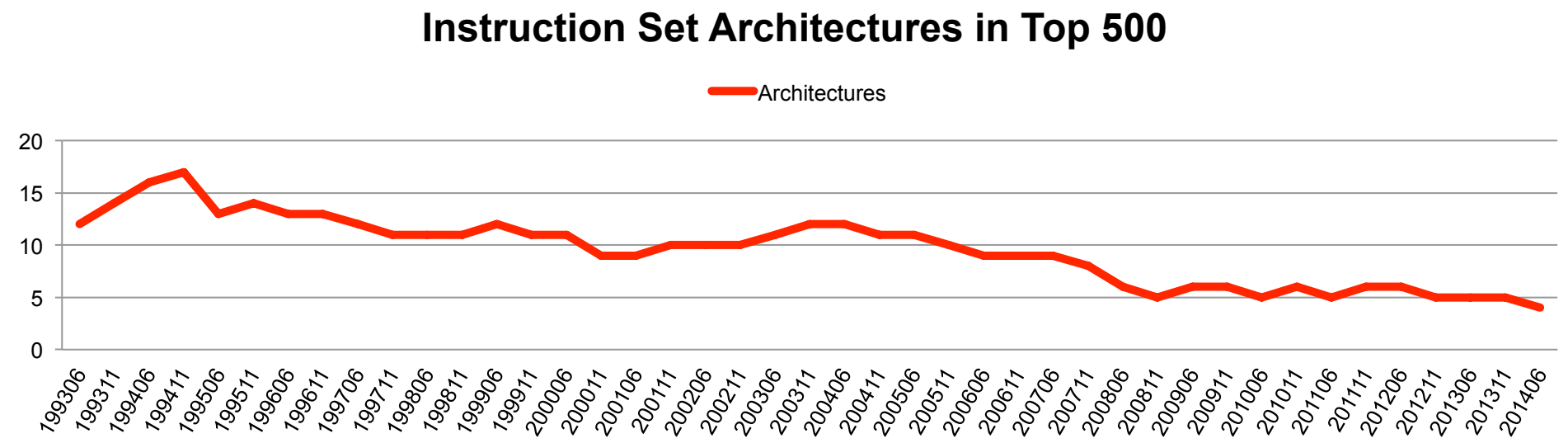
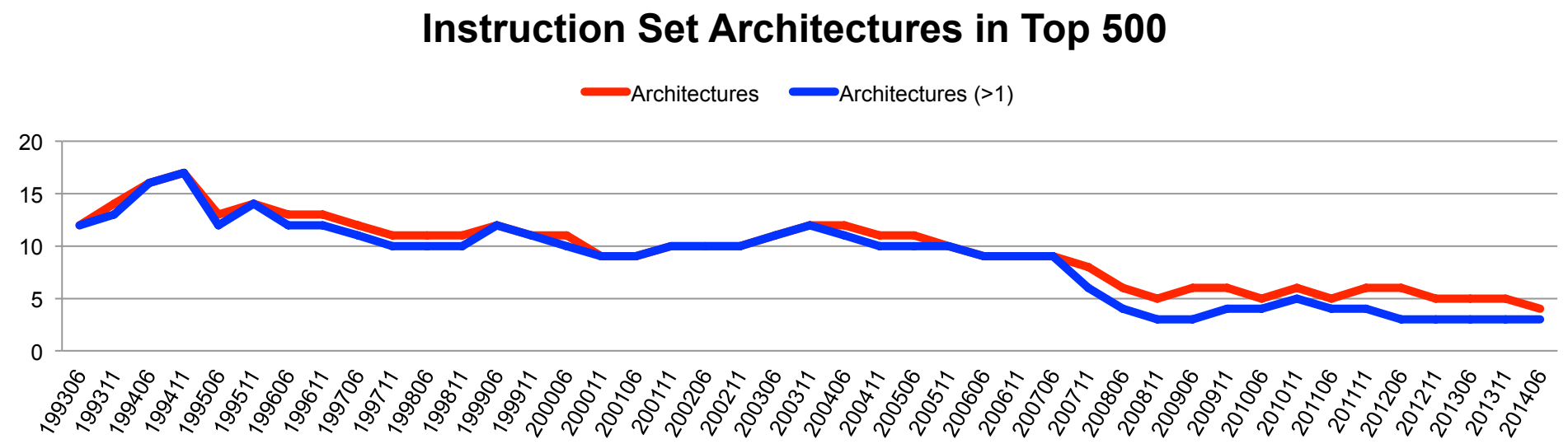
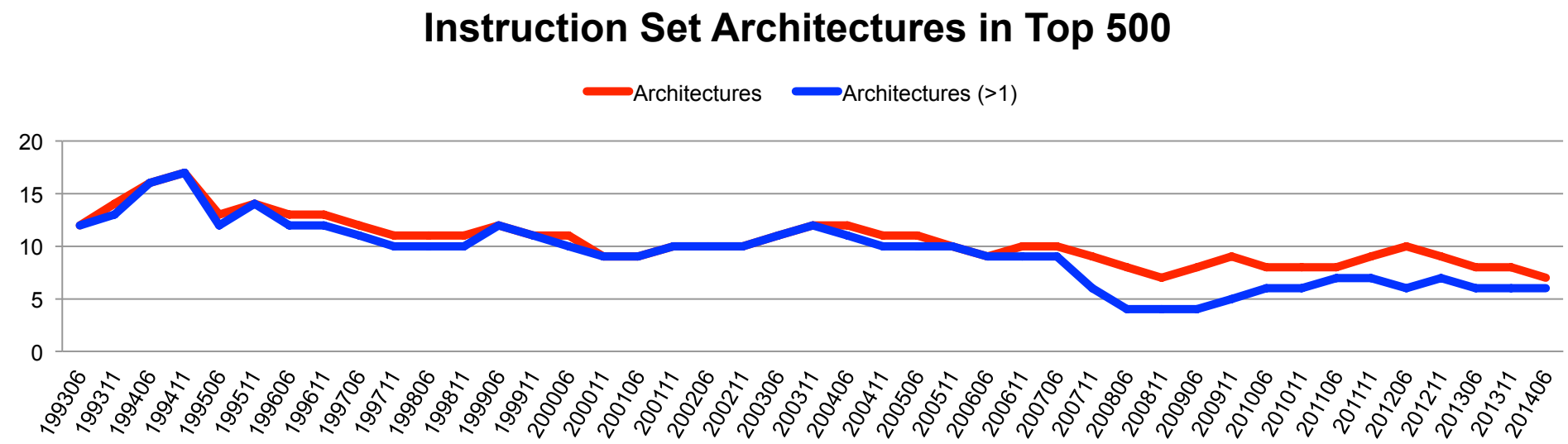
A Compiler Engineer's View of High Performance Technical Computing



Architectural Diversity



Architectural Diversity



Architectural Trends

- Vectors getting longer
- Multiprocessors getting larger
- Memory hierarchies getting deeper and more interesting
- Heterogeneity becoming common

Language Trends

- Fortran evolving; array operations, do concurrent, PGAS parallelism
- C and C++ each looking to add loop and task parallelism
- OpenACC parallelism across accelerators and multicore
- OpenMP task parallelism, simd parallelism, device constructs

metalanguages

```
      do 10 i = 1, len
10      y(i) = y(i) + a*x(i)
```

metalanguages

```
      subroutine daxpy( y, a, x, n )
       real y(*), x(*), a
       integer len, i
       do 10 i = 1, n
10      y(i) = y(i) + a*x(i)
      end
....
      call daxpy( y, a, x, len )
```

megalanguages

```
void daxpy( float* y, double a, float* x, int n ){
    for( int i=0; i<n; ++i )
        y[i] += a*x[i] ;
}

...

daxpy( y, a, x, len );  saxpy(); caxpy();...
```

metalanguages

```
forall( 0, len, [&](int i){
    y[i] += a*x[i] ;
} );
```

Compiler Challenges

- Effective parallelism management and exploitation
- Predictable performance (no surprises)
- Data management (cache, scratchpad, HBM)
- Heterogeneity (ISA, performance)
- More parallelism in language (Fortran, more to come)
- C++ keeps getting more interesting
- PEACE continues in force