Final Report

Professional Capacity Building for Communications

by

Leann Koon, Research Associate
Bill Jameson, Senior Research Scientist
Douglas Galarus, Program Manager/Senior Research Associate

Western Transportation Institute
College of Engineering
Montana State University

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LIST OF ABBREVIATIONS

ADN	Advanced Digital Network
BTS	BreakThru Training Solutions
CCTV	Closed Circuit Television
CDMA	Code Division Multiple Access
CITE	Consortium for ITS Training and Education
CMS	Changeable Message Sign
CompTIA	Computing Technology Industry Association
CRC	Curriculum Review Committee
DS1	Digital Signal at Level 1 (1.544 Mb/s)
EMS	Extinguishable Message Signs
FHWA	Federal Highway Administration
G	Generation (e.g., 3G is 3rd Generation)
GKT	Global Knowledge Training
GSM	Global System for Mobile Communications
HAR	Highway Advisory Radio
IEEE	Institute of Electrical and Electronics Engineers
IEEE WCET	IEEE Wireless Communication Engineering Technologies certification
IP	Internet Protocol
ISDN	Integrated Services Digital Network
ITE	Institute of Transportation Engineers
ITS	Intelligent Transportation Systems
ITSA	Intelligent Transportation Society of America
IWCE	International Wireless Communications Expo
LAN	Local Area Network
OPCD	Office of Professional Corporate Development (FHWA)
POTS	Plain Old Telephone Service
RF	Radio Frequency
RWIS	Road Weather Information Systems
TERACOM	Teracom Training Institute, Ltd.
TONEX	Technology and Management Training
TMC	Transportation Management Center

TRA	Telecommunications Research Associates
WAN	Wide Area Network
WiMAX	Worldwide Interoperability for Microwave Access
xDSL	Digital Subscriber Line (of any type such as ADSL, HDSL, or VDSL)

EXECUTIVE SUMMARY

Under contract with the California Department of Transportation (Caltrans), the Western Transportation Institute at Montana State University researched and initiated development of a comprehensive training curriculum for transportation communication systems that will build the professional capacity of rural intelligent transportation system (ITS) engineers and technicians. The principal deliverables of this project were a Literature Review Summary (1), a Needs Assessment Summary and Gap Analysis (2), a Curriculum Scope and Sequence (3), and a Pilot Course Summary and Evaluation Report (4). In this first phase, a pilot course was delivered to Caltrans ITS engineers to gauge viability and assess methodology of the overall curriculum. While that course was generally well received by participants, a number of necessary improvements were identified that must be addressed in subsequent project phases and course delivery.

Development of the Literature Review Summary, Needs Assessment Summary and the Gap Analysis were critical information-gathering steps in the process, and along with the original scope of work, they generally defined the curriculum. In the Literature Review Summary, a number of training providers and courses were identified and documented. It was observed, however, that no single provider offers an entire curriculum that meets the needs of rural ITS engineers. A survey was administered to Caltrans ITS engineers to assess related needs. Subsequently, a gap analysis matched needs to course offerings, and priorities were set based on interest, applicability and experience of the ITS engineers.

Five major subjects were identified within the curriculum: Plant Wireless, Telco Wireless, Plant Wired, Telco Wired and Internet Protocol (IP) Fundamentals. These subjects were further refined to include four to eight topics each. Each topic would generally correspond to at least one course with a duration of one to four days. Thus, the overall curriculum corresponds to approximately 50 to 75 days of in-depth instruction.

Based on identified needs, staff experience, and overall prerequisites, Plant Wireless Core and RF System Design, the first topics within the Plant Wireless subject, were chosen for the first course. A vendor was identified to deliver this course to Caltrans ITS engineers. The duration of the course was four days and the class was based almost entirely on existing offerings from that vendor. Using an established course was beneficial in that the course did not have to be developed from scratch. However, despite requiring that the course include significant hands-on components and that it be tailored to rural ITS communications, the result was found to be lacking significantly in both of these essential aspects. Participants did generally rate the pilot course high in an evaluation survey, indicating they did benefit from the course.

The project curriculum review committee determined that there was significant room for improvement in future courses, and that the hands-on and rural aspects couldn't be emphasized enough. A second phase of the project is anticipated to start in 2011 with plant wired as the target subject area. One or several of the topics within that subject area will be delivered in a second pilot course. It may be necessary to develop a lab portion for the course to accompany a more traditional fundamentals or core curriculum that may be available from existing vendors. This lab portion would include the necessary hands-on and rural components.

1. INTRODUCTION

"A skilled workforce is a critical element in a transportation agency's ability to successfully develop, deliver, operate, and maintain regional and local transportation systems," according to the U.S. Department of Transportation (5). However, retention of experienced staff and attracting new entrants to the transportation workforce are significant challenges faced by transportation agencies around the country.

At the same time, the demand on America's transportation system is growing quickly. Americans have come to expect a certain level of service from the transportation system and an effective, efficient, and safe transportation system is critical to economic growth and quality of life (6). A recovering economy, a population over 300 million, suburban sprawl, an increasing number of vehicle-miles traveled, and an aging population are all putting the pressure on local, state, and federal transportation agencies. This pressure comes with growing expectations and an acute need to be more efficient with limited resources on all fronts.

Adding to the mix of challenges involving the transportation workforce is the rapidly changing and evolving technology requiring employees to have new and dynamic skill sets. The Federal Highway Administration's (FHWA) Office of Professional and Corporate Development (OPCD) asserts, "Technology innovation is the essence of efficiency and it is only through the application of technology by a skilled workforce that transportation can hope to close the gap between growing demand and available resources" (7). Furthermore, as many ITS engineers would concur, technical information becomes obsolete so quickly that many transportation professionals find it challenging to stay abreast of the latest technologies available on the market. Implementing ITS in rural and remote areas provides a clear and pertinent example of advancing technology and the critical need for a skilled workforce with the same advancing skill sets.

Rural ITS deployments are becoming increasingly complex in order to adequately address the challenges that rural transportation presents. A greater number and variety of field devices are being utilized to improve the safety and operations of rural travel. Communication between devices such as Highway Advisory Radio (HAR), Road Weather Information Systems (RWIS), Changeable Message Signs (CMS), Closed-Circuit Television (CCTV), Extinguishable Message Signs (EMS), roadway sensors, and the Transportation Management Center (TMC) that collects and responds to the information is a key factor in the successful implementation of such field devices. However, many ITS engineers lack the critical skills for designing and maintaining reliable and robust communications networks for rural ITS field equipment. As one Caltrans official put it, "As new technologies emerge, engineers and technicians will be required to understand the reality of what is possible versus the glossy specification sheets from vendors" (8).

Rapidly changing technology, intense competition for skilled workers, high expectations, limited resources, an increasing demand on the transportation system, and an overall smaller labor pool all contribute to the necessity for enhanced workforce development. Specifically, the area of rural ITS communications systems is compromised because of the lack of professional capacity.

To realize the full benefits of rural ITS, engineers as well as technicians must not only be aware of what technologies are available, but also how to best select, implement, and maintain those technologies. Due to challenges presented by rural ITS communications, there is a clear need for an educational curriculum that addresses rural ITS communications engineering across the board

with a hands-on approach. The purpose of the Professional Capacity Building for Communications Systems project was to research and develop a comprehensive training curriculum for transportation communication systems that will build the professional capacity of ITS engineers and technicians.

Over the course of this project, several deliverables were completed to address the proposed tasks. For the sake of clarity, these deliverables were left as stand-alone documents. As the final report and to eliminate redundancy, this document includes only critical elements and summarizes the main points from these other deliverables.

The deliverables include:

- Literature Review Summary, (1)
- Needs Assessment Summary and Gap Analysis, (2)
- Curriculum Scope and Sequence, (3)
- Pilot Course Summary and Evaluation Report. (4)

2. BACKGROUND/HISTORY

To maintain the viability of the American transportation system as it is challenged by a smaller labor pool, higher and more intense demands, and limited resources, workforce development must be promptly and pro-actively addressed (9). However, the Framework for Workforce Planning, Development, Management and Evaluation as developed by the Transportation Workforce Development sector of the FHWA OPCD recognizes that a new generation of employees is emerging. This generation of workers brings a different set of priorities to the workplace. They "…grew up in the electronic age, [are] more comfortable with change, have greater expectations for job satisfaction, and are more willing to challenge and to be challenged" (6). How successful they are in meeting the current challenges of the transportation industry "will depend to a great extent on the ability of employers to introduce the emerging workforce to new and innovative approaches in workforce planning and development" (6).

Improving the safety and operations of transportation in often rugged and remote areas is a focal point for rural ITS installations. Designing and maintaining a reliable communications infrastructure to retrieve data from these sites is a challenge even for the most experienced engineer. As Caltrans states in its description of this project (8):

> *Understanding what communication technologies exist and how the underlying principles work will allow an engineer to design a communications network that will work reliably when needed most—during an incident. Often, because an engineer does not have the underlying knowledge of a communication technology, a less than reliable network is designed, often with undesirable results based on claims from a vendor or unrealistic expectations from technologies that were not designed to perform the task at hand.*

This lack of skill is partially the function of information existing in a multitude of formats from many different sources, with no one comprehensive and easily accessible resource.

Indeed, an overview for a college graduate level engineering course offered at U.C. Berkeley in 1996 stated, "Ubiquitous access to information, anywhere, anyplace, and anytime, will characterize whole new kinds of information systems in the 21st Century" (10). Particularly in relationship to wireless communications and mobile information systems, the professor said, "there exists no well-defined body of knowledge that a student must learn to become proficient" (10). While this course was offered some years ago, these statements still ring true.

To address the challenges of rural ITS communications and the need for related professional capacity building, the project team proposed to develop a comprehensive training curriculum for rural ITS communications and deliver a pilot course. The remainder of this document describes this project and its results.

3. METHODOLOGY

This project consisted of seven tasks: Project Management, Needs Assessment and Literature Review, Course Scope and Sequence Development, Curriculum Development, Pilot Course, Evaluation and Feedback, and Identification of Next Steps. This section includes a summary of the methodologies used for each task. More detailed descriptions and plans can be found in the related deliverable documents and are referenced below.

Project management involved regular communication (in person, electronically, and by telephone) between members of the project team, the Caltrans project manager, and the Curriculum Review Committee (CRC), as well as subject matter experts and course instructors. Project meetings were held as necessary to discuss the status of the project and address any issues or questions. Quarterly progress and financial reports were submitted by the project team to the Caltrans project manager. This final report represents the completion of the project management task.

The purpose of the literature review was two-fold in that it identified and defined important topics in ITS communication technology in addition to documenting available training opportunities in relevant subject areas. To conduct the literature review, the project team worked from a preliminary list of subject matter provided by Caltrans to search for and review training topics and classes applicable to ITS communication technologies. Where readily available, information about existing training opportunities was collected to include course topics and descriptions, learning objectives, presentation method, and cost. The list of training topics was further refined and expanded over the course of the literature review. One major subject area was added to the preliminary list from Caltrans and specific topics for each subject area were defined (1).

A needs assessment survey was subsequently developed based on the identified subject areas and topics. The Professional Capacity Building for Communications survey was an online survey designed and facilitated using the SurveyMonkey tool. The Caltrans project manager identified the target population and sample, which consisted of engineers and technicians working on ITS projects throughout Caltrans, particularly in rural areas. The survey collected demographic characteristics such as job title and years in position, as well as information on the level and kind of technical training already received. Participants were asked several questions about each subject area and topic, including level of experience, importance of training, whether training was desired, and how often the technology was used on the job. Finally, training objectives for a sample course in each technology were evaluated for level of detail (2).

The gap analysis consisted of three related parts: needs, available opportunities, and a comparison. The needs were determined through the needs assessment survey described above. Available opportunities were identified through the literature review. Using the literature review as a guideline, the identified opportunities were assessed on whether they offered a training opportunity that addressed each topic and to what depth the topic was covered. The gap analysis then compared the recognized needs with the available training opportunities to identify gaps in communications training for ITS engineers (2).

Based on the literature review (1) and the needs assessment (2) conducted with Caltrans engineers, five major subjects with associated topics were identified as important knowledge and skill areas for successful rural ITS implementations. To build the curriculum scope, learning

objectives were developed for each topic within each subject area. The proposed sequence of training topics is based on the identified needs of Caltrans ITS engineers as well as the necessary prerequisite skills required to participate in and fully benefit from the subject area trainings (3).

The needs assessment and gap analysis (2) identified four topics that could be considered a higher priority for training, two of which fell under the Plant Wireless communications subject area. These needs and related discussions with the CRC led the project team to select Plant Wireless as the subject area for the pilot course. RF system basics was then chosen as the specific topic area based on the assumption that it was important to first provide students with the fundamentals needed to design and deploy robust, reliable ITS communication systems that meet the needs of rural transportation. After assessing three different training providers, the project team and the CRC chose BreakThru Training Solutions (BTS) to deliver the pilot course. The project team and the CRC worked with BTS to customize an existing RF System Design course to meet the needs and expectations for the pilot course. The project team coordinated logistics and the pilot course was delivered October 4–7, 2010, at the Sacramento Regional Transportation Management Center in Rancho Cordova, California. Students completed two evaluation forms and members of the project team and CRC attended the course. Evaluations and CRC feedback were compiled and analyzed by the project team (4).

Finally, the project team identified next steps using the results from the project tasks, and input and feedback from the CRC.

4. NEEDS ASSESSMENT AND LITERATURE REVIEW (TASK 2)

4.1. Literature Review

As part of Task 2, a literature search was performed on the state of the practice in rural ITS communications training. Training opportunities for available technologies were surveyed, including best practices, and engineering and design principles. Courses and certifications in industry, academics, and public service organizations were reviewed with emphasis on those that are applicable to rural ITS deployments. It should be noted that the project team did not conduct a general review of practice or technology.

A variety of training options for communications were available commercially from academic institutions, organizations, and industry. However, opportunities to gain training particular to *transportation* communications was limited. There were even fewer options directly addressing professional capacity development for *rural* transportation communications.

The review of the literature and state of the practice formed the basis for a list of subject areas and related topics that the project team felt would be important to include in a communications training curriculum geared specifically to transportation engineers and technicians. Important subject areas were originally Telco and Plant Wired and Wireless Communications. However, after further review, IP Networking Fundamentals and Usage was added to the list. Many of the subject and topic areas were addressed by at least one corresponding training course, but the project team did reveal gaps in both content and depth of training available.

In conjunction with the literature review, the project team generated a list of vendors and potential resources for curriculum development and course presentation, a key objective for this project task.

The project team also made a best effort to document training logistics and details such as prerequisites, length, style, type, cost and whether a participant receives a credit, certification or other recognition of completion. This information will be useful for subsequent analysis.

Most courses called for no specific prerequisites, but many were targeted to a particular audience and mentioned a need for basic knowledge levels. Other programs were designed as a series with courses taken one after the other to receive a final certification. Classes ranged in length from one hour seminars or webinars to several days of on-site study. Some courses were taught by experts and others were self-study. In some cases, the training was a single event whereas other opportunities provided a series of courses or workshops. Training opportunities were available online or at a central location. Companies specializing in communications training allowed some customization. Depending on the method of presentation, training was instructor-led classroom, laboratories, simulations, or other learning situations. Of the training opportunities reviewed, costs ranged from free to several thousand dollars, generally related to length and intensity of the course or training. Continuing education credits and certifications were available for several of the training opportunities reviewed.

The list of subjects and specific topics was incorporated into a needs assessment survey that was administered to Caltrans personnel. Comparing the survey results with the current state of the practice and findings of the literature review, the project team conducted a gap analysis to determine scope and sequence of the proposed transportation communications training curriculum.

4.2. Needs Assessment

Considering the results of the needs assessment survey, a greater need for training in four topics in three subject areas became apparent. The sample of Caltrans ITS engineers demonstrated a need for professional capacity building for Plant Wireless technologies including RF system basics and microwave, Plant Wired xDSL technology, and network security under IP Fundamentals.

Close to 92 percent of the sample desired training in RF system basics, microwave, and network security, while 88 percent were interested in training in xDSL technology as applied to ITS communications. Furthermore, just over 96 percent thought xDSL training was very important or important and almost 92 percent indicated training in RF system basics, microwave, and network security was of significant importance. These results provided strong evidence of a considerable need for training on these topics.

Lending further support to this identified need was the percentage of the sample with substantial experience in these technologies and how frequently they are used. The percentage of respondents with substantial experience in these technologies was less than 10 percent for all four topics. Only 8 percent of the sample said they possessed substantial experience with RF system basics, microwave, or xDSL technologies as applied to ITS communications. The portion with substantial experience in network security was even less at only 4 percent. Roughly half of the sample used these technologies on a regular basis, which indicated that ITS engineers were utilizing the technologies and therefore adequate training was needed.

In general, the need for professional capacity building in rural ITS communication technologies, most notably the specific technologies addressed in the survey, was evident in the results of the needs assessment. The high percentages desiring training, and those considering training important, coupled with the lower numbers of individuals with substantial experience, lent credence to this observation. Even among the technologies that had a relatively lower percentage interested in training and considering it important, the percentages still represented a majority of the sample.

4.3. Gap Analysis

Over the course of the literature review (1), a number of organizations were found to provide training in communications technologies. Several provided training applicable to Caltrans and rural ITS implementations while others provided training relevant to the broader communications industry. The eight training providers that offered courses and / or curriculums identified by the project team as most relevant to ITS communications and Caltrans were the following:

- BTS – BreakThru Training Solutions
- CITE – Consortium for ITS Training and Education
- FHWA – Federal Highway Administration
- GKT – Global Knowledge Training
- IEEE WCET – Institute of Electrical and Electronics Engineers Wireless Communication Engineering Technologies certification

- TERACOM – Teracom Training Institute, Ltd.
- TONEX – Technology and Management Training
- TRA – Telecommunications Research Associates

Other organizations that provided communications training included Cisco, the Computing Technology Industry Association (CompTIA), IEEE, Institute of Transportation Engineers (ITE), Intelligent Transportation Society of America (ITSA), International Wireless Communications Expo (IWCE), and the U.S. Department of Transportation's ITS Professional Capacity Building program.

Definitive gaps in communications training were evident if no training opportunity appeared to be available that adequately addressed identified needs of Caltrans ITS engineers.

According to the results of the needs assessment survey, training for all of the listed topics was desirable. Some topics could be considered a higher priority for training, namely Plant Wired xDSL, RF system basics, microwave, and network security. All of these topics were addressed by one or more providers in detail. BTS and TRA both offered more in-depth training for Plant Wired xDSL. TERACOM also provided some treatment of this topic. RF system basics and microwave communication technologies were covered in courses offered by TONEX. TRA also dealt with microwave technology on a more limited basis and the IEEE WCET certification program included the basics of RF systems as well. In addition to Cisco, GKT also provided more extensive training for network security. Both of these organizations were listed by name when survey participants were asked about technical training they had received related to their job/career.

On the other hand, none of these organizations were geared toward transportation technology applications, let alone rural transportation communications. In fact, of the eight providers listed above, only the FHWA and CITE offered training that was directly applicable to transportation and those courses did not necessarily have a rural component. However, providers like BTS allowed flexibility in course content and would tailor their training to meet specific learning objectives established by the client.

ADN, switched 56, analog data circuits, and serial connectivity would also be considered important training topics, albeit of lesser priority. However, little or no coverage was provided for these technologies. Therefore, for ADN and switched 56, technologies addressed by none of the identified organizations, a gap did exist. For analog data circuits and serial connectivity, some training was provided, but on a very limited basis. A comparatively smaller gap existed between needs and training opportunities for these technologies.

4.4. Recommendations

Based on the literature review and needs assessment survey, and subsequent gap analysis, the project team made the following recommendations (2):

- The needs assessment and gap analysis clearly showed the need for comprehensive communications training geared toward ITS. This training should have a distinctly rural focus, with wider applicability to urban transportation as well.

- The curriculum should include the identified topics under each of the subject areas at the minimum. Those designated as a higher priority need should be given more in-depth treatment.
- One or more of the acknowledged providers could be used to cover certain topics and/or subject areas. A preliminary dialogue should be started with BTS, TONEX, and TRA, and possibly GKT and Cisco. Factors such as course content, flexibility in training objectives, cost, availability, materials, instructors, and method of presentation, among others, should be ascertained and compared.
- One topic for the pilot course should be decided upon. RF system basics, microwave, Plant Wired xDSL, and network security are all candidates. Once this decision is made, steps should be taken to determine how the pilot course will be administered. Factors to consider include provider, instructor, location, dates, and length, to name a few.
- Consideration may be given to transportation-specific (ITS) customization or augmentation of course content. This could be accomplished in a number of ways, including custom lab exercises.
- Based on the literature review, needs assessment, and gap analysis, a draft curriculum and a subject matter expert list should be developed.

5. COURSE SCOPE AND SEQUENCE DEVELOPMENT (TASK 3)

5.1. Content Scope and Sequence

Through a comprehensive literature review and a needs assessment conducted with Caltrans engineers, five major subjects were identified as important knowledge and skill areas for successful rural ITS implementations. These subject areas are: Plant Wireless, Plant Wired, Telco Wireless, Telco Wired, and IP Fundamentals. The curriculum scope and sequence that was developed for this task is based upon these five subject areas and includes descriptions, prerequisites, duration, method of presentation, and specific learning objectives. The target audience includes field engineers and technicians who apply ITS technologies in rural areas to improve transportation safety and operations.

The project team felt it would be useful to have the scope and sequence available as a separate document. Therefore, to eliminate redundancy, the curriculum can be found in the document titled *Professional Capacity Building for Communications: Curriculum Scope and Sequence* (3). For quick reference, the subject areas and associated topics are outlined below:

A. Plant Wireless
    a. Plant Wireless Core and RF System Design
    b. 802.11 (WiFi) and Related
    c. Microwave
    d. Short Haul Radio
    e. Privately Owned WiMAX

B. Telco Wireless
    a. Telco Wireless Core and Cellular/PCS Basics
    b. GSM Data, 3G and Next Generations
    c. CDMA Data, 3G and Next Generations
    d. Telco Owned WiMAX

C. Plant Wired
    a. Plant Wired Core/Plant Wiring Basics
    b. Serial Connectivity
    c. xDSL
    d. Optical Fiber

D. Telco Wired
    a. POTS
    b. ISDN
    c. xDSL
    d. DS1/T1

e. Fractional DS1/T1
f. Frame Relay
g. Analog Data Circuits
h. ADN, Switched 56

E. IP Fundamentals
   a. Understanding IP Networks/IP Networking Core
   b. Local Area Networks (LANs)
   c. Wide Area Networks (WANs)
   d. Network Security
   e. Cisco Specific Equipment

5.2. Subject Matter Expert List

One of the core tenets for this project was to develop training that would be presented by experts in their field. As stated in Section 4.3. *Gap Analysis*, the project team identified eight different organizations that offered training relevant to ITS communications and the needs of Caltrans ITS engineers and technicians. A subject matter expert list with contact information for these organizations is provided below.

5.2.1. BTS

Name:	BreakThru Training Solutions
Address:	Regional Office P.O Box 46905 Kansas City, MO 64118-6905
Telephone:	(816) 584-8177 ext. 771 or 877-463-6232
Website:	http://www.btstraining.com/

5.2.2. CITE

Name:	Consortium for ITS Training and Education
Address:	CITE Attn: (for names, see below) University of Maryland Bldg 806, Suite 3103 College Park, MD 20742

Telephone and Email:	Thomas Jacobs, Director (301) 403-4534, tjacobs@umd.edu Kathleen Frankle, Program Manager (410) 414-2925, kfrankle@umd.edu Denise Twisdale, CITE Coordinator (301) 403-4592, mztwiz@umd.edu Dorothy Parnian, Instructional Designer dparnian@umd.edu Jennie Prevots, CATT Coordinator (301) 403-4525, jprevots@glue.umd.edu
Website:	http://www.citeconsortium.org/

5.2.3. FHWA

Name:	Federal Highway Administration
Address:	U.S. Department of Transportation Federal Highway Administration 1200 New Jersey Ave. SE Washington, D.C. 20590
Telephone:	(202) 366-4000
Website:	http://www.fhwa.dot.gov/

5.2.4. GKT

Name:	Global Knowledge Training
Address:	P.O. Box 1039 Cary, NC 27512
Telephone:	1-800-COURSES, 1-800-268-7737
Website:	http://www.globalknowledge.com/

5.2.5. IEEE WCET

Name:	Institute of Electrical and Electronics Engineers Wireless Communication Engineering Technologies Certification

Address:	IEEE WCET Certification Program IEEE Communications Society (IEEE ComSoc) 3 Park Avenue, 17th Floor New York, NY 10016
Telephone and Email:	(212) 705-8900 cert@comsoc.org
Website:	http://www.ieee-wcet.org/

5.2.6. Teracom Training Institute

Name:	Teracom Training Institute, Ltd.
Address:	4625 W Nevso Dr., Suite 2 Las Vegas, NV 89103
Telephone:	1-877-412-2700
Website:	http://www.teracomtraining.com/

5.2.7. TONEX

Name:	TONEX: Technology & Management Training
Address:	The Centrum 3102 Oak Lawn Avenue, Suite 700 Dallas, TX 75219
Telephone:	1-888-868-6639
Website:	http://www.tonex.com/

5.2.8. TRA

Name:	Telecommunications Research Associates
Address:	PO Box A 505 W. Bertrand Avenue St. Marys, KS 66536-0016
Telephone:	1-800-872-4736
Website:	http://www.tra.com/

6. CURRICULUM DEVELOPMENT (TASK 4)

This task was designed to initiate detailed curriculum development for at least one of the proposed curriculum modules. The deliverables for this task included student materials, an instructor guide, assessment tools, and hands-on activities or a lab manual.

The project team, with input from the CRC, chose to develop the curriculum materials for the Plant Wireless topic RF System Design. To maintain the scope of the project, this topic was the choice for the pilot course (See Section 8. *Pilot Course (Task 5)*). Subsequently, a subject matter expert was hired to develop the module content including a course outline with learning objectives and duration, student materials, an instructor guide, and hands-on activities. The project team and CRC actively reviewed draft materials throughout the process.

The Pilot Course Evaluation Report (4) includes a discussion and critique of the module materials and curriculum. Materials that were developed and presented for the RF System Design module (Pilot Course) include the following (copies of which were retained by the project team):

- Hard copy of the *Student Manual, RFSD-HOT, RF System Design;*
- Electronic version of the *Student Manual, RFSD-HOT, RF System Design* with instructor notes; and
- Various tools, spreadsheets, software and references relevant to RF system design.

It was proposed to develop appropriate assessment tools as part of the module's curriculum. Oral questions and a written pre-test and post-test were suggested as methods for assessment. While students were orally quizzed and review questions asked throughout the pilot class, no formal pre-test or post-test was developed. After consideration, the project team determined this type of assessment was not practical for the scope of this project. The project team worked under the assumption that adult learners voluntarily participating in this type of course will likely take the initiative to learn the material. Therefore, such an assessment would do little to enhance the overall project beyond the information collected by the course evaluations completed by the students. In retrospect, we believe that further consideration should be given to administering an assessment of learning. Student perception of the effectiveness of the course and instructor may not match the expectations of the CRC, and high evaluation marks may not equate to the course meeting its intended objectives. Thus, course evaluations alone may not give a sufficient indication of course effectiveness.

7. SUMMARY OF EVALUATORS' REVIEW

A summary of the evaluators' review was partially completed in conjunction with the pilot course evaluation (Section 8. *Pilot Course (Task 5)*; (4)) and finished in parallel with *Task 7: Identify Next Steps*. The deliverable for this task is the summaries from those two tasks, which are presented in the following two sections (Section 8. *Pilot Course (Task 5)*, and Section 9. *Next Steps*).

8. PILOT COURSE (TASK 5)

The project team felt it would be useful to keep the summary and review of the pilot course as a separate document for easy reference. Therefore, to eliminate redundancy, the review report can be found in the document titled *Pilot Course Summary and Evaluation Report for Professional Capacity Building for Communications* (4).

To summarize, the project team made the following recommendations based on the planning and delivery of the pilot course:

- The time of year the course was held seemed to work well and a similar timeframe for future courses would be appropriate. A summer course may also be a feasible choice, possibly in conjunction with the Western States Rural Transportation Technology Implementers Forum, which is a meeting attended by many in the target audience.
- The location of the pilot course was also a good choice. The Sacramento Regional TMC has further potential for case studies and field trips as well. Consideration should be given to similar locations in different regions of the state if multiple iterations of an identical course are offered.
- It is recommended that potential course instructors be thoroughly vetted by the CRC and the project team to determine levels of knowledge and experience.
- It is recommended that direct means for communication with the instructor be provided to the CRC.
- It is recommended that instructors be included in course curriculum development. Clear expectations for relevancy and laboratory exercises must be expressed and understood by all involved in the development process. Solid confirmation of actual hands-on activities to be conducted during the course should be received from the instructor by the CRC and project team.
- It is recommended that further consideration be given to administering an assessment of learning. Student perception of the effectiveness of the course and instructor may not match the expectations of the CRC, and high evaluation marks may not equate to the course meeting its intended objectives. Thus, course evaluations alone may not give a sufficient indication of course effectiveness.
- Class size should be about 10 students with a maximum of 15 to ensure quality of student and teacher interactions.
- It is recommended that the CRC consider different options for course presentation. One idea may be to conduct two or three days of training with a trainer such as BTS and then do a practical field experience with nearby ITS installations or case studies, or some combination thereof. The field experience may be led by a Caltrans engineer or other subject matter expert.
- It is further recommended that the CRC explore the possibility of engaging Caltrans engineer to develop and present professional capacity building courses in ITS communications. We note that this would likely require a sabbatical program for Caltrans engineers.

- Having project team and CRC members attend the pilot course was valuable and should be continued in some capacity for future training classes.

9. NEXT STEPS

This project was a positive step towards providing critical professional capacity building training to Caltrans ITS engineers and technicians. A comprehensive curriculum was developed and a successful pilot course delivered. The results of this project have shown enough potential for Caltrans to move towards a second phase.

Based on the experiences completing this project and with significant input from the CRC, the project team suggests the following next steps:

- Further detailed development of the curriculum should continue similar to what was done for the topic of RF System Design.
- The RF System Design topic was only one of several in the Plant Wireless subject area. Further consideration should be given to the other topics in the Plant Wireless subject area, as well as the potential for offering the RF System Design course on more occasions.
- Carefully reconsider how best to approach securing subject matter experts who can deliver quality training that is hands-on and applicable to rural ITS engineering. The feasibility of engaging a Caltrans engineer or an industry vendor to develop and deliver training courses should be explored.
- Delivering hands-on and practical, relevant training is of crucial importance to this project. Alternative delivery methods, securing suitable subject matter experts, and coordination with college/university programs or other technical training programs are all options to investigate in order to insure quality professional capacity building in ITS communications.
- While not pursued within the scope of this project, the possibility of offering professional development credits or more direct preparation for certification exams are concepts to bear in mind for future professional capacity building.
- This project has been developed based on the needs of Caltrans ITS engineers and technicians. The project team is unaware of any similar efforts at other state departments of transportation. The potential exists for adaptation, adoption, and delivery of ITS communications professional capacity building curricula in other states and on a national level. Future research should investigate such opportunities as well as probe prospective "sponsor" organizations (e.g., FHWA, IEEE, ITSA) to sustain the program.

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