Actility ThingPark
Self-hosted ThingPark Enterprise v7.3 Performance Benchmark Report

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VERSIONS

Version	Date	Author	Details
01	2023/10/03	Actility	Initial Version

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ACRONYMS AND DEFINITIONS

Acronyms	Definitions
ABP	Activation By Personalization
ADR	Adaptive Data Rate
AES	Advanced Encryption Standard
AS	Application Server
BPM	Business Process Management
BSS	Billing Support Systems
CSP	Communication Service Provider
DC	Duty Cycle
End Device	A sensor or actuator
ESP	Estimated Signal Power
HAN	Home Area Network
HSM	Hardware Security Module
IEC	International Electrotechnical Commission
IoT	Internet of Things
ISM	Industrial Scientific Medical
GTM	Go To Market
KPI	Key Performance Indicator
LC	Logical Channel
LoRaWAN™	Long Range Wide Area NW
LPWAN	Low Power Wide Area Network
LRC	Long Range Controller
LRR	Long Range Relay
MAC	Media Access Control
M2M	Machine-2-Machine
MTBF	Mean Time Before Failure
NAT	Network Address Translation

NW	Network
NSCL	Network Service Capability Layer. Also called RMS.
OSS	Operations Support Systems
OTA	Over The Air
PER	Packet Error Rate
PKI	Public Key Infrastructure
POC	Proof Of Concept
REST	Representational State Transfer
RF	Radio Frequency
RIT	Receiver Initiated Transmit
RSSI	Received Signal Strength Indicator
SaaS	Software as a Service
SF	Spreading Factor
SLRC	Secured LRC (VPN Concentrator)
SMP	System Management Platform
SMTP	Simple Mail Transfer Protocol
SNMP	Simple Network Management Protocol
SNR	Signal to Noise Ratio
SSH	Secure SHell
SSO	Single Sign On
TLS	Transport Layer Security
TWA	ThingPark Wireless Application
UNB	Ultra Narrow Band
VM	Virtual Machine
VPN	Virtual Private Network
WS	Web Service

1 SCOPE

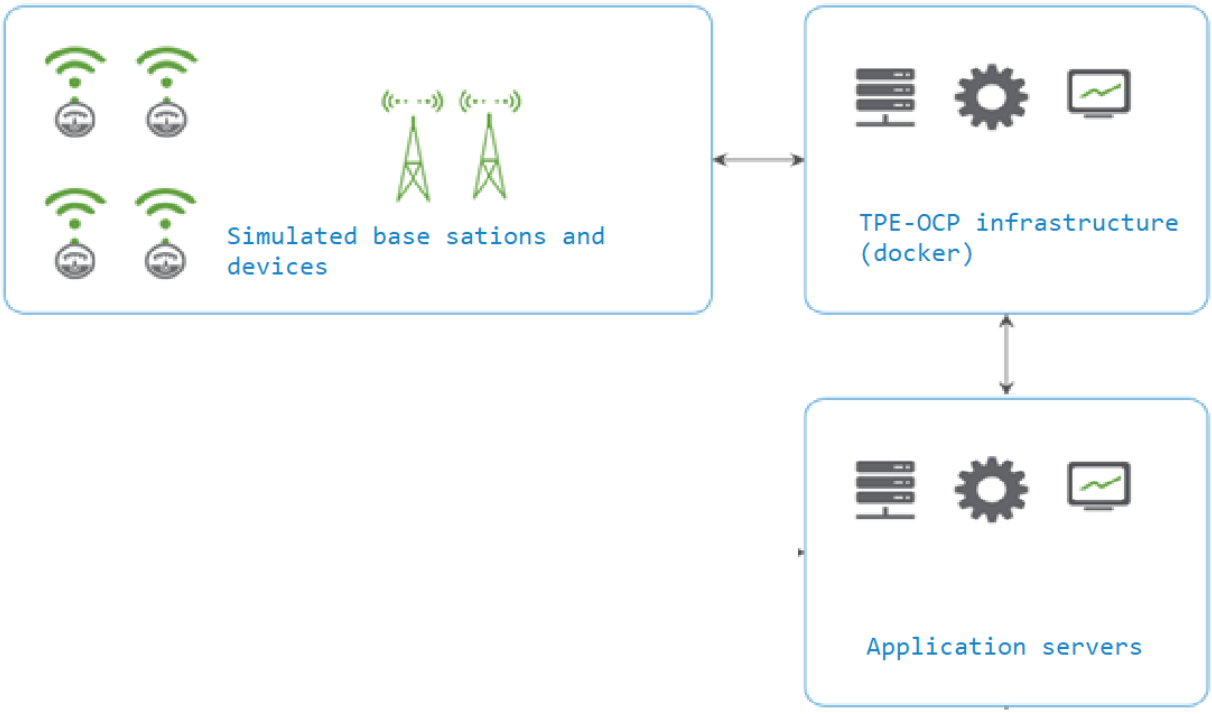
The scope of this document is to present the performance benchmark results related to self-hosted ThingPark Enterprise (also known as TPE-OCP) release 7.3, with both LoRaWAN radio traffic and API traffic.

The results of performance tests enable proper system dimensioning in terms of CPU, memory, disk and network.

The system under test is a standalone self-hosted TPE platform dimensioned according to the “Small” sizing profile and using the appliance/VM deployment method. For more information about hardware sizing profiles, see online documentation.

2 BENCHMARK ENVIRONMENT AND MODELLING ASSUMPTIONS

The following figure shows the high-level diagram representing the test platform used in the performance test campaign.



The self-hosted ThingPark Enterprise 7.3 benchmark focuses on LoRaWAN UL and DL processing in addition to API traffic:

- Scan, Create, Update, Mass Updates devices and base stations through DX API.
- Get details of devices and base stations with OSS API, to simulate user activity on TPE User Portal.

2.1 Key modeling assumptions

Title	Value
TPE instance	Self-hosted appliance using standalone mode and the small sizing profile
Account settings	2 Connections - 1 HTTP Generic - 1 IOT Flow HTTP
Number of devices (1)	2000
Number of LRR (1)	10
Devices repartition	1960 devices on IOT Flow connection 40 devices on the HTTP generic connections

Note To monitor the system under test, several components are deployed on the TPE instance:

- cadvisor to collect containers metrics,
- node_exporter to collect system metrics on the host,
- telegraf to collect mongoDB metrics,
- jmxtrans to collect jvm metrics.

2.2 API scenario injection

The API bench consists of a set of scenarios launched in parallel for 24 hours. For each scenario, the details of injection rate and API requests are listed below.

Use cases	Description	Use-Case Injection Rate
tpe_use_case_1	[DX] Scan Base Stations + for each base station, get details and get alarms	900 s (15 mn)
tpe_use_case_2	[DX] Scan Devices + for each device, get details and get alarms	3600 s (60 mn)
tpe_use_case_3	[DX] Unitary Base Station creation	18000 s (5 hours)
tpe_use_case_4	[DX] Unitary Device creation	3600 s (1 hour)
tpe_use_case_5	[DX] Unitary update of Base Station RF region	18000 s (5 hours)

tpe_use_case_6	[DX] Unitary update of Device Connection	18000 s (5 hours)
tpe_use_case_7	[DX] Unitary send downlink on Device using DX API	300 s (5 mn)
tpe_use_case_8	[OSS] Get Base Station details	14400 s (4 hours)
tpe_use_case_9	[OSS] Get Devices details	21600 s (6 hours)
tpe_use_case_10	[DX] Mass update Base Station RF region	36000 s (10 hours)
tpe_use_case_11	[DX] Mass update Device's Device_Profile	39600 s (11 hours)

2.3 Radio traffic profile

LoRaWAN traffic is generated by a Perl utility simulating base stations and devices. The simulated base stations are connected to the self-hosted TPE platform through TLS protocol.

The simulated LoRaWAN traffic load corresponds to a constant load of 3 uplink packets/sec (after packet deduplication by the core network) over 24 hours, spread over the 2000 devices and the 10 base stations defined on this platform.
Hence, the simulated load is much higher than the average traffic load corresponding to "Small" sizing profile (0.6 packets/sec) to benchmark a worst-case load scenario.

2.4 Hardware description

One physical server was used to launch docker self-hosted TPE environment as detailed in *Software versioning*. The specification is shown below:

Name: HOST1	
Model	ADVANTECH (UNO-2484G)
Memory	7.8 GB
Processor	3 x Intel(R) Core(TM) i3-7100U CPU @ 2.40GHz Cores: 2
OS	CentOS version 7

Below is the output result of the "tpe-bench" script:

```
CPU model:  Intel(R) Core(TM) i3-7100U CPU @ 2.40GHz
CPU score:  M (27705)
RAM:        S(7.7 G)
Disk size:  XL (236 G)
Disk write score: XL(1075 w/s)
Disk read score: XXL(30597 r/s)
```

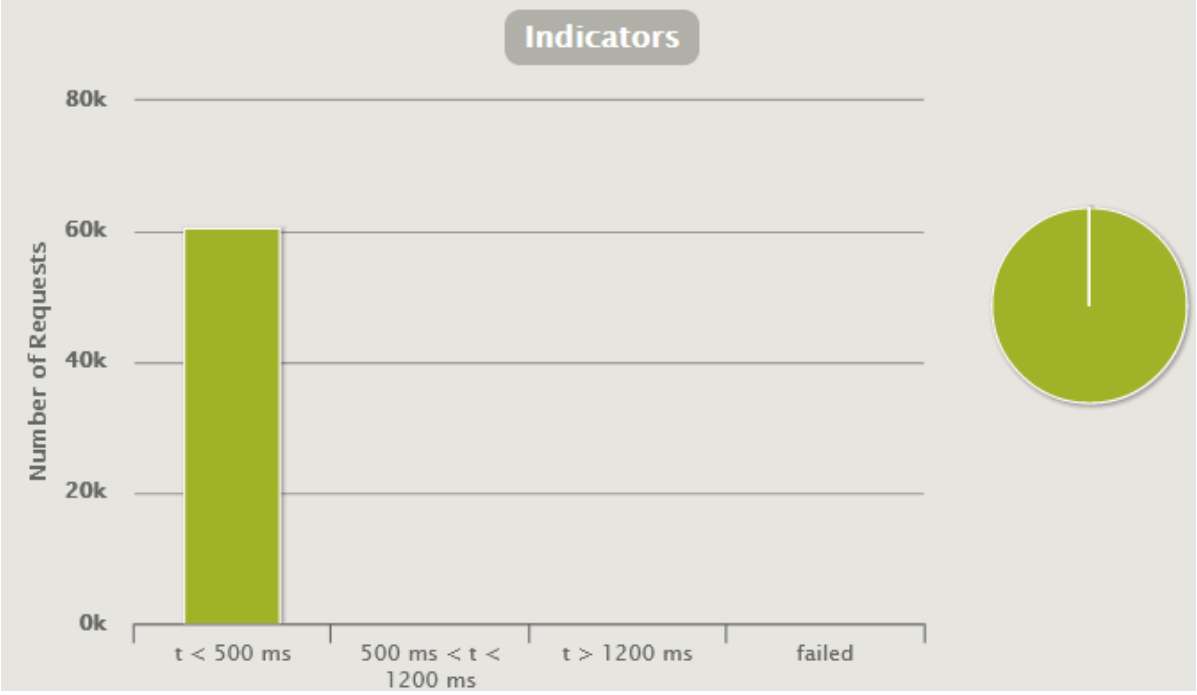
3 TESTS RESULTS

The performance benchmark tools report the following metrics:

- API response time
- Radio traffic statistics
- Overall CPU, RAM, Disk and Network usage of the self-hosted TPE instance

3.1 API response time and injection status

All graphs are set to show 24-hours period.



The overall response time distribution of the API tests shows that 100% of API requests are answered within 500ms.

This table summarizes the overall results and response time per API request:

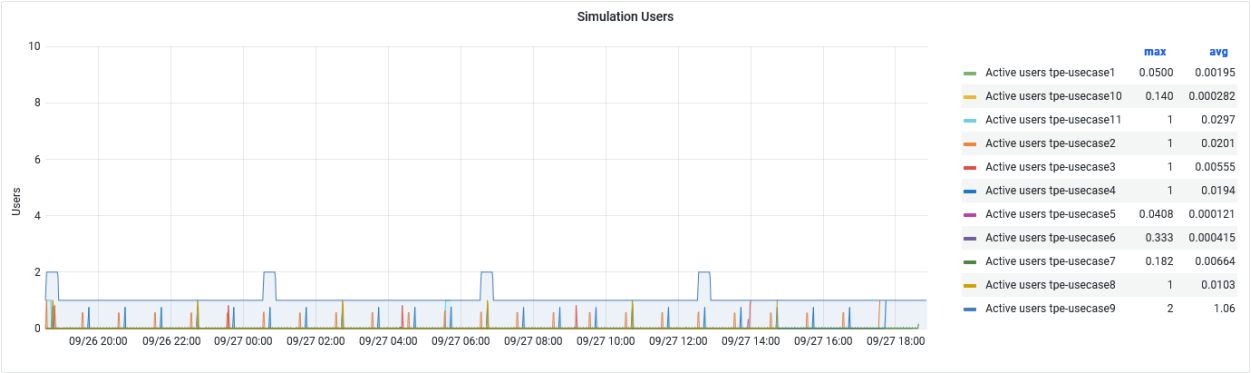
STATISTICS

Expand all groups | Collapse all groups

Requests	Executions					Response Time (ms)							
	Total	OK	KO	% KO	Cnt/s	Min	50th pct	75th pct	95th pct	99th pct	Max	Mean	Std Dev
Global Information	60784	60784	0	0%	0.696	4	31	47	168	271	5499	52	70
DX Get token	822	822	0	0%	0.009	56	98	119	162	207	380	104	32
DX Get devices	839	839	0	0%	0.01	21	104	137	200	276	790	116	52
DX Get BSs	103	103	0	0%	0.001	37	58	73	103	139	590	68	55
DX Get BS	25	25	0	0%	0	65	97	109	156	307	354	110	54
DX Get device	4006	4006	0	0%	0.046	60	80	98	152	213	457	90	32
DX Update BS	25	25	0	0%	0	115	160	216	309	607	701	203	115
DX Update device	4006	4006	0	0%	0.046	139	180	213	330	465	988	200	68
DX Get d...e alarms	48000	48000	0	0%	0.549	16	29	36	55	78	287	33	12
Login	10	10	0	0%	0	5	8	64	75	77	77	32	31
Get WL Access Code	4	4	0	0%	0	7	9	10	11	11	11	9	2
Get DM Access Code	4	4	0	0%	0	5	7	8	10	10	10	7	2
Create DM Session	4	4	0	0%	0	17	18	23	34	36	37	23	8
Get Wlogger user	4	4	0	0%	0	163	174	190	203	205	206	179	18
Get Devices	80	80	0	0%	0.001	50	86	104	159	177	215	92	31
Get Device	80	80	0	0%	0.001	30	41	53	75	96	109	46	16
Get Device tags	80	80	0	0%	0.001	26	36	45	66	96	101	40	14
Get Device frames	80	80	0	0%	0.001	310	572	700	1077	1605	2551	639	294
Get Devi...ribution	80	80	0	0%	0.001	29	47	62	99	119	129	53	20
Get Devi... packets	80	80	0	0%	0.001	9	12	15	26	65	99	16	13
DX Send ...o device	288	288	0	0%	0.003	37	53	70	103	121	142	60	20
DX Get routes	24	24	0	0%	0	175	255	303	375	409	419	267	63
DX Create device	24	24	0	0%	0	668	729	773	896	1069	1118	752	99
Get NM Access Code	6	6	0	0%	0	4	7	7	15	17	17	8	4
Create NP Session	6	6	0	0%	0	11	17	19	28	30	31	19	6
Get BSs	6	6	0	0%	0	34	45	52	57	58	58	46	8
Get BS frames	12	12	0	0%	0	36	91	145	329	477	514	128	124
Get BS D...ribution	12	12	0	0%	0	22	30	46	60	71	74	36	15
Get BS IEC packets	12	12	0	0%	0	106	249	428	695	895	945	315	236
Get BS CPU history	12	12	0	0%	0	63	86	111	232	330	354	112	76
Get BS RAM history	12	12	0	0%	0	52	59	73	94	96	97	65	15
Get BS Disk history	12	12	0	0%	0	49	58	65	76	79	80	60	9
Get BS S...ribution	12	12	0	0%	0	19	22	27	32	34	34	24	5
Get BS R...ribution	12	12	0	0%	0	23	28	32	45	47	48	30	8
Get BS d... history	12	12	0	0%	0	24	31	37	59	63	64	35	12
Get BS W...bitrates	12	12	0	0%	0	91	121	126	141	142	142	116	16
Get BS W...nd trips	12	12	0	0%	0	56	64	69	76	78	78	64	7
Get BS l... history	12	12	0	0%	0	56	62	66	72	78	79	63	6
DX Get BS alarms	1920	1920	0	0%	0.022	15	23	29	41	56	254	25	10
DX Delete device	24	24	0	0%	0	583	599	622	650	653	654	608	21
DX Create BS	5	5	0	0%	0	2431	3661	5245	5448	5489	5499	3991	1196
DX Delete BS	5	5	0	0%	0	203	245	281	303	307	308	253	38

Note The 99th percentile of the response time for the OSS API request “Create BSs” is greater than 3s. The ticket RDTP-19920 ([BENCH-TPE-OCP] Long response time for creation base station request) was raised to fix this issue.

The API injection rate is represented in the following graph:



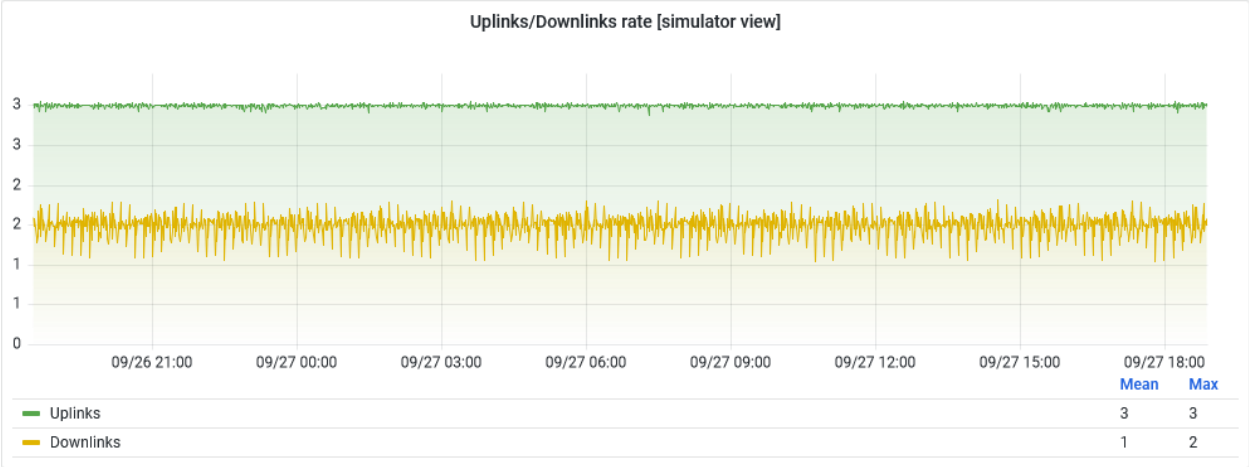
This table summarizes the status of each execution per simulation scenario. No error was raised during the 24 hours test.

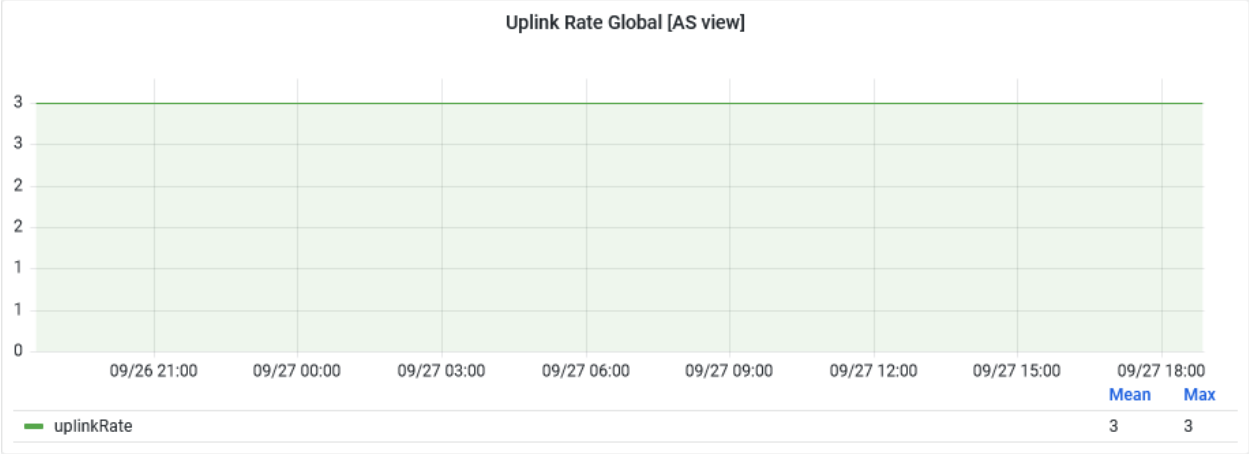
Statistics on simulation

simulation	total	success	failure ↓
tpe-usecase9	865	865	0
tpe-usecase8	174	174	0
tpe-usecase7	864	864	0
tpe-usecase6	17	17	0
tpe-usecase5	20	20	0
tpe-usecase4	96	96	0
tpe-usecase3	15	15	0
tpe-usecase2	48494	48494	0
tpe-usecase11	8037	8037	0
tpe-usecase10	35	35	0
tpe-usecase1	2112	2112	0
Total	60729	60729	0

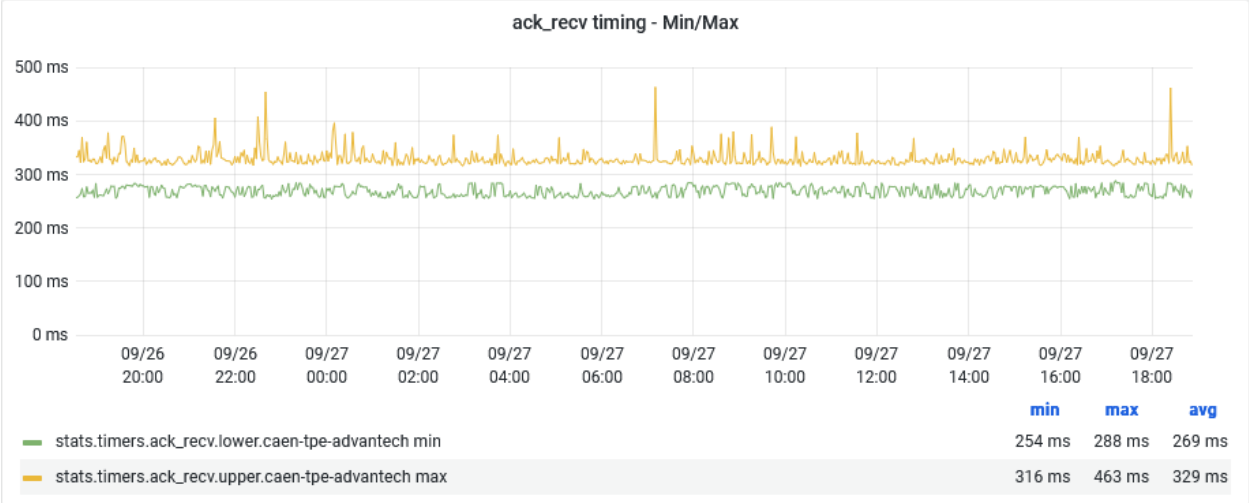
3.2 Radio traffic statistic

The following graphs show the number uplink and downlink packets per second, illustrating stable rate at 3 packets/sec from Simulation Utility (“simulator view”) and from the Application Server (“AS view”)



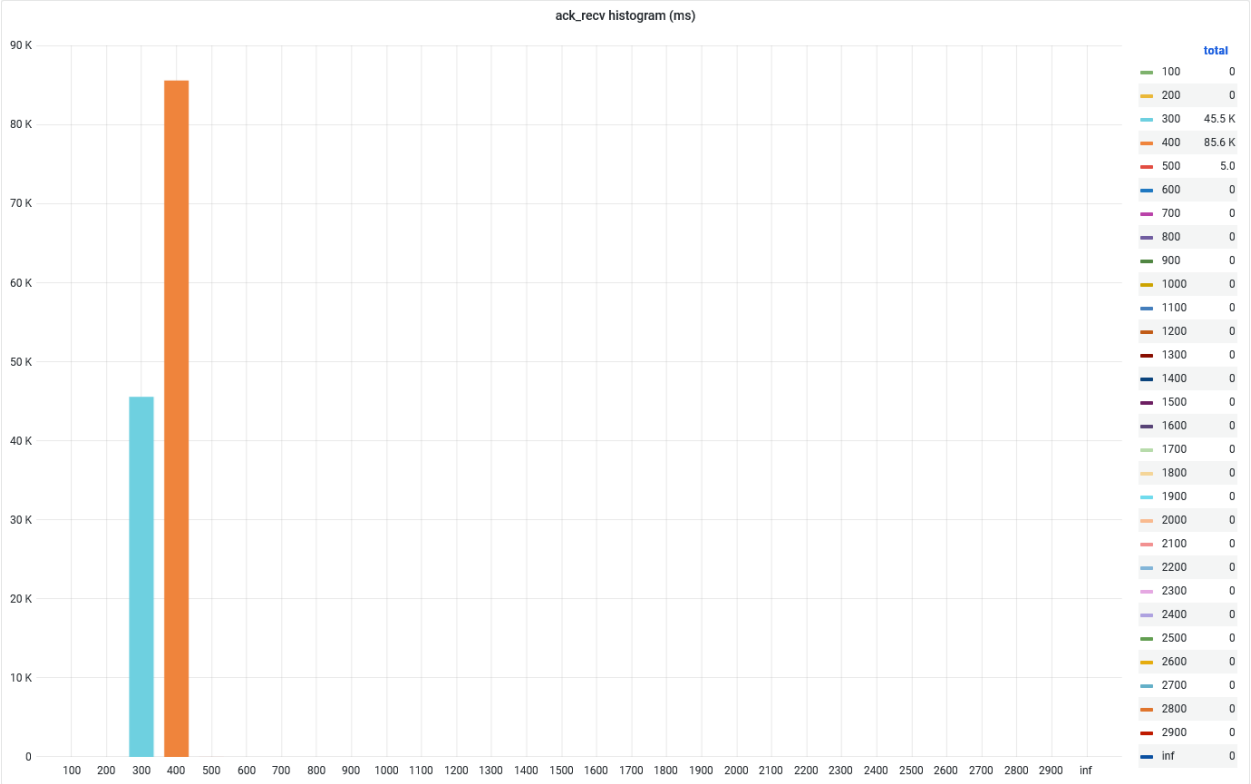


LoRaWAN average response time shown in the figure below, is constant over time:



During the test, the minimum response time is 254 ms and max response time is around 463 ms. The minimum response time is always greater than 250 ms which is fully explained by the LRC network server's deduplication window of 250 ms.

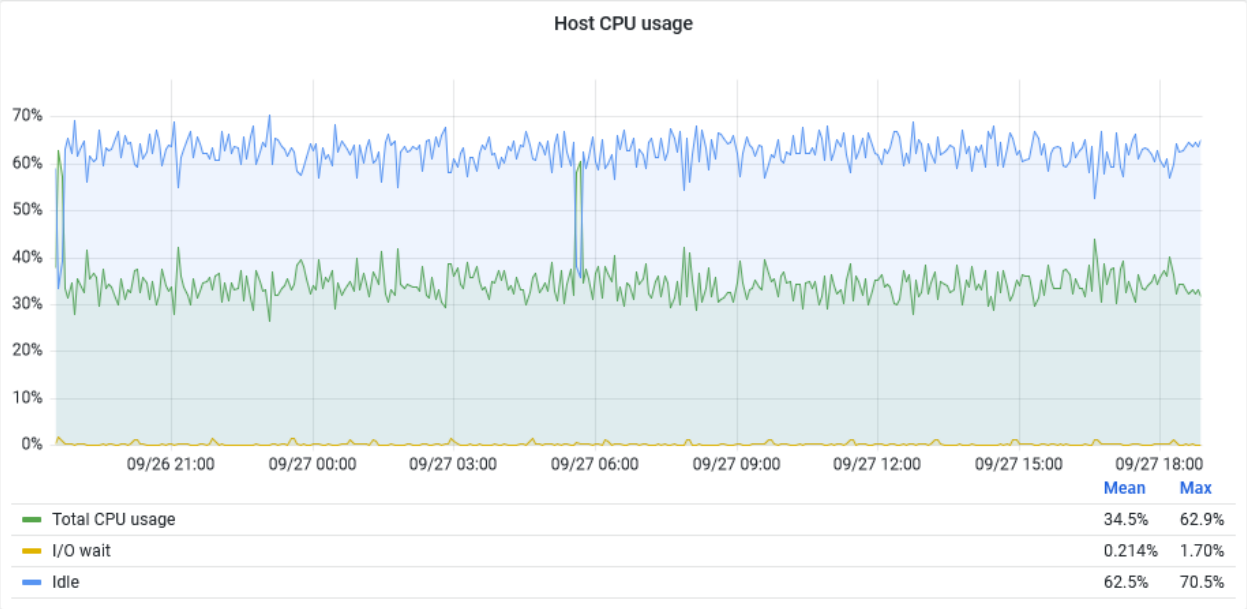
LoRaWAN average response time distribution is shown in the figure below. 100% response time is lower 600ms, compatible with RX1 (assuming a RX1 delay = 1s).



Note These 2 previous metrics show the core network processing delay starting from the reception of the UL frame in confirmed mode until the generation of the DL ACK by the network server.

3.3 Host and docker monitoring

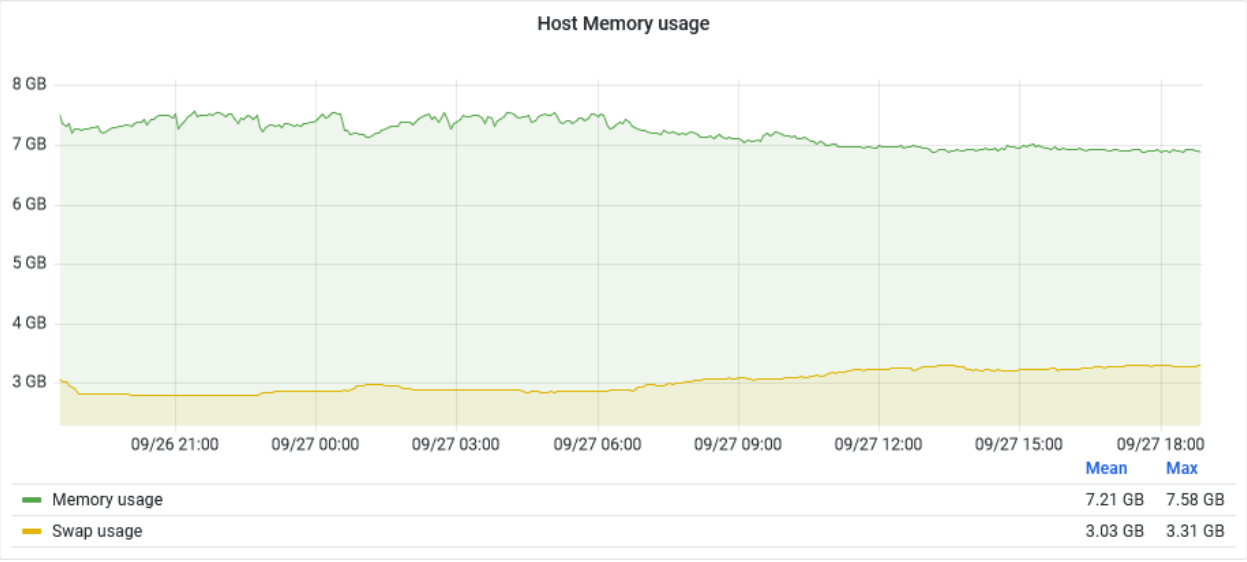
The following graph shows CPU usage on the TPE instance host server across all CPU cores:



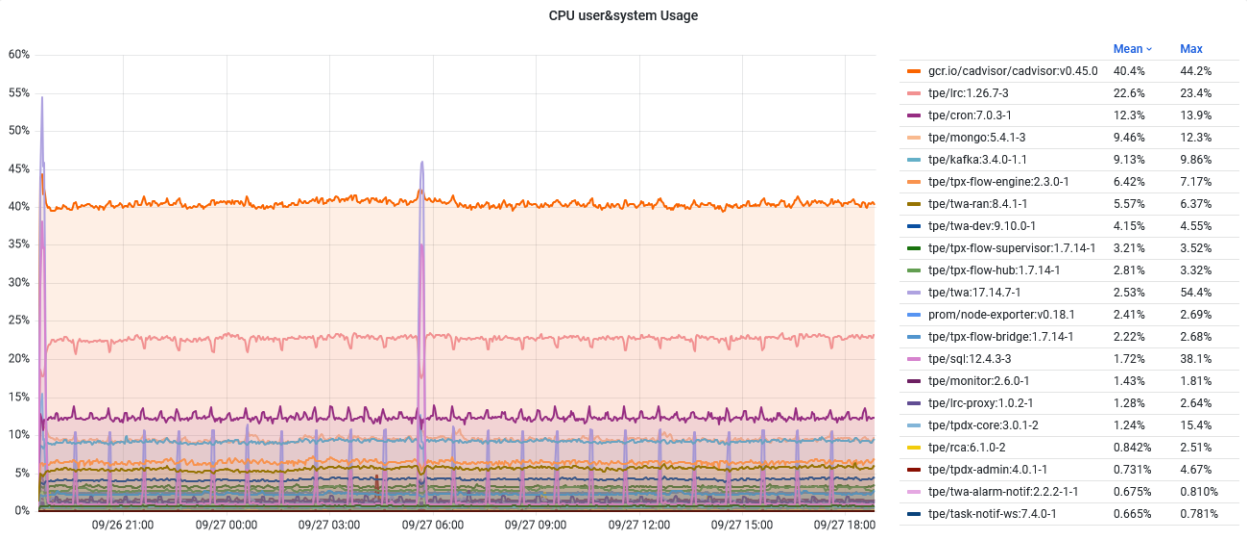
CPU is normalized between 0% … 100% (regardless the number of CPU on the host).

Note We can see two spikes on CPU used by TWA and SQL containers around 18:30 and 05:30 due to the execution of the mass updates use cases on devices (tpe_usecase11).

The host RAM usage remains stable during the test:

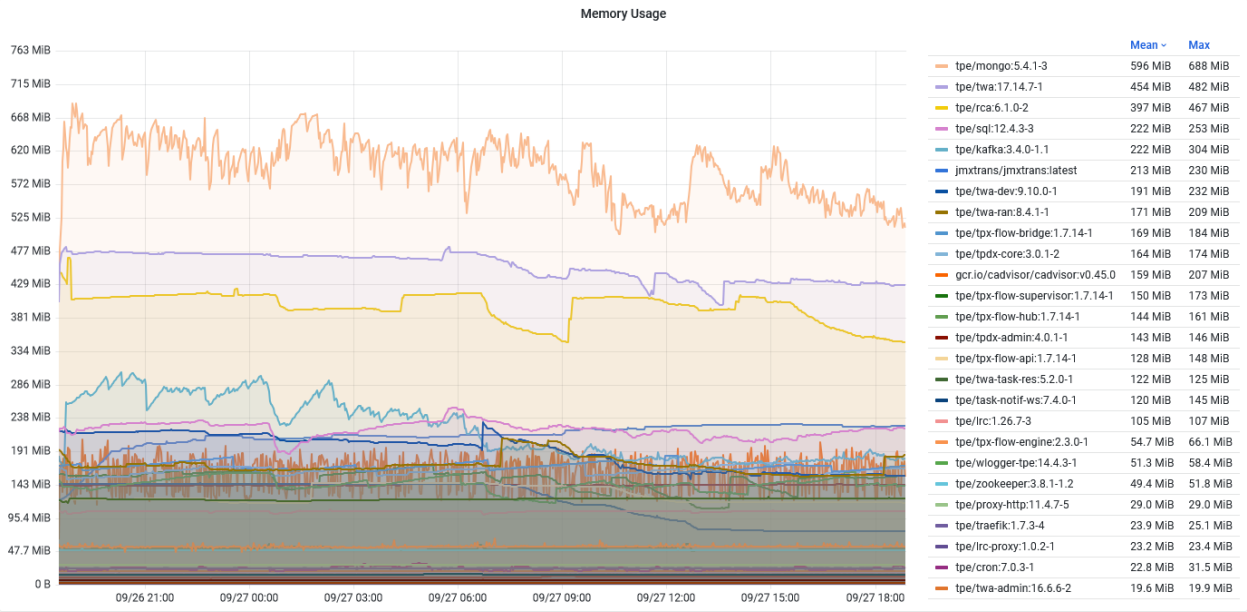


On the following graph, we can see the CPU usage by service.



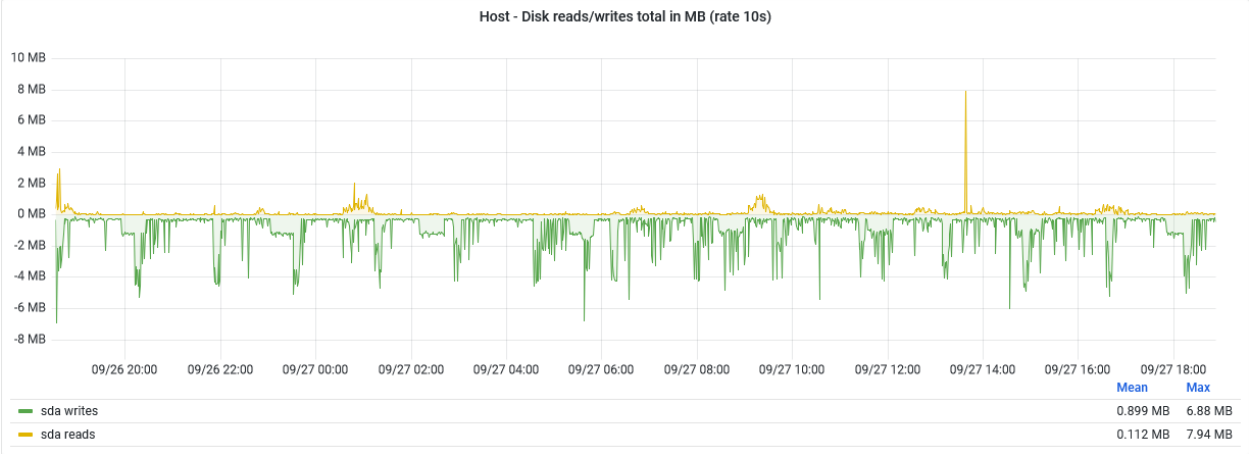
Note We can see two spikes on CPU used by TWA and SQL containers around 18:30 and 05:30 due to the execution of the devices mass update use case (tpe_usecase11).

The following graph shows the memory usage by service:

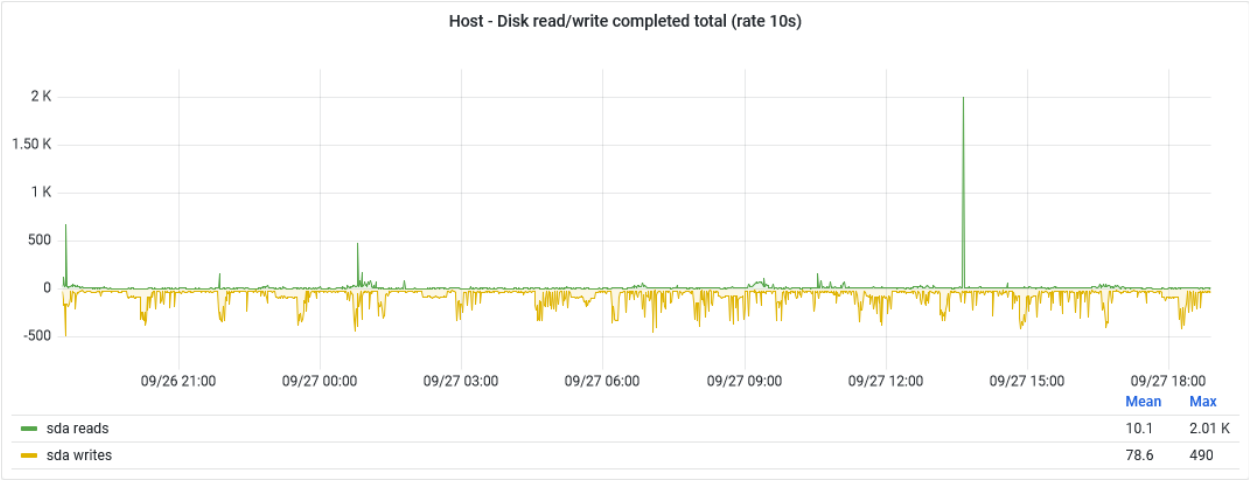


The following graph displays the disk throughput in MB/s (number of bytes read from or written to a block device per second). For readability, read operations have positive values, and write operations have negative values.

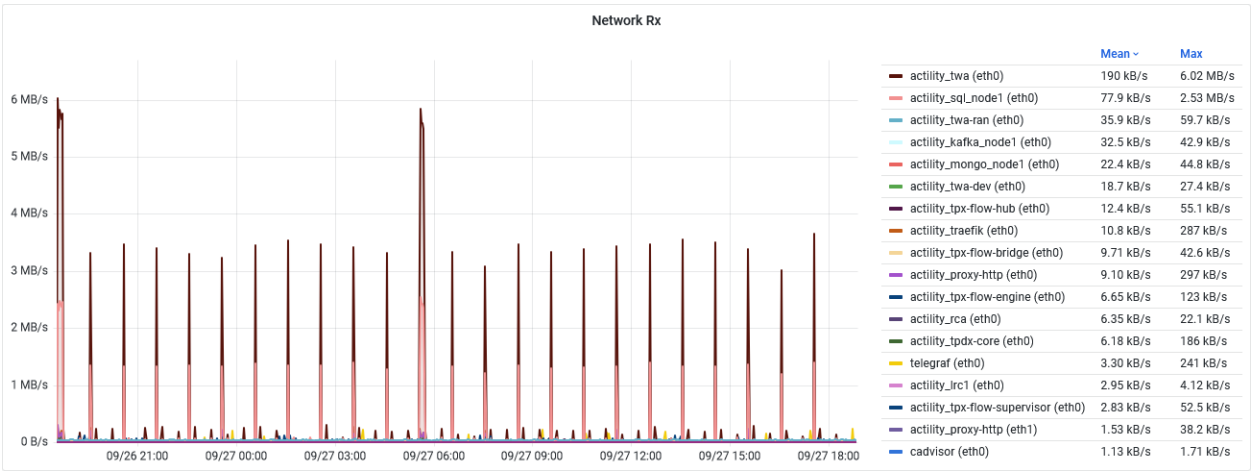
Observed spikes are mostly related to parallel API activities (e.g. base station or device scan API tests).

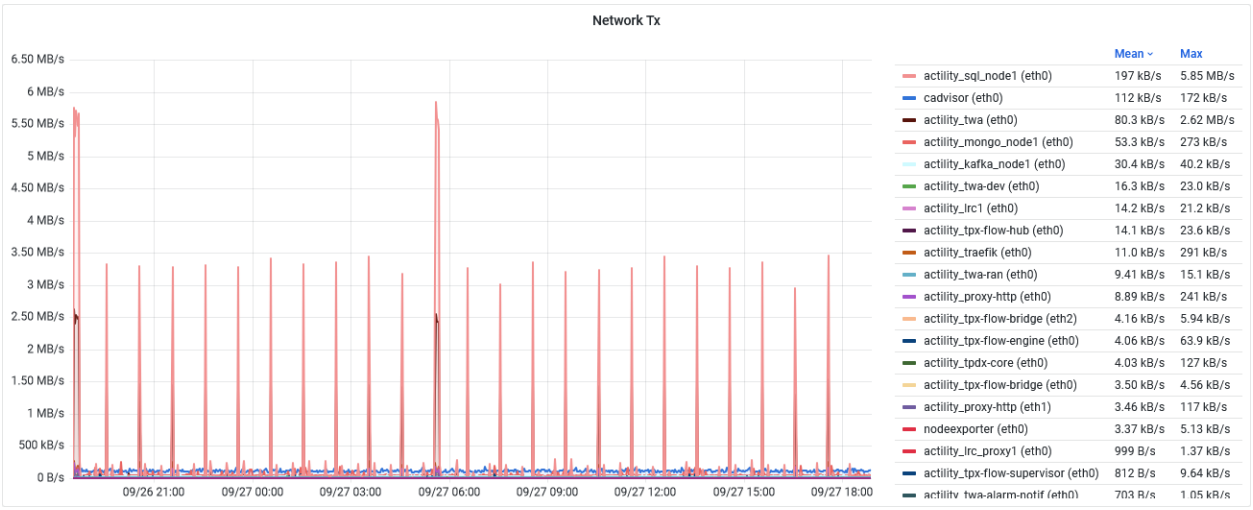


The following graph displays completed I/O requests (reads and writes). For readability, read operations have positive values, and write operations have negative values.



The following graph displays the inbound and outbound network traffic for all services:





Note We can see two spikes in network traffic on TWA and SQL containers around 18:30 and 05:30 due to the execution of the devices mass update use case (tpe_usecase11).

The following table displays the amount of memory used by each service at the end of the test (against the memory limit of the service).

Memory usage	
Container name	Current memory usage ↓
actility_mongo_node1	69.33%
actility_proxy-http	60.95%
actility_cron	60.67%
actility_sql_node1	58.74%
actility_tpx-flow-bridge	57.20%
actility_tpdx-core	56.38%
actility_twa	54.06%
actility_lrc1	53.77%
actility_traefik	53.06%
actility_tpx-flow-supervisor	52.74%
actility_lrc_proxy1	50.03%
actility_tpdx-admin	48.77%
actility_tpx-flow-hub	47.96%
actility_twa-alarm-notif	45.06%
actility_wlogger	43.78%
actility_cron-rfscan1	41.53%
actility_twa-task-res	41.43%
actility_tpx-flow-api	40.33%
actility_smp-tpe	40.09%
actility_monitor	40.07%
actility_zk_node1	36.82%
actility_rca	35.36%
actility_twa-ran	31.15%
actility_kafka_node1	30.00%
actility_hyper-scheduler	29.19%
actility_task-notif-ws	26.29%
actility_twa-dev	26.27%
actility_tpx-flow-engine	22.85%
actility_twa-admin	15.60%
actility_locsolver	11.16%
actility_network-survey	5.70%
actility_snmp-tpe	2.66%
actility_lrc-sync1	1.23%
actility_ftp1	1.18%
actility_spectrum-analysis	0.66%
actility_support1	0.58%
actility_shellinabox	0.53%

4 CONCLUSIONS

The performance benchmark for ThingPark Enterprise version 7.3 demonstrates that with a heavy radio traffic profile (peak traffic for 24 hours) and under constant API load, the TPE instance remains stable, without degradation of the appliance under test.

5 APPENDIX

5.1 Software versioning

Here is the detailed version of main components used during the performance test campaign:

Component name	Version
ThingPark Enterprise	7.3.0-6
thingpark-enterprise-node	7.3.0-6.el7
cockpit-tpe	10.3.8
thingpark-enterprise-benchmark	1.1.1-1

About Actility

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