



WHAT IS RDS/RBDS?

The **European Broadcasting Union (EBU)** first introduced the official RDS specification in March 1984 after nearly a decade of development.

The United States officially adopted its own version, called RBDS (Radio Broadcast Data System), on January 8, 1993, though the technical standard framework was completed by the National Radio Systems Committee (NRSC) in late 1992.





WHAT DOES RBDS DO?

It puts data on your FM signal. Your radio reads it and shows you things — the station name, what song is playing, the format, the time. It's how your car knows you're listening to WLCW instead of just seeing "100.1."

It does this by piggybacking 1,187.5 bps of data on a 57 kHz subcarrier -- silent, automatic, and invisible until something breaks.



RDS Injection Level

RDS rides on a 57 kHz subcarrier -- exactly 3x the 19 kHz stereo pilot, phase-locked to it. Injection level is how much of your total FM modulation budget the RDS subcarrier consumes. It counts against your composite headroom just like audio does.

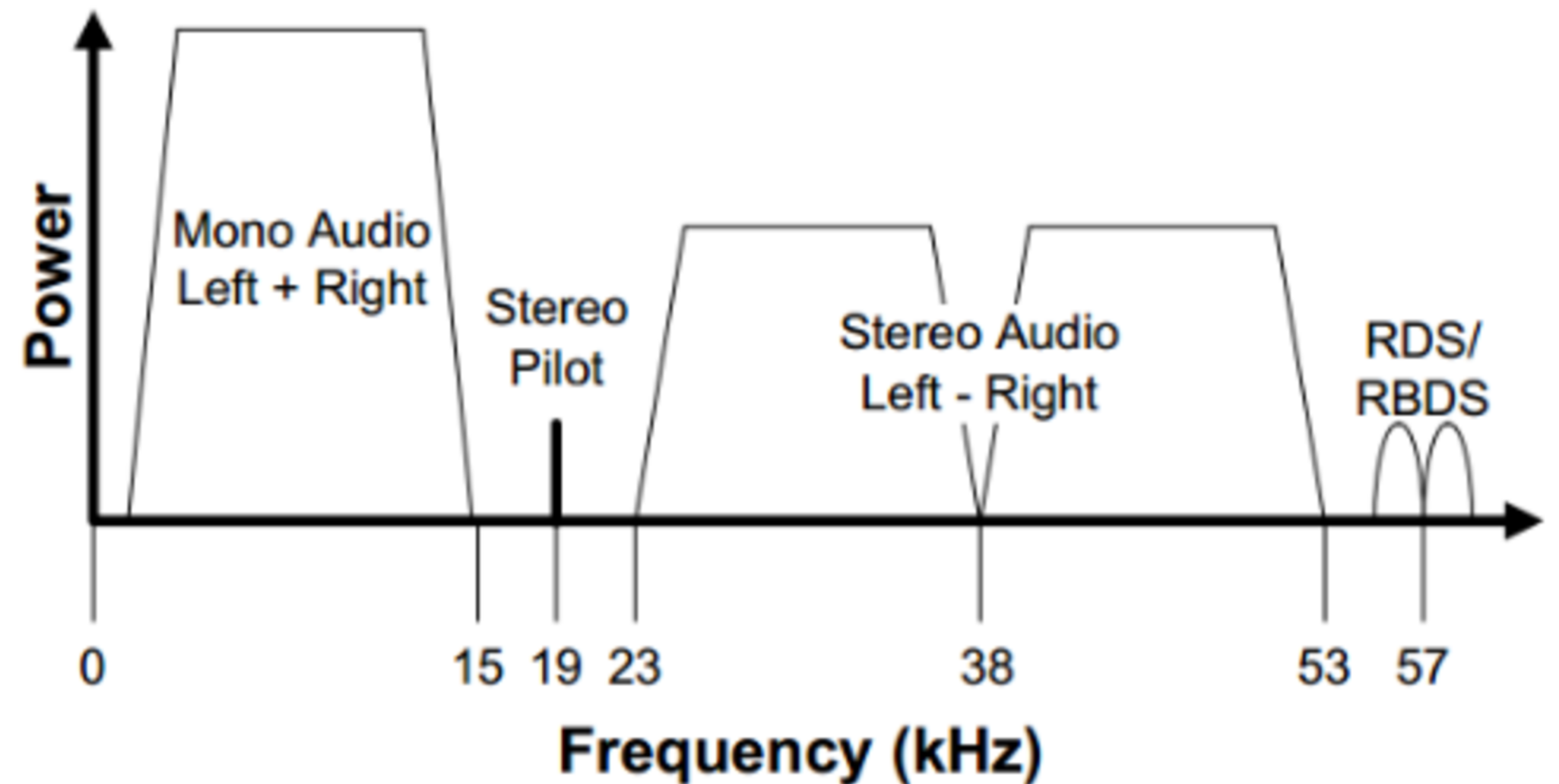


Figure 5. MPX Baseband Spectrum

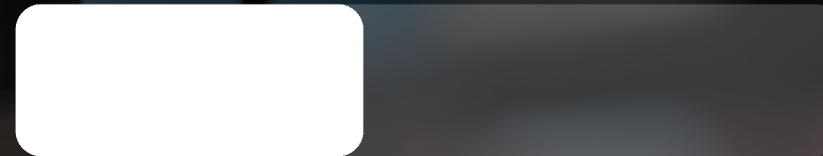
TOO LOW, TOO HIGH, AND THE SWEET SPOT...



RBDS INJECTION

TOO LOW, TOO HIGH, THE SWEET SPOT

Too low (below ~2%)



Sweet spot (2-4%)



Too high (above ~5%)



WHAT HAPPENS?

Decode errors, intermittent group loss, receivers that catch RDS for a few seconds then drop it. PI lookups fail silently.

Clean decode on virtually all receivers. Reliable group delivery. PI code stable. IEC 62106 and NRSC both land here.

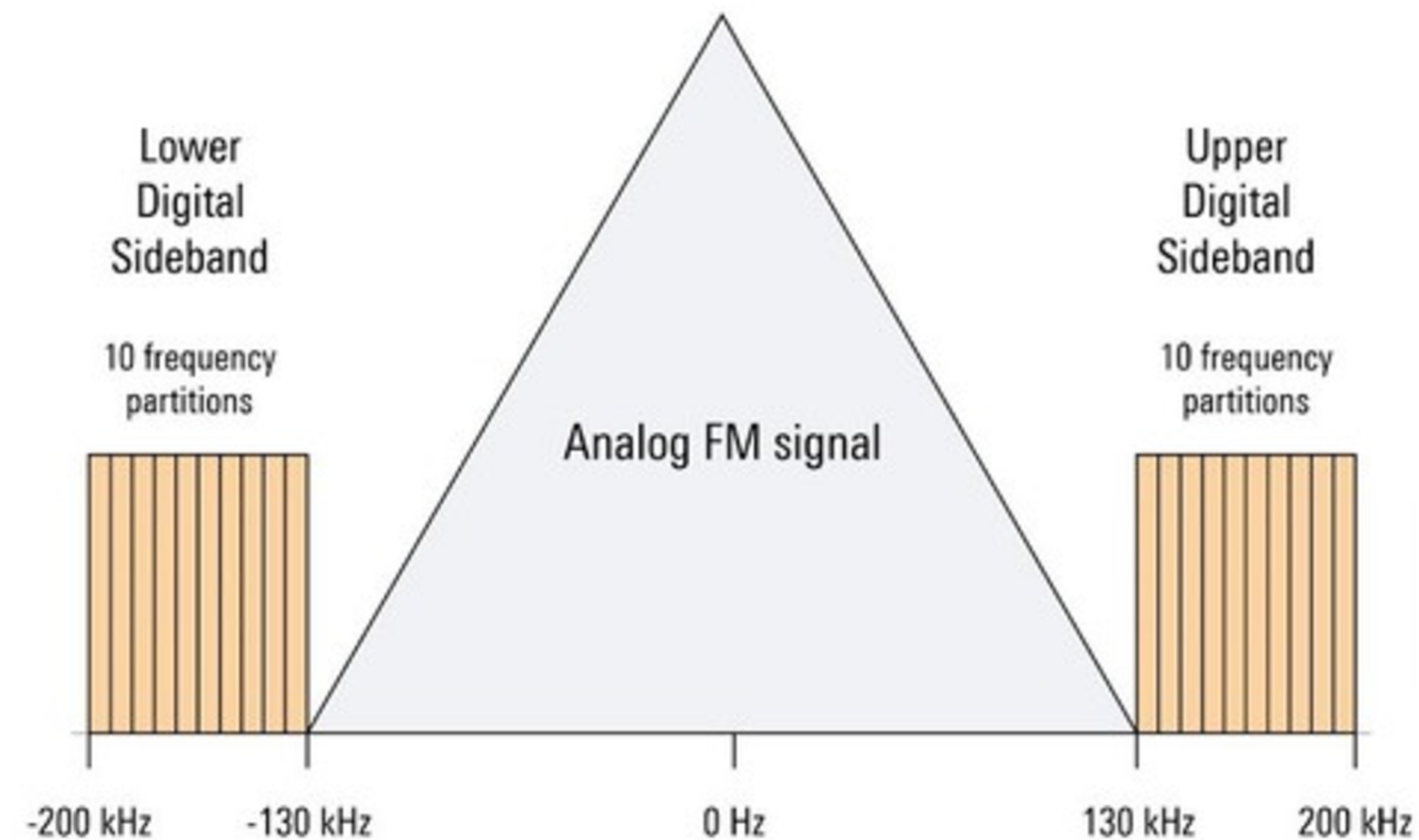
Eats into audio modulation headroom. Can cause composite clipping if your processor isn't accounting for the subcarrier load.

RBDS INJECTION

TOO LOW, TOO HIGH, THE SWEET SPOT

FM IBOC signals

- ▶ FM HD Radio is encoded as upper and lower sidebands
- ▶ Each ~70 kHz wide
- ▶ OFDM used for modulation
 - Signal consists of subcarriers
 - Subcarriers are each individually modulated
 - Resists multipath / fading
- ▶ 190 subcarriers per sideband
 - 10 **frequency partitions** each containing 19 subcarriers
 - 18 data + 1 reference



RDS Data Fields

What Each One Does

Program Service

8-character station name on the radio face. Static. *Don't* scroll it.

PS

Group 0A/0B

RadioText

Now-playing text up to 64 chars. Artist – Title. Updates each song.

RT

Group 2A

Program ID

4-digit hex station fingerprint. Used by RadioDNS & AutoStage. Never change it.

PI

All Groups

Program Type

Format code (Rock, News, Country...). Don't leave it at 0.

PTY

All Groups

RadioText+

ODA extension that tags what each part of RT is (title, artist, album, station name).

RT+

Group 3A + ODA

Alt Frequencies

Translator list for auto-retuning on a drive. Bad AF = retunes to dead air.

AF

Group 0A



RDS Data Fields

What Each One Does

Music/Speech

1-bit flag. Lets receivers adjust EQ. Set it correctly for your format.

Group 0A/0B

M/S

Clock Time

UTC clock, fires once per minute. Only transmit if it's accurate.

Group 4A

CT

Program Type Name

PTYN stands for Program Type Name. It allows a radio station to display a customized, 8-character description of their music genre

Group 3A

PTYN

Traffic Programming

Set to 1 if station carries traffic programming.

All Groups

TP

Traffic Announcement

Active traffic announcement. Auto-switching discouraged in the US.

Groups 0A, 0B, 14B, 15B

TA

Decoder Information

A 4-bit signal that tells your radio how to dynamically process the audio coming from the station

Group 0A/0B

DI



Group Allocation

What Those Percentages Mean??

The Workhorse

PS: Program Service
AF: Alternate Frequency
TP: Traffic Programming
TA: Traffic Announcement
MS: Music or Speech

Sends 4 times every second

0A

RT (Standard RadioText)

a 64-character text field that allows FM stations to transmit longer alphanumeric messages directly to your radio's display

Sends 3 times every 2 seconds

2A

RT+ Identification Packet

This group acts as the signpost, telling the radio: "Hey, we have RT+ here, and you can find the actual digital tags over inside Group 12A.

Sends every 10 seconds

3A

RDS Block Error Rate							
0.00%							
0A	25.00%	0B	0%	8A	0%	8B	0%
1A	0%	1B	0%	9A	0%	9B	0%
2A	68.77%	2B	0%	10A	0%	10B	0%
3A	2.08%	3B	0%	11A	0%	11B	0%
4A	0%	4B	0%	12A	4.15%	12B	0%
5A	0%	5B	0%	13A	0%	13B	0%
6A	0%	6B	0%	14A	0%	14B	0%
7A	0%	7B	0%	15A	0%	15B	0%

Alternative Frequencies	0	Open Data Applications	1
		12A	0x4BD7 (RadioText+)

RT+ RadioText+ Tagging

While Group 2A sends the actual text ("Blinding Lights by The Weeknd"), Group 12A sends the invisible binary codes that say: "The title starts at letter 14 and is 15 letters long".

Sends every 2 seconds

12A

What is 4BD7?

It is a "Free Format" group: In the official RDS specifications, Group 12A is originally left blank for custom applications. When Group 3A broadcasts the AID code 4BD7, it tells your radio to specifically use Group 12A for RT+.

The AID code: The label that says, "This package contains Radio Text Plus data; open it using your RT+ software."



RDS transmits at 1,187.5 bps. The percentages show how much of that fixed bandwidth each group type consumes.

⚠ Common failure: TMC/EON default-on with nothing feeding them → OA and 2A get starved → PS sluggish, RT lags 20-30 sec. Fix: switch off unused groups.



RadioText+

RT+1 & RT+2

PS	PI Code	Callsign	
DON	1965	KDON	
RadioText 64 / 64			
The Central Coast's #1 Hit Music Station			
RT+1		RT+2	
32 Name Long - The Central Coast's #1 Hit Music Station			
PTY	PTYN	Time	
Top 40			
M/S	DI	TP	TA
Speech	Mono	Off	Off

RT+1

Common RT+ Content Type Codes
The software in your screenshot uses these fixed numeric identifiers to understand what it is displaying:

- 1 = Item.Title (Song Name)
- 2 = Item.Artist (Performer)
- 3 = Item.Composition (Composer)
- 4 = Item.Movement (Classical music section)
- 32 = Station Name Long (As seen on your screen)

RT+1

Why is RT+2 Empty?



Stations use RT+1 for single items like station slogans (code 32). The RT+2 box stays empty because there is no second metadata type to tag. When a song plays, the encoder uses both slots simultaneously: RT+1 switches to code 1 (Song Title) and RT+2 switches to code 2 (Artist Name).

RT+2



Program Type Name

A Little Extra...

PS	PI Code	Callsign	
DON	1965	KDON	
RadioText 64 / 64			
The Central Coast's #1 Hit Music Station			
RT+1	RT+2		
32 Name Long - The Central Coast's #1 Hit Music Station			
PTY	PTYN	Time	
Top 40			
M/S	DI	TP	TA
Speech	Mono	Off	Off

Program Type Name

- If the station wants to be more specific than just "Top 40", they can use the PTYN field to broadcast a custom nickname (e.g., **HITLIST**, **CHR**, or **LIVE MIX**)
- It is optional: If a station is perfectly fine with the default label "Top 40", they can leave PTYN completely blank.
- The Data Envelope: PTYN information is transmitted over the inside Group 10A.
- **Display Only:** Car stereos cannot use the custom PTYN text for automatic tuning or station searching; it is purely visual eye candy for your dashboard.

PTYN



Program Type

It tells your car or home stereo exactly what kind of content is currently broadcasting.

PS

DON

PI Code

1965

Callsign

KDON

RadioText

The Central Coast's #1 Hit Music Station

RT+1

32 Name Long - The Central Coast's #1 Hit Music Station

RT+2

PTY

Top 40

PTYN

Time

M/S

Speech

DI

Mono

TP

Off

TA

Off

0	None	16	Rhythm and Blues (R&B)
1	News	17	Religious Music
2	Information	18	Religious Talk
3	Sports	19	Personality
4	Talk	20	Public
5	Rock	21	College
6	Classic Rock	22	Spanish
7	Adult Hits	23	Talk (Spanish)
8	Soft Rock	24	Hip Hop / Rap
9	Top 40 (CHR)	25	N/A
10	Country	26	N/A
11	Oldies	27	N/A

Program Type

It tells your car or home stereo exactly what kind of content is currently broadcasting.

PS

DON

PI Code

1965

Callsign

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RadioText

The Central Coast's #1 Hit Music Station

RT+1

32 Name Long - The Central Coast's #1 Hit Music Station

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PTY

Top 40

PTYN

Time

M/S

Speech

DI

Mono

TP

Off

TA

Off

12	Soft	28	N/A
13	Nostalgia	29	Weather
14	Jazz	30	Emergency Test
15	Classical	31	EMERGENCY ALERT (EAS)

Code 31 (Emergency Alert):

This code is highly protected. When triggered, it forces your car stereo to instantly switch away from your CD, Bluetooth, or auxiliary audio input to broadcast the local **Emergency Alert System (EAS)** audio.

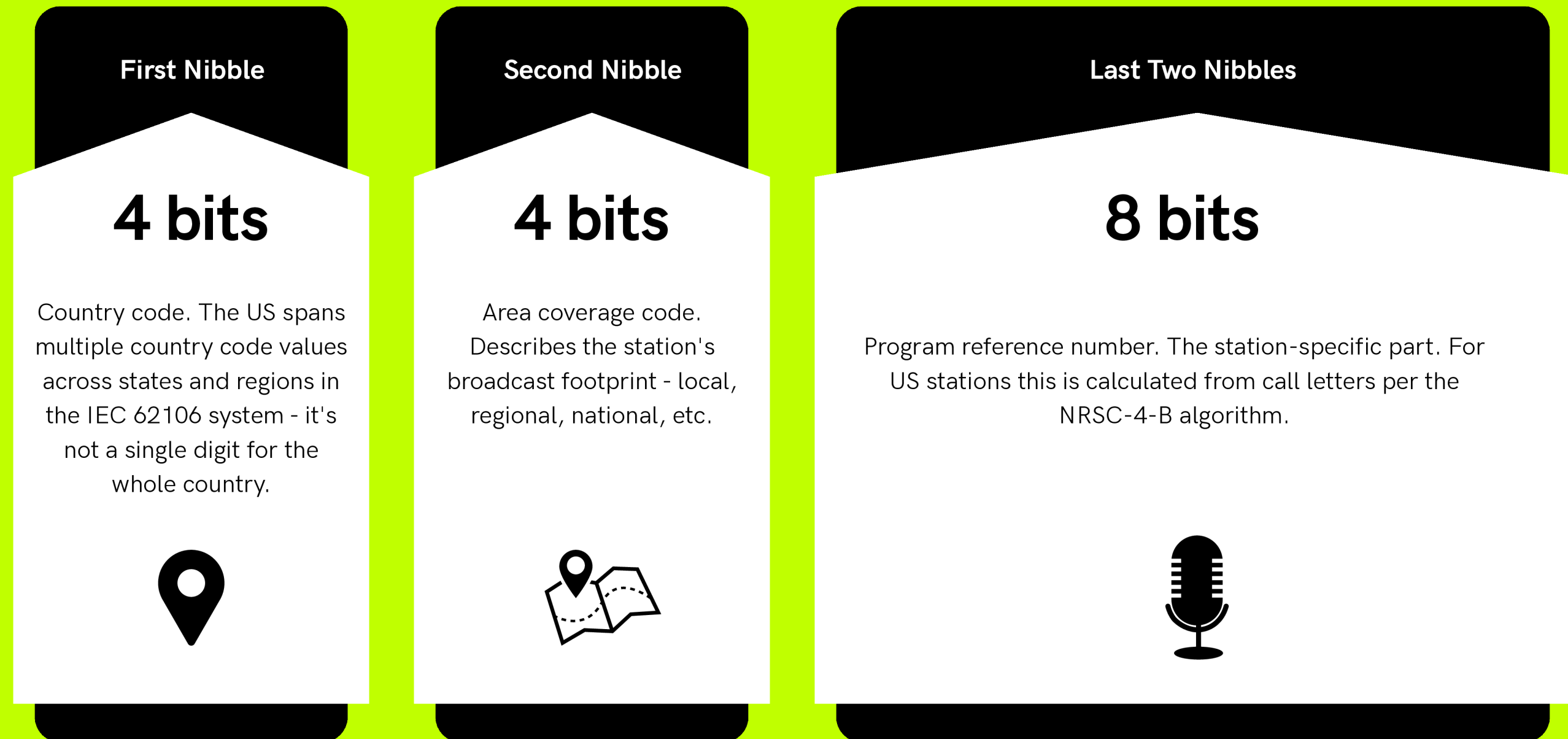
In the United States, almost no one uses PTY Code 31 anymore.

Because it acts as a "forced hijack," if an engineer accidentally misconfigures a radio station encoder and leaves Code 31 running, it will freeze every car stereo within a 30-mile radius onto that station. Fearing massive FCC fines for disrupting consumer equipment with accidental false alarms, most stations permanently disable the code in their automation software.



The PI Code

How It Works and Why It Matters Downstream



A 16-bit value displayed as 4 hex characters (e.g., 1965). It's the station's unique fingerprint in the entire RDS ecosystem. It rides in every single RDS group, not as a separate transmission



16

17

18

19

NRSC-4-B

- 3) If station call sign begins with K, add <VAL> to (decimal) 4096 and convert the result to hexadecimal (HEX (<VAL> + 4096)) to obtain four digit PI code. However, if call sign begins with W, add <VAL> to (decimal) 21672 and convert to hexadecimal (HEX (<VAL> + 21672)) to obtain four digit PI code.

IF K... HEX(<VAL> + 4096) = FOUR DIGIT PI CODE

IF W... HEX(<VAL> + 21672) = FOUR DIGIT PI CODE

EXCEPTIONS TO ABOVE ASSIGNMENTS:

- 1) CALL LETTERS THAT MAP TO PI CODES = 0
European receivers will treat a PI code that has a second nibble of zero as a local station (unique broadcast) and will not AF switch. If a station's call letters map to a PI code = 0 , the PI code assignment needs to be reassigned into the A group as follows:

P1 P2 P3 P4 → A P1 P2 P4

Examples: 1045 → A145; 30F2 → A3F2; 80A1 → A8A1; etc.

- 2) CALL LETTERS THAT MAP TO PI CODES = 0 0
If station's PI code ends with 00, the PI code will be reassigned into the A F group as follows:

P1 P2 0 0 → A F P1 P2

Examples: 1000 → AF10; 3200 → AF32; 8C00 → AF8C; etc.

NOTE: For 9 special cases—1000, 2000, ..., 9000—a double mapping occurs utilizing exceptions 1 and 2:

1000 → A100 → AFA1; 2000 → A200 → AFA2; ...; 8000 → A800 → AFA8; 9000 → A900 → AFA9

- 3) TWO STATIONS CARRY THE IDENTICAL PROGRAMMING
These stations will need to assign the same PI code for both stations. The radio will need an identical PI code match to switch to the alternate frequency. The call letters can still be displayed independently with the PS information.

Example: If WYAY and WYAJ have identical programming, either the mapping of WYAY (PI code = 4F78) or WYAJ (PI code = 4F68) will need to be used.

- 4) 3-LETTER-ONLY CALL LETTERS
For 3-letter call sign stations, a mapping of pre-assigned PI codes is shown in Table D.7, TABLE OF PI CODE POSSIBILITIES. The mapping of 3-letter-only call letters is reserved in PI codes ranging from 9950 to 9EFF.
- 5) NATIONALLY-LINKED RADIO STATIONS CARRYING DIFFERENT CALL LETTERS
These stations will need to be assigned a PI code with a first nibble of B (B_01 to B_FF, D_01 to D_FF, E_01 to E_FF). NOTE: Nibble 2 can only be filled with 1 through F. If a 0 is used, some receivers may not switch to Alternate Frequencies.





Get this wrong and your translators retune to the wrong station, your AF list breaks, and your RadioDNS lookup goes nowhere. Every system downstream depends on this one code being correct

Your Call Letters, In Hex

739C isn't a random number. It's **WLSU**, expressed in hex.

PS	PI Code	Callsign	
WLSU	739C	WLSU	
RadioText 22 / 64			
Wisconsin Public Radio			
RT+1	RT+2		
PTY	PTYN	Time	
Public		15:36 UTC-05:00 06/08/26	
M/S	DI	TP	TA
Music	Stereo	Off	Off

<https://picodes.nrscstandards.org>



What is AF?

A list of up to 25 frequencies that carry the same programming. Your main signal plus any translators. Stored in Group OA and broadcast continuously.

Program Type (PTY):	Adult Hits	
Program Type Name (PTYN):		Save
Alternative Frequencies (AFs):	Add AF	
	Alternative Frequencies 2	
	AF3: 88.9 MHz	×
	AF4: 90.3 MHz	×
Traffic Alert (TA):	☒ Off ☐ On	
TA Time (Sec):	30 <input type="range"/>	



PI Code: 1313



When signal strength drops, the receiver doesn't just jump to the next frequency on the AF list and hope for the best. It tunes there quietly in the background, checks the PI code, and only switches if it matches. The listener never hears it happen.

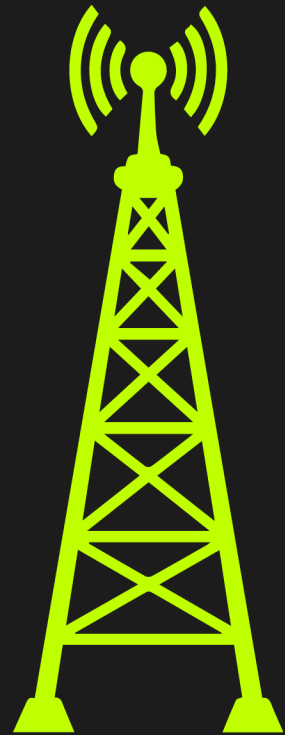
PI Code: 1313



PI Code: 1313

AF is the first place a wrong PI code costs you listeners. RadioDNS and DTS AutoStage are the next two.





That PI Code
4 hex digits.
Your station's identity.


PI



RadioDNS


our PI code and frequency become a DNS lookup. The receiver uses it to find whatever internet services your station has registered — metadata, logos, program guides. Wrong PI code, the lookup goes nowhere.



DTS AutoStage


The car reads your PI code, sends it to Xperi's platform, and gets back album art and station branding. Wrong PI code means no match — plain text or someone else's content on the display.



*all without HD Radio

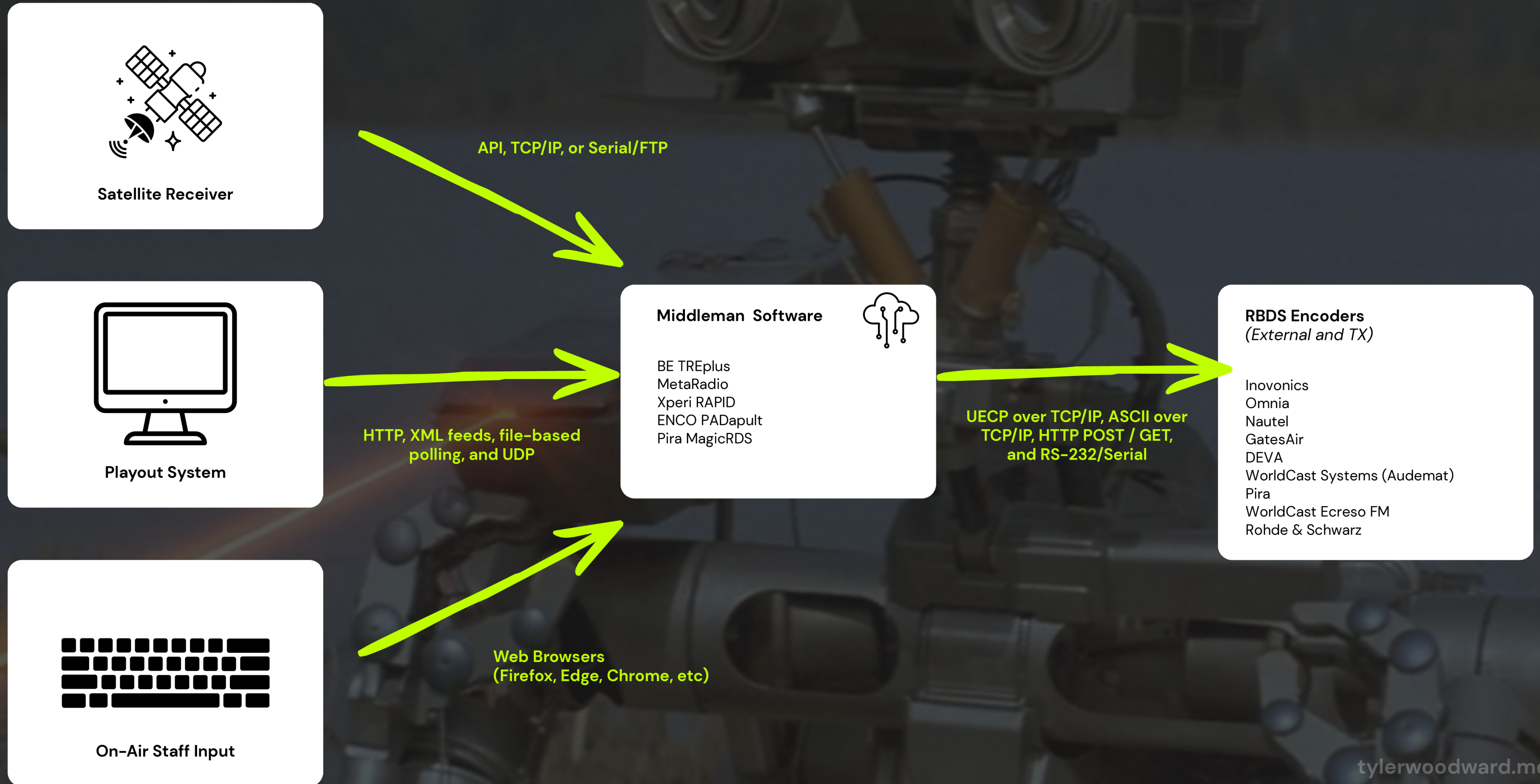
WHO SUPPORTS WHAT?

THE CARS ALREADY LISTENING FOR IT



THE ENCODER DOESN'T KNOW WHAT'S PLAYING

YOU HAVE TO GIVE IT INPUT LIKE JOHNNY 5



BEST PRACTICES

WHAT GOOD LOOKS LIKE

PS Name

Static. 8 characters. Call letters or brand name. Never scroll it.

RadioText

Dynamic. Artist – Title. Updated on every song change. Both RT and PS -- car displays vary on which field they show.

PI Code

Set correctly per NRSC-4. Never change it. Verify with FCCdata.org. Translators need the NRSC translator PI table.

PTY

Set accurately for your format. Leave it alone. Do not leave it at 0.

TP/TA

Only set TP if you actually carry traffic. Never leave TA stuck on.

AF List

List every translator and same-format frequency accurately. Test by driving -- does the radio retune correctly?

Group Allocation

OA: 40-60%. 2A: 20-30% if using dynamic RT. 4A: 5-10%. Disable every group not in use. Check for TMC and EON running by default.

DTS AutoStage

Register your station. Upload logos in all required sizes. Connect automation to push now-playing in real time. Free to participate.

RadioDNS

Host an SI XML file on a public web server. Create the DNS records. Register with RadioDNS. Required for Audi, VW, Porsche, BMW hybrid radio listeners.

Monitor, Monitor!

Inovonics 551 for HD stations. Inovonics 541 for FM-only. RTL-SDR for free spot-checking. RDS doesn't fail loudly -- it just quietly sends wrong data.



WRAP UP AND GOTCHAS

HD Radio PSD does NOT use the PI code



HD Radio has its own PAD/PSD delivery mechanism. The PI code is an FM RDS thing. RadioDNS and AutoStage both need the FM RDS PI. If someone asks 'does HD Radio help with RadioDNS,' the answer is no -- the FM RDS subcarrier has to be there and correct regardless of whether the station has HD.

Most US stations do NOT use RBDS for EAS



The capability exists in the spec. Group 3A can carry Open Data Applications including EAS. The Inovonics 730 + SAGE ENDEC 3644 integration can do it. But the vast majority of US stations are not using it, and most receiver implementations don't act on it.

AutoStage works without HD Radio and without RDS (sort of)



AutoStage can fall back to geo-location to identify a station if RDS is absent or broken. But to get the PI-based lookup chain working correctly, the RDS subcarrier has to be present and the PI has to be right. Geo-fallback is a crutch, not a design strategy.

The listener experience gap is real and visible



A Spotify or SiriusXM stream on the same head unit shows album art, branding, and metadata instantly. An FM station with broken RDS shows a frequency and nothing else. AutoStage and RadioDNS exist to close that gap. Stations that ignore it are choosing to look worse than a streaming service on their own listeners' dashboards.



RESOURCES AND LINKS

EXTRA GOODIES

[HTTPS://WWW.NRSCSTANDARDS.ORG/](https://www.nrscstandards.org/)

[HTTPS://WWW.RADIOWORLD.COM/RESOURCE-CENTER/RDS-BASICS-BEST-PRACTICES](https://www.radioworld.com/resource-center/rds-basics-best-practices)

[HTTPS://DTS.COM/AUTOSTAGE/](https://dts.com/autostage/)

[HTTPS://RADIODNS.ORG/](https://radiodns.org/)

[HTTPS://PICODES.NRSCSTANDARDS.ORG/](https://picodes.nrscstandards.org/)

