Always green for emergency vehicles

A modern traffic signal preemption system is expanding in Finland. At this moment the concept and the source code are owned by local authorities in the Oulu region and shared openly with other authorities. The HALI system has potential to become a standard-like function.

Summary

Priorities for emergency vehicles are a much-wanted function and have many benefits related to safety and efficiency. It’s possible to provide fully automatic, comprehensive and affordable preemption in all traffic signal controlled intersections with generic technologies. The authorities in the Oulu region, Northern Finland, have planned and acquired a system that is expanding in Finland as an open system for authorities. The so-called HALI system has potential to become a standard-like function since it works very well, is quite easy to implement and is very cost efficient.

There is a definitive need for emergency vehicle priorities

Traffic signal priorities for emergency vehicles are not a new concept. They have been used all over the world for decades and people generally expect those. Still priorities, which are also known as preemption, usually cover only the main routes away from fire stations and many cities don’t have any. This probably has something to do with implementation costs, lacking human resources and challenges in co-operation needed from several different organizations, but also with the benefits being unknown and spreading mostly to parties not paying for the system.

With generic technologies a fully automatic and comprehensive preemption system to a medium sized city can be built with costs less than one serious accident and the costs will be significantly lower in the future. In Finland there are about 20 accidents for emergency vehicles per year in traffic signal controlled intersections and almost always the emergency vehicle ran a red light. Average accident costs per year are more than 4.000.000 euros. Still about 80% of the benefits come from more efficient rescue and police services where every second counts. The return on investment for preemption even on a national level would be very high and the benefits would spread to the whole society.

A new concept has been developed in Oulu

The City of Oulu is a 200.000 inhabitant provincial center located in Northern Finland. Oulu has had traffic signal preemption since the 1980’s. First the preemption was turned on from a switchboard in an emergency response center and later from a graphical user interface. Only main routes were included and priorities were a lot longer than actually needed because of human interaction and controlling many intersections at the same time. In early 2000’s the emergency response centers in Finland were re-organized and the duty officers could not be used for manual preemption any longer. The idea of fully automated and comprehensive preemption is from the year 2004. The technology was not ready then for a cost effective implementation and a temporary fix was made to control manual preemption from vehicles touch screens by using an intelligent routing tree.

Since a suitable commercial product was not found, the authorities planned a system and the so-called HALI system was piloted in 2008 with few intersections. The company that built the pilot system was given a chance to make a commercial product of the system, but it didn’t take the bait. In 2010 tenders for a region wide system were requested as public procurement and in 2013 a system covering 160 intersections and 30 vehicles was ready. The system cost about 215.000 euros and additional costs were about 160.000 euros. Maintenance costs are currently only about 10.000 euros per year with an even bigger system.

HALI works very well giving automatic
green in all of the intersections and directions. Also traffic cameras are integrated to the system recording all priorities in the main intersections and showing a real time video stream to a traffic management centre.

So far no accidents have happened to vehicles using HALI and the drivers have been very pleased with the system. The negative effects for other traffic are limited since the preemption is stopped as soon as possible and the traffic signal controllers return quickly to normal function. Also the extra green is usually given to the main directions with most traffic. According to an impact evaluation the system has paid itself back in less than a year.

The authorities own the HALI concept and the source code. One of the main ideas was to build a system that could be expanded to whole Northern Finland. In 2014 the system covered two regions with 200 intersections and 100 vehicles. By the end of this year the numbers are about 300 intersections and 200 vehicles with two central systems. So far more than 30 organizations have taken part to implementing or using the system of which 11 are cities or municipalities, 1 provincial road authority, 9 emergency authorities and the rest different kinds of private companies.

Generic technology and a relatively simple concept

The current HALI system works with separate vehicle devices, which are basically programmable 3G modems with a use panel, a connection to the vehicle CANbus, a separate antenna and some cables. Most of the intelligence is in server software, which sends on and off commands to programmable I/O logics at traffic signal controller cabinets. The logics send relay data to the controllers I/O inputs. HALI works basically with any traffic signal controller as long as there are good quality communications available at the controller cabin. There are plans to start using the controller software inputs with proxy software from different vendors, but it still needs some development.

With the current system preemption is turned on while emergency lights are on and stopped by turning the preemption or the emergency lights off or using hand brake or park gear. The vehicle devices mostly send simple status data as often as possible. Central software in the server side receives vehicles satellite positioning and controls data and makes smart decisions to start and stop priorities on the probable route of the vehicle. The next intersections are forecasted early enough to get a fluent green traffic signal after the longest minimum green and safety time of a conflicting direction or pedestrian crossing. Intersections at crossing streets are forecasted by the use of a turn signal. Cur-

Figure 1: The HALI system gives automatic green traffic signals for emergency vehicles in Finland.
currently the distances where to start the pre-emption are calculated with driving speeds of 120 km/h on main roads, speed limit + 40 km/h in urban areas and 60 km/h in city centres.

According to a research commissioned by the Foundation for Finnish Inventions HALI is not breaching existing patents and the method could possibly be patented. But a patent would not be a strong one because the system uses generic technologies and the concept is very public by nature.

An open system for authorities that has started to scale-up

In the next few years at least seven cities from four more provinces in Finland are going to implement HALI. Finnish fire chiefs have stated that HALI is a wanted feature in all of Finland. A possibility to use HALI with new traffic signal central systems has become a quite common requirement. A national pilot for Police is on going in Oulu right now and the results have been very promising. Before that only fire trucks and ambulances got priorities.

So far the home base for HALI has been a consortium of three authorities: the City of Oulu, Oulu-Koillismaa Department for Rescue Services and the Northern Ostrobothnia Centre for Economic Develop-

The interfaces need to be open so that HALI could be integrated to different vendors’ existing products and no vendor locks can form. Also the companies benefit from a new-networked business model when there is more customer demand than with several proprietary systems that work differently.

Some ideas for the next steps and potential risks

The next HALI version is going to be mainly software. The emergency vehicles already have in-vehicle computers that can be used to send position and controls data. Also the communications are probably more resilient than with additional devices since quite often more than one wireless network are being used. This is a significant reduction on costs. The other cost reduction is using software interfaces to the traffic signal controllers. The current programmable I/O logics are basically only proxies and can be replaced with central proxy software. Older controllers can still be used with I/O logics. A third cost reduction is to make the system cover a larger geographical area – even a whole country. The savings are both in implementation and maintenance. It is hard to figure a more cost efficient way of providing preemption – almost free software, easy implementation and very low costs in usage.

The biggest risks with HALI are service interruptions with the wireless communications or satellite positioning. If the vehicle data doesn’t reach the server or if it is unusable the preemption won’t work. The interruptions are fortunately very rare and can be made rarer by using more than one communication network and satellite positioning system. Also new promising technologies could be used such as Galileo PRS or emergency service-oriented LTE networks. There are some concerns about hacking the system that are taken into account cybersecurity wise and will be done even more so in the future. Also some privacy and public safety issues have been raised. More congested streets and city centers with higher urban canyons (taller buildings) might be risks too and it would be good to pilot the system in a really big city. At this point the risks seem to be manageable and the system works very well.