GeoEvents and Processing with GeoMQTT

Stefan Herle
RWTH Aachen University
Chair for Computing in Civil Engineering and Geo Information Systems & Geodetic Institute
Geospatial Sensor Webs Conference 2017– from data to information in the Sensor Web
29th August 2017, Münster
Outline

1 GeoEvents & GeoPipes
2 Message Queue and Telemetry Transport (MQTT)
3 Extension GeoMQTT
4 Processing with GeoMQTT and WPS
5 EarlyDike Project
6 Conclusion and future developments
• GeoEvent:

“an occurrence of a change of state associated to a phenomenon of interest, which is related to a geographic location and a specific time”

Garcia & Morales (2015)

1) Phenomenon of interest
2) Geographic space
3) Time

• Spatiotemporal data stream: unbounded sequence of GeoEvents

→ GeoPipes: Linking different producers and consumers of real-time geospatial data in a push-based manner

Which protocol to define GeoEvents & GeoPipes? What are the requirements?
• Addressing with **topics**
• Publish event with a topic name: room/237/temperature
• Subscribe to topic filters
  • Entire topic name -> room/237/temperature
  • „+“: single level wildcard -> room/+/temperature
  • „#“: multi level wildcard -> room/237/#
Topic-based publish/subscribe model, message transmission in near real-time

Open standard by OASIS 2013

Low Overhead (2 bytes header) -> lightweight messaging

Standard gives guidance for security implementation

Quality of Service (QoS) & Last Will and Testament (LWT) feature provides reliability

Scalable with TCP load balancers

MQTT for Sensor Networks for constrained devices and connectionless environments -> interoperability
3 Extension GeoMQTT

- GeoPipe message:
  
  \[(<\text{time stamp/period}>, <\text{geometry}>, <\text{eventname}>, <\text{payload}>)\]

- Spatiotemporal data stream: stream of GeoEvent tuples
  
  (2015-09-22T11:21+00:00; POINT(6.06799 50.77906); temperature; 20.752)
  (2015-09-22T11:22+00:00; POINT(6.06799 50.77906); temperature; 20.760)
  (2015-09-22T11:23+00:00; POINT(6.06799 50.77906); temperature; 20.769)
  (2015-09-22T11:24+00:00; POINT(6.06799 50.77906); temperature; 20.759)
  ...
  (2015-09-22T11:25+00:00; POINT(6.06799 50.77906); temperature; 20.750)

\[\text{GeoPublish}\]

- Time stamp/period: <\text{ISO8061}>
- Geometry: <\text{WKT, GeoJSON, …}>
- Topic name: <\text{MQTT topic string}>
- Payload: <\text{arbitrary}>

\[\text{temporal filter}\]

\[\text{spatial filter}\]
4 Processing with GeoMQTT

- **Goal:** Implementation of WPS services performing functions on spatiotemporal data streams
Demo - Computing the moving average

Size of Sliding Window (max 10)
5

TTL (max 300 sec.)
30

Input GeoPipe
wpsdemo.gia.rwth-aachen.i
1883
node/m1/temperature
temporalfilter
BBOX(-180,-90,180,90)

Output GeoPipe
wpsdemo.gia.rwth-aachen.i
1883
movingaverage/temperature

Execute
Demo - Map matching cars
Taxi trajectory points

Stream Processing Engine

Map Matching

Visualization in a MapViewer
5 EarlyDike Project

http://www.earlydike.de

WP1: Storm Surge Monitor and Simulator
WP2: Wave Monitor and Wave Load Simulator
WP3: Dike Monitor and Dike Simulator
WP4: Flood Simulator and Flood Damage Simulator
WP5: Sensor and Spatial Data Infrastructure
5 EarlyDike – Geo Event Bus

Geo Event Bus

MQTT

SWE Services

SOS SPS SES

WPS’ for data streams

QGIS Client

REST

Simulators

Bridges

3rd party services/data

Observation layer

Integration layer

Presentation layer

Read Events

Publish Events

Request Service

Recv. Data

29.08.2017

Geospatial Sensor Webs Conf. 2017
5 GeoMQTT in geo sensor networks

- Extending MQTT-SN to GeoMQTT-SN:
  - Added three message type: GeoPublish, GeoSubscribe & GeoUnsubscribe
  - Adjusted to constrained devices (Arduinos, Waspmotes, etc.)

Diagram showing the components of GeoMQTT-SN and their connections:

- Dike equipped with sensors e.g. geo textile
- GeoMQTT-SN Client
  - GeoMQTT-SN
    - ZigBee
    - IEEE 802.15.4
- GeoMQTT-SN Gateway
  - GeoMQTT-SN
    - ZigBee
    - TCP
    - IP
    - IEEE 802.15.4
    - Link
- Broker
  - GeoMQTT
    - TCP
    - IP
    - Link
EarlyDike – Lab Dike
5 EarlyDike – Dike Monitor

Diagram of a dike showing various components such as a retaining wall, stone-filled gabion, and instrumentation points labeled as gla1, gla2, etc. The diagram also includes a cross-section with dimensions and notes about the structure, such as 'retaining wall (concrete) with conic apertures', 'stone-filled gabion', and 'perforated plate allows drainage of dike toe'.

29.08.2017  Geospatial Sensor Webs Conf. 2017
5 Conclusion and future developments

- GeoMQTT encapsulates GeoEvents to initiate spatiotemporal data streams
- GeoPipes for couple IoTs with GIS and geo web service
- WPS extension to set up services performing functions on spatiotemporal data streams
- Enables real-time spatial workflows from data collection till visualization
- -> EarlyDike project for early warning of dike failures
- Future developments: Couple GeoPipes with stream processing engines: -> spatial mining, interpolation…