Low-Cost High-Accuracy GNSS Receiver

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High Accuracy Receivers are Expensive

- High-Accuracy Survey Grade Receivers are multi-frequency and multi-system receivers
  - L1/L2/L5, G1/G2, B1/B2/B3 etc
  - GPS, GLONASS, BGALILEO, BeiDou, QZSS etc
  - Price varies from $5,000 to $30,000 or more.
- However, Low Cost Receivers are also capable of
  - Multi-System: GPS, GLONASS, GALILEO, BeiDou, QZSS, SBAS etc
  - Currently only in L1-Band Frequency
  - Low Cost: $300
  - Very soon: Multi Frequency, L1/L5
    - Broadcom already announced production of L1/L5 GNSS chip

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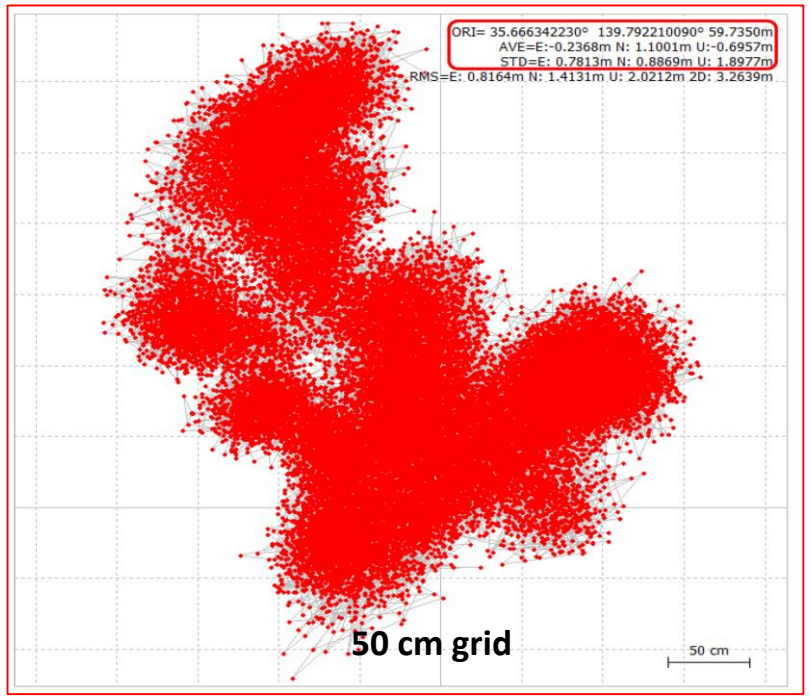
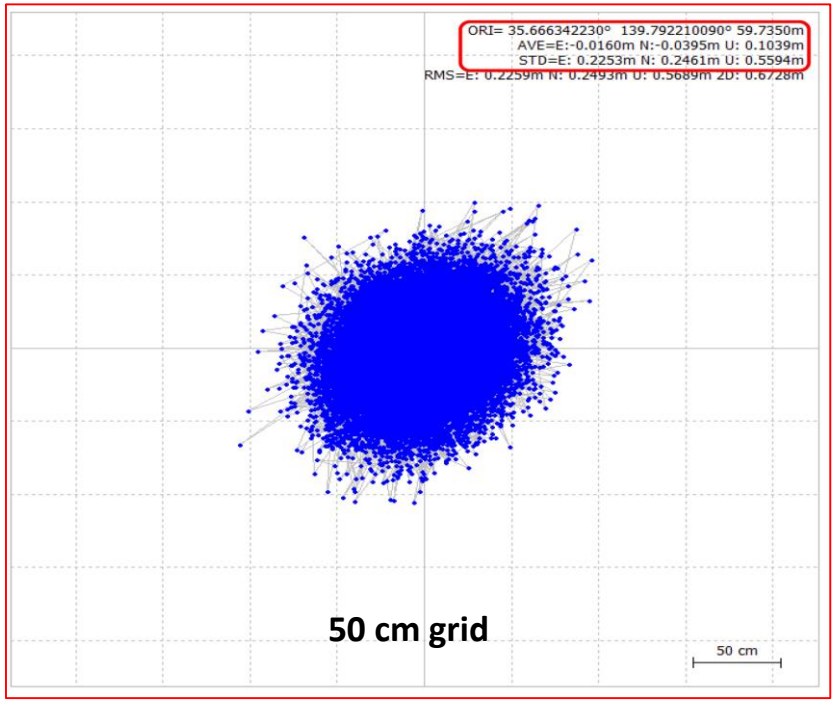
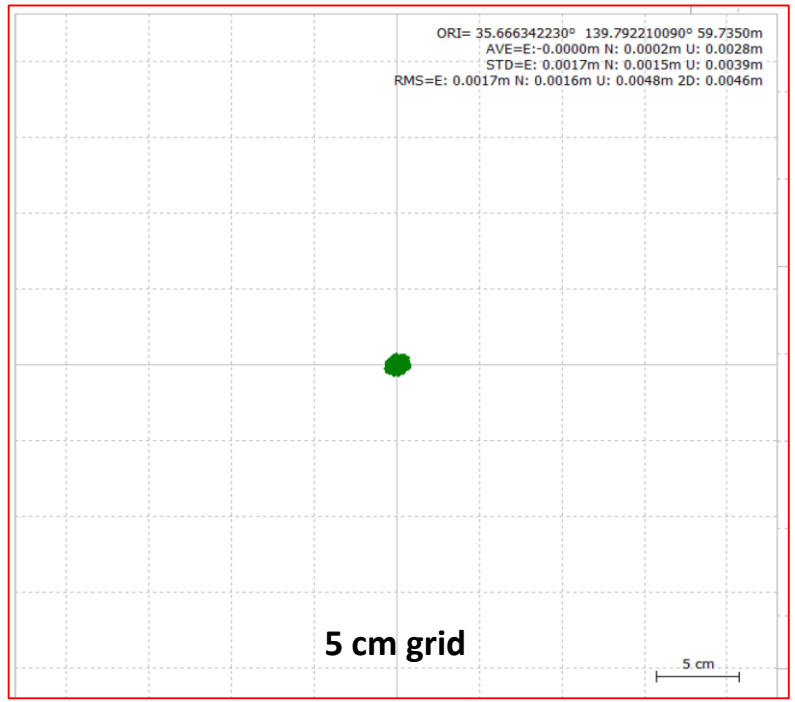
How accurate is GPS Position?



SPP (Single Point Position)



DGPS (Differential GPS)



RTK (Real Time Kinematic)

Errors in GPS Observation (L1C/A Signal)

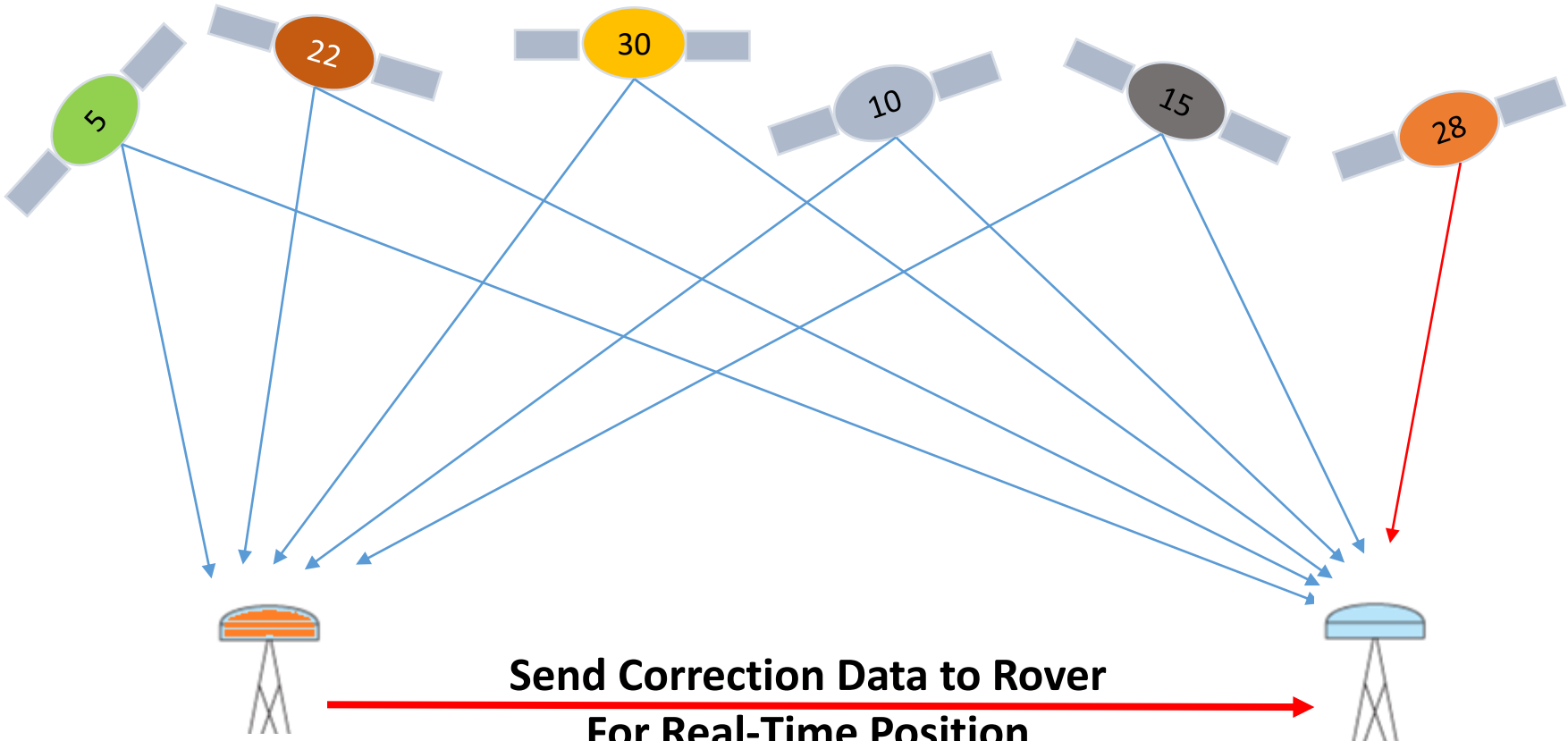
Error Sources	One-Sigma Error , m		Comments
	Total	DGPS	
Satellite Orbit	2.1	0.0	Common errors are removed
Satellite Clock	2.1	0.0	
Ionosphere Error	4.0	0.4	Common errors are reduced
Troposphere Error	0.7	0.2	
Multipath	1.4	1.4	
Receiver Circuits	0.5	0.5	

If we can remove common errors, position accuracy can be increased.

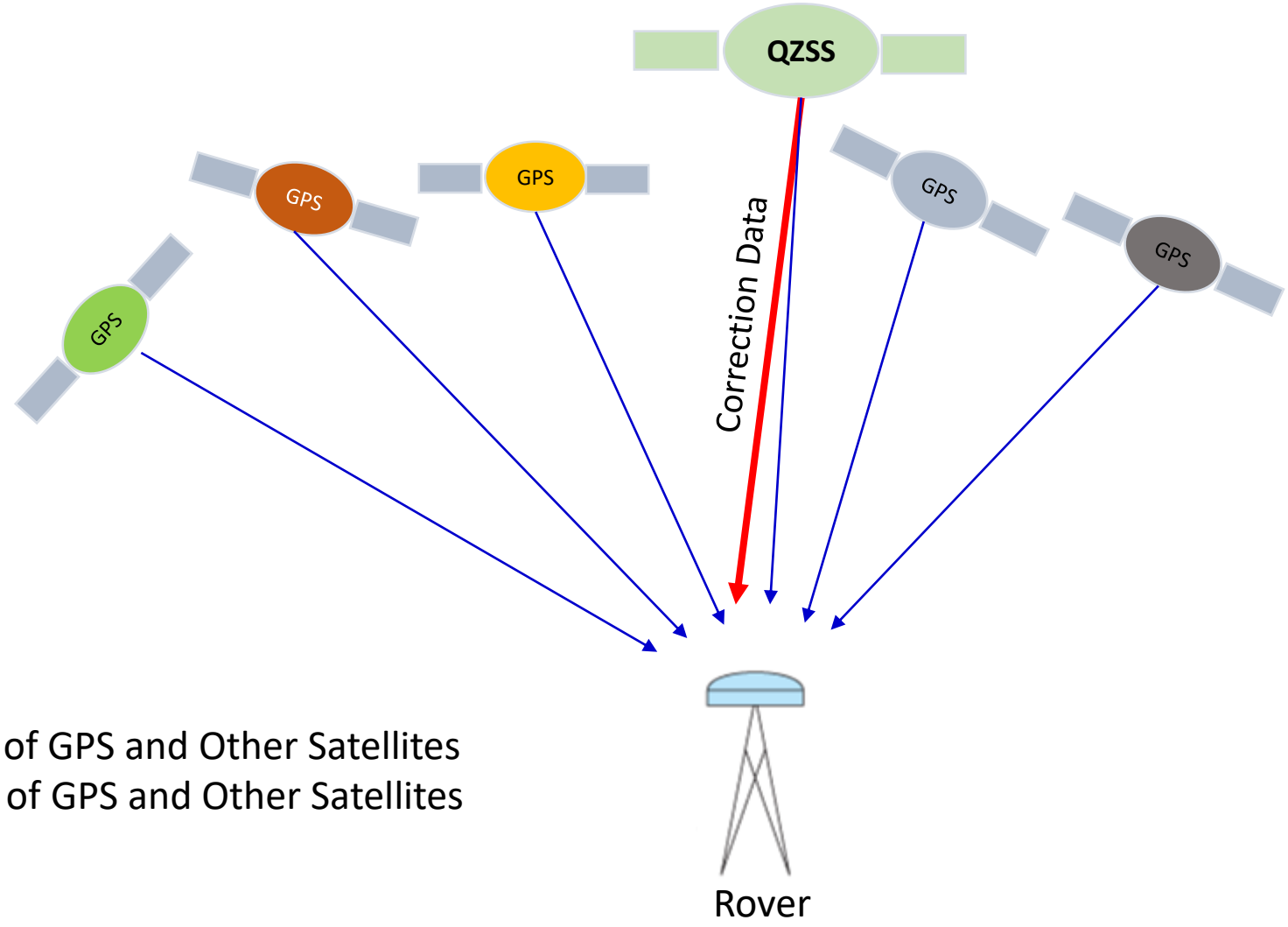
Common errors are: <u>Satellite Orbit Errors, Clock Errors and Atmospheric Errors (within few km)</u>

Table Source : http://www.edu-observatory.org/gps/gps_accuracy.html#Multipath

Principle of Differential Correction

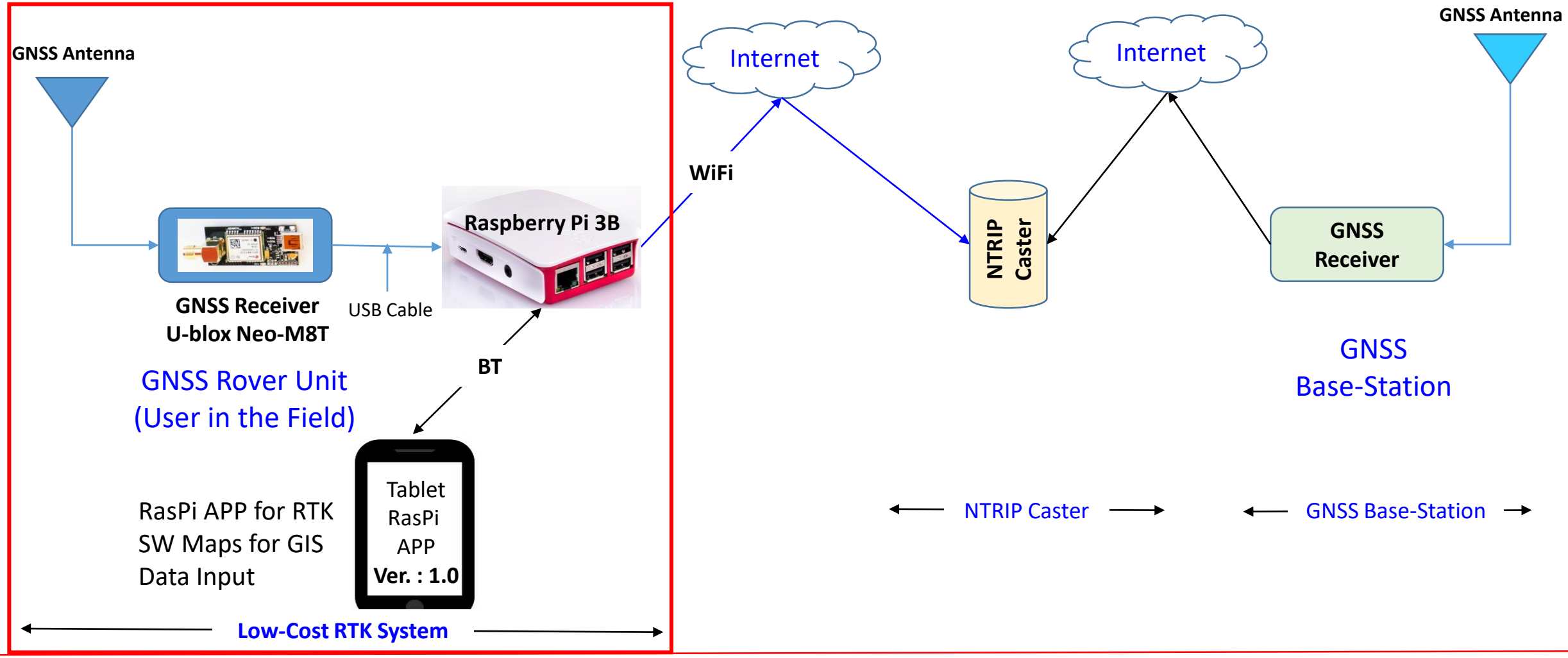


Principle of QZSS MADOCA / CLAS Service



Correction Data:
Satellite Orbit Error of GPS and Other Satellites
Satellite Clock Error of GPS and Other Satellites

Low-Cost High Accuracy System



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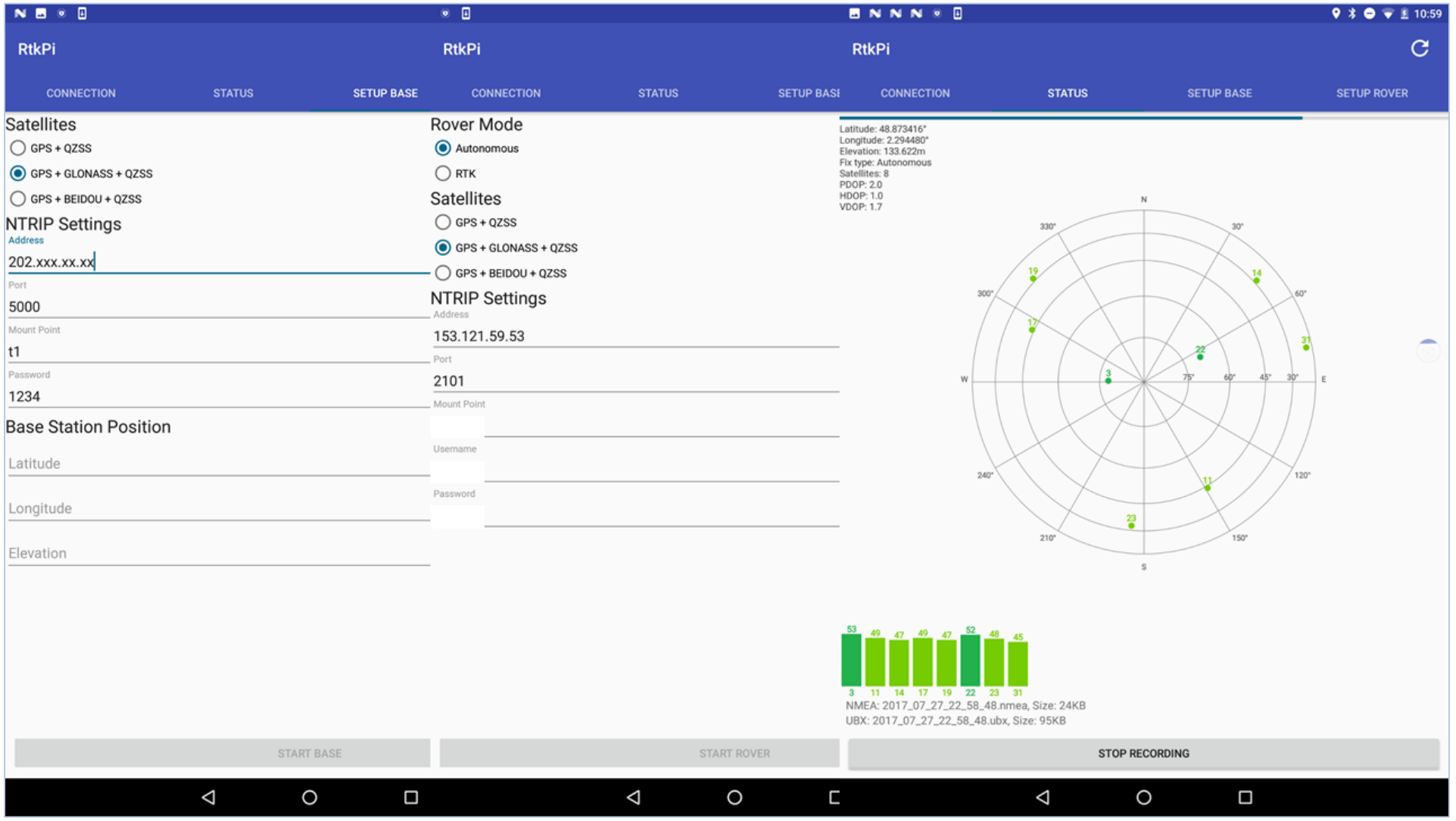
RtkPi APP for Low-Cost RTK System



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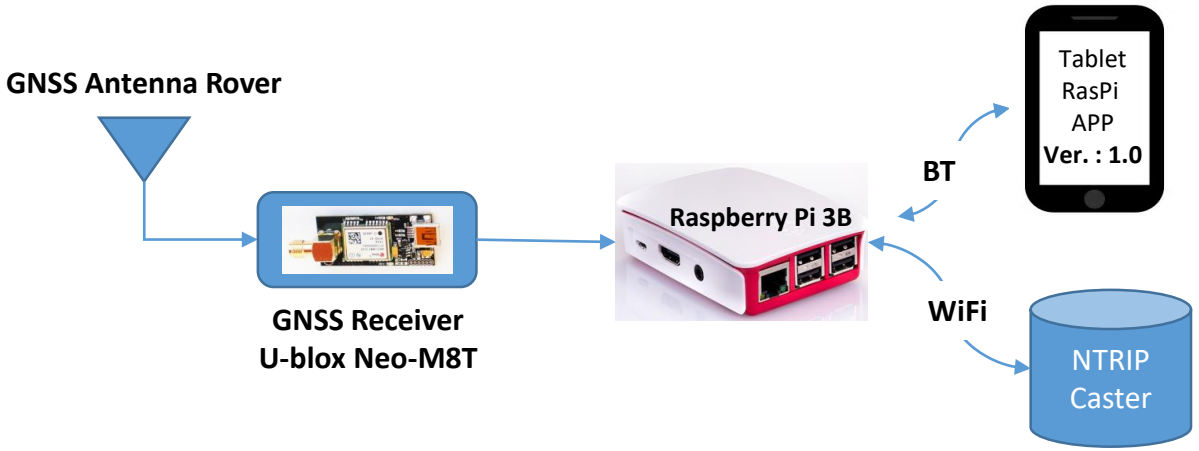
Board Computer for Low-Cost RTK System

Raspberry Pi 3B for Realtime and Postprocessing RTK

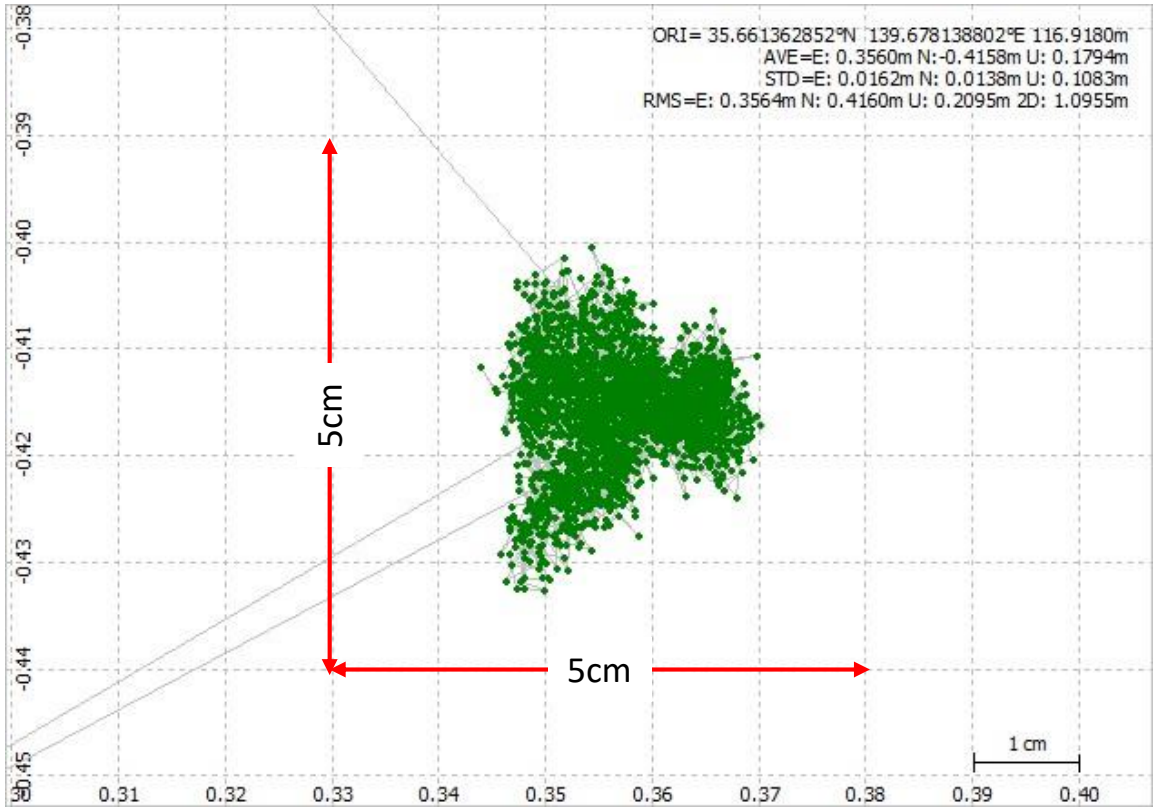
Raspberry Pi Zero w/WiFi & BT for Post-processing RTK

Accuracy from Low-Cost RTK System

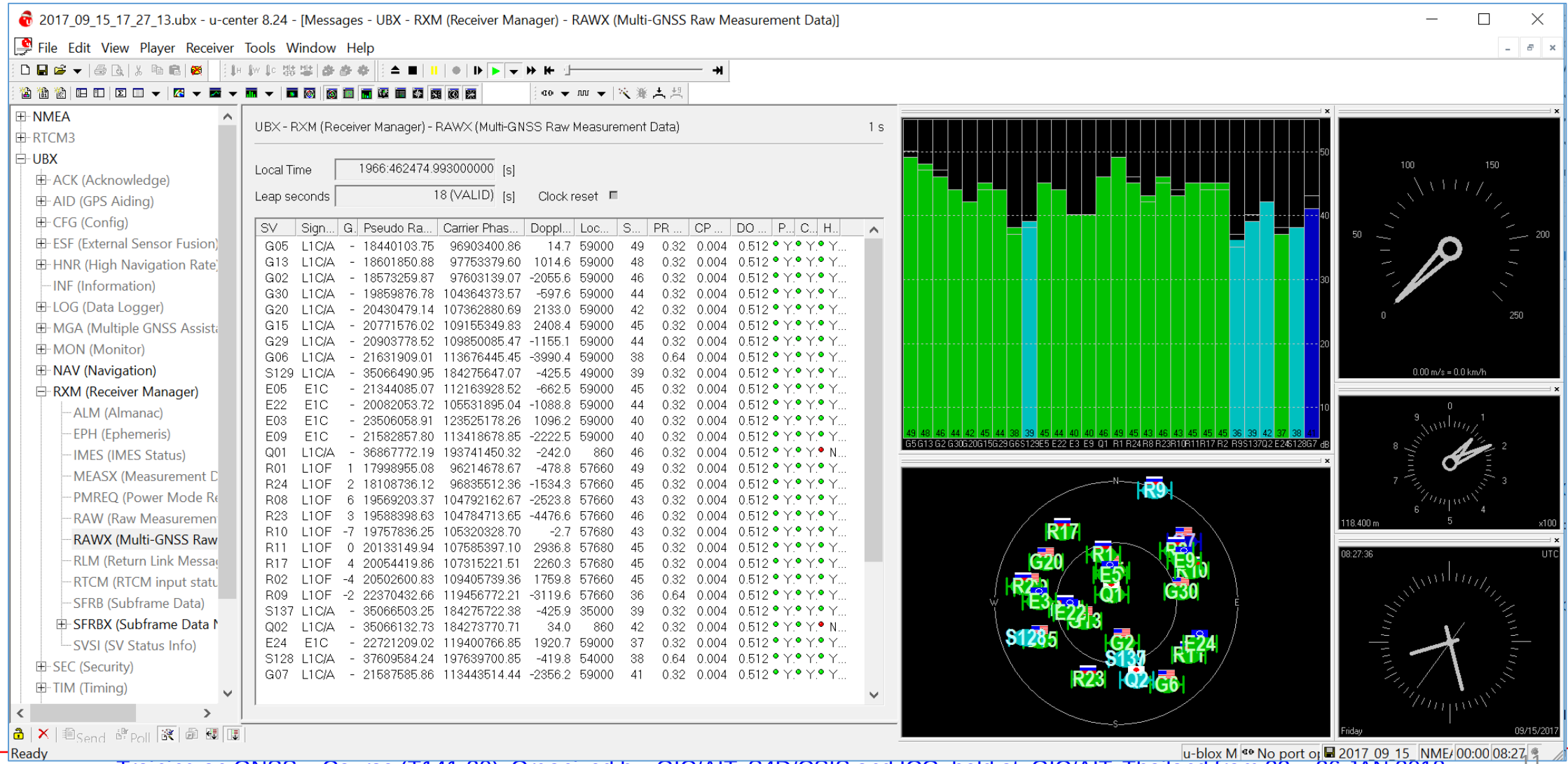


Rover-Station:
Receiver: u-blox M8T
Antenna: Zephyr 2
Computer: RaspberryPi 3B+
Distance between Base and Rover : about 12Km

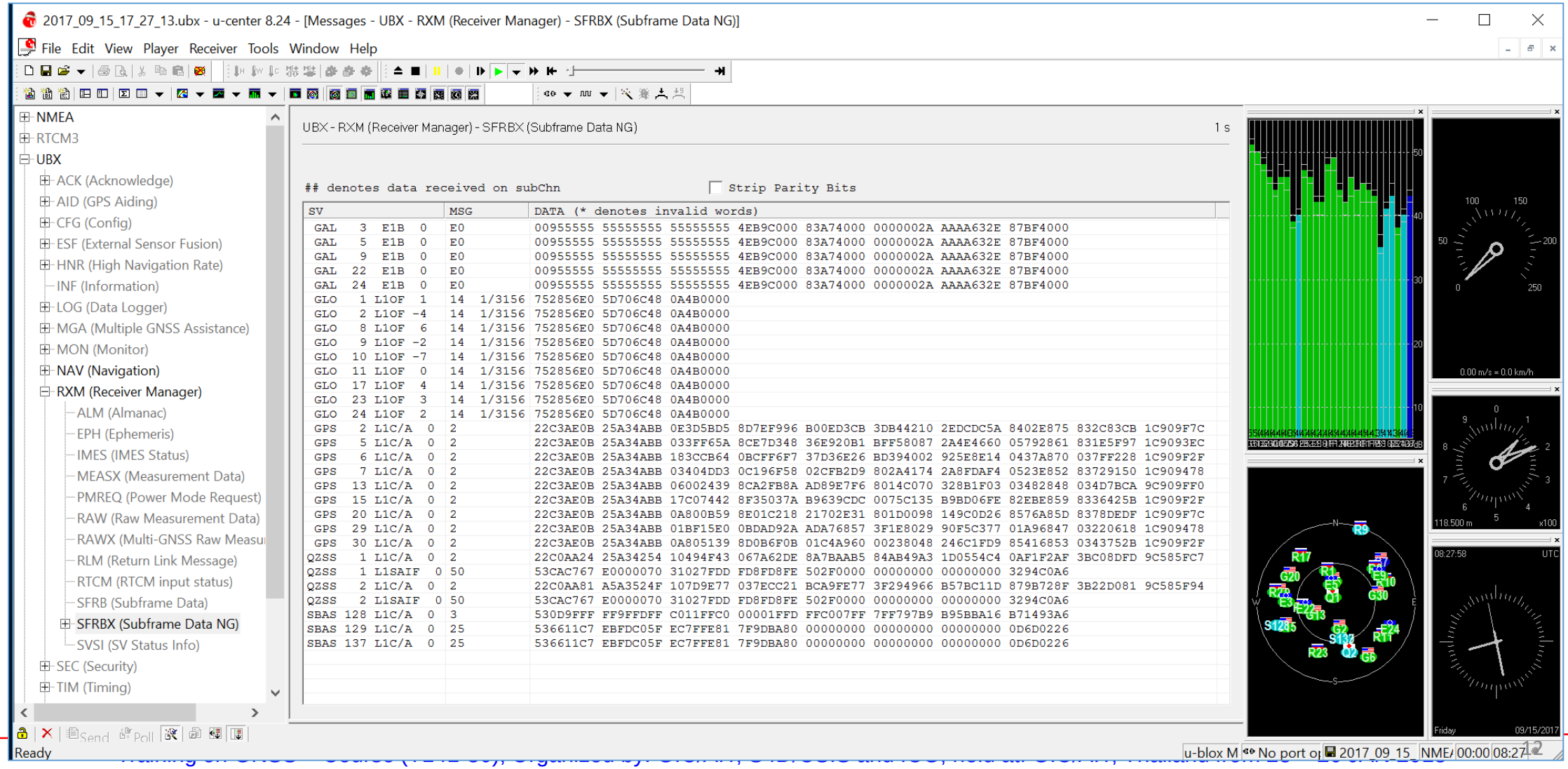
Base-Station:
Receiver: Trimble NetR9
Antenna: Zephyr 2



Data from Low-Cost RTK System

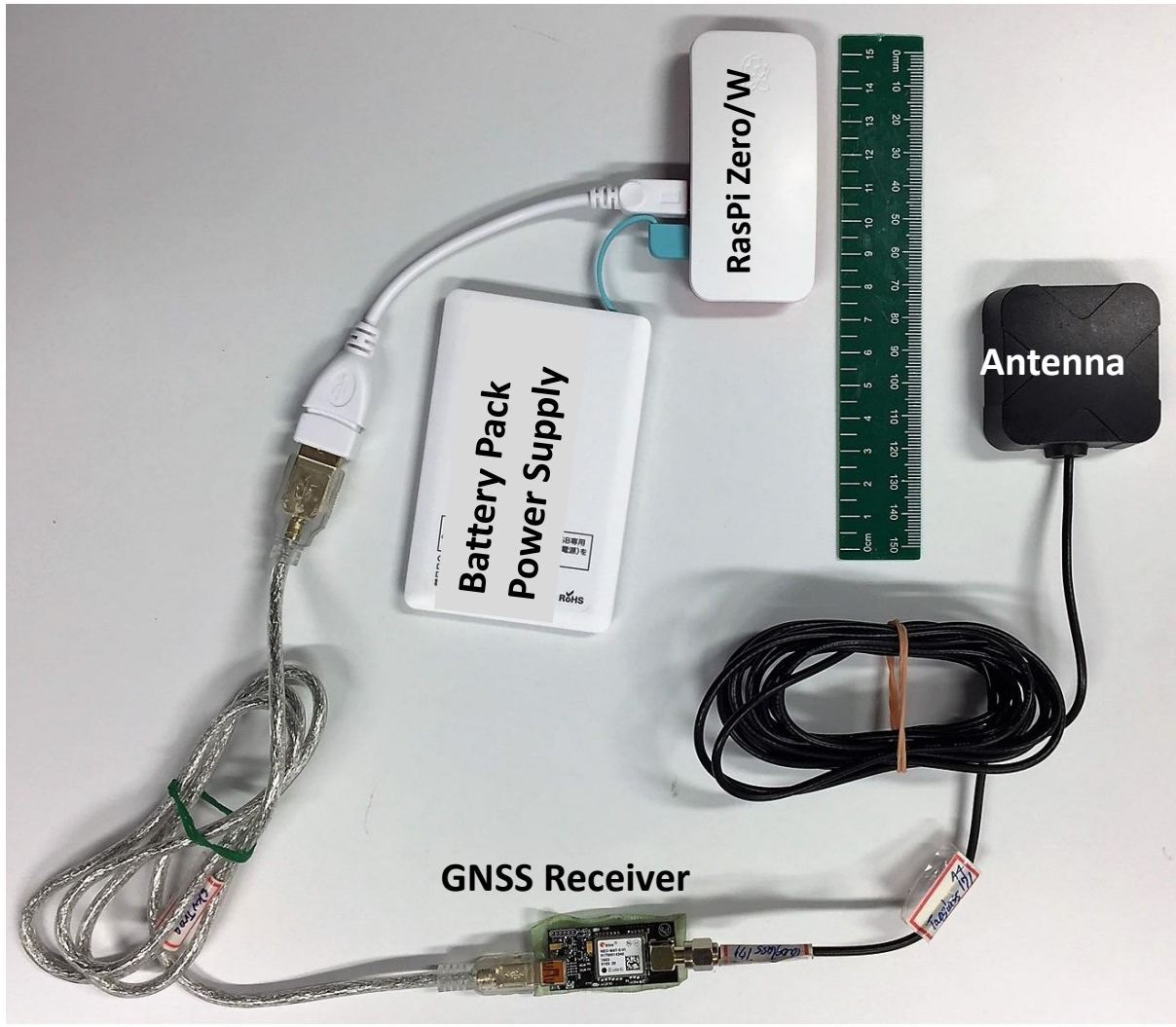


Data from Low-Cost RTK System



Simple to Use, Low-Cost System

Simple to Use, No Commands, Just One Time Setting
Connect Antenna, Receiver and Battery Pack
Device Starts Logging GNSS Raw Data required for RTK Post-Processing



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SW Maps APP to integrate GPS Data into GIS