ERICSSON

IMPROVING PUBLIC TRANSPORT WITH 5G

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Ericsson has built a prototype testbed for applying 5G networking functions and data analytics to public transport. One use case under study is to optimize the operations of a public bus service to save resources and reduce its environmental impact.[1] Using simulated traffic and passenger data, results indicate changing to dynamic bus scheduling is possible while maintaining service levels and reducing the number of buses on a route by an average of 15 percent. Additional gains are expected as the research progresses stepwise to include dynamic bus stops, flexible routing and vehicle platooning

In the future, where mobile broadband will co-exist with critical network services such as those used to optimize public transport, a service isolation approach will be essential to guarantee QoS. Depending on their criticality, services may have different network requirements. For example, emergency response or traffic flow services require priority over infotainment. The primary aim of the research is to test the viability of 5G network functionality to enable the automation of service creation, allowing the economic deployment of thousands of mobile services with diverse Quality of Service (QoS) attributes. The ability to secure prioritized network resources even in high network traffic scenarios allows the 5G system to be used as a foundation on which to build urban transport optimization solutions.

5G beyond mobile broadband services

5G mobile networks will offer significantly higher throughput, lower latency, and more data capacity compared to previous generations of mobile networks. Beyond improvements in mobile broadband services, 5G is about catering for a rapidly widening range of use cases related to the Internet of Things (IoT). 5G is envisioned to deal with complexity in the network as services beyond voice and mobile broadband are integrated. Operators will be able to provide virtual network slices, each with their own set of performance characteristics to offer optimal support for different types of services for different types of customer segments.

Growing urban traffic challenges

The urbanization of the world's population is forecast to continue during the next few decades. There will be many challenges for cities in the future, including dealing with increased traffic congestion, and decreased quality of life due to longer commute times. Dense urban mobile coverage can provide ubiquitous connectivity, opening up opportunities to improve public transportation, resulting in reduced congestion and increased availability. Vehicles that interact with each other and with roadside infrastructure may improve traffic flow and increase safety for both vehicle occupants and pedestrians.

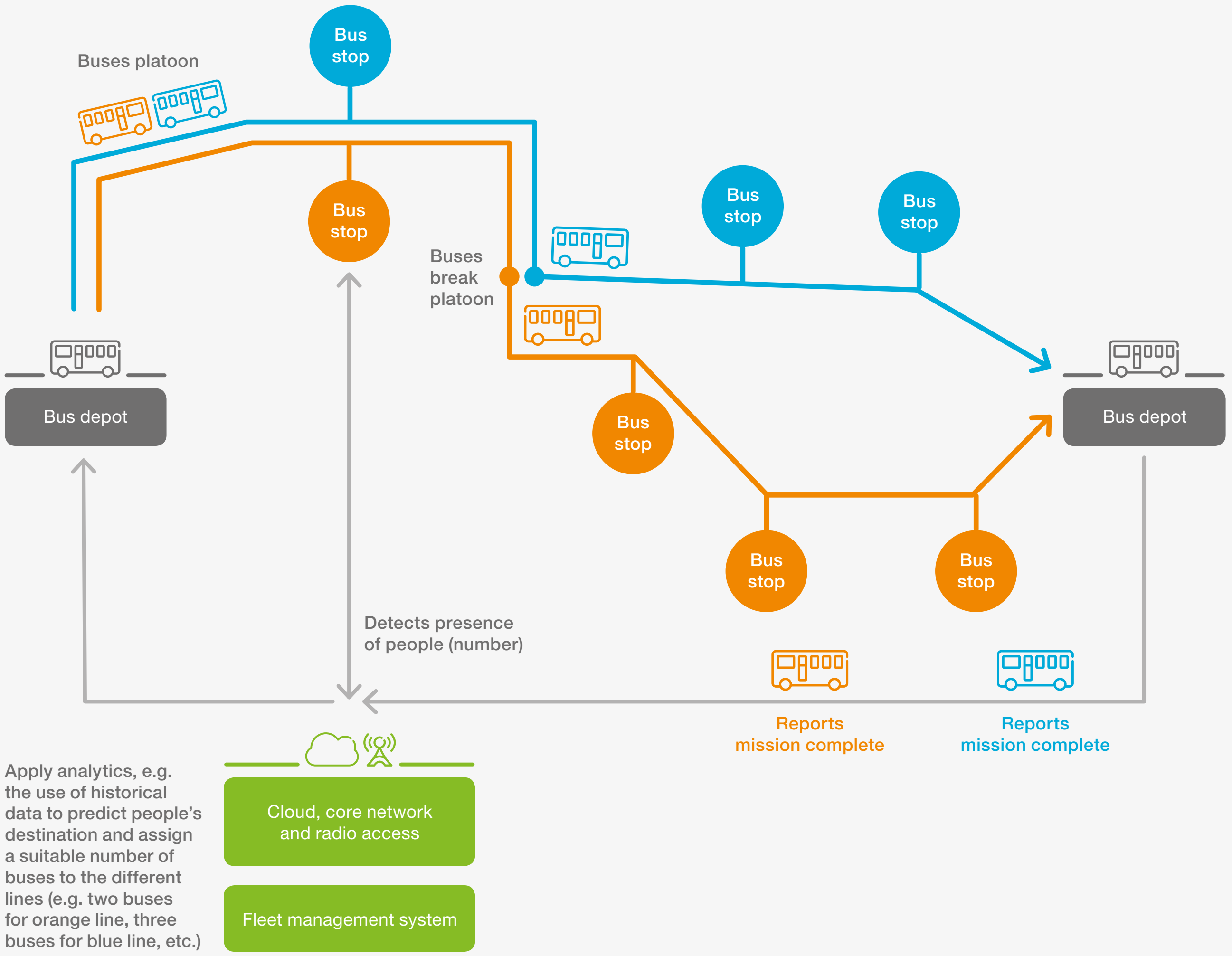
The optimization of urban traffic flows will be enabled by reliable connectivity combined with data analytics. Vast amounts of data and information from a large number of heterogeneous devices will need to be exchanged, analyzed, combined and actioned upon in a secure way, creating a complexity that goes far beyond the capabilities of human management.

As mobile technology evolves toward 5G, network services with mission-critical data traffic, such as instructions sent from a cloud service to a driver or to an automated vehicle, will coexist with other types of network services (e.g. web browsing and media streaming). The 5G network enabling the connectivity will guarantee QoS for the critical data traffic by prioritizing it over non-critical data traffic.

Ericsson has joined forces with Scania, one of the world's leading manufacturers of trucks and buses for heavy transport applications, and Sweden's Royal Institute of Technology in their Integrated Transport Research Lab (ITRL) to explore future transport solutions

[1] "5G for Improving Urban Transport", Leonid Mokrushin, Rafia Inam, Elena Fersman, Hongxin Liang, Keven Wang, Athanasios Karapantelakis, www.ericsson.com/research-blog/5g/5g-for-improving-urban-transport

Automated vehicle fleet management



Smarter public transport is possible through data analytics and connectivity

Public transport is efficient and sustainable, but also relatively inflexible today. Cities around the world are now exploring intelligent transport systems (ITS) to improve commuting by using demand prediction, dynamic trip planning and integrated payment solutions. ITS continually analyzes commuting patterns and takes into account upcoming sports events, concerts or road maintenance projects. Adaptive ITS provides real-time recommendations to drivers and passengers, thus offering a more compelling service at a lower operational cost and reduced environmental impact.

Traffic authorities can also benefit from using data provided by ITS (such as location, speed and intended route) to improve urban traffic flow by optimizing traffic signals. Various strategies such as traffic signal preemption can be applied to prioritize public transport and emergency vehicles.

Vehicle platooning optimized by 5G networks

Vehicle platooning creates a convoy in which vehicles travel in line very close to each other, coordinating breaking and acceleration. This increases road capacity, and, in the case of urban transportation, can help address commuting demands at peak hours while reducing marginal cost. Dynamically adding driverless buses into a route to meet additional passenger demand is an attractive situation for fleet operators, as the cost of a driver is typically the largest operational cost.

5G mobile networks can enhance this by enabling platoons of multi-vendor vehicles, and connecting platoons to roadside infrastructure, such as traffic signals. Using a common interface for dynamic forming and decommissioning of a platoon, supported by a 5G network, vehicles could join and leave the platoon at any time. Platooning is an example of a service class that would benefit from automated service lifecycle management.

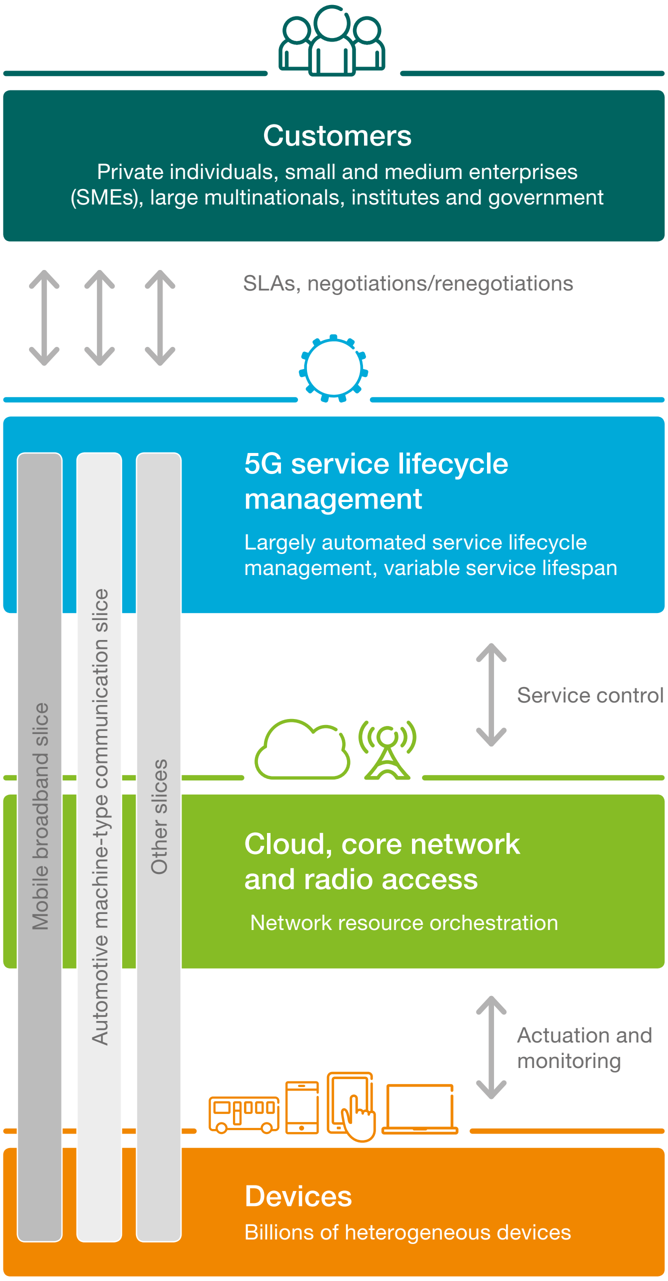
Automated service lifecycle management – a key 5G functionality

The current generation of mobile networks was designed to support a limited set of long-duration telecom network services (e.g. voice, messaging and mobile broadband). As a result, service lifecycle management is often handled manually. In addition to well-defined, long-standing traditional telecom services, 5G opens up the possibility of having many services that vary in terms of duration and QoS requirements. The management of a large number of network services with different QoS requirements will increase complexity enormously. Therefore, 5G networks will have an automated service lifecycle management function. Automation of the network service lifecycle management function, from negotiation of a Service Level Agreement (SLA), to network service deployment and operation and eventually decommissioning, is a key requirement in the design of 5G systems.

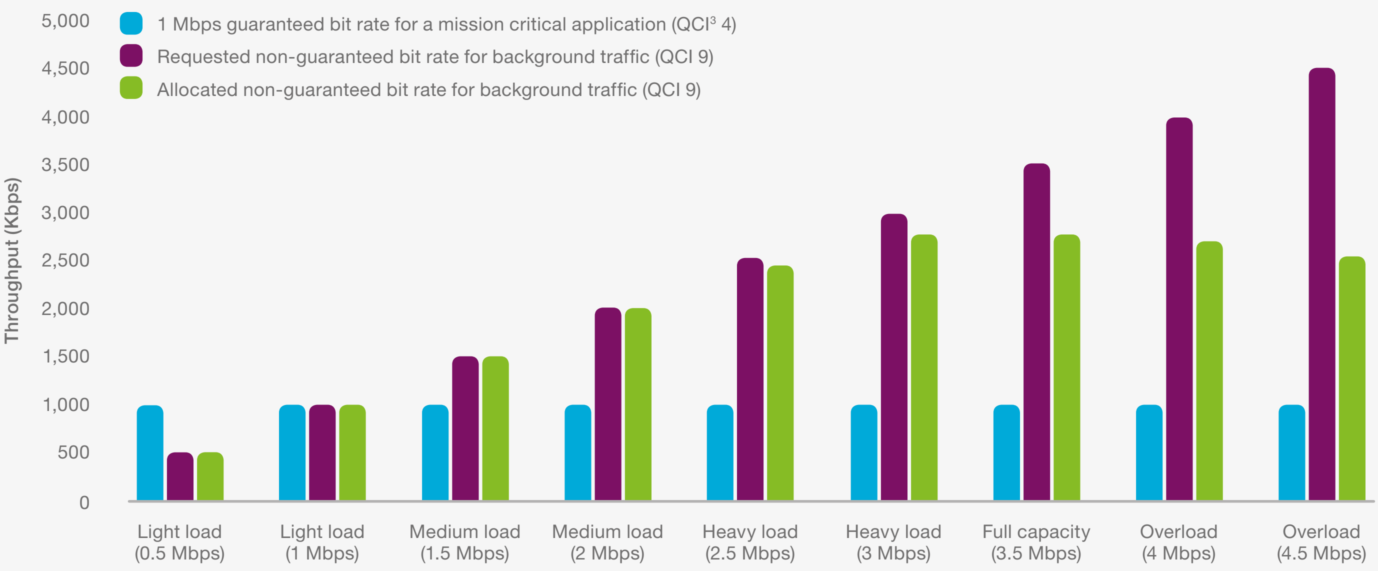
As services in the future will have different requirements on the QoS from the supporting network infrastructure, more focus will be placed on how these services are ordered from customers, i.e. the Service Level Agreement (SLA) negotiation process, as well as how the network resources are orchestrated per service. For example, a service may need a specified minimum bandwidth, along with a maximum latency to function properly. The SLA captures the QoS requirements, which are then monitored and controlled throughout the lifecycle of the service. In order to deal with the complexity and to achieve the economies of scale necessary to handle hundreds or even thousands of services, provisioning in 5G networks needs to be automated.

Resource prioritization is a technique to allocate the required network and cloud resources (e.g. radio, processing, memory, and storage) in order to provide the functionality and characteristics of a dedicated network, while actually utilizing only a portion of the available network resources. Services are isolated by allocating resources in such a way as to fulfill respective QoS requirements. This facilitates the addition, updating, or removal of services in real time, as well as the dynamic mapping of different network resources to services.

5G network slicing



Data traffic (uplink) throughput[2] under different network loads for different priority classes



5G network test bed measurements

To explore the optimization of public transport systems, a prototype 5G system for automating network service lifecycle management has been developed. Network service deployments include both deployment of software in a private cloud as well as configuration on a core network to comply with the QoS requirements of the network service.

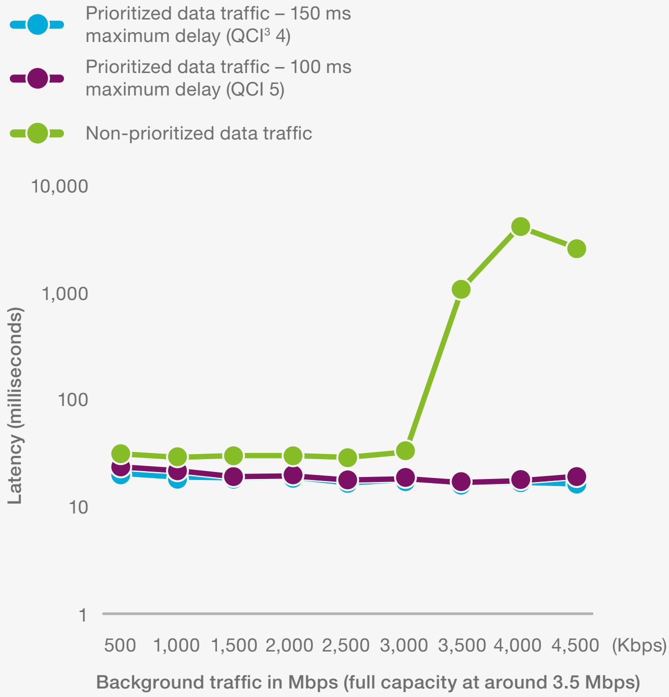
The system is able to deploy, monitor and decommission network services automatically on request. For measuring performance of the traffic prioritization function, a number of network load scenarios have been tested. Throughput as well as end-to-end network latency were measured under different background traffic conditions.

Resource prioritization test results

The first graph illustrates guaranteeing an uplink throughput of 1 Mbps to a prioritized radio bearer for a mission critical application. Background traffic is increased until the system is congested. The measurements show that even as the network becomes overloaded with traffic, the mission critical traffic is still served with no performance degradation. Furthermore, the second graph shows that when the network reaches congestion level, background traffic is delayed while latency of the mission critical traffic is still preserved.

Network resource prioritization can assure pre-defined QoS levels for mission-critical applications regardless of the level of background data traffic

Two-way latency (RTT) under different network loads for different priority classes



[2] Between user equipment and network test bed using different bearers
[3] The QoS concept as used in LTE networks is class-based, where each bearer type is assigned one QoS Class Identifier (QCI) by the network. QCI in LTE networks enables the association of relative prioritization among interactive bearers

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Our services, software and infrastructure – especially in mobility, broadband and the cloud – are enabling the telecom industry and other sectors to do better business, increase efficiency, improve the user experience and capture new opportunities.

With approximately 115,000 professionals and customers in 180 countries, we combine global scale with technology and services leadership. We support networks that connect more than 2.5 billion subscribers. Forty percent of the world's mobile traffic is carried over Ericsson networks. And our investments in research and development ensure that our solutions – and our customers – stay in front.

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