The Future of FITS and Other Standardized Astronomical Data Formats

Jessica Mink (SAO) and Preben Grosboel (retired)

- Why are where we are?
- Can we improve FITS?
- How are new standards to be set?
  (IAU Astronomical Data Representation Working Group)
- Using FITS
- Standard Data Formats Now and Beyond FITS
- VO data formats as IAU Standards

The Past of Astronomical Data Formats.

- The FITS data standard has served astronomers well for four decades. The original integer image format has been revised to support additional pixel data types, to support world coordinates and other scientific metadata, to include an integrated data compression framework, and to support generalized binary tables, among other features.
- Over the years, a variety of alternative scientific data standards have been proposed. These usually reach only a limited audience specific to a particular project or community.
- No other format has ever garnered the widespread support of FITS.

The Past of Astronomical Data Formats

Contributed by Preben Grosboel

- FITS was primary intended as the data transport format (ref. Flexible Image Transport System), not as an internal format for image processing.
- The choice of the Network Byte Order seems reasonable considering the emphasis on the transport of data. That some common processors use another byte order is a historical fact but as long as the data are translated to the internal processor format once, the overhead is small.

The Past of Astronomical Data Formats

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- The data formats of the Image and Table extensions are very efficient.
- It is important to note at a change in data formats is extremely expensive both in software and administration. Whereas the software for a stable format, like FITS, may need occasional updates due to compiler changes, a changing data format requires policies for software migration, distribution and version management.
- Old readers (without updates) must be able to read a new FITS file without an error, even without being able to understand some new format data.

The Past of Astronomical Data Formats

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- It is clear that the 80-character Header format is inflexible and has significant limitations. It would be possible to create, e.g. an XML-extension to transport more complex data structures.
- It is reasonable for projects to create their own efficient, internal format data as long as a translation to FITS is available. History shows that projects and image processing systems have a limited lifetime e.g. due to financing or changes in technology.
  [Preben] I still have data from the 80's (e.g. from VAX and HP systems) which I only can access because the internal format were translated to FITS.
  [Jessica] And from the 1970's through the 2020's for me.

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- If ever one would consider the creation of a new data format for exchange, the following points should be considered:
- Once defined, it must obey the FITS rule: **Once FITS always FITS.**
- Image and Table format should be retained as they are efficient.
- The WCS should be retained as it is unique.
- It should be easy to navigate through the data stream e.g. to skip over data.
  [Jessica] Tables of contents in Primary Headers would be nice.

The Future of Astronomical Data Formats

- The IAU DATA Representation Working Group was set up as a node in the structure of the IAU under which the FITS Working Group and other data format standards working groups (such as VO?) could reside, but:
- The IAU Data Representation Working Group has never been formalized.
- The FITS Special Expert Group has never been convened in its post-IAUFWG composition.
- Both suffer from aging/retired membership

The Future of Astronomical Data Formats

The IAU Data Representation Working Group could include:

- Should we add VO data formats as IAU Standards?
- Structured Data Formats (ASDF, HDF)?
- FITS (already there)
- What other formats may need to be standardized?

The Future of Astronomical Data Formats

- What FITS Extensions can be made?
- Arbitrary length keywords?
- Arbitrary length lines?
- Header lines extending across 2880-byte blocks?
- Could these be added with SIMPLE=F?

Astronomical Data Formats Right Now

- Are you generating data?
- How are you using FITS standards?
- Are you extending or creating standards for new projects?
- Are you talking across projects about new standards, even partial ones?
- Have you published details of your standard formats and metadata?
- Where?