NAIC-ID(RS)T-0224-95

NATIONAL AIR INTELLIGENCE CENTER

SINGLE GEOSTATIC ORBITAL SATELLITE IN TRACKING
GROUND-BASED MOBILE RADIO TRANSMITTER

by

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HUMAN TRANSLATION

NAIC-ID(RS)T-0224-95 11 October 1995

MICROFICHE NR: 95C000633

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English pages: 18

Source: Unknown

Country of origin: China
Translated by: SCITRAN
F33657-84-D-0165
Requester: NAIC/TASS/Scott Feairheller
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Abstract

ESLS is a very specialized satellite geo-position system. It is also used in satellite tracking and communication system(SAT/TARC). It can be used to pinpoint any objects that are equipped with ESLS low power radio transmitter. This technology can be used as a new method in radio tracking.

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/139*

I. Introduction

A mobile ground launcher uses either Doppler tracking of low earth orbit satellite or triangular tracking of geostatic orbit satellite. An unique geo-position system, which has been developed by Anglewood Limited Inc. of Colorado, can locate low power transmitter using single geostatic satellite. This is a satellite tracking, measuring and communication system. It has a 165 feet diameter antenna. Single satellite such as this can meet the needs of 10,000 households. In conjunction with a similar satellite, the service can be expanded to 6,000,000 households with considerable amount of improvement in timing and locating accuracy.

II. Satellite Description

The satellite has a 165 feet wide stretchable antenna as it is shown in fig.1. It projects on the earth surface in a rectangular fashion. The satellite can self rotate along the axis of the antenna. It also circle around the plane which is perpendicular to the earth axis. Such rotation and circling covers certain geographic region as it was shown in fig.2. The position of the ground transmitter can be located when emitting signals are received as the antenna is turning.

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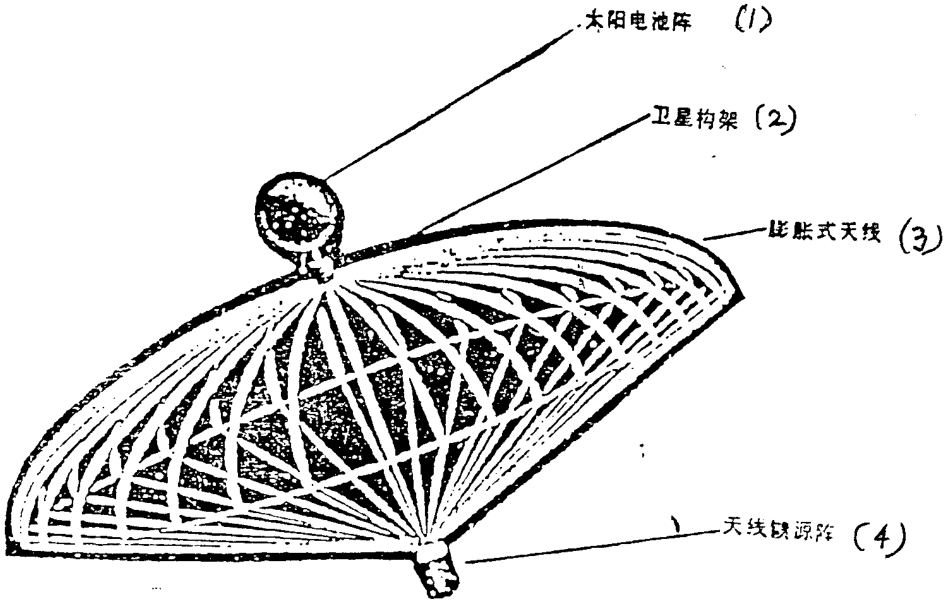


Fig. 1

Key:
(1) Solar panel; (2) Satellite frame; (3) Stretchable antenna;
(4) Satellite power source panel;

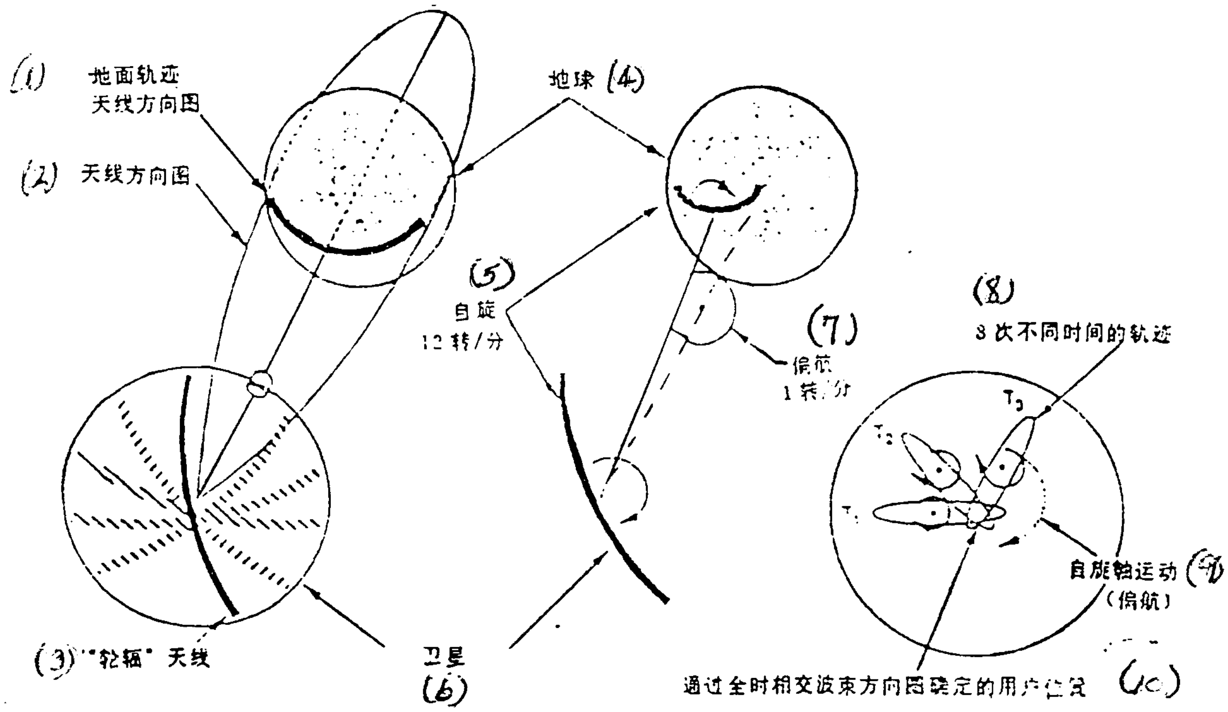


Fig. 2 Satellite tracking and communication system diagram

Key:
(1) Ground orbit antenna direction (2) Antenna direction
(3) "Radial" antenna (4)Earth (5) Self-rotating(12 circles/min)
(6) Satellite (7) Deviation(1 circle/min)
(8) Orbits at three different time points (9) Self-rotating (deviation)
(10) Locate household position using whole phase alternating wave

The working principle of the system

This system can serve customers full time or serve only upon request as it was shown in fig.3. During the full time service, the codes sent by customer's transmitter are relayed to the ground processing station. A mobile ground transmitter can meet the needs.

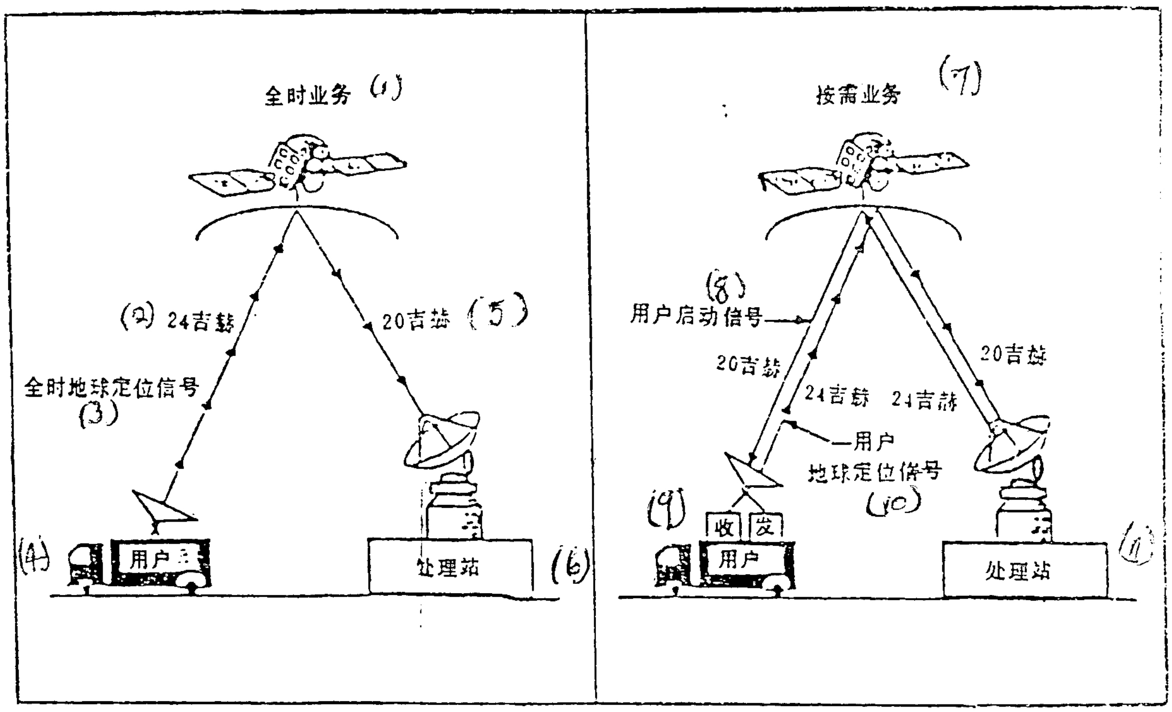


Fig.3 The comparison of full time service transmitter and needs based service transmitter

Key: (1) Full time service; (2) 24 gigaHz; (3) Full time geo-position signal; (4) customer; (5) 20 gigaHz; (6) signal processing station;
(7) Need based service; (8) customer activated signal; (9) receiving and sending by customer; (10) geo-positioning signals from customer; (11) signal processing station.

By providing customer with a small mobile transmitter, the ground processing station can activate the transmitter regularly to meet the needs of the customers.

The characteristics of the system are listed in table 1. It depicts both single satellite effective system and two satellite working system. The communication time is dramatically reduced from 20 min to 1 minute. Single satellite effective system can be converted into two satellite working system by adding the second satellite. The resolution is increased from 1,000 feet to 50 feet. The analysis of single and two satellite system is shown in table 2 and table 3. Studies show that customers only need 5 watt all direction radiating power. The 24 giga Hz working mode can only be achieved by using modern MIMIC technology.

/141

Three pairs of satellite are needed to cover the whole continent as it was shown in fig.4.

为了提供主要大陆的覆盖，则需要如图4所示的三组卫星。

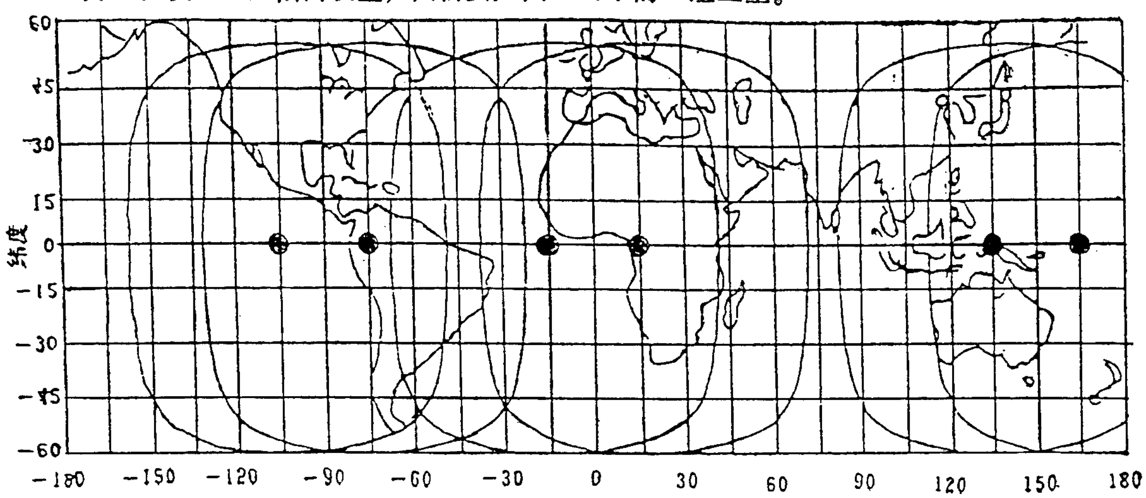


Fig.4 Satellite tracking, measuring and covering range.

Table 1 System characteristics

characteristics	effective system	working system
user antenna	half sphere	half sphere
user receiver	need based	need based
user amplifier	5 watt	5 watt
user basic unit	1.5 MC/s	1.5 MC/s
satellite region	1	2
constellation size	4.5	6.7
satellite antenna	24 radials	24 radials
satellite self rotating rate	0.6 circle/min	0.02 circle/min
satellite deviation rate	0.05 circle/min	None
satellite power	use only 1 of the 24 30 watt	24 30 watt
CPA antenna	1	2
CPA antenna size	90 feet	90 feet
CPA adjust	1000	60,000-100,000
customer	10,000(capable of expand--ing to 6,000,000)	6,000,000
response time	20 min	1 min
Average service response /day	selectable	8
upper chain circuit width	1.5 GHZ	1.5 GHZ
lower chain circuit width	1.5 GHZ	36 GHZ
resolution	1,000 feet	50 feet

/142

Table 2 Chain Circuit Analysis
Single satellite(effective system)

Parameter	synchronous orbit upper chain circuit	synchronous orbit lower chain circuit	communication lower chain circuit	unit
Bozman constant	-198.6	-198.6	-198.6	dBm/Hz/K
noise temperature	30.0	26.2	28.2	dB.K
corresponding spectrum width	11.9(16 Hz)	11.9(16 Hz)	0.0(1 Hz)	dB.Hz
resolution spectrum width	15.7(1,000) ft	15.7(1,000) ft	-	dB.Hz
E/N Interference noise	3.0	3.0	-	
LNA minimum signal	-131.0(satellite)	-134.8(CPA)	-160.8	dBm
antenna wear	-52.5(satellite)			
wave edge wear	3.0	0.5		
opening signal	-180.5(satellite)	-206.8(CPA)	-159.9(user)	dBm
transmission wear	211.5	210.3	210.3	dB
moisture absorption	1.5	1.2	1.2	dB

Required EIRP 32.5(user) 4.7(satellite)
51.6(satellite) Antenna wear -2.1 -20.0
-20.0 dBi
antenna/large power
amplifier wear 1.5 2.0 2.0
edge of wave beam 1.0 3.0 3.0

single user large
power amplifier 32.9 -10.3(satellite)
36.6(satellite)

effective signal
number 0.0 14.0 -
compensation 0.0 3.0 3.0

required large
power amplifier 32.9(user) 6.7(satellite) 39.6(satellite)

large power amplifier 2 watt(user) 10 watt(satellite)

Note: BER-error rate; EIRP-equivalent irradiation power
LNA-low noise amplifier

/143

Table 3 Chain Circuit Analysis
Twin satellite(working system)

Parameters	upper chain circuit on synchronous orbit	lower chain circuit on synchronous orbit	lower communication chain circuit	unit
Bozman cons- -tant	-198.6			
noise temper- -ature	30.09(satellite)			
corresponding spectrum width	28.5(50 ft)	28.5(50 ft)		
$E/N(10^{-3}$ BER)				
Interference Noise	3.0	3.0		
antenna minimum signal	-129.9(satellite)	-133.7(CPA)	-157.6(user)	dBm
antenna wear	-49.3(satellite)	-72.5	-2.1	dBi
wave edge wear	3.0	0.5		
opening signal	-176.2(satellite)	205.7(CPA)	-156.7(user)	
transmission wear	211.5	210.3		
moisture absorption	1.5	1.2	1.2	
required EIRP	36.9(user)	5.8(satellite)		
antenna wear	-2.1	-20.0(satellite)		
antenna/large power amplifier				

wear	1.5	2.0	2.0
wave edge wear	1.0	3.0	3.0
user's large power amplifier signal	37.2(user)	-9.2(satellite)	
effective opening times	-	35.5(3600)	
compensation	-	3.0	3.0
required large power amplifier	37.2(user)	29.3(satellite)	42.8(satellite)
large power amplifier	5 watt(user)	20 watt(satellite)	

IV. Project

Satellite tracking, measuring and communication involves several technical subjects. Some preliminary characteristics on satellite and effective carrying capacity are listed in table 4.

/144

Table 4. Satellite effective carrying capacity feature (major feature in satellite tracking, measuring and communication system)

geo-positioning antenna diameter	165 feet
geo-positioning antenna width	0.15 feet
diversion from the center of earth	0.0
self-rotating rate	0.02 circle/min
benefit for 25 GHZ geo-positioning antenna along the axis	49 dBi
Geo-positioning	1000 feet
benefit for 20 GHZ earth-covering antenna	20 dBi
convertor belt width(upper chain circuit)	1.5 GHZ
convertor belt width(lower chain circuit)	36 GHZ
TT & C system	S wave(major) Ku wave(minor)

1. Antenna error estimate

Antenna error estimate is shown in fig.5. The major technical issue that is facing this 165 feet diameter hyperbola shaped antenna is how to guarantee its surface delicacy. As it was shown in fig.5, a 2.0 mm error in mechanical alignment can often lead to 6 dB loss in antenna power. Therefore, this expandable antenna often has to be calibrated mechanically after it is unfold on orbit.

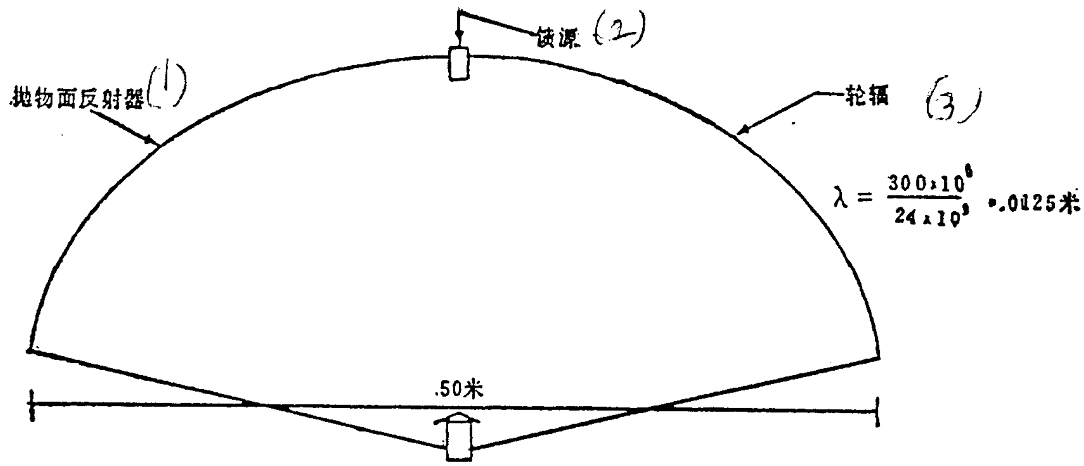
2. Self-interference

Self-interference mostly results from increasingly high customer response and full time customer usage. The measurements and wave beam response estimate are shown in fig.6. The ideal solution is to adopt wider belt and more powerful transmitter. The assignment of radio wavelength restricts the width of belt, while light weight mobile receiver restricts the real usable power.

/145

3. Satellite power requirement

The power requirements for satellite tracking, measuring and instruction are listed in table 5. A "director" satellite requires more panel surface area than the one provided by spreading solar panel of a regular satellite. In order to increase power, an expandable globe structure antenna is installed away from the earth with resilient and economical solar panel.



天线机械精度	近似增益损耗
0.0mm	0.0dB
1.0mm	1.2dB
1.5mm	3.0dB
2.0mm	6.0dB

Fig.5 Antenna error estimate

Antenna mechanical accuracy approximate benefit loss

0.0mm 0.0dB

/146

Antenna benefit is contingent upon surface roughness and the shape of fully unfolded hyperbola under that particular kinetic and thermodynamic condition.

Key: (1) hyperbola shaped reflector; (2) reflecting source; (3) wheel radius.

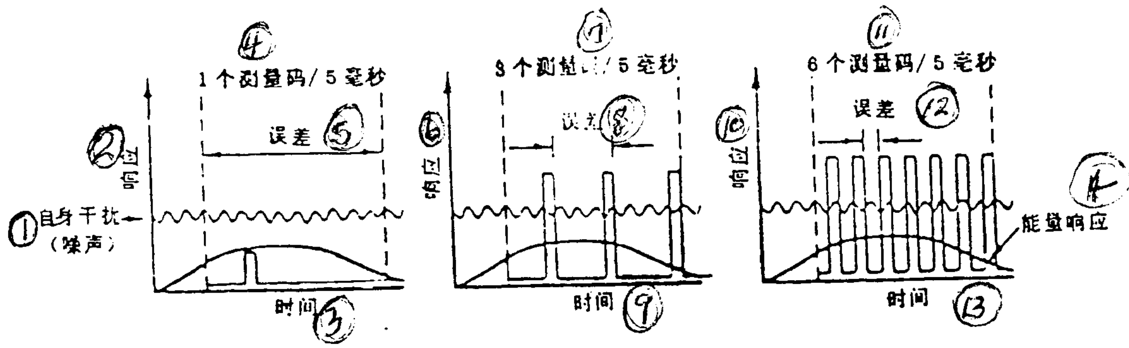


Fig. 6 Measurement/wave response estimate
better resolution=wider belt width=more customer usage power

Key: (1) self-interference; (2) response; (3) time; (4) one measurement unit=5 msec; (5) error; (6) response; (7) 3 measuring unit=5 msec;
(8) error; (9) time; (10) response; (11) 6 measuring unit=5 msec; (12) error; (13) time; (14) energy response.
a) 5 msec shining(7 mile width).

. Due to the high self-interference level, it is impossible to test energy level. The response does not exceed noise level.
. Specific user codes can be used to distinguish customers.
. Coded instruction have to be received within 5 msec. of wave scanning.
. The higher the frequency of measurement per scanning, the higher accuracy in positioning.

Table 5. Summary on power

subsystem	power(watt)	working cycle	average power
electric source subdivision (adjustor use 75% power)	8.5	1.00	8.5
communication & digital processing			
processor	10.00	1.00	10.00
quality storing	10.00	0.65	6.5
global positioning system receiver	8.00	0.50	4.00
transmission system			
instruction receiver	2.30	1.00	2.30
S wavelength transmitter	22.40	0.12	2.70
position control system			
reaction momentum wheel(2)	14.00	0.25	3.50
magnetic meter	1.00	0.10	0.10
torsional pendulum speed(3)	2.70	1.00	2.70
earth sensor	1.00	1.00	1.00
momentary control(i.e. work motor)	120.00	0.01	1.20
effective carrying capacity			
total capacity(orbital average)			115.00
battery wear(orbital average)			16.00
total power(orbital average)			131.00

V. Conclusion

The new satellite tracking, measuring and communication concepts developed by Kinetic Energy Company Limited proved to be very practical based on preliminary system engineering analysis. Although, some technical details on providing this new earth positioning service remain to be addressed, they are within the scope of current available technology.

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