Personal Computers in Satellite Command & Control Systems

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Abstract

• The use of personal computers has increased dramatically over the last 20 years

• They have transformed the workplace and become essential to many aspects of daily business and academic endeavors

• For over 30 years, satellite command and control systems have used computers, but only in recent years have PCs been used in roles other than the traditional office applications like word processing and e-mail

• Just as the PC has transformed the office environment, it is poised to transform the traditional paradigms associated with flying satellites
Why PCs?

- Lower hardware cost
- Comparable performance
- Ability to interface with a variety of COTS tools (e.g. Excel, Matlab)
- Well-known Graphical User Interface
- Main programming languages are supported
- Tools and support for developers are available
- High performance machines, storage, network connectivity
- Portability
Hardware Advances

• The IBM PC was introduced in 1981
  – 16 k memory (expandable to 256 k)
  – one or two 160 k floppy disk drives
  – $1575 ($3000 if color monitor and printer added)

• Today
  – 64 to 512 Megabytes memory
  – 300 to 500 megahertz processor speeds common
  – Gigabytes of storage
  – $$$ about the same

• Market demand and competition amongst PC and processor manufacturers will continue the trend
AMD is now shipping their new Athalon processor which boasts clock speeds in the 600-700 MHz region.
Until recently, PCs were employed in satellite ground systems but only in peripheral roles
- running stand-alone tools (adapted from mainframe/workstation versions)
- providing access to office networks
- e-mail

Can PCs take on more critical roles?

One example of core processing now successfully performed by a PC is that of Telemetry decommutation
- Decom is a critical process that extracts information out of the satellite’s raw downlink and converts it into meaningful measurands (typically numbering in the thousands)
- Many measurands can change on a second-by-second basis
Telemetry Decom Performance

Intel PC vs. DEC Alpha

Frames per sec

CPU Utilization (%)

Proliant 1600
Proliant 6400
Alpha
Other useful aspects of PC hardware
- Audio support
- Multiple head video support
- Multiple processors (SMP)
- Embedded PCs and single-board computers
- Portable computers
• Good development tools are available for all of the languages commonly used in satellite command & control systems
  – C/C++
  – PowerBuilder (for database applications)
  – JAVA
  – FORTRAN

• Good utilities are available that make administration of systems easier
  – Exceed
  – Screen capture tools (e.g. SnagIt)
  – PCAnywhere
  – Netview
The advent of the Windows NT operating system was a milestone in the development and acceptance of the PC platform.

- A group of developers left DEC in 1988 and joined Microsoft. The group had experience in VAX/VMS (a successful real-time OS).
- Windows NT offers advanced security features and multiprocessor support.
- Major versions released to date:
  - 3.1 - 1993
  - 3.5 - 1994
  - 4.0 - 1996
- Windows 2000 is now being released.
• **Windows 2000**
  - Based on the NT kernel and yet includes many of the successful features of the 9x series like “plug-and-play”
  - A larger number of server-class versions will be offered including Datacenter Server which will support up to 16-way SMP

• **Linux**
  - Created by a young student, Linus Torvalds, at the University of Helsinki in Finland.
  - Version 1 was released in 1994 - Open Source under the GNU General Public License
  - It runs on the PC platform and has a strong following
  - Limited numbers of applications are available at this time
  - Offers an alternative to Microsoft’s products for UNIX faithful
Some Current & Future Applications

- **STK - Satellite Toolkit**
  - Widely used package for performing orbit/attitude modeling and visualization
- **Braxton Technologies & L3-Com**
  - Both companies offer PC-based command & control software packages
  - Both openly advertise that use of the PC platform and Windows NT are an advantage
- **Raytheon’s Eclipse and Perigee**
  - Eclipse is a tailorable satellite ground system capable of flying a fleet of satellites with either small or large numbers of operators
  - Eclipse uses PCs for Human-Machine Interface
  - Eclipse can use PCs for servers
  - Perigee is a lower-cost, all-PC system to fly a single satellite
Conclusions

- PCs have evolved tremendously over the last 20 years
- The PC’s performance has increased but the look and feel remains familiar (even around the globe)
- Due to the huge installed base and constantly improving products, PCs will be around well into the 21st century
- PCs have started to take on the core processing associated with satellite command & control (many available systems are fully PC-based). The distinction between the office and control center environments is lessening
- In many cases, even if a satellite ground system vendor does not currently offer a PC-based system… they soon will