You Want Us To Do What?
The Evolution of SLR/LLR in Response to Mission Needs

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Network Performance and Results
The “spirit” of this talk ...

- The ILRS and the laser ranging network
- A continuing evolution in laser ranging
- New experiments keep us young and excited
- Seeing and solving the laser ranging problems
- How well are we doing?
- What will we be doing tomorrow?
The ILRS SLR Network
In the beginning ...

- Just get us the data ...
- Building a better mousetrap ...
  - Lasers, clocks, mirrors, mounts, PMT’s, MCP’s
- Can we do it in software (and hardware)?
  - Automation is the key ingredient
    - Observation logs
    - Reception of predicts
    - Setting of priorities
    - Data transmission
Learning the ropes ...

- Do we know where to look?
  - Tarot cards and crystal balls don’t seem to work too well
  - Bootstrapping the predicts
    - better orbits and gravity fields were the answer

- Is less better? (but let’s be smart about it)
  - Ameliorating the data glut
    - What about normal pointing
    - But, sometimes full-rate is good, too
Getting more data ...
(... but, can we do it cheaper?)

- Are you lonesome tonight?
  - Radars and diligence reduce manpower needs
  - Safety still reigns supreme

- Who do you think we are? (Kilo) Hertz?
  - The same power
  - Smaller pieces, more often
More than data...can we do science?

- Can you get the data to me quicker?
  - Real and near-time automated data transfers
- What time is it?
  - Earth rotation and polar motion
- Are these things really moving?
  - Coordinate/reference frames
- You mean the Moon is not made of green cheese?
  - Core and mantle
- It’s all relative!
  - Einstein still has it right.
- (Scotch and) water, on the rocks...
  - Melting ice and rising sea level
An early time transfer experiment

- This is the early 1990’s!
- Let’s use the LLR-capable stations at OCA and Texas
  - We need simultaneous visibility of a common target
  - We need the epoch at the ns level (ouch!)
  - Can we correlate and coordinate laser firing times?
    - We “ask” the laser to fire, we do not “tell” it to fire
    - Meteosat MP-3 is the geo-stationary intermediary
- Excellent results at the nanosecond level (cf. C. Veillet)
Increasing the challenge
(this is a real drag!)

- Duck! (...and it is really going fast!)
  - Not quite a perfect vacuum
  - Going to 5 degrees...

- People at prediction centers do it several times a day...
  - Integrating state vectors or generating ephemerides?
Maybe two is better than one...

- The interspersing of data
  - Interrupting a long pass for a short one
- The challenges of priorities and scheduling
  - The Honeymooners (...remember Ralph and Norton?)
  - Just a follow-up (Jason/TOPEX, then GRACE)
  - Can we tell the difference?
    - We did with TIPS
    - Can we do it with ANDE?
Here’s looking at you, kid...

- Do you feel that someone is watching us?
- Here come the altimeters and the photographers!
  - elevation restrictions
  - “go/no-go” restrictions
  - pass-segment restrictions
- Some targets require none, one, two or all three of the above.
- The present challenges of ICESat, ALOS, and other targets
What’s next?

- Your guess is as good as mine
- The ILRS has a good record
- It’ll do whatever has to be done
Summary Remarks

- Nothing really new under the sun …
- As scientific experiments become more complicated, greater pressures are placed upon operational logistics in order to perform necessary operations, and yet retain personnel safety and instrumental integrity.
- Thorny logistical problems have been solved by a combination of computer power, internet communications, orbital dynamics and precisely defined inter-relationships among several reference frames.
- The results
  - More and better “science”
  - And …. 
Summary Remarks (con’t)

- YES! Job Security
- Thank you!