

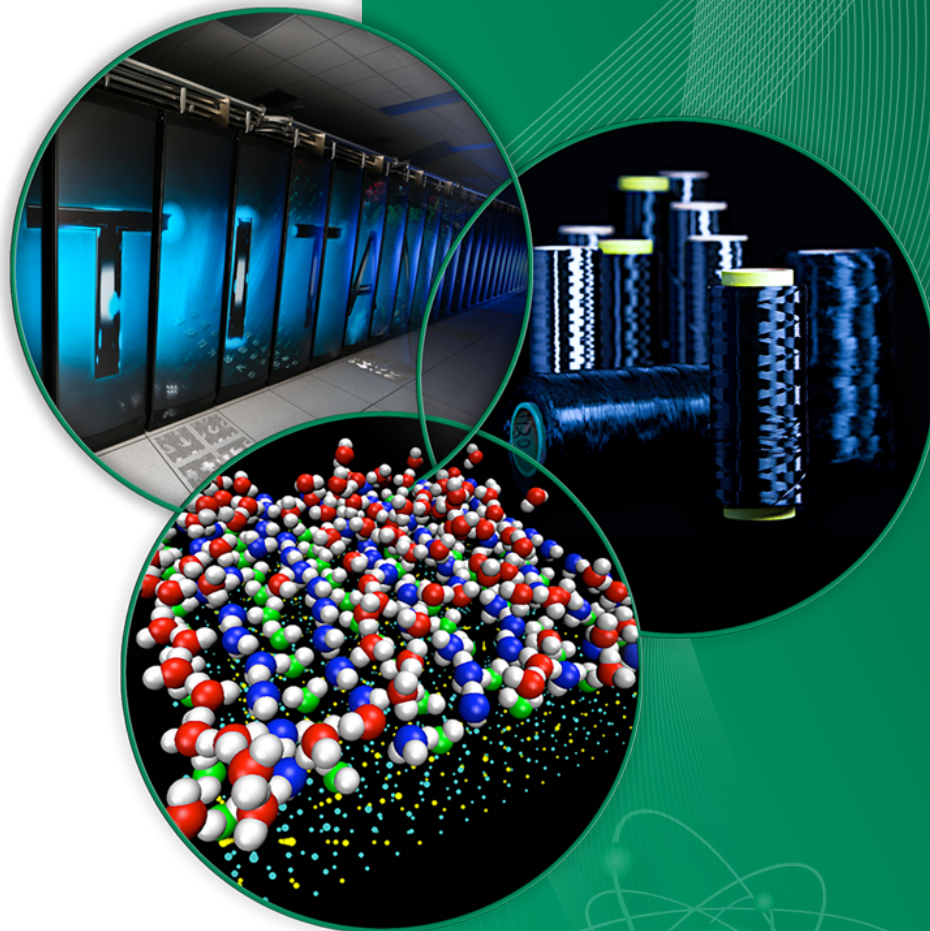
Oak Ridge Urban Dynamics Institute

Presented to

ORNL NEED Workshop

Budhendra Bhaduri, Director
Corporate Research Fellow

July 30, 2014
Oak Ridge, TN

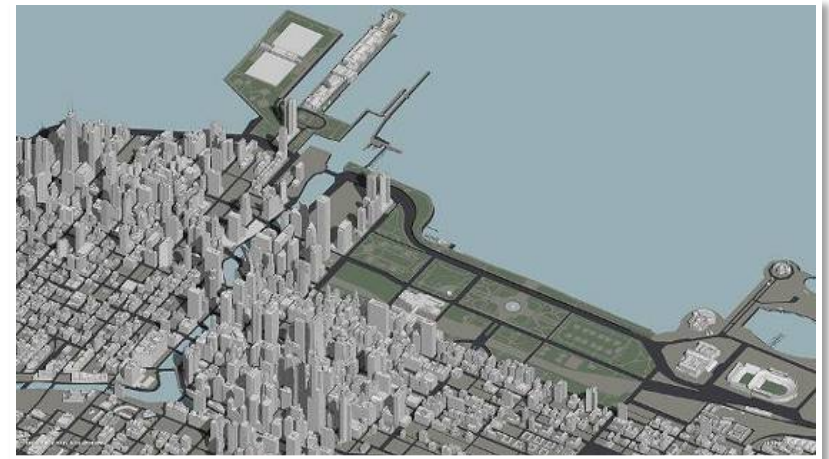


Our societal challenges and solutions are often local to regional and mostly urban

Energy consumption and savings potential is a macro-level (regional to national) phenomenon driven by individual entity and socioeconomic behavior at the micro-level (local)

Useful insights will come from characterizing interactions among human (communication), energy, transportation, and cyber networks

Success of future strategies depends on understanding complexity and consequences of proposed systems in which energy, environment and mobility interests are simultaneously optimized



Big Cities, Big Data



NEW YORK UNIVERSITY



CENTER FOR URBAN SCIENCE + PROGRESS

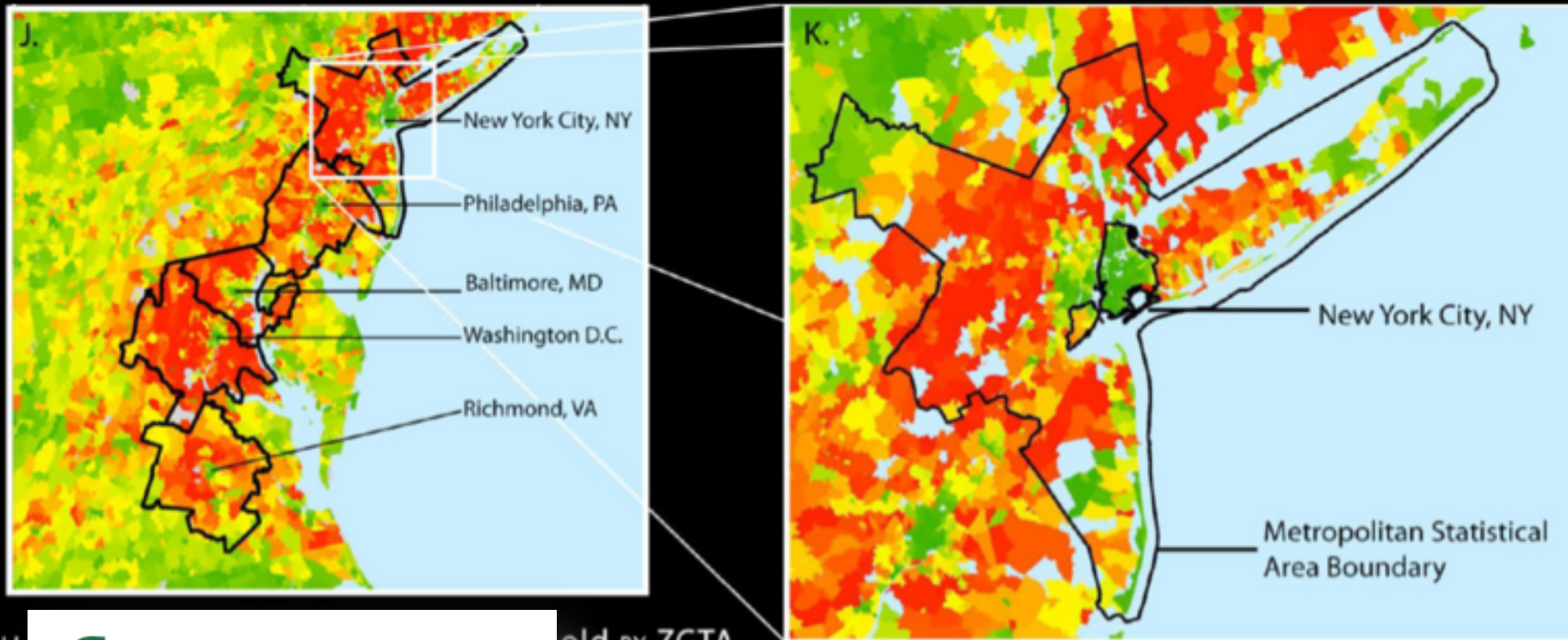


Chicago: City of Big Data

URBAN
CENTER FOR
COMPUTATION
AND DATA

source: from the
University of Chicago

Spatial Distribution of U.S. Household Carbon Footprints Reveals Suburbanization Undermines Greenhouse Gas Benefits of Urban Population Density



ALL
old by ZCTA

ENVIRONMENTAL
Science & Technology

Christopher Jones *† and Daniel M. Kammen *†‡§

†*Environ. Sci. Technol.*, 2014, 48 (2), pp 895–902

 OAK RIDGE NATIONAL LABORATORY

MANAGED BY UT-BATTELLE FOR THE U.S. DEPARTMENT OF ENERGY

Urbanization challenges

JACKSON COUNTY
Georgia

Home

About Jackson County

Maps & Directions

County History

Staff Directory

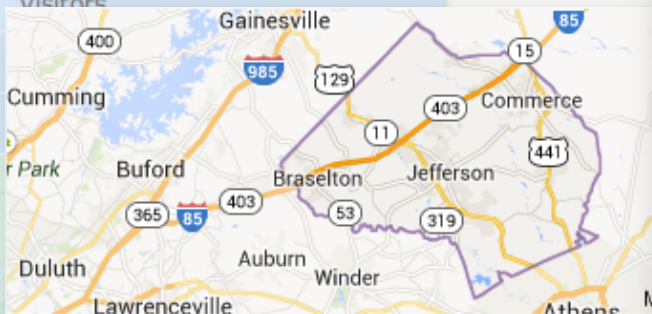
Links

Visitors

ABOUT

E-mail

• [Maps & D](#)



Jackson County

US County in Georgia

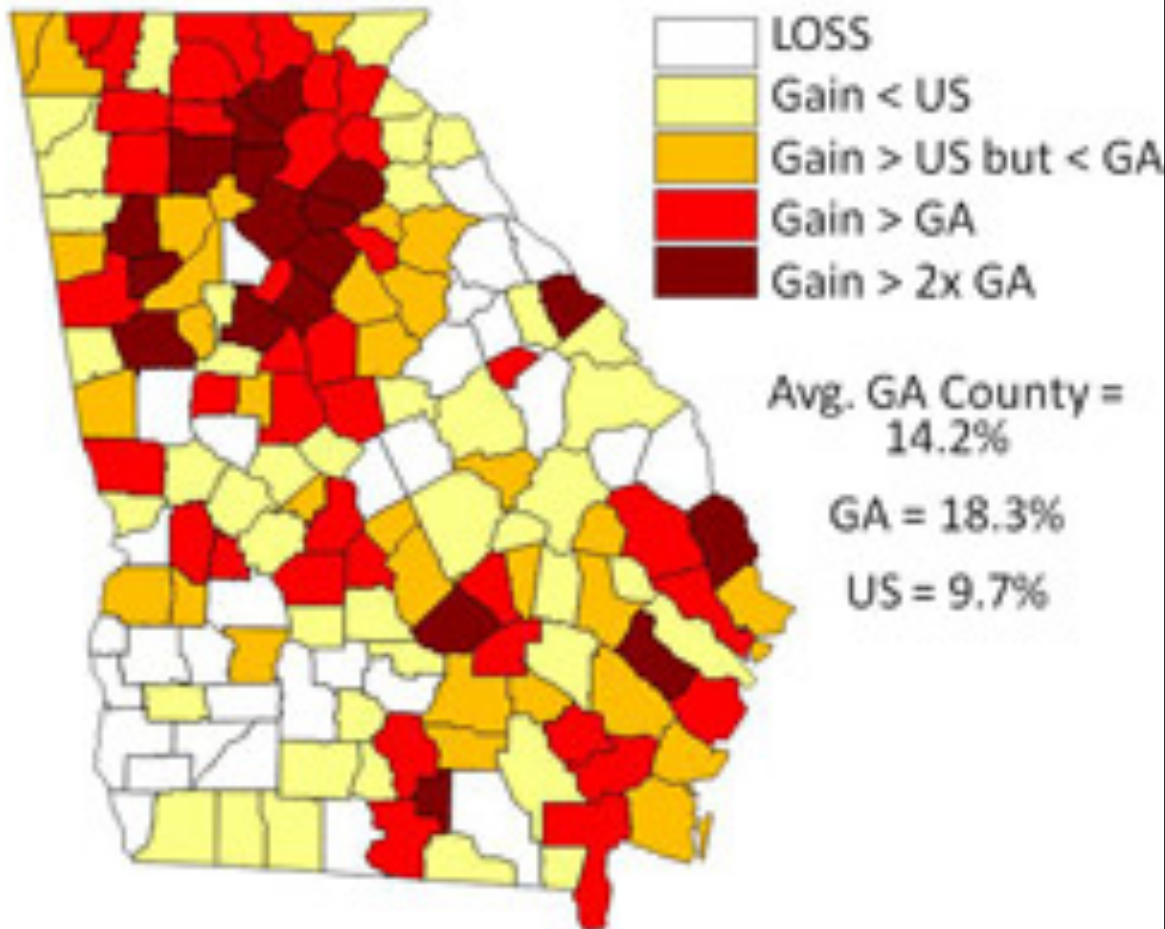
Jackson County is a county located in the U.S. state of Georgia. As of the 2010 census, the population was 60,485. The county seat is Jefferson. [Wikipedia](#)

Area: 343 sq miles (888.4 km²)

Founded: 1796

Population: 60,571 (2012)

Population Change: 2000-2010



New cross-cutting initiative: Science and Informatics for Energy and Urban Infrastructures

Opportunity:

- Open Data initiatives for addressing the overall sustainability and security of urban infrastructures
- Provide a national platform for data, analytics, and simulation services to growing urban infrastructure outside the current scope of mega-city initiatives
- Position ORNL as a world leader in urban science and informatics to impact scientific and technological missions across energy, environment, and national security

ORNL resources:

- **Capability integration across**
 - Unique datasets, data analytics, and computing
 - Transportation, energy, and cyber sciences
 - Infrastructure modeling
 - Spatial demography
- **Program leaderships in**
 - Computing and computational science
 - Transportation science
 - GIScience & technology
 - Climate change science
- **Knowledge Discovery via dynamic data analytics, management, and distribution**
- **Scalable, high performance computing and visualization**

Strategy:

- Establish an urban dynamics institute at ORNL
- Develop interdisciplinary bridge between foundational R&D, operational communities, and industry
- Focus initially on key opportunities in transportation and water
- Develop and deploy a multiagency strategy to grow and sustain the institute for urban dynamics

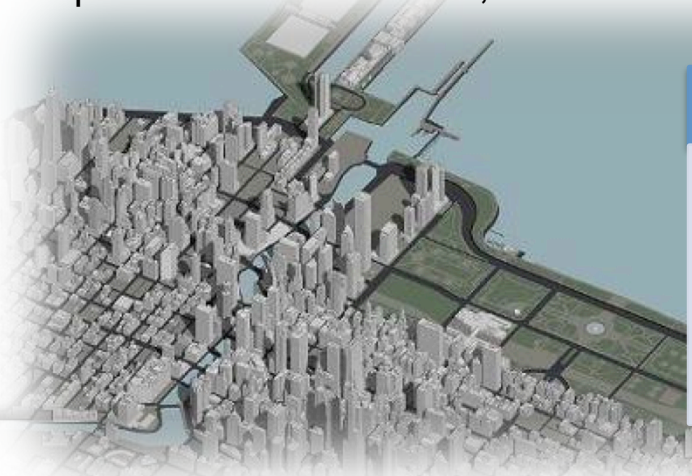
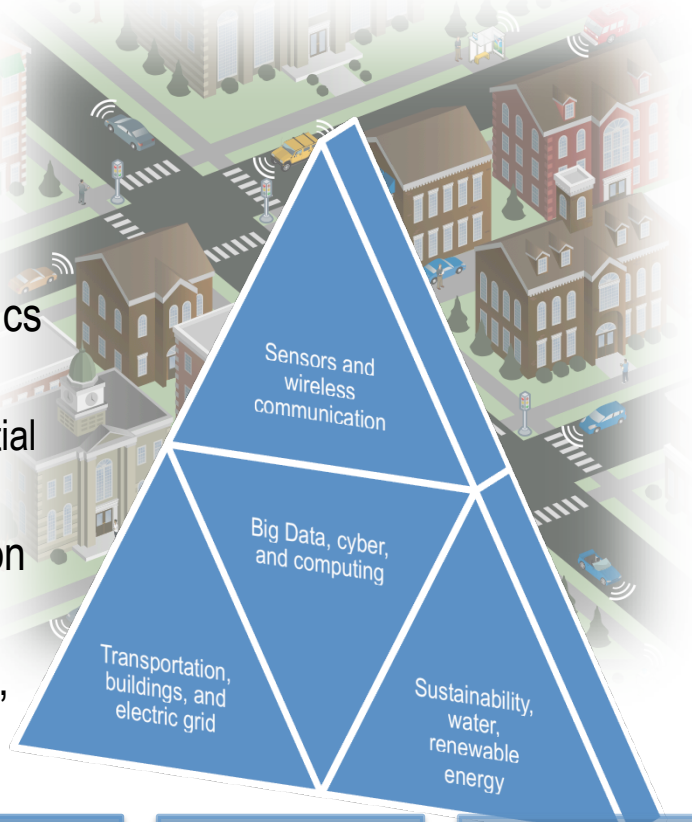


Outcome: Cross-cutting national programs in energy and urban infrastructure modeling, data analytics, and computational sciences

Oak Ridge Urban Dynamics Institute

Delivering transformational science and technology capabilities

- Science and informatics for energy and urban infrastructures
 - Data from individual components (sensors) of infrastructure networks (energy, water, transportation, telecommunication,...)
 - Data from users of infrastructure (human network)
- Characterization of the interaction between the human dynamics and integrated infrastructures
 - Discovering emerging behavior of urban systems over large spatial and temporal scales (at unprecedented resolution)
- Efficient data management, analysis, creation, and visualization of meaningful information within useful timeframe
- Developing interdisciplinary bridge between foundational R&D, operational communities, and industry



Population	Mobility	Energy	Resiliency
<ul style="list-style-type: none"> • Distribution and dynamics • Land use change • Citizen science 	<ul style="list-style-type: none"> • Connected vehicles • Driver-assistance systems • Safety 	<ul style="list-style-type: none"> • Efficiency • Pollution • Sustainability 	<ul style="list-style-type: none"> • Cyber security • Communication • Disaster management

Research and development focus areas

FY15 LDRD initiative: Science and Informatics for Energy and Urban Infrastructure

Population
and Land Use

Sustainable
Transportation

Energy-Water
Nexus

Resiliency
and Disaster
Management

Fine-resolution Modeling of Urban-Energy Systems' Water Footprint in River Networks

A high performance, data-driven simulator of the American population for modeling urban dynamics

Scalable Data and Informatics for Connected Vehicles Leveraged to Enhance Efficiency

Integrated Framework for Urban Climate Adaptation Tool (Urban-CAT)

ORNL: well positioned to make an impact

- Critical strengths in domain science and engineering
- Unique infrastructure and data resources
- Ability to define interdisciplinary vision together with decision makers
- Virtualize and extend access to S&T capabilities
 - Urban and urbanizing communities
- Integrate Big Data with scientific mission and governance
 - Extend science of Big Data analysis beyond addressing volume
- Measurable societal impact
 - Local to national to global (beyond academic scope) scales

Interactive and Interoperable Visualization

Development of High Performance,
Scalable Simulations

Analysis Models and Tools Development

Knowledgebase Creation

Dynamic Collection, Integration,
Management and Dissemination of
Disparate Data Resources

Data and computing for urban science

Big Spatiotemporal Databases



Social Media



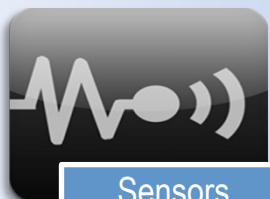
LiDAR



Text



Images



Sensors



Video

Smart Cities

- Sustainable mobility
- Energy efficiency
- Resilient infrastructure

Energy

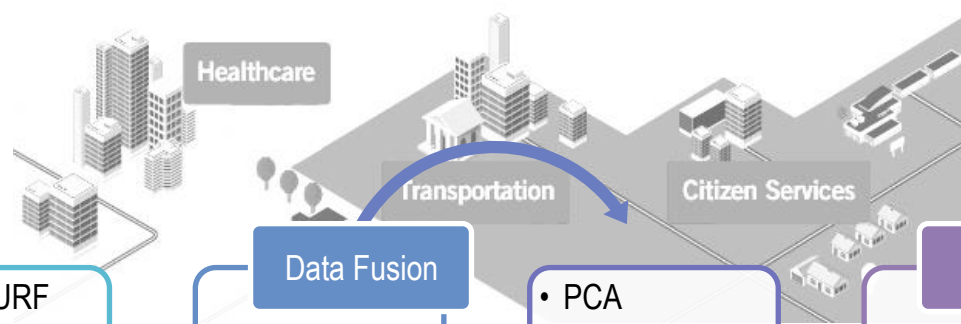
- Transportation
- Electricity
- Water
- Buildings

Environment

- Pollution
 - Air
 - Water
 - Noise
- Public health

Security

- Cyber
- Communication
- Disaster management



- SIFT/ SURF
- Node degree
- ...

Feature Extraction

Data Fusion

- Multi-resolution
- Multi-sensor
- Multi-modal

- PCA
- Compression
- ...

Feature Selection

Knowledge Discovery

- Data Mining
- Machine Learning

Challenges (Increased I/O: 150X, Computation: $O(n^2)$ -

$O(n^3)$)