Revitalization of information systems by using Long-Reach Ethernet technology

Adam Stančić B.Eng., Ivan Grgurević B.Eng.

***Abstract* — Removal, upgrade and revitalization of old traffic information infrastructure is very expensive and demanding task. Long-Reach Ethernet technology provides utilization of the copper pairs infrastructure as the digital data and voice transportation medium. Voice and data travels simultaneously with symmetric rate 5-15 Mbps and distances 100 – 1.500 m without losses.**

***Keywords* — Old infrastructure, Long-Reach Ethernet, revitalization, information system, video surveillance.**

I. Introduction

Modern traffic equipment, assets, infrastructure and facilities are prepared to utilize ICT technology. Development and usage of traffic assets began more than hundred years ago. Such old infrastructure is unprepared to utilize modern technology and provide many services. Replacement or revitalization of the old infrastructure may be very expensive and requires major efforts and interventions. Sometimes rewiring, new ICT infrastructure or wireless technology cannot be implemented due to certain obstacles and before mentioned large costs.

Old telephone infrastructure can be used as digital data transportation medium by using Long-Reach Ethernet (LRE) technology. LRE enables transportation of the analog voice signal and transfer digital data simultaneously over existing copper pairs. Main disadvantage of LRE technology is decrease of bandwidth with distance. LRE technology allows communication and data transfer range longer then typical UTP (Unshielded Twisted Pair) infrastructure. This article will explain basics about LRE technology and how it can be implemented inside the traffic information system.

II. Objective of research

As is mentioned before, old traffic infrastructure and facilities are not prepared to receive and implement modern ICT equipment and infrastructure. On the other hand it is poor decisions to retain "ICT unreachable pockets" in traffic company information system. Rewiring, cabling and wireless infrastructure may help us, but it is very expensive because of the previously laid infrastructure. Problem becomes more complex if you need to connect several locations in one integrated information system. The underground and above ground infrastructure, neighboring buildings, auxiliary facilities, workshops, traffic routes, moving machinery and crowded working surface represent a great obstacle.

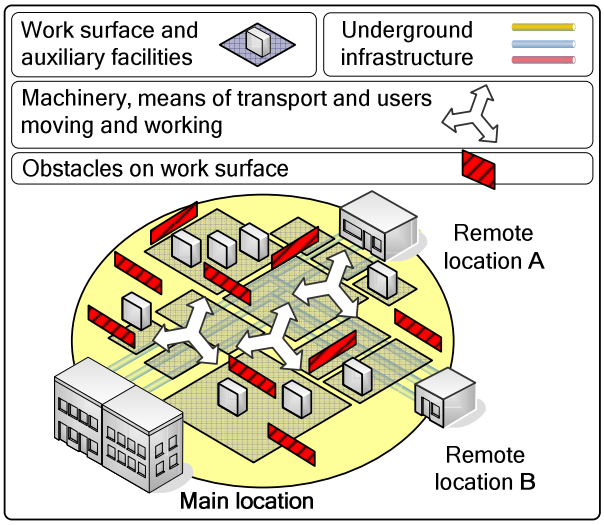

Fig. 1. Possible location obstacles and constraints.

Implementation of wireless local area network (WLAN) can easily bypass problem of inappropriate wire infrastructure. WLAN also has sufficient transportation capacities and acceptable implementation expenses. WLAN technology has weak security and reliability, signal interference, congestion avoidance problems, variable network speed and range. Enhanced wireless solutions are very expensive. Optical visibility between company's locations is the main condition for efficient utilization of WLAN. In some cases optical visibility varies due to means of transport moving or cargo deploying and warehousing. WLAN signal is very sensitive to electromagnetic and atmospheric interference. Because all said WLAN technology is not appropriate solution for revitalization of the ICT system.

Regardless of the age of the buildings and facilities, it is likely that they have an internal telephone network in place. Private branch exchange infrastructure connects main location with all remote locations. Internal telephone network is also connected to the public switched telephone network (PSTN).

Adam Stančić, Ultra d.o.o, M. Laginje 1, 47 000 Karlovac, Croatia (telefon: 385-47-645511; faks: 385-47-645506; e-mail: adam.stancic@gmail.com).

Ivan Grgurević, Fakultet prometnih znanosti, Vukelićeva 4, 10 000 Zagreb, Croatia (telefon: 385-1-2380225; faks: 385-1-2314415; e-mail: ivan.grgurevic@fpz.hr).

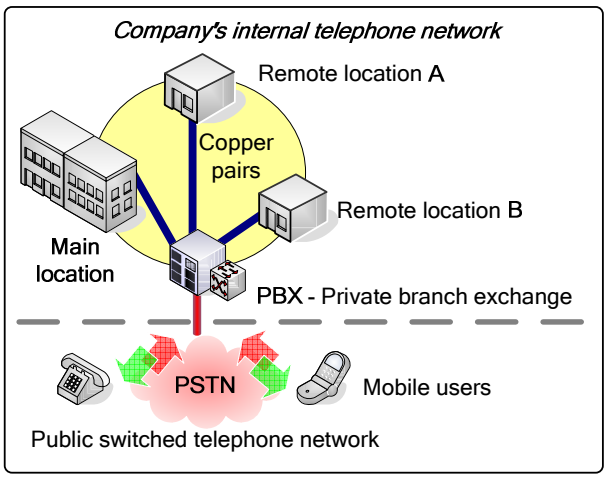

Fig. 2. Internal telephone network and PSTN.

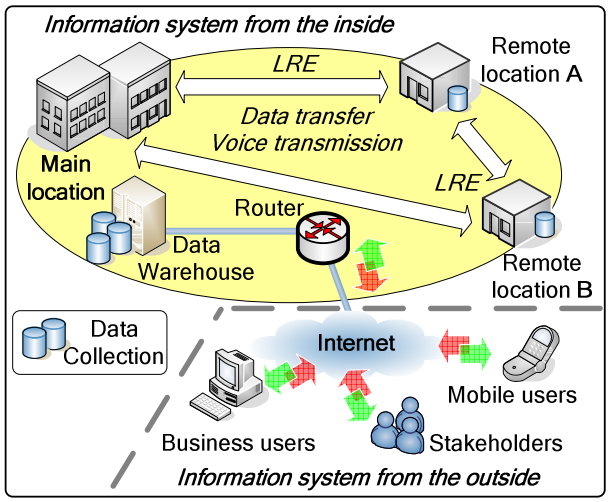

Fig. 3. Traffic company's information system.

Usage of the internal telephone infrastructure largely impacts the IT system revitalization expenses. Researchers tried to find answers to the question of delivering a mix of data and analog phone signals. LRE technology support data and voice travels over a local telephone network without requiring any rewiring of the infrastructure. The Cisco (LRE) broadband networking solution is the first end-to-end product line for delivering 5-15 Mbps performance over company's existing internal telephone network with performance that reaches up to 1.500 m.

III. Revitalization of Traffic Information Systems

Construction and implementation of the integrated information and telecommunication system inside company contributes:

- Faster and more efficient information exchange, briefing and remote access;
- Company's centralized database, security, archiving, surveillance and management system;
- Efficiency of entire business system by using: Business Intelligence (BI), Enterprise Resource Planning (ERP) and Customer Relationship Management (CPM) systems;
- Integration, coordination and supervision of larger number of users, processes, flows and activities;
- Web access, video and IP telephony services.

Revitalization of traffic and transportation company's information system must deal with certain conditions such as:

- Utilization of currently installed ICT infrastructure;
- Data transmission on larger distances;
- Data security during transmission;
- Network congestion control and avoidance algorithms;
- Network scalability and robustness;
- Acceptable costs of implementation.

IV. Long-Reach Ethernet Technology Properties

Long-Reach Ethernet technology was committed to provide high-bandwidth service to multiunit facilities such as business, commercial, hotel and residential buildings. The current local area standards mostly use UTP cables. Basic disadvantage of UTP is that the (single branch of the) local area network is limited to 100 meters distance. LRE technology overcomes the shortcomings and enables much higher distances between nodes:

Table 1: LRE bandwidth and distance relationship.[1]

Bandwidth	Rate	Distance
5 Mbps	Symmetric	~ 1.5 km
10 Mbps	Symmetric	~ 1.25 km
15 Mbps	Symmetric	~ 1 km

The condition of copper pair wiring varies from location to location. LRE uses Quadrature Amplitude Modulation (QAM): QAM-256, 128, 64, 32, 16, 8 and 4. Different modulations are used according to line specification and to achieve performance as close to the physical limit as possible.

By using internal telephone network inside building and remote location it is possible to bring LAN connection to the computers of all users. The LRE system requires three main components: Customer Premise Equipment (CPE) unit, Plain Old Telephone Service (POTS) splitter and Long-Reach Ethernet switch.

Customer Premise Equipment (CPE) Unit: device includes two standard RJ-11 ports and one RJ-45 port at the side of the user. One RJ-11 sockets will be connected to the telephone of the user. The other socket will be connected to the telephone wire in the wall jack. RJ-45 Ethernet port will be connected to the Ethernet card of the user's computer. Analog phone calls will be transmitted without any changes. Digital data will be modulated and send thru the same copper pairs as a phone call on higher frequencies. CPE unit supports POTS, ISDN and digital phone traffic.

Plain Old Telephone Service (POTS) splitter: enables coexistence of Long-Reach Ethernet technology and plain old telephone service on the same telephone line. Voice and data travels through the PBX system simultaneously, POTS splitter separates them on their destination.

Long-Reach Ethernet (LRE) switch: Switch accepts and sending digital data from LAN to POTS splitter and vice versa. Data transmission rate depends on the distance between remote destination and company's main location. LRE may have additional properties such as IEEE 802.1Q Virtual Local area Network (VLAN) standard, port aggregation and implementation of user's Access Control List or ACL. Simple Network Management Protocol (SNMP), telnet and remote monitoring (RMON) software provides constant and efficient LRE switch management.

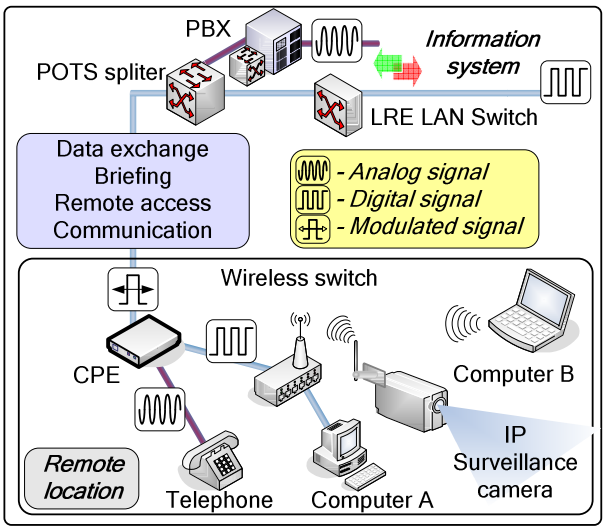

Fig. 4. LRE system components and connected equipment.

Long-Reach technology is especially suitable in following situations:

- Installation of new ICT infrastructure is very expensive and/or hardly feasible (large old buildings and facilities);
- End-to-end distances exceed 100 m due to UTP cable limitations;
- Requirement for symmetric data rate;
- Remote and separated locations, terminals, centers, objects and facilities where installation of new ICT infrastructure is very expensive and/or hardly feasible.

Next figure represents how Long-Reach Ethernet equipment is connected:

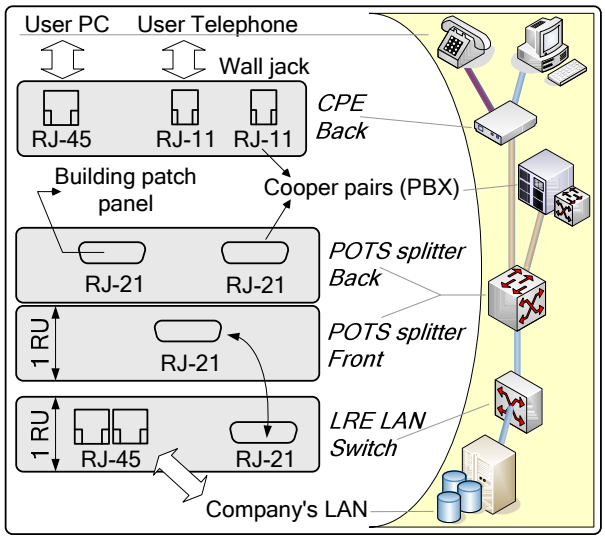

Fig. 5. LRE system equipment connectors.

V. Examples of Implementation

Long-Reach Ethernet is suitable for transfer of large amounts of data between many spatial dispersed locations. Distance between them should be at maximum 1.500 m so that the LRE technology can ensure the transfer rate of 5 – 15 Mbps.

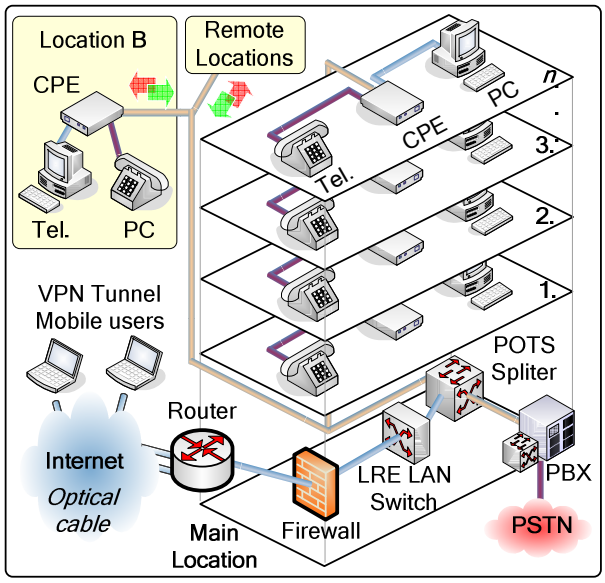

Fig. 6. Implementation of the LRE system inside building and/or facilities.

Long-Reach Ethernet was primary aimed to serve as an upgrade for residential, commercial or business buildings UTP infrastructure. The purpose is the upgrade of old ICT infrastructure or use currently installed telephone infrastructure to gain higher data transfer rates and distances.

This solution is appropriate to get access to optical cable infrastructure and broadband services - so called "last mile" access.

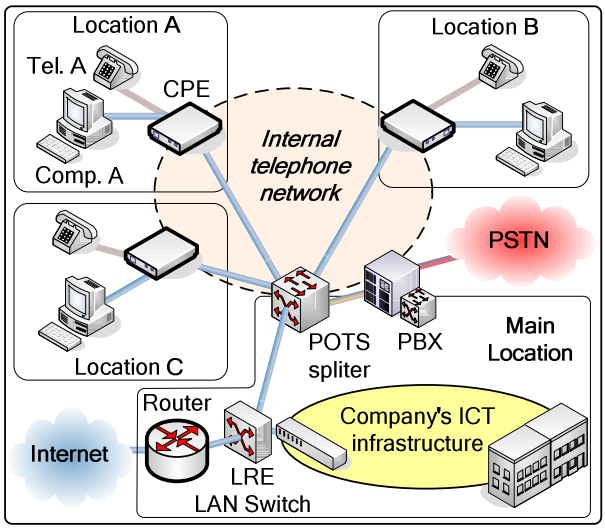

Fig. 7. Implementation of the LRE system on company's remote locations.

This paper is mainly focused on implementation of the LRE on company's remote locations. For example old railway terminal, seaport, logistics and distribution centers may have many spatial dispersed objects and facilities. Most of them are connected with internal telephone network. It is necessary to link all computers (and other installed equipment) on remote locations in one unique information system. Instead of deploying new infrastructure Long-Reach Ethernet uses currently installed copper pairs infrastructure as a data and voice transportation medium. In this way remote locations are connected to company's information system and Internet.

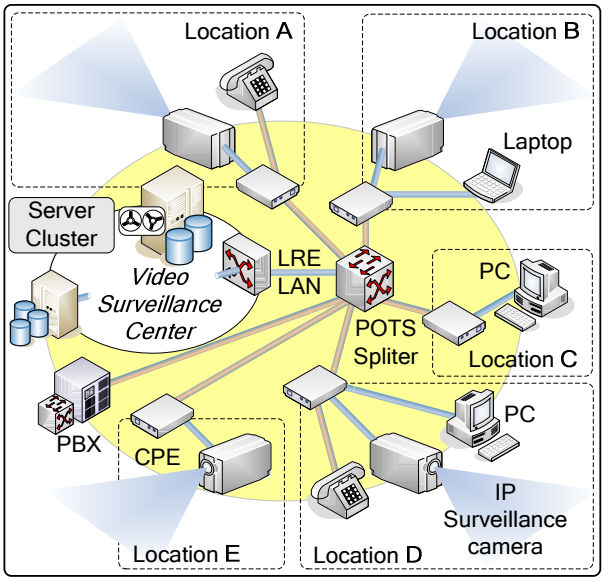

Fig. 8. Implementation of the LRE system as the video surveillance transfer network.

This example shows usage of the Long-Reach Ethernet as the video surveillance center data transportation medium. Deployment and installation of a new video surveillance equipment and infrastructure can become very expensive. IP surveillance cameras on remote locations send video digital data towards the center so LRE treats them as any other data inside company's LAN. CPE unit, POTS splitter and LRE switch may be configured to manage traffic by priority. Those data that are sensitive to delays, such as video and audio material, can have a higher priority.

VI. Conclusion

Based on presented facts and figures revitalization of information systems by using Long-Reach Ethernet technology we can draw the following conclusions:

- Utilization of internal telephone network infrastructure as a data transportation medium significantly reduces expenses;
- Analog and digital phone calls, ISDN, PBX traffic and digital data travel thru network simultaneously without interference;
- No network congestion, signal degradation and data loss;
- Overcome UTP distance limitations to 1.500 m with rate 5 Mbps;
- Easy and fast equipment installation;
- Web-based network and equipment monitoring and adjustments;
- Network scalability and robustness;
- Acceptable costs of implementation.

Literature

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