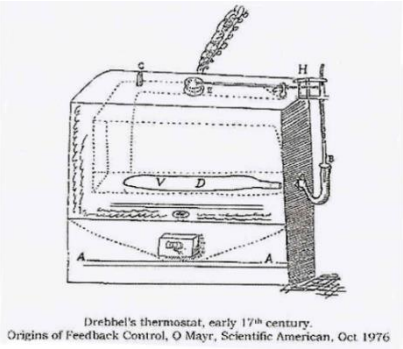
TOPAs, an open BMS IoT driven framework for energy efficiency of buildings

Maxime Louvel

The Evolution of Building Management Systems



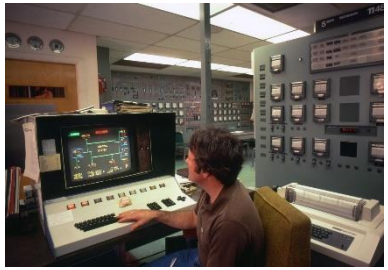


Photo: www.schneider-electric.com

Photo: http://amvsystems.ie

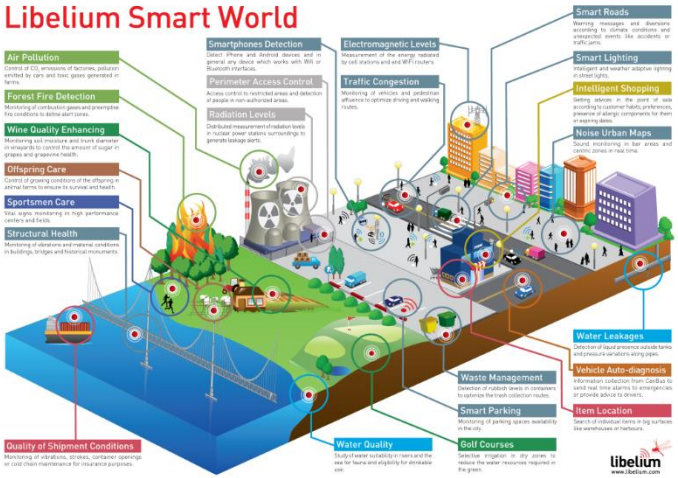
Photo: siemans.com

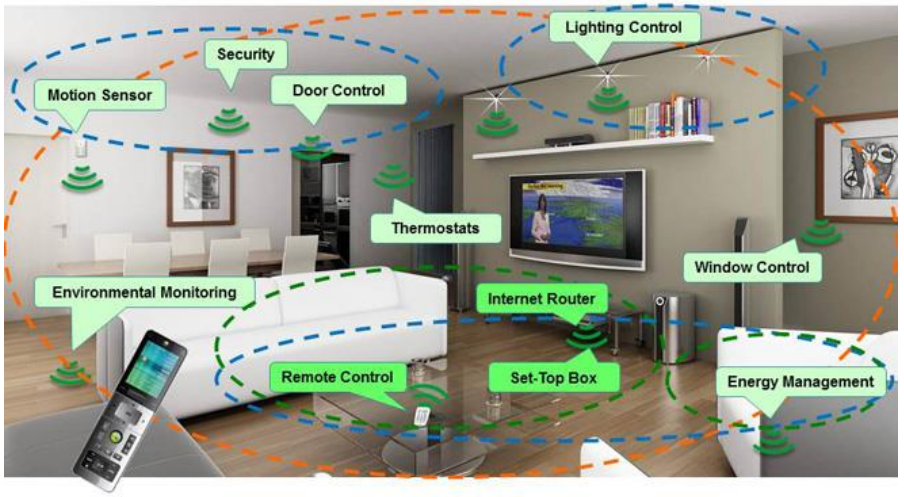
1600's Cornelius Van Drebbels' Incubator Thermostat

1950s to 1990s BMS evolved from pneumatics to electronics to open protocols like BACnet.

Wireless Sensors, Web based interfaces, multiple platforms, remote access.

Making “Things” Interesting



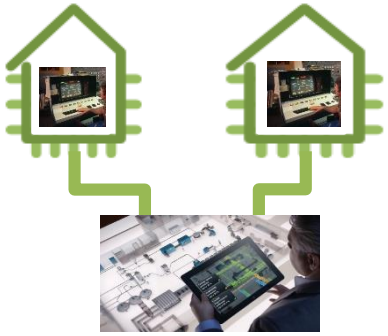


“IoT is not complicated in conception, but it is complex in its execution”*

*http://www.eeweb.com/blog/embedded_developer/designing-embedded-systems-for-the-internet-of-things1

IoT Architectures & Internet of Buildings

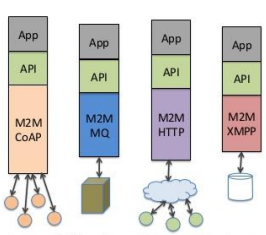
Standalone BMS



Managed Portfolio

Internet of Buildings

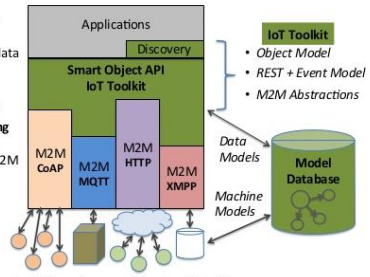
IoT 1.0 – Things Connected to Apps

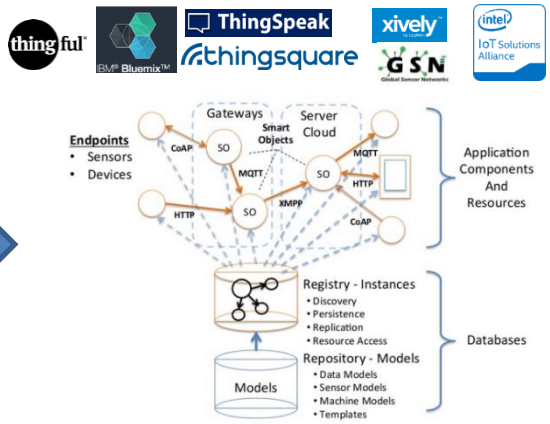


- App runs on single service – Single Points Of Failure
- Each app written to a custom API
- Diverse M2M is sometimes required but can inhibit interoperability
- Software, User data, and Things are trapped in **Silos**
- Difficult to connect new types of things and deploy new platforms
- Very difficult to share resources or connect across platforms
- Apps are not network-effect enabled

IoT 2.0 – Interoperability

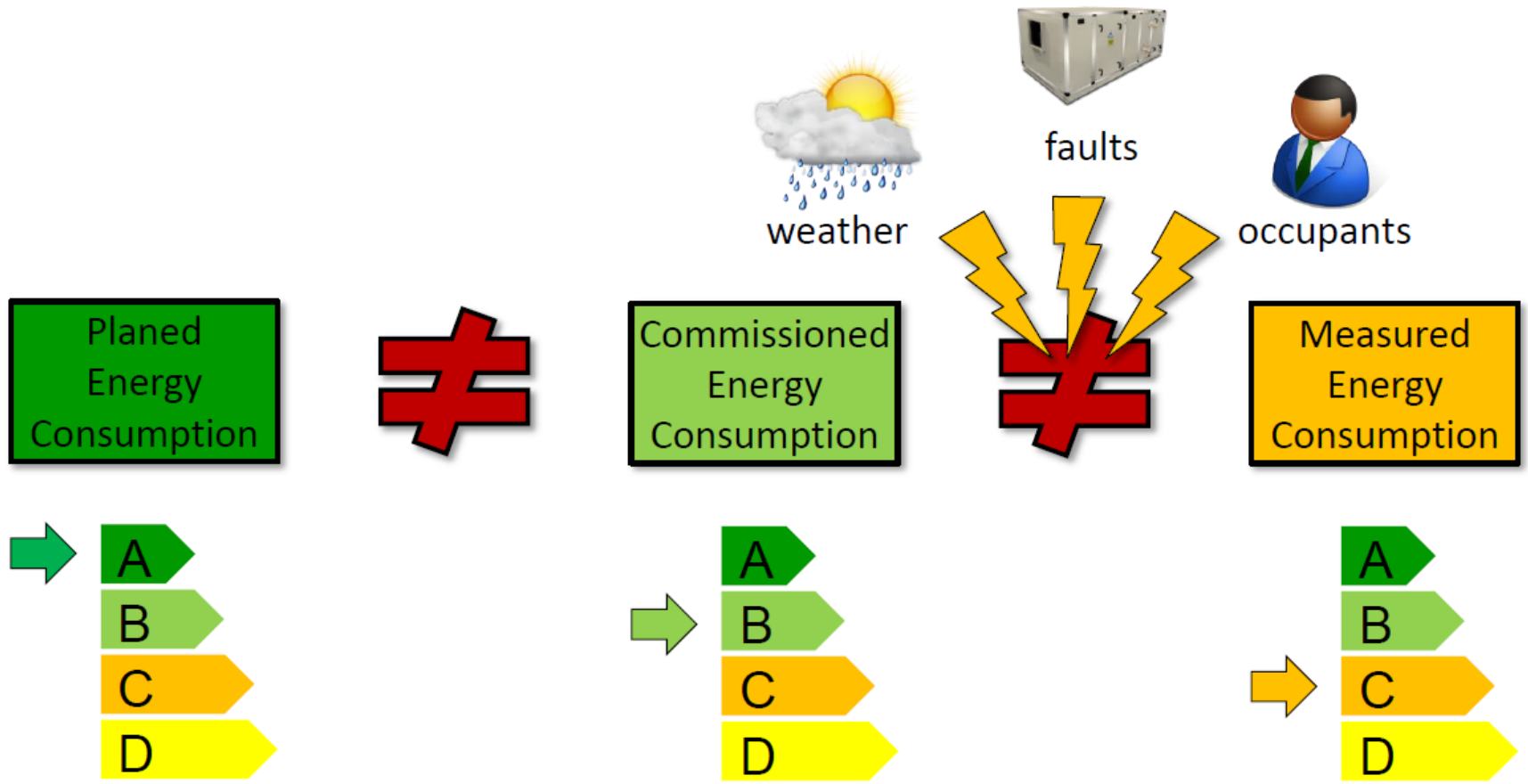
- Easy to deploy new things and applications using data models
- Write once, run anywhere software
- **Any app** to **any thing** via **any M2M**, use-case appropriate M2M
- Network effect enabled





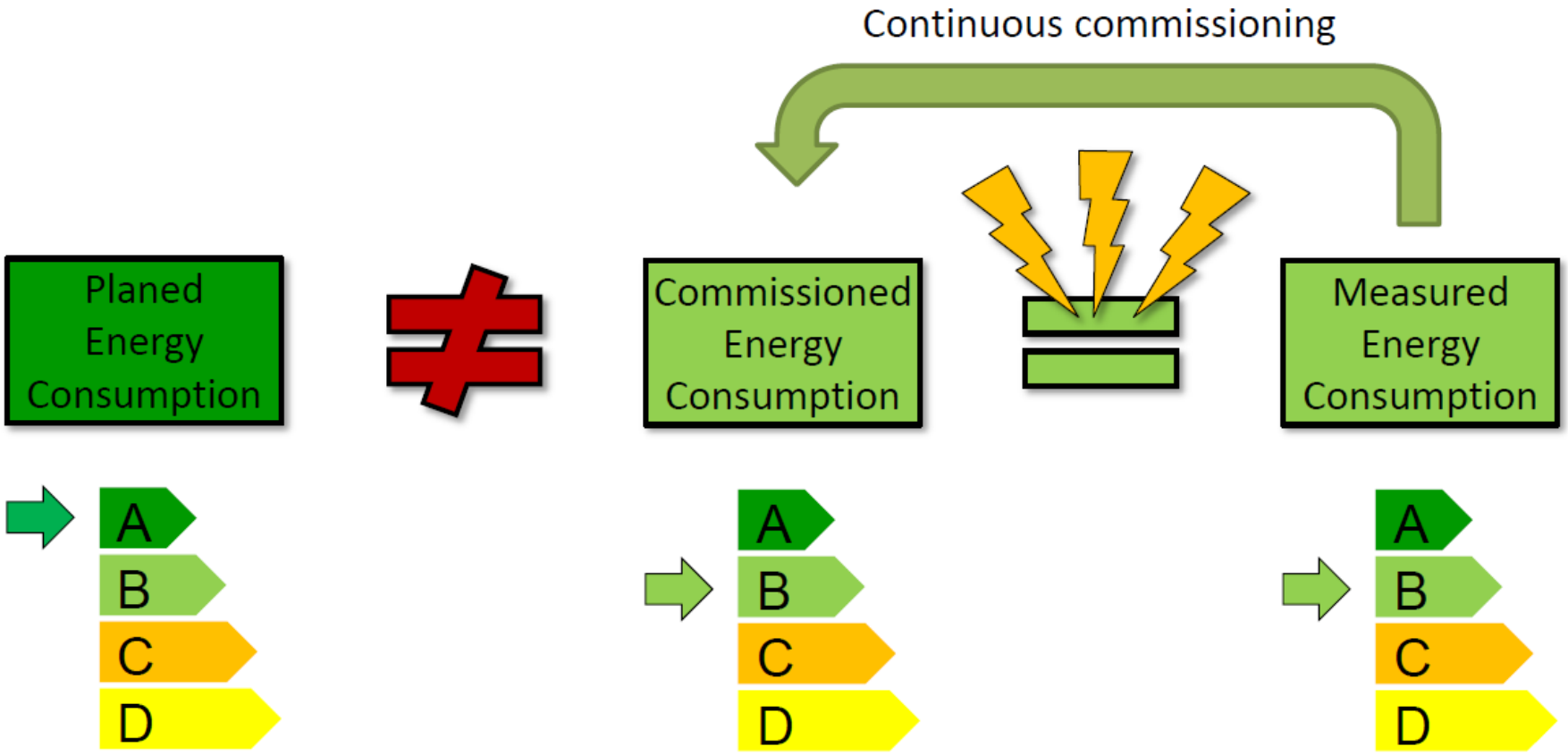
Michael Koster - IoT Research and Development at ARM
http://www.slideshare.net/michaeljohnkoster/iot-toolkit-and-the-smart-object-api-architecture-for-interoperability

TOPAs Objectives



Building energy performance predictions show *major differences to measurements*.
This is even worse for building blocks.

Challenges to be overcome



Tools and methods for measuring and analysing real building energy performance for FM and ESCOs.

TOPAs Cognitive Loop

- **Sense:** Device/System connection, **data is abstracted** from the environment
- **Learn:** Big data analytics, models
- **ACT:** Transform analysis to actions
- **Operate:** better utilize assets and manage blocks of buildings, create human value

- **Aim**: A **platform**, **tools** and **services** to allow **coordinated management** of **blocks** of **buildings**

Demonstration Sites

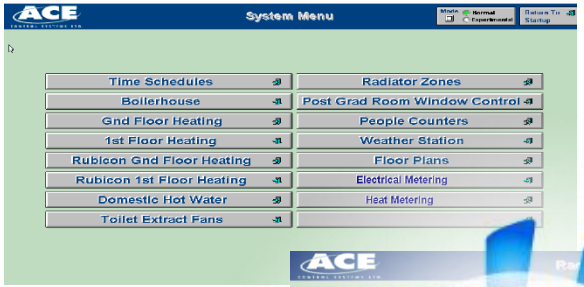
IBM CAMPUS
DUBLIN, IRELAND

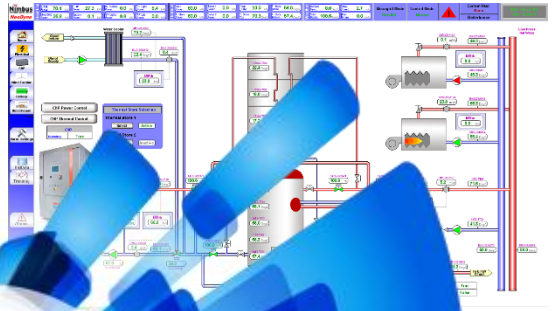
CIT CAMPUS
CORK, IRELAND

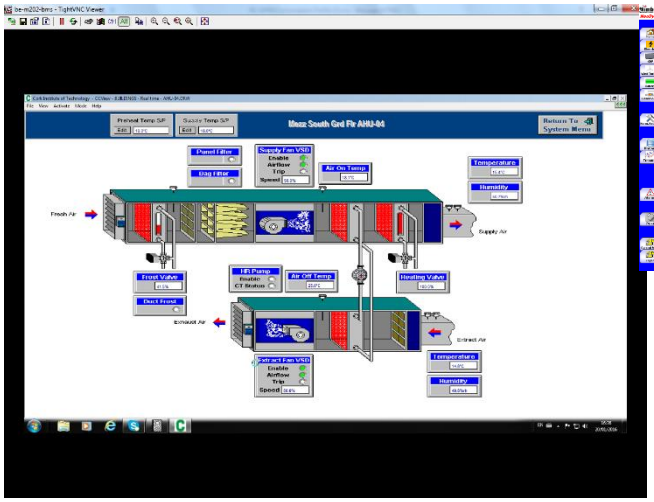
GALEO BUILDING
PARIS, FRANCE

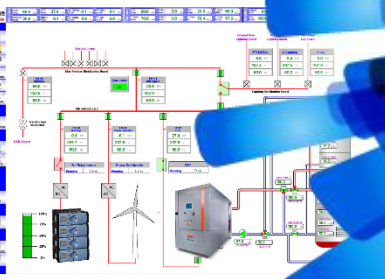
TOPAs Platform Prototype @ CIT

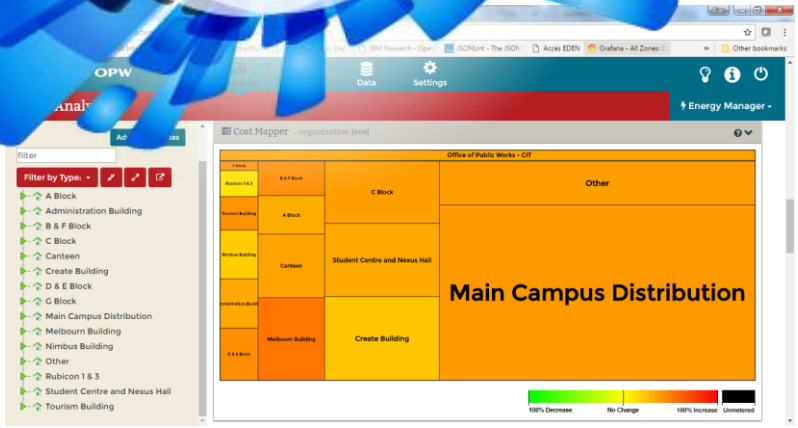
CIT Bishopstown Campus





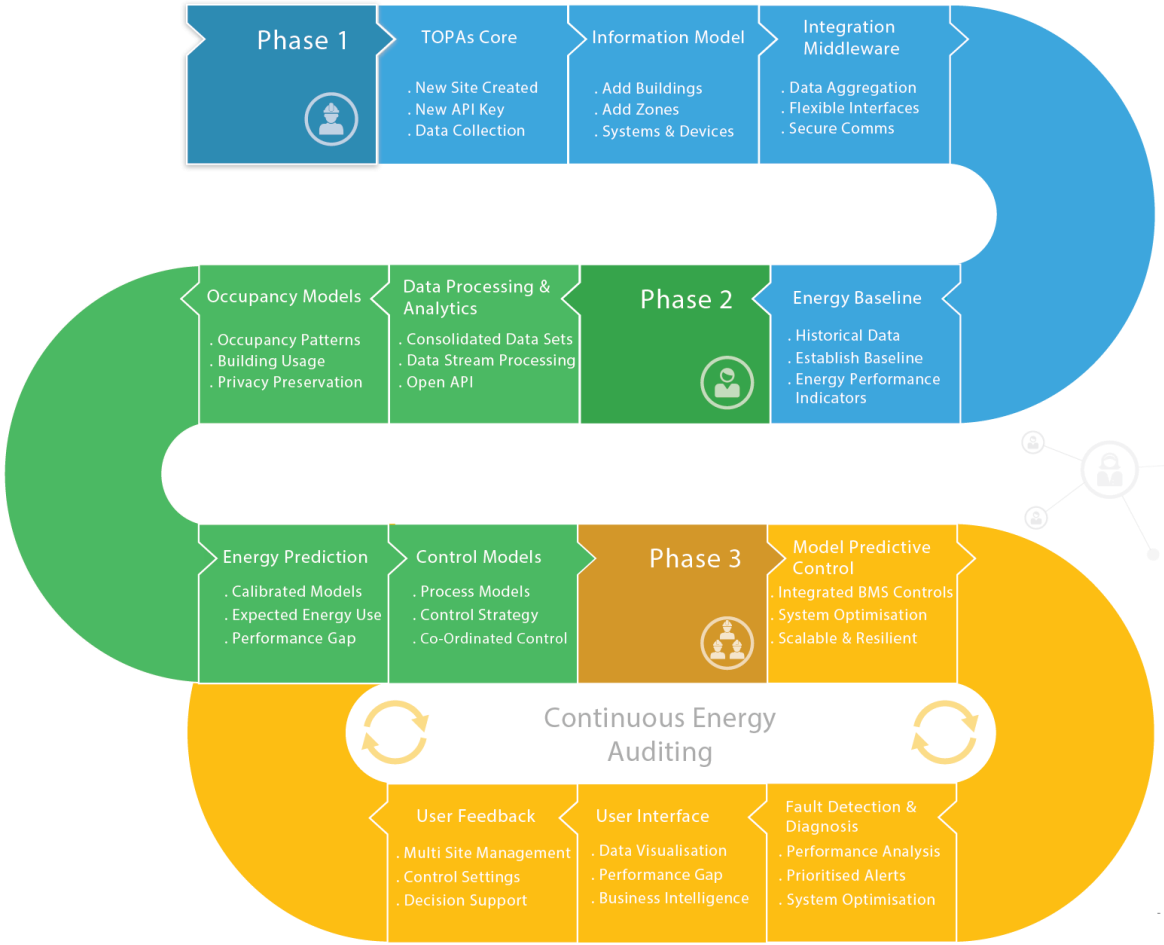




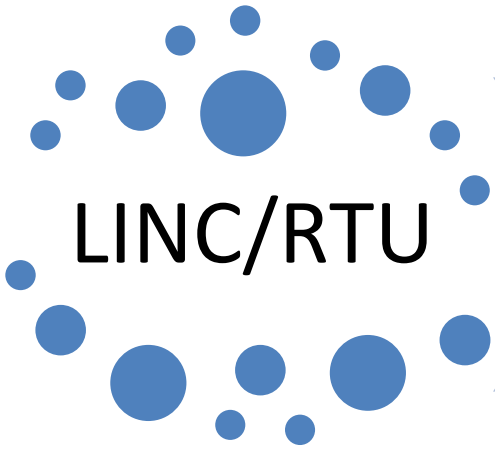


TOPAs in Action

- **Phase 1**: System/Building connection & connectivity, data sensing & collecting, data transport & access
- **Phase 2**: Data analytics, APIs & processes, services
- **Phase 3**: Applications & services – gap reduction, energy saving, FDD, data presentation, intelligent interfaces



TOPAs core services



Heterogenous Buildings & Systems

oBMS/NIM

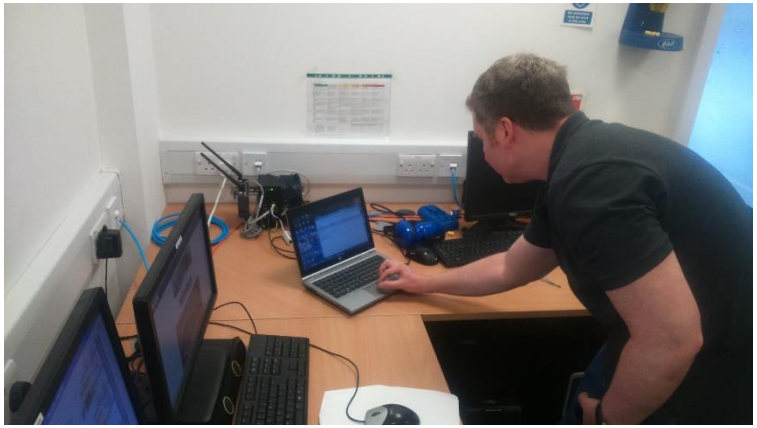
Data Processings, Storage and Access

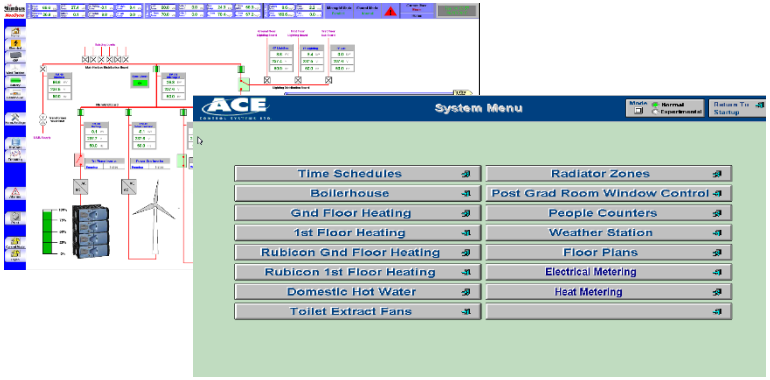
HMI

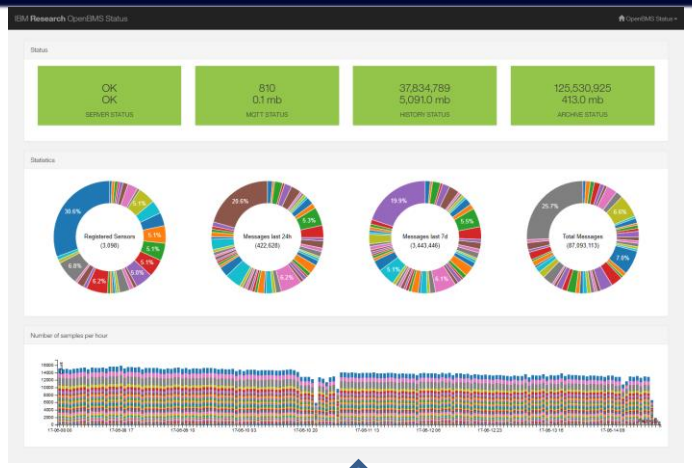
Common Front End, Data Visualisation

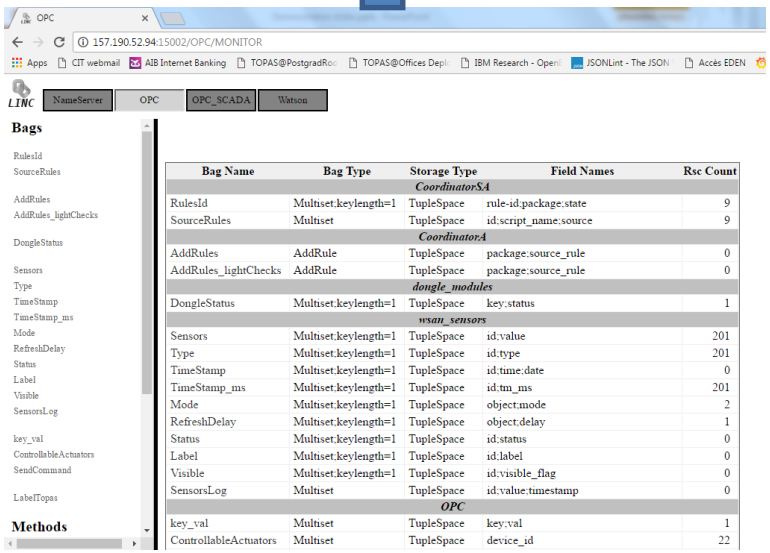
TOPAs in Action: Phase 1

Phase 1	TOPAs Core	Information Model	Integration Middleware
	. New Site Created . New API Key . Data Collection	. Add Buildings . Add Zones . Systems & Devices	. Data Aggregation . Flexible Interfaces . Secure Comms









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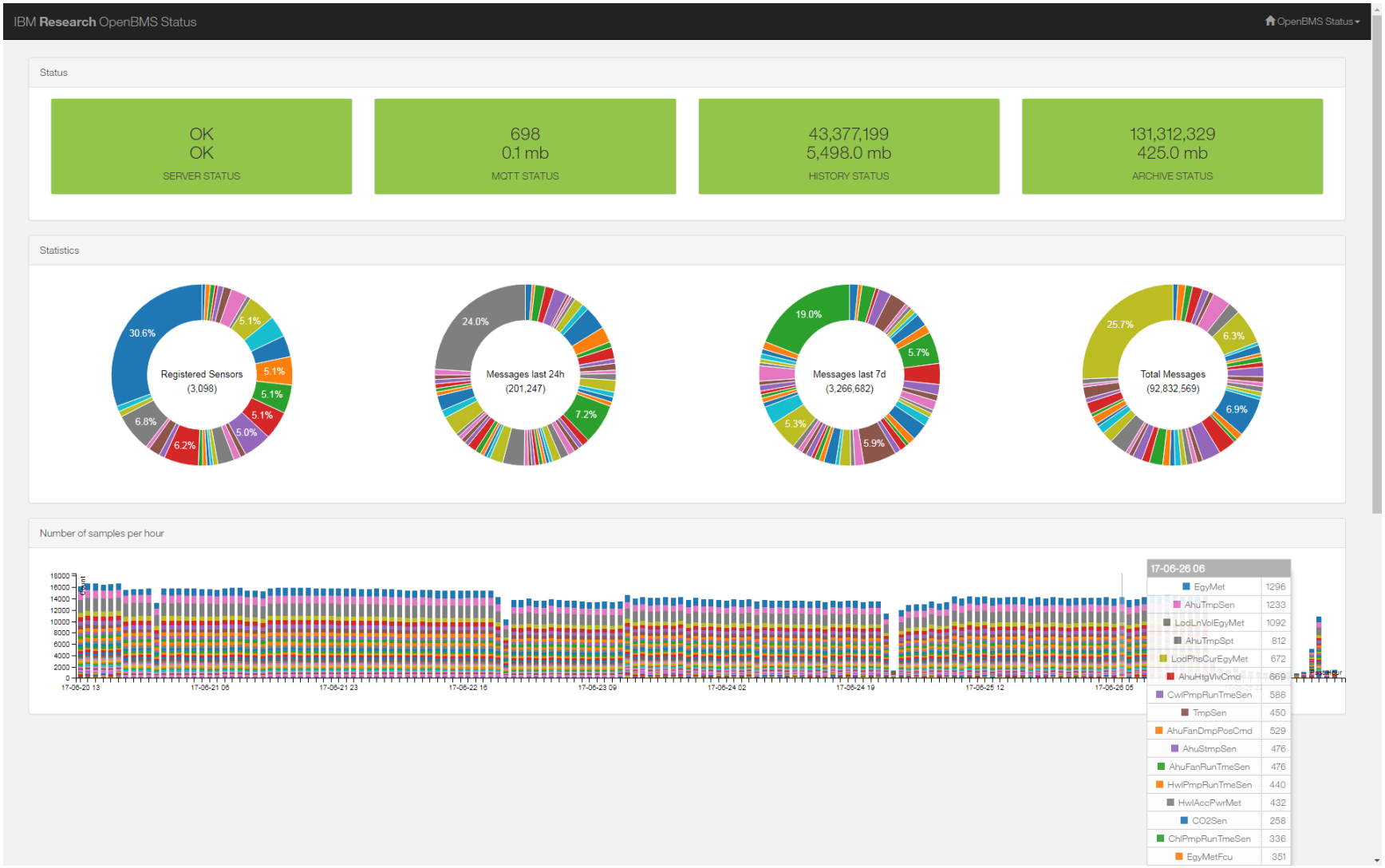
		CoordinatorSA		
RulesId	Multiset;keylength=1	TupleSpace	rule-id;package;state	9
SourceRules	Multiset	TupleSpace	id;script_name;source	9
		CoordinatorA		
AddRules	AddRule	TupleSpace	package;source_rule	0
AddRules_lightChecks	AddRule	TupleSpace	package;source_rule	0
		dongle_modules		
DongleStatus	Multiset;keylength=1	TupleSpace	key;status	1
		wsan_sensors		
Sensors	Multiset;keylength=1	TupleSpace	id;value	201
Type	Multiset;keylength=1	TupleSpace	id;type	201
TimeStamp	Multiset;keylength=1	TupleSpace	id;time;date	0
TimeStamp_ms	Multiset;keylength=1	TupleSpace	id;tm_ms	201
Mode	Multiset;keylength=1	TupleSpace	object;mode	2
RefreshDelay	Multiset;keylength=1	TupleSpace	object;delay	1
Status	Multiset;keylength=1	TupleSpace	id;status	0
Label	Multiset;keylength=1	TupleSpace	id;label	0
Visible	Multiset;keylength=1	TupleSpace	id;visible_flag	0
SensorsLog	Multiset	TupleSpace	id;value;timestamp	0
		OPC		
key_val	Multiset	TupleSpace	key;val	1
ControllableActuators	Multiset	TupleSpace	device_id	22

oBMS - 1


IBM Research OpenBMS Status
OpenBMS Status
Status
OK
OK
SERVER STATUS
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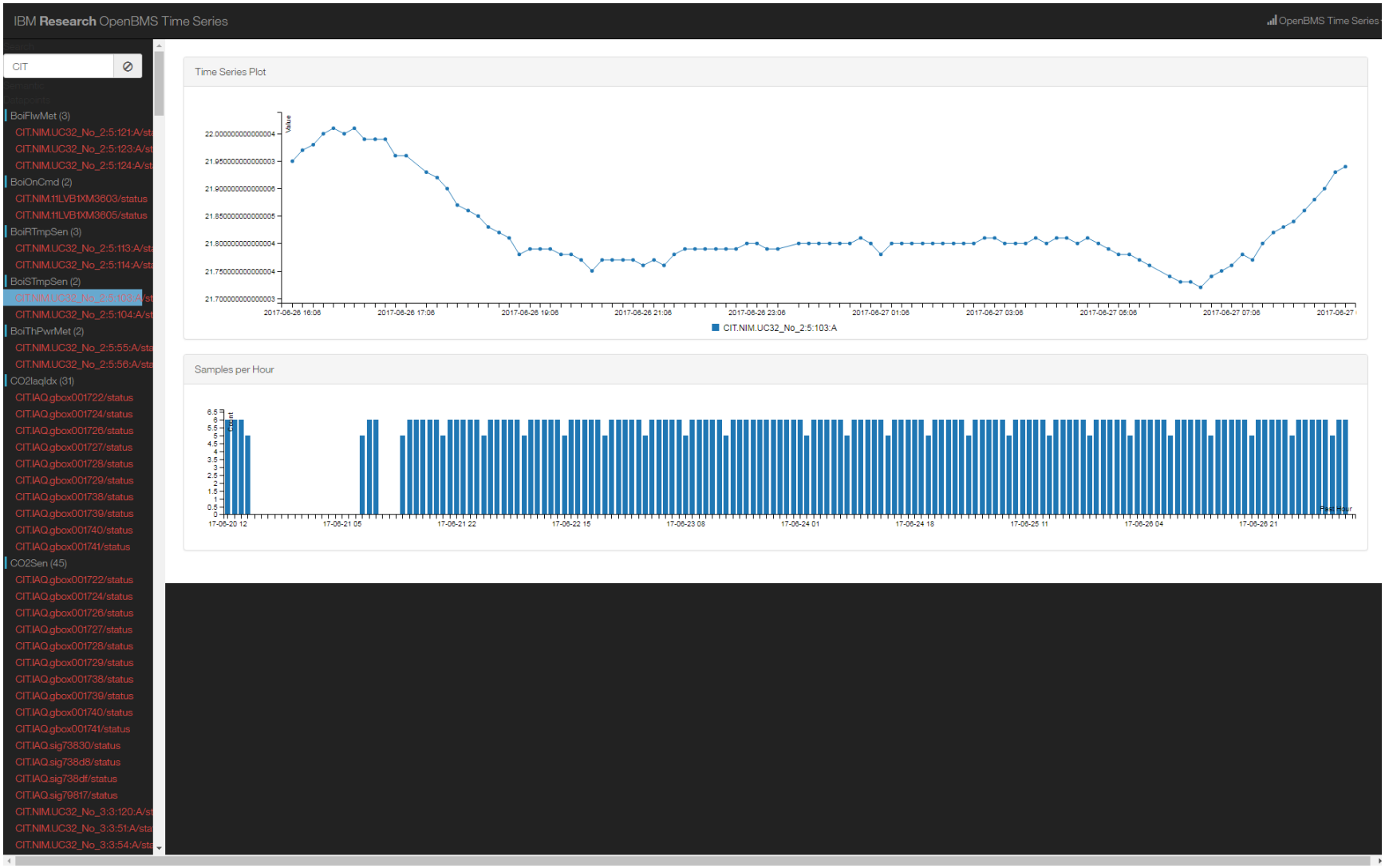
0.1 mb
MQTT STATUS
43,377,199
5,498.0 mb
HISTORY STATUS
131,312,329
425.0 mb
ARCHIVE STATUS
Statistics
Registered Sensors
(3,098)
30.6%
5.1%
5.1%
5.1%
5.1%
5.0%
6.2%
6.8%
Messages last 24h
(201,247)
24.0%
7.2%
Messages last 7d
(3,266,682)
19.0%
5.7%
5.9%
5.3%
Total Messages
(92,832,569)
25.7%
6.3%
6.9%
Number of samples per hour
Count
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
17-06-20 13
17-06-21 06
17-06-21 23
17-06-22 16
17-06-23 09
17-06-24 02
17-06-24 19
17-06-25 12
17-06-26 05
17-06-26 06
EgyMet 1296
AhuTmpSen 1233
LodLnVolEgyMet 1092
AhuTmpSpt 812
LodPhsCurEgyMet 672
AhuHtgVlvCmd 669
CwlPmpRunTmeSen 588
TmpSen 450
AhuFanDmpPosCmd 529
AhuStmpSen 476
AhuFanRunTmeSen 476
HwlPmpRunTmeSen 440
HwlAccPwrMet 432
CO2Sen 258
ChlPmpRunTmeSen 336
EgyMetFcu 351

oBMS - 2


IBM Research OpenBMS Time Series
OpenBMS Time Series
CIT
BoiFlwMet (3)
CIT.NIM.UC32_No_2:5:121:A/st
CIT.NIM.UC32_No_2:5:123:A/st
CIT.NIM.UC32_No_2:5:124:A/st
BoiOnCmd (2)
CIT.NIM.11LVB1XM3603/status
CIT.NIM.11LVB1XM3605/status
BoiRTmpSen (3)
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BoiSTmpSen (2)
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BoiThPwrMet (2)
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CIT.NIM.UC32_No_2:5:56:A/st
CO2IaqIdx (31)
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CIT.IAQ.gbox001724/status
CIT.IAQ.gbox001726/status
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CIT.IAQ.gbox001741/status
CO2Sen (45)
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CIT.IAQ.sig738df/status
CIT.IAQ.sig79817/status
CIT.NIM.UC32_No_3:3:120:A/st
CIT.NIM.UC32_No_3:3:51:A/st
CIT.NIM.UC32_No_3:3:54:A/st
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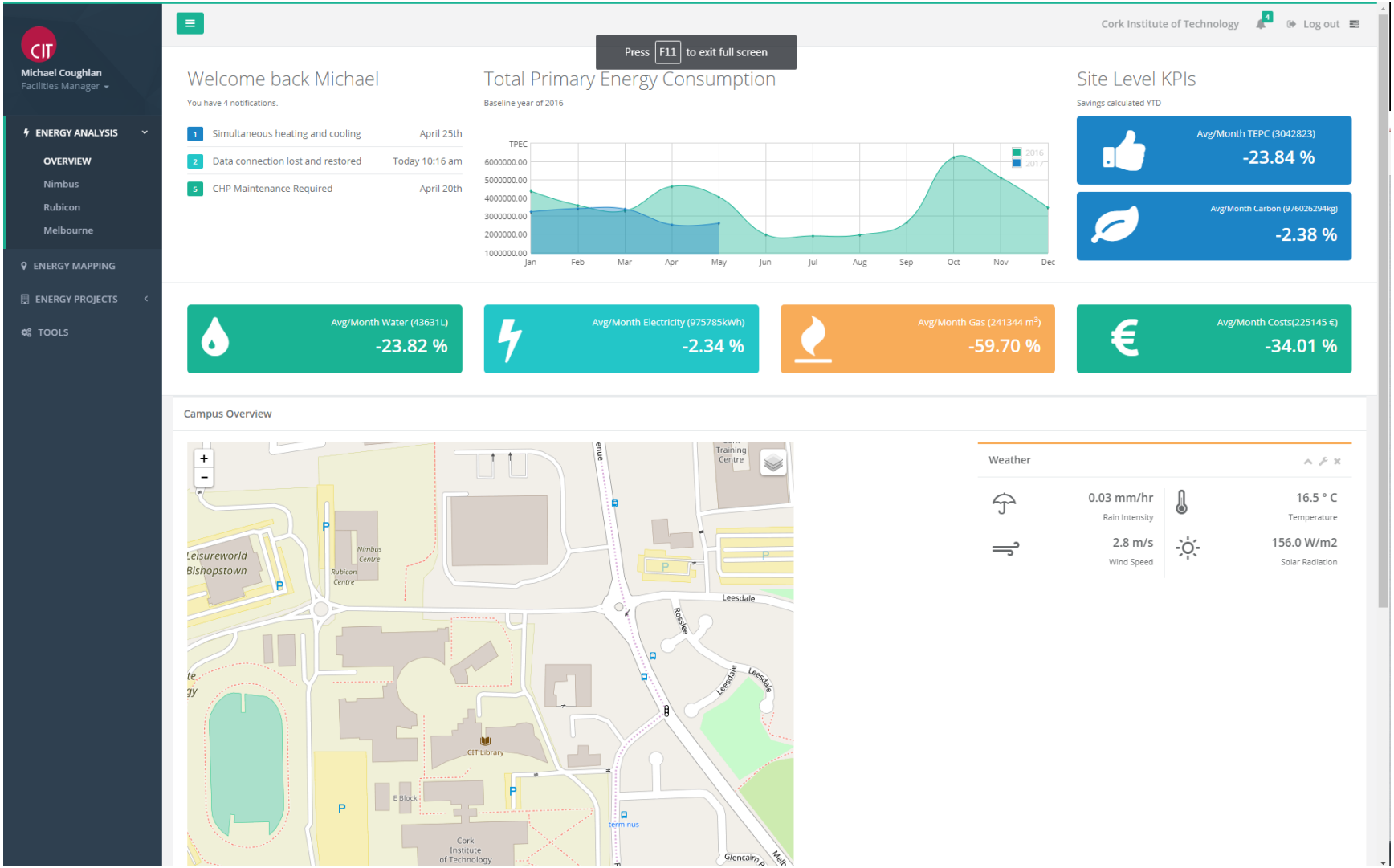
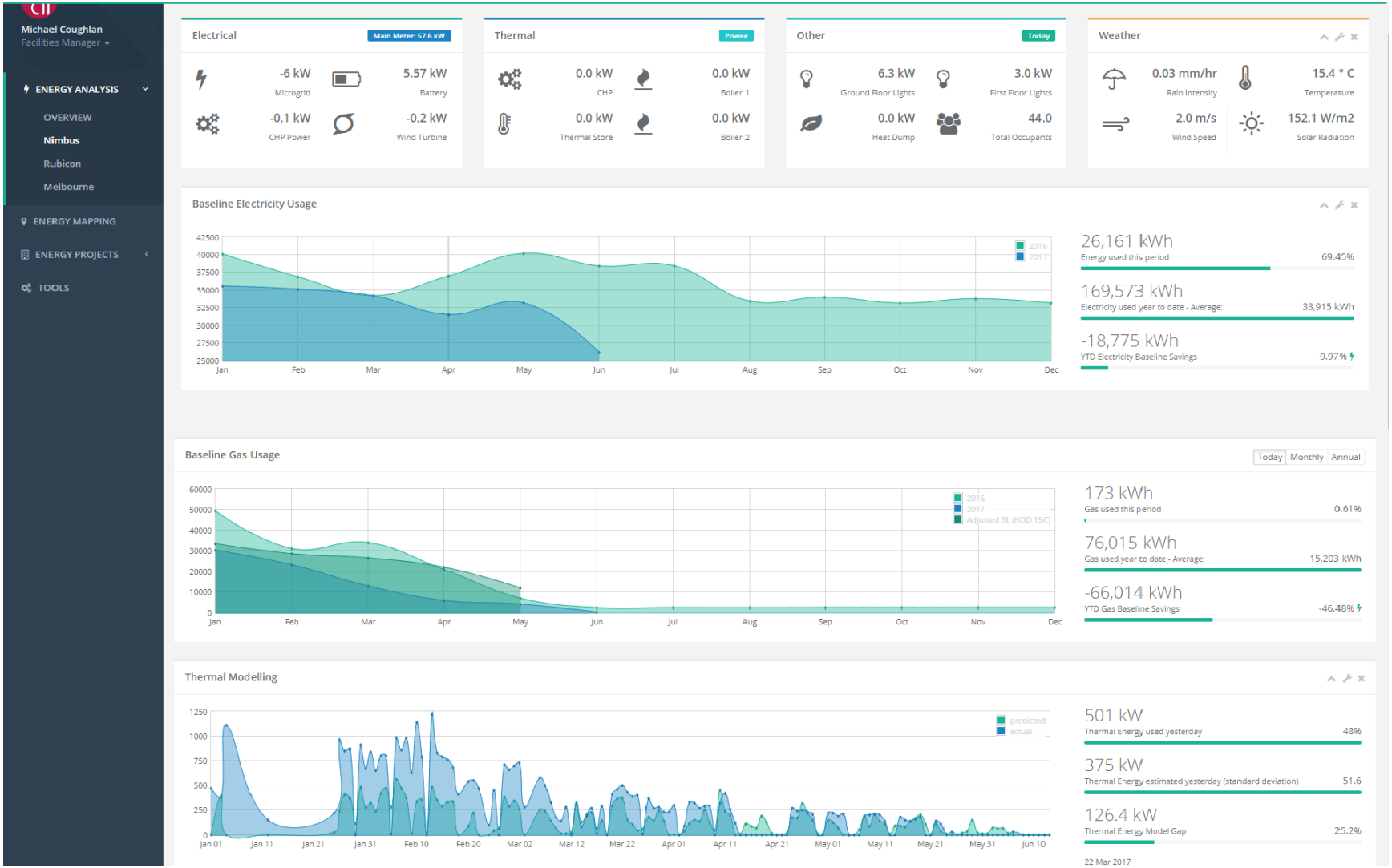
2017-06-26 19:06
2017-06-26 21:06
2017-06-26 23:06
2017-06-27 01:06
2017-06-27 03:06
2017-06-27 05:06
2017-06-27 07:06
CIT.NIM.UC32_No_2:5:103:A
Samples per Hour
Count
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
17-06-20 12
17-06-21 05
17-06-21 22
17-06-22 15
17-06-23 08
17-06-24 01
17-06-24 18
17-06-25 11
17-06-26 04
17-06-26 21
Past Hour

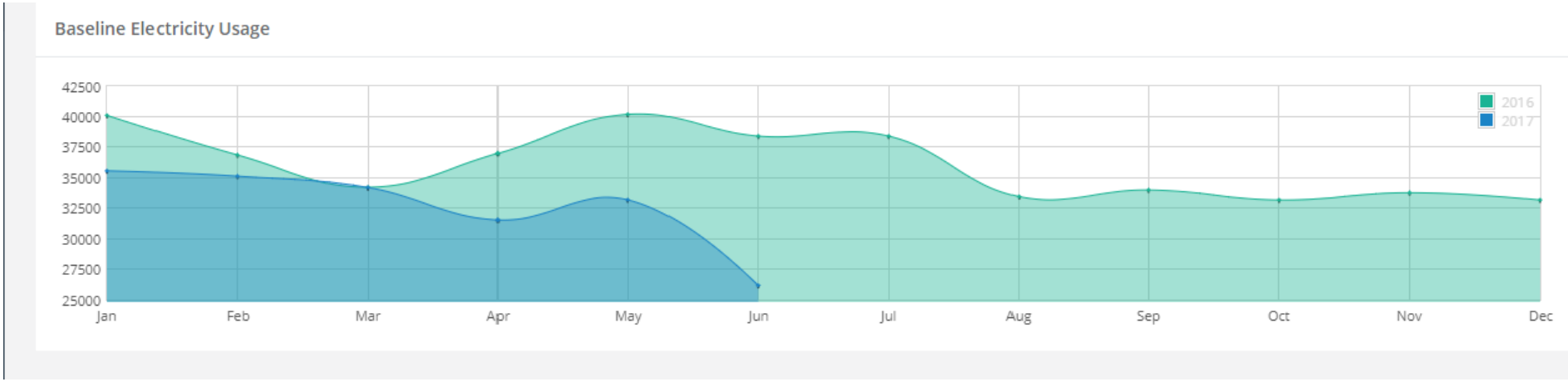
HMI – common frontend, global view

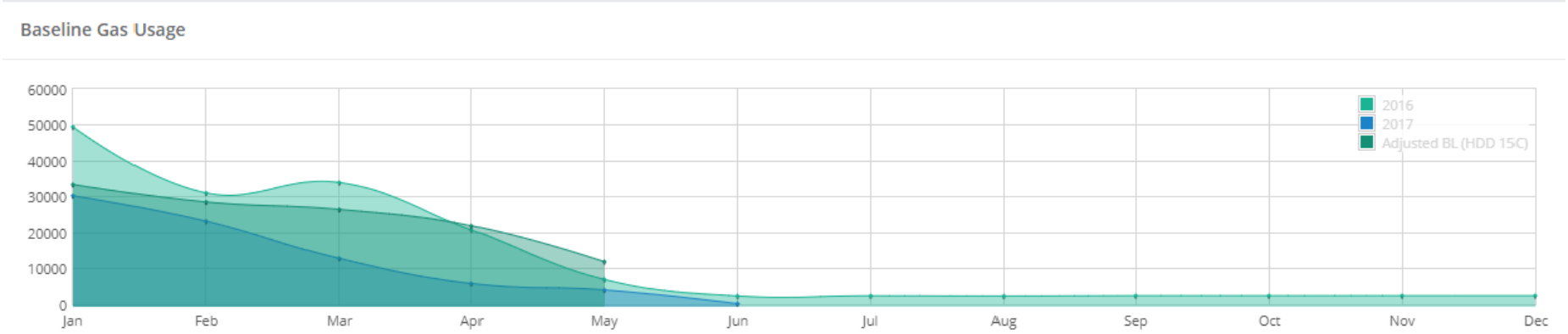


HMI – model prediction



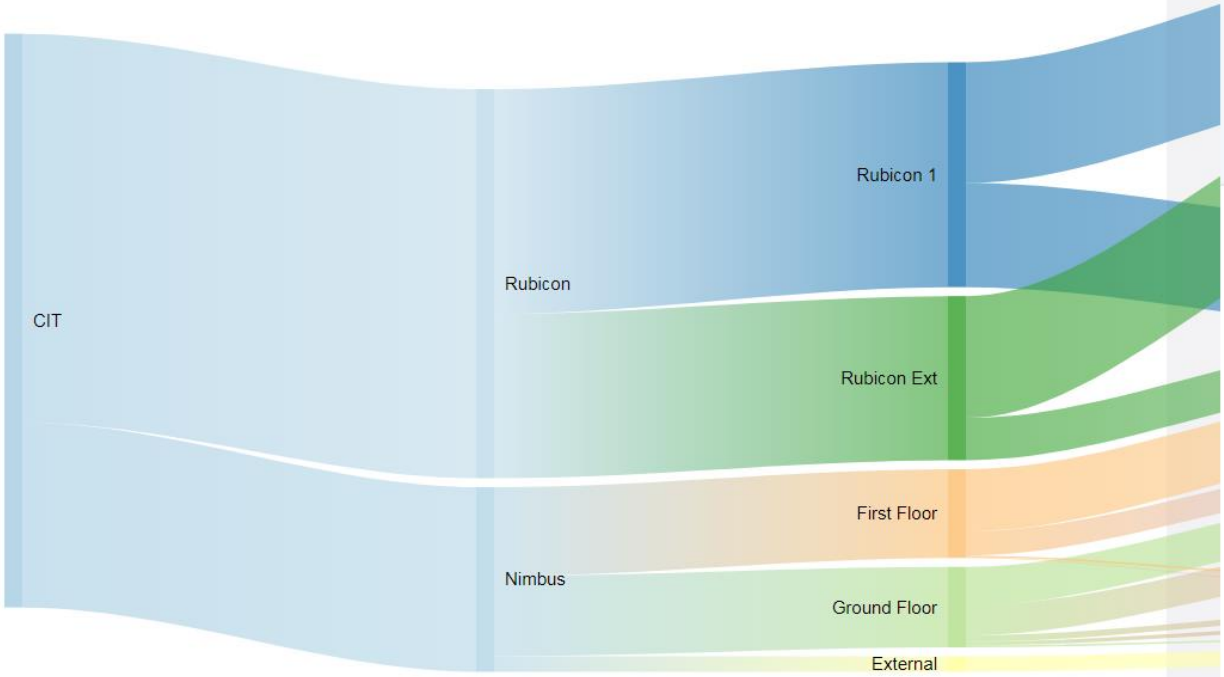
HMI – model prediction





HMI – aggregated view

Meter Overview



Energy Updates

CHP is scheduled for maintenance!

Meeting is on 1:00pm. Check your schedule to see detail.

14:00
29/04/2017

Model Predictive Control

Nimbus thermal controller running, set point tracking per zone in place.Thermal comfort levels are within user bounds(°C)

7:00 am
29/04/2017

Audit Report

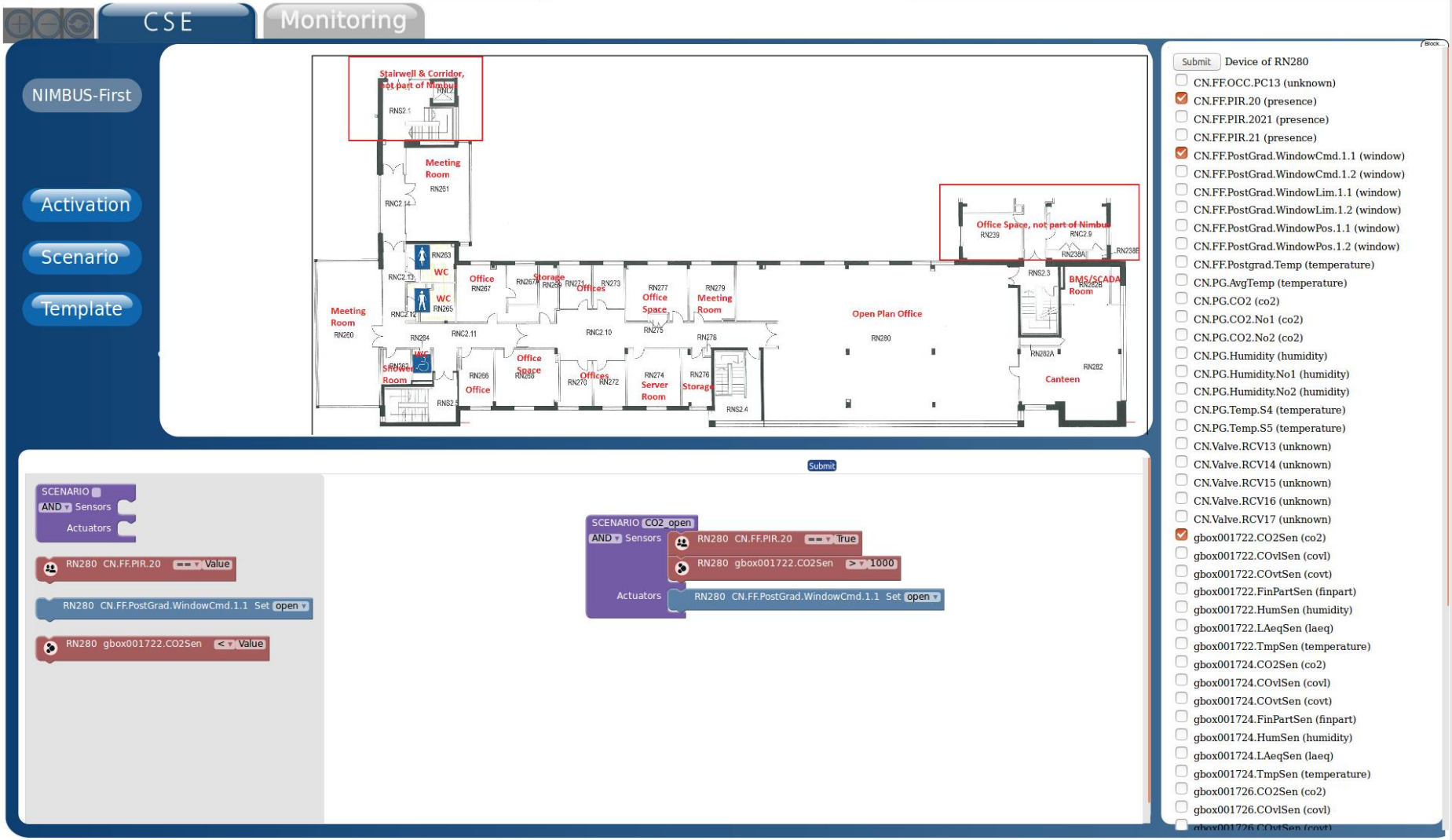
End of month audit report is available for download, share it with your energy team

13:00
28/04/2017

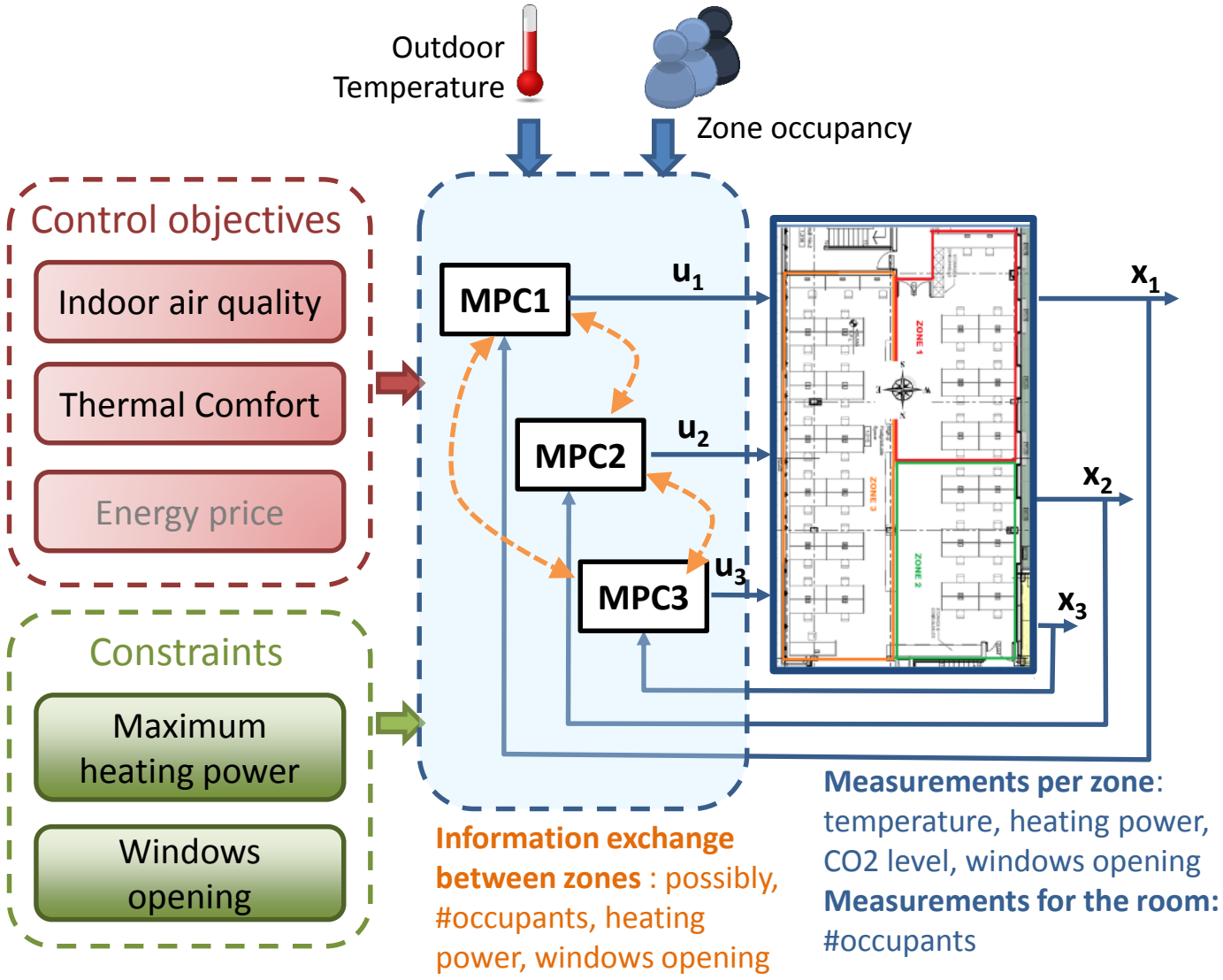
Breakout space

Occupancy levels have increased by 20% over the last 2 weeks, occupancy prediction model has been adjusted.

BMS extension - Coordination Scheme Editor



Advanced controllers



Conclusion

- TOPAs core services and add-ons
- Aggregated view of buildings
- Common front end
- BMS extension
- Advanced models taking into account user comfort
- **Demonstration on real buildings**
  - Currently monitoring 1200 data points
  - 3 blocks of buildings
- **Targets:**
  - Gap reduction to 10%
  - Energy reduction up to 20%

Thank you

Questions?