CTT Topological Resonator: Core Integration Specifications

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1 Introduction

The CTT Topological Resonator is designed as a high-precision phase-tracking module for the SatDump manifold. It provides frequency stabilization for L-band signals, specifically targeting the 1.7 GHz downlink window.

2 Mathematical Framework

The core of the resonator utilizes a Discrete-Time Topological Recurrence. Given a complex IQ input stream $z[n]$, the phase state ϕ evolves according to the following control law:

$$\phi[n+1] = \phi[n] + \omega + K \cdot \text{Im}\{z[n] \cdot e^{-j\phi[n]}\}$$

Where:

- $\phi[n]$ is the instantaneous phase at sample n.
- ω is the center frequency offset ($2\pi f_c / f_s$).
- K is the topological coupling constant.

3 Software Implementation

To prevent linker optimization errors (dead code elimination), the module is hard-linked into the SatDump core.

3.1 Registry Injection

The module is registered in `src-core/pipeline/module.cpp` using the following macro call:

```
REGISTER_MODULE(CTTTopologicalResonator);
```

3.2 Module Identification

The module manifests in the CLI with the following metadata:

- **Internal ID:** `ctt_phi24_resonator`
- **Type:** `ProcessingModule`

4 Compilation and Verification

The binary was successfully compiled on Fedora using `GCC 15`. Verification was performed via:

```
./satdump modules list | grep ctt
```