



*Network-Based RTK-GPS Experiment
Using Area Correction Parameter (FKP)
via TV Wave in Japan*



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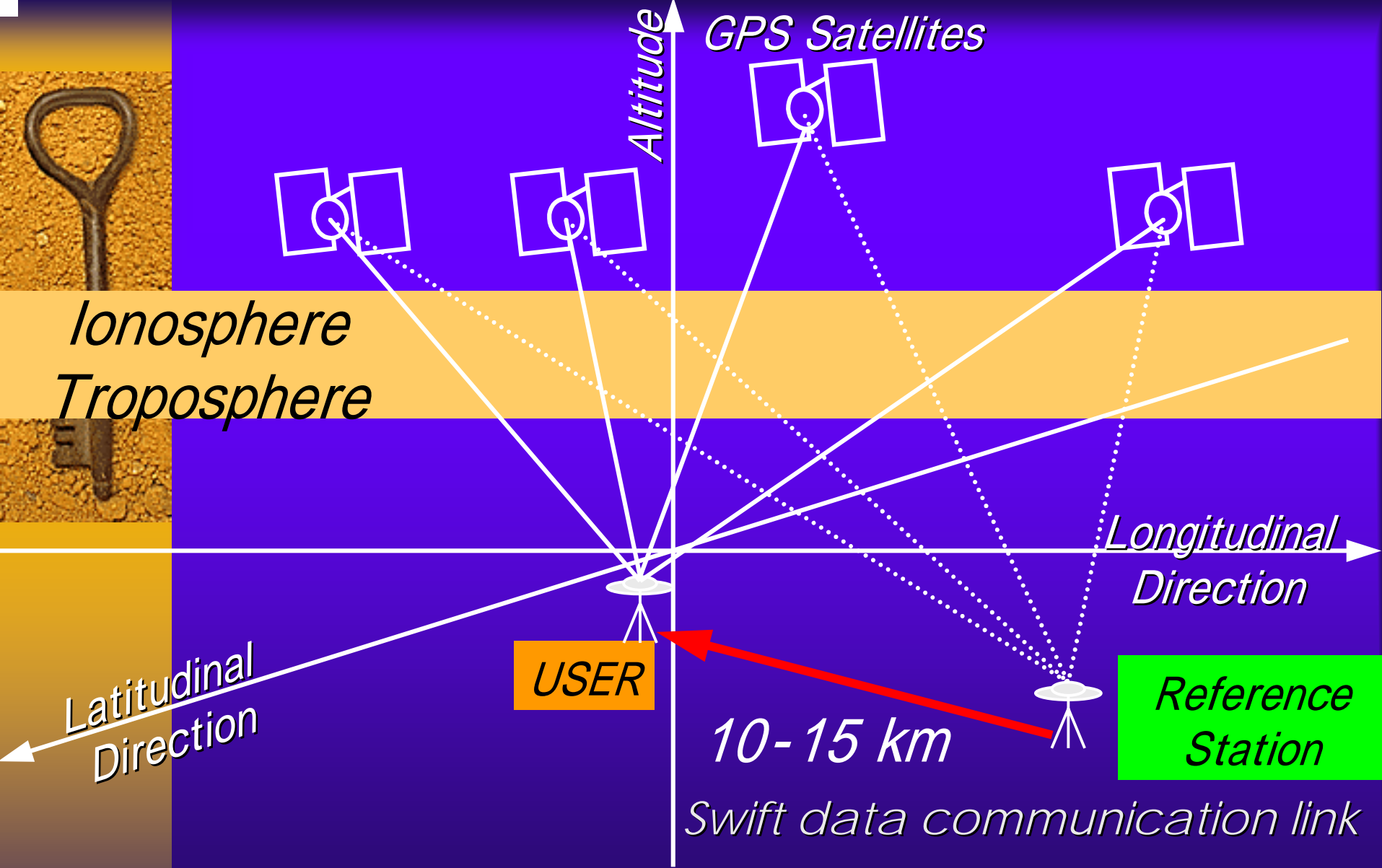
Brief

- ◆ *Our presentation is just about experiment of RTK-GPS using FKP data via TV wave.
(not algorithm)*
- ◆ *Network-based system*
- ◆ *TV broadcasting system*
- ◆ *Mobile and static experiment results*
 - *Public phone line and TV wave*
 - *Normal RTK and network based RTK
(normal RTK means it doesn't consider atmospheric correction)*



Outline of RTK-GPS

- ◆ *Precise real time Satellite Positioning System*
- ◆ *Carrier Phase Positioning*
- ◆ *Ranging mm Order*
- ◆ *Positioning Precision a few cm (2drms)*
- ◆ *Real-Time Positioning*
- ◆ *Many Applications*



A radio communication device with low power
Diagram of RTK-GPS



Altitude

Low power radio => 1km
Atmospheric effects => 10km

RTK-GPS users in Japan have desired more flexible, wider and less expensive service for a long time.

10-15 km
Radius

Longitudinal
Direction

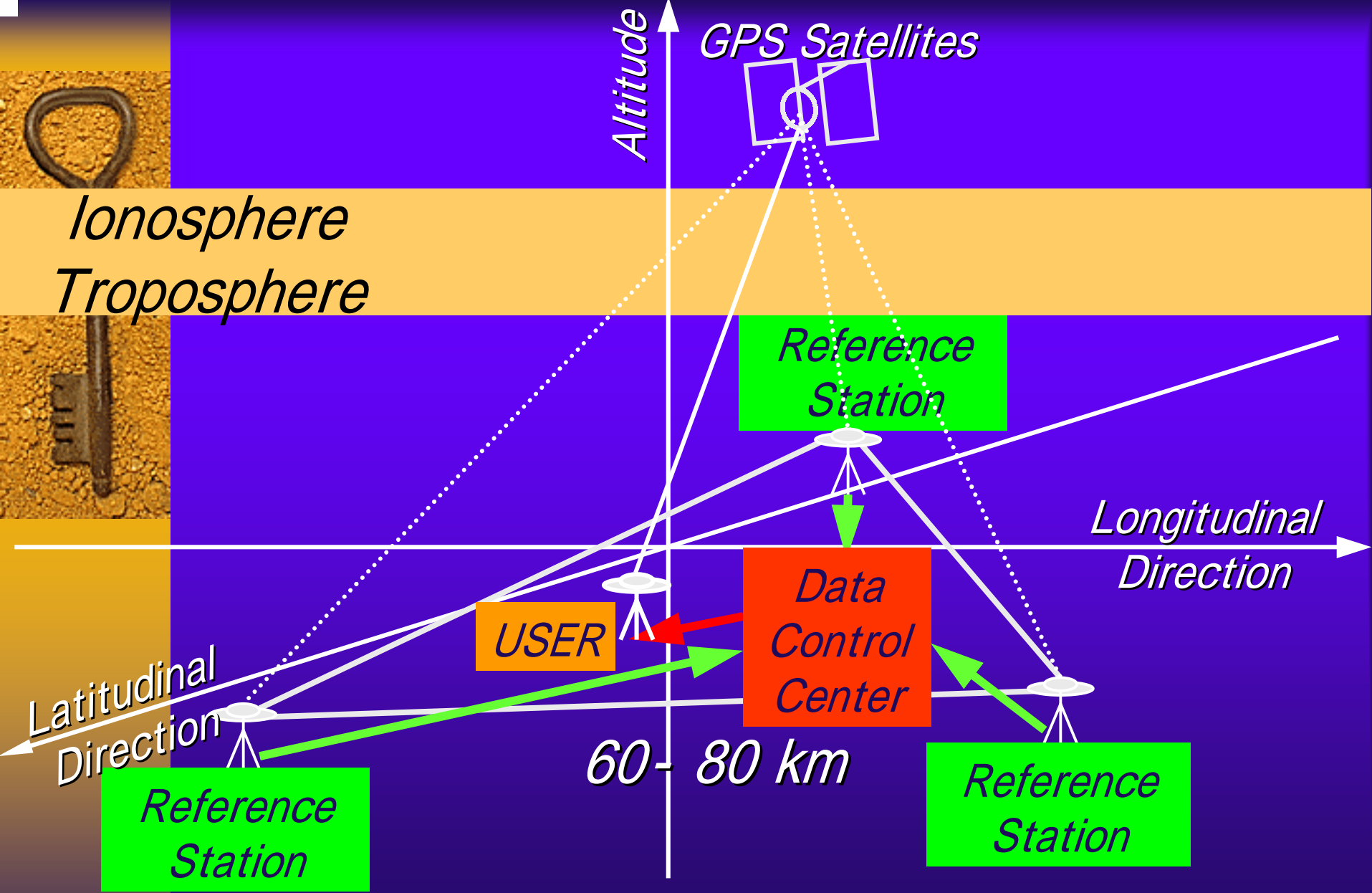
Latitudinal
Direction

Reference
Station

Reference
Station

Reference
Station

Area Diagram of RTK-GPS

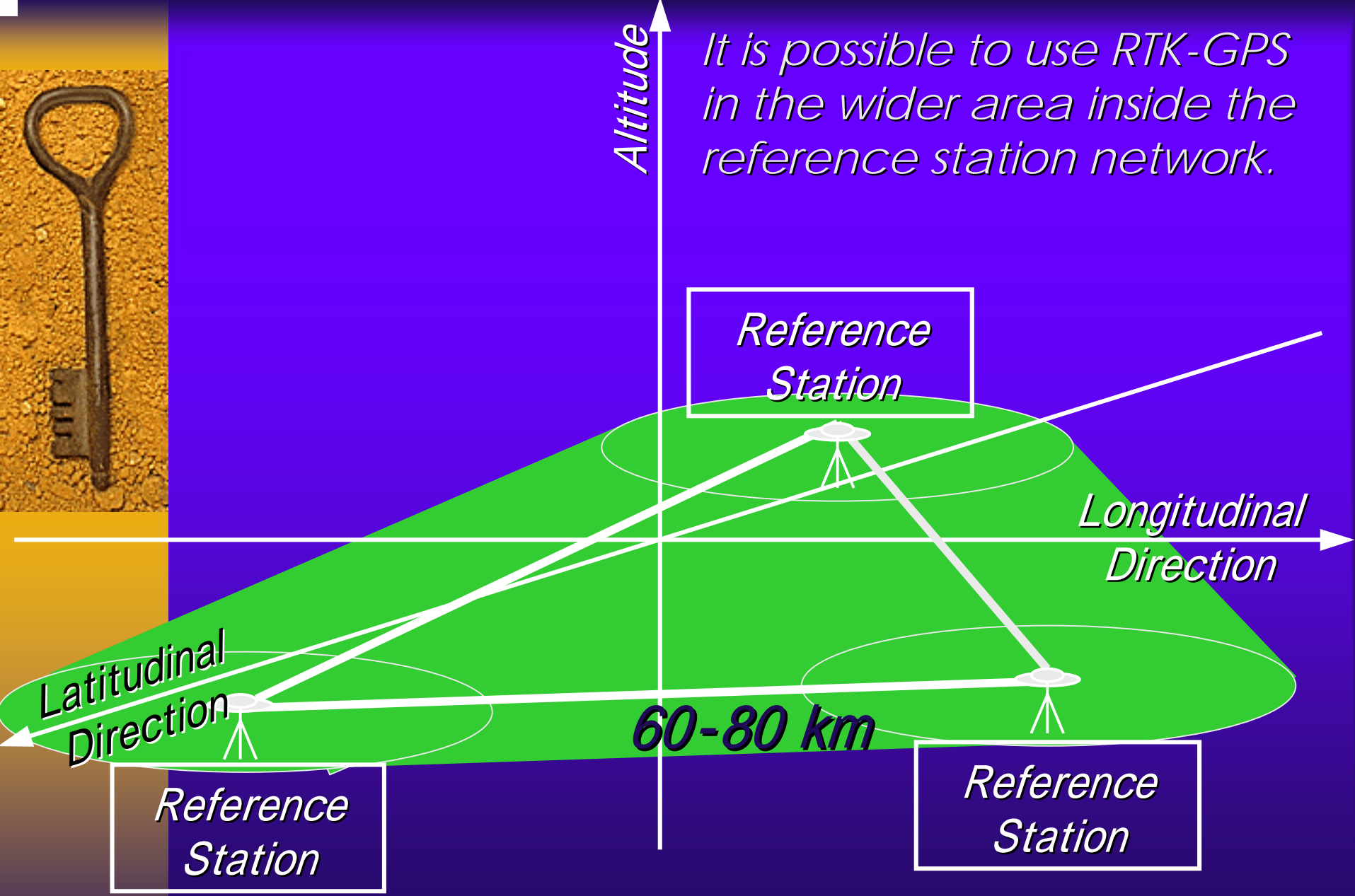


Conceptual view of Network-Based GPS



Altitude

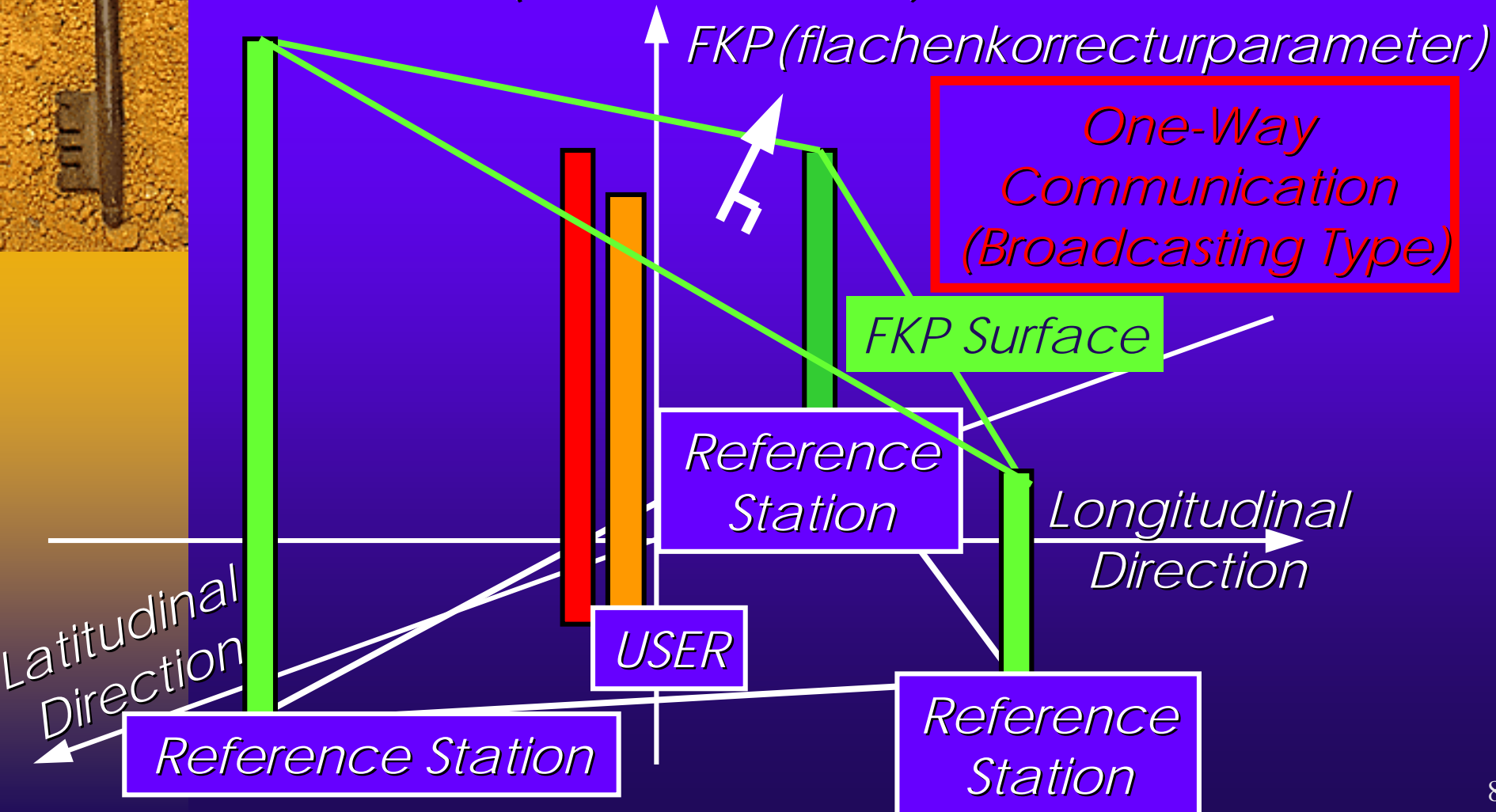
It is possible to use RTK-GPS in the wider area inside the reference station network.




Area Diagram of Network-Based RTK-GPS

Diagram of Area Correction Parameter (FKP)

Carrier Phase Raw Data
(Each Satellite)






Transmission System for RTK-GPS Correction Data

- ◆ *Cellular Phone Line*
 - *9,600 bps*
 - *Two-Way Communication*
 - *High Price*
 - *Re-Connection*
- ◆ *Specific Low Power Radio Device*
 - *No Need a License*
 - *Area: Several Hundreds meters*

We need more useful data transmission method

> Broadcasting Type



TV ASC (Audio Sub-carrier Channel) Audio Multiplex Data Broadcasting

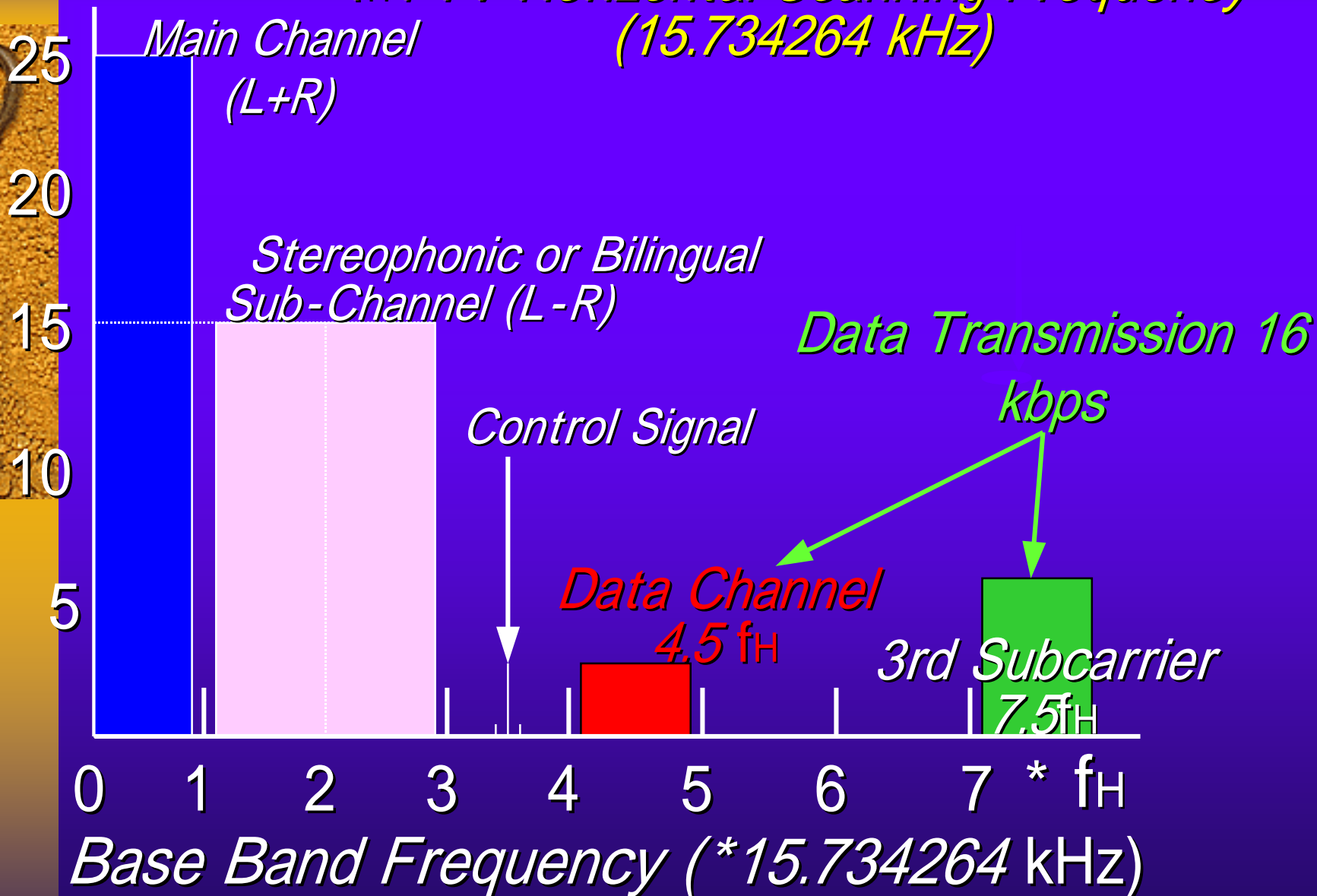
- ◆ *TV Audio Sub-carrier Channel -> Data Transmission System*
- ◆ *TV Asahi Co.*
- ◆ *1997 Ministerial Ordinance*

Advantages

- ◆ *It can be disseminated to many users in a wide area simultaneously*
- ◆ *Low Price*
- ◆ *Receive by usual TV antenna*
- ◆ *Data Transmission Rate
-> 16kbps*

f_H : TV Horizontal Scanning Frequency
(15.734264 kHz)

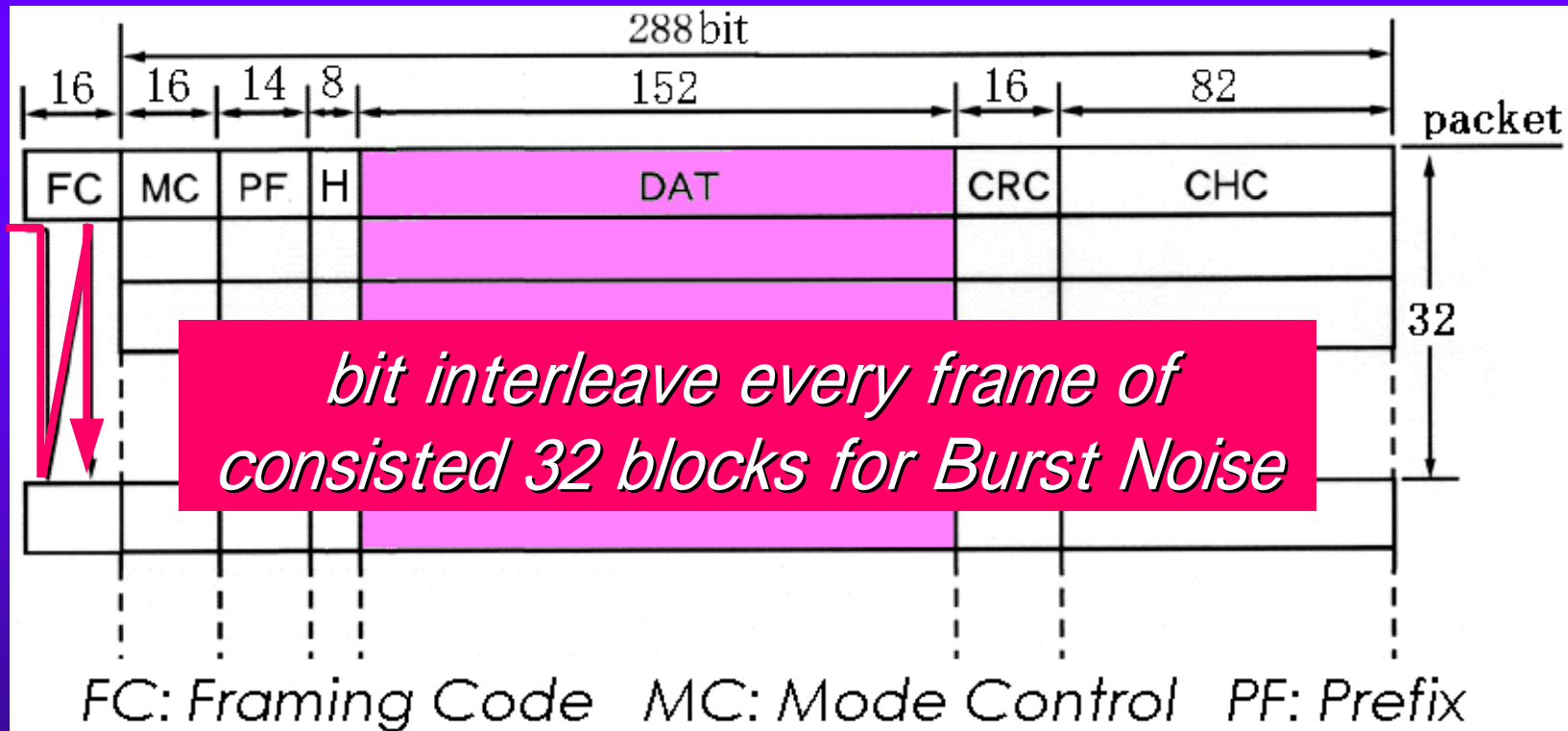
Carrier Frequency Deviation(kHz)



Frequency Spectrum of TV Audio Band

$$(16 \text{ bits} + 288 \text{ bits/packet} * 32 \text{ packets}) / 16 \text{ kbps} = 0.577 \text{ s}$$

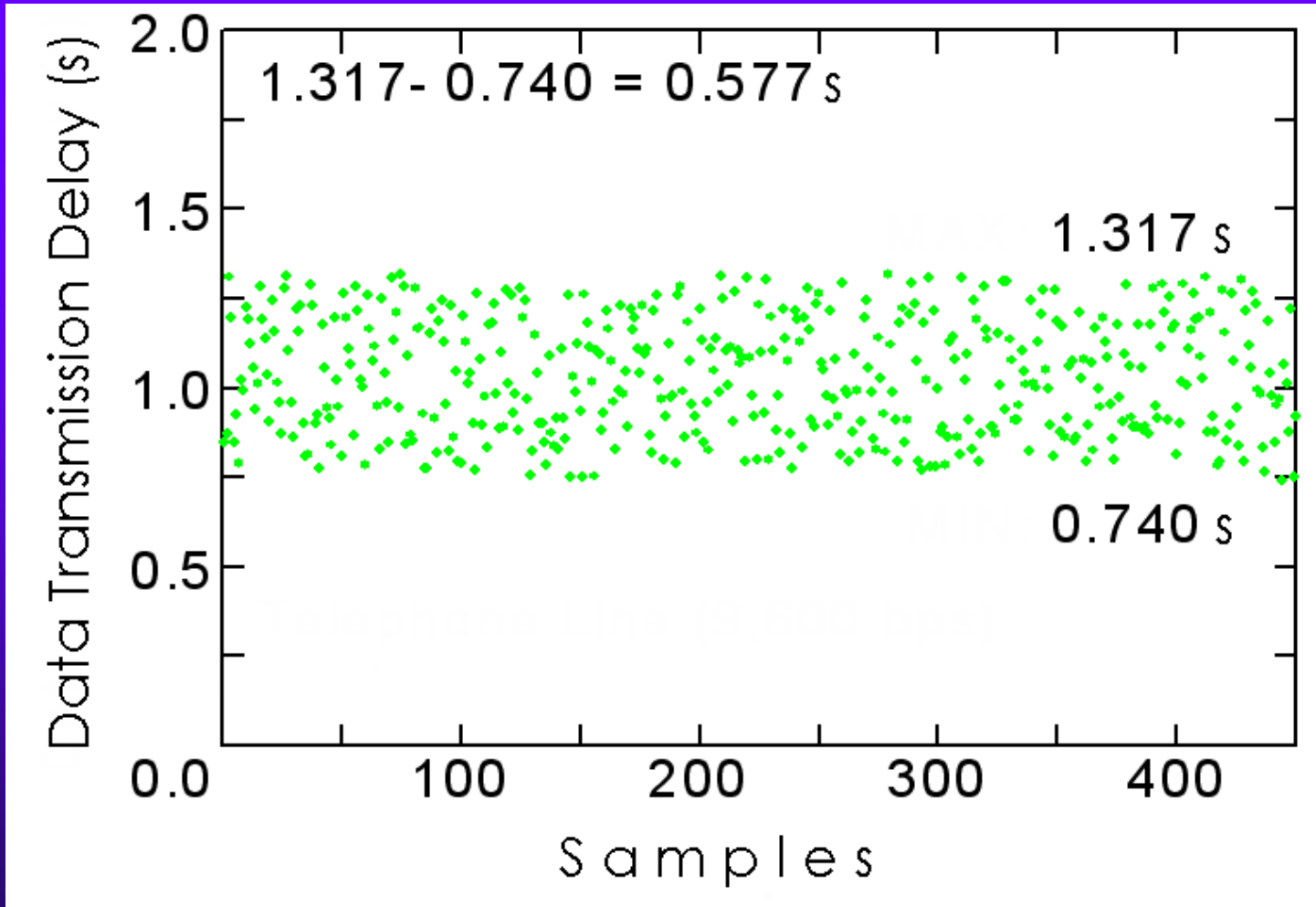
0.740sec to arrange the format



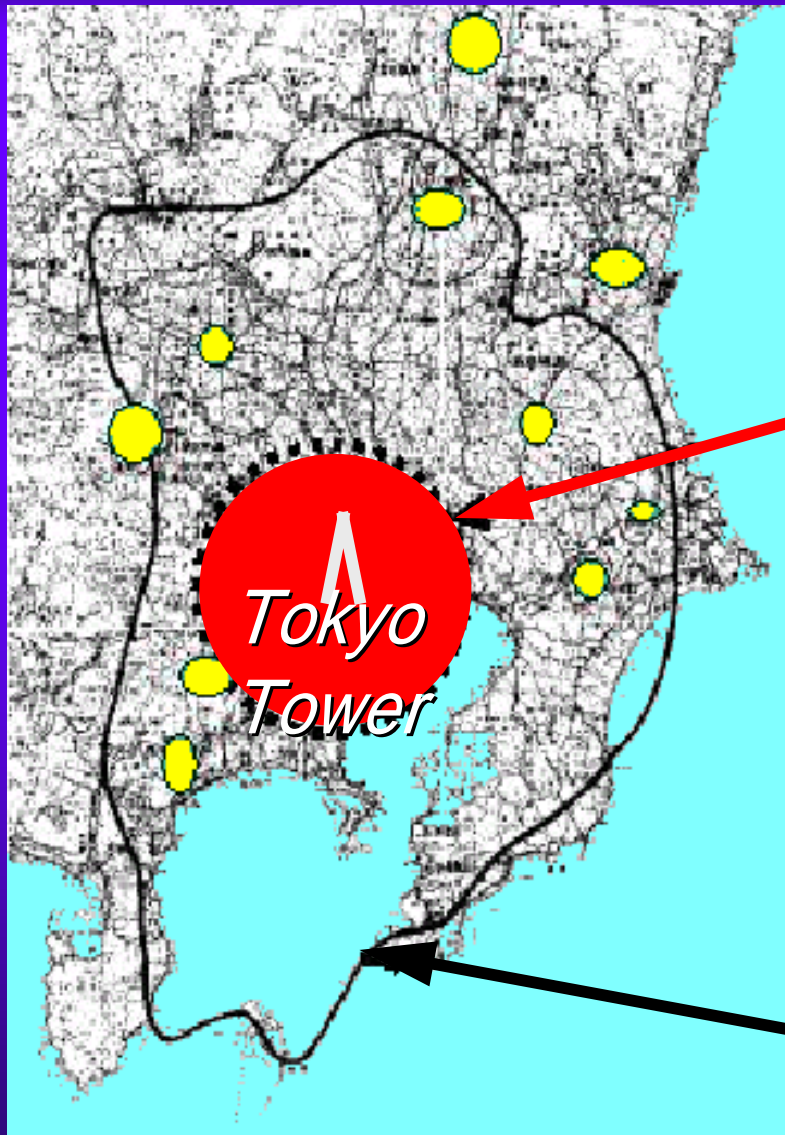
Practical Data Transmission Rate 8.43 kbps

Format for Data Frame of ASC

$(16 \text{ bits} + 288 \text{ bits/packet} * 32 \text{ packets}) / 16 \text{ kbps} = 0.577 \text{ s}$



Data Transmission Delay of ASC



● *TV Relay Station*

Mobile Reception Area with Whip Antenna

Fixed Reception Area by TV Yagi Antenna

Service Area of ASC in Kanto Region



*Size: W195 * H25 * D132 mm*

ASC Receiver (ASC2001)

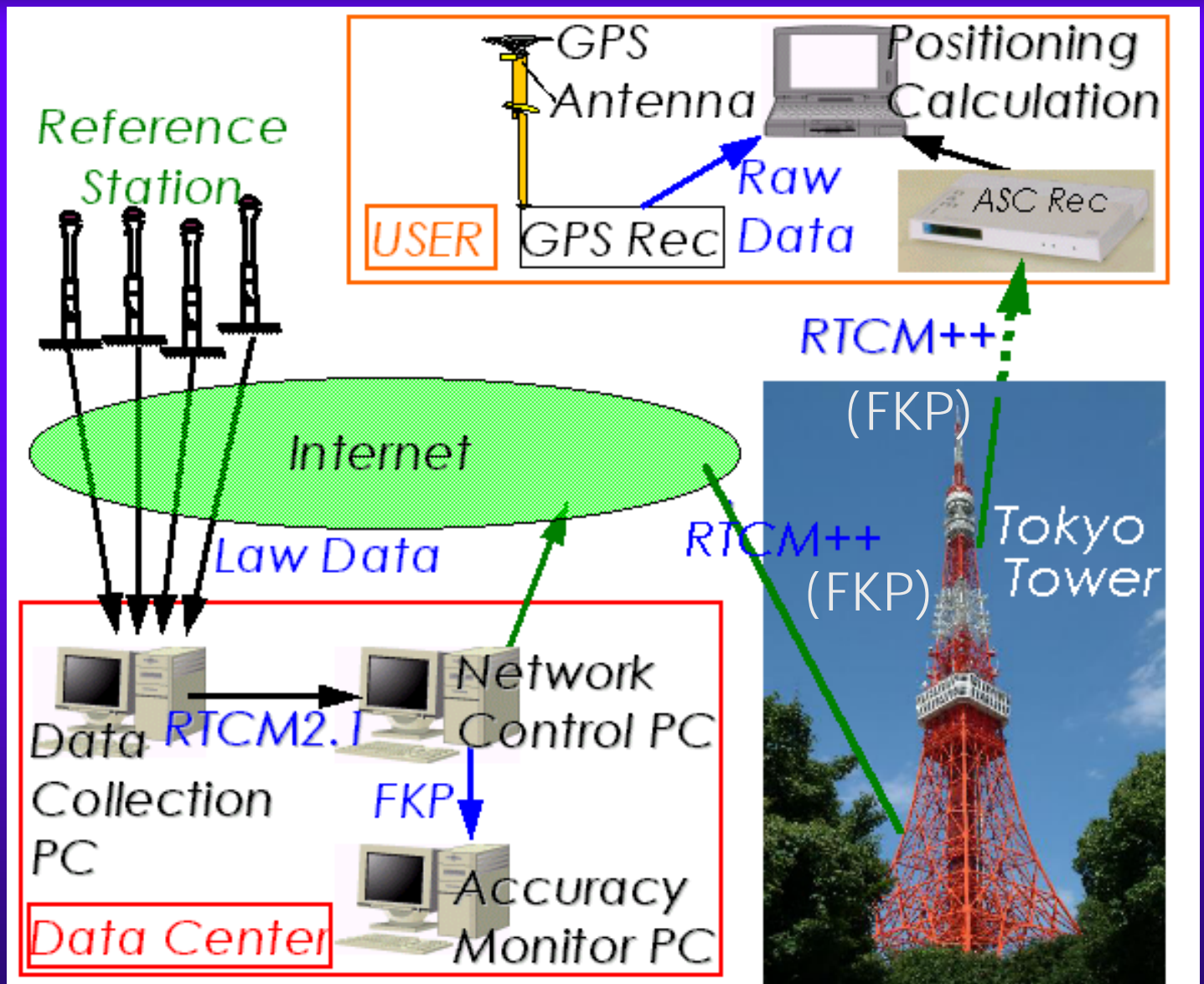
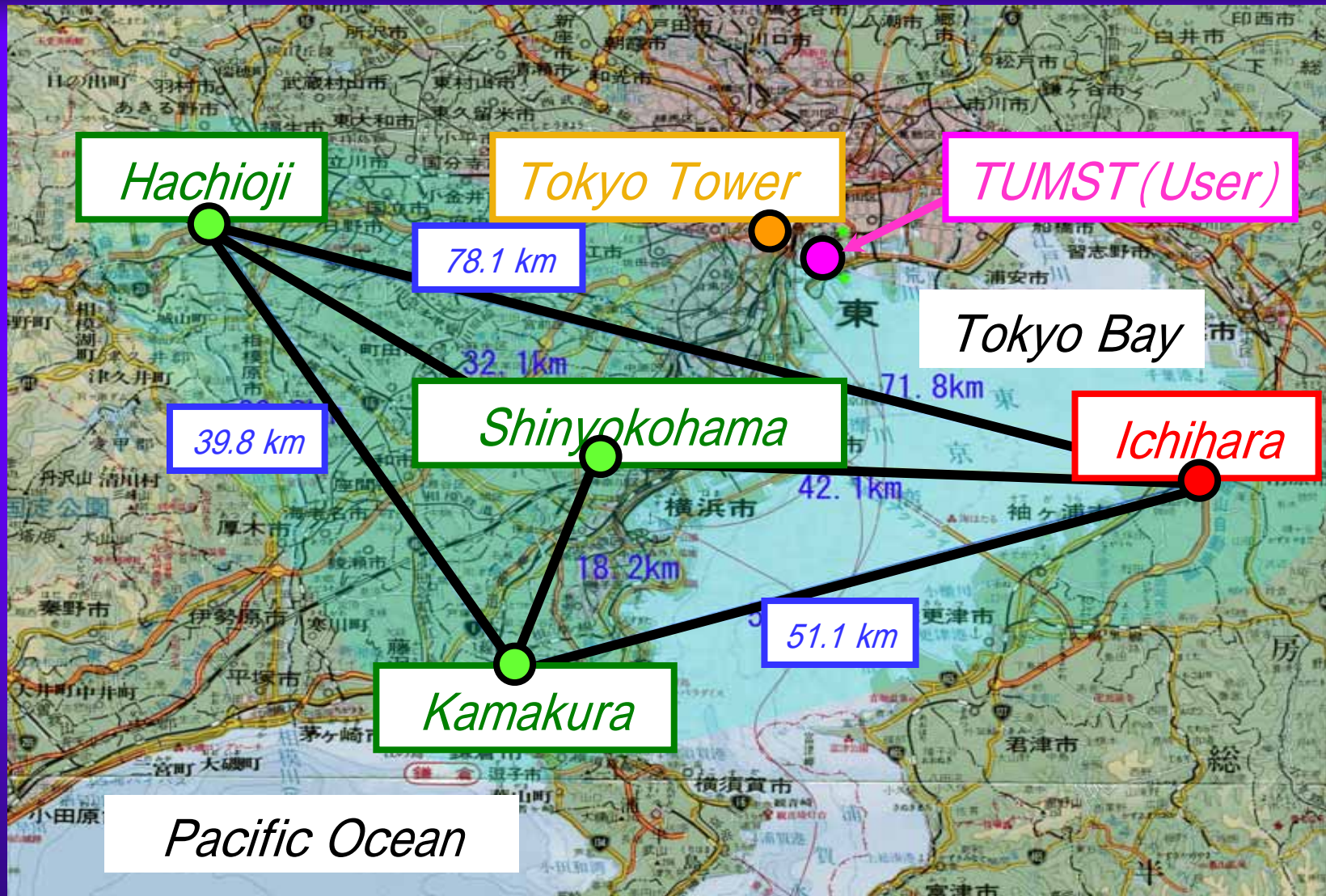


Diagram of the data flow in this experiment



Map of GPS Reference Station



*GPS & ASC
Receivers*



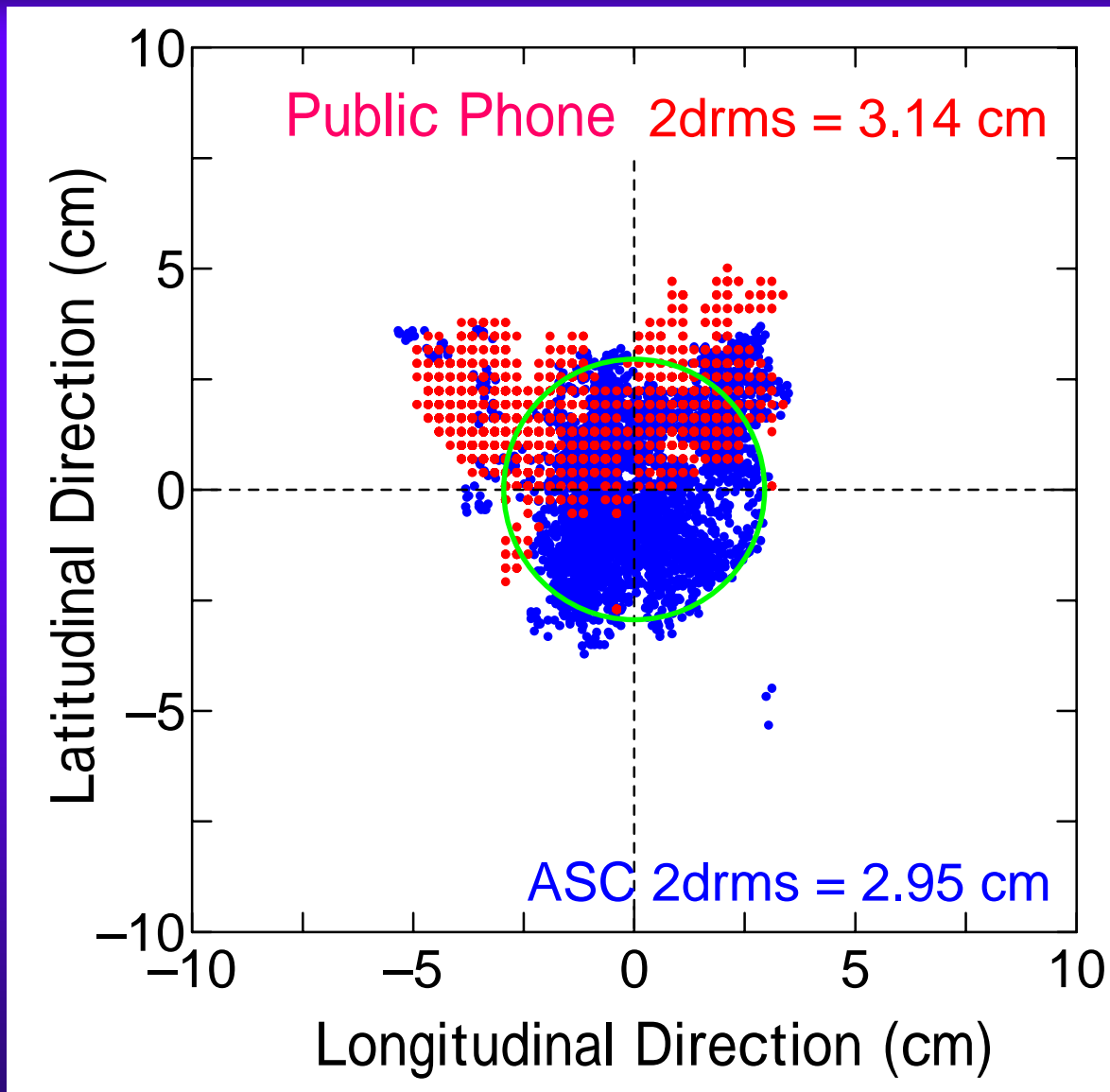
GPS Antenna

*Via Public phone
Via ASC*

*TV Antenna
(Rod Type)*



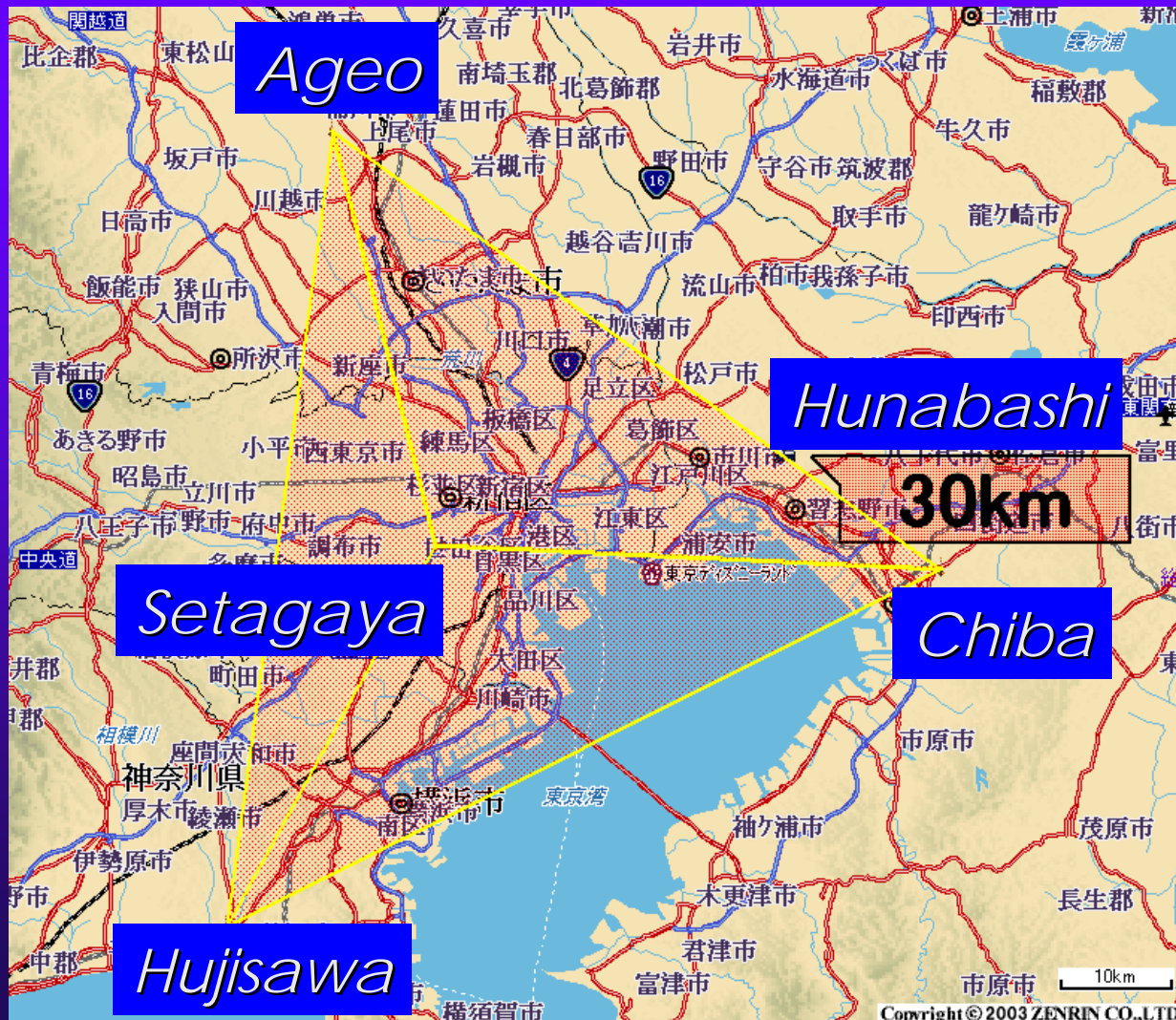
Scenery of User Station



*2hours
7/2003*

Horizontal Positioning Distribution

Another Static Test in the outside of FKP area

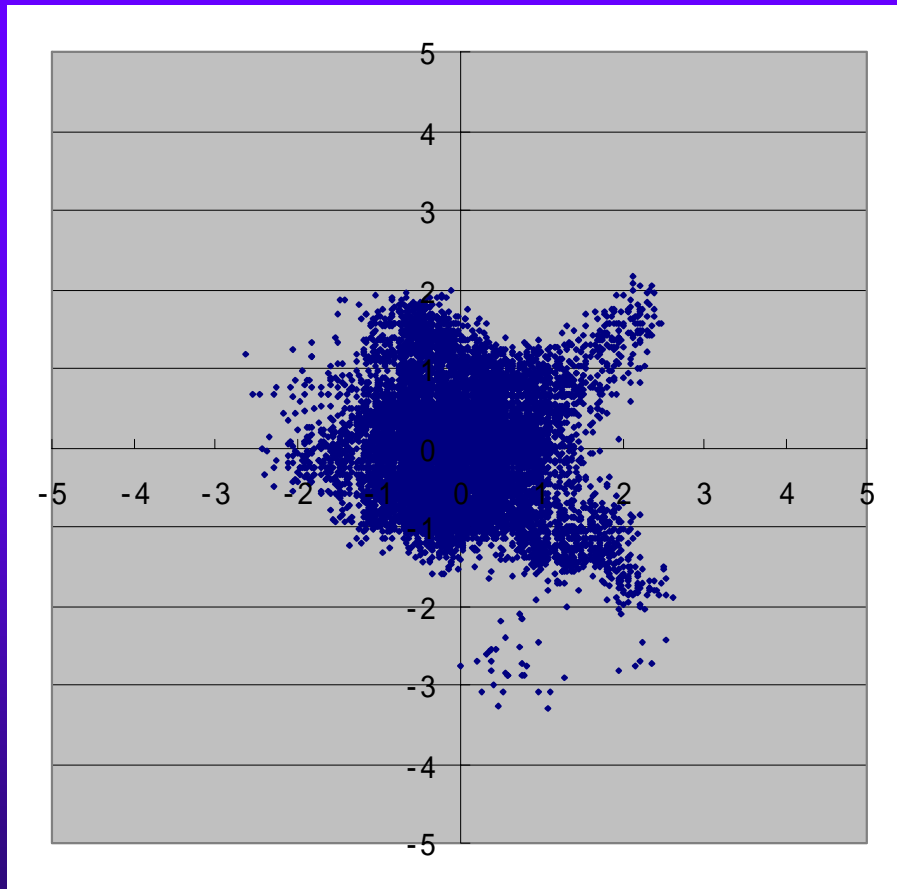


References

- 1, Ageo
- 2, Setagaya
- 3, Chiba
- 4, Hujisawa

Rover
Hunabashi

Horizontal result

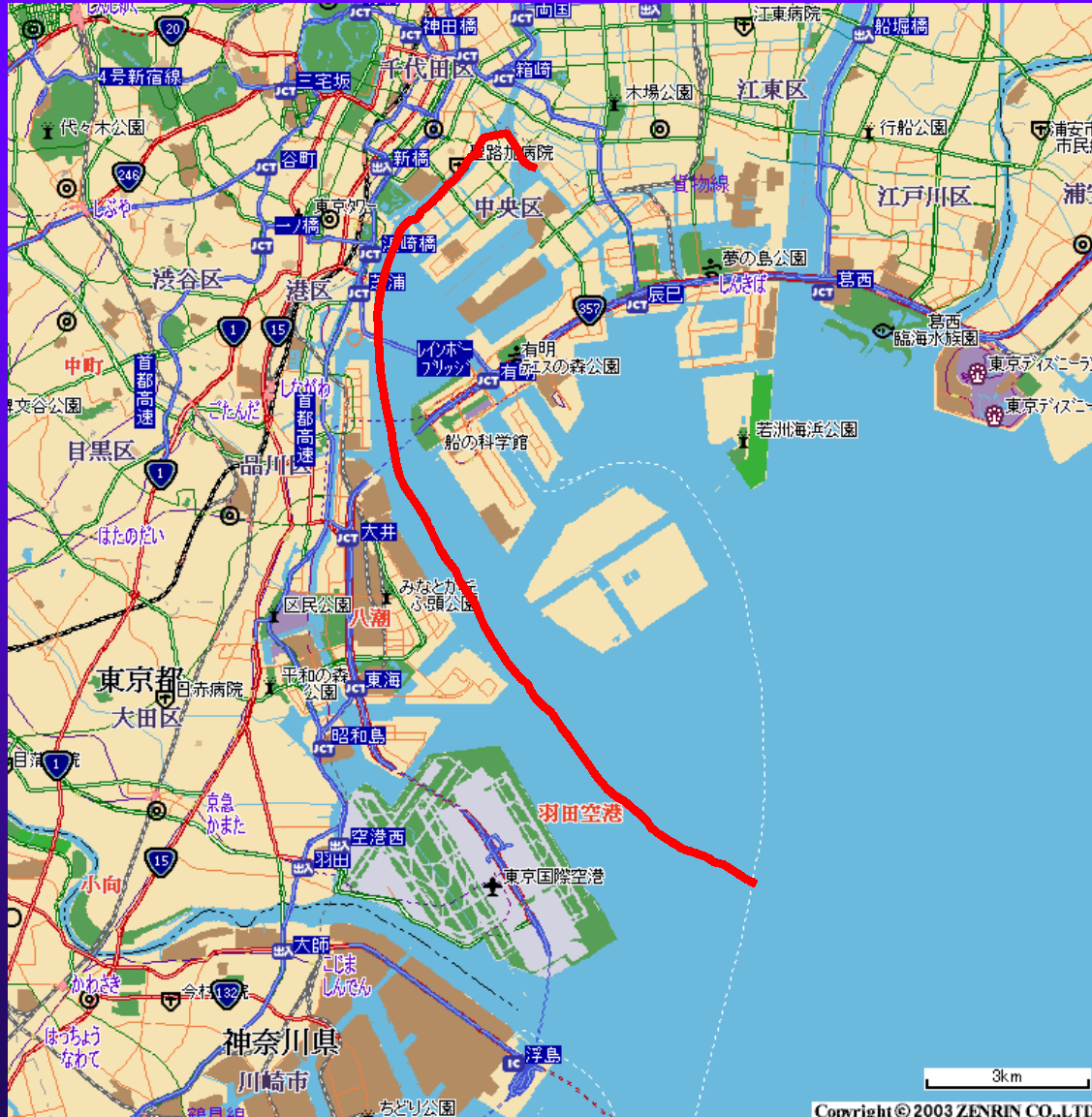


*2003/12/16
4 hours*

*Almost of epochs
can be fixed by
using FKP data
(over 90%)*

*In the normal RTK, fixed positions were not available
in the almost epochs. (under 30%)*

Ship Experiment



*Red line
Route for ship
1/8/2004
About 2hours*

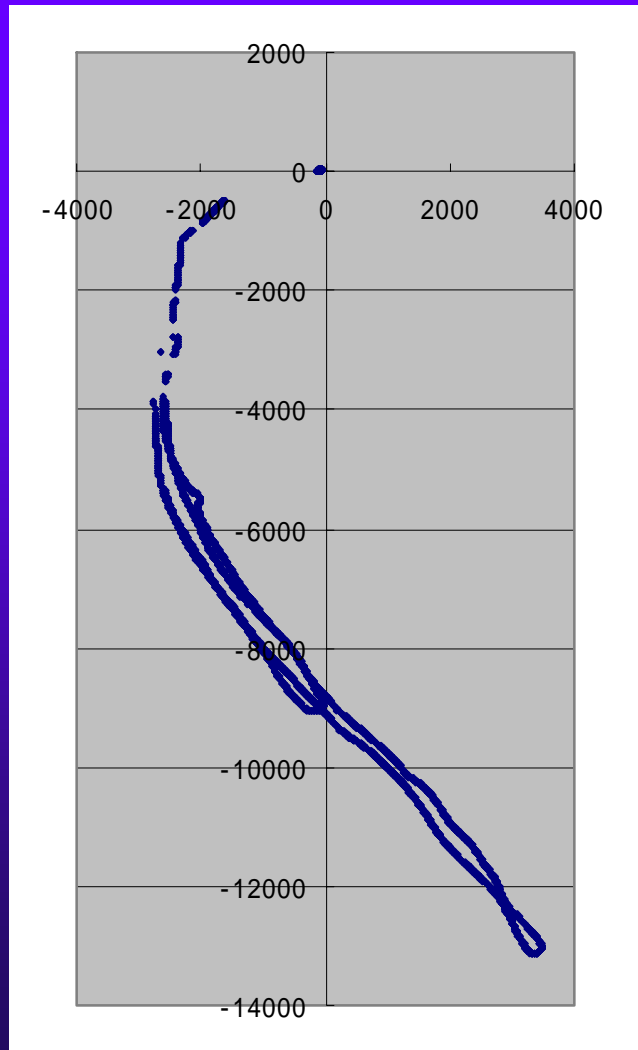
Picture for Ship



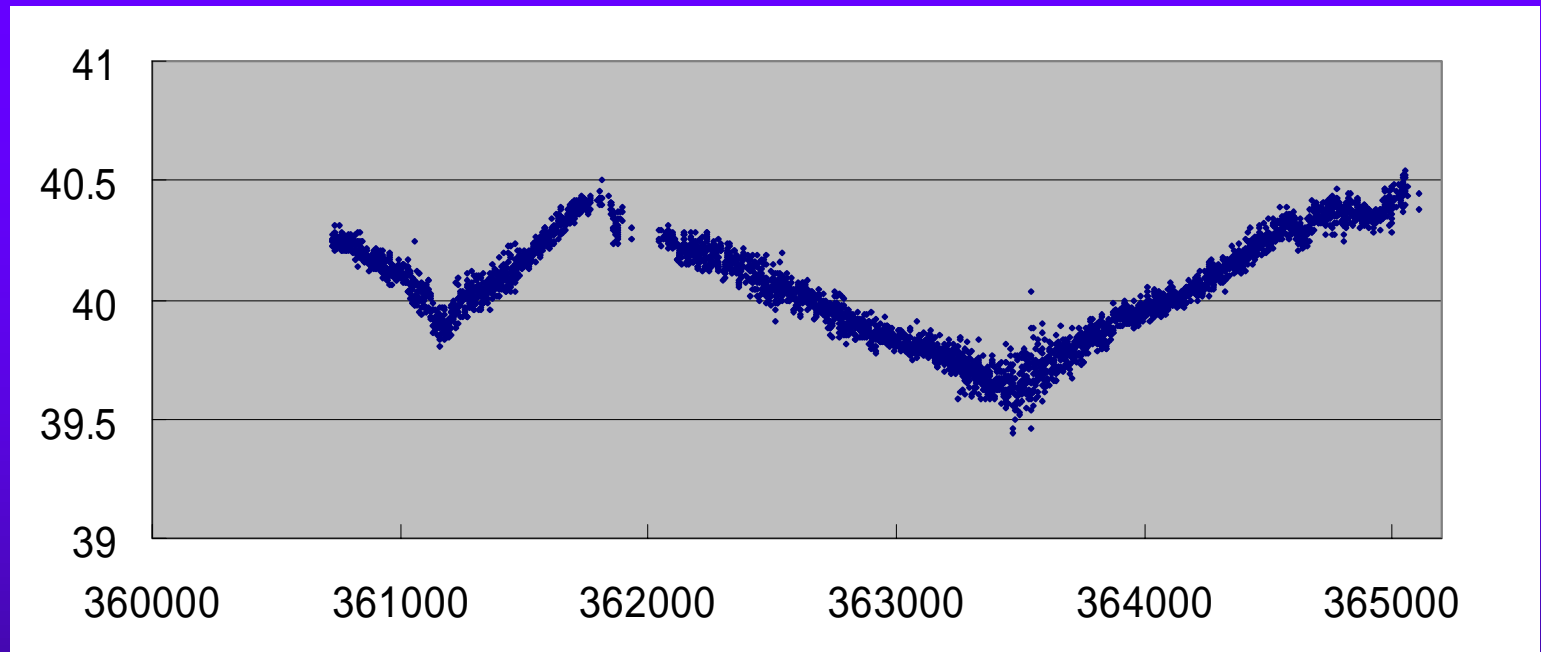
Picture for Antennas



Horizontal result (only fix)



Ellipsoidal height result (only fix)



This height result corresponds to the 2 times Round trips in the Tokyo Bay. We also conducted the traditional RTK with baseline up to about 14km. The results agreed well each other. (network based ->80%, normal RTK -> over 99%)

Conclusion

- ◆ *Network-Based RTK-GPS Positioning by FKP via TV ASC*
- ◆ *2-3cm Precision can be obtained in the case that baseline is over 30km, outside of the network*
- ◆ *Transmission delay is almost same via ASC or public phone line*
- ◆ *Static and Mobile Positioning have been done.*
- ◆ *Future*
 - *Promote and stimulate practical use of network RTK GPS in Japan*
 - *Reduce time to fix (can be used not only static user but also mobile user)*
 - *Analyze raw data using network-based system*