GCPC EPISODE 558 - GPSr Changes with Limax

SB: Welcome everyone! It's Wednesday, its 8:30 which means that it is once again, time for the Geocaching podcast. I'm Scott Berks, we have shortyknits manning the phones and please welcome to my virtual left, my co-host, Taz427!

CC: Howdy all, GPSr's everywhere are,.... Uhm…. still working.

SB: Tonight's Episode **558,** recorded live on **April 10, 2019** is **GPSr Changes with Limax.** The phone lines are open so give us a call at 808-468-7924, that's 808 GOT SWAG

SB: Let's talk Patreon. It costs a lot of money to make this podcast work and we really could use your help. Thanks to all of our current subscribers and our new subscribers:

- Danelle (o0rxkxrox0o) out of Ooltewah, TN

Please give anything you can. PATREON.com/thegeocachingpodcast

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SB: And it's also sponsored by **Logwerk!**
Logwerk are the creators of the FANtastic logbook, made with genuine Rite in the Rain paper. The logbooks designed for the micro containers of the present and future, geared towards the hider who rather goes caching than doing cache maintenance. Find them at Logwerk.com

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SHOW NOTES:

NEWS:

- none

EMAIL:

- I didn't hear you guys mention my biggest pet peeve on your "what irks ya?" show. I generally agree with Jessie's philosophy of not getting too worked up over people who play the game differently than I do. Most of the actions I don't agree with have little impact on me or other cachers, so I just grumble a bit and move on. But one thing I can't let go is a throwdown.

  I'm talking about a cacher that would rather drop a new container than take a DNF. With the exception of powertrails where the practice is generally accepted, throwdowns often do not match the style of the original hide, and that does directly affect the experience of future finders. Sometimes it takes a really unique cache and turns it into something boring and mundane. I've also seen plenty of instances where the original was still present and now there's an extra container for no reason. And if the CO isn't active, replacing the container only prolongs the life of a neglected cache while blocking the area from a potentially better hide. I'm

all for reasonable cache maintenance, but I draw the line at replacing containers unless I have explicit permission from the CO.

Keep up the good work! I've got just one week of bowling left, so hopefully I'll be able to call in a bit more often after that.

Carson
a.k.a. ACME_WildCachers

- WVTIm is not only releasing a GeoTrail, but it is the first GeoTour in the area

  I heard this was coming, but the event was just published

  I hope to be there.
  Team G Winchester

  Just wanted to pass along we will have a new GeoTour. Berkley County, WV and WVTim will be kicking off a new GeoTour. Kickoff event below.
  https://www.geocaching.com/geocache/GC84M1N_berkeley-gadgets-geotour-kickoff
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- Chaz, Jessie, and Scott -

  First of all, thank you all for the work you've done over the years to keep us informed and entertained. Scott, I have listened to you since episode 3 of the Chicago Geocacher Podcast, and I'm still hooked. I am at best a fair weather geocacher (a whopping 148 finds in eleven years), but I do love geocaching, and I do it when I'm able.

  I am considering a front porch cache on my home, probably a gadget cache, but I have a unique issue with how to post the cache. This is my home:

  …and no, this is not a joke. This really is my home. I think I'll hang the gadget cache from the pink arm that sticks off the front, and put a bench below it so geocachers can sit and figure out the cache in comfort, and also not have to see me watching TV in my underwear.

  But this is not the issue I'm concerned about. My issue is that my house is mobile. It doesn't move every day - most of the time it's parked in Crystal Lake, IL

- but it does move, and as far as I know, there in no way to have a mobile front yard cache, unless your house is the ISS. And in a couple of years, I intend to keep traveling for a while - so the solution that's best for now won't always be the right one. What do you suggest?

Aaron Carlson

- Hi Scott, Jessie, and Chad,
  How are you doing on your Cache Carnival promotion? Just like Chad, I got points without doing anything. I'm (unusually) waiting to the last moment to work on mine...I'm getting all the points in the last weekend of the promotion. So far, I've earned 100 points from favourite points on my hides. As a geocache hider, you get notifications for everything (finds, DNFs, notes, etc.), including when you or a reviewer make changes (notifications when you disable, enable, and archive, for example). So I find it weird that you don't get notifications when your geocache earns favourite points. Until this favourite points-based promotion I never noticed it. I understood how this promotion's scoring worked. I just assumed that because I hadn't gotten a notification about my hides getting favourite points that I hadn't earned any points yet.

  Have any of you noticed this notification anomaly before? Do you have any thoughts on this?

  Thank you for the awesome show!
  Paula (CuriosityGirl)

  I know this is dated.
  This was my first hide and since I really didn't know much about cache hiding why not one in my own front yard.

  GC35VVR Snoopy's Watching It has 38 FP's and has never been muggled. It is actually fun to watch the cachers search even though the hint says right where the container is.

  Gary
  Caching name: GB's

SB:

- https://www.gps-repeaters.com/blog/gps-week-number-rollover-april-6th-2019/
- What is this and why is it happening?
    - The problem stems from the fact GPS signals include a timestamp and part of the timestamp is a week number stored as ten binary bits. Ten bits allows it to store 1,024 weeks before it resets, which means the reset happens after roughly 20 years. On April 6, that reset happens, potentially causing GPS devices around the world to stop working.
    - The good news is, existing GPS devices can be patched to avoid this being a problem. However, a patch being available depends on how old your device is and how reliable the company who sold it to you is for issuing software updates. If your device isn't patched, then it will revert to an earlier period of time and GPS positioning will most likely fail.

- Who will be affected?
    - Any GPS device manufactured after 2010 should be fine as long as it conforms to the ICD-200/IS-GPS-200 specification. Thankfully, we won't have to face this problem again as modern GPS navigation systems including CNAV and MNAV use a 13-bit week number, meaning a reset won't be required before we don't care about GPS anymore.
    - For now, if there are some old GPS devices you still rely on, check to see if they can be patched and whether a patch has been released. If one hasn't, and the manufacturer is remaining silent on the subject, don't be surprised if you device starts acting strangely in April.

- What's gonna break?
    - For GPS devices that are affected, after the rollover occurs, an incorrect date and time will be displayed. This incorrect time will also be used to timestamp track logs, compute sunrise and sunset, and other functions that rely upon the correct date and time. However, **the positioning accuracy will not be affected**. The device will continue to deliver the same positioning performance as before the rollover.

CC:

- none

SK:

- None

LIMAX:

Article from AOPA:

https://www.aopa.org/news-and-media/all-news/2019/march/29/gps-receiver-clocks-reset-april-6

GPS (US System)

- Operated by Schriever Air Force Base (2SOPS - 2nd Space Operations Squadron)
- 28(?) satellites in constellation (31 is stated in Pinpoint, probably includes WAAS)
- Orbit
    - Six circular orbits with four or more satellites each
    - 55° inclination relative to equator, separated by multiples of 60° right ascension
    - Approximately circular with a radius of about 26,560 km
    - Orbital period about one half sidereal day (approx. 11.967 hrs)
    - Three WAAS satellites at GEO
- Frequencies
    - (L_1) f_1 = 1575.42 MHz, (L_2) f_2 = 1227.6 MHz & (L_5) f_3 = 1176.45 MHz (added to GPS IIF satellites)

GLONASS (Russian System)

- Operated by Krasnoznamensk
- 24(?) satellites in system
- Orbit
    - Distributed uniformly in three orbital planes (as opposed to six for GPS) of eight satellites each (as opposed to four for GPS)
    - 64.8º inclination relative to the equator separated by multiples of 120º right ascension
    - Approximately circular radius of about 25,510km
    - Orbital period approximately 8/17 of a sidereal day.
- Frequencies
    - (L_1) f_1 = (1.602 + 9k/16) GHz & (L_2) f_2 = (1.246 + 7k/16) k = 0...23 (Satellite number)

A GLONASS satellite and a GPS satellite will complete 17 and 16 revolutions, respectively, around the earth every 8 days.

GALILEO (European System)

- Operated by GSA (Ground Control) in Oberpfaffenhofen and ESA (Mission Control) in Fucino
- 30 satellites in system (24 operational, 6 spares)
- Orbit
    - Distributed uniformly in three orbital planes of eight satellites each (and two spares)
    - 56º inclination relative to the equator separated by multiples of 120º right

ascension
    - Approximately circular radius of 23,222km
    - Orbital period approximately 7/12 of a sidereal day.
- Frequencies
    - (E_1) f_1 = 1575.42 MHz, (E_6) f_2 = 1278.75 MHz & (E_5) f_3 = 1191.795 MHz
    - Interferes with the 23cm (1240-1300 MHz) ham band in the Netherlands

BEIDOU (Chinese System)

- Operated by CNSA
- 35 Satellites in system (5 in GEO, 27 in MEO, 3 in IGSO)
- Orbit
    - GEO
        - 158.75E, 180E, 210.5E, 240E,260E
        - Approximately circular radius of 42,164 km
    - MEO
        - Distributed uniformly in three planes (24 operational, 3 spares)
        - 55º inclination relative to the equator separated by multiples of 120º right ascension (assumed)
        - Approximately circular radius of 27,878 km
    - IGSO
        - 218E,98E,338E
        - 55º inclination relative to the equator
        - Radius same as GEO
- Frequencies
    - (B1) f_1 = 1561.098 MHz, (B1-2) f_2 = 1589.742 MHz (B2) f_3= 1207.14 MHz (B3) f_4 = 1268.52 MHz

Both Galileo and Beidou will not reach full capability until around 2020.

From Pinpoint

“The GPS receiver performs [calculations] by constructing imaginary spheres. The first GPS signal tells the receiver how far it is from the satellite. It could thus be anywhere on the surface of a sphere with the satellite at the center. The second signal creates a second sphere centered on the second satellite, thus placing the receiver somewhere on the circle where those two spheres intersect. The third satellite, by adding a new sphere to the mix, narrows the location down to two points, one of which is obviously wrote - usually miles above the surface of the planet, or deep in the earth’s mantle - and can be discarded. The fourth satellite signal resolves any timing ambiguities, since phones [(and GPSrs)] don’t come with superprecise atomic

clocks.”

Orbital Mechanics and Coordinate Systems

Satellite Orbit Coordinates

- Right Ascension of the ascending node
- Orbit Inclination

ECI (Earth-Centered inertial coordinates)

- Axis in the direction of the Vernal Equinox (X_{ECI})
- Axis direction parallel to the rotation axis (north polar axis) of the earth (Z_{ECI})
- An additional axis to make it a right-handed orthogonal coordinate system (Y_{ECI})

ECEF (Earth-centered, earth-fixed)

- Axis in the direction of the prime meridian (X_{ECEF})
- Axis in the direction parallel to the rotation axis (north polar axis) of the earth (Z_{ECEF})
- An additional axis to make it a right-handed orthogonal coordinate system (Y_{ECEF})

GPS Technology

Uses Spread Spectrum Technology (Invented by Hedy Lamarr & George Antheil)

GPS Signals

- 50-bps Data Stream
    - Conveys the navigation message
    - Includes but is not limited to, the following information
        - Satellite Almanac Data
            - Enables user to calculate approximate location of ever satellite at any given time (stored in the receiver and remains valid for many months)
        - Satellite Ephemeris Data
            - Much more accurate determination of satellite position
            - Needed to convert signal propagation delay into an estimate of the user position (only valid for several hours)
        - Signal Timing Data
            - Time tagging
            - Used to establish transmission time of specific points on the GPS signal
        - Ionospheric Delay Data
            - Ranging errors due to ionospheric effects can be partially cancelled by the estimates in this data stream
        - Satellite Health Message

            - Contains information regarding the current health of the satellite
            - Receiver can ignore satellite if not operating properly
    - Complete message is 25 frames, containing 1500 bits.
        - Each subframe contains 10 words of 30 bits each
            - Each subframe takes 6 s to transmit, one frame takes 30s
        - Transmission of complete message takes 750s (12.5min)
        - Each subframe begins with a telemetry word, followed by a handover word (60 bits total)
        - The following 240 bits of the subframe contains the part of the data stated above

GPS Satellite position calculations

- Spread-spectrum L-Band carrier signals provide continuous earth coverage for signals that provide ranging codes and system data to the user needed to accomplish the GPS navigation mission
    - Two L-Bands are used (Three on GPS IIF and later)
        - L_1 - carrier frequency of f_1 = 1575.42 MHz
            - Uses binary phase-key shifting modulated by two pseudorandom noise (PRN) codes, designated as the Coarse/Acquisition code (C/A-code) and the Precision Code (P-code).
        - L_2 - carrier frequency of f_2 = 1227.6 MHz
            - Uses binary phase-key shifting modulated by only the Precision pseudorandom noise (PRN) code (P-code).
    - Both are integer multiples of a base frequency f_0 = 1.023 MHz ($f_1 = 1540 f_0$, $f_2 = 1200 f_0$)
    - Knowledge of the PRN codes allows users independent access to multiple GPS satellite signals on the same carrier frequency.
    - C/A-Code
        - 1023-chip (time segment) sequence, which has a period of 1ms and a chipping rate of 1.023MHz
        - Establishes position of user within 10-100m
        - Permits simultaneous range measurements from several satellites
        - Provides protection from jamming
    - P-Code
        - 204,600-chip sequence, which has a period of 1 week ($\approx 6.19 \times 10^{12}$ chips)
        - Used primarily for military applications
        - Increased jamming protection
        - Provision for antispoofing
        - Denial of P-Code use
            - Encryption of P-Code by the military will deny use by unauthorized parties

        - Increased Code Range Measurement Accuracy
- Finding a Position
    - Four satellites are needed - it's just a linear equation.
        - Known variables
            - Positions of satellites (ECEF coordinates: x_n, y_n, z_n, n = satellite number)
            - Pseudoranges of satellite to user (p_m, n = satellite number)
                - Calculated by signal transmission time information, ephemeris data
                - Basically the difference between received time and transmitted time multiplied by the speed of light
                - To get a very accurate range would require incredibly accurate time synchronization
            - Radius of the earth (r)
        - Unknown variables
            - Position of user (ECEF coordinates: X, Y, Z)
            - Clock bias correction (C_{rr})
        - One line of the simultaneous equations
            - $p^2_{r1} - (x^2_1 + y^2_1 + z^2_1) - r^2 = C_{rr} - 2Xx_1 - 2Yy_1 - 2Zz_1$
        - Once solved, the ECEF coordinates can be converted to lat/long, corrected by the clock bias

Receiver and Antenna Design

- Purpose is to filter and amplify the incoming GPS signal
    - To make it useable for digital processing, the incoming signal needs to be amplified by as much as 33-55 dB.
- Antenna
    - Short wavelengths of L_1 and L_2 designs provide for compact antenna designs
    - Right-hand Circularly Polarized, normally

<u>Bibliography</u>

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Pinpoint - How GPS is Changing Technology, Cuture, and our Minds by Greg Milner ©2016

You are Here- From the Compass to GPS, the History and Future of How We Find Ourselves by

NEXT WEEK'S SHOW:

- First Aid Discussion with MontanaCPRGuy

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That’s all we got this week so we’ll see you next week talking geocaching and taking your phone calls. In the meantime, be good, be safe, and hug your loved ones. Talk to ya next week.