3GC-II Workshop

What will it take to deliver SKA_1 and SKA_2 ?

Duncan Hall
2011-09-26

Some Out Of the Box (OOB) solution(s) will be required

OOB #1: Beyond conventional approaches

OOB #2: Making use of pre-existing - perhaps shrink-wrapped - codes, because coordinating development of order 10^5 to 10^7 new and effective source lines of code is way beyond a "hero" mode of development

OOB #3: Descriptions beyond PowerPoint boxes with labels like “a miracle happens here” are required

OOB #4: We can’t rely on Moore’s Law as some kind of deus ex machina solution: while the number of transistors per chip will likely continue to increase towards year 2020, the transistors will be organised into multiple parallel processors which the software will have to coordinate, so the hardware guys are turning a Moore’s Law hardware solution into an increasingly complicated software problem - however there is no Moore’s Law for software

What prompted this talk?

What will it take

to operate data processing

in real-time pipeline modes

to deliver the published aspirations

for SKA proposed Phase 1

and

for SKA proposed Phase 2 ?

A digression: one common rhetorical process

- Situation
- Complication
- Question
- Answer
- Proof
- Call to action

Minto: The Pyramid Principle

Situation:
DRM 1.3 (SKA_1) imaging rqmts:

[1] System level specifications	Wording	Details, details, details ...
• Survey "On Sky" Time:	• 2 years	• Excludes calibration, maintenance, "inefficiencies" etc. • So elapsed time could be ~5 years
• Deep Field Integration Time:	• 1,000 hr (~3 x 10^6 seconds)	• Excludes calibration, maintenance, "inefficiencies" etc. • So elapsed time could be 3 times larger
• Fractional Instantaneous Bandwidth:	• ~1	• So as to perform "at least as well as the current systems" for continuum observations
• Spectral Baseline:	• Sufficiently flat to enable spectral line observations	• "bandpass does not show ripples or systematic fluctuations on scales smaller than a frequency corresponding to about 300 km s^{-1} that are larger than would be achieved by twice the thermal noise level after an integration of 1,000 hr"
• Correlator Integration Time:	• Sufficient to mitigate time-average smearing	• "does not result time-average smearing at the edge of the field of view exceeding 2%."
• Spectral Resolution:	• Sufficient to mitigate bandwidth smearing	• "does not result in the bandwidth smearing at the edge of the field of view being larger than 2%." • Doesn't address RFI requirements

Situation: DRM 1.3 (SKA_1) imaging rqmts:

[2] Probing Neutral IGM in EoR	Wording	Details, details, details ...
• Frequency range:	• 50 ~ 240 MHz • [Table 8-2: 70 MHz ~ 240 MHz] • *ν_{crit}= 100 MHz*	• *100 MHz is the frequency for which the collecting area and SNR should be optimised*
• Fractional Instantaneous Bandwidth:	• Δν/ν of ~1	• Desirable for increasing the sensitivity of the observations, foreground removal and constraining the ionosphere
• Frequency resolution	• 100 kHz • *1 kHz*	• Radial (velocity) resolution • *RFI, bandwidth smearing, and calibrate ionospheric effects*
• Maximum baseline :	• ~200 km outer baselines	• “Accurate identification and removal of out-of-beam sources requires higher angular resolution” • “also required to reduce ionospheric effects on a large field of view”
• Antenna diameter:	• 7m ~ 30m	• “minimum field of view of 5° leads to maximum antenna diameter of 30m” • “Fields of view of less than 20° would have an imprint in the ionosphere <200 km, leading to the requirement that the antenna diameters are greater than 7m”

Situation: DRM 1.3 (SKA_1) imaging rqmts:

[3] Galaxy evol'n via H I absorp'n	Wording	Details, details, details ...
• Frequency range:	• 0.2 ~ 1.4 GHz	• Follows directly from the redshift coverage requirement and rest frequency of H I = 1.4 GHz
• Frequency resolution	• 5 kHz	• Follows directly from the stated velocity resolution requirement at a nominal frequency of 200 MHz
• Imaging dynamic range:	• 35 dB	• Imaging strong sources could produce spectral artefacts ...
• Spectral dynamic range:	• 43 dB or better	• "imaging dynamic range (35 dB) and signal-to-noise ratio considerations (8 dB), for a final requirement of at least 43 dB"
• Field of view:	• 4.5 deg^2	• Within a 4.5 deg^2 field of view, "WENSS source counts indicate that there will be, on average, a source of strength 1.5 Jy or stronger ... "

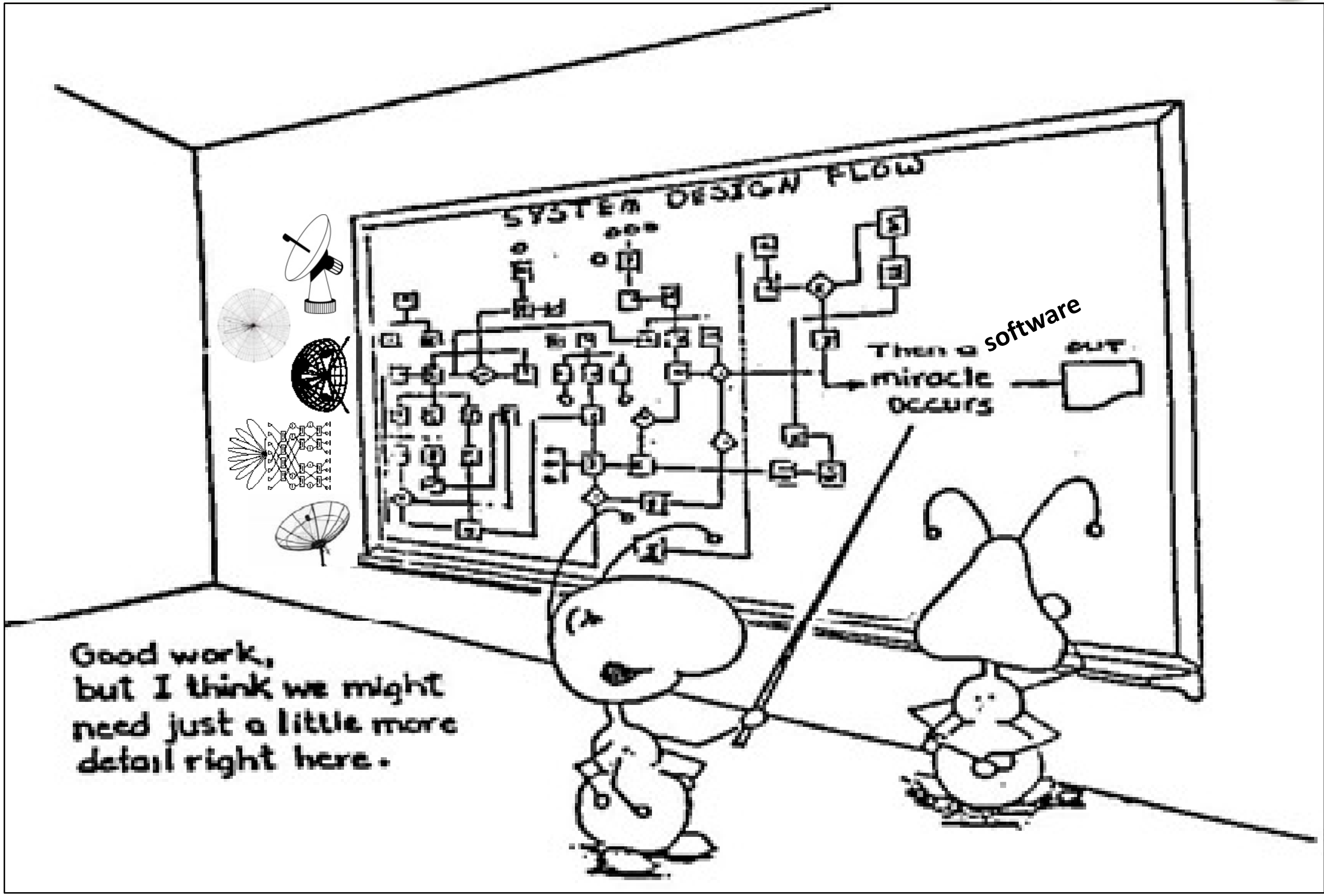
Situation:
DRM 1.3 (SKA_1) imaging rqmts:

[4] Probe EoR with 21cm Forest	Wording	Details, details, details ...
• Frequency range:	• 70–200 MHz	• Follows directly from the redshift coverage requirement and rest frequency of H I = 1.4 GHz
• Frequency resolution	• 200 Hz	• Follows directly from the stated velocity resolution requirement at a nominal frequency of 200 MHz
• Imaging dynamic range:	• 54 dB	• In order that any spectral artefacts from the strong source are below the level of the absorption line requires an imaging dynamic range of 54 dB
• Spectral dynamic range:	• 61 dB or better	• In order that any spectral artefacts from the strong source are below the level of the absorption line requires an imaging dynamic range of 54 dB • Plus signal-to-noise ratio considerations of 7 dB
• Field of view:	• 10 deg^2	• "consider a nominal field of view to be 10 deg^2 at 150 MHz (z ~ 8)"

Situation:
Just for fun – SKA_2 imaging rqmts:

[7] SKA_1 to SKA_2 considerations	Wording	Details, details, details ...
• Frequency coverage	• 70 MHz ~ 10+ GHz	• Signatures of complex organic molecules around proto-planetary disks
• Dynamic range for continuum deep field:	• 74 dB "capable"	• the strongest source in the field of view [may be limited] to approximately 0.1 Jy. • Detecting luminous infrared galaxies (LIRGs) at redshift 7 will require a sensitivity of 4 nJy
• Spectral dynamic range for deep H I surveys:	• 67 dB	• Signal-to-noise ratios of at least 7 (8 dB) are probably required to identify emission line features • We expect, on average, one source with a flux density of order 1 Jy or stronger within the field of view, and want to detect a $5 \times 10^9 M_{\odot}$ galaxy at z ~ 2 (need 1.4 µJy rms) [~59 dB] • The total dynamic range requirement for HI survey is then 59 + 8 = 67 dB
• Polarisation purity	• 25 dB	• Studies of cosmic magnetism. .. require Q, U, and V purity, after calibration, of at least 25 dB, (i.e., 0.5%)

Complications:
Are software miracles required?



[A] Required size of convolutional kernel:

Short Description	Why is research required?	What might research resolve?
• Baseline length and field of view: impact on **required size of convolutional kernel**	• Standard convolutional re-sampling involves the convolution of visibility function samples (a collection of weighted Dirac delta-functions) with a constrained kernel to produce a smooth function which is sampled at the regularly spaced grid points required by an FFT algorithm • The processing scales as the number of visibility samples, and the size of the convolutional kernel • The required sizes of kernels for SKA_1 and SKA_2 have not yet been estimated, but are likely to be larger than current practice	• The required sizes of convolutional kernels • And therefore an indication of the scale of processing required for an automated pipeline

[B] Fidelity of GSM and LSMs:

Short Description	Why is research required?	What might research resolve?
• **Fidelity of** Global Sky Model (**GSM**) and Local Sky Models (**LSMs**)	• If the fidelities of the GSM and LSMs are such that many iterations over the observed data are required, then much greater levels of processing will be required than is currently expected	• How much effort should be invested in GSM and LSMs?

[C] Smearing:

Short Description	Why is research required?	What might research resolve?
• **<u>Smearing</u>**: impact on achievable image dynamic range	• The relationship between smearing in the uv plane and the processing required to achieve a specified image dynamic range is non-deterministic • The processing required to routinely achieve image dynamic ranges in an automated pipeline of order more than 60 dB may be much greater than current expectations.	• How much smearing can generally be tolerated • And therefore how much effort should be put into limiting smearing – which increases the data rate into the calibration and imaging process • As opposed to how much additional processing is tolerable to deconvolve smearing

[D] Receptor pointing errors:

Short Description	Why is research required?	What might research resolve?
• Calibration of **<u>receptor pointing errors</u>**	• The relationship between calibration to correct for receptor pointing error and achieving high dynamic range is instrument specific • Systematic errors in source or beam models prevent pointing calibration accuracy at the level required by the SKA	• How much pointing error is tolerable for SKA_1 and SKA_2

[E] Modelling bright sources outside the primary beam:

Short Description	Why is research required?	What might research resolve?
• **Modelling** the effects of **bright sources outside the primary beam**	• Side lobes well outside the primary beam need to be accurately modelled to take into account artifacts from bright sources that happen to lie within the side lobes • We need to know how well modelling artifacts from bright sources works for arrays under construction	• How much effort should be put into modelling side lobes and implementing those models in calibration and imaging algorithms

[F] Characterisation of primary beam:

Short Description	Why is research required?	What might research resolve?
• **<u>Parameterisation of primary beam responses for calibration purposes</u>**	• Smirnov: “Know Thy Beams”	• How much effort should be put into characterising primary beam response

[G] Stability of side lobe responses:

Short Description	Why is research required?	What might research resolve?
• **Stability of side lobe responses**	• The array uv coverage has to be very complete and side lobes very stable • The point spread function level of side lobes must be <0.01% (derived from the square root of the maximum noise to achieve the required dynamic range of order 60 dB) • If the point spread function level of side lobes is variable, then much greater levels of processing will be required than is currently expected	• How much effort should be put into modelling the variability of side lobe responses and implementing those models in calibration and imaging algorithms

[H] Relativistic effects:

Short Description	Why is research required?	What might research resolve?
• Consideration of **relativistic effects** in high dynamic range imaging	• To achieve high dynamic range – i.e. greater than 60 dB – we will have to consider relativistic effects, as well as tectonic movement within 8 hour periods over long baselines. • If relativistic effects must be considered, then greater levels of processing will be required than is currently expected	• How much effort should be put into modelling the relativistic effects and implementing those models in calibration and imaging algorithms

[I] Non-uniqueness of solutions:

Short Description	Why is research required?	What might research resolve?
• <u>**Non-uniqueness of solutions**</u> found to automated model fitting	• The Jones matrix solutions are not unique: there is unavoidable ambiguity in their solution set • Automated software solvers will simply pick one of the possible solutions – and there may be other more reasonable solutions	• How much we should worry about this

[J] Sparse array configuration:

Short Description	Why is research required?	What might research resolve?
• **Sparse array configuration**	• The sparse array configuration specification is not sufficiently mature to guarantee that the number of stations, their diameter and the number of beams may change	• How much we should worry about this

[K] Packing density of the core:

Short Description	Why is research required?	What might research resolve?
• Compromise on the **packing density of the** telescope **core**	• The requirements for imaging oppose requirements for non-imaging processing • This means that the close packing requirement specified in the DRM is a compromise with a comparatively large core diameter of 5km • Beamforming across this diameter results in very small diameter pencil beams with implications on the data rates and required processing power for a given survey speed	• How much we should worry about this

[L] Full-field gain self-calibration:

Short Description	Why is research required?	What might research resolve?
• **<u>Full-field gain self-calibration</u>**	• Full-field gain self-calibration may prove to be infeasible at mid to high frequencies with weaker sources and smaller fields-of-view	• How much we should worry about this

[M] General parameterised models:

Short Description	Why is research required?	What might research resolve?
• **<u>General</u>**, position-dependent **<u>parameterised models</u>**	• Development of more general, parameterised models may be needed to address non-isoplanatism at the level of SKA calibration and imaging goals	• How much we should worry about this

[N] Non-closing errors:

Short Description	Why is research required?	What might research resolve?
• **Non-closing errors**	• Non-closing errors may provide a ceiling to achievable SKA imaging dynamic range, and this is beneath the target SKA requirements	• How much we should worry about this

[O] ‘Estimation noise’:

Short Description	Why is research required?	What might research resolve?
• <u>**‘Estimation noise’**</u> restricts achievable dynamic range	• Estimation noise is the contribution to the noise floor caused by the fact that estimation of calibration parameters extracts information from the data that can no longer be used to reconstruct the source image • At some point, too much information is lost to calibration to achieve the desired dynamic range • May provide a ceiling to achievable SKA imaging dynamic range, and this is beneath the target SKA requirements	• How much we should worry about this

[P] Time-varying Direction Dependent Effects:

Short Description	Why is research required?	What might research resolve?
• Inability to deal with **Time-varying Direction Dependent Effects** (TDDEs)	• Current imaging software may not be able to address TDDEs • May provide a ceiling to achievable SKA imaging dynamic range, and this is beneath the target SKA requirements	• How much we should worry about this

[Q] Fundamental limits:

Short Description	Why is research required?	What might research resolve?

• Some things can never be "calibrated away"	• Carozzi's Intrinsic Cross Polarisation (IXR) ratio characterizes polarimetric calibratability
	• Analogous IXR for full RIME under development
	  • "Bad telescope design can never be replaced by clever software"
	  • "Computational muscle is not the end all of CalIm: it's applying it where/when it makes a difference"
	• May provide a ceiling to achievable SKA imaging dynamic range, and this is beneath the target SKA requirements
		• How much we should worry about this

CALIM 2011 workshop suggestions:

Short Description	Why is research required?
• Deconvolution algorithms and errors [can be done "soon"]	• Represents a significant proportion of processing load which may limit scalability to SKA • Limits imaging fidelity
• Imaging quality for extended sources [can be done "soon"]	• Currently a difficult question to answer, for example what is required to observe Epoch of Reionisation • Need some experiences from precursors and pathfinders
• Mitigating antenna sidelobes [can be done "soon"]	• In addition, "how well do we know the primary beam" – required to achieve the dynamic ranges SKA aspires to • ASKAP will experiment with switching sky de-rotation on and off
• Focus on system performance	• We don't really know "how to get from A to B" in terms of modelling integrated system performance
• Hardware-software tradeoffs	• We already know that high frequencies put tighter constraints on antenna design (e.g. ALMA) • An antenna designed for high frequencies should work better at lower frequencies
• Error budget	• For example system level error budget engineering typically done for optical systems, e.g. for LSST • ALMA project carried out an error budget analysis – but it wasn't integrated end to end, and it should have been done earlier
• Fundamental limits	• Fundamental limits are intrinsically "hard limits"; as opposed to ... • Computational challenges – potentially can be overcome with time, technology and algorithm development
• Precise definitions of metrics	• For example image fidelity, various measures of polarisation purity – needs to be done earlier rather than later • DRM really needs a lot more work to define exactly what the criteria for engineering design should be • Verification criteria should be incorporated in the definitions
• IXR (Intrinsic Cross Polarization) metric and extensions	• Polarisation requirements could easily be got wrong – SKA_1 polarisation purity metric was "plucked out of the air" • An example of both precise definition of a metric and highlighting fundamental limits to imaging fidelity
• ALMA definition of image fidelity	• Various confusing definitions currently in use; rather than "Dynamic Range" perhaps better to use "Effective Noise" • ALMA struggling with how to make its "image fidelity" metric testable – ALMA's work could be shared
• More spectral line cases	• Realisation that SKA_1 as currently defined in DRM 1.3 is not an HI telescope – an original motivator for the SKA

Challenges (complications) of your choice:

Short Description	Why is research required?	What might research resolve?

Even more challenges / complications
Scale: correlator output data rates

DRM Chapter	Correlator Output for AA-Low (minimum dump time)	Correlator Output for Dishes (minimum dump time)
2. EoR	23 Gbits per second	-
3. Galaxy Evolution	450 Gbits per second	2,900 Gbits per second
4. EoR Forest	11,000 Gbits per second	-

DRM Chapter	Correlator Output for AA-Low (baseline dependent dump time)	Correlator Output for Dishes (baseline dependent dump time)
2. EoR	5 Gbits per second	-
3. Galaxy Evolution	100 Gbits per second	580 Gbits per second
4. EoR Forest	2,400 Gbits per second	-

Source: W. Turner: note WIP

Scale complications: *O*[4 Byte float correlator output]:

DRM Chapter	Correlator Output for AA-Low (minimum dump time)	Correlator Output for Dishes (minimum dump time)
2. EoR	1×10^{9} per second	-
3. Galaxy Evolution	1×10^{10} per second	1×10^{11} per second
4. EoR Forest	3×10^{11} per second	-

DRM Chapter	Correlator Output for AA-Low (baseline dependent dump time)	Correlator Output for Dishes (baseline dependent dump time)
2. EoR	1×10^{8} per second	-
3. Galaxy Evolution	3×10^{9} per second	2×10^{10} per second
4. EoR Forest	1×10^{11} per second	-

Source: W. Turner: note WIP

Scale complications:

$10^5 \sim 10^6$ operations / [4 Byte float]:

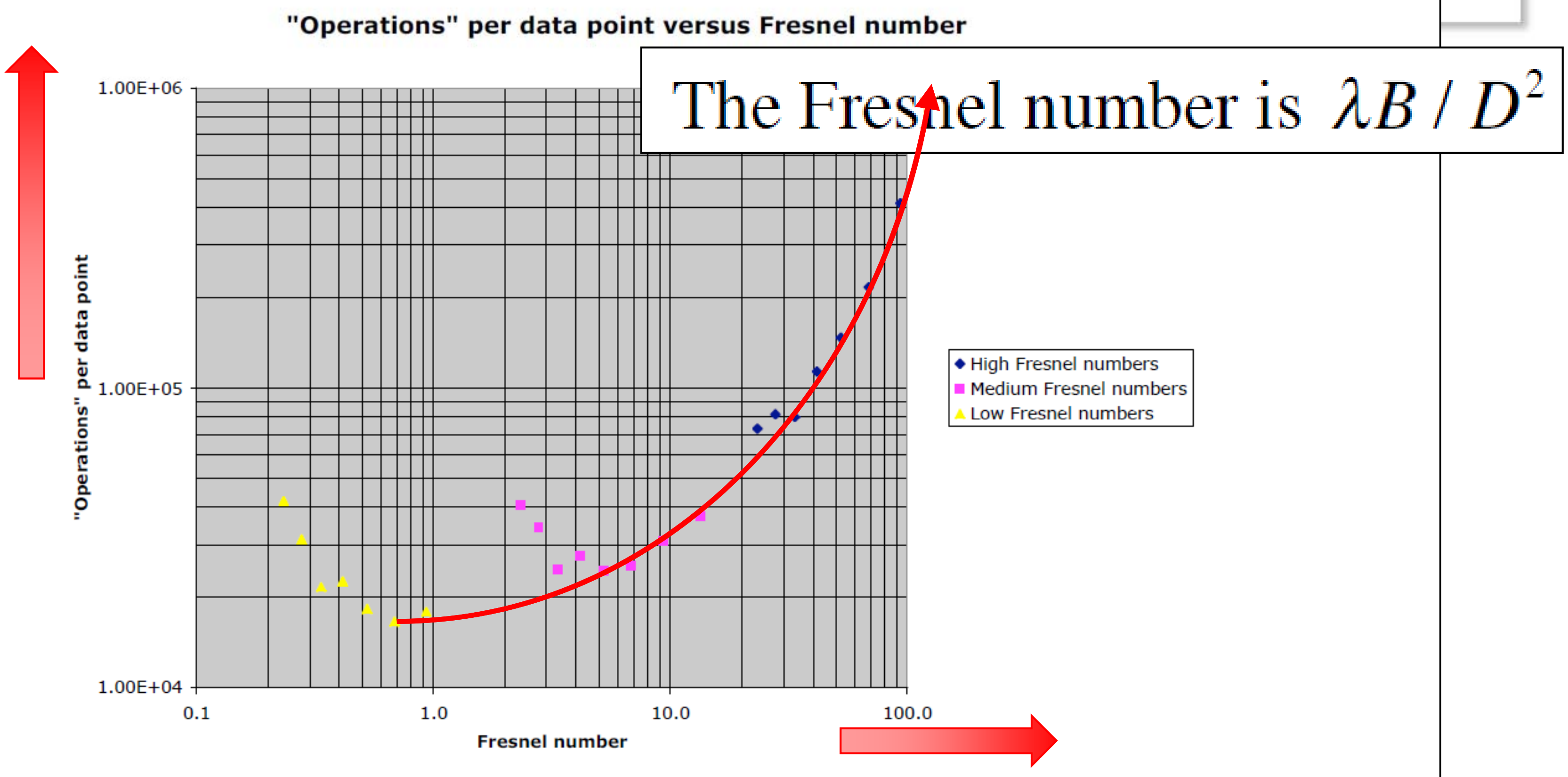


Figure 4 Operations per data point versus Fresnel number, calculated by scaling time by clock frequency, dividing by number of data points. The left end of each curve is biased upwards by constant cost terms.

Source: Tim Cornwell; EVLA Memo 77

Scale complications: O[floating point operations per sec]:

DRM Chapter	Required flops for AA-Low (minimum dump time)	Required flops for Dishes (minimum dump time)
2. EoR	1 x $10^{14\sim16+}$ flops	-
3. Galaxy Evolution	1 x $10^{15\sim17+}$ flops	1 x $10^{16\sim18+}$ flops
4. EoR Forest	3 x $10^{16\sim18+}$ flops	-

DRM Chapter	Required flops for AA-Low (baseline dependent dump time)	Required flops for Dishes (baseline dependent dump time)
2. EoR	1 x $10^{13\sim15+}$ flops	-
3. Galaxy Evolution	3 x $10^{14\sim16+}$ flops	2 x $10^{15\sim17+}$ flops
4. EoR Forest	1 x $10^{16\sim18+}$ flops	-

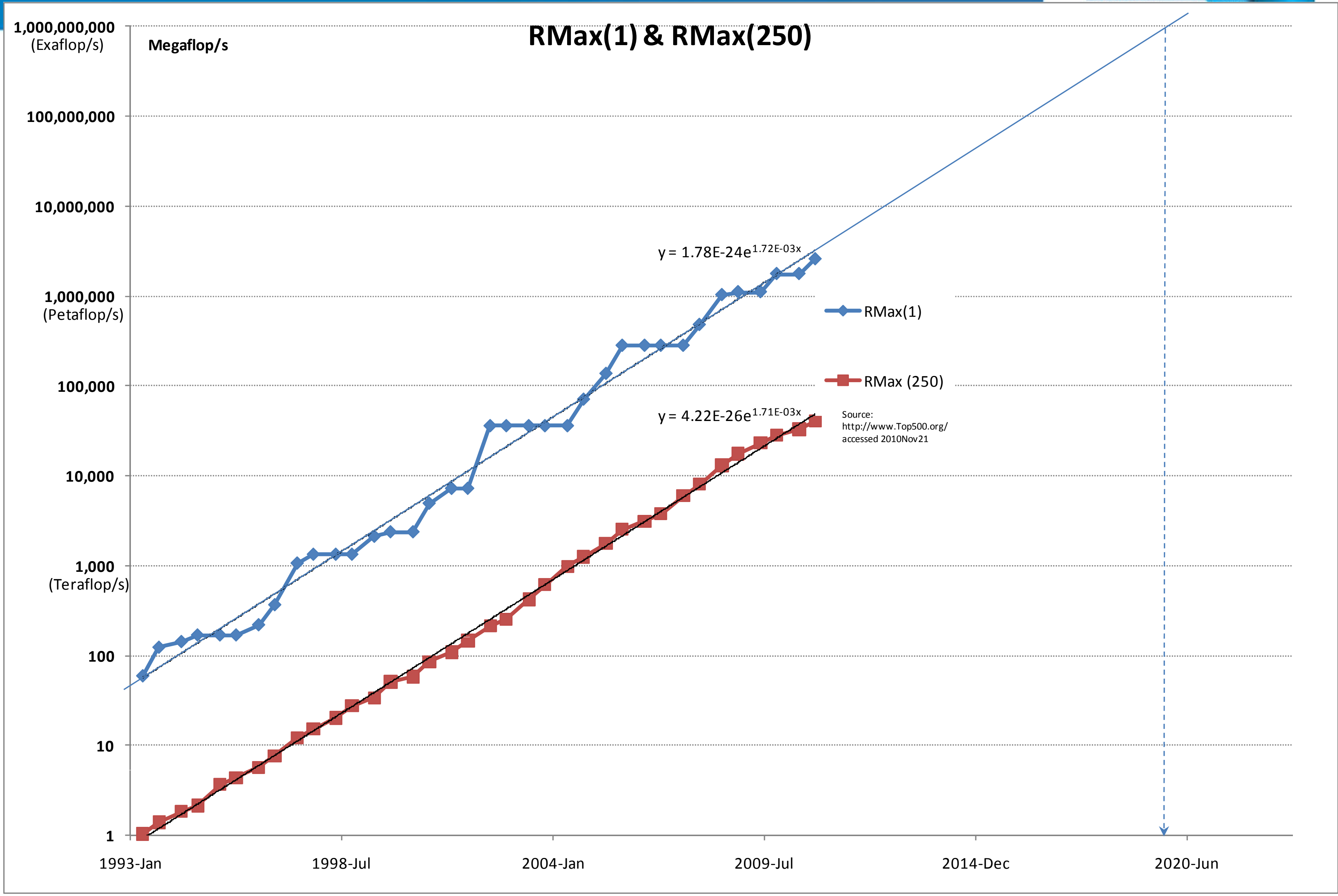
Source: W. Turner: note WIP

Scale complications:
Image cube output data rates:

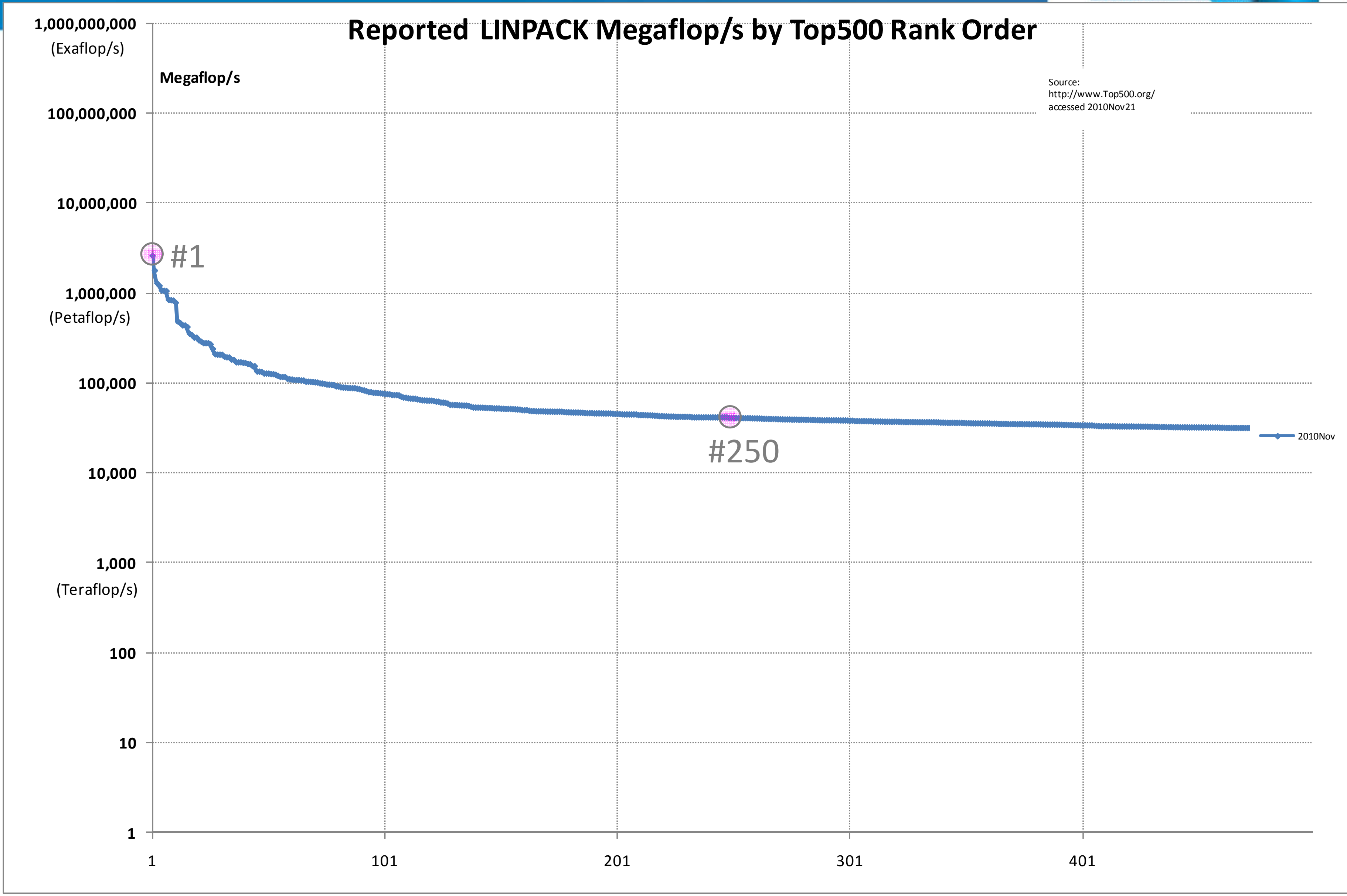
Image Integration Time	*AA-Low Full Image Cube Size* **AA-Low Image Cube Output Rate**	*Dish Full Image Cube Size* **Dish Image Output Rate**
	3 petaBytes	***213 teraBytes***
3,600 seconds (1 hour)	6,666 Gbits per second	474 Gbits per second
36,000 seconds (10 hours)	666 Gbits per second	47 Gbits per second
360,000 seconds (100 hours)	66 Gbits per second	5 Gbits per second
3,600,000 seconds (1,000 hours)	6 Gbits per second	1 Gbits per second

Based on SKADS White Paper formulations

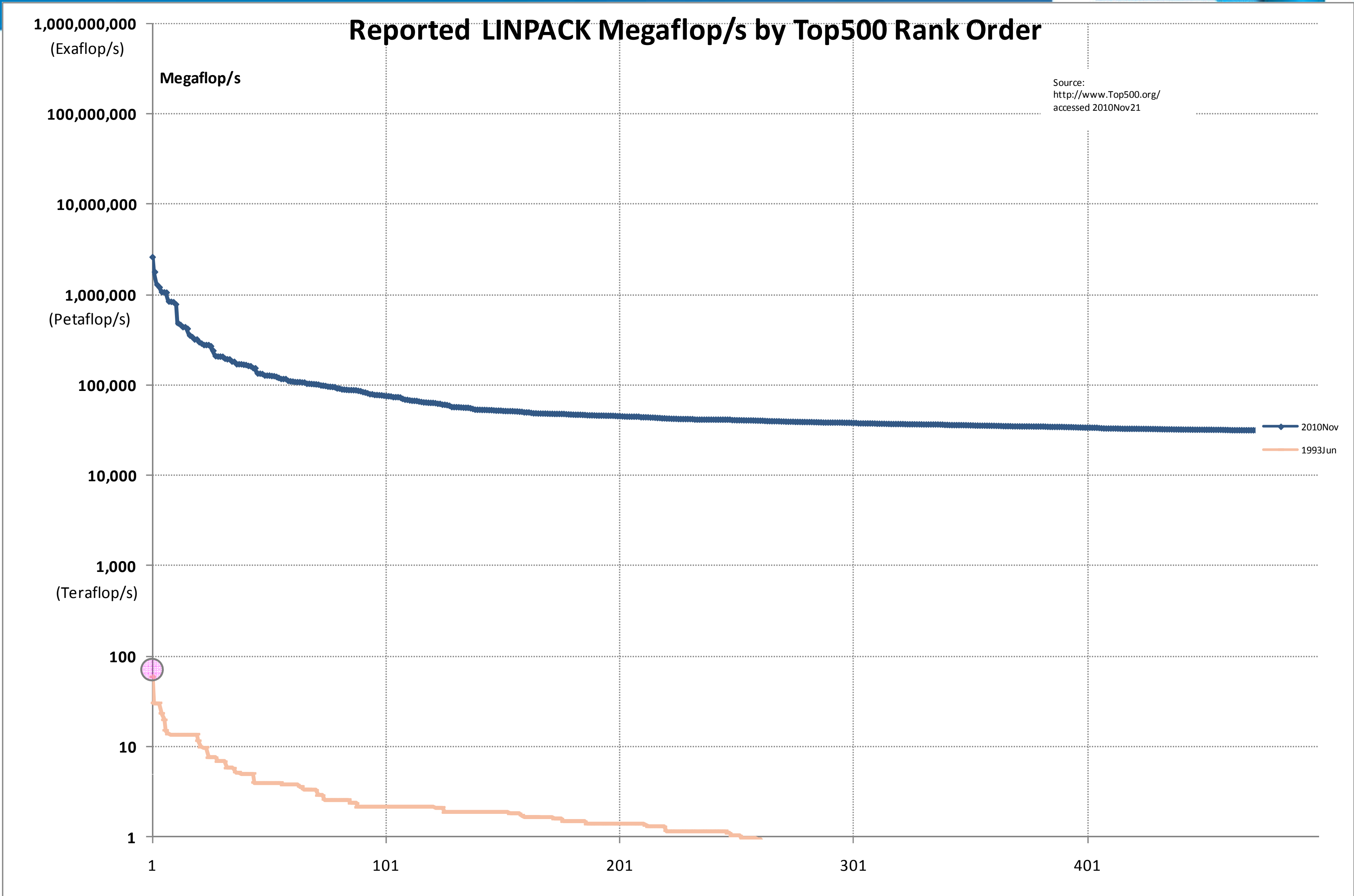
Number 1 & Number 250 in the Top500:



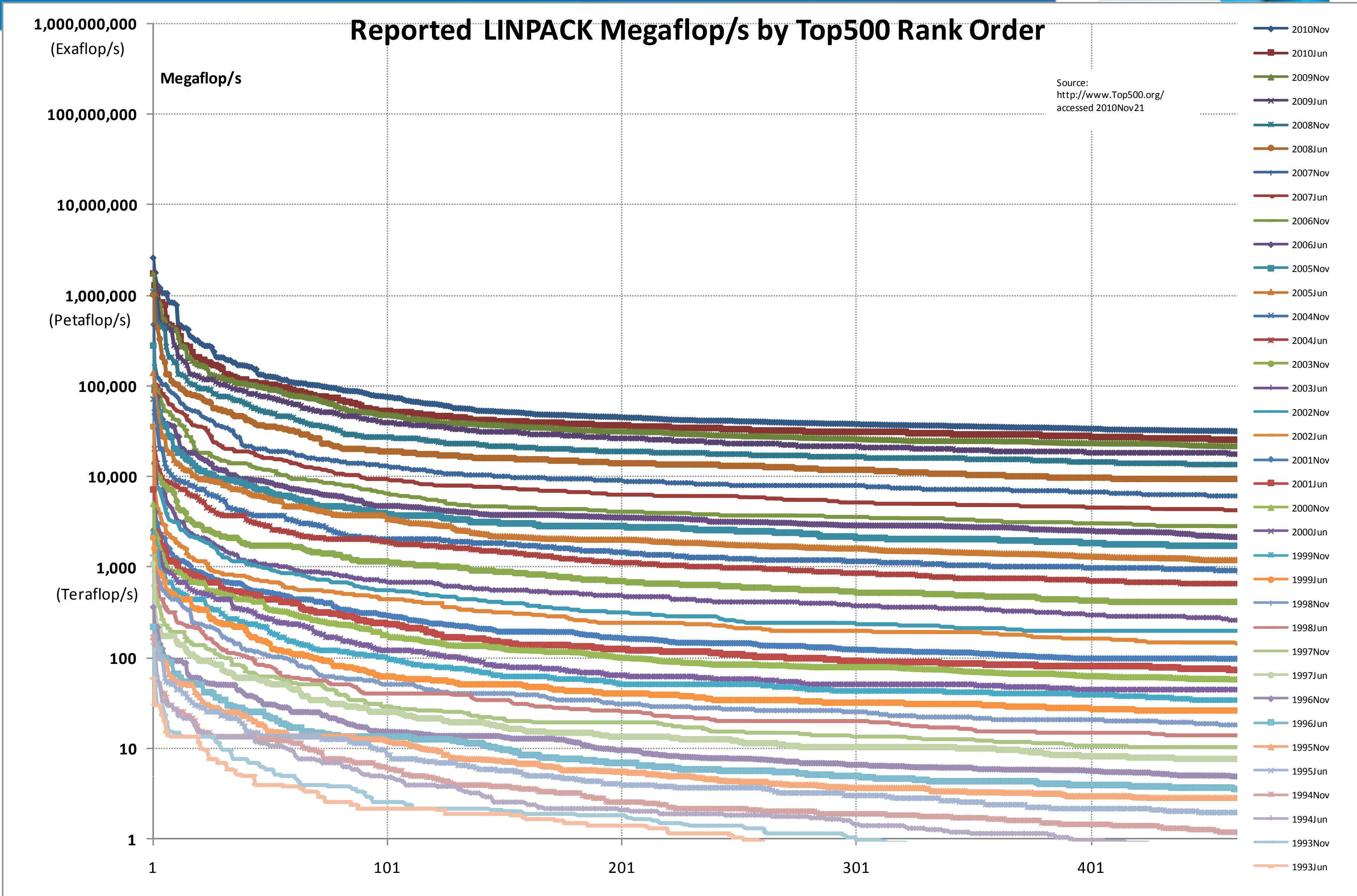
The 2010Nov Top500: decreasing capability



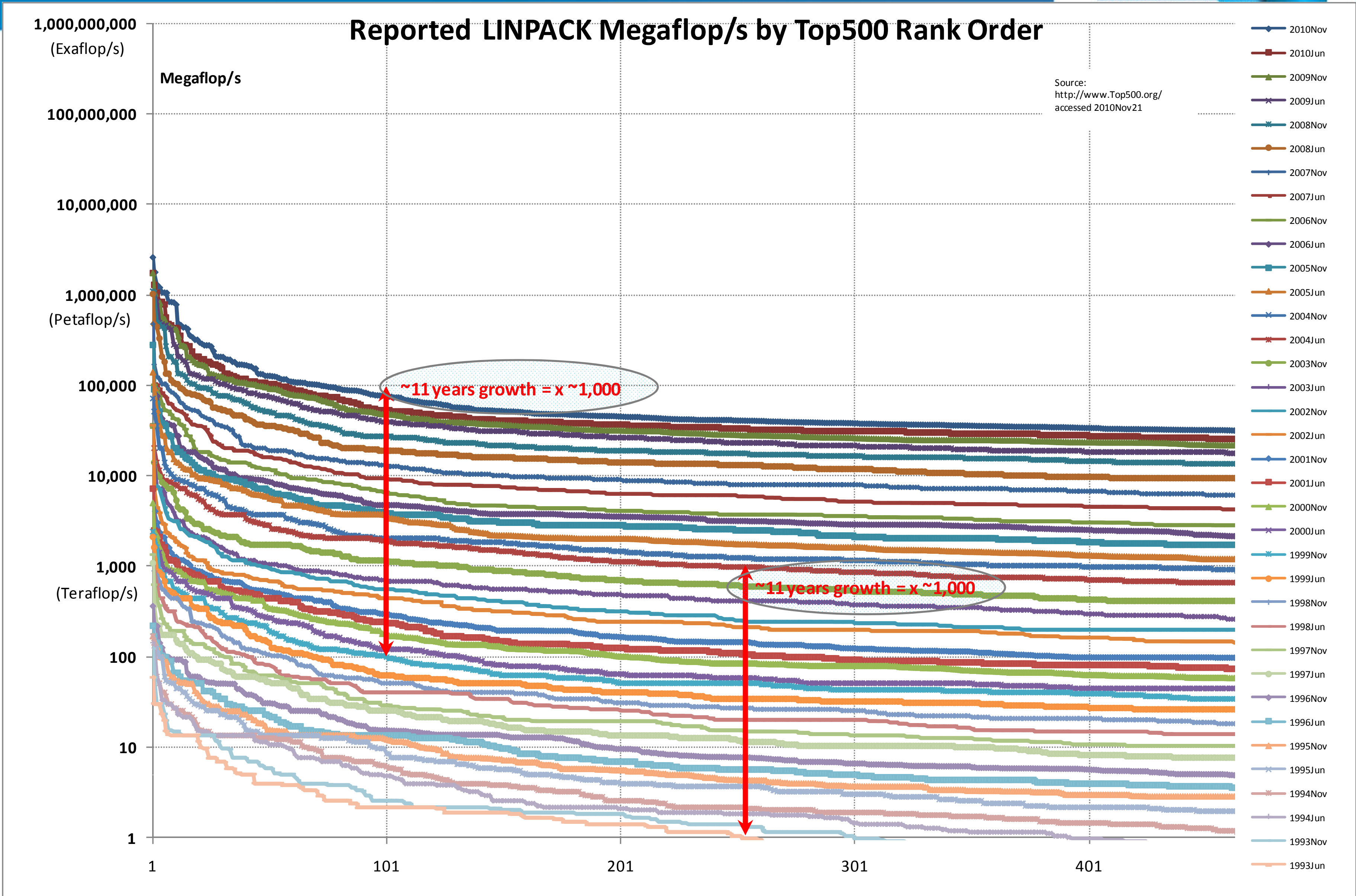
The Top500 18 years ago:



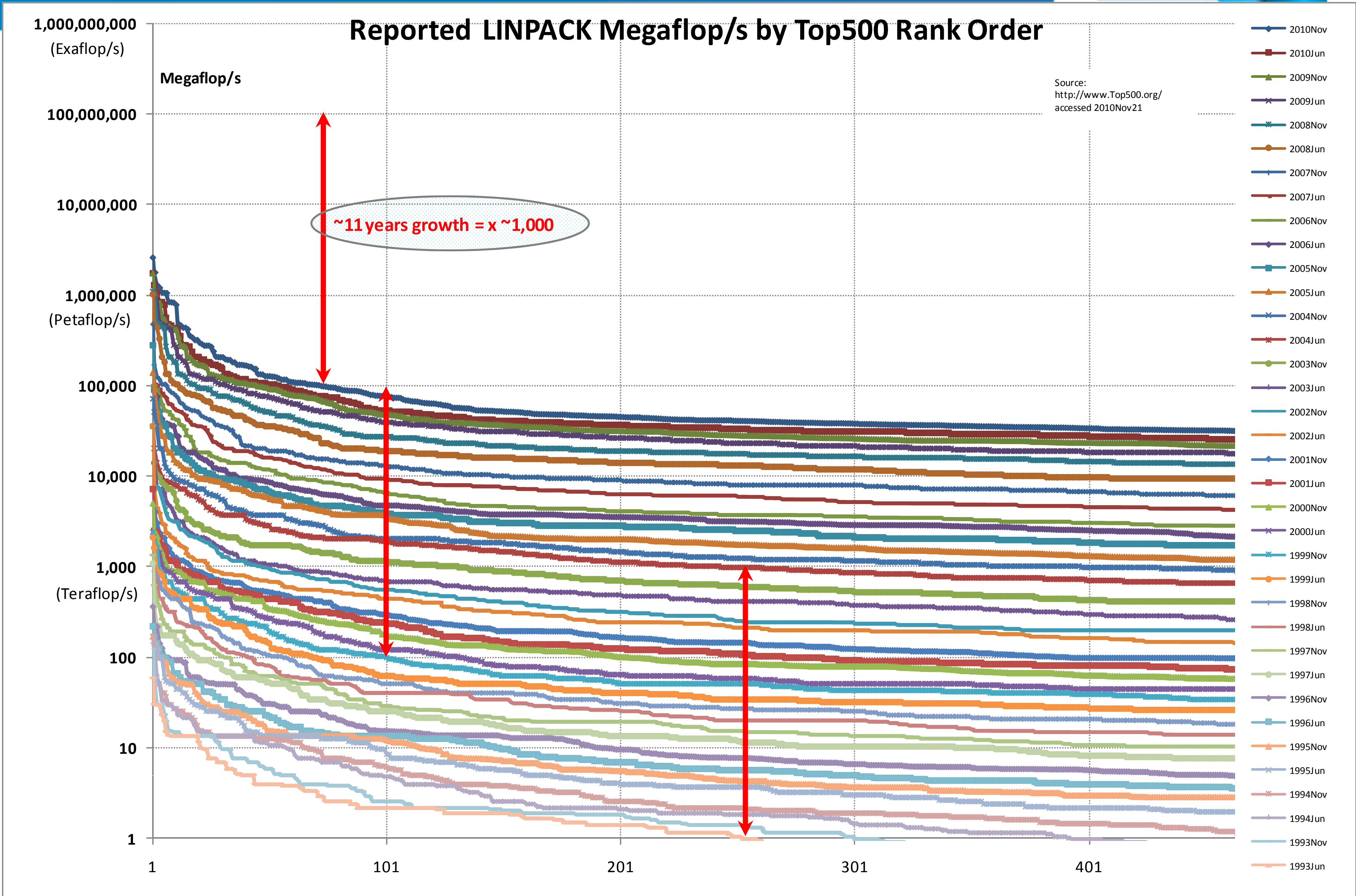
The Top500: an 18 year history



Top500: growth of about x1,000 in 11 years



In 2021 #75 may be ~100 Petaflop/s



<u>Over-riding complication</u>:
Poor cost estimation

Daily Mail

THURSDAY, SEPTEMBER 22, 2011 · www.dailymail.co.uk · 55p

Femail magazine STARTS PAGE 37

HOW PSYCHICS PREY ON THE BEREAVED

A TV illusionist exposes the tricks of the trade

SEE PAGE 15

£12BN NHS COMPUTER SYSTEM IS SCRAPPED

...and it's all YOUR money that Labour poured down the drain

EXCLUSIVE

By **Daniel Martin**
Whitehall Correspondent

MINISTERS are to axe Labour's disastrous £12billion NHS computer scheme.

The Coalition will today announce it is putting a halt to years of scandalous waste of taxpayers' money on a system that never worked.

It will cut its losses and 'urgently' dismantle the National Programme for IT – a monument to Whitehall folly during Labour's 13 years in power.

The biggest civilian IT project of its kind in the world, it has already squandered at least £12.7billion. Some estimates put the cost far higher.

Analysts say the sum would have paid the salaries of more than 60,000 nurses for a decade.

The announcement follows strong criticism from MPs who accused Labour of wasting a further £500million of taxpayers' money on a failed bid to set up a network of regional Fire Brigade control centres.

And it comes as Chancellor George Osborne was warned he faces a £12billion black hole in his deficit reduction plan – the same amount as that lost to the NHS scheme.

Following an official review, the 'one size fits all' IT project will be replaced by much cheaper regional initiatives, with hospitals and GPs choosing the IT system they need.

And a new national watchdog will be established to ensure such huge

Turn to Page 6

Nick Clegg's wife Miriam at the Lib Dem conference

Miriam steals the show in £46 Topshop frock

SEE PAGES 8-9

Over-riding complication:
Agencies seek to limit delivery risks

Need to deliver to funding agencies a:

- Credible,
- Traceable, and
- Robust

estimate of costs and benefits

Question:
Are 3GC outcomes useful *PoCs* ?

Can we deliver to funding agencies a:

- Credible,
- Traceable, and
- Robust

estimate of costs and benefits based on:

- ***Proofs of Concept***
- ***Closely analogous demonstrations ?***

Answer:

YES!

Proof:
Grady Booch on architectural simplicity

- "Simple architectures have conceptual integrity
- Architectures that are simple are better than those that are more complex
- A process of continuous architectural refactoring helps to converge a system to its practical and optimal simplicity"

Grady Booch, 2009: "The Defenestration of Superfluous Architectural Accoutrements", IBM Research presentation

Proof:
Implementing architectural simplicity

- "The fundamentals:
  - Define crisp abstractions
  - Employ a good separation of concerns
  - Have a balanced distribution of responsibilities
- Insofar as a system embraces these fundamentals, it is simple
- When and where it strains these fundamentals, it is complex"

Grady Booch, 2009: "The Defenestration of Superfluous Architectural Accoutrements", IBM Research presentation

Proof:
Identifying architectural complexity

- "Kent Beck
  - Code smells as a metaphor for identifying these points of stress
- Heinlein in *The Moon is a Harsh Mistress*
  - How does one design an electric motor? Would you attach a bathtub to it, simply because one was available? Would a bouquet of flowers help? A heap of rocks? No, you would use just those elements necessary to its purpose and make it no larger than needed – and you would incorporate safety factors. Function controls design.
- Simple architectures have conceptual integrity"

Grady Booch, 2009: "The Defenestration of Superfluous Architectural Accoutrements", IBM Research presentation

Proof: Measuring architectural complexity

- “Mass: calculated in SLOC
- Regularity: measured in patterns per view
- States:
  - Software-intensive system (as opposed to hardware): combinatorial explosion of states”

Grady Booch, 2009: “The Defenestration of Superfluous Architectural Accoutrements”, IBM Research presentation

Proof:
Planning for architectural simplicity

- "Simon:
  - Complex systems [should be] hierarchical
  - Complex systems [should be] decomposable
- Brooks:
  - Conceptual integrity is the most important consideration in system design
- Weinberg:
  - Unorganised complexity is the most wicked form of complexity"

Grady Booch, 2009: "The Defenestration of Superfluous Architectural Accoutrements", IBM Research presentation

Proof:
What happens to outmoded architectures?

"A thousand cuts:

- Collapse happens because of the accumulated weight of well-intentioned and reasonable local decisions that assemble over time at the expense of global optimization and simplicity

Nibble to death by ducks:

- You rarely see the end coming, until some factor pushes your fragile, complex system over the edge into collapse"

Grady Booch, 2009: "The Defenestration of Superfluous Architectural Accoutrements", IBM Research presentation

Proof:
Tony Willis, 2011-09-21:

How to quantitatively select between different SKA dish designs?

- At present - just a bunch of 'My dish is better than your dish' opinions
- We need a to provide a quantitative way to distinguish between dish designs
- Simulation can be an important part of this process. It can also help antenna designers refine their designs
- We should learn a lot about the beam pattern behaviour of various antennas at this workshop
- MeqTrees is as far as I know, the only data processing system which can eeasily 'observe' a sky model with a wide variety of potential beam patterns
  - We need to select a model sky (something from the SKADS mdel skies developed at Oxford?)
  - Select the various effects which will be included in the simulations besides the beam characteristics
  - Define the characteristics of the array which would be used for the simulated observations (maximum size, range of frequency, number of channels, number of dishes etc)
- Do simulations and provide feedback to the dish designers as they optimize designs.
- Produce a report where weighted evaluations are given to different designs

Call to action:
9 things you can do with old software:

- Give it away
- Ignore it
- Put it on life support
- Rewrite it
- Harvest from it
- Wrap it up
- Transform it
- Preserve it

Grady Booch, 2009: "The Defenestration of Superfluous Architectural Accoutrements", IBM Research presentation

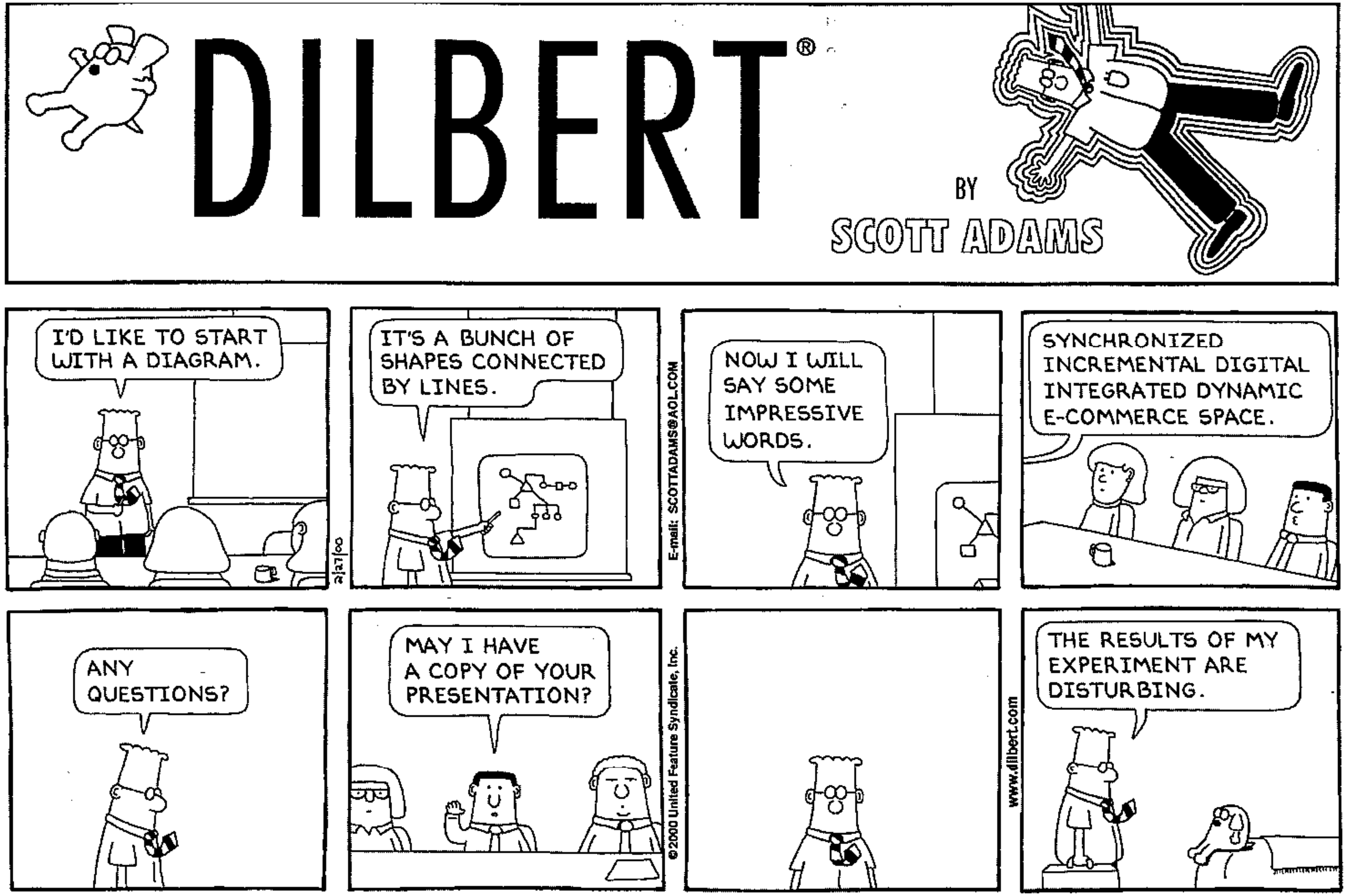
Call to action:
6 things you can do for new software:

- Nurture it through childhood and adolescence
- Use it to tackle real problems that others have had difficulties in addressing
- Build an enthusiastic user base
- Whenever possible, keep it platform agnostic
- Maintain internal architectural integrity
- Maintain user interface simplicity

There is a time to laugh,
and a time not to laugh:
and this is not one of them

Clouseau

More "PowerPoint" rhetoric – if you want it ...



Ignorance may be a strength:

Ignorance of the domain is thought by some to be helpful in software development activities that require some critical, out-of-the-box thinking.

An example is brainstorming for requirement-idea generation.

Ignorance of a domain is believed to help one to avoid the domain's tacit assumptions and to think outside of the domain's box.

The right kind of ignorance helps expose all the tacit assumptions that someone experienced in the domain takes for granted.

Who has not observed the phenomenon that the one who seems to know the least about a problem seems to come up with the best solutions in a brainstorming session?

This observation leads to the suggestion that there may be some software development activities that are aided by some degree of ignorance.

Gaurav Mehrotra, 2011: "Role of Domain Ignorance in Software Development", Master's Thesis, University of Waterloo