



IoT middleware for water management

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EWaS 2018, Lefkada, Greece



Agenda

- Problem and motivation
- System description
 - System architecture
 - Retrievers
 - Collector
 - API management
 - Watchdog
- Results
 - Water data
 - Traffic data

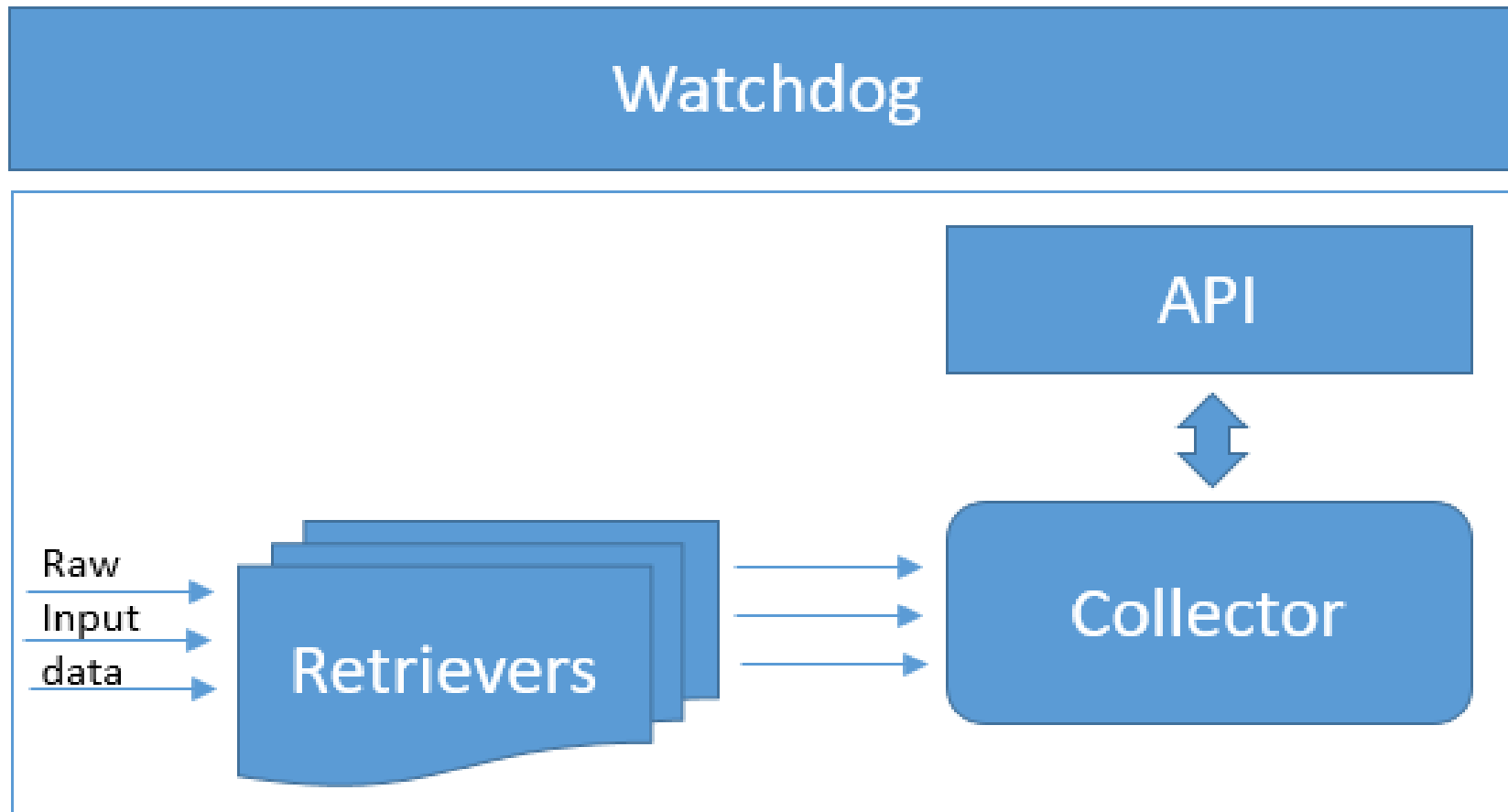


Problem definition

- Half of the world's megacities are groundwater-dependent
- Over 40% of water supply in Europe is based on water pumped from aquifers beneath urbanized areas.
- With proposed system architecture are focusing on data integration and standardization of data schema

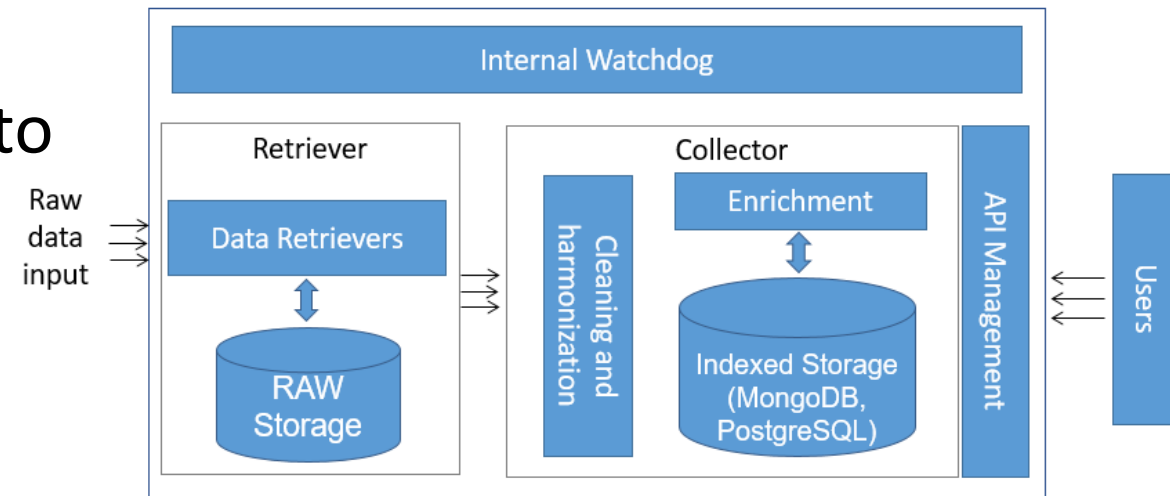


System architecture



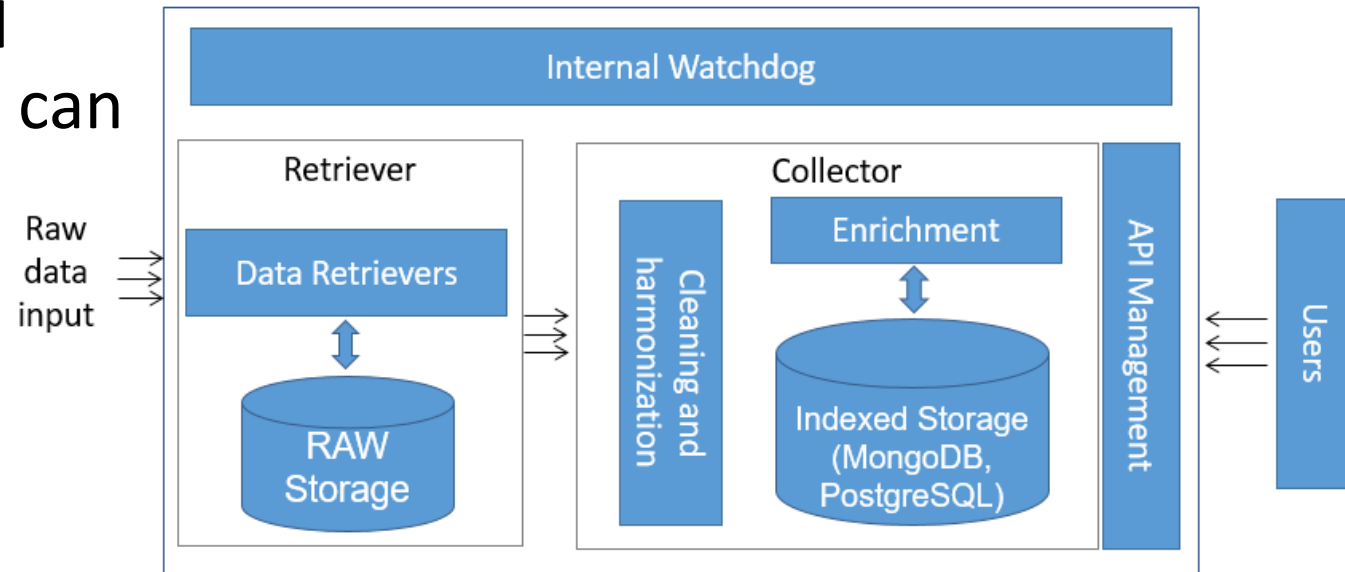
Data Collectors – Retrievers

- Daemon which function as data feed extractors by periodically polling an external data sources for updates
- Enable transforming pooled data into a common format
- Data can be stored by either writing to a file or forwarding it to a collection service
- Handle all data as JSON/XML objects



Collector

- Service that is backed by a Mongo database, containing real-time data, historical data
- Server uses Java servlets as API endpoints, through which data can be pushed to or queried from Mongo database.



API Management (1)

- tool for managing access to API endpoints for end users
- MongoDB database for storing users and API endpoint data, graphical interface for managing users and APIs

Add user

Username IJS Optimum

Email john@example.com

Organization Org

Select APIs ▾

Submit

User listing

User	Organization	Email	Select API	Token	Delete	RelTok
Luka Bradesko	IJS	luka.bradesko@ijs.si	Select APIs ▾	Show token	✕	↻
Klemen Kenda	W4C	klemen.kenda@ijs.si	Select APIs ▾	Show token	✕	↻
Matej S	W4C	matej.senozetnik@ijs.si	Select APIs ▾	Show token	✕	↻
W4C Project	W4C		Select APIs ▾	Show token	✕	↻
Timon	IJS	tine.subic@ijs.si	Select APIs ▾	Show token	✕	↻

Export JSON Apply changes



API Management (2)

- Users can view the list of APIs entered into the system
- Also possible to delete APIs, check notes or edit API properties
- Each API status can be set to “private”, meaning end users need authentication token and appropriate access rights to call this API

Add API route

API URL

Service Host

Project

API Access Controls

Edit	API Route	Public	Active	Project	Notes	Delete
	opendata/promet/burja/	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	opendata		<input checked="" type="checkbox"/>
	opendata/promet/burjaznaki/	<input checked="" type="checkbox"/>	<input type="checkbox"/>	opendata		<input checked="" type="checkbox"/>
	opendata/promet/events/	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	opendata		<input checked="" type="checkbox"/>
	opendata/vreme/report/	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	opendata		<input checked="" type="checkbox"/>
	uninova/get_weather_data	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	uninova		<input checked="" type="checkbox"/>
	w4c/pumpSensors	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	w4c		<input checked="" type="checkbox"/>
	w4c/undergroundWater	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	w4c		<input checked="" type="checkbox"/>
	w4c/weather	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	w4c		<input checked="" type="checkbox"/>



Watchdog

- Watchdog is a server with the purpose of having an overview of the numerous data retrievers
- When necessary, it (re)starts a retriever and keeps basic log of the retrievers activities in one place
- The aim is significantly lowering maintenance time and complexity of retrieving data from multiple sources

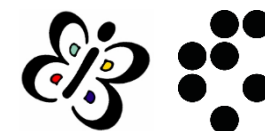
Retriever	Status	Details	New records received in last request / All records received	Size of last request / Size of all data [MB]	Last data update	Number of records / hour					Disable pingdom alert	
1. BarjaRetriever	●		0 / 0	0,003 / 744,465	11/19/2017 06:27:34	0	Change parameters	Restart	Stop	Delete	Disable	Show log
2. LppRetriever	●		6 / 15614309	0,088 / 352731,362	11/19/2017 06:27:51	4671	Change parameters	Restart	Stop	Delete	Disable	Show log
3. BTBicycleRetriever	●	java.lang.ClassCastException: No data for time interval to 2017-10-25T02:15:00Z	3 / 3299647	0,001 / 418,227	11/19/2017 05:45:52	12889	Change parameters	Restart	Stop	Delete	Disable	Show log
4. CamerasRetriever	●	'Received' parameter is missing. 'LastUpdated' parameter is missing. 'Size' parameter is missing.	196 / 107127521	0,133 / 71884,697	11/19/2017 06:26:03	21904	Change parameters	Restart	Stop	Delete	Disable	Show log
5. CollectorBicycle	●	Remote retriever OK	121 / 17123283	0 / 0	11/19/2017 06:27:16	8010	Change parameters	Restart	Stop	Delete	Disable	Show log
6. TrafficEventsRetrieverUK	●		0 / 0	0 / 0	11/19/2017 06:25:32	0	Change parameters	Restart	Stop	Delete	Disable	Show log
7. TrafficEventsRetrieverSI	●		0 / 4523	0 / 0	11/19/2017 06:27:44	6	Change parameters	Restart	Stop	Delete	Disable	Show log
8. HopinRetriever	●		8 / 8945103	0,003 / 3176,199	11/19/2017 06:27:50	9107	Change parameters	Restart	Stop	Delete	Disable	Show log
9. CollectorParking	●	Remote retriever OK	0 / 2524448	0 / 0	11/19/2017 06:27:20	320	Change parameters	Restart	Stop	Delete	Disable	Show log
10. Bicike@Ljubljana	●		55 / 2178806	0,021 / 2532,827	11/19/2017 06:26:54	1045	Change parameters	Restart	Stop	Delete	Disable	Show log
11. MarBus	●	Remote retriever Restarted retriever - didn't ping for more than 120 minutes	0 / 356880	0 / 61,125		5490	Change parameters	Restart	Stop	Delete	Disable	Show log
12. OptimumApiBicycle	●	Remote retriever	0 / 0	0 / 0	11/19/2017 06:26:57	0	Change parameters	Restart	Stop	Delete	Disable	Show log
13. TwitterService	●	Remote retriever Restarted retriever - didn't ping for more than 120 minutes	0 / 0	-1 / -1		0	Change parameters	Restart	Stop	Delete	Disable	Show log
14. APICountersSlovenia	●		0 / 7386240	0,403 /	11/19/2017	11566	Change	Restart	Stop	Delete	Disable	Show



Results (1)

- Groundwater from Slovenia
- Pump sensors from Skiathos
- Weather for both Skiathos and Ljubljana

Name of the dataset	Records/day
Groundwater levels	518
Pump sensors	4
Weather (Ljubljana and Skiathos)	30

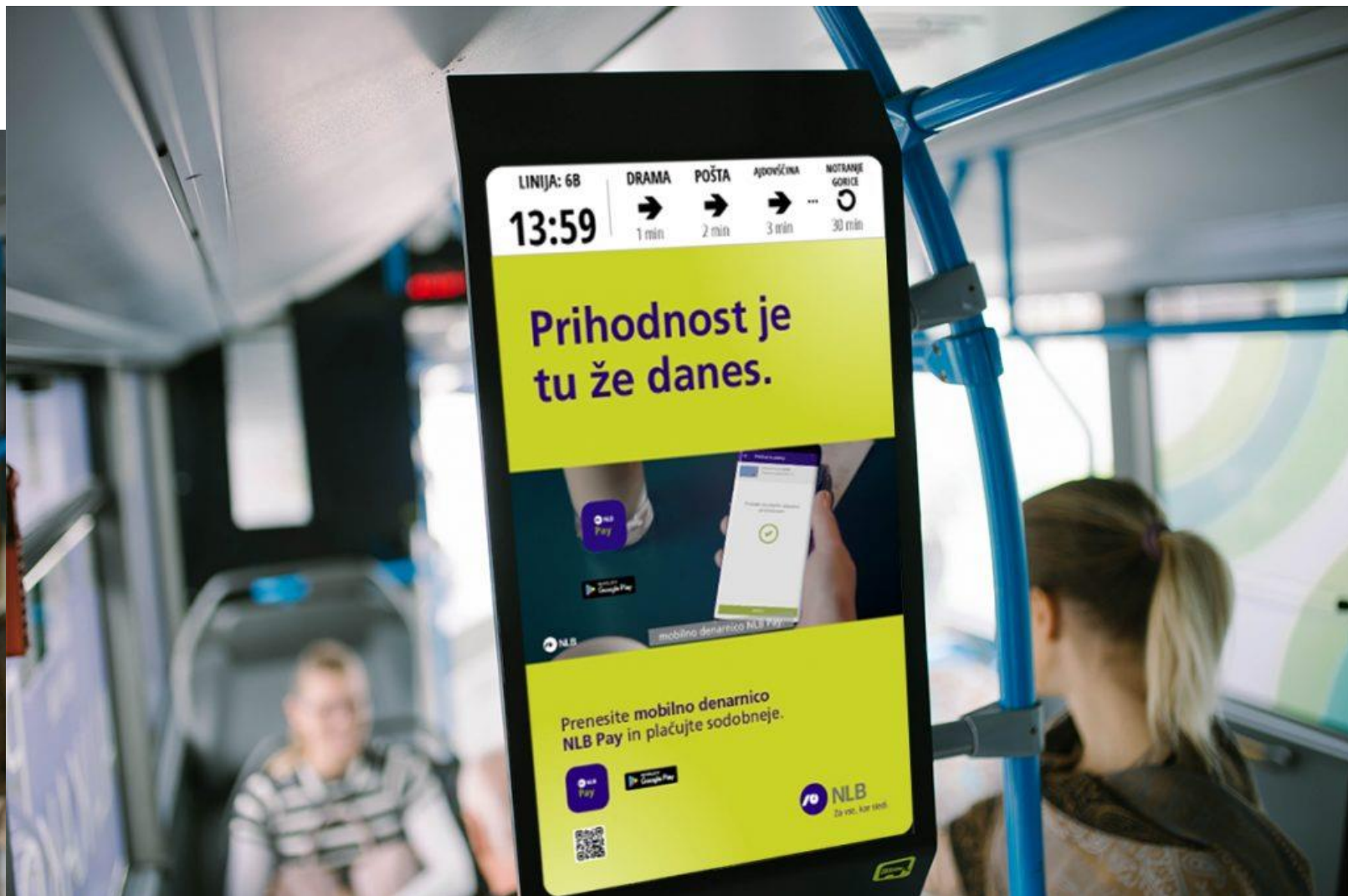


Result (2)

- 30 data retriever collecting the traffic data in several cities in Europe
- The data has been captured from Watchdog on the 9th of May, 2018.

Name of the dataset	Records / h
Bus Retriever (Ljubljana)	5828
Taxi Coordinates (Ljubljana)	4863
Motorhome Coordinates (Europe)	194
Parking Data OD (Ljubljana)	316
Collector Parking (Ljubljana and Vienna)	316
Collector Loop Sensors (Slovenia)	12170
Loop sensors (Slovenia)	12170
Collector Bicycle (Ljubljana and Vienna)	7912
Shared Bicycle (Ljubljana)	879
Shared Bicycle (Vienna)	6981
Truck Coordinates (Croatia and UK)	31533
Traffic Events (Slovenia)	1
Wind (Burja) data (Slovenia)	10
Road cameras (Slovenia)	8668
Tweets (Slovenia)	1

Practical results



Conclusions and future work

- The system supports ingestion of any spatiotemporal data with additional meta-information.
- The system contributes to consistency, standardization and data sharing.
- The system could be improved by adding coverage for new data domains.
- Outlier detection and missing data imputation



Questions ?

