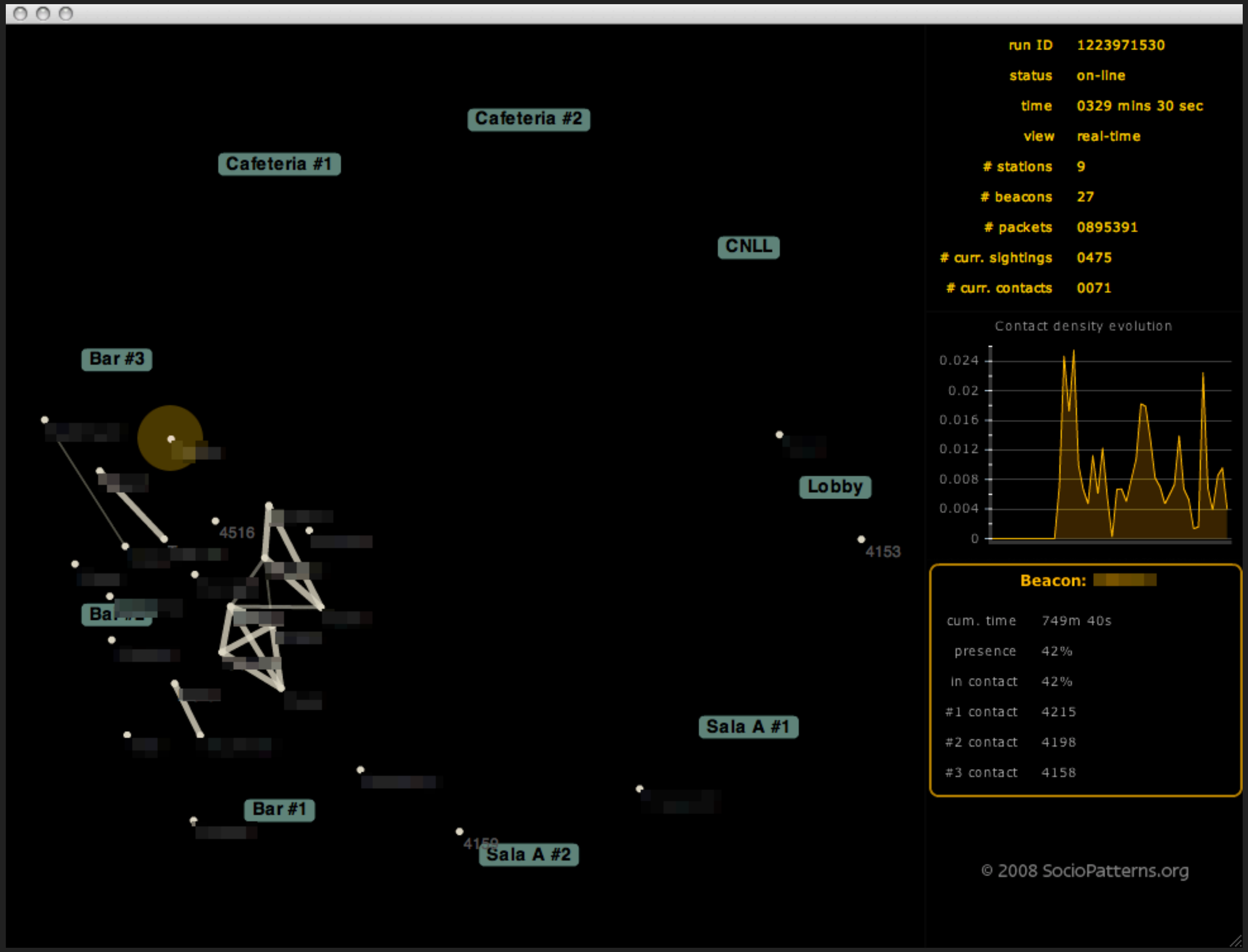
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status on-line
time 0329 mins 30 sec
view real-time
stations 9
beacons 27
packets 0895391
curr. sightings 0475
curr. contacts 0071
Contact density evolution
0.024
0.02
0.016
0.012
0.008
0.004
0
Beacon:
cum. time 749m 40s
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#1 contact 4215
#2 contact 4198
#3 contact 4158
Cafeteria #2
Cafeteria #1
CNLL
Bar #3
Lobby
4516
4153
Sala A #1
Bar #1
Sala A #2
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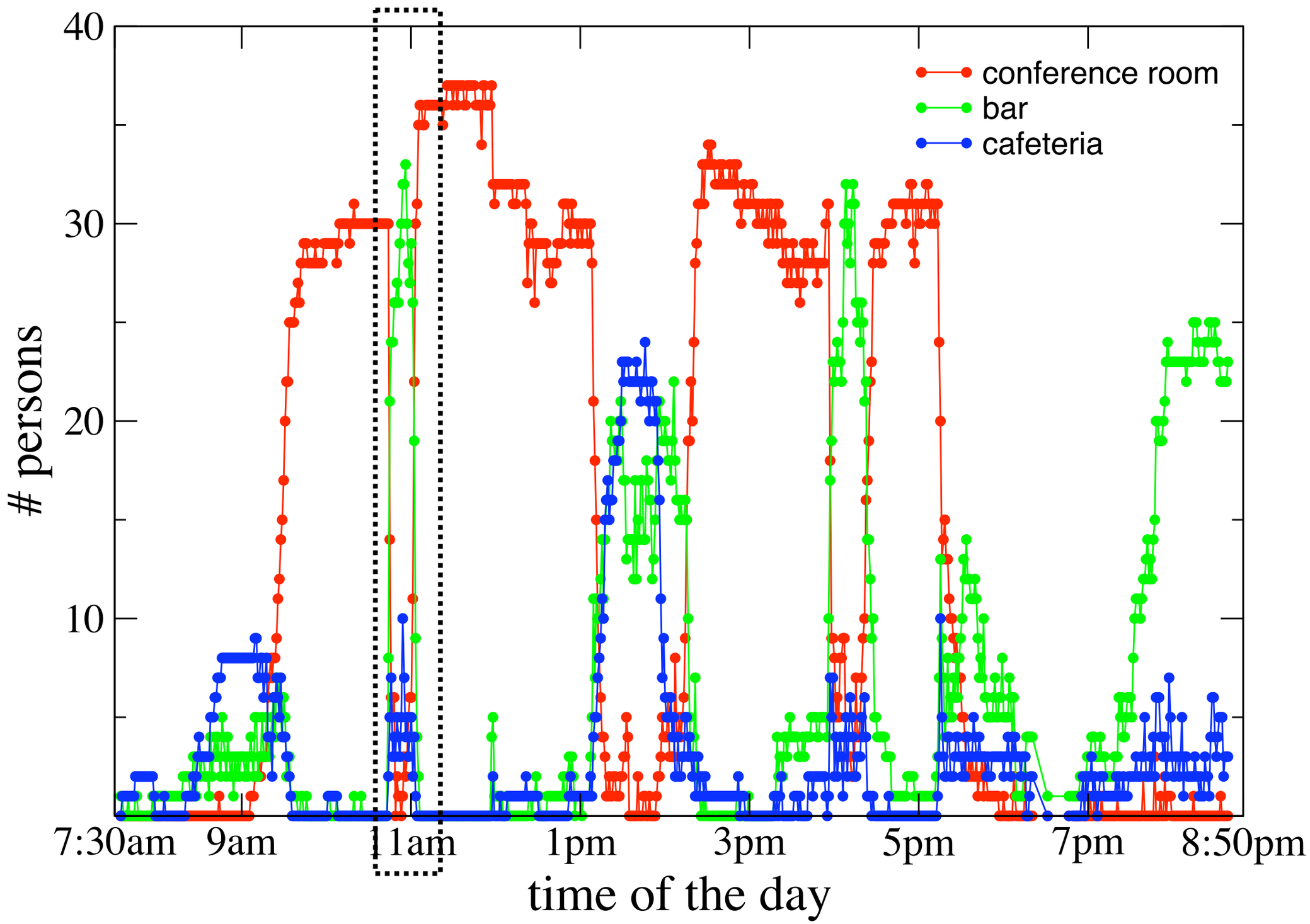
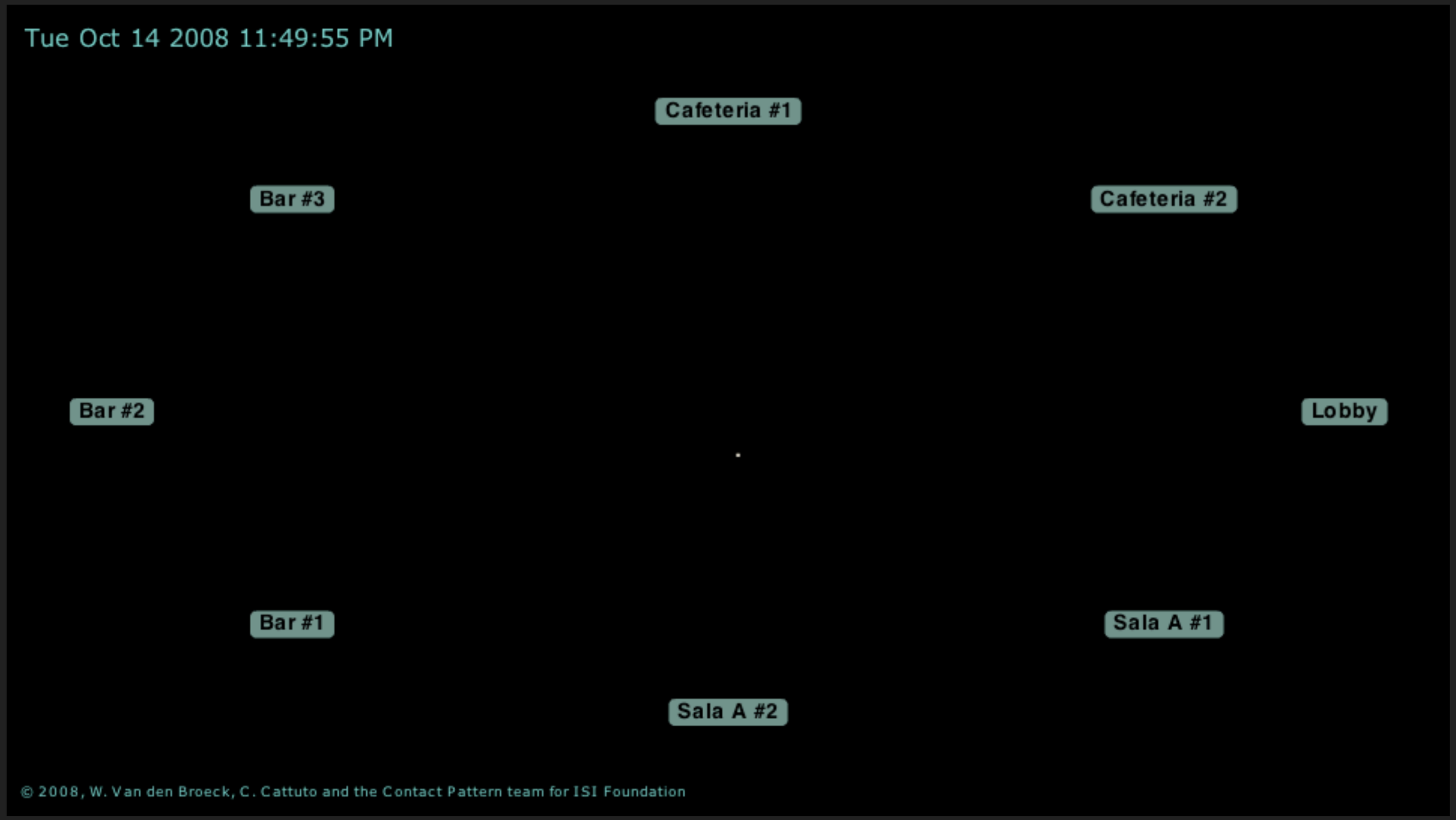
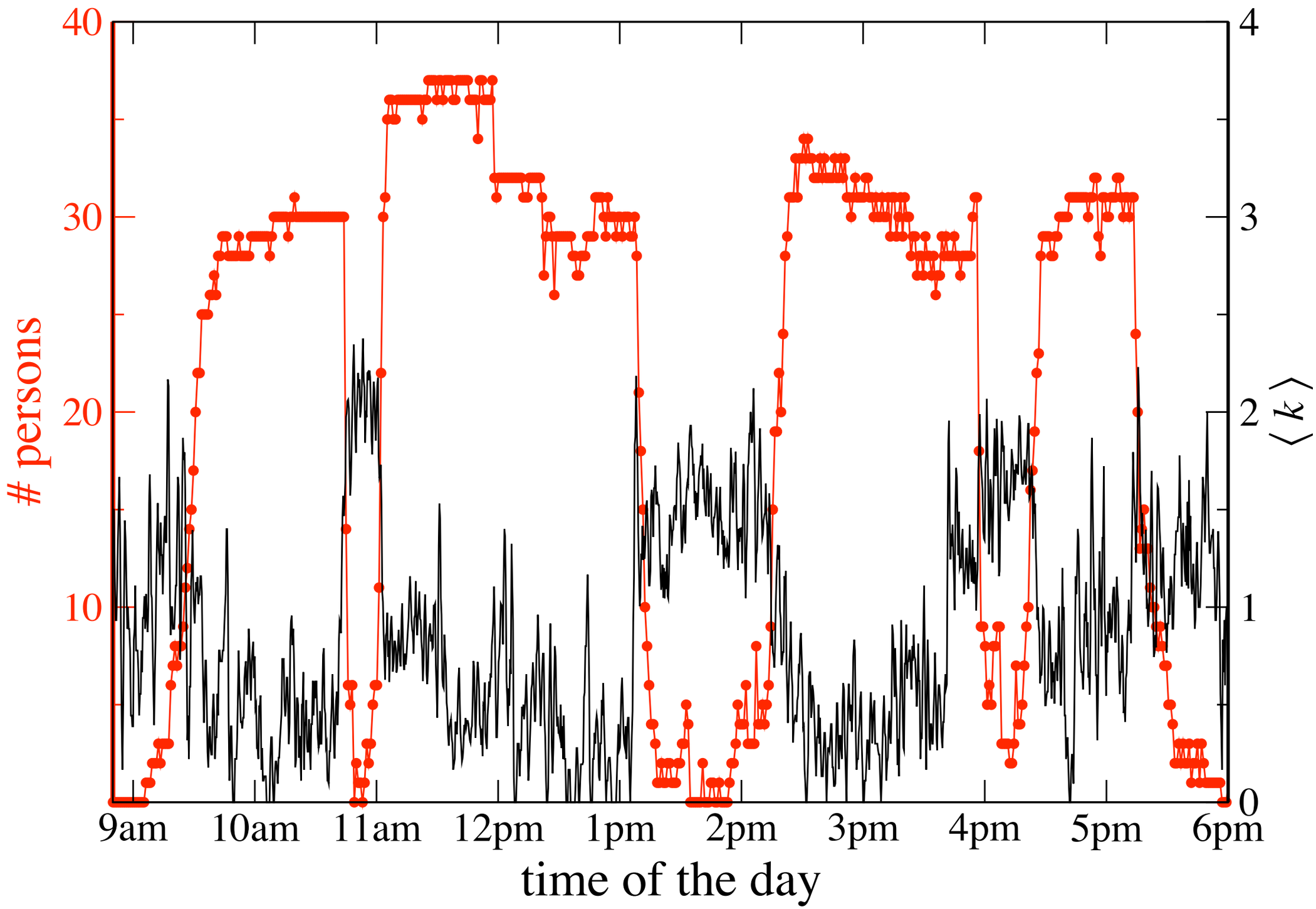
presence of attendees



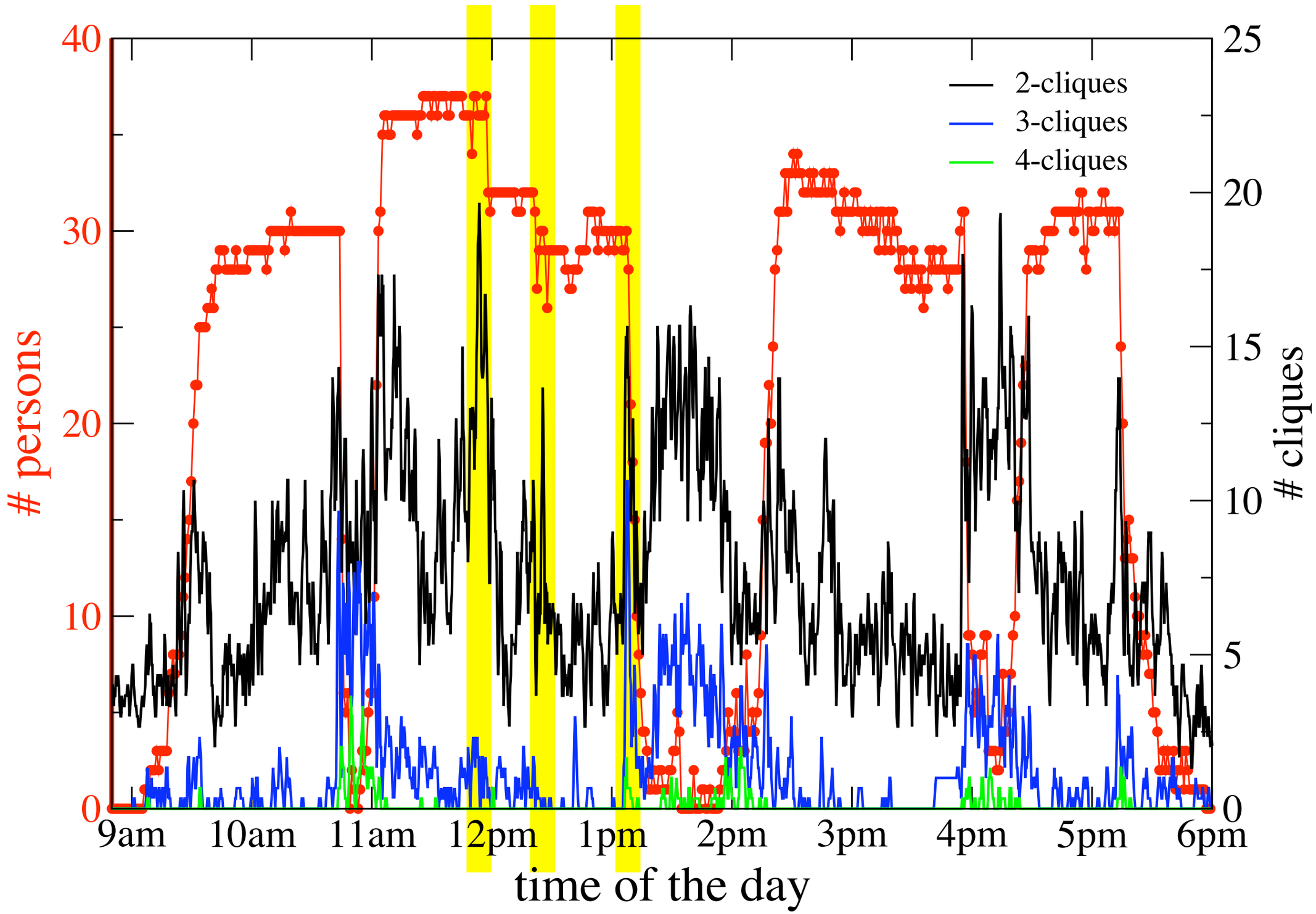
instantaneous contact network



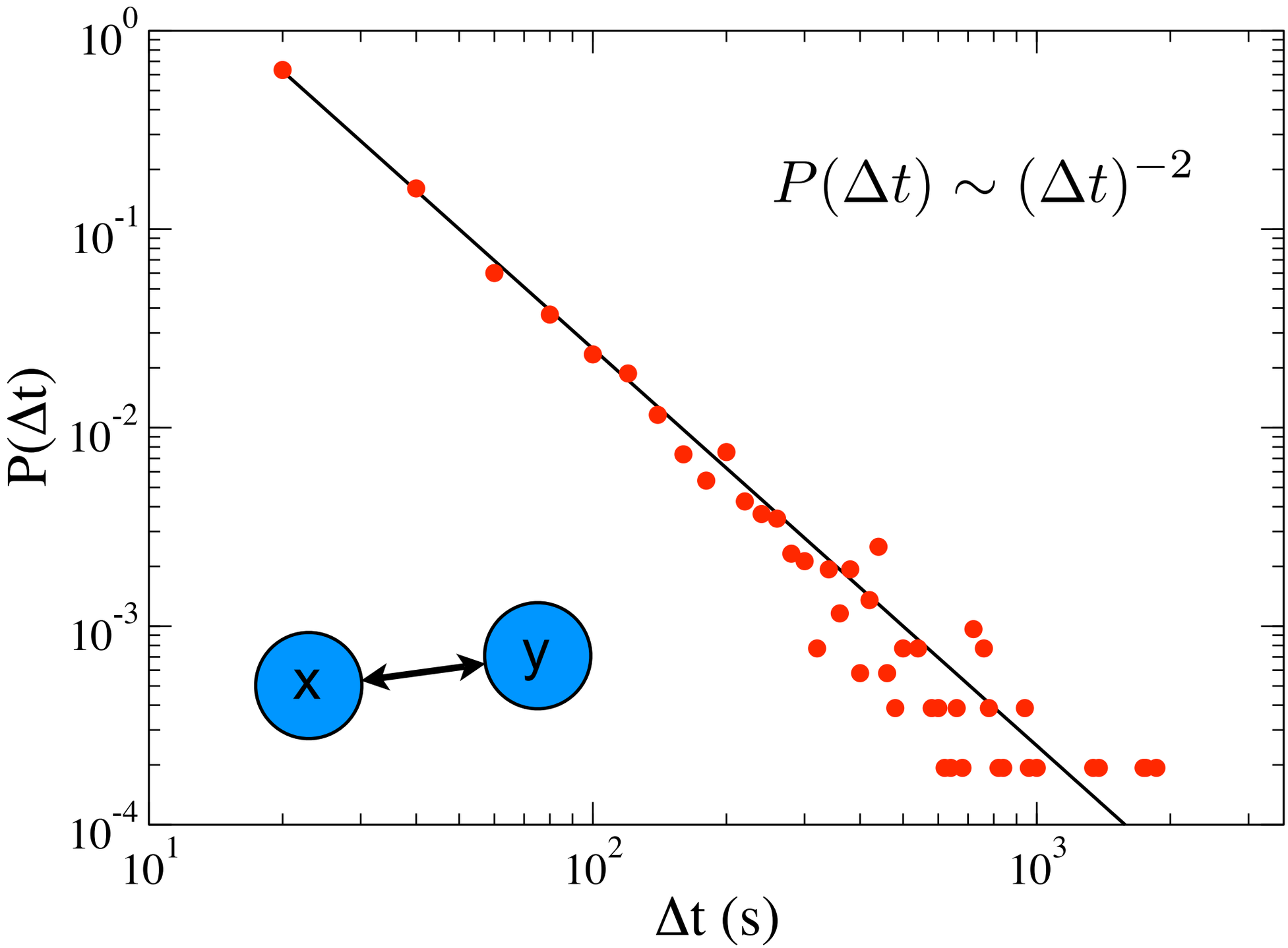
number of active contacts



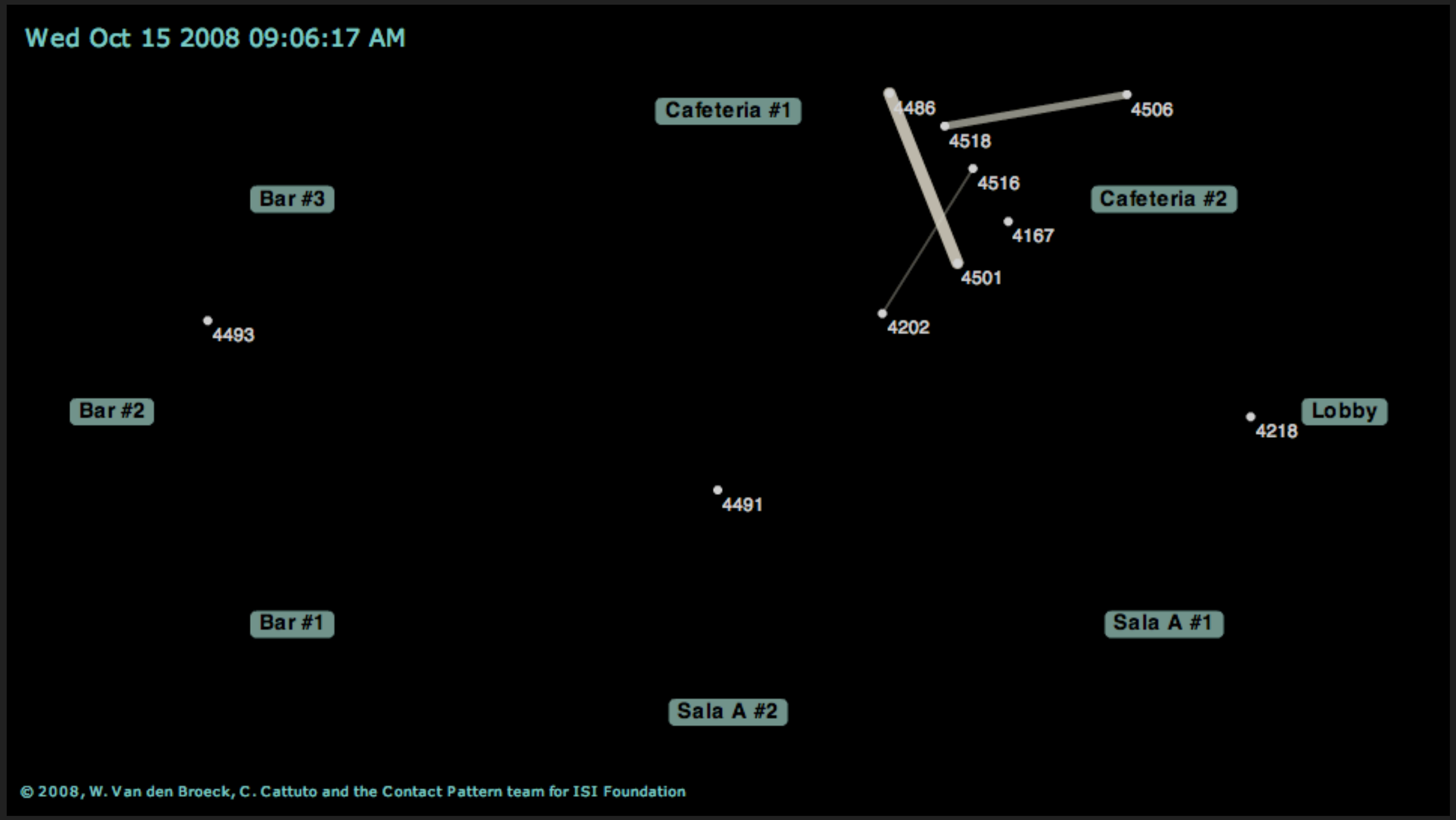
number of cliques



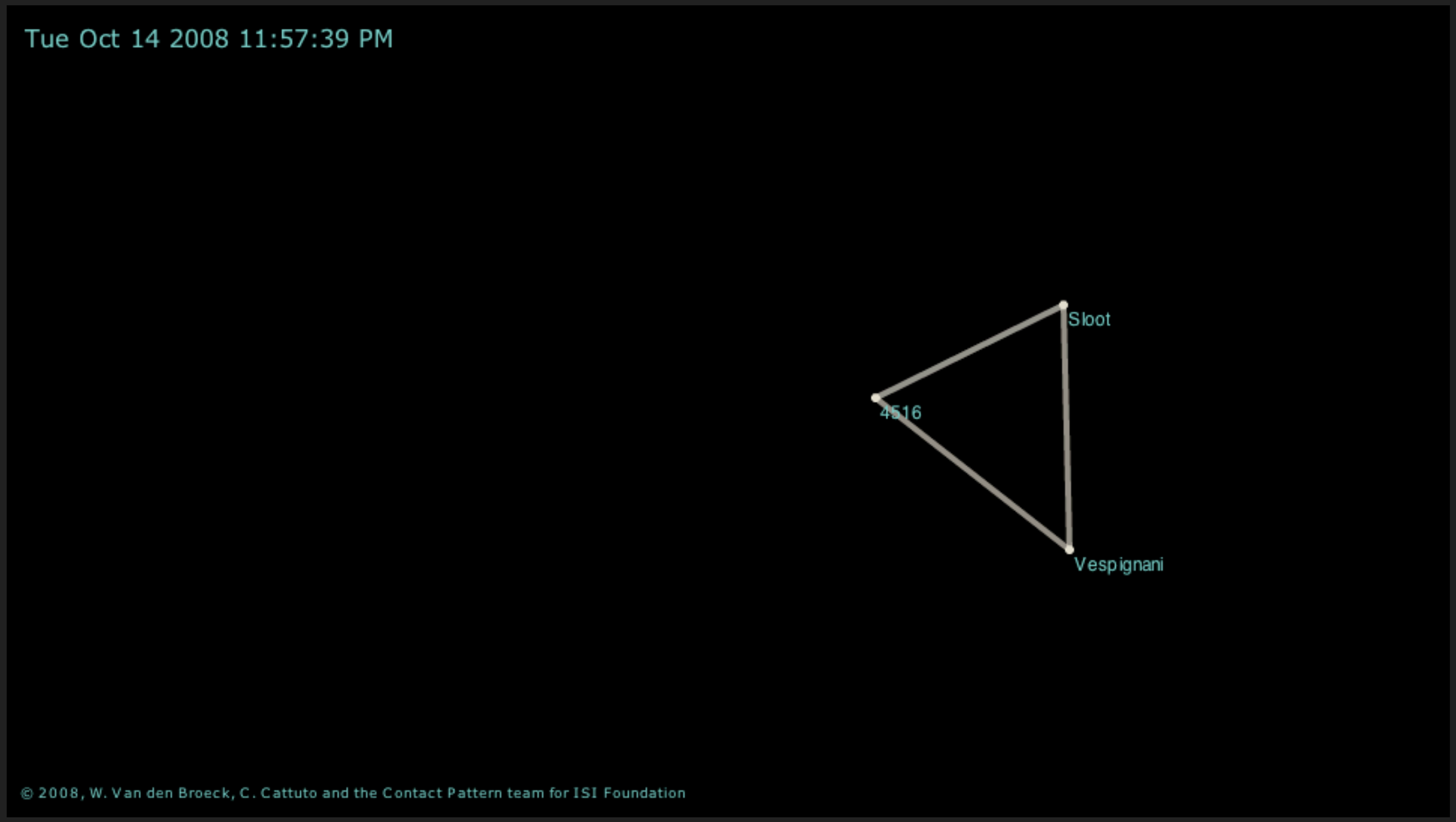
contact duration

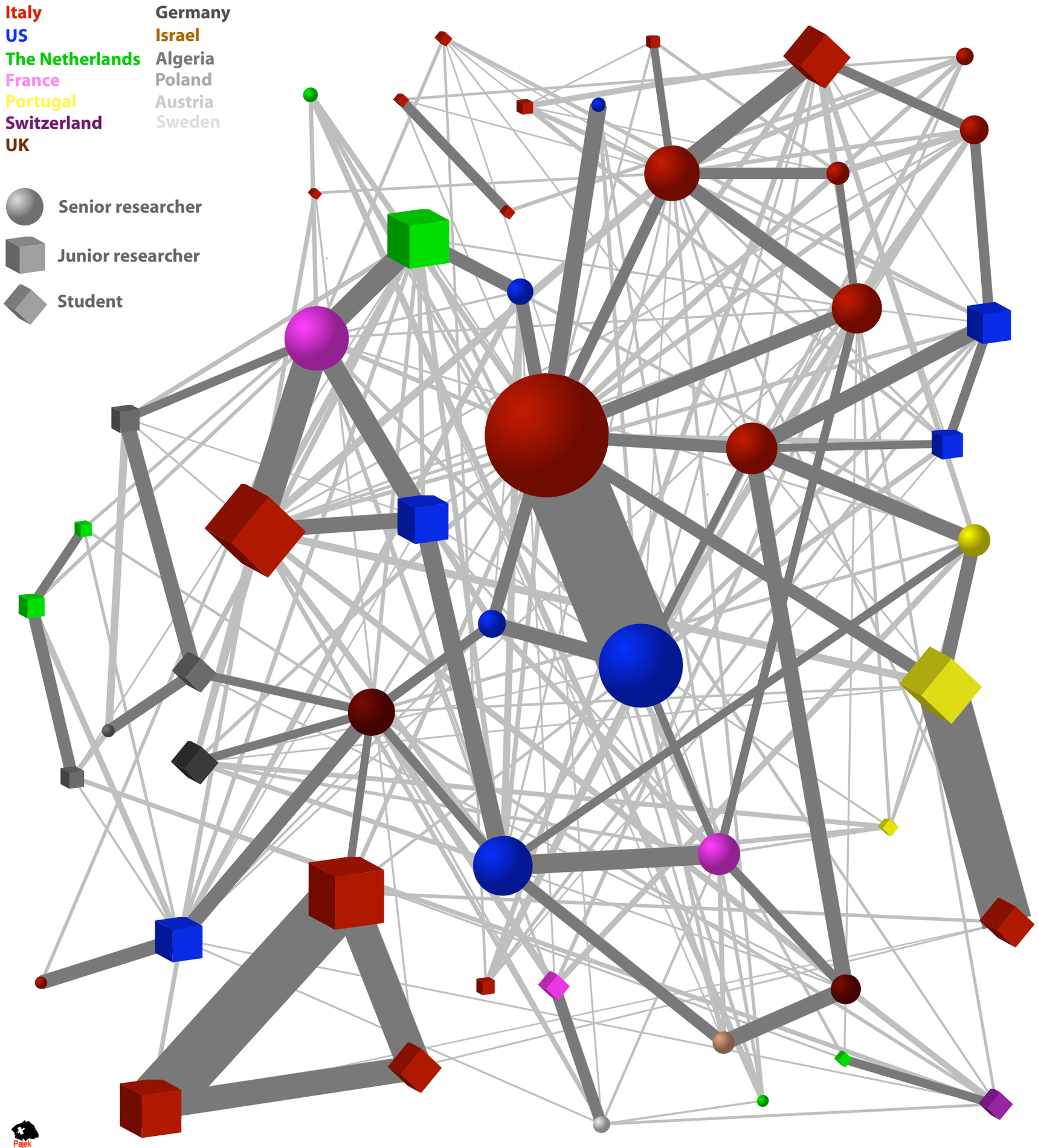


epidemics on real contact patterns



cumulative contact networks




Italy
US
The Netherlands
France
Portugal
Switzerland
UK
Germany
Israel
Algeria
Poland
Austria
Sweden
Senior researcher
Junior researcher
Student
Pajek

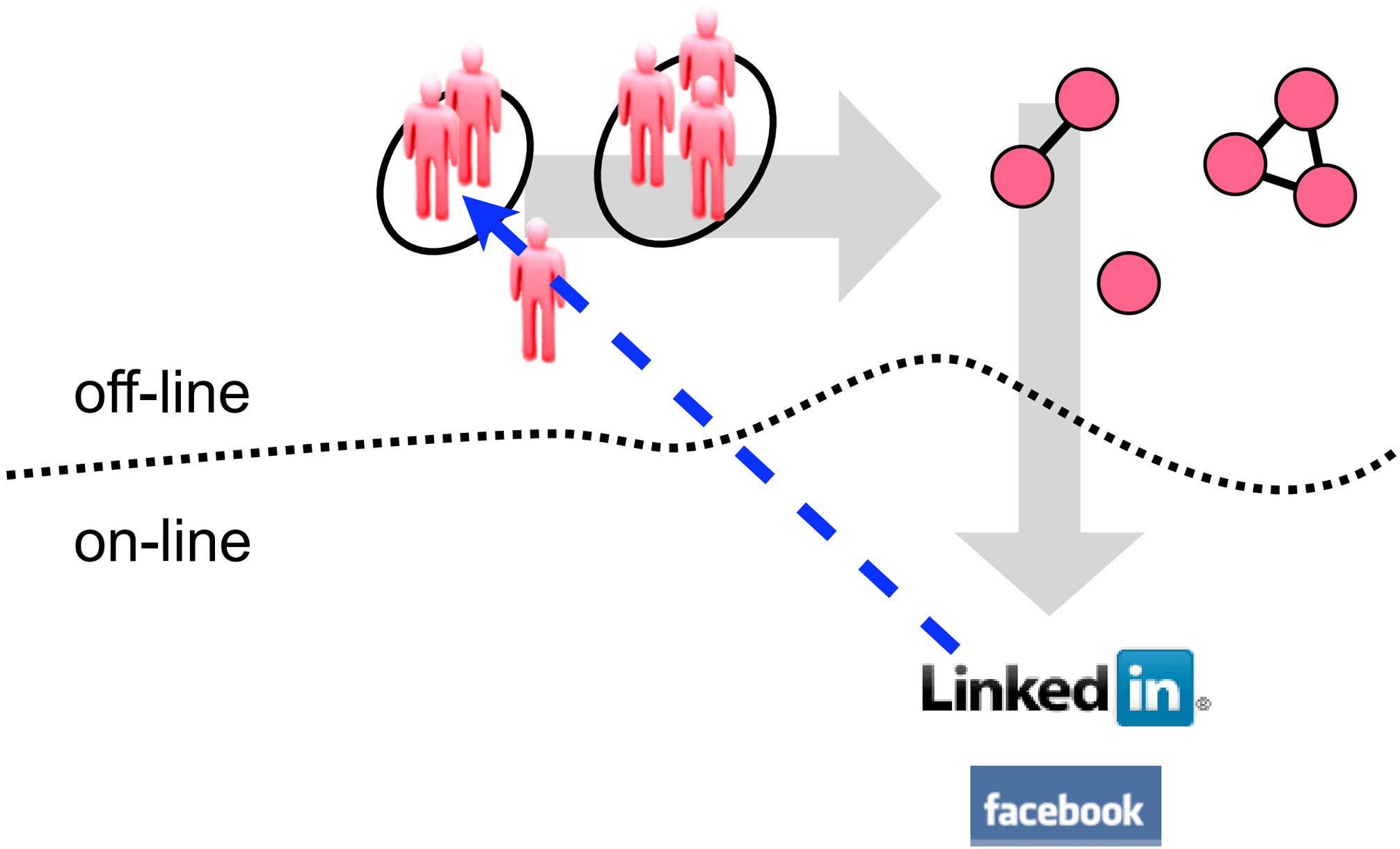
outlook

- large-scale experiments (> 1,000 persons) in early 2009
- several medium scale experiments planned

- variety of contexts
  - conference
  - office
  - hospital
  - museum

- models of human dynamics
- longitudinal contact network analysis
- epidemiology
- organizational studies
- integration with background knowledge
- social networking services

“social serendipity”



finding *surprising* connections

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acknowledgements:

- aestetix
- Janette Lehmann
- Brita Meriac
- Milosch Meriac
- Aurora Mazzone
- Eric
- Marco Perosa
- Tomasz Rybak

- YOU