Experimental Laboratory Testbed for Mobile Robot Applications over IP Networks

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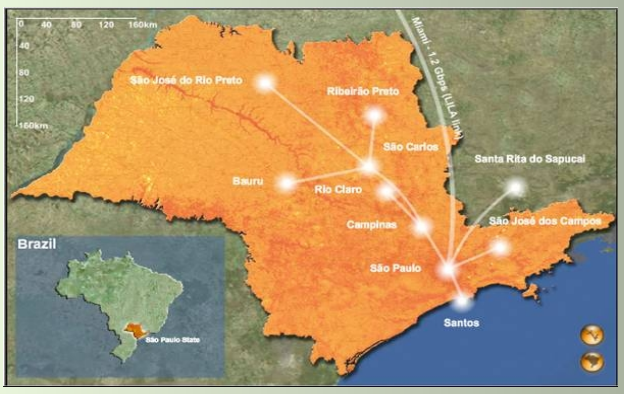
Abstract

This poster presents the experimental laboratory testbed implemented for control of mobile robots in real-time through an IP/MPLS (Multiprotocol Label Switching) network. It is being developed in the context of the Kyatera Project at São Paulo State in Brazil. In our Lab (LACE – Automation and Evolutive Computer Laboratory - UNESP), which is connected to other labs of the Kyatera network, we are implementing a GMPLS control plane using an open source software from NSF (National Science Foundation) named DRAGON as a basis and adding new functionalities on it for control of mobile robots, using a high speed network backbone .

Kyatera Network

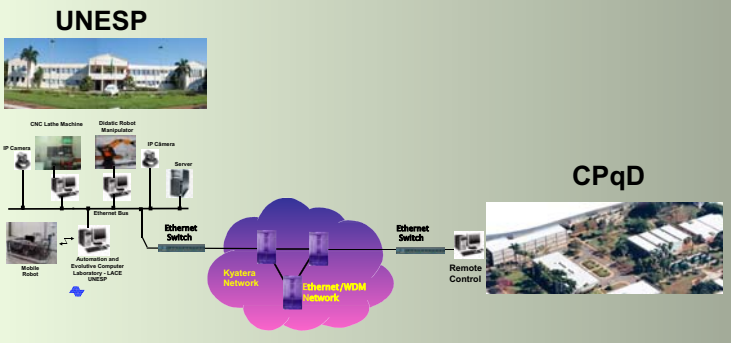
Kyatera is a network of researchers interconnected through a fiber-to-the-lab optical network dedicated to research, working remotely from their institutions in a cooperative way. “KyaTera” refers to our high speed network (Kya = “net” in Tupi-Guarani, one of the languages of the aboriginal people in Brazil; Tera = from Terabits per seconds) [1].



The main objective of our project is to provide the remote control of a mobile robot platform, using Kyatera Network to receive data of the sensors (ultrasound, infrared, Computer Vision Cameras, etc.) and to send control data signals to the actuators (dc motor drivers, etc). The backbone of the KyaTera Network was designed to have some features of a MAN (Metropolitan Area Network) such as:

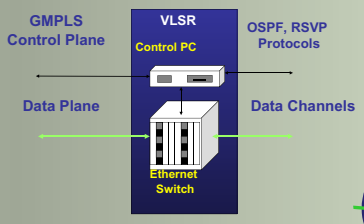
- it is an optical, high speed network, packet network (Gigabit Ethernet);
- it interconnects LANs (Local Area Networks).

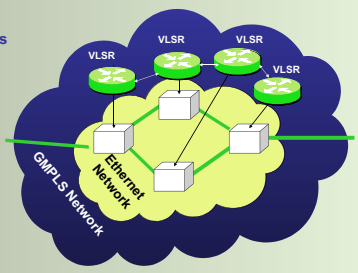
Deploying Gigabit Ethernet in the metropolitan and wide area network is a compelling and commercially proven approach to break the bandwidth bottleneck due to cost effectiveness, rapid provisioning on demand, packet-based and easiness of inter-working.
The Kyatera Network connects (between others cities and institutions) the cities of Campinas (CPqD) to São José do Rio Preto (UNESP) through an optical link (342 km) equipped with 1xGbE. This link is connected to Ethernet switches in the local area network of the CPqD and UNESP.



GMPLS Control Plane

In order to improve Ethernet switches with bandwidth reservation and QoS, both necessaries to better control mobile robots, a GMPLS (Generalized Multi-protocol Label Switching) control plane was added to Ethernet switches in the local network. This joining gave rising to a new element named VLSR (Virtual Label Switch Router). The network architecture consists of a mesh topology with off-the-shelf low-cost Ethernet switches in the core and on it, Linux PC routers enhanced with GMPLS control plane (VLSRs).

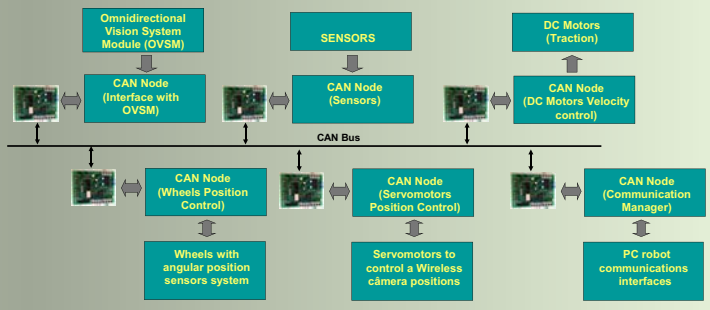




This GMPLS control plane was implemented using open source software from NSF (National Science Foundation) named DRAGON [2] as a basis and new functionalities will be added on it to real time control of mobile robots. The use of IP/MPLS network to implement control network is very attractive due to shared infrastructure, resource reservation and controlled QoS.
The mobile robot control platform is based on a CAN (Controller Area Network Protocol) protocol bus, in which nodes with specific functions are connected:

- Control Nodes, that implement the control strategies of the robot movements (autonomous displacement, obstacles avoidance, goal seeking, etc.);
- Sensor Nodes, that capture input signals to the robot control (ultrasound sensors, infrared sensors, odometry, etc.);
- Communications Node, that provide data communications tools to the CAN bus with the PC (Personal Computer) installed in the robot.

This control structure is showed bellow.



Results and Roadmap

The GMPLS control plane was already introduced and the network infrastructure is being tested. The next step is connect the robot control platform to the IP/MPLS network and control it from CPqD laboratory. The roadmap of our project includes the implementation of a convergent mobile robot and wireless sensor networks including concepts of autonomic communications, required for the future Internet.

Acknowledments

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References

[1] Kyatera project: http://kyatera.incubadora.fapesp.br/portal/kyatera-1/view?set_language=en
[2] Dragon (Dynamic Resource Allocation via GMPLS Optical Networks): http://dragon.maxgigapop.net/twiki/bin/view/DRAGON/WebHome