ENTERPRISE COMPUTING—SYSTEM-LEVEL THINKING, MUCH MORE THAN AN IT DATA FOCUS, AND PEDAGOGICAL AND CAREER IMPERATIVES TO INCLUDE SUCH TOPICS IN IT CURRICULA

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WHAT IS ENTERPRISE COMPUTING?

Fundamentally, and its reason for existence, systems that handle vast quantities of data that must be available to end users anytime, anywhere, and on any device, error-free and properly source-synchronized, all with the intention of being continuously protected from threats.

To that end it is:

- A large system, much bigger than SOHO and SMB deployments
- A multi-tiered architecture, with enterprise hardware (mainframe servers!) on the back end
- A physically expansive system, with footprints sometimes covering many acres of property
- A power-hungry construct, sometimes exceeding local power sourcing capacity
- A heat producing construct, almost always requiring external cooling capacity
- A system housed in a facility requiring protection from natural and man-made threats, while permitting access by authorized persons
- In most cases, a system split among multiple geographic locations for the purposes of data replication and disaster-recovery scenarios

WHAT IS ENTERPRISE COMPUTING?

- It is also:
- A paradigm that has a multitude of employment possibilities for our students after graduation
  - From the enterprise server (mainframe requirements), there are job functions relating to the programming and maintenance of the hardware and software attributes of the system
  - Potential job applicants will be much-better positioned in the interview process by having infrastructure knowledge of large-scale systems
  - For graduates with a penchant for programming and application development, the COBOL programming environment is alive and well AND THRIVING in the enterprise arena. This language is seldom taught in universities today and MUST be brought back into IT curricula.
- A paradigm where students with other technical interests can merge their talents with traditional IT and be that much more valuable.

The bottom line, and what got me personally enthused about large-scale computing:

According to the Bureau of Labor Statistics, IT-related occupations are growing at a 12% rate, faster than ALL other occupations, with a median salary of $82,860.00 compared to $37,040.00 for ALL other occupations. The specific jobs listed are mostly related to large-scale enterprises.

In "The Most New Jobs" category, "software developers, applications", "computer systems analysts", were listed in the top 20 newest occupations, and these specifically relate to systems computing.

"The programming languages most often used are C, C++, and Java, with Fortran and **Cobol** used less commonly". [Less commonly when referenced to ALL software written, but is used universally in the financial and large database spaces. This author's comment] As an example, M&T Bank uses 1.6 million lines of COBOL code in their banking software applications.

Anecdotally, this author has heard from numerous students, either after co-op placement Or graduation, that they wished they would have had this systems knowledge as they Were convinced they would have been more effective on the job.

Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Outlook Handbook, 2016-17 Edition*, Computer and Information Technology, on the Internet at https://www.bls.gov/ooh/computer-and-information-technology/.htm (visited *June 01, 2017*).

WHY IS THE JUSTIFICATION OF SYSTEM TOPICS IMPORTANT?

- There is more to "IT" than the data! While that data is the ultimate rationale for the presence of IT, IT cannot exist without many support functions.
- Classic IT curricula are based upon five defined (ACM model IT curriculum) pillars of knowledge (in no particular order):
  - Programming
  - Database
  - Networking
  - Web
  - Human-Computer Interaction
- System (some might define as "engineering") topics were deemed to be out of the IT curricular scope.

WHY IS THE JUSTIFICATION OF SYSTEM TOPICS IMPORTANT?

- Enterprise IT is a complex system requiring skills from many domains.
- The IT system domain consists of too much knowledge for any one person's competency.
- People with skills from many trades are required to build commission, operate, maintain, upgrade, and ensure the safety of these systems (and, of course do the "IT" handling and dissemination of the DATA—the classic IT job).
- Pure IT professionals (our graduates!) need to understand and at least be conversant when communicating with those people at all times.
- System-level analyses require critical thinking processes in multiple domains, supporting a crucial learning outcome in our program when attained by the students.

DATACENTER OPERATIONS COURSE DESCRIPTION

“This course provides students with a background in the technologies and techniques used to design, implement and maintain a modern data center. This course will help students to see the interrelated nature of many of these topics and to gain a better understanding of the role of the following technologies in a modern data center: physical facility design, network infrastructures, power distribution, heating, ventilation and air conditioning (HVAC), storage, high-availability computing, disaster recovery, and emerging datacenter technologies.”

CLASSIC "IT" TOPICS IN THE DATACENTER OPERATIONS COURSE

- Introduction to data centers
- The role of data centers in organizational computing strategies
- Physical facility design
- Data center requirements
- Alternative models
- Application and data characteristics
- Floating point operations
- Transaction processing
- Input/output requirements
- Storage technologies
- Emerging datacenter technologies

SYSTEM LEVEL TOPICS IN THE DATACENTER OPERATIONS COURSE

- Green computing and facility design
- Fault tolerance
- Network infrastructures
- Power distribution
- Heating, ventilation and air conditioning (HVAC)
- Large scale computing architectures
- Reliability, availability, and serviceability
- High-availability computing
- Clustering technologies
- Disaster recovery
- Replication requirements
- Rules and regulations

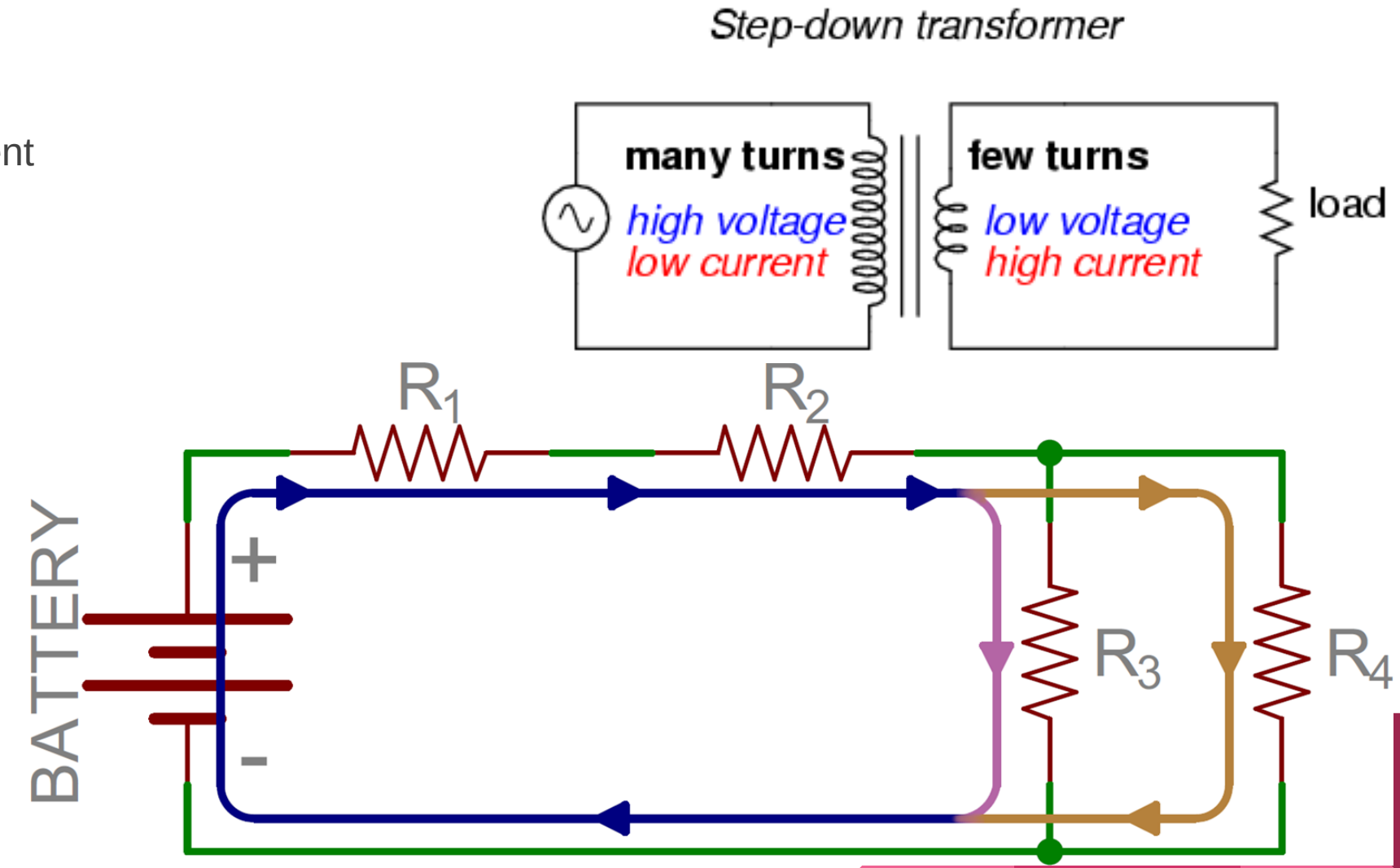
What I learned in Data Center Ops is…(blankety…blankety…blank)

By: Peter Steinberg

Used by permission. Peter was a student in NSSA425-2165

Physics

Transformers: voltage vs current



Power (it ain’t clean)

Flywheel/Battery Backup

Redundancy

More Redundancy

Safety

Fire suppressants

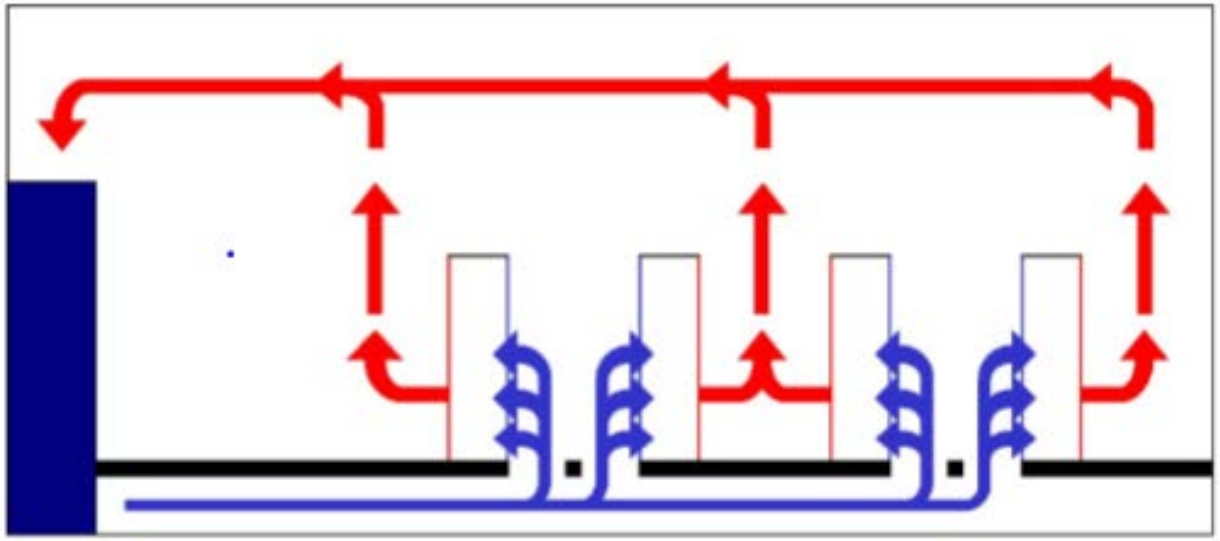
Arc Flashes

Cooling

Hot-Aisle/Cold-Aisle

Raised floors

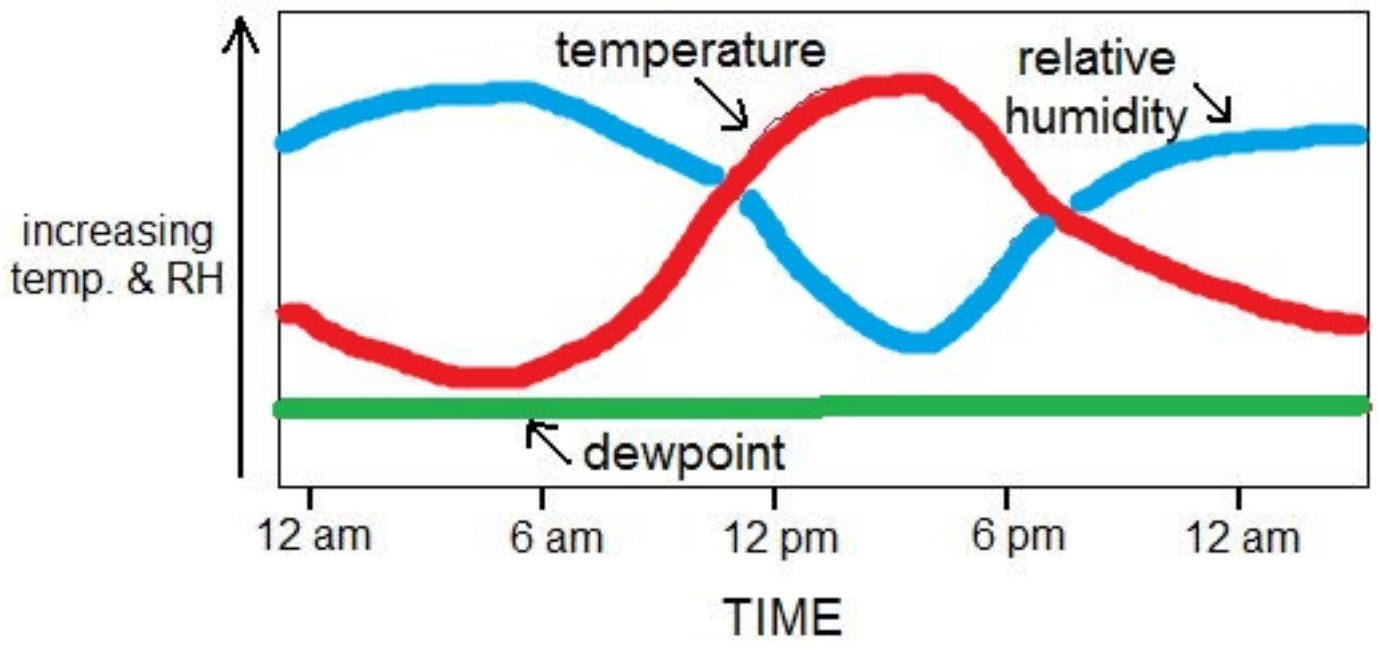
Sensors



Temperature

Location Location Location

Dew Point and Relative humidity: monitor it



Datacenter Operations & Me

What I learninated in NSSA 425.

By: Morgan Harvey

Used by permission. Morgan was a student in NSSA425-2165

Math!

- One thing you always wonder in class:
  - ‘When the hell will I ever need this?’
- Being able to math is a very important skill/tool in datacenter operations!
  - Practice makes perfect.

Physics!

- Knowing proper energy requirements to operate the datacenter is crucial.
- Ensuring the facility and equipment can handle fluctuations in power is required to ensure continual operation.
- More math!

Thermal Dynamics!

- A lot more thought and planning needs to go into cooling a datacenter than just ‘lets get the heat out.’
- Hot aisles and cold aisles!
  - Where do you want to keep your pizza warm?
- What type of cooling do you want?
  - Air?
  - Water?
  - Refrigerant?

Meteorology!

- Weather matters!
- Knowing what kind of fronts are en route will allow you to ensure the facility is ready.
  - This could include:
    - Raising/lowering the HVAC output.
    - Getting (de)humidifiers prepped.
    - In extreme circumstances, bracing for impact!

Geography!

- Location! Location! Location!
- Where you put your datacenter is as important as what you put inside it.
- All locations will have some sort of natural disaster potential.
  - Know what kinds of disasters can happen where your datacenter is located and take the appropriate measures to be ready for when they hit.

Nephology!

- No matter where you look, there will be clouds!
- There are many ways for datacenters to scale out into the cloud.
  - SaaS, IaaS, PaaS, DRaaS, XaaS….

Just because it's there doesn't mean you have to use it.

Safety!

- Arc Flashes are (not) fun!
  - Especially in Russia!
- Make sure you are always following safety code.
  - They are there for a reason!