Teaching the Internet of Things Has Just Become FAR More Interesting
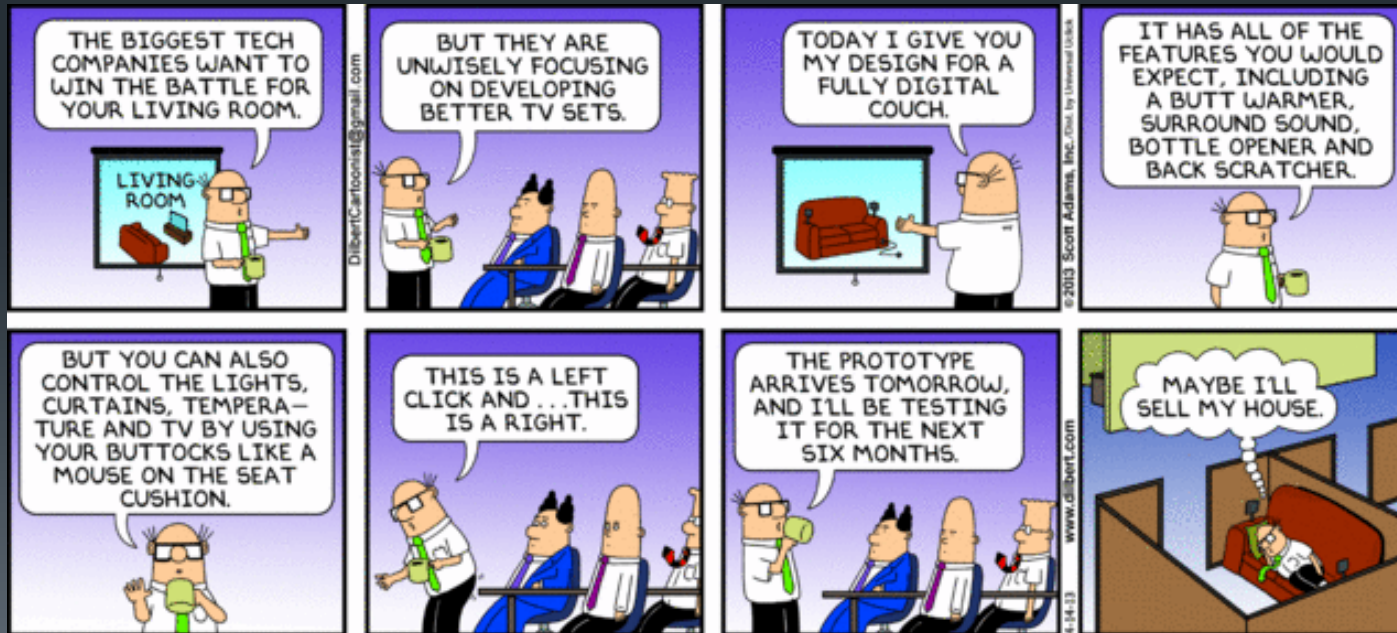
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Perspectives on
The Internet of Things

Why the Internet of Things Is Important to Teach

- The IoT Industry is advancing at a faster rate than anyone else has envisioned.
  - There are dozens of new devices being released all the time
  - The leveraging of "standard" protocols has been accelerated
  - The security issues STILL have not been addressed
    - In fact the more devices that are deployed, the more vulnerable we are
  - The "human" elements that IoT technologies influence are being ignored

More and More Players
Are Joining the Party

- Traditional IT Companies
  - Cisco
    - Has just introduced a new class into the Networking Academy curriculum
    - Packet Tracer v7 has incorporated a whole cadre of IoT devices
  - Microsoft
  - Apple
    - We think Apple has evolved to something beyond a traditional IT company
- Newer, smaller (more nimble??) IT Companies
  - TPLINK
  - DLink
  - Belkin (they even have a whole line … WeMo)
  - Nest (well, it was bought by Google … we may NOT want to talk about it)
  - Orvibo
  - There are literally hundreds of small company's making s*** using the same chipsets
    - What they all have in common … "Works with Alexia"

More and More Players Are Joining the Party

- Thingy Manufactures
  - Samsung
  - GE
  - Sylvania
  - Amazon
  - Google
  - Honeywell
  - Philips
  - Siemens Technologies
  - Allen Bradley
  - Leviton Lighting
  - Lutron Lighting
  - Carrier HVAC
  - Ecobee HVAC
  - Bose Audio
  - Logitech AV Controls
  - Schlage Locks
  - Kwikset Locks
  - … and many, many more

The IoT Landscape Has Changed

- 1st Generation
  - Discrete IoT Components controlling a limited set of devices
  - Even though common protocols were used (TCP/IP, Ethernet, Wifi, Bluetooth, Zigbee and ZWave) there were little to no interoperability.
    - Example … Phillips Hue lighting system still prefers to use their own controller
- 2nd Generation (today)
  - Manufactures, such as Samsung, are developing multiple device controllers using a common set of APIs to encourage development of integrated components using common communications and networking protcols.
- 3rd Generation (future prognostication on my part)
  - Common controller protocols and languages will enable true interoperabiliy

Challenges in Teaching
The Internet of Things

- You will need lots of "things"
  - The pieces are small, and individually, not expensive
  - However, you will need multiples of the "things"
- You will need specialized labs for the "things"
  - Because there are so many "things", it makes it difficult to setup/teardown labs for every class
- Students can come in from other programs with little to no networking background or experience
- "Buy-in" from the programs who would be using the "things"
- Instructors will need to have knowledge of the "things"
  - For example:
    - Thermostats – knowledge of HVAC
    - Media Distribution – knowledge of Audio/Video technologies
    - Lighting Controls – knowledge of electrical wiring and lighting design
    - VoIP – knowledge of the public switched telephone network
    - Home Security – knowledge of legal issues

Challenges in Teaching
The Internet of Things

- And the number one challenge …

SECURITY

- Both knowledge and teaching

The Internet of Things Will Attract New Students from Diverse Backgrounds

- Students from traditional Computer Science
  - In order to program IoT applications, they MUST understand the technology and their protocols
- Students from "Trade" Industries
  - Construction
  - Architecture
  - Plumbing and Electrical
  - Industrial Engineering
  - Aerospace
  - Manufacturing
  - Aviation (*think "Drones"*)

So ….
How Do We Approach IoT Curriculum

- We have found that we have two groups of students who need IoT
  - "Traditional" IT/Networking students
    - These students have, *probably*, already taken one or two IT classes such as A+, Network+, Cisco, etc
    - They have been exposed to general networking technologies, including Ethernet/WiFi, TCP/IP and resource sharing
  - Students from the "trades" mentioned on the previous slides
    - No IT or networking technologies

So …
How Do We Approach IoT Curriculum

- There needs to be both a "100-Level" and "200-Level" classes
  - 1st Year – 100-Level
    - Brings in the students with little or no experience in IT and Networking
  - 2nd Year – 200-Level
    - Course becomes more of a capstone course and assumes the students have fundamental networking concepts

IoT – As a First Year Class

- No Prerequisites
  - Picks up students from other programs
- Introduce basic concepts
  - Cable Construction
  - Basic Electronic and Instrumentation Concepts
  - Basic Networking
    - Wired
    - Wifi
    - Zwave, Zigbee
  - Audio / Video Distribution
  - Basic HVAC controls
  - Lighting Controls
  - Security and Surveillance
  - Controllers
  - Controller Application

IoT – As a First Year Class

- Controller Application
  - Raspberry Pi based
  - Home Assistant Software
    - Open Source
    - Extensive User Base
    - Great Documentation
    - Extensive Component Support
    - https://home-assistant.io/
  - Variety of IT fundamentals in the set up

IoT – As a First Year Class

- Controller Set-up
  - Download Image file and burn to microsd using Etcher
  - Create LAN
  - Connect network, keyboard and monitor to Pi
  - Power up – observe IP address
  - Use Putty to SSH in
  - Run Configs for Time Zone, Zwave, Samba Sharing and Nmap using Linux commands
  - Use Notepad++ to modify config.yaml file in the shared folder to add components
  - Test and iterate
  - Add automations

IoT – As a Second Year Class

- Has "recommended preparation" (hard prereqs can be problematic) classes or existing knowledge
  - A+
  - Network+
  - Cisco CCNA Semester 1
  - … and it is helpful if they have:
    - Wireless technologies
    - Virtualization (VMware)
    - Storage and Cloud techologies

IoT – As a Second Year Class

- Take the basic concepts and expand with …
    - More in-depth hands-on labs
    - Discussion of protocols and their implication
        - For example, using Wireshark to do packet and traffic analysis
    - Team-level working with associated technology areas
        - Architecture
        - Construction
        - HVAC and Environmental Systems
        - Interior Design
    - System-level design and integration
    - Large scale practicum

IoT – As a Second Year Class

- Controller Applications
  - Use commercial and industrial microcontrollers
    - Samsung
    - Wink
  - Using the IDEs design and implement custom skills
    - Program an integrated activity that can be initialed by voice command through the Amazon Echo or the Google Home

IoT – As a Second Year Class

- Security and Advanced Networking
  - VPN Access
    - OpenVPN on open-source DD-WRT routers and Raspberry Pi's
  - IoT Appliances / Storage Services
    - Steaming media services
    - CODECs and Encryption
    - Voice Over IP
    - Network Attached Storage

Approaching the Internet of Things In the Classroom

- Some IT classes that would benefit from adding IoT curriculum
  - Comptia A+, Network+ and Security+
  - Cisco Semester 1 (Introduction to Networking)
  - Voice Over IP
  - Ethical Hacking (actually, ALL security classes)
  - Fundamentals of Wireless ← Hyper-Important
- If you had a Digital Home Technology or Residential Networking class it could easily be repurposed for an IoT class

Approaching the Internet of Things In the Classroom

- There are FANTASTIC opportunities to establish relationships with other departments and programs
  - Architecture
  - Construction Technologies
  - HVAC
  - Electronics
  - Interior Design
  - Health Care Information
  - Digital Media Arts
  - Aviation Science and Unmanned Arial Systems

In Conclusion

The **Internet** gave us the opportunity to connect in ways we could never have dreamed possible.
The **Internet of Things** will take us beyond connection to become part of a living, moving, **global nervous system**.

Whether you are an individual, technology developer, or adopter of these technologies, the Internet of Things will stretch the boundaries of today's systems. *Are you prepared for the changes in the way we will learn, work, and innovate?*