Setting the scene: Scientific Applications of eVLBI

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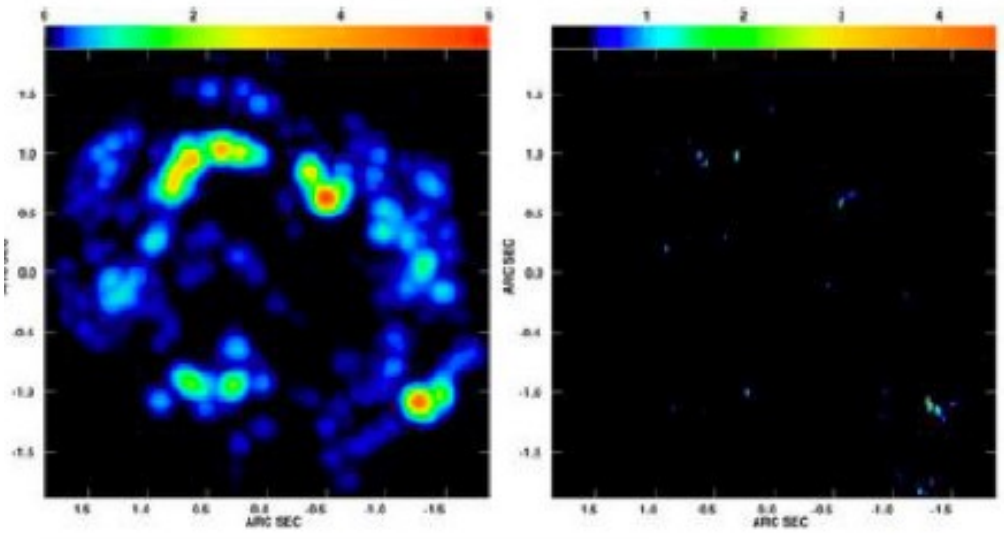
Outline

1. Quick review of how far we have come last 5 years in science applications.
2. Advantages of eVLBI.
3. Tools and proposals for eEVN.
4. Synergy with other instruments eLOFAR/eMERLIN/SKA
5. Future and Conclusions

Apologies in advance for an EVN centred talk

1) Progress- First steps

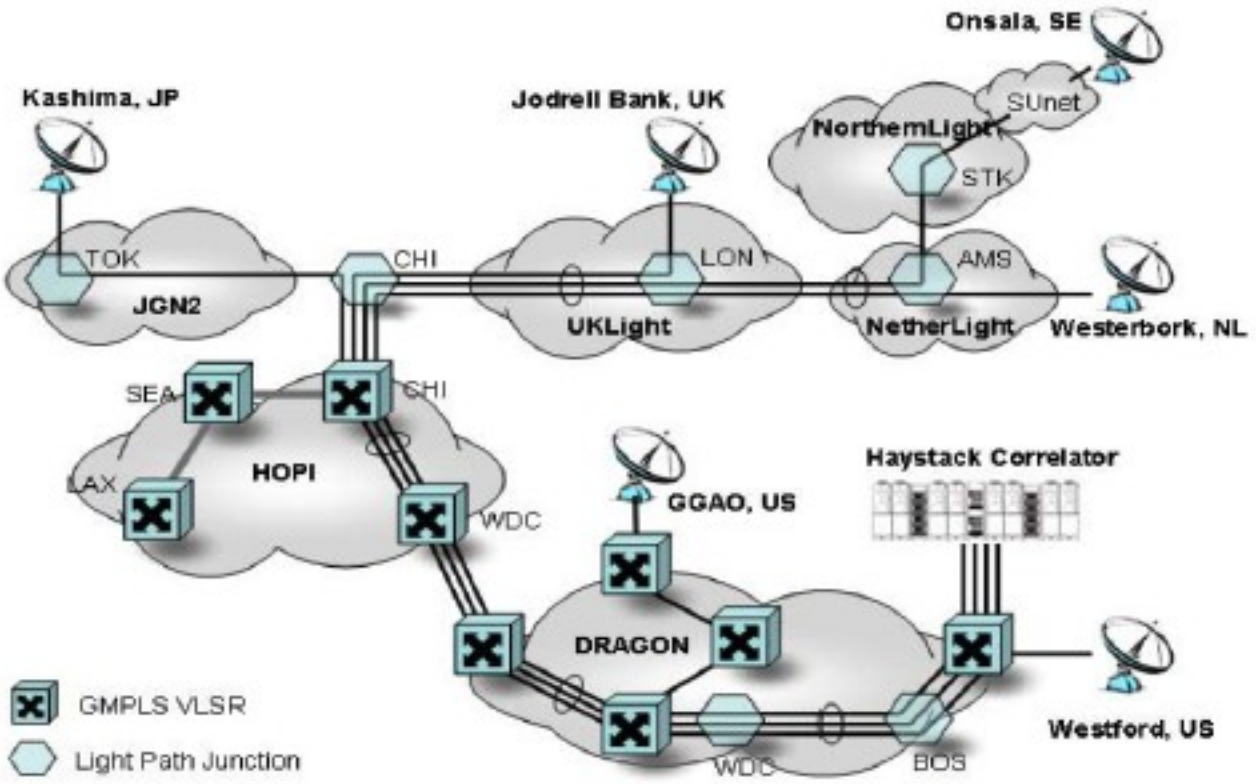
- I got involved in 2004 when I was asked to ‘say a few words....’ at EVN directors meeting. Asked to set up group to look at astronomy applications and help in demo.



First EVN eVLBI science demo September 2004, 32Mbit/s, required ‘running the correlator inside out’ (Huib van Langevelde) many manual restarts etc ec

First real time internet Transatlantic fringes

Also in 2004, first transatlantic fringes at 32 Mbit/s



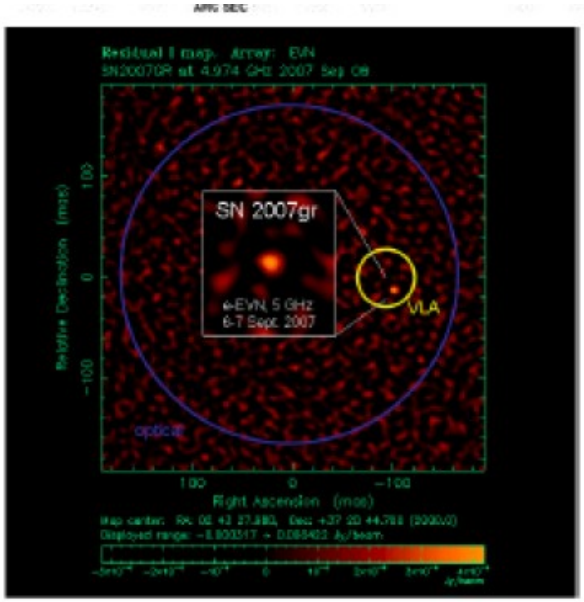
Demo at iGRID 2005 conference, September 2005 – succesful fringes Onsala-Haystack at 512Mbit/s

First Transatlantic Radio Interferometry, Onsala, January 1968

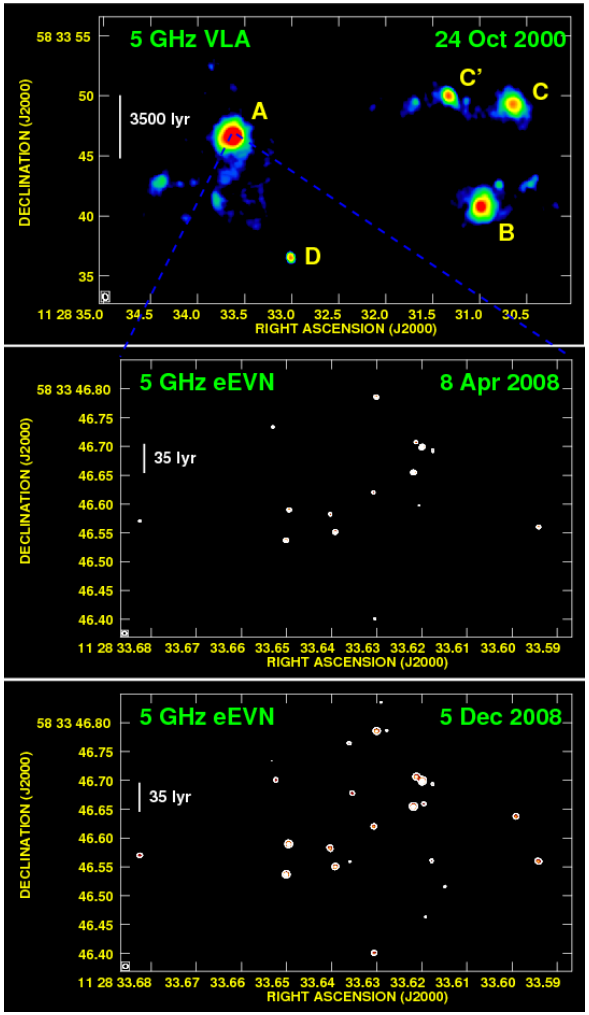
Using recorded media, definitely not real-time.

More Recent results

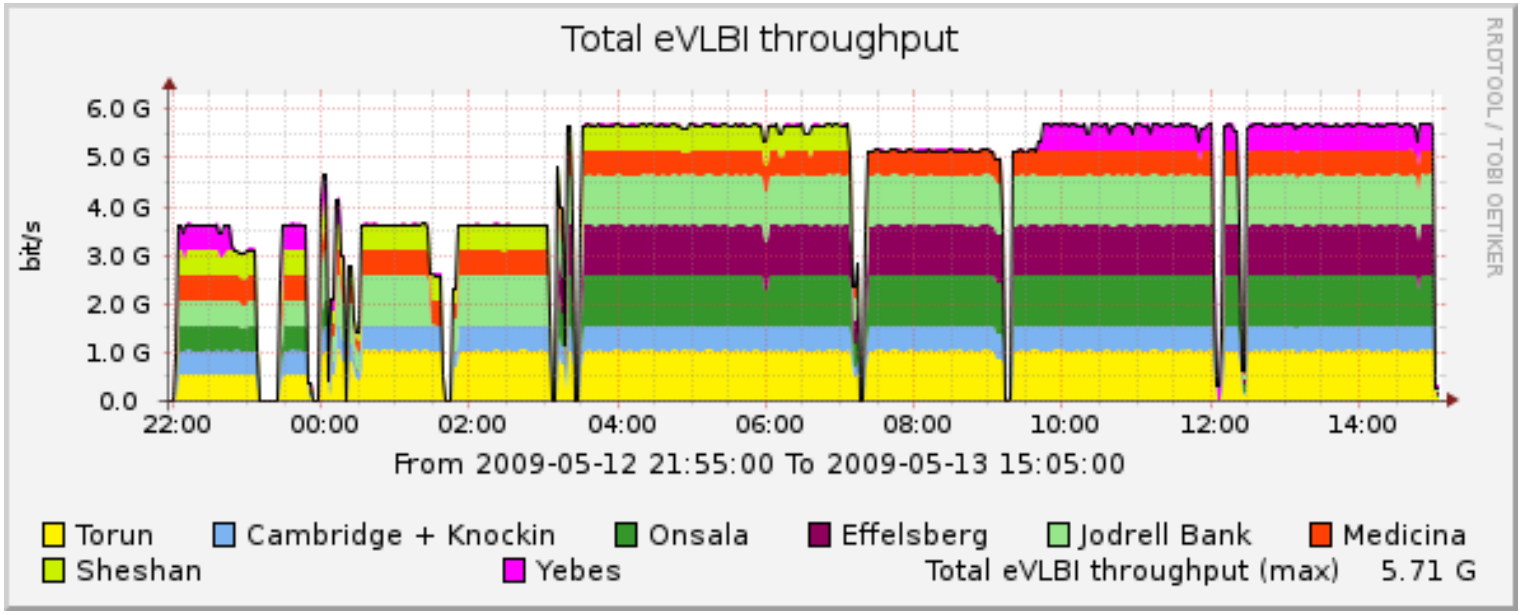
Sept 2007, Paragi obs of SN2007gr, first eVLBI astronomical telegram



Apr/Dec 2008 eEVN obserations of Sne/SNRs in Arp299 Perez-Torres et al (Science, submitted)



State of Art



May 2009 observations, full 1024Mbit/s from Tr,On,Ef,Jb,Wb (also Yb) all stations with 10G connections-Others have 512Mbit/s (or close to 1Gbit/s with bit dropping) - See Arpad's talk on Wednesday for current status.

Thanks!

- To Arpad Szomuru and all at JIVE – for piping data into the correlator and getting sense out.
- To Paco Colomer and people at stations for ‘last mile’ connections
- To the academic service providers – amazing support!
- EVN PC/eVSAG members proposal handling , Zsolt Paragi for setting up sessions. Richard Porcas for scheduling them
- To Mike Garrett and Huib van Langevelde for getting the money and their leadership
- The EU and taxpayers of Europe.....

2. Advantages of eVLBI -Why eVLBI?

- Unless you had to would you ever choose to build a non-real time (recorded media based) array??

- Answer is No, because its a big hassle (time and labour consuming, long feedback loop in testing)

- On the other hand (us old timers at least) we have learnt to live with traditional VLBI with media recording - can argue that most VLBI science can be done with disks.

- So two types of advantages of eVLBI – those that make traditional VLBI science easier and those that enable new types of science

Making traditional VLBI science easier

- Reliability – fringe testing before sessions has helped EVN reliability.
- Fast results – especially important for new/young users.
- Saving manpower handling media, cost of shipping.
- Easier upgrade to higher bandwidth – no need for recorder development.

New capabilities from eVLBI-I

- Most obvious -speed of results, note the speed of response only marginally improved
- Rapid results useful in themselves, because ‘perishable’, i.e. some cases of spacecraft navigation, perhaps Earth orientation? OR more likely to plan new observation of transient events.
- Enable via ToO’s and triggered observation

New capabilities from eVLBI -II

- Automation. Another advantage of eVLBI when combined with software correlation could be automated observations allowing long observations.
- Observations lasting months with few telescopes could do large surveys, parallax of OH or CH3OH masers, interrupt to do transient follow-up.
- Easier interoperation with other real time arrays (i.e. eMERLIN see later)

4. Tools and Proposals for eEVN

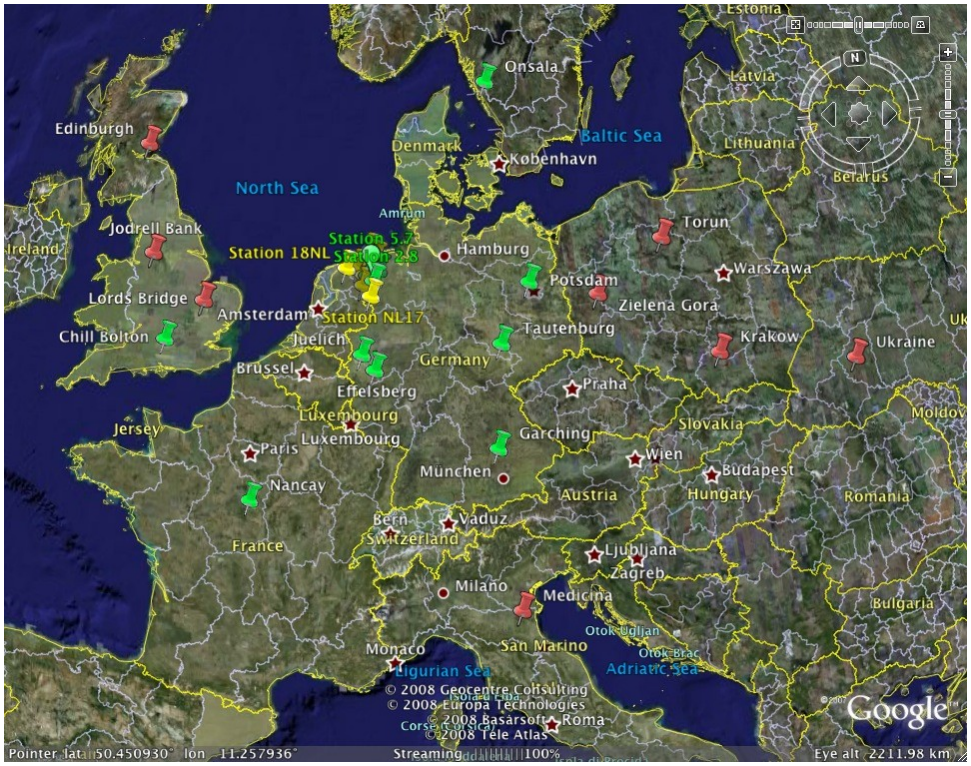
- Recent technical advantages – 1024Mbit/s on most stations. Mixed bit rates operation possible. Tipping point - nearly as sensitive as disk recording at present highest bit rate, but quicker results- choose for standard VLBI projects.
- Sharing observations between disk/e-VLBI can allow EVN goal of all continuum at 1024Mbit/s?
- Record and transmit mode tested. Important for ToO's. Combine fast initial results with larger array disk correlation later – no excuse for not doing eVLBI in ToO's

eVLBI runs

- Designed by EXPReS-eVSAG (eVLBI Science Advisory Group) together with PC.
- Presently outside of main sessions because uses different MkV kernel.
- Decided early on to marry technical advantages to organisational ones with now 10-12 x 24hrs sessions through year.
- Can propose A) Standard B) Triggered C) Short obs, on the fixed dates, first two using proposals at standard deadlines (Conway, Charlot, Garrington)
- Additional defined ToO policy/procedure (Porcas et al) from Nov 2007, observation can be proposed anytime for observations anytime.

5. Synergy with eLOFAR/eMERLIN/ SKA

- This decade a golden one for European radio astronomy. eEVN, eMERLIN, eLOFAR



The extension of LOFAR to international baselines – makes use of expertise and infrastructure from EXPreS

Funded stations at Onsala, Bonn use EXPReS links, as will proposed stations at Torun and Medicina.

Would eLOFAR exist now without EXPReS??

eMERLIN

- Deliverable of 4 x 1Gbit/s into JIVE correlator, for seamless eEVN+ eMERLIN

- Also testing 4Gbps from Onsala into eMERLIN, perhaps up to two external telescopes in eMERLIN (see M.Lindquist poster)- talk Richard Hughes-Jones

SKA

- eVLBI activity an important precursor for long baselines of SKA in Southern hemisphere.

- Role of northern hemisphere VLBI in SKA era, N-hemisphere has more landmass (much better long baseline uv coverage) and more population (affordable long baseline bandwidth).

- With 32Gbit/s, 10% SKA collecting area, 10,000km baselines, can observe thermal emission at mas resolution. Stars, high-z SNe star-formation structure. Complementary instrument in N. Hemisphere, with different science goals.

6) Future and Conclusions

- Largest scientific payoff for many station, long baselines at >512Mbit/s. Extra stations in China, station or two in North America.
- Explore idea of ‘continuous eVLBI’ few stations always observing astro VLBI - doing continuous program with software correlator (i.e. maser astrometry, could be a global baseline at 32Mbit/s), switch to large BW and JIVE correlator to observe suitable announce transients, get sizes/limits. When fringes confirmed other antennas join in.
- Future is bright. Expansion to ever higher bandwidths (4Gbps and beyond), future eVLBI projects NEXPReS etc