ITU KALEIDOSCOPE
SANTA FE 2018

Machine learning for a 5G future

A Machine Learning Management Model for QoE Enhancement in Next Generation Wireless Ecosystems

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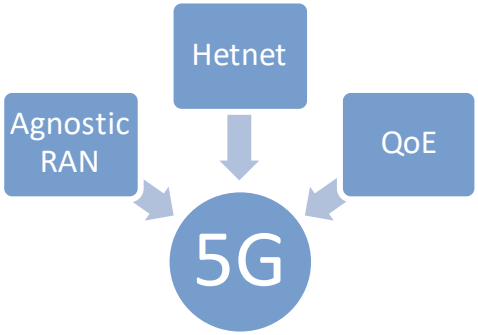
26-28 November
Santa Fe, Argentina

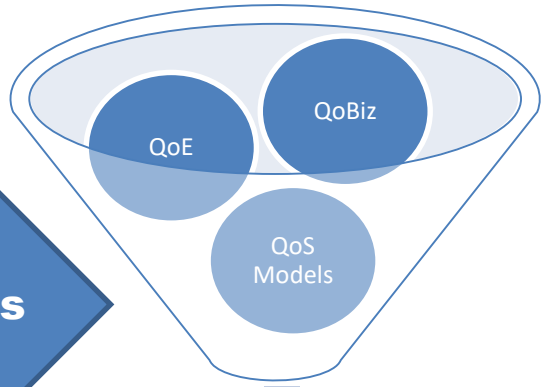
Outline

- Introduction
- Background
- Proposal
  - QoXphere Management Model
  - Machine Learning Methodology
- Case study
- Conclusions

Introduction

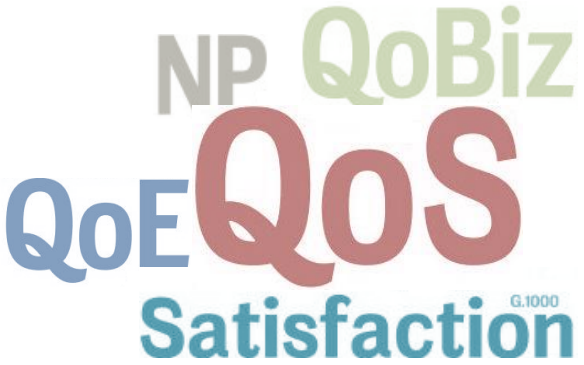
- Evolution of Internet users' behavior
- Increasing variety of free applications and services
- Internet access something indispensable
- Next-generation wireless era
  - Multiple technologies, network slicing, NFV, SDN…
  - Alternative business and QoS models



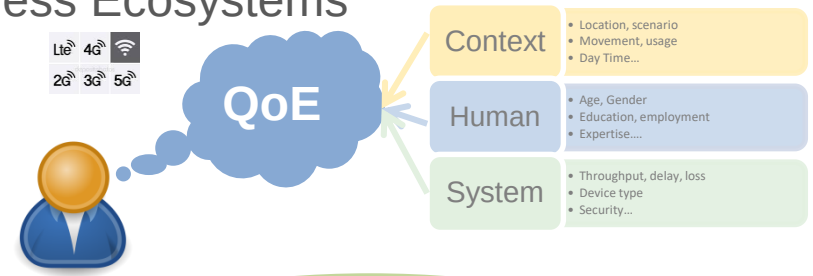


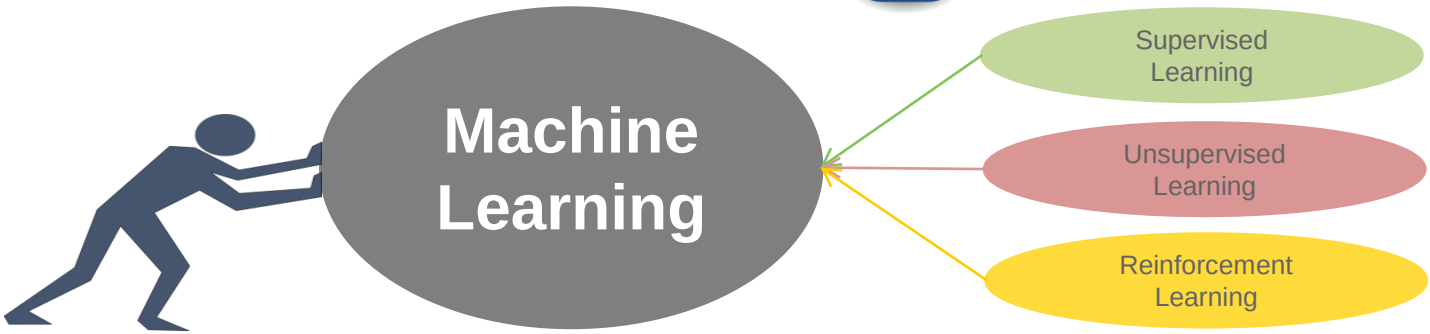
New QoS methodologies needed for 5G!

Background



- Evolution of QoS concept: from NP to QoE
- New QoS models embracing all QoS dimensions
- Difficult task when dealing with NG Wireless Ecosystems
  - Different networks sharing spectrum
  - Many user´s QoE influence factors
- To face this challenge:





QoE, ML & Standards

Focus Group on Machine Learning for Future Networks including 5G

YOU ARE HERE HOME > ITU-T > FOCUS GROUPS > ML5G

- Focus Group on Artificial Intelligence for Health
- Focus Group on Vehicular Multimedia
- Focus Group on Technologies for Network 2030
- Focus Group on Machine Learning for Future Networks including 5G
- Focus Group on Application of Distributed Ledger Technology
- Focus Group on Digital Currency including Digital Fiat Currency
- Focus Group on Data Processing and Management

FG-ML5G

The ITU-T Focus Group on Machine Learning for Future Networks including 5G was established by ITU-T Study Group 13 at its meeting in Geneva, 6-17 November 2017. The Focus Group will draft technical reports and specifications for machine learning (ML) for future networks, including interfaces, network architectures, protocols, algorithms and data formats.

Terms of Reference:

- Overall ToR of FG ML5G
- WG1 "Use cases, services and requirements"
- WG2 "Data formats & ML technologies"
- WG3 "ML-aware network architecture"

Participation in FG-ML5G is free of charge and open to all. To receive updates and announcements related to this group, please subscribe to the FG-ML5G mailing list (see the "FG-ML5G Mailing lists" tab on the right of this page).

Parent group: ITU-T Study Group 13

INTERNATIONAL TELECOMMUNICATIONUNION
TELECOMMUNICATION STANDARDIZATION SECTOR
STUDY PERIOD 2017-2020

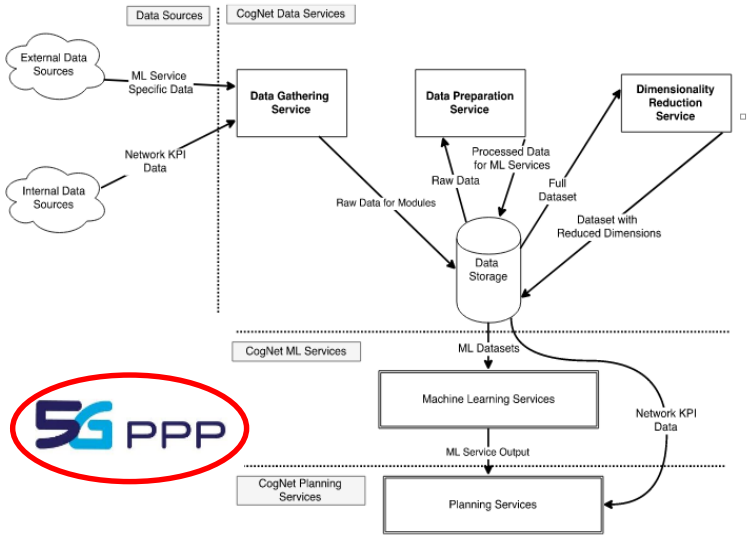
SG12-C191
STUDY GROUP 12
Original: English

Question(s): 15/12 Geneva, 1- 10 May 2018

CONTRIBUTION

Source:	InfoVista	
Title:	Proposed text for P.VSQMTF "Voice service quality monitoring and troubleshooting framework for intrusive parametric voice Woe prediction"	
Purpose:	Proposal	
Contact:	Dr. Irina Cotanis InfoVista USA	Tel: +1-703-956-5374 Fax: +1-703-956-5649 E-mail: irina.cotanis@infovista.com
Contact:	Per Johansson Info Vista Sweden	Tel: +46-910480821 Fax: +46-910480822 E-mail: per.johansson@infovista.com

Keywords: Intrusive parametric models for voice Woe prediction, framework, machine learning, learning and evaluation database generator, machine learning features, statistical evaluation module



5G PPP

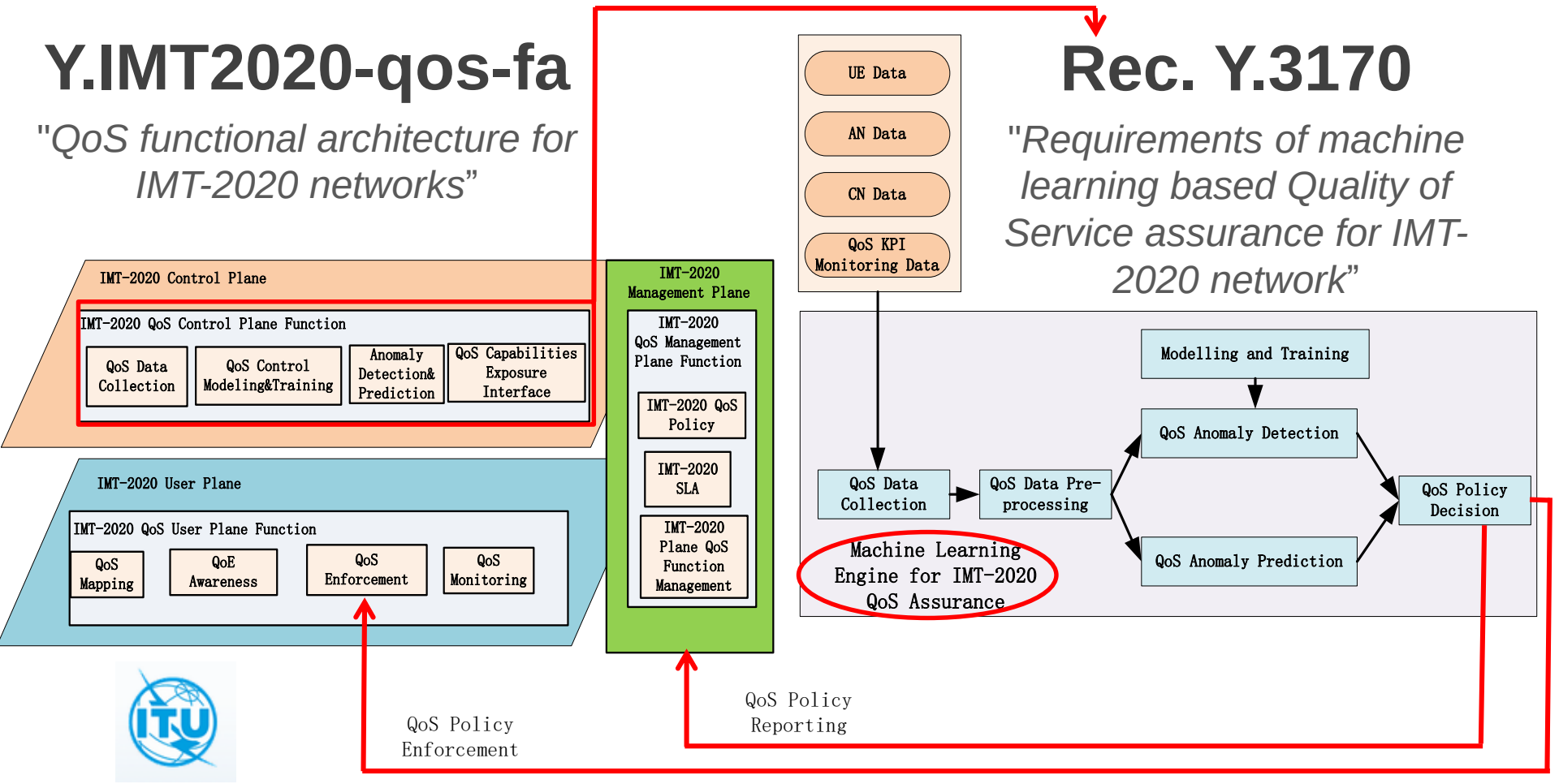
Methodologies needed to be deployed in 5G!

Y.IMT2020-qos-fa

"QoS functional architecture for IMT-2020 networks"

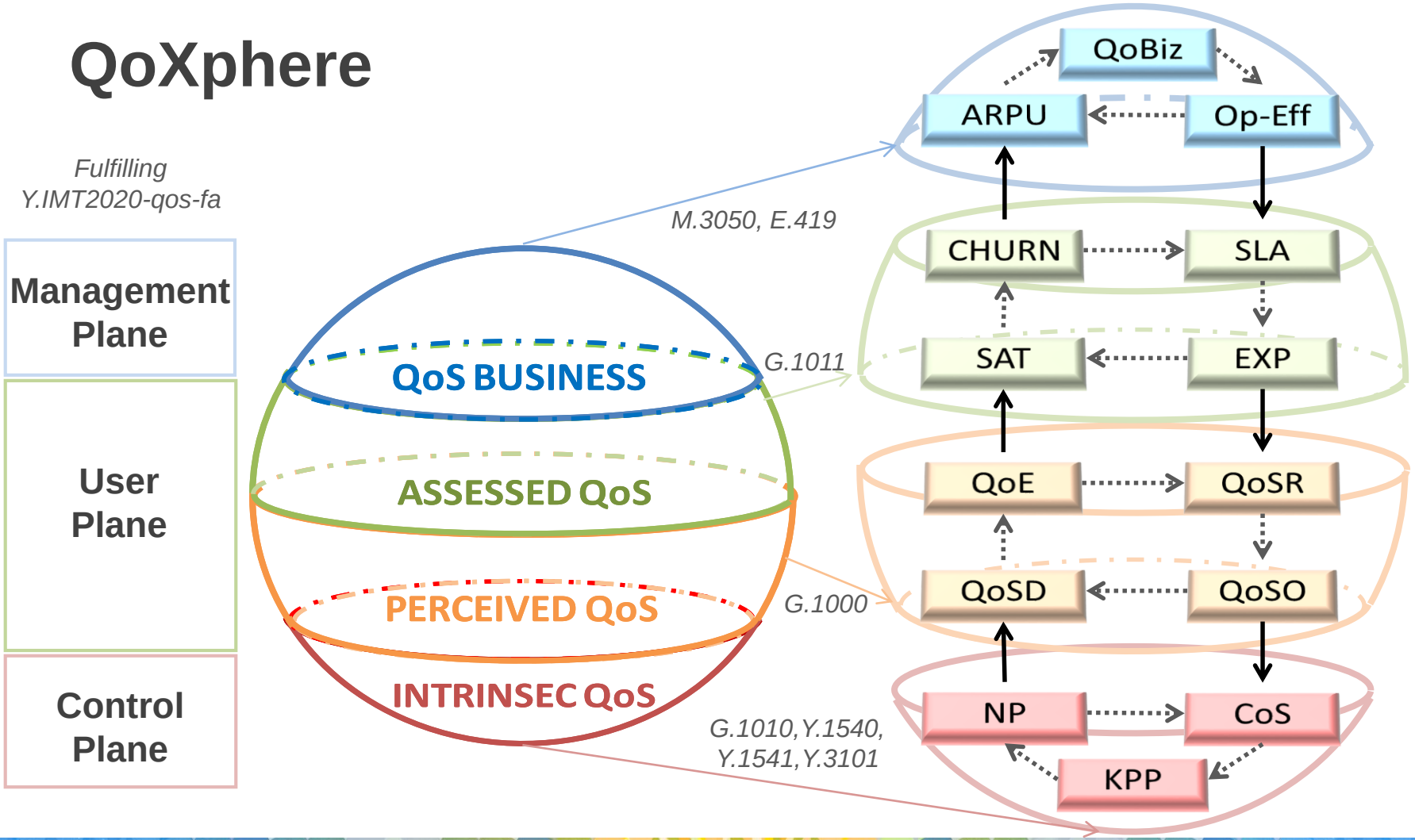
Rec. Y.3170

"Requirements of machine learning based Quality of Service assurance for IMT-2020 network"



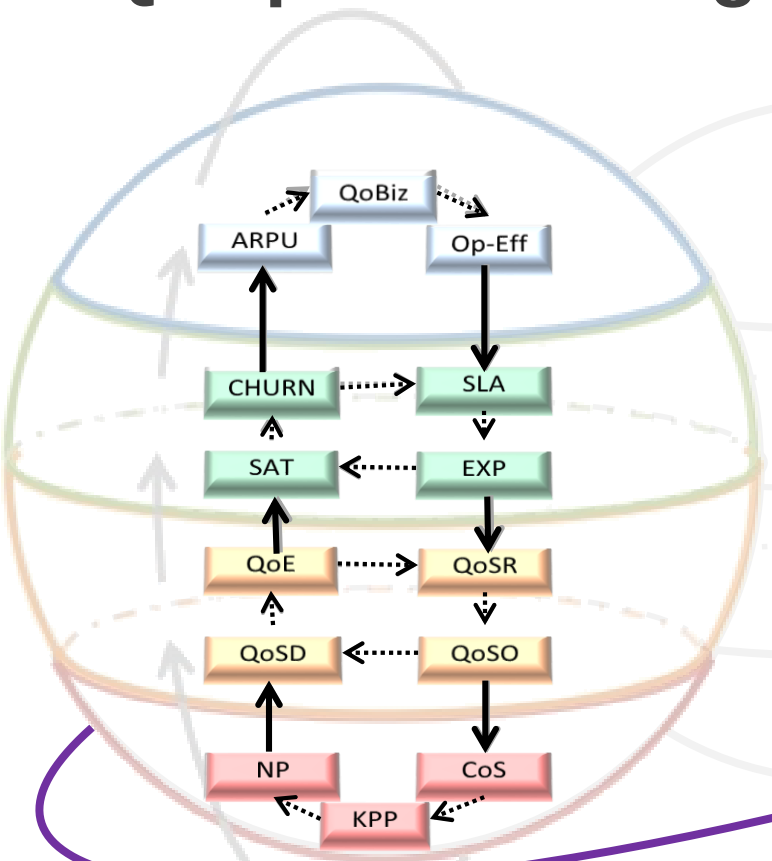
QoXphere

Fulfilling Y.IMT2020-qos-fa



QoXphere Management Model

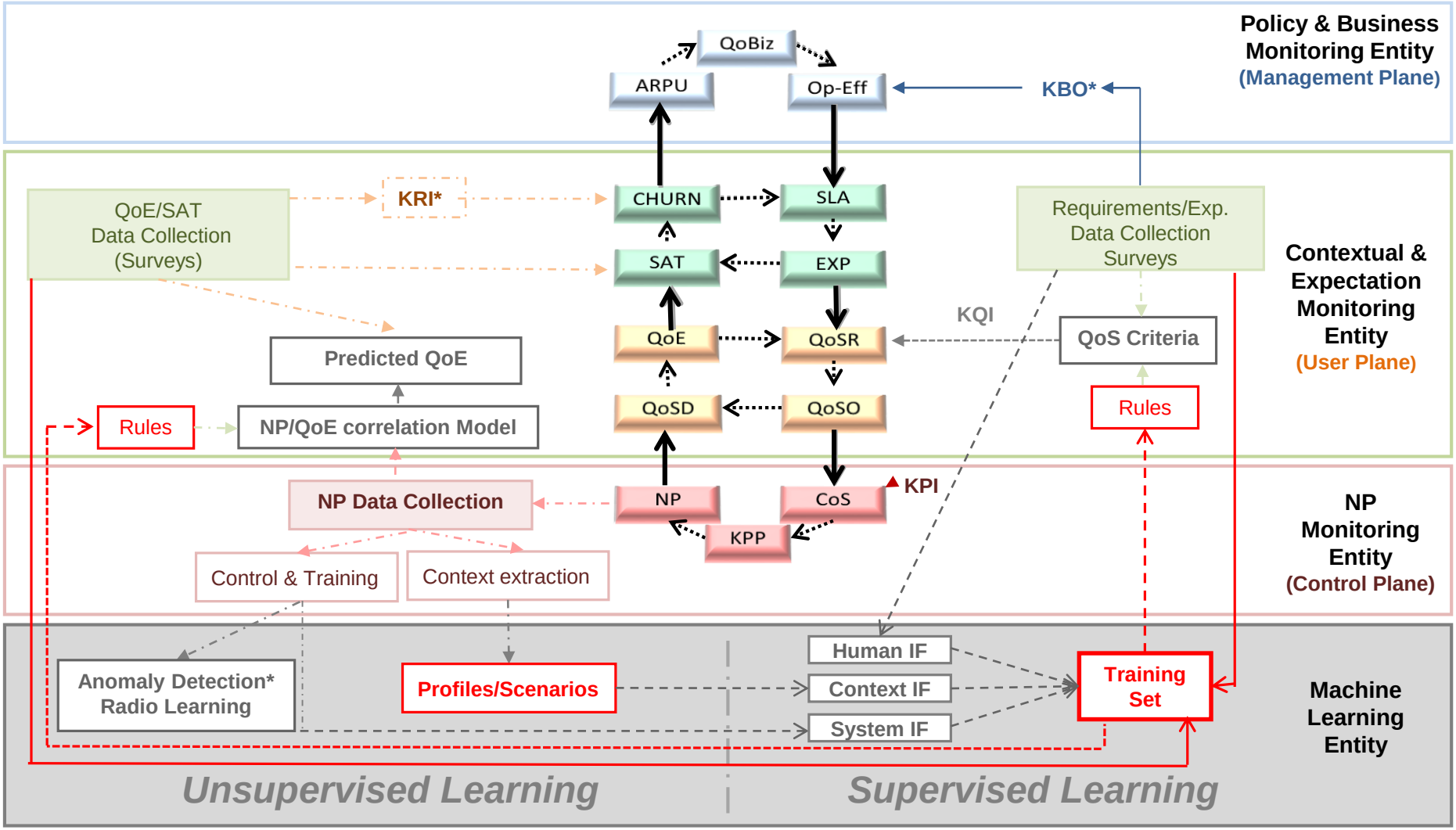
Working for a long time to find a methodology to automate the interrelations and intra-relations between different layers!



CUSTOMER FIDELITY

Machine Learning

ML METHODOLOGY

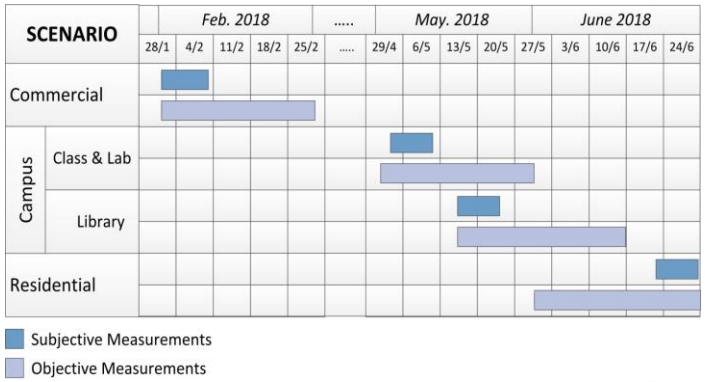


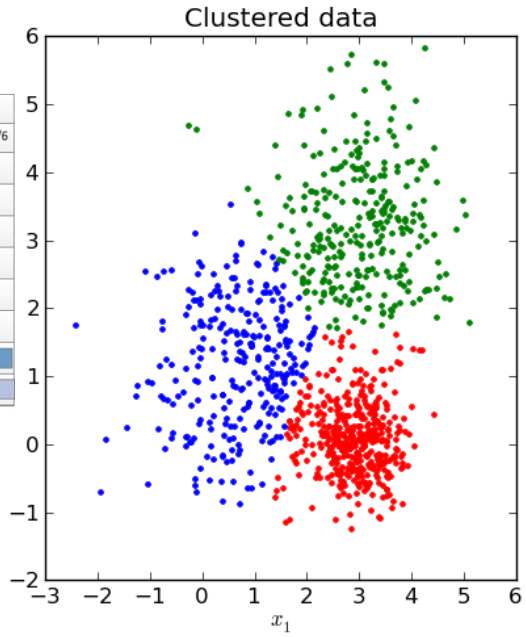
Case Study: IEEE 802.11

- **Unsupervised Learning** to identify scenarios/profiles
  - K-means
  - DBSCAN

Probes captured data

OptiWi-fi
Making Wi-Fi Better





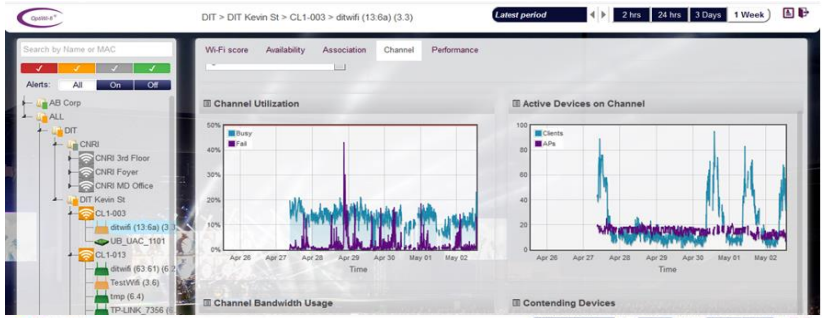
Comercial (CHQ)

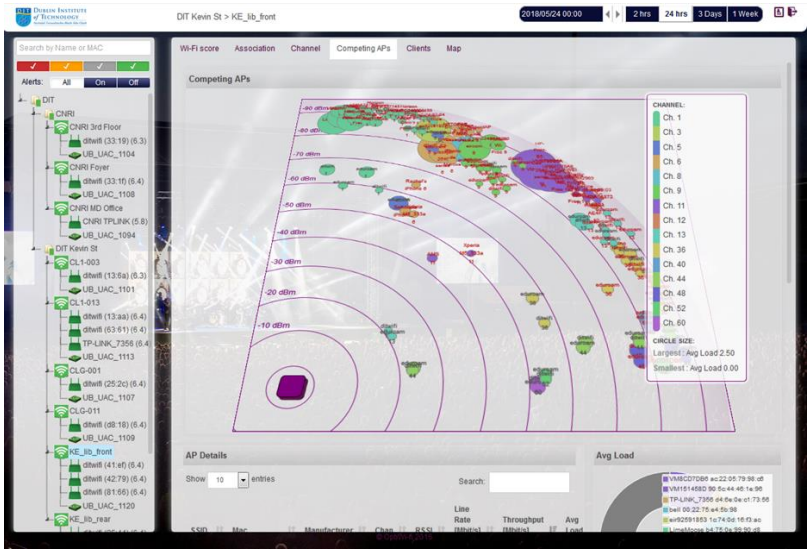
Campus (DIT)

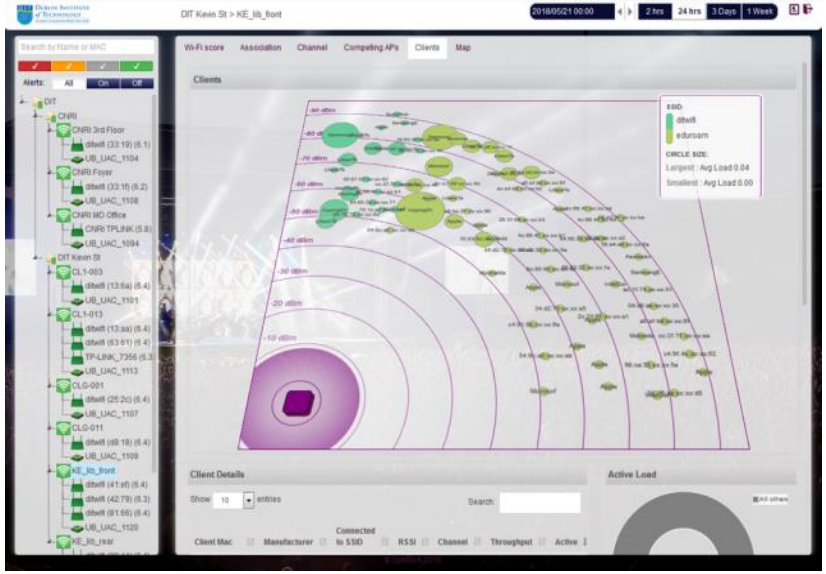
Residential (Gasworks)

Case Study: Objective Measurements

- **OptiWi-fi probes** (2 probes/scenario)
  - NP data
  - Numbers of APs
  - Numbers of clients…

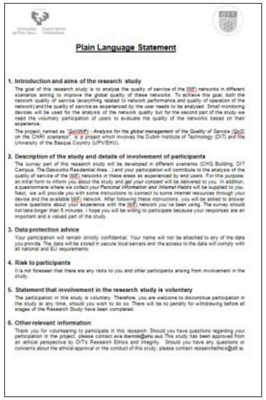


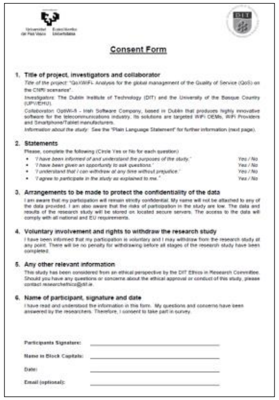


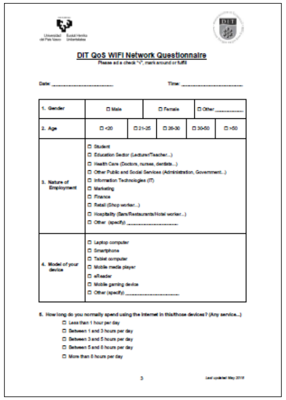


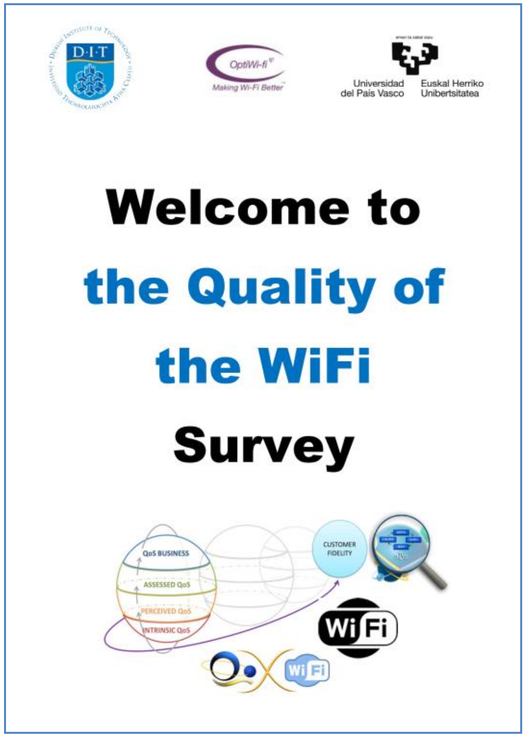
Case Study: Subjective measurements

- **Surveys**
  - Plain Language Statement
  - Consent Form
  - Questionnaire
    - Personal information
    - Internet habits
    - QoS requirements/expectation
    - QoE assessment information


Plain Language Statement

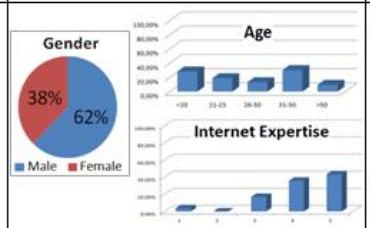
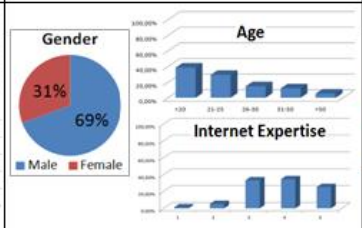
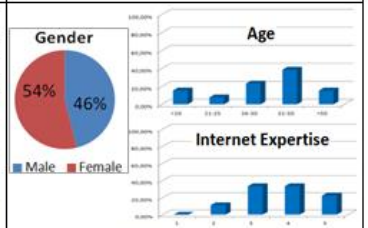
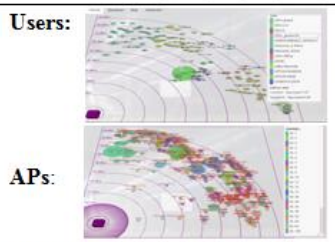
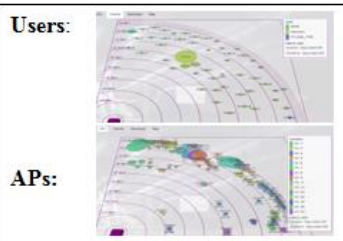
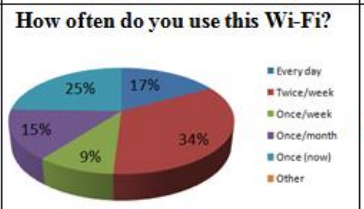
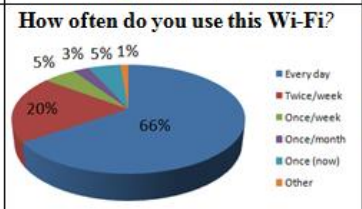
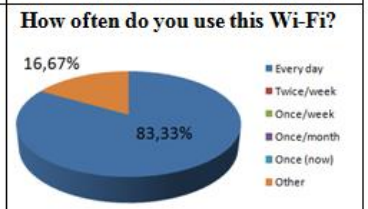

Consent Form


DIT QoS WIFI Network Questionnaire



Case Study: Results on QoS criteria & KQIs

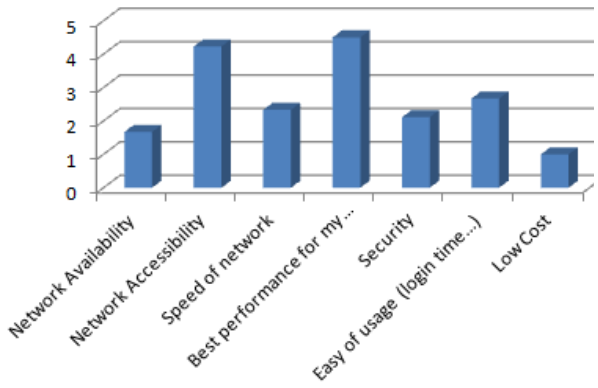
- **Influence factors**
  - Important differences between user's **Influence Factors**
  - Building **training set**
  - Find **the rules** on their affection on QoS criteria & KQIs identification

	Commercial	Campus	Residential
Human IF			
System IF			
Context IF			

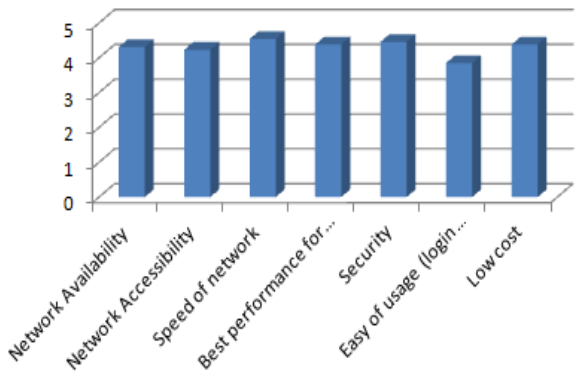
Case Study: QoS criteria & KQIs

- **KQIs Identification**
  - Relevant QoS criteria and KQIs **very different**
  - Supervised machine learning proposed to **automatically update the KQIs**
  - It is essential given the **number and changing nature of the influence factors**

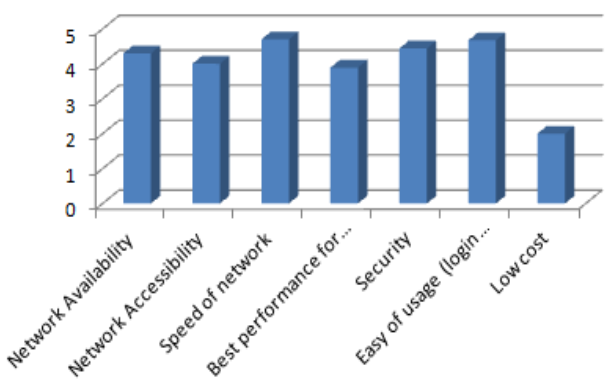
Commercial



Residential



Campus



Case Study: Control and User Plane

- **Control Plane: Data collected from the probes**
  - To learn about use's behavior (mobility patterns, connection time…)
  - Extract context information (number of users, number of APs…)
  - To detect anomalies and enhance the channel selection process through unsupervised learning
- **User Plane: Data collected from surveys and the probes**
  - Inductive supervised learning is proposed for the NP-QoE correlation model
  - Results of the surveys about user's QoE and satisfaction are proposed to feed the model and infer the rules to automatically predict the QoE (based on NP and the influence factors).
  - ML techniques may also be implemented to enhance the satisfaction model (CSAT)

Case Study: Results

- **The validation of the methodology is still at a premature stage**
  - The case study has revealed that the proposed methodology can be very useful to deploy the QoS management model and enhance the user's QoE
  - Results have indicated several corrective actions that could be implemented through ML in the scenarios under study
    - ✓ *Commercial scenario*: Analysis in NP data of AP capacity and use of ML to enhance the channel selection mechanism
    - ✓ *Campus scenario*: Customize AP performance through ML techniques and revise login procedures according to the learned rules
    - ✓ *Residential scenario*: Customize residential Wi-Fi APs for optimal throughput through ML and enhance the business model using supervised ML through the survey's observation set

Conclusions

- A methodology to implement a global QoS management model for the next generation wireless ecosystem has been presented
- The proposed methodology is based on ITU standards and takes advantage of big data and ML techniques and may help to enhance the new ITU related standards
- Even though the definition of the methodology and the validation of the approach is still at an early stage, the results of the case study reveal that the proposed methodology may aid to enhance QoE in next generation wireless environments

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Thank you