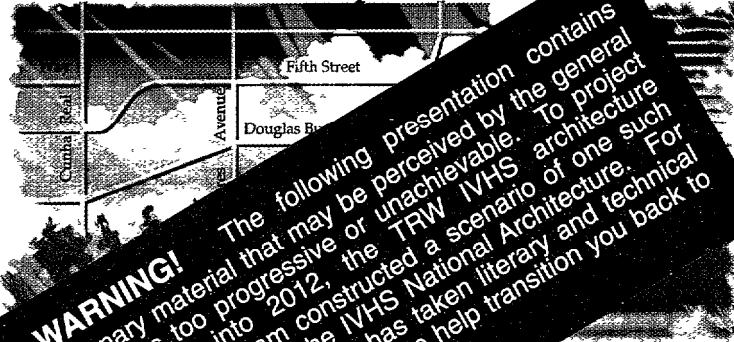


## Intelligent Vehicle Highway System Architecture Development



**WARNING!** The following presentation contains visionary material that may be perceived by the general public as too progressive or unachievable. To project the reader into 2012, the TRW IVHS architecture development team constructed a scenario of one such implementation of the IVHS National Architecture. For this scenario, the team has taken literary and technical license wherever possible to help transition you back to the future.

# VISION

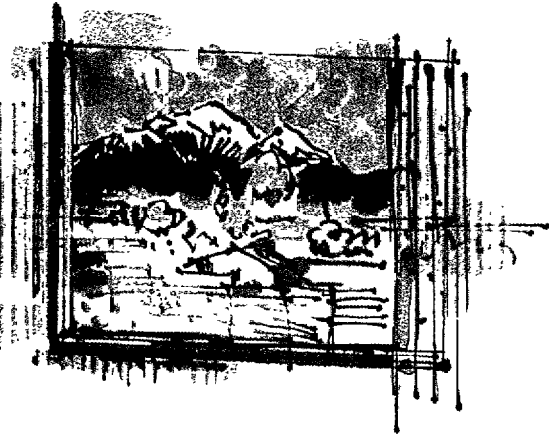
# Good Morning USA 7:01

“Good Morning, U.S.A. It’s seven a.m. on what’s going to be a beautiful April 23, in the year 2012. It’s Shakespeare’s four hundred and forty-eighth birthday so kiss your own Romeo or Juliet and have a great Monday!”

Pat, our Predominantly-Average Traveler, coaxes her eyes open against the onslaught of the caffeine fueled morning disk

jockey. Pat has been looking forward to this day. She will be traveling to Megalopolis to speak at a sales training seminar. Knowing Pat would be in the twin cities area, her cousin, Ted, the Traffic Operations Center (TOC) Executive Director has invited her to tour his Metropolis facility.

Pat lives in the suburbs. Her normal routine is to be at work at The Major Downtown Department Store by 8:30 a.m. She likes to be ready when the store opens at 9:00 a.m. As Pat eats breakfast and



scans the morning news on her monitor, she decides to query the latest traffic conditions on The Traffic Channel. She usually rides her bike to the park-and-ride lot, but today is different. At 1:00 p.m., she will be leaving directly from the store for the airport. The Interactive Traffic Channel gives her detailed information on travel times, accidents, construction, congestion as well as public transportation routing and scheduling information. Pat requests the current and predicted status of her usual route to work.

“Great! The traffic will be light today. No problems.”

Earlier that week. Pat had checked airline and rail schedules on her voice interactive workstation to help her plan her 600-kilometer trip to Metropolis. She really wanted to take the high-speed rail line and review



her presentation, if she did not allow the pleasant blur of the rural landscape to distract her. But she wanted to spend all her free time with Ted, so she decided to fly.

The on-line transportation system has all kinds of information about rental cars and hotels. Her personal transportation file stores her preferences. She was pleased that it had been so easy to book her allergen-free room at a hotel near her seminar. Her plans would get her to the hotel in plenty of time to enjoy the evening.

As Pat finished dressing, she reached down to the nightstand for her final accessory, the watch that contains her low-power transmitter. One of the nicer perks of her transmitter was all of the user services she received just by her proximity to each provider. It provided keyless entry to her vehicle and home along with built-in personal security functions. It was hard to imagine what life would be like without one now. She could access personal mobile units and designate where she wanted to go. This level of utility ranged from simple in-route guidance to complete navigation and control of her vehicle. The system verified she was the authorized user and provided her the requested service

Once seated, she started her vehicle and left for work. The onboard Advanced Traveler Information System (ATIS) continually provided real-time traffic conditions and displayed the estimated time of arrival to her job. Pat opted to transmit this arrival time to her workstation on the department store's network server.

She had originally acquired the ATIS specifically because her boss needed to know exactly when she would be getting to work each day. Lately she had discovered many uses for the system in

her daily commuting. She had had the same experience when she had bought her first personal computer when all she had wanted was a word processor in her home. Before long she was networked to on-line data bases and began telecommuting part time as



a merchandising consultant. She was glad that the computer developers had the foresight to design a flexible computer architecture that could take advantage of technical advances.

Pat was familiar with her normal route to work, so she set the audio route guidance to buzz her only for abnormal conditions. As she got closer to the store, an advisory tone sounded. The display and voice system told her an accident had occurred near the main entrance of the store and recommended an alternate route.

“Accept alternative route,” Pat said, and the navigational system took her down a side street to the back entrance of the store. The system directed Pat to parking space A13. It was the closest available space to the elevator she normally took. Pat thought about how accidents used to make her late for work. Just 20 years ago the navigation system in her vehicle was available only on experimental rental cars. Now the system is available in most major cities and on all new vehicle models.

By noon her obligations at the store were completed and Pat prepared to leave for the airport for her flight to Metropolis.

She looked outside and was greeted by the sight of dark clouds and pouring rain.

“You’d think that meteorologists would finally figure out how to predict the weather,” she muttered to herself.

Not wanting to fight the elements in her own vehicle, Pat searched, via the office transportation monitor for an alternate way to the

airport. The response was immediate. Taxi or an automated para-transit vehicle. The best available para-transit vehicle required a wait of 13 minutes. Pat opted for the taxi and arrived at the airport dry and in plenty of time to view and order a few items from the on-line fashion catalog monitors located in the terminal.

After forty minutes in the air, Pat was behind the wheel of her rental car in the Metropolis airport parking structure. All her destinations were preprogrammed at home by her personal transportation monitor. As soon as Pat sat in the automobile it initiated her journey to the Traffic Operations Center. Before leaving the airport, she received automated traffic information over the local ATIS system. Since she had no idea what streets were named and which interstate went where, Pat used the auto pilot function, and let the onboard navigation system take her the most efficient way.



The ETA indicator read 15:41, Pat called Ted. “I’m about five minutes out. Meet me in the TOC lobby? Great!”

Ted met her with a big hug.

“This place is impressive. With a view like this, you can monitor traffic conditions from the windows.”

Ted laughed. “Some cities tried that several years ago but even from the top floor, we can’t provide the coverage of a totally integrated transportation management system.”

“Pat, what we have here is an integrated transportation management system called Intelligent Vehicle Highway System or IVHS, which developed as a result of Federal Highway Administration funding. IVHS now comprises five major user service systems, Advanced Traffic Management (ATMS), Advanced Traveler Information (ATIS), Advanced Vehicle Control (AVCS), Commercial Vehicle Operations (CVO), and Advanced Public Transportation (APTS). You probably come in contact with each of these services every day and not even realize it.”

Looking around the TOC, Pat was reminded of classic sci-fi shows with the fancy graphic screens and lack of clutter. Ted started his tour.

“All operator stations are identical and provide overall system monitoring. The system really runs itself and operators only get involved in unusual situations. A good example is unexpected equipment failure. We have six operator stations so we can handle several distinct events at any one time.”

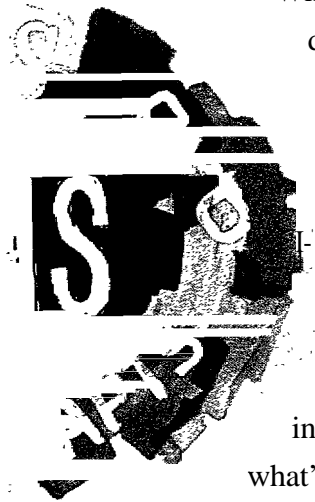
“Is that adequate capacity?” Pat asked.

“Sure, we used to be busy all the time. However, with the increasing maturity of expert systems and equipment, traffic runs so smoothly that we have freed the traffic engineer to concentrate his expertise in future planning.”

Pat points to the workstation in the center and higher than the others. “Is that the supervisor’s?”

“Yes,” Ted answered. “From that spot, the supervisor can see the other screens and redirect communications if necessary. It can also be used as an operator station.”

“So, how do you handle a problem?”



“When an accident or congestion buildup is detected, the system automatically informs the TOC and takes the appropriate action. It might reroute traffic by changing control information. You probably experienced it today on your way to work with your ATIS.” Pat nodded and Ted continued, “If an accident occurs, the selected operator’s console would provide on-site information regarding the incident as well as what’s happening upstream and downstream from that site. If the car is equipped with emergency sensors, the operator can also use this information when summoning the proper authorities or emergency equipment.”

“But,” Pat said, “how can you do that without a number of video monitors at each operator’s station?”

“We used to have plenty. Advances in communication and computer equipment have made dedicated video monitors obsolete. Voice, data, and video are all consolidated into the one workstation monitor. “The TOC was an impressive place and Pat was glad to have an insider’s view of her dashboard wizard.



“You know, Pat, we have really come a long way in the past 15 to 20 years. Early versions of TOCs were popping up independently in several cities. The development of the National Architecture in 1997 established the standards, protocols, and commercial possibilities. More important, it established people’s understanding of the benefits so they quickly became commonplace. Most major cities now have a TOC. Since the data protocols are standardized, TOCs can share data with each other to indicate things like expected traffic volume density expected between neighboring cities.

It’s like the air traffic control network, only for the ground. There are parallels you know. The first airplanes didn’t have sophisticated instrumentation or integrated communications devices. These advances occurred over time and were driven by safety issues and the needs of the pilots for increased information about the environment.”

Pat was almost overpowered by Ted’s enthusiasm. “But what about older vehicles, you know, like pre-2007, that don’t have built-in systems?”

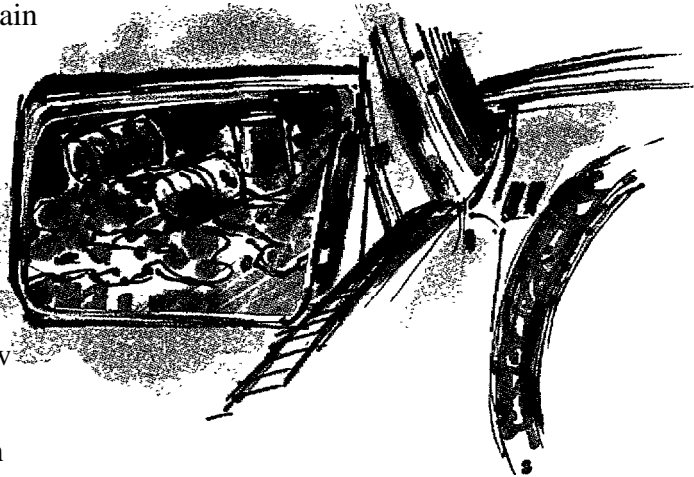
Ted walked over to another workstation. As he pointed, he said, “We still have a network of variable message signs that are controlled automatically from the TOC. Localized highway advisory radio broadcasts are generated from the center as well as distributed to TV and radio stations like The Traffic Channel.”

Ted took a deep breath. “Hey, how about I buy my favorite cousin a drink?”

Pat and Ted grabbed a couple of drinks in the cafeteria. Between sips they talked about the significant changes of the last 20 years. Too soon, Pat's day planner emitted a tone to let her know it was time for her to go. Ted wished her a safe trip and good luck on her presentation.

It had stopped raining. As Pat began her journey to Metropolis, she thought about how pretty it was here and about the effect that in-vehicle signing and traveler information systems had made. No more billboards and informational signs. She only saw safety signs in deference to the few remaining vehicles without in-vehicle capability. The cruise control slowed her car to avoid closing too rapidly as the car ahead of her changed lanes into the transition lane to leave the freeway.

Minutes later, a traveler advisory indicated a hazardous material spill had blocked most of the road three miles ahead. The system suggested an alternate route of leaving the highway one mile ahead. Pat took the alternate route around the overturned chemical truck on the main road. As Pat drove along the frontage road, she could see that one response truck and a few workers had the situation in



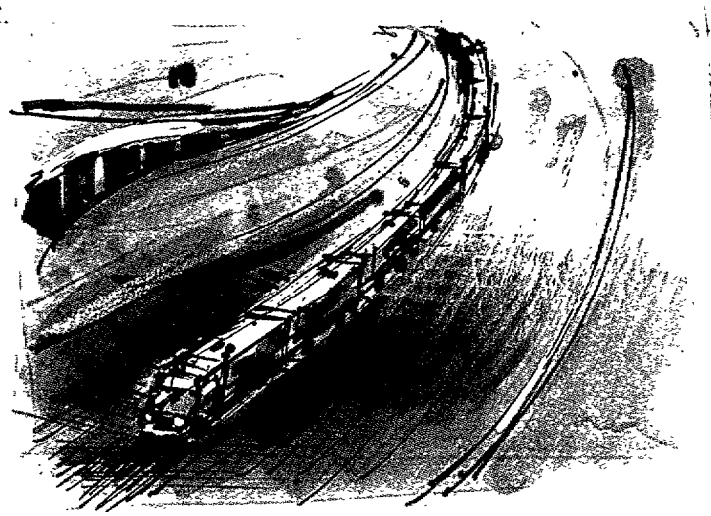
hand. Today's HAZMAT cargo tracking systems allowed authorities to know immediately when a problem occurred and, based on the cargo contents, dispatch only the required emergency personnel.

Back on the main highway, she was startled when a tire exploded on a car ahead of her in one of the uncontrolled lanes. The driver veered off the road, down an embankment, and into a small tree. The 1996 car was a model without a standard Mayday device installed. Wanting to help, Pat immediately activated her Mayday system. This action informed the authorities of the geolocation of the situation and allowed her to pass on details for assistance. All new vehicles have automatic Mayday devices that identify the



vehicle when a situation occurs. If the Mayday system was installed in the car, traffic safety operators could also assess the condition of the accident victims to determine the level of emergency response required.

Pat noticed trucks passing an enforcement station on the other side of the highway. Not many years ago, lines of trucks were backed-up onto the highway waiting their turn in the queue. With the success of two operational tests about 15 to 20 years ago, automatic mainline weighing along with electronic transfer of weight and necessary credentials became accepted. Now, only commercial vehicles not properly equipped or with detectable safety problems had to enter the enforcement station. No more wasted

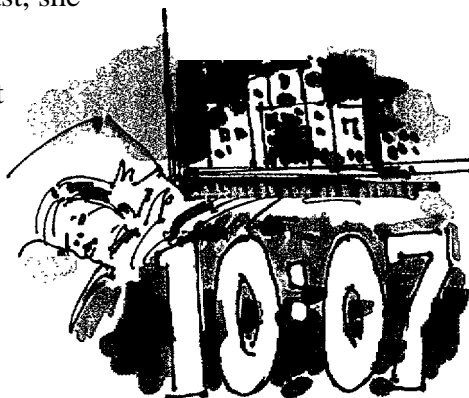


fuel and extra pollution generated by idling trucks. She smiled at the thought of the mile long convoys of trucks now controlled on the highway safely away from the smaller vehicles. Fleet managers determine routes and get the proper credentials for each vehicle before it leaves the yard. Companies and States save millions of dollars in operating costs making it possible to reduce costs to consumers like herself.

Turning onto a toll road for the final leg of her trip, Pat breezed through the toll station without slowing down. The dash sounded a short audible tone. It may have become easier to travel, but Pat knew her transportation account had been automatically debited for the toll. Pat smiled. Small price to avoid the delays, frustration, and worries about exact change that she used to encounter at the old, manual toll booths. Along the way, Pat passed the original Automated Highway test road.

As she arrived in downtown Metropolis, the navigational system directed her straight to her hotel parking structure

Once in her room, Pat accessed the interactive yellow pages to view the dining and entertainment possibilities for the evening. Behind a stress-free smile, she thought about the Traffic Operations Center and how, in the past, she would have arrived at the hotel so late from a trip like this, that she would not have had a chance to relax and enjoy the evening. Later, as Pat fell asleep, she knew her presentation tomorrow would be an unqualified success.



“Thanks Ted...and thank you Federal Highway Administration.”