COMMUNICATIONS
FORUM

MOBILE MIS

April 23, 1987

Seminar Notes

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

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Robert B. Euler
Radio Data Systems Group
Motorola Inc.

Joe Hinson
Operations Research
Federal Express, Inc.

MOBILE MIS

The moderator, Prof. Henderson, defined the topic for discussion more specifically as the "use of radio technology in providing information type services to a mobile user community." The speakers, he said, would address the topic from two perspectives - vendor, and user. They would describe their current status with regard to radio technology and then go on to talk about future plans.

Robert B. Euler - Radio Data Systems Group, Motorola Inc.

Euler began by describing his division, Radio Data Products Division (RDPD), which is a part of the Communications Section of Motorola. The Communications Section, he said, is in the FM radio communications business and within it the RDPD is concerned with dedicated radio data systems - radio systems communicating digital information. The Communications Sector accounts for about 40% of Motorola's business and focuses on radio paging (one-way communication), two-way voice radio, cellular telephones, wireless data, satellite communication, and on-site communications.

RDPD's focus, he said, is on dedicated wireless radio data communication. The age and trends in this business are given in exhibit A, with the first one-way full text mobile printer being introduced in 1968. Euler pointed out that the trend over the years has been to increase the data rate

communicated over the air, to equal or approach wire communication speeds, and further, to increase the response time.

He then described the systems characteristics of radio data communication developed by RDPD. It is real time two-way packet communication (limited character length messages) that is capable of penetrating buildings. The products are categorized as portable (carried by individuals) and mobile (used in vehicles.) The systems have a 3-10 second response time (terminal to host and back), which is not as fast as wire communication, but close, and carries 4800 bits of information per second of which a little more than half are error detection and correction, to preserve data integrity. Therefore the Baud data rate is a little less than 2400. Further, the data communications are transparent to the terminal user, has data integrity comparable to wire communication, and on a single channel about 20,000 transactions can be handled per hour (i.e. very efficient compared with voice communication.) The terminals produced by the company vary widely while some are capable of intelligence and computer skills. Euler exhibited the KDT 800 portable data terminal, the capabilities of which are described in exhibit B. He also showed slides of other portable and mobile data terminals produced by Motorola's RDPD. The KDT 800, including radio, would cost, he said, in the region of $3,000 - $4,000.

Euler discussed a variety of applications for these devices - high tech repair personnel, sales & marketing, pick-up & delivery, insurance sales & adjusting, building permits and

inspection, medical personnel, large area warehousing, machine control & data collection, and financial data distribution. Then taking one application, high tech repair personnel, he described what that industry is doing with this technology. In the past, the industry used voice pagers to send messages and the repairman would call in for information and instructions. At the end of the day the repairman had to fill out lots of paper to detail the work done etc. All this can now be handled efficiently and effectively with a portable data terminal like the KDT 800, from receiving initial job instructions through to final data entry. The specific uses of this technology for a high tech repairman are listed in exhibit C.

The use of radio data communication systems, he said, yield significant productivity gains. He described the time taken, prior to this technology, for service dispatch applications comparing it with the current situation when using radio data communication systems. the efficiency gain calculated was 94% (exhibit D) - a dramatic time saving is evident, even while accounting for error factors in time allocation.

Euler stated that IBM was their largest customer and had invested in a nationwide system costing in the region of $100 million. It was capable of accommodating 20,000 users. The effectiveness, he said, of the system was seen in the fact that the savings resulting from its implementation paid for it in less than two years with an additional $500 million savings over ten years. All these savings came from productivity gains resulting

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from time saved by repair personnel. In addition, savings were made in such areas as financial savings by reduced invoice cycle time, reduced number of dispatchers, better spare part inventories, reduced paper flows, and messaging between technicians. Starting with two applications (dispatching and repair parts ordering), IBM now has over thirty new applications. He also mentioned that initially service personnel were concerned about the control and restriction the new system would impose on them, however, they are generally very pleased with it because of all the benefits it provides - particularly the improved customer service capability.

However, Euler asserted that companies like IBM and Federal Express which have financial muscle to implement such systems together with the required infrastructure are few in number. As such Motorola has taken the initiative to implement the same infrastructure (Data Radio Network) in metropolitan areas to serve customers who have smaller number of users. The Data Radio network (DRN) system architecture is described in exhibit E. It is capable of providing the necessary integrity to safeguard each users communication. The network will eventually be based on individual customer requirements and be operated with 200 to 300 cities nationwide. Currently the system is operational in Chicago and Los Angeles with faicilities for New York under construction. The cities will be connected to each other by landline, either leased or based on Motorola's own data network, so that users could communicate with their host computer hundreds of miles away (e.g. Seattle to Dallas.) The system will

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operate using multiple protocol conversion enabling a wide variety of users to link up with it. The charge to users will be fee based, and depending on the application, and time of day, it will be about $0.05 to $0.10 per message. From the transaction rates seen in a field service environment this could add up to about $100 to $250 per month per service person.

In closing, Euler stated that one of the limitations in the growth of this business is in the development of applications to make use of this technology. The companies that have been able to put these systems to best use are the ones that already had highly automated facilities, internally, at the time this radio technology was introduced. In other words companies like IBM and Federal Express were ready to move onto this next level of advancement in their operations. The other limitation is whether a particular company has a real time need for the information service that this radio technology could deliver. However, Euler anticipated a significant increase in the use of mobile MIS in the next five to ten years both in the US and around the world.

SPEAKER'S COMMENTS AND ANSWERS TO QUESTIONS

The question of security in such radio communication was raised. Euler pointed out that a proprietary signalling system was being used. This signalling system belongs to Motorola. The signalling was quite complex and very difficult to

decipher. In addition, he said, encryption could be used if a client so required it. Apart from the issues of signalling and encryption, the system architecture was such that it prevented information/messages going to the wrong terminal.

Responding to inquiries regarding encryption costs, he said that data encryption had still not been carried out. However, voice encryption currently requires a premium of $1,000 to $2,000 for the terminal and encoding/decoding software at the host end would cost about $50,000 to $100,000.

A member of the audience inquired about the possible competition from cellular radio communication. Euler replied that in principle they would not mind it as they are in the cellular business as well. However, he did not foresee competition because cellular communication required high channel management costs due to the longer time periods of average cellular use (typically from 20 seconds up to 3-10 minutes) whereas this cost did not occur in mobile radio data communication because of the much shorter average usage time (typically 1/2 second.) Therefore, he asserted, radio data communication had basic economic advantages.

Commenting on broadcast frequency and regulations, Euler said that the system operates on the same frequency as cellular radio and other radio technology equipment (i.e. 800 MHz.) They use the standard voice channel of 25 KHz with 45 MHz spacing. As far as the regulations are concerned this system falls into the FCC non-common carrier, special mobile radio service category. The licensee is the user company and not

Motorola.

Joe Hinson - Operations Research, Federal Express Inc.

Hinson centered his remarks around two systems that
Federal Express has been involved with. The first is the DADS
(Digitally Assisted Dispatch System) which they installed five
years ago. Initially the company began using two-way radios to
assist dispatchers in effectively operating the pick-up service.
However, with increasing business volumes radio voice channels
began crowding up, and also Federal Express had problems in some
situations where they were sharing frequencies with other
companies. The solution to this bottleneck was to limit the use
of air time by changing to digital data communication.

The company now operates 14 customer service centers
(CSC) nationwide in an effort to regionalize its operations. The
CSC assigns a courier to pick-up the package. The system used by
the dispatcher to assign and notify the courier is one of the
functions of the DAD system unit that he/she uses. Hinson showed
slides of the DAD system equipment and described the process for
pick-up assignment. The couriers terminal which is part of the
DAD system could be a mobile unit (fitted to the vehicle) or a
hand held unit.

At the dispatcher's end DADS gives the details
and status of all packages including the location of the
package to be picked up and the status of pick-up. The primary

function of the system is to get information out to the courier.

Federal Express now realizes that what is important to the

customer is the current status and location of his/her particular

package at any particular time. This requires continuous

monitoring which is the function of the second system called the

COSMOS IIB. The company is currently testing this

system. Hinson demonstrated the hand held scanning device which

is used to scan the zip code, airbill number, and service type.

The COSMOS IIB tracker fits into a shoe in the DADS unit in the vehicle

through which it transmits the scanned information via the CSC to

the COSMOS computer at the "hub" (Memphis.) As the package moves

through the transport system, subsequent scans at various stages

will update the COSMOS computer as to the status and location of

the package. At night when the courier gets back to the CSC the

scanner fits into a computer at the CSC which unloads the day's

data and unpdates the scanner with information for the next day's

operation.

Finally, Hinson showed a slide that described the

various possible scanning stages as a package goes through the

system.

NOON			
		PUPS	(pick-up package scan)
6.00 PM			
		SOPS	(station outbound package scan)
		PMX	(PM exception scan - problem detected at night)
MIDNIGHT			
		HOPS	(hub outbound package scan)
		HEX	(hub exception scan)
6.00 AM			
		SIPS	(station inbound package scan)
		VANS	(van scan)

```
AMX       (AM exception)
POD/DEX (proof of delivery/ or delivery
          exception scan)
```

He emphasized that often a customer will forgive them for a "mess-up" but not if they did not know where the package was. This, he said, is the driving reason for this new system. Currrently, the tracking system is being tested using 800 units at 11 test stations primarily on a SIPS basis. The test, he said, was going well and they planned to have 1,500 units by November. They have not yet decided on the number of scans to be eventually used. However, it is unlikely, he said, that they will use all the scans described above as it will be too time consuming and cost ineffective. The full system is due to be in operation next year.

SPEAKER'S COMMENTS AND ANSWERS TO QUESTION

In response to questions about the equipment, Hinson said that the scanning devices were manufactured by a company called Hand Held Products. All the radio system equipment was manufactured by Motorola. The links between the CSC and the "hub" computer, he said, were mostly by satellite with a few landlines. They had 12,000 vehicles equipped with the DAD system and they also had some voice capability still in use, though it was very minimal.

At the organizational level, when the system was introduced, the couriers were initially concerned about the level of corporate control and monitoring. However, their fears were

soon dispelled when they realized the benefits/convenience the system provided, not only to them but more importantly to the customer.
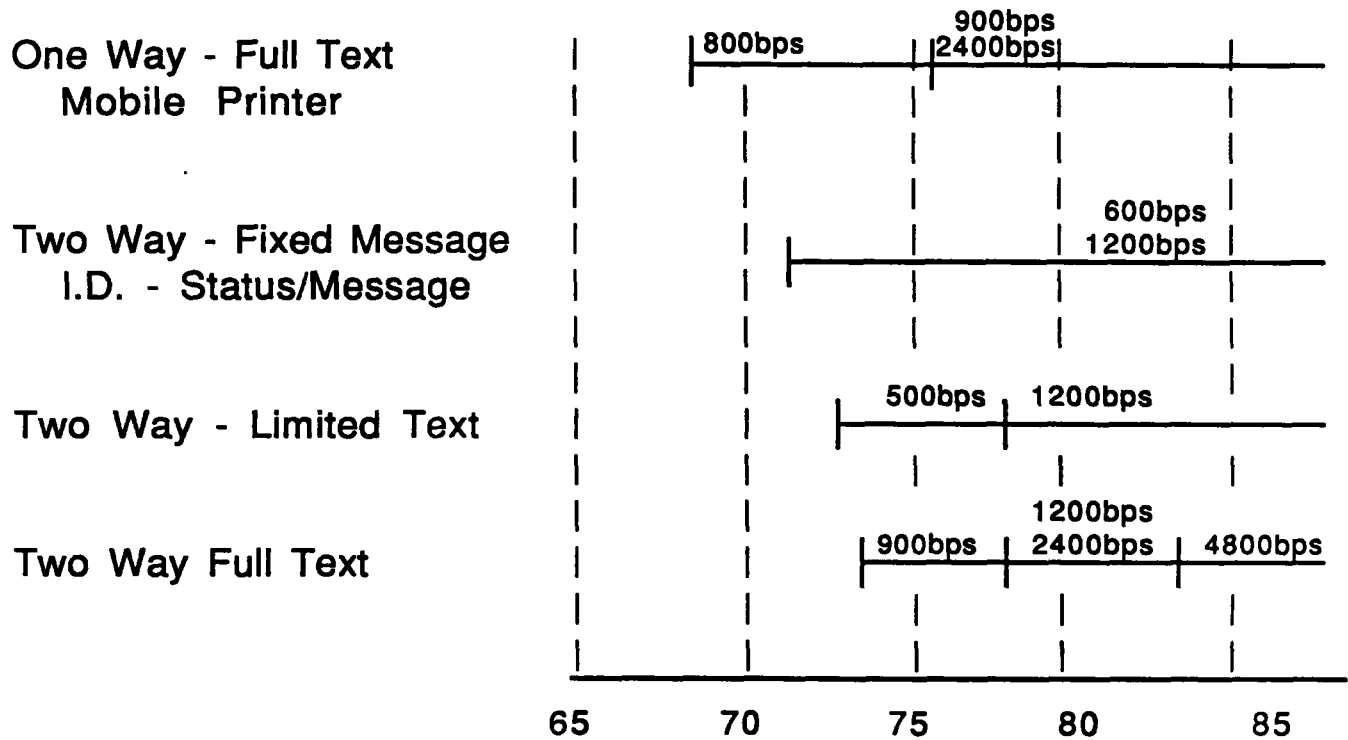
Responding to a query about nine digit zip codes, Hinson asserted that it would certainly help them in further streamlining the pick-up service. However, the problem, he said, is to get people to use the nine digit zip codes. Also related to the topic of zip codes was the problems they faced in overseas markets. For example in the UK most people do not use zip codes, and as a result the company has to stick with the old fashioned manifest, etc.

He said that they were currently testing devices (non-voice) that customers could use to place their orders directly. As the next stage in the evolutionary process, Hinson suggested the possibility of equipping customers with computers so they can access information directly without calling the company.

While it was a temptation for a department like his to think in terms of a general service level business, the company, he said, would in all probability keep them too busy modernizing the current "product" to make it easier for customers to reach Federal Express. The biggest systems problem they face right now, is not knowing what workload to anticipate in the morning. i.e. till the packages are opened.

MOTOROLA
RADIO DATA COMMUNICATIONS SYSTEMS

One Way - Full Text
Mobile Printer

800bps

900bps
2400bps

Two Way - Fixed Message
I.D. - Status/Message

600bps
1200bps

Two Way - Limited Text

500bps   1200bps

Two Way Full Text

1200bps
900bps   2400bps   4800bps

65   70   75   80   85

CURRENT PRODUCT CAPABILITY

Portable - KDT 800
    2 Microprocessors

    160K ROM - 80K Ram
    Pocket ROMS for Personality
    2 x 27 LCD Display

    Full Keyboard
    Programming Capability - Basic
    Integral 800 MHz Transceivers & Diversity
       Antenna
    RS232 Peripheral Port
    Telephone Modem
    Expanded Temperature Range -30° to $+60^{\circ}$C
    12 Hour Battery Life

Mobile - KDT 480
    14 x 40 CRT Display
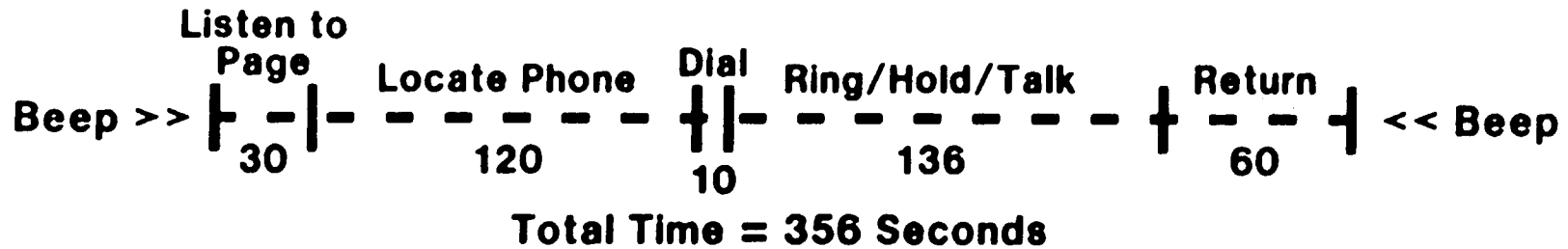   3000 Character Message Buffer
    External Transceiver

EXHIBIT C

FIELD FORCE APPLICATIONS

- Dispatching Personnel

- Job Opening and Closing

- Service Order Accounting and Invoicing

- Customer Data Base Inquiry

- Customer Problem Reporting

- Parts Availability and Order Entry

- Parts Shipment Status

- Diagnostic Support Inquiry

- Remote Testing

- Messaging
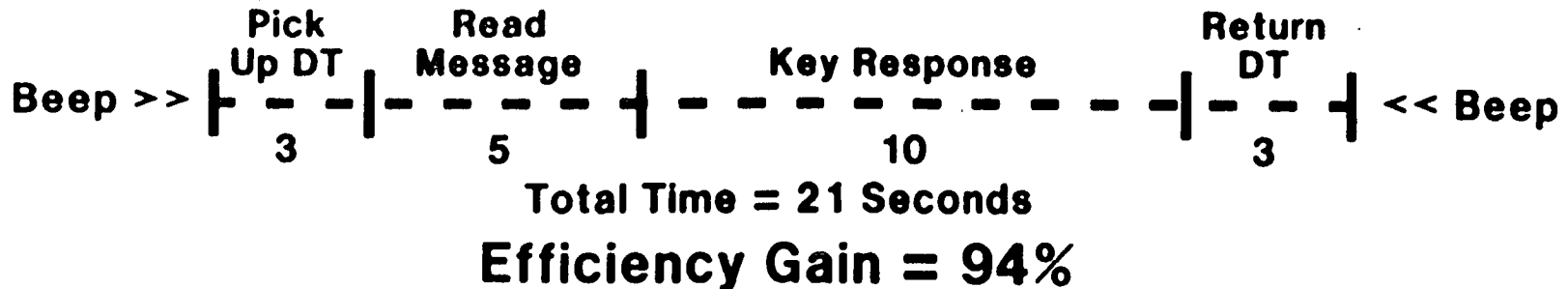
- System/Product Configuration

PRODUCTIVITY IMPROVEMENT

SERVICE DISPATCH APPLICATION
Assignment Time

Paging Approach (Voice Pager)

```
              Listen to
                Page      Locate Phone   Dial   Ring/Hold/Talk        Return
Beep >>    ├ ─ ─ ┤─ ─ ─ ─ ─ ─ ┤├─ ─ ─ ─ ─ ─ ─ ┼ ─ ─ ┤  << Beep
              30              120       10         136              60
```

Total Time = 356 Seconds

Data/Radio Approach

```
              Pick      Read                                    Return
             Up DT     Message         Key Response                DT
Beep >>    ├ ─ ─ ┤─ ─ ─ ─ ┤ ─ ─ ─ ─ ─ ─ ─ ─ ─┤─ ─ ┤  << Beep
              3          5                 10                     3
```

Total Time = 21 Seconds

Efficiency Gain = 94%

DRN SYSTEM ARCHITECTURE