A VOEVENT STANDARD FOR FAST RADIO BURSTS AND ITS APPLICATIONS
FAST RADIO BURSTS

- Bright, impulsive transients
- Millisecond timescales
- High dispersion measure
- Rate $\sim O[1000]$ day$^{-1}$
- $O[\sim 100]$ sources currently known

Thornton et al. (2013)
REAL-TIME DETECTION OF FRBS  
Hundreds (to thousands) of FRBs per year 

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COMMUNICATING NEW FRBS

- Fast
- Informative
- Standardized
- Agreed upon by the majority of the community
- Well-established
VOEvent Standard for Fast Radio Bursts

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ABSTRACT

Fast radio bursts are a new class of transient radio phenomena currently detected as millisecond radio pulses with very high dispersion measures. As new radio surveys begin searching for FRBs a large population is expected to be detected in real-time, triggering a range of multi-wavelength and multi-messenger telescopes to search for repeating bursts and/or associated emission. Here we propose a method for disseminating FRB triggers using Virtual Observatory Events (VOEvents). This format is developed and is used successfully for transient alerts across the electromagnetic spectrum and for multi-messenger signals such as gravitational waves. In this paper we outline a proposed VOEvent standard for FRBs that includes the essential parameters of the event and where these parameters should be specified within the structure of the event. An additional advantage to the use of VOEvents for FRBs is that the events can automatically be ingested into the FRB Catalogue (FRBCAT) enabling real-time updates for public use. We welcome feedback from the community on the proposed standard outlined below and encourage those interested to join the nascent working group forming around this topic.

Introduction

Fast radio bursts (FRBs) are one of the most exciting topics in modern astrophysics. FRBs are detected as millisecond radio pulses, with high dispersion measures (DM), defining the frequency-dependent delay of the pulse arrival time across an observing bandwidth. Physically, this DM is related to the electron column density along the line of sight as

\[ \text{DM} = \int n_e \cdot dL \]

where \( D \) is the distance between the source and the observer along some path.

Twenty five FRB sources have been published, to name a few. The designation of a bright single pulse as an FRB (as opposed to a bright single pulse from a Galactic pulsar) has been based on its DM.

FRBs originate extragalactically leading to energetic progenitor theories such as binary neutron star mergers, neutron stars to black holes, and young magnetars in dense supernova remnants, to name a few. The designation of a bright single pulse as an FRB (as opposed to a bright single pulse from a Galactic pulsar) has been based on its DM. The first FRB was discovered in 2007 by Lorimer et al. and since then progress has increased rapidly.

All publicly available FRBs are included in the FRB Catalogue (FRBCAT); http://www.frbcat.org

FRBs currently follow the date-based naming conventions for gamma-ray burst and gravitational wave events: FRB YYMMDD.

FRB 010724, and one source, FRB 121102, has been seen to repeat, and young magnetars in dense supernova remnants have been published, and since then progress has increased rapidly.
ELEMENTS OF A VOEVENT

- **<Who>** : Telescope and author information
- **<What>** : All parameters that describe the FRB go here
- **<WhereWhen>** : Time of observation, position in the sky, telescope location
- **<How>** : Data links, survey webpage, instrument details, etc.
- **<Why>** : FRB name (still working on this), importance
TYPES OF VOEVENTS

1. Detection
2. Subsequent
3. Update
4. Retraction
   A. Search
   B. Targeted
REQUIRED PARAMETERS

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<Param name="scan_type" value="" "> Fixed or drift scan performed? </Description>
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  <Param name="galactic_electron_model" value="" "> [In case "other": give DOI or discription of model used

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This catalogue contains up-to-date information for the published population of Fast Radio Bursts (FRBs). This site is maintained by the FRBCAT team and is updated as new sources are published or refined numbers become available. Sources can now be added to the FRBCAT automatically via the VOEvent Network, details of this process are given in Petroff et al., 2017. FRBs confirmed via publication, or received with a high importance score over the VOEvent Network, are given 'Verified' status and are shown on the default homepage; to see all events (including unverified candidates received via the VOEvent Network) toggle the "Verified events/All events" button below.

Information for each burst is divided into two categories: observed parameters from the available data, and derived parameters produced using a model. Cosmological values are obtained using the Cosmology Calculator (Wright, 2008). The observed parameters are sometimes either lower or upper limits, due to the limitations of the data acquisition systems. Where multiple fits or measurements of a burst have been made each one is provided as a separate sub-entry for the FRB.

You may use the data presented in this catalogue for publications; however, we ask that you cite the paper (Petroff et al., 2016) and provide the url (http://www.frbcat.org). Any issues relating to the use of the catalogue should be addressed to FRBCAT team (primary contact: Emily Petroff).

An up-to-date CSV file containing all parameters for all FRBs is available at the following stable link: http://www.frbcat.org/frbcat.csv

```
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<th>DECJ</th>
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<th>gb</th>
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<th>Width</th>
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FRBCAT AND VOEVENTS

- FRBCat VOEvent Broker
WHY SHOULD YOU USE FRB VOEVENTS?

- Standardized
- Open source
- Low latency
- Automatically added to FRBCAT
- We’ve done most of the work for you!
- Broad agreement to use this standard throughout the FRB community

Apertif
ASKAP
CHIME
MeerKAT
Realfast (VLA)
UTMOST
++

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HOW TO GET STARTED

- arXiv: 1710.08155
- https://github.com/ebpetroff/FRB_VOEEvent
- https://github.com/AA-ALERT/frbcatdb
- FRB parsing/triggering scripts and unit tests coming soon
- Get in touch!
LESSONS FROM THE FRB CASE

Pros:
- Standardization makes communication easy
- Lower barrier to entry
- Standardized parameters allow integration with FRBCAT
- Good exercise in community engagement

Challenges:
- Involving the entire community
- Finding something everyone can agree on
- Leaving sufficient space for flexibility
- More difficult in more established fields?

Thank you!