

GNSS –from Experts to Everybody

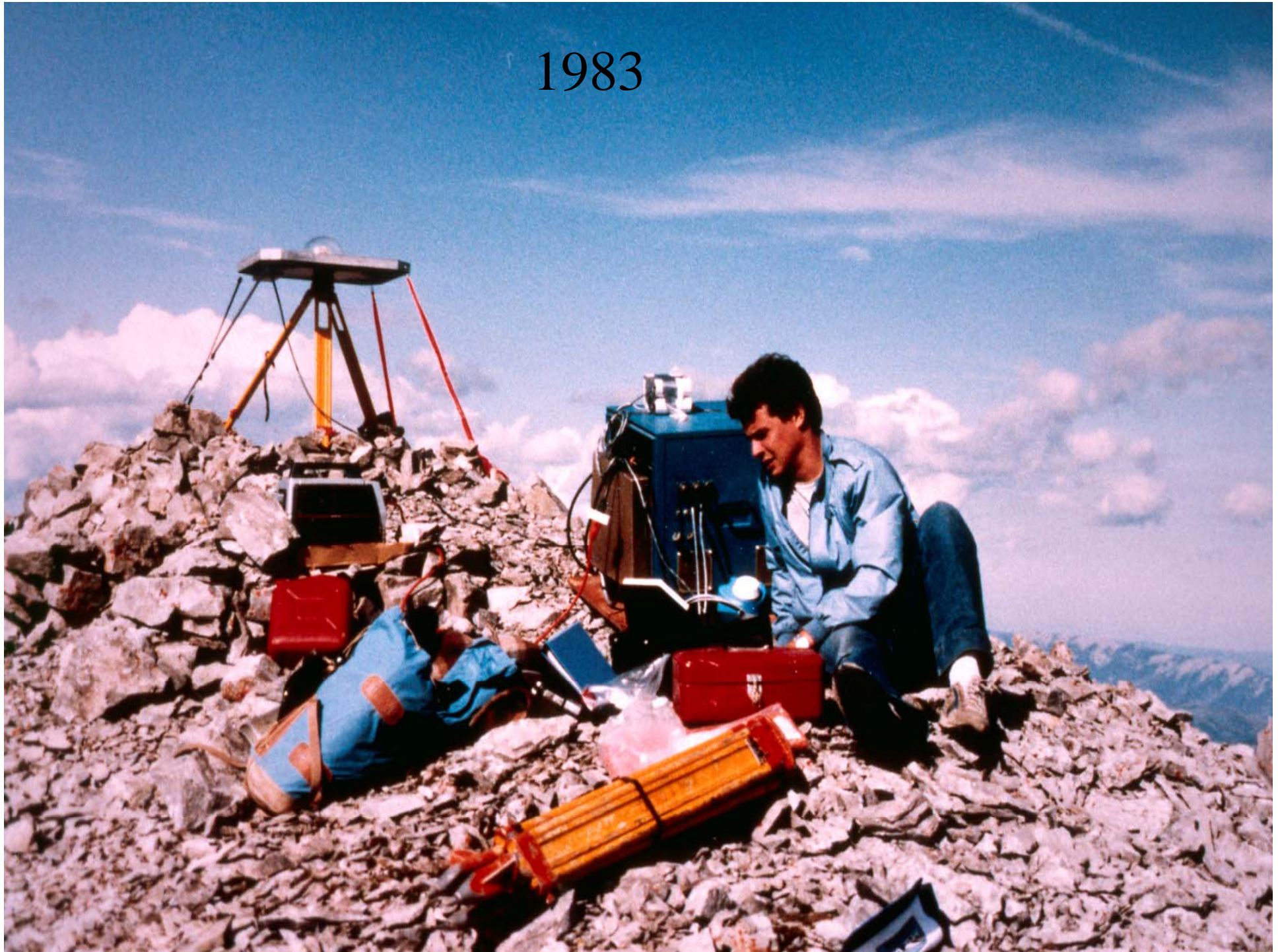
- Case study 1: Surveying
- Case study 2: Vehicle navigation

(Technology management in user segment – lessons learned)

- You wish maybe to talk about technology, I will to talk about money
- Standardization

Case 1: Surveying

1983



Macrometer V-1000

- Codeless L1 receiver (turned out to have major technological shortcomings, despite of high accuracy)
- Heavy 60 – 80 kg, could not acquire time or almanac, needed to be preprogrammed location specific.
- introduced 1983 – outdated 1986
- Cost \$250,000 (1983) -> in current money \$525,000 per unit (3%)
- Geo/Hydro Inc. went bankrupt as new technology (and thereby competition emerged).

1985



Trimble 4000(s)

- Code correlating unit, which could acquire time and satellite signals independently.
- Significantly lighter (20 kg), smaller and less expensive \$40,000 (1986) -> today's money \$75,000 per unit.
- Post processing automated and could be done with any PC.
- Still had deficiencies, like required car battery to run, external PC for data logging and GUI.

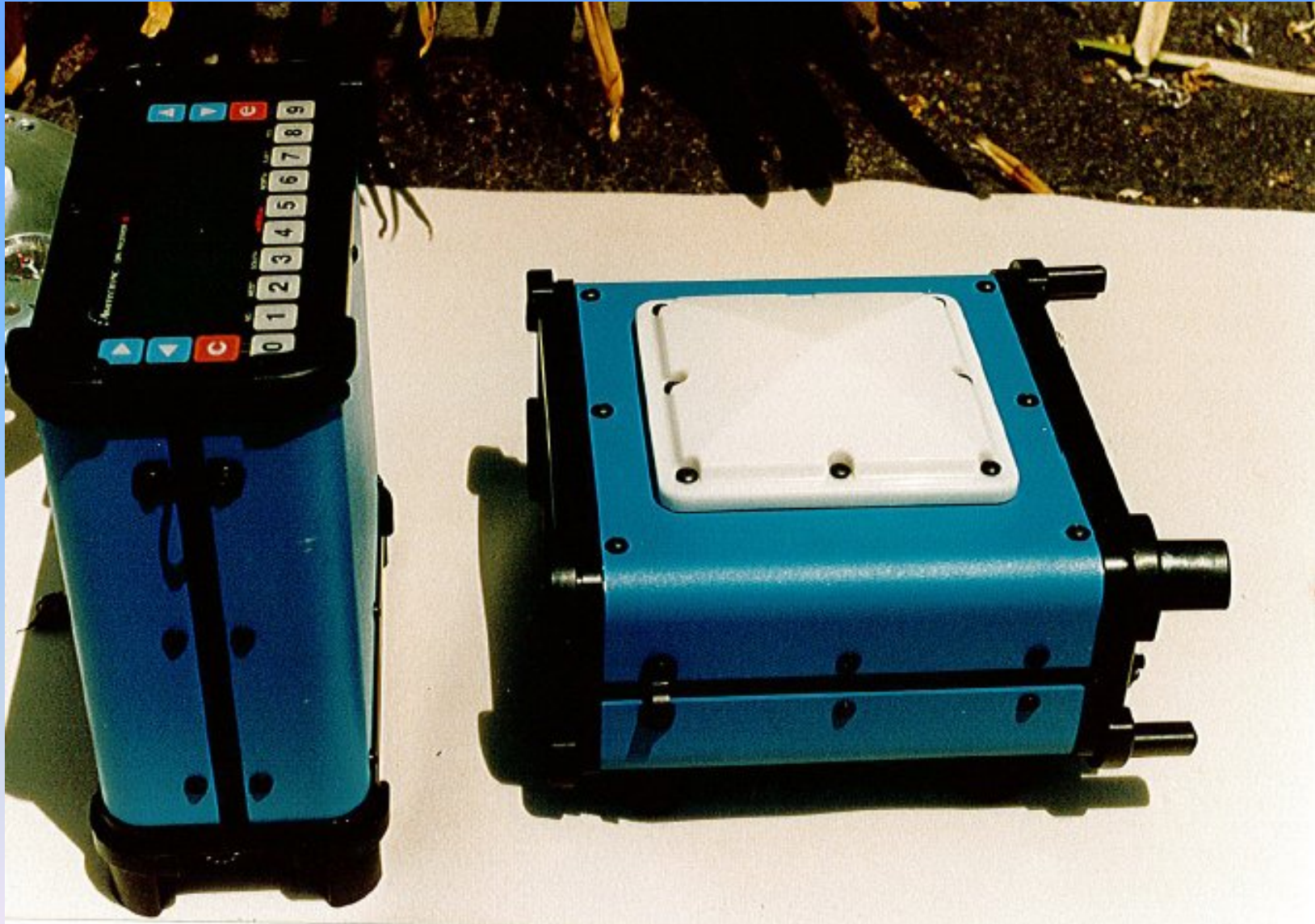
GPS satellite vs. User equipment disparity

- I have to admire the people who designed GPS, because it was designed not for the 1980s but for the modern days.
- The satellite constellation was so much more advanced to anything we could build in the electronics industry in the 80's (ASICs, memory capacity, CPU power, telecom,...)
- Electronics industry needed to catch up.
- Then something happened...

January 28th, 1986



1990

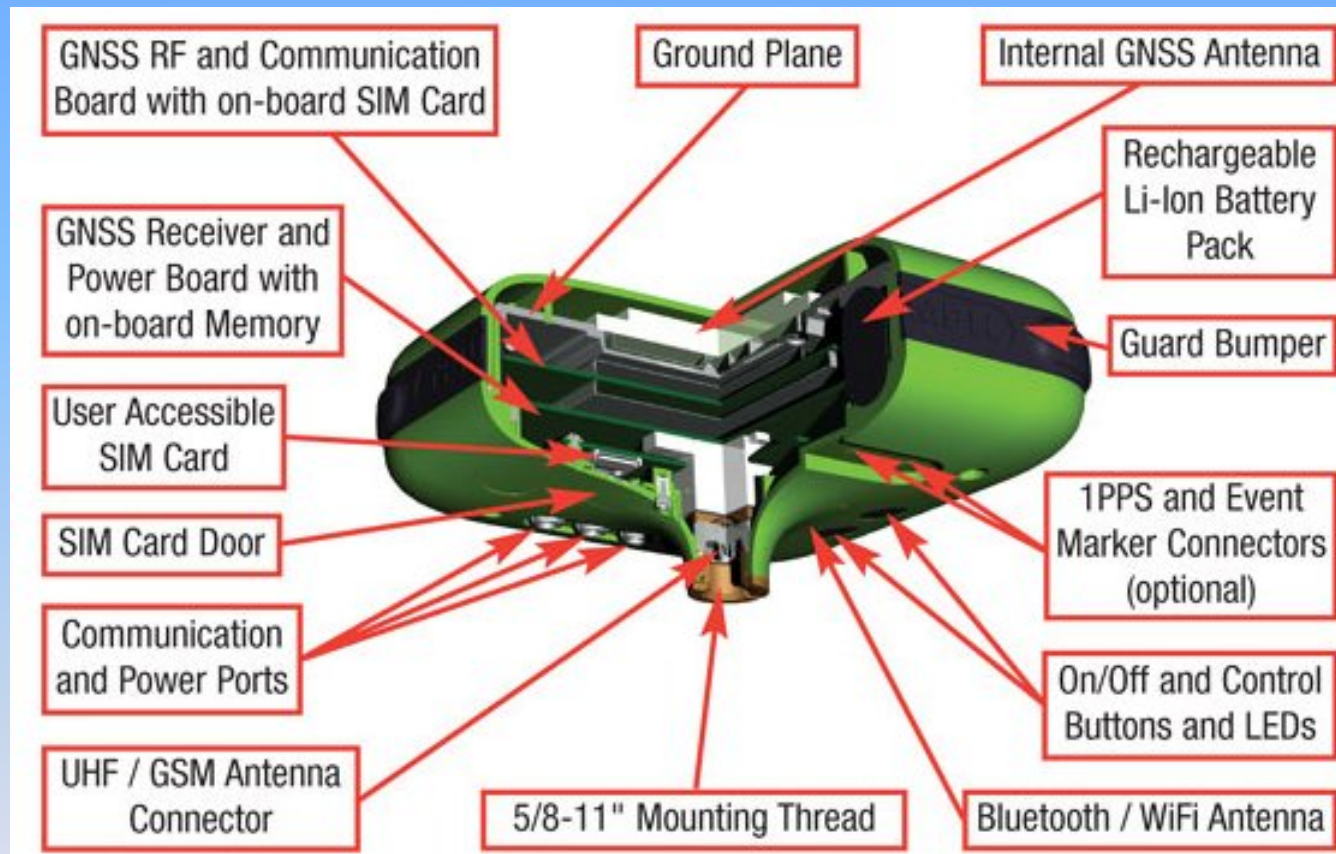


Ashtech MD-12

- Integrated receiver, antenna, GUI and data memory
- First model, where the basic technological concept has survived to modern day.
- Cost \$30,000 (in today's money \$50,000). The price curve was very steep in 1980's, but flattens out in the 1990s.
First 7 years -> 1/10th of the cost
Next 14 years -> 1/10th of the remainder
- The early pioneers were not successful as they could/did not plan for the fast development of the electronics industry and equipment price decline.

I will skip a few years...

2008



2009

Conclusion:

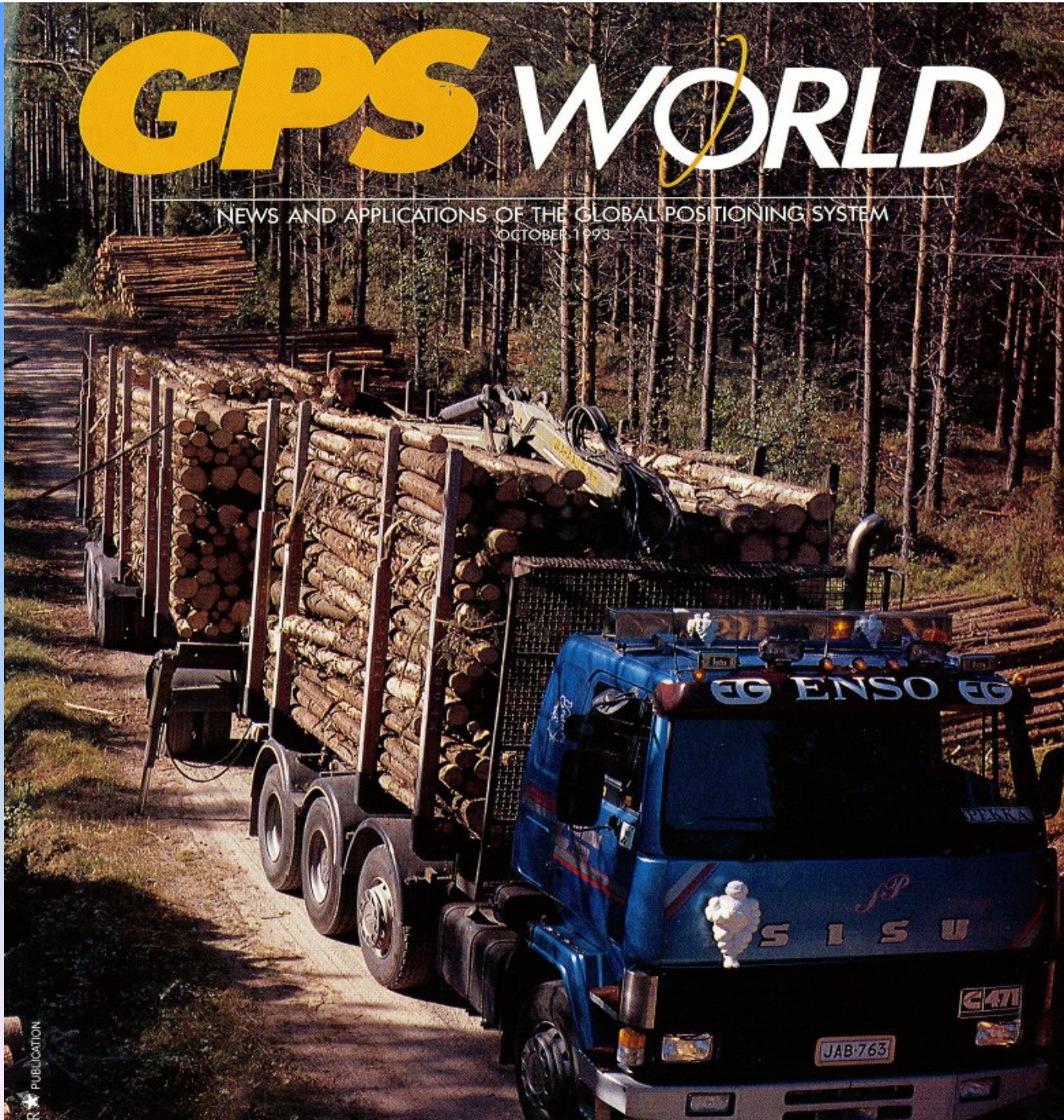
GPS has taken the skill out of surveying

Case 2: Vehicle Navigation

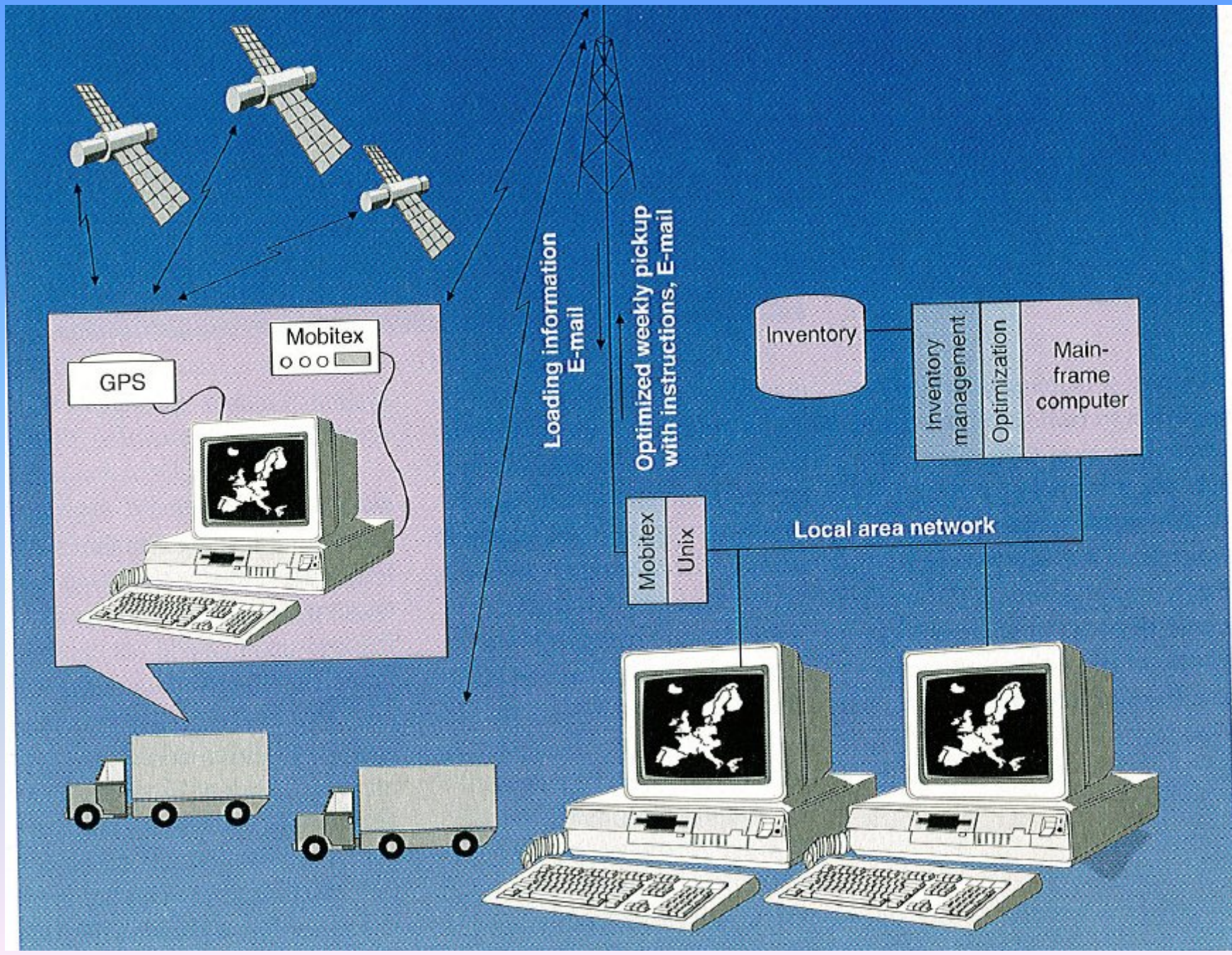
GPS WORLD

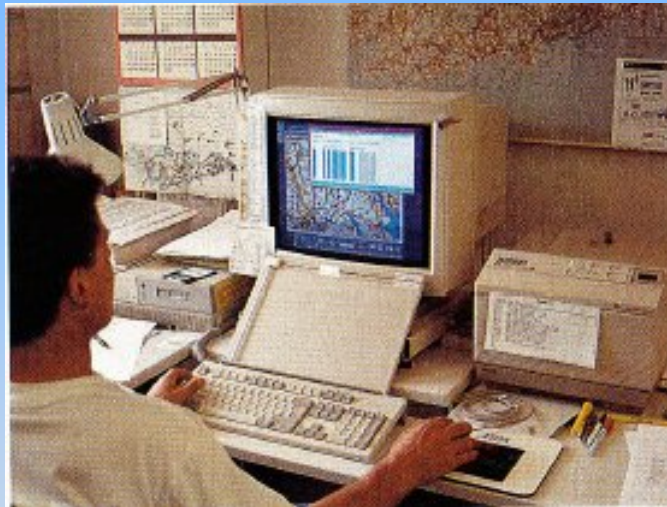
NEWS AND APPLICATIONS OF THE GLOBAL POSITIONING SYSTEM
OCTOBER 1993

1993









In vehicle cost in 1993 \$12,000 -> in today's money \$18,500

2008



Garmin: \$250, inclusive of all US maps

2009

Conclusion:

GPS has taken most of the skill out of navigation

Conclusion overall

- Cost reduction drives the market
- New applications arise when lower price for GPS and related technology is reached or when more availability is produced (INS+GPS or GPS+Glonass)
- More people can afford using GPS when price is lowered
- Cost of GPS has been low for some time, but adjacent technology has been catching up (memory, digital maps, flat screens)

Standardization

- Has been elementary for the success of GPS
- RTCM (2.1., 2.2., 2.3., 3.0), NMEA 0183, FGCC tests for performance and compatibility
- For the Glonass and interoperability of GNSS we need stronger control and standardization on how to handle Glonass interchannel bias to maintain compatibility especially in the VRS networks.