

What Makes an Embedded Application Tick?

How Many Embedded Systems?

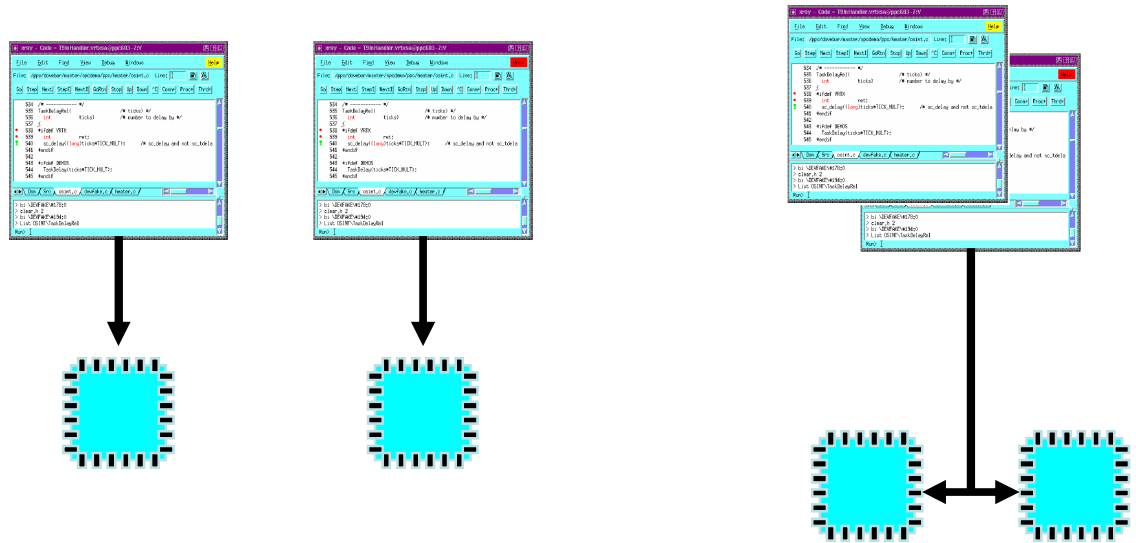
- In the average American household:
around 40 microprocessors; not counting:
 - PCs, which contribute another 5-10 each
 - cars, which typically contain a few dozen
- Will rise 100X over next couple of decades
- Most people don't know what "embedded" means

Development Challenges

- Multiple processors
- Limited memory
- User interface

Multiple Processors

- Key challenge is debugging
- Need multi-core support



Limited Memory

- May not be small, but probably not extendable
- Cost and power consumption issues
- Understand optimization
- C++ requires skill and the right tools

User Interface

- Critically important
- Mainly implemented in software
- Ideal steps:
 - design the hardware
 - make some prototypes
 - implement the software [UI]
 - try the device with the UI and refine/re-implement as necessary

UI Development

- Hardware not available
- Design may not even be complete
- Need to use prototyping/simulation technology to model on host computer

Re-usable Software

- Used to be a “start from scratch” approach
- Now software is too big and too complex
- Nobody can have all the expertise
- Time to market pressure drives short development cycles
- Reuse widely accepted in hardware design – same needed in software

Software Components

Examples:

- Real-time operating system
- File system
- USB
- Graphics
- Networking

Real Time Operating Systems

- 200 products on the market
- Still common to implement in-house
- Need to understand selection criteria

RTOS Selection Factors

- Hard Real Time
- Royalty Free
- Support
- Tools
- Ease of Use
- Networking
- Broad CPU Support

RTOS Standards

- Many proprietary
- Some standards available:
 - OSEK/VDX [automotive/transportation]
 - μ ITRON [Japan]
 - POSIX [migration from UNIX host]

File System

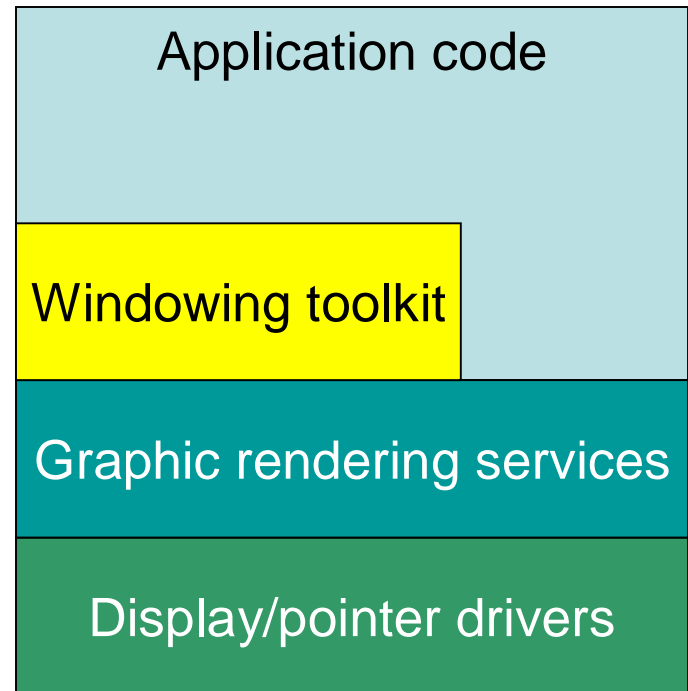
- Persistent storage
- Magnetic, optical or NVRAM [flash]
- Standards-based approach best
 - interoperability issues
 - data transfer
- MS-DOS the easiest standard to adopt

USB

- Implementation is very complex
 - hence ease of use
- Smart part is software not hardware
- Support already done for host computer
- Needed for embedded devices
- USB On-The-Go becoming available

Graphics

- LCD panel may have 2 functions
 - graphic output
 - user interface
- Doing graphics seems easy, but can quickly become complex
 - simplified with graphics library
- GUI is typically another library on top of regular graphics



Networking

- At least a third of embedded system are connected
- May be wired or wireless
- TCP/IP is quite straightforward to program
 - additional applications and protocols are challenging

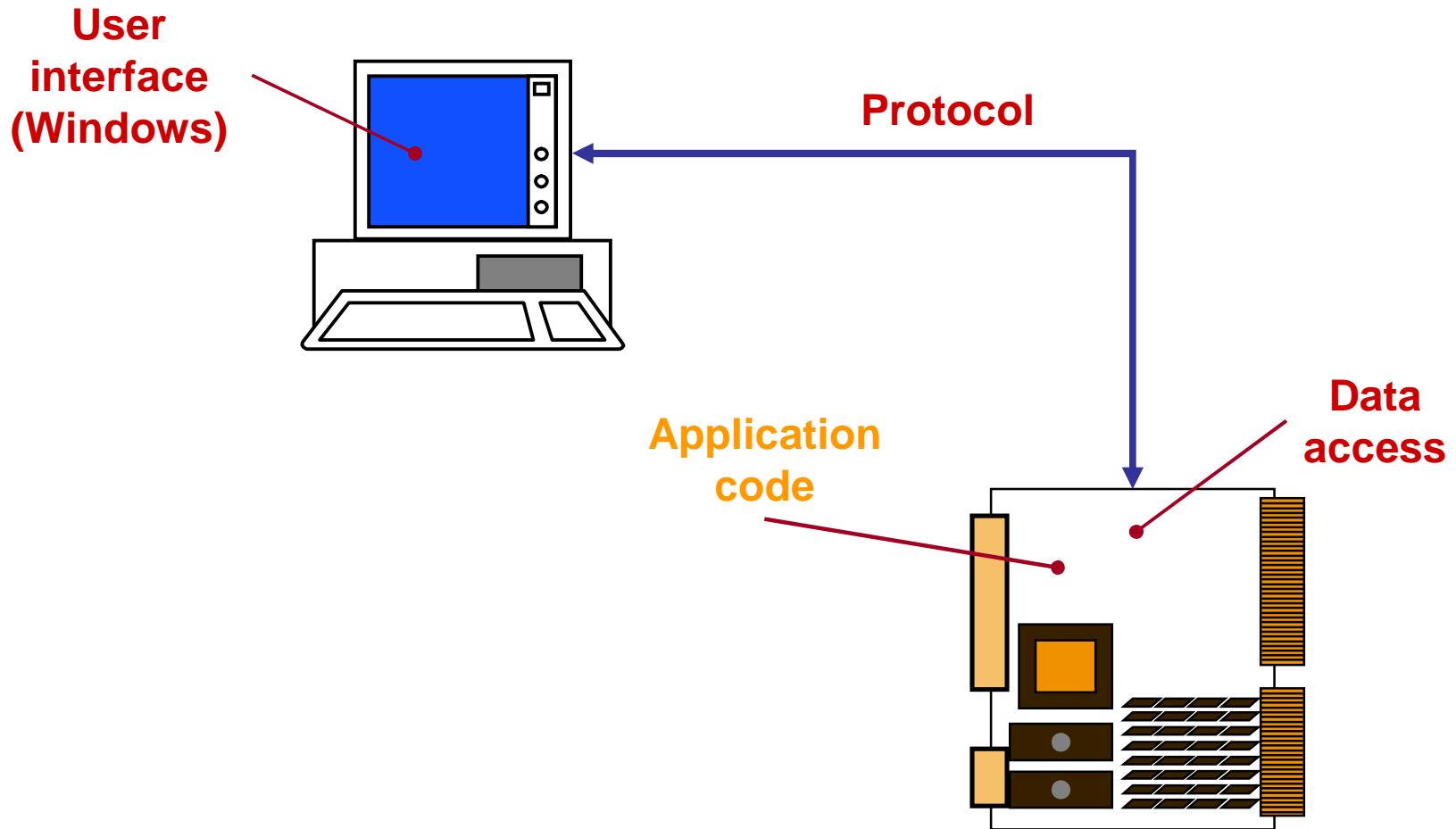
IPv6

- IPv6 is the next version of the Internet Protocol
 - Rules that define communication over networks
 - Current version is IPv4
- IPv6 solves a number of problems with IPv4
 - Virtually Unlimited Address Space
 - Robust Addressing Architecture
 - Lower Maintenance Costs
 - Increased Flexibility

IPv6 Addressing

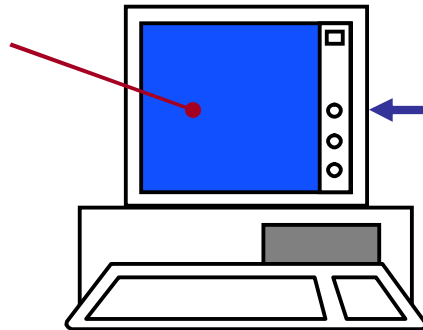
- Standard Format
 - 3ffe:2900:0102:0001:0000:0000:0000:0002
- Leading Zeros removed
 - 3ffe:2900:102:1:0:0:0:2
- Double Colon Notation
 - 3ffe:2900:102:1::2

Who Needs a Web Server?



Web Server Solution

Any Web browser
(any OS,
any platform)



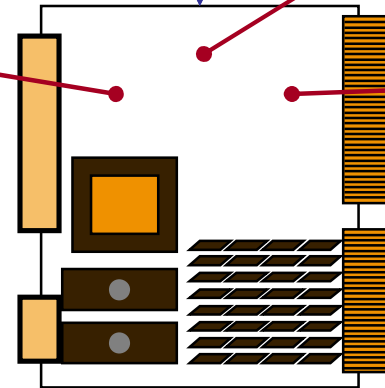
HTTP



Application code

WebServ

Simple data access



SNMP vs Web server

- SNMP
 - Complex security features built in
 - MIBs can be added easily
 - Browser format fixed
 - Browsers cost money
- WebServ
 - SSL optional
 - HTML and coding straightforward
 - Interface can be customized to the application
 - Browsers free