e-EVN: a Real-time Radio Telescope as large as Europe with sub-microJy sensitivity.

Mike Garrett (JIVE)
• e-VLBI goal is to connect radio telescopes around the world via broad-band optical fibre networks.

• e-EVN will use GÉANT to transport 1-10 Gbps from each EVN telescope to JIVE.

• Gbps data rates will permit noise levels better than 1 microJY.

• Current status:
  • JIVE connected to GÉANT at 6 x 1 Gbps,
  • Five EVN telescopes “on-line”,
  • First e-EVN Proof-of-Concept tests already under-way...
e-EVN Design Goals (1)

- **Embarrassingly sensitive:**
  - Sub-microJy noise levels achieved in 12 hours.

- Full uv-coverage via Multi-frequency Synthesis.

- Frequency Flexibility & Broad Coverage:
  - 0.3-1 GHz
  - 1-3 GHz
  - 4-8 GHz (incl. Methanol)
  - 15, 22, 43 GHz.
e-EVN Design Goals (2)

- Milliarcsecond Resolution & sub-milliarcsecond Astrometry.

- Wide-field Imaging as a standard correlator mode:
  - Field-of-view of 10 arcmins at 1.4 GHz,
  - AVO-like archive to interface with pipelined images.

- “Phase stable” at 1-10 GHz using “full-beam” calibration.
e-EVN Design Goals (3)

- Seamless co-observations with e-MERLIN of 1-200 milliarcseconds:
  - The e-EVN/e-MERLIN combination will be the most powerful radio imaging instrument on the planet.

- Simultaneous continuum and multi-line spectroscopy.

- Dynamic, central scheduling (telescopes and Correlator) and pipelined imaging.
Current e-EVN Activity

• EVN is leading an e-VLBI proof-of-concept project with GÉANT and NRENs (e.g. SurfNET).

• The first real-time e-EVN image produced April 2004:
• Current network topology used for tests (right)
  • 340 Mbps recently achieved JIVE (NL) – Torun (PL).
• 6 EVN telescopes on-line by end of 2004,
• Successful transatlantic fringes Onsala (SE) – Westford (USA)
• Tests with world’s largest telescope Arecibo Sep. 2004?
• First Science PoC tests scheduled for later this month.
e-EVN and e-VLBI Science
e-EVN Sky

- 10’s of thousands of potential targets in e-EVN field-of-view...

- On-going sub-mJy VLBI Deep Field studies suggest ~ 8% will be compact on milliarsecond scales.

- Figure (right):
  - Blue = > 100uJy
  - Green = 10-100 uJy
  - Red = 1-10 uJy.
e-EVN Key Science Projects (1)

- Ultra-Deep Field VLBI Studies:
  - Combined e-MERLIN/e-EVN can probe the structure of star-forming galaxies – locally and at high-z,
  - Establish a cosmic census of AGN & the accretion history of super-massive black holes,
  - Detection of high-z AGN unique to radio-waves and without MIR, optical, x-ray counterparts.
e-EVN Key Science Projects (2)

- e-EVN sensitivity will permit the detection of individual hypernovae in distant galaxies...
- Distinguish between Starburst and AGN activity in dusty SCUBA SMGs,
- Study the physics of GRB jet formation in nearby galaxies.
e-EVN Key Science Projects (3)

• Other Key Science Projects include:
  • Cosmology – gravitational lenses – constraining cosmological parameters.
  • Study the physics of GRB jet formation in nearby galaxies.
  • Imaging thermal jets and outflows in YSOs, SNe, SNR.
  • Study of micro-quasars, relativistic jets and their local environment.
e-EVN Technical Challenges

• Other technological challenges:
  • Data Processing – new correlator required:
    • Software correlator?
    • GRID-based solution feasible?
    • Purpose built?
  • Correlator would produce many tens of Terrabytes per day...
  • Upgrade of EVN Telescope VLBI hardware to > 1Gbps (started in 2004 DBBC project).