VLBI Backends and Recorders

Perspectives and Projections

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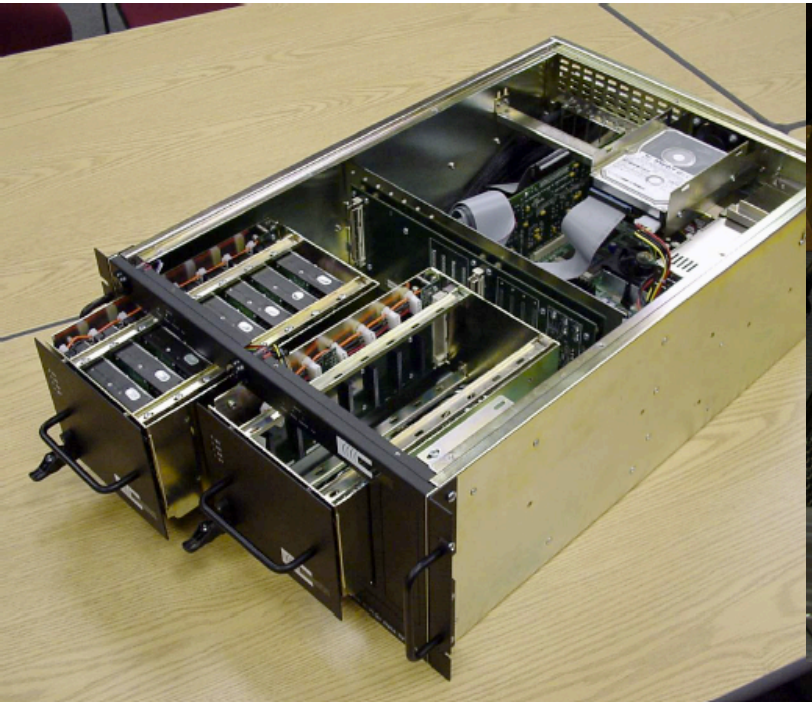
January 27, 2011

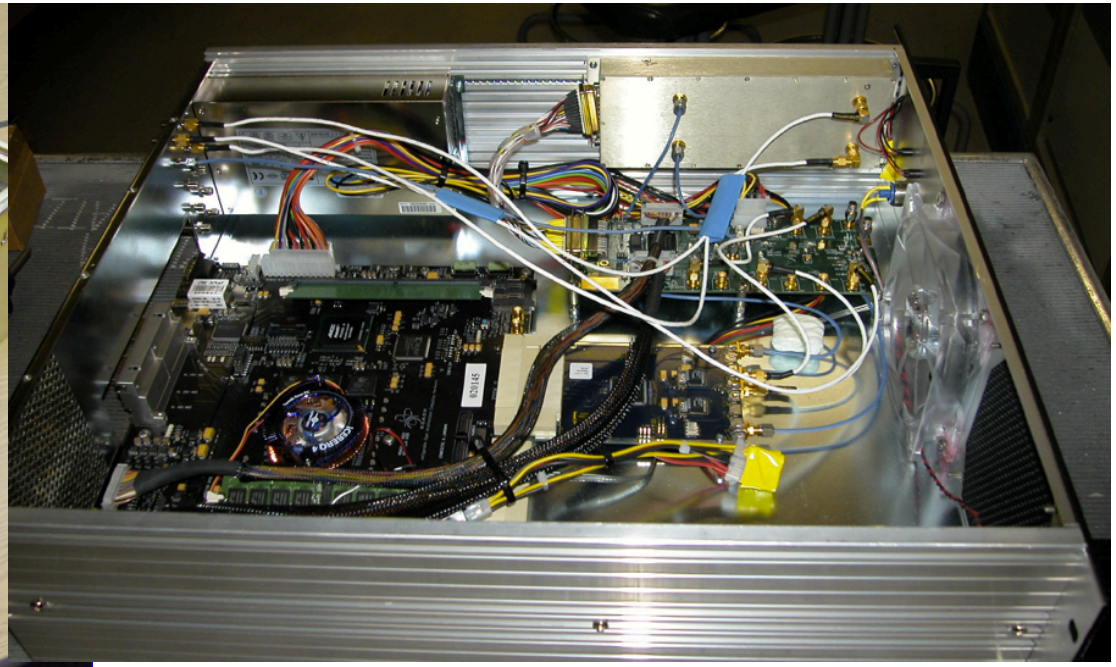
Where are we Headed?

- Briefly remind where we are now
  - RDBE, Mk5C etc
- The last 20+ years in VLBI-relevant technology
  - Milestones, trends, lessons learned
- The Future
  - The logical endpoint - when?
  - The drive to COTS
  - Compatibility and interoperability challenges

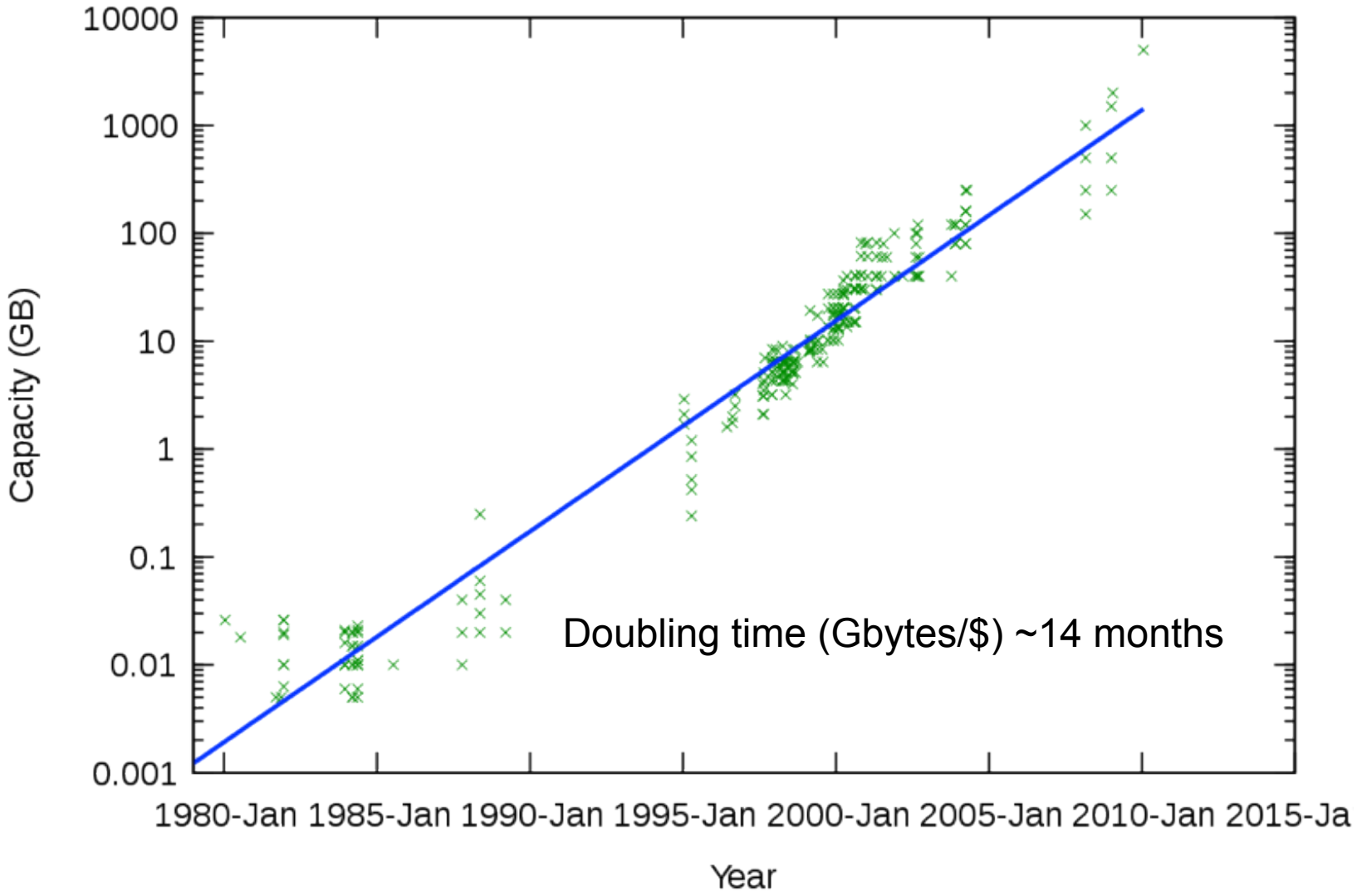
The not-too-distant past

Replaced by …

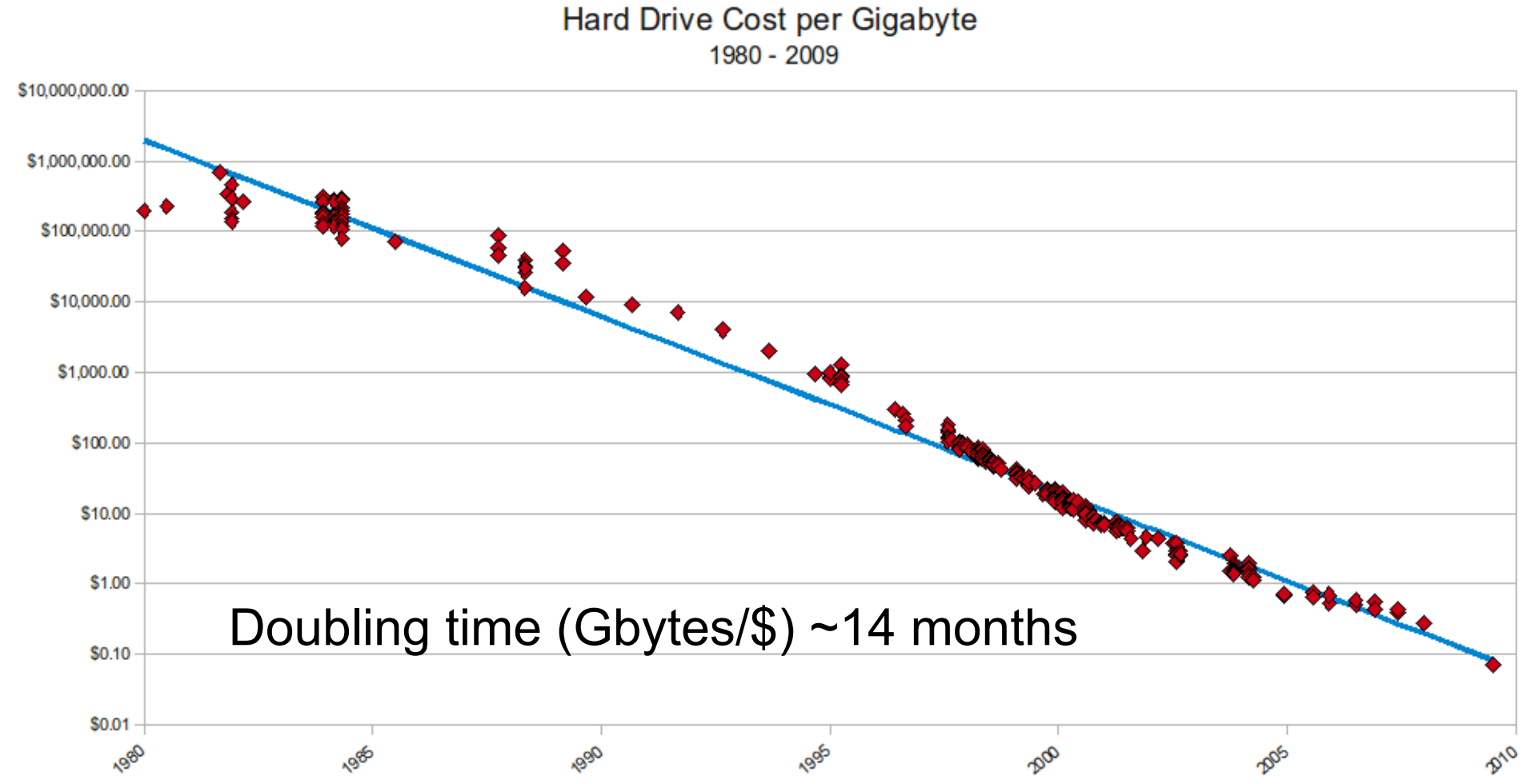




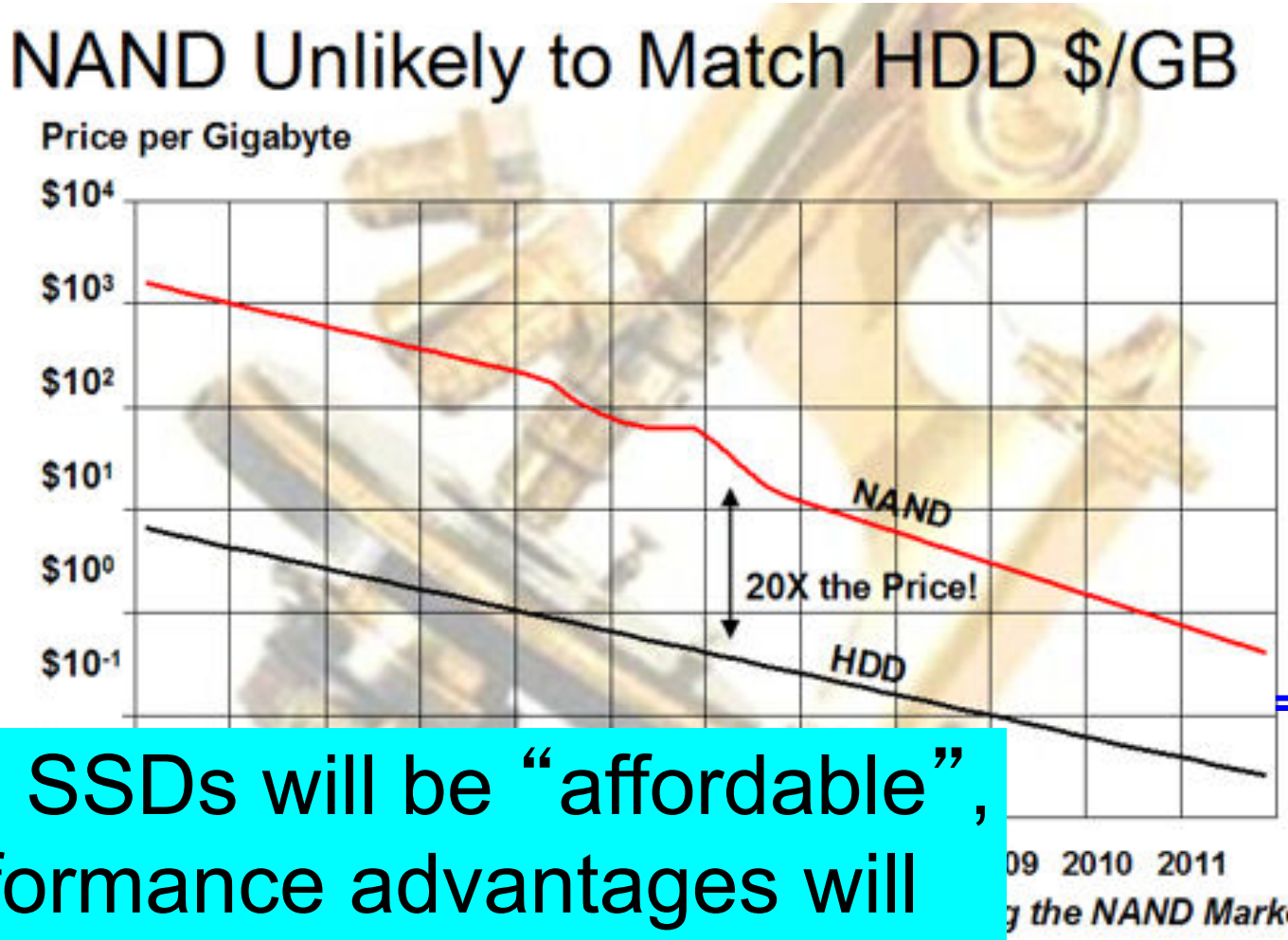
HDD Capacities



HDD Storage Cost



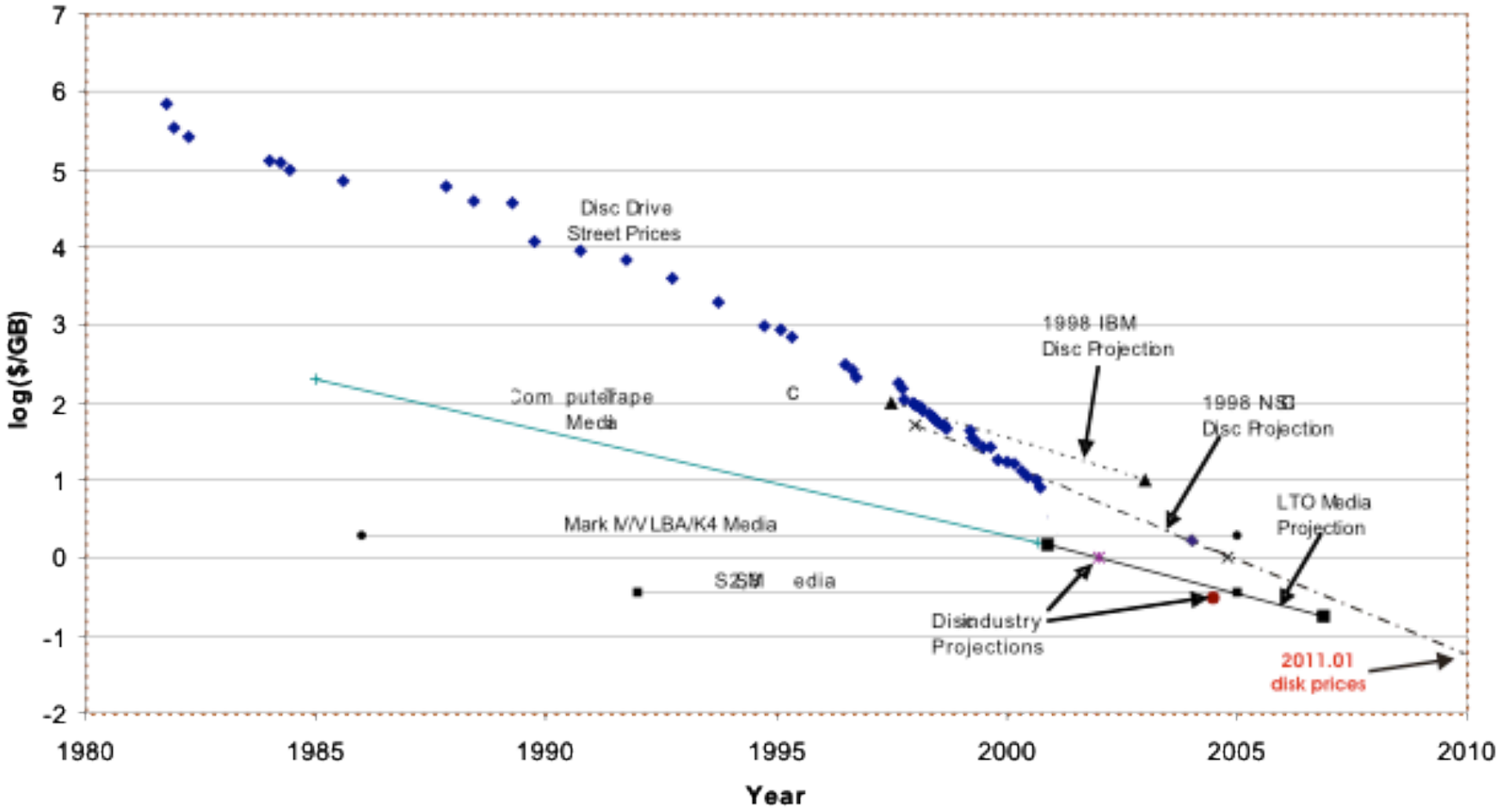
What about solid state disks?

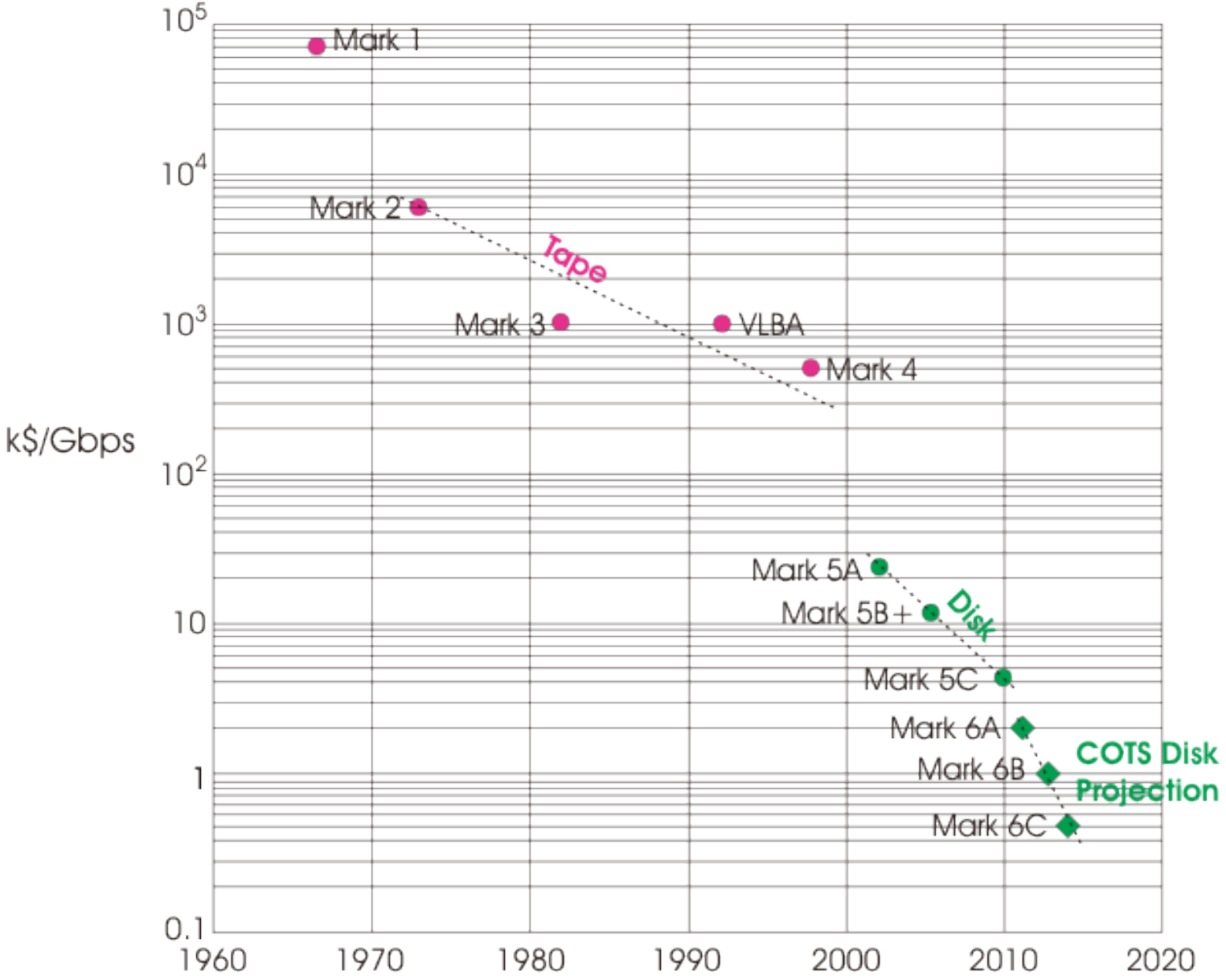


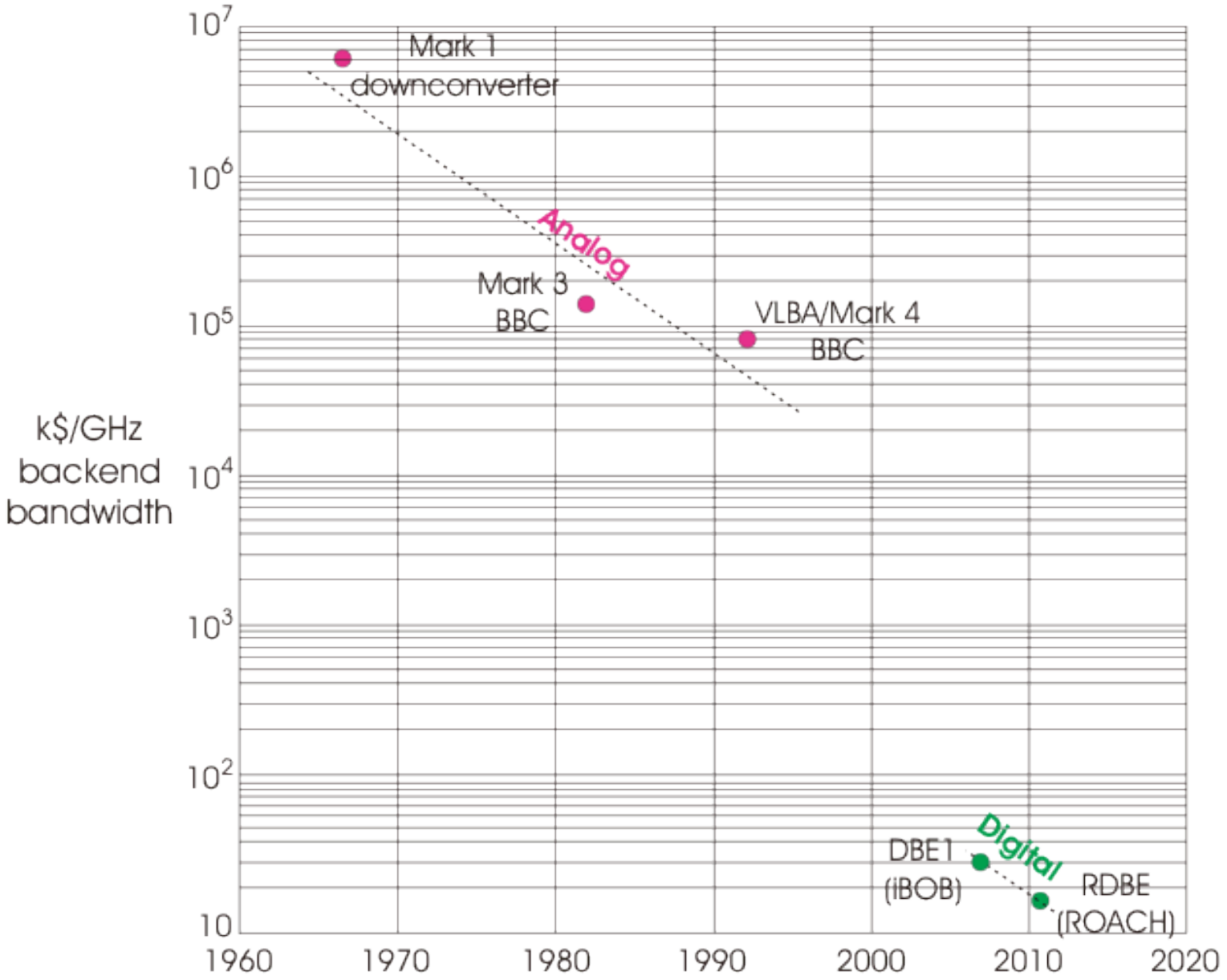
= 4 year lag

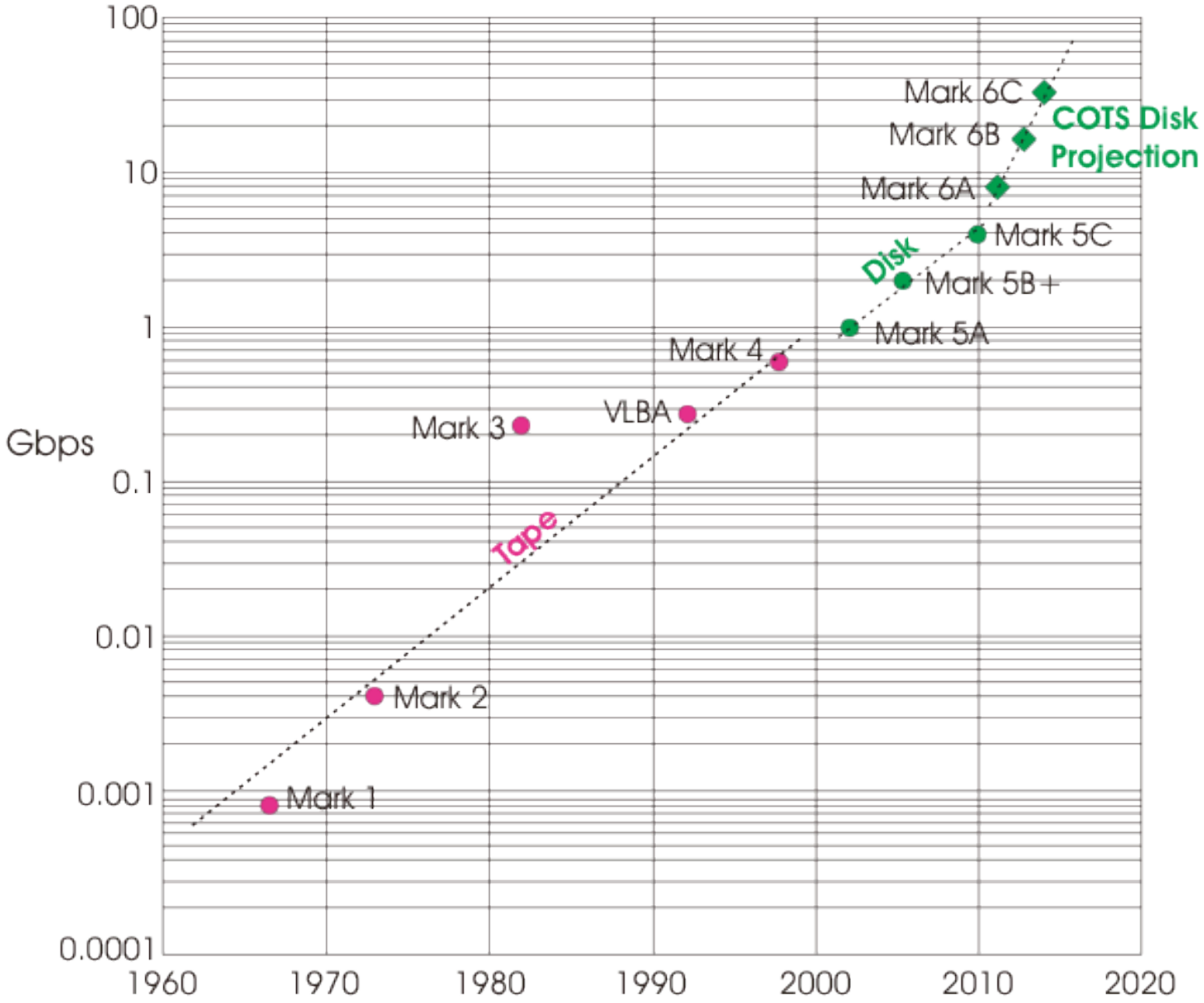
Soon, SSDs will be “affordable”, performance advantages will make them compelling for VLBI

VLBI now on HDD cost curve




k$/Gbps
10^5
10^4
10^3
10^2
10
1
0.1
1960
1970
1980
1990
2000
2010
2020
Mark 1
Mark 2
Tape
Mark 3
VLBA
Mark 4
Mark 5A
Mark 5B+
Disk
Mark 5C
Mark 6A
Mark 6B
Mark 6C
COTS Disk
Projection


k$/GHz
backend
bandwidth
10^7
10^6
10^5
10^4
10^3
10^2
10
1960
1970
1980
1990
2000
2010
2020
Mark 1
downconverter
Analog
Mark 3
BBC
VLBA/Mark 4
BBC
Digital
DBE1
(iBOB)
RDBE
(ROACH)


100
10
1
0.1
0.01
0.001
0.0001
Gbps
1960
1970
1980
1990
2000
2010
2020
Mark 6C
Mark 6B
Mark 6A
Mark 5C
Mark 5B+
Mark 5A
COTS Disk
Projection
Disk
Mark 4
VLBA
Mark 3
Tape
Mark 2
Mark 1

How many Gbps can we use?

- Extreme projection
  - 20 GHz of RF bandwidth (at sub-cm wavelengths)?
  - Dual pol, 2 bits/sample
  - 160 Gbps
- Beyond that we run out of RF (at least for VLBA)
- How long before 160 Gbps is feasible?
- How long before it is easy?
- How long before it is cheap?

It won't take that long!

- Current status
  - 8 Gbps just becoming feasible
  - 4 Gbps is becoming easy/routine
  - 2 Gbps is arguably "cheap"
- For 160 Gbps:
  - Feasible by ~2017
  - Easy by ~2019
  - "Cheap" beyond ~2020
- Innovation frontier will be elsewhere by 2020

What do we have to do?

- Facilitate transitions to COTS solutions
  - Easier said than done
- VLBI applications differ from typical commercial
  - Disk packs, shipping
  - High altitude sites
  - High sample rates, low bit depths, ...
- Must interface with complex VLBI infrastructure
  - Hardware
  - Software

Challenges

- Goal - minimizing time lag in tracking COTS performance curves
- Manage a changing technical landscape
  - Mk5, Mk6, ...
  - Address issues of obsolescence, interoperability
- Agility in adapting new devices, e.g.
  - Portable FPGA firmware modules
  - Scalable dataflow architectures, data formats
  - Flexibility across media types and packaging

Conclusion

- The end is in sight
  - Within ~10 years, digitizing/recording will no longer be cost/performance limit
- Our actions determine how fast and well we take advantage of this
  - Requires careful management of migration paths, technology choices
- Benefits are great, so resource the effort adequately