Improve processes, detect current problems,
prevent costly downtimes, and produce better products

MAINFLUX LABS

Open Source Internet of Things Technology & Consulting Services

PITCH DECK

Mainflux Labs
Veljka Dugosevica 54
Belgrade Science Park
11000 Belgrade, Serbia
www.mainflux.com

Company Representative
Sasa Klopanovic
Tel: + 381 64 143 0781
sasa@mainflux.com

Company Overview and Traction

Mainflux Labs Company

COMPANY

MAINFLUX LABS

Founded in 2015

Crossfunctional team of 7 industry professionals with unviersity degree

Covering software and hardware layers of the internet of things technology

LOCATION

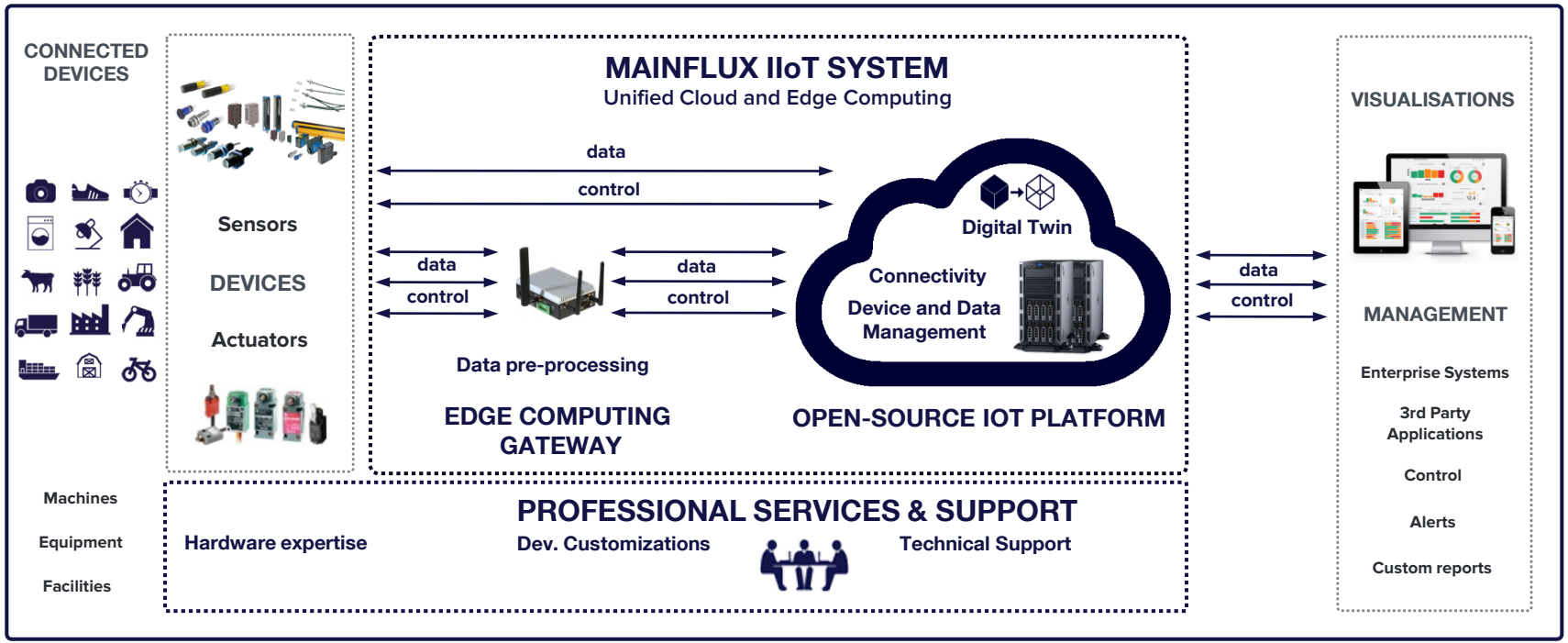
SERBIA
BELGRADE OFFICE
Mainflux at The Science Technology Park – Belgrade
Veljka Dugoševića 54
11050 Belgrade

What We Do

Mainflux Labs is providing

A **Mainflux IIoT System**

B **Professional Services & Support**



What We Do

PROFESIONAL SERVICES

Based on
one-off contractual agreements

- Consultancy Around Product Design, And Architecturing
- Proof Of Concept (Poc) Project's
- Integration's And Pilot's
- Advanced Services And Customizations

SUPPORT

Based on
subscription package

- Technical Support
- Workshops
- Training

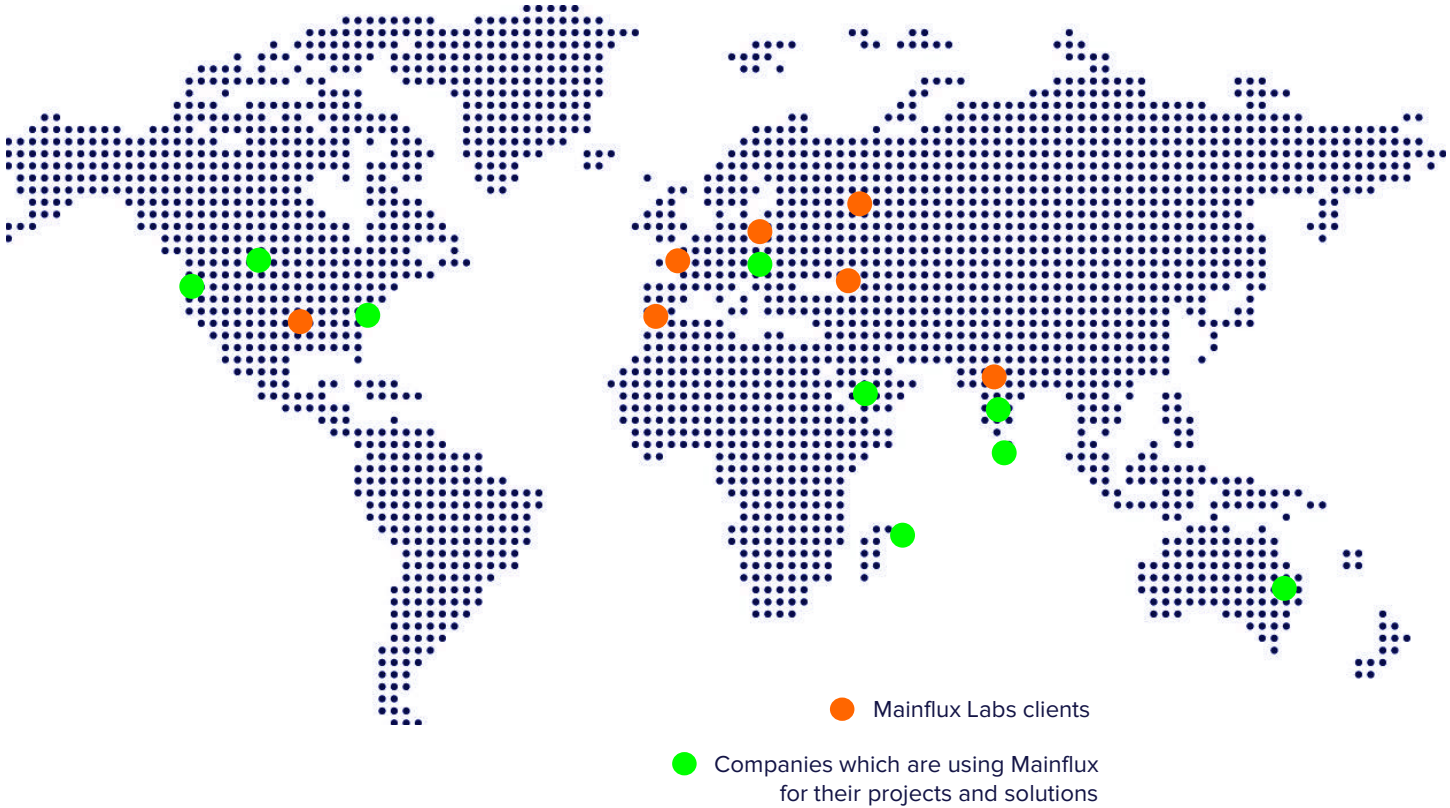
MAINFLUX ENTERPRISE EDITION

Packaged collection of open source Mainflux IoT platform components
provided as a signed binaries and/or Docker images

Mainflux Technology – Deployed Globally

Countries in which Mainflux is deployed

- USA
- India
- Sri Lanka
- Mauritius
- Australia
- United Arab Emirates
- Russia
- Georgia
- Switzerland
- France
- Spain
- Germany



Mainflux Technology Adoption

Target USA - 1800 Stores
Non-contractual Partnership

Implementation of Mainflux IoT Platform as Core IoT platform in Smart Retail Store project. Extending LoRa support in Mainflux. Using Mainflux IoT Platform for management of remote gateways. Mainflux IoT platform deployed in 50 stores, preparing for launch the remaining 1800 stores.
Video: Principal Engineer of Target's IoT platform Dan Cundiff: Building an IoT Platform at Target.

O'REILLY GoLab ONS
OPEN SOURCE SUMMIT EUROPE
IOT SOLUTIONS {codemotion} FOSDEM

Conferences
Speaking Engagements

Presented on 16 world conferences in Europe, USA and China

Open Networking Summit - Santa Clara
O'Reilly Software Architecture - London
ITNext Summit & Codemotion - Amsterdam
Embedded Linux Conference - Portland
IoT Solutions World Congress - Barcelona
Redis Lab - San Francisco
ONS - Shanghai

intel Software DEVELOPER ZONE

Intel USA - Non-contractual Cooperation

Intel demonstrates Mainflux IoT Platform for metering on the edge, with article "View Metering In Action On Edge Middleware Platforms"

THE LINUX FOUNDATION COLLABORATIVE PROJECTS
EDGEXFOUNDRY LFEDGE
2018 CONTRIBUTION EDGEXFOUNDRY
2018 INNOVATION EDGEXFOUNDRY

Linux Foundation
Membership & Awards

Two awards from the community of 80 companies and EdgeX Governing board:

1. Community Contribution Award for Exemplary Leadership

2. Innovation Award for Extensive Technical Contribution.

400,000 DOWNLOADS
of Mainflux SW Repositories

572,426 DL
MQTT adapter service

106,287 DL
WebSocket

413,010 DL
Users service

451,601 DL
HTTP adapter service

447,629 DL
Things service

Mainflux Technology Adoption – EU H2020

Participation in projects funded by EU H2020 Research and Innovation program

EU H2020 - EUR 5mil
Digital Building Twins

Member of the consortium funded by EU H2020 Research and Innovation program for development of assistants for Safe, and Productive Virtual Construction Design, Operation & Maintenance using a Digital Twin. Mainflux was invited by TU Berlin, other members include Erasmus Universiteit Rotterdam, German and Scandinavian construction structural engineering companies. Duration 2020-2023.

EU H2020 - EUR 5mil
Trustworthy AI

Member of the consortium funded by EU H2020 Research and Innovation program for development developing resilient accountable metrics, privacy-preserving methods, verification tools and system framework that will serve as critical building blocks to achieve trustworthy AI in security solutions. Member of consortium Includes Fraunhofer, Delft University of Technoogy, Telefonica, NEC, among the others. Duration 2021-2024.

Participation in consortiums that competed for EU H2020 funding

Quality Control In Smart Manufacturing EUR 10 mil

Mainflux Labs was invited by Fraunhofer IAPT to participate on 10 million EUR Call which aims to address the challenge of data reliability, the sensors, actuators and instruments used at various levels of integration in the manufacturing process.

Cloud Computing: Towards A Smart Cloud Computing Continuum EUR 4mill

Invited by Universidad Politecnica de Catalunya, Barcelona, to participate on a 4million EUR H2020 call for comprehensive cloud solutions and testbeds combining for ubiquitous and seamless execution computing environments.

Upgrading Smartness of existing Buildings EUR 5mil

Mainflux Labs was invited by by TU Berlin to participate on a call which aims improve the smart readiness of buildings to allow for energy savings, more flexible operations, increased usability, and better maintainability.

Mainflux Technology Adoption – EU H2020

Demo-sites and Implementation of Mainflux IoT Technology in 2022

Horizon 2020
European Union Funding
for Research & Innovation

Technische Universität Berlin

sbp
schlaich bergermann partner

NCC

EU H2020 - EUR 5mil
Digital Building Twins

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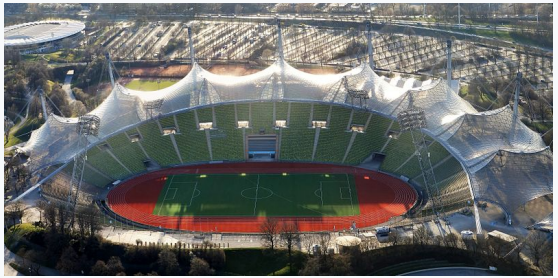
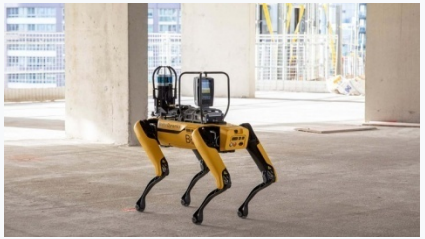


Munich
Olympic Stadium



Gothenburg
110 meters office building and Boston Dynamics Robot

Port of Rotterdam
Euromax, Yangstehaven, Maasvlakte II

Barcelona
Two office buildings

Mainflux Technology Adoption – EU HORIZON 2021 - 2027

Grant Agreement preparation 2022

Horizon 2020
European Union Funding
for Research & Innovation

TU Delft
Delft University of Technology

BAM
Bundesanstalt für Materialforschung und -prüfung

Technische Universität Berlin

The Hong Kong Polytechnic University
香港理工大學

EU HORIZON - EUR 5mil
Twin - Transition

Reincarnation of construction products and materials by slowing down and extending cycles

Reincarnate aims at enabling the European construction industry to significantly reduce construction and demolition waste (CDW) by providing a circular potential assessment information model platform (CP-IM) and a set of innovations to make use of the CP-IM. The CP-IM will provide a digital representation of building materials and products with life-cycle information and prediction methods for tracing and predicting the lifetime of a products / material.

Submitted proposal in 2021

Horizon 2020
European Union Funding
for Research & Innovation

IBM
Telefónica
FUJITSU
UNIVERSITY OF AMSTERDAM
Universität Zürich[UZH]

Invited by Mainflux Labs

EMC
ЈАВНО ПРЕДУЗЕЋЕ ЕЛЕКТРОМРЕЖА СРБИЈЕ
MP institut MIHAJLO PUPIN

EU Horizon - EUR 8mil
Edge: Meta Operating Systems

Device-to-Edge-to-Cloud Continuum for the Next Generation European Operating Systems

The goal of GENESYS is to materialize such a continuum, developing a secure Meta Operating System (Meta-OS) with underlying platform for orchestration and automation that will integrate IoT solutions with cloud providers, and distributed services, ensuring efficient multi-tenant architecture, based on network slicing, comprehensive hardware-software support, complemented by a hierarchical resource management framework.

Researches which used Mainflux IoT Platform

Publications	Authors	Description
Enabling the Orchestration of IoT Slices through Edge and Cloud Microservice Platforms	MDPI sensors; uc3m Universidad Carlos III de Madrid; ERICSSON	This article addresses one of the main challenges related to the practical deployment of Internet of Things (IoT) solutions: the coordinated operation of entities at different infrastructures to support the automated orchestration of end-to-end Internet of Things services. This idea is referred to as “Internet of Things slicing” and is based on the network slicing concept already defined for the Fifth Generation (5G) of mobile network. Link
A Multi-Site NFV Testbed for Experimentation With SUAV-Based 5G Vertical Services	IEEE Access; uc3m Universidad Carlos III de Madrid; IMDEA Networks; UNIVERSITAT POLITÈCNICA DE CATALUNYA BARCELONATECH; University of the Basque Country	The goal of this testbed is to explore synergies among NFV, SUAVs, and vertical services, following a practical approach primarily governed by experimentation. To verify our testbed design, we realized a reference use case where a number of SUAVs, cloud infrastructures, and communication protocols are used to provide a multi-site vertical service. Link
ETSI - TECHNICAL REPORT SmartM2M; Guidelines for using semantic interoperability in the industry	ETSI TECHNICAL REPORT	The main objective of the present document is to push semantic interoperability in IoT forward in raising awareness about its importance in industry in order to unlock the potential economic value of IoT. A major focus is on thedevelopment of guidelines on how to use semantic interoperability in the industry. 5.2.5 Open source - 5.2.5.1 Mainflux / Link

Organizations which are using Mainflux IoT Platform

ORGANIZATIONS AND COMPANIES WHICH ARE USING MAINFLUX AS AN OPEN-SOURCE SOLUTION

open source

TARGET – USA
Implementation of Mainflux IoT Platform as Core IoT platform in Smart Retail Store project

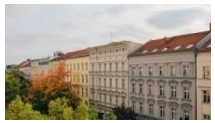
XEROX PARC – USA
Predictive maintenance for manufacturing

OSIRIS SYSTEMS FOR INDIAN COAST GUARD - INDIA
Osiris system used Mainflux IoT platform to develop solution for the centralized monitoring and control of vital metrics of geographically spread multitude of data centers

TALOSLOGY – SRI LANKA
Taloslogy uses Mainflux to create IoT based Building Automation System for the mix-used facility in Sri Lanka that cost significantly less than the traditional BAS solutions

TECHOLUTION FOR MAURITIUS TELECOM – USA/INDIA
Techolution uses Mainflux to monitor hard-to-reach BST Towers and replaces expensive manual maintenance to prevent power outages

TOUCH PANEL CONTROL - AUSTRALIA
School Management System for Australian Universities



DIGITAL TWIN TECHNOLOGY- GERMANY
Mainflux is used for health monitoring solution deployed in 40 buildings in Berlin

Mainflux Labs Clients

CLIENTS

MULTINATIONAL COMPANY'S STARTUP - FRANCE
Development of blockchain powered data marketplace.

WORLDWIDE PROVIDER OF OILFIELD & GAS EQUIPMENT - USA
Implementation of Mainflux IoT Platform for gathering operational data from Oil & Gas equipment.

INDEPENDENT SOFTWARE VENDOR - RUSSIA
PoC - Monitoring of operational indicators of underlying IoT specific IT-infrastructure, remote control of the lifecycle of remote devices.

SYSTEM INTEGRATOR - GERMANY
PoC - Connecting pharma manufacturing machines via enterprise network to Mainflux.

SYSTEM INTEGRATOR - INDIA
PoC - IoT Platform connected with provisioning, monitoring & analysis with mongoDB with full UI. First phase: Oil & Gas use case demo kit.

SYSTEM INTEGRATOR - GEORGIA
Customization of IoT platform for NB-IoT devices for smart metering aimed for Eastern Europe Telecom.

LEADER IN RECYCLING AND WASTE MANAGEMENT VENTURES - EU
Mainflux IoT Platfrom deployment as company-wide general IoT platform
Development of custom components and knowledge transfer and trainings.

Mainflux IoT Platform

Innovation

TAKING ADVANTAGES OF CLOUD AND EDGE IN ONE SYSTEM

CONNECTED DEVICES

Machines

Equipment

Facilities

Sensors

DEVICES

Actuators

MAINFLUX IIoT SYSTEM

Unified Cloud and Edge Computing

data

control

data

control

data

control

Data pre-processing

Digital Twin

Connectivity

Device and Data Management

EDGE COMPUTING GATEWAY

- Sends only filtered data to the cloud, reducing the cost
- Isolates data completely if customers prioritize data security
- Reduce latency, quick responses time and data processing
- Eliminates intermittent connectivity

OPEN-SOURCE IOT PLATFORM

- Complex processing of entire data platforms and multiple applications
- Flexible and automated allocation of resources
- Support for virtualization and standart OS
- Connects enterprise solutions

data

control

VISUALISATIONS

MANAGEMENT

3rd Party Applications

Enterprise Systems

Control

Alerts

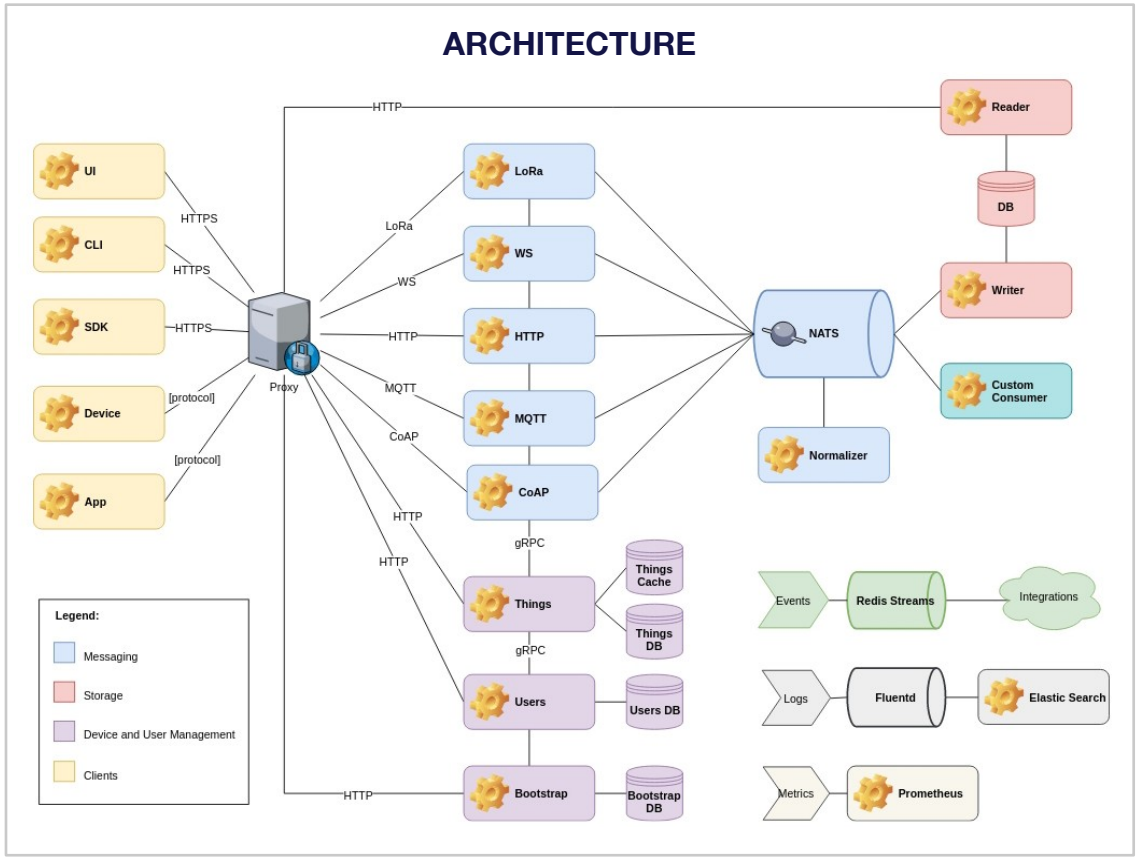
Custom reports

Mainflux IoT Platform

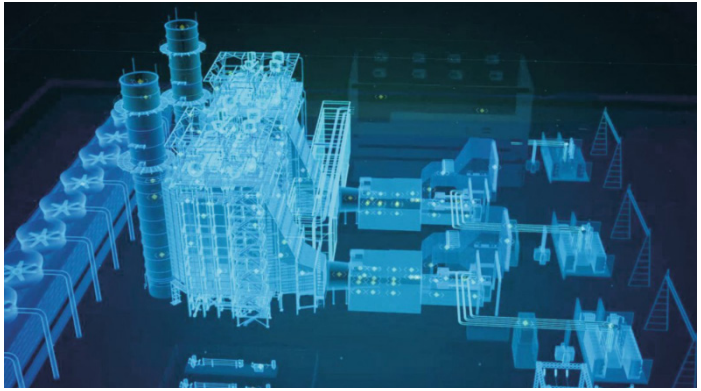
COMPREHENSIVE - FULL-SCALE FUNCTIONALITIES

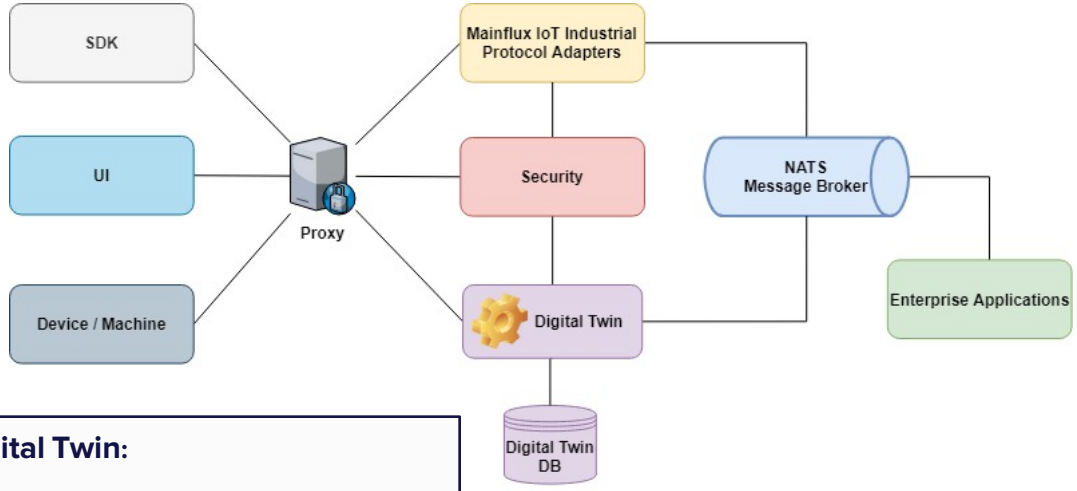
1. Storage and connectivity management
2. Device and user management
3. Data aggregation and data management
4. Messaging
5. Persistence
6. Rules engines
7. Administration
8. Digital Twin backend
9. User Interface

ARCHITECTURE



Digital Twin





Features

- State of the model
- State history
- Real-time state attribute updates
- State change notifications
- Model representation
- Delta state queries

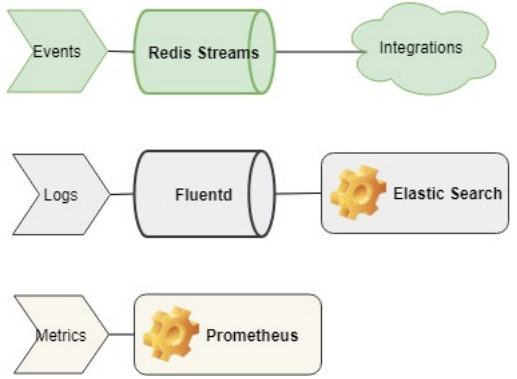
Digital Twin:

- Device / Machine connects over some of industrial protocols (e.g. MQTT or OPC-UA)

- After authorization, Digital Twin service updates virtual device representation with data from physical device

- Notifications and messages are published on NATS message broker

- System collects events, logs and metrics in a distributed manner



Mainflux IoT Platform – Technology Choices

Microservices - modern architecture, complete set of easy-to-maintain services with clear division of responsibility

Golang - modern, highly concurrent, readable, easier to maintain, fast/efficient, highly portable (runs on Windows, Linux, Mac and both Intel and ARM CPUs)

Docker containers - good isolation, fast startup, easy to distribute, small footprint due to Go and multi-stage builds (~5MB per microservice), production deployment using Kubernetes

SQL database for structured data **NoSQL** database for Telemetry

InfluxDB, MongoDB

PUB/SUB multiprotocol messaging bridge (HTTP, MQTT, WebSocket, CoAP) based on **NATS** ultra-performant broker

NGINX Reverse Proxy for security, load-balancing and termination of TLS and DTLS connections

Mutual TLS Authentication with X.509 Certificates

Mainflux IoT Platform – Benchmark

TESTING INFRASTRUCTURE

- Managed Kubernetes cluster on Digitalocean with deployed Mainflux IIoT using helm charts.
- Kubernetes cluster size: 5 Nodes CPU Optimized droplet - 8 vCPU 16 GB RAM
- Estimated monthly costs for this cluster: $500/month

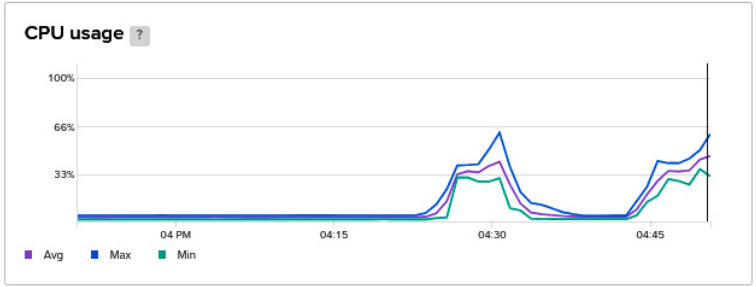
TESTING RESULTS - Messaging Benchmark (MQTT)

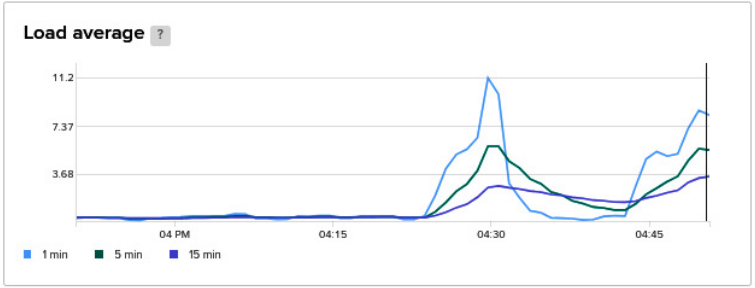
1. With this cluster and allocated compute power from 5 Nodes, we have successfully managed 10 000 concurrent connections, each client sending 1 message every second, **which is 10 000 messages per second.**
2. **Quality of service level 2** is used, which is the highest level of service in MQTT. This level guarantees that each message is received only once by the intended recipients. QoS 2 is the safest and slowest quality of service level.
3. **No message lost** detected.

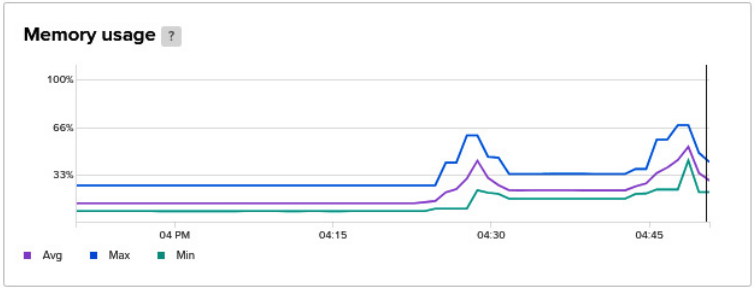
- **Total messages sent in 5 min is 3 000 000**
- **Message published acknowledge latency**
  - Max latency was up to 20 sec
  - 95% of clients had latency from 5 sec up to 15 sec under high load - Average latency was 5 sec without pekas
- **Total message sent per second is 10 000**
- **Message Publish received ACK Latency**
  - Max latency was up to 8 sec
  - 95% Of clients had latency from 0.5sec up to 6sec under high load - Average latency was ~2sec without peaks

Mainflux IoT Platform – Benchmark

Digitalocean Kubernetes cluster node's insights during testing







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CPU USAGE

Avg	45.91 %
Max	61.33 %
Min	31.63 %

LOAD AVERAGE

1 min	8.26
5 min	5.55
15 min	3.50

MEMORY USAGE

Avg	29.13 %
Max	42.11 %
Min	21.05 %

DISK USAGE

Avg	5.53 %
Max	6.07 %
Min	4.86 %

DISK I/O

Read avg	0.00B/s
Write avg	980B/s
Read max	0.00B/s
Write max	1.96kB/s

PUBLIC BANDWIDTH

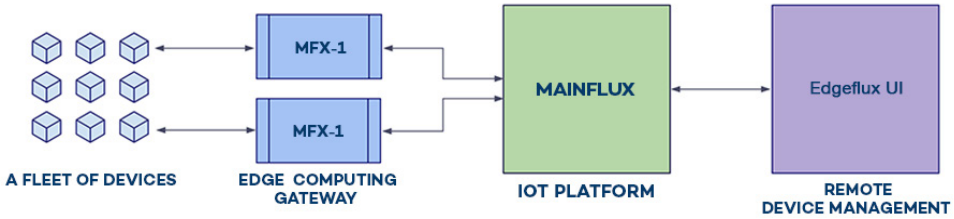
Incoming avg	206bps
Outgoing avg	49.5kbps
Incoming max	426bps
Outgoing max	85.9kbps

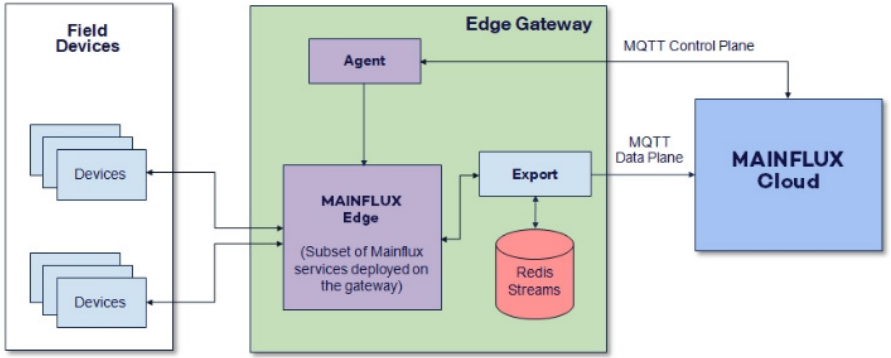
Mainflux Labs
IoT Edge Computing Gateway

Edge Computing Gateway

EDGE COMPUTING FUNCTIONALITIES

1. Data collection, filtering & compression
2. Data analyzed on the source
3. Data transmission
4. Buffering of data
5. Data verification
6. Data encrypment
7. Remote management of devices
8. Real-Time control





DEVELOPED TO MEET INDUSTRIAL AND THE B2B MARKET DEMANDS

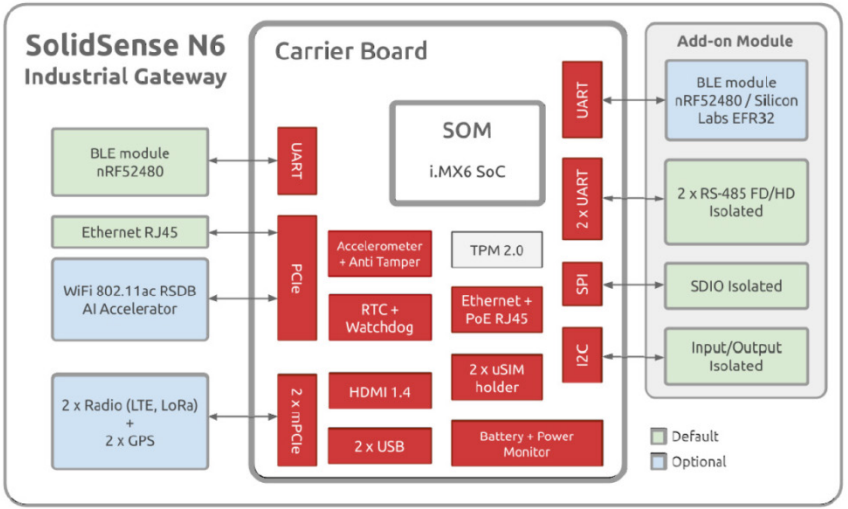
Edge Computing Gateway

EDGE COMPUTING GATEWAY HARDWARE

MFX-1 IoT Edge Gateway is developed on the optimized hardware, the SolidSense N6 IndustrialInternet of Things gateway designed for servicing a local network of IoT devices with a range of solutions and business applications.

SolidSense N6 Industrial Common Features

SOM Model	NXP i.MX6 based Solo to Quad Core SOM
Processor	i.MX6 single to quad core Arm® Cortex® A9 (800 MHz)
Memory and Storage	Up to 2GB DDR3 eMMC (8GB by default))*
Network	2 x Ethernet RJ45 10/100/1000 WiFi (2.4 GHz) Bluetooth Low Energy 5.0 (nRF52840 - software defined radio based on Nordic Semiconductor) LTE Cat 4 EU + GPS (with fallback on 3G/2G) LTE Cat M1 EU/US + GPS (with fallback on 3G) Additional mPCIe slot available for networking options
Connectivity	2 x USB 2.0 type A HDMI MicroSD 2 x Physical uSIM
Power	7V to 36V with reverse polarity protection (battery backup) PoE 802.3at PD for external peripheral
Development & Debug Interfaces	Console port (UART)
Certifications	CE, FCC/CSA
Environment	Ambient temperature: -25°C to 65°C Max CPU die temperature: 105°C Humidity (non-condensing): 10% - 90%
Dimensions (WxL)	132.5 x 144 x 40.5mm
Enclosure	Extruded Aluminum (IP32), 8 x SMA Optional DIN rail mounting



Mainflux Labs Team

Mainflux Labs Team

SASA KLOPANOVIC - DIRECTOR

Marketing & Communications

Sasa is responsible for the business strategy and execution of all marketing activities. Recognized for the ability to work in different industries, he brings more than 15 years of marketing experience ranging from start-ups to large companies. Significant working experience Sasa gained in Port of Belgrade and its development of 96 ha waterfront district, master-planned by world-renowned and global companies, as well in the crowd-funding campaign for the IoT hardware - WeIO, and its commercialization in 40 countries. Sasa holds MSc degree in Philosophy from Belgrade University.

MIRKO TEODOROVIC - TECHNICAL DIRECTOR

Hardware & Embedded Software Development

Mirko has 14 years of experience in development of web and enterprise applications in financial domain, working as a full stack developer in FIS Global Bussines Solutions. Over the time he gained significant experience in software development as well as system administration. He also acquired experience in hardware development working R&D for RFID card reader system. Mirko holds MSc degree in Electrical Engineering from University of Belgrade.

MANUEL IMPERIALE – PRODUCT MANAGER

Hardware & Embedded Software Development

Manuel gained MSc. EE at University Pierre and Marie Curie, where he specialized in industrial informatics and both software and hardware technologies. He was working in The Institute for Intelligent Systems and Robotics (ISIR), and companies Devialet 3D Sound Labs on the wireless sound system which has the longest positive review in the history of magazine WIRED.

STEFAN KOVACEVIC – SOFTWARE ARCHITECT

Software Development

Stefan has been working as a software developer for the last 11 years, with a variety of technologies and frameworks. During those years, he has been mainly concentrated on web development and enterprise apps as a full stack developer. Stefan worked 3 years as a consultant and SW developer for UNIQA insurance group, MSG global, and also 3 years on projects for Telekom of Serbia. He holds a MSc degree in Information Systems from the University of Belgrade.

Mainflux Labs Team

DUSAN BOROVCANIN - SOFTWARE DEVELOPER

Software Development

Dušan is software developer. He holds bachelor degree in software engineering from Faculty of Technical Sciences of Novi Sad. Dusan is working as software developer with experince in web development. He is fluent in Python, Javaand Go. His fields of interest include scalable distributed systems, web development and mobile development. Dusan has MSc in computer sciences.

IVAN MILOSEVIC - SOFTWARE DEVELOPER

Software Development, DevOps

Ivan has more than nine years expirience in Serbian largest hosting companies EUnet/SBB and mCloud. He has been developing control panels that integrate with various shared and cloud hosting platforms (cPanel, OnApp, AppLogic, Hyper-V...) and domain registrars. Ivan also developed systems that automate billing operations and integrates with payment gateways. Fluent in PHP, SQL, JavaScript. Ivan holds MSc degree in Electrical Engineering from University of Belgrade.

Mainflux Labs Advisors

BORIS BOKUN - TECHNICAL ADVISOR

Quality Management and Industrial Automation

Boris has 20 years of successful entrepreneurship as the founder of software companies Pragmatic-IT, strictit and emoneo PR. He has 20 + years of experience developing Industrial software solutions for Quality Management and industrial automation, deployed mostly in German SME as well in industrial facilities on 4 continents of the world. Additionaly 15 years experience in development and successful regional commercialization of ERP Solution for Pharma wholesalers and pharmacy in SE Europe - 250 pharmacies and 10 wholesaler clients. Boris company Pragmatic-IT and its ERP Solution is acquired by German Phoenix group - one of the biggest pharma wholesaler group in Europe.

NIKOLA MARCETIC - TECHNICAL ADVISOR

Software Development

Nikola has experience of more than eight years , covering a wide range of technologies and IT directions, from IT administration over computer networks and security, system architecture to software development and testing. Currently, he is working as a software developer with great expertise in Web development and connected things over. His clients includes. Flair Airlines, Air Dynamic, Music First and Disruptive Multimedia on the Superphone project funded by Ben Horowitz Co- Founder of Andreessen Horowitz.

MAINFLUX LABS

THANK YOU!

www.mainflux.com
info@mainflux.com