Smart Grids and the Emerging Internet of Things (IoT)

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Three Internet Waves

Internet 1.0: desktops and laptops

Internet 2.0: smartphones and tablets

Internet 3.0: infrastructure and industrial equipment

Internet 1.0

- Connected desktops and laptops to the Internet
- 1 billion users connected

Internet 2.0

- Connected smartphones and tablets to the Internet
- 2 billion users connected

Internet 3.0

- Connecting infrastructure and equipment to the Internet
- 28 billion “things” connected

Source: Goldman Sachs IoT Report, September 2014

New Companies Created

Internet 1.0 companies: defied geography

Internet 2.0 companies: prize mobility

Internet 3.0 companies: redefining ubiquity

Internet 1.0

- Google
- Amazon
- Old Netflix (renting DVDs)
- EBay

Internet 2.0

- Foursquare
- Waze
- Uber
- New Netflix (streaming movies and shows)

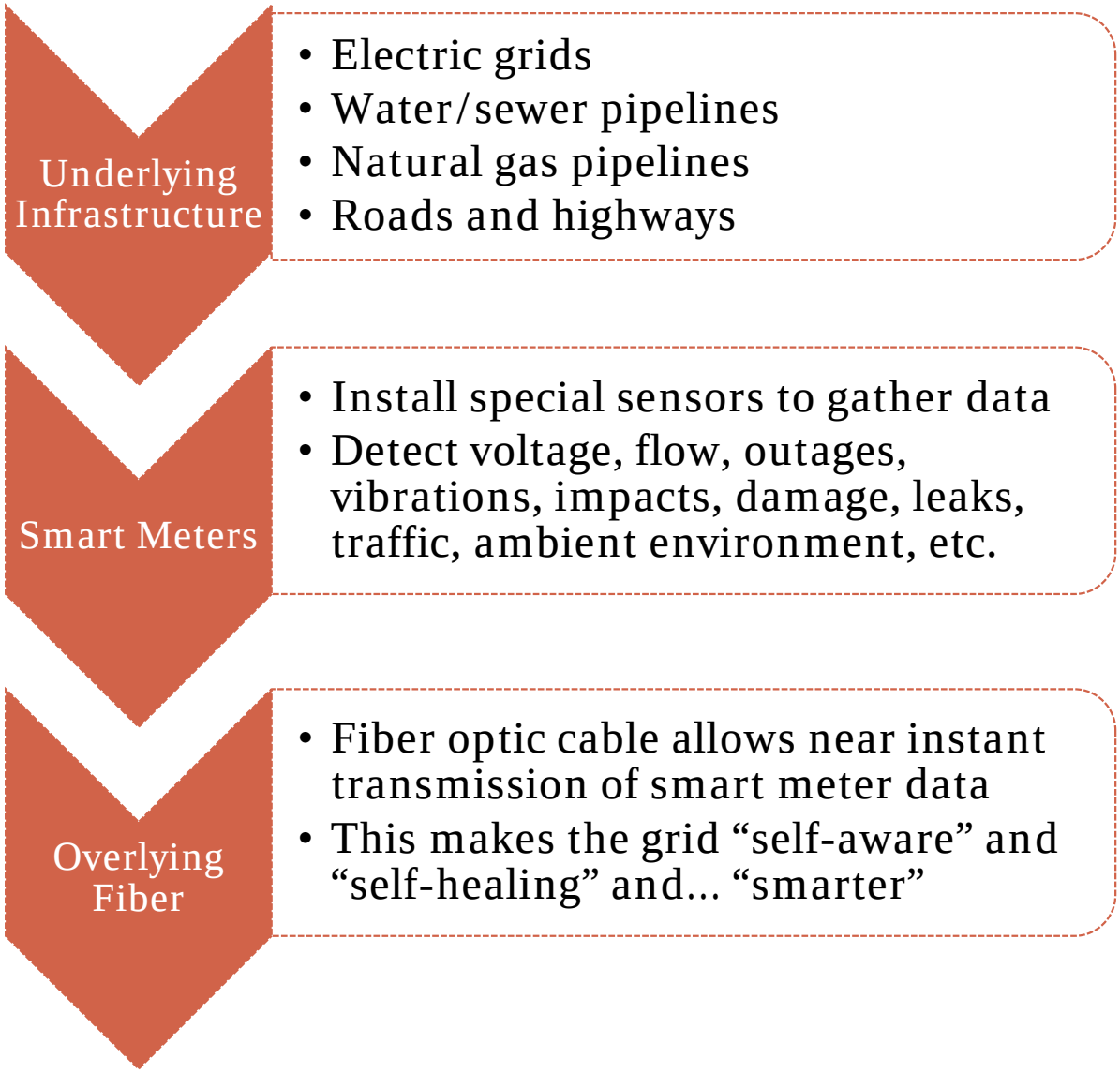
Internet 3.0

- Fitbit (wearables)
- Nest (smart home appliances)
- Opower (energy demand management)
- Airware (software for drones)

What Are Smart Grids?

Physical Infrastructure + Data Infrastructure

Data Infrastructure = Smart Meters + Fiber Optic Cable



Smart Grids Are Everywhere

- Smart Electric Meters
- Smart Water Meters
- Smart Gas Meters
- Smart Roads

CPWS

- Columbia Power and Water Systems (CPWS) in Columbia, TN installed smart electric meters and water meters that communicate over its fiber optic backbone

SoCalGas

- Southern California Gas (SoCalGas) is installing fiber optic cable and smart meters to detect impacts and leaks along its gas pipeline system

UDOT

- Hundreds of miles of fiber optic cable, buried along freeways and major surface streets, lets Utah DOT (UDOT) monitor and manage traffic flow and communicate in real time

Why Smart Grids?

Utilities can detect leaks, recover lost revenue, and manage demand

The overlying fiber optic network can be used to deliver broadband service

The data generated can fuel new Internet 3.0 applications

Revenue Recovery & Cost Savings

- Recover lost revenue from leaks and theft
- Save costs by detecting damage early
- Provide utility customers with data to manage demand

Bonus Fiber Optic Broadband

- The fiber is primarily used by the underlying grid to communicate with itself
- But the overlying fiber can be leveraged to provide an additional broadband service to customers
- Fiber-to-the-meter = fiber-to-the-home/premise

Innovative Data

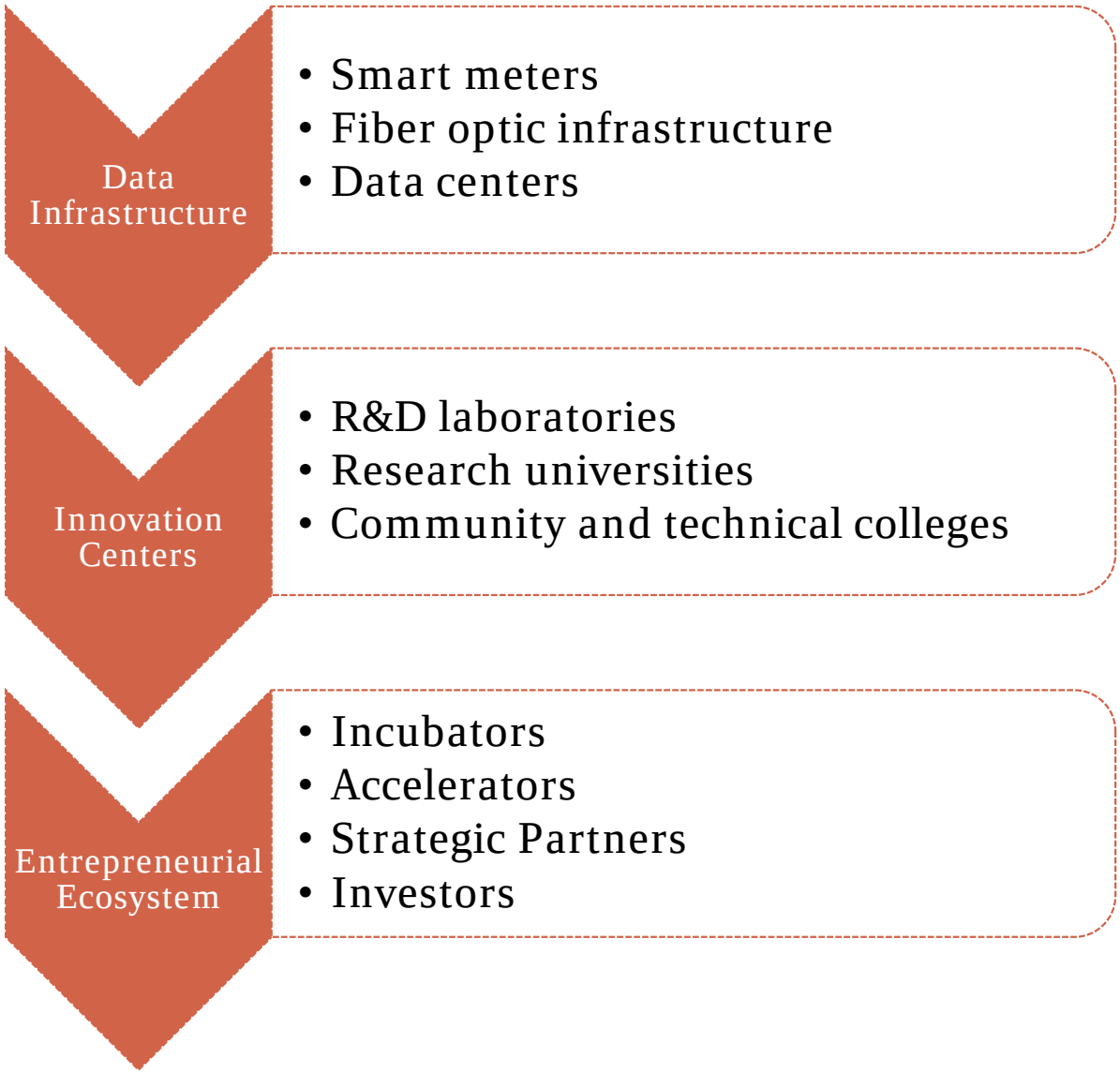
- Smart grid data can be used to develop applications that benefit utilities and customers
- These applications can be commercialized to drive local innovation and transform local economies

Building a Smart Grid Innovation Platform

Generate Smart Grid/Meter Data

Prototype Smart Grid Applications

Commercialize and Accelerate Smart Grid Solutions



Smart Grid Innovation Platform: Chattanooga EPB

Municipal Electric Utility

National Laboratory and Local University

Regional Entrepreneur Center & Accelerator

Chattanooga EPB

- Chattanooga Electric Power Board (EPB) smart grid collects billions of data points annually from 175,000 customers in 600 square mile service area

ORNL & UT-Chattanooga

- Oak Ridge National Laboratory partnering with EPB to test smart grid sensors of ambient environment (e.g., wind & sun)
- UT-Chattanooga regularly feeds innovation into CO.LAB and GIGTANK

CO.LAB & GIGTANK

- The Company Lab (CO.LAB) coordinates entrepreneurship in the Chattanooga region
- GIGTANK is the first smart grid accelerator in the US and leverages EPB's gigabit-speed fiber optic network (The Gig)

Smart Grid Innovation Platform: Volunteer Energy Cooperative

Rural Electric Cooperative

National Laboratory and Local University

Regional Entrepreneur Center & Accelerator

Volunteer Energy Cooperative

- VEC project would serve at least 15,000 customers in 3 counties and connect existing smart meters to a new gigabit-speed fiber network
- Some upgraded meters that interact with home appliances would be installed at 500 homes

MITLL & Tennessee Tech

- MIT Lincoln Laboratory is partnering to create a "digital twin" of the VEC grid and prototype solutions from resulting smart grid data
- Tennessee Tech University would contribute research on smart grid cybersecurity

The Biz Foundry & TN Code Academy

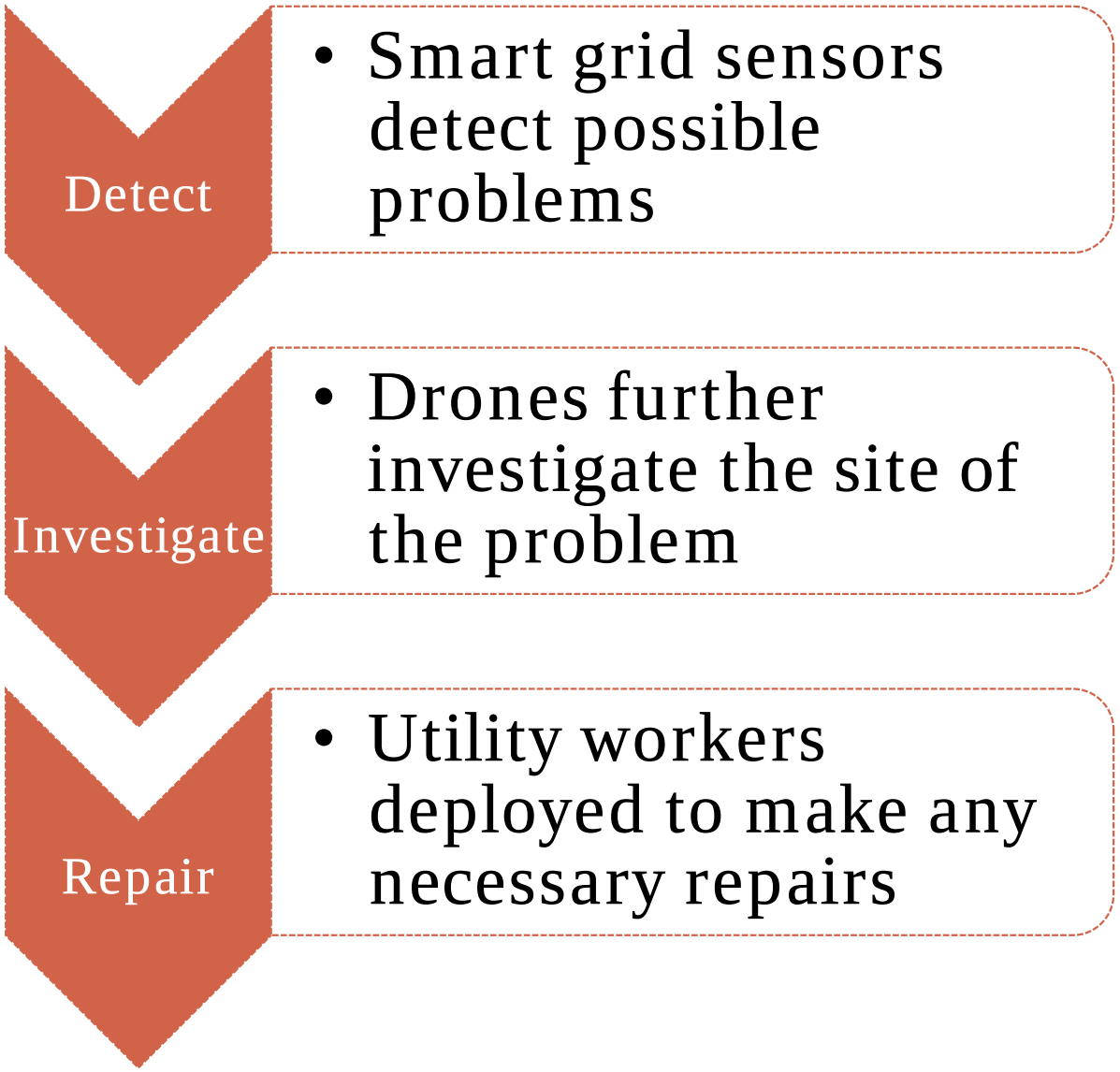
- The Biz Foundry coordinates entrepreneurship in the Cookeville region of Tennessee
- TN Code Academy is a Biz Foundry program that will involve students and entrepreneurs developing smart grid software applications

Integrating Smart Grids with Drones

Detect grid problems

Send drones to further investigate

Send utility workers to make repairs



Bringing It All Together

Fixed Sensors

Mobile Sensors

Big Data

Smart Grids

- Fixed sensors generate incidental data

Drones

- Mobile sensors generate situational data

Data Centers

- Collect continuous sensor data
- Need for real-time data storage and analytics

The Rural Advantage

Smart grid use cases drive innovation

Ideal drone testing environment

Ideal conditions for data centers

Need for Smart Grids

- Rural electric co-ops: 7 customers/mile
- Investor-owned utilities: 35 customers/mile
- Municipal utilities: 48 customers/mile

Ideal Drone Testbed

- Low population density of rural areas makes testing safer

Data Center Friendly

- Cheap plentiful land
- Cheap utilities, especially power
- Distant from population centers

Source: National Rural Electric Cooperative Association (NRECA) data on utilities