Transient Response Astronomy

How & Why

Rob Seaman, NOAO
Roy Williams, Caltech

(present & past Chairs of the IVOA VOEvent WG)
Many meetings since 2005

- VOEvent workshops
- HTN workshops
- Transient Universe 2006 meeting
- Hotwired meetings (http://hotwireduniverse.org)
- IVOA sessions (VOEvent & Semantics WGs)
- ADASS BoFs
- NVO Summer Schools
- SPIE 2006
- VOEveentNet meeting
- Robots at the Austin AAS
More meetings coming…

- IVOA InterOp – 9-13 Nov 2009
- dotAstronomy – 30 Nov - 4 Dec 2009
- *The Eventful Universe* (NOAO 50th) – 17-20 Mar 2010
- IVOA InterOp – 17-21 May 2010
- VAO @ AAS – 23-27 May 2010
- ADASS XX BoF – 7-11 Nov 2010
- 2011 – Hotwired III
- 2012 – Joint Discussion @ IAU General Assembly?
- Comm. 5 (WG-VO) & Comm. 6 (Astronomical Telegrams)
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Transient Response Astronomy

How & Why
Sherlock Holmes

The patron saint of How & Why, suggesting a different title…
…or

The Giant Rat of Sumatra

“…a story for which the world is not yet prepared.”

- “The Adventure of the Sussex Vampire” by Sir Arthur Conan Doyle
**Why transient response?**

- Things go bump in the night
- The sky is big
- Transients are rare
- Events occur randomly in space & time
- ...and have obscure physical signatures
- Vs. contention for observing resources
- Even giant rats can be hard to find
“A halfassed comeback containing only one good joke.” - Rolling Stone
Why? The Rat has friends

- Large Synoptic Survey
- Pan-STARRS
- Dark Energy Survey
- ...

5 October 2009
ADASS XIX, Sapporo, Japan
The Rat is rare & valuable

- Gamma-Ray Bursts
- Neutrinos
- Gravitational waves
- Solar system debris
- ...

ADASS XIX, Sapporo, Japan
The Rat will always remain a target-of-opportunity, requiring:

- Rapid response
- Ubiquitous delivery
- Diverse subscribers
- Flexible follow-up
- Reliable semantic classification
- Autonomous workflows

We must build a better rat-trap
But the Rat lives within a background limited universe
Further in space, Deeper in time

Transients are milestones in the master timeline of cosmic history

Distant transients probe the moment of creation

Local transients are close enough to touch

*meteors, comets, ...*
How to respond to transients?

To quote from Sherlock Holmes:

“Results without causes are much more impressive.”
How?

The VOEvent standard of the IVOA is one ingredient for constructing flexible, efficient, autonomous architectures for carrying out experimental investigations when time is of the essence.
How?

“VOEvent defines the content & meaning of a standard information packet for representing, transmitting, publishing & archiving the discovery of a transient celestial event, with the implication that timely follow-up is being requested.”
VOEvent

- Who
- What
- Where
- When
- How
- Why
VOEvent

- **Who** – author’s provenance
- **What**
- **Where**
- **When**
- **How**
- **Why**
VOEvent

- **Who** – author’s provenance
- **What** – empirical measurements
- **Where**
- **When**
- **How**
- **Why**
VOEvent

- Who – author’s provenance
- What – empirical measurements
- Where – targeting in space
- When – constraints in time
- How
- Why
VOEvent

✧ Who – author’s provenance
✧ What – empirical measurements
✧ WhereWhen – targeting in spacetime
✧ How
✧ Why
VOEvent

✦ Who – author’s provenance
✦ What – empirical measurements
✦ WhereWhen – targeting in spacetime
✦ How – instrumental signature
✦ Why
VOEvent

- Who – author’s provenance
- What – empirical measurements
- WhereWhen – targeting in spacetime
- How – instrumental signature
- Why – scientific characterization
VOEvent

✧ IVOA recommendation:
  ✧ http://www.ivoa.net/Documents/latest/VOEvent.html

✧ XML schema:
  ✧ http://www.ivoa.net/xml/VOEvent/VOEvent-v1.1.xsd

✧ Working group:
  ✧ http://voevent.org
VOEventNet
VOEventNet

- **Publish / Subscribe** paradigm
- **Backbone sites** – full packet feeds
- **Network of brokers**
  - forwarding
  - filtering
  - bridging
VOEvent is transport-neutral

- Backbone:
  - TCP “vanilla”
  - Jabber
  - XML-RPC
- Clients:
  - SMTP, SMS, RSS, …
VOEvent is **IVOA-aware**

- **SEAP** – Simple Event Access Protocol
- **STC**
- **Vocabularies & semantics**
- **VOTable**
- **SAMP-enabled**
- …
VOEvent is growing

- V2.0 (time series, orbital elements, …)
- VOEventStreams in registry
- SEAP
- Infrastructure (& transport)
- Client applications (author & subscribe)
- Community (eg., LSST data challenge)
VOEvent is growing

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5 October 2009
Sherlock Holmes on Transient Response Astronomy

“\textit{When you have excluded the impossible, whatever remains, however improbable, must be the truth.}”

\begin{itemize}
\item In the time domain, astronomers study unprecedented phenomena subject to dramatically differing interpretations.
\end{itemize}
“Chance has put in our way a most singular and whimsical problem, and its solution is its own reward.”

Serendipity is the engine of discovery.

VOEvent is a luck management system.
“The world is full of obvious things which nobody by any chance ever observes.”

Taking advantage of rare opportunities requires careful planning and the deployment of resources in advance.
“It is a capital mistake to theorize before you have all the evidence. It biases the judgment.”

Science depends on synthesizing diverse observations to discover underlying rules, that is, on building empirical workflows.
“I am glad of all details, whether they seem to you to be relevant or not.”

Filtering of data should be postponed to as late in the workflow as possible.

Different investigators need different things from the event stream.
“The reasoner can produce an effect which seems remarkable to his neighbor, because the latter has missed the one little point which is the basis of the deduction.”

Information without efficient access and effective query tools is useless.
“I have no desire to make mysteries, but it is impossible at the moment of action to enter into long & complex explanations.”

Autonomous systems are needed to allow removing humans from the loop.
“What one man can invent, another can discover.”

Astronomy requires a standard transient alert protocol

...only a *single* transient alert protocol.
“I wonder how a battery feels when it pours electricity into a non-conductor.”

Astronomy requires a common transient alert network

…only a single transient alert network.
“My life is spent in one long effort to escape from the commonplace of existence.”

Time domain projects (synoptic as well as transient-response) require commitment to a lengthy and diligent search process.
“Nothing clears up a case so much as stating it to another person.”

A publish-subscribe paradigm is needed to connect surveys that discover celestial transients with the astronomical assets used to study these events.
“Only one important thing has happened in the last three days, and that is that nothing has happened.”

Steady state behavior is also significant in classifying, characterizing and understanding phenomena.
“It is the second most interesting object that I have seen in the North.”

Celestial transient alerts must convey human-oriented context and semantics.

...even as humans recede from direct control of observatory systems.
Two more quotes from Holmes

✧ “Mrs. Hudson has been knocked up!”

✧ “If you approach me, Watson, I shall order you out of the house.”
The game is afoot!

Coming soon, our book:

http://hotwireduniverse.org

Questions?