Retro Platforms Overview

Talk Series
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Sponsored by Green Hills Software
What's the purpose of this talk?

- To learn some cool history
- To understand why we're stuck with some seemingly arbitrary design decisions today
- To give you the chance to ask questions you may have about various retro platforms.
- To give me a chance to spout off about a topic I'm really passionate about – the history of computing, and how where we were over the years got us to where we are today.
- This talk will mostly focus on platforms that were common in the U.S.
  - But there were a lot of cool computer platforms from other countries. Come to Demosplash 2014 if you'd like to learn more about those.
What's NOT the purpose of this talk?

• To be a complete history of the past 50 years of computing.
  – We don't have enough time for that.

• To go into deep technical detail about individual platforms.
  – I want to give you an overview of different eras of computing, not spend an hour debating the merits of x86 vs 68000 or VMS vs UNIX, etc.

• To be in perfect chronological order.
  – Since home computing and business/academic computing developed somewhat separately from each other, this would get confusing. We'll still get confused in some places, but I'll do my best to explain.
What is Retro?

- Depends on who you ask, and when you ask it.
- Most people tend to be nostalgic for the first computers they remember using.
Side Note – My first experience with computers

- When I was a little kid, I didn't know computers were a real thing.
  - I had heard of them, but only on Star Trek.
  - In 1994, I saw a real computer for the first time.
  - I asked my kindergarten teacher “Why are there TV sets sitting on top of the typewriters?”
  - She then proceeded to explain that this was a computer. I didn't bother asking if we had phasers and transporters.

Zenith 9” television set, circa 1992
Olympia portable typewriter, circa 1959.
What is Retro?

- Right now?
  - A lot of hardware older than the late 90s could be called retro.
  - Even common and uninteresting Pentium II era PC clones are starting to get attention.
  - In general, pre-1990 computer hardware is becoming more uncommon and valuable, and 1990 to mid-90s hardware is still fairly common but increasing in value.
What is Retro?

• 10 years from now? The stuff that's considered yard sale junk today.
  - Original Xboxes
  - CRT iMacs
  - PlayStation 2s
  - Maybe early 2000s PCs.

'Flower Power' iMac G3, Circa 2001.
What is Retro?

- Case in point: One of the most valuable retro machines the club owns is an Apple Lisa 2.
  - Working ones are worth at least $2,500 now.
  - In 1989 Apple had so many unsellable ones they (supposedly) dumped them in a landfill for a tax writeoff.
  - Moral of the story – don't throw away your Zune just yet.

The club's restored Lisa 2/10. Apologies for the dark photo, I wanted the screen image to be visible.
What is Retro?

- Note that old doesn't always mean valuable.
  - Atari 2600s are both old and cool, but so many were produced that they're still not worth more than $40-50.
  - Nor are E.T. Cartridges (which really were buried in a landfill) worth much.
What is Retro?

- 20 years from now? The stuff that's considered new and awesome today.
- But first, that stuff will be worthless in 10 years (or less).
The Evolution of Computing

- In the very beginning, computers were not terribly powerful or user-friendly.

- Very early machines were built out of vacuum tubes and relays, and programmed via toggle switches.

- These machines are historically significant, but not really that exciting to most people these days, so we won't spend much time on them.

UNIVAC 1, Circa 1951.
The Evolution of Computing

- But we will go over a few aspects of these machines that still remain with us today.
- Ever wonder why you get asked to keep code for programming classes to 80 columns or less?

IBM System/360 Model 40B
The Evolution of Computing

• Answer: Punch Cards.
  - The standard IBM 5081 card had 80 columns and 12 rows.
  - Early compilers typically expected one line of code per card.
  - So, that's how we end up with 80 columns (or 72 if you're a FORTRAN programmer).

Many common UNIX commands are only 2 or 3 letters long.
- This makes things a bit confusing for novice users.
- Is there a good reason for this?

### File Commands

<table>
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<tr>
<th></th>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
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<tr>
<td>1</td>
<td>ls</td>
<td>Directory listing</td>
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<tr>
<td>2</td>
<td>ls -al</td>
<td>Formatted listing with hidden files</td>
</tr>
<tr>
<td>3</td>
<td>ls -lt</td>
<td>Sorting the Formatted listing by time modification</td>
</tr>
<tr>
<td>4</td>
<td>cd dir</td>
<td>Change directory to dir</td>
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<tr>
<td>5</td>
<td>cd</td>
<td>Change to home directory</td>
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<td>6</td>
<td>pwd</td>
<td>Show current working directory</td>
</tr>
<tr>
<td>7</td>
<td>mkdir dir</td>
<td>Creating a directory dir</td>
</tr>
<tr>
<td>8</td>
<td>cat &gt;file</td>
<td>Places the standard input into the file</td>
</tr>
<tr>
<td>9</td>
<td>more file</td>
<td>Output the contents of the file</td>
</tr>
<tr>
<td>10</td>
<td>head file</td>
<td>Output the first 10 lines of the file</td>
</tr>
<tr>
<td>11</td>
<td>tail file</td>
<td>Output the last 10 lines of the file</td>
</tr>
<tr>
<td>12</td>
<td>tail -f file</td>
<td>Output the contents of file as it grows, starting with the last 10 lines</td>
</tr>
<tr>
<td>13</td>
<td>touch file</td>
<td>Create or update file</td>
</tr>
<tr>
<td>14</td>
<td>rm file</td>
<td>Deleting the file</td>
</tr>
<tr>
<td>15</td>
<td>rm -r dir</td>
<td>Deleting the directory</td>
</tr>
<tr>
<td>16</td>
<td>rm -f file</td>
<td>Force to remove the file</td>
</tr>
<tr>
<td>17</td>
<td>rm -rf dir</td>
<td>Force to remove the directory dir</td>
</tr>
<tr>
<td>18</td>
<td>cp file1 file2</td>
<td>Copy the contents of file1 to file2</td>
</tr>
<tr>
<td>19</td>
<td>cp -r dir1 dir2</td>
<td>Copy dir1 to dir2; create dir2 if not present</td>
</tr>
<tr>
<td>20</td>
<td>mv file1 file2</td>
<td>Rename or move file1 to file2, if file2 is an existing directory</td>
</tr>
<tr>
<td>21</td>
<td>ln -s file link</td>
<td>Create symbolic link link to file</td>
</tr>
</tbody>
</table>

### Process management

<table>
<thead>
<tr>
<th></th>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ps</td>
<td>To display the currently working processes</td>
</tr>
<tr>
<td>2</td>
<td>top</td>
<td>Display all running process</td>
</tr>
</tbody>
</table>
The Evolution of Computing

- Answer: When UNIX was originally being developed at Bell Labs, the primary input device available was a machine called a teletype.
  - These devices, intended for sending text over phone lines, were relatively easy to interface to a computer.
  - This is also why consoles in UNIX-like operating systems are still called 'tty' now (it's short for 'teletypewriter').
  - However, these machines were really slow – 110 baud, or roughly 10 characters per second on the common Model 33 Teletype.
The Evolution of Computing

- Teletypes were painfully slow to use, and produced piles of often-useless paper.
- As the technology became more affordable, teletypes were largely replaced with CRT based terminals.
- Early ones were basically a teletype without the paper, but as time went on, more features were added.

DEC VT-52, Circa 1975
Lear-Siegler ADM-3a. Circa 1975. This is the model of terminal used by Bill Joy when he was developing the original \texttt{vi} text editor, and the reason that H, J, K, and L were used for motion in \texttt{vi} and are still used in \texttt{vim} today (The ADM-3a did not have arrow keys).
The Evolution of Computing

- These are the devices that your 'terminal emulator' on Linux or OS X emulates.

- Most ones made after the mid-1970s have standard RS-232 serial interfaces and can still be used with modern PCs running UNIX-like operating systems.
  - On newer PCs without serial ports, a USB to RS-232 adapter is needed.

Digital VT420, Circa 1989, attached to an embedded PC, connected to a modern server via SSH.
What's an old terminal good for?

The Evolution of Computing

- These developments are great, and very important.
  - From the vacuum tube days to the days of early UNIX, computers grew from an expensive novelty for university researchers and the military to a serious tool for research and business.
  - 'Computer Science' became a legitimate field of study, as opposed to science fiction.
- However, computers still weren't exactly mainstream.
  - You don't want an IBM mainframe (or probably even a DEC minicomputer) in your living room.
  - Even if you did, you probably couldn't afford one (or to power and maintain it).
- The next great step in the evolution of computing would have to make computers more widely available:
  - Make them less expensive, smaller, maybe even easier to use.
Home Computers

• In the mid 1970s, microprocessors became relatively affordable.
  - Small designs such as the MOS Technology 6502 and Intel 8080 were inexpensive to produce and could be sold at relatively low prices.
  - This made it possible to produce small, somewhat reasonably priced computers for personal use.
  - This also made it possible to put computers in unusual places such as cars, microwave ovens, etc.
Home Computers

- The first home computers weren't terribly user-friendly.
- To keep costs down, the 'user interface' was often toggle switches and light bulbs just like a machine from the 1950s.
- Permanent storage? Nope. You permanently stored your programs in a notebook and toggled them in each time.

MITS Altair 8800. Intel 8080 based, circa 1974. Also significant as the first machine that Microsoft (back when they were just Bill Gates & Paul Allen) wrote a BASIC interpreter for.
With some extra parts, you could connect a terminal to one of these machines.

A surplus teletype or early CRT terminal might be obtainable for a reasonable price.

Or you could build your own and plug it into your TV set, following a project like the TV Typewriter.

Pictured is a Southwest Technical Products CT-1024 terminal kit, an improved version of the TV Typewriter.
Home Computers

- Communities built up around these primitive home computers, exchanging programs, hardware designs, etc.
  - Cassette tapes for storage – painful, but better than notebooks or paper tape.
- Gradually, things got more commercial.
  - Bill Gates once famously chewed out the Homebrew Computer Club for pirating BASIC on paper tape.
  - Existing companies (Commodore, Radio Shack, etc.) got into the home computer business.
  - And some hobbyists launched their own computer companies.

IMSAI 8080 (Altair 8800 clone) from the movie War Games. Seen with add-on keyboard, dual 8” floppy drives, and video monitor.
Home Computers - Apple

- Founded by 2 guys in a garage.
- First machine, Apple I, was just a circuit board – add your own keyboard, monitor, and power.
  - It used the low-cost ($20 in small quantities) 6502 processor.
  - This combined with clever hardware design led to a relatively inexpensive (~$600) and expandable computer.
Home Computers - Apple

• The later Apple II was actually a fully assembled machine with an integrated keyboard.

• More clever hardware design let Apple offer a low-cost floppy drive, and color display.
Home Computers - Commodore

● First Machine – the PET (1977)
  – 6502 based, like the Apple.
  – Had a built-in keyboard, display, and cassette drive.
Home Computers - Commodore

- This machine was very quickly designed after Commodore declined an offer to buy the Apple II from Apple.
  - Terrible keyboard, borrowed from desktop calculator keyboards.
  - "Built-In" cassette drive is actually a desktop tape recorder with the speaker removed.

Look at this awful keyboard layout. Keys in straight columns instead of staggered like a typewriter, Run/Stop key next to return, etc.
Home Computers - Commodore

- The Commodore 64
  - Still 6502 based, but much nicer than the PET.
  - A floppy drive was available
    - But stupid engineering led to it being bigger, heavier, slower, and more expensive than the Apple II's drive.

Commodore 64, pictured with color monitor and model 1541 floppy drive.
The IBM PC

- The IBM PC wasn't a terribly interesting platform, but since its descendants are what most of us are stuck with today, let's spend a few minutes discussing it.
  - The PC was released in 1981 as IBM's “Me Too” small computer.
  - Unusual for IBM, it was built out of off the shelf parts, and powered by a 4.77 MHz Intel 8088 CPU.
  - Also unusual for IBM, the operating system was a CP/M knockoff called PC-DOS, developed (or rather acquired from another company) by Microsoft.
Home Computers

• These machines were a key part of making computing available to the general public.
  – Educational software was developed, bringing computers into classrooms.
  – Built in BASIC interpreters on most popular machines encouraged users to learn programming.

• But there was still a pretty steep learning curve.
  – Remembering often-cryptic commands.
  – Understanding enough about computer hardware to handle installing expansion cards and troubleshooting.

• What could be done to make computers more accessible to the masses?
The Graphical User Interface

• First of all, Apple did not invent it.
  - They weren't even the first to commercialize it.
  - That honor probably goes to a CMU startup called Three Rivers Computer Corporation (who wasn't very successful).

• Neither did Microsoft.
  - Early versions of Windows did copy bits and pieces of the Macintosh 'look and feel,' leading to a lawsuit that dragged on for years.

• Everyone stole from Xerox.
  - But Xerox management wasn't interested in commercializing it, and the researchers who toiled away on it encouraged this 'theft'.
The Macintosh

• Released in January 1984, the Macintosh was the first commercially successful computer with a GUI.
  – Other companies had GUIs first. They even tried (mostly unsuccessfully) to sell them.
  – Apple even had a previous attempt, the Lisa. It wasn't very successful either.
The Macintosh

- What made the Macintosh successful?
  - It was (relatively) cheap at $2,495, thanks to clever hardware design (and skimping on expensive RAM).
    - Compare to $9,995 for a Lisa.
    - Or $75,000 for a Xerox Star.

Macintosh 128k logic board. The large purple and gold IC is the Motorola MC68000 CPU (in 64 pin DIP package).
The Macintosh

- What made the Macintosh successful?
  - Attention to user interface design made it easy to use.
    - The use of a single mouse button, while somewhat limiting, led to less confusion for new users.
    - Apple encouraged consistent program behavior (menu layout, etc.) which made the Macintosh far easier to learn than IBM PCs, Apple IIs, etc. where every single application had its own keyboard shortcuts.
  - Apple encouraged third party software development through good documentation and affordable development tools.
    - Fun fact, Microsoft Word and Excel (as we know them today) were both originally developed for the Macintosh.
The Macintosh

- What were some of the downsides of the early Mac?
  - 128 KB of RAM really wasn't enough. Apple quickly released a 512 KB model, but it cost another $300.
  - Despite having a very polished user interface, the Mac's OS was very primitive under the hood.
    - No multitasking (other than Desk Accessories) until 1987.
    - Unintelligent memory management. This wasn't fixed until 2001 with the release of the UNIX-based Mac OS X.
  - No color and no expandability until the release of the Mac II in 1987.

The Commodore Amiga was a slightly less well-known early GUI based home computer.

- Used the same Motorola 68000 CPU as the Macintosh, but added some more advanced supporting hardware to make a more powerful machine.
- A custom-designed chipset allowed the Amiga to generate color video and relatively advanced graphics, making the Amiga a common choice for TV graphics design in the 1980s and early 90s, as well as making it a popular machine in the Demoscene.
- As a side note, the Amiga 1000 was the machine that Andy Warhol worked with as part of a Commodore marketing campaign.
  - Years later, a couple of CMU Computer Club members recovered much of this work from Warhol's old floppy disks.
  - Want to hear more? Come to Demosplash, where there will be a talk on this by the guys who actually did it.
The Amiga

- The Amiga Workbench (Commodore's OS for the machine) featured a GUI similar to the Macintosh OS, but in color.
- Graphics weren't quite as high-resolution initially, but that was the sacrifice that had to be made to get a color GUI in 1985 unless you wanted a computer that cost more than a new car.
- The Amiga OS also implemented preemptive multitasking, which the Macintosh wouldn't get for years.

A screenshot of Amiga Workbench 1.0
The Amiga

- Amiga hardware and software gradually became more powerful.
  - Processors were upgraded from the Motorola 68000 to the faster 68020, and later the 68030 and 040.
  - The OS's graphics became more polished.

A screenshot of Amiga OS 3.5
The Amiga

- Unfortunately, Commodore and the Amiga did not have lasting commercial success.
  - Commodore went bankrupt in 1994.
  - The Amiga brand name, OS, etc. got passed around to a few different companies with no great successes.
  - The brand name later turned up on an x86 based Mac Mini knockoff running a version of Linux customized to resemble Amiga OS.

'Commodore Amiga Mini' x86 PC Circa 2012. A Commodore, and an Amiga in name only.
IBM PC again

- IBM, and others who cloned the PC's architecture made improvements as time went on.
  - On the hardware side, the original 16 bit Intel 8088/8086 CPU was replaced by the improved 80286, and later the 32-bit 80386.
  - On the software side, however, the most common OS was still the primitive and clunky MS-DOS.
GUIs on the IBM PC

- Microsoft's Windows GUI shell was released in 1985 as a rather unimpressive imitation of the Macintosh's user interface.
  - Windows 1 and 2 were mostly ignored or seen as a novelty.
  - By version 3.0, Windows had evolved to the point of actually being usable and useful. Microsoft's own business software such as Word and Excel, as well as some popular third-party Macintosh software was ported to it.
- Other GUIs were released for the PC, but none had much success.
UNIX Workstations

- As we've seen, affordable microprocessors made the home computer revolution possible, and these microprocessors becoming more powerful made home computer GUIs possible.

- But what effect did microprocessors have on business and academia, where computers were commonplace before they were affordable?
  - More powerful personal workstations began to replace text terminals.
    - These machines often ran UNIX based operating systems, offering the familiar command line, as well as more fully-featured GUIs.
  - IBM PCs started appearing in these environments as well, but we'll get to that later.
Sun Microsystems

• Started out of Stanford University (SUN was originally an acronym for 'Stanford University Network').

• Early Sun hardware used Motorola 68000 series processors.
  - This CPU was used in many computers from the late 80s/early 90s as we've seen so far.

Sun-1 Workstation Circa 1982
Later machines used Sun's own SPARC CPU.

- This was also a common thing in workstations, replacing the 68000 CPU with some RISC CPU.

Sun's computers ran the UNIX based SunOS, later called Solaris, and were common in academia and the tech industry.

- Many engineering applications were originally written for Sun workstations.
- Because of this, Sun was probably the most successful of the UNIX workstation vendors.
NeXT Computer

- After Steve Jobs was forced out of Apple Computer by new management, he founded yet another company to make expensive graphical workstations.

- NeXT workstations were somewhat similar to Macs in terms of hardware (Motorola 68000 series CPUs, ADB keyboard/mouse interface, etc.) but the big innovation was in the operating system.

- High resolution graphics, network support, and UNIX based OS made these a powerful but expensive machine mostly seen in academia.

The NeXT Cube, produced from 1990 to 1993.
Tim Berners-Lee's NeXT Cube, the original World Wide Web server at CERN.
NeXT Computer

- NeXT later released more desk-friendly 'slab' form factor cases, and added color.
- We own a working NeXTStation Turbo Color, and have discussed writing a demo for it before.
  - This could be a really cool opportunity for anybody who likes retro hardware and likes demos (hint, hint...)

NeXTStation Turbo Color in more convenient case form factor.
Silicon Graphics

- Silicon Graphics (commonly referred to as SGI) was another manufacturer of high-end workstations.
- Once again, early models used Motorola 68000 series processors, but later ones used the MIPS architecture.
- These machines ran IRIX, yet another UNIX based OS.
Silicon Graphics

- SGI machines saw extensive use in filmmaking due to their graphics capabilities.
- SGI was also well known for colorful hardware and unusual case designs.
  - Because of this, in addition to being used to make movies, SGI hardware often appeared in them too.
The Beginnings of Open Source

- In the early days of computing, software, and the source code itself was often distributed free of charge.

- As computers became more affordable, and third parties entered the software industry, charging for software and requiring restrictive license agreements became commonplace.

- This was not to the liking of many academics and system administrators, who enjoyed being able to improve on software and adapt it for their own computing environments.
The Beginnings of Open Source

• In 1983, Richard Stallman founded the GNU project.

• Fun Fact – The reason Stallman has never spoken at CMU is that in the events leading up to GNU, a CMU employee refused to violate a Xerox license agreement and give source code for a printer driver to him.

• The mission of GNU was to develop replacements for all the components of UNIX, distributed with full source code under a permissive license.
The Beginnings of Open Source

- GNU got quite far along in producing replacements for UNIX userland tools like shells and text editors, but was missing a kernel.

- In 1990, the GNU/HURD project was started to deal with this issue.

- But, before HURD was complete, a Finnish college student named Linus Torvalds decided to write his own OS kernel, Linux.
  - Combining the Linux kernel with the GNU userland, libraries, etc. produced a reasonable UNIX clone capable of running on commodity IBM PC hardware.
  - Since the GNU project comprises a significant quantity of the code found in a typical Linux distribution, it is appropriate to refer to such distributions as 'GNU/Linux.'
Where We Are Today

- Most computers, excluding mobile devices like tablets and cell phones, are descended from the original 1981 IBM PC. It wasn't a great design, but it became cheap and ubiquitous.
- IBM doesn't even make PCs anymore, but nonetheless, their hardware platform lives on.
- Many of the home computer vendors such as Commodore, Texas Instruments, and Tandy left the market or went out of business altogether.
- Most of the superior CPU architectures of the 1980s and 1990s faded into obscurity due to the dominance of the x86 PC (and Intel having a lot of money).
  - MIPS lives on in cheap embedded hardware, and in China.
  - ARM lives on in not-so-cheap embedded hardware, smart phones, etc.
  - PowerPC lives on in a few gaming consoles and some expensive IBM servers.
  - Alpha was unceremoniously sold to Intel and discontinued in favor of the Itanium, Intel's failed attempt to replace x86.
  - SPARC got mothballed when Sun was acquired by Oracle.
Where We Are Today

- At least one expensive workstation is still around and still pretty popular.
  - The hardware is basically another IBM PC clone, but just proprietary enough.
  - The operating system
  - The desktop models even come in crazy case designs that make some of SGI's cases look almost normal.

SGI O2+, Circa 2002
Where We Are Today

• Of course, I'm talking about NeXT... I mean, Apple.
  − In 1996, Apple acquired NeXT Computer, a workstation manufacturer founded by Apple co-founder Steve Jobs.
  − The reason – Apple's Mac OS was a mess – shiny on the outside, primitive, clunky, and crash-prone on the inside.
  − The UNIX-based NeXTStep was seen as a possible replacement for Mac OS, and in 2001 the first version of Mac OS X was released.
  − Apple switched from IBM/Motorola PowerPC processors to Intel x86 in 2007 due to IBM heat and supply issues.
Where We Are Today

- Microsoft is still around, and still selling Windows.
  - It's come a long way from the Macintosh knock-off of 1985, but many people still see it as clunky and bothersome.
  - But businesses like it, mainly because they liked it 20 years ago because it was cheaper than buying a bunch of Sun or SGI workstations, and switching is hard.
Where We Are Today

- GNU/Linux has grown from a conglomeration of various programmers’ pet projects into an operating system that sees heavy use in servers, and some use as a desktop OS.
  - At this point, GNU/Linux is probably more common than operating systems that are actually descended from the original UNIX.
  - Free and open-source clones of UNIX functionality combined with cheap and readily available commodity PC hardware allows users to have many of the features of the expensive UNIX workstations at a low price.
Where We Are Today

- Thanks to the free (as in freedom) nature of GNU/Linux, many different distributions exist. Some are free (as in beer), others, mostly geared toward large businesses are not.
  - Distributions such as Ubuntu and Linux Mint are aimed toward consumers, and are designed to be easy to install, and quick for Windows/Mac users to adapt to.
  - Debian (the CMU Computer Club's current distro of choice) is useful for servers and desktops, and more free (as in freedom) than some of the more consumer-friendly distros, but at the expense of being a little harder to set up and use.
  - Red Hat Enterprise Linux is a commercial GNU/Linux distro commonly used by large businesses. The main appeal of this distro (and reason for it costing money) is professional support.
Want to learn more?

- The club owns a substantial collection of home computers and gaming consoles from the 1970s through 1990s.
  - If you can think of it, it's highly likely we have it.
  - If we don't, and it's interesting, we might be able to acquire it.
- We also have a few operating retro servers in our Cyert Hall machine room:
  - A small cluster of DEC VAX and Alpha machines running OpenVMS.
  - An assortment of other VAX hardware mostly running NetBSD.
- If you have specific questions, feel free to ask me. If I know, I'll tell you. If I don't, I could try to research it.
- Or, you could...
Come to Demosplash 2014

- October 3-4, right on campus.
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- http://www.demosplash.org