SAMP: Architecture, JSAMP and sampjs

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BoF: Interoperability with SAMP
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Outline

- SAMP overview and architecture
- JSAMP: Java toolkit for SAMP
  - Diagnostic tools
  - Library for adding SAMP to Java applications
- sampjs: JavaScript library for SAMP
  - Library for adding SAMP to web pages

Background and History

SAMP = Simple Applications Messaging Protocol

allows astronomy software tools to exchange control and data

History:

- PLASTIC v1 (Platform for Astronomical InterConnection), Euro-VO protocol 2006
- SAMP v1.11, IVOA Recommendation 2009
- Useful client-side technology for VO work patterns
- . . . but not specific to VO applications

Status:

- Quite widely used in desktop tools
  - ▷ SAOImage ds9, Aladin, TOPCAT, SPLAT, WWT, VOSpec, IRAF, HIPE, Astro-WISE, Aspro2, JSky, SkyCat/Gaia, VirGO, . . .
  - ▷ Java, Python, Perl, C, C#, Tcl, IDL, . . .
- Visible at ADASS

  ADASS XIX: 5 subject index entries for "SAMP"

  ADASS XX: 16 subject index entries for "SAMP" *(5th after Java, Python, VO & XML)*

  ADASS XXI: 7 subject index entries for "SAMP"

Design for Interoperability

Principles to maximise interoperability:

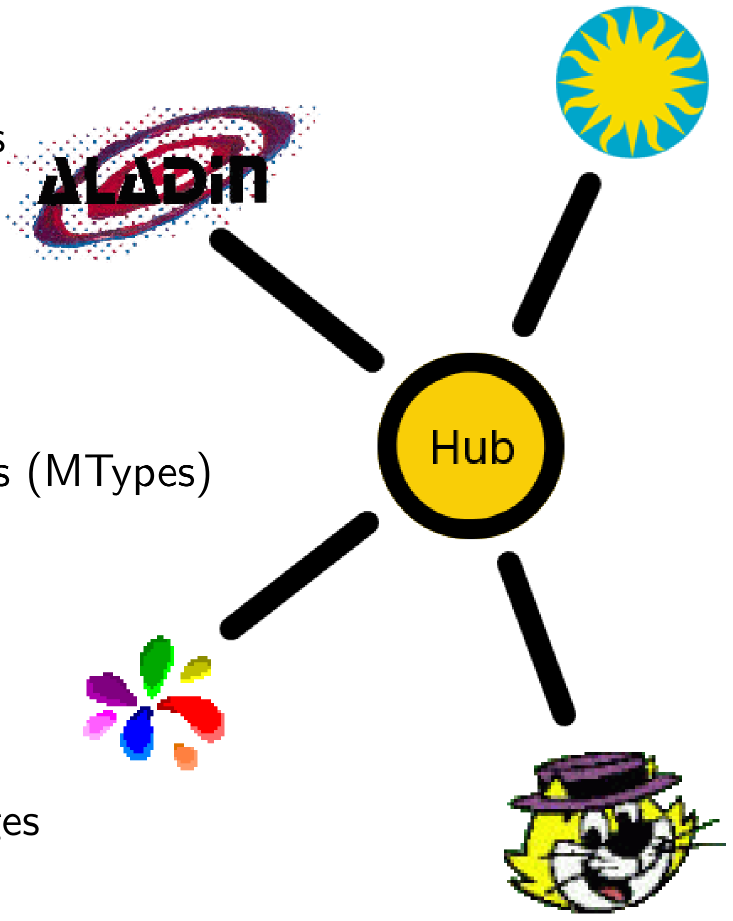
- Simple to use and learn for client developers and users
  - ▷ Platform independent
  - ▷ Lightweight to implement
- Message semantics are typically vague
  - ▷ *"Here's a table!"* not *"Plot entries from this catalogue over the current image"*
  - ▷ but also extensible
  - ▷ Arise from usage, not decreed by committee

Consequences:

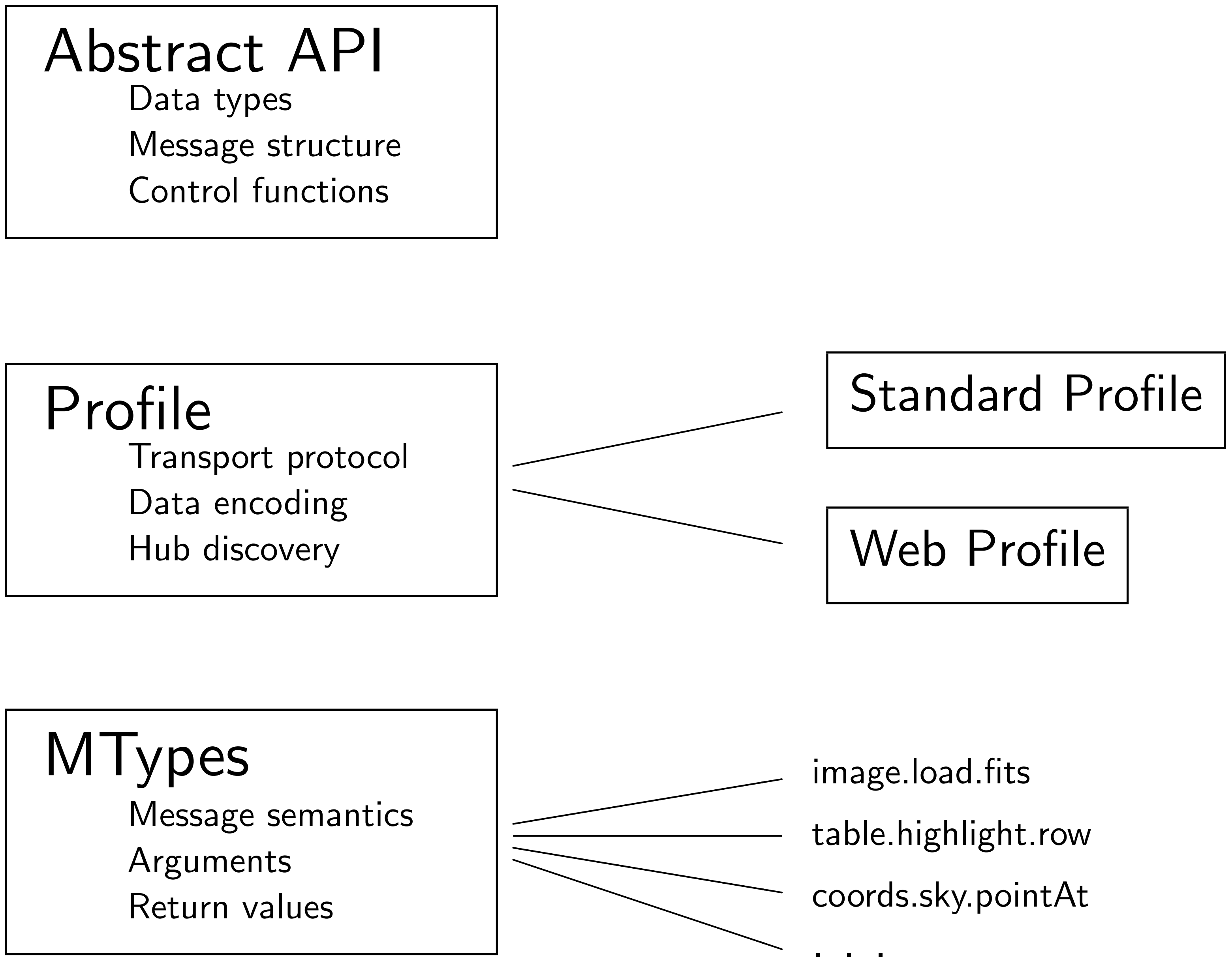
- Loosely coupled suites of interoperating tools
  - ▷ ... selected by the user
    - ○ ... without conscious effort
  - ▷ ... from a pool of tools contributed by developers
    - ○ ... who do not need close collaboration
- It works!

Key Concepts

- Hub-based operation
  - *Hub* is a daemon process, conceptually freestanding (though may run within one client)
  - Clients *register* with Hub to send/receive messages
  - Hub brokers messages and provides directory services
  - All communication is Client $\leftrightarrow$ Hub (but messaging conceptually Client $\leftrightarrow$ Client)
- Publish/Subscribe
  - Each client *subscribes* to zero or more message types (MTypes)
  - Clients can only receive subscribed messages
- Callable Clients
  - All clients can *send* messages
  - Only *callable* clients can subscribe to/receive messages
  - Callability is optional



3-Layer Architecture



Layer 1: Abstract API

Hub API:

```
register()
unregister()

declareMetadata(map metadata)
declareSubscriptions(map subscriptions)

getRegisteredClients()
getSubscribedClients(string mtype)
getMetadata(string client-id)
getSubscriptions(string client-id)

notify(string recipient-id, map message)
notifyAll(map message)
call(string recipient-id, string msg-tag, map message)
callAll(string msg-tag, map message)
callAndWait(string recipient-id, map message, string timeout)

reply(string msg-id, map response)
```

Callable Client API *(optional)*:

```
receiveNotification(string sender-id, map message)
receiveCall(string sender-id, string msg-id, map message)

receiveResponse(string responder-id, string msg-tag, map response)
```

Layer 2: Profile

The *Profile* maps the abstract API to bits on the wire (or similar)

- Two profiles currently defined:
    - ▷ Standard Profile:
        - ◦ Suitable for desktop applications
        - ◦ Based on XML-RPC
        - ◦ Hub discovered using local lockfile `~/.samp` (usually)
        - ◦ Callable clients run their own XML-RPC server to receive messages
    - ▷ Web Profile *(since April 2012 only)*:
        - ◦ Suitable for web applications (e.g. JavaScript)
        - ◦ Based on XML-RPC
        - ◦ Hub discovered at fixed port 21012
        - ◦ Special measures for safe sandbox evasion
        - ◦ Callable clients use long pull
- Profile interoperability:
    - ▷ Each client uses one appropriate profile
    - ▷ The hub can accept connections using multiple profiles
    - ▷ Clients are treated the same regardless of profile

Layer 3: MTypes

MTypes (message types) define message semantics

- An MType is:
  - ▷ A short hierarchical string (a.b.c)
  - ▷ . . . with associated input parameters
  - ▷ . . . and associated return type
  - ▷ . . . and associated semantics
- Think of it like a function call definition in an API
- Example:

table.load.votable: Loads a table in VOTable format

Arguments:

`url` *(string)*: URL of table to load
`table-id` *(string)*: Identifier for use with subsequent messsages *(optional)*
`name` *(string)*: Name to label loaded table for user *(optional)*

Return values:

None

- Other examples:
  - ▷ `table.load.fits`, `table.highlight.row`, `image.load.fits`, `coord.pointAt.sky`, `samp.hub.event.register`, `samp.app.ping`
  - ▷ More at `http://wiki.ivoa.net/twiki/bin/view/IVOA/SampMTypes` (add your own!)

Other Details

Things I haven't mentioned

- Subscription wildcarding
- Extensible parameter model
- Parameter data model
- Message delivery patterns (call/notify)
- Message targets (broadcast/send)
- Asynchronous processing model
- Error processing
- Client tracking

Hub Availability

Hub Implementations:

- JSAMP (Java)
- SAMPy (Python)
- ... some others, but implementations partial

How do I make sure a hub is running?

- Runs within some applications
  - ▷ Tools which include hub capability often run one on startup, if not already running (Aladin, TOPCAT, Iris, ...)
- Start one externally as an application (download and run JSAMP/SAMPy)
- Start one using WebStart (JSAMP) — e.g. `http://astrojs.github.com/sampjs/hub/webhub.jnlp`

Rule of thumb: *If you're using a hub-capable toolkit, try starting a hub on startup if none is already running. Otherwise, don't worry — probably someone else (another application or the user) will start one. You do not need to implement a hub to be a SAMP citizen.*

JSAMP

JSAMP Java Toolkit/Library

- Contains:
  - ▷ Hub implementation
  - ▷ Client library
  - ▷ Diagnostic tools
- Availability:
  - ▷ Java 1.4+ (may move to 1.5)
  - ▷ One jar file (750 Kb), no external dependencies
  - ▷ Open source, unrestrictive licence (Academic Free/BSD)

`http://software.astrogrid.org/doc/jsamp/`

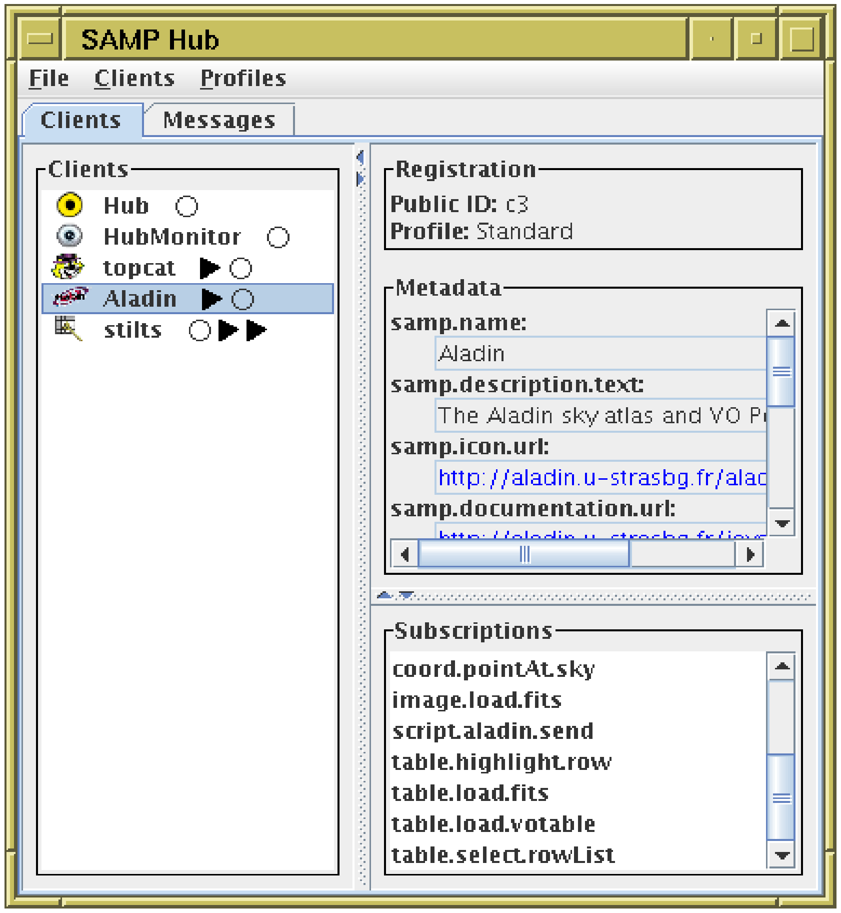
JSAMP GUI

JSAMP hub status GUI shows:

- Which clients are registered
- Metadata for each client
- MType subscriptions for each client (what messages they receive)
- All messages sent/received with content and responses

Availability:

- Optionally displayed by hub
- Optionally view from client using JSAMP lib (only messages to/from that client shown)
- Standalone command-line `hubmonitor` tool (only messages to/from `hubmonitor` shown)



Public ID: c3
Profile: Standard

samp.name:
Aladin
samp.description.text:
The Aladin sky atlas and VO P
samp.icon.url:
http://aladin.u-strasbg.fr/alad
samp.documentation.url:

coord.pointAt.sky
image.load.fits
script.aladin.send
table.highlight.row
table.load.fits
table.load.votable
table.select.rowList

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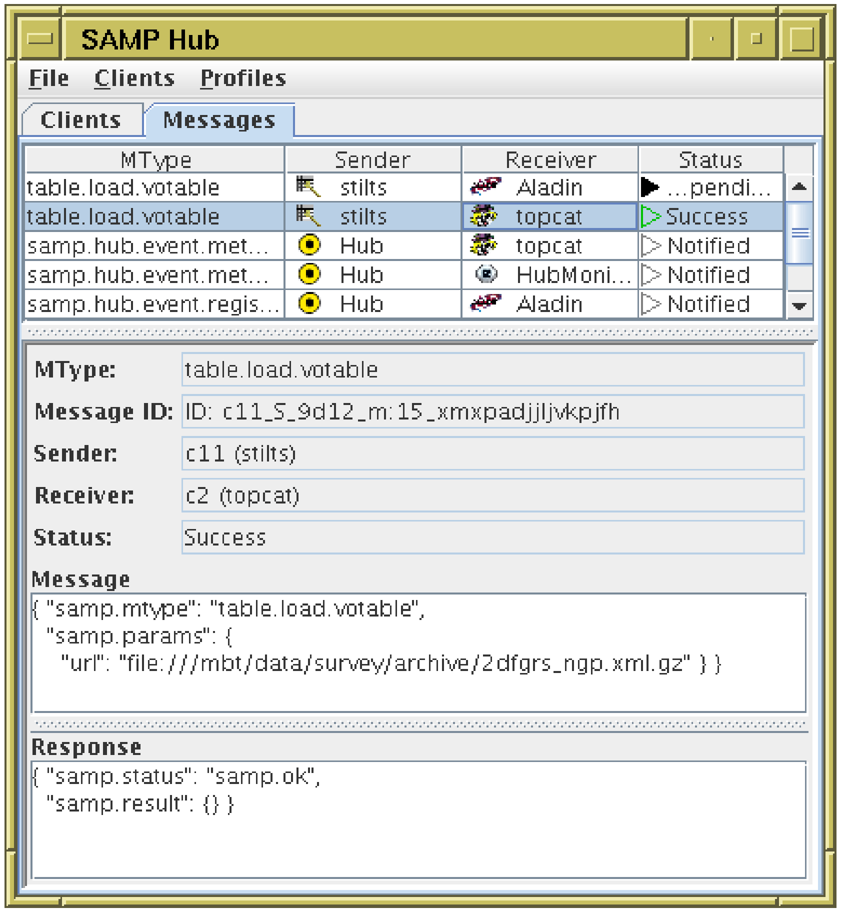


MType	Sender	Receiver	Status
table.load.votable	stilts	Aladin	▶ ...pendi...
table.load.votable	stilts	topcat	▷ Success
samp.hub.event.met...	Hub	topcat	▷ Notified
samp.hub.event.met...	Hub	HubMoni...	▷ Notified
samp.hub.event.regis...	Hub	Aladin	▷ Notified

MType:	table.load.votable
Message ID:	ID: c11_S_9d12_m:15_xmxpadjjljvkpjfh
Sender:	c11 (stilts)
Receiver:	c2 (topcat)
Status:	Success

Message

```
{ "samp.mtype": "table.load.votable",
  "samp.params": {
    "url": "file:///mbt/data/survey/archive/2dfgrs_ngp.xml.gz" } }
```

Response

```
{ "samp.status": "samp.ok",
  "samp.result": {} }
```

JSAMP Logging

Log SAMP communications at HTTP, XML or RPC level

- Standard profile (desktop applications):
  - ▷ Use java system property `-Djsamp.xmlrpc.impl=xml-log|rpc-log`
  - ▷ Set it on the hub to see all communications
  - ▷ Set it on any JSAMP client to see only communications to/from that client (no application code changes required to switch logging on/off)
- Web profile:
  - ▷ Hub flag `-web:log http|xml|rpc`
  - ▷ Can log full HTTP communications including headers etc

Logging can be verbose, but it's extremely useful to see exactly what HTTP/XML/RPC is being exchanged to diagnose problems.

Other JSAMP Capabilities

Command-line tools:

- `messagesender`: command-line send tool
- `snooper`: subscribes to some/all MTypes and logs messages
- `hubtester`: hub test suite
- `calcstorm`: hub stress tester

Non-standard profile support

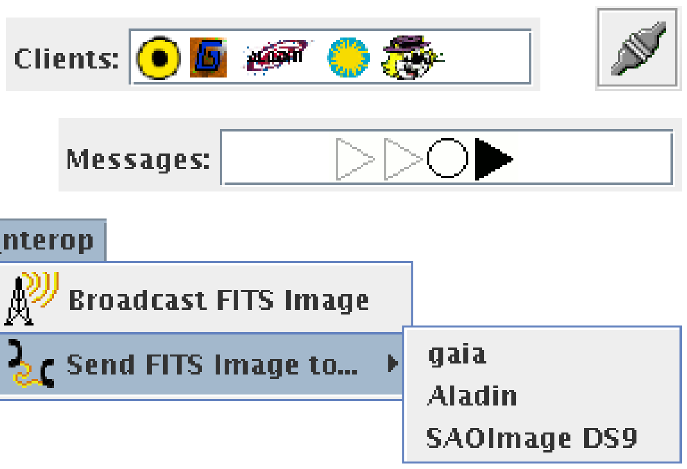
- Run multiple desktop hubs at once
- Set fixed hub XML-RPC endpoint URL
- Implement custom/experimental profiles
- Tweak/relax web profile authorization policy

Multi-host support

- Hub flag `-std:httplock`: use HTTP URL not local filename as lockfile
- `bridge`: join two hubs (maybe on different hosts) together

JSAMP Client Library

- Basic client use:
  - `HubConnection` object provides all hub methods
    - ▷ `HubConnection c = profile.register();` *do SAMP stuff*; `c.unregister();`
    - ▷ Suitable for short-lived or send-only clients
  - `HubConnector` creates `HubConnection`s as required
    - ▷ Watches for hubs starting and stopping
    - ▷ Manages registration, metadata and subscriptions across hub reconnections
    - ▷ Keeps track of other clients (live id→Client map)
    - ▷ Suitable for long-lived, GUI-based, send/receive clients
- GUI features:
  - Registered client icon panel
  - Subscribed client send menus
  - Hub view with client and message status display
  - Hub start/reg/unreg methods and Actions
  - MType-specific send menus



JSAMP Example 1: Send table to all subscribed clients (HubConnection)

```
public static void main(String[] args) throws SampException {

    // Prepare message to send.
    Map params = new HashMap();
    params.put("url", args[0]);
    params.put("name", "Command-line");
    Message msg = new Message("table.load.votable", params);

    // Register with hub.
    HubConnection conn = DefaultClientProfile.getProfile().register();

    // Send message (send-and-forget to all).
    conn.notifyAll(msg);

    // Unregister.
    conn.unregister();
}
```

JSAMP Example 2: Send table to single subscribed client

```
public static void main(String[] args) throws SampException {

    // Prepare message to send.
    Map params = new HashMap();
    params.put("url", args[0]);
    params.put("name", "Command-line");
    Message msg = new Message("table.load.votable", params);

    // Register with hub.
    HubConnection conn = DefaultClientProfile.getProfile().register();

    // Declare application metadata.
    Map meta = new HashMap();
    meta.put(Metadata.NAME_KEY, "Sender");
    meta.put("author.name", "Mark");
    conn.declareMetadata(meta);

    // Locate the first client that can load VOTables.
    Map tableClients = conn.getSubscribedClients("table.load.votable");
    String id1 = tableClients.keySet().iterator().next().toString();
    String name1 = (String) conn.getMetadata(id1).get(Metadata.NAME_KEY);

    // Send message (call and wait for response to a single client).
    System.out.println("Send to: " + name1);
    Response reply = conn.callAndWait(id1, msg, 5);
    System.out.println(reply.isOK() ? "... OK"
                                    : ("... failed: " + reply.getErrInfo().getUsertxt()));

    // Unregister.
    conn.unregister();
}
```

JSAMP Example 3: Send and receive messages (HubConnector)

```
public static void main( String[] args ) {
    final HubConnector connector = new HubConnector(DefaultClientProfile.getProfile());

    // Post a button which will broadcast a Ping message.
    postButton(new AbstractAction("Ping") {
        public void actionPerformed(ActionEvent evt) {
            try {
                connector.getConnection().notifyAll(new Message("bof.ping"));
            } catch (SampException e) { e.printStackTrace(); }
        }
    } );

    // Respond to a Ping with a Pong; respond to a Pong by doing nothing.
    connector.addMessageHandler(new AbstractMessageHandler("bof.ping") {
        public Map processCall(HubConnection conn, String senderId, Message msg) throws SampException {
            conn.notify(senderId, new Message("bof.pong"));
            return null;
        }
    } );
    connector.addMessageHandler(new AbstractMessageHandler("bof.pong") {
        public Map processCall(HubConnection conn, String senderId, Message msg) {
            return null;
        }
    } );

    // Prepare connector with subscriptions and metadata, and set it running.
    Metadata meta = new Metadata();
    meta.setName("PingPong");
    meta.setDescriptionText("Sends and receives ping messages");
    connector.declareMetadata(meta);
    connector.declareSubscriptions(connector.computeSubscriptions());
    connector.setAutoconnect(5);
}
```

sampjs

JavaScript SAMP library

- 1000 lines of JavaScript
- No dependencies, but optionally comes with Flash machinery for old browsers
- Initially written as proof of concept, not intended for release
- But got used; seems to work
- Listed at `http://astrojs.org/`
- Source and docs on GitHub `http://github.com/astrojs/sampjs/`
- Documentation includes live examples (SAMP-enabled web pages)
- Contributions encouraged

sampjs Example 1: Send a table

```
<html>
<head><title>Send Table</title></head>
<body>
<script src="samp.js"></script>
<script>
  // Broadcasts a table given a hub connection.
  var send = function(connection) {
      var msg = new samp.Message("table.load.votable",
                                 {"url": "file:///mbt/data/table/messier.xml"});
      connection.notifyAll([msg]);
  };

  // Adjusts page content depending on whether the hub exists or not.
  var configureSampEnabled = function(isHubRunning) {
      document.getElementById("sendButt").hidden = !isHubRunning;
  };

  // Arrange for document to be adjusted for presence of hub every 2 sec.
  var connector = new samp.Connector("Sender");
  onload = function() {
      connector.onHubAvailability(configureSampEnabled, 2000);
  };
  onunload = function() {
      connector.unregister();
  };
</script>

<p><b>I have a table.</b>
<button id="sendButt" type="button" onclick="connector.runWithConnection(send)">Send It!</button>
</p>

</body>
</html>
```

sampjs Example 2: Steer (e.g.) Aladin from a web page

```
<html>
<body>
  <script src="samp.js"></script>
  <script>

    // Set up hub registration/unregistration.
    var meta = { "samp.name": "SkyNavigator" };
    var connector = new samp.Connector("SkyNavigator", meta);
    onload = function() { document.getElementById("regPanel").appendChild(connector.createRegButtons()); };
    onunload = function() { connector.unregister(); };

    // Action to send message when sliders change value.
    var posChange = function() {
        var ra = document.getElementById("RA").value;
        var dec = document.getElementById("Dec").value;
        document.getElementById("pos").innerHTML = ra + ", " + dec;
        var message = new samp.Message("coord.pointAt.sky", {"ra": ra, "dec": dec});
        connector.connection.notifyAll([message]);
    };
  </script>

  // Page content.
  <div id="regPanel"></div>
  <div>RA:  <input id="RA"  type="range" onchange="posChange()" min="0" max="360"  step="0.25" /></div>
  <div>Dec: <input id="Dec" type="range" onchange="posChange()" min="-90" max="90" step="0.25" /></div>
  <div>Pos: <span id="pos"></span></div>
</body>
</html>
```

Resources

SAMP info Page: `http://www.ivoa.net/samp/`

SAMP Standard: `http://www.ivoa.net/Documents/latest/SAMP.html`

Mailing list: apps-samp@ivoa.net

JSAMP: `http://software.astrogrid.org/doc/jsamp/`

sampjs: `http://github.com/astrojs/sampjs/samp.js`