

EMIT

a system for monitoring networks of MQTT clients

Jérôme Rocheteau
AeLoS Seminar
2018-06-21



EMIT

Overview

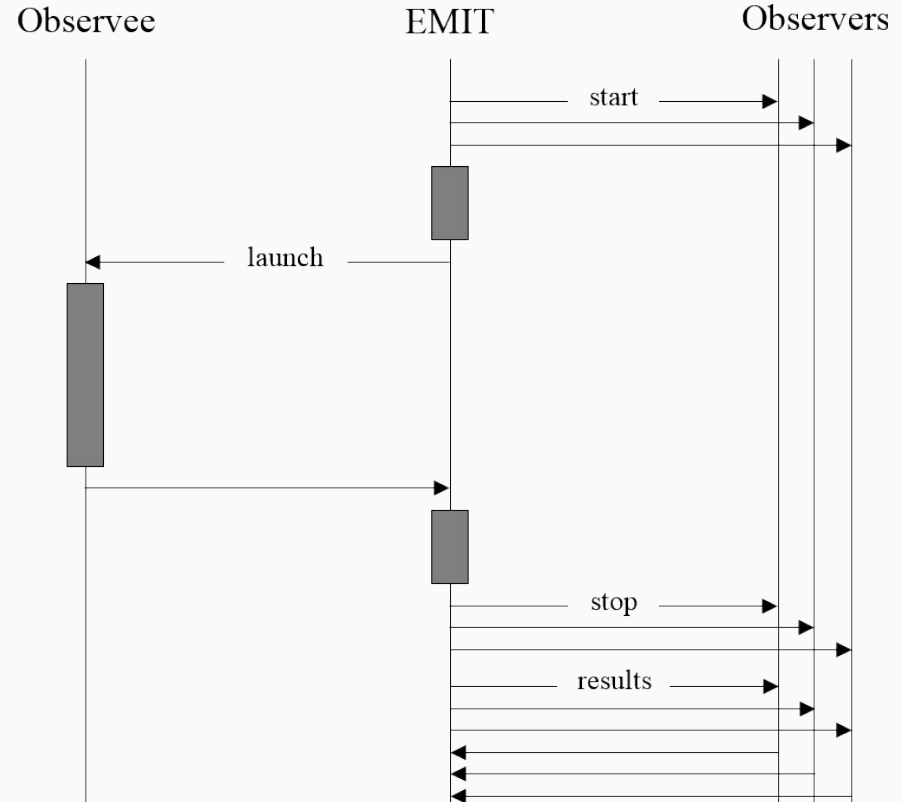
1. History
 - the « Code Vert » project
 - the MEASURE project
2. Functionalities
 - Prerequisites on MQTT
 - Configuring MQTT clients
 - Monitoring MQTT clients
3. Challengers
 - Eclipse MQTT Spy
 - IBM Watson IoT
4. Prospects

Objectives & Means

- Energy Efficiency of Best Coding Practices
- Energy Consumption Difference (see [1])
 - Best Coding Practice
 - Not-that-Best Practice
- Fine-Grained Power Measurements

Power Meters

- Slave Mode (On-Demand)
 - Start Measuring
 - Stop Measuring
 - Retrieve Measurements



EMIT – Energy MonIToring (2017)

Objectives & Means

- SEC Metrics in Production Phase
- Continuous Power Measurements

Power Meters

- Connected Objects (MQTT clients)
- EMIT = MQTT client monitoring system

Feedback

- Reliable and Flexible Architecture
- Generic vs Specific



EMIT

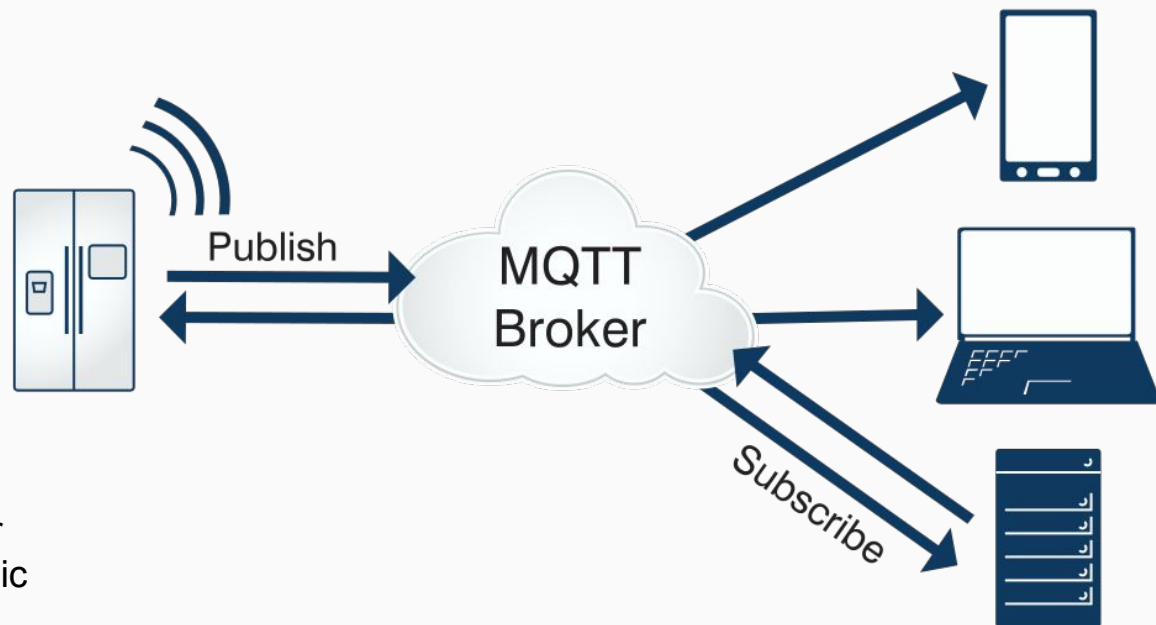
Functionalities

- MQTT
- Configuring
 - Brokers
 - Clients
 - Callbacks
- Monitoring
 - Controls
 - Records
 - Messages
- Dashboard

MQTT

Message Queuing Telemetry Transport

- open messaging protocol
- TCP/IP communication
- ISO standard
- publish / subscribe pattern



MQTT Client Status

- connect (disconnect) to a broker
- subscribe (unsubscribe) to a topic
- publish a message to a topic

The screenshot shows a web browser window with the URL `app.icam.fr/emit/configuring/brokers.html`. The page has a dark navigation bar with 'Home', 'Configuring', and 'Monitoring' menus, and an 'Account' dropdown. Below the navigation bar, the EMIT logo and tagline 'a supervisory & control system for networks of MQTT clients' are displayed. The main content area is divided into two sections: 'Brokers (1 items)' and 'Update a broker'. The 'Brokers' section shows a list of one broker, 'Mosquitto Broker', with its address 'tcp://172.21.50.3:1883' and an 'Edit' button. Below the list is a 'Create' button. The 'Update a broker' section contains form fields for 'tcp://172.21.50.3:1883', 'Mosquitto Broker', 'Username', and 'Password', along with 'Cancel', 'Delete', and 'Update' buttons. At the bottom of the page, the copyright notice 'Copyright © 2015-2018. ICAM. All rights reserved.' is visible.

Configuring

- Brokers
edit MQTT brokers
- Clients
edit MQTT clients
- Callbacks
edit message processing

Monitoring

- Controls
update MQTT client status
- Records
view MQTT client status updates
- Messages
view messages

Dashboard

Emit | Configuring x

app.icam.fr/emit/configuring/clients.html

Home Configuring Monitoring Account

EMIT

a supervisory & control system for networks of MQTT clients

Clients (2 items)

1/1

- PeakTech Power Meter**
Mosquito Broker (tcp://172.21.50.3:1883)
[Edit](#)
- Ardgetti PowerMeter**
Mosquito Broker (tcp://172.21.50.3:1883)
[Edit](#)

[Create](#)

Update a client

1aee9bf8-81a5-455c-af27-835fd9b1ec42

PeakTech Power Meter private

Mosquito Broker

[Cancel](#) [Delete](#) [Update](#)

Copyright © 2015-2018. ICAM. All rights reserved.

Configuring

- Brokers
edit MQTT brokers
- Clients
edit MQTT clients
- Callbacks
edit message processing

Monitoring

- Controls
update MQTT client status
- Records
view MQTT client status updates
- Messages
view messages

Dashboard

The screenshot shows a web browser window with the URL `app.icam.fr/emit/configuring/callbacks.html`. The page has a dark navigation bar with 'Home', 'Configuring', and 'Monitoring' menus, and an 'Account' dropdown. The main content area features the EMIT logo and tagline: 'a supervisory & control system for networks of MQTT clients'. Below this, there is a 'Callbacks (3 items)' section with a list of three items: 'Cast to Float' (type callback), 'Persist in Messages' (storage callback), and 'Cast to Float and Persist in Messages' (guard callback). Each item has an 'Edit' button. To the right, there is an 'Update a type callback' form with a text input containing 'Cast to Float', a dropdown menu set to 'float', and 'Cancel', 'Delete', and 'Update' buttons. A 'Create' button is visible at the bottom of the list. The footer contains the copyright notice: 'Copyright © 2015-2018. ICAM. All rights reserved.'

Configuring

- Brokers
edit MQTT brokers
- Clients
edit MQTT clients
- Callbacks
edit message processing

Monitoring

- Controls
update MQTT client status
- Records
view MQTT client status updates
- Messages
view messages

Dashboard

The screenshot shows the EMIT web interface in a browser window. The URL is `app.icam.fr/emit/monitoring/controls.html`. The navigation bar includes 'Home', 'Configuring', 'Monitoring', and 'Account'. The main heading is 'EMIT a supervisory & control system for networks of MQTT clients'. The interface is divided into several sections:

- Clients (2 items):** A list of two MQTT clients: 'PeakTech Power Meter' and 'Ardgetti PowerMeter', both connected to a Mosquitto Broker. Each client has a 'Select' button.
- Callback:** A dropdown menu set to 'Cast to Float and Persist in Messages' and a 'Detach' button.
- Connection:** Shows 'connected to Mosquitto Broker' with a 'Disconnect' button.
- Subscription:** Shows 'subscribed to peaktech/power' with an 'Unsubscribe' button.
- Publication:** Includes input fields for 'Topic' and 'Payload', dropdown menus for 'QoS', 'Retained', and 'Persisted', a 'Clear' button, and a 'Publish' button.

Copyright © 2015-2018. ICAM. All rights reserved.

Configuring

- Brokers
edit MQTT brokers
- Clients
edit MQTT clients
- Callbacks
edit message processing

Monitoring

- Controls
update MQTT client status
- Records
view MQTT client status updates
- Messages
view messages

Dashboard

The screenshot shows a web browser window with the URL `app.icam.fr/emit/monitoring/records.html`. The page title is "Emit | Monitoring" and the breadcrumb navigation is "Home > Configuring > Monitoring". The main heading is "EMIT a supervisory & control system for networks of MQTT clients". Below this, there is a section titled "Records of PeakTech Power Meter (3 items)".

#	type	started	stopped	topic	user
41	subscribe	2018-06-04 11:24:12		peaktech/power	measure@emit.icam.fr
39	subscribe	2018-06-04 11:17:58	2018-06-04 11:24:06	peaktech/power	measure@emit.icam.fr
91	connect	2018-06-04 11:17:32			measure@emit.icam.fr

At the bottom of the table, there are navigation controls: a left arrow, a right arrow, the text "1/1", and a "Close" button.

Copyright © 2015-2018. ICAM. All rights reserved.

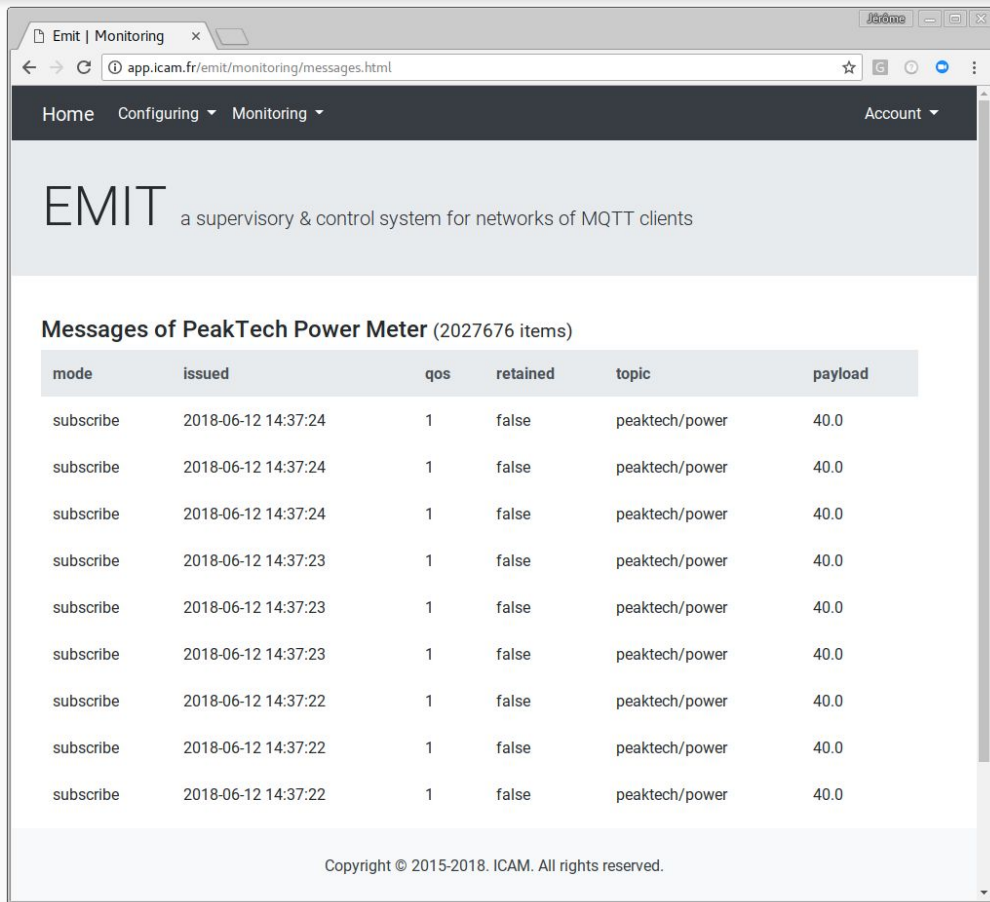
Configuring

- Brokers
edit MQTT brokers
- Clients
edit MQTT clients
- Callbacks
edit message processing

Monitoring

- Controls
update MQTT client status
- Records
view MQTT client status updates
- Messages
view messages

Dashboard



The screenshot shows a web browser window with the URL `app.icam.fr/emit/monitoring/messages.html`. The page title is "Emit | Monitoring". The navigation menu includes "Home", "Configuring", "Monitoring", and "Account". The main heading is "EMIT a supervisory & control system for networks of MQTT clients". Below this, there is a section titled "Messages of PeakTech Power Meter (2027676 items)". A table displays the following data:

mode	issued	qos	retained	topic	payload
subscribe	2018-06-12 14:37:24	1	false	peaktech/power	40.0
subscribe	2018-06-12 14:37:24	1	false	peaktech/power	40.0
subscribe	2018-06-12 14:37:24	1	false	peaktech/power	40.0
subscribe	2018-06-12 14:37:23	1	false	peaktech/power	40.0
subscribe	2018-06-12 14:37:23	1	false	peaktech/power	40.0
subscribe	2018-06-12 14:37:23	1	false	peaktech/power	40.0
subscribe	2018-06-12 14:37:22	1	false	peaktech/power	40.0
subscribe	2018-06-12 14:37:22	1	false	peaktech/power	40.0
subscribe	2018-06-12 14:37:22	1	false	peaktech/power	40.0

Copyright © 2015-2018. ICAM. All rights reserved.

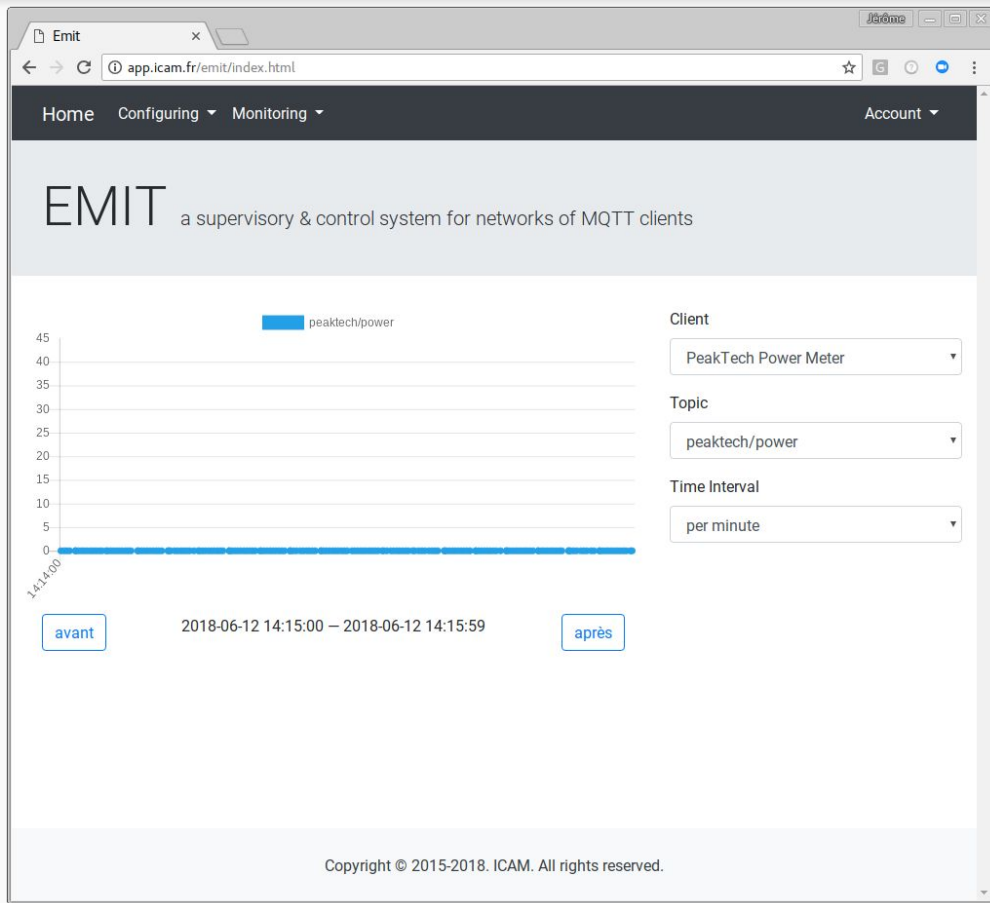
Configuring

- Brokers
edit MQTT brokers
- Clients
edit MQTT clients
- Callbacks
edit message processing

Monitoring

- Controls
update MQTT client status
- Records
view MQTT client status updates
- Messages
view messages

Dashboard



Configuring

- Brokers
edit MQTT brokers
- Clients
edit MQTT clients
- Callbacks
edit message processing

Monitoring

- Controls
update MQTT client status
- Records
view MQTT client status updates
- Messages
view messages

Dashboard

EMIT

Callbacks

- Types
- Topics
- Storages
- Features
- Guards
- *Sequences*

The screenshot shows a web browser window with the URL `app.icam.fr/emit/configuring/callbacks.html`. The page title is "Emit | Configuring". The navigation bar includes "Home", "Configuring", "Monitoring", and "Account". The main heading is "EMIT a supervisory & control system for networks of MQTT clients".

The "Callbacks (3 items)" section displays a list of three items:

- Cast to Float** (type callback) with an "Edit" button.
- Persist in Messages** (storage callback) with an "Edit" button.
- Cast to Float and Persist in Messages** (guard callback) with an "Edit" button.

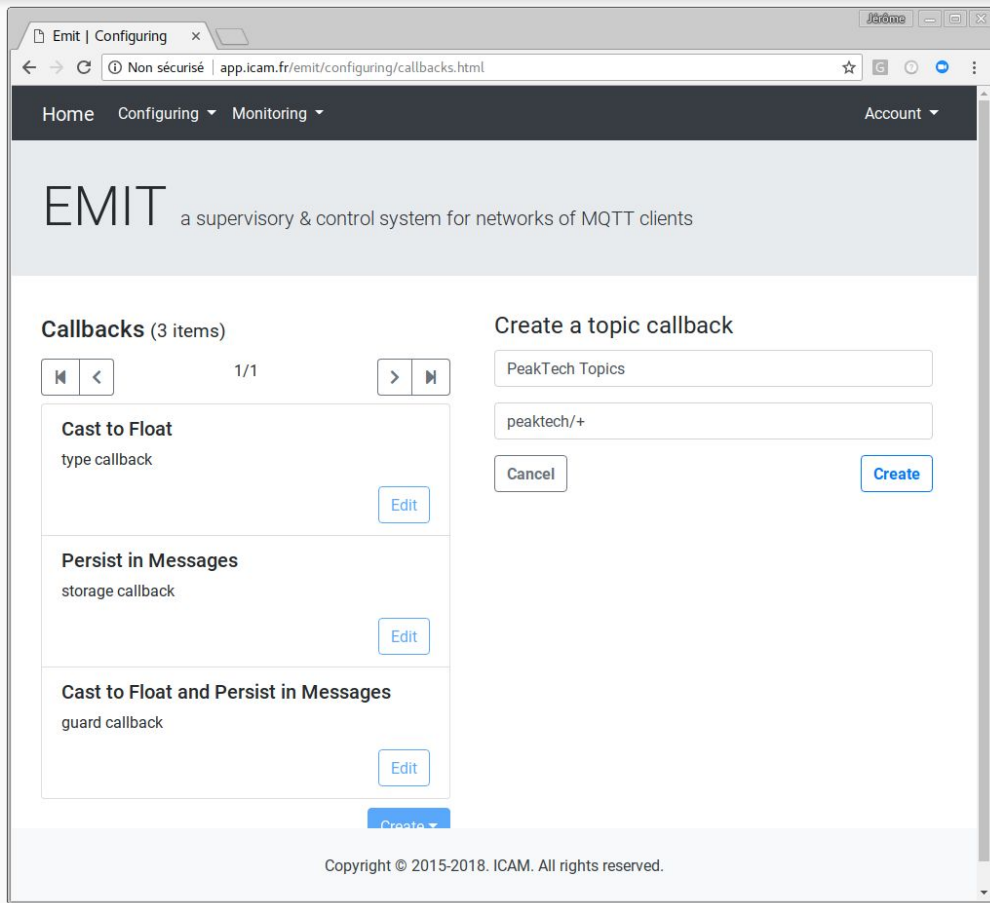
Below the list is a "Create" button. To the right, the "Update a type callback" form is shown, with the following fields and buttons:

- Text input: "Cast to Float"
- Dropdown menu: "float"
- Buttons: "Cancel", "Delete", "Update"

At the bottom of the page, the copyright notice reads: "Copyright © 2015-2018. ICAM. All rights reserved."

Callbacks

- Types
- Topics
- Storages
- Features
- Guards
- *Sequences*



EMIT | Configuring x

Non sécurisé | app.icam.fr/emit/configuring/callbacks.html

Home Configuring Monitoring Account

EMIT

a supervisory & control system for networks of MQTT clients

Callbacks (3 items)

1/1

- Cast to Float**
type callback
[Edit](#)
- Persist in Messages**
storage callback
[Edit](#)
- Cast to Float and Persist in Messages**
guard callback
[Edit](#)

Create a topic callback

PeakTech Topics

peaktech/+

[Cancel](#) [Create](#)

[Create](#)

Copyright © 2015-2018. ICAM. All rights reserved.

Callbacks

- Types
- Topics
- Storages
- Features
- Guards
- *Sequences*

The screenshot shows a web browser window with the URL `app.icam.fr/emit/configuring/callbacks.html`. The page title is "Emit | Configuring" and the breadcrumb navigation shows "Home", "Configuring", and "Monitoring". The main header displays "EMIT a supervisory & control system for networks of MQTT clients".

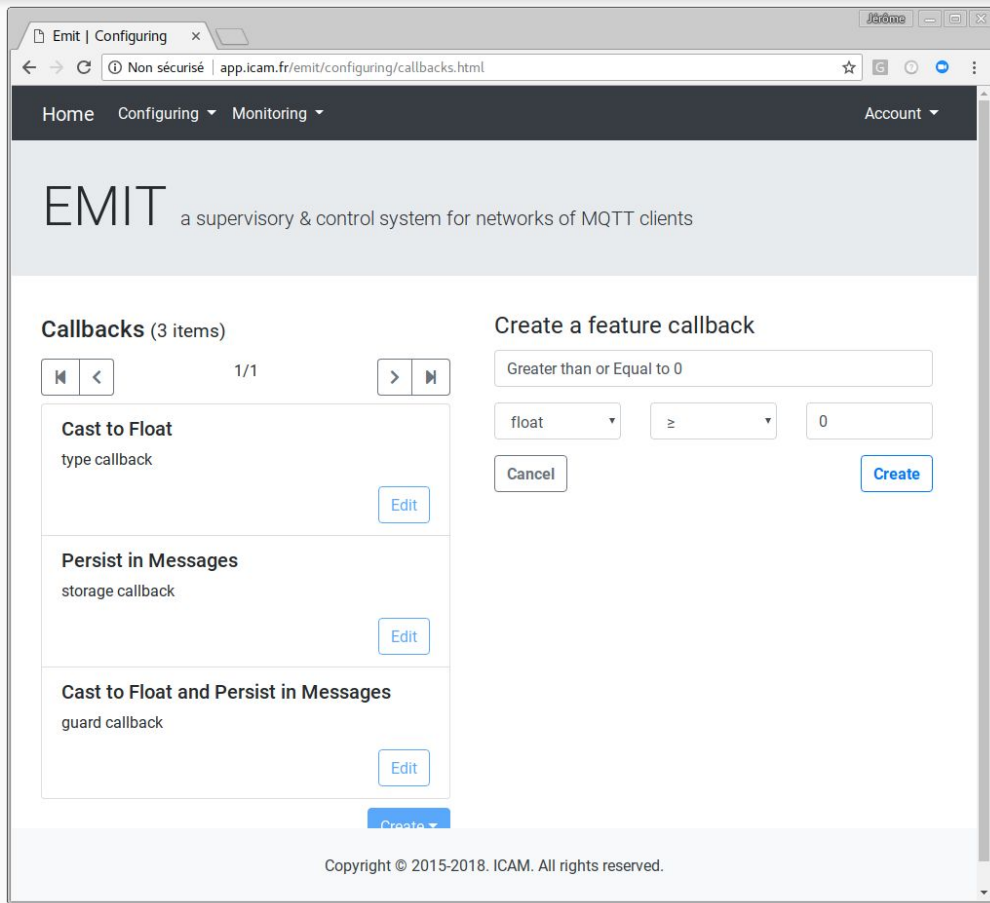
The main content area is divided into two sections:

- Callbacks (3 items):** A list of three callbacks, each with an "Edit" button:
 - Cast to Float** (type callback)
 - Persist in Messages** (storage callback)
 - Cast to Float and Persist in Messages** (guard callback)
- Update a storage callback:** A form for editing a storage callback. It includes a text input field containing "Persist in Messages", a dropdown menu with "messages" selected, and three buttons: "Cancel", "Delete", and "Update".

At the bottom of the page, there is a "Create" button and a copyright notice: "Copyright © 2015-2018. ICAM. All rights reserved."

Callbacks

- Types
- Topics
- **Storages**
- Features
- Guards
- *Sequences*



EMIT a supervisory & control system for networks of MQTT clients

Callbacks (3 items)

1/1

- Cast to Float**
type callback
[Edit](#)
- Persist in Messages**
storage callback
[Edit](#)
- Cast to Float and Persist in Messages**
guard callback
[Edit](#)

[Create](#)

Create a feature callback

Greater than or Equal to 0

float ≥ 0

[Cancel](#) [Create](#)

Copyright © 2015-2018. ICAM. All rights reserved.

Callbacks

- Types
- Topics
- Storages
- Features
- Guards
- *Sequences*

The screenshot shows a web browser window with the URL `app.icam.fr/emit/configuring/callbacks.html`. The page title is "Emit | Configuring". The navigation bar includes "Home", "Configuring", "Monitoring", and "Account". The main heading is "EMIT a supervisory & control system for networks of MQTT clients".

The page is divided into two main sections:

- Callbacks (3 items):** A list of three callbacks, each with an "Edit" button:
 - Cast to Float** (type callback)
 - Persist in Messages** (storage callback)
 - Cast to Float and Persist in Messages** (guard callback)
- Update a guard callback:** A form for editing a guard callback. The current callback is "Cast to Float and Persist in Messages". The form includes:
 - A text input field containing "Cast to Float and Persist in Messages".
 - A dropdown menu with "Cast to Float" selected.
 - A dropdown menu with "Persist in Messages" selected.
 - An empty text input field.
 - Buttons for "Cancel", "Delete", and "Update".

At the bottom of the page, there is a "Create" button and a copyright notice: "Copyright © 2015-2018. ICAM. All rights reserved."

Callbacks

- Types
- Topics
- Storages
- Features
- Guards
- *Sequences*

EMIT

Challengers

- Evaluation Criterion
- Eclipse MQTT Spy
- IBM Watson IoT

Security

- ✓ Authentication
- ✗ SSL / TLS

Communication

- ✓ Automatic Reconnect
- ✓ TCP
- ✗ Websocket

Messages

- ✗ Filtering
- ✗ Statistics
- ✓ Processing

Usage

- ✓ Application
- ✓ HTTP API

The screenshot displays the EMIT monitoring interface in a web browser. The browser tab is titled "Emit | Monitoring" and the address bar shows "app.icam.fr/emit/monitoring/controls.html". The interface has a dark navigation bar with "Home", "Configuring", and "Monitoring" menus, and an "Account" dropdown. The main header reads "EMIT a supervisory & control system for networks of MQTT clients".

The "Clients (2 items)" section shows a list of two clients, each with a "Select" button and a lock icon. The first client is "PeakTech Power Meter" connected to a Mosquitto Broker at tcp://172.21.50.3:1883. The second client is "Ardgetti PowerMeter" also connected to the same Mosquitto Broker.

The "Callback" section features a dropdown menu set to "Cast to Float and Persist in Messages" and a "Detach" button.

The "Connection" section shows the status "connected to Mosquitto Broker" with a "Disconnect" button.

The "Subscription" section shows the status "subscribed to peaktech/power" with an "Unsubscribe" button.

The "Publication" section includes input fields for "Topic" and "Payload", dropdown menus for "QoS" (set to 0), "Retained" (set to false), and "Persisted" (set to false), a "Clear" button, and a "Publish" button.

At the bottom of the page, the copyright notice reads: "Copyright © 2015-2018. ICAM. All rights reserved."

Eclipse MQTT Spy

Security

- ✓ Authentication
- ✓ SSL / TLS

Communication

- ✓ Automatic Reconnect
- ✓ TCP
- ✓ Websocket

Messages

- ✓ Filtering
- ✓ Statistics
- ✓ Processing

Usage

- ✓ Application
- ✗ HTTP API

The screenshot displays the Eclipse MQTT Spy application window. The title bar reads "mqtt-spy". The menu bar includes "File", "Configuration", "Connections", "Window", and "Help".

The "Control panel" shows the connection "mqtt-spy@localhost". Below it, the "Publish message" section has a "Topic" field with "home/office/temp" and a "Data" field with "20". A "Publish" button is visible.

The "Scripted publications" section contains a table with the following data:

Script name	Source	Repeat	Status	Messages	Last published
bedroom	Script folder	✓	Running	274	2016/04/03 21:25:58
office	Script folder	✓	Running	266	2016/04/03 21:25:58
kitchen	Script folder	✓	Running	182	2016/04/03 21:25:58

The "Subscriptions and received messages" section shows a list of subscriptions: "home/bedroom/#", "home/kitchen/#", "home/office/#", and "\$SYS/#". The "Message 1 / 1053" section displays a message with "Topic" "home/kitchen/current" and "Data" "20.2".

The "Received messages summary" section shows a table with the following data:

Topic	Content	Browse	Messages	Last received
home/office/current	21.7	✓	190	2016/04/03 21:25:58:328
home/kitchen/current	20.2	✓	151	2016/04/03 21:25:58:410
home/bedroom/current	19.9	✓	226	2016/04/03 21:25:58:255
\$SYS/broker/version	mosquitto version 1.4.8	✓	1	2016/04/03 21:22:57:387
\$SYS/broker/uptime	1111 seconds	✓	17	2016/04/03 21:25:48:320

Security

- ✓ Authentication
- ✓ SSL / TLS

Communication

- ✗ Automatic Reconnect
- ✓ TCP
- ✗ Websocket

Messages

- ✓ Filtering
- ✓ Statistics
- ✗ Processing

Usage

- ✓ Application
- ✓ HTTP API

Device B2

Device Refresh

Connection Information ⓘ

Device ID: B2
Device Type: elevator-B
Date Added: Thursday, 18 February 2016
Added By: bboyd@us.ibm.com
Connection State: Connected on Monday, 25 July 2016 at 07:24:32 from 192.155.247.240 with an insecure connection [Refresh](#)

Recent Events ⓘ

Event	Format	Time Received
status	json	27 Jul 2016 09:53:08
status	json	27 Jul 2016 09:53:10
status	json	27 Jul 2016 09:53:12

Sensor Information ⓘ

Event	Datapoint	Value	Time Received
status	location.height	24	27 Jul 2016 09:53:12
status	location.floor	6	27 Jul 2016 09:53:12
status	weight.value	154	27 Jul 2016 09:53:12
status	weight.perc	0.08	27 Jul 2016 09:53:12

EMIT

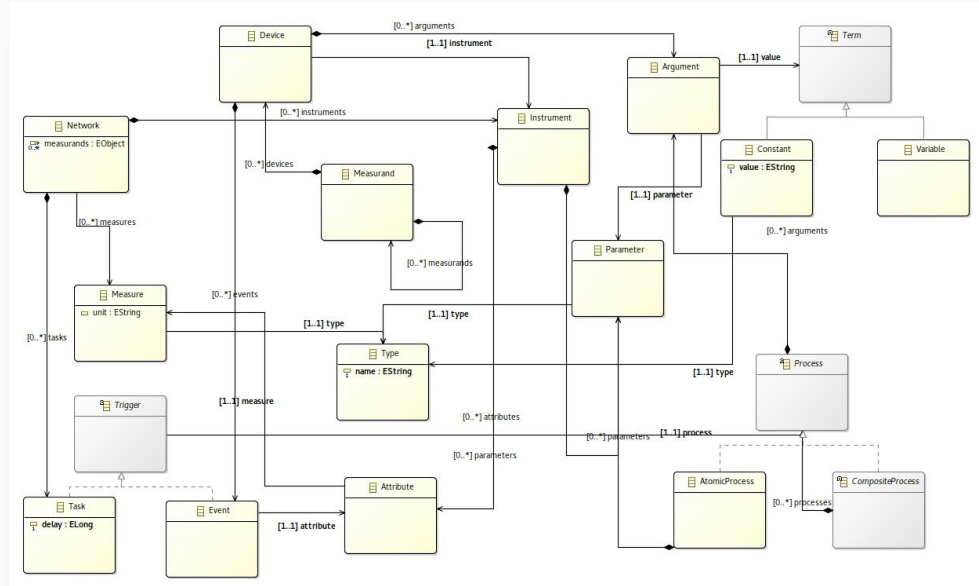
Prospects

Callback System

- Callback for Status Updates
 - connect / disconnect a client
 - subscribe / unsubscribe to a topic
 - publish a message to a topic
- Extensible Integration System

Model-Driven IoT Engineering

- Models of IoT Systems
- Validation Support
 - Client and Callback Compliance
 - Requirements over Status Updates
- Configuration Generation
 - EMIT
 - IBM Watson IoT



Thank you!

