

FEDERAL COMMUNICATIONS COMMISSION
WASHINGTON, D.C. 20564

JUN 9 1992

IN REPLY REFER TO:
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DOR - 4/29/92

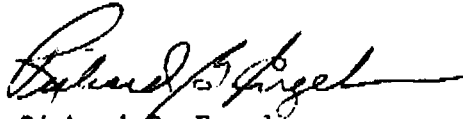
Ms. Joy G. Kellman
Business Administrator
Savi Technology, Inc.
Suite 200
260 Sheridan Avenue
Palo Alto, CA 94306

Dear Ms. Kellman:

In reply to your letter of April 28, 1992, the TagOS - Asset Management System, as described in the April 1992 paper by Vikram Verma, appears to comply with the operational requirements in Section 15.231 of our regulations. As long as testing demonstrates compliance with our technical standards, I see no reason why this system should not be authorized by the Commission.

I trust that the above responds to your inquiry. Additional questions should be directed to John Reed at Room 7122 at the address on the letterhead or at (202) 653-7313.

Sincerely,



Richard B. Engelman
Chief, Technical Standards Branch
Office of Engineering and Technology



April 28, 1992

Mr. John Reed
Federal Communications Commission
2025 M Street West
Room 7112
Washington, DC 20554

Dear Mr. Reed:

At the request of Vikram Verma, Director of Engineering, I am enclosing five copies of the FCC White Paper.

If you have any questions in this regard, please do not hesitate to contact him.

Very truly yours,

A handwritten signature in black ink, appearing to read "Joy G. Kellman". The signature is fluid and cursive, with a large initial "J" and "K".

Joy G. Kellman
Business Administrator



260 Sheridan Avenue

Palo Alto, California 94306

TagOS™ - Asset Management System

By Vikram Verma
Director of Engineering

April 1992

Introduction

The TagOS™ - Asset Management System uses the concept of cellular communication to monitor the movement and status of Tags affixed to Assets. Strategically placed, low power, short range Interrogators communicate with the short range, low power radio Tags. Each Interrogator is assigned to a limited area called a cell. Cellular communication permits the short range Interrogators to track and monitor the Tags over a relatively large area. Interrogators poll the Tags and determine the location and status of the tagged Asset. Figure I shows the cellular communication concept as it applies to the TagOS - Asset Management System.

In addition, the system can activate an audible beeper on the Tag. This makes it easy to locate (or identify the loss of) any individual Asset. Finally, the system can read from and write to the Tag. This allows the Tags to store specific information about the Asset.

System Components

The TagOS - Asset Management System includes the following components: Tags, Interrogators, Portable Interrogators, TagOS Software and a Central Computer.

Tags are miniature radio transmitters/receivers that are attached to Assets. Tags respond to the polling signal from an Interrogators by transmitting their unique recognition code. In addition, the Interrogators can write to and read from the Tag's local memory (EEPROM).

Interrogators are radio transmitters/receivers typically attached to the ceiling or mounted on poles. The Interrogators connect to the central computer via a RS-485 network and communicate with the Tags via radio frequency. The collected Tag status information updates the central computer database with the Tags current location and status. The Interrogator's internal database keeps a record of the Tag identification codes received during a poll. The Interrogator uses this database to rapidly determine if there has been a change in Asset status since the last collection.

Portable Interrogators are mobile Interrogators and are identical to the Interrogators in operation, but are not directly connected to the Central Computer. The Portable Interrogators are manually controlled.

Central Computer is an IBM compatible personal computer. It maintains all information about the Assets and displays the processed data on the terminal in either a graphic format or table format.

BUILDING V - 1st Floor

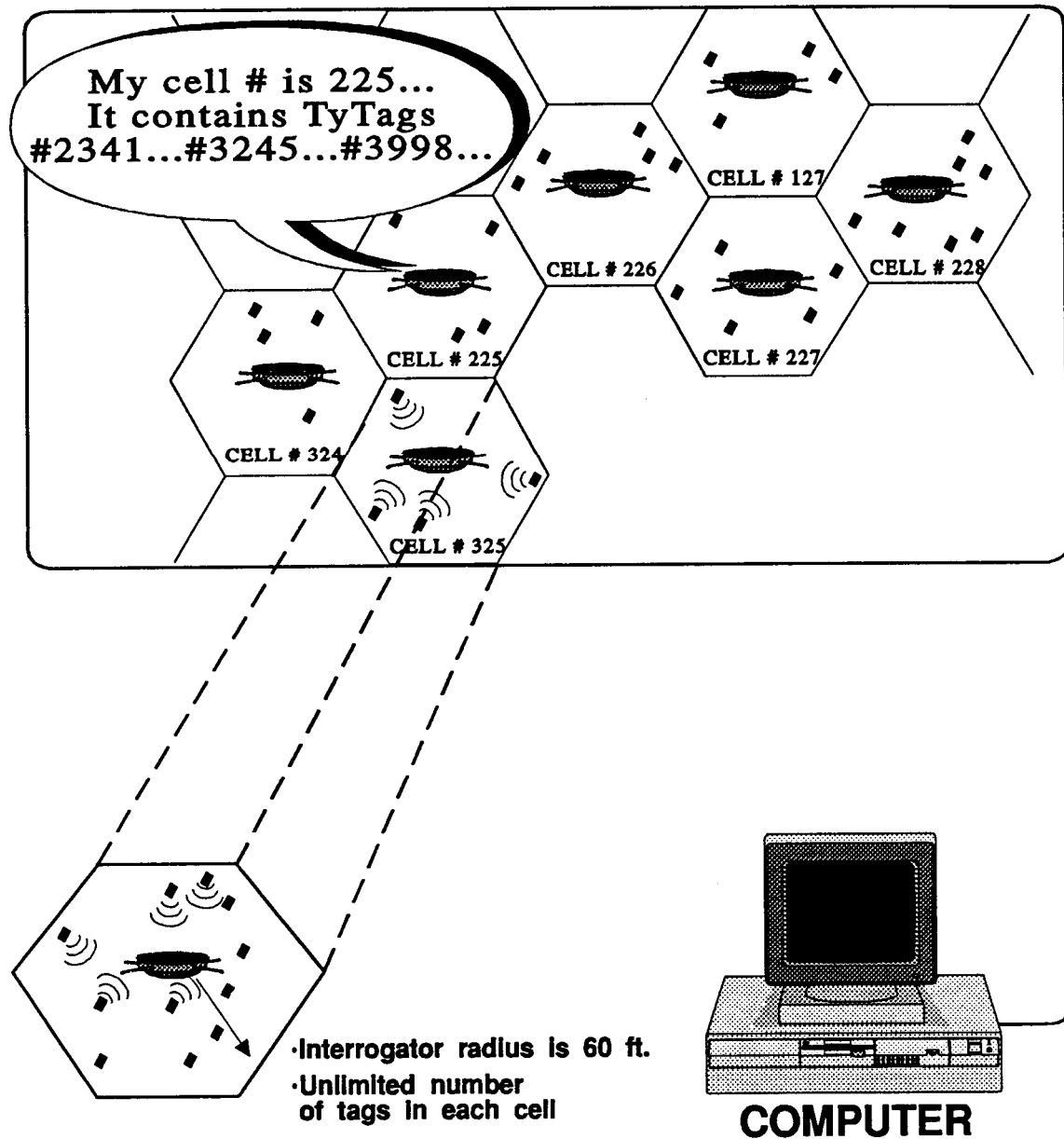
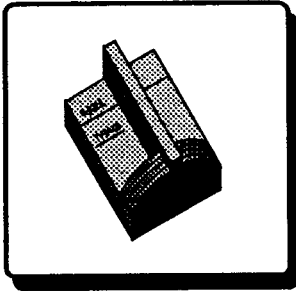
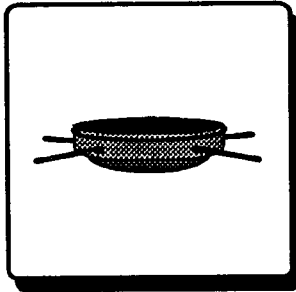


Figure 1 Wide-Area Asset Tracking



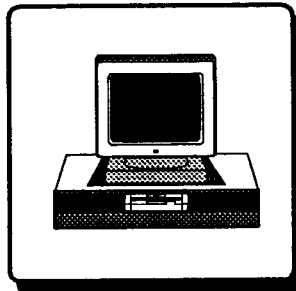
TYTAG

- Affixed to item
- Small radio transmitter/receiver
- Built-in memory
- 50-70 foot range



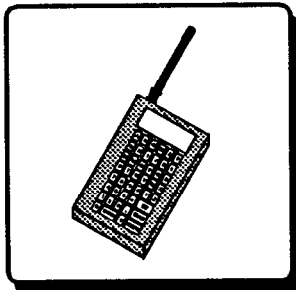
INTERROGATOR

- Ceiling-mounted
- Highly reliable radio transmitter/receiver
- Finds all tagged items in its area (cell)
- Reads/writes data to tags
- Sends data to central computer



COMPUTER

- Manages system communications
- Compiles data for inventories
- IBM PC-compatible
- Graphic user-interface



PORTABLE INTERROGATOR

- Hand-held Interrogator
- Finds all tagged items in an area
- Reads/writes data to tags
- 4-line display and alphanumeric keypad
- Connects to computer to download data

Figure 2 TyTag System Components

TagOS software provides a Graphical User Interface that displays the location of the Assets. This data is either real-time data or recent-time data. Real-time data requires the system to collect information from the Tags immediately prior to producing a report. Recent-time data uses the most recent database information that may be several days old. The data is displayed either in a table format or a graphic format. The Graphical User Interface also allows manual control of the system. Finally, The TagOS software manages the communication between the Interrogator and the Central Computer.

Figure II shows the components of the System in graphic format.

How it Works

The TagOS - Asset Management System operation has three major categories:

- a) Random Collection
- b) Real Time Collection
- c) User Initiated Tag Commands

The basic system protocol depends on the Interrogator sending a sequence of control signals to the Tag and the Tag responding. The predominant operation of the system is the polling or collection of the Tag ID. This polling operation is activated manually by the user or automatically (at random times during a day) by the Interrogator.

In addition to the polling function, the TagOS - Asset Management System allows the user to directly initiate other commands to the Tag. These commands include reading from or writing to a Tag memory, checking Tag status and activating the Tag beeper.

These different operations and their command sequences are described below in greater detail.

Random Collection

Each Interrogator automatically initiates random collections, typically two or three times per day. The randomness reduces the probability of interference caused by other products operating within the system frequency ranges, and thus improves the communication integrity. The random collection sequence of commands are described below:

Sequence of Commands

Wake Up The Interrogator initiates a **Tag wake up command** consisting of a FM pulse for 3.5 seconds. The tone wakes up all the Tags within a 50 ft. approximate radius of the Interrogator (as limited by the Interrogator transmitter's radiated power).

Classification: Control Signal under 15.231 (a) (b) (c) restricted to less than 5 seconds.

Hello The Interrogator initiates a **Hello command** which consists of a 3 ms FM pulse. This command requests that all the Tags within the radius of the Interrogator send their unique identification code along with their respective status.

Classification: Polling or supervision transmission under 15.231 (a) (b) (c) restricted to less than 1 second.

Response Each Tag **responds** by sending its identification code after it receives the hello command from the Interrogator. The response for each Tag is not more than 6 ms in duration and is made only once in any given 10 second

interval. The Interrogator listens for the Tag identification codes sent in response to the Hello.

Classification: Tag recognition code transmission is under 15.231 (e).

Acknowledge and Sleep The Interrogator transmits an **acknowledgment / go to sleep command** to each Tag whose unique identification code was received by the Interrogator. This command is a 10 ms FM pulse. Each Tag that hears the acknowledgment of its identification code goes to sleep.

Classification: Control Signal under 15.231 (a) (b) (c) restricted to less than 5 seconds.

Find Tag The Interrogator checks its internal database and determines if any Tags previously reported have failed to respond. *If (and only if)* a Tag has failed to respond, the Interrogator activates an **alarm condition** and initiates a Find Tag command. This 10 ms FM pulse requests the status of *only those Tags* that have failed to respond to the earlier hello command. If the missing Tags still do not respond, the Interrogator activates an alarm on the Central Computer. This alarm notifies the user about the missing Tag(s).

Classification: Control Signal under 15.231 (a) (b) (c) restricted to less than 5 seconds.

Real-Time Collection

Real Time Collections are **manual commands initiated by the User from the computer**. The command prompts the Interrogators to check the status of all Tags within their respective cells. The basic sequence of commands is the same as in a random collection.

Sequence of Commands

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Classification: Control Signal under 15.231 (a) (b) (c) restricted to less than 5 seconds.

User Initiated Tag Commands

The User can also initiate several Tag commands through the TagOS Graphical User Interface. These commands are directed at a specific Tag and can initiate the following operations:

- a) Activate Tag beeper
- b) Read contents of Tag memory
- c) Get Tag Status
- d) Write data to Tag memory

The first three commands involve the interrogator in a control mode only. A 10-20 ms FM pulse is sent by the Interrogator. The pulse causes a **specified** Tag to respond. The specified Tag **responds** by activating its beeper, sending the contents of its memory or by sending its status.

The fourth command prompts the Interrogator to write data into a specified Tags internal memory. It causes the Interrogator to operate in both a control and data mode. In this mode, the interrogator operates at a significantly lower power level as it sends both control signals and data. The sequence of commands for all four user initiated commands is described below.

Sequence of Commands for (a) (b) and (c)

Directed Wake Up The User initiates a **Directed Wake Up Command** which consists of a 3.5 second FM modulated pulse. This command wakes up all Tags within a 50 ft. approximate radius of the Interrogator. It is followed immediately by a **Sleep All Except Command**. This command sends all the Tags to sleep except the specified Tag. This command takes about 20 ms.

Classification: Control Signal under 15.231 (a) (b) (c) restricted to less than 5 seconds.

Activate Beeper or Send Contents of Your Memory or Send Status. The specified Tag that is awake is then sent a **single command**. The Interrogator can initiate a **command** to the Tag to activate its beeper **or** send the contents of its memory **or** send its status. The Tag is required to respond to the command as well as send an acknowledgment. These commands consists of a 10-20 ms FM pulse.

Classification: Control Signal under 15.231 (a) (b) (c) restricted to less than 5 seconds.

Acknowledge The Tag **responds** with an acknowledgment if the command is successfully implemented. The Tag also carries out the command by either activating its beeper **or** sending the contents of its memory **or** sending it status. **Each Tag responds only once.**

Classification: The Tag acknowledgment as well as data transmission are both under 15.231 (e).

Sequence of Commands for (d)

Directed Wake Up The User initiates a **Directed Wake Up Command** which consists of a 3.5 second FM modulated pulse. This command wakes up all Tags within a 50 ft. approximate radius of the Interrogator. It is followed immediately by a **Sleep All Except Command**. This command sends all the Tags to sleep except the specified Tag. This command takes about 20 ms.

Classification: Control Signal under 15.231 (a) (b) (c) restricted to less than 5 seconds.

Write Data The Interrogator sends a **Write Data command** to the Tag. This command tells the Tag the location and size of memory it requires for the data placement and also tells the Tag to be ready to receive this data. The data pulse is transmitted immediately following the place data command and consists of an FM pulse of less than 1 second.

Classification: The data transmission from the Interrogator is under 15.231 (e) and it is restricted to less than 1 second.

Acknowledge The Tag acknowledges the successful receipt of the data. This acknowledgment is less than 10 ms.

Classification: The Tag acknowledgment transmission is under 15.231 (e).