ITUEvents

ITU-ML5G-PS-038: Traffic recognition and Long-term traffic forecasting based on AI algorithms and metadata

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SPbSUT, 31 Aug 2020

ITU
AI/ML in 5G
Challenge
Applying machine learning in communication networks

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Agenda

- Common Background
- SDN as a part of 5G/IMT-2020 and related AI technologies
- Our SDNLab infrastructure
- Problem with fastly traffic recognition on the DataPlane
- Problem Statement. Key Features
- Challenges
- Research Background. Examples
- Task. Output Format
- Q/A

Common Background

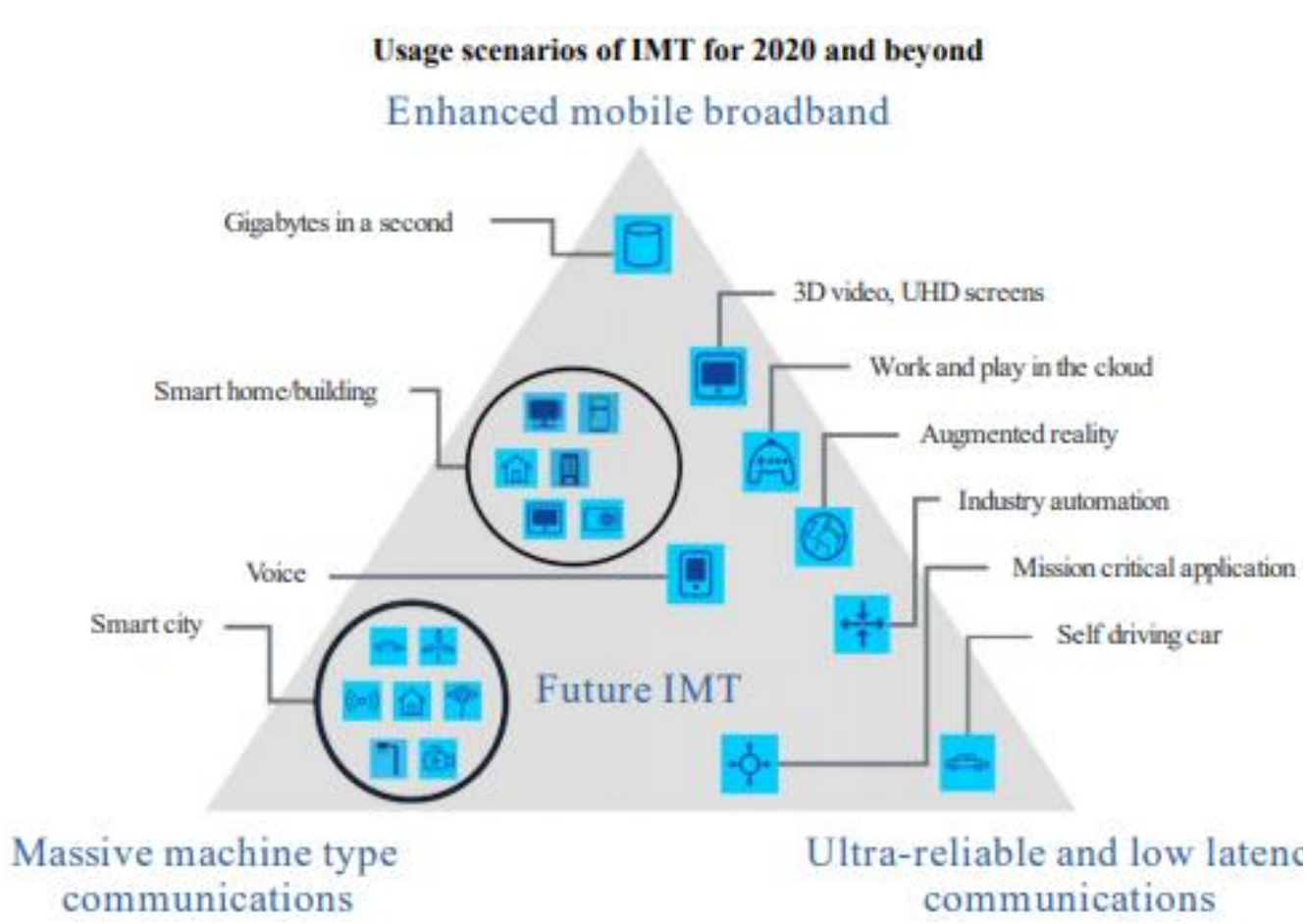


Fig. 1*

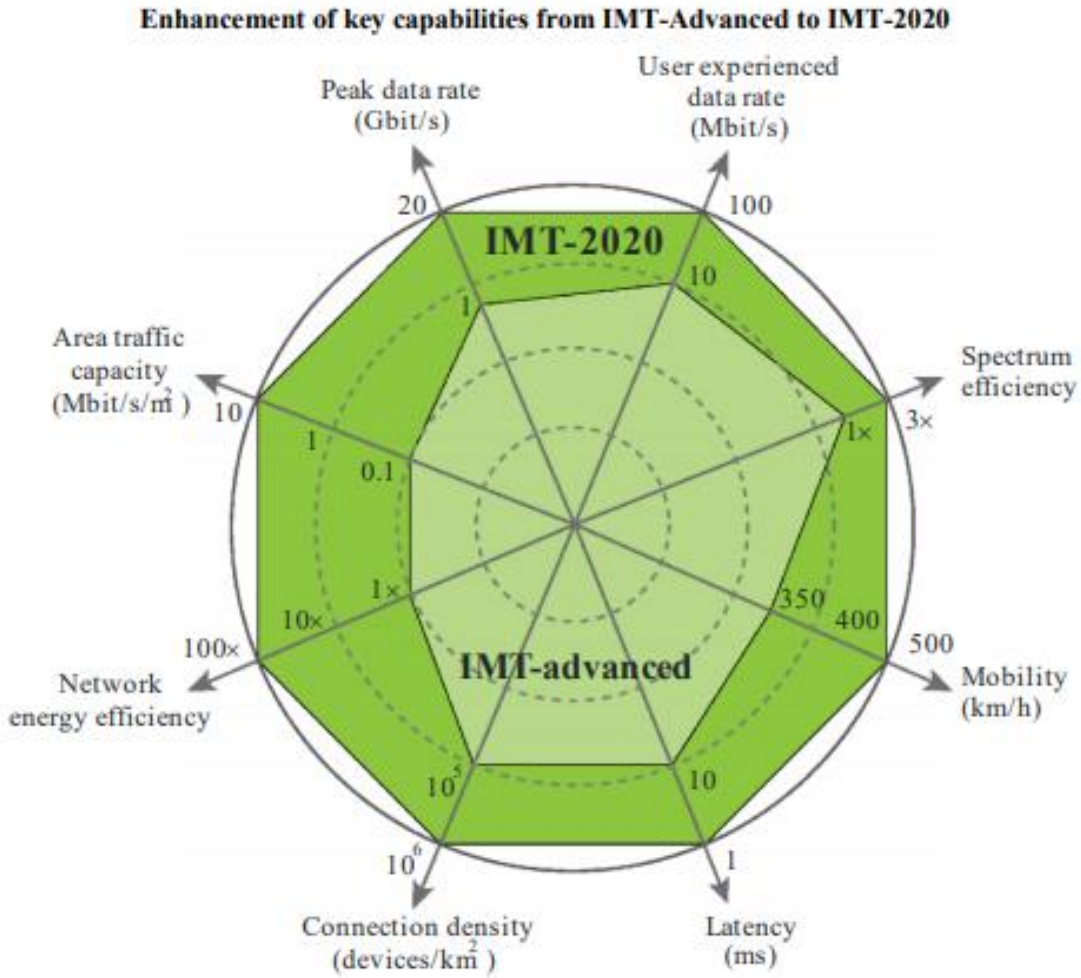
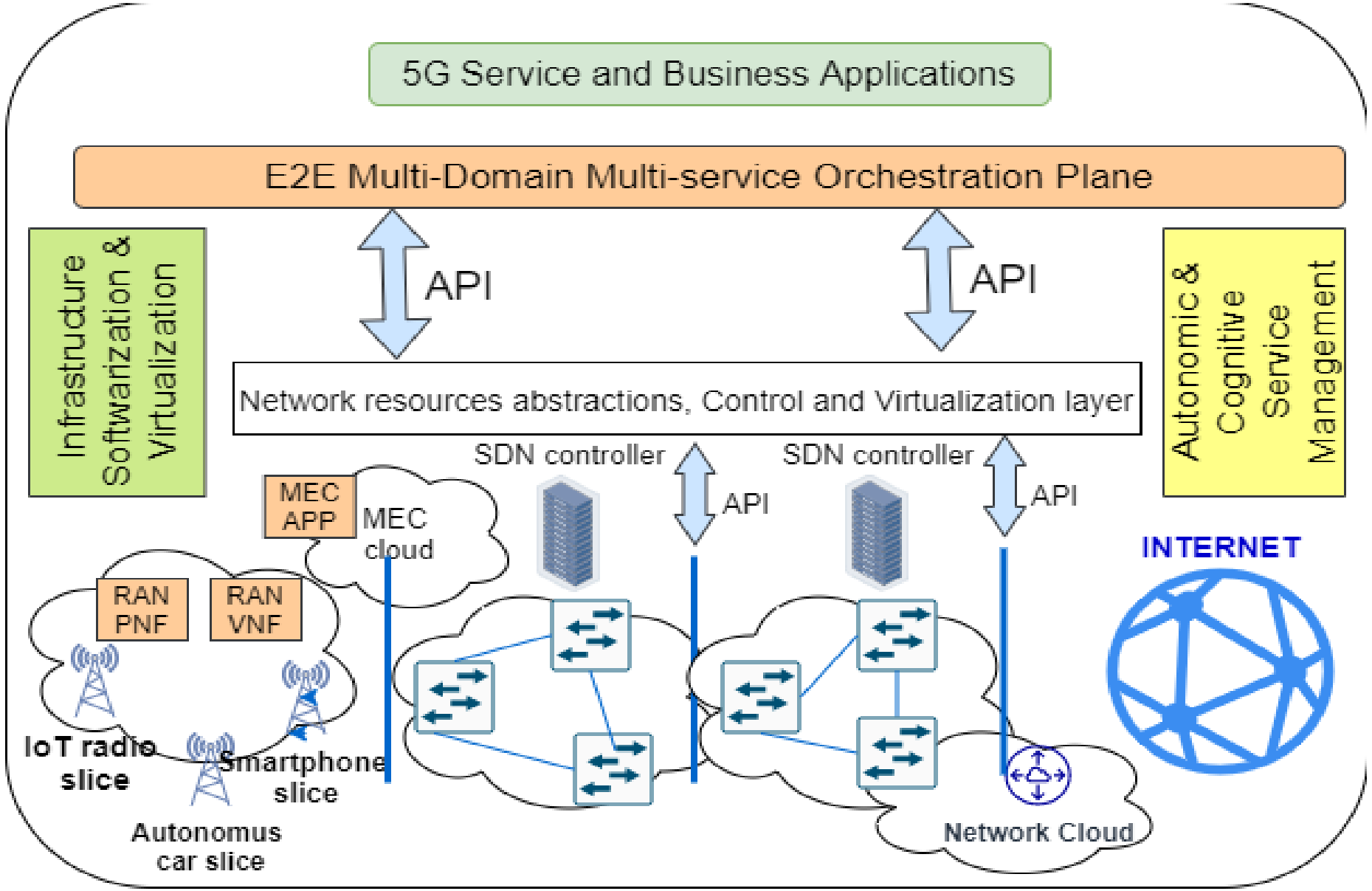


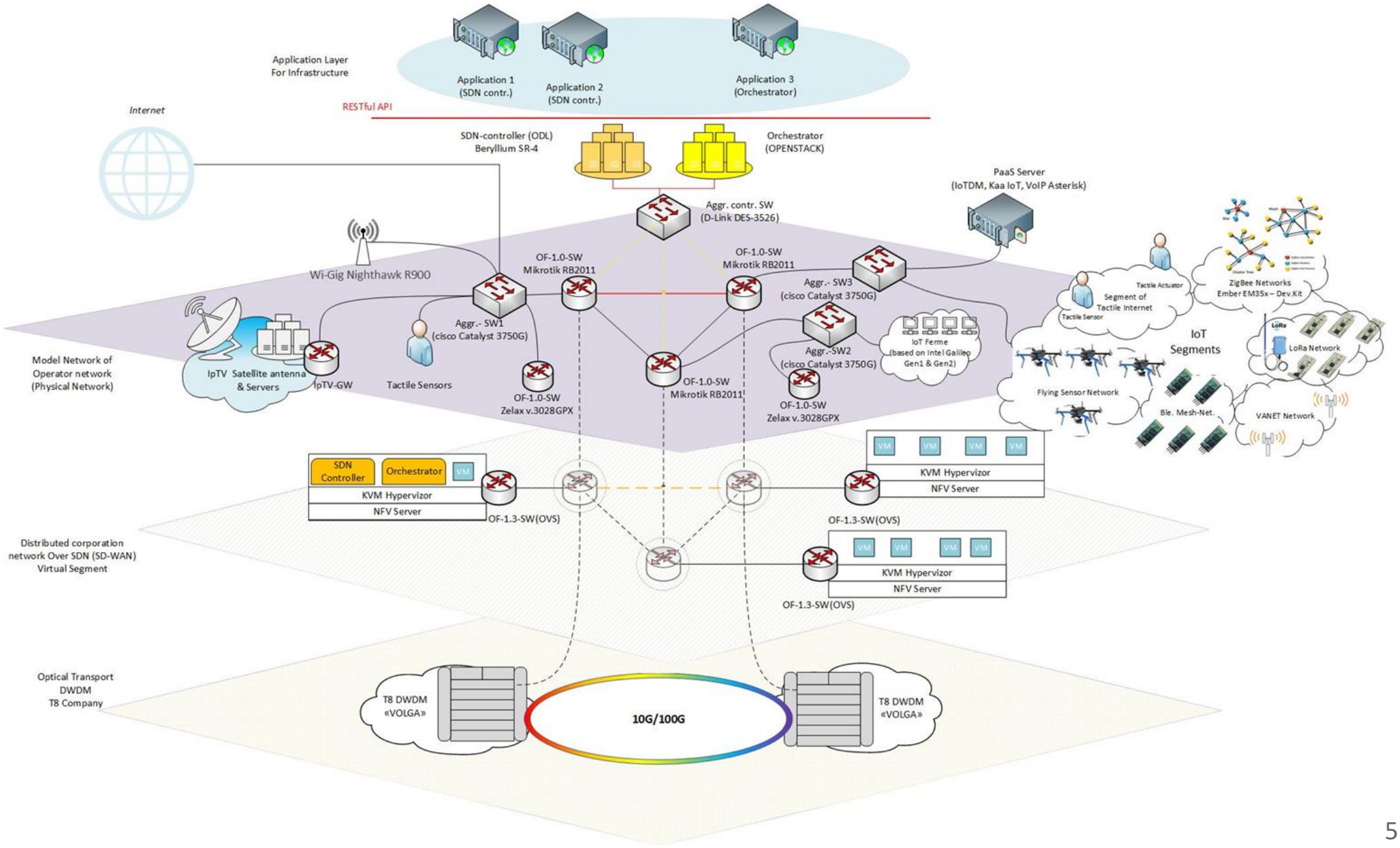
Fig. 2*

** - Reference to ITU-R 2083-0 (09/2015) "IMT Vision – Framework and overall objectives of the future development of IMT for 2020 and beyond "*

SDN as a part of 5G/IMT-2020 and related AI technologies



Our SDNLab Infrastructure



Problem with fastly traffic recognition on the DataPlane

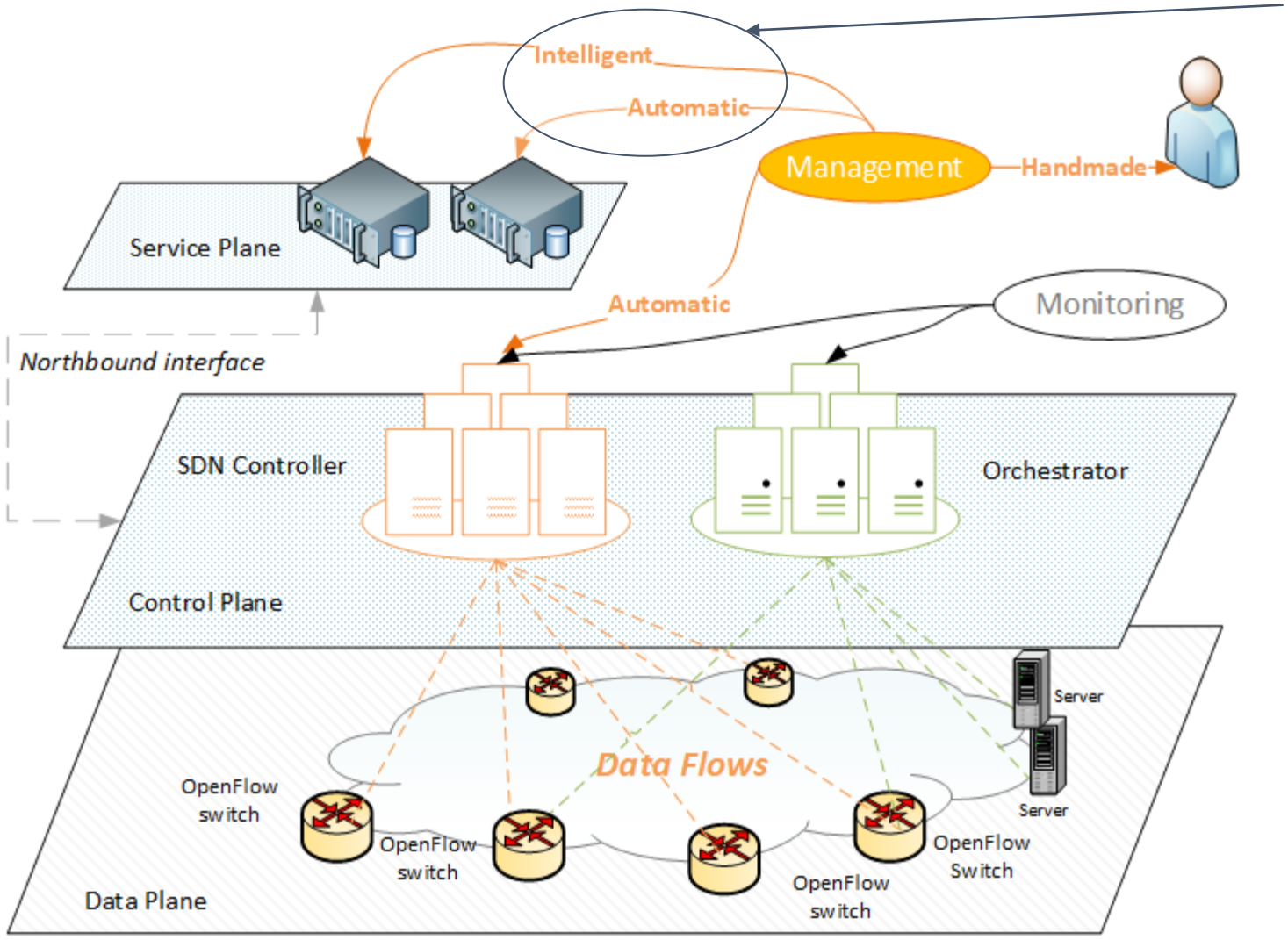


Fig. 3

Traffic recognition on the Data Plane is required for Intelligent and Automatic management

De-facto requirements

- SaaS approach
- Independence from the vendor's solutions (open API);
- OpenSource platforms;
- Cross-platform
- live-migration (it's desirable)

Problem Statement. Key Features

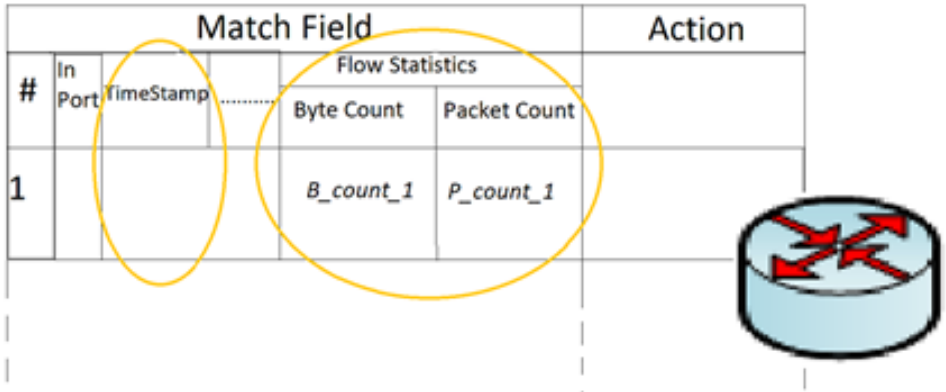


Fig.4 - Flow Table (ver. Openflow 1.0)

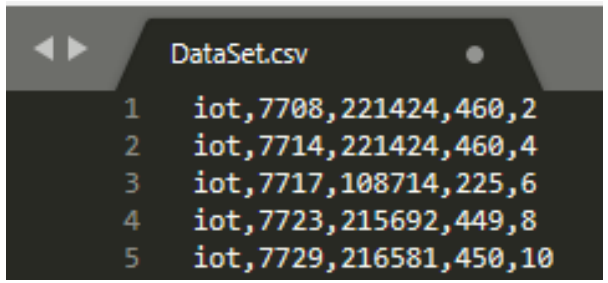


Fig.5 - Example of Marked Data Sets

Define, PacketCount_delta – PC_{delta},

ByteCount_delta – BC_{delta}, a

TimeStamp_deltas – TS = 1 [sec.] = *const*, тогда:

$$DataSet_{RQ} = \begin{matrix} [TimeStamp] & [ByteCount] & [PacketCount] \\ TimeStamp_{11} & ByteCount_{12} & PacketCount_{13} \\ TimeStamp_{21} & ByteCount_{22} & PacketCount_{23} \\ \dots & \dots & \dots \\ TimeStamp_{N1} & ByteCount_{N2} & PacketCount_{N3} \end{matrix}$$

$$\begin{cases} BC\_delta_{N2} = ByteCount_{N2} - ByteCount_{(N-1)2}, & if\ N \geq 1 \\ PC\_delta_{N2} = PacketCount_{N2} - PacketCount_{(N-1)2}, & if\ N \geq 1 \end{cases}$$

$$DataSet_{ML} = \begin{matrix} [TimeStamp] & [ByteCount] & [PacketCount] \\ TS & BC_{delta_{12}} & PC_{delta_{13}} \\ TS & BC_{delta_{22}} & PC_{delta_{23}} \\ \dots & \dots & \dots \\ TS & BC_{delta_{N2}} & PC_{delta_{N3}} \end{matrix}$$

Key features:

Metadata, Long-term forecasting

Challenges

Part 1: AI for traffic recognition and classification*

Propose for traffic types recognition based on Machine Learning, using Metadata of flows

Part 2: AI for Long-term traffic forecasting*

Propose long-term traffic forecasting on the data plane, using Metadata of recognized flows

Part 3: Suggestion with both 1st and 2nd algorithms (theoretical)

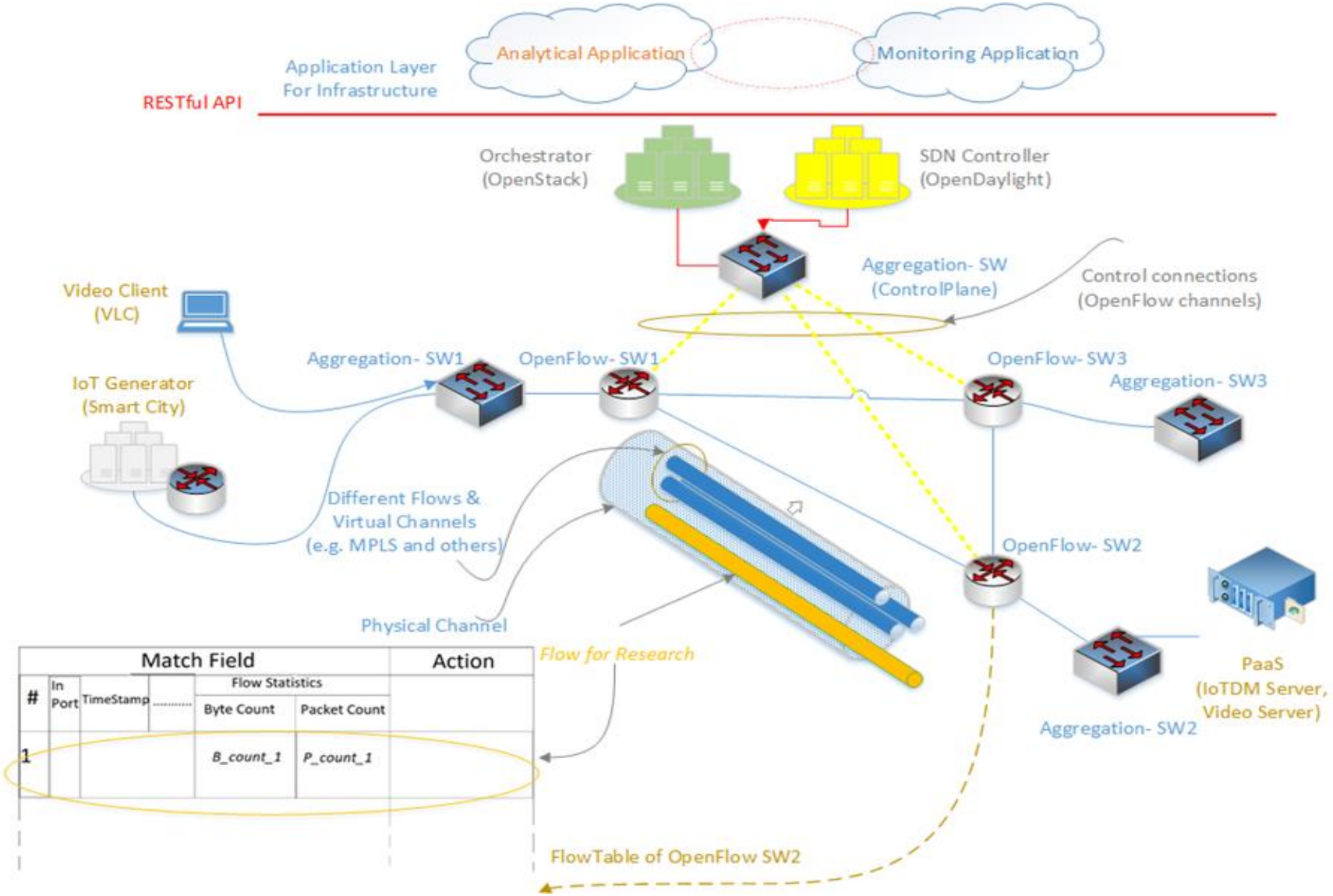
Propose theoretical models for both 1st & 2nd algorithms collaboration (UML Scheme with definition and description)

The key features of the proposal is to use the metadata of flows on the data plane at the same time the analytical application with AI/ML algorithms is located on the service level and working with the SDN/NFV network via northbound API.

For Challenge we prepared the ready to make the ML models data sets of IoT and Video traffic.

** Reference to the 6.2.1 and 6.2.2 clauses were taken from the following document "ITU AI/ML in 5G Challenge - Participation guidelines"]*

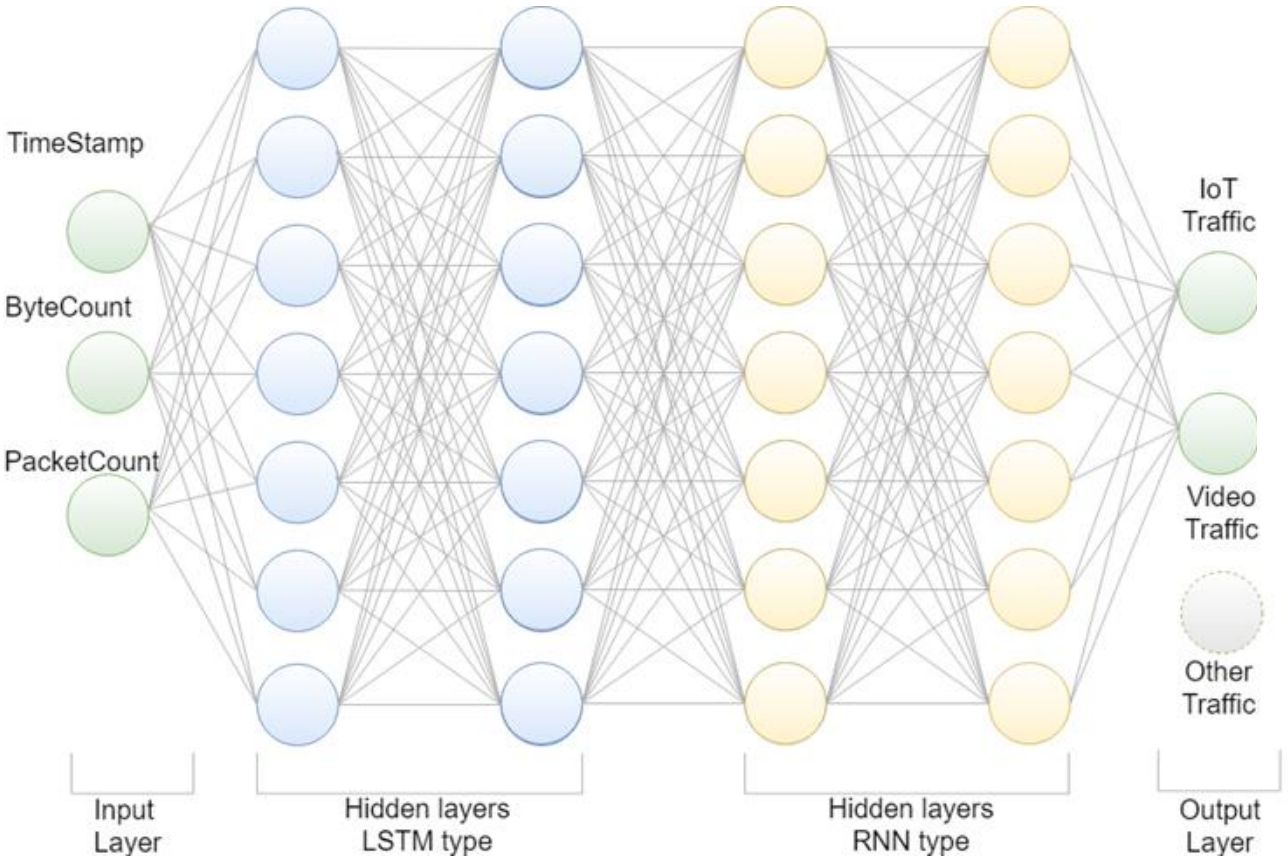
Research Background. Part 1 - Traffic recognition (Examples)

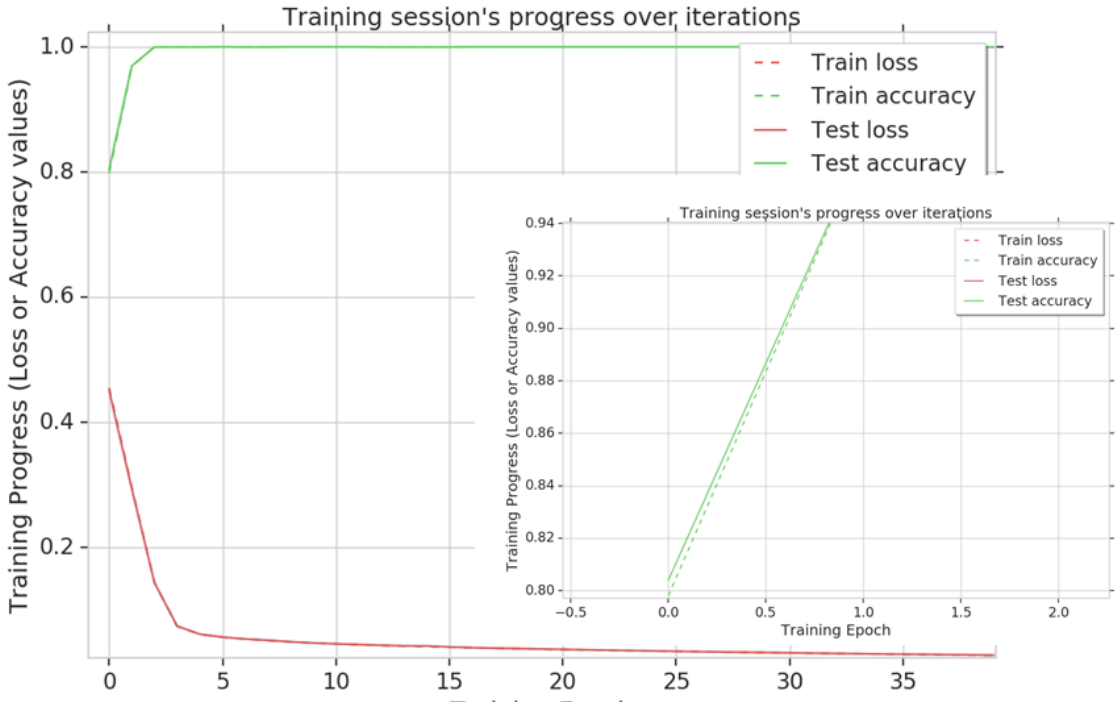


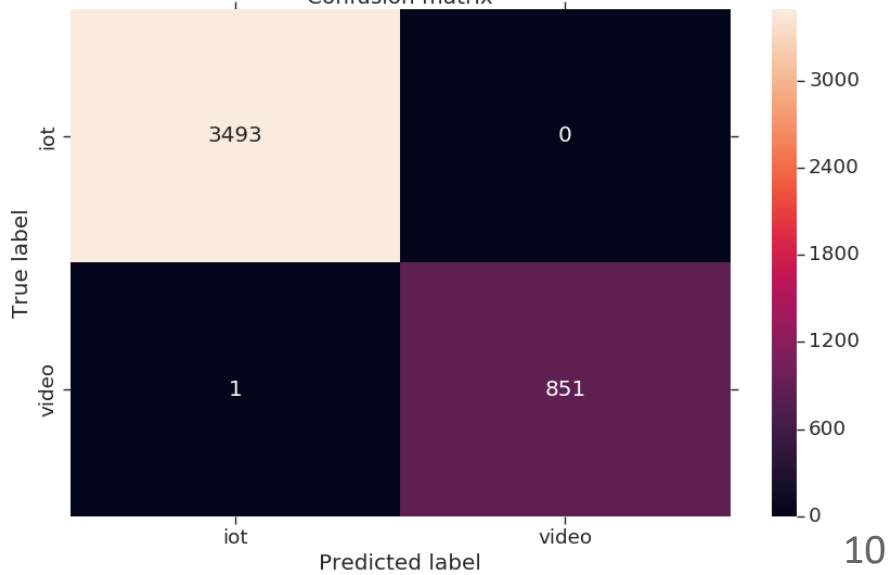
*Reference: Volkov, A., Ateya, A. A., Muthanna, A., Koucheryavy, A. (2019). Novel AI-Based Scheme for Traffic Detection and Recognition in 5G Based Networks. In Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics) (Vol. 11660 LNCS, pp. 243{255). Springer Verlag. https://doi.org/10.1007/978-3-030-30859-921.

Research Background. Part 1 - Traffic recognition (Examples)

$$DataSet_{ML} = \begin{matrix} [TypeOfTraffic] & [\text{TimeStamp}] & [\text{ByteCount}] & [\text{PacketCount}] \\ IoT & TS & BC_{delta_{12}} & PC_{delta_{13}} \\ IoT & TS & BC_{delta_{22}} & PC_{delta_{23}} \\ \cdots & \cdots & \cdots & \cdots \\ Video & TS & BC_{delta_{N2}} & PC_{delta_{N3}} \\ others & TS & BC_{delta_{(N+1)2}} & PC_{delta_{(N+1)3}} \end{matrix}$$

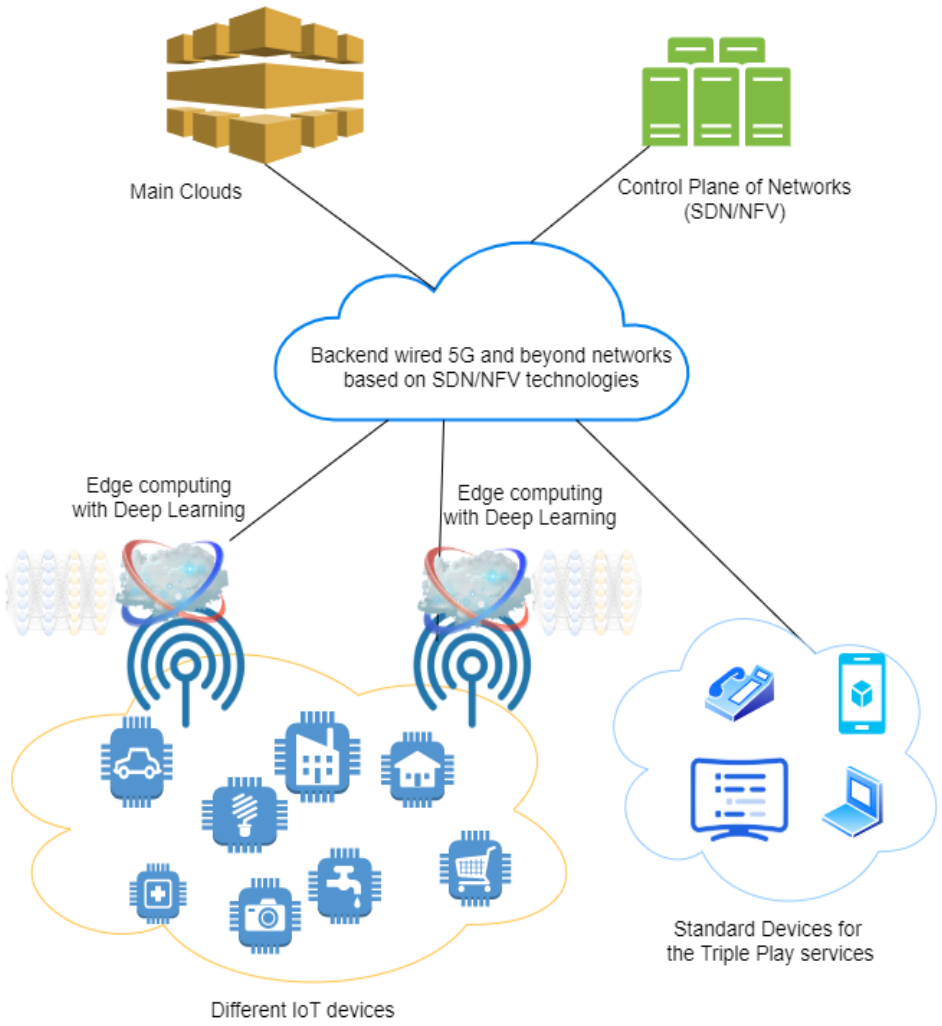


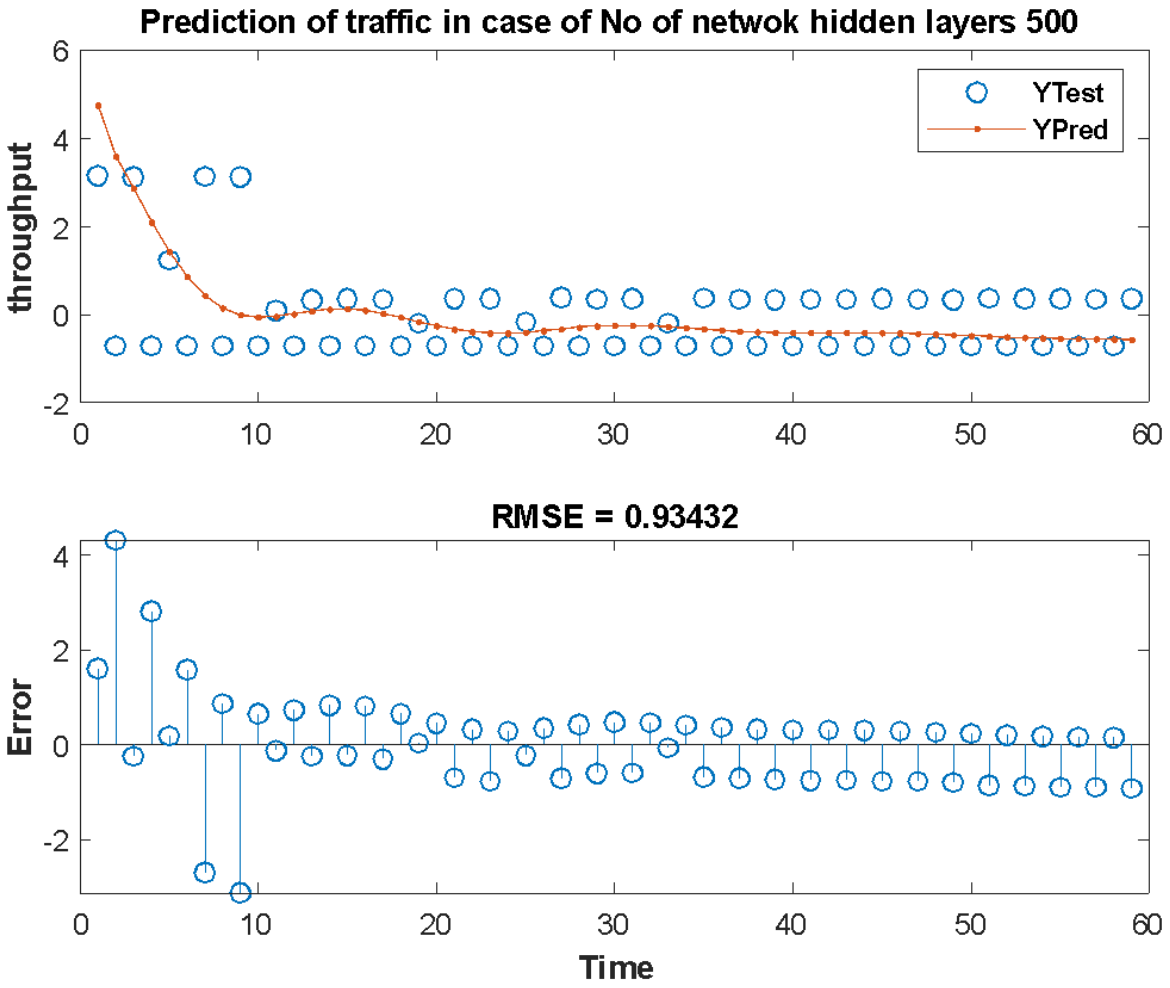




*Reference: Volkov, A., Ateya, A. A., Muthanna, A., Koucheryavy, A. (2019). Novel AI-Based Scheme for Traffic Detection and Recognition in 5G Based Networks. In Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics) (Vol. 11660 LNCS, pp. 243{255). Springer Verlag. https://doi.org/10.1007/978-3-030-30859-921.

Research Background. Part 2 - Traffic prediction (Examples)





*Reference: Ali R. Abdellah , Artem Volkov , Ammar Muthanna , Andrey Koucheryavy. Deep Learning for IoT Traffic Prediction based on Edge Computing. 23rd International Conference on Distributed Computer and Communication Network 2020. [Accepted. Publishing in process]

Research Background. Direction 1/ Direction 2

1. Volkov, A., Ateya, A. A., Muthanna, A., Koucheryavy, A. (2019). Novel AI-Based Scheme for Traffic Detection and Recognition in 5G Based Networks. In Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics) (Vol. 11660 LNCS, pp. 243{255). Springer Verlag. https://doi.org/10.1007/978-3-030-30859-921.

1. Volkov, A., Proshutinskiy, K., Adam, A. B. M., Ateya, A. A., Muthanna, A., Koucheryavy, A. (2019). SDN Load Prediction Algorithm Based on Artificial Intelligence. In Communications in Computer and Information Science (Vol. 1141 CCIS, pp. 27{40). Springer. https://doi.org/10.1007/978-3-030-36625-43

1. Ali R. Abdellah, Omar Abdul Kareem Mahmood, Alexander Paramonov, Andrey Koucheryavy, “IoT traffic prediction using multi-step ahead prediction with neural network”, IEEE 11th International Congress on Ultra-Modern Telecommunications and Control Systems and Workshops (ICUMT), 2019. https://doi.org/10.1109/ICUMT48472.2019.8970675 .

1. Ali R. Abdellah , Artem Volkov , Ammar Muthanna , Andrey Koucheryavy. Deep Learning for IoT Traffic Prediction based on Edge Computing. 23rd International Conference on Distributed Computer and Communication Network 2020. [Accepted. Publishing in process]

1. Artem Volkov , Ali R. Abdellah , Ammar Muthanna , Andrey Koucheryavy. IoT traffic prediction with Neural networks learning based on SDN infrastructure. 23rd International Conference on Distributed Computer and Communication Network 2020. [Accepted. Publishing in process]

Task. Output Format

Task

Based on the the proposed method make the suggestions:

1. Propose for traffic types recognition based on Machine Learning, using Metadata of flows;
2. Propose long-term traffic forecasting on the data plane, using Metadata of recognized flows;
3. Propose theoretical models for both 1st & 2nd algorithms collaboration (UML Scheme with definition and description)

The output format is the report (expected) which include the following:

- Problem analysis include the Gap analysis of current approaches for solve defined research problem;
- Architectural scheme, models, algorithm in UML notation;
- Description of solution;
- Results of modeling in the graphs and their explanation;
- Software with ML and Big data (if necessary) algorithms,
- trained ML-models;
- results in the CSV file, which contains results of training: necessary parameters (find in the evaluation clause).

*the ".docx" format is required for report.

Tools:

Python (version: 2.7 - 3.4)

or Matlab

Thank you!

https://www.sut.ru/

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ITUEvents

Invited talk – Milvus: An Open Source Vector Similarity Search Engine

Jun Gu, ZILLIZ, 1 Sep 2020

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