

THE US NATIONAL VIRTUAL OBSERVATORY

# VOEvent

~~*Life Cycle of a  
Sky Transient Alert*~~

Rob Seaman  
*National Optical Astronomy Observatory*



Transient Universe 2006

14 Mar 2005

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# Some VOEvent Happenings

- VOEvent Workshop - *April*
- IVOA Kyoto InterOp - *May*
- VOEvent v1.0 specification - *June*
- HTN Workshop - *July*
- NVO Summer School Demo - *September*
- VOEventNet NSF grant (*big*) - *September*
  - *“robust”, “federated”, “synergy”*
- ADASS XV VOEvent BoF - *October*
- IVOA Madrid InterOp - *October*
- VOEvent II Workshop - *December*
- NVO grant (*little*) for NOAO SNe events - *December*
  - *“lustrous”, “enabling”, “beneficiary”*
- AAS Demo - *January*
- IVOA Victoria InterOp - *May*
- SPIE - *May*
- Heterogeneous Telescope Network II - *July*
- VOEvent III, ADASS XVI, ...
  - <http://www.ivoa.net/twiki/bin/view/IVOA/IvoaVOEvent>

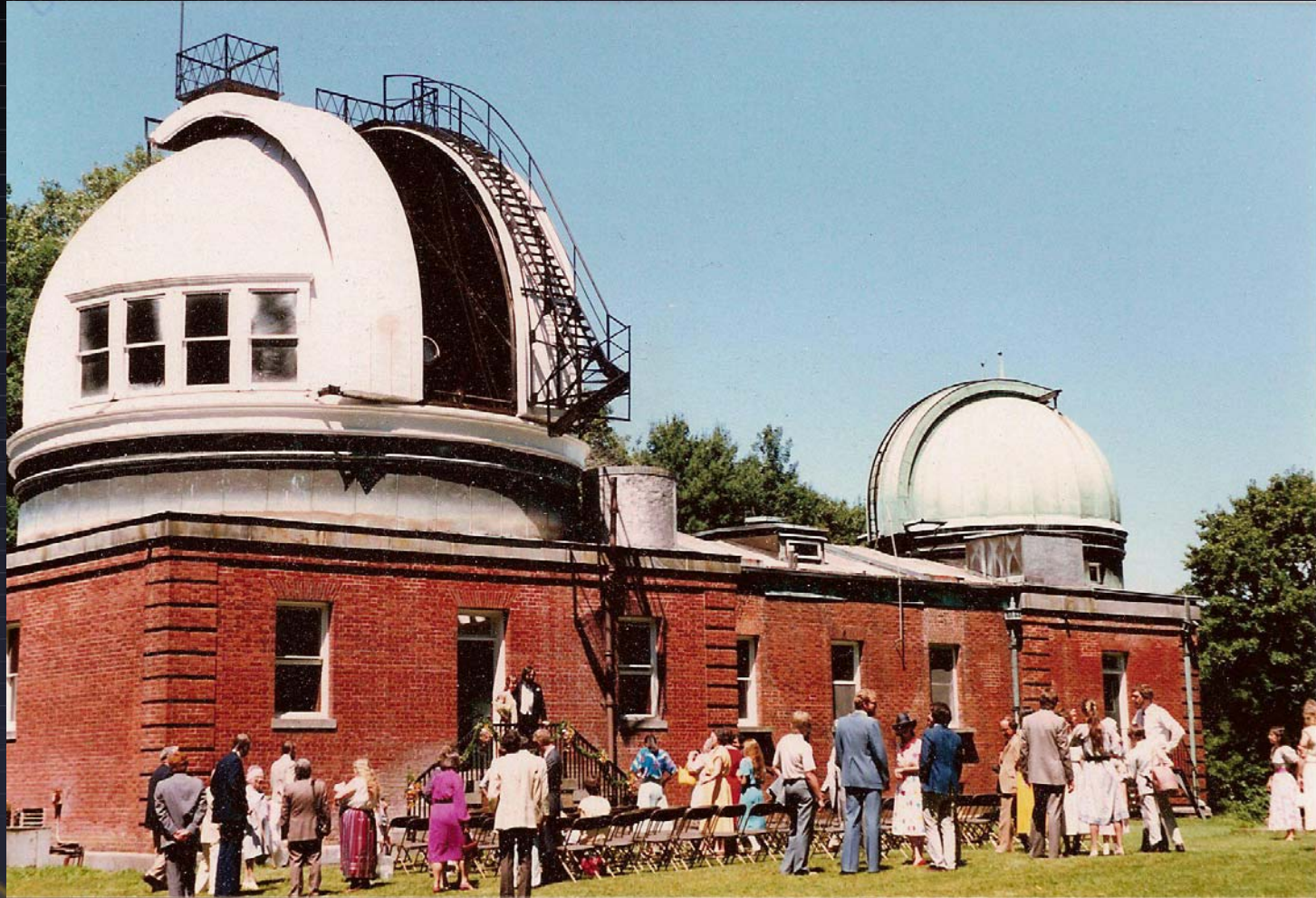


# VOEvent Technologies (*XML*)

- *<VOEvent>*
  - *<Who>*
  - *<What>*
  - *<WhereWhen>*
  - *<How>*
  - *<Why>*
  - *<Citations>*
  - *<Description>*
  - *<Reference>*
- *IVO Identifiers*
  - *Resource Metadata*
  - *VOTables*
  - *STC*
  - *RTML*
  - *UCDs, ontologies*
  - *IVO Identifiers*
  - *natural language*
  - *everything else*
- *<http://www.ivoa.net/Documents/latest/VOEvent.html>*

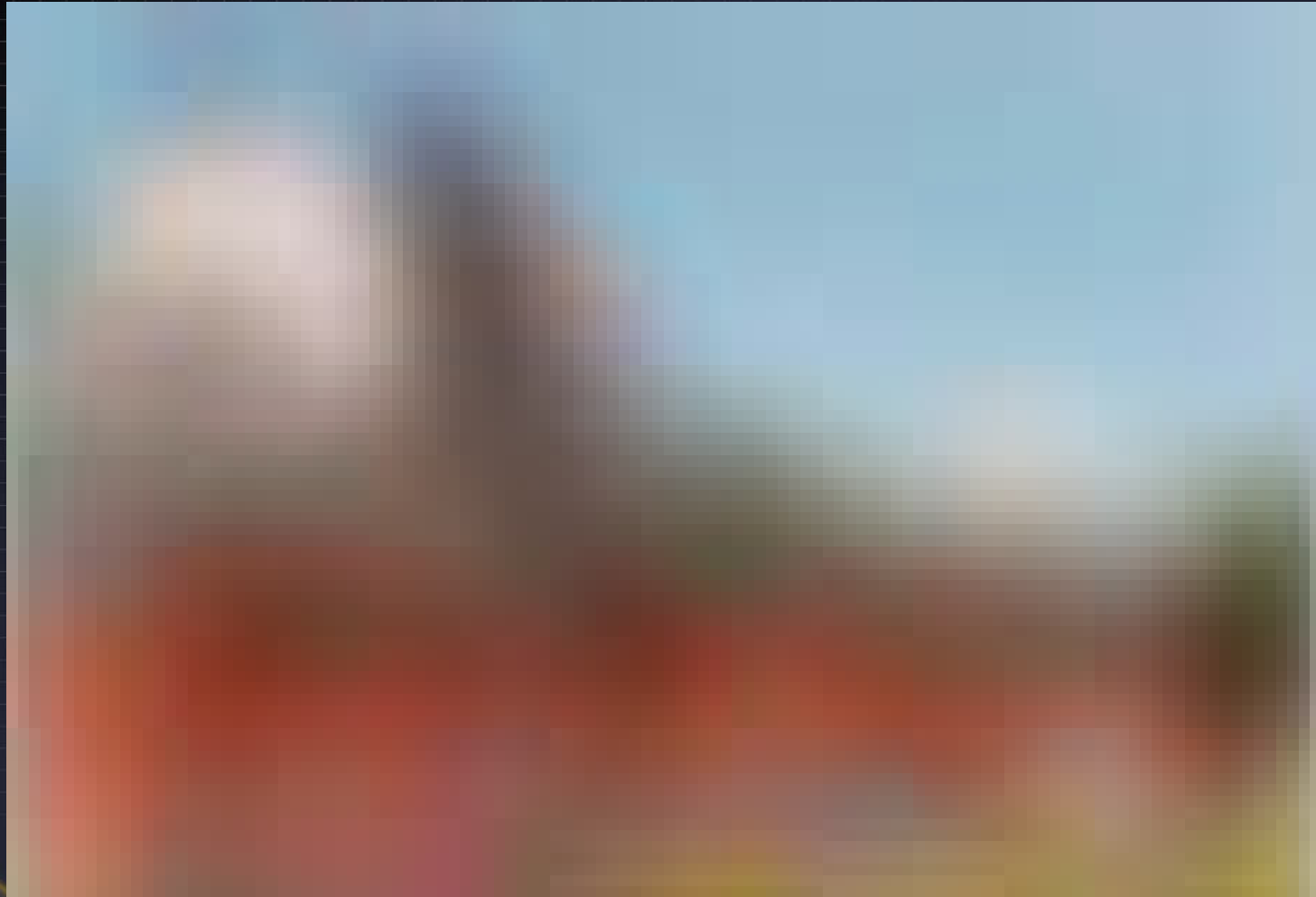
# A Transient Astronomical Event

(epoch 1986, published 1993)

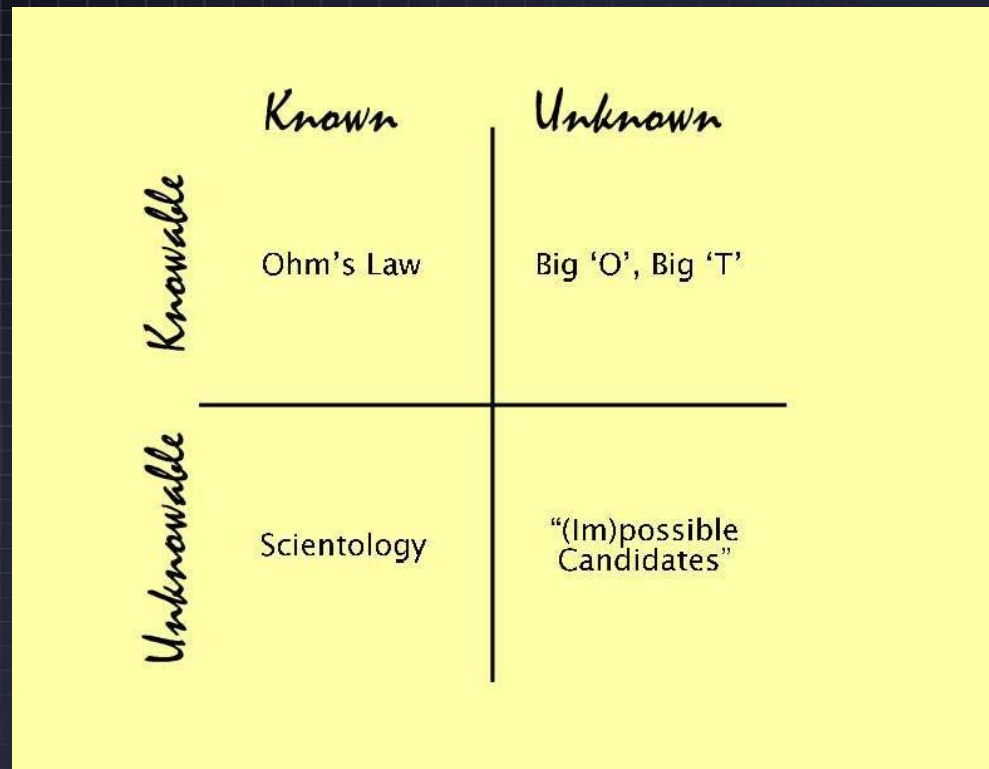


# What we actually see

(won't belabor analogy)



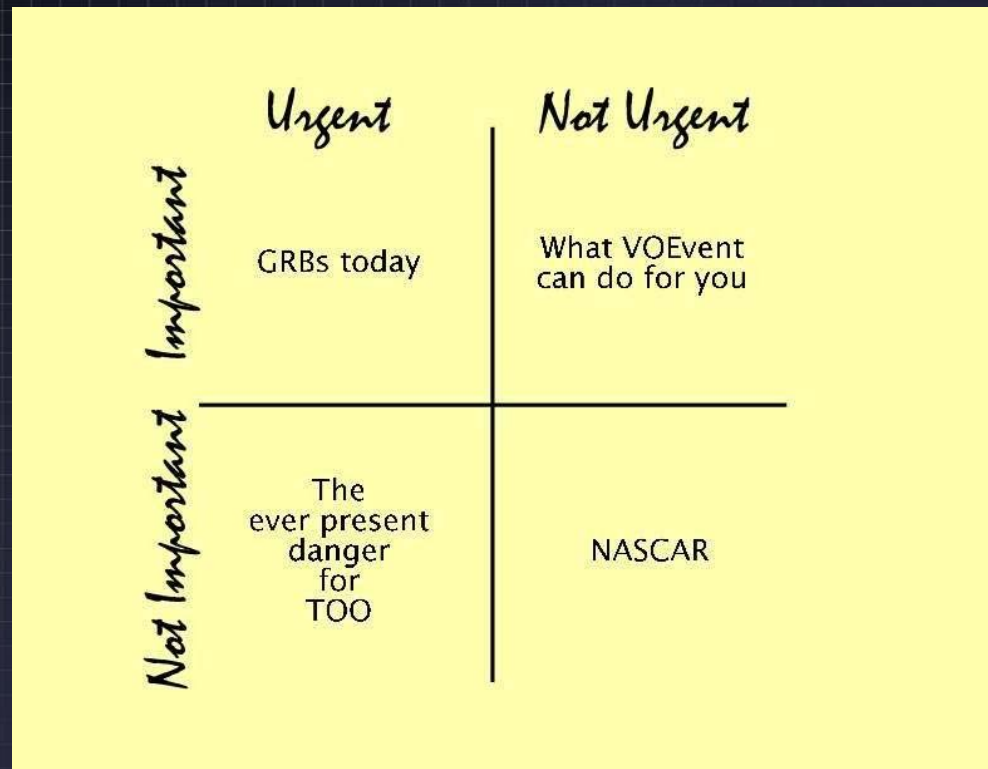
We also know there are known unknowns – *Donald Rumsfeld*  
The Zeitgeist encouraged Philosopher-Kings – *James Atlas*



Ask yourself, what is this thing in itself, by its own special constitution? What is it in substance, and in form, and in matter? What is its function in the world? For how long does it subsist?

– *Marcus Aurelius*

# First Things First



*Covey's "highly effective" habit #3*

# What is a transient “event”?

Want to express both:

- Detections
- Physical processes

Must distinguish types of aliasing:

- Multiple representations of same observation
- Multiple observations of same event
- Chance observations of multiple events

Need to push envelope in phase space:

- Temporal, spatial, spectral, ...
- How to describe events never previously seen?
- How to *recognize* events not previously seen?

*It's all still about good experimental design*



# State of the art

- GCN – short latency, migrating to VOEvent
  - (as are RAPTOR, eSTAR, AAVSO, *etc.*)
- IAU Circulars – “Newspaper of Record”
- ATel – “Alternative weekly”
  
- Want something with the short latency of GCN, *and* the semantic richness of IAUC
  
- Need modern trust model for issuing alerts
  - peer review is *so* 20th Century
  
- Mechanisms for organizing observing campaigns?
- Extensible framework (*XML*)



# VOEvent Specification, v1.0

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Roy Williams, *California Institute of Technology, USA*

Alasdair Allan, *University of Exeter, UK*

Scott Barthelmy, *NASA Goddard Spaceflight Center, USA*

Joshua Bloom, *University of California, Berkeley, USA*

Matthew Graham, *Caltech, USA*

Frederic Hessman, *University of Göttingen, Germany*

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Kate Scholberg, *Duke University, USA*

Chris Stoughton, *Fermi National Accelerator Laboratory, USA*

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Robert White, *LANL, USA*

Przemyslaw Wozniak, *LANL, USA*



# VOEvent Technologies

- $\langle$ VOEvent $\rangle$  – *IVO Identifiers*
- $\langle$ Who $\rangle$  – *Resource Metadata*
- $\langle$ What $\rangle$  – *VOTables*
- $\langle$ WhereWhen $\rangle$  – *STC*
- $\langle$ How $\rangle$  – *RTML*
- $\langle$ Why $\rangle$  – *UCDs, ontologies*
- $\langle$ Citations $\rangle$  – *IVO Identifiers*
- $\langle$ Description $\rangle$  – *natural language*
- $\langle$ Reference $\rangle$  – *everything else*

# <VOEvent> – Sky Transient Event

- `<VOEvent event_id="ivo://uraniborg.hven/VOEvent#1572-11-11/0001" role="observation" version="1.0" xmlns:... >`
- `event_id="ivo://uraniborg.hven/VOEvent#1572-11-11/0001"`  
Every packet has a unique ID, assigned by a publisher
- `role="observation"`  
Roles: “observation”, “prediction”, “iamalive”, “ack” & “test”
- `version="1.0"`  
Version is implicit in XML schema,  
explicit attribute for non-XML use
- *Digital signatures for authentication*  
Authorization for proprietary streams is out of scope

# <Who> – Curation Metadata

- `<Who>`  
`<PublisherID>ivo://uraniborg.hven/Tycho</PublisherID>`  
`<Date>1573-05-05T01:23:45Z</Date>`  
`</Who>`
  - `<PublisherID>`  
URI of the responsible entity for the VOEvent
  - `<Contact>`, *etc.*  
conforms to IVOA Resource Metadata specification (Dublin Core), also see RTML usage
  - `<Date>` – creation date of packet (UTC)

# <What> – Event Characterization

- ```
<Group type="GRB_INTEN">  
<Param name="cnts" value="73288" unit="ct" ucd="phot.count" />  
<Param name="peak" value="1310" unit="ct/s" ucd="arith.rate;phot.count" />  
</Group>
```
- *<Param>* – arbitrarily named quantities
  - *name* – descriptive identifier
  - *value* – string with implicit numeric conversions
  - *unit* – Vizier unit specification
  - *ucd* – Unified Content Descriptor
- *<Group>* – typed associations
  - name
  - type – application dependent “datatype”

# <WhereWhen> – Space–Time Coordinates

- Space–Time Coordinate (STC) specification
- STC may be the VO’s most esoteric standard
- Very general support for representing near and far data in same system, spectral data, redshifts, velocities (*e.g.*, proper motions), orbital motions in the solar system, *etc.*
- Specify location of observer as well as object
- Specify time “properly”
- VOEvent primarily needs target coordinates for next observation
- STC often overkill –> STCLite?!?
- Specify coordinates (*e.g.*, RA & Dec) as separate elements
- XLink (instead of Xinclude)
- XSL transformations (XPath)

# <How> – Instrument Configuration

- *<How>*  
*<Reference uri="http://nsa.noao.edu/kp012345.rtml" type="rtml" name="Echelle" />*  
*</How>*
- Details of experimental design
- Intent of VOEvent is to represent events in the sky, not (typically) in the focal plane of a telescope
- Relies on *<Reference>* to RTML document
- RTML = Robotic Telescope Markup Language
- Other options than RTML?



# <Why> – Initial Scientific Assessment

```
<Why importance="1.0" expires="1574-05-11T12:00:00">  
  <Inference probability="1.0">  
    <Name>Tycho's Stella Nova</Name>  
    <Concept>SN Ia</Concept>  
  </Inference>  
  <Inference probability="1.0" relation="associated">  
    <Name>3C 10</Name>  
    <Concept>supernova remnant</Concept>  
  </Inference>  
</Why>
```

## <Why> – *continued*

- *importance* – relative value from 0.0 to 1.0
- *expires* (urgency) – ISO 8601 expiration date
  
- <*Inference*> – assert categories
  - *probability* – likelihood between 0.0 and 1.0
  - *relation* – natural language “kinship”
  
- <*Name*> – identification
- <*Concept*> – classification

## <Why> – *continued, #2*

- Classification is by natural language
- VOEvent (& VO, in general) is evolving toward ontologies (e.g., semantic web)
- UCDs are first step – “this is an R magnitude”
- VOConcepts – “this is a SN remnant”
- Namespaces
- Versioning
- Who maintains the lists?

# <Citations> – Follow-up Observations

<Citations>

<EventID cite="retraction">

*ivo://uraniborg.hven/VOEvent#1572-11-11/0001*

</EventID>

<Description>Oops!</Description>

</Citations>



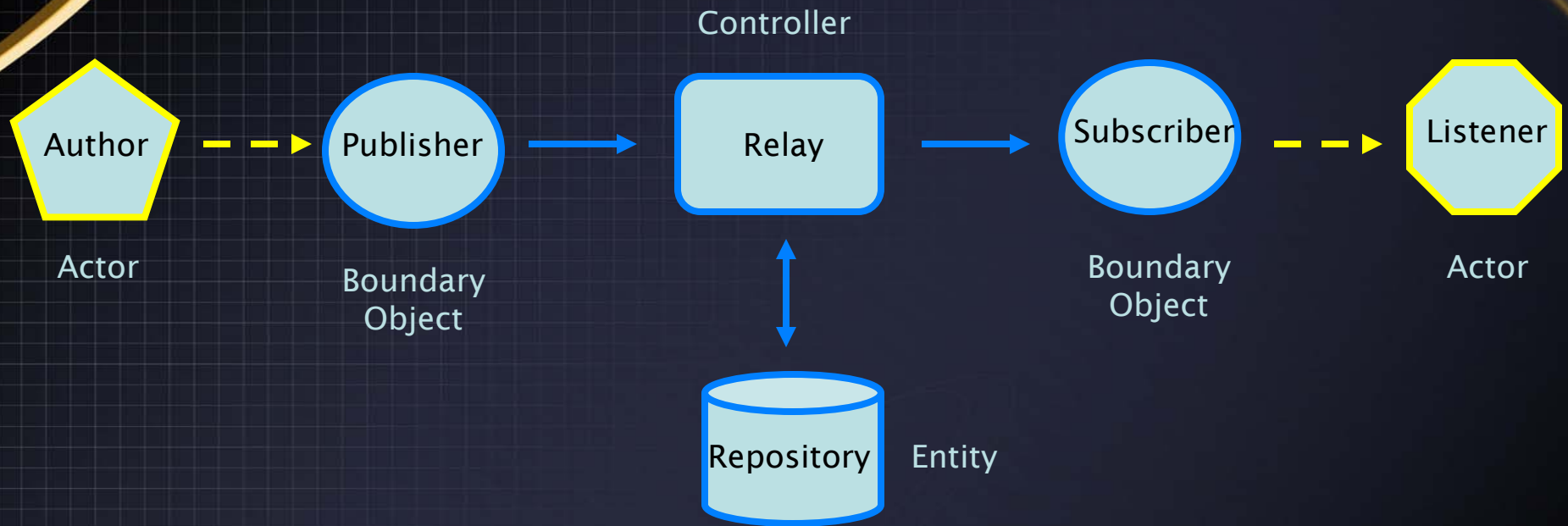
## <Citations> – *continued*

- <EventID> – pointer to previous event packet
  - Cite
    - “*followup*” – extend previous event trail
    - “*supersedes*” – revise previous event
      - can also be used to merge events,
      - or to split event in two
    - “*retraction*” – terminate event

# <Description> and <Reference>

- May be included in any element
- <*Descriptions*> may not include <*References*>
- Human readable descriptions (and links)
- CDATA can provide HTML-like structure
- <*Reference*> points to external data via URI:
  - *uri* – other documents (VOTable, FITS, etc.)

# Actors' Roles (flow and UML robustness diagram)



- Blue Components are **VOEvent**
- **Yellow** are not
- A **Broker** is a combined component

# Network Topology?

