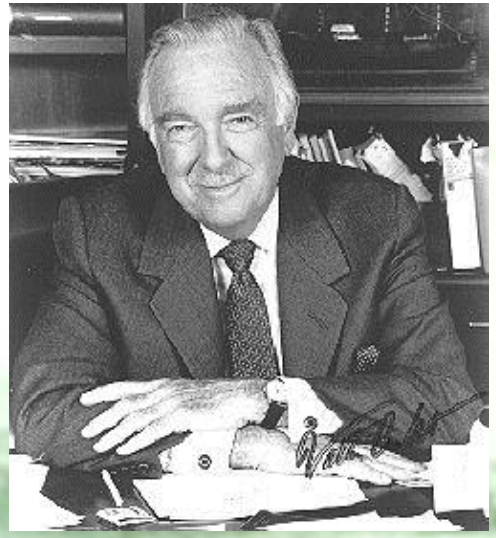
Basic Building Blocks of a Smarter Grid

February 9, 2015

THE CHATTANOOGA STORY

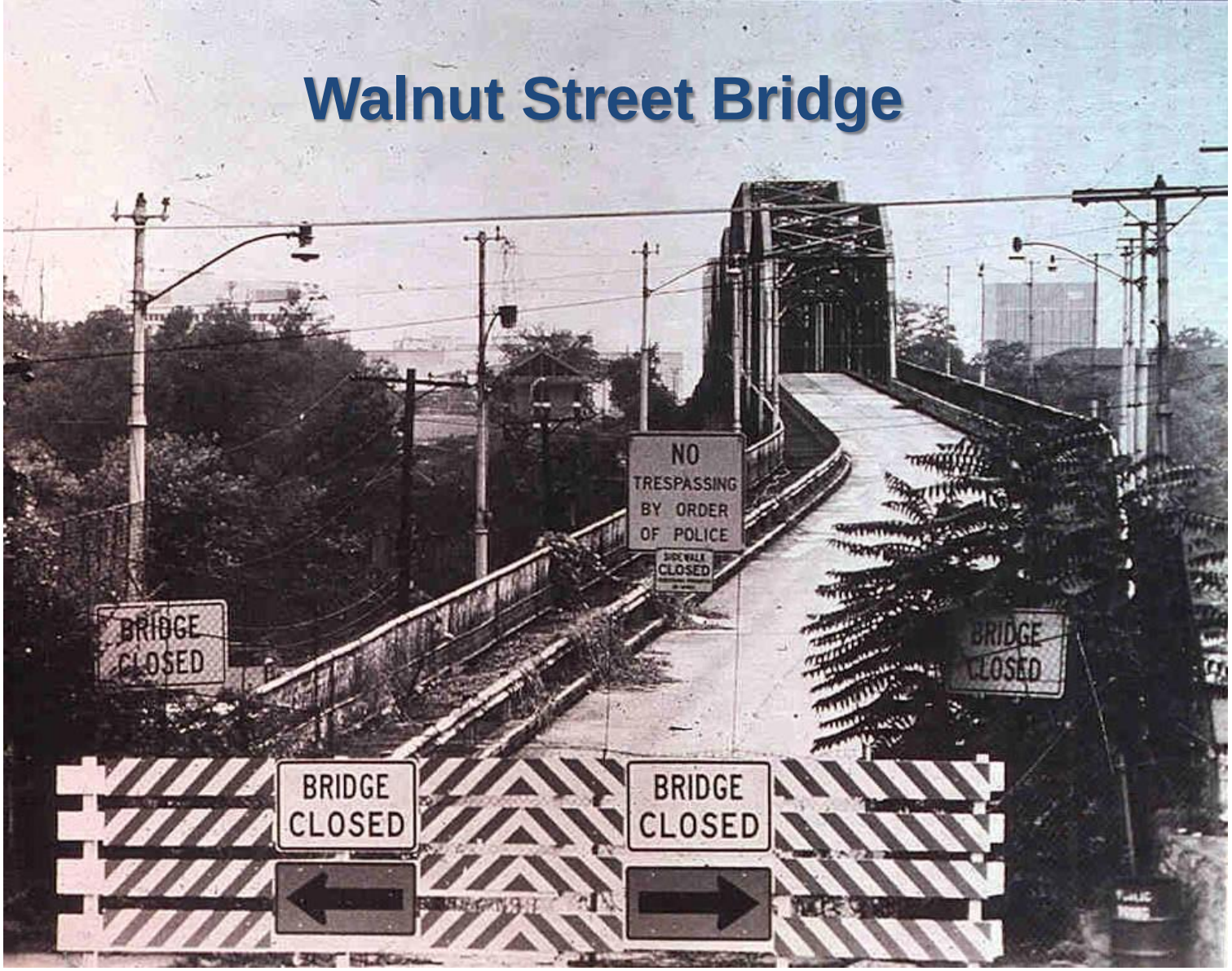
1969: A Rude Awakening



Walter Cronkite

"The nation's dirtiest air"

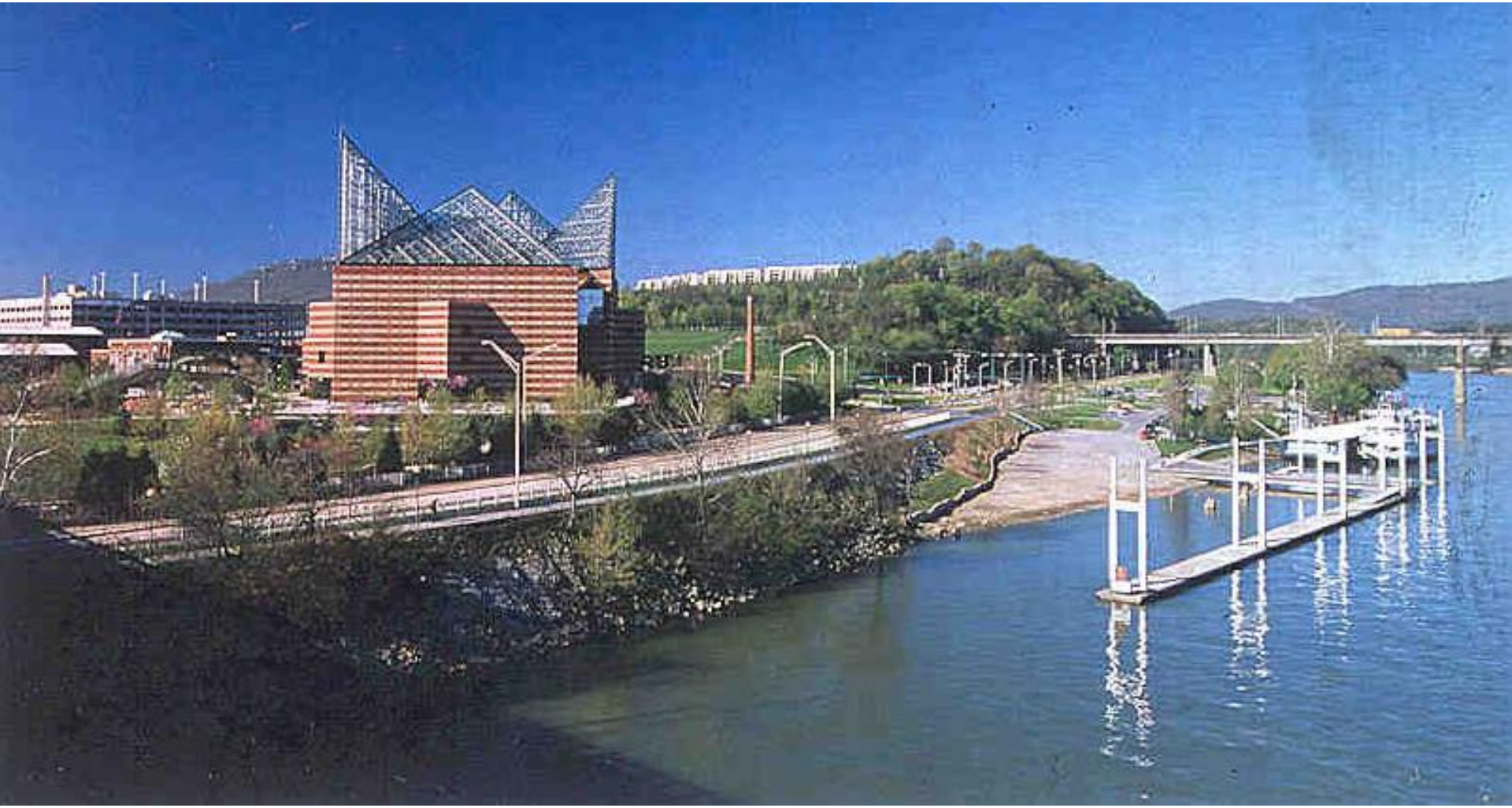
Walnut Street Bridge



Walnut Street Bridge

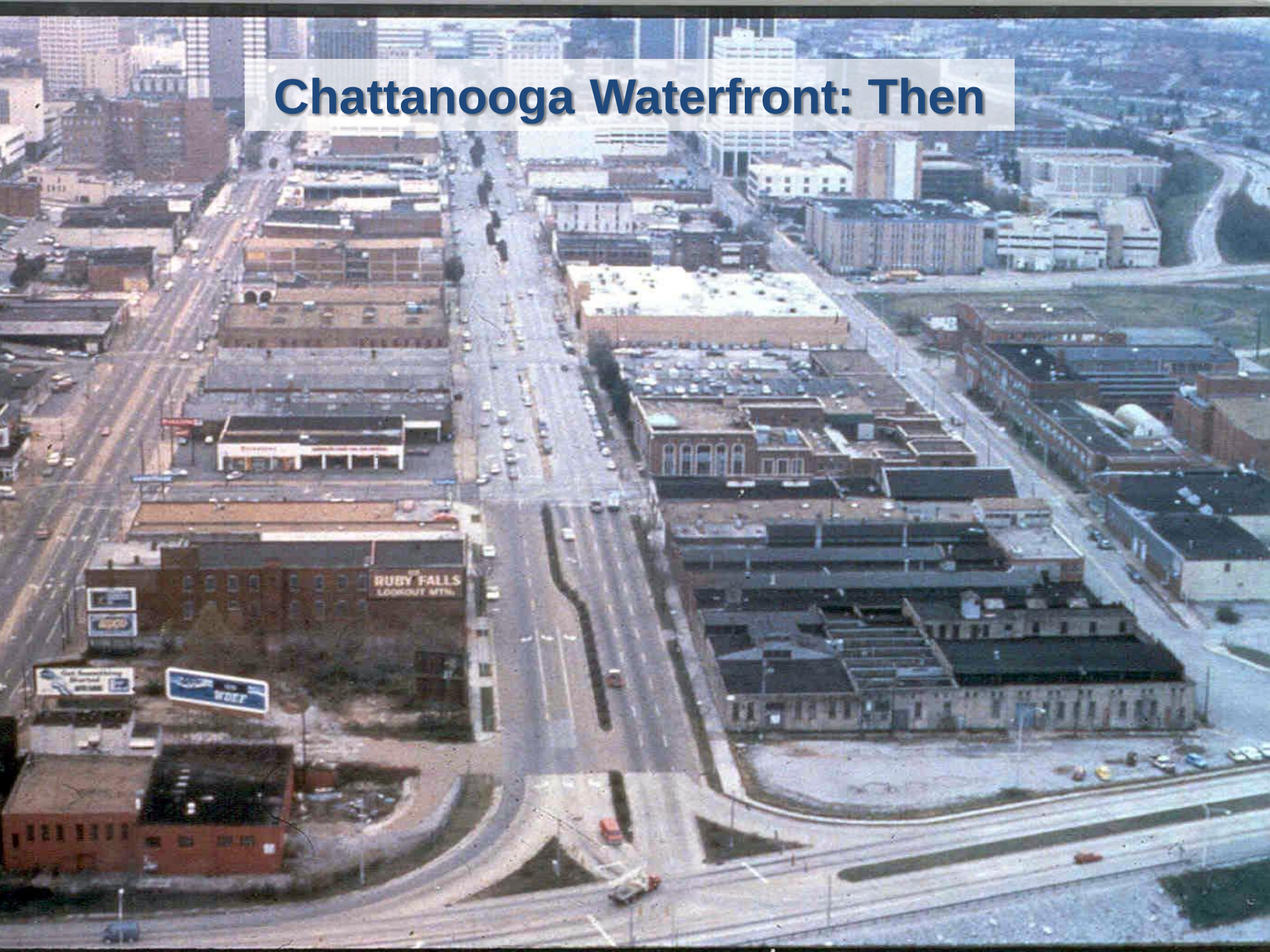
1980s: Riverfront Ghost Town

1990s: Tennessee Aquarium

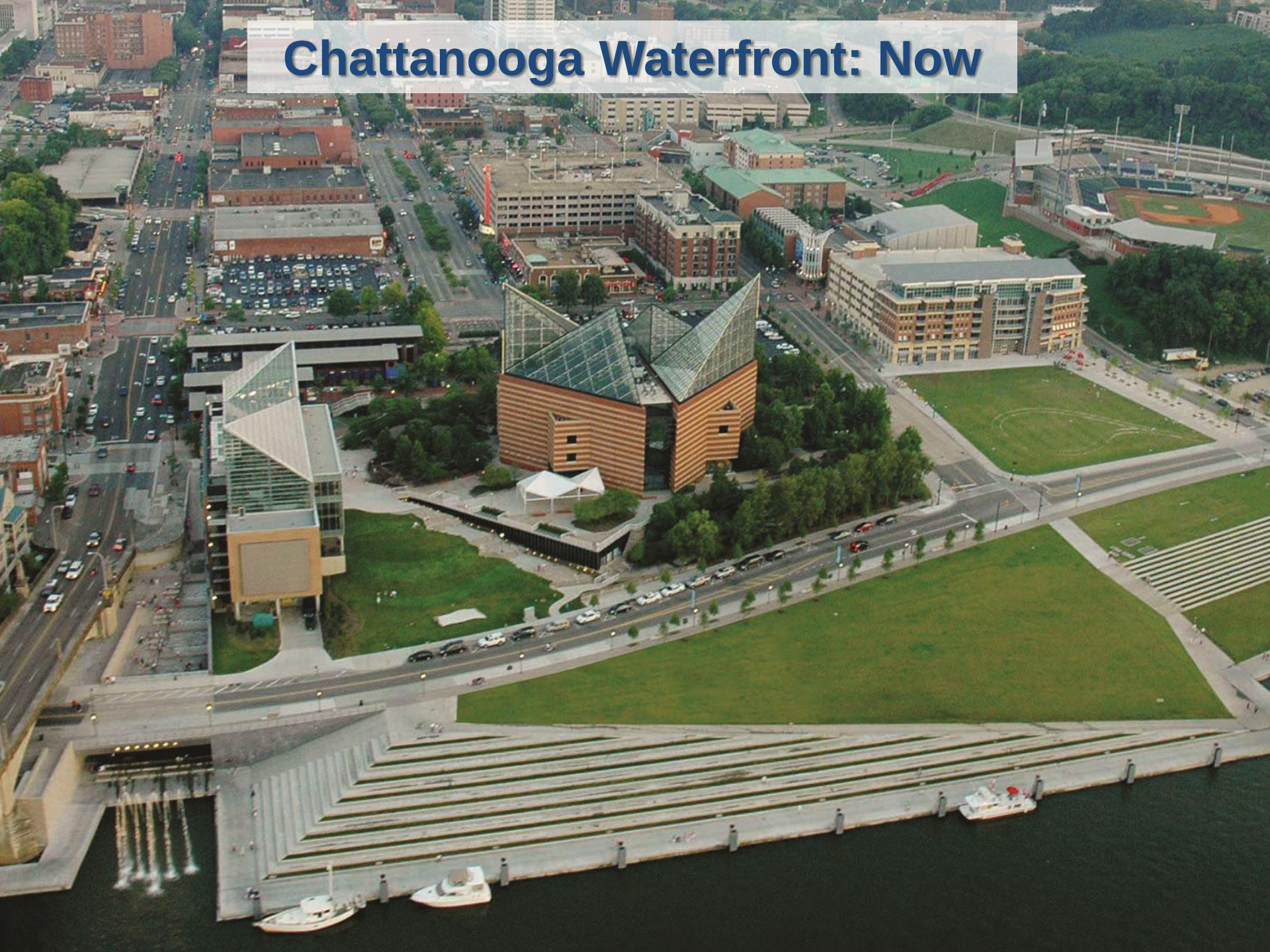


Today: Tennessee Aquarium

Chattanooga Waterfront: Then



Chattanooga Waterfront: Now



North Chattanooga: Then

North Chattanooga: Now

Volunteer Army Ammunition Plant: Then

Volkswagen Chattanooga: Now

Chattanooga Today

What is a Smarter Grid?

What Is It We Want?

- Intelligent
- Interactive
- Self healing

Is it an operating system?

An engineering system?

An IT system?

Or an opportunity to re-engineer the whole organization

(Who does it belong to and who does it serve)

Four Obstacles

- Silos — A smarter grid requires a smarter organization
- Reactionary, risk averse, inflexible people
- A strategy of low costs
- A lack of automation infrastructure

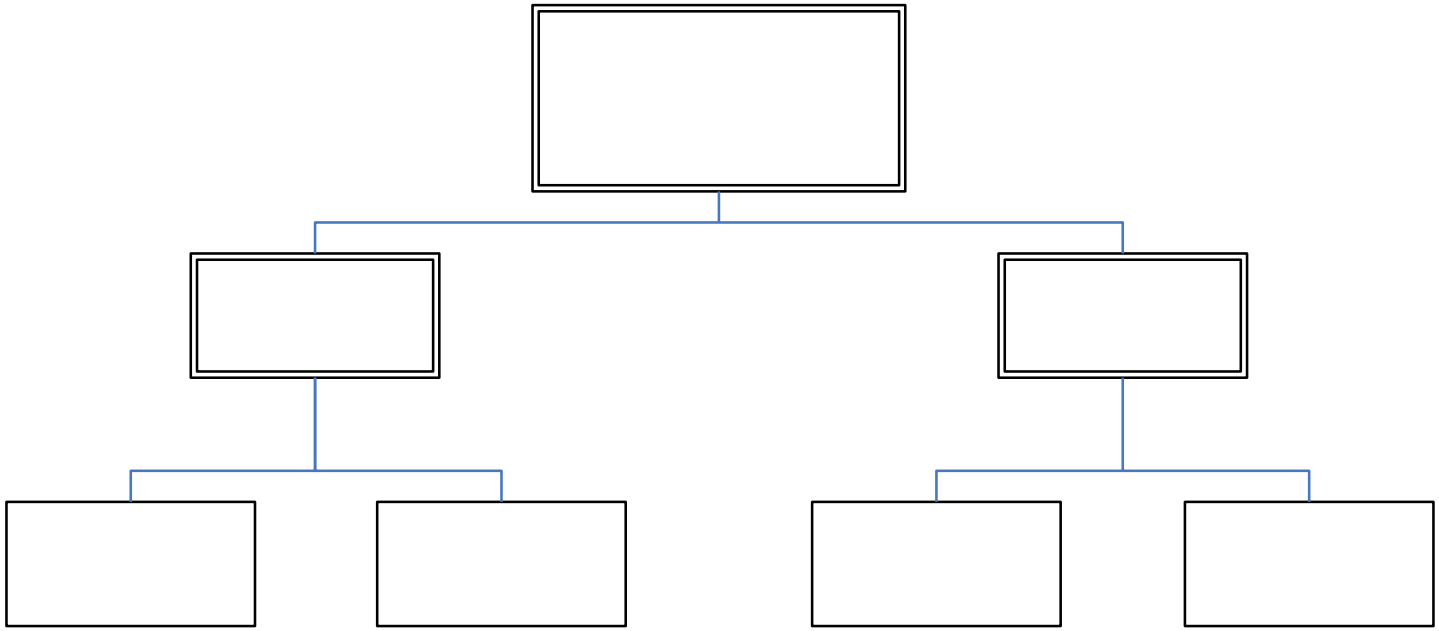
The Building Blocks

- Culture
- Automation
- Integration
- Communications

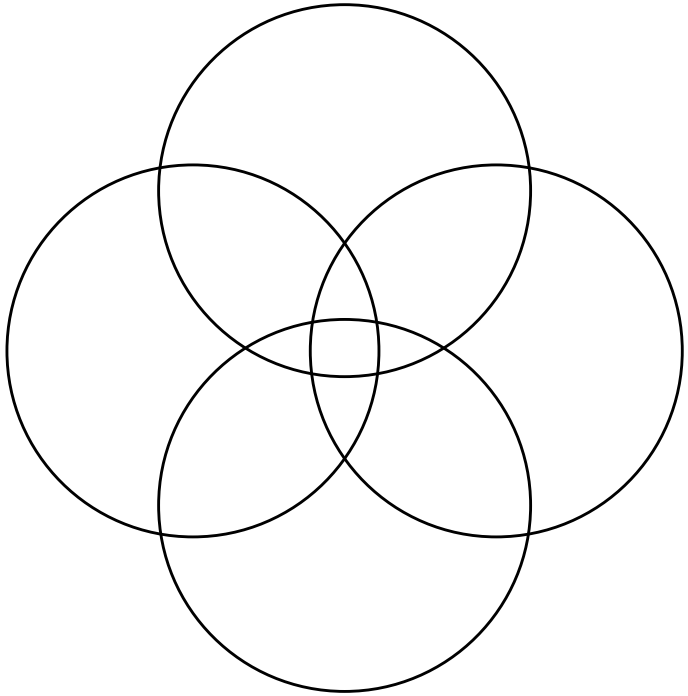
Culture

(A Smarter Organization)

The Typical Utility Organization



EPB's Integrated Organization



Building a Smarter Organization

1. Focus on the future
   - Reporting
   - Strategy
2. Require teamwork & collaboration
   - A new vocabulary
   - The free flow of information and work across all organizational boundaries
3. Recognize the Power of Processes
4. Learn to measure things
5. Design & build a new culture

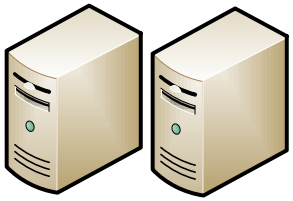
   At EPB we wanted:
   - Innovation & high achievement in all areas
   - Which derives from
     - Trust
     - Respect
     - No fear of hierarchy
     - Customer & community focus
     - Corporate success aligned with personal growth

Automation

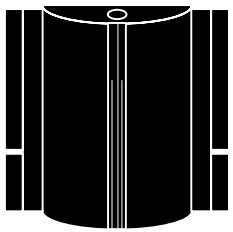
Growth of EPB Computer System

Mainframe

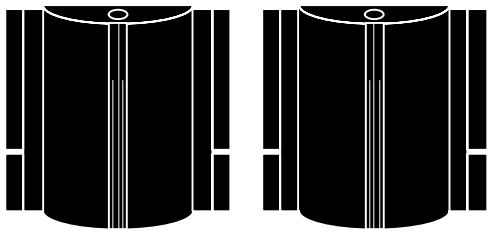
servers



SAN



Hitachi Redundant SAN



1996

1 Mainframe
2 servers
2 PCs
500 Giga Bytes of storage

2001

1 Mainframe
3 servers
50 PCs
850 Giga Bytes of storage

2006

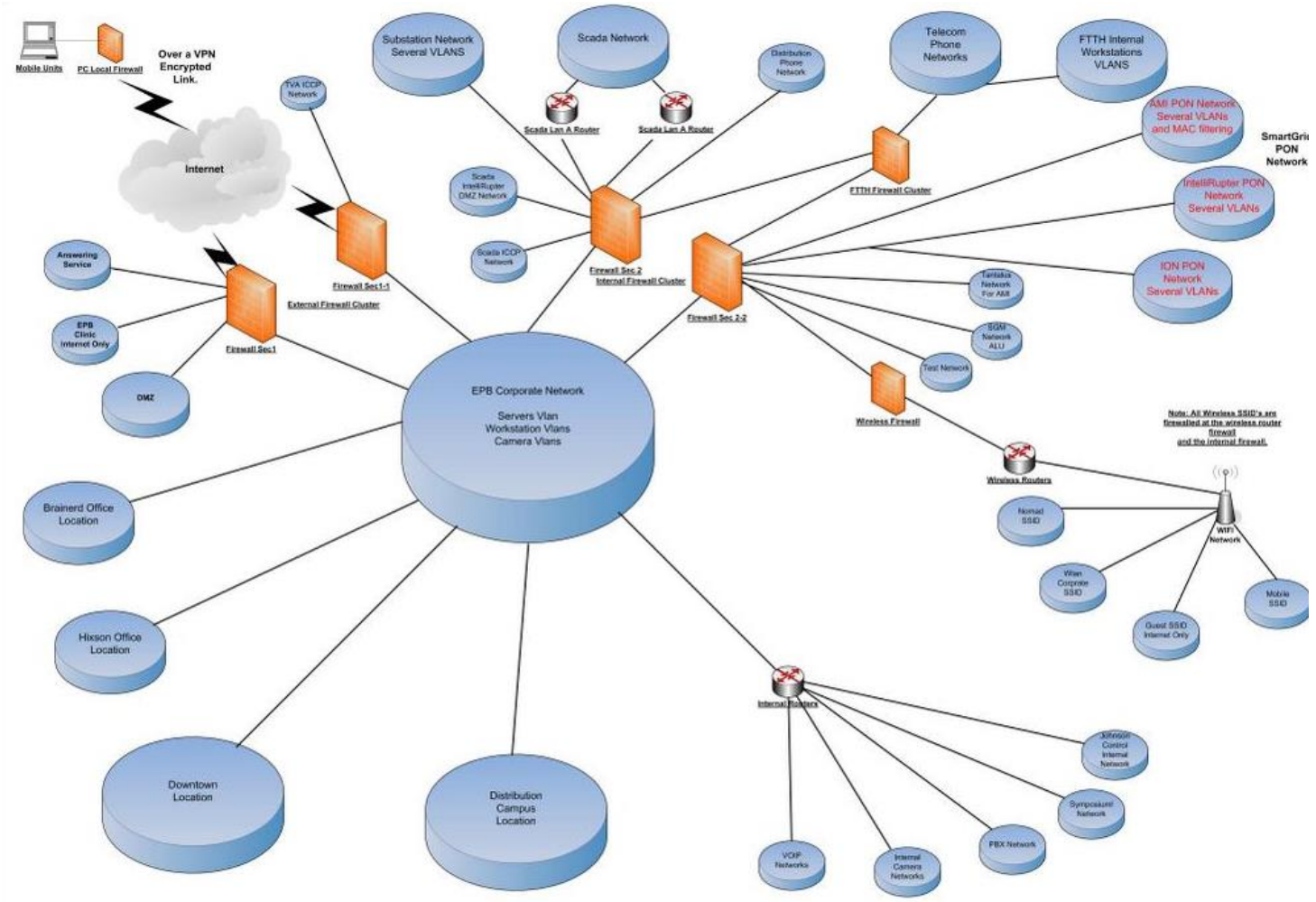
50 Servers
350 PCs
5 Tera Bytes of SAN storage

2014

350 servers
600 PCs/Laptops
450 Mobile PC Units
248 smart mobile devices
915 Tera Bytes of SAN storage

EPB Corporate Computer Architecture

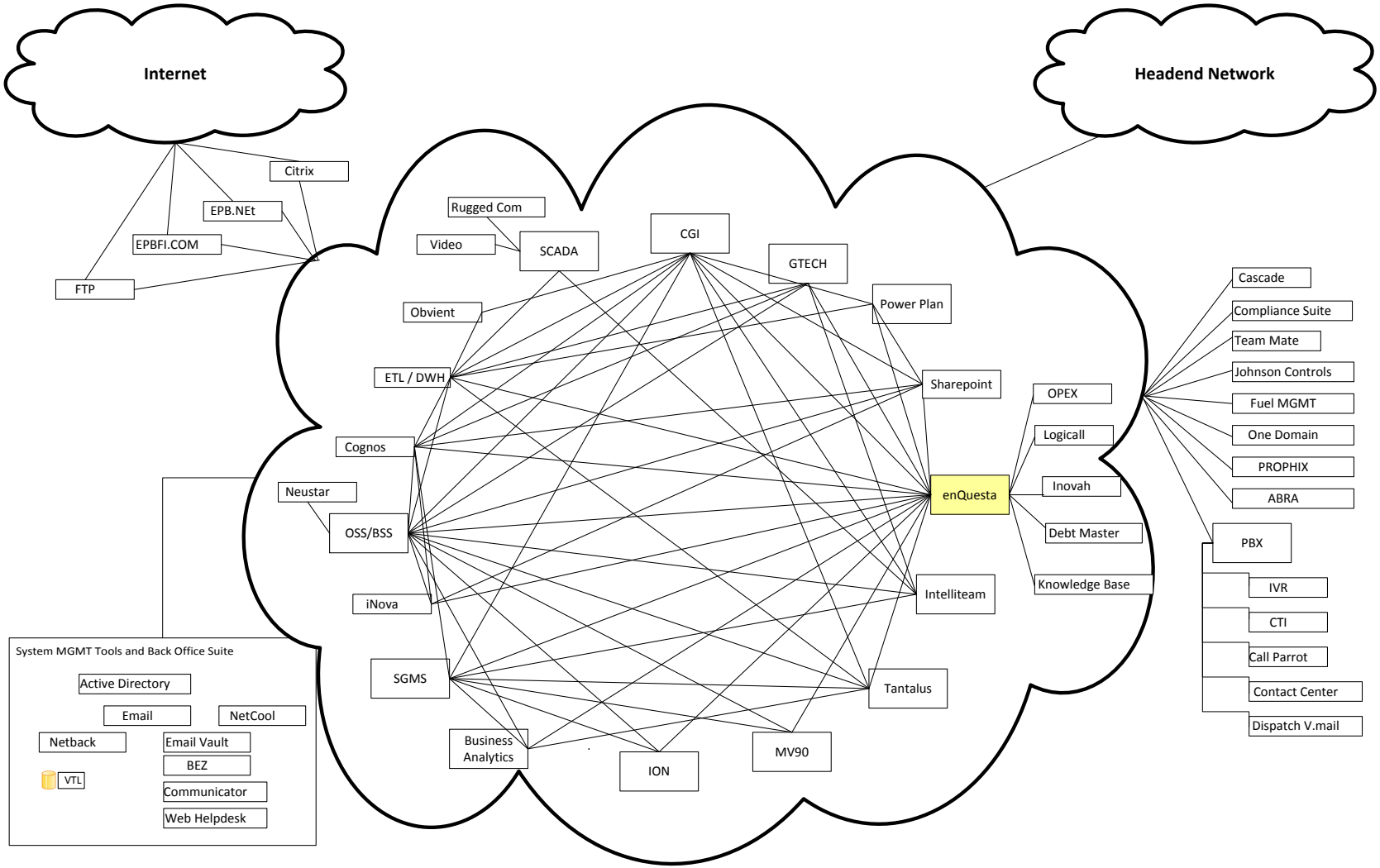
Computer Architecture



Integration

EPB Corporate Software Systems Integration

Automation Across Boundaries

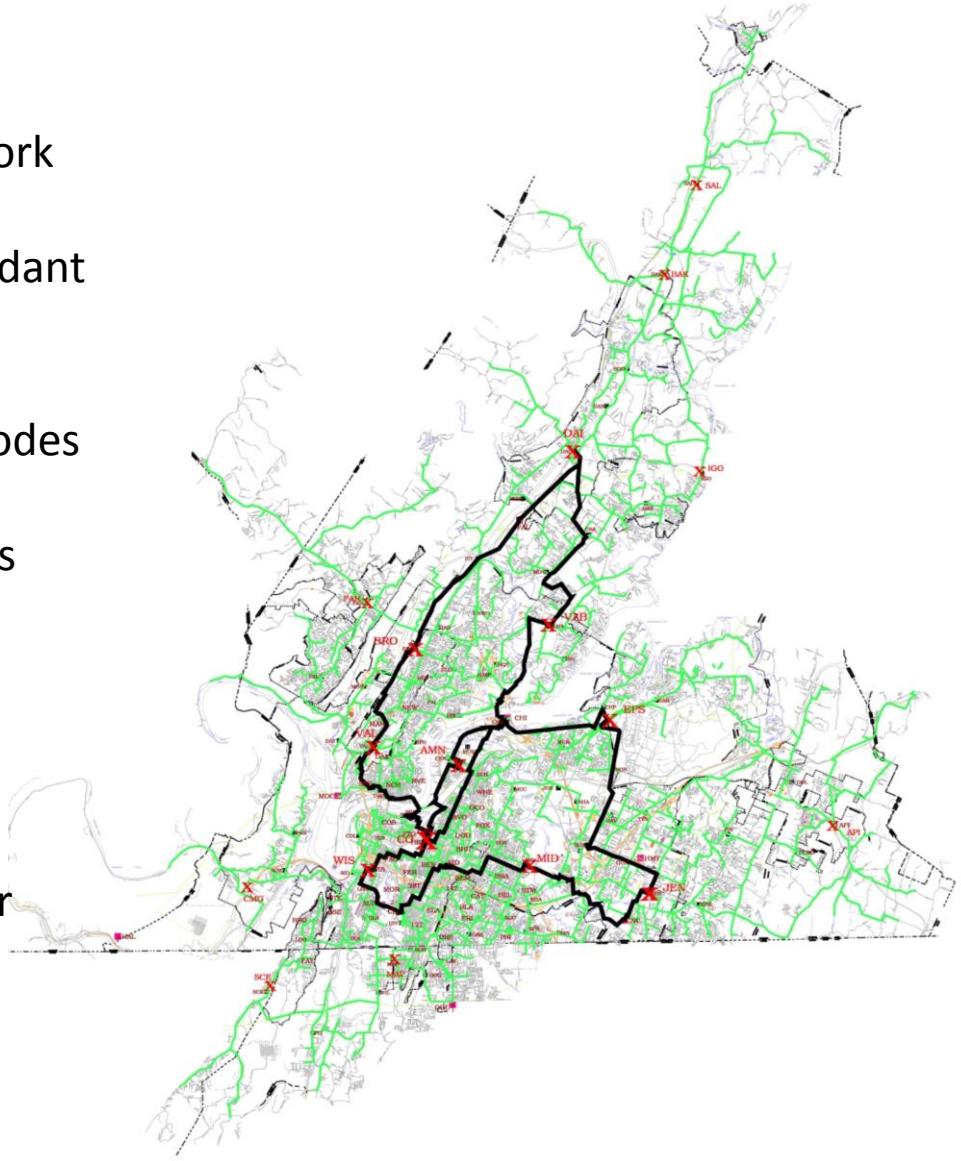


Communications

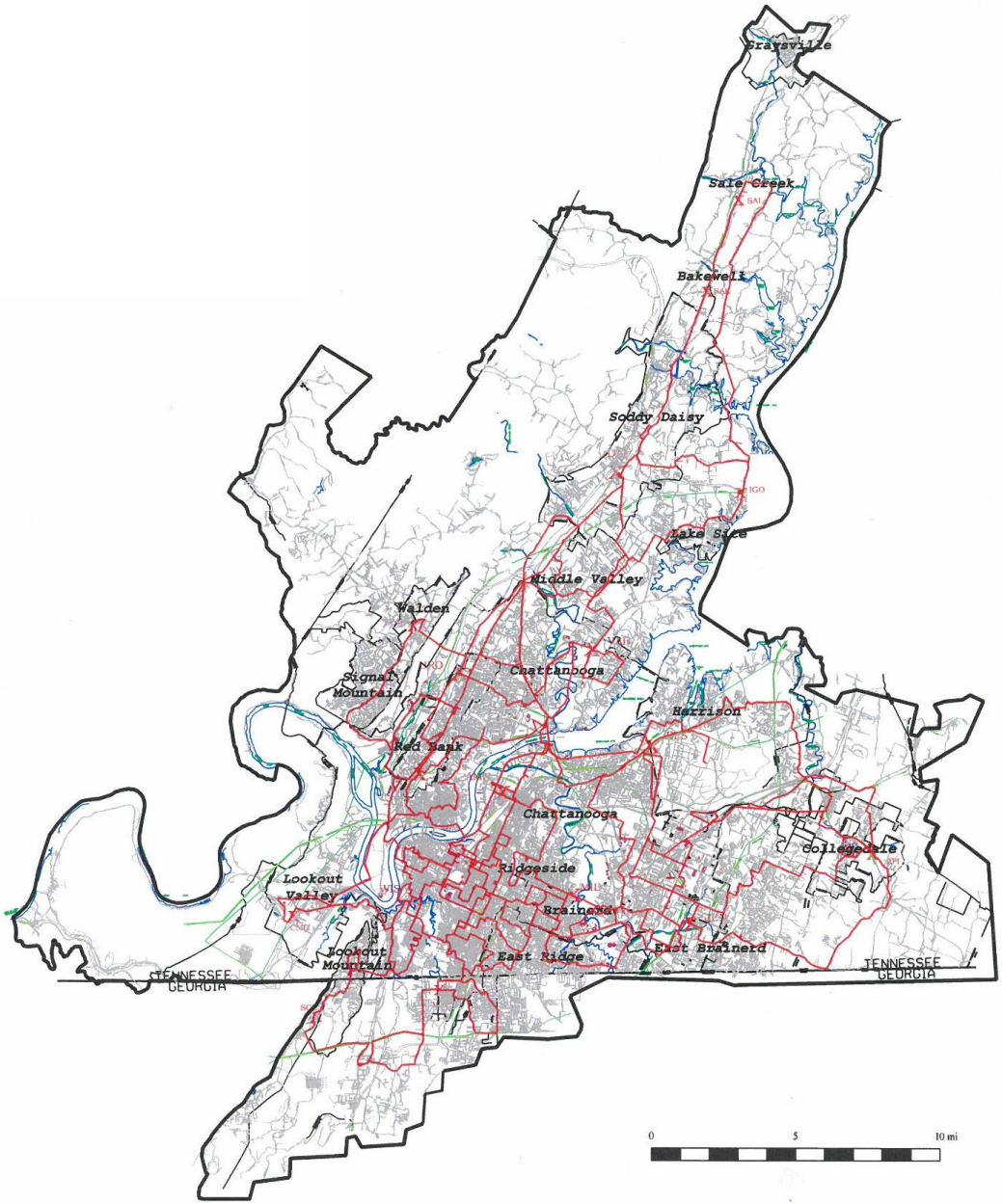
Chattanooga's Fiber Network

Fiber-To-The-Home

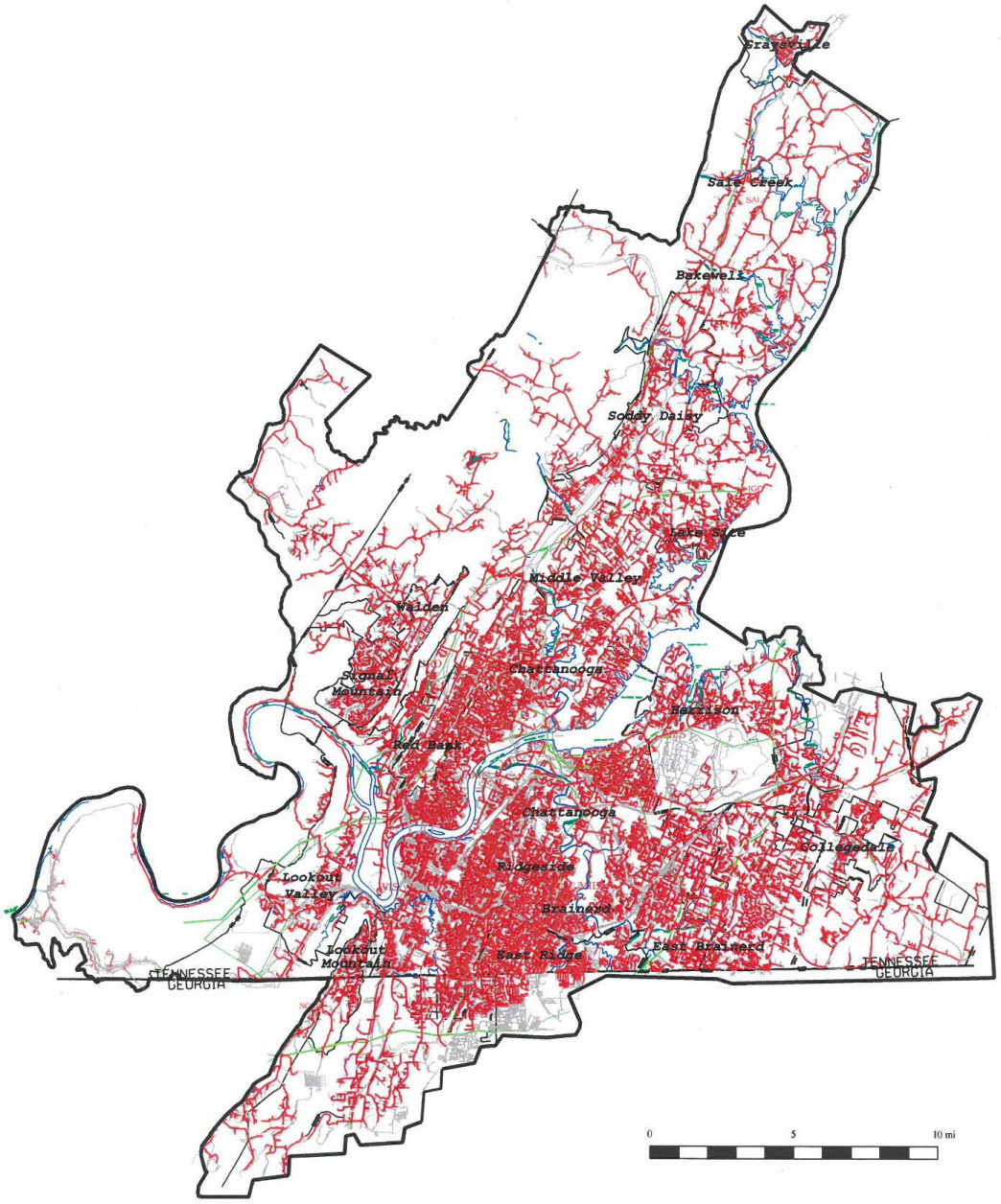
- A GPON-Gigabit Passive Optic Network
  - Two multiple 10 gig fully redundant rings
  - 11 Super Nodes & 5 Remote Nodes
  - Central Office-GPON Electronics
  - 91 miles of Transport fiber
  - 802 miles of Feeder fiber
  - 3,365 miles of Distribution fiber
  - Over 4,300 miles of Drop fiber



Fiber Rings


Graysville
Sale Creek
Bakewell
Soddy Daisy
Lake Site
Middle Valley
Walden
Signal Mountain
Chattanooga
Harrison
Red Bank
Chattanooga
Collegedale
Ridgeside
Lookout Valley
Brainerd
East Brainerd
Lookout Mountain
East Ridge
TENNESSEE
GEORGIA
TENNESSEE
GEORGIA
0
5
10 mi

Radial Fiber

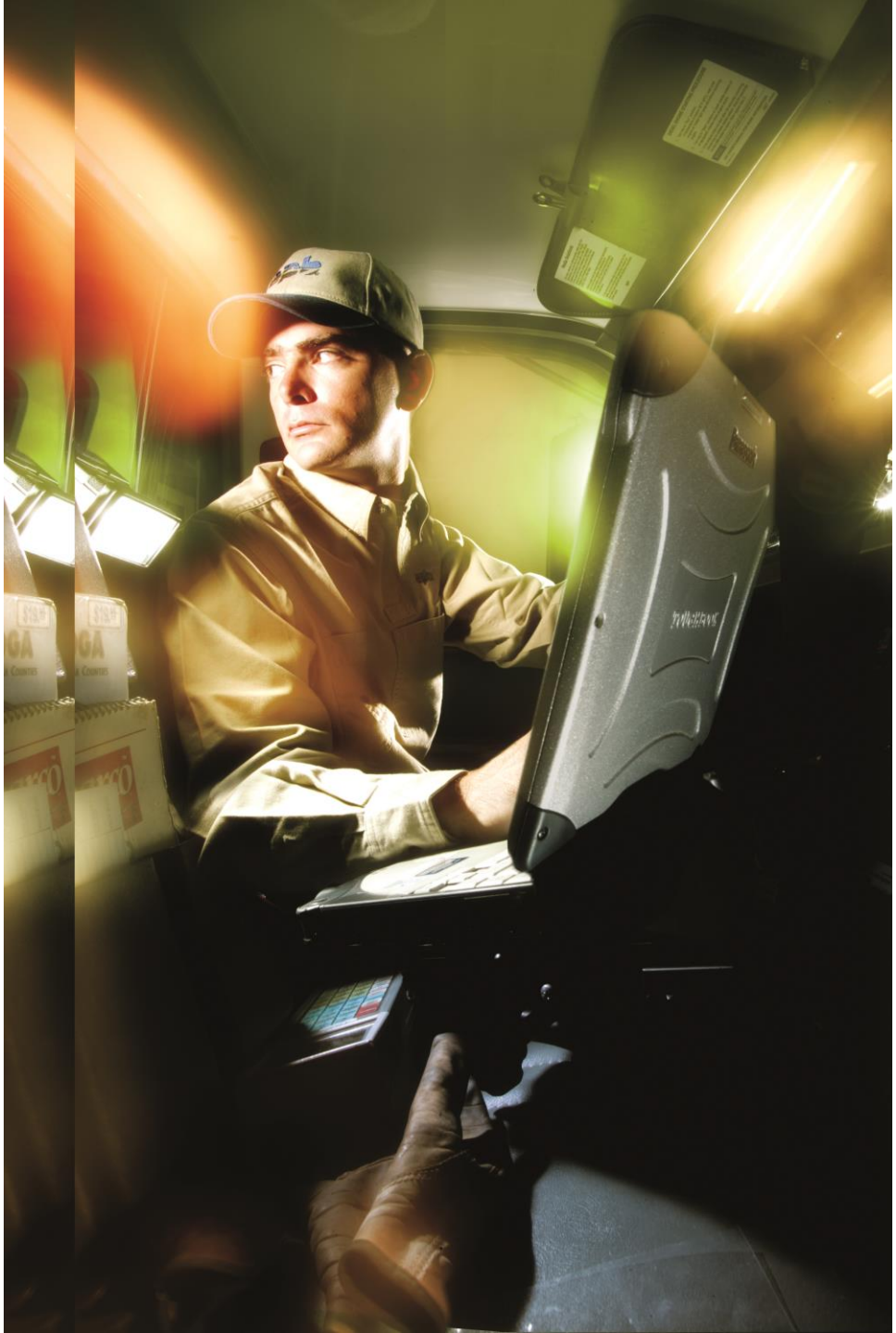



COMMANDER
TERAX


NOTICE
Electric Power
Itron

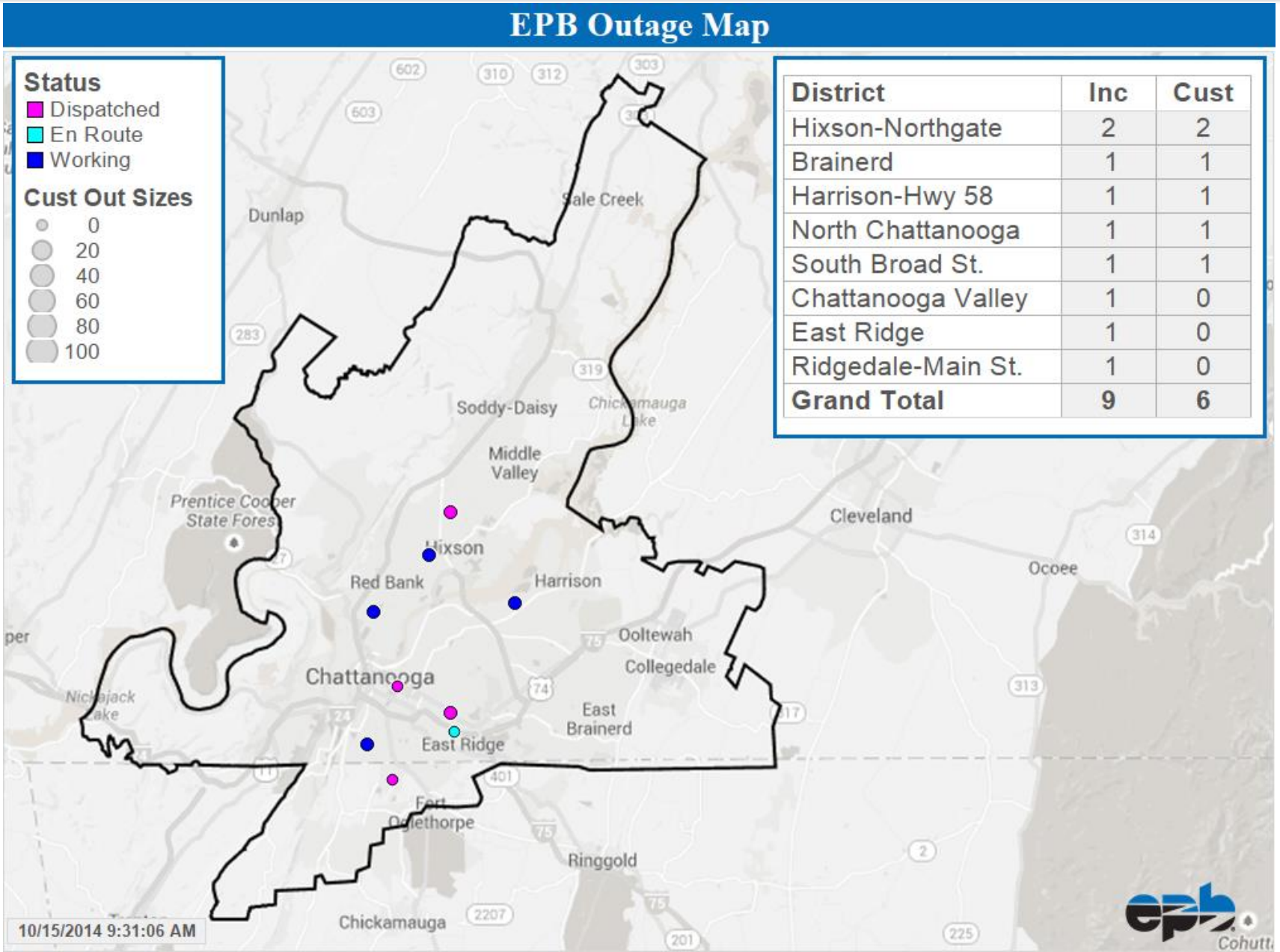

Altec


OPEN
CLOSE
STOP



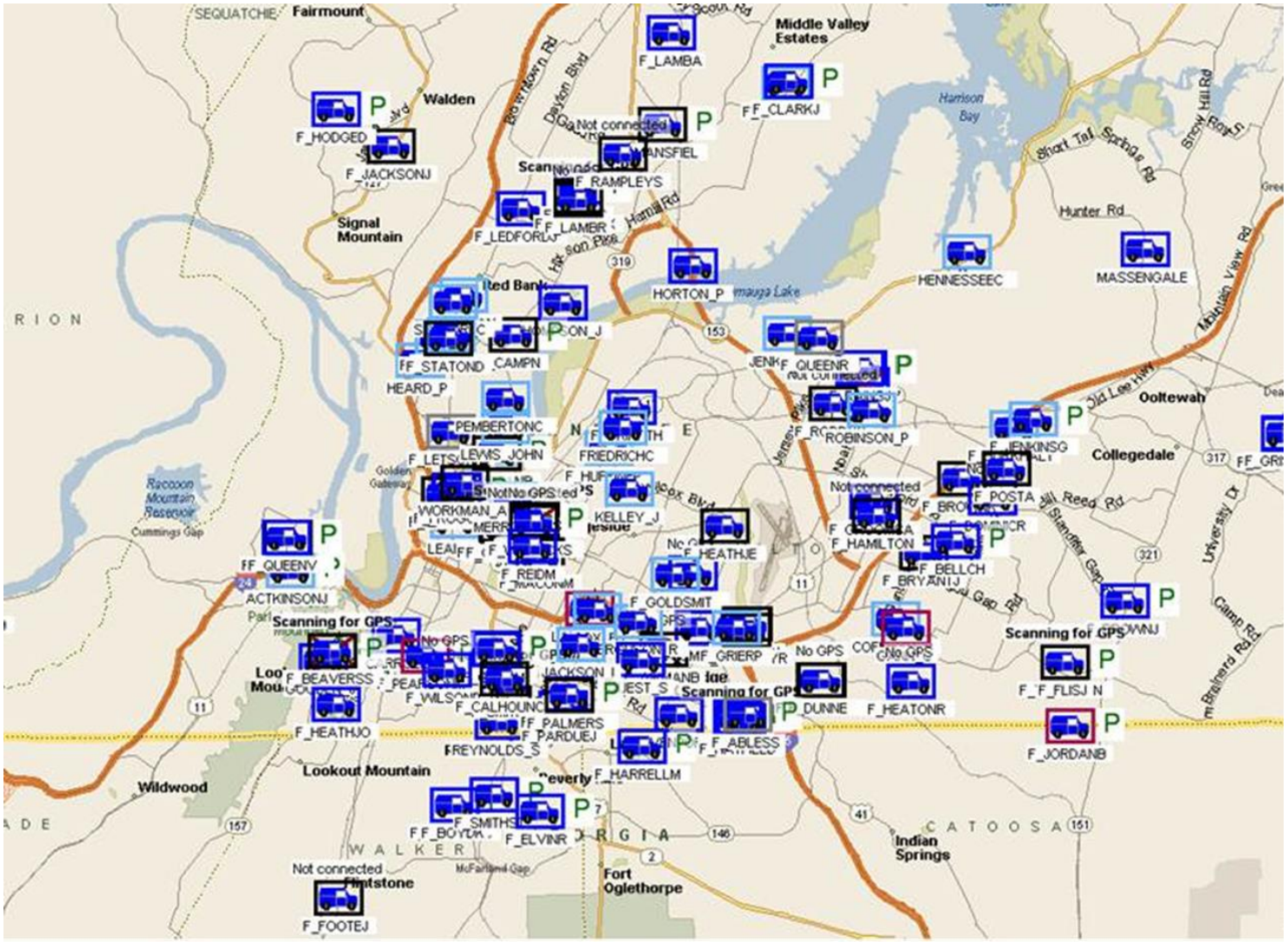
How It All Works Together

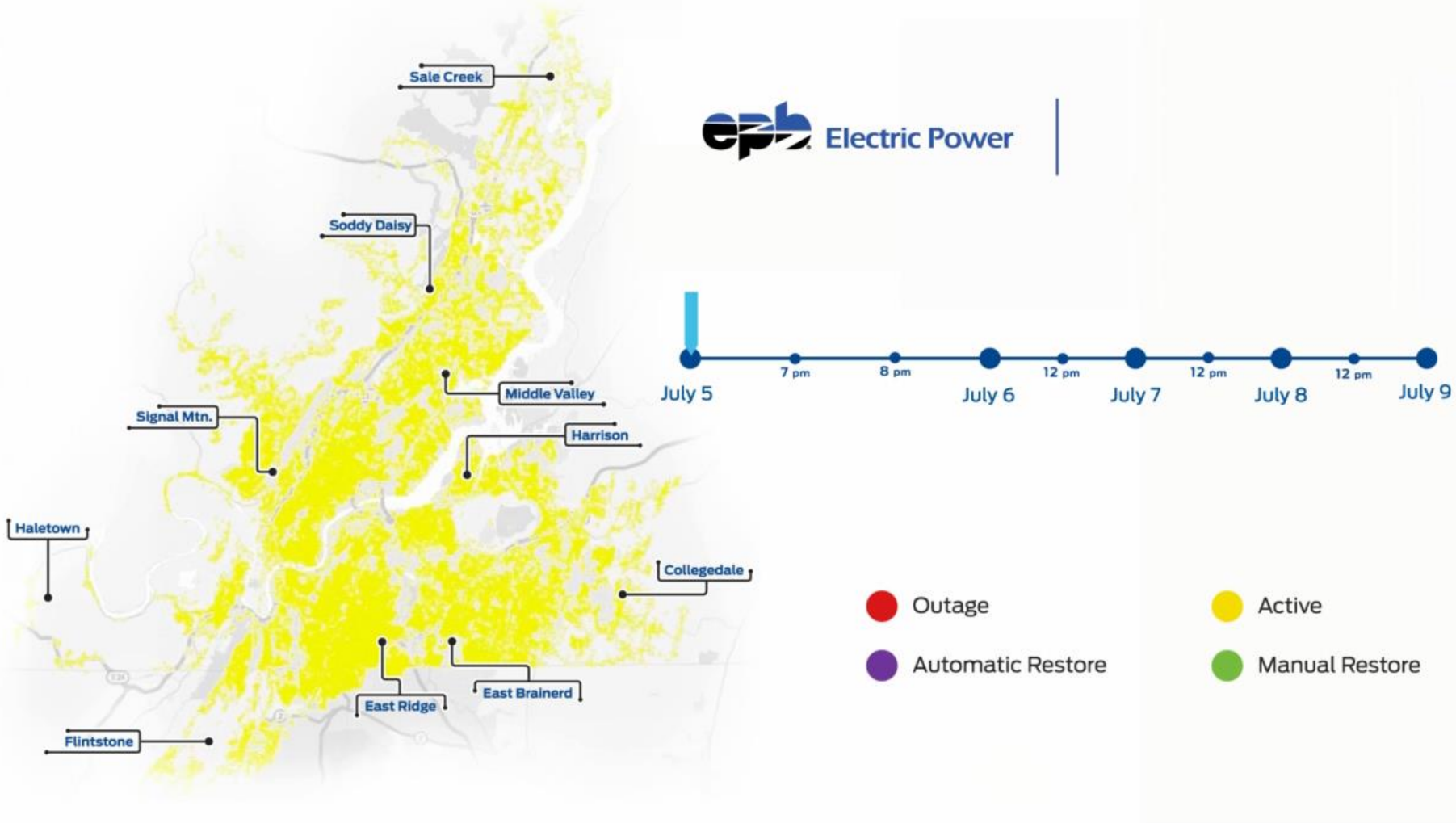
Information From the Smart Grid



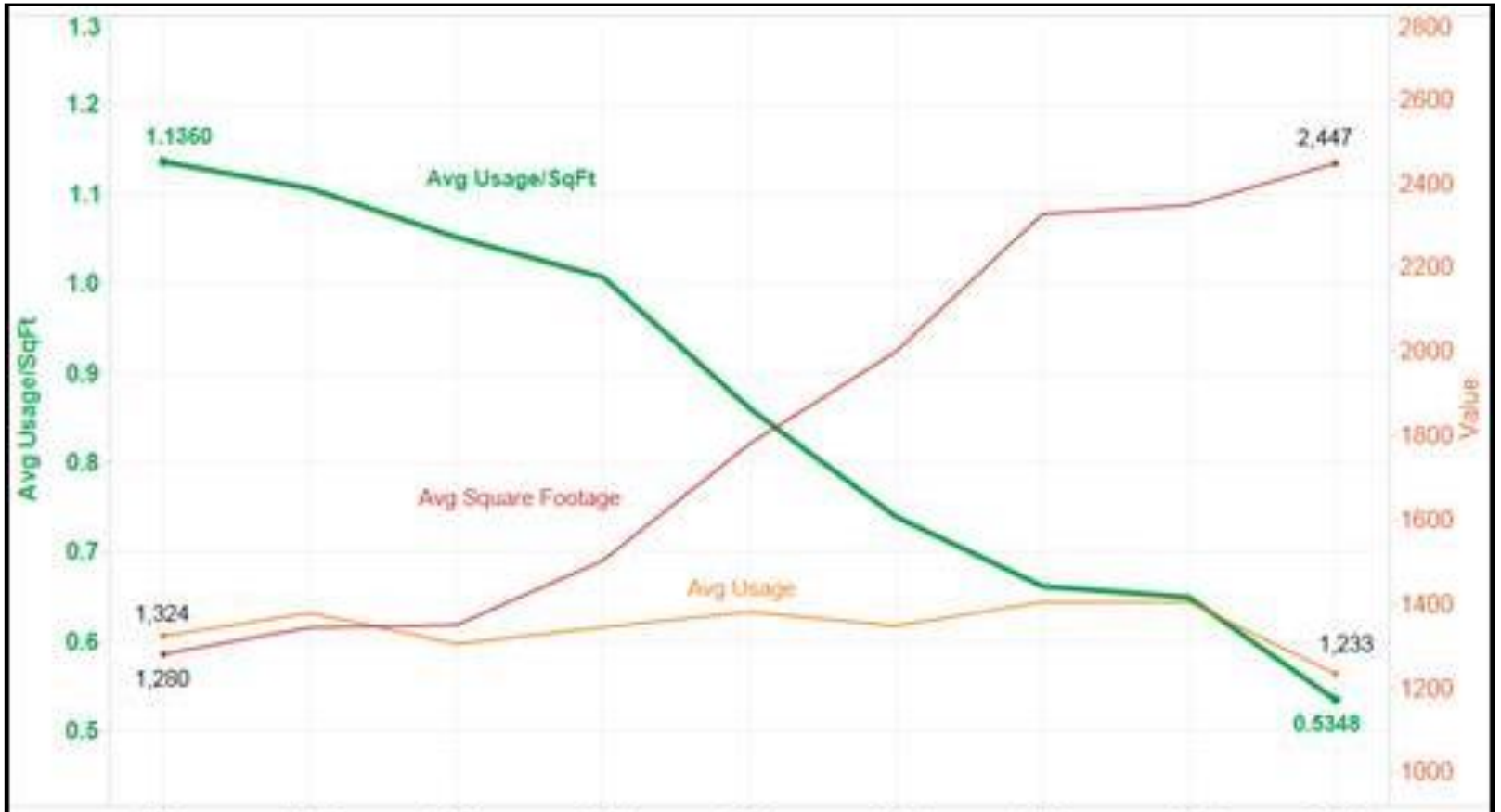
EPB Smart Grid Major Process Automation

Mobile Workforce Automation



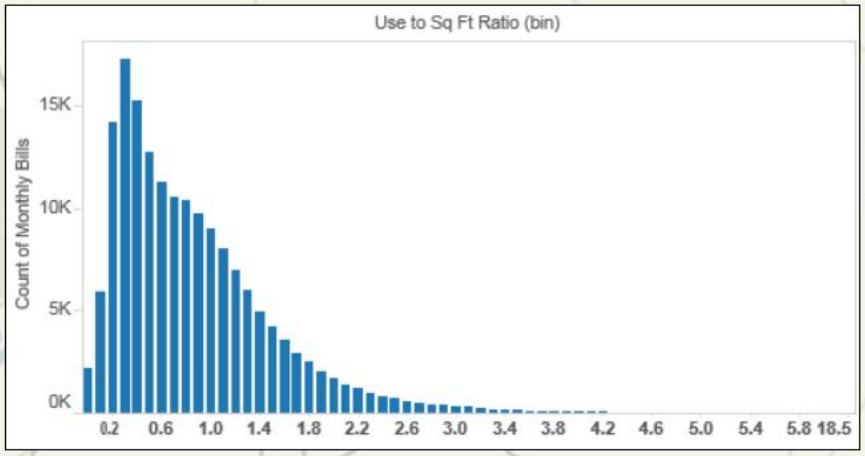

Sale Creek
Soddy Daisy
Middle Valley
Signal Mtn.
Harrison
Haletown
Collegedale
East Ridge
East Brainerd
Flintstone
Electric Power
July 5
7 pm
8 pm
July 6
12 pm
July 7
12 pm
July 8
12 pm
July 9
Outage
Active
Automatic Restore
Manual Restore

Energy Usage Intensity by Decade Built with 2012-13 Usage Data



	1930	1940	1950	1960	1970	1980	1990	2000	2010
Avg Usage/SqFt	1.1360	1.1062	1.0515	1.0071	0.8605	0.7394	0.6616	0.6493	0.5348
Avg(Usage)/Avg(SqFt)	1.0337	1.0257	0.9668	0.8946	0.7758	0.6737	0.6035	0.5981	0.5040
Avg Usage	1,324	1,378	1,305	1,344	1,381	1,347	1,404	1,404	1,233
Avg Sq Ft	1,280	1,344	1,349	1,503	1,780	2,000	2,327	2,348	2,447
Premise Count	243	929	2,602	5,515	21,424	30,699	10,380	11,988	1,202
# Monthly Bills	5,842	22,349	62,733	132,855	516,427	740,377	250,297	289,736	28,943
Monthly Bills/Premise	24.04	24.06	24.11	24.09	24.11	24.12	24.11	24.17	24.08

KWH/SqFt by Month for 2012-13



Avg Usage/SqFt	0.9155
Avg. USE	1,551
Avg. Sq Ft	1,977
Premise Count	85,194
# Monthly Bills	170,907
Monthly Bills/Premise	2.01

Month Filter
- [ ] (All)
- [x] 1
- [ ] 2
- [ ] 3
- [ ] 4
- [ ] 5
- [ ] 6
- [ ] 7
- [ ] 8
- [ ] 9
- [ ] 10
- [ ] 11
- [ ] 12

Year Filter
- [x] (All)
- [x] 2012
- [x] 2013

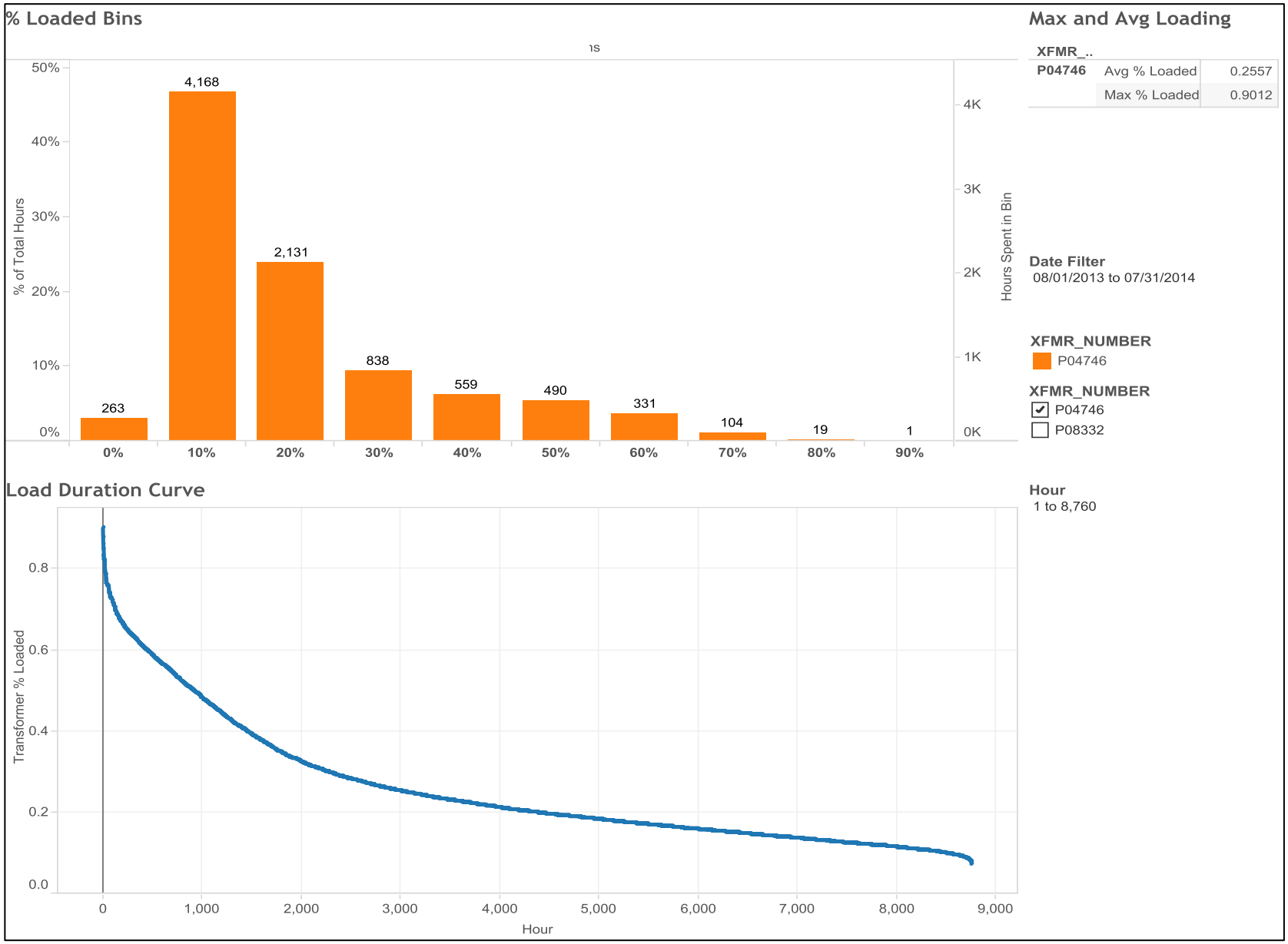
 # Premises at Location
1 548

Eff Yr Built
1,875 1,994

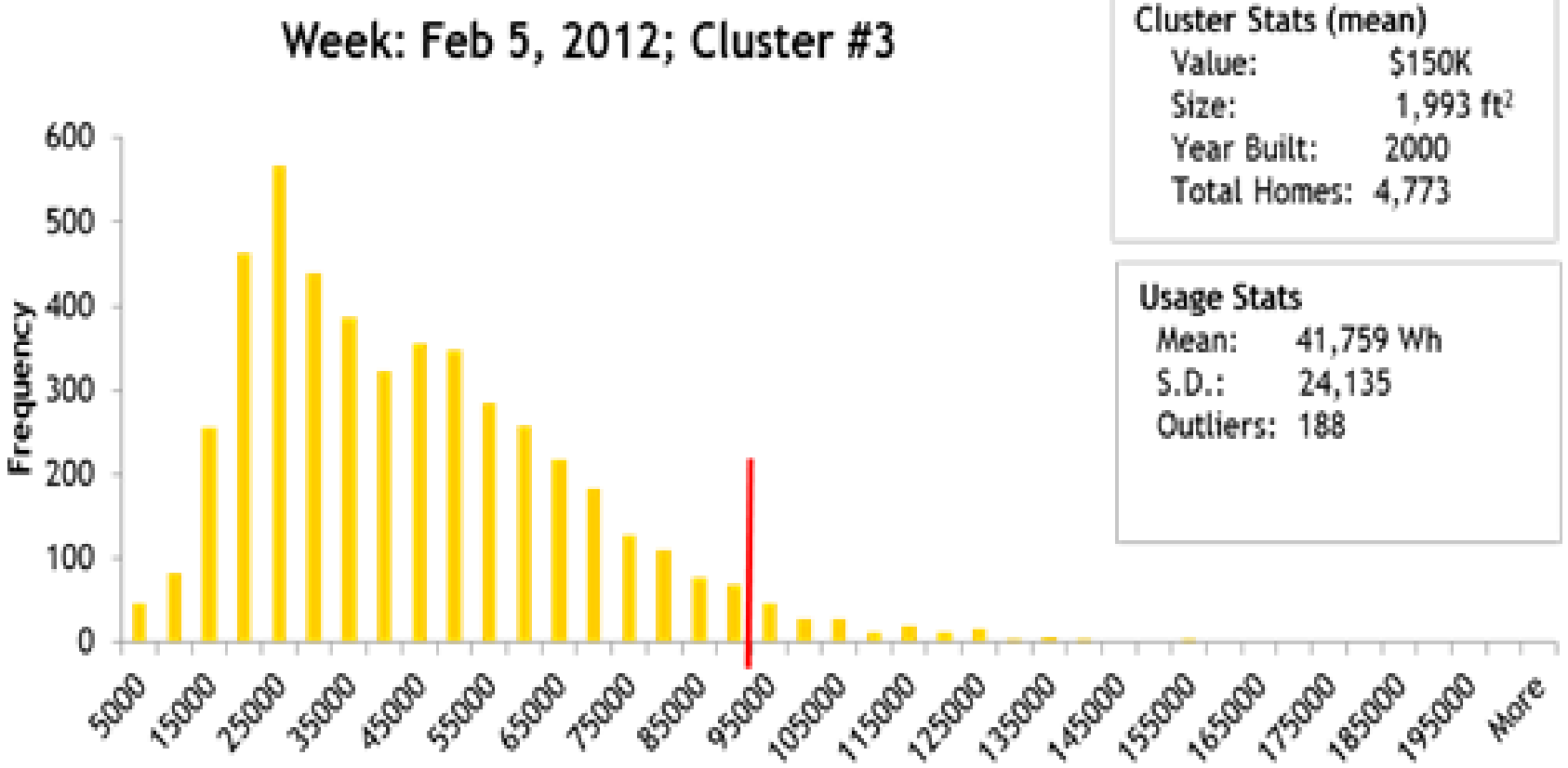
Eff Yr Built by Decade
- [x] (All)
- [x] 1870
- [x] 1880
- [x] 1890
- [x] 1900
- [x] 1910
- [x] 1920
- [x] 1930
- [x] 1940
- [x] 1950
- [x] 1960
- [x] 1970
- [x] 1980
- [x] 1990
- [x] 2000
- [x] 2010

1. This map rounds the latitude and longitude for every premise of interest to the nearest hundredth. This effectively groups premises into locations with a diameter of <1.2km.
2. The "# Premises at Location" filter determines which dots show up on the map. If the user only wants to show dots that represent locations with 5 or more premises, change the min filter to 5.
3. "Average Usage" is the average of the premise monthly bills.
4. "Square Footage" is from publicly available Hamilton County data (that's why the heat map is only for Hamilton County).

Transformer % Loaded Bins



Average Daily Usage (Wh) for the Week



Thank You