The Commission has a unique opportunity to achieve in wireless messaging the same economies of scale and competitive market opportunities that its allocation of spectrum to cellular mobile radio provided in the 1980s. Personal Information Messaging Service resolves the major technical and engineering issues that limit the usefulness of conventional paging systems in messaging, namely system capacity and cost per byte. PIMS thus provides a unique opportunity to address the broad base of demand for messaging services and is designed as a platform for development of an entire messaging services industry.

PIMS will meet the following needs and objectives:

(1) Broad demand of serving millions of users nationwide;

(2) Allow multiple unaffiliated service providers to offer competitive service offerings and stimulate innovative new services;

(3) Attract many suppliers of equipment and software to bring innovative new equipment and price competition to a wide variety of users;

(4) Create interest among many retail channels to support a broad base of subscriber unit distribution.

PageMart submits that Personal Information Messaging Service is clearly superior to existing and proposed uses of the reserve spectrum, and is optimally positioned to serve as the foundation to a vigorous and productive wireless messaging industry. This is an objective for which an allocation of 800 kHz for multiple competitive providers is fully justified.

VI. THE LICENSING PROCEDURES FOR PERSONAL INFORMATION MESSAGING SERVICE SHOULD STIMULATE SERVICE AND EQUIPMENT COMPETITION WHILE AVOIDING LICENSE SPECULATION

A. PIMS Licensing Procedures Should Accommodate Multiple Providers

Consistent with the Commission's policies in the cellular mobile radio, long-distance telephone and other markets, the benefits of competition should be made available in Personal Information Messaging Service by the implementation of licensing procedures and standards that accommodate multiple service providers. Spectrum resources are sufficient to accommodate two tiers of competitive service providers: (a) a nationwide service composed of two licensed carriers, and (b) a local service in each MSA of two licensed carriers. Under this approach, PIMS would benefit from the same competitive market structure which has spurred the rapid development of cellular telephony in each local MSA, plus an additional level of nationwide coverage and competition currently unavailable from any wireless technology or service.

PIMS could be developed under either Part 22 or Part 90 rules as a common carrier or private radio service. In either case, PIMS licensees would be expected to comply with all rules under Subpart N of Part 22, together with all other common carrier licensing standards.

PageMart supports a streamlined comparative hearing process for selection of licenseholders, particularly in the case of the nationwide license applicants. Because the advantages of PIMS technology are interrelated to system design and deployment, a demonstrated capability to implement advanced communications systems and system coverage proposals in addition to financial showing should be required. In particular, potential applicants should be required to demonstrate, prior to any license award, that they have the financial, technical and administrative capabilities to complete system construction in at least 10 markets (for nationwide carriers) within two years. The Commission should conduct streamlined comparative hearings, permitting adversarial inquiry into each applicant's qualifications, including provisions for the grant of a significant pioneer's preference. In the case of local providers, more flexibility regarding applicants could be extended to accommodate potentially less-experienced applicants -- since engineering resources for relatively smaller systems are more easily obtained on the market -- but all MSA by MSA applications should reflect system design and operations suitable for efficient and practical implementation regardless of mode of selection. The overriding objective of the selection process should be that only qualified and dedicated applicants are licensed without any unnecessary delay in the availability of PIMS to the public.

B. PIMS Rules Should Standardize System Approach While Allowing Future Design Improvement to Benefit All Carriers

PageMart believes that there should be flexibility in the technical rules governing PIMS. Nonetheless, standardization of certain basic specifications, such as channel bandwidth and masking requirements, is necessary to ensure economies of scale flowing from broad support of manufacturers of both network and subscriber equipment. Indeed, manufacturers can assist the development of personal wireless messaging by an early involvement in setting PIMS standards and through developing modulation schemes (within FCC specifications) which provide for higher data throughput rates.

In order to facilitate consistency in system and equipment design, PageMart proposes that the Commission establish the following minimal technical standards:

First, emission mask requirements under the proposed 25 kHz channel bandwidth should follow those specifications in place for paging systems, that is, the requirements in Section 22.106(b)(2) of the FCC's Rules for the 929-32 MHz frequency bands. These masking requirements should cover polling channels, return link channels and data channels.

Second, a maximum power of 3,500 watts ERP at any antenna height should be permitted to the nationwide PIMS providers, given the fact that no co-channel licensees will be present. On the other hand, for the local providers, power emission standards need to be imposed as to antenna height due to the possibility of co-channel assignments of different carriers.

Third, the maximum return link power should be limited to 1 watt or less to ensure minimum interference with other computer and communications equipment that do not have a high tolerance for high RF energy fields. Also, low power is prudent from a personal health perspective, given the personal use and close proximity of the transceiver equipment.

Fourth, the construction of systems should be accomplished in the shortest time possible once systems network equipment is commercially available. At the time the Commission is satisfied that qualified systems network equipment is available, commercial coverage should be made available in the top 10 MSAs in no more than two years after license grants, and commercial coverage should be extended to at least the top 100 MSAs within five years. Furthermore, local providers would be required to provide commercial coverage one year after license grant.

Commercial coverage should be defined as data transmission coverage of at least 75 percent of the geographical area or population for a given MSA. No rules are proposed for the return link, given the substantial impact terrain and type of vegetation has on the return link reception. PageMart believes that the investment required to meet the forward transmission or "Carey" type rules is sufficient economic commitment to ensure that the return link is constructed in a commercially viable fashion.

CONCLUSION

PageMart's proposal for Personal Information Messaging Service is uniquely suited to merge the benefits of wireless, ubiquitous, cost-effective communication with the ongoing development of portable information-processing devices. Through the use of an open protocol platform which incorporates the technological advantages of frequency reuse, radiolocation capabilities and adaptive architecture, PIMS can achieve spectrum efficiencies, cost savings and network capacities which are orders of magnitude superior to any existing or proposed service or technology. The Commission should expeditiously initiate a rulemaking proceeding to establish the spectrum allocation and rules and policies necessary to make Personal Information Messaging Service a reality throughout the United States.

Respectfully submitted,

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Dated: February 28, 1992.

TECHNICAL APPENDIX

The Personal Information Messaging Service (PIMS) proposed by PageMart incorporates a number of new technology and service innovations. PIMS is an advanced messaging service which permits users instantaneously to receive or send text and graphic information of any length, in any format, to or from a wide variety of portable or stationary devices - including personal organizers, pagers and palmtop computers - anywhere in the United States. PIMS is provided by means of an open protocol platform which incorporates the technological advantages of frequency reuse, radiolocation capabilities and adaptive architecture. Using this system design, PIMS achieves spectrum efficiencies, cost savings and network capacities which are orders of magnitude superior to existing or proposed services or technologies. The purpose of this appendix is to provide a working understanding of the key components of the PIMS system, how they are individually configured and how they interrelate to achieve the objectives of the service concept.

A clear advantage of the PIMS concept is that while it offers an entirely new service that will meet currently unmet user requirements, it does so making optimum use of commercially available equipment. As with any complex system proposal, final decisions about system design can only be made after extensive testing of configuration trade-offs have been completed and equipment manufacturing vendors have confirmed findings and conclusions. PageMart is currently engaged in such experimental efforts under a license granted by the FCC for this purpose. PageMart's objectives are to achieve a service design that will support multi-market products and will avoid the imposition of restrictive requirements regarding the design of end-user equipment - in other words, to serve as a market and service-bridging technology.

I. <u>System Overview</u>

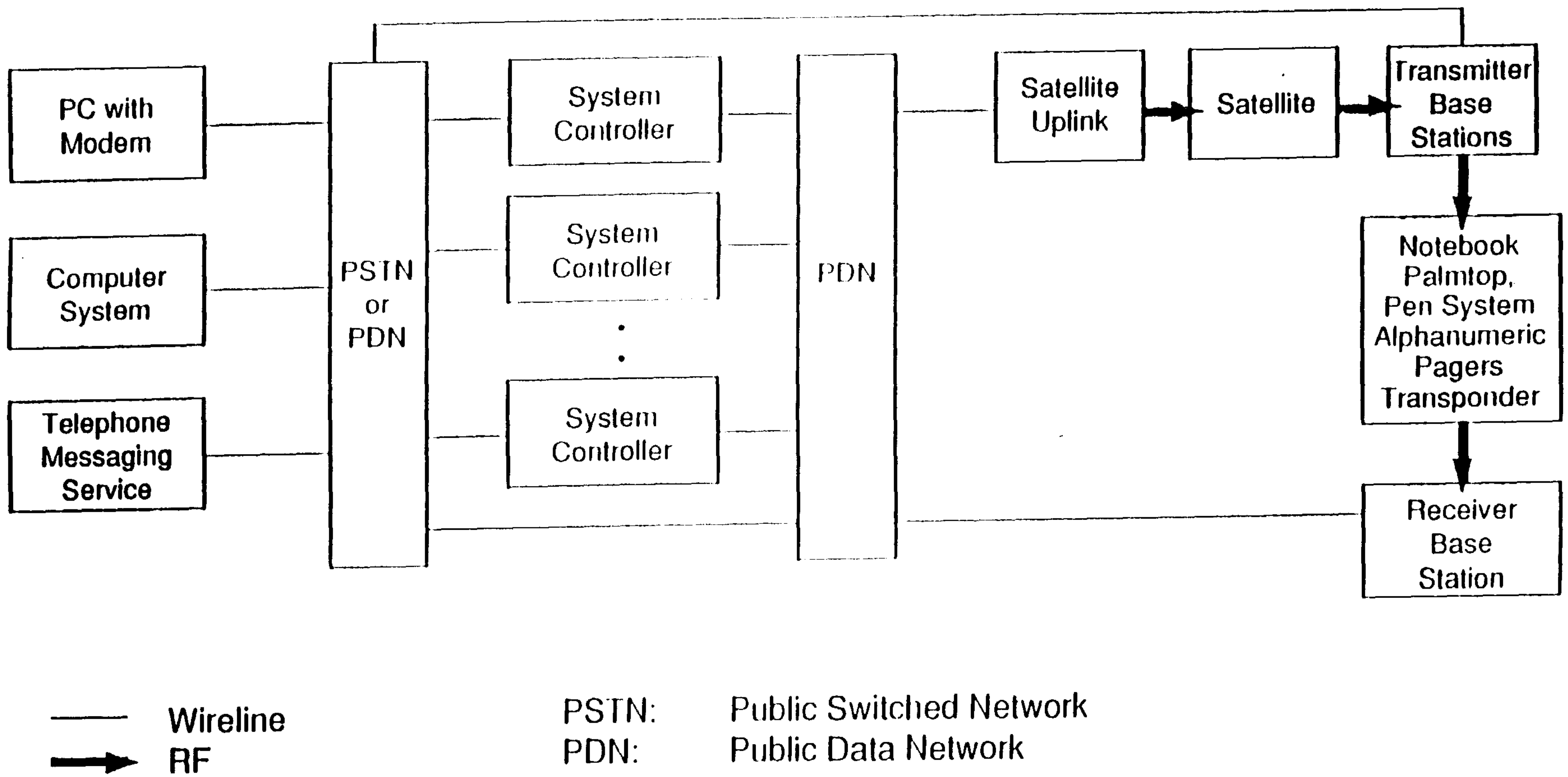
The Personal Information Messaging Service proposed by PageMart is predicated on the use of multiple 25 KHz channels by each service provider. Two nationwide licensees would each be allocated 250 KHz for use in a ten-channel configuration consisting of eight data channels and two command/control channels, the Polling Channel and the Return Link Channel. Two local licensees would be allocated 150 KHz, configured as four Data Channels and the Polling and Return Link Channels. When a message is to be sent, the command/control channels would be used to locate the subscriber in a particular "cell," identify the "best" base station for providing the service link, and set up and control the use of the particular Data Channel that will be assigned for that message.

The system architecture is premised on the use of small, low-power subscriber transceiver units, which will communicate with base RF stations located in a hierarchy of individual "cells." The base stations are controlled by system controllers located in each region or MSA, which are connected to the base stations in their area by means of both satellite links and existing landline networks (Exhibit I). This basic architecture as developed and proposed by PageMart, offers enormous flexibility of design while still achieving the fundamental objectives of the service concept. In particular, alternative approaches could be taken for both data rate and modulation techniques without sacrificing the basic service concept and benefits of high spectrum efficiency, high throughput, and low cost operation and user equipment.

In the PageMart design prototype presented here, which is the baseline system being tested by PageMart under its experimental FCC license, the system operates as a protocol transparent network, and makes use of an innovative signalling approach together with well

EXHIBIT I

CMS Functional Block Diagram



PSTN: Public Switched Network
PDN: Public Data Network

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established constant amplitude modulation techniques to achieve a data rate that approaches about one-half of the effective bandwidth without requiring the use of any restrictive coding or modulation. The system design can initially offer operating data rates of 4800-6250 bps, with even higher rates (9600-12,000 bps) possible.[1]

II. System Description

The key elements of the baseline system for providing Personal Information Messaging Service are:

- An innovative three-tiered "cell" architecture, which allows for extensive and highly efficient reuse of the spectrum;
- Unique application of radiolocationing techniques, to identify the "best" cell for serving the subscriber's current location, thereby using only as much spectrum as is required to meet the needs of a particular message;
- A low-power subscriber transceiver unit, which provides the subscriber with a personal, low cost hand-held RF interface to the service and to the applications products that the subscriber uses;
- Out-bound message transmission techniques that rely on proven technology to provide high spectrum efficiency with error-correction transmission control and low power equipment;
- Spectrum efficient in-bound transmission from the subscriber unit that permits full two-

[1] A key objective of the PIMS design is to keep data rates manageable in order to keep end-user equipment costs down.

way communications; and,

- System control that provides effective management of the system components and ensures high, error-free, throughput in a low cost, spectrum efficient manner.

A. Three-Tiered Cell Architecture

In order to provide a high degree of frequency reuse, the PIMS concept incorporates an innovative hierarchical "cell" architecture. PageMart's experience and research indicates that much of the demand for information messaging will occur in relatively small and crowded metropolitan areas. Accordingly, PageMart has designed the PIMS service concept to achieve reuse of the spectrum to a much greater extent than is possible with traditional cellular designs, by creating cells not only in broad geographic areas but also in individual buildings and even individual office suites within buildings.

The geographic cells would be designed in much the same way as typical cellular telephone cells are today, using a 4-cell reuse pattern, as depicted in Exhibit II. These geographic, or "free space," cells would utilize facilities and equipment comparable to conventional radio sites, except that the transmitting stations would also be configured with satellite dishes to communicate, via a Ku Band satellite, with the system controller.[2] Broadcasting and receiving would take place in free space from towers and building tops.[3]

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[2] Transmitter locations not suitable for satellite dishes would be connected to GPS receivers or similar time delivery receivers and terrestrial facilities or terrestrial facilities only.

[3] In addition to the receivers located at the transmitter sites, additional receivers would be sited based on the particular terrain and urban office building environment to be served, in order to provide a "seamless" coverage pattern for the return link. The deployment of transmitter base receivers and dedicated receivers is depicted in Exhibit III. Propagation analysis can be used to approximate where dedicated receiver sites should be located to augment the transmitter base (continued...)

"Free Space" Frequency Re-Use - Practical Application

(20-cell system - 4-cell re-use plan)

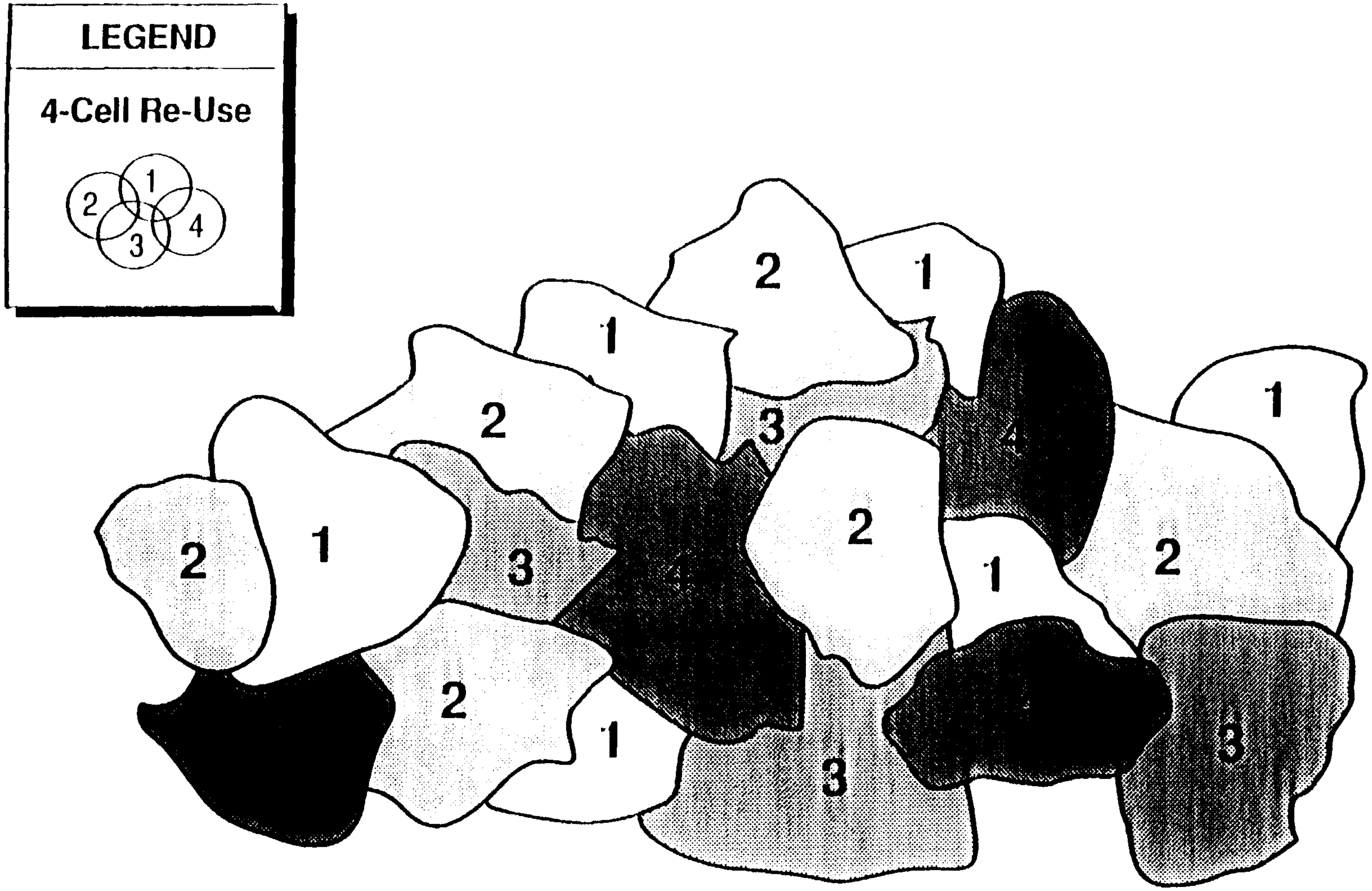

EXHIBIT II

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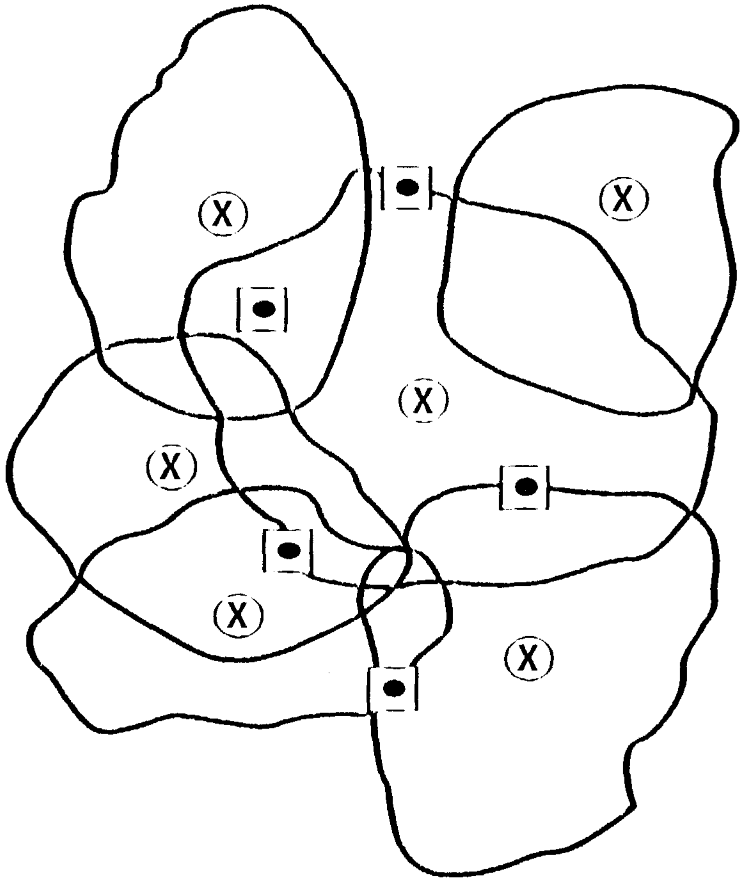
Deployment of Transmitter Base Station Receivers and Dedicated Receivers



(X) — Transmitter Base Station Receiver Sites

[•] — Dedicated Receiver Sites

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EXHIBIT III

Exhibit IV shows the operation of such a geographic cell in the network. This example shows (i) how command/control with the transmitter base station is accomplished using a satellite link to the transmitter, (ii) how the return link and data channel transmission occur from the subscriber unit, and (iii) how the PSTN interconnects the base station return link receivers as well as the transmitter base stations to the system controller for messages to be delivered, stored and transmitted (forwarded) at their appropriate time.

In this example, the out-going message is generated by the system controller, which is the central computer coordinating all message traffic within a MSA, and which accepts and collects all messages and data transmissions. The system controller analyzes the phone number record for coverage and then "pages" the subscriber transceiver unit over the polling channel for location and disposition of the message.

To send a message after locating the subscriber, the system controller sends a GoTo command to the subscriber unit, which instructs the transceiver to go to that specific channel to receive its message, along with the time "marker" for when that message will be delivered. Concurrently, the system controller transfers the message, along with command information, to that specific transmitter cell, such as a geographic cell (Exhibit V), to be broadcast in an assigned broadcast interval (i.e. stored and forwarded on command). The command information contains the time "marker" for the broadcast, the duration of broadcast interval, and the data channel frequency of broadcast, given the need for multiple frequencies to achieve maximum

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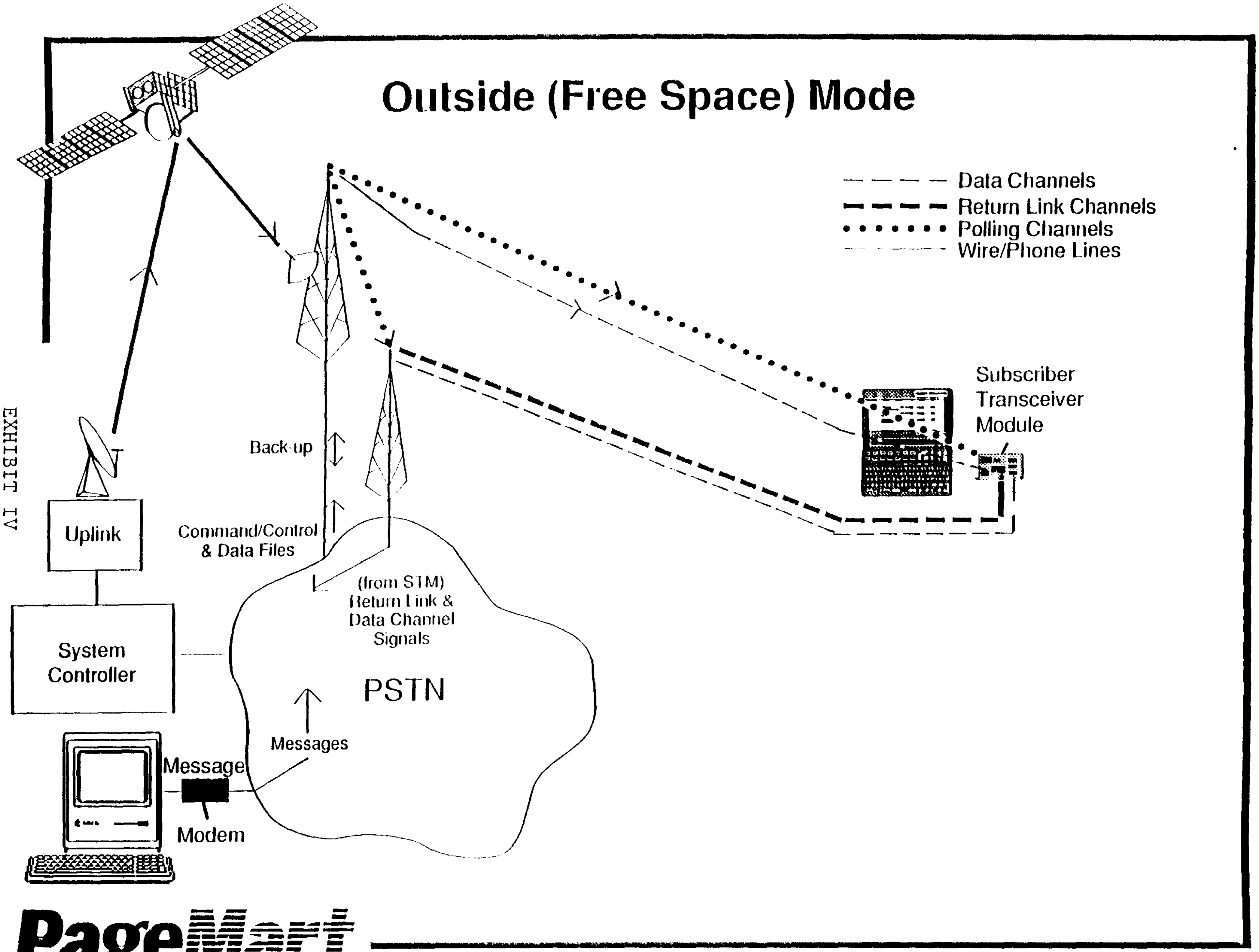
[3](...continued)
station location, but field testing will be needed to confirm coverage and "fill-in" receiver sites will be added where necessary. Initial propagation analysis has indicated that approximately twice as many dedicated receiver sites as there are base station locations will be needed.

EXHIBIT IV

Outside (Free Space) Mode



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Geographic Cell

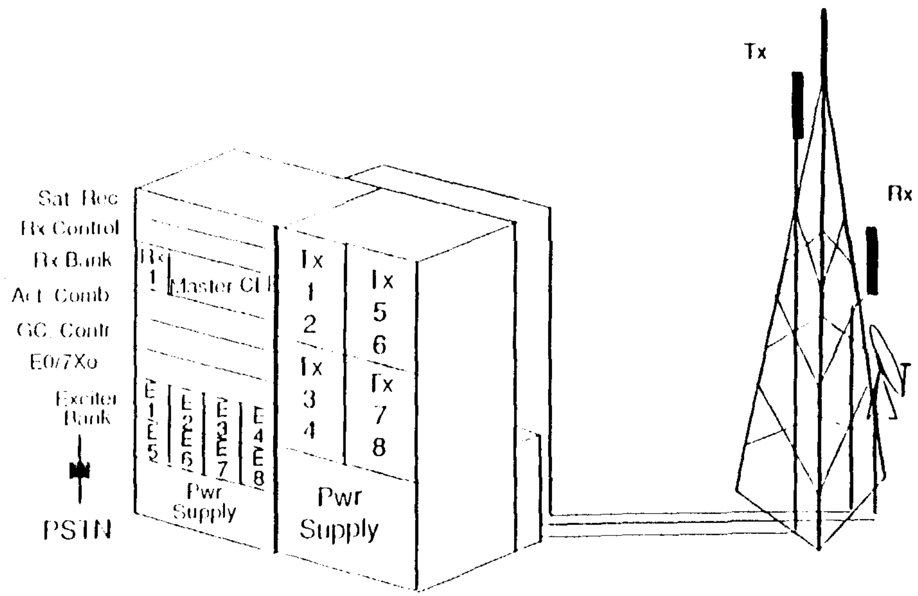
EXHIBIT V

Operating Functions

1) Receive satellite signal
2) Transmit simulcast broadcast on Polling channel
3) Receive Return Link data from STMs
4) Receive data over PSTN for transmission on Data channels
5) Transmit on Data channels to STMs
6) Receive data from STMs over assigned Data channel(s)

Operational Sequence

Polling channel data is received by satellite channel then processed, re-clocked, POCSAG formatted and transmitted. The Polling channel continuously transmits a POCSAG formatted signal. The Return Link signal is received, processed and sends the response and EOT signals back to the system controller with ARQ management at cell site. Messages to be transmitted are time and frequency "marked" by the system controller and are held in memory until transmission time at the cell site. The control module formats data, sets exciter frequency and time controls the data to be transmitted. Subscriber requests for data transmission are received on the Return Link receiver and forwarded on to the system controller which optimally selects the receiver site. Subsequently, Data channel frequency and time interval is set aside for STM transmissions.



Technical Specifications

Input	• PSTN (V.32 or similar modem)
	• KU band satellite
	• Return link channels (-100dbm)
Output	• PSTN (V.32 or similar modem)
	• Forward link channels (100W-300W / channel)
Channels	• 1 Polling channel (transmit only)
	• 1 Return link channel (receive only)
	• 8 Data channels (4 for local carriers)(transmit & receive)

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throughput. After each message packet has been successfully received, an acknowledgement, or Automatic Repeat Request (ARQ), is sent back on the return link channel in its designated time frame. If the message received contains errors, a request for re-transmission (NACK) is made on the return link channel.[4]

The time markers data channel assignment, and messages for broadcast are sent out to the assigned transmission cell over phone lines, given the large amount of information to be transmitted, and a satellite direct broadcast control link or the polling channel itself is used for command/control and to precisely determine broadcast time intervals at each transmitter location.

Of course, the geographic cells can also provide effective coverage inside many buildings located within their service patterns, either through the use of office cells or by means of direct signals to a subscriber transceiver unit. Such a service configuration is depicted in Exhibit VI. In this situation, the system operates in the same way as in "free space," except that the subscriber unit uses either a power module or a separate office cell to communicate with the base station.

Building cells would be created to service the highly clustered in-building demand in the major high rise office buildings where large groups of subscriber units will be served, mostly during the busy hour period of the normal business day. The use of building cells further enhances frequency reuse, since in-building use is isolated from free-space use. The structure of many office high-rise buildings, characterized by high entry/exit insertion loss, provides a natural electromagnetic enclosure. Through the use of slotted coaxial cable run through the

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[4] This process will continue until the last message packet has been received with an End-of-Text (EOT) sent back over the return link.

Inbuilding Operation Modes
(without a building cell)

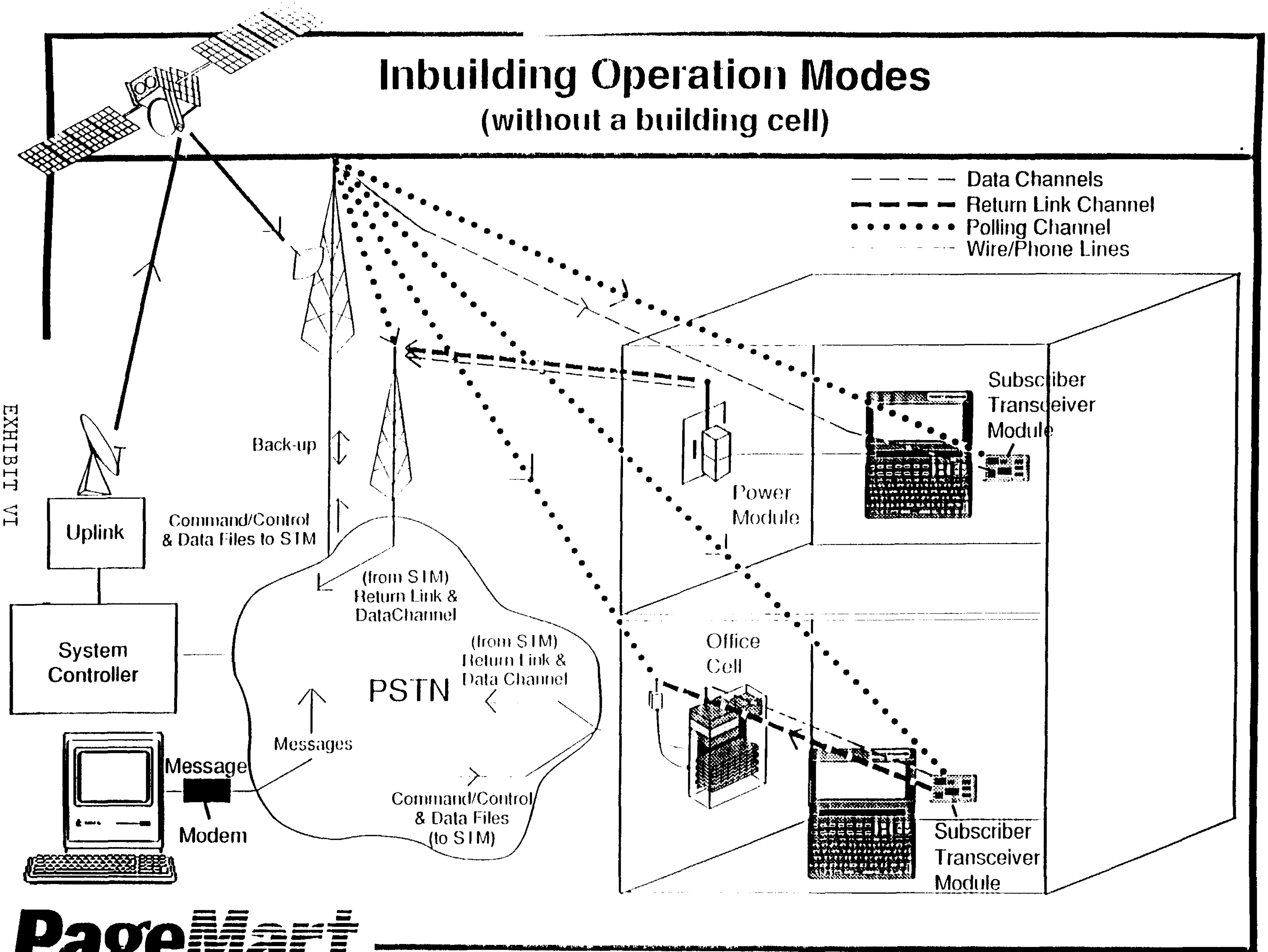

EXHIBIT VI

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building's mechanical space, or core, transmitted signals can be inexpensively distributed throughout the building and serve as low power transmit antennas.[5] Distributed receiver antennas are connected to other similarly placed coaxial cables to optimize reception patterns and overcome floor-to-floor insertion loss in the high rise buildings.[6]

Exhibit VII depicts the configuration of such building cells, using roof-mounted satellite dish antennas, for the polling channel, plus the transmit and receive antenna cables. These building cells use coaxial cables hung vertically in a building's core as distributed transmit and receive antennas. They are also able to be connected to one of the public networks for communication with the system controller, as shown in the detailed description of building cell's function in Exhibit VIII.

Finally, individual office cells would be installed within buildings to create an untethered environment for the subscriber units while providing a mechanism for establishing more cells in buildings where building cells are not installed. The office cell, which could be configured either as a small wall-mount or even a desk-top unit,[7] is expected to be able to transmit data in the 1 watt range. The office cell would operate somewhat differently from the other cells, in keeping with its more limited function and small size requirements. It is configured to have several receiving channels - polling, return link, and data - but typically only a single transmit channel for data. For out-bound messages that it receives, it would not perform the transmit/receive radiolocation search function, but rather would automatically treat itself as the

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[5] Power per channel would likely be in the 10 watt range for these facilities.

[6] Distributed receivers are also under consideration.

[7] If wall mounted, it would be about the size of an electrical junction box or a small telephone 66-block. The desk top unit would be approximately the size of a slim VCR.

EXHIBIT VII

Building Cells - Cellular Paging System

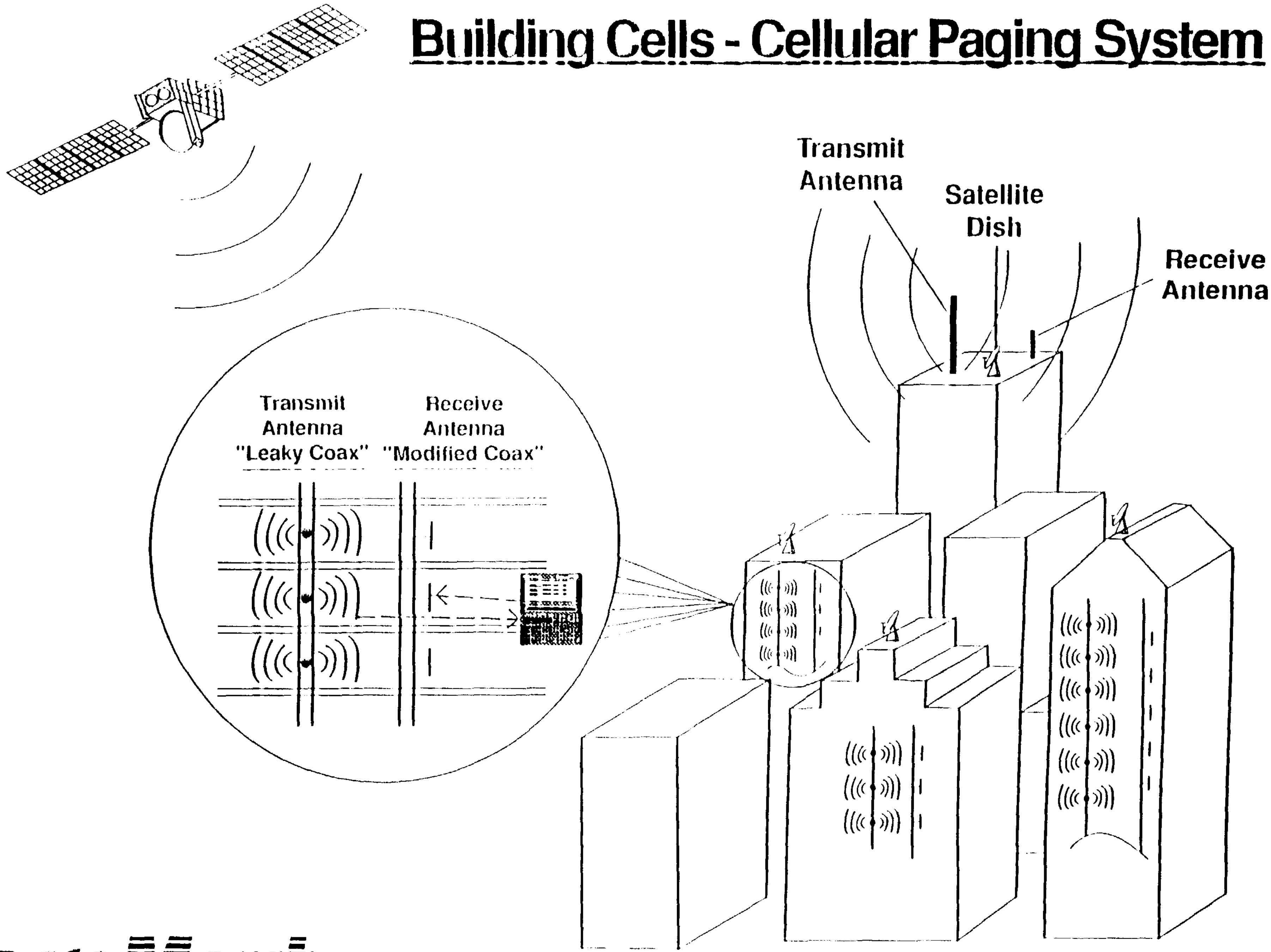

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EXHIBIT VIII

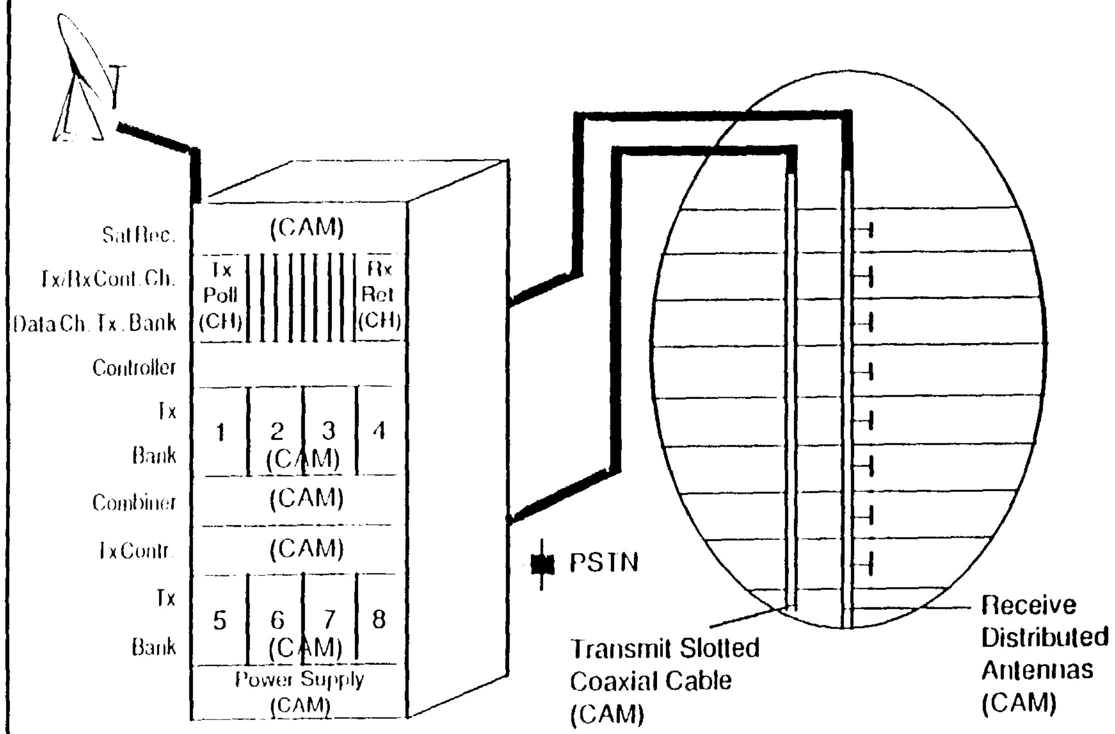
Building Cell

Operating Functions

1) Receive control channel
2) Transmit simulcast broadcast on Polling channel
3) Receive Return Link data from inbuilding STMs
4) Receive data over PSTN for transmission on Data channels
5) Transmit on Data channels to inbuilding STMs
6) Receive data from inbuilding STMs over assigned Data channel(s)

Operational Sequence

Polling channel data is received by satellite channel then processed, re-clocked, POCSAG formatted and transmitted. The Polling channel continuously transmits a POCSAG formatted signal. The Return Link signal is received, processed and sends the response and EOT signals back to the system controller with ARQ management at cell site. Messages to be transmitted are time and frequency "marked" by the system controller and are held in memory until transmission time at the cell site. The control module formats data, sets exciter frequency and time controls the data to be transmitted. Subscriber requests for data transmission are received on the Return Link receiver and forwarded on to the system controller which optimally selects the receiver site. Subsequently, Data channel frequency and time interval is set aside for STM transmissions.



Technical Specifications

Input:	•	KU Band Satellite Rec.
	•	PSTN (V.32 or similar modem)
	•	930 MHz Return Link (-100 dbm)
Output:	•	PSTN (V.32 or similar)
	•	930 MHz Forward Link (10W-50W / channel)
Size:		Rackable Configuration
Channels:	•	1 Polling channel
	•	1 Return link channel
	•	8 Data channels (4 for local carriers)

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"best" serving transmitter for any subscriber unit responding on the return link, and insert its ID in order to receive the transmission from the system controller. The same mode would be followed when it seeks assignment of a data channel for an in-bound transmission originated by a subscriber unit. The office cell would link back to the system controller by connection to the public switched telephone network or other networks as appropriate. Exhibit IX shows the key components of an office cell and how it would operate. An important feature of the service design is the incorporation of the adaptive control of cell utilization to maximize throughput and frequency reuse. As user demands change within a given area, the system controller will automatically reconfigure the RF interface to match the particular spatial loading profile of the data being transmitted. By continuously varying cell broadcast sequences depending on the demand at each cell location, the system can achieve significant economies in the use of the available spectrum.

As illustrated in Exhibit X, the system controller can vary the sequence, number of data channels, and batch cycles dedicated to each type of cell. For instance, if during the peak busy hour period building cell message loading is large, then data channel capacity and batch cycles can be disproportionately allocated to building and office cells versus geographical cells.

B. Radiolocationing of Subscriber Modules

A central element of the PIMS service concept is the use of radiolocation technology to greatly enhance spectrum efficiency and increase data throughput at a low cost. Rather than have the subscriber unit remain in continuous "ID" contact with the base stations in the area, it would only come on-line to identify itself when there is a request to send or receive a message. Thus, when the system receives such a request, the radiolocationing process is

Office Cell

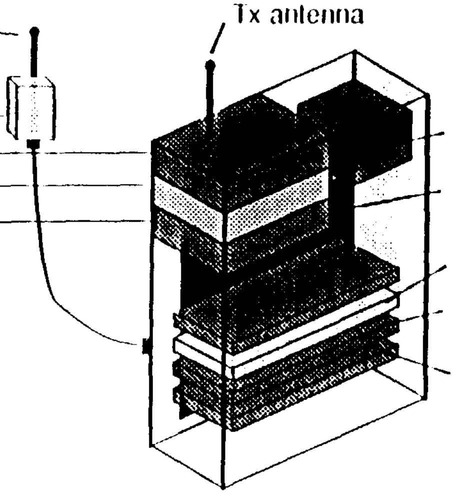
Operating Functions

1) Receive timing, plus command and control form Polling channel
2) Receive Return Link data from in office STMs (Subscriber Transceiver Module)
3) Send return link data to system controller over PSTN but insert office cell ID in place of Polling link ID
4) Receive data over PSTN for transmission on Data channel
5) Transmit data to in-office STMs
6) Receive data from in-office STMs over assigned Data channel

Operational Sequence

The receiver module demodulates the Polling, Data and Return Link channels. The Processor Manager extracts timing plus command and control from the Polling channel, IDs, instructions and ARQ from the Return Link. Office cell sends its office ID plus user ID over the phone line to the system controller. Then, data to be transmitted with transmission instructions are received over the phone line and held in memory until transmission time. Then the computer accesses that file and transmits that file at that assigned time and ARQ procedures. The receiver module is linked to the cabinet using phone extension cables with RJ11 jacks.

Modified Telepoint Base Station



(CAM) - Commercial Available Module

Technical Specifications

Rx Channels	3+	Selectable 8 Fixed 2channels
Bandwidth	25 kHz	Channel bandwidth
Frequency	930.0125 MHz + n25 kHz	Channel center frequency
	n = {0,1,2...9}	n = channel number
RF Power	10w ERP	Effective Radiated Power
Receive Specs	4,800 bps	Match POCSAG 1200
Receiver Module	Pager case size	RF board of pager
Tx Module	10 watts, one channel	Pager transmitter

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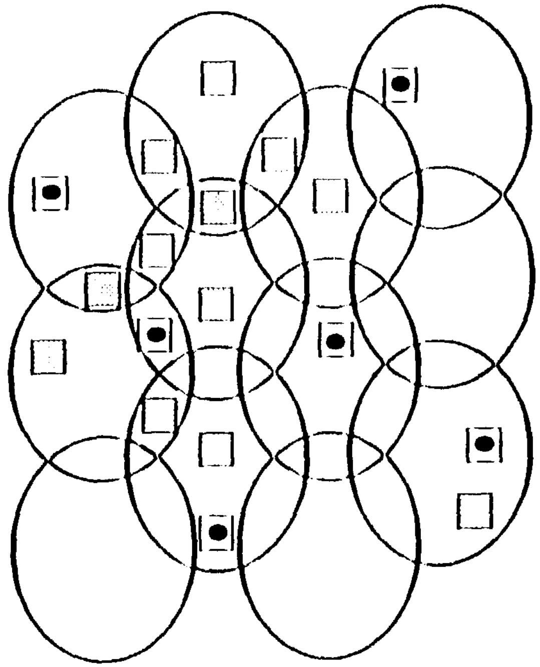
EXHIBIT IX

Adaptive Cellular Messaging System Operation for Data Channel Transmission

TRANSMISSION SEQUENCE (Data Packets in Integer POCSAG Batches)

Flow of Data Channel #3

GC(n)	BC/OC(n)	BC/OC(n+1)	GC(n+1)	GC(n+2)	GC(n+3)	BC/OC(n+2)	BC/OC(n+3)



GC=GeographicCellsTransmission ○
BC=BuildingCellsTransmission □
OC=OfficeCellsTransmission [•]

EXHIBIT X

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performed.

The purpose of the radio locationing function is to identify the base station that provides the strongest signal to the subscriber unit wherever it is currently located. This is done by means of a signal discrimination process using FM detection, which is depicted in Exhibit XI.

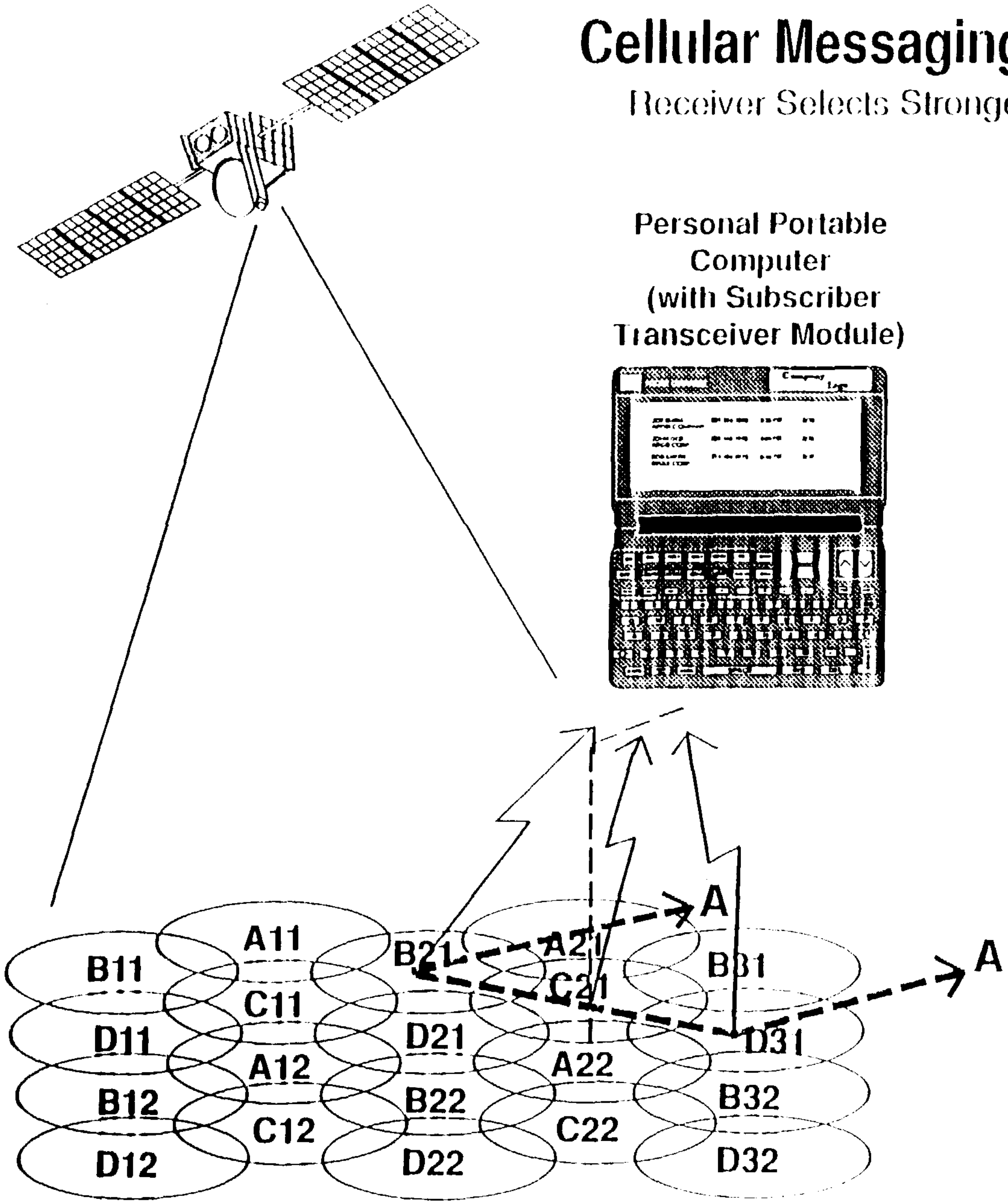
Several approaches are possible. For instance, the system controller can pass along instructions by satellite to each transmitter so that one geographic cell, in each four geographic cell group, is to broadcast its station identification in each frame for a designated batch. During this batch the other three geographic cells simply broadcast sync pulse and power down, while all building cells located within the same service coverage area broadcast their station identification. After four batch cycles, all geographic and building transmitters will have broadcast their station identification.

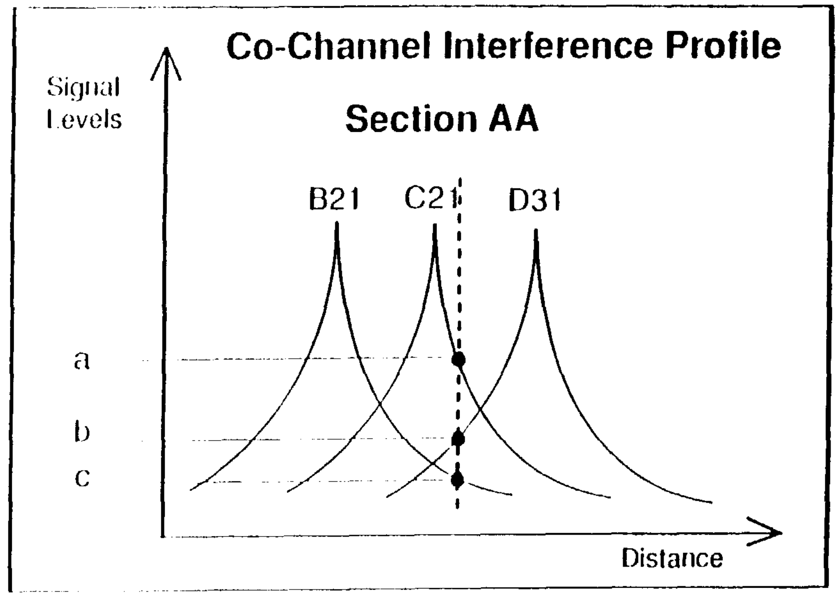
A more spectrum efficient approach to station identification is to transmit the station identification concurrently and synchronously with the polling channel signal at a low data rate using a small percentage of the modulation. The basic approach is to set the station identification signalling rate at the POCSAG batch rate (544 times slower and synchronous with the polling channel rate), plus 10% to 15% of the modulation. Therefore, the station identification signalling approach would use less than 3% of the transmission modulation power yet obtain a SNR superior to the polling channel because the 544 reduction in signalling rate is greater than the power difference. The subscriber transceiver unit extracts the station identification signal by processing the demodulated signal through a low-pass filter to remove the polling channel signal and passing the transmitter identification signal, which is then "hard" limited, to obtain the station identification.

EXHIBIT XI

Cellular Messaging System

Receiver Selects Strongest Signal.





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