Presence Detection in SmartRoom: Experimental Performance Evaluation

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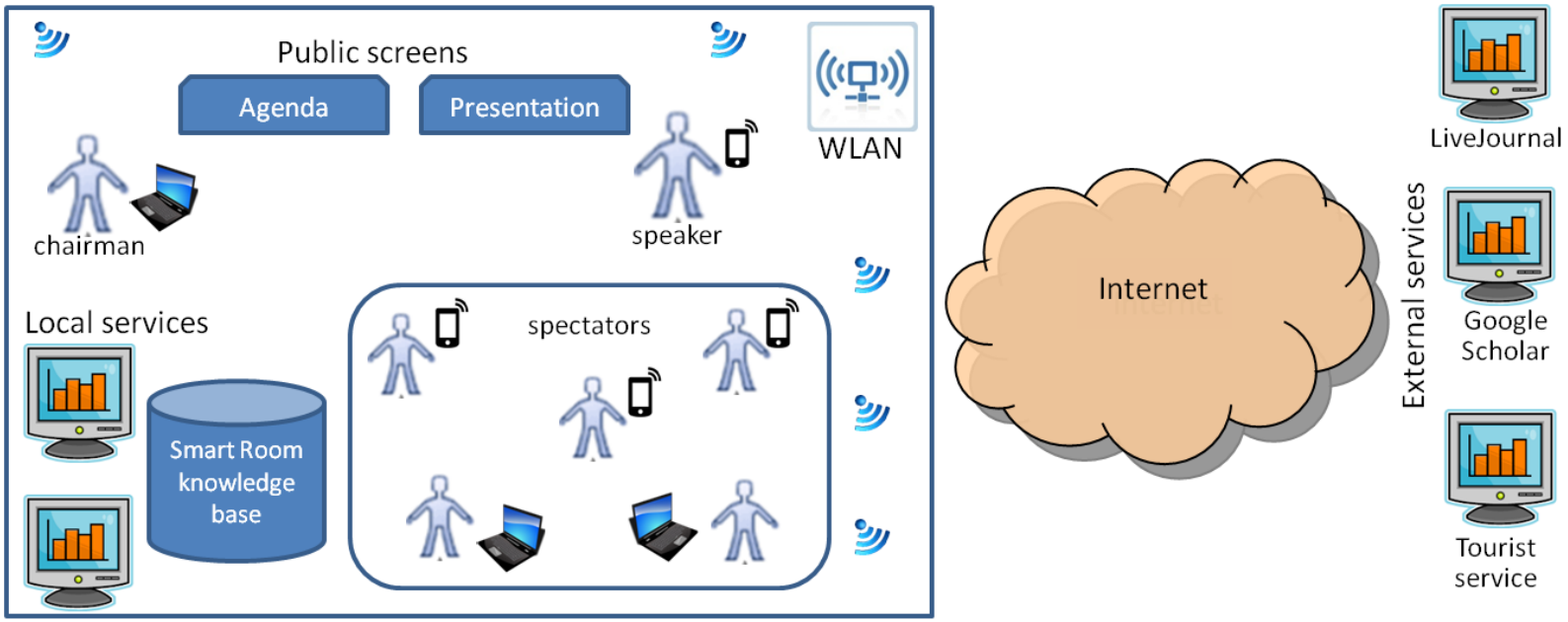
User Presence: Scenarios

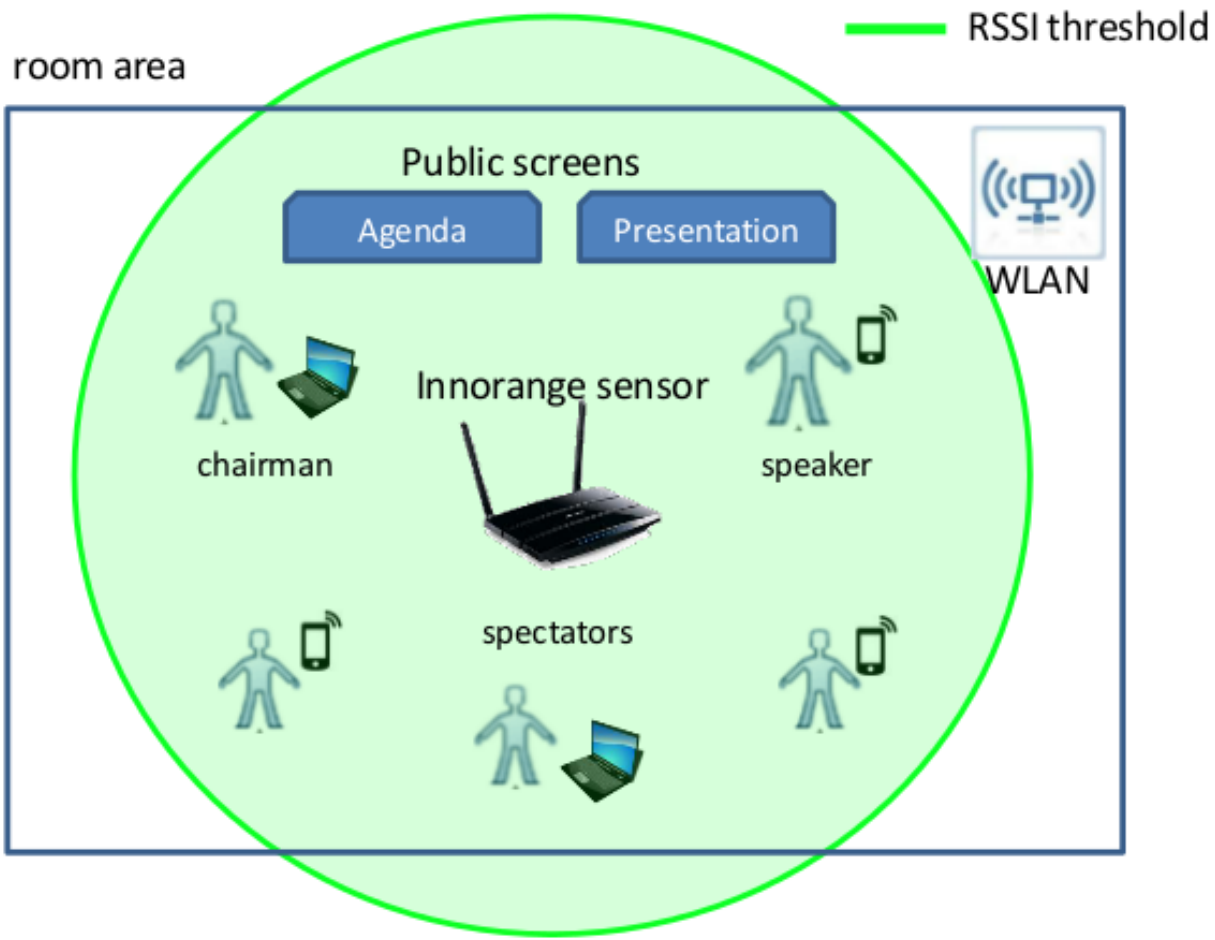
SmartRoom provides a set of digital services to many participants



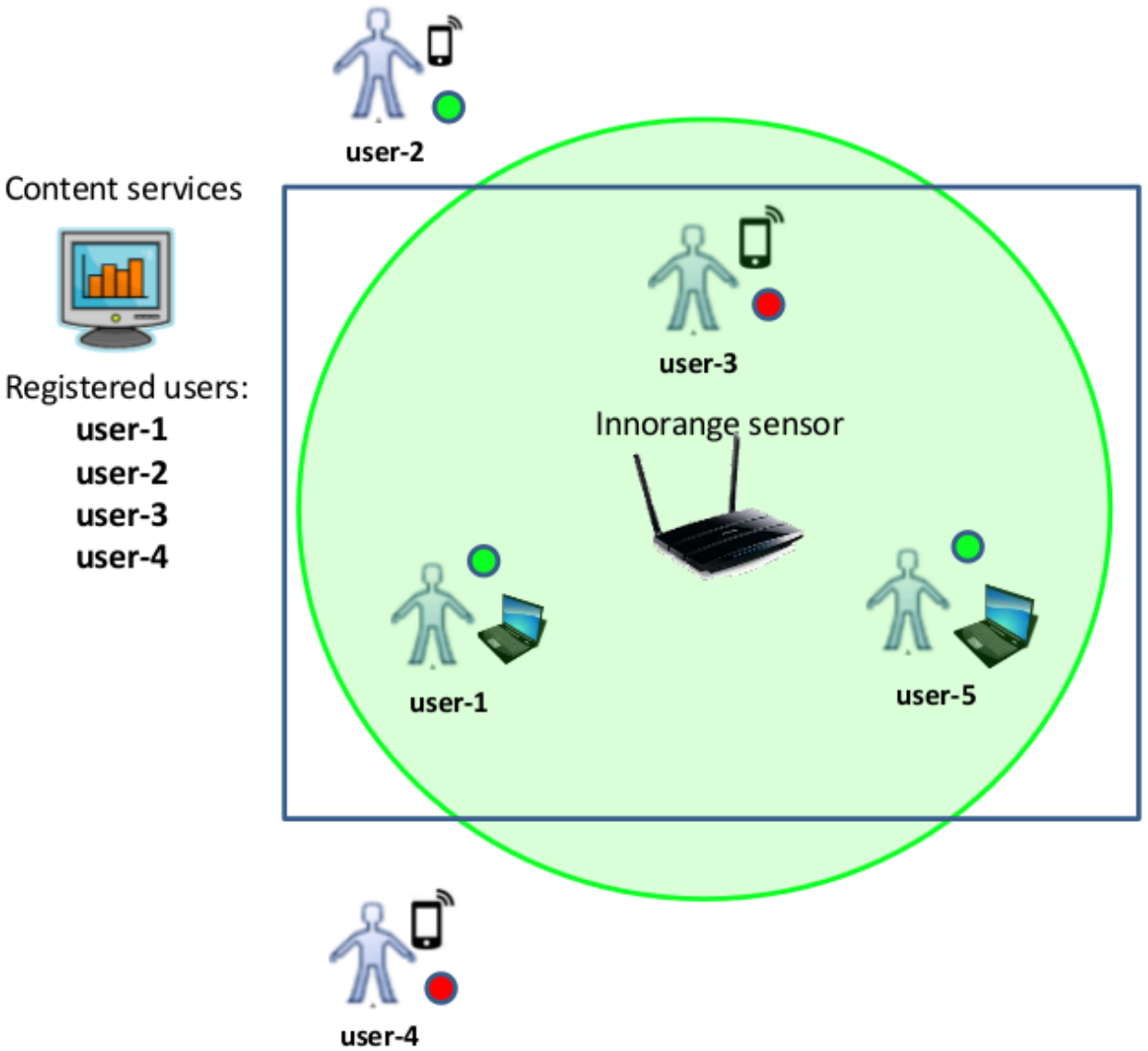
- S_1: User arrival to the room (spatial physical area)
- S_2: User joins and leaves during the main activity
- S_3: User activity statistics

User Presence Detection: Technology Enablers

- End-users have personal computers and mobile devices
- Radio Detection using Received Signal Strength Indication
- Innorange Footfall Technology



User Presence State



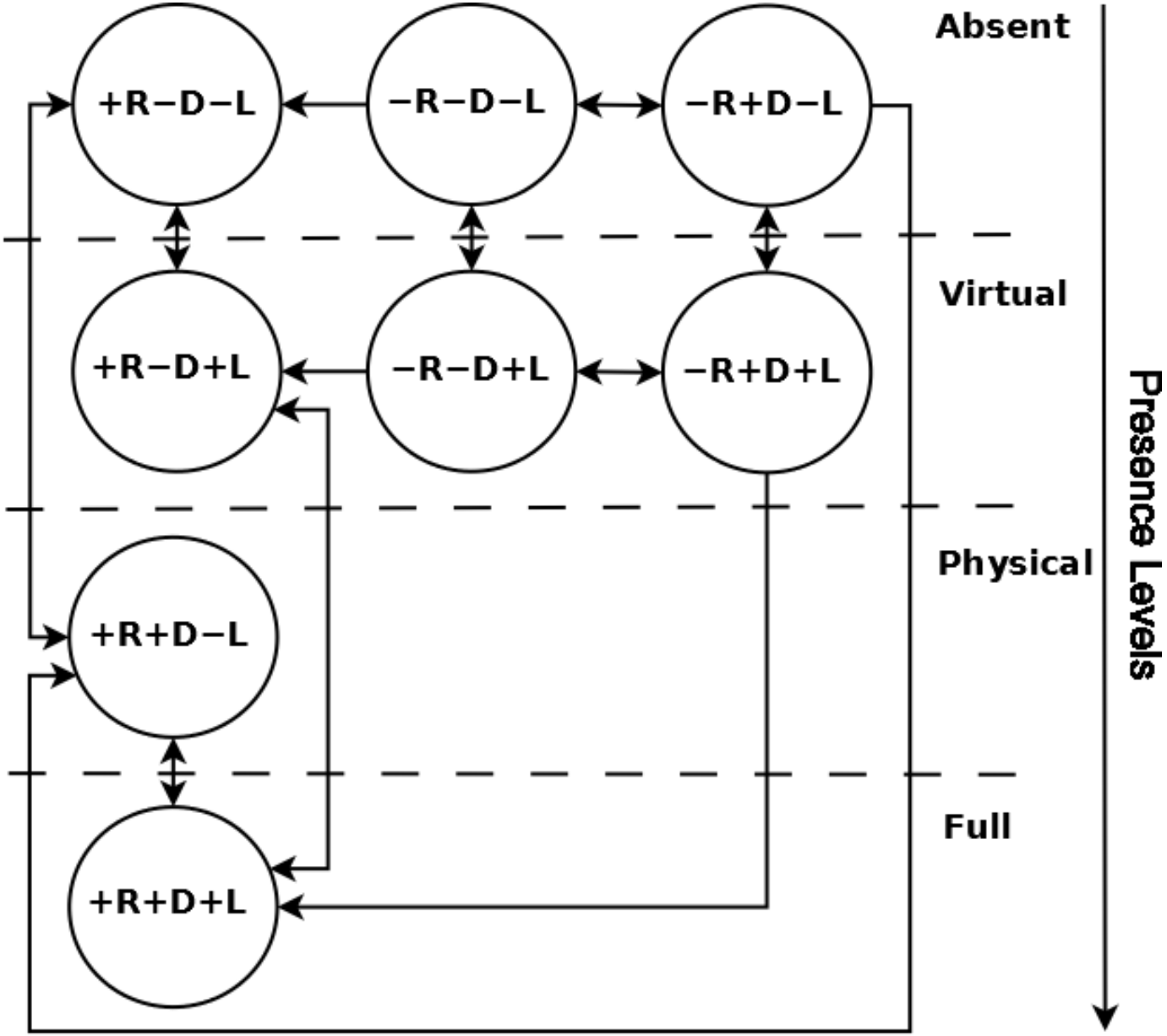
R: the user is registered in the system

D: the sensor is detected user's device

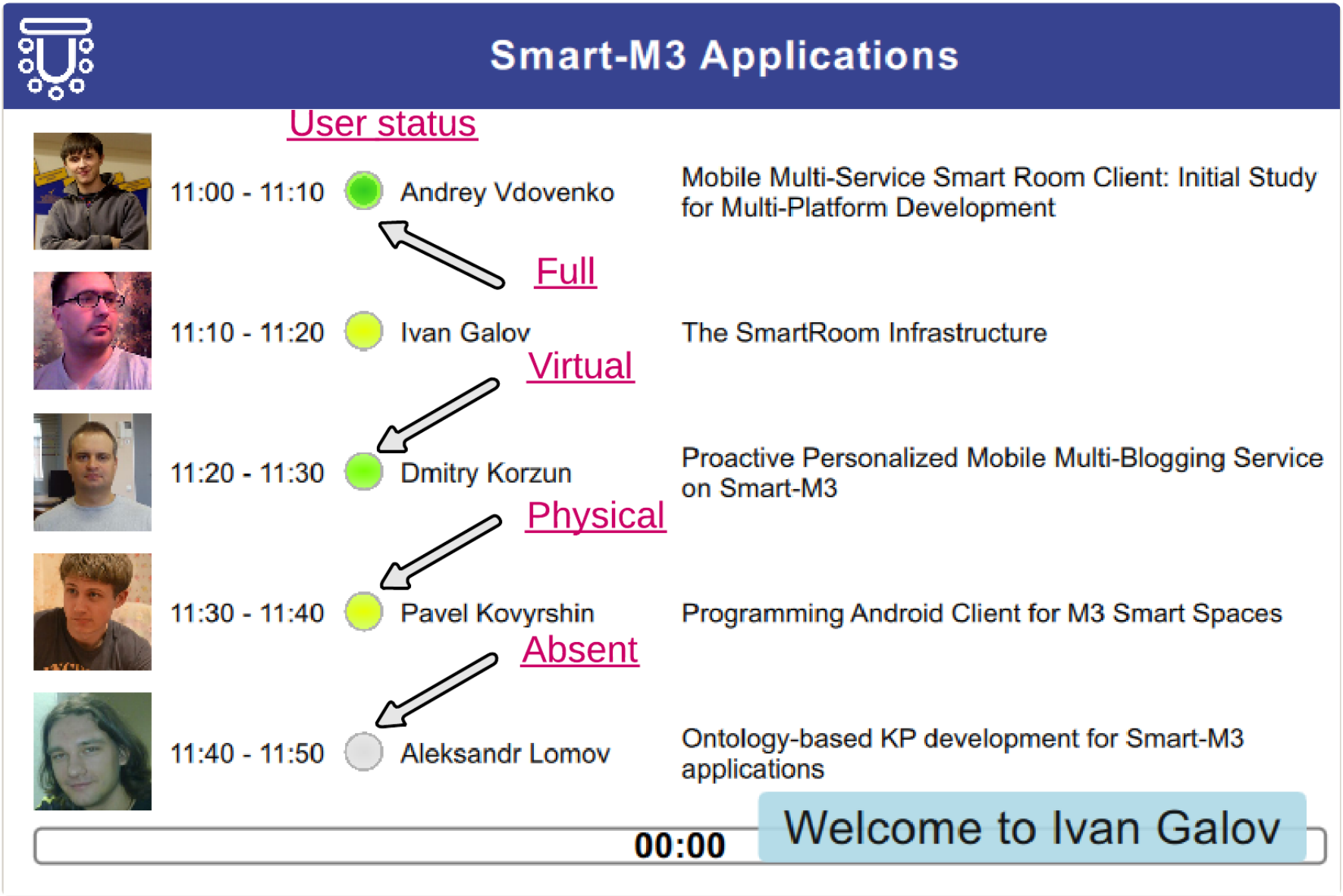
L: the user accessed the system

user-1 $\leftrightarrow +\mathrm{R} +\mathrm{D} +\mathrm{L}$
user-2 $\leftrightarrow +\mathrm{R} -\mathrm{D} +\mathrm{L}$
user-3 $\leftrightarrow +\mathrm{R} +\mathrm{D} -\mathrm{L}$
user-4 $\leftrightarrow +\mathrm{R} -\mathrm{D} -\mathrm{L}$
user-5 $\leftrightarrow -\mathrm{R} +\mathrm{D} +\mathrm{L}$

Discrete Measure for User Presence



Visualization of the Presence Levels

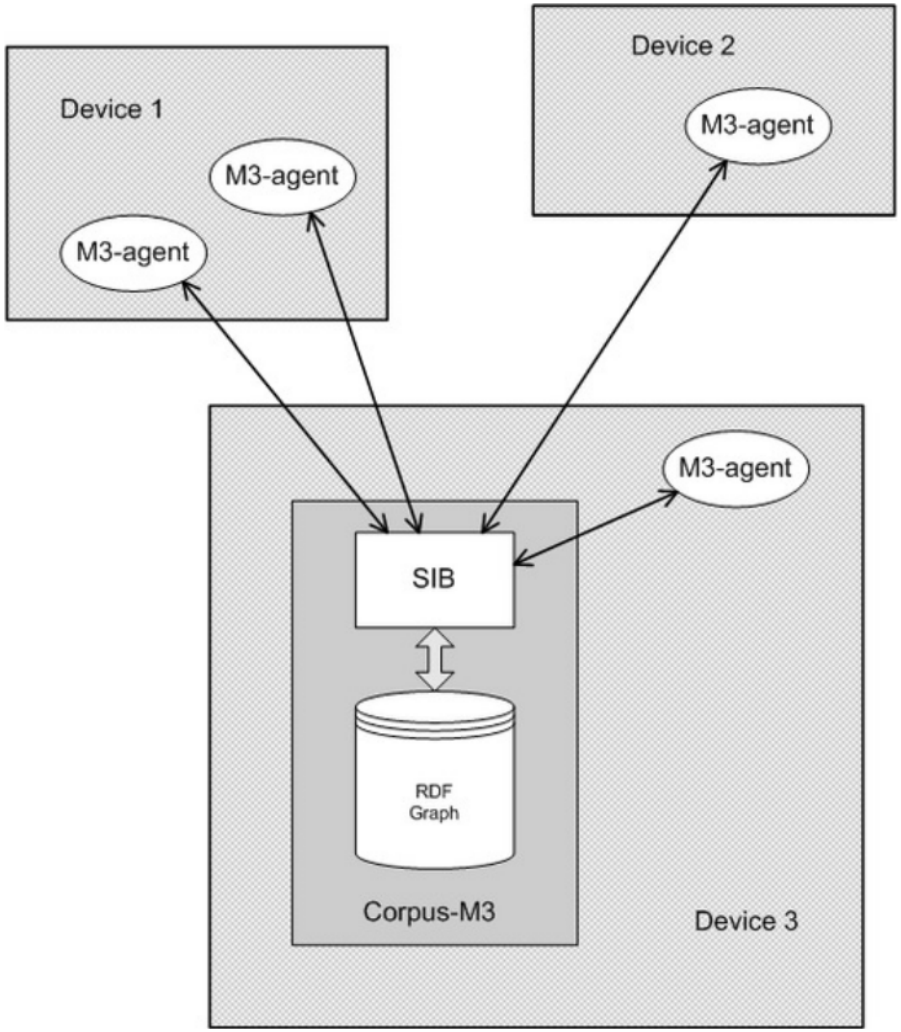


State Transitions

Use case	S_1: **User arrival to the room**	S_2: **User joins and leaves during the main activity**
User arrival is detected before starting main activity	$+\mathrm{R}\,-\mathrm{D}\,-\mathrm{L} \;\rightarrow\; +\mathrm{R}\,+\mathrm{D}\,-\mathrm{L}$	–
User is detected after the first arrival	–	$+\mathrm{R}\,-\mathrm{D}\,+\mathrm{L} \;\leftrightarrow\; +\mathrm{R}\,+\mathrm{D}\,+\mathrm{L}$ $+\mathrm{R}\,-\mathrm{D}\,-\mathrm{L} \;\leftrightarrow\; +\mathrm{R}\,+\mathrm{D}\,-\mathrm{L}$

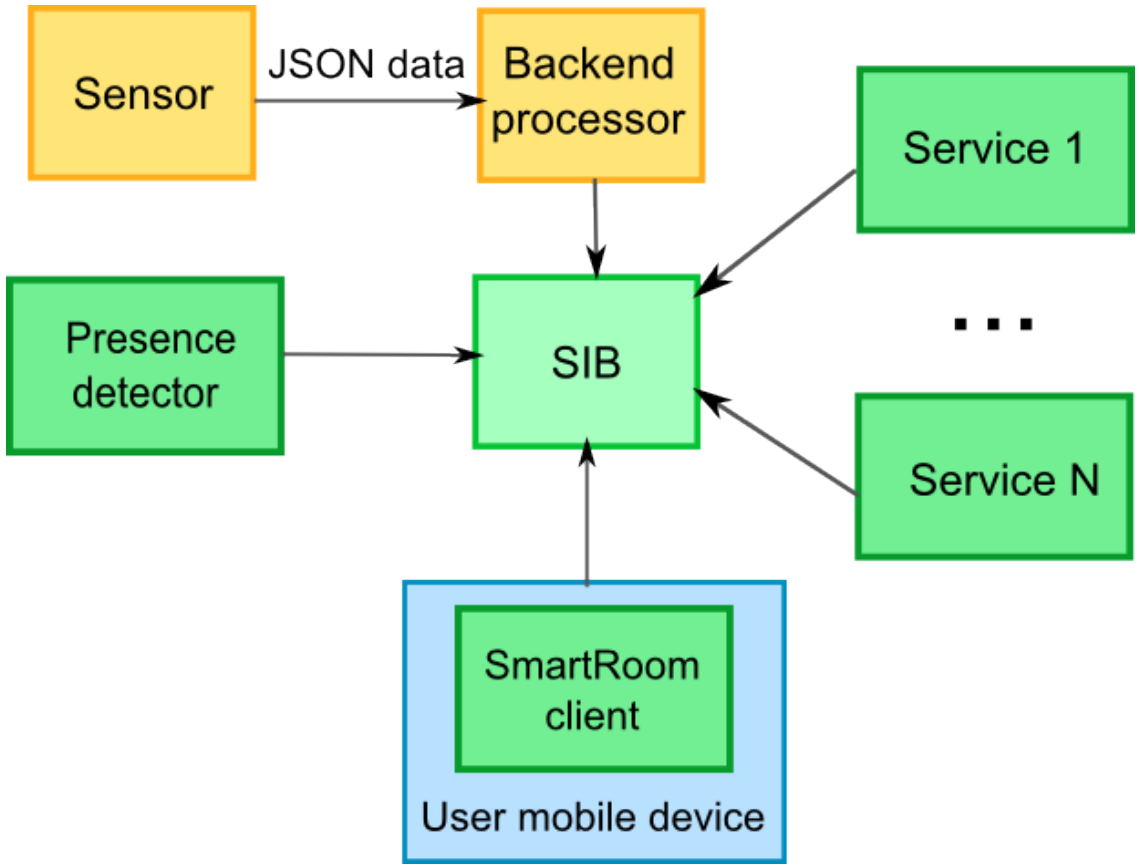
- S_1 and S_2 are based on detecting the transitions between states
- Evaluate the time required to detect transitions of S_1 and S_2

Smart-M3 Platform



- Implement infrastracture of Smart Spaces for knowledge separation between agents. (M3-agent, knowledge processor, KP)
- SIB - semantic information brocker
- For information storing used RDF data model

Architecture



- The sensor sends its measurements: MAC address, RSSI value and timestamp
- Backend processor is HTTP endpoint to processing presence data from sensor
- Presence detector KP detects presence information change

Performance

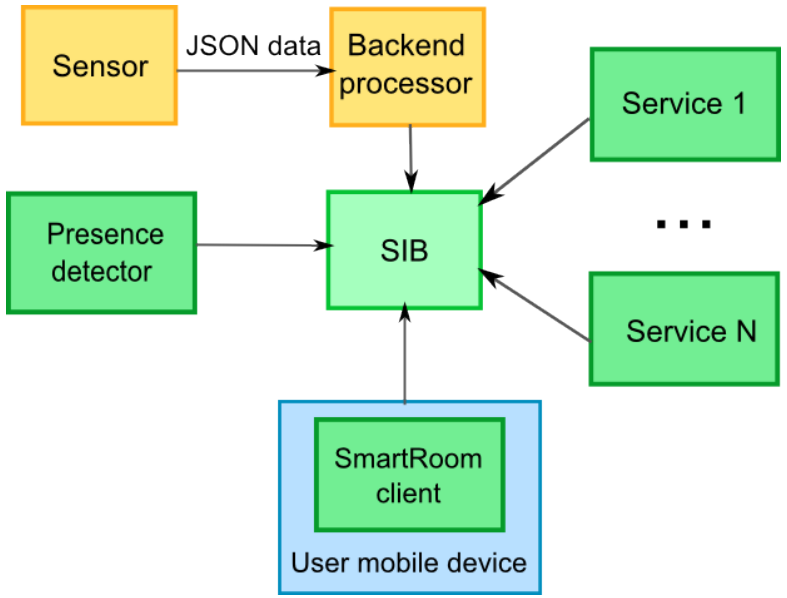
Steps for S_1:

1. The sensor determines close device and sends the device presence data
2. The backend processor publishes presence data in ontological form
3. The presence detector (notified by subscription) updates the data properties

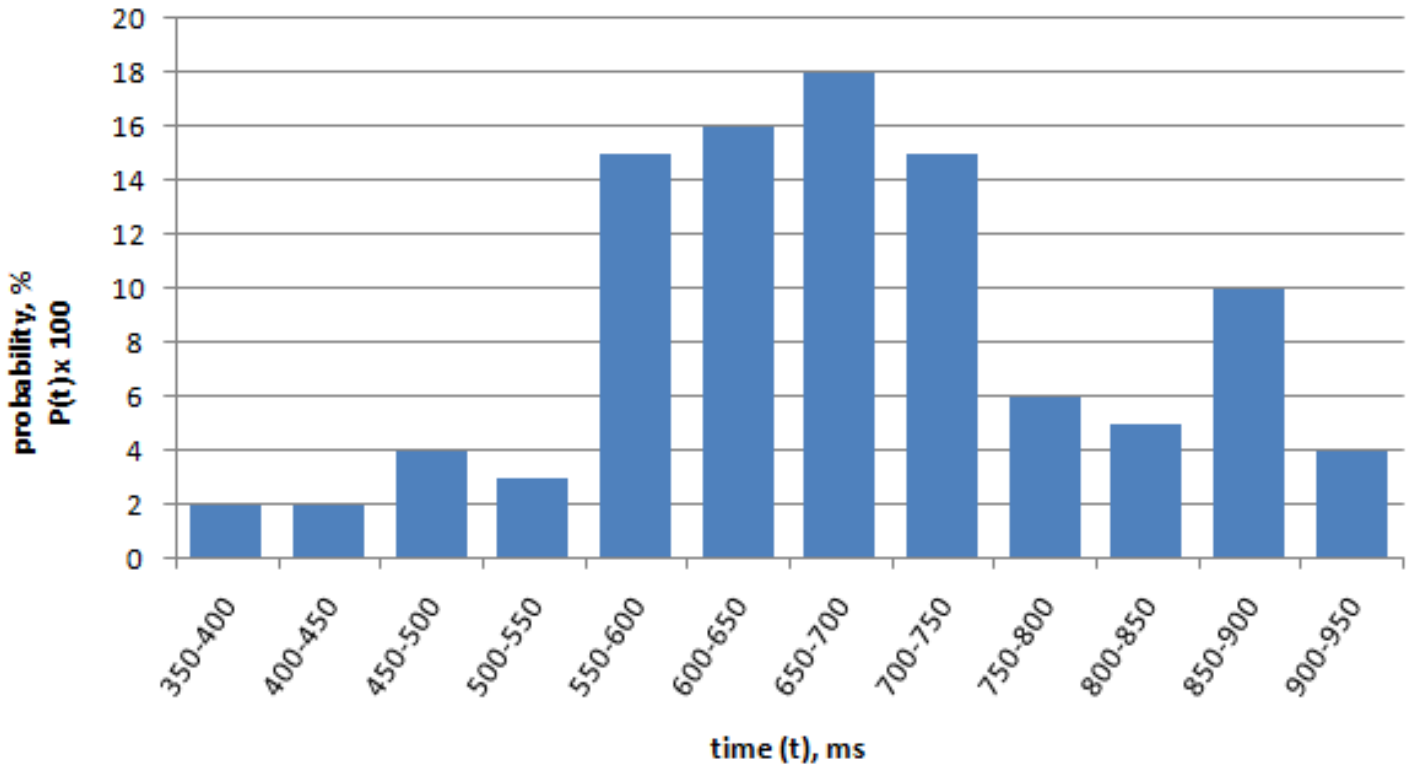
Detection time includes Steps 1–3 of S_1

The issues for the scenario S_2:

1. **Leave threshold**
2. Re-joining the main activity (similarly as in S_1)



Performance of Detection



- Sample size is **100**
- Average detection time is **677 ms**
- Detection time does not depend on the number of devices

Evaluation of the Leave Threshold

- Time of appearance when not actively transmit data

Devices	Operating System	Time of Appearance(s)
Nokia Lumia 920	Windows Phone 8.0	10.7
iPhone 5	iOS 7.1	18.3
Nokia 603	Symbian Belle	115.8
Galaxy Tab 7.7	Android 4.0.4	14.6
Galaxy S3	Android 4.3	13.6

- Leave threshold determines the maximum time of appearance of used devices or greater
- Current threshold: $T > 116$

Conclusion

- Model discrete scale for measuring the presence levels
- Architectural scheme for user presence detection and performance evaluation
- Performance evaluation:
  - Average detection time is 677 ms
  - Leave threshold : $T > 116$
- Source code: `http://sourceforge.net/projects/smartroom/services/presence-service`