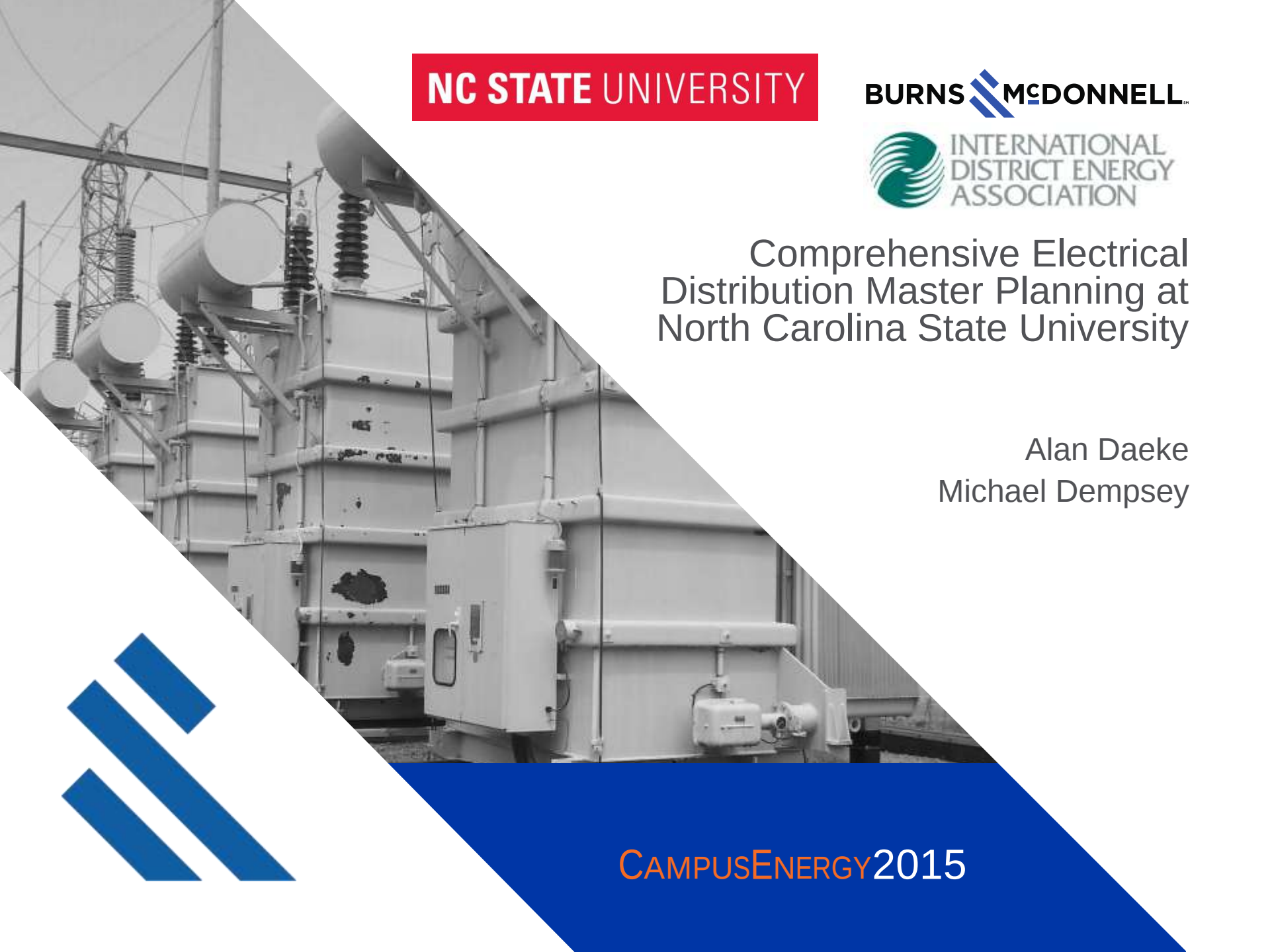




NC STATE UNIVERSITY

BURNS  **McDONNELL**

 **INTERNATIONAL
DISTRICT ENERGY
ASSOCIATION**

Comprehensive Electrical Distribution Master Planning at North Carolina State University

Alan Daeke
Michael Dempsey



CAMPUSENERGY2015



Agenda

- Campus Overview
- Overview of Existing System
- Project Goals
- Project Challenges
- Existing System Issues
- Electrical Master Planning Process
- Proposed System Configuration
- Questions & Answers

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Campus Overview

North Carolina State University

- ▶ Land Grant University
Founded in 1887
- ▶ 12 Colleges
- ▶ 31,000 Students
- ▶ 8,100 Faculty and Staff
- ▶ 12.9 million square feet of facilities
- ▶ 2,000 acres on 3 Main Campuses in Raleigh



Overview of Existing System

- ▶ Sullivan Substation – Progress Energy Carolina Connection
- ▶ Two Transformer Banks
 - One Old - 1964 Vintage – Four 16.67MVA Units
 - One New – Installed 2012 – One 50MVA Unit
 - All Load Served by New Transformer
- ▶ Four Express Feeds to Central Plants
 - Two Feeds to Cates
 - Two Feeds to Yarbrough
- ▶ Four Express Feeds to Bragaw Switchyard
 - Seventeen Feeders to North and Central Campuses



Project Goals

- ▶ Develop long term plan to replace aging cable and switches (oil filled)
- ▶ Establish utility corridors
- ▶ Prepare for self healing/smart grid technologies
 - Standardize SCADA hardware and functionality
- ▶ Gain stakeholder support on campus

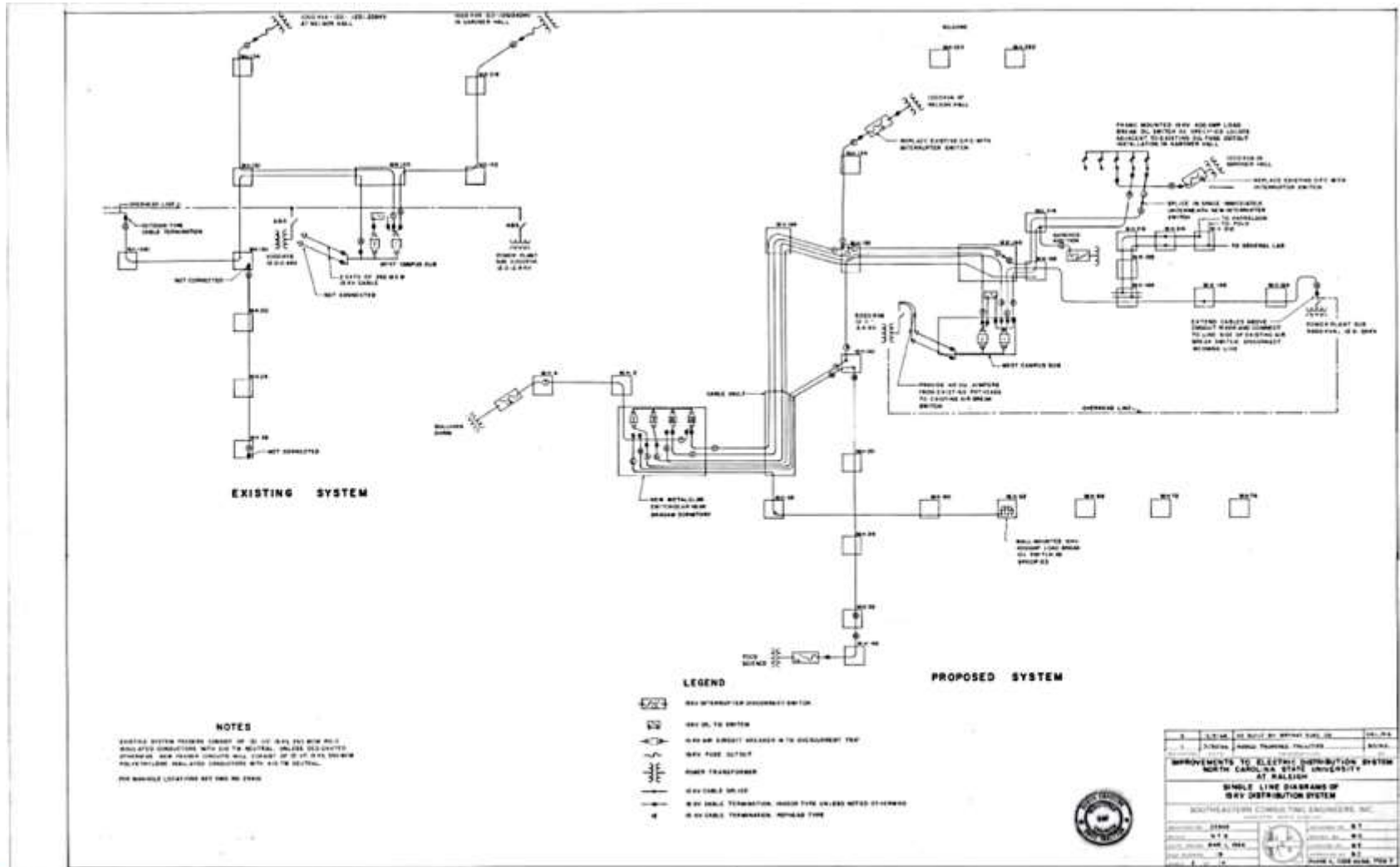


Project Challenges

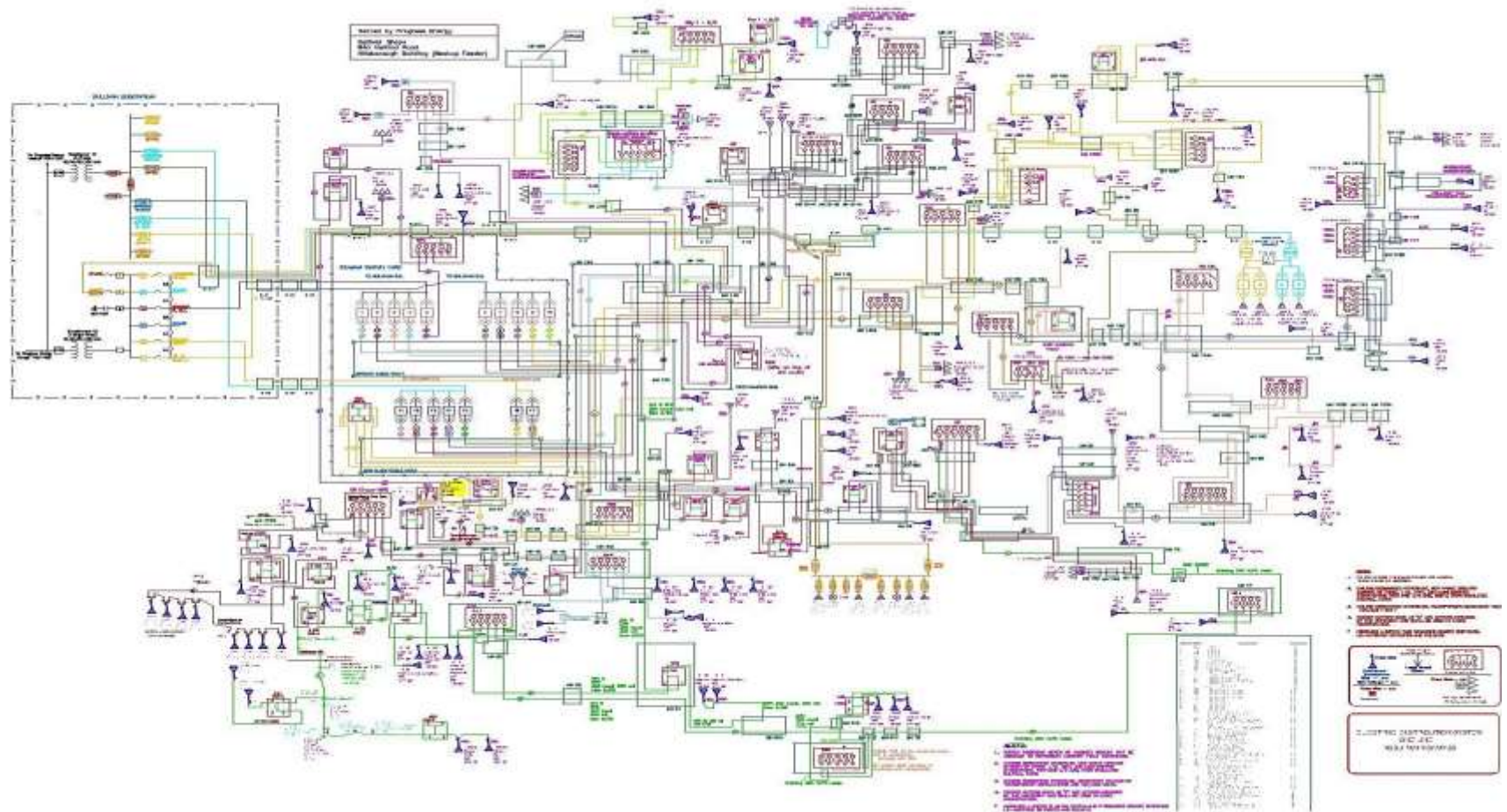
- ▶ 50 year growth without HV master plan
- ▶ System age: cable, distribution switches
- ▶ Concrete encased fiber ductbank
- ▶ Complex system arrangement – multiple circuits connected
- ▶ Out of sight/out of mind
- ▶ No funding or donors available to implement plan!



Life was Good Back in the 1960's

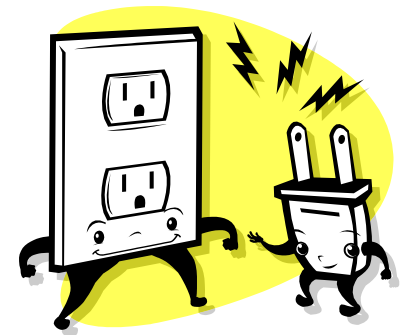


50 Years of Growth Presents Challenges



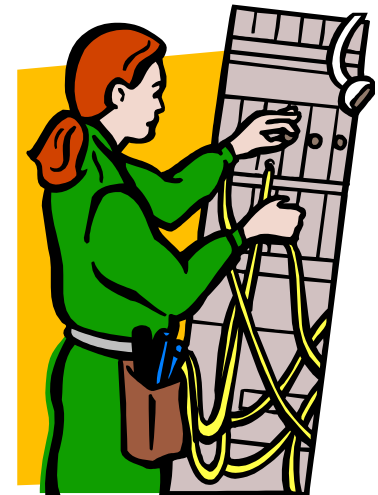
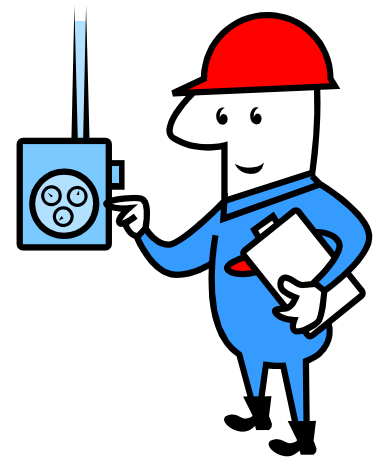
Existing System Issues

- ▶ Equipment and Infrastructure Age
- ▶ Reaching End of Useful Life
- ▶ Bragaw Switchyard – Air-Magnetic Breakers
- ▶ Switchgear and Cable Dating Back to 1960's
- ▶ Ductbank Dating Back to 1950's
- ▶ Fiber Ducts Collapse
 - Can't Remove Old Cable or Install New Cable



Existing System Issues

- ▶ Feeder Configuration
 - Many Nested Connections
 - Expanded Over Time
 - Not Optimized
- ▶ Complicated Switching Schemes
- ▶ Potential for Overload
- ▶ Switches in Manholes Dangerous to Operate
 - Confined Spaces
 - Required to be Deenergized

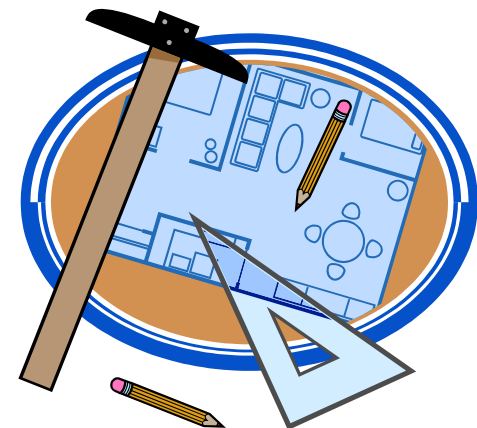


Bottom Line – Need to Untangle the Spaghetti

Master Planning Process

- ▶ Survey Existing System Conditions
- ▶ Identify Single Points of Failure
- ▶ Develop Campus Load Profiles
 - NCSU Meter Data
 - PEC Meter Data
- ▶ Analyze Proposed Building Additions and Renovations
- ▶ Plan Future System
 - Configuration
 - Capacity
 - Redundancy

NORTH CAROLINA STATE UNIVERSITY'S 2013 ELECTRICAL USAGE						
PROGRESS ENERGY METER DESCRIPTION						
LOCATION	ADDRESS	ACCOUNT NUMBER	METER ID	TOTAL USAGE (kWh)	MONTHLY MAX DEMAND (kW)	2013 USAGE DATA
Main Campus - Res Annex	169 LIGON ST #B RALEIGH, NC	860-972-6276	T14815	136,820	17,790	97
Medicine Office Bldg	169 LIGON ST #C RALEIGH, NC	860-966-5059	T18744	7,860	1,120	8
Main Campus 6	3200 LIGON ST RALEIGH, NC	657-672-6171	T14158	176,760	18,700	99
NCSU Bldg	3220 LIGON ST RALEIGH, NC	866-991-1777	T14036	145,320	18,000	60
Small Animal Res	3220 LIGON ST RALEIGH, NC	319-772-6176	T10463	53,760	5,300	28
Aquatic Res Main Campus	3220 LIGON ST RALEIGH, NC	277-687-7953	PG4787	1,027	110	0.2
Laboratory	3223 LIGON ST RALEIGH, NC	867-976-0863	T16984	149,880	17,850	64
Reynolds Plz Main Campus	3223 LIGON ST RALEIGH, NC	373-772-6173	166363	918	173	0.3
Genetics Res Fac	3225 LIGON ST RALEIGH, NC	184-372-6176	931548	6,771	1,047	7
Genetics Res Bldg	3226 LIGON ST RALEIGH, NC	184-372-6176	T28976	1,299	173	0.3
Reynolds Plz Family Club	4200 HILL SBOROUGH ST RALEIGH, NC	752-523-3116	043311	2,171	361	1
Faculty Rec Center	4200 HILL SBOROUGH ST RALEIGH, NC	577-933-3367	T135816	110,240	26,720	101
Turf Center	4200 HILL SBOROUGH ST RALEIGH, NC	664-933-2860	T12263	52,840	7,990	26
Greenhouse Beryl Rd 3	4301 BERYL RD RALEIGH, NC	359-182-6174	TC4062	34,070	4,760	11
ARB Garden Ponds	4301 BERYL RD RALEIGH, NC	359-182-6170	043358	3,852	1,085	2
Reynolds Beryl Rd	4301 BERYL RD RALEIGH, NC	761-651-2253	043355	7,719	1,042	2
Greenhouse 2	4301 BERYL RD RALEIGH, NC	645-130-6448	T13010	85,560	8,520	22
Greenhouse 411 CHK 08-06	4301 BERYL RD RALEIGH, NC	370-282-6172	043349	4,063	646	1
Greenhouse 430	4301 BERYL RD RALEIGH, NC	671-628-8903	043336	9,375	1,626	2
Greenhouse 435 Arboretum	4301 BERYL RD RALEIGH, NC	666-904-5893	043350	16,645	2,139	5
Greenhouse Beryl Rd	4301 BERYL RD RALEIGH, NC	669-972-6174	043354	14,835	1,764	3
Greenhouse Beryl Rd 2	4301 BERYL RD RALEIGH, NC	148-872-6173	043353	2,358	361	1
Greenhouse Blvd Rd	4301 BERYL RD RALEIGH, NC	683-972-6171	T12177	50,420	5,300	12
Greenhouse Pole by 431	4301 BERYL RD RALEIGH, NC	799-082-6178	043351	3,244	1,354	2
Recreational Center	4301 BERYL RD RALEIGH, NC	664-082-6172	043352	8,426	1,254	2
Bray CPP 12-05	4301 BERYL RD RALEIGH, NC	683-674-4992	554354	1,548	303	1
Pump On CHK 01-05	4301 BERYL RD RALEIGH, NC	386-182-2993	T146055	3,250	2,000	9
Reynolds Research	4301 BERYL RD RALEIGH, NC	671-125-7547	043359	18,344	6,203	16
JC Raulston Arboretum	4413 BERYL RD RALEIGH, NC	770-244-9439	T13107	181,360	17,200	60
Biological	4700 HILL SBOROUGH ST RALEIGH, NC	358-043-3369	563462	1,065	165	0
MT RD SVC	612 BIRCHDALE DR RALEIGH, NC	287-617-6383	T147418	847,700	80,720	192
Main Campus 3	620 HUFFTON ST #104 RALEIGH, NC	163-493-4762	T12949	297,280	32,360	111
Conditional PWR	840 METHOD RD RALEIGH, NC	421-986-2509	T109531	866,800	43,090	116
Reynolds 1 Main Campus	840 METHOD RD RALEIGH, NC	676-242-4292	T14865	1,531,460	123,610	252
Reynolds 4 Main Campus	840 METHOD RD RALEIGH, NC	415-342-4298	T147417	485,360	53,260	106
Main Campus 2	840 METHOD RD RALEIGH, NC	860-132-4291	T138111	487,480	52,090	119
Reynolds 2	865-638-7743	048431	554	554	15	0
Soccer Field Seasonal	METHOD RD & LIGON ST RALEIGH, NC	688-628-3880	VF4403	1,209	124	0
Greenhouse Main Campus	METHOD RD RALEIGH, NC	125-052-4293	T18952	493,200	53,490	122
Reynolds 10 West Conn Lib	WESTERN CONTROL LABS LIGON METHOD, NC	292-548-3881	T17792	170,320	17,640	42
Main Campus 4	WESTERN & GORMAN NORTH RALEIGH, NC	202-632-4296	OV5492	9,166	967	2
Main Campus	WESTERN & GORMAN S-SIDE RALEIGH, NC	321-647-4407	555008	17,395	1,985	3
Reynolds Main Area	FALSE	592-172-6179	T10807	24,320	4,390	10
TOTAL USAGE						
MINIMUM				652		
MAXIMUM				1598		



Master Planning Process

► Loop Design

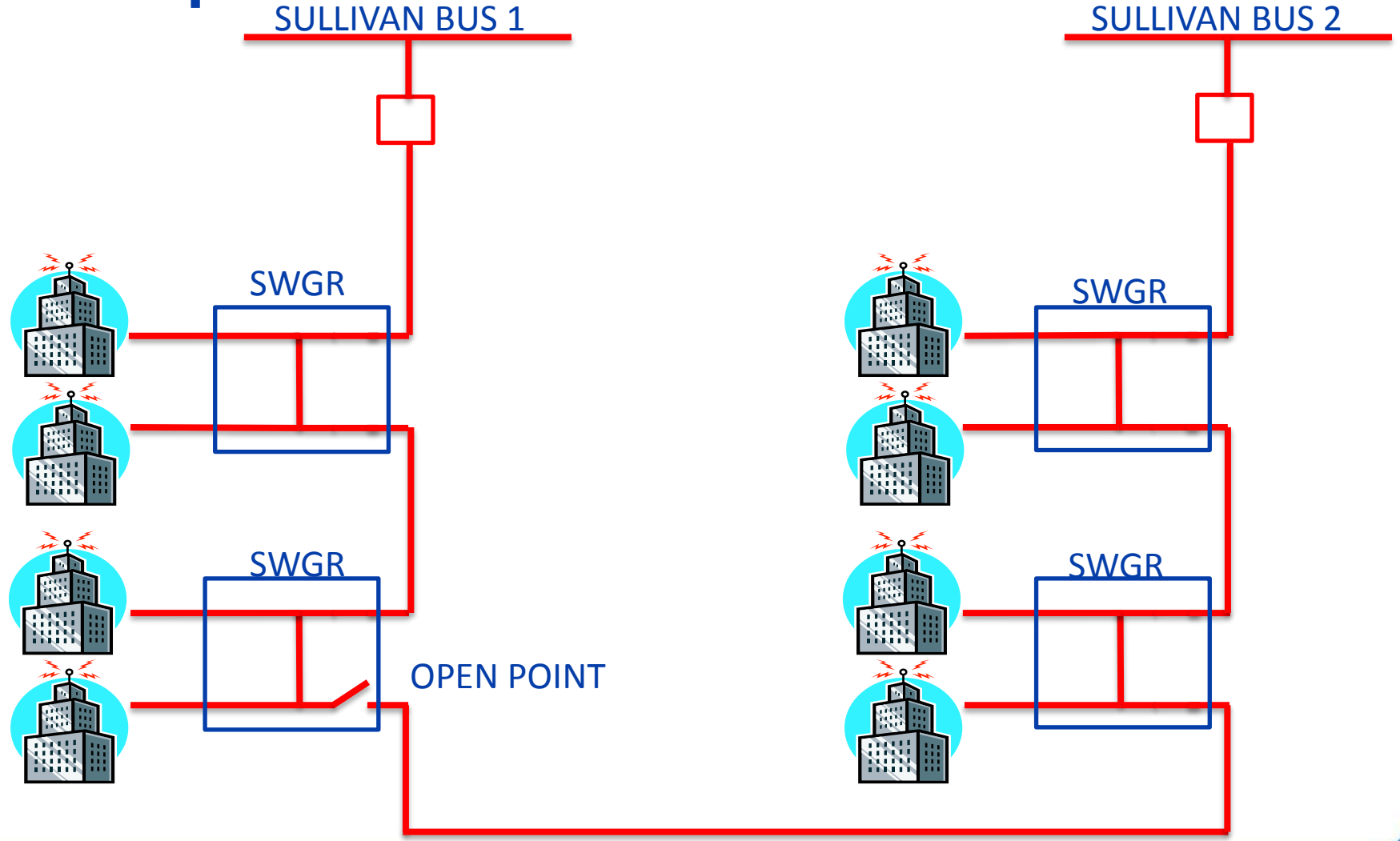
- Two-Way Feed – Normal Operation
- Sized for One-Way Feed – Redundant
- Normal Open Point – Middle of Loop
- One Loop = Two Feeders

► Develop Standardized Loop Feeder Cable Sizing

- Based on Future Loading Calculations
- Derate for Ductbank Installation
- Safety Factor for Unplanned Growth

XFMR name	Old Feeder	Building	Future Estimated Demand [kW]	Future Estimated Demand [A] .85 PF
T00751	P-3	David Clark	465	25
T00761	K-13	Fox Science Teaching Lab	485	26
T00782	M-7	Nelson	219	12
T00691	K-13	Kilgore Hall (backup from feeder 7)	168	9
T00682	K-13	Scott Addition (backup from feeder 7)		0
T00681	K-13	Scott Hall (backup from feeder 7)	526	29
T067A1	F-8	Bostian	288	16
T00701	D-5	Phytotron	1593	87
T00671	D-5	Gardner	583	32
T00721	D-5	Biological Resources	160	9
T0067B1	F-8	Thomas Hall	844	46
T00601	E-6	Dan Allen Parking Deck	68	4
Txxx		Academic Teaching Facilities Nelson	76	4
		Total	5475	298
		Total .8 Diversity	4380	239

Loop Automation

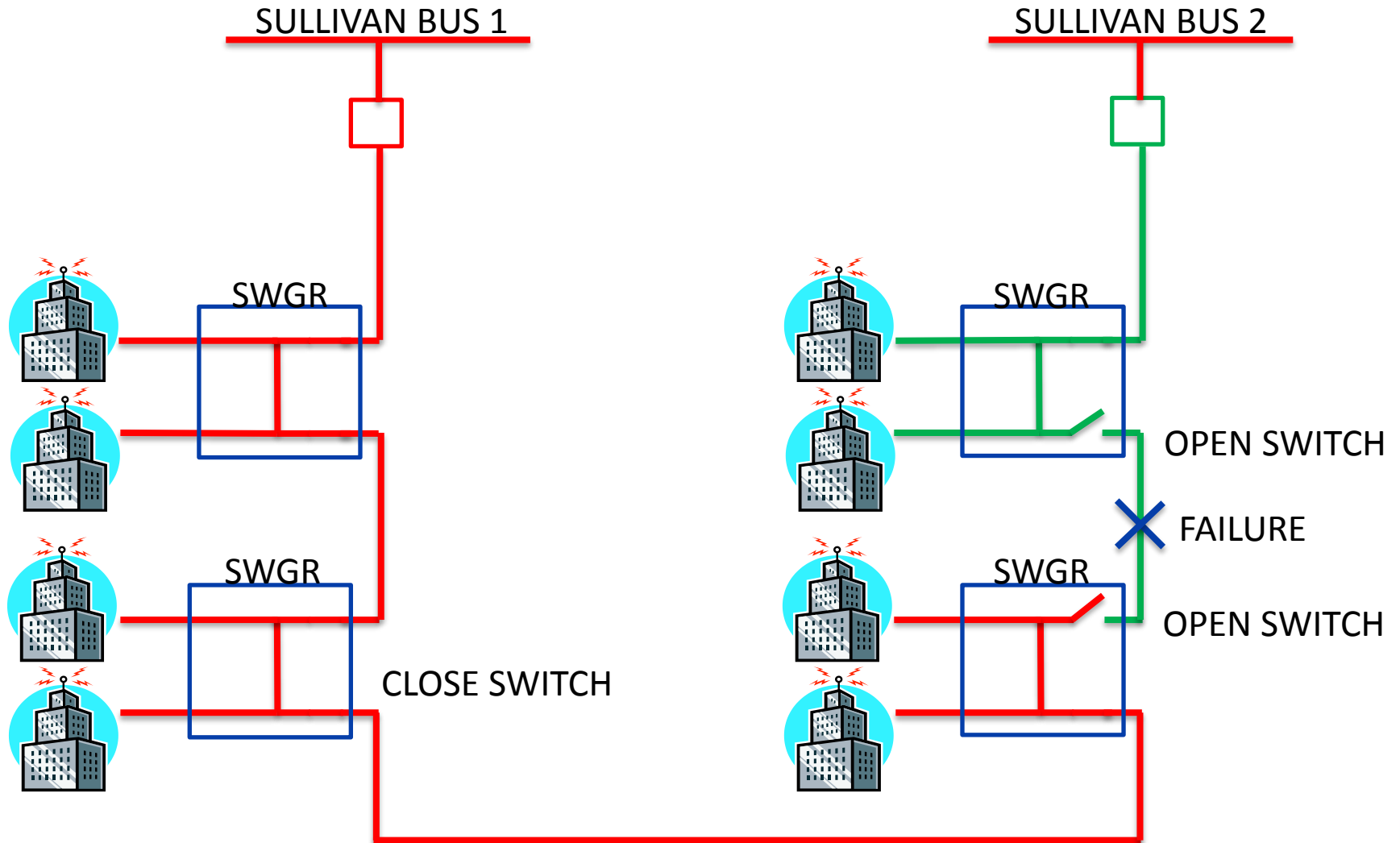


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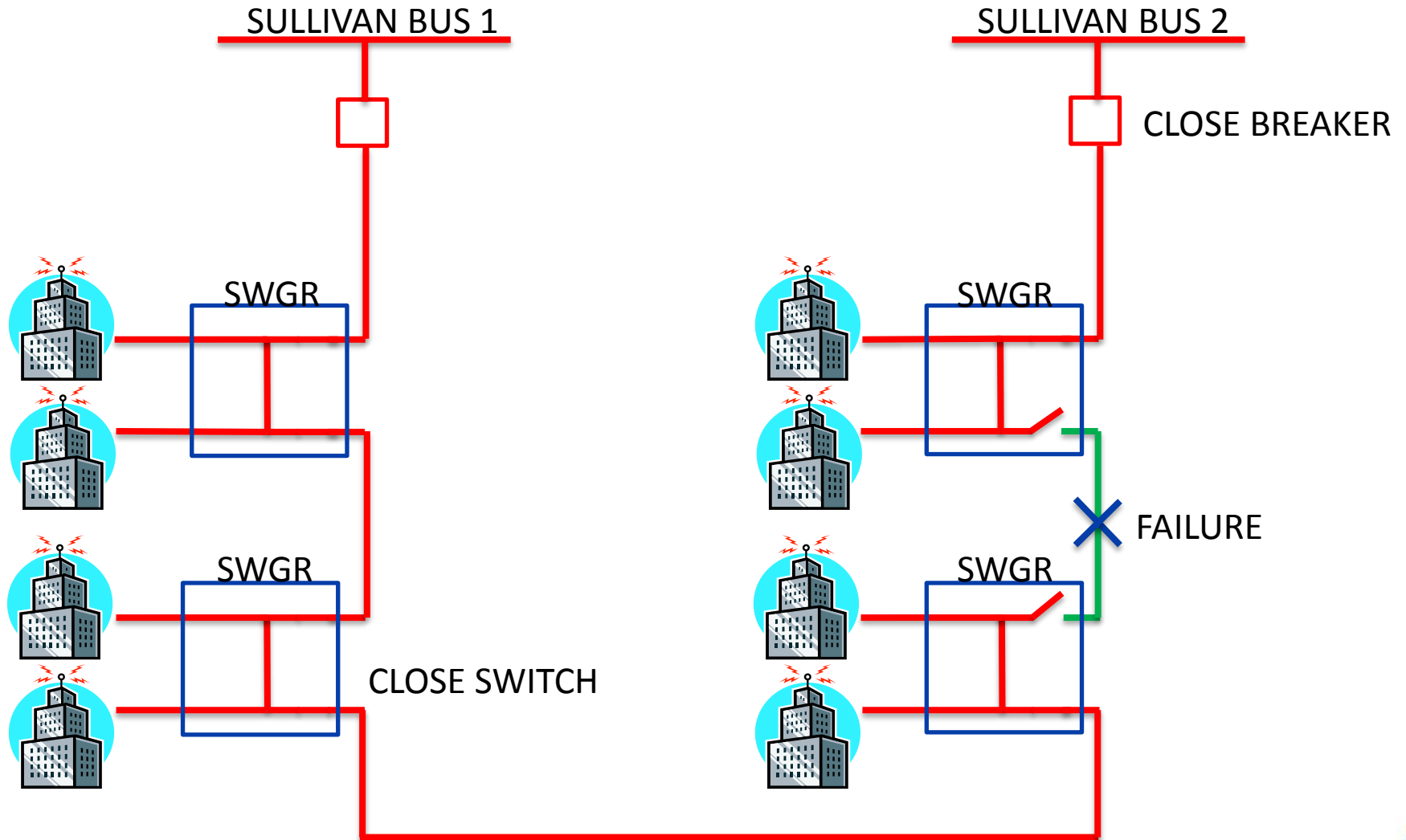
Loop Automation – Feeder

Restoration



Loop Automation – Feeder

Restoration



Proposed System Configuration

- ▶ Serve Future Building Load
- ▶ Serve Future Building Renovations – Load Reduction
- ▶ Feeder Loops – Evenly Loaded
 - North Campus – Three Loops
 - Central Campus – Three Loops
 - West Campus – One Loop



Ductbank Design

- ▶ Standardized Configuration
- ▶ 6" Diameter PVC
 - Won't Collapse
- ▶ Nine Conduit Configuration
 - 3 X 3 Configuration
 - 2" Conduits for Fiber
- ▶ Precast Manholes
- ▶ Separate Feeder Loops
- ▶ New Ductbank Corridors



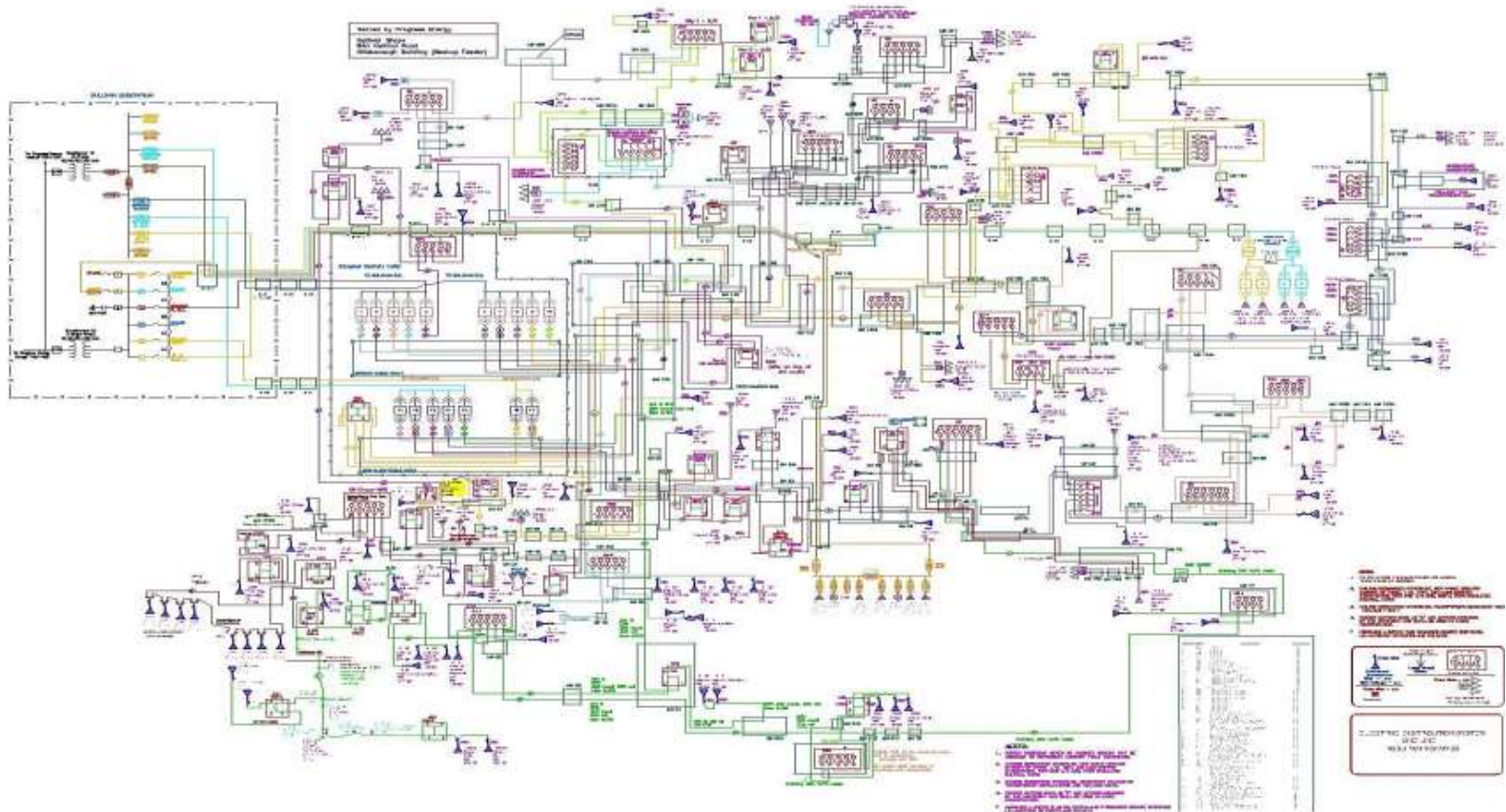
SCADA Design

- ▶ Standardized Configuration
- ▶ Supervisory Control and Data Acquisition
 - Remote Control and Monitoring
 - Reduce Outage Durations
 - Improve Operator Safety
- ▶ Building Meters
 - Nexus 1262 – Current Standard



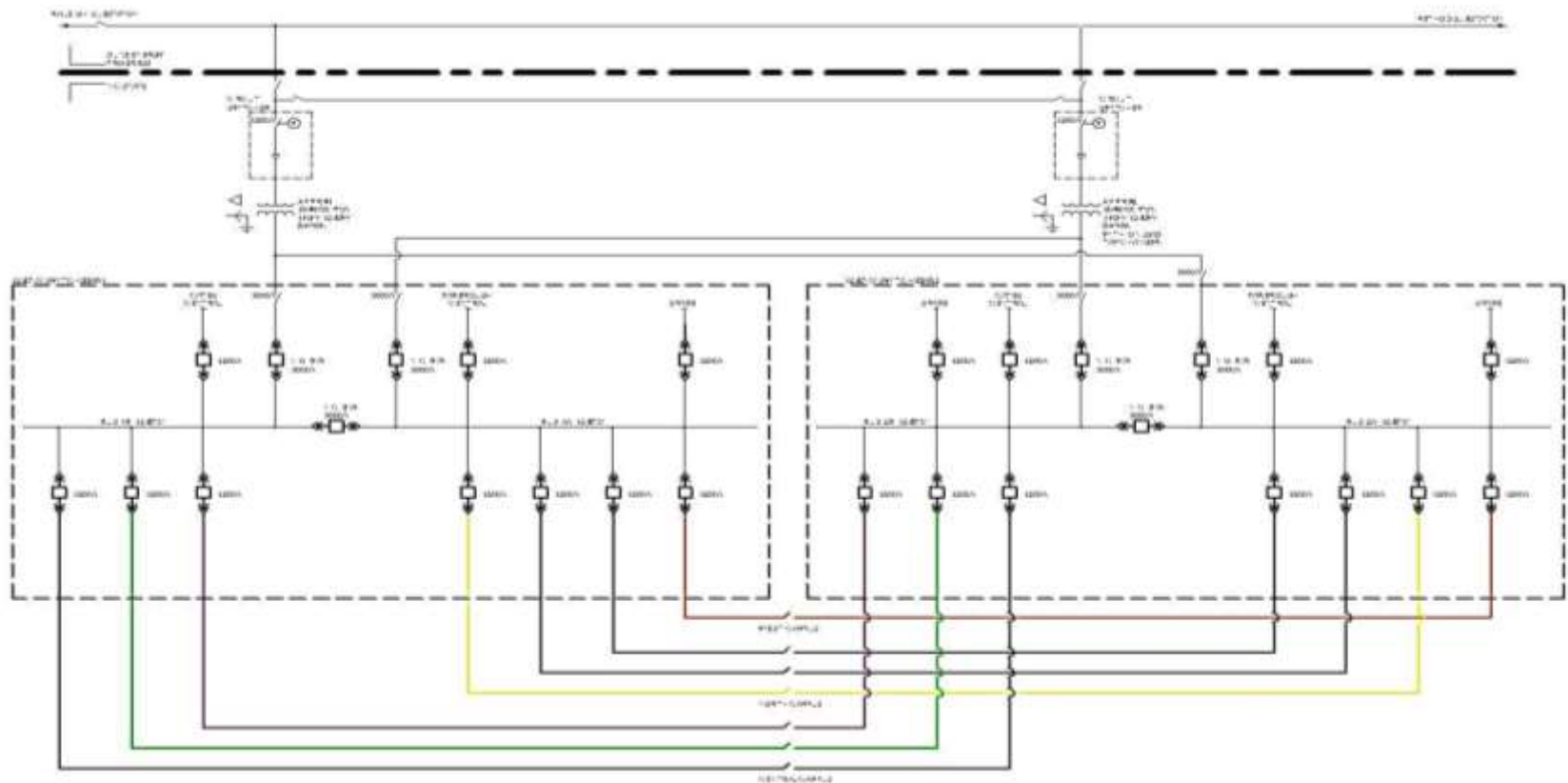
Proposed Solution

Remember the Before System:



Proposed Solution

Now the After System:



Proposed Solution

- ▶ Simplified Design
- ▶ Phased Installation Approach
- ▶ Three Loops North Campus
- ▶ Three Loops Central Campus
- ▶ One Loop West Campus
- ▶ Upgrade Sullivan Substation Bank 1 Secondary Metalclad Switchgear
 - Already Planned Upgrade
- ▶ Replace Ductbank Corridors

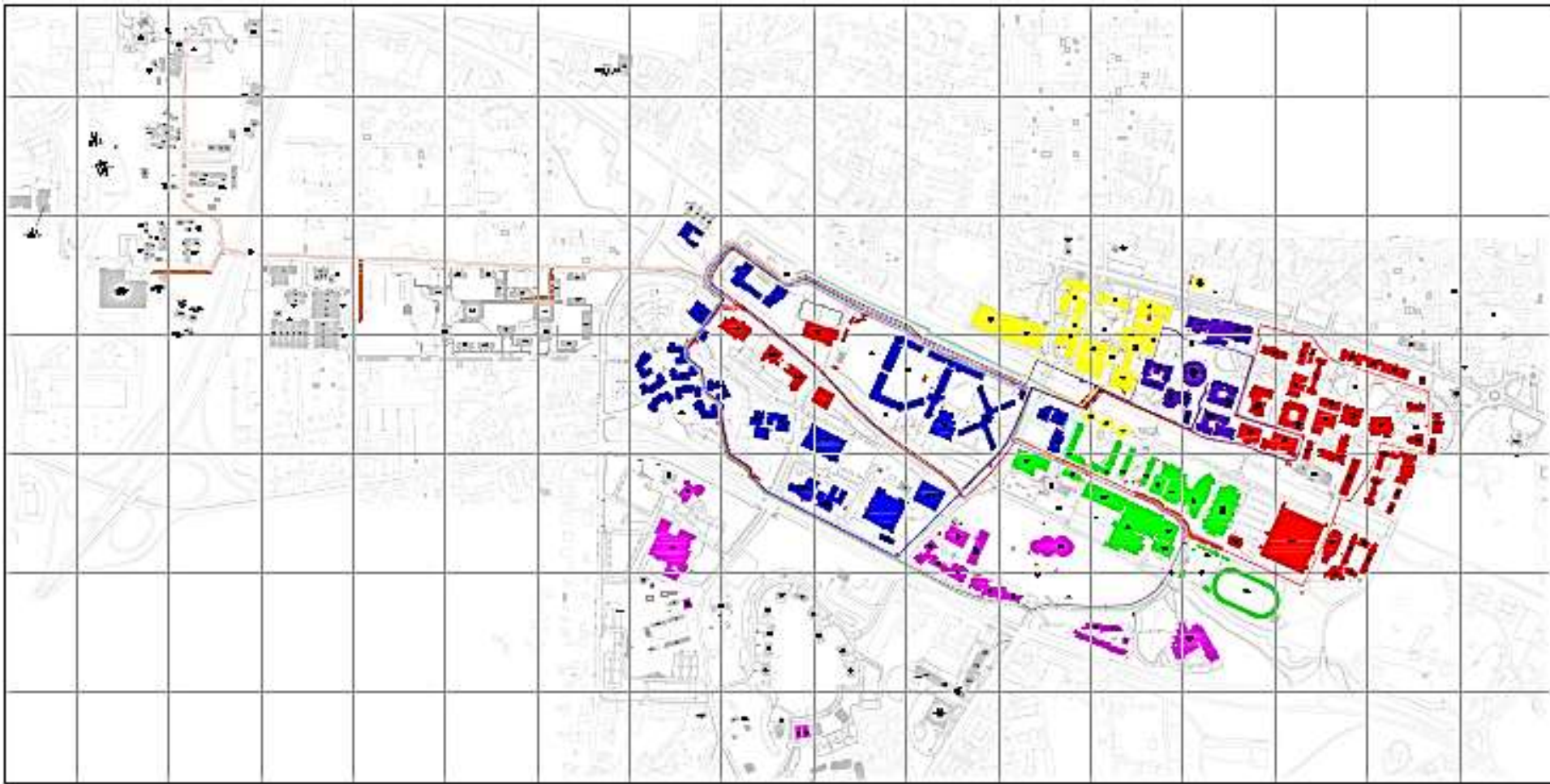


Stakeholder Charrette

- ▶ Campus Architect
- ▶ Operations
- ▶ Environmental Health and Public Safety
- ▶ Landscape Architect
- ▶ Communication Technologies
- ▶ Capital Project Management
- ▶ Housing
- ▶ Dining
- ▶ Athletics



Overall Ductbank Corridors – Post Charrette



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