

CONSTRUCTION INDUSTRY INSTITUTE

WIRELESS COMMUNICATION
AND COMPUTING
AT THE
CONSTRUCTION JOBSITE

Construction Industry Institute

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Wireless Communication and Computing at the Construction Jobsite

**Prepared by
The Construction Industry Institute
Wireless Communication and Computing Research Team**

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Executive Summary

The walkie-talkie, a World War II technology, is synonymous with the construction industry. Today's wireless communications technologies, however, have the potential to enable the transmission of all project information instantaneously to the foreman's work station. Database management systems can link the engineering office to the foreman's desk and allow, for example, the latest drawing revisions to be viewed and discussed immediately with the field personnel who will execute the changes.

Wireless communication technologies, the transmission of voice, video, and data without the use of wire linkage, are capable of enabling on-demand access to all project information by all parties at any location. The technologies include the use of cellular phones, mobile phones, personal and portable computing devices, video communication, voice clips, faxes, and modems. Such capabilities were investigated by the CII Wireless Computing and Communications Research Team. The research team was formed to assess the applicability of wireless communication technology to the construction industry. The specific objectives were: to survey the information needs at the jobsite; to survey the emerging wireless communications technologies; and to assess the extent to which wireless data technology can fulfill the information needs of jobsites.

This publication is a summary of the efforts by the research team. It describes the available technologies and discusses the particular applications that can enable cost-effective decisions to be made for a particular job. Ultimately, wireless communication technology will improve the important issues of reliability and quality that are so vital to the engineering and construction facilities of today.

Introduction

For many years, the walkie-talkie has been synonymous with construction, and thus wireless voice communication at the jobsite is a well-established technology. Recent technological advances, however, have provided new and different wireless information services at the jobsite. Such advances allow “mobile” communicators to be located at various places within a construction site and communicate with each other as well as with a central, fixed location such as the jobsite trailer.

The quality, quantity, and timing of information exchange during project execution at the jobsite have a major impact on project success. Paper-based jobsite construction processes are becoming obsolete because they are unable to deliver just-in-time information. Shifting to electronic, or wireless, exchange of information can help improve the timely delivering and accessing of information.

Wired telephone and/or Internet links will still transfer data to desired off-site locations, but the wireless communications can serve primarily as the “last mile” from the trailer to a desired location on the jobsite. Because timely access keeps information relevant, wireless technology has the potential of providing productivity benefits far beyond those already achieved with the symbol of construction communications technology: the walkie-talkie.

The manufacturing, trucking, and package-delivering industries already have incorporated wireless communication systems into their respective work places. The construction industry faces many of the same challenges found within these industries in addition to some that are unique to construction. Some generic concepts, however, can be learned by following the lead of the other industries.

All parties involved in a constructed facility are both suppliers and consumers of information. Hence, owners, designers, contractors, suppliers, and construction managers will benefit from having the means to deliver and access information wherever and whenever it is needed.

Purpose, Scope, and Objectives

The purpose of this study was to assess wireless data communication technologies that are applicable to the construction jobsite. The specific objectives of this study were to:

- 1) Survey information needs at the jobsite, with a focus on type, amount, quality, and timeliness.
- 2) Survey emerging wireless data communications technology.
- 3) Assess the extent to which wireless data technology can fulfill the information needs of the jobsite.

The study was limited in scope in that it was concentrated primarily on jobsite information needs of the Industrial Process construction sector. To this effect, the Lyondell/CITGO Refinery (LCR) revamp/expansion project in Houston, Texas, was used as the primary source of data. One CII member company was already pioneering wireless data communication at this jobsite to track the percent complete of major work packages as well as to perform basic material management functions.

Methodology

The LCR revamp/expansion project supplied information needs as well as the opportunity to assess the impact that the typical construction environment may have on the effectiveness of wireless data communication technologies. Also, a survey of wireless

technology that was available off-the-shelf was conducted. This survey examined several different formats of wireless communication from several different manufacturers.

Once the information needs at the construction jobsite and the wireless products that were currently available were identified, a framework for determining and/or eliminating wireless products for a given set of information needs was developed. Two hypothetical case studies were developed to illustrate the use of this framework. One such case study is included in this document and the other may be found in CII Research Report 136-11.

Cost Versus Benefit of Wireless Communication Technology

It is important to consider the trade-off between the *value* of transmitting information wirelessly on demand against the *cost* of transmitting it. Wireless communication is not an inexpensive technology. Included are initial equipment expenses, expenses associated with service fees and maintenance, and indirect expenses. Some of the costs of investing in wireless technology that need to be considered are:

- The purchase of hardware and software (a one-time cost).
- The maintenance and upgrading of hardware (an ongoing cost).
- The upgrading and licensing of software (an ongoing cost).
- The fees of wireless service providers (an ongoing cost).
- The salaries of in-house technical support personnel (an ongoing cost).
- The training of the users (an ongoing cost).
- The fees to a specialized wireless consultant (an ongoing cost).

There is almost always a cost associated with not having certain information at specific places and times. If this information can be provided at the required place and time, such a cost may be avoided. This avoided cost, in turn, represents the value. Ultimately, a decision as to implementing a jobsite wireless communication system is based on the comparison of the cost to the value. This comparison is required for determining the need for the wireless system.

Jobsite Information Needs

Overview

Jobsite information needs were organized into the following nine major categories:

- a) Requests for Information
- b) Materials Management
- c) Equipment Management
- d) Cost Management
- e) Schedule and Means & Methods
- f) Jobsite Recordkeeping
- g) Submittals
- h) Safety
- i) QC/QA.

Each category was analyzed in terms of its appropriateness to take advantage of wireless technology.

The following four formats for communicating information were considered:

- Live voice
- Live video
- Batched data files
- Live data transfer

Live voice communication allows a party in the field to be able to talk with a party in the trailer, or somewhere else, without having to leave the field. The walkie-talkie is an example of a live voice wireless communication device.

Live video communication brings the jobsite to the trailer. The crew at the jobsite would need a video camera. Once the signal is received at the trailer, it can be relayed to any location in the world using wireline communication technology or satellite-based technology.

Practically any computer application such as text, spreadsheets, databases, graphics, pictures, three-dimensional CAD models, and movies can be batched and sent via wireless means. The size of the file that is being sent and the speed of the wireless communication technology being used are the determining factors in how long it will take to transfer a file. Batched file transfer also includes direct access to the contractor's computer network from the field. Payroll, costing, and scheduling applications are ideal candidates for a batched wireless approach. Two of the biggest advantages to be gained by allowing a foreman or superintendent access to applications on the network are (1) eliminating duplication of work, and (2) providing more up-to-date information.

A live data feed is a continuous stream of information that flows between a transmitter and a receiver. This type of transfer requires that both transmitter and receiver be capable of handling significant amounts of information with no or extremely minimal latency.

Legend

Tables are used within this book to articulate and organize the content within each of the information needs categories. Table 1 describes the meaning of each of the tables' headings.

Table 1. Information Needs Charts Headings

Information Subcategory	Explanation	Formats of Info Transfer	Type	Delay (mins)	Importance	Simplex/Duplex	Data Rate (kbps)

- **Information Subcategory** — This column identifies specific subtypes of information that are needed at the jobsite.
- **Explanation** — This column gives a brief definition of what each information subcategory involves.
- **Formats of Information Transfer** — This column identifies the format in which the information could be transmitted wirelessly.
- **Type** — This column further defines the format column. The different types for each format are as follows:
 - Voice is defined by quality of service (QOS) as low, medium or high.
 - Video is defined by quality of service (QOS) as low, medium or high.
 - Batched Data Files are divided by file size as follows:
 1. Small: (< 5 kilobytes); Included are e-mail, short text messages, and simple line drawings.
 2. Medium: (> 5 kilobytes, < 100 kilobytes); Included are medium resolution graphics, large text documents and medium resolution digital pictures.
 3. Large: (> 100 kilobytes, < 1 Megabyte); Included are high resolution compressed graphics or pictures, moderate to high resolution video, CAD files and multimedia applications.

- **Delay** — The delay column defines how much of a delay in information transfer is allowable for a given format. The delay scale is as follows:
 - 5 – Data can be transmitted within .01 minutes (No Latency)
 - 4 – Data can be transmitted within .1 minutes (Minimal Latency)
 - 3 – Data can be transmitted within 1 minute
 - 2 – Data can be transmitted within 10 minutes
 - NF – Time is not a factor
- **Importance** — This column gives a rating as to how useful the information being transferred using a given format is. This scale is based primarily on the information gathered during the LCR site visit.
 - 5 – Very Important
 - 4 – Somewhat Important
 - 3 – As Important as Unimportant
 - 2 – Not Very Important
 - 1 – Unimportant
- **Simplex/Duplex** — This column defines whether one-way or two-way communication is necessary for a given application. If an application is simplex then the table defines whether the originating point of the information is the field or the trailer (SF – Simplex originating in the field, ST – Simplex originating in the trailer, D – Duplex).
- **Data Rate** — For each information subcategory, a transmission data rate is determined. It is based on the amount of information to be transmitted and the allowable delay. The following formula was used to determine transmission data rates of batched files: