



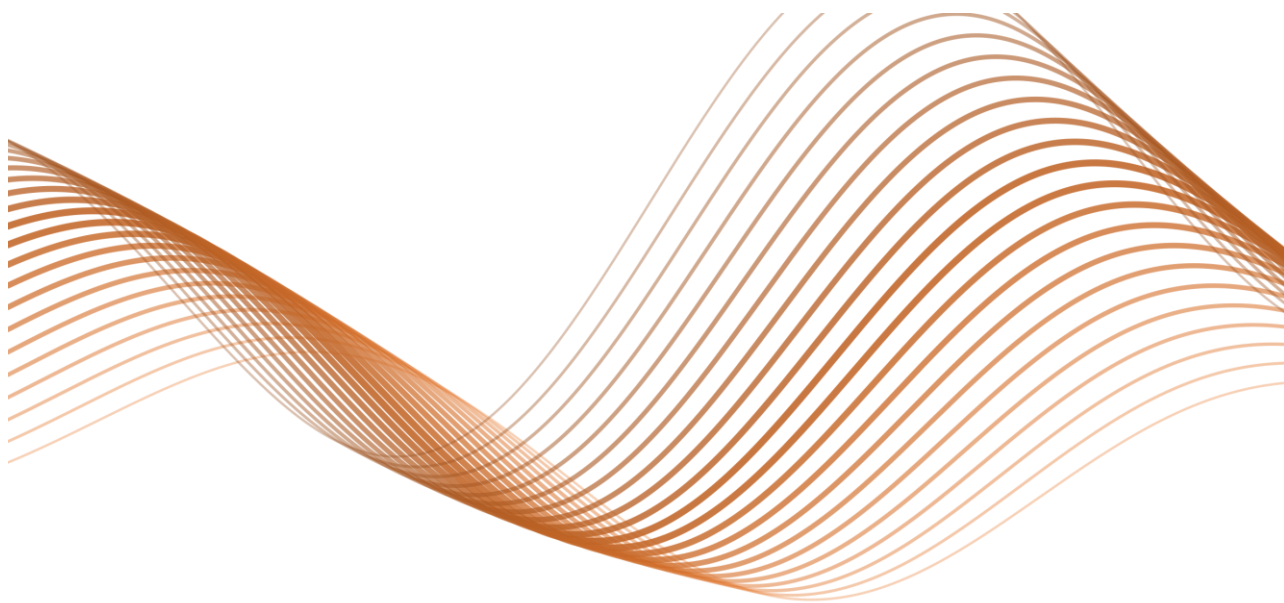
PANEDA®

APPENDIX 1

Key Benefits

Paneda DAB Multiplexing System

Software-based DAB/DAB+ head-end · System version 2026-04-02



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Executive Summary

Paneda develops DAB/DAB+ head-end systems and is today a world leader in the field. The flexible, generic system is built on the most modern technology and offers several unique features – such as state-of-the-art redundancy mechanisms based on the unique Paneda **SMART Content Switch**.

Security is another key focus: all internal and external connections are encrypted using TLS/HTTPS. The system has been tested by independent security companies and is graded **A+**, the highest possible level. Easy integration with third-party products for contribution, metadata and distribution is ensured through Paneda's **OpenAPI v3 JSON-based RESTful API**.

~20

years of DAB head-end
experience

200+

installations worldwide

A+

security grade from
independent testing

100%

software, managed via web
browser

Key benefits at a glance

Future-proof software

Runs on any standard server or virtual machine. Add stations and multiplexers at any time – without new hardware.

No vendor lock-in

Hardware- and OS-independent, built on Docker containers and Linux. Easy to migrate to new servers.

Unique redundancy

Smart Content Switch, PFT-synchronised outputs and time-shifting deliver broadcast-grade availability.

Security by design

A+ graded. HTTPS/TLS, two-factor authentication, role-based access and encrypted metadata.

Emergency ready

EWB+ breaks into all services with one click or API call – compatible with every DAB receiver.

Open integration

OpenAPI v3 RESTful JSON API covering everything from configuration to monitoring and PAD data.

1. About the Paneda DAB Multiplexing System

1.1 Overview

Paneda has developed a completely new head-end system from the ground up, drawing on almost 20 years of experience and feedback from more than 200 installations worldwide. The system is based on a modern architecture with RESTful APIs and has been designed with security as a top priority. The first version was released in 2015, and the system has since been continuously developed in line with new requirements in the DAB standard and input from our customers.

The Paneda DAB head-end is realised mainly as software and is based on **Docker containers**, giving a highly flexible setup and easy maintenance. New multiplexers can be added at any point without further hardware investment, and system upgrades are simple to manage.

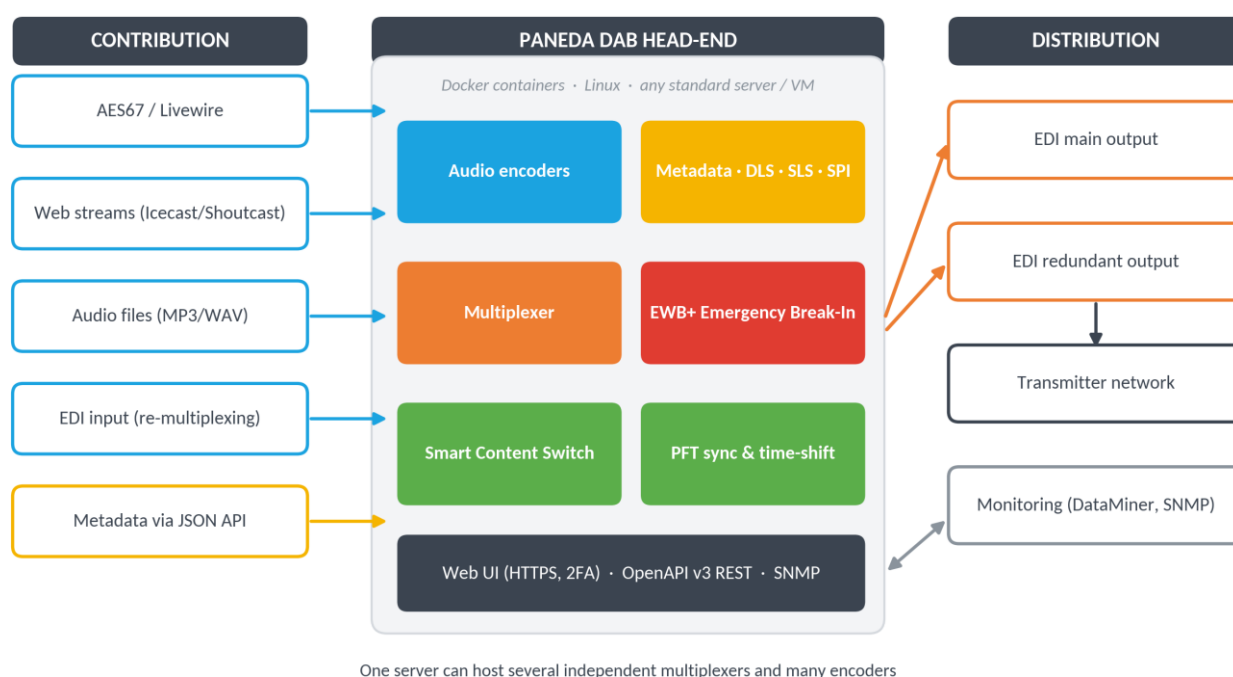


Figure 1. System overview – from contribution to distribution in one software platform.

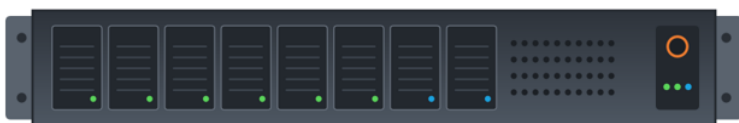
Future-proof. Easily add more stations and new multiplexers at any time – using the same hardware.

1.2 Software versus hardware

A software-based head-end offers clear advantages over a traditional hardware solution: it is generic, continuously developed and can be installed on any hardware platform. It is also independent of the operating system, which means **no vendor lock-in**.

	Paneda software head-end	Traditional hardware head-end
Hardware platform	✓ Any standard server or virtual machine	Dedicated, vendor-specific units
Vendor lock-in	✓ None – hardware- and OS-independent	Tied to one vendor's hardware
Adding multiplexers	✓ Start a new container on existing hardware	Requires additional hardware
Upgrades & maintenance	✓ Simple software updates, remote support	Hardware replacement or site visits
Management	✓ 100% web-based, no config files	Often local or proprietary tools

1.3 Deployment – server version (recommended)



The Paneda system is installed on a standard server – either supplied by Paneda or in **your existing environment**. Because it runs on standard hardware, it is easy to migrate to a new server in the future.

The multiplexing system runs in Docker containers on a Linux operating system. The very same server can host **several multiplexers and many encoders**.



Redundancy made affordable. To encourage redundant setups, Paneda offers substantial discounts on redundant systems.

2. Focus Areas

2.1 Security

Security is built into every layer of the Paneda system. The platform has been tested by independent security companies and is ranked at security level **A+**.

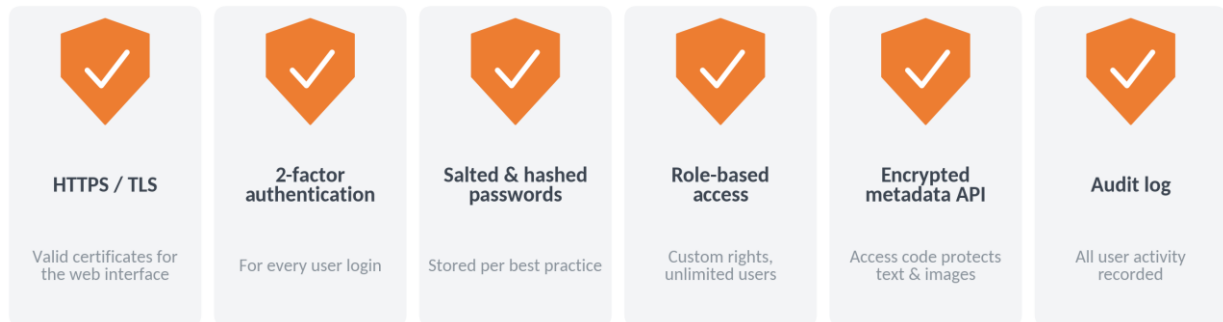


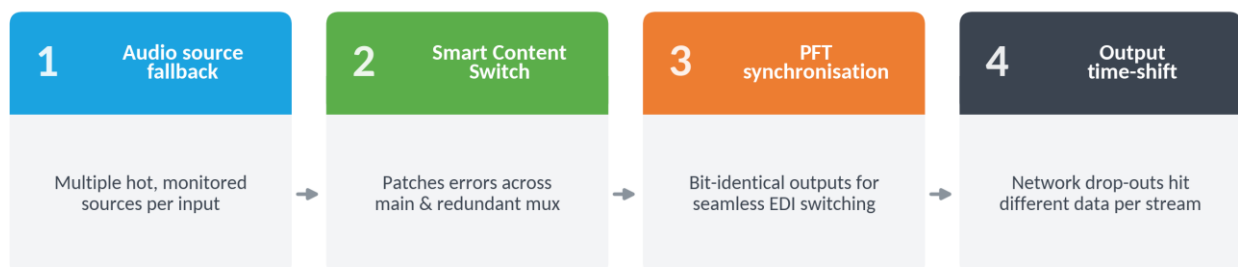
Figure 2. Security features of the Paneda system.

The system supports:

- **Encrypted connections** wherever applicable, for example for metadata – unauthorised parties cannot manipulate text or images.
- **A secure user database** – every user registers with a real e-mail address and a self-selected password. Passwords are individually salted and hashed according to best practice.
- **Custom user rights and roles** – with no limit on the number of users.
- **Two-factor authentication (2FA).**
- **HTTPS/SSL** for the management web interface, with valid certificates.

2.2 Redundancy

Broadcast systems require very high availability, and redundancy and back-up have therefore been a major focus. Paneda has developed new features that provide a new and higher level of redundancy – across the entire chain from audio input to distribution network.



Audio → Multiplexer → Distribution network

Figure 3. Four layers of redundancy in the Paneda system.

Audio

Paneda's audio handling is service-oriented: a service refers to a matrix of selectable audio sources. Combined with redundant audio sources, this ensures far more fault-tolerant audio handling.

- A service points to an audio source rather than an audio encoder – giving maximum flexibility, with no need to change encoder when changing audio source.
- Each audio input can be defined with multiple audio sources, such as web streams, fallback sources or an audio file.
- All defined audio inputs are “hot” and monitored – the system never switches over to non-working audio.
- A service can refer to any available audio source at any time.

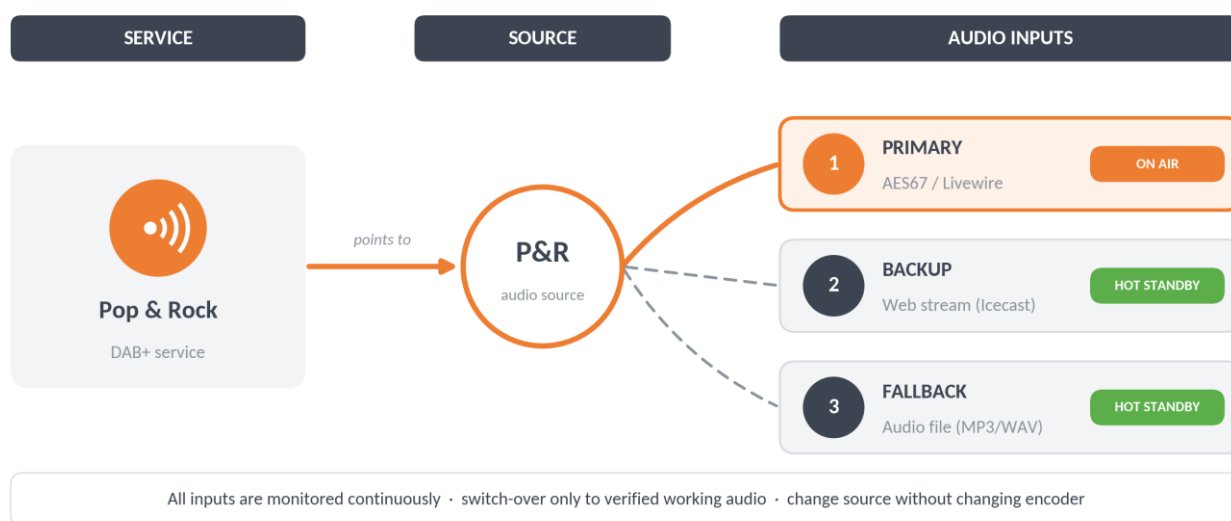


Figure 4. A service points to an audio source with primary, backup and fallback inputs – all hot and monitored.

EWB+ – Emergency Warning Break-In

The Paneda system includes a built-in break-in function called **EWB+ (Emergency Warning Break-In)**. The principle is simple: with a single button press, all audio services are switched to a dedicated audio source for broadcasting an important message.

EWB+ is compatible with all receivers on the market and fully complies with the **DAB standard**. It is particularly suitable when critical information must be disseminated quickly using a solution that works on every receiver.

As a complement, the standard-based **DAB Alarm Announcement** feature can also be used. It has the additional ability to wake receivers from stand-by, ensuring that important messages reach listeners even when their devices are not in active use.

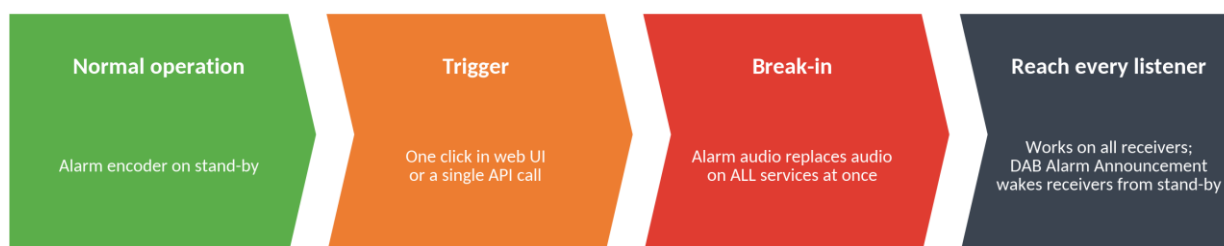


Figure 5. EWB+ – from normal operation to a break-in on all services.

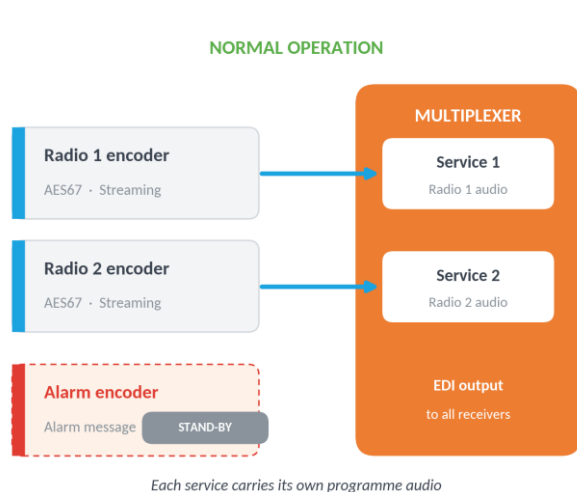


Figure 6. Normal operation – the alarm encoder is on stand-by.

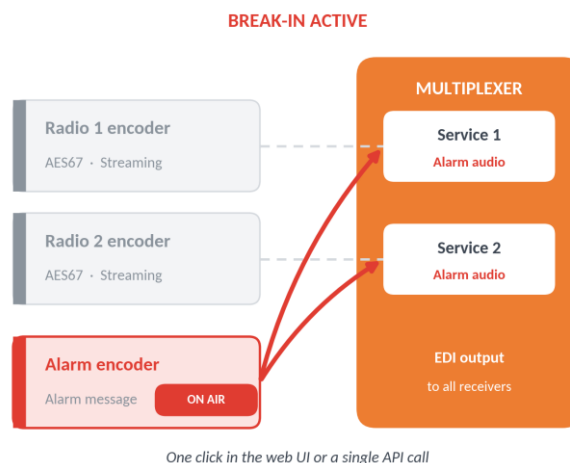


Figure 7. Break-in – the alarm encoder replaces the audio on all services simultaneously.

EWB+ can be triggered from the web interface or automated via an API command.

SMART Content Switch

The unique Paneda SMART Content Switch “patches” two faulty signals into one error-free output. An audio error in one multiplexer combined with a different audio error in the redundant multiplexer still results in an error-free output.

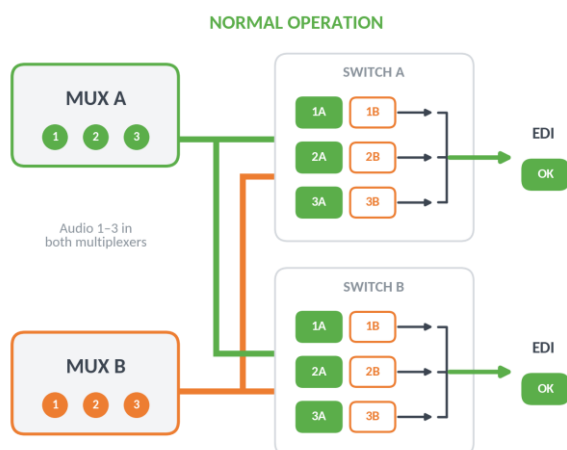


Figure 8. Normal operation – each switch selects every subchannel from MUX A, with MUX B ready.

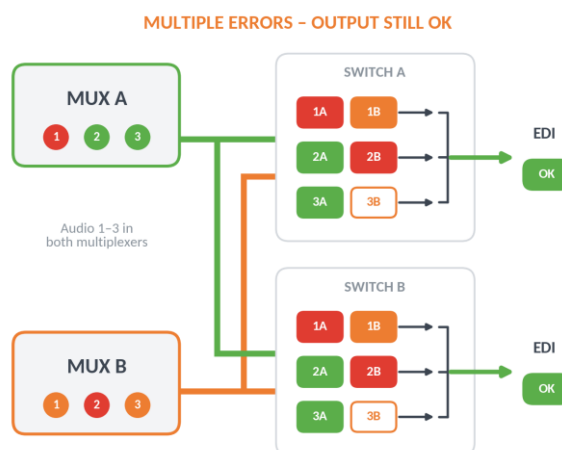


Figure 9. Multiple errors: service 1 fails in the main system and service 2 in the redundant system – both outputs remain OK.

Synchronisation with PFT (Protection, Fragmentation and Transport)

Multiplexer redundancy includes synchronisation of the configuration **and** frame synchronisation of the multiplexer output. Multiplexers in redundant mode are 100% synchronised, enabling seamless switching at EDI level in the transmitters or in the IP network.

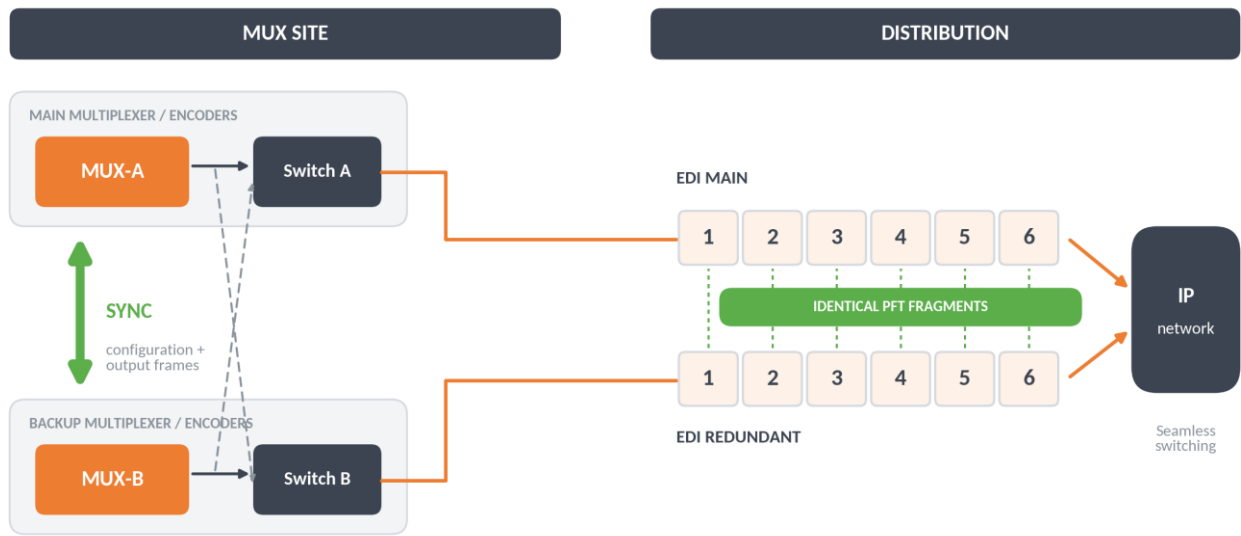


Figure 10. Paneda outputs are synchronised and PFT-aligned – each PFT fragment contains exactly the same data.

Synchronisation with time-shift

In addition to PFT synchronisation, Paneda supports time-shifting of the outputs, providing an even higher level of redundancy in the distribution network.

- On a network drop-out, a time-shifted output ensures that different data is affected in each stream.
- A receiver supporting PFT handling can cherry-pick fragments from either stream.

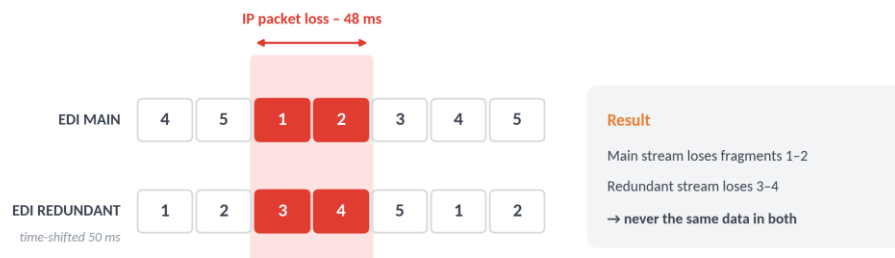


Figure 11. A network drop-out affects different data content in the two streams.

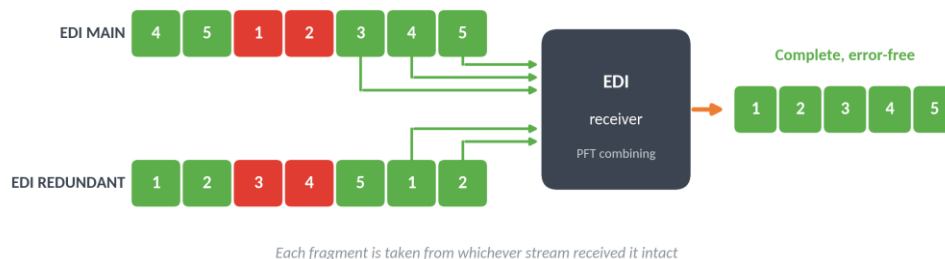


Figure 12. An EDI receiver can cherry-pick individual PFT fragments from either stream.

2.3 Providers

The system offers a flexible way to handle different providers. Each provider logs in to the system and manages its own assigned capacity – completely isolated from and independent of the others. This approach replaces the older service-multiplexer concept and eliminates its disadvantages.

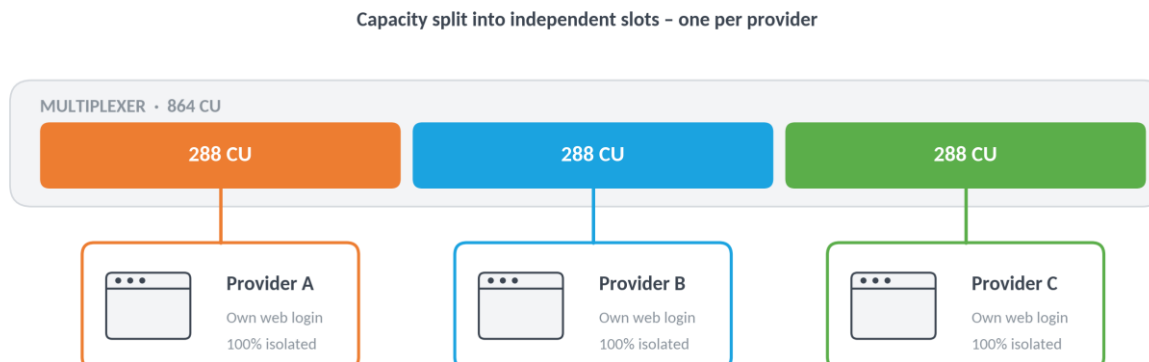


Figure 13. The multiplexer is divided into capacity slots – one per provider. Each provider has its own web interface and is 100% isolated from the others.

2.4 Metadata

- Text and images can be added directly in the web interface.
- Text and image metadata are easily integrated via the web-based JSON API.
- Metadata insertion is encrypted and requires an access code, preventing manipulation.

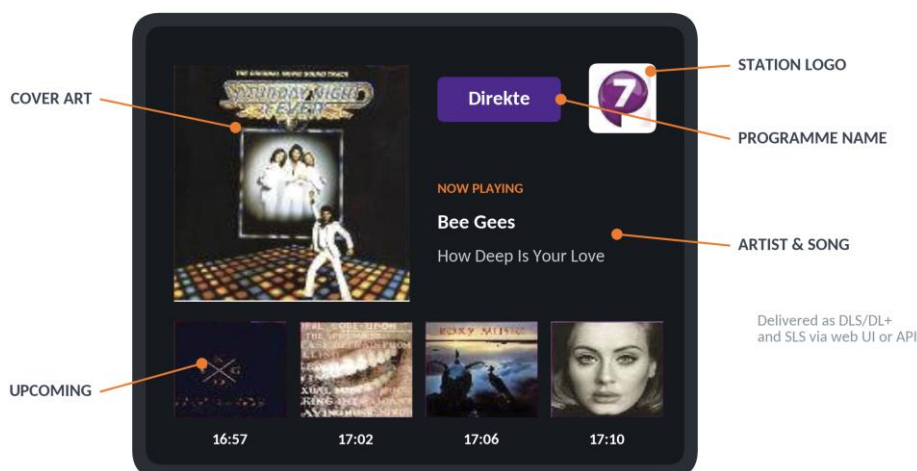
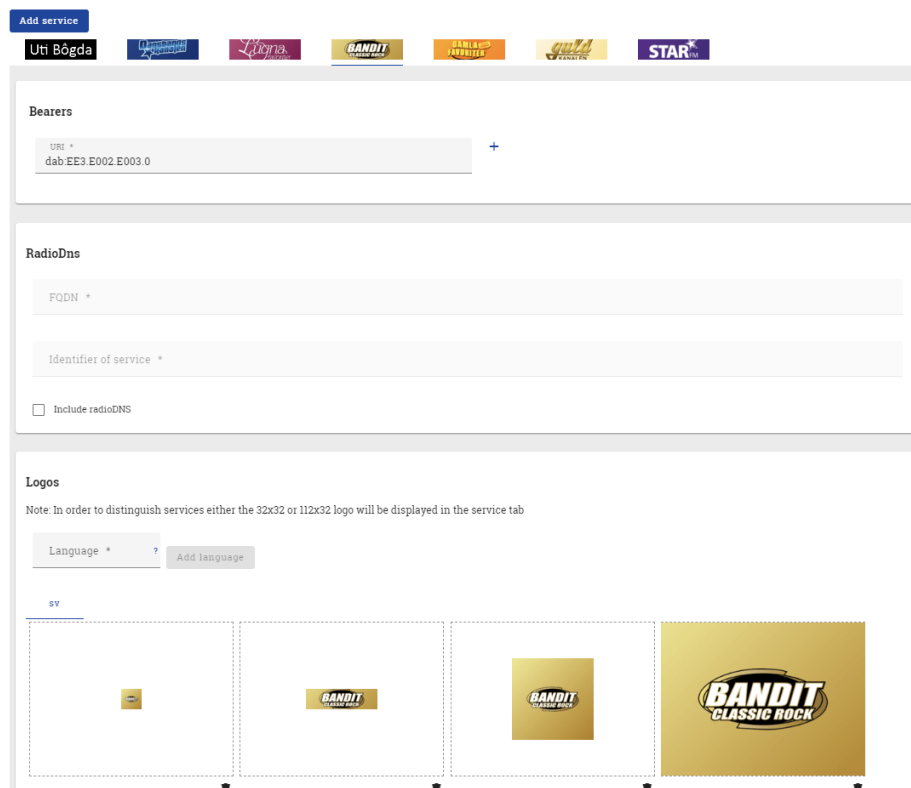


Figure 14. SLS example – cover art, station logo, programme name, artist, song and upcoming tracks on the receiver display.

2.5 SPI Station Logo

The Paneda system provides complete handling of **SPI Station Logos**. Each radio station simply adds its logos in the web interface (or via the API), and the multiplexer composes a complete SPI service for all stations in the multiplexer – no external systems required.



The screenshot shows the 'Add service' interface in the Paneda system. At the top, there is a row of logos for 'Uti Böga', 'Lugna', 'BANDIT', 'BANDIT FAVORITES', 'GULL', and 'STAR'. Below this, the 'Bearers' section contains a 'URI *' field with the value 'dab:EE3.E002.E003.0' and a '+' button. The 'RadioDns' section has an 'FQDN *' field, an 'Identifier of service *' field, and a checkbox labeled 'Include radioDNS'. The 'Logos' section includes a note: 'Note: In order to distinguish services either the 32x32 or 112x32 logo will be displayed in the service tab'. Below the note is a 'Language *' dropdown menu with a '?' icon and an 'Add language' button. The 'sv' language is selected. The main area displays four logos in a row: a small 32x32 logo, a 112x32 logo, another 112x32 logo, and a larger 112x32 logo. Each logo is shown within a dashed border, and there are small icons below each logo.

Figure 15. Managing station logos in the web interface.

2.6 Virtualisation

The Paneda system is designed for container-based installation using Docker. On a server with a minimal operating system such as Fedora CoreOS, several DAB multiplexer systems and encoders can run on the very same hardware. Each system is independent and runs in its own isolated container environment.

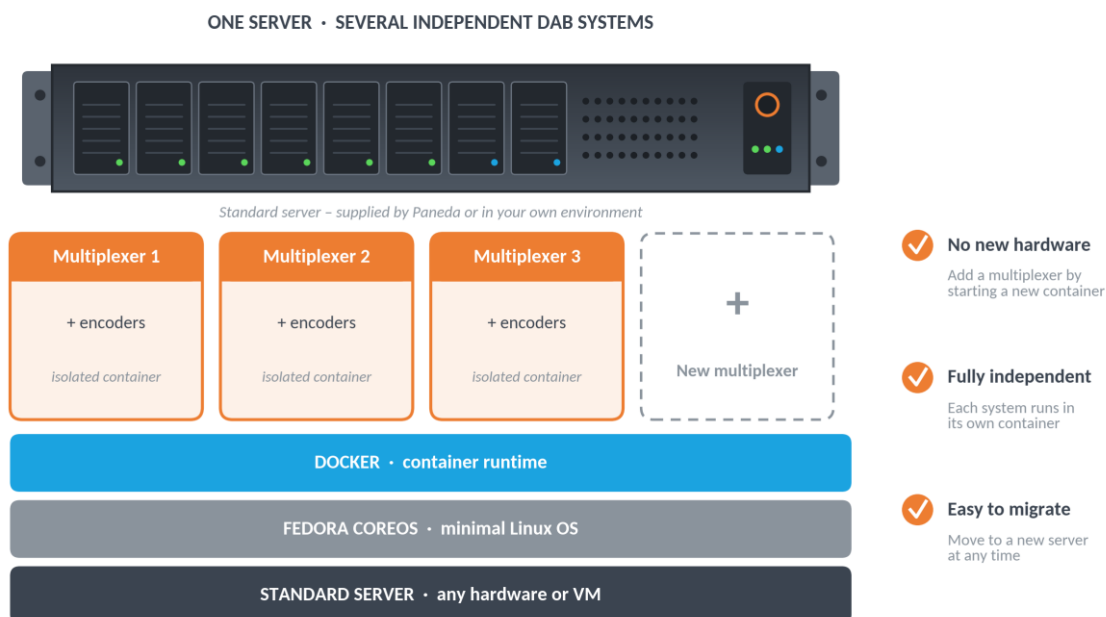


Figure 16. Several independent multiplexers on one standard server.

2.7 Status monitoring

The Paneda system gives you a complete overview of all relevant statistics – for example audio input performance, FIG repetition rates, server hardware performance and much more.

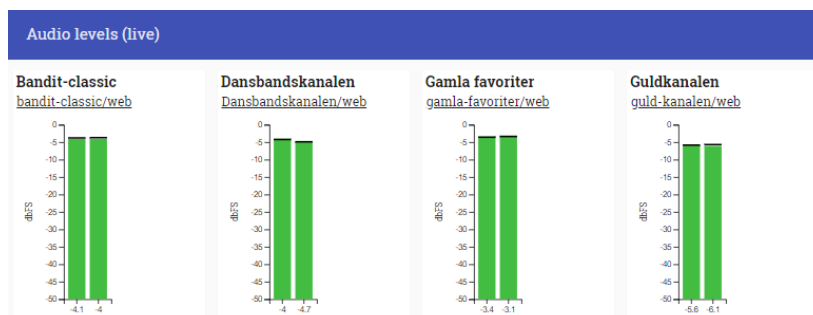


Figure 17. Audio levels, including fallback audio inputs.

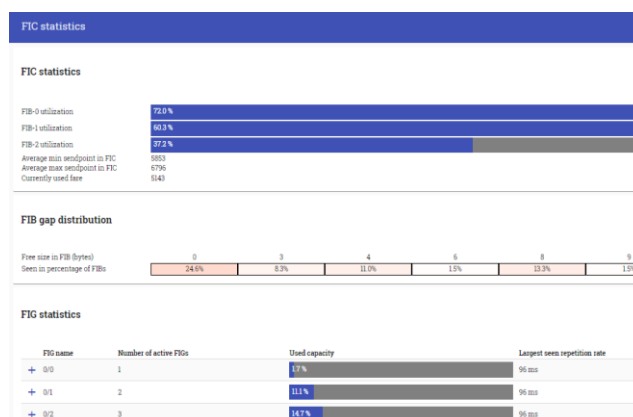


Figure 18. FIG statistics with repetition rate per FIG.

3. Supported Features

Audio and metadata

- A service points to an audio source rather than an audio encoder – no need to change encoder when changing audio source.
- Each audio input can have multiple audio sources, such as web streams, fallback sources or an audio file.
- Easy insertion of audio from remote sites.
- Text and image metadata easily integrated via the web-based JSON API.
- Text and images can be added directly in the web interface.
- Alarm if no metadata is present.

Monitoring

- Custom-defined SNMP channels.
- Monitoring via the Paneda API, with support for major monitoring systems such as DataMiner.
- Real-time status overview in the web interface, including real-time VU meters.
- All activities in the system are recorded in an audit log.

General system support and functions

- Only a web browser is needed for configuration, control and monitoring – no configuration files or other tools.
- The web interface uses TLS (SSL) for maximum security, including two-factor authentication.
- Multi-language support, including local languages in the web interface.
- Easy remote support.
- Built to run in a Docker container setup or on VMware.
- Linux-based operating system (non-Windows).
- Scalable – new services, providers or even complete systems can be started without hardware investment.
- Service following between DAB and FM, including support for the latest “linkage actuator” standard.
- Measurement of audio levels (VU meters) in the web interface.
- Custom FIG signalling.
- Support for additional codecs, such as the open-source codec and the professional Dolby codec.
- Seamless change of service bitrate and codec.
- Web radio streams as audio source, e.g. Shoutcast/Icecast and other common formats.
- EDI input, including “re-multiplexing” and subchannel-based extraction.
- Responsive web interface for control and monitoring from mobile devices.
- Support for the All In Media “RAPID” content system.
- 1+1 redundancy with synchronisation of configuration **and** multiplexer output frames – multiplexers in redundant mode are 100% bit-synchronised for seamless switching at EDI level in the transmitters or IP network.

4. Technical Features

Legend: ● Included in the standard system ○ Available as option

AUDIO ENCODER	INCLUDED	OPTION
Open-source codec MP I/II & AAC	●	
AES67 / Livewire	●	
AES/EBU		○
Streaming formats (Icecast, Shoutcast etc.)	●	
Audio input redundancy, multiple sources		○
Fraunhofer PRO AAC codec		○
Dolby Professional AAC codec		○
External encoders		○
Audio input as file (MP3 or WAV)	●	
Drift compensation for web streams	●	
Silence detector	●	
Gain control	●	
Real-time VU meter	●	
Seamless changes of audio parameters	●	
External hardware encoder		○

MULTIPLEXER	INCLUDED	OPTION
EDI input re-multiplexing	●	
Full EDI standard implementation	●	
Multiple EDI outputs	●	
Individual settings per EDI output	●	
EDI PFT synchronisation	●	
EDI PFT address field support	●	
Advanced configuration scheduler	●	
Service following FIG 0/6	●	
Linkage actuator	●	
Frequency Information FIG 0/21	●	
Other Ensemble FIG 0/24	●	
FIG analyser	●	
ETI recording at output		○
Virtual service provider	●	
SMART Content Switch		○
Seamless built-in EDI switch		○
Graphical performance monitor	●	
Announcement support	●	
Extended label support (FIG 2)	●	
iDLP, FIG 0/6 with low/high priority "Push to local"	●	
ASA – Automatic Safety Alert warning system		○

SECURITY	INCLUDED	OPTION
HTTPS (SSL) encryption	●	
Certificate handling	●	
Two-factor authentication	●	
Encrypted internal and external connections	●	
User database with custom user rights	●	
User audit log	●	

DATA	INCLUDED	OPTION
DLS	●	
DL+	●	
SLS	●	
EPG		○
TPEG		○
External content systems such as RAPID	●	
Alarm on missing metadata	●	
Backup metadata when no content	●	
SPI Station Logo without external systems		○

GENERAL	INCLUDED	OPTION
Support for all languages	●	
Mobile-friendly GUI	●	
JSON web API	●	
Custom-defined SNMP	●	
100% web interface for setup and management	●	
Remote support and upgrades	●	
Backup & restore from GUI	●	
Docker container support	●	
Real-time status monitoring in web interface	●	
Management of third-party system web interfaces	●	
Graphical event log overview	●	
Unlimited number of users	●	
Emergency Warning Break-In (EWB+)	●	
EDI over SRT		○

5. Example Screenshots

A selection of views from the Paneda web interface. All management and monitoring is done in the browser – on desktop or mobile.

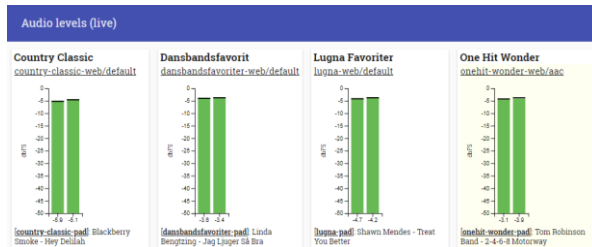


Figure 20. Audio status overview with PAD data

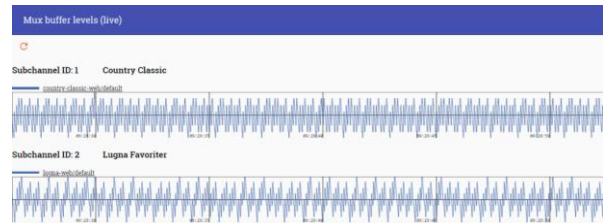


Figure 21. Real-time buffer level status



Figure 22. Graphical alarm history log



Figure 23. Performance monitor

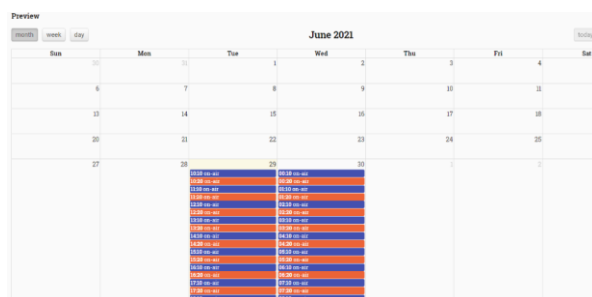


Figure 24. Calendar-based scheduler

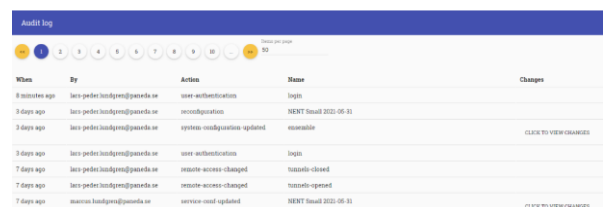


Figure 25. Audit log per user

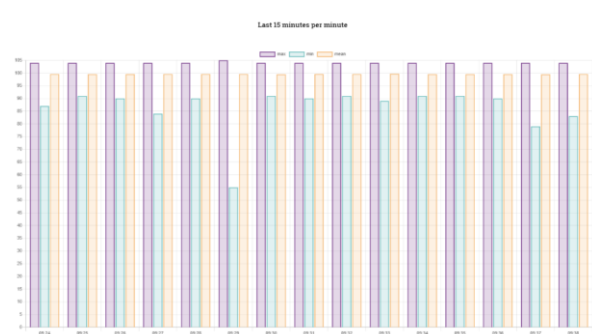


Figure 26. Output buffer status overview

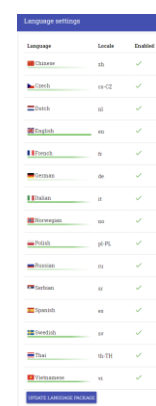


Figure 27. Multi-language support