Welcome to the 5GAA webinar

Predictive QoS:
A Key Technology for the Automotive Industry

Learn more at WWW.5GAA.ORG

5GAA bridges the automotive and telecommunication industries in order to address society's connected mobility and road safety needs with applications such as automated driving, ubiquitous access to services, integration into intelligent transportation and traffic management

AUTOMOTIVE INDUSTRY

Vehicle Platform, Hardware and Software Solutions

TELECOMMUNICATIONS

Connectivity and Networking Systems, Devices and Technologies

5GAA unites today 134 members from around the world working together on all aspects of C-V2X including technology, standards, spectrum, policy, regulations, testing, security, business models and go-to-market

5GAA Members*

*as of March 2020

5GAA Priority Areas

Digital Roads

Engage with road operators to **fully integrate the road infrastructure**

Trust

Implement state-of-the-art **security and privacy** by design in the V2X ecosystem

Vulnerable Road Users

Enable **smart devices** to deliver services protecting pedestrians, cyclists, …

Interoperable, deployable & secure

5GAA Automotive Association

Connected mobility for people, vehicles and transport infrastructure

end-to-end connectivity solutions

Mobile Networks

Build upon **cellular network deployments** to fast track new mobility services

Precise Positioning

Foster advanced **positioning solutions** for all road users

Flexible Service Architectures

Leverage **distributed cloud and edge computing** capabilities

Interoperable Ecosystem

Satisfy **business needs** for interoperation between devices and services across ecosystem partners

Sustained Technology Evolution

Accelerate evolution of cellular technologies towards **5G V2X**

5GAA Organisational Structure

BOARD

EXECUTIVE COMMITTEE

GENERAL ASSEMBLY

WG1	WG2	WG3	WG4	WG5	WG6	WG7
Use Cases and Technical Requirements	System Architecture and Solution Development	Evaluation, Testbeds and Pilots	Standards and Spectrum	Business Models and Go-To-Market Strategies	Regulatory and Public Affairs	Security and Privacy

Predictive QoS:
Using 5G Network Data Analytics to enable Proactive C-V2X Application Adaptation

Ali Hamidian, R&D Manager, Huawei Sweden

5GAA Webinar, 26 March 2020

Authors: Antonio Consoli, Mats Eriksson, Andrey Krendzel, Ali Hamidian

Content

1. Which problem is Predictive QoS addressing?
2. What is Predictive QoS?
3. How can automotive applications make use of it?
4. Has it been implemented?
5. What is the status in terms of standardization?

Which problem is Predictive QoS addressing?

A real need formulated by vertical industries

Source: Volkswagen

Mission-critical applications rely on their QoS requirements being met, since application failure or suspended operation can have a **high cost**.

However, the "*network **may not be able to always guarantee** the required QoS of the service.*" (*)

Source: ABB

Therefore, mission-critical applications may **need to adapt** to QoS changes. This adapation should complete **before a potential QoS change**.

(*) 3GPP TS 22.261, Section 6.23

What is Predictive QoS?

Predictive QoS: A feature that allows the mobile network to provide notifications about predicted QoS changes to enable **in-advance adjustment** of the application behaviour.

"QoS is estimated to drop in x seconds and degradation may last for y seconds"

5G

IQN

Tele-Operating driver

1 Connected vehicle is being driven through tele-operation

2 Application receives *in-Advance QoS Notification* (IQN) of potential network quality degradation

3 Application takes appropriate action/countermeasure (e.g. decrease speed, change lane)

4 Network QoS degradation takes effect. Necessary action has already been taken.

5 Network QoS is back to normal

Vehicle speed: 50 km/h

Example of QoS parameters for To

Application class	5QI	5QI features
Video and audio	2	Resource type: GBR PDB: 150 ms

Note:

C-V2X defines two transmission modes:

- long-range communications via the mobile network, using Uu interface
- direct short-range communications, using PC5 interface, also known as "sidelink"

This webinar focuses on Uu-based long-range communications via the mobile network.

Three main steps of Predictive QoS

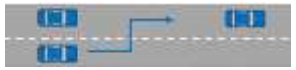
1. Collect Data
(required to support prediction)

2. Analyze and Make Prediction
(using ML or other technologies)

3. Deliver Prediction

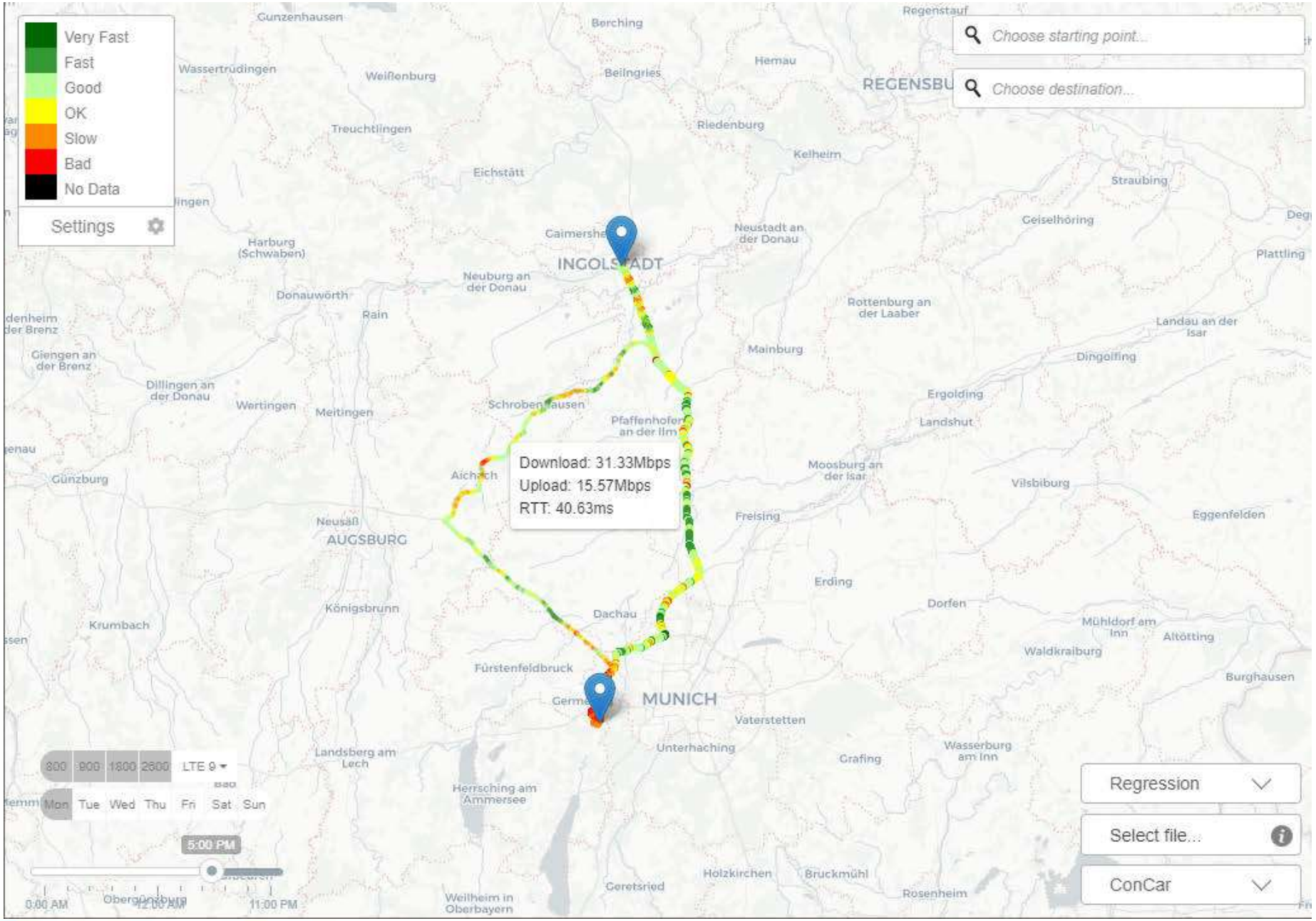
- **Vehicle** (location, planned route, speed, performance measurements, detected hazardous road conditions, situational awareness)
- **Road infrastructure** (road topology, traffic signs, road traffic)
- **Network** (network load, resources, O&M measurements)
- **Weather** (rainfall, visibility due to fog, wind speed)
- **Coverage** (e.g. coverage maps with performance measurements)
- **Large events** (sports, concerts, festivals)
- **Analytics** (handover failure rate, statistics)

Examples of Use Cases and Application Reactions

	Use Cases	QoS KPIs to be Predicted	Examples of Potential Application Reactions
	**High-Density Platooning**	**latency, reliability, coverage**	change inter-vehicle distance, handover to driver, change platoon speed or length, terminate platoon
	**Tele-Operated Driving**	**data rate, latency, reliability, coverage**	change route, change ToD mode (e.g. from maneuvering to trajectory provisioning), handover to nearby driver, change sensor properties, park vehicle
	**Lane Merge Assist**	**latency, reliability, coverage**	change speed of merging attempt, abort lane merge
	**Infotainment**	**data rate, coverage**	change video quality
	**Software Update**	**data rate**	reschedule, stop or resume download
	**Hazardous Location Warning**	**reliability, coverage**	change driving properties, detour

Live Demo by DT

- Predicted QoS on two road segments between Munich and Ingolstadt at Monday 5:00 PM



Source: DT

Poll

- Question:
  - When would you expect Predictive QoS to be widely available in mobile networks to further enable advanced driving services?

- Answer alternatives:
  - Before 2025
  - 2025-2030
  - After 2030
  - Never

Predictive QoS is Widely Recognized in the Industry

- **NESQO (Predictable QoS and End-to-end Network Slicing for Automotive Use Cases)** defined the requirements and the architectural enhancements needed to support Predictive QoS in the 3GPP System, addressing both MNO-based and OTT-based predictions.
- **eNESQO (Enhanced E2E Network Slicing and Predictive QoS)** brings forward the results of previous WI NESQO, e.g., in the areas of Making Predictions, Prediction Function Location, Application and Network Reaction to QoS Prediction and proposes 6 areas of improvement for current 5G solution
- **MEC4AUTO (Multi-access Edge Computing Technology for Automotive Services)** studies the use of MEC in multi-MNO and multi-OEM scenarios. The WI evaluates support for In-advance QoS Notification (IQN) management in multi-operator scenarios, including a potential definition of a NESQO-Edge API.

- **ADAPT (In-advance/Predicted QoS Notification for 5G)** investigates usage of Predictive QoS for Industrial Automation.

- **SA1: TS 22.186** "Enhancement of 3GPP support for V2X scenarios" (Release 16) received 5GAA NESQO requirements on Predictive QoS
- **SA2: TS 23.288** "Architecture enhancements for 5G System (5GS) to support network data analytics services" (Release 16) defines the QoS Sustainability Analytics that includes QoS predictions. QoS-related prediction analytics also introduced in the context of other key issues.
- **SA2: TS 23.287** "Architecture enhancements for 5G System (5GS) to support Vehicle-to-Everything (V2X) services" (Release 16) includes procedure for V2X Application adjustment based on the QoS sustainability analytics.
- **SA2: TR 23.700** "Enablers for Network Automation for 5G – phase 2)" includes a key issue "NWDA-assisted predictable network performance" which addresses Predictive QoS topics.
- **SA6: TR 23.764** "Study on enhancements to application layer support for V2X services" (Release 17) includes a key issue (2a) about exposing potential QoS change procedure in TS 23.287 to dynamically provide/adapt the service operation and related QoS requirements for single or groups of UEs.

- **ETSI ISG MEC (Multi-Access Edge Computing)** has studied Predictive QoS for V2X as part of the completed study item on MEC support for V2X use cases, captured in the **ETSI GR MEC 022** V2.1.1. The resulting normative work on V2X Information Service API is ongoing and being documented in the **ETSI GS MEC 030**.

- **GSMA Generic Slice Template (GST) NG.116** V2.0 included **performance prediction** as one attribute for the capability of the mobile system to predict the network and service status.

- **5G-PPP 5GCroCo (5G Cross-Border Control)** within EU research program H2020 has the objective to test and validate advanced 5G features, including Predictive QoS.

Key Take-Away Messages

Predictive QoS …

1. **… allows applications to prepare for varying network conditions *well ahead***
2. **… is a *real need*, a requirement formulated by 5GAA Automotive Industry**
   - VW, Daimler, BMW, etc.
3. **… is now widely recognized in the industry and work is ongoing in major standards organizations and industry associations**
   - 5GAA, 3GPP, 5G-ACIA, ETSI, 5GCroCo, 5G NetMobil, GSMA, etc.
4. **… has basic foundation in place in 3GPP Rel-16 but key challenges remain**
   - Some gaps are identified for existing solution to evolve in Rel-17 and later.

5GAA is driving forward Predictive QoS together with key organizations such as 3GPP, ETSI, 5G-ACIA and 5G-PPP as a good example of cross-industry collaboration.

Companies contributing to 5GAA Predictive QoS work items.

Download the 5GAA White Paper to know more about Predictive QoS

https://5gaa.org/news/5gaa-releases-white-paper-on-making-5g-proactive-and-predictive-for-the-automotive-industry/

5GAA Automotive Association

Thank You!

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