Evaluation of the Smart Space Approach in Mobile Data Processing

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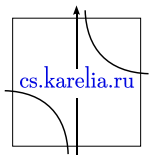

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Lausanne Data Collection Campaign by NRC–Lausanne

- Nearly 200 individuals
- Duration of 17 months from Sep. 2009
- Nokia N95 mobile phone were used to collect the data
- Continuously collected spatial data
- Social interaction data
- Phone use data

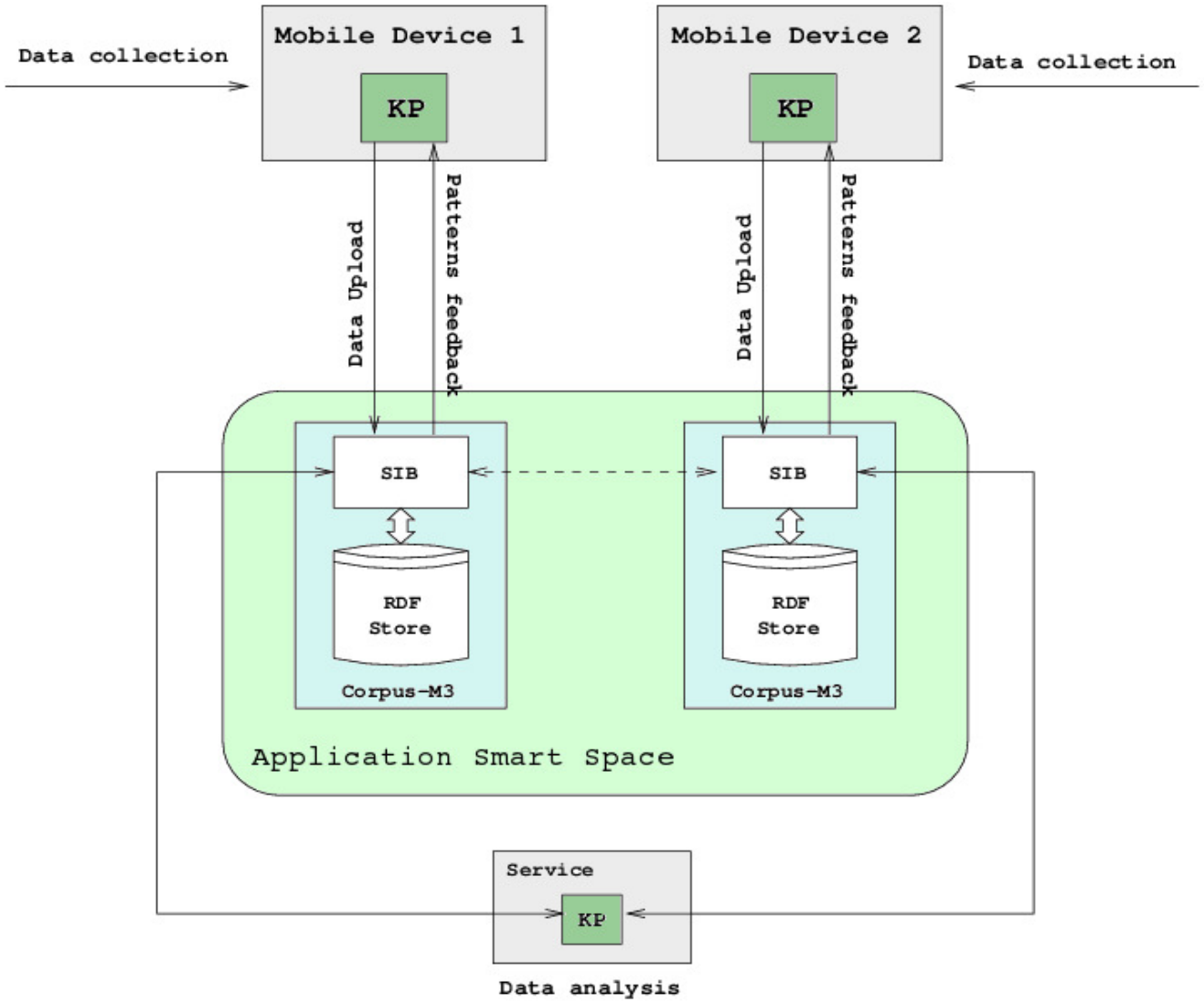
Mobile Data Challenge by NRC–Lausanne

- Releases the Lausanne data (MDC Data Set) made available for the research community in Jan. 2012
- Two alternative tracks: Open Track and Dedicated Track
- Around 700 individual researchers registered, almost 500 challenge tasks were registered
- “Mobile Data Challenge by Nokia” workshop in connection with Pervasive 2012 (June 18th 2012, Newcastle, UK)

Characteristics of the MDC Data Set

- Data on 38 individuals, Sep. 2009 — Apr. 2011
- Data size 17.7 GB
- 13 types of data:
  - accel – scan of the accelerometer sensors
  - application – application events
  - bluetooth – bluetooth devices seen by the user
  - calendar – calendar entries
  - calllog – calls log
  - contacts – contact entries
  - gps – gps positions of the user
  - gsm – gsm cells that the user has seen
  - media – media found on the device
  - mediaplay – information on how user had play media
  - process – informations on the running processes
  - sys – general system informations about the phone
  - wlan – wlan devices seen by the user
  - wlan_loc – geo-position of the wlan access points

Mobile data processing with Smart-M3

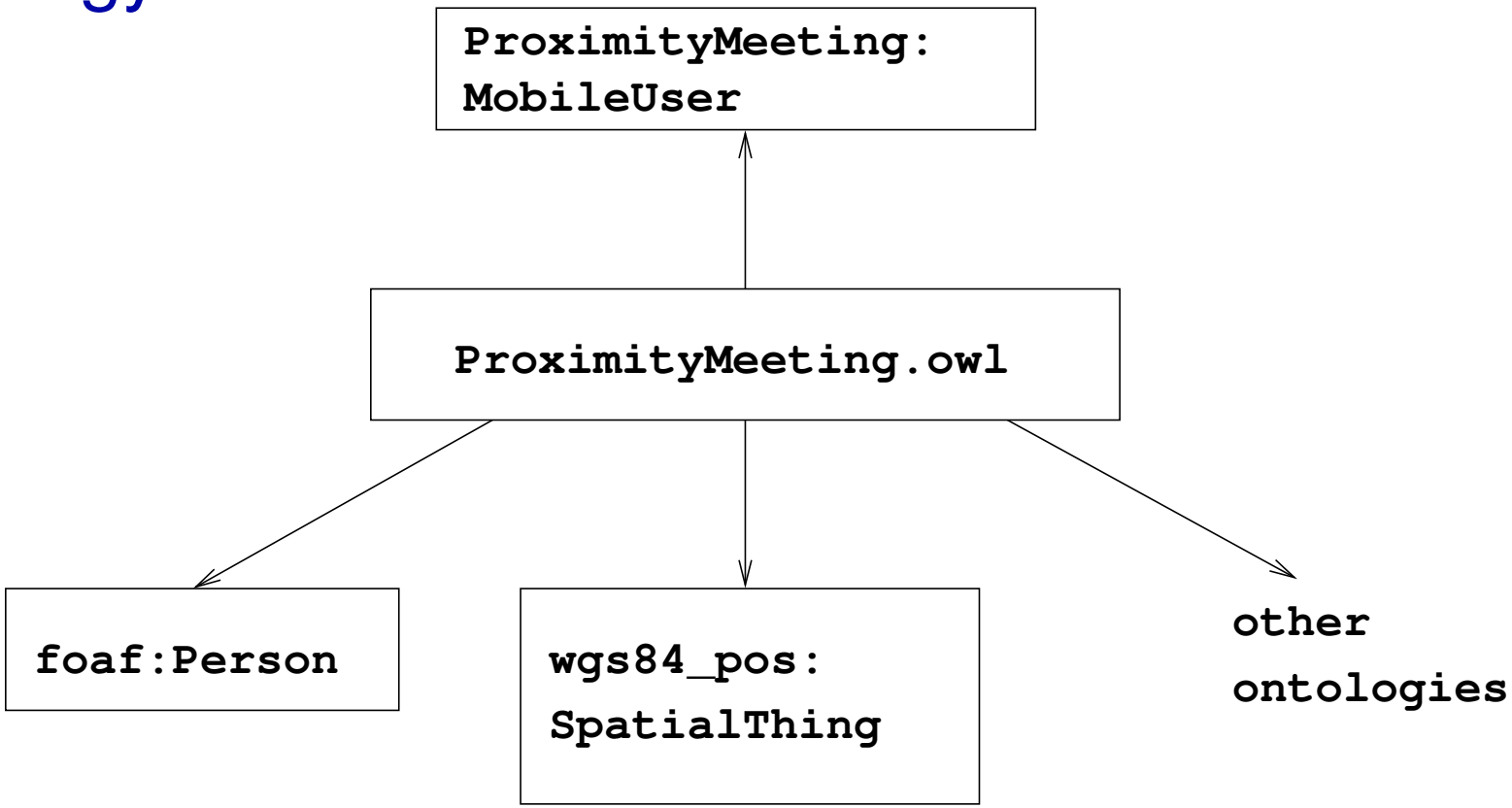


- Distributed computing
- Many mobile participants, a lot of data
- Ontology-driven data processing
- Dynamic data sharing and knowledge reasoning

Open questions

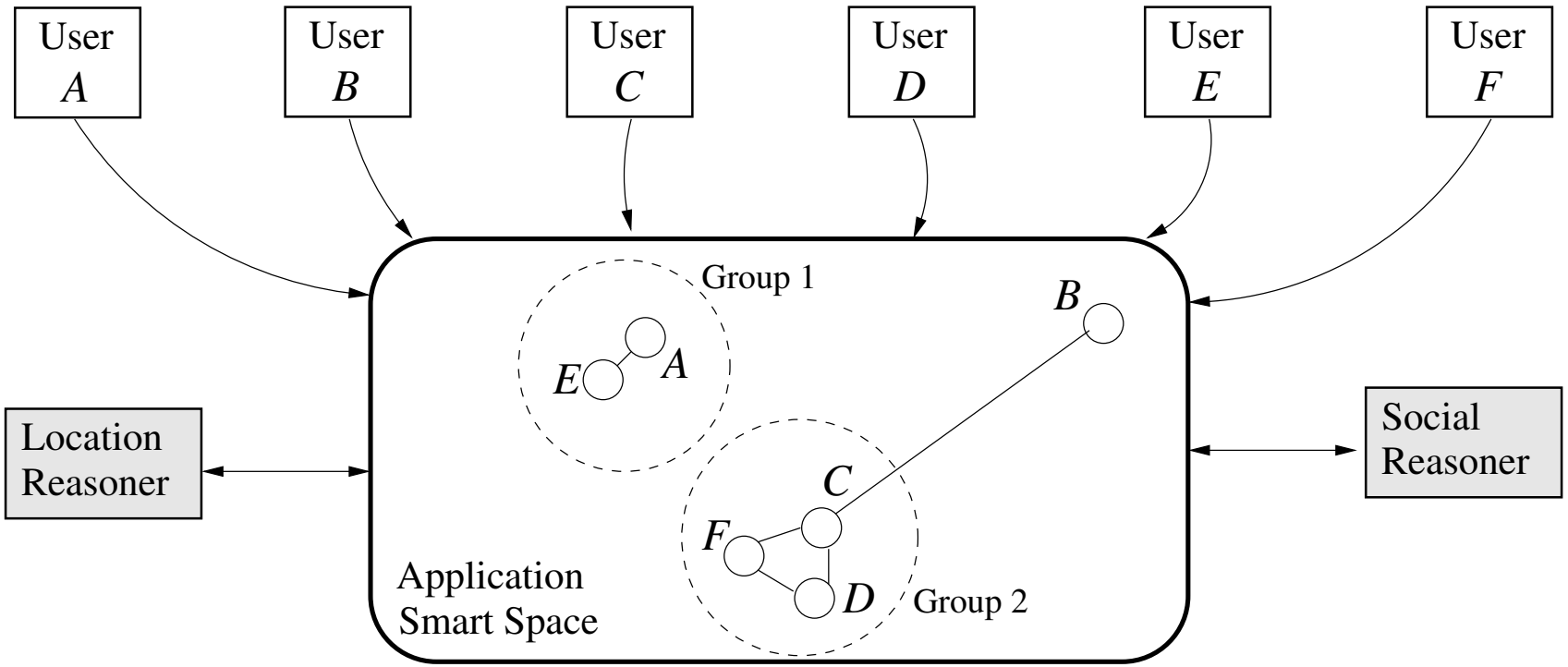
1. Is it possible to apply ontological approach of Smart-M3?
   - behavior traces of people living in their everyday lives
   - RDF/OWL representation models
   - operations with huge multi-person data amounts
2. Is it possible to effectively implement such applications?
   - rapid development in problem-domain terms
   - latest version of FRUCT developed Smart-M3 SDK

Ontology



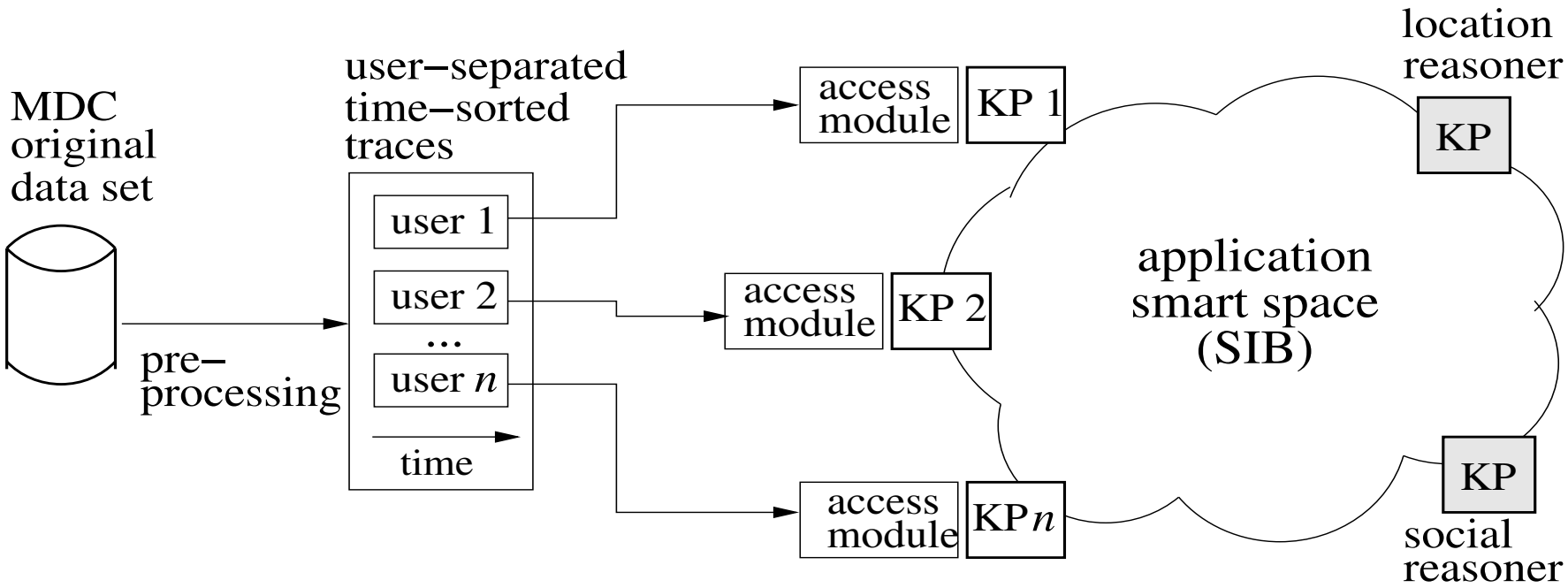
- OWL and standard dictionaries (FOAF, WGS84)
- The modularity allows adaptation to changes
- SmartSlog OWL-to-code generator

Scenario: “Who is near?”



- Mobile users $A, \ldots, F$ share their sensed data
- Reasoners derive knowledge (operationally)

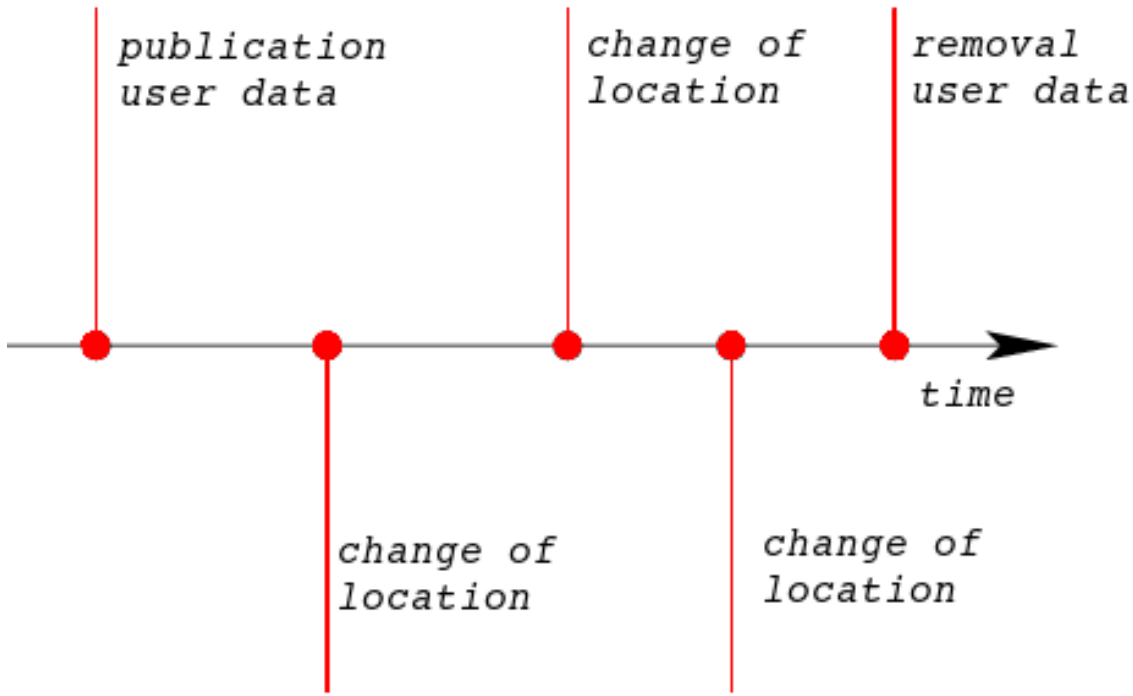
Architecture



- User KP *i* simulates its user by reading own trace produced from the MDC data set for *n* users
- Reasoner KPs operates as in the real scenario

User KP: associated with a mobile user

- Ontology-driven data processing:
  RDF and OWL representation models
- Change over time the smart space: accessing SIB by SSAP



- User KP makes low load: join, insert, updates, leave

Location Reasoner: searching users nearby

- Personalization: reasoning is for a given user
- KP detects when other users are close
  - with a given radius
- Dynamic knowledge reasoning
  - Search queries to the space
  - Subscription
- Focus is on the performance
  - Accessing the data
  - Local reasoning

Samples construction

- A sample is produced for each $n \in [1, 30]$, all run on the same physical machine and start at the same time
- User KP reads the next event data every δ seconds $\delta = 5, 10$ seconds and at least 100 read events
- User KP
  - U_{loc}: local transformation "sensed data $\rightarrow$ OWL/RDF"
  - U_{ss}: access operation for publishing the data to the space
- Reasoner KP
  - R_{loc}: search query construction locally
  - R_{ss}: access operation for resolving the query
  - R_{rsn}: local reasoning based on the reply
- Median ($Q_{50\%}$), average and percentiles ($Q_{10\%}$, $Q_{25\%}$, $Q_{75\%}$, $Q_{90\%}$)

Local processing performance: U_{trs} and R_{ptr}

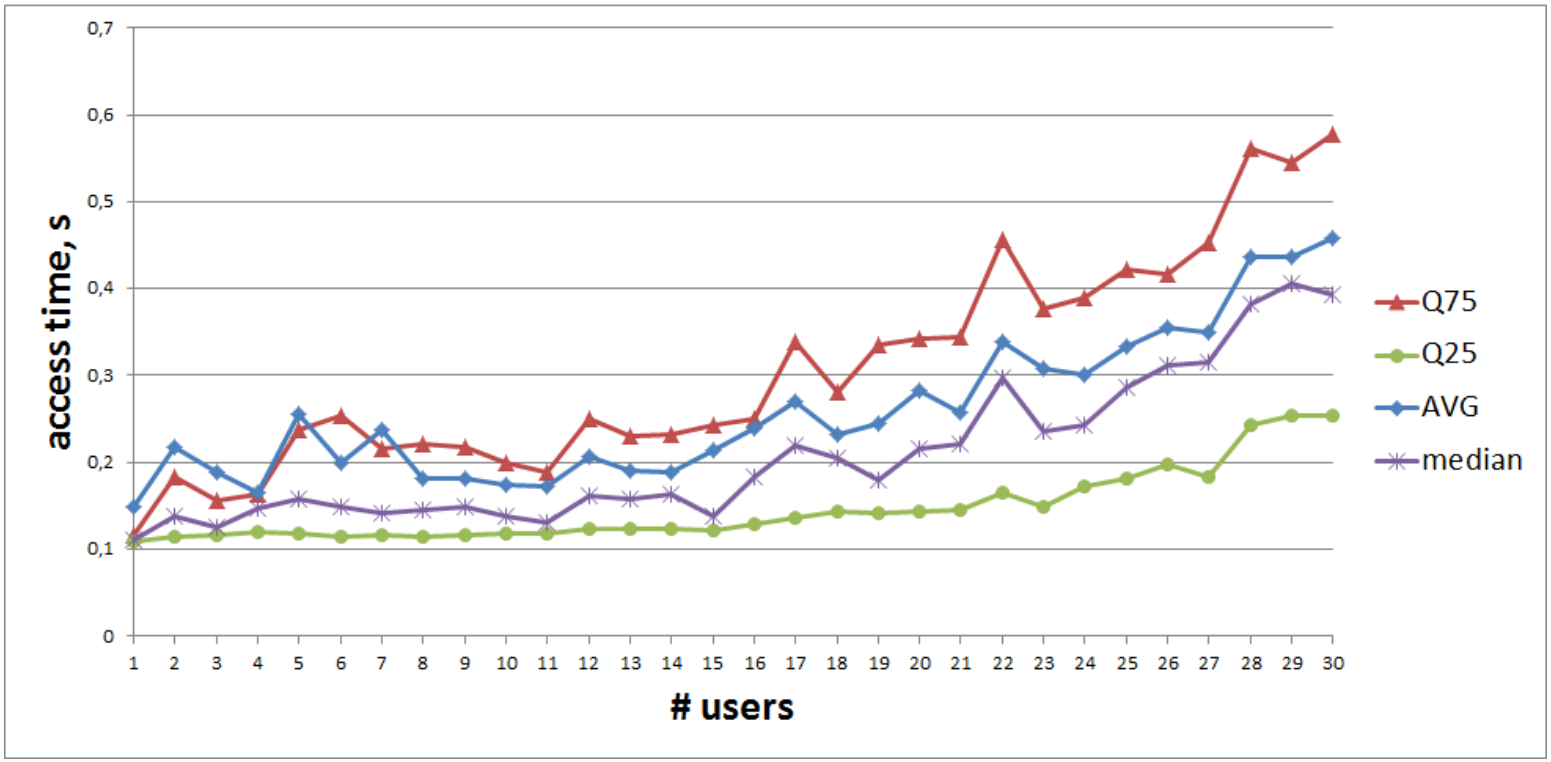
- No significant dependency on the number of participating users n
- Median, average and percentiles for each sample for given n, then averaged over all $n \in [1, 30]$
- Translation of a small set of personal sensed data (U_{trs}) and construction of knowledge pattern (R_{ptr}) are fast and comparable each with another

	$Q_{90\%}$	$Q_{75\%}$	median	average	$Q_{25\%}$	$Q_{10\%}$
U_{trs}	0,7733	0,0264	0,0206	0,1978	0,0184	0,0172
R_{prn}	0,7984	0,0437	0,0357	0,2211	0,0314	0,0286

- Median is lower than average: the majority of samples is fast and there are a few high picks
- User KP can run on low-performance mobile devices like phones

Access time of user KP: U_{ss}

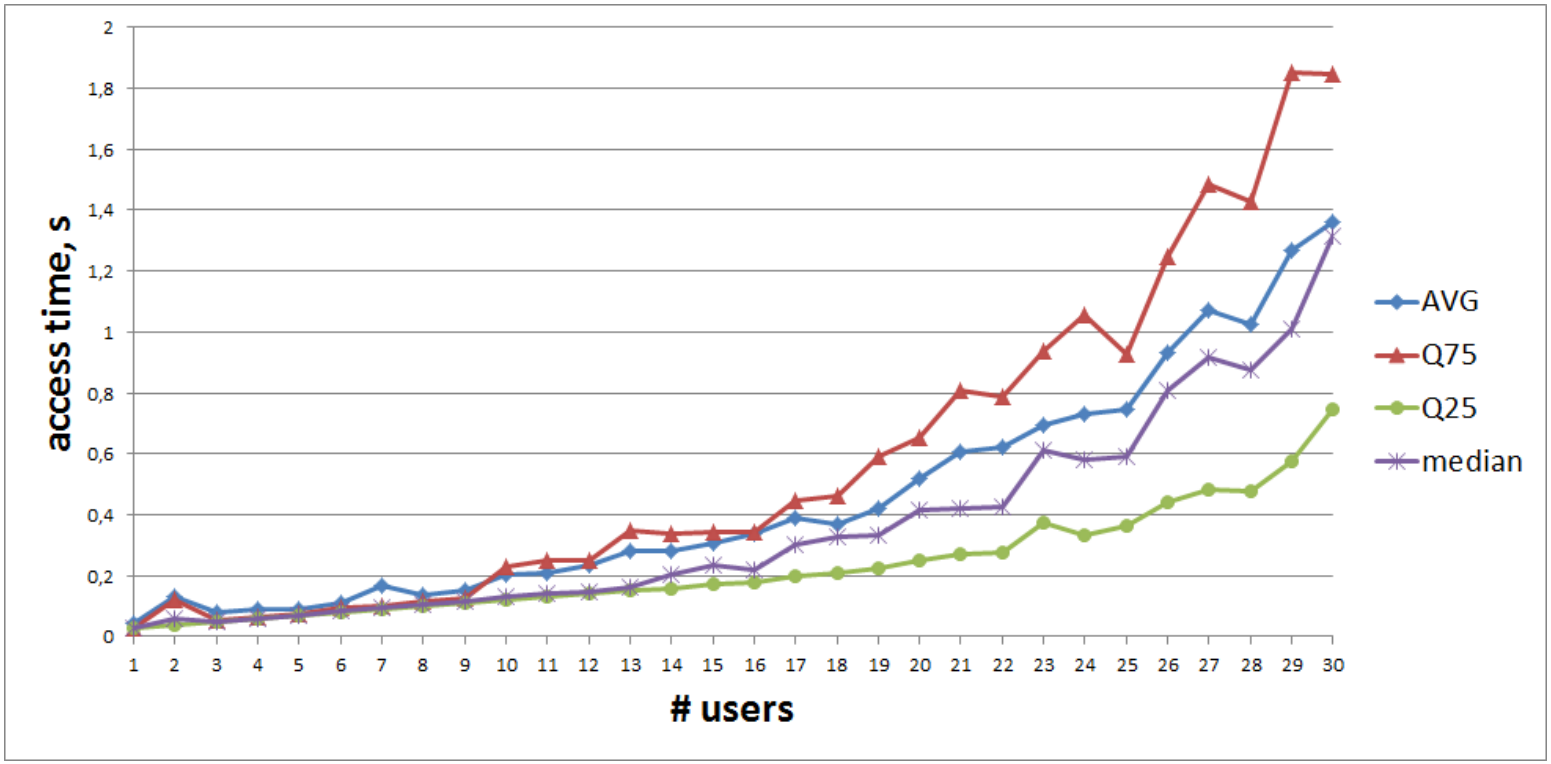
- User KP publishes a portion of personal sensed data



- Dependence on the number of users n, slow growth
- Relatively small, less than 1 second

Access time of reasoner KP: R_{ss}

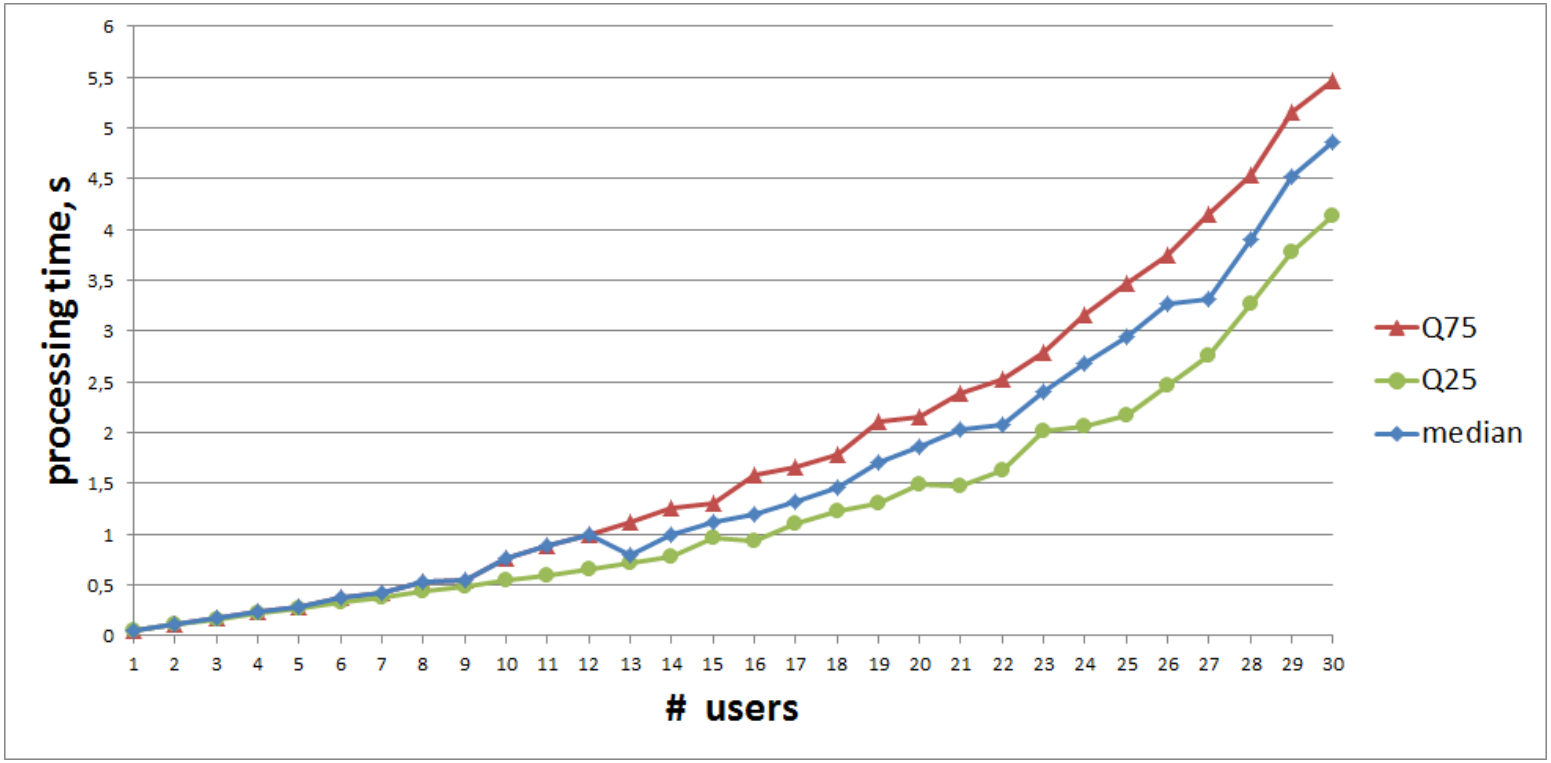
- User KP queries the space for locations of all active users



- Dependence on the number of users n, growth
- About 1…2 seconds

Local reasoning time: R_{rsn}

- Reasoner KP analyzes queried data to find the users nearby



- Dependence on the number of users n, essential growth as $O(n^{1+\epsilon})$ for small $0 < \epsilon < 1$
- The worst-case scenario: reasoning is on the KP side

Conclusion

- The smart-M3 platform is in a phase of research prototyping
- It can be used for applications:
  people centric sensing and many mobile users
- Mobile phones as simple sensing devices
- Mechanisms for processing balance between SIB and KP are needed for more efficient reasoning

Q&A