A Study on an Evolution of a Data Collection System for Knowledge Representation

Jari SOINI, Markku KUUSISTO, Petri RANTANEN, Mika SAARI and Pekka SILLBERG

Tampere University, Pori, Finland

EJC 2019: The 29th International Conference on Information Modelling and Knowledge Bases, Lappeenranta, Finland, June 3—7, 2019

Background

- There are still places where data collection have not been fully automated
  - No applicable automated systems exists
  - Fully automated systems would be too expensive for the use case
  - Routines are wanted to be preserved as they were before (familiarity, resistance to change)

- Manual data collection is often error-prone, and there are several identifiable challenges such as:
  - Mistyped values
  - Issues with validating and processing data
  - Extra labor

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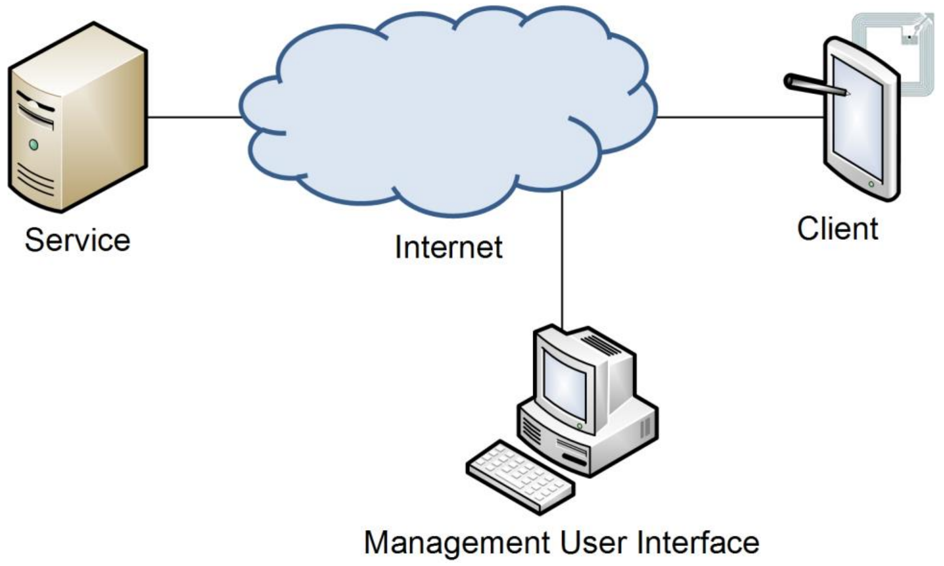
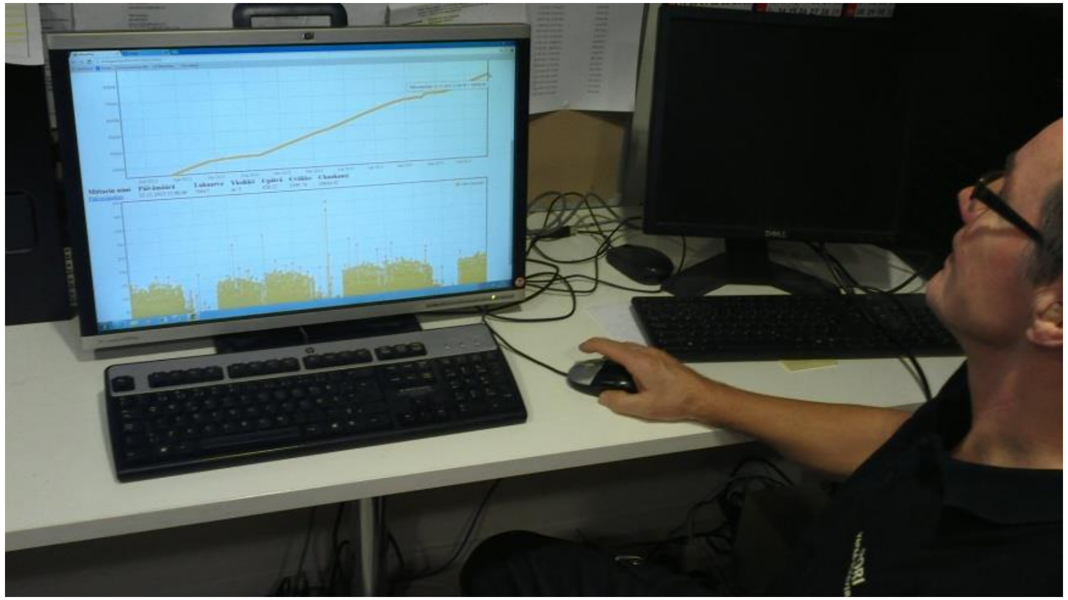
Reference System

- The main purpose was to improve the collection of energy measurements from a public indoor swimming pool as opposed to the original pen & paper and Excel approach
  - Case: Electricity, heat, and water consumption were logged daily by hand for two years since the completion of the new swimming pool in year 2012

- Client (Android tablet)
  - Data input, RFID tags for detecting meters
- Management UI (Web-site)
  - Data monitoring, visualization, and export (e.g., graphs of energy use)

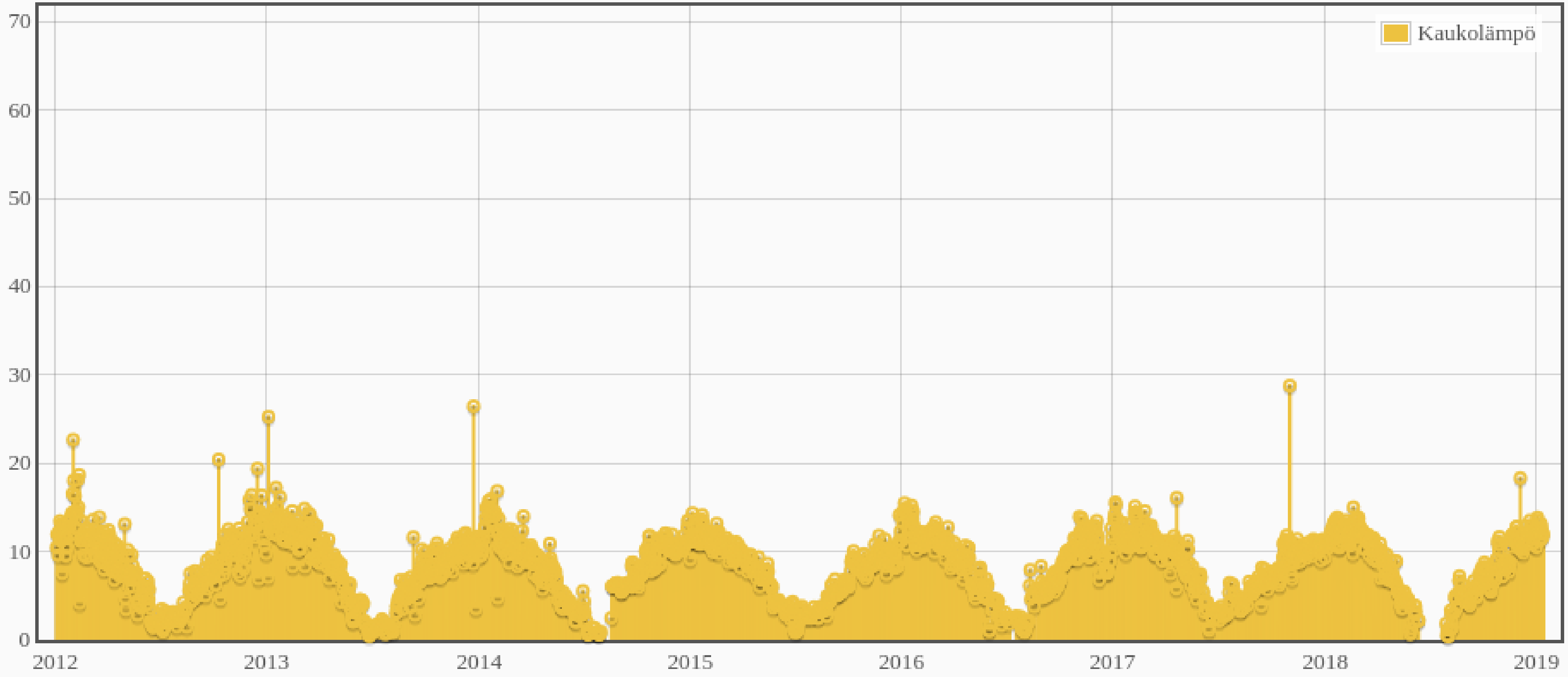


Use Case: Energy Consumption Measurement

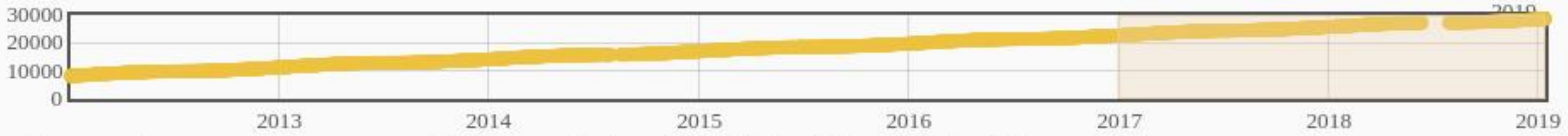


Examples of Collected Data 1/2

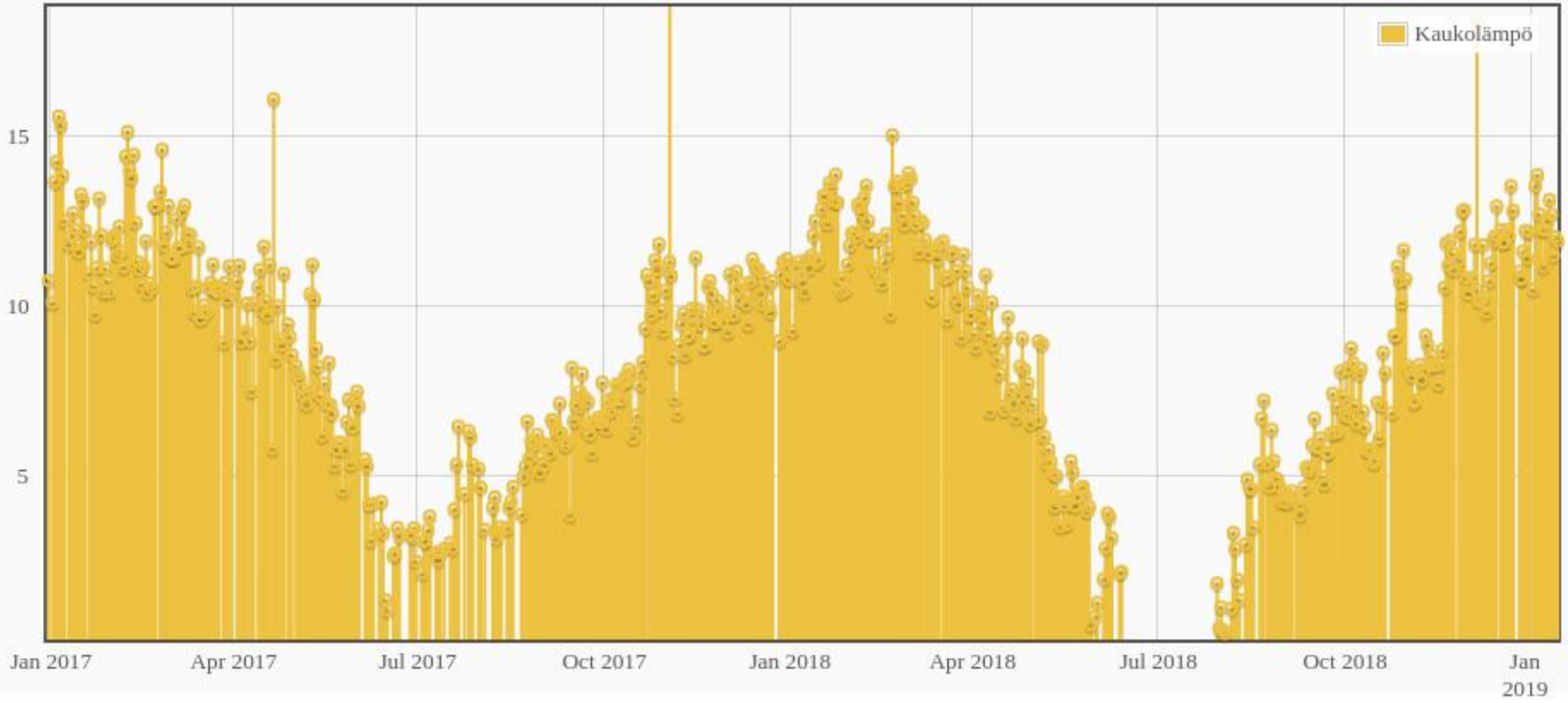
Meter Name	Date	Value	Unit	€ (daily)	€ (weekly)	€ (monthly)
Kaukolämpö	1/14/2019, 6:51:21 AM	28598.62	MWh	540.22	3861.75	16374.26
Huomioita	4/1/2017, 10:10:51 AM	23729.05				



Examples of Collected Data 2/2



Meter Name	Date	Value	Unit	€ (daily)	€ (weekly)	€ (monthly)
Kaukolämpö	1/2/2019, 6:39:32 AM	28448.72	MWh	475.54	3565.70	15694.35
Huomioita	4/1/2017, 10:10:51 AM	23729.05				



System Evolution at a Glance

- Externally the look'n’feel of the user interface remained similar (throughout the entire evolution of system)
- The idea was to pass the system maintenance to a local software company
- Behind the scenes, certain architectural changes were required
- The long term pilot was conducted from 2014 until 2019

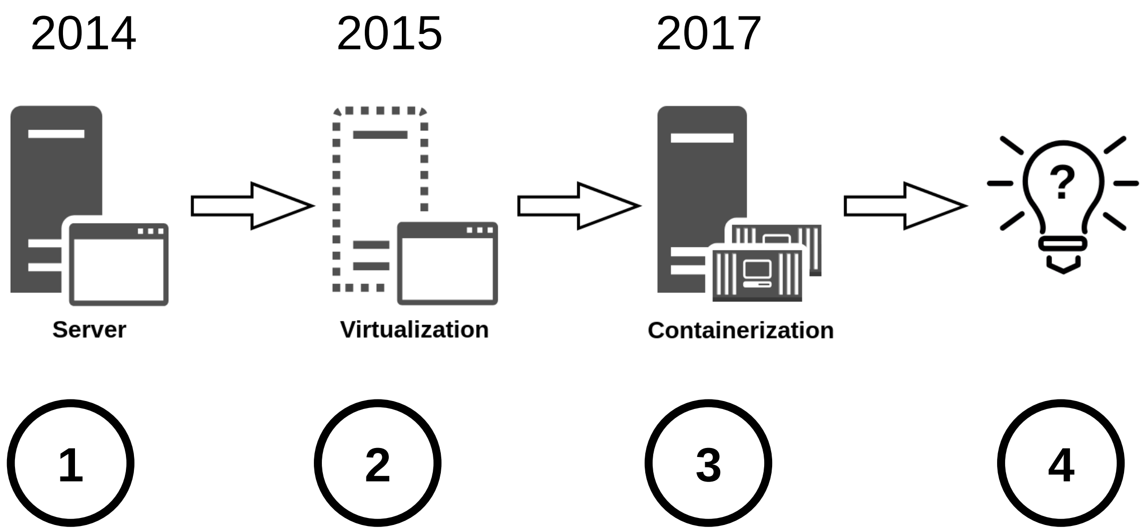
System Evolution in Depth

1. The initial service was deployed on a basic computer (PC) used as a web server on university premises

2. Basically the same service, but moved to run on a virtualized server instance (isolation, security)

3. The service was packaged into a set of Docker images, to facilitate the migration and deployment of the system to alternative service providers (e.g., cloud platforms). Enables further isolation, maintenance and transferability of the service.

4. The next evolution phase is a question mark, also, the service might be evolve to other modern service implementations (e.g., microservices, serverless environments...)



System Maintenance During the Piloting 1/2

- Only a few minor feature requests (slight modifications to how the data is displayed on the web page)

- Software libraries updated on the client device and in the service implementation (bug & security fixes)

- Issues with client’s development environment updates (Google moved from Eclipse-based SDK to IntelliJ-based Android Studio, which in practice caused the old codes and project structures to become uncompilable, requiring the upgrade of the entire codebase to a new project structure)

System Maintenance During the Piloting 2/2

- Minimal effort on system maintenance and occasional “Sanity checks" by the university personnel (user can still log in OK; data can be viewed OK on the web page; occasional corrections of incorrectly inserted data; database backups)

- Slight problems with the Android client device (mainly because of old age: SIM card not connected properly; battery died out)

- Planned and un-planned network downtimes at university premises which caused unavailability of the service

User Experiences

- Management point-of-view
  - Detection and identification of problems became easier
  - Data is archived in more consistent fashion and more convenient to access
  - There were interest in buying a similar solution from a commercial service provider

- End-user point-of-view
  - There were very few issues to report, and no major problems that could be directly traced to any particular evolutionary modification
  - The staff felt reluctant to change back to the old ways (pen-and-paper recording)
  - The simplicity of the application was much appreciated and it was seen as a handy and reliable tool for collecting data

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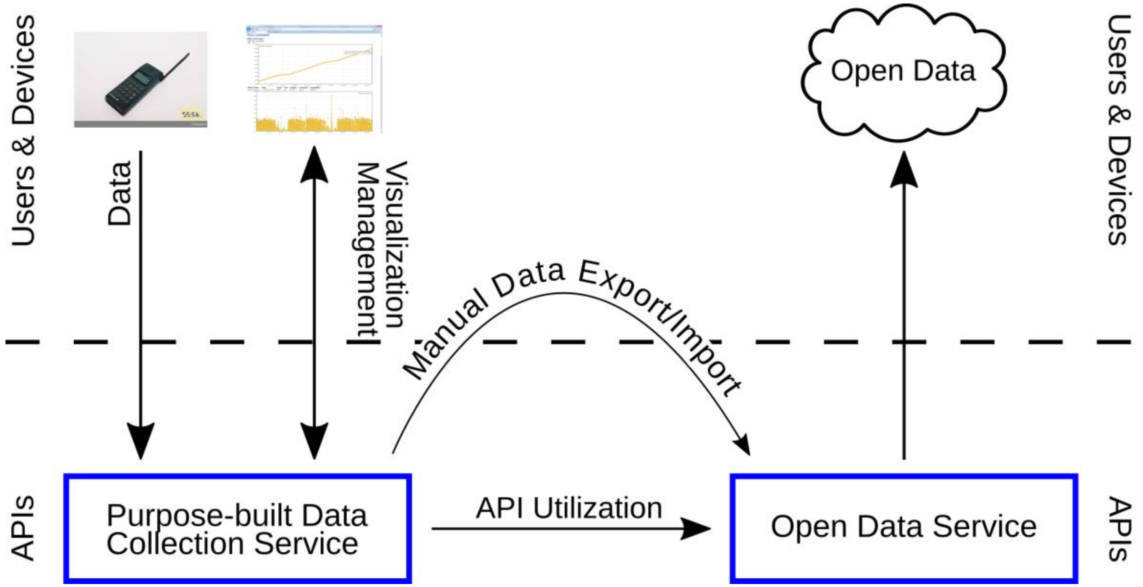
Future Studies 1/2

- Current use is limited to validation (collected data is checked if/when problems arrive)
  - → Possibilities for pre-emptive problem detection, smart data analysis, etc...

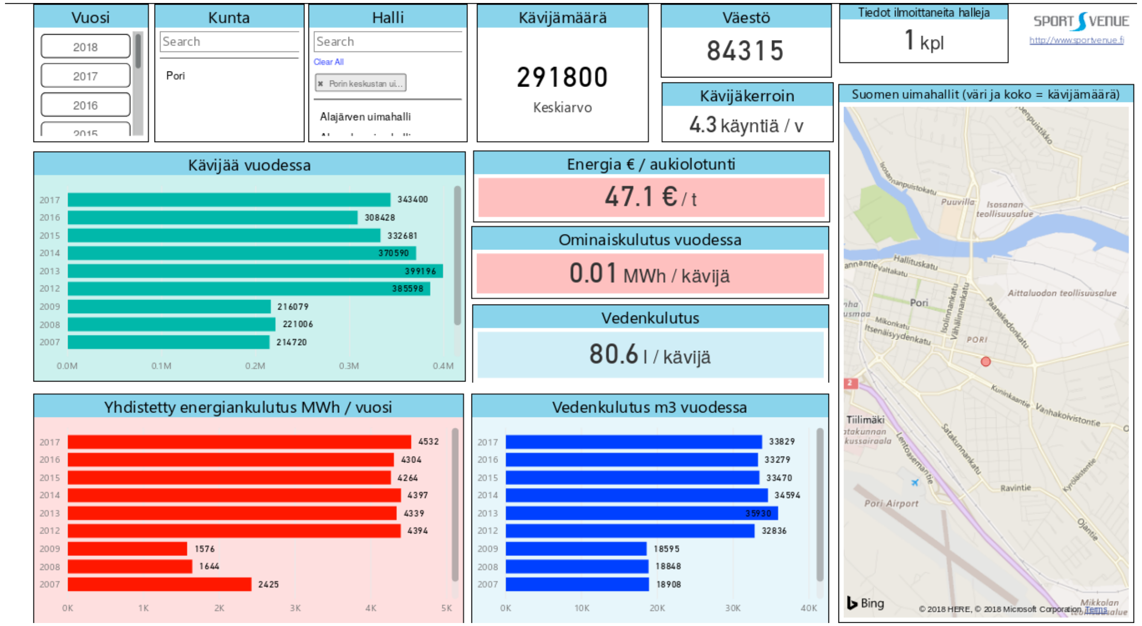
- Combining data with other collected data (unit price is combined with usage)
  - →Energy consumption optimization based on the actual usage (e.g. visitors amounts)

(methods for both of these already exists through created APIs, though currently manual data export in csv/excel files is used)



Future Research 2/2

- Use of collected data in external services
  - E.g. LIPAS service created by the University of Jyväskylä
- Providing data for external open data services



Conclusions

- Low downtimes (though informing the end-users about upcoming downtimes could have been better)
- Successful choice of technologies ("correct" and perhaps slightly lucky choice of promising technologies)
- Modifications to the service "backbone" hidden behind consistent and unchanged UI look'n'feel
- Clear separation of responsibilities for overall system maintenance
  - The property maintenance staff were strictly responsible for the maintenance of the devices integral to the management of the swimming pool itself, but had no role other than providing the basic requirements for the design and management of the data collection service. The manual data collection (users typing the values into the client device) also allowed the various systems to remain very loosely coupled.

→ Piloting period was very successful

Thank You