

MONITORING THE CHANDRA X-RAY OBSERVATORY VIA THE WIRELESS INTERNET

Bradley D. Spitzbart, Scott J. Wolk, and Robert A. Cameron
 Chandra X-ray Center
 Harvard-Smithsonian Center for Astrophysics, Cambridge, MA, USA



The Chandra X-ray Observatory, launched in July 1999, continues to provide unprecedented high energy astrophysical discoveries with efficiency and reliability. From time to time, though, urgent operational decisions must be made by engineers, instrument teams, and scientists, often on short notice and at odd hours. There are several real-time, mostly Internet-based data resources available to aid in the decision-making discussions when a crisis arises. Chandra's Science Operations Team (SOT) has been experimenting with emerging Wireless Application Protocol (WAP) technologies to create yet another pathway for data flow. Our WAP Internet pages provide anytime, anywhere access to critical spacecraft information through cellular phones or other WAP-enabled devices. We currently offer several dynamic web pages including a live telemetry stream, information on the radiation environment, the real-time contact schedule, the week's observing schedule, and contact information for key personnel. The protocol even allows CGI or other server-side executable code, which is implemented here to facilitate users' queries for past data sets. There are, of course, many challenges in attempting to present useful, meaningful content on a 5 X 12 character screen over limited bandwidth in a way that is user-friendly and beneficial. This paper will discuss our experience with this developing and promising new medium, design strategies, and future enhancements.

OVERVIEW

The Chandra wireless web pages were conceived and evolved to provide ready access to the most relevant spacecraft information at the most critical, decision-making times. In its first incarnation, data was requested and passed through two-way pagers. Here we describe our next generation approach of using Wireless Application Protocol (WAP)-enabled devices and Wireless Markup Language (WML) for a more comprehensive and accessible application. At present the pages are customized for viewing on cell phones. These same devices are also capable of acting as pagers through text messaging and in fact most of the team uses the phone to its full, versatile convenience for voice, text, and browsing. E-mails are sent directly to the devices by SOT monitoring software, alerting to high radiation conditions, and spacecraft or system anomalies. As with any emerging technology, the learning curve is quite steep, but we have solved several technical and design issues along the way. The URL for SOT Home is

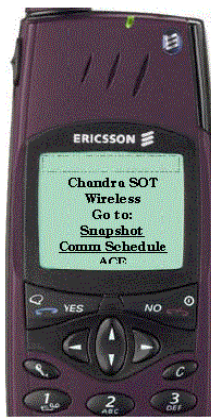
<http://cxc.harvard.edu/mta/WL/sot.wml>

Key design drivers and principles:

- Mirror the most mission-critical of our myriad standard web pages (see <http://cxc.harvard.edu/mta/sot.html>).
- Use a simple, server-side approach for quick creation and maintenance.
- No need to recreate front-end, real-time telemetry decommutation scheme.
- Add a module to back-end of existing HTML-generating PERL code to output a plain text log of telemetry values.
- Run an underlying PERL (CGI) code to extract and format the user requested data.
- Implement a CGI interface to handle "browser" buttons which make data available from the past three days.
- Preserve the color coding of the original pages by displaying separate pages for each color. That is, the "RED Flags" link shows all values that are colored red indicating a limit violation or unexpected state.
- Expand the site to include WAP pages of real-time spacecraft ephemeris, configuration, and radiation environment, real-time ACE data and observing schedules derived from mission planning products, and contact information for key personnel.

```
<?xml version="1.0"?>
<!DOCTYPE wml PUBLIC "-//WAPFORUM/DTD WML 1.1/EN"
"http://www.wapforum.org/DTD/wml_1.1.xml">
<wml>
<card id="init" newcontext="true">
<p align="center">
Chandra SOT Wireless<br>
Go to:<br>
<a href="snap.wml">Snapshot</a><br>
<a href="comm.wml">Comm Schedule</a><br>
<a href="ace.wml">ACE</a><br>
<a href="text.cgi?file=rad_sum.txt">Rad/Config/CRM</a><br>
<a href="sts_dat/sts.wml">Obs. Schedule</a><br>
<a href="Contacts/contacts.wml">Contacts</a><br>
</p>
</card>
</wml>
```

Sample WML code of SOT wireless home page.



Design Issues	Resolutions
12 character screen width	shortened mnemonic descriptions
5 line screen length	break long pages into multiple pages, provide navigation links atop and occasionally throughout long pages (ACE)
no color or font capability	provide separate "color" pages eg. Red flags page in Snapshot
device auto-caching, no reload capability	specify expiration time in wml header
wide variety of device types	use web-based emulators for testing

UT
 282:1950-2150
 288:0640-0840
 288:1615-1715
 284:0100-0200*
 284:0830-1030

The DSN comm schedule is presented as a static page, updated every 10 minutes. * marks the current or next scheduled support for easy reference.

Oct 8
 Oct 9
 Oct 10
 Oct 11
 Oct 12
 Oct 13

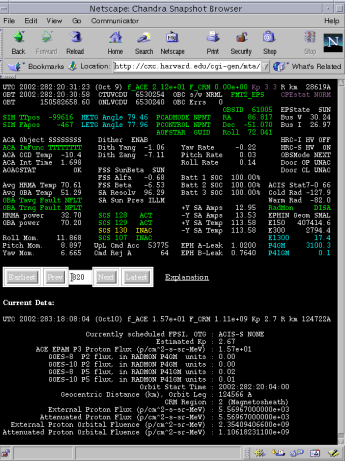
The weekly observing schedule is shown, with links for each day.

2002:282:09:11:18
 | 02597 BETA_PIC
 | ACIS-S NONE
 | 2002:282:12:25:48
T_E88 CAL-ER

Observation start times, OBSID, target name, and instrument/gratings configurations are given. Often used to assess the impact of stopping science loads in cases of high radiation.

MINIMUM
 4.540e+02
 FLUENCE
 7.1209e+06
 p/cm2-s-sr-MeV

Radiation information from the ACE spacecraft is displayed.



Chandra Snapshot
 Current/Rad
 CCDM/OBC
 PCAD/ACA
 EPHIN
 INSTR

The Chandra Snapshot web page is mapped to numerous wireless pages for easier browsing and scrolling.

CGI

2002:282:20:30:58
 OBT15082688.60
 CTUVCDU6580254
 ONLVCDU6580244
 OBC s/w NRML
 OBC Error

A perl interface calls up the requested data. Each subsystem has its own page.

Earliest
 Previous
 Latest
 Current i: 783 of 788
 Goto i:

A cgi-based browser is built-in to access the past three days' worth of data.

RED Flags
 YELLOW Flags
 STALE Flags
 SOT Home

"Color" indications are represented on separate pages.

```
Expires: Mon, 01 Jan 1980 05:00:00 GMT
Date: Mon, 01 Jan 1980 06:00:00 GMT
Content-Type: text/vnd.wap.wml
<?xml version="1.0"?>
<!DOCTYPE wml PUBLIC "-//WAPFORUM/DTD WML 1.1/EN"
"http://www.wapforum.org/DTD/wml_1.1.xml">
<wml>
<card id="index">
<p>
UTC 2002:282:20:31:23 (Oct 9) <br>
OBT 2002:282:20:30:58 <br>
OBT 15082688.60 <br>
CTUVCDU 6530254 <br>
OBC s/w NRML <br>
OBC Error 0 <br>
FMT2_EPS <br>
<del>CPEstat NORM 0</del> <br>
OBSID 61005 <br>
SCS 128 ACT <br>
SCS 129 ACT <br>
<del>SCS 130 INAC</del> <br>
SCS 107 INAC <br>
UpL CmdAcc 53775 <br>
Cmd Rej A 64 <br>
<a href="snap.cgi?dat=Snap_dat/ccdm.0">Earliest</a><br>
<a href="snap.cgi?dat=Snap_dat/ccdm.1488">Previous</a><br>
<a href="snap.cgi?dat=Snap_dat/ccdm.1488">Next</a><br>
<a href="snap.cgi?dat=Snap_dat/ccdm">Latest</a><br>
Current i: 1487 of 1577<br>
Goto i:
<input type="text" name="indx" value="1487" size="4" format="*N"/>
<a href="snap.cgi?dat=Snap_dat/ccdm.S(indx)">GO</a><br>
<a href="snap.wml">Index</a><br>
<a href="snap.cgi?dat=Snap_dat/cur">Current</a><br>
<a href="http://cxc.harvard.edu/mta/WL/sot.wml">SOT Home</a><br>
<br>
</p>
</card>
</wml>
```

Force reload on each invocation. Most devices will default to cached page otherwise.

WML header/card identification

Data Section

Note tag to mark "stale" and <u> tag to mark "yellow" conditions, although most devices can not yet display such characters.

Archive browser links/information

SOT Wireless links and WML endtags

FUTURE DEVELOPMENTS

Wireless Internet technology will continue to advance. More bandwidth, larger displays, and greater graphical capability will be made commercially available incrementally. This will allow us to offer more Chandra systems and scientific data quickly and conveniently via wireless devices.

A few of our short and long term visions:

- Make more text-only pages accessible.
- Explore adding some simple graphical representations (ACE data, for instance) in the near future.
- Expanded graphical services as we convert our many monitoring and trending plots for wireless access.
- Enhanced user interactivity for searching and requesting specific data values and timeframes for trending and analysis.
- Supply products appropriate to a wide variety of devices. Compatibility and translation issues will be investigated to implement our wireless web on upgraded cell phones, PDAs and other devices.

The wireless web has proven to be a valuable resource for Chandra Operations and will continue to evolve and expand.

REFERENCES

S.J. Wolk et al., "Chandra Monitoring, Trends, and Response," ADASS XII, Poster 6.10.

Emulator courtesy of www.gelon.net

www.wap.com is currently being rebuilt, but was a useful site when this project was started.

We acknowledge valuable user feedback and bug reports.

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