

THOUGHTS ON DATA MANAGEMENT

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Key Points

- **Experimental data management has greatly improved over the years, to the benefit of experimentalists; the lessons learned can be applied to simulation data**
 - What has been referred to as “every man for himself” data management does not scale
- **Simulation data management should provide long-term, searchable storage of important code runs accessible in a secure, uniform way**
 - SWIM leading to FSP should be a national resource
- **Comparison of theory and experiment is critical for progress**
 - Comparing simulations to measured data during experiments
idea

Outline

- The “bad old days” of experimental data management
- The value of a standard way of getting data
- How experimentalists want to use simulation data
- Ideas for simulation data management

Experimental data was unmanaged back in the “bad old days”

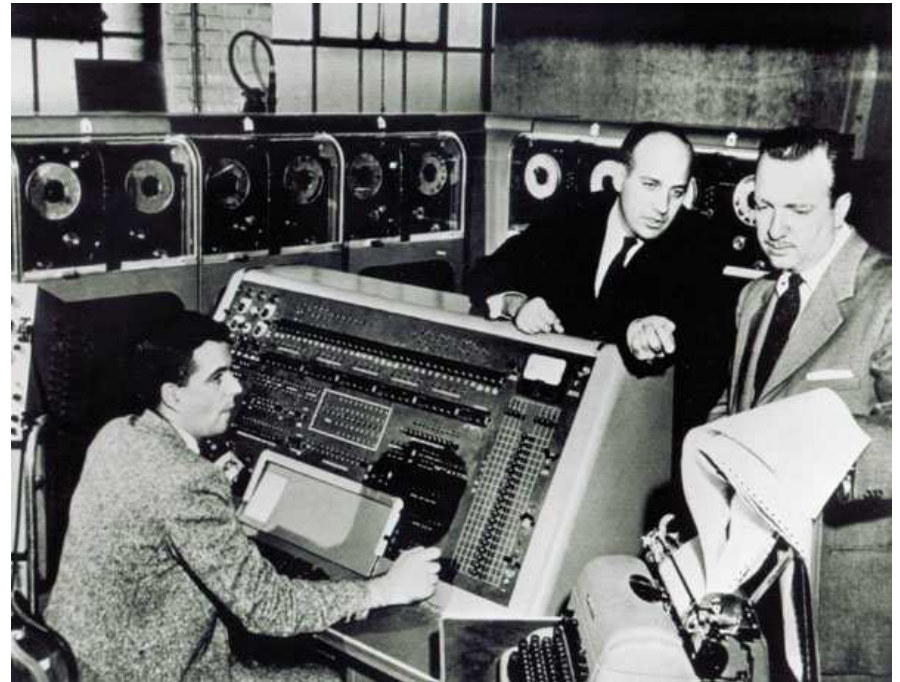
- Each code had different output and input formats
- To get data, you had to walk down the hall and ask for it
- **No standard API**
 - Different visualization tools for each data format
 - Hard to compare data from different sources
- **No way to search or do data mining**



On the upside, walking down the hallway to get data was a chance to socialize

The “walking down the hall” approach does not scale

- As the number of different data formats and visualization tools increases, you spend more time figuring out how to *get* data, leaving less time to actually analyze and compare
- Need an efficient way to share your data with others



When it was difficult to share data, you would print your plots and share those

Today data sharing is routine



- 90 institutions participate
- 425 active users
- 317 scientific authors
- Students and faculty from
 - 65 universities
 - 28 states

Active Collaborations 2004

US Labs

- ANL (Argonne, IL)
- LANL (Los Alamos, NM)
- LBNL (Berkeley, CA)
- LLNL (Livermore, CA)
- ORNL (Oak Ridge, TN)
- PPPL (Princeton, NJ)
- SNL (Sandia, NM)

Industries

- Calabasas Creek (CA)
- CompX (Del Mar, CA)
- CPI (Palo Alto, CA)
- Digital Finetec (Ventura, CA)
- DRS (Dallas, TX)
- DTI (Bedford, MA)
- FAR Tech (San Diego, CA)
- IOS (Torrance, CA)
- Lodestar (Boulder, CO)
- SAIC (La Jolla, CA)
- Spinner (Germany)
- Tech-X (Boulder, CO)
- Thermacore (Lancaster, PA)
- Tomlab (Willow Creek, CA)
- TSI Research (Solana Beach, CA)

US Universities

- Auburn (Auburn, Alabama)
- Colorado School of Mines (Golden, CO)
- Columbia (New York, NY)
- Georgia Tech (Atlanta, GA)
- Hampton (Hampton, VA)
- Lehigh (Bethlehem, PA)
- Maryland (College Park, MD)
- Mesa College (San Diego, CA)
- MIT (Boston, MA)
- Palomar (San Marcos, CA)
- New York U. (New York, NY)
- SDSU (San Diego, CA)
- Texas (Austin, TX)
- UCB (Berkeley, CA)
- UCI (Irvine, CA)
- UCLA (Los Angeles, CA)
- UCSD (San Diego, CA)
- U. New Mexico (Albuquerque, NM)
- U. Rochester (NY)
- U. Utah (Salt Lake City, UT)
- Washington (Seattle, WA)
- Wisconsin (Madison, WI)

Russia

- Ioffe (St. Petersburg)
- Keldysh (Udmutria, Moscow)
- Kurchatov (Moscow)
- Moscow State (Moscow)
- St. Petersburg State Poly (St. Petersburg)
- Triniti (Troitsk)
- Inst. of Applied Physics (Nizhny Novgorod)

European Community

- Cadarache (St. Paul-lez, Durance, France)
- Chalmers U. (Goteberg, Sweden)
- CFN-IST (Lisbon, Portugal)
- CIEMAT (Madrid, Spain)
- Consorzio RFX (Padua, Italy)
- Culham (Culham, Oxfordshire, England)
- EFDA-NET (Garching, Germany)
- Frascati (Frascati, Lazio, Italy)
- FOM (Utrecht, The Netherlands)
- Helsinki U. (Helsinki, Finland)
- IFP-CNDR (Italy)
- IPP (Garching, Greifswald, Germany)
- ITER (Garching, Germany)
- JET-EFDA (Oxfordshire, England)
- KFA (Julich, Germany)
- Kharkov IPT, (Ukraine)
- Lausanne (Lausanne, Switzerland)
- IPP (Greifswald, Germany)
- RFX (Padova, Italy)
- U. Dusseldorf (Germany)
- U. Naples (Italy)
- U. Padova (Italy)
- U. Strathclyde (Glasgow, Scotland)

Japan

- JAERI (Naka, Ibaraki-ken, Japan)
- JT-60U
- JFT-2M
- Tsukuba University (Tsukuba, Japan)
- NIFS (Toki, Gifu-ken, Japan)
- LHD

Other International

- Australia National U. (Canberra, AU)
- ASIPP (Hefei, China)
- Dong Hau U. (Taiwan)

**Widespread collaboration
impossible without
good data management**

The experimental community primarily uses MDSplus as a standard data format

- **Much easier to get data because of a standard API**
 - Application Programming Interface (API)
 - The set of functions that you call to interact with the application, in this case the data
 - Examples from MDSplus:
 - MdsOpen opens database
 - MdsValue evaluates expression
- **Standard API means you can write general applications to read and work with MDSplus data of all types**
 - Example: general visualization tools
 - One less new thing to learn when you can reuse the same viz. tool

Example: getting data with and without an API...

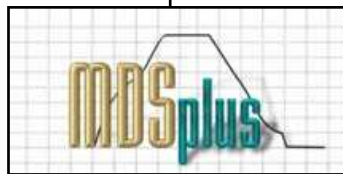
API, MANAGED DATA

- Scientist #1 “my data is in MDSplus in XYZ shot 123”
- Scientist #2 “No problem, I know the two commands it takes to get data from MDSplus”
 - MdsOpen
 - MdsValue

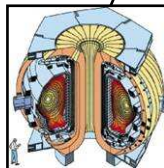
NO API, UNMANAGED

- Scientist #1 “my data is somewhere in my home directory in my own special data format”
- “Oh wait I forgot I moved those files, they’re on that other computer now”
- “OK, now follow these 15 steps to read data from my file format”
- “Oh, wait this is an old version, you need these extra 5 steps”
- ...etc.

A standard API can serve as a wrapper, thus leaving legacy systems in place behind the scenes



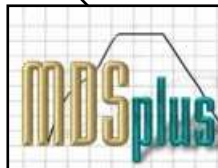
JET



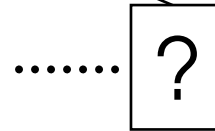
DIII-D



SRB



Other
MDSplus

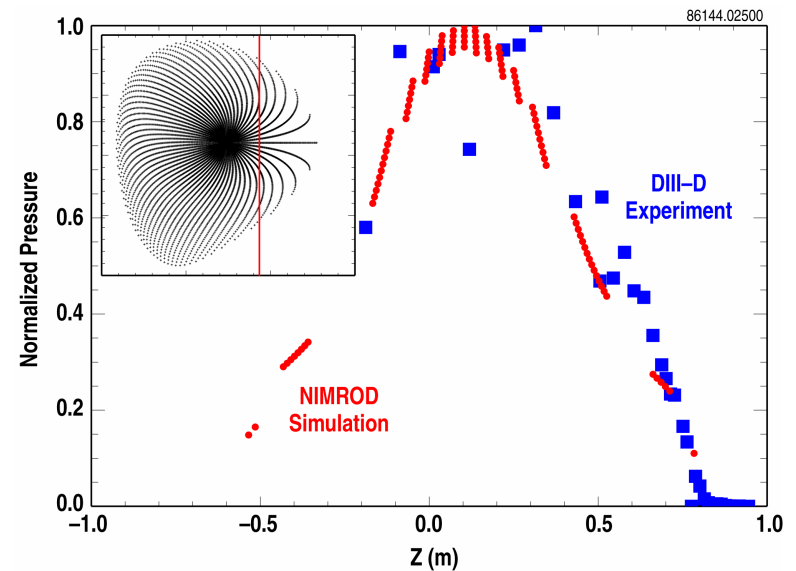


Future
Systems

- MDSplus has been used as a front end for other data systems
 - DIII-D (PTDATA), JET, SRB
- Leave the old data systems in place, but allow them to be called from MDSplus through MdsValue
- Can be secure via X.509

A synthetic diagnostic: one way experimentalists would use simulation data

- Want to be able to use general-purpose visualization tools to compare the two
- Simulation data in physical units
- Must be rapid
 - Quick plots for comparison during tokamak experiments



Lessons learned from NIMROD Storage in MDSplus

- **Experience with NIMROD revealed limitations in MDSplus**
 - Too much data
- **MDSplus updated to accommodate larger “node” and “tree” sizes**
- **Sending 100s GBs – TBs of data over WAN is slow**
 - Small chunks, single TCP stream with ACKs over high latency
- **MDSplus being updated with parallel I/O streams (GridFTP)**
 - Will make WAN transfer faster
- **A bulk transfer method would further speed up MDSplus**
 - i.e. send the whole “tree” (database) not pieces of the data

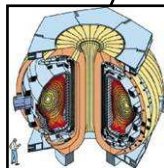
Some other system could be used if experimentalists could get to it through the familiar MDSplus interface



- Experimentalists already familiar with MDSplus
- Many visualization tools already exist
- Reuse the standard MDSplus API



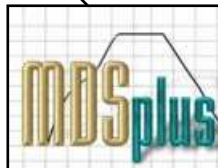
JET



DIII-D



SRB



Other
MDSplus



Future Simulation
Database

New storage system should store code run information

- **Experimental community augments MDSplus with relational database for tracking code runs and for shot summary data**
- **Important because it allows for rapid queries across servers/trees/shots**
 - Fewer file opens = faster
- **Identify each code run with a unique ID**
- **The best “scratch” runs are “pasted” (aka “blessed”)**
 - Not all runs must be archived permanently
- **Also store other metadata such as comments, “run type”, who ran the code, date started/completed, etc.**
 - Discovery of data much easier

Simulation storage system must allow for retrieval many years after initial code run

- Cannot have a situation where old data is lost forever
- Must be able to get to old data
- Can't recreate old data if code versions change
- Should have plenty of useful metadata for better searching



Try getting your data from these

Simulation data management scheme should make data accessible by small institutions, too



**Expensive solutions
may preclude
widespread collaboration**

Conclusion: data management is important

- **Simulation data management means:**
 - Important data is saved forever
 - Standard way to get to the data
 - Data is shared, organized, searchable
- **Experimentalists want to compare simulation with experiment**
 - Must be able to do so rapidly
 - Need “real” units for data
- **Could use MDSplus, or provide an MDSplus façade**
 - Improvements to MDSplus in progress

Aux slides...

MDSplus Security: host-based or certificate-based

- **Host-based is not particularly secure**
 - Great for local access where you trust peers
- **Certificate-based is secure**
 - Each user has their own certificate
 - Agree on a Certificate Authority
 - Works with delegated proxy certificates (MyProxy)
 - Your “ID” is on a server
 - No messing around with files
 - Authorization via Resource Oriented Authorization Manager
 - Flexible, simple, free
 - Empower stakeholders
 - Easy web interface