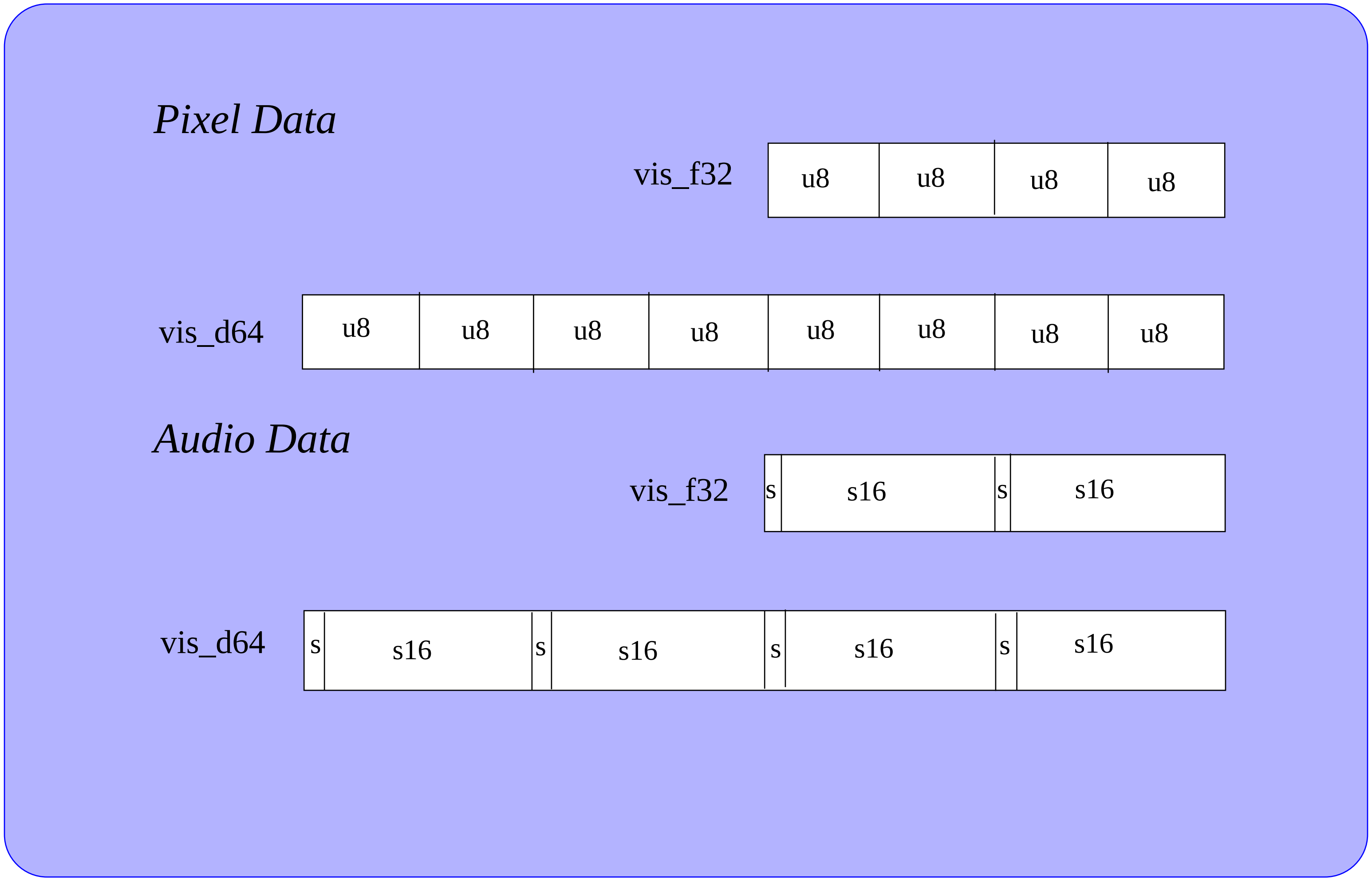
VIS data formats



Performance Results

With no fixed-point scaling

With scaling: 2.0

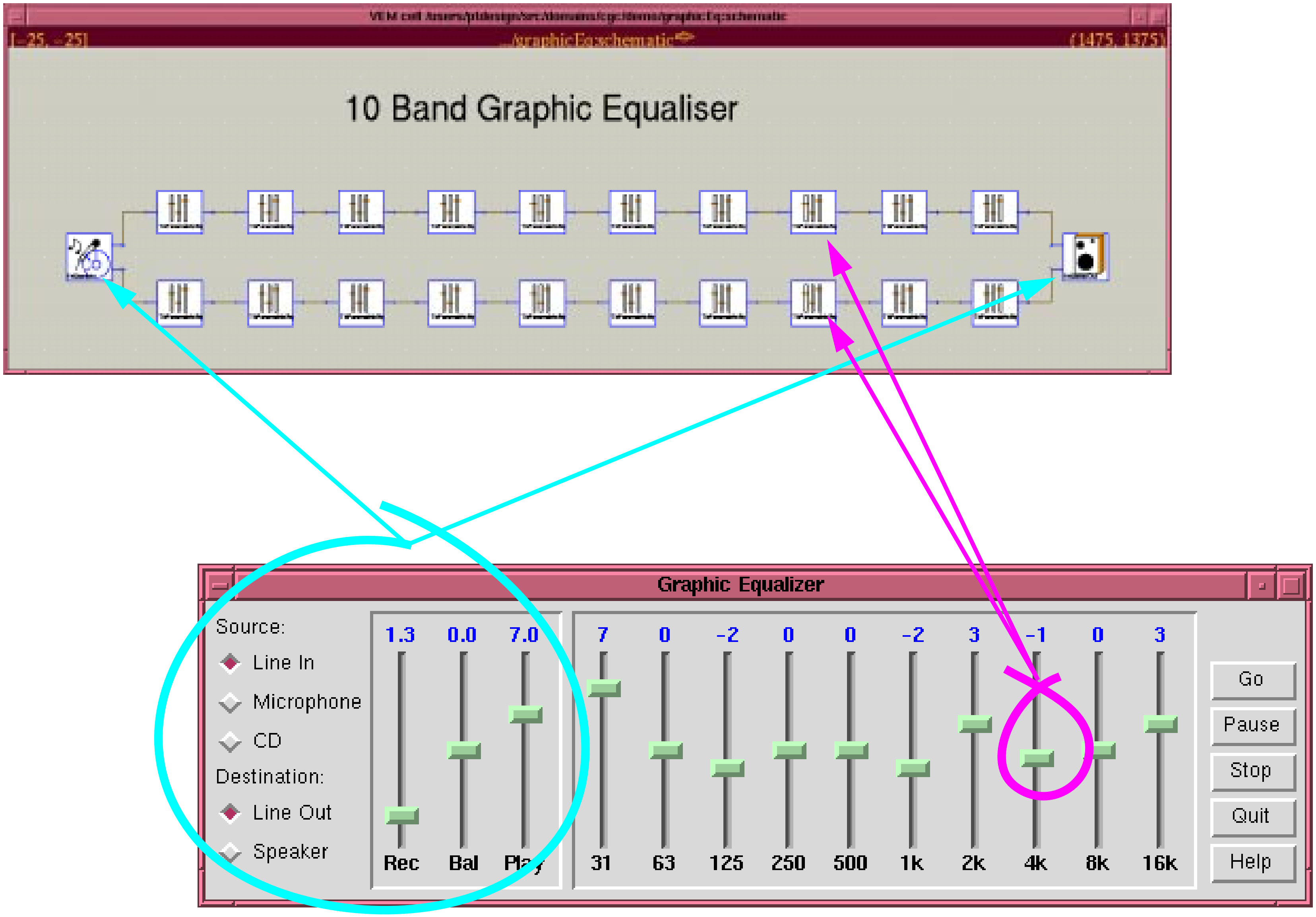
Realistic comparison

Kernels	VIS/Float	VIS/Integer
FIR	3.43	6.33
FFT	1.28	N/A
Biquad	0.99	2.76

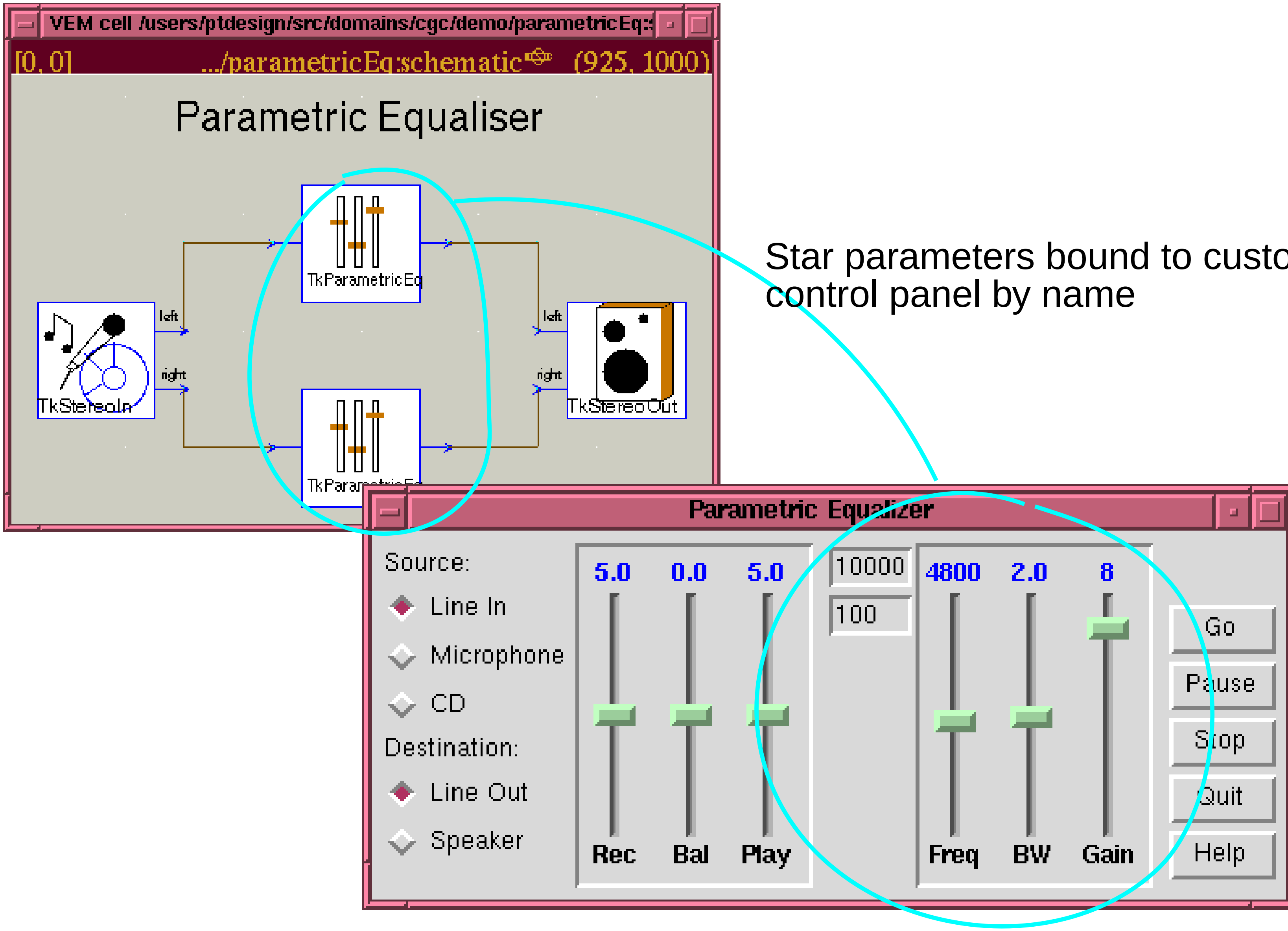
Marginal improvement

Recursive algorithm prevents parallelism

Graphic equalizer in Ptolemy



Parametric equalizer in Ptolemy



Star parameters bound to custom control panel by name

Closed-form biquadratic filter

Analog Bandpass Filter

$$H(s) = \frac{s^2 + \frac{s\omega_C}{Q_Z} + \omega_C{}^2}{s^2 + \frac{s\omega_C}{Q_P} + \omega_C{}^2}$$

$$Q_P = \frac{\sqrt{k}\,\omega_C\omega_1}{\omega_C{}^2 - \omega_1{}^2}$$

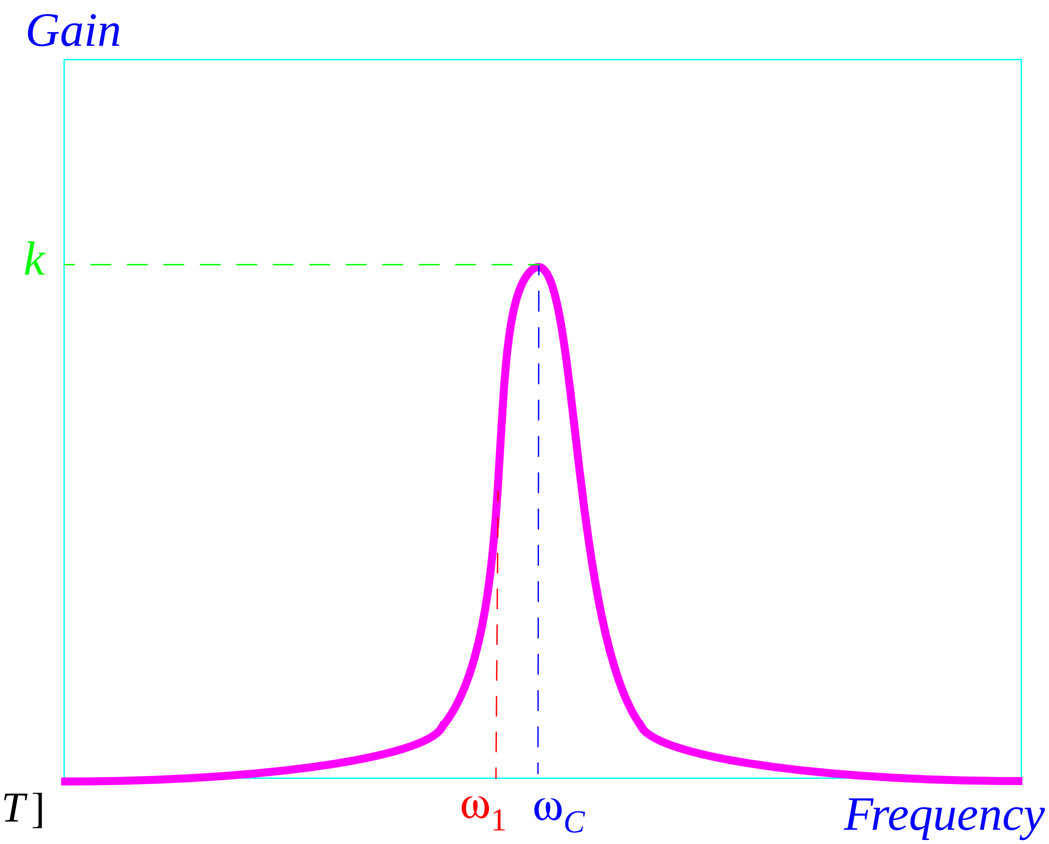
$$Q_Z = \frac{Q_P}{k}$$

Digital Bandpass Filter

$$a2 = Q_P[Q_Z(4 + \omega_C{}^2 T^2) + 2\omega_C T]$$

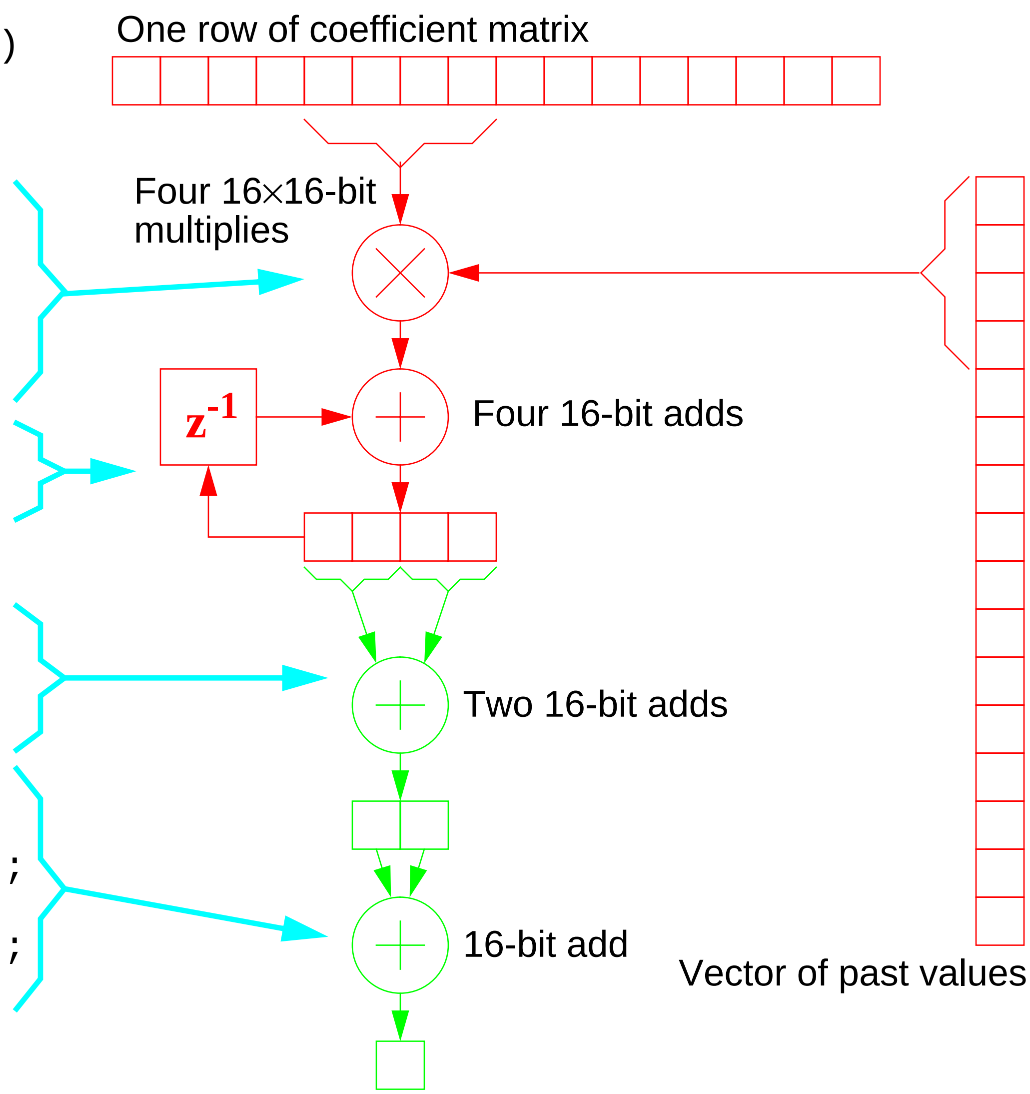
$$a1 = \frac{Q_P Q_Z(-4 + \omega_C{}^2 T^2)}{a2}$$

$\ldots$



FIR filter code

```
for (outerloop = 0;
     outerloop < n; outerloop++)
{
  data = src[nminusk];
  tapvalue = *tapptr0++;
  pairhi = vis_fmul8sux16(data,
                  tapvalue);
  pairlo = vis_fmul8ulx16(data,
                  tapvalue);
  pair = vis_fpadd16(pairhi,
                  pairlo);
  accum0 = vis_fpadd16(accum0,
                  pair);
  ...
}
splithi = vis_read_hi(accum0);
splitlo = vis_read_lo(accum0);
split = vis_fpadd16s(splithi,
                  splitlo);
accum0u = *((vis_u32*) &split);
splithihi = (short)
              ((accum0u>>16));
splitlolo = (short)
             (accum0u&0xffff);
y11 = splithihi + splitlolo;
...
```



FIR filter formulation

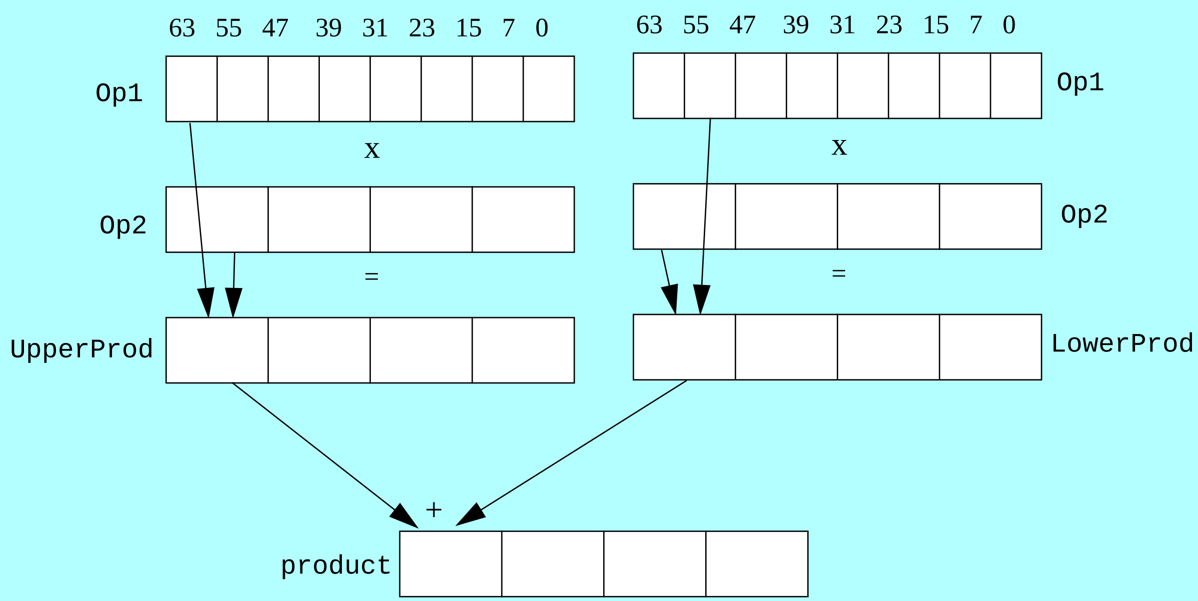
$$y[n] = \sum_{k=0}^{n} h[k]x[n-k]$$

$$\Downarrow$$

$$\begin{bmatrix} y[11] \\ y[10] \\ y[9] \\ y[8] \end{bmatrix} = \begin{bmatrix} h[0] & h[1] & h[2] & h[3] & h[4] & h[5] & h[6] & h[7] & h[8] & h[9] & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & h[0] & h[1] & h[2] & h[3] & h[4] & h[5] & h[6] & h[7] & h[8] & h[9] & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & h[0] & h[1] & h[2] & h[3] & h[4] & h[5] & h[6] & h[7] & h[8] & h[9] & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & h[0] & h[1] & h[2] & h[3] & h[4] & h[5] & h[6] & h[7] & h[8] & h[9] & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} x[11] \\ x[10] \\ x[9] \\ x[8] \\ x[7] \\ x[6] \\ x[5] \\ x[4] \\ x[3] \\ x[2] \\ x[1] \\ x[0] \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

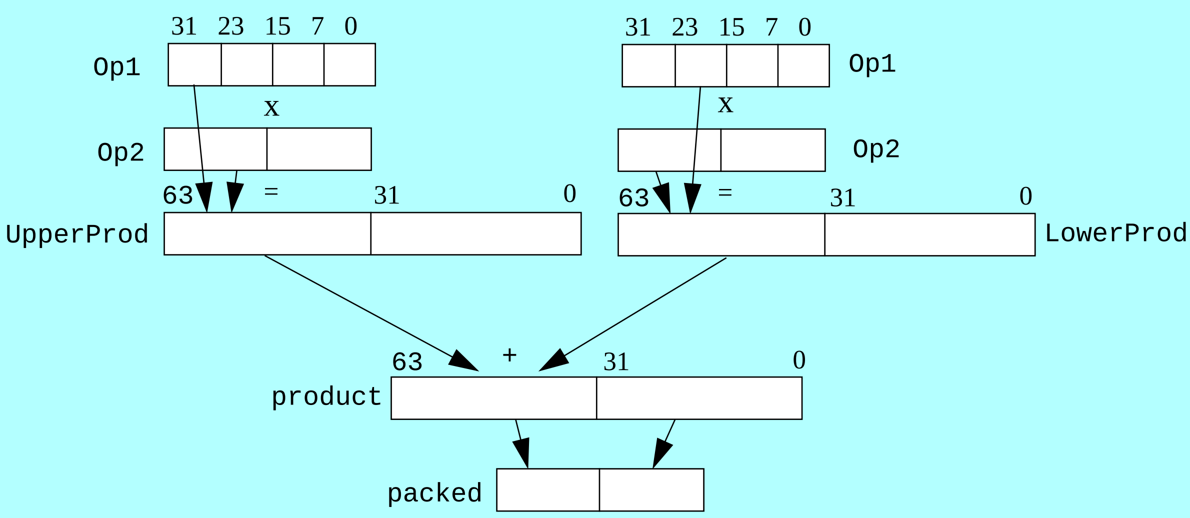
Parallel multiply, 4 x 16-bit

```
vis_d64 Op1, Op2, product;
vis_d64 UpperProd, LowerProd;
LowerProd = vis_fpmul8ul16(Op1,Op2);
UpperProd = vis_fpmul8sux16(Op1,Op2);
product = vis_fpadd16(LowerProd,UpperProd);
```



Parallel multiply: 2 x 16-bit

```
vis_f32  Op1, Op2, packed;
vis_d64 UpperProd, LowerProd, product;
vis_write_gsr(1<<3);
LowerProd = vis_fpmuld8ul16(Op1,Op2);
UpperProd = vis_fpmuld8sux16(Op1,Op2);
product = vis_fpadd32(LowerProd,UpperProd);
packed = vis_fpack16(product);
```



VIS instructions

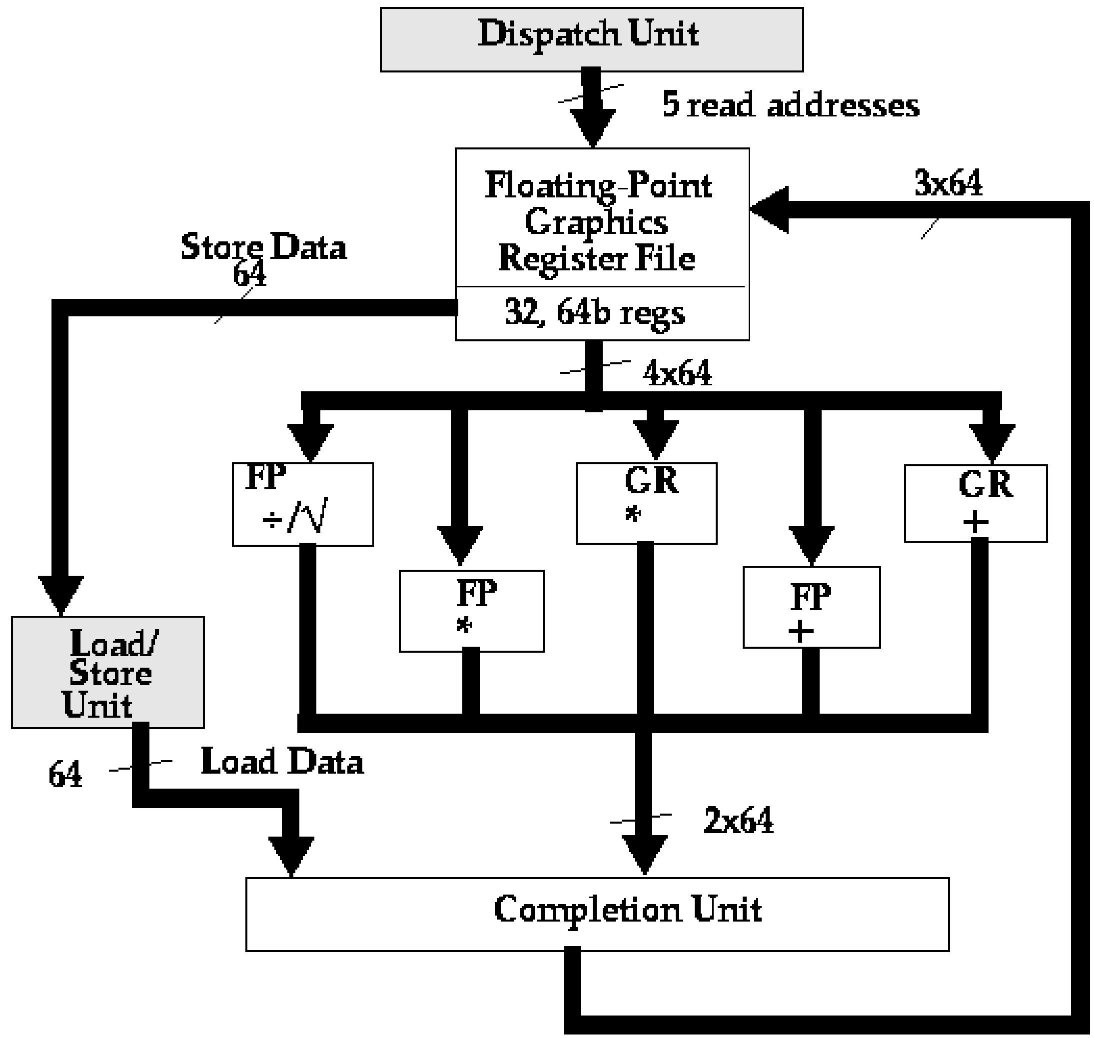
- ***VIS Utility Inlines***
  - **set gsr: vis_write_gsr(), vis_read_gsr()**
  - **manipulate vis_d64 register: vis_read_hi(), vis_read_lo(), vis_write_hi(), vis_write_lo()**

- ***VIS Arithmetic***
  - **add/subtract: vis_fpadd16(), vis_fpsub16**
  - **multiply: vis_fmul8sux16(), vis_fmul8ulx16()**

- ***VIS Data Formatting***
  - **load/store 16 bit data: vis_st_u16(), vis_ld_u16**
  - **memory alignment: vis_faligndata()**

VIS architecture

- **Four-instruction issue**
- **Two integer units, three FP units, two “graphics” units**



Issues

- **Other algorithms**

Native Signal Processing on the UltraSparc in the Ptolemy Environment

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