

# Consolidated Advanced Technologies for Law Enforcement Program

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**Abstract**— The Consolidated Advanced Technologies for Law Enforcement Program (CAT Program) is a collaborative effort between the University of New Hampshire and the New Hampshire Department of Safety. The program addresses related problems in the integration of electronic devices within police vehicles, and in the network communications integrating vehicles and law enforcement agencies, all of which impact the ability to seamlessly collect, interpret and exchange information in real time. Since the program was first funded in September, 1999, major technological changes have been put into place within the NHDS. All cruisers in the NH State Police have been provided with wireless access to standard state and national law enforcement databases. All new cruisers are being equipped with a unique voice actuated computer system which integrates the control of in-cruiser devices such as lights and siren, radar, and video, as well as performing voice driven data queries. In parallel to redesigning the in-cruiser environment, new server systems for NHDS headquarters operations have been specified and acquired with program funds. These server systems directly impact daily dispatch operations for the NH State Police and some local agencies, and they lead the way towards reducing paper records and automating the flow of law enforcement information within the state.

## I. INTRODUCTION

An original objective of the Consolidated Advanced Technologies for Law Enforcement Program (CAT Program) was to develop, evaluate, demonstrate, and finally deploy throughout the New Hampshire Department of Safety (NHDS) a highly integrated hardware/software system for law enforcement vehicles, called the Project54 system [1]. The Project54 system emphasizes both hardware and software interconnections based on industry

standards and open-interface specifications to maximize flexibility and to facilitate progressive upgrades and repairs. The system integrates general purpose computing facilities, voice and data radio communications, and special purpose devices such as radar, lights and siren, video units, and GPS units. The system software provides centralized control of the local devices. Multiple modes of user interaction have been provided for all functionality including voice-command input and feedback, touch screen LCD display and traditional keyboard and mouse. The system provides access to both local and remote data in support of typical public-safety applications such as license and registration checks, computer aided dispatch, vehicle navigation, reports/forms entry and so forth. The data system architecture being deployed in New Hampshire is being optimized to provide maximal functionality considering the low-bandwidth and possibly intermittent wireless data channels typically encountered in public-safety operating environments.

## II. BACKGROUND

Researchers at Texas A&M worked on improving the functionality of police cruisers using advanced electronics through the ALERT project [2]. The project addressed the need to integrate various electronic devices in police cruisers. However the project did not result in the acceptance of a standard for integration; rather it was a proof-of-concept effort. Wahab et al. worked on creating a dashboard system for intelligent vehicles that would be able to handle data and speech communication [3]. They paid special attention to combating noise in the car that interferes with voice communication. Muthusamy et al. created a prototype system for information retrieval in cars [4]. The system has a voice interface (input and output), and it can be used for voice dialing, Internet operations, and help with navigation.

Speech recognition in cars is of great interest to researchers as well as industry. An ambitious effort uniting car manufacturers, telecommunications equipment manufacturers, mobile telephone network operators, and universities is the SpeechDat-Car data collection effort. SpeechDat-Car collected in-car speech data from multiple languages [5]. The data is available in databases that can be

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used to improve the performance of speech recognition in cars.

In [6] Kun et al describe Version 1 of the Project54 system software. Version 1 of the software implemented a speech user interface. It was a modular system based on Microsoft's Component Object Model (COM). Version 2 of the Project54 software [7] allows one-to-one communication between modules of the software. This allows modules to cooperate, thereby enhancing the system functionality.

### III. PROJECT54 IN-CRUISER SYSTEM

#### A. Project54 Hardware

The major problem in integrating the control of the various devices in a police cruiser is that in general the devices are not designed to be connected to any type of shared data bus. Each device uses different (and sometimes proprietary) electronic signaling and needs a special connection to the computer. In order to control several different devices the computer must have several hardware interfaces and a web of interconnect wiring. Many agencies have seen this problem on a smaller scale when trying, for example, to connect a GPS, a barcode scanner and a data modem to a laptop computer which has only one serial port.

Our solution to this problem (Fig. 1) was to design low-cost interface boxes which sit between each device and an industry standard in-vehicle communications bus (CAN version 2.0B) [8]. CAN bus technology has a substantial track record of reliable performance in automotive applications and is the technology behind typical in-vehicle buses used by automobile manufacturers. The computer has only one connection to the bus (requiring only a single serial port on the computer) and can control up to 30 devices connected to the bus throughout the vehicle. The data bus is constructed using standard CAT-5 networking cables identical to those used to create networks of computers in offices. Thus, no hard-to-find cabling or special connectors are required.

The Project54 system is compatible with any standard computer running the Microsoft Windows 2000 or Microsoft Windows XP operating system, with standard Windows compatible audio input and output and a single serial (COM) port. In our installations in New Hampshire, we use a small commercial embedded PC module mounted in the center console (Fig. 2), along with a detached LCD touch screen and keyboard. However, a standard laptop computer with a touch screen, or a standard integrated mobile data terminal with separate keyboard, could be used as well.

The Project54 system is connected in parallel to each device's traditional control head and each device can be

activated and deactivated both through the standard control head and through the Project54 system. The Project54 system is capable of controlling each device, but the Project54 system does not take over control of any devices. Even while the Project54 system is turned off or while the operating system is first booting, each device can be activated and deactivated through its standard control head.

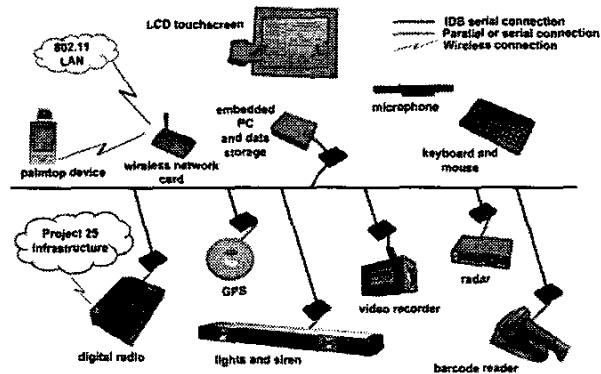


Fig. 1 Hardware outline

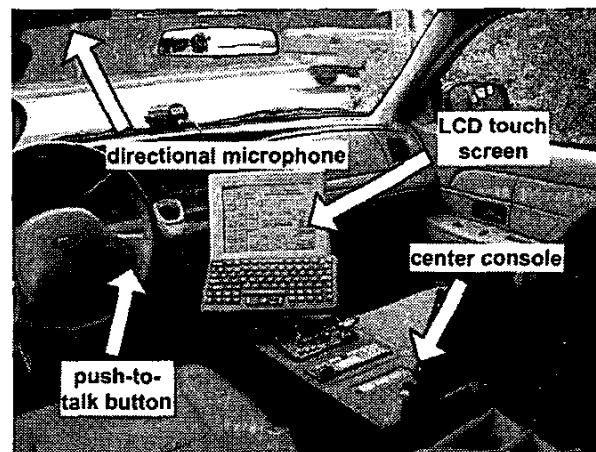
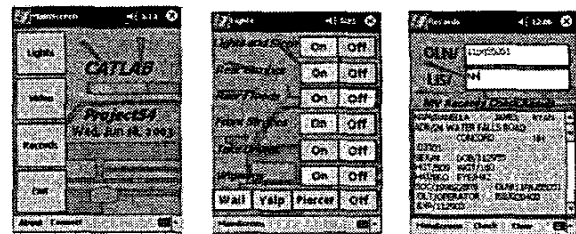
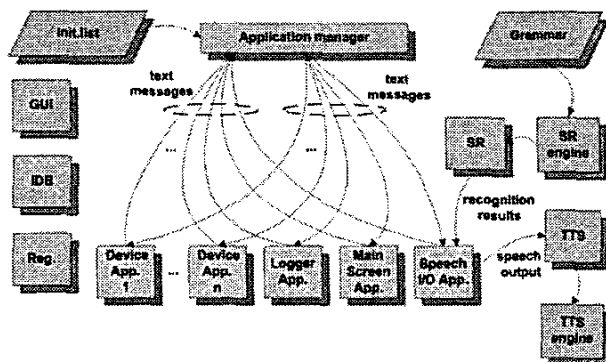


Fig. 2 Project54 system in a cruiser

#### B. Project54 Software

The Project54 in-cruiser software system was designed to be fully modular and configurable (Fig. 3), reflecting the modularity of the hardware architecture (Fig. 1). For each device that can be controlled by the software there is a corresponding application module. A mixture of application modules can be selected to meet the needs of each cruiser; matching the application modules to each individual cruiser's type of radar, lights and siren, video system, and so forth. This is valuable within a single agency, where different subsets of the fleet may be equipped differently, and is invaluable for making the same software useful across agencies, where equipment varies widely. If a piece of equipment is added or updated in a

Speech provides a hands off and eyes off means of communicating with the Project54 system while driving. Speech input and output for all applications is handled by a single module, which in turn interacts with the commercial speech recognition and text-to-speech engines. Individual applications handle speech as text messages received from or sent to the speech module. This greatly facilitates developing new applications which communicate via speech. For example, the radar application simply receives the text message "SPEECHIN Front Antenna Off" when the command "Front Antenna Off" is spoken by the officer. As another example, the data query application simply sends the message "SAYTHIS New Query Result Received" in order to notify the officer that the results of a previously submitted remote data query are now available. Since the individual Project54 applications are completely isolated from the speech recognition and text-to-speech engines, new speech engines from any vendor can easily be integrated to take advantage of the latest speech technology.



network communications. The Project54 system supports both classes of devices, maximizing the flexibility in the choice of PDA for a particular agency.

#### IV. INFORMATION MANAGEMENT AT HEADQUARTERS AND IN THE FIELD

A parallel major focus of the CAT Program has been on enhancing the flow of information within the NH Department of Safety. Before the start of the CAT Program, the real time information flow between headquarters and officers in the field was limited to voice communications over police band VHF radios (Fig. 5). Other than direct voice communications, the major pathway for the flow of information was on paper. Officers prepared and submitted paper field reports, paper tickets, and so forth. Dispatch operations were handled in a traditional manner. The on-duty dispatcher received calls and dispatched officers via verbal communications. Motor vehicle license and registration information, NCIC (National Crime Information Center) information, and so forth were computerized, but were only directly accessible by headquarters personnel. In order to obtain this information in the field, an officer needed to call headquarters, request the data query, and then wait for the query response, all performed via verbal communications between the officer and the dispatcher. NH State Police officers had laptop computers in their cruisers, but the use of these computers was largely limited to preparing field reports which could subsequently be printed and submitted in paper form.

##### A. State-wide Wireless Access to State Motor Vehicle and National Databases

One of the first goals of the CAT Program was to assist NHDS in creating a statewide wireless data access system for troopers in the NH State Police and the NH Highway Patrol. Prior to the beginning of the program NHDS had acquired and installed a statewide digital radio system capable of handling both voice and data communications. This digital radio system is compliant with the APCO Project 25 specification which is being promoted as a standard for law enforcement communications by both APCO (Association of Public-Safety Communications Officials) and by the federal government. However, at that time there were virtually no actual implementations of APCO Project 25 mixed voice and data in the nation, and no commercial software available to support mixed voice and data over APCO Project 25 compliant digital radio. To our knowledge, NHDS is still the only agency with a wide scale implementation of mixed voice and data over APCO Project 25 compliant digital radio.

It was thus necessary for UNH personnel to create both server side software and client software to support data queries over the data radio. The server side software was

necessary to buffer data packets to and from the mobile clients, isolating that traffic from data packets to and from the network data servers. This buffering is necessary because the radio system delivers data packets with transmission times measured in tenths of seconds, and response times measured in seconds; while the network servers deliver data packets with transmission times measured in millionths of seconds and response times measured in thousandths of seconds. Thus, using standard software to establish direct communications between the mobile clients and the network data servers would cause immediate time-out errors on the network servers and resultant communications failure.

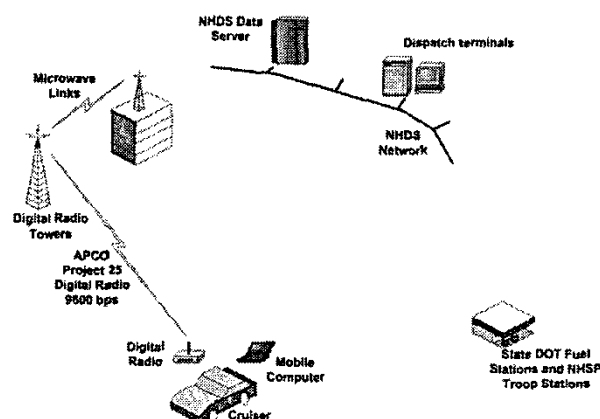


Fig. 5 Communications network before Project54

Essentially, mobile users log on to the mobile data server which was written by CAT Program personnel. This server software “understands” and compensates for the variable data packet timing of the mixed voice/data radio system: when no one is talking, data packets can be separated by as little as 0.5 seconds, while when there is heavy voice activity sequential data packets might be separated by several to many seconds. In addition, the custom mobile data server software must transparently handle incoming or outgoing data packets lost in radio transmission as mobile clients go in and out of radio coverage. The mobile data server in turn logs on to the standard network data server on the mobile user’s behalf, via the state wide-area network (WAN), so that the network data server always sees traditional wired network packet timing and reliability. The mobile server supports in-state and out-of-state motor vehicle checks, hazardous materials checks, and a variety of NCIC data checks (gun checks, wanted person checks, and so forth).

A major goal of the program was also to develop a new, voice actuated computer system for police cruisers (the Project54 system). However, it was anticipated that development and field testing of a reliable system would

take at least 2 years, and then agency wide deployment of the new system would take an additional 3 years. In order to provide wireless data query capabilities as quickly as possible, it was decided to develop traditional query client software that would run on the trooper's existing Windows 95 based laptops, which did not have touchscreens or audio input/output. This client software was designed to be compatible with the Project54 software in terms of query handling, but with only a traditional keyboard/mouse user interface. The mobile data server software was designed to be transparently compatible with both the traditional and new mobile data client query modules.

The first versions of the mobile data server and traditional mobile data client software were implemented by UNH personnel during calendar year 2000. Field testing occurred during the first half of calendar year 2001, and agency wide trooper training and deployment occurred during the second half of calendar year 2001. By the end of that year, the wireless data access system developed within the CAT Program was live agency wide and statewide. All NH State Police troopers then had access for the first time to wireless data from their cruisers. A subsequent major upgrade to the server software occurred in October 2002, supporting a variety of server activity monitoring and management functions. Broad deployment of the new Project54 client software began in June, 2003.

#### *B. Records Management System and Computer Aided Dispatch*

In another headquarters side effort, the CAT Program specified and acquired a commercial Computer Aided Dispatch (CAD) system for the NH Department of Safety, and interfaced it to the existing state infrastructure (Fig. 6). The CAD system automates call taking and dispatching functions, and provides for call mapping using digitized NH maps. It enables public safety dispatchers to quickly and easily record incident information while talking to callers and dispatching appropriate units to the scene. The CAD system is operational state-wide, handling dispatch functions for the NH State Police, NH Highway Patrol, and multiple NH local police agencies. With client software which will be issued to the police cruisers in the future, detailed dispatch information will be sent directly to the officer in the field in text form. This will eliminate the need for officers to memorize or write down addresses, telephone numbers or other dispatch details delivered verbally, which may be needed for handling the incident. Related efforts within the CAT Program have targeted the addition of automatic vehicle location (AVL) capabilities to the CAD client/server system. AVL capabilities will soon enable the CAD system to automatically display on the dispatch map the locations and current status of all cruisers in the vicinity of an incoming 911 call. This will greatly increase the efficiency and effectiveness of the emergency

dispatch function. In addition, it will enable headquarters personnel to accurately locate emergency incidents which are reported from the field, and to systematically analyze the distribution of officers in the field during various shifts.

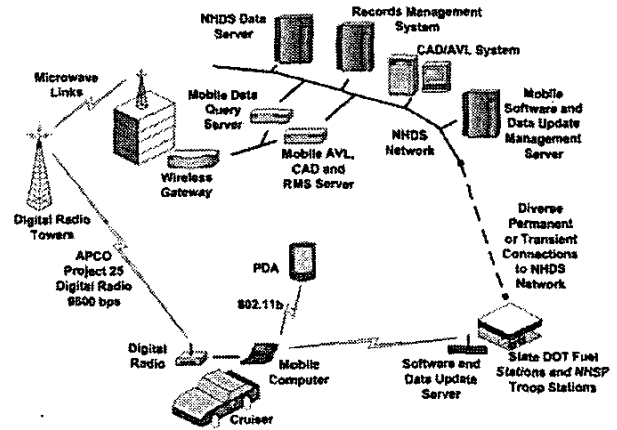


Fig. 6 Communication network with Project54

A concurrent effort during the CAT Program focused on acquiring a commercial Law Records Management System (LRMS) for the NH Department of Safety. An LRMS server system enables law enforcement personnel to record, track, report and analyze law enforcement records data. Field reporting software which will be issued to NH State Police vehicles in the future will enable officers to receive detailed dispatch information (names, addresses, etc) electronically during a dispatch event, and to prepare and submit subsequent incident reports from the field over their wireless data link. These reports will be automatically routed electronically within headquarters through the approval chain and into the LRMS system, and matched to the original dispatch information submitted automatically to the LRMS system by the CAD server.

#### *C. Automated Download/Upload of Cruiser Data and Software*

A separate aspect of the commercial hardware/software installation within the CAT Program involves installing a network of 20 servers with high bandwidth wireless networking access points throughout the state of New Hampshire, at State Police troop stations and select NH Department of Transportation (DOT) fuel stations. Cruisers with the Project54 mobile system installed will establish an 802.11b wireless network link while refueling or at the troop station. The temporary high speed wireless link will support the automatic uploading of reports, log files, etc. from the mobile units to the headquarters server systems, and the automatic downloading of software upgrades, in-cruiser database files, etc. from the servers to the mobile units. Initial field testing of the wireless update system was performed at UNH, and field testing within NHDS will

start by the end of the first quarter of 2004. Fig. 6 shows the multi-modal client-server connectivity in the final UNH/NHDS Project54 system developed within the CAT Program. The state-wide, low bandwidth (9600 bps) APCO Project 25 compliant wireless data link is used for all real time data interactions between police vehicles and headquarters servers. The local, high bandwidth (11 Mbps) 802.11b compliant data link will be used for all large volume, non-time-critical data transfers between mobile units and headquarters servers.

#### *D. Statewide Motor Vehicle Information Integration and Management*

Project54 equipped vehicles have two modes for obtaining traditional motor vehicle (MV) records data. First, queries can be submitted to the state query server over the low bandwidth wireless data link. This mode supports the full range of in-state and out-of-state queries, NLETS (National Law Enforcement Telecommunications System) queries, and so forth without dispatcher involvement. In-state motor vehicle queries can also be completed using the cruiser's in-vehicle database. Such in-vehicle queries are completed nearly instantaneously, place no overhead on the limited bandwidth data link, and are available in poor data radio reception areas.

The flow of information from headquarters to the officer in the field is being automated via the efforts of the CAT Program. However, human intervention is still required for many system aspects relative to the entering, sorting and transferring of data within headquarters and between headquarters and the related state-wide infrastructure (municipal agents, troop stations, and so forth). MAAP is an acronym for Municipal Agent Automation Project. It represents a project underway within NHDS to assess and improve the current Motor Vehicle Online Registration and Title System as used by Department of Safety and Municipal Agents. Its major goal is to fully automate the MV records system within New Hampshire, from the point of data entry by clerical and other staff at diverse locations, to the on demand delivery to headquarters staff or officers in the field. CAT Program personnel are not directly involved in the primary design and implementation of MAAP. However, the NH MAAP effort is clearly closely associated with the overall program goals.

#### V. CONCLUSION

As a direct result of the past CAT Program activities, a very close cooperation has developed between the New Hampshire State Police, information technology and other administrators in the New Hampshire Department of Safety, and scientists and engineers at the University of New Hampshire. From the beginning, the CAT Program has emphasized the use of modular hardware and software systems, built upon open interconnection standards. This

principle was paramount in the design of the Project54 in-vehicle system, and in the structuring of the state-wide wireless data system. The modular, flexible, standards-driven technology infrastructure already developed for New Hampshire by the CAT Program, coupled with the unique collaboration between scientists, engineers, law enforcement officers and administrators, makes the CAT Program a truly unique resource for developing and evaluating information and technology standards in real law enforcement operating environments.

Various versions of the Project54 system were installed in six NH State Police cruisers for testing purposes during the initial years of the project. The Project54 system is currently being installed in all 2003 model year cruisers for deployment in the NH State Police fleet, paced by the normal State Police cruiser rotation schedule. It is anticipated that a total of 140 vehicles will be issued within the NH State Police and approximately 57 vehicles will be issued within the NH Division of Motor Vehicles by the end of calendar year 2004. In addition, independent contractors who equip police cruisers for NH local police agencies have been trained to perform Project54 system installations. Via these contractors, Project54 technology is also being provided to local agencies within New Hampshire. It is anticipated that a total of 189 Project54 equipped vehicles will be issued for use by 38 local NH police agencies by the end of calendar year 2004.

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