Why Google Protocol Buffers?
- fast serialization and deserialization of structured data
- separation of data structure definition and code
- simple, extendable message definition language
- code generators for many programming languages
- thread safe
- forward and backward binary compatibility
- definition available at runtime
- very well tested and widely used

Protocol Buffer definition

I/O library
- C++ and Python libraries
- direct I/O and RPC access
- adaption & adapter APIs
- human-readable representation of messages and metadata
- assists in multithreading
- manages message descriptors

Channels
- The call channel("mu") in a processor triggers a re-run of the whole analysis on this event, but all histograms will have the prefix "channelmu.
- Only in this run the call channel("mu") call will return.

I/O use at the LHC
A4 is currently being used to process ~1 billion ATLAS events per run on a local cluster. Results from the histograms, cuts and systematics uncertainties evaluated using A4 have contributed to published ATLAS results.

Benchmarking A4
- fast stub-like synthetic events with random entries
- entries can be numbers or variable-length arrays
- processing = adding up all entries
- comparison: ROOT 5.32 706e

ROOT conversion
All files with histograms or events can be converted to ROOT files, and ROOT Trees can be converted to A4 files.

Histogram Store
The histogram store enables re-reading, initialising, filling and saving histograms on one short line of code:
S.addHist( "HistoName", Hist, 2, "Histogram details" );
The store object "S" can be a subdirectory, and some stores event weights.
All this is very fast, since no streams are involved.

MCViz:
Visualization of HEP Monte Carlo
The background image of this poster has been generated using MCViz, another project of the authors. It can convert HepMC, LHE and Pythia events into beautiful graphs in a variety of styles. It is available at mcviz.net

Summary and Outlook
- The A4 library, while still experimental, can be used successfully for fast HEP data analysis.
- Almost no manual bookkeeping is necessary due to the use and automatic handling of metadata
- Histograms and cuts/file can be added quickly, and powerful tools to structure the analysis are available.
- Use and collaboration is invited, visit us at liba4.net